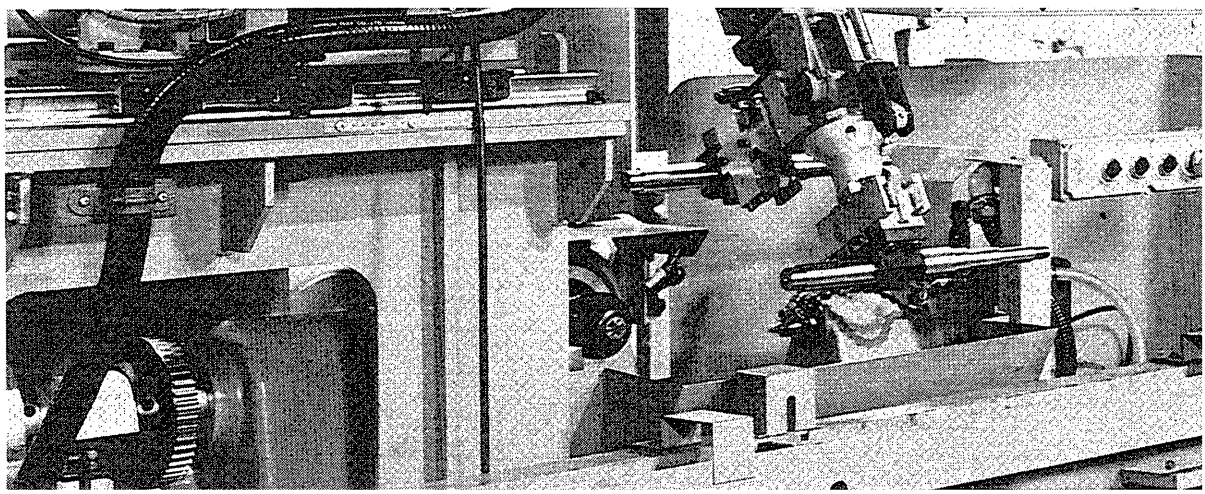
YASKAWA MOTION CONTROLLER

MOTIONPACK FD MODEL 0

DESCRIPTIVE INFORMATION

SINGLE-AXIS POSITIONING ABSOLUTE VALUE TYPE



YASKAWA

MANUAL NO. SIE-C883-1.1C

INTRODUCTION

The MOTIONPACK FD Series are single-axis motion controllers succeeding the MOTIONPACK-34. The MOTIONPACK FD has a built-in servo controller and is suitable for mechanical feeders, transfer machines, and exclusive-use machines.

This manual describes functions and operations of model 0 as the basic system of MOTIONPACK FD series. Refer to other user's manuals for models 1 and 3.

<Reference Manual>

- MOTIONPACK FD Model 1 (SIE-C883-1.2)
- MOTIONPACK FD Model 3 (SIE-C883-1.4)

General Precautions

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

Notes for Safe Operation

Read this manual thoroughly before installation, operation, maintenance or inspection of the MOTIONPACK FD.

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

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

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

Please note that symbol mark used to indicate caution differs between ISO and JIS.

ISO	JIS
⚠	◇!

In this manual, symbol mark stipulated by ISO is used.

On products, caution symbol marks of ISO and JIS are used in labels. Please follow the same safety instructions concerning caution.

⚠ WARNING

(WIRING)

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

(OPERATION)

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

(INSPECTION AND MAINTENANCE)

- Be sure to turn OFF power before inspection or maintenance.
  Otherwise, electric shock may result.
- After turning OFF power, wait at least five minutes before servicing the product.
  Otherwise, residual electric changes may result in electric shock.

⚠ CAUTION

(RECEIVING)

- Use the specified combination of Servomotor and MOTIONPACK FD.
  Failure to observe this caution may lead to fire or failure.

(INSTALLATION)

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

(WIRING)

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

(OPERATION)

- To avoid inadvertent accidents, run the Servomotor only in test run (without load).
  Failure to observe this caution may result in personal injury.
- Before starting operation with load connected, make sure emergency-stop procedures are in place.
  Failure to observe this caution may result in personal injury.
- Never change wiring while power is ON.
  Failure to observe this caution may result in electric shock or personal injury.

(INSPECTION AND MAINTENANCE)

- Do not disassemble the Servomotor.
  Failure to observe this caution may result in electric shock or personal injury .
- Be sure to change the battery with ER6VC3.
  Failure to observe this caution may lead to fire or failure.

CONTENTS

CONTENTS

CONTENTS (Cont'd)

INDEX

INDEX (Cont'd)

1. FEATURES

(1) Since an all-digital servo is employed for the servo controller section, the MOTIONPACK FD achieve high speed, driftless and volumeless control. Additionally, an absolute value positioning system can be realized by combining with an AC SERVOMOTOR (M, F, S, D or G series) containing an absolute value encoder.

(2) A servo controller and motion controller are incorporated to realize space-saving or less wiring, compared to the conventional models.

(3) The following optimum and powerful functions are available for mechanical feeders, transfer machines or exclusive-use machines.

① Home position return is not necessary at power ON because of the absolute value method.

② A no-limit switch system can be built using zone signal outputs.

③ Since each feeding function contains a programmable thrust limit function, the following can be available:

- Home position setting using stopper
- Prevention of tool damage or drive system faults by detecting abnormal torque

④ The MOTIONPACK FD exceeds all features of the conventional MOTIONPACK-33 and -34.

(4) Since the auxiliary axis control function is provided, 2-axis operation such as S-command output, solid tap function (Model 2), etc. can be performed.

(5) Serial communication with the master controller can be available by adding serial interface board (option), which makes a less-wiring system easy to be built. (Model 1 to Model 3)

(6) The following options are provided for program setting and monitor:

- New, small-size and easy to use exclusive-use programmer
- Lap-top personal computer

NOTE

Angle indexing and indefinite positioning function of the MOTIONPACK-34 are not provided for the FD series.

2. SYSTEM CONFIGURATION

2.1 BASIC SYSTEM

Fig. 2.1 shows the basic system (Model 0) of the MOTIONPACK FD series. In the basic system, discrete I/O are used as a interface between the controller (FD) and master PLC. Any serial interface functions such as interface between modules are not provided.

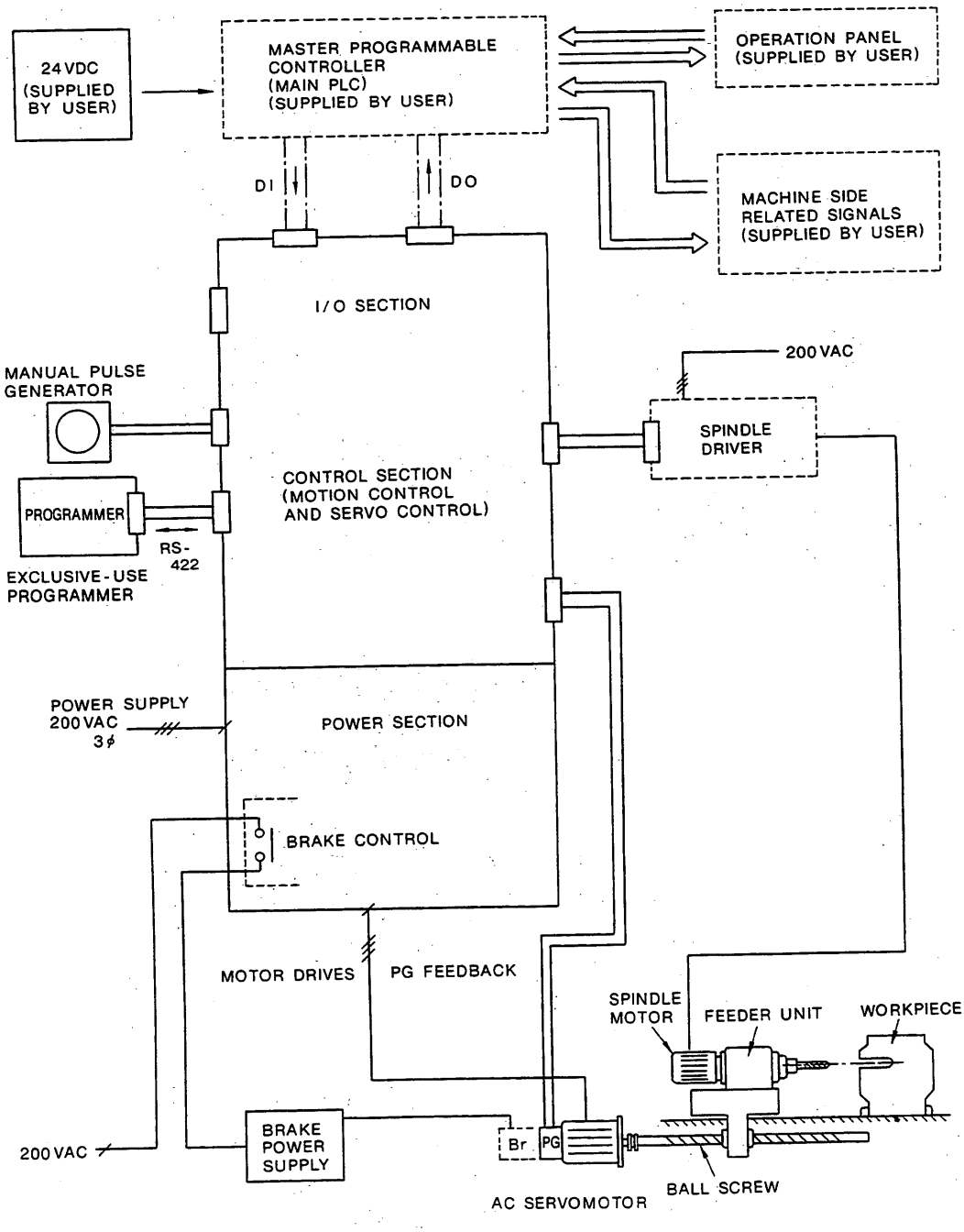
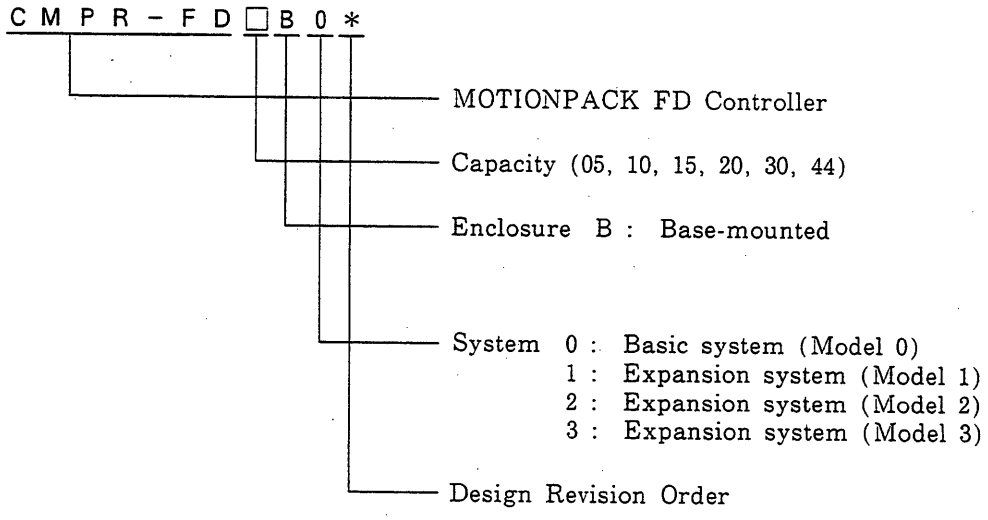


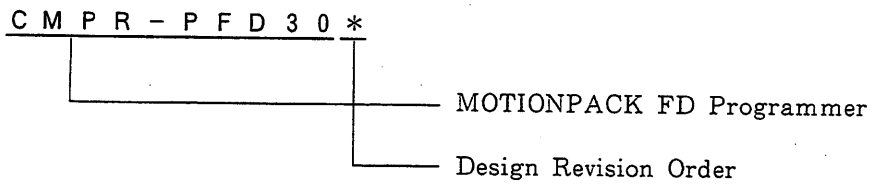
Fig. 2.1 Basic System

2.2 TYPE DESIGNATION

(1) Controller

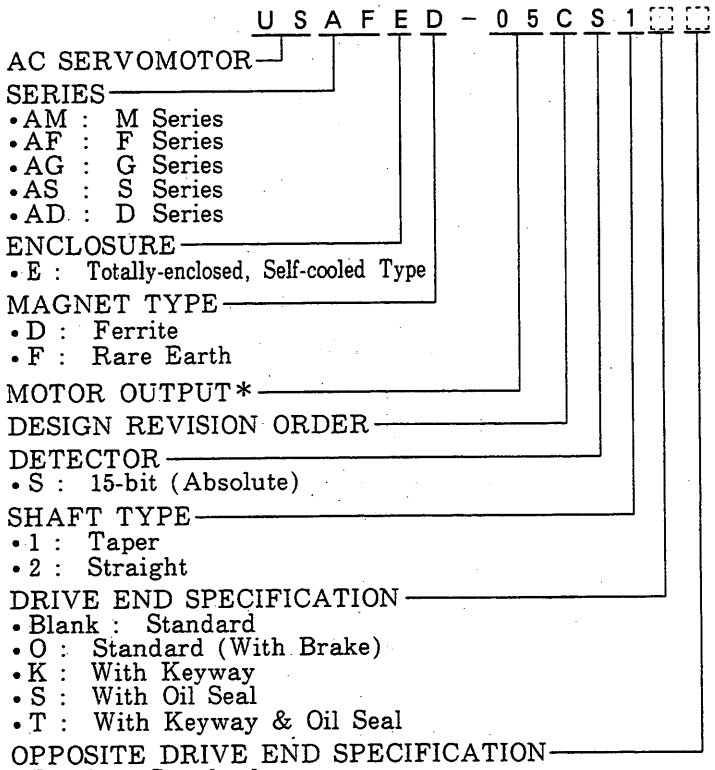


(2) Programmer



2.2 TYPE DESIGNATION (Cont'd)

(3) AC SERVOMOTOR



* MOTOR OUTPUT

	M Series	F Series	G Series	S Series	D Series
02	—	0.15 kW	0.15 kW	154 W	—
03	0.3 kW	0.3 kW	0.3 kW	308 W	—
05	—	0.45 kW	0.45 kW	462 W	0.5 kW
06	0.6 kW	—	—	—	—
08	—	—	—	771 W	—
09	0.9 kW	0.85 kW	0.85 kW	—	—
10	—	—	—	—	1.0 kW
12	1.2 kW	—	—	—	—
13	—	1.3 kW	1.3 kW	—	—
15	—	—	—	1540 W	1.5 kW
20	2.0 kW	1.8 kW	1.8 kW	—	—
22	—	—	—	—	2.2 kW
30	3.0 kW	2.9 kW	2.9 kW	3080 W	—
37	—	—	—	—	3.7 kW
44	4.4 kW	4.4 kW	4.4 kW	—	—

Table 2.1 System Component List

Output (kW)	Applicable Motor	Connector for Power Cable (Motor Side)		Connector for Encoder Cable (Motor Side)		Controller	Programmer	Connector	Manual Pulse Generator	24 VDC Power Supply for I/O Signal	Manual Driver
		Plug	Clamp	Plug	Clamp						
0.5	USAFED-02CS1	MS310 ☐ B14-2S	MS3057-6A	MS310 ☐ B20-29S ☐ = 8 : L-plug = 6 : Straight plug	MS3057-12A	CMPR -FD05B ☐☐	CMPR -PFD30	1CN : MR-20M 20P (MR-20L) 2CN : MR-20F 20P (MR-20L) 3CN : MR-34F 34P (MR-34L) 4CN : MR-34M 34P (MR-34L) 7CN : MR-8F 8P (MR-8L) 8CN : MR-16M 16P (MR-16L) 9CN : MR-16F 16P (MR-16L) 10CN : MR-34F 34P (MR-34L) 11CN : MR-34M 34P (MR-34L)	PREH -2E5T /100-M1 (made by YASKAWA CONTROLS CO.,LTD.)	EWS50-24 24 V 2.4 A (made by NEMIC LAMBDA CO.,LTD.)	VS-616G3 (made by YASKAWA ELECTRIC CORPORATION.)
	USAGED-02AS1										
	USASEM-02AS2	MS310 ☐ B18-10S	MS3057-10A								
	USAMED-03BS1	MS310 ☐ B18-10S	MS3057-10A								
	USAFED-03CS1	MS310 ☐ B14-2S	MS3057-6A								
	USAGED-03AS1										
	USASEM-03AS2	MS310 ☐ B18-10S	MS3057-10A								
	USAFED-05CS1	MS310 ☐ B18-10S	MS3057-10A								
	USAGED-05AS1										
	USASEM-05AS2										
	USADED-05EW2	MS310 ☐ B20-15S	MS3057-12A								
0.6	USAMED-06BS1	MS310 ☐ B18-10S	MS3057-10A	MS310 ☐ B20-29S ☐ = 8 : L-plug = 6 : Straight plug	MS3057-12A	CMPR -FD10B ☐☐					
1.0	USAMED-09BS2	MS310 ☐ B18-10S	MS3057-10A								
	USAFED-09CS1										
	USAGED-09AS1										
	USASEM-08AS1	MS310 ☐ B20-4S	MS3057-12A								
1.5	USAMED-12BS2	MS310 ☐ B22-22S	MS3057-12A	MS310 ☐ B20-29S ☐ = 8 : L-plug = 6 : Straight plug	MS3057-12A	CMPR -FD15B ☐☐					
	USAFED-13CS2	MS310 ☐ B18-10S	MS3057-10A								
	USAGED-13AS2										
	USASEM-15AS1	MS310 ☐ B20-4S	MS3057-12A								
	USADED-10ES2	MS310 ☐ B20-15S	MS3057-12A								
2.0	USAMED-20BS2	MS310 ☐ B22-22S	MS3057-12A	MS310 ☐ B20-29S ☐ = 8 : L-plug = 6 : Straight plug	MS3057-12A	CMPR -FD20B ☐☐					
	USAFED-20CS2										
	USAGED-20AS2										
	USADED-15ES2	MS310 ☐ B24-10S	MS3057-16A								
3.0	USAMED-30BS2	MS310 ☐ B22-22S	MS3057-12A	MS310 ☐ B20-29S ☐ = 8 : L-plug = 6 : Straight plug	MS3057-12A	CMPR -FD30B ☐☐					
	USAFED-30CS2										
	USAGED-30AS2										
	USASEM-30AS1	MS310 ☐ B20-4S	MS3057-12A								
	USADED-22ES2	MS310 ☐ B24-10S	MS3057-16A								
4.4	USAMED-44BS2	MS310 ☐ B32-17S	MS3057-20A	MS310 ☐ B20-29S ☐ = 8 : L-plug = 6 : Straight plug	MS3057-12A	CMPR -FD44B ☐☐					
	USAFED-44CS2	MS310 ☐ B22-22S	MS3057-12A								
	USAGED-44AS2										
	USADED-37ES2	MS310 ☐ B24-10S	MS3057-16A								

2.4 STANDARD SYSTEM COMBINATION

Table 2.2 Standard System Combination

Controller CMPR-FD	M Series USAMED-	F Series USAFED-	G Series USAGED-	S Series USASEM-	D Series USADED-
05	03 (0.3 kW)	02 (0.2 kW) 03 (0.3 kW)	02 (0.2 kW) 03 (0.3 kW)	02 (0.2 kW) 03 (0.3 kW)	
		05 (0.5 kW)	05 (0.5 kW)	05 (0.5 kW)	05 (0.5 kW)
10	06 (0.6 kW) 09 (0.9 kW)	09 (0.9 kW)	09 (0.9 kW)	08 (0.8 kW)	
15	12 (1.2 kW)	13 (1.3 kW)	13 (1.3 kW)	15 (1.5 kW)	10 (1.0 kW)
20	20 (2.0 kW)	20 (2.0 kW)	20 (2.0 kW)		15 (1.5 kW)
30	30 (3.0 kW)	30 (3.0 kW)	30 (3.0 kW)	30 (3.0 kW)	22 (2.2 kW)
44	44 (4.4 kW)	44 (4.4 kW)	44 (4.4 kW)		37 (3.7 kW)

3. UNIT SPECIFICATIONS/RATINGS

3.1 MOTIONPACK FD SERIES CONTROLLER

3.1.1 Basic Specifications

Table 3.1 Basic Specifications

Item	Ratings
Type Designation	CMPR-FD ☐☐ B 0 ☐ MOTIONPACK FD Series Motor Output Construction* System† Design Revision Order
Construction	Motion controller with built-in servo controller Unit Construction (1) Basic section : Motion control section and servo control section are incorporated. (2) Option section : Option board added on the upper part of the basic section (such as M-NET interface)
No. of Control Axes	1 axis + spindle (auxiliary axis)
Applicable SERVOMOTOR	YASKAWA AC SERVOMOTOR (M, F, S, D, G series) : 0.15 to 4.4 kW
Holding Brake	Holding brake control signal provided. Brake power supply has to be installed separately.
Encoder	Absolute encoder made by YASKAWA (8192 P/R)
Peripheral Device	Programmer : Exclusive-use programmer, personal computer (IBM compatible), manual pulse generator
Installation	In-panel mounted type (base-mounted construction)
Power Supply	200 VAC to 230 VAC (+10%, −15%) 50/60 Hz both for main circuit and control power supplies
Environment	Ambient temperature : 0 to +55℃ Storage temperature : −20 to +85℃ Humidity : 90% RH (non-condensing) Atmosphere : Free from corrosive gases, dust, metallic powder, high humidity or high temperature Grounding : 100Ω or less

* B : Base-mounted
† 0 : Without option
1 : With build-in PLC and M-NET interface
3 : Correspondence to mecha-feed drive

3.1.2 Servo Control Section Specifications

Ratings and specifications are shown below, in combination with SERVOMOTOR.

(1) M Series SERVOMOTOR

Table 3.2 Ratings and Specifications in Combination with M Series SERVOMOTOR

MOTIONPACK FD Type CMPR-FD ☐☐☐☐☐			05B ☐	10B ☐		15B ☐	20B ☐	30B ☐	44B ☐
SERVOMOTOR Type USAMED-☐☐☐☐☐			03BS1	06BS1	09BS2	12BS2	20BS2	30BS2	44BS2
SERVOMOTOR	Rated Output *	kW	0.3	0.6	0.9	1.2	2.0	3.0	4.4
		HP	0.4	0.8	1.2	1.6	2.7	4.0	5.9
	Rated Torque *	N・m	2.84	5.67	8.63	11.5	19.1	28.4	41.9
		lb・in	25	50	76	102	169	252	372
	Instantaneous Peak Torque *	N・m	7.17	14.1	19.3	28.0	44.0	63.7	91.9
		lb・in	63	125	171	248	390	564	807
	Rated Speed *	r/min	1000						
	Max Speed *	r/min	2000						1500
	Moment of Inertia J_M (= $GD^2_M/4$)	kg・m² × 10^{-4}	13.5	24.3	36.7	66.8	110	143	240
		lb・in・s² × 10^{-3}	12.0	21.5	32.5	51.2	97.2	126.7	212.6
	Power Rate *	kW/s	6.1	13.3	20.3	19.7	33.2	48.6	66.9
	Speed/Positioning Detector		Absolute encoder (8192 P/R)						
	General		• Time Rating : Continuous • Insulation : Class F • Ambient Temperature : 0 to +40℃ • Vibration : 15 μm or below • Finish in Munsell Notation : N1.5 • Drive Method : Direct drive • Excitation : Permanent magnet • Enclosure : Totally-enclosed, self-cooled • Mounting : Flange-mounted						
Servo Control Section	Basic Specifications	Power Supply	Main Circuit and Control Circuit	Three-phase 200 to 230 VAC $^{+10\%}_{-15\%}$, 50/60 Hz						
		Continuous Output Current A(rms)		3	5.8	7.6	11.7	18.8	26	33
		Max Output Current A(rms)		7.3	13.9	16.6	28	42	56.5	70
		Control Method		Transistorized PWM control						
		Feedback		Absolute encoder (8192 P/R)						
		Environmental Conditions	Ambient Temp.	0 to +55℃						
			Storage Temp.	−20 to +85℃						
			Ambient/Storage Humidity	90%RH or less (non-condensing)						
			Vibration-/Shock-resistance	0.5G/2G						
		Mounting Structure		Base-mounted						
	Performance	Speed Control Range		1 : 5000						
		Speed Reg.	Load (0 to 100%)	−0.01% or less at rated speed						
			Voltage (+10% to −15%)	0%						
			Temp. (25 ± 25°C)	±0.01% or less at rated speed						
		Frequency Response		100 Hz ($J_L = J_M$)						
	Built-in Functions	Dynamic Brake (DB)		Built-in automatic DB activated at : main power OFF, servo alarm, servo OFF						
		Regeneration		Built-in regenerative resistor						
		Load Inertia J_L		Up to 5 times motor inertia (J_M)						
		Protection		Communication error, overcurrent, MCCB trip, regenerative trouble, overvoltage, overspeed, undervoltage, overload, reference point error, overrun, open phase, CPU error						
		Display		7-segment LED (Alarm, status)						
		Overtravel Prevention		Stops when P・OT or N・OT operates.						
		Others		Torque control, brake interlock, RVS-run connection, soft start, zero-clamp						
Optional				SERVOMOTOR with holding brake (Power supply is externally installed.)						

* Ratings are obtained at armature winding temperature of 20℃, in combination with MOTIONPACK.

(2) F Series SERVOMOTOR

Table 3.3 Ratings and Specifications in Combination with F Series SERVOMOTOR

MOTIONPACK FD Type CMPR-FD [ ][ ][ ][ ]			05B [ ]			10B [ ]	15B [ ]	20B [ ]	30B [ ]	44B [ ]
SERVOMOTOR Type USAFED-[ ][ ][ ][ ]			02CS1	03CS1	05CS1	09CS1	13CS2	20CS2	30CS2	44CS2
SERVOMOTOR	Rated Output *	kW	0.15	0.3	0.45	0.85	1.3	1.8	2.9	4.4
		HP	0.2	0.4	0.6	1.1	1.7	2.4	3.9	5.9
	Rated Torque *	N・m	0.98	1.96	2.84	5.39	8.34	11.5	18.6	28.4
		lb・in	8.7	17	25	48	74	102	165	252
	Instantaneous Peak Torque *	N・m	2.91	5.83	8.92	15.2	24.7	34.0	54.1	76.2
		lb・in	26	52	79	135	219	304	479	675
	Rated Speed *	r/min	1500							
	Max Speed *	r/min	2500							
	Moment of Inertia J_M (= $GD^2_M/4$)	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	12.0	21.5	32.5	51.2	97.2	126.7
	Power Rate *	kW/s	7.4	18.3	6	12	18.9	22.7	31.5	57
	Speed/Positioning Detector		Absolute encoder (8192 P/R)							
	General		• Time Rating : Continuous • Insulation : Class F • Ambient Temperature : 0 to +40℃ • Vibration : 15 μm or below • Finish in Munsell Notation : N1.5 • Drive Method : Direct drive • Excitation : Permanent magnet • Enclosure : Totally-enclosed, self-cooled • Mounting : Flang-mounted							
Servo Control Section	Basic Specifications	Power Supply	Main Circuit and Control Circuit	Three-phase 200 to 230 VAC $^{+10\%}_{-15\%}$, 50/60 Hz							
		Continuous Output Current A(rms)		3.0	3.0	3.8	6.2	9.7	15.0	20.0	33.0
		Max Output Current A(rms)		8.5	8.5	11.0	17.0	27.6	42.0	56.5	77.0
		Control Method		Transistorized PWM control							
		Feedback		Absolute encoder (8192 P/R)							
		Environmental Conditions	Ambient Temp.	0 to +55℃							
			Storage Temp.	−20 to +85℃							
			Ambient/Storage Humidity	90%RH or less (non-condensing)							
			Vibration-/Shock-resistance	0.5G/2G							
		Mounting Structure		Base-mounted							
	Performance	Speed Control Range		1 : 5000							
		Speed Reg. Load (0 to 100%)		−0.01% or less at rated speed							
		Speed Reg. Voltage (+10% to −15%)		0%							
		Speed Reg. Temp. (25 ± 25°C)		±0.01% or less at rated speed							
		Frequency Response		100 Hz ($J_L = J_M$)							
	Built-in Functions	Dynamic Brake (DB)		Built-in automatic DB activated at : main power OFF, servo alarm, servo OFF							
		Regeneration		Built-in regenerative resistor							
		Load Inertia J_L		Up to 5 times motor inertia (J_M)							
		Protection		Communication error, overcurrent, MCCB trip, regenerative trouble, overvoltage, overspeed, undervoltage, overload, reference point error, overrun, open phase, CPU error							
		Display		7-segment LED (Alarm, status)							
		Overtravel Prevention		Prevented by P・OT or N・OT							
		Others		Torque control, brake interlock, RVS-run connection, soft start, zero-clamp							
Optional				SERVOMOTOR with holding brake (Power supply is externally installed.)							

* Ratings are obtained at armature winding temperature of 20℃, in combination with MOTIONPACK.

3.1.2 Servo Control Section Specifications (Cont'd)

(3) G Series SERVOMOTOR

Table 3.4 Ratings and Specifications in Combination with G Series SERVOMOTOR

MOTIONPACK FD Type CMPR-FD ☐☐☐☐☐			05B ☐			10B ☐	15B ☐	20B ☐	30B ☐	44B ☐
SERVOMOTOR Type USAGED-☐☐☐☐			02AS1	03AS1	05AS1	09AS1	13AS2	20AS2	30AS2	44AS2
SERVOMOTOR	Rated Output *	kW	0.15	0.3	0.45	0.85	1.3	1.8	2.9	4.4
		HP	0.2	0.4	0.6	1.1	1.7	2.4	3.9	5.9
	Rated Torque *	N · m	0.98	1.96	2.84	5.39	8.34	11.5	18.6	28.4
		lb · in	8.7	17	25	48	74	102	165	252
	Instantaneous Peak Torque *	N · m	2.91	5.83	8.92	13.3	23.3	28.0	45.1	66.2
		lb · in	26	52	79	118	207	248	339	587
	Rated Speed *	r/min	1500							
	Max Speed *	r/min	3000							
	Moment of Inertia J_M (= $GD^2_M/4$)	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	12.0	21.5	32.5	51.2	97.2	126.7
	Power Rate *	kW/s	7.4	18.3	6	12	18.9	22.7	36.5	57
	Speed/Positioning Detector		Absolute encoder (8192 P/R)							
	General		• Time Rating : Continuous • Insulation : Class F • Ambient Temperature : 0 to +40℃ • Vibration : 15 μm or below • Finish in Munsell Notation : N1.5 • Drive Method : Direct drive • Excitation : Permanent magnet • Enclosure : Totally-enclosed, self-cooled • Mounting : Flange-mounted							
Servo Control Section	Basic Specifications	Power Supply	Main Circuit and Control Circuit	Three-phase 200 to 230 VAC +10% −15%, 50/60 Hz							
		Continuous Output Current A(rms)		3.0	3.0	3.8	7.6	11.7	19.0	26.0	33.0
		Max Output Current A(rms)		8.5	8.5	11.0	17.0	28.0	42.0	56.5	70.0
		Control Method		Transistorized PWM control							
		Feedback		Absolute encoder (8192 P/R)							
		Environmental Conditions	Ambient Temp.	0 to +55℃							
			Storage Temp.	−20 to +85℃							
			Ambient/Storage Humidity	90%RH or less (non-condensing)							
			Vibration-/Shock-resistance	0.5G/2G							
		Mounting Structure		Base-mounted							
	Performance	Speed Control Range		1 : 5000							
		Speed Reg. Load (0 to 100%)		−0.01% or less at rated speed							
		Speed Reg. Voltage (+10% to −15%)		0%							
		Speed Reg. Temp. (25 ± 25°C)		±0.01% or less at rated speed							
		Frequency Response		100 Hz ($J_L = J_M$)							
	Built-in Functions	Dynamic Brake (DB)		Built-in automatic DB activated at : main power OFF, servo alarm, servo OFF							
		Regeneration		Built-in regenerative resistor							
		Load Inertia J_L		Up to 5 times motor inertia (J_M) †							
		Protection		Communication error, overcurrent, MCCB trip, regenerative trouble, overvoltage, overspeed, undervoltage, overload, reference point error, overrun, open phase, CPU error							
		Display		7-segment LED (Alarm, status)							
		Overtravel Prevention		Prevented by P · OT or N · OT							
		Others		Torque control, brake interlock, RVS-run connection, soft start, zero-clamp							
Optional				SERVOMOTOR with holding brake (Power supply is externally installed.)							

* Ratings are obtained at armature winding temperature of 20℃, in combination with MOTIONPACK.

† For type USAGED-20AS2 to -44AS2, refer to actual data.

(4) S Series SERVOMOTOR

Table 3.5 Ratings and Specifications in Combination with S Series SERVOMOTOR

MOTIONPACK FD Type CMPR-FD ☐☐☐☐			05B ☐			10B ☐	15B ☐	30B ☐
SERVOPACK Type USASED-☐☐☐☐			02AS2	03AS2	05AS2	08AS2	15AS2	30AS2
SERVOMOTOR	Rated Output*	kW	0.15	0.31	0.46	0.77	1.54	3.08
		HP	0.2	0.4	0.6	1.0	2.1	4.1
	Rated Torque*	N・m	0.49	0.93	1.47	2.45	4.90	9.80
		lb・in	4.3	8.7	13	22	43	87
	Instantaneous Peak Torque*	N・m	1.47	2.94	4.02	7.35	13.7	29.0
		lb・in	13	26	36	65	122	257
	Rated Speed*	r/min	3000					
	Max Speed*	r/min	4000					
	Moment of Inertia J_M (= $GD^2_M/4$)	$kg \cdot m^2 \times 10^{-4}$	0.13	0.51	0.76	2.85	3.30	5.74
		$lb \cdot in \cdot s^2 \times 10^{-3}$	0.11	0.45	0.67	2.53	2.88	5.09
	Power Rate*	kW/s	13.5	18.9	28.9	21	74	167
	Speed/Positioning Detector		Absolute encoder (8192 P/R)					
	General		• Time Rating : Continuous • Insulation : Class F • Ambient Temperature : 0 to +40℃ • Vibration : 15 μm or below • Finish in Munsell Notation : N1.5 • Drive Method : Direct drive • Excitation : Permanent magnet • Enclosure : Totally-enclosed, self-cooled • Mounting : Flange-mounted					
Servo Control Section	Basic Specifications	Power Supply	Main Circuit and Control Circuit	Three-phase, 200 to 230 VAC $^{+10\%}_{-15\%}$, 50/60 Hz					
		Continuous Output Current A(rms)		2.1	3.0	4.2	5.3	10.4	19.9
		Max Output Current A(rms)		6.0	8.5	11.0	15.6	28.0	56.5
		Control Method		Transistorized PWM control					
		Feedback		Absolute encoder (8192 P/R)					
		Environmental Conditions	Ambient Temp.	0 to +55℃					
			Storage Temp.	−20 to +85℃					
			Ambient/Storage Humidity	90%RH or less (non-condensing)					
			Vibration-/Shock-resistance	0.5G/2G					
		Mounting Structure		Base-mounted					
	Performance	Speed Control Range		1 : 5000					
		Speed Reg.	Load (0 to 100%)	−0.01% or less at rated speed					
			Voltage (+10% to −15%)	0%					
			Temp. (25 ± 25°C)	±0.01% or less at rated speed					
		Frequency Response		100 Hz ($J_L = J_M$)					
	Built-in Functions	Dynamic Brake (DB)		Built-in automatic DB activated at : main power OFF, servo alarm, servo OFF					
		Regeneration		Built-in regenerative resistor					
		Load Inertia J_L		Up to 5 times motor inertia (J_M)					
		Protection		Communication error, overcurrent, MCCB trip, regenerative trouble, overvoltage, overspeed, undervoltage, overload, reference point error, overrun, open phase, CPU error					
		Display		7-segment LED (Alarm, status)					
		Overtravel Prevention		Prevented by P・OT or N・OT					
		Others		Torque control, brake interlock, RVS-run connection, soft start, zero-clamp					
Optional				SERVOMOTOR with holding brake (Power supply is externally installed.)					

* Ratings are obtained at armature winding temperature of 20℃, in combination with MOTIONPACK.

3.1.2 Servo Control Section Specifications (Cont'd)

(5) D Series SERVOMOTOR

Table 3.6 Ratings and Specifications in Combination with D Series SERVOMOTOR

MOTIONPACK FD Type CMPR-FD ☐☐☐☐				05B ☐		15B ☐		20B ☐	30B ☐	44B ☐
SERVOMOTOR Type USADED-☐☐☐☐				05ES2		10ES2		15ES2	22ES2	37ES2
SERVOMOTOR	Rated Output *		kW	0.5		1.0		1.5	2.2	3.7
			HP	0.67		1.3		2.0	2.9	5.0
	Rated Torque *		N・m	2.35		4.80		7.16	10.5	17.7
			lb・in	21		43		63	93	156
	Instantaneous Peak Torque *		N・m	8.24		16.9		25.1	36.8	61.8
			lb・in	173		149		222	326	547
	Rated Speed *		r/min	2000						
	Max Speed *		r/min	2500						
	Moment of Inertia † J_M (= $GD^2_M/4$)		kg・m²×10^{-4}	21	13†	32	24†	62 59†	83 80†	148 145†
			lb・in・s²×10^{-3}	13.2	11.3†	28.0	21.5†	54.7 52.1†	73.8 72.1†	131 128†
	Power Rate *		kW/s	2.7		7.3		8.2	13	21
	Speed/Positioning Detector			Absolute encoder (8192 P/R)						
	General			・Time Rating : Continuous ・Insulation : Class F ・Ambient Temperature : 0 to +40℃ ・Vibration : 15 μm or below ・Finish in Munsell Notation : N1.5 ・Drive Method : Direct drive ・Excitation : Permanent magnet ・Enclosure : Totally-enclosed, self-cooled ・Mounting : Flange-mounted						
Servo Control Section	Basic Specifications	Power Supply	Main Circuit and Control Circuit	Three-phase, 200 to 230 VAC $^{+10\%}_{-15\%}$: 50/60 Hz						
		Continuous Output Current A(rms)		3.5		7.9		12.6	16.6	23.3
		Max Output Current A(rms)		10.6		25.2		40.7	54.0	77.0
		Control Method		Transistorized PWM control						
		Feedback		Absolute encoder (8192 P/R)						
		Environmental Conditions	Ambient Temp.	0 to +55℃						
			Storage Temp.	−20 to +85℃						
			Ambient/Storage Humidity	90%RH or less (non-condensing)						
			Vibration-/Shock-resistance	0.5G/2G						
		Mounting Structure		Base-mounted						
	Performance	Speed Control Range		1 : 5000						
		Speed Reg.	Load (0 to 100%)	−0.01% or less at rated speed						
			Voltage (+10% to −15%)	0%						
			Temp. (25 ± 25°C)	±0.01% or less at rated speed						
		Frequency Response		100 Hz ($J_L = J_M$)						
	Built-in Functions	Dynamic Brake (DB)		Built-in automatic DB activated at : main power OFF, servo alarm, servo OFF						
		Regeneration		Built-in regenerative resistor						
		Load Inertia J_L		Up to 5 times motor inertia (J_M)						
		Protection		Communication error, overcurrent, MCCB trip, regenerative trouble, overvoltage, overspeed, undervoltage, overload, reference point error, overrun, open phase, CPU error						
		Display		7-segment LED (Alarm, status)						
		Overtravel Prevention		Prevented by P・OT or N・OT						
		Others		Torque control, brake interlock, RVS-run connection, soft start, zero-clamp						
Optional				SERVOMOTOR with holding brake (Power supply is externally installed.)						

* Ratings are obtained at armature winding temperature of 20℃, in combination with MOTIONPACK.

† Values show those of D series without holding brake.

3.1.3 Motion Controller Specifications

Table 3.7 Motion Controller Specifications

No.	Item	Specifications
1	No. of Control Axes	1 axis + spindle
2	Position Reference Value	Sign + 8 digits
3	Position Reference Unit	Set by parameter according to system specifications.
4	Speed Reference Value	5-digit decimal
5	Max Pulse Speed	4MPPS (Position feedback pulse speed possible to read-in)
6	Torque Limit	10 to 250% of rated torque
7	Automatic Accel/Decel Control	Linear accel/decel S-curve accel/decel
8	Position Detector	Absolute encoder
9	Home Positioning	Automatic home position setting up ① Full-automatic setup method (using stopper) ② Semi-automatic setup method
10	Program Selection	Designation method by program No.
11	Program Capacity	No. of programs : Up to 16 【Option : up to 32 (Models 1 to 3)】 No. of blocks : Up to 1000
12	Operation Mode	① EDIT (editing) mode ② JOG (manual) mode ③ SET-UP (home position setting up) mode ④ AUTO (automatic) mode ⑤ HANDLE (handle) mode
13	Overtravel	Prevented by software overtravel function or by external N・OT, P・OT limit switches
14	Program Reference Items	G : Function reference M : Auxiliary function X : Absolute position reference U : Incremental position reference F : Speed reference I : Torque limit reference S : Spindle reference D : Dwell reference T : Coordinate system setting L : Subprogram repeating time designation P : Subprogram starting program No.
15	Function Reference	① Positioning : G01X/U_F_I_S_ ② Skip positioning (G05, G06) : G05X/U_F_I_S_ ③ Positioning with passing signal : G07X/U_ G12X/U_F_I_ M＊＊ ④ Speed profile positioning : G08X/U_ G12X/U_F_I_ G12X/U_F_ ⑤ External positioning : G34X/U_F_I_ ⑥ Secondary external positioning : G35X/U_F_I_ ⑦ S-curve accel/decel positioning : G10 : S-curve accel/decel set G01X/U : S-curve accel/decel positioning G11 : S-curve accel/decel reset

3.1.3 Motion Controller Specifications (Cont'd)

Table 3.7 Motion Controller Specifications (Cont'd)

No.	Item	Specifications
15	Function Reference (Cont'd)	⑧ Dwell : In-position waiting : G04 Time dwell : G04D__ ⑨ Coordinate setting : G52X/U__T__ ⑩ Coordinate switching : G53T__ ⑪ In-position check : G67P__ ⑫ Subprogram call : Repeating time designation G68L__P__ Ending position designation G68X/U__P__ ⑬ Jump : Simple jump G69P__ Subprogram return G69 ⑭ Spindle reference : Spindle FWD rotation M03S__ Spindle RVS rotation M04S__ Spindle stop M05 ⑮ Auxiliary function : M50 to M58 Program end M30 ⑯ No operation : NOP
16	Indirect Register Designation	Provided : R01 to 99 Specifies by R__ in item X/U, F, I or S. (Example) G01X R01 F R02 I 200 S 100
17	Coordinate System	T0 : ABSO-PG coordinate + home position offset T1 to T7 : Set by G52 command T8 to T9 : Set by G52 command and set by compensation function
18	Compensation Function	① By compensation parameter × number of compensation signals ② By external compensation data input (Models 1 to 3)
19	Zone Signal	4 signals (PSW1 to PSW4) 4-zone setting possible every signal
20	Solid Tap	Option (Model 2 : To be released soon)
21	I/O Signal	Input 24 points, output 24 points
22	Built-in Sequencer Board (Option)	① Input points : 48, output points : 48 when built-in PLC is used (Models 1 and 2) Standard : Input : 24 points Output : 24 points Built-in sequencer board : Input : 24 points Output : 24 points ② M-NET (Interface between modules) : serial interface (Models 1 and 2)
23	Spindle Reference	Analog reference ± 10V
24	External Display	Connected via RS-232C
25	Programmer	① Exclusive-use programmer ② Lap top personal computer (IBM compatible)

3.2 RATINGS AND SPECIFICATIONS OF SERVOMOTORS

(1) M Series AC SERVOMOTORS

(a) Ratings

Time Rating: Continuous
Insulation: Class F
Isolation Voltage: 1500 VAC, one minute
Insulation Resistance: 500 VDC, 10 MΩ or more
Enclosure: Totally-enclosed, self-cooled
(Equivalent to IP-55 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 3.8 Ratings and Specifications of M Series AC SERVOMOTORS

Item \ Motor Type USAMED-†		03BS1	06BS1	09BS2	12BS2	20BS2	30BS2	44BS2
Rated Output*	kW	0.3	0.6	0.9	1.2	2.0	3.0	4.4
	(HP)	(0.4)	(0.8)	(1.2)	(1.6)	(2.7)	(4.0)	(5.9)
Rated Torque*	N・m	2.84	5.68	8.63	11.5	19.1	28.4	41.9
	(lb・in)	(25)	(50)	(76)	(102)	(169)	(252)	(372)
Continuous Max Torque*	N・m	2.94	5.88	8.82	11.8	21.6	32.3	46.1
	(lb・in)	(26)	(52)	(78)	(104)	(191)	(286)	(408)
Instantaneous Peak Torque*	N・m	7.17	14.1	19.3	28.0	44.0	63.7	91.1
	(lb・in)	(63)	(125)	(171)	(248)	(390)	(564)	(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	1.01	1.04	1.21	1.02	1.07	1.16	1.33
	(lb・in/A)	(8.9)	(9.2)	(10.7)	(9.0)	(9.5)	(10.2)	(11.8)
Moment of Inertia J_M ($= GD^2/4$)	$kg \cdot m^2 \times 10^{-4}$	13.5	24.3	36.7	58.0	110	143	240
	$(lb \cdot in \cdot s^2 \times 10^{-3})$	(12.0)	(21.5)	(32.5)	(51.2)	(97.2)	(126.7)	(212.6)
Power Rate*	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
Speed/Position Detector		Absolute encoder (8192 P/R)						

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

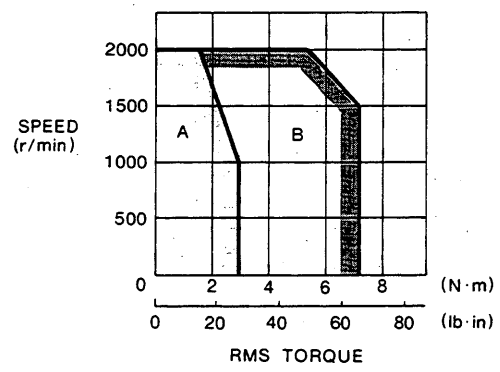
† The blank ☐ of motor type depends on class of detectors (P/R).
Absolute : S (8192 P/R)
Optical encoder is used as a detector.

