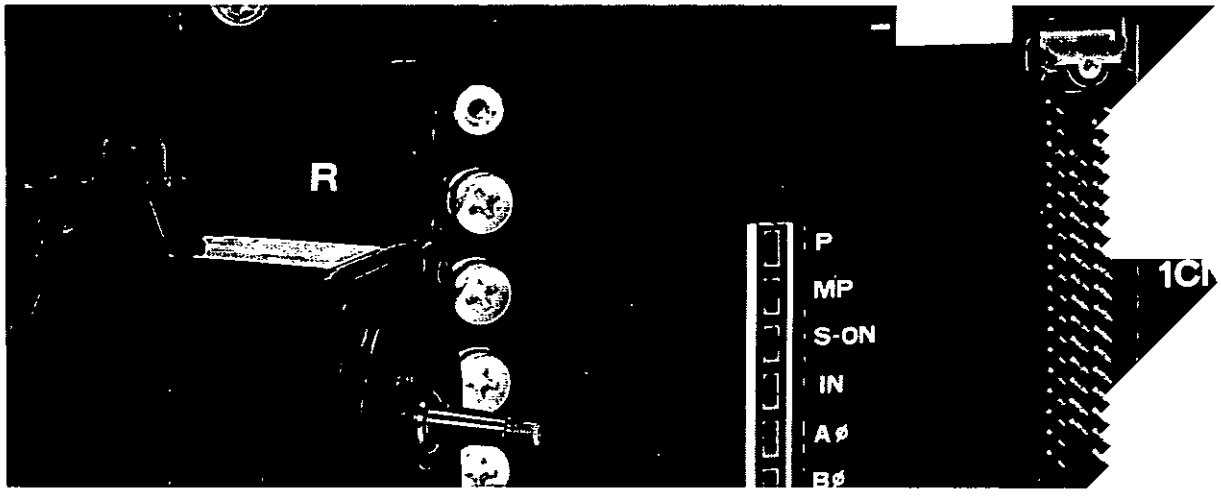
AC SERVO DRIVES

M, F, S, D SERIES FOR SPEED CONTROL

SERVOMOTOR TYPES USAMED, USAFED, USASEM, USADED
SERVOPACK TYPES CACR-SR□□□BC (RACK-MOUNTED TYPE)



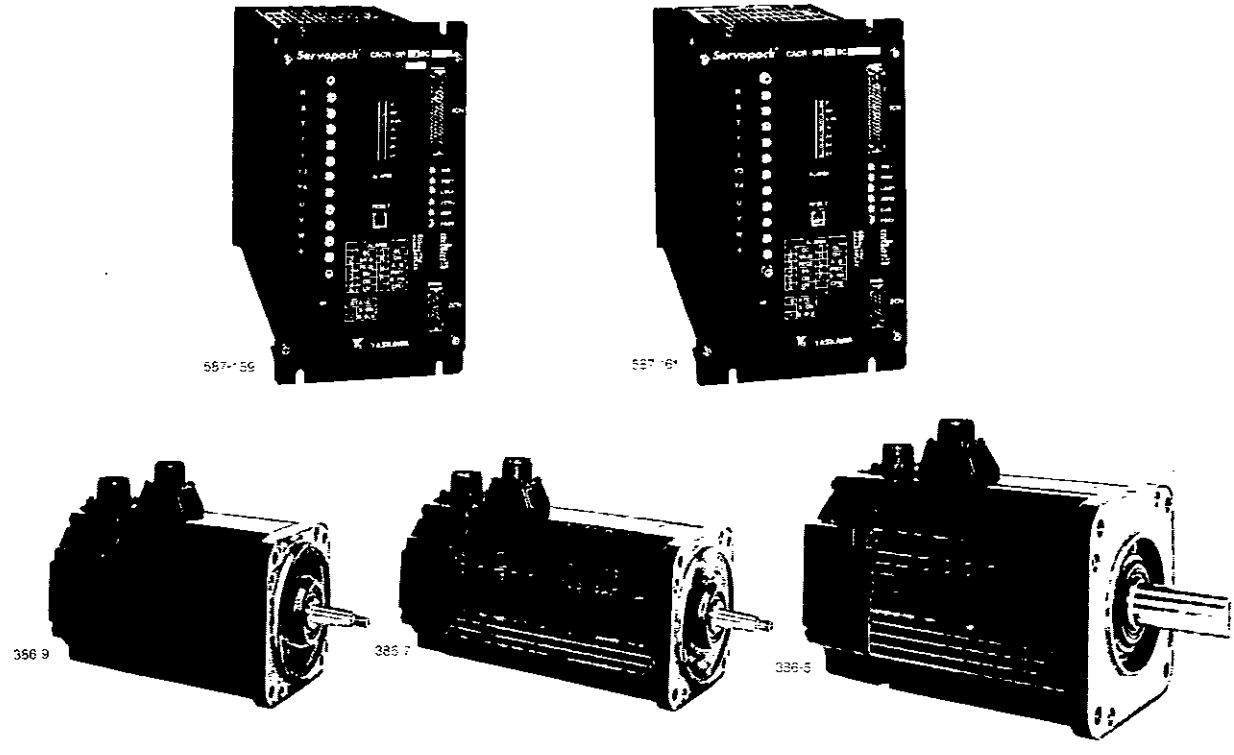
YASKAWA

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

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

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

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



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

CONTENTS

1. RATINGS AND SPECIFICATIONS 6

1.1 RATINGS AND SPECIFICATIONS OF M SERIES AC SERVOMOTORS 6

1.2 RATINGS AND SPECIFICATIONS OF F SERIES AC SERVOMOTORS 8

1.3 RATINGS AND SPECIFICATIONS OF S SERIES AC SERVOMOTORS 10

1.4 RATINGS AND SPECIFICATIONS OF D SERIES AC SERVOMOTORS 12

1.5 RATINGS AND SPECIFICATIONS OF SERVOPACK 14

2. TYPE DESIGNATION 16

3. LIST OF STANDARD COMBINATION 18

4. CHARACTERISTICS 22

4.1 OVERLOAD CHARACTERISTICS 22

4.2 STARTING AND STOPPING TIME 22

4.3 ALLOWABLE FREQUENCY OF OPERATION 22

4.4 SERVOMOTOR FREQUENCY 23

4.5 MOTOR SPEED—REFERENCE INPUT CHARACTERISTICS 23

4.6 MOTOR MECHANICAL CHARACTERISTICS 23

5. CONFIGURATION 26

5.1 CONNECTION DIAGRAM 26

5.2 INTERNAL BLOCK DIAGRAM 27

5.3 EXTERNAL TERMINALS 28

5.4 CONNECTOR TERMINAL (1CN) FOR INPUT/OUTPUT SIGNALS 28

5.5 CONNECTOR TERMINAL (2CN) FOR OPTICAL ENCODER (PG) CONNECTION 31

6. OPERATION 33

6.1 POWER ON AND OFF 33

6.2 SPEED REFERENCE 34

6.3 EXTERNAL CURRENT LIMIT REFERENCE CIRCUIT [P-CL, N-CL] 35

6.4 CONFIGURATION OF I/O CIRCUITS 36

6.5 PROTECTIVE CIRCUIT 39

6.6 LED INDICATION 40

6.7 PRECAUTIONS FOR APPLICATION 40

6.8 PRECAUTIONS OF OPERATION 40

6.9 APPLICATION 42

7. INSTALLATION AND WIRING 44

7.1 RECEIVING 44

7.2 INSTALLATION 44

7.3 WIRING 45

8. DIMENSIONS in mm (inches) 47

8.1 SERVOMOTOR: M SERIES 47

8.2 SERVOMOTOR: F SERIES 49

8.3 SERVOMOTOR: S SERIES 52

8.4 SERVOMOTOR: D SERIES 56

8.5 SERVOPACK 57

8.6 PERIPHERAL EQUIPMENT 59

9. TEST RUN 60

9.1 CHECK ITEMS BEFORE TEST RUN 60

9.2 TEST RUN PROCEDURES 60

10. ADJUSTMENT 61

10.1 SETTINGS AT THE TIME OF DELIVERY 61

10.2 CHARACTERISTICS AT THE TIME OF DELIVERY 65

10.3 READJUSTMENT 65

10.4 ADJUSTMENT PROCEDURES 65

10.5 SWITCH SETTING 69

11. INSPECTION AND MAINTENANCE 70

11.1 AC SERVOMOTOR 70

11.2 SERVOPACK 71

12. TROUBLESHOOTING GUIDE 72

12.1 AC SERVOMOTOR 72

12.2 SERVOPACK 73

INDEX

	Subject	Chapter	Section No.	Page
A	ADJUSTMENT	10		61
	ADJUSTMENT PROCEDURES	10	10.4	65
	ALLOWABLE FREQUENCY OF OPERATION	4	4.3	22
	Allowable Radial Load and Thrust Load	4	4.6.2	24
	APPLICATION	6	6.9	42
	Auxiliary Input Circuit	6	6.2.4	34
C	CHARACTERISTICS	4		22
	CHARACTERISTICS AT THE TIME OF DELIVERY	10	10.2	65
	CHECK ITEMS BEFORE TEST RUN	9	9.1	60
	CONFIGURATION	5		26
	CONFIGURATION OF I/O CIRCUITS	6	6.4	36
	CONNECTION DIAGRAM	5	5.1	26
	Connection for Reverse Motor Running	6	6.9.1	42
	Connector 1 CN Layout and Connection of SERVOPACK	5	5.4.2	28
	CONNECTOR TERMINAL (1 CN) FOR INPUT/OUTPUT SIGNALS	5	5.4	28
	CONNECTOR TERMINAL (2 CN) FOR OPTICAL ENCODER (PG) CONNECTION	5	5.5	31
	Current Limit when Motor is Locked	6	6.3.3	35
D	DIMENSIONS in mm (inches)	8		47
	Direction of Rotation	4	4.6.4	24
E	Examples of Troubleshooting for Defective Wiring or Parts	12	12.2.2	74
	Examples of Troubleshooting for Incomplete Adjustment	12	12.2.3	74
	EXTERNAL CURRENT LIMIT REFERENCE CIRCUIT	6	6.3	35
	EXTERNAL TERMINALS	5	5.3	28
H	Handling of Speed Reference Input Terminal	6	6.2.3	34
	High Voltage Line	6	6.7.3	40
I	Impact Resistance	4	4.6.5	25
	Input Circuit	6	6.4.1	36
	INSPECTION AND MAINTENANCE	11		70
	Inspection during Test Run	9	9.2.3	60
	INSTALLATION	7	7.2	44
	INSTALLATION AND WIRING	7		44
	INTERNAL BLOCK DIAGRAM	5	5.2	27
L	LED INDICATION	6	6.6	40
	LED Indication(7-segment) for Troubleshooting	12	12.2.1	73
	LIST OF STANDARD COMBINATION	3		18
	Load Inertia (J_L)	6	6.7.2	40
M	Mechanical Specifications (M, F, S and D series)	4	4.6.3	24
	Mechanical Strength	4	4.6.1	23
	Method of giving External Current Limit Reference	6	6.3.1	35
	MOTOR MECHANICAL CHARACTERISTICS	4	4.6	23
	MOTOR SPEED-REFERENCE INPUT CHARACTERISTICS	4	4.5	23
N	Noise Control	6	6.8.1	40
O	OPERATION	6		33
	Operation	9	9.2.2	60
	Optical Encoder (PG) Output Circuit	6	6.4.3	37
	Output Circuit	6	6.4.2	36
	Overhanging Loads	6	6.7.1	40
	OVERLOAD CHARACTERISTICS	4	4.1	22
P	PERIPHERAL EQUIPMENT	8	8.6	59
	Power Line Protection	6	6.8.2	42
	Power Loss	7	7.3.3	46
	POWER ON AND OFF	6	6.1	33

INDEX (Cont' d)

	Subject	Chapter	Section No.	Page
P	PRECAUTIONS FOR APPLICATION	6	6.7	40
	PRECAUTIONS OF OPERATION	6	6.8	40
	Preparation of Operation	9	9.2.1	65
	PROTECTIVE CIRCUIT	6	6.5	39
	PERIPHERAL EQUIPMENT	8	8.6	59
R	Rated Current and Cable Size	7	7.3.1	45
	RATINGS AND SPECIFICATIONS	1		6
	RATINGS AND SPECIFICATIONS OF D SERIES AC SERVOMOTORS	1	1.4	14
	RATINGS AND SPECIFICATIONS OF F SERIES AC SERVOMOTORS	1	1.2	8
	RATINGS AND SPECIFICATIONS OF M SERIES AC SERVOMOTORS	1	1.1	6
	RATINGS AND SPECIFICATIONS OF S SERIES AC SERVOMOTORS	1	1.3	10
	RATINGS AND SPECIFICATIONS OF SERVOPACK	1	1.5	14
	READJUSTMENT	10	10.3	65
	RECEIVING	7	7.1	44
S	SERVOMOTOR DIMENSIONS : D SERIES	8	8.4	57
	SERVOMOTOR DIMENSIONS : F SERIES	8	8.2	49
	SERVOMOTOR DIMENSIONS : M SERIES	8	8.1	47
	SERVOMOTOR DIMENSIONS : S SERIES	8	8.3	52
	SERVOMOTOR FREQUENCY	4	4.4	23
	SERVOPACK	11	11.2	71
	SERVOPACK Connector (2CN) Terminal Layout and Connection	5	5.5.2	31
	Set Voltage and Current Limit Values	6	6.3.2	35
	SETTINGS AT THE TIME OF DELIVERY	10	10.1	61
	Specifications of Applicable Receptacles	5	5.4.1	28
	Specifications of Applicable Receptacles and Cables	5	5.5.1	31
	Speed and Torque Measurement	6	6.9.2	43
	SPEED REFERENCE	6	6.2	34
	Speed Reference Circuit	6	6.2.1	34
	STARTING AND STOPPING TIME	4	4.2	22
	Stop Reference Circuit	6	6.2.2	34
	SWITCH SETTING	10	10.5	69
T	TEST RUN	9		60
	TEST RUN PROCEDURES	9	9.2	60
	TROUBLESHOOTING GUIDE	12		72
	TYPE DESIGNATION	2		16
V	Vibration Class	4	4.6.7	25
	Vibration Resistance	4	4.6.6	25
W	WIRING	7	7.3	45
	Wiring Precautions	7	7.3.2	46

1. RATINGS AND SPECIFICATIONS

1.1 RATINGS AND SPECIFICATIONS OF M SERIES AC SERVOMOTORS

(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℃

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

Vibration: 15 μm or below

Finish in Munsell Notation: N1.5

Excitation: Permanent magnet

Mounting: Flange mounted

Drive Method: Direct drive

Table 1.1 Ratings and Specifications of M Series AC SERVOMOTORS

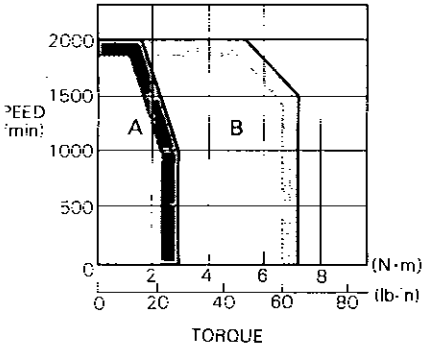
Item \ Motor Type		USAMED -03□□1	USAMED -06□□1	USAMED -09B□2	USAMED -12B□2	USAMED -20B□2	USAMED -30B□2	USAMED -44B□2
Rated Output*	kW (HP)	0.3 (0.4)	0.5 (0.8)	0.9 (1.2)	1.2	2.0	3.0	4.4
Rated Torque*	N·m (lb·in)	2.84 (25.3)	5.68 (50.5)	8.62 (76.6)	11.5 (102)	19.1 (170)	28.4 (253)	41.9 (373)
Continuous Max Torque*	N·m (lb·in)	2.94 (26.1)	5.88 (52.3)	8.82 (78.4)	11.8 (105)	21.6 (192)	32.3 (287)	46.1 (409)
Instantaneous Peak Torque*	N·m (lb·in)	7.17 (63.8)	14.1 (125)	19.3 (178)	28.0 (249)	44.0 (391)	63.7 (566)	91.1 (810)
Rated Current*	A	3.0	5.8	7.6	11.7	18.8	26	33
Rated Speed*	r/min	1000						
Instantaneous Max Speed*	r/min	2000						1500
Torque Constant	N·m/A(rms) (lb·in/A)(rms)	1.01 (8.97)	1.04 (9.23)	1.21	1.02 (9.06)	1.07 (9.49)	1.16 (10.3)	1.33 (11.8)
Moment of Inertia J_M (=$GD^2/4$)	kg·m²×10⁻⁴	13.5	24.3	36.7	58	110	143	240
	lb·in·s²×10⁻³	12	21.6	32.6	51.6	97.6	127.2	213.4
Power Rating*	kW/s	6.0	13.3	20.3	22.7	33.2	57.0	74.0
Inertia Time Constant	ms	12.8	6.3	4.4	6.0	5.2	3.5	3.6
Inductive Time Constant	ms	2.7	5.1	6.5	10.4	12.9	15.3	16.2
Insulation		Class F						

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

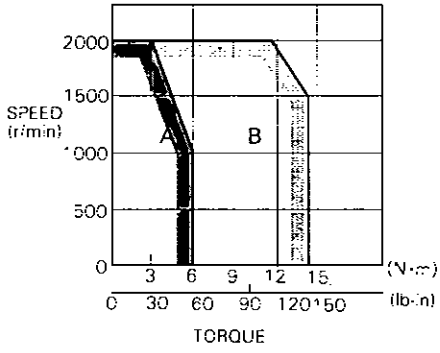
Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   •Standard: A (6000 P/R)
   •Optional: B (5000 P/R), D (4000 P/R)
2. The power supply unit for brake has two types:
   •Type B9400876-2: Input 100 VAC, Output 90 VDC
   •Type B9400876-1: Input 200 VAC, Output 90 VDC
   For details, see Par. 8.3 (2).

(2) Torque-Speed Characteristics

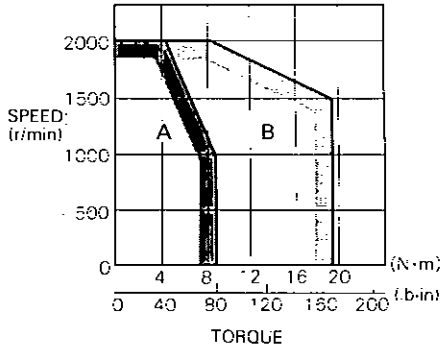
·TYPE USAMED - 03□



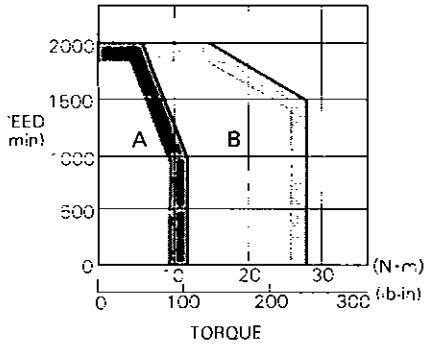
·TYPE USAMED - 06□



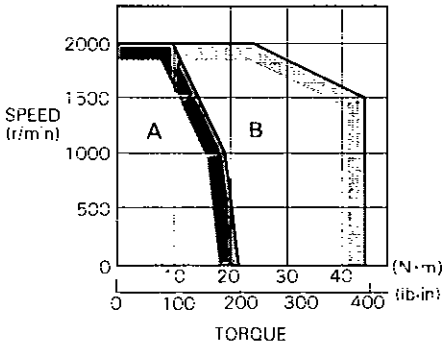
·TYPE USAMED - 09B



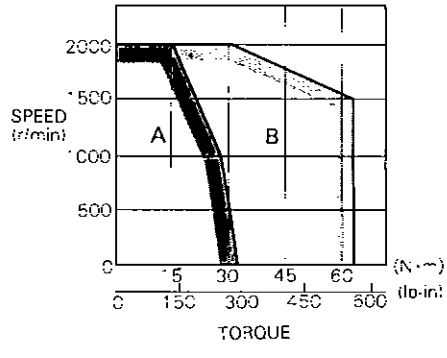
·TYPE USAMED - 12B



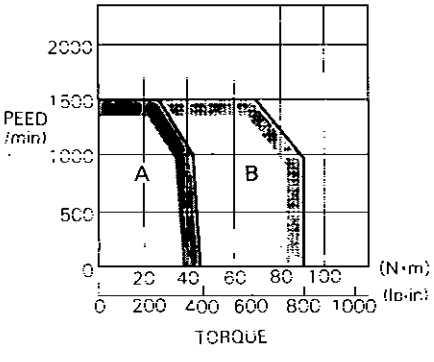
·TYPE USAMED - 20B



·TYPE USAMED - 30B



·TYPE USAMED - 44B



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

1.2 RATINGS AND SPECIFICATIONS OF F SERIES AC SERVOMOTORS

(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℃

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

Vibration: 15 μm or below

Finish in Munsell Notation: N1.5

Excitation: Permanent magnet

Mounting: Flange mounted

Drive Method: Direct drive

Table 1.2 Ratings and Specifications of F Series AC SERVOMOTORS

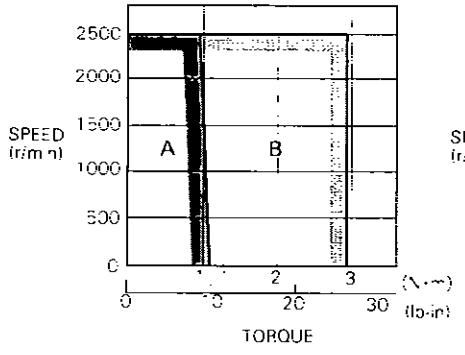
Item \ Motor Type		USAFED -02□□1	USAFED -03□□1	USAFED -05□□1	USAFED -09□□1	USAFED -13C□2	USAFED -20C□2	USAFED -30C□2	USAFED -44C□2
Rated Output*	kW (HP)	0.15 (0.2)	0.3 (0.4)	0.45 (0.6)	0.85 (1.2)	1.3	1.8	2.9	4.4
Rated Torque*	N·m (lb·in)	0.98 (8.7)	1.96 (17)	2.84 (25)	5.39 (48)	8.34 (74)	11.5 (102)	18.6 (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 (25.8)	5.83 (51.6)	8.92 (79)	15.2 (135)	24.7 (219)	34.0 (310)	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(rms) (lb·in/A)(rms)	0.36 (3.2)	0.72 (6.4)	0.80 (7.1)	0.92 (8.2)	0.92 (8.2)	0.82 (7.3)	0.98 (8.7)	1.02 (9.06)
Moment of Inertia J_M	(=GD²/4) kg·m²×10⁻⁴	1.3	2.06	13.5	24.3	36.7	58	110	143
	lb·in·s²×10⁻³	1.2	1.8	12	21.5	32.5	59.2	97.4	127
Power Rating*	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℃.
Values shown are normal (TYP) values.

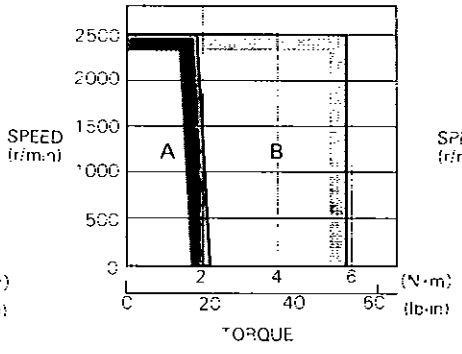
Notes :
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   - Standard: A (6000 P/R)
   - Optional: B (5000 P/R), D (4000 P/R)
2. The power supply unit for brake has two types:
   - Type B9400876-2: Input 100 VAC, Output 90 VDC
   - Type B9400876-1: Input 200 VAC, Output 90 VDC
   For details, see Par. 8.3 (2).

(2) Torque-Speed Characteristics

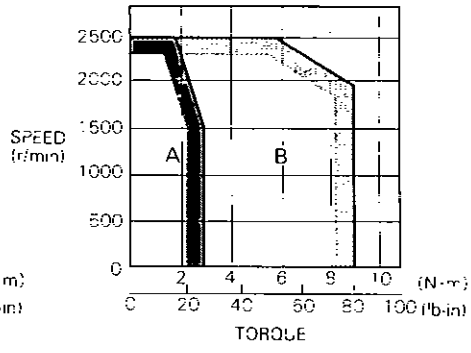
·TYPE USAFED-02□



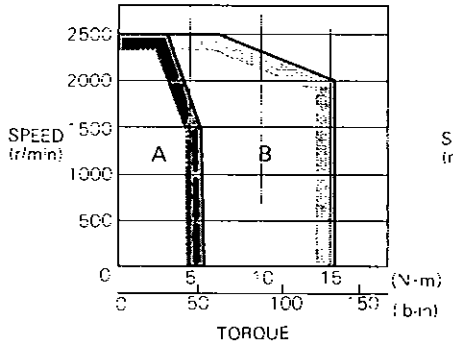
·TYPE USAFED-03□



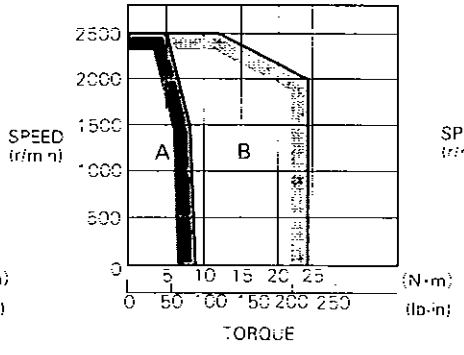
·TYPE USAFED-05□



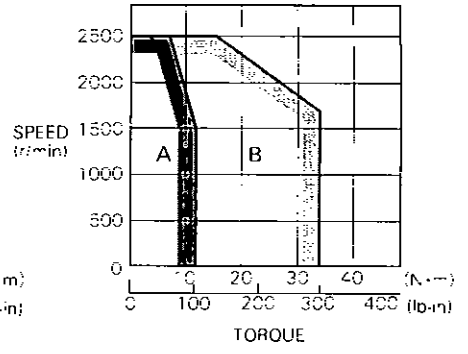
·TYPE USAFED-09□



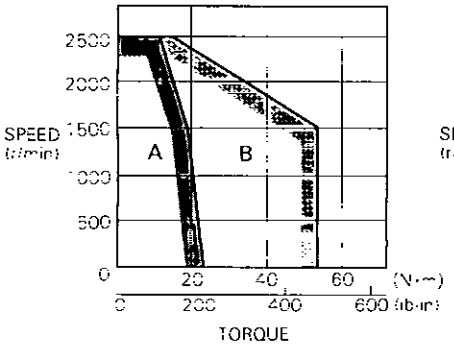
·TYPE USAFED-13C



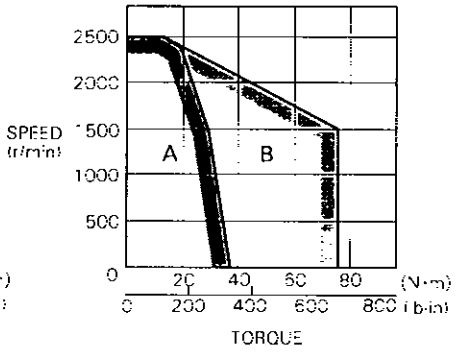
·TYPE USAFED-20C



·TYPE USAFED-30C



·TYPE USAFED-44C



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

1.3 RATINGS AND SPECIFICATIONS OF S SERIES AC SERVOMOTORS

(1) Ratings

Time Rating: Continuous

Insulation: Class B (Types USASEM-02A□2 to -05A□2) Class F (Types USASEM-08A□2 to -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℃

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

Vibration: 15 μm or below

Finish in Munsell Notation: N1.5

Excitation: Permanent magnet

Mounting: Flange mounted

Drive Method: Direct drive

Table 1.3 Ratings and Specifications of S Series AC SERVOMOTORS

Item \ Motor Type		USASEM -02A□2	USASEM -03A□2	USASEM -05A□2	USASEM -08A□1	USASEM -15A□1	USASEM -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 (4.34)	0.98 (8.69)	1.47 (13)	2.45 (21.7)	4.90 (43.3)	9.81 (86.8)
Continuous Max Torque*	N·m (lb·in)	0.57 (5.03)	1.18 (10.4)	1.67 (14.8)	3.33 (29.5)	6.18 (54.7)	12.2 (108)
Instantaneous Peak Torque*	N·m (lb·in)	1.47 (13)	2.94 (26)	4.02 (35.6)	7.35 (65.0)	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(rms) (lb·in/A)(rms)	0.25 (2.19)	0.35 (3.1)	0.37 (3.28)	0.51 (4.49)	0.50 (4.43)	0.53 (4.64)
Moment of Inertia J_M	(=GD²/4) kg·m²×10⁻⁴	0.13	0.51	0.75	2.85	3.25	5.74
	lb·in·s²×10⁻³	0.11	0.45	0.67	2.53	2.88	5.09
Power Rating*	kW/s	18.5	18.9	28.9	27	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℃. Values shown are normal (TYP) values.

