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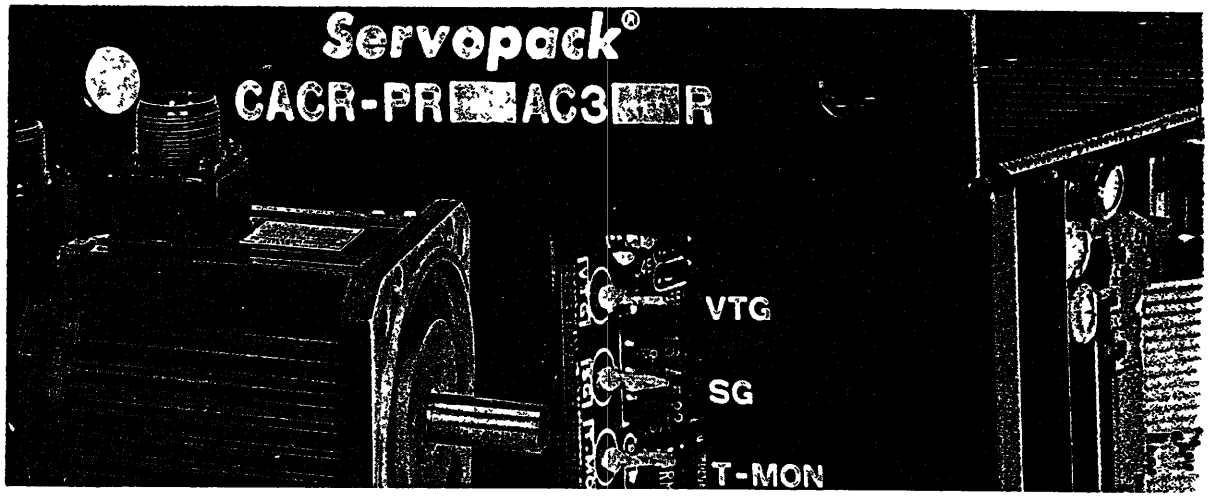
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# AC Servo Drives

## R SERIES FOR POSITIONING CONTROL

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




YASKAWA

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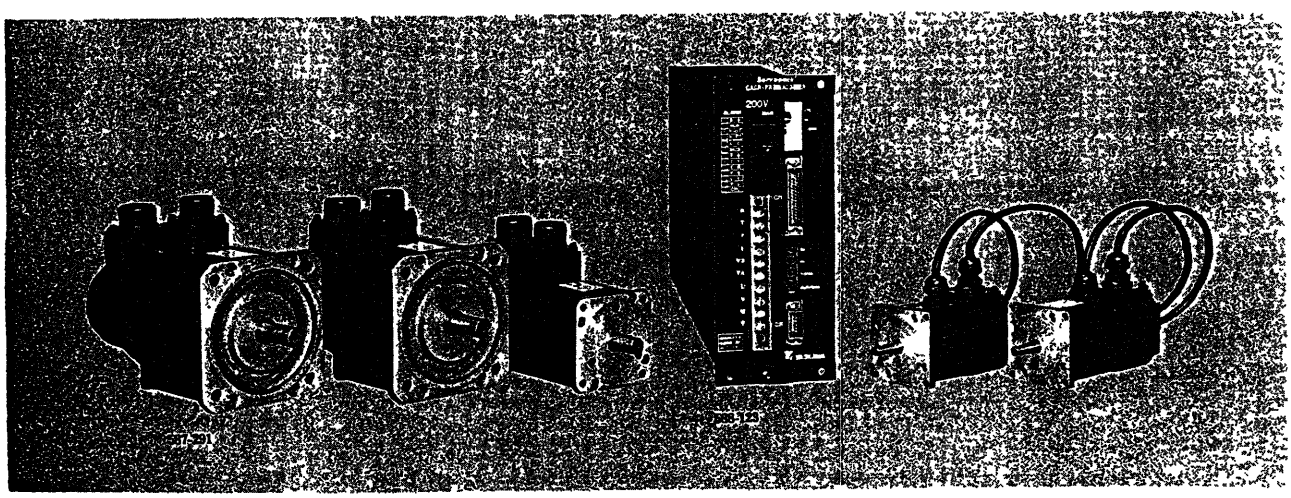
Yaskawa AC Servo Drives have been developed as the basic mechatronics drives for the most advanced FA and FMS including robots and machine tools.

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

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

## FEATURES

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



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# 1. RATINGS AND SPECIFICATIONS

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

### (1) Ratings

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

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

| Item \ Motor Type USAREM- | | A5C□2 | 01C□2 | 02C□2 | 03C□2 | 05C□2 | 07C□2 |
|---|---|---|---|---|---|---|---|
| Rated Output* | W (HP) | 50 (0.07) | 100 (0.13) | 200 (0.27) | 300 (0.40) | 500 (0.67) | 700 (0.93) |
| Rated Torque* | N-m (oz·in) | 0.159 (22.5) | 0.318 (45) | 0.637 (90) | 0.955 (135) | 1.59 (225) | 2.23 (316) |
| Continuous Max. Torque* | N-m (oz·in) | 0 19 (26 9) | 0 382 (54 2) | 0 765 (108 3) | 1.15 (162 5) | 1 90 (269 4) | 2 67 (378) |
| Peak Torque* | N-m (oz·in) | 0.476 (67.5) | 0.955 (135) | 1.91 (270) | 2.86 (405) | 4.76 (675) | 6.67 (948) |
| Rated Current* | A | 0.71 | 1.0 | 2.0 | 2.7 | 3.6 | 5.7 |
| Rated Speed* | r/min | 3000 | | | | | |
| Max. Speed* | r/min | 4500 | | | | | |
| Torque Constant | N-m/A (oz·in/A) | 0.235 (33.3) | 0.353 (50.0) | 0.346 (49.0) | 0.378 (53.6) | 0.466 (66.0) | 0.426 (60.4) |
| Moment of Motor Inertia $J_M$ (=$GD^2/4$) | kg·m²×10⁻⁶ (oz·in·s²×10⁻³) | 7.64 (1.08) | 12.5 (1.78) | 50.7 (7.18) | 76.6 (10.9) | 272 (38.6) | 372 (52.8) |
| Power Rate* | kW/s | 3.30 | 8.09 | 8.01 | 11.9 | 9.26 | 13.3 |
| Inertia Time Constant | ms | 4.4 | 3.4 | 2.9 | 2.6 | 2.8 | 2.5 |
| Inductive Time Constant | ms | 1.3 | 1.6 | 4.1 | 4.5 | 9.4 | 10.0 |

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

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



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

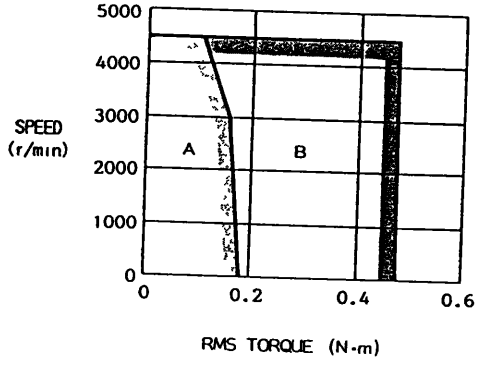
### (2) Torque-Speed Characteristics

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

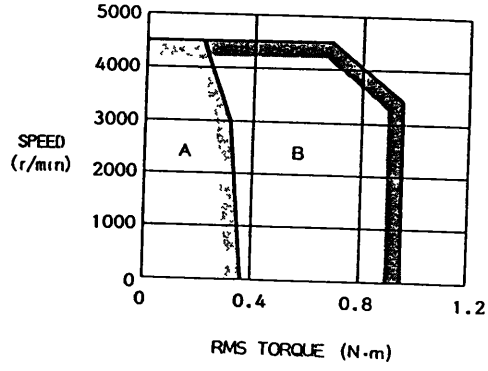
If 200 VAC or below, the output characteristics may be decreased even if the data is within allowable variation.

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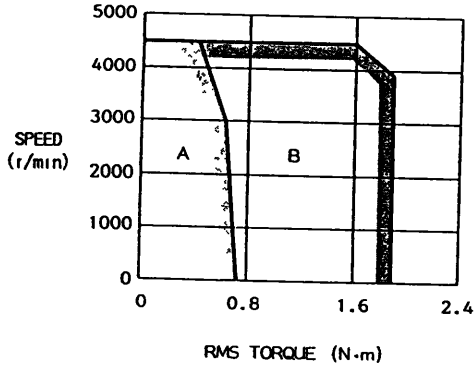
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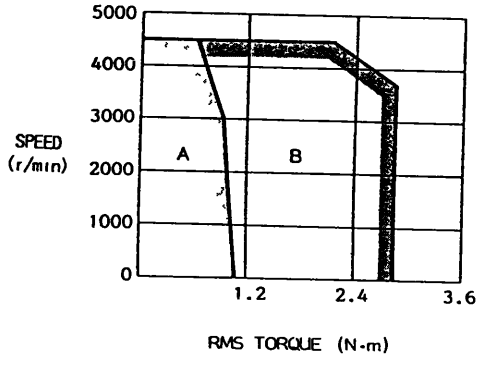

Type USAREM-01C



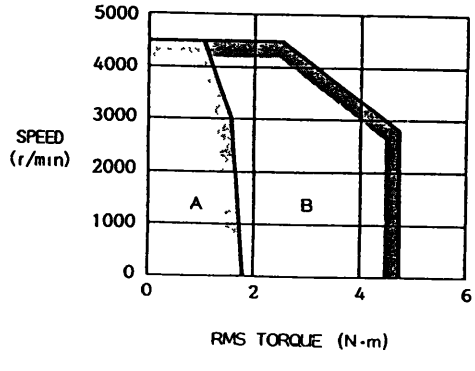

Type USAREM-02C



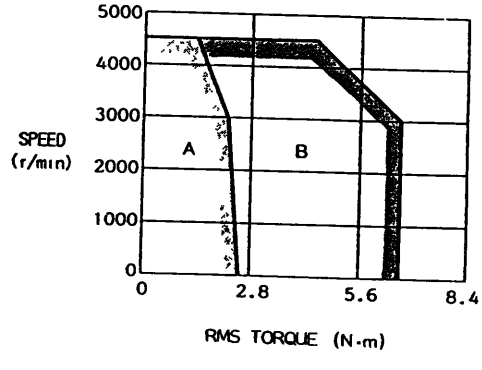

Type USAREM-03C




Type USAREM-05C




Type USAREM-07C




A : Continuous Duty Zone

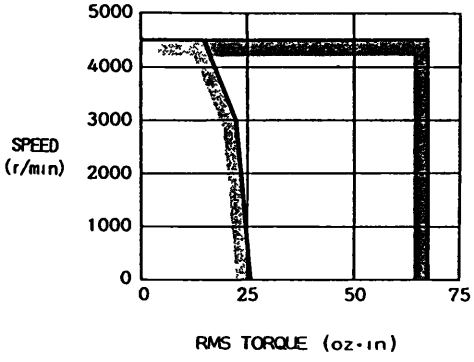
B : Intermittent Duty Zone



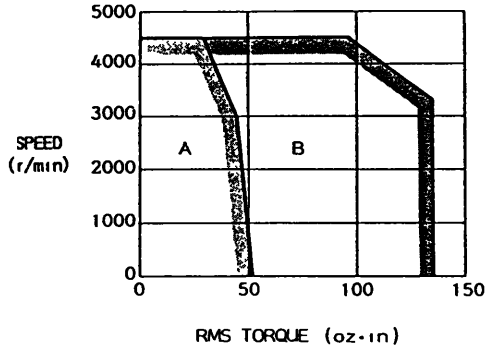
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■ r/min-oz · in

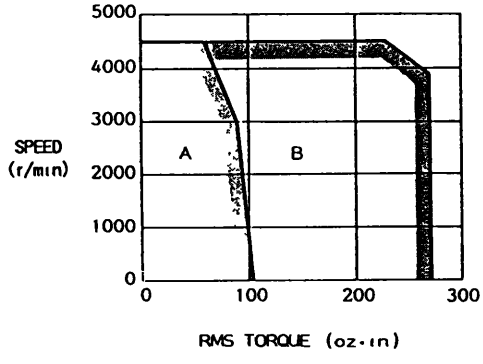
### Type USAREM-A5C



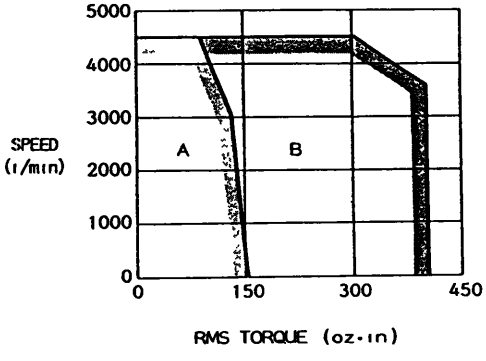

### Type USAREM-01C



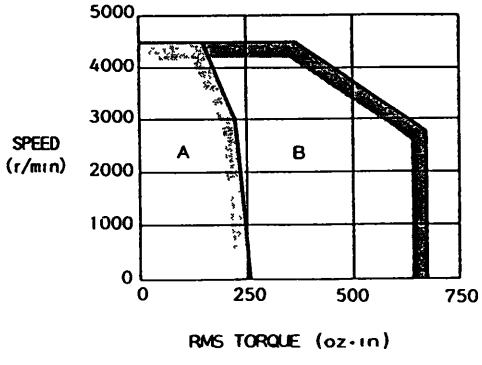

### Type USAREM-02C



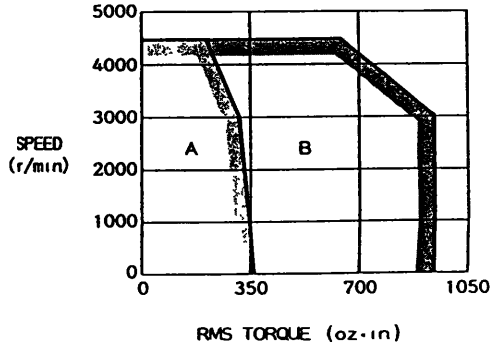

### Type USAREM-03C




### Type USAREM-05C




### Type USAREM-07C




A : Continuous Duty Zone

B : Intermittent Duty Zone



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

(1) Ratings

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

Table 1.2 Ratings and Specifications of R Series AC Servomotors (For 100 V)

| Item \ Motor Type USAREM- | | A5D□2 | 01D□2 | 02D□2 | 03D□2 | 05D□2 |
|---|---|---|---|---|---|---|
| Rated Output* | W (HP) | 50 (0.07) | 100 (0.13) | 200 (0.27) | 300 (0.40) | 500 (0.67) |
| Rated Torque* | N-m (oz-in) | 0.159 (22.5) | 0.318 (45) | 0.637 (90) | 0.955 (135) | 1.59 (225) |
| Continuous Max. Torque* | N-m (oz-in) | 0.19 (26.9) | 0.382 (54.2) | 0.765 (108.3) | 1.15 (162.5) | 1.90 (269.4) |
| Peak Torque* | N-m (oz-in) | 0.476 (67.5) | 0.955 (135) | 1.91 (270) | 2.86 (405) | 4.76 (675) |
| Rated Current* | A | 1.2 | 1.7 | 2.9 | 3.6 | 5.5 |
| Rated Speed* | r/min | 3000 | | | | |
| Max. Speed* | r/min | 4000 | | | | |
| Torque Constant | N-m/A (oz-in/A) | 0.136 (19.3) | 0.198 (28.1) | 0.235 (33.3) | 0.284 (40.3) | 0.308 (43.6) |
| Moment of Motor Inertia $J_M$ (=$GD^2/4$) | $kg \cdot m^2 \times 10^{-6}$ ($oz \cdot in \cdot s^2 \times 10^3$) | 7.64 (1.08) | 12.5 (1.78) | 50.7 (7.18) | 76.6 (10.9) | 272 (38.6) |
| Power Rate* | kW/s | 3.30 | 8.09 | 8.01 | 11.9 | 9.26 |
| Inertia Time Constant | ms | 4.2 | 3.2 | 3.0 | 2.5 | 2.7 |
| Inductive Time Constant | ms | 1.4 | 1.7 | 4.0 | 4.6 | 9.6 |

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

Notes
1. □ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows:
   · Standard: E (1500 pulses/rev)
   · Optional: F (1000 pulses/rev)
2. The power supply unit for brake:
   · Input 100 VAC, Output 90 VDC (DP8401002-2)
   For details, see Par. 8.3 on page 46.



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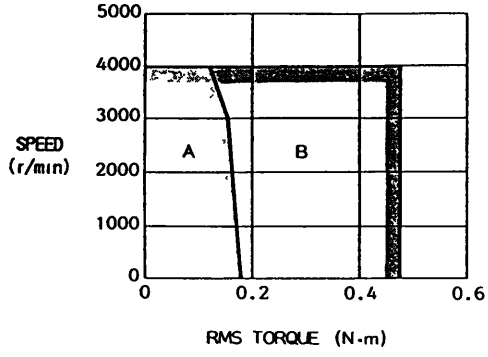
(2) Torque-Speed Characteristics

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

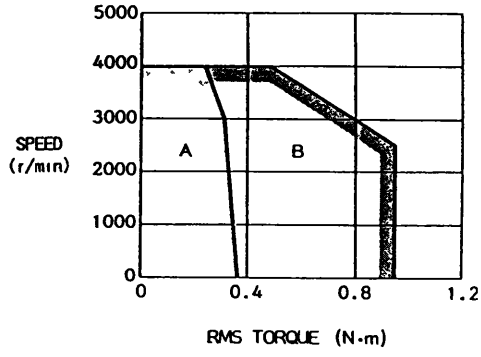
If 100 VAC or below, the output characteristics may be decreased even if the data is within allowable variation.

■ r/min-N · m

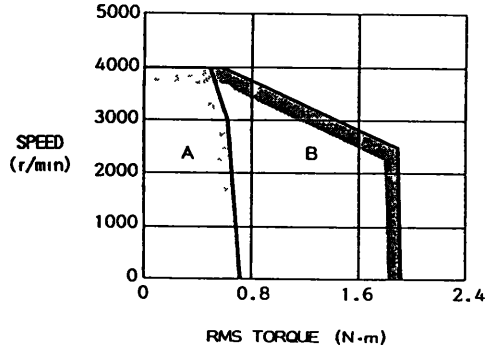
Type USAREM-A5D



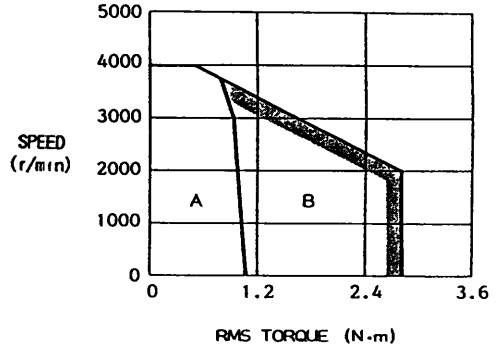

Type USAREM-01D



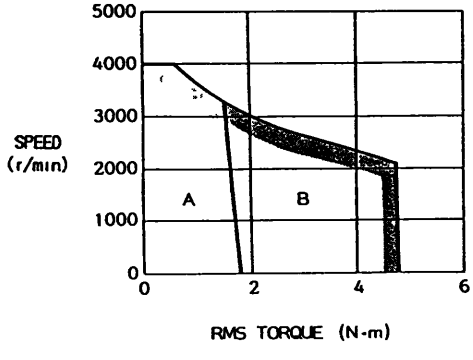

Type USAREM-02D




Type USAREM-03D




Type USAREM-05D




A : Continuous Duty Zone

B : Intermittent Duty Zone

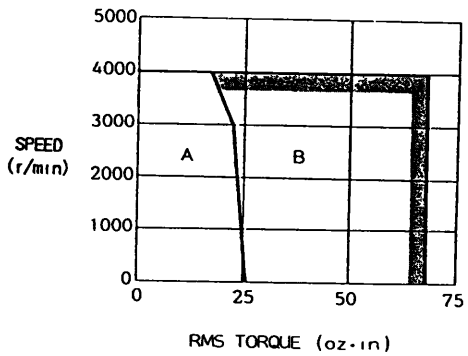


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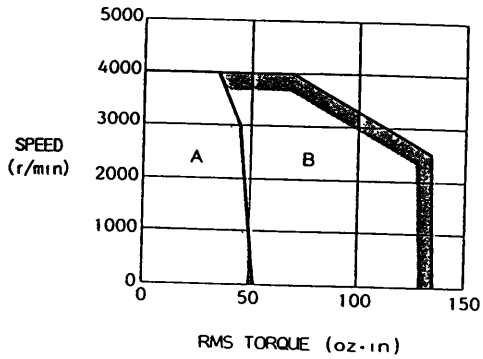
## 1. 2 RATINGS AND SPECIFICATIONS OF R SERIES AC SERVOMOTORS (FOR 100V) (Cont'd)

■ r/min-oz · in

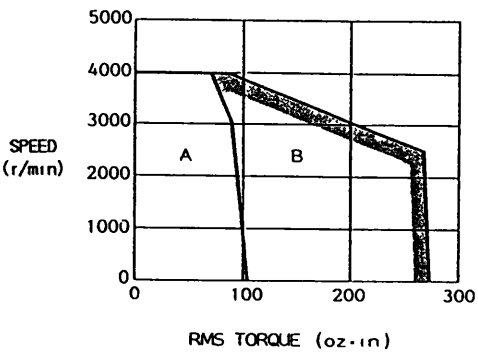
Type USAREM-A5D



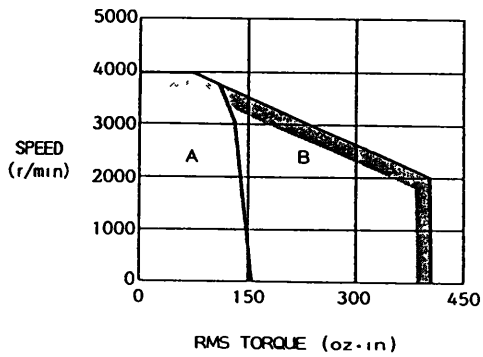

Type USAREM-01D



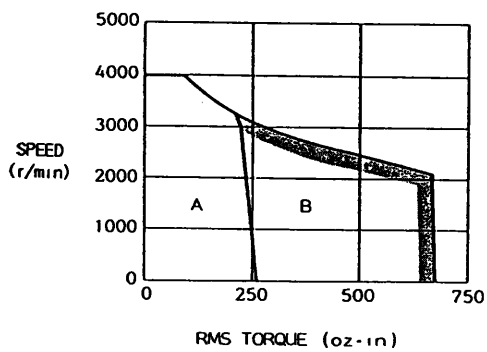

Type USAREM-02D




Type USAREM-03D




Type USAREM-05D




A : Continuous Duty Zone

B : Intermittent Duty Zone



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## 1.3 RATINGS AND SPECIFICATIONS OF SERVOPACK

