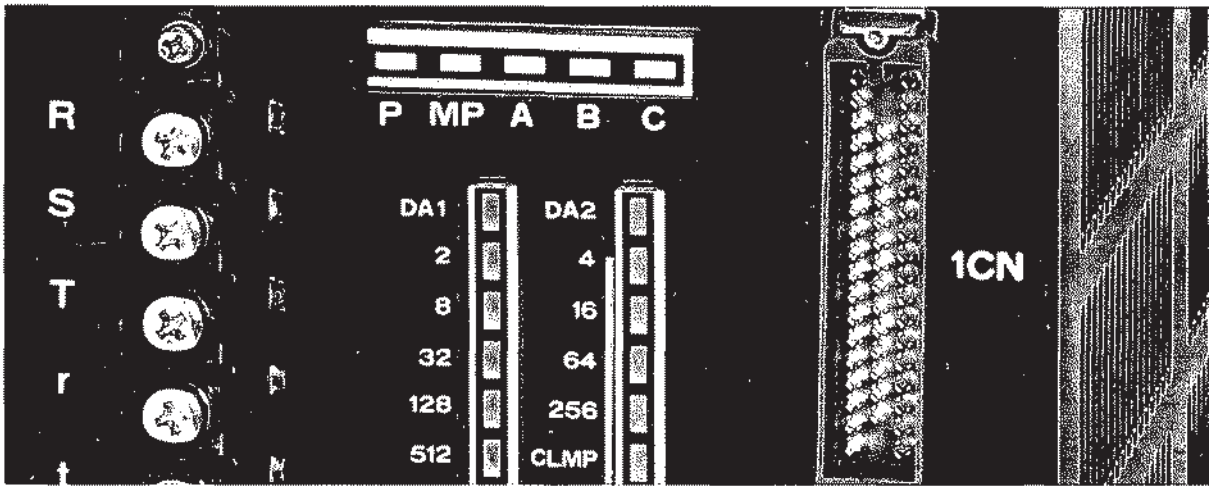
AC SERVO DRIVES

M, F, S SERIES FOR POSITIONING CONTROL

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



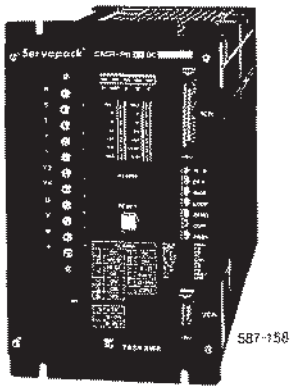
YASKAWA

Yaskawa AC Servo Series has been developed as basic mechatronics drive for the most advanced FA and FMS. The extensive DC servo manufacturing technology accumulated through a half century of servo drive applications created and nurtured a new phase of AC servo drives.

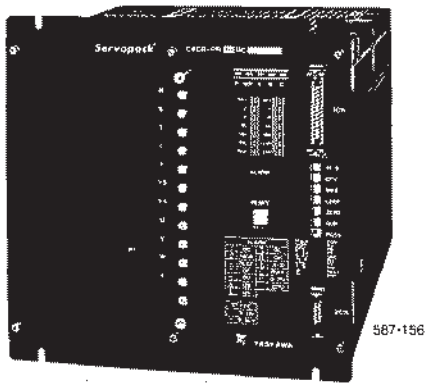
The AC servo drives consist of a flexible combination of our AC SERVOMOTOR and its controller, SERVOPACK. The AC SERVOMOTOR features a high-power rate for achieving quick response. The AC SERVOPACK type CACR-PR□BC~ is designed for integrated construction of Positionpack for digital positioning control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

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

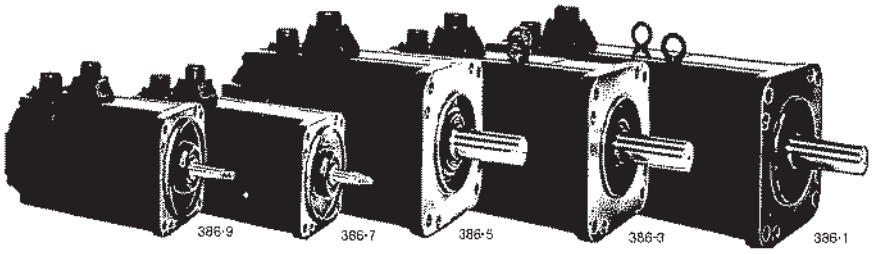
- High accuracy and quick response for speed control
- Rack-mounted type to conserve mounting space
- Easy maintenance by a wide range of display functions
- Highly reliable protective functions
- Selectable drive to suit the requirement
- Applicable to multiaxis applications



Type CACR-PR10BC



Type CACR-PR30BC



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

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

1. RATINGS AND SPECIFICATIONS

1.1 M SERIES AC SERVOMOTORS

1.1.1 Ratings

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

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

Table 1.1 Ratings and Specifications of M Series AC SERVOMOTORS

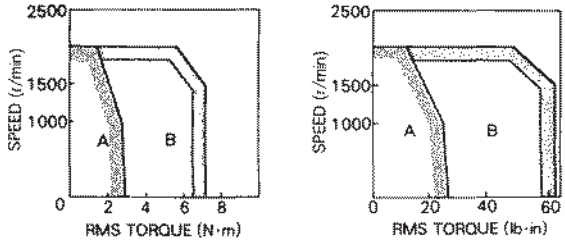
Item \ Motor Type USAMED-		03M□1	06M□1	09M□2	12M□2	20M□2	30M□2	44M□2
Rated Output*	kW (HP)	0.3 (0.4)	0.6 (0.8)	0.9 (1.2)	1.2 (1.6)	2.0 (2.7)	3.0 (4.1)	4.4 (6.0)
Rated Torque*	N·m (lb·in)	2.8 (25)	5.7 (50)	8.6 (76)	11.5 (102)	19.1 (169)	28.4 (252)	41.9 (372)
Continuous Max Torque*	N·m (lb·in)	2.9 (26)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

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

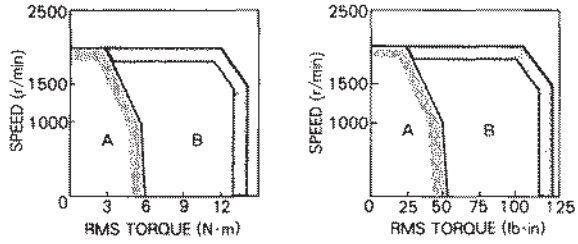
Notes:
1. □ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows:
   Standard: A (6000 pulses/rev)
   Optional: B (5000 pulses/rev), D (4000 pulses/rev)
2. There are two types of power supply units for brake.
   - Input 100 VAC, output 90 VDC (OPR 109 F)
   -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

