AC SERVO DRIVES

HIGH-ACCURACY QUICK-RESPONSE VS-800 SERIES

C SERIES FOR SPEED/POSITIONING CONTROL

YASKAWA

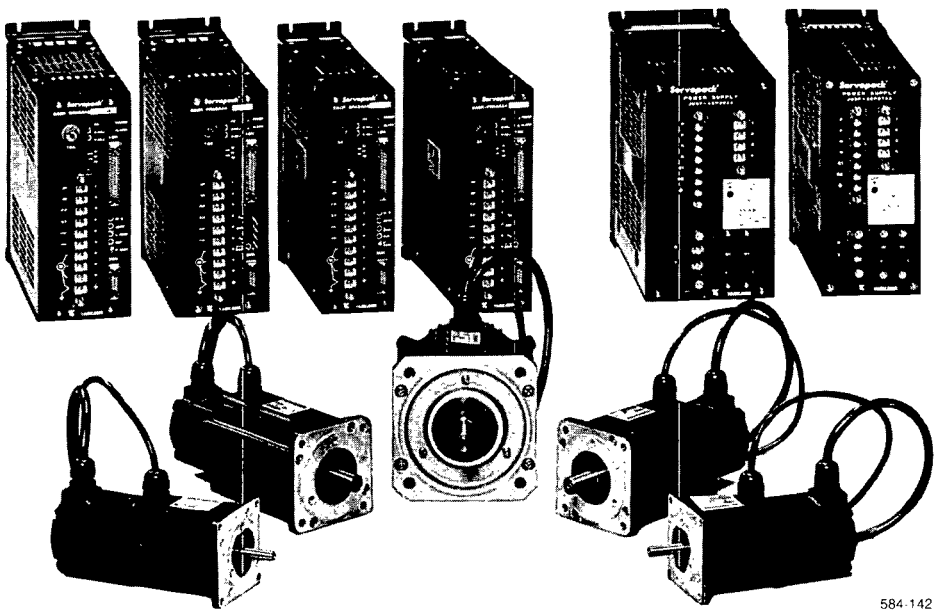
CONTENTS

Yaskawa AC Servo Drives have been developed as the basic mechatronics drives for the most advanced FA and FMS including robots and machine tools. The extensive servo manufacturing technology accumulated through 30 years of servo drive applications has created and nurtured a new phase of AC servo drives.

The AC Servo Drives consist primarily of AC servomotors and their controllers, Servopacks. The AC servomotor features a high power rate for achieving quick response. Custom LSI and hybrid ICs packaged in Servopack reduce the unit size and simplify wiring. The additional feature of a highly accurate pulse resolution offers stepless pulse flow.

For your mechatronics systems, the flexible combination of our AC servomotor and Servopack achieves stable control operation with high accuracy, quick response control under any environmental condition, and smooth, powerful operation even at low-speed range. Some outstanding features are as follows.

- High accuracy and quick response for speed control
- Compact design and high reliability
- Light weight and high power
- Highly reliable protective functions
- Selectable drive to meet users' requirements
- Application for multi-axis use



AC SERVOMOTORS and Their Controllers, SERVOPACKS – Essentials for Yaskawa AC Servo Drives, C Series

1. RATINGS AND SPECIFICATIONS

1.1 RATINGS AND SPECIFICATIONS OF AC SERVOMOTORS

1.1.1 Ratings

Time Rating: Continuous
Insulation: Class B
Isolation Voltage: 1500 VAC, one minute
Enclosure: Totally-enclosed self-cooled
Ambient Temperature: 0 to +40°C

Vibration: 15 μm or below
Finish in Munsell Notation: N1.5
Excitation: Permanent magnet
Mounting: Flange mounted
Drive Method: Direct drive

1.1.2 Characteristics

Table 1.1 Ratings and Specifications of AC SERVOMOTORS

Item \ Motor Type USACEM-			A5AA2□□	01AA2□□	02AA2□□	03AA2□□	05AA2□□
Rated Output*		W (HP)	50 (0.07)	100 (0.14)	200 (0.27)	300 (0.41)	500 (0.68)
Rated Torque*		N•m (lb•in)	0.16 (1.41)	0.32 (2.82)	0.64 (5.63)	0.96 (8.45)	1.59 (14.06)
Rated Current*		Arms	1.0	1.6	2.9	4.2	5.3
Rated Speed*		r/min	3000				
Instantaneous Max Speed*		r/min	3000				
Instantaneous Peak Torque*		N•m (lb•in)	0.59 (5.18)	1.00 (8.85)	2.02 (17.9)	2.89 (25.6)	4.88 (43.2)
Torque Constant		N•m/A (lb•in/A)	0.023 (1.92)	0.025 (2.15)	0.025 (2.17)	0.026 (2.18)	0.038 (3.26)
Moment of Inertia	$J_M(=GD^2/4)$	kg•m² (lb•in•s²×10⁻³)	0.06×10^{-4} (0.05)	0.11×10^{-4} (0.10)	0.46×10^{-4} (0.40)	0.71×10^{-4} (0.62)	2.55×10^{-4} (2.21)
Power Rate*		kW/s	4.2	9.2	9.0	13.0	10.1
Inertia Time Constant		ms	1.94	1.43	1.51	1.24	1.40
Inductive Time Constant		ms	1.18	1.40	3.08	3.39	6.60
Insulation			Class B				
Approx Mass†		kg (lb)	1.2 (2.64)	1.5 (3.3)	2.4 (5.28)	3.3 (6.6)	5.5 (12.1)
Magnetic Brake Specifications‡	Type		MBS/90-3UG		NCNB10-5		SCFB/90-24ZST
	Inertia	kg•m² (lb•in•s²×10⁻³)	0.005×10^{-4} (0.0044)		0.0826×10^{-4} (0.0717)		0.623×10^{-4} (0.541)
	Static Friction Torque	N•m (lb•in)	0.29 (2.6)		0.98 (8.6)		1.96 (17.3)
	Voltage VDC	VDC	90				

* Values when SERVOMOTOR is combined with SERVOPACK and the armature winding temperature is 75℃. Other values are for temperature of 20℃.
† Includes the detector.
‡ Brake specification of AC SERVOMOTOR with magnetic brake.

Note:
An optical encoder (PG) is used as a detector. The PG output pulse is 1500 pulses / rev or 1000 pulses / rev, but can be divided by frequency using the divider in the SERVOPACK.
The standard is 1500 pulses / rev, but designate 1000 pulses / rev if any of the following are required:

Pulse frequency dividing output: 40, 80 and 400 pulses / rev
For details, refer to Table 6.6. When the optical encoder uses 1000 pulses / rev, SERVOMOTOR is type USACEM-□□AB2.

1.2 RATINGS AND SPECIFICATIONS OF SERVOPACK

Table 1.2 Ratings and Specifications of SERVOPACK

SERVOPACK Type CACR-			SRA5AA2□H PRA5AA4□H	SR01AA2□H PR01AA4□H	SR02AA2□H PR02AA4□H	SR03AA2□H PR03AA4□H	SR05AA2□H PR05AA4□H
Motor Output		W (HP)	50 (0.07)	100 (0.14)	200 (0.27)	300 (0.41)	500 (0.68)
Power Supply	Main Circuit		100 to 160 VDC (supplied by power unit)				
	Control Circuit		24 VDC, 1.4A (supplied by power unit)				
Continuous Output Current (R•M•S)		A	1.0	1.6	2.9	4.2	5.3
Max Output Current (R•M•S)		A	3.5	4.9	9.2	12.7	16.3
Control Method			Transistorized PWM control				
Feedback			Optical encoder (PG), 1000 pulses / rev or 1500 pulses / rev				
Positioning Signal Output			1 / N time (N=1 to 32) of PG pulses or 2 / N time (N=2 to 32)				
Built-in Function	Input Signal		Servo ON, P drive, reverse / forward running prohibit, external current limit detection				
	Output Signal		Servo alarm, current limit detecting, TG ON				
	Protective Function		Overvoltage, overcurrent, overload, heatsink overheat, blown fuse, overrun, regeneration trouble				
Environmental Conditions	Ambient Temperature		0 to +55℃ (0 to +55℃ in panel)				
	Storage Temperature		-20 to +80℃				
	Humidity		90% or less (non-condensing)				
Mounting Structure*			Rack mounted (Panel mounted or base mounted)				
Applicable Load Inertia†			Up to 5 times motor inertia				
Speed Control	Type CACR-		SRA5AA	SR01AA	SR02AA	SR03AA	SR05AA
	Speed Control Range		1:1000				
	Speed Regulation	Load Regulation 0 to 100%	+0.1% or less at 3000 r / min, ± 0.05% or less at 3 r / min				
		Voltage Regulation ± 10%	±0.1% or less at 3000 r / min, ±0.02% or less at 3 r / min				
		Temperature Regulation 25 $^{+35}_{-25}$℃	±0.5% or less at 3000 r / min, ±0.1% or less at 3r / min				
	Frequency Response Characteristics		50Hz or more (J_L=J_M)				
	Speed Reference Input	Rated Reference Voltage	±6 VDC at 3000 r / min (Forward running at plus reference)				
		Input Impedance	Approx 30 kΩ				
		Circuit Time Constant	Approx 35 μΩ				
	Auxiliary Reference Input‡	Rated Reference Voltage	±2 to ±10VDC at 3000 r / min (Forward running at plus reference)				
		Input Impedance	Approx 5 kΩ / V				
		Circuit Time Constant	Approx 22 μs or less				
	Power Supply for Reference (Built-in)		±8VDC ±5%, ±10mA or less				
Positioning Control	Type CACR-		PRA5AA	PR01AA	PR02AA	PR03AA	PR05AA
	Max Input Pulse Frequency		200 kpps (max motor speed or less), 12V / 5V switching				
	Input Pulse Type		Sign signal ("H": forward running, "L": reverse running), pulse train				
	Positioning Completion Signal Output		Output transistor ON at less than set value of deviation				

* Mounted on the base during shipping.

† When load inertia J_L exceeds applicable range, be sure to refer to 6.6.2, "Load Inertia".

‡ Used for application at rated reference voltages other than ± 6V.

Notes:

1. In the speed control range, the lowest speed is defined as the condition in which there is 100% load variation, but not stopped.
2. 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.
3. When housed in a panel, the inside temperature must not exceed ambient temperature range.

1.3 RATINGS AND SPECIFICATIONS OF POWER UNIT

Table 1.3 Ratings and Specifications of Power Unit

Item		Type JUSP-	ACP07AA	ACP15AA	ACP20AA
Power Supply	Voltage		Single-phase 100 / 110 VAC $^{+10\%}_{-15\%}$, 50 / 60Hz		
	Capacity (Rated Output)*		1.5kVA	3kVA	5kVA
Main Circuit	Continuous Output Voltage		100 to 160 VDC		
	Continuous Output Current		7 ADC	15 ADC	20 ADC
Control Circuit Continuous Output Voltage			24 VDC, 6A		
Protective Function			Circuit breaker		
Environmental Conditions	Ambient Temperature		0 to +60℃ (0 to +40℃ in panel)		
	Storage Temperature		–20 to +85℃		
	Humidity		90% or less (non-condensing)		
Mounting Structure†			Base mounted		
Built-in Function		OV	Detects main-circuit overvoltage (0V) and outputs 0V signal to SERVOPACK.		
		PR	Detects main-circuit deficient voltage and outputs PR signal to SERVOPACK.		
		MP	When power is turned on, green LED [MP] lights.		
Applicable Range	No. of Axes		4 max		
	Total Output of SERVOMOTORS		Approx 0.6kW max (0.80HP)	Approx 1.2kW max (1.61HP)	Approx 1.8kW max (2.41HP)

* For 200VAC power supply, power transformers are required.
† Convertible to panel mounting type by changing metal fitting.

2. TYPE DESIGNATION

• AC SERVOMOTOR

USACEM-02AA2□□

- AC SERVOMOTORS
- C Series
- Totally-enclosed Self-cooled Type
- Motor Construction
  Rare earth magnet
- Capacity
  - A5: 50W
  - 01: 100W
  - 02: 200W
  - 03: 300W
  - 05: 500W
- Design Revision Order
  (A, B, C ....)
- Opposite-drive-end Specifications
  - Blank : Standard
  - B : With brake
- Drive-end Specifications
  - Blank : Standard
  - O : Standard (with brake on opposite drive end)
  - K : With keyway
  - S : With oil seal
  - T : With keyway and oil seal
- Main Mechanical Structure
  - 2 : Flange-mounted, straight shaft
- Detector Specifications
  - A : Optical encoder (PG) with 1500 pulses / rev
  - B : Optical encoder (PG) with 1000 pulses / rev

• SERVOPACK

CACR-SR□□AA2AH

- SERVOPACK
  (AC Servo Drive)
- Control Type
  - SR : Speed control
  - PR : Positioning control
- Capacity
  - A5: 50W
  - 01: 100W
  - 02: 200W
  - 03: 300W
  - 05: 500W
- C Series
- Design Revision Order
  (A, B, C....)
- Input Form
  - 2 : Analog input (speed control), for 100V
  - 4 : Pulse input (positioning control), for 100V
- Detector (Optical Encoder)
  - A : 1500 pulses / rev
  - B : 1000 pulses / rev
- Motor Speed to be applied
  - H : C Series

• Power Unit

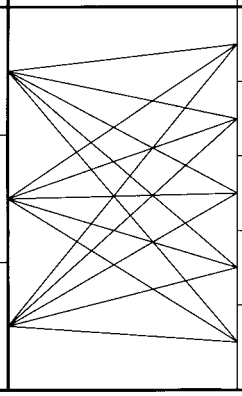
JUSP-ACP□□AA

- Peripheral Devices for SERVOPACK
- Power Unit for SERVOPACK
- Output Power Supply
  - 07 : 7 ADC
  - 15 : 15 ADC
  - 20 : 20 ADC
- Usage
  - A : Power supply for C series
- Design Revision Order
  (A, B, C....)

3. LIST OF STANDARD COMBINATION

3.1 COMBINATION OF POWER UNIT, SERVOPACK AND SERVOMOTOR

Table 3.1 Combination of Power Unit, SERVOPACK and SERVOMOTOR

Power Unit Type JUSP-	Applicable Combination	SERVOPACK Type CACR-	Applicable SERVOMOTORS		
			Motor Type USACEM-	Output W(HP×10^{-3})	Optical Encoder pulses/rev
ACP07AA 700W		SRA5AA2 □ H PRA5AA4 □ H	A5AA2	50 (67.0)	1500
			A5AB2		1000
		SR01AA2 □ H PR01AA4 □ H	01AA2	100 (134)	1500
			01AB2		1000
ACP15AA 1500W		SR02AA2 □ H PR02AA4 □ H	02AA2	200 (268)	1500
			02AB2		1000
		SR03AA2 □ H PR03AA4 □ H	03AA2	300 (402)	1500
			03AB2		1000
ACP20AA 2000W		SR05AA2 □ H PR05AA4 □ H	05AA2	500 (670)	1500
			05AB2		1000

Note : SERVOPACK type is indicated in □ as follows;
A : Motors with PG of 1500 pulses/rev
B : Motors with PG of 1000 pulses/rev

3.2 COMBINATION OF POWER UNIT WITH SERVOPACK IN MULTI-AXIS DRIVES

In multi-axis drives, up to 4 Servopacks(4-axis) can be connected to one power unit within a range of total outputs of servomotors. Example of combination for speed control is shown in **Table 3.2.**

Table 3.2 Combinations of Power Unit with SERVOPACK in Multi-axis Drives

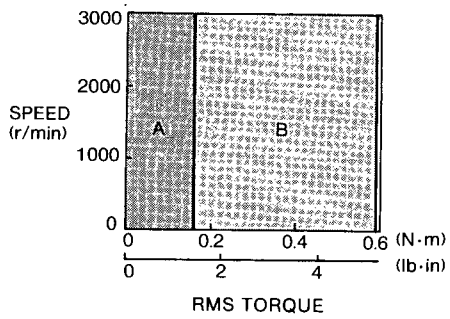
No. of Axes / Power Unit Type JUSP-	Applicable SERVOPACK			
	1 Axis (One used)	2 Axes (Two used in parallel)	3 Axes (Three used in parallel)	4 Axes (Four used in parallel)
ACP07AA	SR/PR 05AA (100%)	SR/PR 03AA ⊕ SR/PR 03AA	SR/PR 03AA ⊕ SR/PR 02AA ⊕ SR/PR 02AA	SR/PR 02AA ⊕ SR/PR 02AA ⊕ SR/PR 02AA ⊕ SR/PR 01AA
ACP15AA	SR/PR 05AA (100%)	SR/PR 05AA ⊕ SR/PR 05AA	SR/PR 05AA ⊕ SR/PR 05AA ⊕ SR/PR 05AA	SR/PR 05AA ⊕ SR/PR 05AA ⊕ SR/PR 03AA ⊕ SR/PR 02AA
ACP20AA	SR/PR 05AA (100%)	SR/PR 05AA ⊕ SR/PR 05AA	SR/PR 05AA ⊕ SR/PR 05AA ⊕ SR/PR 05AA	SR/PR 05AA ⊕ SR/PR 05AA ⊕ SR/PR 05AA ⊕ SR/PR 05AA

Notes:
1. For one-axis operation, load factor is 100%; for two-, three- and four-axis operation, 80%.
2. Combinations other than those shown in the table above are also available depending on load factors.

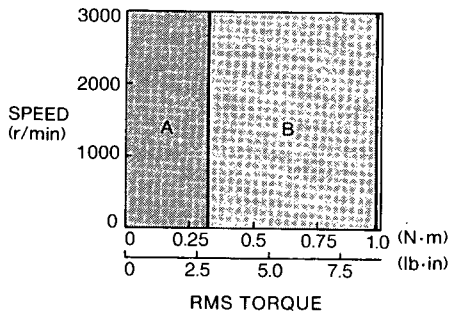
4. CHARACTERISTICS

4.1 TORQUE-SPEED CHARACTERISTICS

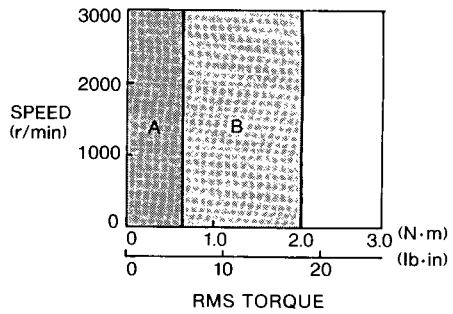
● Type USACEM-A5A



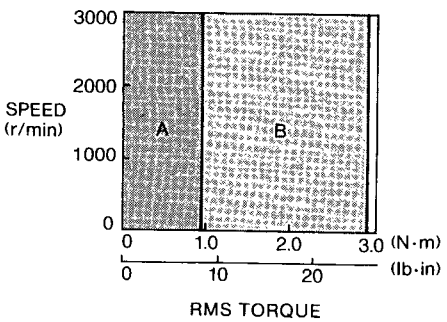
● Type USACEM-01A



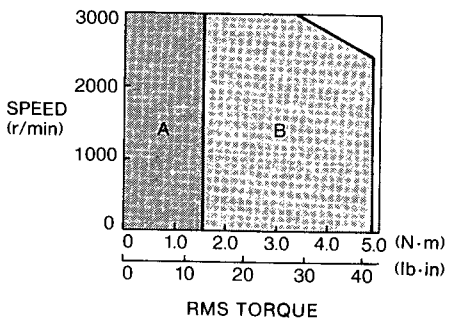
● Type USACEM-02A



● Type USACEM-03A



● Type USACEM-05A



A: Continuous Duty Zone
B: Intermittent Duty Zone
(At 75°C)

Fig. 4.1
Torque-Speed Characteristics

4.2 OVERLOAD CHARACTERISTICS

The allowable conduction time of Servopack is restricted by the built-in overload protective circuit. Its overload detection level is set precisely by the hot start conditions at ambient temperature of 60°C and cannot be changed.

NOTE

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

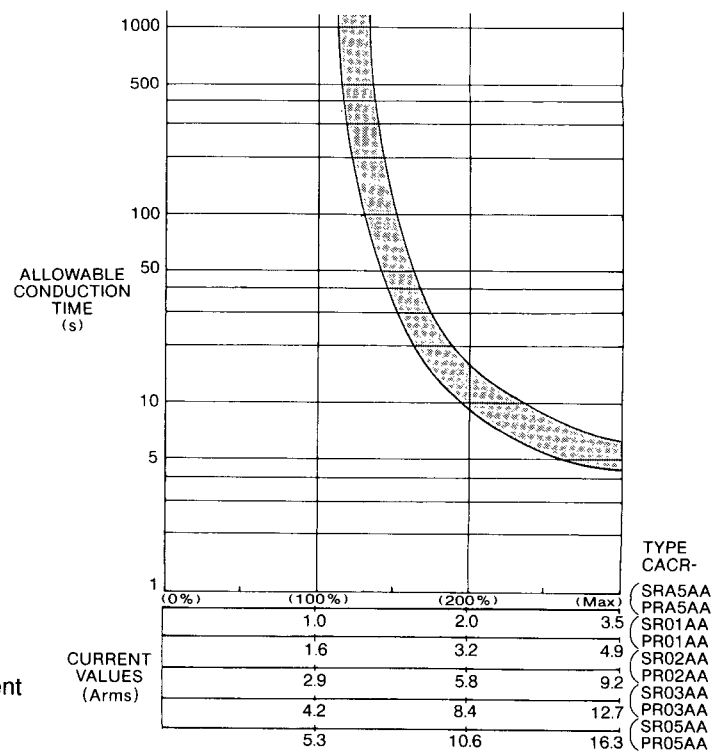


Fig. 4.2 Allowable Conduction Current of SERVOPACK

4.3 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 neglected.

Starting Time:

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

Stopping Time:

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

Where,

N_R : Rated motor speed (r/min)

J_M: Motor inertia (kg·m²)

J_L: Moment of inertia of motor (kg·m²)

Kt: Torque constant of motor (N·m/A)

I_R: Motor rated current (A)

$\alpha = I_P / I_R$: Acceleration/deceleration current constant

I_P: Acceleration/deceleration current (Acceleration/deceleration 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)

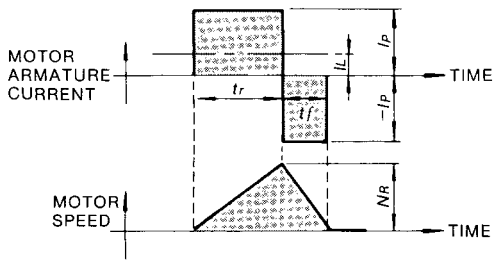


Fig. 4. 3 Timing Chart of
Motor Armature Current and Speed

4.4 ALLOWABLE FREQUENCY OF OPERATION

The allowable frequency of operation of the servomotor varies depending upon the load and the operating condition. The following show the allowable frequency of operation in typical operations.

- When the motor repeats rated-speed operation and being at standstill (Fig. 4. 4)

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

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

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

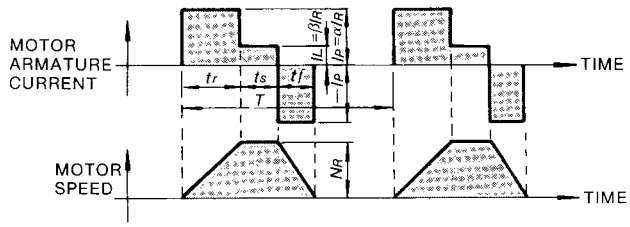


Fig. 4. 4 Timing Chart of
Motor Armature Current and Speed

- When the motor remains at standstill between cycles of acceleration and deceleration without continuous rated speed running (Fig. 4. 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:

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

(times/min)

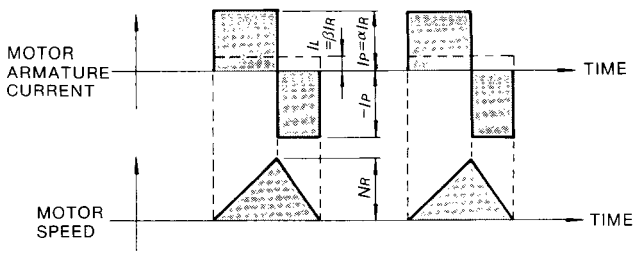


Fig. 4. 5 Timing Chart of
Motor Armature Current and Speed

- When the motor accelerates, runs at constant speed, and decelerates in a continuing cycle without being at standstill (Fig. 4. 6)

The timing chart of the motor armature current and speed is as shown in Fig.4.6. 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)

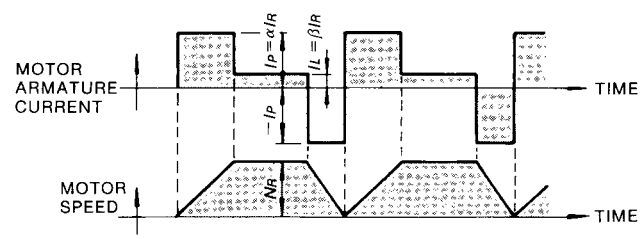


Fig. 4. 6 Timing Chart of
Motor Armature Current and Speed

4.5 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:

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

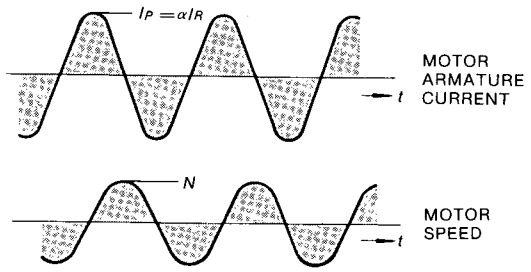


Fig. 4.7 Timing Chart of Motor Armature Current and Speed

4.6 MOTOR SPEED – REFERENCE INPUT CHARACTERISTICS

4.6.1 Speed Control (Type CACR-SR□AA)

Fig. 4.8 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. 4.9.

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

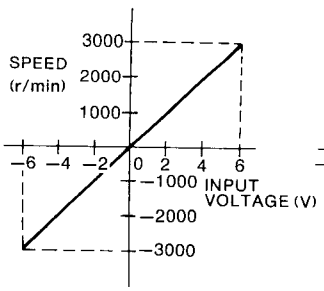


Fig. 4.8 Speed-Input Voltage Characteristics

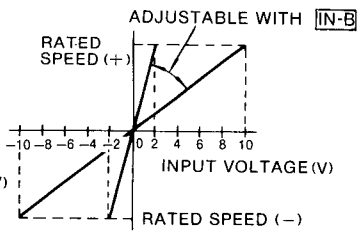


Fig. 4.9 Speed-Input Voltage Characteristics when Auxiliary Input Terminals 1CN-⑭ and ⑮ are used

4.6.2 Positioning Control (Type CACR-PR□AA)

In Type CACR-PR, the speed is determined by parameters such as the reference pulse frequency and multiplier(output). Fig. 4.10 shows speed-reference pulse frequency characteristics.

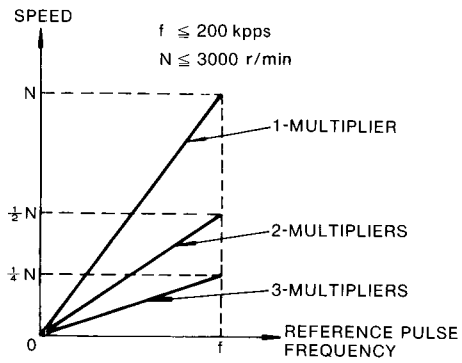


Fig. 4.10 Speed-Reference Pulse Frequency Characteristics

4.7 MOTOR MECHANICAL CHARACTERISTICS

4.7.1 Mechanical Strength

AC servomotors can carry up to 500% of the rated momentary maximum torque at output shaft.

4.7.2 Allowable Radial Load and Thrust Load

Table 4.1 shows allowable loads according to AC servomotor types.