Table 1 3 Ratings and Specifications of SERVOPACK

| Voltage Class | | | 200V | | | | | |
|---|---|---|---|---|---|---|---|---|
| SERVOPACK Type CACR- | | | PRA5AC3[ ]R | PR01AC3[ ]R | PR02AC3[ ]R | PR03AC3[ ]R | PR05AC3[ ]R | PR07AC3[ ].R |
| Combined Specifications | Applicable AC SERVO MOTOR | Type USAREM- | A5C | 01C | 02C | 03C | 05C | 07C |
| | | Output W (HP) | 50 (0.07) | 100 (0.13) | 200 (0.27) | 300 (0.40) | 500 (0.67) | 700 (0.93) |
| | | Rated/Max. Speed r/min | 3000/4500 | | | | | |
| | Continuous Output Current A (rms) | | 0.7 | 1.0 | 2.0 | 2.7 | 3.6 | 5.7 |
| | Max. Output Current A (rms) | | 2.1 | 2.8 | 5.7 | 7.8 | 10 6 | 16.3 |
| | Allowable Load J *1 ($=GD^2/4$) kg·m²×10⁻⁴ (oz·in·s²×10⁻³) | | 0.764 (10.8) | 1.25 (17.8) | 5 07 (71 8) | 7.66 (109) | 27 2 (386) | 37.2 (528) |
| Basic Specifications | Power *2 Supply | Main / Control | 1-Phase 200 to 230 VAC +10% -15% 50/60Hz | | | | | |
| | Control Method | | 1-Phase full-wave rectifying, transistorized PWM control | | | | | |
| | Feedback | | Optical encoder (1500 or 1000 pulses/rev) | | | | | |
| | Environmental Conditions | Ambient Temp.*3 | 0 to +55°C | | | | | |
| | | Storage Temp. | -20 to +85°C | | | | | |
| | | Ambient and Storage Humidity | 90% or less (non-condensing) | | | | | |
| | | Vibration-/Shock-Resistance | 0.5G/2G | | | | | |
| | Mounting Structure | | Rack mounted | | | | | |
| | Approx Weight kg (lb) | | 2.0 (4.4) | 2.1 (4.6) | 2.6 (5.7) | 2 9 (6.4) | 3 5 (7.7) | 5 4 (11 9) |
| Basic Functions | Kv Setting (SW4) | | 1 00 to 30 0 (×1, ×4) | | | | | |
| | Kp Setting (SW5) | | 5.0 to 200.0 $S^{-1}$ (×1, ×0.5, ×0 25, ×0 125) | | | | | |
| | CUR Setting (SW6)*4 | | 100 to 300% | | | | | |
| | Bias Setting (SW6)*4 | | 0 to 450 r/min (10% of max. motor speed) | | | | | |
| | Kr Setting (SW7) | | 2 ms to ∞ | | | | | |
| I/O Signal | Reference Pulse | Input Type | Sign + pulse train (SIGN + PULSE signal), Two-phase pulse with 90° phase difference (phase A + B), CCW pulse + CW pulse | | | | | |
| | | Input Pulse Form | +5 V level (TTL, line driver) or +12 V open collector | | | | | |
| | | Pulse Frequency | 0 to 200 kpps | | | | | |
| | Aux Reference Pulse | Reference Pulse Input Type | Effective at inhibit ($\overline{INH}$) signal input | | | | | |
| | | Input Pulse Form | Two-phase pulse with 90° phase difference (phase A + B) | | | | | |
| | | Pulse Frequency | +12 V open collector | | | | | |
| | Control Signal | | 0 to 100 kpps (4 multipler internal processing) | | | | | |
| | | Input Pulse Form | Clear and inhibit signals | | | | | |
| | PG Pulse Output | Output Form | +5 V level (TTL, line driver) or +12 V open collector | | | | | |
| | | Frequency Dividing Ratio | Phases A, B, and C Line driver, Phase C Open collector | | | | | |
| | Sequence Input Signal | | 1/1, 1/2, 1/3, 1/4, 1/5, 1/6, 1/10, 1/12, 1/15, 1/20, 1/30, 2/3, 2/5 (Hexadecimal rotary switch, SW8) | | | | | |
| | Sequence Output Signal | | Servo ON, F run inhibit (P-OT), R run inhibit (N-OT), alarm reset | | | | | |
| | Dynamic Brake | | Servo alarm, servo ready, excessive error, positioning completion, alarm code (3-bit) | | | | | |
| | Regeneration | | Operated at main power OFF, servo alarm, servo OFF, stop after deceleration at P/N-OT, | | | | | |
| | Applicable Load Inertia | | · 50/100 W type Not provided<br>· 200 to 700 W: Provided (containing regenarative resistor) | | | | | |
| | Overtravel Prevention | | Up to 10 times motor inertia | | | | | |
| | Protection Function | | Stop after deceleration at P/N-OT, Free running stop *4 | | | | | |
| | Indication | | Overvoltage (OV), overcurrent (OC), overload (OL), overspeed (OS), MCCB trip (MCCB), PG trouble (PG), voltage drop (UV), CPU error (CPU), overflow (OF), regeneration trouble (RG) | | | | | |
| | Monitor Output | | Power supply (MAIN LED), alarm (7-segment LEDs) | | | | | |
| | Positioning Control | | Speed: 2 V ± 5% at 1000 r/min, Torque 3 V ±10%/100% (or speed reference· 2 V ± 10% at 1000 r/min) | | | | | |
| | Others | | Input multiplier: ×1, ×2, ×4 (For aux. reference input, phases A and B are fixed at ×4.)<br>Output multiplier. ×1, ×2, ×4<br>Feedforward compensation. selecting possible<br>Reference pulse logic reverse: L active, H active | | | | | |
| | | | Reverse run connection possible (Reverse at plus reference)<br>Overflow alarm selecting usage (Warning/servo alarm*4) | | | | | |

*1 When load J exceeds applicable range, see Par 6 7 2, "Load Inertia (J) "

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

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

*4 Use by selecting internal setting SW.



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## 1.3 RATINGS AND SPECIFICATIONS OF SERVOPACK (Cont'd)

Table 1.3 Ratings and Specifications of SERVOPACK (Cont'd)

| Voltage Class | | | 100V | | | | |
|---|---|---|---|---|---|---|---|
| SERVOPACK Type CACR- | | | PRA5AC4□R | PR01AC4□R | PR02AC4□R | PR03AC4□R | PR05AC4□R |
| Combined Specifications | Applicable AC SERVO MOTOR | Type USAREM- | A5D | 01D | 02D | 03D | 05D |
| | | Output W (HP) | 50 (0.07) | 100 (0.13) | 200 (0.27) | 300 (0.40) | 500 (0.67) |
| | | Rated/Max. Speed r/min | 3000/4000 | | | | |
| | Continuous Output Current A (rms) | | 1.2 | 1.7 | 2.9 | 3.6 | 5.5 |
| | Max. Output Current A (rms) | | 3.6 | 5.0 | 8.5 | 10.6 | 16.3 |
| | Allowable Load J *1 ($=GD^2/4$) | $kg \cdot m^2 \times 10^{-4}$ ($oz \cdot in \cdot s^2 \times 10^{-3}$) | 0.76 (10.8) | 1.25 (17.8) | 5.07 (71.8) | 7.66 (109) | 27.2 (386) |
| Basic Specifications | Power*2 Supply | Main | 1-Phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60Hz*2 | | | | |
| | | Control | | | | | |
| | Control Method | | 1-Phase full-wave rectifying, transistorized PWM control | | | | |
| | Feedback | | Optical encoder (1500 or 1000 pulses/rev) | | | | |
| | Environmental Conditions | Ambient Temp.*3 | 0 to +55°C | | | | |
| | | Storage Temp. | -20 to +85°C | | | | |
| | | Ambient and Storage Humidity | 90% or less (non-condensing) | | | | |
| | | Vibration-/Shock-Resistance | 0.5G/2G | | | | |
| | Mounting Structure | | Rack mounted | | | | |
| | Approx. Weight kg (lb) | | 2.1 (4.6) | 2.6 (5.7) | 2.9 (6.4) | 3.5 (7.7) | 5.4 (11.9) |
| Basic Functions | Kv Setting (SW4) | | 1.00 to 30.0 (×1, ×4) | | | | |
| | Kp Setting (SW5) | | 5.0 to 200.0 $S^{-1}$ (×1, ×0.5, ×0.25, ×0.125) | | | | |
| | CUR Setting (SW6)*4 | | 100 to 300% | | | | |
| | Bias Setting (SW6)*4 | | 0 to 450 r/min (10% of max. motor speed) | | | | |
| | Ki Setting (SW7) | | 2 ms to ∞ | | | | |
| I/O Signal | Reference Pulse | Input Type | Sign + pulse train (SIGN + PULSE signal), Two-phase pulse with 90° phase difference (phase A + B), CCW pulse + CW pulse | | | | |
| | | Input Pulse Form | +5 V level (TTL, line driver) or +12 V open collector | | | | |
| | | Pulse Frequency | 0 to 200 kpps | | | | |
| | Aux Reference Pulse | Reference Pulse | Effective at inhibit (INH) signal input | | | | |
| | | Input Type | Two-phase pulse with 90° phase difference (phase A + B) | | | | |
| | | Input Pulse Form | +12 V open collector | | | | |
| | | Pulse Frequency | 0 to 100 kpps (4 multipler internal processing) | | | | |
| | Control Signal | | Clear and inhibit signals | | | | |
| | | Input Pulse Form | +5 V level (TTL, line driver) or +12 V open collector | | | | |
| | PG Pulse Output | Output Form | Phases A, B, and C: Line driver, Phase C: Open collector | | | | |
| | | Frequency Dividing Ratio | 1/1, 1/2, 1/3, 1/4, 1/5, 1/6, 1/10, 1/12, 1/15, 1/20, 1/30, 2/3, 2/5 (Hexadecimal rotary switch, SW8) | | | | |
| | Sequence Input Signal | | Servo ON, F run inhibit (P-OT), F run inhibit (N-OT), alarm reset | | | | |
| | Sequence Output Signal | | Servo alarm, servo ready, excessive error, positioning completion, alarm code (3-bit) | | | | |
| | Dynamic Brake | | Operated at main power OFF, servo alarm, servo OFF, stop after deceleration at P/N-OT. | | | | |
| | Regeneration | | · 50 W type: Not provided<br>· 100 to 500 W: Provided (containing regenarative resistor) | | | | |
| | Applicable Load Inertia | | Up to 10 times motor inertia | | | | |
| | Overtravel Prevention | | Stop after deceleration at P/N-OT, Free running stop *4 | | | | |
| | Protection Function | | Overvoltage (OV), overcurrent (OC), overload (OL), overspeed (OS), MCCB trip (MCCB), PG trouble (PG), voltage drop (UV), CPU error (CPU), overflow (OF), regeneration trouble (RG) | | | | |
| | Indication | | Power supply (MAIN LED), alarm (7-segment LEDs) | | | | |
| | Monitor Output | | Speed: 2 V ± 5% at 1000 r/min, Torque 3 V ±10%/100% (or speed reference 2 V ± 10% at 1000 r/min) | | | | |
| | Positioning Control | | Input multipler: ×1, ×2, ×4 (For aux. reference input, phases A and B are fixed at ×4.)<br>Output multipler ×1, ×2, ×4<br>Feedforward compensation selecting possible<br>Reference pulse logic reverse: L active, H active | | | | |
| | Others | | Reverse run connection possible (Reverse at plus reference)<br>Overflow alarm selecting usage (Warning/servo alarm*4) | | | | |

*1 When load J exceeds applicable range, see Par. 6.7.2, "Load Inertia (J)."

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

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

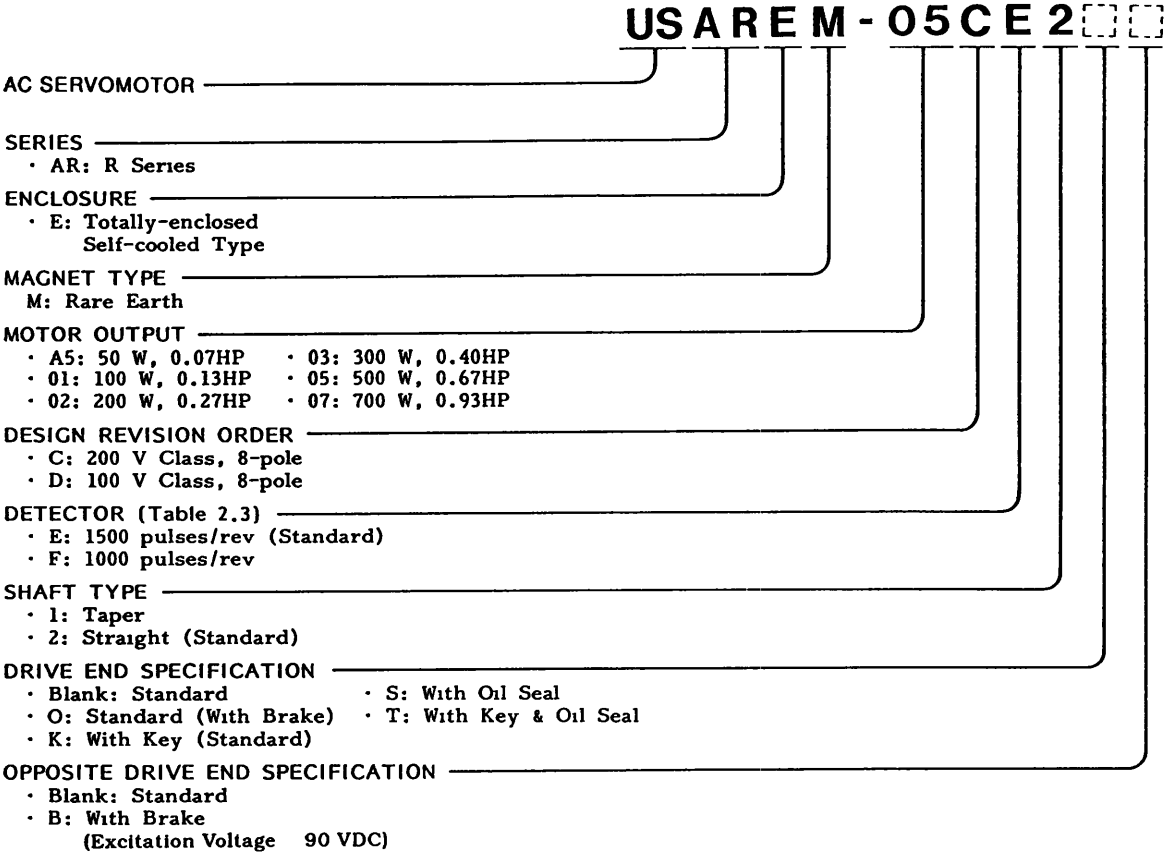
*4 Use by selecting internal setting SW.



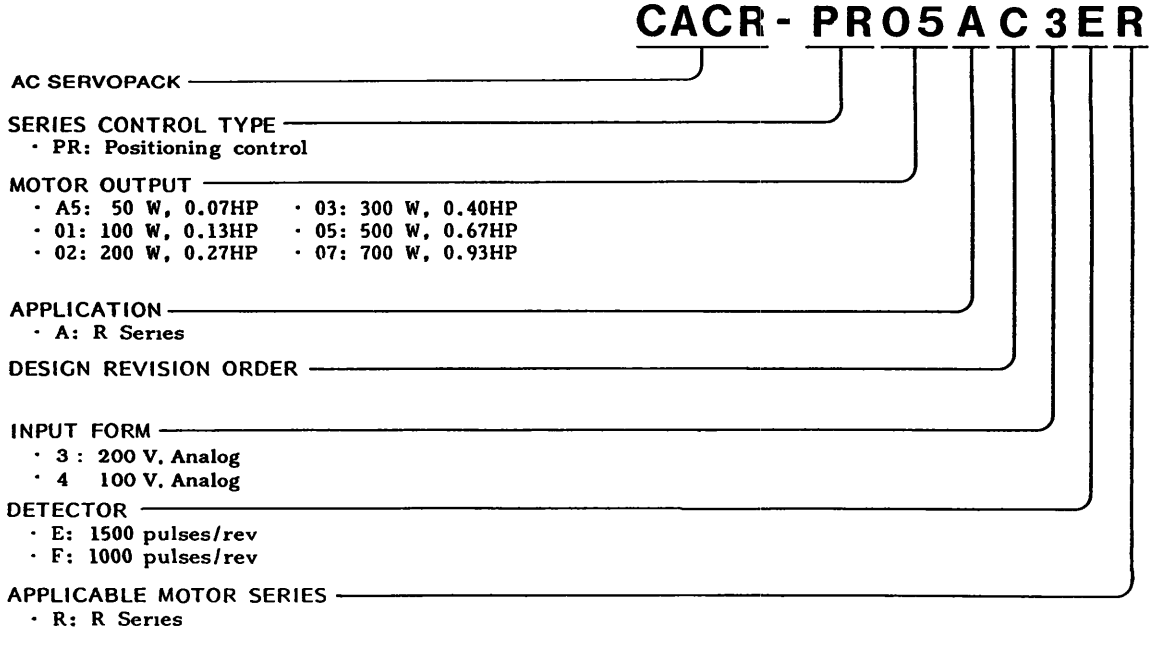
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## 2. TYPE DESIGNATION

• AC SERVOMOTOR




• SERVOPACK






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# 3. LIST OF STANDARD COMBINATION

Table 3 1 List of Standard Combination

| Class | SERVOPACK Type CACR- | | AC SERVOMOTOR Type USAREM- | AC SERVOMOTOR Optical Encoder pulses/rev | Power Capacity per Servopack* kVA | Current Capacity per MCCB of Fuse† A | Applicable Noise Filter | Recommended Noise Filter‡ Type | Recommended Noise Filter‡ Specification | | Power ON/OFF Switch |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 V | 50 W (0.07 HP) | PRA5AC3ER | A5CE2 | 1500 | 0.3 | 5 | Good | LF-205A | Single-phase, 200 VAC class | 5A | Yaskawa type HI-15E$_2$ rated 30 A or equivalent |
| | | PRA5AC3FR | A5CF2 | 1000 | | | | | | | |
| | 100 W (0.13 HP) | PR01AC3ER | 01CE2 | 1500 | 0.5 | | | | | | |
| | | PR01AC3FR | 01CF2 | 1000 | | | | | | | |
| | 200 W (0.27 HP) | PR02AC3ER | 02CE2 | 1500 | 0.75 | | | | | | |
| | | PR02AC3FR | 02CF2 | 1000 | | | | | | | |
| | 300 W (0.40 HP) | PR03AC3ER | 03CE2 | 1500 | 1.0 | 7 | | LF-210 | | 10A | |
| | | PR03AC3FR | 03CF2 | 1000 | | | | | | | |
| | 500 W (0.67 HP) | PR05AC3ER | 05CE2 | 1500 | 1.4 | 11 | | LF-215 | | 15A | |
| | | PR05AC3FR | 05CF2 | 1000 | | | | | | | |
| | 700 W (0.93 HP) | PR07AC3ER | 07CE2 | 1500 | 2.0 | 15 | | LF-220 | | 20A | |
| | | PR07AC3FR | 07CF2 | 1000 | | | | | | | |
| 100 V | 50 W (0.07 HP) | PRA5AC4ER | A5DE2 | 1500 | 0.3 | 5 | Poor | LF-205A | Single-phase, 200 VAC class | 5A | |
| | | PRA5AC4FR | A5DF2 | 1000 | | | | | | | |
| | 100 W (0.13 HP) | PR01AC4ER | 01DE2 | 1500 | 0.5 | | | | | | |
| | | PR01AC4FR | 01DF2 | 1000 | | | | | | | |
| | 200 W (0.27 HP) | PR02AC4ER | 02DE2 | 1500 | 0.75 | 8 | | LF-210 | | 10A | |
| | | PR02AC4FR | 02DF2 | 1000 | | | | | | | |
| | 300 W (0.40 HP) | PR03AC4ER | 03DE2 | 1500 | 1.0 | 11 | | LF-215 | | 15A | |
| | | PR03AC4FR | 03DF2 | 1000 | | | | | | | |
| | 500 W (0.67 HP) | PR05AC4ER | 05DE2 | 1500 | 1.4 | 15 | | LF-220 | | 20A | |
| | | PR05AC4FR | 05DF2 | 1000 | | | | | | | |

* Values at rated load.

† Operating characteristic (25℃): 200% 2 s or more, 700% 0.01 s or more.

‡ Made by Tokin Corp.

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

| Class | SERVOPACK Type CACR- | AC SERVOMOTOR Type USAREM- | AC SERVOMOTOR Receptacle Type | AC SERVOMOTOR L-type Plug | AC SERVOMOTOR Cable Clamp | Detector Receptacle Type | Detector L-type Plug | Detector Cable Clamp | Holding Brake Receptacle Type | Holding Brake L-type Plug | Holding Brake Cable Clamp |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 V | PRA5AC3ER | A5CE2KB | MS3101A 14S-2P | MS3106B* 14S-2S | MS3057 -6A | MS3101A 20-29A | MS3106B 20-29S* | MS3057 -12A | MS3101A 14S-6P | MS3106B 14-6S* | MS3057 -6A |
| | PRA5AC3FR | A5CF2KB | | | | | | | | | |
| | PR01AC3ER | 01CE2KB | | | | | | | | | |
| | PR01AC3FR | 01CF2KB | | | | | | | | | |
| | PR02AC3ER | 02CE2KB | MS3102A 18-10P | MS3108B 18-10S | MS3057 -10A | MS3102A 20-29A | MS3108B 20-29S | | MS3102A 18-12P | MS3108B 18-12S | MS3057 -10A |
| | PR02AC3FR | 02CF2KB | | | | | | | | | |
| | PR03AC3ER | 03CE2KB | | | | | | | | | |
| | PR03AC3FR | 03CF2KB | | | | | | | | | |
| | PR05AC3ER | 05CE2KB | MS3102A 20-4P | MS3108B 20-4S | MS3057 -12A | | | | MS3102A 20-17P | MS3108B 20-17S | MS3057 -12A |
| | PR05AC3FR | 05CF2KB | | | | | | | | | |
| | PR07AC3ER | 07CE2KB | | | | | | | | | |
| | PR07AC3FR | 07CF2KB | | | | | | | | | |
| 100 V | PRA5AC4ER | A5DE2KB | MS3101A 14S-2P | MS3106B 14S-2S* | MS3057 -6A | MS3101A 20-29A | MS3106B 20-29S* | MS3057 -12A | MS3101A 14S-6P | MS3106B 14-6S* | MS3057 -6A |
| | PRA5AC4FR | A5DF2KB | | | | | | | | | |
| | PR01AC4ER | 01DE2KB | | | | | | | | | |
| | PR01AC4FR | 01DF2KB | | | | | | | | | |
| | PR02AC4ER | 02DE2KB | MS3102A 18-10P | MS3108B 18-10S | MS3057 -10A | MS3102A 20-29P | MS3108B 20-29S | | MS3102A 18-12P | MS3108B 18-12S | MS3057 -10A |
| | PR02AC4FR | 02DF2KB | | | | | | | | | |
| | PR03AC4ER | 03DE2KB | | | | | | | | | |
| | PR03AC4FR | 03DF2KB | | | | | | | | | |
| | PR05AC4ER | 05DE2KB | MS3102A 20-4P | MS3108B 20-4S | MS3057 12A | | | | MS3102A 20-17P | MS3108B 20-17S | MS3057 -12A |
| | PR05AC4FR | 05DF2KB | | | | | | | | | |

* Straight plug.



