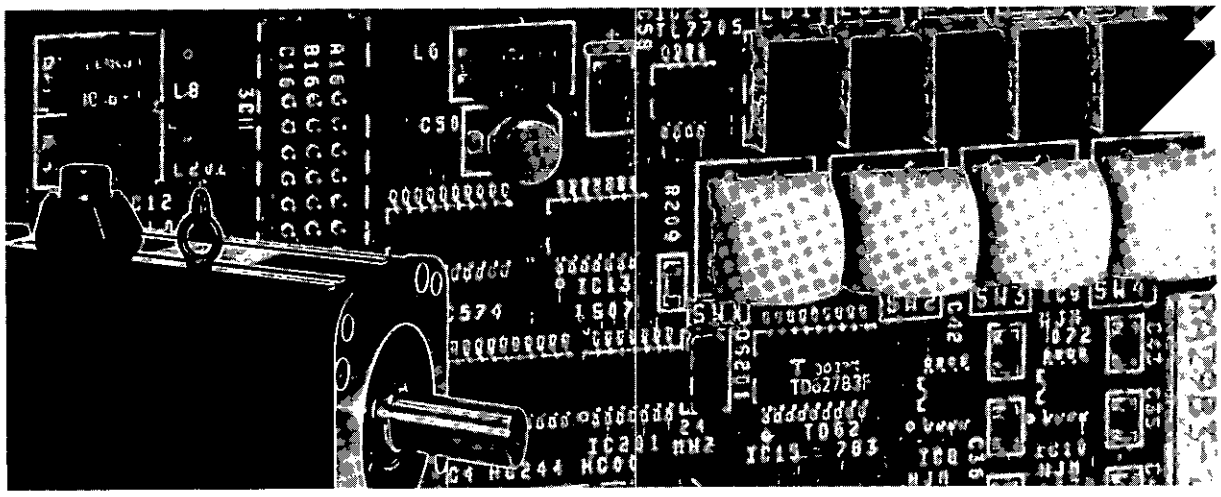
AC SERVO DRIVES

ALL DIGITAL/FOR SPEED CONTROL

SERVOMOTOR TYPES USAMED, USAFED, USAGED,
USASEM, USADED (With Absolute Encoder)

SERVOPACK TYPE CACR-SR□□□BY1□□□



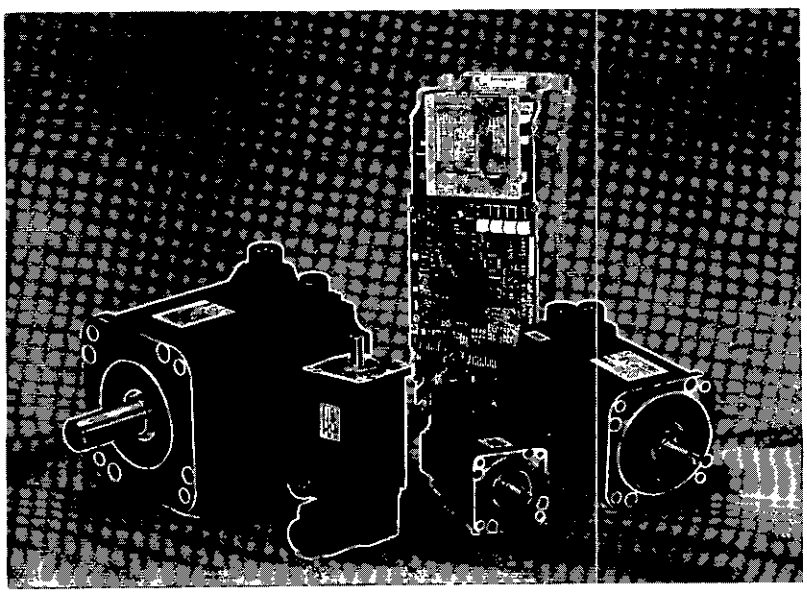
YASKAWA

YASKAWA all-digital AC Servo Drives provide mechatronics drives for the most advanced FA and FMS including robots and machine tools. These drives are the result of the most advanced servo drive manufacturing technology available anywhere in the world.

For your mechatronics systems, take advantage of the flexible combination of our AC SERVOMOTOR and SERVOPACK to achieve quick response and smooth, powerful operation even at low-speed range.

FEATURES

- Compact design and simple wiring
- Stable operation with all digital control
  (Stable adjustment with parameter)
- Versatile Functions (torque control, soft start, etc)
- High reliability



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

Table 1.1 Ratings and Specifications of M Series AC SERVOMOTORS

Item \ Motor Type USAMED-†		03B□1	06B□1	09B□2	12B□2	20B□2	30B□2	44B□2	USAMKD -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)	8.63 (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)	58.0 (51.2)	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 are normal (TYP) values above.

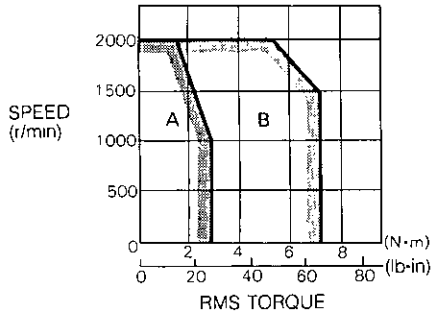
†: The blank □ of motor type depends on class of detectors.
Standard: S (8192 pulses/rev)
Semi-Standard: W (1024 pulses/rev)
Absolute encoder is used as a detector.

Note: The power supply units for brake:
- Input 100 VAC, Output 90 VDC: Type OPR 109 F
- Input 200 VAC, Output 90 VDC: Type OPR 109 A

For details, see Par. 10.3 (2).

1.1.2 Torque-Speed Characteristics

- TYPE USAMED-03B



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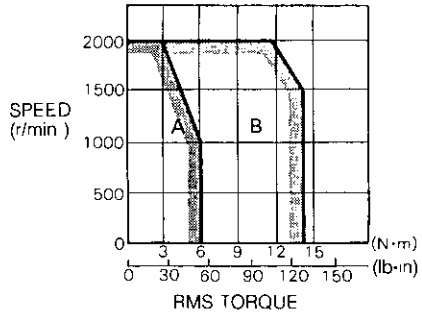
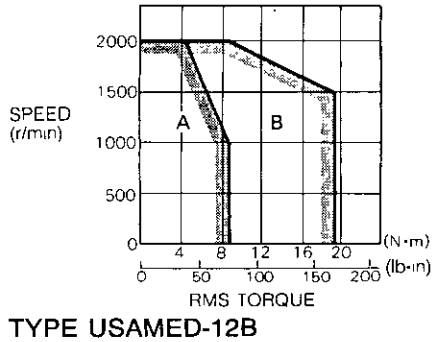
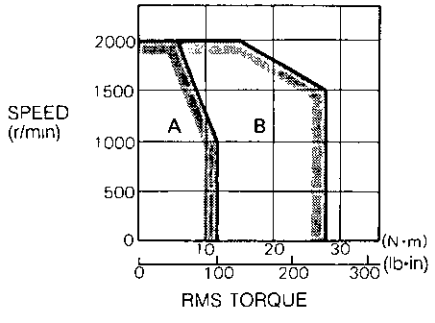


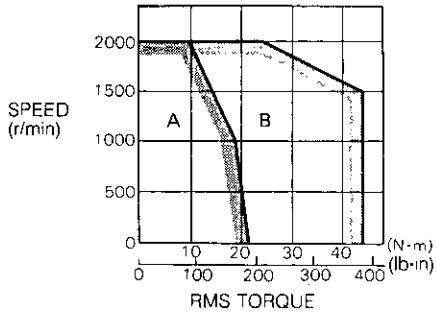
- TYPE USAMED-09B



- TYPE USAMED-12B



- TYPE USAMED-20B



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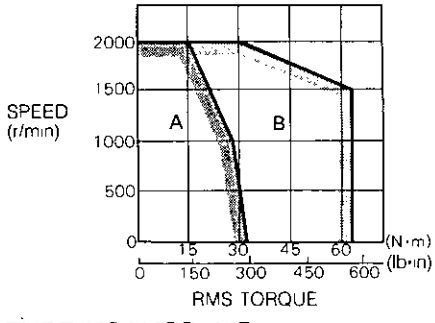
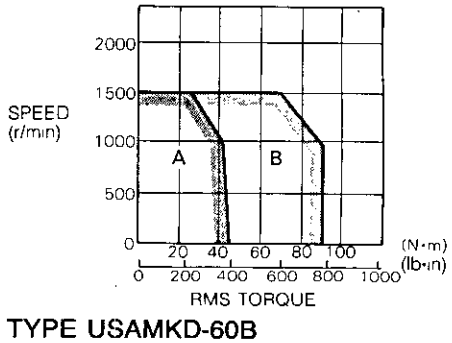
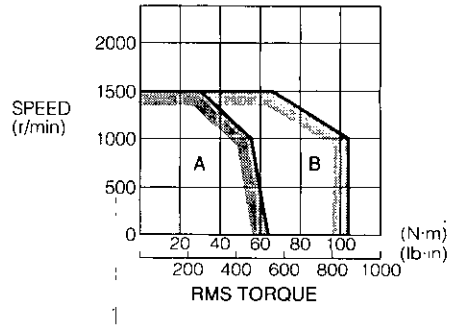


- TYPE USAMED-44B



- TYPE USAMKD-60B



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

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
Ambient Humidity: 20% to 80% (non-condensing)
Vibration: 15μm 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-†		02C□□1	03C□□1	05C□□1	09C□□1	13C□□1	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 (7.9)	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 (=$GD^2/4$)	$kg·m^2 \times 10^{-4}$ ($lb·in·s^2 \times 10^{-3}$)	1.3 (1.2)	2.06 (1.8)	13.5 (12.0)	24.3 (21.5)	36.7 (32.5)	58 (51.2)	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 are normal (TYP) values above.

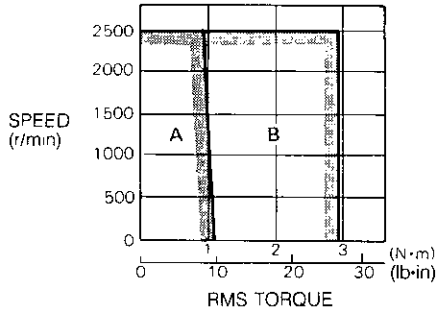
†: The blank □ of motor type depends on class of detectors.
Standard: S (8192 pulses/rev)
Semi-Standard: W (1024 pulses/rev)
Absolute encoder is used as a detector.

Note: The power supply units for brake:
- Input 100 VAC, Output 90 VDC: Type OPR 109 F
- Input 200 VAC, Output 90 VDC: Type OPR 109 A

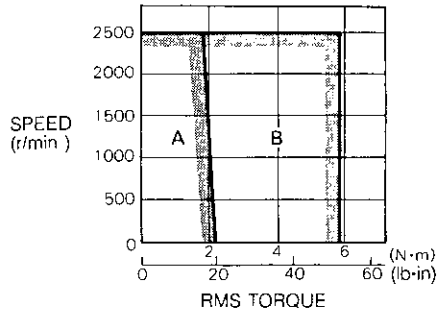
For details, see Par. 10.3 (2).

1.2.2 Torque-Speed Characteristics

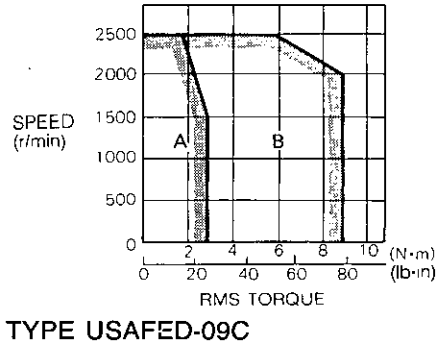
- TYPE USAFED-02C



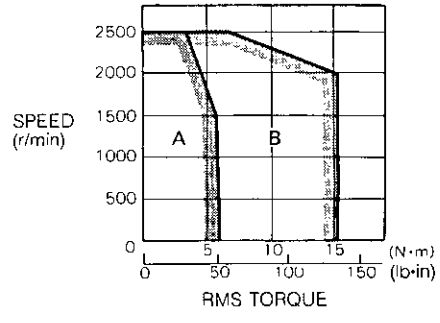
- TYPE USAFED-03C



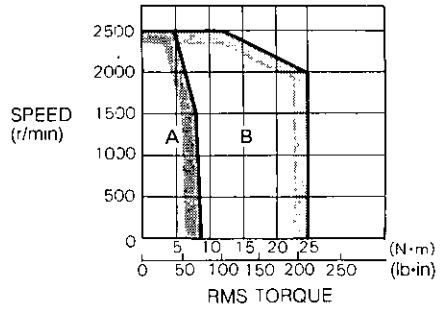
- TYPE USAFED-05C1



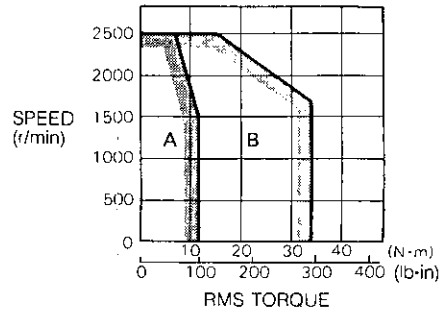
- TYPE USAFED-09C



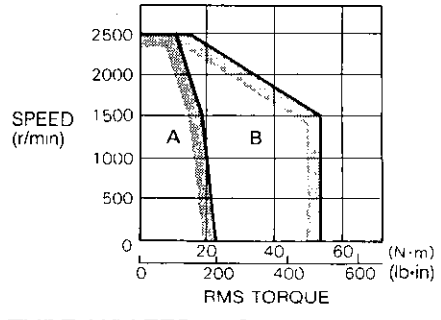
- TYPE USAFED-13C



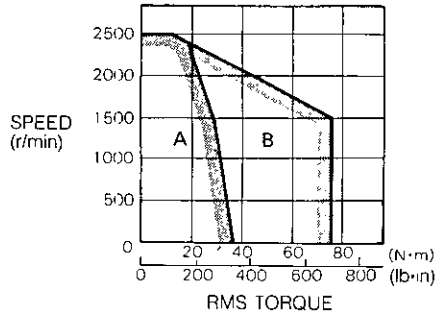
- TYPE USAFED-20C



- TYPE USAFED-30C



- TYPE USAFED-44C



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

1.3 RATINGS AND SPECIFICATIONS OF G SERIES AC SERVOMOTORS

1.3.1 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
Ambient Humidity: 20% to 80% (non-condensing)
Vibration: 15μm 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 G Series AC SERVOMOTORS

Item \ Motor Type USAGED-†		02A□1	03A□1	05A□1	09A□1	13A□1	20A□2	30A□2	44A□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)	2.9 (26)	5.83 (52)	8.92 (79)	13.3 (118)	23.3 (207)	28.0 (248)	45.1 (400)	66.2 (587)
Rated Current*	A	3.0	3.0	3.8	7.6	11.7	19	26	33
Rated Speed*	r/min	1500							
Instantaneous Max Speed*	r/min	3000							
Torque Constant	N·m/A (lb·in/A)	0.36 (3.2)	0.72 (6.3)	0.8 (7.1)	0.8 (7.1)	0.83 (7.4)	0.67 (5.9)	0.80 (7.1)	0.95 (8.4)
Moment of Inertia J_M (=$GD^2/4$)	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	1.3 (1.2)	2.06 (1.8)	13.5 (12.0)	24.3 (21.5)	36.7 (32.5)	58 (51.2)	110 (97.2)	143 (126.7)
Power Rate *	kW/s	7.4	18.3	6.0	12	18.9	22.7	36.5	57.0
Inertia Time Constant	ms	4.5	2.5	10.9	6.1	4.3	5.8	5.2	3.4
Inductive Time Constant	ms	3.4	4.3	3.2	5.2	6.7	10.6	13.2	15.9
Insulation		Class F							

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

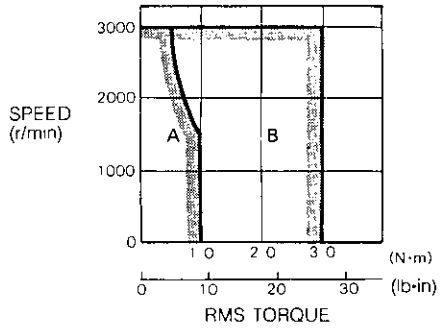
†: The blank □ of motor type depends on class of detectors.
Standard: S (8192 pulses/rev)
Semi-Standard: W (1024 pulses/rev)
Absolute encoder is used as a detector.

Note: The power supply units for brake:
- Input 100 VAC, Output 90 VDC: Type OPR 109 F
- Input 200 VAC, Output 90 VDC: Type OPR 109 A

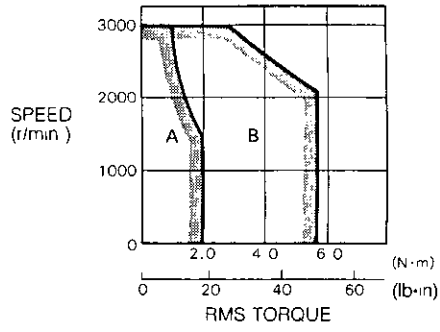
For details, see Par. 10.3 (2).

1.3.2 Torque-Speed Characteristics

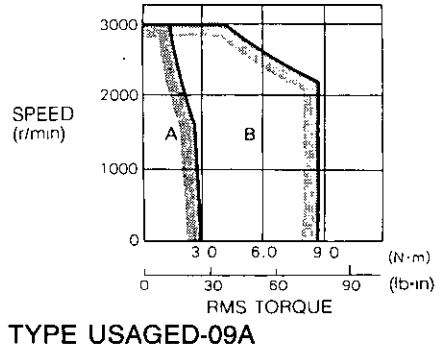
- TYPE USAGED-02A



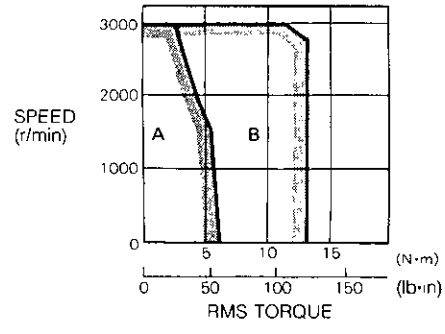
- TYPE USAGED-03A



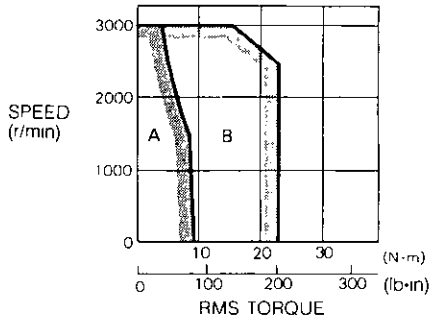
- TYPE USAGED-05A



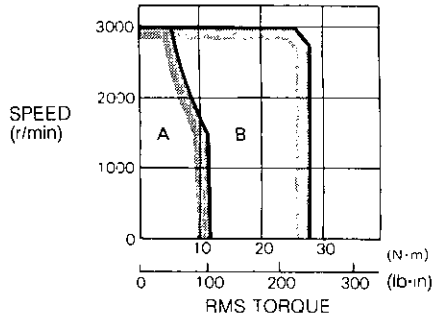
- TYPE USAGED-09A



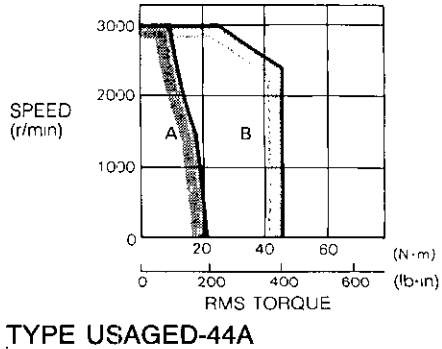
- TYPE USAGED-13A



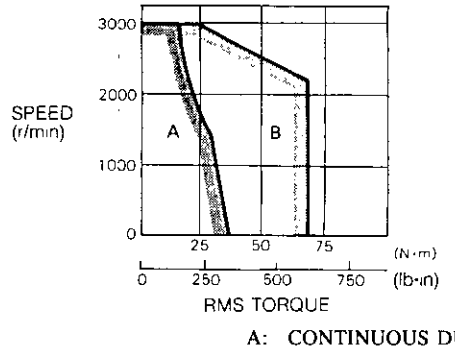
- TYPE USAGED-20A



- TYPE USAGED-30A



- TYPE USAGED-44A



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

1.4 RATINGS AND SPECIFICATIONS OF S SERIES AC SERVOMOTORS

1.4.1 Ratings

Time Rating: Continuous
Insulation: Class B (Types USASEM-02A□2, -03A□2, -05A□2)
Class F (Types USASEM-08A□1, -15A□1, -30A□1)
Isolation Voltage: 1500 VAC, one minute
Insulation Resistance: 500 VDC, 10MΩ or more
Enclosure: Totally-enclosed, self-cooled
(Equivalent to IP-44 exclusive shaft opening)

Ambient Temperature: 0 to +40°C
Ambient Humidity: 20% to 80% (non-condensing)
Vibration: 15μm or below
Finish in Munsell Notation: N1.5
Excitation: Permanent magnet
Mounting: Flange mounted
Drive Method: Direct drive

Table 1.4 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)	9.80 (87)
Continuous Max Torque*	N·m (lb·in)	0.57 (5.0)	1.18 (10)	1.67 (15)	3.33 (30)	6.17 (55)	12.2 (108)
Instantaneous 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 (3.25)	0.51 (4.49)	0.50 (4.43)	0.52 (4.64)
Moment of Inertia J_M ($=GD^2/4$)	$kg \cdot m^2 \times 10^{-4}$ $(lb \cdot in \cdot s^2 \times 10^{-3})$	0.13 (0.11)	0.51 (0.45)	0.75 (0.67)	2.85 (2.53)	3.3 (2.88)	5.74 (5.09)
Power Rate *	kW/s	18.5	18.9	28.9	21	74	167
Inertia Time Constant	ms	1.8	2.2	1.8	1.9	0.7	0.4
Inductive Time Constant	ms	1.5	2.7	3.1	6.2	13	26
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.

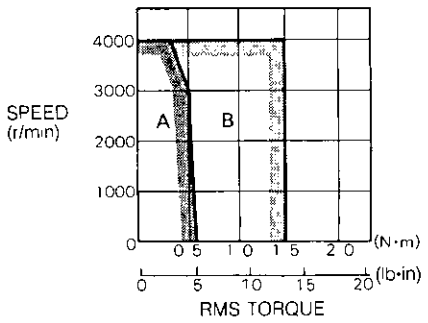
† The blank □ of motor type depends on class of detectors.
Standard: S (8192 pulses/rev)
Semi-Standard: W (1024 pulses/rev)
Absolute encoder is used as a detector.

Note: The power supply units for brake:
- Input 100 VAC, Output 90 VDC: Type OPR 109 F (DP8401002-2)
- Input 200 VAC, Output 90 VDC: Type OPR 109 A (DP8401002-1)

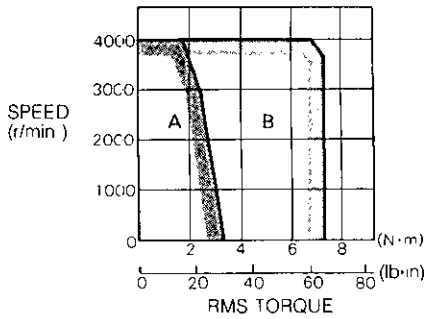
For details, see Par.10.3 (2)

1.4.2 Torque-Speed Characteristics

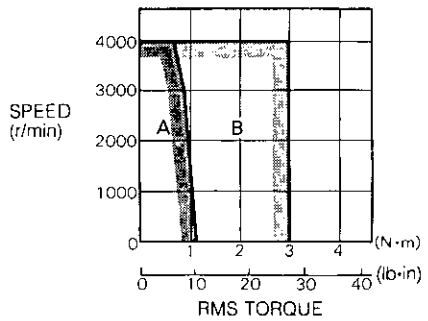
- TYPE USASEM-02A



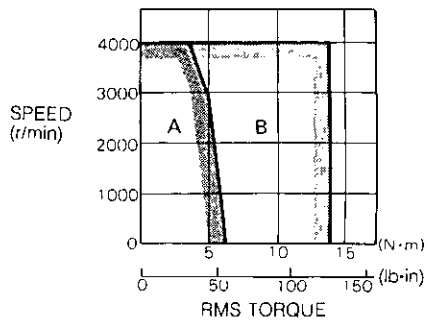
- TYPE USASEM-08A



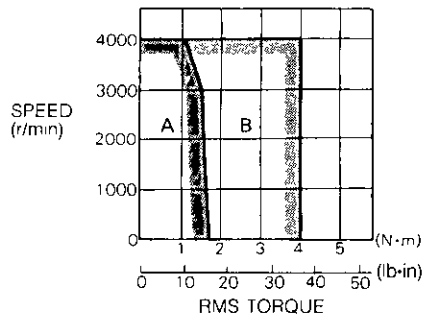
- TYPE USASEM-03A



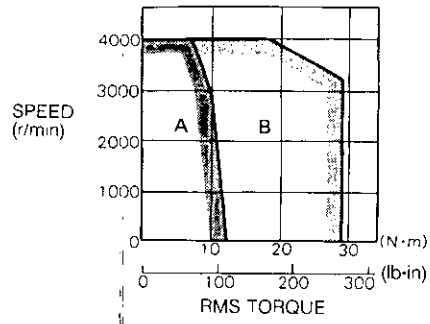
- TYPE USASEM-15A



- TYPE USASEM-05A



- TYPE USASEM-30A



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

1.5 RATINGS AND SPECIFICATIONS OF D SERIES AC SERVOMOTORS

1.5.1 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
Ambient Humidity: 20% to 80% (non-condensing)
Vibration: 15μm or below
Finish in Munsell Notation: N1.5
Excitation: Permanent magnet
Mounting: Flange mounted
Drive Method: Direct drive
Holding Brake Provided.

Table 1.5 Ratings and Specifications of D Series AC SERVOMOTORS

Item \ Motor Type USADED-†			05E□3	10E□3	15E□3	22E□3	37E□3
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)	4.80 (43)	7.16 (63)	10.5 (93)	17.7 (156)
Continuous Max Torque*		N·m (lb·in)	3.43 (30)	6.37 (56)	8.82 (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 Max 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 (=$GD^2/4$)		$kg·m^2 \times 10^{-4}$ ($lb·in·s^2 \times 10^{-3}$)	21, 13† (182, 11.3†)	32, 24† (28.6, 21.5†)	62, 59† (54.7, 52.1†)	83, 80† (73.8, 71.1†)	148, 145† (131, 128†)
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 Function 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. Shwon are normal (TYF) values above.

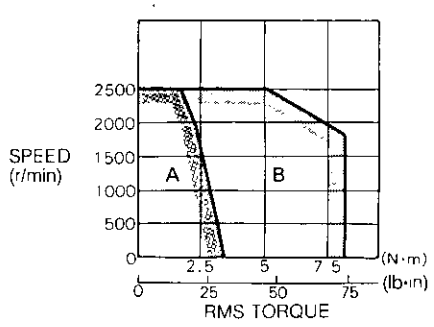
† The blank □ of motor type depends on class of detectors.
Standard: W (1024 pulses/rev)
Semi-Standard: S (8192 pulses/rev)
Absolute encoder is used as a detector.

Brake power supply specifications: 2 types.
- Input: 100 VAC Output: 90 VDC; OPR 109 F Type
- Input: 200 VAC Output: 90 VDC; OPR 109 A Type

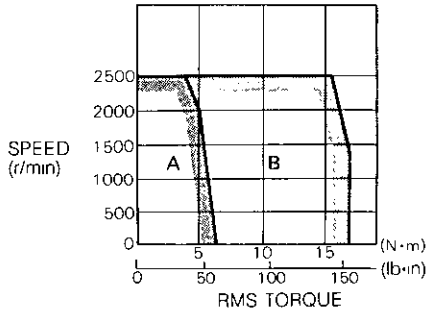
For details, refer to Par. 10.3.

1.5.2 Torque-Speed Characteristics

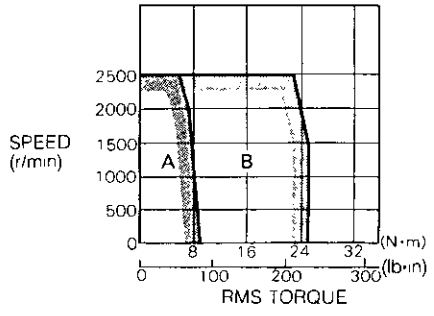
- TYPE USADED-05E



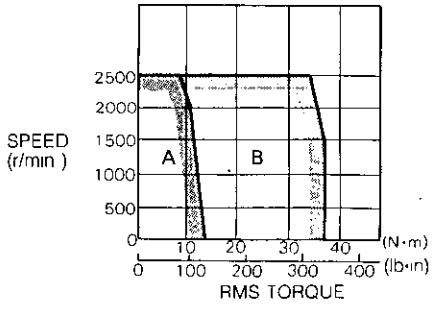
- TYPE USADED-10E



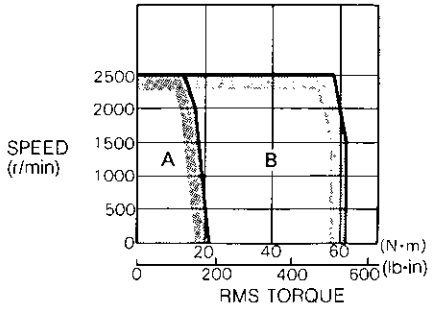
- TYPE USADED-15E



- TYPE USADED-22E



- TYPE USADED-37E



A: CONTINUOUS DUTY ZONE
B: INTERMITTENT DUTY ZONE

1.6 RATINGS AND SPECIFICATIONS OF SERVOPACK

Table 1.6 Ratings and Specifications of SERVOPACK

M Series	SERVOPACK Type CACR-		—	SR03BY1SM	—	SR07BY1SM	SR10BY1SM	SR15BY1SM	SR20BY1SM	SR30BY1SM	SR44BY1SM	SR60BY1SM
	Applicable Optical Encoder		Standard: 8192 pulses/rev (Semi-Standard: 1024 pulses/rev)									
	AC SERVOMOTOR	Type USAMED-	—	03BS	—	06BS	09BS	12BS	20BS	30BS	44BS	60BS
		Output kW (HP)	—	0.3 (0.4)	—	0.6 (0.8)	0.9 (1.2)	1.2 (1.6)	2.0 (2.7)	3.0 (4.1)	4.4 (5.9)17	6.0 (8.0)
		Rated/Max Speed r/min	1000/2000 (44BS, 60BS: 1000/1500)									
	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	56.6	70.0	80.6
	Allowable J_L ($=GD_L^2/4$)	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	—	67.5 (60)	—	122 (107.5)	184 (162.5)	334 (296)	550 (486)	715 (633.5)	1200 (1063)	1200 (1063)

F Series	SERVOPACK Type CACR-		SR02BY1SF	SR03BY1SF	SR05BY1SF	—	SR10BY1SF	SR15BY1SF	SR20BY1SF	SR30BY1SF	SR44BY1SF
	Applicable Optical Encoder		Standard: 8192 pulses/rev (Semi-Standard: 1024 pulses/rev)								
	AC SERVOMOTOR	Type USAFED-	02CS	03CS	05CS	—	09CS	13CS	20CS	30CS	44CS
		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/Max Speed r/min	1500/2500								
	Continuous Output Current	Arms	3.0	3.0	3.8	—	6.2	9.7	15.0	20.0	30.0
	Max Output Current	Arms	8.5	8.5	11.0	—	17.0	27.6	42.0	56.5	77.0
	Allowable J_L ($=GD_L^2/4$)	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	6.5 (5.75)	10.3 (9)	67.5 (60)	—	122 (107.5)	184 (162.5)	334 (296)	550 (486)	715 (633.5)

G Series	SERVOPACK Type CACR-		SR02BY1SG	SR03BY1SG	SR05BY1SG	—	SR10BY1SG	SR15BY1SG	SR20BY1SG	SR30BY1SG	SR44BY1SG
	Applicable Optical Encoder		Standard: 8192 pulses/rev (Semi-Standard: 1024 pulses/rev)								
	AC SERVOMOTOR	Type USAGED-	02AS	03AS	05CS	—	09AS	13AS	20AS	30AS	44AS
		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/Max Speed r/min	1500/3000								
	Continuous Output Current	Arms	3.0	3.0	3.8	—	7.6	11.7	19.0	26.0	33.0
	Max Output Current	Arms	8.5	8.5	11.0	—	17.0				
	Allowable J_L ($=GD_L^2/4$)	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	6.5 (57.5)	10.3 (9)	67.5 (60)	—	122 (107.5)	184 (162.5)	290 (256)	475 (418)	715 (630)

S Series	SERVOPACK Type CACR-		SR02BY1SS	SR03BY1SS	SR05BY1SS	—	SR01BY1SS	SR15BY1SS	—	SR30BY1SS	—
	Applicable Optical Encoder		Standard: 8192 pulses/rev (Semi-Standard: 1024 pulses/rev)								
	AC SERVOMOTOR	Type USASEM-	02AS	03AS	05AS	—	08AS	15AS	—	30AS	—
		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/Max Speed r/min	3000/4000								
	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 J_L ($=GD_L^2/4$)	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	0.65 (0.55)	2.55 (2.25)	3.8 (0.67)	—	14.3 (12.65)	16.5 (14.4)	—	28.7 (25.4)	—

D Series	SERVOPACK Type CACR-		—	SR05BY1WD	—	—	SR15BY1WD	SR20BY1WD	SR30BY1WD	SR44BY1WD
	Applicable Optical Encoder		Standard: 1024 pulses/rev (Semi-Standard: 8192 pulses/rev)							
	AC SERVOMOTOR	Type USADED-	—	05EW	—	—	10EW	15EW	22EW	37EW
		Output kW (HP)	—	0.5 (0.67)	—	—	1.0 (1.34)	1.5 (2.0)	2.2 (2.9)	3.7 (4.9)
		Rated/Max Speed r/min	2000/2500							
	Continuous Output Current	Arms	—	3.8	—	—	7.9	12.6	16.6	23.3
	Max Output Current	Arms	—	11.0	—	—	25.2	40.7	54.0	77.0
	Allowable J_L ($=GD_L^2/4$)	$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	—	105 (91)	—	—	160 (143)	310 (273.5)	415 (369)	740 (655)

Table 1.7 Ratings and Specifications of SERVOPACK

SERVOPACK Type CACR-			SR02BY	SR03BY	SR05BY	SR07BY	SR10BY	SR15BY	SR20BY	SR30BY	SR44BY	SR60BY
Max Motor Output		kW (HP)	0.2 (0.3)	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 (5.9)	6.0 (8.0)
Basic Specifications	Power Supply	Main Circuit	Three-phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60 Hz *1									
		Control Circuit	Single phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60 Hz *1									
	Control Method		Three-phase Full-wave Rectifier Transistorized-PWM Control (Sine Wave Drive)									
	Feedback		Absolute encoder (8192 pulses/rev, 1024 pulses/rev)									
	Ambient Temperature		0 to 55°C *5 (for type with cover, 0 to 50°C) *6									
	Storage Temperature		−20°C to +85°C									
	Ambient and Storage Humidity		90% or less (non-condensing)									
	Vibration-resistance/Impact-resistance		0.5G/2G									
	Mounting Structure		Base mounted									
	Approx Mass	kg (lb)	6.0 (13.2)							7.0 (15.4)		13.5 (29.8)
Speed Control	Speed Control Range*2		1 : 5000									
	Speed*3 Regulation	Load Regulation 0 to 100%	+0.01% or less at rated r/min									
		Voltage Regulation ±10%	0%									
		Temp. Regulation 25 ± 25°C	±0.1% or less at rated r/min									
	Frequency Response Charactristics		100 Hz ($J_L=J_M$)									
Signals I/O	Speed Reference Input	Rated Reference Voltage	Speed Control Mode	±6 VDC at rated r/min (forward run at plus reference)								
			Torque Control Mode	±3 VDC at rated torque (forward torque generated all plus reference)								
		Input Impedance	Approx 30kΩ									
		Circuit Time Constant	Approx 70 μs									
	Auxiliary Reference Input*4	Reference Voltage	±12 VDC at rated r/min (forward run at plus reference)									
		Input Impedance	Approx 30kΩ									
		Circuit Time Constant	Approx 70 μs									
	Built-in Reference Power Supply		±12 VDC ±5%, ±30mA Output-able									
	Position Output (PG Pulse)	Output Form	Line Driver (A-phase, B-phase, C-phase)									
		Division Pulse Output	15-bit absolute encoder 1 to 8192 P/R 12-bit absolute encoder 1 to 1024 P/R									
	Sequence Input Signal		Servo ON, P drive, F run stop, R run stop, etc.									
	Sequence Output Signal		Servo ready, TG ON, current limit, servo alarm, overload, MCCB trip									
	External Current Limit		0 to max current in each of P and N (3V/100% current)									
Built-in Functions	Dynamic Brake		Operated at main power OFF, servo alarm, servo OFF, overtravel, etc.									
	Regeneration		Provided (Separately provided for SR60BY type)									
	Applicable Load Inertia J_L		Up to 5 times motor inertia *7									
	Overtravel Prevention		DB stop or slowdown stop at P-OT, N-OT									
	Protection		Communication error, over current (OC), MCCB trip (MCCB), Regenerative error (RG), overvoltage (OV), overload (OL), origin error, overrun, open phase detection, CPU error (CPU,A/D), encoder error, undervoltage (UV)									
	Indication		7-segment LEDs × 5 figures (Alarm, status, parameter indications)									
	Monitor Output		Speed monitor: 2V (4V) ±5%/1000r/min, Torque monitor: 3V (2V) ±10%/100%									
	Other Functions		Torque control, zero cramp, soft start, brake interlock, reverse turn connection, JOG Operation *8									

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

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

*3 Speed regulation is generally defined as follows:

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

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

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

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

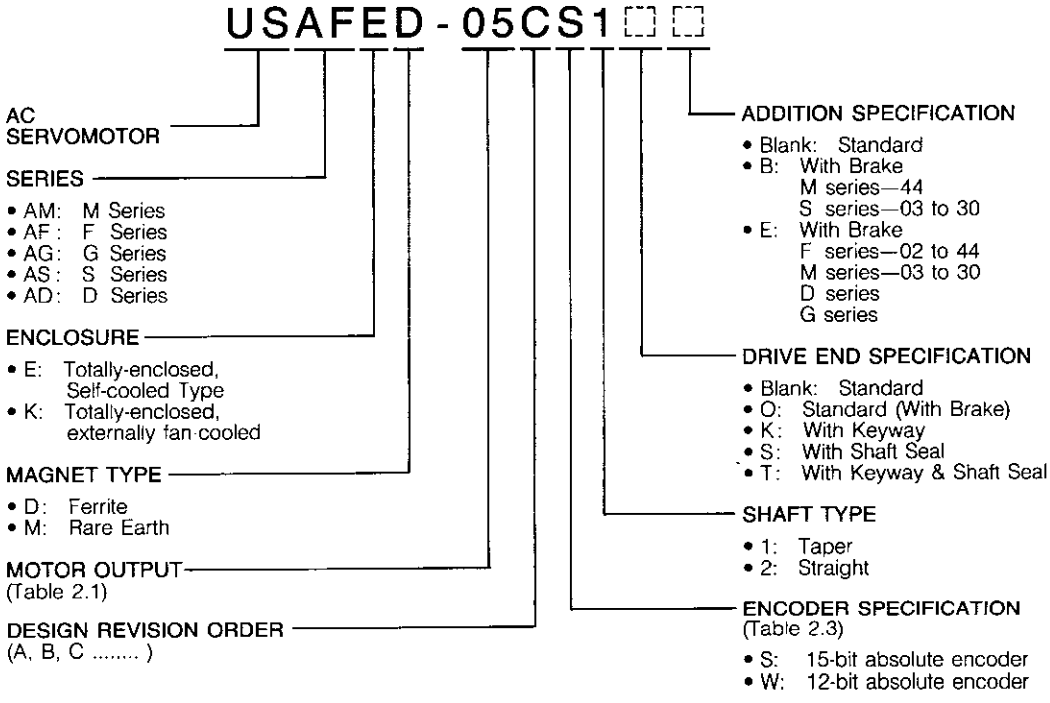
*6. CACR-SR□BY10□-C for SERVOPACK type with cover.

*7. When load J_L exceeds applicable range, be sure to refer to 6.7.2. Load Inertia.

*8. JOG operation with monitor switch.

2. TYPE DESIGNATION

• AC SERVOMOTOR



• SERVOPACK

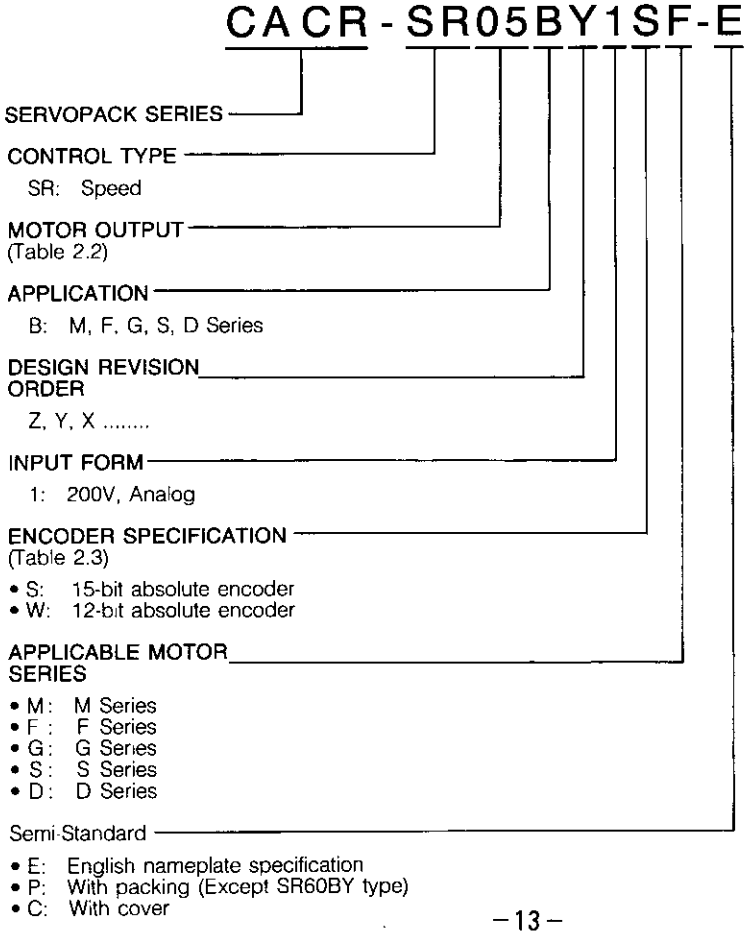


Table 2.1

	Motor Output				
	M Series	F Series	G Series	S Series	D Series
02	—	0.15kW (0.2HP)	0.15kW (0.2HP)	154W (0.2HP)	—
03	0.3kW (0.4HP)	0.3kW (0.4HP)	0.3kW (0.4HP)	308W (0.4HP)	—
05	—	0.45kW (0.6HP)	0.45kW (0.6HP)	462W (0.6HP)	0.5kW (0.67HP)
06	0.6kW (0.8HP)	—	—	—	—
08	—	—	—	771W (10HP)	—
09	0.9kW (1.2HP)	0.85kW (1.1HP)	0.85kW (1.1HP)	—	—
10	—	—	—	—	1.0kW (1.3HP)
12	1.2kW (1.6HP)	—	—	—	—
13	—	1.3kW (1.7HP)	1.3kW (1.7HP)	—	—
15	—	—	—	1540W (2.1HP)	1.5kW (20HP)
20	2.0kW (2.7HP)	1.8kW (2.4HP)	1.8kW (2.4HP)	—	—
22	—	—	—	—	2.2kW (2.9HP)
30	3.0kW (4.1HP)	2.9kW (3.9HP)	2.9kW (3.9HP)	3080W (4.1HP)	—
37	—	—	—	—	3.7kW (5.0HP)
44	4.4kW (5.9HP)	4.4kW (5.9HP)	4.4kW (5.9HP)	—	—
60	6.0kW (8.0HP)	—	—	—	—

Table 2.2

	Motor Output				
	M Series	F Series	G Series	S Series	D Series
02	—	0.15kW (0.2HP)	0.15kW (0.2HP)	0.15kW (0.2HP)	—
03	0.3kW (0.4HP)	0.3kW (0.4HP)	0.3kW (0.4HP)	0.3kW (0.4HP)	—
05	—	0.45kW (0.6HP)	0.45kW (0.6HP)	0.46kW (0.6HP)	0.5kW (0.67HP)
07	0.6kW (0.8HP)	—	—	—	—
10	0.9kW (1.2HP)	0.85kW (1.1HP)	0.85kW (1.1HP)	0.77kW (10HP)	—
15	1.2kW (1.6HP)	1.3kW (1.7HP)	1.3kW (1.7HP)	1.54kW (2.1HP)	1.0kW (1.3HP)
20	2.0kW (2.7HP)	1.8kW (2.4HP)	1.8kW (2.4HP)	—	1.5kW (2.0HP)
30	3.0kW (4.1HP)	2.9kW (3.9HP)	2.9kW (2.4HP)	3.08kW (4.1HP)	2.2kW (2.9HP)
44	4.4kW (5.9HP)	4.4kW (5.9HP)	4.4kW (5.9HP)	—	3.7kW (5.0HP)
60	6.0kW (8.0HP)	—	—	—	—

Table 2.3

Motor Type	Standard (pulses/rev)		Semi-standard (pulses/rev)	
M Series	S	8192	W	2048
F Series	S	8192	W	2048
G Series	S	8192	W	2048
S Series	S	8192	W	1024
D Series	W	1024	S	8192

3. LIST OF STANDARD COMBINATION

Table 3.1 Combination of SERVOPACK, AC SERVOMOTORS and Associate Uni

• M SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Power Capacity*1 per SERVOPACK kVA	Current Capacity per MCCB or Fuse A	Applicable Noise Filter
SR03BY1SM	USAMED-03BS1	0.65	5	
SR07BY1SM	USAMED-06BS1	1.5	8	
SR10BY1SM	USAMED-09BS2	2.1	8	
SR15BY1SM	USAMED-12BS2	3.1	10	Good
SR20BY1SM	USAMED-20BS2	4.1	12	
SR30BY1SM	USAMED-30BS2	6.0	18	
SR44BY1SM	USAMED-44BS2	8.0	24	
SR60BY1SM	USAMKD-60BS2	11	32	Poor

*1. Values at rated load. *2: Made by Tokin Corp.

