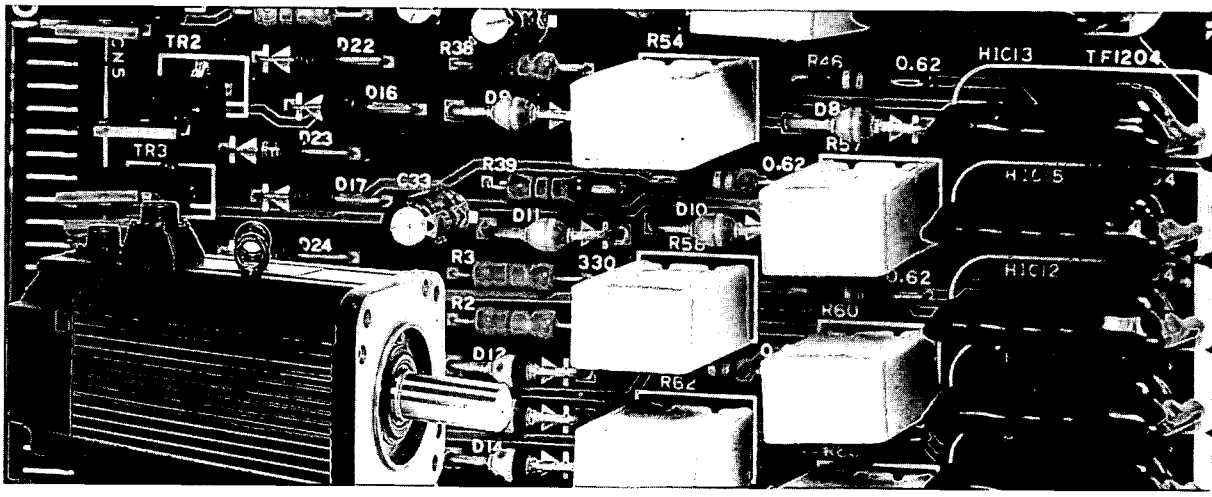
AC SERVO DRIVE M•F•S•D SERIES
BULLETIN

WITH INCREMENTAL ENCODER, FOR SPEED CONTROL

SERVOMOTOR TYPES USAM□D, USAFED, USASEM, USADED
SERVOPACK TYPES CACR-SR□BB1□



YASKAWA

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

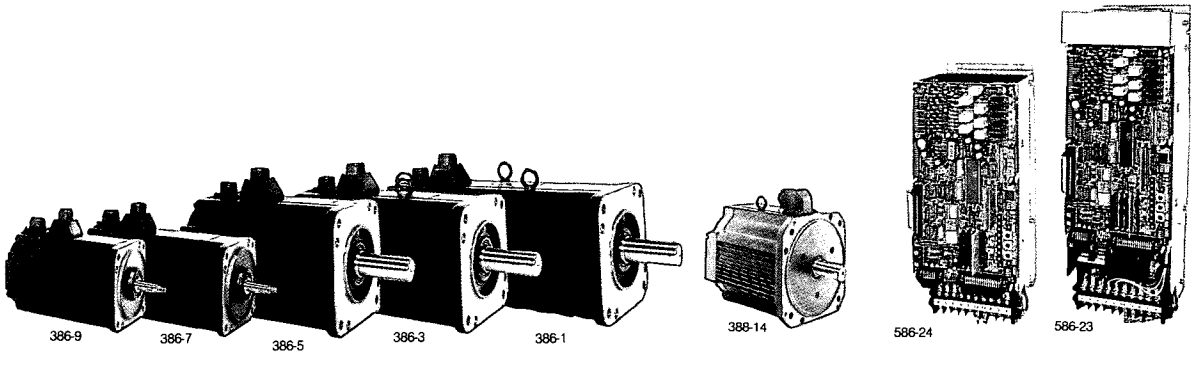
This manual covers AC servo drives M, F, S and D series for speed control. The AC Servo Drives consist primarily of AC SERVOMOTORS and their controllers, SERVOPACKS. The AC SERVOMOTOR features a high power rating for achieving quick response. Custom LSI and hybrid ICs built in SERVOPACK reduce the unit size and simplify wiring. The additional feature of a highly accurate pluse resolution offers non-stop pulse flow.

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

- High accuracy and quick response forspeed control
- Compact design and high reliability
- Light weight and high power
- Highly reliable protective functions
- Selectable drive to meet users' requirements

General Precautions

- Some drawings in this manual are shown with the protective cover or shields removed, in order to describe the detail with more clarity. Make sure all covers and shields are replaced before operating this product.
- This manual may be modified when necessary because of improvement of the product, modification, or changes in specifications.
  Such modification is made as a revision by renewing the manual No.
- To order a copy of this manual, if your copy has been damaged or lost, contact your YASKAWA representative listed on the last page stating the manual No. on the front cover.
- YASKAWA is not responsible for accidents or damages due to any modification of the product made by the user since that will void our guarantee.



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

NOTES FOR SAFE OPERATION

Read this manual thoroughly before installation, operation, maintenance or inspection of the AC Servo Drives. In this manual, the NOTES FOR SAFE OPERATION are classified as "WARNING" or "CAUTION".

⚠WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious personal injury.

⚠ CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate personal injury and/or damage to the equipment.

In some instances, items described in ⚠ CAUTION may also result in a serious accident. In either case, follow these important items.

⚠ WARNING

(WIRING)

- **Grounding must be in accordance with the national code and consistent with sound local practices.**
  Failure to observe this warning may lead to electric shock or fire.

(OPERATION)

- **Never touch any rotating motor parts during operation.**
  Failure to observe this warning may result in personal injury.

(INSPECTION AND MAINTENANCE)

- **Be sure to turn OFF power before inspection or maintenance.**
  Otherwise, electric shock may result.
- **Never open the panel cover while power is ON, and never turn ON power when the panel cover is open.**
  Otherwise, electric shock may result.
- **After turning OFF power, wait at least five minutes before servicing the product.**
  Otherwise, residual electric charges may result in electric shock.

⚠ CAUTION

(RECEIVING)

- **Use the specified combination of SERVOMOTOR and SERVOPACK.**
  Failure to observe this caution may lead to fire or failure.

(INSTALLATION)

- **Never use the equipment where it may be exposed to splashes of water, corrosive or flammable gases, or near flammable materials.**
  Failure to observe this caution may lead to electric shock or fire.

(WIRING)

- **Do not connect three-phase power supply to output terminals Ⓤ Ⓥ and Ⓦ.**
  Failure to observe this caution may lead to personal injury or fire.
- **Securely tighten screws on the power supply and motor output terminals.**
  Failure to observe this caution can result in a fire.

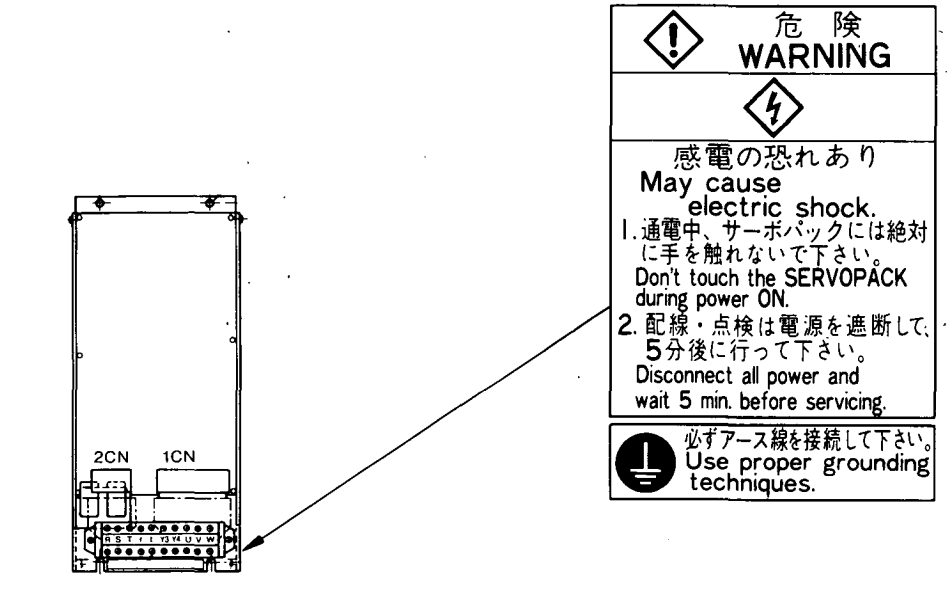
⚠ CAUTION

(OPERATION)

- **To avoid inadvertent accidents, run the SERVOMOTOR only in test run (without load).**
  Failure to observe this caution may result in personal injury.
- **Before starting operation with a load connected, set up parameters suitable for the machine.**
  Starting operation without setting up parameters may lead to overrun failure.
- **Before starting operation with a load connected, make sure emergency-stop procedures are in place.**
  Failure to observe this caution may result in personal injury.
- **During operation, do not touch the heat sink.**
  Failure to observe this caution may result in burns.

(INSPECTION AND MAINTENANCE)

- **Do not disassemble the SERVOMOTOR.**
  Failure to observe this caution may result in electric shock or personal injury.
- **Never change wiring while power is ON.**
  Failure to observe this caution may result in electric shock or personal injury.



Warning Label and Grounding Mark on SERVOPACK

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1. RATINGS AND SPECIFICATIONS

1.1 RATINGS AND SPECIFICATIONS OF 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: totally-enclosed, externally fan-cooled for type USAMKD-60MA2 (Equivalent to IP-65 exclusive shaft opening)

Ambient Temperature: 0 to +40°C

Storage Temperature: -20 to +60°C

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

Vibration: 15 μm or below

Finish in Munsell Notation: N1.5

Excitation: Permanent magnet

Mounting: Flange mounted

Drive Method: Direct drive

Table 1.1 Ratings and Specifications of M Series AC SERVOMOTORS

Item \ Motor Type USAM□D-		03□□1	06□□1	09B□2	12B□2	20B□2	30B□2	44B□2	60B□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 (4.0)	4.4 (5.9)	6.0 (8.0)
Rated Torque*	N·m (lb·in)	2.84 (25)	5.68 (50)	8.62 (76)	11.5 (102)	19.1 (169)	28.4 (252)	41.9 (372)	57.2 (507)
Continuous Max Torque*	N·m (lb·in)	2.94 (26)	5.88 (52)	8.82 (78)	11.8 (104)	21.6 (191)	32.3 (286)	46.1 (408)	62.9 (557)
Instantaneous Peak Torque*	N·m (lb·in)	7.17 (63)	14.1 (125)	19.3 (171)	28.0 (248)	44.0 (390)	63.7 (564)	91.1 (807)	106 (938)
Rated Current*	A	3.0	5.8	7.6	11.7	18.8	26	33	45
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)	1.16 (10.2)	1.33 (11.8)	1.33 (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)	58 (51.3)	110 (97.2)	143 (126.7)	240 (212.6)	240 (212.6)
Power Rate*	kW/s	6.0	13.3	20.3	22.7	33.2	57.0	74.0	138
Inertia Time Constant	ms	12.8	6.3	4.4	6.0	5.2	3.5	3.6	3.6
Inductive Time Constant	ms	2.7	5.1	6.5	10.4	12.9	15.3	16.2	16.2
Insulation		Class F							

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

Notes:

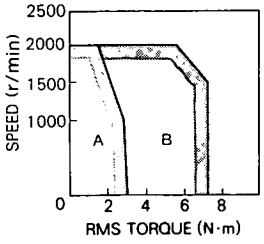
1. □□ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows:
   - Standard: A (6000 pulses/rev)
   - Optional: B (5000 pulses/rev), D (4000 pulses/rev)

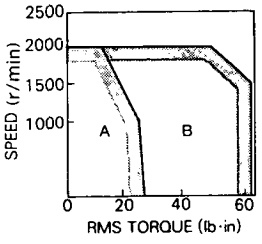
2. The power supply unit for brake has two types:
   - Type LPDE-1H01 B9400876-2: Input 100VAC, Output 90VDC
   - Type LPSE-2H01 B9400876-1: Input 200VAC, Output 90VDC

For details, see Par. 8.6 (3) on page 61.

1.1.2 Torque-Speed Characteristics

• TYPE USAMED-03□





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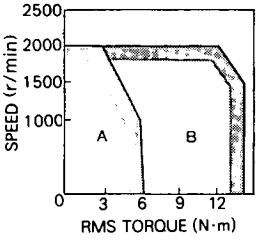

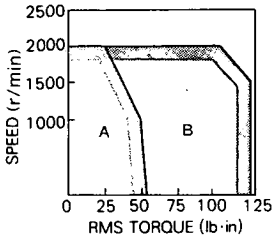

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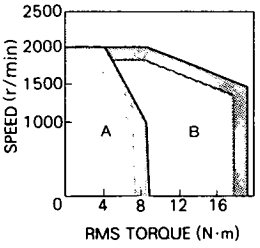

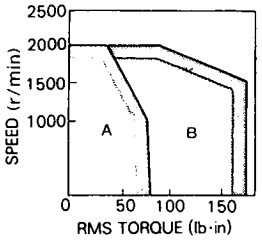

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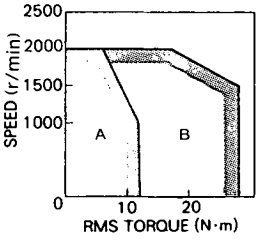

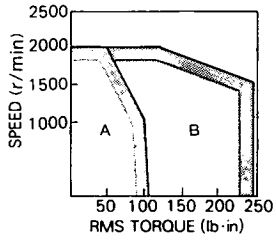

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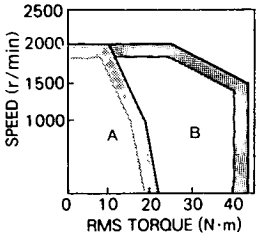

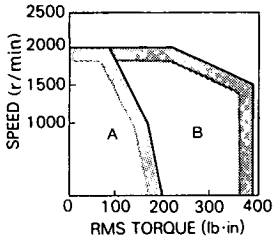

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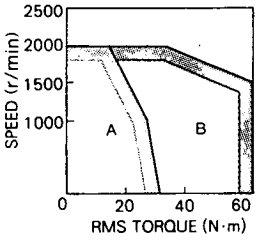

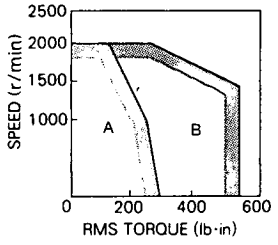

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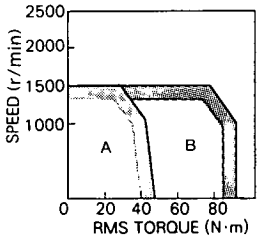
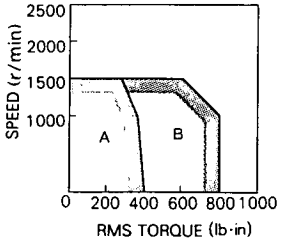
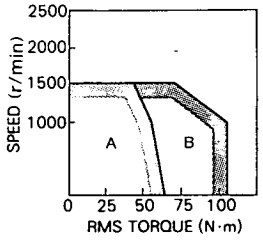
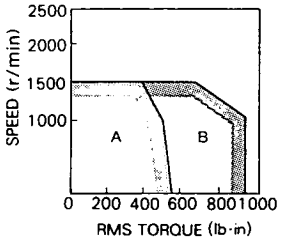




• TYPE USAMKD-60B





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

1.2 RATINGS AND SPECIFICATIONS OF 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-65 exclusive shaft opening)
Ambient Temperature: 0 to +40°C
Storage Temperature: -20 to +60°C
Ambient Humidity: 20% to 80% (non-condensing)
Vibration: 15 μm or below
Finish in Munsell Notation: N1.5
Excitation: Permanent magnet
Mounting: Flange mounted
Drive Method: Direct drive

Table 1.2 Ratings and Specifications of F Series AC SERVOMOTORS

Item \ Motor Type USAFED-		02□□1	03□□1	05□□1	09□□1	13C□2	20C□2	30C□2	44C□2
Rated Output*	kW (HP)	0.15 (0.2)	0.3 (0.4)	0.45 (0.6)	0.85 (1.1)	1.3 (1.7)	1.8 (2.4)	2.9 (3.9)	4.4 (5.9)
Rated Torque*	N·m (lb·in)	0.98 (8.7)	1.96 (17)	2.84 (25)	5.39 (48)	8.34 (74)	11.5 (102)	18.6 (165)	28.4 (252)
Continuous Max Torque*	N·m (lb·in)	1.08 (10)	2.16 (19)	2.94 (26)	5.88 (52)	8.83 (78)	11.8 (104)	22.6 (200)	37.3 (330)
Instantaneous Peak Torque*	N·m (lb·in)	2.91 (26)	5.83 (52)	8.92 (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)	0.72 (6.3)	0.80 (7.1)	0.92 (8.2)	0.92 (8.2)	0.82 (7.3)	0.98 (8.7)	1.02 (9.0)
Moment of Inertia $J_M(=GD^2/4)$	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	1.30 (1.2)	2.06 (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	22.7	31.5	57.0
Inertia Time Constant	ms	3.9	2.5	10.9	6.0	4.4	5.9	5.2	3.7
Inductive Time Constant	ms	3.4	4.3	3.2	5.2	6.1	10.4	13.0	15.2
Insulation		Class F							

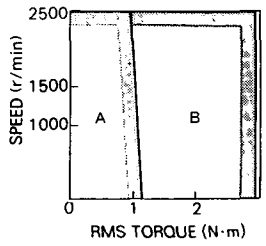
*Values when SERVOMOTOR is combined with SERVOPACK and the armature winding temperature is 20°C. Shown above are normal (TYP) values.

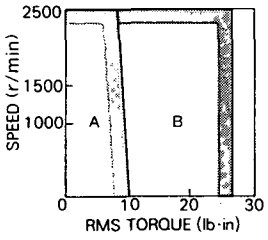
Notes:
1. □□□ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows:
   •Standard: A (6000 pulses/rev)
   •Optional: B (5000 pulses/rev), D (4000 pulses/rev)
2. The power supply unit for brake has two types:
   •Type LPDE-1H01 B9400876-2: Input 100VAC, Output 90VDC
   •Type LPSE-2H01 B9400876-1: Input 200VAC, Output 90VDC

For details, see Par. 8.6 (3) on page 61.

1.2.2 Torque-Speed Characteristics

• TYPE USAFED-02□





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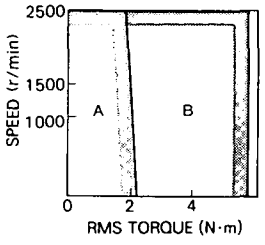

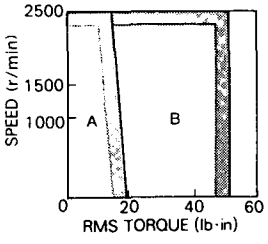

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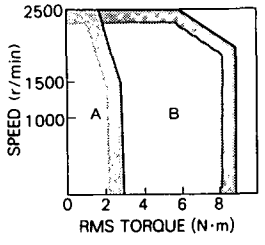

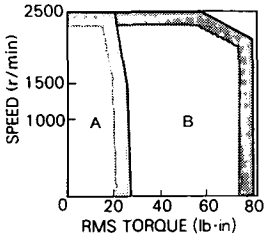

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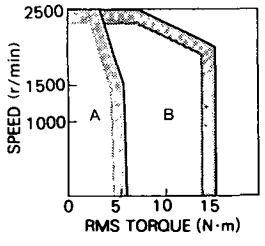

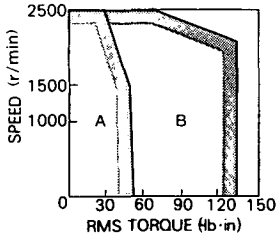

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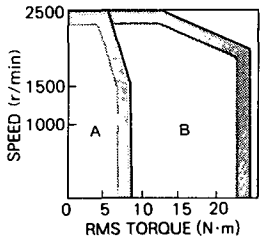

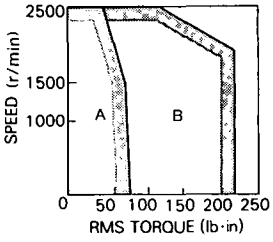

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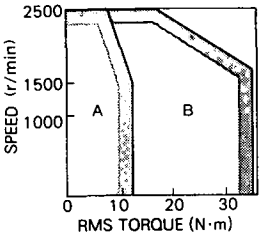

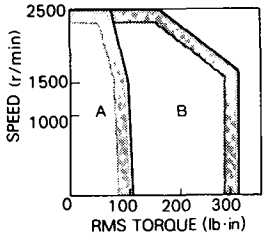

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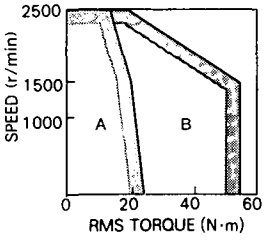
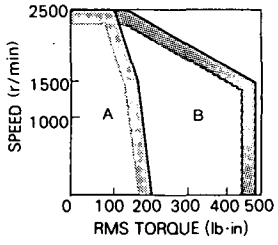
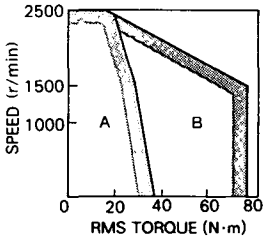
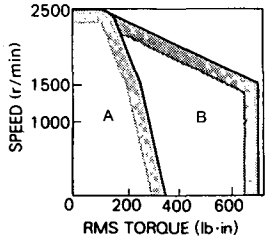




• TYPE USAFED-44C





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

1.3 RATINGS AND SPECIFICATIONS OF S SERIES AC SERVOMOTORS

1.3.1 Ratings

Time Rating: Continuous

Insulation: Class B (Types USASEM-02A□2, -05A□2)
Class F (Types USASEM-08A□2, -15A□2, -30A□1)

Isolation Voltage: 1500 VAC, one minute

Insulation Resistance: 500 VDC, 10MΩ or more

Enclosure: Totally-enclosed, self-cooled
(Equivalent to IP-44 exclusive shaft opening)

Ambient Temperature: 0 to +40°C

Storage Temperature: -20 to +60°C

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

Vibration: 15 μm or below

Finish in Munsell Notation: N1.5

Excitation: Permanent magnet

Mounting: Flange mounted

Drive Method: Direct drive

Table 1.3 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*	kW (HP)	0.15 (0.2)	0.31 (0.4)	0.46 (0.6)	0.77 (1.0)	1.54 (2.1)	3.08 (4.1)
Rated Torque*	N·m (lb·in)	0.49 (4.3)	0.98 (8.7)	1.47 (13)	2.45 (22)	4.90 (43)	9.81 (87)
Continuous Max Torque*	N·m (lb·in)	0.57 (5.0)	1.18 (10)	1.67 (15)	3.33 (30)	6.18 (55)	12.2 (108)
Instantaneous Peak 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)	0.25 (2.19)	0.35 (3.10)	0.37 (3.28)	0.51 (4.49)	0.50 (4.43)	0.53 (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)	3.25 (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
Insulation		Class B			Class F		

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

† 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:

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

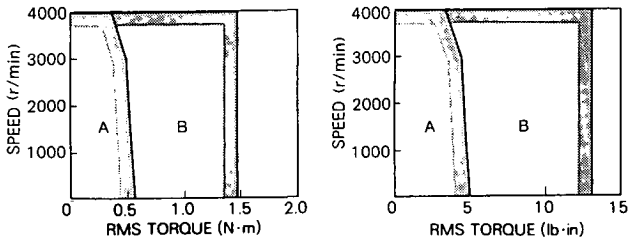
2. *The power supply unit for brake has two types:*

- Type LPDE-1H01 B9400876-2: Input 100VAC, Output 90VDC
- Type LPSE-2H01 B9400876-1: Input 200VAC, Output 90VDC

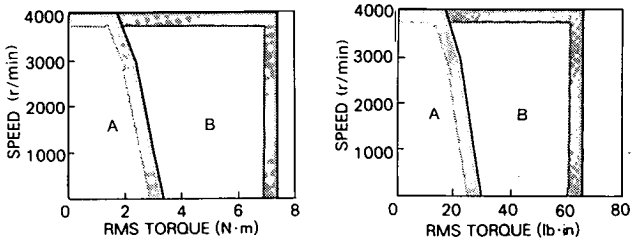
For details, see Par. 8.6 (3) on page 61.

1.3.2 Torque-Speed Characteristics

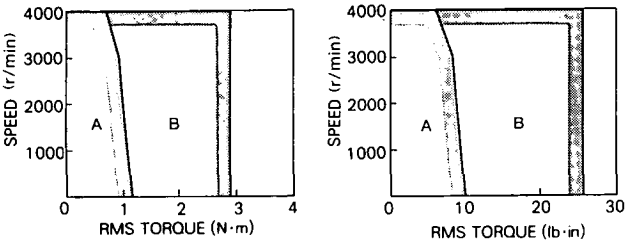
• TYPE USASEM-02A



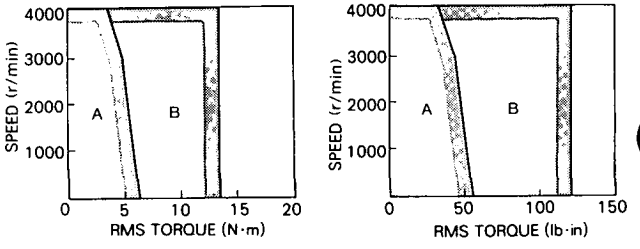
• TYPE USASEM-08A



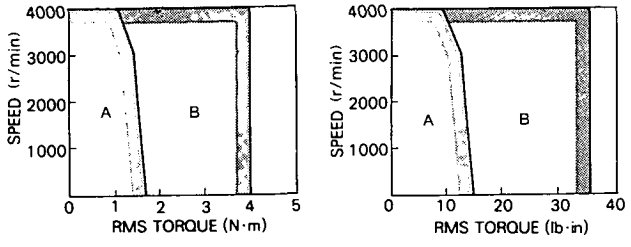
• TYPE USASEM-03A



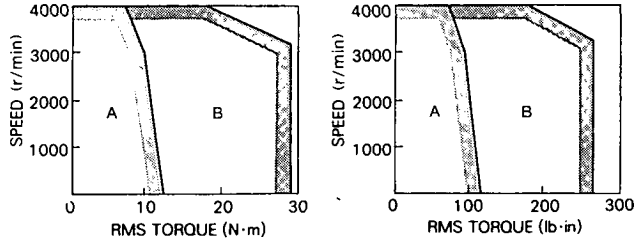
• TYPE USASEM-15A



• TYPE USASEM-05A



• TYPE USASEM-30A



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

1. 4 RATINGS AND SPECIFICATIONS OF D SERIES AC SERVOMOTORS

1. 4. 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-65 exclusive shaft opening)

Ambinent Temperature: 0 to +40 C

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

Storage Temperature: -20 to +60°C

Vibration: 15 μm or below

Finish in Munsell Notation: N1.5

Excitation: Permanent magnet

Mounting: Flange mounted

Drive Method: Direct drive

Holding Brake Provided

Table 1.4 Ratings and Specifications of D Series AC SERVOMOTORS

Item \ Motor Type USADED-			05E□2	10E□2	15□2	22E□2	37E□2
Rated Output*		kW (HP)	0.5 (0.67)	1.0 (1.3)	1.5 (2.0)	2.2 (2.9)	3.7 (5.0)
Rated Torque*		N·m (lb·in)	2.35 (21)	4.81 (43)	7.16 (63)	10.5 (93)	17.7 (156)
Continuous Max Torque*		N·m (lb·in)	3.43 (30)	6.37 (56)	8.83 (78)	13.7 (122)	21.6 (191)
Instantaneous Peak Torque*		N·m (lb·in)	8.24 (73)	16.9 (149)	25.1 (222)	36.8 (326)	61.8 (547)
Rated Current*		A	3.5	7.9	12.6	16.6	23.3
Rated Speed*		r/min	2000				
Instantaneous Peak Speed*		r/min	2500				
Torque Constant		N·m/A (lb·in/A)	0.83 (7.38)	0.69 (6.07)	0.64 (5.64)	0.71 (6.25)	0.82 (7.29)
Moment of Inertia J_M(=GD²/4)		kg·m²×10⁻⁴ (lb·in·s²×10⁻³)	21, 13† (18.6, 11.5†)	32, 24† (28.3, 21.2†)	62, 59† (54.9, 52.2†)	83, 80† (73.5, 70.8†)	148,145† (131, 128.3†)
Power Rate*		kW/s	2.7 4.4†	7.3 9.7†	8.2 8.6†	13 14†	21 22†
Inertia Time Constant		ms	18 11†	7.8 5.9†	7.1 6.8†	6.2 6.0†	4.3 4.2†
Inductive Time Constant		ms	4.4	6.9	9.4	11	15
Insulation			Class F				
Holding Brake	Power Supply	VDC	90				
	Static Friction Torque	N·m(lb·in)	8.82 (78)		21.56 (191)		
Approx. Mass		kg (lb)	17, 16† (37.5, 35.3†)	19, 18† (41.9, 39.7†)	30, 27† (66.2, 59.5†)	32, 29† (70.6, 64†)	39, 36† (86.0, 79.4†)

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

†Values when holding brake is not provided.