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

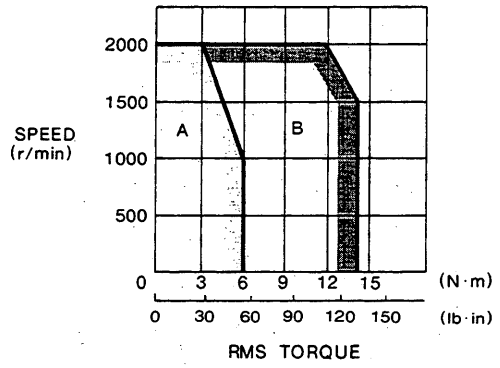
3.2 RATINGS AND SPECIFICATIONS OF SERVOMOTORS (Cont'd)

(b) Torque-Speed Characteristics

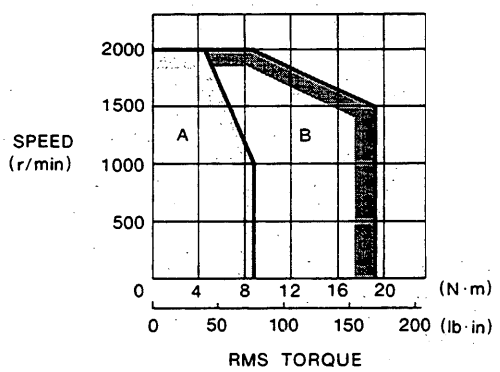
· TYPE USAMED-03B



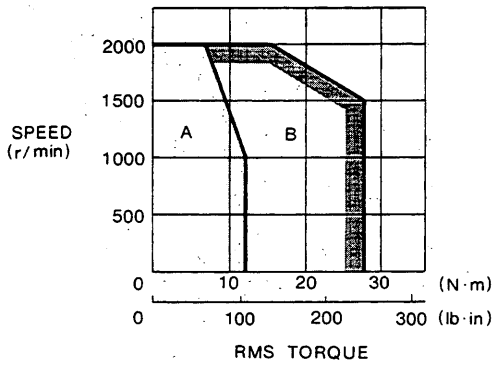
· TYPE USAMED-06B



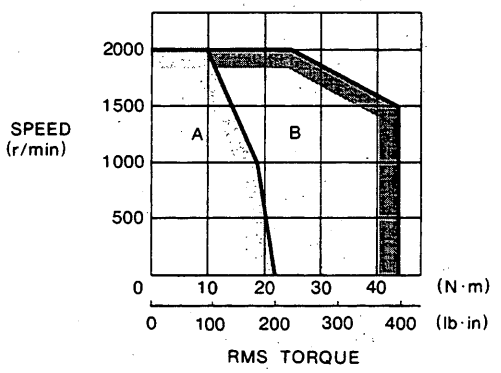
· TYPE USAMED-09B



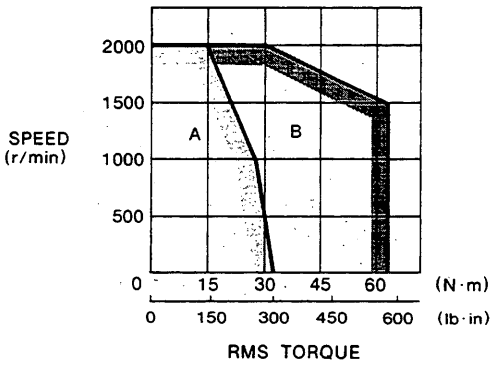
· TYPE USAMED-12B



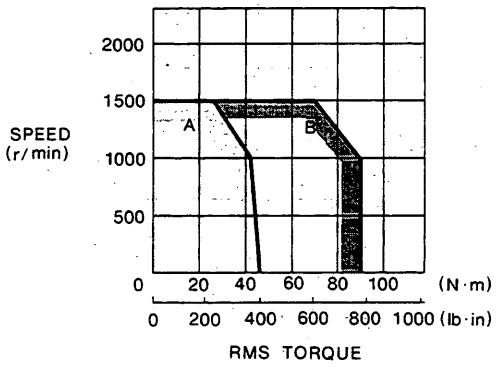
· TYPE USAMED-20B



· TYPE USAMED-30B



TYPE USAMED-44B



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

(2) F Series AC SERVOMOTORS

(a) Ratings

Time Rating: Continuous
Insulation: Class F
Isolation Voltage: 1500 VAC, one minute
Insulation Resistance: 500 VDC, 10 MΩ or more
Enclosure: Totally-enclosed, self-cooled
(Equivalent to IP-55 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 3.9 Ratings and Specifications of F Series AC SERVOMOTORS

Item \ Motor Type USAFED-†		02CS1	03CS1	05CS1	09CS1	13CS2	20CS2	30CS2	44CS2
Rated Output*	kW	0.15	0.3	0.45	0.85	1.3	1.8	2.9	4.4
	(HP)	(0.2)	(0.4)	(0.6)	(1.1)	(1.7)	(2.4)	(3.9)	(5.9)
Rated Torque*	N・m	0.98	1.96	2.84	5.39	8.34	11.5	18.6	28.4
	(lb・in)	(8.7)	(17)	(25)	(48)	(74)	(102)	(165)	(252)
Continuous Max Torque*	N・m	1.08	2.16	2.94	5.88	8.83	11.8	22.6	37.3
	(lb・in)	(10)	(19)	(26)	(52)	(78)	(104)	(200)	(330)
Instantaneous Peak Torque*	N・m	2.91	5.83	8.92	15.2	24.7	34.0	54.1	76.2
	(lb・in)	(26)	(52)	(79)	(135)	(219)	(301)	(479)	(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	0.36	0.72	0.80	0.92	0.92	0.82	0.98	1.02
	(lb・in/A)	(3.2)	(6.3)	(7.1)	(8.2)	(8.2)	(7.3)	(8.7)	(9.0)
Moment of Inertia J_M ($= GD^2/4$)	$kg \cdot m^2 \times 10^{-4}$	1.3	2.06	13.5	24.3	36.7	58	110	143
	$(lb \cdot in \cdot s^2 \times 10^{-3})$	(1.2)	(1.8)	(12.0)	(21.5)	(32.5)	(51.2)	(97.2)	(126.7)
Power Rate*	kW/s	7.4	18.3	6.0	12	18.9	22.7	31.5	57.0
Inertia Time Constant	ms	3.9	2.5	10.9	6.0	4.4	5.9	5.2	3.7
Inductive Time Constant	ms	3.4	4.3	3.2	5.2	6.1	10.4	13.0	15.2
Speed/Position Detector		Absolute encoder (8192 P/R)							

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

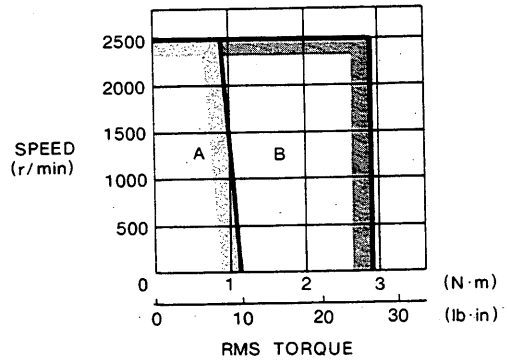
† The blank [ ] of motor type depends on class of detectors (P/R).
Absolute : S (8192 P/R)
Optical encoder is used as a detector.

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

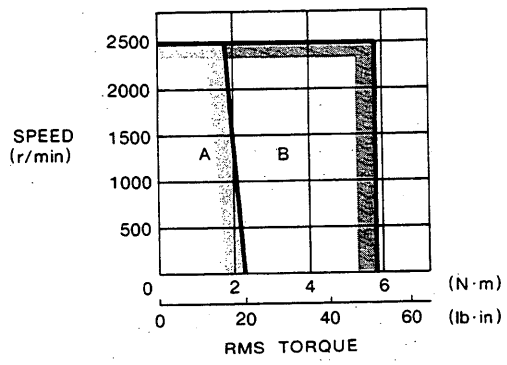
3.2 RATINGS AND SPECIFICATIONS OF SERVOMOTORS (Cont'd)

(b) Torque-Speed Characteristics

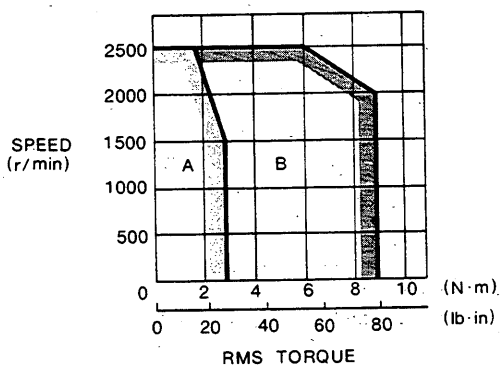
· TYPE USAFED-02C



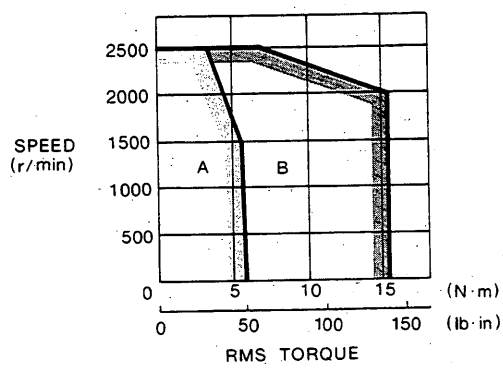
· TYPE USAFED-03C



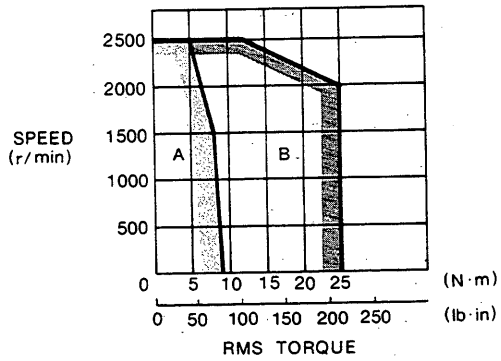
· TYPE USAFED-05C



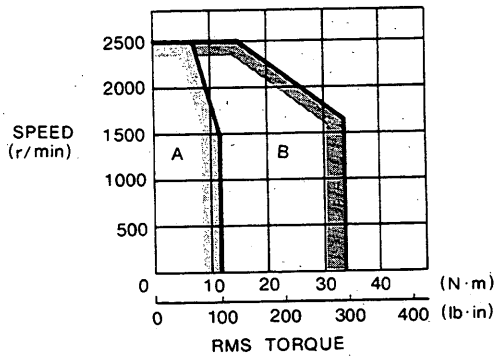
· TYPE USAFED-09C



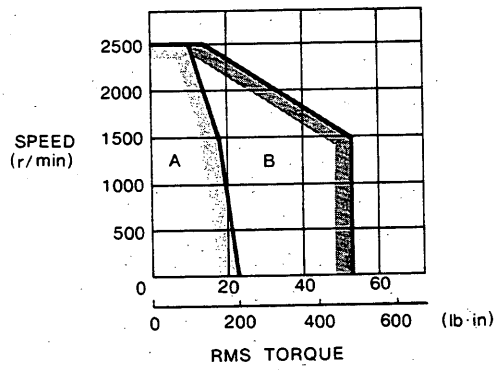
· TYPE USAFED-13C



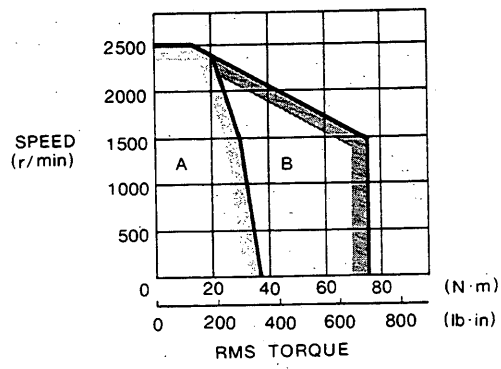
· TYPE USAFED-20C



· TYPE USAFED-30C



· TYPE USAFED-44C



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

(3) G Series AC SERVOMOTORS

(a) Ratings

Time Rating: Continuous
Insulation: Class F
Isolation Voltage: 1500 VAC, one minute
Insulation Resistance: 500 VDC, 10 MΩ or more
Enclosure: Totally-enclosed, self-cooled
(Equivalent to IP-55 exclusive shaft opening)
Ambient Temperature: 0 to+40℃
Ambient Humidity: 20% to 80% (non-condensing)
Vibration: 15 μ m or below
Finish in Munsell Notation: N1.5
Excitation: Permanent magnet
Mounting: Flange-mounted
Drive Method: Direct drive

Table 3.10 Ratings and Specifications of G Series AC SERVOMOTORS

Item \ Motor Type USAGED-†		02AS1	03AS1	05AS1	09AS1	13AS2	20AS2	30AS2	44AS2
Rated Output*	kW	0.15	0.3	0.45	0.85	1.3	1.8	2.9	4.4
	(HP)	(0.2)	(0.4)	(0.6)	(1.1)	(1.7)	(2.4)	(3.9)	(5.9)
Rated Torque*	N・m	0.98	1.96	2.84	5.39	8.34	11.5	18.6	28.4
	(lb・in)	(8.7)	(17)	(25)	(48)	(74)	(102)	(165)	(252)
Continuous Max Torque*	N・m	1.08	2.16	2.94	5.88	8.83	11.8	22.6	37.3
	(lb・in)	(10)	(19)	(26)	(52)	(78)	(104)	(200)	(330)
Instantaneous Peak Torque*	N・m	2.91	5.83	8.92	13.3	23.3	28.0	45.1	66.2
	(lb・in)	(26)	(52)	(79)	(118)	(207)	(248)	(339)	(587)
Rated Current*	A	3.0	3.0	3.8	7.6	11.7	19	26	33
Rated Speed*	r/min	1500							
Instantaneous Max Speed*	r/min	3000							
Torque Constant	N・m/A	0.36	0.72	0.80	0.8	0.83	0.67	0.80	0.95
	(lb・in/A)	(3.2)	(6.3)	(7.1)	(7.1)	(7.4)	(5.9)	(7.1)	(8.4)
Moment of Inertia J_M (= $GD^2/4$)	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)	(12.0)	(21.5)	(32.5)	(51.2)	(97.2)	(126.7)
Power Rate*	kW/s	7.4	18.3	6.0	12	18.9	22.7	36.5	57.0
Inertia Time Constant	ms	4.5	2.5	10.9	6.1	4.3	5.8	5.2	3.4
Inductive Time Constant	ms	3.4	4.3	3.2	5.2	6.7	10.6	13.2	15.9
Speed/Position Detector		Absolute encoder (8192 P/R)							

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

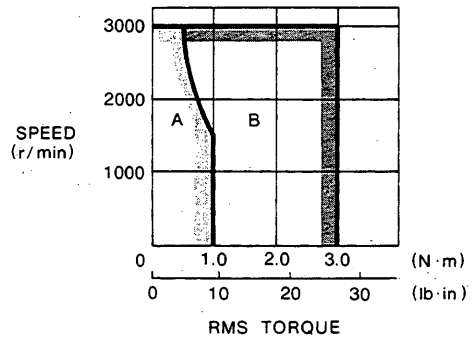
† The blank ☐ of motor type depends on class of detectors (P/R).
Absolute : S (8192 P/R)
Optical encoder is used as a detector.

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

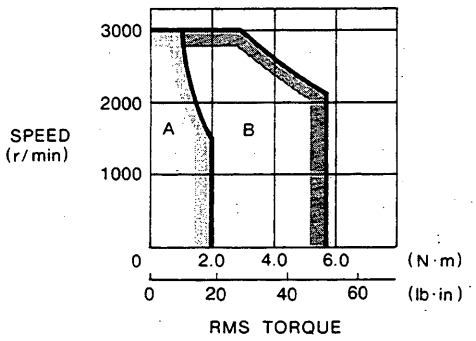
3.2 RATINGS AND SPECIFICATIONS OF SERVOMOTORS (Cont'd)

(b) Torque-Speed Characteristics

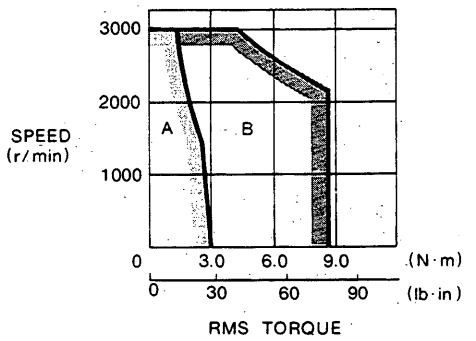
· TYPE USAGED-02A



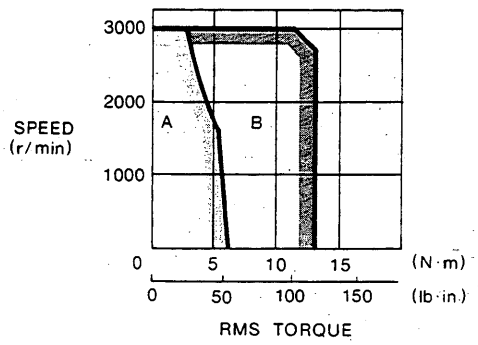
· TYPE USAGED-03A



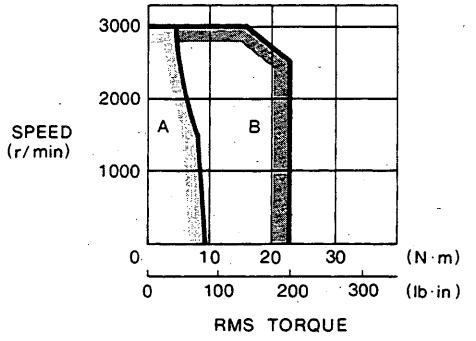
· TYPE USAGED-05A



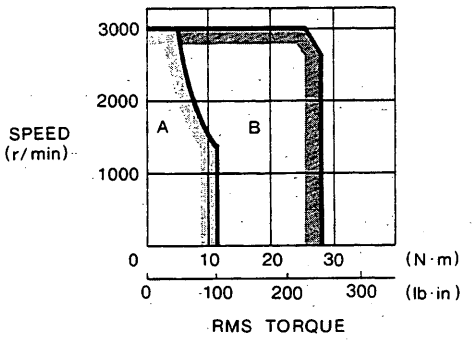
· TYPE USAGED-09A



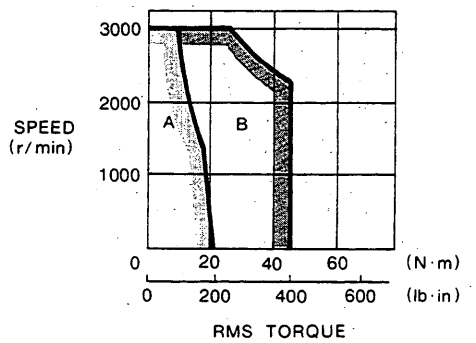
· TYPE USAGED-13A



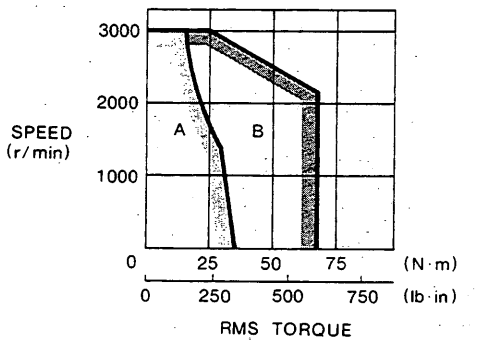
· TYPE USAGED-20A



· TYPE USAGED-30A



· TYPE USAGED-44A



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

(4) S Series AC SERVOMOTORS

(a) Ratings

Time Rating: Continuous
Insulation: Class B (Types USASEM-02AS2, -03AS2, -05AS2)
Class F (Types USASEM-08AS1, -15AS1, -30AS1)
Isolation Voltage: 1500 VAC, one minute
Insulation Resistance: 500 VDC, 10 MΩ or more
Enclosure: Totally-enclosed, self-cooled
Ambient Temperature: 0 to+40℃
Ambient Humidity: 20% to 80% (non-condensing)
Vibration: 15 μ m or below
Finish in Munsell Notation: N1.5
Excitation: Permanent magnet
Mounting: Flange-mounted
Drive Method: Direct drive

Table 3.11 Ratings and Specifications of S Series AC SERVOMOTORS

Item \ Motor Type USASEM-		02AS2	03AS2	05AS2	08AS1	15AS1	30AS1
Rated Output*	kW (HP)	0.15 (0.2)	0.31 (0.4)	0.46 (0.6)	0.77 (1.0)	1.54 (2.1)	3.08 (4.1)
Rated Torque*	N・m (lb・in)	0.49 (4.3)	0.98 (8.7)	1.47 (13)	2.45 (22)	4.90 (43)	9.80 (87)
Continuous Max Torque*	N・m (lb・in)	0.57 (5.0)	1.18 (10)	1.67 (15)	3.33 (30)	6.17 (55)	12.2 (108)
Instantaneous Peak Torque*	N・m (lb・in)	1.47 (13)	2.94 (26)	4.02 (36)	7.35 (65)	13.7 (122)	29.0 (257)
Rated Current*	A	2.1	3.0	4.2	5.3	10.4	19.9
Rated Speed*	r/min	3000					
Instantaneous Max Speed*	r/min	4000					
Torque Constant	N・m/A (lb・in/A)	0.25 (2.19)	0.35 (3.10)	0.37 (3.25)	0.51 (4.49)	0.50 (4.43)	0.52 (4.64)
Moment of Inertia J_M (= $GD^2/4$)	kg・m² × 10^{-4} (lb・in・s² × 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
Speed/Position Detector		Class B			Class F		

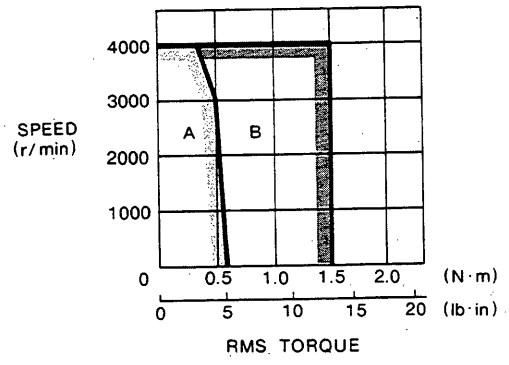
* Values when SERVOMOTOR is combined with MOTIONPACK and the armature winding temperature is 100℃.
Shown are normal (TYP) values above.

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

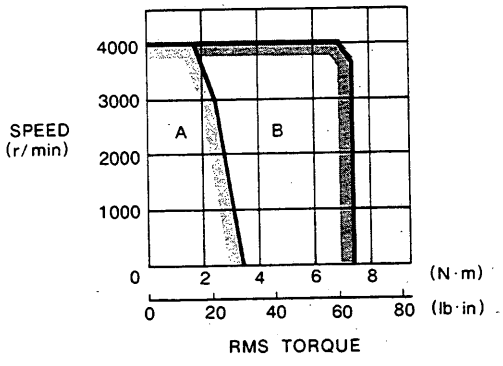
3.2 RATINGS AND SPECIFICATIONS OF SERVOMOTORS (Cont'd)

(b) Torque-Speed Characteristics

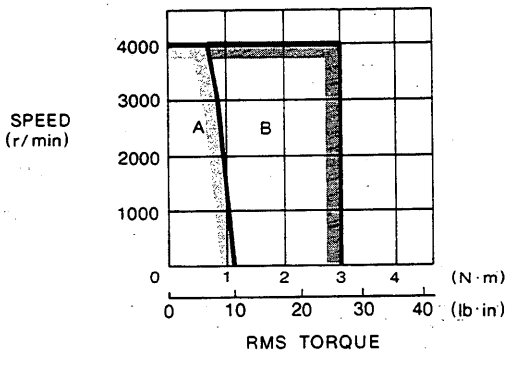
· TYPE USASEM-02A



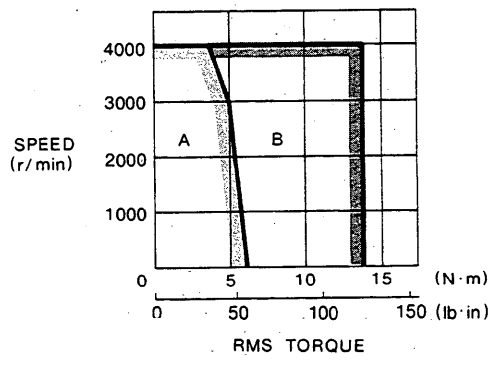
· TYPE USASEM-08A



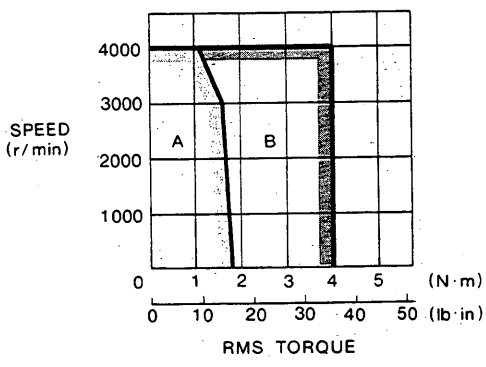
· TYPE USASEM-03A



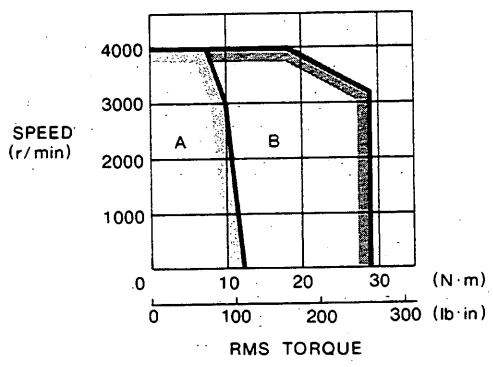
· TYPE USASEM-15A



· TYPE USASEM-05A



· TYPE USASEM-30A



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

(5) D Series AC SERVOMOTORS

(a) Ratings

Time Rating: Continuous
Insulation: Class F
Isolation Voltage: 1500 VAC, one minute
Insulation Resistance: 500 VDC, 10 MΩ or more
Enclosure: Totally-enclosed, self-cooled
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 (holding brake provided.)

Table 3.12 Ratings and Specifications of D Series AC SERVOMOTORS

Item \ Motor Type USADED-			05ES3	10ES3	15ES3	22ES3	37ES3
Rated Output *		kW (HP)	0.5 (0.67)	1.0 (1.3)	1.5 (2.0)	2.2 (2.9)	3.7 (5.0)
Rated Torque *		N・m (lb・in)	2.35 (21)	4.80 (43)	7.16 (63)	10.5 (93)	17.7 (156)
Continuous Max Torque *		N・m (lb・in)	3.43 (30)	6.37 (56)	8.82 (78)	13.7 (122)	21.6 (191)
Instantaneous Peak Torque *		N・m (lb・in)	8.24 (73)	16.9 (149)	25.1 (222)	36.8 (326)	61.8 (547)
Rated Current *		A	3.5	7.9	12.6	16.6	23.3
Rated Speed *		r/min	2000				
Instantaneous Max Speed *		r/min	2500				
Torque Constant		N・m/A (lb・in/A)	0.83 (7.38)	0.69 (6.07)	0.64 (5.64)	0.71 (6.25)	0.82 (7.29)
Moment of Inertia $J_M (= GD^2/4)$		$kg \cdot m^2 \times 10^{-4}$ ($lb \cdot in \cdot s^2 \times 10^{-3}$)	21, 13† (18.2, 11.3†)	32, 24† (28.6, 21.5†)	62, 59† (54.7, 52.1†)	83, 80† (73.8, 71.1†)	148, 145† (131, 128†)
Power Rate *		kW/s	2.7 4.4†	7.3 9.7†	8.2 8.6†	13 14†	21 22†
Inertia Time Constant		ms	18 11†	7.8 5.9†	7.1 6.8†	6.2 6.0†	4.3 4.2†
Inductive Time Constant		ms	4.4	6.9	9.4	11	15
Speed/Position Detector			Absolute encoder (8192 P/R)				
Holding Brake	Power Supply	VDC	90				
	Static Function Torque	N・m (lb・in)	8.82 (78)		21.56 (191)		
Approx Mass		kg (lb)	17, 16† (37.5, 35.3†)	19, 18† (41.9, 39.7†)	30, 27† (66.2, 59.5†)	32, 29† (70.6, 64†)	39, 36† (86.0, 79.4†)

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

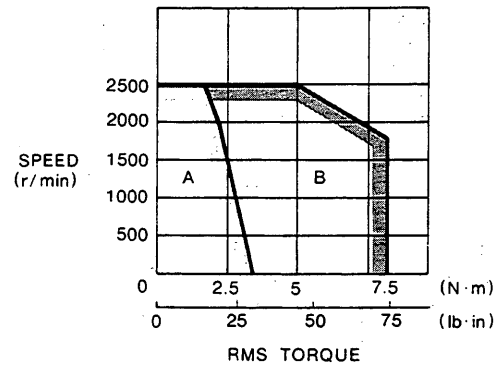
† Values show those of D series without holding brake.

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

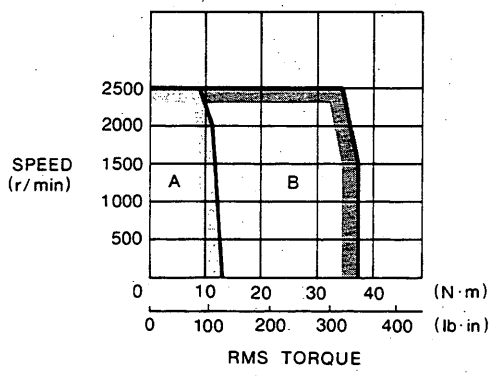
3.2 RATINGS AND SPECIFICATIONS OF SERVOMOTORS (Cont'd)

(b) Torque-Speed Characteristics

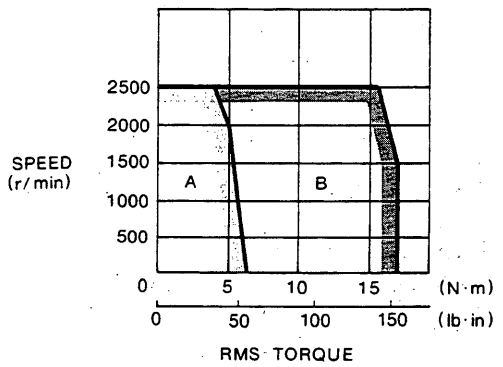
· TYPE USADED-05A



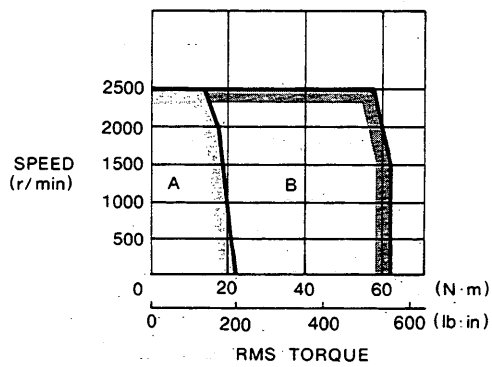
· TYPE USADED-22A



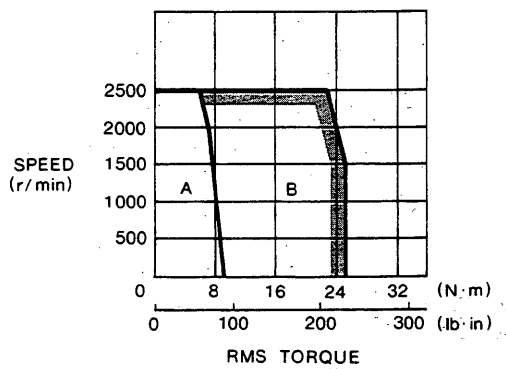
· TYPE USADED-10A



· TYPE USADED-37A



· TYPE USADED-15A



A : CONTINUOUS DUTY ZONE
B : INTERMITTENT DUTY ZONE

3.3 PROGRAMMER

Table 3.13 Programmer Specifications

Item	Specifications
Type	CMPR-PFD30
Indicator	Liquid crystal module with EL back-light 16 characters × 4 lines and display LEDs
EL Service Lifetime	Luminance is deteriorated a little after approx 2000 hours.
Switch	Operation key switch × 40
Auxiliary Memory Unit	No-contact method memory card (built-in reader/writer)
Printer Port	Built-in RS-232 interface (D-SUB 9-pin)
Power Supply	Supplied from FD controller through cable
Environment	Operation ambient temperature : 0 to 50℃ natural air cooling Storage ambient temperature : −20 to +60℃ Ambient humidity : 30 to 95% RH (non-condensing) Vibration resistance : In accordance with JIS C 0911 (up to 1G) Shock resistance : In accordance with JIS C 0912 (up to 10G) Atmosphere : Free from inflammables, corrosive gases, dust, metallic dust, high temperature or high humidity.
External Dimensions (in mm)	85 (W) × 190 (H) × 37 (D)
Approx Mass	Approx 450 g (1 lb)

3.4 I/O SIGNAL DC POWER SUPPLY

Recommended power supply is as follows.

(1) Type: EWS50-24

(2) Manufacturer: NEMIC · LAMBDA Co., Ltd.

(3) Specifications

Table 3.14 Specifications of I/O Signal DC Power Supply

Items \ Type	EWS 50-5	EWS 50-6	EWS 50-9	EWS 50-12	EWS 50-15	EWS 50-18	EWS 50-24	EWS 50-28
1. Rated DC Output Voltage	5 V	6 V	9 V	12 V	15 V	18 V	24 V	28 V
2. Max DC Output Current	10.0 A	8.4 A	5.6 A	4.4 A	3.6 A	3.2 A	2.4 A	2.0 A
3. Max Output Power Supply	50.0 W	50.4 W	50.4 W	52.8 W	54.0 W	57.6 W	57.6 W	56.0 W
4. Efficiency (TYP)*	75%	75%	75%	76%	77%	78%	78%	80%
5. Input Current (TYP)	100 VAC ··· 1.2 A/200 VAC ··· 0.6 A (At full load)							
6. Input Surge Current (TYP)	100 VAC ··· 6.8 A/200 VAC ··· 13.5 A (With input surge current prevention circuit)							
7. Output Voltage Regulation (TYP)	±10%							
8. Max Lipple Voltage (Including Noise)	120 mV	120 mV	150 mV	150 mV	150 mV	150 mV	200 mV	200 mV
9. Max Input Regulation †	20 mV	24 mV	36 mV	48 mV	60 mV	72 mV	96 mV	112 mV
10. Max Load Regulation ‡	40 mV	50 mV	76 mV	100 mV	120 mV	140 mV	150 mV	160 mV
11. Overload Current Prevention#	10.5 A to	8.8 A to	5.9 A to	4.6 A to	3.8 A to	3.4 A to	2.5 A to	2.1 A to
12. Overvoltage Prevention**	5.75 to 6.75 V	6.9 to 8.1 V	10.4 to 12.2 V	13.8 to 16.2 V	17.3 to 20.3 V	20.7 to 24.3 V	27.6 to 32.4 V	32.2 to 37.8 V
13. Mass	450 g (1 lb)							
14. UL Standard	Qualified part							
15. CSA Standard	Qualified part	Conformity		Qualified part		Conform-ity	Qualified part	Conform-ity
16. VDE Standard	TüV qualified part							

* At 100 VAC Max. output power supply

† At Max. output power supply

‡ At no-load ⇄ full load

\# Drooping automatic reset type (at factory test).

** Cut-off manual reset type (at factory test).

3.5 SPINDLE DRIVE

For spindle drive, VS-616G3 inverter made by YASKAWA is recommended.

Table 3.15 VS-616G3 Specifications

Inverter Model CIMA-G3 A□		200 V Class											400 V Class													
		20P4	20P7	21P5	22P2	23P7	25P5	27P5	2011	2015	2018	2022	40P4	40P7	41P5	42P2	43P7	45P5	47P5	4011	4015	4018	4022	4030	4037	4045	4L45
Max Applicable Motor Output Hp (kW)*		0.5 (0.4)	1 (0.75)	2 (1.5)	3 (2.2)	5 (3.7)	7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	30 (22)	0.5 (0.4)	1 (0.75)	2 (1.5)	3 (2.2)	5 (3.7)	7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	30 (22)	40 (30)	50 (37)	60[2] (45)	
Output Characteristics	Inverter Capacity kVA	1.4	2.1	2.7	4.1	6.9	10.3	13.7	20.6	27.4	34	41	1.4	2.2	3.4	4.1	6.9	10.3	13.7	20.6	27.4	34	41	54	68	82	
	Rated Output Current A	3.2	4.8	6.4	9.6	16	24	32	48	64	80	96	1.6	2.6	4.0	4.8	8	12	16	24	32	40	48	64	80	96	
	Max Continuous Output Current† A	3.6	5.4	7.2	10.8	18	27	36	54	72	90	108	1.8	2.9	4.5	5.4	9	13.5	18	27	36	45	54	72	90	108	
	Max Output Voltage	3-Phase, 200/208/220/230 V (Proportional to input voltage)											3-Phase, 380/400/415/440/460 V (Proportional to input voltage)														
	Rated Output Frequency	50, 60, 72, 90, 120, 180 Hz (up to 400 Hz available)																									
Power Supply	Rated Input Voltage and Frequency	3-Phase 200/208/220 V, 50 Hz 200/208/220/230 V, 60 Hz											3-Phase 380/400/415/440/460 V, 50/60 Hz														
	Allowable Voltage Fluctuation	±10%																									
	Allowable Frequency Fluctuation	±5%																									
Control Characteristics	Control Method	Since wave PWM																									
	Frequency Control Range	0.1 to 400 Hz																									
	Frequency Accuracy	Digital command : 0.01% (+14 to 104°F / −10 to† 40°C) Analog command : 0.1% (77 ± 18°F / 25 ± 10°C)																									
	Frequency Resolution	Digital operator reference : 0.1 Hz Analog reference : 0.06 Hz/60 Hz																									
	Output Frequency Resolution	0.01 Hz (1/30000)																									
	Overload Capacity	150% rated output current for one minute																									
	Frequency Setting Signal	0 to† +10 VDC (20kΩ), 4 to 20 mA (250Ω) 0 to ±10 V (Optional)																									
	Accel/Decel Time	0.1 to 6000 sec (Accel/Decel time setting independently)																									
	Conversion Efficiency	Approx 95%																									
	Braking Torque	Approx 20%																									
	No. of V-f Patterns (Total of 16)	4 : For general purpose 4 : For high starting torque : 1 : For adjustable pattern 4 : For fans and pumps 3 : For machine tools.																									
Protective Functions	Motor Overload Protection	Electronic thermal overload relay																									
	Instantaneous Overcurrent	Motor coasts to a stop at approx 200% rated current.																									
	Blown Fuse Protection	Motor coasts to a stop by blown-fuse.																									
	Overload	Motor coasts to a stop after 1 minute at 150% rated output current.																									
	Overvoltage	Motor coasts to a stop if converter output voltage exceeds 400 V.											Motor coasts to a stop if converter output voltage exceeds 800 V (700 V).‡														
	Undervoltage	Motor coasts to a stop if converter output voltage drops to 210 V or below.											Motor coasts to a stop if converter output voltage drops to 420 V or below.														
	Momentary Power Loss	Immediately stop by 15 ms and above longer power loss. (Continuous system operation during power loss less than 2 sec is equipped as standard.)# Setting mode before shipment.																									
	Fin Overheat	Thermostat																									
	Stall Prevention	Stall prevention at acceleration/deceleration and constant speed operation																									
	Ground Fault	Provided by electronic circuit																									
	Power Charge Indication	Charge lamp stays ON until bus voltage drops below 50 V.																									
Environmental Conditions	Location	Indoor (protected from corrosive gases and dust)																									
	Ambient Temperature	+14 to 140°F (−10 to +40°C) (not frozen)																									
	Storage Temperature[1]	−4 to 140°F (−20 to +60°C)																									
	Humidity	90% RH (non-condensing)																									
	Vibration	1 G less than 20 Hz, up to 0.2 G at 20 to 50 Hz																									

* Our standard 4-pole motor is used for max applicable motor output.

† Allowable values for the applications not requiring overload.

‡ 800 V for input voltage (Cn-01) more than 400 V and 700 V for less than 400 V.

For Models of 2.2 kVA or less, continuous system operation during power loss less than 1 sec. Two seconds ride-thru available as option.

[1] Temperature during transportation (for short period)

[2] Both low noise type model-4L45 and low carrier frequency, compact type model-4045 are available.

3.6 MANUAL PULSE GENERATOR

Table 3.16 Manual Pulse Generator Specifications

Item	Specifications
Model	PREH-2E5T/100M1
Power Supply	4.5 to 13.2 VDC, 50 mA
Output Waveform and Type	Rectangular voltage output, open collector
Output Level	1 : power voltage 1 V or greater, 0 : 0.5 V or below
Tr Collector Current	20 mA
Output Impedance	2 kΩ
Pulse Duty	50 ± 10%
Output Phase Difference	25 ± 10%
Response Frequency	0 to 10 kHz
Allowable Maximum Speed	500 r/min
Starting Torque	150 to 600 g · cm
Operating Ambient Temperature	0℃ to +60℃
Storage Ambient Temperature	−30℃ to +70℃
Ambient Humidity	30% to 85% RH (non-condensing)
Withstand Vibration	2G 50 Hz
Withstand Shock	30G/11 ms
Atmosphere	Must be free from inflammable or corrosive gases.
Outside Dimensions	77 mm (dia.) × 177 mm (D)
Approx Mass	540 g (1.19 lb)

3.7 MEMORY CARD

Table 3.17 Memory Card Specifications

Items	Specifications
Type	R-128KB-Y
Memory Capacity	128 k byte, CMOS memory
Backup Battery	Lithium battery Service lifetime : 5 years from date of manufacture
Data Transmission Speed	500 kbps
Operation Ambient Temperature	0 to 50℃
Storage Ambient Temperature	−10 to +65℃
Ambient Humidity	Condensation allowed
Vibration Resisitance	Drop test upon concrete from 1 m high in direction X, Y or Z for three times each
Bending Test	Load 10 kg for 10 seconds
Waterproof, Oilproof	Immersed in water or cutting oil for 24 hours (25℃)
Outside Dimensions	85.6 (W) × 54 (H) × 3.8 (D) mm
Approx Mass	20 g (0.71 oz)

4. CONTROLLER OPERATION

4.1 CIRCUIT CONFIGURATION

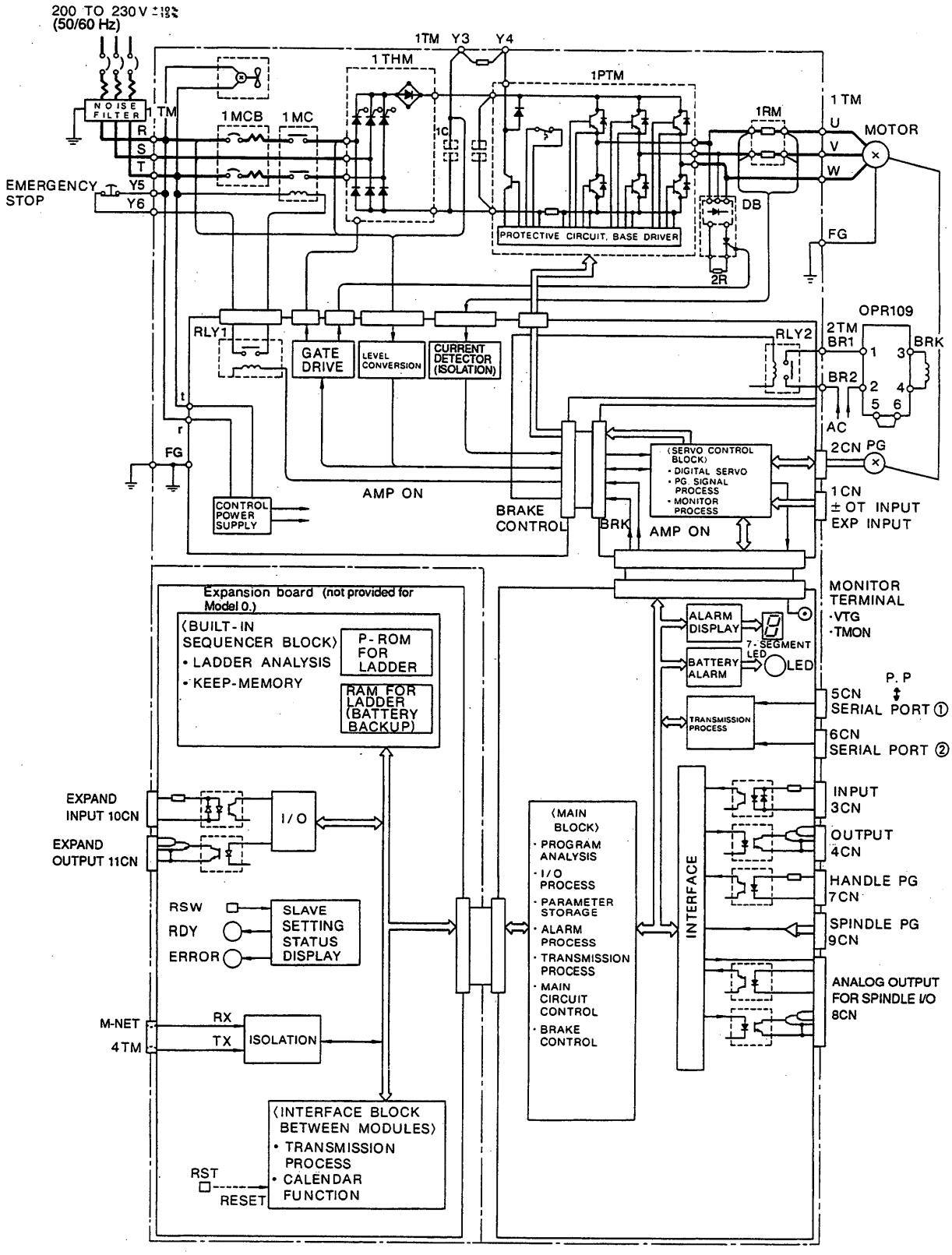


Fig. 4.1 Circuit Configuration

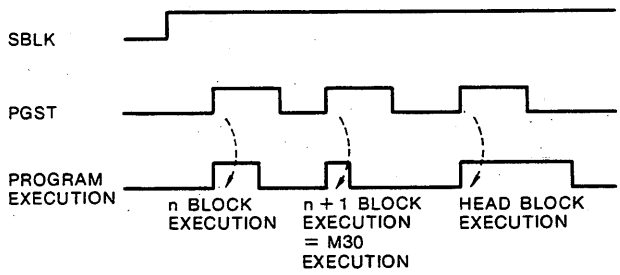
4.2 OPERATION MODE

No.	Item	Description
1	Types of Operation Modes	There are four modes : ① EDIT, ② HANDL operation, ③ JOG operation and ④ automatic operation. Single-block operation mode can be specified for automatic operation mode. The mode priority is provided in the above order.
2	JOG Operation	Conditions : EDIT signal = OFF, JOG signal = ON, HANDL signal = OFF Start/stop : Starts moving in FWD direction when +JS signal is ON. Stops when +JS signal is OFF. Starts moving in REV direction when −JS signal is ON. JOG speed : Pr1 = JOG low speed Pr2 = JOG high speed JOG low speed selected at JSPD signal is OFF. JOG high speed selected at JSPD signal is ON. Torque limit : Torque limit specified by Pr4 is effective only at JOG low speed operation. Relation with other operation modes : When JOG signal is turned ON during AUTO operation, the motion under execution is interrupted and decelration is performed to stop.
3	HANDL Operation	Conditions : EDIT signal = OFF, HANDL signal = ON Start/stop : Moves in FWD direction by FWD direction pulse input from handle PG. Moves in REV direction by REV direction pulse input. Speed : Moving amount = number of pulse inputs at JSPD signal = OFF Moving amount = number of pulse inputs × 100 at JSPD signal = ON Max. speed limit : Set in Pr3. Input pulse process above setting of Pr3 varies depending on Pr5 setting. (Refer to the description of Pr3.) Reference switching Speed/position reference modes can be switched by Pr5 setting. Pr5 = 0 : Position reference mode is entered and moves as many as number of input pulses. Therefore, the machine keeps moving a distance equivalent to number of remaining pulses even after HANDL PG stop. Pr5=1 : Speed reference mode is entered and moves according to input pulse speed. Therefore, moving distance differs from HANDL PG rotation amount since the machine stops when HANDL PG stop.