• F SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Power Capacity per SERVOPACK kVA	Current Capacity per MCCB or Fuse A	Applicable Noise Filter
SR02BY1SF	USAFED-02CS1	0.65	5	
SR03BY1SF	USAFED-03CS1			
SR05BY1SF	USAFED-05CS1	1.1	5	
SR10BY1SF	USAFED-09CS1	2.1	8	Good
SR15BY1SF	USAFED-13CS2	3.1	10	
SR20BY1SF	USAFED-20CS2	4.1	12	
SR30BY1SF	USAFED-30CS2	6.0	18	Poor
SR44BY1SF	USAFED-44CS2	8.0	24	

• G SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Power Capacity per SERVOPACK kVA	Current Capacity per MCCB or Fuse A	Applicable Noise Filter
SR02BY1SG	USAGED-02AS1	0.65	5	
SR03BY1SG	USAGED-03AS1			
SR05BY1SG	USAGED-05AS1	1.1	5	
SR10BY1SG	USAGED-09AS1	2.1	8	Good
SR15BY1SG	USAGED-13AS2	3.1	10	
SR20BY1SG	USAGED-20AS2	4.1	12	
SR30BY1SG	USAGED-30AS2	6.0	18	Poor
SR44BY1SG	USAGED-44AS2	8.0	24	

• S SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Power Capacity per SERVOPACK kVA	Current Capacity per MCCB or Fuse A	Applicable Noise Filter
SR02BY1SS	USASEM-02AS2	0.65	5	
SR03BY1SS	USASEM-03AS2			
SR05BY1SS	USASEM-05AS2	1.1	5	
SR10BY1SS	USASEM-08AS1	2.1	8	Good
SR15BY1SS	USASEM-15AS1	3.1	10	
SR30BY1SS	USASEM-30AS1	6.0	18	Poor

• D SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Power Capacity per SERVOPACK kVA	Current Capacity per MCCB or Fuse A	Applicable Noise Filter
SR05BY1WD	USADED-05EW2	1.5	8	
SR15BY1WD	USADED-10EW2	3.1	10	
SR20BY1WD	USADED-15EW2	4.1	12	Good
SR30BY1WD	USADED-22EW2	6.0	18	
SR44BY1WD	USADED-37EW2	8.0	24	Poor

Recommended Noise Filter *2		Power ON/OFF Switch
Type	Specifications	
LF-305	3-phase 200 VAC class, 5A	YASKAWA type HI-16E, rated 35A or equivalent
LF-310	3-phase 200 VAC class, 10A	
LF-315	3-phase 200 VAC class, 15A	
LF-315	3-phase 200 VAC class, 15A	
LF-320	3-phase 200 VAC class, 20A	YASKAWA type HI-16E, rated 35A or equivalent
LF-330	3-phase 200 VAC class, 30A	
LF-340	3-phase 200 VAC class, 40A	
LF-350	3-phase 200 VAC class, 50A	YASKAWA type HI-25E rated 50A or equivalent

Recommended Noise Filter		Power ON/OFF Switch
Type	Specifications	
LF-305	3-phase 200 VAC class, 5A	YASKAWA type HI-16E, rated 35A or equivalent
LF-305	3-phase 200 VAC class, 5A	
LF-305	3-phase 200 VAC class, 5A	
LF-315	3-phase 200 VAC class, 15A	
LF-315	3-phase 200 VAC class, 15A	
LF-320	3-phase 200 VAC class, 20A	YASKAWA type HI-16E, rated 35A or equivalent
LF-330	3-phase 200 VAC class, 30A	
LF-340	3-phase 200 VAC class, 40A	

Recommended Noise Filter		Power ON/OFF Switch
Type	Specifications	
LF-305	3-phase 200 VAC class, 5A	YASKAWA type HI-16E, rated 35A or equivalent
LF-305	3-phase 200 VAC class, 5A	
LF-305	3-phase 200 VAC class, 5A	
LF-315	3-phase 200 VAC class, 15A	
LF-315	3-pahse 200 VAC class, 15A	
LF-320	3-phase 200 VAC class, 20A	YASKAWA type HI-16E, rated 35A or equivalent
LF-330	3-phase 200 VAC class, 30A	
LF-340	3-phase 200 VAC class, 40A	

Recommended Noise Filter		Power ON/OFF Switch
Type	Specifications	
LF-305	3-pahse 200 VAC class, 5A	YASKAWA type HI-16E, rated 35A or equivalent
LF-305	3-pahse 200 VAC class, 5A	
LF-305	3-phase 200 VAC class, 5A	
LF-315	3-phase 200 VAC class, 15A	
LF-315	3-phase 200 VAC class, 15A	
LF-330	3-phase 200 VAC class, 30A	YASKAWA type HI-16E, rated 35A or equivalent

Recommended Noise Filter		Power ON/OFF Switch
Type	Specifications	
LF-310	3-phase 200 VAC class, 10A	YASKAWA type HI-16E, rated 35A or equivalent
LF-315	3-phase 200 VAC class, 15A	
LF-320	3-phase 200 VAC class, 20A	YASKAWA type HI-16E, rated 35A or equivalent
LF-330	3-phase 200 VAC class, 30A	
LF-340	3-phase 200 VAC class, 40A	

Table 3.2 Specifications of AC SERVOMOTORS, Detectors and Holding Brakes

• M SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
SR03BY1SM	USAMED-03BS	MS3102A 18-10P	MS3108B 18-10S	MS3106B 18-10S	MS3057 -10A
SR07BY1SM	USAMED-06BS				
SR10BY1SM	USAMED-09BS				
SR15BY1SM	USAMED-12BS	MS3102A 22-22P	MS3108B 22-22S	MS3106B 22-22S	MS3057 -12A
SR20BY1SM	USAMED-20BS				
SR30BY1SM	USAMED-30BS				
SR44BY1SM	USAMED-44BS	MS3102A 32-17P	MS3108B 32-17S	MS3106B 32-17S	MS3057 -20A
SR60BY1SM	USAMKD-60BS	MS3102A 32-17P	MS3108B 32-17S	MS3106B 32-17S	MS3057 -20A

• F SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
SR02BY1SF	USAFED-02CS	MS3102A 14S-2P	MS3108B 14S-2S	MS3106B 14S-2S	MS3057 6A
SR03BY1SF	USAFED-03CS				
SR05BY1SF	USAFED-05CS	MS3102A 18-10P	MS3108B 18-10S	MS3106B 18-10S	MS3057 -10A
SR10BY1SF	USAFED-09CS				
SR15BY1SF	USAFED-13CS				
SR20BY1SF	USAFED-20CS	MS3102A 22-22P	MS3108B 22-22S	MS3106B 22-22S	MS3057 -12A
SR30BY1SF	USAFED-30CS				
SR44BY1SF	USAFED-44CS				

• G SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
SR02BY1SG	USAGED-02AS	MS3102A 14S-2P	MS3108B 14S-2S	MS3106B 14S-2S	MS3057 6A
SR03BY1SG	USAGED-03AS				
SR05BY1SG	USAGED-05AS	MS3102A 18-10P	MS3108B 18-10S	MS3106B 18-10S	MS3057 -10A
SR10BY1SG	USAGED-09AS				
SR15BY1SG	USAGED-13AS				
SR20BY1SG	USAGED-20AS	MS3102A 22-22P	MS3108B 22-22S	MS3106B 22-22S	MS3057 -12A
SR30BY1SG	USAGED-30AS				
SR44BY1SG	USAGED-44AS				

• S SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Receptacle Type	L-type Plug	Cable Clamp
SR02BY1SS	USASEM-02AS	—	—	—
SR03BY1SS	USASEM-03AS	MS3102A 18-10P	MS3108B 18-10S	MS3057 -10A
SR05BY1SS	USASEM-05AS			
SR10BY1SS	USASEM-08AS	MS3102A 20-4P	MS3108B 20-4S	MS3057 -12A
SR20BY1SS	USASEM-15AS			
SR30BY1SS	USASEM-30AS			

• D SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Receptable Type	L-type Plug	Straight Plug	Cable Clamp
SR05BY1WD	USADED-05EW	MS3102A 20-15P	MS3108B 20-15S	MS3106B 20-15S	MS3057 -12A
SR15BY1WD	USADED-10EW				
SR20BY1WD	USADED-15EW	MS3102A 24-10P	MS3108B 24-10S	MS3106B 24-10S	MS3057 -16A
SR30BY1WD	USADED-22EW				
SR44BY1WD	USADED-37EW				

for Connection

	Detector				Holding Brake			
	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
	MS3102A 20-29P	MS3108B 20-29S	MS3106B 20-29S	MS3057 -12A	MS3102A 20-15P	MS3108B 20-15S	MS3106B 20-15S	MS3057 -12A
					MS3102A 24-10P	MS3108B 24-10S	MS3106B 24-10S	MS3057 -16A
					—	—	—	—
	MS3102A 20-29P	MS3108B 20-29S	MS3106B 20-29S	MS3057 -12A	—	—	—	—

	Detector				Holding Brake			
	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
	MS3102A 20-29P	MS3108B 20-29S	MS3106B 20-29S	MS3057 -12A	MS3102A 14S-6P	MS3108B 14S-6S	MS3106B 14S-6S	MS3057 -6A
					MSA3102A 20-15P	MS3108B 20-15S	MS3106B 20-15S	MS3057 -12A
					MS3102A 24-10P	MS3108B 24-10S	MS3106B 24-10S	MS3057 -16A

	Detector				Holding Brake			
	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
	MS3102A 20-29P	MS3108B 20-29S	MS3106B 20-29S	MS3057 -12A	MS3102A 14S-6P	MS3108B 14S-6S	MS3106B 14S-6S	MS3057 -6A
					MSA3102A 20-15P	MS3108B 20-15S	MS3106B 20-15S	MS3057 -12A
					MS3102A 24-10P	MS3108B 24-10S	MS3106B 24-10S	MS3057 -16A

	Detector			Holding Brake		
	Receptacle Type	L-type Plug	Cable Clamp	Receptacle Type	L-type Plug	Cable Clamp
	—	—	—	—	—	—
	MS3102A 20-29P	MS3108B 20-29S	MS3057 -12A	MS3102A 18-12P	MS3108B 18-12S	MS3057 -10A
				MS3102A 20-17P	MS3108B 20-17S	MS3057 -12A

	Detector			
	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
	MS3102A 20-29P	MS3108B 20-29S	MS3106B 20-29S	MS3057 -12A

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

4. CHARACTERISTICS

4.1 OVERLOAD CHARACTERISTICS

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

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

NOTE

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

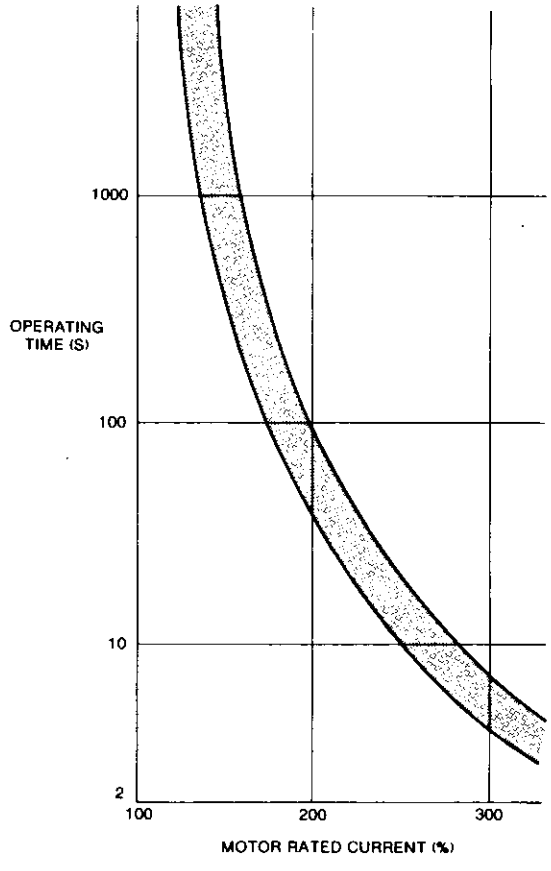


Fig. 4.1 Allowable Conduction Current of SERVOPACK

4.2 STARTING AND STOPPING TIME

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

Starting Time:

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

Stopping Time:

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

Where,

N_R: Rated motor speed (r/min)
$J_M\ (= GD_M^2/4)$: Moment of rotor inertia (kg•m²=lb•in•s²)
$J_L\ (= GD_L^2/4)$: Moment of load inertia (kg•m²=lb•in•s²)
K_t: Torque constant of motor (N•m/A=lb•in/A)
I_R: Motor rated current (A)
$\alpha = I_P/I_R$: Accel/decel current constant
I_P: Accel/decel current
(Accel/decel current α times the motor rated current) (A)
$\beta = I_L/I_R$: Load current constant
I_L: Current equivalent to load torque
(Load current β times the motor rated current) (A)

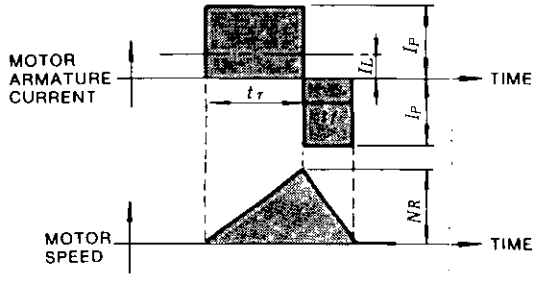


Fig. 4.2 Timing Chart of
Motor Armature Current and Speed
(Constant Load)

4.3 ALLOWABLE FREQUENCY OF OPERATION

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

- Allowable frequency of operation restricted by the SERVOPACK

The allowable frequency of operation restricted by the SERVOPACK varies depending on the motor types, capacity, load J (J_L), acceleration/deceleration current values, and motor speed. If the frequency of operation is high, 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 STOPPIMG 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:

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

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

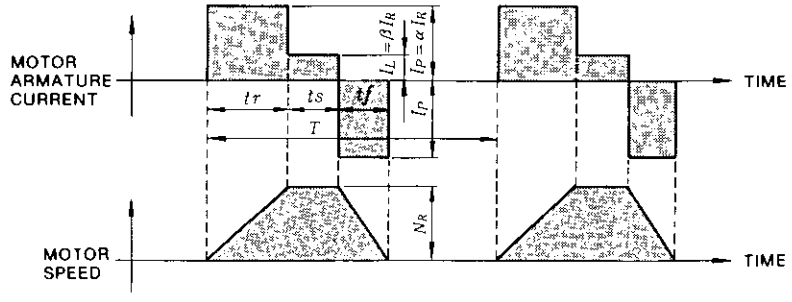


Fig. 4.3 Timing Chart of
Motor Armature Current and Speed
(Restricted by SERVOMOTOR)

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

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

$$n = 286.5 \times \frac{K_t \cdot I_R}{N_R\,(J_M + J_L)} \times \left(\frac{1}{\alpha} - \frac{\beta^2}{\alpha^3}\right) \quad \text{(times/min)}$$

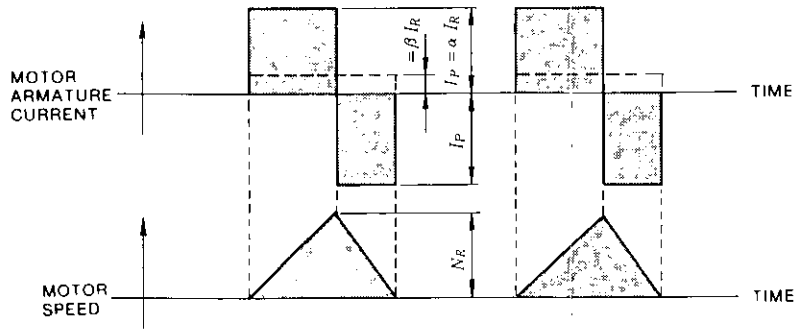


Fig. 4.4 Timing Chart of
Motor Armature Current and Speed
(The motor remains at standstill between cycles of accel/decel without continuous rated speed running)

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

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

$$n = 286.5 \times \frac{K_t \cdot I_R}{(J_M + J_L)} \times \left(\frac{1}{\alpha} - \frac{\beta^2}{\alpha}\right) \quad \text{(times/min)}$$

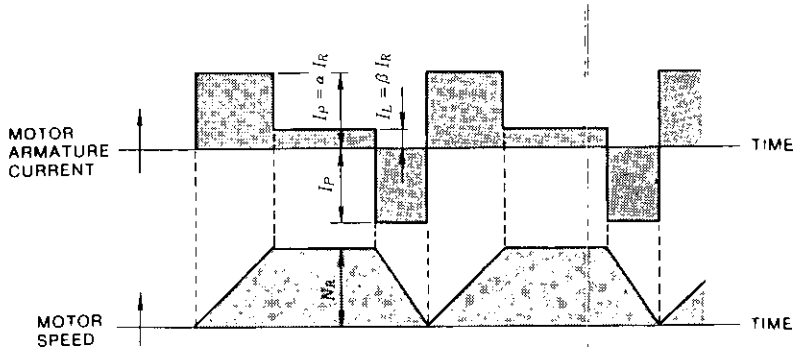


Fig. 4.5 Timing Chart of
Motor Armature Current and Speed
(The motor accelerates, runs at constant speed, and decelerates in a continuing cycle without being at standstill)

4.4 SERVOMOTOR FREQUENCY

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

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

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

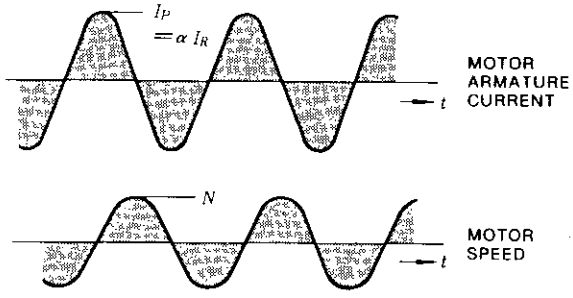


Fig. 4.6 Timing Chart of
Motor Armature Current and Speed
(Restricted by the maximum armature current)

4.5 MOTOR SPEED-REFERENCE INPUT CHARACTERISTICS

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

The forward motor rotation (+) means counterclockwise rotation when viewed from the drive end. [When reverse rotation mode is selected, the CW (clockwise) direction rotation viewed from the load connecting side is regarded as motor forward rotation.]

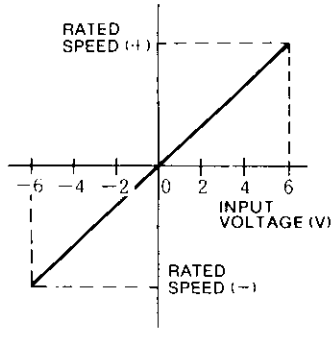


Fig. 4.7 Speed-Input Voltage Characteristics

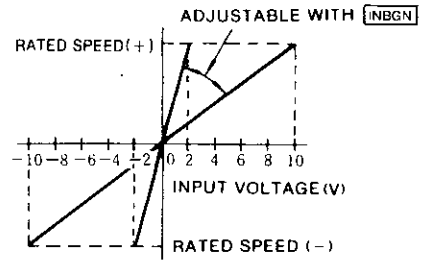


Fig. 4.8 Speed-Input Voltage Characteristics when Auxiliary Input Terminals 1CN-⑭ and ⑮ are used.

4.6 MOTOR MECHANICAL CHARACTERISTICS

4.6.1 Mechanical Strength

AC SERVOMOTORS can carry up to the momentary maximum torque of each motor 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)
03BS1	490 (110)	98 (22)†
06BS1	490 (110)	98 (22)†
09BS2	686 (154)	343 (77)
12BS2	1470 (330)	490 (110)
20BS2	1470 (330)	490 (110)
30BS2	1470 (330)	490 (110)
44BS2	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)
02CS1	147 (33)	49 (11)†
03CS1	147 (33)	49 (11)†
05CS1	490 (110)	98 (22)†
09CS1	490 (110)	98 (22)†
13CS2	686 (154)	343 (77)
20CS2	1470 (331)	490 (110)
30CS2	1470 (331)	490 (110)
44CS2	1470 (331)	490 (110)

Table 4.3 G Series Allowable Radial Load and Thrust Load

Motor Type USAGED-	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
02AS1	147 (33)	49 (11)
03AS1	147 (33)	49 (11)
05AS1	490 (110)	98 (22)
09AS1	490 (110)	98 (22)
13AS2	686 (154)	343 (77)
20AS2	1470 (331)	490 (110)
30AS2	1470 (331)	490 (110)
44AS2	1470 (331)	490 (110)

Table 4.4 S Series Allowable Radial Load and Thrust Load

Motor Type USASEM-	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
02AS2	78.4 (18)	39.2 (9)
03AS2	245 (55)	98 (22)
05AS2	245 (55)	98 (22)
08AS1	392 (88)	147 (33)
15AS1	490 (110)	147 (33)
30AS1	686 (154)	196 (44)

Table 4.5 D Series Allowable Radial Load and Thrust Load

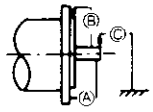
Motor Type USADED-	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
05EW2	686 (154)	343 (77)
10EW2	686 (154)	343 (77)
15EW2	1176 (265)	490 (110)
22EW2	1176 (265)	490 (110)
37EW2	1176 (265)	490 (110)

* 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

Table 4.6 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)*	

† T.I.R. (Total Indicator Reading)
‡ Accuracy for motor types USADED-15E3, -22E3, and -37E3.
* Accuracy for motor type USAMED-44B22.

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. (When reverse rotation mode is selected, the CW direction rotation is regarded as forward rotation.)

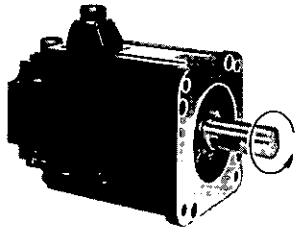
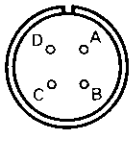


Fig. 4.9 AC SERVOMOTOR

(1) Connector Specifications for Standard SERVOMOTORS

(a) Motor receptacle

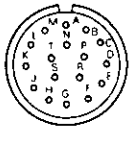
• M,F,G,D,S Series



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

(b) Detector receptacle

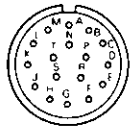
15 bit



A	Channel A output	K	—
B	Channel $\overline{A}$ output	L	—
C	Channel B output	M	—
D	Channel $\overline{B}$ output	N	—
E	Channel C output	P	—
F	Channel $\overline{C}$ output	R	Reset
G	0V	S	0V (battery)
H	+5 VDC	T	3.6V (battery)
J	Frame ground	—	—

(c) Detector receptacle

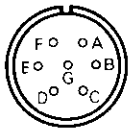
12 bit



A	Channel A output	K	Channel S output
B	Channel $\overline{A}$ output	L	Channel $\overline{S}$ output
C	Channel B output	M	—
D	Channel $\overline{B}$ output	N	—
E	Channel C output	P	—
F	Channel $\overline{C}$ output	R	Reset
G	0V	S	0V (battery)
H	+5 VDC	T	3.6V (battery)
J	Frame ground	—	—

(2) Connector Specifications for SERVOMOTOR with Brake

• M, F, G, 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		

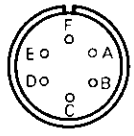
Types without brake of D series do not use E and F.

(Types USASEM-02A)

Red	Phase-U
White	Phase-V
Light-Blue	Phase-W
Black	Brake terminal
Black	Brake terminal
Green	Frame ground

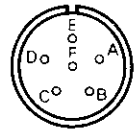
Note: Cable without connector type

(Types USASEM-03A, -05A)



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

(Types USASEM-08A to 30A)



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

4.6.5 Impact Resistance

When mounted horizontally and exposed to vertical shock impulses, the motor can withstand up to two impacts with impact acceleration of 50G (Fig.4.10).

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.

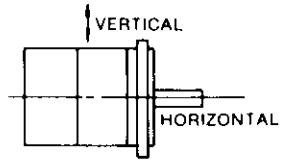


Fig. 4.10 Impact Resistance

4.6.6 Vibration Resistance

When mounted horizontally, the motor can withstand vibration (vertical, lateral, axial) of 2.5 G (Fig.4.11).

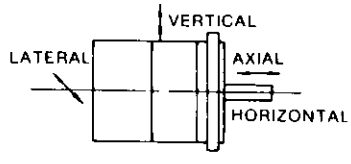


Fig. 4.11 Vibration Resistance

4.6.7 Vibration Class

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

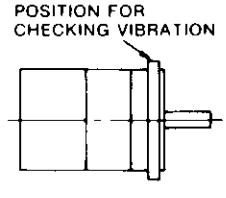


Fig. 4.12 Vibration Checking

5. CONFIGURATION

5.1 CONNECTION DIAGRAM

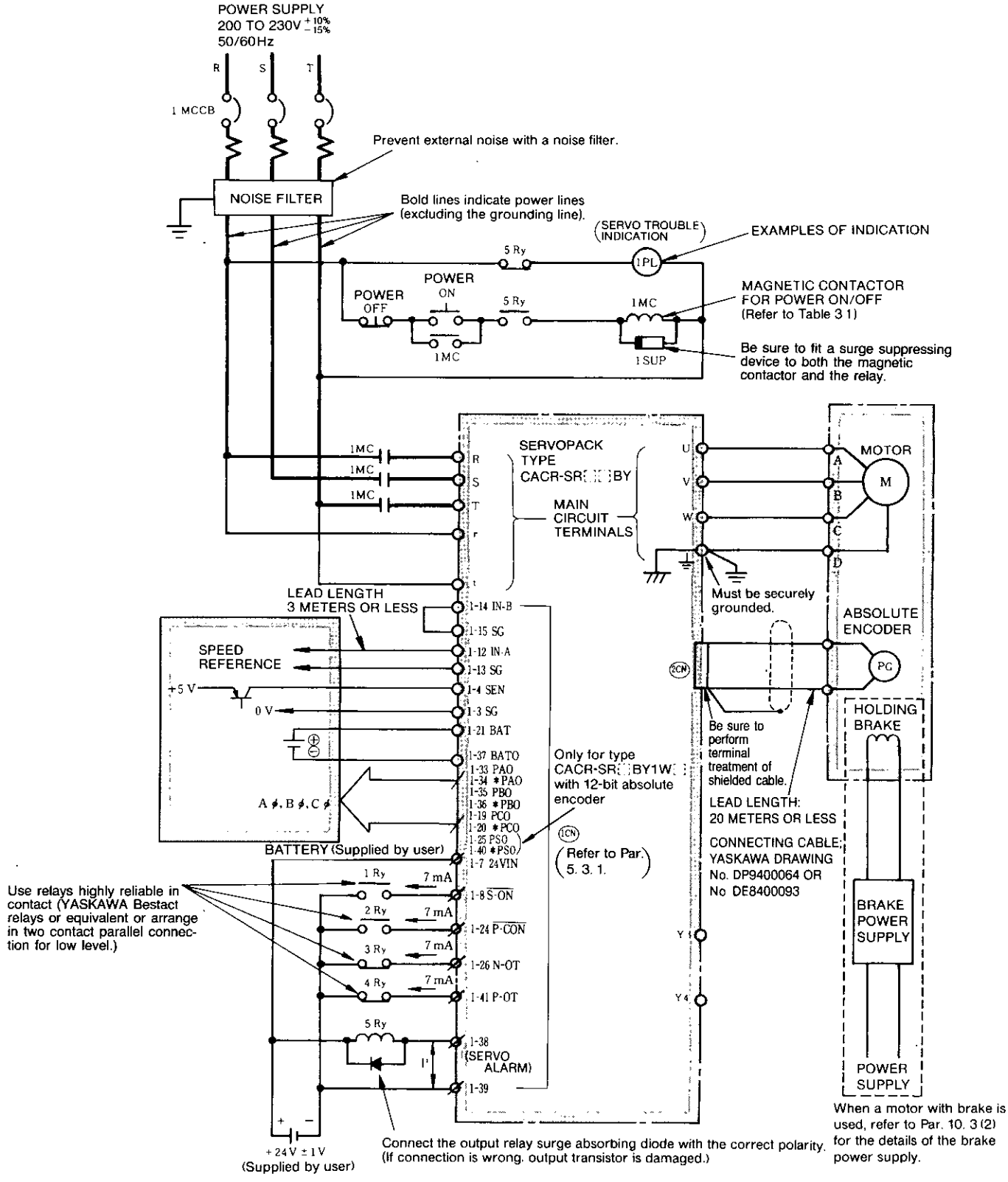
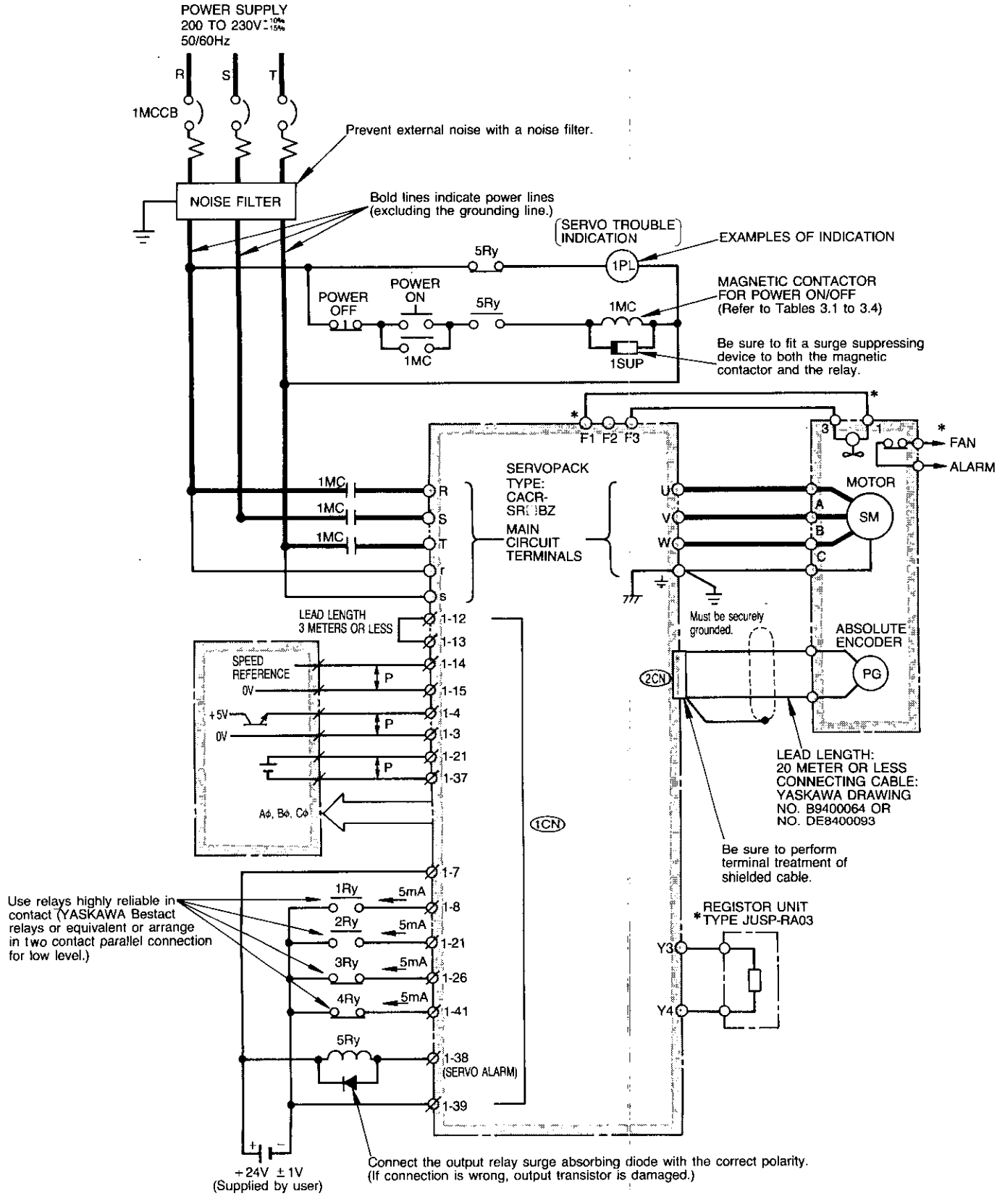


Fig. 5.1 Example of Connection Diagram of SERVOPACK with a SERVOMOTOR and Peripherals



*: Added only for type 60BY (externally fan-cooled type)

Fig. 5.2 Example of Connection Diagram of SERVOPACK with a SERVOMOTOR and Peripherals

5.2 MAIN CIRCUIT TERMINALS

Table 5.1 shows the specifications of main circuit terminals for SERVOPACK.

Table 5.1 Main Circuit Terminals for SERVOPACK

Terminal Symbol	Name	Description
Ⓡ Ⓢ Ⓣ	Main-circuit AC input	Three-phase 200 to 230 VAC $^{+10}_{-15}$%, 50/60Hz.
Ⓤ Ⓥ Ⓦ	Motor connection	Connects terminal Ⓤ to motor terminal A, Ⓥ to B and Ⓦ to C.
ⓡ ⓣ	Control power input	Single-phase 200 to 230 VAC $^{+10}_{-15}$%, 50/60Hz
⏚	Frame ground	Connects to motor terminal D. Must be securely grounded.
Ⓨ3 Ⓨ4	Regenerative resistor	External connection not usually required except type SR60BY.
Ⓕ1 Ⓕ3	Fan connecting terminal	Connected only to type SR60BY.

5.3 APPLICABLE RECEPTACLES

5.3.1 Specifications of Connector Terminal (1CN) for Input/Output Signal

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

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., Ltd.
† Attached to SERVOPACK at shipment.

5.3.2 Specifications of Connector Terminal (2CN) for Encoder

Table 5.3 Specifications of Applicable Receptacles for SERVOPACK Encoder

Connector Type * used in SERVOPACK	Applicable Receptacle Type				Cable Specifications
	Manufacturer	Soldering Type	Caulking Type	Case	
MR-50RMA (Right angle 20 P)	Honda Tsushin Co., Ltd.	MR-20†	MRP-20F01	MR-20L†	YASKAWA Drawing No. DP8409123 or No. DE8400093

* The connectors for encoder used are made by Honda Tsushin Co., Ltd.
† Attached to SERVOPACK at shipment.

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

5.4.1 Connector 1CN Layout and Connection of SERVOPACK (for type CACR-SR□BY1S□ with 15-bit Absolute Encoder)

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

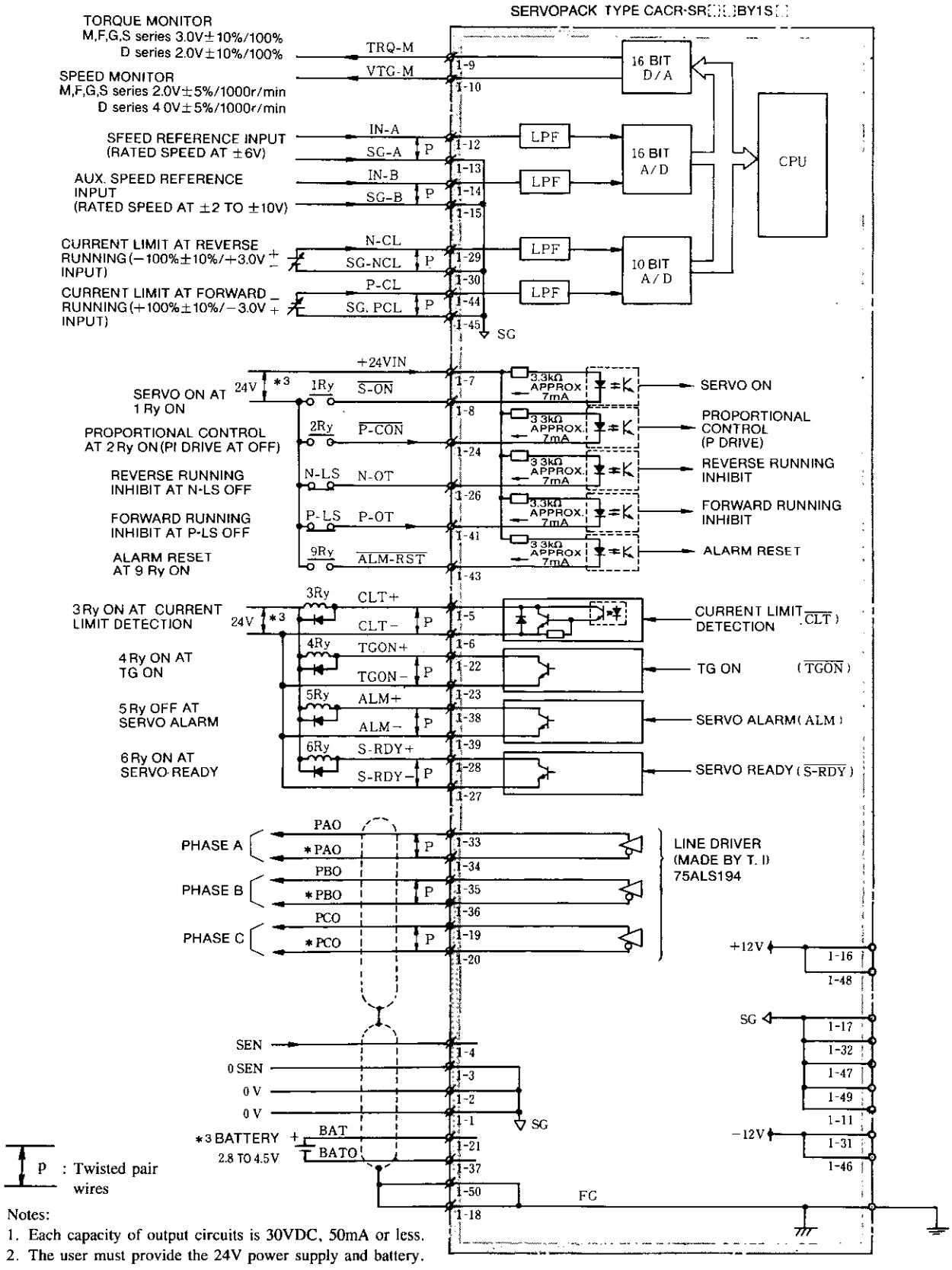
Table 5.4 Connector 1CN Layout of SERVOPACK (for 15-bit Absolute Encoder)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0V	0V	0SEN	SEN	CLT +	CLT −	+24V IN	$\overline{\text{S-ON}}$	TRQ -M	VTG -M	SG	IN-A	SG-A	IN-B	SG-B	+12V	SG	FG
0V for PG Output Signal		SEN Signal Input		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	BAT	TGON +	TGON −	$\overline{\text{P-CON}}$		NOT	S-RDY −	S-RDY +	N-CL	SG-NCL	−12V	SG		
		PC Output Phase C		Battery (+)	TG ON Signal Output		P Drive Input		Reverse Prohibit Input	Servo Ready Output		Reverse Current Limit Input		−12V Output			

33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	58	59	50
PAO	*PAO	PBO	*PBO	BATO	ALM +	ALM −		P-OT		$\overline{\text{ALM-RST}}$	P-CL	SG-PCL	−12V	SG	+12V	SG	FG
PG Output Phase A		PG Output Phase B		Battery (−)	Servo Alarm Output			Fwd. Prohibit Input		Alarm Reset Input	Fwd. Current Limit Input		−12V Output		+12V Output		Frame Ground

Note: For input signal and method of application, refer to Table 5.6 and 5.7.



Notes:
1. Each capacity of output circuits is 30VDC, 50mA or less.
2. The user must provide the 24V power supply and battery.

Fig. 5.3 Input/output of Signals and Connector 1CN for 15-bit Absolute Encoder

5.4.2 Connector 1CN Layout and Connection of SERVOPACK (for type CACR-SR□BY1W□ with 12-bit Absolute Encoder)

The terminal layout of the SERVOPACK input/output signal connectors (1CN) is shown in Table 5.5. The external connection and external signal processing are shown in Fig. 5.4.

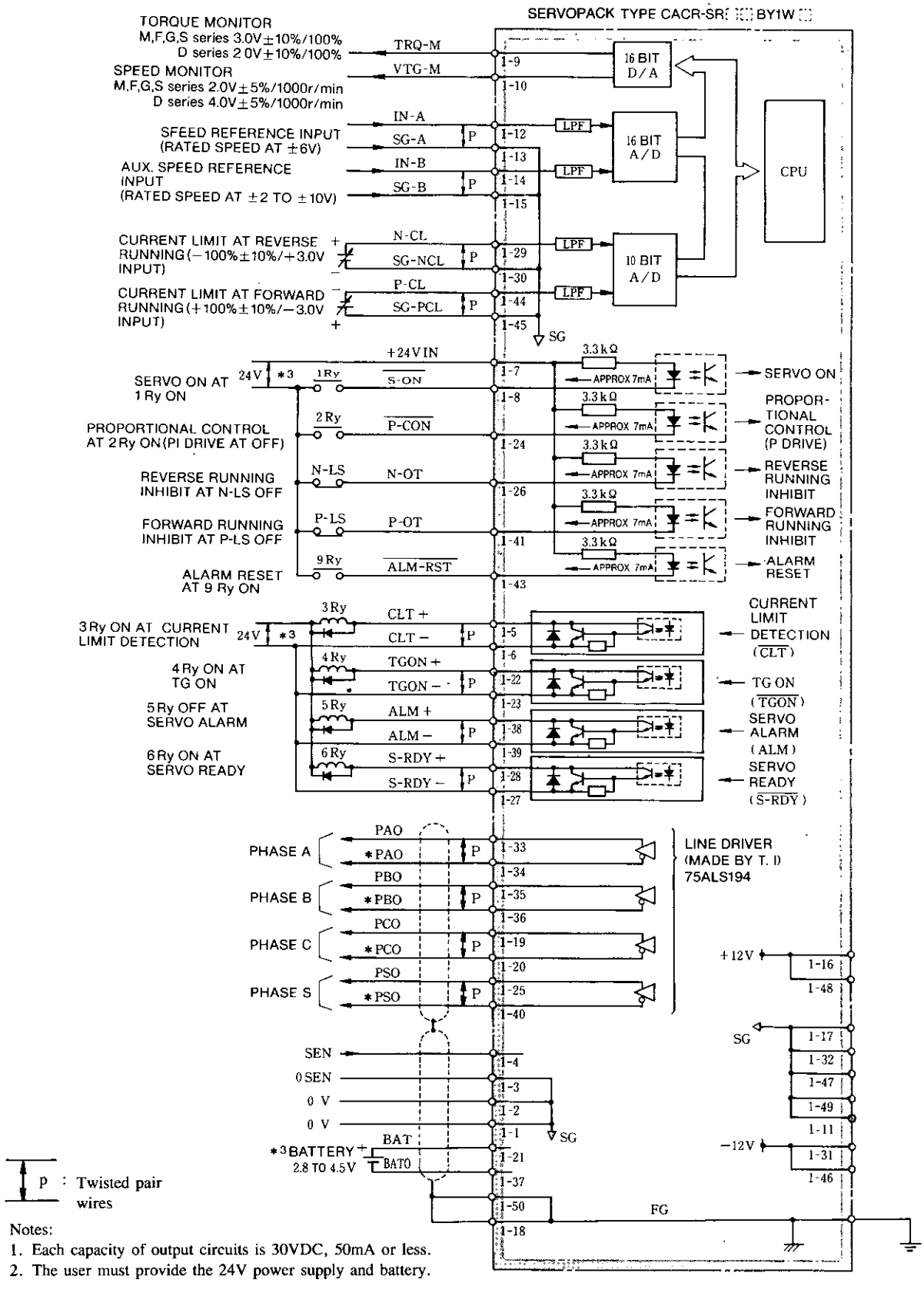
Table 5.5 Connector 1CN Layout of SERVOPACK (for 15-bit Absolute Encoder)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0V	0V	0SEN	SEN	CLT +	CLT −	+24V IN	$\overline{\text{S-ON}}$	TRQ -M	VTG -M	SG	IN-A	SG-A	IN-B	SG-B	+12V	SG	FG
0V for PG Output Signal		SEN Signal Input		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	BAT	TGON +	TGON −	$\overline{\text{P-CON}}$	PSO	N-OT	S-RDY −	S-RDY +	N-CL	SG-NCL	−12V	SG
		PC Output Phase C		Battery (+)	TG ON Signal Output		P Drive Input	Position Output (+)	Reverse Inhibit Input	Servo Ready Output		Reverse Current Limit Input	−12V Output		

33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	58	59	50
PAO	*PAO	PBO	*PBO	BATO	ALM +	ALM −	*PSO	P-OT		$\overline{\text{ALM-RST}}$	P-CL	SG-PCL	−12V	SG	+12V	SG	FG
PG Output Phase A		PG Output Phase B		Battery (−)	Servo Alarm Output		Position Output (−)	Fwd. Inhb. Input		Alarm Reset Input	Fwd. Current Limit Input		+12V Output		+12V Output		Frame Ground

Note: For input signal and method of application, refer to Table 5.6 and 5.7.



Notes:
1. Each capacity of output circuits is 30VDC, 50mA or less.
2. The user must provide the 24V power supply and battery.

Fig. 5.4 Input/output of Signals and Connector 1CN for 12-bit Absolute Encoder

5.4.3 Input Signal and Method of Application

Table 5.6 Input Signals of Connector 1CN

Signal Name	Connector 1CN No.	Function	Description
$\overline{\text{S-ON}}$	1CN-8	Servo ON	• Inputting this signal makes the SERVOPACK ready to receive speed reference input (+6 V). • Base block and dynamic brake are cleared.
$\overline{\text{P-CON}}$	1CN-24 (Three functions are selectable with user constant setting.)	Proportional drive reference	• Proportional control command applies friction torque to the motor to prevent drifting when the motor is left motionless without command input, while the main circuit is kept energized.
		Zero clamp operation reference	• Inputting this signal makes the motor keep speed zero (stop) state and prevent drifting.
		Changeover command for torque control/ speed control	• In torque control II mode, inputting this signal makes the SERVOPACK change torque control to speed control.
N-OT	1CN-26	Reverse running prohibit	• In the case of linear motion, etc., connect limit switch signal according to the run direction. Since it is a bar signal (reverse signal), it is "closed" during normal run. When limit switch is tripped, it becomes "open". • Inputting this signal makes the SERVOPACK cancel the functions and become "normally $\overline{\text{N-OT}}$" or "normally $\overline{\text{P-OT}}$".
P-OT	1CN-41	Forward running prohibit	
$\overline{\text{ALM-RST}}$	43	Alarm reset	Resets Servo alarm state.
+24 VIN	1CN-7	24 V	• External power supply to 1CN-8, 24, 26, 41 and 43. Prepare a 24 VDC (25 mA min.) power supply.
IN-A	1CN-12 (13)	Speed command input*	At ±6.0 V, ±rated speed is obtained.
IN-B	1CN-14 (15)	Aux. command input*	At ±2.0V to ±10.0V, ±rated speed is obtained.
		• When either of IN-A or IN-B is used, be sure to turn off SG the unused input or set it "Zero specification" by user constant.	
N-CL	1CN-29 (30)	Current limit reference at reverse running	+3.0 V ±10%/100% torque +9V max.
P-CL	1CN-44 (45)	Current limit reference at forward running	−3.0 V ±10%/100% torque −9V max.
SEN	4 (3)	Sensor ON	• When this signal is changed from low level (0V) to high level (5V), +5V is supplied to absolute encoder and normal operation is started after serial data and initial pulse are output. • By changing SEN signal from high to low level, the absolute encoder power supply is turned OFF.
BAT BATO	21 37	Battery ⊕ input Battery ⊖ input	Backup battery connection terminal at absolute encoder power loss. (Battery is to be supplied by users.)

* Torque command input: ±3V/rated torque. (Level can be set by user constants.)

5.4.4 Input Circuit

There are five types of external sequence input signals: Servo ON inputs, proportional drive inputs, overtravel protective inputs both in forward and reverse directions, and alarm reset inputs. Construct the input circuit using 24V power supply (Fig.5.5). Typical circuits are shown in Fig. 5.3.

NOTE

The user must provide the 24V power supply:
24VDC ±1V, 25mA or more (approx 5mA / circuit)

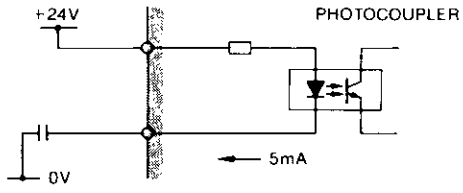


Fig. 5.5 Configuration of Input/Output Circuit

(1) S-ON [Servo ON]

This circuit is used to turn on the main-circuit power-drive circuit of the Servopcak. When the signal of the circuit is not input (Servo OFF state) the motor cannot be driven. If this signals is not input during motor running, the motor will stop by DB. (The motor coasts to stop when user constant Cn-01, 6-bit =1.) Servo ON signal can be omit with user constant setting (Cn-01, 0-bit=1). Do not stop the motor by Servo ON/OFF.

(2) $\overline{\text{P-CON}}$

This input signal is used with three types as follows:

(a) Proportional Drive

The drive may drift in open position loop. 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.

(b) Zero-clamp Operation

After the motor stops, it may be locked electrically. This function is applicable vertical loads. Continuous operation torque in servo-lock may not exceed 70% of the motor's rated torque.

(c) Torque/Speed Control Changeover

Torque control mode II is entered by setting Cn-01 A-bit and B-bit to 1.
In torque control mode II, the P-CON signal input determines whether the torque or speed control system takes effect.

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

These circuits are used to stop the forward running of the motor (counterclockwise when viewed from the drive end of the motor) and reverse running.

When the overtravel prevention circuit is not used, this function can be canceled with connecting. Four operations are selectable with user constant setting when the overtravel prevention circuit is used. 1CN- ㉖ and ㊶ to the 0 V terminal of the external 24 V power supply or user constant setting.

(a) Coasting to a stop: Cn-01, 6-bit=1

In the overtravel state, the motor coasts.

(b) DB Stop

In the overtravel state, the motor can be stopped by the dynamic brake. A user constant (Cn-01, 7-bit) is used to determine whether the stopped motor is to be continuously locked by the dynamic brake or freed.