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

Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:

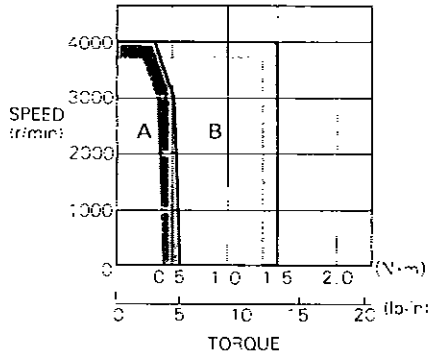
AC SERVOMOTOR Type USASEM-	02A, 03A, 05A		08A	
Standard (P/R)	E	1500	C	2500
Optional (P/R)	C	2500	E	1500
	F	1000	F	1000

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

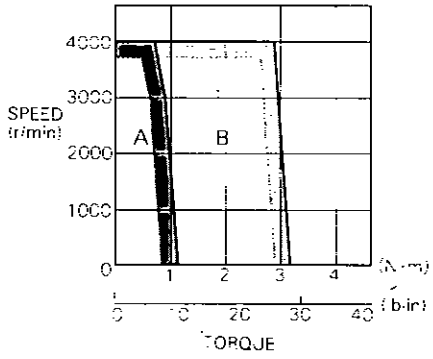
For details, see Par. 8.3 (2).

(2) Torque-Speed Characteristics

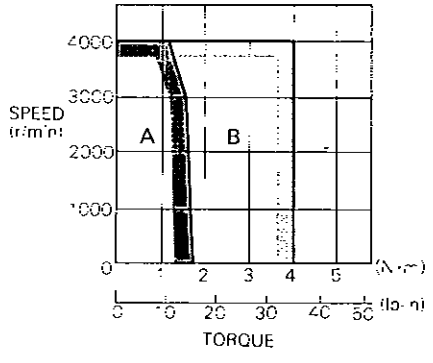
•TYPE USASEM - 02A



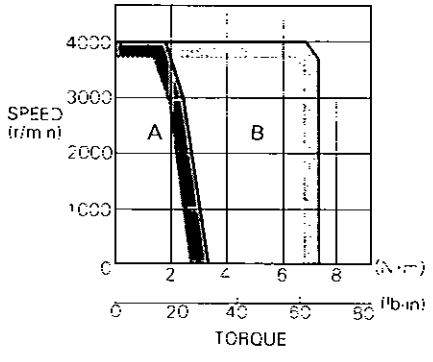
•TYPE USASEM - 03A



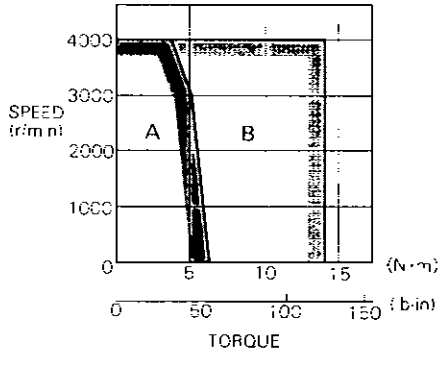
•TYPE USASEM - 05A



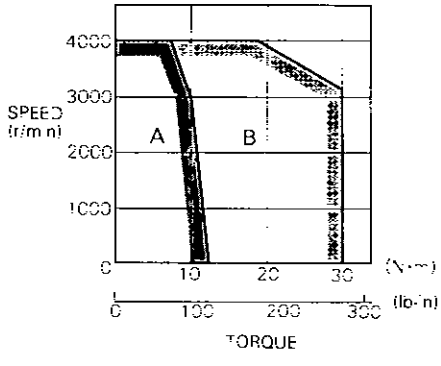
•TYPE USASEM - 08A



•TYPE USASEM - 15A



•TYPE USASEM - 30A



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

1.4 RATINGS AND SPECIFICATIONS OF D SERIES AC SERVOMOTORS

(1) 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℃

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

Storage Temperature: −20 to +60℃

Vibration: 15 μm or below

Finish in Munsell Notation: N1.5

Excitation: Permanent magnet

Mounting: Flange mounted

Drive Method: Direct drive

Holding brake Provided

Table 1.4 Ratings and Specifications of D Series AC SERVOMOTORS

Item \ Motor Type		USADED -05E□2	USADED -10E□2	USADED -15E□2	USADED -22E□2	USADED -37E□2
Rated Output*	kW (HP)	0.5 (0.67)	1.0 (1.3)	1.5 (2.0)	2.2 (2.9)	3.7 (5.0)
Rated Torque*	N·m (lb·in)	2.35 (21)	4.8 (43)	7.16 (63)	10.5 (93)	17.7 (156)
Continuous Max Torque*	N·m (lb·in)	3.43 (30)	6.37 (56)	8.83 (78)	13.7 (122)	21.6 (191)
Instantaneous Peak Torque*	N·m (lb·in)	8.24 (73)	16.9 (149)	25.1 (222)	36.8 (326)	61.8 (547)
Rated Current*	A	3.5	7.9	12.6	16.6	23.3
Rated Speed*	r/min	2000				
Instantaneous Max Speed*	r/min	2500				
Torque Constant	N·m/A(rms) (lb·in/A)(rms)	0.83 (7.38)	0.69 (6.07)	0.64 (5.64)	0.71 (6.25)	0.82 (7.29)
Moment of Inertia J_M (=GD²/4)	kg·m²×10⁻⁴	21, 13†	32, 24	62, 59†	83, 80	148, 145
	lb·in·s²×10⁻³	18.6, 11.5	28.3, 21.2†	54.9, 52.2	73.5, 70.8†	131, 128.3†
Power Rating*	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				
Holding Brake Static Friction Torque	N·m (lb·in)	8.82 (78)			21.56 (191)	
Approx. Mass	kg (lb)	17, 16 (37.5, 35.3)	19, 18† (41.9, 39.7)	30, 27 (66.2, 59.5†)	32, 29† (70.6, 64)	39, 36 (86.0, 79.4†)

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

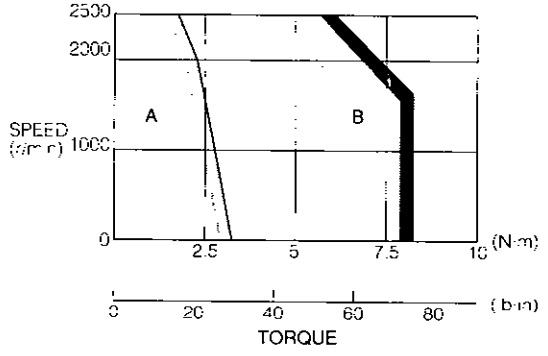
Notes :

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

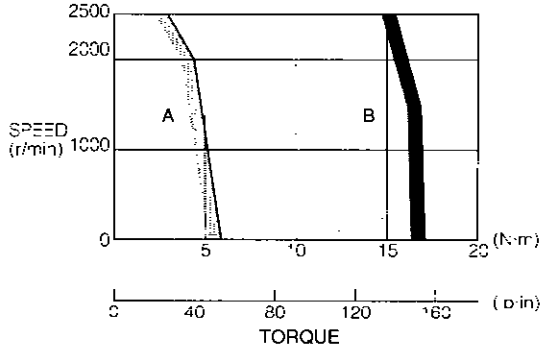
   For details, see Par. 8.3 (3).

(2) Torque-Speed Characteristics

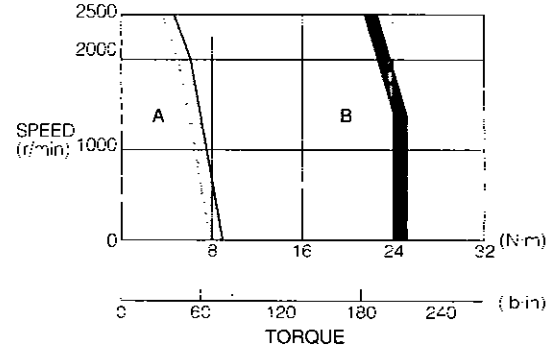
·TYPE USADED-05E



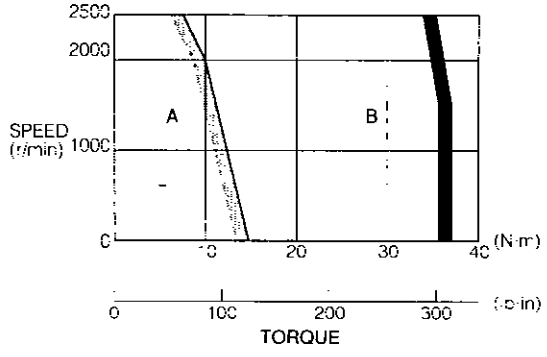
·TYPE USADED-10A



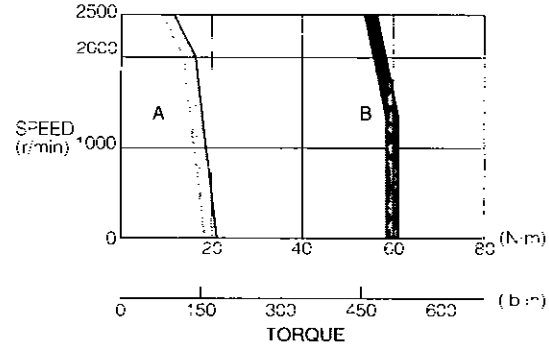
·TYPE USADED-15E



·TYPE USADED-22E



·TYPE USADED-37E



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

1.5 RATINGS AND SPECIFICATIONS OF SERVOPACK

Table 1.4 Ratings and Specifications of SERVOPACK

	SERVOPACK Type CACR-		SR03BC	SR05BC	SR07BC	SR10BC	SR15BC	SR20BC	SR30BC	SR44BC
	Max Motor Output	kW (HP)	0.3 (0.4)	0.5 (0.67)	0.7 (0.94)	1.0 (1.34)	1.5 (2.01)	2.0 (2.68)	3.0 (4.02)	4.4 (5.90)
M Series	Applicable Optical Encoder		A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev)							
	AC SERVOMOTOR Type USAMED-*		03□□□1	–	06□□□1	09B□2	12B□2	20B□2	30B□2	44B□2
	AC SERVOMOTOR Output	kW (HP)	0.3 (0.4)	–	0.6 (0.8)	0.9 (1.2)	1.2 (1.61)	2.0 (2.68)	3.0 (4.02)	4.4 (5.90)
	AC SERVOMOTOR Rated Speed	r/min	3000							
	SERVOPACK Type CACR-		03BC1AM	–	SR07BC1AM	SR10BC1AM	SR15BC1AM	SR20BC1AM	SR30BC1AM	SR44BC1AM
	Continuous Output Current	Arms	3.0	–	5.9	7.6	11.7	18.6	26.0	33.0
	Max Output Current	Arms	7.3	–	13.9	16.8	28.0	42.0	56.5	70.0
	Allowable Load Inertia J_L	kg·m²×10⁻⁴ (lb·in·s²×10⁻³)	67.5 (60)	–	121.5 (108)	183.5 (163.1)	334 (296.9)	550 (488.8)	715 (635.5)	1225 (1088.8)
F Series	Applicable Optical Encoder		A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev)							
	AC SERVOMOTOR Type USAFED-*		02□□□1	03□□□1	05□□□1	–	09□□□1	13C□2	20C□2	30C□2	44C□2
	AC SERVOMOTOR Output	kW (HP)	0.15 (0.2)	0.3 (0.4)	0.45 (0.6)	–	0.85 (1.2)	1.3 (1.74)	1.8 (2.41)	2.9 (3.89)	4.4 (5.90)
	AC SERVOMOTOR Rated Speed	r/min	1500							
	SERVOPACK Type CACR-		SR03BC1AF		SR05BC1AF	–	SR10BC1AF	SR15BC1AF	SR20BC1AF	SR30BC1AF	SR44BC1AF
	Continuous Output Current	Arms	3.0	3.0	3.8	–	6.2	9.7	15.0	20.0	30.0
	Max Output Current	Arms	8.5	8.5	11.0	–	17.0	27.6	42.0	56.5	77.0
	Allowable Load Inertia J_L	kg·m²×10⁻⁴ (lb·in·s²×10⁻³)	6.5 (5.8)	6.5 (5.8)	67.5 (60)	–	121.5 (108)	183.5 (163.1)	334 (296.9)	550 (488.8)	715 (635.5)
S Series	Applicable Optical Encoder		C: 2500 pulses, E: 1500 pulses/rev (F: 1000 pulses/rev)							
	AC SERVOMOTOR Type USASEM-*		02A□2	03A□2	05A□2	–	08A□1	15A□*	–	30A□1	–
	AC SERVOMOTOR Output	kW (HP)	0.15 (0.2)	0.3 (0.4)	0.45 (0.6)	–	0.77 (1.1)	1.54 (2.07)	–	3.08 (4.13)	–
	AC SERVOMOTOR Rated Speed	r/min	3000							
	SERVOPACK Type CACR-		SR03BC*ES-Y41	SR03BC*ES	SR05BC*ES	–	SR10BC1CS	SR15BC1CS	–	SR30BC1CS	–
	Continuous Output Current	Arms	2.1	3.0	4.3	–	5.3	10.4	–	19.9	–
	Max Output Current	Arms	6.0	8.5	11.0	–	15.6	28.0	–	56.5	–
	Allowable Load Inertia J_L	kg·m²×10⁻⁴ (lb·in·s²×10⁻³)	9.65 (8.58)	2.55 (2.3)	3.75 (3.3)	–	14.25 (12.7)	16.5 (14.7)	–	28.7 (25.5)	–
D Series	Applicable Optical Encoder		A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev)							
	AC SERVOMOTOR Type USADED-*		–	05E□2	–	–	10E□2	15E□2	22E□2	37E□2
	AC SERVOMOTOR Output	kW (HP)	–	0.5 (0.67)	–	–	1.0 (1.34)	1.5 (2.0)	2.2 (2.9)	3.7 (5.0)
	AC SERVOMOTOR Rated Speed	r/min	2000							
	SERVOPACK Type CACR-		–	SR05BC1AD	–	–	SR15BC1AD	SR20BC1AD	SR30BC1AD	SR44BC1AD
	Continuous Output Current	Arms	–	3.5	–	–	7.9	12.6	16.6	23.3
	Max Output Current	Arms	–	10.5	–	–	25.2	42.5	54.0	76.7
	Allowable Load Inertia J_L	kg·m²×10⁻⁴ (lb·in·s²×10⁻³)	–	135 (91)	–	–	180 (143)	310 (273.6)	415 (369)	755 (655)

Table 1.4 Ratings and Specifications of SERVOPACK (Cont'd)

SERVOPACK Type CACR-			SR03BC	SR05BC	SR07BC	SR10BC	SR15BC	SR20BC	SR30BC	SR44BC
Max Motor Output		kW (HP)	0.3 (0.4)	0.5 (0.67)	0.7 (0.94)	1.0 (1.34)	1.5 (2.01)	2.0 (2.68)	3.0 (4.02)	4.4 (5.90)
Basic Specifications	Power* Supply	Main Circuit	Three-phase 200 to 230 VAC +10% -15% 50/60 Hz							
		Control Circuit	Single-phase 200 to 230 VAC +10% -15% 50/60 Hz							
	Control Method		Transistorized PWM Control							
	Feedback		Optical encoder (A: 8000 pulses/rev, B: 6000 pulses/rev, C: 2500 pulses/rev, D: 4000 pulses/rev, E: 1500 pulses/rev, F: 1000 pulses/rev)							
	Ambient Temperature		0 to +55°C							
	Storage Temperature		−20°C to +85°C							
	Ambient and Storage Humidity		90% or less (non-condensing)							
	Mounting Structure		Rack mounted							
	Approx Mass	kg (lb)	5 (13)	6 (13)	6 (13)	7 (16)	7 (15)	12 (26)	12 (26)	12 (26)
Speed Control	Speed Control Range		1: 3000							
	Speed Regulation	Load Regulation 0 to 100%	±0.03% or less at rated r/min, ±0.015% or less at 1/3 r/min							
		Voltage Regulation ±10%	±1% or less at rated r/min, ±0.05% or less at 1/3 r/min							
		Temp. Regulation 25±25°C	±0.5% or less at rated r/min, ±0.2% or less at 1/3 r/min							
	Frequency Response Characteristics		100Hz ($GD^2_L = GD^2_M$)							
I/O Signals	Speed Reference Input	Rated Reference Voltage	±6VDC at rated r/min (forward run at plus reference)							
		Input Impedance	Approx 12kΩ							
		Circuit Time Constant	Approx 75μs							
	Auxiliary Reference Input†	Reference Voltage	±2 to ±10VDC at rated r/min (forward run at plus reference)							
		Input Impedance	Approx 5 to 7kΩ							
		Circuit Time Constant	Approx 22μs or less							
	Torque Limit Input		±3VDC ±10% at ±100% torque							
	Built-in Reference Power Supply		±12VDC ±5%, ±20mA							
	Input Signal		Servo ON, P drive, P overtravel, N overtravel, ext. current limit, alarm reset							
	Output Signal		Servo ready, TG ON, current limit, servo alarm, overload, MCCB trip							
	Positioning Signal Output		1/N time (N=1 to 64) of PG pulses or 2/N time (N=2 to 64)							
Built-in Functions	Protection		Overvoltage, overload, overcurrent, overspeed, overrun, open phase detection, MCCB trip, heatsink overheat, undervoltage, AD error, regeneration trouble, CPU error							
	Indication		Power supply, reference input, alarm, status indications, pulse display of encoder (A, B, C-phase)							
	Dynamic Brake		Built-in (non-contact dynamic brake)							
	Regenerative Resistor		Built-in							
	Applicable Load Inertia‡		Up to 5 times motor inertia							
	Monitor Output		Torque reference monitor: 3.0V ±10% at rated torque Speed monitor: 4.0V ±5% at 1000 r/min (M, F, D series), 2.0V ±5% at 1000r/min (S series)							

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

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

‡When load GD^2 exceeds applicable range, be sure to refer to Par. 6.7.2, "Load Inertia."

#□ in type designation is determined by output pulses (P/R) of optical encoder as follows:

Type	Standard (P/R)		Optional (P/R)				Remarks
M Series	A	6000	B	5000	D	4000	
F Series	A	6000	B	5000	D	4000	
S Series	E	1500	C	2500	F	1000	02A, 03A, 05A
	C	2500	E	1500	F	1000	08A, 15A, 30A
D Series	A	6000	B	5000	D	4000	

Notes:

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

2. TYPE DESIGNATION

·AC SERVOMOTOR

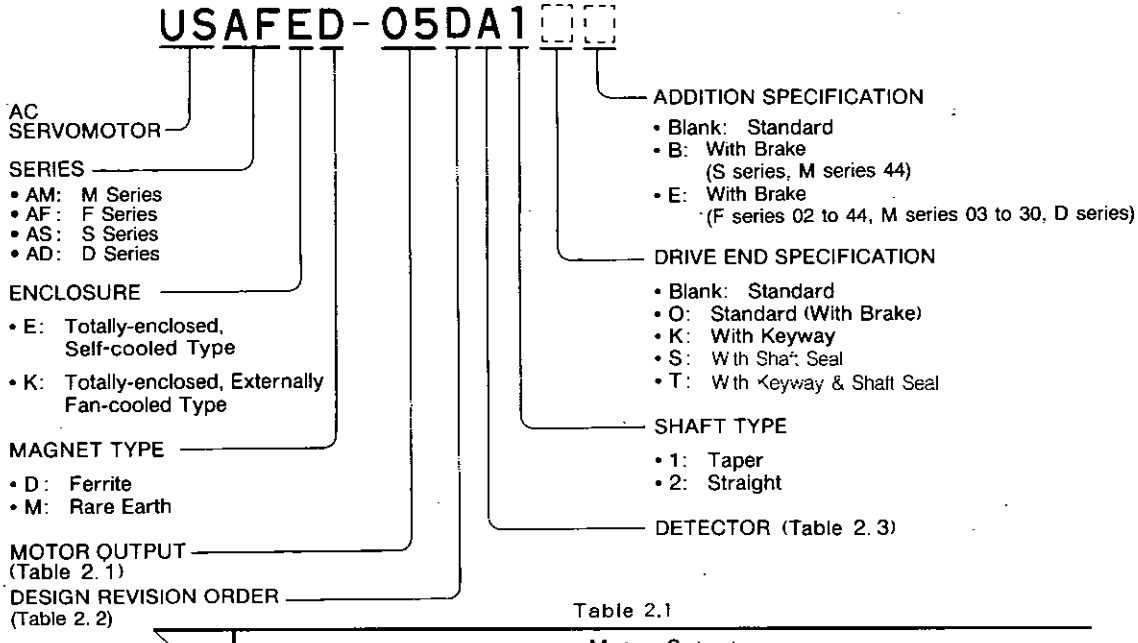


Table 2.1

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

Table 2.2

	Motor Output			
	M Series	F Series	S Series	D Series
03	0.3kW (0.4HP)	0.15kW (0.2HP)	0.15kW (0.2HP)	–
		0.3kW (0.4HP)	0.3kW (0.4HP)	
05	–	0.45kW (0.6HP)	0.46kW (0.6HP)	0.5kW (0.7HP)
07	0.6kW (0.8HP)	–	–	–
10	0.9kW (1.2HP)	0.85kW (1.2HP)	0.77kW (1.1HP)	–
15	1.2kW (1.6HP)	1.3kW (1.7HP)	1.5kW (2.0HP)	1.0kW (1.3HP)
20	2.0kW (2.7HP)	1.8kW (2.4HP)	–	1.5kW (2.0HP)
30	3.0kW (4.0HP)	2.9kW (3.9HP)	3.0kW (4.0HP)	2.2kW (2.9HP)
44	4.4kW (5.9HP)	4.4kW (5.9HP)	–	3.7kW (5.0HP)

·SERVOPACK

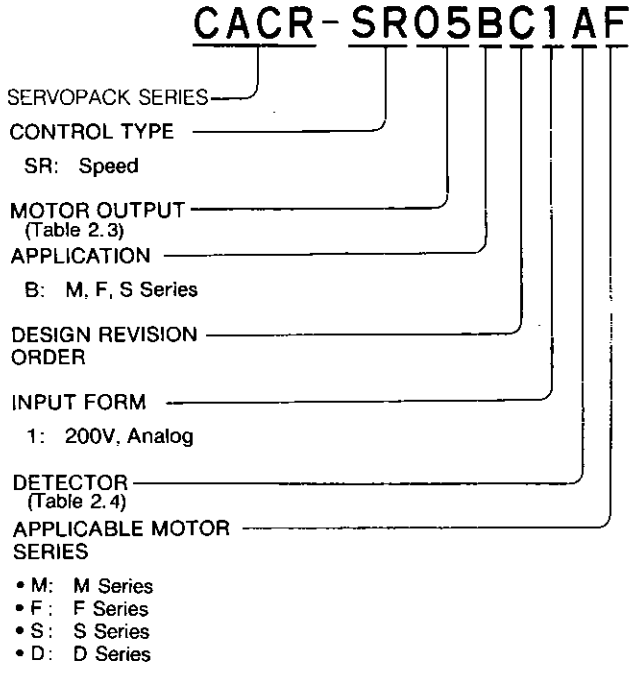


Table 2.3

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

Table 2.4

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

3. LIST OF STANDARD COMBINATION

Table 3.1 List of Standard Combination

·M SERIES

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Optical Encoder pulses/rev	Power Capacity* per SERVOPACK kVA	Current Capacity per MCCB or Fuse A	Applicable Noise Filter	Recommended Noise Filter† Type	Specifications	Power ON/OFF Switch
SR03BC1AM	USAMED-03□A1	6000	0.65	5	Good	LF-305	3-phase 200VAC class, 5A	Contactor 30A or above
SR03BC1BM	USAMED-03□B1	5000						
SR03BC1DM	USAMED-03□D1	4000						
SR07BC1AM	USAMED-06□A1	6000	1.5	8		LF-310	3-phase 200VAC class, 10A	
SR07BC1BM	USAMED-36□B1	5000						
SR07BC1DM	USAMED-06□D1	4000						
SR10BC1AM	USAMED-09BA2	6000	2.1	8		LF-315	3-phase 200VAC class, 15A	
SR10BC1BM	USAMED-36BB2	5000						
SR10BC1DM	USAMED-09BD2	4000						
SR15BC1AM	USAMED-12BA2	6000	3.1	10		LF-315		
SR15BC1BM	USAMED-12BB2	5000						
SR15BC1DM	USAMED-12BD2	4000						
SR20BC1AM	USAMED-20BA2	6000	4.1	12	Poor	LF-320	3-phase 200VAC class, 20A	
SR20BC1BM	USAMED-20BB2	5000						
SR20BC1DM	USAMED-20BD2	4000						
SR30BC1AM	USAMED-30BA2	6000	6.0	18		LF-330	3-phase 200VAC class, 30A	Contactor 35A or above
SR30BC1BM	USAMED-30BB2	5000						
SR30BC1DM	USAMED-30BD2	4000						
SR44BC1AM	USAMED-44BA2	6000	5.0	24		LF-340	3-phase 200VAC class, 40A	
SR44BC1BM	USAMED-44BB2	5000						
SR44BC1DM	USAMED-44BD2	4000						

·F SERIES

SR03BC1AF	USAFED-02□A1	6000	1.1	5	Good	LF-305	3-phase 200VAC class, 5A	Contactor 30A or above
SR03BC1BF	USAFED-02□B1	5000						
SR03BC1DF	USAFED-02□D1	4000						
SR03BC1AF	USAFED-03□A1	6000						
SR03BC1BF	USAFED-03□B1	5000						
SR03BC1DF	USAFED-03□D1	4000						
SR05BC1AF	USAFED-05□A1	6000						
SR05BC1BF	USAFED-05□B1	5000						
SR05BC1DF	USAFED-05□D1	4000						
SR10BC1AF	USAFED-09□A1	6000	2.1	8		LF-315	3-phase 200VAC class, 15A	
SR10BC1BF	USAFED-09□B1	5000						
SR10BC1DF	USAFED-09□D1	4000						
SR15BC1AF	USAFED-13CA2	6000	3.1	10		LF-315		
SR15BC1BF	USAFED-13CB2	5000						
SR15BC1DF	USAFED-13CD2	4000						
SR20BC1AF	USAFED-20CA2	6000	4.1	12	Poor	LF-320	3-phase 200VAC class, 20A	
SR20BC1BF	USAFED-20CB2	5000						
SR20BC1DF	USAFED-20CD2	4000						
SR30BC1AF	USAFED-30CA2	6000	6.0	18		LF-330	3-phase 200VAC class, 30A	Contactor 35A or above
SR30BC1BF	USAFED-30CB2	5000						
SR30BC1DF	USAFED-30CD2	4000						
SR44BC1AF	USAFED-44CA2	6000	8.0	24		LF-340	3-phase 200VAC class, 40A	
SR44BC1BF	USAFED-44CB2	5000						
SR44BC1DF	USAFED-44CD2	4000						

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

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).