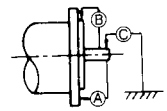
Table 4.1 Allowable Radial Load and Thrust Load

Motor Type USACEM-	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
A5 AA2	78.4(17)	39.2(8.8)
01 AA2	78.4(17)	39.2(8.8)
02 AA2	245 (55)	98 (22)
03 AA2	245 (55)	98 (22)
05 AA2	392 (88)	147 (33)

*Maximum values of the load applying to the shaft extension.

4.7.3 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)

4.7.4 Direction of Rotation

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

- Motor lead connections

  Red: Phase U
  White: Phase V
  Blue: Phase W
  Black: Magnetic brake lead (2 leads)

- Detector lead connections

  Red: +5 VDC
  Black: OV
  Blue: Channel A output
  White(Blue): Channel $\overline{A}$ output
  Yellow: Channel B output
  White(Yellow): Channel $\overline{B}$ output
  Green: Channel Z output
  White(Green): Channel $\overline{Z}$ output
  Orange: Channel U output
  Purple: Channel V output
  White(Purple): Channel $\overline{V}$ output
  Grey: Channel W output
  White(Grey): Channel $\overline{W}$ output
  Green(Yellow): Frame ground

4.7.5 Impact Resistance

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

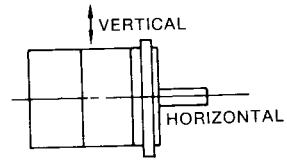


Fig. 4.11 Impact Resistance

4.7.6 Vibration Resistance

With mounted horizontally, the motor can withstand the vibration (vertical, lateral, axial) with vibration of 2.5 G.

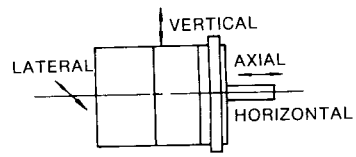


Fig. 4.12 Vibration Resistance

4.7.7 Vibration Class

Vibration of the motor running at rated speed is 15μm or below.

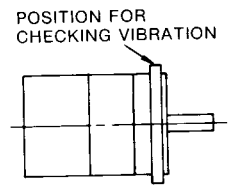


Fig. 4.13 Vibration Checking

5. CONFIGURATION

5.1 INTERNAL BLOCK DIAGRAM

5.1.1 Speed Control (Type CACR-SR□AA)

Figs. 5.1 and 5.2 show internal block diagrams of Servopack.

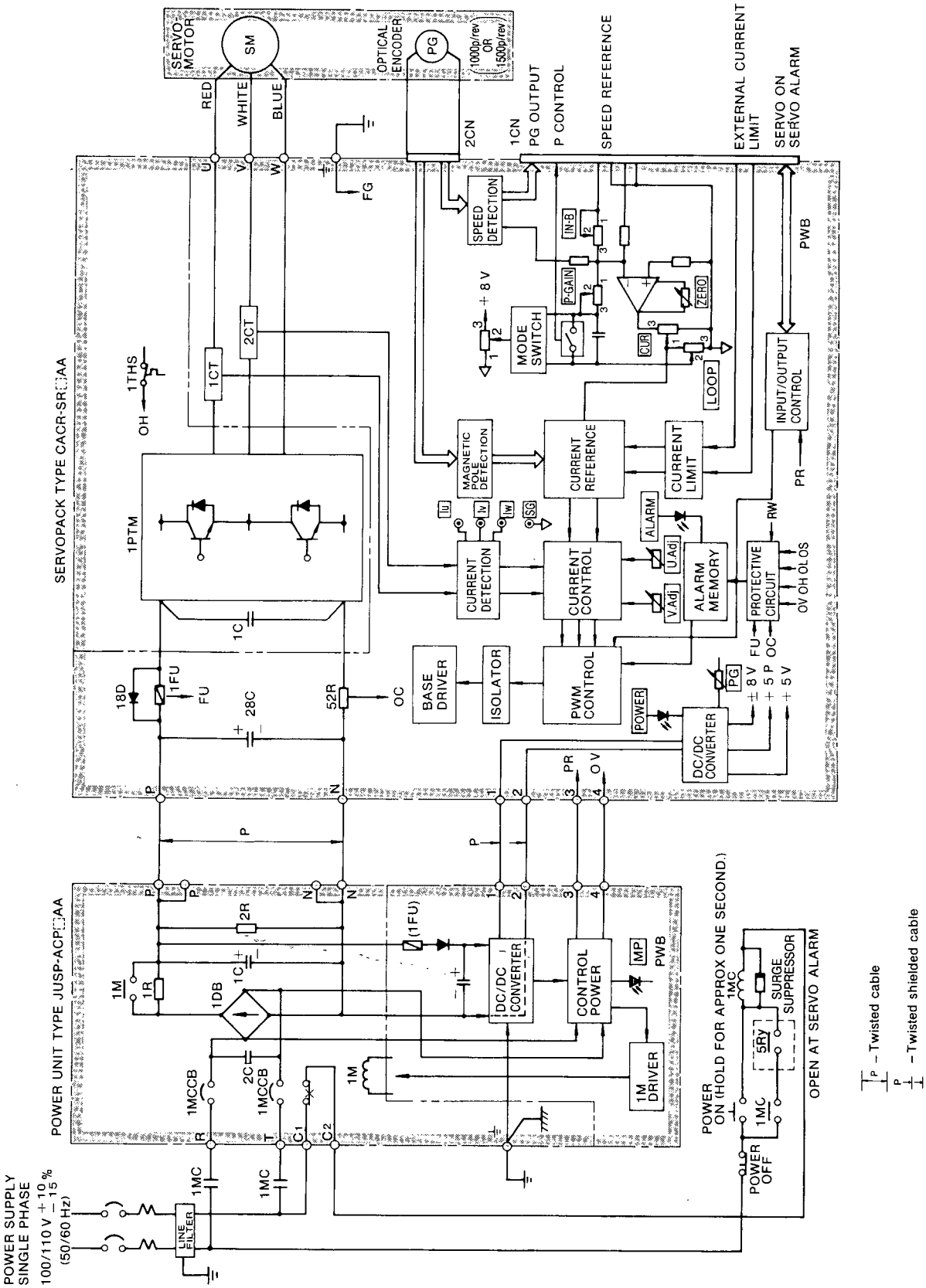


Fig. 5.1 Internal Block Diagram of Types JUSP-ACP□AA and CACR-SR□AA

5.1.2 Positioning Control (Type CACR-PR□AA)

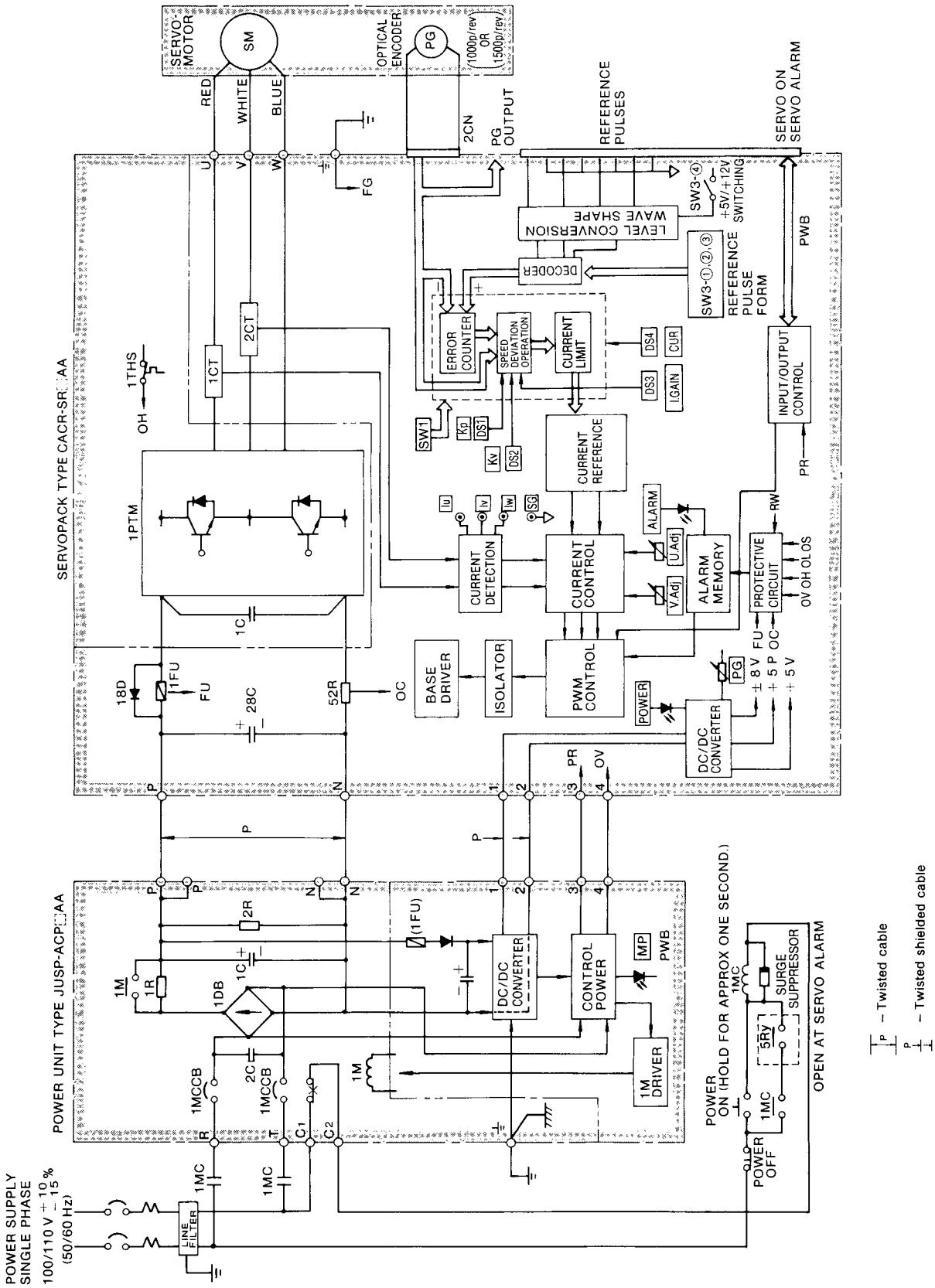


Fig. 5. 2 Internal Block Diagram of Types JUSP-ACP□AA and CACR-PR□AA

5. 2 EXTERNAL TERMINALS

5. 2. 1 External Terminals for Power Unit

Table 5.1 shows the specifications of external terminals for power unit.

Table 5.1 External Terminals for Power Unit Types JUSP-ACP07AA to -ACP20AA

Terminal Symbol	Name	Description
Ⓡ Ⓣ	AC Power Input Terminal	Single phase 100/110VAC $^{+10}_{-15}$ %, 50/60Hz
Ⓟ Ⓝ	Main Circuit DC Output Terminal	Connects to terminals Ⓟ and Ⓝ of SERVOPACK.
C_1 C_2	MCCB Trip Output Terminal	When 1 MCCB in the power unit trips, the output contact of 250V1A opens.
① ②	Control Circuit DC Output Terminal*	Connects to terminals ① and ② of SERVOPACK and outputs 24VDC.
③	PR Output Terminal*	Connects to terminal ③ of SERVOPACK and outputs PR signal.
④	0V† Output Terminal*	Connects to terminal ④ of SERVOPACK and outputs 0V signal.
⏚	Ground Terminal	Frame ground terminal. Must be securely grounded.

* High voltage is applied because of internal connection to the main circuit.

† 0V means overvoltage.

5.2.2 External Terminals for SERVOPACK

Table 5.2 shows the specifications of external terminals for Servopack.

Table 5.2 External Terminals for SERVOPACK Types CACR-SR □ AA and -PR □ □ AA

Terminal Symbol	Name	Description
Ⓟ Ⓝ	Main Circuit DC Input Terminal	Connects to terminals Ⓟ and Ⓝ of power unit.
Ⓤ Ⓥ Ⓦ	Motor Connection Terminal	Connects terminal Ⓤ to motor terminal U (red lead), Ⓥ to V (white lead) and Ⓦ to W (blue lead).
① ②	Control Circuit Input Terminal*	Connects to terminals ① and ② of power unit and inputs 24 VDC.
③	PR Input Terminal*	Connects to terminal ③ of power unit and inputs PR signal.
④	0V† Input Terminal*	Connects to terminal ④ of power unit and inputs 0V signal.
⏚	Ground Terminal	Frame ground terminal. Must be securely grounded.

* High voltage is applied because of internal connection to the main circuit.

† 0V means overvoltage.

5. 3 CONNECTOR TERMINAL (1CN) FOR INPUT/ OUTPUT SIGNAL

For Servopack Types CACR-SR□AA and -PR□AA, the connectors for input/output signals used are Type MR-50RMA made by Honda Tsushin Co., Ltd. The applicable receptacles are as shown in Table 5.3.

Note that the input/output signals and the connector terminal number differ in part between Types CACR-SR and CACR-PR. For connection to connectors 1CN, be sure to use the receptacle listed in Table 5.3.

Table 5.3 Specifications of Applicable Receptacles for SERVOPACK Input/Output Signal

SERVOPACK Type	Connector Symbol	Connector Type used in SERVOPACK	Applicable Receptacle Type			
			Manufacturer	Soldered Type	Caulking Type	Case*
SR	1CN	MR-50RMA (Right angle 50P)	Honda Tsushin Co.,Ltd.	MR-50F†	MRP-50F01	MR-50L†
PR	1CN					

* Attached to each applicable receptacle (soldered and caulking types).

† Attached to SERVOPACK when shipping.

5.3.1 Speed Control (Type CACR-SR□AA)

The terminal layout of the Servopack Type CACR-SR□AA input/output signal connectors (1CN) is shown in **Table 5.4**. The terminal specifications are shown in **Table 5.5**, and external connection and external signal processing, in **Fig. 5.3** on page 15.

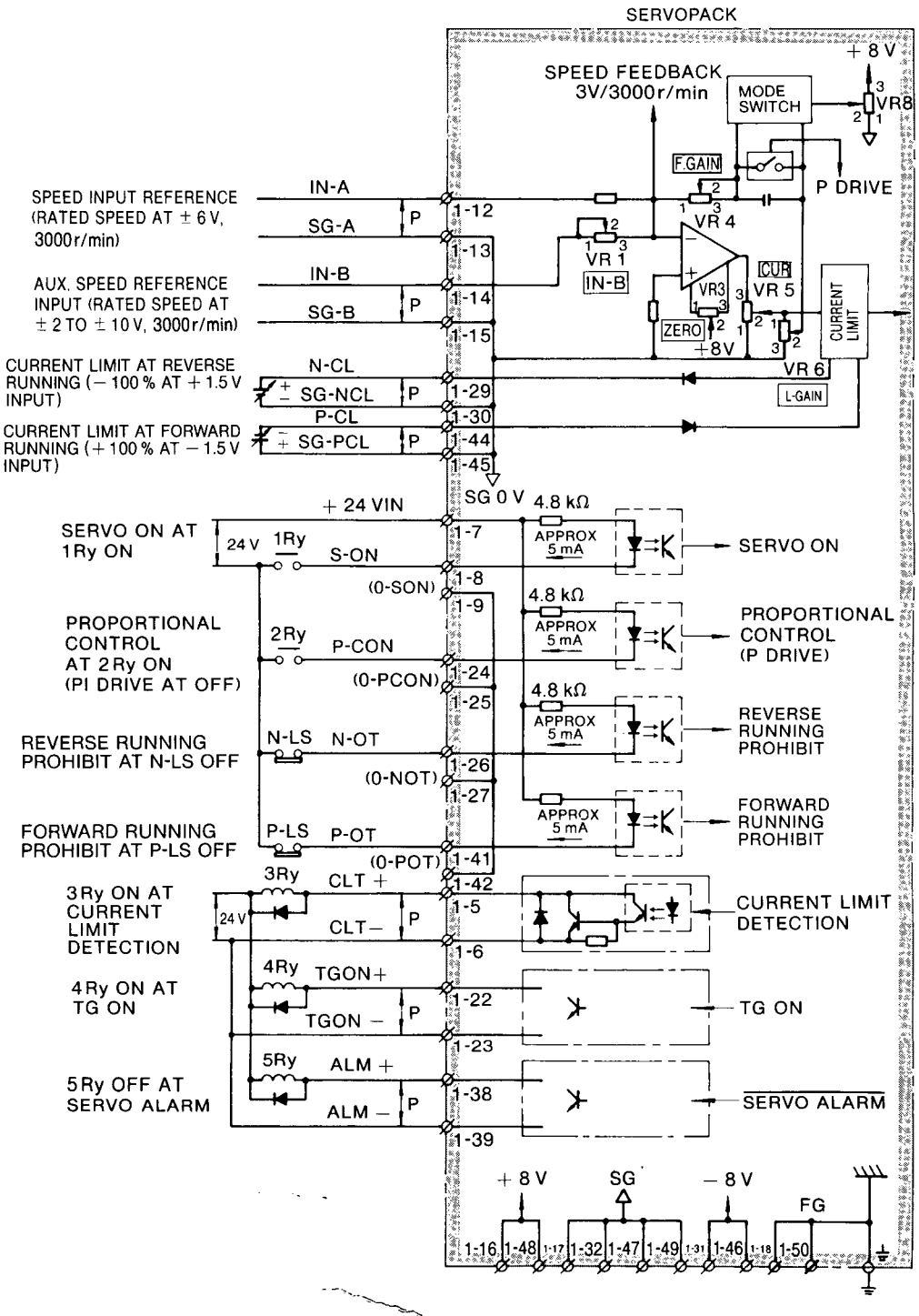
Table 5.4 Connector 1 CN Layout of SERVOPACK Type CACR-SR □ AA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0V	0V	0V		CLT+	CLT–	+24V IN	S-ON	0-SON			IN-A	SG-A	IN-B	SG-B	+8V	SG	FG
0V for PG Output Signal				Current Limit Detection Output		Ext.Input Power	Servo ON Input				Speed Reference Input		Auxiliary Input		+8V Output		Frame Ground
		19	20	21	22	23	24	25	26	27	28	29	30	31	32		
		PCO	*PCO		TG ON +	TG ON –	P-CON	0-PCON	N-OT	0-NOT		N-CL	SG-NCL	– 8V	SG		
		Output Signal			TG ON Output Signal		P Drive Input		Reverse Inhibit Input			Reverse Current Lmit Input		– 8V Output			
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
PAO	*PAO	PBO	*PBO		ALM+	ALM–		P-OT	0-POT		P-CL	SG-PCL	– 8V	SG	+8V	SG	FG
Output Signal		Output Signal			Servo Alarm Output			Fwd. Inhb. Input			Fwd. Current Limit Input		– 8V Output		+8V Output		Frame Ground

Tabale 5.5 Connector 1CN Specifications of SERVOPACK Type CACR-SR □ AA

Connector No.	Signal Name	Description	Connector No.	Signal Name	Description
1CN-12	IN-A	Forward rated speed (3000r/min) at +6V Reverse rated speed (3000r/min) at –6V	1CN-5	CLT+	Current limit detection output External relay 3Ry (+24V) ON during current limit
1CN-13	SG-A	SG 0V (0V signal)	1CN-6	CLT–	0V of external power (+24V)
1CN-14	IN-B	Reference to obtain the rated speed (3000r/min) by a voltage (±2 to ±10V) other than the rated reference voltage ±6V.	1CN-22	TGON+	External relay 4Ry (+24V) ON at motor speed of more than 30r/min.
1CN-15	SG-B	SG 0V (0V signal)	1CN-23	TGON–	0V of external power (+24V)
1CN-29	N-CL	Used to apply a reverse current limit from outside. –100%/+1.5V input	1CN-38	ALM+	External relay 5Ry (+24V) OFF at Servo trouble detection.
1CN-30	SG-NCL	SG 0V (0V signal)	1CN-39	ALM–	0V of external power (+24V)
1CN-44	P-CL	Used to apply a forward current limit from outside. +100%/–1.5V input	1CN -16, 48	+8V	Control power supply +8V, +10mA output possible.
1CN-45	SG-PCL	SG 0V (0V signal)	1CN -17,-47 -32,-49	SG	SG 0V (0V signal)
1CN-7	+24V IN	24V ±1 VDC input	1CN -31,-46	–8V	Control power supply –8V, –10mA output possible.
1CN-8	S-ON	Servo ON input Servo ON at external relay 1Ry ON	1CN -18,-50	FG	Frame ground
1CN-9	(0-SON)	(EX 0V)†	1CN-33	PAO	Phase-A pulse output (PAo)
1CN-24	P-CON	P drive input Proportional control at external relay 2Ry ON	1CN-34	*PAO	Phase-$\overline{A}$ pulse output (PAo)
1CN-25	(0-CON)	(EX0V)†	1CN-35	PBO	Phase-B pulse output (PBo)
1CN-26	N-OT	Reverse running prohibit at reverse limit switch N-LS OFF	1CN-36	*PBO	Phase-$\overline{B}$ pulse output (PBo)
1CN-27	(0-NOT)	(EX 0V)†	1CN-19	PCO	Phase-C (original point) pulse output (PCo)
1CN-41	P-OT	Forward running prohibit at forward limit switch P-LS OFF	1CN-20	*PCO	Phase-$\overline{C}$ pulse output (PCo)
1CN-42	(0-POT)	(EX 0V)†	1CN -1,-2,-3	0V	0V signal of PG output

† Not usually used.



Notes:

1. Each capacity of output circuits is 24 VDC, 100mA or less.
2. P – Twisted cable.
3. 24V power should be supplied by user.

Fig. 5. 3 Input/Output Signals and Connectors of Speed Control of Type CACR-SR

5.3.2 Positioning Control (Type CACR-PR□AA)

The terminal layout of the Servopack Type CACR-PR□AA input/output signal connectors (1CN) is shown in **Table 5.6**. The terminal specifications in **Table 5.7**, and external connection and external signal processing, in **Fig. 5.4**.

Table 5.6 Connector 1 CN Layout of SERVOPACK Type CACR-PR □ AA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0V	0V	0V	0V	0V	0V	+24 VIN	S-ON	0-SON				$\overline{INH}$	0V		F/V	SG	FG
0V for PG Output Signal			PULS 0V	SIGN 0V	$\overline{CL}$ 0V	Ext. Input Power	Servo ON Input					Inhibit Input	$\overline{INH}$ 0V		F/V Output		Frame Ground

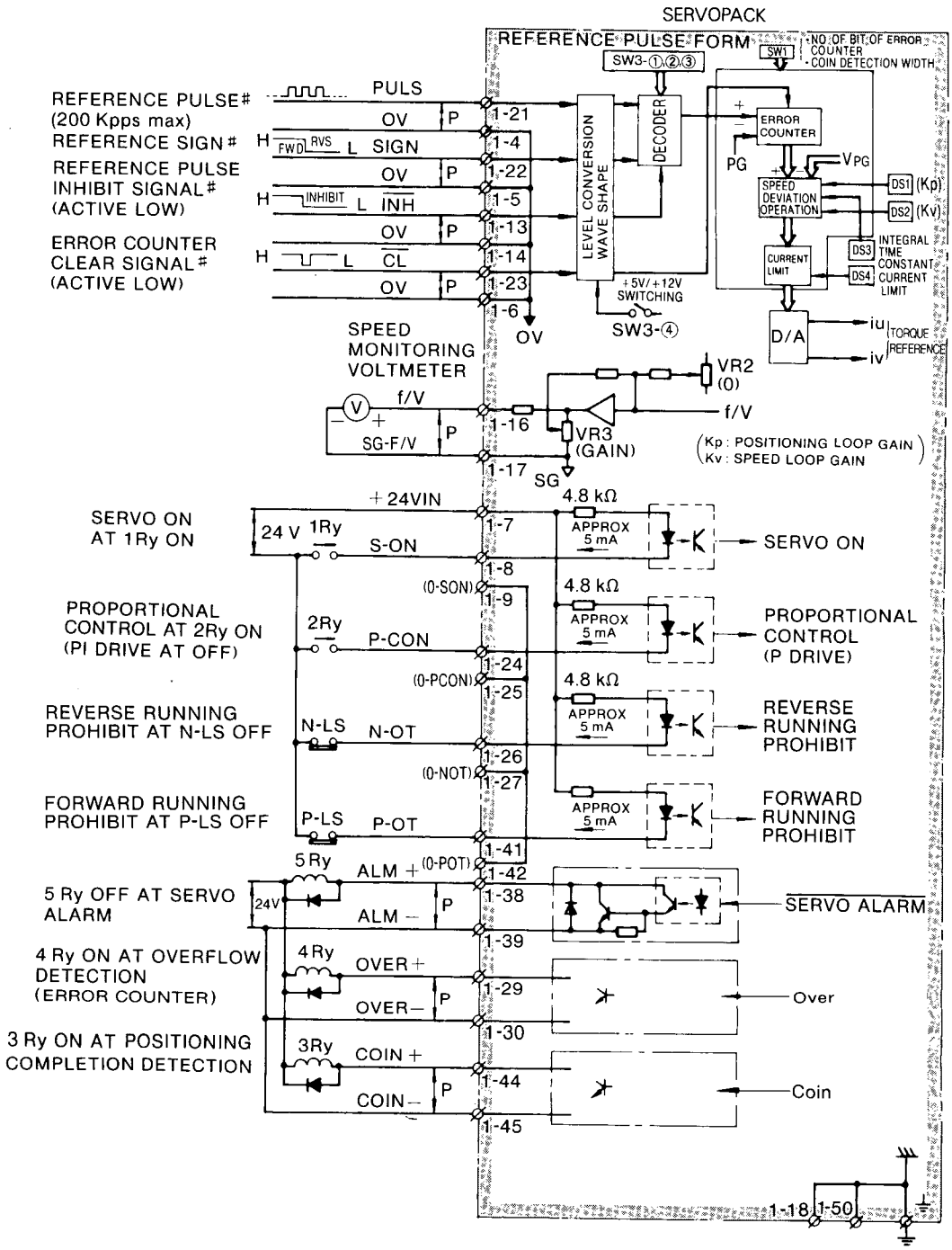
		19	20	21	22	23	24	25	26	27	28	29	30	31	32		
		PCO	*PCO	PULS	SIGN	$\overline{CL}$	P-CON	0-PCON	N-OT	0-NOT		OVER+	OVER-				
		Output Signal		Ref. Pulse Input	Ref. Sign Input	Clear Input	P Drive Input		Rev. Inhb. Input			Overflow Output					

33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
PAO	*PAO	PBO	*PBO		ALM+	ALM-		P-OT	0-POT		COIN+	COIN-					FG
Output Signal		Output Signal			Servo Alarm Output			Fwd. Inhb. Input			Positioning Compl. Detection						Frame Ground

Table 5.7 Connector 1CN Specifications of SERVOPACK Type CACR-PR □ AA

Connector No.	Signal Name	Description	Connector No.	Signal Name	Description
1CN-21	PULS	Reference pulse input	1CN-41	P-OT	Forward running prohibit at forward limit switch P-LS OFF
1CN-4	0V	Digital 0V	1CN-42	(0-POT)	(EX 0V)†
1CN-22	SIGN	Reference sign input	1CN-38	ALM+	External relay 5Ry (+24V) OFF at servo trouble detection
1CN-5	0V	Digital 0V	1CN-39	ALM –	0V of external power supply (+24V)
1CN-13	$\overline{INH}$	Reference pulse inhibit input Reference pulse inhibit at Low level	1CN-29	OVER+	External relay 4Ry (+24V) ON at internal counter overflow detection
1CN-14	0V	Digital 0V	1CN-30	OVER –	0V of external power supply (+24V)
1CN-23	$\overline{CL}$	Deviation counter clear input Deviation counter reset at LOW level	1CN-44	COIN+	External relay 3Ry (+24V) ON at positioning completion detection
1CN-6	0V	Digital 0V	1CN-45	COIN –	0V of external power supply (+24V)
1CN-16	f/V	f/V output Analog voltage output proportional to motor speed	1CN -18, -50	FG	Frame ground
1CN-17	SG·f/V	SG 0V (0V Signal)	1CN-33	PAO	Phase-A pulse output (PAo)
1CN-7	+24V IN	24 ± 1VDC input	1CN-34	*PAO	Phase-$\overline{A}$ pulse output (PAo)
1CN-8	S-ON	Servo ON input Servo ON at external relay 1Ry ON	1CN-35	PBO	Phase-B pulse output (PBo)
1CN-9	(0·SON)	(EX 0V)†	1CN-36	*PBO	Phase-$\overline{B}$ pulse output (PBo)
1CN-24	P-CON	P drive input Proportional control at external relay 2Ry ON	1CN-19	PCO	Phase-C (original point) pulse output (PCo)
1CN-25	(0·CON)	(EX 0V)†	1CN-20	*PCO	Phase-$\overline{C}$ pulse output (PCo)
1CN-26	N-OT	Reverse running prohibit at reverse limit switch N-LS OFF	1CN -1,-2,-3	0V	0V signal of PG output
1CN-27	(0·NOT)	(EX 0V)†			

† Not usually used.