No.	Item	Description
4	Automatic Operation (AUTO Mode)	Conditions : EDIT signal = OFF, JOG signal = OFF, HANDL signal = OFF and AUTO signal = ON Program selection : specified by PGSL 1 to 4. Start : Execution starts from program block selected by turning PGST signal OFF to ON. Programs (except for feed-hold) are executed in order until M30 is executed. Stop : M30 is executed. Or the machine is stopped by turning PGST signal ON to OFF and performing feed-hold. Program functions : Refer to SECTION 6. Program blocks : 1000 blocks (0 to 999) Start block designation : Blocks 000 to 015 are specified by combination of PGSL1 to 4. A function to jump to the heading block of execution programs is set to blocks 000 to 015. Relation between combination of PGSL 1 to 4 and heading block is shown in the following table. Program switching : ① PGSL (program select) signal is switched after M30 execution. ② Switching on the way of program is performed by switching PGSL signal after feed-hold. <Relation between combination of PGSL1 to 4 and heading block> Feed-hold : To interrupt program operation temporarily. When PGST (program start) signal is turned ON to OFF, decelerates to a stop even during block execution. Turning PGST signal ON again continues program operation.

PGSL1	PGSL2	PGSL3	PGSL4	Heading Block
0	0	0	0	000
1	0	0	0	001
0	1	0	0	002
1	1	0	0	003
0	0	1	0	004
1	0	1	0	005
0	1	1	0	006
1	1	1	0	007
0	0	0	1	008
1	0	0	1	009
0	1	0	1	010
1	1	0	1	011
0	0	1	1	012
1	0	1	1	013
0	1	1	1	014
1	1	1	1	015

4.2 OPERATION MODE (Cont'd)

No.	Item	Description
5	Single-block Operation	Conditions : SBLK (single-block) signal is turned ON in the automatic operation mode ([EDIT] = OFF, [JOG] = OFF, [HANDL] = OFF, [AUTO] = ON). Start : One block is executed from the selected program block at the rising edge of the PGST signal. Head block is executed at the rising edge of the PGST signal after M30 execution. Stop : Stop at completion of 
6	Editing	Conditions : EDIT signal = ON Relation with other modes : The EDIT mode has highest priority to any other operation modes. Servo clamp : Effective in the EDIT mode. Controller ready signal (MRDY) is OFF. Function : Programs or parameter can be set by programmer. The following describes parameter change in accordance with parameter classification : Classification U = Can be changed at any time. S = Can be changed at motor stop. P = Can be changed at motor stop but becomes effective after control power is cycled (only in the EDIT mode).

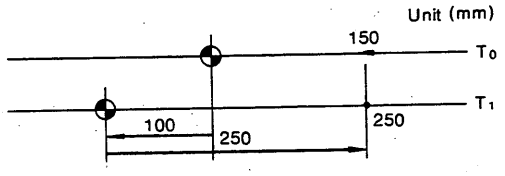
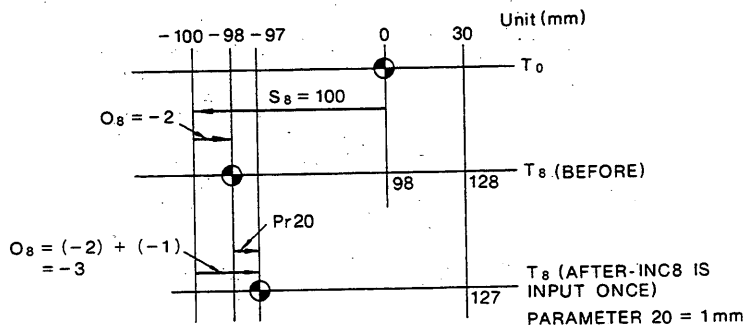
4.3 COORDINATE SYSTEM AND COMPENSATION

<table>
<tr><th>No.</th><th>Item</th><th>Description</th></tr>
<tr><td>1</td><td>Coordinate System</td><td>Total 10 (T_0 to T_9)
Coordinate T_0 :
Defined by encoder output.
Coordinates T_1 to T_9 :
Set by the procedures described below with the reference of coordinate system T_0.</td></tr>
<tr><td>2</td><td>Coordinate Setting Method</td><td>Effective setting method differs partially on each coordinate.

○ : Effective × : Ineffective

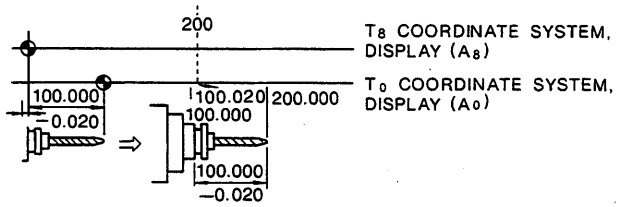
<table>
<tr><th>Method</th><th>G52</th><th>Preset by Programmer</th><th>± INC Signal Input</th><th>Compensation by External Data</th><th>ABS–PG Setup</th></tr>
<tr><td>T_0</td><td>×</td><td>×</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>T_1</td><td>○</td><td>○</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T_2</td><td>○</td><td>○</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T_3</td><td>○</td><td>○</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T_4</td><td>○</td><td>○</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T_5</td><td>○</td><td>○</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T_6</td><td>○</td><td>○</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T_7</td><td>○</td><td>○</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T_8</td><td>○</td><td>○</td><td>○</td><td>○*</td><td>×</td></tr>
<tr><td>T_9</td><td>○</td><td>○</td><td>○</td><td>○*</td><td>×</td></tr>
</table>
* Effective for Model 1 and 2.</td></tr>
<tr><td>3</td><td>Interrelation between Coordinates</td><td>Interrelation between coordinates T_0 and T_1 to T_9, is defined by shift register (S_n) and offset register (O_n) corresponding to coordinate Nos.

<table>
<tr><th>Coordinate System</th><th>Reference System Current Value</th><th>Shift Register</th><th>Offset Register</th></tr>
<tr><td>T_0</td><td>A_0</td><td></td><td></td></tr>
<tr><td>T_1</td><td>A_1</td><td>S_1</td><td></td></tr>
<tr><td>T_2</td><td>A_2</td><td>S_2</td><td></td></tr>
<tr><td>T_3</td><td>A_3</td><td>S_3</td><td></td></tr>
<tr><td>T_4</td><td>A_4</td><td>S_4</td><td></td></tr>
<tr><td>T_5</td><td>A_5</td><td>S_5</td><td></td></tr>
<tr><td>T_6</td><td>A_6</td><td>S_6</td><td></td></tr>
<tr><td>T_7</td><td>A_7</td><td>S_7</td><td></td></tr>
<tr><td>T_8</td><td>A_8</td><td>S_8</td><td rowspan="2">O_8, O_9</td></tr>
<tr><td>T_9</td><td>A_9</td><td>S_9</td></tr>
</table></td></tr>
</table>

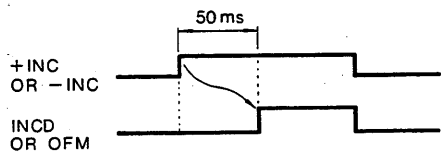
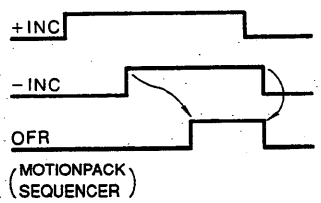
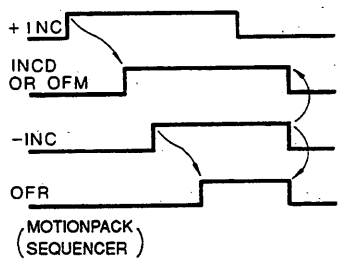
No.	Item	Description
4	Coordinate Shift (Tool Length Compensation)	When coordinate value in coordinate T_n is t_0 and shifting register value corresponding to coordinate T_n is S_n, the coodinate value t_n for T_n coordinate is expressed by the following equation : $t_n = t_0 + S_n$ 〈EXAMPLE〉 The following shows the relation between coordinate T_0 and T_1 when shifting register value (S_1) in T_1 coordinate system is 100 :  Coordinate value t_1 in coordinate T_1 at 150 mm in coordinate T_0 is as shown below : $t_1 = t_0 + S_1$ = 150 mm (T_0) + 100 mm = 250 mm When a positive value is set to S_n, the home position of coordinate T_n is shifted for the value in the negative direction. Thus, coordinate setting by shifting makes tool length compensation easier to perform. That is, by setting tool length to shifting register S_n, coordinate system with coordinate home position moved back by the value.
5	Coordinate Shift of T_8, T_9 Coordinate Systems (Tool Wear)	T_8 or T_9 coordinate system is provided with offset registers (O_8 , O_9) in addition to shifting registers (S_8 , S_9). When coodinate value in T_8 coordinate system is t_8 and corresponding shifting register and offset register are S_8 and O_8 , respectively, the coordinate value is as shown below : $t_8 = t_0 + S_8 + O_8$ 〈EXAMPLE〉 When the value of T_8 coordinate system shifting register S_8 is 100 mm and that of offset register O_8 is −2 mm, the relation between coordinate systems T_0 and T_8 is as shown below :  Coordinate value t_8 in T_8 coordinate system at 30 mm in T_0 coordinate system is expressed by the following equations : $t_8 = t_0 + S_8 + O_8$ = 30 + 100 + (−2) = 128 mm Coordinate setting by offset amount can be used for tool wear compensation. That is, by setting tool wear amount to offset register, the coordinate home position is shifted by the value. Concerning shifting direction, when offset register is negative, the coordinate home position is shifted in the positive direction.

<table>
<tr><th>No.</th><th>Item</th><th>Description</th></tr>
<tr><td>6</td><td>Coordinate Shift by +INC/−INC Signals (T_8, T_9)</td><td>
T_8 coordinate system can add (or subtract) a value set in parameter 20 by +INC (or −INC) ON/OFF to offset register.
The coodinate value is expressed by (or from) an offset register.
Therefore, by setting wear compensated value per one time to parameter 20 and turning ON/OFF −INC signal, automatic compensation can be performed.
The same can be applied to T_9 coordinate system.

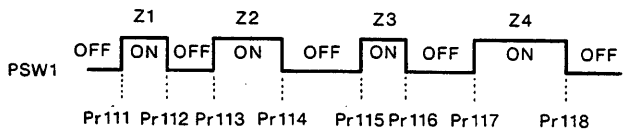
INC8/9 signals specify whether T_8 or T_9 coordinate is compensated for by +INC and −INC signals.
INC8/9 = OFF : T_8 coordinate system specified
INC8/9 = ON : T_9 coordinate system specified

<table>
<tr><th>Coordinate System</th><th>Coordinate Designation</th><th>+ Compensation</th><th>− Compensation</th><th>Correction for One Time</th><th>Max Correction</th></tr>
<tr><td>T_8</td><td>INC8/9 = OFF</td><td>+INC = ⎍</td><td>−INC = ⎍</td><td>P_r20</td><td>P_r21</td></tr>
<tr><td>T_9</td><td>INC8/9 = ON</td><td>Same as above</td><td>Same as above</td><td>P_r22</td><td>P_r23</td></tr>
</table>
〈EXAMPLE〉 When shifting amount (S_8) from T_0 of coordinate No. T_8 is 100.000 and offset amount (O_8) is −0.20, G01X200.000 makes positioning at a point of A_8 = 200.000 (A_0 = 100.020) as shown below :


</td></tr>
</table>

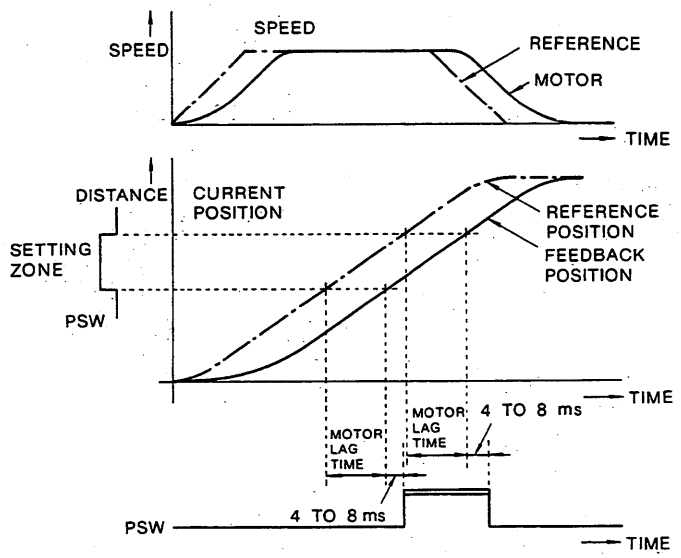
No.	Item	Description
7	Coordinate Shifting Operation by +INC/ −INC	Execution conditions : Not when moving in automatic operation mode Operation : After offset register addition is completed by + (or −) incremental reference, if offset value ± maximum value is reached (or exceeded), offset value ± Max. reach siganl (OFM) is output ; if not ± incremental completion (INCD) signal is output.  Offset value clear : When both + and − incremental references are turned on simultaneously, offset register 8 is cleared to output offset value 0 (OFR) signal is output. ① When −INC is ON before completion (INCD or OFM) signal is output by +INC :  ② When −INC is ON after completion signal is output by +INC : 
8	Coordinate Setting by Programmer	T_1 to T_9 coordinate systems can be used by presetting by programmer. Both shifting value (S_n) and offset value (O_n)can be preset by programmer. (However, only T_8 and T_9 coordinate systems have O_n.) These preset values are renewed by coordinate setting performed during run or coordinate shifting by INC signals.

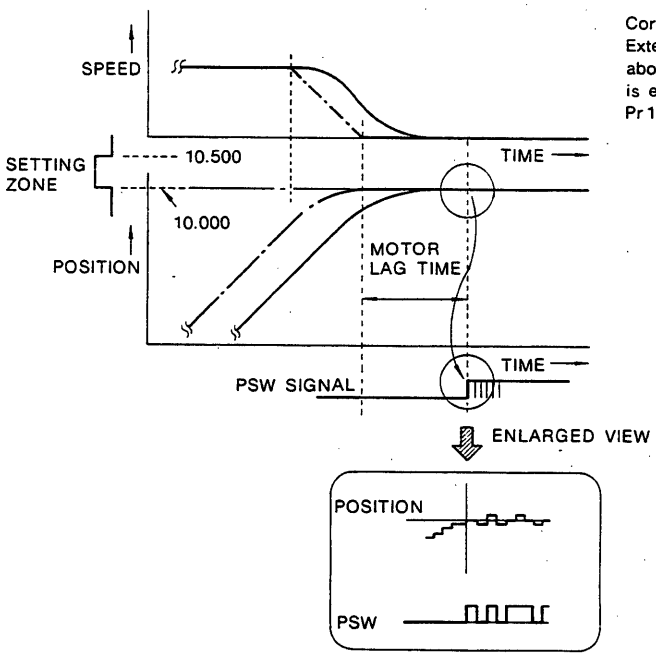
4.4 ZONE SIGNAL OUTPUT

<table>
<tr><th>No.</th><th>Item</th><th>Description</th></tr>
<tr><td>1</td><td>Specifications of Zone Signal Output</td><td>No. of output signals : 4
Signal names :
PSW1, PSW2, PSW3, PSW4
No. of zones :
4 zones for each signal (total 16)
An zone can be set independently for each signal.</td></tr>
<tr><td>2</td><td>Operation</td><td>After the power supply is turned on and absolute value data transmission is completed to establish the position data, the zone signal output function becomes effective.
After that, when the current position (feedback) is in the set zone, regardless of program execution, the corresponding zone signal (PSW1 to PSW4) is turned ON.</td></tr>
<tr><td>3</td><td>Zone Setting</td><td>Each zone signal (PSW1 to PSW4) can define four zones. Since an zone is defined at both ends, eight parameters are necessary for one zone signal.
The following shows the relation between zone signal zones and parameters.
<table>
<tr><th rowspan="2">Signal Name</th><th colspan="8">Zone Signal</th></tr>
<tr><th colspan="2">Z1</th><th colspan="2">Z2</th><th colspan="2">Z3</th><th colspan="2">Z4</th></tr>
<tr><td>PSW1</td><td>Pr111</td><td>Pr112</td><td>Pr113</td><td>Pr114</td><td>Pr115</td><td>Pr116</td><td>Pr117</td><td>Pr118</td></tr>
<tr><td>PSW2</td><td>Pr121</td><td>Pr122</td><td>Pr123</td><td>Pr124</td><td>Pr125</td><td>Pr126</td><td>Pr127</td><td>Pr128</td></tr>
<tr><td>PSW3</td><td>Pr131</td><td>Pr132</td><td>Pr133</td><td>Pr134</td><td>Pr135</td><td>Pr136</td><td>Pr137</td><td>Pr138</td></tr>
<tr><td>PSW4</td><td>Pr141</td><td>Pr142</td><td>Pr143</td><td>Pr144</td><td>Pr145</td><td>Pr146</td><td>Pr147</td><td>Pr148</td></tr>
</table></td></tr>
<tr><td>4</td><td>Relation between Zone and Output</td><td>The following shows the relation between areas,parameters and output signals, taking an example of PSW1 :
 
</td></tr>
<tr><td>5</td><td>Value Comparison among Zone Setting Parameter</td><td>It is necessary to keep the relation of parameter values as :
Pr111<Pr112<Pr113<Pr114<Pr115<Pr116<Pr117<Pr118
When the above relation is reversed or some parameters are made equal, the zones are not defined.

〈EXAMPLE〉 Pr111 = Pr112
Therefore, it is appropriate to set 0 to both parameters for zones that are not used.</td></tr>
</table>

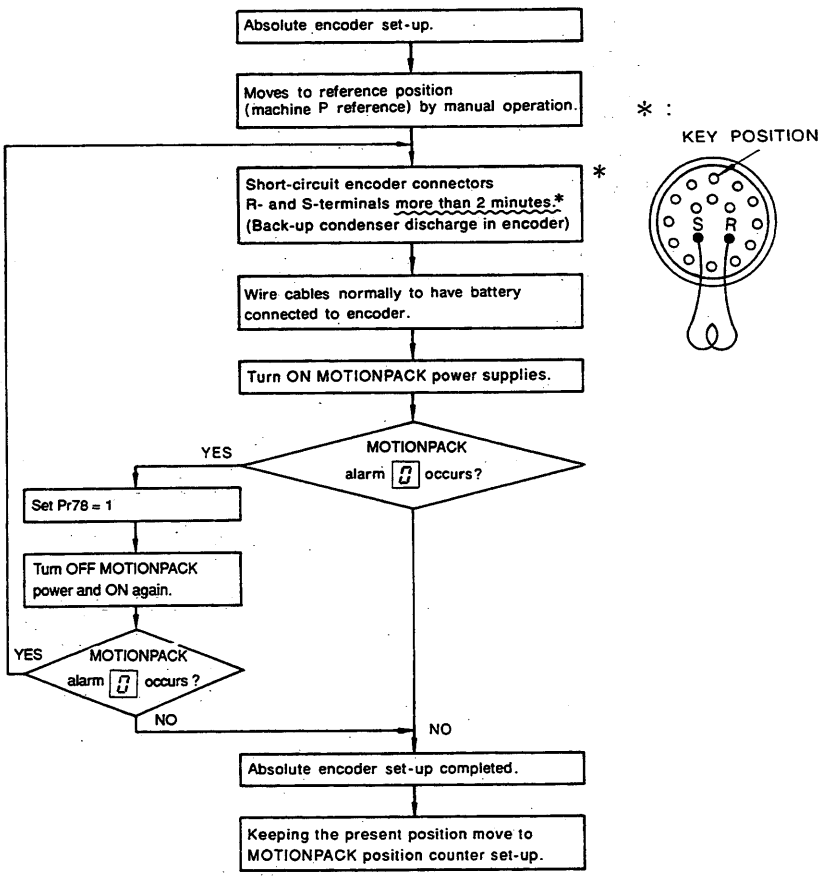
4.4 ZONE SIGNAL OUTPUT (Cont'd)

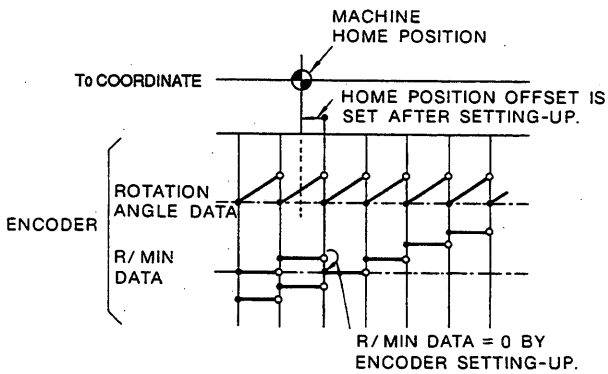
No.	Item	Description
6	Applications	• When the current position is in a zone that has been set by parameters in advance, PSW signal is turned ON. (The current position is feedback position.) • Four PSW signals (PSW1 to PSW4) are provided. Each PSW signal can define four zones (Z1 to Z4) by using eight parameters. • PSW signals become effective when the power supply is turned ON, absolute position initial data transmission is completed and the controller is in RDY (ready) status. After that, regardless of program execution, they are output according to the current position. (Ignore PSW signals before RDY since the signals are uncertain.) • At absolute encoder home positioning, when $P_r73 = 1$ (home position setting-up command) is set, the PSW signal is turned OFF and becomes ineffective. It beocmes effective when home position setting-up is completed and $P_r73 = 0$. • The zone signals can be used as limit switches to detect feeder unit position.
7	Output Lag Time	The following figure shows zone signal output lag time : 

No.	Item	Description
8	Precautions for Zone Setting	When a zone is set at a positioning point, pay attention to the following items. Assume that the program starts from X = 0.000 as shown below and positioning is to be performed at X = 10.000. And the zone is set from 10.000 to 10.500. PROGRAM ⋮ G01x10.000F__I__ M30 Pr111=10.000 Pr112=10.500 In the above case, PSW output is as shown below. After completion of positioning, the feedback position varies in width of some pulses with the aimed position as the center. Therefore, PSW output causes chattering.  Corrective Action : Extend zone setting. For the above example, the following is effective: Pr 111 = 10.000 ↓ = 9.980

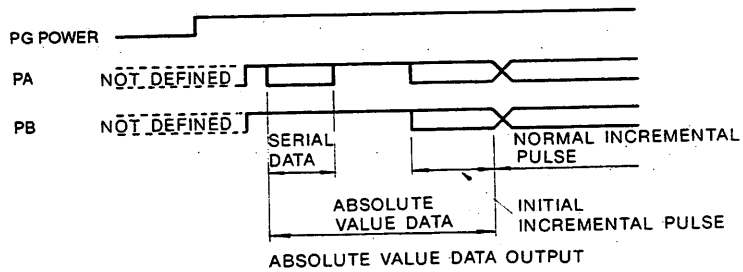
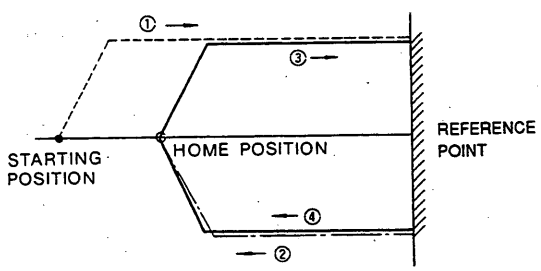
4.5 HOME POSITION COORDINATE SETTING-UP

No.	Item	Description
1	Necessity of Home Position Setting-up	The MOTIONPACK FD series constructs an absolute value positioning system by combining YASKAWA absolute encoder. Set up the absolute encoder and home position in the following cases : ① Motor with absolute encoder is provided for machine. ② More than 2 days pass with encoder not connected to battery. ③ Position data is abnormal. ④ Battery voltage becomes low.
2	Home Position Setting-up Procedures	The following shows the procedures for home position setting-up. Set up absolute encoder. ↓ Set up MOTIONPACK coordinate home position.
3	Absolute Encoder Setting-up	(1) Short the terminals Ⓡ and Ⓢ of encoder. (See *.) (2) Connect the battery before turning on power.



No.	Item	Description
4	Coordinate Home Position Setting-up Method	The following two types of home position setting up methods are provided for the MOTIONPACK FD series : (1) Full-automatic setting-up method (2) Semi-automatic setting-up method
5	Absolute Value Position Data	There are two types of data which compose position data output from the absolute encoder. • Serial data : Indicate how many turns the motor shaft is rotated from the reference position (defined by setting-up). • Initial incremental pulse : Pulses will be transmitted at the same pulse speed as when the motor shaft rotates from the origin to the current position at about 2747 r/min. The position data value can be obtained as shown below : $P = M \times R + P_0$ P : Absolute value position data M : Number of turns (serial data) R : Number of output pulses per motor rotation (pulse/rev) P_0 : Initial incremental pulse count 
6	Serial Data Specifications	Data transmission method : Asynchronous (ASYNC) Baud rate : 9600 Baud Start bit : 1 bit Stop bit : 1 bit Parity : Even Character code : ASCII 7 bits Data format : 8 characters (P) (+/−) (0 to 9) × 5 digits (CR)

4.5 HOME POSITION COORDINATE SETTING-UP (Cont'd)

No.	Item	Description
7	Absolute Encoder Output Data	Absolute encoder outputs absolute value position data to phase A signal line in serial data when the power supply is turned ON. Then the initial incremental pulses are output in two-phase pulses to phases A and B. After that, 2-phase pulses with 90° phase difference are output according to position change, as well as a conventional incremental encoder. 
8	Full-automatic Setting-up Method	Full-automatic setting-up method (stopper method) ① Set Pr73 = 1 and enter the home position setup mode. Then turn ON ZRN, and the machine starts moving from the current position at the Pr74 speed to the direction that is set in Pr70, until it reaches the stopper (reference point) Pushing torque : Pr75 Pushing time : Pr76 ② Perform positioning at a temporary home position (A_0 = 0.000) assuming the stopper (reference point) position = Pr72. ③ The home position coordinate offset is set automatically by moving the machine toward the stopper (reference point) position from the temporary home position again until it reaches there. ④ Perform positioning by moving the machine to the home position (A_0 = 0.000) and stopping it there. 

No.	Item	Description
9	Semi-automatic Setting-up Method	The machine is moved to the reference point by manual operation. Then the home position offset value is automatically set by inputting the ZRN signal at that point to set up the home position.
10	Setting-up at Machine Transfer	When the factory test run is completed and the machine is transferred to the end user's location, the encoder cannot be backed up by battery if the cables between the MOTIONPACK and motor are disconnected. In this case, make sure to set up the encoder before the power supply is first turned on after the transfer. If the encoder super capacitor doesn't charge full or discharge, the battery may be consumed excessively or malfunction may occur.
11	ABS-PG Alarm Reset	ABS-PG alarm cannot be reset by the ERS signal. This is because ABS-PG alarm is caused by absolute value position data and distinguished from the other alarms. To reset ABS-PG alarm, set Pr78 = 1 and turn ON and OFF the power supply. After resetting, Pr78 becomes 0 automatically.

5. CONTROLLER PARAMETERS

5.1 PARAMETER LIST

Remarks :
U : Can be changed anytime.
S : Can be changed when motor stops.
P : Can be changed when motor stops in EDIT mode.
Effective after turning OFF the power supply once and then ON again.

Pr No.	Name	Range	Unit	Remarks	Reference Page
Pr0	(Reserved)				
Pr1	JOG Low Speed	0 to 99999	Speed unit	P	
Pr2	JOG High Speed	0 to 99999	Speed unit	P	
Pr3	HANDLE Feed Speed	0 to 99999	Speed unit	P	
Pr4	JOG Low Speed Feed Torque Limit	0 to 400	%	S	
Pr5	HANDLE Reference Speed/ Position Change	0, 1 (0 : position, 1 : speed)	—	S	
Pr6	Rapid Return Speed	0 to 99999	Speed unit	P	
Pr7	Dwell Position	−99999999 to +99999999	Reference unit	P	
Pr8	External OT Effective/Ineffective	0, 1 (0 : ineffective, 1 : effective)	—	P	
Pr9	(For future use)				
Pr10	(Reserved)				
Pr11	Brake Release Time	0 to 2000 Accuracy : 2ms	ms	P	
Pr12 to Pr19 (For future use)					
Pr20	Coordinate System 8 One-time Offset Value	0 to 255	Reference unit	P	
Pr21	T_8 Coordinate System 8 Maximum Offset Value	0 to 99999999	Reference unit	P	
Pr22	T_9 Coordinate System 9 One-time Offset Value	0 to 255	Reference unit	P	
Pr23	T_9 Coordinate System 9 Maximum Offset Value	0 to 99999999	Reference unit	P	
Pr24	(Reserved)			P	
Pr25	(Reserved)			P	
Pr26 to Pr29 (For future use)					
Pr30	Maximum Speed	0 to 99999	Speed unit	P	
Pr31	Linear Accel/decel Time	0 to 60000	ms	P	
Pr32	S-curve Accel/decel Time	0 to 10000	ms	P	

Pr No.	Name	Range	Unit	Remarks	Reference Page
Pr33	S-curve Accel/decel	0 to 2000	ms	P	
Pr34	Position Loop Gain	0 to 255	s^{-1}	U	
Pr35	Speed Loop Gain	0 to 600	Hz	U	
Pr36	In-position Range	0 to 255	Pulse	S	
Pr37	Allowable Following Error	0 to 999999	Pulse	P	
Pr38	Motor Selection Code	0 to 99	—	P	
Pr39	MRDY Output Mode Change	0, 1	—	P	
Pr40 to Pr49 (Reserved)					
Pr50	Minimum Reference Unit	0 to 5	10^{-n}(mm)	P	
Pr51	Ball Screw Pitch	1000 to 99999	μm/r	P	
Pr52	Gear Ratio 1 (Numerator)	1 to 999999	—	P	
Pr53	Gear Ratio 2 (Denominator)	1 to 999999	—	P	
Pr54	Decimal Point Position (Speed Unit)	0 to 5	Reference unit $\times 10^{n}$/min	P	
Pr55	Number of Encoder Pulses	1000 to 32768 (No multiplier)	Pulse	P	
Pr56	Rotation Direction Designation	0, 1 (0 : FWD, 1 : REV)	—	P	
Pr57 to Pr59 (For future use)					
Pr60	Minus Direction Soft Stroke Limit	−99999999 to +99999999	Reference unit	P	
Pr61	Plus Direction Soft Stroke Limit	−99999999 to +99999999	Reference unit	P	
Pr62 to Pr69 (For future use)					
Pr70	Home Position Coordinate Setting Method	—	—	P	
Pr71	T_0 Coordinate Offset Value	−99999999 to +99999999	Reference unit	P	
Pr72	Reference Point Coordinate Value	−99999999 to +99999999	Reference unit	S	
Pr73	Home Position Setup Command	0, 1	—		
Pr74	Home Position Feed Speed	0 to 99999	Speed unit	P	
Pr75	Pushing Torque	0 to 400	%	S	
Pr76	Stopper Pushing Time	0 to 60000	ms	S	
Pr77	Encoder Allowable Moving Value	0 to 99999990	Reference unit	P	
Pr78	ABS-PG Alarm Reset Command	0, 1	—	P	

5.1 PARAMETER LIST (Cont'd)

Pr No.	Name	Range	Unit	Remarks	Reference Page
Pr79	(Reserved)				
Pr80 to Pr89 (For future use)					
Pr90	Spindle Maximum Speed	0 to 99999	r/min	P	
Pr91	Spindle Reference Method Selection	—	—	P	
Pr92	Spindle PG Disconnection Detection	0, 1 (0 : not provided, 1 : provided)	—	P	
Pr93 to Pr99 (Reserved)					
Pr100	Transmission Baud Rate	0.3, 0.6, 1.2, 2.4 4.8, 9.6, 19.2	kBaud	P	
Pr101	MF Output Delay Time	0 to 1000	ms	P	
Pr102 to Pr110 (For future use)					
Pr111	PSW1 1st Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr112	PSW1 1st Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr113	PSW1 2nd Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr114	PSW1 2nd Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr115	PSW1 3rd Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr116	PSW1 3rd Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr117	PSW1 4th Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr118	PSW1 4th Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr119 to Pr120 (For future use)					
Pr121	PSW2 1st Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr122	PSW2 1st Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr123	PSW2 2nd Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr124	PSW2 2nd Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr125	PSW2 3rd Zone Lower Limit	−99999999 to +99999999	Reference unit	P	

Pr No.	Name	Range	Unit	Remarks	Reference Page
Pr126	PSW2 3rd Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr127	PSW2 4th Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr128	PSW2 4th Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr129 to Pr130 (For future use)					
Pr131	PSW3 1st Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr132	PSW3 1st Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr133	PSW3 2nd Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr134	PSW3 2nd Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr135	PSW3 3rd Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr136	PSW3 3rd Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr137	PSW3 4th Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr138	PSW3 4th Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr139 to Pr140 (For future use)					
Pr141	PSW4 1st Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr142	PSW4 1st Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr143	PSW4 2nd Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr144	PSW4 2nd Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr145	PSW4 3rd Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr146	PSW4 3rd Zone Upper Limit	−99999999 to +99999999	Reference unit	P	
Pr147	PSW4 4th Zone Lower Limit	−99999999 to +99999999	Reference unit	P	
Pr148	PSW4 4th Zone Upper Limit	−99999999 to +99999999	Reference unit	P	

5.2 DETAILS OF PARAMETERS

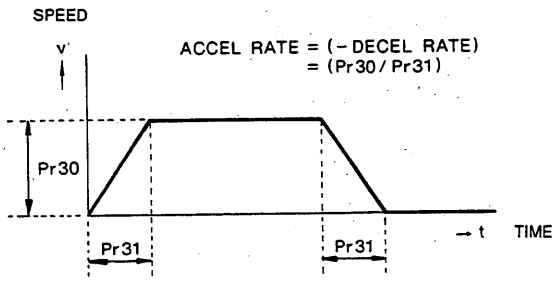
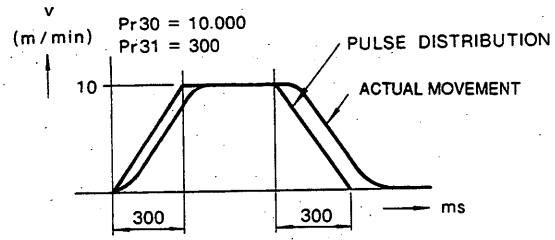
Changing Method

U : Can be changed anytime.
S : Can be changed when motor stops.
P : Can be changed in EDIT mode. Effective after turning OFF the power supply once and then ON again.

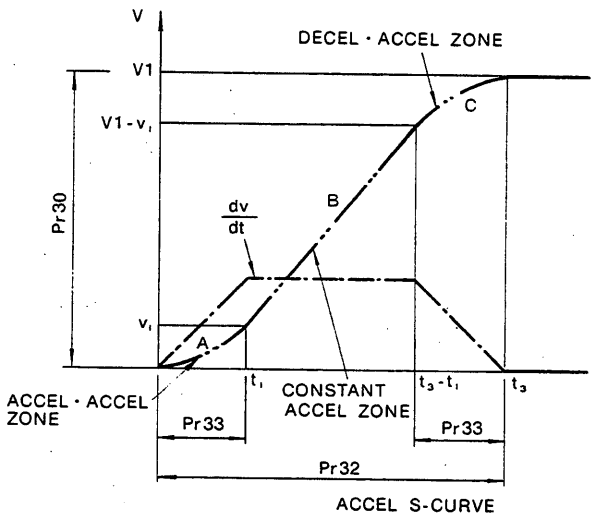
Pr No.	Name (Range/Unit)	Change	Description
Pr1	JOG Low Speed (0 to 99999/speed unit)	P	Parameter to define JOG speed. JOG speed becomes this parameter value when JSPD signal is OFF.
Pr2	JOG High Speed (0 to 99999/speed unit)	P	Parameter to define JOG speed. JOG speed becomes this parameter value when JSPD signal is ON.
Pr3	HANDLE Feed Speed (0 to 99999/speed unit)	P	Parameter to define the maximum speed at HANDLE operation. Pr5=0 : Pulses above Pr3 are accumulated and the motor rotates even after handle operation is stopped. Pr5=1 : Pulses above Pr3 are revoked.
Pr4	JOG Low Speed Feed Torque Limit (0 to 400/ %)	S	Parameter to set JOG low speed feed torque limit. Set in % for the motor rated torque.
Pr5	HANDLE PG Reference Speed/Position Change (0, 1/-----)	S	0 : Position reference is given and the motor moves as many pulses as HANDLE PG generates. When the number of pulses is so large that the motor cannot follow, the motor keeps rotating even after HANDLE PG is stopped. 1 : Speed reference is given and the motor moves as many pulses as HANDLE PG generates. When the number of pulses is so large that the motor cannot follow, the pulses that cannot be discharged are revoked. The motor will not rotate after HANDLE PG is stopped.
Pr6	Rapid Return Speed (0 to 99999/speed unit)	P	When the return signal (ZRN) is turned ON during program operation, "rapid return" operation is entered regardless of executing program and the axis returns to the dwell position. This parameter defines the speed.

Pr No.	Name (Range/Unit)	Change	Description
Pr7	Dwell Position (−99999999 to +99999999/ reference unit)	P	Defines "rapid return" dwell position. The dwell position is set in T_0 coordinate.
Pr8	External OT Effective/ Ineffective (0, 1/-----)	P	0 : External OT ineffective 1 : External OT effective Motor stop at OT signal open.
Pr11	Servo Clamp Release Time (0 to 2000/ms)	P	When SVON signal is turned OFF, set the time between braking reference and servo clamp release . This is used to prevent drop for vertical axis. When the motor holding brake is not used, or when TM2 brake control contact output is not used, set 0.
Pr20	Coordinate System 8 One-time Offset Value (0 to 255/reference unit)	P	Defines offset value for one-time set up by incremental signal (+INC or −INC). At this time, it is necessary to turn OFF coordinate system designation signal INC8/9.
Pr21	Coordinate System 8 Maximum Offset Value (0 to 99999999/reference unit)	P	Defines maximum offset value for coordinate system T_8 by incremental signal (+INC or −INC). Any signals exceeding this maximum value cannot be accepted. Set 0 when the offset function is not used.
Pr22	Coordinate System 9 One- time Offset Value (0 to 255/reference unit)	P	Defines offset value for one-time set up by incremental signal (+INC or −INC). At this time, it is necessary to turn ON coordinate system designation signal INC8/9.
Pr23	Coordinate System 9 Maximum Offset Value (0 to 99999999/reference unit)	P	Defines maximum offset value for coordinate system T_9 by incremental signal (+INC or −INC). Any signals exceeding this maximum value cannot be accepeted. Set 0 when the correction function is not used.
Pr24	(Reserved)		
Pr25	(Reserved)		

5.2 DETAILS OF PARAMETERS (Cont'd)

Pr No.	Name (Range/Unit)	Change	Description
Pr30	Maximum Speed (0 to 99999/speed unit)	P	Motor accel/decel speed is defined by Pr30 or Pr31. Set the maximum speed to be used in the system for Pr30. Set the time to reach the maximum speed to Pr31. ACCEL RATE = (−DECEL RATE) = (Pr30/Pr31)  For accel/decel speed setting, calculate mechanical inertia and the time in which acceleration is possible. When torque limit is provided in program, the accel/decel time slows in accordance with the torque limit. <EXAMPLE> Drill Machines Assuming speed reference unit is mm/min, when maximum speed 10 m/min is reached in 300 ms, set the parameters as follows : Pr30 = 100000 Pr31 = 300 
Pr31	Linear Accel/Decel Time (0 to 60000/ms)	P	

Pr No.	Name (Range/Unit)	Change	Description
Pr32	S-curve Accel/Decel Time (0 to 10000/ms)	P	S-curve accel/decel control is defined by three parameters, Pr30, Pr32 and Pr33. Pr30 defines the maximum speed and is used in common for linear accel/decel control. Pr32 defines S-curve accel/decel time and is equivalent to Pr31 of linear accel/decel control. Pr33 defines the S-curve time in constant accel/decel zone. This time indicates the length of accel · accel zone (accel rate increases at a constant ratio) and decel · accel zone (accel rate decreases at a constant ratio). The upper limit value of Pr33 is smaller value of either 200 ms or Pr32/2.
Pr33	S-curve Accel/Decel Time (0 to 2000/ms) (Constant accel/decel zone)	P	



Pr No.	Name (Range/Unit)	Change	Description
Pr34	Position Loop Gain (K_P) (0 to 255/s^{-1})	U	The ratio between SERVOMOTOR response delay time and servo moving reference value is called position loop gain. The optimum position loop gain varies in accordance with SERVOMOTOR types and machine designs. By decreasing position loop gain , the response delay time becomes longer, while by increasing it, the response delay time becomes shorter. However, excessively large position loop gain causes oscillation. Normally, it is set in the range of K_P = 20 to 40. Fig. (A) shows time-speed curve. In this figure, the area indicated by hashed lines is following error (distance). Fig. (U) shows time-position curve. Following error (ε) is motor delay for reference position at certain time. • When following error is shown by ε : ε =(PPS at rated speed)/K_P

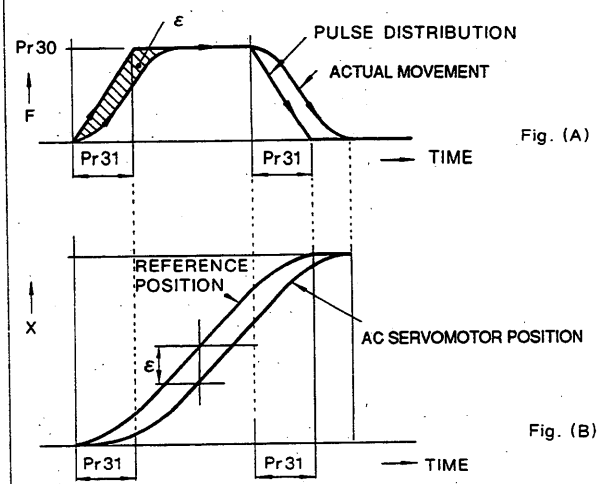
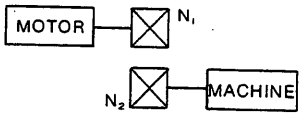
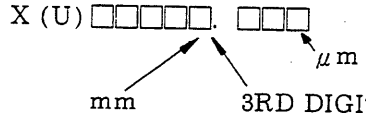
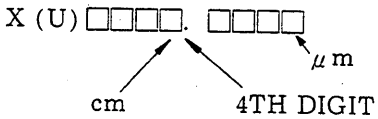


Fig. (A)

Fig. (B)

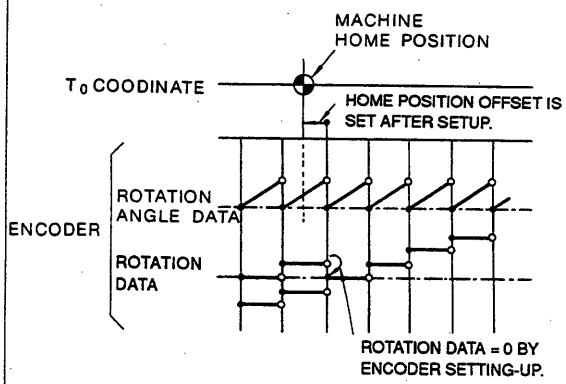
Pr No.	Name (Range/Unit)	Change	Description
Pr35	Speed Loop Gain K_V (0 to 600/Hz)	U	By increasing K_V, the response becomes better. However, it may cause vibration or audible noise. Assuming load inertia J_L, motor inertia J_M and speed loop frequency for one second is f, the following equation can be obtained : $K_V = \{(1 + J_L / J_M) \times f\} / 2$ For example, a machine with load inertia twice as large as motor inertia has speed loop frequency characteristic of 26.7 Hz by setting $K_V = 40$ according to the following equation : $40 = (1 + 2) \times f/2$ $f = 26.7$
Pr36	In-position Range (0 to 255/pulse)	S	The allowable number of accumulated pulses is set when in-position check is performed by G04 command. By decreasing the in-position range, the setting time becomes longer, therefore positioning time also becomes longer. It is set in the range of approx 30 to 50 pulses for general-purpose machine tools.
Pr37	Allowable Following Error (0 to 999999/pulses)	P	This parameter is used to detect servo system faults. When the servo system is normal, the number of following error pulses is set in a range that does not exceed the setting range. The number of following error pulses ε can be obtained as shown below. ε = PPS (at maximum seed)/K_P Normally, a value that is approx twice as large as the number of servo following error pulses is set to allowable following error Pr37.

