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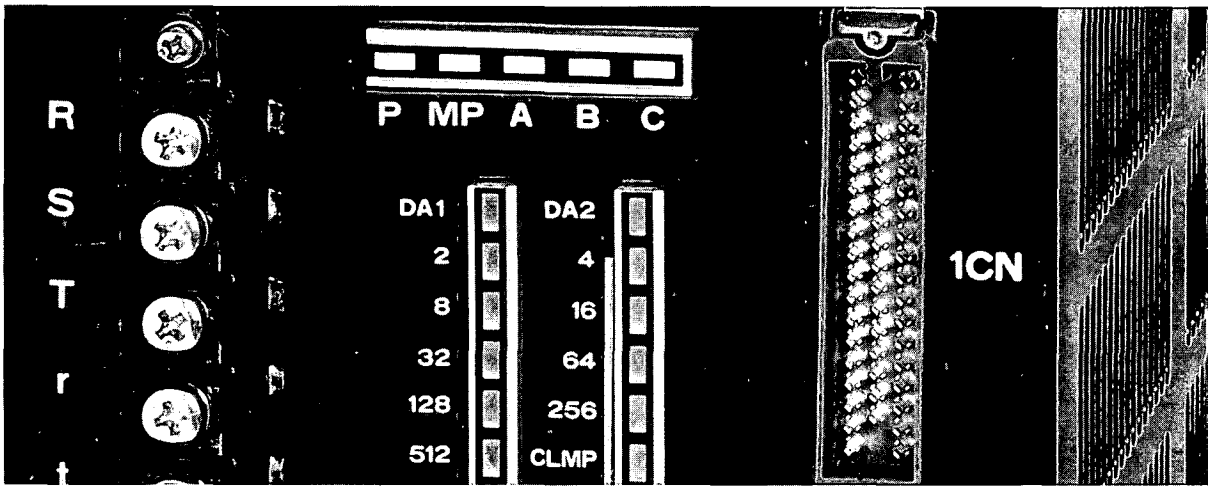
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# AC SERVO DRIVES

## M, F, S SERIES FOR POSITIONING CONTROL

SERVOMOTOR TYPES : USAMED, USAFED, USASEM
(With Incremental Encoder)
SERVOPACK TYPE : CACR-PR□BC (Rack-mounted Type)




YASKAWA

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◆平成８年７月１日から下記の住所に変わります。ご注意ください。

新　住　所　〒530 大阪市北区堂島２丁目４番27号
　　新藤田ビル４階
電 話 番 号　(06)346-4500（代表）
ＦＡＸ番号　(06)346-4555　(06)346-4556（新設）
業務開始日　平成８年７月１日(月)

## Change of address

We are pleased to announce the relocation of YASKAWA ELECTRIC CORPORATION Osaka Office with effect from July 1 1996, to the following address;

Address : Shin-Fujita Building, 2-4-27, Doujima,
　　Kita-ku, Osaka 530, Japan
Phone　: (06)346-4500　　Fax : (06)346-4555, (06)346-4556

◆技術的問い合せ相談窓口は次のとおりです。

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　　ニューピア竹芝サウスタワービル８階
電 話 番 号　(03)5402-4511（代表）
ＦＡＸ番号　(03)5402-4580
業務開始日　平成８年５月７日(火)

## Change of address

We are pleased to announce the relocation of YASKAWA ELECTRIC CORPORATION Tokyo Branch, with effect from May 7 1996, to the following address;

Address : New Pier Takeshiba South Tower, 1-16-1, Kaigan,
　　Minatoku, Tokyo 105, Japan
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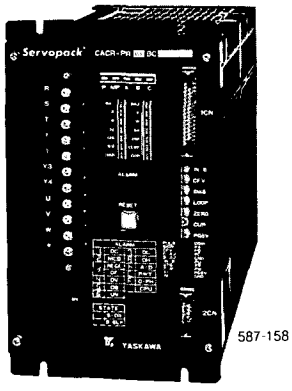
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Yaskawa AC Servo Series has been developed as basic mechatronics drive for the most advanced FA and FMS. The extensive DC servo manufacturing technology accumulated through a half century of servo drive applications created and nurtured a new phase of AC servo drives.

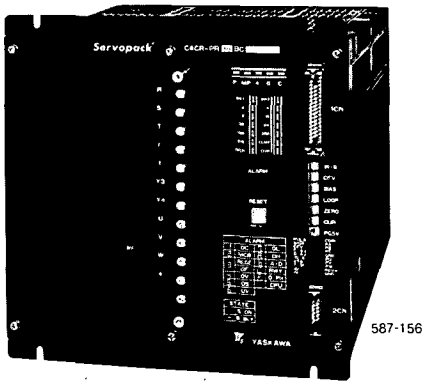
The AC servo drives consist of a flexible combination of our AC SERVOMOTOR and its controller, SERVOPACK. The AC SERVOMOTOR features a high-power rate for achieving quick response. The AC SERVOPACK type CACR-PR□BC~ is designed for integrated construction of Positionpack for digital positioning control (type CPCC-PP100) and AC SERVOPACK for speed control (type CACR-SR□BB).

For your mechatronics systems, our AC servo drives achieves stable control operation with high accuracy, quick response control even under adverse environmental conditions. Furthermore, these have succeeded in providing reliable, durable and easy maintenance by various display and protective functions. Some outstanding features are as follows :

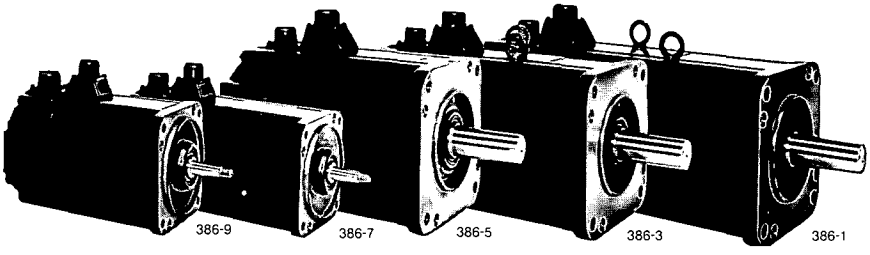
- High accuracy and quick response for speed control
- Rack-mounted type to conserve mounting space
- Easy maintenance by a wide range of display functions
- Highly reliable protective functions
- Selectable drive to suit the requirement
- Applicable to multiaxis applications




Type CACR-PR10BC




Type CACR-PR30BC




Type USAMED-03MA1 Type USAMED-09MA2 Type USAMED-44MA2
Type USAMED-06MA1 Type USAMED-20MA2

M Series AC Servo Drives for Speed Contol
— AC SERVOMOTORS and Their Controllers SERVOPACKS —

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# 1. RATINGS AND SPECIFICATIONS

## 1.1 M SERIES AC SERVOMOTORS

### 1.1.1 Ratings

**Time Rating:** Continuous
**Insulation:** Class F
**Isolation Voltage:** 1500 VAC, one minute
**Insulation Resistance:** 500 VDC, 10MΩ or more
**Enclosure:** Totally-enclosed, self-cooled
(Equivalent to IP-55 exclusive shaft opening)

**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 1.1 Ratings and Specifications of M Series AC SERVOMOTORS

| Item \ Motor Type USAMED- | | 03M□1 | 06M□1 | 09M□2 | 12M□2 | 20M□2 | 30M□2 | 44M□2 |
|---|---|---|---|---|---|---|---|---|
| Rated Output* | kW (HP) | 0.3 (0.4) | 0.6 (0.8) | 0.9 (1.2) | 1.2 (1.6) | 2.0 (2.7) | 3.0 (4.1) | 4.4 (6.0) |
| Rated Torque* | N·m (lb·in) | 2.8 (25) | 5.7 (50) | 8.6 (76) | 11.5 (102) | 19.1 (169) | 28.4 (252) | 41.9 (372) |
| Continuous Max Torque* | N·m (lb·in) | 2.9 (26) | 5.9 (52) | 8.8 (78) | 11.8 (104) | 21.6 (191) | 32.3 (286) | 46.1 (408) |
| Instantaneous Max Torque* | N·m (lb·in) | 7.2 (63) | 14.1 (125) | 19.3 (171) | 28.0 (248) | 44.0 (390) | 63.7 (564) | 91.1 (807) |
| Rated Current* | A | 3.0 | 5.8 | 7.6 | 11.7 | 18.8 | 26 | 33 |
| Rated Speed* | r/min | 1000 | | | | | | |
| Instantaneous Max Speed* | r/min | 2000 | | | | | | 1500 |
| Torque Constant | N·m/A (lb·in/A) | 1.01 (8.9) | 1.04 (9.2) | 1.21 (10.7) | 1.02 (9.0) | 1.07 (9.5) | 1.15 (10.2) | 13.6 (11.8) |
| Moment of Inertia $J_M(=GD^2/4)$ | $kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$) | 13.5 (12.0) | 24.3 (21.5) | 36.7 (32.5) | 66.8 (59.2) | 110 (97.2) | 143 (126.7) | 240 (212.6) |
| Power Rate* | kW/s | 6.1 | 13.3 | 20.3 | 19.7 | 33.2 | 57.0 | 74.0 |
| Inertia Time Constant | ms | 8.3 | 5.9 | 4.6 | 6.9 | 5.2 | 4.1 | 4.0 |
| Inductive Time Constant | ms | 4.2 | 5.4 | 6.5 | 10.4 | 12.9 | 15.3 | 16.2 |

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

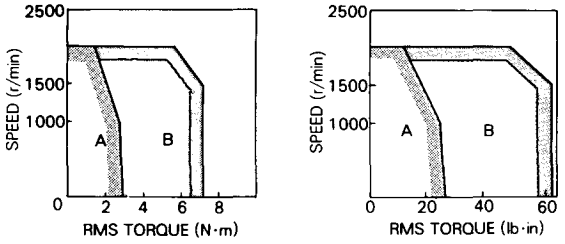
Notes:
1. □ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows;
   Standard: A (6000 pulses/rev)
   Optional: B (5000 pulses/rev), D (4000 pulses/rev)
2. There are two types of power supply units for brake.
   - Input 100 VAC, output 90 VDC (OPR 109 F)
   - Input 200 VAC, output 90 VDC (OPR 109 A)
   For details, refer to Par. 8.5, "PERIPHERAL EQUIPMENT."



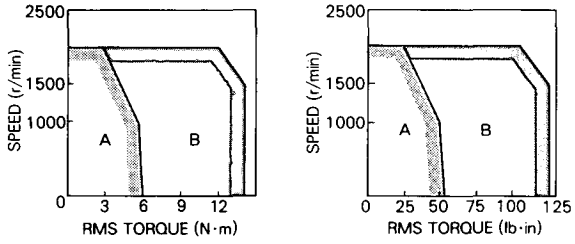
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## 1. 1. 2 Torque-Speed Characteristics

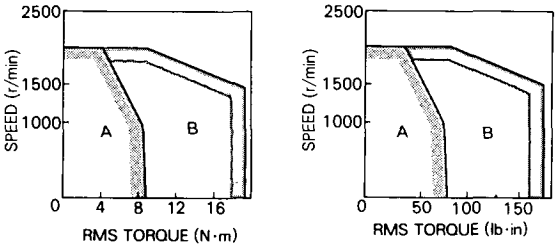
• TYPE USAMED-03M



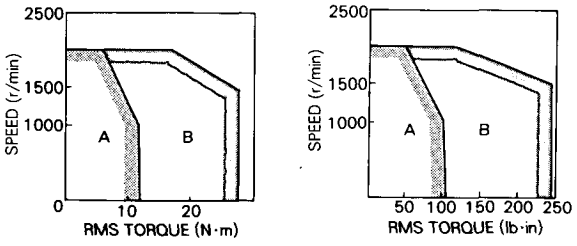

• TYPE USAMED-06M



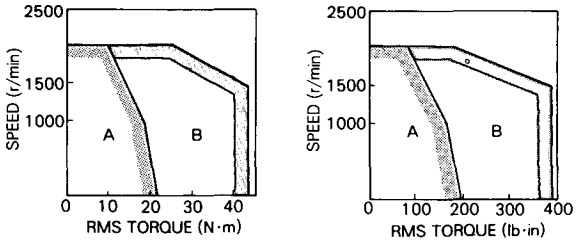

• TYPE USAMED-09M



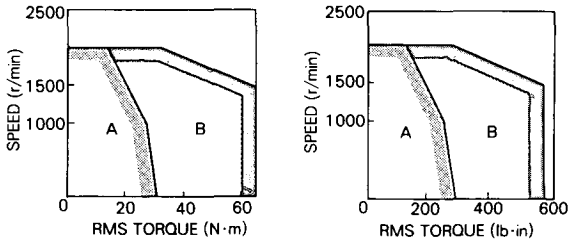

• TYPE USAMED-12M



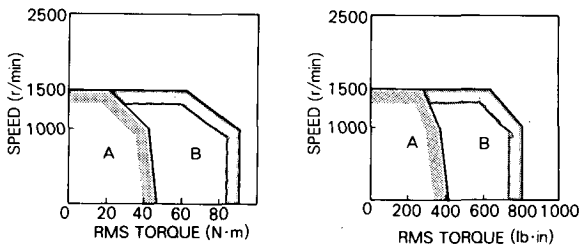

• TYPE USAMED-20M



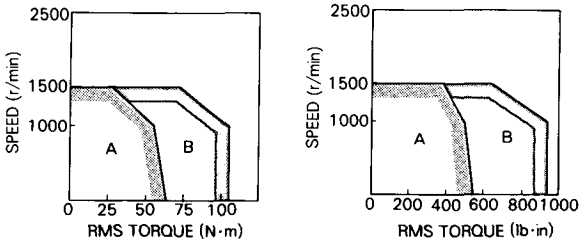

• TYPE USAMED-30M




• TYPE USAMED-44M




• TYPE USAMKD-60M




A: CONTINUOUS DUTY ZONE
B: INTERMITTENT DUTY ZONE
POWER SUPPLY: 200V



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## 1. 2 F SERIES AC SERVOMOTORS

### 1. 2. 1 Ratings

**Time Rating**: Continuous
**Insulation**: Class F
**Isolation Voltage**: 1500 VAC, one minute
**Insulation Resistance**: 500 VDC, 10MΩ or more
**Enclosure**: Totally-enclosed, self-cooled
(Equivalent to IP-55 exclusive shaft opening)

**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 F Series AC SERVOMOTORS

| Item \ Motor Type USAFED- | | 02F□1 | 03F□1 | 05F□1 | 09F□1 | 13F□2 | 20F□2 | 30F□2 | 44F□2 |
|---|---|---|---|---|---|---|---|---|---|
| Rated Output* | kW (HP) | 0.15 (0.2) | 0.3 (0.4) | 0.45 (0.6) | 0.85 (1.2) | 1.3 (1.8) | 1.8 (2.4) | 2.9 (3.9) | 4.4 (6.0) |
| Rated Torque* | N·m (lb·in) | 1.0 (8.7) | 2.0 (17) | 2.8 (25) | 5.4 (48) | 8.3 (74) | 11.5 (102) | 18.6 (165) | 28.4 (252) |
| Continuous Max Torque* | N·m (lb·in) | 1.1 (10) | 2.2 (19) | 2.9 (26) | 5.9 (52) | 8.8 (78) | 11.8 (104) | 22.5 (200) | 37.2 (330) |
| Instantaneous Max Torque* | N·m (lb·in) | 2.9 (26) | 5.7 (51) | 8.9 (79) | 15.2 (135) | 24.7 (219) | 34.0 (301) | 54.1 (479) | 76.2 (675) |
| Rated Current* | A | 3.0 | 3.0 | 3.8 | 6.2 | 9.7 | 15 | 20 | 30 |
| Rated Speed* | r/min | 1500 | | | | | | | |
| Instantaneous Max Speed* | r/min | 2500 | | | | | | | |
| Torque Constant | N·m/A (lb·in/A) | 0.36 (3.2) | 0.71 (6.3) | 0.81 (7.1) | 0.92 (8.2) | 0.92 (8.2) | 0.82 (7.3) | 0.98 (8.7) | 1.01 (9.0) |
| Moment of Inertia $J_M$(=GD²/4) | kg·m²×10⁻⁴ (lb·in·s²×10⁻³) | 1.3 (1.1) | 2.0 (1.8) | 13.5 (12.0) | 24.3 (21.5) | 36.7 (32.5) | 66.8 (59.2) | 110 (97.2) | 143 (126.7) |
| Power Rate* | kW/s | 7.4 | 18.3 | 6.0 | 12 | 18.9 | 19.7 | 31.5 | 57.0 |
| Inertia Time Constant | ms | 4.5 | 2.5 | 8.3 | 5.7 | 4.7 | 6.8 | 5.1 | 4.1 |
| Inductive Time Constant | ms | 3.4 | 4.3 | 4.2 | 5.5 | 6.4 | 10.4 | 13.0 | 15.2 |

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

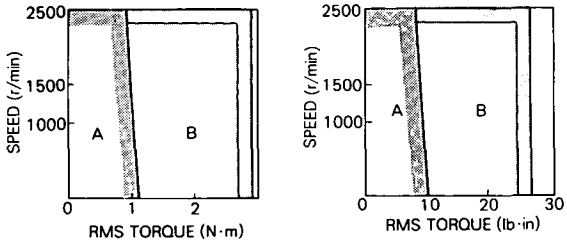
Notes:
1. □ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows;
   Standard: A (6000 pulses/rev)
   Optional: B (5000 pulses/rev), D (4000 pulses/rev)
2. There are two types of power supply units for brake.
   · Input 100 VAC, output 90 VDC (OPR 109 F)
   · Input 200 VAC, output 90 VDC (OPR 109 A)
   For details, refer to Par. 8.5, "PERIPHERAL EQUIPMENT."



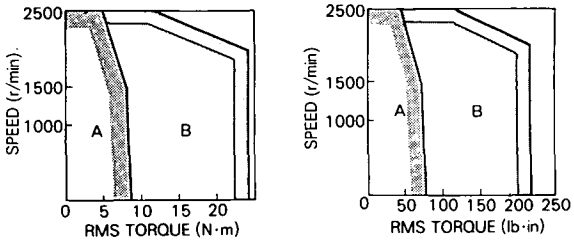
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## 1. 2. 2 Torque-Speed Characteristics

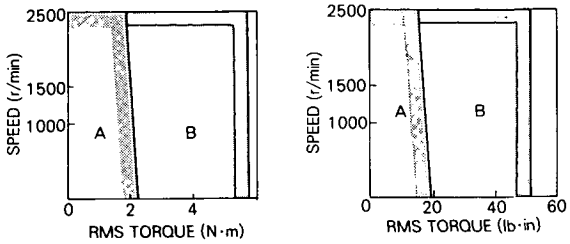
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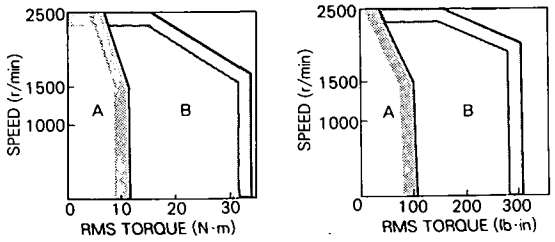

• TYPE USAFED-13F



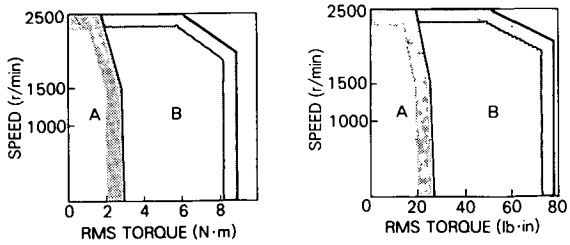

• TYPE USAFED-03F



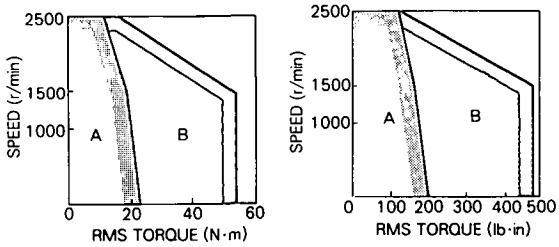

• TYPE USAFED-20F



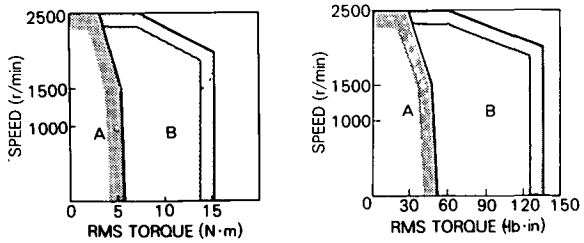

• TYPE USAFED-05F



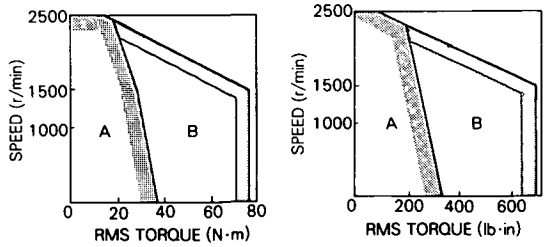

• TYPE USAFED-30F




• TYPE USAFED-09F




• TYPE USAFED-44F




A: CONTINUOUS DUTY ZONE
B: INTERMITTENT DUTY ZONE
POWER SUPPLY: 200V



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## 1. 3 S SERIES AC SERVOMOTORS

### 1.3.1 Ratings

**Time Rating**: Continuous

**Insulation**: Class B (Types USASEM-03A□2, -05A□2)
Coass F (Types USASEM-08A□1, -15A□1, -30A□1)

**Isolation Voltage**: 1500 VAC, one minute

**Insulation Resistance**: 500 VDC, 10MΩ or more

**Enclosure**: Totally-enclosed, self-cooled

**Ambient Temperature**: 0 to +40°C

**Ambient Humidity**: 20% to 80% (non-condensing)

**Vibration**: 15 μm or below

**Finish in Munsell Notation**: N1.5

**Excitation**: Permanent magnet

**Mounting**: Flange mounted

**Drive Method**: Direct drive

Table 1.3 Ratings and Specifications of S Series AC SERVOMOTORS

| Item \ Motor Type USASEM- | | 02A□2 | 03A□2 | 05A□2 | 08A□1 | 15A□1 | 30A□1 |
|---|---|---|---|---|---|---|---|
| Rated Output* | W (HP) | 154 (0.2) | 308 (0.4) | 462 (0.6) | 771 (1.1) | 1540 (2.1) | 3080 (4.2) |
| Rated Torque* | N·m (lb·in) | 0.49 (4.3) | 0.98 (8.7) | 1.47 (13) | 2.45 (22) | 4.90 (43) | 9.80 (87) |
| Continuous Max Torque* | N·m (lb·in) | 0.57 (5.0) | 1.18 (10) | 1.67 (15) | 3.33 (30) | 6.17 (55) | 12.2 (108) |
| Instantaneous Max Torque* | N·m (lb·in) | 1.47 (13) | 2.94 (26) | 4.02 (36) | 7.35 (65) | 13.7 (122) | 29.0 (257) |
| Rated Current* | A | 2.1 | 3.0 | 4.2 | 5.3 | 10.4 | 19.9 |
| Rated Speed* | r/min | 3000 | | | | | |
| Instantaneous Max Speed* | r/min | 4000 | | | | | |
| Torque Constant† | N·m/A (lb·in·A) | 0.247 (2.19) | 0.35 (3.10) | 0.37 (3.25) | 0.51 (4.49) | 0.50 (4.43) | 0.524 (4.64) |
| Moment of Inertia $J_M(=GD^2/4)$ | $kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$) | 0.13 (0.11) | 0.51 (0.45) | 0.75 (0.67) | 2.85 (2.53) | 3.3 (2.88) | 5.74 (5.09) |
| Power Rate* | kW/s | 18.5 | 18.9 | 28.9 | 21 | 74 | 167 |
| Inertia Time Constant† | ms | 1.8 | 2.2 | 1.8 | 1.9 | 0.7 | 0.4 |
| Inductive Time Constant† | ms | 1.5 | 2.7 | 3.1 | 6.2 | 13 | 26 |

* Values when SERVOMOTOR is combined with SERVOPACK and the armature winding temperature is 100°C. Values shown are normal (TYP) values.

† Values when SERVOMOTOR is combined with SERVOPACK and the armature winding temperature is 20°C. Values shown are normal (TYP) values.

Notes:

1. □ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows;

| AC Servomotor Type USASEM– | 02A, 03A, 05A | | 08A, 15A, 30A | |
|---|---|---|---|---|
| Standard (pulses/rev) | E | 1500 | C | 2500 |
| Optional (pulses/rev) | C | 2500 | E | 1500 |
| | F | 1000 | F | 1000 |

2. There are two types of power supply units for brake.
   - Input 100 VAC, output 90 VDC (DP 8401002 - 2)
   - Input 200 VAC, output 90 VDC (DP 8401002 - 1)

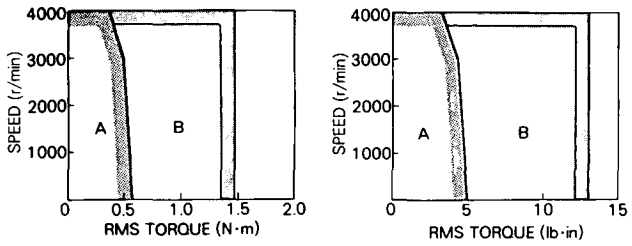
   For details, refer to Par. 8.5 , "PERIPHERAL EQUIPMENT"



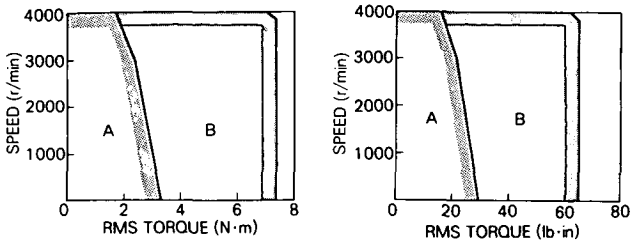
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## 1.3.2 Torque-Speed Characteristics

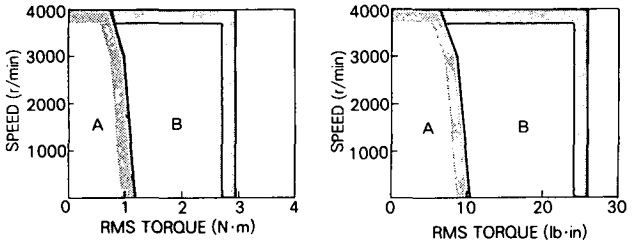
• TYPE USASEM-02A



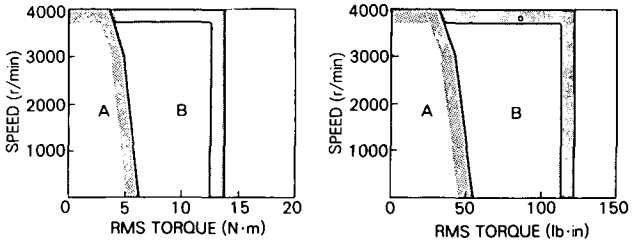

• TYPE USASEM-08A



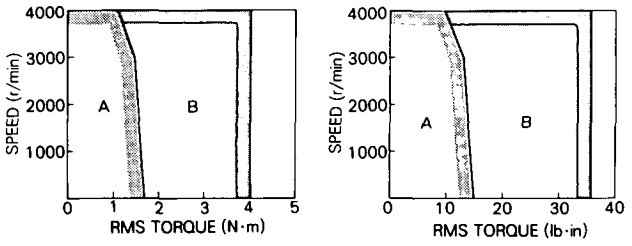

• TYPE USASEM-03A



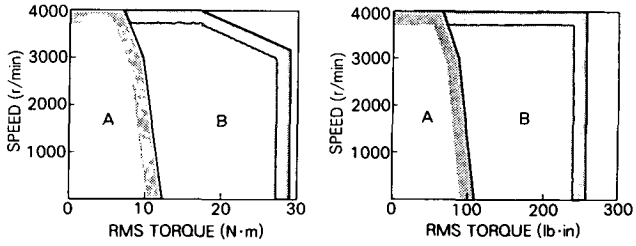

• TYPE USASEM-15A




• TYPE USASEM-05A




• TYPE USASEM-30A




A: CONTINUOUS DUTY ZONE
B: INTERMITTENT DUTY ZONE
POWER SUPPLY: 200V



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## 1.4 RATINGS AND SPECIFICATIONS OF SERVOPACK

Table 1.4 Ratings and Specifications of SERVOPACK

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SERVOPACK Type CACR- | | | | PR03BC | PR05BC | PR07BC | PR10BC | PR15BC | PR20BC | PR30BC | PR44BC |
| Max Motor Output | | | kW (HP) | 0.3 (0.4) | 0.5 (0.67) | 0.7 (0.94) | 1.0 (1.34) | 1.5 (2.01) | 2.0 (2.7) | 3.0 (4.1) | 4.4 (6.0) |
| M Series | Applicable Optical Encoder | | | A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev) | | | | | | | |
| | AC SERVOMOTOR | Type USAMED- | | 03MA | – | 06MA | 09MA | 12MA | 20MA | 30MA | 44MA |
| | | Output | kW (HP) | 0.3 (0.4) | – | 0.6 (0.8) | 0.9 (1.2) | 1.2 (1.2) | 3.0 (2.7) | 3.0 (4.1) | 4.4 (6.0) |
| | | Rated Speed | r/min | 1000 | | | | | | | |
| | SERVOPACK Type CACR- | | | PR03BC3AM | – | PR07BC3AM | PR10BC3AM | PR15BC3AM | PR20BC3AM | PR30BC3AM | PR44BC3AM |
| | Continuous Output Current | | Arms | 3.0 | – | 5.8 | 7.6 | 11.7 | 18.8 | 26.0 | 33.0 |
| | Max Output Current | | Arms | 7.3 | – | 13.9 | 16.6 | 28.0 | 42.0 | 56.5 | 70.0 |
| | Allowable $J_L (=GD_L^2/4)$ | | $kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$) | 67.5 (60) | – | 121.5 (107.5) | 183.5 (162.5) | 334 (296) | 550 (486) | 715 (633.5) | 1200 (1063) |
| F Series | Applicable Optical Encoder | | | A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev) | | | | | | | |
| | AC SERVOMOTOR | Type USAFED- | | 02FA | 03FA | 05FA | – | 09FA | 13FA | 20FA | 30FA | 44FA |
| | | Output | kW (HP) | 0.15 (0.2) | 0.3 (0.4) | 0.45 (0.6) | – | 0.85 (1.2) | 1.3 (1.8) | 1.8 (2.4) | 2.9 (3.9) | 4.4 (6.0) |
| | | Rated Speed | r/min | 1500 | | | | | | | |
| | SERVOPACK Type CACR- | | | PR03BC3AF | | PR05BC3AF | – | PR10BC3AF | PR15BC3AF | PR20BC3AF | PR30BC3AF | PR44BC3AF |
| | Continuous Output Current | | Arms | 3.0 | 3.0 | 3.8 | – | 6.2 | 9.7 | 15.0 | 20.0 | 30.0 |
| | Max Output Current | | Arms | 8.5 | 8.5 | 11.0 | – | 17.0 | 27.6 | 42.0 | 56.5 | 77.0 |
| | Allowable $J_L (=GD_L^2/4)$ | | $kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$) | 6.5 (5.75) | 10.3 (9) | 67.5 (60) | – | 121.5 (107.5) | 183.5 (162.5) | 334 (296) | 550 (486) | 715 (633.5) |
| S Series | Applicable Optical Encoder | | | C: 2500 pulses (E: 1500 pulses/rev, F: 1000 pulses/rev) | | | | | | | |
| | AC SERVOMOTOR | Type USASEM- | | 02AE | 03AE | 05AE | – | 08AC | 15AC | – | 30AC | – |
| | | Output | kW (HP) | 0.1 6 (0.2) | 0.3 (0.4) | 0.46 (0.6) | – | 0.77 (1.1) | 1.54 (2.1) | – | 3.08 (4.2) | – |
| | | Rated Speed | r/min | 3000 | | | | | | | | |
| | SERVOPACK Type CACR- | | | PR03BC3ES-Y41 | PR03BC3ES | PR05BC3ES | – | PR10BC3CS | PR15BC3CS | – | PR30BC3CS | – |
| | Continuous Output Current | | Arms | 2.1 | 3.0 | 4.3 | – | 5.3 | 10.4 | – | 19.9 | – |
| | Max Output Current | | Arms | 6.0 | 8.5 | 11.0 | – | 15.6 | 28.0 | – | 56.5 | – |
| | Allowable $J_L (=GD_L^2/4)$ | | $kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$) | 0.65 (0.55) | 2.55 (2.25) | 3.75 (3.35) | – | 14.25 (12.65) | 16.5 (14.4) | – | 28.7 (25.45) | – |
| Basic Specifications | Power Supply | Main Circuit * | | Three-phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60 Hz | | | | | | | |
| | | Control Circuit | | Single-phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60 Hz | | | | | | | |
| | Control Method | | | Transistorized PWM Control | | | | | | | |
| | Feedback | | | Optical encoder (A: 6000 pulses/rev, B: 5000 pulses/rev, C: 2500 pulses/rev, D: 4000 pulses/rev, E: 1500 pulses/rev, F: 1000 pulses/rev) | | | | | | | |
| | Ambient Temperature † | | | 0 to +55°C | | | | | | | |
| | Storage Temperature | | | −20°C to +85°C | | | | | | | |
| | Ambient and Storage Humidity | | | 90 % or less (non-condensing) | | | | | | | |
| | Mounting Structure | | | Rack mounted | | | | | | | |
| | Approx Mass | | kg (lb) | 7.0 (16) | | 7.0 (16) | 7.0 (16) | 7.0 (16) | 12.5 (28) | 12.5 (28) | 12.5 (28) |
| I/O Signal | Reference Pulse | | | Sign + pulse train input, + 12 V/+ 5 V level selection available (CW/CCW pulse train input available) | | | | | | | |
| | Reference Pulse Frequency | | | fin: 0 to 100 kpps max | | | | | | | |
| | Control Signal | | | Servo ON, error counter clear, reference pulse block (reference pulse input selection), P drive, alarm reset, forward/reverse run stop. | | | | | | | |
| | Output Signal | | | Encoder (A, B and C phase) pulse, positioning completion, error counter overflow, servo ready, servo alarm, MCCB trip, overload, TG ON. | | | | | | | |
| Built-in Functions | Protection | | | Overvoltage, overload, overcurrent, overrun, open phase detection, MCCB trip, heatsink overheat, undervoltage, A/D error, regeneration trouble, CPU error, overflow. | | | | | | | |
| | Indication | | | Power supply, reference input, alarm, status, lag pulse, encoder (A, B and C phase) pulse indications. | | | | | | | |
| | Dynamic Brake | | | Built-in (non-contact dynamic brake) | | | | | | | |
| | Regenerative Resistor | | | Built-in | | | | | | | |
| | Applicable Load Inertia † | | | Up to 5 times motor inertia | | | | | | | |
| | Monitor Output | | | Torque monitor: 3.0V ± 10% at rated r/min<br>Speed monitor: 4.0V ± 5% at 1000r/min. (M, F series), 2.0V ± 5% at 1000r/min (S series) | | | | | | | |

* Supply voltage should not exceed 230 V + 10 % (253 V). If the voltage should exceed this value, a step down transformer is required.