Notes:

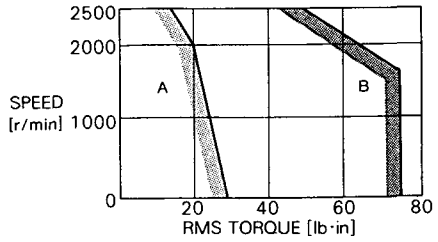
1. □ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows:
   - •Standard: A (6000 pulses/rev)
   - •Optional: B (5000 pulses/rev), D (4000 pulses/rev)

2. The power supply unit for brake has two types:
   - •Type LPDE-1H01 B9400876-2: Input 100VAC, Output 90VDC
   - •Type LPSE-2H01 B9400876-1: Input 200VAC, Output 90VDC

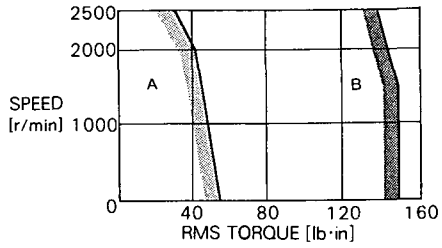
For details, see Par. 8.6 (3) on page 61.

1.4.2 Torque-Speed Characteristics

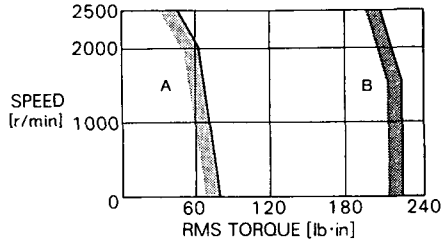
• USADED-05E



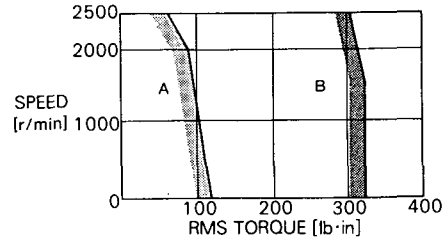
• USADED-10E



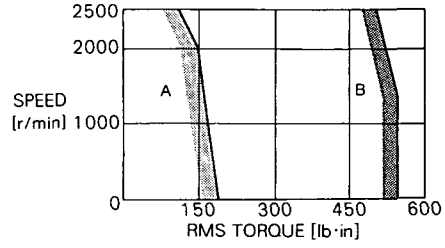
• USADED-15E



• USADED-22E

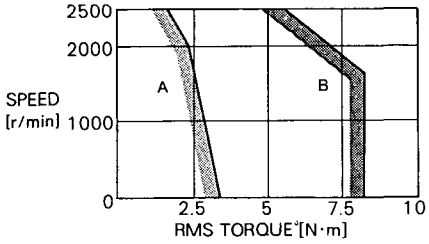


• USADED-37E

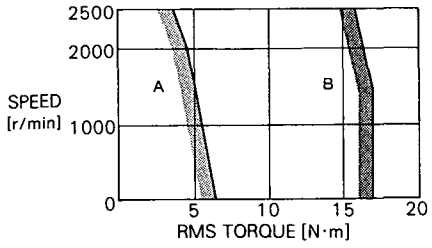


A: Continuous Duty Zone
B: Intermittent Duty Zone

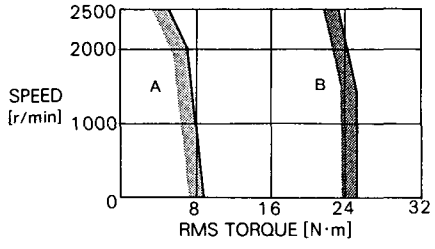
• USADED-05E



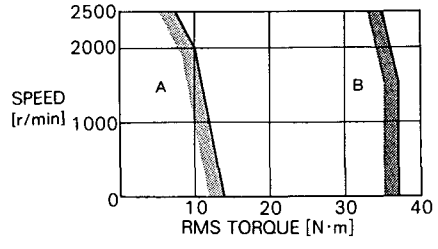
• USADED-10E



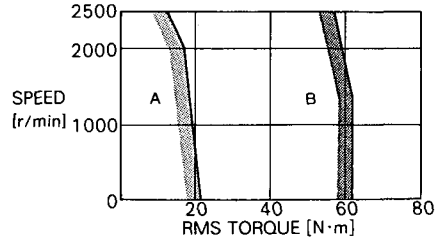
• USADED-15E



USADED-22E



• USADED-37E



A: Continuous Duty Zone
B: Intermittent Duty Zone

1.5 RATINGS AND SPECIFICATIONS OF SERVOPACK

Table 1.5 Ratings and Specifications of SERVOPACK

SERVOPACK Type CACR-				SR03BB	SR05BB	SR07BB	SR10BB	SR15BB	SR20BB	SR30BB	SR44BB	SR60BB
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)	6.0 (8.2)
SERVOMOTOR	M Series	Applicable Optical Encoder		A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev)								
		AC SERVOMOTOR	Type USAMED-	03□□□1	–	06□□□1	09B□□2	12B□□2	20B□□2	30B□□2	44B□□2	60B□□2*1
			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 (4.0)	4.4 (5.9)	6.0 (8.0)
			Rated Speed r/min	1000								
		SERVOPACK Type CACR-		SR03BB1AM	–	SR07BB1AM	SR10BB1AM	SR15BB1AM	SR20BB1AM	SR30BB1AM	SR44BB1AM	SR60BB1AM
		Continuous Output Current	Arms	3.0	–	5.8	7.6	11.7	18.8	26.0	33.0	45.0
		Max Output Current	Arms	7.3	–	13.9	16.6	28.0	42.0	56.5	70.0	80.6
		Allowable Load Inertia J_L	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	67.5 (60)	–	121.5 (107.5)	183.5 (162.5)	334 (296)	550 (486)	715 (633.5)	1200 (1063)	1200 (1063)
	F Series	Applicable Optical Encoder		A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev)								
		AC SERVOMOTOR	Type USAFED-	02□□1	03□□1	05□□1	–	09□□1	13C□2	20C□2	30C□2	44C□2	–
			Output kW (HP)	0.15 (0.2)	0.3 (0.4)	0.45 (0.6)	–	0.85 (1.1)	1.3 (1.7)	1.8 (2.4)	2.9 (3.9)	4.4 (5.9)	–
			Rated Speed r/min	1500								
		SERVOPACK Type CACR-		SR03BB1AF		SR05BB1AF	–	SR10BB1AF	SR15BB1AF	SR20BB1AF	SR30BB1AF	SR44BB1AF	–
		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 Load Inertia J_L	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	6.5 (5.75)	10 (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/rev (E: 1500 pulses/rev, F: 1000 pulses/rev)								
		AC SERVOMOTOR	Type USASEM-	02A□2	03A□2	05A□2	–	08A□1	15A□1	–	30A□1	–	–
			Output kW (HP)	0.15 (0.2)	0.3 (0.4)	0.46 (0.6)	–	0.77 (1.0)	1.54 (2.1)	–	3.08 (4.1)	–	–
			Rated Speed r/min	3000								
		SERVOPACK Type CACR-		SR03BB1ES-Y41	SR03BB1ES	SR05BB1ES	–	SR10BB1CS	SR15BB1CS	–	SR30BB1CS	–	–
		Continuous Output Current	Arms	2.1	3.0	4.2	–	5.3	10.4	–	19.9	–	–
		Max Output Current	Arms	6.0	8.5	11.0	–	15.6	28.0	–	56.5	–	–
		Allowable Load Inertia J_L	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	0.65 (0.55)	2.55 (2.25)	3.75 (3.35)	–	14.25 (12.65)	16.5 (14.4)	–	28.7 (25.45)	–	–
	D Series	Applicable Optical Encoder		A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev)								
		AC SERVOMOTOR	Type USADED-	–	05E□2	–	–	10E□2	15E□2	22E□2	37E□2	–
			Output kW (HP)	–	0.5 (0.67)	–	–	1.0 (1.34)	1.5 (2.0)	2.2 (2.9)	3.7 (5.0)	–
			Rated Speed r/min	–	2000							
		SERVOPACK Type CACR-		–	SR05BB1AD	–	–	SR15BB1AD	SR20BB1AD	SR30BB1AD	SR44BB1AD	–
		Continuous Output Current	Arms	–	3.5	–	–	7.9	12.6	16.6	23.3	–
		Max Output Current	Arms	–	10.6	–	–	25.2	40.7	54.0	76.7	–
		Allowable Load Inertia J_L	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	–	26.25 (22.75)	–	–	40 (35.75)	77.5 (68.38)	103.75 (92.25)	188.75 (163.75)	–

Table 1.5 Ratings and Specifications of SERVOPACK (Cont'd)

			SERVOPACK Type CACR-	SR03BB	SR05BB	SR07BB	SR10BB	SR15BB	SR20BB	SR30BB	SR44BB	SR60BB
SERVOPACK	Basic Specifications	Power Supply *1	Main Circuit	Three-phase 200 to 230 VAC $^{+10\%}_{-15\%}$, 50/60 Hz *2								
			Control Circuit	Single-phase 200 to 230 VAC $^{+10\%}_{-15\%}$, 50/60Hz								
		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 *3								
		Storage Temperature		−20°C to +85°C								
		Ambient and Storage Humidity		90% or less (non-condensing)								
		Vibration/Shock Resistance		0.5/2G								
		Mounting Structure		Base mounted								
		Approx Mass	kg (lb)	5.5 (13)	5.5 (13)	5.5 (13)	5.5 (13)	5.5 (13)	9.5 (21)	9.5 (21)	11 (24)	13 (29)
	Speed Control	Speed Control Range *4		1 : 3000								
		Speed *5 Regulation	Load Regulation 0 to 100%	+0.03% or less at rated r/min, ±0.015% or less at 1/3000 rated r/min								
			Voltage Regulation ±10%	+0.1% or less at rated r/min, ±0.05% or less at 1/3000 rated r/min								
			Temp. Regulation 25 ±25°C	+0.5% or less at rated r/min, ±0.2% or less at 1/3000 rated r/min								
		Frequency Response Characteristics		100Hz (at $J_L = J_M$)								
	I/O Signals	Speed Reference Input *6	Rated Reference Voltage	±6VDC at rated r/min (forward run at plus reference)								
			Input Impedance	Approx 12kΩ								
			Circuit Time Constant	Approx 75μs								
		Auxiliary Reference Input †	Reference Voltage	±2 to ±10VDC at rated r/min (forward run at plus reference)								
			Input Impedance	Approx 5 to 7 kΩ								
			Circuit Time Constant	Approx 22 μs								
		Torque Limit Input		±3VDC ±10% at ±100% torque								
		Built-in Reference Power Supply		±12 VDC ±5%, 30mA								
		Input Signal		Servo ON, P drive, F overtravel, R overtravel, external current limit								
		Output Signal		Servo ready, TG ON, current limit, servo alarm, overload, MCCB trip								
		Positioning Signal Output		1/N time (N = 1 to 64) of PG pulses or 2/N time (N = 2 to 64)								
	Built-in Functions	Protective Function		Overvoltage, overload, overcurrent, overspeed, overrun, open phase detection, MCCB trip, heatsink overheat, undervoltage, AD error, regeneration trouble, CPU error								
		Indication		Power supply, reference input, alarm, status indications								
		Dynamic Brake		Built-in (non-contact dynamic brake)								
		Regenerative Resistor		Built-in								Separately installed
		Applicable Load Inertia *7		Up to 5 times motor inertia								
		Monitor Output		Torque monitor: 3.0V ±10% at rated r/min Speed monitor: 4.0V ±5% at 1000r/min (M, F, D series), 2.0V ±5% at 1000r/min (S series)								

*1 AC SERVOMOTOR type USAMKD-60MA due to externally fan-cooled.

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

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

*4 In the speed control range, the lowest speed is defined as the condition in which there is 100% load variation, but not stopped.

*5 Speed regulation is generally defined as follows:

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

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

*6 Used for application at rated reference voltage other than ±6V.

*7 When load inertia JL (load GD^2) exceeds applicable range, be sure to refer to 6.7.2, "Load Inertia."

2. TYPE DESIGNATION

·AC SERVOMOTOR

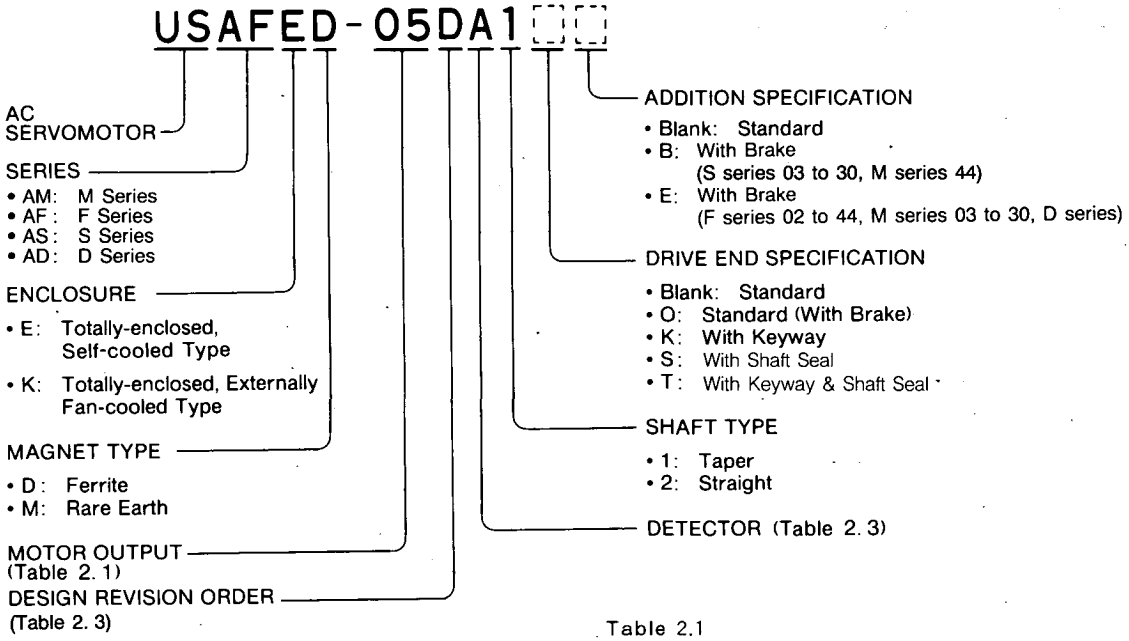


Table 2.1

	Motor Output			
	M Series	F Series	S Series	D Series
02	–	0.15kW (0.2HP)	0.15kW (0.2HP)	–
03	0.3kW (0.4HP)	0.3kW (0.4HP)	0.31kW (0.4HP)	–
05	–	0.45kW (0.6HP)	0.46kW (0.6HP)	0.5kW (0.7HP)
06	0.6kW (0.8HP)	–	–	–
08	–	–	0.77kW (1.1HP)	–
09	0.9kW (1.2HP)	0.85kW (1.2HP)	–	–
10	–	–	–	1.0kW (1.3HP)
12	1.2kW (1.6HP)	–	–	–
13	–	1.3kW (1.7HP)	–	–
15	–	–	1.54kW (2.0HP)	1.5kW (2.0HP)
20	2.0kW (2.7HP)	1.8kW (2.4HP)	–	–
22	–	–	–	2.2kW (2.9HP)
30	3.0kW (4.0HP)	2.9kW (3.9HP)	3.08kW (4.0HP)	–
37	–	–	–	3.7kW (5.0HP)
44	4.4kW (5.9HP)	4.4kW (5.9HP)	–	–
60	6.0kW (8.0HP)	–	–	–

Table 2.2

	Motor Output			
	M Series	F Series	S Series	D Series
02	–	0.15kW (0.2HP)	0.15kW (0.2HP)	–
03	0.3kW (0.4HP)	0.3kW (0.4HP)	0.31kW (0.4HP)	
05	–	0.45kW (0.6HP)	0.46kW (0.6HP)	0.5kW (0.7HP)
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 (1.7HP)	1.54kW (2.0HP)	1.0kW (1.3HP)
20	2.0kW (2.7HP)	1.8kW (2.4HP)	–	1.5kW (2.0HP)
30	3.0kW (4.0HP)	2.9kW (3.9HP)	3.08kW (4.0HP)	2.2kW (2.9HP)
44	4.4kW (5.9HP)	4.4kW (5.9HP)	–	3.7kW (5.0HP)

•SERVOPACK

CACR-SR05BC1AF

SERVOPACK SERIES

CONTROL TYPE
SR: Speed

MOTOR OUTPUT (Table 2.2)

APPLICATION
B: M, F, S Series

DESIGN REVISION ORDER

INPUT FORM
1: 200V, Analog

DETECTOR (Table 2.4)

APPLICABLE MOTOR SERIES
- M: M Series
- F: F Series
- S: S Series
- D: D Series

Table 2.3

Encoder Resolution (P/R)	Series	Type
6000	M	USAMED - 03CA - 06CA - 09BA to - 44BA
	F	USAFED - 02DA to - 09DA - 13CA to - 44CA
	D	USADED - 05EA to - 37EA
5000	M	USAMED - 03CB - 06CB - 09BB to - 44BB
	F	USAFED - 02DB to - 09DB - 13CB to - 44CB
	D	USADED - 05EB to - 37EB
4000	M	USAMED - 03CD - 06CD - 09BD to - 44BD
	F	USAFED - 02DD to - 09DD - 13CD to - 44CD
	D	USADED - 05ED to - 37ED
2500	S	USASEM - 02AC to - 30AC
1500		USASEM - 02AE to - 30AE
1000		USASEM - 02AF to - 30AF

Table 2.4

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
D Series	A	6000	B	5000	D	4000	–

3. LIST OF STANDARD COMBINATION

Table 3.1 Combination of SERVOPACK, AC SERVOMOTOR and Accessories

• M SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	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
SR03BB1□M	USAMED-03□□□1	0.65	5	Good	LF-305	3-phase 200 VAC class, 5 A	Contactor 30A or above
SR07BB1□M	USAMED-06□□□1	1.5	8		LF-310	3-phase 200 VAC class, 10 A	
SR10BB1□M	USAMED-09B□□2	2.1	8		LF-315	3-phase 200 VAC class, 15 A	
SR15BB1□M	USAMED-12B□□2	3.1	10		LF-315	3-phase 200 VAC class, 15 A	
SR20BB1□M	USAMED-20B□□2	4.1	12	Poor	LF-320	3-phase 200 VAC class, 20 A	Contactor 35A or above
SR30BB1□M	USAMED-30B□□2	6.0	18		LF-330	3-phase 200 VAC class, 30 A	
SR44BB1□M	USAMED-44B□□2	8.0	24		LE-340	3-phase 200 VAC class, 40 A	
SR60BB1□M†	USAMKD-60B□□2	11	32		LF-350	3-phase 200 VAC class, 50 A	Contactor 50A or above

• F SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	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
SR03BB1□F	USAFED-02□□□1, -03□□□1	0.65	5	Good	LF-305	3-phase 200 VAC class, 5 A	Contactor 30A or above
SR05BB1□F	USAFED-05□□□1	1.1	5		LF-305	3-phase 200 VAC class, 5 A	
SR10BB1□F	USAFED-09□□□1	2.1	8		LF-315	3-phase 200 VAC class, 15 A	
SR15BB1□F	USAFED-13C□□2	3.1	10		LF-315	3-phase 200 VAC class, 15 A	
SR20BB1□F	USAFED-20C□□2	4.1	12	Poor	LF-320	3-phase 200 VAC class, 20 A	Contactor 35A or above
SR30BB1□F	USAFED-30C□□2	6.0	18		LF-330	3-phase 200 VAC class, 30 A	
SR44BB1□F	USAFED-44C□□2	8.0	24		LF-340	3-phase 200 VAC chass, 40 A	

• S SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	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
SR03BB1□S Y41	USASEM-02A□□2	0.65	5	Good	LF-305	3-phase 200 VAC class, 5 A	Contactor 30A or above
SR03BB1□S	USASEM-03A□□2	0.65	5		LF-305	3-phase 200 VAC class, 5 A	
SR05BB1□S	USASEM-05A□□2	1.1	5		LF-305	3-phase 200 VAC class, 5 A	
SR10BB1□S	USASEM-08A□□1	2.1	8		LF-315	3-phase 200 VAC class, 15 A	
SR15BB1□S	USASEM-15A□□1	3.1	10	Poor	LF-315	3-phase 200 VAC class, 15 A	
SR30BB1□S	USASEM-30A□□1	6.0	18		LF-330	3-phase 200 VAC class, 30 A	Contactor 35A or above

• D SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	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
SR05BB1□D	USADED-05E□□2	1.1	5	Good	LF-305	3-phase 200 VAC class, 5A	Contactor 30A or above
SR15BB1□D	USADED-10E□□2	3.1	10		LF-315	3-phase 200 VAC class, 15A	
SR20BB1□D	USADED-15E□□2	4.1	12	Poor	LF-320	3-phase 200 VAC class, 20 A	Contactor 35A or above
SR30BB1□D	USADED-22E□□2	6.0	18		LF-330	3-phase 200 VAC class, 30 A	
SR44BB1□D	USADED-37E□□2	8.0	24		LF-340	3-phase 200 VAC class, 40 A	

* Values at rated load.
† Made by Tokin Corp.
‡ Regenerative resistor unit is required.

Note: □ in type designation is determined by output pulses (pulses/rev) of optical encoder.

Table 3.2 Specifications of AC SERVOMOTORS Detectors and Holding Brakes

• M SERIES

AC SERVOMOTOR					Detector			
Type	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
USAMED-03[][]	MS3102A 18-10P	MS3108B 18-10S	MS3106B 18-10S	MS3057 -10A	MS3102A 20-29P	MS3108B 20-29S	MS3106B 20-29S	MS3057 -12A
USAMED-06[][]								
USAMED-09B[]								
USAMED-12B[]	MS3102A 22-22P	MS3108B 22-22S	MS3106B 22-22S	MS3057 -12A				
USAMED-20B[]								
USAMED-30B[]								
USAMED-44B[]	MS3102A 32-17P	MS3108B 32-17S	MS3106B 32-17S	MS3057 -20A				
USAMKD-60B[]								
USAFED-02[][]	MS3102A 14S-2P	MS3108B 14S-2S	MS3106B 14S-2S	MS3057 -6A	MS3102A 20-29P	MS3108B 20-29S	MS3106B 20-29S	MS3057 -12A
USAFED-03[][]								
USAFED-05[][]	MS3102A 18-10S	MS3108B 18-10S	MS3106B 18-10S	MS3057 -10A				
USAFED-09[][]								
USAFED-13C[]								
USAFED-20C[]	MS3102A 22-22P	MS3108B 22-22S	MS3106B 22-22S	MS3057 -12A				
USAFED-30C[]								
USAFED-44C[]								
USASEM-02A[]	MS3102A 18-10P	MS3108B 18-10S	MS3106B 18-10S	MS3057 -10A	MS3102A 20-29P	MS3108B 20-29S	MS3106B 20-29S	MS3057 -12A
USASEM-03A[]								
USASEM-05A[]								
USASEM-08A[]	MS3102A 20-4P	MS3108B 20-4S	MS3106B 20-4S	MS3057 -12A				
USASEM-15A[]								
USASEM-30A[]								
USADED-05E[]	MS3102A 20-15P	MS3108B 20-15S	MS3106B 20-15S	MS3057 -12A	MS3102A 20-29P	MS3108B 20-29S	MS3106B 20-29S	MS3057 -12A
USADED-10E[]								
USADED-15E[]	MS3102A 24-10P	MS3108B 24-10S	MS3106B 24-10S	MS3057 -16A				
USADED-22E[]								
USADED-37E[]								

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

Table 3.3 Specifications of Holding Brake

·M SERIES

AC SERVOMOTOR Type	AC SERVOMOTOR + Holding Brake			
	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
USAMED-03□□	MS3102 20-15P	MS3108B 20-15S	MS3106B 20-15S	MS3057-12A
USAMED-06□□				
USAMED-09B□				
USAMED-12B□	MS3102A 24-10P	MS3108B 24-10S	MS3106B 24-10S	MS3057-16A
USAMED-20B□				
USAMED-30B□				
USAMED-44B□	MS3102A 32-17P* MS3102A14S -7P†	MS3108B 32-17S* MS3108B14S -7S†	MS3106B 32-17S* MS3106B14S-7S†	MS3057-20A* MS3057- 6A†
USAMED-60B□	4.4kW+ (FAN)MS3102A14S-6P	MS3108B14S-6S	MS3106B14S-6S	MS3057-6A

* : Motor side
† : Brake side

·F SERIES

USAFED-02□□	MS3102A 14S-6P	MS3108BA 14S-6S	MS3106B 14S-6S	MS3057-6A
USAFED-03□□				
USAFED-05□□	MS3102A 20-15P	MS3108B 20-15S	MS3106B 20-15S	MS3057-12A
USAFED-09□□				
USAFED-13C□				
USAFED-20C□	MS3102A 24-10P	MS3108B 24-10S	MS3106B 24-10S	MS3057-16A
USAFED-30C□				
USAFED-44C□				

·S SERIES

USASEM-02A□	MS3102A 18-12P	MS3108B 18-12S		MS3057-10A
USASEM-03A□				
USASEM-05A□				
USASEM-08A□	MS3102A 20-17P	MS3108B 20-17S		MS3057-12A
USASEM-15A□				
USASEM-30A□				

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℃ and cannot be changed.

NOTE

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

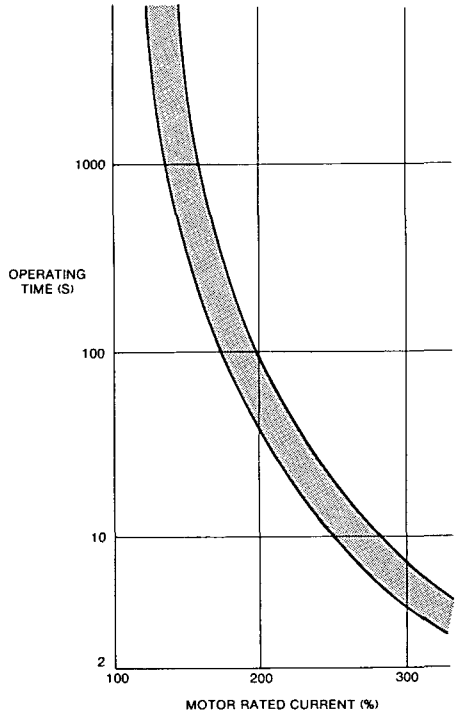


Fig. 4.1 Allowable Overload Curve of SERVOPACK

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 :

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

Stopping Time :

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

Where,

N_R : Rated motor speed (r/min)
J_M $(=GD_M^2/4)$: Motor moment of inertia ($kg \cdot m^2 \times 10^{-4} = lb \cdot in \cdot s^2 \times 10^{-3}$)
J_L $(=GD_L^2/4)$: Load moment of inertia ($kg \cdot m^2 \times 10^{-4} = lb \cdot in \cdot s^2 \times 10^{-3}$)
Kt : Torque constant of motor ($N \cdot m/A = lb \cdot in/A$)
I_R : Motor rated current (A)
$\alpha = I_P / I_R$: Acceleration/deceleration current constant
I_P : Acceleration/deceleration current (Acceleration/deceleration current α times the motor rated current) (A)
$\beta = I_L / I_R$: Load current constant
I_L : Current equivalent to load torque (Load current β times the motor rated current) (A)

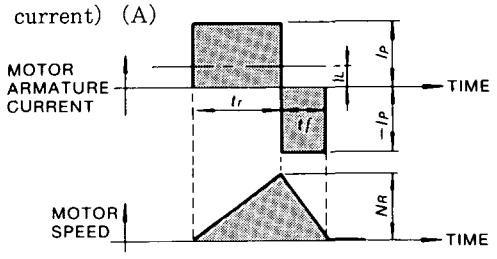


Fig. 4.2 Timing Chart of Motor Armature Current and Speed

4.3 ALLOWABLE FREQUENCY OF OPERATION

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

·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 :

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

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

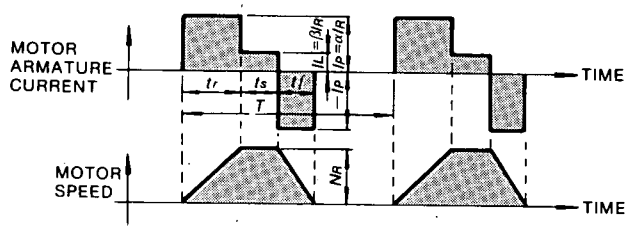


Fig. 4.3 Timing Chart of Motor Armature Current and Speed

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

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 :

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

(times/min)

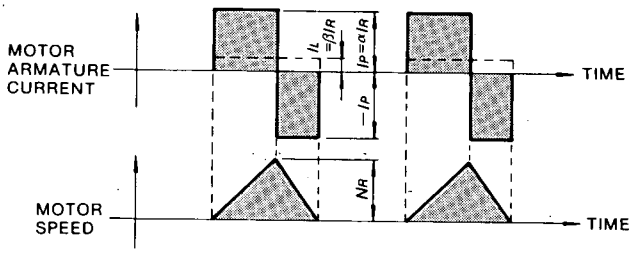


Fig. 4.4 Timing Chart of Motor Armature Current and Speed

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

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 :

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

(times/min)

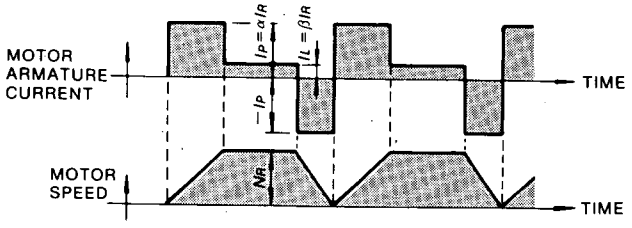


Fig. 4.5 Timing Chart of Motor Armature Current and Speed

4.4 SERVOMOTOR FREQUENCY

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

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

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

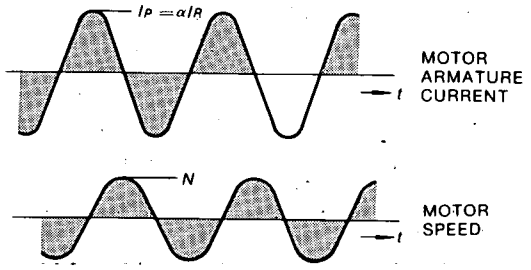


Fig. 4.6 Timing Chart of Motor Armature Current and Speed

4.5 MOTOR SPEED – REFERENCE INPUT CHARACTERISTICS

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

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

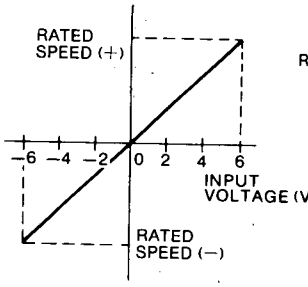


Fig. 4.7 Speed-Input Voltage Characteristics

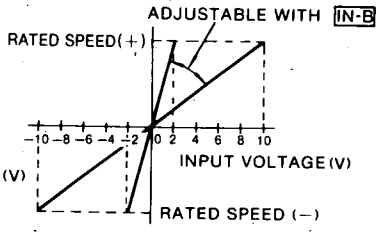


Fig. 4.8 Speed-Input Voltage Characteristics when Auxiliary Input Terminals 1CN-⑭ and ⑮ are used.