(c) Stop at Torque Setting Defined by User Constant: Cn-01, 8-bit=1

In the overtravel state, the internal circuitry forcibly issues a speed reference of 0, without respect to the presence of another speed reference, so as to stop the motor immediately. After the motor is brought to a stop, it becomes free.
Stop torque is set by Cn-06 emergency stop torque.

(d) Stop at Torque Setting Defined by User Constant, Which Is Followed by a Zero Clamp Operation

After the motor stops as indicated in paragraph (C) above, it enters the zero clamp mode.

NOTE

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

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

This is external reset signal for servo alarm. Remove the cause of the alarm before restarting operation. Set a 0V speed reference when inputting the reset signal for safety.

5.4.5 Use of Output Signals

Table 5.7 Output Signals

Signal Name	Connector 1CN No.	Function	Description
ALM	38 (39)	Servo alarm	• Turns OFF when fault is detected. • For details, refer to Table 6.1 Fault Detection Function.
$\overline{\text{TGON}}$ ($\overline{\text{BK}}$)	22 (23) [Function to be selected by user constant setting.]	Rotation detection	• Turns ON when motor speed exceeds speed set with user constant.
		Brake interlock output	• Output timing signal for external brake signal.
$\overline{\text{CLT}}$	5 (6)	Current limit detection	• $\overline{\text{N-CL}}$ or $\overline{\text{P-CL}}$ used: Turns ON when output torque reaches the lower level set by $\overline{\text{N-CL}}$, $\overline{\text{P-CL}}$ or user constant. • $\overline{\text{N-CL}}$ or $\overline{\text{P-CL}}$ not used: Turns ON when output torque reaches the level set by user constant.
$\overline{\text{S-RDY}}$	28 (27)	Servo ready	• Turns ON when main power supply ON and servo alarm OFF.
+12V 0V −12V	16, 48 17, 32, 47, 49 31, 46	±12V Output Power supply	• ±12V ±5% max output current: 30mA • Used with speed command or current input.
TRQ-M	9	Torque monitor	(±3.0V/rated torque) ±10%: M, F, G, S series, load 1mA or less (±2.0V/rated torque) ±10%: D series
VTG-M	10	Speed monitor	±2.0V/1000r/min ±5%: F, G, S, D series, load 1mA or less ±4.0V/1000r/min ±5%: M series
PAO	33	PG Signal Output Phase A	• Pulse after frequency division is output by a line driver (MC3487*). • To be received by a line receiver (MC 3486*).
*PAO	34	Phase $\overline{\text{A}}$	
PBO	35	Phase B	
*PBO	36	Phase $\overline{\text{B}}$	
PCO	19	Phase C	
*PCO	20	Phase $\overline{\text{C}}$	
PSO	25	PG Signal Output Phase S	12-bit absolute encoder (only for CACR-SR□BYIW□) r/min value is always output in serial data (transmission period: 40 msec).
*PSO	40	Phase $\overline{\text{S}}$	

5.4.6 Output Circuit

(1) Sequence signal output circuit

There are four non-contact output signals, employing transistors: Current limit detection, TG ON, Servo alarm, Servo ready, and three alarm codes with open collector output.

Voltage and current specifications are:

Applied Voltage (V max) ≦ 30V
Conduction Current (Ip) ≦ 50 mA

NOTE

The sequence signal output circuit requires a separate power supply. It is recommended to use the same 24V power supply used for the input circuit (Fig. 5.6).

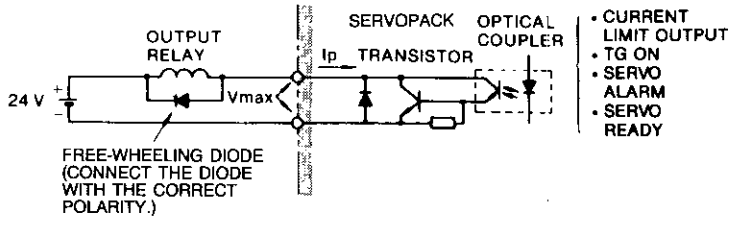


Fig. 5.6 Output Circuit

(2) 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:

(a) Signal form

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

(b) Output circuit and receiver circuit

Two types of output circuits are provided: line driver output and open collector output. Fig. 5.7 shows an example of line driver output.

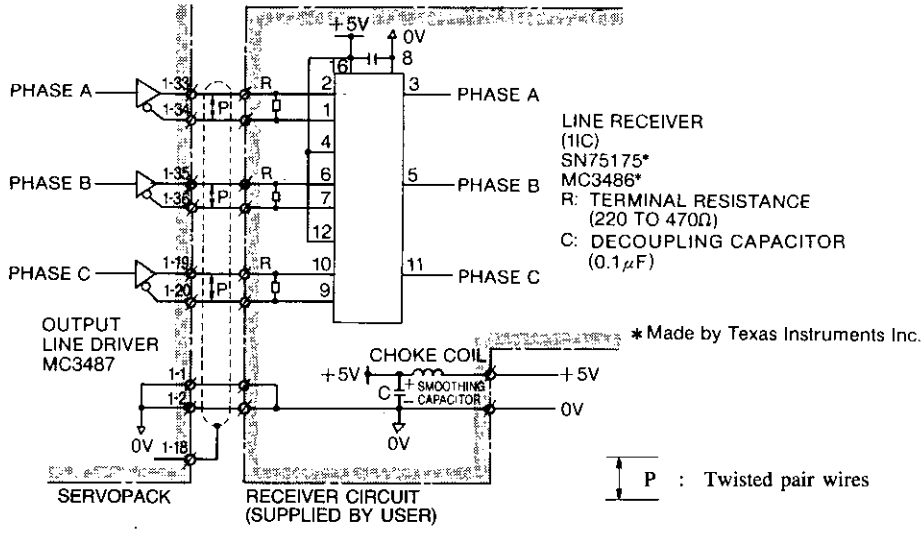


Fig. 5.7 Output Circuit and Receiver Circuit

(c) Output phase (frequency dividing ratio: 1/1)

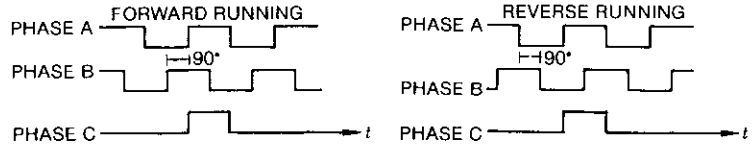


Fig. 5.8 Output Phase

For details of frequency division, refer to sect. 7, "USER CONSTANT (8)".

(2) Holding Brake Interlock Signal

The brake signal output, which is dependent on the motor circuit conduction state and motor revolving speed, can be generated.

<Setup Procedure>

When the user constant (memory switch) is set to provide the braking function, the brake signal output is generated from the 1CN-22, 23 (TG ON). The time interval tB [× 10 ms] between braking and motor conduction termination is determined by the BRKTIM user constant.

5.5 CONNECTOR TERMINAL (2CN) FOR ABSOLUTE ENCODER CONNECTION

5.5.1 Connector Layout

Table 5.8 Connector 2CN Layout of SERVOPACK (for 15-bit Absolute Encoder)

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

8	9	10	11	12	13
		RESET		BAT	BATO

14	15	16	17	18	19	20
PC	*PC	PA	*PA	PB	*PB	FG

Table 5.9 Connector 2CN Layout of SERVOPACK (for 12-bit Absolute Encoder)

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

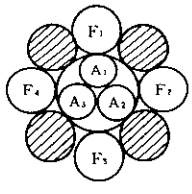
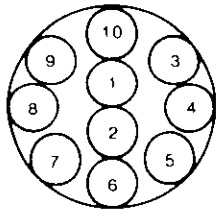
8	9	10	11	12	13
PS	*PS	RESET		BAT	BATO

14	15	16	17	18	19	20
PC	*PC	PA	*PA	PB	*PB	FG

5.5.2 Cable Specifications

If required, purchase in units of standard length.

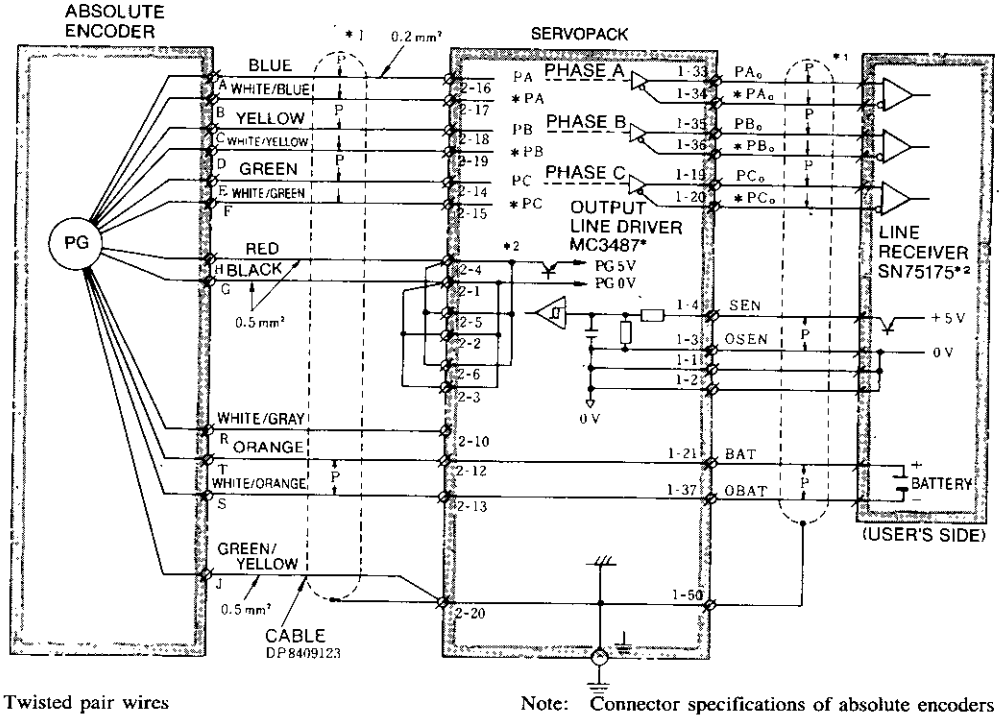
Table 5.10 Cable Specifications

Connection	Soldered Type	Caulking Type
YASKAWA Drawing No.	B9400064	DE8400093
Manufacturer	Fujikura Cable Co.	
General Specifications	Double, KQVV-SW AWG22 × 3C AWG26 × 6P	KQVV-SB AWG26 × 10P
Finishing Dimensions	ϕ7.5mm	ϕ10.0mm
(Recommended Receptacle Type)	For Soldered Type 	For Caulking Type 
Internal Composition and Lead Color (Standard Application: B9400064)	A1 Red A2 Black A3 Green yellow F1 Blue-White/blue F2 Yellow-White/yellow F3 Light green-White/light green F4 Orange-White/orange (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 lengths: 5m, 10m, 20m Terminal ends are not provided (with connectors).	

NOTE

1. When applicable cables listed in Table 5.10 are used, allowable wiring distance between SERVOPACK and motor is 20 meters max. Cables must be assembled by authorized vendor with appropriate tooling.
2. The cable applied for 50 m wiring distance is available on order (YASKAWA drawing No. DP8409179). If wiring distance is 20m or more, contact your YASKAWA representative.

5.5.3 Method of Connection (for 15-bit Absolute Encoder)

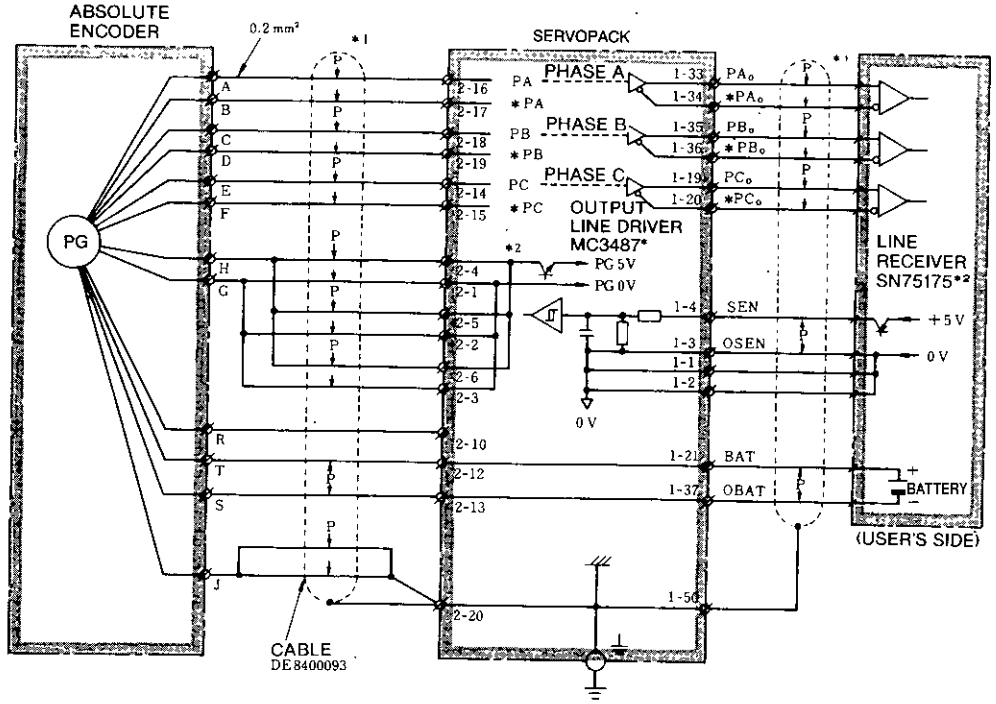


*1 : Twisted pair wires

*Made by Texas Instruments Inc.

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

Fig. 5.9 Soldered Type Connector 2CN Connection and 1CN Output Processing (when using Connection Cable DP8409123)



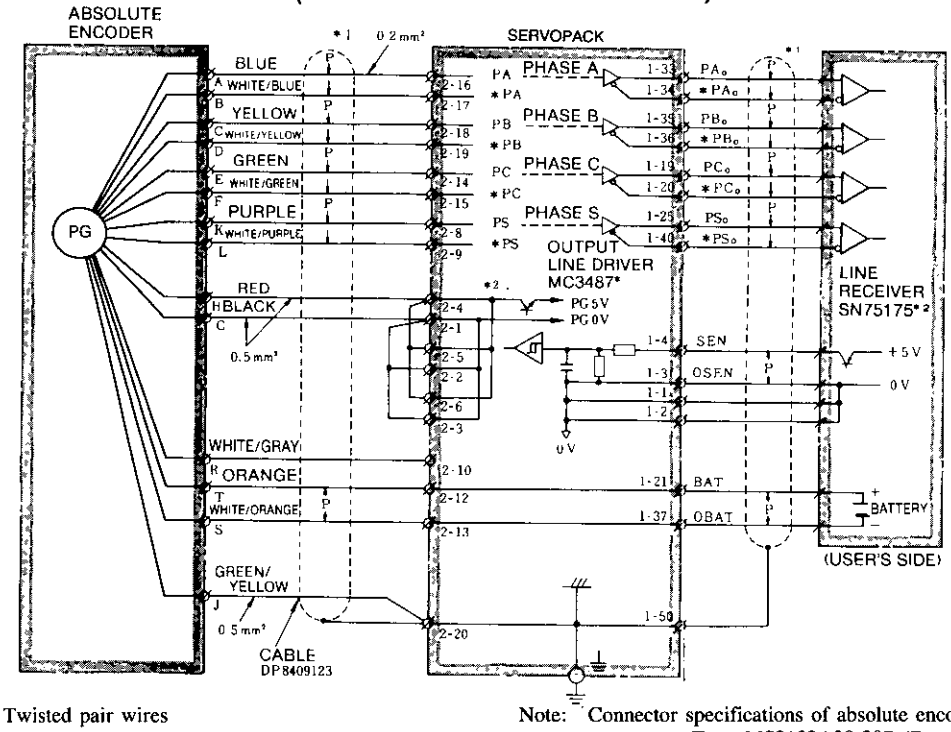
*1 : Twisted pair wires

*Made by Texas Instruments Inc.

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

Fig. 5.10 Caulking Type Connector 2CN Connection and 1CN Output Processing (when using Connection Cable DE8400093)

5.5.4 Method of Connection (for 12-bit Absolute Encoder)

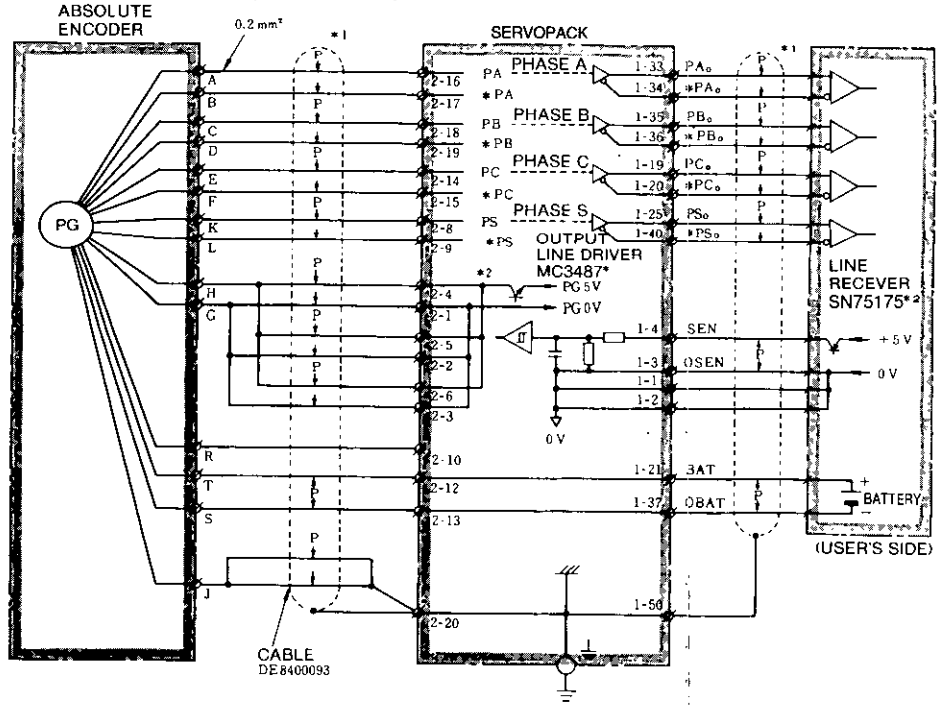


*1 : Twisted pair wires

*Made by Texas Instruments Inc.

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

Fig. 5.11 Soldered Type Connector 2CN Connection and 1CN Output Processing (When using Connection Cable DP8409123)



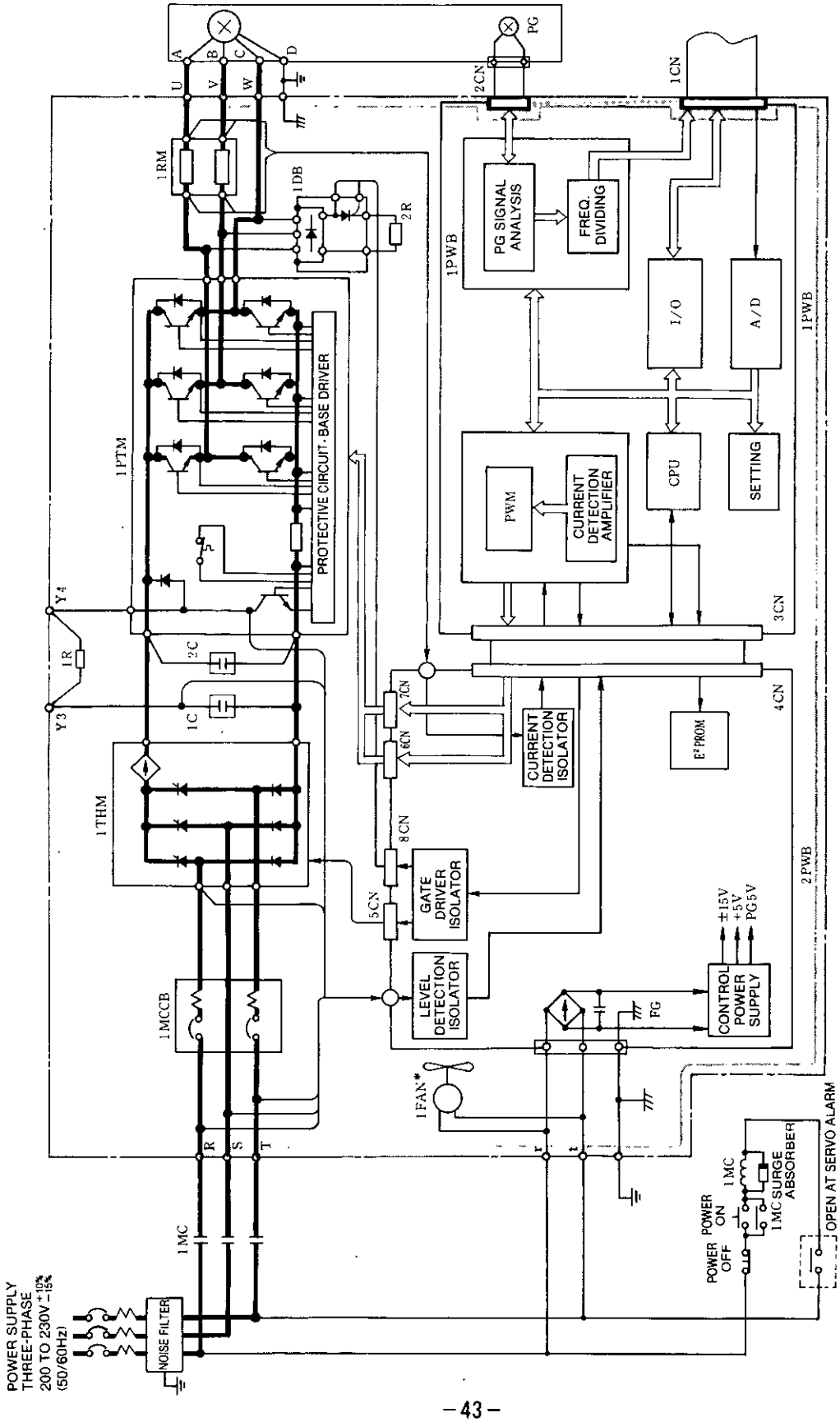
*1 : Twisted pair wires

*Made by Texas Instruments Inc.

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

Fig. 5.12 Caulking Type Connector 2CN Connection and 1CN Output Processing (when using Connection Cable DE8400093)

5.6 INTERNAL CONNECTION DIAGRAM



* 1 FAN is provided only for types CACR-SR15BY and above.

Fig. 5.13 Internal Block Diagram of SERVOPACK

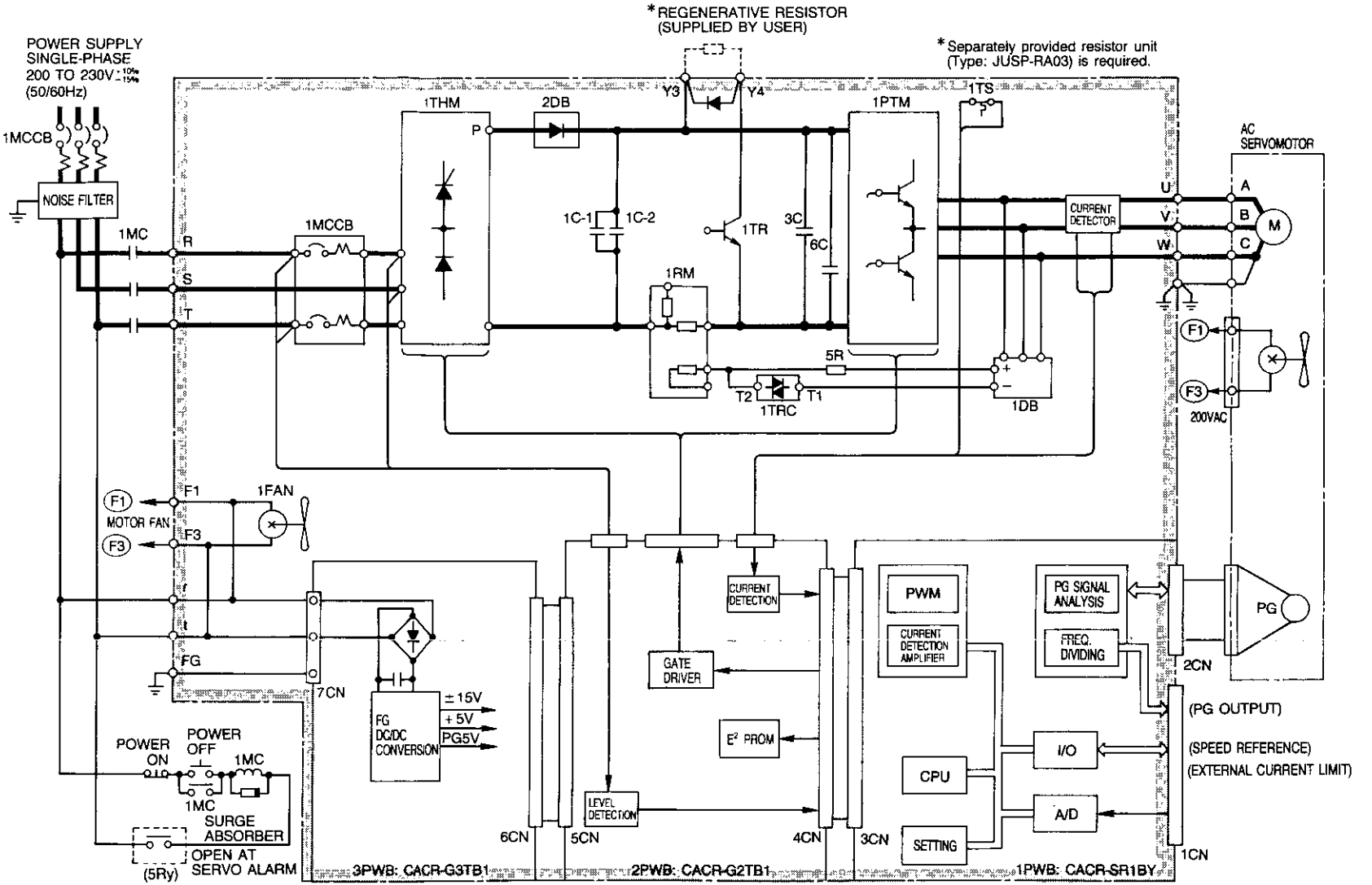


Fig. 5.14 Internal Block Diagram of SERVOPACK (Type SR60DY)

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 to the main circuit (Figs. 6.1 and 6.2).

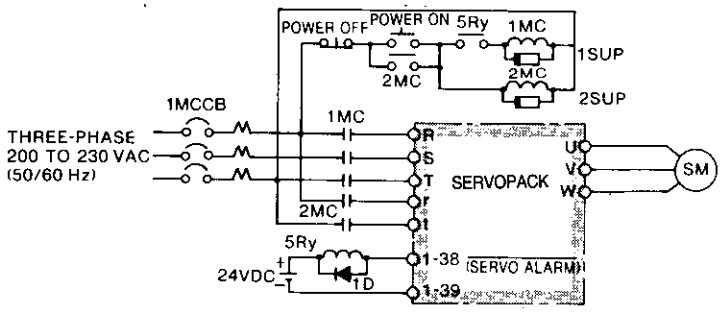
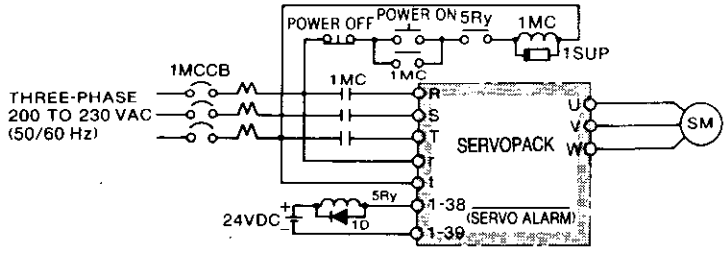


Fig. 6.1 Connection Example for Simultaneous Control Power ON/OFF



1SUP,2SUP: Surge suppressor
1D: Free-wheel diode (to prevent spike of 5Ry)

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

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

Precautions for Connections in Figs. 6.1 and 6.2

- Make sequence to assure that the main circuit power will be cut off by a servo alarm signal. (The alarm information is written on E^2 PROM, so when the power is simultaneously cut, the alarm subject can be checked with the power resupplied.)
- 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 3 seconds.

  Note: When the power is turned ON, a servo alarm signal continues for approximately 3 seconds to initialize the SERVOPACK.
- Since SERVOPACK is of a capacitor input type, large in-rush current flows when the main-circuit power is turned ON (recharging time: 0.5s to 1s). Also, recharging voltage is discharged quickly into discharging resistor when the in-rush circuit power is turned OFF. Therefore, if the power is turned ON and OFF frequently, the recharging-current limit resistor may be degraded and a malfunction may occur.

  When the motor starts, turn ON the speed reference and turn it OFF when the motor stops. Do not turn the power ON or OFF.
- Before power ON or OFF, turn OFF the "Servo ON" switch to avoid transient troubles.

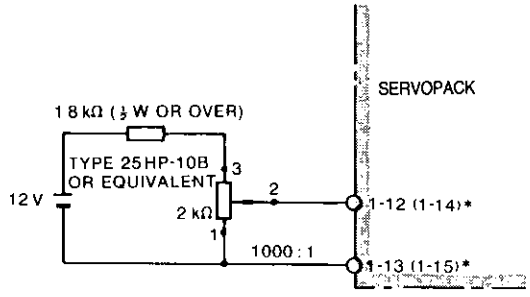
6.2 SPEED REFERENCE

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.

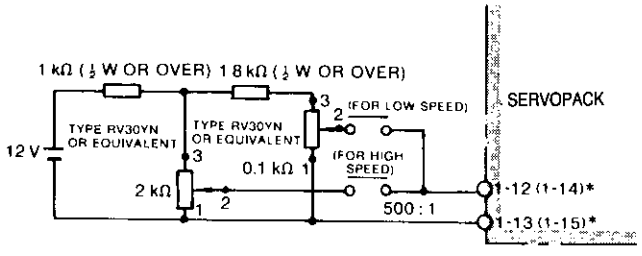
The method for giving speed reference voltage is described below.

(1) For accurate (inching) speed setting



25HP-10B type: Multiple-rotation type, wire wound variable resistor (with dial MD10-30B4)

(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 or low-level relays.

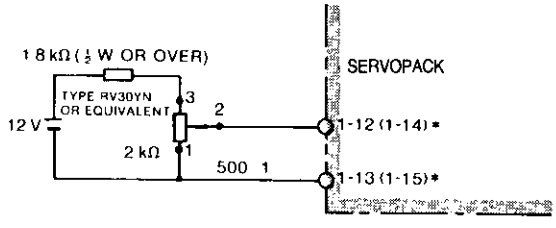
Note: When a carbon resistor is used, a great residual resistance remains, and so the speed control range becomes approximately 500:1.

(b) When Carbon Variable Resistor is used

* Parenthses are for auxiliary input.

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

(2) For relatively rough speed setting



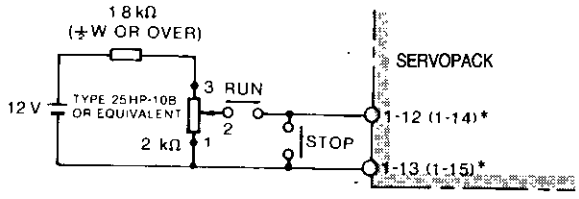
* Parentheses are for auxiliary input.

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

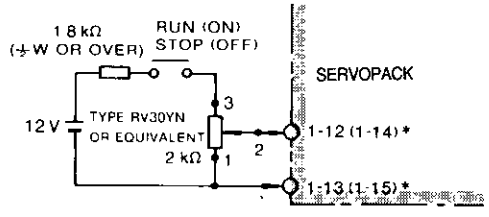
Fig. 6.4 Method for Giving Speed Reference Voltage
(for relatively Rough Speed Setting as Compared with Fig. 6.3)

6.2.2 Stop Reference Circuit

When giving a stop reference, do not open the speed reference circuit (1CN- ⑫ 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 terminal 1CN- ⑭ , ⑮ must be short-circuited or select "Zero-speed Reference" with user constant setting. (Cn-01: bit No. 4, 5. Refer to Table 8.5.)

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
  For parameter setting of auxiliary input reference, input motor rotation per 1V (r/min/V) to user constant INBGN .

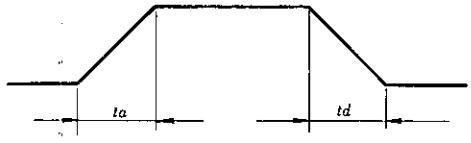
  When combined with YASKAWA POSITIONPACK in positioning system drive, auxiliary input terminals are normally used as speed reference input. In this case, positioning loop gain is adjusted with the user constant INBGN .

6.2.5 Zero Clamp Speed Control

The zero clamp speed control mode can be selected by properly setting user constant Cn-01 (bits A and B). In this mode, the motor rotating speed goes below the user constant Cn-0F [ZCLVL] setting, and the speed reference is cut off to clamp the motor revolving speed to zero when the P-CON signal is turned ON.

In the zero clamp speed control mode, P/PI control changeover cannot be effected as in regular speed control because the P-CON signal serves as the zero clamp function ON/OFF signal.

6.2.6 Soft Start Function



Motor accel/decel time can be set up.

<Setup Procedure>

Enter as the Cn-07 [SFSACC] user constant the time (ms) required for the motor to reach the maximum rotating speed.

6.2.7 Jogging Function

Even if no speed reference is entered during a test run, the motor can be operated by a circuit board mounted switch. The jogging speed (r/min) can be varied by adjusting the JOGSPD user constant Cn-10. Refer to Par. 8.4.3 for the details of the operation method.

6.3 TORQUE CONTROL

In the torque control mode, the speed loop is disconnected and the motor is driven by torque reference. In this mode, torque control I or torque control II can be selected by setting bits A and B of user constant Cn-01.

6.3.1 Torque Control I

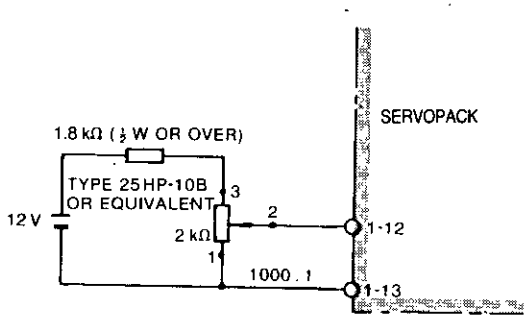
The torque reference voltage is applied between input terminals 1CN 12 and 13 from the SERVOPACK incorporated control power supply (1CN-16, 48: +12 V; 1CN-17, 32, 47, 49: 0 V; 1CN-31, 46: -12 V) or external power supply.

The I/O relationship can be set by user constant Cn-13 [TCRFGN] at standrad 3V/rated torque. Additionally, speed limit value can be set by user constant Cn-14 [TCRLMT]. Cn-14 [TCRLMT] is effective only for torque control mode I.

The method for giving torque reference voltage is described below.

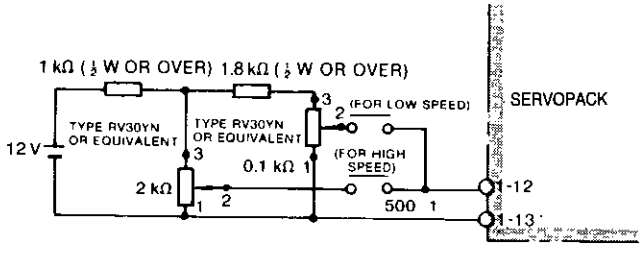
(1) For accurate (inching) torque setting

In Figs. 6.6 and 6.7, 1-12 and 1-13 are the input terminals number of SERVOPACK.



25HP-10B type: Multiple-rotation type, wire wound variable resistor (with dial MD10-30B4)

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



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

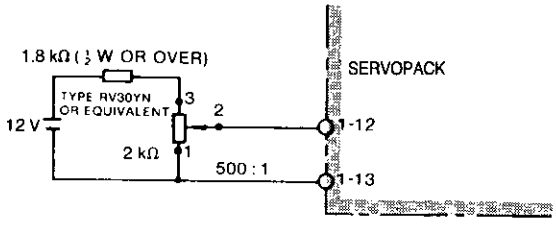
Low- and high-speed relays: Reed relays or low-level relays

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

(b) When Carbon Variable Resistor is used

Fig. 6.6 Method for Giving Torque Reference Voltage (for Accurate Torque Setting)

(2) For relatively rough torque setting



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

Fig. 6.7 Method for Giving Torque Reference Voltage (for relatively Rough Torque Setting as Compared with Fig. 6.6)

6.3.2 Torque Control II (Torque control with Speed Limit + Speed Control)

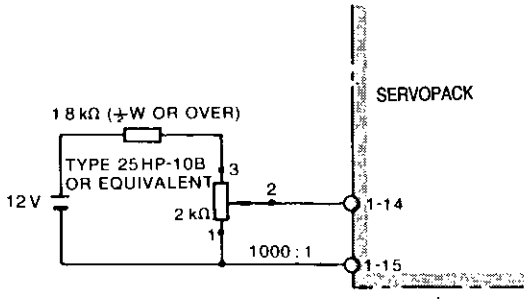
- In torque control II, torque control is performed along with speed control using the motor speed limit function. Switching from torque control to speed control can be available by turning $\overline{\text{P-CON}}$ signal ON.
- In torque control II, $\overline{\text{P-CON}}$ signal is used for switching torque control and speed control so that P/PI control cannot be switched like during usual speed control.
- The torque reference voltage is applied between input terminals 1CN 14 and 15 from the SERVOPACK incorporated control power supply (1CN-16, 48: +12 V; 1CN-17, 32, 47, 49: 0 V; 1CN-31, 46: -12 V) or external power supply. The speed limit voltage (a positive voltage sets both speed limits) is applied between input terminals 1CN 12 and 13. The I/O relationship can be set by user constant Cn-13 TCRFGN at standard 3V/rated torque.

  Torque reference voltage and speed limit voltage application procedure examples are given below.

- For accurate (inching) torque or speed limit setting

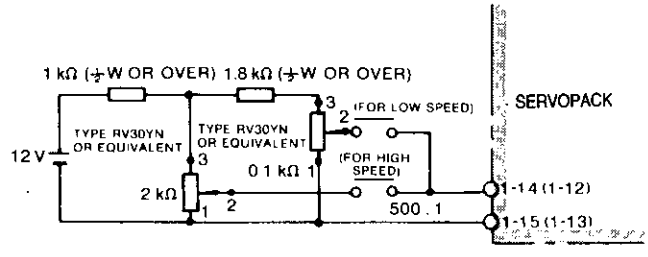
  The SERVOPACK input terminal numbers shown in Figs. 6.8 and 6.9 are for entering torque reference voltage. Parenthesized terminal numbers are for entering speed limit voltage.

(1) For accurate (inching) torque setting or speed limiting



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

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



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

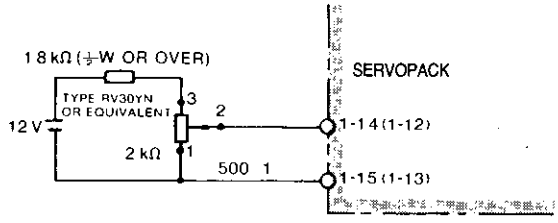
Low- and high-speed relays: Reed relays, or low-level relays.

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

(b) When Carbon Variable Resistor is used

Fig. 6.8 Method for Giving Torque Reference or Speed Limiting Reference Voltage (for Accurate Speed Setting)

(2) For relatively rough torque setting or speed limiting setting



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

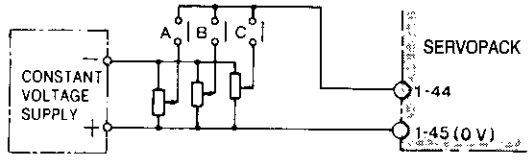
Fig. 6.9 Method for Giving Speed Reference Voltage
(for relatively Rough as Compared with Fig. 6.8)

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

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

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

The current can be limited by multi-stage setting by the use of relays (Fig. 6.10). The same effect can be obtained by giving voltage signals making analog change.



Relay: Low-level relay type G2A-432A made by Omron Corporation.

Fig. 6.10 Multi-stage Switching of Current Value at Forward Side

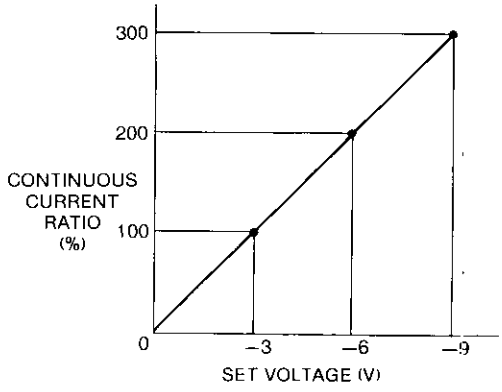
6.4.1 Method of Giving External Current Limit Reference

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 +9.0 V) between terminals 1CN- ㉙ and ㉚ .

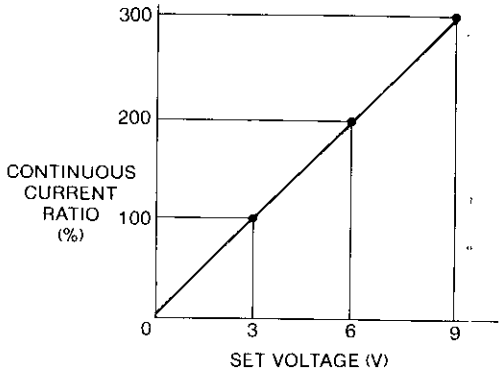
The value of current limit reference voltage is rated current at 3.0 V for applicable motor. The power supply must use an internal resistance less than 2kΩ. The input resistance at SERVOPACK side must be greater than 5kΩ. When external current is not restricted, contacts between terminals 1CN- ㊹ and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

6.4.2 Set Voltage and Current Limit Values

The relationship between set voltages of 0 to ±9.0 V and current limit values are shown in Fig. 6.11.



(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. 6.11 Set Voltage and Current Limit Values

6.4.3 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 Fig 4.1 "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 user constant [INBGN] [LOOPHZ]), the motor lock current sometimes pulsates. If this is not desirable, the current pulsation can be removed by increasing the speed reference voltage.

6.4.4 Using Method of 15-bit Absolute Encoder

The 15-bit absolute encoder outputs PAO, PBO and PCO are shown in Fig. 6.12.

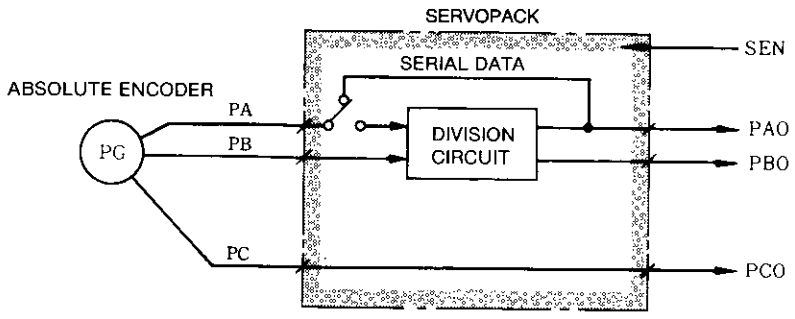


Fig. 6.12 Absolute Encoder Output

When SEN signal is input (from a low to high level), absolute data is first output from PAO as serial data, then as initial incremental pulse PAO, PBO (2-phase pulse with 90-degree phase difference).

After this, output operation same as normal incremental encoder (2-phase pulse with 90-degree phase difference) is performed.

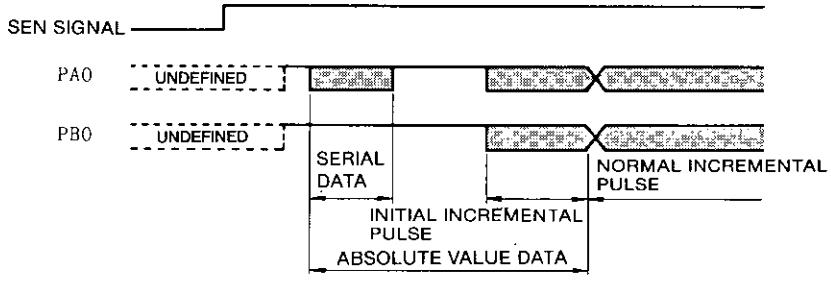


Fig. 6.13 Absolute Value Data Output

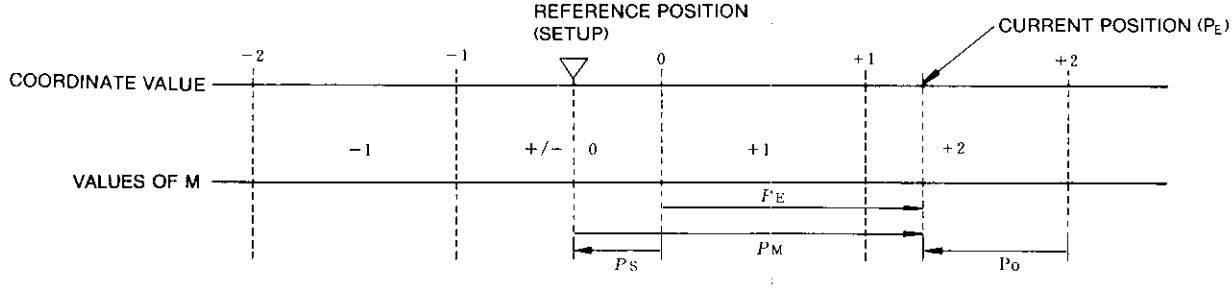
(1) Contents of absolute value data

- Serial data: Indicates the position of the motor shaft (in terms of revolutions) from the reference position (value set at setup time).
- Initial incremental pulse:
  Pulse is output at the same pulse speed as rotation is made at approx. 2700 r/min from the motor shaft origin position to the current motor shaft position.

Assuming that the serial data value is M (rovolutions), initial incremental pulse count value is Po (pulses) and the number of pulses per revolution of the motor (depending on divider circuit setting) is R (P/R), the current position PE can be obtained by the expression:

$$\boxed{P_E = M \times R + P_O}$$

(Example)



P_E : Current value read-out from encoder (servo)

M : Multi-revolution data (servo)

P_O : Initial incremental pulses read-out from encoder (servo)
(Normally, negative value)

P_S : Initial incremental pulses read-out at setup point
(Normally, negative value. This value is stored and controlled by upper controller.)

P_M: Current value required in user's system

R : Number of pulses per encoder rotation
(32768 pulses for this encoder)

$P_E = M \times R + P_O$

$P_M = P_E - P_S$

(2) Typical circuit

Fig. 6.14 shows a typical circuit processing 15-bit absolute encoder output.