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

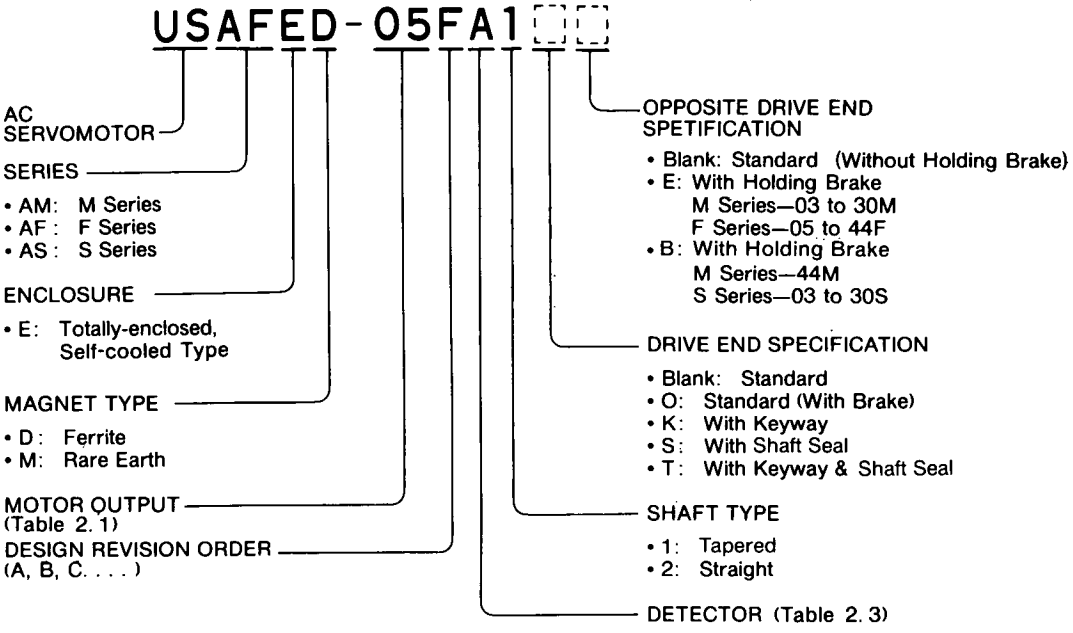
† When load inertia ($GD^2$) exceeds applicable range, be sure to refer to Par. 6. 10. 2, "Load Inertia."



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## 2. TYPE DESIGNATION

• AC SERVOMOTOR




• SERVOPACK

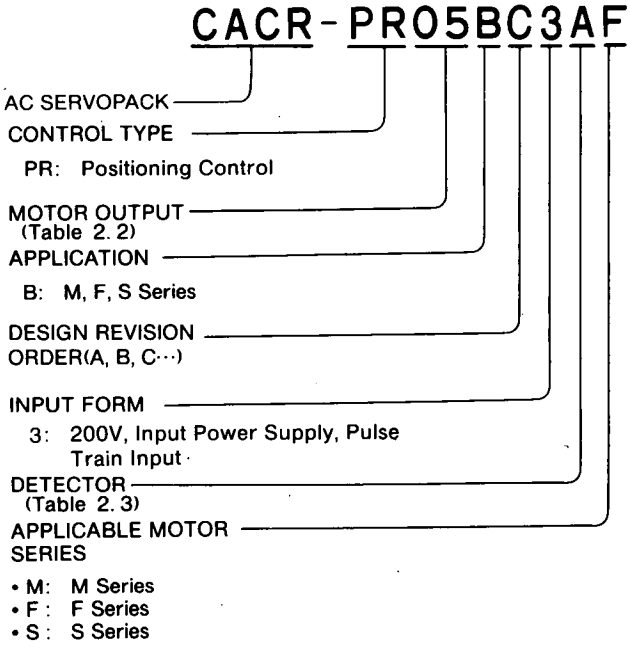



Table 2.1

| | Motor Output | | |
|---|---|---|---|
| | M Series | F Series | S Series |
| 02 | — | 0.15kW(0.2HP) | 0.15kW(0.2HP) |
| 03 | 0.3kW(0.4HP) | 0.3kW(0.4HP) | 0.3kW(0.4HP) |
| 05 | — | 0.45kW(0.6HP) | 0.46kW(0.6HP) |
| 06 | 0.6kW(0.8HP) | — | — |
| 08 | — | — | 0.77kW(1.1HP) |
| 09 | 0.9kW(1.2HP) | 0.85kW(1.2HP) | — |
| 12 | 1.2kW(1.6HP) | — | — |
| 13 | — | 1.3kW(1.8HP) | — |
| 15 | — | — | 1.5kW(2.1HP) |
| 20 | 2.0kW(2.7HP) | 1.8kW(2.4HP) | — |
| 30 | 3.0kW(4.1HP) | 2.9kW(3.9HP) | 3.0kW(4.2HP) |
| 44 | 4.4kW(6.0HP) | 4.4kW(6.0HP) | — |

Table 2.2

| | Motor Output | | |
|---|---|---|---|
| | M Series | F Series | S Series |
| 03 | 0.3kW(0.4HP) | 0.15kW(0.2HP) | 0.15kW(0.2HP) |
| | | 0.3kW(0.4HP) | 0.3kW(0.4HP) |
| 05 | — | 0.45kW(0.6HP) | 0.46kW(0.6HP) |
| 07 | 0.6kW(0.8HP) | — | — |
| 10 | 0.9kW(1.2HP) | 0.85kW(1.2HP) | 0.77kW(1.1HP) |
| 15 | 1.2kW(1.6HP) | 1.3kW(1.8HP) | 1.5kW(2.1HP) |
| 20 | 2.0kW(2.7HP) | 1.8kW(2.4HP) | — |
| 30 | 3.0kW(4.1HP) | 2.9kW(3.9HP) | 3.0kW(4.2HP) |
| 44 | 4.4kW(6.0HP) | 4.4kW(6.0HP) | — |

Table 2.3

| Models | Standard pulses/rev | | Optional pulses/rev | | | | Remarks |
|---|---|---|---|---|---|---|---|
| M Series | A | 6000 | B | 5000 | D | 4000 | — |
| F Series | A | 6000 | B | 5000 | D | 4000 | — |
| S Series | E | 1500 | C | 2500 | F | 1000 | 02A, 03A, 05A |
| | C | 2500 | E | 1500 | F | 1000 | 08A, 15A, 30A |



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# 3. LIST OF STANDARD COMBINATION

Table 3.1 Combination of SERVOPACK, AC SERVOMOTORS and Assocated Units

• M SERIES

| SERVOPACK Type CACR– | AC SERVOMOTOR Type | AC SERVOMOTOR Optical Encoder pulses/rev | Power Capacity* per SERVOPACK kVA | Current Capacity per MCCB or Fuse A | Applicable Noise Filter | Recommended Noise Filter† Type | Recommended Noise Filter† Specifications | Power ON/OFF Switch |
|---|---|---|---|---|---|---|---|---|
| PR03BC3AM | USAMED–03MA1 | 6000 | 0.65 | 5 | Good | LF–305 | 3–phase 200 VAC class, 5 A | Yaskawa type HI–15E$_2$ rated 30 A or equivalent |
| PR03BC3BM | USAMED–03MB1 | 5000 | | | | | | |
| PR03BC3DM | USAMED–03MD1 | 4000 | | | | | | |
| PR07BC3AM | USAMED–06MA1 | 6000 | 1.5 | 8 | | LF–310 | 3–phase 200 VAC class, 10 A | |
| PR07BC3BM | USAMED–06MB1 | 5000 | | | | | | |
| PR07BC3DM | USAMED–06MD1 | 4000 | | | | | | |
| PR10BC3AM | USAMED–09MA2 | 6000 | 2.1 | 8 | | LF–315 | 3–phase 200 VAC class, 15 A | |
| PR10BC3BM | USAMED–09MB2 | 5000 | | | | | | |
| PR10BC3DM | USAMED–09MD2 | 4000 | | | | | | |
| PR15BC3AM | USAMED–12MA2 | 6000 | 3.1 | 10 | | LF–315 | 3–phase 200 VAC class, 15 A | |
| PR15BC3BM | USAMED–12MB2 | 5000 | | | | | | |
| PR15BC3DM | USAMED–12MD2 | 4000 | | | | | | |
| PR20BC3AM | USAMED–20MA2 | 6000 | 4.1 | 12 | | LF–320 | 3–phase 200 VAC class, 20 A | Yaskawa type HI–18E rated 35 A or equivalent |
| PR20BC3BM | USAMED–20MB2 | 5000 | | | | | | |
| PR20BC3DM | USAMED–20MD2 | 4000 | | | | | | |
| PR30BC3AM | USAMED–30MA2 | 6000 | 6.0 | 18 | Poor | LF–330 | 3–phase 200 VAC class, 30 A | |
| PR30BC3BM | USAMED–30MB2 | 5000 | | | | | | |
| PR30BC3DM | USAMED–30MD2 | 4000 | | | | | | |
| PR44BC3AM | USAMED–44MA2 | 6000 | 8.0 | 24 | | LF–340 | 3–phase 200 VAC class, 40 A | |
| PR44BC3BM | USAMED–44MB2 | 5000 | | | | | | |
| PR44BC3DM | USAMED–44MD2 | 4000 | | | | | | |

• F SERIES

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PR03BC3AF | USAFED–02FA1 | 6000 | 1.1 | 5 | Good | LF–305 | 3–phase 200 VAC class, 5 A | Yaskawa HI–15E$_2$ rated 30 A or equivalent |
| PR03BC3BF | USAFED–02FB1 | 5000 | | | | | | |
| PR03BC3DF | USAFED–02FD1 | 4000 | | | | | | |
| PR03BC3AF | USAFED–03FA1 | 6000 | | | | | | |
| PR03BC3BF | USAFED–03FB1 | 5000 | | | | | | |
| PR03BC3DF | USAFED–03FD1 | 4000 | | | | | | |
| PR05BC3AF | USAFED–05FA1 | 6000 | | | | | | |
| PR05BC3BF | USAFED–05FB1 | 5000 | | | | | | |
| PR05BC3DF | USAFED–05FD1 | 4000 | | | | | | |
| PR10BC3AF | USAFED–09FA1 | 6000 | 2.1 | 8 | | LF–315 | 3–phase 200 VAC class,15 A | |
| PR10BC3BF | USAFED–09FB1 | 5000 | | | | | | |
| PR10BC3DF | USAFED–09FD1 | 4000 | | | | | | |
| PR15BC3AF | USAFED–13FA2 | 6000 | 3.1 | 10 | | LF–315 | 3–phase 200 VAC class,15 A | |
| PR15BC3BF | USAFED–13FB2 | 5000 | | | | | | |
| PR15BC3DF | USAFED–13FD2 | 4000 | | | | | | |
| PR20BC3AF | USAFED–20FA2 | 6000 | 4.1 | 12 | | LF–320 | 3–phase 200 VAC class, 20 A | Yaskawa type HI–18E rated 35 A or equivalent |
| PR20BC3BF | USAFED–20FB2 | 5000 | | | | | | |
| PR20BC3DF | USAFED–20FD2 | 4000 | | | | | | |
| PR30BC3AF | USAFED–30FA2 | 6000 | 6.0 | 18 | Poor | LF–330 | 3–phase 200 VAC class, 30 A | |
| PR30BC3BF | USAFED–30FB2 | 5000 | | | | | | |
| PR30BC3DF | USAFED–30FD2 | 4000 | | | | | | |
| PR44BC3AF | USAFED–44FA2 | 6000 | 8.0 | 24 | | LF–340 | 3–phase 200 VAC class, 40 A | |
| PR44BC3BF | USAFED–44FB2 | 5000 | | | | | | |
| PR44BC3DF | USAFED–44FD2 | 4000 | | | | | | |

• S SERIES

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PR03BC3CS–Y41 | USASEM–02AC2 | 2500 | 0.65 | 5 | Good | LF–305 | 3–phase 200 VAC class, 5 A | Yaskawa type HI–15E$_2$ rated 30 A or equivalent |
| PR03BC3ES–Y41 | USASEM–02AE2 | 1500 | | | | | | |
| PR03BC3FS–Y41 | USASEM–02AF2 | 1000 | | | | | | |
| PR03BC3CS | USASEM–03AC2 | 2500 | | | | | | |
| PR03BC3ES | USASEM–03AE2 | 1500 | | | | | | |
| PR03BC3FS | USASEM–03AF2 | 1000 | | | | | | |
| PR05BC3CS | USASEM–05AC2 | 2500 | 1.1 | 5 | | LF–305 | 3–phase 200 VAC class, 5 A | |
| PR05BC3ES | USASEM–05AE2 | 1500 | | | | | | |
| PR05BC3FS | USASEM–05AF2 | 1000 | | | | | | |
| PR10BC3CS | USASEM–08AC1 | 2500 | 2.1 | 8 | | LF–315 | 3–phase 200 VAC class, 15 A | |
| PR10BC3ES | USASEM–08AE1 | 1500 | | | | | | |
| PR10BC3FS | USASEM–08AF1 | 1000 | | | | | | |
| PR15BC3CS | USASEM–15AC1 | 2500 | 3.1 | 10 | | LF–315 | 3–phase 200 VAC class, 15 A | |
| PR15BC3FS | USASEM–15AE1 | 1500 | | | | | | |
| PR15BC3FS | USASEM–15AF1 | 1000 | | | | | | |
| PR30BC3CS | USASEM–30AC1 | 2500 | 6.0 | 18 | Poor | LF–330 | 3–phase 200 VAC class, 30 A | Yaskawa type HI–18E rated 35 A or equivalent |
| PR30BC3ES | USASEM–30AE1 | 1500 | | | | | | |
| PR30BC3FS | USASEM–30AF1 | 1000 | | | | | | |

*Values at rated load.
†Made by Tokin Corp.



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Table 3.2 Specifications of AC SERVOMOTORS and Detectors

• M SERIES

| SERVOPACK Type CACR– | AC SERVOMOTOR | | | | | | Detector | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Type | Optical Encoder pulses/rev | Receptacle Type | L–type Plug | Straight Plug | Cable Clamp | Receptacle Type | L–type Plug | Straight Plug | Cable Clamp |
| PR03BC3AM | USAMED–03MA1 | 6000 | MS 3102A18 –10P | MS 3108B18 –10S | MS 3106B18 –10S | MS 3057 –10A | MS 3102A20 –29P | MS 3108B20 –29S | MS 3106B20 –29S | MS 3057 –12A |
| PR03BC3BM | USAMED–03MB1 | 5000 | | | | | | | | |
| PR03BC3DM | USAMED–03MD1 | 4000 | | | | | | | | |
| PR07BC3AM | USAMED–06MA1 | 6000 | | | | | | | | |
| PR07BC3BM | USAMED–06MB1 | 5000 | | | | | | | | |
| PR07BC3DM | USAMED–06MD1 | 4000 | | | | | | | | |
| PR10BC3AM | USAMED–09MA2 | 6000 | | | | | | | | |
| PR10BC3BM | USAMED–09MB2 | 5000 | | | | | | | | |
| PR10BC3DM | USAMED–09MD2 | 4000 | | | | | | | | |
| PR15BC3AM | USAMED–12MA2 | 6000 | MS 3102A22 –22P | MS 3108B22 –22S | MS 3106B22 –22S | MS 3057 –12A | | | | |
| PR15BC3BM | USAMED–12MB2 | 5000 | | | | | | | | |
| PR15BC3DM | USAMED–12MD2 | 4000 | | | | | | | | |
| PR20BC3AM | USAMED–20MA2 | 6000 | | | | | | | | |
| PR20BC3BM | USAMED–20MB2 | 5000 | | | | | | | | |
| PR20BC3DM | USAMED–20MD2 | 4000 | | | | | | | | |
| PR30BC3AM | USAMED–30MA2 | 6000 | | | | | | | | |
| PR30BC3BM | USAMED–30MB2 | 5000 | | | | | | | | |
| PR30BC3DM | USAMED–30MD2 | 4000 | | | | | | | | |
| PR44BC3AM | USAMED–44MA2 | 6000 | MS 3102A32 –17P | MS 3108B32 –17S | MS 3106B32 –17S | MS 3057 –20A | | | | |
| PR44BC3BM | USAMED–44MB2 | 5000 | | | | | | | | |
| PR44BC3DM | USAMED–44MD2 | 4000 | | | | | | | | |

• F SERIES

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PR03BC3AF | USAFED–02FA1 | 6000 | MS 3102A14S –2P | MS 3108B14S –2S | MS 3106B14S –2S | MS 3057 –6A | MS 3102A20 –29P | MS 3108B20 –29S | MS 3106B20 –29S | MS 3057 –12A |
| PR03BC3BF | USAFED–02FB1 | 5000 | | | | | | | | |
| PR03BC3DF | USAFED–02FD1 | 4000 | | | | | | | | |
| PR03BC3AF | USAFED–03FA1 | 6000 | | | | | | | | |
| PR03BC3BF | USAFED–03FB1 | 5000 | | | | | | | | |
| PR03BC3DF | USAFED–03FD1 | 4000 | | | | | | | | |
| PR05BC3AF | USAFED–05FA1 | 6000 | MS 3102A18 –10P | MS 3108B18 –10S | MS 3106B18 –10S | MS 3057 –10A | | | | |
| PR05BC3BF | USAFED–05FB1 | 5000 | | | | | | | | |
| PR05BC3DF | USAFED–05FD1 | 4000 | | | | | | | | |
| PR10BC3AF | USAFED–09FA1 | 6000 | | | | | | | | |
| PR10BC3BF | USAFED–09FB1 | 5000 | | | | | | | | |
| PR10BC3DF | USAFED–09FD1 | 4000 | | | | | | | | |
| PR15BC3AF | USAFED–13FA2 | 6000 | | | | | | | | |
| PR15BC3BF | USAFED–13FB2 | 5000 | | | | | | | | |
| PR15BC3DF | USAFED–13FD2 | 4000 | | | | | | | | |
| PR20BC3AF | USAFED–20FA2 | 6000 | MS 3102A22 –22P | MS 3108B22 –22S | MS 3106B22 –22S | MS 3057 –12A | | | | |
| PR20BC3BF | USAFED–20FB2 | 5000 | | | | | | | | |
| PR20BC3DF | USAFED–20FD2 | 4000 | | | | | | | | |
| PR30BC3AF | USAFED–30FA2 | 6000 | | | | | | | | |
| PR30BC3BF | USAFED–30FB2 | 5000 | | | | | | | | |
| PR30BC3DF | USAFED–30FD2 | 4000 | | | | | | | | |
| PR44BC3AF | USAFED–44FA2 | 6000 | | | | | | | | |
| PR44BC3BF | USAFED–44FB2 | 5000 | | | | | | | | |
| PR44BC3DF | USAFED–44FD2 | 4000 | | | | | | | | |

• S SERIES

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PR03BC3CS–Y41 | USASEM–02AC2 | 2500 | MS 3102A18 –10P | MS 3108B18 –10S | – | MS 3057 –10A | MS 3102A20 –29P | MS 3108B20 –29S | – | MS 3057 –12A |
| PR03BC3ES–Y41 | USASEM–02AE2 | 1500 | | | | | | | | |
| PR03BC3FS–Y41 | USASEM–02AF2 | 1000 | | | | | | | | |
| PR03BC3CS | USASEM–03AC2 | 2500 | | | | | | | | |
| PR03BC3ES | USASEM–03AE2 | 1500 | | | | | | | | |
| PR03BC3FS | USASEM–03AF2 | 1000 | | | | | | | | |
| PR05BC3CS | USASEM–05AC2 | 2500 | | | | | | | | |
| PR05BC3ES | USASEM–05AE2 | 1500 | | | | | | | | |
| PR05BC3FS | USASEM–05AF2 | 1000 | | | | | | | | |
| PR10BC3CS | USASEM–08AC1 | 2500 | MS 3102A20 –4P | MS 3108B20 –4S | – | MS 3057 –12A | | | | |
| PR10BC3ES | USASEM–08AE1 | 1500 | | | | | | | | |
| PR10BC3FS | USASEM–08AF1 | 1000 | | | | | | | | |
| PR15BC3CS | USASEM–15AC1 | 2500 | | | | | | | | |
| PR15BC3ES | USASEM–15AE1 | 1500 | | | | | | | | |
| PR15BC3FS | USASEM–15AF1 | 1000 | | | | | | | | |
| PR30BC3CS | USASEM–30AC1 | 2500 | | | | | | | | |
| PR30BC3ES | USASEM–30AE1 | 1500 | | | | | | | | |
| PR30BC3FS | USASEM–30AF1 | 1000 | | | | | | | | |

Note: When plugs or clamps are required, contact your YASKAWA representative. The following connections are provided: soldered type (type MS) and solderless type (type JA).



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## Table 3.3 Specifications of Holding Brake

### • M SERIES

| SERVOPACK Type CACR– | AC SERVOMOTOR | | Holding Brake | | | |
|---|---|---|---|---|---|---|
| | Type | Optical Encoder pulses/rev | Receptacle Type | L–type Plug | Straight Plug | Cable Clamp |
| PR03BC3AM | USAMED–03MA1 | 6000 | MS3102A20 –15P | MS3108B20 –15S | MS3106B20 –15S | MS3057 –12A |
| PR03BC3BM | USAMED–03MB1 | 5000 | | | | |
| PR03BC3DM | USAMED–03MD1 | 4000 | | | | |
| PR07BC3AM | USAMED–06MA1 | 6000 | | | | |
| PR07BC3BM | USAMED–06MB1 | 5000 | | | | |
| PR07BC3DM | USAMED–06MD1 | 4000 | | | | |
| PR10BC3AM | USAMED–09MA2 | 6000 | | | | |
| PR10BC3BM | USAMED–09MB2 | 5000 | | | | |
| PR10BC3DM | USAMED–09MD2 | 4000 | | | | |
| PR15BC3AM | USAMED–12MA2 | 6000 | MS3102A24 –10P | MS3108B24 –10S | MS3106B24 –10S | MS3057 –16A |
| PR15BC3BM | USAMED–12MB2 | 5000 | | | | |
| PR15BC3DM | USAMED–12MD2 | 4000 | | | | |
| PR20BC3AM | USAMED–20MA2 | 6000 | | | | |
| PR20BC3BM | USAMED–20MB2 | 5000 | | | | |
| PR20BC3DM | USAMED–20MD2 | 4000 | | | | |
| PR30BC3AM | USAMED–30MA2 | 6000 | | | | |
| PR30BC3BM | USAMED–30MB2 | 5000 | | | | |
| PR30BC3DM | USAMED–30MD2 | 4000 | | | | |
| PR44BC3AM | USAMED–44MA2 | 6000 | – | – | – | – |
| PR44BC3BM | USAMED–44MB2 | 5000 | | | | |
| PR44BC3DM | USAMED–44MD2 | 4000 | | | | |

### • F SERIES

| | | | | | | |
|---|---|---|---|---|---|---|
| PR03BC3AF | USAFED–02FA1 | 6000 | MS3102A14S –6P | MS3108B14S –6S | MS3106B14S –6S | MC3057 –6A |
| PR03BC3BF | USAFED–02FB1 | 5000 | | | | |
| PR03BC3DF | USAFED–02FD1 | 4000 | | | | |
| PR03BC3AF | USAFED–03FA1 | 6000 | | | | |
| PR03BC3BF | USAFED–03FB1 | 5000 | | | | |
| PR03BC3DF | USAFED–03FD1 | 4000 | | | | |
| PR05BC3AF | USAFED–05FA1 | 6000 | MS3102A20 –15P | MS3108B20 –15S | MS3106B20 –15S | MS3057 –12A |
| PR05BC3BF | USAFED–05FB1 | 5000 | | | | |
| PR05BC3DF | USAFED–05FD1 | 4000 | | | | |
| PR10BC3AF | USAFED–09FA1 | 6000 | | | | |
| PR10BC3BF | USAFED–09FB1 | 5000 | | | | |
| PR10BC3DF | USAFED–09FD1 | 4000 | | | | |
| PR15BC3AF | USAFED–13FA2 | 6000 | | | | |
| PR15BC3BF | USAFED–13FB2 | 5000 | | | | |
| PR15BC3DF | USAFED–13FD2 | 4000 | | | | |
| PR20BC3AF | USAFED–20FA2 | 6000 | MS3102A24 –10P | MS3108B24 –10S | MS3106B24 –10S | MS3057 –16A |
| PR20BC3BF | USAFED–20FB2 | 5000 | | | | |
| PR20BC3DF | USAFED–20FD2 | 4000 | | | | |
| PR30BC3AF | USAFED–30FA2 | 6000 | | | | |
| PR30BC3BF | USAFED–30FB2 | 5000 | | | | |
| PR30BC3DF | USAFED–30FD2 | 4000 | | | | |
| PR44BC3AF | USAFED–44FA2 | 6000 | | | | |
| PR44BC3BF | USAFED–44FB2 | 5000 | | | | |
| PR44BC3DF | USAFED–44FD2 | 4000 | | | | |

### • S SERIES

| | | | | | | |
|---|---|---|---|---|---|---|
| PR03BC3CS–Y41 | USASEM–02AC2 | 2500 | MS3102A18 –12P | MS3108B18 –12S | – | MS3057 –10A |
| PR03BC3ES–Y41 | USASEM–02AE2 | 1500 | | | | |
| PR03BC3FS–Y41 | USASEM–02AF2 | 1000 | | | | |
| PR03BC3CS | USASEM–03AC2 | 2500 | | | | |
| PR03BC3ES | USASEM–03AE2 | 1500 | | | | |
| PR03BC3FS | USASEM–03AF2 | 1000 | | | | |
| PR05BC3CS | USASEM–05AC2 | 2500 | | | | |
| PR05BC3ES | USASEM–05AE2 | 1500 | | | | |
| PR05BC3FS | USASEM–05AF2 | 1000 | | | | |
| PR10BC3CS | USASEM–08AC1 | 2500 | MS3102A20 –17P | MS3108B20 –17S | | MS3057 –12A |
| PR10BC3ES | USASEM–08AE1 | 1500 | | | | |
| PR10BC3FS | USASEM–08AF1 | 1000 | | | | |
| PR15BC3CS | USASEM–15AC1 | 2500 | | | | |
| PR15BC3ES | USASEM–15AE1 | 1500 | | | | |
| PR15BC3FS | USASEM–15AF1 | 1000 | | | | |
| PR30BC3CS | USASEM–30AC1 | 2500 | | | | |
| PR30BC3ES | USASEM–30AE1 | 1500 | | | | |
| PR30BC3FS | USASEM–30AF1 | 1000 | | | | |



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# 4. CHARACTERISTICS

## 4.1 OVERLOAD CHARACTERISTICS

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

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.

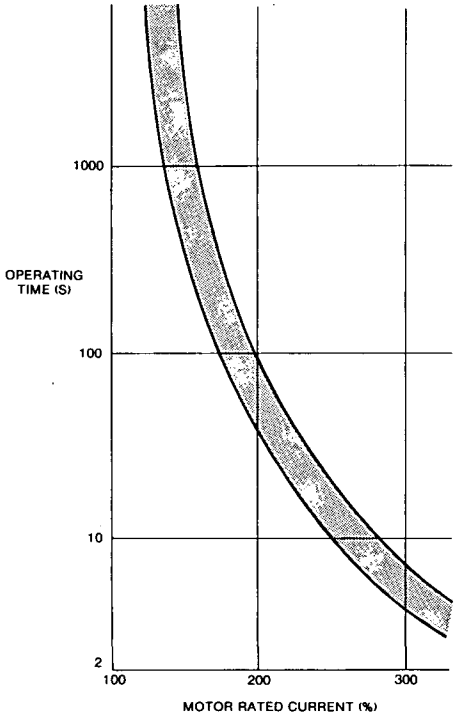



Fig. 4.1 Allowable Conduction Current of ***Servopack***.

## 4.2 STARTING AND STOPPING TIME

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

Starting Time:

$$t_r = 104.7 \times \frac{N_R\ (J_M + J_L)}{Kt \cdot I_R \cdot (\alpha - \beta)} (\text{ms}) \quad \langle \text{Formula } 4\text{-}1 \rangle$$

Stopping Time:

$$t_f = 104.7 \times \frac{N_R\ (J_M + J_L)}{Kt \cdot I_R \cdot (\alpha + \beta)} (\text{ms}) \quad \langle \text{Formula } 4\text{-}2 \rangle$$

Where,

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

$J_M\ (=GD_M^2/4)$ : Moment of motor inertia ($\text{kg}\cdot\text{cm}^2 = \text{lb}\cdot\text{in}\cdot\text{s}^2 \times 10^{-3}$)

$J_L\ (=GD_L^2/4)$ : Moment of load inertia ($\text{kg}\cdot\text{cm}^2 = \text{lb}\cdot\text{in}\cdot\text{s}^2 \times 10^{-3}$)

$Kt$ : Torque constant of motor ($\text{N}\cdot\text{m/A} = \text{lb}\cdot\text{in/A}$)

$I_R$ : 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)

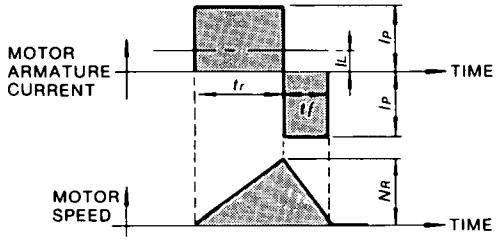



Fig. 4.2 Timing Chart of Motor Armature Current and Speed (Constant Load)

## 4.3 ALLOWABLE FREQUENCY OF OPERATION

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

- Allowable frequency of operation restricted by the SERVOPACK

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

- Allowable frequency of operation restricted by the Servomotor

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

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

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

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



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

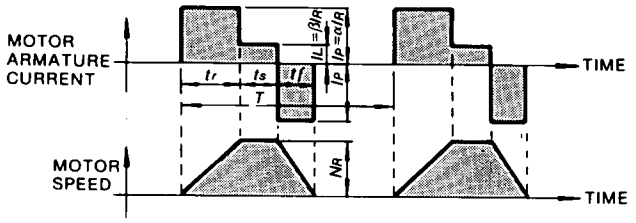



Fig. 4.3 Timing Chart of
Motor Armature Current and Speed
(Restricted by SERVOMOTOR)

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

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

$$n = 286.5 \times \frac{Kt \cdot I_R}{N_R (J_M + J_L)} \left( \frac{1}{\alpha} - \frac{\beta^2}{\alpha^3} \right) \quad \text{(times/min)} \qquad \langle \text{Formula 4-3} \rangle$$

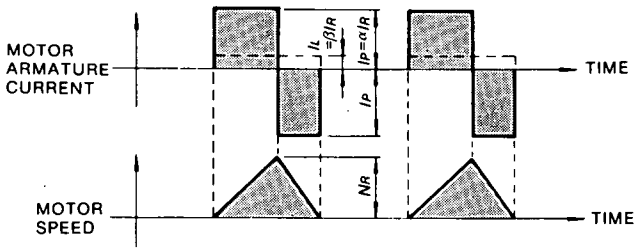



Fig. 4.4 Timing Chart of
Motor Armature Current and Speed
(The motor remains at standstill between cycles of accel/decel without continuous rated speed running.)

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

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

$$n = 286.5 \times \frac{Kt \cdot I_R}{N_R (J_M + J_L)} \left( \frac{1}{\alpha} - \frac{\beta^2}{\alpha} \right) \quad \text{(times/min)} \qquad \langle \text{Formula 4-4} \rangle$$

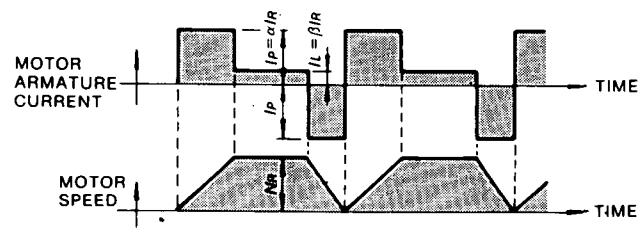



Fig. 4.5 Timing Chart of
Motor Armature Current and Speed
(The motor accelerates, runs at constant speed, and decelerates in a continuing cycle without being at standstill.)

(Reference)
The formulas (4-1 to 4-5) are changed to the calculating method using the international system of units. For reference only, the traditional formulas are shown in **Table 4.1.**

Table 4.1

| Formula | Traditional Formula |
|---|---|
| 4–1 | Starting time : $tr = 26.8\times10^{-3}\times \frac{N_R(GD_M^2+GD_L^2)}{Kt\cdot I_R(\alpha-\beta)}$ [ms] |
| 4–2 | Stopping time : $tf = 26.8\times10^{-3}\times \frac{N_R(GD_M^2+GD_L^2)}{Kt\cdot I_R(\alpha+\beta)}$ [ms]<br>$N_R$ : Rated motor speed (r/min)<br>$GD_M^2$ : Moment of motor inertia (kg·cm² = lb·in·s²×10⁻³)<br>$GD_L^2$ : Moment of load inertia (kg·cm² = lb·in·s²×10⁻³)<br>$K_t$ : Torque constant of motor (kg·cm/A = lb·in/A)<br>$I_R$ : Motor rated current (A)<br>$\alpha = I_P/I_R$ : Accel/decel current constant<br>$I_P$ : Accel/decel current<br>(Accel/decel current $\alpha$ times the motor rated current) (A)<br>$\beta = I_L/I_R$ : Load current constant<br>$I_L$ : Current equivalent to load torque<br>(Load current $\beta$ times the motor rated current) (A) |
| 4–3 | $n = 1.12\times10^6\times\frac{Kt\cdot I_R}{N_R(GD_M^2+GD_L^2)}\times(1/\alpha-\beta^2/\alpha^3)$ [times/min] |
| 4–4 | $n = 1.12\times10^6\times\frac{Kt\cdot I_R}{N_R(GD_M^2+GD_L^2)}\times(1/\alpha-\beta^2/\alpha)$ [times/min] |



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## 4.4 MOTOR MECHANICAL CHARACTERISTICS

### 4.4.1 Mechanical Strength

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

### 4.4.2 Allowable Radial Load and Thrust Load

Tables 4.1 to 4.3 show allowable loads according to AC SERVOMOTOR types.