4.6 MOTOR MECHANICAL CHARACTERISTICS

4.6.1 Mechanical Strength

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

4.6.2 Allowable Radial Load and Thrust Load

Table 4.1 shows allowable loads according to AC SERVOMOTOR types.

Table 4.1 M Series Allowable Radial Load and Thrust Load

Motor Type USAMED-	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
03□□1	490 (110)	98 (22)†
06□□1	490 (110)	98 (22)†
09B□2	686 (154)	343 (77)
12B□2	1470 (330)	490 (110)
20B□2	1470 (330)	490 (110)
30B□2	1470 (330)	490 (110)
44B□2	1764 (397)	588 (132)
USAMKD-60B□2	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)
02□□1	147 (33)	49 (11)†
03□□1	147 (33)	49 (11)†
05□□1	490 (110)	98 (22)†
09□□1	490 (110)	98 (22)†
13C□2	686 (154)	343 (77)
20C□2	1470 (331)	490 (110)
30C□2	1470 (331)	490 (110)
44C□2	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□2	78.4 (18)	39.2 (9)
03A□2	245 (55)	98 (22)
05A□2	245 (55)	98 (22)
08A□1	392 (88)	147 (33)
15A□1	490 (110)	147 (33)
30A□1	686 (154)	196 (44)

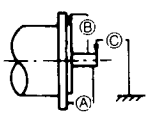
Table 4.4 D Series Allowable Radial Load and Thrust Load

Motor Type USADED-	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
05E□2	686 (154)	343 (77)
10E□2	686 (154)	343 (77)
15E□2	1176 (265)	490 (110)
22E□2	1176 (265)	490 (110)
37E□2	1176 (265)	490 (110)

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

4.6.3 Mechanical Specifications (M, F, S and D Series)

Table 4.5 Mechanical Specifications in mm

Accuracy (T.I.R.)†		Reference Diagram
Flange surface perpendicular to shaft Ⓐ	0.04 (0.06) *	
Flange diameter concentric to shaft Ⓑ	0.04	
Shaft run out Ⓒ	0.02 (0.04) †	

* Accuracy for motor types USADED-15E, -22E, and -37E.
† T.I.R (Total Indicator Reading)
† Accuracy for motor types USAMED-44M□2 and USAMKD-60M□2.

4.6.4 Direction of Rotation

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

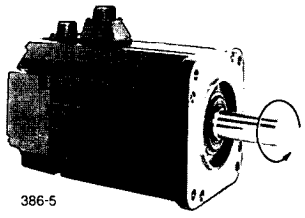
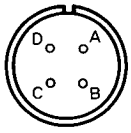


Fig. 4.9 AC SERVOMOTOR

(1) Connector Specifications for Standard SERVOMOTORS

(a) Motor receptacle

· M, F Series

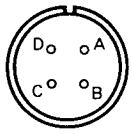


A	Phase U
B	Phase V
C	Phase W
D	Frame ground

· S Series
(Type USASEM-02A)

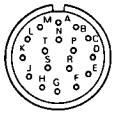
Color of Lead	Applicable
Red	Phase U
White	Phase V
Blue	Phase W

(Types USASEM-03A to 30A)



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

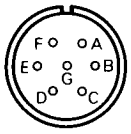
(b) Detector receptacle



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	—	–

(2) Connector Specifications for SERVOMOTOR with Brake

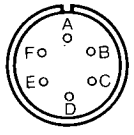
· M, F*, D Series (Brake is provided to all types of D series as standard.)



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

Types without brake of D series do not use E and F.

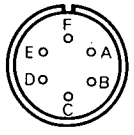
*For USAFEM-02 and-03, see connector on the right.



· S Series (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

(USASEM-03A, -05A)

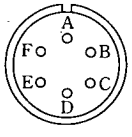


A	Phase U
B	Phase V
C	Phase W
D	Brake terminal
E	
F	Frame ground

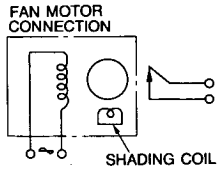
(USASEM-08A to -30A)

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

(3) Fan terminal connector specifications (Type USAMKD-60B□2)



A	Fan motor
B	Fan motor
C	–
D	Alarm terminal
E	Alarm terminal
F	–



Power Supply: Single-phase 200V,50/60Hz, 38/35W
Alarm Contact: OFF when fan is running normally
ON when fan rotation is 1800 ±200 r/min or less.
When cooling fan starts running, ON for 3 seconds.
Contact Capacity: Resistance load is 110V max, 0.3A

Fig. 4.10 Fan Terminal Connection

Arrange the main circuit sequence to stop the SERVOMOTOR and fan motor when cooling fan alarm occurs. (Alarm contact is ON at alarm occurrence).

After alarm occurrence, make sure to stop the SERVOMOTOR and fan motor within five minutes since SERVOMOTOR self-cooling protection is set to five minutes.

When cooling fan starts running, alarm detection signal turns ON for three seconds. Therefore, add a delay relay to the circuit for this time setting (three seconds).

4.6.5 Impact Resistance

When mounted horizontally and exposed to vertical shock impulses, the motor can withstand up to two impacts with impact acceleration of 490m/s²(50G) (Fig. 4.11).

NOTE

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

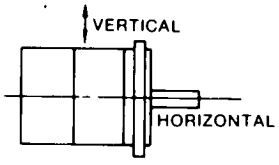


Fig. 4.11 Impact Resistance

4.6.6 Vibration Resistance

When mounted horizontally, the motor can withstand vibration (vertical, lateral, axial) of 24.5m/s² (2.5G) (Fig. 4.12).

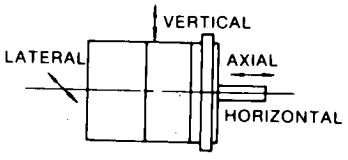


Fig. 4.12 Vibration Resistance

4.6.7 Vibration Class

Vibration of the motor running at rated speed is 15μm or below (Fig. 4.13).

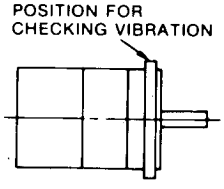


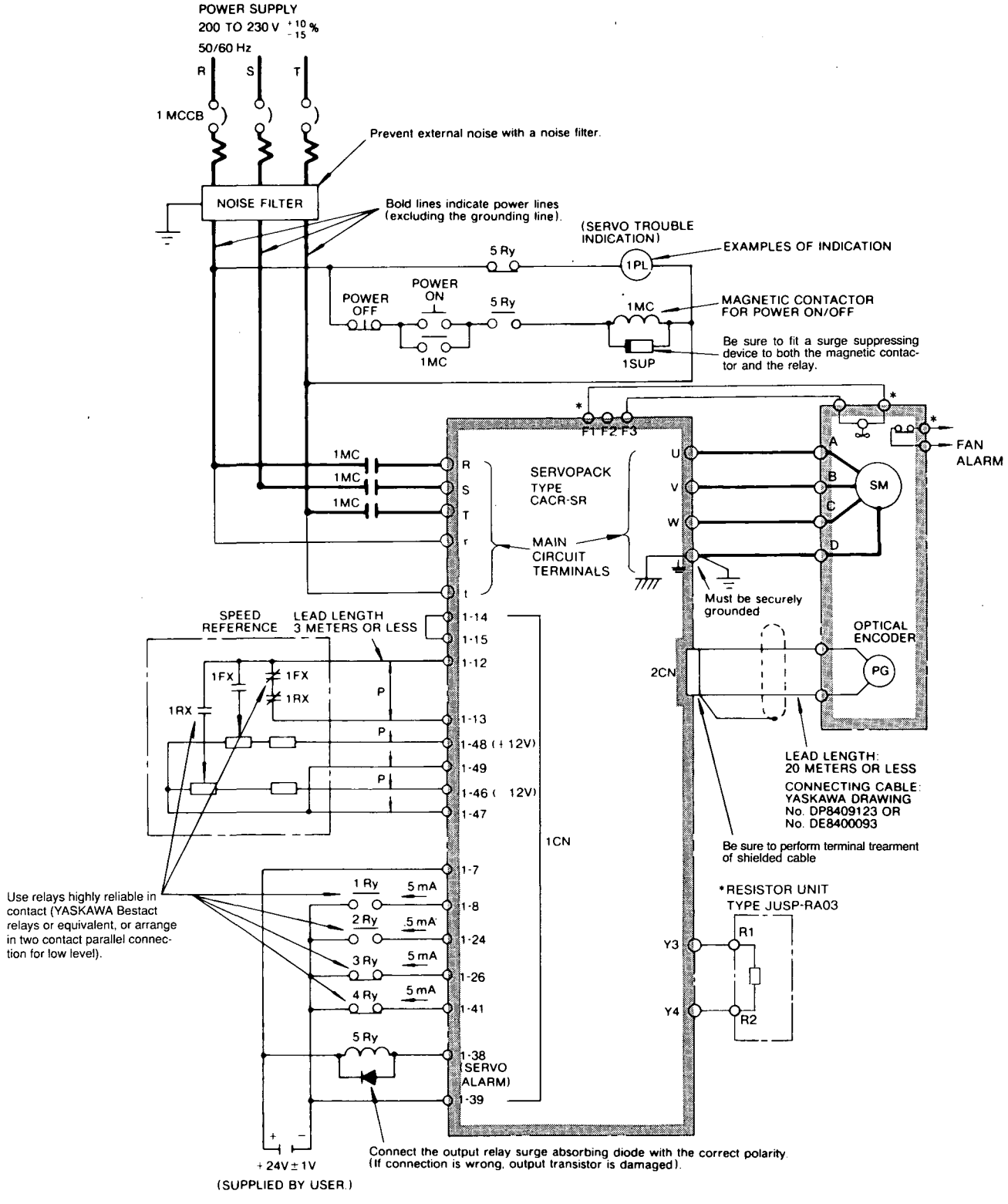
Fig. 4.13 Vibration Checking

4.6.8 Holding Brake

Turn ON/OFF according to Par. 6.9.3, "Application of SERVOMOTORS with Holding Magnetic Brake" since AC SERVOMOTORS with brake is used when the operation is held.

5. CONFIGURATION

5.1 CONNECTION DIAGRAM



*Added only for SERVOPACK type CACR-SR60BB (externally fan-cooled type).

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

5. 2 INTERNAL BLOCK DIAGRAM

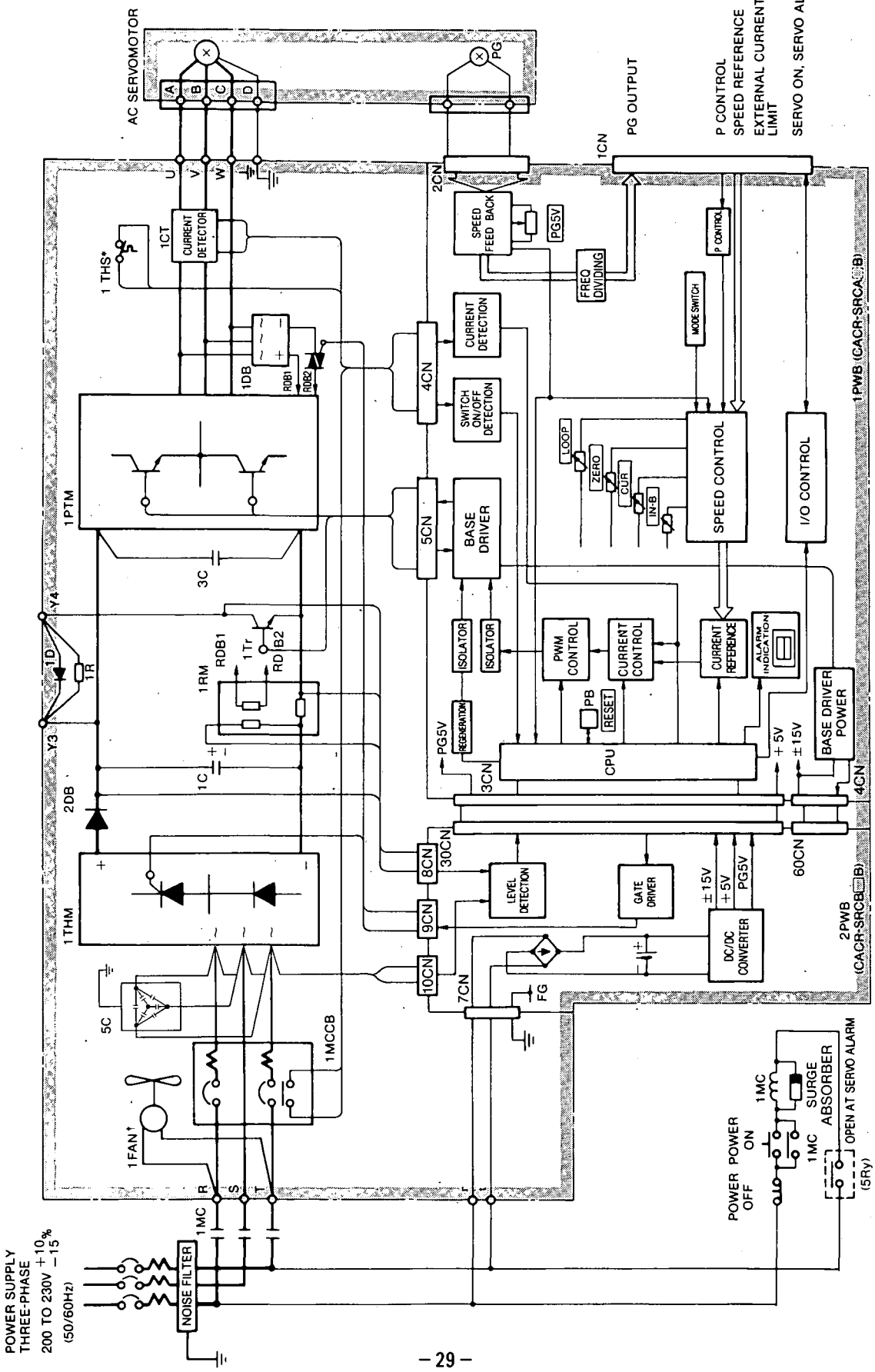


Fig. 5.2 Internal Block Diagram of SERVOPACK
(Type CACR-SR03BB to -SR44BB)

*Not provided for SERVOPACK types CACR-SR03BB to -SR10BB
†Not provided for SERVOPACK types CACR-SR03BB to -SR15BB

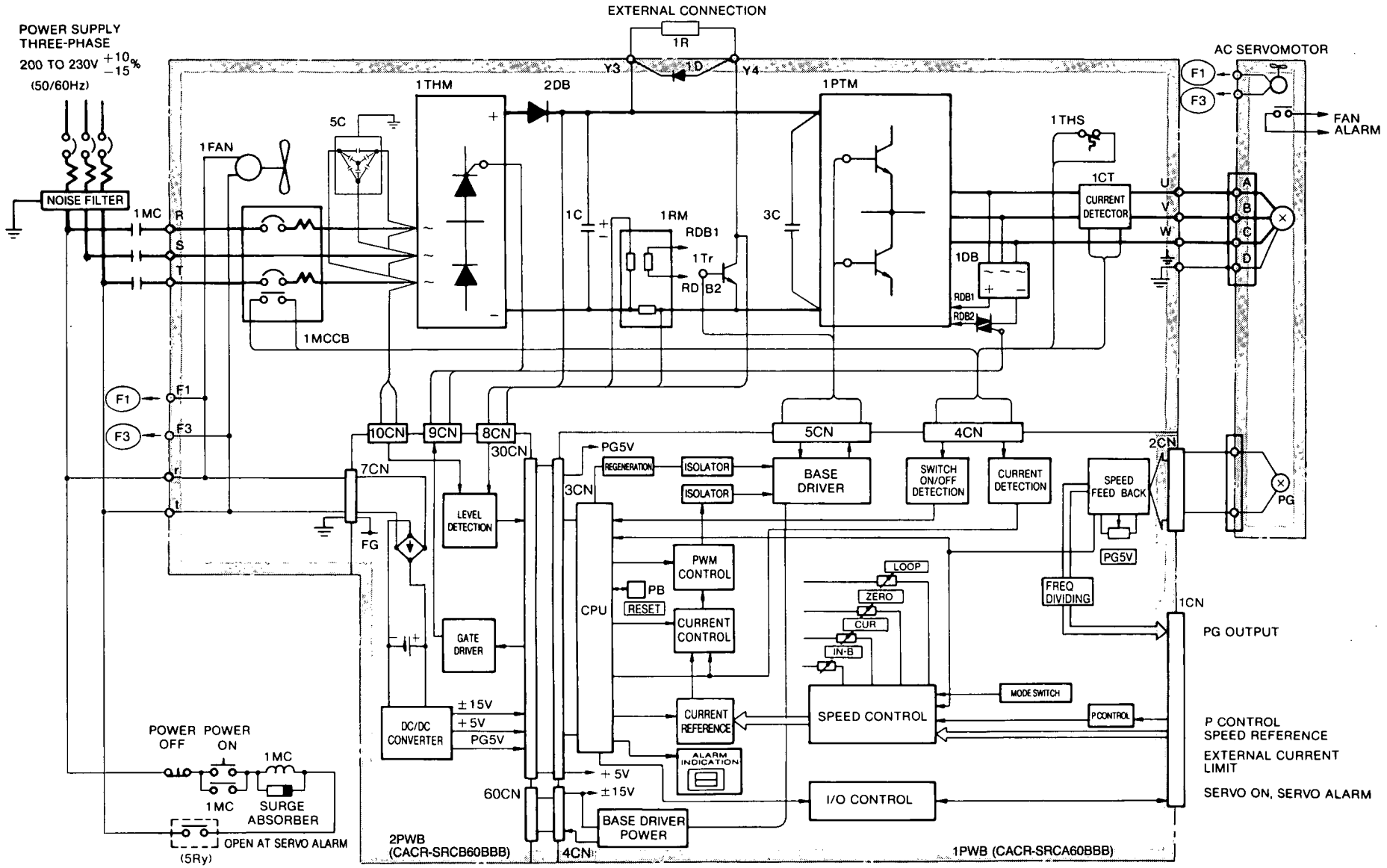


Fig. 5.3 Internal Block Diagram of SERVOPACK
(Type CACR-SR60BB)

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 FG. Must be securely grounded.
Ⓨ3 Ⓨ4	Regenerative resistor	External connection not normally required except SR60BB.

5.4 CONNECTOR TERMINAL (1CN) FOR INPUT/OUTPUT SIGNALS

5.4.1 Specifications of Applicable Receptacles

Table 5.2 Specifications of Applicable Receptacles for SERVOPACK Input/Output Signals

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

* The connectors for input/output signals used are type MR-50RMA made by Honda Tsushin Co.
† Attached to SERVOPACK prior to shipment.

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. 5.4 on page 32.

Table 5.3 Connector 1CN Layout of SERVOPACK

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0 V	0 V	0 V	PHA	CLT+	CLT−	+24V IN	S-ON	TRQ-M	VTG-M	SG	IN-A	SG-A	IN-B	SG-B	+12V	SG	FG
0 V for PG Output Signal			PG Output Signal (phase A)†	Current Limit Detection Output		Ext Power Input	Servo ON Power	Torque monitor	Speed Monitor		Speed Reference Input		Auxiliary Input		+ 12V Output		Frame Ground

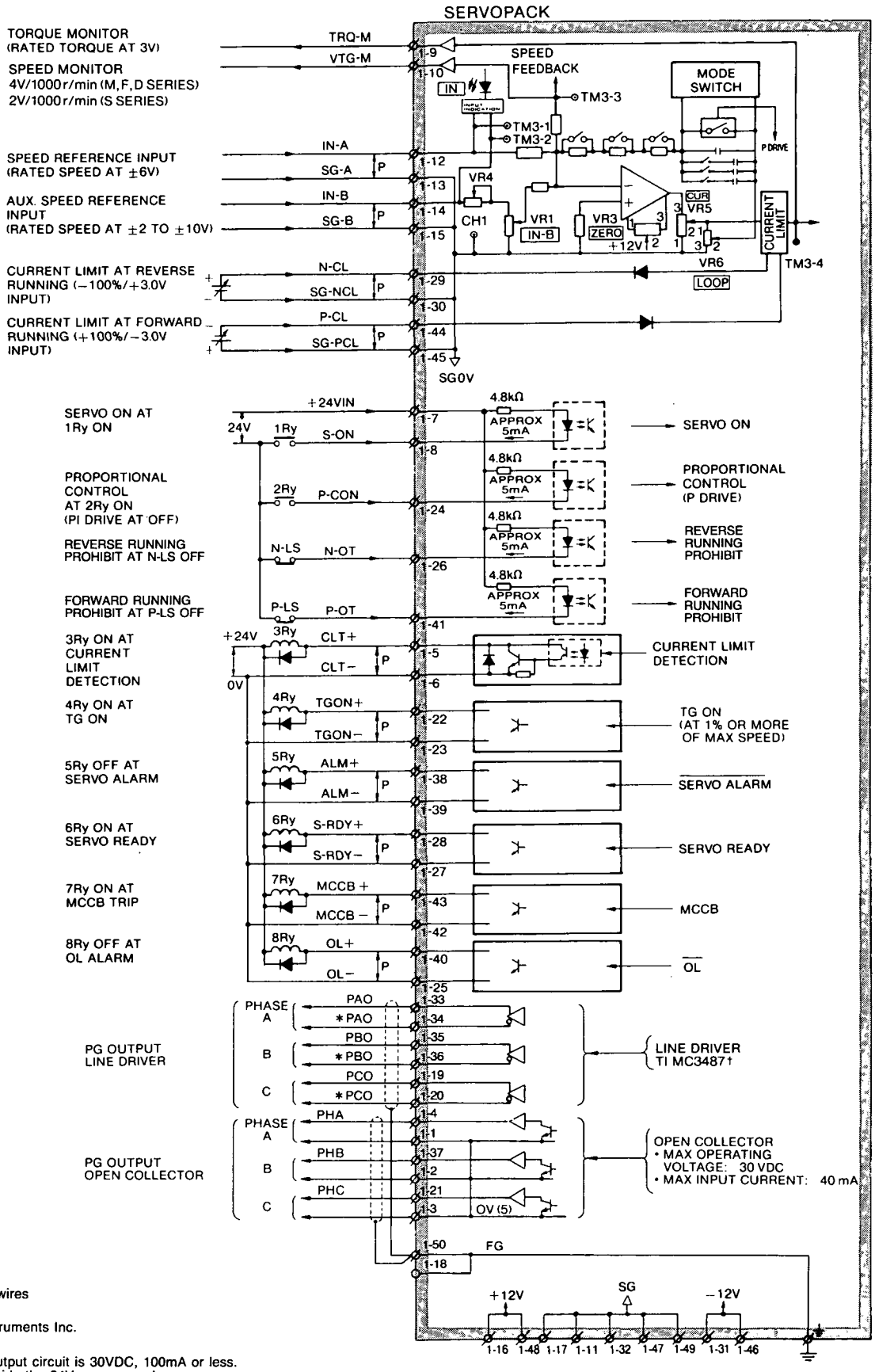
		19	20	21	22	23	24	25	26	27	28	29	30	31	32
		PCO	*PCO	PHC	TG ON +	TG ON −	P-CON	OL −	N-OT	S-RDY −	S-RDY +	N-CL	SG	−12V	SG
		PG Output Signal (Phase C)		PG Output Signal (phase C)†	TG ON Signal Output		P Drive Input	Overload Detecting Signal	Reverse Prohibit Input	Servo Ready Output		Reverse Current Output		−12 V Output	

33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
PAO	*PAO	PBO	*PBO	PHB	ALM+	ALM−	OL +	P-OT	MCCB −	MCCF +	P-CL	SG	−12V	SG	+12V	SG	FG
PG Output Signal (Phase A)		PG Output Signal (Phase B)		PG Output Signal (Phase B)†	Servo Alarm Output		Overload Detecting Signal	Fwd. Prohibit Input	MCCB Trip Signal Output		Fwd. Current Limit Input		12 V Output		+12 V Output		Frame Ground

†Open collector

PG Output Signals +5V | External Sequence Signals +24V | Analog Signals +12V

†: Open collector



P : Twisted pair wires

† Made by Texas Instruments Inc.

Notes:
1. Each capacity of output circuit is 30VDC, 100mA or less.
2. The user must provide the 24V power supply.

Fig. 5.4 Input/output Signals and Connector 1CN

Table 5.4 Input Signals of Connector 1 CN

Signal Name	Connector 1 CN No.	Function	Description
$\overline{\text{SV-ON}}$	1 CN-8	Servo ON	Inputting this signal makes the SERVOPACK ready to receive speed reference input (+6V) Base block and dynamic brake are cleard.
$\overline{\text{P-CON}}$	1 CN-24	Proporitonal drive reference	Proportional control command to prevent drifting when the motor is left motionless without command input, while the main circuit is kept energized.
N-OT	1 CN-26	Reverse running prohibit	In the case of linear drive, etc connect limit switch signal according to the run direction. This is a normally closed contact.
P-OT	1 CN-41	Forward running prohibit	
24 V	1 CN-7	24 V	External power supply to 1 CN-8, 24, 26 and 41. Use an external 24 VDC (20mA min.) power supply.
IN-A	1 CN-12(13)	Speed command input	At ±6.0V, ± rated speed is obtained.
IN-B	1 CN-14(15)	Aux. command input	At ±2.0 to ±10.0V, ± rated speed is obtained. For adjustment, potentiometer [IN−B] is used.
N-CL	1 CN-29(30)	Current limit reference at reverse running	+3.0V ±10%/100% torque +9 V max.
P-CL	1 CN-44(45)	Current limit reference at forward running	−3.0V ±10%/100% torque −9 V max.

Table 5.5 Output Signals of Connector 1 CN

Signal Name	Connector 1 CN No.	Function		Description
OL	1CN-40(25)	Overload detection		Motor overload detection or heat sink overheat detection. Turns OFF when overload is detected. (See Par. 4.1 "OVERLOAD CHARACTERISTICS")
$\overline{\text{MCB}}$	1CN-43(42)	MCCB trip		Turns ON when MCCB trips.
ALM	1CN-38(39)	Servo alarm		Turns OFF when fault is detected. For details, refer to Table 6.2, "Fault Detecting Functions."
$\overline{\text{TGON}}$	1CN-22(23)	Motor run detection		Turns ON when motor speed exceeds following speed. M Series: Approx 20 r/min D Series: Approx 25 r/min F Series: Approx 25 r/min S Seried: Approx 40 r/min
CLT	1CN-5(6)	Current limit detection		• N-CL or P-CL used: Turns ON when output torque reaches the level set by N-CL or P-CL. • N-CL or P-CL not used: Turns ON when output torque reaches the level set by potentiometer [CUR].
$\overline{\text{S-RDY}}$	1CN-28(27)	Servo ready		Turns ON when main power supply ON, and no servo alarm.
+12 V	1CN-16, 48	±12V output power supply		+ 12V ±5% max output current : 30 mA Used with speed command or current input.
0 V	1CN-17, 32, 49			
−12 V	1CN-31, 46			
TRQ-M	1CN-9	Torque monitor		(Rated torque at ±3.0V) ±10%, ±9V max, load 1 mA max
VTG-M	1CN-10	Speed monitor		M, F, D Series (±4.0V/1000 r/min) ±5%. S Series (±2.0V/1000 r/min) ±5%. Load: 1mA max
PAO	1CN-33	Positioning Signal Output 1	Phase A	Pulse after frequency division is output line driver (TI MC3487). To be received by line receiver (TI SN75115).
*PAO	1CN-34			
PBO	1CN-35		Phade B	
*PBO	1CN-36			
PCO	1CN-19		Phase C	
*PCO	1CN-20			
PHA	1CN-4(1)	Positioning Signal Output 2	Phase A	Open collector output, pulse after frequency division. Max operating voltage: 30 VDC. Max input current: 40 mA.
PHB	1CN-37(2)		Phase B	
PHC	1CN-21(3)		Phase C	

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

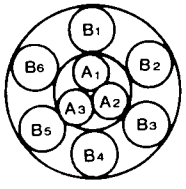
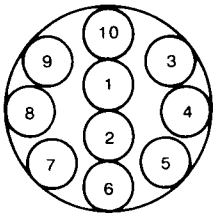
5.5.1 Specifications of Applicable Receptacles and Cables (Table 5.6)

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 prior to shipment.
# The cables listed in Table 5.7 are available on request. If required, purchase in units of standard length as shown in Table 5.7.