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# 4. CHARACTERISTICS

## 4. 1 OVERLOAD CHARACTERISTICS

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

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

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

**NOTE**

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

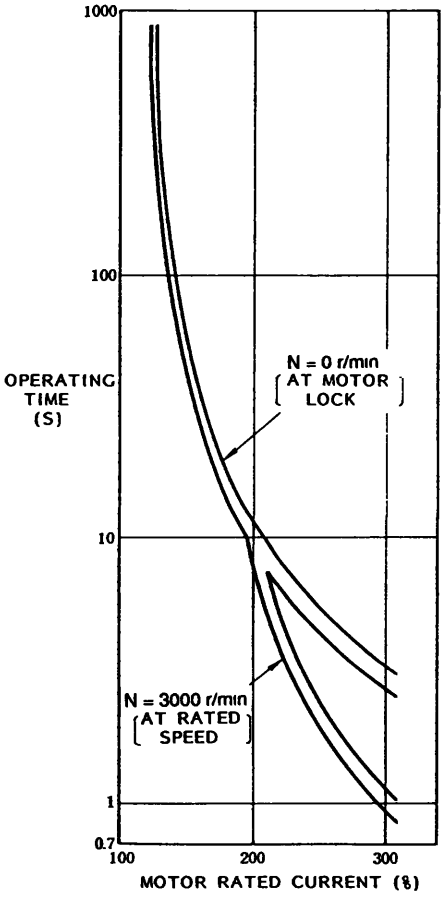



Fig 4 1 Overload Characteristics

## 4. 2 STARTING AND STOPPING TIME

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

Starting Time:

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

Stopping Time:

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

Where,

$N_R$ . Rated motor speed (r/min)

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

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

$K_t$ Torque constant of motor (N · m/A = oz · in/A)

$I_R$ Motor rated current (A)

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

$I_P$ · Accel/decel current (Accel/decel current $\alpha$ times the motor rated current) (A)

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

$I_L$ . Current equivalent to load torque (Load current $\beta$ times the motor rated current) (A)

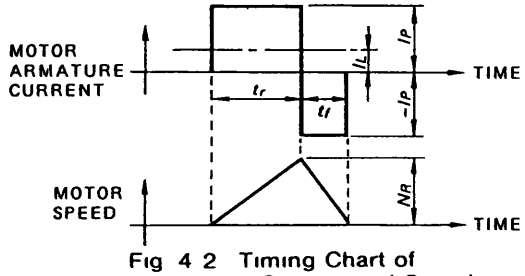



Fig 4 2 Timing Chart of Motor Armature Current and Speed

## 4. 3 ALLOWABLE FREQUENCY OF OPERATION

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

(1) Allowable frequency of operation restricted by the SERVOPACK

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



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# 5. CONFIGURATION

## 5.1 CONNECTION DIAGRAM

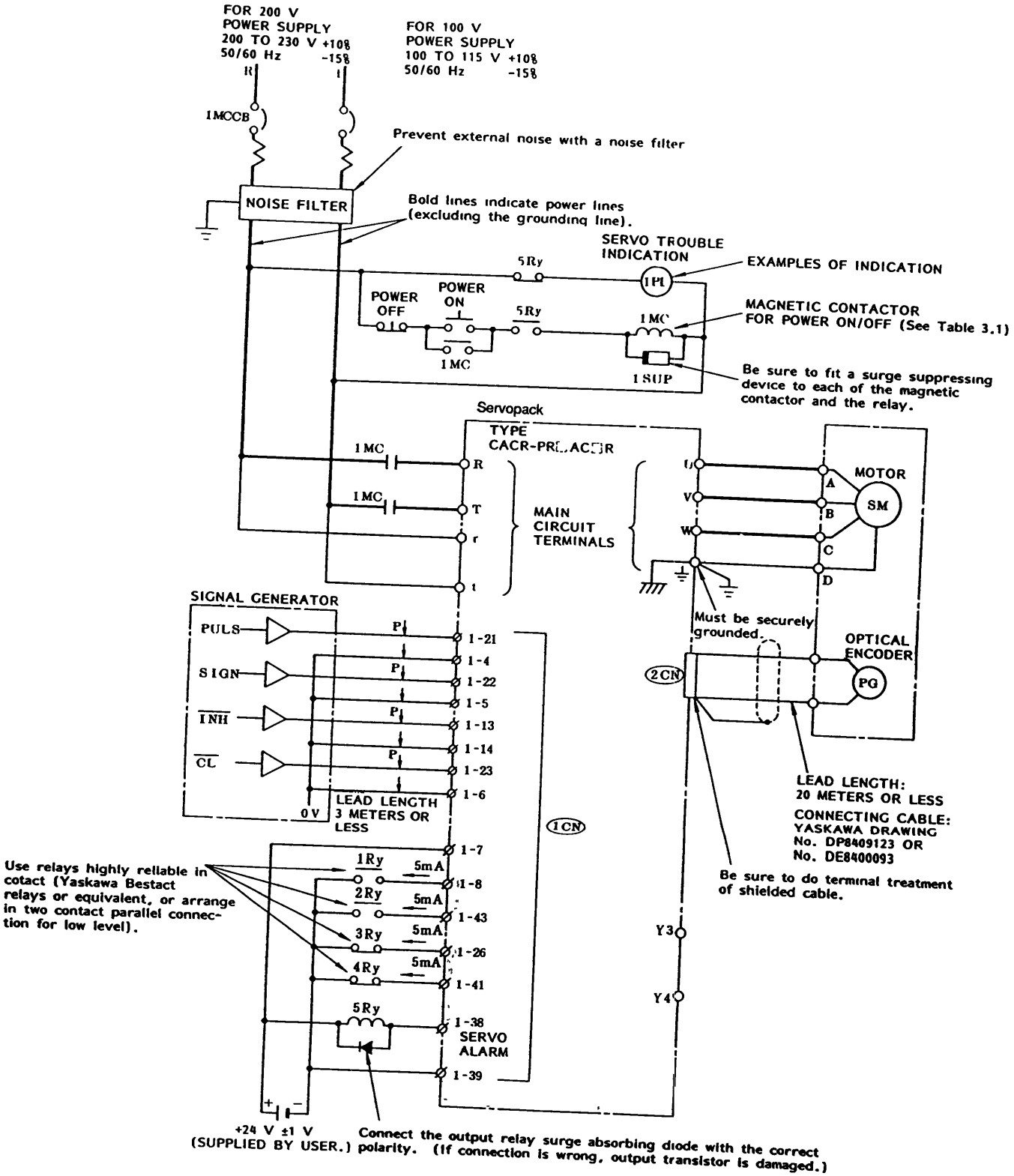



Fig 5.1 Example of Connection Diagram of SERVOPACK with a Servomotor and Peripherals



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## 5. 2 INTERNAL BLOCK DIAGRAM

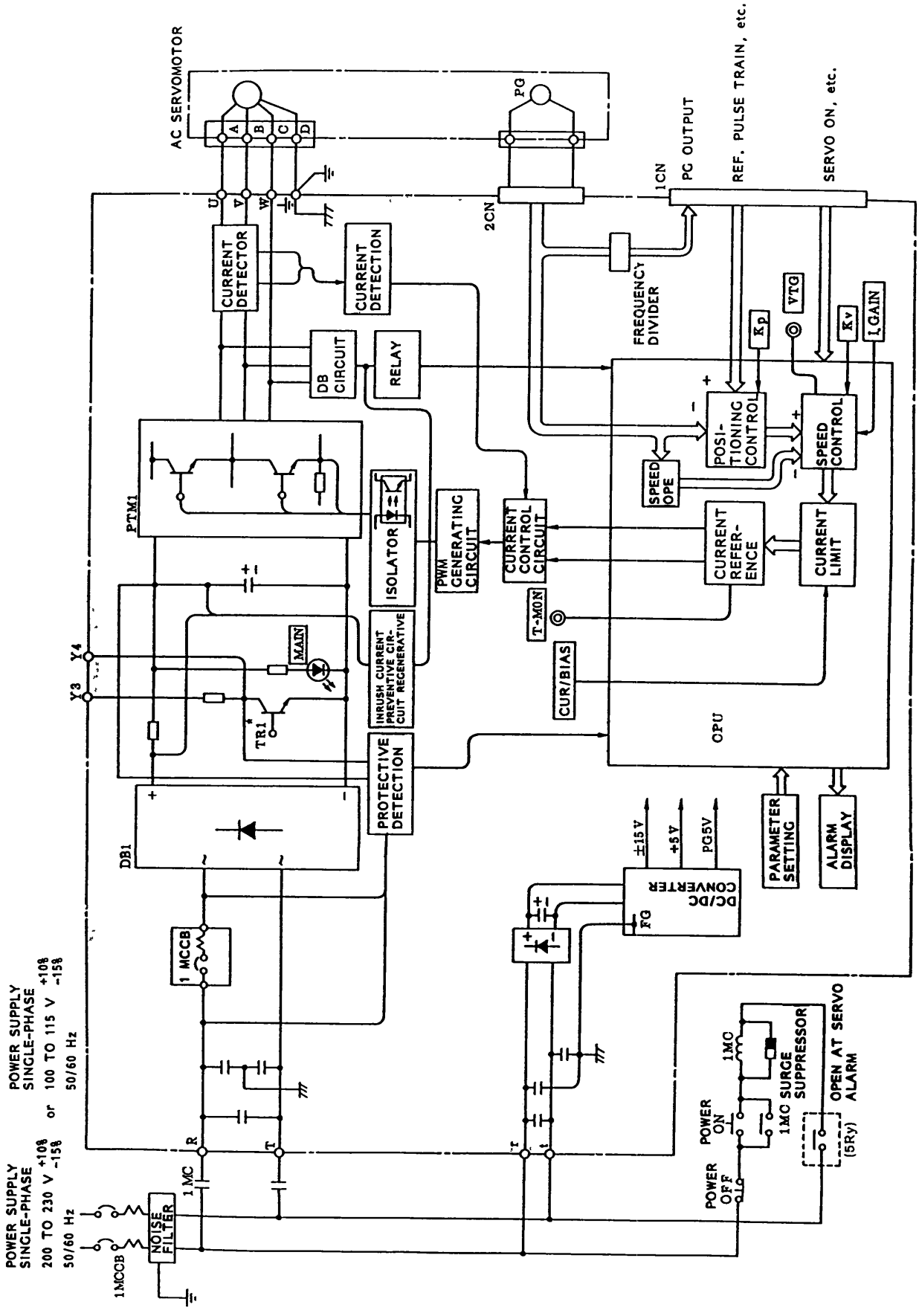



Fig 5.2 Internal Block Diagram of SERVOPACK Type CACR-PR[illegible]AC[illegible]R

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



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## 5. 3 MAIN-CIRCUIT TERMINALS

Table 5 1 Main-Circuit Terminals for SERVOPACK

| Terminal Symbol | Name | Description |
|---|---|---|
| (R) (T) | Main-circuit AC input | • For 200V<br>Single phase 200 to 230V $^{+10\%}_{-15\%}$ 50/60Hz<br>• For 100V<br>Single-phase 100 to 115V $^{+10\%}_{-15\%}$ 50/60Hz |
| (U) (V) (W) | Motor connection | Connects terminal (U) to motor terminal A (V) to B and (W) to C |
| (r) (t) | Control power input | • For 200V<br>Single-phase 200 to 230V $^{+10\%}_{-15\%}$ 50/60Hz<br>• For 100V<br>Single-phase 100 to 115V $^{+10\%}_{-15\%}$ 50/60Hz |
| ⏚ | Ground | Connects to motor terminal D<br>Must be securely grounded |
| (Y3) (Y4) | Regenerative register | External connection not usually required |

## 5. 4 CONNECTOR TERMINAL (1CN) FOR I/O SIGNAL

### 5 4 1 Specifications of Applicable Receptacles

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

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

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

### 5. 4 2 Connector 1CN Layout and Connection of SERVOPACK

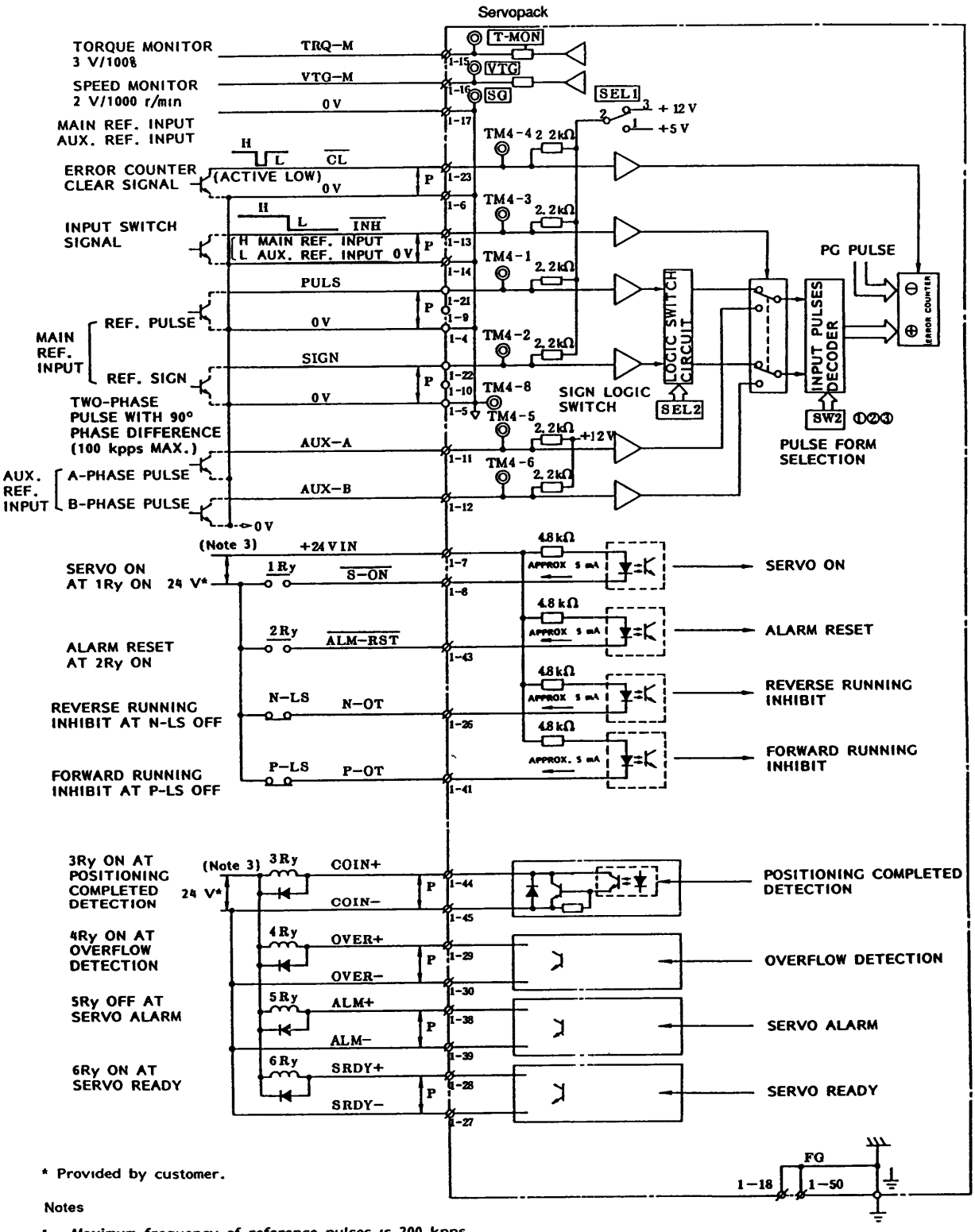
The terminal layout of the SERVOPACK I/O signal connectors (1CN) is shown in Table 5.3. The external connection and external signal processing are shown in Fig.5.4.

Table 5 3 Connector 1CN Layout of SERVOPACK

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



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Notes

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

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



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## 5 4 3 I/O Signals of Connector 1CN

Table 5 4 Input Signals of Connector 1CN

| Signal Name | Connector 1CN No. | Function | | Description |
|---|---|---|---|---|
| $\overline{\text{S-ON}}$ | 8 | Servo ON | | Inputting this signal makes the SERVOPACK ready to receive pulse reference input.<br>Base block is cleared. |
| $\overline{\text{ALM-RST}}$ | 43 | Alarm reset | | This signal resets the alarm. |
| N-OT | 26 | Reverse running inhibit | | In the case of linear drive, etc., connect limit switch signal according to the run direction. It is "closed" during normal run. When limit switch is tripped, it becomes "open". |
| P-OT | 41 | Forward running inhibit | | |
| +24 VIN | 7 | +24 V | | External power supply to 1CN-8, 24, 41 and 43. Prepare a 24 VDC (20 mA min.) power supply. |
| PULS | 21 (4) | Reference pulse input | Main ref. input | Pulse train frequency = $\frac{\text{Motor speed (r/min)}}{60} \times$ Dividing ratio × No. of PG pulses (pulse/rev) × M ≤ 200 kpps. (M:PG multiplication factor ... 1, 2, 4)<br>Pulse width = Duty must be 50% at the maximum frequency used ≥ 2.5 μs. |
| SIGN | 22 (5) | Reference sign input | | (For positive logic)<br>Forward rotation command: H-level<br>Reverse rotation command: L-level |
| *PULS | 9 | (Reference pulse input) | | When reference pulse signal is line driver output, use PULS signal in pairs. |
| *SIGN | 10 | (Reference sign input) | | When reference sign signal is line driver output, use SIGN signal in pairs. |
| $\overline{\text{CL}}$ | 23 (6) | Error counter signal | | Blocks reference and feedback pulses.<br>Clears the error counter at L-level. |
| $\overline{\text{INH}}$ | 13 (14) | Input change signal | | Changes the main reference input and auxiliary reference input.<br>· H-level: Main reference input effective.<br>· L-level: Auxiliary reference input effective. |
| AUX-A | 11 | Aux. reference pulse input | Phase-A signal | Aux. reference pulse is effective when INH signal is in L-level. Inputs two-phase pulse with 90° phase difference, and processed by number of four multipliered pulses.<br>· Phase-B leading: forward running reference<br>· Phase-A leading: reverse running reference |
| AUX-B | 12 | | Phase-B signal | |



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Table 5 5 Output Signals of Connector 1CN

| Signal Name | Connector 1CN No. | Function | | Description |
|---|---|---|---|---|
| ALM | 38 (39) | Servo alarm | | Turns OFF if malfunction is detected. For details, refer to Par 6.10. |
| $\overline{\text{S-RDY}}$ | 28 (27) | Servo ready | | Turns ON when main power supply ON, and no servo alarm. |
| $\overline{\text{COIN}}$ | 44 (45) | Positioning completion signal | | Output when No. of lag pulses of the error counter reaches the range of the set value (±1 to ±7) × 1 or × 5. |
| $\overline{\text{OVER}}$ | 29 (30) | Overflow detection signal | | Outputs when No. of lag pulses of the error counter exceeds the specified value. No. of lag pulses = $\frac{4}{Kp} \times \frac{\text{Motor speed (r/min)}}{60} \times$ (Frequency dividing ratio) × No. of pulses (pulse/rev) × M ≤ $2^{20}$ pulses (M: PG multiplication factor ... 1, 2, 4) |
| TRQ-M | 15 | Torque monitor | | ±3.0 V/rated torque ±10%, ±9 V max., load 1 mA or below. |
| VTG-M | 16 | Speed monitor | | ±2.0 V/1000 r/min ±5%, load 1 mA below. |
| PAO | 33 | Positioning signal output-1 | Phase A | Encoder output signal after frequency division is output at line driver (T1 MC3487). To be received by line receiver (T1 MC3486). |
| *PAO | 34 | | Phase $\overline{\text{A}}$ | |
| PBO | 35 | | Phase B | |
| *PBO | 36 | | Phase $\overline{\text{B}}$ | |
| PCO | 19 | | Phase C | |
| *PCO | 20 | | Phase $\overline{\text{C}}$ | |
| PCOT | 37 | Positioning signal output-2 Phase C | | Open collector output<br>Max. operating voltage: 30 VDC<br>Max. input current: 20 mADC |
| AL01<br>AL02<br>AL03 | 47 (1)<br>48 (2)<br>49 (3) | Alarm output code (BCD code) | | Open collector output<br>Max. operating voltage; 30 VDC<br>Max. input current: 20 mADC |



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

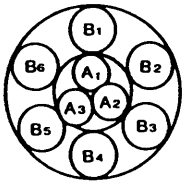
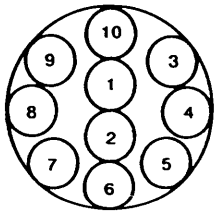
### 5.5.1 Specifications of Applicable Receptacles and Cables (Table 5.6)

Table 5.6 Specifications of Applicable Receptacles and Cables

| Connector Type* used in SERVOPACK | Applicable Receptacle Type | | | | Connection Cable# |
|---|---|---|---|---|---|
| | Manufacturer | Soldered Type | Caulking Type | Case† | |
| MR-20RMA, right angle 20P | Honda Tsushin Co., Ltd | MR-20F‡ | MRP-20F01 | MR-20L‡ | DP8409123 or DE8400093 |

*Made by Honda Tsushin Co., Ltd
†Attached to each applicable receptacle (soldered and caulking types)
‡Attached to SERVOPACK when shipping
#The cables listed in Table 5.7 are available on request. If required, purchase in units of standard length as shown in Table 5.7

Table 5.7 Details of Specifications of Applicable Cables

| Connection | Soldered Type | Caulking Type |
|---|---|---|
| Yaskawa Drawing No | DP 8409123 | DE 8400093 |
| Manufacturer | Fujikura Cable Co | |
| General Specifications | Double, KQVV-SW' AWG 22 × 3 C AWG 26 × 6 P | KQVV-SB AWG 26 × 10 P |
| Internal Composition and Lead Color | For Soldered Type   | For Caulking Type   |
| | A1 Red<br>A2 Black<br>A3 Green yellow<br>B1 Blue White/blue<br>B2 Yellow White/yellow<br>B3 Green White/green<br>B4 orange White/orange<br>B5 Purple White/purple<br>B6 Grey White/grey<br>Twisted cable | 1 Blue-White-<br>2 Yellow-White<br>3 Green-White<br>4 Red-White<br>5 Purple White<br>6 Blue Brown<br>7 Yellow-Brown<br>8 Green-Brown<br>9 Red-Brown<br>10 Purple Brown<br>Twisted Cable |
| Yaskawa Standard Specifications | Standard length 5 m, 10 m, 20 m Terminal ends are not provided (without connectors) | |

### 5.5.2 SERVOPACK Connector (2CN) Terminal Layout and Connection

The terminal layout for the SERVOPACK connectors (2CN) for connecting the optical encoder is shown in Table 5.7, and the connection method of 2CN and the optical encoder, in Figs. 5.4 and 5.5.

Table 5.8 Connector 2CN Layout of SERVOPACK

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

Note: For DIR, see Par 6.9.1.