<table>
<tr><th>Pr No.</th><th>Name (Range/Unit)</th><th>Change</th><th>Description</th></tr>
<tr><td>Pr38</td><td>Motor Selection Code
(0 to 95/-----)</td><td>P</td><td>According to the SERVOMOTOR model to be combined with, set the following values. If wrong values are set, control constants of motor to be combined are not matched and may cause a malfunction.
□: S (ABSO)
<table>
<tr><th colspan="2">M Series</th><th colspan="2">F Series</th><th colspan="2">G Series</th><th colspan="2">D Series</th><th colspan="2">S Series</th></tr>
<tr><th>Motor Type USAMED-</th><th>Code No.</th><th>Motor Type USAFED-</th><th>Code No.</th><th>Motor Type USAGED-</th><th>Code No.</th><th>Motor Type USADED-</th><th>Code No.</th><th>Motor Type USASEM-</th><th>Code No.</th></tr>
<tr><td>—</td><td>0</td><td>02C□1</td><td>10</td><td>02A□1</td><td>50</td><td>—</td><td>40</td><td>02A□</td><td>20</td></tr>
<tr><td>03B□1</td><td>1</td><td>03C□1</td><td>11</td><td>03A□1</td><td>51</td><td>—</td><td>41</td><td>03A□</td><td>21</td></tr>
<tr><td>06B□1</td><td>2</td><td>05C□1</td><td>12</td><td>05A□1</td><td>52</td><td>05B□</td><td>42</td><td>05A□</td><td>22</td></tr>
<tr><td>09B□2</td><td>3</td><td>09C□1</td><td>13</td><td>09A□1</td><td>53</td><td>10B□</td><td>43</td><td>08A□</td><td>23</td></tr>
<tr><td>12B□2</td><td>4</td><td>13C□2</td><td>14</td><td>13A□2</td><td>54</td><td>15B□</td><td>44</td><td>15A□</td><td>24</td></tr>
<tr><td>20B□2</td><td>5</td><td>20C□2</td><td>15</td><td>20A□2</td><td>55</td><td>22B□</td><td>45</td><td>—</td><td>25</td></tr>
<tr><td>30B□2</td><td>6</td><td>30C□2</td><td>16</td><td>30A□2</td><td>56</td><td>37B□</td><td>46</td><td>30A□</td><td>26</td></tr>
<tr><td>44B□2</td><td>7</td><td>44C□2</td><td>17</td><td>44A□2</td><td>57</td><td>—</td><td>47</td><td>—</td><td>27</td></tr>
</table></td></tr>
<tr><td>Pr39</td><td>MRDY Output Mode Change
(0, 1/-----)</td><td>P</td><td>When servo main power is turned ON/OFF by input signal servo ON (SVON), this parameter specifies whether MP ready signal (MRDY) is turned ON or OFF.
0 :
MRDY signal is turned OFF by turning SVON signal OFF to turn OFF servo main power.
1 :
MRDY signal is not turned OFF even by turning OFF SVON signal to turn OFF servo main power if the other conditions are established.</td></tr>
<tr><td>Pr50</td><td>Minimum Reference Unit
(0 to 5/10^{-n}mm)</td><td>P</td><td>The minimum reference unit is expressed in 10^{-n} mm and n value is set.
〈EXAMPLE〉
n = 2 : 10^{-2}mm, or 10 μm
n = 3 : 10^{-3}mm, or 1 μm</td></tr>
<tr><td>Pr51</td><td>Ball Screw Pitch
(1000 to 99999/(μm/r))</td><td>P</td><td>Ball screw pitch is expressed in μm/r.
〈EXAMPLE〉
10 mm/r : Pr51 = 10000
2.5 mm/r : Pr51 = 2500</td></tr>
</table>

Pr No.	Name (Range/Unit)	Change	Description
Pr52	Gear Ratio N_1 (Numerator) (0 to 999999/-----)	P	Gear Ratio N_1/N_2 is set to Pr52/Pr53. Set the number of gears at the motor side to N_1 and that of machine side to N_2. 
Pr53	Gear Ratio N_2 (Denominator) (0 to 999999/-----)	P	
Pr54	Decimal Point Position (Speed Unit) (0 to 5/reference unit$\times 10^n$ / min)	P	Parameter to determine at which digit of the position reference value (expressed in minimum reference unit) the decimal point is to be located. This decimal point position is the speed unit per minute. 〈EXAMPLE 1〉 When position reference unit is 1 μ and Pr54 = 3 :  Then speed unit is mm/min. At this time, if the following is written in the program ; G01 X5000.000 F10000 I200 the moving speed F is as shown below : F = 10000 mm/min. = 10 m/min. 〈EXAMPLE 2〉 When position reference unit is 1 μ and Pr54 = 4 :  Then speed unit is cm/min.
Pr55	Number of Encoder Pulses (1000 to 32768/pulse)	P	The number of encoder output pulses per motor revolution is set without multiplying. 8192 is obtained for an absolute encoder.
Pr56	Rotating Direction Designation (0, 1/-----)	P	0 : FWD rotation connection designation Motor rotates CCW when viewed from the load side according to FWD direction move command. 1 : REV rotation connection designation Motor rotates CW when viewed from the load side according to FWD direction move command.

5

Pr No.	Name (Range/Unit)	Change	Description
Pr60	Minus Direction Stored Stroke Limit (−99999999 to +99999999/ reference unit)	P	Maximum movable range is set. Pr60 : Limited position in minus direction Pr61 : Limited position in plus direction When the current value reaches the stored stroke limit position in JOG or HANDLE operation, the speed reference becomes 0 and the machine cannot move in that direction any more. Returning is possible by JOG or HANDLE operation in the reverse direction. In a feed command that exceeds the stored stroke limit, an alarm occurs without starting the feed command. When Pr60 = Pr61 = 0, the stored stroke limit becomes ineffective. During home position return or home position setup operation, the stored stroke limit is disregarded.
Pr61	Plus Direction Stored Stroke Limit (−99999999 to +99999999/ reference unit)	P	
Pr70	Home Position Coordinate Setting Method	P	The MOTIONPACK FD has two home position coordinate setting methods when absolute encoder is used. Set the following value for each method. Full-automatic setup method : Pr70 = 430□3 Semi-automatic setup method : Pr70 = 40003 □ : Moving direction to start setting up at setup. 0 : Minus direction 1 : Plus direction
Pr71	T_0 Coordinate Offset Value (−99999999 to +99999999/ reference unit)	P	By setting up at mounting absolute encoder on the machine, it is possible to make encoder rotation data (data output by serial data when power supply is turned ON) zero. However, the rotation angle data (data output by initial incremental pulse when power supply is turned ON) are determined by installation of motor and machine shaft. By setting home position offset to Pr71, the MOTIONPACK FD can define the relation between coordinate home position and encoder home position. Therefore, it is possible to match the dislocation of absolute encoder and machine shaft mounting angle.

<table>
<tr><th>Pr No.</th><th>Name (Range/Unit)</th><th>Change</th><th>Description</th></tr>
<tr><td>Pr71
(Cont'd)</td><td>T₀ Coordinate Offset Value
(−99999999 to +99999999/
reference unit)</td><td>P</td><td>Pr71 is equivalent to the distance from coordinate system home position to absolute encoder home position.
 
</td></tr>
<tr><td>Pr72</td><td>Reference Point Coordinate Value
(−99999999 to +99999999/
reference unit)</td><td>S</td><td>Reference point value in the coordinate system after home positioning.
In the full-automatic setup method, it is necessary to keep the following relation for moving starting direction defined by Pr70 and Pr72.
Otherwise, SET UP error occurs when ZRN is input.
<table>
<tr><th>Setup Starting Direction (Pr70)</th><th>Sign of Pr72</th></tr>
<tr><td>0 (Minus)</td><td>Minus</td></tr>
<tr><td>1 (Plus)</td><td>Plus</td></tr>
</table></td></tr>
</table>

5

Pr No.	Name (Range/Unit)	Change	Description
Pr73	Home Position Setup Command (0, 1/-----)	S	Pr73 is set to 1 before home positioning is performed by automatic setup method. By setting Pr73, the MOTIONPACK is in the home position setup mode and it is possible to set up. When the home position setup is completed, this parameter is automatically reset to 0.
Pr74	Home Position Feed Speed (0 to 99999/speed unit)	P	Feed speed at automatic home position setup method is set to Pr74. The unit is speed reference unit and the range is from 0 to 99999.
Pr75	Pushing Torque (10 to 400/%)	S	Pushing torque limit value in the automatic home position setup method is set to Pr75. The unit is % unit for servo rated torque and the range is from 10 to 400.
Pr76	Stopper Pushing Time (0 to 60000/ms)	S	In the automatic home position setup method, the dwell time from when the machine reaches the stopper and the torque limit is exceeded until setup is performed is set to Pr76.
Pr77	Encoder Allowable Moving Value (0 to 99999999/reference unit)	P	In the absolute value method, position data are stored even while the power is shut OFF. At the same time, the position data when power is shut OFF is stored in MOTIONPACK FD. MOTIONPACK FD checks the dislocation when the power supply is turned OFF and that when it is turned ON again. Because of this function, it is possible to detect that the machine has moved for some reason and also to detect an error at absolute encoder position detection. If the dislocation is more than Pr77 in the result of the above checking, an alarm occurs. Pr77 value varies 0 to 99999999. Normally, set at approx 500.

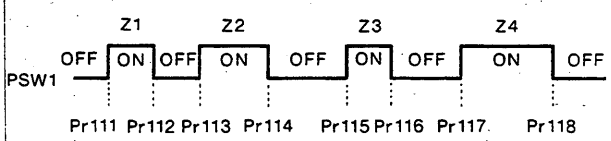
<table>
<tr><th>Pr No.</th><th>Name (Range/Unit)</th><th>Change</th><th>Description</th></tr>
<tr><td>Pr78</td><td>ABS-PG Alarm Reset Command
(0, 1/-----)</td><td>P</td><td>If ABS-PG error occurs, it can be reset by setting Pr78 = 1 and cycle the power.</td></tr>
<tr><td>Pr90</td><td>Maximum Spindle Speed
(0 to 99999/r/min)</td><td>P</td><td>Set the maximum spindle speed. Analog reference voltage becomes ±10 V when spindle reference S equals to Pr90.</td></tr>
<tr><td>Pr91</td><td>Spindle Reference Method Selection</td><td>P</td><td>Reference output is defined corresponding to the specifications of the inverter or servo unit for spindle driver.
<table>
<tr><th rowspan="2">Program</th><th colspan="2">Pr91 = 0</th><th colspan="2">Pr91 = 1</th></tr>
<tr><th>Reference Voltage</th><th>Reference Signal</th><th>Reference Voltage</th><th>Reference Signal</th></tr>
<tr><td>Forward Reference M03</td><td>Positive voltage</td><td>Forward reference signal (8CN-1) ON</td><td>Positive voltage</td><td>Operation reference signal (8CN-1) ON</td></tr>
<tr><td>Reverse Reference M04</td><td>Positive voltage</td><td>Reverse reference signal (8CN-2) ON</td><td>Negative voltage</td><td>Operation reference signal (8CN-1) ON</td></tr>
</table></td></tr>
<tr><td>Pr92</td><td>Spindle PG Disconnection Detection
(0, 1/-----)</td><td>P</td><td>0 : Disconnection detection not provided
1 : Disconnection detection provided</td></tr>
<tr><td>Pr100</td><td>Transmission Baud Rate
(/bps)</td><td>P</td><td>300, 600, 1200, 2400, 4800, 9600, 19200 bps</td></tr>
<tr><td>Pr101</td><td>MF Output Delay Time
(0 to 1000/ms)</td><td>P</td><td>Delay time of strobe output signal for coded M output signals is set .
0 : Coded M signal not provided</td></tr>
</table>

5

<table>
<tr><th>Pr No.</th><th>Name (Range/Unit)</th><th>Change</th><th>Description</th></tr>
<tr><td>Pr111
to 118

Pr121
to 128

Pr131
to 138

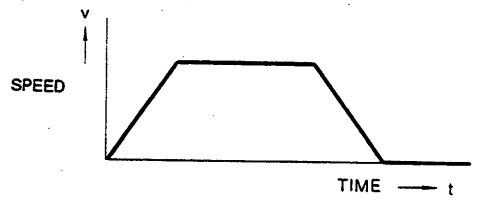
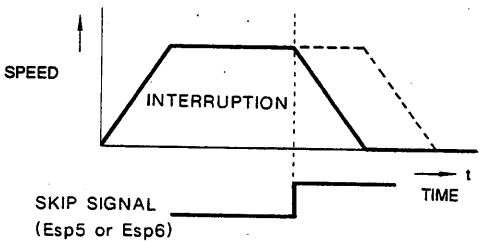
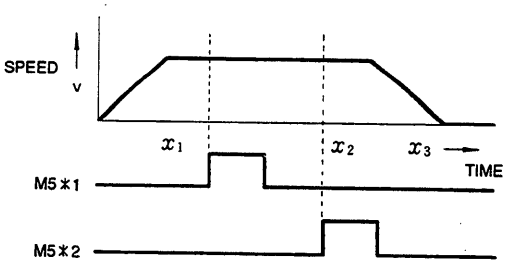
Pr141
to 148</td><td>Zone Signal (PSW 1 to 4)
Relation 1st to 4th Zone Range
(−99999999 to +99999999/ reference unit)</td><td>P</td><td>
In the zone signal output function, the range where zone signal (PSW1 to PSW4) is turned ON is defined by Pr111 to Pr148. It is possible for each zone signal (PSW1 to PSW4) to define four zones. Since a zone is defined at both ends, eight parameters are necessary for each zone signal. The following table shows the relation between zones for each zone signal and parameters.
<table>
<tr><th rowspan="2">Signal Name</th><th colspan="8">Zone Number</th></tr>
<tr><th colspan="2">Z1</th><th colspan="2">Z2</th><th colspan="2">Z3</th><th colspan="2">Z4</th></tr>
<tr><td>PSW1</td><td>Pr111</td><td>Pr112</td><td>Pr113</td><td>Pr114</td><td>Pr115</td><td>Pr116</td><td>Pr117</td><td>Pr118</td></tr>
<tr><td>PSW2</td><td>Pr121</td><td>Pr122</td><td>Pr123</td><td>Pr124</td><td>Pr125</td><td>Pr126</td><td>Pr127</td><td>Pr128</td></tr>
<tr><td>PSW3</td><td>Pr131</td><td>Pr132</td><td>Pr133</td><td>Pr134</td><td>Pr135</td><td>Pr136</td><td>Pr137</td><td>Pr138</td></tr>
<tr><td>PSW4</td><td>Pr141</td><td>Pr142</td><td>Pr143</td><td>Pr144</td><td>Pr145</td><td>Pr146</td><td>Pr147</td><td>Pr148</td></tr>
</table>
It is necessary to keep the following relations among parameters, taking the example of PSW1 :
Pr111<Pr112<Pr113<Pr114<Pr115<Pr116<Pr117<Pr118.
If the parameter value ralation is reversed or the values are made equal, the zone is undefined.
Therefore, set 0 to both parameters of a zone which is not used.
The following shows the ralation between zones, parameters and output signals, taking the example of PSW1 :


</td></tr>
</table>

6. FUNCTION COMMAND

6.1 FUNCTION COMMAND LIST

Table 6.1

Function Command	Symbol	Function Command Format	Contents	Reference Page
Positioning	G01	G01X ... F ... I ... S ... U ...	Positioning to position X (or distance U) at speed F with torque limit I. Spindle command can be set simultaneously. 	65 to 67
Skip Positioning	G05 G06	G05X ... F ... I ... S ... U ...	When the skip signal is turned ON during feed, the execution is interrupted and moves to the next block. 	68 to 71
Positioning with Passing Signal Output	G07	G07X .... G12X .... M5*1 G12X .... M5*2 Note : Both X and U can be used for G07. M-FIN is provided for M50 to M58. M-FIN is not required for M80 to M88/M90 to M98. Other coded M output can be used.	M5* signal is output at the position specified by G12 during feed to the position specified by G07. 	72 to 74

6.1 FUNCTION COMMAND LIST (Cont'd)

Table 6.1

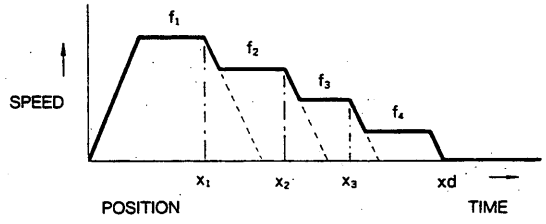
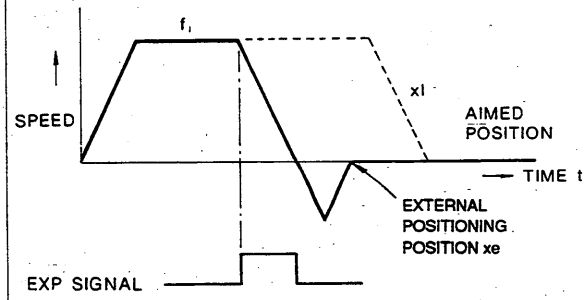
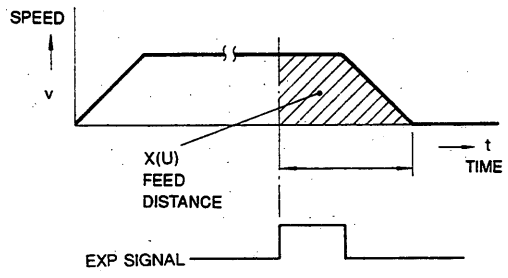
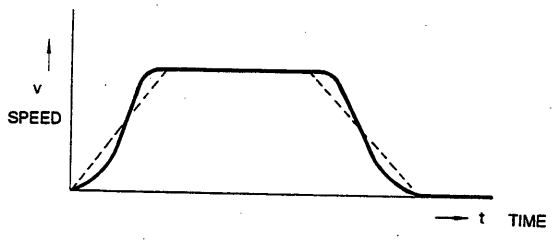
Function Command	Symbol	Function Command Format	Contents	Reference Page
Speed Profile Positioning	G08	G08X..xd.. G12X..x1..F..f1..I .. G12X..x2..F..f2..I .. G12X..x3..F..f3..I .. G12X..xd..F..f4..I .. X or U can be specified for G08 and G12.	Speed is changed at the G12 specified position during G08 positioning. 	75 to 76
External Positioning	G34	G34X..x1..F..f1..I ... U	Positioning is performed at a position where external positioning signal (EXP) is turned ON during feed to X (or U) position at speed F with torque limit I. 	77 to 79
Second External Positioning	G35	G35X (±) F .... I ... U	When the machine continues moving until EXP signal is turned ON and then EXP is turned ON, positioning is performed at the specified position. (1) X designation To point x with EXP position as home position (2) U designation U-distantce move from EXP position 	80 to 81

Table 6.1

Function Command	Symbol	Function Command Format	Contents	Reference Page
S-curve Accel/ Decel Positioning	G10 G11	G10 G01X ..... F ..... I ..... G11 Positioning commands (G01, G05, G06, G34, G35)that are held between G10 and G11 become S-curve accel/decel.	Positioning is performed by S-curve accel/ decel specified by the parameters.  	82 to 86
Time Dwell	G04	In-position check : G04	The next block is executed by waiting for in-position after feed command execution.	87
		Dwell time : G04 D	The next block is executed after time specified by D.	87
Coordinate Setting	G52	G52X..... T..... U..... X or U can be specified for G52.	Current position is set as Tn coordinate system position X (or U).	88 to 89
Coordiante Change	G53	G53T	Changed to Tn coordinate system.	89
In-position Check	G67	G67P	Jumps to P when feedback position is reached in-position without skipping by skip positioning command.	90
Subprogram Call	G68	Repeating number designation : G68L ..... P	Executes subprogram from P block L times.	91
		End position designation : G68X..... P..... U.....	Executes subprogram from P block until position X (or U) is reached.	92
Jump	G69	Simple jump : G69P	Moves to P block execution.	93
		Subprogram return : G69	Returns to main program from subprogram (G68).	93

6

6.1 FUNCTION COMMAND LIST (Cont'd)

Table 6.1

Function Command	Symbol	Function Command Format	Contents	Reference Page
Spindle Control Function	M	M03S ---- M04S ---- M05	M03 : Spindle FWD run command M04 : Spindle REV run command M05 : Spindle stop command The next block is executed by M-FIN signal input.	94 to 97
Auxiliary Function	M	M50 to M58 (Pr101 = 0) Set/reset type, coding available	When M signal is output and M-FIN signal is turned ON, M signal output is reset and then the next block is executed by M-FIN signal.	98 to 99
		Program end : M30	AUTO signal (STL) is reset and M30 signal is output.	100
Ineffective Command	NOP	NOP	No operation	100

6.2 DETAILS OF FUNCTION COMMANDS

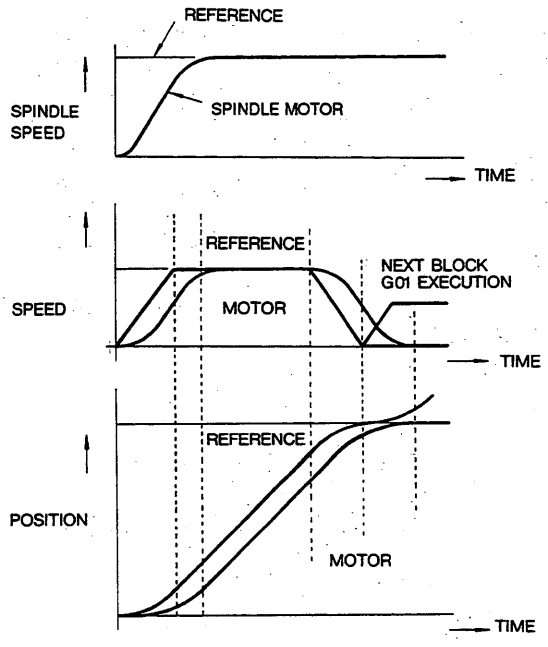
G01	Positioning Command	G01 X (U) ppppppppFfffffIiiiSssssss

1 Value Range

Position reference :
X = Aimed position absolute description (−99999999 to +99999999)
(Position reference unit)
U = Aimed position incremental description (−99999999 to +99999999)
Speed reference :
F = Speed (0 to 99999) (Speed unit)
Torque reference :
I= Torque limit value (10 to 400) (%)
Spindle reference :
S = Spindle speed reference (0 to 60000) (r/min)

2 Related Parameters

	Pr No.	Contents	Unit
Related to Position Reference	Pr36	In-position range	Pulse
	Pr50	Minimum reference unit	10^{-n}(mm)
	Pr51	Ball screw pitch	μm/r
	Pr52	Gear ratio (numerator)	—
	Pr53	Gear ratio (denominator)	—
	Pr54	Decimal point position (speed unit)	Reference unit $\times 10^{n}$/min
	Pr60	Minus direction soft stroke limit	Reference unit
	Pr61	Plus direction soft stroke limit	Reference unit
Related to Servo	Pr30	Maximum speed	Speed unit
	Pr31	Linear accel/decel time	ms
	Pr34	Position loop gain	s^{-1}
	Pr35	Speed loop gain	Hz
	Pr37	Servo allowable following error	Pulse
Spindle	Pr90	Maximum spindle speed	r/min

G01	Positioning Command (Cont'd)	G01 X (U) pppppppFffffffiiiSssssss
3	Operation	The machine moves to position X (or distance U) of the coordinate system that is currently selected at speed F with torque limit I. The aimed position X indicates absolute description and U indicates incremental description. In the incremental description, the moving distance from the former reference position to the current reference position is taken. Spindle command S is output simultaneously with the feed command. Then the spindle starts rotating. However, no spindle rotation speed is not interlocked with feed. The spindle command is modal and the same spindle command is held until another S command is executed.  All positioning commands start or stop in linear accel/decel unless specified by G10/G11. Speed designation (F) can be omitted from positioning command. At this time, the speed is the same as the former feed speed. (Make sure to specify the speed for the first feed command in the program. Otherwise, the speed will be 0.) Torque limit I can be set in the range of 10 to 400. The unit is the percentage (%) of rated torque. However, set it within 250% for linear accel/decel. Torque is provided with the same limit both in plus and minus directions at the same time, which may have ±5% of error. Torque limit designation can be omitted from positioning command. At this time, the torque limit is the same value as the former torque limit. It is set to 250% torque limit at program clear.

G01	Positioning Command (Cont'd)	G01 X (U) pppppppFffffffiiiSssssss
4	Next Block Execution	When the reference up to the aimed position programmed by G01 command is completed, the MOTIONPACK controller starts to execute the next block. The figure shown in previous page indicates the case where G01 command is also stored in the next block. As shown in the figure, the motor moves with a constant error for the reference. Therefore, when reference pulses are completely discharged and the next block starts to be executed, the motor may not reach the aimed position yet. When it is required to execute the next block after the motor reaches the aimed position, it is necessary to insert the in-position check command G04 which will be described later.
5	Spindle Command	Spindle command : Modal. The reference value is held until another command is executed.

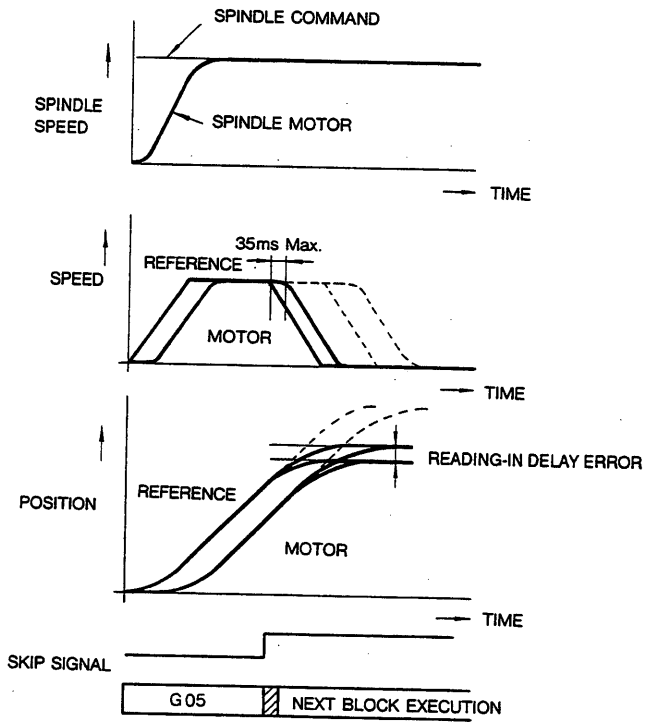
G05, G06	Skip Positioning Command	G05 X (U) pppppppFfffffIiiiSssssss

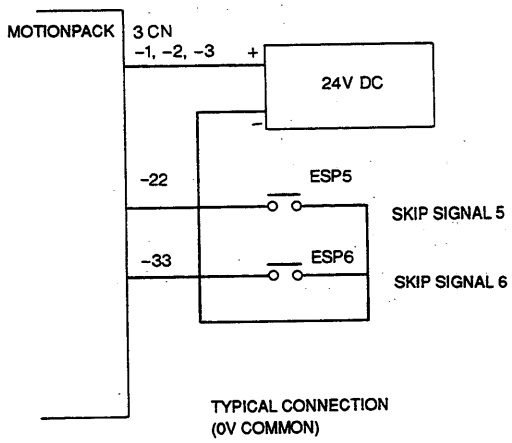
1 Value Range

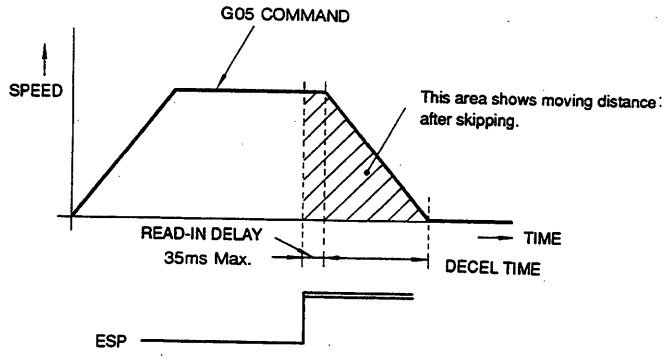
Position reference :
X = Aimed position absolute description (−99999999 to +99999999)
(Position reference unit)
U = Aimed position incremental description (−99999999 to +99999999)
Speed reference :
F = Speed (0 to 99999) (Speed unit)
Torque reference :
I = Torque limit value (10 to 400) (%)
Spindle reference :
S = Spindle speed reference (0 to 60000) (r/min)

2 Related Parameters

	Pr No.	Contents	Unit
Related to Position Reference	Pr36	In-position range	Pulse
	Pr50	Minimum reference unit	10^{-n}(mm)
	Pr51	Ball screw pitch	μm/r
	Pr52	Gear ratio (numerator)	—
	Pr53	Gear ratio (denominator)	—
	Pr54	Decimal point position (speed unit)	Reference unit $\times 10^{n}$/min
	Pr60	Minus direction soft stroke limit	Reference unit
	Pr61	Plus direction soft stroke limit	Reference unit
Related to Servo	Pr30	Maximum speed	Speed unit
	Pr31	Linear accel/decel time	ms
	Pr34	Position loop gain	s^{-1}
	Pr35	Speed loop gain	Hz
	Pr37	Servo allowable following error	Pulse
Spindle	Pr90	Maximum spindle speed	r/min

3	Operation	The machine moves to position X (or distance U) of the coordinate system that is currently selected at speed F with torque limit I. (F or I can be omitted in the same way as the positioning command described before.) When the skip signal is turned ON during moving, the execution is interrupted and the next block is executed. Spindle command S is output simultaneously with the feed command. Then the spindle starts rotating. However, no spindle rotation speed is not interlocked with feed. The spindle command is modal and is not interrupted even by skipping. The same command is held until another S command is executed. 
4	Difference between G01 and G05 (G06)	When the skip signal is not turned ON until the X (U) specified position is reached, the aimed position is reached and the block is completed. In this case, the same operation is performed as G01. The most remarkable difference is given when load torque exceeds the programmed torque limit. • G01 : Command continues regardless of torque limit. • G05 (G06) : Command suspended at torque limit and continues after the limit is released. Therefore, G05 or G06 is more suitable for cutting feed than G01.

G05,G06	Skip Positioning Command (Cont'd)	G05 X (U) pppppppFfffffliiiSssssss
5	Skip Signal	The following shows the relation between the skip commands and skip signals : G05 : ESP5 G06 : ESP6 When the skip signal has already been turned ON at the command execution, the execution is hold until this signal is turned OFF. If the signal is not turned OFF in 2 seconds, a skip signal fault (MP alarm) occurs. 
6	Application (Related to G67)	In-position check command (G67) is a condition jump command to execute jump determining whether skip is performed or not. Therefore, by providing G67 for the next block of G05 (G06), it is possible to branch the program by determining whether skip is performed. According to the above, the skip positioning command stop positioning when external signal is ON and skip the execution to other block.

7	Skip Response Time	The skip signal read-in delay time is up to 35 ms. After skip signal is read-in, feed decelerates and the next block is executed after reference pulses are discharged. 
8	Spindle Command	Spindle command : Modal. The reference value is held until another S command is executed.

G07	Positioning Command with Passing Signal Output	G07 X (U) ppppppp G12 X (U) pppppppFfffffIiii

1 Value Range

Position reference :
X = Aimed position absolute description (−99999999 to +99999999)
(Position reference unit)
U = Aimed position incremental description (−99999999 to +99999999)
Speed reference :
F = Speed (0 to 99999) (Speed unit)
Torque reference :
I = Torque limit value (10 to 400) (%)

2 Related Parameters

	Pr No.	Contents	Unit
Related to Position Reference	Pr36	In-position range	Pulse
	Pr50	Minimum reference unit	10^{-n}(mm)
	Pr51	Ball screw pitch	μm/r
	Pr52	Gear ratio (numerator)	—
	Pr53	Gear ratio (denominator)	—
	Pr54	Decimal point position (speed unit)	Reference unit $\times 10^{n}$/min
	Pr60	Minus direction soft stroke limit	Reference unit
	Pr61	Plus direction soft stroke limit	Reference unit
Related to Servo	Pr30	Maximum speed	Speed unit
	Pr31	Linear accel/decel time	ms
	Pr34	Position loop gain	s^{-1}
	Pr35	Speed loop gain	Hz
	Pr37	Servo allowable following error	Pulse

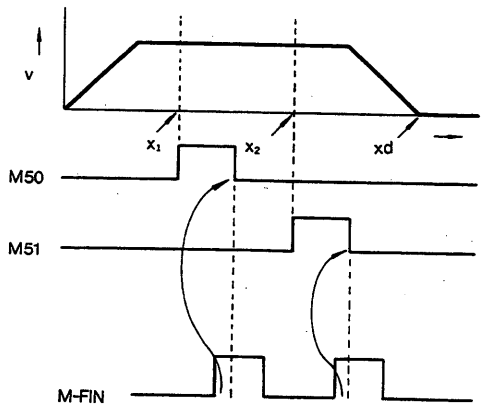
G07	Positioning Command with Passing Signal Output (Cont'd)	G07 X (U) pppppppp G12 X (U) pppppppFfffffIiii

3 Operation

① Positioning point is provided by G07 command. Torque limit and speed are specified by G12.

② A position where passing signal is output is determined by G12.
M50 to M58 : M signal which is required M-FIN signal
M80 to M88 / M90 to M98 :
M signal which is not required M-FIN signal

③ Passing signal is programmed by M command.



Figures left shows operation of following program :

G07X xd
G12X x1 F ____ I ____
M50
G12X x2 F ____ I ____
M51

④ Whether M signal which is required M-FIN signal or not is determined by Pr101 setting. (For details, refer to M signal description.)

4 Passing Signal Output Position

The passing signal output position is the feedback position.

5 Program Limitation

① Do not insert any other positioning commands between G07 and G12. Otherwise, operation cannot be performed normally.

② Arrange the G12 position reference values in order along the moving direction.

Improper example A (Current value : X = 0.000)
G07 × 100.000
G12 × 50.000
M50
G12 × 25.000 ←
M51 — Reversed direction
G12 × 35.000 ←
M52

Improper example B (Current value : X = 100,000)
G07 × 100.000
G12 × −10.000 ← No passing position between X = 0.000 and 100.000
M50

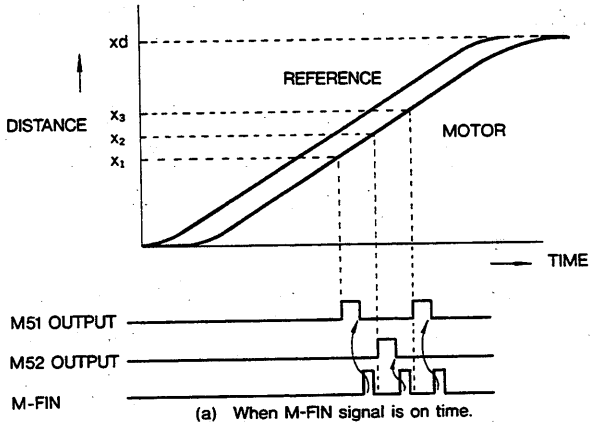
6

G07	Positioning Command with Passing Signal Output (Cont'd)	G07 X (U) pppppppp G12 X (U) pppppppFfffffIiii

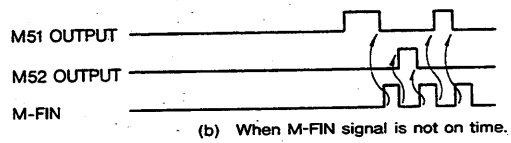
6 M signal when G12 is used

When M signal which is required M-FIN signal is used as a passing signal :

① If the next passing signal is output before M-FIN signal is returned, M signal output waits until the former M signal is reset by M-FIN signal. After the former M-signal is reset by M-FIN and M-FIN signal is turned OFF, the next M signal is immediately output.

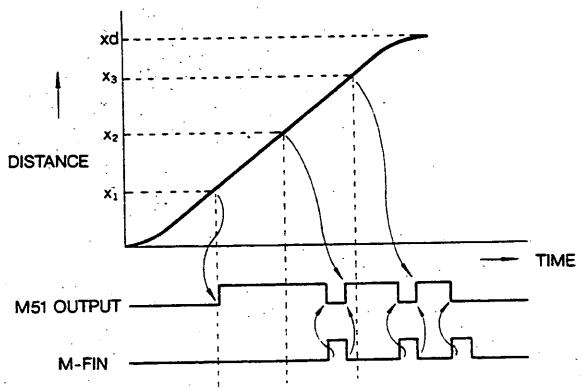


(a) When M-FIN signal is on time.



(b) When M-FIN signal is not on time.

② In the same way as ①, if the next passing signal is turned ON without resetting the former M signal when the same M signal is specified as passing signal, the relation between M signal output and M-FIN signal is as shown below :



When the same M signals waits

7 Output Delay Time

The time from the specified position passing to the next block execution varies up to 4 ms for signal I/O time delay. Therefore, this command is not suitable for applications where high position accuracy is required for passing signals.

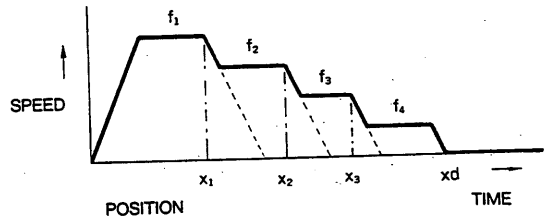
G08	Speed Profile Positioning Command	G08 X (U) ppppppppp G12 X (U) pppppppppFfffffIiii

1 Value Range

Position reference :
X = Aimed position absolute description (−99999999 to +99999999) (Position reference unit)
U = Aimed position incremental description (−99999999 to +99999999)
Speed reference : F = Speed (0 to 99999) (Speed unit)
Torque reference : I = Torque limit value (10 to 400) (%)

2 Related Parameters

	Pr No.	Contents	Unit
Related to Position Reference	Pr36	In-position range	Pulse
	Pr50	Minimum reference unit	10^{-n}(mm)
	Pr51	Ball screw pitch	μm/r
	Pr52	Gear ratio (numerator)	—
	Pr53	Gear ratio (denominator)	—
	Pr54	Decimal point position (speed unit)	Reference unit $\times 10^{n}$/min
	Pr60	Minus direction soft stroke limit	Reference unit
	Pr61	Plus direction soft stroke limit	Reference unit
Related to Servo	Pr30	Maximum speed	Speed unit
	Pr31	Linear accel/decel time	ms
	Pr34	Position loop gain	s^{-1}
	Pr35	Speed loop gain	Hz
	Pr37	Servo allowable following error	Pulse

G08	Speed Profile Positioning Command (Cont'd)	G08 X (U) pppppppp G12 X (U) ppppppppFfffffliii
3	Operation	① Positioning point is provided by G08 command. ② The position where speed is changed during positioning and speed to the position is set by G12 after the next block. G08X _xd_ G12X _x1_ F _f1_ G12X _x2_ F _f2_ G12X _x3_ F _f3_ G12X _xd_ F _f4_ Both X and U can be used for G08/G12.  ③ Set position reference to xd or any position further than xd for the final block G12. The above figure shows the speed diagram that explains the program and its movement.
4	Speed Changing Position	In this function, a position where speed is changed is the current value of the reference (command).
5	Program Limitations	① Do not mix any other positioning commands with G12 to determine the speed change. ② Arrange the G12 position reference values in order. Do not provide any reference to positions that are not within the moving range.
6	Speed Change Delay Time	Speed change (accel/decel start) may be delayed up to 15 ms. Therefore, the changing point varies at the maximum distance of (speed before/after change × 15 ms).
7	Speed Change Distance	In this function, linear accel/decel are used. Therefore, as a minimum time, total of change delay time (described in item 6) and accel/decel time is required. In the meantime, the motor keeps rotating and the position is changing moment by moment. In some programs, the next speed changing point may be passed before the next speed is reached. The setting of speed and speed changing positions must be examined.

G34	External Positioning Command	G34 X (U) pppppppFfffffliii

1 Value Range

Position reference :
X = Aimed position absolute description (−99999999 to +99999999)
(Position reference unit)
U = Aimed position incremental description (−99999999 to +99999999)
Speed reference : F = Speed (0 to 99999) (Speed unit)
Torque reference : I = Torque limit value (10 to 400) (%)

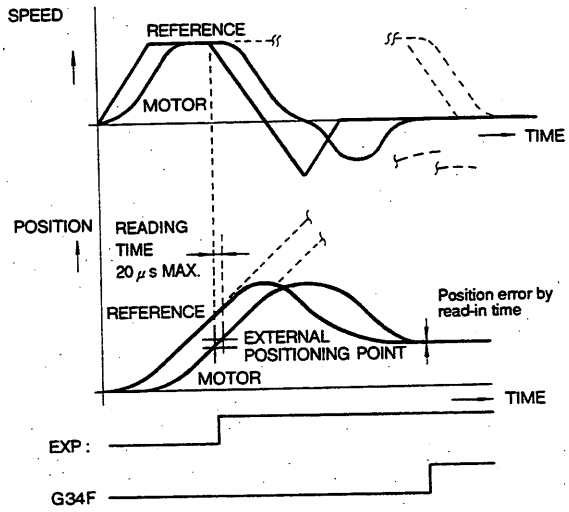
2 Related Parameters

	Pr No.	Contents	Unit
Related to Position Reference	Pr36	In-position range	Pulse
	Pr50	Minimum reference unit	10^{-n}(mm)
	Pr51	Ball screw pitch	μm/r
	Pr52	Gear ratio (numerator)	—
	Pr53	Gear ratio (denominator)	—
	Pr54	Decimal point position (speed unit)	Reference unit $\times 10^{n}$/min
	Pr60	Minus direction soft stroke limit	Reference unit
	Pr61	Plus direction soft stroke limit	Reference unit
Related to Servo	Pr30	Maximum speed	Speed unit
	Pr31	Linear accel/decel time	ms
	Pr34	Position loop gain	s^{-1}
	Pr35	Speed loop gain	Hz
	Pr37	Servo allowable following error	Pulse

6

G34	External Positioning Command (Cont'd)	G34 X (U) pppppppF fffffliii

The machine moves at speed F with torque limit I to the position X (U) of the coordinate value that is currently selected. (F and I can be omitted as well as the positioning command.) When the external positioning signal (EXP) is turned ON during moving, the machine returns to the position where EXP is turned ON.



3 Operation

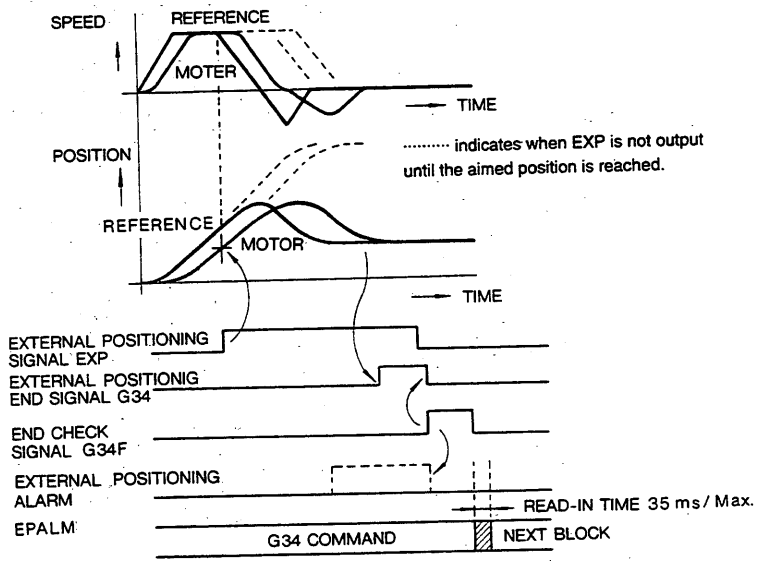
Since the external positioning signal read-in time varies in 50 μs, it is necessary to set the feed speed less than 20 kpps.