AC SERVOMOTOR*				Detector*				Holding Brake*			
Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
MS3102A18-10P	MS3108B18-10S	MS3106B18-10S	MS3057-10A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A20-15P	MS3108B20-15S	MS3106B20-15S	MS3057-12A
MS3102A18-10P	MS3108B18-10S	MS3106B18-10S	MS3057-10A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A20-15P	MS3108B20-15S	MS3106B20-15S	MS3057-12A
MS3102A18-10P	MS3108B18-10S	MS3106B18-10S	MS3057-10A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A20-15P	MS3108B20-15S	MS3106B20-15S	MS3057-12A
MS3102A22-22P	MS3108B22-22S	MS3106B22-22S	MS3057-12A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A24-10P	MS3108B24-10S	MS3106B24-10S	MS3057-16A
MS3102A22-22P	MS3108B22-22S	MS3106B22-22S	MS3057-12A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A24-10P	MS3108B24-10S	MS3106B24-10S	MS3057-16A
MS3102A22-22P	MS3108B22-22S	MS3106B22-22S	MS3057-12A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A24-10P	MS3108B24-10S	MS3106B24-10S	MS3057-16A
MS3102A32-17P	MS3108B32-17S	MS3106B32-17S	MS3057-20A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	—	—	—	—

AC SERVOMOTOR*				Detector*				Holding Brake*			
Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
MS3102A14S-2P	MS3108B14S-2S	MS3106B14S-2S	MS3057-6A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A14S-6P	MS3108B14S-6S	MS3106B14S-6S	MS3057-6A
MS3102A14S-2P	MS3108B14S-2S	MS3106B14S-2S	MS3057-6A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A14S-6P	MS3108B14S-6S	MS3106B14S-6S	MS3057-6A
MS3102A18-10P	MS3108B18-10S	MS3106B18-10S	MS3057-10A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A20-15P	MS3108B20-15S	MS3106B20-15S	MS3057-12A
MS3102A18-10P	MS3108B18-10S	MS3106B18-10S	MS3057-10A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A20-15P	MS3108B20-15S	MS3106B20-15S	MS3057-12A
MS3102A18-10P	MS3108B18-10S	MS3106B18-10S	MS3057-10A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A20-15P	MS3108B20-15S	MS3106B20-15S	MS3057-12A
MS3102A22-22P	MS3108B22-22S	MS3106B22-22S	MS3057-12A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A24-10P	MS3108B24-10S	MS3106B24-10S	MS3057-16A
MS3102A22-22P	MS3108B22-22S	MS3106B22-22S	MS3057-12A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A24-10P	MS3108B24-10S	MS3106B24-10S	MS3057-16A
MS3102A22-22P	MS3108B22-22S	MS3106B22-22S	MS3057-12A	MS3102A20-29P	MS3108B20-29S	MS3106B20-29S	MS3057-12A	MS3102A24-10P	MS3108B24-10S	MS3106B24-10S	MS3057-16A

3. LIST OF STANDARD COMBINATION (Cont'd)

Table 3.1 List of Standard Combination (Cont'd)

SERVOPACK Type CACR-	AC SERVOMOTOR Type	Optical Encoder pulses/rev	Power Capacity* per SERVOPACK kVA	Current Capacity per MCCB or Fuse A	Applicable Noise Filter	Recommended Noise Filter† Type	Recommended Noise Filter† Specifications	Power ON/OFF Switch
·S SERIES								
SR03BC1CSY41	USASEM-02AC2	2500	0.65	5	Good	LF-305	3-phase 200VAC class, 5A	Contactor 30A or above
SR03BC1ESY41	USASEM-02AE2	1500						
SR03BC1FSY41	USASEM-02AF2	1000						
SR03BC1CS	USASEM-03AC2	2500						
SR03BC1ES	USASEM-03AE2	1500						
SR03BC1FS	USASEM-03AF2	1000						
SR05BC1CS	USASEM-05AC2	2500	1.1	5		LF-305		
SR05BC1ES	USASEM-05AE2	1500						
SR05BC1FS	USASEM-05AF2	1000						
SR10BC1CS	USASEM-08AC1	2500	2.1	8	Poor	LF-315	3-phase 200VAC class, 15A	
SR10BC1ES	USASEM-08AE1	1500						
SR10BC1FS	USASEM-08AF1	1000						
SR15BC1CS	USASEM-15AC1	2500	3.1	13		LF-315		
SR15BC1ES	USASEM-15AE1	1500						
SR15BC1FS	USASEM-15AF1	1000						
SR30BC1CS	USASEM-30AC1	2500	6.0	18		LF-330	3-phase 200VAC class, 30A	Contactor 35A or above
SR30BC1ES	USASEM-30AE1	1500						
SR30BC1FS	USASEM-30AF1	1000						
·D SERIES								
SR05BC1AD	USADED-05EA2	6000	1.1	5	Good	LF-305	3-phase 200VAC class, 5A	Contactor 30A or above
SR05BC1BD	USADED-05EB2	5000						
SR05BC1DD	USADED-05ED2	4000						
SR15BC1AD	USADED-10EA2	6000	3.1	10		LF-315	3-phase 200VAC class, 15A	
SR15BC1BC	USADED-10EB2	5000						
SR15BC1DD	USADED-10ED2	4000						
SR20BC1AD	USADED-15EA2	6000	4.1	12		LF-320	3-phase 200VAC class, 20A	
SR20BC1BD	USADED-15EB2	5000						
SR20BC1DD	USADED-15ED2	4000						
SR30BC1AD	USADED-22EA2	6000	6.0	18	Poor	LF-330	3-phase 200VAC class, 30A	Contactor 35A or above
SR30BC1BD	USADED-22EB2	5000						
SR30BC1DD	USADED-22ED2	4000						
SR44BC1AD	USADED-37EA2	6000	8.0	24		LF-340	3-phase 200VAC class, 40A	
SR44BC1BD	USADED-37EB2	5000						
SR44BC1DD	USADED-37ED2	4000						

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

Notes: 1. Draw-out construction of type USASEM-02 is waterproof grand method.
2. When plugs or clamps are required, contact your YASKAWA representative. The following connections are provided: soldered type (type MS) and solderless type (type JA).

AC SERVOMOTOR*				Detector*				Holding Brake†			
Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp	Receptacle Type	L-type Plug	Straight Plug	Cable Clamp
MS3102A18 -10P	MS3108B18 -10S	MS3106B18 -10S	MS3057 -10A	MS3102A20 -29P	MS3108B20 -29S	MS3106B20 -29S	MS3057 -12P	MS3102A18 -12A	MS3108B18 -12S	—	MS3057 -10A
MS3102A18 -10P	MS3108B18 -10S	MS3106B18 -10S	MS3057 -10A	MS3102A20 -29P	MS3108B20 -29S	MS3106B20 -29S	MS3057 -12P	MS3102A18 -12A	MS3108B18 -12S		MS3057 -10A
MS3102A20 -4P	MS3108B20 -4S	MS3106B20 -4S	MS3057 -12A	MS3102A20 -29P	MS3108B20 -29S	MS3106B20 -29S	MS3057 -12P	MS3102A20 -17A	MS3108B20 -17S		MS3057 -12A
MS3102A20 -4P	MS3108B20 -4S	MS3106B20 -4S	MS3057 -12A	MS3102A20 -29P	MS3108B20 -29S	MS3106B20 -29S	MS3057 -12P	MS3102A20 -17A	MS3108B18 -12S		MS3057 -12A
MS3102A20 -4P	MS3108B20 -4S	MS3106B20 -4S	MS3057 -12A	MS3102A20 -29P	MS3108B20 -29S	MS3106B20 -29S	MS3057 -12P	MS3102A20 -17A	MS3108B18 -12S		MS3057 -12A
MS3102A20 -15P	MS3108B20 -15S	MS3106B20 -15S	MS3057 -12A								
MS3102A24 -10P	MS3108B24 -10S	MS3106B24 -10S	MS3057 -16A	MS3102A20 -29P	MS3108B20 -29S	MS3106B20 -29S	MS3057 -12A				

4. CHARACTERISTICS

4.1 OVERLOAD CHARACTERISTICS

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

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

NOTE

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

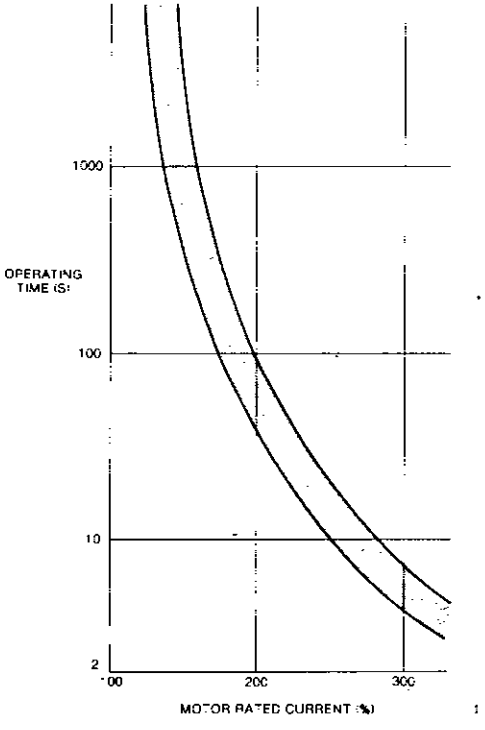


Fig. 4.1 Allowable Overload Curve of SERVOPACK

4.2 STARTING AND STOPPING TIME

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

Starting Time :

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

Stopping Time :

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

Where,

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

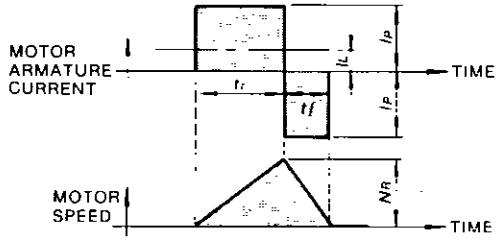


Fig. 4.2 Timing Chart of Motor Armature Current and Speed

4.3 ALLOWABLE FREQUENCY OF OPERATION

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

·Allowable frequency of operation restricted by the SERVOPACK

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

·Allowable frequency of operation restricted by the SERVOMOTOR

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

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

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

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

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

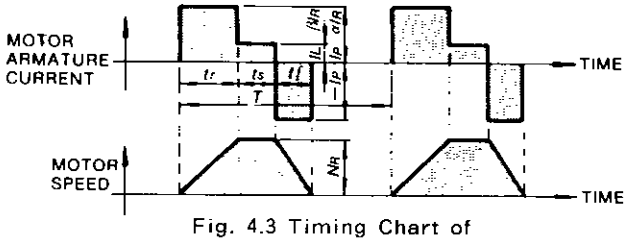


Fig. 4.3 Timing Chart of Motor Armature Current and Speed

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

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

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

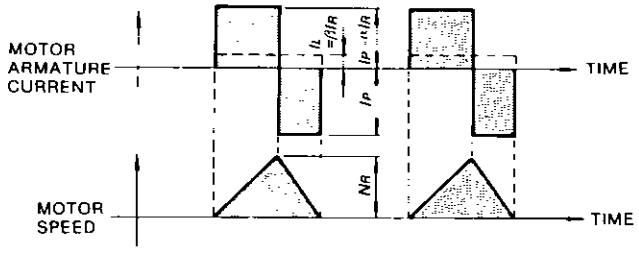


Fig. 4.4 Timing Chart of Motor Armature Current and Speed

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

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

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

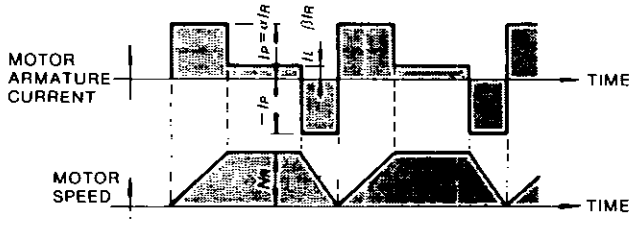


Fig. 4.5 Timing Chart of Motor Armature Current and Speed

4.4 SERVOMOTOR FREQUENCY

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

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

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

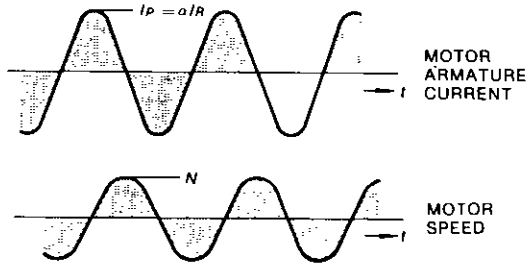


Fig. 4.6 Timing Chart of Motor Armature Current and Speed

4.5 MOTOR SPEED-REFERENCE INPUT CHARACTERISTICS

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

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

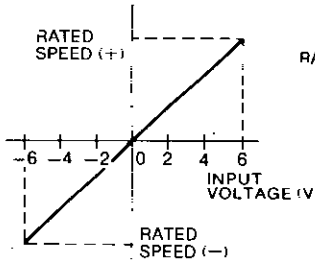


Fig. 4.7 Speed-Input Voltage Characteristics

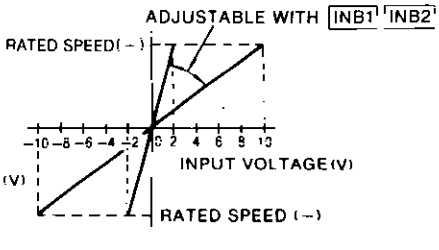


Fig. 4.8 Speed-Input Voltage Characteristics when Auxiliary Input Terminals 1CN-⑭ and ⑮ are used.

4.6 MOTOR MECHANICAL CHARACTERISTICS

4.6.1 Mechanical Strength

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

4.6.2 Allowable Radial Load and Thrust Load

Table 4.1 shows allowable loads according to AC SERVOMOTOR types.

Table 4.1 M Series Allowable Radial Load and Thrust Load

Motor Type USAMED-	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
03□□1	490 (110.5)	98 (22.1)†
06□□1	490 (110.5)	98 (22.1)†
09B□2	686 (154.7)	343 (77.4)
12B□2	1470 (331.5)	490 (110.5)
20B□2	1470 (331.5)	490 (110.5)
30B□2	1470 (331.5)	490 (110.5)
44B□2	1764 (397.8)	588 (132.6)

Table 4.2 F Series Allowable Radial Load and Thrust Load

Motor Type USAFED-	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
02□□1	147 (33.2)	49 (11.1)†
03□□1	147 (33.2)	49 (11.1)†
05□□1	490 (110.5)	98 (22.1)†
09□□1	490 (110.5)	98 (22.1)†
13C□2	686 (154.7)	343 (77.4)
20C□2	1470 (331.5)	490 (110.5)
30C□2	1470 (331.5)	490 (110.5)
44C□2	1470 (331.5)	490 (110.5)

Table 4.3 S Series Allowable Radial Load and Thrust Load

Motor Type USASEM-	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
02A□2	78.4 (17.7)	39.2 (8.8)
03A□2	245 (55.3)	98 (22.1)
05A□2	245 (55.3)	98 (22.1)
08A□1	392 (88.4)	147 (33.2)
15A□1	490 (110.5)	147 (33.2)
30A□1	686 (154.7)	196 (44.2)

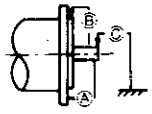
Table 4.4 D Series Allowable Radial Load and Thrust Load

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

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

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

Table 4.5 Mechanical Specifications in mm

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

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

4.6.4 Direction of Rotation

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

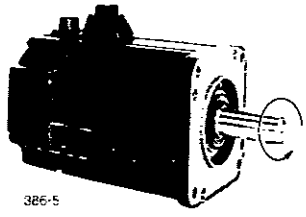
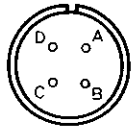


Fig. 4.9 AC SERVOMOTOR

(1) Connector Specifications for Standard SERVOMOTORS

(a) Motor receptacle

· M, F, D Series

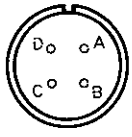


A	Phase U
B	Phase V
C	Phase W
D	Frame ground

· S Series
(Type USASEM-02A)

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

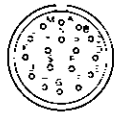
(Types USASEM-03A to 30A)



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

(b) Detector receptacle

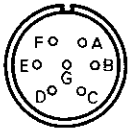
· M, F, S, D Series



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

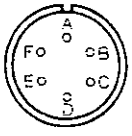
(2) Connector Specifications for SERVOMOTOR with Brake

·M, F, D Series



A	Phase U	E	Brake termina
B	Phase V	F	
C	Phase W	G	—
D	Frame ground	—	—

*For USAFEM-02 and 03, see connector below.

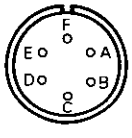


A	Phase U	E	Brake terminal
B	Phase V	F	
C	Phase W	—	—
D	Frame ground	—	—

·S Series
(Type USASEM-02A)

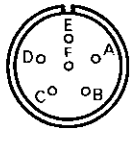
Color of Lead	Applicable	Color of Lead	Applicable
Red	Phase U	Black	Brake
White	Phase V	Black	
Blue	Phase W	Green	Frame ground

(Types USASEM-03A, -05A)



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

(Types USASEM-08A to 30A)



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

4.6.5 Impact Resistance

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

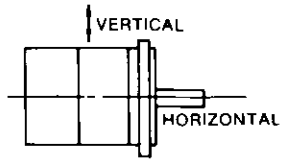


Fig. 4.10 Impact Resistance

4.6.6 Vibration Resistance

When mounted horizontally, the motor can withstand vibration (vertical, lateral, axial) of 24.5m/s² (2.5G) (Fig. 4.11).

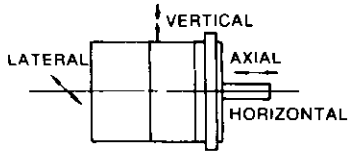


Fig. 4.11 Vibration Resistance

4.6.7 Vibration Class

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

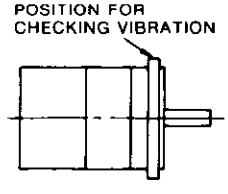


Fig. 4.12 Vibration Checking

5. CONFIGURATION

5.1 CONNECTION DIAGRAM

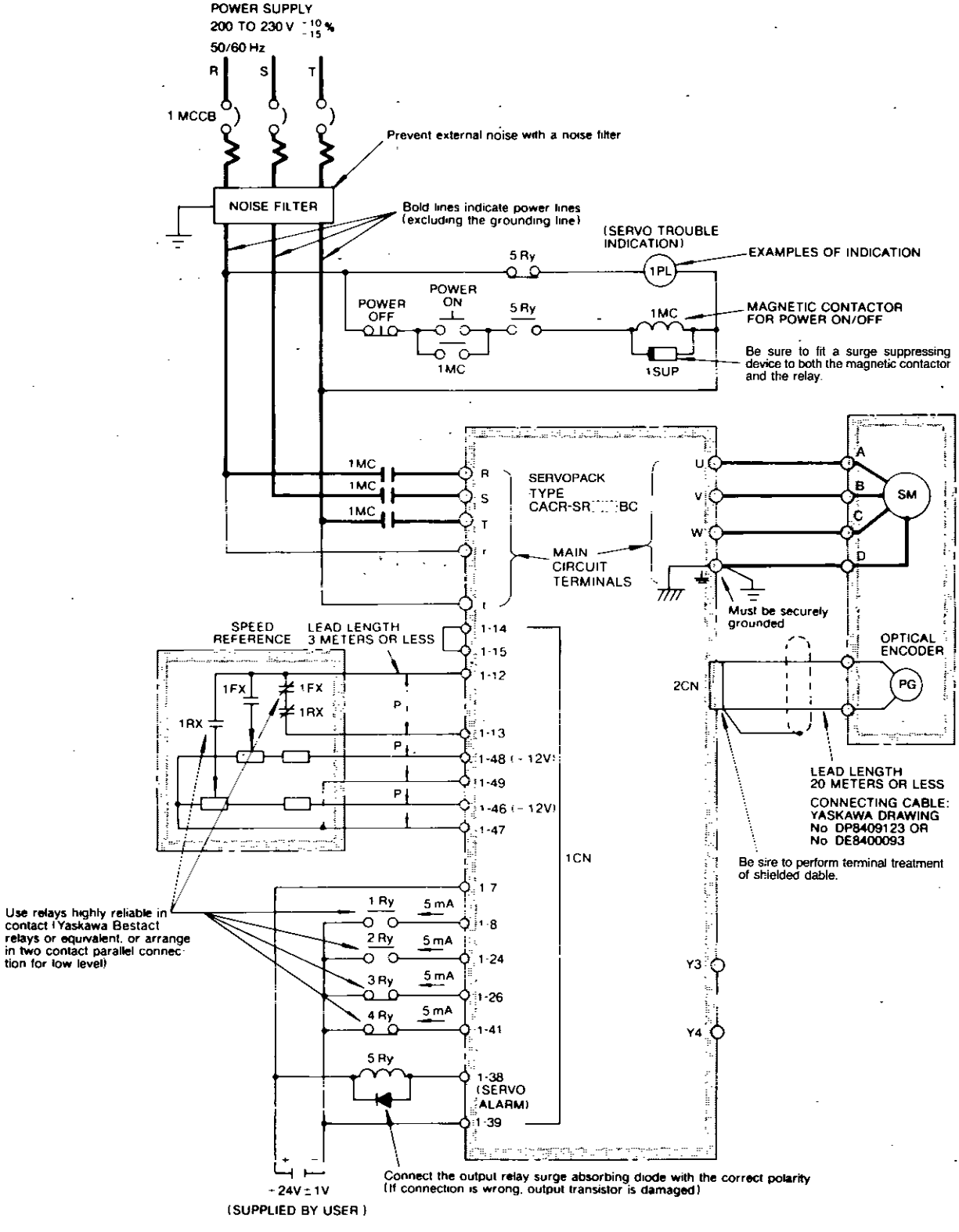


Fig. 5.1 Example of Connection Diagram of SERVOPACK with a SERVOMOTOR and Peripherals

5.2 INTERNAL BLOCK DIAGRAM

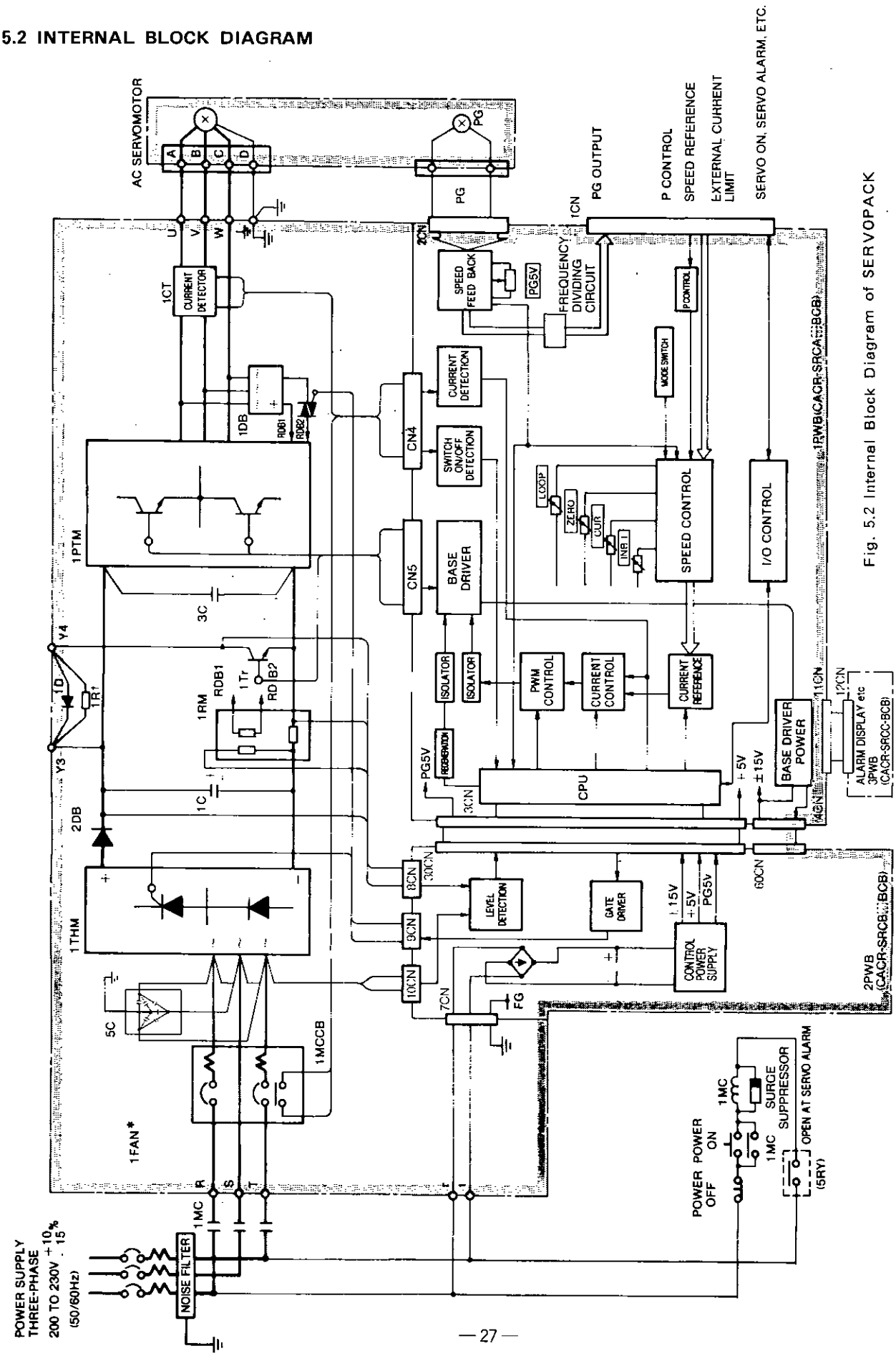


Fig. 5.2 Internal Block Diagram of SERVOPACK

5.3 EXTERNAL TERMINALS

Table 5.1 shows the specifications of external terminals for SERVOPACK.

Table 5.1 External Terminals for SERVOPACK

Terminal Symbol	Name	Description
ⓇⓈⓉ	Main-circuit AC input	Three-phase 200 to 230 VAC +10% 50/60Hz.
ⓊⓋⓌ	Motor connection	Connects terminal Ⓤ to motor terminal A, Ⓥ to B and Ⓦ to C.
⊖①	Control power input	Single-phase 200 to 230 VAC +10% 50/60HZ.
⏚	Ground	Connects to motor terminal D. Must be securely grounded.
Ⓨ3Ⓨ4	Regenerative resistor	External connection

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

5.4.1 Specifications of Applicable Receptacles

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

Connector Type* used in SEVOPACK	Applicable Receptacle Type			
	Manufacturer	Soldering Type	Caulking Type	Case
MR-50RMA4 (Right angle 50 P)	Honda Tsushin Co., Ltd.	MR-50F1	MR-50FC1	MR-50L*

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

5.4.2 Connector 1CN Layout and Connection of SERVOPACK

The terminal layout of the SERVOPACK input/output signal connectors (1CN) is shown in Table 5.3.
The external connection and external signal processing are shown in Fig. 5.3 on page 23.

Table 5.3 Connector 1CN Layout

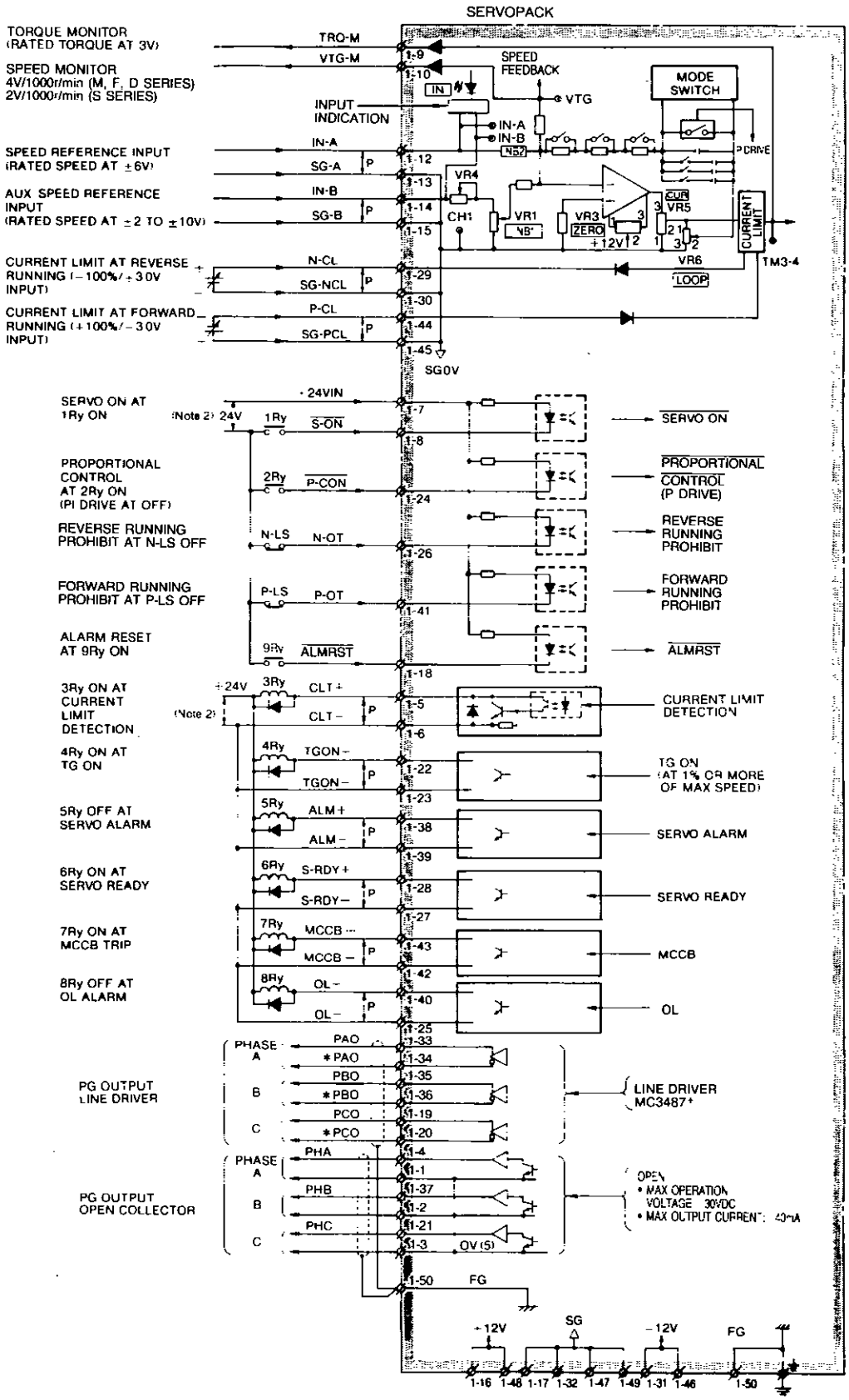
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0 V	0 V	0 V	PHA	CLT+	CLT−	+24V IN	S-ON	TRQ-M	V-M	SG	IN-A	SG•A	IN-B	SG•B	+12V	SG	$\overline{\text{ALMRS}}$
0 V for PG Output Signal			PG Output Signal (Phase A)	Current Limit Detection Output		Ext. Power Input	Servo ON Power	Torque reference monitor	Speed Monitor		Speed Reference Input		Auxiliary Input		+12V Output		Alarm Reset Input

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

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

*Open collector

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



P : Twisted pair wires

*Made by Texas Instruments Inc.