Table 5.7 Cable Specifications

Connection	Soldered Type	Caulking Type
YASKAWA Drawing No.	DP 8409123	DE 8400093
Manufacturer	Fujikura Cable Co.	
Approx Specifications	Double, KQVV-SW AWG 22×3C AWG 26×6P	KQVV-SB AWG 26×10P
Finishing Dimensions	φ8.0mm(φ0.31in.)	φ10.0mm(φ0.39in.)
Internal Composition and Lead Color	For Soldered Type 	For Caulking Type 
	A1 Red A2 Black A3 Green-yellow B1 Blue-White/blue B2 Yellow-White/yellow B3 Green-White/green B4 Orange-White/orange B5 Purple-White/purple B6 Grey-White/grey } Twisted pair wires	1 Blue-White 2 Yellow-White 3 Green-White 4 Red-White 5 Purple-White 6 Blue-Brown 7 Yellow-Brown 8 Green-Brown 9 Red-Brown 10 Purple-Brown } Twisted pair wires
YASKAWA Standard Specifications	Standard length : 5m, 10m, 20m Terminal ends are not provided (with connectors).	

NOTE

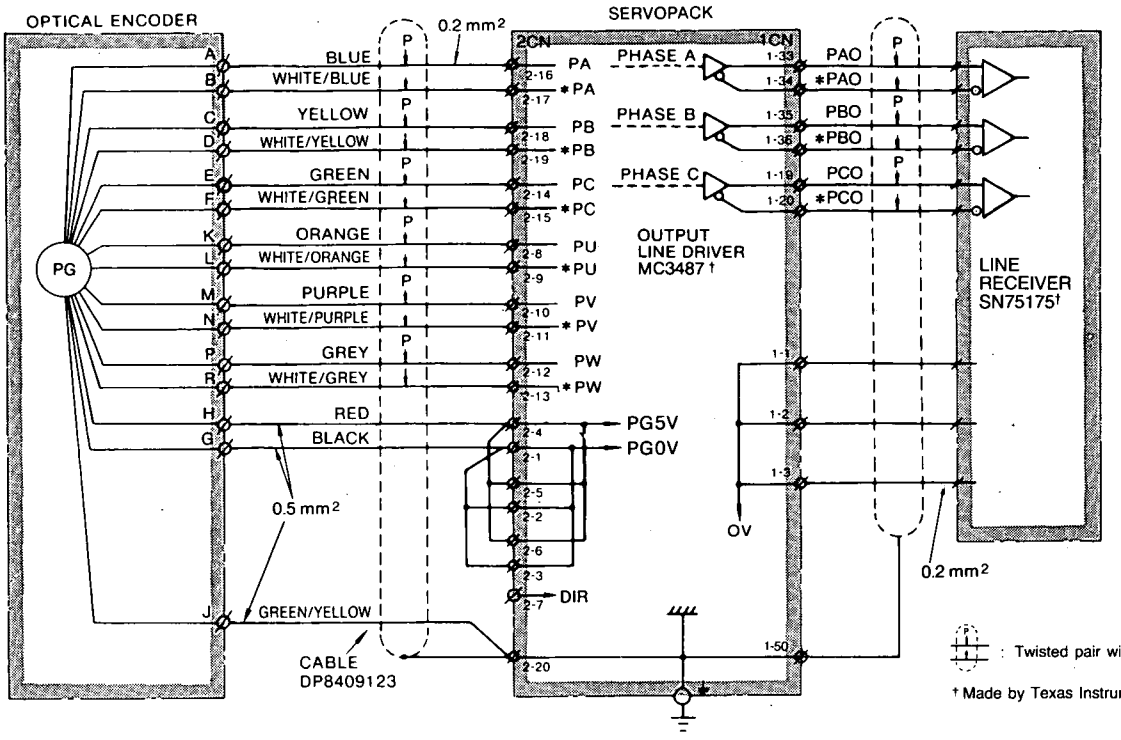
1. When applicable cables listed in Table 5.7 are used, allowable wiring distance between SERVOPACK and motor is a maximum of 20 meters.
2. The cable applied for 50m wiring distance is available on order (YASKAWA drawing No. DP8409179).
   If wiring distance is 20m or longer, contact your YASKAWA representative.
3. Cables must be assembled by authorized vendor with appropriate tooling.

5.5.2 SERVOPACK Connector (2CN) Terminal Layout and Connection

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

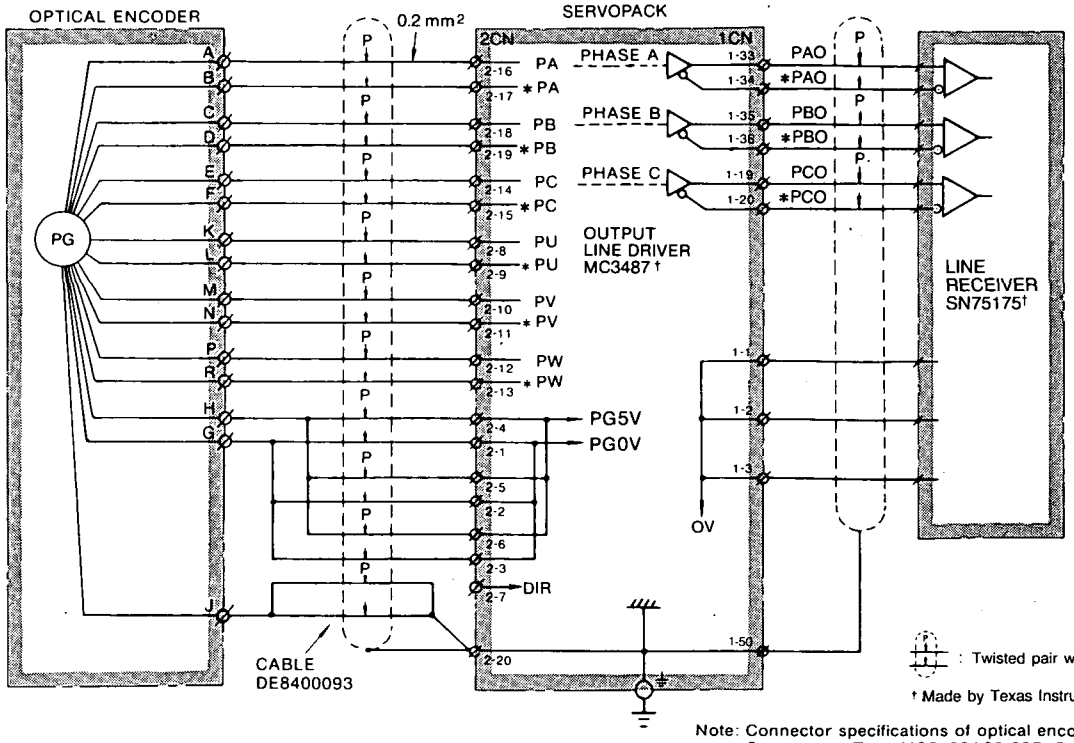
Table 5.8 Connector 2CN Layout of SERVOPACK

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



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

Fig. 5.5 Soldered Type Connector 2CN Connection and 1CN Output Processing (when using Connection Cable DP8409123)



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

Fig. 5.6 Caulking Type Connector 2CN Connection and 1CN Output Processing (when using Connection Cable DE8400093)

6. OPERATION

6.1 POWER ON AND OFF

Arrange the sequence so that the power is simultaneously supplied to the main circuit (R, 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).

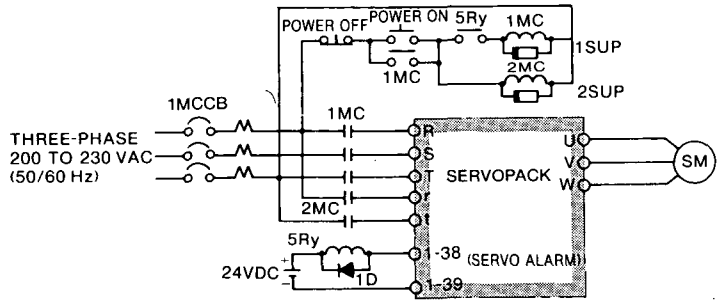
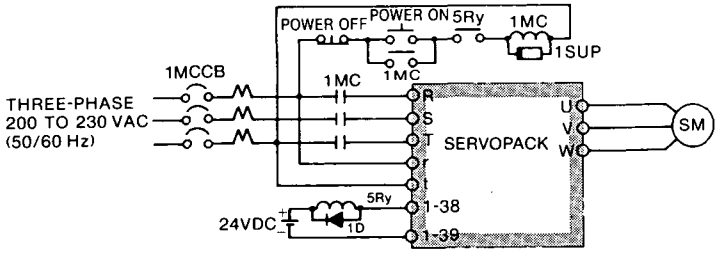


Fig. 6.1 Connection Example for Simultaneous Control Power ON/OFF



1SUP, 2SUP: Surge suppressor
1D: Flywheel diode (to prevent 5Ry spike)

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.

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

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

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

NOTE

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

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 in-rush current flows when the main-circuit power is turned ON (recharging time: 0.5 to 1.0s). If the power is turned ON and OFF frequently, the in-rush current limit resistor may be degraded and a malfunction may occur. When the motor starts, turn ON the speed reference and turn it OFF when the motor stops. Do not turn the power ON or OFF.

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

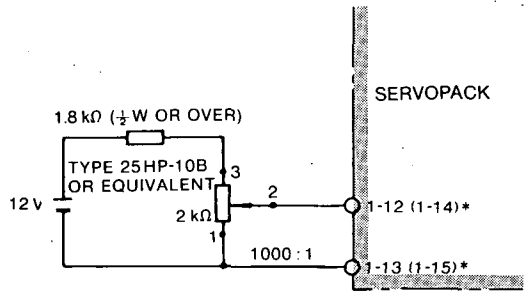
6.2 SPEED REFERENCE

6.2.1 Speed Reference Circuit

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

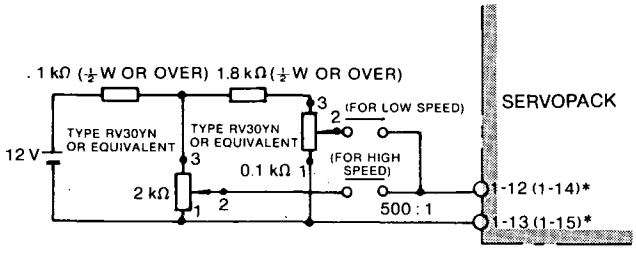
The method for giving speed reference voltage is described below.

(1) For accurate (inching) speed setting



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

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



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

Low-and high-speed relays : Reed relays

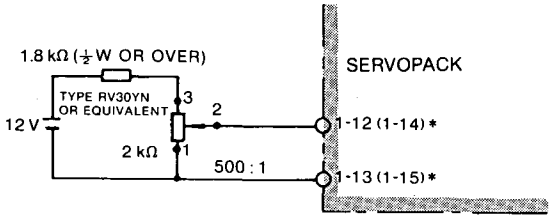
Note : When a carbon resistor is used, great residual resistance remains, so the speed control range becomes approximately 500 :1

(b) When Carbon Variable Resistor is used

* Parentheses are for auxiliary input.

Fig. 6.3 Method for Giving Speed Reference Voltage (for Accurate Speed Setting)

(2) For relatively rough speed setting



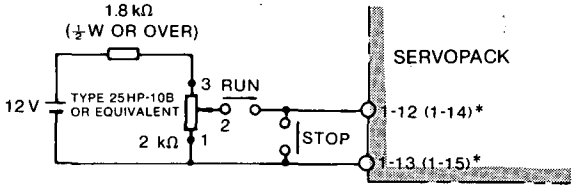
* Parentheses are for auxiliary input.

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

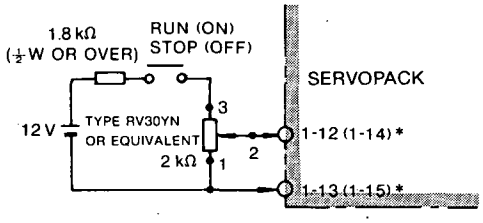
Fig. 6.4 Method for Giving Speed Reference Voltage (for relatively Rough Speed Setting as compared with Fig. 6.3)

6.2.2 Stop Reference Circuit

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



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



(b) When Carbon Variable Resistor is used

* Parentheses are for auxiliary input.

Fig. 6.5 Method for Giving Stop Reference

6.2.3 Handling of Speed Reference Input Terminal

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

6.2.4 Auxiliary Input Circuit (±2 to ±10V)

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

· Adjustment procedures

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

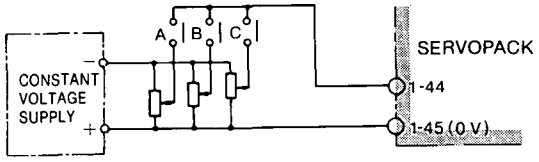
When combined with YASKAWA POSITIONPACK in positioning system drive, auxiliary input terminals are normally used as speed reference input. In this case, positioning loop gain is adjusted with the potentiometer IN-B. For adjustment, be sure to refer to POSITIONPACK instruction manuals.

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

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

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

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



Relay: Low level relay

Fig. 6.6 Multi-stage Switching of Current Value at Forward Side

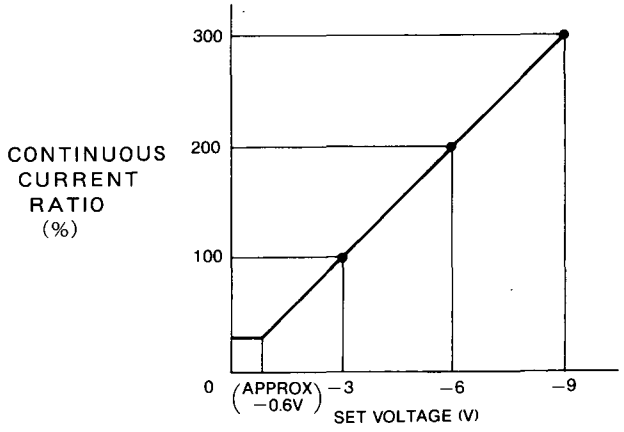
6.3.1 Method of Giving External Current Limit Reference

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

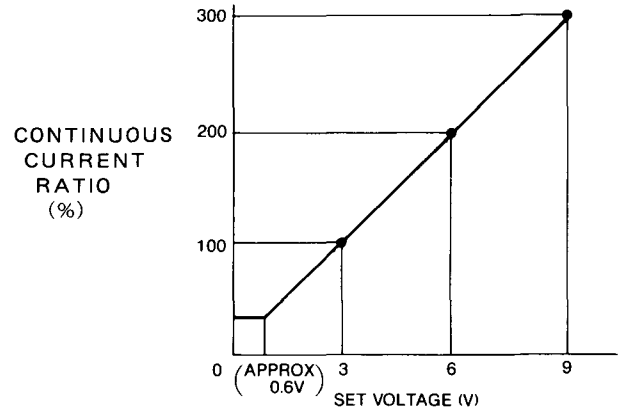
The relation between the rated current of the motor and applicable motor. The power supply must use an internal resistance less than 2kΩ. The input resistance at SERVOPACK side must be greater than 5kΩ. When external current is not restricted, contacts between terminals 1CN-㊹ and ㊺ and between 1CN-and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

6.3.2 Set Voltage and Current Limit Values

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



(a) Current Limit at Forward Side



(b) Current Limit at Reverse Side

Note : If setting value exceeds max output current value of SERVOPACK, max output current value becomes saturation value.

Fig. 6.7 Set Voltage and Current Limit Values

6.3.3 Current Limit when Motor is Locked

When locking a motor by applying a current limit, determine a current limit value less than 70% of the rated current of the motor. If the load condition requires a current limit exceeding the rated motor current, refer to Par. 6.5.(3), "Overload detection level" and make sure to unlock the motor before reaching the trip level.

Note that when the speed reference voltage is less than tens or so millivolts (affected by setting of GAIN of VR4, VR6 and SW3), the motor lock current sometimes pulsates. If this is not desirable, the current pulsation can be removed by increasing the speed reference voltage.

6.4 CONFIGURATION OF INPUT/OUTPUT CIRCUITS

For proportional drive, overtravel, servo ON, servo alarm output, current limit detection output and TG ON output, each input/output circuit is a non-contact circuit insulated with optical couplers. The external circuit, therefore, must be constructed with the specified voltage and current.

6.4.1 Input Circuit

There are four types of protective functions to prevent continued rotation of the motor in forward and reverse direction: Servo ON, proportional drive, and overtravel prevention (forward and reverse). Construct the input circuit using 24V power supply (Fig. 6.8). Typical circuits are shown in Fig. 5.3.

NOTE

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

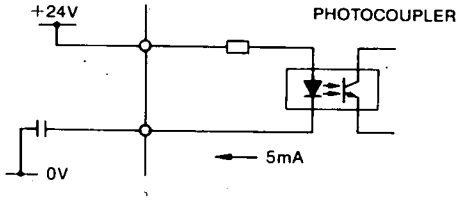


Fig. 6.8 Configuration of Input/Output Circuits

(1) Proportional Drive Reference [P-CON]

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

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

These circuits are used to stop the forward running of the motor (counterclockwise when viewed from the drive end of the motor) and reverse running. This circuit stops output current to drive the motor. Therefore, the motor will coast to a stop. If braking is required, set the speed reference voltage to 0V or set the dynamic braking circuit from OFF to ON.

NOTE

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

(3) Servo ON [S-ON]

This circuit is used to turn ON the main-circuit power-drive circuit of the SERVOPACK. When the signal of the circuit is not input (Servo OFF status), the motor cannot be driven. If this signal is applied during motor running, the motor will coast to a stop. Never stop the motor using Servo OFF except in emergency during motor running.

NOTE

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

6.4.2 Output Circuit

There are six output signals: Current limit detection, TG ON, Servo alarm, Servo ready, MCCB trip and OL alarm.

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

Applied Voltage (Vmax) ≦30V

Conduction Current (Ip) ≦100mA

NOTE

The output circuit requires a separate power supply. It is recommended to use the same 24V power supply used for the input circuit (Fig. 6.9).

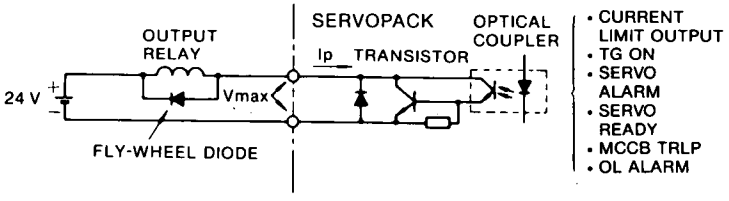


Fig. 6.9 Output Circuit

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

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

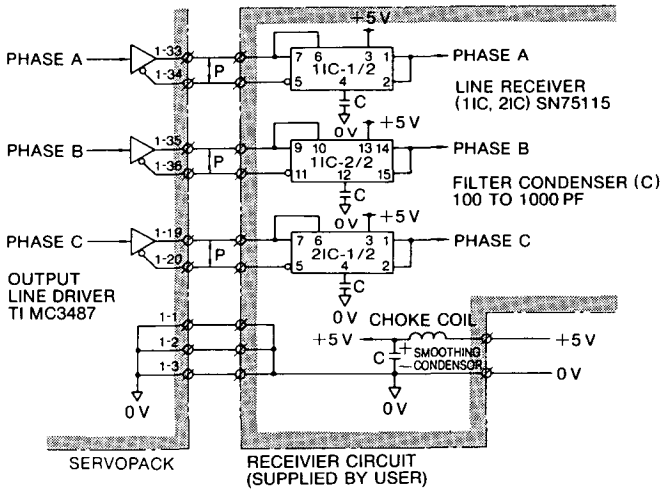
Use these signals as positioning signals. The output signal specifications are as follows :

(1) Signal form

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

(2) Output circuit and receiver circuit

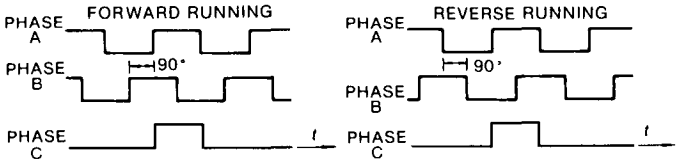
Two types of output circuits are provided : line driver output and open collector output (SN74LS07N). Fig.6.10 shows an example of line driver output.



PT : Twisted pair wires.

Fig. 6.10 Line Driver Output Circuit

(3) Output phase



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

Fig. 6.11 Output Phase

(4) Pulse resolution

The pulse frequency of the PG can be further divided into 1/N (N=1 to 64) 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 6.1.

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

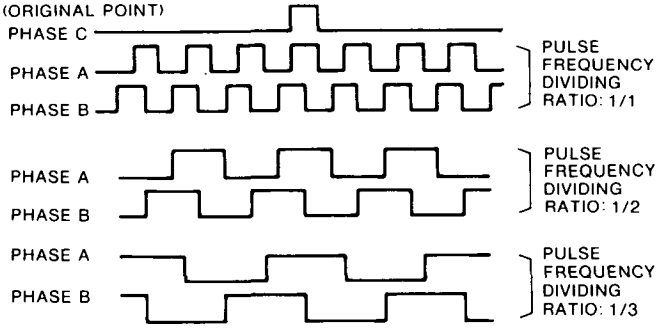


Fig. 6.12 Output Waveform of Optical Encoder

Table 6. 1 Setting of PG Pulse Frequency Dividing Ratio

SW2									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	—

↑
Spare

6.5 PROTECTIVE CIRCUIT

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

(1) Dynamic brake function

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

- Alarm (fault detection) occurs.
- Servo ON command is opened.
- Main power supply is tuned OFF.

Normally, this dynamic brake is not applied while the motor stops, but can operate by switching built-in switch (SW 4-5) from OFF to ON. Use this function only in emergency. Don't use the dynamic brake to stop the motor normally.

(2) Trouble detecting functions

Table 6.2 Fault 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

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

If any trouble detection circuits in Table 6.2 functions, the power drive circuit in the SERVOPACK goes OFF, 7-segments LED indicate the operation condition and a servo alarm signal is output.

(4) 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 0V before supplying power to the main circuit to resume the operation.

(5) Resetting servo alarm

To reset the servo alarm, press the RESET (blue pushbutton switch) on the printed circuit board in the SERVOPACK.

If 7. or A is ON (e.g., SERVOPACK is overloaded or the heat sink is overheated), the reset alarm is not immediate and occurs a few minutes later.

6.6 LED INDICATION

Table 6.3 LED Status Indications (Green)

LED Name	Conditions
MP	SERVOPACK main circuit voltage (200 VDC or more) is proper.
P	SERVOPACK control circuit voltage (+5V) is proper.
IN	Speed reference (approx 60 mV or more) is input.

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 protector tripped		
3.	Regeneration trouble		
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		

6.7 PRECAUTIONS FOR APPLICATION

6.7.1 Overhanging Loads

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

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

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

6.7.2 Load Inertia (J_L)

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

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

For details, contact your YASKAWA representative.

6.7.3 High Voltage Line

If the supply voltage is 400/440V, the voltage must be dropped three-phase, 400/440V to 200V using a power transformer. Table 6.6 shows the transformer selection. Connection should be made so that the power is supplied and cut through the primary side of the transformer. Single-phase 100V class power supply should not be used.

6.8 PRECAUTIONS OF OPERATION

6.8.1 Noise Control

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

The SERVOPACK incorporates a 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. 6.13.

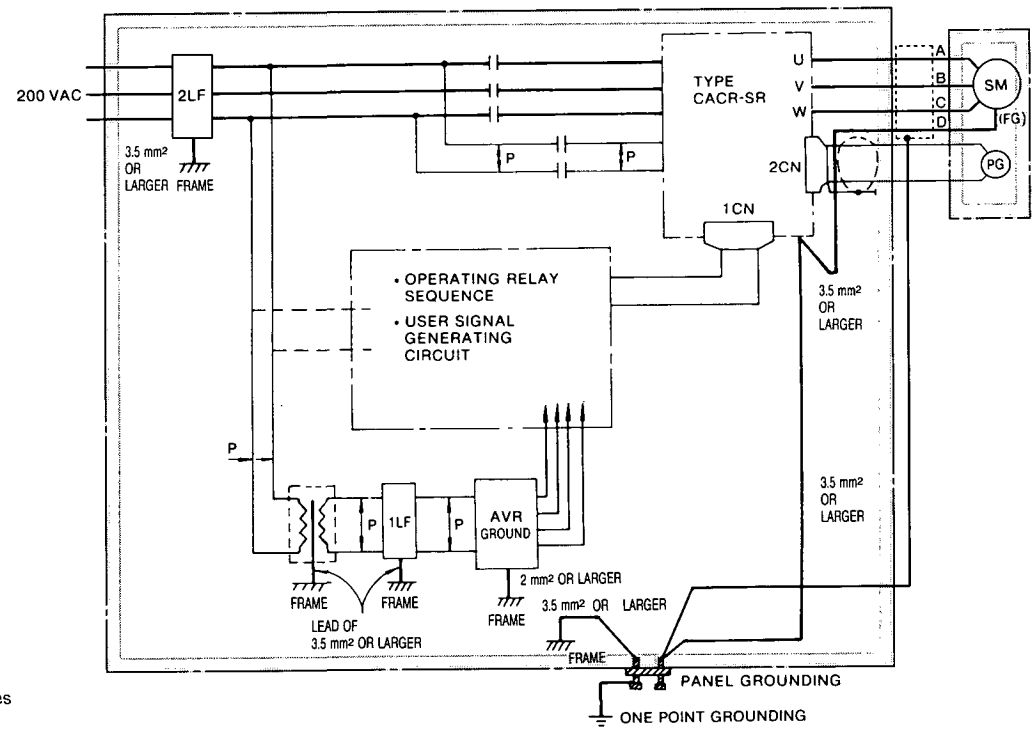
(1) Grounding method (Fig. 6.13.)

- 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 stress capacitance of the motor. To prevent this effect of current, motor ground terminal FG (motor frame) should be connected to terminal ⏚ of SERVOPACK (Terminal ⏚ of SERVOPACK should be directly grounded.)

- SERVOPACK SG 0V

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



P : Twisted pair wires

Notes
1. Use wires of 3.5mm² or larger 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. 6.13 Grounding Method

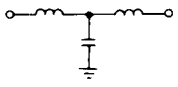
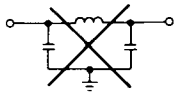
(2) Noise filter installation

When noise filters are installed to prevent noise from the power line, the block type must be used. The recommended noise filters are shown in Table 6.5. 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. 6.14 to 6.17.

Table 6.5 Recommended Noise Filter

SERVOPACK Type CACR-	Applicable Noise Filter	Recommended Noise Filter	
		Type	Specifications
SR03BB SR05BB		LF-305	Three-phase 200 VAC class, 5 A
SR07BB		LF-310	Three-phase 200 VAC class, 10 A
SR10BB SR15BB	CORRECT	LF-315	Three-phase 200 VAC class, 15 A
SR20BB		LF-320	Three-phase 200 VAC class, 20 A
SR30BB		LF-330	Three-phase 200 VAC class, 30 A
SR44BB		LF-340	Three-phase 200 VAC class, 40 A
SR60BB	WRONG	LF-350	Three-phase 200 VAC class, 50 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.