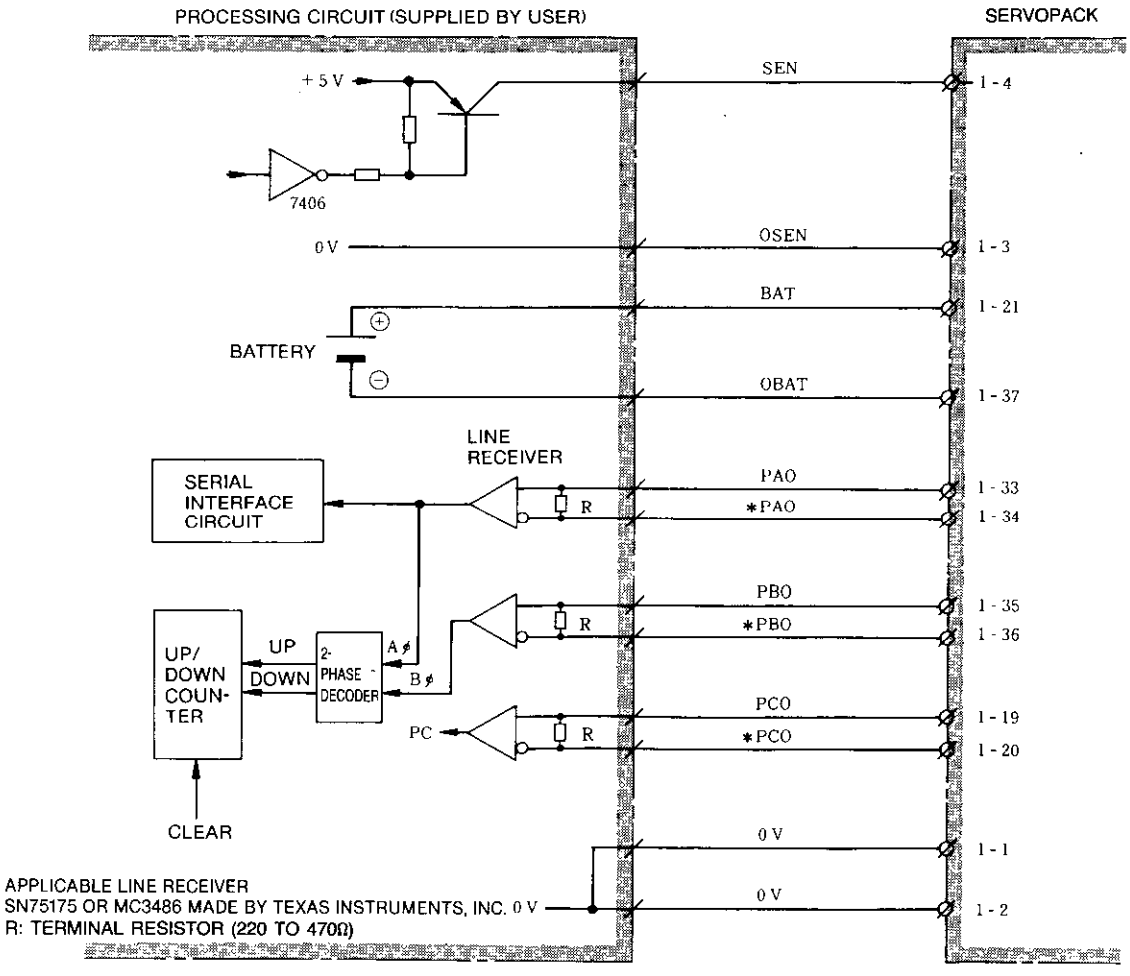


Fig. 6.14 Typical Output Processing Circuit

(3) Absolute data receiving

Absolute data must be processed in such a sequence as shown in Fig. 6.15.

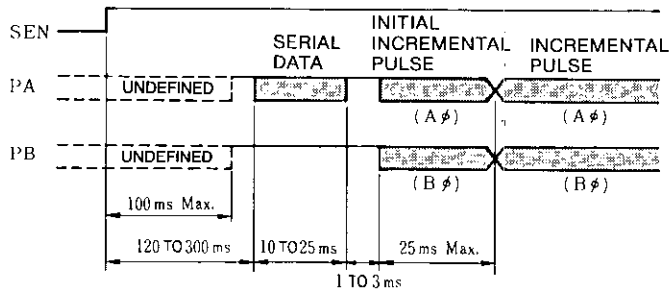


Fig. 6.15 How to Process Absolute Data Receiving

① Make the SEN signal high level.

② After 100ms, set serial data reception-waiting-state.
Clear the up/down counter (for incremental pulse counting) to zero.

③ Receive serial data of 8 bytes.

④ Normal incremental operation status is entered in approx. 50 ms after the last serial data are received.

(4) 15-bit absolute encoder phase A (PAO) serial data specifications

Table 6.1 Phase-A Serial Data Specifications (15-bit)

Data Transmission Method	Asynchronous (ASYNC)
Baud Rate	9600 bauds
Start Bit	1 bit
Stop Bit	1 bit
Parity	Even
Character Code	ASCII 7 bits
Data Format	8 characters (P) (+/−) (0 to 9) 5 digits (CR)

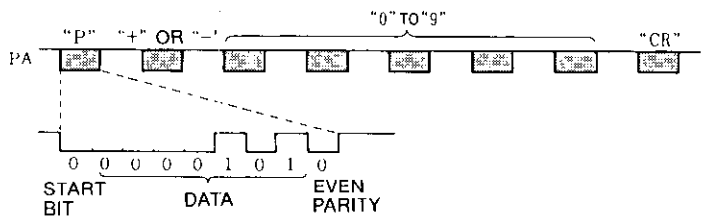


Fig. 6.16 Serial Data

During normal operation, serial data of the number of cumulative rotations (in 5 digits) from the reference point (set at setup time) are output in the format show in Table 6.1.

Zero rotation is displayed by either P+00000 (CR) or P−00000 (CR).

Number of cumulative rotations is counted from 0 through ±99999, then rotation register rolls over to ±00000.

(5) Incremental pulse

Initial incremental pulse giving absolute data and normal incremental pulse are output through the divider. (See Fig. 6.17.) The frequency divider is set by user constant Cn-0A.

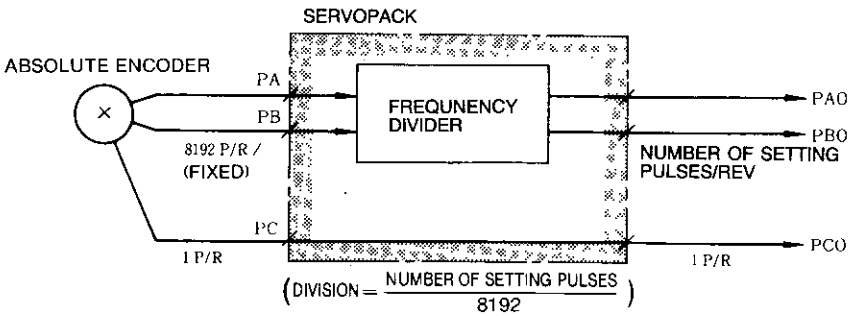


Fig. 6.17 Incremental Pulse

① Output phase

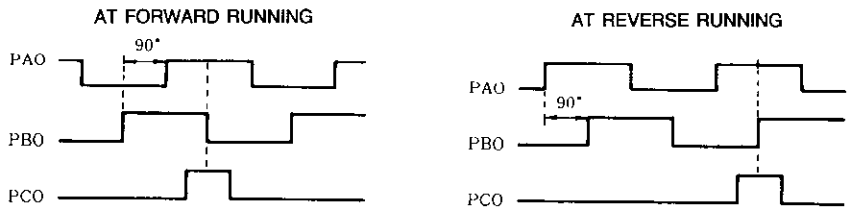
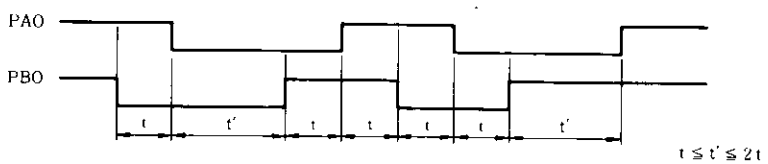


Fig. 6.18 Output Phase at Forward/Reverse Run

PCO (reference pulse) synchronizes with PAO, but the pulse width becomes narrow because PCO is not divided. If the dividing ratio is not 1/2n, accurate 90-degree phase difference is not made and the pulses are output as in Fig. 6.19.



(The phase difference t, t' part equally exists within one revolution, thus the minimum position error results.)

Fig. 6.19 Division Ratio and Output Phase Difference

(6) SEN signal

① When the SEN signal level is changed from low to high, +5V power supply is applied to the absolute encoder and serial data and initial incremental pulse are sent; then normal operation is started.

If the SEN signal is changed from high level to low level when the motor is not energized, +5V power is not supplied to the absolute encoder.

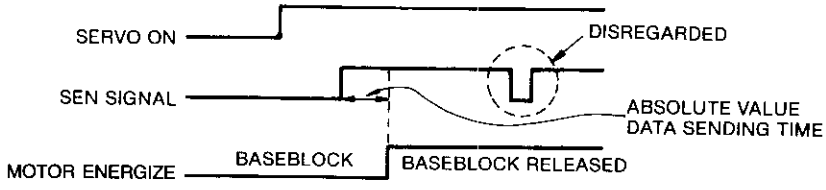
② Do not change the SEN signal level from low to high for 1 second after the control power supply and main power supply are turned ON.

(Undefined time of PAO and PBO before serial data is sent is prolonged.)

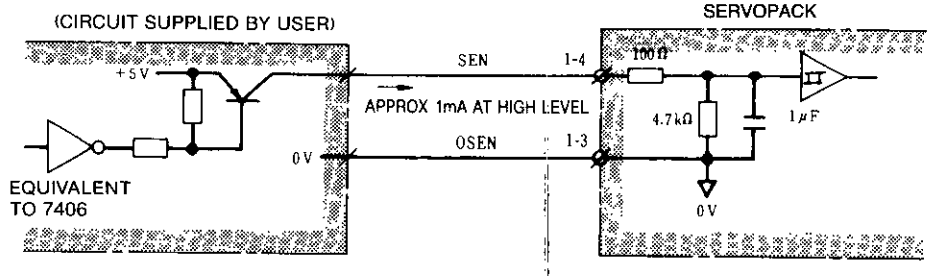
③ When the SEN signal is in the low-level status, the motor cannot be under current conduction. (Baseblock is set.)

④ Even if servo ON signal is entered, the motor is not energized until the SEN signal is input and the encoder starts normal operation, that is, sending of serial data and initial incremental pulse is complete.

⑤ When the motor is energized, the dropped SEN signal is disregarded as follows:



⑥ Electrical specifications



- PNP type is recommended for transistor.
- Signal level (high level: 4V min., low level: 0.7V max.)

Fig. 6.20 Electrical Specifications of SEN Signal

(7) Battery

Be sure to use battery to store position information if absolute encoder power should fail.

- The following battery is recommended:
  Lithium battery (made by Toshiba, type ER6C 3.6V × 1)
- Be sure to connect the battery so as to prevent an environmental change or a change with the passage of time from causing contact failure.
- Since battery voltage is not monitored in the SERVOPACK, make sure that voltage will not be less than 2.8V. Provide a low battery voltage detecting circuit or monitor if necessary in the system.
- Refer to Par. 13.3 "PRECAUTIONS FOR BATTERY REPLACEMENT" for battery replacement method.

(8) Setup method for 15-bit absolute encoder

To clear the cumulative rotation number to zero for testing the motor, or when the absolute encoder has been left disconnected to a battery for more than four days, the encoder needs to be setup by the following procedure. (Under the above conditions, capacitors in the encoder may be charged insufficiently so that the internal circuits may malfunction.)

① SERVOPACK power supply OFF
Turn OFF the power supply if it is turned ON.

↓

② Battery power supply OFF
Remove the battery for the encoder.

↓

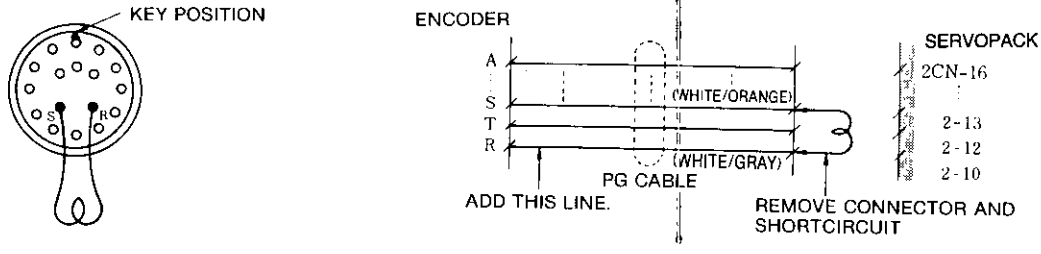
③ Discharging (The capacitor in the encoder is discharged.)
- When discharged at SERVOPACK
  Shortcircuit the reset terminal (SW6-1, 2) on the SERVOPACK board for 2 minutes or more. (For details, refer to Fig. 6.40.)
- When discharged by encoder connector
  Shortcircuit between the encoder connectors R and S for 2 minutes or more.
- When discharged by encoder signal line (non-twisted wire)
  Shortcircuit between reset signal line (white/gray) and 0V (white/orange) for 2 minutes or more.

↓

④ Wiring and battery connection
Restore the normal wiring and connect the battery to the encoder.

↓

⑤ Power ON
Turn ON the SERVOPACK power supply and set the SEN signal to high level. If no error occurs, setup has been completed. If there is any, restart from ① again.



Setup Method by PG Cable

6.4.5 Using Method of 12-bit Absolute Encoder

The 12-bit absolute encoder outputs PAO, PBO, PCO and PSO are shown in Fig. 6.21.

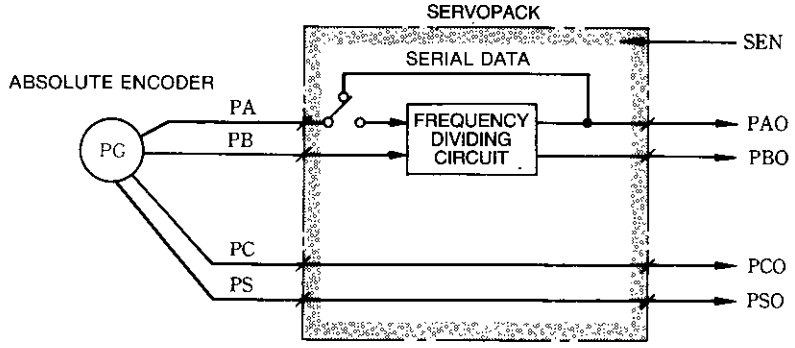


Fig. 6.21 Absolute Encoder Output

When SEN signal is input (from a low to high level), absolute data is first output from PAO as serial data, then as "initial incremental pulse" PAO and PBO (2-phase pulse with 90-degree phase difference). (See Fig. 6.22.)

After this, output operation same as normal incremental encoder (2-phase pulse with 90-degree phase difference) is performed.

No. of rotations (serial data) is output from PSO.

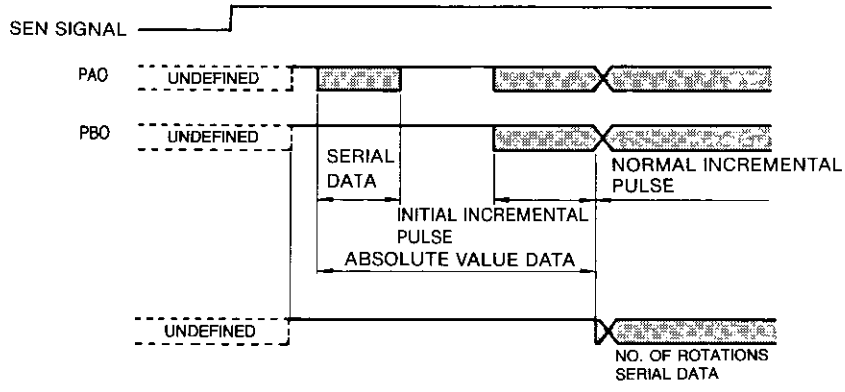


Fig. 6.22 Absolute Value Data Output

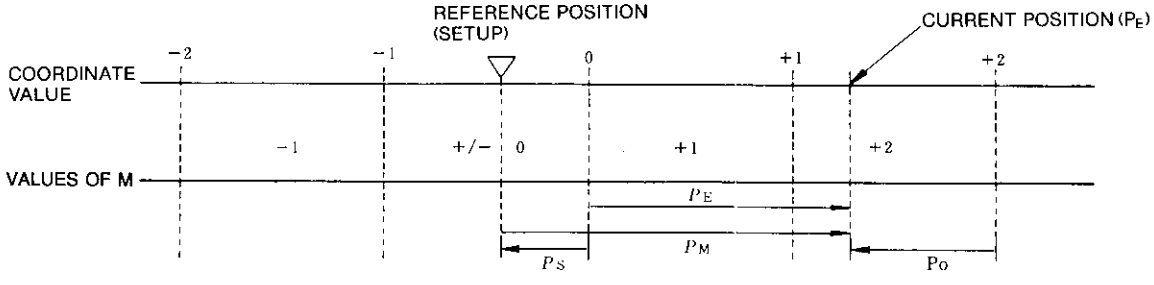
(1) Absolute data contents

- Serial data: Indicates the position of the motor shaft (in terms of revolutions) from the reference position (value set at setup time).
- Initial incremental pulse:
  Pulse is output at the same pulse speed as rotation is made at approx. 4900 r/min from the motor shaft origin position to the current motor shaft position.

Assuming that the serial data value is M (revolutions), the initial incremental pulse count value is Po (pulses) and the number of pulses per revolution of the motor (depending on divider circuit setting) is R (P/R), the current position PE can be obtained by the expression:

$$P_E = M \times R + P_O$$

(Example)



P_E : Current value read-out from encoder (servo)

M : Multi-revolution data (servo)

P_O : Initial incremental pulses read-out from encoder (servo)
(Normally, negative value)

P_S : Initial incremental pulses read-out at setup point
(Normally, negative value. This value is stored and controlled by upper controller.)

P_M: Current value required in user's system

R : Number of pulses per encoder rotation
(4096 pulses for this encoder)

$P_E = M \times R + P_O$

$P_M = P_E - P_S$

(2) Typical circuit

Fig. 6.23 shows a typical circuit processing 12-bit absolute encoder output.

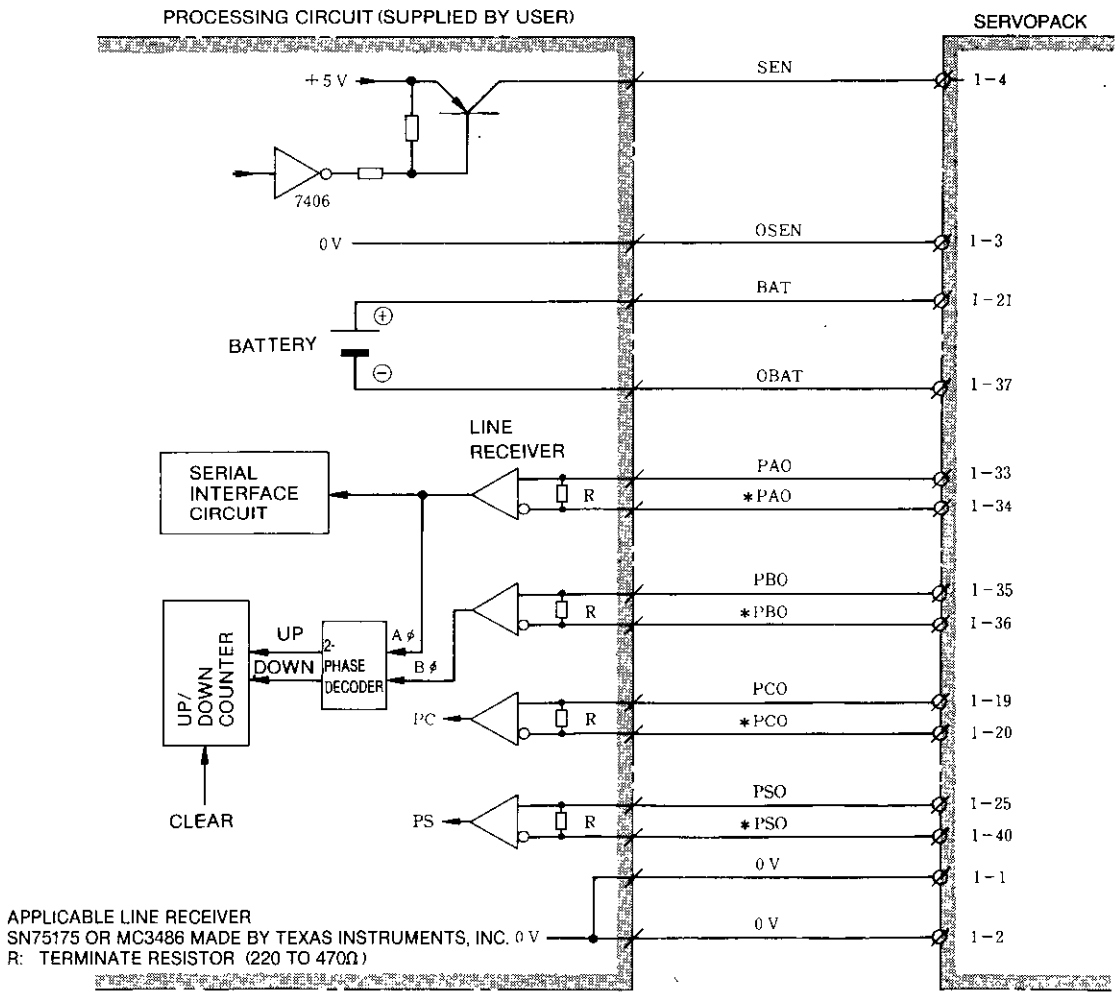


Fig. 6.23 Typical Output Processing Circuit

(3) Absolute data receiving

Absolute data must be processed in a sequence as shown in Fig. 6.24.

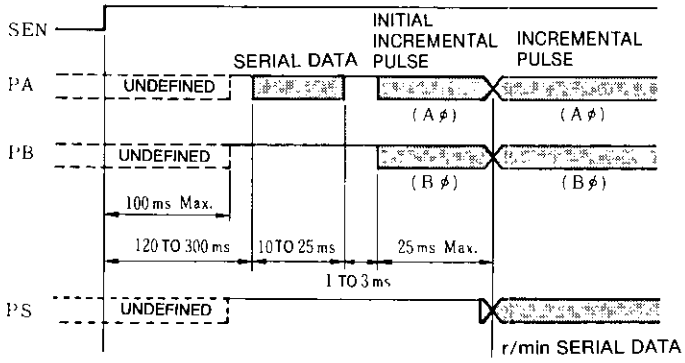


Fig. 6.24 How to Process Absolute Data Receiving

① Make the SEN signal high level.

② After 100 ms, set serial data reception-waiting-state.
Clear the up/down counter (for incremental pulse counting) to zero.

③ Receive serial data of 8 bytes.

④ Normal incremental operation status is entered in approx. 50 ms after the last serial data are received.

(4) 12-bit absolute encoder phase A (PAO) serial data specifications

Table 6.2 Phase-A Serial Data Specifications (12-bit)

Data Transmission Method	Asynchronous (ASYNC)
Baud Rate	9600 bauds
Start Bit	1 bit
Stop Bit	1 bit
Parity	Even
Character Code	ASCII 7 bits
Data Format	8 characters (P/A) (+/−) (0 to 9) × 5 digits (CR)

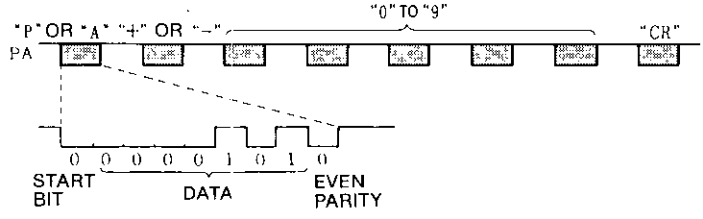


Fig. 6.25 Serial Data

During normal operation, serial data of the number of cumulative rotations (in 5 digits) from the reference point (set at setup time) are output in the format shown in Table 6.2.

Zero rotation is displayed by either P+00000 (CR) or P−00000 (CR).

Number of cumulative rotations is counted from 0 through ±99999, then rotation register rolls over to ±00000.

(5) Phase-S (PSO) r/min serial data specifications

Table 6.3 Phase-S Serial Data Specifications (15-bit)

Data Transmission Method	Asynchronous (ASYNC)
Baud Rate	9600 bauds
Start Bit	1 bit
Stop Bit	1 bit
Parity	Even
Character Code	ASCII 7 bits
Data Format	8 characters (P/A) (+/−) (0 to 9) × 5 digits (0 to 9) × 4 digits (CR)

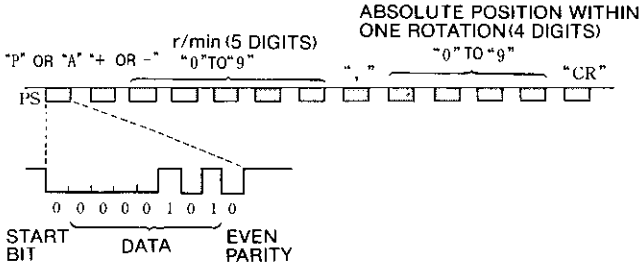


Fig. 6.26 Serial Data

During normal operation, serial data of the number of cumulative rotations (in 5 digits) and absolute position within one rotation (in 4 digits) are output in the format shown in Table 6.3.

Sending period is approx. 40 msec.

The absolute position data are increased in the CCW direction rotation when viewed from the motor shaft.

(6) Incremental pulse

Initial incremental pulse giving absolute data and normal incremental pulse data are output through the divider. (See Fig. 6.27.) The frequency divider is set by user constant Cn-0A.

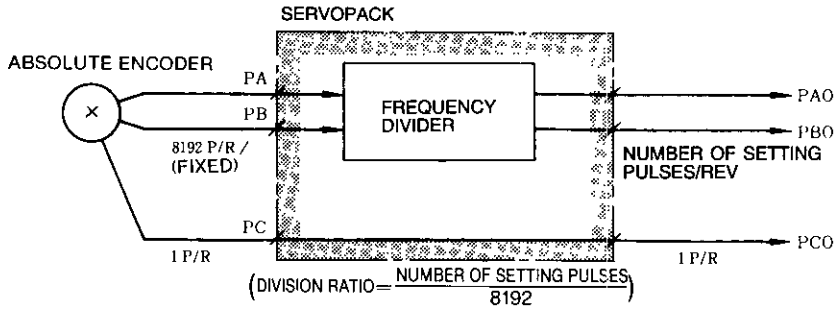


Fig. 6.27 Incremental Pulse

① Output phase

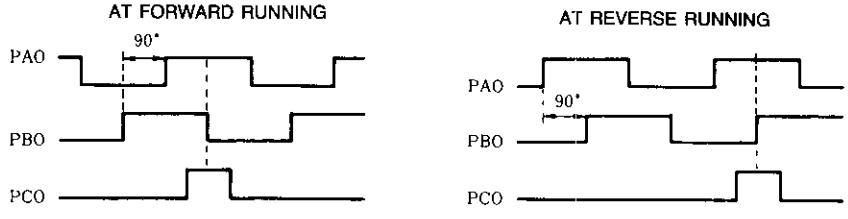
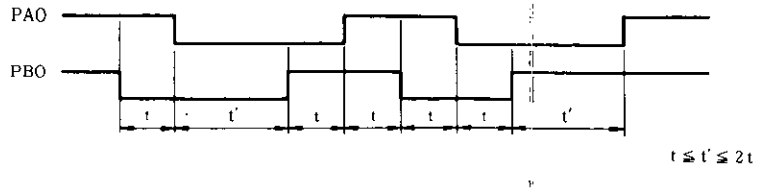


Fig. 6.28 Output Phase at Forward/Reverse Run

PCO (reference pulse) synchronizes with PAO, but the pulse width becomes narrow because PCO is not divided. If the dividing ratio is not 1/2n, accurate 90-degree phase difference is not made and the pulses are output as in Fig. 6.29.



(The phase difference t, t′ part equally exists within one revolutions, thus the minimum position error results.)

Fig. 6.29 Division Ratio and Output Phase Difference

(7) SEN signal

① When the SEN signal level is changed from low to high, +5V power supply is applied to the absolute encoder and serial data and initial incremental pulse are sent; then normal operation is started.

If the SEN signal is changed from high level to low level when the motor is not energized, +5V power is not supplied to the absolute encoder.

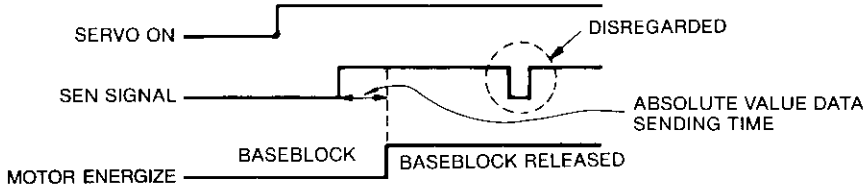
② Do not change the SEN signal level from low to high for 1 second after the control power supply and main power supply are turned ON.

(Undefined time of PAO and PBO before serial data is sent is prolonged.)

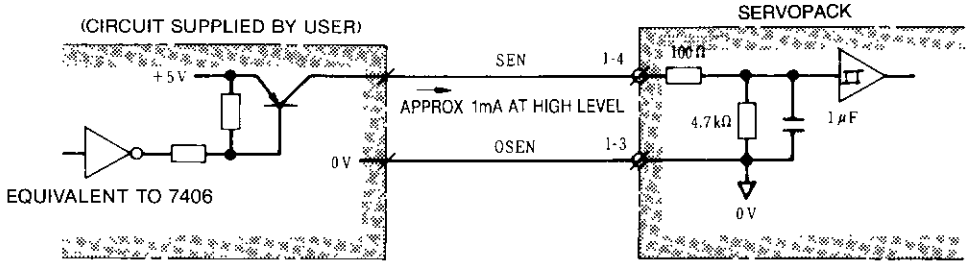
③ When the SEN signal is in the low-level status, the motor cannot be under current conduction. (Baseblock is set.)

④ Even if servo ON signal is entered, the motor is not energized until the SEN signal is input and the encoder starts normal operation, that is, sending of serial data and initial incremental pulse is complete.

⑤ When the motor is energized, the dropped SEN signal is disregarded as follows:



⑥ Electrical specifications



- PNP type is recommended for transistor.
- Signal level (high level: 4V min., low level: 0.7V max.)

Fig. 6.30 Electrical Specifications of SEN Signal

(8) Battery

Be sure to use battery to store position information if absolute encoder power should fail.

- The following battery is recommended:
  Lithium battery (made by Toshiba type ER6C 3.6V × 1)
- Be sure to connect the battery so as to prevent an environmental change or a change with the passage of time from causing contact failure.
- Since battery voltage is not monitored in the SERVOPACK, make sure that voltage will not be less than 2.8V. Provide a low battery voltage detecting circuit or monitor if necessary in the system.
- Refer to Par. 13.3 "PRECAUTIONS FOR BATTERY REPLACEMENT" for battery replacement method.

(9) Setup method for 12-bit absolute encoder

To clear the cumulative rotation number to zero for testing the motor, or when the absolute encoder has been left disconnected to a battery for more than four days, the enocder needs to be setup by the following procedure. (Under the above conditions, capacitors in the encoder may be charged insufficiently so that the internal circuits may malfunction.)

① SERVOPACK power supply OFF
Turn OFF the power supply if it is turned ON.

↓

② Set the SEN signal to high.
When the SEN signal is high, +5V power is supplied to the encoder. Keep this condition for more than 2 minutes to fully charge the backup capacitor. In this stage, the encoder is in alarm status.

↓

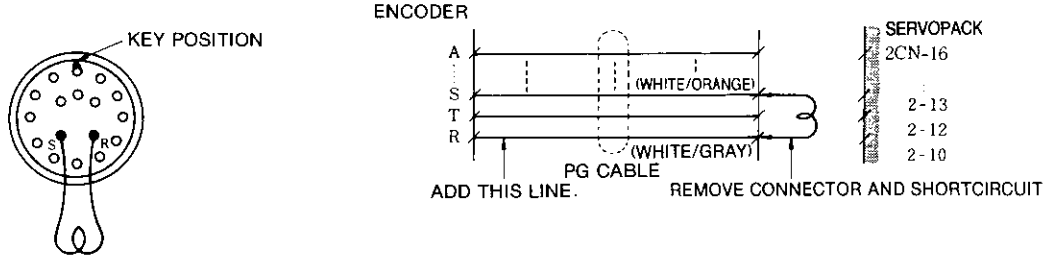
③ Discharging (The capacitor in the encoder is discharged.)
- When discharged at SERVOPACK
  Shortcircuit the reset terminal (SW6-1, 2) on the SERVOPACK board for 2 minutes or more. (For details, refer to Fig. 6.40.)
- When discharged by encoder connector
  Shortcircuit between the encoder connectors R and S for 2 minutes or more.
- When discharged by encoder signal line (non-twisted wire)
  Shortcircuit between reset signal line (white/gray) and 0V (white/orange) for 2 minutes or more.

↓

④ Wiring and battery connection
When the wiring is removed for resetting, restore the normal wiring and connect the battery to the encoder.
(Battery can be removed from the beginning.)

↓

⑤ Power ON
Turn ON the SERVOPACK power supply and set the SEN signal to high level. If no error occurs, setup has been completed. If there is any, restart from ① again.



Setup Method by PG Cable

(10) Alarm output of the 12-bit absolute encoder

12-bit absolute encoder has alarm detection function as shown in Table 6.4.

If an error occurs in the encoder while the SERVOPACK is operating, the SERVOPACK displays [ ][ ][A.][8][0] in SERVOPACK LED.

Set the SEN signal (1CN-4) to low (or, turn OFF the 5V power supply to the encoder) in this stage. SERVOPACK alarm code ALM 80 [CR] is output from PAO output terminals (1CN-33, 34).

Turn the SEN signal to high again (or, turn ON the 5V power supply to the encoder). Phase-A serial data ALARMO* [CR] and phase S-serial data ALARMO*, * [CR] are output from the encoder to SERVOPACK. SERVOPACK in turn outputs these phases-A and -S serial data from the PAO and PSO output terminals.

Also, the type of alarm is distinguished by using these data and LED display is changed to [ ][ ][A.][8][*] in SERVOPACK.

Turn the SEN signal to low again (or, turn OFF the 5V power supply to the encoder). SERVOPACK alarm code ALM8* [CR] is distinguished and output from the PAO output terminal.

If the SGD SERVOPACK miscounts PG pulses and the number of pulses per rotation is an odd sum, the SGD SERVOPACK displays [ ][ ][A.][8][0] in LED but phases-A and -S serial data are not output since the encoder is functioning normally. (For details of the serial data, see Table 6.4.)

Table 6.4 Alarm Output

Name	Contents
Backup Alarm	Backup voltage drop is detected (This check ensures data reliability of the number of cumulative rotations.)
Battery Alarm	Battery voltage drop is detected. (This checks for battery replacement timing or break in wire.)
Checksum Error	Memory data check resulted in an error.
Overspeed	Rotation speed is 400 r/min. or higher when 5 V power is turned ON.
Absolute Error	Sensor check resulted in an error (indicating an internal error in the encoder).

Table 6.5 Encoder Alarm Output

Status	Input	Display	Output	
	SEN Signal	LED Display	Phase-A Output (PAO)	Phase-S Output (PSO)
Normal Operation	High	r u n (SV ON) or b b (SV OFF)		P+□□□□□, □□□□ CR
Error Occurrence		A. 8 0		H+□□□□□, □□□□ CR The haed character shows alarm contents.(Note)
	Low (Encoder power supply OFF)		ALM80. CR (Servopack alarm code)	Not defined
	High (Encoder power supply ON)	A. 8 *	ALARM0* CR (Phase A serial data)	ALARM0*, **** CR
	Low (Encoder power supply OFF)		ALM8 * CR (Servopack alarm code)	Not defined
Alarm Reset (Refer to Par. 8.3.)				
No Fault Occurrence	Low → High (Encoder power supply ON)	b b	A+□□□□□ CR (P)	A+□□□□□, □□□□ CR
		r u n (SV ON)		P+□□□□□, □□□□ CR

□□□□ : Optional numbers

**** : Optional characters and numbers

(If depends on a type of alarm code. For details, refer to the table on the next page.)

Note: Alarm contents are the same as last characters of phase-A serial data in Table 6.6.

Table 6.6 Typical Output in accordance with Encoder Alarm Type

Alarm Type	Display	Phase-A Output (PAO)		Phase-S Output (PSO)
	LED Display	(Phase-A Serial Data)	(SERVOPACK Alarm Code)	(Phase-S Serial Data)
Backup Alarm	A. 8 1	ALARMOA CR	ALM81. CR	ALARMOA, BACK CR
Battery Alarm	A. 8 3	ALARMOD CR	ALM83. CR	ALARMOD, BATT CR
Checksum Error	A. 8 2	ALARMOB CR	ALM82. CR	ALARMOB, CHEC CR
Overspeed	A. 8 5	ALARMOP CR	ALM85. CR	ALARMOP, 0VER CR
Absolute Error	A. 8 4	ALARMOH CR	ALM84. CR	ALARMOH, ABS0 CR
Backup and Battery Compound Alarm	A. 8 1	ALARMOE CR	ALM81. CR	ALARMOE, BACK CR (or BATT)

For alarms occurring in the SERVOPACK, other than described above, LED display and SERVOPACK alarm code output are provided.
Refer to Par. 6.5 "PROTECTIVE CIRCUIT" for details of the SERVOPACK alarm codes.

6.5 PROTECTIVE CIRCUIT

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

(1) Alarm detecting function

When a fault occurs in operation or circuit, the SERVOPACK stops current conduction to the motor owing to various fault detecting functions.

The contents of faults are displayed on the SERVOPACK monitor panel.

For details of fault detecting functions, refer to Table 14.2.

(2) Emergency stop function

The SERVOPACK has a function to stop the motor at emergency in case of the above-mentioned faults.

For the emergency stopping method, various modes can be set by user constants.

(Cn-01)

① The following three modes can be selected for the stopping method:

- DB (dynamic brake) stop
- Coasting to a stop
- Zero-speed stop

② The following four modes can be selected after stopping.

- DB stopping status
- DB stop release
- BB (baseblock) status
- Zero-clamp status

(For details, refer to Par. 7, "USER CONSTANTS".)

The standard setting is the stopping method using dynamic brake, which operates in the following cases.

- Alarm (fault) detection operates
- Servo OFF
- Main circuit power supply is turned off
- Overtravel (P-OT/N-OT)

Use the motor stopping method using dynamic brake only at emergency. If emergency stop by using dynamic brake is applied frequently, internal element may be degraded and a malfunction may occur. Therefore, set speed reference to zero for motor stop under normal operation. Do not use the emergency stopping function.

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

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

(4) Alarm code serial output

The alarm contents are output as serial data from PAO output (1CN-33, 34 pins).

(a) Serial data receiving

Use a sequence as shown in Fig. 6.30 to process alarm data.

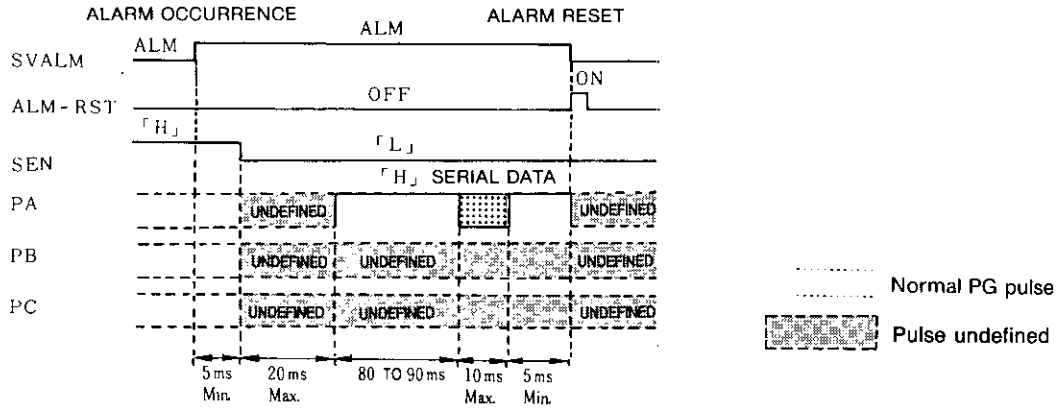


Fig. 6.30 Alarm Data Receiving Process

① Make the SEN signal low level at servo alarm occurrence (in alarm status).

② After 20 ms, set serial data reception-waiting-state.

③ Receive serial data of 7 bytes.

④ Alarm releasing process is enabled approx. 5 ms after the last serial data are received.

Note: When any SEN signals other than in servo alarm status are changed from low level to high level, absolute data are transferred. (For details, refer to Pars. 6.4.4 and 6.4.5, "Absolute Encoder Using Method".)

(b) Alarm data specifications

Data Transmission Method	Asynchronous (ASYNC)
Baud Rate	9600 bauds
Start Bit	1 bit
Stop Bit	1 bit
Parity	Even
Character Code	ASCII 7 bits
Data Format	7 characters (A) (L) (M) (alarm code) (.) (CR)

• Alarm serial data

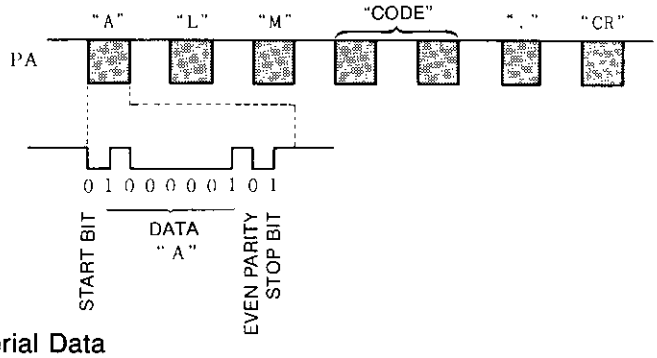


Fig. 6.31 Serial Data

• 7 bytes of serial data (7 characters) are sent.

(A), (L), (M) (alarm code), (.) and (CR) are available for the format.
(CR) is the code of carriage return.
Refer to Table 8.9 for alarm codes.
In servo alarm status, wait 200ms or longer when changing the SEN signal to low level and restart operation.

(5) Protective circuit operation

An alarm signal indicates some trouble. Check the cause and correct the trouble, and restart the operation. Before checking the cause, turn OFF the power to the main circuit to avoid danger. Apply the sequence so that the alarm signal turns OFF only the main circuit (Ⓡ, Ⓢ, Ⓣ), as shown in Figs. 6.1 and 6.2. allows rapid reaction in the event of a malfunction. Since alram traceback is enabled only by turning ON the control power supply (ⓡ, ⓣ troubleshooting can be performed immediately. For traceback, refer to Par. 8.6, " Abnormal Traceback Mode."

CAUTION

When an alarm signal cuts off only the main circuit, do not restart operation unless the cause of the fault is investigated and processed. Be sure to set the speed reference to 0V to avoid possible dangerous conditions.

(6) Resetting servo alarm

Servo alarms are reset by using external signal input ($\overline{\text{ALM-RST}}$, 1CN-43).
Or depress SW1, SW2 and SW3 simultaneously in the monitor panel status indication mode. (Refer to Par. 8.3.)

However, overcurrent detection (A, 10) can not be reset for safe operation.

Do not turn ON the power supply again unless the power supply is turned OFF to check that there is no fault in wiring.

Since SERVOPACK is overheated at overload detection (A71, A72), it is necessary to leave it for one minute or more before alarm reset or power supply ON.

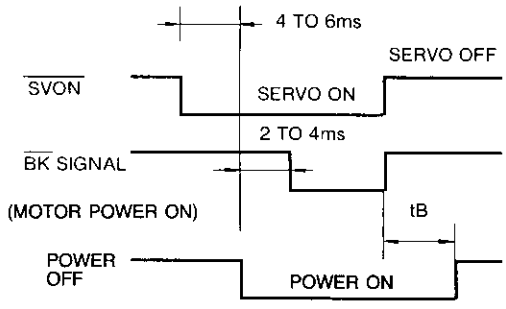
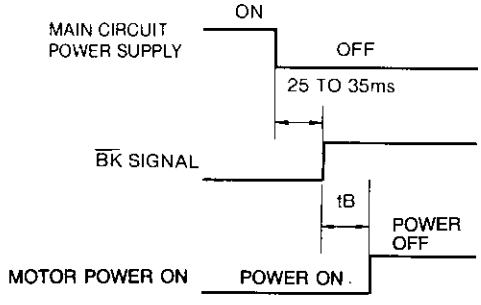
(7) Holding brake interlock signal

By setting use constants, a brake signal can be output for interlocking motor circuit power ON/OFF status and motor rotation speed.

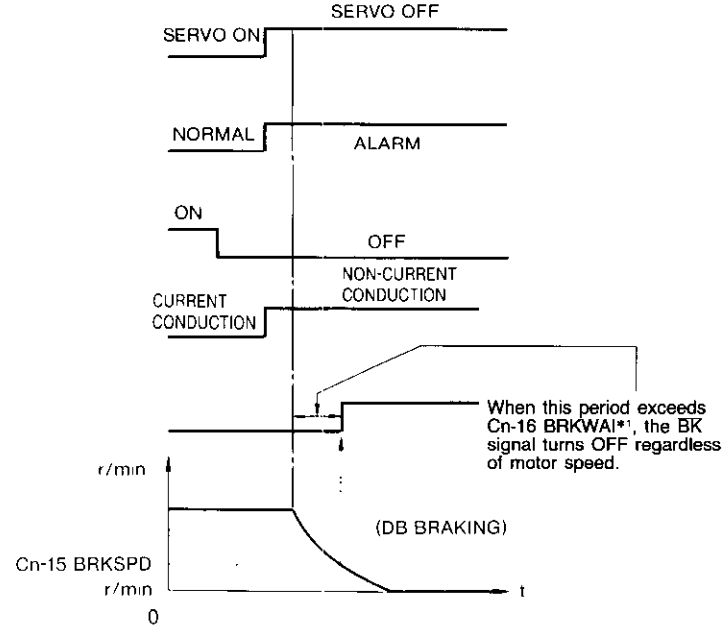
〈Setting procedure〉

When user constant (memory switch) is set to "brake command function provided" (Cn-01, bit E ON), brake signal (BK) is output from 1CN-22, 23 (TGON). Delay time tB from start of braking to motor power OFF can be adjusted by setting a value for user constant Cn-12 BRKTIM.

Table 6.7 Servo ON Signal and Main Circuit Power Supply Timing

<table>
<tr><td rowspan="2">At Motor Stops</td><td>Timing with Servo ON Signal</td><td>Timing with Main Circuit Power Supply</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td colspan="2">tB : Braking time (setting 10 to 500 ms at BRKTIM : Cn-12)</td></tr>
<tr><td>During Motor Running</td><td colspan="2">Timing at Servo OFF, Main Circuit Power Supply OFF, or Alarm Occurrence

•Servo OFF
•Alarm Occurrence
•Main Circuit Power Supply OFF
•Motor Under Current Conduction
BK SIGNAL
MOTOR ROTATING SPEED
BRKSPD*2 r/min

*1: BRKWAI: User constant Cn-16
*2: BRKSPD: User constant Cn-15</td></tr>
</table>

6.6 PRECAUTIONS FOR APPLICATION

6.6.1 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.

6.6.2 Load Inertia (J_L)

The allowable load inertia J_L converted to the motor shaft must be within five times the inertia of the applicable AC SERVOMOTOR. If the allowable inertia is exceeded, an overvoltage alarm may be occurred 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.

6.6.3 High Voltage Line

If the supply voltage is 400/440 V, the voltage must be dropped to 200 V using a power transformer. Table 6.9 shows the transformer selection. Connection should be made so that the power is supplied and cut through the primary side of the transformer.

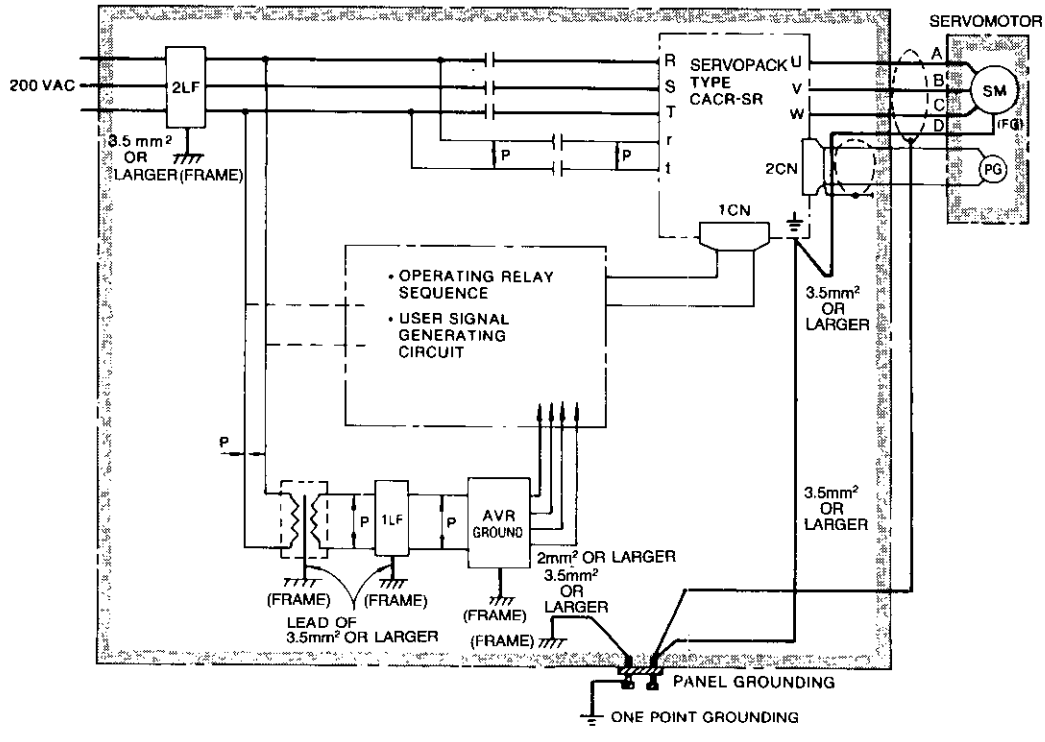
6.7 PRECAUTIONS FOR OPERATION

6.7.1 Noise Control

SERVOPACK uses high-speed switching elements in the main circuit. When these high-speed switching elements 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. 6.32.

