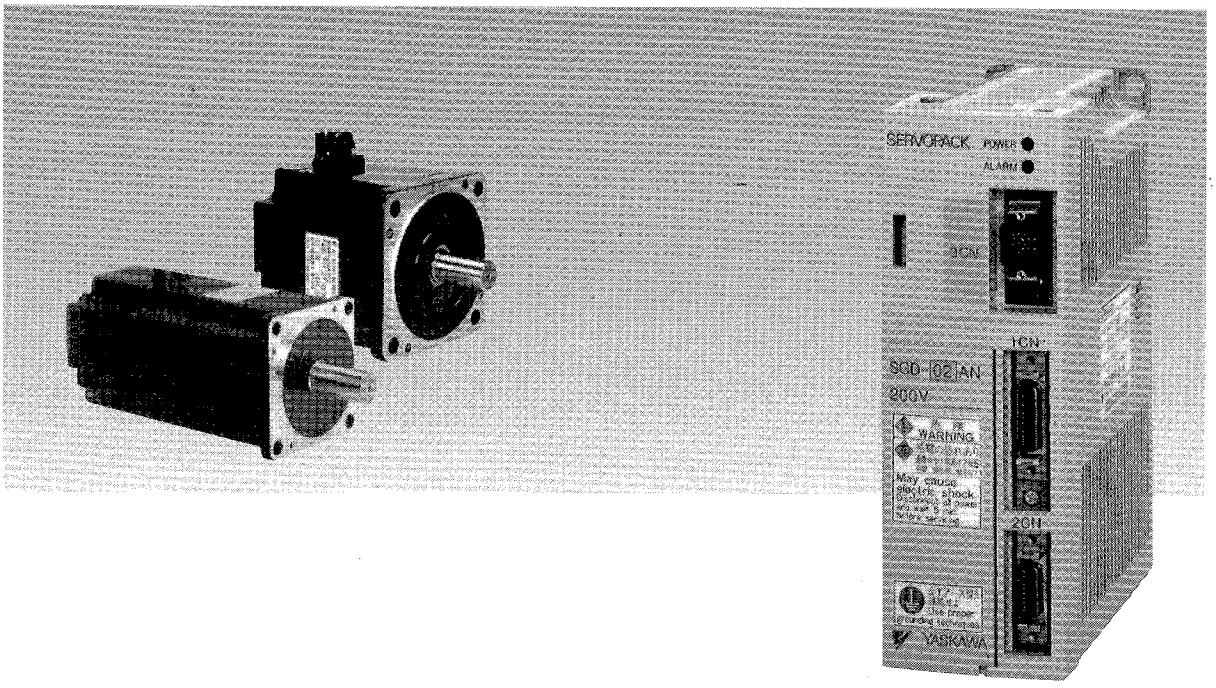
Σ Series SGM□/SGD

USER'S MANUAL

AC Servodrives

SGM/SGMP Servomotors
SGD-□N SERVOPACK



YASKAWA

MANUAL NO. SIE-S800-26.3B

Safety Information

The following conventions are used to indicate precautions in this manual. Failure to heed precautions provided in this manual can result in serious or possibly even fatal injury or damage to the products or to related equipment and systems.

⚠ **WARNING** Indicates precautions that, if not heeded, could possibly result in loss of life or serious injury.

⚠ **CAUTION** Indicates precautions that, if not heeded, could result in relatively serious or minor injury, damage to the product, or faulty operation.

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Preface

Based on Yaskawa servo manufacturing technology and servo application technology accumulated over the last half a century, Yaskawa has launched the AC Servo Series that, together with its rich line of products, meets the needs of the modern needs of FA and FMS in their application to machining tools and robots.

AC Servos not only provide stable, highly accurate, and high-speed response control even under adverse environments, but also provide such features as easy application, flexibility, and easy maintain. The new Yaskawa AC Servos can be used in various servo fields, including machining tools and robots.

Features

- The highest available power rates and response in this class of servo.
- Compared with conventional products, these servomotors are approximately 1/3 both in volume and weight and SERVOPACKS are approximately 1/4 in volume.
- The book-shape SERVOPACKS can be used with either incremental encoders or absolute encoders.
- Positioning is performed using the MECHATROLINK High-speed Field Network.
- Electronic gear function provided.
- For incremental encoders, there are now only 9 lines to wire between the encoder and the SERVOPACK (previously: 15 lines).
- There are now only 6 I/O points to wire (previously: 15 I/O points).
- Improved environmental resistance by using varnish coating.
- Improved dispersion with command cable length up to 50 m (previously: 3 m).

Related Manuals

Refer to the following manuals as required

Read this manual carefully to ensure the proper use of the SERVOPACKS. Also, keep this manual in a safe place so that it can be referred to whenever necessary.

Manual Name	Manual No.	Contents
MECHATROLINK Systems User's Manual	SIE-S800-26.1	Gives a detailed description of the MECHATROLINK Network.
MECHATROLINK Servo Command User's Manual	SIE-S800-26.2	Provides a detailed description of the MECHATROLINK servo commands.