1.1.2 Torque-Speed Characteristics

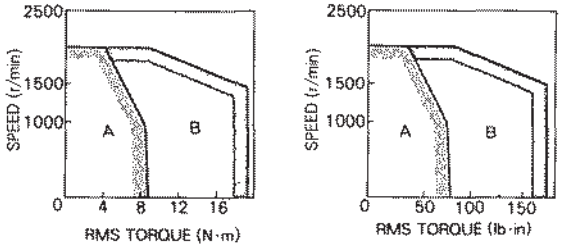
• TYPE USAMED-03M



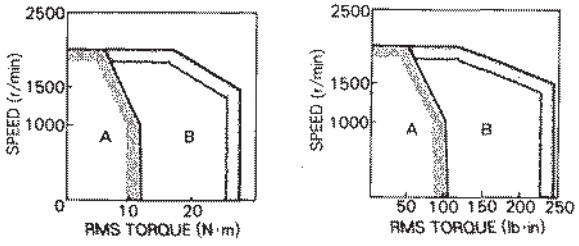
• TYPE USAMED-06M



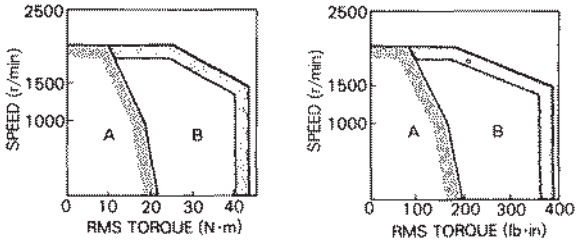
• TYPE USAMED-09M



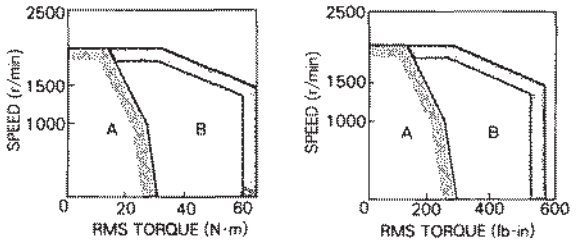
• TYPE USAMED-12M



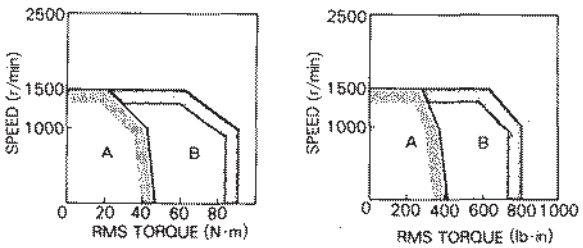
• TYPE USAMED-20M



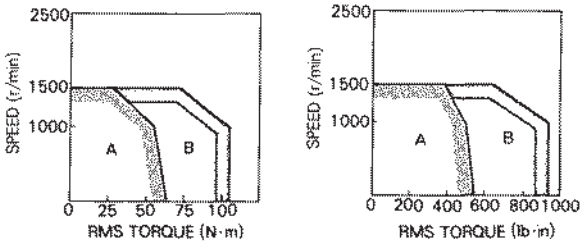
• TYPE USAMED-30M



• TYPE USAMED-44M



• TYPE USAMKD-60M



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

1.2 F SERIES AC SERVOMOTORS

1.2.1 Ratings

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

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

Table 1.2 Ratings and Specifications of F Series AC SERVOMOTORS

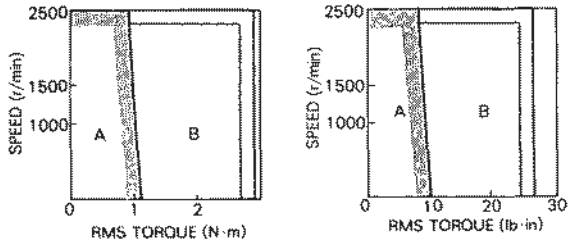
Item \ Motor Type USAFED-		02F□1	03F□1	05F□1	09F□1	13F□2	20F□2	30F□2	44F□2
Rated Output*	kW (HP)	0.15 (0.2)	0.3 (0.4)	0.45 (0.6)	0.85 (1.2)	1.3 (1.8)	1.8 (2.4)	2.9 (3.9)	4.4 (6.0)
Rated Torque*	N·m (lb·in)	1.0 (8.7)	2.0 (17)	2.8 (25)	5.4 (48)	8.3 (74)	11.5 (102)	18.6 (165)	28.4 (252)
Continuous Max Torque*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

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

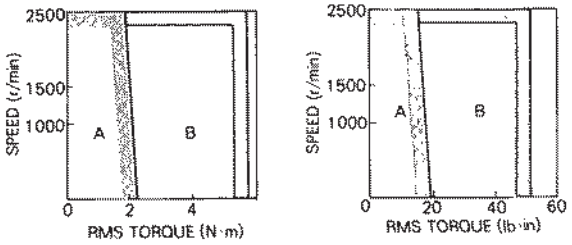
Notes:
1. □ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows;
   Standard: A (6000 pulses/rev)
   Optional: B (5000 pulses/rev), D (4000 pulses/rev)
2. There are two types of power supply units for brake.
   · Input 100 VAC, output 90 VDC (OPR 109 F)
   ·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

1. 2. 2 Torque-Speed Characteristics

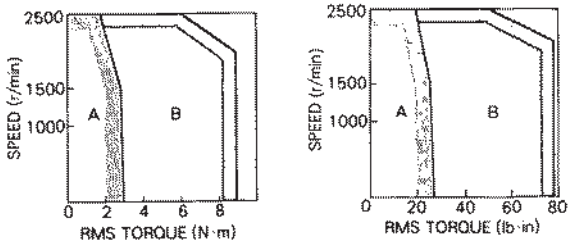
• TYPE USAFED-02F



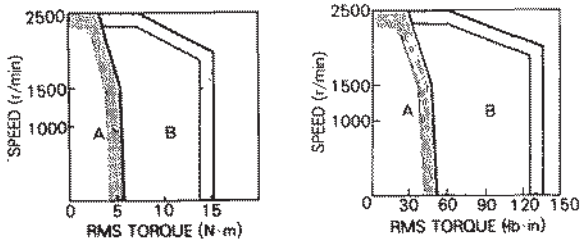
• TYPE USAFED-03F



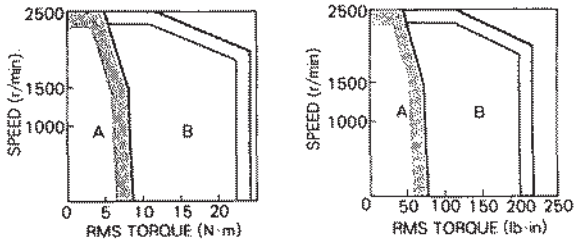
• TYPE USAFED-05F



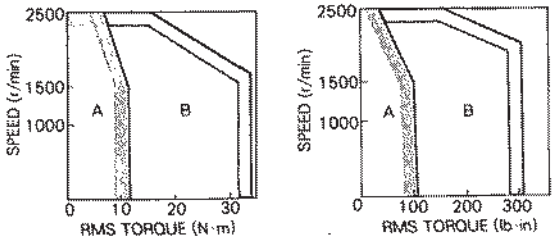
• TYPE USAFED-09F



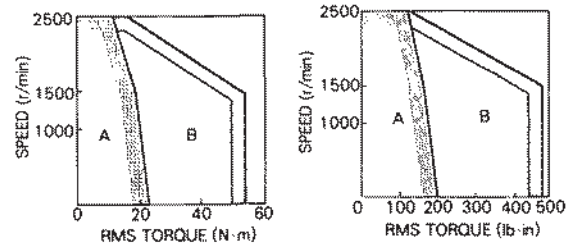
• TYPE USAFED-13F



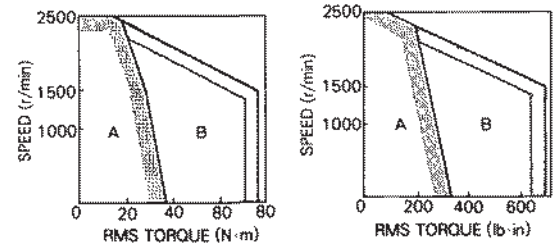
• TYPE USAFED-20F



• TYPE USAFED-30F



• TYPE USAFED-44F



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

1.3 S SERIES AC SERVOMOTORS

1.3.1 Ratings

Time Rating: Continuous

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

Isolation Voltage: 1500 VAC, one minute

Insulation Resistance: 500 VDC, 10MΩ or more

Enclosure: Totally-enclosed, self-cooled

Ambient Temperature: 0 to +40°C

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

Vibration: 15 μm or below

Finish in Munsell Notation: N1.5

Excitation: Permanent magnet

Mounting: Flange mounted

Drive Method: Direct drive

Table 1.3 Ratings and Specifications of S Series AC SERVOMOTORS

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

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

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

Notes:

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

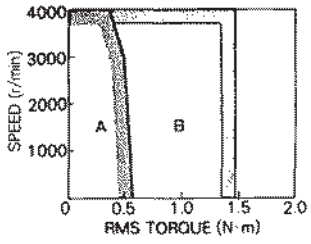
AC Servomotor Type USASEM-	02A, 03A, 05A		08A, 15A, 30A	
Standard (pulses/rev)	E	1500	C	2500
Optional (pulses/rev)	C	2500	E	1500
	F	1000	F	1000

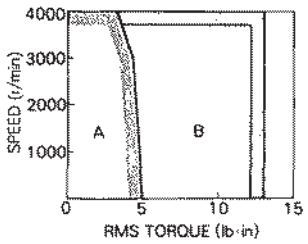
2. There are two types of power supply units for brake.
   - Input 100 VAC, output 90 VDC (DP 8401002 · 2)
   - Input 200 VAC, output 90 VDC (DP 8401002 · 1)