Notes
1 When applicable cables listed in Table 5.7 are used, allowable wiring distance between SERVOPACK and motor is a maximum of 20 meters
2 The cable applied for 50 m wiring distance is available on order (Yaskawa drawing No DP8409179) If wiring distance is 20 m or more, contact your Yaskawa representative



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

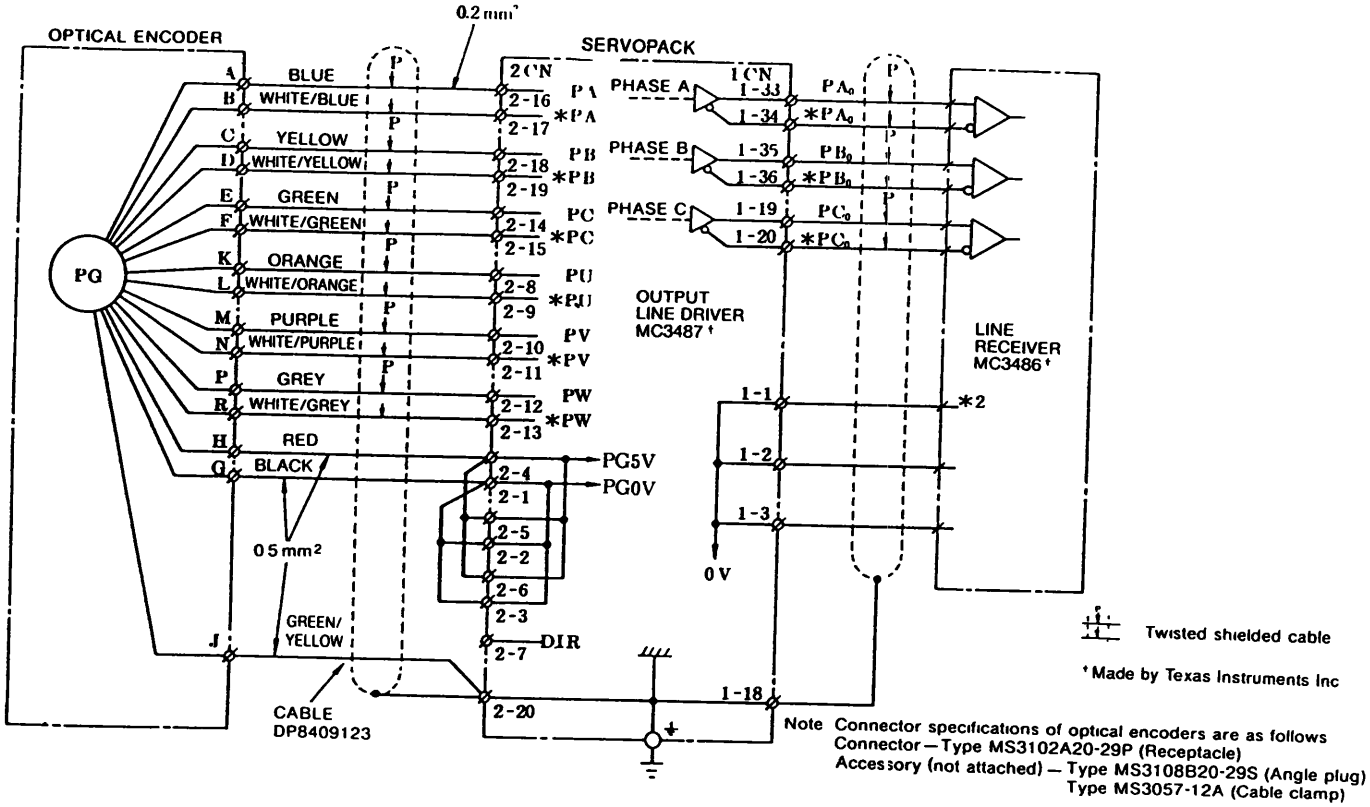



Fig 5 4 Soldered Type Connector 2CN Connection and 1CN Output Processing
(When using Connection Cable DP8401923)

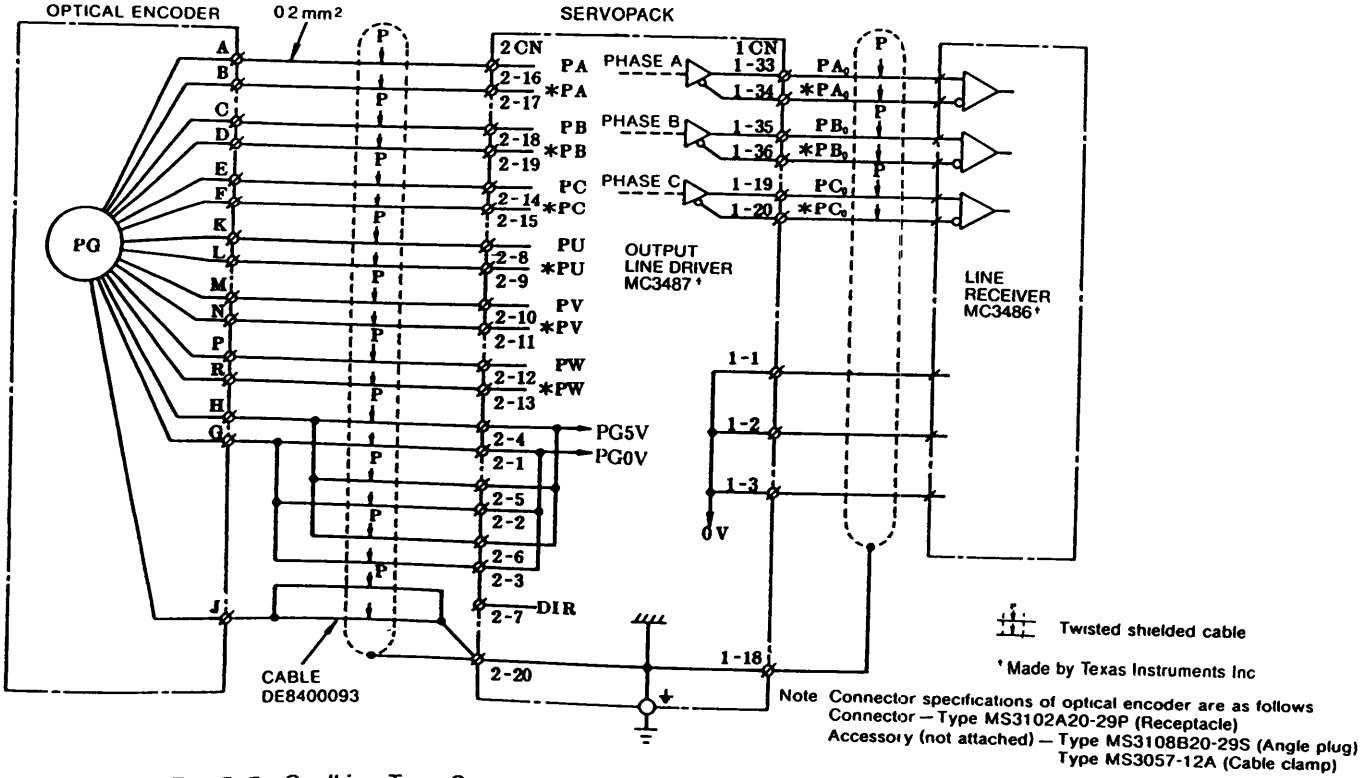



Fig 5 5 Caulking Type Connector 2CN Connection and 1CN Output Processing
(When using Connection Cable DE8400093)



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# 6. OPERATION

## 6.1 POWER ON AND OFF

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

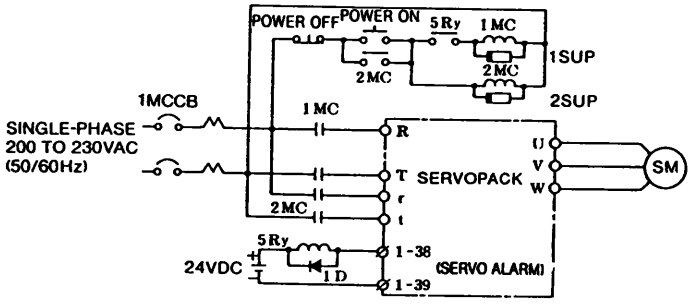
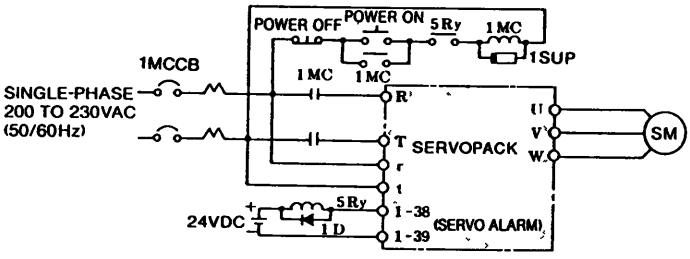



Fig 6 1 Connection Example for Simultaneous Control Power ON/OFF
(When using AC SERVOMOTOR for 200V)




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

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

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

Precautions for connections
(in Figs.6.1 and 6.2)

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

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

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

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



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## 6.2 POSITIONING REFERENCE

### 6 2.1 Input Reference Pulse

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

(1) Logic level of input reference pulse

For input reference pulse, positive logic (active H) or negative logic (active L) can be selected by switch SEL2. See Table 6.1.

(2) Reference pulse mode

Three types of signals can be input as reference pulses. Set switches SW3-①, -②, and ③ according to the reference pulse modes and multipliers (only for 2-phase signals), as shown in Table 6.2.

Table 6 1 Logic Level of Reference Pulse

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

○. Short-circuited ○ Open

* Standard factory-adjusted switch setting

Table 6 2 Reference Pulse Mode

| | Reference Pulse Mode | Input Pin No. | Forward Running Reference of Motor | Reverse Running Reference of Motor | Input Multiplier* | SW2† ① | ② | ③ |
|---|---|---|---|---|---|---|---|---|
| Positive Logic Setting | Sign + Pulse Train | 1CN- ㉑ 1CN- ㉒ | "H" | "L" | — | | ○ | ○ |
| | Two-Phase Pulse Train with 90° Phase Difference (1, 2 or 4 Times) | 1CN- ㉑ 1CN- ㉒ | 90° | 90° | × 1 | ○ | ○ | ○ |
| | | | | | × 2 | ○ | ○ | |
| | | | | | × 4 | ○ | | ○ |
| | CW Pulse Train + CCW Pulse Train | 1CN- ㉑ 1CN- ㉒ | "L" | "L" | — | | ○ | |
| | Reference Pulse Mode | Input Pin No. | Forward Running Reference of Motor | Reverse Running Reference of Motor | Input Multiplier* | SW2† ① | ② | ③ |
| Negative Logic Setting | Sign + Pulse Train | 1CN- ㉑ 1CN- ㉒ | "L" | "H" | — | | ○ | ○ |
| | Two-Phase Pulse Train with 90° Phase Difference (1, 2 or 4 Times) | 1CN- ㉑ 1CN- ㉒ | 90° | 90° | × 1 | ○ | ○ | ○ |
| | | | | | × 2 | ○ | ○ | |
| | | | | | × 4 | ○ | | ○ |
| | CW Pulse Train + CCW Pulse Train | 1CN- ㉑ 1CN- ㉒ | "H" | "H" | — | | ○ | |

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

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



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

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

* Motor speed

(3) Interface of reference pulse

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

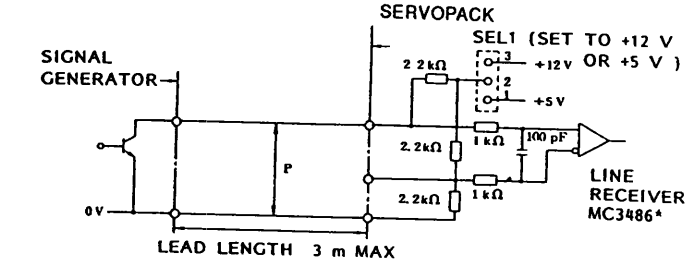
Table 6 4 Voltage Level Setting of Reference Pulse

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

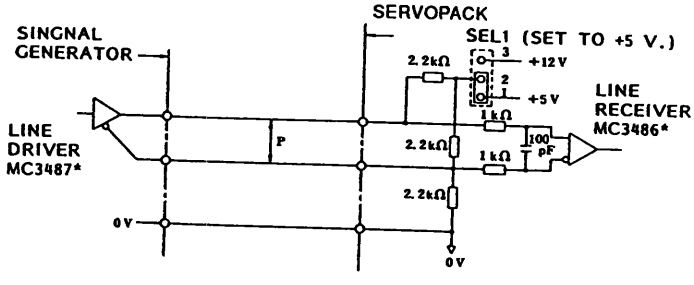
* The voltage level set by SEL1 can also operate $\overline{CL}$ and $\overline{INH}$.
† Line driver is set the setting plugs to this position.

(4) Input circuit

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




(a) For open collector




(b) For line driver

* Made by Texas Instruments Inc

Fig 6 3 Reference Pulse Input Circuit

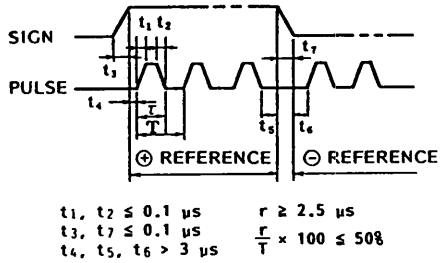
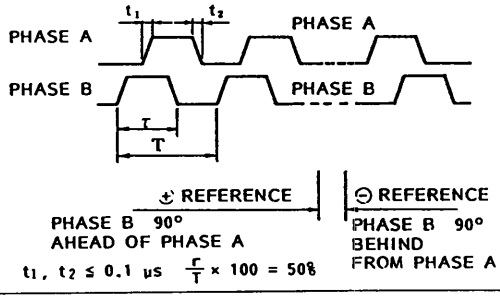
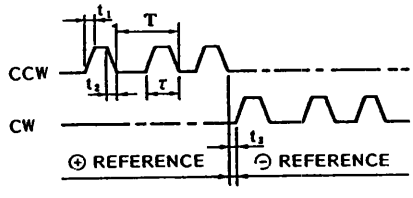


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(5) Reference pulse voltage and timing

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

Table 6 5 Applicable Voltage Level and Timing

| Item | | Electrical Specifications | | Remarks |
|---|---|---|---|---|
| Voltage Level of Signal | +12 V Level | H Level | +10.8 V to +12 V | +5 V level or +12 V level is set by internal switch SEL1. |
| | | L Level | 0 V to +1.2 V | |
| | +5 V Level | H Level | +4.2 V to +5 V | |
| | | L Level | 0 V to +0.8 V | |
| | | Line driver | (H level-L level) > 2.0 V | |
| Reference Pulse Signal Mode | Sign + Pulse Train Input (SIGN + PULSE Signal) |  t1, t2 ≤ 0.1 μs; t3, t7 ≤ 0.1 μs; t4, t5, t6 > 3 μs; τ ≥ 2.5 μs; $\frac{\tau}{T}$ × 100 ≤ 50% | SIGN: H - ⊕ Reference L - ⊖ Reference |
| | 2-phase Pulse with 90° Phase Difference (Phase A + Phase B) |  t1, t2 ≤ 0.1 μs $\frac{\tau}{T}$ × 100 = 50% | Multipher mode is set by the internal switch SW2- ① to - ③ . |
| | CCW Pulses + CW Pulses |  t1, t2 ≤ 0.1 μs; t3 > 3 μs; τ ≥ 2.5 μs; $\frac{\tau}{T}$ × 100 ≤ 50% | — |

Note Maximum reference frequency is 200 kpps

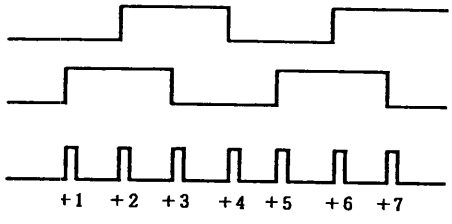
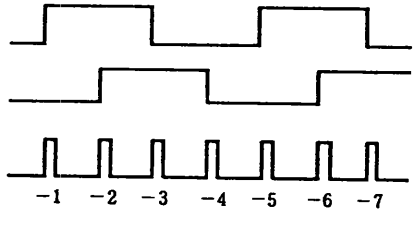
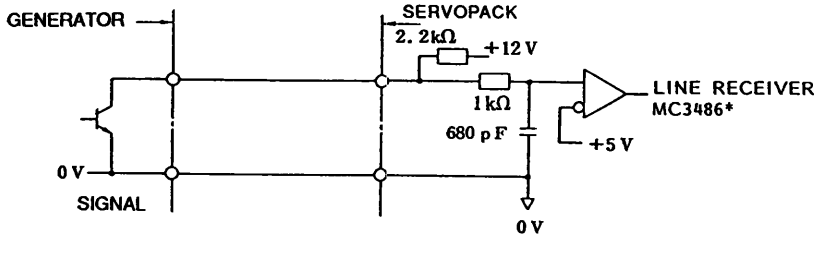


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### 6.2.2 Auxiliary Reference Pulse Signal

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

Table 6.6 Specifications of Auxiliary Reference Pulse

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

* Made by Texas Instruments Inc



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### 6 2 3 Other Input Signals

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

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

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

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

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

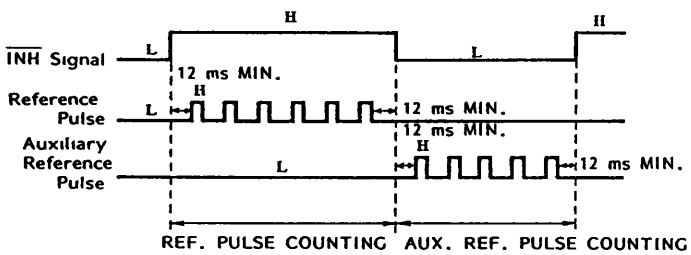



Fig 6 4 Timing of $\overline{INH}$, Reference Pulse and Auxiliary Reference Pulse Signals

### 6. 2. 4 Other Output Signals

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

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

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

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

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

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

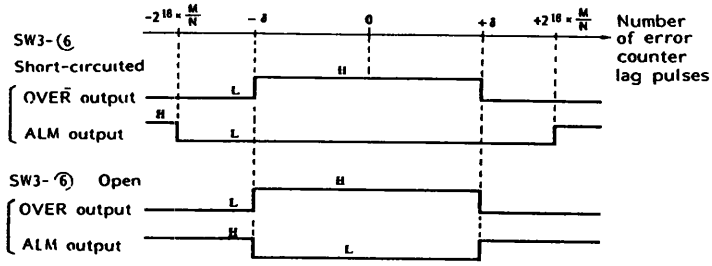



Fig 6 5 Relationship of $\overline{OVER}$ and $\overline{ALM}$ Outputs

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

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

Table 6. 7 Setting of Lag Pulses

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

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

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

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

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

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



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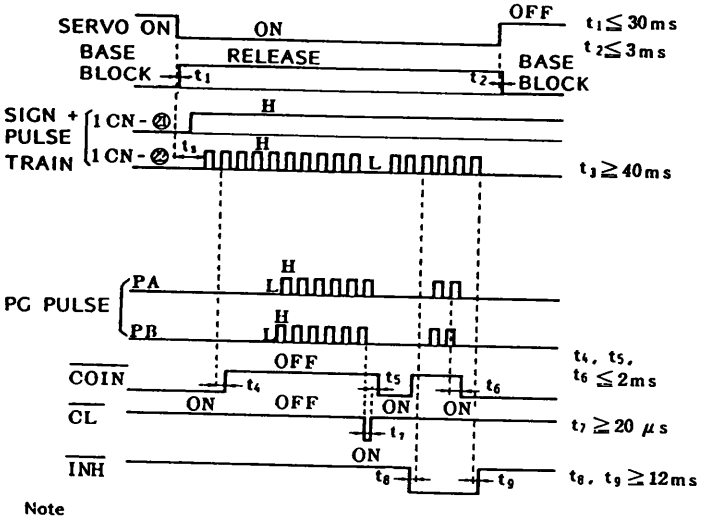
## 6.3 I/O SIGNAL TIMING

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

: PG pulse frequency dividing ratio = 1

: Output multiplier = 1

: Width of positioning completion = ±1 pulse




Note

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

Fig 6 6 Timing Chart of I/O Signal

## 6.4 CONFIGURATION OF I/O CIRCUIT

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

### 6.4 1 Input Circuit

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

**NOTE**

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

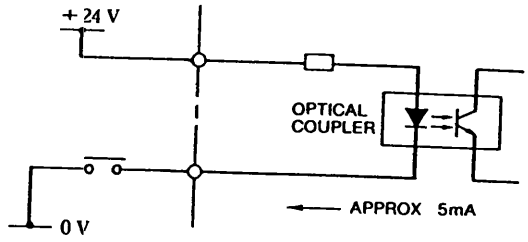



Fig 6 7 Configuration of I/O Circuit

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

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

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

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

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

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

**NOTE**

When the overtravel prevention circuit is not used, connect 1CN-㉖ and ㊶ to the 0 V terminal of the external 24 V power supply.