Table 4.1 M Series Allowable Radial Load and Thrust Load

| Motor Type USAMED- | Allowable Radial Load* N (lb) | Allowable Thrust Load N (lb) |
|---|---|---|
| 03MA1 | 490 (110) | 98 ( 22)† |
| 06MA1 | 490 (110) | 98 ( 22)† |
| 09MA2 | 686 (154) | 343 ( 77) |
| 12MA2 | 1470 (330) | 490 (110) |
| 20MA2 | 1470 (330) | 490 (110) |
| 30MA2 | 1470 (330) | 490 (110) |
| 44MA2 | 1764 (397) | 588 (132) |

Table 4.2 F Series Allowable Radial Load and Thrust Load

| Motor Type USAFED- | Allowable Radial Load* N (lb) | Allowable Thrust Load N (lb) |
|---|---|---|
| 02F⬚ | 147( 33) | 49( 11)† |
| 03F⬚ | 147( 33) | 49( 11)† |
| 05F⬚ | 490(110) | 98( 22)† |
| 09F⬚ | 490(110) | 98( 22)† |
| 13F⬚ | 686(154) | 343( 77) |
| 20F⬚ | 1470(331) | 490(110) |
| 30F⬚ | 1470(331) | 490(110) |
| 44F⬚ | 1470(331) | 490(110) |

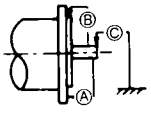
Table 4.3 S Series Allowable Radial Load and Thrust Load

| Motor Type USASEM- | Allowable Radial Load* N (lb) | Allowable Thrust Load N (lb) |
|---|---|---|
| 02A⬚ | 78.4( 18) | 39.2( 9) |
| 03A⬚ | 245 ( 55) | 98 (22) |
| 05A⬚ | 245 ( 55) | 98 (22) |
| 08A⬚ | 392 ( 88) | 147 (33) |
| 15A⬚ | 490 (110) | 147 (33) |
| 30A⬚ | 686 (154) | 196 (44) |

*Maximum values of the load applying to the shaft extension.
†Do not apply the exceeding load because motor cannot be rotated.

### 4.4.3 Mechanical Specifications (M, F and S series)

Table 4.4 Mechanical Specifications in mm

| Accuracy (T.I.R.)† | | Reference Diagram |
|---|---|---|
| Flange surface perpendicular to shaft Ⓐ | 0.04 |  |
| Flange diameter concentric to shaft Ⓑ | 0.04 | |
| Shaft run out Ⓒ | 0.02 (0.04)‡ | |

†T.I.R. (Total Indicator Reading)
‡Accuray for motor type USAMED-44MA2.

### 4.4.4 Direction of Rotation

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

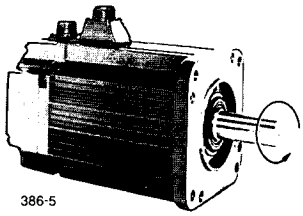
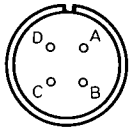



Fig. 4.6 AC SERVOMOTOR

(1) Connector Specifications for Standard SERVOMOTORS

(a) Motor receptacle

· M,F Series

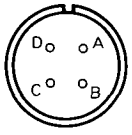



| | |
|---|---|
| A | Phase U |
| B | Phase V |
| C | Phase W |
| D | Frame ground |

· S Series
(Type USASEM-02A)

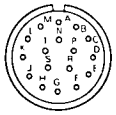
| Color of Lead | Applicable |
|---|---|
| Red | Phase U |
| White | Phase V |
| Blue | Phase W |
| Green | Frame ground |

(Types USASEM-03A to 30A)




| | |
|---|---|
| A | Phase U |
| B | Phase V |
| C | Phase W |
| D | Frame ground |

(b) Detector receptacle



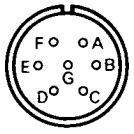
| | | | |
|---|---|---|---|
| A | Channel A output | K | Channel U output |
| B | Channel $\overline{A}$ output | L | Channel $\overline{U}$ output |
| C | Channel B output | M | Channel V output |
| D | Channel $\overline{B}$ output | N | Channel $\overline{V}$ output |
| E | Channel Z output | P |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



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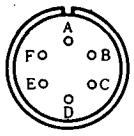
(2) Connector Specifications for SERVOMOTOR with Brake

· M, F Series
(Types USAFED-05 to -44)




| | | | |
|---|---|---|---|
| A | Phase U | E | Brake terminal |
| B | Phase V | F | |
| C | Phase W | G | – |
| D | Ground | – | – |

· F Series
(Types USAFED-02 and -03)

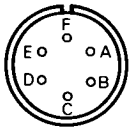



| | |
|---|---|
| A | Phase U |
| B | Phase V |
| C | Phase W |
| D | Frame ground |
| E | Brake terminal |
| F | Brake terminal |

· S Series
(Type USASEM-02A)

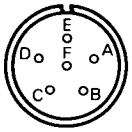
| Color of Lead | Applicable | Color of Lead | Applicable |
|---|---|---|---|
| Red | Phase U | Black | Brake |
| White | Phase V | Black | |
| Blue | Phase W | Green | Frame Ground |

(Types USASEM-03A, -05A)




| | |
|---|---|
| A | Phase U |
| B | Phase V |
| C | Phase W |
| D | Brake terminal |
| E | |
| F | Frame ground |

(Types USASEM-08A to 30A)




| | |
|---|---|
| A | Phase U |
| B | Phase V |
| C | Phase W |
| D | Brake terminal |
| E | |
| F | Frame ground |

### 4.4.5 Impact Resistance

When mounted horizontally and exposed to vertical shock impulses, the motor can withstand up to two impacts with impact acceleration of 50G (Fig. 4.7).

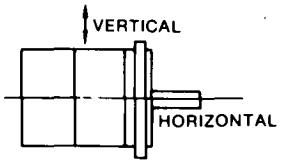



Fig. 4.7 Impact Resistance

**NOTE**

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

### 4.4.6 Vibration Resistance

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

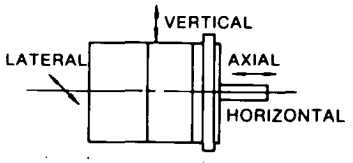



Fig. 4.8 Vibration Resistance

### 4.4.7 Vibration Class

Vibration of the motor running at rated speed is 15 $\mu$m or below (Fig.4.9)

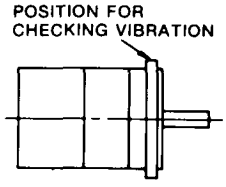



Fig. 4.9 Vibration Checking

### 4.4.8 Holding Brake

Turn on/off according to Par. 6.12.2, "Use of SERVOMOTORS with Holding Magnetic Brake" since AC SERVOMOTORS with brake is used when the operation is held.



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# 5. CONFIGURATION

## 5.1 CONNECTION DIAGRAM

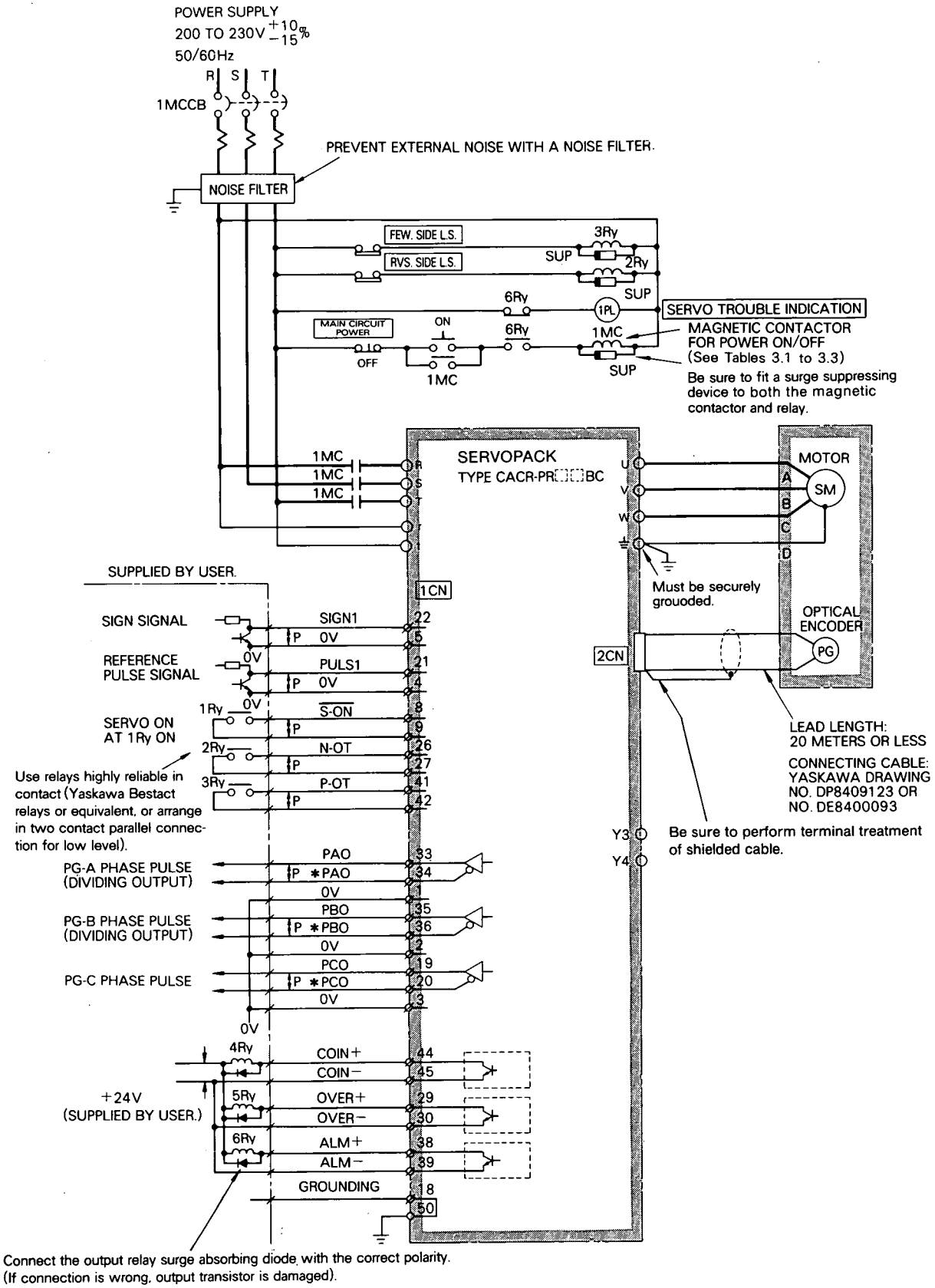
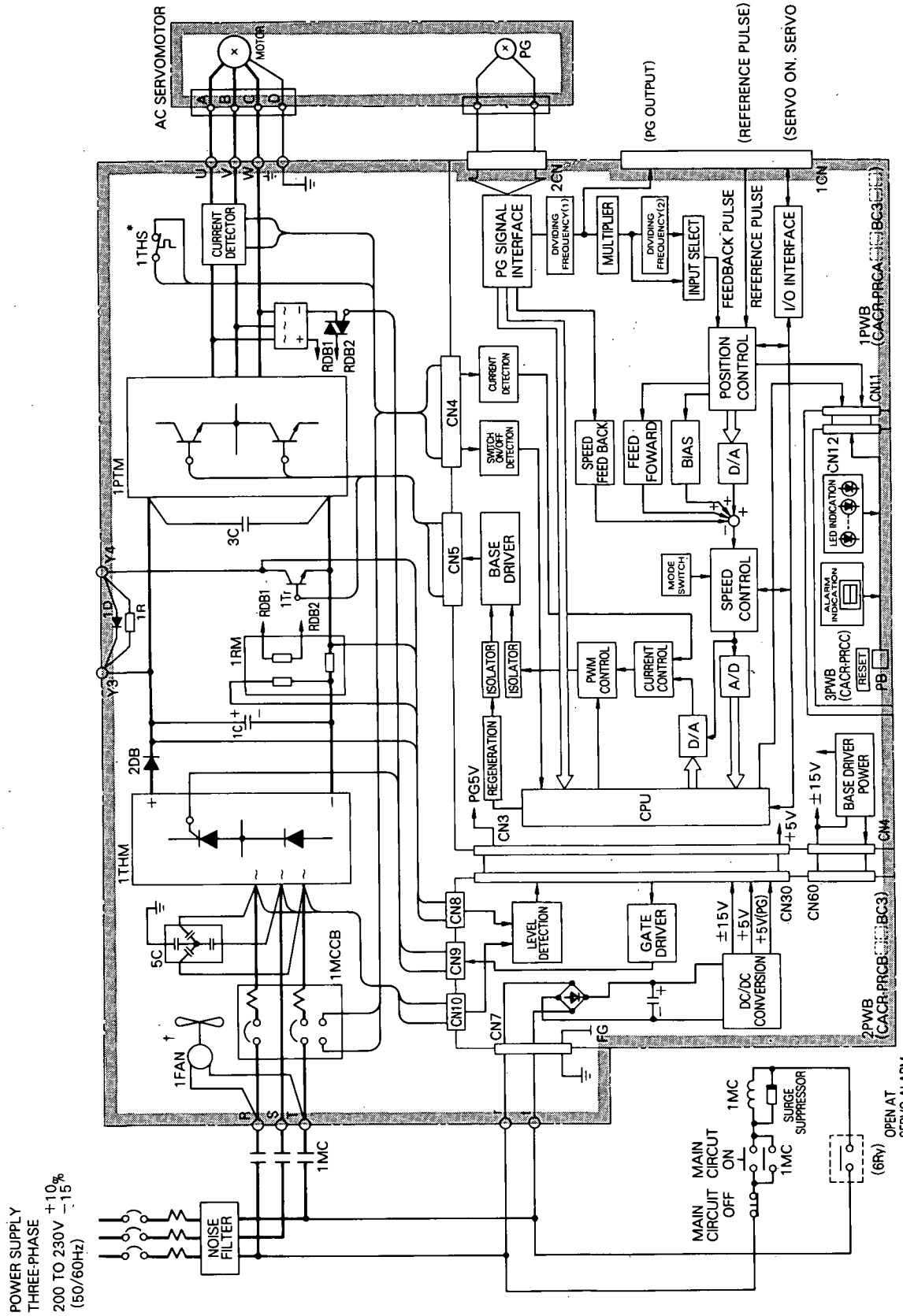



Fig. 5.1 Example of Connection Diagram of SERVOPACK with a SERVOMOTOR and Peripherals



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## 5. 2 INTERNAL BLOCK DIAGRAM




*Not provided for SERVOPACK types CACR-PR03BC to -PR10BC.
†Not provided for SERVOPACK types CACR-PR03BC to -PR15BC.

Fig. 5. 2 Internal Block Diagram of SERVOPACK



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## 5.3 EXTERNAL TERMINALS

**Table 5.1** shows the specifications of external terminals for SERVOPACK.

Table 5.1 External Terminals for SERVOPACK

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

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

### 5.4.1 Specifications of Applicable Receptacles

Table 5.2 Specifications of Applicable Receptacles for SERVOPACK I/O Signal

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

*Use connector type MR-50RMA made by Honda Tsushin Co.
†Attached to SERVOPACK when shipping.

### 5.4.2 Connector 1CN Layout and Connection of SERVOPACK

The terminal layout of the SERVOPACK input/output signal connectors (1CN) is shown in Table 5.3. The external connection and external signal processing are shown in **Fig. 5.3** on page 18.

Table 5.3 Connector 1 CN Layout of SERVOPACK

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0V | 0V | 0V | 0V | 0V | 0V | — | $\overline{\text{S-ON}}$ | 0V | OL+ | OL− | $\overline{\text{ALRES}}$ | $\overline{\text{INH}}$ | 0V | TRQ-M | VTG-M | 0V | FG |
| 0V for PG Output Signal | | | 0V for PULS | 0V for PULS | 0V for $\overline{\text{CL}}$, $\overline{\text{INH}}$ | — | Servo ON Input | 0V for $\overline{\text{S-ON}}$ | Overload Output | | Alarm Reset Input | Ref. Pulse Block Input | 0V for $\overline{\text{ALRES}}$ | Torque Ref. Monitor Output | Speed Monitor Output | 0V for TRQ-M VTG-M | Frame Ground (Interruption) |
| | | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | | |
| | | PCO | *PCO | PULS 1 | SIGN1 | $\overline{\text{CL}}$ | $\overline{\text{P-CON}}$ | 0V | N-OT | 0V | PULS 2 | OVER+ | OVER− | TGON+ | TGON− | | |
| | | PG Output Signal (Phase C) | | First Ref. Pulse Input | First Ref. Sign Input | Clear Input | P Drive Input | 0V for $\overline{\text{P-CON}}$ | Rvs. Inhb. Input | 0V for N-OT | Second Ref. Pulse Input | Overflow Output | | TGON Signal Output | | | |
| 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| PAO | *PAO | PBO | *PBO | *PULS 1 | ALM+ | ALM− | *SIGN 1 | P-OT | 0V | SIGN 2 | COIN+ | COIN− | S-RDY+ | S-RDY− | MCB+ | MCB− | FG |
| PG Signal Output (Phase A) | | PG signal Output (Phase B) | | Line Driver Input of PULS 1 | Servo Alarm Output | | Line Driver Input of SIGN 1 | Fwd. Inhb. Input | 0V for P-OT | Second Ref. Sign Input | Positioning Completion Output | | Servo Ready Output | | MCCB Trip Signal Output | | Frame Ground (Interruption) |



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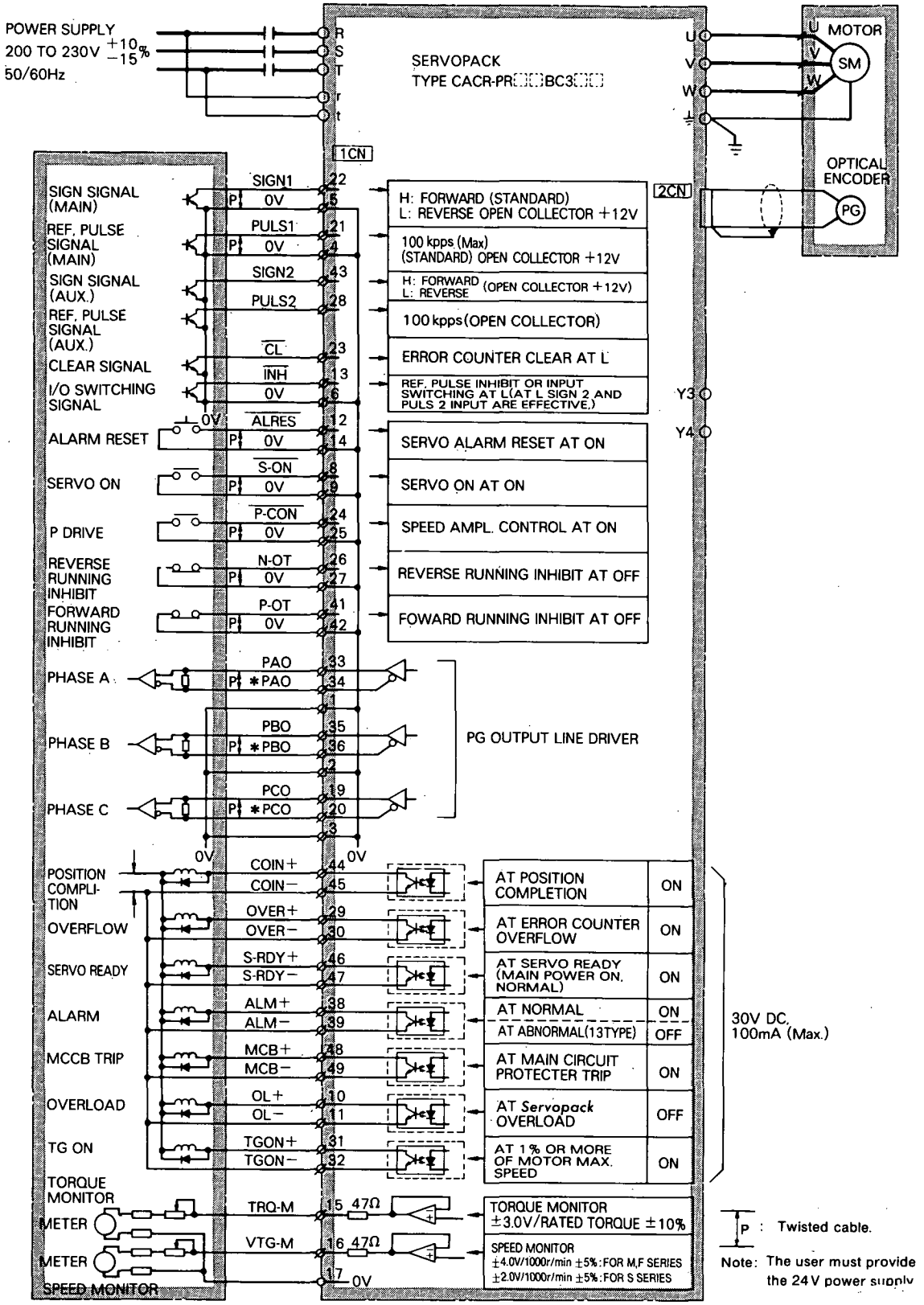



Fig. 5.3 I/O of Signals and Connector 1CN



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### 5.4.3 I/O Signals of Connector 1CN

Table 5.4 Input Signals of Connector 1CN

| Signal Name | Connector 1 CN No. | Function | Description |
|---|---|---|---|
| $\overline{\text{S-ON}}$ | 1CN-8 | Servo ON | Upon inputting this signal, base block of main circuit transistor is released, and motor is servo locked, SERVOPACK is made ready to receive reference pulse input. |
| $\overline{\text{P-CON}}$ | 1CN-24 | Speed amplifier proportional drive reference | Upon inputting this signal, control mode of speed amplifier is switched from PI (proportional-integral) drive to P(proportional) drive. |
| N-OT | 1CN-26 | Reverse running prohibit | In the case of linear drive, etc., connect limit switch signal according to the run direction. These signals are "closed" during normal run. When limit switch is tripped, it becomes "open." |
| P-OT | 1CN-41 | Forward running prohibit | |
| $\overline{\text{ALRES}}$ | 1CN-12 | Alarm reset | This signal resets the alarm status. Check the alarm contents before this signal is turned ON. |
| SIGN 1 | 1CN-22 | Reference sign input (main) | These signals are reference pulse inputs.<br>The following input forms are available.<br>• Sign + pulse train input.<br>• CW/CCW pulse train input etc. |
| PULS 1 | 1CN-21 | Reference pulse input (main) | |
| SIGN 2 | 1CN-43 | Reference sign input (aux.) | These signals are auxiliary reference pulse inputs.<br>The following input forms are available.<br>• Sign + pulse train input.<br>• CW/CCW pulse train input etc. |
| PULS 2 | 1CN-28 | Reference pulse input (aux.) | |
| $\overline{\text{CL}}$ | 1CN-23 | Clear | This signal is error counter clear input. |
| $\overline{\text{INH}}$ | 1CN-33 | Reference pulse input switching | This signal makes the auxiliary reference pulse input effective by blocking of the main reference pulse input signal. |

Table 5.5 Output Signals of Connector 1CN

| Signal Name | Connector 1CN No. | Function | Description |
|---|---|---|---|
| $\overline{\text{COIN}}$ | 1CN-45(45) | Position completion | Turns ON when number of lag pulses in error counter reaches the setting value or less. |
| $\overline{\text{OVER}}$ | 1CN-29(30) | Overflow | Turns ON when lag pulses become double the number of lag pulses of the error counter setting bits. |
| ALM | 1CN-38(39) | Servo alarm | Turns OFF when falut is detected.<br>For details, refer to Table 6.11, "Fault Detection Function." |
| $\overline{\text{S-RDY}}$ | 1CN-46(47) | Servo ready | Turns ON when main power supply ON, and these are no servo alarm conditions. |
| $\overline{\text{MCB}}$ | 1CN-48(49) | MCCB trip | Turns ON when MCCB trips. |
| OL | 1CN-10(11) | Overload detection | Turns OFF when overload is detected.<br>Refer to Fig. 6.2 "Overload characteristics." |
| TGON | 1CN-31(32) | Motor run detection | Turns ON when motor speed exceeds the following speeds:<br>• M Series: 20r/min ±10%<br>• F Series: 25r/min ±10%<br>• S Series: 40r/min ±10% |
| PAO | 1CN-33 | PG-phase A | Pulse after frequency division is output line driver(TI MC 3487).<br>To be received by line receiver (TI 75175). |
| *PAO | 1CN-34 | | |
| PBO | 1CN-35 | PG-phase B | |
| *PBO | 1CN-36 | | |
| PCO | 1CN-19 | PG-phase C | |
| *PCO | 1CN-20 | | |
| TRQ-M | 1CN-15 | Torque monitor | (±3.0V/rated torque) ±10%,<br>output voltage ±9V max,<br>output current 1mA max |
| VTG-M | 1CN-16 | Speed monitor | M, F Series (±4.0V/1000r/min) ±5%,<br>S Series (±2.0V/1000r/min)±5%,<br>output current 1mA max |



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

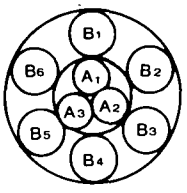
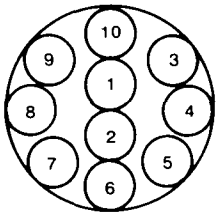
### 5.5.1 Specifications of Applicable Receptacles and Cables (Table 5.6)

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 and 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. | |
| Approx 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   |
| | $A_1$ Red<br>$A_2$ Black<br>$A_3$ Green yellow<br>$B_1$ Blue-White/blue<br>$B_2$ Yellow-White/yellow<br>$B_3$ Green-White/green<br>$B_4$ orange-White/orange<br>$B_5$ Purple-White/purple<br>$B_6$ 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 lengths: 5m, 10m, 20m Terminal ends are not provided (with connectors). | |

**NOTE**

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

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

The terminal layout for the SERVOPACK connectors (2CN) for connecting the optical encoder is shown in **Table 5.8**, and the connection method of 2CN and the optical encoder, in **Figs. 5.4** and **5.5**.

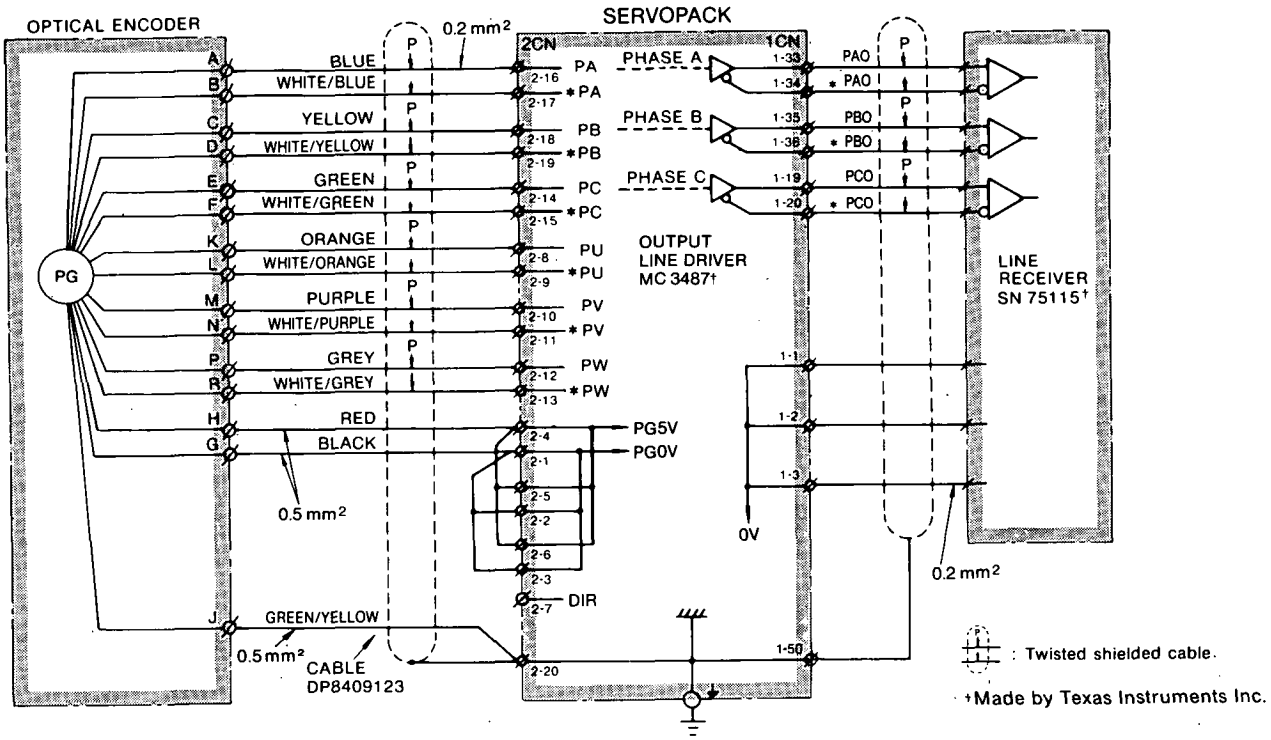
Table 5.8 Connector 2 CN Layout of SERVOPACK

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



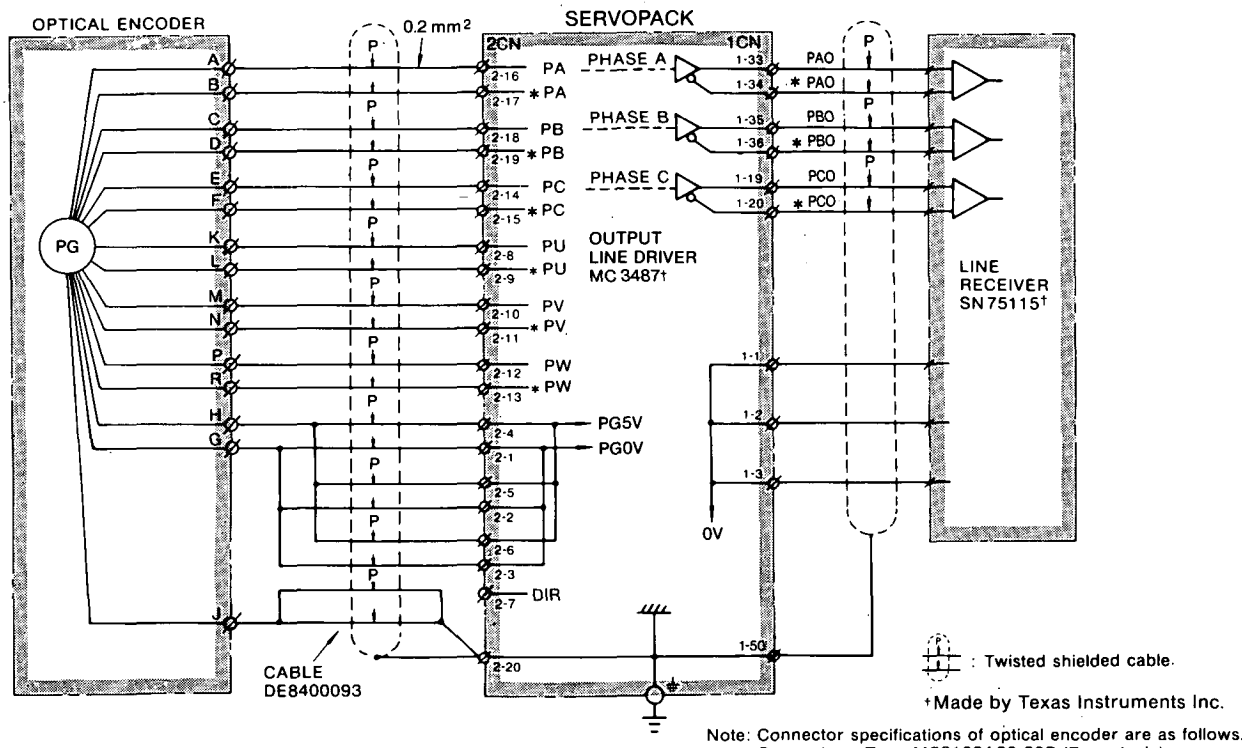
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## 5. 5. 2 SERVOPACK Connector (2CN) Terminal Layout and Connection (Cont'd)




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

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




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

Fig. 5. 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.S.T) and the control circuit (r,t), or supplied to the control circuit first, then the main circuit (**Figs. 6.1 and 6.2**).

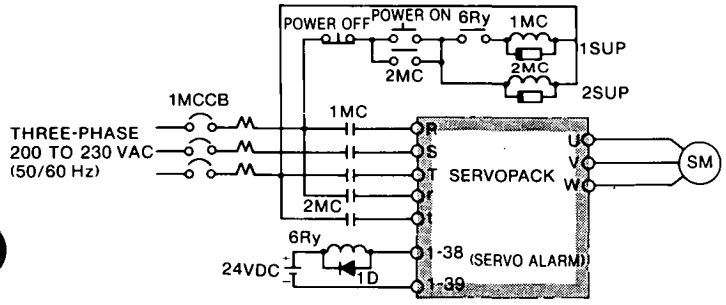
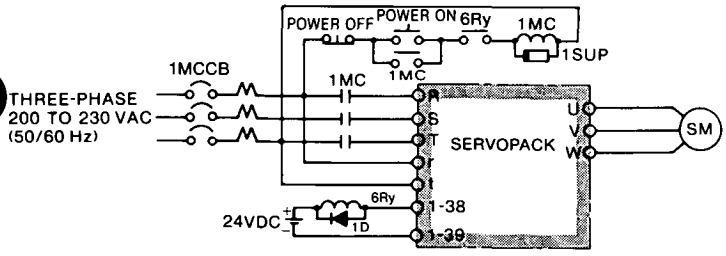



Fig. 6.1 Connection Example for Simultaneous Control Power ON/OFF




1SUP, 2SUP: Surge absorber CR50500BA or equivalent (made by Okaya Electric Industries Co., Ltd.)
1D: Flywheel diode (to prevent spike of 6Ry)

Fig. 6.2 Connection Example for Main-circuit Power ON/OFF

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 are as follows.