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

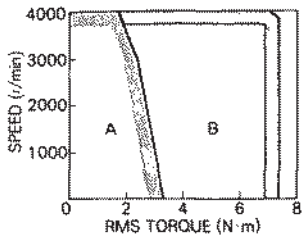
1.3.2 Torque-Speed Characteristics

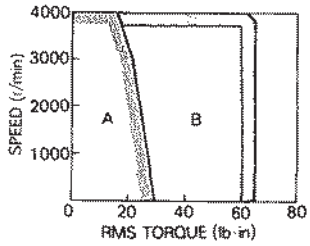
• TYPE USASEM-02A



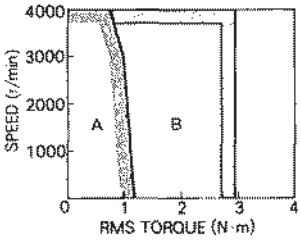


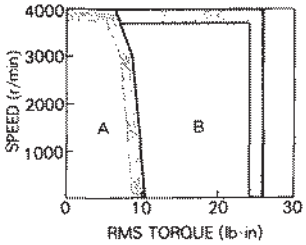
• TYPE USASEM-08A



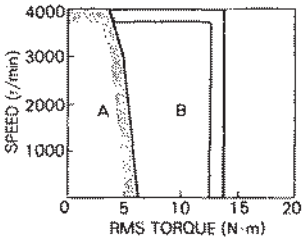


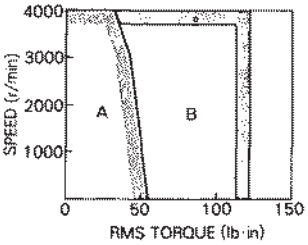
• TYPE USASEM-03A



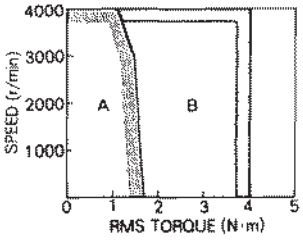


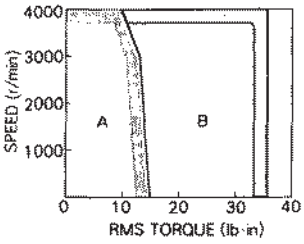
• TYPE USASEM-15A



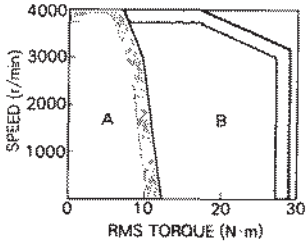


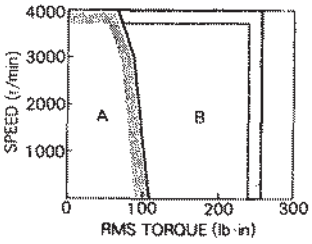
• TYPE USASEM-05A





• TYPE USASEM-30A





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

1.4 RATINGS AND SPECIFICATIONS OF SERVOPACK

Table 1.4 Ratings and Specifications of SERVOPACK

SERVOPACK Type CACR-				PR03BC	PR05BC	PR07BC	PR10BC	PR15BC	PR20BC	PR30BC	PR44BC
Max Motor Output			kW (HP)	0.3 (0.4)	0.5 (0.67)	0.7 (0.94)	1.0 (1.34)	1.5 (2.01)	2.0 (2.7)	3.0 (4.1)	4.4 (6.0)
M Series	Applicable Optical Encoder			A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev)							
	AC SERVOMOTOR	Type USAMED-		03MA	—	06MA	09MA	12MA	20MA	30MA	44MA
		Output	kW (HP)	0.3 (0.4)	—	0.6 (0.8)	0.9 (1.2)	1.2 (1.2)	3.0 (2.7)	3.0 (4.1)	4.4 (6.0)
		Rated Speed	r/min	1000							
	SERVOPACK Type CACR-			PR03BC3AM	—	PR07BC3AM	PR10BC3AM	PR15BC3AM	PR20BC3AM	PR30BC3AM	PR44BC3AM
	Continuous Output Current		Arms	3.0	—	5.8	7.6	11.7	18.8	26.0	33.0
	Max Output Current		Arms	7.3	—	13.9	16.6	28.0	42.0	56.5	70.0
	Allowable J_L ($=GD_L^2/4$)		$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	67.5 (60)	—	121.5 (107.5)	183.5 (162.5)	334 (296)	550 (486)	715 (633.5)	1200 (1063)
F Series	Applicable Optical Encoder			A: 6000 pulses/rev (B: 5000 pulses/rev, D: 4000 pulses/rev)							
	AC SERVOMOTOR	Type USAFED-		02FA	03FA	05FA	—	09FA	13FA	20FA	30FA	44FA
		Output	kW (HP)	0.15 (0.2)	0.3 (0.4)	0.45 (0.6)	—	0.85 (1.2)	1.3 (1.8)	1.8 (2.4)	2.9 (3.9)	4.4 (6.0)
		Rated Speed	r/min	1500								
	SERVOPACK Type CACR-			PR03BC3AF		PR05BC3AF	—	PR10BC3AF	PR15BC3AF	PR20BC3AF	PR30BC3AF	PR44BC3AF
	Continuous Output Current		Arms	3.0	3.0	3.8	—	6.2	9.7	15.0	20.0	30.0
	Max Output Current		Arms	8.5	8.5	11.0	—	17.0	27.6	42.0	56.5	77.0
	Allowable J_L ($=GD_L^2/4$)		$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	6.5 (5.75)	10.3 (9)	67.5 (60)	—	121.5 (107.5)	183.5 (162.5)	334 (296)	550 (486)	715 (633.5)
S Series	Applicable Optical Encoder			C: 2500 pulses (E: 1500 pulses/rev, F: 1000 pulses/rev)								
	AC SERVOMOTOR	Type USASEM-		02AE	03AE	05AE	—	08AC	15AC	—	30AC	—
		Output	kW (HP)	0.16 (0.2)	0.3 (0.4)	0.45 (0.6)	—	0.77 (1.1)	1.54 (2.1)	—	3.08 (4.2)	—
		Rated Speed	r/min	3000								
	SERVOPACK Type CACR-			PR03BC3ES-Y46	PR03BC3ES	PR05BC3ES	—	PR10BC3CS	PR15BC3CS	—	PR30BC3CS	—
	Continuous Output Current		Arms	2.1	3.0	4.3	—	5.3	10.4	—	19.9	—
	Max Output Current		Arms	6.0	8.5	11.0	—	15.6	28.0	—	56.5	—
	Allowable J_L ($=GD_L^2/4$)		$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	0.65 (0.55)	2.55 (2.25)	3.75 (3.35)	—	14.25 (12.65)	16.5 (14.4)	—	28.7 (25.45)	—
Basic Specifications	Power Supply	Main Circuit *		Three-phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60 Hz								
		Control Circuit		Single-phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60 Hz								
	Control Method			Transistorized PWM Control								
	Feedback			Optical encoder (A: 6000 pulses/rev, B: 5000 pulses/rev, C: 2500 pulses/rev, D: 4000 pulses/rev, E: 1500 pulses/rev, F: 1000 pulses/rev)								
	Ambient Temperature †			0 to +55°C								
	Storage Temperature			−20°C to +85°C								
	Ambient and Storage Humidity			90% or less (non-condensing)								
	Mounting Structure			Rack mounted								
	Approx Mass		kg (lb)	7.0 (16)		7.0 (16)	7.0 (16)	7.0 (16)	7.0 (16)	12.5 (28)	12.5 (28)	12.5 (28)
I/O Signal	Reference Pulse			Sign + pulse train input, +12 V/+5 V level selection available (CW/CCW pulse train input available)								
	Reference Pulse Frequency			fin: 0 to 100 kpps max								
	Control Signal			Servo ON, error counter clear, reference pulse block (reference pulse input selection), P drive, alarm reset, forward/reverse run stop.								
	Output Signal			Encoder (A, B and C phase) pulse, positioning completion, error counter overflow, servo ready, servo alarm, MCCB trip, overload, TG ON.								
Built-in Functions	Protection			Overvoltage, overload, overcurrent, overrun, open phase detection, MCCB trip, heatsink overheat, undervoltage, A/D error, regeneration trouble, CPU error, overflow.								
	Indication			Power supply, reference input, alarm, status, lag pulse, encoder (A, B and C phase) pulse indications.								
	Dynamic Brake			Built-in (non-contact dynamic brake)								
	Regenerative Resistor			Built-in								
	Applicable Load Inertia ‡			Up to 5 times motor inertia								
	Monitor Output			Torque monitor: 3.0V ± 10% at rated r/min Speed monitor: 4.0V ± 5% at 1000r/min. (M, F series), 2.0V ± 5% at 1000 r/min (S series)								

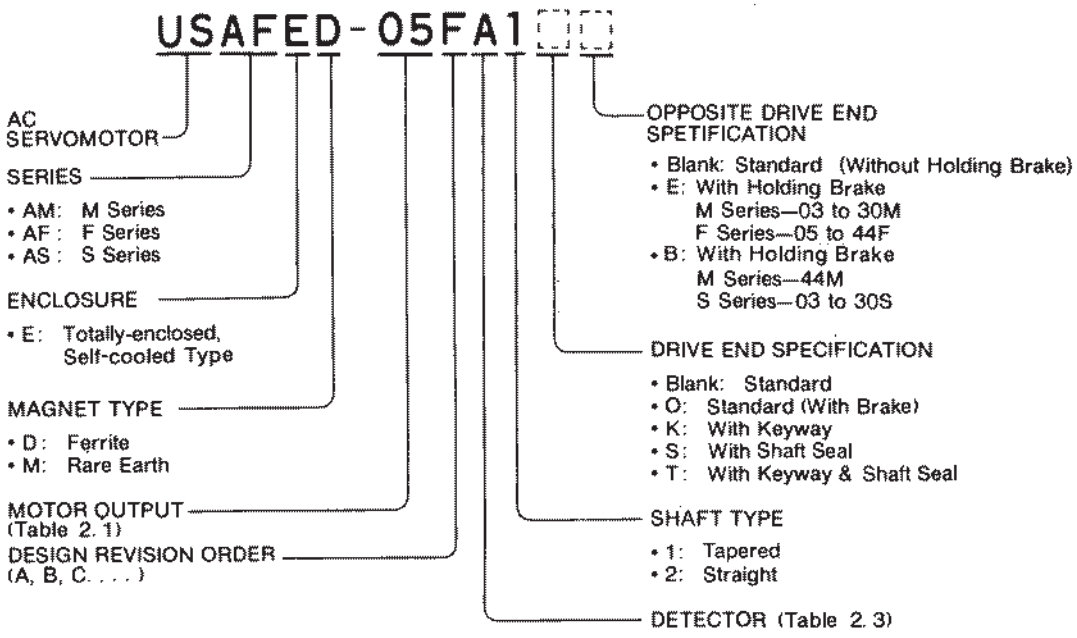
* Supply voltage should not exceed 230 V +10% (253 V). If the voltage should exceed this value, a step down transformer is required.