* Signal with # should be input at +5V (TTL) or +12V level.

Notes:

1. Each capacity of output circuits is 24 VDC, 100mA or less.
2. $\overset{P}{\underset{P}{\uparrow\downarrow}}$ – Twisted cable.
3. 24V power should be supplied by user.

Fig. 5. 4 Input/Output Signals and Connectors of Positioning Control of Type CACR-PR

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

The following method is applied to connect Servopack to the optical encoder both in Types CACR-SR and CACR-PR.

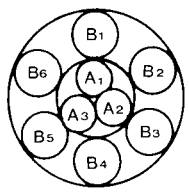
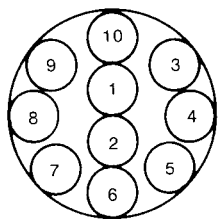
5.4.1 Specifications of Applicable Receptacles and Cables (Table. 5.8)

Table 5.8 Specifications of Applicable Receptacles and Cables

SERVOPACK Type	Connector Symbol	Connector Type used in SERVOPACK	Applicable Receptacle Type				Connection Cable‡
			Manufacturer	Soldered Type	Caulking Type	Case*	
SR	2 CN	MR-20RMA, Right angle 20P	Honda Tsushin Co.,Ltd.	MR-20F†	MRP-20F01	MR-20L†	DP8409123 or DE8400093
PR	2 CN						

* Attached to each applicable receptacle (soldered and caulking types).
† Attached to SERVOPACK when shipping.
‡ The cables listed in Table 5.9 are available on request. If required, purchase in units of standard length as shown in Table 5.9.

Table 5.9 Details of Specifications of Applicable Cables

Yaskawa Drawing No.	DP 8409123 *	DE 8400093
Manufacturer	Fujikura Cable Co.	
Approx Specifications	Double, KQVV-SW AWG 22 × 3 C AWG 26 × 6 P	KQVV-SB AWG 26 × 10 P
(Recommended Receptacle type)	(Soldered type) 	(Caulking type) 
Internal Composition and Lead Color	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
Finish Dimensions	Approx 80 mm dia	Approx 10.0 mm dia
Yaskawa Standard Specifications	Standard length: 5 m, 10m, 20 m Terminal ends are not treated (without connector).	

*Standard

5.4.2 SERVOPACK Connector Terminal Layout and Connection

The terminal layout for the Servopack connectors (2CN) for connecting the optical encoder is shown in **Table 5.10**, and the connection method of 2CN and the optical encoder, in **Figs. 5.5** and **5.6.**

Table 5.10 Connector 2CN Layout of SERVOPACK

1	2	3	4	5	6	7
PG 0V	PG 0V	PG 0V	PG 5V	PG 5V	PG 5V	

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: If wiring distance between servopack and motor (PG) exceeds 20 meters, use cable as specified in Yaskawa drawing No. DP8409179. The maximum wiring distance of the cables is 50 meters. Contact your Yaskawa representative.

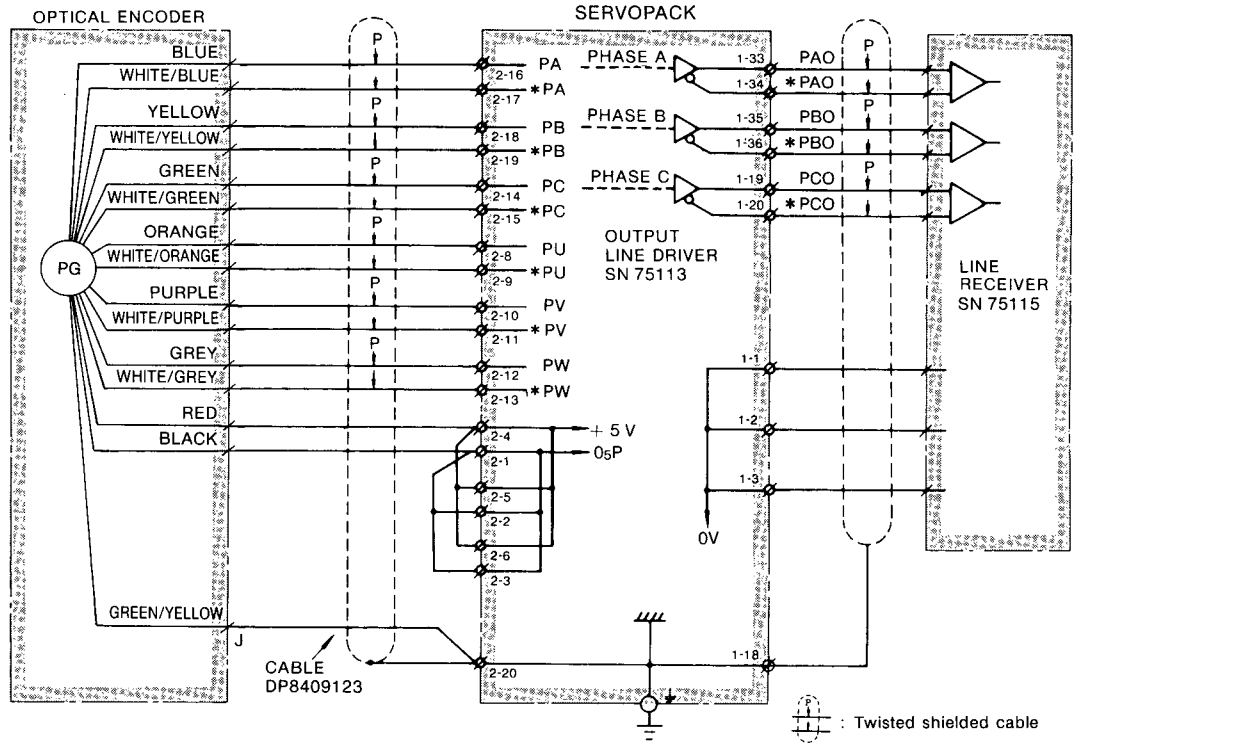


Fig. 5. 5 Connector 2CN Connection and 1CN Output Processing
(when using Connection Cable DP8401923)

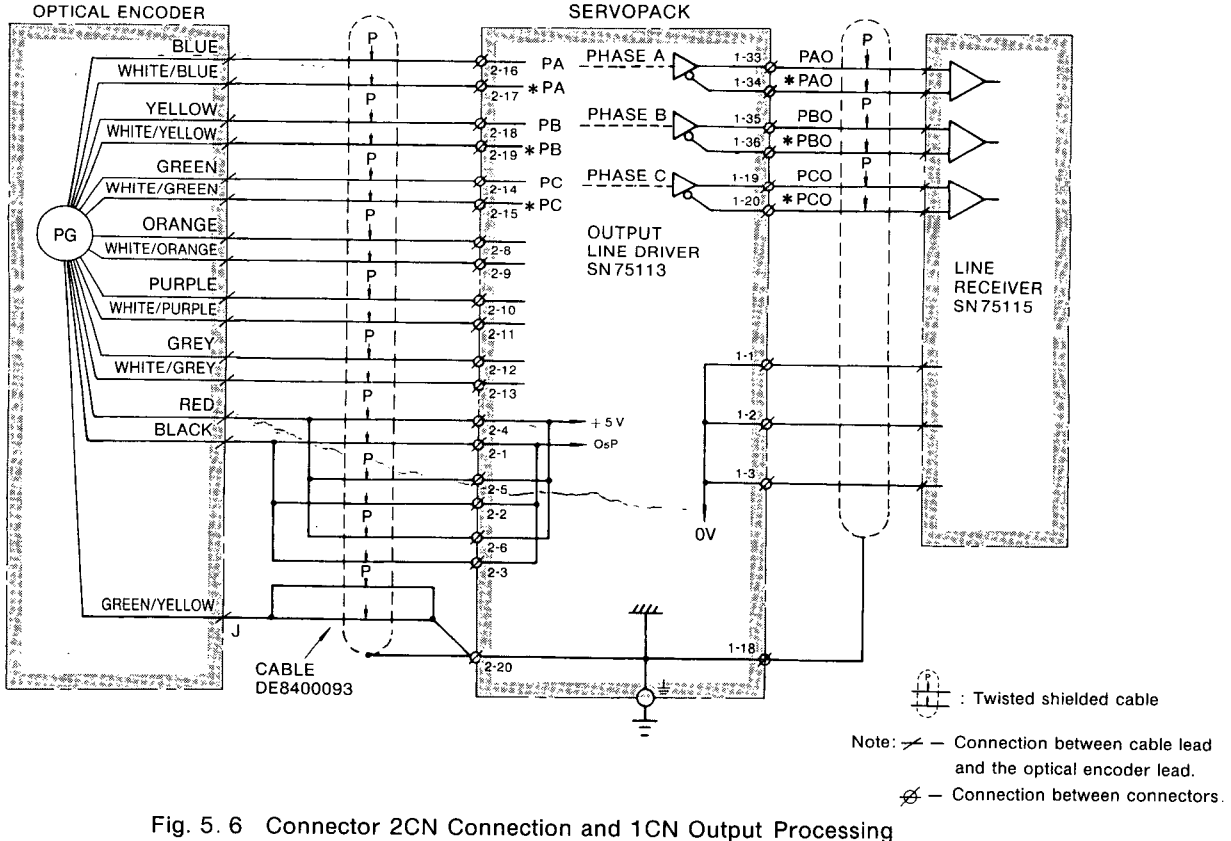


Fig. 5. 6 Connector 2CN Connection and 1CN Output Processing
(when using Connection Cable DE8400093)

6. OPERATION

Note that operation differs in part between Servopack types CACR-SR□AA and -PR□AA.

6.1 POWER ON AND OFF

The sequence configuration for turning main-circuit power on and off should be as shown in Fig. 6.1 and 6.2.

- Turn on or off the power unit for switching on or off Servopack.
- Make sequence to assure that the main-circuit power will be cut off by a servo alarm signal. (In a multi-axis drives, make connection so that, if a servo alarm occurs in a single Servopack, the power to all axes turns off.)
- When the power is turned on, the normal signal is set in the control circuit after a maximum of 1 second. Hold the main-circuit power ON signal for approximately 1 second.

NOTE

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

- Since the power unit is of a capacitor input type, a large recharging current flows when the main-circuit power is turned on. If the power is turned on and off frequently, the recharging-current limit resistor may be degraded and a malfunction may occur. The power ON and OFF sequence should be activated less than 3 times per hour(less than 20 to 30 times per day).

NOTE

For switching the motor on or off, turn the speed reference on or off. Do not turn the power supply on or off.

- Before turning power on or off, turn off the "Servopack-ON" switch to avoid troubles resulting from transient current.
- Depending on the power unit, select the power ON/OFF switch as shown in Table 6.1.

Table 6.1 Power ON/OFF Switch

Power Unit Type JUSP-	Powe ON/OFF Switch	Rate (Contact Operational Current)
ACP07AA	Yaskawa contactor type HI-A15 or equivalent	30 A
ACP15AA	Yaskawa contactor type HI-A25 or equivalent	50 A
ACP20AA	Yaskawa contactor type HI-A35 or equivalent	75 A

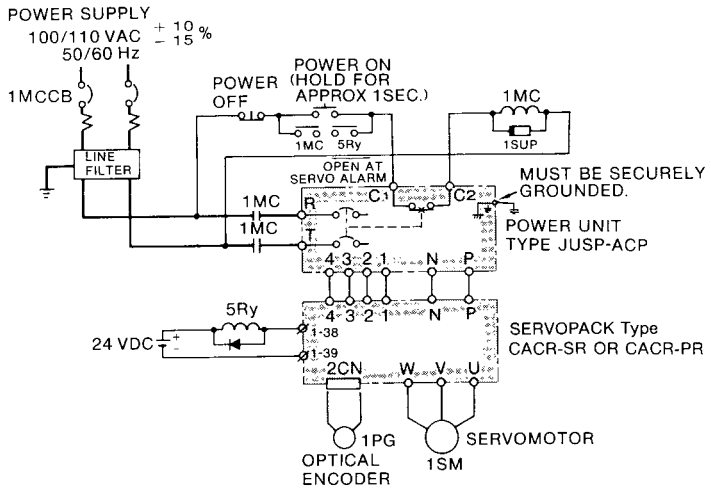


Fig.6.1 Power Sequence Example when using one SERVOPACK

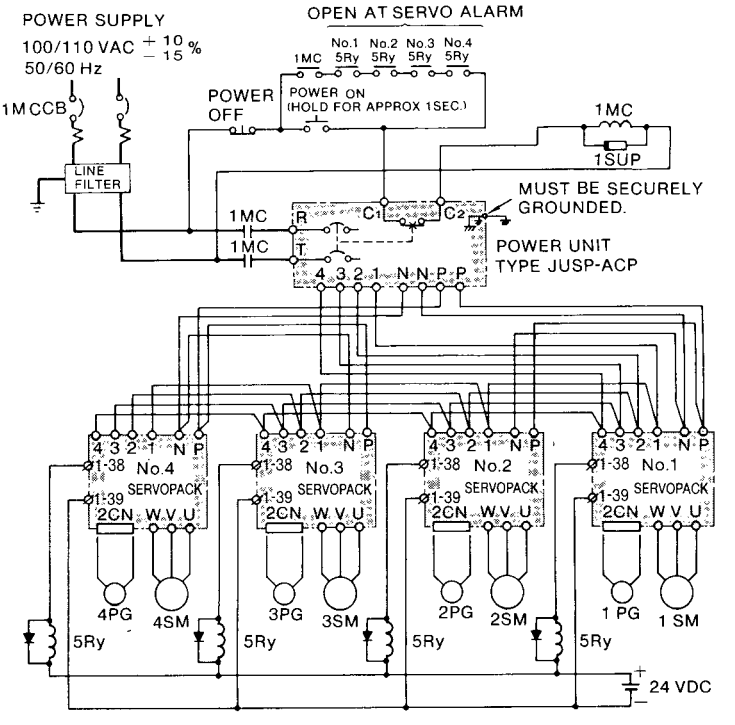


Fig. 6.2 Power Sequence Example in Multi-axis Drives

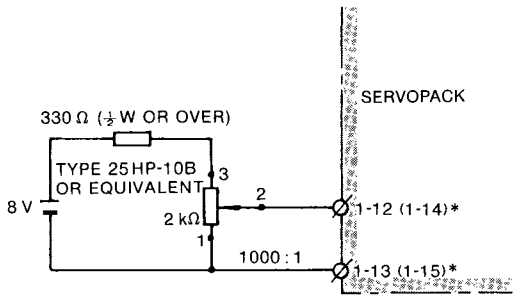
6.2 SPEED REFERENCE (FOR TYPE CACR-SR)

6.2.1 Speed Reference Circuit

From the Servopack built-in control power(1CN-⑯, ㊽: +8V, 1CN-⑰, ㉜, ㊼, ㊾: OV, 1CN-㉛, ㊻: -8 V) 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.

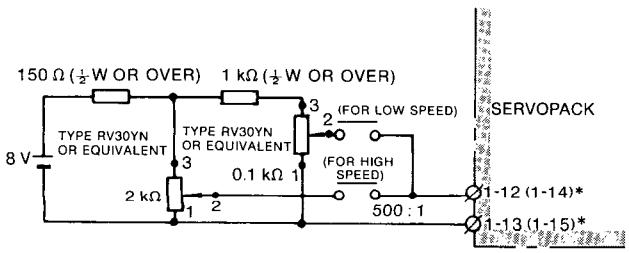
The method for giving speed reference voltage is described below.

(1) For accurate(inching) speed setting



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

(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 (PG series) made by Nippon Electric or equivalent, or low-level relay (G_2A-432) made by Tateishi Electric or equivalent.

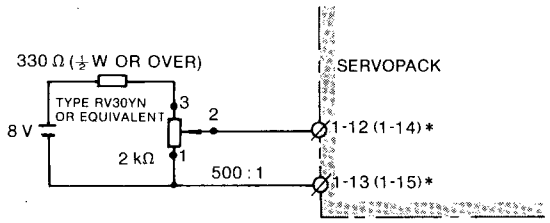
Note: When a carbon resistor is used, a great residual resistance remains, and so the speed control range becomes approximately 500:1.

(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

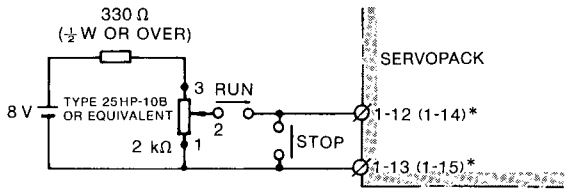


* Parentheses are for auxiliary input.
Note: When a carbon resistor is used, a great residual resistance remains, and so the speed control range becomes about 500:1.

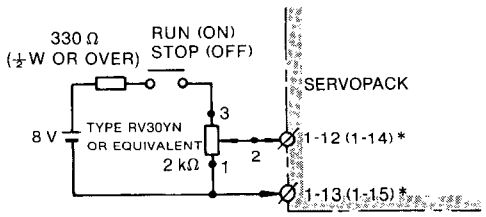
Fig. 6.4 Method for Giving Speed Reference Voltage (for relatively Rough Speed Setting as compared with Fig. 6.4)

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 terminal 1CN-⑫, ⑬ and the auxiliary input terminal 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 0 V), input the voltage to be used to set the rated speed, and adjust the potentiometer IN-B so that the rated speed is achieved.

6.3 POSITIONING REFERENCE (FOR TYPE CACR-PR)

6.3.1 Input Reference Pulse

"H" level is effective for input $\overline{\text{INH}}$(abbreviation of $\overline{\text{INHIBIT}}$) signal. Three types of signals can be input as reference pulses.

(1) Reference pulse mode

Only for 2-phase signals as shown in Table 6.1, set switches SW3-nos. 1, 2 and 3 according to the reference pulse modes and the multipliers.

Table 6.1 Reference Pulse Mode

Reference Pulse Mode	Input Pin No.	Forward Running Reference of Motor	Reverse Running Reference of Motor	Input Multiplier*	SW3 ①	SW3 ②	SW3 ③
Sign + Pulses	1CN-㉑ 1CN-㉒	"H"	"L"	—		○	○
90° Phase Difference 2-phase Pulses (1, 2 or 4 Times)	1CN-㉑ 1CN-㉒	90°	90°	× 1	○	○	○
				× 2	○	○	
				× 4	○		○
CW Pulses + CCW Pulses	1CN-㉑ 1CN-㉒	"L"	"L"	—		○	

* Defines the method of counting the input pulse waves in SERVOPACK. Table 6.2 shows the forward running reference for 90° phase difference 2-phase pulses when phase A = phase B = f (pps).

Notes:
1. Circles in SW3 show the positions for installing the setting plugs on the pins.
2. The multiplier can be set for 90° phase difference, 2-phase pulse input.

Table 6.2 Counting Method of Reference Pulse

Multiplier	Content of Pulse Counting of SERVOPACK	Reference Pulse Frequency of SERVOPACK
× 1	Counts only the leading edge of phase-A pulse input (1CN-㉑). PHASE A(1-21) PHASE B(1-22) SERVOPACK COUNTING PULSES	f (pps) [Nr/min*]
× 2	Counts the leading and trailing edges of phase-A pulse input (1CN-㉑). PHASE A(1-21) PHASE B(1-22) SERVOPACK COUNTING PULSES	2 × f (pps) [2×Nr/min]
× 4	Counts the leading and trailing edges of phase-A pulse input (1CN-㉑) and phase-B pulse input (1CN-㉒). PHASE A(1-21) PHASE B(1-22) SERVOPACK COUNTING PULSES	4 × f (pps) [4×Nr/min]

* Motor speed

(2) Reference pulse voltage and timing

The applicable voltage level of reference pulse is +12 V and +5 V and set as follows, using switch SW3-no.4.

SW3-④, without short-circuit pin(open): +5 V level

SW3-④, with short-circuit pin (shorted): +12 V level

The applicable voltage level and timing are detailed in **Table 6.3**

(3) Input circuit

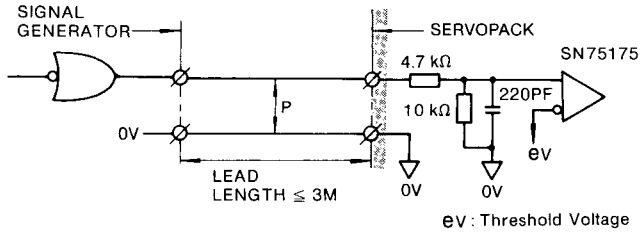
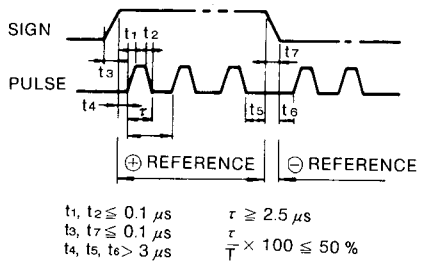
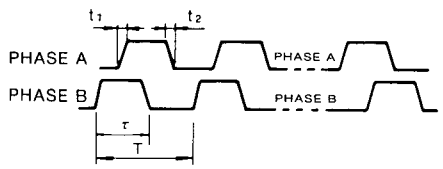
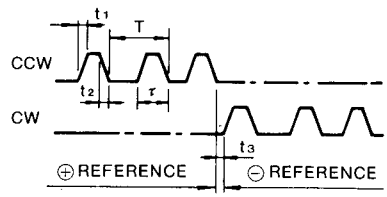


Fig. 6. 6 Input Circuit

Table 6.3 Applicable Voltage Level and Timing

Item			Electrical Specifications		Remarks
Voltage Level of Signal		+ 2 V Level	H Level	+ 10.8 V to + 12 V	+ 5 V level or + 12 V level is set by internal switch SW3.
			L Level	0 V to + 1.2 V	
		+ 5 V Level	H Level	+ 4.2 V to + 5 V	
			L Level	0 V to + 0.8 V	
Reference Pulse Signal Mode	Sign + Pulse Input (SIGN + PULSE Signal)		 $t_1, t_2 \leqq 0.1\ \mu s$ $t_3, t_7 \leqq 0.1\ \mu s$ $t_4, t_5, t_6 > 3\ \mu s$ $\tau \geqq 2.5\ \mu s$ $\frac{\tau}{T} \times 100 \leqq 50\ \%$	SIGN : H — ⊕ REFERENCE L — ⊖ REFERENCE
	90° Phase Difference 2-phase Pulse (Phase A + Phase B)		 ⊕ REFERENCE: PHASE B : 90° AHEAD OF PHASE A ⊖ REFERENCE: PHASE B : 90° BEHIND FROM PHASE A $t_1, t_2 \leqq 0.1\ \mu s$ $\frac{\tau}{T} \times 100 = 50\ \%$	Multiplier Mode is set by the internal switch SW3.
	CCW Pulses + CW Pulses		 $t_1, t_2 \leqq 0.1\ \mu s$ $t_3 > 3\ \mu s$ $\tau \geqq 2.5\ \mu s$ $\frac{\tau}{T} \times 100 \leqq 50\ \%$	—

Note: Maximum reference frequency is 200 kpps.

6.3.2 Other Input Signals

Other input signals are $\overline{CL}$ (abbreviation of $\overline{CLEAR}$) and $\overline{INH}$. The voltage level of these signals are the same as that of the reference pulse (the voltage level set by SW3-no.4 can operate $\overline{CL}$ and $\overline{INH}$).

(1) $\overline{CL}$ signal

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

(2) $\overline{INH}$ signal

When $\overline{INH}$ signal goes L, the reference pulse input gate closes, and the error counter does not count, but the positioning error counter is not cleared, so the servo is clamped. This signal is usually held at H level during operation.

6.3.3 Other Output Signals

See 6.4.2 Output Circuit for the output circuit configuration.

(1) Overflow detection signal(OVER)

This signal is output when No. of lag pulses in error counter becomes abnormally large.

No. of lag pulses in error counter > 20 bits

When overflow occurs, the servo alarm is also output because of an error similar to a servo error.

(2) Positioning completion signal(COIN)

This signal is output when the lag pulses in error counter fall within the set values. The lag pulses in error counter are set by switch SW3-nos. 5, 6, 7 and 8.

Table 6.4 Setting of Lag Pulses

Item	SW 3				Remarks
	⑤	⑥	⑦	⑧	
Data	D_0	D_1	D_2	D_3	
Without Short-circuit Pin	1	1	2	4	Setting of lag pulses
With Short-circuit Pin	10	0	0	0	

Note: When all switches above are short-circuited with pins, setting value is ±1 pulse.

$$\text{No. of lag pulses} = \left(\sum_{N=1}^{3} D_N\right) \times D_0$$

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

$$\frac{N}{P \times M} \times \left(\sum_{N=1}^{3} D_N\right) \times D_0 \text{ (rev)}$$

P: No. of pulses from optical encoder (pulse/rev)

N: Pulse frequency dividing ratio

M: Multiplier ratio

NOTE

SW3 is located inside the SERVOPACK. Set SW3 by removing the side cover from the SERVOPACK. For details, see 6.7.2, "Operation of Setting Switches."

6.4 CONFIGURATION OF INPUT/OUTPUT CIRCUIT

The built-in functions in the Servopack differ in types CACR-SR and CACR-PR: for proportional drive, Overtravel, Servo ON, Servo alarm output(for types SR and PR), Current limit detection output, TG ON output(for type SR), OVER, and COIN(for type PR), each input/output circuit is composed of non-contact circuit insulated with optical couplers. The external circuit, therefore, must be constructed with the specified voltage and current.

6.4.1 Input Circuit (For Types SR and PR)

Input signals are Servo ON input, proportional drive circuit, overtravel protection circuit to prevent further rotation of motor in forward or reverse direction. Construct the input circuit using 24 V power supply. Typical circuits are shown in **Figs. 5.3** and **5.4**.

NOTE

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

6.4.2 Output Circuit

The content of output differs in types SR and PR. There are three output signals each, for types SR and PR.

Type SR: Current limit detection, TG ON, and Servo alarm

Type PR: Large deviation(OVER), Positioning completion (COIN), and Servo alarm

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

Applied Voltage (VMax) ≦ 30 V

Conduction Current (Ip) ≦ 100 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. 6.7)**.

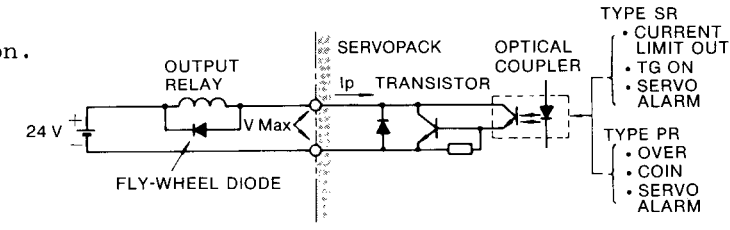


Fig. 6.7 Output Circuit

6.5 BUILT-IN FUNCTION

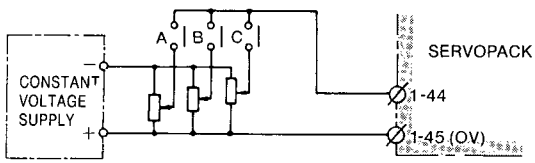
Built-in functions differ in part between Servopack types CACR-SR and CACR-PR.