### PRECAUTIONS FOR CONNECTIONS

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

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

- When power is supplied to the power ON/OFF sequence shown in Fig. 6.1, the normal signal is set (6Ry is turned ON) in the control circuit after a maximum delay of 1 second.

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

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

- Since SERVOPACK is of a capacitor input type, large recharging current flows when the main circuit power is turned ON (recharging time: 0.5s). If the power is turned ON and OFF frequently, the recharging-current limit resistor may be degraded and a malfunction may occur. Do not turn the power ON or OFF frequently.

- Before power ON or OFF, turn OFF the "Servo-ON" switch to avoid transient troubles.

## 6.2 CONFIGURATION OF I/O CIRCUIT

### 6.2.1 Input Circuit

#### (1) Servo ON [$\overline{\text{S-ON}}$]

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

**NOTE**

**Before turning power ON or OFF, turn OFF the "Servo-ON" switch to avoid troubles resulting from transient current.**

#### (2) Proportional drive reference circuit [$\overline{\text{P-CON}}$]

This circuit switches the speed amplifier from PI drive to P drive.

Normally, motor repeats vibration by one-pulse response with Servo locked (motor stop) status. However, this vibration can be decreased by P drive reference ON.

For attaching load at Servo locked, this circuit cannot be used because Servo rigidity decreases under P drive.



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### 6.2.1 Input Circuit (Cont'd)

#### (3) Forward and reverse running prohibit [P-OT, N-OT]

These circuits are used to stop the forward running of the motor (counterclockwise when viewed from the drive end of the motor) and reverse running. These circuits prohibit output current to drive the motor. Therefore, the motor will be free running at prohibit input open.

**NOTE**

When the overtravel prevention circuit is not used, connect 1CN-㉖ and ㉗ and 1CN-㊶ and ㊷ .

#### (4) Alarm reset [$\overline{\text{ALRES}}$]

This signal resets the alarm status. While this signal is turned ON, error counter also is cleared.

After checking alarm contents, turn ON the alarm reset signal by snapping action (10 $\mu$s or more, ON) under Servo OFF status.

If this signal is turned ON at no alarm status, clear operation is executed for error counter.

Fig. 6.3 shows input circuit (1) to (4) above.

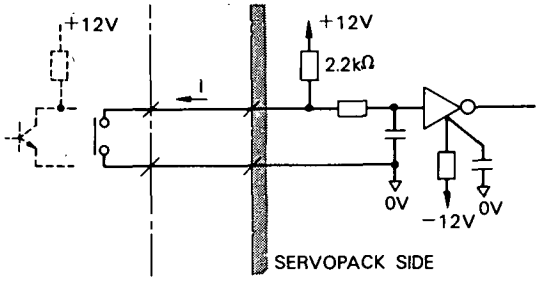



Fig. 6.3 Input Circuit (1)

Drive by relay contact or transistor (collector open or with +12V pull-up resistor). For relay contact, use high reliable contact relay for low level (12V, 5mA).

#### (5) Input Reference Pulse

There are two types of modes for reference pulse input:

- Main input (SIGN 1, PULS 1)
- Auxiliary input(SIGN 2, PULS 2)

(a) Main input [PULS 1 (*PULS 1), SIGN 1(*SIGN 1)]

(i) Reference pulse mode

The following input mode can be selected by setting of SW 20-①, ② and ③ . Refer to Table 6.2.

- Sign + pulse train
- Two-phase pulse with 90° phase difference
- CW/CCW pulse train

(ii) Voltage level and timing of reference pulse

The voltage levels of available reference pulses are +12V and +5V levels. Set by switch SL20.

Table 6.1 Reference Pulse Voltage Level Setting

| Voltage Level | SL 20 Setting |
|---|---|
| +12 V | 1 2 3 (1 and 2 closed) |
| +5 V | 1 2 3 (2 and 3 closed) |

For details, refer to Table 6.4.

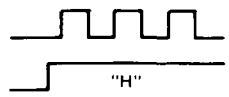
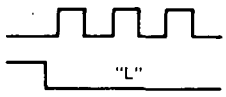
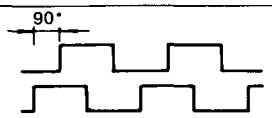
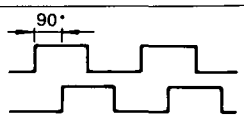
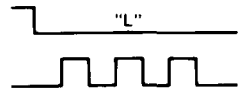
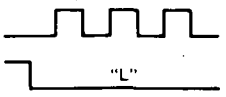
(iii) Input circuit

Fig. 6.4 shows the configuration of input circuit. For output type of drive side, open collector, with pull-up resistor or line driver are available. For driving the line driver, connect the reversal output to *SIGN 1 and *PULS 1, respectively. Set the voltage level to +5 V.



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Table 6. 2 Reference Pulse Mode

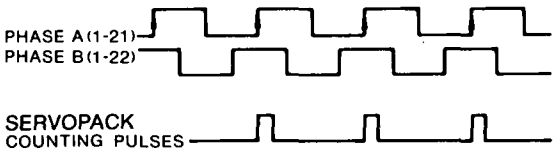
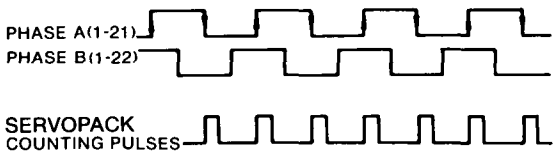
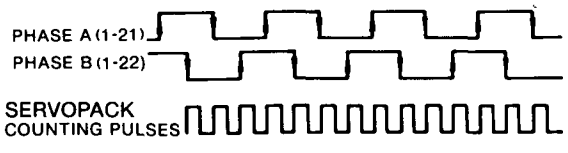
| Reference Pulse Mode | Input Pin No. | Forward Running Reference of Motor | Reverse Running Reference of Motor | Input Multiplier † | SW20† ① | ② | ③ |
|---|---|---|---|---|---|---|---|
| Sign + Pulses | 1CN-㉑<br>1CN-㉒ |  |  | — | ○ | ○ | |
| 90° Phase Difference 2-phase Pulses* (1, 2 or 4 Times) | 1CN-㉑<br>1CN-㉒ |  |  | × 1 | ○ | ○ | ○ |
| | | | | × 2 | | ○ | ○ |
| | | | | × 4 | ○ | | ○ |
| CW Pulses + CCW Pulses | 1CN-㉑<br>1CN-㉒ |  |  | — | | ○ | |

* The multiplier can be set for 90° phase difference, 2-phase pulse input.

† Defines the method of counting the input pulse waves in Servopack. Table 6.3 shows the forward running reference for 90° phase difference 2-phase pulses when phase A = phase B = f(pps).

‡ Circles in SW20 show the positions for installing the setting plugs on the pins.

Table 6. 3 Counting Method of Reference Pulse

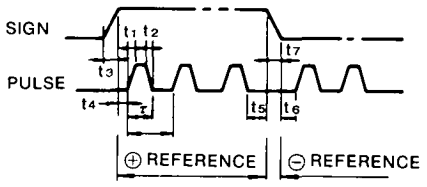
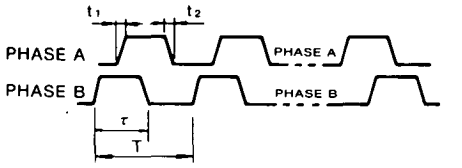
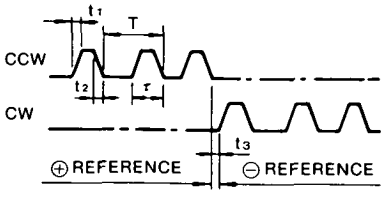
| Multiplier | Content of Pulse Counting of SERVOPACK | Reference Pulse Frequency of SERVOPACK |
|---|---|---|
| × 1 | Counts only the leading edge of phase-A pulse input (1CN-㉑).<br> | *f* (pps)<br>[Nr/min*] |
| × 2 | Counts the leading and trailing edges of phase A pulse input (1CN-㉑).<br> | 2 × *f*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

* Motor speed



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Table 6. 4 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 SW20. |
| | | | L Level | 0 V to + 1.2 V | |
| | | + 5 V Level | H Level | + 4.2 V to + 5 V | |
| | | | L Level | 0 V to + 0.8 V | |
| Reference Pulse Signal Mode | Sign + Pulse Input (SIGN + PULSE Signal) • Max Reference Frequency: 100 kpps | |  $t_1, t_2 \leqq 0.1\ \mu s$ $t_3, t_7 \leqq 0.1\ \mu s$ $t_4, t_5, t_6 > 5\ \mu s$ $\tau \geqq 5\ \mu s$ $\frac{\tau}{T} \times 100 \leqq 50\ \%$ | SIGN : H — ⊕ REFERENCE L — ⊖ REFERENCE |
| | 90° Phase Difference 2-phase Pulse (Phase A + Phase B) • Max Reference Frequency: 100 kpps | |  PHASE B : 90° AHEAD OF PHASE A PHASE B : 90° BEHIND PHASE A $t_1, t_2 \leqq 0.1\ \mu s$ $\frac{\tau}{T} \times 100 = 50\ \%$ | Multiplier Mode is set by the internal switch SW20. • Max rerence frequency: × 1: 100 kpps × 2: 50 kpps × 4: 25 kpps |
| | CCW Pulses + CW Pulses • Max Reference Frequency: 100 kpps | |  $t_1, t_2 \leqq 0.1\ \mu s$ $t_3 > 5\ \mu s$ $\tau \geqq 5\ \mu s$ $\frac{\tau}{T} \times 100 \leqq 50\ \%$ | — |

Note: Maximum reference frequency is 200 kpps.

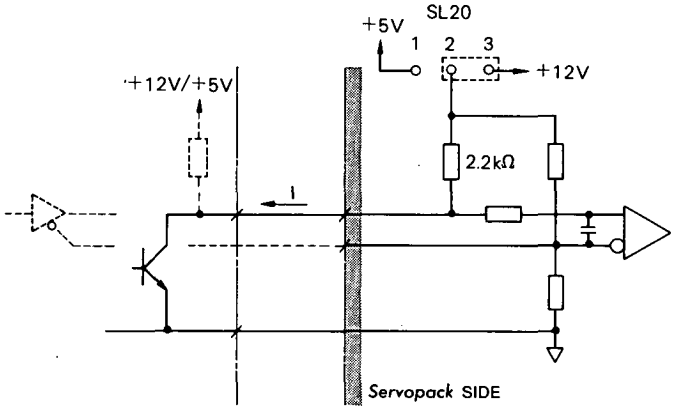



Fig. 6. 4 Input Circuit (2)



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(iV) Other functions

The effective logic of reference pulse mode is H lavel in Table 6.2. The effective logic can be changed to L level by SW 40 - ③ and ④.

- Short pin OFF on SW 40 - ③ and ④: Logic in Table 6.2 is effective.
- Short pin ON on SW 40 - ③ and ④: Logic in Table 6.2 is reversed.

Where the effective logic of reference pulse is reversed individually, set the setting pins indivividually. The short pins correspond as follows:

- SW 40 - ③ → 1 CN - ㉑ input
- SW 40 - ④ → 1 CN - ㉒ input

(Example)

Reference pulse mode: Sign + pulses
SW40 - ③ : setting pin OFF
SW40 - ④ : setting pin ON

Motor is forward running when 1 CN - ㉒ input is L.

(b) Auxiliary input [PULS 2, SIGN 2]

(i) Reference pulse mode

The three modes can be selected by setting of SW20 - ④, ⑤ and ⑥, as shown in Table 6.5.

Table 6.5 Reference Pulse Mode Setting

| Reference Pulse Mode | Input Multiplier | SW 20 | | |
|---|---|---|---|---|
| | | ④ | ⑤ | ⑥ |
| Sign + Pulses | — | ○ | ○ | |
| 90° Phase Difference 2-phase | × 1 | ○ | ○ | ○ |
| | × 2 | | ○ | ○ |
| | × 4 | ○ | | ○ |
| CW/CCW Pulse Train | — | | ○ | |

(ii) Voltage level and timing of reference pulse

The voltage level is +12V(fixed). The timing is the same as Table 6.4.

(iii) Input circuit

The configuration of input circuit is the same as Fig. 6.3. However, input filter constant differs from it. Driving by line driver cannot be accomplished. Reverse function of effective logic is not available.

(6) Clear Signal (CL)

Normally, set the clear signal to 'H.' If 'L' is set, the contents of error counter become zero and positioning loop will be ineffective.

(a) Voltage level

Voltage level +12V/+5V can be switched at SL 10.

Table 6.6 Voltage Level Setting

| Voltage Level | SL10 |
|---|---|
| +12 V | 1 2 3 ○ ▣ ○ |
| +5 V | 1 2 3 ▣ ○ |

(b) Logic reversion

Effective logic can be reversed when setting pin of SW40 - ② is turned OFF.

- Setting pin of SW40 - ②
  ON: Clear at L
  OFF: Clear at H

(c) Derivative action

During clear signal turning ON, differential action can be executed when setting pin of SW40 - ⑤ is turned ON. However, contents of error counter are always zero.

- Setting pin of SW40 - ⑤
  ON: Differential action
  OFF: General action (always clear during clear signal turning ON)

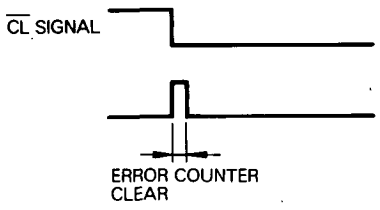



Fig. 6.5 Defferential Action of Clear Signal

(d) Note for clear signal usage

- When the clear signal is turned on when applying the reference pulse, the contents of error counter become zero. However, when applying the feed foward compensation, speed command voltage by feedfoward compensation is output.
- When the motor shaft is rotated at servo OFF, lag pulses are given to the error conter by feedback pulse. In this case, be sure to turn ON the Servo ON signal after turning on the clear signal.



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### 6.2.1 Input Circuit (Cont'd)

- When the clear signal is used with the Servo ON signal, connect as shown in Fig. 6.6. For clear signal, set the voltage level to +12V, and reverse the logic and clear by H.

In this way, error counter is utilized by Servo ON or clear state at Servo OFF.

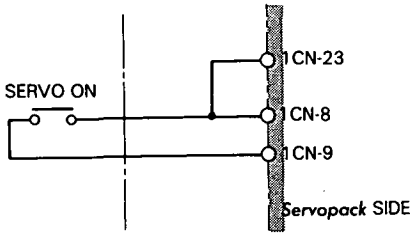



Fig. 6.6 Sequential Operation of Servo ON and Clear Signals

- The voltage level settings of $\overline{CL}$ signal and $\overline{INH}$ signal are in common. Therefore if $\overline{CL}$ signal is set to +12V level, $\overline{INH}$ signal is also at the +12V level and vice versa.

### (7) Reference pulse input switching signal [$\overline{INH}$]

Normally, set the reference pulse input to "L." Main reference pulse input is closed and auxiliary reference pulse input is effective by L setting of $\overline{INH}$ signal.

(a) Voltage level

Refer to Table 6.6.

(b) Logic reversion

Effective logic can be reversed when setting pin of SW 40 - ① is turned ON.

- Setting pin of SW40 - ①

ON: Input switching at H
OFF: Input switching at L

### 6.2.2 Output Circuit

There are seven output circuits for each sequence: position completion, overflow, servo alarm, servo ready, MCCB trip, overload detection, and motor run detection. These output circuits are non-contact output. Voltage and current specifications are as follows:

- Applied voltage (Vmax)≦30 VDC
- Operational current (Ip) ≦ 100 mA

The construction of output circuit is shown in Fig. 6.7. Output circuit needs a separate power supply. It is recommended to use +24V power.

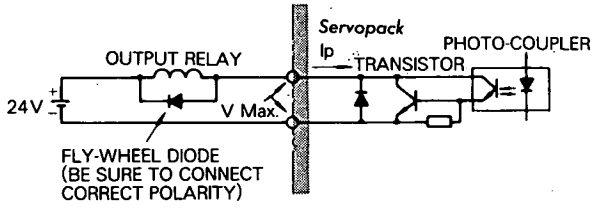



Fig. 6.7 Output Circuit

### (1) Position completion signal [$\overline{COIN}$]

position completion signal is turned ON when contents of error counter are within internal setting values. As internal setting values, ±1 to ±7 pulses or ±63 pulses can be set. This signal is used to advance the sequence.

The position completion width is set at SW10 - ③, ④, ⑤ and ⑥. (See Table 6.7.) However, this setting must correspond to the number of error counter bits (bit numbers of D/A converter). (See Table 6.8.)

Table 6.7 Position Completion Width Setting

| Position Completion Width Setting (Pulses) | SW10 | | | |
|---|---|---|---|---|
| | ③ | ④ | ⑤ | ⑥ |
| ± 1 | | ○ | ○ | |
| ± 2 | ○ | | ○ | |
| ± 3 | | | ○ | |
| ± 4 | ○ | ○ | | |
| ± 5 | | ○ | | |
| ± 6 | ○ | | | |
| ± 7 | | | | |
| ± 63 | | | | ○ |

Table 6.8

| Bit Numbers of D/A Converter | Position Completion Width (Pulses) |
|---|---|
| 9 | ± 2 |
| 10 | ± 3 |
| 11 | ± 4 |
| 12 | ± 5 |



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Bit numbers of D/A converter are set at SW10 -①and②. (See Table 6.9) These bit numbers are determined according to condition of applied motor or machine or applied condition of reference pulse. The smaller the setting bit numbers, the higher the position loop gain becomes.

Table 6.9 Setting of Bit Numbers of D/A Converter

| Bit Numbers of D/A Converter | SW10 | |
|---|---|---|
| | ① | ② |
| 9 | ○ | ○ |
| 10 | | ○ |
| 11 | ○ | |
| 12 | | |

### (2) Overflow detecting signal [$\overline{\text{OVER}}$]

This signal is turned ON when lag pulses of error counter reach two times or more the setting bit number of D/A converter.

If overflow is detected, SERVOPACK becomes Servo OFF mode abruptly and coasts to a stop.

### (3) Servo alarm [ALM]

This signal monitors alarm state of 13 types. If any trouble occurs, the power drive circuit in the SERVOPACK goes OFF. For details of alarm contents, see Par. 6.3(2).

### (4) Servo ready [$\overline{\text{S-RDY}}$]

After control power and main circuit power are turned ON, this signal is turned ON with no alarm.

### (5) MCCB trip [$\overline{\text{MCB}}$]

This signal is turned on when the SERVOPACK built-in circuit protector trips.

### (6) Overload detection [OVER]

This signal is turned off when overload of SERVOPACK is detected. For details, see Par. 6.3.(3).

### (7) Motor run detection [$\overline{\text{TGON}}$]

When motor speed average for 5ms exceeds following speed, after 1 or 2 ms, this signal is turned on.

- M series motor: +20r/min ±10% or more
- F series motor: +25r/min ±10% or more
- S series motor: +40r/min ±10% or more

## 6.2.3 Optical Encoder (PG) Output Circuit [PAO, ＊PAO, PBO, ＊PBO, PCO, ＊PCO]

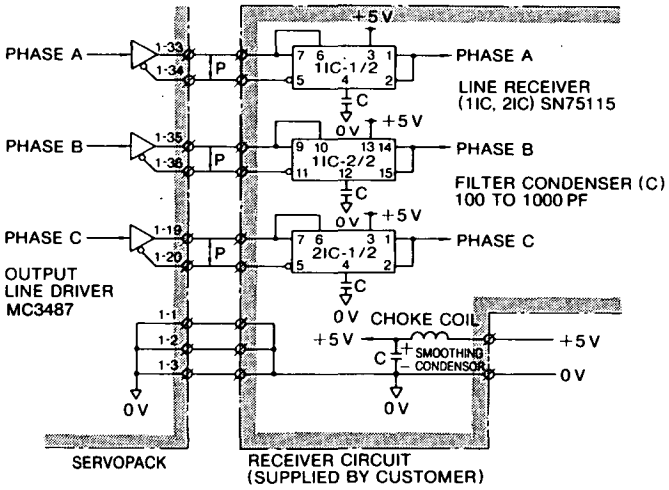
Phases A, B and C (original point) signals for the optical encoder, PG are output. The output signal specifications are as follows:

### (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

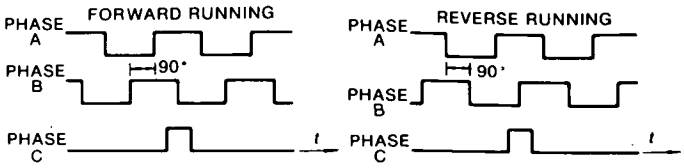
Output circuit is line driver output. For connection, see Fig. 6.8.




PT : Twisted cable

Fig. 6.8 Output Circuit and Receiver Circuit

### (3) Output phase




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

Fig. 6.9 Output Phase



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### 6.2.3 Optical Encoder (PG) Output Circuit [PAO, ∗PAO, PBO, ∗PBO, PCO, ∗PCO] (Cont'd)

#### (4) Pulse resolution

The pulse frequency of the PG can be further divided into 1/N (N=1 to 60) or 2/N(N=2 to 64) 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 6.10.

The dividing ratio must be able to divide the pulses of the optical encoder. For example, in an optical encoder of 5000 pulses/rev, 1/3, 1/6, or 1/7 cannot be used. The dividing output is input to positioning control circuit as a positioning feedback pulse. For details, see Par. 6.4. Fig. 6.10 shows the optical encoder output waveform under the dividing pulse frequency. The C-phase (original point) pulse has the same pulse width of dividing ratio 1/1 as PG dividing.

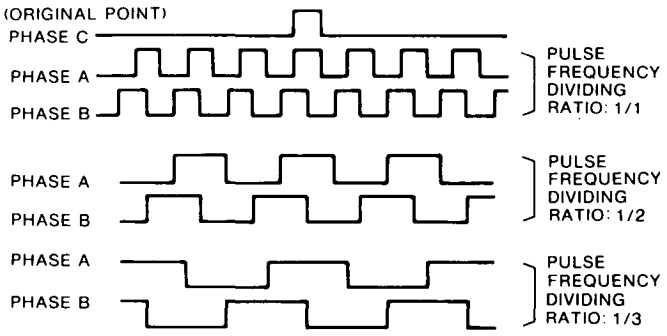



Fig. 6.10 Output Waveform of Optical Encoder

Table 6.10 Setting of PG Pulse Frequency Dividing Ratio

| SW2 | | | | | | | | | Pulse Frequency Dividing Output (pulses/rev) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | PG Pulse Frequency Dividing Ratio (1/N) | PG=6000 | PG=5000 | PG=4000 | PG=2500 | PG=1500 | PG=1000 |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | | 1/1 | 6000 | 5000 | 4000 | 2500 | 1500 | 1000 |
| | ○ | ○ | ○ | ○ | ○ | ○ | | 1/2 | 3000 | 2500 | 2000 | 1250 | 750 | 500 |
| ○ | | ○ | ○ | ○ | ○ | ○ | | 1/3 | 2000 | — | — | — | 500 | — |
| | | ○ | ○ | ○ | ○ | ○ | | 1/4 | 1500 | 1250 | 1000 | 625 | 375 | 250 |
| ○ | ○ | | ○ | ○ | ○ | ○ | | 1/5 | 1200 | 1000 | 800 | 500 | 300 | 200 |
| | ○ | | ○ | ○ | ○ | ○ | | 1/6 | 1000 | — | — | — | 250 | — |
| | | | ○ | ○ | ○ | ○ | | 1/8 | 750 | 625 | 500 | — | — | 125 |
| | ○ | ○ | | ○ | ○ | ○ | | 1/10 | 600 | 500 | 400 | 250 | 150 | 100 |
| | | ○ | | ○ | ○ | ○ | | 1/12 | 500 | — | — | — | 125 | — |
| ○ | | | | ○ | ○ | ○ | | 1/15 | 400 | — | — | — | 100 | — |
| | | | | ○ | ○ | ○ | | 1/16 | 375 | — | 250 | — | — | — |
| | | ○ | ○ | | ○ | ○ | | 1/20 | 300 | 250 | 200 | 125 | 75 | 50 |
| | | | ○ | | ○ | ○ | | 1/24 | 250 | — | — | — | — | — |
| ○ | ○ | ○ | | | ○ | ○ | | 1/25 | 240 | 200 | 160 | 100 | 60 | 40 |
| | ○ | | | | ○ | ○ | | 1/30 | 200 | — | — | — | 50 | — |
| | | | ○ | ○ | | ○ | | 1/40 | 150 | 125 | 100 | — | — | 25 |
| | | | | ○ | | ○ | | 1/48 | 125 | — | — | — | — | — |
| | ○ | ○ | ○ | | | ○ | | 1/50 | 120 | 100 | 80 | 50 | 30 | 20 |
| | | ○ | | | | ○ | | 1/60 | 100 | — | — | — | 25 | — |
| | ○ | ○ | ○ | ○ | ○ | | | 2/2 | 6000 | 5000 | 4000 | 2500 | 1500 | 1000 |
| ○ | | ○ | ○ | ○ | ○ | | | 2/3 | 4000 | — | — | — | 1000 | — |
| | | ○ | ○ | ○ | ○ | | | 2/4 | 3000 | 2500 | 2000 | 1250 | 750 | 500 |
| ○ | ○ | | ○ | ○ | ○ | | | 2/5 | 2400 | 2000 | 1600 | 1000 | 600 | 400 |
| | ○ | | ○ | ○ | ○ | | | 2/6 | 2000 | — | — | — | 500 | — |
| | | | ○ | ○ | ○ | | | 2/8 | 1500 | 1250 | 1000 | 625 | — | 250 |
| | ○ | ○ | | ○ | ○ | | | 2/10 | 1200 | 1000 | 800 | 500 | 300 | 200 |
| | | ○ | | ○ | ○ | | | 2/12 | 1000 | — | — | — | 250 | — |
| ○ | | | | ○ | ○ | | | 2/15 | 800 | — | — | — | 200 | — |
| | | | | ○ | ○ | | | 2/16 | 750 | — | 500 | — | — | 125 |
| | | ○ | ○ | | ○ | | | 2/20 | 600 | 500 | 400 | 250 | 150 | 100 |
| | | | ○ | | ○ | | | 2/24 | 500 | — | — | — | 125 | — |
| ○ | ○ | ○ | | | ○ | | | 2/25 | 480 | 400 | 320 | 200 | 120 | 80 |
| | ○ | | | | ○ | | | 2/30 | 400 | — | — | — | 100 | — |
| | | | ○ | ○ | | | | 2/40 | 300 | 250 | 200 | 125 | 75 | 50 |
| | | | | ○ | | | | 2/48 | 250 | — | — | — | — | — |
| | ○ | ○ | ○ | | | | | 2/50 | 240 | 200 | 160 | 100 | 60 | 40 |
| | | ○ | | | | | | 2/60 | 200 | — | — | — | 50 | — |

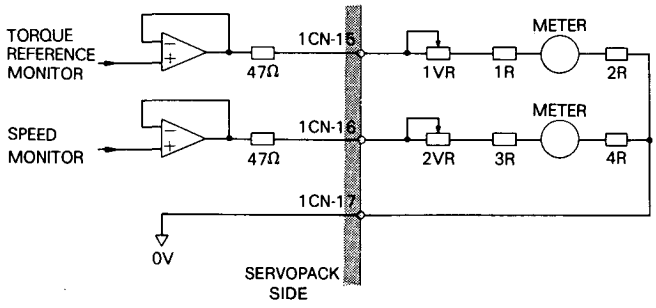


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### 6.2.4 Torque Reference Monitor and Speed Monitor [TRO-M, VTG-M]

Motor output is used for monitoring torque and speed at motor running. When an instrument is connected to measure torque and speed, make the connection as shown in Fig. 6.11, using a DC ammeter of full scale +1mA (both swing).

- Torque monitor output (1CN-15): ±3.0V ±10%/rated torque
- Speed monitor output (1CN-16): M,F series — ±4.0V ±5%/1000r/min S series — ±2.0V ±5%/1000r/min
- Instrument: Full scale ±1mA (both swing) ammeter. Use ammeter of DCF-6 or DCF-12F or equivalent made by Toyo Instrument Co., Ltd.




Notes:

1. Torque reference monitor increases output error in range of motor rated speed or more.
2. 1R to 4R, 1VR, 2VR are selected by full-scale setting. (Select 1R=2R, 3R=4R. 1VR and 2VR is for fine adjustment.)

Fig. 6.11 Connection with Monitor Output

## 6.3 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, or
- Servo ON command is opened, or
- Main power supply is tuned off.

Normally, this dynamic brake is not applied while the motor stops, but can be made operational by switching built-in switch (SW 4-5) from OFF to ON.

(2) Trouble detecting functions

Table 6.11 Trouble Detecting Functions

| Trouble | Detection |
|---|---|
| Overcurrent | Overcurrent flow in the main circuit (at 1.2 times min. inst max current.) |
| Circuit Protector Trip | Circuit protecter tripped |
| Regeneration Trouble | Regenerative circuit not activated in SERVOPACK. |
| Overvoltage | Excessively high DC voltage in the main circuit (approx 420V.) |
| Overspeed | Excessively large speed reference input. |
| Voltage Drop | Low DC voltage in the main circuit after power ON. (150V or less.) |
| Overload | Overload condition of motor and SERVOPACK. |
| Heat Sink Overheat | Overheat of heat sink (approx 85°C min.) |
| A/D Error | Element error on the printed circuit board of SERVOPACK. |
| Open Phase | Any one phase open in three-phase power supply. |
| Overrun Prevention | Wrong wiring of motor circuit or PG signal line. |
| CPU Error | Any error of CPU |
| Over Flow | Lag pulses of error counter reach two times or more the setting bit number of D/A converter. |



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## 6.3 PROTECTIVE CIRCUIT (Cont'd)

(3) Overload (OL) detection level

**Fig. 6.12** shows the setting of overload detection level at 100% rated motor current.

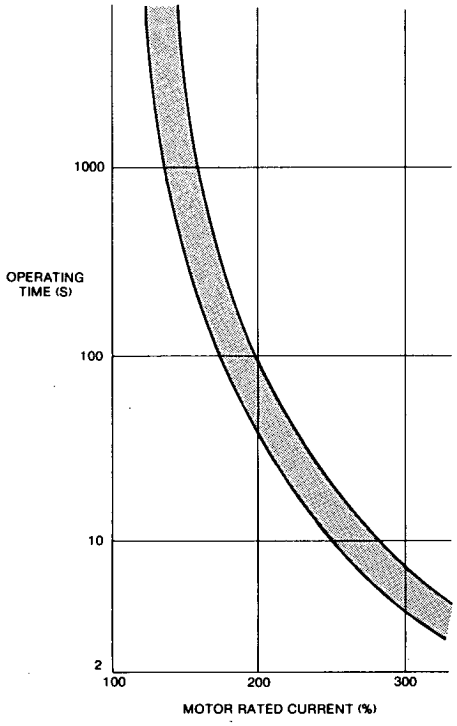



Fig. 6.12 Overload Characteristics

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

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

### NOTE

- Regeneration trouble and overflow among LED trouble indications are displayed in common. But these troubles are distinguished by other LED indications. **(See Par. 6.6.)**
- If overflow is detected, SERVOPACK abruptly becomes Servo OFF mode and the motor coasts to a stop. Batched servo alarm output and LED trouble indications are executed after waiting approximately 0.5 second after alarm occurs. If main circuit power is cut off within 0.5 second after overflow occurs, servo alarm outputs and LED trouble indications are ineffective.

(5) Protective circuit operation

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

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

### CAUTION

**When an alarm signal cuts off only the main circuit, set the speed reference to OFF before supplying power to the main circuit to resume the operation.**

(6) Resetting servo alarm

To reset the servo alarm, depress the [RESET] (blue pushbutton switch) alarm release [ALRES] signal of input signals on the printed circuit board in the SERVOPACK. See Par. 6.2.1.(4).

If [7.] or [A] is on (e.g., SERVOPACK is over loaded or the heat sink is overheated), the reset alarm is not immediate and occurs a few minutes later.

(7) LED trouble indications

Table 6.4 LED Trouble Indications (7-segment, Red)

| Indication | Detection | | Output Signals |
|---|---|---|---|
| [.] | Base current not interrupted (normal operation). | | — |
| [-.] | Base current is interrupted in Servopack power circuit. | | — |
| [1.] | Overcurrent | When a protection circuit in SERVOPACK functions, power drive circuit is base-blocked. This block-status is released by "RESET" operation. | Servo alarm output |
| [2.] | Circuit protecter tripped | | |
| [3.] | Regeneration trouble, overflow | | |
| [4.] | Overvoltage | | |
| [5.] | Overspeed | | |
| [6.] | Voltage drop | | |
| [7.] | Overload | | |
| [A.] | Heat sink overheat | | |
| [b.] | A/D error | | |
| [F.] | Open phase | | |
| [C.] | Overrun prevention | | |
| [ ] | CPU error | | |



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## 6.4 CONFIGURATION OF POSITIONING CONTROL LOOP

Fig. 6.13 shows basic block diagram of positioning control loop. The reference pulse frequency is 100 kpps (max). Therefore, feedback pulse frequency of error counter input should be 100 kpps or below.