Safety Precautions

The following precautions are for checking products upon delivery, installation, wiring, operation, maintenance and inspections.

■ Checking Products on Delivery

⚠ CAUTION
• Be sure to use the specified Servomotor and SERVOPACK combination. Fire or damage may result if the wrong combination is used..

■ Installation

⚠ CAUTION
• Do not use the products in or near environments exposed to moisture, corrosive gases, flammable gases , or other flammable materials. Electric shock or fire may result.

■ Wiring

⚠ WARNING
• Be sure to ground the SERVOPACK ground terminal ⏚ less than 100 Ω. Electric shock or fire may result if the SERVOPACK is not grounded properly.

⚠ CAUTION
• Do not connect a three–phase power supply to the U, V, and W output terminals of the SERVO-PACK. Injury or fire may result. • Make sure the power supply and Servomotor output terminals are securely tightened. Fire may result if terminals are loose.

■ Operation

⚠ WARNING

- Do not touch rotating parts of the Servomotor during operation.

  Injury may result.

⚠ CAUTION

- In order to avoid accidents, do not connect the Servomotor shaft to the controlled equipment during the trial operation.

  Injury may result.

- Be sure to set the proper user constants for the controlled equipment prior to starting operation with the Servomotor connected to the equipment.

  Equipment overrun or damage may result without proper settings prior to the start of operation.

- Always set up an emergency stop prior to starting operation with the Servomotor connected to the equipment.

  Injury may result if an emergency stop is not readily available.

- Do not touch the heat sink area during operation.

  Severe burns due to high temperatures may result.

■ Maintenance and Inspection

⚠ WARNING

- Do not touch areas inside the SERVOPACK.

  Electric shock may result.

- Make sure the panel cover is attached when power is ON.

  Electric shock may result if the panel cover is left open.

- Turn OFF power and wait 5 minutes before touching terminals.

  Electric shock from residual voltage may result if terminals are touched within 5 minutes of turning OFF power.

⚠ CAUTION

- Do not disassemble the Servomotor.

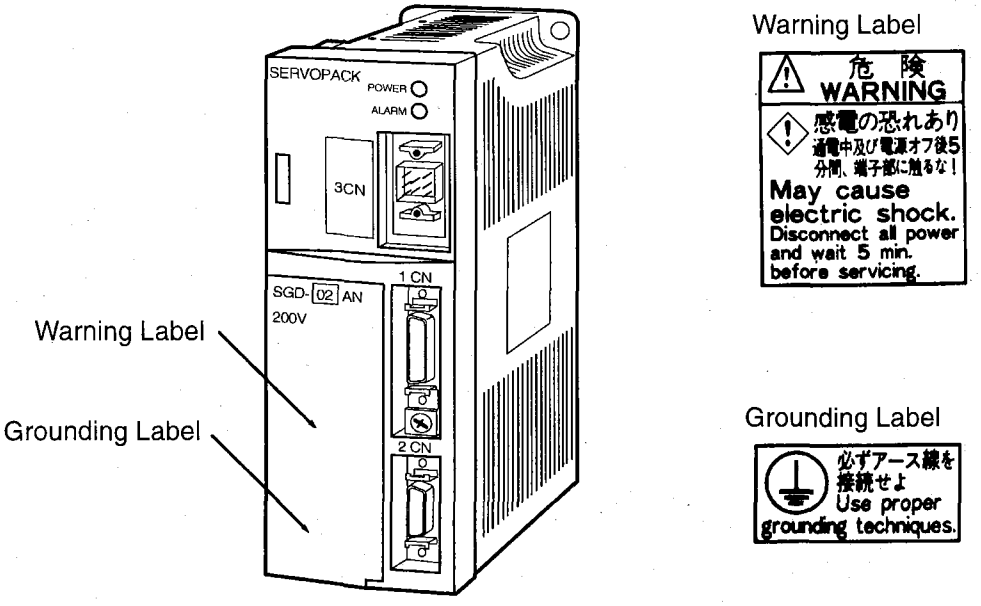
  Electric shock or injury may result.

- Do not change wiring with the power turned ON.

  Electric shock or injury may result.

■ General Precautions

Note the following to ensure safe application.
• The drawings presented in this manual are sometimes shown without covers or protective guards. Always replace the cover or protective guard as specified first, and then operate the products in accordance with the manual. • The drawings presented in this manual are typical examples and may not match the product you received. • This manual is subject to change due to product improvement, specification modification, and manual improvement. When this manual is revised, the manual code is updated and the new manual is published as a next edition. The edition number appears on the front and back covers. • If the manual must be ordered due to loss or damage, inform your nearest Yaskawa representative or one of the offices listed on the back of this manual. • Yaskawa will not take responsibility for the results of unauthorized modifications of this product. Yaskawa shall not be liable for any damages or troubles resulting from unauthorized modification.



Warning Label and Grounding Label Sticker Attachment Positions

1

Configuration and Model Numbers

This chapter describes the configuration and model numbers for Servodrives.