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

‡ When load inertia (GD^2) exceeds applicable range, be sure to refer to Par. 6.10.2. "Load Inertia."

2. TYPE DESIGNATION

• AC SERVOMOTOR



• SERVOPACK

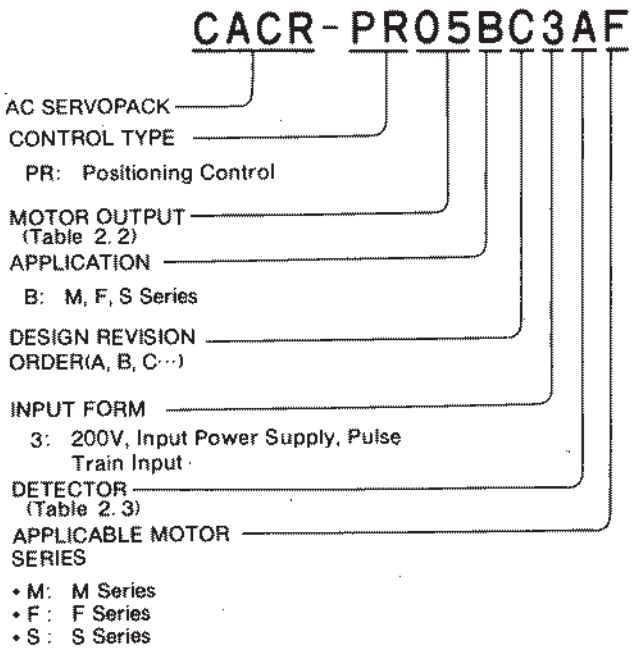


Table 2.1

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

Table 2.2

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

Table 2.3

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

3. LIST OF STANDARD COMBINATION

Table 3.1 Combination of SERVOPACK, AC SERVOMOTORS and Assocated Units

• M SERIES

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

• F SERIES

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

• S SERIES

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

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

Table 3.2 Specifications of AC SERVOMOTORS and Detectors

• M SERIES

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

• F SERIES

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

• S SERIES

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

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

Table 3.3 Specifications of Holding Brake

• M SERIES

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

• F SERIES

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

• S SERIES

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

4. CHARACTERISTICS

4.1 OVERLOAD CHARACTERISTICS

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

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

NOTE

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

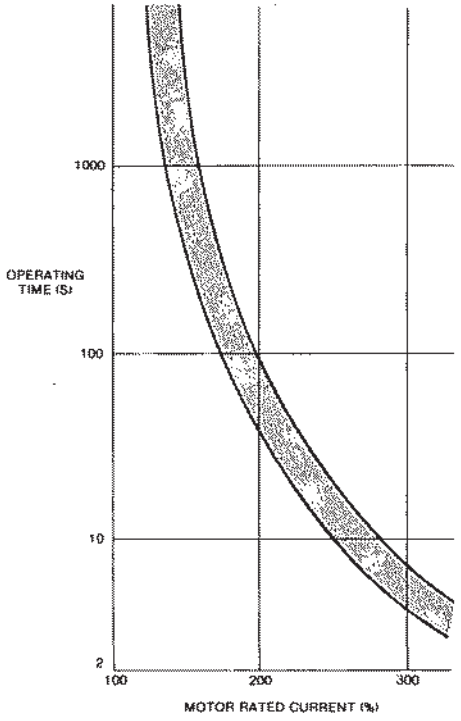


Fig. 4.1 Allowable Conduction Current of ***Servopock***

4.2 STARTING AND STOPPING TIME

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

Starting Time:

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

Stopping Time:

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

Where,

N_R : Rated motor speed (r/min)

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

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

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

I_R : Motor rated current (A)

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

I_P : Accel/decel current (Accel/decel current α times the motor rated current) (A)

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

I_L : Current equivalent to load torque (Load current β times the motor rated current) (A)

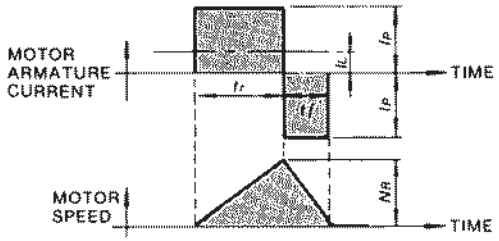


Fig. 4.2 Timing Chart of Motor Armature Current and Speed (Constant Load)

4.3 ALLOWABLE FREQUENCY OF OPERATION

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

- Allowable frequency of operation restricted by the SERVOPACK

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

- Allowable frequency of operation restricted by the Servomotor

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

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

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

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

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

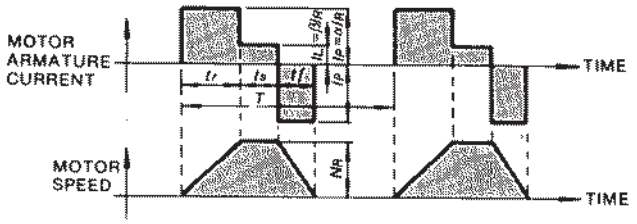


Fig. 4.3 Timing Chart of Motor Armature Current and Speed
(Restricted by SERVOMOTOR)

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

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

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

(times/min)

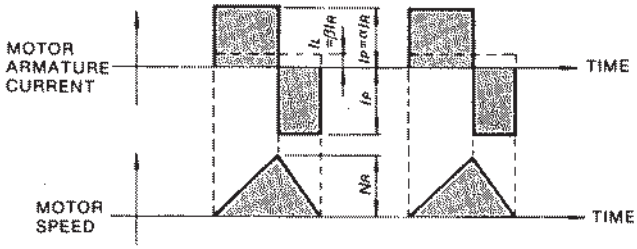


Fig. 4.4 Timing Chart of Motor Armature Current and Speed
(The motor remains at standstill between cycles of accel/decel without continuous rated speed running.)

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

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

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

(times/min)

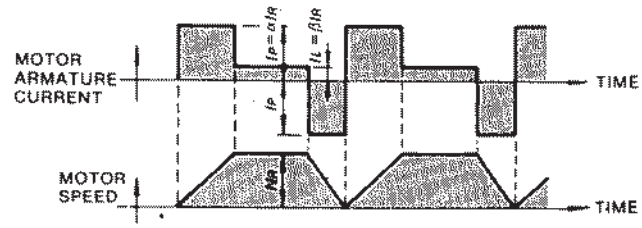


Fig. 4.5 Timing Chart of Motor Armature Current and Speed
(The motor accelerates, runs at constant speed, and decelerates in a continuing cycle without being at standstill.)