6.5.1 External Current Limit Reference Circuit [P-CL, N-CL] (For Type CACR-SR)

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. 6.8**). The same effect can be obtained by giving voltage signals making analog change.



Relay: Low-level relay type G2A-432A made by Tateishi Electric Co.

Fig. 6.8 Multi-stage Switching of Current Value at Forward Side

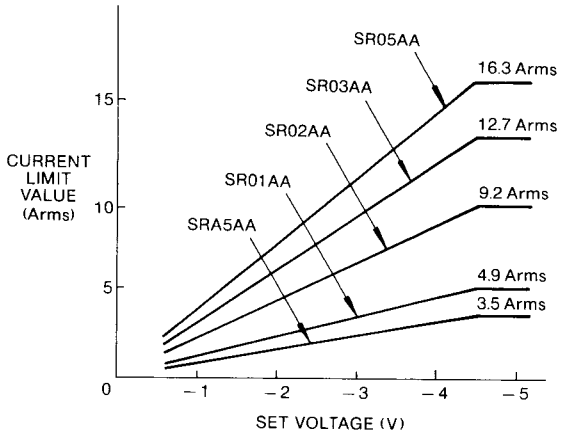
(1) Method of giving external current limit reference

Forward current and reverse current can be controlled independently. The forward current can be controlled by giving a reverse voltage (0 to -4.5 V) between Servopack terminals 1CN-㊹ and ㊺; the reverse current by a forward voltage(0 to +4.5 V) between terminals 1CN-㉙ and ㉚.

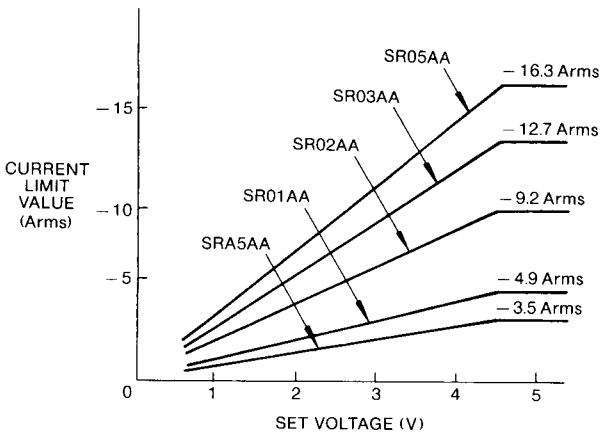
The relation between the rated current of the motor and current limit values is approximately 1.5V/100% of rated current for applicable motor. The power supply must use an internal resistance less than 2kΩ. The input resistance at Servopack side must be greater than 5kΩ. When external current is not restricted, contacts between terminals 1CN-㊹ and ㊺ and between 1CN-㉙ and ㉚ are opened.

(2) Set voltage and current limit values

The relationship between set voltages of 0 to ± 4.5 V and current limit values are shown in **Fig. 6.9.**



(a) Current Limit at Forward Side



(b) Current Limit at Reverse Side

Fig. 6.9 Set Voltage — Current Limit Characteristics

(3) Current limit when motor is locked

When locking a motor by applying a current limit, determine the 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 6.5.6 (2) 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 potentiometers P-GAIN and L-GAIN, the motor lock current sometimes pulsates. If this is not desirable, the current pulsation can be removed by increasing the speed reference voltage.

6.5.2 Proportional Drive Reference Circuit [P-CON] (For Types CACR-SR and -PR)

(1) Type CACR-SR

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 system drops and the drift decreases. With several percent of friction load, the motor stops completely. Input the proportional drive reference according to 6.4.1 Input Circuit.

(2) Type CACR- PR

There is usually no need for using the proportional drive reference circuit.

6.5.3 Overtravel Prevention Circuit [P-OT, N-OT] (For Types CACR-SR and -PR)

The overtravel prevention circuit is used to stop the forward running of the motor(counterclockwise viewed from the drive end of the motor) and reverse running. This circuit stops output voltage to drive the motor. Therefore, the motor will coast to a stop. If braking is required, set the speed reference voltage to 0V or use the dynamic braking circuit(generator control). For the dynamic braking circuit, see 6.9.1 Emergency Stop Dynamic Braking Circuit.

Supply power to the overtravel prevention circuit according to 6.4.1 Input Circuit, and **Figs. 5.3** and **5.4**. When the overtravel prevention circuit is not used, connect 1CN-㉖ and ㊶ to the 0V terminal of the external 24 V power supply.

6.5.4 Servo ON Input Circuit [S-ON] (For Types CACR-SR and -PR)

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.

6.5.5 Optical Encoder(PG) Output Circuit [PAO, *PAO, PBO, *PBO, PCO, *PCO] (For Types CACR-SR and -PR)

Phases A, B, and C(original point) signals for the optical encoder, PG(1500 pulses/rev or 1000 pulses/rev).

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

(1) Signal form

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

(2) Example of output circuit and receiver circuit

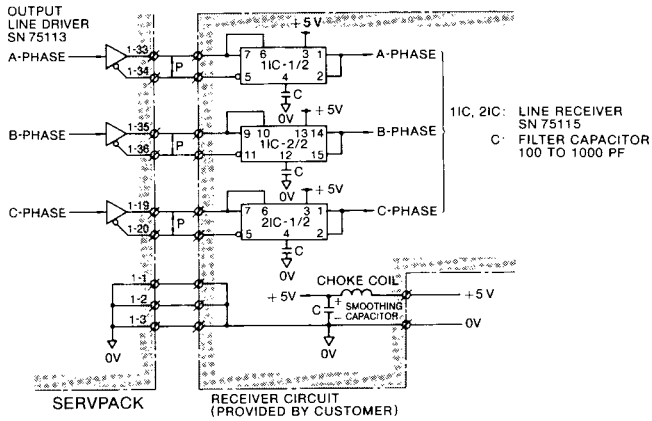
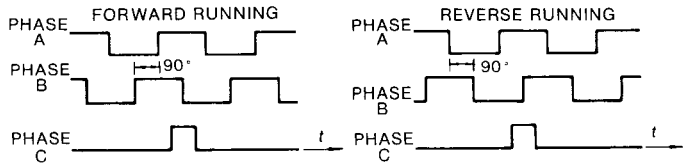


Fig. 6.10 Output Circuit

(3) Output phase



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

Fig. 6.11 Output Phase

(4) Pulse resolution

The PG outputs 1500 pulses/rev or 1000 pulses/rev. The pulse frequency can be further divided into 1/N(N=1 to 32) of 1500 pulses/rev or and 2/N(N=2 to 32) of 1000 pulses/rev, by using the divider in the Servopack. The phase relation is the same in (3), above. Set the pulse frequency dividing ratio according to **Table 6.6.**

The dividing ratio must be able to divide the pulses of the optical encoder. For example, in an optical encoder of 1000 pulses/rev, 1/3, 1/6, or 1/7 cannot be used. **Fig. 6.12** shows the optical encoder output waveform under the divided pulse frequency.

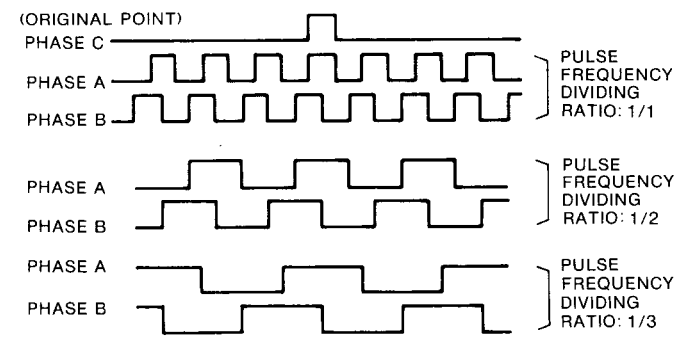


Fig. 6.12 Output Waveform of Optical Encoder

(5) Output multiplier circuit(for type CACR-PR)

According to the combination of switch SW2-nos. 7 and 8 in the Servopack, the number of optical encoder frequency(output) can be multiplied by the user. See **Table 6.5.**

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

NOTE

SW2 is in the SERVOPACK. To set SW2, remove the side cover from the SERVOPACK and follow detailed handling instructions listed in 6.7.2 Operation of Setting Switch.

Table 6.5 Setting of Output Multiplier Circuit

SW 2 ⑦	SW 2 ⑧	Multiplier
○	○	× 1
	○	× 1
○		× 2
		× 4

Notes :
1. Circles indicate the positions of short-circuit pins.
2. For type CACR-SR, spare short-circuit pins are inserted in SW-2 ⑦ and ⑧.
3. The relationship of pulse frequency dividing ratio (N), multiplier (M) and rotation angle per pulse are as follows :

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

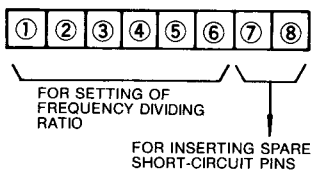
N : Pulse frequency dividing ratio
M : Multiplier
P : Number of PG pulses (pulses/rev)

Table 6.6 Setting of PG Pulse Frequency Dividing Ratio

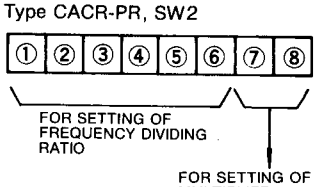
PG Pulse Frequency Ratio Dividing (1/N)	SW 2 ①	②	③	④	⑤	⑥	Pulse Frequency Dividing Output 1500p/rev	1000p/rev	PG Pulse Frequency Dividing Ratio (2/N)	SW 2 ①	②	③	④	⑤	⑥	Pulse Frequency Dividing Output 1500p/rev	1000p/rev
1	○	○	○	○	○	○	1500	(1000)	2							×	×
1/2		○	○	○	○	○	750	(500)	2/2		○	○	○	○		1500	(1000)
1/3	○		○	○	○	○	500	×	2/3	○		○	○	○		1000	×
1/4			○	○	○	○	375	(250)	2/4			○	○	○		750	(500)
1/5	○	○		○	○	○	300	(200)	2/5	○	○		○	○		600	(400)
1/6		○		○	○	○	250	×	2/6		○		○	○		500	×
1/7	○			○	○	○	×	×	2/7	○			○	○		×	×
1/8				○	○	○	×	(125)	2/8				○	○		×	(250)
1/9	○	○	○		○	○	×	×	2/9	○	○	○		○		×	×
1/10		○	○		○	○	150	(100)	2/10		○	○		○		300	(200)
1/11	○		○		○	○	×	×	2/11	○		○		○		×	×
1/12			○		○	○	125	×	2/12			○		○		250	×
1/13	○	○			○	○	×	×	2/13	○	○			○		×	×
1/14		○			○	○	×	×	2/14		○			○		×	×
1/15	○				○	○	100	×	2/15	○				○		200	×
1/16					○	○	×	×	2/16					○		×	×
1/17	○	○	○	○		○	×	×	2/17	○	○	○	○			×	×
1/18		○	○	○		○	×	×	2/18		○	○	○			×	×
1/19	○		○	○		○	×	×	2/19	○		○	○			×	×
1/20			○	○		○	75	(50)	2/20			○	○			150	(100)
1/21	○	○		○		○	×	×	2/21	○	○		○			×	×
1/22		○		○		○	×	×	2/22		○		○			×	×
1/23	○			○		○	×	×	2/23	○			○			×	×
1/24				○		○	×	×	2/24				○			×	×
1/25	○	○	○			○	60	(40)	2/25	○	○	○				120	(80)
1/26		○	○			○	×	×	2/26		○	○				×	×
1/27	○		○			○	×	×	2/27	○		○				×	×
1/28			○			○	×	×	2/28			○				×	×
1/29	○	○				○	×	×	2/29	○	○					×	×
1/30		○				○	50	×	2/30		○					100	×
1/31	○					○	×	×	2/31	○						×	×
1/32						○	×	×	2/32							×	×

Notes
1. Circles indicate the short-circuit pin is inserted into the switch.
2. The pulse frequency dividing ratio indicated by × cannot be used.
3. Apply a PG of 1500 p/rev except for pulse frequency dividing output of 400 p/rev, 80 p/rev and 40 p/rev.
4. The contents of SW-2 ⑦ and ⑧ differ between types CACR-SR and CACR-PR.

• Type CACR-SR, SW2



• Type CACR-PR, SW2



6.5.6 Protective Circuit (For Types CACR-SR and -PR)

Servopack types CACR-SR and -PR provide functions to protect the body and motor from malfunctions.

(1) Trouble detecting functions

Table 6.7 Trouble Detecting Functions

Trouble	Cause	Symptom
Overrun (RW) (Overrun Prevention)	• Wrong wiring of motor circuit • No wire connection (one phase connection) • Wrong wiring of PG signal line	• Excessively high-speed running of the motor (Wrong speed is detected at 10% rated motor speed)
Overspeed (OS)	• Excessively large speed reference input	• Motor overspeed : Type SR-approximately 4800r/min or more Type PR-approximately 4000r/min or more
Overcurrent (OC)	• Defective insulation of the motor • Defection current detection circuit	• Overcurrent flow in the main circuit
Overcurrent (OV)	• Deceleration under large load inertia GD^2	• Excessively high DC voltage in the main circuit
Heatsink Overheat (OH)	• Increase of heat generation loss due to defective cooling conditions or defect in main circuit elements	• Overheat of heat sink
Overload (OL)	• Overload of driven machine	• Overload condition of motor and SERVOPACK
Blown Fuse (FU)	• Defect in main circuit elements	• Blown fuse of SERVOPACK
Overflow (OVER)	• Overload of driven machine	• More than 20 bits of log pulses of the error counter in SERVOPACK (for type PR only)

(2) Overload (OL)detection level(for types CACR-SR and -PR)

Fig. 6.13 shows the setting of overload detection level at 100% rated motor current.

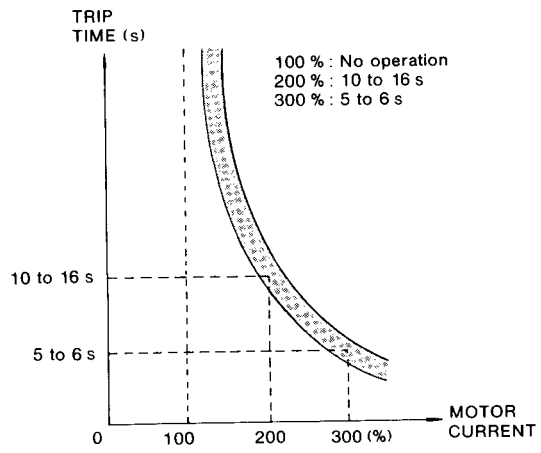


Fig. 6.13 Overload Characteristics

(3) Servo alarm output [ALM+, ALM-] (For types CACR-SR and -PR)

If any of trouble detection circuits shown in **Table 6.7** functions, the base of the power drive circuit in the Servopack is interrupted, LED [ALARM] lights, and the servo alarm signal is output. To restart the operation, the power supply must be turned off once. Note that it takes several minutes to reset the internal alarm hold circuit after the power is turned off because the power supply to the control circuit has a large time constant for discharging.

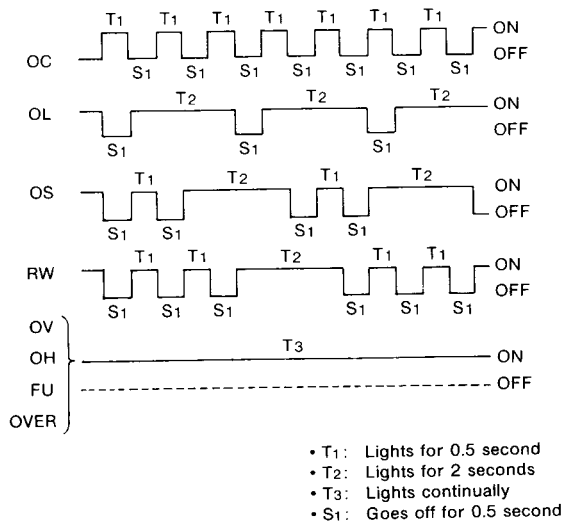
Before turning on the power again, make sure that LEDs of [MP] on the power unit and [POWER] and [ALARM] on the controller are all off.

6.5.7 LED Indication (For Types CACR-SR and -PR)

Table 6.8 Specifications of LED Indication

Specifications / Product Name	LED Name	Indicating Color	Lighting Conditions
Power Unit	[MP]	Green	Power is supplied to the power unit. (Power is also applied to SERVOPACK connected to the power unit, so be careful when handling).
SERVOPACK	[POWER]	Green	SERVOPACK control circuit voltage is proper.
	[ALARM]	Red	Trouble detecting circuit is activated.

For only type CACR-PR□AB, [ARARM] LEDs light by time-shared system. See Fig. 6.14.



- T_1: Lights for 0.5 second
- T_2: Lights for 2 seconds
- T_3: Lights continually
- S_1: Goes off for 0.5 second

Fig. 6.14

6.5.8 f/V Output Circuit [f/V] (For Type CACR-PR)

f/V output circuit monitors the motor speed. A minus signal is output when forward running at 3V/3000 r/min and a plus signal at reverse running. For tachometer connection, see par. 6.9.3 Tachometer Connection.

6.6 PRECAUTIONS FOR APPLICATION

6.6.1 Minus Load

The motor is rotated by the load; it is impossible, by the use of types CACR-SR and CACR-PR, 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 Yaskawa representative.

6.6.2 Load Inertia (J_L)

The allowable load inertia J_L converted to the motor shaft must be within five 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 Yaskawa representative.

6.6.3 Regenerative Processing Unit Type JUSP-RG

The power unit and regenerative processing unit type JUSP-RG□ are provided as separate units. Type CACR-SR and -PR employ the regenerative method as the motor braking system. When braking, the regenerative power increases the DC voltages both in the power unit and in the control circuit in the Servopack.

When a high inertia load is run or when continuous regeneration occurs in a minus load, this voltage increases and parts in the main circuit might be damaged by overvoltage. Type JUSP-RG□ clamps this voltage rise to a given value and protects the parts of the main circuit in the power unit and parts in Servopack.

Type JUSP-RG□ contains the circuit to detect an overvoltage caused by incomplete processing of regeneration. It also contains the circuit to detect and protect the regenerative circuit and issues alarm signal indicating the operating condition through the reed relay contact. These functions are used to improve the regenerative processing fuction to meet the change in load condition or to correct the trouble.

Regenerative processing unit is used one per one power unit, even if plural Servopack (Type CACR-SR and-PR) are used.

(1) Specifications of regenerative processing unit

Table 6.9 Specifications of Regenerative Processing Unit

Item		Specifications
Regenerative Processing Unit Type JUSP-		RG001
Applicable Power Unit Type JUSP-		ACP07AA to ACP20AA
Regenerative Operating Voltage		170 VDC
Regenerative Processing Current		8 ADC
Protective Function	Overvoltage Detection*	192 V ± 5 V
		Instantaneous operation at the above voltage
	Regenerative Fault Detection†	Operates when the regenerative circuit fails for approx 0.5 seconds.
	Protective Circuit Operation Output Relay (Alarm Relay)‡	• Lead relay** • 1NO contact • Contact capacity : 100V max, 0.3A max(15VA max)
External Additional Resistor#		20 Ω or more (100W or more)

* This function operates when the voltage in the main circuit exceeds the value in the table, due to trouble in the regenerative circuit or insufficient regenerative processing.

† Regenerative circuit trouble includes a short-circuit malfunction of the regenerative power transistor and breakage of the wire-wound resistor for regeneration.

‡ Overvoltage detection signal and regenerative trouble detection signal are output through the same relay.

If the regenerative processing is insufficient, this resistor is connected to the unit terminals (R1) and (R2) to increase the current for regenerative processing.

** Type PG series made by Nippon Denki Co.

(2) Internal circuit

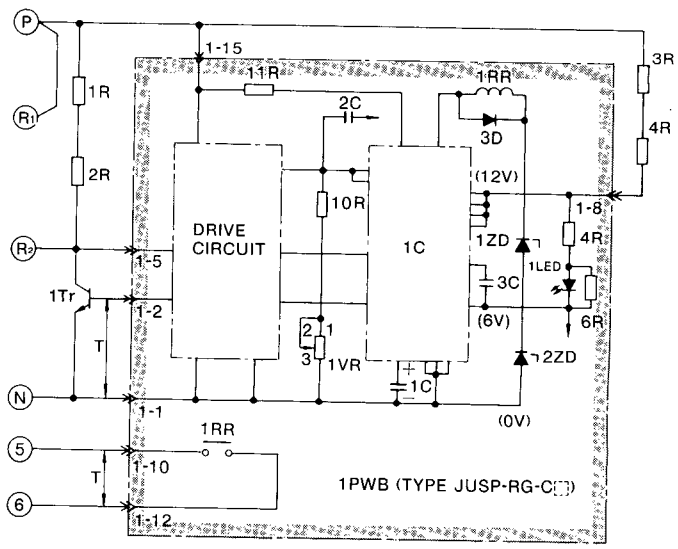


Fig. 6.15 Internal Block Diagram of Regenerative Processing Unit

(3) Connection

See **Fig. 6.16.**

(4) Precautions for use

(a) Installation

Frequent start and stop operations may cause the regenerative processing unit to be overheated. The parts vulnerable to heat should be located more than 15cm above and below the resistor unit.

(b) Actions when the protective circuit (alarm relay) activates

. During braking

Cause: May be incomplete regenerative processing due to a large load inertia.

Action: Connect an additional resistor between the regenerative processing unit terminals (R1) and (R2).

. Approximately 0.5 second after the power is turned on

Cause: May be trouble(short-circuit) in the regenerative power transistor or damage to the porcelain resistor for regeneration.

Action: Check the regenerative power transistor and the porcelain resistor for regeneration and replace the faulty parts.

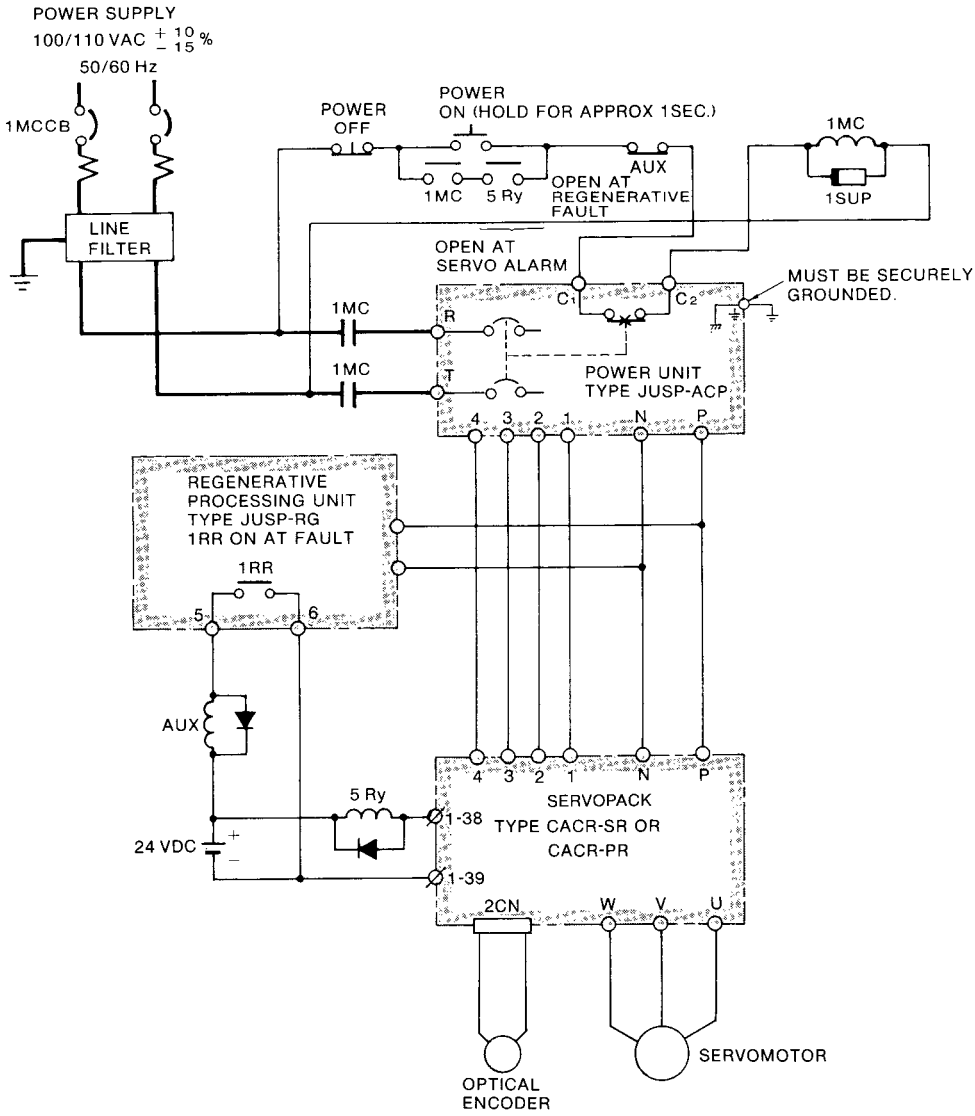


Fig. 6.16 Example of Connection Diagram of Regenerative Processing Unit

6.6.4 High Voltage Line

If the supply voltage is 200/220 V or 400/440 V, the voltage must be dropped to 100 V by using a power transformer. **Table 6.10** is the transformer selection guide. Connection should be made so that the power is supplied and cut through the primary side of the transformer (**Fig. 6.17**).

Table 6.10 Selection Guide of Power Transformer

Power Unit Type JUSP-		ACP07AA	ACP15AA	ACP20AA
Transformer Capacity	Selection Criterion	2.5 times of total motor output (VA)		
	Under Maximum Load	1.5 kVA (0.6 kW)*	3.0 kVA (1.2 kW)*	5.0 kVA (1.8 kW)*

*Total motor output

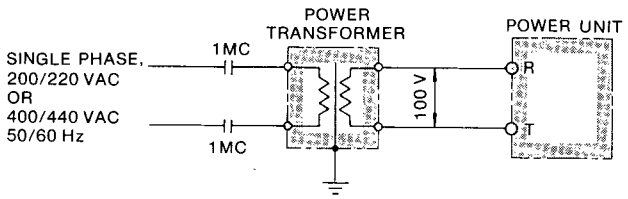


Fig. 6.17 Power Transformer Connection

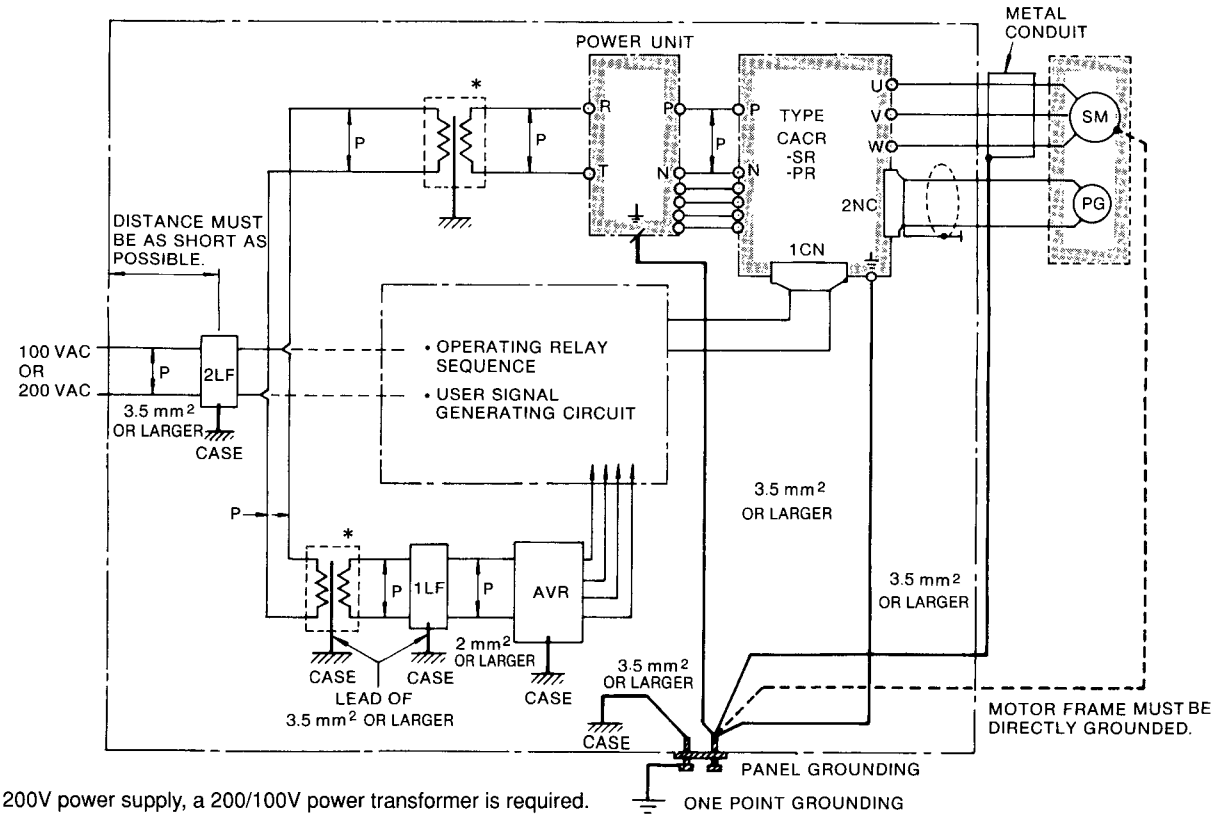
6.7 PRECAUTIONS OF OPERATION

6.7.1 Noise Treatment

Servopack types CACR-SR and -PR use 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. 6.18**.