(1) Grounding method



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. 6.32 Grounding Method

- Motor frame grounding

  Motor ground terminal Ⓔ (motor frame) should be connected to terminal ⏚ of SERVOPACK. (Terminal ⏚ of SERVOPACK should be directly grounded.).

- SERVOPACK SG 0 V

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

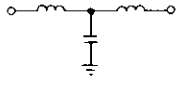
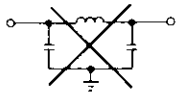
(2) Noise filter installation

When noise filters are installed to prevent noise from the power line, the block type must be used. The recommended noise filter is shown in Table 6.8. 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. 6.33 to 6.36.

Table 6.8 Recommended Noise Filter

SERVOPACK Type CACR-	Applicable Noise Filter	Recommended Noise Filter	
		Type	Specifications
SR02BY SR03BY SR05BY		LF-305	Three-phase 200 VAC class, 5A
SR07BY		LF-310	Three-phase 200 VAC class, 10A
SR10BY SR15BY	GOOD	LF-315	Three-phase 200 VAC class, 15A
SR20BY		LF-320	Three-phase 200 VAC class, 20A
SR30BY		LF-330	Three-phase 200 VAC class, 30A
SR44BY	POOR	LF-340	Three-phase 200 VAC class, 40A

Note: Noise filter made by Tokin Corp.

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

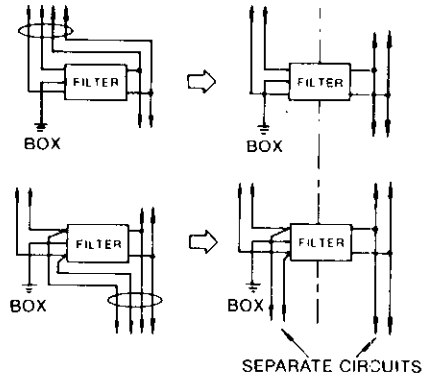


Fig. 6.33

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

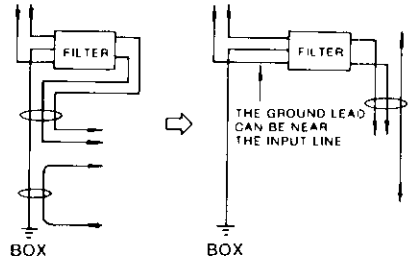


Fig. 6.34

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

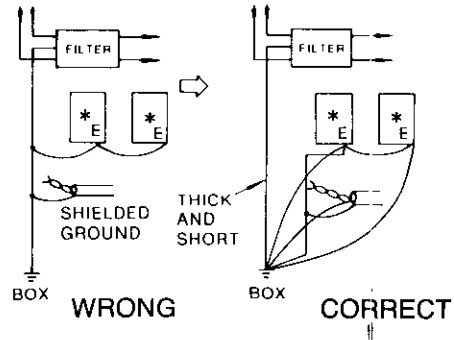
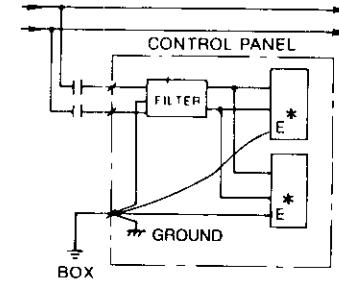


Fig. 6.35

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



* Equipment

Fig. 6.36

6.7.2 Power Line Protection

The SERVOPACK is operated through the commercial power line (200 V). To prevent the power line accidents due to grounding error, contact error, or to protect the system from a fire, circuit breakers (MCCB) or fuses must be installed according to the number of SERVOPACKS used (Table 6.9).

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

Table 6.9 Power Supply Capacity and MCCB or Fuse Capacity

SERVOPACK Type CACR-	Power Capacity* per SERVOPACK	Current Capacity per MCCB or Fuse
SR02BY•SR03BY	0.65 kVA	5 A
SR05BY	1.1 kVA	5 A
SR07BY	1.5 kVA	8 A
SR10BY	2.1 kVA	8 A
SR15BY	3.1 kVA	10 A
SR20BY	4.1 kVA	12 A
SR30BY	6.0 kVA	18 A
SR44BY	8.0 kVA	24 A
SR60BY	11 kVA	32 A

* Values at rated load.

6.8 APPLICATION

6.8.1 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, perform the followings:

① Short across 2CN-1 and 2CN-7 of connector 2CN for the PG. Or
② Set user constant Cn-02, 0 bit to 1 before turning on power supply again.

When both ① and ② are performed, reverse rotation connection is also applied.

In this case, other change of motor and PG connection is not required. At this time, normal incremental pulse and initial incremental pulse in absolute value data are provided in the opposite direction to the normal case. However, the sign of serial data in the absolute value data is not reversed. Therefore, when the motor is used in reverse rotation connection, the sign of serial data must be reversed.

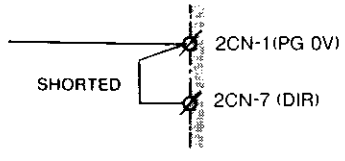
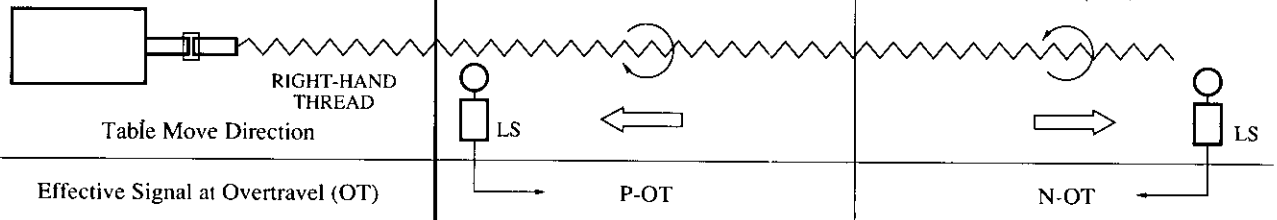
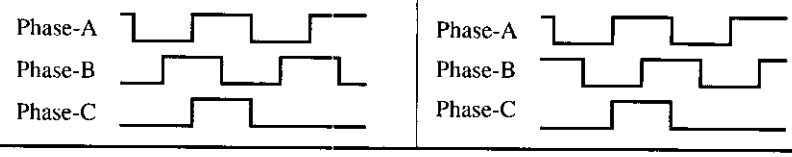


Fig. 6.37

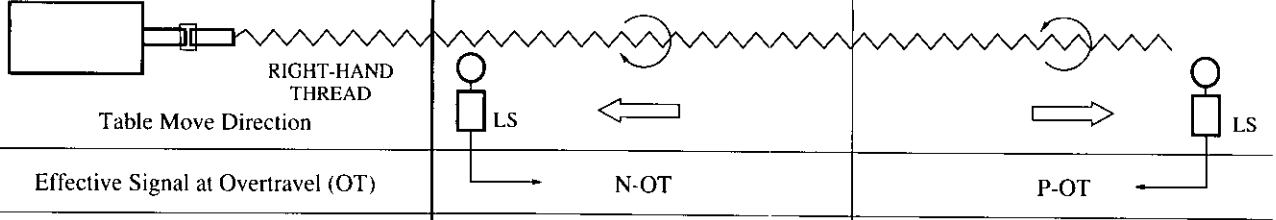
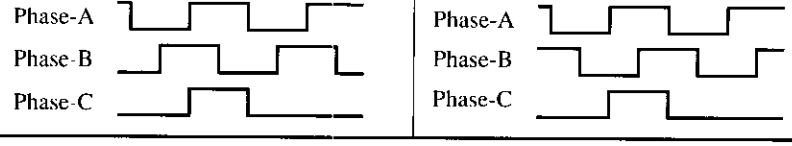
In forward running reference, frequency dividing output from SERVOPACK applies phase-B lead.

Table 6.10 Motor Rotating Direction and I/O Signals

Running Mode (Standard)

Speed Reference	Voltage input (plus)	Voltage input (minus)
Speed Monitor	Voltage output (minus)	Voltage output (plus)
Torque Reference Monitor	Voltage output (minus)	Voltage output (plus)
Motor Rotating Direction  	Forward (CCW)	Reverse (CW)
Effective Signal at Overtravel (OT)	P-OT	N-OT
Effective Signal at Current Limit Reference	P-CL (Minus voltage input)	N-CL (Plus voltage input)
PG Feedback Output (After frequency dividing output)  		

Running Mode (Reverse)

Speed Reference	Voltage input (minus)	Voltage input (plus)
Speed Monitor	Voltage output (plus)	Voltage output (minus)
Torque Reference Monitor	Voltage output (plus)	Voltage output (minus)
Motor Rotating Direction  	Reverse (CCW)	Forward (CW)
Effective Signal at Overtravel (OT)	N-OT	P-OT
Effective Signal at Current Limit Reference	N-CL (Plus voltage input)	P-CL (Minus voltage input)
PG Feedback Output (After frequency dividing output)  		

Note : As for the sign of rotation amount serial data, motor counterclockwise (CCW) direction is plus.

6.8.2 Motor Speed Measurement and Torque Reference

(1) Motor speed and torque output

When an instrument is connected to measure speed and torque, make the connection as shown in Fig. 6.38, using a DC ammeter of ±1 mA (both swing).

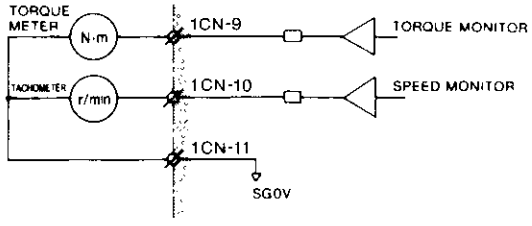


Fig. 6.38 Speed and Torque Measurement

(2) Monitor terminal

- Torque monitor output TRF (1CN-9): M,F,G, S series — ±3.0V ±10%/∓100% torque
  D series — ±2.0V ±10%/∓100% torque
- Speed monitor output VTG (1CN-10):
  M, series — ±4.0 V ±5%/∓1000 r/min
  F, D,G, S series — ±2.0 V ±5%/∓1000 r/min
- Instrument: ±1 mA (both swing) ammeter.
  Use ammeter of DCF-6 or DCF-12N by Toyo Instrument or equivalent.
- Example: When an M Series motor (rated speed: 1000 r/min) is used, and speeds are to be measured up to the maximum speed (2000 r/min) in both directions, use ±8V(both swing) DC voltmeter.
- Normal input minitor IN-A: ±Rated r/min/±6V
- Aux. input monitor IN-B: ±Rated r/min/±2V to ±10V
- Encoder power supply monitor PG5V: Voltage supplied to encoder can be measured.
- SW6: Encoder can be reset by shortcircuiting ① — ②.
  When the power supply is turned ON, open the SW6.
  Otherwise the encoder may mulfunction.
- Encoder power supply calibration variable potentiometer:
  Calibrated to 5.35V ±50mV.
  When the encoder cable is longer than 20m, rotate this potentiometer in the CW direction to increase voltage. (Re-adjustment is needed basically.)

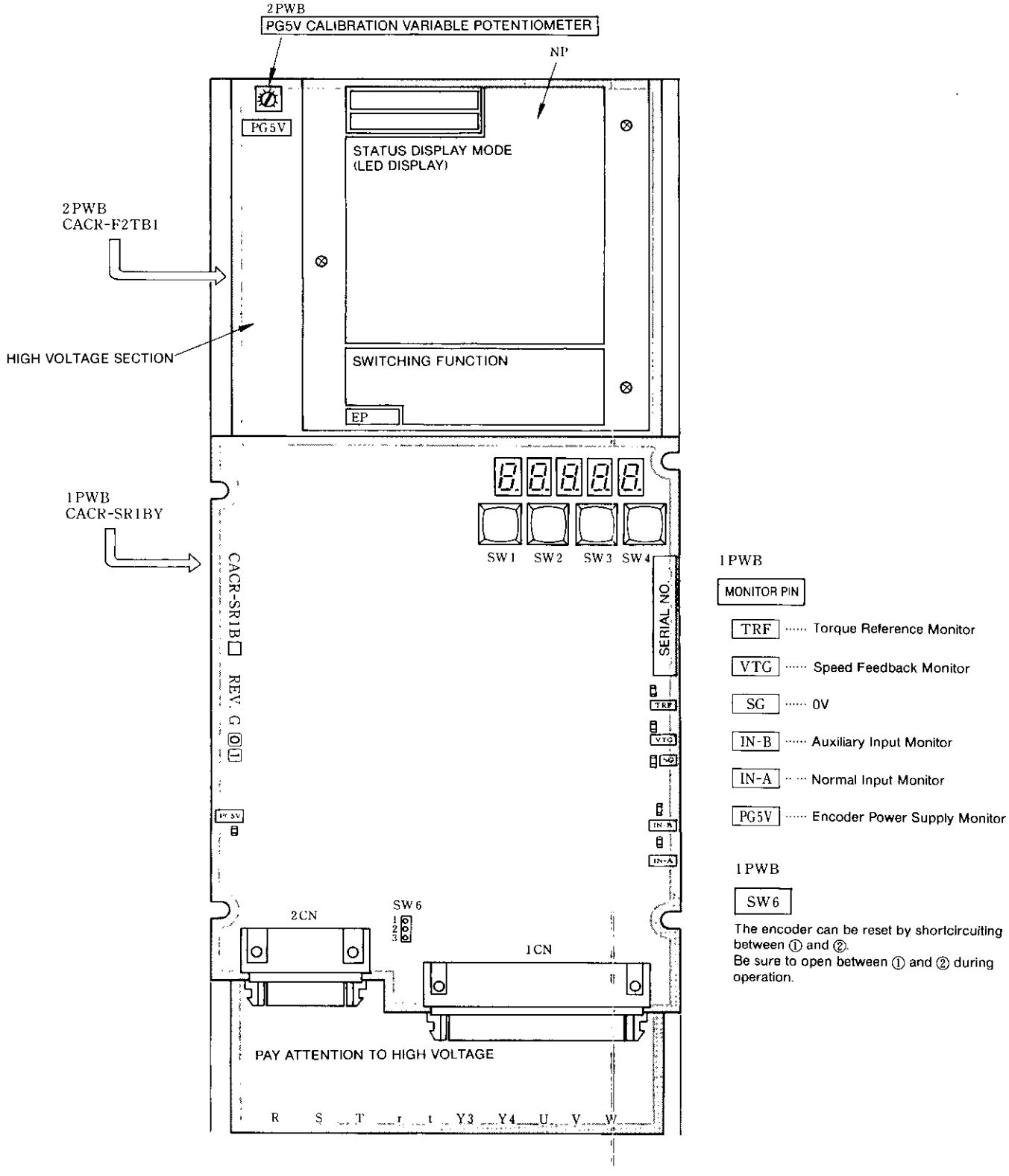


Fig. 6.39 Position of Switches and Check Terminals

6.8.3 Use of SERVOMOTOR with Magnetic Holding Brake

Since AC SERVOMOTORS with brake are used exclusively for holding, the following items must be observed for use of them.

(1) This brake is of non-magnetized operation exclusively for holding. Therefore, do not release (or turn OFF) the brake power supply unless the motor stops.

If the brake is applied during motor rotation, the contact section wears excessively and the brake may malfunction in a shorter period.

(2) Since operation lag time is provided for the brake, perform operation ON/OFF timing as shown in Fig. 6.40.

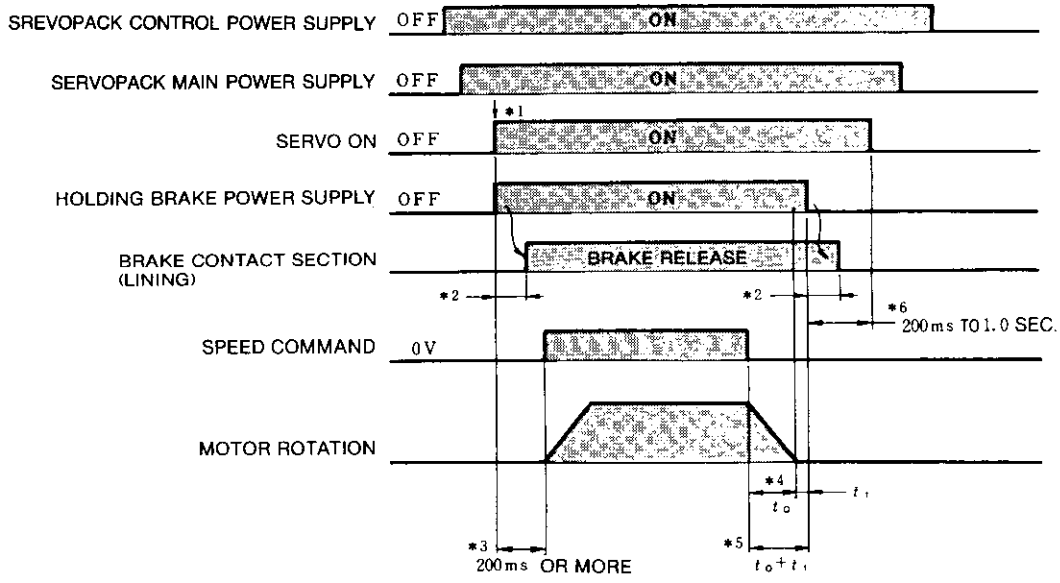


Fig. 6.40 Brake Timing

(Timing)

*1: "SERVO ON" and holding brake power supply can have the same timing.

*2: It takes up to approx. 180ms from when the brake power supply is turned ON until mechanical contact is released. On the other hand, it takes up to approx. 100ms at brake power supply OFF.

*3: 200ms or more are needed from when the brake power supply is turned ON to when speed reference is input.

*4: "to" indicates the motor stopping time and is calculated as shown in the table below.

*5: Do not turn OFF the brake power supply unless the motor stops. Normally, to+t1 is to be approx. 1 to 2 seconds.

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

Equation in SI Unit System	Conventional Equation
$t_o = \frac{(J_M + J_L) \times N_M}{375 \times (T_P + T_L)}$ (sec)	$t_o = \frac{(GD_M^2 + GD_L^2) \times N_M}{375 \times (T_P + T_L)}$ (sec)
J_M : Rotary inertia (kg·m²) ··· $(=GD_M^2/4)$	GD_M^2: Motor GD^2 (kg·m²)
J_L : Load inertia (kg·m²) ··· $(=GD_M^2/4)$	GD_L^2: Load GD^2 (kg·m²)
N_M: Motor rotating speed (r/min)	N_M: Motor rotating speed (r/min)
T_P : Motor deceleration torque (N·m)	T_P : Motor deceleration torque (N·m)
T_L : Load torque (kg·m)	T_L : Load torque (kg·m)

7. USER CONSTANTS

The SERVOPACK supports the following user constants. These constants can be set up and modified to fit for the system. Learn the meanings of these constants and use them. For constant setup or adjustment, use the monitor panel (see Section 8, "MONITOR PANEL OPERATIONS").

(1) Speed Reference Adjustment Gain: Cn-03 [INBGN]

- IN-B input motor speed adjustment constant. The adjustment range is from 0 through 2000 r/min/V.
- For position control purposes, the loop gain increases with an increase in this gain setting.
- This constant is preset at the factory to rated speed reference at 10 V input prior to shipment.

(2) Speed Loop Gain: Cn-04 [LOOPHZ]

- This is the proportional gain for the speed controller. Adjustment range is from 20 through 500 Hz (when used at an equivalent inertia).
- This constant is preset at the factory to 40 Hz prior to shipment.

$$\text{Speed Loop Gain} = \frac{2 \cdot J_M}{J_M + J_L} \times \text{LOOPHz}$$

J_M: Rotor Inertia
J_L: Load Inertia

(3) Speed Loop Integration Time Constant: Cn-05 [PITIME]

- This is integration time for the speed controller. Adjustment range is from 2 through 5112 ms.
- This constant is preset at the factory to 20 ms prior to shipment.

(4) Emergency Stop Torque: Cn-06 [EMGTRQ]

- Set braking torque for overtravel stop (percentage of the motor is rated torque). Setting range is from 0 through MAX (%).
- This constant is preset at the factory to MAX (%) prior to shipment.
- This setting is effective only when user constant Cn-01 7th bit=1.

(5) Soft Start time: Cn-07 [SFSACC]

- This constant sets time required to accelerate from 0 (r/min) to the maximum rotating speed and decelerate from the maximum rotating speed to 0 (r/min). Setting range is from 0 through 10,000 ms.
- This constant is preset at the factory to 0 ms prior to shipment.
- If positioning control is to be performed, this constant should normally be set to 0 ms.

(6) Forward Running Torque Limit: Cn-08 [TLMTF]

- This is torque limit of the motor in the forward running direction. Setting range is from 0 through the maximum torque (%)
- This constant is preset at the factory to MAX (%) of the rated torque prior to shipment.

(7) Reverse Running Torque Limit: Cn-09 TLMTR

- This is torque limit of the motor in the reverse running direction. Setting range is from 0 through the maximum torque (%).
- This constant is preset at the factory to MAX (%) of the rated torque prior to shipment.

(8) PG Dividing Ratio: Cn-0A PGRAT

- Number of detected (phase-A and -B) pulses per rotation sent from the PG (encoder) is converted to the pulse number according to the setting of this constant and is output to 1CN-33 and -36.
- Set the number of output pulses per rotation. Setting range depends on the PG.

SERVOPACK Type CACR-	Encoder	Number of Encoder PG Pulses (P/R)	Division Pulse Set Value
SR□BY1S□	15-bit absolute encoder	8192	Any integer from 1 to 8192
SR□BY1W□	12-bit absolute encoder	1024	Any integer from 1 to 1024

(9) Zero Speed Level: Cn-0B TGONLV

- This is motor zero-speed judgment level. Setting range is from 1 (r/min) through max. speed.
- When the motor rotating speed lowers below this setting, sequence output TGON turns OFF (between 1CN terminals 22 and 23 is closed).
- This constant is preset at then factory to 20 r/min prior to shipment.

(10) Mode Switches (Torque Reference)

- The following constants are used for setting mode switch operating point. Detection points where PI control is switched to P control are set for improving transient characteristic of acceleration, deceleration and output saturation of the speed controller. Different levels can be set for three types of detection points for the mode switch.
- Detection point selection is made by performing user constant Cn-01 bit setting.

Detection Point	Cn-01 Bit Setting	Mode Switch Lebel	Unit
① Torque Reference (Speed Controller Output)	C bit = 0, D bit = 0	Cn-0C (TRQMSW)	%
② Speed Reference	C bit = 1, D bit = 0	Cn-0D (REFMSW)	r/min
③ Motor Acceleration Detected	C bit = 0, D bit = 1	Cn-0E (ACCMSW)	10 (r/min)/s
④ Motor Switching not Operated	C bit = 1, D bit = 1		

(11) Zero-clamp Level: Cn-0F ZCLVL

- This is motor rotating speed level at which zero clamping is performed. Setting range is from 0 through 100 r/min.
- During speed control with zero-clamp (Cn-01 A-bit=1, Cn-01 Bit=0), if contact input $\overline{\text{P—CON}}$ is ON when the motor rotation speed drops to the set value or lower, speed reference is disconnected and the motor speed is reduced to zero. After the motor is stopped, servo lock status is maintained.
- In this setting, proportional operation function by $\overline{\text{P-CON}}$ input does not work.
- This setting is effective only when user constant Cn-01 A-bit=1, B-bit=0.

(12) Jogging Speed: Cn-10 JOGSPD

- This constant refers to the jogging operation speed. Setting range is from 0 through 1000 r/min.
- In the jogging mode, enter the operation reference from the setup panel.
- This constant is preset at the factory to 100 r/min prior to shipment.

(13) Number of Encoder Pulses: Cn-11 PULSNO

- This constant indicates the number of pulses per encoder revolution. Set the corresponding value to the motor encoder. This setting must not be changed by users.

(14) Delay Time from Brake Reference Output to SVOFF Operation: Cn-12 BRKTIM

- Setting range: 0 to 50 (× 10ms)
- Setting prior to shipping: 20 (× 10ms)

  This setting outputs brake timing signal from TGON output only when user constant Cn-01 E bit = 1.

(15) Brake timing at motor rotation (speed): Cn-15 (BRKSPD)

- Speed level to output braking command (r/min)
- Setting range: 0 to maximum rotating speed (r/min)
- Setting prior to shipping: 100 (r/min)

  This setting outputs brake timing signal from TGON output only when user constant Cn-01 E bit = 1.

(16) Brake timing at motor rotation (time): Cn-16 (BRKWAI)

- Waiting time from SVOFF to braking command output
- Setting range: 10 to 3100 (× 10ms)
- Setting prior to shipping: 50 (× 10ms)

  This setting outputs brake timing signal from TGON output only when user constant Cn-01 E bit = 1.

(17) Torque reference gain: Cn-13 (TCRFGN)

Torque reference input level in the torque control mode is set.

- Setting range: 10 to 100 (1/10V/rated torque)
- Setting prior to shipping: 30 (1/10V/rated torque)

(18) Speed limit at torque I: Cn-14 (TCRLMT)

- Setting range: 0 to maximum speed (r/min)
- Setting prior to shipping: maximum speed (r/min)

(19) Torque reference filter: Cn-17 (TRQFIL)

If load rigidity is low and shaft oscillation occurs, filter is made larger.

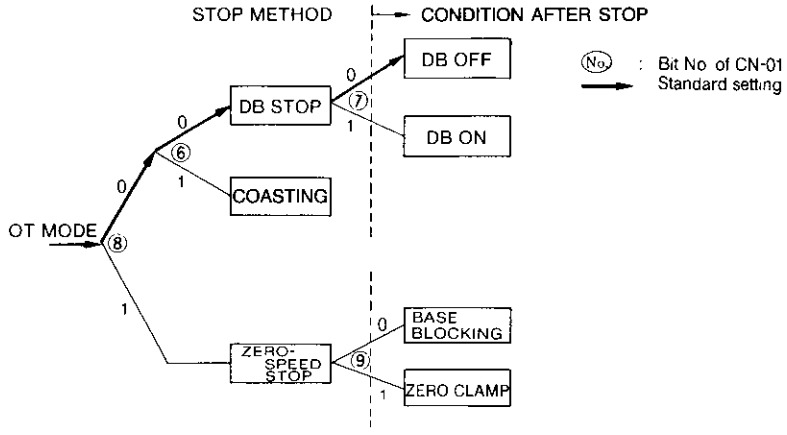
However, an excessively large filter reduces servo performance.

- Setting range: 4 to 250 (× 100μs)
- Setting prior to shipping: 4 (× 100μs)

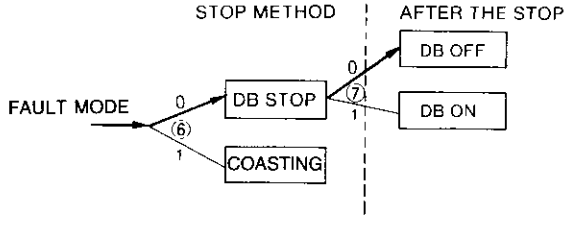
(20) Selection of Sequence Inputs, Reference Signal Error Stop Methods, Control Modes, and Mode Switches Selection

Use user constant Cn-01 memory switch for the above selections. (See Table 7.1,"User Constant Cn-01 List" for the assignment and explanation of the memory switches.)

In accordance with sequence (1) or (2) below, select an error stop method suitable for the system.



(a) Sequence on OT mode



(b) Sequence on fault mode (except OT mode)

Fig. 7.1 Error Stop Sequence

8. MONITOR PANEL OPERATION

8.1 SWITCH OPERATION

Fig. 8.1 shows the monitor panel. The monitor panel has various functions which are divided into the following modes (see Par. 8.2, " FUNCTION OF MONITOR PANEL"). Functions of control switches SW1 through SW4 vary with monitor panel mode. Switch function diagram (see Fig. 8.2) is provided in each mode, and indication of f1 through f7 in the figure is the function of switch.

Notes:

1. The monitor panel's constant setup data are retained even after the power is turned OFF.
2. Even if the power is turned OFF after fault occurrence, the fault data is retained in memory. Therefore, it is possible to check the fault data after the power is turned back ON.
3. The monitor mode can be changed even during operations.

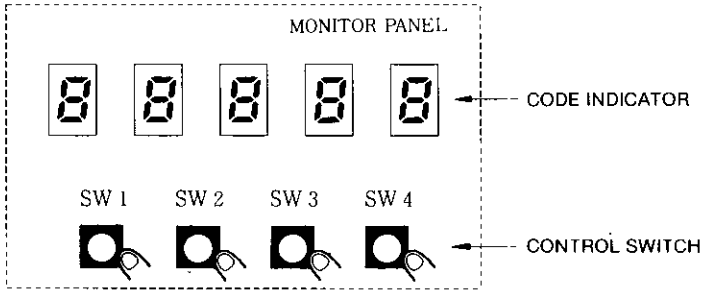
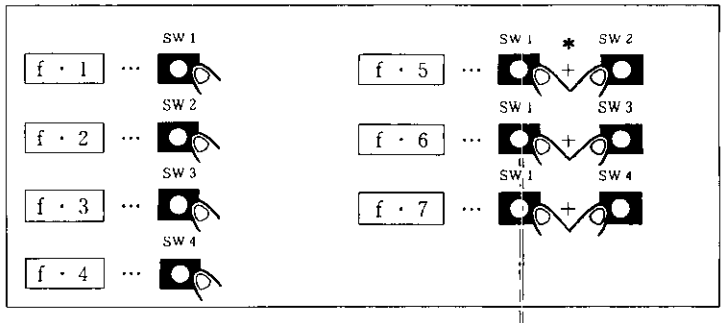


Fig. 8.1 Monitor Panel



* Indicates depressing SW1 simultaneously with SW2 (3 or 4).
(This applies to the figures below.)

Fig. 8.2 Description of Switch Function

8.2 FUNCTIONS OF MONITOR PANEL

Table 8.1 shows the monitor panel functions. The status display is the default when control power is turned ON. To change the mode, use switch SW4 as shown in Fig. 8.3.

Table 8.1 Monitor Panel Functions

Mode	Function
State Indcation Mode	Various States Indication • Base Block • On Operation • Trouble For details, refer to Table 8.2
Setting Mode	Refer to "User Constant Setting."
	• Operation (JOG) from Monitor Panel • Speed Reference Offset Adjustment
Monitor Mode	Various Monitoring • Speed • Speed Reference • Torque Reference • Number of Pulses from Origin (Phase-U) • Electrical Equipment • Interior Status Bit
Fault Traceback Indication Mode	Fault History

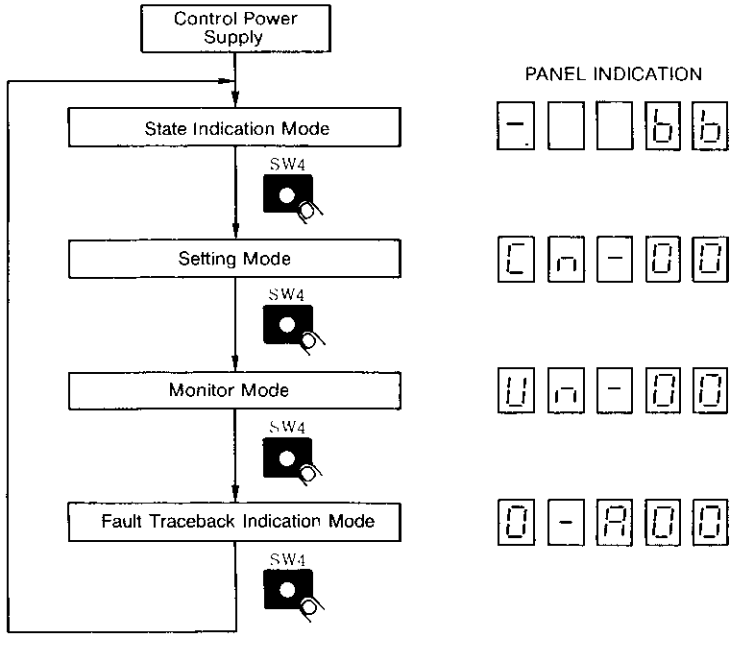


Fig. 8.3 Mode Changeover

8.3 STATUS INDICATION MODE

When this mode is selected, the condition of SERVOPACK is indicated with bit and code as shown in Fig. 8.4. Figs. 8.2 and 8.3 show the bits and the conditions. Fig. 8.5 shows the function allocations of switches.

RST : Becomes alarm reset switch.

SET : Changes status indication mode into setting mode.

Panel Display

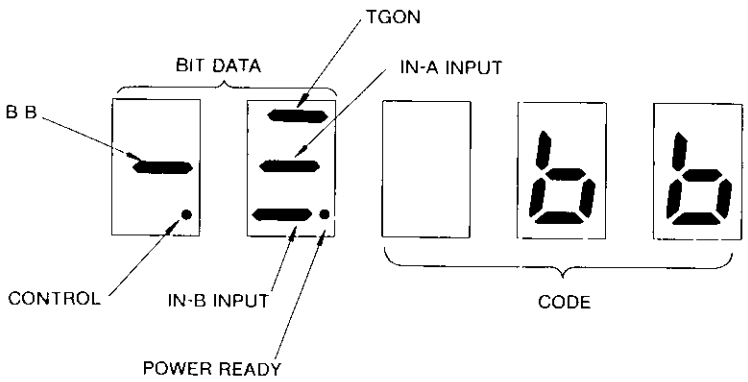


Fig. 8.4 Status Indication Mode

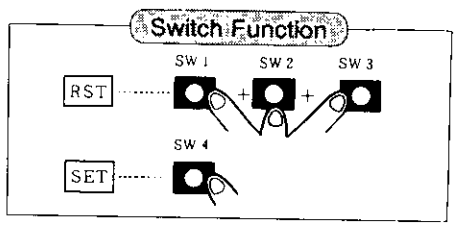


Fig. 8.5 Switch Functions

Note: Since A.10 (overcurrent) cannot be reset, turn OFF the power supply and check that motor wiring is proper, and turn ON the power supply again.

Table 8.2 Contents of Bit Data

Bit Data	Contents
Control ON	Lights when control power supply is turned ON.
BB	Lights at baseblock, extinguished at servo ON.
TGON	Lights when motor rotating speed exceeds TGON level (20 r/min as standard)
During IN-A input	Lights with IN-A input exceeding TGON level.
During IN-B input	Lights with IN-B input exceeding TGON level.
Power Ready	Lights when main circuit power supply is turned ON.

Table 8.3 Codes and Status

Code	Status
bb	Base Block
run	On Operation
Pot	Forward Running Interrupted
not	Reverse Running Interrupted
A. 00	Alarm Contents Refer to Par. 6.6,"STATUS INDICATION".
A. 01	
1	

8.4 SETTING MODE

In this mode, the following operations can be performed.

- User constant setup and check
- Offset adjustment
- Controlling operations from the monitor panel
- Fault traceback data clear

8.4.1 User Constant (Data) Setup and Check

The switch functions are indicated in Fig. 8.6.

Panel Display

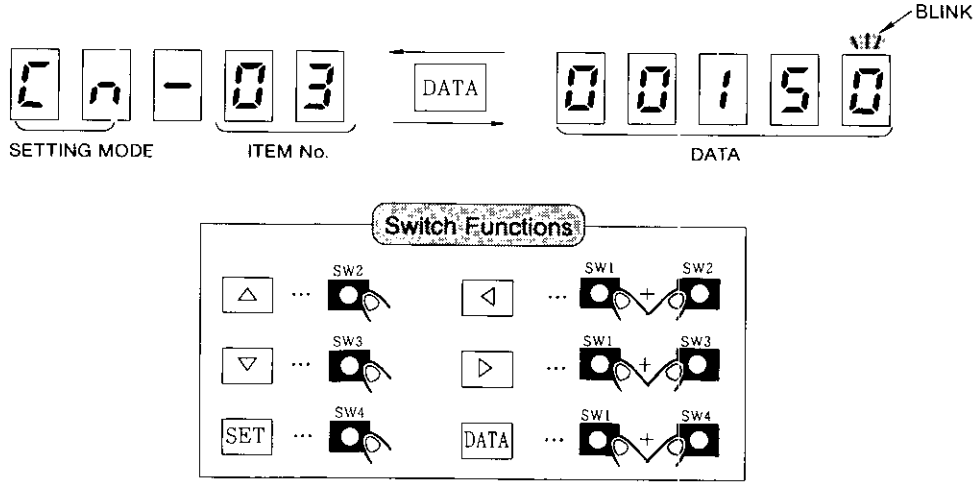


Fig. 8.6 Switch Functions for User Constant Setting

1. Set up the item number with the [△], [▽], [◁], and [▷] keys.
   - With the [◁] and [▷] keys, choose a setup digit. The chosen digit then starts blinking to indicate that its numerical value can be changed.
   - With the [△] and [▽] keys, increase or decrease the numerical value until the desired value is obtained.
2. With the [DATA] key, display the data related to the selected item number.
3. With the [△], [▽], [◁], and [▷] keys, set up the data. (Operation method is the save as [1].)
4. Store the data with the [SET] key.
5. With the [DATA] key, return to the item No. display state.
6. Repeat steps [1] through [5] as needed.
7. Using the [SET] key, switch from the setting mode to the monitor mode.

Table 8.4 shows user constants (constant setting).

Table 8.4 User Constant Cn-03 to Cn-12 (Constant Setting)

	User Constant	Code	Name	Unit	Lower Limit	Upper Limit	Setting before Shipment	Remarks
Constants for Gains	Cn-03	INBGN	Speed Reference Adjustment Gain	(r/min)/V	0	2000	Rating/10V	
	Cn-04	LOOPHZ	Speed Loop Gain	Hz	1	500	40	
	Cn-05	PITIME	Speed Loop Integral Time Constant	ms	2	512	20	
Constants for Torque	Cn-06	EMGTRQ	Emergency Stop Torque	%	0	Maximum Torque	Maximum Torque	OT Mode
	Cn-08	TLMTF	Forward Torque Limit	%	0	Maximum Torque	Maximum Torque	
	Cn-09	TLMTR	Reverse Torque Limit	%	0	Maximum Torque	Maximum Torque	
	Cn-13	TCRFGN	Torque Reference Gain	1/10V Rated Torque	10	100	30	Torque Control Mode
	Cn-14	TCRLMT	Speed Limit in Torque Control I	r/min	0	Maximum Speed	Maximum Speed	
	Cn-17	TRQFIL	Torque Reference Filter Time Constant	100 μs	0	250	4	
Constants for Sequences	Cn-07	SFSACC	Soft Start Time	ms	0	10000	0	Up to Maximum Speed
	Cn-0B	TGONLV	Zero-speed Level	r/min	10	Maximum Speed	Maximum Speed × 20%	TGON Output
	Cn-0F	ZCLVL	Zero-clamp Level	r/min	0	100	10	Zero Clamp Function
	Cn-12	BRKTIM	Delay Time from Brake Reference to SVOFF	10ms	0	50	20	
	Cn-15	BRKSPD	Brake Timing at Motor Rotating (Speed Level that Outputs Brake Reference)	r/min	0	Maximum Speed	100	Brake Command Function
	Cn-16	BRKWAI	Brake Timing at Motor Rotating (Waiting Time from SVOFF until Brake Reference is output)	10ms	10	100	50	
Constants for Encoder Pulses	Cn-0A	PGRAT	PG Frequency Dividing Ratio Setting	P/R	1	PG Pulse	PG Pulse	Note 1
	Cn-11	PULSNO	Number of Pluses	P/R	—	—	PG Pulse	Note 2
Constants for Others	Cn-0C	TRQMSW	Mode Switch (Torque Reference)	%	0	Maximum Torque	200	
	Cn-0D	REFMSW	Mode Switch (Speed Reference)	r/min	0	Maximum Speed	0	
	Cn-0E	ACCMSW	Mode Switch (Accelerating Speed)	10(r/min)/S	0	3000	0	
	Cn-10	JOGSPD	JOG Speed	1r/min	0	Maximum Speed	10	

Notes: 1. Turn ON power supply again after setting this constant.
2. Be sure to set only the number of encoder pulses.
3. Refer to Par. 1.6, "RATINGS AND SPECIFICATIONS OF SERVOPACK" for max. torque and max. speed.

8.4.2 User Constant (Memory Switch) and Check

User constant Cn-01 can be set up or checked as memory switch bits. The procedures for item number setup and data display are the same as indicated in Par. 8.4.1.

The switch functions provided after bit data display are indicated in Fig. 8.7.

Panel Display

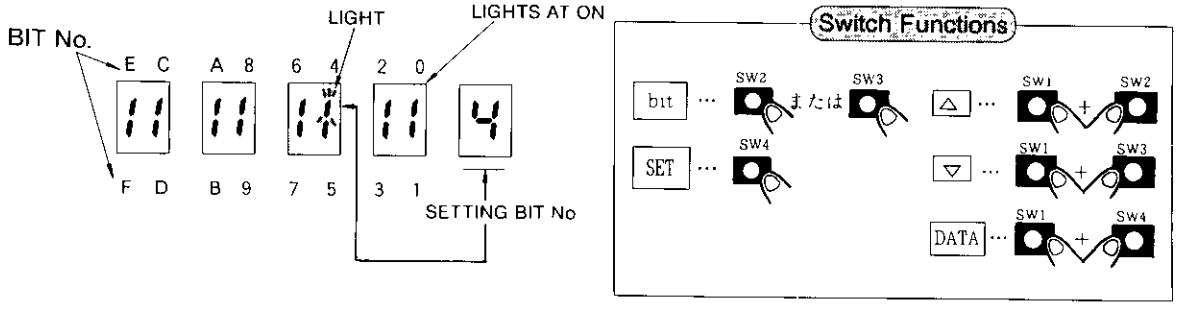


Fig. 8.7 Switch Functions Provided after Bit Data Display

1. With the [△] and [▽] keys, enter the setup memory switch number at the far right end of the panel.
2. With the [bit] key, set the memory switch to ON or OFF (either switch SW2 or SW3 can be used). The panel indication comes on when the switch is ON, and goes off when the switch is OFF.
3. Repeat steps [1] and [2] as needed.
4. With the [SET] key, data is memorized.
5. With the [DATA] key, return to the item No. display state.
6. Using the [SET] key, switch from the setting mode to the monitor mode.

Table 8.5 shows the memory switch description of user constant Cn-01 and table 8.6 shows that of user constant Cn-02.

Table 8.5 User Constant Cn-01 (Memory Switch) List

Selection	Bit No.	Setting	Conditions	Standard
Sequence Input Selection	0	0	Servo ON/OFF by external input (SV-ON).	0
		1	The servo is ON at all times.	
	1	0	The external input (SEN) is used.	0
		1	Regardless of the SEN signal presence, the Servopack automatically conculdes that the "H" level prevails.	
	2	0	The P-OT signal prohibits forward running.	0
		1	Forward running is permitted at all times.	
	3	0	The N-OT signal permits reverse running.	0
		1	Reverse running is permitted at all times.	
Input Signal Selection	4	0	The IN-A input is used.	0
		1	Regardless of the IN-A input presence, the Servopack concludes that the IN-B input is 0.	
	5	0	The IN-B input is used.	0
		1	Regardless of the IN-B input presence, the Servopack concludes that the IN-B input is 0.	
Abnormal Stop Selection	6	0	<DB stop> The dynamic brake stops the motor.	0
		1	<Coasting to stop> The motor is freed and brought to a stop.	
	7	0	<DB OFF after DB stop> The dynamic brake is turned OFF after the motor is stopped.	0
		1	<DB continuously ON after DB stop> The dynamic brake remains activated after the motor is stopped.	
	8 Note 1	0	The overtravel state stop method agrees with bit 6.	0
		1	<Overtravel zero speed stop> In the overtravel state, the motor is stopped at the torque setting defined by user constant Cn-06.	
	9 Note 2	0	In the overtravel state, base blocking (BB) is implemented after the motor stops.	0
		1	In the overtravel state, zero clamping is effected after zero speed stop.	
Mode Switch Selection (for Speed Control only)	D-C Note 3	0-0	<Torque reference> Based on the torque reference level defined by user constant Cn-0C.	00
		0-1	<Speed Reference> Based on the speed reference level defined by user constant CN-0D.	
		1-0	<Acceleration> Based on the acceleration level defined by user constant Cn-0E.	
		1-1	<None> The mode switch function is not provided.	
Presence of External Brake	E	0	The braking command function is not provided.	0
		1	The braking command function is provided.	
Spare	F			0

Notes: 1. The abnormal stop method in the torque control mode complies with bit 6.
2. Selects the status based on the stop method selected for the overtravel state (bit 8).
3. Selects a mode switch operating condition. When the mode switch operates, the speed control mode changes to P control. However, this is effective for speed control only.

Table 8.5 User Constant Cn-01 (Memory Switch) List (Cont'd)

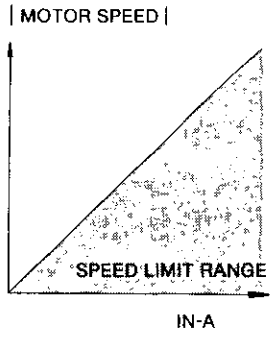
Option	Bit No.	Setting	Description	Reference Input	Sequence Signal Input	Standard
Control Mode Selection	B • A	0 • 0	<Speed control> • Regular speed control. • The $\overline{\text{P-CON}}$ signal (1CN-24) is used to effect P/PI control changeover.	Speed reference (IN-A) Auxiliary reference input (IN-B)	$\overline{\text{P-CON}}$ OFF: PI control ON: P control	0 • 0
		0 • 1	<Zero clamp speed control> • After the motor is stopped (ZCLVL), the speed reference is disconnected to execute the zero speed stop function. • The P-CON signal (1CN-24) is used to turn ON and OFF the zero clamp function.		$\overline{\text{P-CON}}$ OFF: Zero clamp function OFF ON: Zero clamp function ON	
		1 • 0	<Torque control I> • The motor output torque is controlled by the torque reference (IN-A). • The IN-B cannot be used.	Torque reference (IN-A)	None	
		1 • 1	<Torque control II> • The $\overline{\text{P-CON}}$ signal (1CN-24) is used for torque/speed control mode changeover. Torque control mode • The motor output torque is controlled by the torque reference (IN-B). • The speed limit can be entered from outside (IN-A). The IN-A voltage (+) limits both the forward and reverse running speeds.  Speed control mode • The speed reference is entered from the IN-A. • The IN-B cannot be used.	Torque control mode Torque reference (IN-B) Speed limit (IN-A) Speed control mode Speed reference (IN-A) Notes: • When the speed is outside the speed control range, the torque proportional to the speed difference from the limit is negatively fed back to place the speed within the limit. Therefore, the actual motor rotating speed limit varies with the load conditions. • In case of continuous regeneration (tension control), please contact your local YASKAWA representative.	$\overline{\text{P-CON}}$ OFF: Torque control ON: Speed control	

Table 8.6 User Constant Cn-02 (Memory Switch) List

Option	Bit No.	Setting	Description	Standard
Reverse Rotation Mode Selection*	0	0	CCW: Forward Running	
		1	CW: Forward Running	
Encoder Detection Mask	1	0	Alarm is detected at encoder fault.	
		1	Encoder fault is not detected.	
Spare	2 to F		Do not adjust.	

Note: After this user constant setting, turn ON the control voltage again.

8.4.3 JOG Operating Procedure

(1) JOG Operation Mode Selection

When user constant Cn-00 is set to 00, the operations are to be controlled from the monitor panel. The switch functions are indicated in Fig. 8.8.