(2) Servo ON (S-ON)

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

**NOTE**

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



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

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

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

### 6 4 2 Output Circuit

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

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

Applied Voltage(Vmax) ≦ 30 V

Conduction Current (Ip) ≦ 50 mA

**NOTE**

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

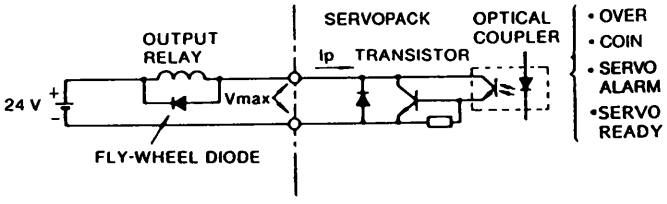



Fig 6.8 Output Circuit

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

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

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

(1) Signal form

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

(2) Output circuit and receiver circuit

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

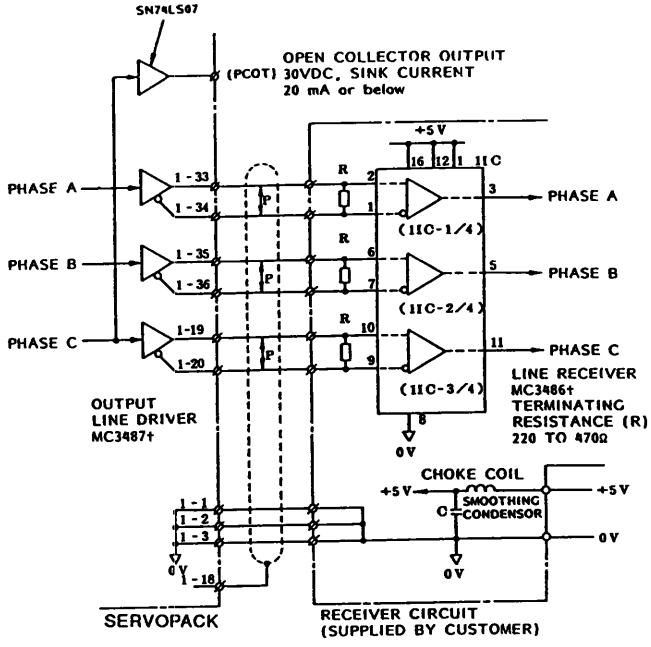
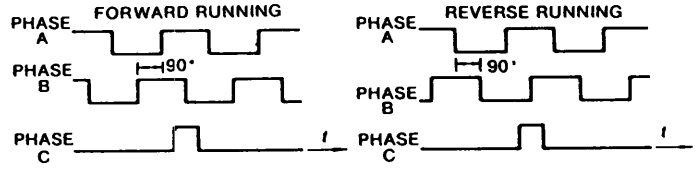



Fig 6 9 Output Circuit and Receiver Circuit

(3) Output phase




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

Fig 6. 10 Output Phase

(4) Pulse resolution

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

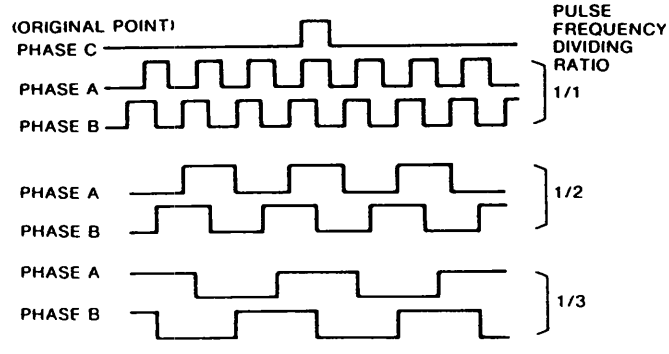



Fig 6 11 Output Waveform of Optical Encoder



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Table 6 8 Setting of PG Pulse Frequency Dividing Ratio

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

＊Hexadecimal digital switch
† Initial setting

(5) Output multiplier circuit

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

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

Table 6 9 Setting of Output Multiplier Circut

| SW1 | | Multiplier |
|---|---|---|
| ① | ② | |
| ○ | ○ | × 1 |
| | ○ | × 1 |
| ○ | | × 2 |
| | | × 4 |

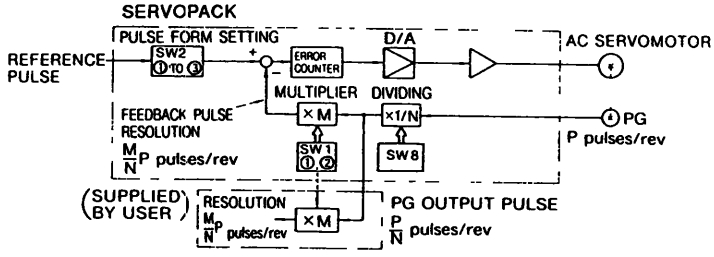
Note
1 Circles indicate the positions of short-circuit pins
2 The relationship of pulse frequency dividing ratio(N), multiplier (M) and rotation angle per pulse are as follows

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

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

6 4.4 I/O Pulses

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



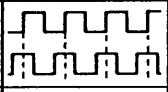
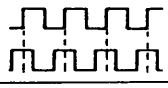
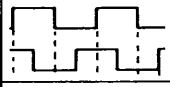
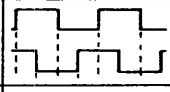
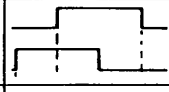
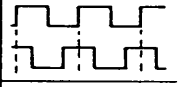
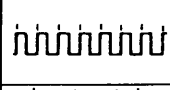
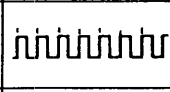
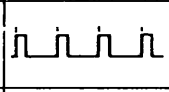
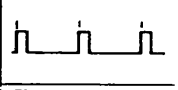
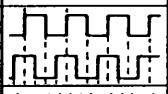
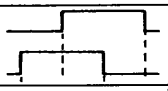
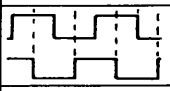
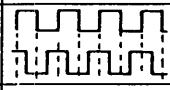
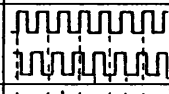
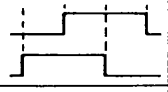
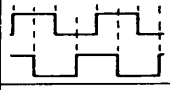
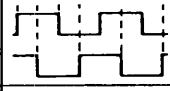
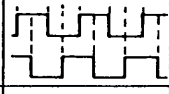
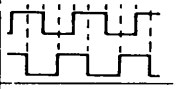

Note When the same number of pulses obtained from feedback pulse resolution is required, multiply the PG output pulses by the number (M) set by switches SW1-① and -② in the SERVOPACK

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



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Table 6 10 I/O Pulses

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

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

### 6.4.5 Setting Number of Optical Encoder Pulses

The optical encoder issues numbers of pulses, 1000 or 1500 pulses/rev. These pulses are set by the short switch (SW3- ③ ) in the SERVOPACK.

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

- The number of pulses of the optical encoder is indicated with the type of the SERVOMOTOR.
- The number of pulses of the SERVOPACK's optical encoder set at the factory is indicated with the type of the SERVOPACK. (The factory setting is E: 1500 pulses/rev.)

If the number of pulses of the SERVOPACK's optical encoder set at the factory is different from the number of motor pulses, change the setting switches in the SERVOPACK according to Tables 10.2 and 10.7.



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## 6.5 PROTECTIVE CIRCUIT

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

(1) Dynamic brake function

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

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

(2) Trouble detecting functions

Table 6.11 Trouble Detecting Functions

| Trouble | Detection |
|---|---|
| Overcurrent (OC) | Overcurrent flow in the main circuit (at 1.2 times min. inst max. current) |
| Circuit Protector Trip (MCCB) | Circuit protector tripped |
| Regeneration Trouble (RG) | Regenerative circuit not activated in SERVOPACK<br>• For 200 V: only 200 to 700 W<br>• For 100 V: only 200 to 500 W |
| Overflow (OF) | Excessively large number of lag pulses of error counter |
| Overvoltage (OV) | Excessively high DC voltage in the main circuit (detected at approx. 420 V) |
| Overspeed (OS) | Excessively large speed reference input (detected at approx. 4900 r/min) |
| Overrun Prevention (PG) | Wrong wiring of motor circuit or PG signal line |
| Voltage Drop(UV) | Low DC voltage in the main circuit after power ON (150 V or less.) |
| Overload (OL) | Overload condition of motor and SERVOPACK |
| CPU Error (CPU) | Any error of CPU |

(3) Overload (OL) detection level

Fig.6.13 shows the setting of overload detection level at 100% rated motor current. If the allowable power-on time during motor locking is maximum, the higher the motor speed is, the quicker the motor responce to the same overload.

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

If any trouble detection circuits in Table 6.11 functions, the power drive circuit in the SERVOPACK goes off, 7-segment LEDs indicate the operation condition and a servo alarm signal is output.

The alarm codes are also output to the external through open collector output circuits of AL01 to AL03. See Table 6.12.

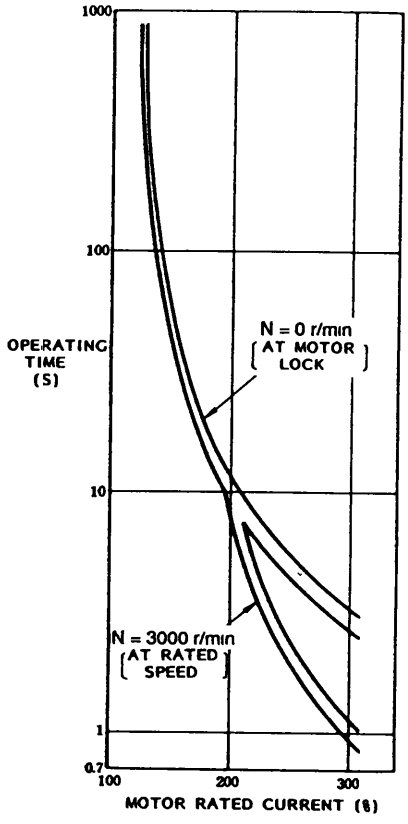



Fig 6.13 Overload Characteristics

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

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

○ . Output transistor is turned ON

× Output transistor is turned OFF

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



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(5) Protective circuit operation

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

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

**CAUTION**

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

(6) Resetting servo alarm

To reset the servo alarm, turn ON the alarm reset (ALM-RST) signal of input signal, or turn OFF the control power supply once.

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

## 6.6 LED INDICATION

Table 6 13 LED Status Indications (Green)

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

## 6.7 PRECAUTIONS FOR APPLICATION

### 6 7 1 Minus Load

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

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

Since SERVOPACK has the regenerative brake capability of short time (corresponding to the motor stopping time), for application to a minus load, contact your YASKAWA representative.

### 6 7 2 Load Inertia (J)

The allowable load inertia J converted to the motor shaft must be within ten times the inertia of the applicable AC SERVOMOTOR. If the allowable inertia is exceeded, and overvoltage alarm may be given during deceleration. If this occurs, take the following actions:

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

For details, contact your YASKAWA representative

### 6.7 3 High Voltage Line

If the supply voltage is 400/440 V, the voltage must be dropped, three-phase 400/440 V to single-phase 200 V or 100 V by using a power transformer. Table 6.15 shows the transformer selection. Connection should be made so that the power is supplied and cut through the primary (or secondary) side of the transformer.

## 6.8 PRECAUTIONS OF OPERATION

### 6 8 1 Noise Treatment

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

The SERVOPACK incorporates CPU. This requires wiring and treatment to prevent noise interference. To reduce switching noise as much as possible, the recommended method of wiring and grounding is shown in Fig. 6.14.



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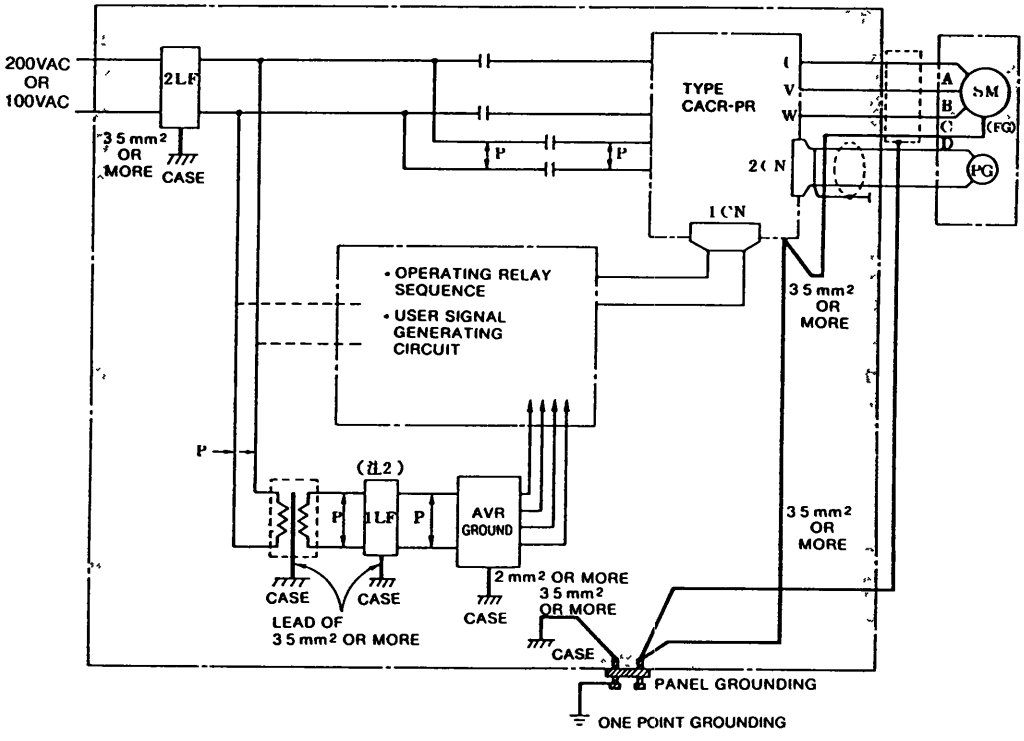
(1) Grounding method (Fig. 6.14)

• Motor frame grounding

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

• SERVOPACK SG 0 V

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




P — Twisted cable

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

Fig 6.14 Grounding Method



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(2) Noise filter installation

When noise filters are installed to prevent noise from the power line, the block type must be used. The recommended noise filter is shown in Table 6.14. The power supply to peripherals also needs noise filter.

**NOTE**

If the noise filter connection is wrong, the effect decreases greatly. Observing the precautions, carefully connect them as shown in Figs. 6.15 to 6.18.

Table 6 14 Recommended Noise Filter

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

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

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

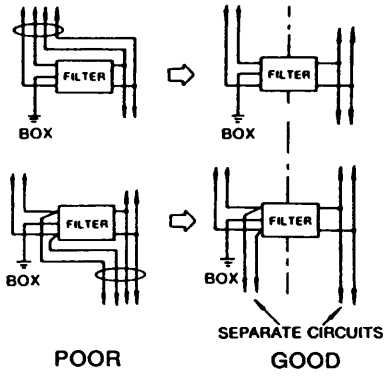



Fig 6.15

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

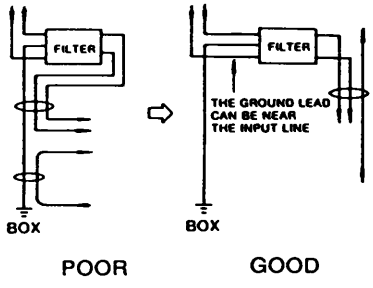



Fig 6 16

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

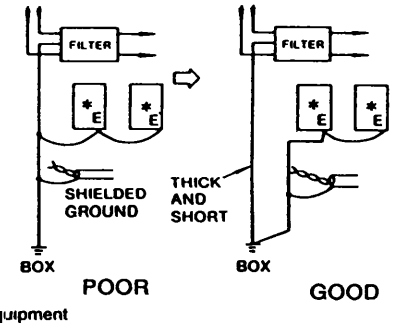



Fig 6.17

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

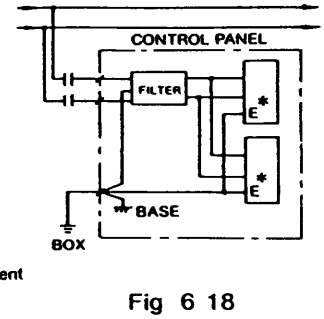



Fig 6 18



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### 6 8 2 Power Line Protection

The Servopack is operated through the commercial power line (200 V or 100 V). To prevent the power line accidents due to grounding error, contact error, or to protect the system from a fire, circuit breakers (MCCB) or fuses must be installed according to the number of SERVOPACKS used (Table 6.15).

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

Table 6 15 Power Supply Capacity and MCCB or Fuse Capacity

| Class | Rated Output W(HP) | SERVOPACK Type CACR- | Power Capacity* per SERVOPACK kVA | Current Capacity† per SERVOPACK A |
|---|---|---|---|---|
| 200V | 50(0.07) | PRA5AC3[ ]R | 0.3 | 5 |
| | 100(0.13) | PR01AC3[ ]R | 0.5 | 5 |
| | 200(0.27) | PR02AC3[ ]R | 0.75 | 5 |
| | 300(0.40) | PR03AC3[ ]R | 1.0 | 7 |
| | 500(0.67) | PR05AC3[ ]R | 1.4 | 11 |
| | 700(0.93) | PR07AC3[ ]R | 2.0 | 15 |
| 100V | 50(0.07) | PRA5AC4[ ]R | 0.3 | 5 |
| | 100(0.13) | PR01AC4[ ]R | 0.5 | 5 |
| | 200(0.27) | PR02AC4[ ]R | 0.75 | 8 |
| | 300(0.40) | PR03AC4[ ]R | 1.0 | 11 |
| | 500(0.67) | PR05AC4[ ]R | 1.4 | 15 |

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

## 6.9 APPLICATION

### 6 9 1 Connection for Reverse Motor Running

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

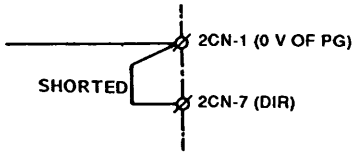



Fig 6 19

### 6 9 2 Speed and Torque Measurement

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

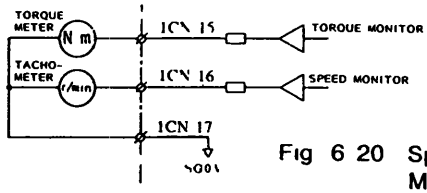
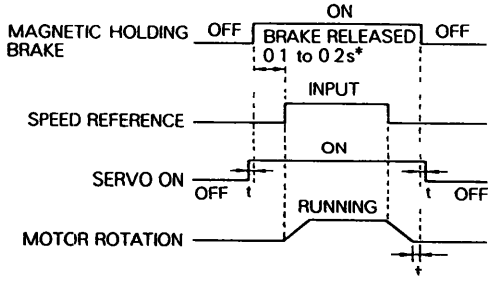



Fig 6 20 Speed and Torque Measurement

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

### 6 9 3 Use of SERVOMOTOR with Holding Magnetic Brake

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




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

Fig 6 21 Magnetic Holding Brake ON-OFF Timing



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# 7. INSTALLATION AND WIRING

## 7.1 RECEIVING

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

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

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

## 7.2 INSTALLATION

### 7 2 1 SERVOMOTOR

AC SERVOMOTOR can be installed either horizontally or vertically.

(1) Before mounting

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

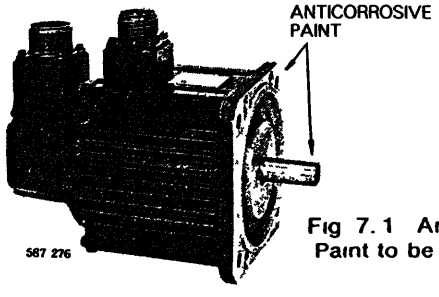



Fig 7.1 Anticorrosive Paint to be Removed

(2) Location

Use the motor under the following conditions.

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

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

(3) Environmental conditions

Ambient Temperature: 0° to +40°C

Storage Temperature: -20°C to +60°C

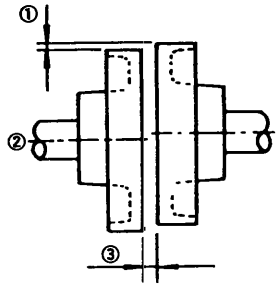
Humidity: 20% to 80% RH (non-condensing)

(4) Load coupling

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

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

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




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

Fig 7 2 Alignment of Coupling

(5) Allowable bearing load

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

When mounting the gear, coupling and pulley, ease the impact on the shaft and avoid excessive force on the bearing. (50G max.)

### 7 2.2 SERVOPACK

(1) Installation

The SERVOPACK type CACR-PR☐☐AC is rack-mounted type.

(2) Location

- When installed in a panel:

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

- When installed near a heat source:

  Keep the temperature around SERVOPACK below 55°C.

- If subjected to vibration:

  Mount the unit on shock absorbing material.

- If corrosive gases are present:

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



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7 2 2 SERVOPACK (Cont'd)

- Unfavorable atmospheric conditions:

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

(3) Mounting Direction

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

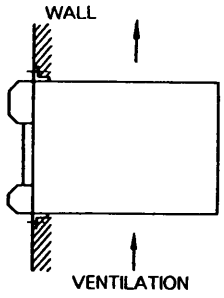



Fig 7 5 Mounting Direction

## 7.3 WIRING

### 7 3 1 Rated Current and Cable Size

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

Table 7 1 Rated Current

| External Terminal | | Type CACR- / Symbol | Rated Current (Effective Current) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 200 V Class | | | | | | 100 V Class | | | | |
| | | | PRA5AC3 | PR01AC3 | PR02AC3 | PR03AC3 | PR05AC3 | PR07AC3 | PRA5AC4 | PR01AC4 | PR02AC4 | PR03AC4 | PR05AC4 |
| On Line | Main Circuit Power Input | Ⓡ Ⓣ | 1.3 | 2.5 | 4.4 | 6.5 | 10.4 | 15.0 | 2.6 | 4.5 | 8.0 | 11.0 | 15.0 |
| | Motor Connection | Ⓤ Ⓥ Ⓦ | 0.7 | 1.0 | 2.0 | 2.7 | 3.6 | 5.7 | 1.2 | 1.7 | 2.9 | 3.6 | 5.5 |
| | Control Power Input | ⓡ ⓣ | 0.5 | | | | | | | | | | |
| Off Line | Control I/O Signal Connector | 1CN | 100 mA DC max. | | | | | | | | | | |
| | PG Signal Connector | 2CN | 100 mA DC max. (500 mA DC for power line only) | | | | | | | | | | |
| | Ground | ⏚ | - | | | | | | | | | | |

Table 7 2 Recommended Cable Size of SERVOPACK

| External Terminal | | Type CACR- / Symbol | Cable Size* $mm^2$ | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 200 V Class | | | | | | 100 V Class | | | | |
| | | | PRA5AC3 | PR01AC3 | PR02AC3 | PR03AC3 | PR05AC3 | PR07AC3 | PRA5AC4 | PR01AC4 | PR02AC4 | PR03AC4 | PR05AC4 |
| On Line | Main Circuit Power Input | Ⓡ Ⓣ | HIV 1.25 or more | | | HIV 2.0 or more | | | HIV 1.25 | | HIV 2.0 or more | | |
| | Motor Connection | Ⓤ Ⓥ Ⓦ | HIV 1.25 or more | | | | | | | | | | HIV 2.0 or more |
| | Control Power Input | ⓡ ⓣ | HIV 1.25 or more | | | | | | | | | | |
| Off Line | Control I/O Signal Connector | 1CN | : Two-core twisted shielded cable<br>: Core must be 0.2 $mm^2$ or more<br>: Tin-plated soft-copper twisted cable<br>· Finished cable dimension. 16 dia or less for 1CN, 11 dia or less for 2CN | | | | | | | | | | |
| | PG Signal Connector | 2CN | | | | | | | | | | | |
| | Ground | ⏚ | HIV 1.25 or more | | | | | | | | | | |

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



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Table 7 3 Cable

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

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

### 7.3 2 Wiring Precautions

The following precautions should be taken for wiring.

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

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

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

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

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

(4) Corrective Action for Radio Frequency Interference (R.F.I)

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

(5) The signal line uses cables whose core is extremely fine (0.2 to 0.3 mm²). Avoid using excessive force which may damage these cables.

### 7 3 3 Power Loss

The power loss of SERVOPACK is shown in Table 7.4. The values are calculated under the following conditions.

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

Table 7 4 Power Loss at Rated Output

| Class | Rated Output W (HP) | SERVOPACK Type CACR-PR | Output Current ±ADC | Power Loss | | | |
|---|---|---|---|---|---|---|---|
| | | | | Main Circuit W | Regenerative Resistance* W | Control Circuit W | Total W |
| 200V | 50 (0.07) | A5AC3□R | 0.7 | 20 | - | 30 | 50 |
| | 100 (0.13) | 01AC3□R | 1.0 | 25 | - | | 55 |
| | 200 (0.27) | 02AC3□R | 2.0 | 30 | 6 | | 66 |
| | 300 (0.40) | 03AC3□R | 2.7 | 35 | 6 | | 71 |
| | 500 (0.67) | 05AC3□R | 3.6 | 55 | 6 | | 91 |
| | 700 (0.93) | 07AC3□R | 5.7 | 50 | 15 | | 95 |
| 100V | 50 (0.07) | A5AC4□R | 1.2 | 20 | - | | 50 |
| | 100 (0.13) | 01AC4□R | 1.7 | 25 | 6 | | 61 |
| | 200 (0.27) | 02AC4□R | 2.9 | 40 | 6 | | 76 |
| | 300 (0.40) | 03AC4□R | 3.6 | 50 | 6 | | 86 |
| | 500 (0.67) | 05AC4□R | 5.5 | 45 | 15 | | 90 |

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



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# 8. DIMENSIONS

## 8.1 SERVOMOTOR DIMENSIONS in mm (inches)

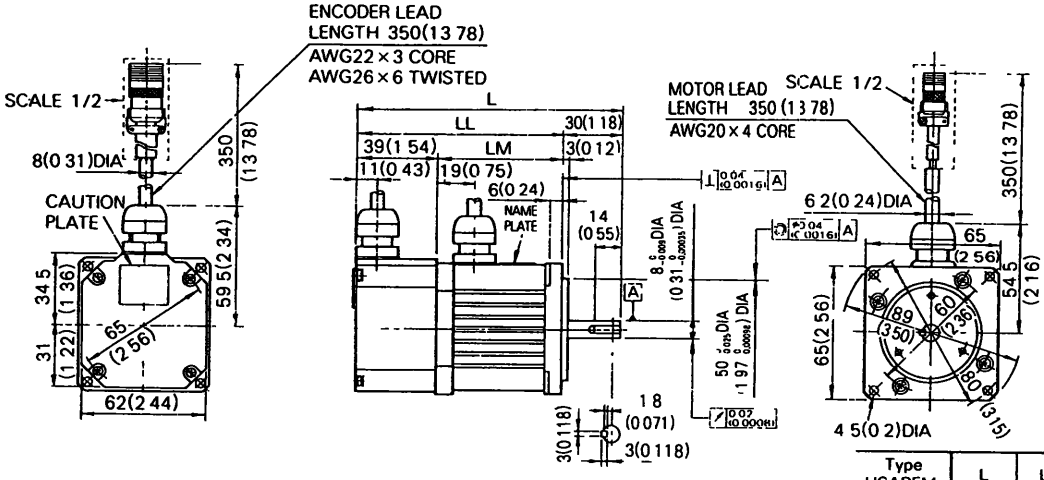
If the capacity is the same, the dimensions are the same even if the voltage or pulse specifications differ (100 V, 200 V, 1500 pulses or 1000 pulses).