(1) Grounding method (**Fig. 6.18**)



* For 200V power supply, a 200/100V power transformer is required.

Notes :

1. Use wires of 3.5 mm^2 or larger for grounding to the case. (preferably flat-woven copper wire).
2. Connect line filters observing the precautions as shown in 6.7.1 (2), "Line filter installation."

Fig. 6.18 Example of Noise Treatment

6.7.1 Noise Treatment (Cont'd)

- 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, the motor frame is 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.

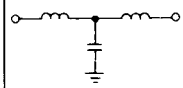
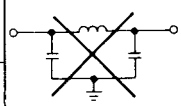
- Grounding for multi-axis drives

  Ground the power unit and all ground terminals of the Servopack at one point of the ground panel.

(2) Line filter installation

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

Table 6.11 Recommended Line Filter

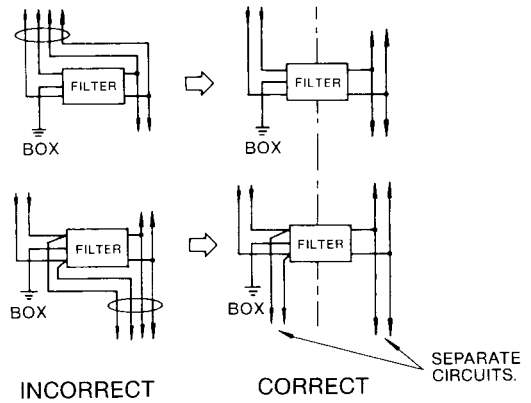
Power Unit Type JUSP-	Kind of Applicable Line Filter	Recommend Line Filter	
		Type	Specifications
ACP07AA	 CORRECT	LF-205F	Single phase 200, 100VAC class 5 A
		LF-210	Single phase 200, 100VAC class 10A
		LF-215	Single phase 200, 100VAC class 15A
ACP15AA		LF-220	Single phase 200, 100VAC class 20A
	 WRONG	LF-230	Single phase 200, 100VAC class 30A
ACP20AA		LF-240	Single phase 200, 100VAC class 40A
		LF-250	Single phase 200, 100VAC class 50A

Note: Line filt made dy Tokin Ind., Co.

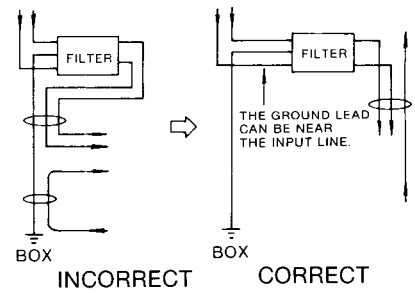
NOTE

If the line filter connection is wrong, the effect decreases greatly. Observing the precautions, carefully connect them as shown in Fig. 6.19.

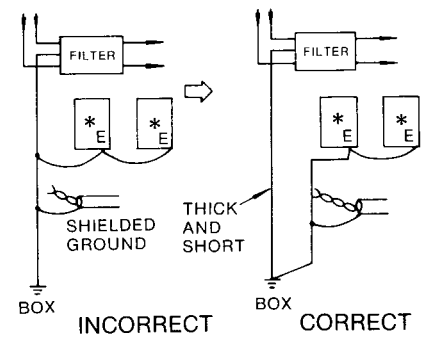
(a) Separate the input and output leads. Do not bundle or run them in the same duct.



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

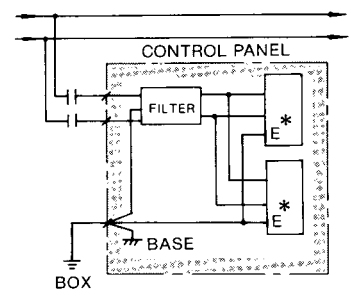


(c) Connect the ground lead singly to the box or the ground panel.



*Equipment

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



*Equipment

Fig. 6.19 Line Filter Connection

6.7.2 Operation of Setting Switches

The Servopack types CACR-SR and -PR contain the following setting switches:

SW1: Sets the motor parameters. (For types CACR-SR and -PR)

SW2: Sets the dividing ratio and multiplier ratio. (Multiplier ratio only for type PR)

SW3: Sets the reference level, input signal voltage level, and the number of contained coin pulses for type PR only.

These parameters should be set after by removing the side cover from the Servopack, using the following procedures.

1. Remove the right hand side cover from the Servopack. (**Fig. 6.20**) Be careful not to lose the cover-mounting screws (M3 flush screw × 6) × 4.
2. The printed circuit boards are exposed as shown in **Figs. 6.21** and **6.22**. SW1, SW2, SW3 and their numbers are shown in these figures.
3. Check or set SW1, SW2, SW3, then replace the cover.

NOTE

Do not leave the cover open, for the vulnerability to radiation noise will increase slightly.

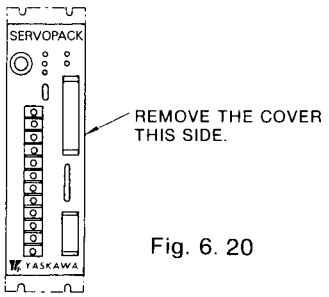


Fig. 6.20

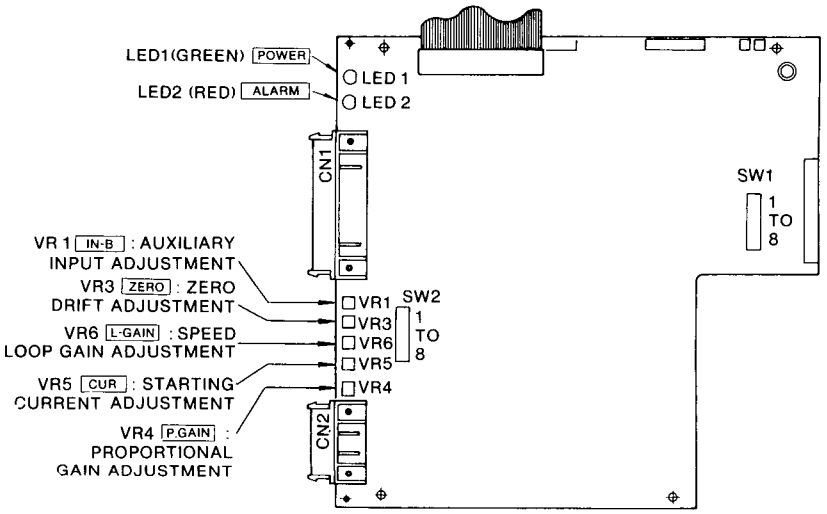


Fig. 6.21 Type CACR-SR□□AA Printed Wiring Board (1PWB)

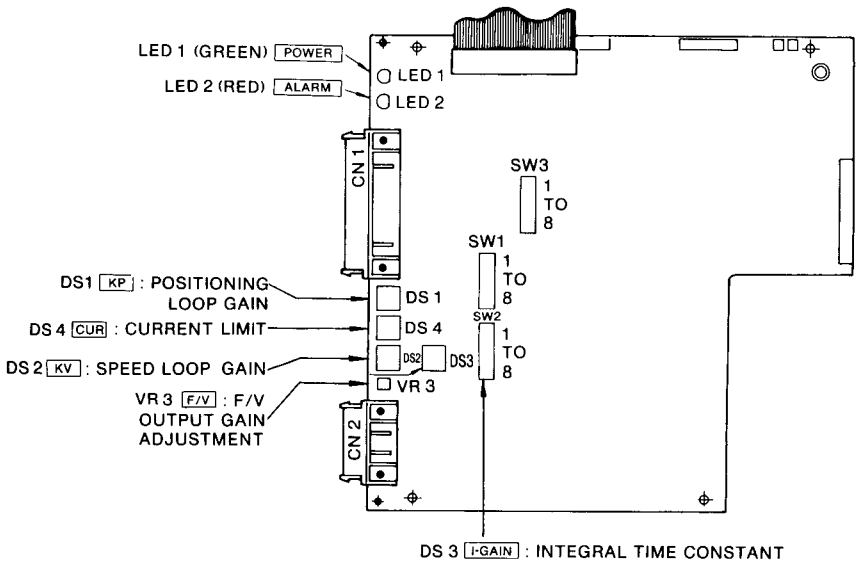
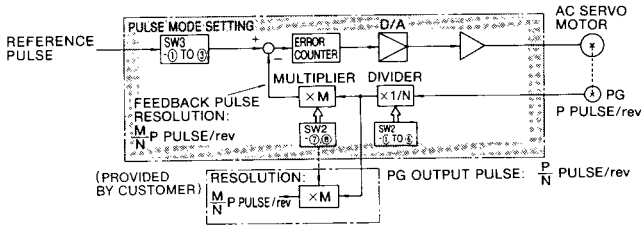


Fig. 6.22 Type CACR-PR□AA Printed Wiring Board (1PWB)

6.7.3 Input and Output Pulses in Type CACR-PR

Type CACR-PR multiplies the reference input pulses and divides and multiplies the PG output. **Table 6.12** shows a typical relationship between these functions when the reference input pulses and PG output pulses are combined.



Note: Where the same resolution as feedback pulse is necessary, multiply PG output pulse by multiplier using setting SW2-⑦ and ⑧.

Fig. 6.23 Input and Output Pulses in Type CACR-PR

Table 6.12 Input and Output Pulses in Type CACR-PR

Input Multiplier (SW 3 - ①, ②, ③)		1	1	4	4	4	1
PG Pulse Frequency Dividing (SW 2-① to ⑥)		1	1	1	2	3	3
Output Multiplier (SW 2-⑦, ⑧)		1	4	4	4	1	1
Reference Pulse Train	For 2-phase Pulse Train Input						
	For Sign + Pulse Train Input						
PG, FB Pulse	PA PB						
PG Output	PAo PBo						
Pulse Resolution		1500	6000	6000	3000	500	500

Notes :

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

6.7.4 Setting Number of Optical Encoder Pulses

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

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

- The number of pulses of the optical encoder is indicated with the type of the servomotor.
- The number of pulses of the Servopack's optical encoder set at the factory is indicated with the type of the Servopack. (The factory setting is A: 6000 P/R.)

If the number of pulses of the Servopack's optical encoder set at the factory is different from the number of motor pulses, change the setting switches in the Servopack according to **Tables 10.2** and **10.3**, and 6.7.2 Operation of Setting Switches.

6.7.5 Positioning Signal when Power is Supplied

In type CACR-PR, when the power is supplied to the control circuit, a positioning signal(COIN output) continues for approximately 150 ms to initialize the Servopack. Note that this is an invalid signal and should not be taken this into the unit to be used.

Example: Take interlock with a servo alarm output.

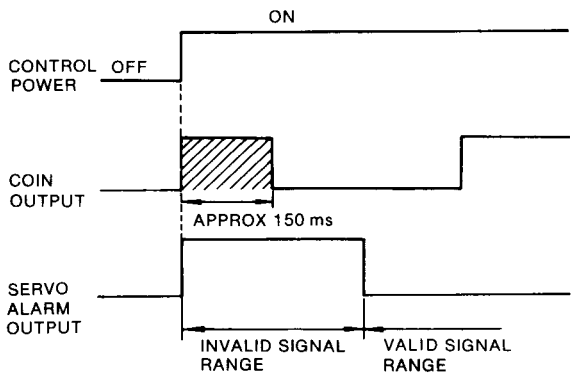


Fig. 6.24 Positioning Signal COIN Output

6.8 CONNECTION DIAGRAM OF SERVOPACK

6.8.1 One-axis Drive

· Type CACR-SR

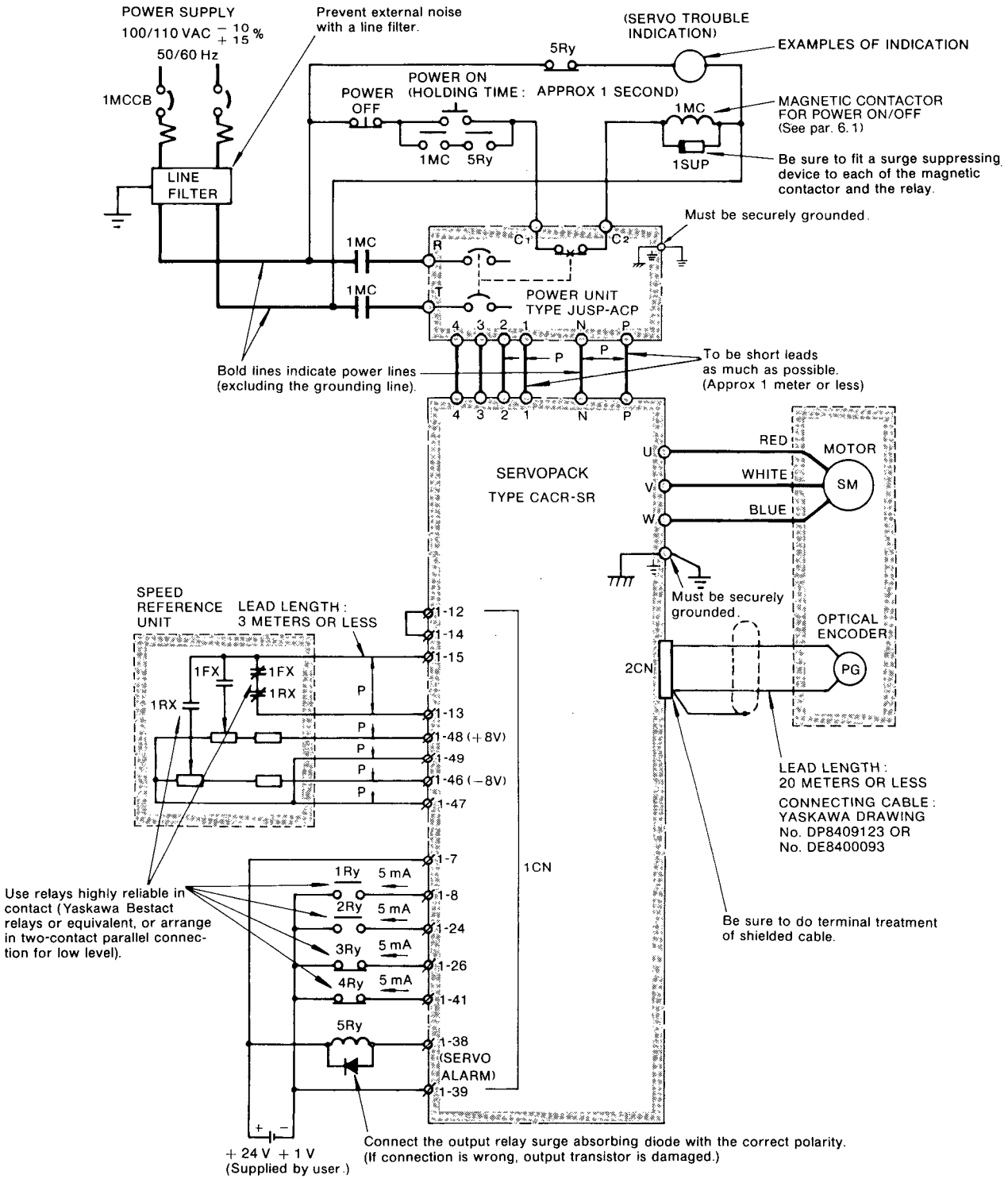


Fig. 6.25 Example of Connection Diagram of SERVOPACK with a SERVOMOTOR and Peripherals

· Type CACR-PR

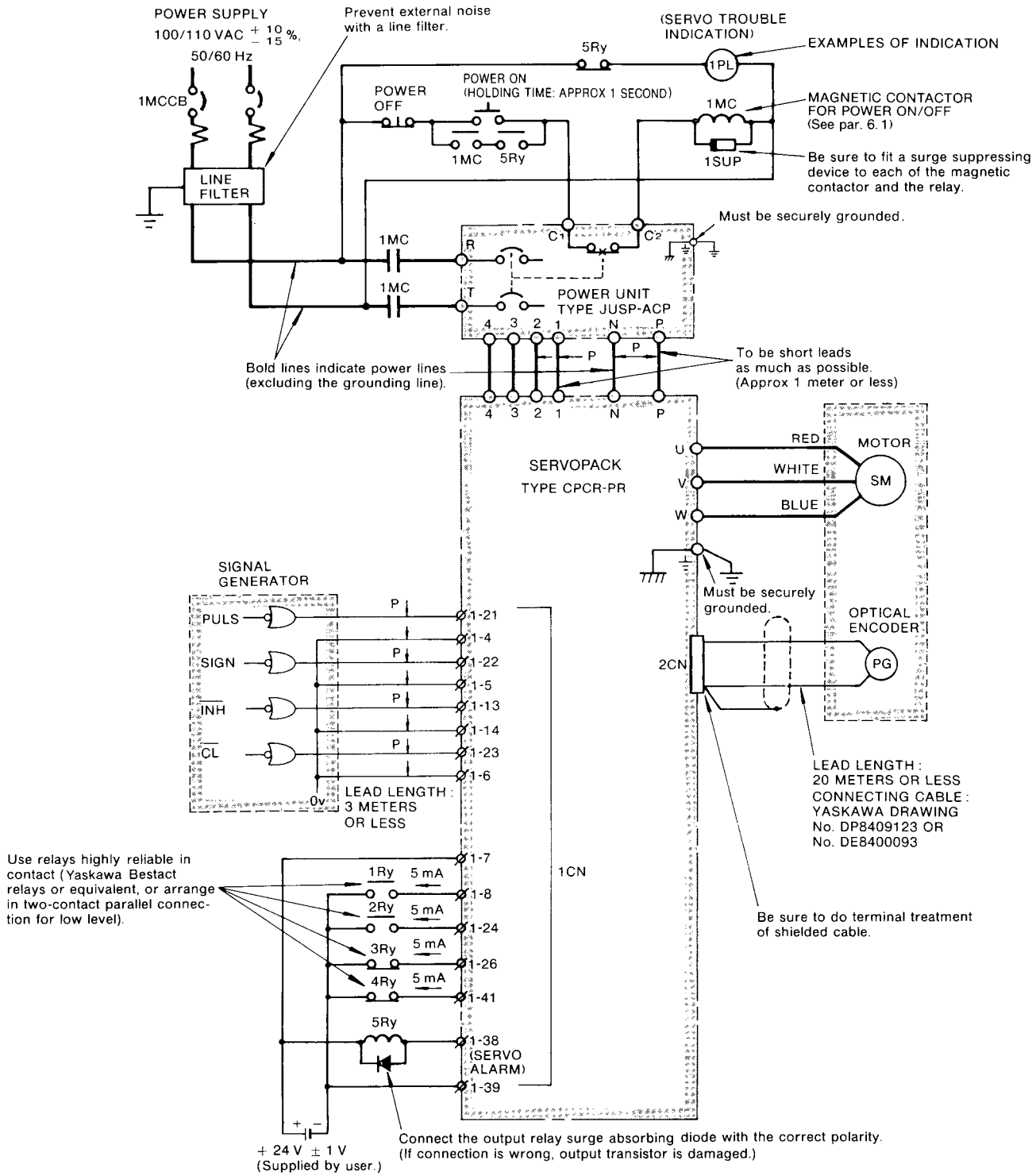


Fig. 6.26 Example of Connection Diagram of SERVOPACK with a SERVOMOTOR and Peripherals

6.8.2 Multi-axis Drives

. Type CACR-SR

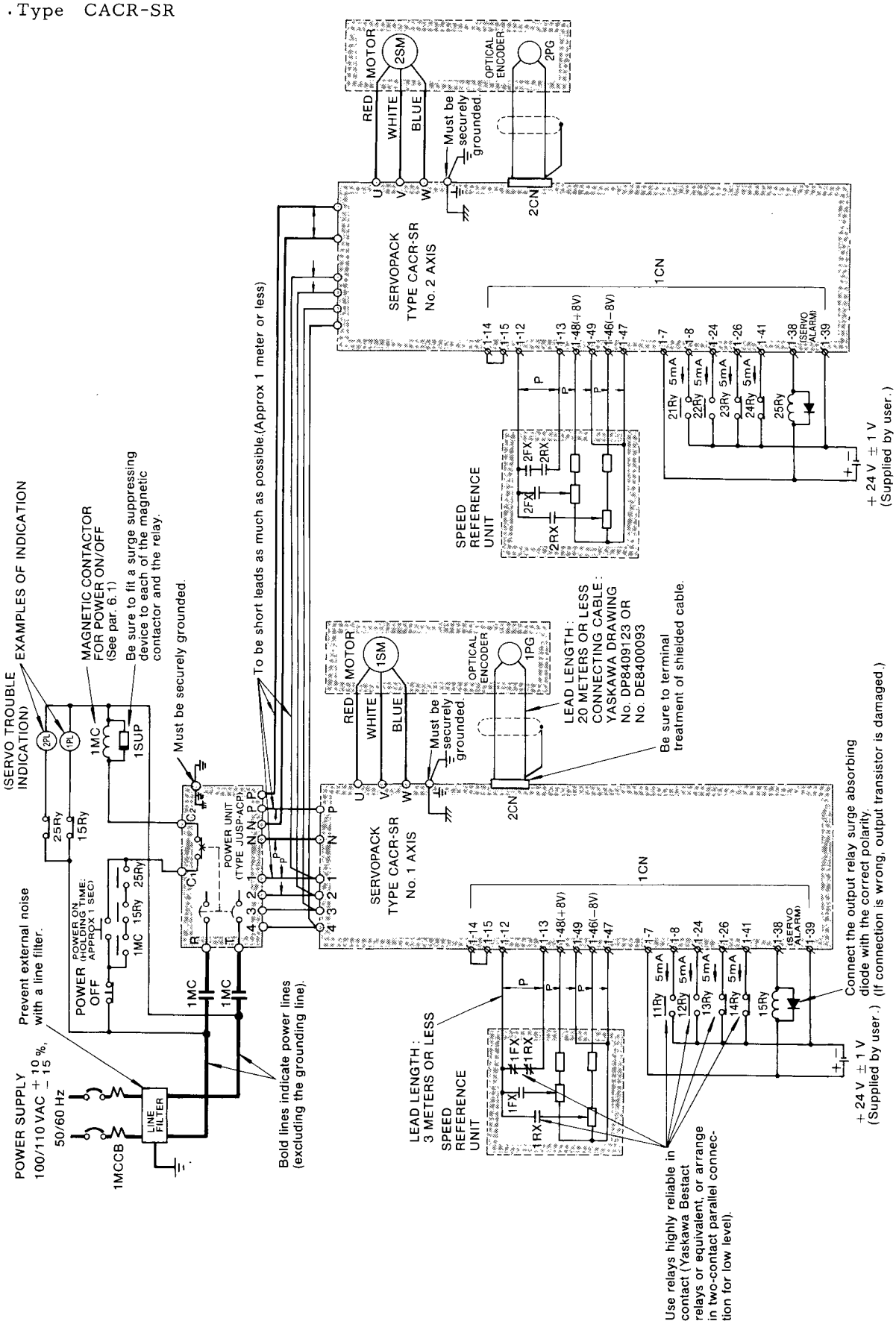


Fig. 6.27 Example of Connection Diagram using Two SERVOPACKS (2-Axis), Type CACR-SR

·Type CACR-PR

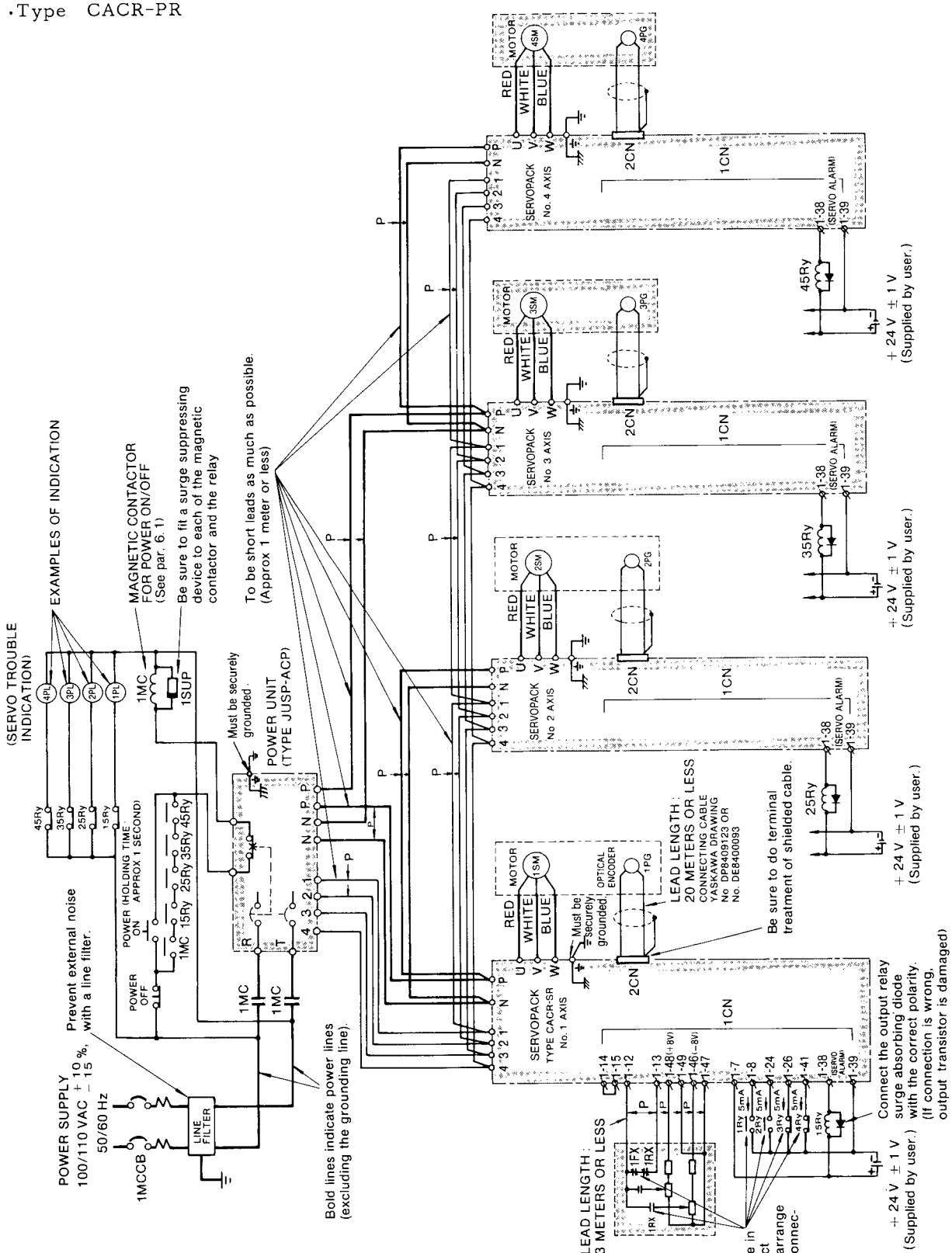


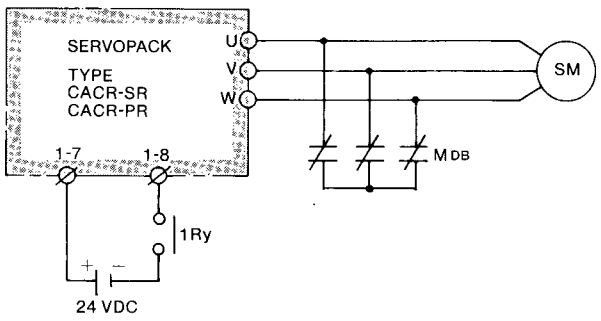
Fig. 6.28 Example of Connection Diagram using Four SERVOPACKS (4-Axis), Type CACR-SR

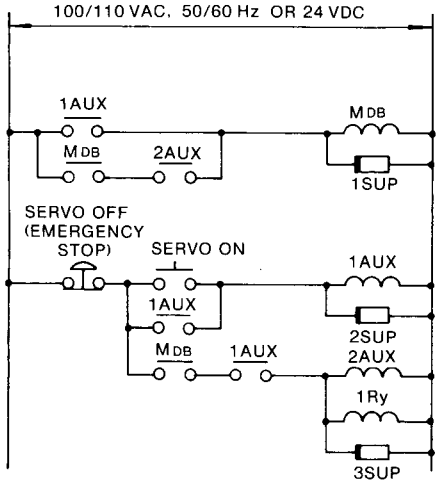
6.9 APPLICATION

6.9.1 Emergency Stop Dynamic Braking (DB) Circuit (For Types CACR-SR and -PR)

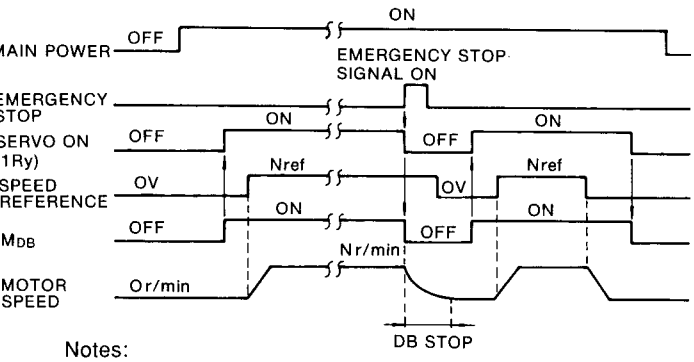
When an external DB circuit for emergency stop is used, make and break the DB circuit in the sequence shown below.