Where encoder resolution is P (pulse/rev) and revolution range is N (r/min), set the frequency dividing (1) and multiplier mode so that the following formula is formed.

$$f_{PG(2)} = \frac{N \cdot P}{D_1} \times \frac{N}{60} \leqq 100\ kHz$$

*Note:*

*1/D : Ratio of frequency dividing (1)*

*M : Multiplier after frequency dividing (1)*

$f_{PG(1)}$: $\begin{cases} M=1 \ldots f_{PG(1)} \leqq 100\ kHz \\ M=2 \ldots f_{PG(1)} \leqq 50\ kHz \\ M=4 \ldots f_{PG(1)} \leqq 25\ kHz \end{cases}$

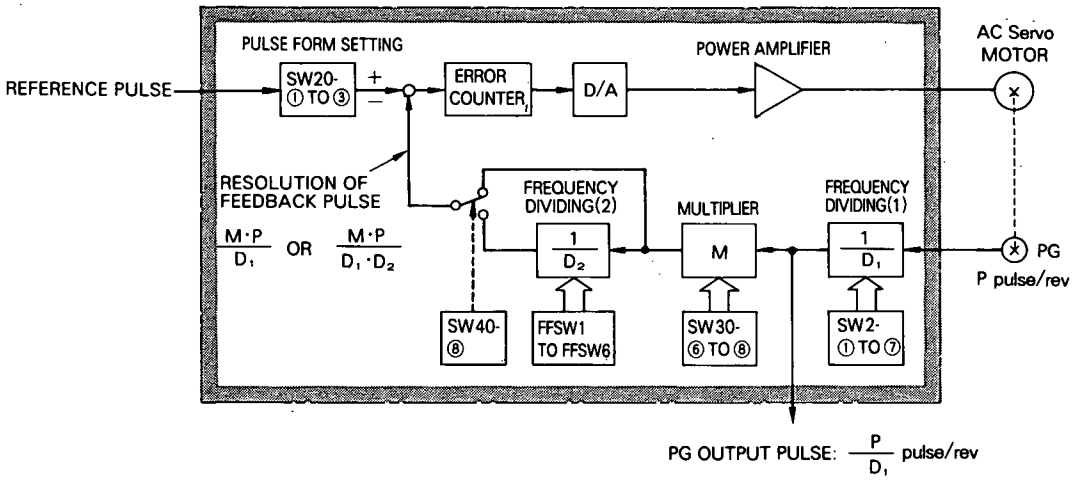



Fig. 6.13 Basic Block Diagram of Positioning Control Loop

### 6.4.1 Frequency Dividing (1) Setting ($I/D_1$)

Frequency dividing (1) is set at SW2-① to ⑦, referring to Table 6.10.

### 6.4.2 Multiplier Setting (M)

Multiplier mode can be set at 1, 2 or 4 multiplier. (See Table 6.13.) According to multiplier modes, output frequency of frequency dividing (1) should be the following values or below.

| Multiplier mode | Output frequency of frequency dividing (1) [$f_{PG(1)}$] |
|---|---|
| × 1 ..... | 100 kHz max. |
| × 2 ..... | 50 kHz max. |
| × 4 ..... | 25 kHz max. |

Table 6.13 Multiplier Mode Setting

| Multiplier Mode | SW30 | | |
|---|---|---|---|
| | ⑥ | ⑦ | ⑧ |
| ×1 | ○ | ○ | ○ |
| ×2 | | ○ | ○ |
| ×4 | ○ | | ○ |

### 6.4.3 Frequency Dividing (2) Setting ($I/D_2$)

(1) Where the frequency dividing ratio = 1:

If the frequency dividing (2) function is not used, turn off SW40 - ⑧ (no installation of setting plug).

(2) Where the frequency dividing setting is to be made:

Frequency dividing ratio k ($o<k<1$) is obtained by the formula below, when the following data are given from the specifications:

- Load displacement per motor revolution= $\triangle L$ mm
- Displacement per pulse (lowest setting unit)= $\triangle \ell$ mm/pulse
- Number of output pulses of PG per motor revolution = n pulses

$$0< k = \frac{\triangle L / \triangle \ell}{n \times k} <1$$

$k$ : Multiplier (1, 2, 4)



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**NOTE**

The positioning accuracy is influenced by the value of the frequency dividing ratio k. Calculate it to at least 8 digits after the decimal point.

(a) Turn ON switch SW40 - ⑧ (install the setting plug).

(b) Calculate setting data of frequency dividing ratio.

The frequency dividing ratio data is set by rotary switches FFSW 1 to 6.

$$k = \frac{1}{D_2} = \frac{\sum_{n=1}^{6} (FFSW.n)}{2^{23}}$$

Convert the value of [8388608 × k] into binary form.

[8388608×k]=1×(FFSW-1 Data)+16
×(FFSW-2 Data)+$16^2$(256)
×(FFSW-3 Data)+$16^3$(4896)
×(FFSW-4 Data)+$16^4$(65536)
×(FFSW-5 Data)+$16^5$(1048576)
×(FFSW-6 Data)

(c) Set each scale of FFSW-1 to 6 according to each datum (0 to 15) shown in Table 6.14.

Table 6.14 Frequency Dividing Setting List

| Data of FFSW-1 to 6 | Scale of FFSW |
|---|---|
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 8 | 8 |
| 9 | 9 |
| 10 | A |
| 11 | B |
| 12 | C |
| 13 | D |
| 14 | E |
| 15 | F |

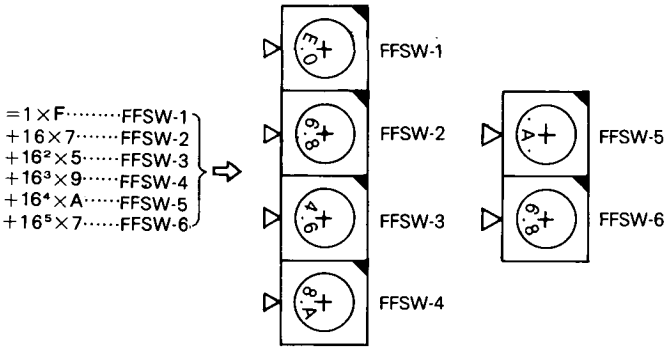
(3) Setting example:

Where frequency dividing ratio
k = 0.95768726,

(a) $\sum_{n=1}^{6} (FFSW.n)$
= 8388608 x 0.95768726= 8033663.011

(b) Round out decimals larger than 0.5 or otherwise disregard them and convert the result into hexadecimal form.

(c) 8033663 = (7A957F) HEX




Note: Operation of frequency dividing (2) is 100kHz maximum. Where the frequency dividing (2) function is used, set $D_1$ as the formula below.

$$\frac{P}{D_1} \times \frac{N}{60} < 50\ kHz$$

The multiplied data M (1.2 or 4) should be meet the formula below.

$$\frac{M.P}{D_1} \times \frac{N}{60} \leqq 100\ kHz$$



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## 6.5 RESOLUTION OF POSITIONING FEEDBACK PULSE

Table 6.15 shows resolution of positioning encoder for AC SERVOMOTOR and combined encoder at maximum speed. The standard encoder is set to maximum speed.

If operating resolution is reduced, resolution of positioning encoder can be increased according to the set frequency dividing (See Par. 6.4.)

Table 6.15 Resolution of Positioning Encoder (Standard)

| AC SERVOMOTOR | | | Combined Encoder pulse/rev | Encoder Output Frequency kHz | | Frequency Dividing | | Multiplier Mode | Resolution of Positioning Encoder pulse/rev |
|---|---|---|---|---|---|---|---|---|---|
| Series | Rated Speed r/min | Max Speed r/min | | At Rated Speed | At Max Speed | (1) | (2) | | |
| M | 1000 | 2000 | 6000 | 100 | 200 | 1/6 | – | 2 | 2000 |
| | | | 5000 | 83.3 | 166.7 | 1/5 | – | 2 | |
| | | | 4000 | 66.7 | 133.3 | 1/4 | – | 2 | |
| F | 1500 | 2500 | 6000 | 150 | 250 | 1/6 | – | 2 | 2000 |
| | | | 5000 | 125 | 208.3 | 1/5 | – | 2 | |
| | | | 4000 | 100 | 166.7 | 1/4 | – | 2 | |
| S | 3000 | 4000 | 2500 | 125 | 166.7 | 1/5 | – | 2 | 1000 |
| | | | 1500 | 75 | 100 | 1/3 | – | 2 | |
| | | | 1000 | 50 | 66.7 | 1/2 | – | 2 | |

## 6.6 DISPLAY

There are the following LED indications other than the 7-segment LED indications on the panel.

[P] : Control power (+5V) in SERVOPACK is normal.

[MP] : Main circuit voltage (200 VDC or more) in Servopack is normal.

[A] [B] [C] : PG-phase A, phase B [frequency dividing (2) output] and phase C (origin pulse)

[DA1] [DA2] : Setting bit numbers of D/A converter (See Table 6.16.)

[2] [4] [8] to [512] : Lag pulse of error counter (See Table 6.17.)

[CLMP] *: D/A converter output is clamped (saturation).

[OVER] *: Overflow of error counter

[COIN] : Positioning completion

*The relation of [CLMP] and [OVER]

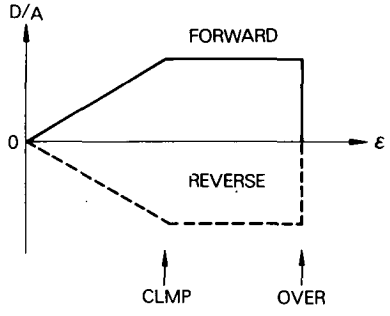



Fig. 6.14

- [CLMP] lights when lag pulses reach setting bit numbers of D/A converter.
- [OVER] lights when lag pulses reach two times the setting bit numbers of D/A converter. At this time, an alarm occurs and the motor will coast to a stop at Servo OFF mode. The error counter will be cleared.



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Table 6.16 Setting Bit Numbers of D/A Converter

| Setting Bit Numbers | LED Display | |
|---|---|---|
| | DA1 | DA2 |
| 9 | | |
| 10 | ● | |
| 11 | | ● |
| 12 | ● | ● |

Note: The mark ● shows that LED lights.

Table 6.17 Lag Pulse Numbers of Error Counter

| Setting Bit Numbers of D/A Converter | Lag Pulse Numbers |
|---|---|
| 9 | $D(\epsilon)/2$ |
| 10 | $D(\epsilon)$ |
| 11 | $2 \times D(\epsilon)$ |
| 12 | $4 \times D(\epsilon)$ |

Note: Calculate the lag pulse number using table 6.17. Because the relationship of lag pulse numbers($\varepsilon$) and total values D at error display LED lighting differ according to setting bit numbers of D/A converter.

## 6.7 SETTING OF INTERNAL SWITCHES

### 6.7.1 Switch Functions

The switches below are on the control circuit board.

3P switch: SL1, SL2, SL10 to SL40
(See Table 6.18.)

Setting pin: SW1 to SW4, SW10 to SW40
(See Table 6.19.)

Rotary switch: FFSW1 to FFSW6
(See par. 6.4.3.)

Table 6.18 3P Switch Functions List

| 3P Switch | Function | User Setting |
|---|---|---|
| SL1 | Variable range of positioning loop gain adjustable volume. | Not possible |
| SL2 | – | Not possible |
| SL10 | Voltage level switching of $\overline{INH}$ and $\overline{CL}$ inputs. | +5V/+12V switching possible: 5V 1 2 3 12V ○ ○ ○ |
| SL20 | Voltage level switching of PULS 1 and SIGN 1 inputs. | |
| SL30 | Feedfoward circuit filter time constand | Not possible |
| SL40 | – | Not possible |



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Table 6.19 Setting Pin Functions List

| Setting Pin. | | Function | User Setting |
|---|---|---|---|
| SW1 | 1 | Selection of AC SERVOMOTOR Type | See Table 6.20 |
| | 2 | | |
| | 3 | | |
| | 4 | | |
| | 5 | Selection of combined encoder (PG) | See Table 6.21 |
| | 6 | | |
| | 7 | | |
| | 8 | | |
| SW2 | 1 | Setting of PG frequency dividing ratio [Frequency dividing (1)] | See Table 6.10 For setting method, see Par. 6.4 |
| | 2 | | |
| | 3 | | |
| | 4 | | |
| | 5 | | |
| | 6 | | |
| | 7 | | |
| | 8 | Spare | — |
| SW3 | 1 | PI constant setting of speed amplifier | See Fig. 6.15 (Normally, retain the position preset at the factory.) |
| | 2 | | |
| | 3 | | |
| | 4 | | |
| | 5 | | |
| | 6 | | |
| | 7 | f/V filter of speed feedback | ON: 1.2ms OFF: 0.1ms |
| | 8 | Mode switch | ON: Without OFF: With |
| SW4 | 1 | Setting of motor characteristics and SERVOPACK function | Do not adjust. |
| | 2 | | |
| | 3 | | |
| | 4 | | |
| | 5 | | |
| | 6 | | |
| | 7 | | |
| | 8 | Spare | — |

| Setting Pin | | Function | | User Setting |
|---|---|---|---|---|
| SW10 | 1 | Bit numbers setting of D/A converter | | See Table 6.9. |
| | 2 | | | |
| | 3 | Setting and positioning completion lag pulse width | | See Table 6.7. |
| | 4 | | | |
| | 5 | | | |
| | 6 | | | |
| | 7 | Gain compensation of D/A converter output | | ON: Not possible OFF: Possible |
| | 8 | Switching of speed amplifier automatic P/PI control | | ON: Not possible OFF: Possible |
| SW20 | 1 | Input form setting of reference pulse (main input) | | See Table 6.2 |
| | 2 | | | |
| | 3 | | | |
| | 4 | Input from setting of reference pulse (auxiliary input) | | See Table 6.5. |
| | 5 | | | |
| | 6 | | | |
| | 7 | — | | Not possible |
| | 8 | | | |
| SW30 | 1 | — | | Not possible |
| | 2 | | | |
| | 3 | | | |
| | 4 | Parameter setting for speed amlifier automatic P/PI control | | Not possible |
| | 5 | | | |
| | 6 | Setting of multiplier mode | | See Table 6.13. |
| | 7 | | | |
| | 8 | | | |
| SW40 | 1 | Setting effective logic | $\overline{\text{INH}}$ input signal | ON: H level effective OFF: L level effective |
| | 2 | | $\overline{\text{CL}}$ input signal | ON: L level effective OFF: H level effective |
| | 3 | | PULS 1 input signal | ON: L active OFF: H active |
| | 4 | | SING 1 input signal | ON: L active OFF: H active |
| | 5 | Clear form setting of error counter | | ON:Differential action OFF: General active |
| | 6 | BIAS compensation function | | ON: Possible OFF: Not possible |
| | 7 | — | | Not possible |
| | 8 | Frequenay dividing (2) function | | ON: Possible OFF: Not possible |

Note: SW100 is spare for setting pin storage.



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## 6.7.1 Switch Functions (Cont'd)

Table 6.20 Selection of AC SERVOMOTOR Type

| Type | SW1 | | | |
|---|---|---|---|---|
| | ① | ② | ③ | ④ |
| M Series | ○ | | | ○ |
| F Series | | | | ○ |
| S Series | ○ | ○ | | ○ |

Note: This setting may differ from other standard motors.

Table 6.21 Selection of Encoder (PG)

| Encoder Resolution pulses/rev | SW1 | | | |
|---|---|---|---|---|
| | ⑤ | ⑥ | ⑦ | ⑧ |
| 6000 | ○ | ○ | ○ | |
| 5000 | | | | ○ |
| 4000 | ○ | | | ○ |
| 2500 | ○ | ○ | | ○ |
| 1500 | ○ | | ○ | ○ |
| 1000 | ○ | ○ | ○ | ○ |

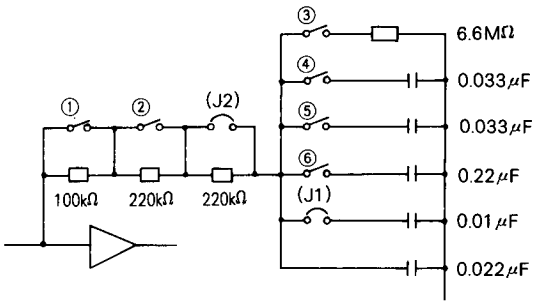



Fig. 6.15 Speed Amplifier PI Constant (SW3-① to ⑥)

## 6.7.2 Internal Switch Arrangements

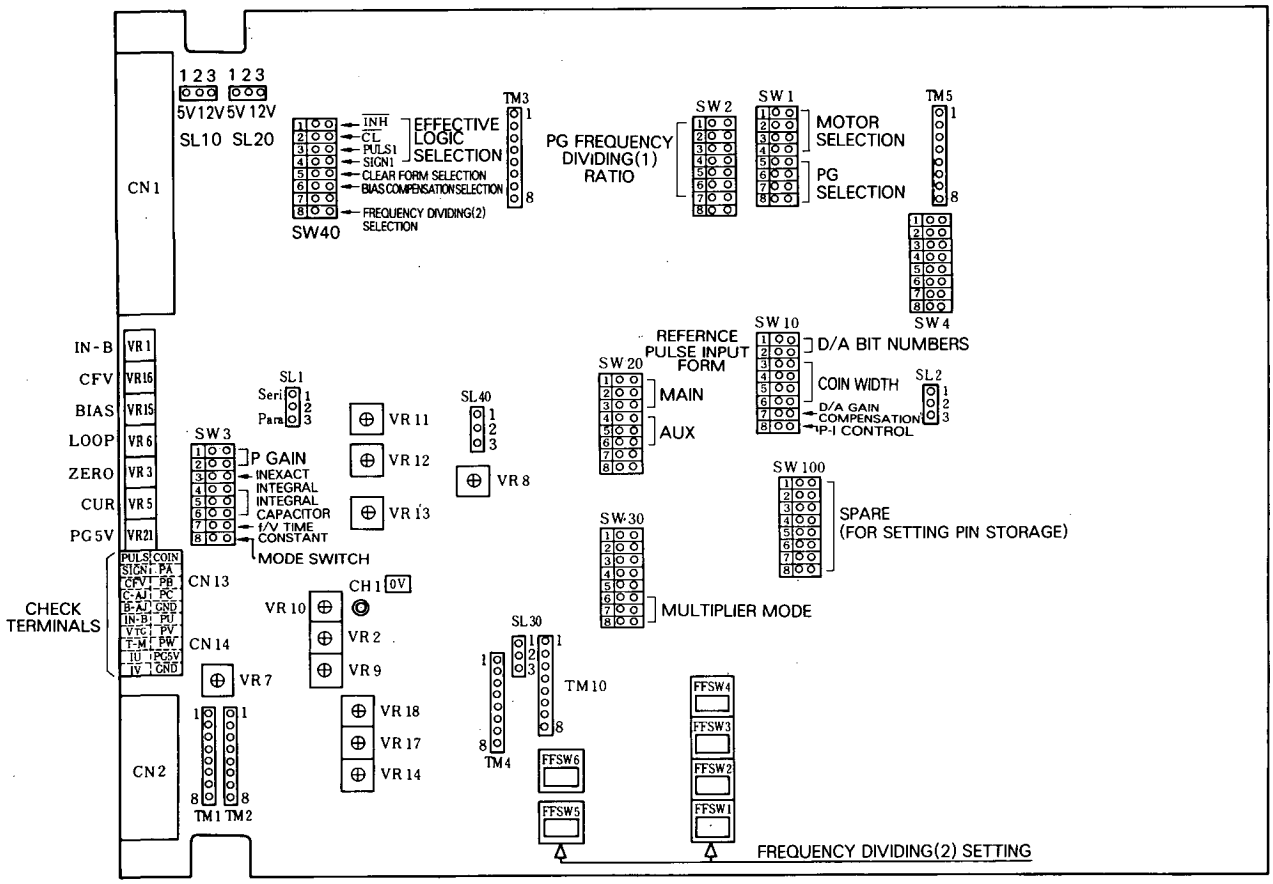



Fig. 6.16 Internal Switch Arrangements SERVOPACK Type CACR-PR□□BC3□□



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### 6.7.3 Switch Setting Procedure

If setting alteration is required, reset using procedures below.

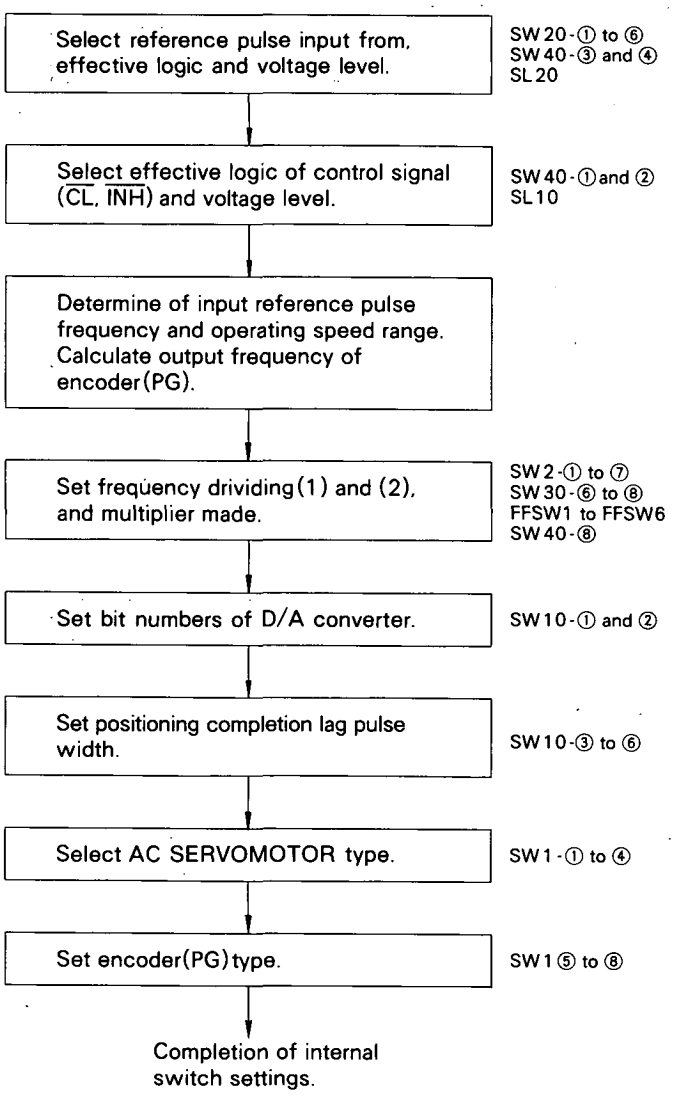



Fig. 6.17 Procedure for Switch Settings

## 6.8 ADJUSTMENT

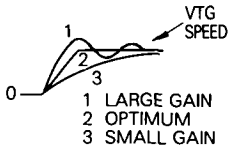
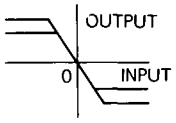
There are seven potentiometers on the SERVOPACK panel: IN-B, CFV, BIAS, LOOP, ZERO, CUR and PG5V. Normally, where adjustment is required depending on the use, readjust the IN-B and LOOP. The adjustment of CFV and BIAS is used to compensate for high speed positioning. Table 6.22 shows potentiometer adjustment.

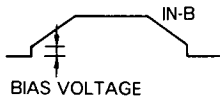


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## 6. 8 ADJUSTMENT (Cont'd)

Table 6. 22 Potentiometer Adjustment

| Potentiometer | VR1 (IN-B) | VR3 (ZERO) | VR5 (CUR) |
|---|---|---|---|
| Functions | Position Loop Gain Adjustment | Speed Amplifier Zero Adjustment | Starting Current Adjustment |
| How to Adjust | To increase gain, turn VR1 CW. | Compensate the following condition with zero adjustment.<br>• Where the positioning completion signal is output unbalanced.<br>• Where the vibration of one pluse response is large at servo lock. | Turning VR5 CCW decreases the peak value of starting current.<br>VR5 has been preset fully CW at the factory. |
| Characteristics |  | — | <br>Maximum output voltage of speed amplifier varies. |

| Potentiometer | VR6 (LOOP) | VR15 (BIAS) | VR16 (CFV) | VR21 (PG5V) |
|---|---|---|---|---|
| Functions | Speed Loop Gain Adjustment | Speed Reference Bias Compensation | Speed Reference Feed Forward Compensation | Voltage Adjustment of PG + 5 V Power |
| How to Adjust | To increase gain, turn. VR6 CW. | To increase bias compensation voltage, turn VR15 CW.<br>If compensation is excessive, the motor will hunt. | Adds feed forward compensation to increase the apparent Kp value and to improve the response.<br>Turning VR16 CW increases the compensation. | Voltage adjustment for PG power.<br>VR21 has been preset at 5.25V at the factory. |
| Characteristics | To prevent hunting, turn VR6 CCW. |  | If compensation is excessive, the motor will hunt. | Turning VR21 CW increases the voltage.<br>If the influence of voltage drop occurs due to long wiring PG, increase the voltage.<br>Do not set VR21 to 6V or above. |



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## 6. 9 CHECK TERMINAL

The check terminal arrangement on the panel is shown in Fig. 6.18. The check teminal functions are shown in Table 6.23.
Do not saturate the check terminal with irrelevant or extraneous substance.

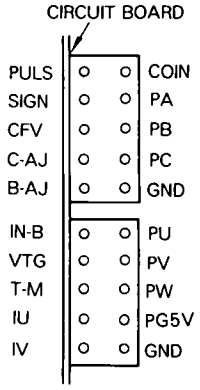


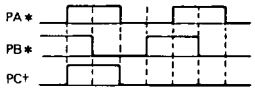

Fig. 6. 18 Check Terminal Arrangement

Table 6. 23 Check Terminal Functios

| Symbol | Functions | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PULS | Reference pulse (main input) signal | PULS1 (or CW pulse train, two-phase pulse) | | | | | | | | |
| SIGN | | SIGN1 (or CCW pulse train, two-phase pulse) | | | | | | | | |
| CFV | Reference pulse f/V converter output. | | | | | | | | | |
| C-AJ | Speed reference feed forward compensation voltage. | | | | | | | | | |
| B-AJ | Speed reference BIAS compensation voltage. | | | | | | | | | |
| IN-B | Speed reference (D/A converter output voltage): approx. ± 6V/full bit. | | | | | | | | | |
| VTG | Speed feedback signal: • M, F series ± 4V/1000 r/min • S series ± 2V/1000 r/min | | | | | | | | | |
| T-M | Torque reference monitor signal: ± 3.0V/100% | | | | | | | | | |
| IU | Motor current (Phase-U) | Type | 03 | 05 | 07 | 10 | 15 | 20 | 30 | 44 |
| IV | Motor current (Phase-V) | [V/A] | 0.4 | 0.24 | 0.20 | 0.16 | 0.08 | | 0.04 | |
| COIN | Positioning completion signal; COIN at L. | | | | | | | | | |
| PA | Optical encoder (PG) input signal. | Phase A pulse input. | | | | | | | | |
| PB | | Phase-B pulse input. | | | | | | | | |
| PC | | Phase-C pulse input. | | | | | | | | |
| PU | Pole sensor input signal. | Phase-U pulse input. | | | | | | | | |
| PV | | Phase-V pulse input. | | | | | | | | |
| PW | | Phase-W pulse input. | | | | | | | | |
| PG5V | Optical encoder (PG) power supply voltage: + 5V. | | | | | | | | | |
| GND | Signal 0V. | | | | | | | | | |

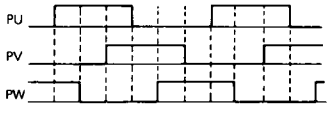
Notes:

1. Optical encoder (PG) input signal
   • Waveform at motor forward running.

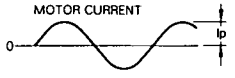



   * Two-phase pulse with 90° phase difference.
   † One generation per motor turning. Synchronizing with PA.

2. Pole sensor input signal.
   • Waveform at motor forward running.




3. The motor generating torque conversion by torque reference monitor signal is large at high-speed range. Compute the precise data by motor current measurement.




MOTOR GENERATING TORQUE
$= \frac{Ip}{\sqrt{2}} \times$ TORQUE CONSTANT



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## 6.10 PRECAUTIONS FOR APPLICATION

### 6.10.1 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 short time regenerative brake capability (corresponding to the motor stopping time), for application to a minus load, contact your YASKAWA representative.

### 6.10.2 Load Inertia ($J_L$)

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

- Slow down the deceleration curve.
- Decrease the maximum speed.

For details, contact your YASKAWA representative.

### 6.10.3 High Voltage Line

If the supply voltage is 400/440 V, the voltage must be dropped three-phase, 400/440V to 200 V by using a power transformer. **Table 6.26** 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. Single-phase 100V class power supply should not be used.

## 6.11 PRECAUTIONS OF OPERATION

### 6.11.1 Noise Control

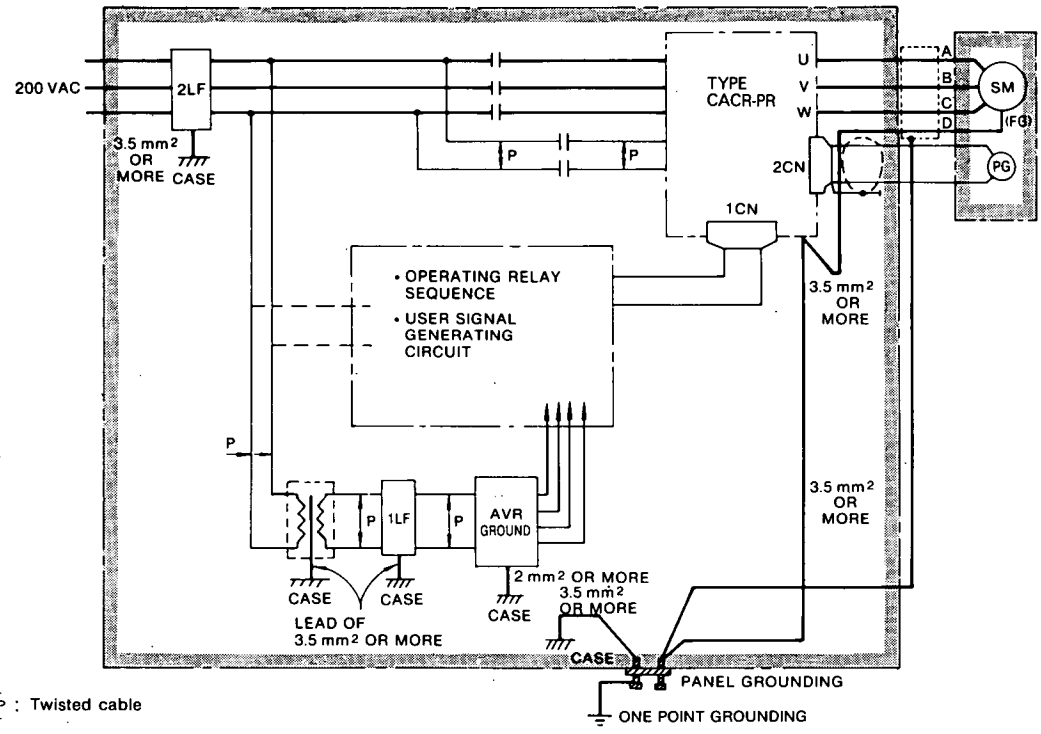
SERVOPACK uses is a power transistor in the main circuit. When these transistors are switched, the effect of $\frac{di}{dt}$ or $\frac{dv}{dt}$ (switching noise) may sometimes occur depending on the wiring or grounding method.

The SERVOPACK incorporates CPU. This requires wiring and provision to prevent noise interference. To reduce switching noise as much as possible, the recommended method of wiring and grounding is shown in **Fig. 6.19.**

(1) Grounding method **(Fig.6.19)**

- Motor frame grounding

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




Notes:
1. Use wires of 3.5 mm² 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. 6.19 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 filters are shown in Table 6.25. The power supply to peripherals also needs noise filters.

**NOTE**

If the noise filter connection is wrong, the effect decreases greatly. Observing the precautions, carefully connect them as shown in Figs. 6.20 to 6.23.

Table 6.25 Recommended Noise Filter

| SERVOPACK Type CACR- | Applicable Noise Filter | Recommended Noise Filter | |
|---|---|---|---|
| | | Type | Specifications |
| PR03BC PR05BC | CORRECT | LF-305 | Three-phase 200 VAC class, 5 A |
| PR07BC | | LF-310 | Three-phase 200 VAC class, 10 A |
| PR10BC PR15BC | | LF-315 | Three-phase 200 VAC class, 15 A |
| PR20BC | WRONG | LF-320 | Three-phase 200 VAC class, 20 A |
| PR30BC | | LF-330 | Three-phase 200 VAC class, 30 A |
| PR44BC | | LF-340 | Three-phase 200 VAC class, 40 A |

Note: Noise filter made by Tokin Corp.

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

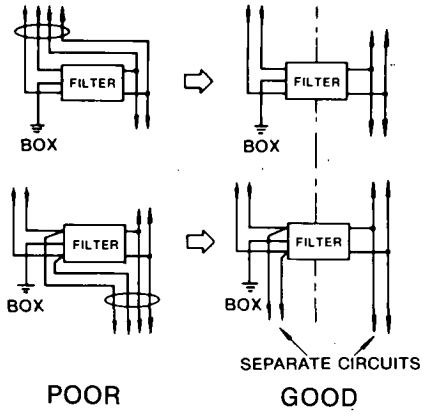



Fig. 6.20

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

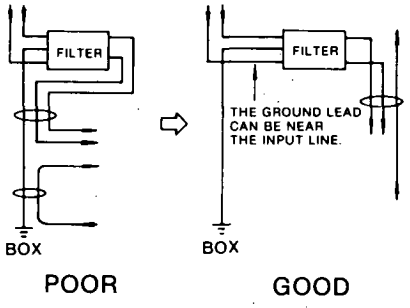



Fig. 6.21

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

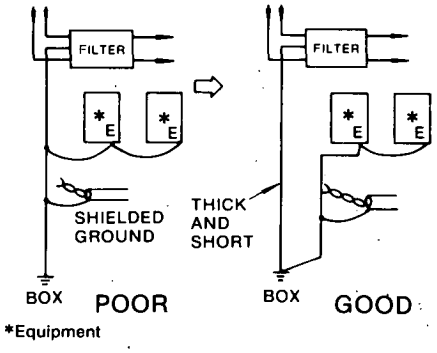



Fig. 6.22

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

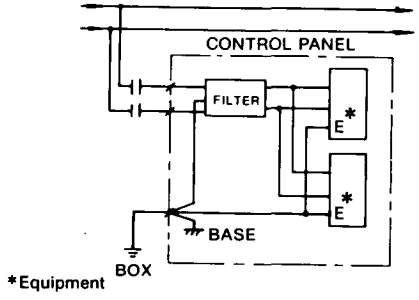



Fig. 6.23

### 6.11.2 Power Line Protection

The SERVOPACK is operated through the commercial power line (200V). To prevent 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 6.26**).