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

(1) Standard (with key, straight shaft)

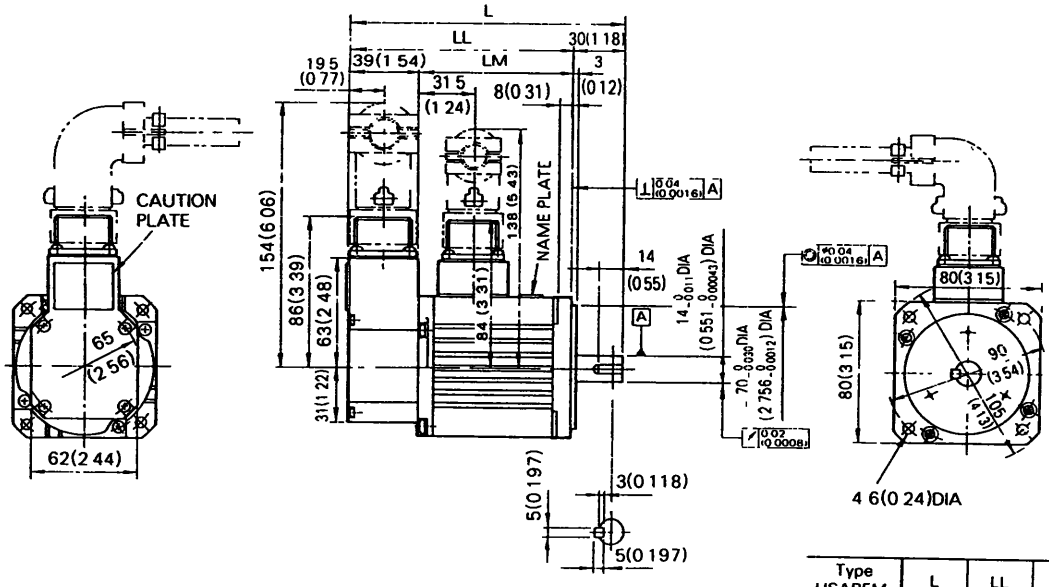
Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1031 "Sunk keys and their corresponding keyways." Parallel key has been attached.

• TYPES USAREM-A5[ ][ ]2K,-01[ ][ ]2K




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

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

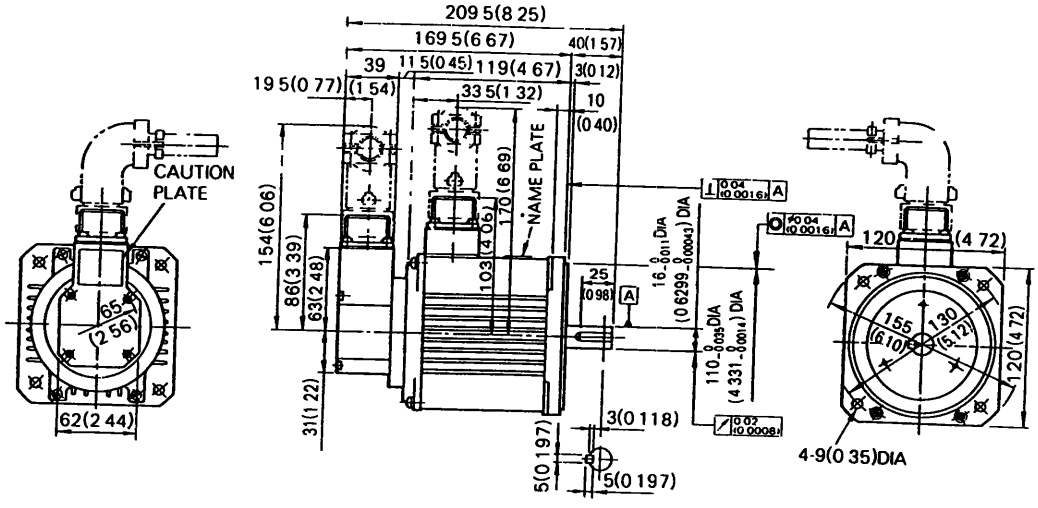



| Type USAREM | L | LL | LM | Approx Mass kg (lb) |
|---|---|---|---|---|
| 02[ ]2K | 156 5 (6 16) | 126 5 (4 98) | 87 5 (3 44) | 2 0 (4 4) |
| 03[ ]2K | 180 5 (7 11) | 150 5 (5 93) | 111 5 (4 39) | 2 6 (5 7) |



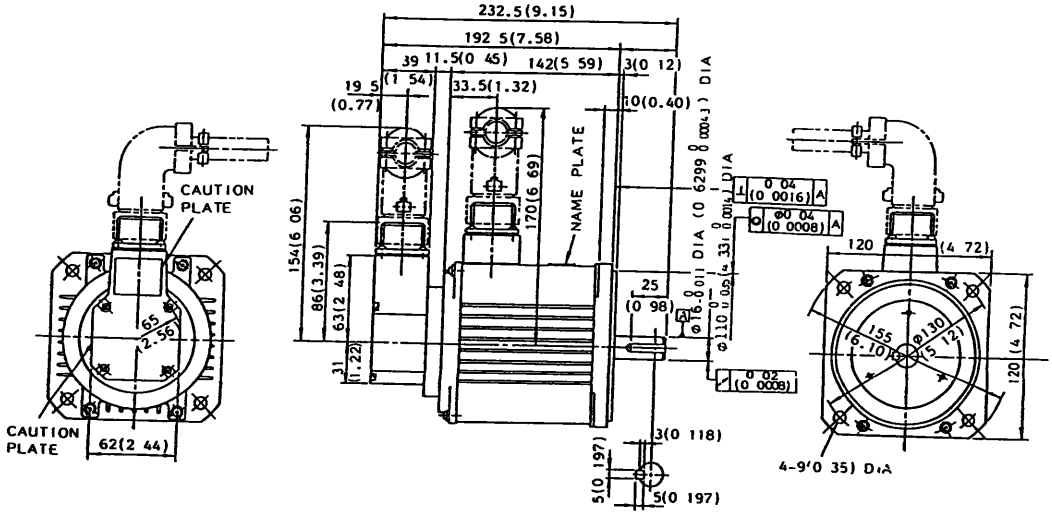
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• TYPE USAREM-05A[ ]2K




Approx Mass 4.4 kg (9.7 lb)

• TYPE USAEM-07C[ ]2K




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

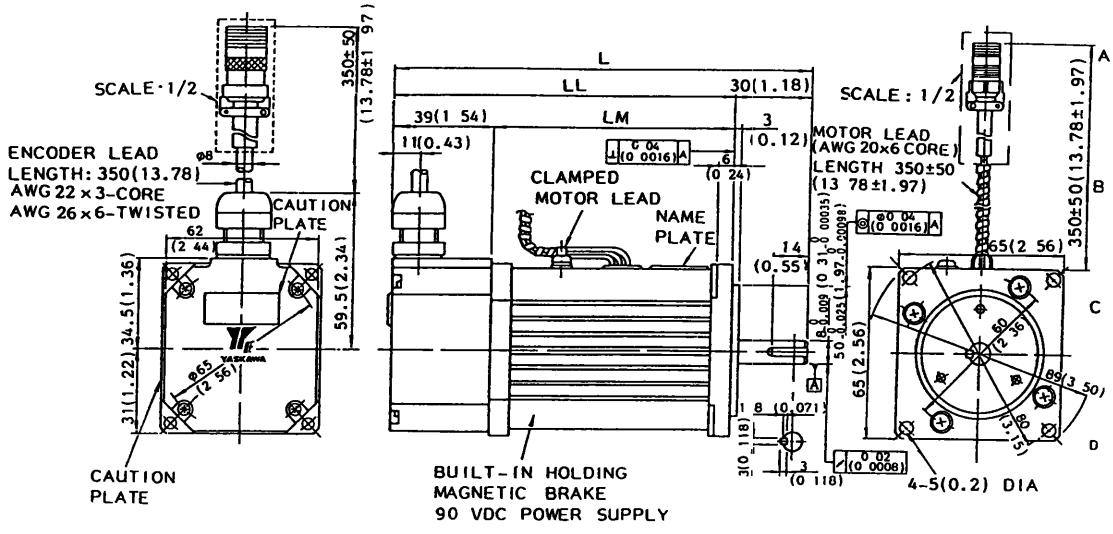
Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1031 "Sunk keys and their corresponding keyways)." Parallel key has been attached.



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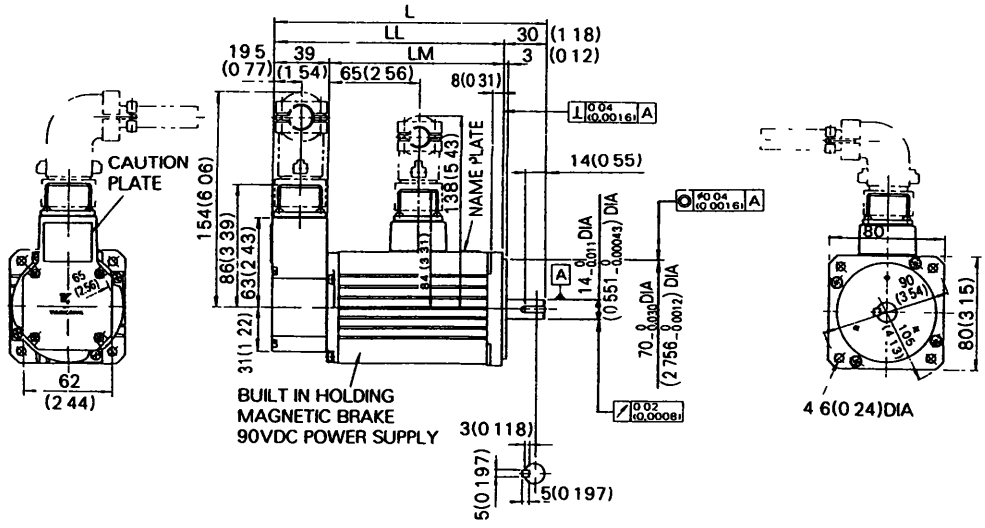
## 8. 1 SERVOMOTOR DIMENSIONS in mm (inches)
(Cont'd)

• TYPES USAREM-A5[ ][ ]2KB, 01[ ][ ]2KB




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

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

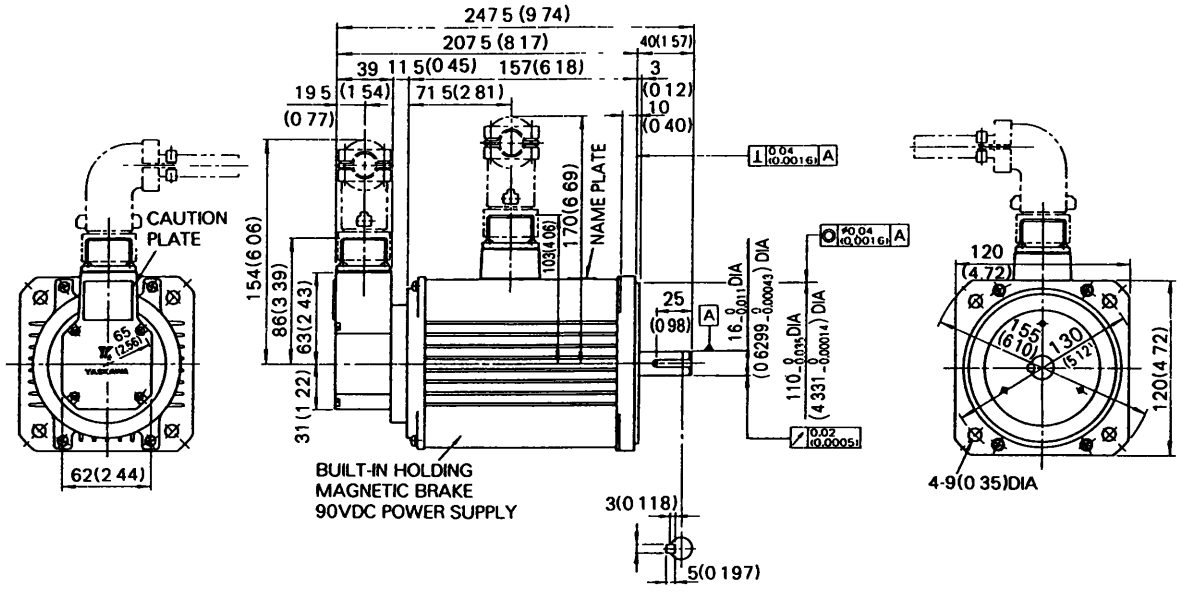



| Type USAREM- | Dimensions L | LL | LM | Magnetic Brake Type | Inertia kg·m²×10⁻⁴ (oz·in·s²×10⁻³) | Static Friction Torque N·m (oz·in) | Voltage VDC | Approx Mass kg (lb) |
|---|---|---|---|---|---|---|---|---|
| 02[ ][ ]2KB | 194 (7 64) | 164 (6 46) | 125 (4 92) | MSB/ 90 20YN | 0 19 (2 73) | 1 961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



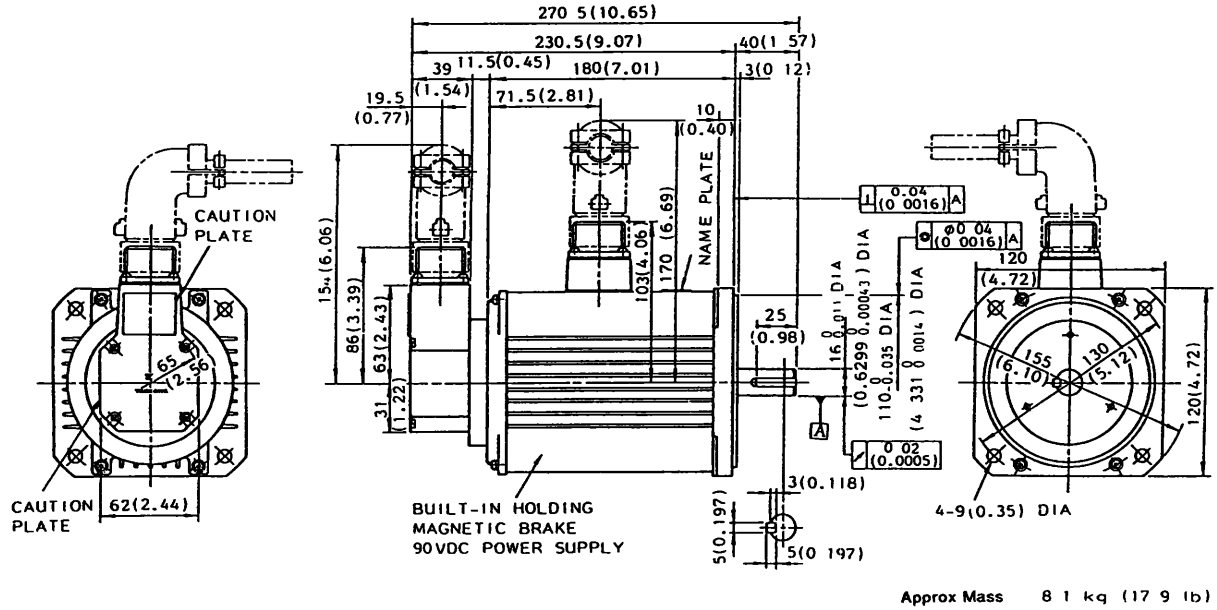
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• TYPES USAREM-05A□2KB




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

• TYPE USAREM-07C□2KB




Approx Mass 8.1 kg (17.9 lb)



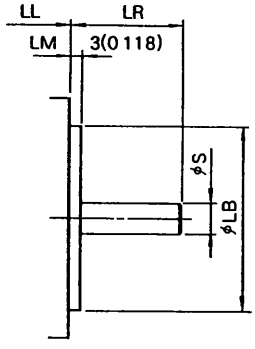
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## 8. 1 SERVOMOTOR DIMENSIONS in mm (inches)
(Cont'd)

### (3) Shaft Externsion of Straight Shaft

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

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

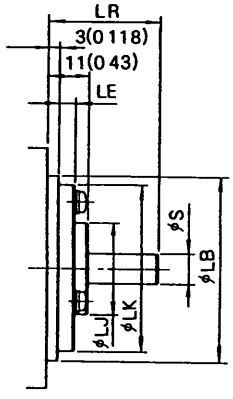



| Without Brake Type USAREM | With Brake Type USAREM | LR | S | LB |
|---|---|---|---|---|
| A5□□2 | A5□□2B | 30 (1 18) | 8 $^{0}_{-0.009}$ (0 31 $^{0}_{-0.00035}$) | 50 $^{0}_{-0.025}$ (1 97 $^{0}_{-0.00098}$) |
| 01□□2 | 01□□2B | | 14 $^{0}_{-0.011}$ (0 551 $^{0}_{-0.00043}$) | 70 $^{0}_{-0.030}$ (2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

### (4) Shaft Extension of Straight Shaft with Oilseal

- TYPE USAREM-A5□2S to -07C□2S (without brake)
- TYPE USAREM-A5□2SB to -07C□2SB (with brake)

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




| Without Brake Type USAREM | With Brake Type USAREM | LR | LE | LJ | LK | S | LB | Oilseal* |
|---|---|---|---|---|---|---|---|---|
| A5□□2S | A5□□2SB | 30 (1 18) | 45 (0 18) | 25 (0 98) | 45 (1 77) | 8 $^{0}_{-0.009}$ (0 31 $^{0}_{-0.00035}$) | 50 $^{0}_{-0.025}$ (1 97 $^{0}_{-0.00098}$) | SB08187 |
| 01□□2S | 01□□2SB | | | | | | | |
| 02□□2S | 02□□2SB | | | 36 (1 42) | 60 (2 36) | 14 $^{0}_{-0.011}$ (0 551 $^{0}_{-0.00043}$) | 70 $^{0}_{-0.030}$ (2 756 $^{0}_{-0.0012}$) | SB14287 |
| 03□□2S | 03□□2SB | | | | | | | |
| 05A□□2S | 05A□□2SB | 40 (1 57) | 25 (0 10) | 50 (1 97) | 73 (2 87) | 16 $^{0}_{-0.011}$ (0 6299 $^{0}_{-0.00043}$) | 110 $^{0}_{-0.035}$ (4 331 $^{0}_{-0.00014}$) | SB16307 |
| 07C□□2S | 07C□□2SB | | | | | | | |

* Nippon Oil Seal Industry Co Ltd

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

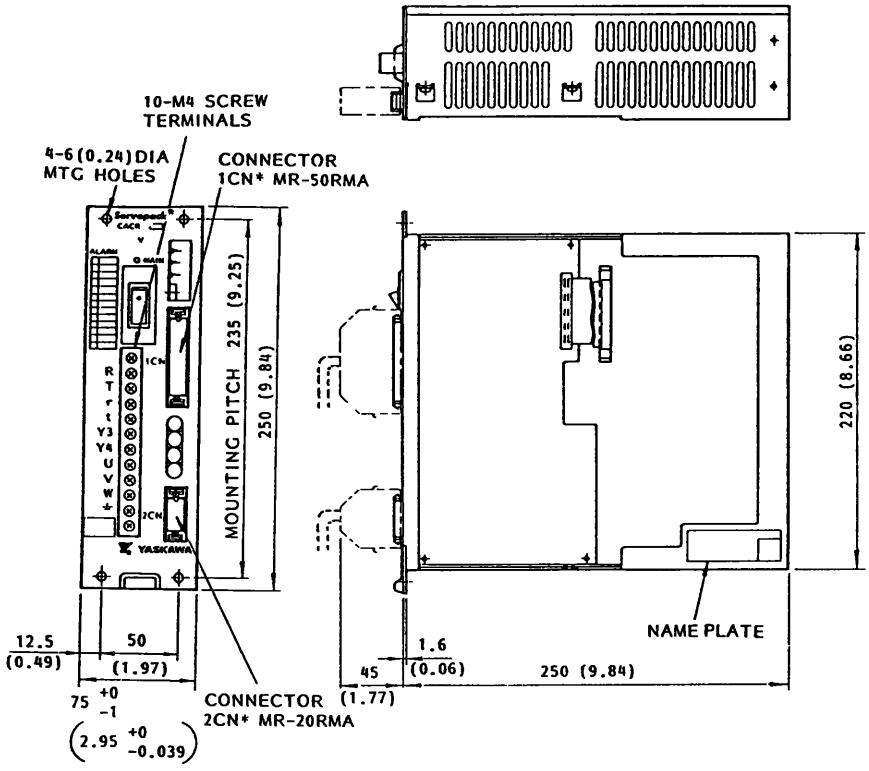
SERVOMOTOR proper and shaft extension are same dimensions as standard SERVOMOTOR. See Par 8.1 (1) and (2). Oilseal is same dimensions as shown in Par. 8.1 (4).