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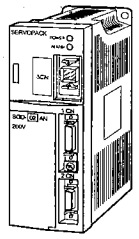
1.2.2 SERVOPACK Model Numbers ..... 1 - 3

1.1 Configuration

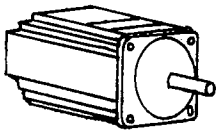
Servodrives are configured using a SERVOPACK (Controller) and Servomotors.

SGD-□□AN SERVOPACK

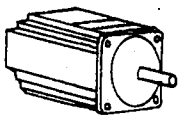


SERVOPACK

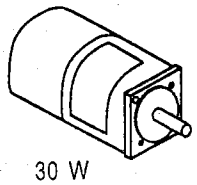
Servomotors



750 W



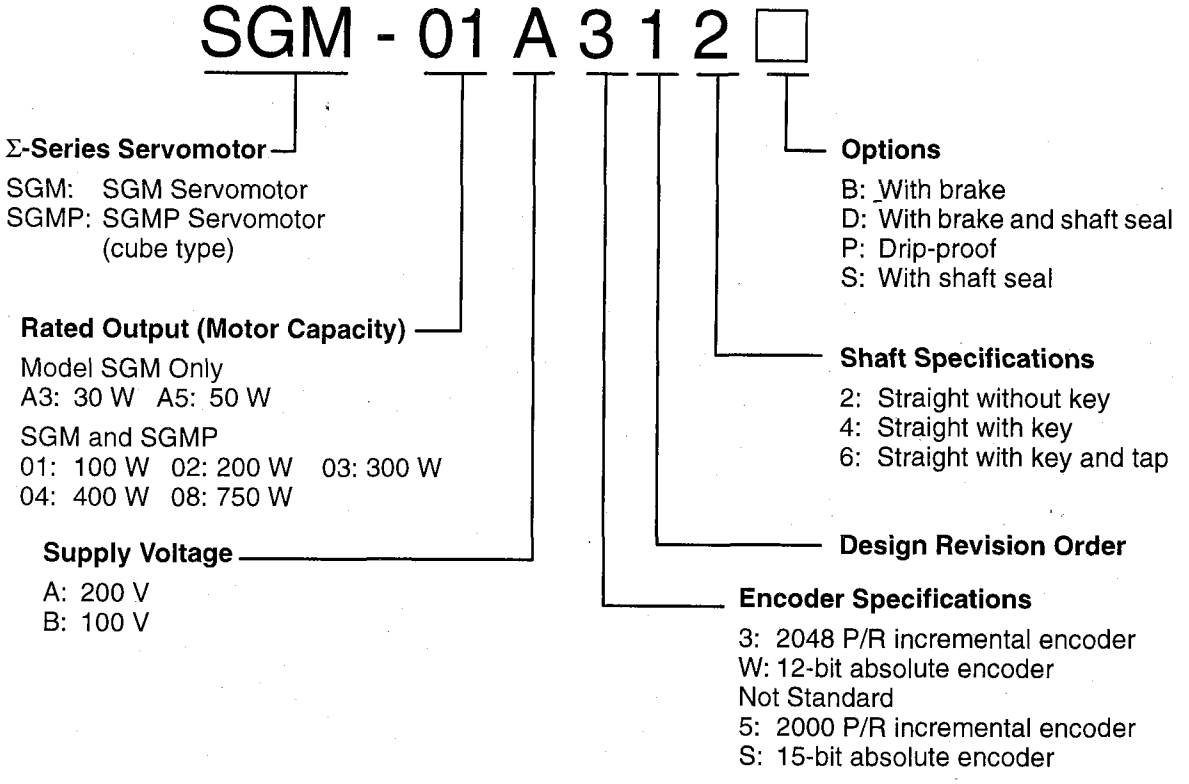
200 W
300 W
400 W



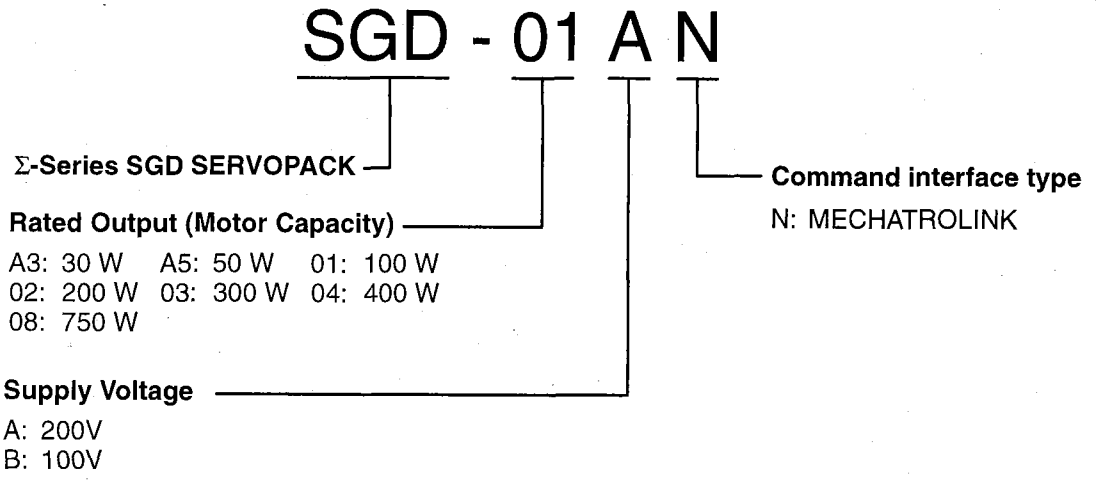
30 W
50 W
100 W

1.2 Models

1.2.1 Servomotor Model Numbers



1.2.2 SERVOPACK Model Numbers



2

Ratings and Characteristics

This chapter provides Servomotor ratings, specifications, and torque-speed characteristics, as well as SERVOPACK ratings and specifications.

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2.1 Ratings/Specifications for 200-VAC SGM Servomotors

2.1.1 Ratings and Specifications

- Time Rating: Continuous
- Enclosure: Totally enclosed, self cooled
- Excitation: Permanent magnet
- Thermal Class: B
- Ambient Temperature: 0 to 40°C
- Drive Method: Direct drive
- Vibration Class: 15 μm or below
- Ambient Humidity: 20% to 80% (with no condensation)
- Mounting: Flange method
- Withstand Voltage: 1500 VAC
- Insulation Resistance: 500 VDC, 10 MΩ min.

Table 2.1 200-VAC SGM Servomotor Ratings and Specifications

SGM Servomotor Type: SGM-		A3A	A5A	01A	02A	04A	08A
Rated Output*1	W	30	50	100	200	400	750
Rated Torque*1*2	N·m	0.095	0.159	0.318	0.637	1.27	2.39
	oz·in *3	13.5	22.5	45.0	90.2	180	338
Instantaneous Peak Torque*1	N·m	0.29	0.48	0.96	1.91	3.82	7.1
	oz·in *3	41.1	68.0	136	270	541	1005
Rated Current*1	A (rms)	0.42	0.6	0.87	2.0	2.6	4.4