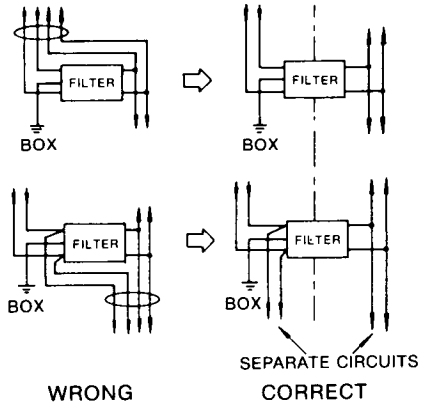


Fig. 6.14

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

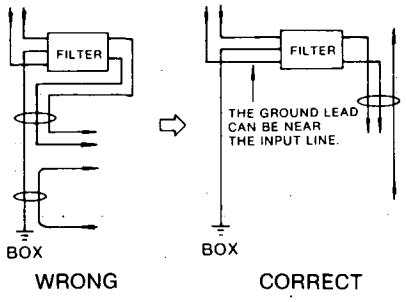


Fig. 6.15

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

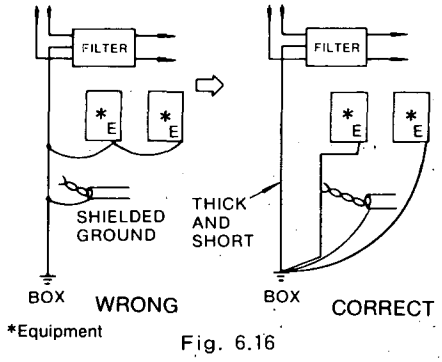


Fig. 6.16

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

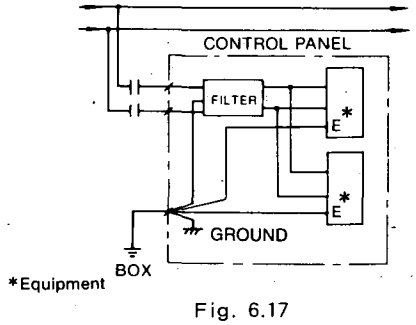


Fig. 6.17

6.8.2 Power Line Protection

The SERVOPACK is operated through the commercial power line (200V). To prevent the power line accidents due to grounding error, contact error, or to protect the system from a fire, circuit breakers (MCCB) or fuses must be installed according to the number of SERVOPACKS used (Table 6.6).

A fast blow fuse cannot be used, because of the in-rush current.

Table 6.6 Power Supply Capacity and MCCB or Fuse Capacity

SERVOPACK Type CACR-	Power Capacity* per SERVOPACK	Current Capacity per MCCB or Fuse
SR03BB	0.65 kVA	5 A
SR05BB	1.1 kVA	5 A
SR07BB	1.5 kVA	8 A
SR10BB	2.1 kVA	8 A
SR15BB	3.1 kVA	10 A
SR20BB	4.1 kVA	12 A
SR30BB	6.0 kVA	18 A
SR44BB	8.0 kVA	24 A
SR60BB	11 kVA	32 A

*Values at rated load.

6.9 APPLICATION

6.9.1 Connection for Reverse Motor Running

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

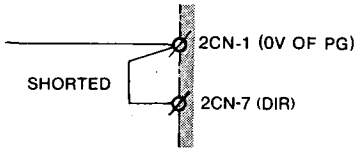


Fig. 6.18

6.9.2 Speed and Torque Measurement

When an instrument is connected to measure speed and torque, make the connection as shown in Fig. 6.19, using a DC ammeter which is ±1 mA (both swing) load at fullscale voltage.

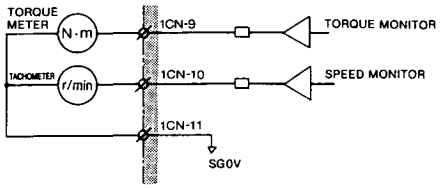


Fig. 6.19 Speed and Torque Measurement

- Torque monitor output (1CN-9): ±3.0v ±10%/100% torque
- Speed monitor output (1CN-10):

  M, F, D series — ±4.0V ±5%/1000r/min
  S series — ±2.0V ±5%/1000r/min

- Instrument : DC ammeter which is ±1 mA (both swing) load at fullscale voltage. Use ammeter of DCF-6 or DCF-12N by Toyo Instrument or equivalent.
- Example : When an M Series motor (rated speed: 1000r/min) is used, and speeds are to be measured up to the maximum speed (2000r/min) in both directions, use ±8V (both swing) DC voltmeter.

6.9.3 Application of SERVOMOTORS with Holding Magnetic Brake

AC SERVOMOTORS with brake is held by the brake when it stops operation. Follow the procedures below for use.

(1) This brake locks st non-magnetization. Therefore, turn OFF the brake power supply when the motor stops. Should the brake work while the motor is running the contact causes excessive abrasion and the brake may be defective in shorter period.

(2) The brake has delay time. For operation timing of ON/OFF, see Fig. 6.20.

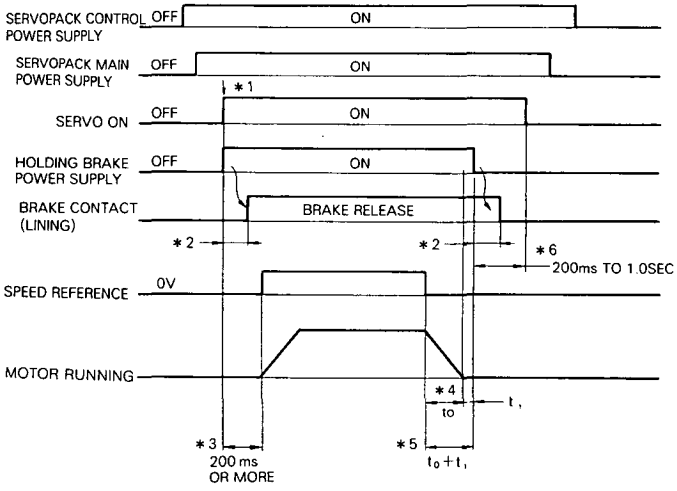


Fig. 6.20 Brake Timing

Timming

*1 "Servo ON" and the holding brake power supply can be operated simultaneously.

*2 It takes a maximum of 180ms from when the brake power supply is ON till when mechanical contact is released. It takes a maximum of 100ms when the brake power supply is OFF.

*3 More than 200ms must be considered from when the brake power supply is ON till when speed reference is input.

*4 t_0 shows motor stopping time and is calculated as follows :

$$t_0 = 0.1047 \times \frac{(J_M + J_L) \times N_M}{(T_P + T_L)} \quad (ms)$$

$J_M (= GD_M^2/4)$: Motor moment of inertia ($kg \cdot m^2 = lb \cdot in \cdot s^2 \times 10^{-3}$)

$J_L (= GD_L^2/4)$: Load moment of inretia ($kg \cdot m^2 = lb \cdot in \cdot s^2 \times 10^{-3}$)

N_M : Motor speed (r/min)

T_P : Motor speed reduction torque (N·m)

T_L : Load torque (N·m)

*5 Turn OFF the brake power supply when the motor stops. For normal operation, $t_0 + t_1$ is approximately 1 to 2 seconds.

*6 Turn OFF "servo ON" 0.2 to 1.0 second after the brake power supply is turned OFF.

7. INSTALLATION AND WIRING

7.1 RECEIVING

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

- Its nameplate ratings meet your requirements.
- It has sustained no damage during transportation.
- The output shaft should be hand-rotated freely. However, motors with holding brake do not rotate.
- Fastening bolts and screws are not loose.

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

7.2 INSTALLATION

7.2.1 SERVOMOTOR

AC SERVOMOTOR can be installed either horizontally or vertically.

(1) Before mounting

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

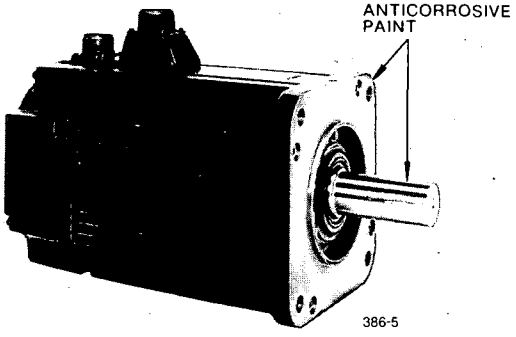


Fig. 7.1 Anticorrosive Paint to be Removed

(2) Location

Use the motor under the following conditions.

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

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

(3) Environmental conditions

Ambient Temperature: 0℃ to +40℃

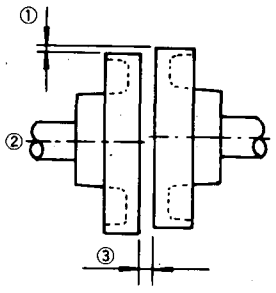
Storage Temperature: -20℃ to +60℃

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 couplings for direct drives. The alignment should be made in accordance with Fig. 7.2.



① Measure the gap between a straight edge and coupling halves at four equidistant points of the coupling. Each reading should not exceed 0.03mm.
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 0.03mm.

Fig. 7.2 Alignment of Coupling

(5) Allowable bearing Load

Avoid shock to the motor shaft when mounting gear box, coupling or pulley. Don't exceed thrust and radial loads specified in Table 4.1 to 4.3.

7.2.2 SERVOPACK

(1) Installation

The SERVOPACK type CACR-SR is mounted on the base as standard.

(2) Location

- When installed in a panel:

  Keep the temperature around SERVOPACK at 55℃ or below. (Fig. 7.3)

- When installed near a heat source:

  Keep the temperature around SERVOPACK below 55℃. (Fig. 7.4)

- If subjected to vibration:

  Mount the unit on shock absorbing material.

- If corrosive gases are present:

  Avoid locations where corrosive gases exist as it may cause extensive damage over long use. Contactors and relays are especially vulnerable.

- Unfavorable atmospheric conditions:

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

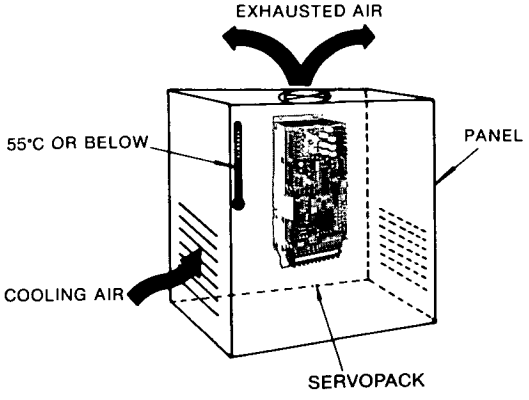


Fig. 7.3 Typical Layout for Panel Mounting

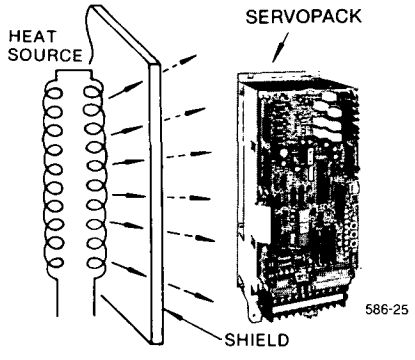


Fig. 7.4 Protection against Heat Radiation

(3) Mounting Direction

Mount the unit vertically on the wall using the mounting holes (4) on the base plate, with main terminals at the bottom. (Fig. 7.5)

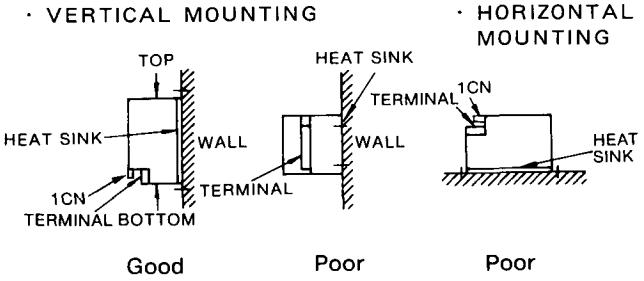


Fig. 7.5 Mounting of SERVOPACK

7.3 WIRING

7.3.1 Rated Current and Cable Size

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

Table 7.1 Rated Current

External Terminal		Type CACR- / Symbol	Rated Current A (Effective Current)								
			SR 03BB	SR 05BB	SR 07BB	SR 10BB	SR 15BB	SR 20BB	SR 30BB	SR 44BB	SR 60BB
On Line	Main Circuit Power Input	R, S, T	2	5	6	8	10	12	18	24	32
	Motor Connection	U, V, W	3.0	4.2	5.8	7.6	11.7	18.8	26.0	33.0	45
	Control Power Input	r, t	0.5A								
Off Line	Control I/O Signal Connector	1CN	100mA DC max								
	PG Signal Connector	2CN	100mA max (500mA DC for power line only)								
	Ground	⏚	—								

Table 7.2 Recommended Cable Size of SERVOPACK

External Terminal		Type CACR- / Symbol	Cable Size mm²								
			SR 03BB	SR 05BB	SR 07BB	SR 10BB	SR 15BB	SR 20BB	SR 30BB	SR 44BB	SR 60BB
On Line	Main Circuit Power Input	R, S, T	HIV 1.25 or more		HIV 2.0 or more		HIV 3.5 or more		HIV 5.5 or more	HIV 5.5 or more	HIV 8 or more
	Motor Connection	U, V, W	HIV 1.25 or more		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 shielded cable • Core must be 0.2 mm² or more • Tin-plated soft-copper twisted cable • Finished cable dimension: 16 dia or less for 1CN, 11 dia or less for 2CN								
	PG Signal Connector	2CN									
	Ground	⏚	HIV 2.0 or more								

Table 7.3 Cable

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

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

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

Cable length is a maximum of 3m for reference input lines and a maximum of 20m 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 10Ω or less). Use central grounding point. If the motor and machine are insulated, ground the motor.

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

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

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

SERVOPACK may interfere with radio reception. If the controller interferes with radio reception, connect a noise filter to power supply.

(5) The signal line uses cables whose core is extremely fine (0.2 to 0.3㎟). 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 st Rated Output

SERVOPACK Type CACR-	Output Current A	Power Loss			
		Main Circuit W	Regenerative Resistance W	Control Circuit W	Total W
SR03BB	3.0	20	10	60	90
SR05BB	4.2	40			110
SR07BB	5.8	60	20		140
SR10BB	7.6	70			150
SR15BB	11.7	80			160
SR20BB	18.8	100	40		200
SR30BB	26.0	160	80		300
SR44BB	33.0	210	100		370
SR60BB	45.0	300	120		480

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

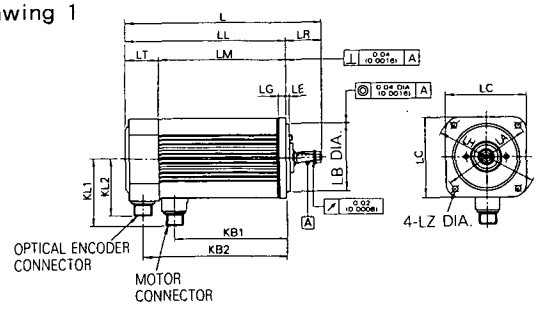
8. DIMENSIONS in mm (inches)

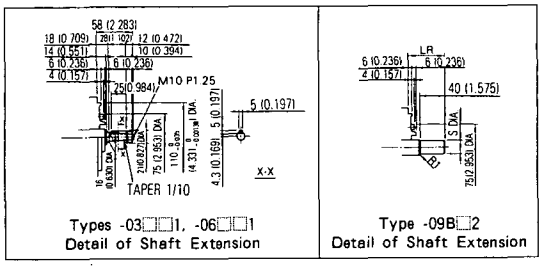
8.1 SERVOMOTOR : M SERIES

(1) Standard

Types USAMED-03□□1, -06□□1 (Taper Shaft)
Type USAMED-09B□2 (Straight Shaft)

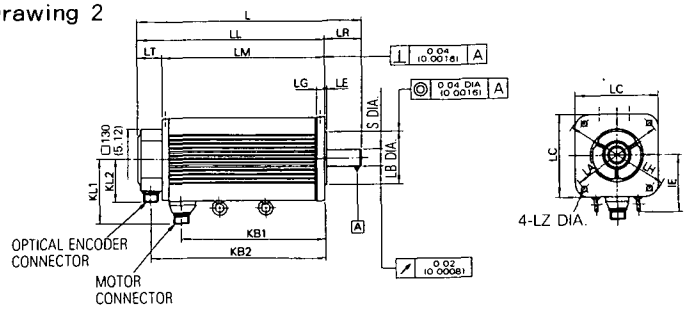
Drawing 1

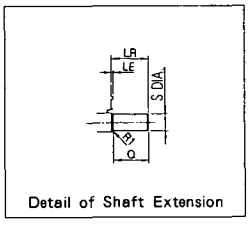




Types USAMED-12B□2 to -44B□2 (Straight Shaft)

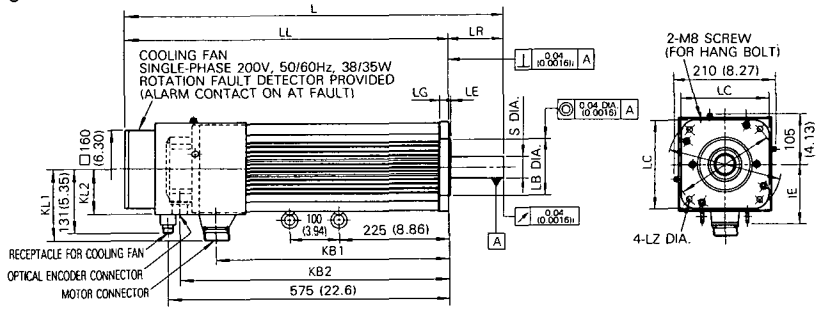
Drawing 2

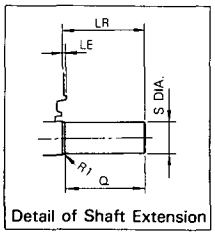




Type USAMKD-60B□2 (Straight Shaft)

Drawin 3



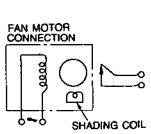


AC SERVOMOTOR Type	Dwg No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface LA	LB	LC	LE	LG	LH	LZ
USAMED-03□□1*	1	263 (10.354)	205 (8.071)	150 (5.906)	58 (2.283)	55 (2.165)	127 (5.0)	177 (6.969)	—	109 (4.291)	92 (3.622)	145 (5.709)	$110\ ^{0}_{-0.035}$ ($4.331\ ^{0}_{-0.00138}$)	130 (5.118)	6 (0.236)	12 (0.472)	165 (6.496)	9 (0.354)
USAMED-06□□1*	1	320 (12.60)	262 (10.318)	207 (8.150)			184 (7.244)	234 (9.213)										
USAMED-09B□2*	1	389 (15.315)	331 (13.031)	276 (10.866)			253 (9.961)	303 (11.929)										
USAMED-12B□2*	2	344 (13.543)	265 (10.433)	211 (8.307)	79 (3.11)	54 (2.126)	172 (6.772)	237 (9.331)	123 (4.843)	139 (5.472)		200 (7.874)	$114.3\ ^{0}_{-0.025}$ ($4.5\ ^{0}_{-0.00098}$)	180 (7.087)	3.2 (0.126)	18 (0.709)	230 (9.055)	13.5 (0.531)
USAMED-20B□2	2	401 (15.787)	322 (12.677)	268 (10.551)			229 (9.016)	294 (11.575)										
USAMED-30B□2	2	486 (19.134)	407 (16.024)	353 (13.898)			314 (12.362)	379 (14.921)										
USAMED-44B□2	2	688 (27.087)	578 (22.756)	524 (20.630)	110 (4.331)	—	476 (18.74)	550 (21.654)		149 (5.866)								
USAMKD-60B□2	3	775 (30.512)	665 (26.181)	—														

AC SERVOMOTOR Type	Dwg No.	Shaft Extension S	Shaft Extension Q	Approx Mass kg (lb)	Motor Connector Types: Receptacle	L-type Plug	Straight Plug	Cable Clamp	Optical Encoder Connector Types: Receptacle	L-type Plug	Straight Plug	Cable Clamp
USAMED-03□□1*	1	See Drawing 1.		8.5 (18.7)	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-06□□1*	1			13 (28.7)								
USAMED-09B□2*	1	$22\ ^{0}_{-0.013}$ ($0.886\ ^{0}_{-0.0005}$)	40 (1.575)	20 (44.1)								
USAMED-12B□2*	2	$35\ ^{+0.01}_{-0.009}$ ($1.378\ ^{+0.0004}_{-0.0004}$)	76 (2.992)	22 (48.5)	MS 3102 A 22 - 22 P	MS 3108 B 22 - 22 S	MS 3106 B 22 - 22 S	MS 3057 - 12 A				
USAMED-20B□2	2			29 (63.9)								
USAMED-30B□2	2			41 (90.4)								
USAMED-44B□2	2	$42\ ^{0}_{-0.016}$ ($1.654\ ^{0}_{-0.0006}$)	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 - 20 A				
USAMKD-60B□2	3			75 (165)								

Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: A (6000 P/R)
   Optional: B (5000 P/R), D (4000 P/R)
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Fan terminal connection (for only type USAMKD-60B□2).

A	Fan motor
B	Fan motor
C	—
D	Alarm terminal
E	Alarm terminal
F	—

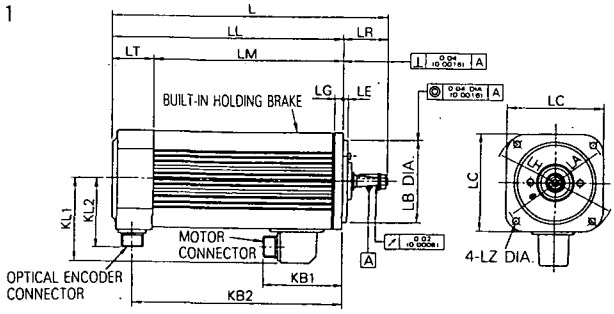


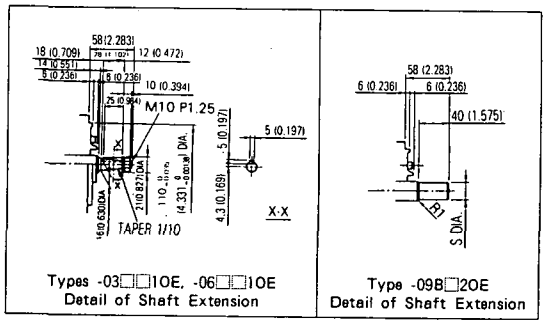
Power Supply: Single-phase 200/200/220V, 50/60/60Hz
Alarm Contact: OFF when fan is running normally
ON when fan rotation is 1800±200 r/min or less.
When cooling fan starts running, ON for 3 seconds.
Contact Capacity: Resistance load is 110V max. 0.3A

(2) With Brake

Types USAMED-03□□1OE, -06□□1OE (Taper Shaft)
Type USAMED-09B□2OE (Straight Shaft)

Drawing 1



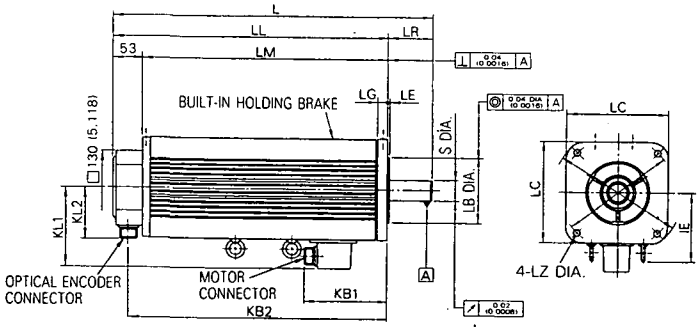


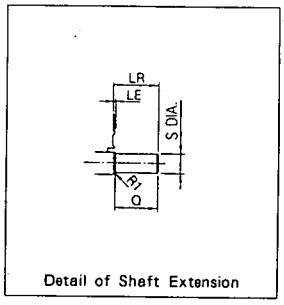
Types -03□□1OE, -06□□1OE
Detail of Shaft Extension

Type -09B□2OE
Detail of Shaft Extension

Types USAMED-12B□2OE to -30B□2OE

Drawing 2





Detail of Shaft Extension

AC SERVOMOTOR Type USAMED-	Dwg No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension	
												LA	LB	LC	LE	LG	LH	LZ	S	Q
03□□1OE*	1	320 (12.598)	262 (10.315)	207 (8.150)	58 (2.283)	55 (2.165)	128 (5.039)	234 (9.213)	—	113 (4.449)	92 (3.622)	145 (5.709)	110 -0.035 -0.087 (4.331 -0.0014 -0.0034)	130 (5.118)	6 (0.236)	12 (0.472)	165 (6.496)	9 (0.354)	21 (0.827)	28 (1.102)
06□□1OE*	1	366 (14.409)	308 (12.126)	253 (9.961)			118 (4.646)	280 (11.024)											22 -0.052 -0.104 (0.866 -0.0020 -0.0041)	40 (1.575)
09B□2OE*	1	436 (17.165)	378 (14.882)	323 (12.717)				350 (13.780)												
12B□2OE	2	422 (16.614)	343 (13.504)	289 (11.378)	79 (3.110)	54 (2.126)	164 (6.457)	315 (12.402)	123 (4.843)	143 (5.630)		200 (7.874)	114.3 -0.025 -0.075 (4.5 -0.0010 -0.0030)	180 (7.087)	3.2 (0.126)	18 (0.709)	230 (9.055)	13.5 (0.531)	35 +0.01 0 (1.378 +0.00039 0)	76 (2.992)
20B□2OE	2	486 (19.134)	407 (16.024)	353 (13.898)				379 (14.921)												
30B□2OE	2	567 (22.323)	488 (19.213)	434 (17.087)				460 (18.110)												

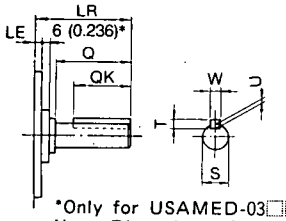
AC SERVOMOTOR Type USAMED-	Dwg No.	Approx Mass kg (lb)	Magnetic Brake			Connector Types for Motor and Brake				Optical Encoder Connector Types			
			Wattage W	Inertia kg·m² (lb·in·s²)	Static Friction Torque N·m (lb·in)	Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L-type Plug	Straight Plug	Cable Clamp
03□□1OE*	1	11.5 (25.4)	18	0.85×10⁻⁴ (7.52×10⁻⁴)	5.88 (52.1)	MS 3102 A20 - 15P	MS 3108 B20 - 15S	MS 3106 B20 - 15S	MS 3057 - 12A	MS 3102 A20 - 29P	MS 3108 B20 - 29S	MS 3106 B20 - 29S	MS 3057 - 12A
06□□1OE*	1	15 (33.1)											
09B□2OE*	1	23 (50.7)	18	0.9×10⁻⁴ (7.97×10⁻⁴)	8.83 (78.1)								
12B□2OE	2	30 (66.1)	31	6.25×10⁻⁴ (55.3×10⁻⁴)	35.3 (312.5)	MS 3102 A24 - 10P	MS 3108 B24 - 10S	MS 3106 B24 - 10S	MS 3057 - 16A				
20B□2OE	2	37 (81.6)											
30B□2OE	2	49 (108)											

*Not provided with an eyebolt.

Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: A (6000 P/R)
   Optional: B (5000 P/R), D (4000 P/R)
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Power supply for brake is 90 VDC.
5. For type USAMED-44B□20B (4.4kW), contact your YASKAWA representative.

(3) Shaft Extension of Straight Shaft with Keyway

Both SERVOMOTORS without brake and with vrake bave the same dimensions except for shaft extension.
Sjaft extensions are shown below:



AC SERVOMOTOR Type USAMED-		LR	LE	Shaft Extension					
Without Brake	With Brake			S	Q	QK	T	U	W
03□□2K	03□□2KE	58 (2.283)	6 (0.236)	19 -0.013 (0.748 -0.00051)	40 (1.575)	25 (0.984)	5 (0.197)	3 (0.118)	5 (0.197)
06□□2K	06□□2KE								
09B□2K	09B□2KE			22 -0.013 -0.033 (0.866 -0.0005 -0.0013)			6 (0.236)	3.5 (0.138)	6 (0.236)
12B□2K	12B□2KE	79 (3.110)	3.2 (0.126)	35 +0.01 0 (1.378 +0.00039 0)	76 (2.992)	60 (2.362)	8 (0.315)	5 (0.197)	10 (0.394)
20B□2K	20B□2KE								
30B□2K	30B□2KE								
44B□2K	44B□2KB	110 (4.331)		42 -0.016 -0.050 (1.654 -0.00063 -0.0020)	110 (4.331)	90 (3.543)			12 (0.472)

*Only for USAMED-03□□2 to -09B□2

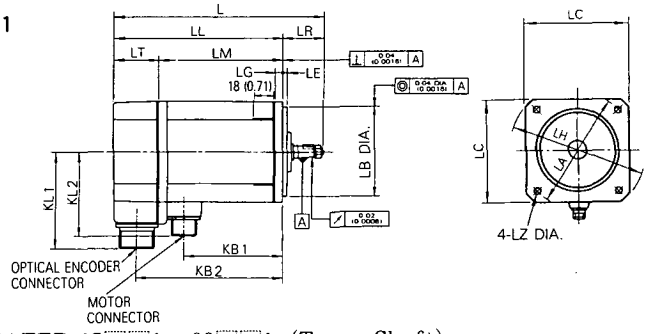
Note: Dimensions of the shaft extension key and keyway are based on JIS (Japanese Industrial Standard) B 1301 "Sunk Keys and Their Corresponding Keyways (Normal keys)." Shaft extension key is furnished.