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

Table 4.1

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

4.4 MOTOR MECHANICAL CHARACTERISTICS

4.4.1 Mechanical Strength

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

4.4.2 Allowable Radial Load and Thrust Load

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

Table 4.1 M Series Allowable Radial Load and Thrust Load

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

Table 4.2 F Series Allowable Radial Load and Thrust Load

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

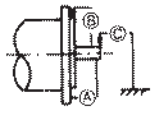
Table 4.3 S Series Allowable Radial Load and Thrust Load

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

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

4.4.3 Mechanical Specifications (M, F and S series)

Table 4.4 Mechanical Specifications in mm

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

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

4.4.4 Direction of Rotation

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

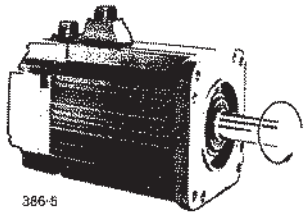
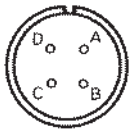


Fig. 4.6 AC SERVOMOTOR

(1) Connector Specifications for Standard SERVOMOTORS

(a) Motor receptacle

· M,F Series

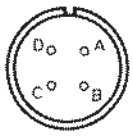


A	Phase U
B	Phase V
C	Phase W
D	Frame ground

· S Series
(Type USASEM-02A)

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

(Types USASEM-03A to 30A)



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

(b) Detector receptacle

A	Channel A output	K	Channel $\overline{U}$ 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 Series
(Types USAFED-05 to -44)

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

· F Series
(Types USAFED-02 and -03)

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

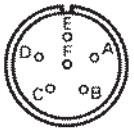
· S Series
(Type USASEM-02A)

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

(Types USASEM-03A, -05A)

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

(Types USASEM-08A to 30A)



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

4.4.5 Impact Resistance

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

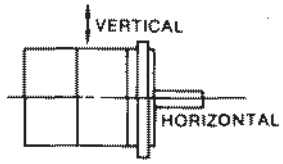


Fig. 4.7 Impact Resistance

NOTE

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

4.4.6 Vibration Resistance

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

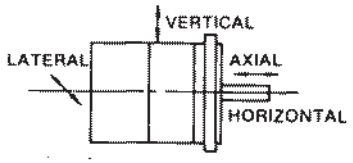


Fig. 4.8 Vibration Resistance

4.4.7 Vibration Class

Vibration of the motor running at rated speed is 15 μm or below (Fig.4.9)

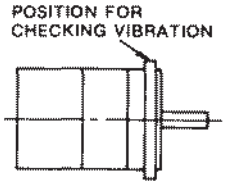


Fig. 4.9 Vibration Checking

4.4.8 Holding Brake

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

5. CONFIGURATION

5.1 CONNECTION DIAGRAM

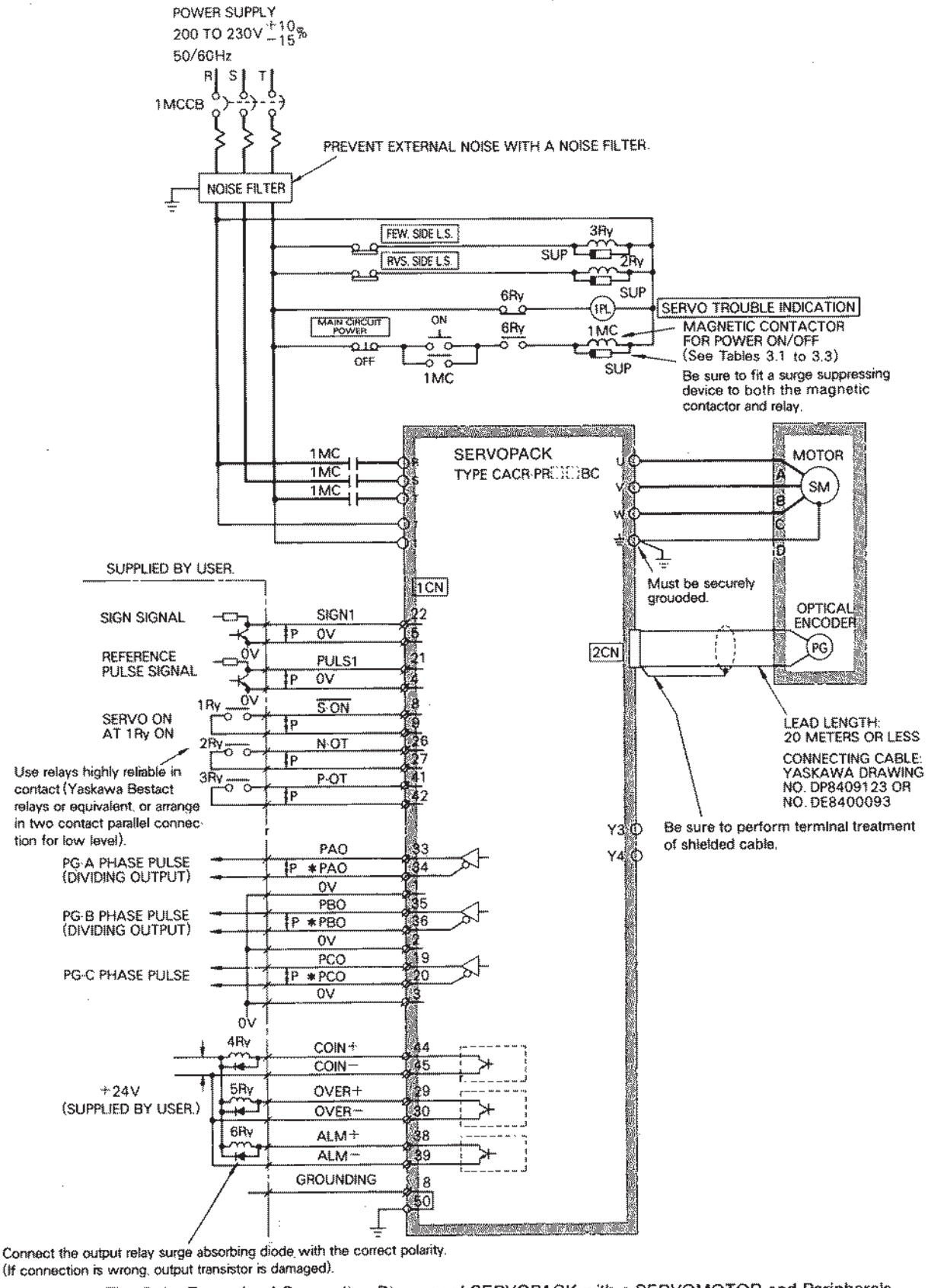
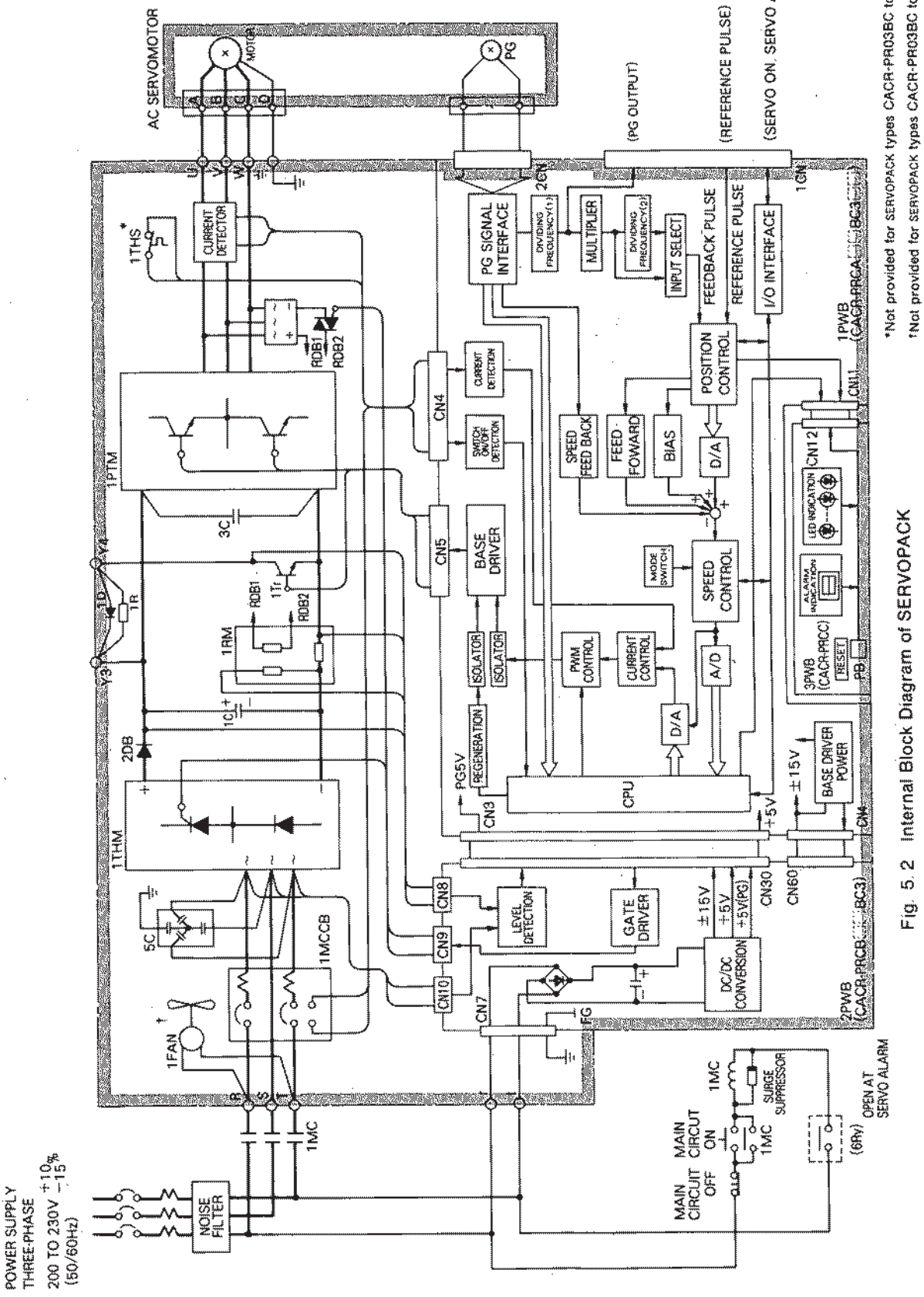


Fig. 5.1 Example of Connection Diagram of SERVOPACK with a SERVOMOTOR and Peripherals

5. 2 INTERNAL BLOCK DIAGRAM



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

Fig. 5. 2 Internal Block Diagram of SERVOPACK

5.3 EXTERNAL TERMINALS

Table 5.1 shows the specifications of external terminals for SERVOPACK.