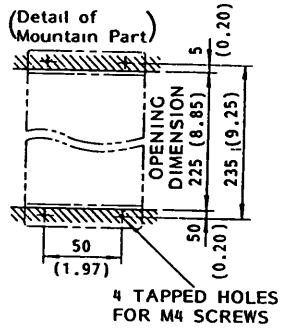


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## 8.2 SERVOPACK DIMENSIONS in mm (inches)

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

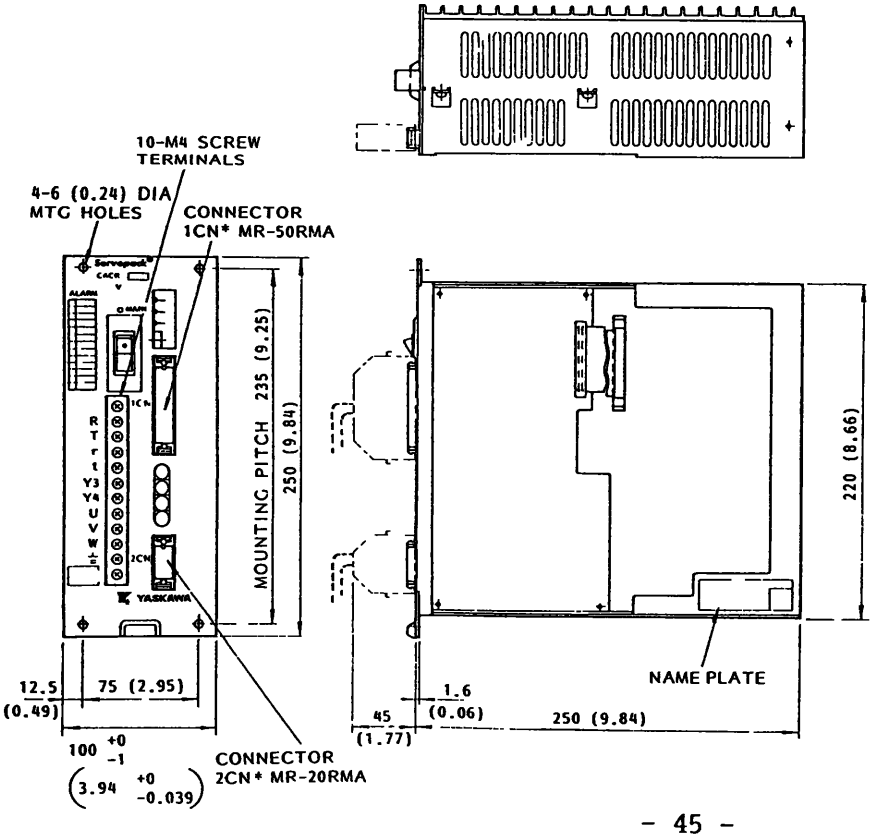


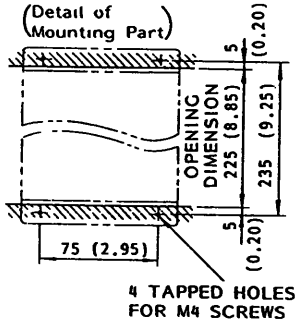




*Made by Honda Tushin Co Ltd

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

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




*Made by Honda Tushin Co Ltd

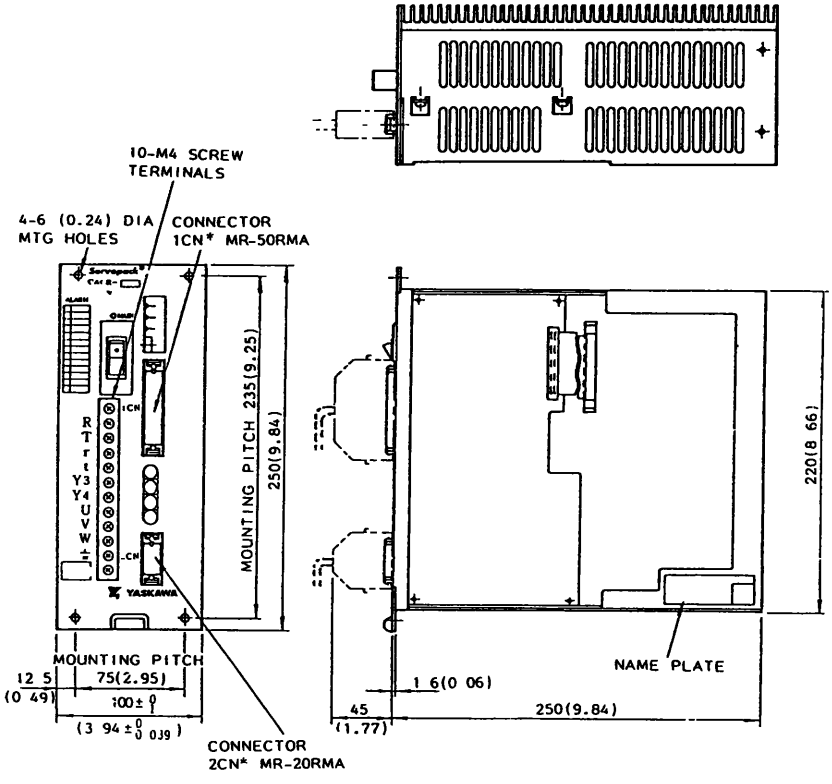
| Connector Symbol | Attachments | | |
|---|---|---|---|
| | Manufacturer | Receptacle Type | Case Type |
| 1CN | Honda Tsushin Co Ltd | MR 50F | MR 50L |
| 2CN | | MR 20F | MR 20L |

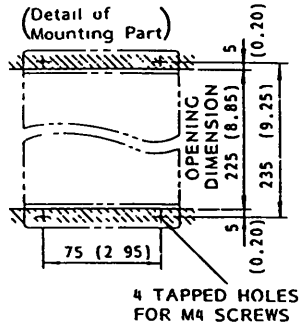


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## 8.2 SERVOPACK DIMENSIONS in mm (inches)
(Cont'd)

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

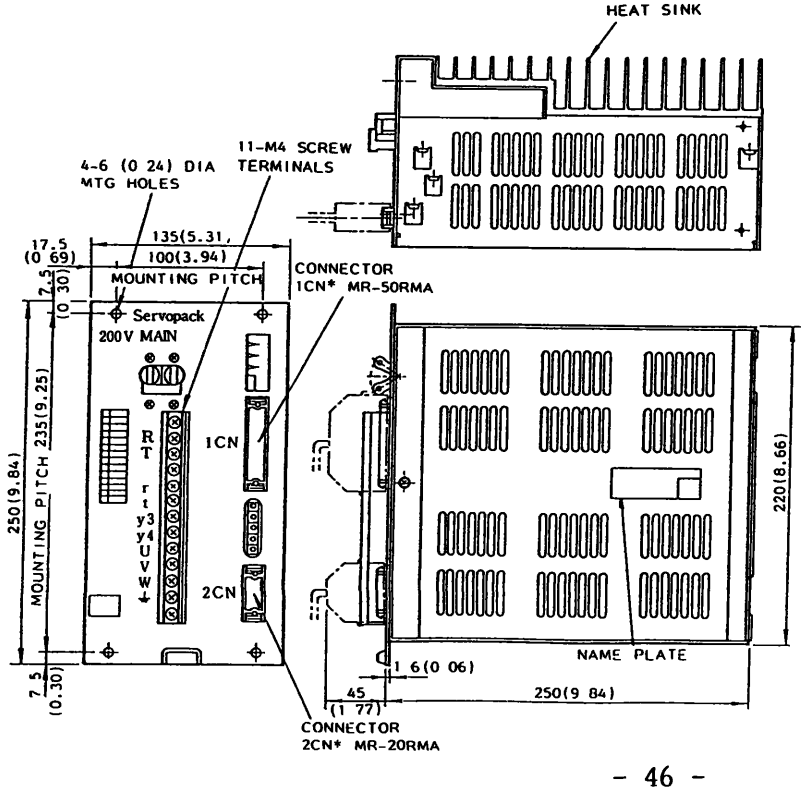


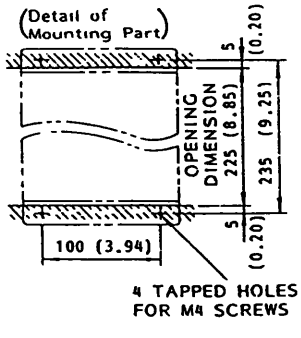




* Made by Honda Tushin Co Ltd

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

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




* Made by Honda Tushin Co Ltd

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



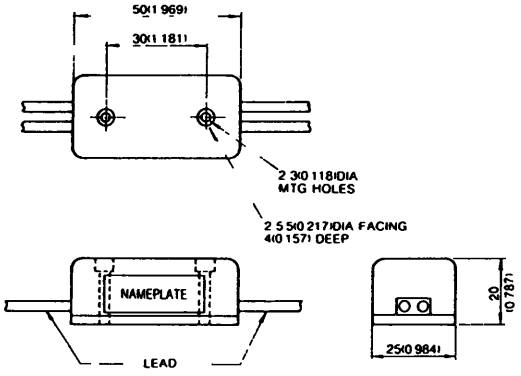
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## 8. 3 PERIPHERAL EQUIPMENT in mm (inches)

Power Supply for Brake

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

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

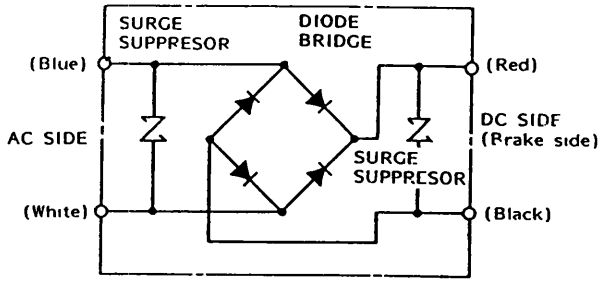



- Lead length: each 500 mm (19.69 inches)
- Lead color:

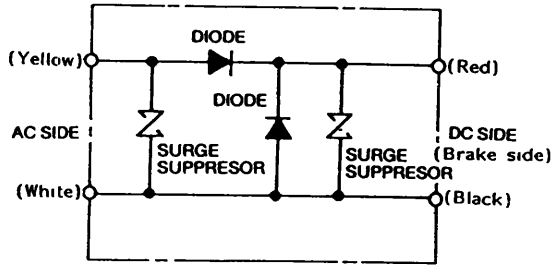
| AC Input Side | | Brake Side |
|---|---|---|
| 100V | 200V | |
| Blue<br>White | Yellow<br>White | Red<br>Black |

- Maximum ambient temperature: 60°C

- Internal circuit for 100 VAC




- Internal circuit for 200 VAC




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



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# 9. TEST RUN

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

## 9.1 CHECK ITEMS BEFORE TEST RUN

### 9 1 1 SERVOMOTOR

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

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

### 9 1 2 SERVOPACK

- Setting switches are correctly set to satisfy the specifications for the applicable SERVOMOTOR and optical encoder.
- Connection and wiring leads are firmly connected to terminals or inserted into the connectors.
- The power supply is turned off if servo alarm outputs.
- Voltage supplied to SERVOPACK is 200 to 230V $^{+10}_{-15}$ % or 100 to 115 V $^{+10}_{-15}$ %.
- The speed reference should be 0 V.

## 9.2 TEST RUN PROCEDURES

### 9 2 1 Preparation of Operation

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

- Power ON

  After checking items in Par. 9.1, turn on the power supply. When the power on sequence is correct, according to Par. 6.1, the power is turned on by depressing the POWER pushbutton.

- When the power is correctly supplied, the following green [LED]s light: [-.] and [MAIN].

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

### 9 2 2 Operation

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

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

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

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

- The motor is stopped by cutting the reference pulse.

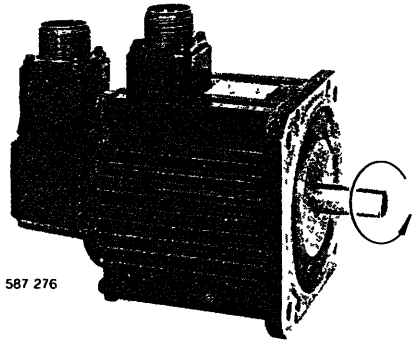



Fig 9 1 Motor Forward Running

### 9 2 3 Inspection during Test Run

The following items should be checked during the test run.

- Unusual vibration
- Abnormal noise
- Excessive temperature rise

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



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# 10. ADJUSTMENT

## 10.1 SETTINGS AT THE TIME OF DELIVERY

The SERVOPACK has been factory-adjusted as follows:

Table 10 1 Standard Adjustment and Setting Specifications

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

* Effective value.

Notes.

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

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

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

The following relation is also observed.

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

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

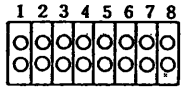
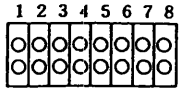
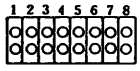
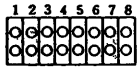
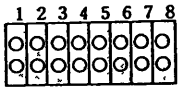
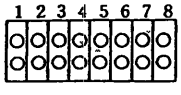
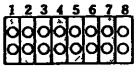
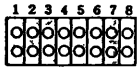
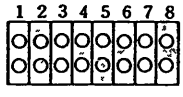
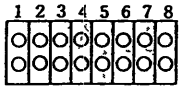
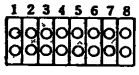
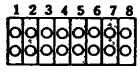
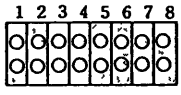
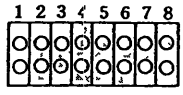
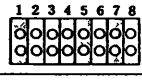
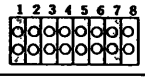
SERVOPACK PG output pulses = P/N
(per rotation of motor)

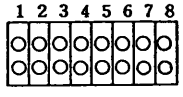
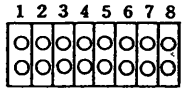
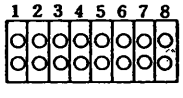
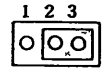
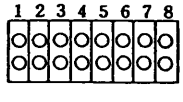
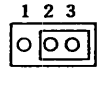
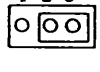


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## 10.1 SETTINGS AT THE TIME OF DELIVERY (Cont'd)

Table 10.2 Standard Factory-adjusted Switch Settings

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

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

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

Note: See Table 10.7 for other functions.



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Table 10 3 Standard Factory-adjusted Setting of Rotary Switch

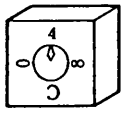
| SERVOPACK | | | SW5 Kp | SW4 Kv | SW7 I-GAIN | SW6 CUR/BIAS | SW8 |
|---|---|---|---|---|---|---|---|
| Class V | Rated Output W (HP) | Type CACR- | Position Loop Gain | Speed Loop Gain | Integration Constant | Current Limit | – |
| 200 | 50 (0.07) | PRA5AC3[ ]R | 6 | 4 | 4 | F | 0 (Frequency dividing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

Notes

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

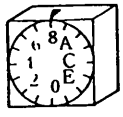
⟨Example⟩

· SW4 to SW7




indicates scale 4.

· SW8




indicates scale 8.

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

## 10. 2 CHARACTERISTICS AT THE TIME OF DELIVERY

The SERVOPACK has been adjusted prior to shipping as follows.

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

· No load
· Continuous pulses

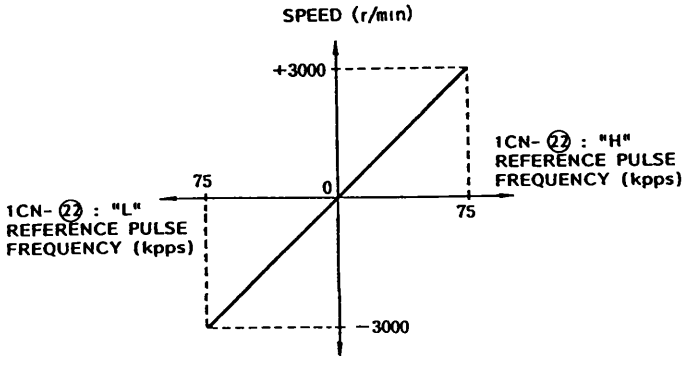



Fig 10. 1 Reference Input Frequency and Motor Speed Characteristics

(b) Start-stop response characteristics

• Load $J_L = J_M$

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

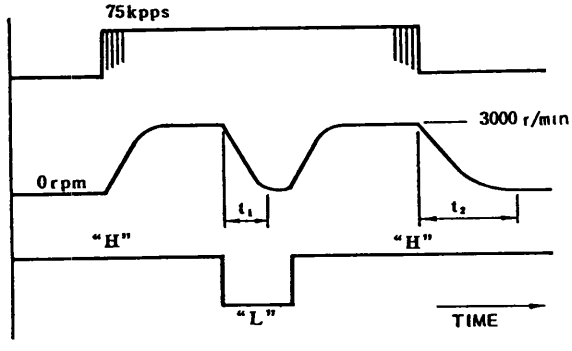



Fig 10 2 Start-stop Response Characteristics



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## 10. 3 READJUSTMENT

The SERVOPACK has been adjusted at the factory to obtain optimum characteristics, and no further adjustment is required. If adjustment is required depending on the use, readjust the SERVOPACK referring to Par.10.4.

## 10. 4 ADJUSTMENT PROCEDURES

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

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

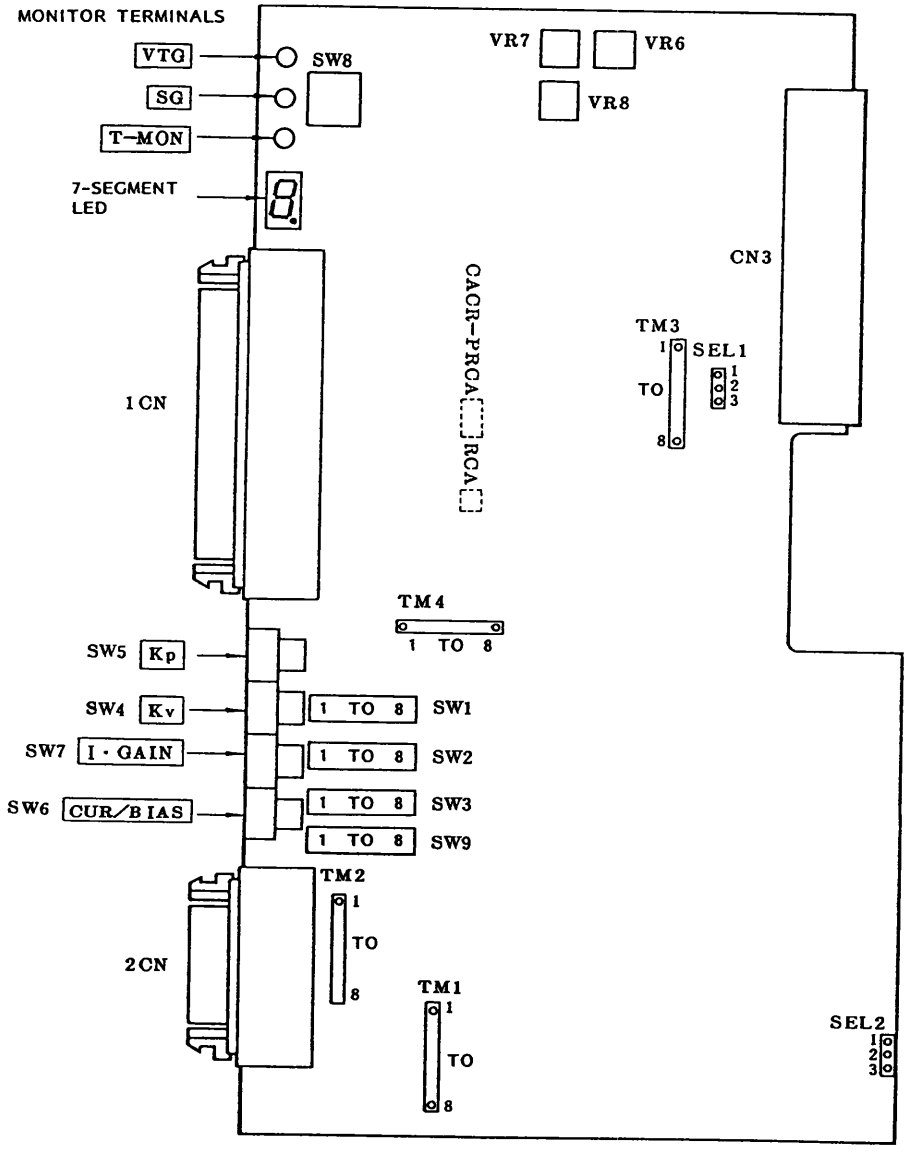


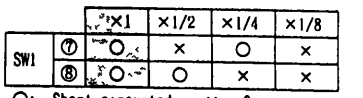

Fig 10 3 Printed Circuit Board Type CACR-PRCA RCA

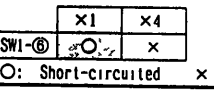


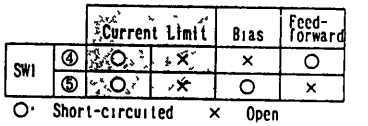
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## Table 10.4 Contents of Setting Rotary Switch (Normal Mode Setting)

| Digital Switch \ Scale | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kp Position loop Gain | ×1 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96 | 104 | 112 | 120 | 128 | 144 | 160 | 176 | 200 | The selection of ×1 to ×1/8 depends on the setting of SW1-⑦ and -⑧. |
| | ×1/2 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 | 64 | 72 | 80 | 88 | 100 | |
| | ×1/4 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 36 | 40 | 44 | 50 | |
| | ×1/8 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 18 | 20 | 22 | 25 | |
| Kv Speed loop Gain | ×1 | 10 | 15 | 20 | 25 | 30 | 35 | 45 | 55 | 65 | 80 | 10.0 | 12 5 | 15 5 | 19.5 | 24 | 30 | |
| | ×4 | 40 | 6.0 | 80 | 10 | 12 | 14 | 18 | 22 | 26 | 32 | 40 | 50 | 62 | 78 | 96 | 120 | |
| I·GAIN Integration Constant | | ∞ | 256 | 171 | 128 | 85.3 | 64 | 46 5 | 32 | 22 3 | 16 | 11 4 | 8 | 5 7 | 4 | 2.8 | 2 | (ms) |
| CUR/BIAS (Current limit) for 200V | CACR-PRA5AC3[ ]R | 1 0A 99% | 1 1A 112% | 1.3A 125% | 1.4A 138% | 1 5A 152% | 1 7A 165% | 1.8A 178% | 1.9A 191% | 2 0A 204% | 2.2A 218% | 2 3A 231% | 2 4A 244% | 2 6A 257% | 2 7A 271% | 2 8A 284% | 3 0A 296% | • The selection of Current limit, Bias and Feedforward depends on the setting of SW1-④ and -⑤ |
| | CACR-PR01AC3[ ]R | 1 3A 94% | 1 5A 106% | 1 7A 119% | 1 9A 131% | 2 0A 143% | 2 2A 156% | 2 4A 168% | 2.6A 181% | 2.7A 193% | 2 9A 205% | 3 1A 218% | 3.3A 230% | 3 4A 243% | 3.6A 255% | 3 8A 267% | 4 0A 280% | |
| | CACR-PR02AC3[ ]R | 2 7A 95% | 3 0A 107% | 3 4A 120% | 3 8A 133% | 4.1A 145% | 4 5A 158% | 4 8A 171% | 5 2A 183% | 5.6A 196% | 5 9A 209% | 6.3A 221% | 6.6A 234% | 7 0A 247% | 7 3A 260% | 7 7A 272% | 8 1A 285% | |
| | CACR-PR03AC3[ ]R | 3 7A 96% | 4 2A 109% | 4 7A 122% | 5 2A 134% | 5 6A 147% | 6 1A 160% | 6 6A 173% | 7 1A 186% | 7.6A 199% | 8 1A 212% | 8 6A 225% | 9 1A 237% | 9 6A 250% | 10 1A 263% | 10 5A 276% | 11 0A 289% | |
| | CACR-PR05AC3[ ]R | 5.0A 98% | 5 7A 111% | 6 3A 124% | 7 0A 137% | 7 7A 150% | 8 3A 163% | 9 0A 176% | 9 7A 189% | 10 3A 203% | 11.0A 216% | 11 7A 229% | 12 3A 242% | 13 0A 255% | 13 7A 268% | 14 3A 281% | 15 0A 294% | |
| | CACR-PR07AC3[ ]R | 7 7A 96% | 8.7A 108% | 9 7A 120% | 10 7A 133% | 11 8A 146% | 12 8A 159% | 13.8A 171% | 14 8A 184% | 15 8A 196% | 16.9A 210% | 17 9A 222% | 18 9A 234% | 19 9A 247% | 21.0A 261% | 22.0A 273% | 23 0A 285% | |
| for 100V | CACR-PRA5AC4[ ]R | 1.7A 100% | 1.9A 113% | 2 2A 126% | 2 4A 140% | 2 6A 153% | 2 8A 167% | 3 1A 180% | 3 3A 193% | 3 5A 207% | 3.7A 220% | 4 0A 233% | 4 2A 247% | 4 4A 260% | 4 7A 273% | 4 9A 287% | 5 1A 300% | |
| | CACR-PR01AC4[ ]R | 2 4A 98% | 2 7A 111% | 3 0A 124% | 3 3A 137% | 3 6A 150% | 3 9A 163% | 4 2A 176% | 4 6A 189% | 4 9A 202% | 5 2A 216% | 5 5A 229% | 5 8A 242% | 6 1A 255% | 6 4A 268% | 6 8A 281% | 7 1A 294% | |
| | CACR-PR02AC4[ ]R | 4 0A 97% | 4.5A 110% | 5.1A 123% | 5 6A 136% | 6 1A 149% | 6 7A 162% | 7 2A 175% | 7 7A 188% | 8 3A 202% | 8 8A 215% | 9.4A 228% | 9 9A 241% | 10 4A 254% | 11.0A 267% | 11.5A 280% | 12 0A 293% | • Percent indicates values when the rated current of the motor used is 100% The current value in the table is Ao-p value |
| | CACR-PR03AC4[ ]R | 5 0A 98% | 5 7A 111% | 6.3A 124% | 7 0A 137% | 7 7A 150% | 8 3A 163% | 9 0A 176% | 9.7A 189% | 10.3A 203% | 11.0A 216% | 11.7A 229% | 12 3A 242% | 13 0A 255% | 13.7A 268% | 14.3A 281% | 15 0A 294% | |
| | CACR-PR05AC4[ ]R | 7.7A 99% | 8 7A 112% | 9 7A 125% | 10 7A 138% | 11.8A 152% | 12.8A 165% | 13.8A 177% | 14 8A 190% | 15.8A 203% | 16.9A 217% | 17 9A 230% | 18.9A 243% | 19.9A 256% | 21 0A 270% | 22.0A 283% | 23.0A 296% | |
| BIAS* | | 0 | 10 | 15 | 20 | 30 | 40 | 60 | 80 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | (rpm) |
| Feedforward* | | 0 | 10 | 20 | 30 | 40 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | (%) |