Notes:

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

Fig. 5.3 I/O Signals and Connector 1CN

Table 5.4 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(−6V). Base block and dynamic brake are reset.
$\overline{\text{P-CON}}$	1CN-24	Proportional drive reference	Proportional control command to prevent drifting when the motor is left motionless without command input, while the main circuit is kept energized.
N-OT	1CN-26	Reverse running prohibit	In the case of linear drive, etc., connect limit switch signal according to the run direction. This is a normally closed contact. When limit switch is tripped, it becomes "open".
P-OT	1CN-41	Forward running prohibit	
+24V	1CN-7	24V	External power supply to 1CN-8, 18, 24, 26 and 41. Use an external 24VDC(25mA min.)power supply.
IN-A*	1CN-12(13)	Speed command input	At ±6.0V, ±rated speed is obtained.
IN-B*	1CN-14(15)	Aux. command input	At ±2.0 to ±10.0V, ±rated speed is obtained. For adjustment, potentiometer INB1 INB2 is used.
N-CL	1CN-29(30)	Current limit reference at reverse-running	+3.0V ±10%/100% torque −9V max.
P-CL	1CN-44(45)	Current limit reference at forward running	−3.0V ±10%/100% torque −9V max.
$\overline{\text{ALMRST}}$	1CN-18	Alarm reset	This signal resets the alarm. Turn ON after checking the status of the alarm.

Signal Name	Connector 1CN No.	Function		Description
OL	1CN-40(25)	Overload detection		Motor overload detection or heat sink overheat detecion. Turns off when overload is detected.(See Fig. 4.1 "Overload characteristic".)
$\overline{\text{MCB}}$	1CN-43(42)	MCCB trip		Turns ON when MCCB trips.
ALM	1CN-30(39)	Servo alarm		Turns OFF when fault is detected. For details, refer to Table 6.2, "Fault Detection Function".
$\overline{\text{TGON}}$	1CN-22(23)	Motor run detector		Turns ON when motor speed exceeds following speed. M Series: 20r/min F Series: 25r/min S Series: 40r/min D Series: 25r/min ON at ±10% or more.
$\overline{\text{GLT}}$	1CN-5(6)	Current limit detection		•N-CL or P-CL used: Turns ON when output torque reaches the level set by N-CL or P-CL. •N-CL or P-CL not used: Turns ON when output troque reaches the level set by potentiometer CUR.
$\overline{\text{S-RDY}}$	1CN-27(28)	Servo ready		Turns ON when main power supply ON, and no servo alarm.
+12V	1CN-16, 48	±12V output power supply		−12V ±5% max output cuttent: 30mA Used with speed command or current input.
0V	1CN-17,32,49			
−12V	1CN-31, 46			
TRQ-M	1CN-9	Torque reference monitor		(Rated torque at ±3.0V),±10%, ±9V max. load: 1mA max.
VTG-M	1CN-10	Speed monitor		M, F, D Series(±4.0V/1000r/min) ±5%. S Series(±2.0V/1000r/min) ±5%. Load: 1mA max.
PAO	1CN-33	Positioning Signal Output 1	Phase A	Encoder output signal after frequency division is output at line driver(TI MC3487). To be received by line receiver(TI MC3486 or equivalent).
*PAO	1CN-34			
PBO	1CN-35		Phase B	
*PBO	1CN-36			
PCO	1CN-19		Phase C	
*PCO	1CN-20			
PHA	1CN-4(1)	Positioning Signal Output 2	Phase A	Oper collector output, encoder output signal after frequency division. Max operating voltage: 30VDC. Max output current: 40mA.
PHB	1CN-37(2)		Phase B	
PHC	1CN-21(3)		Phase C	

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

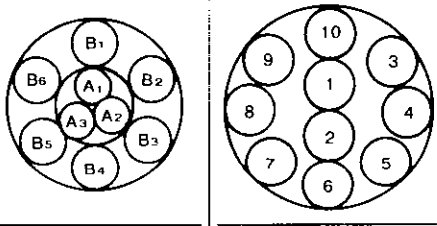
5.5.1 Specifications of Applicable Receptacles and Cables (Table 5.6)

Table 5.6 Specifications of Applicable Receptacles and Cables

Connector Type* used in SERVOPACK	Applicable Receptacle Type				Connection Cable‡
	Manufacturer	Soldered Type	Caulking Type	Case†	
MR-20RMA4, right angel 20P	Honda Tsushin Co., Ltd.	MR-20F:	MRP-20F01	MR-20L:	DP8409123 or DE8400093

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

Table 5.7 Cable Specifications

Connection	Soldered Type	Caulking Type
YASKAWA Drawing No.	DP 8409123	DE 8400093
Manufacturer	Fujikura Cable Co.	
Approx Specifications	Double, KQVV-SW AWG 22×3C AWG 26×6P	KQVV-SB AWG 26×10P
Internal Composition and Lead Color	For Soldered Type: A_1 Red; A_2 Black; A_3 Green-yellow; B_1 Blue-White/blue; B_2 Yellow-White/yellow; B_3 Green-White/green; B_4 Orange-White/orange; B_5 Purple-White/purple; B_6 Grey-White/grey; Twisted pair wires. For Caulking Type: 1 Blue-White; 2 Yellow-White; 3 Green-White; 4 Red-White; 5 Purple-White; 6 Blue-Brown; 7 Yellow-Brown; 8 Green-Brown; 9 Red-Brown; 10 Purple-Brown; Twisted pair wires. 	
YASKAWA Standard Specifications	Standard length : 5m, 10m, 20m Terminal ends are not provided (with connectors).	

NOTE

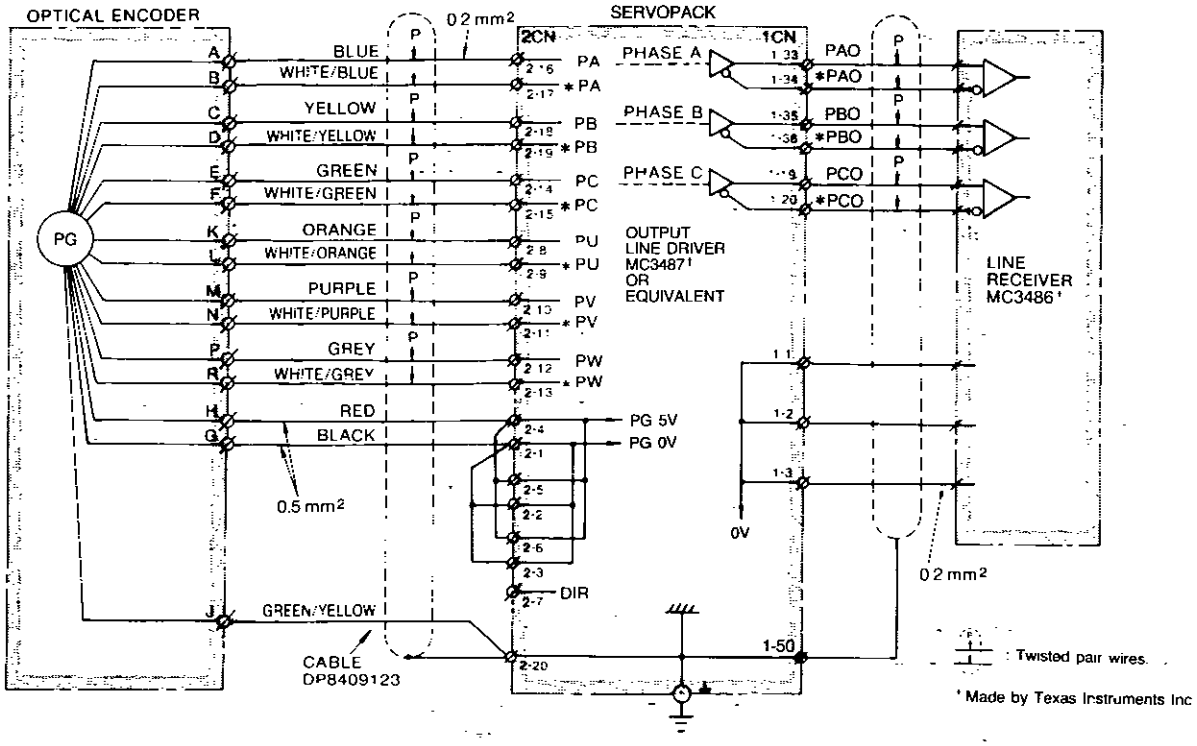
1. When applicable cables listed in Table 5.7 are used, allowable wiring distance between SERVOPACK and motor is a maximum of 20 meters.
2. The cable applied for 50m wiring distance is available on order (YASKAWA drawing No. DP8409179).
   If wiring distance is 20m or more, contact your YASKAWA representative.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

5.5.2 SERVOPACK Connector (2CN) Terminal Layout and Connection

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

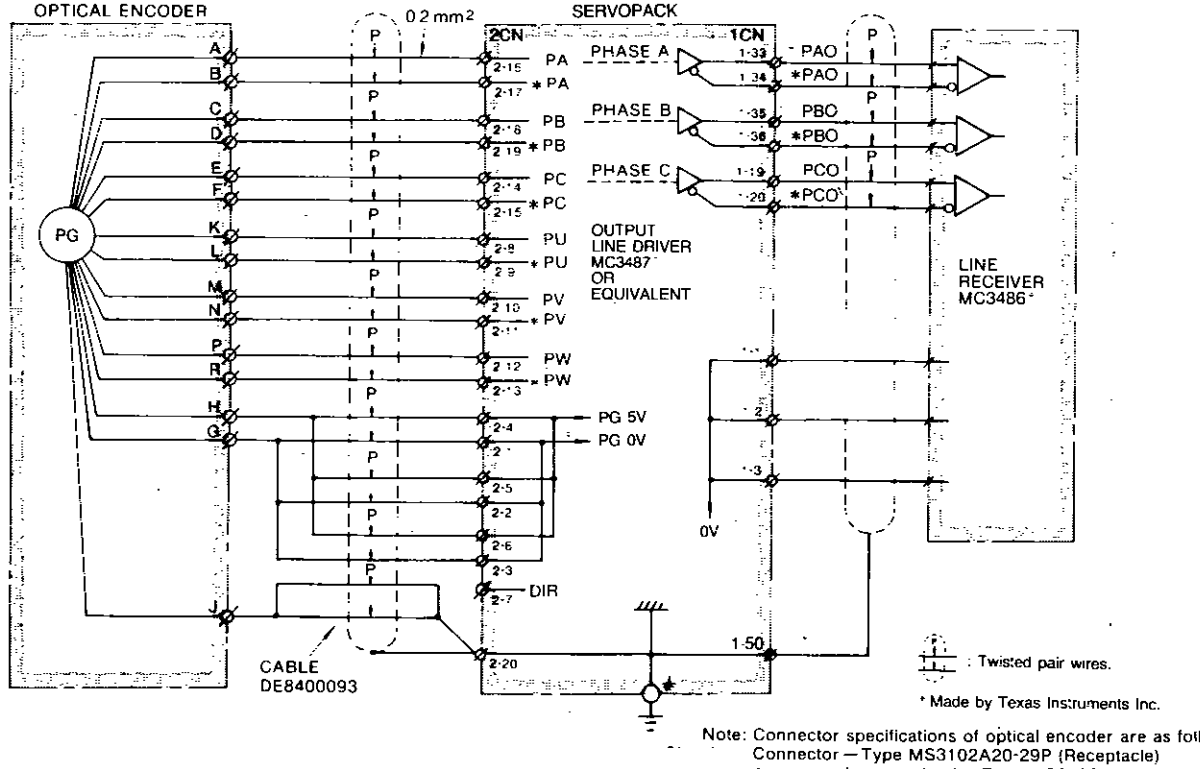
Table 5.8 Connector 2CN Layout of SERVOPACK

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



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

Fig. 5.4 Soldered Type Connector 2CN Connection and 1CN Output Processing (when using Connection Cable DP8401923)



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

Fig. 5.5 Caulking Type Connector 2CN Connection and 1CN Output Processing (when using Connection Cable DE8400093)

6. OPERATION

6.1 POWER ON AND OFF

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

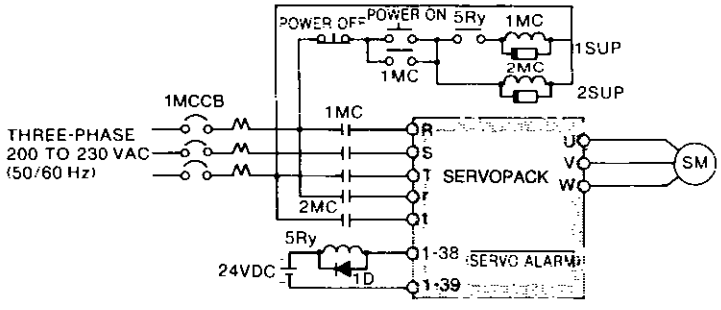
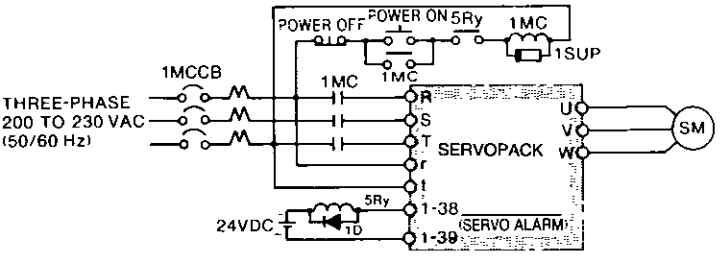


Fig. 6.1 Connection Example for Simultaneous Control Power ON/OFF



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

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

Arrange the sequence so that the power is simultaneously OFF (including momentary power failure) (Fig. 6.1), or the power to the main circuit is OFF first, then the control circuit (Fig. 6.2). The order is the reverse of the power ON sequence. Precautions for connections in Figs. 6.1 and 6.2 are as follows.

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

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

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

NOTE

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

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

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

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

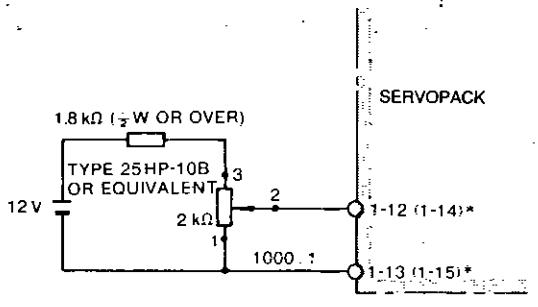
6.2 SPEED REFERENCE

6.2.1 Speed Reference Circuit

From the SERVOPACK built-in control power (1CN-⑯, ㊽: +12V, 1CN-⑰, ㉜, ㊼, ㊾: 0V, 1CN-㉝, ㊻: -12V) or the external power, the speed reference voltage is given to 1CN-⑫ and ⑬ or to 1CN-⑭ and ⑮. When the SERVOPACK built-in control power is used, the motor speed fluctuates in the range of ±2% of the speed set value.

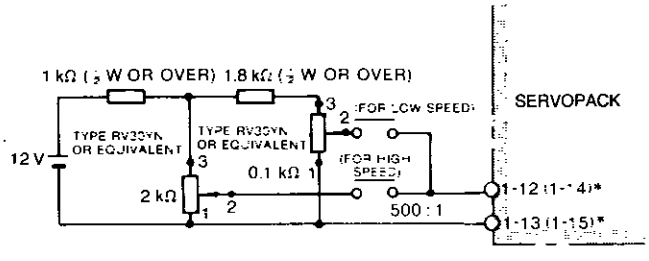
The method for giving speed reference voltage is described below.

(1) For accurate (inching) speed setting



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

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



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

Low-and high-speed relays : Reed relays (PG series) made by Nippon Electric or equivalent, or low-level relay (G₂A-432) made by Tateishi Electric or equivalent.

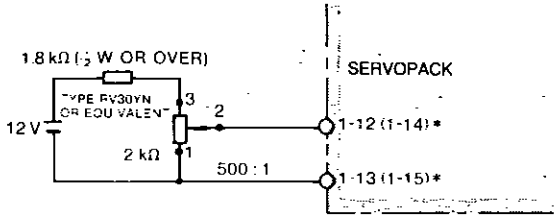
Note : When a carbon resistor is used, great residual resistance remains, so the speed control range becomes approximately 500 :1

(b) When Carbon Variable Resistor is used

* Parentheses are for auxiliary input.

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

(2) For relatively rough speed setting



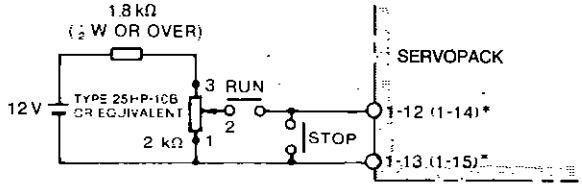
* Parentheses are for auxiliary input.

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

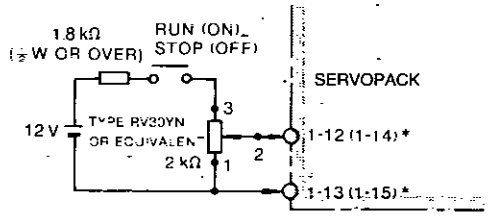
Fig. 6.4 Method for Giving Speed Reference Voltage (for relatively Rough Speed Setting as compared with Fig. 6.3)

6.2.2 Stop Reference Circuit

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



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



(b) When Carbon Variable Resistor is used

* Parentheses are for auxiliary input.

Fig. 6.5 Method for Giving Stop Reference

6.2.3 Handling of Speed Reference Input Terminal

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

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

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

· Adjustment procedures

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

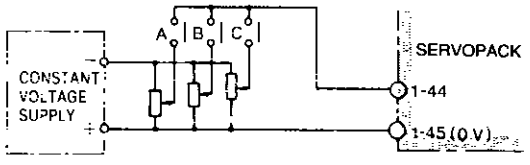
When combined with YASKAWA POSITIONPACK in positioning system drive, auxiliary input terminals are normally used as speed reference input. In this case, positioning loop gain is adjusted with the potentiometer [INB 1] [INB 2]. For adjustment, be sure to refer to POSITIONPACK instruction manuals.

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

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

- To protect the motor from 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. 6.6). 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. 6.6 Multi-stage Switching of Current Value at Forward Side

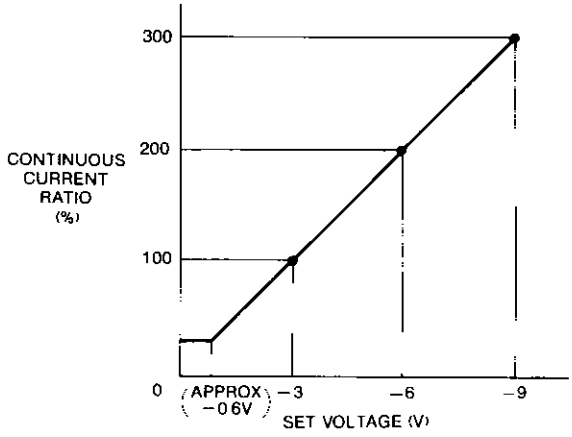
6.3.1 Method of Giving External Current Limit Reference

Forward current and reverse current can be controlled independently. The forward current can be controlled by giving a reverse voltage (0 to −9.0 V) between SERVOPACK terminals 1CN-㊸ and ㊺; the reverse current can be controlled by a forward voltage (0 to +9.0V) between terminals 1CN-㉙ and ㉚.

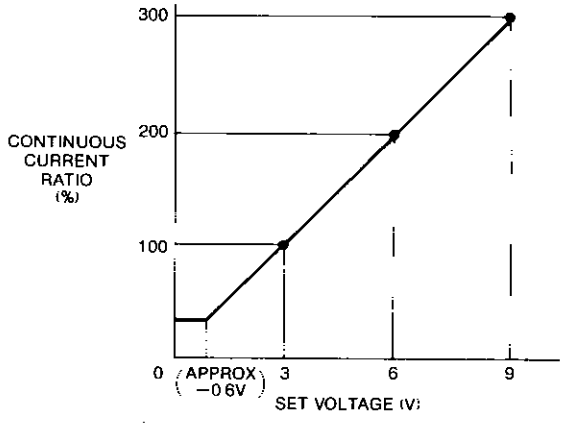
The relation between the rated current of the motor and current limit values is rated current at 3.0V for applicable motor. The power supply must use an internal resistance less than 2kΩ. The input resistance at SERVOPACK side must be greater than 5kΩ. When external current is not restricted, contacts between terminals 1CN-㊹ and ㊻ and between 1CN-and ㉙ and ㉚ are opened.

6.3.2 Set Voltage and Current Limit Values

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



(a) Current Limit at Forward Side



(b) Current Limit at Reverse Side

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

Fig. 6.7 Set Voltage and Current Limit Values

6.3.3 Current Limit when Motor is Locked

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

Note that when the speed reference voltage is less than tens or so millivolts (affected by setting of GAIN of 4VR, 6VR and SW3), the motor lock current sometimes pulsates. If this is not desirable, the current pulsation can be removed by increasing the speed reference voltage.

6.4 CONFIGURATION OF I/O CIRCUITS

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

6.4.1 Input Circuit

There are five input signals: Servo ON, proportional drive reference, forward/reverse overtravel protection, alarm reset. Construct the input circuit using 24V power supply (Fig. 6.8). Typical circuits are shown in Fig. 5.3.

NOTE

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

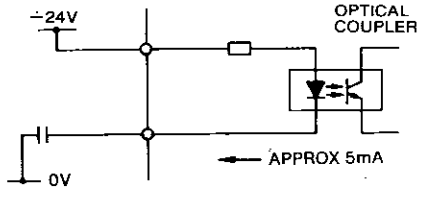


Fig. 6.8 Configuration of Input/Output Circuits

(1) Proportional Drive Reference [$\overline{\text{P-CON}}$]

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

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

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

NOTE

When the overtravel prevention circuit is not used, connect 1CN-㉘ and ㊶ to the 0V terminal of the external 24V power supply.

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

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

NOTE

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

(4) Alarm reset [ALRES]
This signal is used to reset the alarm of SERVOPACK. After the status of alarm is checked, turns ON this signal by switch (ON at 10 μs or more), at Servo OFF.

6.4.2 Output Circuit

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

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

Applied Voltage (Vmax) ≦30V

Conduction Current (Ip) ≦100mA

NOTE

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

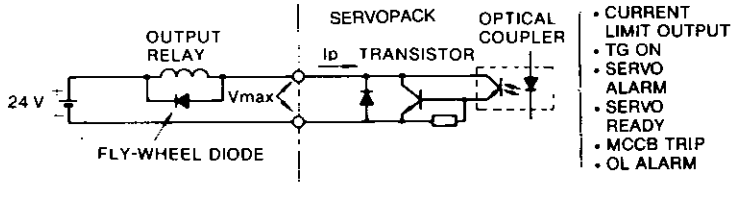


Fig. 6.9 Output Circuit

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

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

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

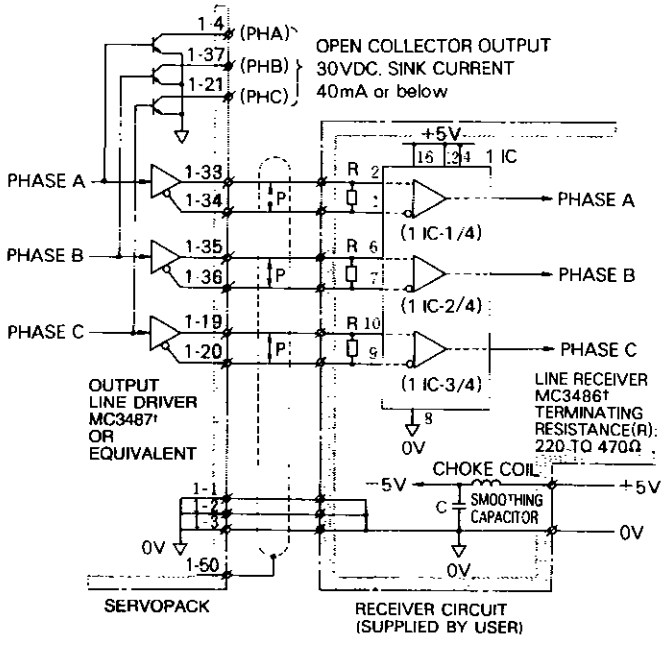
(1) Signal form

·Two-phase pulse with 90° pulse difference (phases A and B)

·Original point pulse (phase C)

(2) Output circuit and receiver circuit

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

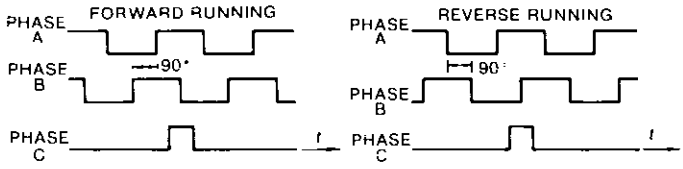


P : Twisted pair wires

*Made by Texas Instruments Inc.

Fig. 6.10 Line Driver Output Circuit

(3) Output phase



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

Fig. 6.11 Output Phase

(4) Pulse resolution

The pulse frequency of the PG can be further divided into 1/N (N=1 to 64) or 2/N (N=2 to 64) by using the divider in the SERVOPACK. The phase relation is the same as in (3), above. Set the pulse frequency dividing ratio according to Table 6.1.

The dividing ratio must be able to divide the pulses of the optical encoder. For example, in an optical encoder of 5000 pulses/rev, 1/3, 1/6, or 1/7 cannot be used. Fig. 6.12 shows the optical encoder output waveform under the dividing pulse frequency.

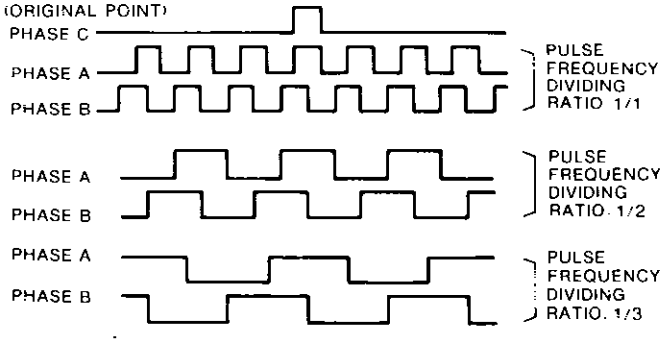


Fig. 6.12 Output Waveform of Optical Encoder

Table 6.1 Setting of PG Pulse Frequency Dividing Ratio

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

6.5 PROTECTIVE CIRCUIT

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

(1) Dynamic brake function

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

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

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

(2) Trouble detecting functions

Table 6.2 Fault Detecting Functions

Trouble	Detection
Overcurrent	Overcurrent flow in the main circuit (at 1.2 times min. inst max current.)
Circuit Protector Trip	Circuit protecter tripped
Regeneration Trouble	Regenerative circuit not activated in SERVOPACK.
Overvoltage	Excessively high DC voltage in the main circuit (approx 420V.)
Overspeed	Excessively large speed reference input.
Voltage Drop	Low DC voltage in the main circuit after power ON. (150V or less.)
Overload	Overload condition of motor and SERVOPACK.
A/D Error	Element error on the printed circuit board of SERVOPACK.
Open Phase	Any one phase open in three-phase power supply.
Overrun Prevention	Wrong wiring of motor circuit or PG signal line.
CPU Error	Any error of CPU

(3) Overload (OL) detection level

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

(4) Servo alarm output [ALM+, ALM−]

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

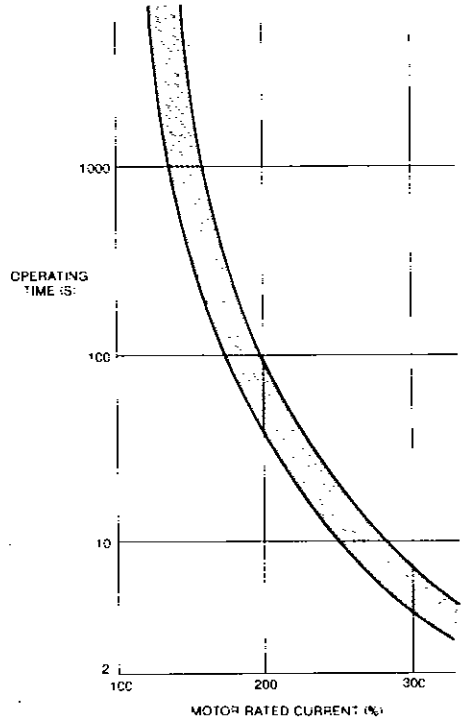


Fig. 6.13 Overload Characteristics

(5) Protective circuit operation

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

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

CAUTION

When an alarm signal cuts OFF only the main circuit, set the speed reference to 0V before supplying power to the main circuit to resume the operation.