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



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### 6.11.2 Power Line Protection (Cont'd)

Table 6.26 Power Supply Capacity and MCCB or Fuse Capacity

| SERVOPACK Type CACR- | Power Capacity* per SERVOPACK | Current Capacity per MCCB or Fuse |
|---|---|---|
| PR03BC | 0.65 kVA | 5 A |
| PR05BC | 1.1 kVA | 5 A |
| PR07BC | 1.5 kVA | 8 A |
| PR10BC | 2.1 kVA | 8 A |
| PR15BC | 3.1 kVA | 10 A |
| PR20BC | 4.1 kVA | 12 A |
| PR30BC | 6.0 kVA | 18 A |
| PR44BC | 8.0 kVA | 24 A |

*Values at rated load.
Note: For ground fault interruptor, specify the high-speed type. The time delay type is not adopted.

## 6.12 APPLICATION

### 6.12.1 Connection for Reverse Motor Running

If the machine construction requires that the normal forward reference is used for reverse motor running and the normal reverse reference for forward running, short circuit across CN2-1 and CN2-7 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.

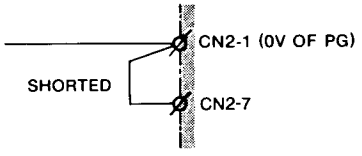
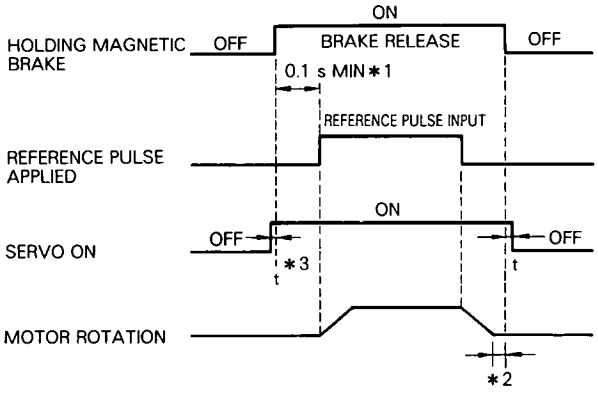



Fig. 6.24

### 6.12.2 Use of Servomotor with Holding Magnetic Brake

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




*1 Input speed reference 0.1s or more after the brake release reference has been input.

*2 Apply brake after the motor has stopped completely. (Do not use the brake to decelerate the motor.)

*3 "t" shows a delay time greater than the operating time(10ms) of one relay.

Note: Turn on SW4- ⑥ (installation of setting plug). Servo lock status after Servo OFF is held during approximately 200 ms.

Fig. 6.25 Holding Magnetic Brake ON-OFF Timing



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# 7. INSTALLATION AND WIRING

## 7.1 RECEIVING

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

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

If any part of the motor is damaged or lost, immediately contact your YASKAWA representative giving full details and nameplate data.

## 7.2 INSTALLATION

### 7.2.1 SERVOMOTOR

AC SERVOMOTOR can be installed either horizontally or vertically.

(1) Before mounting

Wipe anticorrosive paint on shaft extension and flange surface with a cloth before connecting the motor to the driven machine. See **Fig. 7.1.**

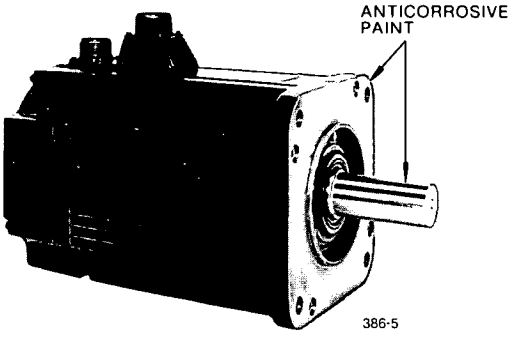



Fig. 7.1 Anticorrosive Paint to be Removed

(2) Location

Use the motor under the following conditions.

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

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

(3) Environmental conditions

Ambient Temperature: 0°to +40°C

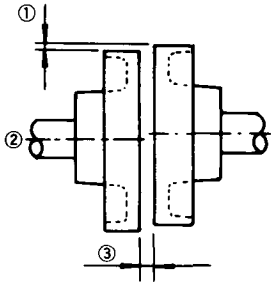
Storage Temperature: -20°to +80°C

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

(4) Load coupling

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

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




① Measure the gap between a straightedge and coupling halves at four equidistant points of the coupling. The each reading should not exceed 0.03 mm.

② Align the shafts.

③ Measure the gap between the coupling faces at four equidistant points around the coupling rim with a thickness gage. The maximum variation between any two readings should not exceed 0.03 mm.

Fig. 7.2 Alignment of Coupling

(5) Allowable bearing load

Avoid both thrust and radial loads to the motor shaft. If unavoidable, never exceed the values in Tables 4.1 to 4.3.



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### 7.2.2 SERVOPACK

(1) Installation

The SERVOPACK type CACR-PR□□BC is a rack-mounted type as standard.

(2) Location

- When installed in a panel:

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

- When installed near a heat source:

  Keep the ambient temperature around SERVOPACK below 55°C.

- If subjected to vibration:

  Mount the unit on shock absorbing material.

- If corrosive gases are present:

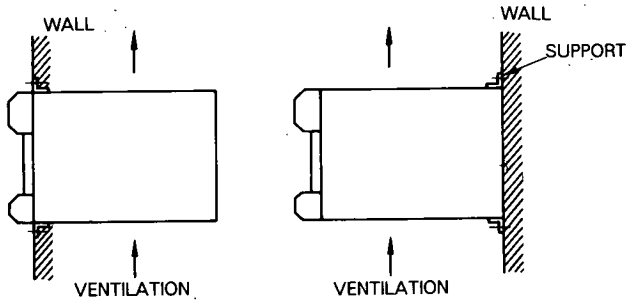
  Avoid locations where corrosive gases exist since it may cause extensive damage over long use. Especially vulnerable are switching operations of contactors and relays.

- Unfavorable atmospheric conditions:

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

(3) Mounting Direction

Mount the SERVOPACK unit vertically on the wall with main terminals being at the bottom to take advantage of natural air convection. (See Fig. 7.3(a).) Install it with setscrews tightened at four mounting holes in the unit bace. To change to base-mounted type, change the support position as shown in Fig. 7.3(b). Mounting screws of base support are attached to the SERVOPACK.




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

Fig. 7.3 Mounting of SERVOPACK

## 7.3 WIRING

### 7.3.1 Rated Current and Cable Size

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

Table 7.1 Rated Current

| External Terminal | | Type CACR- / Symbol | Rated Current A (Effective Current) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PR 03BC | PR 05BC | PR 07BC | PR 10BC | PR 15BC | PR 20BC | PR 30BC | PR 44BC |
| On Line | Main Circuit Power Input | R, S, T | 2 | 5 | 6 | 8 | 10 | 12 | 18 | 24 |
| | Motor Connection | U, V, W | 3.0 | 3.8 | 5.8 | 7.6 | 11.7 | 18.8 | 26.0 | 33.0 |
| | Control Power Input | r, t | 0.5 | | | | | | | |
| Off Line | Control I/O Signal Connector | 1CN | 100 mA DC max | | | | | | | |
| | PG Signal Connector | 2CN | 100 mA DC max (500 mA DC for power line only) | | | | | | | |
| | Ground | ⏚ | — | | | | | | | |

Table 7.2 Recommended Cable Size of SERVOPACK

| External Terminal | | Type CACR- / Symbol | Cable Size mm² | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PR 03BC | PR 05BC | PR 07BC | PR 10BC | PR 15BC | PR 20BC | PR 30BC | PR 44BC |
| On Line | Main Circuit Power Input | R, S, T | HIV 2.0 or more | | | | HIV 3.5 or more | | HIV 5.5 or more | HIV 5.5 or more |
| | Motor Connection | U, V, W | HIV 2.0 or more | | | HIV 3.5 or more | | | | |
| | Control Power Input | r, t | HIV 1.25 or more | | | | | | | |
| Off Line | Control I/O Signal Connector | 1CN | • Two-core twisted shiled cable<br>• Core must be 0.2 mm² 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 2.0 or more | | | | | | | |



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Table 7.3 Cable

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

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

### 7.3.2 Wiring Precautions

SERVOPACK is a device for speed control of 3000: 1, and signal level of several milli-volts or less. The following precautions should be taken when wiring.

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

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

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

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

- Place noise filters, SERVOPACK and I/O reference as near as possible to each other.
- Make sure to mount a surge suppressing circuit into the relay, electromagnetic contact, and solenoid coils.
- Run the power line and signal line, keeping the distance to 30 cm or more; do not run them in the same duct or in a bundle.
- When the same power is used for SERVOPACK, as for an electric welder or electrical discharge machine or when a high-frequency noise source is present in the vicinity, use filters in the power and input circuits.

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

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

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

### 7.3.3 Power Loss

The power loss of SERVOPACK is shown in Table 7.4.

Table 7.4 Power Loss at Rated Output

| SERVOPACK Type CACR- | Output Current A | Power Loss | | | |
|---|---|---|---|---|---|
| | | Main Circuit W | Regenerative Resistance W | Control Circuit W | Total W |
| PR03BC | 3.0 | 20 | 10 | 60 | 90 |
| PR05BC | 3.8 | 40 | | | 110 |
| PR07BC | 5.8 | 60 | 20 | | 140 |
| PR10BC | 7.6 | 70 | | | 150 |
| PR15BC | 11.7 | 80 | | | 160 |
| PR20BC | 18.8 | 100 | 40 | | 200 |
| PR30BC | 26.0 | 160 | 80 | | 300 |
| PR44BC | 33.0 | 210 | 100 | | 370 |

Note: The regenerative resistor causes power loss when the motor is decelerated, but is negligible if the motor is not started and stopped frequently.



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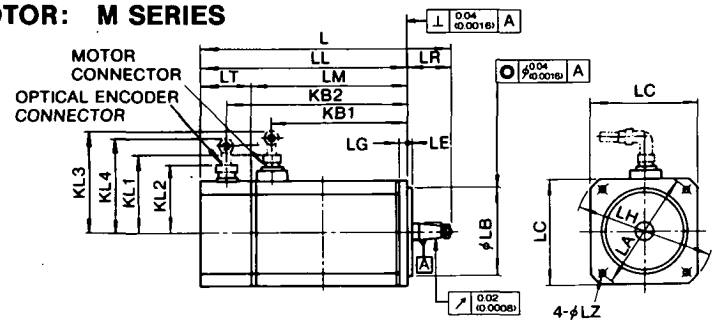
# 8. DIMENSIONS in mm (inches)

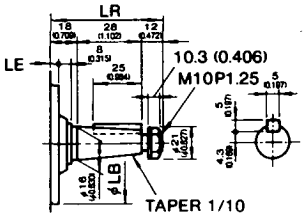
## 8.1 SERVOMOTOR: M SERIES

(1) Standard

Taper Shaft

Drawing 1

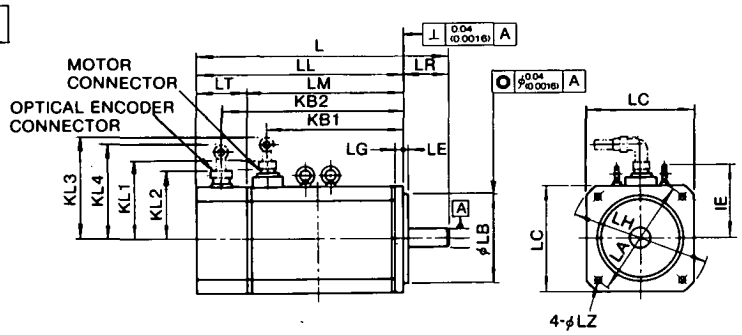


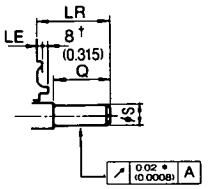




Detail of Shaft Extension

Straight Shaft

Drawing 2




*For USAMED-44MA2, 0.04 (0.0016).
†Only for USAMED-09MA2.

Detail of Shaft Extension

| AC SERVOMOTOR Type | Dwg No. | L | LL | LM | LR | LT | KB1 | KB2 | IE | KL1 | KL2 | KL3 | KL4 | Flange Surface | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | LA | LB | LC | LE | LG | LH | LZ |
| USAMED-03MA1* | 1 | 261 (10.276) | 203 (7.992) | 157 (6.181) | 58 (2.283) | 46 (1.811) | 124 (4.882) | 176 (69.29) | — | 112 (4.409) | 93 (3.661) | 168 (6.614) | 158 (6.22) | 145 (5.709) | $110\ ^{0}_{-0.035}$ ($4.331\ ^{0}_{-0.00138}$) | 130 (5.118) | 6 (0.236) | 12 (0.472) | 165 (6.496) | 9 (0.354) |
| USAMED-06MA1* | 1 | 318 (12.52) | 260 (10.236) | 214 (8.425) | | | 181 (7.126) | 233 (9.173) | | | | | | | | | | | | |
| USAMED-09MA2* | 2 | 406 (15.984) | 348 (13.701) | 302 (11.890) | | | 250 (9.843) | 322 (12.677) | | | | | | | | | | | | |
| USAMED-12MA2* | 2 | 350 (13.78) | 271 (10.669) | 213 (8.386) | 79 (3.11) | 58 (2.283) | 171 (6.732) | 232 (9.134) | 124 (4.882) | 137 (5.394) | 110 (4.331) | 202 (7.953) | 175 (6.89) | 200 (7.874) | $114.3\ ^{0}_{-0.025}$ ($4.5\ ^{0}_{-0.000984}$) | 180 (7.087) | 3.2 (0.126) | 18 (0.709) | 230 (9.055) | 13.5 (0.531) |
| USAMED-20MA2 | 2 | 408 (16.063) | 329 (12.953) | 271 (10.669) | | | 229 (9.016) | 290 (11.417) | | | | | | | | | | | | |
| USAMED-30MA2 | 2 | 493 (19.409) | 414 (16.299) | 356 (14.016) | | | 314 (12.362) | 375 (14.764) | | | | | | | | | | | | |
| USAMED-44MA2 | 2 | 725 (28.543) | 615 (24.213) | 557 (21.929) | 110 (4.331) | | 482 (18.976) | 587 (23.11) | | 150 (5.906) | 100 (3.937) | 235 (9.252) | 165 (6.496) | | | | | | | |

| AC SERVOMOTOR Type | Dwg No. | Shaft Extension S | Shaft Extension Q | Approx Mass kg (lb) | Motor Connector Types: Receptacle | Motor Connector Types: L-type Plug | Motor Connector Types: Straight Plug | Motor Connector Types: Cable Clamp | Optical Encoder Connector Types: Receptacle | Optical Encoder Connector Types: L-type Plug | Optical Encoder Connector Types: Straight Plug | Optical Encoder Connector Types: Cable Clamp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| USAMED-03MA1* | 1 | See Drawing 1. | | 8.5 (19) | MS 3102 A 18 -10 P | MS 3108 B 18 -10 S | MS 3106 B 18 -10 S | MS 3057 -10 A | MS 3102 A 20 -29 P | MS 3108 B 20 -29 S | MS 3106 B 20 -29 S | MS 3057 -12 A |
| USAMED-06MA1* | 1 | | | 13 (29) | | | | | | | | |
| USAMED-09MA2* | 2 | $22\ ^{0}_{-0.013}$ ($0.886\ ^{0}_{-0.000512}$) | 40 (1.575) | 20 (44) | | | | | | | | |
| USAMED-12MA2* | 2 | $35\ ^{+0.01}_{0}$ ($1.378\ ^{+0.000394}_{0}$) | 76 (2.992) | 22 (48) | MS 3102 A 22 -22 P | MS 3108 B 22 -22 S | MS 3106 B 22 -22 S | MS 3057 -12 A | | | | |
| USAMED-20MA2 | 2 | | | 29 (64) | | | | | | | | |
| USAMED-30MA2 | 2 | | | 41 (90) | | | | | | | | |
| USAMED-44MA2 | 2 | $42\ ^{0}_{-0.016}$ ($1.654\ ^{0}_{-0.00063}$) | 110 (4.331) | 66 (145) | MS 3102 A 32 -17 P | MS 3108 B 32 -17 S | MS 3106 B 32 -17 S | MS 3057 -16 A | | | | |

*Not provided with an eyebolt.

Notes:
1. Optical encoder (6000 pulses/rev) is used as a detector.
2. Vibration : 15μm or below.
3. Plug and clamp are not attached for receptacle connection.

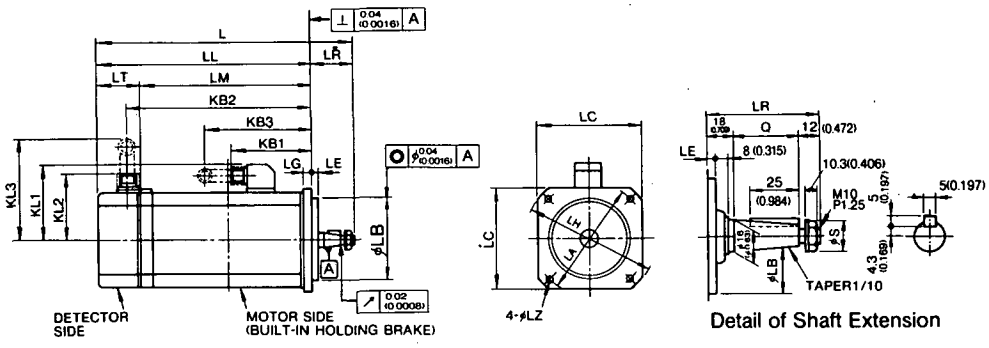


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## (2) With Brake

**Taper Shaft**

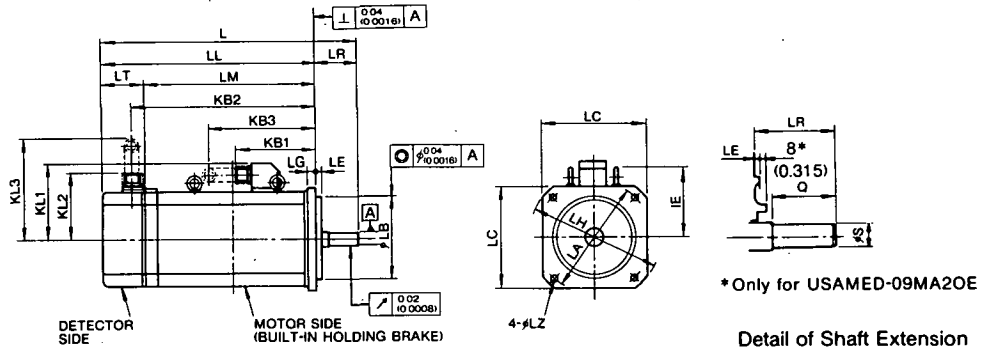
Drawing 1




Detail of Shaft Extension

**Straight Shaft**

Drawing 2




*Only for USAMED-09MA2OE

Detail of Shaft Extension

| AC SERVOMOTOR Type USAMED- | Dwg No. | L | LL | LM | LR | LT | KB1 | KB2 | KB3 | IE | KL1 | KL2 | KL3 | Flange Surface | | | | | | | Shaft Extension | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | LA | LB | LC | LE | LG | LH | LZ | S | Q |
| 03MA10E* | 1 | 316 (12.441) | 258 (10.157) | 214 (8.425) | 58 (2.283) | 44 (1.732) | 116 (4.567) | 233 (9.173) | 158 (6.220) | — | 113 (4.449) | 93 (3.661) | 147 (5.787) | 145 (5.709) | $110^{\ 0}_{-0.035}$ ($4.331^{\ 0}_{-0.00138}$) | 130 (5.118) | 6 (0.236) | 12 ((0.472) | 165 (6.496) | 9 (0.354) | 21 (0.827) | 28 (1.102) |
| 06MA10E* | 1 | 362 (14.252) | 304 (11.969) | 260 (10.236) | | | | 279 (10.984) | | | | | | | | | | | | | $22^{\ 0}_{-0.013}$ ($0.866^{\ 0}_{-0.000512}$) | 40 (1.575) |
| 09MA20E* | 2 | 452 (17.795) | 394 (15.512) | 350 (13.780) | | | | 369 (14.528) | | | | | | | | | | | | | | |
| 12MA20E | 2 | 426 (16.772) | 347 (13.661) | 292 (11.496) | 79 (3.110) | 55 (2.165) | 165 (6.496) | 311 (12.244) | 220 (8.661) | 124 (4.882) | 143 (5.630) | 110 (4.331) | 171 (6.732) | 200 (7.874) | $114.3^{\ 0}_{-0.025}$ ($4.5^{\ 0}_{-0.000984}$) | 180 (7.087) | 3.2 (0.126) | 18 (0.709) | 230 (9.055) | 13.5 (0.531) | $35^{\ +0.01}_{\ 0}$ ($1.378^{\ +0.000394}_{\ 0}$) | 76 (2.992) |
| 20MA20E | 2 | 490 (19.291) | 411 (16.181) | 356 (14.016) | | | | 375 (14.764) | | | | | | | | | | | | | | |
| 30MA20E | 2 | 571 (22.480) | 492 (19.370) | 437 (17.205) | | | | 456 (17.953) | | | | | | | | | | | | | | |

| AC SERVOMOTOR Type USAMED- | Dwg No. | Approx Mass kg (lb) | Brake Torque N·m (lb·in) | Connector Types for Motor and Brake | | | | Optical Encoder Connector Types | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Receptacle | L-type Plug | Straight Plug | Cable Clamp | Receptacle | L-type Plug | Straight Plug | Cable Clamp |
| 03MA10E* | 1 | 11.5 (25) | 5.88 (52.1) | MS 3102 A 20 -15 P | MS 3108 B 20 -15 S | MS 3106 B 20 -15 S | MS 3057 -12 A | MS 3102 A 20 -29 P | MS 3108 B 20 -29 S | MS 3106 B 20 -29 S | MS 3057 -12 A |
| 06MA10E* | 1 | 15 (33) | | | | | | | | | |
| 09MA20E* | 2 | 23 (51) | | | | | | | | | |
| 12MA20E | 2 | 30 (66) | 35.28 (312.5) | MS 3102 A 24 -10 P | MS 3108 B 24 -10 S | MS 3106 B 24 -10 S | MS 3057 -16 A | | | | |
| 20MA20E | 2 | 37 (81) | | | | | | | | | |
| 30MA20E | 2 | 49 (108) | | | | | | | | | |

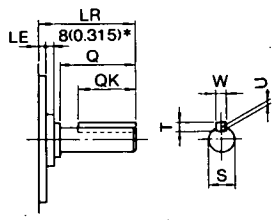
* Not provided with an eyebolt.

Notes :

1. Optical encoder (6000 pulses/rev) is used as a detector.
2. Vibration: 15 $\mu$m or below.
3. Plug and clamp are not attached for receptacle connection.
4. Power supply for brake is 90 VDC.
5. For type USAMED-44MA20E, contact your YASKAWA representative.

## (3) Shaft Extension of Straight Shaft with Keyway

Both SERVOMOTORS without brake and with brake have the same dimensions except for shaft extension. Shaft extensions are shown below:




*Only for USAMED-03MA2□ to-09MA2□

| AC SERVOMOTOR Type USAMED- | | LR | LE | Shaft Extension | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Without Brake | With Brake | | | S | Q | QK | T | U | W |
| 03MA2K | 03MA2KE | 58 (2.283) | 6 (0.236) | $19^{\ 0}_{-0.013}$ ($0.748^{\ 0}_{-0.000512}$) | 40 (1.575) | 25 (0.984) | 5 (0.197) | 3 (0.118) | 5 (0.197) |
| 06MA2K | 06MA2KE | | | | | | | | |
| 09MA2K | 09MA2KE | | | $22^{\ 0}_{-0.013}$ ($0.866^{\ 0}_{-0.000512}$) | | | 6 (0.236) | 3.5 (0.138) | 6 (0.236) |
| 12MA2K | 12MA2KE | 79 (3.11) | 3.2 (0.126) | $35^{\ +0.01}_{\ 0}$ ($1.378^{\ +0.000394}_{\ 0}$) | 76 (2.992) | 60 (2.362) | 8 (0.315) | 5 (0.197) | 10 (0.394) |
| 20MA2K | 20MA2KE | | | | | | | | |
| 30MA2K | 30MA2KE | | | | | | | | |
| 44MA2K | 44MA2KE | 110 (4.331) | | $42^{\ 0}_{-0.016}$ ($1.654^{\ 0}_{-0.00063}$) | 110 (4.331) | 90 (3.543) | | | 12 (0.472) |



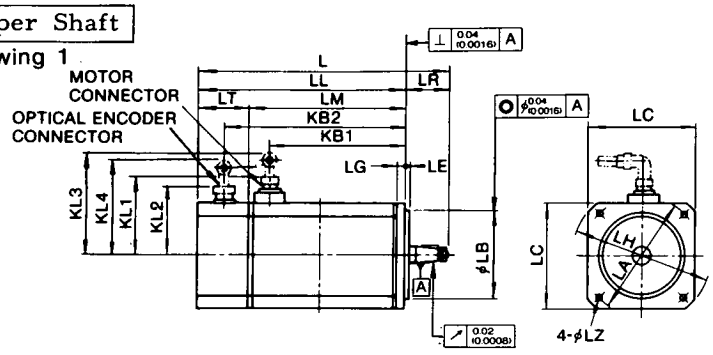
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## 8. 2 SERVOMOTOR: F SERIES

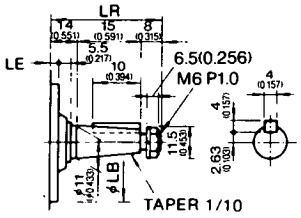
(1) Standard

Taper Shaft

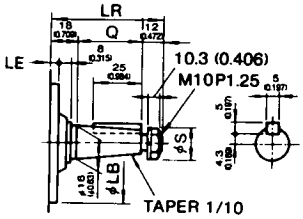
Drawing 1




Types USAFED-02FA1, and -03FA1



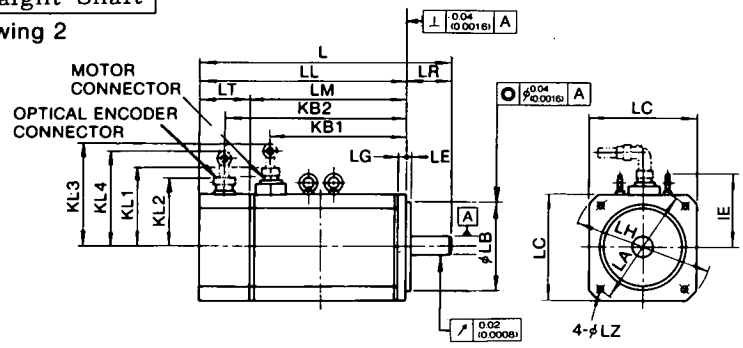

Types USAFED-05FA1, and-09FA1

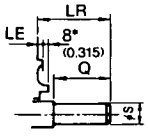



Detail of Shaft Extension

Straight Shaft

Drawing 2




*Only for USAFED-13FA2

Detail of Shaft Extension

| AC SERVOMOTOR Type USAFED- | Dwg No. | L | LL | LM | LR | LT | KB1 | KB2 | IE | KL1 | KL2 | KL3 | KL4 | Flange Surface LA | LB | LC | LE | LG | LH | LZ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 02FA1 | 1 | 190 (7.480) | 153 (6.024) | 113 (4.449) | 37 (1.457) | 40 (1.575) | 89.5 (3.524) | 132 (5.197) | — | 76 (2.992) | 89 (3.503) | 126 (4.961) | 139 (5.472) | 100 (3.937) | 80 $^{0}_{-0.030}$ (3.150 $^{0}_{-0.00118}$) | 90 (3.543) | 4 (0.157) | 7 (0.276) | 120 (4.724) | 6.6 (0.260) |
| 03FA1 | 1 | 236 (9.291) | 199 (7.835) | 159 (6.260) | | | 135.5 (5.335) | 178 (7.001) | | | | | | | | | | | | |
| 05FA1* | 1 | 261 (10.276) | 203 (7.992) | 157 (6.181) | 58 (2.283) | 46 (1.811) | 124 (4.882) | 124 (6.929) | — | 112 (4.409) | 93 (3.661) | 168 (6.614) | 158 (6.22) | 145 (5.709) | 110 $^{0}_{-0.035}$ (4.331 $^{0}_{-0.00138}$) | 130 (5.118) | 6 (0.236) | 12 (0.472) | 165 (6.496) | 9 (0.354) |
| 09FA1* | 1 | 318 (12.52) | 260 (10.236) | 214 (8.425) | | | 181 (7.126) | 233 (9.137) | | | | | | | | | | | | |
| 13FA2* | 2 | 406 (15.984) | 348 (13.701) | 302 (11.890) | | | 250 (9.843) | 322 (12.677) | | | | | | | | | | | | |
| 20FA2* | 2 | 350 (13.78) | 271 (10.669) | 213 (8.386) | 79 (3.11) | 58 (2.283) | 171 (6.732) | 232 (9.134) | 124 (4.882) | 137 (5.394) | 110 (4.331) | 202 (7.953) | 175 (6.89) | 200 (7.874) | 114.3 $^{0}_{-0.025}$ ( 4.5 $^{0}_{-0.000984}$) | 180 (7.087) | 3.2 (0.126) | 18 (0.709) | 230 (9.055) | 13.5 (0.531) |
| 30FA2 | 2 | 408 (16.063) | 329 (12.953) | 271 (10.669) | | | 229 (9.016) | 290 (11.417) | | | | | | | | | | | | |
| 44FA2 | 2 | 493 (19.409) | 414 (16.299) | 356 (14.016) | | | 314 (12.326) | 375 (14.764) | | | | | | | | | | | | |

| AC SERVOMOTOR Type USAFED- | Dwg No. | Shaft Extension S | Shaft Extension Q | Approx Mass kg (lb) | Motor Connector Types Receptacle | Motor Connector Types L-type Plug | Motor Connector Types Straight Plug | Motor Connector Types Cable Clamp | Optical Encoder Types Receptacle | Optical Encoder Types L-type Plug | Optical Encoder Types Straight Plug | Optical Encoder Types Cable Clamp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 02FA1 | 1 | 11.5 (0.453) | 15 (0.591) | 3.5 (8) | MS 3102 A 14 S -2 S | MS 3108 B 14 S -2 S | MS 3106 B 14 S -2 S | MS 3057 -6 A | MS 3102 A 20 -29 P | MS 3108 B 20 -29 S | MS 3106 B 20 -29 S | MS 3057 -12 A |
| 03FA1 | 1 | | | 4 (9) | | | | | | | | |
| 05FA1* | 1 | 21 (0.827) | 28 (1.102) | 8.5 (19) | MS 3102 A 18 -10 P | MS 3108 B 18 -10 S | MS 3106 B 18 -10 S | MS 3057 -10 A | | | | |
| 09FA1* | 1 | | | 13 (29) | | | | | | | | |
| 13FA2* | 2 | 22 $^{0}_{-0.013}$ (0.866 $^{0}_{-0.000512}$) | 40 (1.575) | 20 (44) | | | | | | | | |
| 20FA2* | 2 | 35 $^{+0.01}_{0}$ (1.378 $^{+0.000394}_{0}$) | 76 (2.992) | 22 (48) | MS 3102 A 22 -22 P | MS 3108 B 22 -22 S | MS 3106 B 22 -22 S | MS 3057 -12 A | | | | |
| 30FA2 | 2 | | | 29 (64) | | | | | | | | |
| 44FA2 | 2 | | | 41 (90) | | | | | | | | |

* Not provided with an eyebolt.

Notes:

1. Optical encoder (6000 pulses/rev) is used as a detector.
2. Vibration: 15 $\mu$m or below.
3. Plug and clamp are not attached for receptacle connection.