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

: Standard factory-adjusted switch setting

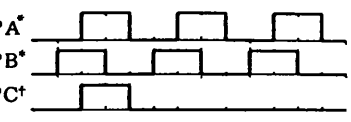


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## 10. 4 ADJUSTMENT PROCEDURES (Cont'd)

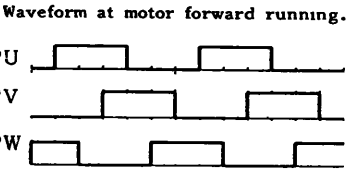
Table 10 5 Check Terminal Functions

| Equipment Symbol | | Signal Name | Description |
|---|---|---|---|
| TM1 | 1 | PA | PG input signal: Phase A pulse input. |
| | 2 | *PA | Phase A reverse input. |
| | 3 | PB | Phase B pulse input. |
| | 4 | *PB | Phase B reverse input. |
| | 5 | PC | Phase C pulse input. |
| | 6 | *PC | Phase C reverse input. |
| | 7 | - | Not used. |
| | 8 | PG5V | Optical encoder (PG) power supply voltage: +5V. |




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

| Equipment Symbol | | Signal Name | Description |
|---|---|---|---|
| TM2 | 1 | PU | Phase U pulse input from pole sensor. |
| | 2 | *PU | Phase U reverse input. |
| | 3 | PV | Phase V pulse input from pole sensor. |
| | 4 | *PV | Phase V reverse input. |
| | 5 | PW | Phase W pulse input from pole sensor. |
| | 6 | *PW | Phase W reverse input. |
| | 7 | DIR | Monitoring of setting for motor running direction switching. |
| | 8 | PG0V | Optical encoder (PG) power supply voltage: 0V (PG, common terminal of signal from pole sensor) |




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

| Equipment Symbol | | Signal Name | Description |
|---|---|---|---|
| TM4 | 1 | PULS | Reference pulse input "PULS" (Connector 1CN-21) monitoring* |
| | 2 | SIGN | Reference pulse input "SIGN" (Connector 1CN-22) monitoring* |
| | 3 | INH | Reference pulse inhibit input "INH" (Connector 1CN-13) monitoring |
| | 4 | CL | Error counter clear signal "CL" (Connector 1CN-23) monitoring |
| | 5 | AUXA | Auxiliary reference pulse input "AUX-A" (1CN-11) monitoring † |
| | 6 | AUXB | Auxiliary reference pulse input "Aux-B" (1CN-12) monitoring† |
| | 7 | - | - |
| | 8 | SG | Signal 0V |
| TM101 | 1 | +16V | Control power ±16V (16.1 V ± 0.1 V) |
| | 2 | - | - |
| | 3 | +15V | Control power +15V (±5%) |
| | 4 | PG5V | Optical encoder (PG) power +5V (5.25V ± 50mV) |
| | 5 | +5V | Control power +5V (±5%) |
| | 6 | -15V | Control power -15V (±5%) |
| | 7 | - | - |
| | 8 | SG | Signal 0V |
| TM102 | 1 | Valm | Alarm detection voltage (6.385V ± 10mV) |
| | 2 | - | - |
| | 3 | Oalm | For observation of TM102-1. |

See the next page for the notes of this table.



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

Notes

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

· Estimation of position loop gain (Kp)

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

Table 10 6 Specifications of Motor, SERVOPACK and Machine

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

(a) Motor starting time

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

(b) Position loop gain

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

(c) No. of lag pulses in error counter

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

$fin$ . Reference pulse frequency (pps)

## 10. 5 ROTARY SWITCH ADJUSTMENT

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

(1) CUR/BIAS

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

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

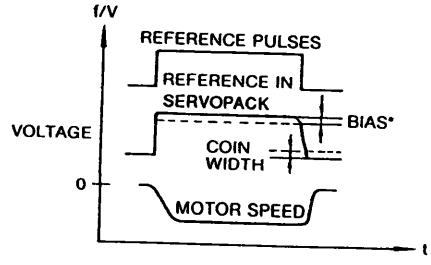
○: Short-circuited ×: Open

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

The maximum current of the Servopack is adjusted.

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

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




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

Fig 10 4 Bias Setting



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## 10. 5 ROTARY SWITCH ADJUSTMENT (Cont'd)

(c) Feedforward compensation

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

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

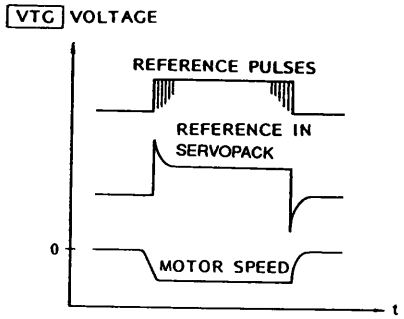


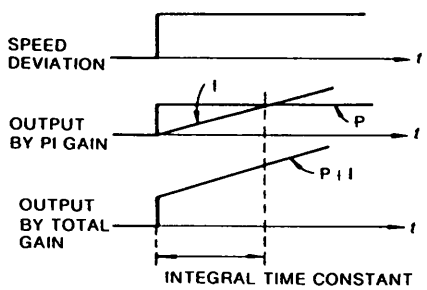

Fig 10 5 Feed Forward Compensation

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

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

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

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




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

Fig 10 6 Integral Gain

(3) Kv (Speed loop gain):

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

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

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

$Ti$: Integral time constant

### NOTE

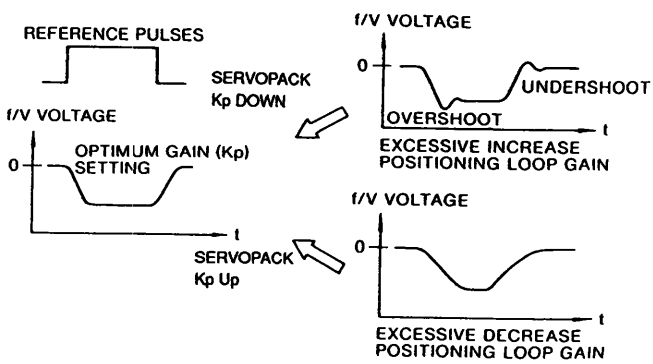
If the rigidity of the mechanical system is poor, Kv cannot be increased. If Kv is increased, oscillation occurs. Adjust the Kv when the $\overline{CL}$ is turned on and the position error counter is cleared to 0, then the effect of the position loop gain Kp can be removed.

(4) Kp (Position loop gain):

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

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

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




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

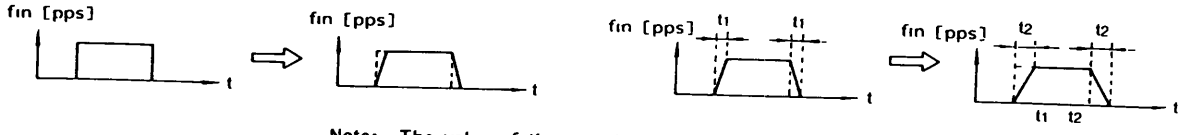
Fig 10 7 Positioning Loop Gain Adjustment



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

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




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

Fig 10 8 Speed Up and Slow Down of Reference Pulse

## 10.6 SWITCH SETTING

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

Table 10 7 Switch Setting and Functions

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

(a) SW1 Setting and Functions

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

(b) SW2 Setting and Functions

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



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## 10. 6 SWITCH SETTING (Cont'd)

### (c) SW3 Setting and Functions

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

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

### (d) SW9 Setting and Functions

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

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

Motor Speed Setting with Short-circuited SW9- ④

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

### (e) SEL Setting and Functions

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

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



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(f) SW8 (digital switch) Setting and Functions

□: Standard factory adjusted switch setting

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

## 10.7 ALTERATION OF INTERNAL SWITCHES

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

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

<Switch setting order>

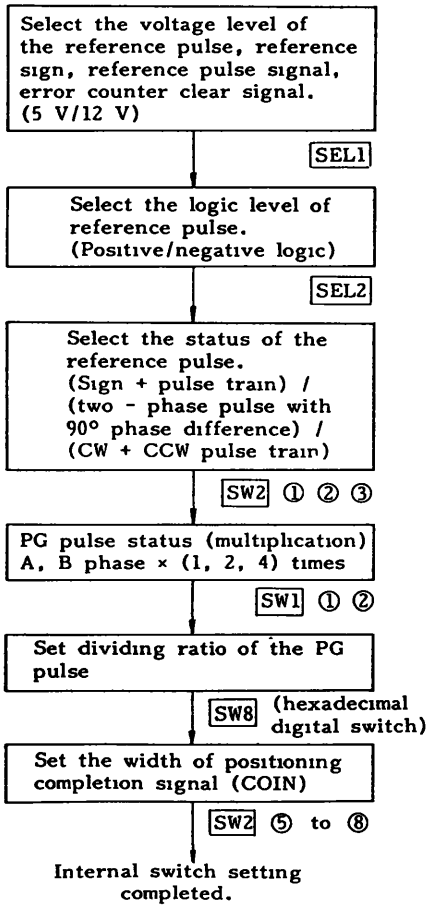



Fig 10 9 Order of Switch Setting

# 11. INSPECTION AND MAINTENANCE

## 11.1 AC SERVOMOTOR

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

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

Table 11 1 Inspection Schedule for Motors

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

## 11.2 SERVOPACK

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



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# 12. TROUBLESHOOTING GUIDE

## 12. 1 AC SERVOMOTOR

**WARNING**

Remedies in [ ] should be practiced after turning off the power

Table 12 1 Troubleshooting Guide for AC SERVOMOTOR

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



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## 12. 2 SERVOPACK

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

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



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

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



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## 12. 3 TROUBLESHOOTING

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

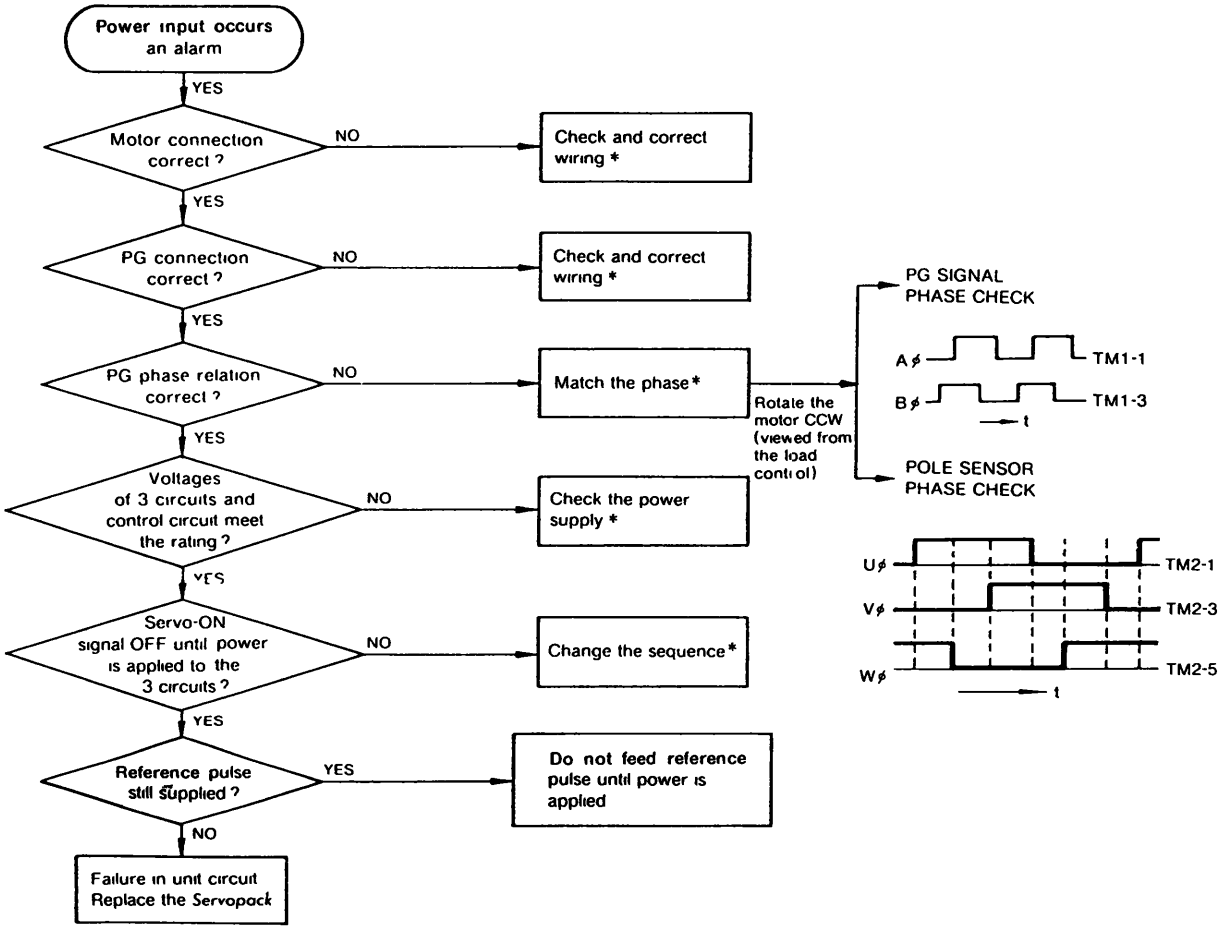
### 12 3 1 DC Power Supply

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

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

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

### 12. 3 2 Alarm Occurance at Power Input

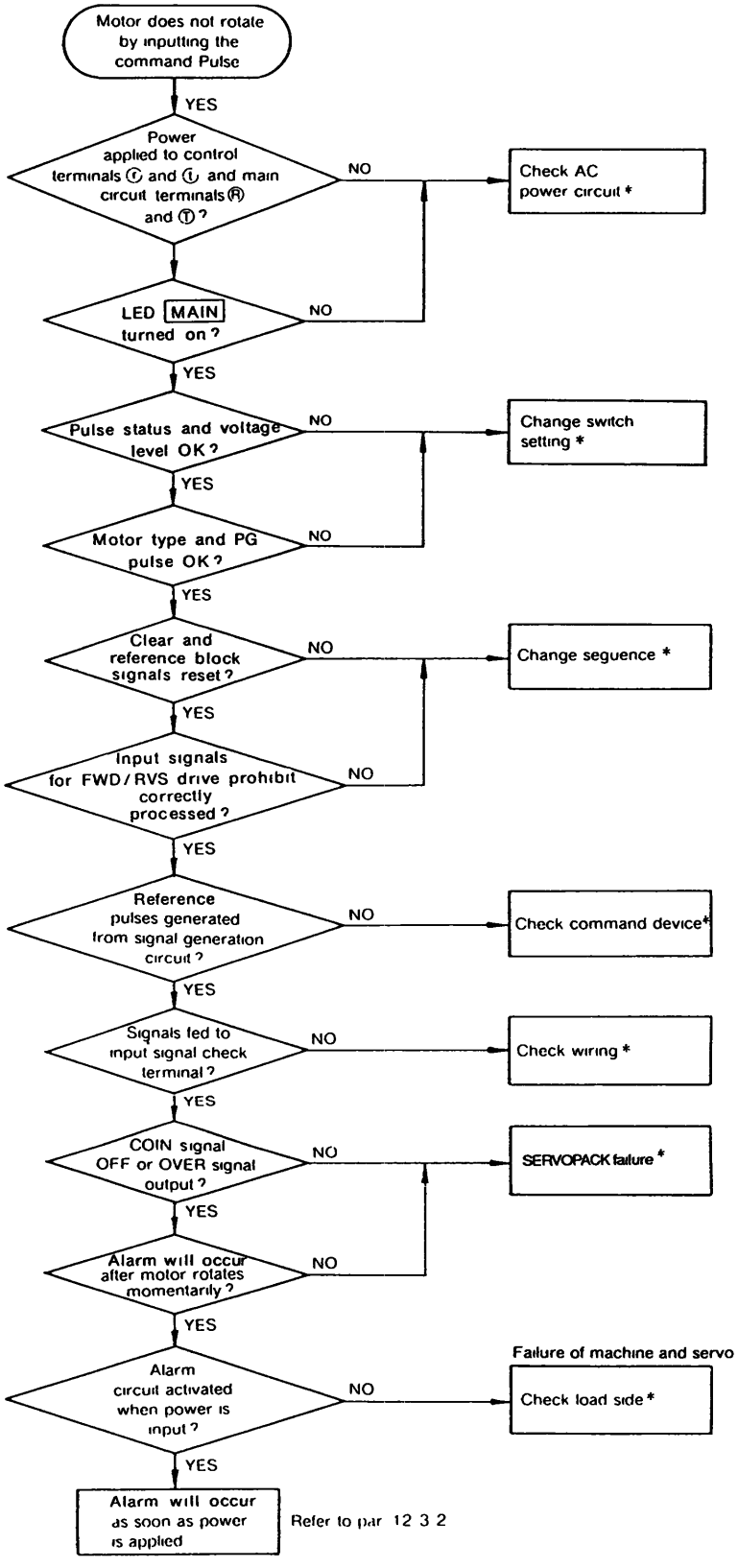



*If alarm does not go off, continue sequence



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## 12. 3 3 No Motor Rotates by Inputting Reference Pulse

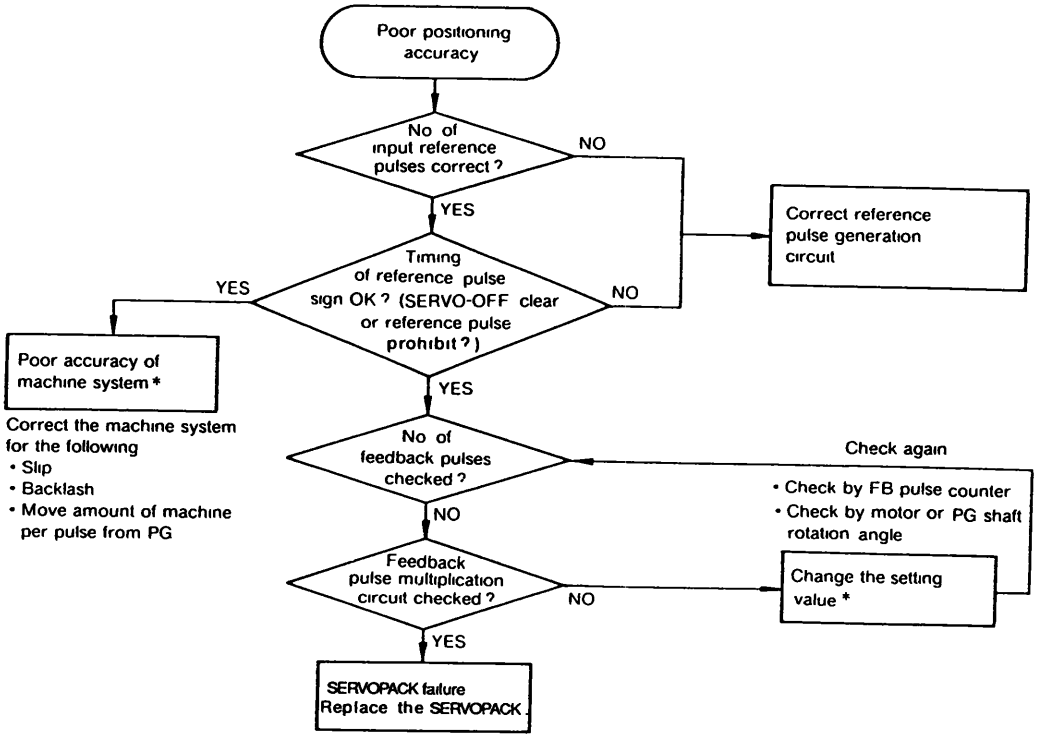



*If alarm does not go off, continue sequence



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### 12 3 4 Poor Positioning Accuracy




*If alarm does not go off, continue sequence

### 12 3 5 Examples of Troubleshooting for Defective Wiring or Parts

Table 12 3 Example of Troubleshooting for Defective Wiring or Parts

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



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## 12 3 6 Examples of Troubleshooting for Incomplete Adjustment

Table 12 4 Examples of Troubleshootings for Incomplete Adjustment

| Trouble | Check Items | What to do |
|---|---|---|
| Servo performance is improper | Positioning loop gain too low | Increase positioning loop gain [Kp]<br>If hunting, increase the speed loop gain [Kv]<br>(Even if hunting occurs by increasing the speed loop gain positioning loop gain cannot be increased<br>This is a limit of Servo performance ) |



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# AC Servo Drives

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### SERVOPACK : TYPE CACR-PR☐R (Rack-mounted Type)

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