(6) Resetting servo alarm

To reset the servo alarm, depress the RESET (blue pushbutton switch) on the panel in the SERVOPACK, or turn ON the alarm reset (ALMRST) signal of input signal.

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

6.6 LED INDICATION

Table 6.3 LED Status Indications (Green)

LED Name		Conditions	
Power	MP	SERVOPACK main circuit voltage (200VDC or more) is proper	
	P	SERVOPACK control circuit voltage (+5V) is proper.	
Servo ON	S-ON	SERVO ON signal is turning ON.	
Speed Reference Input	IN	Speed reference (approx 60 mV or more) is input.	
Encoder Pulses	Aϕ	PG-phase A pulse	Frequency dividing output by SW2
	Bϕ	PG-phase B pulse.	
	Cϕ	PG-phase C (origin) pulse.	

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

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

6.7 PRECAUTIONS FOR APPLICATION

6.7.1 Overhanging Loads

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

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

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

6.7.2 Load Inertia (GD^2)

The allowable load inertia GD^2 converted to the motor shaft must be within five times the inertia of the applicable AC SERVOMOTOR. If the allowable inertia is exceeded, an overvoltage alarm may be given during deceleration. If this occurs, take the following actions :

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

For details, contact your YASKAWA representative.

6.7.3 High Voltage Line

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

6.8 PRECAUTIONS OF OPERATION

6.8.1 Noise Control

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

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

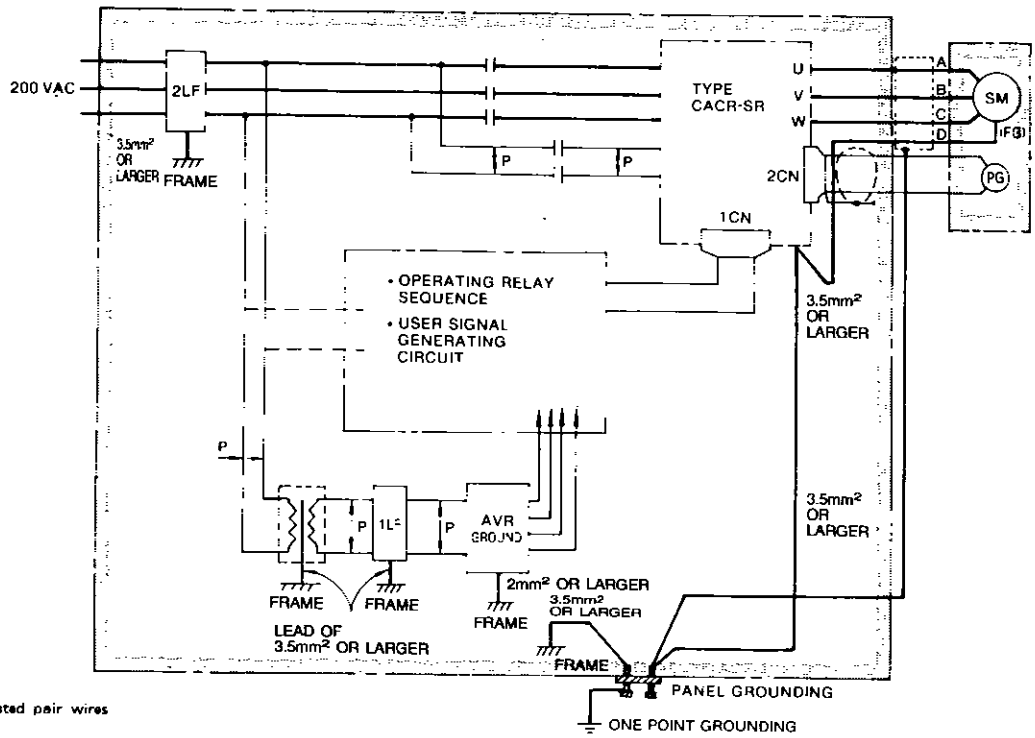
(1) Grounding method (**Fig. 6.14**)

- Motor frame grounding

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

- SERVOPACK SG 0V

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



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. 6.14 Grounding Method

(2) Noise filter installation

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

NOTE

If the noise filter connection is wrong, the effect decreases greatly. Observing the precautions, carefully connect them as shown in Figs. 6.14 to 6.17.

Table 6.5 Recommended Noise Filter

SERVOPACK Type CACR-	Applicable Noise Filter	Recommended Noise Filter	
		Type	Specifications
SR03BC SR05BC	CORRECT	LF-305	Three-phase 200VAC class, 5A
SR07BC		LF-310	Three-phase 200VAC class, 10A
SR10BC SR15BC		LF-315	Three-phase 200VAC class, 15A
SR20BC	WRONG	LF-320	Three-phase 200VAC class, 20A
SR30BC		LF-330	Three-phase 200VAC class, 30A
SR44BC		LF-340	Three-phase 200VAC 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.

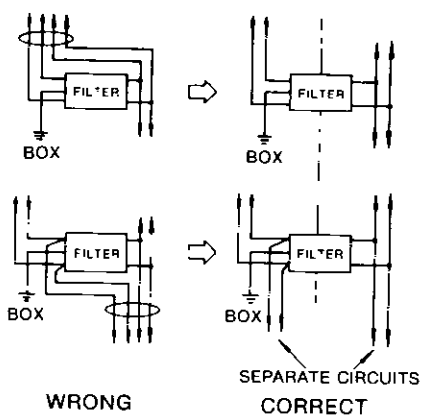


Fig. 6.15

6.8.1 Noise Control (Cont'd)

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

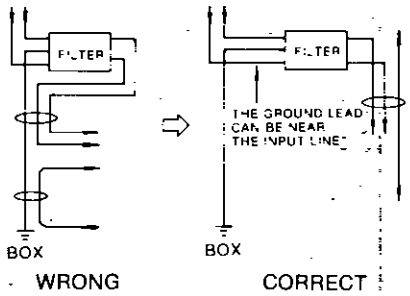


Fig. 6.16

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

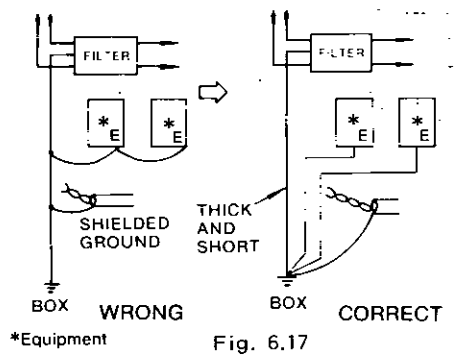


Fig. 6.17

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

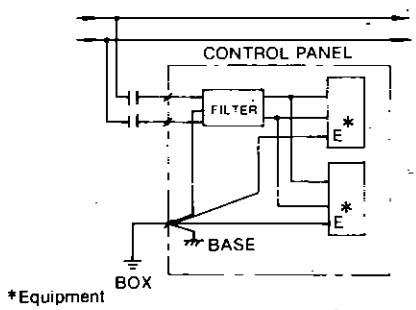


Fig. 6.18

6.8.2 Power Line Protection

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

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

Table 6.6 Power Supply Capacity and MCCB or Fuse Capacity

SERVOPACK Type CACR-	Power Capacity* per SERVOPACK	Current Capacity per MCCB or Fuse
SR03BC	0.65kVA	5A
SR05BC	1.1kVA	5A
SR07BC	1.5kVA	8A
SR10BC	2.1kVA	8A
SR15BC	3.1kVA	10A
SR20BC	4.1kVA	12A
SR30BC	6.0kVA	18A
SR44BC	8.0kVA	20A

*Valuse at rated load.

Note: For ground fault detector, specify fast-response type. Do not use a time-delay type.

6.9 APPLICATION

6.9.1 Connection for Reverse Motor Running

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

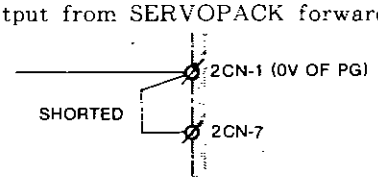


Fig. 6.19

6.9.2 Speed and Torque Measurement

When an instrument is connected to measure speed and torque, make the connection as shown in Fig. 6.20, using a DC ammeter which is ±1 mA (both swing).

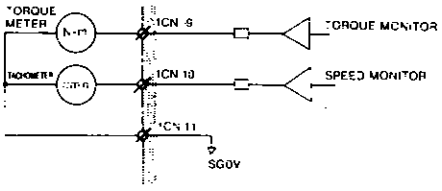


Fig. 6.20 Speed and Torque Measurement

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

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

6.9.3 Application of SERVOMOTORS with Holding Magnetic Brake

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

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

(2) The brake has delay time. For operation timing of ON/OFF, see Fig. 6.21.

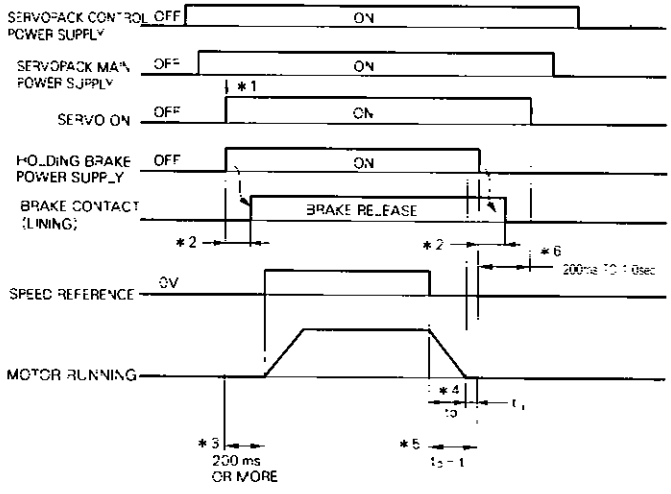


Fig. 6.21 Brake Timing

Timing

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

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

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

*4 t_3 shows motor stopping time and is calculated as follows :

$$t_3 = 0.1047 \times \frac{(J_M + J_L) \times N_M}{(T_P + T_L)} \quad (ms)$$

$J_M (= GD_M^2/4)$: Motor moment of inertia ($kg \cdot m^2 = lb \cdot in \cdot s^2 \times 10^{-3}$)
$J_L (= GD_L^2/4)$: Load moment of inertia ($kg \cdot m^2 = lb \cdot in \cdot s^2 \times 10^{-3}$)
N_M : Motor speed (r/min)
T_P : Motor speed reduction torque (N·m)
T_L : Load torque (N·m)

*5 Turn OFF the brake power supply when the motor stops. For normal operation, $t_2 + t_1$ is approximately 1 to 2 seconds.

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

7. INSTALLATION AND WIRING

7.1 RECEIVING

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

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

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

7.2 INSTALLATION

7.2.1 SERVOMOTOR

AC SERVOMOTOR can be installed either horizontally or vertically.

(1) Before mounting

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

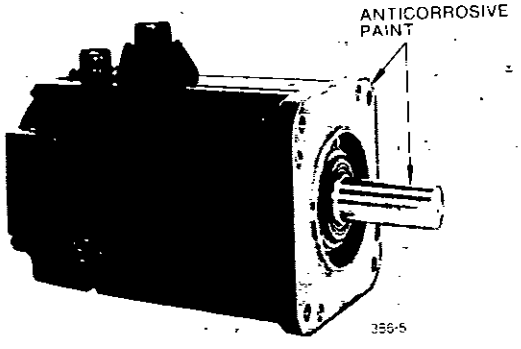


Fig. 7.1 Anticorrosive Paint to be Removed

(2) Location

Use the motor under the following conditions.

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

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

(3) Environmental conditions

Ambient Temperature: 0℃ to +40℃

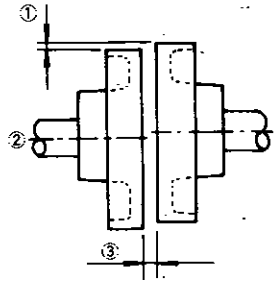
Storage Temperature: -20℃ to +80℃

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

(4) Load coupling

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

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



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

② Align the shafts.

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

Fig. 7.2 Alignment of Coupling

(5) Allowable bearing Load

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

7.2.2 SERVOPACK

(1) Installation

The SERVOPACK type CACR-SR □□BC is rack-mounted type.

(2) Location

- When installed in a panel:

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

- When installed near a heat source:

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

- If subjected to vibration:

  Mount the unit on shock absorbing material.

- If corrosive gases are present:

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

- Unfavorable atmospheric conditions:

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

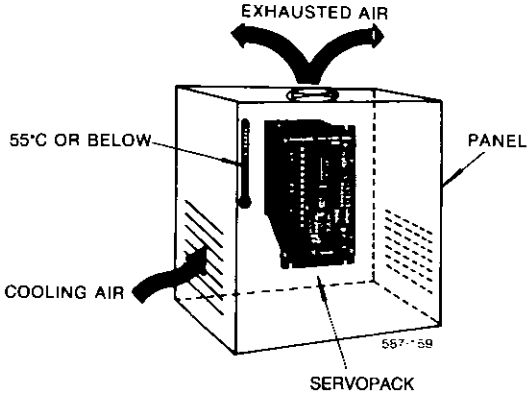


Fig. 7. 3 Typical Layout for Panel Mounting

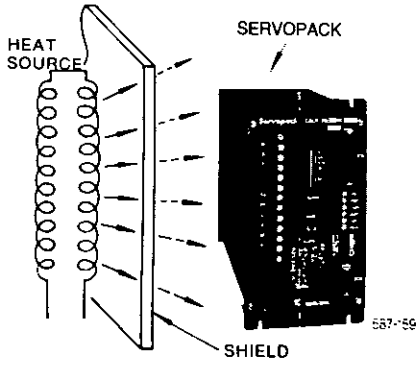
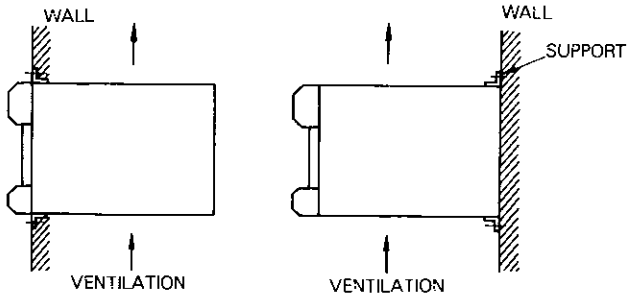


Fig. 7. 4 Protection against Heat Radiation

(3) Mounting Direction

Mount the SERVOPACK unit vertically on the wall with main teminals being bottom to take advantage of natural air convection. (See Fig. 7.5(a).) Install it with setscrews tightened at four mounting holes in the unit base. To change to base-mounted type, change the support position as shown in fig. 7.5(b). Mouting screws of base support are attached to the SERVOPACK.



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

Fig. 7.5 Mounting Direction

7.3 WIRING

7.3.1 Rated Current and Cable Size

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

Table 7.1 Rated Current

External Terminal		Type CACR- / Symbo	Rated Current A (Effective Current)							
			SR03BC	SR05BC	SR07BC	SR10BC	SR15BC	SR20BC	SR30BC	SR44BC
On Line	Main Circuit Power Input	R, S, T	2	5	6	6	10	12	18	24
	Motor Connection	U, V, W	3.0	3.5	5.8	7.6	11.7	18.9	26.0	33.0
	Control Power Input	r, t	0.5A							
Off Line	Control I/O Signal Connector	1CN	100mA DC max							
	PG Signal Connector	2CN	100mA max (500mA DC for power line only)							
	Ground	⏚	—							

Table 7.2 Recommended Cable Size of SERVOPACK

External Terminal		Type CACR- / Symbol	Cable Size mm²							
			SR03BC	SR05BC	SR07BC	SR10BC	SR15BC	SR20BC	SR30BC	SR44BC
On Line	Main Circuit Power Input	R, S, T	HIV 2.0 or more				HIV 3.5 or more		HIV 5.5 or more	
	Motor Connection	U, V, W	HIV 2.0 or more				HIV 3.5 or more			
	Control Power Input	r, t	HIV 1.25 or more							
Off Line	Control I/O Signal Connector	1CN	•Two-core twisted shielded cable •Core must be 0.2mm² or more •Tin-plated soft-copper twister 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							

7.3.1 Rated Current and Cable Size (Cont'd)

Table 7.3 Cable

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

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

7.3.2 Wiring Precautions

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

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

Cable length is a maximum of 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. If the motor and machine are insulated, ground the motor.

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

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

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

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

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

7.3.3 Power Loss

The power loss of SERVOPACK is shown in Table 7.4.

Table 7.4 Power Loss st Rated Output

SERVOPACK Type CACR-	Output Current	Power Loss			
		Main Circuit W	Regenerative Resistance W	Control Circuit W	Total W
SR03BC	3.0	20	10	60	90
SR05BC	4.2	40			110
SR07BC	5.8	60	20		140
SR10BC	7.6	70			150
SR15BC	11.7	80			160
SR20BC	18.8	100	40		200
SR30BC	26.0	160	80		300
SR44BC	33.0	210	100		370

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

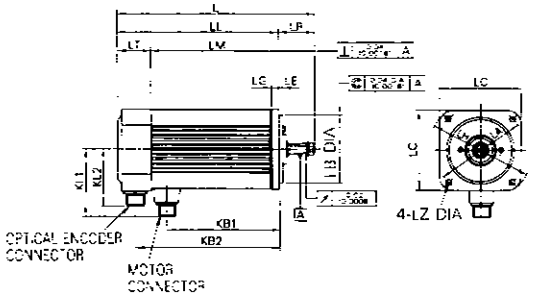
8. DIMENSIONS in mm (inches)

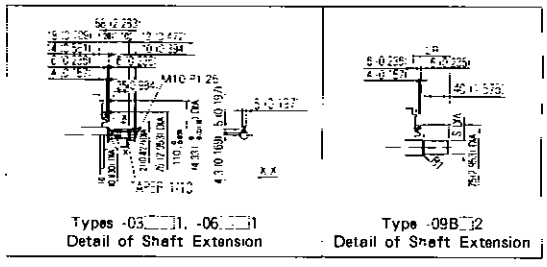
8.1 SERVOMOTOR : M SERIES

(1) Standard

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

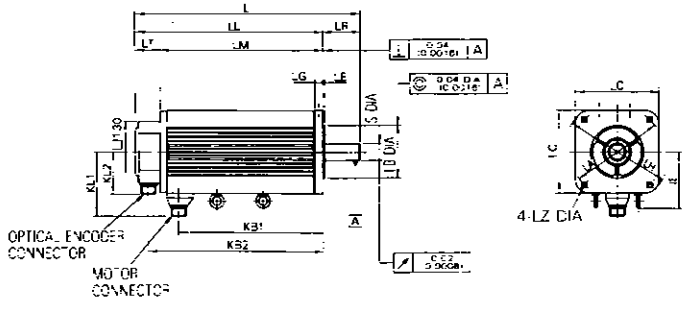
Drawing 1

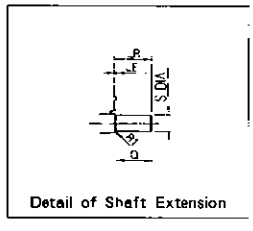




Types USAMED-12B□□2 to -44B□□2 (Straight Shaft)

Drawing 2





AC SERVOMOTOR Type	Dwg No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface LA	LB	LC	LE	LG	LH	LZ
USAMED-03i□□1*	1	263 (10.354)	205 (8.071)	150 (5.906)			127 (5.0)	177 (6.969)										
USAMED-06□□□1*	1	320 (12.60)	262 (10.315)	207 (8.150)	58 (2.283)	55 (2.165)	184 (7.244)	234 (9.212)	—	109 (4.291)		145 (5.709)	110 $^{0}_{-0.035}$ (4.331 $^{0}_{-0.0014}$)	130 (5.118)	6 (0.236)	12 (0.472)	165 (6.496)	9 (0.354)
USAMED-09Bi□2*	1	389 (15.315)	331 (13.031)	276 (10.866)			253 (9.96)	303 (11.929)										
USAMED-12Bi□2*	2	344 (13.543)	265 (10.433)	211 (8.307)			172 (6.772)	237 (9.331)			92 (3.622)							
USAMED-20Bi□2	2	401 (15.787)	322 (12.677)	268 (10.551)	79 (3.11)	54 (2.126)	229 (9.016)	294 (11.575)		139 (5.472)		200 (7.874)	114.3 $^{0}_{-0.035}$ (4.5 $^{0}_{-0.0014}$)	180 (7.087)	3.2 (0.126)	18 (0.709)	230 (9.055)	13.5 (0.531)
USAMED-30B□2	2	486 (19.134)	407 (16.024)	353 (13.898)			314 (12.362)	379 (14.921)	123 (4.843)									
USAMED-44B□2	2	688 (27.087)	578 (22.756)	524 (20.630)	110 (4.331)		476 (18.74)	550 (21.654)		149 (5.866)		240 (9.449)						

AC SERVOMOTOR Type	Dwg No.	Shaft Extension S	Shaft Extension Q	Approx Mass kg (lb)	Motor Connector Types: Receptacle	L-type Plug	Straight Plug	Cable Clamp	Optical Encoder Connector Types: Receptacle	L-type Plug	Straight Plug	Cable Clamp
USAMED-03□□1*	1	See Drawing 1.		8.5 (18.7)	MS 3102 A 18 - 10 P	MS 3108 B 18 - 10 S	MS 3106 B 18 - 10 S	MS 3057 - 10 A				
USAMED-06□□1*	1			13 (28.7)								
USAMED-09B□2*	1	22 $^{0}_{-0.013}$ (0.866 $^{0}_{-0.0005}$)	40 (1.575)	20 (44.1)								
USAMED-12Bi2*	2	35 $^{+0.01}_{-0.018}$ (1.378 $^{+0.0004}_{-0.0007}$)	76 (2.992)	22 (48.5)	MS 3102 A 22 - 22 P	MS 3108 B 22 - 22 S	MS 3106 B 22 - 22 S	MS 3057 - 12 A	MS 3102 A 20 - 29 P	MS 3108 B 20 - 29 S	MS 3106 B 20 - 29 S	MS 3057 - 12 A
USAMED-20B□2	2			29 (63.9)								
USAMED-30B□2	2			41 (90.4)								
USAMED-44Bi2	2	42 $^{0}_{-0.016}$ (1.654 $^{0}_{-0.0006}$)	110 (4.331)	66 (145)	MS 3102 A 32 - 17 P	MS 3108 B 32 - 17 S	MS 3106 B 32 - 17 S	MS 3057 - 20 A				

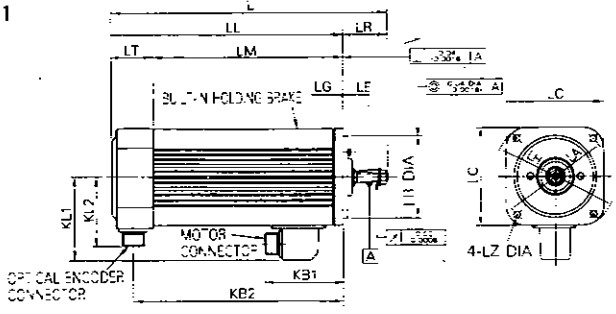
*Not provided with an eyebolt.

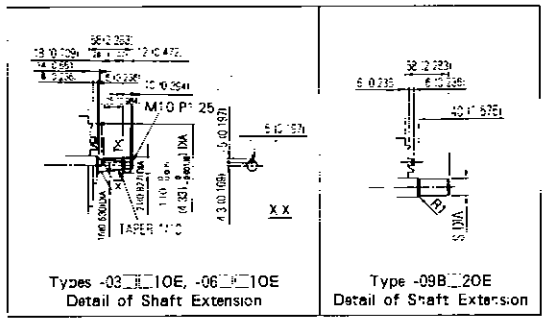
Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: A (6000 P/R)
   Optional : B (5000 P/R), D (4000 P/R)
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.

(2) With Brake

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

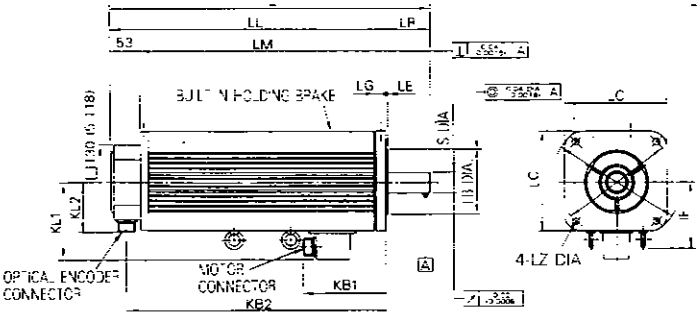
Drawing 1

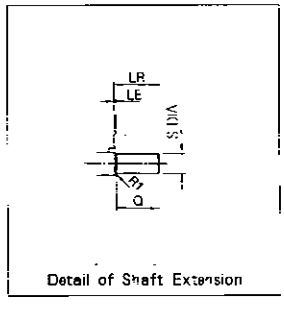




Types USAMED-12B□2OE to -30B□2OE

Drawing 2





AC SERVOMOTOR Type USAMED-	Dwg No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface LA	LB	LC	LE	LG	LH	LZ	Shaft Extension S	Q
03□□1OE*	1	320 (12.598)	262 (10.315)	207 (8.150)			128 (5.039)	234 (9.213)												
06□□1OE*	1	366 (14.409)	308 (12.126)	253 (9.961)	58 (2.283)	55 (2.165)	118 (4.646)	280 (11.024)	—	113 (4.449)	92 (3.622)	145 (5.709)	110 $^{0}_{-0.035}$ ($4.331^{0}_{-0.0014}$)	130 (5.118)	6 (0.236)	12 (0.472)	165 (6.496)	9 (0.354)	21 (0.827)	28 (1.102)
09B□2OE*	1	436 (17.165)	378 (14.882)	323 (12.717)				350 (13.780)											22 $^{0}_{-0.033}$ ($0.866^{0}_{-0.0013}$)	40 (1.575)
12B□2OE	2	422 (16.614)	343 (13.504)	289 (11.378)				315 (12.402)												
20B□2OE	2	486 (19.134)	407 (16.024)	353 (13.898)	79 (3.110)	54 (2.126)	164 (6.457)	379 (14.921)	123 (4.842)	143 (5.630)	114 (4.488)	200 (7.874)	114.3 $^{0}_{-0.035}$ ($4.5^{0}_{-0.0014}$)	180 (7.087)	3.2 (0.126)	18 (0.709)	230 (9.055)	13.5 (0.531)	35 $^{+0.018}_{+0.002}$ ($1.378^{+0.0007}_{+0.0001}$)	76 (2.992)
30B□2OE	2	567 (22.323)	488 (19.213)	434 (17.087)				460 (18.110)												

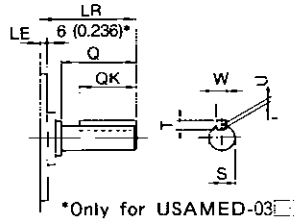
AC SERVOMOTOR Type USAMED-	Dwg No.	Approx. Mass kg (lb)	Magnetic Brake Wattage W	Magnetic Brake Inertia kg·m² (lb·in·s²)	Magnetic Brake Static Friction Torque N·m (lb·in)	Connector Types for Motor and Brake Receptacle	L-type Plug	Straight Plug	Cable Clamp	Optical Encoder Connector Types Receptacle	L-type Plug	Straight Plug	Cable Clamp
03□□1OE*	1	11.5 (25.4)	18	3.85×10^{-4} (8.52×10^{-3})	5.88 (52.1)	MS 3102 A20 - 15P	MS 3108 B20 - 15S	MS 3106 B20 - 15S	MS 3057 - 12A	MS 3102 A20 - 29P	MS 3108 B20 - 29S	MS 3106 B20 - 29S	MS 3057 - 12A
06□□1OE*	1	15 (33.1)											
09B□2OE*	1	23 (50.7)	18	9.5×10^{-4} (7.97×10^{-3})	8.83 (78.1)								
12B□2OE	2	30 (66.1)	31	5.25×10^{-4} (55.3×10^{-4})	35.3 (312.5)	MS 3102 A24 - 10P	MS 3108 B24 - 10S	MS 3106 B24 - 10S	MS 3057 - 16A				
20B□2OE	2	37 (81.6)											
30B□2OE	2	49 (108)											

*Not provided with an eyebolt.