(1) DB circuit and input timing (Fig. 6.27)





1 SUP TO 3 SUP: Surge absorber CR 50500 BA or equivalent (made by Okaya Electric Industries CO., Ltd.)
MDB: Magnetic contactor
1 AUX, 2 AUX: Auxirialy relay MY-4Z or equivalent (made by Tateishi Electronics Co.)
1 Ry: Servo ON reference relay MY-4Z or equivalent (made by Tateishi Electronics Co.)



Notes:
1. MDB OFF: break state, MDB ON: make state
2. Arrows ↑↓ show delay time greater than the operating time of one relay.
3. Although the emergency stop signal is indicated by pulses, it is the same as a status signal (solid line).
4. Before restarting (Servo ON), set the speed reference once to 0V (for type PR) or stop the reference pulse and turn on $\overline{CL}$ to clear the internal counter.

Fig. 6.29

· Operation at emergecy stop

Emergency stop ON
↓
1AUX OFF
↓
1Ry, 2AUX OFF (Servo OFF)
↓
MDB OFF (Break)
↓
DB stop

· Operation at restarting

Emergency stop OFF
↓
Restart (Servo ON SW ON)
↓
1AUX ON
↓
MDB ON (Make)
↓
1Ry, 2AUX ON (Servo ON)
↓
Preparation completion for operation

(2) DB Resistor

Depending on the motor speed, select the standard value shown in **Table 6.13.**

Table 6.13 DB Resistor for AC SERVOMOTOR

Motor Type USACEM-	DB Resistance	MDB
A5AA 01AA 02AA 03AA 05AA	DB resistor is not required for speed from 0 to 3000r/min.	Yaskawa RA-6E2 (3NO 3NC) or equivalent

Note: If DB is used for speed of 3000r/min or more, contact Yaskawa representative.

6.9.2 Connection for Reverse Motor Running (For Type CACR-SR)

If the machine construction requires that the normal forward reference is used for reverse motor running and the normal reverse reference for forward running, the following connection should be provided. The phase (PAO, PBO) of PG output for this connection is shown below.

(1) Lead change

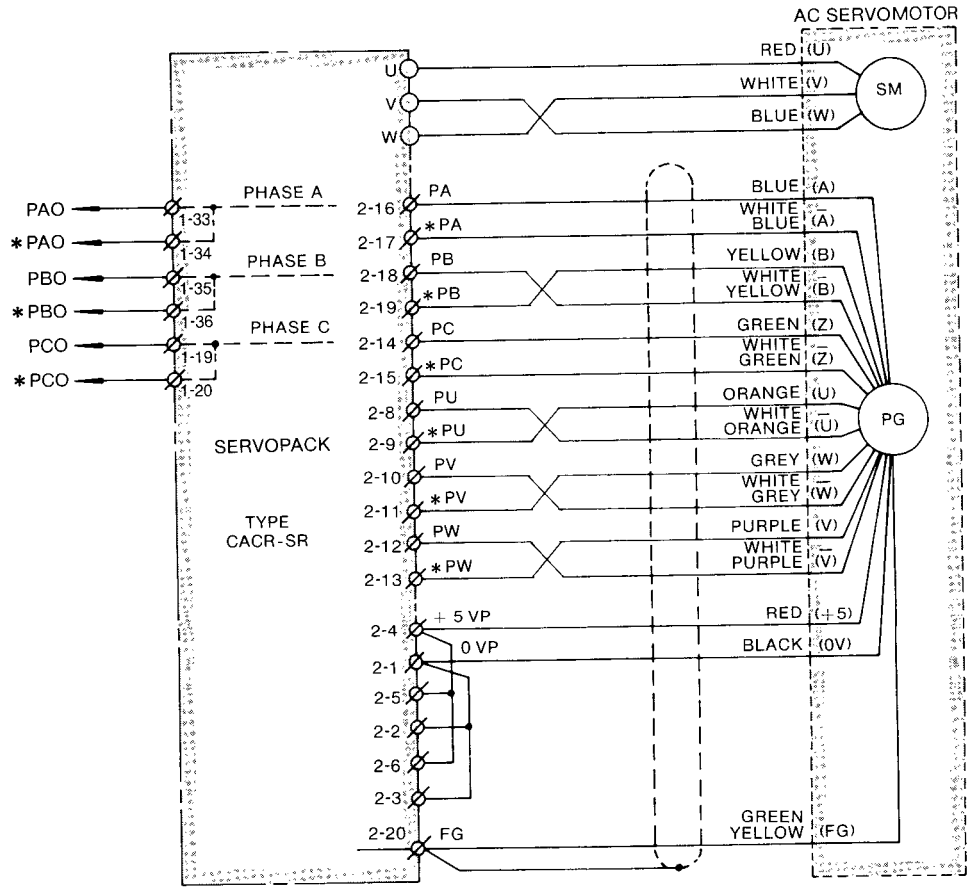
Motor Lead	Optical Encoder Lead
V ⟷ W	PU ⟷ *PU
	PV ⟷ *PW
	PW ⟷ *PV
	PB ⟷ *PB

⇩

PG Output Phase

Reverse Motor Running (PBO Ahead)	Forward Motor Running (PAO Ahead)
PAO 	PAO 
PBO 	PBO 

(2) Typical Connection Example (Fig. 6.30)



Notes:
1. Signal PCO is synchronized with PAO.
2. This connection does not apply to type CACR-PR.

Fig. 6.30 Typical Connection Example

6.9.3 Tachometer Connection

When a tachometer is connected to f/V output, make the connection as shown in **Fig. 6.31**, using a DC ammeter of ±1 mA(both swing).

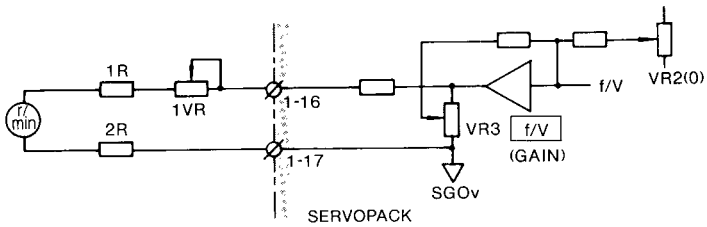


Fig. 6. 31 Tachometer Connection

· Instrument: ±1 mA(both swing) ammeter. Use ammeter of DCF-6 or DCF-12N by Toyo Instrument or equivalent.

f/V output in Servopack is set at 1V/1000r/min Using resistances 1R and 2R and a potentiometer 1VR, set the maximum speed per full scale. (Select 1R=2R; 1VR is for fine adjustment.)

7. INSTALLATION AND WIRING

7.1 RECEIVING

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

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

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

7.2 INSTALLATION

7.2.1 SERVOMOTOR

AC Servomotor can be installed either horizontally or vertically.

(1) Before mounting

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

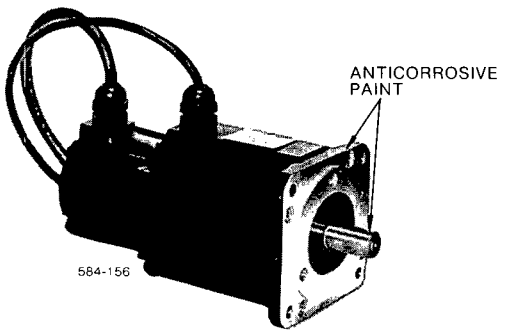


Fig. 7.1 Anticorrosive Paint to be Removed

(2) Location

Use the motor under the following conditions.

- Indoors
- Free from corrosive and/or explosive gases or liquids
- Ambient temperature: -10°C to +40°C
- Clean and dry
- Accessible for inspection and cleaning

If the AC servomotor is subject to excessive water or oil droplets, protect the motor with a cover. The motor can withstand a small amount of splashed water or oil (IP 44 structure).

(3) Environmental conditions

Ambient Temperature: 0°C to +40°C

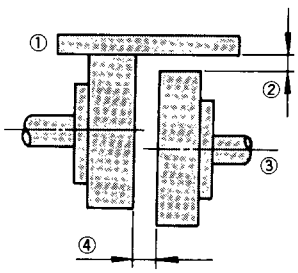
Storage Temperature: -20°C to +60°C

Humidity: 20% to 80% RH

(4) Load coupling

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

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



① Straightedge

② Measure the gap between the straightedge and coupling halves at four equidistant points of the coupling. The each reading should not exceed 0.05 mm.

③ Align the shafts.

④ Measure the gap between the coupling faces at four equidistant points around the coupling rim with thickness gage. The maximum variation between any two readings should not exceed 0.05 mm.

Fig. 7.2 Alignment of Coupling

(5) Allowable bearing load

Avoid both thrust and radial loads to the motor shaft. If unavoidable, never exceed the values in Table 4.1 on page 9.

7.2.2 SERVOPACK and Power Unit

(1) Installation

The Servopack and power unit can be mounted on the base or in a panel.

As standard, they are of base mounted construction. To mount in a panel, relocate the base support as shown in **Figs. 7.3** and **7.4**.

Make sure to use the base-support mounting screws attached to the units.

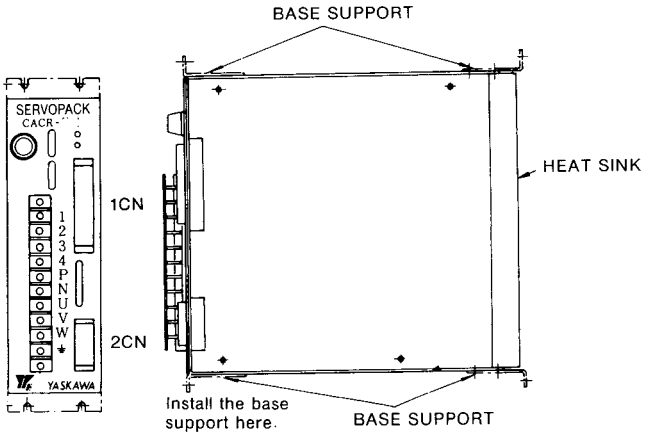


Fig. 7.3 SERVOPACK

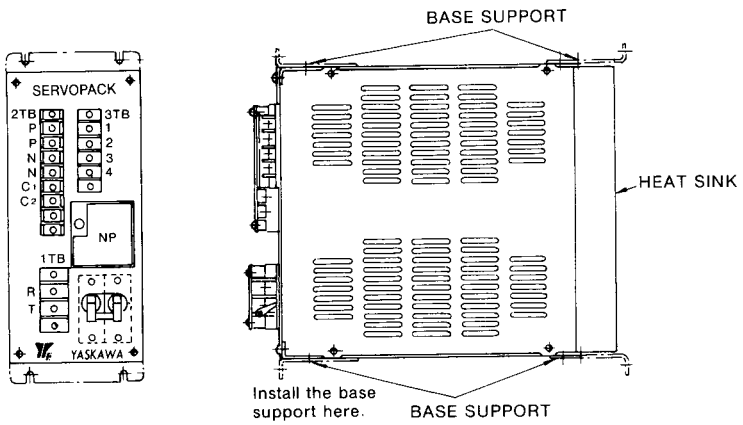


Fig. 7.4 Power Unit

(2) Location

- When installed in a panel:

  Keep the temperature around Servopack at 60°C or below. (**Fig. 7.5**)

- When installed near a heat source:

  Keep the temperature around power unit and Servopack below 60°C.(**Fig. 7.6**)

- If subjected to vibration:

  Mount the unit on shock absorbing material.

- If corrosive gases present:

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

- Unfavorable atmospheric conditions:

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

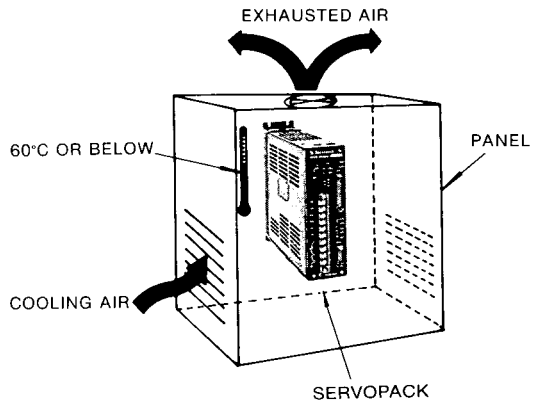


Fig. 7.5 Typical Layout for Panel Mounting

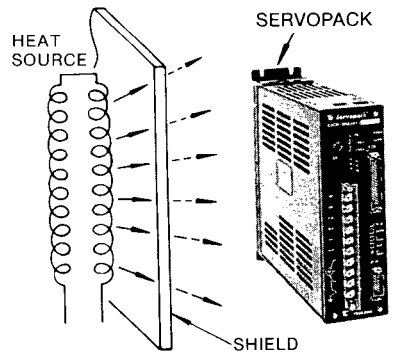


Fig. 7.6 Protection against Heat Radiation

(3) Mounting

- Direction

  Mount the unit vertically on the wall using the mounting holes (4) on the base plate, with main terminals at the bottom. (**Fig. 7.7**)

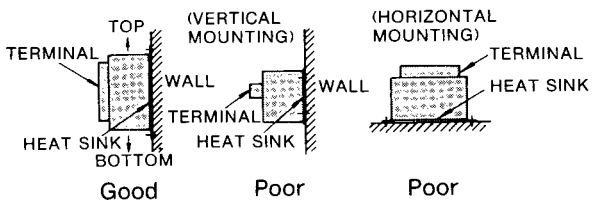


Fig. 7.7 Mounting Direction of SERVOPACK

7.3 WIRING

7.3.1 Rated Current and Cable Size

Tables 7.1 and 7.2 show external terminals, rated current, and cable size of the power unit and Servopack, respectively. Select the type and size of cables to meet the ambient condition and the current capacity. The cable size is determined 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 and Recommended Cable Size of Power Unit

External Terminal		Type JUSP- / Symbol	Rated Current			Cable Size mm²		
			ACP07AA	ACP15AA	ACP20AA	ACP07AA	ACP15AA	ACP20AA
ON Line	Main Circuit Power Input	R, T	15A	30A	40A	HIV 2.0 or more	HIV 5.5 or larger	HIV 8.0 or larger
	Main Circuit DC Power Output	P, N	7ADC	15ADC	20ADC		HIV 2.0 or larger	HIV 3.5 or larger
	24V Control Power Output	1, 2	7.5ADC			HIV 2.0 or larger		
	PR Signal Output	3	50mADC max			PVC 1.25 or larger		
	0V Signal Output	4						
Off Line	Overcurrent Detection Circuit	C_1, C_2	220VAC 1A*					
	Ground	⏚	—			HIV 2.0 or larger		

*Asterisked value shows allowable conduction current value.

Table 7.2 Rated Current and Recommended Cable Size of SERVOPACK

External Terminal		Type CACR- / Symbol	Rated Current					Cable Size mm²				
			SR PR -A5A	SR PR -01A	SR PR -02A	SR PR -03A	SR PR -05A	SR PR -A5A	SR PR -01A	SR PR -02A	SR PR -03A	SR PR -05A
On Line	Motor Connection	U,V,W	1.4Ao-p	2.2Ao-p	4.1Ao-p	6.0Ao-p	7.5Ao-p	HIV2.0 or larger				
	Main Circuit DC Power Input	P,N	0.7ADC	1.3ADC	2.6ADC	3.9ADC	6.4ADC					
	24 V Control Power Input	1,2	1.8ADC									
	PR Signal Input	3	100mADC					PVC 1.25 or larger				
	0V Signal Input	4										
Off Line	Control I/O Signal Connector	1CN	100mADC max					• Two-core twisted shielded cable. • Core must be 0.2mm² or larger. • Tin-plated soft-copper twisted cable. • Finished cable dimension: 16 dia or less for 1CN, 11 dia or less for 2 CN.				
	PG Signal Connector	2CN	100mADC max (500mA for power line only)									
	Ground	⏚	—					HIV 2.0 or larger				

Table 7.3 Cable

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

Notes:
1. For main circuits, use cables of 600V 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℃ to 60℃), use heat-resistance 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 for wiring.

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

Cable length is a maximum of 3 m for reference input lines and a maximum of 20 m for PG feedback lines. Use the shortest possible length.

(2) For DC power line, use cables larger than $2mm^2$. The cable should be as short as possible.

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

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

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

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

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

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

7.3.3 Power Loss

The power loss of power unit and Servopack is shown in **Table 7.4.**

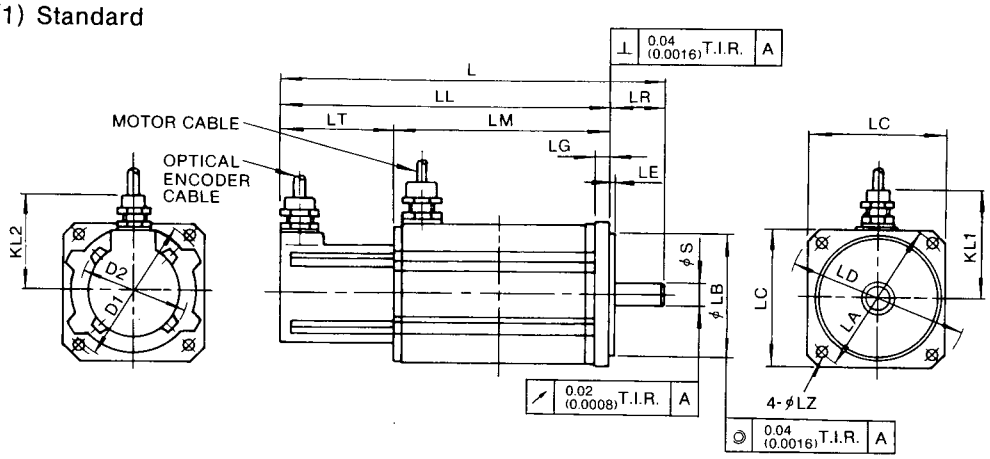
Table 7.4 Power Loss at Rated Output

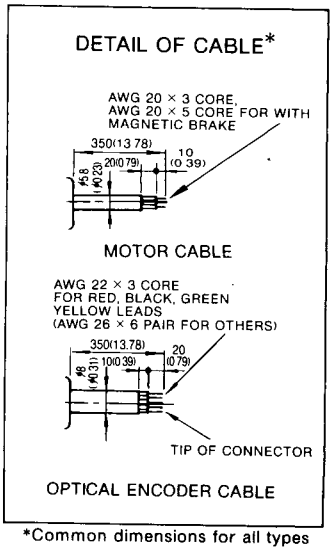
	Type	Rated Output Current A (RMS)	Power Loss		
			Main Circuit W (HP×3 [3])	Control Circuit W (HP×3 [3])	Total W (HP×3 [3])
Power Unit	JUSP-ACP07A	7ADC	20 (27)	30 (40)	50 (67)
	JUSP-ACP15A	15ADC	40 (54)		70 (94)
	JUSP-ACP20A	20ADC	50 (67)		80 (107)
SERVOPACK	CACR-$^{SR}_{PR}$ A5A	1.0 (1.4 Ao-p)	10 (14)	50 (67)	60 (81)
	CACR-$^{SR}_{PR}$ 01A	1.6 (2.2 Ao-p)			
	CACR-$^{SR}_{PR}$ 02A	2.9 (4.1 Ao-p)			
	CACR-$^{SR}_{PR}$ 03A	4.2 (6.0 Ao-p)	20 (27)		70 (94)
	CACR-$^{SR}_{PR}$ 05A	5.3 (7.5 Ao-p)	30 (40)		80 (107)

8. DIMENSIONS in mm (inches)

8.1 SERVOMOTOR

(1) Standard



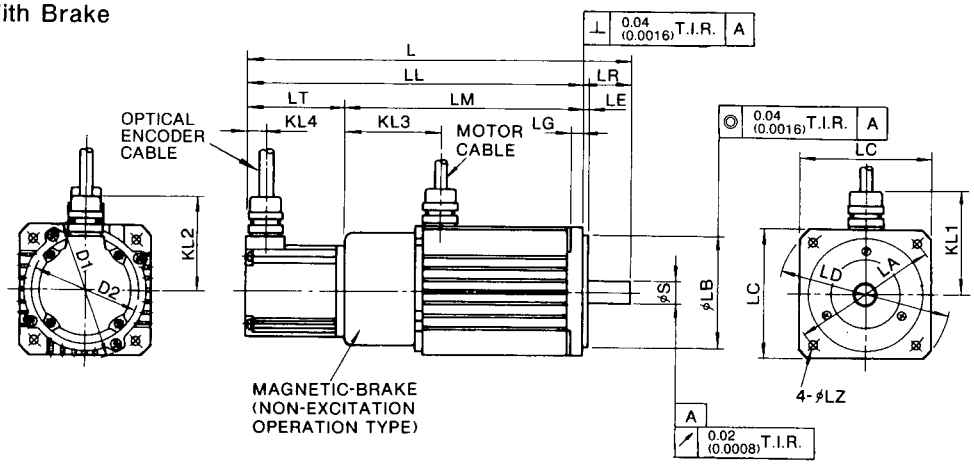


*Common dimensions for all types

Type USACEM-	D1	D2	KL1	KL2	L	LL	LM	LR	LT	S	Flange Surface LA	LB	LC	LE	LG	LD	LZ	Approx Mass kg (lb)
A5AA2	68 (2.677)	67 (2.638)	56 (2.205)	58 (2.283)	163 (6.417)	133 (5.236)	72 (2.834)	30 (1.181)	61 (2.402)	$8\ ^{0}_{-0.009}$ ($0.315\ ^{0}_{-0.00035}$)	80 (3.15)	$50\ ^{0}_{-0.025}$ ($1.969\ ^{0}_{-0.00098}$)	65 (2.560)	3 (0.118)	6 (0.236)	90 (3.543)	5 (0.197)	1.2 (2.65)
01AA2					181 (7.126)	151 (5.945)	90 (3.543)											1.5 (3.31)
02AA2	88 (3.465)		65 (2.559)		195 (7.677)	165 (6.496)	104 (4.094)			$14\ ^{0}_{-0.011}$ ($0.551\ ^{0}_{-0.00043}$)	90 (3.543)	$70\ ^{0}_{-0.030}$ ($2.756\ ^{0}_{-0.00118}$)	80 (3.15)		8 (0.315)	105 (4.134)	6 (0.236)	2.4 (5.29)
03AA2					217 (8.543)	187 (7.362)	126 (4.960)											3.0 (6.61)
05AA2	136 (5.354)		78 (3.071)		245.5 (9.666)	205.5 (8.091)	144.5 (5.689)	40 (1.575)		$16\ ^{0}_{-0.011}$ ($0.630\ ^{0}_{-0.00043}$)	130 (5.118)	$110\ ^{0}_{-0.035}$ ($4.331\ ^{0}_{-0.00138}$)	120 (4.724)		10 (0.394)	155 (6.102)	9 (0.354)	5.5 (12.13)

Note: Shaft extension with keyway is the same dimensions as with brake, shaft extension with keyway shown (3) in par. 8.1.