Panel Display

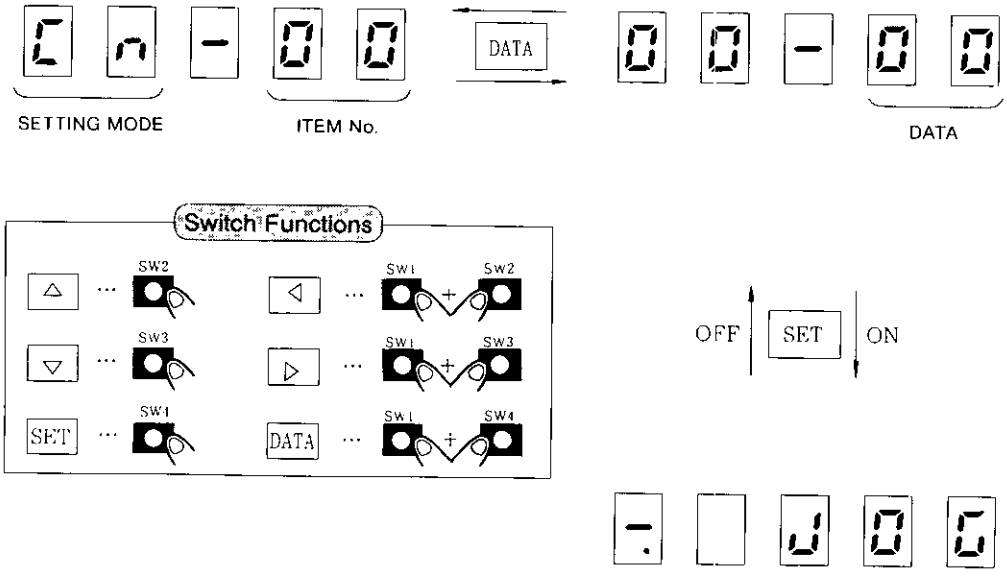


Fig. 8.8 Switch Functions in JOG Operation Mode

1. Select the item number 00 with the [△], [▽], [◁] and [▷] keys.
2. With the [DATA] key, display the data related to the selected item number.
3. With the [△], [▽], [◁] and [▷] keys, select the number 00.
4. With the [SET] key, turn ON or OFF the JOG operation mode.
5. With the [DATA] key, return to the item No. display state.
6. Using the [SET] key, switch from the setting mode to the monitor mode.

(2) JOG Operation Procedure

For speed reference adjustment, use user constant Cn-10 (see Par. 8.4.1).

The switch functions provided for monitor panel JOG operations are indicated in Fig. 8.9.

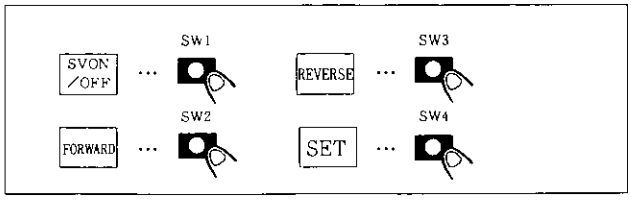


Fig. 8.9 Switch Functions for JOG Operations

1. With the [SVON/OFF] switch, effect SVON/SVOFF changeover.
2. The motor runs in the forward direction while the [FORWARD] key is held down.
3. The motor runs in the reverse direction while the [REVERSE] key is held down.
4. The [SET] key is used to switch from the JOG operation mode to the user constant Cn-00 data display state.
5. With the [DATA] key, return to the item No. display status.
6. Using the [SET] key, switch from the setting mode to the monitor mode.

8.4.4 Speed Reference Offset Adjustment

When user constant Cn-00 is set to 01, the system enters the speed reference off set adjustment mode. The switch functions are indicated in Fig. 8.9.

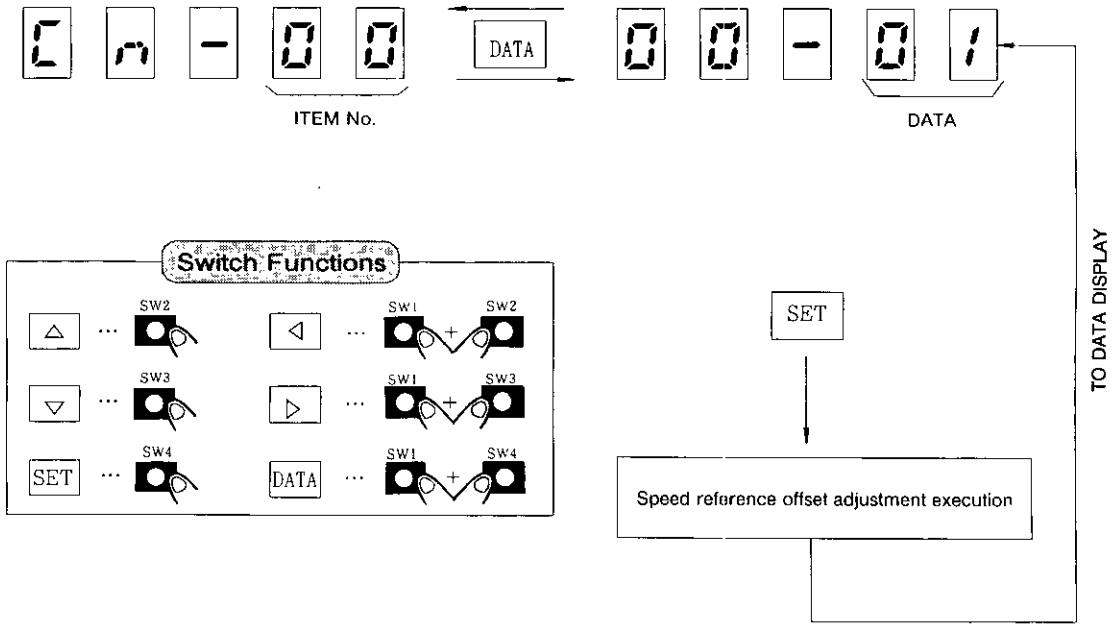


Fig. 8.9 Speed Reference Offset Adjustment

1. Select the item number 00 with the [△], [▽], [◁] and [▷] keys.
2. With the [DATA] key, display the data related to the selected item number.
3. With the [△], [▽], [◁] and [▷] keys, select the number 01.
4. Apply a desired zero speed reference voltage between speed reference input terminals IN-A and IN-B (a voltage of 0V should normally be applied).
5. With the [SET] key, make speed reference offset adjustment and return to 00-01 data display state.
6. With the [DATA] key, return to the item No. display status.
7. Using the [SET] key, switch from the setting mode to the monitor mode.

8.4.5 Clearing Fault Traceback Data

When user constant Cn-00 is set to 02, fault traceback data are cleared. The switch functions are indicated in Fig. 8.11.

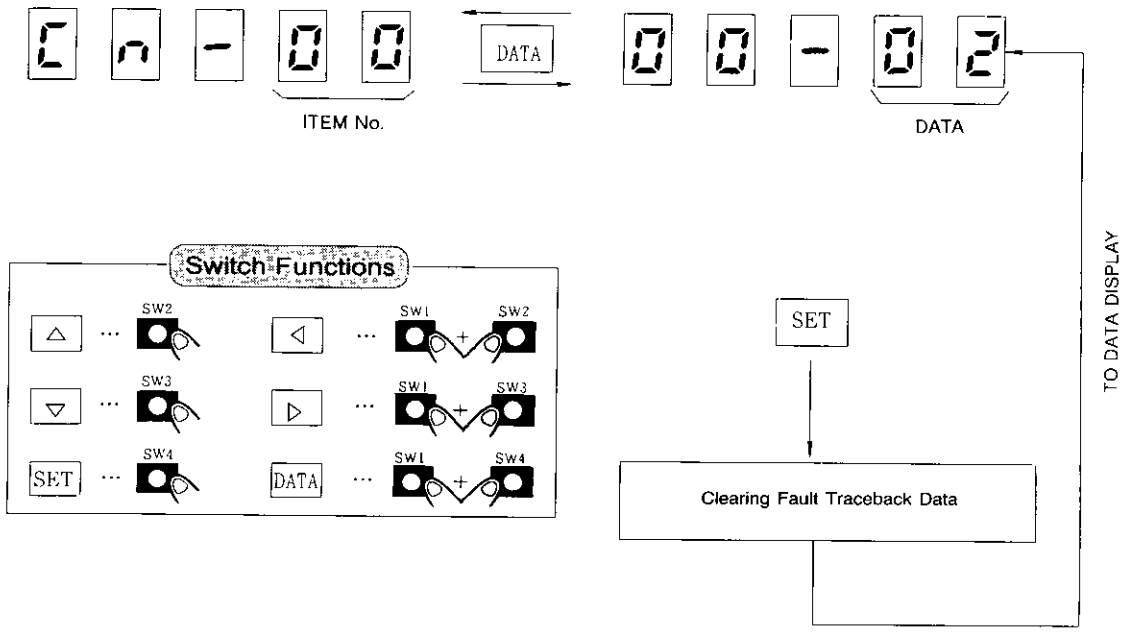


Fig. 8.11 Clearing Fault Traceback Data

1. Select the item number 00 with the [△], [▽], [◁] and [▷] keys.
2. With the [DATA] key, display the data related to the selected item number.
3. With the [△], [▽], [◁] and [▷] keys, select the number 02.
4. With the [SET] key, clear fault traceback data and return to the user constant 00-02 data display status.
5. With the [DATA] key, return to the item No. display state.
6. Using the [SET] key, switch from the setting mode to the monitor mode.

8.4.6 Speed Reference Offset Manual Adjustment

(1) Speed Reference Offset Manual Adjustment Mode Selection

When user constant Cn-00 is set to 03, the system enters the speed reference offset manual adjustment mode. The switch functions are indicated in Fig. 8.12.

Panel Display

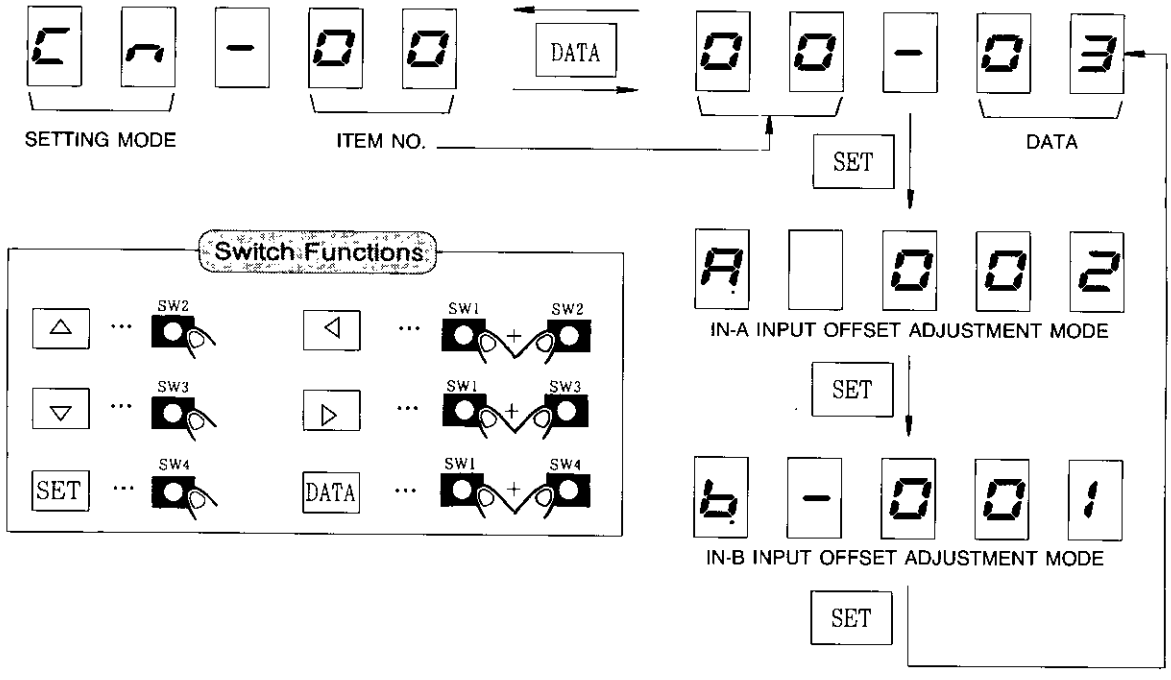


Fig. 8.12 Switch Functions in Speed Reference Offset Manual Adjustment Mode

1. Select the item number 00 with the [△], [▽], [◁] and [▷] keys.
2. With the [DATA] key, display the data related to the selected item number.
3. With the [△], [▽], [◁] and [▷] keys, select the number 03.
4. With the [SET] key, turn ON or OFF the adjustment mode.
5. With the [DATA] key, return to the item No. display status.
6. Using the [SET] key, switch from the setting mode to the monitor mode.

(2) Speed Reference Offset Manual Adjustment Procedure

Input voltage which is to be zero-speed reference to speed reference input terminals IN-A and IN-B. (Normally, 0V.)

Fig. 8.13 shows the switch functions at speed reference offset manual adjustment.

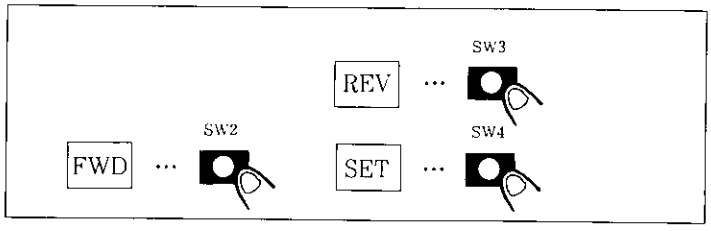


Fig. 8.13 Switch Functions at Speed Reference Offset Manual Adjustment

1. While the [FWD] key is being depressed, offset is added to the forward rotation side.
2. While the [REV] key is being depressed, offset is added to the reverse rotation side.
3. The [SET] key stores the offset data and switches to the next mode.

Offset adjustment is performed basically in the direction where LED display becomes zero. However, completely zero-display does not mean the optimum adjustment; perform offset adjustment according to the actual motor behavior, etc.

8.4.7 Current Detection Offset Manual Adjustment

(1) Current Detection Offset Manual Adjustment Mode Setting Procedure

When user constant Cn-00 is set to 04, the system enters the current detection offset adjustment mode. The switch functions are indicated in Fig. 8.14.

Panel Display

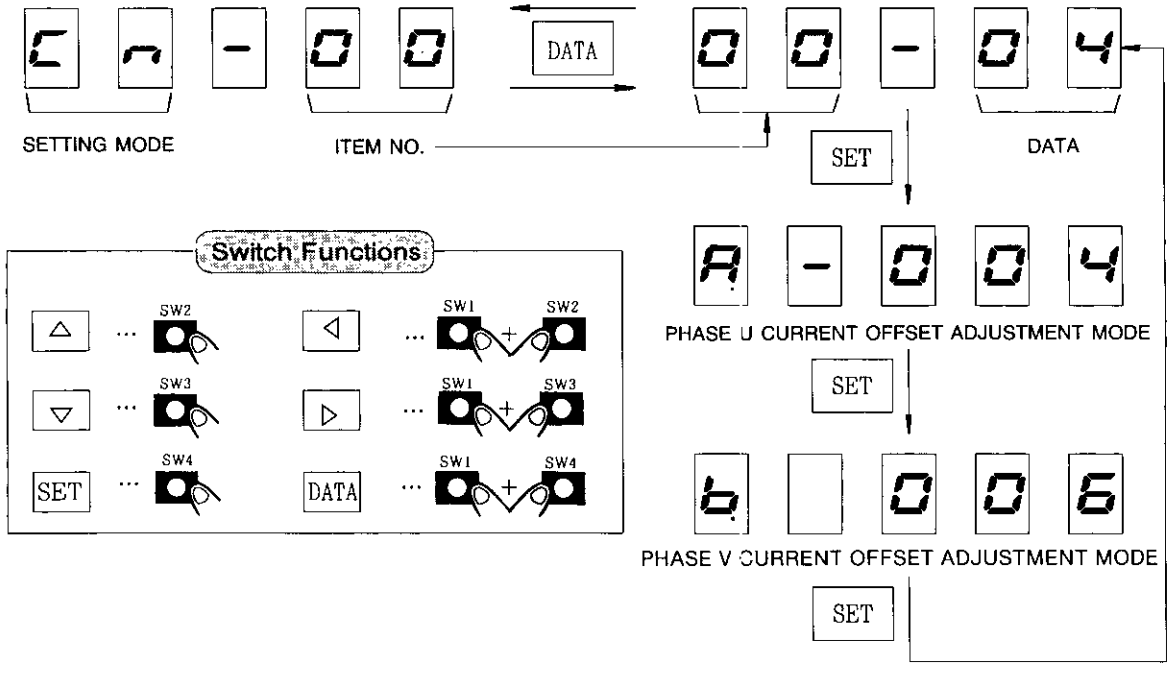


Fig. 8.14 Switch Functions in Current Detection Offset Adjustment Mode

1. Select the item number 00 with the [△], [▽], [◁] and [▷] keys.
2. With the [DATA] key, display the data related to the selected item number.
3. With the [△], [▽], [◁] and [▷] keys, select the number 04.
4. With the [SET] key, turn ON or OFF the adjustment mode.
5. With the [DATA] key, return to the item No. display status.
6. Using the [SET] key, switch from the setting mode to the monitor mode.

(2) Current Detection Offset Adjustment Operation Procedure

Since current detection offset is adjusted at the factory prior to shipping, basically, users do not have to adjust it.

However, when adjustment is required for higher accuracy by combination with motor, perform adjustment as shown below.

Fig. 8.15 shows the switch functions at current detection offset adjustment.

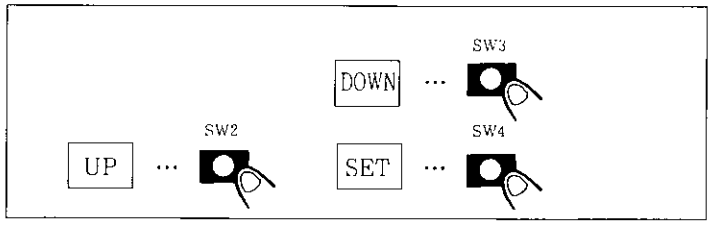


Fig. 8.15 Switch Functions at Current Detection Offset Manual Adjustment

1. Rotate the motor approx. 100 r/min and monitor the torque monitor terminal MON1 by using an oscilloscope.
2. Depress the [UP] and [DOWN] keys and adjust so that torque ripple will be at a minimum.
3. The [SET] key stores the offset data and switches to the next mode.
4. It is necessary to adjust phase-U and -V offset for good balance for torque ripple. Perform 2 to 3 several times to check the optimum value.

8.4.8 Check of Motor Parameters

(1) Check Method of Motor Parameters

Setting user constant Cn-00 is set to 04. The system enters the motor parameter check mode. The switch functions are indicated in Fig. 8.16.

Panel Display

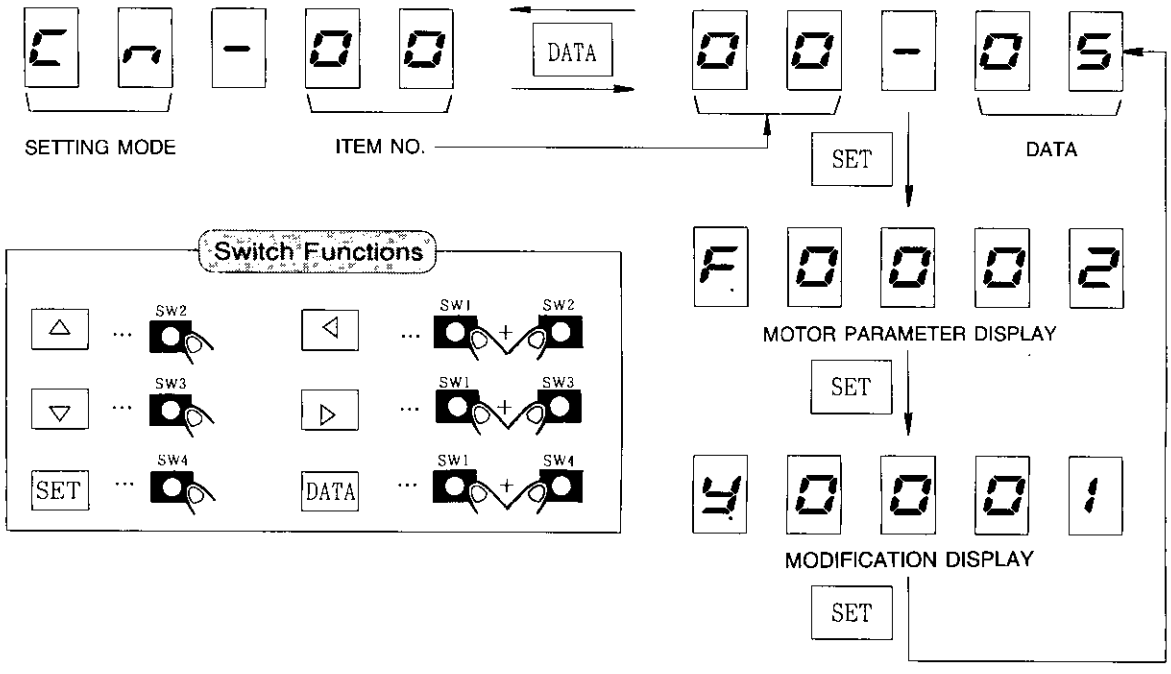
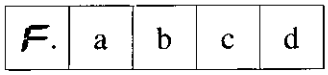


Fig. 8.16 Switch Functions at Motor Parameter Checking

1. Select the item number 00 with the [△], [▽], [◁] and [▷] keys.
2. With the [DATA] key, display the data related to the selected item number.
3. With the [△], [▽], [◁] and [▷] keys, select the number 05.
4. With the [SET] key, turn the adjustment mode ON or OFF.
5. With the [DATA] key, return to the item No. display status.
6. Using the [SET] key, switch from the setting mode to the monitor mode.

(2) How to Read Parameter Indication

• Motor parameter



MOTOR CAPACITY

$(c \times 16 + d) \times 100$ [W]

CORRESPONDING ALPHABET AND NUMBER

A = 10
b = 11
C = 12
d = 13
E = 14
F = 15

MOTOR TYPE

0 .... M SERIES
1 .... F
2 .... S
4 .... D
5 .... G

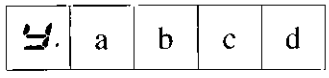
ENCODER TYPE

0 .... INCREMENTAL
1 .... ABSOLUTE VALUE
2 .... FORMER INCREMENTAL
3 .... ABSOLUTE VALUE

Typical Motor Capacity Indication

Motor Capacity	Indication				
200W	F.			0	2
300W	F.			0	3
500W	F.			0	5
700W	F.			0	7
900W	F.			0	9
1.0kW	F.			0	A
1.2kW	F.			0	C
1.5kW	F			0	F
2.0kW	F.			1	4
3.0kW	F.			1	E
4.4kW	F.			2	C

• Modification index



MODIFICATION NUMBER (YASKAWA REGISTER NUMBER)

8.5 MONITOR MODE

In this mode, the speed reference, torque reference, and other data can be observed on the monitor panel.

Table 8.7 lists the data that can be monitored. The switch functions are indicated in Fig. 8.17.

Table 8.7 Data Monitored

Moniter No.	Data Monitored
00	Feedback Speed (r/min)
01	Speed Reference (r/min)
02	Torque Reference (%)
03	No. of Pulses from Phase-C edge (For YASKAWA check)
04	Electrical Angle (1/10deg) (For YASKAWA check)
05	Internal Status Bit Display (Refer to Table 8.8.)

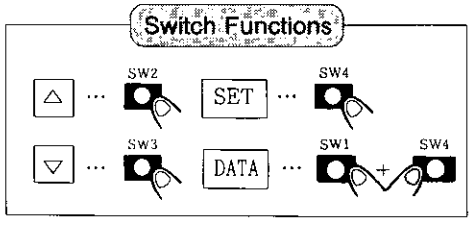
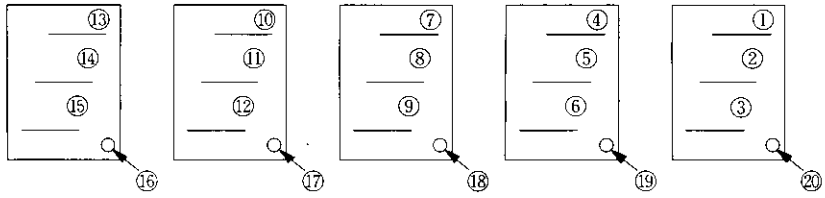


Fig. 8.17 Switch Functions in Monitor Mode

Table 8.8 Monitor Mode Un-05 Internal Status Bit Display



Bit. No.	Symbol	Contens
①	SVALM	Servo Alarm
②	DBON	Dynamic Brake ON
③	DIR	Reverse Run Mode
④	CLT	Current Limit
⑤	TGON	Motor Running
⑥	MSON	Mode Switch ON
⑦	ACON	AC Power Supply ON
⑧	SVRDY	Servo Ready
⑨	B-ON	Motor Under Current Conduction
⑩	PA	Phase-A
⑪	PB	Phase-B
⑫	PC	Phase-C
⑬		
⑭		
⑮		
⑯	SVON	Servo ON
⑰	P-CON	P Operation Input
⑱	P-OT	Forward Running Prohibit Input
⑲	N-OT	Reverse Running Prohibit Input
⑳	SEN	SEN Signal Input

1 With the [△] and [▽] keys, select a desired monitor No.

2 With the [DATA] key, initiate monitor display.

3 Using the [DATA] key, return to the monitor No. selection status.

4 With the [SET] key, switch from the monitor mode to the fault traceback mode.

8.6 FAULT TRACEBACK MODE

In this mode, the information on past fault occurrences can be displayed.

- The information on up to 10 past fault occurrences can be stored.
- When a fault is reset or the control power is turned ON, traceback data A. 99 is saved (These data are also counted as one of a total of 10 stored items of fault information).
- For the relationship between traceback data and fault descriptions, refer to Table 8.9. The switch functions are indicated in Fig. 8.18.

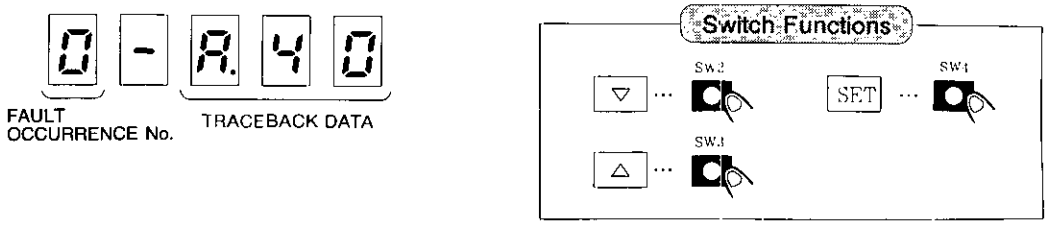


Fig. 8.18 Switch Functions in Fault Traceback Mode

1. With the [△] and [▽] keys, increase or decrease the fault occurrence number. The fault information related to the selected number is then displayed. (The higher the fault occurrence number, the older the fault occurrence.)
2. With the [SET] key, switch from the fault traceback mode to the status display mode.

Table 8.9 Trouble Indications

	Monitor Panel Indication (Traceback Data)	Alarm Code Serial Output	ALM Output	Alarm Contents	
	A.00	ALM00. C_R	*1 ×	Absolute error	
	A.02	ALM02. C_R	×	Parameter breakdown	
	A.03	ALM03. C_R	×	Main circuit detection error	
	A.04	ALM04. C_R	×	Parameter setting error	
	A.10	ALM10. C_R	×	Overcurrent or heatsink overheat or ground fault	
	A.20	ALM20. C_R	×	MCCB trip	
	A.30	ALM30. C_R	×	Regeneration error	
	A.40	ALM40. C_R	×	Overvoltage (detected at approx. 420V)	
	A.51	ALM51. C_R	×	Overspeed (detected at 120% of maximum speed)	
	A.52	ALM52. C_R	×	Excessive reference input (detected at 110% of maximum speed)	
	A.60	ALM60. C_R	×	Undervoltage (detected at approx. 150V)	
	A.71	ALM71. C_R	×	Overload (momentary maximum load)	
	A.72	ALM72. C_R	×	Overload (continuous maximum load)	
	A.80	ALM80. C_R	×	Encoder fault	
*2	A.81	ALM81. C_R	×	Encoder backup error	
*2	A.82	ALM82. C_R	×	Encoder check sum error	
*2	A.83	ALM83. C_R	×	Encoder battery error	
*2	A.85	ALM85. C_R	×	Encoder overspeed	
	A.b1	ALMb1. C_R	×	Reference input read error	
	A.b2	ALMb2. C_R	×	External current limit read error	
	A.C1	ALMC1. C_R	×	Overrun (wrong wiring of motor circuit PG signal line)	
	A.C3	ALMC3 C_R	×	Encoder PA, PB phase disconnection	
	A.C4	ALMC4. C_R	×	Encoder PC disconnection of PG signal line	
	A.F1	ALMC1. C_R	×	Power supply line open-phase	Detected at power supply ON.
	A.F2	ALMC2. C_R	×	Power supply startup error	
—			×	CPU error	
	A.99			Alarm reset, turning on power supply (Traceback data only)	

*1: × Output transistor off

*2: Detected only for (12-bit absolute encoder Servopack) CACR-SR□BY1W□

9. INSTALLATION AND WIRING

9.1 RECEIVING

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

- Nameplate ratings meet your requirements.
- It has sustained no damage while in transit.
- 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 contact your YASKAWA representative giving full details and nameplate data.

If the SERVOPACK MCCB is turned OFF, turn it ON. (For the position of MCCB, refer to Par. 11.1.2.)

9.2 INSTALLATION

9.2.1 AC SERVOMOTOR

AC SERVOMOTOR can be installed either horizontally or vertically.

(1) Before mounting

Remove anticorrosive paint on shaft extension and flange surface with thinner before connecting the motor to the driven machine. Do not subject other parts of the motor to thinner. See Fig. 9.1.

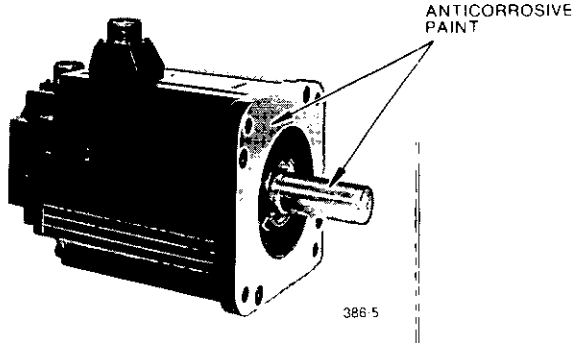


Fig. 9.1 Anticorrosive Paint to be Removed

(2) Location

Use the motor under the following conditions.

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

If the AC SERVOMOTOR is subject to excessive water or oil droplets or mist, protect the motor with a cover. The motor can withstand a small amount of splashed water or oil (except for C series).

It is recommended that the motor be mounted with its connector placed down.

(3) Environmental conditions

Ambient Temperature: 0 to +40°C

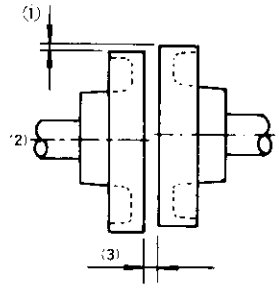
Storage Temperature: −20 to +60°C

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

(4) Load coupling

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

Use flexible couplings for direct drives. Alignment should be made in accordance with Fig. 9.2.



① Measure the gap between a straightedge and coupling halves at four equidistant points of the coupling. Each reading should not exceed 0.03 mm (0.0012 in.).

② Align the shafts.

③ Measure the gap between the coupling faces at four equidistant points around the coupling rim with a thickness gage. The maximum variation between any two readings should not exceed 0.03 mm (0.0012 in.).

Fig. 9.2 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 Tables 4.1 to 4.5.

9.2.2 SERVOPACK

(1) Installation

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

(2) Location

- When installed in a panel:

  Keep the ambient temperature around SERVOPACK at 55°C or below. (Fig. 9.3)

- When installed near a heat source:

  Keep the ambient temperature around SERVOPACK below 55°C. (Fig. 9.4)

- 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.

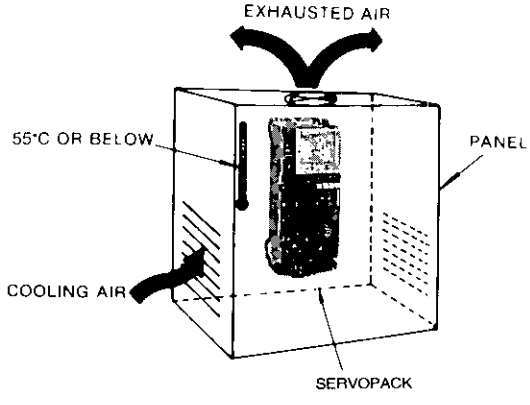


Fig. 9.3 Typical Layout for Panel Mounting

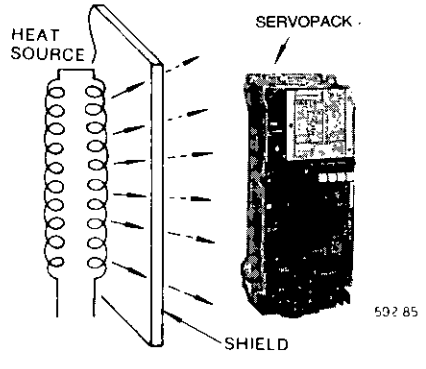


Fig. 9.4 Protection against Heat Radiation

(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. 9.5)

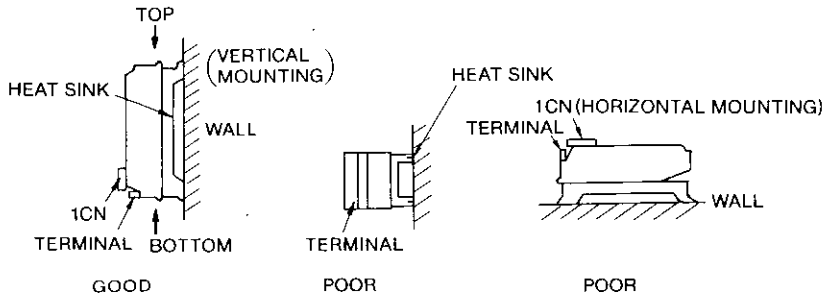
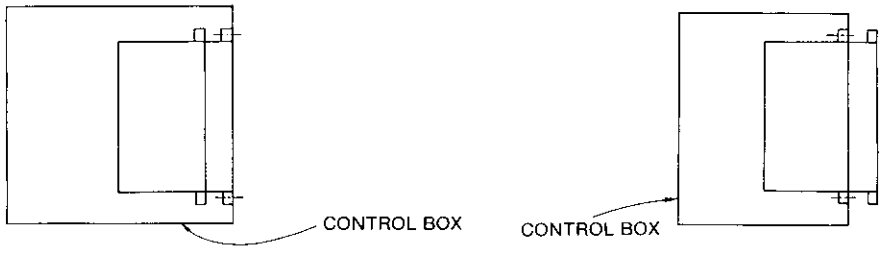


Fig. 9.5 Mounting Direction



(a) Usual Mounting (b) Mounting with Radiation Fin out

Fig. 9.6 Method of Mounting

Fig. 9.7 shows mounting hole processing with radiation fin out.

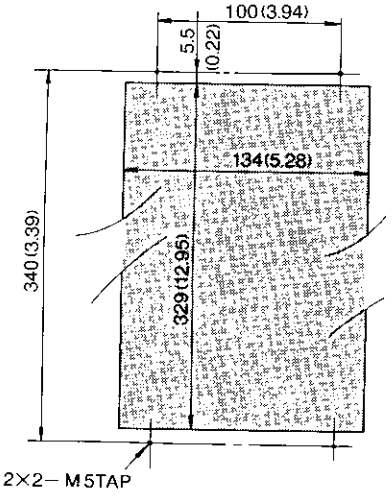


Fig. 9.7 Mounting Hole Processing in mm (inch)

(4) Precautions

- Mounting Pitch

Standard mounting pitch is 150mm (5.91 in). If panel inside circulation is sufficient, such as when housed into the panel, 145mm (5.71 in) is also available.

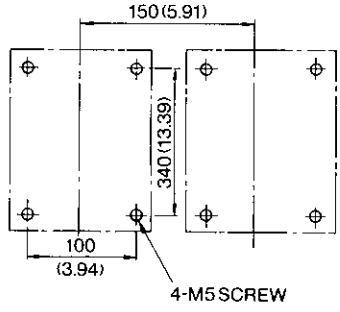
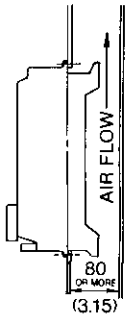


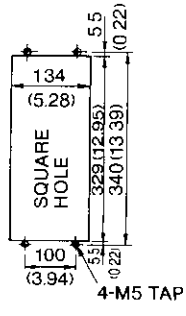
Fig. 9.8 Mounting Pitch

- Duct Ventilation

When heat sink section of SERVOPACK is stored on the panel exterior or in the duct, refer to Fig. 9.9.



Mounting of Duct Ventilation Type



Panel Punching size

Fig. 9.9 Mounting SERVOPACK

Note: It is necessary to mount packing on the SERVOPACK mounting section when airtightness is needed for duct ventillation. Provid "—p" at the end of type description.

9.3 WIRING

9.3.1 Rated Current and Cable Size

Tables 9.1 and 9.2 show external terminals, rated current, and cable sizes of the power unit and SERVOPACK, respectively. Select the type and size of cables to meet ambient conditions and current capacity. The cable size is calculated so that a bundle of three cables can bear the rated current at an ambient temperature of 40°C. Table 9.3 lists the type of cables.

Table 9.1 Rated Current (A: rms)

External Terminal		Type CACR- / Symbol	Rated Current A (Effective Current)									
			SR02BY	SR03BY	SR05BY	SR07BY	SR10BY	SR15BY	SR20BY	SR30BY	SR44BY	SR60BY
On Line	Main Circuit Power Input	R, S, T	2	2	5	6	8	10	12	18	24	32
	Motor Connection	U, V, W	3.0	3.0	4.2	5.8	7.6	11.7	18.8	26.0	33.0	45
	Control Power Input	r, t	0.5									
Off Line	Control I/O Signal Connector	1CN	100 mA DC max									
	PG Signal Connector	2CN	100 mA DC max (500 mA DC for power line only)									
	Ground	⏚	—									
	Regenerative Resistor Connecting Terminal*	(Y3) (Y4)	15 A							30 A		50 A
	Fan Connecting Terminal (SR60BY type)	(F1) (F3)	—									0.2 A

*: Maximum current when external regenerative registor is connected.

Table 9.2 Recommended Cable Size of Servopack

External Terminal		Type CACR- / Symbol	Cable Size mm²									
			SR02BY	SR03BY	SR05BY	SR07BY	SR10BY	SR15BY	SR20BY	SR30BY	SR44BY	SR60BY
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 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									
	Regenerative Resistor Connecting Terminal	(Y3) (Y4)	HIV 1.25 or more									HIV 5.5 or more
	Fan Connecting Terminal (SR60BY type)	(F1) (F3)										AWG 20 or more

Note: Conditions of applicable cable size selection: Rated current applied in three-twisted lead wire at ambient temperature 40 °C.

Table 9.3 Applicable Cable

Cable Type		Conductor Allowable Temperature
Symbol	Name	
PVC	General-purpose vinyl cable	—
IV	600V vinyl cable	60°C
HIV	Special heat-resistant vinyl cable	75°C

Notes: 1. For main circuits, use cables of 600 V or more.

2. Where cables are bundled or run through a duct (unplasticized polyvinyl chloride conduit or metalic conduit), select the larger cable size than listed considering the current drop rate of the cables.

3. Where the ambient (panel inside) temperature is high (40°C to 60°C), use heat-resistant cables.

9.3.2 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 3 m for reference input lines and a maximum of 20 m for PG feedback lines. Use the shortest possible length.

(2) For ground line, cable should be as heavy as possible to provide class 3 ground (ground resistance 100 Ω or less). Use central grounding point.

(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 insert a surge absorbing circuit into the relay, electromagnetic contact, and solenoid coils.
- Run the power line and signal line, holding the distance to 30 cm or more; do not run them in the same duct or in a bundle.
- When the same power is used for SERVOPACK, as for an electric welder or 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 mm^2). Avoid using excessive force which may damage these cables.

9.3.3 Power Loss

The power loss of SERVOPACK is shown in Table 9.4.

Table 9.4 Power Loss at Rated Output

SERVOPACK Type CACR-	Output Current A	Power Loss			
		Main Circuit W	Regenerative Resistance W	Control Circuit W	Total W
SR02BY	3.0	20	10	60	90
SR03BY	3.0	20			90
SR05BY	4.2	40			110
SR07BY	5.8	60	20		140
SR10BY	7.6	70			150
SR15BY	11.7	80			160
SR20BY	18.8	100	40		200
SR30BY	26.0	160	80		300
SR44BY	33.0	210	100		370
SR60BY	45.0	300	120		480

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

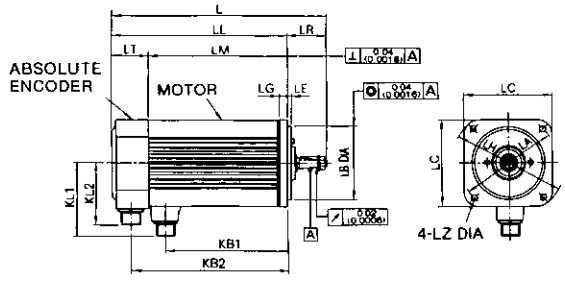
10. DIMENSIONS in mm (inches)

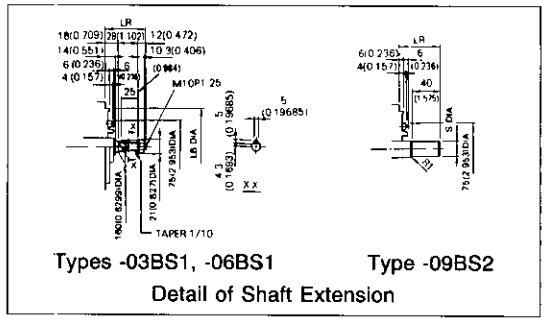
10.1 SERVOMOTOR

10.1.1 M Series

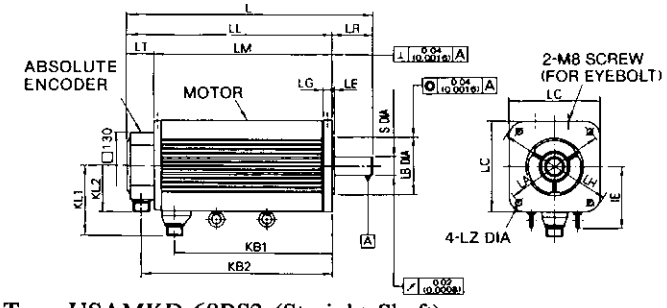
(1) Standard Type

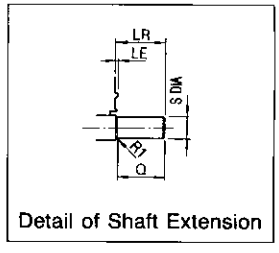
• Types USAMED-03BS1, -06BS1 (Taper Shaft), -09BS2(Straight Shaft)



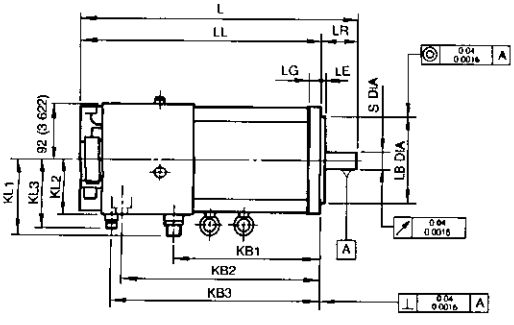


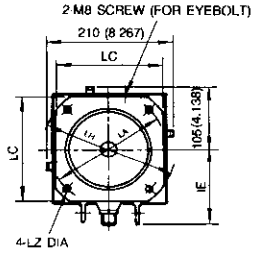
• Types USAMED-12BS2, -20BS2, -30BS2, -44BS2 (Straight Shaft)

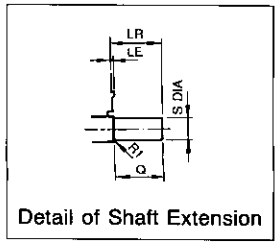




• Type USAMKD-60BS2 (Straight Shaft)







AC SERVOMOTOR Type USAMED-	L	LL	LM	LR	LT	KB1	KB2	KB3	IE	KL1	KL2	KL3	Flange Surface							Shaft Extension		Approx Mass kg (lb)
													LA	LB	LC	LE	LG	LH	LZ	S	Q	
03BS1*	277 (10.91)	219 (8.63)	150 (5.91)	58 (2.28)	69 (2.72)	127 (5.0)	177 (6.97)	–	–	109 (4.29)	92 (3.62)	–	145 (5.71)	110 (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	9 (19.9)
06BS1*	334 (13.15)	276 (10.87)	207 (8.15)	58 (2.28)	69 (2.72)	184 (7.24)	234 (9.21)	–	–	109 (4.29)	92 (3.62)	–	145 (5.71)	110 (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	14 (30.9)
09BS2*	403 (15.87)	345 (13.59)	276 (10.87)	58 (2.28)	69 (2.72)	253 (9.96)	303 (11.93)	–	–	109 (4.29)	92 (3.62)	–	145 (5.71)	110 (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	22 $^{0}_{-0.0065}$ (0.8661 $^{0}_{-0.0026}$)	40 (1.575)	20 (44.1)
12BS2*	344 (13.55)	265 (10.44)	211 (8.30)	79 (3.11)	54 (2.13)	172 (6.78)	237 (9.33)	–	–	139 (5.47)	92 (3.62)	–	200 (7.87)	114.3 $^{0}_{-0.005}$ (4.5 $^{0}_{-0.0018}$)	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3779 $^{+0.0004}_{0}$)	76 (2.992)	22 (48.6)
20BS2	401 (15.79)	322 (12.68)	269 (10.60)	79 (3.11)	54 (2.13)	229 (9.01)	295 (11.61)	–	123 (4.85)	139 (5.47)	92 (3.62)	–	200 (7.87)	114.3 $^{0}_{-0.005}$ (4.5 $^{0}_{-0.0018}$)	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3779 $^{+0.0004}_{0}$)	76 (2.992)	29 (64.0)
30BS2	486 (19.13)	407 (16.02)	354 (13.94)	79 (3.11)	54 (2.13)	314 (12.36)	380 (14.96)	–	123 (4.85)	139 (5.47)	92 (3.62)	–	200 (7.87)	114.3 $^{0}_{-0.005}$ (4.5 $^{0}_{-0.0018}$)	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3779 $^{+0.0004}_{0}$)	76 (2.992)	41 (90.4)
44BS2	688 (27.09)	578 (22.76)	524 (20.63)	110 (4.33)	54 (2.13)	476 (18.74)	550 (21.65)	–	123 (4.85)	149 (5.87)	92 (3.62)	–	200 (7.87)	114.3 $^{0}_{-0.005}$ (4.5 $^{0}_{-0.0018}$)	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	42 $^{0}_{-0.016}$ (1.6535 $^{0}_{-0.0006}$)	110 (4.33)	66 (146)
60BS2	775 (30.51)	665 (26.18)	–	110 (4.33)	–	476 (18.74)	550 (21.65)	575 (22.64)	123 (4.85)	149 (5.87)	92 (3.62)	125 (4.92)	200 (7.87)	114.3 $^{0}_{-0.025}$ (4.5 $^{0}_{-0.001}$)	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	42 $^{0}_{-0.016}$ (1.6535 $^{0}_{-0.0006}$)	110 (4.33)	75 (166)

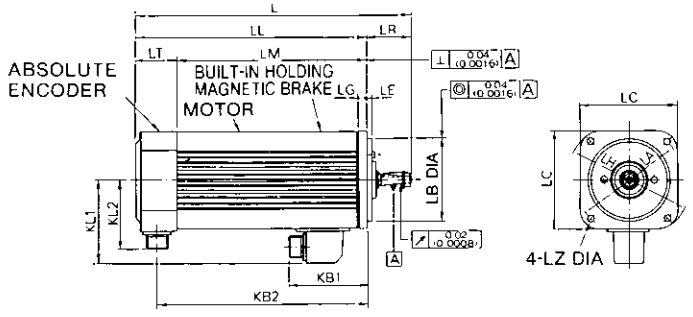
* Not Provided with an eyebolt.