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

(3) Shaft Extension of Straight Shaft with Keyway

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



AC SERVOMOTOR Type USAMED- Without Brake	With Brake	LR	LE	Shaft Extension S	Q	QK	T	U	W
03□□2K	03□□2KE	58 (2.283)	6 (0.236)	19 $^{0}_{-0.013}$ ($0.748^{0}_{-0.0005}$)	40 (1.575)	25 (0.984)	5 (0.197)	3 (0.118)	5 (0.197)
06□□2K	06□□2KE								
09B□2K	09B□2KE			22 $^{0}_{-0.033}$ ($0.866^{0}_{-0.0013}$)			6 (0.236)	3.5 (0.138)	6 (0.236)
12B□2K	12B□2KE	79 (3.110)	3.2 (0.126)	35 $^{+0.018}_{+0.002}$ ($1.378^{+0.0007}_{+0.0001}$)	76 (2.992)	60 (2.362)	8 (0.315)	5 (0.197)	10 (0.394)
20B□2K	20B□2KE								
30B□2K	30B□2KE								
44B□2K	44B□2KB	110 (4.331)		42 $^{0}_{-0.016}$ ($1.654^{0}_{-0.0006}$)	110 (4.331)	90 (3.543)			12 (0.472)

*Only for USAMED-03□□2 to -09B□2

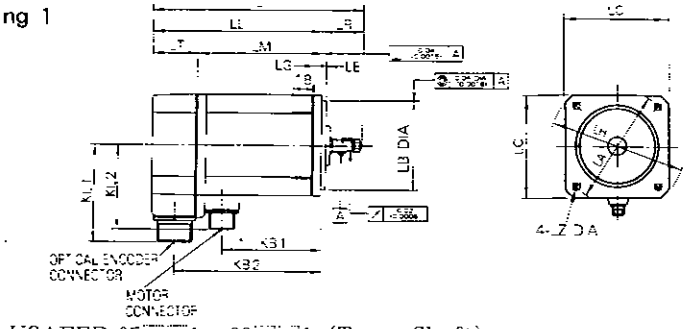
Note: Dimensions of the shaft extension key and keyway are based on JIS (Japanese Industrial Standard) B 1301 "Sunk Keys and Their Corresponding Keyways (Normal keys)." Shaft extension key is furnished.

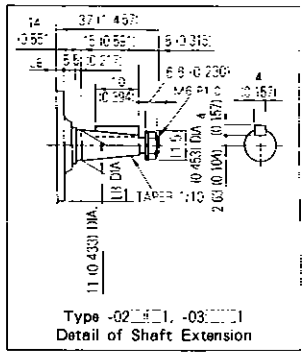
8.2 SERVOMOTOR : F SERIES

(1) Standard

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

Drawing 1

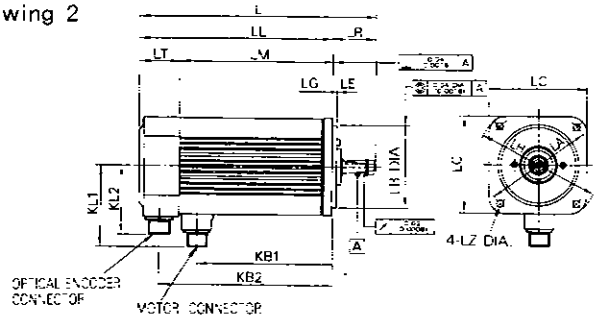


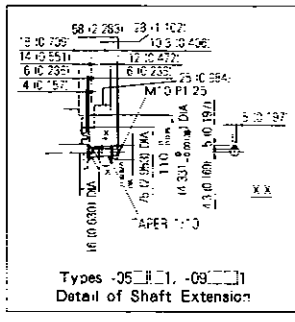


Type -02□□1, -03□□□1
Detail of Shaft Extension

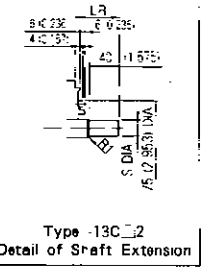
Types USAFED-05□□□1, -09□□□1 (Taper Shaft)
-13C□□2 (Straight Shaft)

Drawing 2





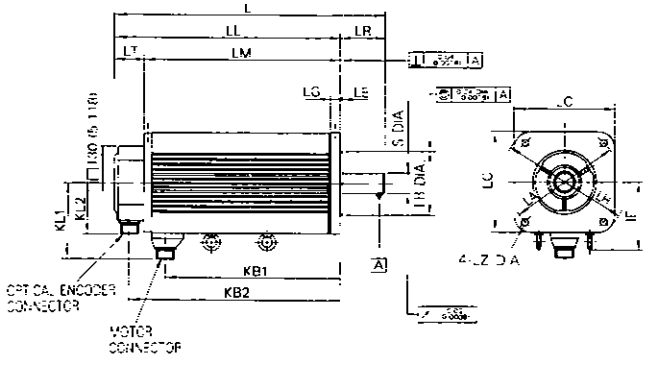
Types -05□□1, -09□□□1
Detail of Shaft Extension

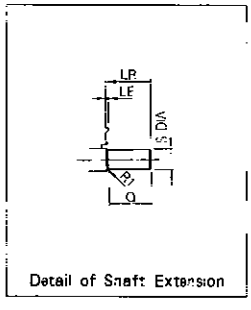


Type -13C□2
Detail of Shaft Extension

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

Drawing 3





Detail of Shaft Extension

AC SERVOMOTOR Type USAFED-	Dwg No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	LA	Flange Surface LB	LC	LE	LG	LH	LZ
02□□□1	1	190	153	113	37	40	90	132	—	76	87	100	80 -0.030 (3.150 -0.0012)	90	4	7	120	6.6
03□□□1	1	236	199	159			136	178										
05□□□1 *	2	263	205	150	58	55	127	177	—	109	92	145	110 -0.035 (4.331 -0.0014)	130	6	12	165	9
09□□□1 *	2	320	262	207			184	234										
13C□□2*	2	389	331	276			253	303										
20C□□2*	3	344	265	211	79	54	172	237	123	139		200	114.3 -0.035 (4.5 -0.0014)	180	3.2	18	230	13.5
30C□□2	3	401	322	268			229	294										
44C□□2	3	486	407	353			314	379										

AC SERVOMOTOR Type USAFED-	Dwg No.	Shaft Extension S	Q	Approx Mass kg (lb)	Motor Connector Types Receptacle	L-type Plug	Straight Plug	Cable Clamp	Optical Encoder Types Receptacle	L-type Plug	Straight Plug	Cable Clamp
02□□□1	1	11.5	15	4	MS 3102 A 14 S - 2 P	MS 3108 B 14 S - 2 S	MS 3106 B 14 S - 2 S	MS 3057 - 6 A	MS 3102 A 20 - 29 P	MS 3108 B 20 - 29 S	MS 3106 B 20 - 29 S	MS 3057 - 12 A
03□□□1	1			6								
05□□□1 *	2	21	28	8.5	MS 3102 A 18 - 10 P	MS 3106 B 18 - 10 S	MS 3106 B 18 - 10 S	MS 3057 - 10 A				
09□□□1 *	2			13								
13C□□2*	2	22	40	20								
20C□□2*	3	35	76	22	MS 3102 A 22 - 22 P	MS 3108 B 22 - 22 S	MS 3106 B 22 - 22 S	MS 3057 - 12 A				
30C□□2	3	(1.378)		29								
44C□□2	3			41								

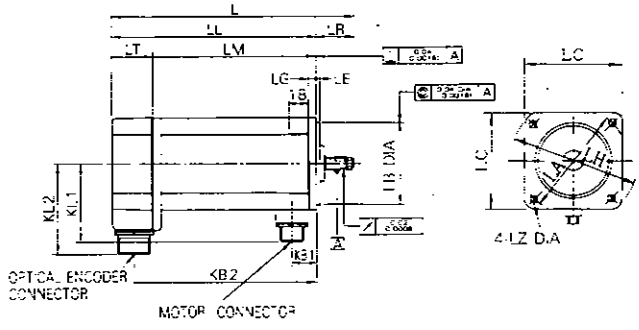
*Not provided with an eyebolt.

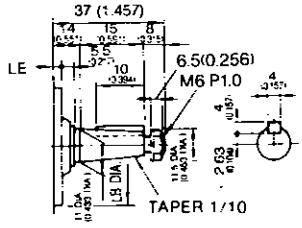
Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: A (6000 P/R)
   Optional: B (5000 P/R), D (4000 P/R)
2. Vibration: 15 μm or below.
3. Plug and clamp are not attached for receptacle connection.

(2) With Brake

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

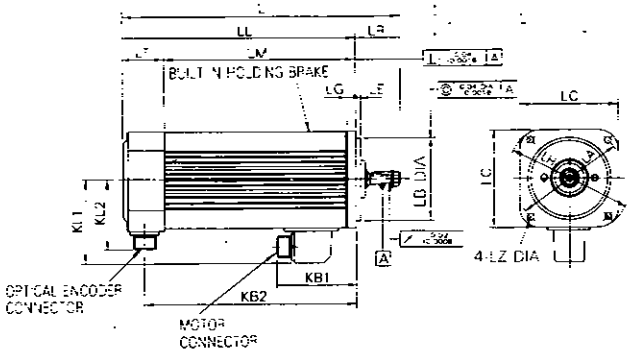
Drawing 1

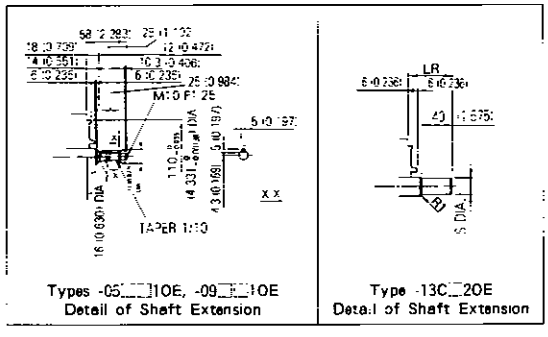




Types USAFED-05□□1OE, -09□□1OE (Taper Shaft)
-13C□2OE (Straight Shaft)

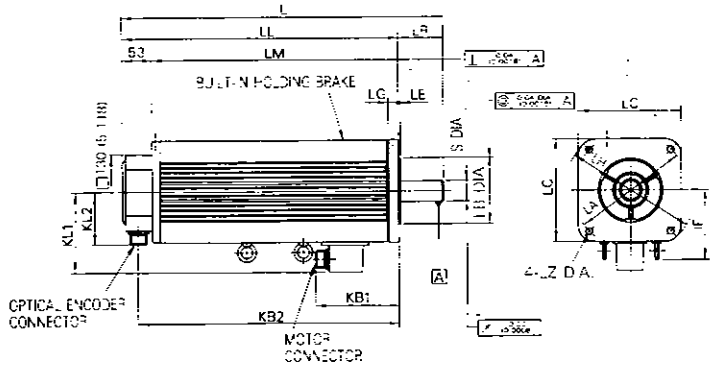
Drawing 2

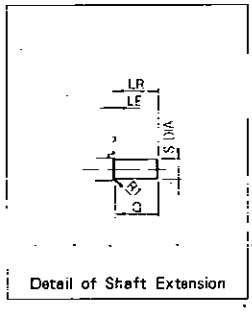




Types USAFED-20C□2OE to -44C□2OE
(Straight Shaft)

Drawing 3





AC SERVOMOTOR Type USAFED -	Dwg No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface LA	LB	LC	LE	LG	LH	LZ	Shaft Extension S	Q
02□□1OE	1	236 (9.291)	199 (7.835)	159 (6.260)	37 (1.457)	40 (1.575)	24 (0.945)	178 (7.008)		76 (2.992)	87 (3.425)	100 (3.937)	80 $^{0}_{-0.030}$ (3.150 $^{0}_{-0.0012}$)	90 (3.543)	4 (0.157)	7 (0.276)	120 (4.724)	6.6 (0.260)	See Drawing 1.	
03□□1OE	1	286 (11.260)	249 (9.803)	209 (8.228)				228 (8.976)												
05□□1OE*	2	320 (12.598)	262 (10.315)	207 (8.150)			128 (5.039)	234 (9.213)	—											
09□□1OE*	2	366 (14.409)	308 (12.126)	253 (9.961)	58 (2.283)	55 (2.165)	118 (4.646)	280 (11.024)		113 (4.449)		145 (5.709)	110 $^{0}_{-0.035}$ (4.331 $^{0}_{-0.0014}$)	130 (5.118)	6 (0.236)	12 (0.472)	165 (6.496)	9 (0.354)	See Drawing 2.	
13C□□2OE*	2	436 (17.165)	378 (14.882)	323 (12.717)				350 (13.780)			92 (3.622)								22 $^{+0.013}_{-0.002}$ (0.866 $^{+0.0005}_{-0.0001}$)	40 (1.575)
20C□□2OE*	3	422 (16.614)	343 (13.504)	289 (11.378)				315 (12.402)												
30C□□2OE	3	486 (19.133)	407 (16.024)	353 (13.898)	79 (3.110)	54 (2.126)	164 (6.457)	379 (14.921)	123 (4.843)	143 (5.630)		200 (7.874)	114.3 $^{0}_{-0.035}$ (4.5 $^{0}_{-0.0014}$)	180 (7.087)	3.2 (0.126)	18 (0.709)	230 (9.055)	13.5 (0.531)	35 $^{+0.018}_{+0.002}$ (1.378 $^{+0.0007}_{+0.0001}$)	76 (2.992)
44C□□2OE	3	567 (22.322)	488 (19.213)	434 (17.087)				460 (18.110)												

AC SERVOMOTOR Type USAFED -	Dwg No.	Approx Mass kg (lb)	Magnetic Brake Wattage W	Inertia kg·m² (lb·in·s²)	Static Friction Torque N·m (lb·in)	Connector Types for Motor and Brake† Receptacle	L-type Plug	Straight Plug	Cable Clamp	Optical Encoder Connector Types Receptacle	L-type Plug	Straight Plug	Cable Clamp
02□□1OE	1	5 (11.0)	8	0.675×10⁻⁴ (0.65×10⁻³)	0.98 (8.67)	MS 3102 A14S-6P	MS 3108 B14S-6S	MS 3106 B14S-6S	MS 3057 - 6 A				
03□□1OE	1	7 (15.4)	12	0.13×10⁻³ (1.15×10⁻³)	1.47 (13.0)								
05□□1OE*	2	11.5 (25.4)	18	0.65×10⁻³ (5.75×10⁻³)	5.88 (52.1)	MS 3102 A20-15P	MS 3108 B20-15S	MS 3106 B20-15S	MS 3057 - 12 A	MS 3102 A20-29P	MS 3108 B20-29S	MS 3106 B20-29S	MS 3057 - 12 A
09□□1OE*	2	15 (33.1)											
13C□□2OE*	2	23 (50.7)	18	0.9×10⁻³ (7.97×10⁻³)	8.83 (78.1)								
20C□□2OE*	3	30 (66.1)	31	6.25×10⁻³ (55.3×10⁻³)	35.2 (312)	MS 3102 A24-10P	MS 3108 B24-10S	MS 3106 B24-10S	MS 3057 - 16 A				
30C□□2OE	3	37 (81.6)											
44C□□2OE	3	49 (108)											

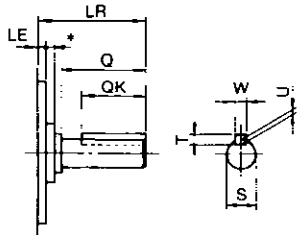
*Not provided with an eyebolt.

Notes:

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

(3) Shaft Extension of Straight Shaft with Keyway

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



AC SERVOMOTOR Type USAFED - Without Brake	With Brake	LR	LE	Shaft Extension S	Q	QK	T	U	W
02□□2K	02□□2KE	37 (1.457)	4 (0.157)	14 $^{0}_{-0.011}$ (0.551 $^{0}_{-0.0043}$)	25 (0.984)	15 (0.591)	5 (0.197)	3 (0.118)	5 (0.197)
03□□2K	03□□2KE								
05□□2K	05□□2KE	58 (2.283)	6 (0.236)	19 $^{0}_{-0.013}$ (0.748 $^{0}_{-0.0051}$)	40 (1.575)	25 (0.984)			
09□□2K	09□□2KE								
13C□□2K	13C□□2KE			22 $^{0}_{-0.013}$ (0.866 $^{0}_{-0.0005}$)			6 (0.236)	3.5 (0.138)	6 (0.236)
20C□□2K	20C□□2KE	79 (3.110)	3.2 (0.126)	35 $^{+0.018}_{0}$ (1.378 $^{+0.0007}_{0}$)	76 (2.992)	60 (2.362)	8 (0.315)	5 (0.197)	10 (0.394)
44C□□2K	44C□□2KE								

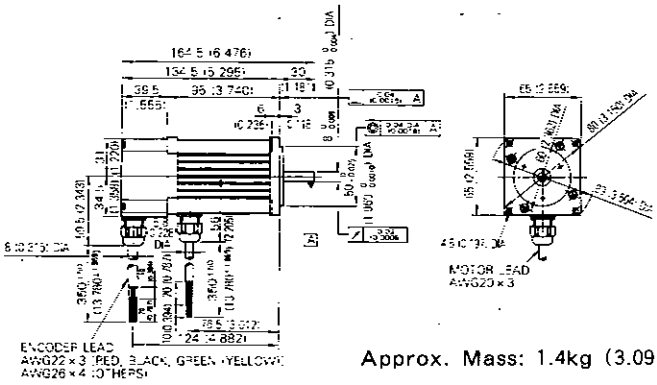
* 4 mm (0.157 in.) for USAFED-02□□2 and 03□□2
  6 mm (0.236 in.) for USAFED-05□□2 to 13C□2

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

8.3 SERVOMOTOR : S SERIES

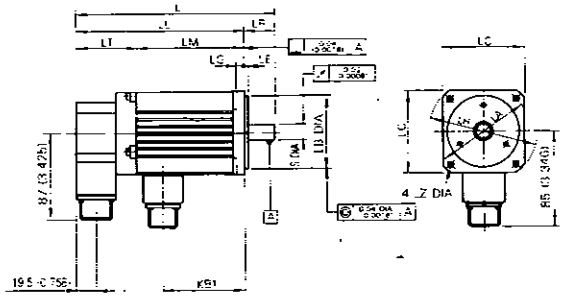
(1) Standard

Type USASEM-02A□2 (Straight Shaft)



Approx. Mass: 1.4kg (3.09lb)

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

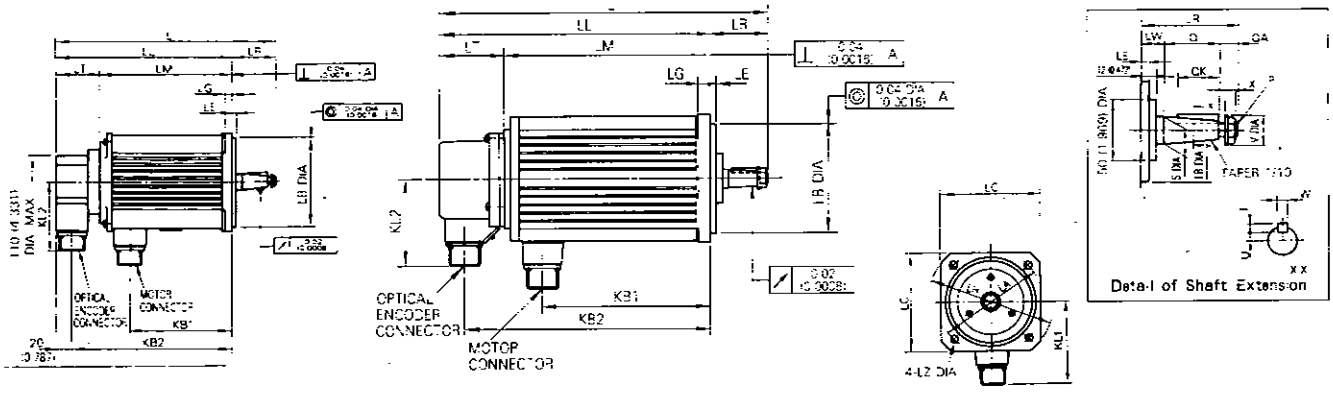


AC SERVOMOTOR Type USASEM-	L	LL	LM	LT	LR	KB1	KL1	Flang Surface and Shaft Extension								Approx Mass kg (lb)
								LA	LB	LC	LE	LG	LH	LZ	S	
03A□2	179	149	110	39	30	78	138	90	70 $^{-3}_{-0.030}$	80	3	8	105	6	14 $^{0}_{-0.011}$	2.6
05A□2	201	171	132			100			(2.756 $^{0}_{-0.0012}$)						(0.551 $^{0}_{-0.0004}$)	3.3

Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: E (1500 P/R)
   Optional : C (2500 P/R), F (1000 P/R)
2. Vibration: 5μm or below.
3. Plug and clamp are not attached for receptacle connection.

Type USASEM-08A□1 (Taper Shaft)

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



AC SERVOMOTOR Type USASEM-	L	LL	LM	LT	LR	KB1	KB2	KL1	KL2	Flang Surface						Shaft Extension									
										LA	LB	LC	LE	LG	LH	LZ	LW	Q	QK	QA	X	S	V	P	U	W	T
08A□1	258	200	149	51	58	115	180	102	87	130	110 $^{-3}_{-0.035}$	120	3	10	155	9	18	28	25	12	10	16	2	M10 P1.25	4.3 $^{-0.1}_{-0.2}$ (0.169 $^{-0.004}_{-0.008}$)	5	5
15A□1	317.5	259.5	203.5	56		167	240	109	96	145	(4.331 $^{0}_{-0.0032}$)	130	6	12	165							19			5.8 $^{-0.1}_{-0.2}$ (0.228 $^{-0.004}_{-0.008}$)		
30A□1	366	296	240		70	206	276	134		200	114.3 $^{-0.04}_{-0.08}$ (4.5 $^{-0.0016}_{-0.0032}$)	180		18	230	13.5	20	36	32	14	12.5	22	24	M12 P1.25	6.6 $^{-0.1}_{-0.2}$ (0.260 $^{-0.004}_{-0.008}$)	6	6

Notes:
1. □ in type designation is determined by output pulses (P/R) of optical encoder as follows:
   Standard: C (2500 P/R)
   Optional : E (1500 P/R), F (1000 P/R)
2. Vibration: 5μm or below.
3. Plug and clamp are not attached for receptacle connection.
4. Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1301 "Sunk keys and Their Corresponding keyways (close keys)."

AC SERVOMOTOR Type USASEM-	Approx Mass kg (lb)	Motor Connector Types Receptacle				Optical Encoder Connector Types			
		Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L-type Plug	Straight Plug	Cable Clamp
03A□2	2.6	MS 3102 A 18 -10P	MS 3108 B 18 -10S	MS 3106 B 18 -10S	MS 3057-10A	MS 3102 A 20 -29P	MS 3108 B 20 -29S	MS 3106 B 20 -29S	MS 3057-12A
05A□2	3.3								
08A□1	6	MS 3102 A 20 -4P	MS 3108 B 20 -4S	MS 3106 B 20 -4S	MS 3057-12A				
15A□1	11								
30A□1	24								

(2) With Brake

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

AC SERVOMOTOR TYPE USASEM -	L	LL	LM	Magnetic Brake			Approx Mass kg (lb)
				Type	Inertia kg·m²X10⁻⁴ (lb·in·s²)	Static Friction Torque N·m (lb·in)	
02A□2OB	228 (8.976)	198 (7.795)	137 (5.394)	MCNB10 - 05	0.0825 (0.0735×10⁻⁴)	0.98 (8.674)	2.2 (4.9)
03A□2OB	241 (9.488)	211 (8.307)	150 (5.906)	MCNB10 - 05	0.0825 (0.0735×10⁻⁴)	0.98 (8.674)	3.5 (7.7)
05A□2OB	263 (10.354)	233 (9.173)	172 (6.772)	MCNB15 - 01	0.0825 (0.0735×10⁻⁴)	1.76 (15.523)	4.1 (9.0)

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

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

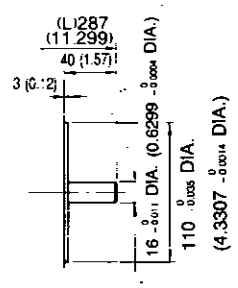
AC SERVOMOTOR Type USASEM -	L	LL	LM	Approx Mass kg (lb)	Magnetic Brake			
					Type	Inertia kg·m²X10⁻⁴ (lb·in·s²)	Static Friction Torque N·m (lb·in)	Voltage VDC
08A□1OB	305 (12.008)	247 (9.724)	146 (5.748)	7 (15.4)	SCFB/90-30	0.5365 (0.4744×10⁻⁴)	2.94 (26)	90
15A□1OB	377.5 (14.862)	319.5 (12.579)	197.5 (7.776)	12.5 (27.6)	RNB0.6K-12	0.875 (0.7744×10⁻⁴)	5.88 (52)	90
30A□1OB	432 (17.008)	362 (14.252)	240 (9.449)	25.5 (56.2)	SCFB/90-120	0.672 (0.5945×10⁻⁴)	11.76 (104)	90

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

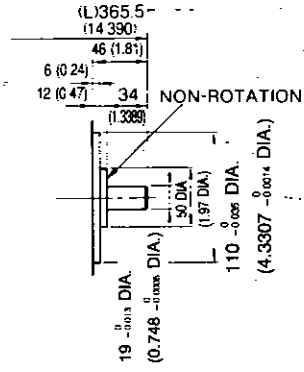
(3) Shaft Extension of Straight Shaft

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

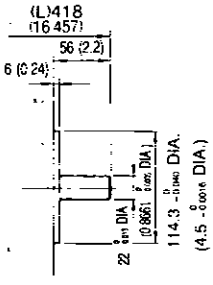
• With brake
Type USASEM-08A□2OB



• With brake
Type USASEM-15A□2OB



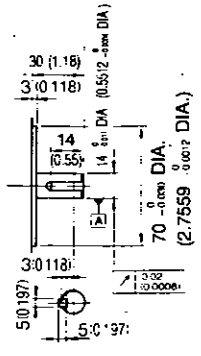
• With brake
Type USASEM-30A□2OB



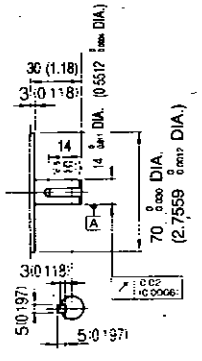
(4) Shaft Extension of Straight Shaft with Keyway

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

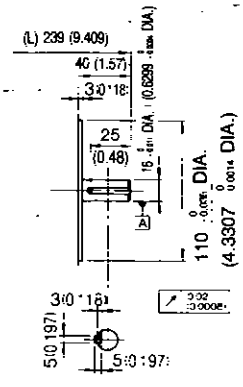
• Without brake
Types USASEM-03A□2K,
-05A□2K



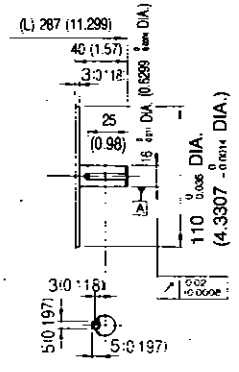
• With brake
Types USASEM-03A□2KB
-05A□2KB



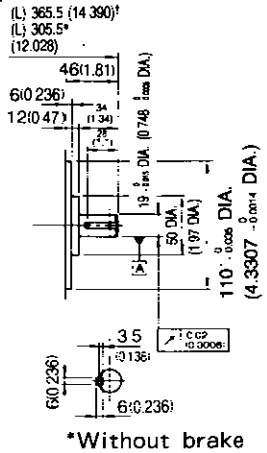
• Without brake
Type USASEM-08A□2K



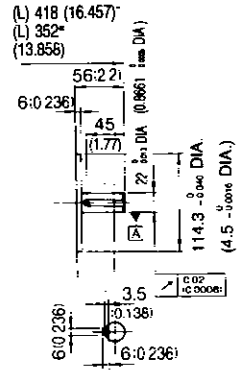
• With brake
Type USASEM-08A□2KB



• Type USASEM-15A□2K*
Type USASEM-15A□2KB†



• Type USASEM-30A□2K*
Type USASEM-30A□2KB†



*Without brake
†With brake

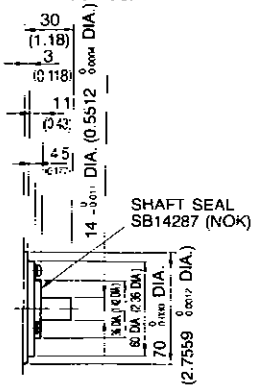
(5) Shaft Extension of Straight Shaft with Shaft Seal