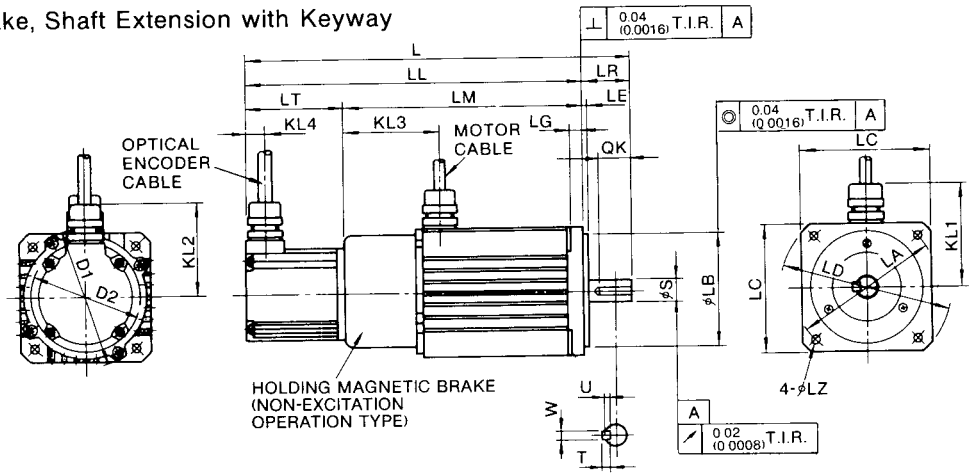
(2) With Brake



Type USACEM-	L	LL	LM	LR	LT	D1	D2	KL1	KL2	KL3	KL4	S	Flange Surface LA	LB	LC	LE	LG	LD	LZ	Approx Mass kg (lb)
A5AA20B	200.5 (7.894)	170.5 (6.69)	109.5 (4.311)	30 (1.181)	61 (2.402)	68 (2.677)	67 (2.638)	56 (2.205)	58 (2.283)	55 (2.165)	12 (0.47)	$8\ ^{0}_{-0.009}$ ($0.315\ ^{0}_{-0.00035}$)	80 (3.15)	$50\ ^{0}_{-0.025}$ ($1.969\ ^{0}_{-0.00098}$)	65 (2.560)	3 (0.118)	6 (0.236)	90 (3.543)	5 5 (0.197)	1.6 (3.53)
01AA20B	218.5 (8.602)	188.5 (7.421)	127.5 (5.019)																	1.9 (4.19)
02AA20B	241 (9.488)	211 (8.307)	150 (5.905)			88 (3.465)		65 (2.559)		61.5 (2.421)		$14\ ^{0}_{-0.011}$ ($0.551\ ^{0}_{-0.00043}$)	90 (3.543)	$70\ ^{0}_{-0.030}$ ($2.756\ ^{0}_{-0.00118}$)	80 (3.15)		8 (0.315)	105 (4.134)	6 (0.236)	3.2 (7.05)
03AA20B	263 (10.354)	233 (9.173)	172 (6.771)																	3.8 (8.38)
05AA02B	287 (11.299)	247 (9.724)	186 (7.322)	40 (1.575)		136 (5.354)		78 (0.709)		58.5 (2.303)		$16\ ^{0}_{-0.011}$ ($0.630\ ^{0}_{-0.00043}$)	130 (5.118)	$110\ ^{0}_{-0.035}$ ($4.331\ ^{0}_{-0.00138}$)	120 (4.724)		10 (0.394)	155 (6.102)	9 (0.354)	7.3 (16.1)

Note: Brake power specifications:
- Input – 100/200 VAC
- Output – 80 VDC

(3) With Brake, Shaft Extension with Keyway

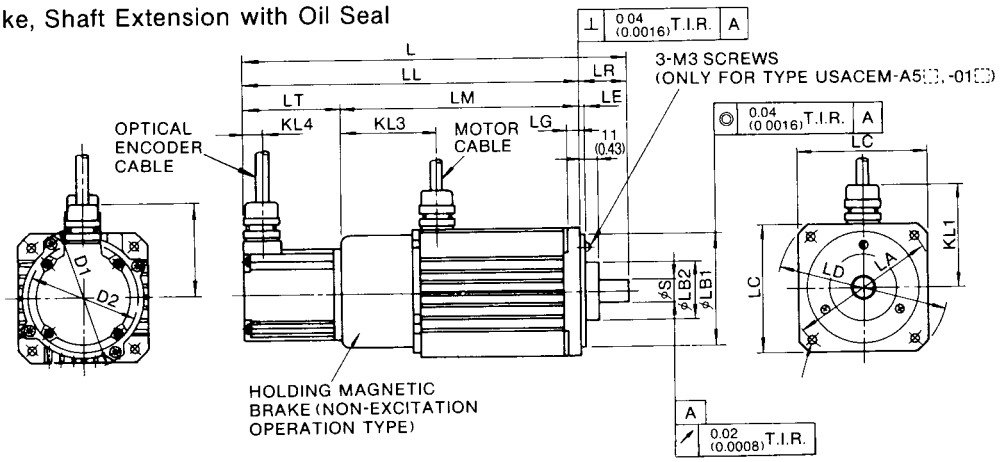


Type USACEM-	L	LL	LM	LR	LT	D1	D2	KL1	KL2	KL3	KL4	Shaft Extension S	Shaft Extension OK	Shaft Extension T	Shaft Extension U	Shaft Extension W	Flange Surface LA	Flange Surface LB	Flange Surface LC	Flange Surface LE	Flange Surface LG	Flange Surface LD	Flange Surface LZ	Approx Mass kg (lb)
A5AA2KB	200.5 (7.894)	170.5 (6.713)	109.5 (4.311)	30 (1.181)	61 (2.402)	68 (2.677)	67 (2.638)	56 (2.205)	58 (2.283)	55 (2.165)	12 (0.47)	$8\ ^{0}_{-0.009}$ ($0.315\ ^{0}_{-0.00035}$)	20 (0.787)	3 (0.118)	1.8 (0.071)	3 (0.118)	80 (3.15)	$50\ ^{0}_{-0.025}$ ($1.969\ ^{0}_{-0.0010}$)	65 (2.560)	3 (0.118)	6 (0.236)	90 (3.543)	5 (0.197)	1.6 (3.53)
01AA2KB	218.5 (8.602)	188.5 (7.421)	127.5 (5.019)																					1.9 (4.19)
02AA2KB	241 (9.488)	211 (8.307)	150 (5.905)			88 (3.465)		65 (2.559)		61.5 (2.421)		$14\ ^{0}_{-0.011}$ ($0.551\ ^{0}_{-0.0004}$)		5 (0.197)	3 (0.118)	5 (0.197)	90 (3.543)	$70\ ^{0}_{-0.030}$ ($2.756\ ^{0}_{-0.0012}$)	80 (3.15)		8 (0.315)	105 (4.134)	6 (0.236)	3.2 (7.05)
03AA2KB	263 (10.354)	233 (9.173)	172 (6.771)																					3.8 (8.30)
05AA2KB	287 (11.299)	247 (9.724)	186 (7.322)	40 (1.575)		136 (5.354)		78 (0.709)		58.5 (2.303)		$16\ ^{0}_{-0.011}$ ($0.630\ ^{0}_{-0.0004}$)	32 (1.260)				130 (5.118)	$110\ ^{0}_{-0.035}$ ($4.331\ ^{0}_{-0.00138}$)	120 (4.724)		10 (0.394)	155 (6.102)	9 (0.354)	7.3 (16.1)

Notes:

1. Dimensions of the shaft extension keyway is based on JIS (Japanese Industrial Standard) B 1301 "Sunk keys and Their Corresponding keyways (Close keys)."
2. Brake power specifications:
   - Input – 100/200VAC
   - Output – 80VDC

(4) With Brake, Shaft Extension with Oil Seal



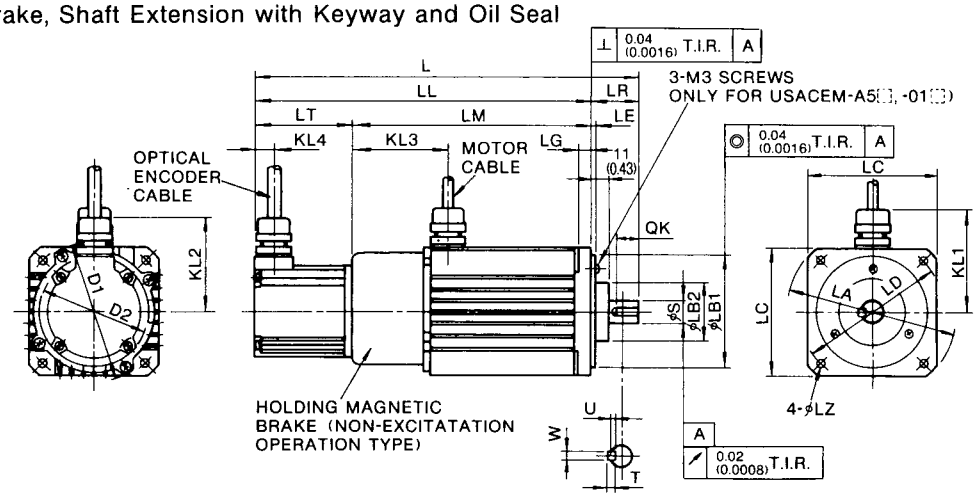
Type USACEM-	L	LL	LM	LR	LT	D1	D2	KL1	KL2	KL3	KL4	S	Oil Seal* Type	Flange Surface LA	Flange Surface LB1	Flange Surface LB2	Flange Surface LC	Flange Surface LE	Flange Surface LG	Flange Surface LD	Flange Surface LZ	Approx Mass kg (lb)
A5AA2SB	200.5 (7.894)	170.5 (6.713)	109.5 (4.311)	30 (1.181)	61 (2.402)	68 (2.677)	67 (2.638)	56 (2.205)	58 (2.283)	55 (2.165)	12 (0.47)	$8\ ^{0}_{-0.009}$ ($0.315\ ^{0}_{-0.00035}$)	SB08187	80 (3.15)	$50\ ^{0}_{-0.025}$ ($1.969\ ^{0}_{-0.0010}$)	26 (1.024)	65 (2.560)	3 (0.118)	6 (0.236)	90 (3.543)	5 (0.197)	1.6 (3.53)
01AA2SB	218.5 (8.602)	188.5 (7.421)	127.5 (5.019)																			1.9 (4.19)
02AA2SB	241 (9.488)	211 (8.307)	150 (5.905)			88 (3.465)		65 (2.559)		61.5 (2.421)		$14\ ^{0}_{-0.011}$ ($0.551\ ^{0}_{-0.0004}$)	SB14287	90 (3.543)	$70\ ^{0}_{-0.030}$ ($2.756\ ^{0}_{-0.0012}$)	36 (1.417)	80 (3.15)		8 (0.315)	105 (4.134)	6 (0.236)	3.2 (7.05)
03AA2SB	263 (10.354)	233 (9.173)	172 (6.771)																			3.8 (8.30)
05AA2SB	287 (11.299)	247 (9.724)	186 (7.322)	40 (1.575)		136 (5.354)		78 (0.709)		58.5 (2.303)		$16\ ^{0}_{-0.011}$ ($0.630\ ^{0}_{-0.0004}$)	SB16307	130 (5.118)	$110\ ^{0}_{-0.035}$ ($4.331\ ^{0}_{-0.00138}$)	50 (1.969)	120 (4.724)		10 (0.394)	155 (6.102)	9 (0.354)	7.3 (16.1)

*Made by Nippon Oil Seal Industry Co., Ltd.

Notes:

1. Oil sealed motors should be operated under the following conditions:
   - Optimum oil level should be below oil seal lip.
   - Oil seal should not be immerged in oil.
2. Brake power specifications:
   - Input – 100/200VAC
   - Output – 80VDC

(5) With Brake, Shaft Extension with Keyway and Oil Seal



Type USACEM-	L	LL	LM	LR	LT	D1	D2	KL1	KL2	KL3	KL4	Shaft Extension S	Shaft Extension QK	Shaft Extension T	Shaft Extension U	Shaft Extension W	Oil Seal* Type	Flange Surface LA	Flange Surface LB1	Flange Surface LB2	Flange Surface LC	Flange Surface LE	Flange Surface LG	Flange Surface LD	Flange Surface LZ	Approx Mass kg (lb)
A5AA2TB	200.5 (7.894)	170.5 (6.713)	109.5 (4.311)	30 (1.181)	61 (2.402)	68 (2.677)	67 (2.638)	56 (2.205)	58 (2.283)	55 (2.165)	12 (0.47)	$8^{\ 0}_{-0.009}$ ($0.315^{\ 0}_{-0.00035}$)	14 (0.551)	3 (0.118)	1.8 (0.071)	3 (0.118)	SB-08187	80 (3.15)	$50^{\ 0}_{-0.025}$ ($1.969^{\ 0}_{-0.0010}$)	26 (1.024)	65 (2.560)	3 (0.118)	6 (0.236)	90 (3.543)	5 (0.197)	1.6 (3.53)
01AA2TB	218.5 (8.602)	188.5 (7.421)	127.5 (5.019)																							1.9 (4.19)
02AA2TB	241 (9.488)	211 (8.307)	150 (5.905)			88 (3.465)		65 (2.559)		61.5 (2.421)		$14^{\ 0}_{-0.011}$ ($0.551^{\ 0}_{-0.0004}$)		5 (0.197)	3 (0.118)	5 (0.197)	SB-14287	90 (3.543)	$70^{\ 0}_{-0.030}$ ($2.756^{\ 0}_{-0.0012}$)	36 (1.417)	80 (3.15)		8 (0.315)	105 (4.134)	6 (0.236)	3.2 (7.05)
03AA2TB	263 (10.354)	233 (9.173)	172 (6.771)																							3.8 (8.38)
05AA2TB	287 (11.299)	247 (9.724)	186 (7.322)	40 (1.575)		136 (5.354)		78 (0.709)		58.5 (2.303)		$16^{\ 0}_{-0.011}$ ($0.630^{\ 0}_{-0.0004}$)	25 (0.984)				SB-16307	130 (5.118)	$110^{\ 0}_{-0.035}$ ($4.331^{\ 0}_{-0.00138}$)	50 (1.969)	120 (4.724)		10 (0.394)	155 (6.102)	9 (0.354)	7.3 (16.1)

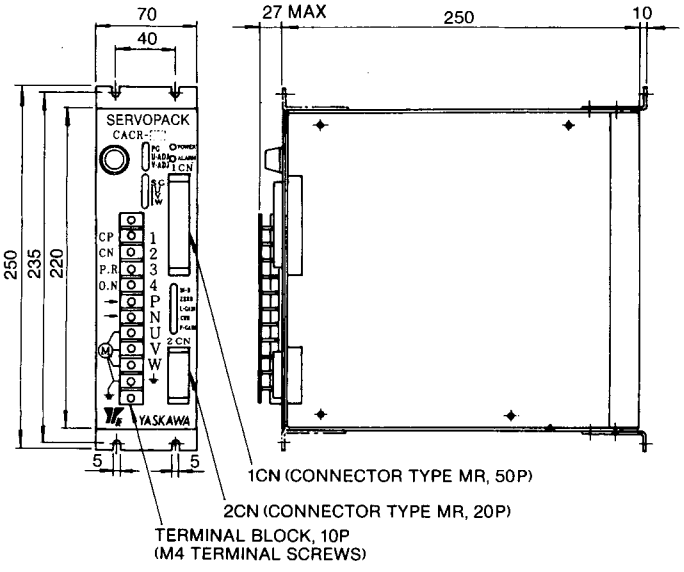
*Made by Nippon Oil Seal Industry Col., Ltd.

Notes:

1. Dimensions of the shaft extension keyway is based on JIS (Japanese Industrial Standard) B 1301 "Sunk keys and Thier Corresponding keyways (Close keys)."
2. Oil sealed motors should be operated under the following conditions:
   - Optimum oil level should be below oil seal lip.
   - Oil seal should not be immerged in oil.
3. Brake power specifications:
   - Input – 100/200VAC
   - Output – 80VDC

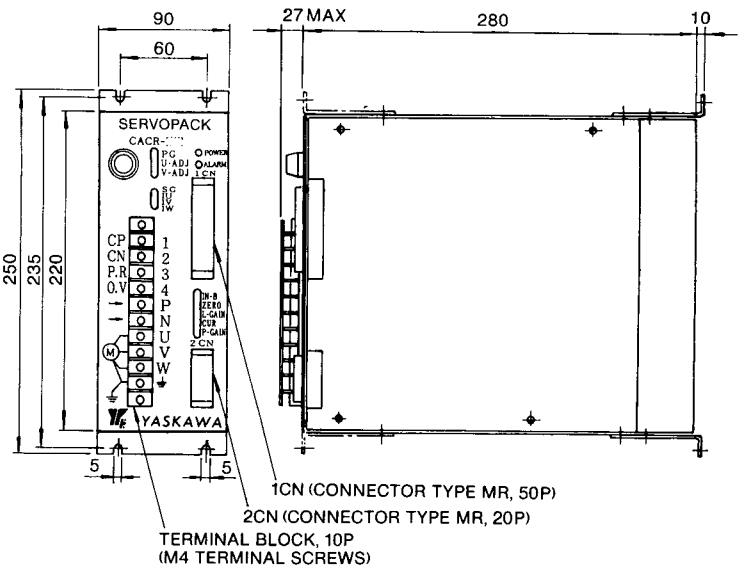
8.2 *Servopack*

- Types CACR-SRA5AA, -SR01AA, -SR02AA
  Types CACR-PRA5AA, -PR01AA, -PR02AA



Approx Mass : 3kg

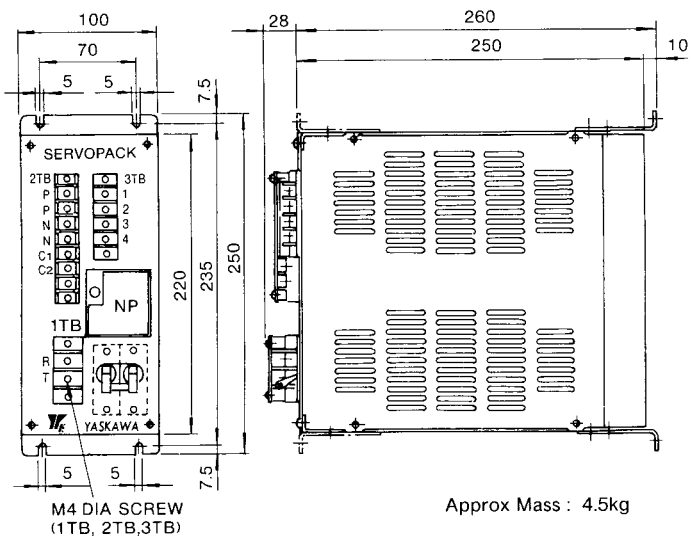
- Types CACR-SR03AA, -SR05AA
  Types CACR-PR03AA, -PR05AA



Approx Mass : 4kg

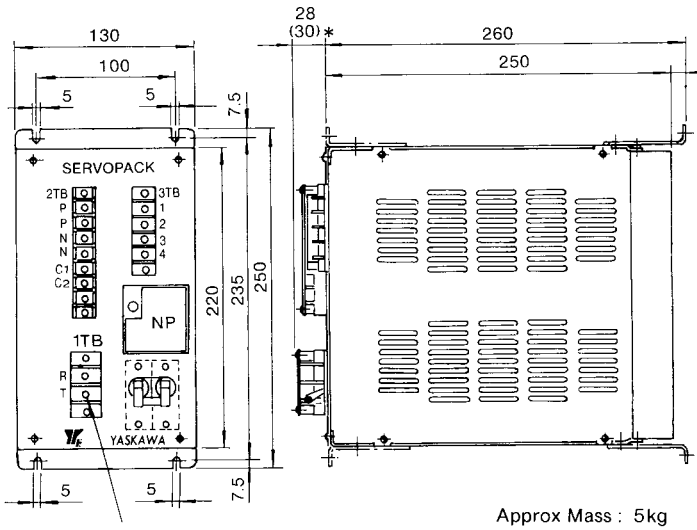
8.3 POWER UNIT

· Type JUSP-ACP07AA



Approx Mass : 4.5kg

· Types JUSP-ACP15AA, -ACP20AA

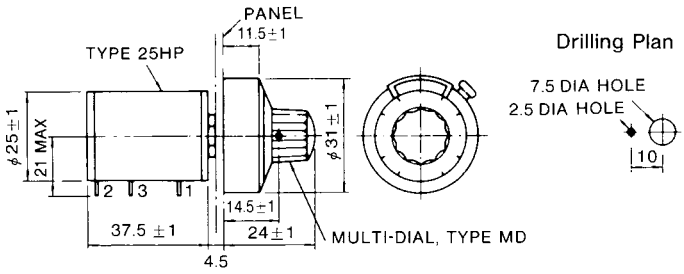


Approx Mass : 5kg

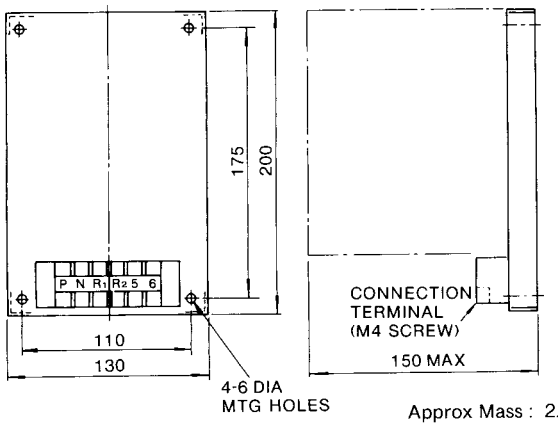
*For type JUSP-ACP20AA

8.4 PERIPHERAL EQUIPMENT

(a) Variable Resistor for Speed Setting
(For Servopack Type CACR-SR)



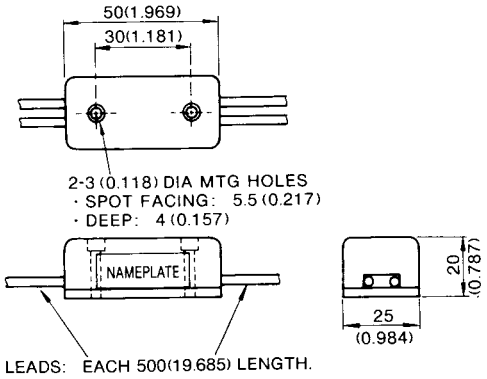
(b) Regenerative Processing Unit Type JUSP-RG001
(Optional for Power Unit Types JUSP-ACP07AA to ACP20AA)



Approx Mass : 2.5kg

(c) Brake Power Terminal (SEL-PACK)

· Input 100VAC, 90VDC (DP8420002-2)
· Input 200VAC, 90VDC (DP8420002-1)



Note: Close or open the brake power supply circuit on DC side. If AC side is operated, brake time becomes extended.

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 11. Inspection and Maintenance.

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

9.1.2 SERVOPACK and Power Unit

- Setting switches are correctly set to satisfy the specifications for the applicable servomotor and optical encoder.
- Connection and wiring leads are firmly connected to terminals or inserted into the connectors.
- The Power supply is turned off if servo alarm outputs.
- Voltage supplied to the power unit is 100/110V $^{+10\%}_{-15\%}$.

  (If a high voltage line is used, the voltage should be dropped to 100 V through a power transformer.)
- For Servopack type CACR-SR, the speed reference should be 0 V (speed reference circuit is short-circuited.)
- For type CACR-PR, no reference pulse is input.

If any deviations of the items above are found, correct them immediately.

9.2 TEST RUN PROCEDURES

9.2.1 Preparation of Operation

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

(1) Power ON

- After checking items in section 9.1, turn on the power supply. When the power on sequence is correct, according to section 6.1, the power is turned on by pressing the POWER pushbutton for approximately 1 second.
- When the power is correctly supplied, the following green [LED]s light

  Power unit: [MP]

  Servopack: [POWER]
- When a Servo ON signal is input (contact is on), the power circuit in the Servopack operates and the motor is ready to run.

9.2.2 Operation

(1) For type CACR-SR

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**).

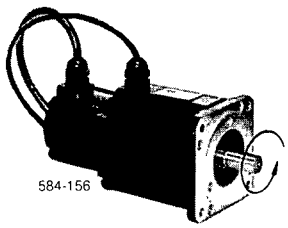


Fig. 9.1 Motor Forward Running

(2) For type CACR-PR

Operation is possible only when Servo ON signal is on.

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

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

  The forward rotation of motor is counterclockwise viewed from drive end (output shaft) See Fig. 9.1.
- The motor is stopped by cutting the reference pulse.

9.2.3 Inspection during Test Run

The following items should be checked during the test run.

- Unusual vibration
- Abnormal noise
- Excessive temperature rise

10. ADJUSTMENT

Note that the adjustment differs in types CACR-SR and -PR.

10.1 SERVOPACK TYPE CACR-SR

10.1.1 Settings and Characteristics at the Time of Delivery

(1) Settings at the time of delivery

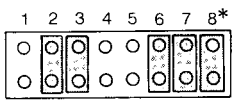
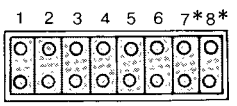
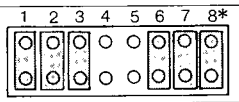
The Servopack has been factory-adjusted as follows:

Table 10.1 Standard Adjustment and Setting Specifications

SERVOPACK Type CACR-	Applicable SERVOMOTOR			SERVOPACK Adjustment		
	Type USACEM-	Optical Encoder p/rev	Rated Current A (RMS)	Speed Setting	Starting Current Setting	PG Frequency Dividing Ratio
SRA5AA2AH	A5AA2	1500	1	3000 r/min at rated speed reference	±5% 3.5Arms	×1
SRA5AA2BH	A5AB2	1000				
SR01AA2AH	01AA2	1500	1.6		±5% 4.9Arms	
SR01AA2BH	01AB2	1000				
SR02AA2AH	02AA2	1500	2.9		±5% 9.2Arms	
SR02AA2BH	02AB2	1000				
SR03AA2AH	03AA2	1500	4.2		±5% 12.7Arms	
SR03AA2BH	03AB2	1000				
SR05AA2AH	05AA2	1500	5.3		±5% 16.3Arms	
SR05AA2BH	05AB2	1000				

Note: At the factory, the SERVOPACKS are set and adjusted as shown in [ ].

Table 10.2 Field-setting Switch Position (SW1 and SW2)

SERVOPACK Type CACR-	SW 1	SW 2
	Motor Characteristics Parameter Setting	Pulse Resolution Setting
	No. of PG Pulses P/R	Pulse Frequency Dividing Ratio
SRA 5 AA 2 AH to SR 05 AA 2 AH	1500	× 1
		
SRA 5 AA 2 BH to SR 05 AA 2 BH	1000	
		

*Spare short-circuit pins are inserted in SW1-⑧, SW1-⑦ and ⑧.

Note: SW1 and SW2 are inside the SERVOPACK. To handle these switches, the side cover must be removed from the controller. To remove the side cover to check and set SW1 and SW2, see 6.7.2 "Operation of Setting Switches."

Table 10.3 Potentiometer Field-set Positions

SERVOPACK Type CACR-	Auxiliary Input Setting	Zero Drift Setting	Speed Loop Gain Setting	Starting Current Setting	Proportional Gain Setting
	IN-B	ZERO	L-GAIN	CUR	P-GAIN
SRA 5 AA	0/10 (min.)	4/10 to 6/10	Approx 1/10	See the column of Starting Current Setting in Table. 10. 1.	Approx 4/10 (2.5/6)
SR 01 AA			Approx 2/10		Approx 3.5/10 (2/6)
SR 02 AA			Approx 4/10		Approx 4/10 (2.5/6)
SR 03 AA			Approx 4/10		Approx 5/10 (3/6)
SR 05 AA			Approx 6/10		Approx 8.5/10 (5/6)

Notes:

1. In the Table, □/□ shows approximate scale of potentiometer.

For example,  indicates 5/10 scale.

2. Besides potentiometers shown in the Table above, PG, U•ADJ and V•ADJ potentiometers are on the SERVOPACK front panel. Do not tamper with these potentiometers except in special cases, since they have been preset at the factory.

(2) Setting at the Time of Delivery

The Servopack has been factory-adjusted as follows:

(a) Speed reference input–servomotor speed ratio (no load) (**Fig. 10.1**).

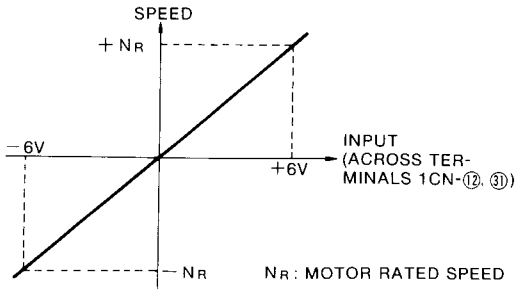


Fig. 10.1 Speed Reference Input–SERVOMOTOR Speed Ratio

Speed Variation (**Fig. 10.2**)

Speed variation ΔN, Δn:

$$\frac{\Delta N}{N_R} \times 100\,\% \leqq 0.1\,\%$$

$$\frac{\Delta n}{N_R} \times 100\,\% \leqq 0.05\,\%$$

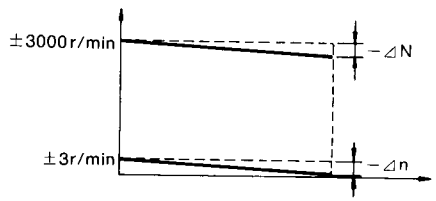


Fig. 10.2 Speed Variation

(c) 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 $J_L = J_M$, are as shown in **Table 10.4** (adjustment level preset at the factory).