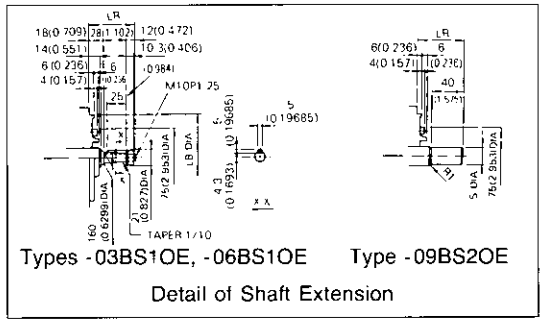
† TIR: Total Indicator Reading

Notes: 1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Connector specifications: Refer to Table 3.6.
5. It is recommended that the motor be mounted with its connector placed down.

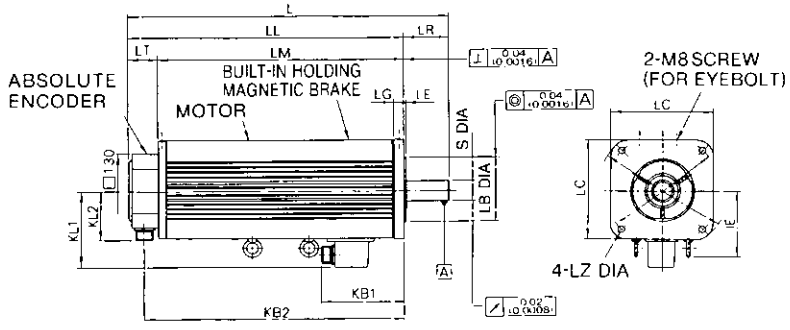
(2) With Brake

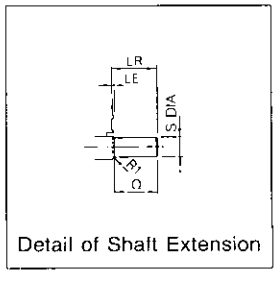
• Types USAMED-03BS1OE, -06BS1OE (Taper Shaft), -09BS2OE (Straight Shaft)





• Types USAMED -12BS2OE, -20BS2OE, -30BS2OE (Straight Shaft)



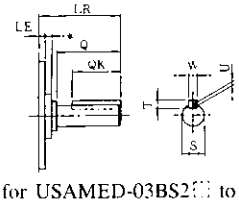


AC SERVOMOTOR Type USANED-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension		Approx Mass kg (lb)	BRAKE	
											LA	LB	LC	LE	LG	LH	LZ	S	Q		BRAKING TORQUE N·m (kg·m)	INERTIA (GD²/4) kg·m²
03BS1OE	335 (13.9)	277 (10.91)	208 (8.2)	58 (2.28)	69 (2.72)	127 (5.0)	235 (9.25)	–	112 (4.41)	92 (3.62)	145 (5.71)	110 (4.3307)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	12 (26.5)	5.88 (0.6)	0.213×10⁻⁴
06BS1OE	380 (14.96)	322 (12.68)	253 (9.97)	58 (2.28)	69 (2.72)	117 (4.61)	280 (11.02)	–	112 (4.41)	92 (3.62)	145 (5.71)	110 (4.3307)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	16 (35.3)		
09BS2OE	450 (17.72)	392 (15.43)	323 (12.73)	58 (2.28)	69 (2.72)	117 (4.61)	350 (13.78)	–	112 (4.41)	92 (3.62)	145 (5.71)	110 (4.3307)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	22 (0.8661)	40 (1.575)	23 (50.7)	8.82 (0.9)	0.9×10⁻⁴
12BS2OE	421 (16.57)	342 (13.46)	289 (11.38)	79 (3.11)	53 (2.08)	165 (6.50)	315 (12.4)	–	142 (5.59)	92 (3.62)	200 (7.87)	114.3 (4.5)	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	35 (1.3779)	76 (2.992)	30 (66.2)	35.3 (3.6)	1.56×10⁻⁴
20BS2OE	486 (19.13)	407 (16.02)	354 (13.94)	79 (3.11)	53 (2.08)	165 (6.50)	380 (14.96)	123 (4.84)	142 (5.59)	92 (3.62)	200 (7.87)	114.3 (4.5)	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	35 (1.3779)	76 (2.992)	37 (81.6)		
30BS2OE	567 (22.32)	488 (19.21)	435 (17.13)	79 (3.11)	53 (2.08)	165 (6.50)	461 (18.15)	123 (4.84)	142 (5.59)	92 (3.62)	200 (7.87)	114.3 (4.5)	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	35 (1.3779)	76 (2.992)	49 (108)		
44BS2OB	815 (32.09)	705 (27.76)	623 (24.53)	110 (4.33)	82 (3.23)	–	680 (26.77)	124 (4.88)	149 (5.87)	92 (3.62)	200 (7.87)	114.3 (4.5)	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	42 (1.6535)	110 (4.331)	80 (177)	58.8 (6)	1.47×10⁻⁴

* Not provided with an eyebolt.
† TIR: Total Indicator Reading
Notes: 1. Absolute encoder 8192 pulses/rev is used as a detector.
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Connector specifications: Refer to Table 3.7.
5. It is recommended that the motor be mounted with its connector placed down.
6. Power supply for brake is 90VDC.
7. Type USAMED-44BS2OB is for 44kW. Contact your Yaskawa representative.

(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:



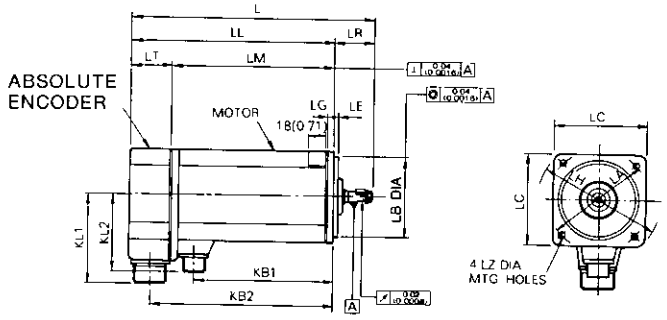
* 6 mm (0.236 in.) for USAMED-03BS2□ to 09BS2□

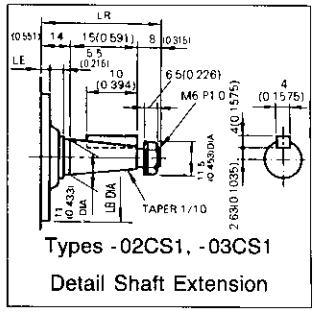
Motor Type		LR	LE	Dimensions of Shaft Extension					
Without Brake	With Brake			S	Q	QK	T	U	W
*USAMED-03BS2K	*USAMED-03BS2KE	58 (2.28)	6 (0.24)	19 (0.7480)	40 (1.57)	25 (0.98)	5 (0.1968)	3 (0.1181)	5 (0.1968)
*USAMED-06BS2K	*USAMED-06BS2KE	58 (2.28)	6 (0.24)	19 (0.7480)	40 (1.57)	25 (0.98)	5 (0.1968)	3 (0.1181)	5 (0.1968)
*USAMED-09BS2K	*USAMED-09BS2KE	58 (2.28)	6 (0.24)	22 (0.8661)	40 (1.57)	25 (0.98)	6 (0.2362)	3.5 (0.1378)	6 (0.2362)
USAMED-12BS2K	USAMED-12BS2KE	79 (3.11)	3.2 (0.13)	35 (1.3779)	76 (2.99)	60 (2.36)	8 (0.3149)	5 (0.1968)	10 (0.3937)
USAMED-20BS2K	USAMED-20BS2KE	79 (3.11)	3.2 (0.13)	35 (1.3779)	76 (2.99)	60 (2.36)	8 (0.3149)	5 (0.1968)	10 (0.3937)
USAMED-30BS2K	USAMED-30BS2KE	79 (3.11)	3.2 (0.13)	35 (1.3779)	76 (2.99)	60 (2.36)	8 (0.3149)	5 (0.1968)	10 (0.3937)
USAMED-44BS2K	USAMED-44BS2KB	110 (4.33)	3.2 (0.13)	42 (1.6535)	110 (4.33)	90 (3.54)	8 (0.3149)	5 (0.1968)	12 (0.4724)

10.1.2 F Series

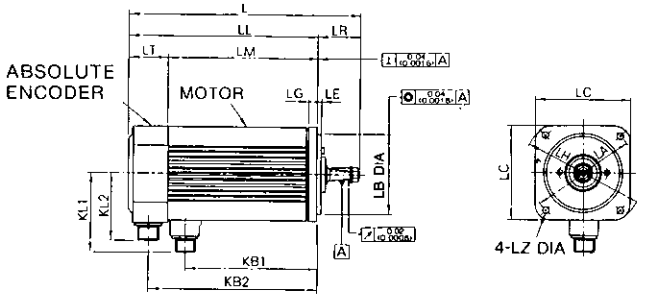
(1) Standard Type

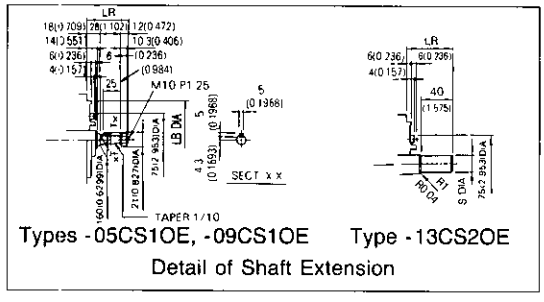
• Types USAFED-02CS1OE, -03CS1OE (Taper Shaft)



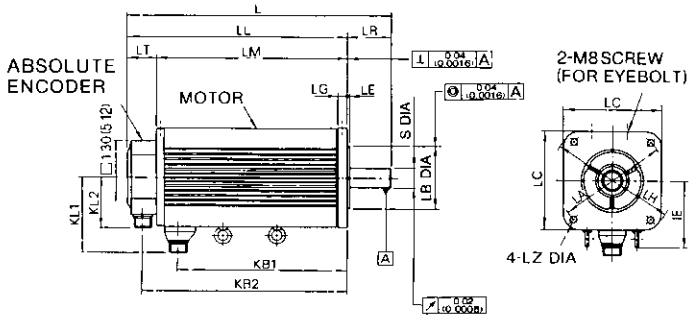


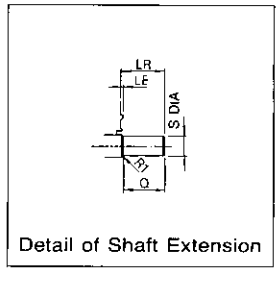
• Types USAFED-05CS1OE, -09CS1OE (Taper Shaft), -13C22 (Straight Shaft)





• Types USAFED-20CS2OE, -30CS2OE, -44CS2OE (Straight Shaft)





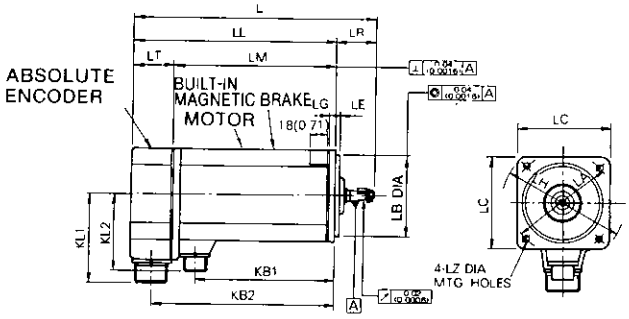
AC SERVOMOTOR Type USAFED-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension		Approx Mass kg (lb)
											LA	LB	LC	LE	LG	LH	LZ	S	Q	
02CS1*	234 (9.21)	197 (7.75)	137 (5.39)	37 (1.46)	60 (2.36)	90 (3.54)	172 (6.77)	–	76 (2.99)	87 (3.43)	100 (3.94)	80 (3.1496 $^{0}_{-0.0012}$)	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	–	–	5 (11.1)
03CS1*	280 (11.02)	243 (9.56)	183 (7.2)	37 (1.46)	60 (2.36)	136 (5.35)	218 (8.58)	–	76 (2.99)	87 (3.43)	100 (3.94)	80 (3.1496 $^{0}_{-0.0012}$)	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	–	–	7 (15.5)
05CS1*	277 (10.90)	219 (8.62)	150 (5.91)	58 (2.28)	69 (2.72)	127 (5.0)	177 (6.97)	–	109 (4.29)	92 (3.62)	145 (5.71)	110 (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	9 (19.9)
09CS1*	334 (13.14)	276 (10.86)	207 (8.16)	58 (2.28)	69 (2.72)	184 (7.24)	234 (9.21)	–	109 (4.29)	92 (3.62)	145 (5.71)	110 (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	14 (30.9)
13CS2*	403 (15.87)	345 (13.59)	276 (10.87)	58 (2.28)	69 (2.72)	253 (9.96)	303 (11.93)	–	109 (4.29)	92 (3.62)	145 (5.71)	110 (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	22 (0.8661 $^{0}_{-0.0007}$)	40 (1.57)	20 (44.1)
20CS2*	344 (13.55)	265 (10.44)	211 (8.3)	79 (3.11)	54 (2.13)	172 (6.78)	237 (9.33)	–	139 (5.47)	92 (3.62)	200 (7.88)	114.3 (4.5 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 (1.3779 $^{0}_{-0.0004}$)	76 (2.99)	22 (48.6)
30CS2	401 (15.79)	322 (12.68)	269 (10.59)	79 (3.11)	54 (2.13)	229 (9.02)	295 (11.61)	123 (4.85)	139 (5.47)	92 (3.62)	200 (7.88)	114.3 (4.5 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 (1.3779 $^{0}_{-0.0004}$)	76 (2.99)	29 (64.0)
44CS2	486 (19.14)	407 (16.02)	354 (13.93)	79 (3.11)	54 (2.13)	314 (12.36)	380 (14.96)	123 (4.85)	139 (5.47)	92 (3.62)	200 (7.88)	114.3 (4.5 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 (1.3779 $^{0}_{-0.0004}$)	76 (2.99)	41 (90.4)

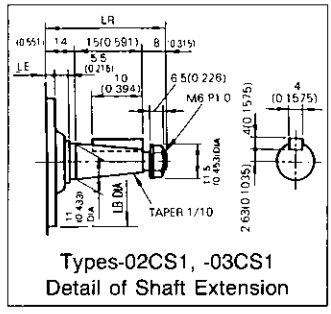
* Not Provided with an eyebolt.

Notes: 1. Absolute encoder 8192 pulses/rev is used as a detector.
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Connector specifications: Refer to Table 3.7.
5. It is recommended that the motor be mounted with its connector placed down.
6. Power supply for brake is 90VDC.

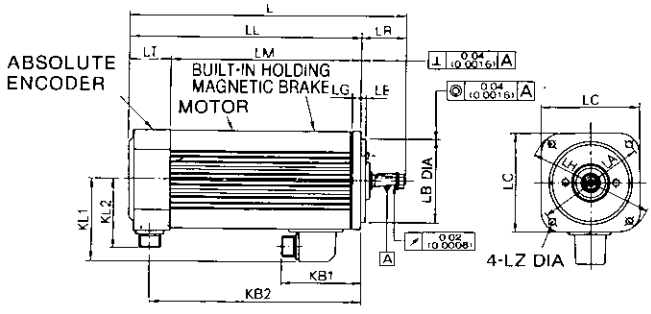
(2) With Brake

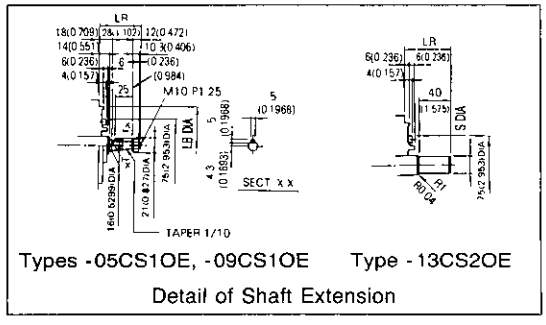
• Types USAFED-02CS1OE, -03CS1OE (Taper Shaft)



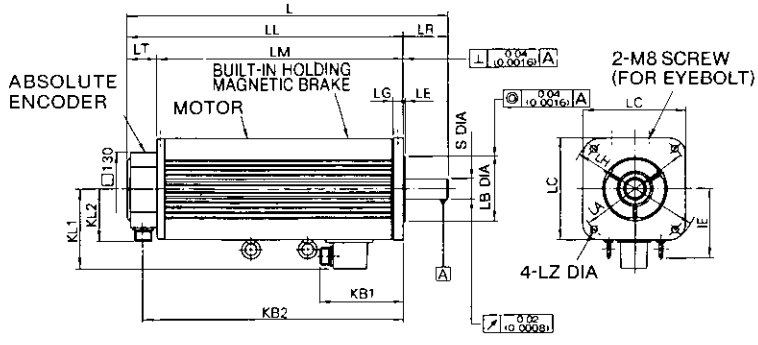


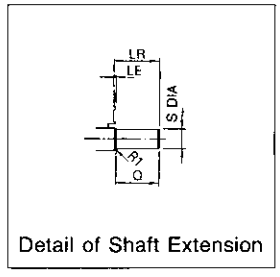
• Types USAFED-05CS1OE, -09CS1OE (Taper Shaft), -13CS2OE (Straight Shaft)





• Types USAFED-20CS2OE, -30CS2OE, -44CS2OE (Straight Shaft)



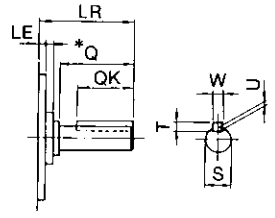


AC SERVOMOTOR Type USAFED-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension		Approx Mass kg (lb)	BRAKE	
											LA	LB	LC	LE	LG	LH	LZ	S	Q		BRAKING TORQUE N·m (kg·m)	INERTIA $\frac{GD^2}{4}$ /kg·m²
02CS1OE	280 (11.02)	243 (9.57)	183 (7.20)	37 (1.46)	60 (2.36)	24 (0.95)	178 (7.0)	–	76 (2.99)	87 (3.43)	100 (3.94)	80 (3.1496 $^{0}_{-0.012}$)	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	–	–	6 (13.3)	0.98 (0.1)	0.0188×10⁻⁴
03CS1OE	330 (12.99)	293 (11.54)	233 (9.17)	37 (1.46)	60 (2.36)	24 (0.95)	228 (8.98)	–	76 (2.99)	87 (3.43)	100 (3.94)	80 (3.1496 $^{0}_{-0.012}$)	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	–	–	7 (15.5)	1.96 (0.2)	0.113×10⁻⁴
05CS1OE	335 (13.19)	277 (10.91)	208 (8.20)	58 (2.28)	69 (2.72)	127 (5.0)	235 (9.25)	–	112 (4.41)	92 (3.62)	145 (5.71)	110 (4.3307 $^{0}_{-0.014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	12 (26.5)	5.88 (0.6)	0.213×10⁻⁴
09CS1OE	380 (14.96)	322 (12.68)	253 (9.97)	58 (2.28)	69 (2.72)	1117 (4.61)	280 (11.02)	–	112 (4.41)	92 (3.62)	145 (5.71)	110 (4.3307 $^{0}_{-0.014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	16 (35.3)		
13CS2OE	450 (17.72)	392 (15.43)	323 (12.73)	58 (2.28)	69 (2.72)	117 (4.61)	350 (13.78)	–	112 (4.41)	92 (3.62)	145 (5.71)	110 (4.3307 $^{0}_{-0.014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	22 (0.8661 $^{0}_{-0.009}$)	40 (1.57)	23 (50.7)	8.82 (0.9)	0.9×10⁻⁴
20CS2OE	421 (16.57)	342 (13.46)	289 (11.38)	79 (3.11)	53 (2.09)	165 (6.50)	315 (12.4)	–	142 (5.59)	92 (3.62)	200 (7.88)	114.3 (4.5 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 (1.3779 $^{+0.001}_{0}$)	76 (2.99)	30 (66.2)	35.3 (3.6)	1.56×10⁻⁴
30CS2OE	486 (19.13)	407 (16.02)	354 (13.94)	79 (3.11)	53 (2.09)	165 (6.50)	380 (14.96)	123 (4.85)	142 (5.59)	92 (3.62)	200 (7.88)	114.3 (4.5 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 (1.3779 $^{+0.001}_{0}$)	76 (2.99)	37 (81.6)		
44CS2OE	567 (22.32)	488 (19.21)	435 (17.13)	79 (3.11)	53 (2.09)	165 (6.50)	461 (18.15)	123 (4.85)	142 (5.59)	92 (3.62)	200 (7.88)	114.3 (4.5 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 (1.3779 $^{+0.001}_{0}$)	76 (2.99)	49 (108)		

* Not provided with an eyebolt.
† TIR: Total Indicator Reading
Notes: 1. Absolute encoder 8192 pulses/rev is used as a detector.
2. Vibration: 15μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Connector specifications: Refer to Table 3.7.
5. It is recommended that the motor be mounted with its connector placed down.
6. Power supply for brake is 90VDC.

(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:



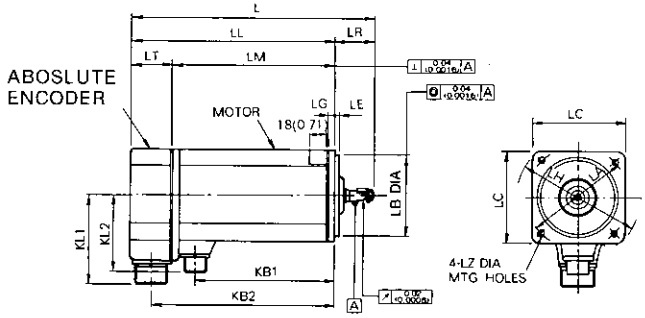
Motor Type		LR	LE	Dimensions of Shaft Extension					
Without Brake	With Brake			S	Q	QK	T	U	W
*USAFED-02CS2K	*USAFED-02CS2KE	37 (1.46)	4 (0.157)	14 (0.5512 $^{0}_{-0.011}$ $^{0}_{-0.0004}$)	25 (0.98)	15 (0.59)	5 (0.1968)	3 (0.1181)	5 (0.1968)
*USAFED-03CS2K	*USAFED-03CS2KE	37 (1.46)	4 (0.157)	14 (0.5512 $^{0}_{-0.011}$ $^{0}_{-0.0004}$)	25 (0.98)	15 (0.59)	5 (0.1968)	3 (0.1181)	5 (0 1968)
*USAFED-05CS2K	*USAFED-05CS2KE	58 (2.28)	6 (0.24)	19 (0.7480 $^{0}_{-0.013}$ $^{0}_{-0.0005}$)	40 (1 57)	25 (0.98)	5 (0.1968)	3 (0.1181)	5 (0.1968)
*USAFED-09CS2K	*USAFED-09CS2KE	58 (2.28)	6 (0.24)	19 (0.7480 $^{0}_{-0.013}$ $^{0}_{-0.0005}$)	40 (1.57)	25 (0 98)	5 (0.1968)	3 (0 1181)	5 (0.1968)
*USAFED-13CS2K	*USAFED-13CS2KE	58 (2.28)	6 (0.24)	22 (0.8661 $^{0}_{-0.013}$ $^{0}_{-0.0005}$)	40 (1.57)	25 (0 98)	6 (0.2362)	3.5 (0.1378)	6 (0.2362)
USAFED-20CS2K	USAFED-20CS2KE	79 (3.11)	3.2 (0.13)	35 (1.3379 $^{+0.01}_{+0.0004}$)	76 (2.99)	60 (2.36)	8 (0.3149)	5 (0 1968)	10 (0.3937)
USAFED-30CS2K	USAFED-30CS2KE	79 (3.11)	3.2 (0.13)	35 (1.3379 $^{+0.01}_{+0.0004}$)	76 (2.99)	60 (2 36)	8 (0.3149)	5 (0 1968)	10 (0.3937)
USAFED-44CS2K	USAFED-44CS2KB	79 (3.11)	3.2 (0.13)	35 (1.3379 $^{+0.01}_{+0.0004}$)	76 (2.99)	60 (2.36)	8 (0.3149)	5 (0.1968)	10 (0.3937)

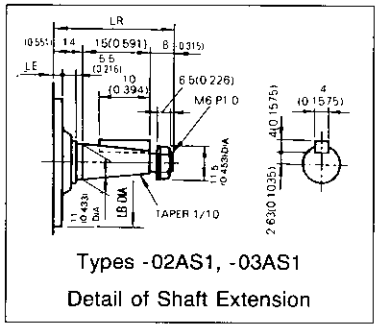
*: 4 mm (in.) for USAFED-02CS2[ ] and 03CS2[ ]
6 mm (in.) for USAFED-05CS2[ ] to 13CS2[ ]

10.1.3 G Series

(1) Standard Type

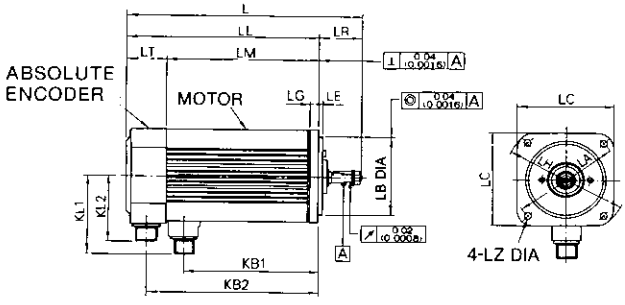
• Types USAGED-02AS1, -03AS1 (Taper Shaft)

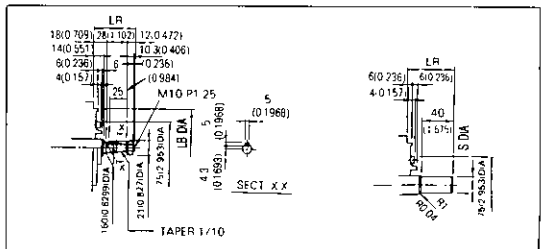




Types -02AS1, -03AS1
Detail of Shaft Extension

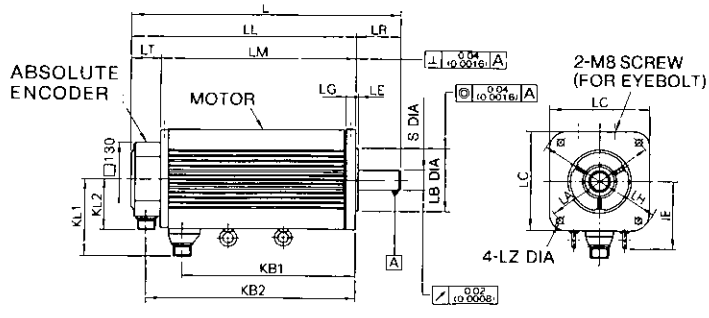
• Types USAGED-05AS1, -09AS1 (Taper Shaft), -13AS2 (Straight Shaft)

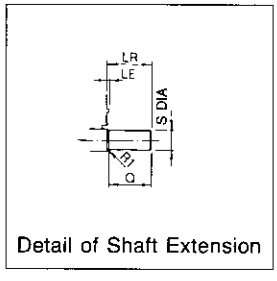




Types -05AS1, -09AS1 Type -13AS2
Detail of Shaft Extension

• Types USAGED-20AS2, -30AS2, -44AS2 (Straight Shaft)





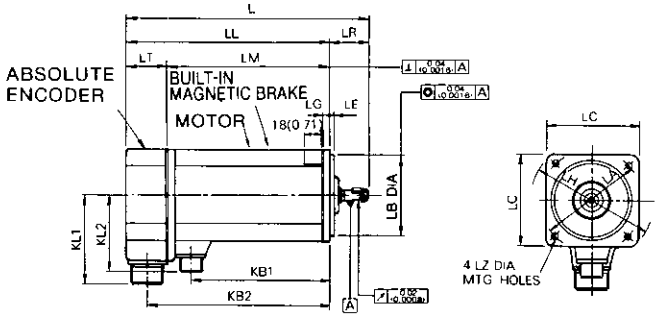
Detail of Shaft Extension

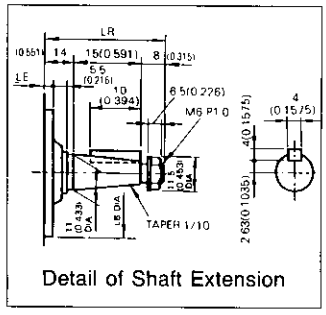
AC SERVOMOTOR Type USAGED-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension		Approx Mass kg (lb)
											LA	LB	LC	LE	LG	LH	LZ	S	Q	
02AS1*	234 (9.21)	197 (7.75)	137 (5.39)	37 (1.46)	60 (2.36)	90 (3.54)	172 (6.77)	–	76 (2.99)	87 (3.43)	100 (3.94)	80 (3.1496)	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	–	–	5 (11.1)
03AS1*	280 (11.02)	243 (9.56)	183 (7.2)	37 (1.46)	60 (2.36)	136 (5.35)	218 (8.58)	–	76 (2.99)	87 (3.43)	100 (3.94)	80 (3.1496)	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	–	–	7 (15.5)
05AS1*	277 (10.90)	219 (8.62)	150 (5.91)	58 (2.28)	69 (2.72)	127 (5.0)	177 (6.97)	–	109 (4.29)	92 (3.62)	145 (5.71)	110 (4.3307)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	9 (19.9)
09AS1*	334 (13.14)	276 (10.86)	207 (8.16)	58 (2.28)	69 (2.72)	184 (7.24)	234 (9.21)	–	109 (4.29)	92 (3.62)	145 (5.71)	110 (4.3307)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	–	–	14 (30.9)
13AS2*	403 (15.87)	345 (13.59)	276 (10.87)	58 (2.28)	69 (2.72)	253 (9.96)	303 (11.93)	–	109 (4.29)	92 (3.62)	145 (5.71)	110 (4.3307)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	22 (0.8661)	40 (1.57)	20 (44.1)
20AS2*	344 (13.55)	265 (10.44)	211 (8.3)	79 (3.11)	54 (2.13)	172 (6.78)	237 (9.33)	–	139 (5.47)	92 (3.62)	200 (7.88)	114.3 (4.5)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 (1.3779)	76 (2.99)	22 (48.6)
30AS2	401 (15.79)	322 (12.68)	269 (10.59)	79 (3.11)	54 (2.13)	229 (9.02)	295 (11.61)	123 (4.85)	139 (5.47)	92 (3.62)	200 (7.88)	114.3 (4.5)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 (1.3779)	76 (2.99)	29 (64.0)
44AS2	486 (19.14)	407 (16.02)	354 (13.93)	79 (3.11)	54 (2.13)	314 (12.36)	380 (14.96)	123 (4.85)	139 (5.47)	92 (3.62)	200 (7.88)	114.3 (4.5)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 (1.3779)	76 (2.99)	41 (90.4)

* Not provided with an eyebolt.
† TIR: Toral Indicator Reading
Notes: 1. Absolute encoder 8192 pulses/rev is used as a detector.
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Connector specifications: Refer to Table 3.8.
5. It is recommended that the motor be mounted with its connector placed down.

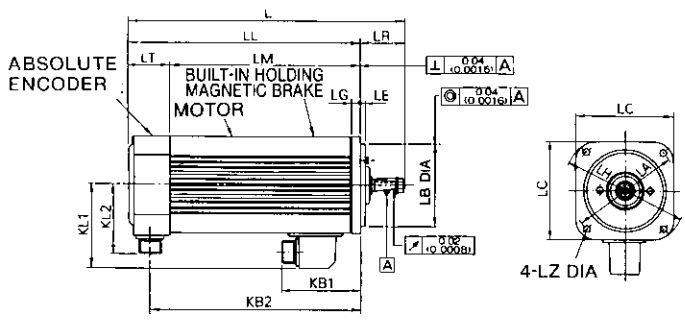
(2) With Brake

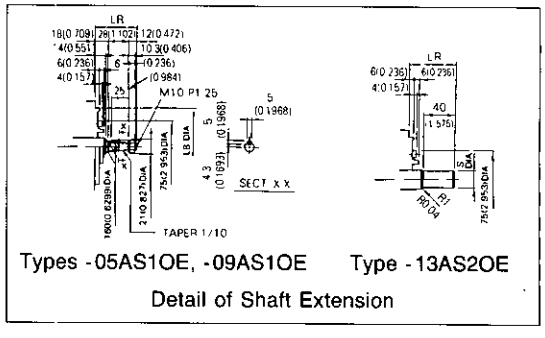
• Types USAGED-02AS1OE, -03AS1OE (Taper Shaft)



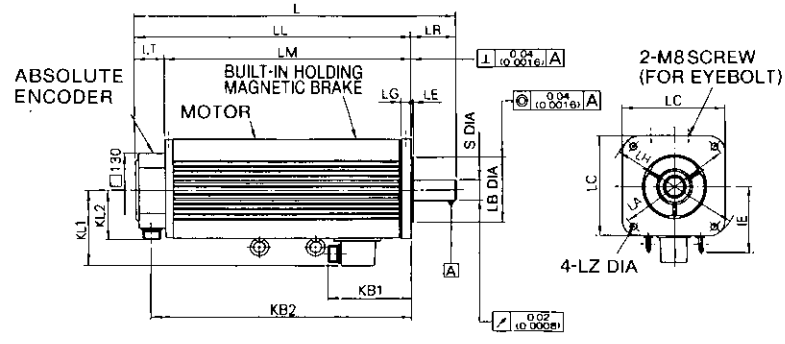


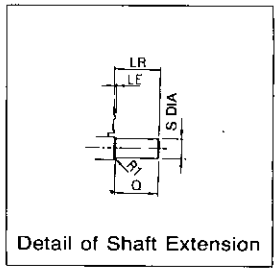
• Types USAGED-05AS1OE, -09AS1OE (Taper Shaft), -13AS2OE (Straight Shaft)





• Types USAGED-20AS2OE, -30AS2OE, -44AS2OE (Straight Shaft)





AC SERVOMOTOR Type USAGED-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension		Approx Mass kg (lb)	BRAKE	
											LA	LB	LC	LE	LG	LH	LZ	S	Q		BRAKING TORQUE N·m (kg·cm)	INERTIA GD²/4 kg·m²
02AS1OE	280 (11 02)	243 (9 57)	183 (7.20)	37 (1.46)	60 (2.36)	24 (0.95)	218 (8 58)	–	76 (2.99)	87 (3.43)	100 (3 94)	80 (3 1496)	90 (3 54)	4 (0.157)	7 (0 276)	120 (4 72)	6 6 (0 26)	–	–	6.5 (14.3)	0 98 (0.1)	0 0188 × 10⁻⁴
03AS1OE	330 (12 99)	293 (11.54)	233 (9 17)	37 (1.46)	60 (2.36)	24 (0.95)	268 (10.55)	–	76 (2.99)	87 (3.43)	100 (3 94)	80 (3 1496)	90 (3 54)	4 (0.157)	7 (0.276)	120 (4 72)	6 6 (0 26)	–	–	7.5 (16.6)	1.96 (0.2)	0 113 × 10⁻⁴
05AS1OE	335 (13.19)	277 (10 91)	208 (8.20)	58 (2 28)	69 (2.72)	127 (5 0)	235 (9.25)	–	112 (4 41)	92 (3.62)	145 (5.71)	110 (4 3307)	130 (5.12)	6 (0.24)	12 (0 47)	165 (6 5)	9 (0 35)	–	–	12 (26.5)	5.88 (0 6)	0 213 × 10⁻⁴
09AS1OE	380 (14 96)	322 (12.68)	253 (9,97)	58 (2 28)	69 (2.72)	117 (4 61)	280 (11 02)	–	112 (4 41)	92 (3.62)	145 (5 71)	110 (4.3307)	130 (5.12)	6 (0 24)	12 (0 47)	165 (6 5)	9 (0.35)	–	–	16 (35.3)		
13AS2OE	450 (17.72)	392 (15 43)	323 (12.73)	58 (2 28)	69 (2 72)	117 (4.61)	350 (13 78)	–	112 (4 41)	92 (3 62)	145 (5.71)	110 (4.3307)	130 (5 12)	6 (0 24)	12 (0 47)	165 (6 5)	9 (0 35)	22 (0.8661)	40 (1 57)	23 (50.7)	8.82 (0.9)	0.9 × 10⁻⁴
20AS2OE	421 (16.57)	342 (13 46)	289 (11 38)	79 (3.11)	53 (2.09)	165 (6 50)	315 (12.4)	–	142 (5 59)	92 (3.62)	200 (7.88)	114 3 (4.5)	180 (7 09)	3.2 (0 13)	18 (0 71)	230 (9.6)	13 5 (0 53)	35 (1 3779)	76 (2.99)	30 (66.2)	35.3 (3.6)	6.25 × 10⁻⁴
30AS2OE	486 (19.13)	607 (16.02)	354 (13 94)	79 (3.11)	53 (2.09)	165 (6.50)	380 (14.96)	123 (4 85)	142 (5.59)	92 (3.62)	200 (7.88)	114.3 (4.5)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9 6)	13.5 (0.53)	35 (1.3779)	76 (2.99)	37 (81.6)		
44AS2OE	567 (22.32)	488 (19.21)	435 (17 13)	79 (3.11)	53 (2.09)	165 (6.50)	461 (18.15)	123 (4 85)	142 (5.59)	92 (3 62)	200 (7 88)	114.3 (4.5)	180 (7.09)	3 2 (0.13)	18 (0 71)	230 (9 6)	13 5 (0.53)	35 (1 3779)	76 (2.99)	49 (108)		

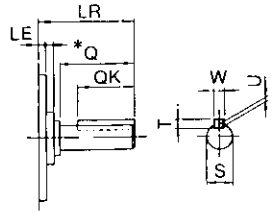
* Not provided with an eyebolt.

† TIR: Total Indicator Reading

Notes: 1. Absolute encoder 8192 pulses/rev is used as a detector.
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Connector specifications: Refer to Table 3.8.
5. It is recommended that the motor be mounted with its connector placed down.
6. Power supply for brake is 90VDC..

(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:



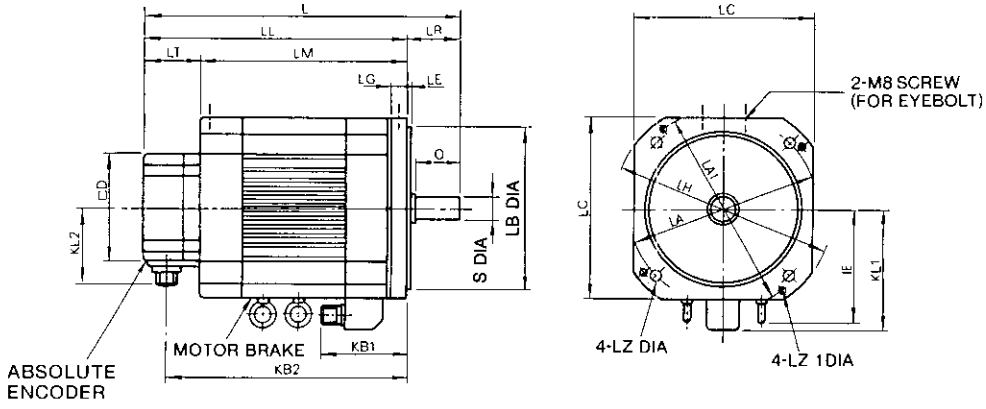
Motor Type		LR	LE	Dimensions of Shaft Extension					
Without Brake	With Brake			S	Q	QK	T	U	W
*USAGED-02AS2K	*USAGED-02AS2KE	37 (1.46)	4 (0.157)	14 (0.5512 $^{0}_{-0.011}$ $^{0}_{-0.0004}$)	25 (0.98)	15 (0.59)	5 (0.1968)	3 (0.1181)	5 (0.1968)
*USAGED-03AS2K	*USAGED-03AS2KE	37 (1.46)	4 (0.157)	14 (0.5512 $^{0}_{-0.011}$ $^{0}_{-0.0004}$)	25 (0.98)	15 (0.59)	5 (0.1968)	3 (0.1181)	5 (0.1968)
*USAGED-05AS2K	*USAGED-05AS2KE	58 (2.28)	6 (0.24)	19 (0.7480 $^{0}_{-0.013}$ $^{0}_{-0.0005}$)	40 (1.57)	25 (0.98)	5 (0.1968)	3 (0.1181)	5 (0.1968)
*USAGED-09AS2K	*USAGED-09AS2KE	58 (2.28)	6 (0.24)	19 (0.7480 $^{0}_{-0.013}$ $^{0}_{-0.0005}$)	40 (1.57)	25 (0.98)	5 (0.1968)	3 (0.1181)	5 (0.1968)
*USAGED-13AS2K	*USAGED-13AS2KE	58 (2.28)	6 (0.24)	22 (0.8661 $^{0}_{-0.013}$ $^{0}_{-0.0005}$)	40 (1.57)	25 (0.98)	6 (0.2362)	3.5 (0.1378)	6 (0.2362)
USAGED-20AS2K	USAGED-20AS2KE	79 (3.11)	3.2 (0.13)	35 (1.3779 $^{+0.01}_{0}$ $^{+0.0004}_{0}$)	76 (2.99)	60 (2.36)	8 (0.3149)	5 (0.1968)	10 (0.3937)
USAGED-30AS2K	USAGED-30AS2KE	79 (3.11)	3.2 (0.13)	35 (1.3779 $^{+0.01}_{0}$ $^{+0.0004}_{0}$)	76 (2.99)	60 (2.36)	8 (0.3149)	5 (0.1968)	10 (0.3937)
USAGED-44AS2K	USAGED-44AS2KB	79 (3.11)	3.2 (0.13)	35 (1.3779 $^{+0.01}_{0}$ $^{+0.0004}_{0}$)	76 (2.99)	60 (2.36)	8 (0.3149)	5 (0.1968)	10 (0.3937)

*: 4 mm for USAGED-02AS2[ ] and 03AS2[ ]
6 mm for USAGED-05AS2[ ] to 13AS2[ ]

10.1.4 D Series

(1) Standard Type

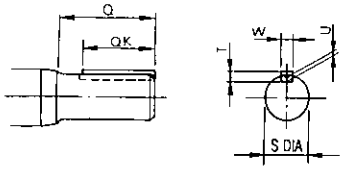
• Types USADED-05EW2OE to -37EW2OE



AC SERVOMOTOR Type USADED-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	D	Flange Surface								Shaft Extension		Approx Mass kg (lb)
												LA	LA1	LB	LC	LE	LG	LH	LZ	LZ1	S	Q	
05EW20E*	237 (9.33)	182 (7.17)	137 (5.39)	55 (2.16)	45 (1.77)	82 (3.23)	158 (6.22)	–	143 (5 63)	92 (3.62)	130 (5 12)	200 (7 87)	–	114 3 (4.5 $^{0}_{-0.001}$)	180 (7 09)	3 2 (0.126)	12 (0.472)	230 (9 06)	13 5 (0 53)	–	22 $^{0}_{-0.013}$ (0 8661 $^{0}_{-0.0005}$)	50 (1.97)	17 (16) (37.5(35 3))
10EW20E*	257 (10.12)	202 (7.96)	157 (6.18)	55 (2.16)	45 (1.77)	82 (3.23)	178 (7 0)	–	143 (5 63)	92 (3.62)	130 (5.12)	200 (7 87)	–	114.3 (4.5 $^{0}_{-0.001}$)	180 (7 09)	3.2 (0.126)	12 (0 472)	230 (9.06)	13.5 (0.53)	–	22 (0.8661 $^{0}_{-0.0005}$)	50 (1.97)	19 (18) (41.9(39.7))
15EW20E	272 (10.71)	217 (8 54)	170 (6 69)	55 (2.16)	47 (1.85)	100 (3.94)	193 (7.60)	142 (5.59)	162 (6.38)	92 (3.62)	130 (5.12)	235 (9.25)	250 (9 84)	200 $^{0}_{-0.046}$ (7.874 $^{0}_{-0.0018}$)	220 (8.66)	4 (0.157)	16 (0.63)	270 (10.63)	13.5 (0.53)	M8	28 $^{0}_{-0.013}$ (1.1024 $^{0}_{-0.0005}$)	50 (1 97)	30 (27) (66.2(59 5))
22EW20E	287 (11.30)	232 (9 13)	185 (7 28)	55 (2 16)	47 (1 85)	100 (3.94)	208 (8.19)	142 (5.59)	162 (6.38)	92 (3.62)	130 (5.12)	235 (9.25)	250 (9.84)	200 $^{0}_{-0.046}$ (7.874 $^{0}_{-0.0018}$)	220 (8.66)	4 (0.157)	16 (0 63)	270 (10.63)	13.5 (0.53)	M8	28 $^{0}_{-0.013}$ (1 1024 $^{0}_{-0.0005}$)	50 (1 97)	32 (29) (70.6(63.9))
37EW20E	347 (13 66)	282 (11 10)	235 (9.25)	65 (2.56)	47 (1.85)	100 (3 94)	251 (9 88)	142 (5.59)	162 (6.38)	92 (3.62)	130 (5.12)	235 (9.25)	250 (9.84)	200 $^{0}_{-0.046}$ (7 874) $^{0}_{-0.0018}$	220 (8.66)	4 (0 157)	16 (0.63)	270 (10.63)	13 5 (0 53)	M8	32 $^{0}_{-0.016}$ (1.2598 $^{0}_{-0.0006}$)	60 (2.36)	39 (36) (86 (79.4))

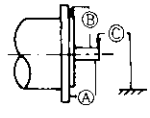
* Not provided with an eyebolt. ‡: ( ) shows without brake.
† TIR: Total Indicator Reading
Notes: 1. Absolute encoder 1024 pulses/rev is used as a detector.
2. Plug and clamp are not attached for receptacle connection.
3. It is recommended that the motor be mounted with its connector placed down.
4. Both SERVOMOTORS with brake and without brake have the same dimension.

(2) Shaft Extension of Straight with Keyway



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.