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

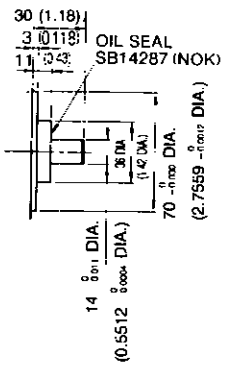
(6) Shaft Extension of Straight Shaft with Keyway and Shaft Seal

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

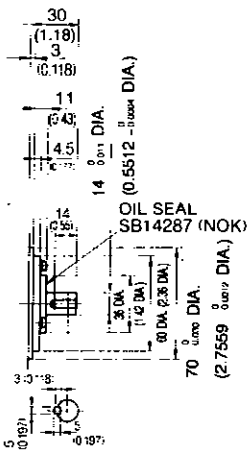
• Without brake
Types USASEM-03A□2S,
-05A□2S



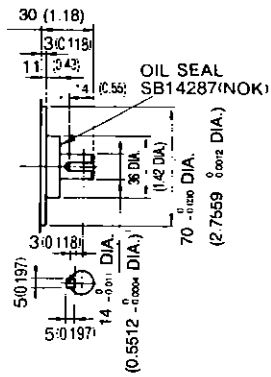
• With brake
Types USASEM-03A□2SB
-05A□2SB



• Without brake
Types USASEM-03A□2T
-05A□2T



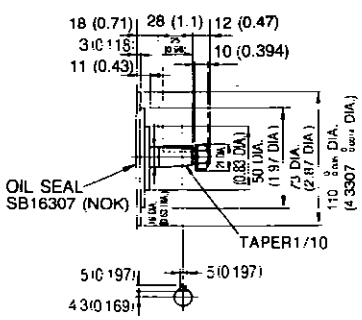
• With brake
Types USASEM-03A□2TB,
-05A□2TB



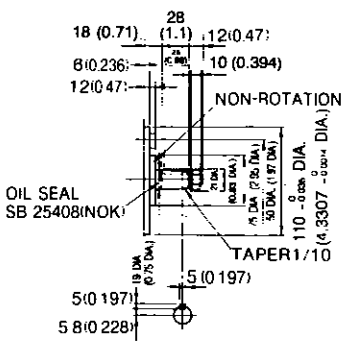
(7) Shaft Extension of Taper Shaft with Shaft Seal

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

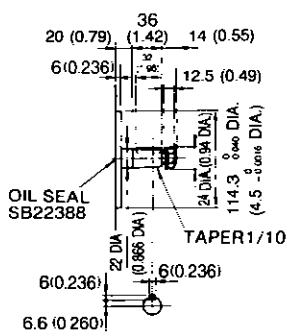
• Without brake
Type USASEM-08A□1S



• Without brake
Type USASEM-15A□1S

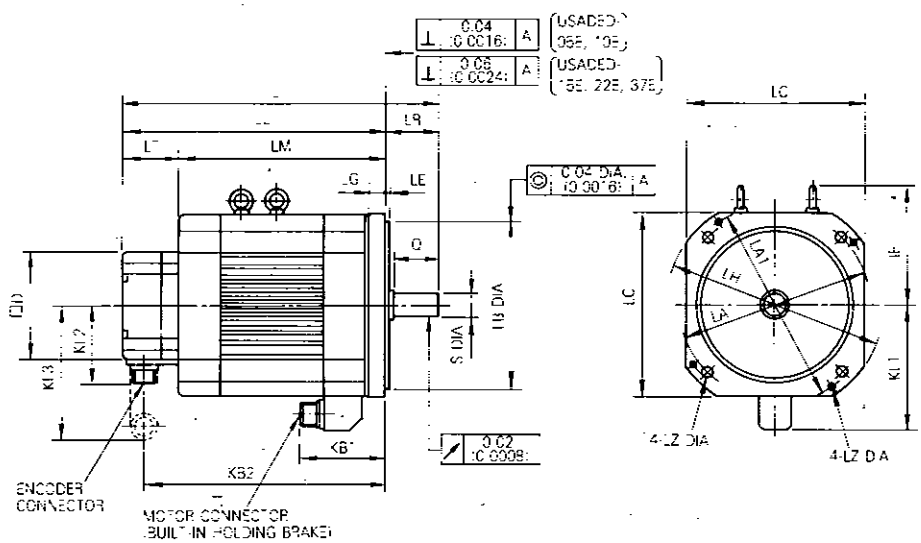


• Without brake
Type USASEM-30A□1S



8. 4 SERVOMOTOR : D SERIES

(1) Standard



AC SERVOMOTOR Type USADED-	L	LL	LM	LR	LT	KB1	KB2	IE	KLi	KL2	KL3	D	Flang Surface and Shaft Extension										Approx Mass kg (lb)
													LA	LA1	LB	LC	LE	LG	LH	LZ	LZI	S	Q	
05E□2OE*	237	182	137	55	45	82	158	—	143	92	164	130	200	—	114.3	180	3.2	12	230	13.5	—	22	50	17
10E□2OE*	257	202	157	55	45	82	178	—	143	92	164	130	200	—	114.3	180	3.2	12	230	13.5	—	22	50	19
15E□2OE*	272	217	170	55	45	100	193	142	143	92	164	130	235	250	200	220	4	16	270	13.5	M8	28	50	30
22E□2OE*	287	232	185	55	45	100	208	142	143	92	164	130	235	250	200	220	4	16	270	13.5	M8	28	50	35
37E□2OE*	347	282	235	65	45	100	258	142	143	92	164	130	235	250	200	220	4	16	270	13.5	M8	32	60	39

*Not provided with an eyebolt.

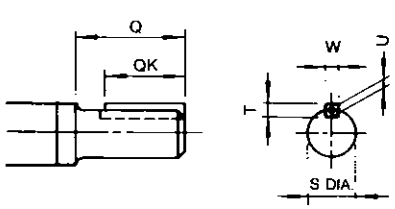
Notes

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

Receptacle Specifications

AC SERVOMOTOR Type USAMED-	Connector Types for Motor and Brake				Optical Encoder Connector Types			
	Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L-type Plug	Straight Plug	Cable Clamp
05E□2□□	MS 3102 A20 - 15P	MS 3108 B20 - 15P	MS 3106 B20 - 15S	MS 3057 - 12A	MS 3102 A20 - 29P	MS 3108 B20 - 29S	MS 3106 - B20 - 29S	MS 3057 - 12A
10E□2□□								
15E□2□□	MS 3102 A24 - 10P	MS 3108 B24 - 10S	MS 3106 B24 - 10S	MS 3057 - 16A				
22E□2□□								
37E□2□□								

(2) Shaft Extention of Straight with Keyway

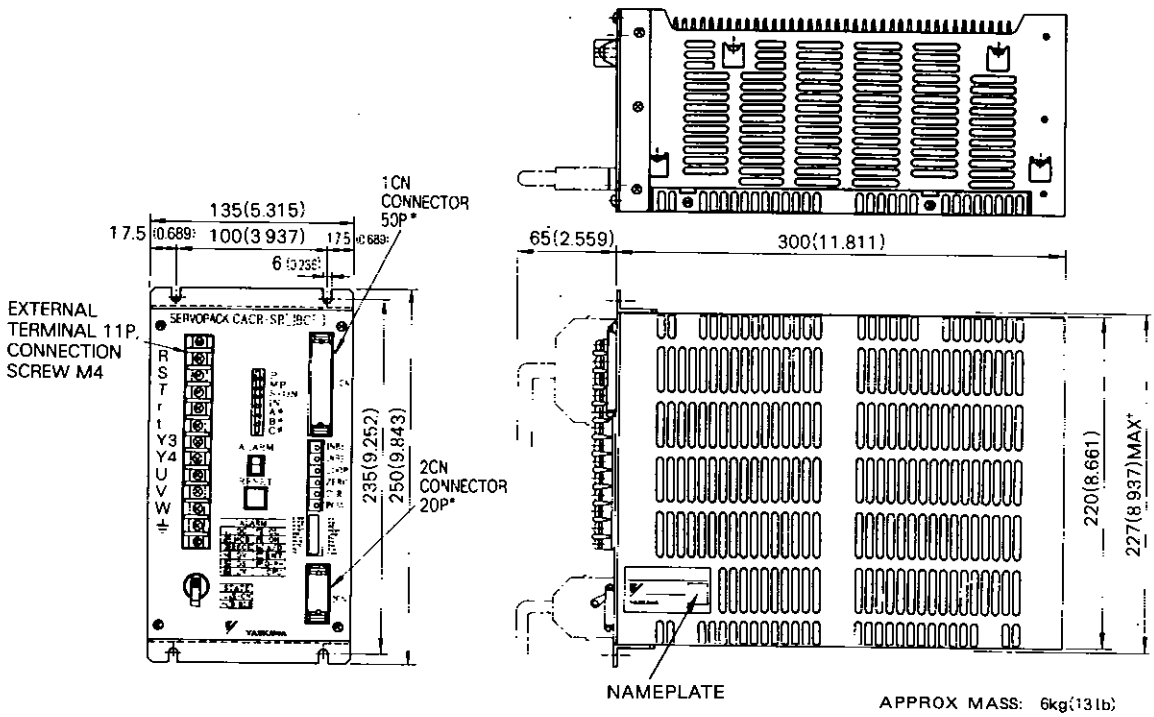


Note: Dimensions of the shaft extension key and keyway are based on JIS (Japanese Industrial Standard) B 1301 "Sunk keys and Their Corresponding Keyways (Normal keys)" Shaft extension key is furnished.

AC SERVOMOTOR Type USAMED-	Shaft Extension					
	S DIA	Q	QK	T	U	W
05E□2K□	22 (0.8661)	50	45	6	3.5	3.5
10E□2K□	22 (0.861)	50	45	6	3.5	6
15E□2K□	28 (1.1024)	50	45	7	4	8
22E□2K□	28 (1.1024)	50	45	7	4	8
37E□2K□	32 (1.2598)	60	50	8	5	10

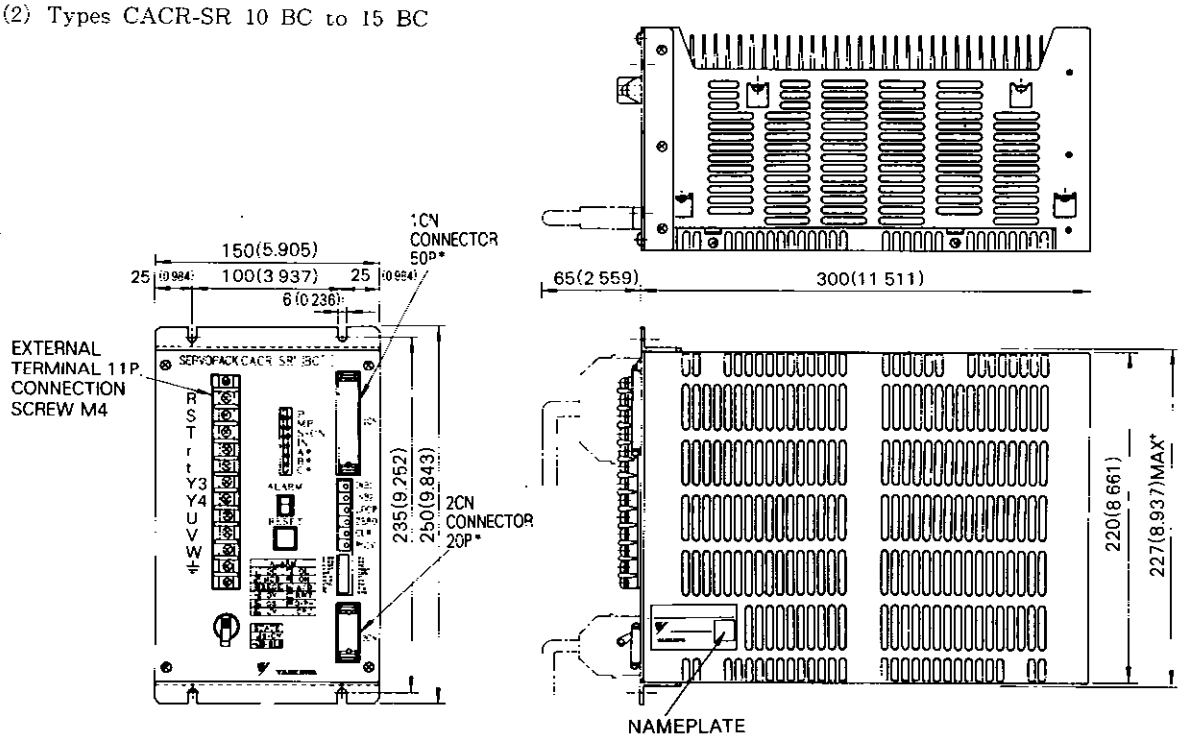
8. 5 SERVOPACK

(1) Types CACR-SR 03 BC to 07 BC



APPROX MASS: 6kg(13lb)

(2) Types CACR-SR 10 BC to 15 BC

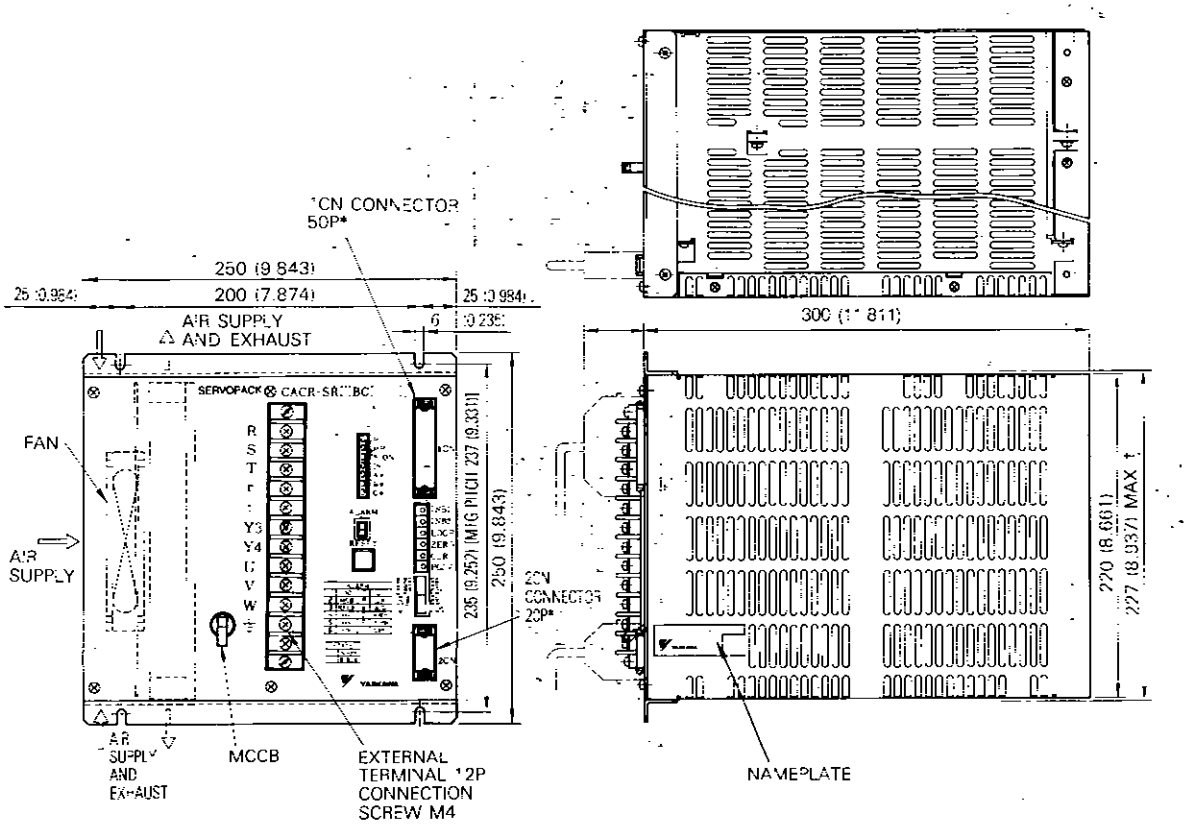


APPROX MASS: 7kg(16lb)

* Made by Honda Tsushin Co.

† Including mounting flange thickness.

(3) Types CACR-SR 20 to 44 BC 1



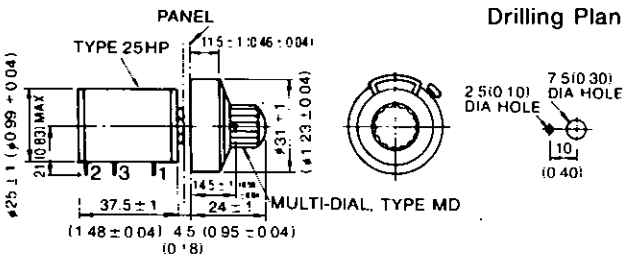
APPROX MASS : 12 kg (26 lb)

* Made by Honda Tsushin Co.

† Including mounting flange thickness.

8. 6 PERIPHERAL EQUIPMENT

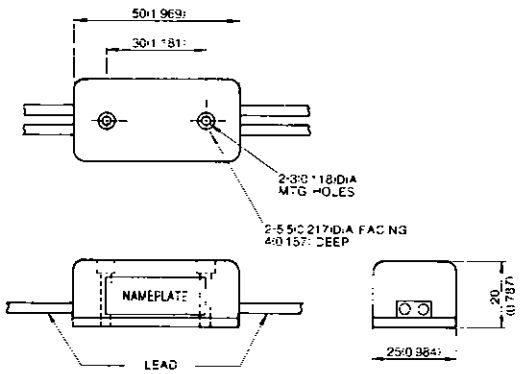
(1) Variable Resistor for Speed Setting
Type 25HP-10B



(2) Power Supply for Brake

(a) Standard Type

- Input 100 VAC, 90 VDC, Max. 1.0 ADC (Type B 9400876-2)
- Input 200 VAC, 90 VDC, Max. 1.0 ADC (Type B 9400876-1)

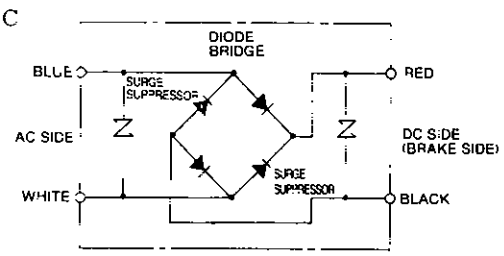


Lead length: 500mm (19.69 in) each
Lead color

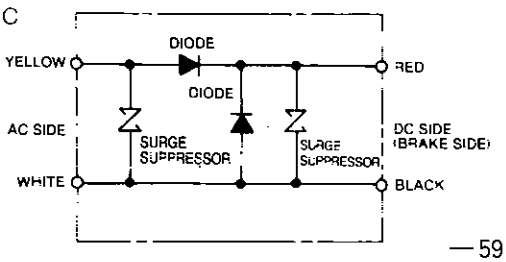
AC Input Side		Brake Side
100V	200V	
Blue White	Yellow White	Red Black

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

·For 100 VAC

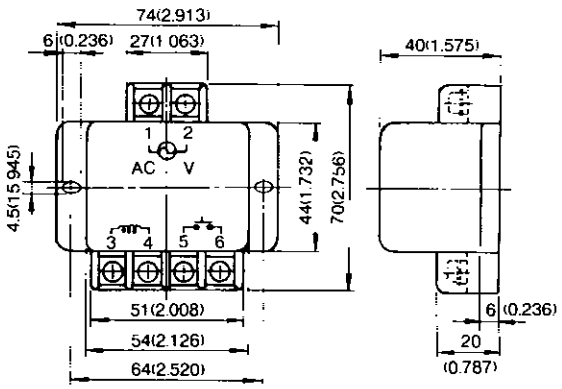


·For 200 VAC

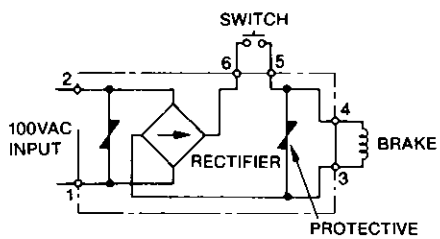


(b) Conventional Type

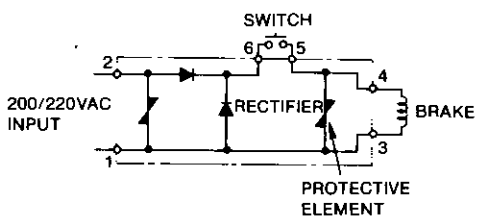
- Input 100 VAC, output 90 VDC, Max. 1.0 ADC (Type OPR 109 F)
- Input 200 VAC, output 90 VDC, Max. 1.0 ADC (Type OPR 109 A)



Type OPR 109 F Circuit Diagram



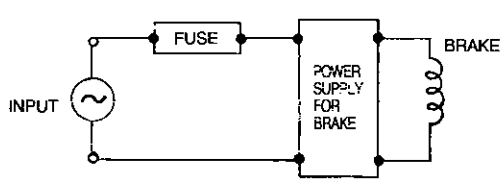
Type OPR 109 A Circuit Diagram



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

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

Circuit Diagram



9. TEST RUN

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

9.1 CHECK ITEMS BEFORE TEST RUN

9.1.1 SERVOMOTOR

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

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

9.1.2 SERVOPACK

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

9.2 TEST PROCEDURES

9.2.1 Preparation of Operation

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

(1) Power ON

- After checking items in Par. 9.1, turn ON the power supply. When the power on sequence is correct according to Par. 6.1, the power is turned ON by pressing the POWER pushbutton for approximately 1 second.
- When the power is correctly supplied, the following green LEDs light: P and MP.
- When a Servo ON signal is input (contact is ON), the power circuit in the SERVOPACK operates and the motor is ready to run.

9.2.2 Operation

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

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

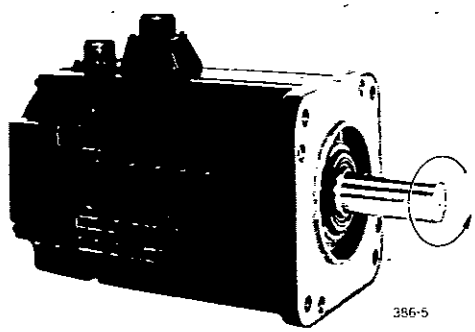


Fig. 9.1 Motor Forward Running

9.2.3 Inspection during Test Run

The following items should be checked during the test run.

- Unusual vibration
- Abnormal noise
- Excessive temperature rise

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

10. ADJUSTMENT

10.1 SETTINGS AT THE TIME OF DELIVERY

The SERVOPACK has been factory-adjusted as follows:

(1) M series

Table 10.1 Standard Adjustment and Setting Specification

SERVOPACK Type CACR-	Applicable SERVOMOTOR			SERVOPACK Adjustment		
	Type USAMED-	Optical Encoder pulses/rev	Rated Current* A	Speed Setting	Starting Current Setting* A	PG Frequency Dividing Ratio
SR03BC1AM	03□A1	6000	3.0	1000 r/min at rated speed reference	7.3	×1
SR03BC1BM	03□B1	5000				
SR03BC1DM	03□D1	4000				
SR07BC1AM	06□A1	6000	6.8		13.9	
SR07BC1BM	06□B1	5000				
SR07BC1DM	06□D1	4000				
SR10BC1AM	09BA2	6000	7.6		16.6	
SR10BC1BM	09BB2	5000				
SR10BC1DM	09BD2	4000				
SR15BC1AM	12BA2	6000	11.7		28.0	
SR15BC1BM	12BB2	5000				
SR15BC1DM	12BD2	4000				
SR20BC1AM	20BA2	6000	18.8		42.0	
SR20BC1BM	20BB2	5000				
SR20BC1DM	20BD2	4000				
SR30BC1AM	30BA2	6000	26.0		56.5	
SR30BC1BM	30BB2	5000				
SR30BC1DM	30BD2	4000				
SR44BC1AM	44BA2	6000	33.0		70.0	
SR44BC1BM	44BB2	5000				
SR44BC1DM	44BD2	4000				

* Effective value

Table 10.2 Standard Factory-adjusted Switch Positions

SERVOPACK Type CACR-		SW1 Motor Type, PG Pulse Setting	SW2 Pulse Resolution Setting	SW3 Speed Loop Condition Setting	SW4 Motor Characteristics, SERVOPACK Function Setting
Standard	SR03BC1AM to SR44BC1AM	6000 1 2 3 4 5 6 7 8 ○○○○○○○○ ○○○○○○○○	×1 1 2 3 4 5 6 7 8 † ○○○○○○○○ ○○○○○○○○	1 2 3 4 5 6 7 8 ○○○○○○○○ ○○○○○○○○	1 2 3 4 5 6 7 8 ○○○○○○○○ ○○○○○○○○
Optional	SR03BC1BM to SR10BC1BM	5000 1 2 3 4 5 6 7 8 ○○○○○○○○ ○○○○○○○○			
	SR03BC1DM to SR44BC1DM	4000 1 2 3 4 5 6 7 8 ○○○●○○○○ ○○○○○○○○			

† Spare short-circuit pin ○ : Shorted ○ : Open

Table 10.3 Standard Factory-adjusted Potentiometer Positions

SERVOPACK Type CACR-	Auxiliary Input Setting VR1 INB1†	Auxiliary Input Fine Setting VR4 INB2	Zero Drift Setting VR3 ZERO	Max Current Setting VR5 CUR	Loop Gain Setting VR6 LOOP
SR03BC1□M	10 V/rated speed (For setting by the user.)	5/10	4/10 to 6/10	10/10 (For setting by the user.)	5/10
SR07BC1□M					
SR10BC1□M					
SR15BC1□M					
SR20BC1□M					
SR30BC1□M					
SR44BC1□M					

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

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

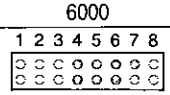
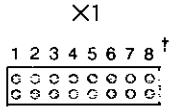
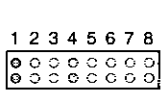
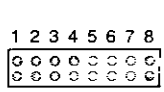
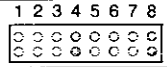
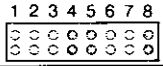
(2) F series

Table 10.4 Standard Adjustment and Setting Specifications

SERVOPACK Type CACR-	Applicable SERVOMOTOR			SERVOPACK Adjustment		
	Type USAFED-	Optical Encoder pulses/rev	Rated Current* A	Speed Setting	Starting Current Setting* A	PG Frequency Dividing Ratio
SR03BC1AF	02□A1	6000	3.0	1500 r/min at rated speed reference	8.5	×1
	03□A1					
SR03BC1BF	02□B1	5000				
	03□B1					
SR03BC1DF	02□D1	4000				
	03□D1					
SR05BC1AF	05□A1	6000	3.8		11.0	
SR05BC1BF	05□B1	5000				
SR05BC1DF	05□D1	4000				
SR10BC1AF	09□A1	6000	6.2		17.0	
SR10BC1BF	09□B1	5000				
SR10BC1DF	09□D1	4000				
SR15BC1AF	13CA2	6000	9.7		27.6	
SR15BC1BF	13CB2	5000				
SR15BC1DF	13CD2	4000				
SR20BC1AF	20CA2	6000	15.0		42.0	
SR20BC1BF	20CB2	5000				
SR20BC1DF	20CD2	4000				
SR30BC1AF	30CA2	6000	20.0		56.5	
SR30BC1BF	30CB2	5000				
SR30BC1DF	30CD2	4000				
SR44BC1AF	44CA2	6000	30.0		77.0	
SR44BC1BF	44CB2	5000				
SR44BC1DF	44CD2	4000				

* Effective value

Table 10.5 Standard Factory-adjusted Switch Positions

SERVOPACK Type CACR-		SW1 Motor Type, PG Pulse Setting	SW2 Pulse Resolution Setting	SW3 Speed Loop Condition Setting	SW4 Motor Characteristics, SERVOPACK Function Setting
Standard	SR03BC1AF to SR44BC1AF	6000 1 2 3 4 5 6 7 8 	×1 1 2 3 4 5 6 7 8† 	1 2 3 4 5 6 7 8 	1 2 3 4 5 6 7 8 
Optional	SR03BC1BF to SR10BC1BF	5000 1 2 3 4 5 6 7 8 			
	SR03BC1DF to SR44BC1DF	4000 1 2 3 4 5 6 7 8 			

† Spare short-circuit pin

Table 10.6 Standard Factory-adjusted Potentiometer Positions

SERVOPACK Type CACR-	Auxiliary Input Setting		Auxiliary Input Fine Setting		Zero Drift Setting		Max Current Setting		Loop Gain Setting	
	VR1	INB1	VR4	INB2	VR3	ZERO	VR5	CUR	VR6	LOOP
SR03BC1□F SR05BC1□F SR10BC1□F SR15BC1□F SR20BC1□F SR30BC1□F SR44BC1□F	10 V/rated speed (For setting by the user.)		5/10		4/10 to 6/10		10/10 (For setting by the user.)		5/10	

Notes:
1. In the Table above, □/□ shows approximate scale of potentiometer.
For example,  indicates 7/10 scale.
2. The potentiometers other than listed in the Table above are provided for the SERVOPACK. Do not change these potentiometers' setting except for a special case since they have been preset at the factoty.