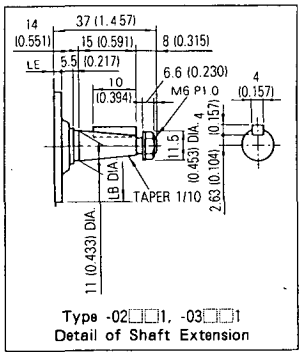
8.2 SERVOMOTOR : F SERIES

(1) Standard

Types USAFED-02□□1, -03□□1 (Taper Shaft)

Drawing 1

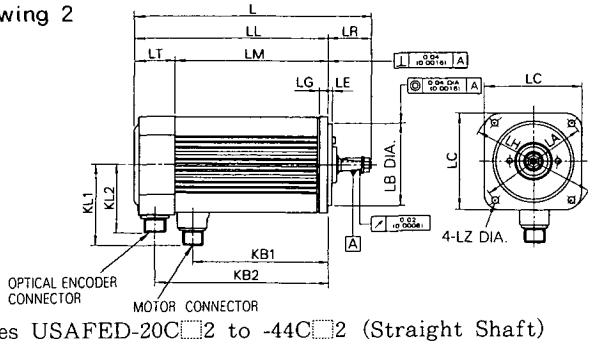


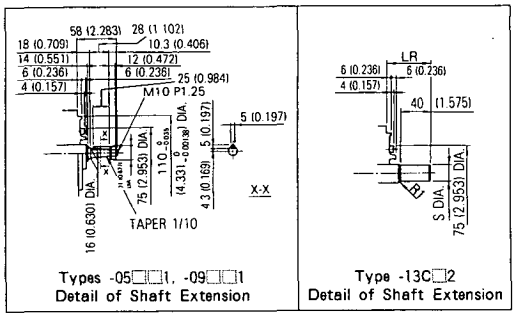


Type -02□□1, -03□□1
Detail of Shaft Extension

Types USAFED-05□□1, -09□□1 (Taper Shaft)
-13C□2 (Straight Shaft)

Drawing 2



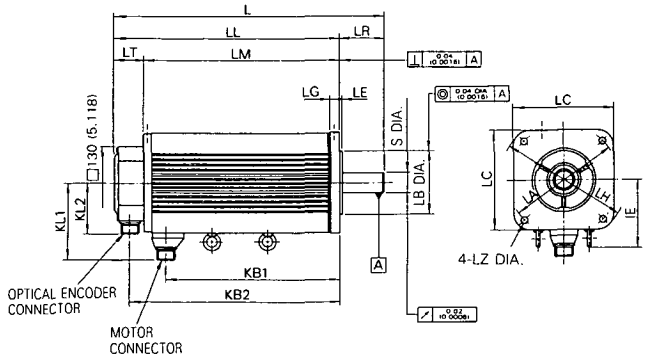


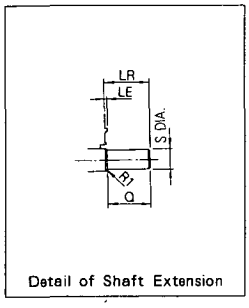
Types -05□□1, -09□□1
Detail of Shaft Extension

Type -13C□2
Detail of Shaft Extension

Types USAFED-20C□2 to -44C□2 (Straight Shaft)

Drawing 3





Detail of Shaft Extension

AC SERVOMOTOR Type USAFED-	Dwg No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface LA	LB	LC	LE	LG	LH	LZ
02□□1	1	190 (7.480)	153 (6.024)	113 (4.449)	37 (1.457)	40 (1.575)	90 (3.543)	132 (5.197)	—	76 (2.992)	87 (3.425)	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)
03□□1	1	236 (9.291)	199 (7.835)	159 (6.260)			136 (5.354)	178 (7.001)										
05□□1 *	2	263 (10.354)	205 (8.071)	150 (5.906)	58 (2.283)	55 (2.165)	127 (5.0)	177 (6.969)	—	109 (4.291)	92 (3.622)	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)
09□□1 *	2	320 (12.60)	262 (10.315)	207 (8.150)			184 (7.244)	234 (9.213)										
13C□2 *	2	389 (15.315)	331 (13.031)	276 (10.866)			253 (9.961)	303 (11.929)										
20C□2 *	3	344 (13.543)	265 (10.433)	211 (8.307)	79 (3.11)	54 (2.126)	172 (6.722)	237 (9.331)	123 (4.843)	139 (5.472)		200 (7.874)	114.3 $^{0}_{-0.025}$ (4.5 $^{0}_{-0.00098}$)	180 (7.087)	3.2 (0.126)	18 (0.709)	230 (9.055)	13.5 (0.531)
30C□2	3	401 (15.787)	322 (12.677)	268 (10.551)			229 (9.016)	294 (11.575)										
44C□2	3	486 (19.134)	407 (16.024)	353 (13.898)			314 (12.326)	379 (14.921)										

AC SERVOMOTOR Type USAFED-	Dwg No.	Shaft Extension S	Shaft Extension Q	Approx Mass kg (lb)	Motor Connector Types: Receptacle	L-type Plug	Straight Plug	Cable Clamp	Optical Encoder Types: Receptacle	L-type Plug	Straight Plug	Cable Clamp
02□□1	1	11.5 (0.453)	15 (0.591)	4 (8.8)	MS 3102 A 14 S - 2 P	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
03□□1	1			6 (13.2)								
05□□1 *	2	21 (0.827)	28 (1.102)	9.5 (18.7)	MS 3102 A 18 - 10 P	MS 3108 B 18 - 10 S	MS 3106 B 18 - 10 S	MS 3057 - 10 A				
09□□1 *	2			13 (28.7)								
13C□2 *	2	22 $^{0}_{-0.013}$ (0.866 $^{0}_{-0.00051}$)	40 (1.575)	20 (44.1)								
20C□2 *	3	35 $^{+0.01}_{0}$ (1.378 $^{+0.000394}_{0}$)	76 (2.992)	22 (48.5)	MS 3102 A 22 - 22 P	MS 3108 B 22 - 22 S	MS 3106 B 22 - 22 S	MS 3057 - 12 A				
30C□2	3			29 (63.9)								
44C□2	3			41 (90.4)								

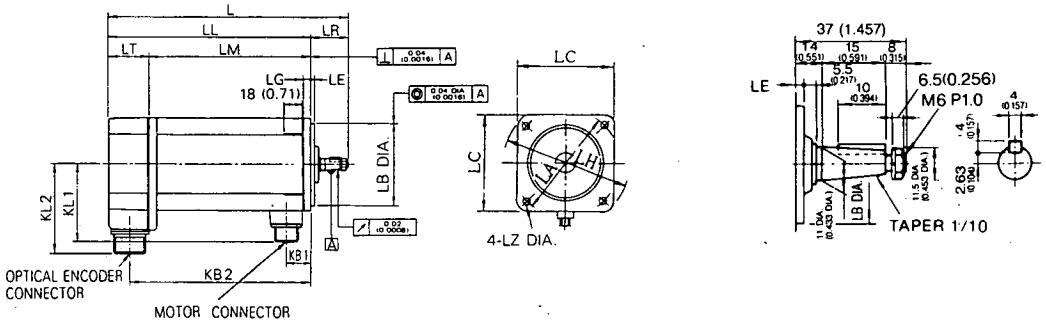
*Not provided with an eyebolt.

Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: A (6000 P/R)
   Optional: B (5000 P/R), D(4000 P/R)
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.

(2) With Brake

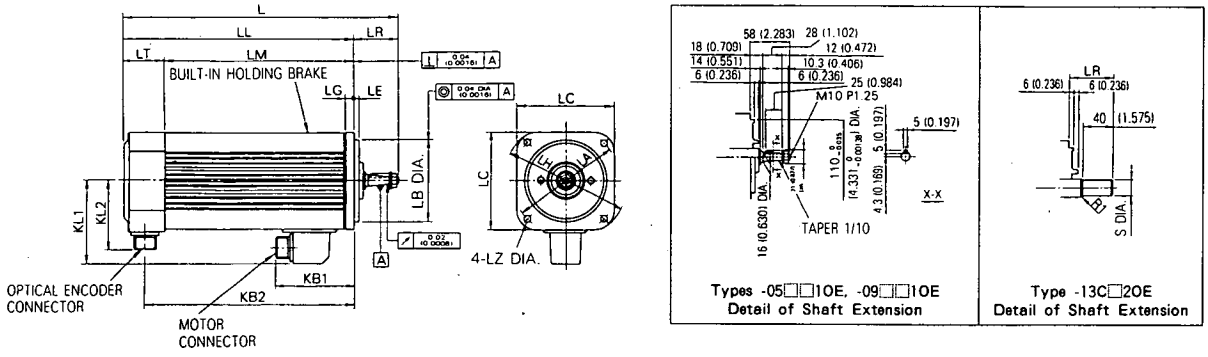
Types USAFED-02□□1OE, -03□□1OE (Taper Shaft)

Drawing 1



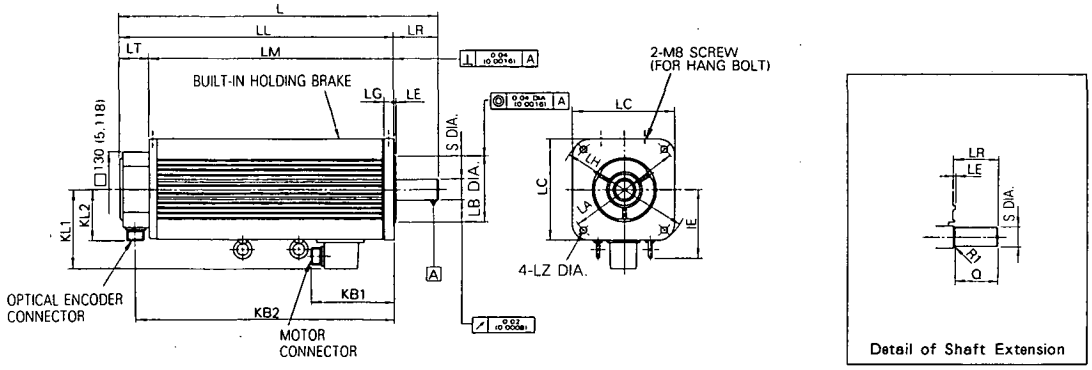
Types USAFED-05□□1OE, -09□□1OE (Taper Shaft)
-13C□2OE (Straight Shaft)

Drawing 2



Types USAFED-20C□2OE to -44C□2OE
(Straight Shaft)

Drawing 3



AC SERVOMOTOR Type USAFED -	Dwg No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension	
												LA	LB	LC	LE	LG	LH	LZ	S	Q
02□□1OE	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)	87 (3.425)	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.	
03□□1OE	1	286 (11.260)	249 (9.803)	209 (8.228)				228 (8.976)												
05□□1OE*	2	320 (12.598)	262 (10.315)	207 (8.150)	58 (2.283)	55 (2.165)	128 (5.039)	234 (9.213)	—	113 (4.449)	92 (3.622)	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)	See Drawing 2.	
09□□1OE*	2	366 (14.409)	308 (12.126)	253 (9.961)			118 (4.646)	280 (11.024)												
13C□2OE*	2	436 (17.165)	378 (14.882)	323 (12.717)				350 (13.780)											$22\ ^{0}_{-0.013}$ $(0.866\ ^{0}_{-0.00051})$	40 (1.575)
20C□2OE*	3	422 (16.614)	343 (13.504)	289 (11.378)	79 (3.110)	54 (2.126)	164 (6.457)	315 (12.402)	123 (4.843)	143 (5.630)		200 (7.874)	$114.3\ ^{0}_{-0.025}$ $(4.5\ ^{0}_{-0.00098})$	180 (7.087)	3.2 (0.126)	18 (0.709)	230 (9.055)	13.5 (0.531)	$35\ ^{+0.01}_{0}$ $(1.378\ ^{+0.00039}_{0})$	76 (2.992)
30C□2OE	3	486 (19.133)	407 (16.024)	353 (13.898)				379 (14.921)												
44C□2OE	3	567 (22.322)	488 (19.213)	434 (17.087)				460 (18.110)												

AC SERVOMOTOR Type USAMED -	Dwg No.	Approx Mass kg (lb)	Magnetic Brake			Connector Types for Motor and Brake				Optical Encoder Connector Types			
			Wattage W	Inertia kg·m² (lb·in·s²)	Static Friction Torque N·m (lb·in)	Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L - type Plug	Straight Plug	Cable Clamp
02□□1OE	1	5 (11.0)	8	0.075×10^{-4} (0.66×10^{-4})	0.98 (8.67)	MS 3102 A14S-6P	MS 3108 B14S-6S	MS 3106 B14S-6S	MS 3057 - 6 A	MS 3102 A20 - 29P	MS 3108 B20 - 29S	MS 3106 B20 - 29S	MS 3057 - 12 A
03□□1OE	1	7 (15.4)	12	0.113×10^{-4} (1.00×10^{-4})	1.96 (17.3)								
05□□1OE*	2	11.5 (25.4)	18	0.85×10^{-4} (7.52×10^{-4})	5.88 (52.1)	MS 3102 A20 - 15P	MS 3108 B20 - 15S	MS 3106 B20 - 15S	MS 3057 - 12 A				
09□□1OE*	2	15 (33.1)											
13C□2OE*	2	23 (50.7)	18	0.9×10^{-4} (7.97×10^{-4})	8.83 (78.1)								
20C□2OE*	3	30 (66.1)	31	6.25×10^{-4} (55.3×10^{-4})	35.3 (312.5)	MS 3102 A24 - 10P	MS 3108 B24 - 10S	MS 3106 B24 - 10S	MS 3057 - 16 A				
30C□2OE	3	37 (81.6)											
44C□2OE	3	49 (108)											

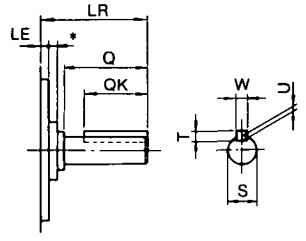
*Not provided with an eyebolt.

Notes:

1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: A (6000 P/R)
   Optional: B (5000 P/R), D (4000 P/R)
2. Vibration: 15 μm 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:



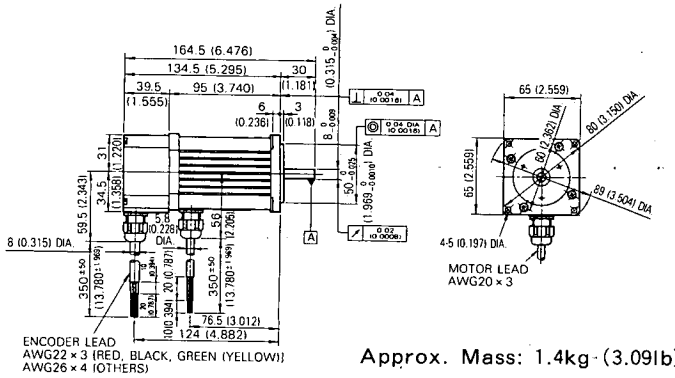
*4 mm (0.157 in.) for USAFED-02□□2 and 03□□2
6 mm (0.236 in.) for USAFED-05□□2 to 13C□2

AC SERVOMOTOR Type USAFED -		LR	LE	Shaft Extension					
Without Brake	With Brake			S	Q	QK	T	U	W
02□□2K	02□□2KE	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)
03□□2K	03□□2KE								
05□□2K	05□□2KE	58 (2.283)	6 (0.236)	$19\ ^{0}_{-0.013}$ $(0.748\ ^{0}_{-0.00051})$	40 (1.575)	25 (0.984)			
09□□2K	09□□2KE								
13C□2K	13C□2KE			$22\ ^{0}_{-0.013}$ $(0.866\ ^{0}_{-0.00051})$			6 (0.236)	3.5 (0.138)	6 (0.236)
20C□2K	20C□2KE	79 (3.110)	3.2 (0.126)	$35\ ^{+0.01}_{0}$ $(1.378\ ^{+0.00039}_{0})$	76 (2.992)	60 (2.362)	8 (0.315)	5 (0.197)	10 (0.394)
30C□2K	30C□2KE								
44C□2K	44C□2KE								

8.3 SERVOMOTOR : S SERIES

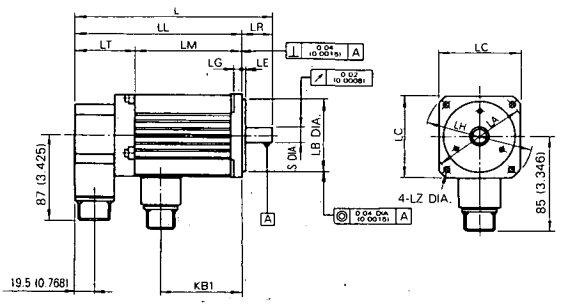
(1) Standard

Type USASEM-02A□2 (Straight Shaft)



Approx. Mass: 1.4kg (3.09lb)

Types USASEM-03A□2, -05A□2 (Straight Shaft)

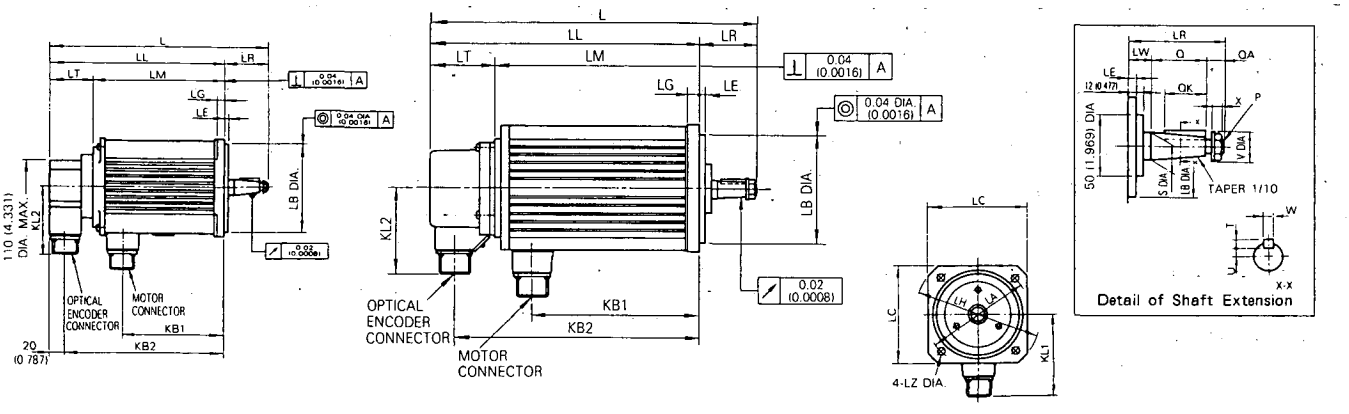


AC SERVOMOTOR Type USASEM -	L	LL	LM	LT	LR	KB1	KL1	Flang Surface and Shaft Extension								Approx Mass kg (lb)
								LA	LB	LC	LE	LG	LH	LZ	S	
03A□2	179 (7.047)	149 (5.866)	110 (4.331)	39 (1.535)	30 (1.181)	78 (3.071)	138 (5.433)	90 (3.543)	70 $^{0}_{-0.030}$ ($2.756\ ^{0}_{-0.0012}$)	80 (3.150)	3 (0.118)	8 (0.315)	105 (4.134)	6 (0.236)	14 $^{0}_{-0.011}$ ($0.551\ ^{0}_{-0.0004}$)	2.6 (5.73)
05A□2	201 (7.913)	171 (6.732)	132 (5.197)			100 (3.937)										3.3 (7.28)

Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: E (1500 P/R)
   Optional : C (2500 P/R), F (1000 P/R)
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.

Type USASEM-08A□1 (Taper Shaft)

Types USASEM-15A□1, -30A□1 (Taper Shaft)



AC SERVOMOTOR Type USASEM -	L	LL	LM	LT	LR	KB1	KB2	KL1	KL2	Flang Surface							Shaft Extension										
										LA	LB	LC	LE	LG	LH	LZ	LW	Q	QK	QA	X	S	V	P	U	W	T
08A□1	258 (10.157)	200 (7.874)	149 (5.866)	51 (2.008)	58 (2.283)	115 (4.528)	180 (7.087)	102 (4.016)	87 (3.425)	130 (5.118)	110 $^{0}_{-0.035}$ ($4.331\ ^{0}_{-0.0013}$)	120 (4.724)	3 (0.118)	10 (0.394)	155 (6.102)	9 (0.354)	18 (0.709)	28 (1.102)	25 (0.984)	12 (0.472)	10 (0.394)	16 (0.63)	21 (0.827)	M10 P1.25	4.3 $^{0}_{-0.1}$ ($0.169\ ^{0}_{-0.0039}$)	5 (0.197)	5 (0.197)
15A□1	317.5 (12.5)	259.5 (10.217)	203.5 (8.012)	56 (2.205)		167 (6.575)	240 (9.449)	109 (4.291)	96 (3.780)	145 (5.709)		130 (5.118)	6 (0.236)	12 (0.472)	165 (6.496)	13.5 (0.531)						19 (0.748)			5.8 $^{0}_{-0.1}$ ($0.228\ ^{0}_{-0.0039}$)		
30A□1	366 (14.409)	296 (11.654)	240 (9.449)		70 (2.756)	206 (8.110)	276 (10.866)	134 (5.276)		200 (7.874)	114.3 $^{0}_{-0.040}$ ($4.5\ ^{0}_{-0.0016}$)	180 (7.087)		18 (0.709)	230 (9.005)		20 (0.787)	36 (1.417)	32 (1.260)	14 (0.351)	12.5 (0.492)	22 (0.866)	24 (0.945)	M12 P1.25	6.6 $^{0}_{-0.1}$ ($0.260\ ^{0}_{-0.0039}$)	6 (0.236)	6 (0.236)

Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: C (2500 P/R)
   Optional: E (1500 P/R), F (1000 P/R)
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 -	Approx Mass kg (lb)	Motor Connector Types Receptacle				Optical Encoder Connector Types			
		Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L-type Plug	Straight Plug	Cable Clamp
03A□2	2.6 (5.73)	MS 3102 A 18 -10P	MS 3108 B 18 -10S	MS 3106 B 18 -10S	MS 3057-10A	MS 3102 A 20 -29P	MS 3108 B 20 -29S	MS 3106 B 20 -29S	MS 3057-12A
05A□2	3.3 (7.28)								
08A□1	6 (13.2)	MS 3102 A 20 -4P	MS 3108 B 20 -4S	MS 3106 B 20 -4S	MS 3057-12A				
15A□1	11 (24.3)								
30A□1	24 (52.9)								

(2) With Brake

Types USASEM-02A□2OB, 03A□2OB,
-05A□2OB (Straight Shaft)

AC SERVOMOTOR TYPE USASEM -	L	LL	LM	Magnetic Brake			Approx Mass kg (lb)
				Type	Inertia $kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2$)	Static Friction Torque N·m (lb·in)	
02A□2OB	228 (8.976)	198 (7.795)	137 (5.394)	MCNB10 - 05	0.0825 (0.0735×10^{-3})	0.98 (8.674)	2.2 (4.9)
03A□2OB	241 (9.488)	211 (8.307)	150 (5.906)	MCNB10 - 05	0.0825 (0.0735×10^{-3})	0.98 (8.674)	3.5 (7.7)
05A□2OB	263 (10.354)	233 (9.173)	172 (6.772)	MCNB15 - 01	0.0825 (0.0735×10^{-3})	1.76 (15.623)	4.1 (9.0)

Notes:
1. Drawout construction of Type USASEM-02AE20B is waterproof gland method. Therfore, connector part differs from figure above. For details, request another dimensions to YASKAWA representaive.
2. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: E (1500 P/R)
   Optional : C (2500 P/R), F (1000 P/R)
3. Vibration: 15 μm or below.
4. Plug and clamp are not attached for receptacle connection.
5. Power supply for brake is 90 VDC.

Types USASEM-08A□1OB, -15A□1OB, -30A□1OB (Taper Shaft)

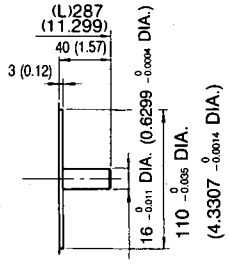
AC SERVOMOTOR Type USASEM -	L	LL	LM	Approx Mass kg (lb)	Magnetic Brake			
					Type	Inertia $kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2$)	Static Friction Torque N·m (lb·in)	Voltage VDC
08A□1OB	305 (12.008)	247 (9.724)	146 (5.748)	7 (15.4)	SCFB/90-30	0.5365 (0.4744×10^{-3})	2.94 (26)	90
15A□1OB	377.5 (14.862)	319.5 (12.579)	197.5 (7.776)	12.5 (27.6)	RNB0.6K-12	0.875 (0.7744×10^{-3})	5.88 (52)	90
30A□1OB	432 (17.008)	362 (14.252)	240 (9.449)	25.5 (56.2)	SCFB/90-120	0.672 (0.5948×10^{-3})	11.76 (104)	90

Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: C (2500 P/R)
   Optional : E (1500 P/R), F (1000 P/R)
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Dimensions of keyway are based on JIS (Japanese Industrial Standard) B 1301 "Sunk keys and Their Corresponding keyways (Close keys)"

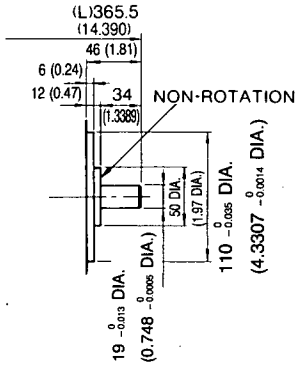
(3) Shaft Extension of Straight Shaft

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:

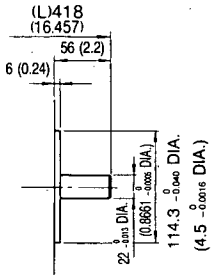
• With brake
Type USASEM-08A□2OB



• With brake
Type USASEM-15A□2OB



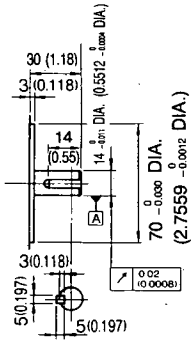
• With brake
Type USASEM-30A□2OB



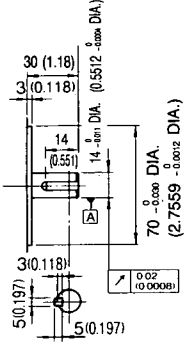
(4) Shaft Extension of Straight Shaft with Keyway

SERVOMOTOR proper is the same dimensions as standard SWEVOMOTOR in S series but dimensions L of type USASEM - 08 A□2K□ or higher is the different dimensions. See Par. 8.3 (1). Details of shaft extension are shown below.