Instantaneous Max Current*1	A (rms)	1.3	1.9	2.8	6.0	8.0	13.9
Rated Speed*1	r/min	3000					
Instantaneous Max Speed*1	r/min	4500					
Torque Constant*1	N·m/A (rms)	0.255	0.286	0.408	0.355	0.533	0.590
	kgf·cm/A (rms) *3	2.60	2.92	4.16	3.62	5.44	6.01
Moment of Inertia [J_M]	$\times 10^{-4}$ kg·m^2	0.021	0.026	0.040	0.123	0.191	0.671
	$\times 10^{-3}$ oz·in·s^2 *3	0.288	0.368	0.576	1.74	2.70	9.52
Rated Power Rate*1	kW/s	4.36	9.63	25.4	32.8	84.6	85.1
Rated Angular Acceleration*1	rad/s^2	45200	61200	79500	51800	66600	35600
Inertia Time Constant	ms	1.5	0.9	0.5	0.4	0.3	0.3
Inductive Time Constant	ms	1.5	1.8	1.9	5.4	6.4	13

* 1. These items and torque-motor speed characteristics quoted in combination with a SERVOPACK are at an armature winding temperature of 100°C. Other values quoted at 20°C. All values are typical.

* 2. Rated torques are continuous allowable torque values at 40°C with a 250×250×6 (mm) (9.84×9.84×0.24 (in.)) heat sink attached.

* 3. These values are reference values.

Note When a motor is fitted with a shaft seal, use the following reduction ratings because of the higher friction torque.

SGM-	A3A	A5A	01A	02A	04A	08A
Reduction Rating (%)	70	80	90		95	

Add the numerical values given below to the moment of inertia values in the table for a motor attatched with a holding brake and/or a 12-bit absolute encoder. Other specifications will also change.

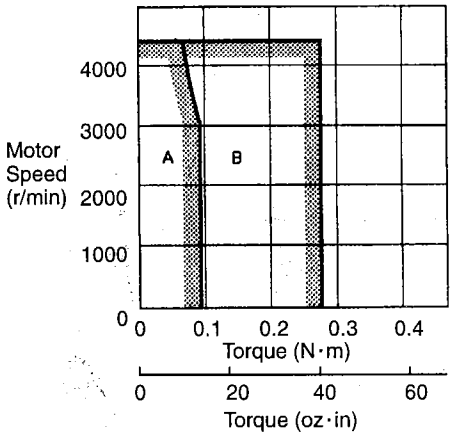
Item \ Type		SGM-					
		A3A	A5A	01A	02A	04A	08A
Holding brake	$\times 10^{-4}$ kg·m^2	0.0085			0.058		0.14
	$\times 10^{-4}$ oz.in·s^2 *	0.12			0.821		1.98
12-bit absolute encoder	$\times 10^{-4}$ kg·m^2	0.025					
	$\times 10^{-4}$ oz.in·s^2 *	0.354					

* These values are reference values.