Table 5.1 External Terminals for SERVOPACK

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

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

5.4.1 Specifications of Applicable Receptacles

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

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

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

5.4.2 Connector 1CN Layout and Connection of SERVOPACK

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

Table 5.3 Connector 1 CN Layout of SERVOPACK

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0V	0V	0V	0V	0V	0V	—	$\overline{\text{S-ON}}$	0V	OL+	OL−	$\overline{\text{ALRES}}$	$\overline{\text{INH}}$	0V	TRQ-M	VTG-M	0V	FG
0V for PG Output Signal			0V for PULS	0V for PULS	0V for $\overline{\text{CL}}$, $\overline{\text{INH}}$	—	Servo ON Input	0V for $\overline{\text{S-ON}}$	Overload Output		Alarm Reset Input	Ref. Pulse Block Input	0V for $\overline{\text{ALRES}}$	Torque Ref. Monitor Output	Speed Monitor Output	0V for TRQ-M, VTG-M	Frame Ground (Interruption)
		19	20	21	22	23	24	25	26	27	28	29	30	31	32		
		PCO	*PCO	PULS 1	SIGN1	$\overline{\text{CL}}$	$\overline{\text{P-CON}}$	0V	N-OT	0V	PULS 2	OVER+	OVER−	TGON+	TGON−		
		PG Output Signal (Phase C)		First Ref. Pulse Input	First Ref. Sign Input	Clear Input	P Drive Input	0V for $\overline{\text{P-CON}}$	Rvs. Inhb. Input	0V for N-OT	Second Ref. Pulse Input	Overflow Output		TGON Signal Output			
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
PAO	*PAO	PBO	*PBO	*PULS1	ALM+	ALM−	*SIGN1	P-OT	0V	SIGN 2	COIN+	COIN−	S-RDY+	S-RDY−	MCB+	MCB−	FG
PG Signal Output (Phase A)		PG signal Output (Phase B)		Line Driver Input of PULS 1	Servo Alarm Output		Line Driver Input of SIGN 1	Fwd. Inhb. Input	0V for P-OT	Second Ref. Sign Input	Positioning Completion Output		Servo Ready Output		MCCB Trip Signal Output		Frame Ground (Interruption)

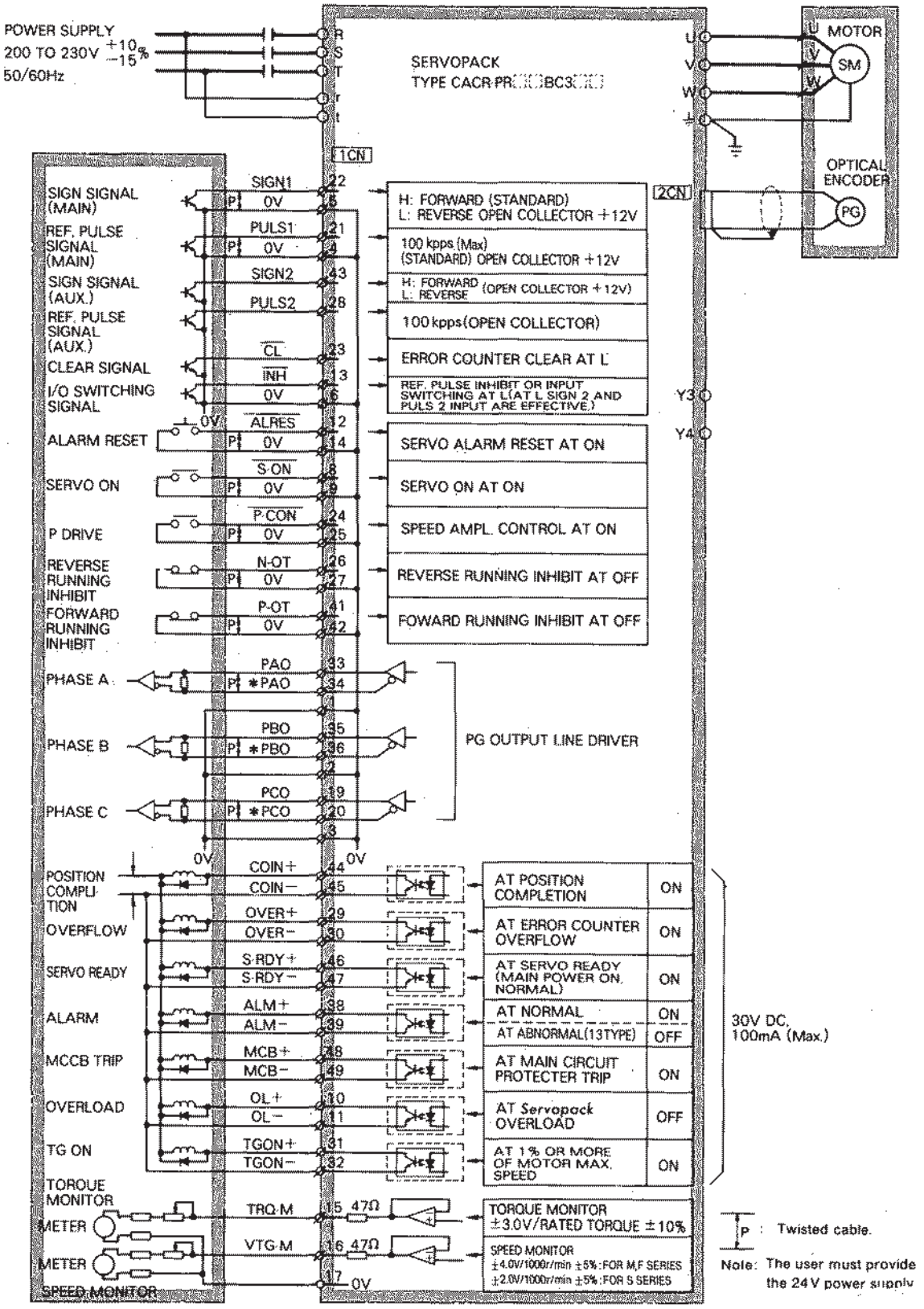


Fig. 5.3 I/O of Signals and Connector 1CN

5.4.3 I/O Signals of Connector 1CN

Table 5.4 Input Signals of Connector 1CN

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

Table 5.5 Output Signals of Connector 1CN

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

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

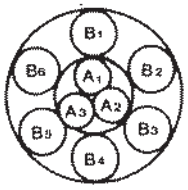
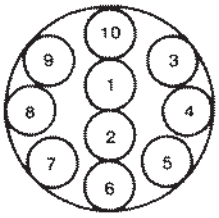
5.5.1 Specifications of Applicable Receptacles and Cables (Table 5.6)

Table 5.6 Specifications of Applicable Receptacles and Cables

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

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

Table 5.7 Details of Specifications of Applicable Cables

Connection	Soldered Type	Caulking Type
Yaskawa Drawing No.	DP 8409123	DE 8400093
Manufacturer	Fujikura Cable Co.	
Approx Specifications	Double, KQVV-SW AWG 22 × 3 C AWG 26 × 6 P	KQVV-SB AWG 26 × 10 P
Internal Composition and Lead Color	For Soldered Type 	For Caulking Type 
	A1 Red A2 Black A3 Green-yellow B1 Blue-White/blue B2 Yellow-White/yellow B3 Green-White/green B4 orange-White/orange B5 Purple-White/purple B6 Grey-White/grey Twisted cable	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 Cable
Yaskawa Standard Specifications	Standard lengths: 5m, 10m, 20m Terminal ends are not provided (with connectors).	