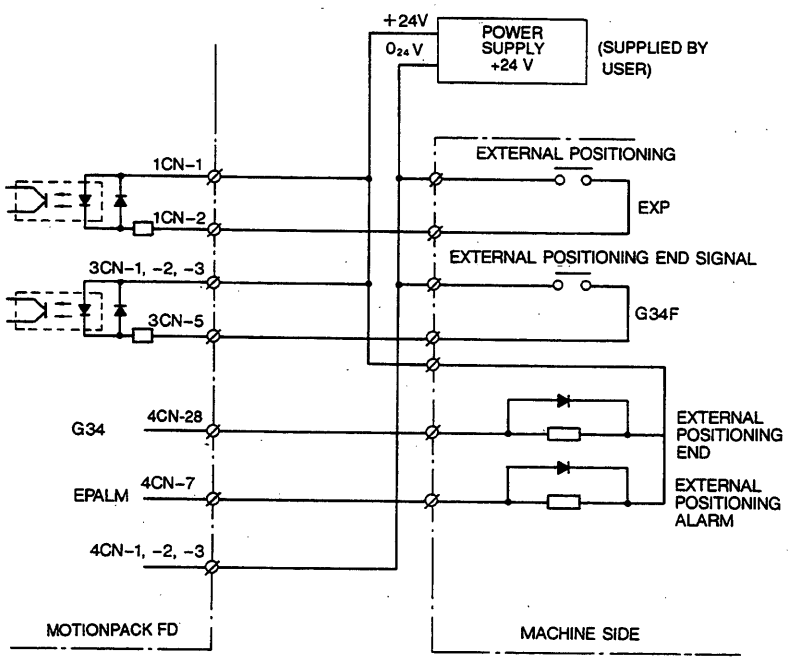
After stopping by external positioning, if feed is in-position, the external positioning end signal (G34) is turned ON. Then when the end check signal (G34F) is input (or turned ON), G34 signal is turned OFF.

If EXP is not turned ON until the machine reaches the X (U) specified position and feed is in-position, the external positioning alarm (EPALM) signal is output.

When the end check signal (G34F) is turned ON, the end signal (G34) or alarm signal (EPALM) is reset.

If EXP or G34F signal has already been turned ON at G34 execution start, both signals are waited to be OFF. If they are not turned OFF in 2 seconds, an alarm (EPALM) is output.



4	Related Signals	
5	EPALM Reset Conditions	External positioning alarm (EPALM) is reset : ① When G34F signal is turned ON. ② When mode is changed.
6	Signal Read-in	EXP signal : 50 μs Max. G34F : 35 ms Max.
7	Next Block Execution	When the end check signal (G34F) is turned ON, the external positioning end signal (G34) or alarm (EPALM) is reset and the program moves to the next block.

G35 | Second External Positioning Command | G35 X (U) pppppppFfffffliii

1 Value Range

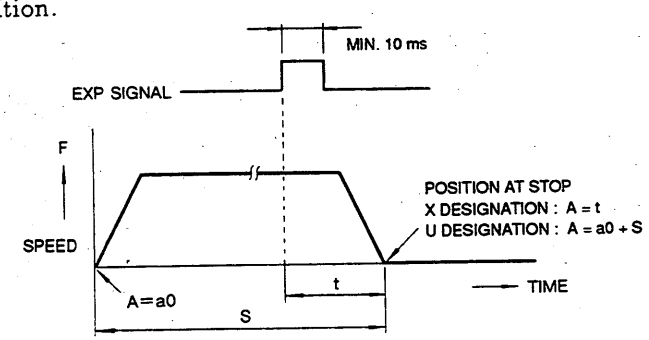
Position reference :
X = Aimed position absolute description (−99999999 to +99999999)
(Position reference unit)
U = Aimed position incremental description (−99999999 to +99999999)
Speed reference : F = Speed (0 to 99999) (Speed unit)
Torque reference : I = Torque limit value (10 to 400) (%)

2 Related Parameters

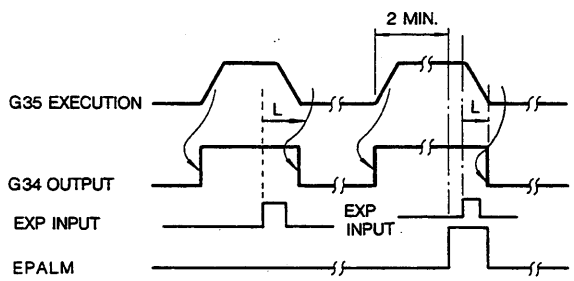
	Pr No.	Contents	Unit
Related to Position Reference	Pr36	In-position range	Pulse
	Pr50	Minimum reference unit	10^{-n}(mm)
	Pr51	Ball screw pitch	μm/r
	Pr52	Gear ratio (numerator)	—
	Pr53	Gear ratio (denominator)	—
	Pr54	Decimal point position (speed unit)	Reference unit $\times 10^{n}$/min
	Pr60	Minus direction soft stroke limit	Reference unit
	Pr61	Plus direction soft stroke limit	Reference unit
Related to Servo	Pr30	Maximum speed	Speed unit
	Pr31	Linear accel/decel time	ms
	Pr34	Position loop gain	s^{-1}
	Pr35	Speed loop gain	Hz
	Pr37	Servo allowable following error	Pulse

3 Operation

Feed by G35 command continues until the EXP signal is turned ON. Then positioning is performed at the position of specified length L after the EXP signal is turned ON.
Therefore, it is possible to perform positioning by external signals after infinite length operation.



G35	Second External Positoning Command (Cont'd)	G35 X (U) pppppppFfffffliii

4	Moving Direction	Direction of a sign specified by G35X(U) Even in subprograms specified with the end position, it is possible to specify the moving distance L exceeding the G68 specified position X. The G68 specified position X only specifies the limit position to search the EXP signal.
5	Maximum Moving Distance	When the machine moves a distance of approx 5×10^8 in position reference unit or it keeps moving more than 2 minutes, the EPALM signal is turned ON. However, the machine keeps moving as it does. When the soft stroke limit is reached, the EPALM signal is also turned ON.
6	Moving Distance after EXP Signal ON	The machine moves distance L regardless of position designation X or U.
7	Coordinate after EXP	• U designation Coordinate system does not change before/after the G34 command is started. Therefore, the current position after external positioning is completed is displayed, adding the G35 starting point value with the moving distance. • X designation The position where the EXP signal is turned ON becomes the home position. Coordinate shift is effective.
8	Stop Operation	When the machine cannot decelerate in the distance L after the EXP signal is turned ON, it passes the specified position. Then it returns to the position where the machine moves L distance after the EXP is turned ON.
9	Timing Chart	

G10/G11 S-curve Accel/decel Positioning Command | G10/G11

1 S-curve Accel/decel Positioning

Positioning reference between G10 and G11 becomes S-curve accel/decel positioning command.

〈EXAMPLE〉

⋮

G10

G01X (U)---- F ---- I ---- ← S-CURVE ACCEL/DECEL POSITIONING

G11

2 Value Range

Position Reference :

X = Aimed position absolute description (−99999999 to +99999999)
(Position reference unit)

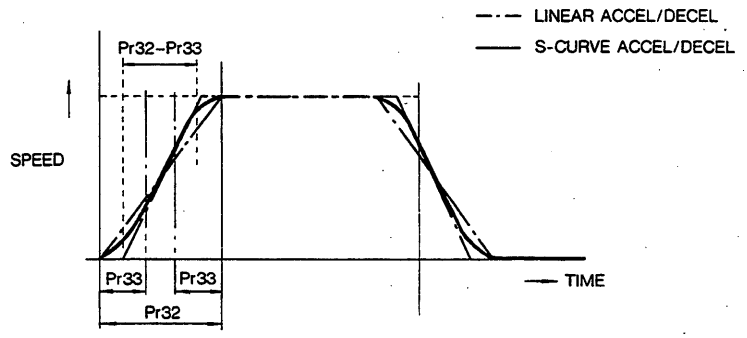
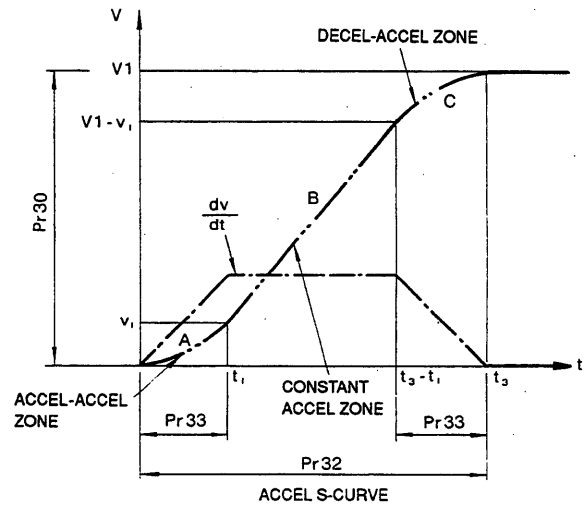
U = Aimed position incremental description (−99999999 to +99999999)

Speed reference : F = Speed (0 to 99999) (Speed unit)

Torque reference : I = Torque limit value (10 to 400) (%)

3 Related Parameters

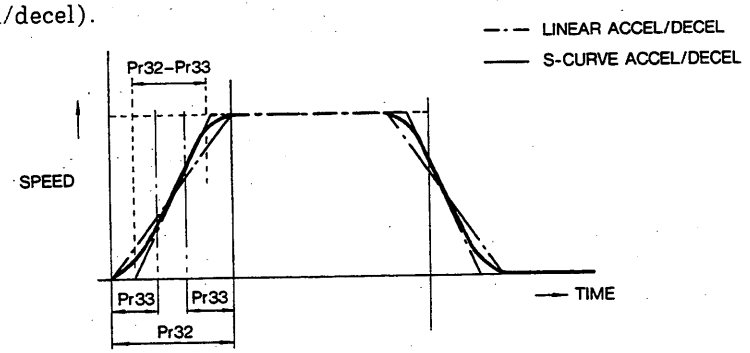
	Pr No.	Contents	Unit
Related to Position Reference	Pr36	In-position range	Pulse
	Pr50	Minimum reference unit	10^{-n}(mm)
	Pr51	Ball screw pitch	μm/r
	Pr52	Gear ratio (numerator)	—
	Pr53	Gear ratio (denominator)	—
	Pr54	Decimal point position (speed unit)	Reference unit $\times 10^{n}$/min
	Pr60	Minus direction soft stroke limit	Reference unit
	Pr61	Plus direction soft stroke limit	Reference unit
Related to Servo	Pr30	Maximum speed	Speed unit
	Pr32	S-curve accel/decel time	ms
	Pr33	S-curve accel/decel time (constant accel/decel zone)	ms
	Pr34	Position loop gain	s^{-1}
	Pr35	Speed loop gain	Hz
	Pr37	Servo allowable following error	Pulse

4	Operation	S-curve accel/decel positioning is performed according to the S-curve accel/decel curve defined by Pr32 (all S-curve accel/decel time) and Pr33 (S-curve section accel/decel time). 
5	Definition of S-curve Accel/decel Curve	① S-curve accel/decel curve is composed of three zones as shown in the figure below. A : Accel-accel zone B : Constant accel zone C : Decel-accel zone ② Acceleration and decleration are symetric patterns. ③ S-curve accel/decel curve is defined by the following three parameters : V1 = Pr30 : Maximum speed (10 to 99999) ta = Pr32 : Accel time (unit : ms, 10 to 60000) tl = Pr33 : S-curve accel/decel time (unit : ms, 10 to 60000) The upper limit value of Pr33 is smaller value of 10000 or Pr32 × ½. 

G10/G11	S-curve Accel/decel Positioning Command (Cont'd)	G10/G11

6 Operation Curve

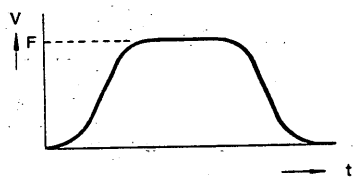
The basic operation is the same as G01 positioning operation. Only accel/decel curve becomes S-curve. The S-curve accel/decel times are the same (symmetric type accel/decel).



When the stop signal is input during operation, the movement is shown in figure below.

① Normal operation
Positioning by symmetric type S-curve accel/decel shown in the figure below is executed.

② Operation with short moving distance
When reference moving distance is short, positioning without constant accel zone or constant speed zone is performed as shown in the figure below.



Normal Operation Speed Curve

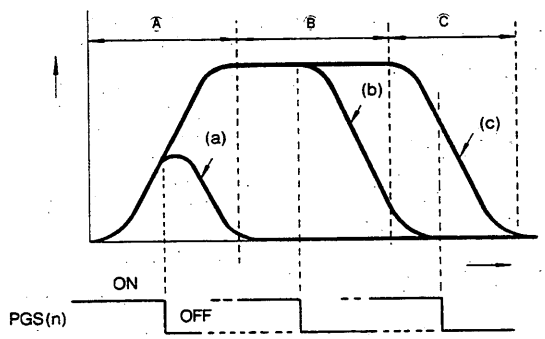
Speed Curve at Short Moving Distance

③ Speed curve when operation is suspended
When the operation is suspended, the operation speed curve varies according to the timing, as shown below :

A : When suspended during accel, the machine stops by symmetric curve as curve (a).

B : When suspended during constant speed, the machine stops by decel curve of S-curve accel/decel curve.

C : When suspended during deceleration, the machine continues to decelerate to a stop.



Speed Curve when Operation Suspended

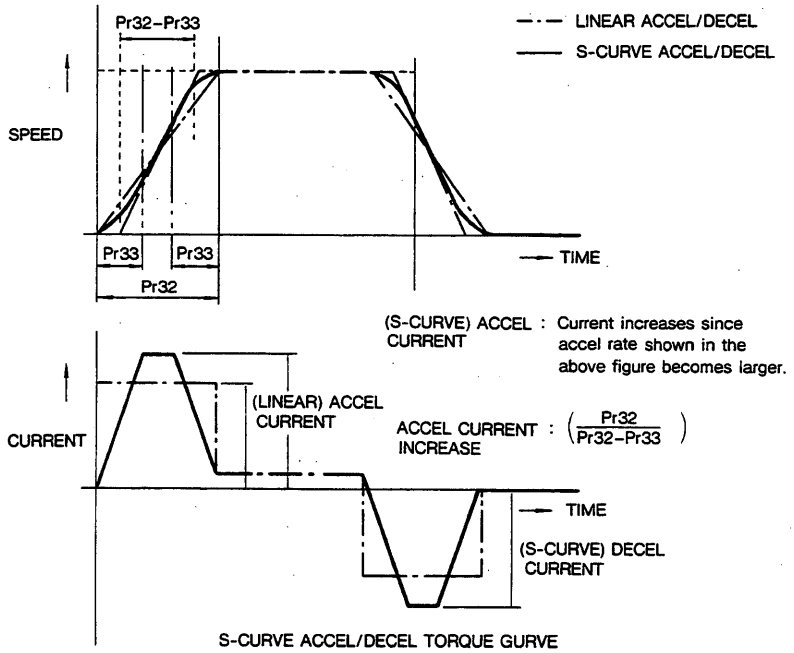
7 Using Method

Accel (decel) torque
As shown in the figure below, S-curve accle (decel) defined by Pr33 is provided at the beginning and the end of accel (decel). Then linear accel (decel) speed in the middle of accel or decel becomes larger as ratio of Pr33/Pr32 increase. Accel (decel) speed becomes linear when accel (decel) time reaches (Pr32−Pr33). At that point torque becomes the peak torque of S-curve accel/decel positioning.

Peak torque at S-curve accel/decel

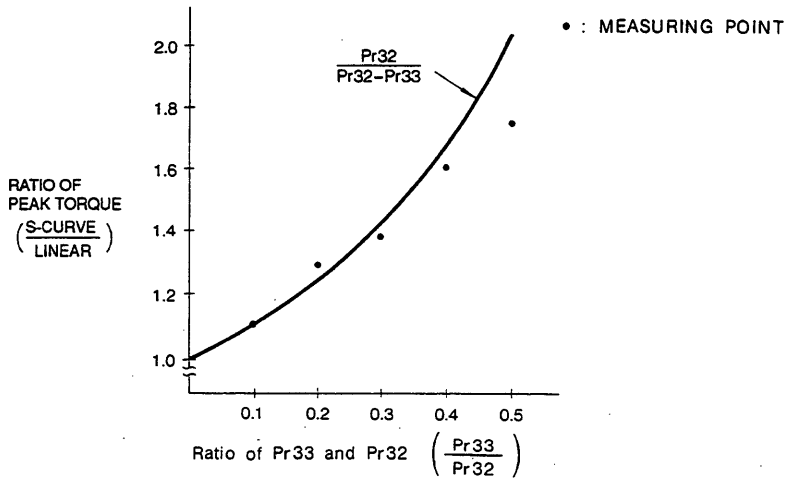
$$= \frac{Pr32}{Pr32-Pr33} \times \text{peak torque at linear accel/decel}$$

According to the above equation, when Pr33 = 0, S-curve and linear peak torque are equal. When $Pr33 = \frac{Pr32}{2}$ (or linear section is not provided), S-curve peak torque becomes twice as large as that of linear accel/decel.



S-CURVE ACCEL/DECEL TORQUE GURVE

The ratio of Pr33 and Pr32 peak torque is shown below :



G10/G11	S-curve Accel/decel Positioning Command (Cont'd)	G10/G11
8	Accel/decel Time Adjusting Method	① Measure accel current waveform of linear accel/decel operation by using an oscilloscope. ② Calculate the ratio of linear accel current and motor rated current. $a = \frac{\text{Motor rated current} \times 2^*}{\text{Linear accel current}}$ *: Normally I = 250% for MOTIONPACK Up to 400% can be set for insufficient torque. ③ According to a obtained in ② ; $a \leqq 1$: MOTIONPACK momentary current has already come to the limit with linear accel current. It is necessary to increase accel time to use S-curve accel/decel. $a > 1$: S-curve accel/decel possible. ④ According to the figure in page 85 ; The ratio of Pr33 and Pr32 is obtained when accel current ratio is equal to a. At this time, Pr33 is the limit value of S-curve accel/decel time.
9	Applications and Capacity Selection	Since S-curve accel/decel positioning function can supply constant ratios of the accel/decel speed (accel-accel speed or accel-decel speed), it is possible to decrease the shock provided at start/stop. However, this makes it necessary to have larger servo drive capacity than that for linear accel/decel, as described in item 7. If required accel/decel time cannot be obtained and the specifications of accel/decel time cannot be increased after the above adjustment, select the servo capacity again. This means that larger capacity servo must be selected just for the peak torque at accel/decel. However, this servo drive capacity is necessary to perform shockless operation promptly. When the servo capacity is not increased, adjust Pr33, by checking the aimed shockless operation, and control the peak torque within the range of maximum momentary current. ("Servo" includes MOTIONPACK and SERVOMOTOR.)

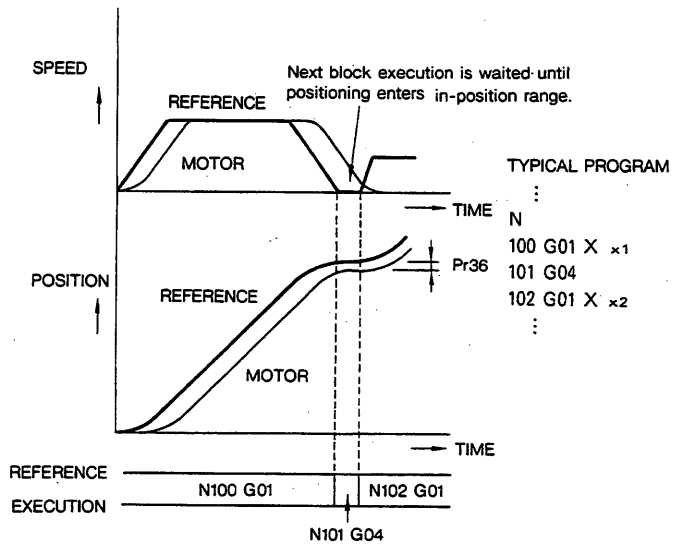
G04	In-Position Waiting Command	G04

1 Related Parameters

Pr No.	Contents	Unit
Pr36	In-position range	Pulse

2 Operation

If dwell time is not specified in G04 command, in-position waiting is applied. Positioning commands G01, G05 and G06 start execution of the next block after the reference pulses are discharged. When it is necessary to start the next command execution after feed is in-position, G04 command is programmed next to the positioning command. If in-position is not applied in 2 seconds after the G04 command execution, the in-position alarm (MP alarm) occurs.
The number of error pulses to determine in-position value is set to Pr36.



3 Next Block Execution

As shown in the figure above, when feed by the positioning command enters in-position range, the next block is executed.

G04	Time Dwell Command	G04 Dddddd

1 Value Range

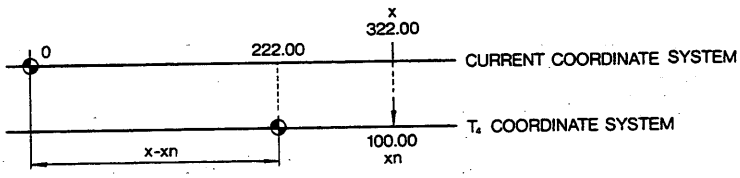
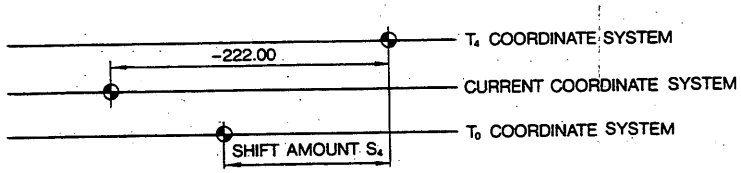
Time setting :
D = Dwell time (1 to 60000)
(unit : 10 ms)

2 Operation

The machine stops temporarily for the period of time specified by D. At this time, in-position check is not performed.

3 Next Block Execution

The next block is executed after the period of time specified by D.

G52	Coordinate Setting Command	G52 X (U) ppppppppTt
1	Value Range	Position reference : X = Aimed position absolute description (−99999999 to +99999999) (Position reference unit) U = Aimed position incremental description (−99999999 to +99999999) Coordinate system : T = Coordinate No. (1 to 9)
2	Operation	The current value is set to position X (or U) in coordinate t. Shifting amount by G52 is set to shift register. Even if a coordinate position is set by G52, the coordinate system is not changed. T_0 coodinate cannot be set by G52 command.
3	Operation (X Command)	G01 X322.00 G52 X100.00 T_4 The current coordinate system position 322.00 is set to position 100.00 in T_4 coordinate system. 
4	Operation (U Command)	G01 X322.00 G52 U-222.00 T_4 T_4 coordinate system is shifted by +222.00 from the currently used coordinate. 

G52	Coordinate Setting Command (Cont'd)	G52 X (U) ppppppppTt

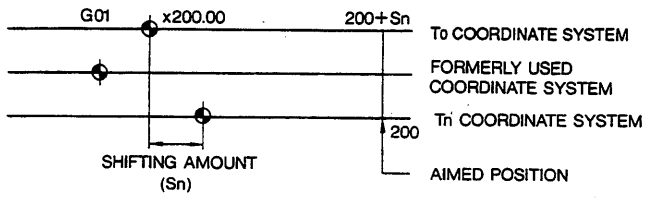
5	Operation (T_8, T_9 coordinate)	100 G01 X100.00 ··· 101 G52 X200.00 T_8 102 G53 T_8 103 G01 X250.00 ⋮ Coordinate system T_8 has shifting register S_8 and offset register O_8. G52 command performs shift register setting. The following table shows the variation of registers A, S and O correponding to program executions.

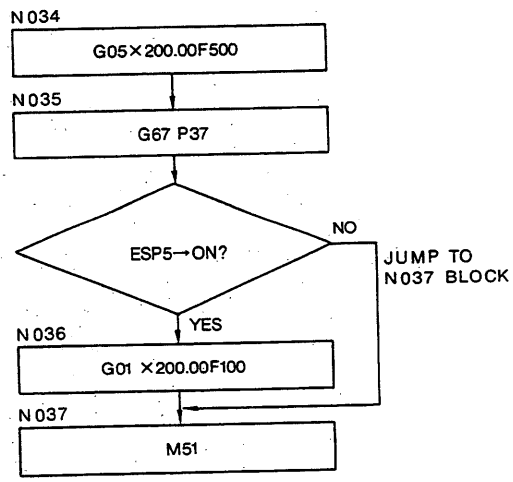
Command	Register Contents after Command Execution			
	A_0	A_8	S_8	O_8
Initial Status	0.000	2.500	0.00	2.500
100 G01 X100.00	100.000	102.500	0.00	↑
101 G52 X200.00 T_8	↑	202.500	100.00	↑
102 G53 T_8	↑	202.500	↑	↑
103 G01 X250.00	147.500	250.000	↑	↑
+INC 8 = ON (1st Time)	147.500	250.002	↑	2.502
+INC 8 = ON (2nd Time)	↑	250.004	↑	2.504
−INC 8 = (1st Time)	↑	250.002	↑	2.502
−INC 8 = (2nd Time)	↑	250.000	↑	2.500
−INC 8 = ON (3rd Time)	↑	249,998	↑	2.498

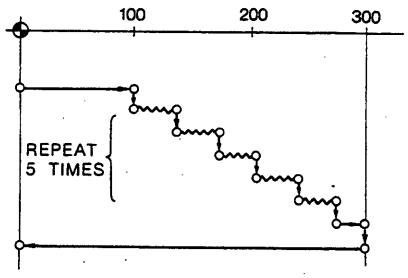
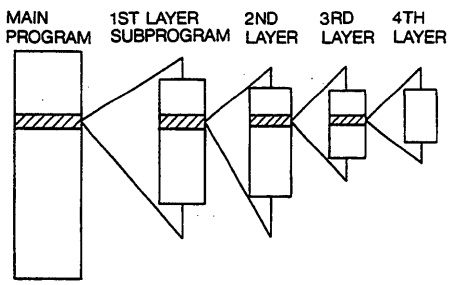
When Pr20 = 2, Pr21 = 10

6	Next Block Execution	The next block is executed after several ms of execution time for G52.

G53	Coordinate Change Command	G53 Tt

1	Value Range	Coordinate system : T = Coordinate No. (0 to 9)
2	Operation	Position is decided using coordinate selected by G53 command. (The position shifted by shifting amount Sn from T_0 coordinate system is obtained. T_8 or T_9 coordinate system is shifted by (shifting amount Sn + offset amount On). T_0 coordinate system has been selected as a default coordinate after the power is turned ON. 

G67	In-position Check Command	G67 Pbbb
1	Value Range	Block No. : P = Jumping destination block No. (000 to 999)
2	Operation	The in-position check command is used together with the skip positioning command (G05, G06). When the skip signal is turned ON and the operation is skipped and execution is interrupted, jump is not executed but the next block is executed. When the skip signal is not turned ON and the machine reaches the position specified by X (U), execution jumps to the block specified by P. ⋮ N034 G05 X200.00 F500 N035 G67 P37 N036 G01 X200.00 F100 N037 M51 When the skip signal 5 (ESP5) is turned ON during N034 execution, N035, N036 and N037 are executed in that order. However, if the skip signal is not turned ON, jump is executed at N035, and N037 is executed. 

G68	Repeating No. Designation Subprogram Call	G68 L1 Pbbb
1	Value Range	L : Repeating No. designation (1 to 99) P : Subprogram head block (000 to 999)
2	Operation	Subprogram starting from the block specified by P is repeatedly executed as many times as specified by L. After execution, the block next to the G68 command is executed.
3	Sample Program	The following shows a sample using the repeating No. designation subprogram call command : N110 G01 X100 F12000 111 G04 112 M51 113 G68 L5 P318 : 5-TIME SUBPROGRAM REPEAT 114 G01 X300 F12000 115 G04 116 M51 117 G01 X0 : HOME POSITION RETURN 118 M30 : END N318 G01 U35 : SUBPROGRAM 319 G04 320 M51 321 G69 : RETURN FROM SUBPROGRAM 
4	Nesting	In a repeating No. designation subprogram, it is possible to jump from the subprogram to the others, up to four layers as shown below : 

G68	End Point Designation Subprogram Call	G68 X (U) pppppppPbbb

1 Value Range

Position reference :
X = Aimed position absolute description (−99999999 to +99999999)
(Position reference unit)
U = Aimed position incremental description (−99999999 to +99999999)
Block No. :
P = Subprogram head block No. (000 to 999)

2 Operation

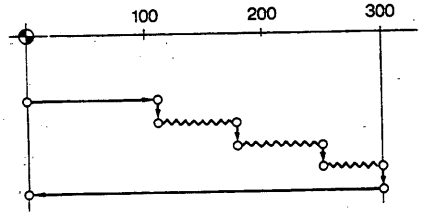
The subprogram starting from the block specified by P is repeatedly executed until the machine reaches the position specified by X (U) in the coordinate system selected at G68 execution.
When the position is reached, the block to G68 is returned even in the middle of feed command.
In subprogram executed by the end point designation command, a feed command block that moves in the direction specified by X (U) is necessary, which must reach the specified position by repeating the subprogram execution.
Even the coordinate value is changed in subprogram, the end point program specified by X (U) does not change.

3 Sample Program

The following shows a sample program using the end point designation subprogram call command :

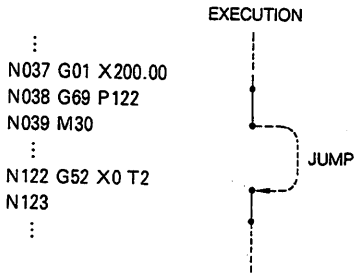
```
N060  G01  X110  F12000
 061  G68  X300  P066 :  SUBPROGRAM REPEATED UNTIL X = 300
 062  G01  X0    F12000
 063  M30

N066  G01  U70   F300 :  SUBPROGRAM
 067  M51
 068  G69 :               RETURN FROM SUBPROGRAM
```



4 Nesting

In a repeating No. designation subprogram, it is possible to jump from the subprogram to the others, up to four layers. However, subroutine call is prohibited in the end point designation subprogram.

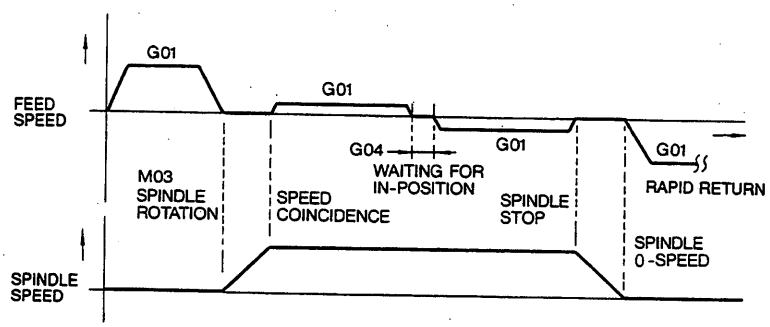
G69	Simple Jump Command	G69 Pbbb
1	Value Range	Block No. : P = Jump designation block No. (000 to 999)
2	Operation	The block specified by P is executed after the jump command execution. 

G69	Subprogram Return Command	G69
1	Operation	Make sure to program this command in the end blocks of the subprogram. This command returns to the block next to the G68 subprogram call command. In the subprogram executed by the repeating No. designation, G68 jumps to the subprogram starting block specified by P until the machine reaches the repeating times specified by L. When reaching the specified repeating times, execution jumps to the block next to G68. G69 in the subprogram executed by the end point designation command jumps to the subprogram starting block until specified end position is reached.

<table>
<tr><td>M03, M04, M05</td><td colspan="2">Spindle Command</td><td>M03 (M04, M05) Ssssss</td></tr>
<tr><td>1</td><td>Value Range</td><td colspan="2">Speed reference :
S = Spindle speed reference (0 to 60000) (r/min)</td></tr>
<tr><td>2</td><td>Related Parameters</td><td colspan="2"><table>
<tr><th></th><th>Pr No.</th><th>Contents</th><th>Unit</th></tr>
<tr><td>Max Spindle Speed</td><td>Pr90</td><td>When spindle speed reference = Pr90, analog voltage for spindle command becomes ±10V.</td><td>r/min</td></tr>
<tr><td>Spindle Command Method Selection</td><td>Pr91</td><td>According to specifications of inverter or servo unit used for spindle driver, the command method is defined.
① Pr91 = 0
FWD run command :
M03 Ssssss
Plus voltage is output to speed reference voltage and FWD run command signal (8CN-1) is turned ON.
REV run command :
M04 Ssssss
Plus voltage is output to speed reference voltage and REV run command signal (8CN-2) is turned ON.
② Pr91 = 1
FWD run command :
M03 Ssssss
Plus voltage is output to speed reference voltage and run command signal (8CN-1) is turned ON.
REV run command :
M04 Ssssss
Minus voltage is output to speed reference voltage and run command signal (8CN-1) is turned ON.</td><td>—</td></tr>
<tr><td>Spindle PG Disconnection Detection</td><td>Pr92</td><td>① Pr92 = 0 :
Spindle PG disconnection detection ineffective.
② Pr92 = 1 :
Spindle PG disconnection detection effective.</td><td>—</td></tr>
</table></td></tr>
<tr><td>3</td><td>Spindle FWD Run Command (M03 Ssssss)</td><td colspan="2">① Type :
M03 Ssssss
② Speed reference :
Signs are not provided for reference value. Modal. S = 0 at power ON.
③ Operation :
Spindle rotation starts simultaneously when this command is executed. Moving condition to next block is that speed coincidence signal (8CN-8) is turned ON.
④ Output signal :
Varies according to the Pr91 setting. (Refer to item 2.)</td></tr>
</table>

4	Spindle REV Run Command (M04 Ssssss)	① Type : M04 Ssssss ② Same as ② to ④ in item 3.
5	Spindle Stop M05	① Type : M05 ② Speed reference : Reference voltage = 0 (modal) Run command signal OFF ③ Operation : Spindle rotation stops simultaneously when this command is executed. Moving condition to next block is that zero-speed signal (8CN−9) is turned ON.
6	Sample Program	(1) When spindle command M03 is used

```
G01   X10.    F24000
M03   S5000 :           TO NEXT BLOCK AFTER WAITING FOR
G01   X20.    F1000     SPEED COINCIDNCE
G04
G01   X10.
M05 :                   TO NEXT BLOCK AFTER 0-SPEED REACHED
G01   X0
M30
```

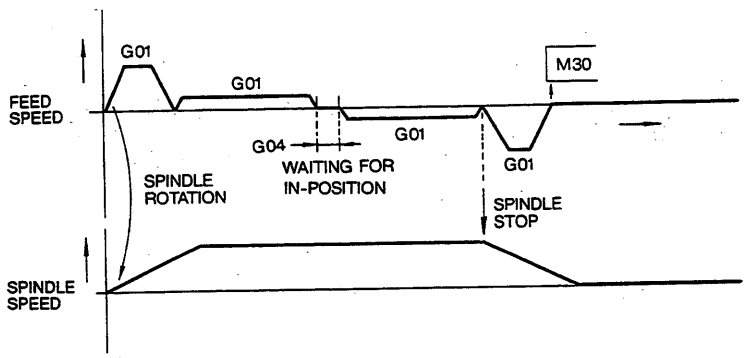


M03, M04, M05	Spindle Command (Cont'd)	M03 (M04, M05) Ssssss

6 Sample Program

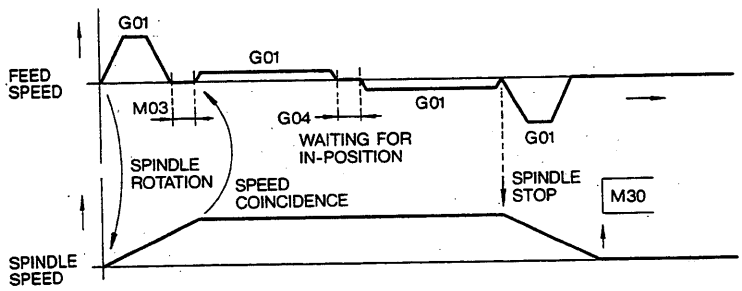
(2) When positioning command S command is used

```
G01  X10.     F24000  S5000 :  EXECUTION  OF
                               :  SPINDLE RUN COMMAND
                               :  TO NEXT BLOCK WITHOUT WAITING SPEED
                                  COINCIDENCE
G01  X20.     F1000
G04
G01  X10.
G01  X0 S0 :                      EXECUTION OF SPINDLE STOP COMMAND
                               :  TO NEXT BLOCK WITHOUT WAITING 0-SPEED
M30
```



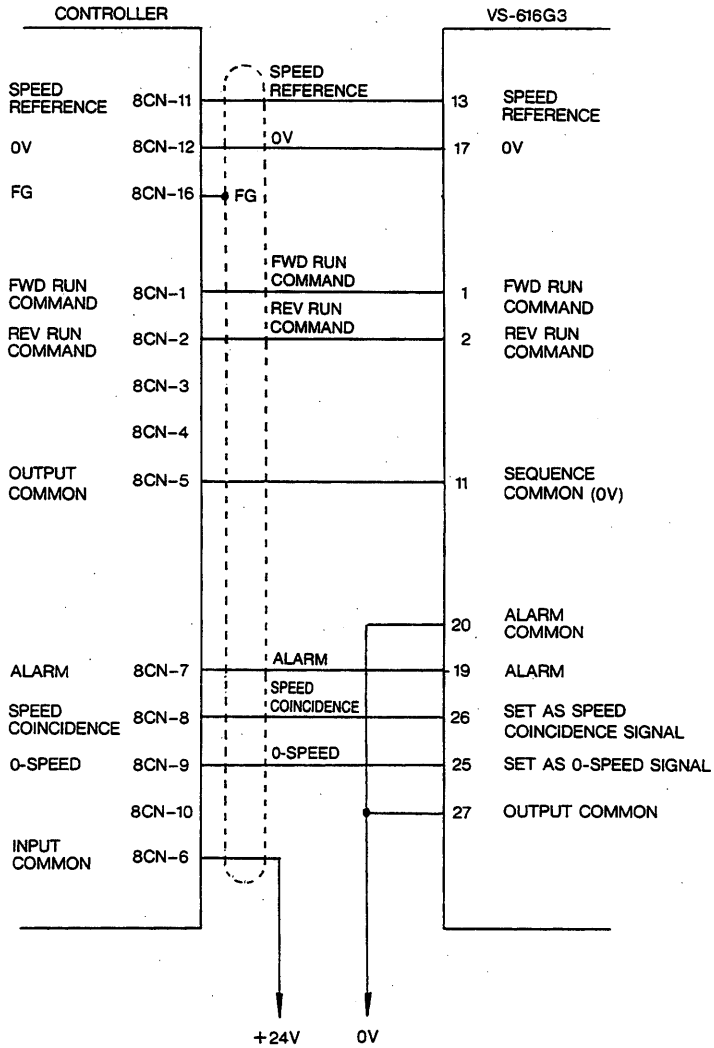
(3) When positioning command S is used and speed coincidence is checked

```
G01  X10.     F24000  S5000 :  EXECUTION OF
                               :  SPINDLE RUN COMMAND
M03  S5000 :                      TO NEXT BLOCK AFTER SPEED COINCIDENCE
                                  CHECKED
G01  X20.     F1000
G04
G01  X10.
G01  X0 S0 :                      EXECUTION OF SPINDLE STOP COMMAND
M05 :                             TO NEXT BLOCK AFTER 0-SPEED CHECKED
M30
```



7 Sample Wiring Diagram

The following figure shows connection with YASKAWA inverter VS-616G3 as a spindle driver. Set 0 for Pr91.



6

6.2 DETAILS OF FUNCTION COMMANDS (Cont'd)

M✳✳	Auxiliary Functions	M50 to M58, M80 to M88 / M90 to M98, M40 to M89

1 Related Parameter

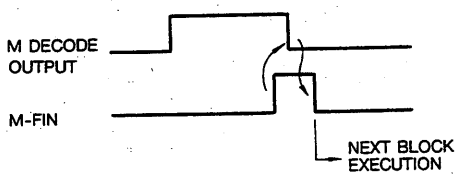
Pr No.	Contents	Unit
Pr101	MF output delay time	ms

2 Individual Signal Mode (M50 to M58)

Assume : Pr101 = 0
Each of auxiliary functions M50 to M58 corresponds to each of output signals M50 to M58. Therefore, when one of M50 to M58 is executed, the corresponding signal among M50 to M58 is output individually.

3 M-FIN Signal (Individual Signal Mode)

For individual signals M50 to M58, M signal is output after checking that M-FIN signal has been turned OFF. If M-FIN signal is ON, it waits to output until the signal is turned OFF.
M signal output is reset when the M-FIN signal is turned ON.
Additionally, the M signal waits for M-FIN to be OFF. When it is turned OFF, the next block is executed.



4 Set/Reset Type M Signal (M80 to M88, M90 to M98)

Assume : Pr101 = 0
When any of M80 to M88 / M90 to M98 is used with the same conditions as individual signal mode, M output that does not need M-FIN signal.

M80 to M88 : Each corresponding M50 to M58 signal is turned ON.
M90 to M98 : Each corresponding M50 to M58 signal is turned OFF.

Output Signal		M50	M51	M52	M53	M54	M55	M56	M57	M58
Code	ON	M80	M81	M82	M83	M84	M85	M86	M87	M88
	OFF	M90	M91	M92	M93	M94	M95	M96	M97	M98

Application :
Using this command for the positioning function provided with passing signal output makes the programming easier.

5 Coded M Signal (M40 to M89)

Assume : Pr101 = 1 to 1000
Output signal M50 to M53 : Coded M function 1st digit (m_1)
Output signal M54 to M57 : Coded M function 2nd digit (m_{10})
Output signal M58 : Strobe signal
When coded M function = M$m_{10}m_1$ is expressed, those codes are as shown below :

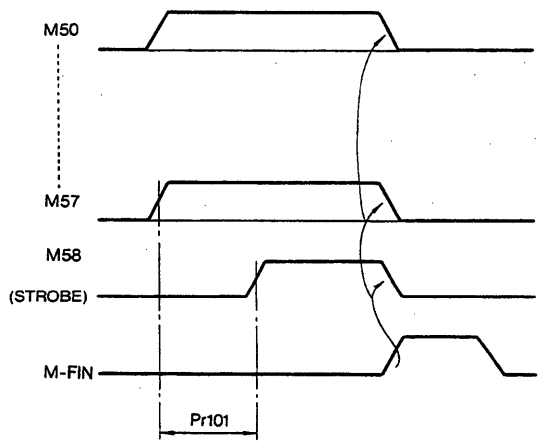
m_1	M50	M51	M52	M53
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

m_{10}	M54	M55	M56	M57
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1

〈EXAMPLE〉 Each M signal status at M45 designation

M50	M51	M52	M53	M54	M55	M56	M57
1	0	1	0	0	0	1	0

6 Coded M Signal, Signal Timing, M-FIN Signal



6

M30	Program End	M30
1	Operation	Run signal (STL) is reset and then M30 signal is reset. When the program start signal (PGST) is turned OFF, the M30 signal is reset.

NOP	Ineffective Command	NOP
1	Operation	Ineffective command does not perform any operation and only execution block is executed.

7. CHARACTERISTICS OF SERVO CONTROL SECTION

7.1 OVERLOAD CHARACTERISTICS

(1) Overload Characteristics

The overload protective circuit built in MOTIONPACK prevents the motor and MOTIONPACK from overloading and restricts the allowable conduction time of MOTIONPACK (See Fig. 7.1).

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 characterisitcs when the MOTIONPACK is running at the rated load and thermally saturated.

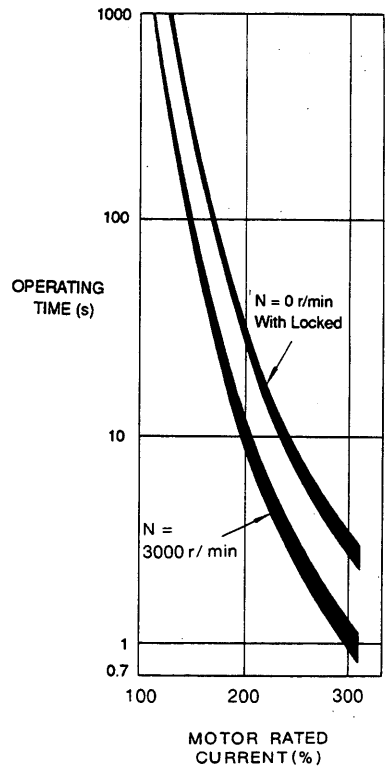


Fig. 7.1 Allowable Overload Curve of MOTIONPACK

7.1 OVERLOAD CHARACTERISTICS (Cont'd)

(2) Starting and Stopping Time

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

Starting Time:

$$tr = 104.7 \times \frac{N_R\ (J_M + J_L)}{K_t \cdot I_R\ (\alpha - \beta)} \quad (ms) \qquad \text{(Formula 7-1)}$$

Stopping Time:

$$tf = 104.7 \times \frac{N_R\ (J_M + J_L)}{K_t \cdot I_R\ (\alpha + \beta)} \quad (ms) \qquad \text{(Formula 7-2)}$$

Where,

N_R: Rated motor speed (r/min)

J_M: (= $GD^2_M/4$): Moment of robot inertia (kg·m²)

J_L: (=$GD^2_L/4$): Moment of robot inertia (kg·m²)

K_t: Torque constant of motor (N · m/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)

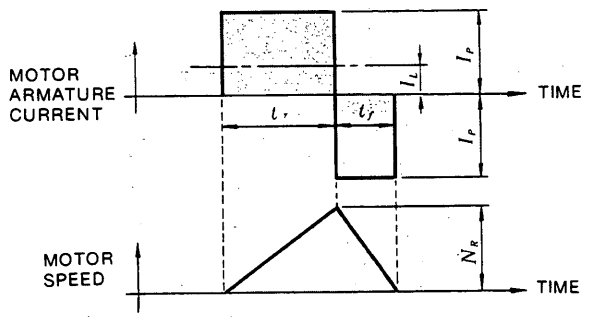


Fig. 7.2 Timing Chart of Motor Armature Current and Speed

(3) Allowable Frequency of Operation

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

① Allowable frequency of operation restricted by the MOTIONPACK

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

② 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.