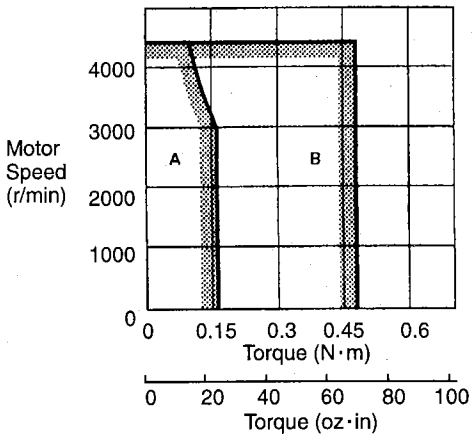
2

■ 200-VAC SGM Servomotor Torque-Motor Speed Characteristics

SGM-A3A



SGM-A5A



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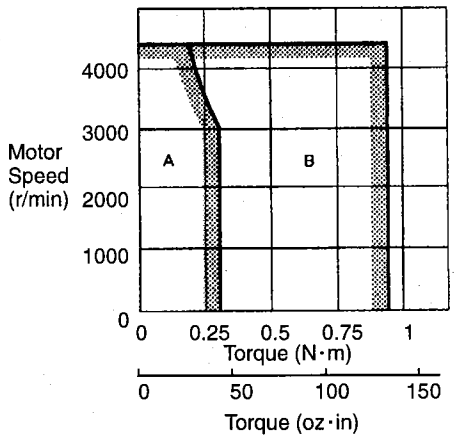

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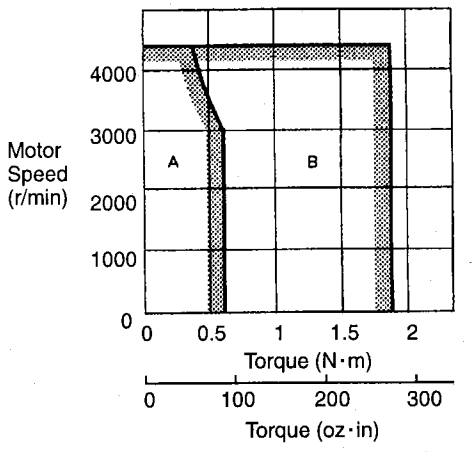
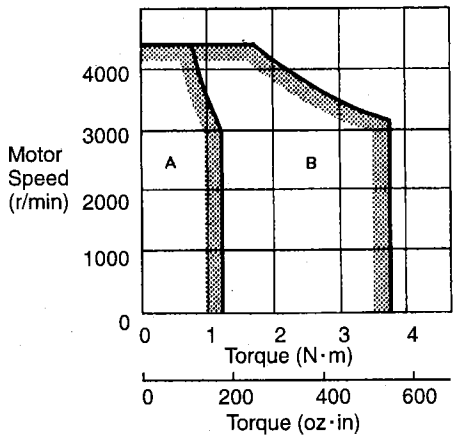
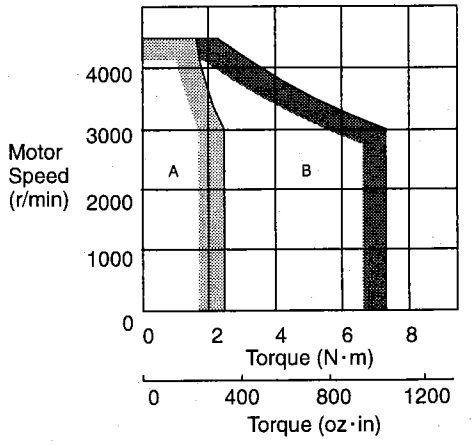


SGM-04A



SGM-08A



A: Continuous Duty Zone
B: Intermittent Duty Zone

2.2 Ratings/Specifications for 100-VAC SGM Servomotors

2.2.1 Ratings and Specifications

- Time Rating: Continuous
- Enclosure: Totally enclosed, self cooled
- Excitation: Permanent magnet
- Thermal Class: B
- Ambient Temperature: 0 to 40°C
- Drive Method: Direct drive
- Vibration Class: 15 μm or below
- Ambient Humidity: 20% to 80% (with no condensation)
- Mounting: Flange method
- Withstand Voltage: 1500 VAC
- Insulation Resistance: 500 VDC, 10 MΩ min.