NOTE

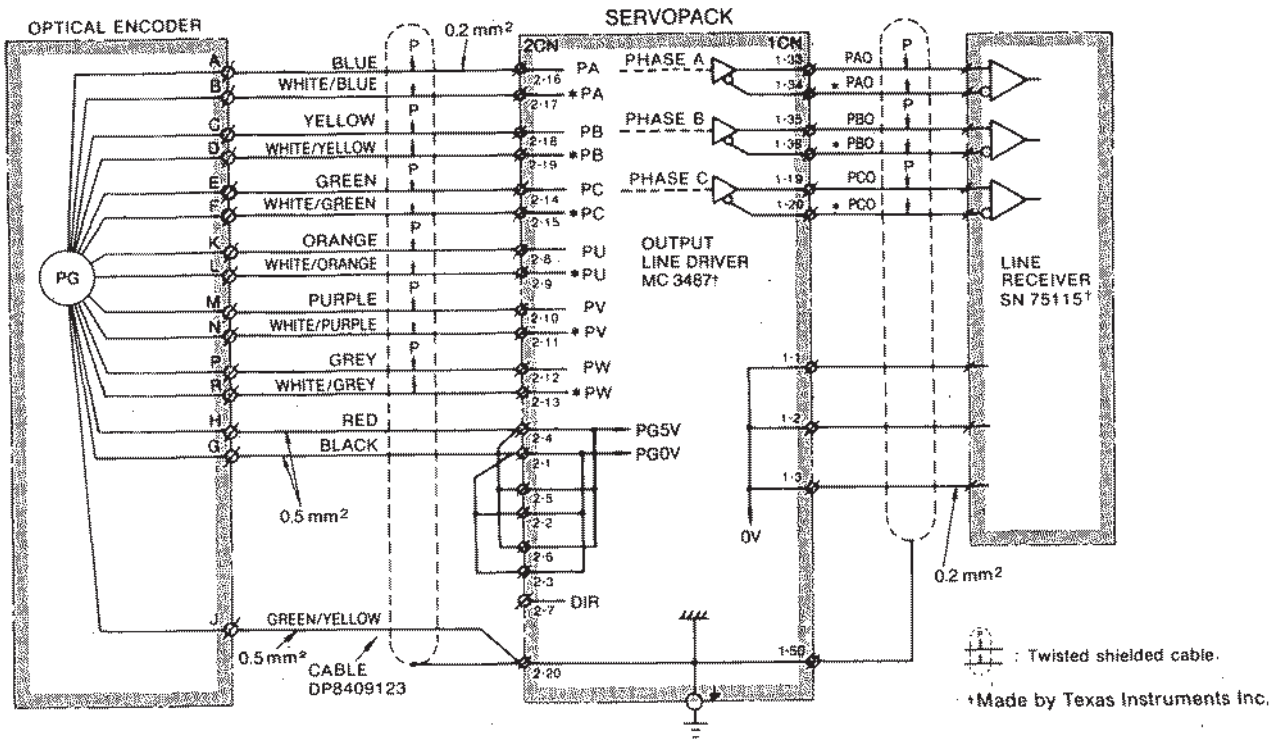
1. When applicable cables listed in Table 5.7 are used, allowable wiring distance between SERVOPACK and motor is a maximum of 20 meters.
2. The cable applied for 50 m wiring distance is available on order (Yaskawa drawing No. DP8409179). If wiring distance is 20 m or more, contact your Yaskawa representative.

5.5.2 SERVOPACK Connector (2CN) Terminal Layout and Connection

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

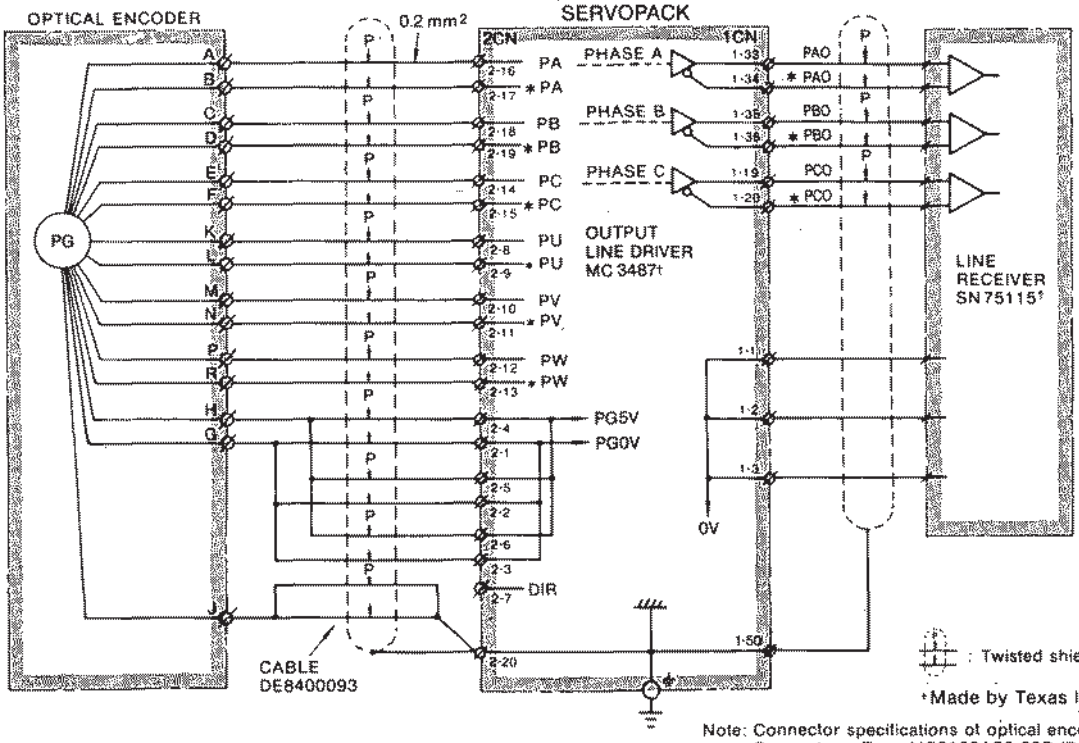
Table 5.8 Connector 2CN Layout of SERVOPACK

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**).

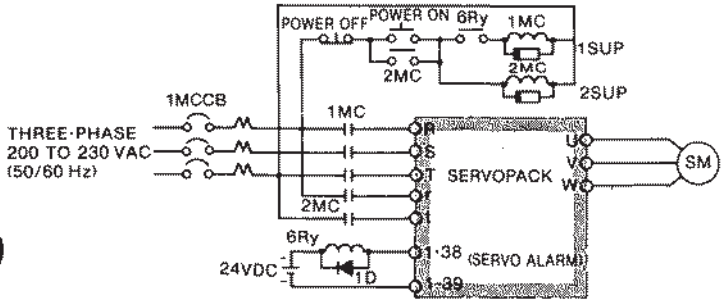
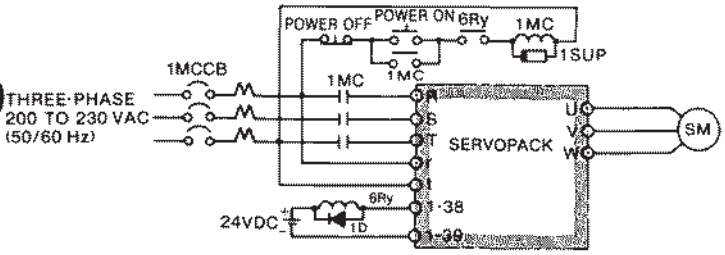


Fig. 6.1 Connection Example for Simultaneous Control Power ON/OFF



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

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

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

PRECAUTIONS FOR CONNECTIONS

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

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

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

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

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

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

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

6.2 CONFIGURATION OF I/O CIRCUIT

6.2.1 Input Circuit

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

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

NOTE

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

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

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

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

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

6.2.1 Input Circuit (Cont'd)

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

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

NOTE

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

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

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

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

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

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

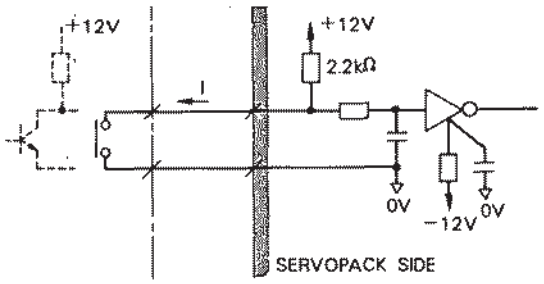


Fig. 6.3 Input Circuit (1)

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

(5) Input Reference Pulse

There are two types of modes for reference pulse input:

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

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

(i) Reference pulse mode

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

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

(ii) Voltage level and timing of reference pulse

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

Table 6.1 Reference Pulse Voltage Level Setting

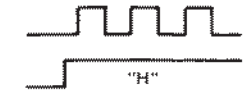
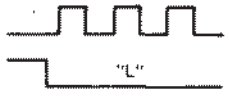
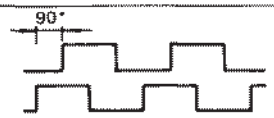
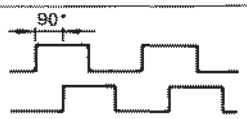
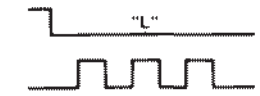
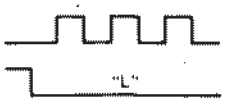
Voltage Level	SL 20 Setting
+12V	1 2 3 (2 and 3 jumpered)
+5V	1 2 3 (1 and 2 jumpered)

For details, refer to Table 6.4.