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	

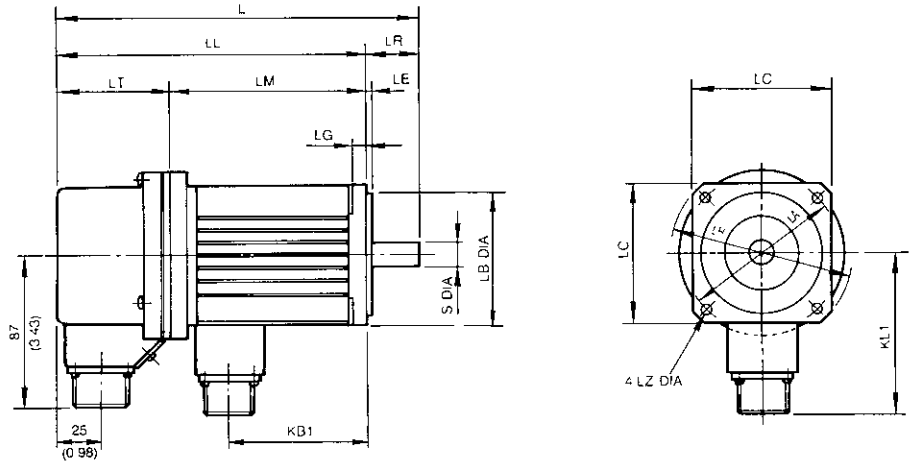
* Accuracy for motor types USADED -15EW, -22EW, and -37ES.
† T.I.R. (Total Indicator Reading)

AC SERVOMOTOR Type USADED-	Shaft Extension					
	S	Q	QK	T	U	W
05EW2K□	22 $^{0}_{-0.021}$ (0.8661 $^{0}_{-0.0008}$)	50 (1.97)	45 (1.77)	6 (0.2362)	3.5 (0.1378)	6 (0.2362)
10EW2K□	22 $^{0}_{-0.021}$ (0.8661 $^{0}_{-0.0008}$)	50 (1.97)	45 (1.77)	6 (0.2362)	3.5 (0.1378)	6 (0.2362)
15EW2K□	28 $^{0}_{-0.013}$ (1.1024 $^{0}_{-0.0005}$)	50 (1.97)	45 (1.77)	7 (0.2756)	4 (0.1575)	8 (0.3149)
22EW2K□	28 $^{0}_{-0.013}$ (1.1024 $^{0}_{-0.0005}$)	50 (1.97)	45 (1.77)	7 (0.2756)	4 (0.1575)	8 (0.3149)
37EW2K□	32 $^{0}_{-0.016}$ (1.2598 $^{0}_{-0.0006}$)	60 (2.36)	50 (1.97)	8 (0.3150)	5 (0.1969)	10 (0.3937)

10.1.5 S Series

(1) Standard Type

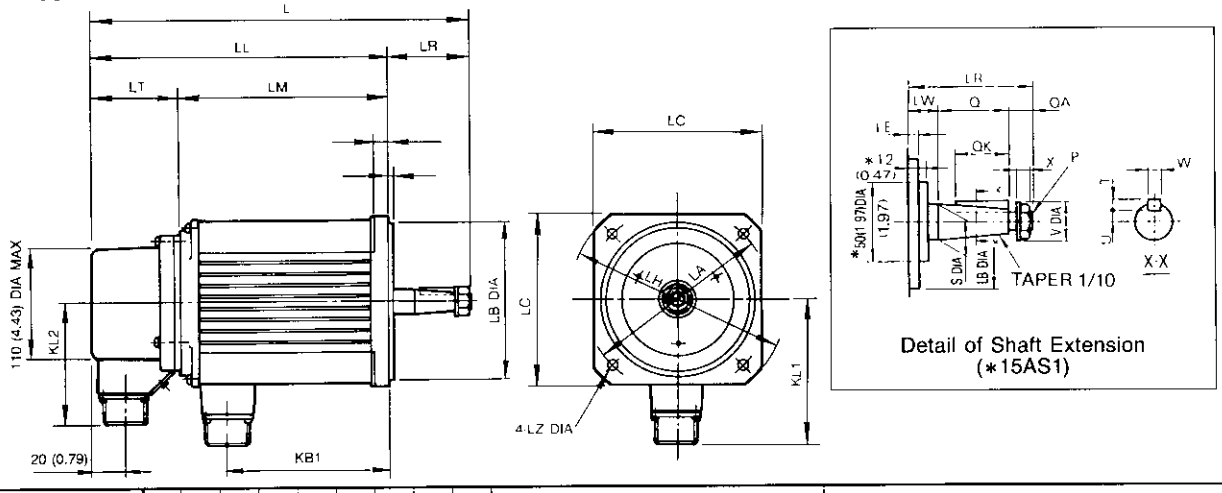
• Types USASEM-03AS2, -05AS2 (Straight Shaft)



AC SERVOMTOR Type USASEM-	L	LL	LM	LT	LR	KB1	KL1	Flange Surface and Shaft Extension								Approx Mass kg (lb)
								LA	LB	LC	LE	LG	LH	LZ	S	
03AS2	208 (8.19)	178 (7.01)	114 (4.49)	64 (2.52)	30 (1.18)	79 (3.11)	91 (3.58)	90 (3.54)	70 (2.7559 $^{0}_{-0.030}$)	80 (3.15)	3 (0.118)	8 (0.31)	105 (4.13)	6 (0.236)	14 (0.5512 $^{0}_{-0.011}$)	3.2 (7.1)
05AS2	230 (9.06)	200 (7.87)	136 (5.35)	64 (2.52)	30 (1.18)	101 (3.98)	91 (3.58)	90 (3.54)	70 (2.7559 $^{0}_{-0.012}$)	80 (3.15)	3 (0.118)	8 (0.31)	105 (4.13)	6 (0.236)	14 (0.5512 $^{0}_{-0.011}$)	3.8 (8.4)

Notes: 1. Absolute encoder 8192 pulses/rev is used as a detector.
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. It is recommended that the motor be mounted with its connector placed down.

• Types USASEM-08AS1, -15AS1, -30AS1 (Taper Shaft)



AC SERVOMOTOR Type USASEM-	L	LL	LM	LT	LR	KB1	KB2	KL1	KL2	Flange Surface								Shaft Extension									Approx Mass kg (lb)
										LA	LB	LC	LE	LG	LH	LZ	LW	Q	QK	QA	X	S	V	P	U	W	T	
08AS1	270.5 (10.65)	212.5 (8.37)	148.5 (5.85)	64 (2.52)	58 (2.28)	115 (4.53)	187.5 (7.38)	103 (4.06)	87 (3.43)	130 (5.12)	110 ($^{0}_{-0.035}$) (4.3307 $^{0}_{-0.0014}$)	120 (4.72)	3 (0.12)	10 (0.4)	155 (6.1)	9 (0.35)	18 (0.71)	28 (1.1)	25 (0.98)	12 (0.47)	10 (0.39)	16 (0.63)	21 (0.83)	M10 P1.25	4.3 (0.169 $^{0}_{-0.018}$)	5 (0.1968)	5 (0.1968)	6.3 (13.9)
15AS1	325.5 (12.81)	267.5 (10.53)	203.5 (8.02)	64 (2.52)	58 (2.28)	166.5 (6.56)	242.5 (9.55)	110 (4.33)	87 (3.43)	145 (5.71)	110 ($^{0}_{-0.035}$) (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	18 (0.71)	28 (1.1)	25 (0.98)	12 (0.47)	10 (0.39)	19 (0.75)	21 (0.83)	M10 P1.25	5.8 (0.228 $^{0}_{-0.018}$)	5 (0.1968)	5 (0.1968)	11.5 (25.4)
30AS1	374 (14.72)	304 (11.97)	240 (9.45)	64 (2.52)	70 (2.76)	206 (8.11)	279 (10.98)	136 (5.35)	87 (3.43)	200 (7.87)	114.3 ($^{0}_{-0.035}$) (4.5 $^{0}_{-0.0014}$)	180 (7.09)	6 (0.24)	18 (0.71)	230 (9.1)	13.5 (0.53)	20 (0.79)	36 (1.42)	32 (1.26)	14 (0.55)	12.5 (0.49)	22 (0.87)	24 (0.94)	M12 P1.25	6.6 (0.26 $^{0}_{-0.018}$)	6 (0.2362)	6 (0.2362)	24.5 (54.1)

Notes: 1. Absolute encoder 8192 pulses/rev is used as a detector.
2. Vibration: 15μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Use hexagon socket head cap screw as flange-mounted bolt.
5. It is recommended that the motor be mounted with its connector placed down.
6. Dimensions of the shaft extension key and keyway are based on JIS (Japaneese Industrial Standard) B 1301 "Sunk Keys and Their Corresponding Keyways (Normal keys)" Shaft extension key is furnished.

(2) With Brake

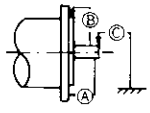
• Types USASEM-03AS2OB, -05AS2OB

Motor Type	L	LL	LM	BRAKE		Approx Mass kg (lb)
				INERTIA $\left(\frac{GD^2}{4}\right)$ kg•m²	BRAKING TORQUE N•m (kg•m)	
USASEM-03AS2OB	251 (9.88)	221 (8.70)	107 (4.21)	0.0825×10^{-4}	0.98 (0.1)	3.9 (8.6)
USASEM-05AS2OB	273 (10.75)	243 (9.57)	129 (5.08)	0.0825×10^{-4}	1.764 (0.18)	4.5 (9.9)

• Types USASEM-08AS1OB, -15AS1OB, -30AS1OB

Motor Type	L	LL	LM	BRAKE			Approx Mass kg (lb)
				INERTIA $\left(\frac{GD^2}{4}\right)$ kg•m²	BRAKING TORQUE N•m (kg•m)	Voltage V	
USASEM-08AS1OB	314 (12.36)	256 (10.08)	146 (5.75)	0.5368×10^{-4}	2.94 (0.3)	DC90	7.5 (16.6)
USASEM-15AS1OB	385.5 (15.18)	327.5 (12.89)	197.5 (7.78)	0.875×10^{-4}	5.88 (0.6)	DC90	13 (28.7)
USASEM-30AS1OB	440 (17.32)	370 (14.57)	240 (9.45)	0.672×10^{-4}	11.76 (1.2)	DC90	26 (57.4)

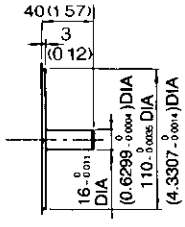
Mechanical Specifications in mm

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

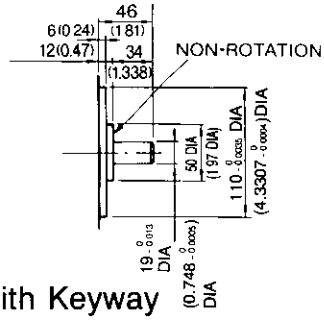
† T.I.R. (Total Indicator Reading)

(3) Shaft Extension of Straight

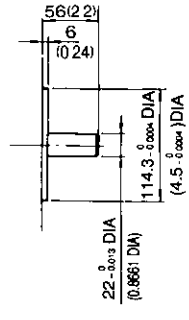
Type USASEM-08A



Type USASEM-15A

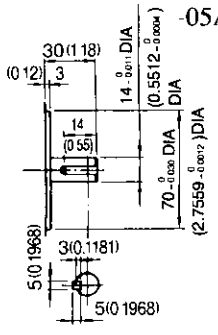


Type USASEM-30

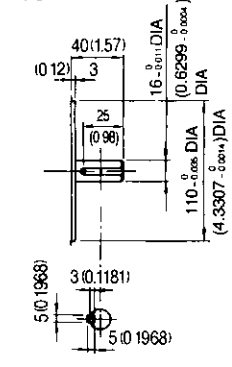


(4) Shaft Extension of Straight with Keyway

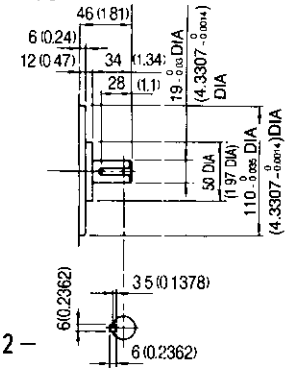
Types USASEM-03A, -05A



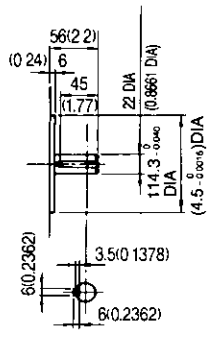
Type USASEM-08A



Type USASEM-15A

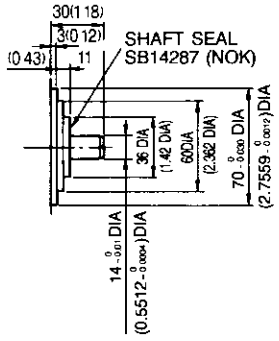


Type USASEM-30A



(5) Shaft Extension of Straight with Shaft Seal

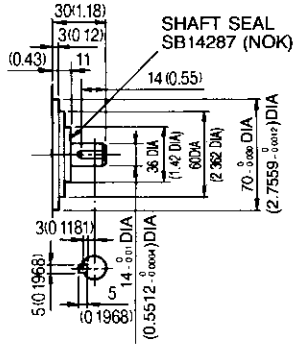
Types USASEM-03A, -05A



Note: Proper dimensions comply with standard dimensions.

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

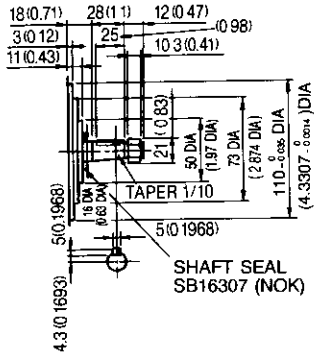
Types USASEM-03, -05A



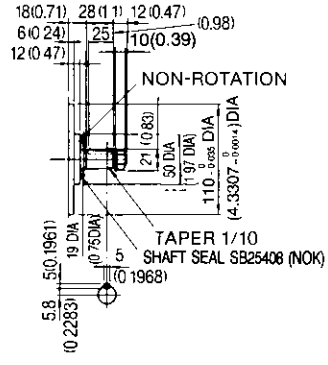
Note: Proper dimensions comply with standard dimensions.

(7) Shaft Extension of Taper with Shaft Seal

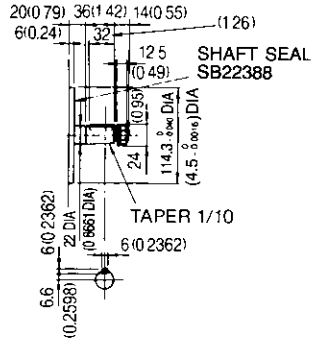
Type USASEM-08A



Type USASEM-15A



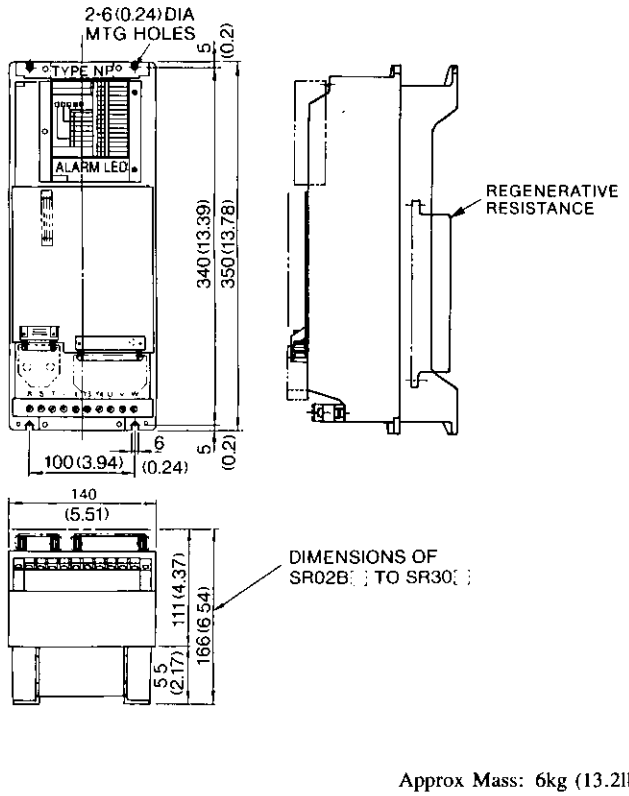
Type USASEM-30A



Note: Proper dimensions comply with standard dimensions.

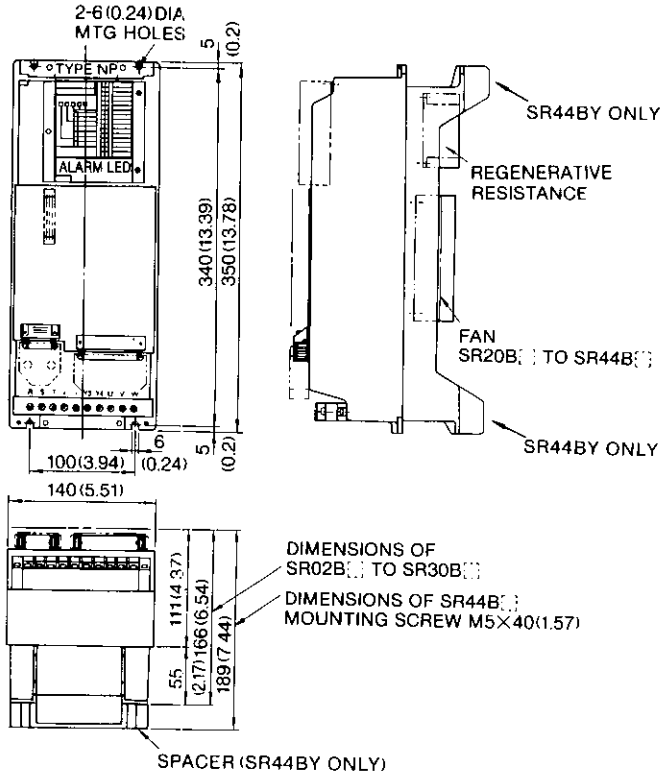
10.2 SERVOPACK

Types CACR-SR03BY to SR15BY



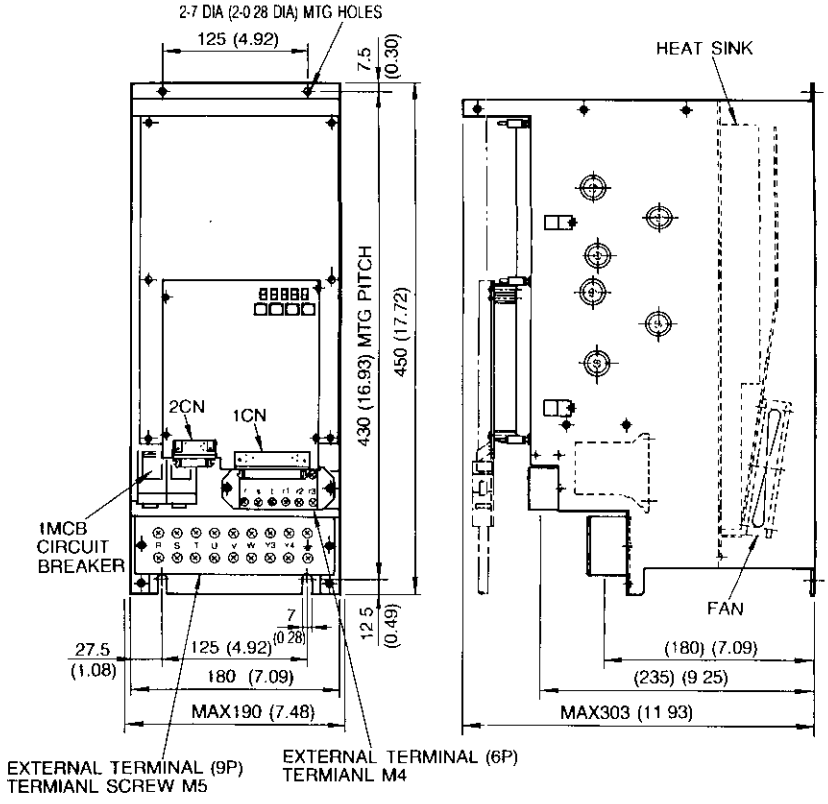
Approx Mass: 6kg (13.2lb)

Types CACR-SR20BY to SR44BY



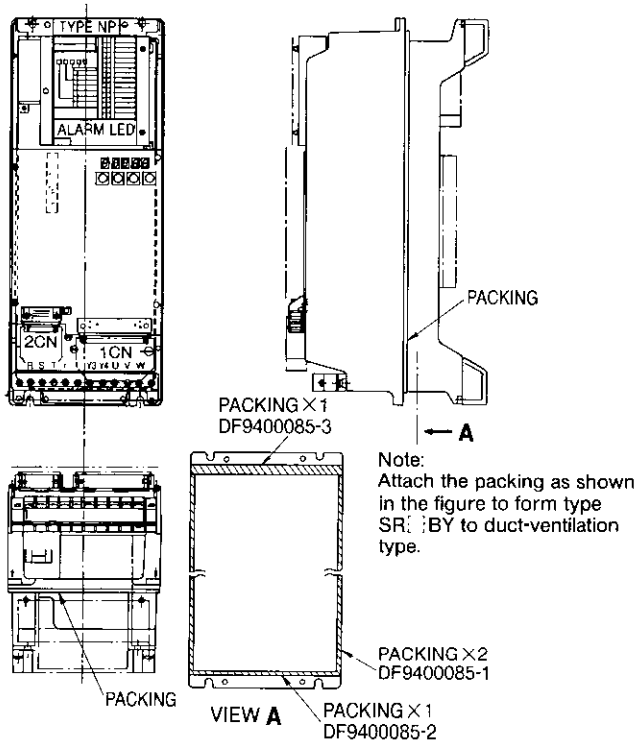
Approx Mass: 7kg (15.4lb)

Types CACR-SR60BY

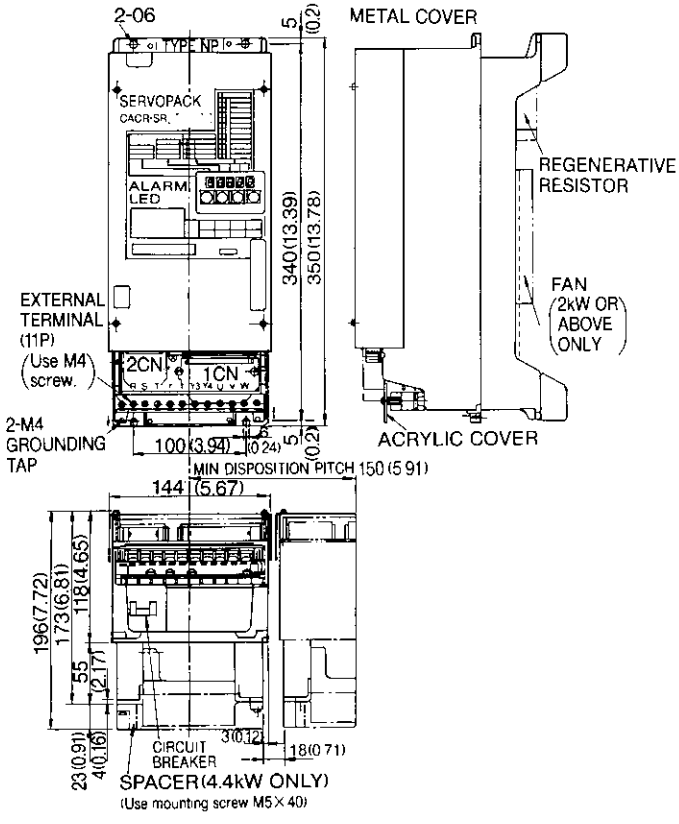


Approx Mass: 13.5kg (29.8lb)

Type CACR-SR□BY1□□-P



Type CACR-SR□BY1□□-C

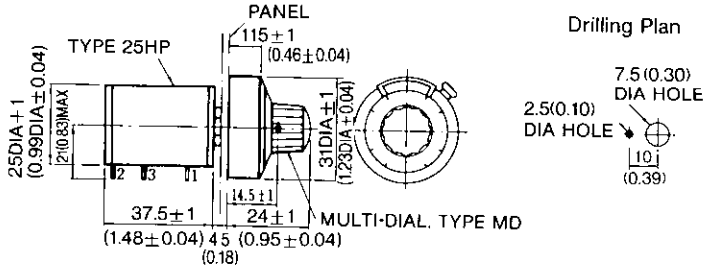


Approx Mass kg (lb)

SR02 to 30BY	SR44BY
6.5 (14.3)	7.5 (16.6)

10.3 PERIPHERAL EQUIPMENT in mm (inches)

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

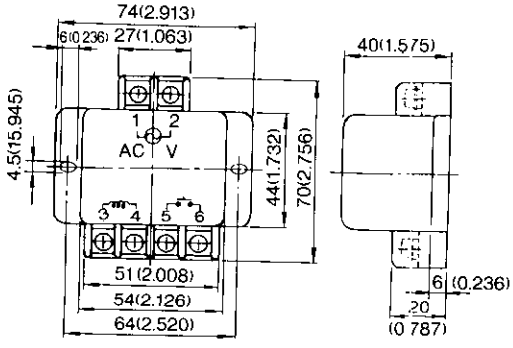


(2) Power Supply for Brake

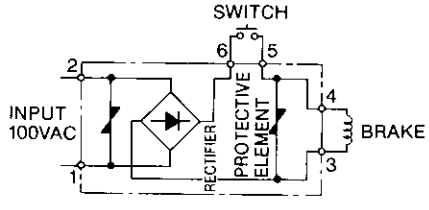
According to the motor, select 100V/200V power supply for brake.

Power Supply for Brake (for M,F,G,D,S Series)

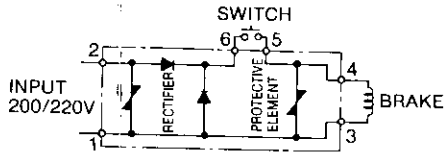
- Input 100VAC, Output 90VDC (Type OPR109F) 0.4ADC Max.
- Input 200VAC, Output 90VDC (Type OPR109A) 0.4ADC Max.



- Type OPR109F Internal Circuit



- Type OPR109A Internal Circuit

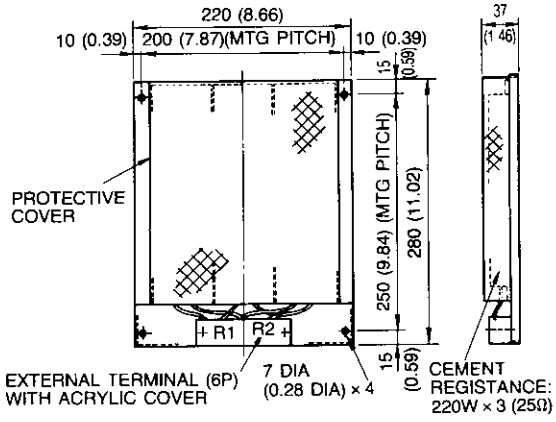


Notes:

1. Do not short-circuit between ouput 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 or output side to protect the power unit.

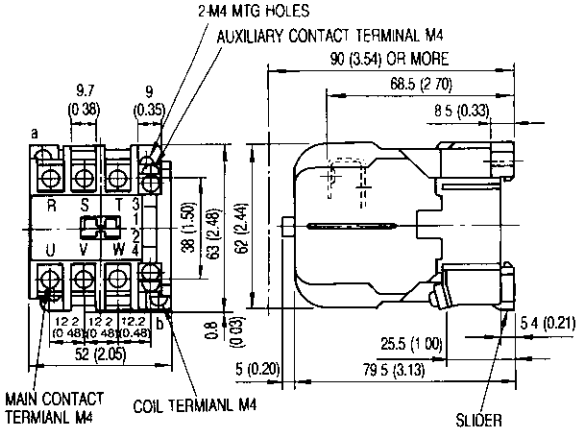
• Peripheral Devices

(3) Registor Unit Type JUSP-RA03 (for Type CACR-SR60BY)



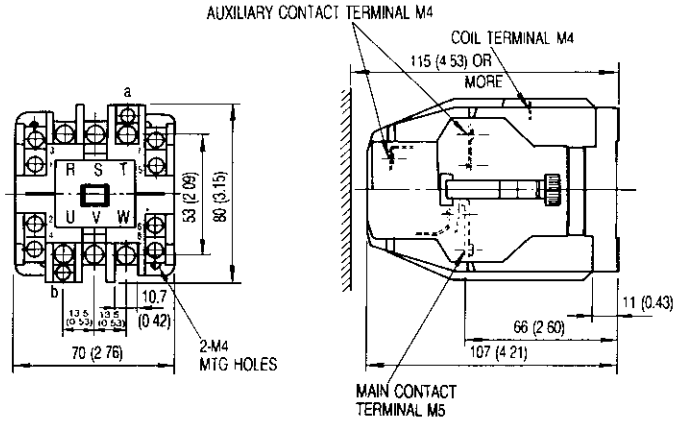
(4) Magnetic Contactor for Power ON/OFF

(a) HI-16E5



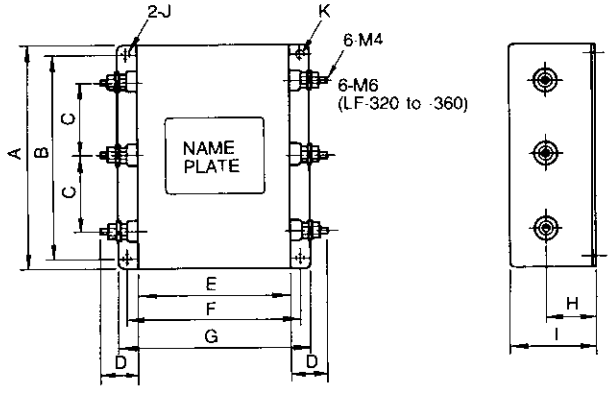
Mass: 0.33kg (0.78lb)

(b) HI-25E



Mass: 0.75kg (1.65lb)

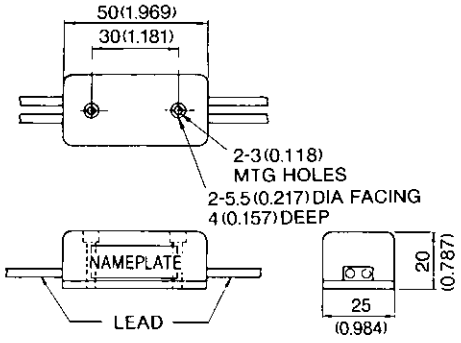
(5) Recommended Noise Filter (Mode by Tokin Corp.)



in mm (inches)

	A	B	C	D	E	F	G	H	I	J	K
LF-305	120 (4.72)	110 (4.33)	40 (1.57)	25 (0.98)	80 (3.15)	95 (3.74)	110 (4.33)	25 (0.98)	45 (1.77)	4.5 × 7 (0.18 × 7)	4.5 DIA (0.18 DIA)
LF-310	180 (7.09)	170 (6.69)	60 (2.36)	25 (0.98)	120 (4.72)	135 (5.31)	150 (5.91)	35 (1.38)	65 (2.56)	4.5 × 7 (0.18 × 7)	4.5 DIA (0.18 DIA)
LF-315	180 (7.09)	170 (6.69)	60 (2.36)	25 (0.98)	120 (4.72)	135 (5.31)	150 (5.91)	35 (1.38)	65 (2.56)	4.5 × 7 (0.18 × 7)	4.5 DIA (0.18 DIA)
LF-320	180 (7.09)	170 (6.69)	60 (2.36)	29 (1.14)	120 (4.72)	135 (5.31)	150 (5.91)	35 (1.38)	65 (2.56)	4.5 × 7 (0.18 × 7)	4.5 DIA (0.18 DIA)
LF-330	180 (7.09)	170 (6.69)	60 (2.36)	29 (1.14)	120 (4.72)	135 (5.31)	150 (5.91)	35 (1.38)	65 (2.56)	4.5 × 7 (0.18 × 7)	4.5 DIA (0.18 DIA)
LF-340	180 (7.09)	160 (6.30)	50 (1.97)	30 (1.18)	200 (7.87)	220 (8.66)	240 (9.45)	40 (1.57)	80 (3.15)	6.5 × 9 (0.26 × 9)	6.5 DIA (0.26 DIA)
LF-350	180 (7.09)	160 (6.30)	50 (1.97)	30 (1.18)	200 (7.87)	220 (8.66)	240 (9.45)	40 (1.57)	80 (3.15)	6.5 × 9 (0.26 × 9)	6.5 DIA (0.26 DIA)

- Power Supply for Brake (for S Series)
  - Input 100VAC Output 90VDC 0.2ADC Max. (DP8401002-2)
  - Input 200VAC Output 90VDC 0.2ADC Max. (DP8401002-1)

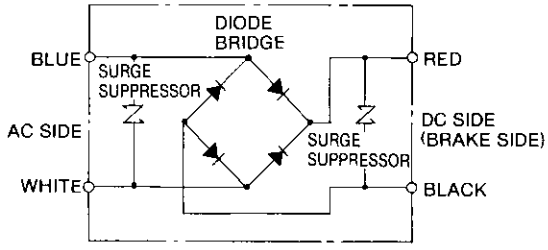


- Lead length: each 500 mm (19.69 inches.)
- Lead Color:

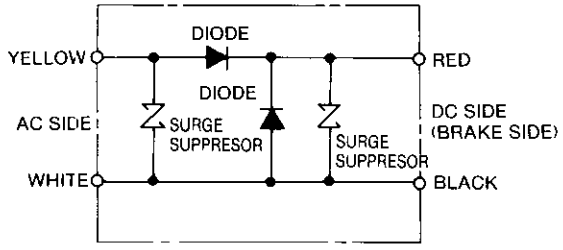
AC Input Side		Brake Side
100V	200V	
Blue White	Yellow White	Red Black

- Max Ambient Temp: 60°C.

- 100VAC Internal Circuit



- 200VAC Internal Circuit



Note:
Open/close of brake power supply circuit is possible at AC and DC sides. Normally safety operation is more available at AC side. If the circuit is opened/closed at DC side, provide surge suppressor near brake coil otherwise the brake coil might be destroyed.

11. TEST RUN

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

11.1 CHECK ITEMS BEFORE TEST RUN

11.1.1 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 motor is properly lubricated.

11.1.2 Servopack

- Parameters are correctly set to satisfy the specifications for the applicable SERVOMOTOR and optical encoer.
- 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 $^{+10}_{-15}$ %.
- The speed reference should be 0V.
- The SERVOPACK MCCB is turned ON.
- Never perform voltage test or insulation resistance test.

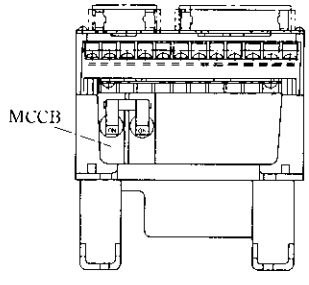


Fig. 11.1 Position of MCCB

11.2 TEST RUN PROCEDURES

11.2.1 Preparation of Operation

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

(1) Power ON

After checking items in Par. 6.1, turn ON the power supply. When the power ON sequence is correct, according to Par 6.1, the power is turned ON by depressing the POWER pushbutton for approximately 1 second.

(2) If power is supplied normally, the following five figures [LED] s light:
(LED indicates the motor is stopped)

(3) By turning ON the "SEN" signal, the power supply is provided for the absolute encoder.

(4) When a S-ON signal is input (contact is ON), the power circuit in the SERVOPACK operats and the motor is ready to run. (LED indicates the motor is stopped.)

11.2.2 Operation

The operation is possible only while S-ON signal is ON.

(1) Increase the speed reference voltage gradually from 0V, then the motor will rotate at a speed proportional to the reference voltage.

(2) When the reference voltage is positive, the motor rotates forward (counterclockwise rotation when viewed from the shaft extension.) (Fig. 11.2)

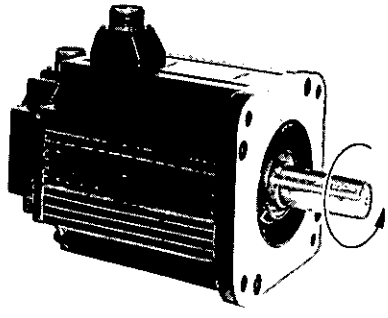


Fig. 11.2 Motor Forward Running

11.2.3 Inspection during Test Run

The follwing items should be checked during the test run.

- Unusual vibration
- Abnormal noise
- Excessive temperature rise

If any fault is found, take corrective actions according to Par. 14. At a test operation, the load and machine may not fit well at first and result in overload.

11.2.4 Absolute Encoder Setup

Setup is an operation required to store the machine zero point or reference point with the absolute encoder mounted on the machine.

Refer to Pars. 6.4.4 (8) and 6.4.5 (9) for the setup method.

12. ADJUSTMENT

12.1 CHARACTERISTICS PRESET AT THE FACTORY PRIOR TO SHIPMENT

The SERVOPACK has been factory-adjusted as follows:

(1) Speed reference input-SERVOMOTOR speed ratio (no load) (Fig. 12.1)

Condition: No load

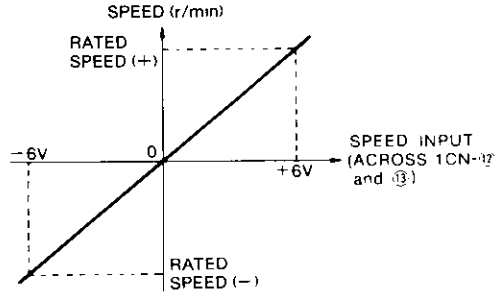


Fig. 12.1 Speed Reference Input-SERVOMOTOR Speed Ratio

(2) Speed Regulation (Fig. 12.2)

Speed regulation ΔN, Δn

$$\frac{\Delta N}{N_R} \times 100\ \% \leqq 0.01\ \%$$

$$\frac{\Delta n}{N_R} \times 100\ \% \leqq 0.01\ \%$$

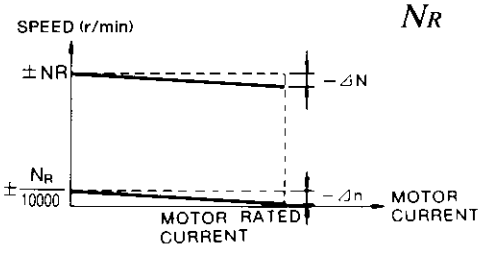


Fig. 12.2 Speed Regulation

(3) Start-stop response characteristics (Fig. 12.3)

Ip: Start current set value in Table 12.1. The overshoot (⊿Nov) and undershoot (⊿NUD) when $J_L = J_M$, are as shown in Table 12.1 (adjustment level preset at the factory).

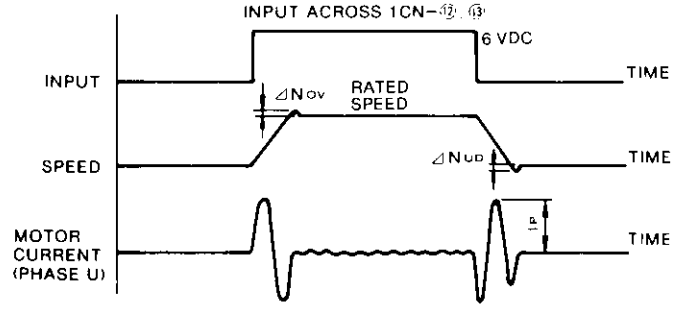


Fig. 12.3 Start-Stop Response Characteristics

Table 12.1 Overshoot and Undershoot at Step Response

Type CACR-	$N_{OV}/N_R \times 100$	$N_{UD}/N_R \times 100$
SR02BY	5 % max	5 % max
SR03BY		
SR05BY		
SR07BY		
SR10BY		
SR15BY		
SR20BY		
SR30BY		
SR44BY		
SR60BY		

12.2 RESET

The SERVOPACK has been adjusted at the factory to obtain optimum characteristics, and readjustment is normally unnecessary. If resetting of parameters is necessary depending on the use, reset the SERVOPACK referring to Par.8, "MONITOR PANEL OPERATION". (Do not tamper with potentiometers.)

13. INSPECTION AND MAINTENANCE

13.1 AC SERVOMOTOR

The AC SERVOMOTOR has no wearing parts (eg. brushes), so simple daily inspection is sufficient. The inspection schedule for the motor is shown in Table 13.1.

Do not disassemble the motor. If disassembly should become necessary, contact your YASKAWA representative.

Table 13.1 Inspection Schedule for Motors

Inspection Item	Frequency	Inspection Operation
Vibration	Daily	Touch by hand.
Noise	Daily	Aurally
Exterior and Cleaning	As required	Clean with dry cloth or compressed air.
Insulation Resistance	Annually	Make sure that it is more than 10MΩ by measuring with a 500V megger after disconnecting the motor from the controller.
Shaft Seal	Every 5000 hours	Replace shaft seal.
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.

13.2 SERVOPACK

The SERVOPACK does not require any special maintenance. Remove dust and tighten screws periodically.

Since user constants are returned to the standard setting prior to shipping for SERVOPACKS overhauled in YASKAWA, check the user constants before operation.

13.3 PRECAUTIONS FOR BATTERY REPLACEMENT

Replace the absolute encoder battery (supplied by user) as described below. Lithium battery (ER6C) has approx. a 10-year service lifetime.

① Turn ON the SERVOPACK power supply and keep the SEN signal in high level for three minutes or more. (The capacitor in the encoder is charged.)

② Replace the battery. (SERVOPACK power supply can be turned ON or OFF.)
In the above-mentioned way, the battery can be replaced with the encoder rotation data retained.
(By step ①, the encoder can operate normally within four days without battery.)

14. TROUBLESHOOTING GUIDE

14.1 SERVOMOTOR

WARINING

Remedies in [ ] should be practiced after turning OFF the power.

Table 14.1 Troubleshooting Guide for AC Servomotor

Trouble	Cause	What to do
Motor does not start.	Loose connection	Tighten connection.
	Wrong wiring	Correct wiring.
	Overload	Reduce load or use a larger motor.
Unstable operatin	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 with driven machine.
	Coupling out of balance	Balance coupling.
	Noisy bearings	Check alignment, noise of bearing, lubrication and contact your YASKAWA representative.
	Vibration of driven machine	Contact the machine manufacturer.

[ ] : Perform after turing OFF power supply.

14.2 SERVOPACK

14.2.1 LED Indication (7-segment) for Troubleshooting

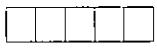
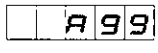
Table 14.2 LED Indication for Troubleshooting

LED Detection	Lighting Condition	Probable Cause	Corrective Action
A.10	Goes ON when power is supplied to the control circuit.	Defective control circuit board (1 PWB).	• Repalce the SERVOPACK.
Overcurrent or Overheat	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.	• Defective main circuit transistor module.	• Replace the SERVOPACK.
	Goes ON during operation. • When power to the control circuit is turned OFF and then turned ON again. When reset later, the operation starts.	• Fan has stopped.	• Check the fan. (SR20, 30, 44)
		• Temperature around the SERVOPACK exceeds 55°C.	• Decrease the temperature below 55°C (The heat sink may be overheated.)
A.20	Goes ON when power is supplied to the control circuit.	• Defective control circuit board (1PWB). (MCCB is ON status.)	• Replace the SERVOPACK.
Circuit protector tripped	Goes ON when power is supplied to the main circuit.	• Defective main circuit thyristor diode module.	• Replace the SERVOPACK.
		• MCCB trips.	• Replace the SERVOPACK.
		• MCCB is not turned own.	• Turn on MCCB.
A.30	Goes ON when power is supplied to the conol circuit.	• Defective control circuit board. (1 PWB).	• Replace the SERVOPACK.
Regenerative trouble	Goes ON approximate 0.5 to 1 second after power is supplied to the main circuit.	• Defective regenerative transistor.	• Replace the SERVOPACK.
		• Regenerative resistor disconnection.	• Check and replace the regenerative resistor. (Replace the SERVOPACK.)
A.40	Goes ON when the motor accelerates or decelerates.	• Load inertia $J_L(GD^2)$ too large.	• Check the inertia of the machine with the value converted to the motor shaft.
Overvoltage		• Defective regenerative circuit.	• Replace the SERVOPACK.
A.51	When the reference is input, the motor runs fast and LED goes ON.	• Motor connection error. • Absolute encoder connection error. • Improper gain adjustment	• Correct the motor connection. • Check pulses in phases A,B,C on 2CN and correct wiring.
A.52	When the reference is input, the motor runs fast and LED goes ON.	• The reference input voltage too large.	• Decrease the reference input voltage.
Overspeed reference detection			
A.60	Goes ON when power is supplied to the main circuit.	• Defective main circuit thyristor-diode module.	• Replace the SERVOPACK.
Undervoltage			
A.71	Goes ON during operation. • When power to the control circuit is turned OFF and then turned ON again, the operation starts.	• Operation with more of the rated torque for a number of seconds.	• Check for overload and adjust as necessary.
Overload	Goes ON when power is supplied to the control circuit.	• Defective control circuit board (1PWB)	• Replace the SERVOPACK.
A.72	The motor rotates, but the torque is unavailable. When power to the control circuit is turned OFF and then turned ON again, the operation starts, but the torque is still unavailable.	• Motor circuit error connection, such as U → V, V → W, W → V or signle-phase connection.	• Check for overload and adjust as necessary. • Correct wiring U→A, V→B, W→C.
Overload			

Table 14.2 LED Indication for Troubleshooting (Cont'd)

LED Detection	Lighting Condition	Probable Cause	Corrective Action
A.80 Encoder error	Goes ON during operation.	• Erroneous wiring or incomplete contact of the absolute encoder.	• Check and correct signal cables of phases A, B and C of 2CN.
		• Malfuction of the SERVOPACK pulse counter.	• Turn OFF the SEN signal to reset the alarm. The turn it ON again. • Provide preventive action for nosie.
*1 A.81 Backup error	Goes ON after SEN signal is input.	• Absolute encoder backup voltage dropped.	• Set the absolute encoder.
*1 A.82 Checksum error	Goes ON after SEN signal is input.	• Absolute encoder memory data check error.	• Set the absolute encoder.
*1 A.83 Battery alarm	Goes ON after SEN signal is input.	• Absolute encoder battery voltage dropped.	• Replace the battery and enter the SEN signal twice.
*1 A.85 Overspeed	Goes ON after SEN signal is input.	• The motor is running when the SEN signal is input.	• Enter the SEN signal when the motor stops.
A.b1 Read-in error	Goes ON during motor operation.	• Malfunction of external current limit read-in section.	• Resume after reset operation.
		• Fault of external current limit read-in section.	• Replace the SERVOPACK.
A.b2 Read-in error	Goes ON during motor operation.	• Malfunction of reference read-in section.	• Resume after reset operation.
		• Fault of reference read-in section.	• Replace the SERVOPACK.
A.C1 Overrun detection	Goes ON when the motor starts and rotates for a moment.	• Motor connection error	• Correct the motor connection.
		• Optical encoder connection error, disconnection.	• Correct the optical encoder connection.
A.C3 Phase PA, PB disconnection	Goes ON when the motor starts and rotates for a moment.	• Phase-A and -B of optical encoder disconnection (PA, PB)	• Correct the optical encoder signal line.
A.C4 Phase PC disconnection	Goes ON when the motor starts and rotates for a moment.	• Phase-C of optical encoder disconnection (PC).	• Correct the optical encoder signal line.
A.F1	Goes ON when power is supplied to the main circuit.	• Open phase of power supply.	• Check the main circuit power supply.
A.F2	Goes ON when power is supplied to the main circuit.	• Large distortion of power supply.	• Check the main circuit power supply.
*2 A.00	Goes ON by SEN signal ON.	• Malfunction of absolute encoder.	• Turn ON the SEN signal again. • Set the absolute encoder.
		• Wrong wiring of absolute encoder.	• Correct absolute encoder wiring.
A.02 Parameter breakdown	Goes ON when power is supplied to the control circuit.	• Defective control circuit board. (1PWB, 2PWB)	• Replace the SERVOPACK.
A.03	Goes ON when power is supplied to the control circuit.	• Defective control circuit board. (1PWB, 2PWB)	• Replace the SERVOPACK.
Defective main circuit section	Goes ON during operation.	• Faulty internal elements.	• Resume after reset operation.
		• Defective internal elements.	• Replace the SERVOPACK.
A.04 Parameter setting error	Goes ON when power is supplied to the control circuit.	• Set value without setting range.	• Reset the parameter.

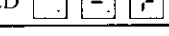
Table 14.2 LED Indication for Troubleshooting (Cont'd)

LED Detection	Lighting Condition	Probable Cause	Corrective Action
 CPU fault	Goes ON when power is supplied to the control circuit.	• Defective control circuit board (1PWB)	• Replace the SERVOPACK.
	Goes ON during motor operation.	• Malfunction of internal elements.	• Restart operation after resetting.
		• Faulty internal elements.	• Replace the SERVOPACK.
	Nothing is displayed when power is supplied to the control circuit.	• Fault of power supply.	• Replace the SERVOPACK.
		• Power is supplied to the control circiut improperly.	• Supply power properly.
	(Goes ON at traceback data.)	• Saved in traceback data at alarm reset or control power supply ON. This is not a fault.	—

Notes: 1. Alarm detection of A.81 to A.85 are available only for CACR-SR[ ]BYIW[ ].
2. A.00 alarm can be reset by turning off the SEN signal. However, it is not applied to normal alarm reset.
2. CPU fault is not stored as traceback data.

14.2.2 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 motor grounding)	• Correct the wiring.
The reference is input, but the motor does not run.	• Voltage across Ⓡ, Ⓢ, and Ⓣ • Trouble LED OFF • Speed reference voltage • P-CON, N-OT, P-OT, S- ON signals • LED  ON	• Check the AC power supply circuit. • If LEDs is ON, check the cause. • Adjust the reference volume.

14.2.3 Examples of Errors Resulting Setting Errors

Table 12.4 Examples of Errors Resulting Setting Errors

Trouble	Cause	What to do
The motor vibrates at a high frequency of about 200 to 300Hz.	Speed loop gain is too high. (influence by induced noise in the SERVOPACK input circuit since the cable is too long or is bundled together with a power line.)	Set Cn-04 LOOPHz to reduce the speed loop gain. • Separate the input circuit cable from the power lines or receive power to the input circuit from a power supply of a lower impedance. (100 ohms or lower)
Motor speed overshoot is too large at starting or stopping.	• Speed loop gain is too high.	• Set Cn-04 LOOPHz to reduce the speed loop gain until vibration stops.
Motor rotates even if the speed reference voltage is 0V.	• There is an offset to the speed reference voltage.	• Adjust the offset to the speed reference voltage. (Refer to Par.8.4.4.)

AC SERVO DRIVES

ALL DIGITAL/FOR SPEED CONTROL

SERVOMOTOR TYPES USAMED, USAFED, USAGED, USASEM, USADED (With Absolute Encoder)
SERVOPACK TYPE CACR-SR ☐☐☐ BY1 ☐☐☐

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