Table 2.2 100-VAC SGM Servomotor Ratings and Specifications

SGM Servomotor Type: SGM-			A3B	A5B	01B	02B	03B
Rated Output *1		W	30	50	100	200	300
Rated Torque *1 *2		N·m	0.095	0.159	0.318	0.637	0.95
		oz·in *3	13.5	22.5	45.0	90.2	135
Instantaneous Peak Torque *1		N·m	0.29	0.48	0.96	1.91	3.72
		oz·in *3	41.1	68.0	136	270	527
Rated Current *1		A (rms)	0.63	0.9	2.2	2.7	3.7
Instantaneous Peak Current *1		A (rms)	2.0	2.9	7.1	8.4	14.8
Rated Rotation Speed *1		r/min	3000				
Max. Rotation Speed *1		r/min	4500				
Torque Constant *1		N·m/A (rms)	0.168	0.194	0.156	0.255	0.279
		kgf·cm/A (rms) *3	1.72	1.98	1.59	2.60	2.85
Moment of Inertia [J_M]	Incremental encoder, no brake	$\times 10^{-4}$ kg·m^2	0.021	0.026	0.040	0.123	0.191
		$\times 10^{-3}$ oz·in·s^2 *3	0.288	0.368	0.576	1.74	2.71
Rated Power Rating *1		kW/s	4.36	9.63	25.4	32.8	47.3
Rated Angular Acceleration *1		rad/s^2	45200	61200	79500	51800	49700
Inertia Time Constant		ms	1.6	0.9	0.6	0.4	0.3
Inductive Time Constant		ms	1.3	1.6	1.6	5.7	5.3

* 1. These items and torque-motor speed characteristics quoted in combination with a SERVOPACK are at an armature winding temperature of 100°C. Other values quoted at 20°C. All values are typical.

* 2. Rated torques are continuous allowable torque values at 40°C with a 250×250×6 (mm) (9.84×9.84×0.24 (in.)) heat sink attached.

* 3. These values are reference values.

Note When a motor is fitted with a shaft seal, use the following reduction ratings because of the higher friction torque.

SGM-	A3B	A5B	01B	02B	03B
Reduction Rating (%)	70	80	90		

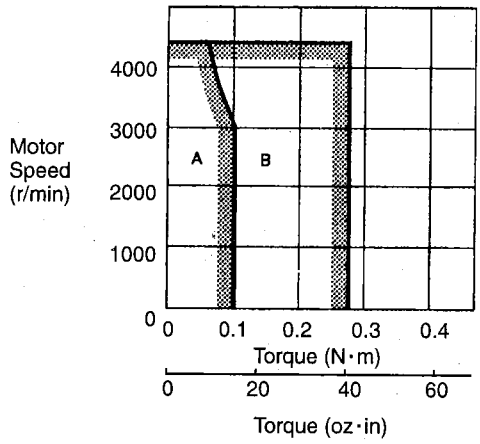
Add the numerical values given below to the moment of inertia values in the table for a motor attached with a holding brake and/or a 12-bit absolute encoder. Other specifications will also change.

Item \ Type		SGM-				
		A3B	A5B	01B	02B	03B
Holding brake	$\times 10^{-4}$ kg·m^2	0.0085			0.058	
	$\times 10^{-4}$ oz·in·s^2 *	0.12			0.821	
12-bit absolute encoder	$\times 10^{-4}$ kg·m^2	0.025				
	$\times 10^{-4}$ oz·in·s^2 *	0.354				

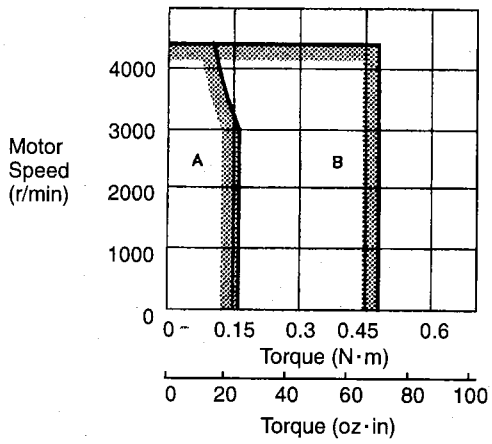
* These values are reference values.