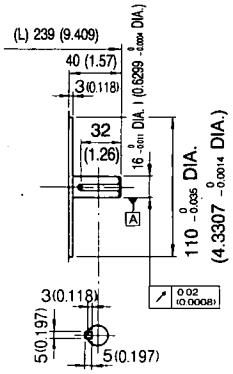
• Without brake
Types USASEM-03A□2K,
-05A□2K



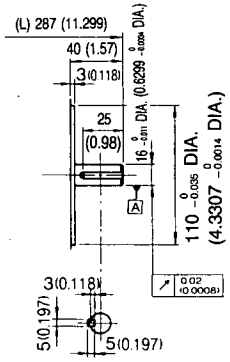
• Without brake
Types USASEM-03A□2KB,
-05A□2KB



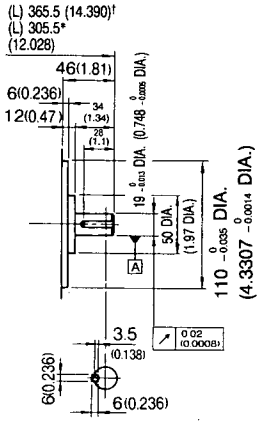
• Without brake
Type USASEM-08A□2K



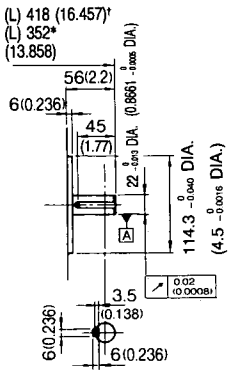
• With brake
Type USASEM-08A□2KB



• Type USASEM-15A□2K (Without brake)
Type USASEM-15A□2KB (With brake)



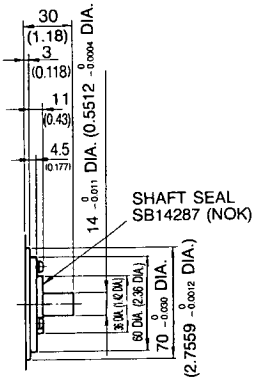
• Type USASEM-30A□2K (Without brake)
Type USASEM-30A□2KB (With brake)



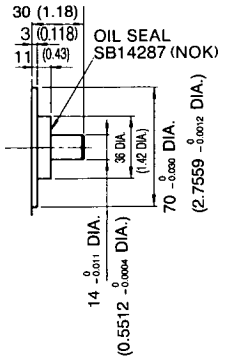
(5) Shaft Extension of Straight Shaft with Shaft Seal

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

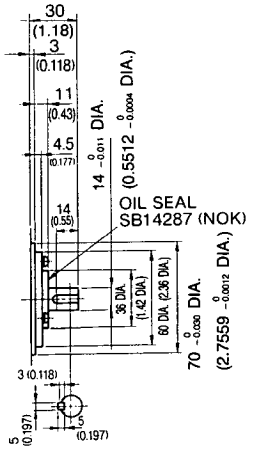
• Without brake
Types USASEM-03A□2S, -05A□2S



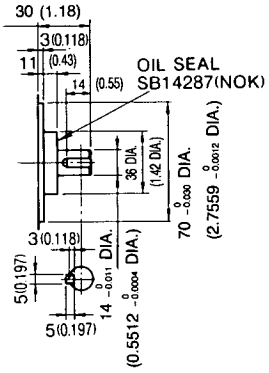
• With brake
Types USASEM-03A 2SB, -05A□2SB



• Without Brake
Types USASEM-03A□2T, -05A□2T



• With brake
Types USASEM-03A□2TB, -05A□2TB



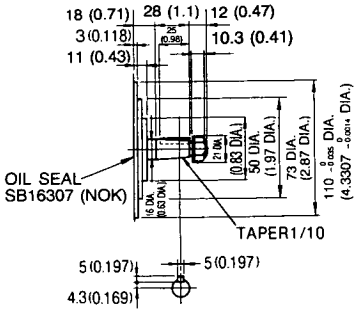
(6) Shaft Extension of Straight Shaft with Keyway and Shaft Seal

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

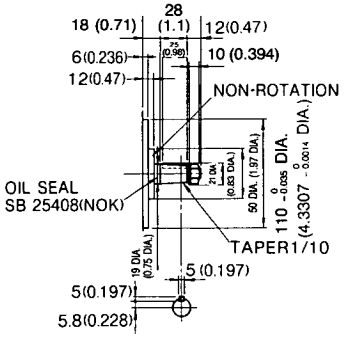
(7) Shaft Extension of Taper Shaft with Shaft Seal

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

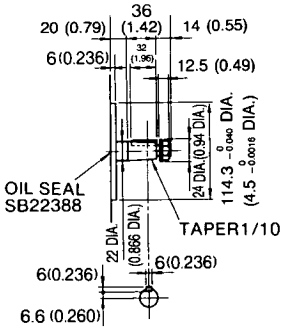
• Without brake
Type USASEM-08A□1S



• Without brake
Type USASEM-15A□1S

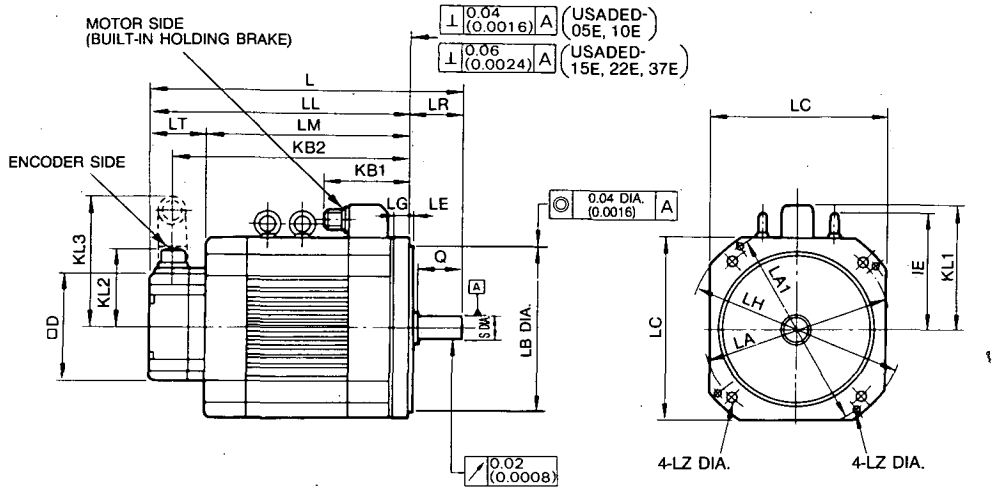


• Without brake
Type USASEM-30A□1S



8.4 SERVOMOTOR: D SERIES

(1) Standard



AC SERVOMOTOR Type USADED-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	KL3	D	Flange Surface and Shaft Extension											Approx Mass kg (lb)
													LA	LA1	LB	LC	LE	LG	LH	LZ	LZ1	S	Q	
05E□2OE*	237 (9.33)	182 (7.17)	137 (5.39)	55 (2.17)	45 (1.77)	82 (3.23)	158 (6.22)	–	143 (5.63)	92 (3.62)	164 (6.46)	130 (5.12)	200 (7.87)	–	114.3 $^{0}_{-0.025}$ ($4.5\ ^{0}_{-0.00098}$)	180 (7.09)	3.2 (0.13)	12 (0.47)	230 (9.06)	13.5 (0.53)	–	22 $^{0}_{-0.013}$ ($0.8661\ ^{0}_{-0.00051}$)	50 (1.97)	17 (37.5)
10E□2OE*	257 (10.1)	202 (7.95)	157 (6.18)	55 (2.17)	45 (1.77)	82 (3.23)	178 (7.01)	–	143 (5.63)	92 (3.62)	164 (6.46)	130 (5.12)	200 (7.87)	–	114.3 $^{0}_{-0.025}$ ($4.5\ ^{0}_{-0.00098}$)	180 (7.09)	3.2 (0.13)	12 (0.47)	230 (9.06)	13.5 (0.53)	–	22 $^{0}_{-0.013}$ ($0.8661\ ^{0}_{-0.00051}$)	50 (1.97)	14 (41.9)
15E□2OE*	272 (10.71)	217 (8.54)	170 (6.69)	55 (2.17)	47 (1.85)	100 (3.94)	193 (7.60)	142 (5.59)	162 (6.38)	92 (3.62)	164 (6.46)	130 (5.12)	235 (9.25)	250 (9.84)	200 $^{0}_{-0.046}$ ($7.874\ ^{0}_{-0.00181}$)	220 (8.66)	4 (0.16)	16 (0.63)	270 (10.6)	13.5 (0.53)	M8	28 $^{0}_{-0.013}$ ($1.1024\ ^{0}_{-0.00051}$)	50 (1.97)	30 (66.1)
22E□2OE*	287 (11.30)	232 (9.13)	185 (7.28)	55 (2.17)	47 (1.85)	100 (3.94)	208 (8.19)	142 (5.59)	162 (6.38)	92 (3.62)	164 (6.46)	130 (5.12)	235 (9.25)	250 (9.84)	200 $^{0}_{-0.046}$ ($7.874\ ^{0}_{-0.00181}$)	220 (8.66)	4 (0.16)	16 (0.63)	270 (10.6)	13.5 (0.53)	M8	28 $^{0}_{-0.013}$ ($1.1024\ ^{0}_{-0.00051}$)	50 (1.97)	32 (70.5)
37E□2OE*	347 (13.66)	282 (11.1)	235 (9.25)	65 (2.56)	47 (1.85)	100 (3.94)	258 (10.16)	142 (5.59)	162 (6.38)	92 (3.62)	164 (6.46)	130 (5.12)	235 (9.25)	250 (9.84)	200 $^{0}_{-0.046}$ ($7.874\ ^{0}_{-0.00181}$)	220 (8.66)	4 (0.16)	16 (0.63)	270 (10.6)	13.5 (0.53)	M8	32 $^{0}_{-0.015}$ ($1.2598\ ^{0}_{-0.00063}$)	60 (2.36)	39 (86.0)

*Not provided with an eyebolt.

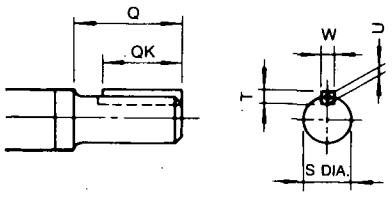
Notes

1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: 3 (2048 P/R)
   Optional: 2 (8192 P/R)
2. Plug and clamp are not attached for receptacle connection.
3. Dimensions avove are applied for servomotor with incremental encoder, with absolute encoder or w/wo holding brake as well.

Receptacle Specifications

AC SERVOMOTOR Type USAMED-	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
05E□2□□	MS 3102 A20 - 15P	MS 3108 B20 - 15P	MS 3106 B20 - 15S	MS 3057 - 12A	MS 3102 A20 - 29P	MS 3108 B20 - 29S	MS 3106 B20 - 29S	MS 3057 - 12A
10E□2□□								
15E□2□□	MS 3102 A24 - 10P	MS 3108 B24 - 10S	MS 3106 B24 - 10S	MS 3057 - 16A				
22E□2□□								
37E□2□□								

(2) Shaft Extention of Straight with Keyway

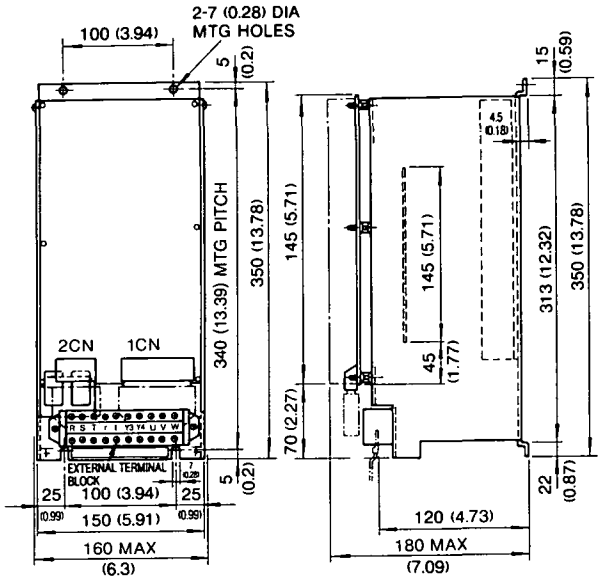


AC SERVOMOTOR Type USAMED-	Shaft Extension					
	S DIA	Q	QK	T	U	W
05E□2K□	22 $^{0}_{-0.013}$ ($0.8661\ ^{0}_{-0.00051}$)	50 (1.97)	45 (1.77)	6 (0.24)	3.5 (0.14)	3.5 (0.14)
10E□2K□	22 $^{0}_{-0.033}$ ($0.861\ ^{0}_{-0.00051}$)	50 (1.97)	45 (1.77)	6 (0.24)	3.5 (0.14)	6 (0.236)
15E□2K□	28 $^{0}_{-0.013}$ ($1.1024\ ^{0}_{-0.00051}$)	50 (1.97)	45 (1.77)	7 (0.28)	4 (0.16)	8 (0.31)
22E□2K□	28 $^{0}_{-0.013}$ ($1.1024\ ^{0}_{-0.00051}$)	50 (1.97)	45 (1.77)	7 (0.28)	4 (0.16)	8 (0.31)
37E□2K□	32 $^{0}_{-0.013}$ ($1.2598\ ^{0}_{-0.00063}$)	60 (2.36)	50 (1.97)	8 (0.31)	5 (0.20)	10 (0.39)

Note: Dimensions of the shaft extension key and keyway are based on JIS (Japanese Industrial Standard) B 1301 "Sunk keys and Their Corresponding Keyways (Normal keys)" Shaft extension key is furnished.

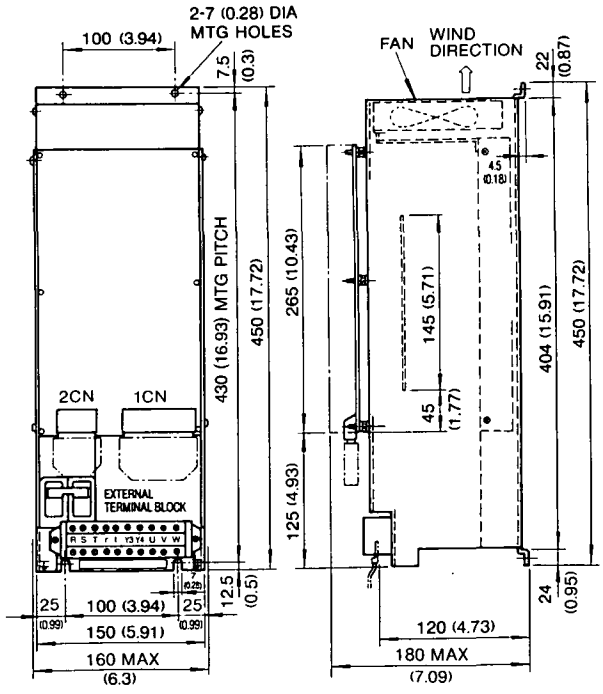
8. 5 SERVOPACK

(1) Types CACR-SR03BB to -SR15BB



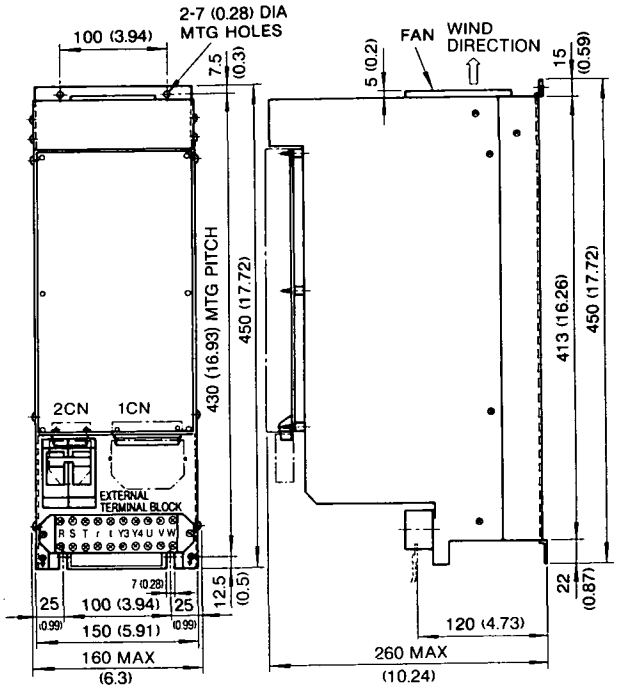
APPROX MASS: 5.5 kg (13 lb)

(2) Types CACR-SR20BB and -SR30BB



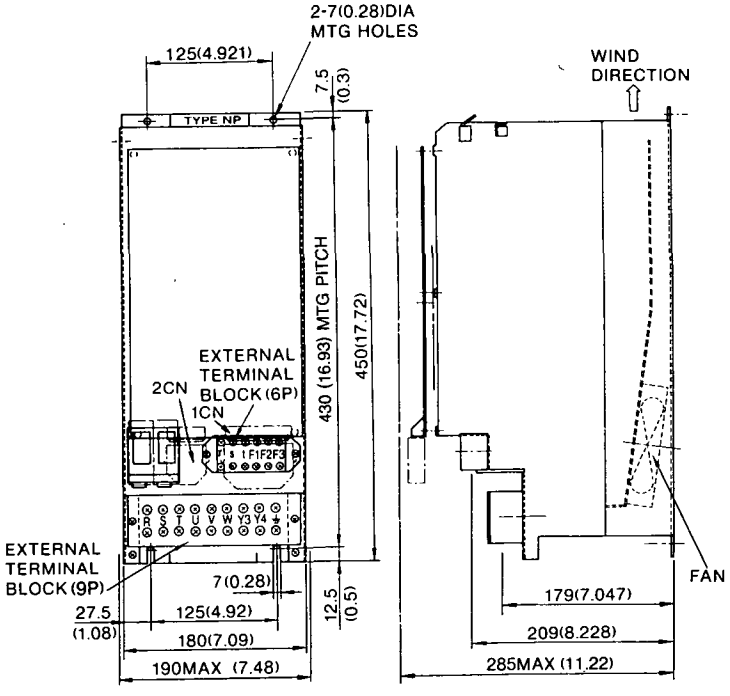
APPROX MASS: 9.5 kg (21 lb)

(3) Type CACR-SR44BB



APPROX MASS: 11 kg (25 lb)

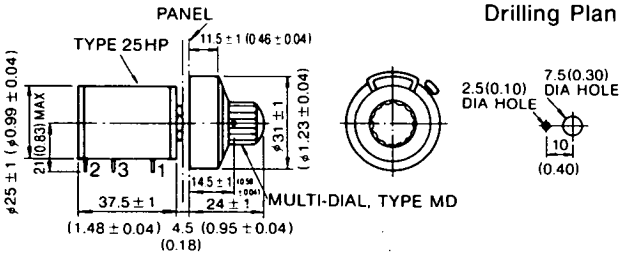
(4) Type CACR-SR60BB



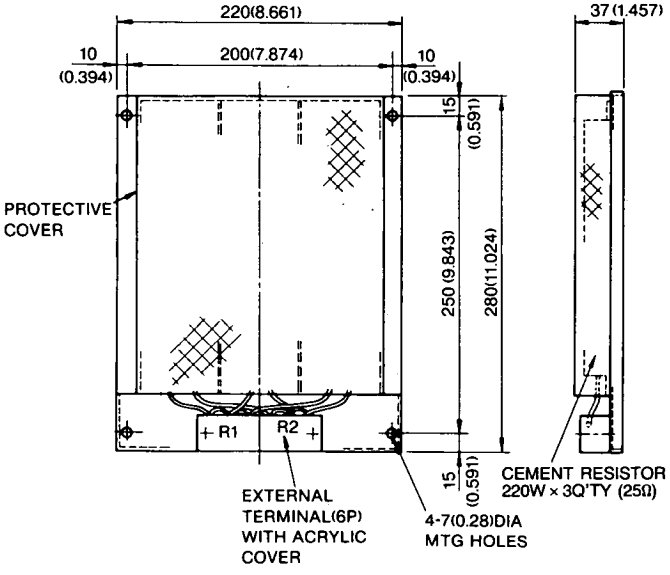
APPROX MASS: 13 kg (28.7 lb)

8.6 PERIPHERAL EQUIPMENT

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



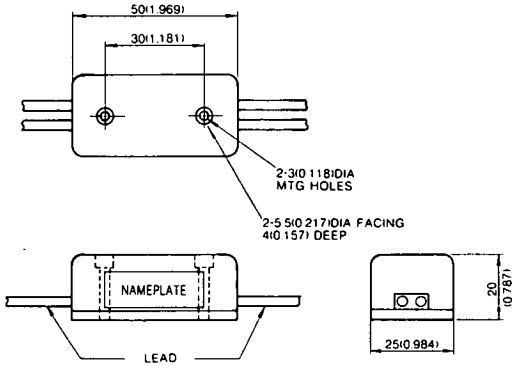
(2) Registor Unit Type JUSP-RA03
For SERVOPACK Type CACR-SR60BB



(3) Power Supply for Brake

(a) Standard Type

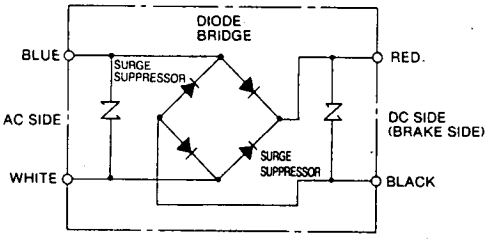
- Input 100 VAC, 90 VDC, Max. 1.0 ADC
  (Type B9400876-2) Type: LPDE-1H01
- Input 200 VAC, 90 VDC, Max. 1.0 ADC
  (Type B9400876-1) Type: LPSE-2H01



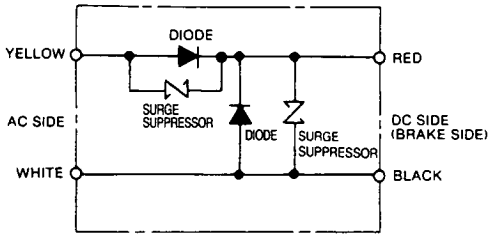
Max. ambient temperature: 60°C
Lead length: 500mm (19.69 in) each
Lead color

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

- For 100 VAC



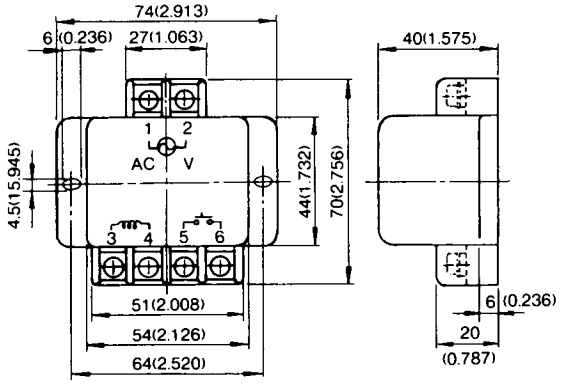
- For 200 VAC



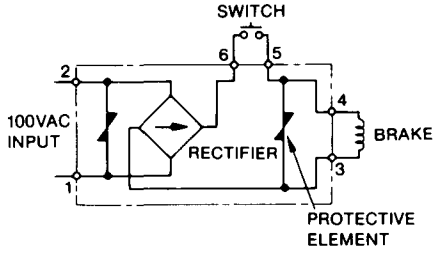
Note: The brake power circuit can be turned ON and OFF on either the AC or DC side. Normally, switching on the AC side is safer. If switched on the DC side, surge voltage may damage the brake coil. To avoid this, place a surge suppressor near the brake coil.

(b) Conventional Type

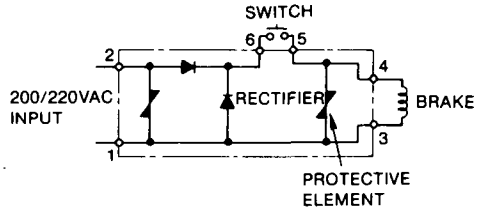
- Input 100 VAC, output 90 VDC, Max. 1.0 ADC (Type OPR109F)
- Input 200 VAC, output 90 VDC, Max. 1.0 ADC (Type OPR109A)



Type OPR109F Circuit Diagram



Type OPR109A Circuit Diagram

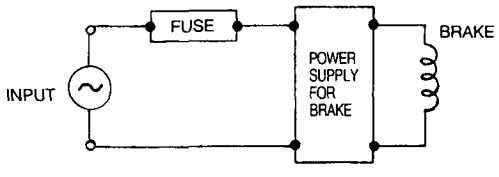


Notes:

1. Do not short-circuit between output terminal Nos. 3 and 4.
2. The open/close value of the contact used for Nos. 5 and 6 is 5 to 10 times the rated current of the brake used.
   Direct current open/close contacts must be used.
3. Insert a fuse in the input side to protect the power unit.

Fuse Type: MF60 NR2
(Made by TOYO FUSE CO., LTD.)

Circuit Diagram



9. TEST RUN

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

9.1 CHECK ITEMS BEFORE TEST RUN

9.1.1 SERVOMOTOR

Before test run, check the following. If the test run is performed after long storage, see Par. 11, "INSPECTION AND MAINTENANCE."

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

9.1.2 SERVOPACK

- Setting switches are correctly set to satisfy the specifications for the applicable SERVOMOTOR and optical encoder.
- Connection and wiring leads are firmly connected to terminals or inserted into the connectors.
- The power supply is turned OFF if servo alarm occurs.
- 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 0V.

9.2 TEST RUN PROCEDURES

9.2.1 Preparation of Operation

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

(1) Power ON

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

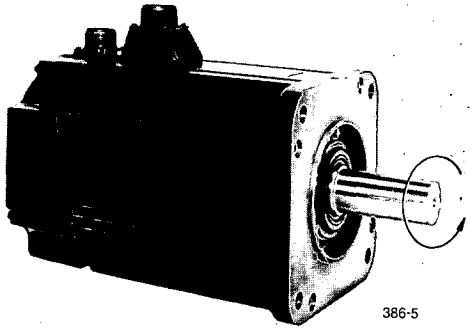


Fig. 9.1 Motor Forward Running

9.2.3 Inspection during Test Run

The following items should be checked during the test run.

- Unusual vibration
- Abnormal noise
- Excessive temperature rise

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

10. ADJUSTMENT

10.1 SETTINGS AT THE TIME OF DELIVERY

The SERVOPACK has been factory-adjusted as follows :

(1) M series

Table 10.1 Standard Adjustment and Setting Specifications

SERVOPACK Type CACR-	Applicable SERVOMOTOR			SERVOPACK Adjustment		
	Type	Optical Encoder pulses/rev	Rated Current* A	Speed Setting	Starting Current Setting* A	PG Frequency Dividing Ratio
SR03BB1AM	USAMED-03□A1	6000	3.0	1000 r/min at rated speed reference	7.3	×1
SR03BB1BM	USAMED-03□B1	5000				
SR03BB1DM	USAMED-03□D1	4000				
SR07BB1AM	USAMED-06□A1	6000	5.8		13.9	
SR07BB1BM	USAMED-06□B1	5000				
SR07BB1DM	USAMED-06□D1	4000				
SR10BB1AM	USAMED-09BA2	6000	7.6		16.6	
SR10BB1BM	USAMED-09BB2	5000				
SR10BB1DM	USAMED-09BD2	4000				
SR15BB1AM	USAMED-12BA2	6000	11.7		28.0	
SR15BB1BM	USAMED-12BB2	5000				
SR15BB1DM	USAMED-12BD2	4000				
SR20BB1AM	USAMED-20BA2	6000	18.8		42.0	
SR20BB1BM	USAMED-20BB2	5000				
SR20BB1DM	USAMED-20BD2	4000				
SR30BB1AM	USAMED-30BA2	6000	26.0		56.5	
SR30BB1BM	USAMED-30BB2	5000				
SR30BB1DM	USAMED-30BD2	4000				
SR44BB1AM	USAMED-44BA2	6000	33.0		70.0	
SR44BB1BM	USAMED-44BB2	5000				
SR44BB1DM	USAMED-44BD2	4000				
SR60BB1AM	USAMED-60BA2	6000	45.0		80.6	
SR60BB1BM	USAMED-60BB2	5000				
SR60BB1DM	USAMED-60BD2	4000				

* Effective value

Table 10.2 Field-setting Switch Position

SERVOPACK Type CACR-		SW1 Motor Type, PG Pulse Setting	SW2 Pulse Resolution Setting	SW3 Speed Loop Condition Setting	SW4 Motor Characteristics, SERVOPACK Function Setting
Standard	SR03BB1AM to SR60BB1AM	6000 1 2 3 4 5 6 7 8 ● ○ ○ ● ● ● ● ○ ● ○ ○ ● ● ● ● ○	×1 1 2 3 4 5 6 7 8 † ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●	1 2 3 4 5 6 7 8 ● ○ ○ ● ○ ○ ○ ○ ● ○ ○ ● ○ ○ ○ ○	1 2 3 4 5 6 7 8 ● ● ● ○ ○ ○ ○ ● ● ● ● ○ ○ ○ ○ ●
Optional	SR03BB1BM to SR60BB1BM	5000 1 2 3 4 5 6 7 8 ● ○ ○ ● ○ ○ ○ ● ● ○ ○ ● ○ ○ ○ ●			
	SR03BB1DM to SR60BB1DM	4000 1 2 3 4 5 6 7 8 ● ○ ○ ● ● ○ ○ ● ● ○ ○ ● ● ○ ○ ●			

† Spare short-circuit pin

Table 10.3 Potentiometer Field-set Positions

SERVOPACK Type CACR-	Auxiliary Input Setting VR1 IN-B	Auxiliary Input Fine Setting VR4	Zero Drift Setting VR3 ZERO	Max Current Setting VR5 CUR	Loop Gain Setting VR6 LOOP
SR03BB1□M	10V at rated speed (For setting by the user.)	5/10	4/10 to 6/10	10/10 (For setting by the user.)	5/10
SR07BB1□M					
SR10BB1□M					
SR15BB1□M					
SR20BB1□M					
SR30BB1□M					
SR44BB1□M					
SR60BB1□M					

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.

(2) F series

Table 10.4 Standard Adjustment and Setting Specifications

SERVOPACK Type CACR-	Applicable SERVOMOTOR			SERVOPACK Adjustment		
	Type USAFED-	Optical Encoder pulses/rev	Rated Current* A	Speed Setting	Starting Current Setting* A	PG Frequency Dividing Ratio
SR03BB1AF	02□A1	6000	3.0	1500 r/min at rated speed reference	8.5	×1
	03□B1					
SR03BB1BF	02□B1	5000				
	03□B1					
SR03BB1DF	02□D1	4000				
	03□D1					
SR07BB1AF	05□A1	6000	3.8		11.0	
SR07BB1BF	05□B1	5000				
SR07BB1DF	05□D1	4000				
SR10BB1AF	09□A1	6000	6.2		17.0	
SR10BB1BF	09□B1	5000				
SR10BB1DF	09□D1	4000				
SR15BB1AF	13CA2	6000	9.7		27.6	
SR15BB1BF	13CB2	5000				
SR15BB1DF	13CD2	4000				
SR20BB1AF	20CA2	6000	15.0		42.0	
SR20BB1BF	20CB2	5000				
SR20BB1DF	20CD2	4000				
SR30BB1AF	30CA2	6000	20.0		56.5	
SR30BB1BF	30CB2	5000				
SR30BB1DF	30CD2	4000				
SR44BB1AF	44CA2	6000	30.0		77.0	
SR44BB1BF	44CB2	5000				
SR44BB1DF	44CD2	4000				

* Effective value

Table 10.5 Field-setting Switch Position

SERVOPACK Type CACR-		SW1 Motor Type, PG Pulse Setting	SW2 Pulse Resolution Setting	SW3 Speed Loop Condition Setting	SW4 Motor characteristic SERVOPACK Function Setting
Standard	SR03BB1AF to SR44BB1AF	6000 1 2 3 4 5 6 7 8 ○○○●●●●○ ○○○●●●●●	×1 1 2 3 4 5 6 7 8 † ●●●●●●●●	1 2 3 4 5 6 7 8 ○○○●○○○○ ○○○●○○○○	1 2 3 4 5 6 7 8 ●●●●○○○●
Optional	SR03BB1BF to SR44BB1BF	5000 1 2 3 4 5 6 7 8 ○○○●○○○● ○○○●○○○●			
	SR03BB1DF to SR44BB1DF	4000 1 2 3 4 5 6 7 8 ○○○●●○○● ○○○●●○○●			

† Spare short-circuit pin

Table 10.6 Potentiometer Field-set Positions

SERVOPACK Type CACR-	Auxiliary Input Setting	Auxiliary Input Fine Setting	Zero Drift Setting	Max Current Setting	Loop Gain Setting
	VR1 IN-B	VR4	VR3 ZERO	VR5 CUR	VR6 LOOP
SR03BB1□F SR05BB1□F SR10BB1□F SR15BB1□F SR20BB1□F SR30BB1□F SR44BB1□F	10V at rated speed (For setting by the user.)	5/10	4/10 to 6/10	10/10 (For setting by the user.)	5/10

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.