For symbols, see Par. (2), "Starting and Stopping Time."

③ When the motor repeats rated-speed operation and being at standstill (See Fig. 7.3)

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

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

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

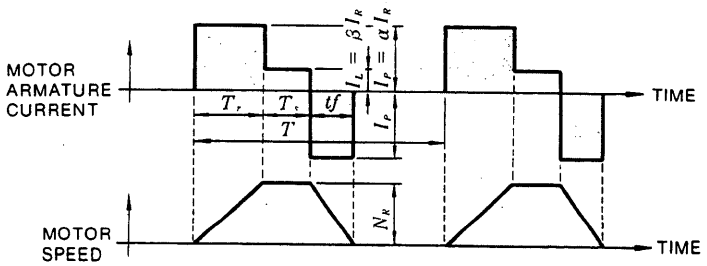


Fig. 7.3 Timing Chart of Motor Armature Current and Speed

7.1 OVERLOAD CHARACTERISTICS (Cont'd)

· When the motor accelerates, runs at constant speed, and decelerates in a continuing cycle without being at standstill.

The timing chart of the motor armature current and speed is as shown in Fig. 7.5. The allowable frequency of operation "n" can be calculated as follows:

$$n = 286.5 \times \frac{K_t \cdot I_R}{N_R\ (J_M + J_L)} \times \frac{1}{\alpha} - \frac{\beta^2}{\alpha^3}\ (times/min) \qquad \text{(Formula 7-3)}$$

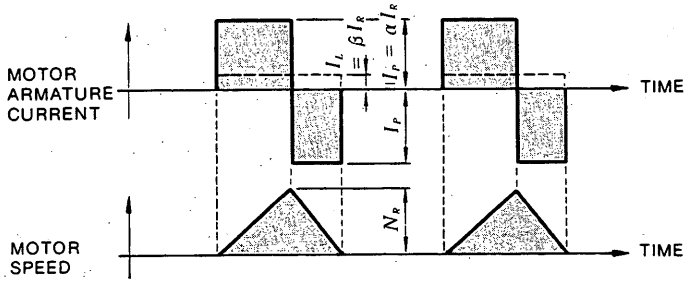


Fig. 7.4 Timing Chart of Motor Armature Current and Speed

· When the motor remains at standstill between cycles of acceleration and deceleration without continuous rated speed running.

The timing chart of the motor armature current and speed is as shown in Fig. 7.4. The allowable frequency of operation "n" can be calculated as follows:

$$n = 286.5 \times \frac{K_t \cdot I_R}{(J_M + J_L)} \times \frac{1}{\alpha} - \frac{\beta^2}{\alpha}\ (times/min) \qquad \text{(Formula 7-4)}$$

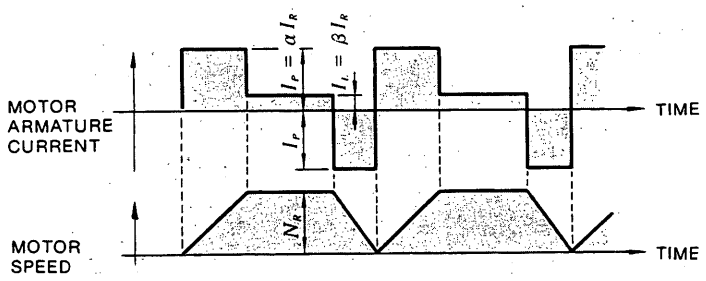


Fig.7.5 Timing Chart of Motor Armature Current and Speed

(4) SERVOMOTOR Frequency

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

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

$$N = 1.52 \times \frac{\alpha \cdot K_t \cdot I_R}{(J_M + J_L)f} \quad (r/min) \qquad \text{(Formula 7-5)}$$

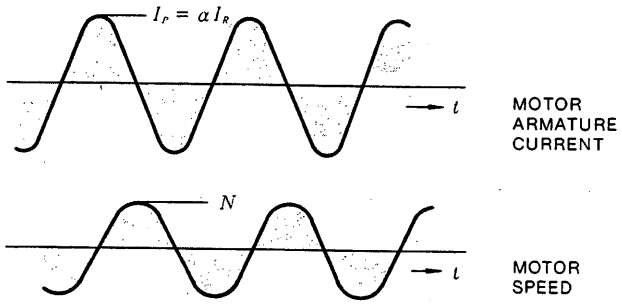


Fig. 7.6 Timing Chart of Motor Armature Current and Speed

<REFERENCE >

Formulas in this section are in SI (International System of Units). For reference, previous formulas are as follows.

Table 7.1

Formula	Previous Formula
7-1 7-2	Starting time : $tr = 26.8 \times 10^{-3} \times \frac{N_R(GD^2_M + GD^2_L)}{KtI_R(\alpha - \beta)}$ [ms] Stopping time : $tf = 26.8 \times 10^{-3} \times \frac{N_R(GD^2_M + GD^2_L)}{KtI_R(\alpha + \beta)}$ [ms] Where, N_R: Rated motor speed (r/min) GD^2_M: Rotor inertia (kg · cm²) GD^2_L: Load inertia (kg · cm²) K_t : Torque constant of motor (kg · cm/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)
7-3	$n = 1.12 \times 10^6 \times \frac{Kt \cdot I_R}{N_R(GD^2_M + GD^2_L)} \times (1/\alpha - \beta^2/\alpha^3)$ [r/min]
7-4	$n = 1.12 \times 10^6 \times \frac{Kt \cdot I_R}{N_R(GD^2_M + GD^2_L)} \times (1/\alpha - \beta^2/\alpha)$ [r/min]
7-5	$N = 5.95 \times 10^3 \alpha \times \frac{Kt \cdot I_R}{(GD^2_M + GD^2_L)f}$ [r/min]

7.2 APPLICABLE MOTORS

Table 7.2 AC SERVOMOTOR Ratings and Specifications

	Type : CMPR-FD		05B			10B		15B	20B	30B	44B
M Series	Applicable Motor	Type : USAMED-	03BS1		—	06BS1	09BS2	12BS2	20BS2	30BS2	44BS2
		Output kW	0.3		—	0.6	0.9	1.2	2.0	3.0	4.4
	Continuous Output Current	A (rms)	3.0		—	5.8	7.6	11.7	18.8	26.0	33.0
	Max Output Current	A (rms)	7.3		—	13.9	16.6	28.0	42.0	56.5	70.0
	Allowable Load Inertia	$J_L(=GD_L^2/4)$ kg·m²	67.5×10^{-4}		—	121.5×10^{-4}	183.5×10^{-4}	334×10^{-4}	550×10^{-4}	715×10^{-4}	1200×10^{-4}
F Series	Applicable Motor	Type : USAFED-	02CS1	03CS1	05CS1	09CS1		13CS2	20CS2	30CS2	44CS2
		Output kW	0.15	0.3	0.45	0.85		1.3	1.8	2.9	4.4
	Continuous Output Current	A (rms)	3.0	3.0	3.8	6.2		9.7	15.0	20.0	33.0
	Max Output Current	A (rms)	8.5	8.5	11.0	17.0		27.6	42.0	56.5	77.0
	Allowable Load Inertia	$J_L(=GD_L^2/4)$ kg·m²	6.5×10^{-4}	10.3×10^{-4}	67.5×10^{-4}	121.5×10^{-4}		183.5×10^{-4}	334×10^{-4}	550×10^{-4}	572×10^{-4}
G Series	Applicable Motor	Type : USAGED-	02AS1	03AS1	05AS1	09AS1		13AS2	20AS2	30AS2	44AS2
		Output kW	0.15	0.3	0.45	0.85		1.3	1.8	2.9	4.4
	Continuous Output Current	A (rms)	3.0	3.0	3.8	7.6		11.7	19.0	26.0	33.0
	Max Output Current	A (rms)	8.5	8.5	11.0	17.0		28.0	42.0	56.5	70.0
	Allowable Load Inertia	$J_L(=GD_L^2/4)$ kg·m²	6.5×10^{-4}	10.3×10^{-4}	67.5×10^{-4}	121.5×10^{-4}		183.5×10^{-4}	223×10^{-4}	393×10^{-4}	360×10^{-4}
D Series	Applicable Motor	Type : USADED-	—		05ES	—		10ES	15ES	22ES	37ES
		Output kW	—		0.5	—		1.0	1.5	2.2	3.7
	Continuous Output Current	A (rms)	—		3.5	—		7.9	12.6	16.6	23.3
	Max Outut Current	A (rms)	—		10.6	—		25.2	40.7	54.0	77.0
	Allowable Load Inertia	$J_L(=GD_L^2/4)$ kg·m²	—		105×10^{-4}	—		160×10^{-4}	310×10^{-4}	415×10^{-4}	575×10^{-4}
S Series	Applicable Motor	Type : USASEM-	02AS2	03AS2	05AS2	08AS2		15AS2	—	30AS2	—
		Output kW	0.154	0.308	0.462	0.771		1.54	—	3.08	—
	Continuous Output Current	A (rms)	2.1	3.0	4.2	5.3		10.4	—	19.9	—
	Max Output Current	A (rms)	6.0	8.5	11.0	15.6		28.0	—	56.5	—
	Allowable Load Inertia	$J_L(=GD_L^2/4)$ kg·m²	0.65×10^{-4}	2.55×10^{-4}	3.75×10^{-4}	14.25×10^{-4}		16.5×10^{-4}	—	28.7×10^{-4}	—

7.3 MOTOR MECHANICAL CHARACTERISTICS

(1) Mechanical Strength

AC SERVOMOTORS can carry up to 300% (350% for D series) of the rated momentary maximum torque at output shaft.

(2) Allowable Radial Load and Thrust Load

Table 7.3 shows allowable loads according to AC SERVOMOTOR types.
If the thrust loads over * are applied, the motor cannot rotate.

Table 7.3 Allowable Radial and Thrust Load

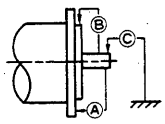
Motor Type		Allowable Radial Load N (kgf)	Allowable Thrust Load N (kgf)
M Series	USAMED-03BS1	490 (50)	98 (10) *
	USAMED-06BS1	490 (50)	98 (10) *
	USAMED-09BS2	686 (70)	343 (35)
	USAMED-12BS2	1470 (150)	490 (50)
	USAMED-20BS2	1470 (150)	490 (50)
	USAMED-30BS2	1470 (150)	490 (50)
	USAMED-44BS2	1764 (180)	588 (60)
F Series	USAFED-02CS1	147 (15)	49 (5) *
	USAFED-03CS1	147 (15)	49 (5) *
	USAFED-05CS1	490 (50)	98 (10) *
	USAFED-09CS1	490 (50)	98 (10) *
	USAFED-13CS2	686 (70)	343 (35)
	USAFED-20CS2	1470 (150)	490 (50)
	USAFED-30CS2	1470 (150)	490 (50)
	USAFED-44CS2	1470 (150)	490 (50)
G Series	USAGED-02AS1	147 (15)	49 (5) *
	USAGED-03AS1	147 (15)	49 (5) *
	USAGED-05AS1	490 (50)	98 (10) *
	USAGED-09AS1	490 (50)	98 (10) *
	USAGED-13AS2	686 (70)	343 (35)
	USAGED-20AS2	1470 (150)	490 (50)
	USAGED-30AS2	1470 (150)	490 (50)
	USAGED-44AS2	1470 (150)	490 (50)
S Series	USASEM-02AS2	78.4 (8)	39.2 (4)
	USASEM-03AS2	245 (25)	98 (10)
	USASEM-05AS2	245 (25)	98 (10)
	USASEM-08AS1	392 (40)	147 (15)
	USASEM-15AS1	490 (50)	147 (15)
	USASEM-30AS1	686 (70)	196 (20)
D Series	USADED-05ES2	686 (70)	343 (35)
	USADED-10ES2	686 (70)	343 (35)
	USADED-15ES2	1176 (120)	490 (50)
	USADED-22ES2	1176 (120)	490 (50)
	USADED-37ES2	1176 (120)	490 (50)

* Maximum values of the load applying to the shaft extension.

7.3 MOTOR MECHANICAL CHARACTERISTICS (Cont'd)

(3) Mechanical Specifications

Table 7.4 Mechanical Specifications (in mm)

Accuracy (T.I.R.)*		Reference Diagram
Flange Surface Perpendicular to Shaft Ⓐ	0.04 0.06†	
Flange Diameter Concentric to Shaft Ⓑ	0.04	
Shaft Run Out Ⓒ	0.02 0.04‡	

* T.I.R. (Total Indicator Reading)

† For type USAMED-44BS2

‡ For type USADED-15ES, -22ES and -37ES

(4) Direction of Rotation

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

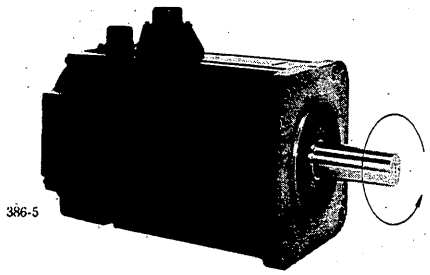
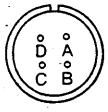


Fig. 7.7 AC SERVOMOTOR

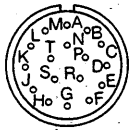
■ Connector Specifications (Standard)

(a) Motor receptacle



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

(b) Encoder receptacle



A	Channel A output	J	F.G (frame ground)
B	Channel $\overline{A}$ output	K	—
C	Channel B output	L	—
D	Channel $\overline{B}$ output	M	—
E	Channel Z output	N	—
F	Channel $\overline{Z}$ output	P	—
G	0 V	R	Reset
H	5 V (power supply)	S	0 V (battery)
—	—	T	3 V (battery)

(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 (See Fig. 7.8).

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.

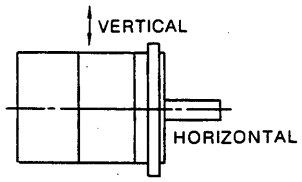


Fig. 7.8 Impact Resistance

(6) Vibration Resistance

When mounted horizontally, the motor can withstand vibration (vertical, lateral, axial) of 2.5G (See Fig. 7.9).

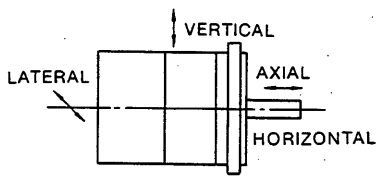


Fig. 7.9 Vibration Resistance

(7) Vibration Class

Vibration of the motor running at rated speed is 15 μm or below (See Fig. 7.10).

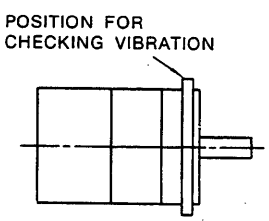
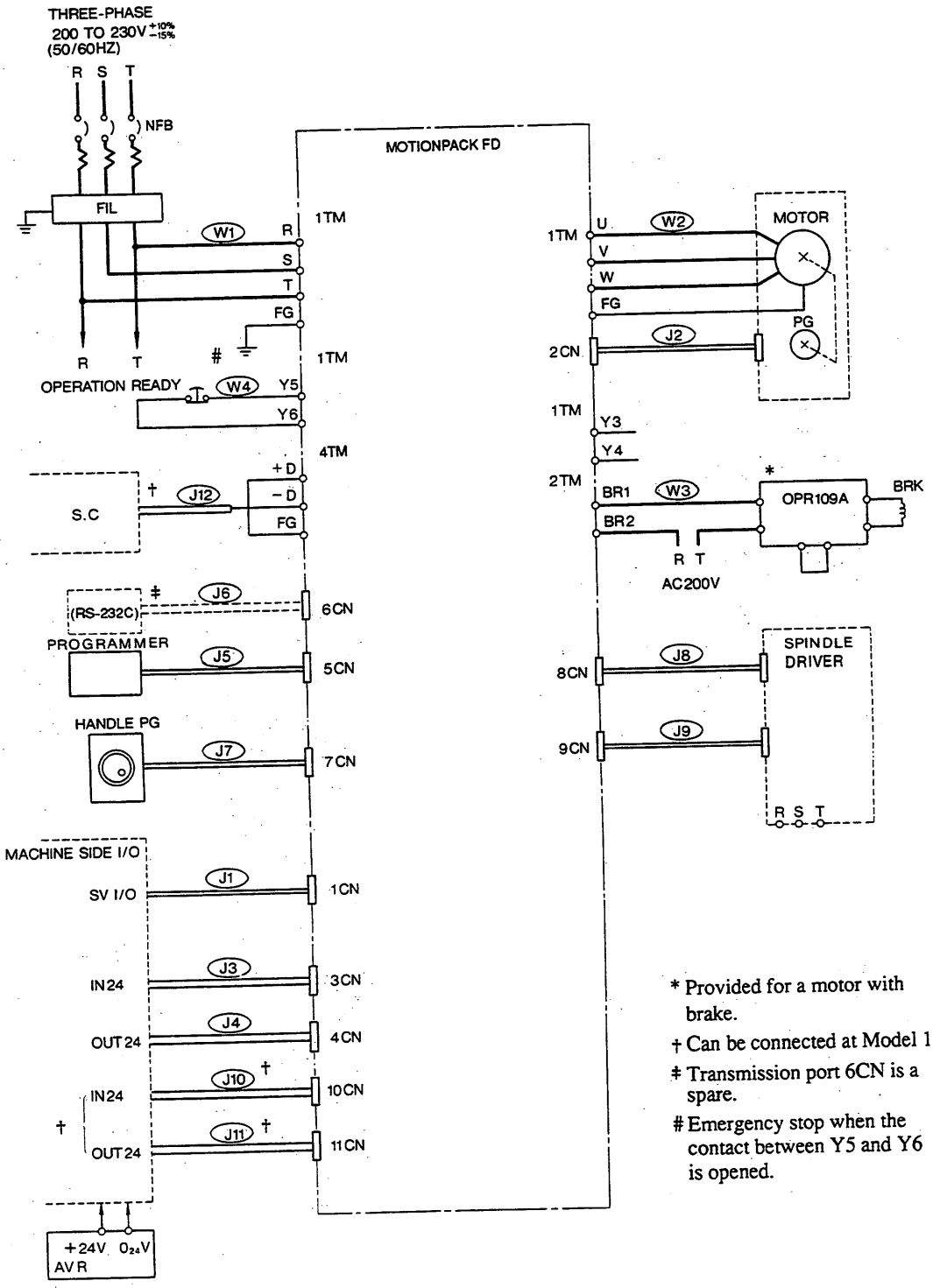


Fig. 7.10 Vibration Checking

8. SPECIFICATIONS FOR CONNECTION

8.1 WIRING DIAGRAM



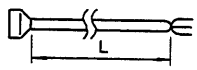
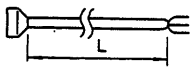
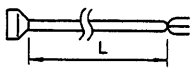
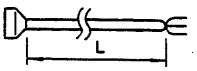
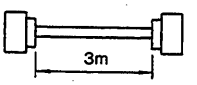
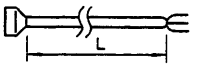
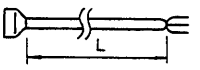
* Provided for a motor with brake.

† Can be connected at Model 1.

‡ Transmission port 6CN is a spare.

Emergency stop when the contact between Y5 and Y6 is opened.

Table 8.1 Cable List

Name	Name/Specifications	MOTION-PACK Connector Symbol	MOTION-PACK Connector Type	Cable Type	Cable Length (L)	Cable Specifications	Controller Connector Type
J1	SV-I/O cable	1CN	MR-20RFA	CMPR-W10	1 m	CM-1CN 	MR-20M/ MR-20L
				CMPR-W11	2 m		
				CMPR-W12	5 m		
J2	Servo PG cable	2CN	MR-20RMA	CMPR-W20	5 m	CM-2CN 	MR-20F/ MR-20L
				CMPR-W21	10 m		
				CMPR-W22	20 m		
J3	Standard input cable	3CN	MR-34RMA	CMPR-W30	1 m	CM-3CN 	MR-34F/ MR-34L
				CMPR-W31	2 m		
				CMPR-W32	5 m		
J4	Standard output cable	4CN	MR-34RFA	CMPR-W40	1 m	CM-4CN 	MR-34M/ MR-34L
				CMPR-W41	2 m		
				CMPR-W42	5 m		
J5	Programmer cable	5CN		JEFMC-WU13	3 m		
J7	Handle PG cable	7CN	MR-8RMD2	CMPR-W70	1 m	CM-7CN 	MR-8F/ MR-8L
				CMPR-W71	2 m		
				CMPR-W72	5 m		
J8	Spindle output cable	8CN	MR-16RFD2	CMPR-W80	1 m	CM-8CN 	MR-16M/ MR-16L
				CMPR-W81	2 m		
				CMPR-W82	5 m		

Notes :

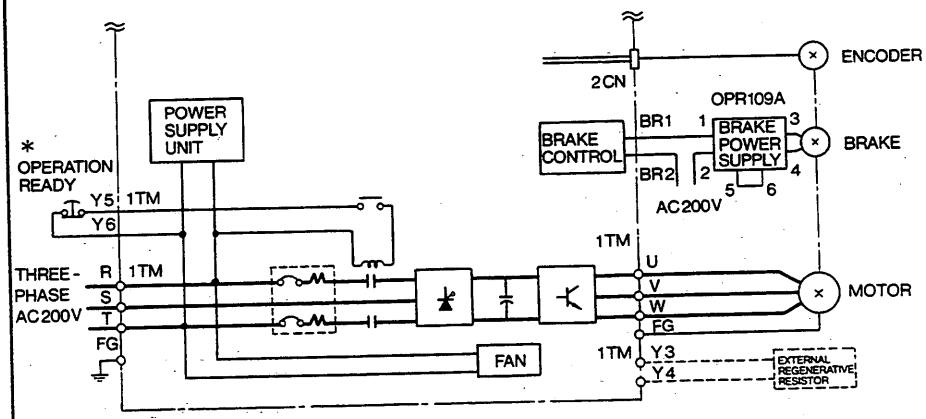
1. Cable connector is not provided with FD unit.
   Since the cable is provided as standard, the connector is available on request.
2. If the cable is provided by user, connector kit is available on request.

〔Connector kit〕

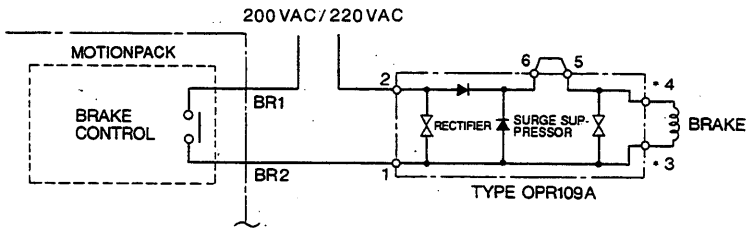
MOTIONPACK Model 0	Soldering Type	CMPR-A01
	Caulking Type	CMPR-A02

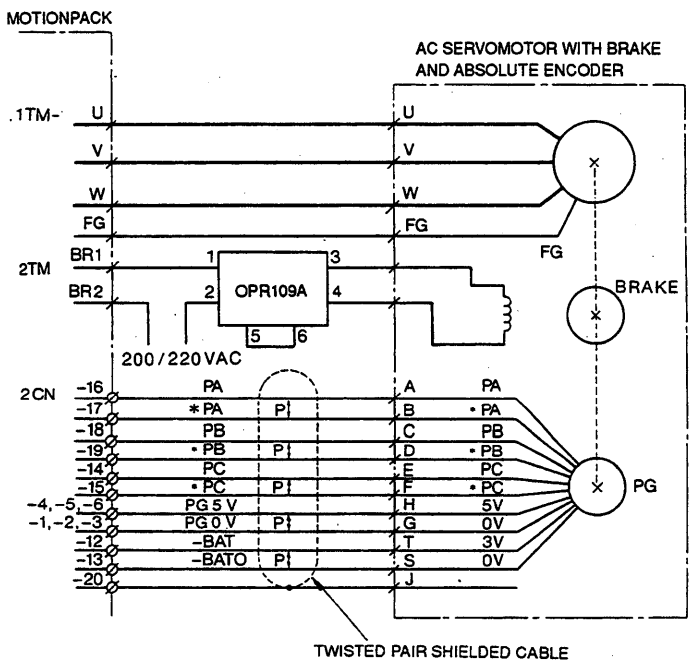
8

8.2 EXTERNAL TERMINAL

<table>
<tr><th>No.</th><th>Item</th><th>Contents</th></tr>
<tr><td>1</td><td>External Terminal Block Diagram</td><td> 

* Emergency stop when the contact between Y5 and Y6 is opened.</td></tr>
<tr><td>2</td><td>External Terminal 1TM</td><td>
<table>
<tr><th>Terminal Symbol</th><th>Name</th><th>Outline</th></tr>
<tr><td>R, S, T</td><td>Power Supply Input Terminal</td><td>3-phase 200/230 VAC, +10%/−15%, 50/60 Hz</td></tr>
<tr><td>U, V, W</td><td>Motor Connection Terminal</td><td>Connecting U with motor terminal A, V with motor terminal B and W with motor terminal C.</td></tr>
<tr><td>⏚</td><td>Grounding Terminal</td><td>Connected with motor terminal D to ground.</td></tr>
<tr><td>Y3, Y4</td><td>Regenerative Connection Terminal</td><td>Normally not used. Changes external resistor if built-in regenerative resistor cannot afford processing.</td></tr>
<tr><td>Y5, Y6</td><td>Operation Ready (Emergency Stop)</td><td>Terminals to turn ON/OFF built-in connector directly. Main power supply can be shut off at contact.
By opening between these terminals, emergency stop can be applied.
Built-in relay coil rating :
200/240 VAC
8.5/10.2 mA $^{+15\%}_{-20\%}$</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>No.</th><th>Item</th><th>Contents</th></tr>
<tr><td>3</td><td>External Terminal 2TM</td><td>Contact output for brake control is provided.
<table>
<tr><th>Terminal Symbol</th><th>Name</th><th>Outline</th></tr>
<tr><td>BR1,
BR2</td><td>Brake Control</td><td>When the servo ON signal is turned ON, turn ON the main circuit power supply and release the holding brake. The following diagram is a typical circuit to be applied. Since a DC circuit cannot be opened/closed by BR1/BR2, open or close at AC side.
 

Contact ratings : 250 VAC 2A
(cos φ = 0.4, L/R = 7 ms)</td></tr>
</table></td></tr>
<tr><td>4</td><td>Connection with Motor</td><td> 
</td></tr>
</table>

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8.2 EXTERNAL TERMINAL (Cont'd)

No. 5 — Item: Rated Current

External Terminal Name		Terminal Symbol \ Type CMPR-	Rated Current A (Effective Value) (03)	FD 05	FD 10	FD 15	FD 20	FD 30	FD 44
On-line Terminal	Main Circuit Power	Ⓡ Ⓢ Ⓣ	2	5	8	10	12	18	24
On-line Terminal	Motor Connection Terminal	Ⓤ Ⓥ Ⓦ	3.0	4.2	7.6	11.7	18.8	26.0	33.0
Off-line Terminal	PG Signal Connector	2CN	Up to DC 100 mA (Power supply line : 500 mA)						
Off-line Terminal	Grounding Terminal	⏚	—						

No. 6 — Item: Applicable Cable Size

Select applicable cable size according to the using environment and current capacity.
The following table shows typical applicable cable sizes with the conditions of ; current applied at ambient temperature 40℃ in three-bundle lead wire.
Refer to the next item for applicable cable types.

External Terminal Name		Terminal Symbol \ Type CMPR-	Typical Applicable Cable Size (mm^2) (03)	FD 05	FD 10	FD 15	FD 20	FD 30	FD 44
On-line Terminal	Main Circuit Power	Ⓡ Ⓢ Ⓣ	HIV 1.25 or more		HIV 2.0 or more	HIV 3.5 or more		HIV 5.5 or more	HIV 5.5 or more
On-line Terminal	Motor Connection Terminal	Ⓤ Ⓥ Ⓦ	HIV 1.25 or more		HIV 3.5 or more				
Off-line Terminal	PG Signal Connector	2CN	Twisted pair cable or twisted pair totally shielded cable. Cable core : 0.2 mm^2 or more, tinned annealed copper stranded wire. Cable finishing dimensions : 2CN-ϕ11 or less						
Off-line Terminal	Grounding Terminal	⏚	HIV 2.0 or more						

Notes :
1. Sizes are all of HIV [ ] or above.
2. Applicable cable size selecting conditions : current applied at ambient temperature 40℃ in three-bundle lead wire.

No. 7 — Item: Applicable Cable

Cable Type Symbol	Cable Type Name	Conductor Allowable Temperature
PVC	General-purpose Vinyl Cable	—
IV	600 V Vinyl Cable	60
HIV	Special Heat-resistant Vinyl Cable	75

Notes :
1. Use cable with more than 600 V resistance for the main power supply.
2. When bundling the wires in a duct (hard vinyl duct or metallic duct), consider the reduction ratio of allowable cable current.
3. With high ambient temperature (in-panel temperature), general-, purpose vinyl cable is deteriorated soon and cannot be used. Therefore, use heat-resistant cable.

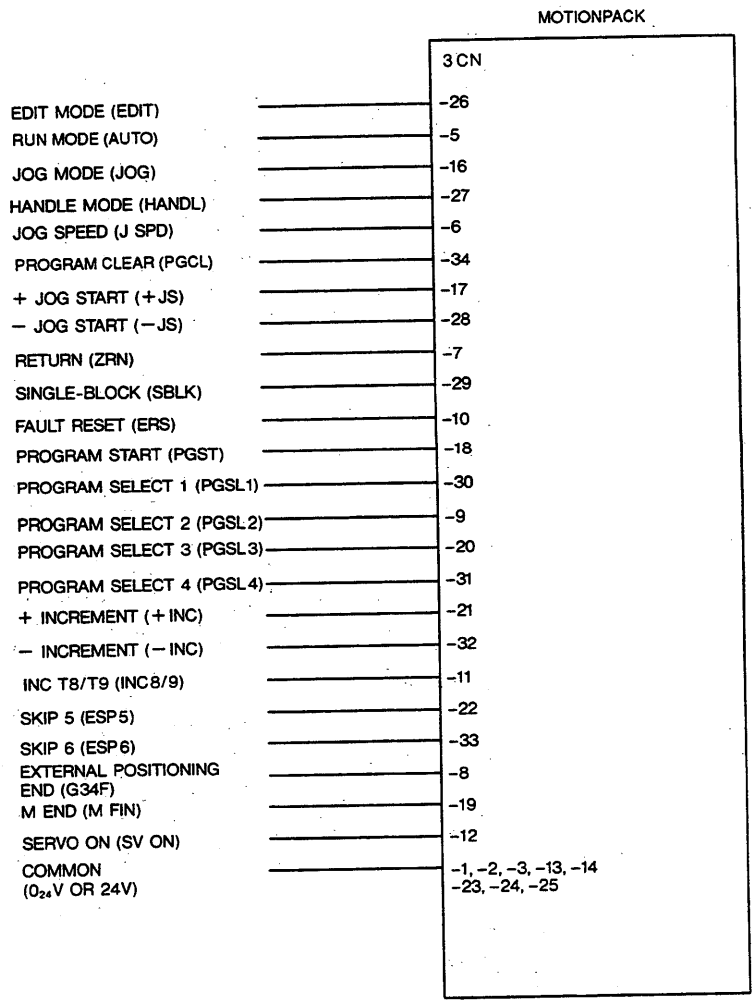
No.	Item	Contents
8	Power Loss	The following table shows power loss at rated output.

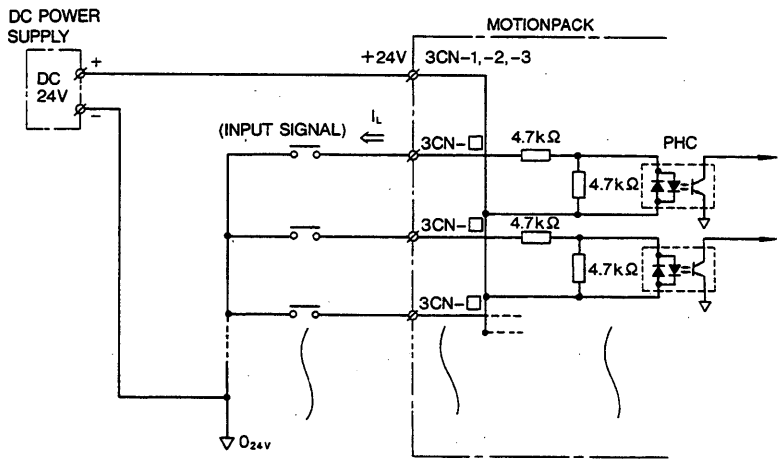
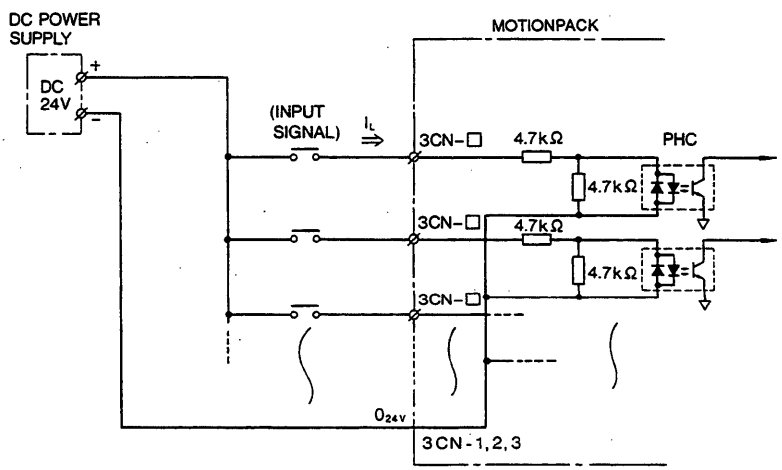
MOTION-PACK Type CMPR-	Output Current (Effective Value) A	Main Circuit Power Loss W	Regenerative Resistor Power Loss W	Control Circuit Power Loss W	Total Power Loss W
(03)	3.0	20	10	60	90
FD05	4.2	40			110
FD10	7.6	70	20		150
FD15	11.7	80	20		160
FD20	18.8	100	40		200
FD30	26.0	160	80		300
FD44	33.0	210	100		370

Note : Regenerative resistor power loss is generated at motor deceleration. Power loss can be disregarded except for applications with large start/stop frequent.

8.3 DIGITAL INPUT SIGNAL

8.3.1 Signal Specifications

No.	Item	Contents
1	Specifications of Signals	Input signal circuit : 24 VDC, 5 mA at ON, 1uA at OFF Input signal circuit : 0 V/24 V common changeable Input signal minimum continuous time : 35 ms Recommended input signal contacts : 30 V, 20 mA class Chattering 5 ms or less
2	Input Signal	
3	Meaning of Input Signals	The meanings of input signals will be described in Par. 8.3.2.

No.	Item	Contents
4	How to Build Input Circuit 24 V Common (Source Current)	
5	How to Build Input Circuit 0 24 V Common (Sink Current)	

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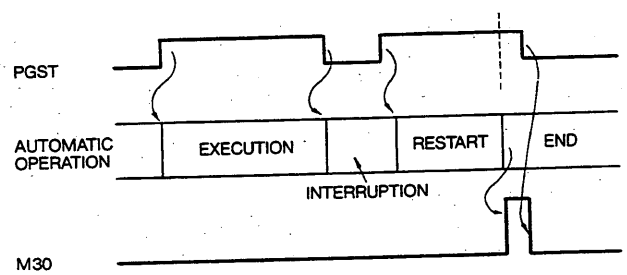
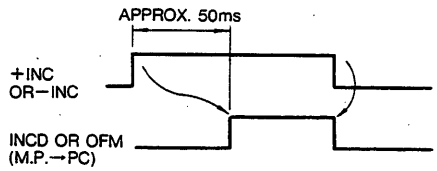
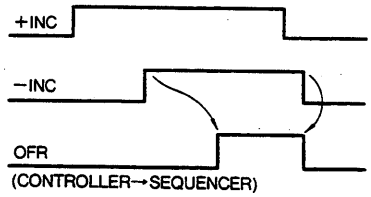
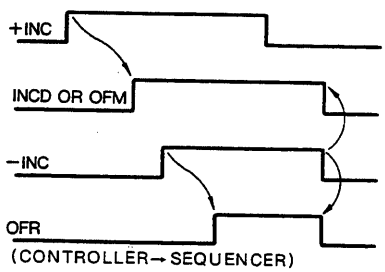
8.3.2 3CN Input Signal Names and Contents

No.	Connector Pin No.	Name	Contents
1	3CN-26	Edit Mode (EDIT)	Turning ON this signal enters the edit mode. Then it becomes possible to set programs or parameters by the programmer. In the edit mode, servo clamp operation continues.
2	3CN-5	Run Mode (AUTO)	In the run mode, automatic operation is possible. When the edit mode signal is turned ON while this signal is turned ON, the edit mode signal has priority. When more than one mode is entered at the same time, EDIT, HANDL, JOG and AUTO have the priority in the order.
3	3CN-29	Single-block (SBLK)	Turning ON this signal in the automatic operation mode starts single-block operation. In this mode, the currently selected program is executed block by block at each time when PGST signal is turned ON. At M30 execution, the program returns to the head and one block is executed.
4	3CN-10	Fault Reset (ERS)	If an alarm occurs, it can be reset by this signal. However, some serious alarms cannot be reset.
5	3CN-18	Program Start (PGST)	Program execution starts when this signal is turned ON. When it is turned OFF during program execution, feed-hold status is entered. Turning it ON again restarts the execution. Turn OFF this signal after M30 signal is turned ON after the program is completed. 

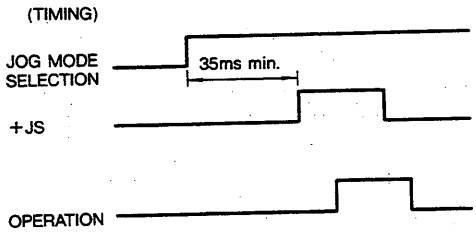
<table>
<tr><th>No.</th><th>Connector Pin No.</th><th>Name</th><th>Contents</th></tr>
<tr><td>6</td><td>3CN-30
3CN-9
3CN-20
3CN-31</td><td>Program Select 1 (PGSL1)
Program Select 2 (PGSL2)
Program Select 3 (PGSL3)
Program Select 4 (PGSL4)</td><td>Turn ON the signal 35 ms prior to input PGST signal.
By combining PGSL1 to 4, the head block of program to be selected is as shown below.
By providing the jump command to this block, each program is executed.
<table><tr><th>PGSL1</th><th>PGSL2</th><th>PGSL3</th><th>PGSL4</th><th>Heading of Block</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>000</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>001</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>002</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>003</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>004</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td><td>005</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>006</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>007</td></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>008</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>009</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td><td>010</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>011</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>012</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>013</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td><td>014</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>015</td></tr></table></td></tr>
<tr><td>7</td><td>3CN-22</td><td>External Skip 5 (ESP5)</td><td>When ESP5 signal is turned ON during feed by G05 command, the machine decelerates to a stop and then the next block is executed.</td></tr>
<tr><td>8</td><td>3CN-33</td><td>External Skip 6 (ESP6)</td><td>ESP6 is for G06 command.</td></tr>
</table>

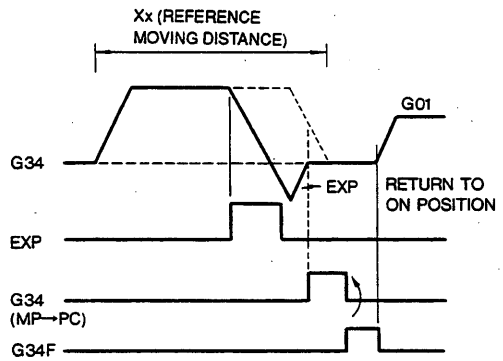
8.3.2 3CN Input Signal Names and Contents (Cont'd)

<table>
<tr><th>No.</th><th>Connector Pin No.</th><th>Name</th><th>Contents</th></tr>
<tr><td>9</td><td>3CN-19</td><td>M End Signal (M-FIN)</td><td>This signal clears M code output (M50 to M59) and advances the program to the next step.
When M-FIN signal is turned ON, M code output is cleared. Then when M-FIN signal is turned OFF, the next block program is executed.</td></tr>
<tr><td>10</td><td>3CN-16</td><td>JOG Mode (JOG)</td><td>When this signal is turned ON while the EDIT signal and HANDL signal are OFF, the JOG mode is entered.
When this signal is turned ON during HANDL operation or AUTO operation, the operation is interrupted and the machine decelerates to a stop. In AUTO operation, program reset is executed and output signals are as shown below at the same time when the JOG mode is switched.
(1) Output signals that are turned OFF
(a) Activation signal (STL)
(b) M code signal (M50 to M58)
(c) External positioning fault signal (EPALM)
(d) External positioning end (G34)
(e) Automatic operation end (G30)
(f) MOTIONPACK alarm (only stored stroke limit alarm)
(2) Output signals to hold the status
(a) Operation ready signal (MRDY)
(b) Battery alarm (BALM)</td></tr>
<tr><td>11</td><td>3CN-6</td><td>JOG Speed (JSPD)</td><td>The following shows the meanings of this signal when MOTIONPACK is in JOG or HANDL mode.
<table>
<tr><th rowspan="2">JSPD</th><th>JOG Operation Mode</th><th>HANDL Operation Mode</th></tr>
<tr><th>JOG Speed *</th><th>Pulse Magnification</th></tr>
<tr><td>OFF</td><td>Low speed</td><td>× 1</td></tr>
<tr><td>ON</td><td>High speed</td><td>× 100</td></tr>
</table>
* JOG speed is set by parameter :
Low speed : Parameter Pr1
High speed : Parameter Pr2</td></tr>
</table>

No.	Connector Pin No.	Name	Contents
			When this signal is turned ON, incremental value (set by parameters Pr20 and 22) is added/subtracted to/from offset register corresponding to the coordinate system specified by INC8/9. These signals are executed only in AUTO mode when the machine stops. When +/− incremental commands are turned ON simultaneously, offset register is cleared to 0 and offset value 0 (OFR) signal is output. When offset register value reaches or exceeds offset value ± maximum value (determined by parameters Pr21, 23) after tool offset register addition is completed by +/− incremental commands, the offset value ± Max reach signal (OFM) signal is output. If not, ± incremental end (INCD) signal is output. 
12	3CN-21 3CN-32	+ Incremental (+INC) − Incremental (−INC)	When +/− incremental commands are turned ON simultaneously, offset register is cleared to 0 and offset value 0 (OFR) signal is output. ① When −INC is turned ON before end (INCD or OFM) is output by +INC  ② When −INC is turned ON after end signal is output by +INC 

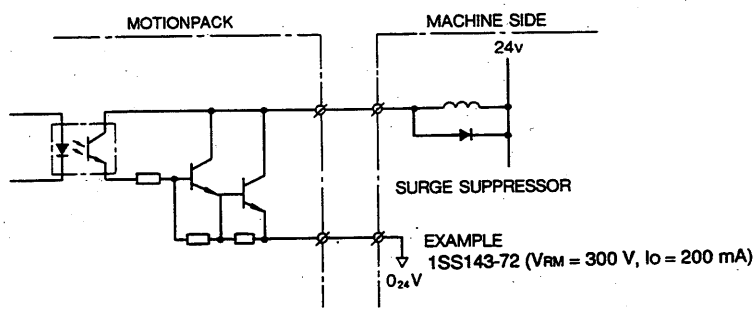
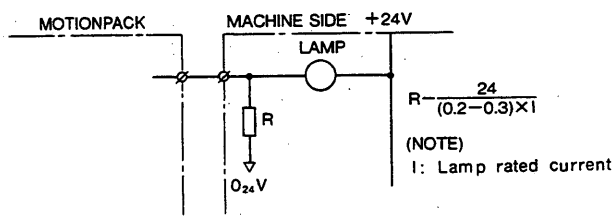
8.3.2 3CN Input Signal Names and Contents (Cont'd)

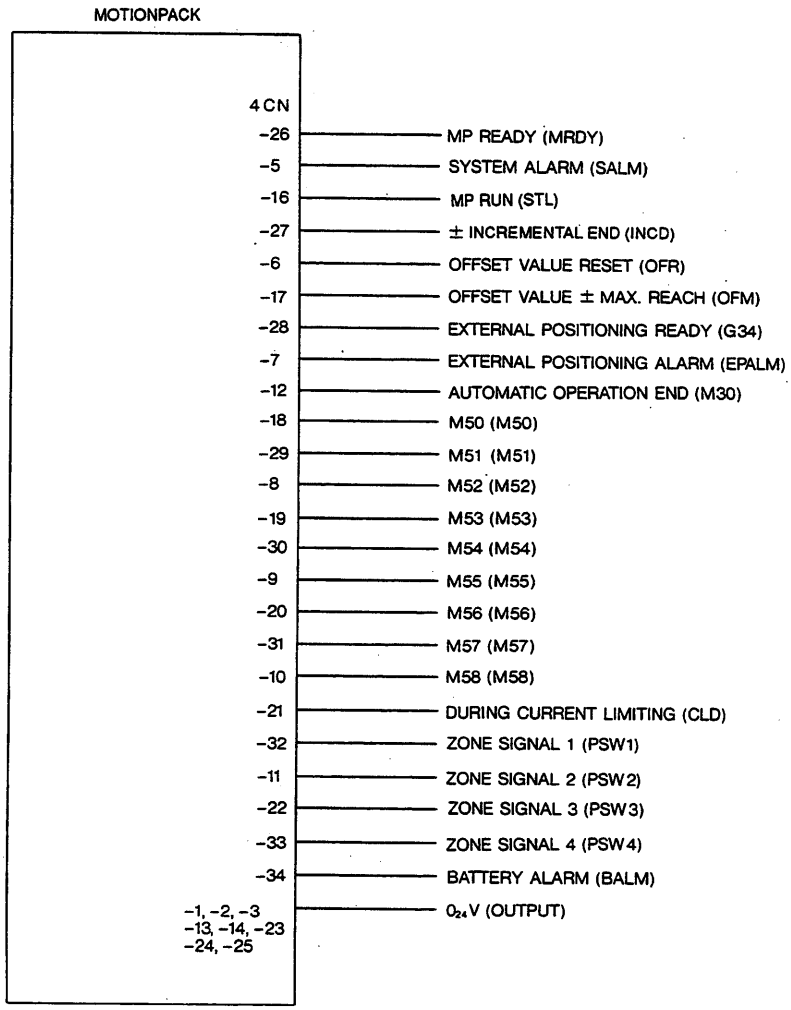
No.	Connector Pin No.	Name	Contents
13	3CN-11	INCT$_8$/T$_9$ (INC8/9)	This signal specifies coordinate (T$_8$ or T$_9$) to perform coordinate compensation by +INC or −INC. INC8/9 = OFF : T$_8$ designation INC8/9 = ON : T$_9$ designation
14	3CN-17	+JOG (+JS)	This signal is a start signal in the plus direction in the JOG mode. The machine moves in the plus direction at the feed speed selected by JOG speed (JSPD) while this signal is turned ON.  Note : Turn ON +JS at least 35 ms after JOG mode selection and JOG speed selection are completed. This signal is ignored during automatic operation.
15	3CN-28	−JOG (−JS)	Same as +JOG except that plus direction is replaced with minus direction.
16	3CN-7	Return (ZRN)	When ZRN signal is turned ON, the operation under execution is interrupted immediately and positioning is performed to the dwell position (defined by Pr7). When ZRN signal is turned OFF during operation, the machine decelerates to a stop. Rapid return operation is effective in the AUTO or JOG mode. Rapid return speed is defined by Pr6. After Pr73 = 1 is set in the ABSO-PG automatic home position setup method, PG home position setup operation is activated when ZRN signal is turned OFF to ON.