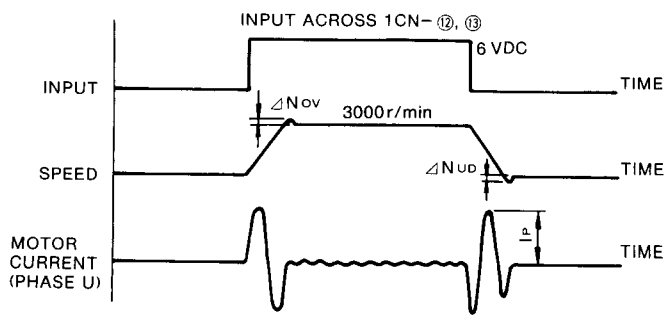


Fig. 10.3 Start–Stop Characteristics

Table 10.4 Overshoot and Undershoot at Step Response

Type CACR-	$\Delta N_{OV}/N_R \times 100$	$\Delta N_{UD}/N_R \times 100$
SRA 5 AA	10 % Max	10 % Max
SR 01 AA		
SR 02 AA	5 % Max	5 % Max
SR 05 AA		

10.1.2 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 10.6**. (Do not tamper with potentiometers.)

10.1.3 Adjustment Procedures

Table 10.6 shows the type and general adjustment specifications of the potentiometers on the front panel of the Servopack. **Table 10.5** shows the specifications of the check pin (CH).

Adjust the potentiometers while observing the specified check locations (Do not tamper with potentiometers.)

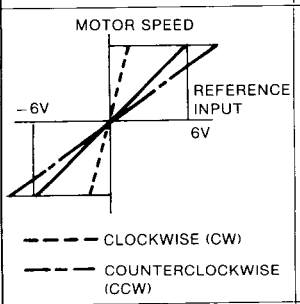
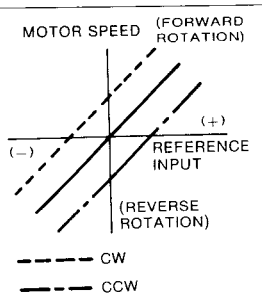
Table 10.5 Check Pin (CH) Specifications

Check Pin (CH) Name	Specifications			
Iu	Phase U current monitor	SRA5AA	PRA5AA	158 mV/A
Iv	Phase V current monitor	SR01AA	PR01AA	113 mV/A
		SR02AA	PR02AA	61 mV/A
Iw	Phase W current monitor	SR03AA	PR03AA	44 mV/A
		SR05AA	PR05AA	34 mV/A
SG	Signal O V when CH-Iu, Iv, Iw are observed.			

Note: The accuracy of CH-Iu, Iv, and Iw to the actual current is ±5 %.

10. 1. 3 Adjustment Procedures (Cont'd)

Table 10. 6 Potentiometer Adjustment for Type CACR-SR

Potentiometer	IN-B	ZERO	L-GAIN	CUR
Functions	Auxiliary input adjustment	Zero drift adjustment	Speed loop gain adjustment	Starting current adjustment
How to Adjust	To be adjusted only when the rated reference voltage (±2 to ±10V) is other than ±6V. Turn 1VR only to get the rated speed and do not operate other VRs.	To be adjusted so that the motor does not turn at the speed reference voltage 0 V. Turning 3VR CW allows the motor to be finely adjusted in forward rotation, and CCW in reverse rotation.	To increase gain, turn CW.	Turning CW increases the starting current.
Check Terminals	—	Observe the operation of motor	—	CH-Iu, Iv, Iw
Characteristics			If hunting, turn CCW to prevent it.	—
Adjustment	○	○	○	×

Potentiometer	P · GAIN	PG	U · ADJ	V · ADJ
Functions	Proportional gain adjustment	PG power voltage adjustment	Phase U current zero adjustment	Phase V current zero adjustment
How to Adjust	Turning clockwise increases the proportional gain. With stepping input, start and stop the motor, and adjust to decrease overshoot and undershoot. (Adjust together with L-Gain.)	Turning clockwise increases the voltage. (This has been adjusted to 5.25 V at the factory.)	Input overtravel prevention for both forward and reverse running and adjust offset of phase U current amplifier to 0.	Input overtravel prevention for both forward and reverse running, and adjust offset of phase V current amplifier to 0.
Check Terminals	—	PG power lead	CH-Au	CH-Av
Characteristics	If the proportional gain is increased excessively, overshoot and undershoot increase. If the proportional gain is decreased excessively, the leading and trailing at starting and stopping are unstable.	If the voltage is dropped by long cable to the PG, increase the voltage. Otherwise, do not adjust the potentiometer. Make sure not to increase the voltage more than 6 V.	If the current amplifier zero adjustment is not correct, an offset occurs, and motor torque ripple increases. The sine wave current is distorted.	If the current amplifier zero adjustment is not correct, an offset occurs, and motor torque ripple increases. The sine wave current is distorted.
Adjustment	△	△	×	×

Adjustment Directions

Mark ○ : Potentiometer should be adjusted in accordance with specifications and application.
Mark △ : Potentiometer should not be adjusted except special cases.
Mark × : Do not adjust.

10.2 SERVOPACK TYPE CACR-PR

10.2.1 Settings and Characteristics at the Time of Delivery

(1) Settings at the Time of Delivery

At the time of delivery, the digital switches, potentiometers and setting switches have been set as shown in **Tables 10.7** and **10.8.**

Table 10.7 Standard Adjustment and Setting Specifications

SERVOPACK Type CACR	Applicable SERVOMOTOR			SERVOPACK Adjusting Specifications							
	Type USACEM-	Optical Encoder p/rev	Rated Current A (RMS)	Reference Mode	Reference Pulse Frequency kpps	Speed Setting r/min	PG Pulse Frequency Dividing Ratio	PG Multiplier	Pulse Resolution per Motor Revolution	f/V Output	Start Current Setting A (RMS)
PRA5AA4AH	A5AA2	1500	1	Sign + pulse train	75	3000	×1	×1	1500	1V/1000 r/min (3V/3000 r/min)	3.5±5%
PRA5AA4BH	A5AB2	1000			50	3000			1000		
PR01AA4AH	01AA2	1500	1.6		75	3000			1500		4.9±5%
PR01AA4BH	01AB2	1000			50	3000			1000		
PR02AA4AH	02AA2	1500	2.9		75	3000			1500		9.2±5%
PR02AA4BH	02AB2	1000			50	3000			1000		
PR03AA4AH	03AA2	1500	4.2		75	3000			1500		12.7±5%
PR03AA4BH	03AB2	1000			50	3000			1000		
PR05AA4AH	05AA2	1500	5.3		75	3000			1500		16.3±5%
PR05AA4BH	05AB2	1000			50	3000			1000		

Notes:

1. At the factory, the SERVOPACKS are preset and adjusted as shown in [ ].
2. The pulse resolution per motor revolution processed in the SERVOPACK is shown by the following formula:

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

P: Number of pulses from optical encoder (pulses/rev)
N: Frequency dividing ratio
M: Multiplier (M = 1, 2, or 4)

The following relationship holds true:

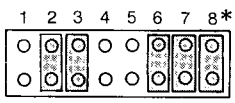
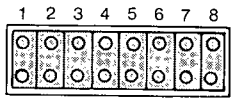
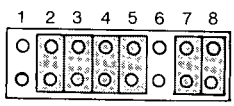
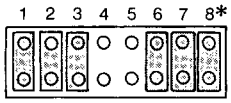
$$\text{Reference pulse frequency} = \frac{\text{Motor speed (r/min)}}{60} \times \text{pulse resolution}$$

3. Number of PG output pulses is shown by the following formula:

$$\text{Number of PG output pulses/motor revolution} = \frac{P}{N}$$

P: Number of pulse from optical encoder (pulses/rev)
N: PG frequency dividing ratio

Table 10.8 Setting Switch Position at the Time of Delivery (SW1, SW2, SW3)

SERVOPACK Type CACR-	SW1	SW2		SW3		
	Motor Characteristics Parameter Setting	Pulse Resolution Setting		Reference Input Specification Setting		
	No. of PG Pulses p/rev	PG Frequency Dividing Ratio	PG Multiplier	Pulse Mode	Voltage Level	COIN Width
PRA5AA4AH-PR05AA4AH	1500	×1	×1	Sign+ Pulse Train	+12V	±10 Pulses
						
PRA5AA4BH-PR05AA4BH	1000					
						

*Spare short-circuit pin is inserted in SW1-⑧.

Note: SW1, SW2, and SW3 are inside the SERVOPACK. To handle these switches, the side cover must be removed from the controller. To remove the side cover to check and set SW1, SW2, and SW3, see Section 6.7.2.

Table 10.9 Digital Switch and Potentiometer Setting Position at the Time of Delivery

SERVOPACK Type CACR- \ Digital Switch	CUR	I-GAIN	Kv	Kp	F/V (VR)
PRA 5 AA	F	5	2	7	Approx 6/10 scales
PR 01 AA		5	2		
PR 02 AA		8	2		
PR 03 AA		8	4		
PR 05 AA		8	4		

Note: Besides digital switches and potentiometers shown in the Table above, PG, U-ADJ and V-ADJ potentiometers are on the Servopack front panel. Do not touch these potentiometers except in special cases, since they have been preset at the factory.

(2) Characteristics at the time of delivery

(a) Speed reference input and servomotor speed ratio (**Fig. 10.4**)

(No load and continuous pulses)

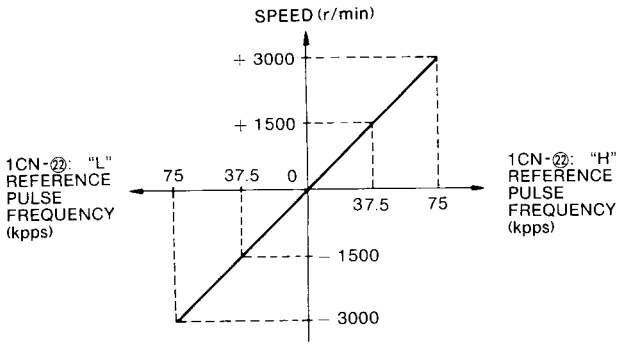


Fig. 10.4 Reference Input Frequency and Motor Speed Characteristics

(b) Start–stop characteristics (**Fig. 10.5**)

(Load $J_L = J_M$, no load)

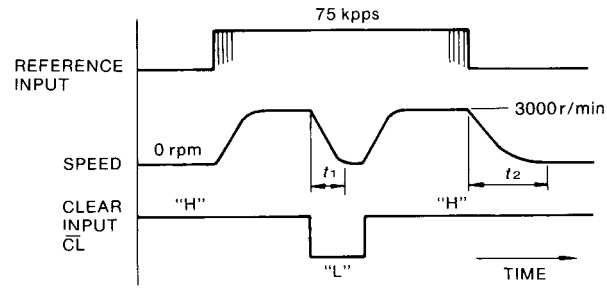


Fig. 10.5 Start–Stop Response Characteristics

10.2.2 Readjustment

The Servopack has been adjusted at the factory to obtain optimum characteristics, and readjustment is normally unnecessary. If adjustment is needed depending on the use, readjust the Servopack according to the instructions in section 10.2.3.

10.2.3 Adjustment Procedures

Table 10.10 shows the scale contents of the digital switches on the front panel of the Servopack, **Table 10.12** shows the general adjustment procedures for potentiometers, and **Table 10.13**, the specifications of the check pins (CH).

Adjust the digital switches and potentiometers while observing the specified check locations (Potentiometer should not be adjusted except in special cases.)

(1) Adjustment procedures for setting digital switch

(a) CUR (Max current adjustment):

Check locations — CH-Iu, Iv, and Iw

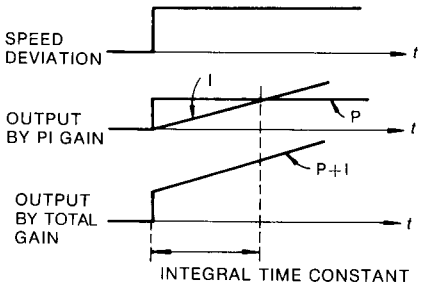
Adjust the maximum current of Servopack.

(b) I-GAIN (Integral gain time constant):

Check locations—F/V output (the motor should not cause vibration or oscillation.)

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

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



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

Fig. 10.6 Integral Gain

(c) [Kv] (Speed loop gain):

Check locations — F/V output (the motor should not cause vibration or oscillation.)

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

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

Ti: Integral time constant

NOTE

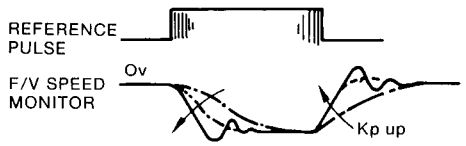
If the rigidity of the mechanical system is poor, Kv cannot be increased. If Kv is increased, oscillation occurs. Adjust the Kv when the $\overline{CL}$ is turned on and the position error counter is cleared to 0, then the effect of the position loop gain Kp can be removed.

(d) [Kp] (Position loop gain):

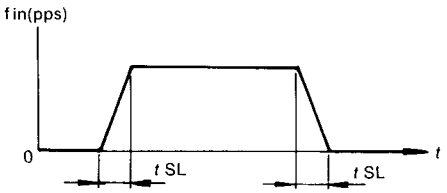
Check locations — f/V output (the motor should not cause overshoot, undershoot, or oscillation.)

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

If relatively high Kp value is needed while overshoot and undershoot are undesirable, then gradually speed up and slow down the pulse frequency. (Fig. 10.7)



Note : If Kp is increased excessively, overshoot and undershoot increase, and, in some case, oscillation occurs even if no reference is input.



Note: Set the acceleration/deceleration time t_{SL} to a value greater than the motor starting time t_a obtained in Table 10.11.
Set Kp to 30 to 70 (s^{-1}).

$t_{SL} \geqq t_a$

Fig. 10.7 Reference Pulse Slow-up and Slow-down

Table 10.10 Contents of Setting Digital Switch

Digital Switch \ Scale		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	Remarks
Kp Position Loop Gain		10.0	12.5	15.0	17.5	20.0	23.0	26.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	—
Kv Speed Loop Gain		1.00	1.24	1.55	1.93	2.40	2.99	3.72	4.63	5.76	7.17	8.93	11.12	13.84	17.23	21.44	26.70	1 at scale "0"
I Gain Integration Constant		∞	166	123	90	66	48	36	26	19	15	10.5	7.7	5.6	4.2	3.0	2.3	(ms)
[CUR] Max Current Adjustment*	CACR-PRA 5 AA	1.7A 121%	2.0A 143%	2.3A 164%	2.7A 193%	3.0A 214%	3.3A 236%	3.5A 250%	3.7A 264%	3.8A 271%	4.0A 286%	4.2A 300%	4.3A 307%	4.5A 321%	4.7A 336%	4.8A 343%	5.0A 357%	—
	CACR-PR 01 AA	2.3A 105%	2.8A 127%	3.3A 150%	3.7A 168%	4.2A 191%	4.7A 214%	4.9A 223%	5.1A 232%	5.4A 245%	5.6A 255%	5.8A 264%	6.1A 277%	6.3A 286%	6.5A 295%	6.8A 309%	7.0A 318%	—
	CACR-PR 02 AA	4.3A 109%	5.2A 127%	6.1A 149%	6.9A 168%	7.8A 190%	8.7A 212%	9.1A 222%	9.5A 232%	10.0A 244%	10.4A 254%	10.8A 263%	11.3A 276%	11.7A 285%	12.1A 295%	12.6A 307%	13.0A 317%	—
	CACR-PR 03 AA	6.0A 100%	7.2A 120%	8.4A 140%	9.6A 160%	10.8A 180%	12.0A 200%	12.6A 210%	13.2A 220%	13.8A 230%	14.4A 240%	15.0A 250%	15.6A 260%	16.2A 270%	16.8A 280%	17.4A 290%	18.0A 300%	—
	CACR-PR 05 AA	7.7A 110%	9.2A 131%	10.7A 153%	12.3A 176%	13.8A 197%	15.3A 219%	16.1A 230%	16.9A 241%	17.6A 251%	18.4A 263%	19.2A 274%	19.9A 284%	20.7A 296%	21.5A 307%	22.2A 317%	23.0A 329%	—

* Percent indicates values when the rated current of the motor used is 100 %. The current value in the above table is Ao-p value. Its accuracy is ± 5 % of the actual current value.

10.2.3 Adjustment Procedures (Cont'd)

· Estimation of position loop gain(Kp)

For stepping input of reference pulses, the approximate value is obtained from the following formula. Motor, controller and machine specifications are shown in **Table 10.11.**

Table 10.11 Specifications of Motor, SERVOPACK, and Machine

Motor		SERVOPACK		Machine	
Rated Speed (N)	r/min	Max Set Current (Ip)	A	Load Torque at Motor Shaft (T_L)	N • m
Rated Motor Torque (T_M)	N • m				
Rotor Inertia (J_M)	kg • m^2	Adjust Ip according to machine specifications.		Load Inertia at Motor Shaft (J_L)	kg • m^2
Rated Motor Current (Ia)	A				

· Starting time

$$ta = 10.48 \times \frac{(J_M + J_L) \times N \times 10^{-2}}{I_P / Ia \times T_M - T_L} \quad [s]$$

· Positioning loop gain

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

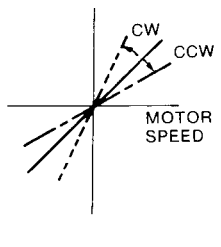
· No. of lag pulses in error counter

$$\varepsilon = \frac{fin}{K_P} \quad [\text{pulses}]$$

fin: Reference pulse frequency(pp

(2) Potentiometer adjustment procedure and check terminal specifications

Table 10.12 General Adjustment for Type CACR-PR

Potentiometer	PG	U · ADJ	V · ADJ	F/V
Functions	PG power voltage adjustment	U-phase current zero adjustment	V-phase current zero adjustment	f/V output gain adjustment
How to Adjust	Turning clockwise increases the voltage. This has been adjusted to 5.5 V at the factory.	Input overtravel prevention for both forward and reverse rotations, and adjust U-phase current 0 ADC.	Input overtravel prevention for both forward and reverse rotations, and adjust V-phase current 0 ADC.	Adjust the voltage to the required level when the motor rotates at the rated speed. This has been preset at the factory to the value shown in Table 10.9.
Check Terminals	PG power lead	CH-Iu	CH-Iv	f/V output
Characteristics	A long cable to the PG will cause a voltage drop, so increase the voltage. Otherwise, do not adjust the voltage. Make sure to increase the voltage to under 6 V.	If the current zero adjustment is not correct, an offset occurs, the motor torque ripple increases, and the sine wave current is distorted.	If the current zero adjustment is not correct, an offset occurs, the motor torque ripple increases, and the sine wave current is distorted.	f/V OUTPUT 
Adjustment	△	×	×	△

Adjustment Directions

Mark ○ : Potentiometer should be adjusted in accordance with specifications and application.
Mark △ : Potentiometer should not be adjusted except special cases.
Mark × : Do not adjust.

Table 10.13 Check Pin (CH) Specifications

Check Pin	Specifications					
Iu	Phase U current monitor	SRA5AA	SR01AA	SR02AA	SR03AA	SR05AA
Iv	Phase V current monitor	PRA5AA	PR01AA	PR02AA	PR03AA	PR05AA
Iw	Phase W current monitor	158mV/A	113mV/A	61mV/A	44mV/A	34mV/A
SG	Signal 0 V when CH-Iu, Iv, Iw are observed.					

Note: Accuracy against each actual current of CH-Iu, Iv, Iw is ±5%.

11. INSPECTION AND MAINTENANCE

11.1 AC SERVOMOTOR

The AC servomotor has no wearing parts(eg. 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 should become necessary, contact your Yaskawa representative.

Table 11.1 Inspection Schedule for Motors

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

11.2 SERVOPACK AND POWER UNIT

The Servopack and power unit are of contactless construction type, so that no special maintenance is required. Remove dust and tighten screws periodically.

If Servopack fuses are blown, rectify the cause and replace fuses with the same type. For type CACR-SR and -PR, fuses of the following types and specifications are used.

Table 11.2 SERVOPACK Built-in Fuse Specifications

SERVOPACK Type CACR-		SRA 5 AA PRA 5 AA	SR 01 AA PR 01 AA	SR 02 AA PR 02 AA	SR 03 AA PR 03 AA	SR 05 AA PR 05 AA
Fuse	Type	SM1101-3	SM1101-5	GGL 10	GGL 10	MF61 NM15
	Capacity	125 V 3 A	125 V 5 A	250 V 10 A	250 V 10 A	250 V 15 A
	Manufacturer	Showa Musen Kogyo Co., Ltd.		Nagasawa Electric Co., Ltd.		

12. TROUBLESHOOTING GUIDE

12.1 AC SERVOMOTOR

WARNING

Corrective actions in ▨ should be practiced after turning off the power.

Table 12.1 Troubleshooting Guide for AC SERVOMOTOR

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

12.2 SERVOPACK AND POWER UNIT

12.2.1 Examples of Service Diagnosis for Defective Wiring or Parts

Table 12.2 Example of Service Diagnosis for Defective Wiring or Parts

Trouble	Check Items	Correction Action
• MCCB in the power unit trips when the power is turned on.	• Connection between SERVOPACK and power unit. (Connection of terminals Ⓟ and Ⓝ.) • Power can be turned on when SERVOPACK is disconnected.	• Correct the wiring. • If the power can be turned on (MCCB does not function), replace the SERVOPACK. • If the power cannot be turned on (MCCB is tripped), replace the power unit.
• [MP] in the power unit and [POWER] in the SERVOPACK do not light after the power is turned on.	• Voltage across Ⓡ and Ⓣ normal. • Voltage across Ⓟ and Ⓝ normal. (Normal voltage: Approx 120 VDC)	• Check the AC power supply circuit. • If no voltage present, replace the power unit.
• When power is turned on, [MP] in the power unit lights, but [POWER] in the SERVOPACK does not light.	• Connection between SERVOPACK and power unit (Connection of terminals ① and ②) • Disconnect the SERVOPACK and check the voltage across terminals ① and ② of the power unit. (Normal voltage: approx 24 VDC)	• If the connection is reversed, replace the SERVOPACK. • If not connected, connect SERVOPACK to power unit. • If 24 VDC is not present across terminals ① and ②, replace the power unit. • If 24 VDC is present across terminals ① and ②, replace the SERVOPACK.
	CAUTION Power unit terminal ② is common to the main circuit.	
• Fuse blows immediately after Servo ON.	• Fuse capacity • Main circuit wiring (such as the ground of motor)	• Replace the fuse, if defective. • Correct wiring, if wrong.
• The reference is input, but the motor (type SR) does not run.	• Voltage across Ⓡ and Ⓣ , and Ⓡ and Ⓝ • LED [ALARM] is off. • Reference voltage across 1CN ⑫ and ⑬ or across ⑭ and ⑮. • SW1	• Check the AC power supply circuit. • Check wiring. • If LED is on, check the cause. • Check the external reference circuit. • Insert 1CN again. • Check the pulses of the optical encoder and SW1 set in the SERVOPACK for verification.
• The reference is input, but the motor (type PR) does not run.	• Voltage across Ⓡ and Ⓣ, and across Ⓟ and Ⓝ. • LED [ALARM] is off. • SW1 and SW3 • $\overline{CL}$ input and $\overline{INH}$ input • The reference pulse input • SIGN input	• Check the AC power supply circuit. • Check wiring. • If LED is on, check the cause. • Check the pulses of the motor and optical encoder and SW1 set in the SERVOPACK for verification. • Check the verification with the reference state. • Insert 1CN again (to check for contact malfunction). • Check the external reference circuit.
• The reference is 0V, but the motor (type SR) vibrates.	• If the sequence causes short-circuit of input at 0V reference. • SG 0V is grounded.	• Correct the sequence. • If the cause is inductive noise, ground SG 0V.
• The motor (type PR) runs but does not stop (or overruns).	• PG feedback signal of A, B, and C • PG feedback signal phases	• Correct the wiring.
• An overflow signal instantly appears (type PR).	• Reference pulse frequency • Motor lock • Load inertia • PG feedback signal of A, B, and C	• Check that fin = $\frac{\text{Motor speed}}{60} \times$ number of PG pulses. • Release the motor lock. • Recheck the inertia converted to the motor shaft. • Correct the wiring.
• Position is inaccurate (type PR).	• Number of input reference pulses • Timing of reference pulse sign • Number of PG feedback pulses • Multiplier of PG feedback pulses	• Correct the reference pulse generation circuit. • Check the set value and change, if necessary.

12.2.2 Examples of Service Diagnosis for Incomplete Adjustment

Table 12.3 Examples of Service Diagnosis for Incomplete Adjustment

Trouble	Cause	Corrective Action
Motor rotates even if the speed reference voltage is 0V. (For type SR)	Incomplete ZERO potentiometer adjustment.	Adjust [ZERO] correctly.
Motor vibrates or vibration frequency is too high, approx 200 to 300 Hz. (For type SR). (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 [LOOP] CCW to decrease 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.
Servo performance is improper.	Positioning loop gain too low.	Increase positioning loop gain [Kp] . If hunting, increase- the speed loop gain [Kv]. (Even if hunting occurs by increasing the speed loop gain, positioning loop gain cannot be increased. This is the limit of servo performance.)
Motor speed overshoot is too large at starting or stopping. (For type SR)	Speed loop gain too high	Turn [LOOP] CCW to decrease the speed loop gain.

AC SERVO DRIVES

HIGH-ACCURACY QUICK-RESPONSE VS-800 SERIES

C SERIES FOR SPEED/POSITIONING CONTROL

TOKYO OFFICE Ohtemachi Bldg. 1-6-1 Ohtemachi, Chiyoda-ku, Tokyo, 100 Japan
Phone (03) 3284-9111 Telex YASKAWA J33530 Fax (03) 3284-9034
SEOUL OFFICE Seoul Center Bldg. 91-1, So Kong-Dong, Chung-ku, Seoul, Korea
Phone (02) 776-7844 Fax (02) 753-2639
TAIPEI OFFICE Shen Hsiang Tang Sung Chiang Building 10F 146 Sung Chiang Road, Taipei, Taiwan
Phone (02) 563-0010, -7732 Fax (02) 567-4677
YASKAWA ELECTRIC AMERICA, INC. : SUBSIDIARY
Chicago-Corporate Headquarters 2942 MacArthur Blvd. Northbrook, Illinois 60062-2028, U.S.A.
Phone (708) 291-2340 Fax (708) 498-2430
Chicago-Technical Center 3160 MacArthur Blvd. Northbrook, Illinois 60062-1917, U.S.A.
Phone (708) 291-0411 Fax (708) 291-1028
Los Angeles Office 7341 Lincoln Way, Garden Grove, California 92641, U.S.A.
Phone (714) 894-5911 Telex (230) 678396 YASKAWAUS TSTN Fax (714) 894-3258
New Jersey Office Riverdale One, 44 Route 23 North, Suite 5 Riverdale, NJ 07457-1619
Phone (201) 835-9512 Fax (201) 835-9511
YASKAWA ELECTRIC EUROPE GmbH : SUBSIDIARY
Niederhöchstädter Straβe 71-73, W 6242 Kronberg-Oberhöchstadt, Germany
Phone (06173) 938-0 Telex 415660 YASE D Fax (06173) 68421
YASKAWA ELÉTRICO DO BRASIL COMÉRCIO LTDA. : SUBSIDIARY
Rua Conde Do Pinhal 8-5°, Andar Sala 51 CEP 01501-São Paulo-SP, Brasil
Phone (011) 35-1911 Fax (011) 37-7375
YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.
CPF Bldg, 79 Robinson Road No. 13-05, Singapore 0106
Phone 2217530 Telex (87) 24890 YASKAWA RS Fax (65) 224-5854

YASKAWA ELECTRIC CORPORATION

YASKAWA

Due to ongoing product modification/improvement, data subject to change without notice.

TSE-S800-2.5D