■ 100-VAC SGM Servomotor Torque-Motor Speed Characteristics

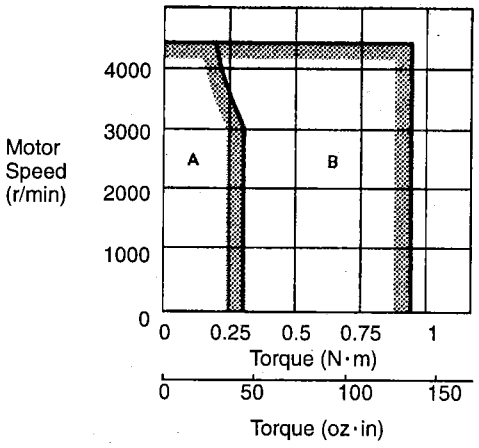
SGM-A3B



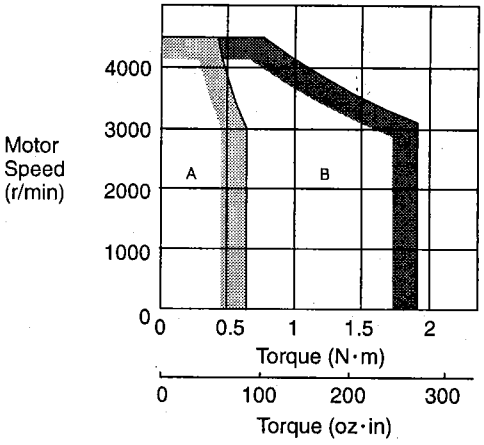
SGM-A5B



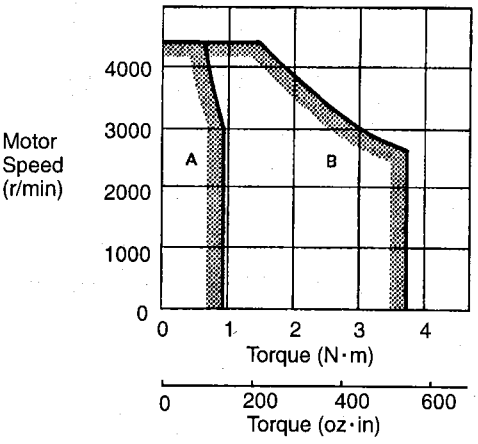
SGM-01B



SGM-02B



SGM-03B



A: Continuous Duty Zone
B: Intermittent Duty Zone

2.3 Ratings/Specifications for 200-VAC SGMP Servomotors

2.3.1 Ratings and Specifications

- Time Rating: Continuous
- Enclosure: Totally enclosed, self cooled
- Excitation: Permanent magnet
- Thermal Class: B
- Ambient Temperature: 0 to 40°C
- Drive Method: Direct drive
- Vibration Class: 15 μm or below
- Ambient Humidity: 20% to 80% (with no condensation)
- Mounting: Flange method
- Withstand Voltage: 1500 VAC
- Insulation Resistance: 500 VDC, 10 MΩ min.

Table 2.3 200-VAC SGMP Servomotor Ratings and Specifications

SGMP Servomotor Type: SGMP-			01A	02A	04A	08A
Rated Output *1		W	100	200	400	750
Rated Torque *1 *2		N·m	0.318	0.637	1.27	2.39
		oz·in *3	45.0	90.2	180	338
Instantaneous Peak Torque *1		N·m	0.96	1.91	3.82	7.1
		oz·in *3	136	270	541	1005
Rated Current *1		A (rms)	0.89	2.0	2.6	4.1
Instantaneous Peak Current *1		A (rms)	2.8	6.0	8.0	13.9
Rated Rotation Speed *1		r/min	3000			
Max. Rotation Speed *1		r/min	4500			
Torque Constant *1		N·m/A (rms)	0.392	0.349	0.535	0.641
		kgf·cm/A (rms) *3	4.00	3.56	5.46	6.55
Moment of Inertia	Incremental encoder without holding brake	$\times 10^{-4}$ kg·m^2	0.065	0.209	0.347	2.11
		$\times 10^{-3}$ oz·in·s^2 *3	0.917	2.96	4.92	29.9
	Incremental encoder with holding brake	$\times 10^{-4}$ kg·m^2	0.09	0.318	0.456	2.99
		$\times 10^{-3}$ oz·in·s^2 *3	1.27	4.50	6.46	35.7
	Absolute encoder without holding brake	$\times 10^{-4}$ kg·m^2	0.090	0.234	0.372	2.14
		$\times 10^{-3}$ oz·in·s^2 *3	1.27	3.31	5.27	30.3
	Absolute encoder with holding brake	$\times 10^{-4}$ kg·m^2	0.119	0.343	0.481	3.01
		$\times 10^{-3}$ oz·in·s^2 *3	1.69	4.86	6.81	42.6
Rated Power Rate *1		kW/s	15.7	19.4	46.8	26.9
Rated Angular Acceleration *1		rad/s^2	49200	30500	36700	11300
Inertia Time Constant		ms	0.7	0.6	0.4	0.7
Inductive Time Constant		ms	3.7	7.4	8.5	18

* 1. These items and torque-motor speed characteristics quoted in combination with a SERVOPACK are at an armature winding temperature of 100°C. Other values quoted at 20°C. All values are typical.

* 2. Rated torques are continuous allowable torque values at 40°C with the specified heat sink attached.
Heat sink dimensions: For 01A, 02A,04A Servomotors: 250 × 250 × 6 (mm) (9.84 × 9.84 × 0.24 (in))
For 08A Servomotors: 300 × 300 × 12 (mm) (11.81 × 11.81 × 0.47 (in))

* 3. These values are reference values.

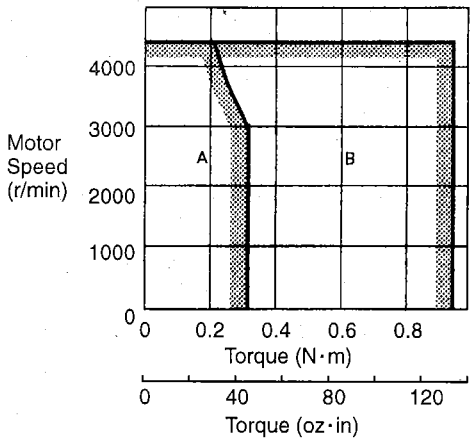
Note 1. When a motor is fitted with a shaft seal, use the following reduction ratings because of the higher friction torque.

2. Holding brakes or 12-bit absolute encoders have larger moments of inertia than incremental encoders. Therefore, the characteristics change slightly.