No.	Connector Pin No.	Name	Contents
17	3CN-8	External Positioning End (G34F)	This is a signal to clear the MOTIONPACK "external positioning end" (G34) output signal in the external positioning by G34 command and advance the program to the next block. When the MOTIONPACK is outputting the external positioning alarm (EPALM) signal, the EPALM signal can be reset by G34F input. When G34F is turned OFF, the program is advanced to the next block.  Note : Response time from EXP ON to position store is 50 μ s.
18	3CN-27	HANDL Mode (HANDL)	When the EDIT mode is not input, turning ON this signal enters HANDL mode. The motor is operated by pulse input from handle PG.
19	3CN-12	Servo ON (SVON)	This signal can turn ON/OFF servo clamp. (SVON) = ON : Servo main power ON (SVON) = OFF : Servo main power OFF When (SVON) = OFF to turn OFF servo main power, MP ready (MRDY) signal is turned OFF. However, when Pr39 = 1, MRDY is not turned OFF even if (SVON) = OFF but if the other conditions are established.
20	3CN-34	Program Clear (PGCL)	When this signal is turned ON in the feed-hold status, program under execution is cleared. M50 to M58, EPALM, G34 and STL signals are reset.

8.4 DIGITAL OUTPUT SIGNAL

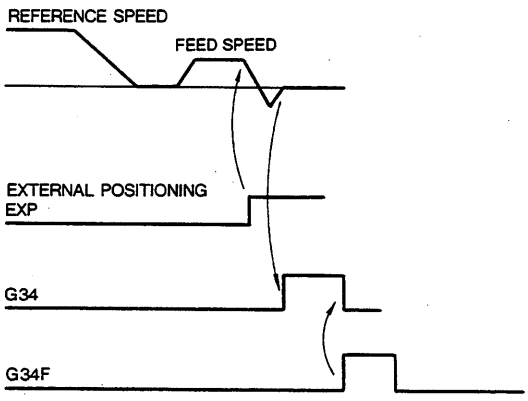
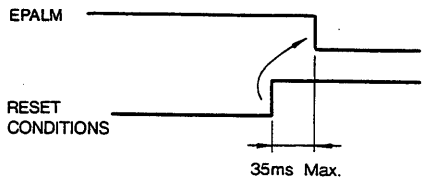
8.4.1 Signal Specifications

No.	Item	Contents
1	Signal Specifications	Output signal capacity : 24 VDC, 50 mA or less Output circuit type : No-contact output
2	Output Circuit Protective Actions	① When an inductive load (e.g. relay coils, etc.) is connected, make sure to insert a surge suppressor within 20 cm of the load. If the surge suppressor polarities are reversed, the controller no-contact output circuit may be broken.  ② Insert a preheating resistor when a lamp load is used. Use the resistor at rated capacity or less including in-rush current. Current flowing in the lamp by preheating resistance must be 20 to 30% of the rated current. 

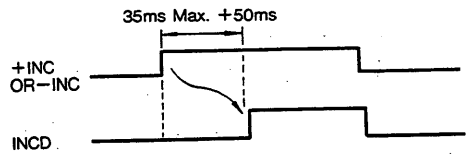
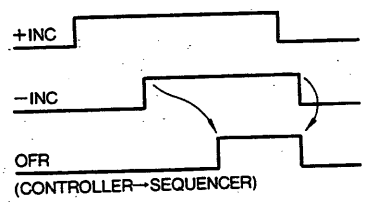
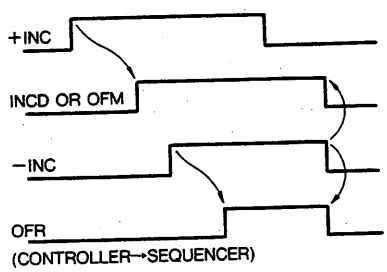
No.	Item	Contents
3	Output Signal	
4	Meaning of Output Signals	The meanings of output signals will be described in the list in Par. 8.4.2.

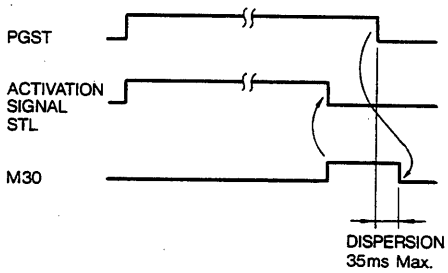
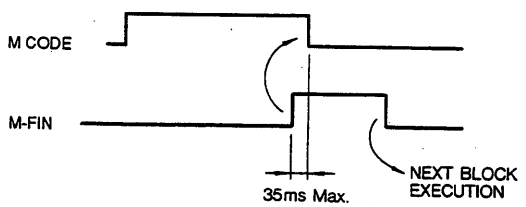
8.4.2 4CN Output Signal Names and Contents

No.	Connector Pin No.	Name	Contents
1	4CN-26	Controller Ready (MRDY)	Indicates that the MOTIONPACK FD is ready for operation. MRDY = (controller run) · (controller RUN mode) · (SVON = ON) · (servo main circuit power ON) · ($\overline{\text{system alarm}}$) · (absolute value data read-in end) When the above conditions are established, the controller becomes ready for operation.
2	4CN-5	System Alarm (SALM)	Alarm output of the MOTIONPACK FD system. Details of alarm contents can be monitored by the programmer. This signal is reset using the alarm reset ERS signal.
3	4CN-32	Zone Signal 1 (PSW1)	Output is turned ON in the zone set by the parameter. There are four signals (PSW1 to PSW4) and four zones can be set independently by parameters. PSW is output after absolute value data are read-in, disregarding program execution.
4	4CN-11	Zone Signal 2 (PSW2)	Output is turned ON in the zone set by the parameter. There are four signals (PSW1 to PSW4) and four zones can be set independently by parameters. PSW is output after absolute value data are read-in, disregarding program execution.
5	4CN-22	Zone Signal 3 (PSW3)	Output is turned ON in the zone set by the parameter. There are four signals (PSW1 to PSW4) and four zones can be set independently by parameters. PSW is output after absolute value data are read-in, disregarding program execution.
6	4CN-33	Zone Signal 4 (PSW4)	Output is turned ON in the zone set by the parameter. There are four signals (PSW1 to PSW4) and four zones can be set independently by parameters. PSW is output after absolute value data are read-in, disregarding program execution.
7	4CN-16	MP Run (STL)	Indicates that the MOTIONPACK FD is in automatic operation. This signal is turned ON during program operation or single-block operation. Even if the program start input signal is turned OFF (or feed-hold status), the MP run (STL) is not turned OFF. The following shows the conditions where the STL signal is turned OFF : ① The mode is changed to the other. ② M30 execution is completed. ③ At emergency stop

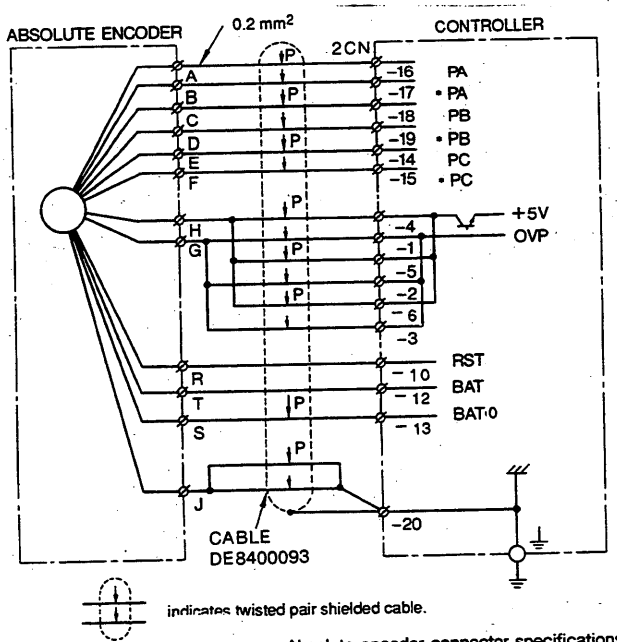
No.	Connector Pin No.	Name	Contents
8	4CN-28	External Positioning End (G34)	In external positioning (G34 command), when the external positioning signal (EXP) is turned ON, the machine decelerates to a stop and returns to the position where the EXP was turned ON . After positioning, in-position check is performed. When there is no error, this external positioning end signal (G34) is turned ON. This signal is turned OFF when the external positioning end signal (G34F) is turned ON. 
9	4CN-7	External Positioning Alarm (EPALM)	An alarm signal at external positioning (G34 command). The following describes the conditions of the alarm. ① The machine reaches the position specified by X (U) after G34 execution and the EXP is not turned ON until feed is in-position. ② If the EXP or G34F signal is already ON when G34 command execution start, execution is hold unitl they are turned OFF and this condition is not established in 2 seconds. The following describes the conditions required for this signal to be reset. ① G34F signal is turned from OFF to ON. ② Operation mode is changed. ③ A new program starts. 

8.4.2 4CN Output Signal Names and Contents (Cont'd)

No.	Connector Pin No.	Name	Contents
10	4CN-27	±Incremental End (INCD)	When offset register addition is completed by + (or −) incremental command, ± incremental end (INCD) signal is output if the offset register value has not reached (or exceeded) the offset value ± Max value. The INCD output delays up to 85 ms. This is because a 50 ms software timer is provided to check whether +/− INC are turned ON simultaneously and because signal read-in time has 35 ms maximum delay. Resetting conditions : +INC (−INC) is turned OFF. 
11	4CN-6	Offset Value Reset (OFR)	When both + and − incremental commands are turned ON simultaneously, offset register is cleared to 0 and the offset value register (OFR) signal is output. ① When −INC is turned ON before end (INCD or OFM) signal is output by +ICN.  ② When −INC is turned ON after end signal is output by +ICN.  • OFR resetting condition is that both + and − signals are turned OFF simultaneously.

No.	Connector Pin No.	Name	Contents
12	4CN-17	Offset Value ±Max Reach (OFM)	This signal is turned ON when offset absolute value in an offset register exceeds the maximum value set by parameter when INC signal is activated. The timing to turn it ON and resetting timing are the same as those of the INCD signal. Refer to the item about "± Incremental End" (No. 10).
13	4CN-12	Automatic Operation End (M30)	This signal is turned ON when the program end command (M30) is executed. When the program start signal (PGST) is turned OFF, this signal is reset. 
14	4CN-18 M50 4CN-29 M51 4CN-8 M52 4CN-19 M53 4CN-30 M54 4CN-9 M55 4CN-20 M56 4CN-31 M57 4CN-10 M58		When M function command is executed, a corresponding signal within M50 to M58 is turned ON. Those signals are reset when the M end signal (M-FIN) is turned ON. 
15	4CN-34	Battery Alarm (BALM)	This signal is turned ON when the battery for memory back-up and absolute encoder, that is built in the MOTIONPACK FD, becomes lower than a certain voltage. Replace the battery within a month. This signal cannot be reset by the ERS (reset) signal. This alarm signal output does not cause any effect on the MOTIONPACK operation.
16	4CN-21	During Current Limiting (CLD)	The CLD signal is turned ON when the motor current exceeds the current limit value.

8.5 ENCODER SIGNALS (2CN)

<table>
<tr><th>No.</th><th>Item</th><th>Contents</th></tr>
<tr><td>1</td><td>Signal Types</td><td>The following table shows the types of signals related to the encoder.
<table>
<tr><th>Signal Name</th><th>Contents</th></tr>
<tr><td>PA/*PA</td><td>Phase A signal, differential type output signal</td></tr>
<tr><td>PB/*PB, PC/*PC</td><td>Phase B signal, phase C signal, differential type output signal</td></tr>
<tr><td>BAT/BAT0</td><td>Battery for encoder
BAT = 3.6 V, BAT0 = 0 V</td></tr>
<tr><td>PG5V/PG0V</td><td>Power supply for PG PG5V = 5, PG0V = 0 V</td></tr>
<tr><td>RST</td><td>Reset terminal for ABS PG setup</td></tr>
<tr><td>FG</td><td>Frame gounding</td></tr>
</table></td></tr>
<tr><td>2</td><td>Connector Arrangement (2CN)</td><td>
<table>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>PG0V</td><td>PG0V</td><td>PG0V</td><td>PG5V</td><td>PG5V</td><td>PG5V</td><td></td></tr>
<tr><td></td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td></tr>
<tr><td></td><td></td><td></td><td>RST</td><td></td><td>BAT</td><td>BAT0</td></tr>
<tr><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td></tr>
<tr><td>PC</td><td>*PC</td><td>PA</td><td>*PA</td><td>PB</td><td>*PB</td><td>FG</td></tr>
</table></td></tr>
<tr><td>3</td><td>Connection Method (When DE8400093 is Used)</td><td>


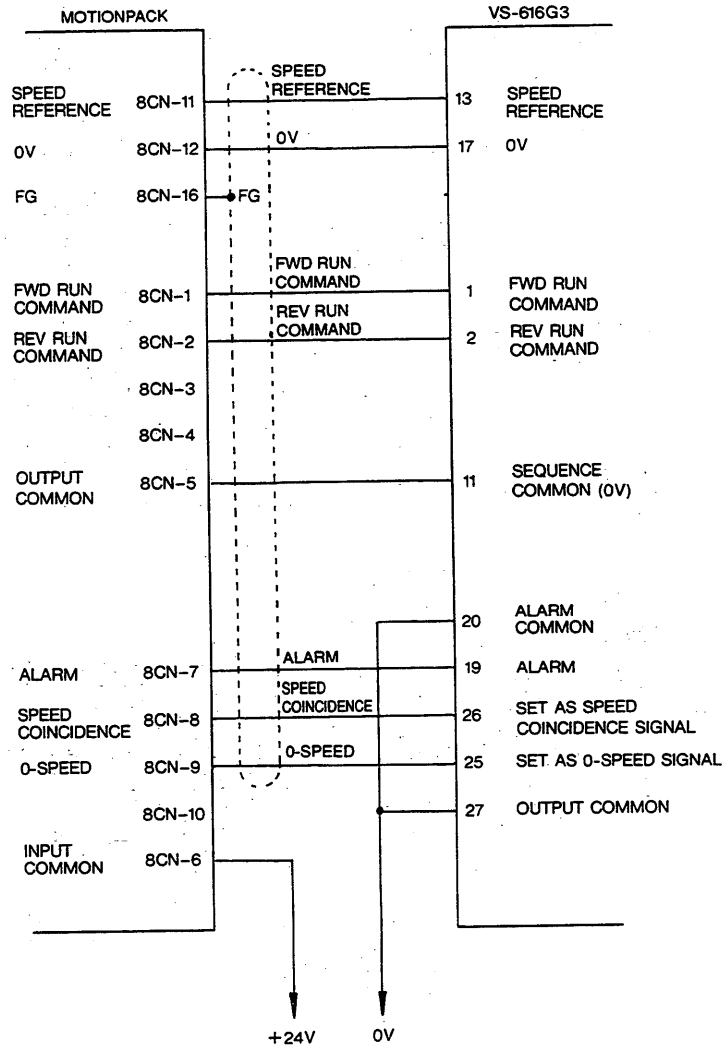
Absolute encoder connector specifications
Connector: MS3102 A20-29P (receptacle)
(Not attached) MS3106 B20-29S (angle plug)
MS3057 IZA-29P (cable clamp)
</td></tr>
</table>

8.6 SPINDLE RELATED SIGNALS (8CN)

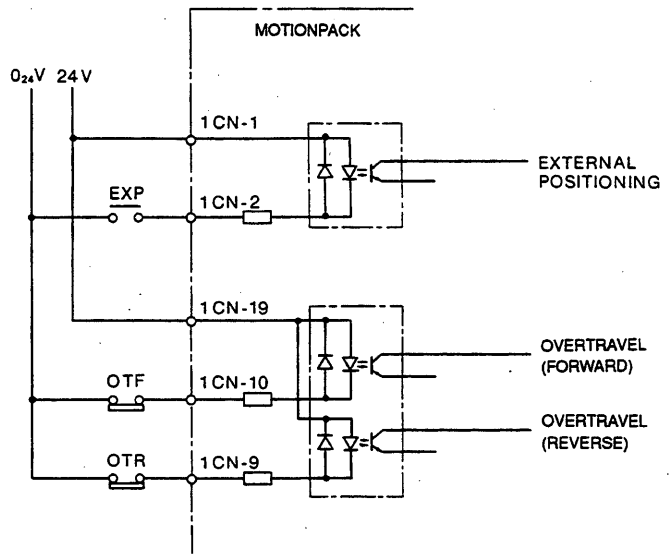
<table>
<tr><th>No.</th><th>Item</th><th>Contents</th></tr>
<tr><td>1</td><td>Signal Types</td><td>
The following table shows the types of signals related to the spindle. The specifications for digital I/O signals are the same as those of 3CN/4CN signals.
<table>
<tr><th>Signal Name</th><th>8CN</th><th>Contents</th></tr>
<tr><td>Speed Reference V_{ref}</td><td>11</td><td>Analog voltage reference,
±10 V MAX./Max. speed</td></tr>
<tr><td>0 V V_{ref} 0</td><td>12</td><td>0 V for speed reference voltage</td></tr>
<tr><td>FG FG</td><td>16</td><td>Frame ground</td></tr>
<tr><td>FWD Run Command FOR</td><td>1</td><td>Output signal for rotating direction designation
FWD run when this signal is turned ON. (Pr91 = 0)</td></tr>
<tr><td>REV Run Command REV</td><td>2</td><td>Output signal for rotating direction designation
REV run when this signal is turned ON. (Pr91 = 0)</td></tr>
<tr><td>Output Common OUT COM</td><td>5</td><td>Common for the output signal (0 V)</td></tr>
<tr><td>Alarm ALM</td><td>7</td><td>Spindle alarm signal
ON at spindle drive fault, OFF at normal spindle operation</td></tr>
<tr><td>Speed Coincidence V_{coin}</td><td>8</td><td>ON when spindle speed coincidens with reference speed.</td></tr>
<tr><td>Zero-speed V_{ZERO}</td><td>9</td><td>ON when spindle speed is zero-speed.</td></tr>
<tr><td>Input Common IN COM</td><td>6</td><td>Common for input signal (24 V)</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>Connector Arrangement (2CN)</td><td>
Connector Type : MR-16M (at cable side)
<table>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>FOR</td><td>REV</td><td></td><td></td><td>OUTCOM</td><td>IN COM</td></tr>
<tr><td></td><td>7</td><td>8</td><td>9</td><td>10</td><td></td></tr>
<tr><td></td><td>ALM</td><td>Vcoin</td><td>VZERO</td><td></td><td></td></tr>
<tr><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td></tr>
<tr><td>Vref</td><td>Vref 0</td><td></td><td></td><td></td><td>FG</td></tr>
</table>
</td></tr>
</table>

8.6 SPINDLE RELATED SIGNALS (8CN) (Cont'd)

No.	Item	Contents
3	Connection Method (Example)	The following shows a wiring diagram when YASKAWA inverter VS-616G3 is applied for the spindle drive (When Pr 91 = 0).

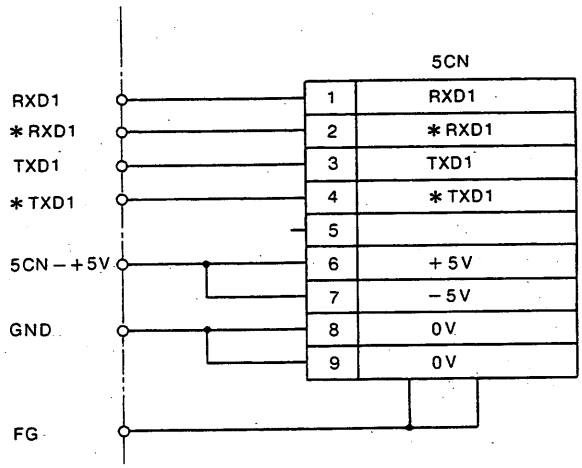


8.7 SERVO I/O SIGNALS (1CN)

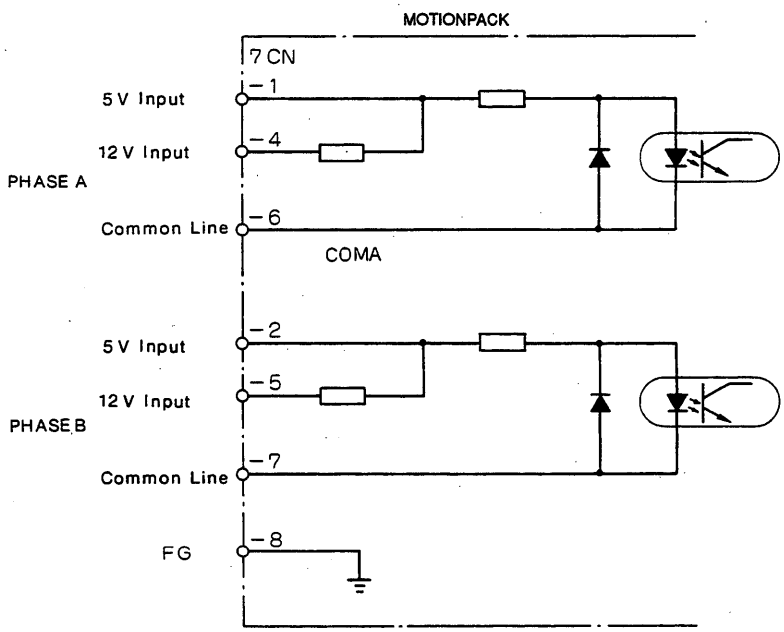
<table>
<tr><th>No.</th><th>Item</th><th>Contents</th></tr>
<tr><td>1</td><td>Signal Types</td><td>The following table shows the types of signals related to the servo I/O.
<table>
<tr><th>Signal Name</th><th>Contents</th></tr>
<tr><td>External Positioning Signal (EXP)</td><td>G34 command external positioning input signal.
Approx. 50 μs required for read-in.</td></tr>
<tr><td>FWD Direction Overtravel (OTF)</td><td>Used when external OT is provided.
Turn it OFF at overtravel.</td></tr>
<tr><td>REV Direction Overtravel (OTR)</td><td>Used when external OT is provided.
Turn it OFF at overtravel.</td></tr>
</table></td></tr>
<tr><td>2</td><td>Connection</td><td> 

Note : When overtravel is not used, the signals do not have to be connected by setting parameter.</td></tr>
</table>

8.8 PROGRAMMER RELATED SIGNALS (5CN)

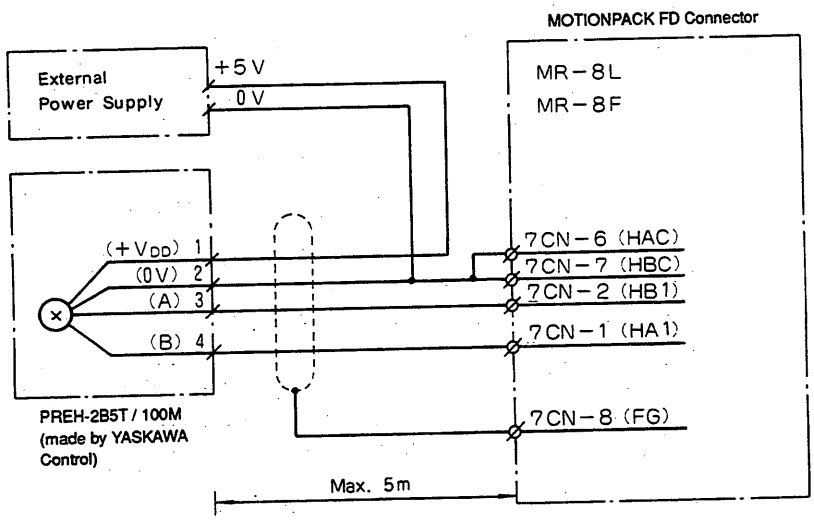
No.	Item	Contents
1	Terminal Location	

8.9 MANUAL PULSE GENERATOR RELATED SIGNALS (7CN)

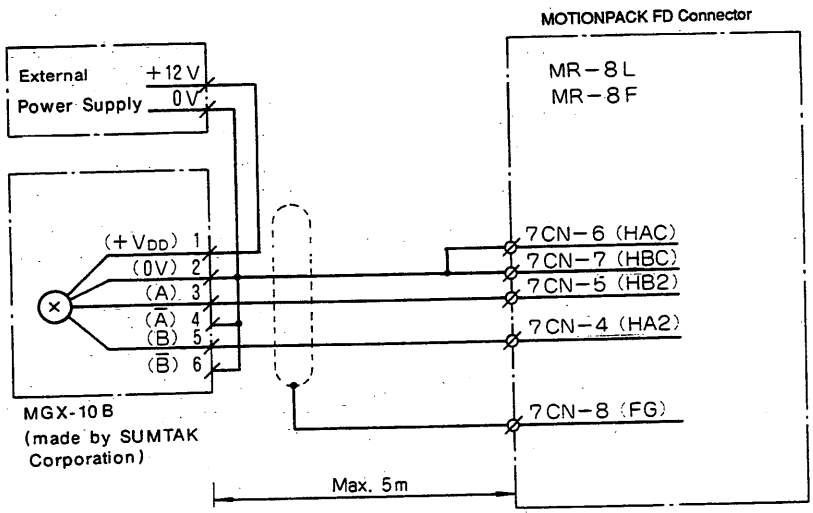
<table>
<tr><th>No.</th><th>Item</th><th>Contents</th></tr>
<tr><td>1</td><td>Terminal Location</td><td>
<table>
<tr><td>8</td><td>7</td><td>6</td></tr>
<tr><td>FG</td><td>HBC</td><td>HAC</td></tr>
<tr><td></td><td>5</td><td>4</td></tr>
<tr><td></td><td>HB2</td><td>HA2</td></tr>
<tr><td>3</td><td>2</td><td>1</td></tr>
<tr><td></td><td>HB1</td><td>HA1</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>Signals</td><td>
<table>
<tr><th>Name</th><th>Contents</th></tr>
<tr><td>HA1, HB1</td><td>5 V input of phase A/B</td></tr>
<tr><td>HA2, HA2</td><td>12 V input of phase A/B</td></tr>
<tr><td>HAC, HBC</td><td>5 V/12 V input of common for phase A/B</td></tr>
<tr><td>FG</td><td>Frame ground</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Input Circuit</td><td>


Input Current $I_{OL} \geq 10$ mA DC
</td></tr>
</table>

No.	Item	Contents
4	Connection Examples	Connection between manual pulse generator and MOTIONPACK FD (1) 5V manual pulse generator



(2) 12 V manual pulse generator



Note : The above figure shows the connection of voltage level output.

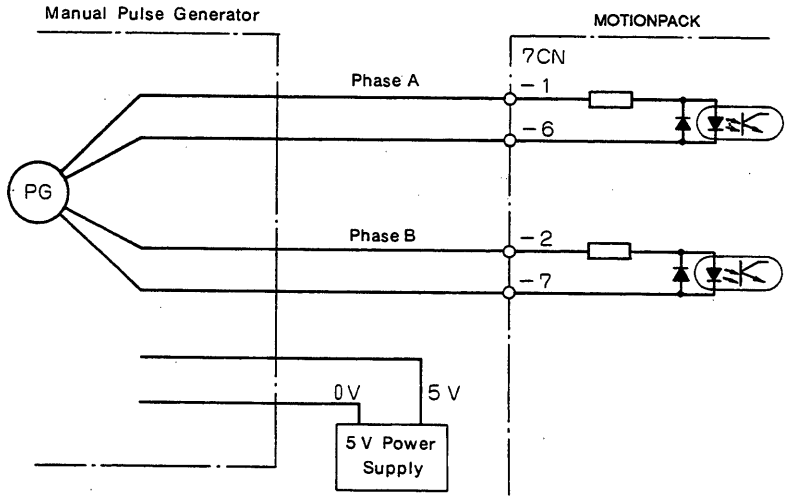
No.	Item	Contents
4	Connection Examples (Cont'd)	(3) Line driver output 

Table 9.1 Alarm List

Code	Alarm	Contents	Process								Resetting Method					P.P Display Message	LED Display No.
			Deceleration to a Stop	Immediate Stop	Main Circuit Shut-off	Servo Base Shut-off	RDY Signal OFF	Alarm Output	Battery Alarm Output	Signal Output during Current Limiting	Automatic Reset	Error Reset Input	Communication Reset Button	Mode Change	External Positioning End Signal Input		
01	CPU Alarm	A fault was found in the system.		○	○	○	○									CPU Error	No lights.
02	Program Fault	A fault was detected in the user program.	○					○				○				Program Alarm	Y.
03	Parameter Fault	A fault was found in a parameter.	○		○	○		○			○ *					Parameter Alarm	Y.
04	Emergency Stop	Emergency stop input is "open"		○	○	○	○				○					Emergency Stop	−.
05																	
06	Current Saturation	Current is being limited.								○	○					Current Limit	
07	Forward Direction Overtravel	+ overtravel signal was turned ON.		○				○			○					Forward O.T.	P.
08	Reverse Direction Overtravel	− overtravel signal was turned ON.		○				○			○					Reverse O.T.	n.
09	Home Position Setup Alarm	A fault was detected during home position setup.	○					○				○				Setup Alarm	d.
10	E^2 PROM Alarm	A fault occurred at nonvolatile memory (E^2 PROM) access.		○	○	○	○	○			○					E^2 PROM Alarm	H.
11	Position Error	The number of encoder pulses per motor revolution differs from the set value.		○	○	○	○	○								Position Alarm	8.
12																	

* It is necessary to turn the power supply OFF to ON

Table 9.1 Alarm List (Cont'd)

Code	Alarm	Contents	Process								Resetting Method					P.P Display Message	LED Display No.
			Deceleration to a Stop	Immediate Stop	Main Circuit Shut-off	Servo Base Shut-off	RDY Signal OFF	Alarm Output	Battery Alarm Output	Signal Output during Current Limiting	Automatic Reset	Error Reset Input	Communication Reset Button	Mode Change	External Positioning End Signal Input		
13	Power Loss	The power supply was turned off during motor operating or program execution.						○				○				Power Down	E.
14	Battery Alarm	Voltage drop was detected in the battery for memory and PG backup.							○		○ *					Battery Down	
15	+ Stored Stroke Limit Over	Specified position (aimed position) exceeded the soft stroke limit	○					○			○	○		○		Pos +Over	d.
16	− Stored Stroke Limit Over	Specified position (aimed position) exceeded the soft stroke limit.	○					○			○	○		○		Pos −Over	d.
17																	
18	Excessive Error	Position following error exceeds the limit value.		○		○	○	○				○				Error Over	E.
19	In-position Alarm	In-position cannot be obtained in a constant period of time (2 seconds) after completion of pulse discharging.	○					○				○				Inpos Alarm	d.
20	External Positioning Fault	A fault occurred at external positioning command execution.	○											○	○	Ext Pos Alarm	d.
21	Skip Signal Fault	The skip signal has been turned on before the skip signal command execution.	○					○				○				Skip On	d.
22	Encoder Position Fault	The motor position stored in the encoder differs from that in the MP FD.		○	○	○	○	○			○ * †					Abso P.G.	O.
23	External Data Setting Fault	A fault occurred at external data setting (at external compensation).						○				○				DGSW Alarm	d.
24	PG Signal Disconnection	PG signal (phase A, B or C) disconnection was detected.		○	○	○	○	○								P.G. Cut	C.

* It is necessary to turn the power supply OFF to ON.
† Setting Pr78 = 1 is needed.

Table 9.1 Alarm List (Cont'd)

Code	Alarm	Contents	Process								Resetting Method					P.P Display Message	LED Display No.
			Deceleration to a Stop	Immediate Stop	Main Circuit Shut-off	Servo Base Shut-off	RDY Signal OFF	Alarm Output	Battery Alarm Output	Signal Output during Current Limiting	Automatic Reset	Error Reset Input	Communication Reset Button	Mode Change	External Positioning End Signal Input		
25	Register Fault		○					○			○ *	○				Register Alarm	Y.
26	DSP-fault	A fault occurred in data sending/ receiving to/from DSP.		○	○	○	○	○								DSP Alarm	H.
27	Power Supply Monitor Circuit Fault	A fault occurred in transmission with the power supply monitor circuit.		○	○	○	○	○								POW SUP Alarm	E.
28	System Alarm	A fault was found by the system RAM check.			○	○	○	○								System Alarm	E.
29	Overcurrent	Overcurrent flowed in the main circuit.		○	○	○	○	○								Over Current	1.
30	Overvoltage	Main circuit DC voltage is above alarm level.		○	○	○	○	○								Over Voltage	4.
31	Overspeed	The motor speed was exceeded max. speed.		○	○	○	○	○				○				Over Speed	5.
32	Overload	Overload occurred.		○	○	○	○	○								Over Load	7.
33	Overrun Prevention	Overrun prevention functioned.		○	○	○	○	○								Over Run	L.
34	Open Phase Detection Fault	One phase of the three-phase power supply is not supplied.		○	○	○	○	○								O-PH Alarm	F.
35	MCB Trip	Built-in circuit protector tripped.		○	○	○	○	○			○ *					MCB Trip	2.
36	Regeneration Fault	A fault occurred in the regeneration processing circuit.		○	○	○	○	○								Regene Alarm	3.

* It is necessary to turn the power supply OFF to ON

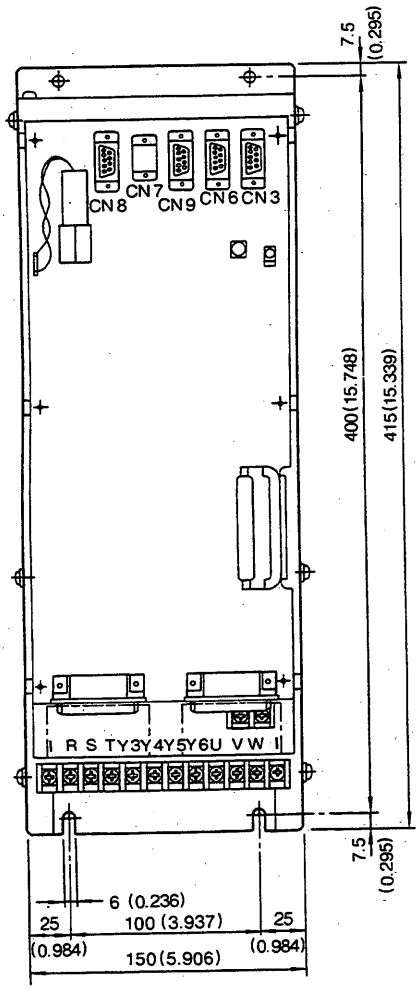
Table 9.1 Alarm List (Cont'd)

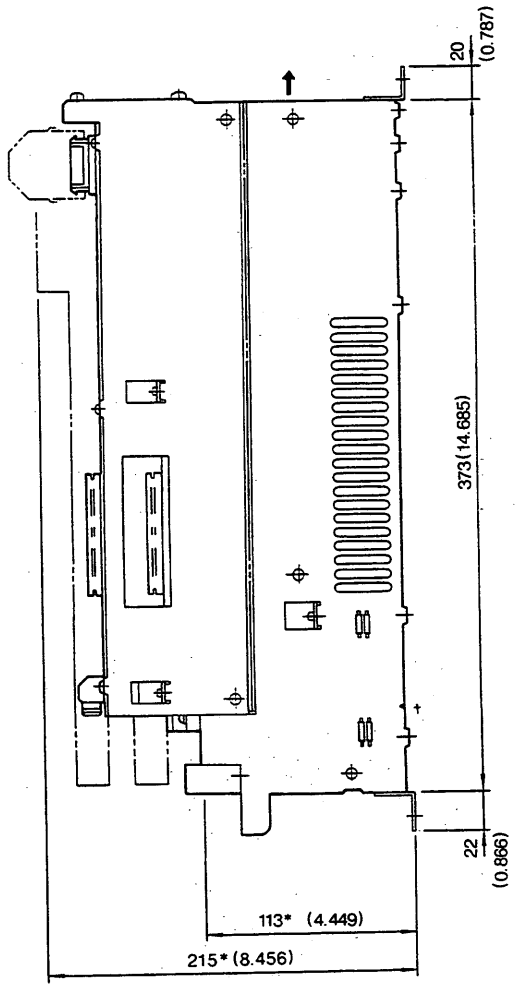
Code	Alarm	Contents	Process								Resetting Method					P.P Display Message	LED Display No.
			Deceleration to a Stop	Immediate Stop	Main Circuit Shut-off	Servo Base Shut-off	RDY Signal OFF	Alarm Output	Battery Alarm Output	Signal Output during Current Limiting	Automatic Reset	Error Reset Input	Communication Reset Button	Mode Change	External Positioning End Signal Input		
37	Undervoltage	Main circuit DC voltage is under alarm level.		○		○	○	○								Under Voltage	6.
38	Transmission Fault	A fault occurred in transmission with P.P.															
39	Spindle Fault	The spindle alarm signal was turned ON.		○				○				○				Spindle Alarm	E.
40	PLC System Fault	A fault was found in the PLC system program or ladder ROM.		○	○	○	○	○								PLC Alarm	o.
41	PLC RAM Fault	A fault was found in the PLC system RAM area.		○	○	○	○	○								PLC Ram Alarm	o.
42	Down-load Fault	A fault occurred in down-loaded ladder.						○			○					Ladder Alarm	o.
43	Communication Setting Fault	A fault occurred in the M-I/F conditional setting parameter.						○			○ *					Condition Par	o.
44	Serial Communication Fault	A fault occurred during M-I/F serial communication.		○		○	○	○					○			Serial Alarm	o.
45	PLC Down	CPU of PLC stopped.		○	○	○	○	○			○ *					PLC Down	o.
46	S-I/0 Down	CPU of M-NET stopped.		○	○	○	○	○			○ *					S-I/F Down	o.
47	Absolute Position Memory Error	Absolute position memory data of FD was destroyed.		○	○	○	○	○			○ *					Pos Mem Alarm	E.
48	DSP-fault 2	A fault was found in the DSP area.		○	○	○	○	○			○ *					DSP Pr Buffer	E.

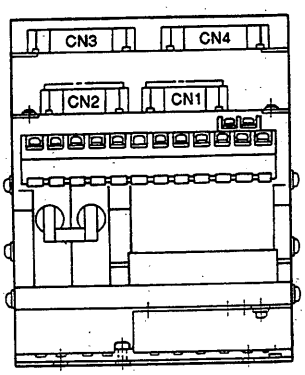
* It is necessary to turn the power supply OFF to ON.

10. DIMENSIONS in mm (inches)

10.1 CONTROLLER DIMENSIONS (TYPE CMPR-FD05B0 TO 44B0)



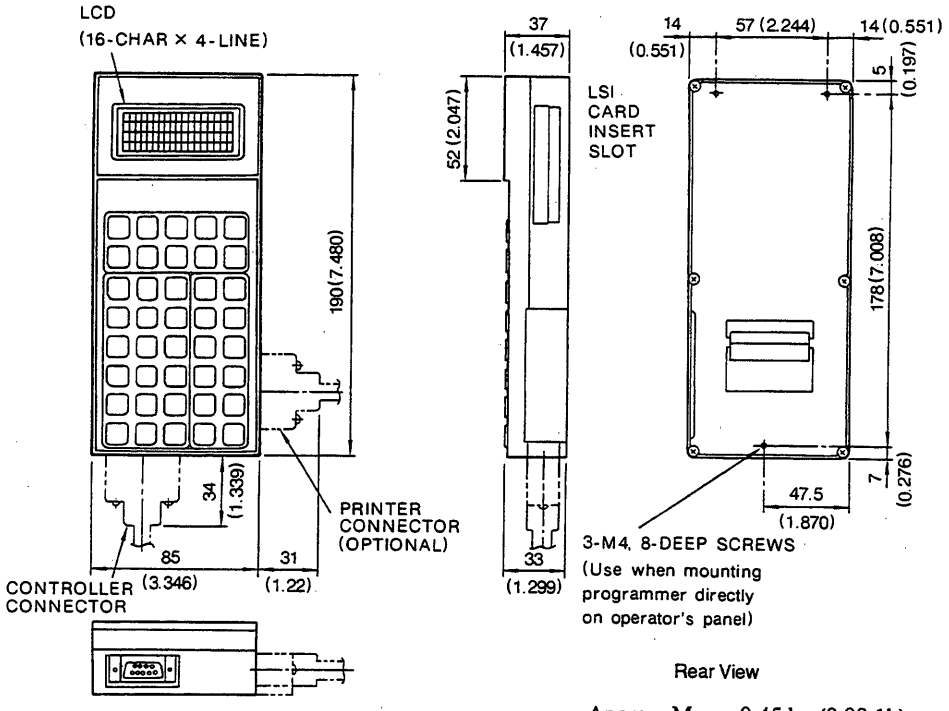




* Add 15 mm (0.59 in.) for 4.4 kW controller.
† Mounting location for brake power supply.

Model	Approx. Mass kg (lb)
FD-05B0	7.6 (16.8)
FD-10B0	
FD-15B0	
FD-20B0	8.8 (19.4)
FD-30B0	9.2 (20.3)
FD-44B0	9.5 (21.0)

10.2 PROGRAMMER DIMENSIONS (TYPE CMPR-PFD30)

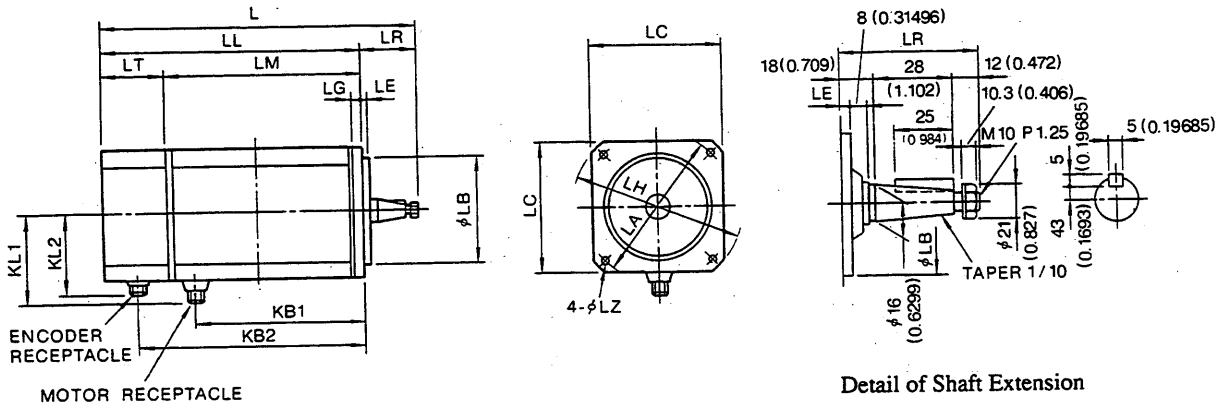


Approx. Mass: 0.45 kg (0.99 1b)

10.3 SERVOMOTOR

(1) M Series (Absolute Encoder)

Drawing 1 Type USAMED-03BS1 and -06BS1

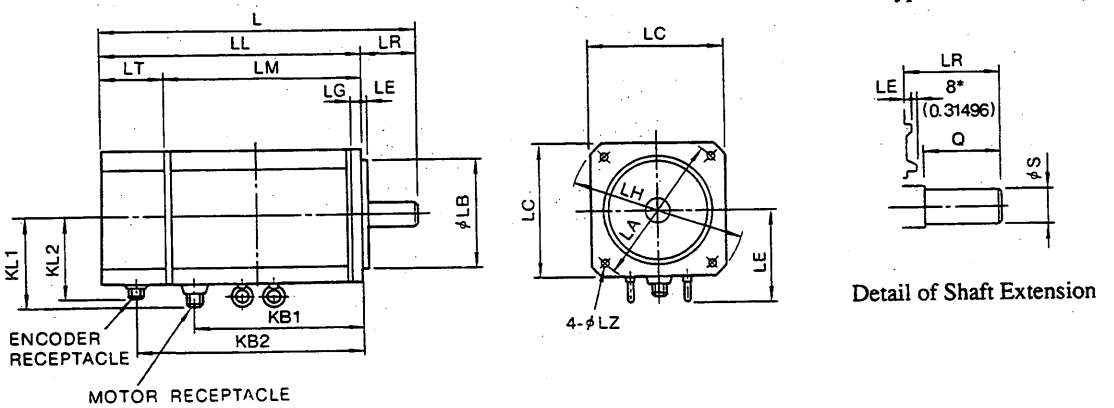


Detail of Shaft Extension

Notes:
1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Key and keyway comply with JIS B 1301-1976.
   (Parallel key, keyway: common class.)
5. Motor should be mounted with connectors down.