(iii) Input circuit

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

Table 6. 2 Reference Pulse Mode

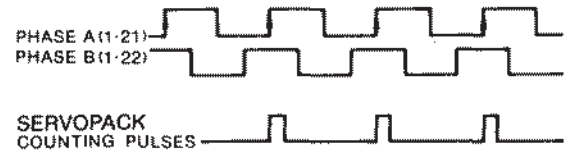
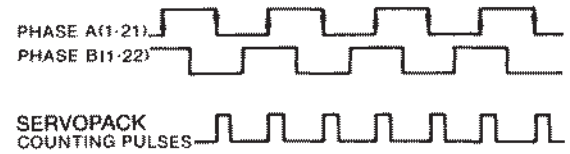
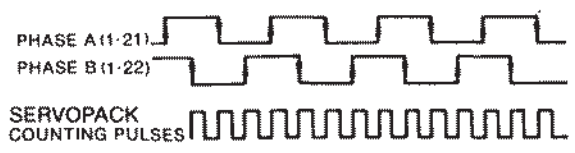
Reference Pulse Mode	Input Pin No.	Forward Running Reference of Motor	Reverse Running Reference of Motor	Input Multiplier †	SW20† ①	②	③
Sign + Pulses	1CN-㉑ 1CN-㉒			—	○	○	
90° Phase Difference 2-phase Pulses* (1, 2 or 4 Times)	1CN-㉑ 1CN-㉒			× 1	○	○	○
				× 2		○	○
				× 4	○		○
CW Pulses + CCW Pulses	1CN-㉑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

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

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

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

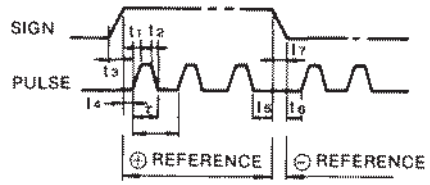
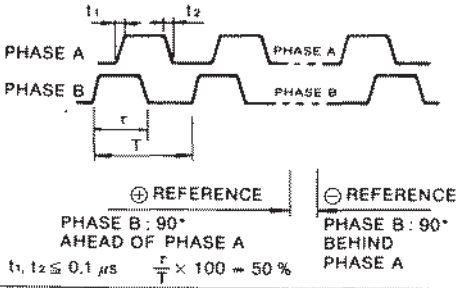
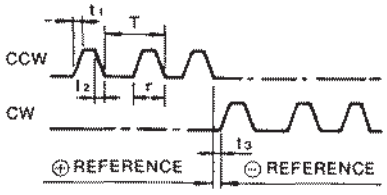
Table 6. 3 Counting Method of Reference Pulse

Multiplier	Content of Pulse Counting of SERVOPACK	Reference Pulse Frequency of SERVOPACK
× 1	Counts only the leading edge of phase-A pulse input (1CN-㉑). 	f (pps) [Nr/min*]
× 2	Counts the leading and trailing edges of phase A pulse input (1CN-㉑). 	2 × f (pps) [2×Nr/min]
× 4	Counts the leading and trailing edges of phase A pulse input (1CN-㉑) and phase B pulse input (1CN-㉒). 	4 × f (pps) [4×Nr/min]

* Motor speed

6.2.1 Input Circuit (Cont'd)

Table 6.4 Applicable Voltage Level and Timing

Item			Electrical Specifications		Remarks
Voltage Level of Signal		+ 12 V Level	H Level	+ 10.8 V to + 12 V	+ 5 V level or + 12 V level is set by internal switch SW20.
			L Level	0 V to + 1.2 V	
		+ 5 V Level	H Level	+ 4.2 V to + 5 V	
			L Level	0 V to + 0.8 V	
Reference Pulse Signal Mode	Sign + Pulse Input (SIGN + PULSE Signal) • Max Reference Frequency: 100 kpps		 $t_1, t_2 \leqq 0.1\ \mu s$ $t_3, t_7 \leqq 0.1\ \mu s$ $t_4, t_5, t_6 > 5\ \mu s$ $\tau \geqq 5\ \mu s$ $\frac{\tau}{T} \times 100 \leqq 50\ \%$	SIGN : H — ⊕ REFERENCE L — ⊖ REFERENCE
	90° Phase Difference 2-phase Pulse (Phase A + Phase B) • Max Reference Frequency: 100 kpps		 $t_1, t_2 \leqq 0.1\ \mu s$ $\frac{\tau}{T} \times 100 = 50\ \%$	Multiplier Mode is set by the internal switch SW20. • Max rerence frequency: ×1: 100 kpps ×2: 50 kpps ×4: 25 kpps
	CCW Pulses + CW Pulses • Max Reference Frequency: 100 kpps		 $t_1, t_2 \leqq 0.1\ \mu s$ $t_3 > 5\ \mu s$ $\tau \geqq 5\ \mu s$ $\frac{\tau}{T} \times 100 \leqq 50\ \%$	—

Note: Maximum reference frequency is 200 kpps.

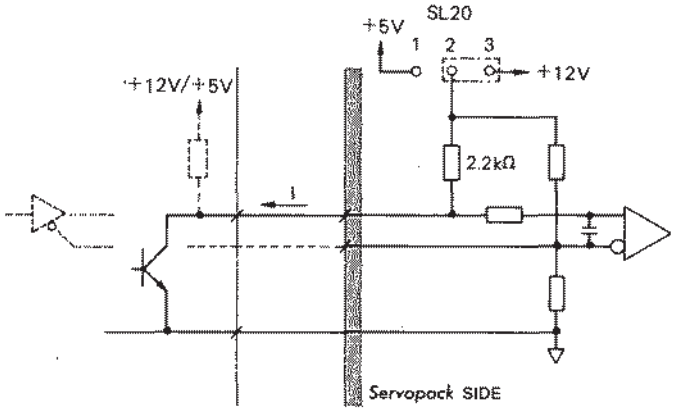


Fig. 6.4 Input Circuit (2)

(iV) Other functions

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

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

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

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

(Example)

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

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

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

(i) Reference pulse mode

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

Table 6.5 Reference Pulse Mode Setting

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

(ii) Voltage level and timing of reference pulse

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

(iii) Input circuit

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

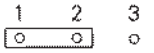
(6) Clear Signal (CL)

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

(a) Voltage level

Voltage level +12V/+5V can be switched at SL10.

Table 6.6 Voltage Level Setting

Voltage Level	SL10
+12 V	
+5 V	

(b) Logic reversion

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

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

(c) Derivative action

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

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

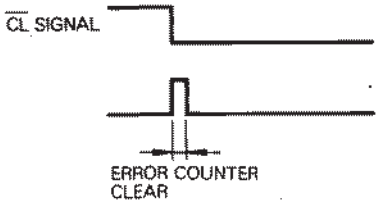


Fig. 6.5 Defferential Action of Clear Signal

(d) Note for clear signal usage

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

6.2.1 Input Circuit (Cont'd)

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

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

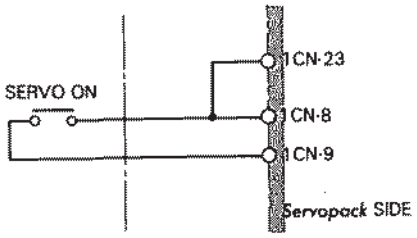


Fig. 6.6 Sequential Operation of Servo ON and Clear Signals

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

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

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

(a) Voltage level

Refer to Table 6.6.

(b) Logic reversion

Effective logic can be reversed when setting pin of SW40 - ① is turned ON.

- Setting pin of SW40 - ①

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

6.2.2 Output Circuit

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

- Applied voltage (V_{max}) ≦ 30 VDC
- Operational current (I_p) ≦ 100 mA

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

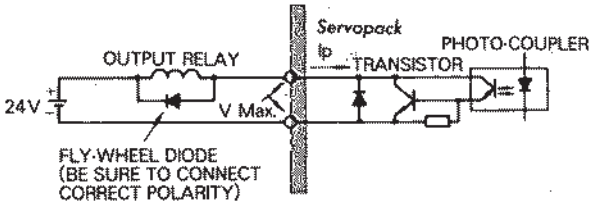


Fig. 6.7 Output Circuit

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

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

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

Table 6.7 Position Completion Width Setting

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

Table 6.8

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