(3) S series

Table 10.7 Standard Adjustment and Setting Specifications

SERVOPACK Type CACR-	Applicable SERVOMOTOR			SERVOPACK Adjustment		
	Type USASEM-	Optical Encoder pulses/rev	Rated Current* A	Speed Setting	Starting Current Setting* A	PG Frequency Dividing Ratio
SR03BC1CS-Y41	02AC2	2500	2.1	3000 r/min at rated speed reference	6.0	×1
SR03BC1ES-Y41	02AE2	1500				
SR03BC1FS-Y41	02AF2	1000				
SR03BC1CS	03AC2	2500	3.0		8.5	
SR03BC1ES	03AE2	1500				
SR03BC1FS	03AF2	1000				
SR05BC1CS	05AC2	2500	4.2		11.0	
SR05BC1ES	05AE2	1500				
SR05BC1FS	05AF2	1000				
SR10BC1CS	08AC1	2500	5.3		15.6	
SR10BC1ES	08AE1	1500				
SR10BC1FS	08AF1	1000				
SR15BC1CS	15AC1	2500	10.4		28.0	
SR15BC1ES	15AE1	1500				
SR15BC1FS	15AF1	1000				
SR30BC1CS	30AC1	2500	19.9		56.5	
SR30BC1ES	30AE1	1500				
SR30BC1FS	30AF1	1000				

* Effective value

Table 10.8 Standard Factory-adjusted Switch Positions

SERVOPACK Type CACR-		SW1 Motor Type, PG Pulse Setting	SW2 Pulse Resolution Setting	SW3 Speed Loop Condition Setting	SW4 Motor Characteristics, SERVOPACK Function Setting
Standard	SR10BC1CS to SR30BC1CS	2500 1 2 3 4 5 6 7 8	×1 1 2 3 4 5 6 7 8†	· SR 10 BC, SR 15 BC 1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Optional	SR03BC1ES to SR05BC1ES	1500 1 2 3 4 5 6 7 8		· SR 03 BC, SR 05 BC · SR 30 BC 1 2 3 4 5 6 7 8	
	SR03BC1FS to SR30BC1FS	1000 1 2 3 4 5 6 7 8			

† Spare short-circuit pin

Table 10.9 Standard Factory-adjusted Potentiometer Positions

SERVOPACK Type CACR-	Auxiliary Input Setting VR1 INB1	Auxiliary Input Fine Setting VR4 INB2	Zero Drift Setting VR3 ZERO	Max Current Setting VR5 CUR	Loop Gain Setting VR6 LOOP
SR03BC□S	10 V/rated speed (For setting by the user.)	5/10	4/10 to 6/10	10/10	5/10
SR05BC□S					
SR10BC□S					
SR15BC□S					
SR30BC□S					

Notes:
1. In the Table above, □/□ shows approximate scale of potentiometer.
For example,  indicates 7/10 scale.
2. The potentiometers other than listed in the Table above are provided for the SERVOPACK. Do not change these potentiometers' setting except for a special case since they have been preset at the factoty.

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

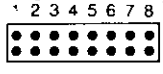
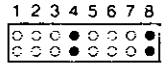
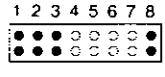
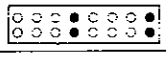
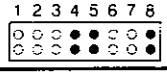
(4) D series

Table 10.10 Standard Adjustment and Setting Specifications

SERVOPACK Type CACR-	Applicable SERVOMOTOR			SERVOPACK Adjustment		
	Type USADED-	Optical Encoder pulses/rev	Rated Current* A	Speed Setting	Starting Current Setting* A	PG Frequency Dividing Ratio
SR05BC1AD	05EA2	6000	3.5	2000 r/min at rated speed reference	10.6	×1
SR05BC1BD	05EB2	5000				
SR05BC1DD	05ED2	4000				
SR15BC1AD	10EA2	6000	7.9		25.2	
SR15BC1BD	10EB2	5000				
SR15BC1DD	10ED2	4000				
SR20BC1AD	15EA2	6000	12.6		40.7	
SR20BC1BD	15EB2	5000				
SR20BC1DD	15ED2	4000				
SR30BC1AD	22EA2	6000	16.6		54.0	
SR30BC1BD	22EB2	5000				
SR30BC1DD	22ED2	4000				
SR44BC1AD	37EA2	6000	23.3		77.0	
SR44BC1BD	37EB2	5000				
SR44BC1DD	37ED2	4000				

* Effective value

Table 10.11 Standard Factory-adjusted Switch Positions

SERVOPACK Type CACR-		SW1 Motor Type, PG Pulse Setting	SW2 Pulse Resolution Setting	SW3 Speed Loop Condition Setting	SW4 Motor Characteristics, SERVOPACK Function Setting
Standard	SR05BC1AD to SR44BC1AD	6000 	×1  †		
	SR05BC1BD to SR44BC1BD	5000 			
Optional	SR05BC1DD to SR44BC1DD	4000 			

† Spare short-circuit pin

Table 10.12 Standard Factory-adjusted Potentiometer Positions

SERVOPACK Type CACR-	Auxiliary Input Setting VR1 INB1	Auxiliary Input Fine Setting VR4 INB2	Zero Drift Setting VR3 ZERO	Max Current Setting VR5 CUR	Loop Gain Setting VR6 LOOP
SR05BC1□D	10 V/rated speed (For setting by the user.)	5/10	4/10 to 6/10	10/10 (For setting by the user.)	5/10
SR15BC1□D					
SR20BC1□D					
SR30BC1□D					
SR44BC1□D					

Notes:

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

   For example,  indicates 7/10 scale.

2. The potentiometers other than listed in the Table above are provided for the SERVOPACK. Do not change these potentiometers' setting except for a special case since they have been preset at the factory.

10.2 CHARACTERISTICS AT THE TIME OF DELIVERY

The SERVOPACK has been factory-adjusted as follows :

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

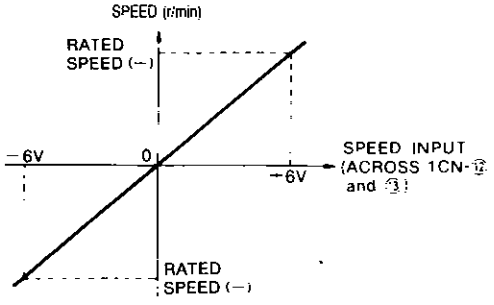


Fig. 10.1 Speed Reference Input-SERVOMOTOR Speed Ratio

(2) Speed Regulation (Fig. 10.2)

Speed regulation $\varDelta N$ $\varDelta n$:

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

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

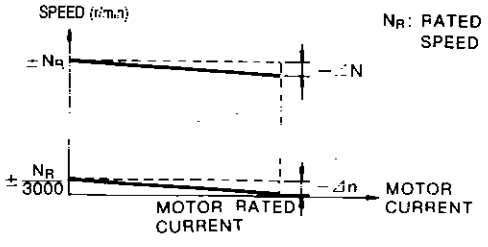


Fig. 10.2 Speed Regulation

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

I_P : Start current set value in Tables 10.1, 10.4, 10.7. The overshoot ($\varDelta$Nov) and undershoot ($\varDelta$Nud) when $GD_M^2 = GD_L^2$, are as shown in Table 10.13 (adjustment level preset at the factory).

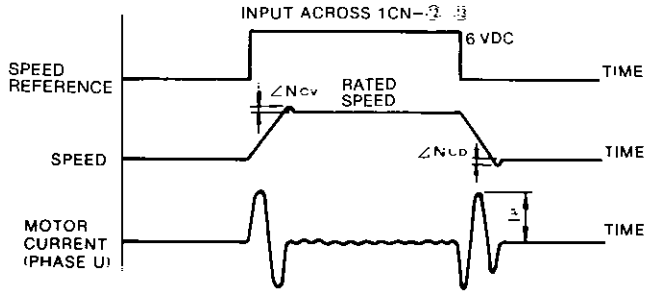


Fig. 10.3 Start — Stop Characteristics

Table 10.13 Overshoot and Undershoot at Step Response

Type CACR-	$\varDelta N_{OV}/N_R \times 100$	$\varDelta N_{UD}/N_R \times 100$
SR03BC	5 % max	5 % max
SR05BC		
SR07BC		
SR10BC		
SR15BC		
SR20BC		
SR30BC		
SR44BC		

10.3 READJUSTMENT

The SERVOPACK has been adjusted at the factory to obtain optimum characteristics, and readjustment is normally unnecessary. If adjustment is required depending on the use, readjust the SERVOPACK referring to Table 10.14. (Do not change the potentiometers' setting except for a special case.)

10.4 ADJUSTMENT PROCEDURES

Fig. 10.4 shows the arrangement of potentiometers, and terminals for checking waveforms; Table 10.14 shows the specifications of the check pin (CH); and Tables 10.15 and 10.16 lists check terminals and functions.

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

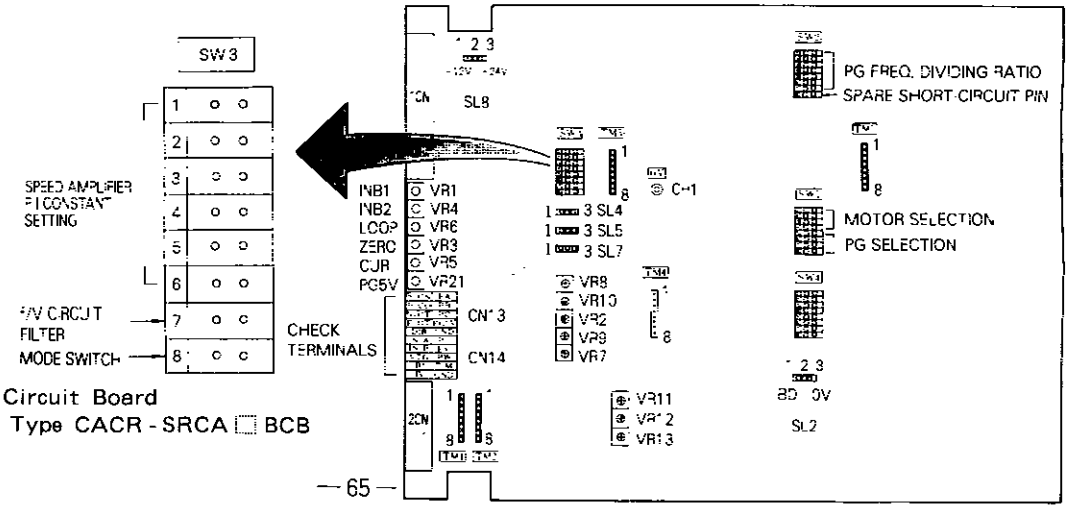
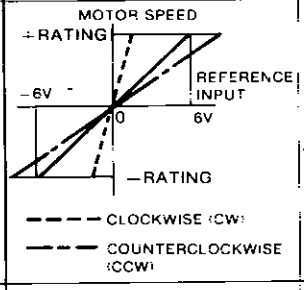
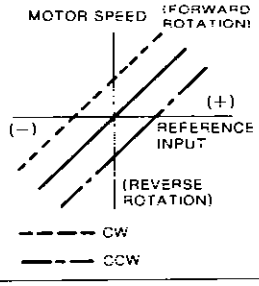


Fig. 10.4 Printed Circuit Board for SERVOPACK Type CACR-SRCA□BCB

10.4 ADJUSTMENT PROCEDURES (Cont'd)

Table 10.14 Potentiometer adjustment

Potentiometer	VR1 INB1	VR4 INB2	VR3 ZERO	VR5 CUR
Functions	Auxiliary input adjustment	Auxiliary input fine adjustment	Zero drift adjustment	Starting current adjustment
How to Adjust	To be adjusted only when the rated reference voltage (±2 to ±10V) is other than ±6V. Turn VR1 only to get the rated speed and do not operate other VRs.	To fine adjust the adjusted value of VR1.	To adjust so that the motor does not turn at the speed reference voltage 0 V. Turning VR3 CW allows the motor to be finely adjusted in forward rotation, and CCW in reverse rotation.	Turning VR5 CCW decreases the starting current. This has been adjusted to full scale CCW at the factory.
Characteristics		Adjustable in units of $\frac{1}{10}$ of VR1 setting.		—
Adjustment	○	○	○	○

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

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

Potentiometer	VR11	VR12	VR13	VR21 PG5V
Function	Phase U current offset adjustment.	Phase V current offset adjustment	Phase W current offset adjustment	PG 5V voltage adjustment
How to Adjust	With only control power turned on, adjust until phase U current amplifier output voltage becomes minimum.	With only control power turned on, adjust until phase V current amplifier output voltage becomes minimum.	With only control power turned on, adjust until phase W current amplifier output voltage becomes minimum.	PG power voltage adjustment. It is set to 5.35V at the factory.
Characteristics	Incorrect adjustment increases torque ripple.			Turning CW increases voltage. If wiring to PG is long, causing voltage drop, increase voltage (6V or below)
Adjustmet	×	×	×	△

Adjustment Directions

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

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

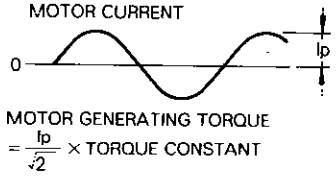
Mark ×: Do not adjust.

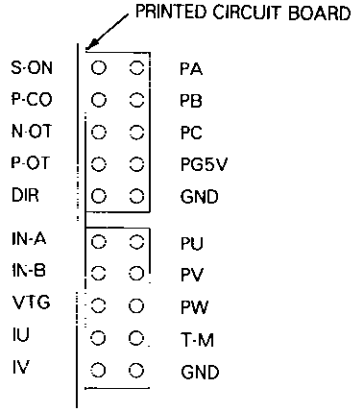
Table 10.15 Check Terminal Functions (on panel)

Symbol	Functions
S-ON	Servo ON (ON at L level).
P-CO	Speed amplifier proportional drive reference (P drive at L level).
N-OT	Reverse running inhibit (approx + 15 V at L of connector 1 CN ㊾).
P-OT	Forward running inhibit (approx − 15 V at L of connector 1 CN ㊽).
DIR	Monitors the setting of direction of motor rotation (H level in normal).
IN-A	Monitors the speed reference input (connector 1 CN ⑫ − ⑬).
IN-B	Monitors the speed reference auxiliary input (connector 1 CN ⑭ − ⑮).
VTG	Speed feedback signal : • M, F, D series ± 4V/1000 r/min • S series ± 2V/1000 r/min
IU	Motor current (Phase-U) Type 03 05 07 10 15 20 30 44
IV	Motor current (Phase-V) Gain[V/A] 0.4 0.24 0.20 0.16 0.08 0.04
PA	Optical encoder (PG) input signal. Phase-A pulse input.
PB	Phase-B pulse input.
PC	Phase-C pulse input.
PG5V	Optical encoder (PG) power supply voltage : +5 V.
PU	Pole sensor input signal. Phase-U pulse input.
PV	Phase-V pulse input.
PW	Phase-W pulse input.
T-M	Torque reference monitor signal ± 3.0V/100 %
GND	Signal 0 V.

Notes :

1. Do not saturate the check terminal with irrelevant or extraneous substance.
2. The motor generating torque conversion by torque reference monitor signal is large at high-speed range. Compute the precise data by motor current measurement.





10.4 ADJUSTMENT PROCEDURES (Cont'd)

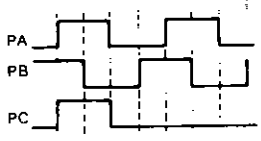
Table 10.16 Check Terminal Functions (internal SERVOPACK)

Equipment Symbol		Signal Name	Description
TM1	1	PA	Phase A pulse is input.
	2	*PA	Reverse pulse of phase A is input.
	3	PB	Phase B pulse is input.
	4	*PB	Reverse pulse of phase B is input.
	5	PC	Phase C pulse is input.
	6	*PC	Reverse pulse of phase C is input.
	7	—	Unused
	8	5VP	PG supply voltage +5V

PG input signals

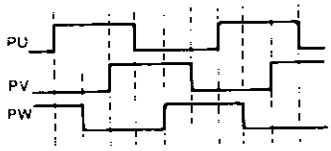
PA and PB are two-phase pulse with 90° phase difference. PC occurs once for each motor rotation, in synchronization with PA.

Waveform at motor forward rotation

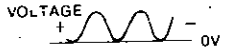


TM2	1	PU	Phase U pulse is input from pole sensor.
	2	*PU	Reverse pulse of phase U is input
	3	PV	Phase V pulse is input from pole sensor
	4	*PV	Reverse pulse of phase V is input
	5	PW	Phase W pulse is input from pole sensor
	6	*PW	Reverse pulse of phase W is input.
	7	DIR	Monitors the setting of direction of motor rotation. (H level in normal)
	8	PG0V	0V of the PG power supply (PG common terminal to signals from the pole sensor)

Waveform at motor forward rotation



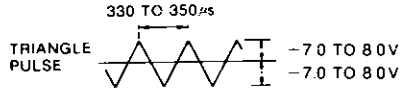
TM3	1	IN-A	Monitors the speed reference input (connector CN ⑫—⑬).
	2	IN-B	Monitors the speed reference auxiliary input (connector CN ⑭—⑮)
	3	V_{TG}	Monitors the motor speed ±4.0V/±1000 r/min (M, F, D Series), ±2.0V/1000 r/min (S Series).
	4	T-Mon	Monitors the motor torque ±3.0V/100%.
	5	T-Ref	Torque reference ±2.0 to ±3.0 VDC/100%
	6	U-sin	Monitors phase U sin waveform.
	7	V-sin	Monitors phase V sin waveform.
	8	—	Unused



- Frequency varies depending on speed
- Amplitude varies depending on torque.

TM4	1	IU	Phase U current monitor.
	2	IV	Phase V current monitor
	3	ACON	Main power ON signal
	4	AU	Phase U current amplification output monitor.
	5	AV	Phase V current amplification output monitor.
	6	AW	Phase W current amplification output monitor.
	7	OSC2	Carrier frequency (triangle pulse)
	8	—	Unused.
CH1		0V	Signal 0V

Type CACR-SR	03	05	07	10	15, 20	30, 44
Monitor Voltage (V/A)	0.4	0.24	0.20	0.16	0.08	0.04



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

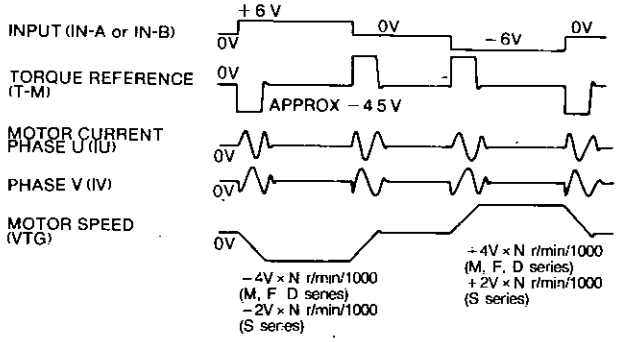


Fig. 10.5 Waveforms at the Respective Check Terminals for Step Responses (No Load)

10.5 SWITCH SETTING

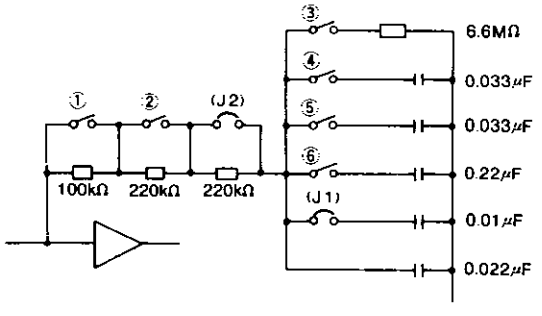
The four switches (SW1 , SW2 , SW3 , SW4) have the following functions :

Table 10.17 Switch Setting and Function

Switch Name	Function	User Adjustment	Remarks
SW1	Motor type setting. Motor PG setting.	Never change this setting.	See Tables 10.2, 10.5, 10.8.
SW2	PG frequency dividing setting	Possible	See Table 6.1.
SW3	Speed loop condition setting.	Possible	See the figure below. As a normal rule, leave the setting as it was preset at the factory.
SW4	Motor characteristics and SERVOPACK function setting.	Never change this setting.	The optimized motor torque characteristics and SERVOPACK functions have already been set at the factory. Do not change the setting. SW4 -5 selection operates the dynamic brake. Refer to Par. 6.5 (1), "Dynamic brake function".

Function of SW3

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



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

SW3 -7	Time Constant
Shorted	1.2 ms
Open	0.1 ms

3. Mode switch setting (SW3 - 8)

SW3 - 8	Mode Switch
Shorted	Not provided
Open	Provided

Note : Do not change the setting of switches SL2 to SL8 on circuit board.

11. INSPECTION AND MAINTENANCE

11.1 AC SERVOMOTOR

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

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

Table 11.1 Inspection Schedule for Motors

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

· Parts Replacement Schedule

The following parts should be replaced periodically since they may become worn mechanically.

Table 11.2 Parts Replacement Schedule

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

11.2 SERVOPACK

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

However, when the SERVOPACK is overhauled by YASKAWA, check the user constants before running since they are reset to the standard setting.

Table 11.3 Inspection Schedule for SERVOPACK

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

· Parts Replacement Schedule

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

Tacle 11.4 Parts Replacement Schedule

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

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

12. TROUBLESHOOTING GUIDE

12.1 AC SERVOMOTOR

WARNING

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

Table 12.1 Troubleshooting Guide for AC Servomotor

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

12.2 SERVOPACK

12.2.1 LED Indication (7-segment) for Troubleshooting

Table 12.2 LED Indication for Troubleshooting

LED	Detection	Lighting Condition	Probable Cause	Corrective Actionb
1.	Over-current	Goes ON when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the SERVOPACK.
		Goes ON when power is supplied to the main circuit and servo power is turned ON. • MCCB does not trips.	• Defective current feedback circuit. • Defective main circuit transistor moudule. • Motor grounding.	• Replace the SERVOPACK. • Corrrect grounding.
		Goes ON when power is supplied to the main circuit and servo power is turned ON. • MCCB trips.	• Defective motor grounding • Defective main circuit transistor module.	• Replace the motor. • Replace the SERVOPACK.
		Goes ON when power is supplied to the main circuit.	• Defective main circuit transistor module.	• Replace the SERVOPACK.
		Goes ON when the motor accelerates or decelerates.	• Incomplete (1 PWB) VR5 adjustment.	• Replace the SERVOPACK.
2.	Circuit protector tripped	Goes ON when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the SERVOPACK.
		Goes ON when power is supplied to the main circuit.	• Defective main circuit thyristor-diode module.	• Replace the SERVOPACK.
			• MCCB trips.	
		Goes ON during operation.	• Defective main circuit of SERVOPACK (Do not turn ON again.)	
3.	Regenerative trouble	Goes ON when power is supplied to the control circuit.	• Defective control circuit board. (1 PWB)	• Replace the SERVOPACK.
		Goes ON approximate 0.5 to 1 second after power is supplied to the main circuit.	• Defective regenerative trnasistor.	• Replace the SERVOPACK.
			• Regenerative resistor disconnection. • No regenerative resistor connection (SR60BB)	• Check and replace the regenerative resistor. (Replace the SERVOPACK)
4.	Over-voltage	Goes ON when the motor accelerates or decelerates.	• Load inertia (GD^2) too large.	• Check the inertia of the machine with the value converted to the motor shaft.
			• Defective regenerative circuit.	• Replace the SERVOPACK.
5.	Over-speed	When the reference is input, the motor runs fast and 5. goes ON.	• Motor connection error. • Optical encoder connection error.	• Correct the motor connection. • Check pulses in phases A, B, C, U, V and W on 2CN and correct wiring.
			• The reference input voltage too large.	• Decrease the reference input voltage.
6.	Voltage drop	Goes ON when power is supplied to the main circuit.	• Defective main circuit thyristor-diode module.	• Replace the SERVOPACK.
7. A.	Overload Heat sink overheat	Goes ON when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the SERVOPACK.
		Goes ON during operation. • When power to the control circuit is turned OFF and then turned ON again, the operation starts.	• Operation with 105% to 130% or more of the rated load.	• Check and correct the load (may be overload).
		Goes ON during operation. • When power to the control circuit is turned OFF and the ON again, 7. and A. goes 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 overheated.)
		The motor rotates, but the torque is unavailable. When power to the control circuit is turned OFF and then turned ON again, the operation starts, but the torque is still unavailable.	• Motor circuit error connection, such as U→V, V→W, W→U or single-phase connection.	• Correct the connection.

Table 12.2 LED Indication for Troubleshooting (Cont'd)

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

12.2.2 Examples of Troubleshooting for Defective Wiring or Parts

Table 12.3 Example of Troubleshooting for Defective Wiring or Parts

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

12.2.3 Examples of Troubleshooting for Incomplete Adjustement

Table 12.4 Examples of Troubleshooting for Incomplete Adjustment

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

NOTES

AC SERVO DRIVES

M, F, S, D SERIES FOR SPEED CONTROL

SERVOMOTOR TYPES USAMED, USAFED, USASEM, USADED
SERVOPACK TYPES CACR-SR□□□BC (RACK-MOUNTED TYPE)

TOKYO OFFICE Ohtemachi Bldg, 1-6-1 Ohtemachi, Chiyoda-ku, Tokyo, 100 Japan
Phone (03) 3284-9111 Telex YASKAWA J33530 Fax (03) 3284-9034
SEOUL OFFICE 8th Floor Seoul Center Bldg, 91-1 Sogong-Dong, Chung-ku, Seoul, Korea 100-070
Phone (02) 776-7844 Fax (02) 753-2639
TAIPEI OFFICE Shen Hsiang Tang Sung Chiang Building 10F 146 Sung Chiang Road Taipei Taiwan
Phone (02) 563-0010 -7732 Fax (02) 567-4677
YASKAWA ELECTRIC AMERICA, INC.
Chicago-Corporate Headquarters 2942 MacArthur Blvd. Northbrook, IL 60062-2028 U.S.A.
Phone (708) 291-2340 Fax (708) 498-2430
Chicago-Technical Center 3160 MacArthur Blvd. Northbrook, IL 60062-1917, U.S.A.
Phone (708) 291-0411 Fax (708) 291-1018
MOTOMAN INC.
805 Liberty Lane West Carrollton OH 45449 U.S.A.
Phone (513) 847-6200 Fax (513) 847-6277
YASKAWA ELECTRIC EUROPE GmbH
Am Kronberger Hang 2, 65824 Schwalbach Germany
Phone (49) 6196-569-300 Fax (49) 6196-888-301
Motoman Robotics AB
Box 130 S-38500, Torsås, Sweden
Phone 0486-10575 Fax 0486-11410
Motoman Robotec GmbH
Kammerfeldstraße 1, 85551 Allershausen, Germany
Phone 08166-900 Fax 08166-9039
YASKAWA ELECTRIC UK LTD.
3 Drum Mains Park Orchardton Woods Cumbernauld Scotland G68 9LD U.K.
Phone (236)735000 Fax (236)458182
YASKAWA ELÉTRICO DO BRASIL COMÉRCIO LTDA.
Rua Conde Do Pinhal 8-5° Andar Sala 51 CEP 01501-São Paulo-SP, Brasil
Phone (011) 35-1911 Fax (011) 37-7375
YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.
Head Office 1 CPF Bldg. 79 Robinson Road #13-05 Singapore 0106 SINGAPORE
Phone 221-7530 Telex (87) 24890 YASKAWA RS Fax 224-5854
Service Center 1 221 Henderson Road, #07-20 Henderson Building Singapore 0315, SINGAPORE
Phone 276-7407 Fax 276-7406
YATEC ENGINEERING CORPORATION
Shen Hsiang Tang Sung Chiang Building 10F 146 Sung Chiang Road, Taipei Taiwan
Phone (02) 563-0010 Fax (02) 567-4677

YASKAWA ELECTRIC CORPORATION

YASKAWA

TSE-S800-2.2D

366-8, 587-159