Drawing 2 Type USAMED-09BS2 to -44BS2

* Dimension for Type USAMED-09BS2



Detail of Shaft Extension

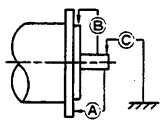
Notes:
1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Motor should be mounted with connectors down.

in mm (inches)

AC SERVOMOTOR Type USAMED-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension		Approx Mass kg (lb)
											LA	LB	LC	LE	LG	LH	LZ	S	O	
03BS1*	277 (10.91)	219 (8.63)	150 (5.91)	58 (2.28)	69 (2.72)	127 (5.0)	177 (6.97)	—	109 (4.29)	92 (3.62)	145 (5.71)	110 $^{0}_{-0.035}$ (4.3307) $^{0}_{-0.0014}$	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	—	—	9 (19.8)
06BS1*	334 (13.15)	276 (10.87)	207 (8.15)	58 (2.28)	69 (2.72)	184 (7.24)	234 (9.21)	—	109 (4.29)	92 (3.62)	145 (5.71)	110 $^{0}_{-0.035}$ (4.3307) $^{0}_{-0.0014}$	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	—	—	14 (30.9)
09BS1*	403 (15.87)	345 (13.59)	276 (10.87)	58 (2.28)	69 (2.72)	253 (9.96)	303 (11.93)	—	109 (4.29)	92 (3.62)	145 (5.71)	110 $^{0}_{-0.035}$ (4.3307) $^{0}_{-0.0014}$	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	22 $^{0}_{-0.0013}$ (0.8661) $^{0}_{-0.0005}$	40 (1.575)	20 (44.1)
12BS2*	343 (13.49)	264 (10.38)	211 (8.30)	79 (3.11)	53 (2.08)	171 (6.73)	237 (9.33)	—	139 (5.47)	92 (3.62)	200 (7.87)	114.3 $^{0}_{-0.025}$ (4.5) $^{0}_{-0.001}$	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3779) $^{+0.0001}_{0}$	76 (2.992)	22 (48.5)
20BS2*	401 (15.79)	322 (12.68)	269 (10.60)	79 (3.11)	53 (2.08)	229 (9.01)	295 (11.61)	123 (4.84)	139 (5.47)	92 (3.62)	200 (7.87)	114.3 $^{0}_{-0.025}$ (4.5) $^{0}_{-0.001}$	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3779) $^{+0.0001}_{0}$	76 (2.922)	29 (63.9)
30BS2*	486 (19.13)	407 (16.02)	354 (13.94)	79 (3.11)	53 (2.08)	314 (12.36)	380 (14.96)	123 (4.84)	139 (5.47)	92 (3.62)	200 (7.87)	114.3 $^{0}_{-0.025}$ (4.5) $^{0}_{-0.001}$	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3779) $^{+0.0001}_{0}$	76 (2.992)	41 (90.4)
44BS2	687 (27.04)	577 (22.71)	524 (20.63)	110 (4.33)	53 (2.08)	476 (18.74)	550 (21.65)	124 (4.88)	149 (5.37)	92 (3.62)	200 (7.87)	114.3 $^{0}_{-0.025}$ (4.5) $^{0}_{-0.001}$	180 (7.08)	3.2 (0.13)	18 (0.71)	230 (9.1)	13.5 (0.53)	42 $^{0}_{-0.016}$ (1.6535) $^{0}_{-0.0005}$	110 (4.33)	66 (145.5)

* Not provided with an eyebolt.

MECHANICAL SPECIFICATIONS

Accuracy (T. I. R)*		Reference Diagram
Flange Surface Perpendicular to Shaft Ⓐ	0.04 (0.0016)	
Flange Diameter Concentric to Shaft Ⓑ	0.04 (0.0016)	
Shaft Run Out Ⓒ	0.02 (0.0008) 0.04† (0.0016)	

SERVOMOTORS with a brake or a modified shaft extension are also available.

* T. I. R. (Total Indicator Reading)
† Accuracy for motor type USAMED-44BS2.

CONNECTOR SPECIFICATIONS

Motor Receptacle

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

Absolute Encoder Receptacle

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

CONNECTOR TYPES

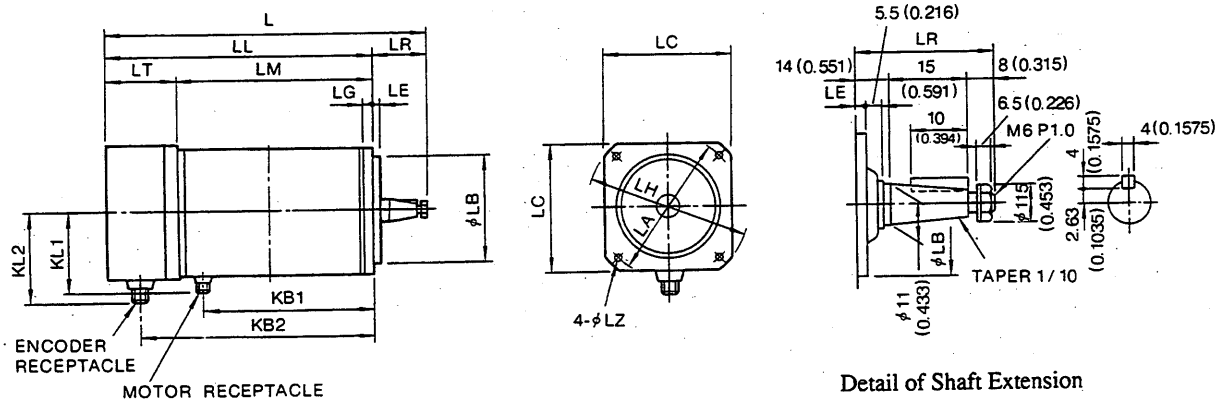
AC SERVOMOTOR Type USAMED-	Motor Connector Types				Absolute Encoder Connector Types			
	Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L-type Plug	Straight Plug	Cable Clamp
03BS1 06BS1 09BS2	MS3102 A18-10P	MS3108 B18-10P	MS3106 B18-10S	MS3057 -10A	MS3102 A20-29P	MS3108 B20-29S	MS3106 B20-29S	MS3057 -12A
12BS2 20BS2 30BS2	MS3102 A22-22P	MS3108 B22-22S	MS3106 B22-22S	MS3057 -12A				
44BS2	MS3102 A32-17P	MS3108 B32-17S	MS3106 B32-17S	MS3057 -20A				

10

10.3 SERVOMOTOR (Cont'd)

(2) F Series (Absolute Encoder)

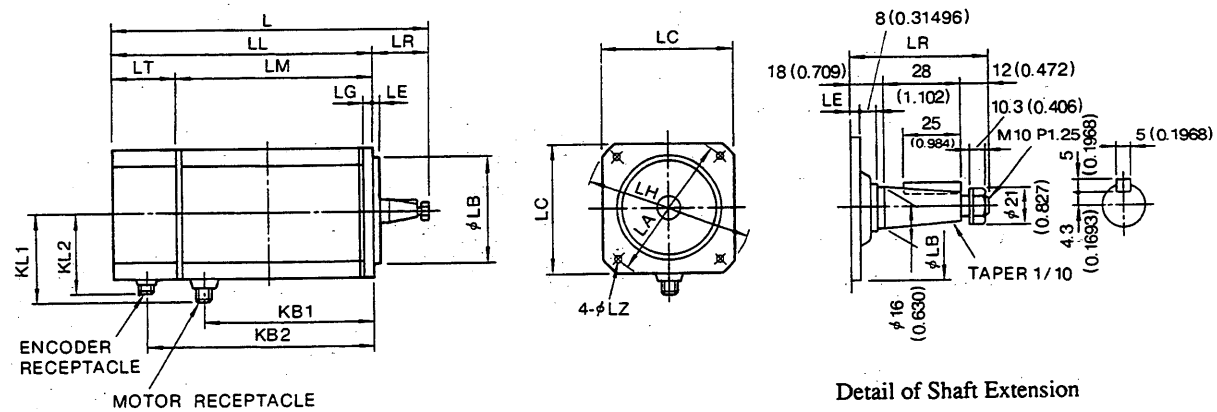
Drawing 1 Type USAFED-02CS1 and -03CS1



Detail of Shaft Extension

Notes:
1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Key and keyway comply with JIS B 1301-1976. (Parallel key, keyway: common class.)
5. Motor should be mounted with connectors down.

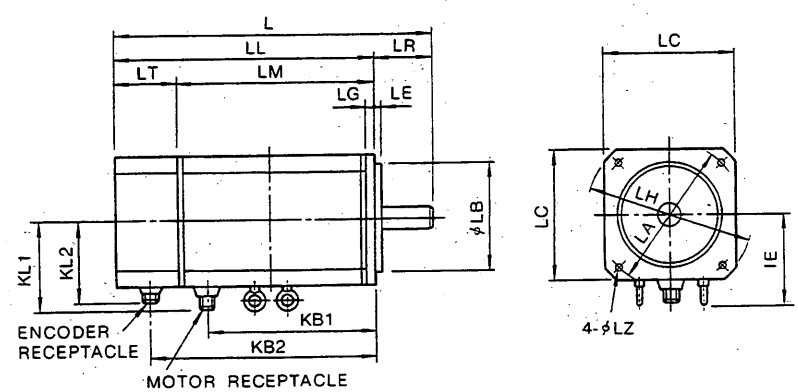
Drawing 2 Type USAFED-05CS1 and -09CS1



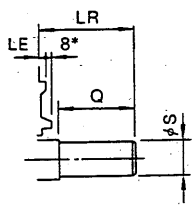
Detail of Shaft Extension

Notes:
1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Key and keyway comply with JIS B 1301-1976 (Parallel key, keyway: common class.)
5. Motor should be mounted with connectors down.

Drawing 3 Type USAFED-13CS2 to -44CS2



* Dimension for Type 13CS2



Detail of Shaft Extension

Notes:
1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Motor should be mounted with connectors down.

in mm (inches)

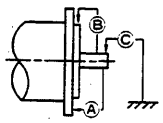
AC SERVOMOTOR Type USAFED-	Dwg. No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension		Approx Mass kg (lb)
												LA	LB	LC	LE	LG	LH	LZ	S	O	
02CS1*	1	234 (9.21)	197 (7.75)	137 (5.39)	37 (1.46)	60 (2.36)	90 (3.54)	172 (6.77)	—	76 (3.43)	87 (3.425)	100 (3.94)	80 $^{0}_{-0.030}$ (3.1496) $^{0}_{-0.0012}$	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	—	—	5.5 (7.7)
03CS1*		280 (11.02)	243 (9.56)	183 (7.2)	37 (1.46)	60 (2.36)	136 (5.35)	218 (8.58)	—	76 (3.43)	87 (3.425)	100 (3.94)	80 $^{0}_{-0.030}$ (3.1496) $^{0}_{-0.0012}$	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	—	—	6.5 (14.3)
05CS1*	2	277 (10.90)	219 (8.62)	150 (5.91)	58 (2.28)	69 (2.72)	127 (5.0)	177 (6.97)	—	109 (4.29)	92 (3.62)	145 (5.71)	110 $^{0}_{-0.035}$ (4.3307) $^{0}_{-0.0014}$	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	—	—	8.5 (18.7)
09CS1*		344 (13.14)	276 (10.86)	207 (8.16)	58 (2.28)	69 (2.72)	184 (7.24)	234 (9.21)	—	109 (4.29)	92 (3.62)	145 (5.71)	110 $^{0}_{-0.035}$ (4.3307) $^{0}_{-0.0014}$	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	—	—	13 (28.7)
13CS2*	3	403 (15.87)	345 (13.59)	276 (10.87)	58 (2.28)	69 (2.72)	253 (9.96)	303 (11.93)	—	109 (4.29)	92 (3.62)	145 (5.71)	110 $^{0}_{-0.035}$ (4.3307) $^{0}_{-0.0014}$	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	22 $^{0}_{-0.0013}$ (0.8661) $^{0}_{-0.0005}$	40 (1.57)	20 (44.1)
20CS2*		343 (13.5)	264 (10.39)	211 (8.3)	79 (3.11)	53 (2.09)	171 (6.73)	237 (9.33)	—	139 (5.47)	92 (3.62)	200 (7.88)	114.3 $^{0}_{-0.025}$ (4.5) $^{0}_{-0.001}$	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3379) $^{+0.0004}_{0}$	76 (2.99)	22 (48.5)
30CS2		401 (15.79)	322 (12.68)	269 (10.59)	79 (3.11)	53 (2.09)	229 (9.02)	295 (11.61)	123 (4.85)	139 (5.47)	92 (3.62)	200 (7.88)	114.3 $^{0}_{-0.025}$ (4.5) $^{0}_{-0.001}$	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3379) $^{+0.0004}_{0}$	76 (2.99)	29 (63.9)
44CS2		486 (19.14)	407 (16.02)	354 (13.93)	79 (3.11)	53 (2.09)	314 (12.36)	380 (14.96)	123 (4.85)	139 (5.47)	92 (3.62)	200 (7.88)	114.3 $^{0}_{-0.025}$ (4.5) $^{0}_{-0.001}$	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3379) $^{+0.0004}_{0}$	76 (2.99)	41 (90.4)

* Not provided with an eyebolt.

MECHANICAL SPECIFICATIONS

Accuracy (T. I. R)*	
Flange Surface Perpendicular to Shaft Ⓐ	0.04 (0.0016)
Flange Diameter Concentric to Shaft Ⓑ	0.04 (0.0016)
Shaft Run Out Ⓒ	0.02 (0.0008)

Reference Diagram



* T. I. R. (Total Indicator Reading)

SERVOMOTORS with a brake or a modified shaft extension are also available.

CONNECTOR SPECIFICATIONS

Motor Receptacle

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

Absolute Encoder Receptacle

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

CONNECTOR TYPES

AC SERVOMOTOR Type USAFED-	Motor Connector Types				Absolute Encoder Connector Types			
	Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L-type Plug	Straight Plug	Cable Clamp
02CS1 03CS1	MS3102 A14S-2P	MS3108 B14S-2S	MS3106 B14S-2S	MS3057 -6A	MS3102 A20-29P	MS3108 B20-29S	MS3106 B20-29S	MS3057 -12A
05CS1 09CS1 13CS2	MS3102 A18-10P	MS3108 B18-10S	MS3106 B18-10S	MS3057 -10A				
20CS2 30CS2 44CS2	MS3102 A22-22P	MS3108 B22-22S	MS3106 B22-22S	MS3057 -12A				

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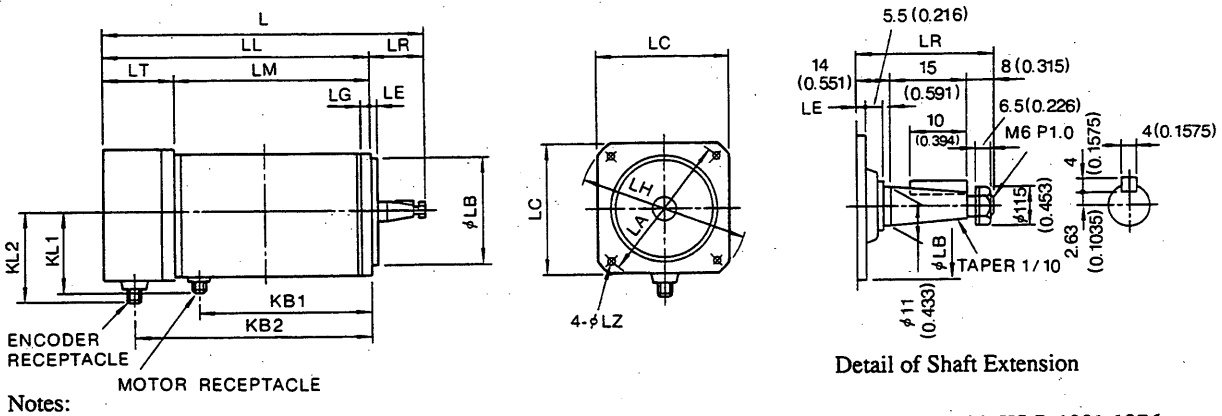
10.3 SERVOMOTOR (Cont'd)

(3) G Series (Absolute Encoder)

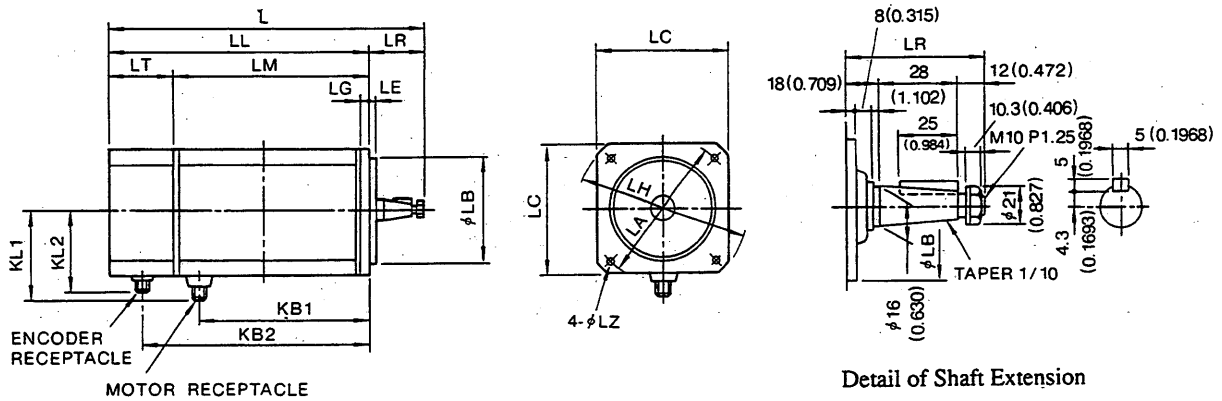
Drawing 1 Type USAGED-02AS1 and -03AS1



Detail of Shaft Extension

Notes:
1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Key and keyway comply with JIS B 1301-1976. (Parallel key, keyway: common class.)
5. Motor should be mounted with connectors down.

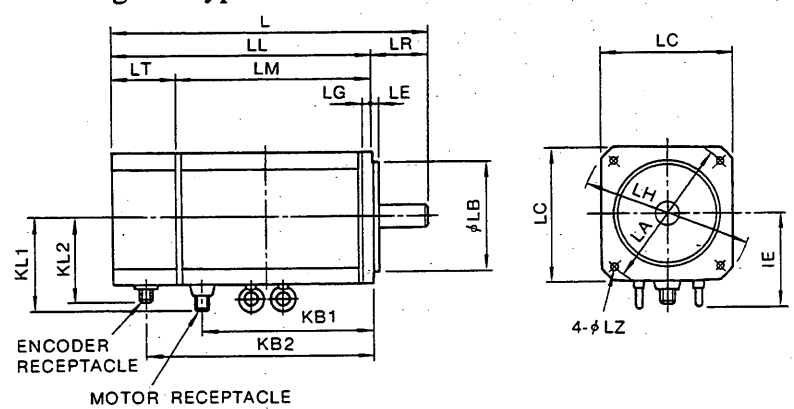
Drawing 2 Type USAGED-05AS1 and -09AS1



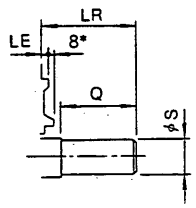
Detail of Shaft Extension

Notes:
1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Key and keyway comply with JIS B 1301-1976. (Parallel key, keyway: common class.)
5. Motor should be mounted with connectors down.

Drawing 3 Type USAGED-13AS2 to -44AS2



* Dimension for Type 13GS2



Detail of Shaft Extension

Notes:
1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Motor should be mounted with connectors down.

in mm (inches)

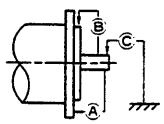
AC SERVOMOTOR Type USAGED-	Dwg. No.	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	Flange Surface							Shaft Extension		Approx Mass kg (lb)
												LA	LB	LC	LE	LG	LH	LZ	S	O	
02AS1*	1	234 (9.21)	197 (7.75)	137 (5.39)	37 (1.46)	60 (2.36)	90 (3.54)	172 (6.77)	—	76 (3.43)	87 (3.425)	100 (3.94)	80 $^{0}_{-0.030}$ (3.1496 $^{0}_{-0.0012}$)	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	—	—	5.5 (7.7)
03AS1*		280 (11.02)	243 (9.56)	183 (7.2)	37 (1.46)	60 (2.36)	136 (5.35)	218 (8.58)	—	76 (3.43)	87 (3.425)	100 (3.94)	80 $^{0}_{-0.030}$ (3.1496 $^{0}_{-0.0012}$)	90 (3.54)	4 (0.157)	7 (0.276)	120 (4.72)	6.6 (0.26)	—	—	6.5 (14.3)
05AS1*	2	277 (10.90)	219 (8.62)	150 (5.91)	58 (2.28)	69 (2.72)	127 (5.0)	177 (6.97)	—	109 (4.29)	92 (3.62)	145 (5.71)	110 $^{0}_{-0.035}$ (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	—	—	8.5 (18.7)
09AS1*		344 (13.14)	276 (10.86)	207 (8.16)	58 (2.28)	69 (2.72)	184 (7.24)	234 (9.21)	—	109 (4.29)	92 (3.62)	145 (5.71)	110 $^{0}_{-0.035}$ (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	—	—	13 (28.7)
13AS2*	3	403 (15.87)	345 (13.59)	276 (10.87)	58 (2.28)	69 (2.72)	253 (9.96)	303 (11.93)	—	109 (4.29)	92 (3.62)	145 (5.71)	110 $^{0}_{-0.035}$ (4.3307 $^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	12 (0.47)	165 (6.5)	9 (0.35)	22 $^{0}_{-0.0013}$ (0.8661 $^{0}_{-0.0005}$)	40 (1.57)	20 (44.1)
20AS2*		343 (13.5)	264 (10.39)	211 (8.3)	79 (3.11)	53 (2.09)	171 (6.73)	237 (9.33)	—	139 (5.47)	92 (3.62)	200 (7.88)	114.3 $^{0}_{-0.025}$ (4.5 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3379 $^{+0.0001}_{0}$)	76 (2.99)	22 (48.5)
30AS2		401 (15.79)	322 (12.68)	269 (10.59)	79 (3.11)	53 (2.09)	229 (9.02)	295 (11.61)	123 (4.85)	139 (5.47)	92 (3.62)	200 (7.88)	114.3 $^{0}_{-0.025}$ (4.5 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3379 $^{+0.0001}_{0}$)	76 (2.99)	29 (63.9)
44AS2		486 (19.14)	407 (16.02)	354 (13.93)	79 (3.11)	53 (2.09)	314 (12.36)	380 (14.96)	123 (4.85)	139 (5.47)	92 (3.62)	200 (7.88)	114.3 $^{0}_{-0.025}$ (4.5 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.13)	18 (0.71)	230 (9.06)	13.5 (0.53)	35 $^{+0.01}_{0}$ (1.3379 $^{+0.0001}_{0}$)	76 (2.99)	41 (90.4)

* Not provided with an eyebolt.

MECHANICAL SPECIFICATIONS

Accuracy (T. I. R)*	
Flange Surface Perpendicular to Shaft Ⓐ	0.04 (0.0016)
Flange Diameter Concentric to Shaft Ⓑ	0.04 (0.0016)
Shaft Run Out Ⓒ	0.02 (0.0008)

Reference Diagram

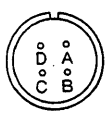


* T. I. R. (Total Indicator Reading)

SERVOMOTORS with a brake or a modified shaft extension are also available.

CONNECTOR SPECIFICATIONS

Motor Receptacle



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

Absolute Encoder Receptacle

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

CONNECTOR TYPES

AC SERVOMOTOR Type USAGED-	Motor Connector Types				Absolute Encoder Connector Types			
	Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L-type Plug	Straight Plug	Cable Clamp
02AS1 03AS1	MS3102 A14S-2P	MS3108 B14S-2S	MS3106 B14S-2S	MS3057 -6A	MS3102 A20-29P	MS3108 B20-29S	MS3106 B20-29S	MS3057 -12A
05AS1 09AS1 13AS2	MS3102 A18-10P	MS3108 B18-10S	MS3106 B18-10S	MS3057 -10A				
20AS2 30AS2 44AS2	MS3102 A22-22P	MS3108 B22-22S	MS3106 B22-22S	MS3057 -12A				

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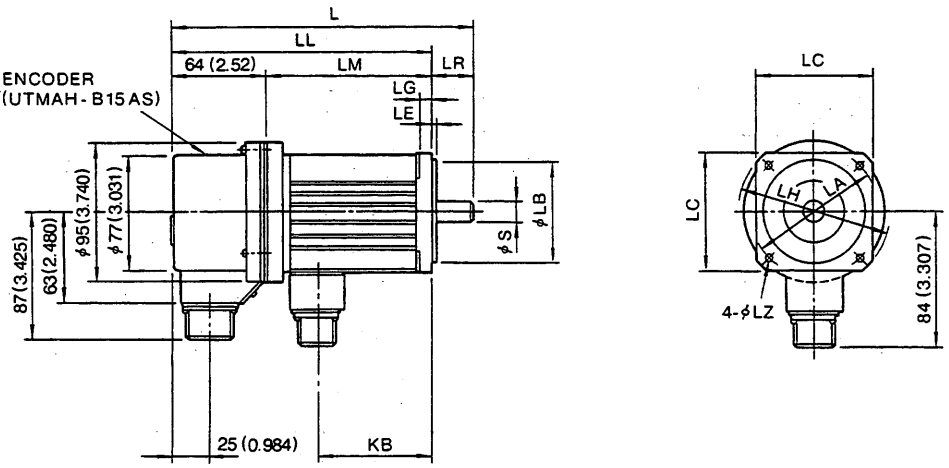
10.3 SERVOMOTOR (Cont'd)

(4) S Series (Absolute Encoder)

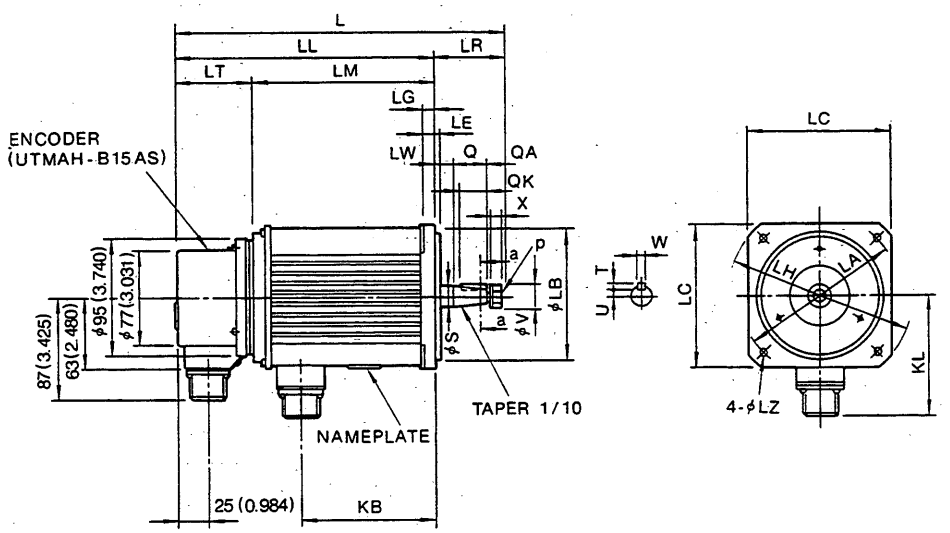
Drawing 1 Type USASEM-03AS2 and -05AS2



Notes:

1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Motor should be mounted with connectors down.

Drawing 2 Type USASEM-08AS1, -15AS1, and -30AS1



Notes:

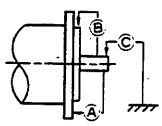
1. Absolute encoder is used as a detector.
2. Vibration: 15 μm or below
3. Plug and clamp are not attached for receptacle connection.
4. Key and keyway comply with JIS B 1301-1976. (Parallel key, keyway: common class.)
5. Motor should be mounted with connectors down.

in mm (inches)

AC SERVOMOTOR Type USASEM-	Dwg. No.	L	LL	LM	LR	LT	KB	KL	Flange Surface							Approx Mass kg (lb)
									LA	LB	LC	LE	LG	LH	LZ	
03AS2	1	208 (8.189)	178 (7.008)	114 (4.488)	30 (1.181)	—	79 (3.110)	—	90 (3.543)	70 $^{0}_{-0.030}$ (2.756 $^{0}_{-0.0012}$)	80 (3.150)	3 (0.118)	8 (0.315)	105 (4.134)	ϕ 6 (0.236)	3.2 (7.1)
05AS2	1	230 (9.055)	200 (7.874)	136 (5.354)	30 (1.181)	—	101 (3.976)	—	90 (3.543)	70 $^{0}_{-0.030}$ (2.756 $^{0}_{-0.0012}$)	80 (3.150)	3 (0.118)	8 (0.315)	105 (4.134)	ϕ 6 (0.236)	3.8 (8.4)
08AS1	2	274 (10.787)	216 (8.504)	152 (5.984)	58 (2.283)	64 (2.52)	115 (4.528)	102 (4.016)	130 (5.118)	100 $^{0}_{-0.035}$ (3.937 $^{0}_{-0.001\,4}$)	120 (4.724)	3 (0.118)	10 (0.394)	155 (6.102)	ϕ 9 (0.354)	6.3 (13.9)
15AS1	2	325.5 (12.815)	267.5 (10.531)	203.5 (8.012)	58 (2.283)	64 (2.52)	166.5 (6.555)	109 (4.291)	145 (5.709)	110 $^{0}_{-0.035}$ (4.331 $^{0}_{-0.001\,4}$)	130 (5.118)	6 (0.236)	12 (0.472)	165 (6.496)	ϕ 9 (0.354)	11.5 (25.4)
30AS1	2	374 (14.724)	304 (11.969)	240 (9.449)	70 (2.756)	64 (2.52)	206 (8.110)	135 (5.315)	200 (7.874)	114.3 $^{0}_{-0.040}$ (4.50 $^{0}_{-0.0016}$)	180 (7.087)	6 (0.236)	18 (0.709)	230 (9.055)	ϕ13.5 (0.531)	24.5 (54.0)

AC SERVOMOTOR Type USASEM-	Dwg. No.	Shaft Extension										
		LW	Q	QK	QA	X	S	V	P	U	W	T
08AS1	2	18 (0.709)	28 (1.102)	25 (0.984)	12 (0.472)	10.3 (0.406)	16 (0.630)	21 (0.827)	M10 P1.25	4.3 $^{0}_{-0.1}$ (0.169 $^{0}_{-0.001}$)	5 (0.197)	5 (0.197)
15AS1	2	18 (0.709)	28 (1.102)	25 (0.984)	12 (0.472)	10.3 (0.406)	19 (0.748)	21 (0.827)	M10 P1.25	5.8 $^{0}_{-0.1}$ (0.228 $^{0}_{-0.001}$)	5 (0.197)	5 (0.197)
30AS1	2	20 (0.787)	36 (1.417)	32 (1.26)	14 (0.551)	12.5 (0.492)	22 (0.866)	24 (0.945)	M12 P1.25	6.6 $^{0}_{-0.1}$ (0.260 $^{0}_{-0.001}$)	6 (0.236)	6 (0.236)

MECHANICAL SPECIFICATIONS

Accuracy (T. I. R)*		Reference Diagram
Flange Surface Perpendicular to Shaft Ⓐ	0.04 (0.0016)	
Flange Diameter Concentric to Shaft Ⓑ	0.04 (0.0016)	
Shaft Run Out Ⓒ	0.02 (0.0008)	

* T. I. R. (Total Indicator Reading)

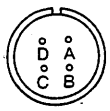
SERVOMOTORS with a brake or a modified shaft extension are also available.

10

10.3 SERVOMOTOR (Cont'd)

CONNECTOR SPECIFICATIONS

Motor Receptacle



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

Absolute Encoder Receptacle

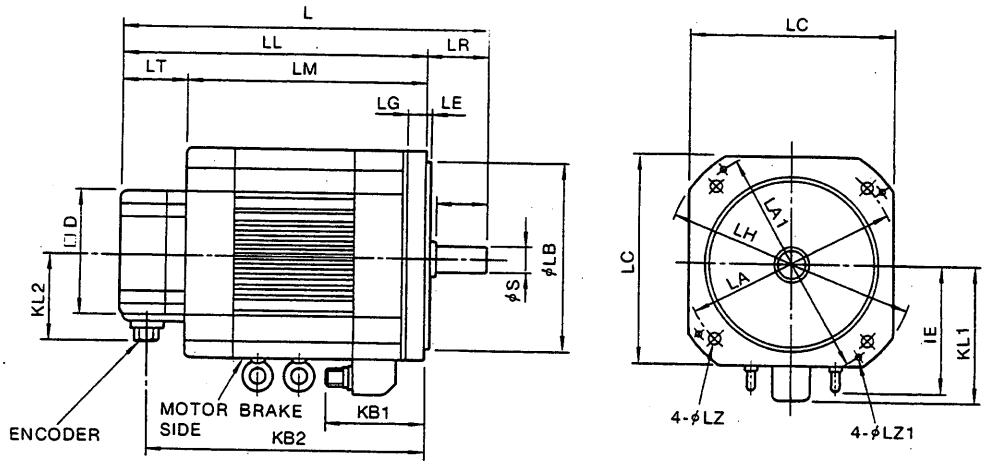
A	Channel A output	K	—
B	Channel $\bar{A}$ output	L	—
C	Channel B output	M	—
D	Channel $\bar{B}$ output	N	—
E	Channel Z output	P	—
F	Channel $\bar{Z}$ output	R	For reset
G	0 V	S	0 V (battery)
H	+5 VDC	T	3 V (battery)
J	Frame ground	—	—

CONNECTOR TYPES

AC SERVOMOTOR Type USASEM-	Motor Connector Types				Absolute Encoder Connector Types			
	Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L-type Plug	Straight Plug	Cable Clamp
03AS2 05AS2	MS3102 A 18 -10P	MS3108 B 18 -10S	MS3106 B 18 -10S	MS3057-10A	MS3102 A 20 -29P	MS3108 B 20 -29S	MS3106 B 20 -29S	MS3057-12A
08AS1 15AS1 30AS1	MS3102 A 20 -4P	MS3108 B 20 -4S	MS3106 B 20 -4S	MS3057-12A				

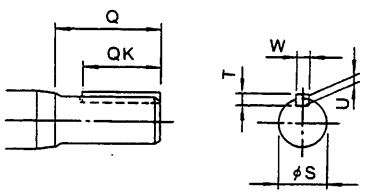
(5) D Series (Absolute Encoder)

Drawing 1 Type USADED-05EW to -37EW



Notes:
1. Absolute encoder is used as a detector.
2. Plug and clamp are not attached for receptacle connection.
3. Motor should be mounted with connectors down.

Detail of Straight Shaft with Key



in mm (inches)

AC SERVOMOTOR Type USADED-	Shaft Extension							
	LR	LE	φS	Q	QK	T	U	W
05EW2K □	55 (2.165)	3.2 (0.126)	22 $^{0}_{-0.021}$ (0.866 $^{0}_{-0.0008}$)	50 (1.97)	45 (1.77)	6 (0.236)	3.5 (0.138)	6 (0.236)
10EW2K □	55 (2.165)	3.2 (0.126)	22 $^{0}_{-0.021}$ (0.866 $^{0}_{-0.0008}$)	50 (1.97)	45 (1.77)	6 (0.236)	3.5 (0.138)	6 (0.236)
15EW2K □	55 (2.165)	4 (0.157)	28 $^{0}_{-0.013}$ (1.102 $^{0}_{-0.0005}$)	50 (1.97)	45 (1.77)	7 (0.276)	4 (0.157)	8 (0.315)
22EW2K □	55 (2.165)	4 (0.157)	28 $^{0}_{-0.013}$ (1.102 $^{0}_{-0.0005}$)	50 (1.97)	45 (1.77)	7 (0.276)	4 (0.157)	8 (0.315)
37EW2K □	65 (2.559)	4 (0.157)	32 $^{0}_{-0.016}$ (1.26 $^{0}_{-0.0006}$)	60 (2.36)	50 (1.97)	8 (0.315)	5 (0.197)	10 (0.394)

Note: Key and keyway comply with JIS B 1301-1976.
(Parallel key, keyway: common class.)

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10.3 SERVOMOTOR (Cont'd)

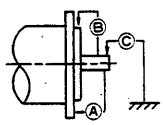
in mm (inches)

AC SERVOMOTOR Type USADED-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2	D	Flange Surface									Shaft Extension		Apprx Mass kg (lb)	
												LA	LA1	ϕLB	LC	LE	LG	LH	LZ	LZ1	ϕS	Q	With Holding Brake	Without Holding Brake
05EW20E*	237 (9.331)	182 (7.165)	138 (5.433)	55 (2.165)	44 (1.732)	90 (3.543)	158 (6.220)	—	138 (5.433)	93 (3.661)	130 (5.118)	200 (7.874)	—	114.3 $^{0}_{-0.025}$ (4.50 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.126)	12 (0.472)	230 (9.055)	13.5 (0.531)	—	22 $^{0}_{-0.013}$ (0.866 $^{0}_{-0.0005}$)	50 (1.97)	17 (37.48)	16 (35.27)
10EW20E*	257 (10.118)	202 (7.953)	158 (6.220)	55 (2.165)	44 (1.732)	90 (3.543)	178 (6.220)	—	138 (5.433)	93 (3.661)	130 (5.118)	200 (7.874)	—	114.3 $^{0}_{-0.025}$ (4.50 $^{0}_{-0.001}$)	180 (7.09)	3.2 (0.126)	12 (0.472)	230 (9.055)	13.5 (0.531)	—	22 $^{0}_{-0.013}$ (0.866 $^{0}_{-0.0005}$)	50 (1.97)	19 (41.88)	18 (39.68)
15EW20E	270 (10.630)	217 (8.543)	171 (6.732)	55 (2.165)	46 (1.811)	95 (3.740)	191 (7.520)	142 (5.591)	160 (6.299)	93 (3.661)	130 (5.118)	235 (9.252)	250 (9.843)	200 $^{0}_{-0.046}$ (7.874 $^{0}_{-0.002}$)	220 (8.66)	4 (0.157)	16 (0.630)	270 (10.630)	13.5 (0.531)	M8	280 $^{0}_{-0.013}$ (1.102 $^{0}_{-0.0005}$)	50 (1.97)	30 (66.14)	27 (59.52)
22EW20E	285 (11.220)	232 (9.133)	186 (7.323)	55 (2.165)	46 (1.811)	95 (3.740)	206 (8.110)	142 (5.591)	160 (6.299)	93 (3.661)	130 (5.118)	235 (9.252)	250 (9.843)	200 $^{0}_{-0.046}$ (7.874 $^{0}_{-0.002}$)	220 (8.66)	4 (0.157)	16 (0.630)	270 (10.630)	13.5 (0.531)	M8	28 $^{0}_{-0.013}$ (1.102 $^{0}_{-0.0005}$)	50 (1.97)	32 (70.55)	29 (63.93)
37EW20E	345 (13.583)	282 (11.102)	236 (9.291)	65 (2.559)	46 (1.811)	95 (3.740)	256 (10.079)	142 (5.591)	160 (6.299)	93 (3.661)	130 (5.118)	235 (9.252)	250 (9.843)	200 $^{0}_{-0.046}$ (7.874 $^{0}_{-0.002}$)	220 (8.66)	4 (0.157)	16 (0.630)	270 (10.630)	13.5 (0.531)	M8	32 $^{0}_{-0.016}$ (1.26 $^{0}_{-0.0006}$)	60 (2.36)	39 (85.98)	36 (79.37)

* Eyebolt is not furnished.

Note : All dimensions are for AC SERVOMOTORS with/without holding brake.

MECHANICAL SPECIFICATIONS

Accuracy (T. I. R)*		Reference Diagram
Flange Surface Perpendicular to Shaft Ⓐ	0.04 (0.0016) 0.06† (0.0024)	
Flange Diameter Concentric to Shaft Ⓑ	0.04 (0.0016)	
Shaft Run Out Ⓒ	0.02 (0.0008)	

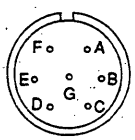
* T. I. R. (Total Indicator Reading)

† Accuracy for motor types USADED-15EW, -22EW, -37EW.

SERVOMOTORS with a brake or a modified shaft extension are also available.

CONNECTOR SPECIFICATIONS

Motor Receptacle



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

Absolute Encoder Receptacle

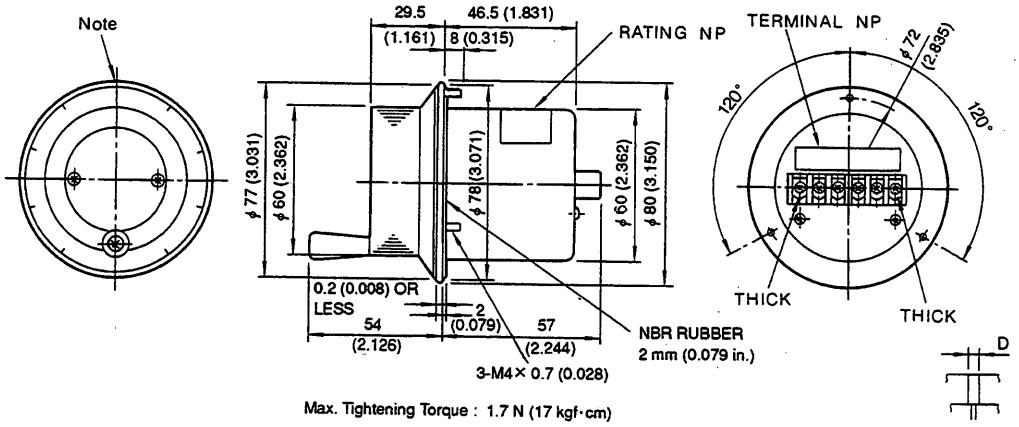
A	Channel A output	K	Channel S output
B	Channel Ā output	L	Channel S output
C	Channel B output	M	—
D	Channel B̄ output	N	—
E	Channel Z output	P	—
F	Channel Z̄ output	R	For reset
G	0 V	S	0 V (battery)
H	+5 VDC	T	3.6 V (battery)
J	Frame ground	—	—

CONNECTOR TYPES

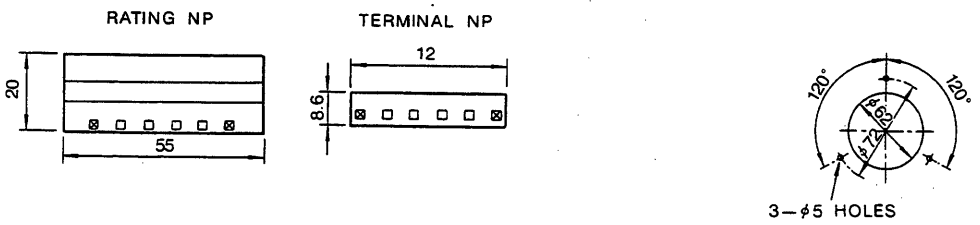
AC SERVOMOTOR Type USADED-	Motor Connector Types				Absolute Encoder Connector Types			
	Receptacle	L-type Plug	Straight Plug	Cable Clamp	Receptacle	L-type Plug	Straight Plug	Cable Clamp
05EW2 ⬚ 10EW2 ⬚	MS3102 A 20 -15P	MS3108 B 20 -15S	MS3106 B 20 -15S	MS3057-12A	MS3102 A 20 -29P	MS3108 B 20 -29S	MS3106 B 20 -29S	MS3057-12A
15EW2 ⬚ 22EW2 ⬚ 37EW2 ⬚	MS3102 A 24 -10P	MS3108 B 24 -10S	MS3106 B 24 -10S	MS3057-16A				

10.4 MANUAL PULSE GENERATOR

TYPE: PREH-2E5T/100-M



Note: To set the dial, dial graduation should be in the width D of the plate center mark with dial stop.



Panel Drilling Plan

MOTIONPACK FD MODEL 0
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YASKAWA ELECTRIC CORPORATION

YASKAWA

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Specifications are subject to change without notice
for ongoing product modifications and improvements.