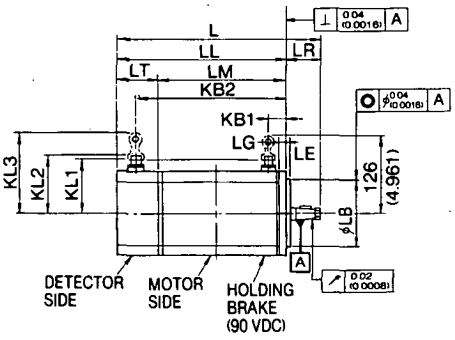


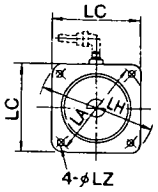
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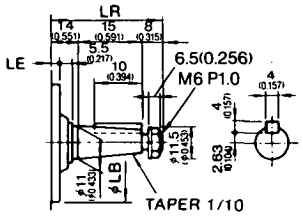
(2) With Brake

Taper Shaft

Drawing 1



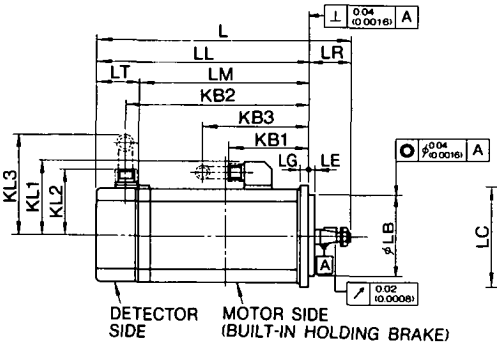



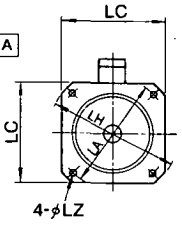



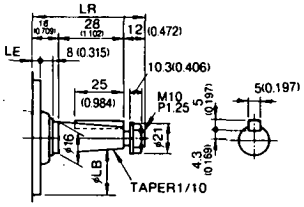

Detail of Shaft Extension

Straight Shaft

Drawing 2



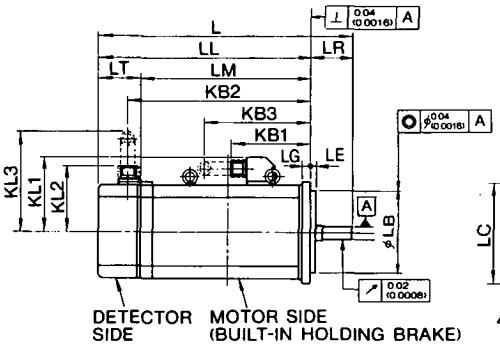



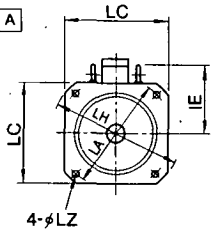



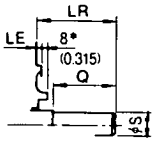

Detail of Shaft Extension

Straight Shaft

Drawing 3




*Only for USAFED-13FA2OE

Detail of Shaft Extension



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## 8. 2 SERVOMOTOR: F SERIES (Cont'd)

| AC SERVOMOTOR Type USAFED- | Dwg No. | L | LL | LM | LR | LT | KB1 | KB2 | KB3 | IE | KL1 | KL2 | KL3 | Flange Surface | | | | | | | Shaft Extension | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | LA | LB | LC | LE | LG | LH | LZ | S | Q |
| 02FA10E | 1 | 236 (9.291) | 199 (7.835) | 159 (6.260) | 37 (1.457) | 40 (1.575) | 24 (0.945) | 178 (7.008) | — | | 76 (2.992) | 89 (3.504) | 154 (6.063) | 100 (3.937) | 80 $^{0}_{-0.030}$ (3.150 $^{0}_{-0.00118}$) | 90 (3.543) | 4 (0.157) | 7 (0.276) | 120 (4.724) | 6.6 (0.260) | See Drawing 1. | |
| 03FA10E | 1 | 286 (11.260) | 249 (9.803) | 209 (8.228) | | | | 228 (8.976) | | | | | | | | | | | | | | |
| 05FA10E* | 1 | 316 (12.441) | 258 (10.157) | 214 (8.125) | 58 (2.283) | 44 (1.732) | 116 (4.567) | 233 (9.173) | 158 (6.220) | — | 113 (4.449) | 93 (3.661) | 147 (5.787) | 145 (5.709) | 110 $^{0}_{-0.035}$ (4.331 $^{0}_{-0.00138}$) | 130 (5.118) | 6 (0.236) | 12 (0.472) | 165 (6.496) | 9 (0.354) | | |
| 09FA10E* | 1 | 362 (14.252) | 304 (11.969) | 260 (10.236) | | | | 279 (10.984) | | | | | | | | | | | | | | |
| 13FA20E* | 2 | 452 (17.780) | 394 (15.512) | 350 (13.780) | | | | 369 (14.528) | | | | | | | | | | | | | (0.866 $^{0}_{-0.013}$ $^{0}_{-0.000512}$) | 40 (1.575) |
| 20FA20E | 2 | 426 (16.772) | 347 (13.661) | 292 (11.496) | 79 (3.110) | 55 (2.165) | 165 (6.496) | 311 (12.244) | 220 (8.661) | 124 (4.882) | 143 (5.630) | 110 (4.331) | 171 (6.732) | 200 (7.874) | 114.3 $^{0}_{-0.025}$ ( 4.5 $^{0}_{-0.000984}$) | 180 (7.087) | 3.2 (0.126) | 18 (0.709) | 230 (9.055) | 13.5 (0.531) | 35 $^{+0.01}_{0}$ (1.378 $^{+0.000394}_{0}$) | 76 (2.992) |
| 30FA20E | 2 | 490 (19.291) | 411 (16.181) | 356 (14.016) | | | | 375 (14.764) | | | | | | | | | | | | | | |
| 44FA20E | 2 | 571 (22.48) | 492 (19.37) | 437 (17.205) | | | | 456 (17.953) | | | | | | | | | | | | | | |

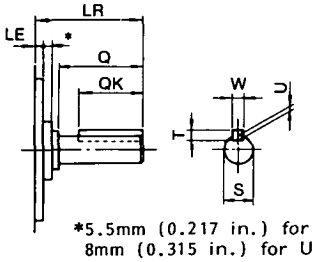
| AC SERVOMOTOR Type USAFED- | Dwg No. | Approx Mass kg (lb) | Brake Torque N·m (lb·in) | Connector Types for Motor and Brake | | | | Optical Encoder Connector Types | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Receptacle | L-type Plug | Straight Plug | Cable Clamp | Receptacle | L-type Plug | Straight Plug | Cable Clamp |
| 02FA10E | 1 | 4.4 (10) | 0.98 (8.7) | MS 3102 A 14 S -6 P | MS 3108 B 14 S -6 S | MS 3106 B 14 S -6 S | MS 3057 -6 A | MS 3102 A 20 -29 P | MS 3108 B 20 -29 S | MS 3106 B 20 -29 S | MS 3057 -12 A |
| 03FA10E | 1 | 5 (11) | | | | | | | | | |
| 05FA10E* | 1 | 11.5 (25) | 5.88 (52.1) | MS 3102 A 20 -15 P | MS 3108 B 20 -15 S | MS 3106 B 20 -15 S | MS 3057 -12 A | | | | |
| 09FA10E* | 1 | 15 (33) | | | | | | | | | |
| 13FA20E* | 2 | 23 (51) | | | | | | | | | |
| 20FA20E | 2 | 30 (66) | 5.88 (312.5) | MS 3102 A 24 -10 P | MS 3108 B 24 -10 S | MS 3106 B 24 -10 S | MS 3057 -16 A | | | | |
| 30FA20E | 2 | 37 (81) | | | | | | | | | |
| 44FA20E | 2 | 49 (108) | | | | | | | | | |

* Not provided with an eyebolt.

Notes:
1. Optical encoder (6000 pulses/rev) is used as a detector.
2. Vibration: 15 $\mu$m or below.
3. Plug and clamp are not attached for receptacle connection.
4. Power supply for brake is 90 VDC.

### (3) Shaft Extension of Straight Shaft with Keyway

Both SERVOMOTORS with brake and without brake have the same dimensions except for shaft extension. Shaft extensions are shown below:




*5.5mm (0.217 in.) for USAFED-02FA2□ and 03FA2□
8mm (0.315 in.) for USAFED-05FA2□ to 13FA2□

| AC SERVOMOTOR Type USAMED- | | LR | LE | Shaft Extension | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Without Brake | With Brake | | | S | Q | QK | T | U | W |
| 02FA2K | 02FA2KE | 37 (1.457) | 4 (0.157) | 14 $^{0}_{-0.011}$ (0.551 $^{0}_{-0.00043}$) | 25 (0.984) | 15 (0.591) | 5 (0.197) | 3 (0.118) | 5 (0.197) |
| 03FA2K | 03FA2KE | | | | | | | | |
| 05FA2K | 05FA2KE | 58 (2.283) | 6 (0.236) | 19 $^{0}_{-0.013}$ (0.748 $^{0}_{-0.000512}$) | 40 (1.575) | 25 (0.984) | | | |
| 09FA2K | 09FA2KE | | | | | | | | |
| 13FA2K | 13FA2KE | | | 22 $^{0}_{-0.013}$ (0.866 $^{0}_{-0.000512}$) | | | 6 (0.236) | 3.5 (0.138) | 6 (0.236) |
| 20FA2K | 20FA2KE | 79 (3.11) | 3.2 (0.126) | 35 $^{+0.01}_{0}$ (1.378 $^{+0.000394}_{0}$) | 76 (2.992) | 60 (2.362) | 8 (0.315) | 5 (0.197) | 10 (0.394) |
| 30FA2K | 30FA2KE | | | | | | | | |
| 44FA2K | 44FA2KE | | | | | | | | |



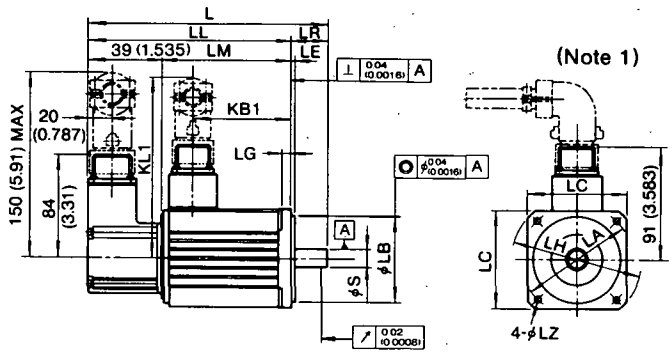
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## 8.3 SERVOMOTOR: S SERIES

(1) Standard

### Straight Shaft

· Types USASEM-02AE2 (Note 1), -03AE2, -05AE2

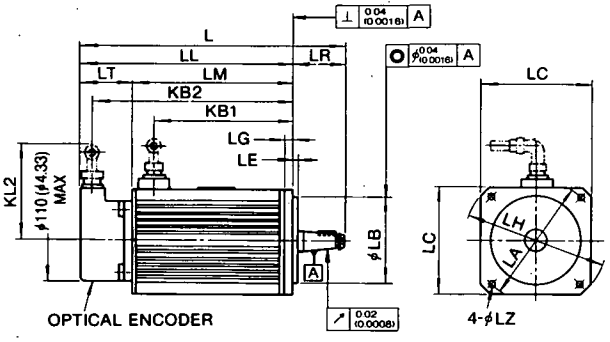



| AC Servomotor Type USASEM- | L | LL | LM | LR | KB1 | KL1 | Flange Surface & Shaft Extension | | | | | | | | Approx Mass kg (lb) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LA | LB | LC | LE | LG | LH | LZ | S | |
| 02AE2 | 164.5 (6.476) | 134.5 (5.295) | 95.5 (3.760) | 30 (1.181) | 72.5 (2.854) | — | 80 (3.150) | 50 $^{0}_{-0.025}$ (1.969 $^{0}_{-0.0010}$) | 65 (2.559) | 3 (0.118) | 6 (0.236) | 90 (3.543) | 5 (0.197) | 8 $^{0}_{-0.009}$ (0.315 $^{0}_{-0.0035}$) | 1.5 (3.3) |
| 03AE2 | 178.5 (7.027) | 148.5 (5.846) | 109.5 (4.311) | 30 (1.181) | 79 (3.11) | 145 (5.708) | 90 (3.543) | 70 $^{0}_{-0.030}$ (2.756 $^{0}_{-0.0012}$) | 80 (3.15) | 3 (0.118) | 8 (0.315) | 105 (4.134) | 6 (0.236) | 14 $^{0}_{-0.011}$ (0.5512 $^{0}_{-0.0043}$) | 2.7 (5.96) |
| 05AE2 | 200.5 (7.893) | 170.5 (6.712) | 131.5 (5.177) | 30 (1.181) | 101 (3.976) | 145 (5.708) | 90 (3.543) | 70 $^{0}_{-0.030}$ (2.756 $^{0}_{-0.0012}$) | 80 (3.15) | 3 (0.118) | 8 (0.315) | 105 (4.134) | 6 (0.236) | 14 $^{0}_{-0.011}$ (0.5512 $^{0}_{-0.0043}$) | 3.3 (7.28) |

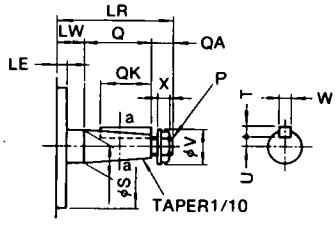
Notes:
1. Drawout construction of Type USASEM-02AE2 is waterproof gland method. Therefore, connector part differs from figure above. For details, request another dimensions to YASKAWA representative.
2. Optical encoder (1500 pulses/rev) is used as a detector.
3. Vibration: 15μm or below.
4. Plug and clamp are not attached for receptacle connection.

### Taper Shaft

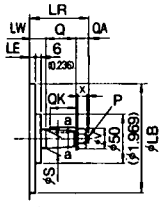
· Types USASEM-08AC1, -15AC1, -30AC1




Types USASEM-08AC1, and -30AC1




Type USASEM-15AC1




Detail of Shaft Extension

| AC SERVOMOTOR Type USASEM- | L | LL | LM | LT | LR | KB1 | KL1 | KL2 | Flange Surface | | | | | | | Shaft Extension | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | LA | LB | LC | LE | LG | LH | LZ | LW | Q | QK | QA | X | S | V | P | U | W | T |
| 08AC1 | 257 (10.118) | 199 (7.835) | 148.5 (5.847) | 50.5 (1.988) | 58 (2.283) | 115 (4.527) | 170 (6.693) | 150 (5.906) | 130 (5.118) | 110 $^{0}_{-0.035}$ (4.3308 $^{0}_{-0.0014}$) | 120 (4.724) | 3 (0.118) | 10 (0.394) | 155 (6.1) | 9 (0.354) | 18 (0.709) | 28 (1.102) | 25 (0.984) | 12 (0.472) | 10.3 (0.406) | 16 (0.63) | 21 (0.827) | M10 P1.25 | 4.3 $^{0}_{-0.1}$ (0.1693 $^{0}_{-0.0039}$) | 5 (0.197) | 5 (0.197) |
| 15AC1 | 317.5 (12.5) | 259.5 (10.217) | 203.5 (8.013) | 56 (2.205) | 58 (2.283) | 166.5 (6.555) | 177 (6.969) | 163 (6.413) | 145 (7.71) | 110 $^{0}_{-0.035}$ (4.3308 $^{0}_{-0.0014}$) | 130 (5.118) | 6 (0.236) | 12 (0.472) | 165 (6.496) | 9 (0.354) | 18 (0.709) | 28 (1.102) | 25 (0.984) | 12 (0.472) | 10.3 (0.406) | 19 (0.748) | 21 (0.827) | M10 P1.25 | 5.8 $^{0}_{-0.1}$ (0.2283 $^{0}_{-0.0039}$) | 5 (0.197) | 5 (0.197) |
| 30AC1 | 366 (14.41) | 296 (11.654) | 240 (9.45) | 56 (2.205) | 70 (2.756) | 206 (8.11) | 205 (8.071) | 165 (6.496) | 200 (7.874) | 114.3 $^{0}_{-0.040}$ (4.5 $^{0}_{-0.0016}$) | 180 (7.09) | 6 (0.236) | 18 (0.708) | 230 (9.055) | 13.5 (0.531) | 20 (0.788) | 36 (1.417) | 32 (1.259) | 14 (0.551) | 12.5 (0.492) | 22 (0.866) | 24 (0.945) | M12 P1.25 | 6.6 $^{0}_{-0.1}$ (0.2598 $^{0}_{-0.0039}$) | 6 (0.236) | 6 (0.236) |

Notes:
1. Optical encoder (2500 pulses/rev) is used as a detector.
2. Vibration: 15 μm or below.
3. Hexagon socket head bolts should be used to mount the motor.
4. Plug and clamp are not attached for receptacle connection.
5. Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1301 "Sunk keys and Their Corresponding keyways (close keys)."

| AC SERVOMOTOR Type USASEM- | Approx Mass kg (lb) | Motor Connector Types | | | | Optical Encoder Connector Types | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Receptacle | L-type Plug | Straight Plug | Cable Clamp | Receptacle | L-type Plug | Straight Plug | Cable Clamp |
| 03AE2 | 2.7 (5.95) | MS 3102 A 18 -10 P | MS 3108 B 18 -10 S | MS 3106 B 18 -10 S | MS 3057-10 A | MS 3102 A 20 -29 P | MS 3108 B 20 -29 S | MS 3106 B 20 -29 S | MS 3057-12 A |
| 05AE2 | 3.3 (7.28) | | | | | | | | |
| 08AC1 | 5.8 (12.8) | MS 3102 A 20 -4 P | MS 3108 B 20 -4 S | MS 3106 B 20 -4 S | MS 3057-12 A | | | | |
| 15AC1 | 11 (24.25) | | | | | | | | |
| 30AC1 | 24 (52.9) | | | | | | | | |

Note: When plugs or clamps are required, contact your YASKAWA representative. The following connections are provided: soldered type MS and solderless type JA.



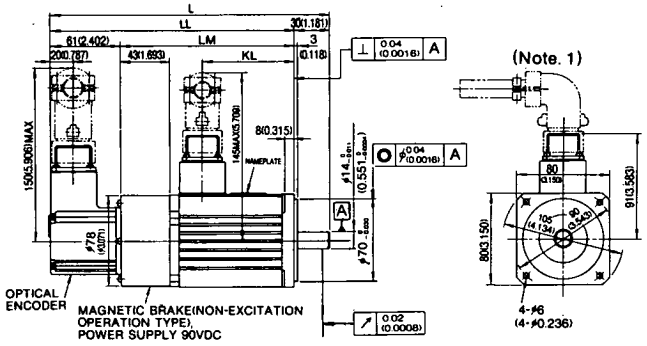
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## 8. 3 SERVOMOTOR: S SERIES (Cont'd)

(2) With Brake

Straight Shaft

. Types USASEM-02AE2OB (Note 1), -03AE2OB, -05AE2OB

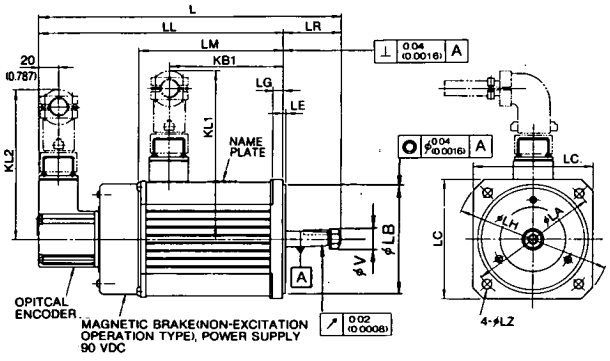



| AC SERVOMOTOR Type USASEM- | L | LL | LM | KL | Magnetic Brake Type | Magnetic Brake Inertia kg·m²×10⁻⁴ (lb·in·s²) | Magnetic Brake Static Friction Torque N·m (lb·in) | Approx Mass kg (lb) |
|---|---|---|---|---|---|---|---|---|
| 02AE2OB | 228 (8.976) | 198 (7.795) | 137 (5.394) | 72.5 (2.854) | MSB/ 90-10 | 0.016 (0.0144×10⁻⁴) | 0.98 (8.680) | 2.2 (4.9) |
| 03AE2OB | 241 (9.488) | 211 (8.307) | 150 (5.906) | 79 (3.110) | MSB / 90-10 | 0.016 (0.0144×10⁻⁴) | 0.98 (8.680) | 3.5 (7.7) |
| 05AE2OB | 263 (10.354) | 233 (9.173) | 172 (6.772) | 101 (3.976) | MSB / 90-20 | 0.016 (0.0144×10⁻⁴) | 1.764 (15.623) | 4.1 (9.0) |

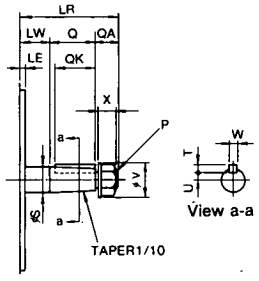
Notes:
1. Drawout construction of Type USASEM-02AE20B is waterproof gland method. Therefore, connector part differs from figure above. For details, request another dimensions to YASKAWA representative.
2. Optical encoder (1500 pulses/rev) is used as a detector.
3. Vibration: 15μm or below.
4. Plug and clamp are not attached for receptacle connection.
5. Power supply for brake is 90VDC.

Taper Shaft

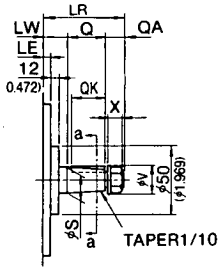
. Types USASEM -08AC1OB, -15AC1OB, -30AC1OB




Types USASEM-08AC1OB, and -30AC1OB




Type USASEM-15AC1OB




Detail of Shaft Extension

| AC SERVOMOTOR Type USASEM- | L | LL | LM | LR | KB1 | KL1 | KL2 | Flange Surface LA | LB | LC | LE | LG | LH | LZ | Shaft Extension LW | Q | QK | QA | X |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 08AC1OB | 305 (12.008) | 247 (9.724) | 146 (5.748) | 58 (2.283) | 115 (4.527) | 170 (6.693) | 150 (5.906) | 130 (5.118) | 110 $^{0}_{-0.035}$ (4.3308 $^{0}_{-0.0013}$) | 120 (4.724) | 3 (0.118) | 10 (0.394) | 155 (6.1) | 9 (0.354) | 18 (0.709) | 28 (1.102) | 25 (0.984) | 12 (0.472) | 10.3 (0.406) |
| 15AC1OB | 377.5 (14.862) | 319.5 (12.578) | 197.5 (7.776) | 58 (2.283) | 166.5 (6.555) | 177 (6.969) | 163 (6.413) | 145 (5.71) | 110 $^{0}_{-0.035}$ (4.3308 $^{0}_{-0.0013}$) | 130 (5.118) | 6 (0.236) | 12 (0.472) | 165 (6.496) | 9 (0.354) | 18 (0.709) | 28 (1.102) | 25 (0.984) | 12 (0.472) | 10.3 (0.406) |
| 30AC1OB | 432 (17.008) | 362 (14.252) | 240 (9.449) | 70 (2.756) | 206 (8.11) | 205 (8.071) | 165 (6.496) | 200 (7.874) | 114.3 $^{0}_{-0.040}$ ( 4.5 $^{0}_{-0.00156}$) | 180 (7.087) | 6 (0.236) | 18 (0.709) | 230 (9.055) | 13.5 (0.531) | 20 (0.788) | 36 (1.417) | 32 (1.259) | 14 (0.551) | 12.5 (0.492) |

| AC SERVOMOTOR Type USASEM- | Shaft Extension S | V | P | U | W | T | Approx Mass kg (lb) | Magnetic Brake Specifications Type | Inertia kg·m²×10⁻⁴ (lb·in·s²) | Static Friction Torque N·m (lb·in) | Voltage VDC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 08AC1OB | 16 (0.63) | 21 (0.827) | M10 P1.25 | 4.3 $^{0}_{-0.1}$ (0.1693 $^{0}_{-0.0039}$) | 5 (0.197) | 5 (0.197) | 7 (15.5) | SCFB / 90-30 | 0.54 (0.4751×10⁻³) | 2.94 (26) | 90 |
| 15AC1OB | 19 (0.748) | 21 (0.827) | M10 P1.25 | 5.8 $^{0}_{-0.1}$ (0.2283 $^{0}_{-0.0039}$) | 5 (0.197) | 5 (0.197) | 12.5 (27.6) | SCFB / 90-60 | 0.67 (0.5949×10⁻³) | 5.88 (52) | 90 |
| 30AC1OB | 22 (0.866) | 24 (0.945) | M12 P1.25 | 6.6 $^{0}_{-0.1}$ (0.2598 $^{0}_{-0.0039}$) | 6 (0.236) | 6 (0.236) | 25.5 (56.2) | SCFB / 90-120 | 0.67 (0.5949×10⁻³) | 11.76 (104) | 90 |

Notes:
1. Optical encoder (2500 pulses/rev) is used as a detector.
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1301 "Sunk keys and Their Corresponding keyways (Close keys)."

| AC SERVOMOTOR Type USASEM- | Connector Types for Motor + Brake Receptacle | L-type Plug | Cable Clamp | Detector Connector Types Receptacle | L-type Plug | Cable Clamp |
|---|---|---|---|---|---|---|
| 03AE2OB, 05AE2OB | MS 3102 A 18 -12 P | MS 3108 B 18 -12 S | MS 3057 -10 A | MS 3102 A 20 -29 P | MS 3108 B 20 -29 S | MS 3057 -12 A |
| 08AC1OB, 15AC1OB, 30AC1OB | MS 3102 A 20 -17 P | MS 3108 B 20 -17 S | MS 3057 -12 A | | | |

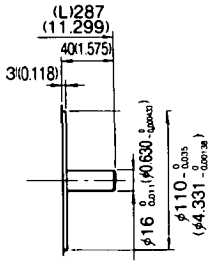


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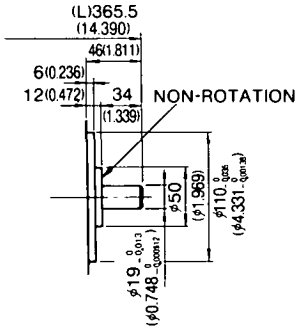
(3) Shaft Extension of Straight Shaft

SERVOMOTOR proper is the same dimensions as standard SERVOMOTOR in S series except for dimension L. See Par. 8.3 (1). Details of shaft extension are shown below:

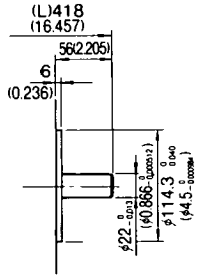
• With brake
Type USASEM-08AC2OB




• With brake
Type USASEM-15AC2OB



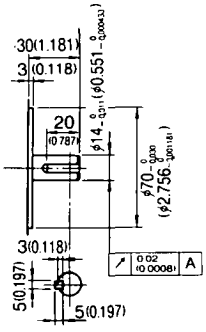

• With brake
Type USASEM-30AC2OB



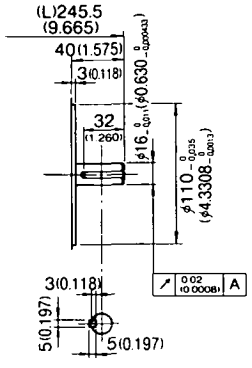

(4) Shaft Extension of Straight Shaft with Keyway

SERVOMOTOR proper is the same dimensions as stanard SERVOMOTOR in S series, but dimensions L of type USASEM-08AC2K[ ] or higher is the different dimensions. See Par. 8.3 (1). Details of shaft extension are shown below.

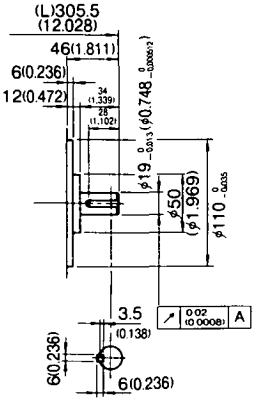
• Types USASEM-03AE2K, -05AE2K*
Types USASEM-03AE2KB, -05AE2KB†



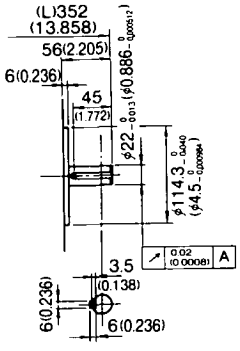

• Type USASEM-08AC2K*
Type USASEM-08AC2KB†




• Type USASEM-15AC2K*
Type USASEM-15AC2KB†




• Type USASEM-30AC2K*
Type USASEM-30AC2KB†




* Without brake
† With brake



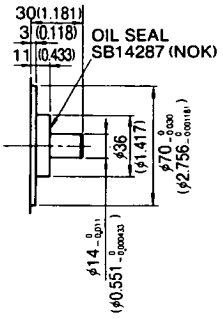
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## 8. 3 SERVOMOTOR: S SERIES (Cont'd)

(5) Shaft Extension of Straight Shaft with Shaft Seal

SERVOMOTOR proper is the same dimensions as standard SERVOMOTOR in S series. See Par. 8.3 (1). Details of shaft extension are shown below:

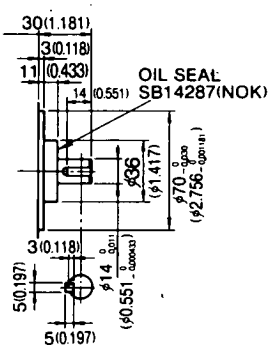
• Without brake
Types USASEM-03AE2S, -05AE2S




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

SERVOMOTOR proper is the same dimensions as standard SERVOMOTOR in S series. See Par. 8.3 (1). Details of shaft extension are shown below:

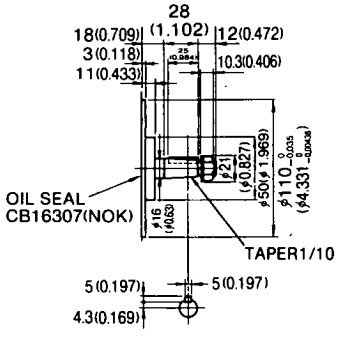
• Without brake
Types USASEM-03AE2T, -05AE2T



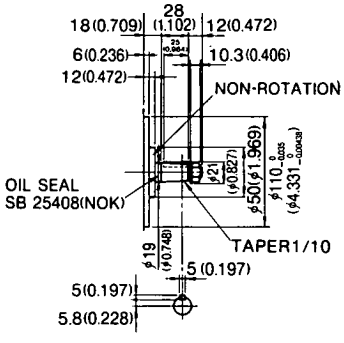

(7) Shaft Extension of Taper Shaft with Shaft Seal

SERVOMOTOR proper is the same dimensions as standard SERVOMOTOR in S series. See Par. 8.3 (1). Details of shaft extension are shown below:

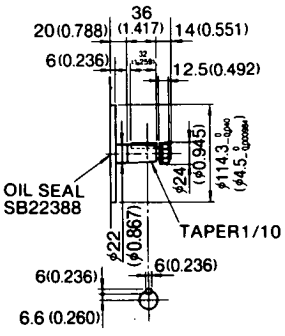
• Without brake
Type USASEM-08AC1S




• Without brake
Type USASEM-15AC1S




• Without brake
Type USASEM-30AC1S

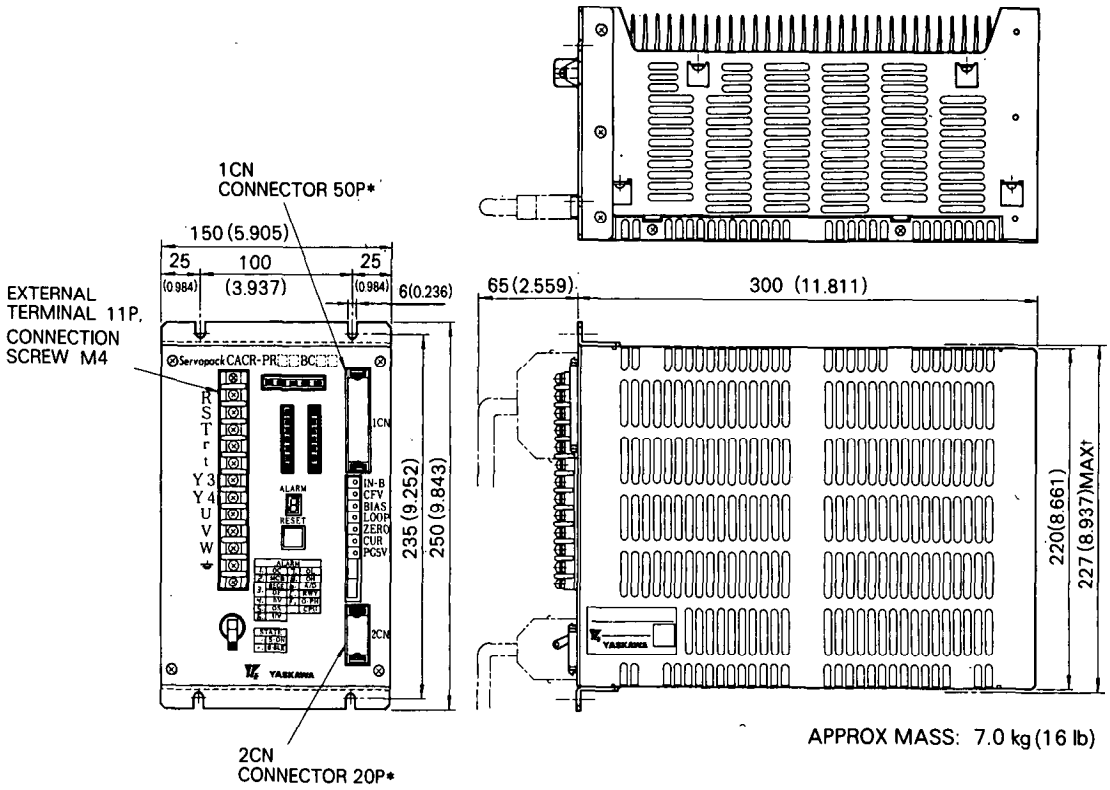





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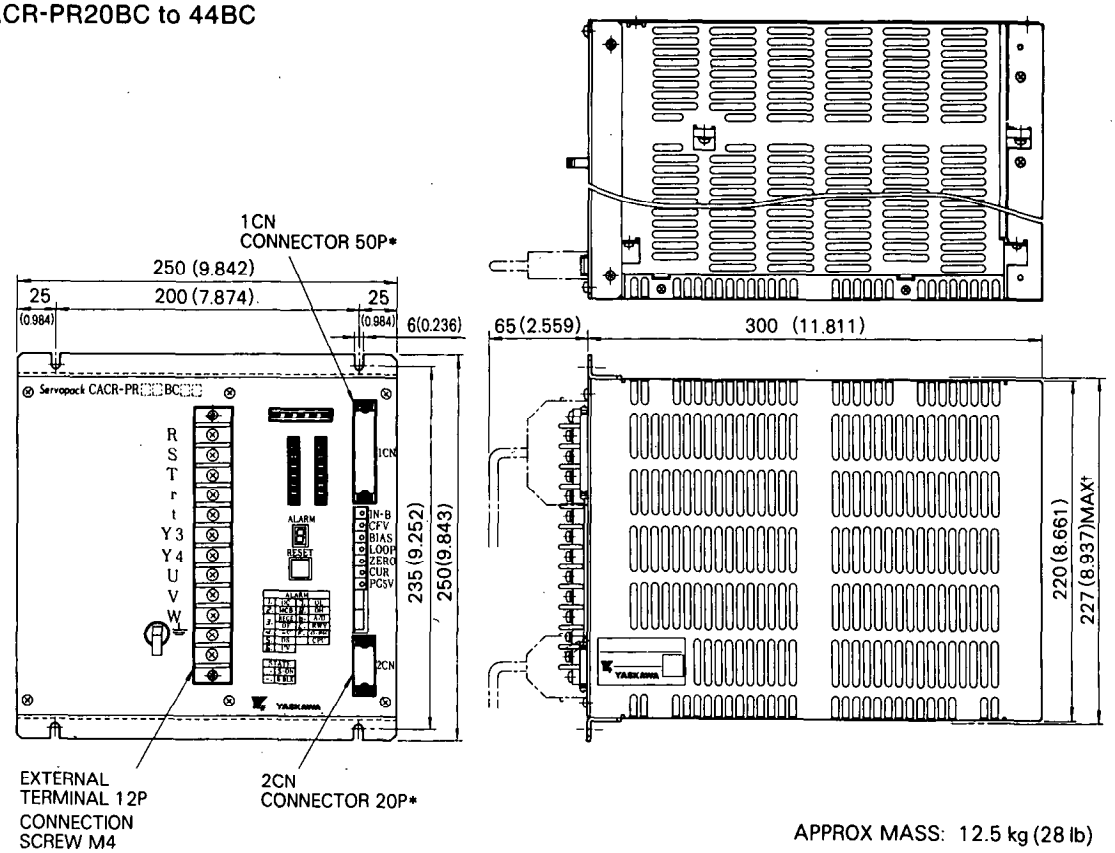
## 8.4 SERVOPACK

### (1) Types CACR-PR03BC to 15BC




APPROX MASS: 7.0 kg (16 lb)

### (2) Types CACR-PR20BC to 44BC




APPROX MASS: 12.5 kg (28 lb)

*Made by Honda Tsushin Co.
†Including mounting flange thickness.