(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	Speed Setting	Starting Current Setting* A	PG Frequency Dividing Ratio
SR03BB1CS–Y41	02AC2	2500	2.1	3000 r/min at rated speed reference	6.0	×1
SR03BB1ES–Y41	02AE2	1500				
SR03BB1FS–Y41	02AF2	1000				
SR03BB1CS	03AC2	2500	3.0		8.5	
SR03BB1ES	03AE2	1500				
SR03BB1FS	03AF2	1000				
SR05BB1CS	05AC2	2500	4.2		11.0	
SR05BB1ES	05AE2	1500				
SR05BB1FS	05AF2	1000				
SR10BB1CS	08AC1	2500	5.3		15.6	
SR10BB1ES	08AE1	1500				
SR10BB1FS	08AF1	1000				
SR15BB1CS	15AC1	2500	10.4		28.0	
SR15BB1ES	15AE1	1500				
SR15BB1FS	15AF1	1000				
SR30BB1CS	30AC1	2500	19.9		56.5	
SR30BB1ES	30AE1	1500				
SR30BB1FS	30AF1	1000				

*Effective value

Table 10.8 Field-setting Switch Position

SERVOPACK Type CACR-		SW1 Motor Type, PG Pulse Setting	SW2 Pulse Resolution Setting	SW3 Speed Loop Condition Setting	SW4 Motor Characteristics, SERVOPACK Function Setting
Standard	SR10BB1CS to SR30BB1CS	2500 1 2 3 4 5 6 7 8 ●●○●●●○●	×1 1 2 3 4 5 6 7 8† ●●●●●●●●	• SR10BB, SR15BB 1 2 3 4 5 6 7 8 ○●○○○●○○	1 2 3 4 5 6 7 8 ●●●○○○○●
	SR03BB1ES to SR05BB1ES	1500 1 2 3 4 5 6 7 8 ●●○●●○●●		• SR03BB, SR05BB SR30BB 1 2 3 4 5 6 7 8 ○●○●○○○○	
Optional	SR03BB1FS to SR30BB1FS	1000 1 2 3 4 5 6 7 8 ●●○●●●●●			

† Spare short-circuit pin

Table 10.9 Potentiometer Field-set Positions

SERVOPACK Type CACR-	Auxiliary Input Setting VR1 IN–B	Auxiliary Input Fine Setting VR4	Zero Drift Setting VR3 ZERO	Max Current Setting VR5 CUR	Loop Gain Setting VR6 LOOP
SR03BB□S	10V at rated speed (For setting by the user.)	5/10	4/10 to 6/10	10/10	5/10
SR05BB□S					
SR10BB□S					
SR15BB□S					
SR30BB□S					

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.

(4) D series

Table 10.10 Standard Adjustment and Setting Specifications

SERVOPACK Type CACR-	Applicable SERVOMOTOR			SERVOPACK Adjustment		
	Type USADED-	Optical Encoder pulses/rev	Rated Current* A	Speed Setting	Starting Current Setting* A	PG Frequency Dividing Ratio
SR05BB1AD	05EA2	6000	3.5	2000 r/min at rated speed reference	10.6	× 1
SR05BB1BD	05EB2	5000				
SR05BB1DD	05ED2	4000				
SR15BB1AD	10EA2	6000	7.9		25.2	
SR15BB1BD	10EB2	5000				
SR15BB1DD	10ED2	4000				
SR20BB1AD	15EA2	6000	12.6		40.7	
SR20BB1BD	15EB2	5000				
SR20BB1DD	15ED2	4000				
SR30BB1AD	22EA2	6000	16.6		54.0	
SR30BB1BD	22EB2	5000				
SR30BB1DD	22ED2	4000				
SR44BB1AD	37EA2	6000	23.3		77.0	
SR44BB1BD	37EB2	5000				
SR44BB1DD	37ED2	4000				

* Effective value

Table 10.11 Field-setting Switch Position

SERVOPACK Type CACR-		SW1 Motor Type, PG Pulse Setting	SW2 Pulse Resolution Setting	SW3 Speed Loop Condition Setting	SW4 Motor Characteristics, SERVOPACK Function Setting
Standard	SR05BB1AD to SR44BB1AD	6000 1 2 3 4 5 6 7 8 ○○○●●●●○ ○○○●●●●○	×1 1 2 3 4 5 6 7 8† ●●●●●●●● ●●●●●●●●	1 2 3 4 5 6 7 8 ○○○●○○○○ ○○○●○○○○	1 2 3 4 5 6 7 8 ●●●○○○○● ●●●○○○○●
	SR05BB1BD to SR44BB1BD	5000 1 2 3 4 5 6 7 8 ○○○●○○○● ○○○●○○○●			
Optional	SR05BB1DD to SR44BB1DD	4000 1 2 3 4 5 6 7 8 ○○○●●○○● ○○○●●○○●			

† Spare short-circuit pin

Table 10.12 Potentiometer Field-set Positions

SERVOPACK Type CACR-	Auxiliary Input Setting	Auxiliary Input Fine Setting	Zero Drift Setting	Max Current Setting	Loop Gain Setting
	VR1 IN-B	VR4	VR3 ZERO	VR5 CUR	VR6 LOOP
SR05BB1□D	10V at rated speed (For setting by the user.)	5/10	4/10 to 6/10	10/10 (For setting by the user.)	5/10
SR15BB1□D					
SR20BB1□D					
SR30BB1□D					
SR44BB1□D					

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.

10. 2 CHARACTERISTICS AT THE TIME OF DELIVERY

The SERVOPACK has been factory - adjusted as follows :

(1) Speed reference input —— SERVOMOTOR speed ratio (no load) (Fig. 10.1)

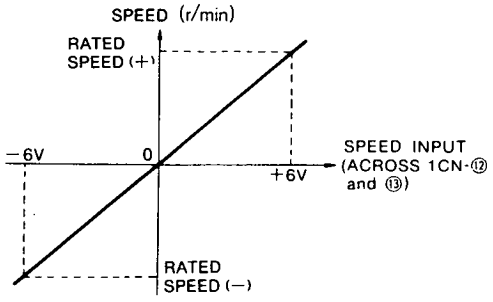


Fig. 10.1 Speed Reference Input-SERVOMOTOR Speed Ratio

(2) Speed Regulation (Fig. 10.2)

Speed regulation ΔN Δn :

$$\frac{\Delta N}{N_R} \times 100\ \% \leqq 0.03\ \%$$

$$\frac{\Delta n}{N_R} \times 100\ \% \leqq 0.015\ \%$$

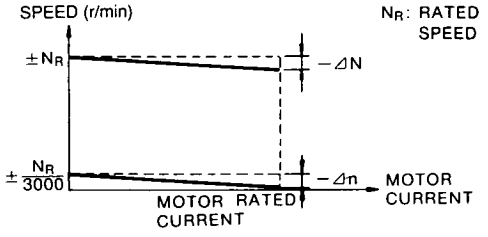


Fig. 10.2 Speed Regulation

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

I_P : Start current set value in Tables 10.1, 10.4, 10.7, 10.10. The overshoot (ΔNov) and undershoot (ΔN_{UD}) when $J_L = J_M$, are as shown in Table 10.13 (adjustment level preset at the factory).

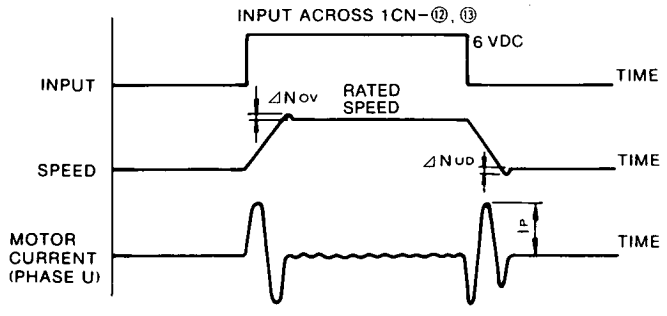


Fig. 10.3 Start-Stop Characteristics

Table 10.3 Overshoot and Undershoot at Stop Response

Type CACR-	$\Delta N_{OV}/N_R \times 100$	$\Delta N_{UD}/N_R \times 100$
SR03BB	5 % max	5 % max
SR05BB		
SR07BB		
SR10BB		
SR15BB		
SR20BB		
SR30BB		
SR44BB		
SR60BB		

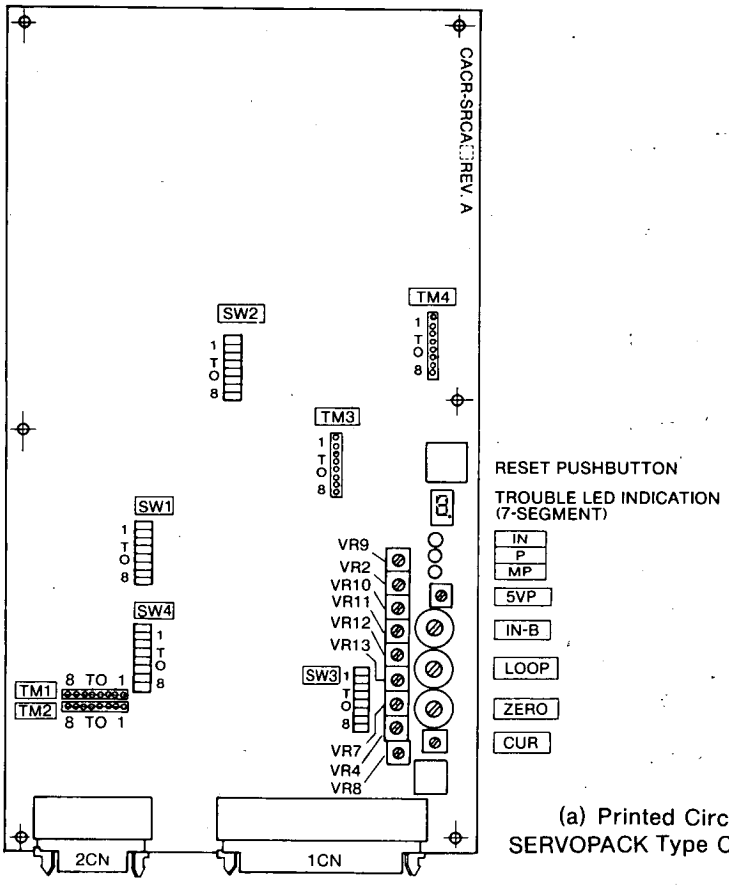
10. 3 READJUSTMENT

The SERVOPACK has been adjusted at the factory to obtain optimum characteristics and readjustment is normally unnecessary. If adjustment is required depending on the use, readjust the SERVOPACK referring to Table 10.14. (Do not temper with potentiometers.)

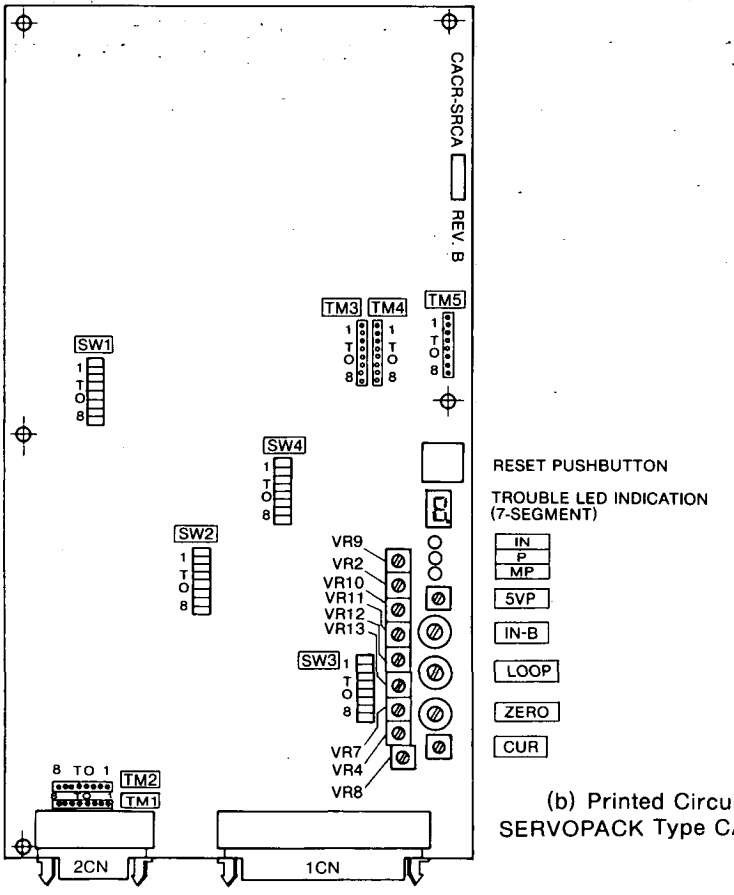
10. 4 ADJUSTMENT PROCEDURES

Fig. 10.4 shows the arrangement of potentiometers, and terminals for checking waveforms; Table 10.11 shows the specifications of the check pin (CH); and Table 10.15 lists check terminals and functions.

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

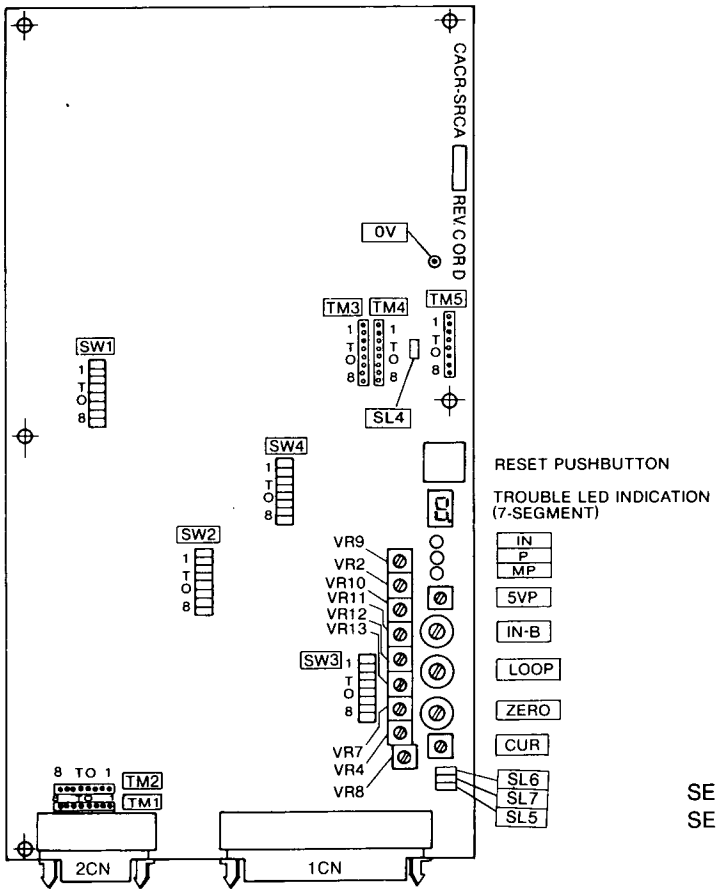


(a) Printed Circuit Board for SERVOPACK Type CACR-SRCA□REV. A



(b) Printed Circuit Board for SERVOPACK Type CACR-SRCA□REV. B

Fig. 10.4 Arrangement of Potentiometers (VR), Check Terminals and Switches (SW)

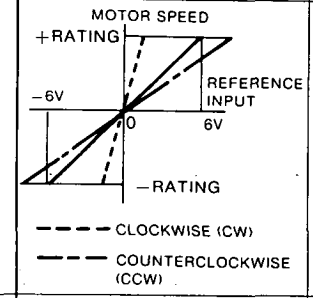
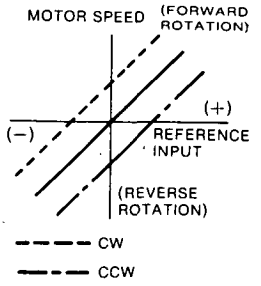


(c) Printed Circuit Board for
SERVOPACK Type CACR-SRCA□REV. C
SERVOPACK Type CACR-SRCA□REV. D

Note: Do not adjust for SL4 to SL7.

Fig. 10.4 Arrangement of Potentiometers (VR), Check Terminals and Switches (SW)

Table 10.14 Potentiometer Adjustment

Potentiometer	VR1 IN-B	VR4	VR3 ZERO	VR5 CUR
Functions	Auxiliary input adjustment	Auxiliary input fine adjustment	Zero drift adjustment	Starting current adjustment
How to Adjust	To be adjusted only when the rated reference voltage (±2 to ±10V) is other than ±6V. Turn VR1 only to get the rated speed and do not operate other VRs.	To fine adjust the adjusted value of VR1.	To adjust so that the motor does not turn at the speed reference voltage 0 V. Turning VR3 CW allows the motor to be finely adjusted in forward rotation, and CCW in reverse rotation.	Turning VR5 CCW decreases the starting current. This has been adjusted to full scale CCW at the factory.
Characteristics		Adjustable in units of $\frac{1}{10}$ of VR1 setting.		—
Adjustment	○	○	○	○

Potentiometer	VR6 LOOP	VR2	VR9	VR10
Functions	Speed loop gain adjustment	f/V gain adjustment	f/V zero adjustment	f/V balance adjustment
How to Adjust	To increase gain, turn VR6 CW.	Turning CW increases feedback voltage.	f/V circuit offset adjustment.	f/V circuit ±output voltage balance adjustment
Characteristics	Turn VR6 CCW to prevent hunting.	Turning CW decreases motor speed.	—	If f/V balance adjustment is not correct, motor does not run at the same speed in both directions under the same absolute reference voltage.
Adjustment	○	×	×	×

Potentiometer	VR7	VR8	—	—
Functions	Torque reference adjustment	Max current adjustment	—	—
How to Adjust	Adjust to rated current at 3V.	Set max current depending on types and motor output. (Turn VR5 CW to full scale.)	—	—
Characteristics	—	Turning CW increases max current.	—	—
Adjustment	×	×	—	—

Potentiometer	VR11	VR12	VR13	VR21
Function	Phase U current offset adjustment.	Phase V current offset adjustment	Phase W current offset adjustment	PG 5V voltage adjustment
How to Adjust	With only control power turned on, adjust until phase U current amplifier output voltage becomes minimum.	With only control power turned on, adjust until phase V current amplifier output voltage becomes minimum.	With only control power turned on, adjust until phase W current amplifier output voltage becomes minimum.	PG power voltage adjustment. It is set to 5.35V at the factory.
Characteristics	Incorrect adjustment increases torque ripple.			Turning CW increases voltage. If wiring to PG is long. causing voltage drop, increase voltage.
Adjustmet	×	×	×	△

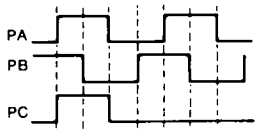
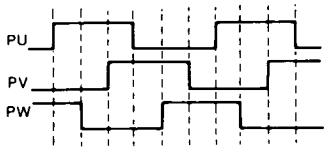
Adjustment Directions

Mark ○: Potentiometer should be adjusted in accordance with specifications and application.

Mark △: Potentiometer should not be adjusted except in special cases.

Mark ×: Do not adjust.

Table 10.15 List of Check Terminals

Equipment Symbol		Signal Name	Description		
TM1	1	PA	PG input signals	Phase A pulse is input.	PA and PB are two-phase pulse 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	IN-A	Monitors the speed reference input (connector 1CN ⑫—⑬).		
	2	IN-B	Monitors the speed reference auxiliary input (connector 1CN ⑭—⑮).		
	3	V_{TG}	Monitors the motor speed ±4.0 VDC/± 1000 r/min. (M, F, D Series), ±2.0 VDC/±1000 r/min (S Series).		
	4	T-Mon	Monitors the motor torque ±3.0 VDC/100 %.		
	5	T-Ref	Torque reference ±2.0 to ±3.0 VDC/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	SG	Signal 0V (for printed circuit board of REV. D), (Not used for printed circuit board of REV. C or later)		
TM4	1	IU	Phase U current monitor.		Type CACR-SR: 03 / 05 / 07 / 10 / 15 / 20 / 30 / 44 / 60 — Monitor Voltage (V/A): 0.4 / 0.24 / 0.20 / 0.16 / 0.08 / 0.04
	2	IV	Phase V current monitor.		
	3		Blank(for printed circuit board of REV. B), (Printed circuit board of REV. C is for power supply ON/OFF confirmation)		
	4	AU	Phase U current amplification output monitor.		330 TO 350μs TRIANGLE PULSE +7.0 TO 8.0V −7.0 TO −8.0V
	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 (for printed circuit board of REV. D), (Not used for printed circuit board of REV. C or later)		
0V		Signal 0V for each signal measurement of TM3 and TM4. (for printed circuit board of REV. C or later)			

Notes:
1. The check terminals allow oscilloscope connection for measurement.
2. Measure waveforms of TM3 and TM4 with TM3-8 or TM4-8 (signal 0V) taken as the reference.
   TM2-8 (PG power 0V) are impedance-connected to TM3-8 and TM4-8 (signal 0V).
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.

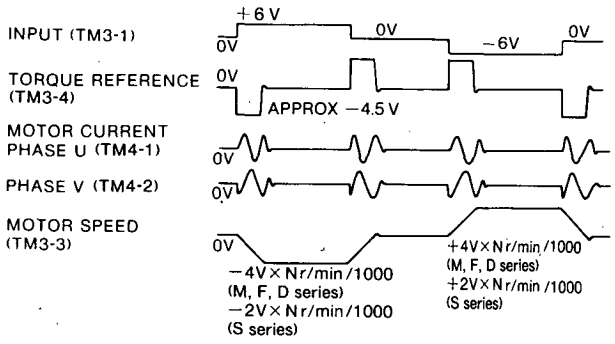


Fig. 10.5 Waveforms at the Respective Check Terminals for Step Responses (No Load)

10.5 SWITCH SETTING

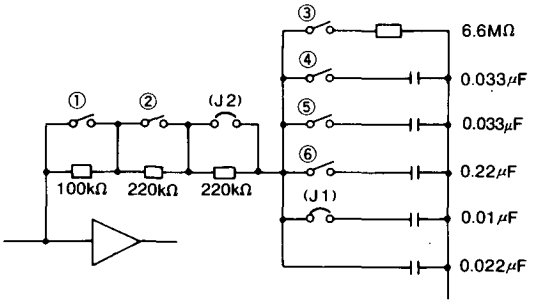
The four switches(SW1 , SW2 , SW3 , SW4) have the following functions:

Table 10.16 Switch Setting and Function

Switch Name	Function	User Adjustment	Remarks
SW1	Motor type setting. Motor PG setting.	Possible	See Tables 10.2, 10.5, 10.8, 10.11.
SW2	PG frequency dividing setting.	Possible	See Table 6.1.
SW3	Speed loop condition setting.	Possible	See the figure below. As a normal rule, leave the setting as it was preset at the factory.
SW4	Motor characteristics and SERVOPACK function setting.	Never change this setting.	The optimized motor torque characteristics and SERVOPACK functions have already been at the factory. SW4-5 selects a dynamic brake function. See Par. 6.5 (1), "Dynamic brake function".

Notes: Function of SW3

1. PI time constant setting (SW3 -1 to -6)



2. f/V filter setting (SW3 -7)

SW3-7	Time Constant
Shorted	1.2 ms
Open	0.1 ms

3. Mode switch setting (SW3 -8)

SW3-8	Mode Switch
Shorted	Not provided
Open	Provided

11. INSPECTION AND MAINTENANCE

11.1 AC SERVOMOTOR

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

Do not disassemble the motor. if disassembly is necessary, contact your YASKAWA representative.

Table 11.1 Inspection Schedule for Motors

Inspection Item	Frequency	Inspection Operation	
Vibration	Daily	Feel manually.	If abnormal vibration or noise is found, contact your YASKAWA representative.
Noise		Aurally	
Exterior and Cleaning	As required	Clean with dry cloth or compressed air.	
Insulation Resistance	Annually	Make sure that it is more than 10MΩ by measuring with a 500V megger after disconnecting the motor from the controller.	
Shaft Seal	Every 5,000 hours	If grease is used for lubrication, replace every 3000 hours.	
Overhaul	Every 20,000 hours or 5 years	If worn or damaged, replace after disconnecting the motor from the driven machine. Contact your YASKAWA representative.	

· Parts Replacement Schedule

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

Table 11.2 Parts Replacement Schedule

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

11.2 SERVOPACK

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

Table 11.3 Inspection Schedule for SERVOPACK

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

· Parts Replacement Schedule

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

Table 11.4 Parts Replacement Schedule

Part Name	Interval	Remarks
Cooling fan	2 to 3 years	Replace with new one.
Smoothing capacitor	7 to 8 years	Replace with new one. (Decided after inspection)
Circuit protector or relays	—	Upon inspection, decided whether they should be replaced.
Fuse	10 years	Replace with new one.
Aluminum electrolytic capacitor on PC board	5 years	Replace with new board. (Decided after inspection)

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

12. TROUBLESHOOTING GUIDE

12. 1 AC SERVOMOTOR

WARNING

Remedies in ▭ should be practiced after turning OFF the power.

Table 12. 1 Troubleshooting Guide for AC SERVOMOTOR

Trouble	Cause	What to do
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 ambient temperature below 40°C.
	Motor surface is dirty	Clean motor surface.
	Overload	Reduce load or use a larger motor.
Unusual noise	Motor loosely mounted	Tighten foundation bolts.
	Motor misaligned	Realign.
	Coupling out of balance	Balance coupling.
	Noisy bearing	Check alignment, noise of bearing, lubrication and contact your YASKAWA representative.
	Vibration of driven machine	Contact the machine manufacturer.

12.2 SERVOPACK

12.2.1 LED Indication (7-segment) for Troubleshooting

Table 12.2 LED Indication for Troubleshooting

LED	Detection	Lighting Condition	Probable Cause	Corrective Action
1.	Over-current	Goes ON when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the SERVOPACK.
		Goes ON when power is supplied to the main circuit and servo power is turned ON. • MCCB does not trip.	• Defective current feedback circuit. • Defective main circuit transistor module. • Motor grounding	• Replace the SERVOPACK. • Correct grounding.
		Goes ON when power is supplied to the main circuit and servo power is turned ON. • MCCB does not trip.	• Defective motor grounding • Defective main circuit transistor module.	• Replace the motor. • Replace the SERVOPACK.
		Goes ON when power is supplied to the main circuit.	• Defective main circuit transistor module.	• Replace the SERVOPACK.
		Goes ON when the motor accelerates or decelerates.	• Incomplete (1 PWB) VR8 adjustment.	• Replace the SERVOPACK.
2.	Circuit protector tripped	Goes ON when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the SERVOPACK.
		Goes ON when power is supplied to the main circuit.	• Defective main circuit thyristor-diode module.	• Replace the SERVOPACK.
			• MCCB trips.	
		Goes ON during operation.	• Defective main circuit of SERVOPACK (Do not turn ON again.)	
3.	Regenerative trouble	Goes ON when power is supplied to the control circuit.	• Defective control circuit board. (1 PWB).	• Replace the SERVOPACK.
		Goes ON approximate 0.5 to 1 second after power is supplied to the main circuit.	• Defective regenerative transistor.	• Replace the SERVOPACK.
			• Regenerative resistor disconnection. • No regenerative resistor connection (SR60BB)	• Check and replace the regenerative resistor. (Replace the SERVOPACK.)
4.	Over-voltage	Goes ON when the motor accelerates or decelerates.	• Load inertia J_L (GD^2) is too large.	• Check the inertia of the machine with the value converted to the motor shaft.
			• Defective regenerative circuit.	• Replace the SERVOPACK.
5.	Over-speed	When the reference is input, the motor runs fast and 5. goes ON.	• Motor connection error. • Optical encoder connection error.	• Correct the motor connection. • Check pulses in phases A, B, C, U, V and W on 2CN, and correct wiring.
			• The reference input voltage is too large.	• Decrease the reference input voltage.
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. • When power to the control circuit is turned OFF and then 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. • When power to the control circuit is turned OFF and then ON again, 7. and 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℃.	• Decrease the temperature below 55°C (The heat sink may be overheated.)
		The motor rotates, but the torque is unavailable. When power to the control circuit is turned OFF and then 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.

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

12.2.3 Examples of Troubleshooting for Incomplete Adjustment

Table 12.4 Examples of Troubleshooting for Incomplete Adjustment

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

NOTES

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