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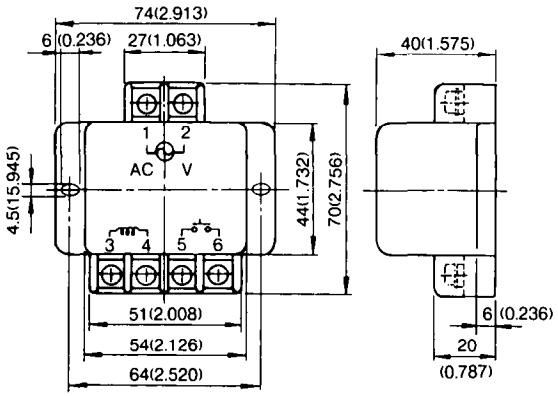
## 8. 5 PERIPHERAL EQUIPMENT

### Power Supply for Brake

According to the motor, select either M/F series or S series.

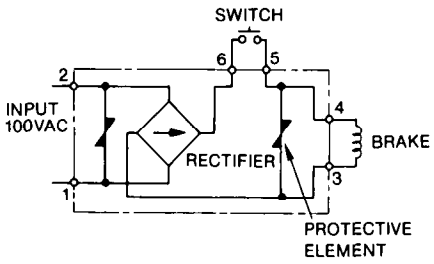
(a) Power supply unit for M and F series

- Input 100 VAC, output 90 VDC (OPR109F)
- Input 200 VAC, output 90 VDC (OPR109A)

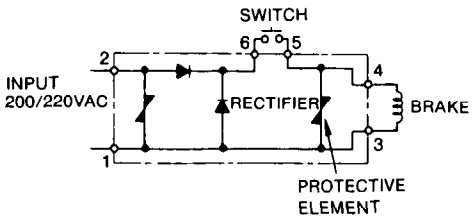



### Circuit Diagram

- Type OPR109F




- Type OPR109A

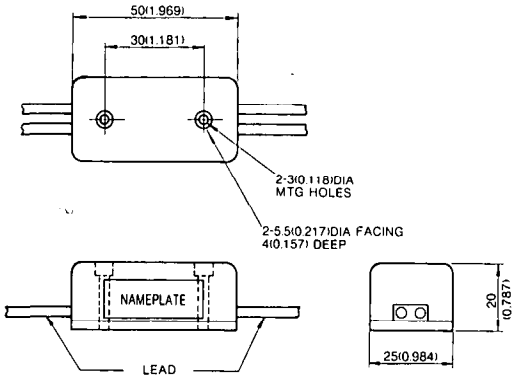



Notes :

1. Do not short between output terminals 3 and 4.
2. Switch (between terminals 5 and 6) conditions are as follows:
   - Contact capacity —— five to ten times as large as rated current.
   - Contact for direct current.
3. Use the fuse on input or output side to protect the power unit.

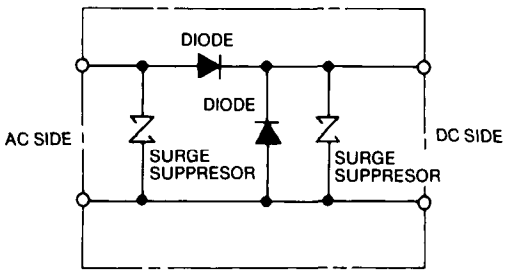
(b) Power supply unit for S series

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




Note: Although opening and closing the brake power supply circuit is possible from either the AC side or DC side, it is usually safer to open and close from the AC side.
Since the brake coil may be damaged due to surge voltage when opened or closed from AC side, always insert a surge suppressor near the brake coil.

### Circuit Diagram






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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 tightened.
- For motors with shaft seals, the seals are not damaged and motor is properly lubricated.

### 9.1.2 SERVOPACK

- Setting switches are correctly set to satisfy the specifications for the applicable SERVOMOTOR and optical encoder.
- Connection and wiring leads are firmly connected to terminals or inserted into the connectors.
- The power supply is turned OFF if servo alarm outputs.
- Voltage supplied to SERVOPACK is 200 to 230V $^{+10}_{-15}$%. If a voltage line other than 200V is used, the voltage should be dropped to 200V through a power transformer.
- The speed reference should be 0 V (speed reference circuit is short-circuited.)

## 9.2 TEST RUN PROCEDURES

### 9.2.1 Preparation for Operation

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

(1) 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 for approximately 1 second.
- When the power is correctly supplied, the following green [LED]s light: [P] and [MP] .
- 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.

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

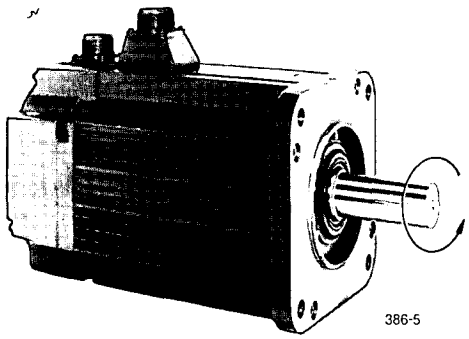



Fig. 9.1 Motor Forward Running

### 9.2.3 Inspection during Test Run

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

- Unusual vibration
- Abnormal noise
- Excessive temperature rise

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

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# 10. ADJUSTMENT

## 10.1 SETTINGS AT THE TIME OF DELIVERY

Table 10.1 Standard Setting Specifications

| Item | | | Standard Specifications |
|---|---|---|---|
| Reference Pulse | | Input Form | Sign + pulse train |
| | | Voltage Level | + 12V |
| Control Signal | $\overline{CL}$ | Effective Logic | Active at L level |
| | | Voltage Level | + 12V |
| | $\overline{INH}$ | Effective Logic | Active at L level |
| | | Voltage Level | + 12V |
| Frequency Dividing | Frequency Dividing (1)* | | 1/2 to 1/6 |
| | Frequency Dividing (2) | | 1/1 |
| | Multiplier Mode | | ×2 |
| D/A Converter Bit Number* | | | 11 and 12 bits |
| Positioning Completion (COIN) | | | ± 7 pulses |

*These data differs from motor series.
Note: Operating speed range is made frequency dividing setting for maximum speed. If the resolution for positioning encoder is required to heighten, change the setting of frequency dividing (1), (2) and multiplier mode.

Table 10.2 3P Switch Setting

| Switch | Standard Setting |
|---|---|
| SL 1 |  |
| SL 2* |  |
| SL10 |  |
| SL20 |  |
| SL30 |  |
| SL40* |  |

*No setting pin



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### 10.1.1 List of Switch Setting

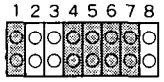
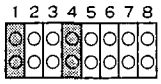
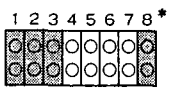
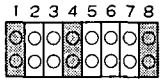
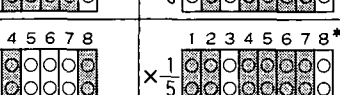
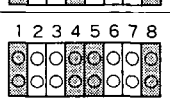
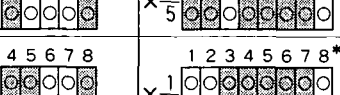
The SERVOPACK has been factory-adjusted as follows:

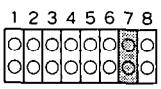
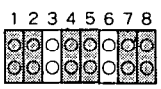
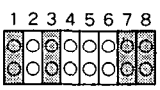
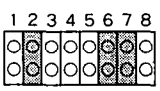
(1) M Series

Table 10.3 Standard Adjustment and Setting Specifications

| SERVOPACK Type CACR- | Applicable SERVOMOTOR | | | SERVOPACK Adjustment | | |
|---|---|---|---|---|---|---|
| | Type USAMED- | Optical Encoder pulses/rev | Rated Current A | Max Output Current A | Speed Setting | Resolution for Positioning Encoder |
| PR03 | 03MA1 | 6000 | 3.0 | 7.3 | 2000 r/min at 66.7 kpps reference pulses | 2000 pulses/rev |
| PR07 | 06MA1 | | 5.8 | 13.9 | | |
| PR10 | 09MA2 | | 7.6 | 16.6 | | |
| PR15 BC3AM | 12MA2 | | 11.7 | 28.0 | | |
| PR20 | 20MA2 | | 18.8 | 42.0 | | |
| PR30 | 30MA2 | | 26.0 | 56.5 | | |
| PR44 | 44MA2 | | 33.0 | 70.0 | | |
| PR03 | 03MB1 | 5000 | 3.0 | 7.3 | | |
| PR07 | 06MB1 | | 5.8 | 13.9 | | |
| PR10 | 09MB2 | | 7.6 | 16.6 | | |
| PR15 BC3BM | 12MB2 | | 11.7 | 28.0 | | |
| PR20 | 20MB2 | | 18.8 | 42.0 | | |
| PR30 | 30MB2 | | 26.0 | 56.5 | | |
| PR44 | 44MB2 | | 33.0 | 70.0 | | |
| PR03 | 03MD2 | 4000 | 3.0 | 7.3 | | |
| PR07 | 06MD2 | | 5.8 | 13.9 | | |
| PR10 | 09MD2 | | 7.6 | 16.6 | | |
| PR15 BC3DM | 12MD2 | | 11.7 | 28.0 | | |
| PR20 | 20MD2 | | 18.8 | 42.0 | | |
| PR30 | 30MD2 | | 26.0 | 56.5 | | |
| PR44 | 44MD2 | | 33.0 | 70.0 | | |

Table 10.4 Standard Factory-adjusted Switch Positions

| SERVOPACK Type CACR- | Optical Encoder(PG) pulses/rev | SW1 Motor Type, Combined PG Setting | SW2 Frequency Dividing(1) Setting | SW3 Speed Loop Condition Setting | SW4 Motor Characteristics, Servopack Function Setting |
|---|---|---|---|---|---|
| PR03BC3AM to PR44BC3AM | 6000 |  |  |  |  |
| PR03BC3BM to PR44BC3BM | 5000 |  |  | | |
| PR03BC3DM to PR44BC3DM | 4000 |  |  | | |

| SERVOPACK Type CACR- | Optical Encoder(PG) pulses/rev | SW10 Number of D/A Bit, COIN Setting† | SW20 Reference Pulse Input From Setting | SW30 Multiplier Mode Setting† | SW40 Effective Logic Setting of Control Signal† |
|---|---|---|---|---|---|
| PR03BC3□M to PR44BC3□M | 6000 5000 4000 |  |  |  |  |

* Spare plug
† For other functions, see Table 6.19.

Notes: 1. SW100 is spare for setting pin storage.
2. □ is A, B or D.



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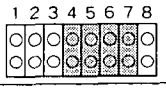
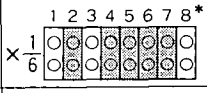
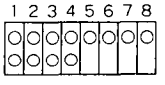
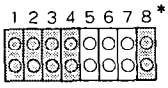
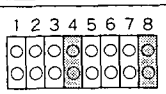
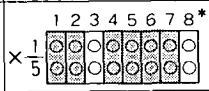
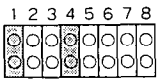
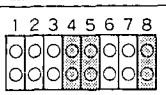
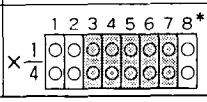
## 10.1.1 List of Switch Setting (Cont'd)

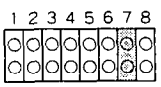
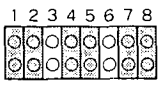
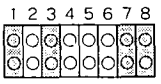
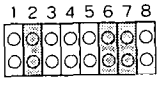
(2) F series

Table 10.5 Standard Adjustment and Setting Specifications

| SERVOPACK Type CACR- | Applicable SERVOMOTOR | | | SERVOPACK Adjustment | | |
|---|---|---|---|---|---|---|
| | Type USAFED- | Optical Encoder pulses/rev | Rated Current A | Max Output Current A | Speed Setting | Resolution for Positioning Encoder |
| PR03 | 02FA1, 03FA1 | 6000 | 3.0 | 8.5 | 2500 r/min at 83.3 kpps reference pulses | 2000 pulses/rev |
| PR05 | 05FA1 | | 3.8 | 11.0 | | |
| PR10 | 09FA1 | | 6.2 | 17.0 | | |
| PR15 BC3AF | 13FA1 | | 9.7 | 27.6 | | |
| PR20 | 20FA1 | | 15.0 | 42.0 | | |
| PR30 | 30FA2 | | 20.0 | 56.5 | | |
| PR44 | 44FA2 | | 30.0 | 77.0 | | |
| PR03 | 02FB1, 03FB1 | 5000 | 3.0 | 8.5 | | |
| PR05 | 05FB1 | | 3.8 | 11.0 | | |
| PR10 | 09FB1 | | 6.2 | 17.0 | | |
| PR15 BC3BF | 13FB2 | | 9.7 | 27.6 | | |
| PR20 | 20FB2 | | 15.0 | 42.0 | | |
| PR30 | 30FB2 | | 20.0 | 56.5 | | |
| PR44 | 44FB2 | | 30.0 | 77.0 | | |
| PR03 | 02FD1, 03FD1 | 4000 | 3.0 | 8.5 | | |
| PR05 | 05FD1 | | 3.8 | 11.0 | | |
| PR10 | 09FD1 | | 6.2 | 17.0 | | |
| PR15 BC3DF | 13FD2 | | 9.7 | 27.6 | | |
| PR20 | 20FD2 | | 15.0 | 42.0 | | |
| PR30 | 30FD2 | | 20.0 | 56.5 | | |
| PR44 | 44FD2 | | 30.0 | 77.0 | | |

Table 10.6 Standard Factory-adjusted Switch Positions

| SERVOPACK Type CACR- | Optical Encoder(PG) pulses/rev | SW1 Motor Type, Combined PG Setting | SW2 Frequency Dividing(1) Setting | SW3 Speed Loop Condition Setting | SW4 Motor Characteristics, Servopack Function Setting |
|---|---|---|---|---|---|
| PR03BC3AF to PR44BC3AF | 6000 |  |  |  |  |
| PR03BC3BF to PR44BC3BF | 5000 |  |  |  | |
| PR03BC3DF to PR44BC3DF | 4000 |  |  | | |

| SERVOPACK Type CACR- | Optical Encoder(PG) pulses/rev | SW10 Number of D/A Bit, COIN Setting† | SW20 Reference Pulse Input Form Setting† | SW30 Multiplier Mode Setting† | SW40 Effective Logic Setting of Control Signal† |
|---|---|---|---|---|---|
| PR03BC3□F to PR44BC3□F | 6000 5000 4000 |  |  |  |  |

*Spare plug
† For other functions, see Table 6.19.

Notes: 1. SW100 is spare for setting pin storage.
2. □ is A, B or D.



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(3) S series

Table 10.7 Standard Adjustment and Setting Specifications

| SERVOPACK Type CACR- | Applicable SERVOMOTOR | | | SERVOPACK Adjustment | | |
|---|---|---|---|---|---|---|
| | Type USASEM- | Optical Encoder pulses/rev | Rated Current A | Max Output Current A | Speed Setting | Resolution for Positioning Encoder |
| PR03BC3CS-Y41 | 02AC2 | 2500 | 2.1 | 6.0 | 4000 r/min at 66.7 kpps reference pulses | 1000 pulses/rev |
| PR03 | 03AC2 | | 3.0 | 8.5 | | |
| PR05 | 05AC2 | | 4.2 | 11.0 | | |
| PR10 BC3CS | 08AC1 | | 5.3 | 15.6 | | |
| PR15 | 15AC1 | | 10.4 | 28.0 | | |
| PR30 | 30AC1 | | 19.9 | 56.5 | | |
| PR03BC3ES-Y41 | 02AE2 | 1500 | 2.1 | 6.0 | | |
| PR03 | 03AE2 | | 3.0 | 8.5 | | |
| PR05 | 05AE2 | | 4.2 | 11.0 | | |
| PR10 BC3ES | 08AE1 | | 5.3 | 15.6 | | |
| PR15 | 15AE1 | | 10.4 | 28.0 | | |
| PR30 | 30AE1 | | 19.9 | 56.5 | | |
| PR03BC3FS-Y41 | 02AF2 | 1000 | 2.1 | 6.0 | | |
| PR03 | 03AF2 | | 3.0 | 8.5 | | |
| PR05 | 05AF2 | | 4.2 | 11.0 | | |
| PR10 BC3FS | 08AF1 | | 5.3 | 15.6 | | |
| PR15 | 15AF1 | | 10.4 | 28.0 | | |
| PR30 | 30AF1 | | 19.9 | 56.5 | | |

Table 10.8 Standard Factory-adjusted Switch Positions

| SERVOPACK Type CPCR- | Optical Encoder (PG) pulses/rev | SW1 Motor Type, Combined PG Setting | SW2 Frequency Dividing(1) Setting | SW3 Speed Loop Condition Setting | SW4 Motor Characteristics, Servopack Function Setting |
|---|---|---|---|---|---|
| PR03BC3CS to PR30BC3CS | 2500 | 1 2 3 4 5 6 7 8 | ×1/5 1 2 3 4 5 6 7 8* | PR03BC PR05BC PR10BC 1 2 3 4 5 6 7 8 | 1 2 3 4 5 6 7 8* |
| PR03BC3ES to PR30BC3ES | 1500 | 1 2 3 4 5 6 7 8 | ×1/3 1 2 3 4 5 6 7 8* | PR15BC PR30BC 1 2 3 4 5 6 7 8 | |
| PR03BC3FS to PR30BC3FS | 1000 | 1 2 3 4 5 6 7 8 | ×1/2 1 2 3 4 5 6 7 8* | | |

| SERVOPACK Type CPCR- | Optical Encoder (PG) pulses/rev | SW10 Number of D/A Bit, COIN Setting† | SW20 Reference Pulse Input Form Setting | SW30 Multiplier Mode Setting† | SW40 Effective Logic Setting of Control Signal† |
|---|---|---|---|---|---|
| PR03BC3□S to PR30BC3□S | 2500 1500 1000 | 1 2 3 4 5 6 7 8 | 1 2 3 4 5 6 7 8 | 1 2 3 4 5 6 7 8 | 1 2 3 4 5 6 7 8 |

*Spare plug
† For other functions, see Table 6.19.

Notes : 1. SW100 is spare for setting pin storage.
2. □ is C, E or F.


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### 10.1.2 Potentiometer Setting

The factory-adiusted potentiometer positions on the panel is shown in Table 10.9. For potentiometer adjustment method, see Table 10.23.

Table 10.9 Standard Factory-adjusted Potemtiometer Positions

| Series | SERVOPACK Type CACR- | Position Loop Gain Adjustment | Speed Amplifier Zero Adjustment | Starting Current Adjustment | Speed Loop Gain Adjustment | Speed Reference Bias Compensation | Speed Reference Feed Foward Compensation | Voltage Adjustment of PG + 5V Power |
|---|---|---|---|---|---|---|---|---|
| | | IN-B VR1 | ZERO VR3 | CUR VR5 | LOOP VR6 | BIAS VR15 | CFV VR16 | PG5V VR21 |
| M | PR03BC3□M to PR44BC3□F | 0 to 5/10 | 5/10 | 10/10 | 2 to 5/10 | 0/10 | 0/10 | + 5.25V |
| F | PR05BC3□F to PR44BC3□F | | | | | | | |
| S | PR03BC3□S to PR30BC3□S | | | | 0 to 4/10 | | | |

Notes:

1. In the Table above, □/□ shows approximate scale of potentiometer.
   For example,  indicates 7/10 scale.
2. The potentiometers other than listed in the Table above are provided for the SERVOPACK. Do not tamper with these potentiometers except for a special case as they have been preset at the factory.



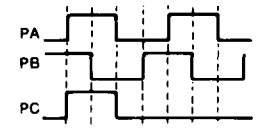
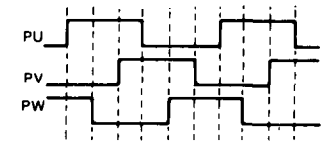
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## 10.2 LIST OF CHECK TERMINALS AND POTENTIOMETER

Table 10.10 lists check terminals and functions. For check terminals on the SERVOPACK panel.

Table 10.11 lists potentiometer inside SERVOPACK. These potentiometers have been adjusted at the factory. (Potentiometers should not be tampered with.)

Table 10.10 List of Cheak Terminals

| Equipment Symbol | | Signal Name | Description | | |
|---|---|---|---|---|---|
| TM1 | 1 | PA | PG input signals | Phase A pulse is input. | PA and PB are two-phase with 90° phase difference. PC occurs once for each motor rotation, in synchronization with PA. Waveform at motor forward rotation   |
| | 2 | *PA | | Reverse pulse of phase A is input. | |
| | 3 | PB | | Phase B pulse is input. | |
| | 4 | *PB | | Reverse pulse of phase B is input. | |
| | 5 | PC | | Phase C pulse is input. | |
| | 6 | *PC | | Reverse pulse of phase C is input. | |
| | 7 | — | Unused | | |
| | 8 | PG5V | PG supply voltage +5V | | |
| TM2 | 1 | PU | Phase U pulse is input from pole sensor. | | Waveform at motor forward rotation   |
| | 2 | *PU | Reverse pulse of phase U is input. | | |
| | 3 | PV | Phase V pulse is input from pole sensor. | | |
| | 4 | *PV | Reverse pulse of phase V is input. | | |
| | 5 | PW | Phase W pulse is input from pole sensor. | | |
| | 6 | *PW | Reverse pulse of phase W is input. | | |
| | 7 | DIR | Monitors the setting of direction of motor rotation. | | |
| | 8 | PG0V | 0V of the PG power supply (PG : common terminal to signals from the pole sensor) | | |
| TM3 | 1 | OC | Overcurrent detection signal output | | |
| | 2 | — | Unused | | |
| | 3 | VTG | Monitors the motor speed ±4.0VDC/1000r/min. (M, F Series), ±2.0VDC/1000r/min(S Series). | | |
| | 4 | T-Mon | Monitors the reference toque ±3.0VDC/100% | | |
| | 5 | T-Ref | Torque reference ±2.0 to ±3.0VDC/100% | | |
| | 6 | U-sin | Monitors phase U sin wavefom. | | VOLTAGE + − 0V • Frequency varies depending on speed. • Amplitude varies depending on torque. |
| | 7 | V-sin | Monitors phase V sin waveform. | | |
| | 8 | — | Unused | | |
| TM4 | 1 | IU | Phase U current monitor. | | Type CACR-SR: 03 / 05 / 07 / 10 / 15 / 20 / 30 / 44 — Monitor Voltage (V/A): 0.4 / 0.24 / 0.20 / 0.16 / 0.08 / 0.04 |
| | 2 | IV | Phase V current monitor. | | |
| | 3 | ACON | Main power ON signal. | | 330 TO 350μs TRIANGLE PULSE +7.0 TO +8.0V −7.0 TO −8.0V |
| | 4 | AU | Phase U current amplification output monitor. | | |
| | 5 | AV | Phase V current amplification output monitor. | | |
| | 6 | AW | Phase W current amplification output monitor. | | |
| | 7 | OSC2 | Carrier frequency (triangle pulse) | | |
| | 8 | SG | Signal 0V | | |
| TM10 | 1 | D/A | Error counter D/A converter output | | |
| | 2 | BIAS | Speed reference bias compensation | | |
| | 3 | PH-A | Frequency dividing(1) output | PG-A phase pulse | Frequency dividing(2) output: PULSE signal |
| | 4 | PH-B | | PG-B phase pulse | SIGN signal |
| | 5 | T4 | Clock Signal | LSI for error counter | |
| | 6 | T24 | | LSI for frequency dividing(2) | |
| | 7 | S-ON | Servo-ON signal (Servo ON at L) | | |
| | 8 | SG | Signal 0V | | |
| CH1 | | OV | Signal 0V (analog signal level 0V) | | |

Notes:
1. For check terminals on SERVOPACK panel, see Table 6. 24.
2. The check terminals allow oscilloscope connection for measurement.
3. During measurement, do not short the adjacent two check terminals, as the connected elements may be destroyed by this.
4. TM5 check terminal is for use only by the manufacturer. Do not make any measurement with it.



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## 10.3 ADJUSTMENT PROCEDURES

Fig. 10.1 shows waveforms at the respective check teminals. Table 10.12 shows gain adjustment method of SERVOPACK.

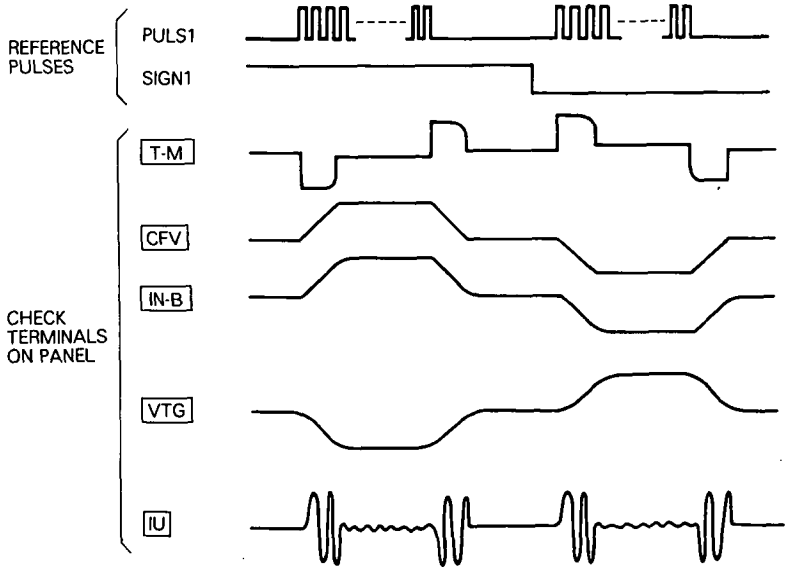
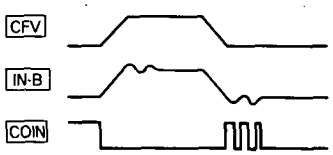
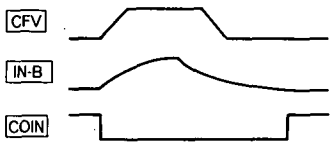
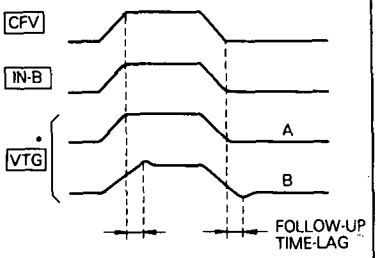



Fig. 10.1 Check Terminal Waveform at Normal

Table 10.12 Servo Gain Adjustment (at Potentiometer on the panel)

| Item | How to Adjust | Remarks |
|---|---|---|
| Overshoot occurs.<br> | • Turn IN–B CCW to decrease the position loop gain.<br>• Turn LOOP CW to increase the gain. | • Adjust the gain gradually.<br>• If IN–B or LOOP gain is too high, motor vibrates. |
| Follow-up response is bad.<br> | • Turn IN–B CW to increase the position loop gain. | • If the variable range of IN–B is small, change the D/A converter bit. For example, where the D/A converter bit is changed from 10 bits to 9 bits, gain becomes two times. |
| To short the positioning time further<br><br>*Monitor by inverting the polarity. | • Apply the feedfoward compensation using CFV .<br>Note: If the follow-up time-lag of VTG is too large, feed forward compensation is ineffective.<br>• Apply the bias compensation using BIAS. | • If CFV and BIAS is not functioning effectively, perform as following:<br>• Set the setting pin of SW10-⑧ to ON.<br>• Turn IN–B CCW to decrease the gain, and set the setting pin of SW10-⑦ to OFF.<br>Readjust the gain using IN–B |



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# 11. INSPECTION AND MAINTENANCE

## 11.1 AC SERVOMOTOR

The AC SERVOMOTOR has no movable 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 should become necessary, contact your YASKAWA representative.

Table 11.1 Inspection Schedule for Motors

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

## 11.2 SERVOPACK

The SERVOPACK is of contactless construction 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**

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

Table 12.1 Troubleshooting Guide for AC SERVOMOTOR

| Trouble | Cause | Corrective Actions |
|---|---|---|
| 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 wiring. |
| | Overload | Reduce load or use a larger motor. |
| | Motor defective | Measure voltage across motor terminals U, V, and W with a tester. When correct, replace motor. |
| Unstable operation | Wrong wiring | Inspect and correct wiring across motor terminals U, V, and W, and PG. |
| Motor overheats. | Excessive ambient temperature. | Reduce below 40 °C. |
| | Motor dirty | Clean motor surface. |
| | Overload | Reduce load or use a larger motor. |
| Unusual noise | Motor loosely mounted | Tighten foundation bolts. |
| | Motor misaligned | Realign with driven machine. |
| | Coupling out of balance | Balance coupling. |
| | Noisy bearings | Check alignment, loading of bearing, lubrication and contact your YASKAWA representative. |
| | Vibration of driven machine | Contact the machine manufacturer. |



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## 12. 2 SERVOPACK

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

Table 12. 2 LED Indication for Troubleshooting

| LED | Detection | Lighting Condition | Probable Cause | Corrective Actions |
|---|---|---|---|---|
| 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. | • 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 starts or slows down. | • Incomplete (1 PWB) VR8 adjustment. | — |
| 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 the wiring leads and joints in the SERVOPACK. |
| 3. | Regenerative trouble, Overflow | 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.<br>• Goes ON when reference pulse is input. | • Defective regenerative transistor. | • Replace the SERVOPACK. |
| | | | • Regenerative resistor disconnection.<br>• Motor vibrates at lock status.<br>• Overload<br>• Servo gain is too low. | • Check and replace the regenerative resistor. (Replace the SERVOPACK)<br>• Ajust the Servo gain.<br>• Check the wiring.<br>• Slowing up or down. |
| 4. | Over-voltage | Goes ON when the motor starts or slows down. | • Load inertia $J_L$(GD²) 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 frequency.<br>• Correct the setting of PG frequency dividing. |
| 6. | Voltage drop | Goes ON when power is supplied to the main circuit. | • Defective main circuit thyristor–diode module. | • Replace the SERVOPACK. |
| 7. | Overload | Goes ON when power is supplied to the control circuit. | • Defective control circuit board (1 PWB). | • Replace the SERVOPACK. |
| | | Goes ON during operation.<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). |
| A. | Heat sink overheat | Goes ON during operation.<br>• When power to the control circuit is turned OFF and then turned ON again, 7. or A. goes ON again. When reset later, the operation starts. | • Fan has stopped. | • Check the fan. (SR20, 30, 44, 60) |
| | | | • Temperature around the Servopack exceeds 55°C. | • Decrease the temperature below 55°C (The heat sink may be overheated.) |
| | | The motor rotates, but the torque is unavailabe. 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. |



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## 12.2.1 LED Indication (7-segment) for Troubleshooting (Cont'd)

Table 12.2 LED Indication for Troubleshooting (Cont'd)

| LED | Detection | Lighting Condition | Probable Cause | Corrective Actions |
|---|---|---|---|---|
| b. | A/D error | Goes ON when power is supplied to the control circuit. | • Defective control circuit board (1PWB). | • Replace the SERVOPACK. |
| □ | CPU error | Goes ON during operation. | • Faulty internal elements. | • Resume after reset operation. |
| | | | • Defective internal elements. | • Replace the SERVOPACK. |
| F. | Open phase | 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. | • Poor connection to 3-phase power supply. | • Check and correct the connection. |
| C. | Overrun prevention | Goes ON when power is supplied to the control circuit. | • Defective control circuit board (1 PWB). | • Replace the SERVOPACK. |
| | | The motor starts momentarily, then C goes ON. | • Motor connection error. | • Correct the motor connection. |
| | | | • Optical encoder connection error. | • Check and correct pulses in phases A, B, C, U, V and W with 2CN. |

## 12.2.2 Examples of Troubleshooting for Defective Wiring or Parts

Table 12.3 Example of Troubleshooting for Defective Wiring or Parts

| Trouble | Check Items | Corrective Actions |
|---|---|---|
| MCCB trips immediately after Power On and Servo On. | • Main circuit wiring (such as motor grounding) | • Correct the wiring. |
| The reference is input, but the motor does not run. | • Voltage across Ⓡ, Ⓢ, and Ⓣ.<br>• LED P and MP ON | • Check the AC power supply circuit. |
| | • Trouble LED OFF | • If LEDs are on, check the cause. |
| | • Reference pulse<br>• Clear signal, alarm release signal input. | • Check the wiring of reference input. |

## 12.2.3 Examples of Troubleshooting for Incomplete Adjustment

Table 12.4 Examples of Troubleshooting for Incomplete Adjustment

| Trouble | Cause | Corrective Actions |
|---|---|---|
| • Motor vibrates when the power supply is turned on or when the motor is running. | • Speed loop gain or position loop gain is too high. | • Turn LOOP or IN–B CCW to decrease the gain. |
| • Overshoot is too large at motor starting and stopping. | • Starting or stopping current is saturating.<br>• Position loop gain is too high. | • Turn IN–B CCW.<br>• Apply the reference pulse slowed up or down. |
| • Alarm by overflow occurs. | • Position loop gain is too low.<br>• Load is large. | • Turn IN–B CW.<br>• Apply the reference pulse slowed up or down. |



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NOTES



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# AC SERVO DRIVES

## M, F, S SERIES FOR POSITIONING CONTROL.

## SERVOMOTOR TYPES : USAMED, USAFED, USASEM (With Incremental Encoder)

## SERVOPACK TYPE : CACR-PR□BC (Rack-mounted Type)

**TOKYO OFFICE** Ohtemachi Bldg, 1-6-1 Ohtemachi, Chiyoda-ku, Tokyo, 100 Japan
Phone (03) 3284-9111 Telex YASKAWA J33530 Fax (03) 3284-9034
**SEOUL OFFICE** Seoul Center Bldg, 91-1, So Kong-Dong, Chung-ku, Seoul, Korea
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