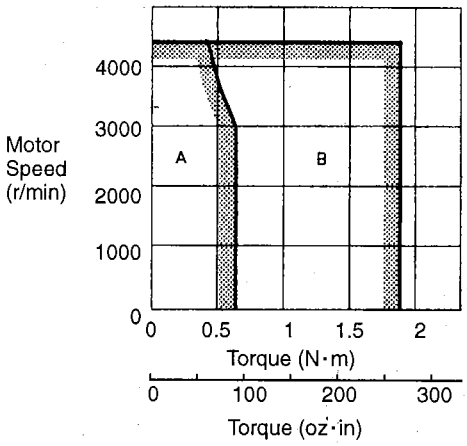
SGMP-	01A	02A	04A	08A
Reduction Rating (%)	90	90	95	95

■ 200-VAC SGMP Servomotor Torque-Motor Speed Characteristics

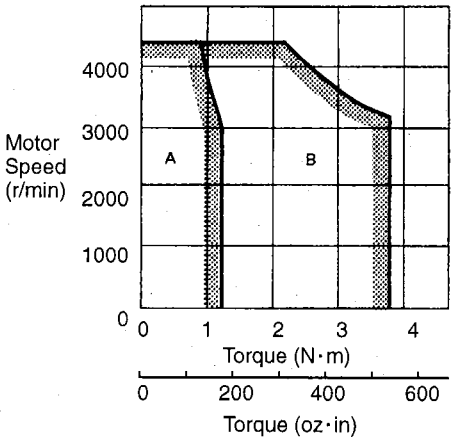
SGMP-01A



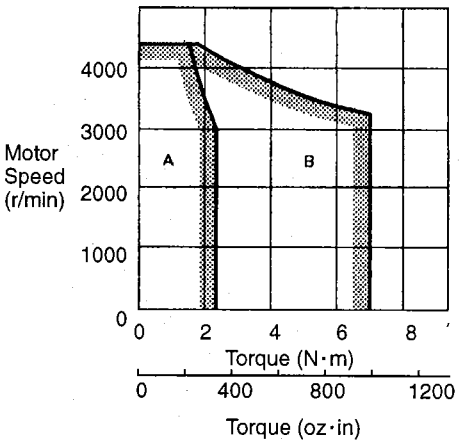
SGMP-02A



SGMP-04A



SGMP-08A



A: Continuous Duty Zone
B: Intermittent Duty Zone

2.4 Ratings/Specifications for 100-VAC SGMP Servomotors

2.4.1 Ratings and Specifications

- Time Rating: Continuous
- Enclosure: Totally enclosed, self cooled
- Excitation: Permanent magnet
- Thermal Class: B
- Ambient Temperature: 0 to 40°C
- Drive Method: Direct drive
- Vibration Class: 15 μm or below
- Ambient Humidity: 20% to 80% (with no condensation)
- Mounting: Flange method
- Withstand Voltage: 1500 VAC
- Insulation Resistance: 500 VDC, 10 MΩ min.

Table 2.4 100-VAC SGMP Servomotor Ratings and Specifications

SGMP Servomotor Type: SGMP-			01B	02B	03B
Rated Output*1		W	100	200	300
Rated Torque*1*2		N·m	0.318	0.637	0.955
		oz·in *3	45.0	90.2	135
Instantaneous Peak Torque*1		N·m	0.96	1.91	2.86
		oz·in *3	136	270	405
Rated Current*1		A (rms)	2.2	2.7	4.3
Instantaneous Peak Current*1		A (rms)	7.1	8.4	13.9
Rated Rotation Speed*1		r/min	3000		
Max. Rotation Speed*1		r/min	4500		
Torque Constant*1		N·m/A (rms)	0.160	0.258	0.246
		kgf·cm/A (rms) *3	1.64	2.63	2.51
Moment of Inertia	Incremental encoder without holding brake	$\times10^{-4}$ kg·m^2	0.065	0.209	0.347
		$\times10^{-3}$ oz·in·s^2 *3	0.917	2.96	4.92
	Incremental encoder with holding brake	$\times10^{-4}$ kg·m^2	0.09	0.318	0.456
		$\times10^{-3}$ oz·in·s^2 *3	1.27	4.50	6.46
	Absolute encoder without holding brake	$\times10^{-4}$ kg·m^2	0.090	0.234	0.372
		$\times10^{-3}$ oz·in·s^2 *3	1.27	3.31	5.27
	Absolute encoder with holding brake	$\times10^{-4}$ kg·m^2	0.119	0.343	0.481
		$\times10^{-3}$ oz·in·s^2 *3	1.69	4.86	6.81
Rated Power Rate*1		kW/s	15.7	19.4	26.3
Rated Angular Acceleration*1		rad/s^2	49200	30500	27500
Inertia Time Constant		ms	0.8	0.7	0.4
Inductive Time Constant		ms	3.6	6.3	7.9

* 1. These items and torque-motor speed characteristics quoted in combination with a SERVOPACK are at an armature winding temperature of 100°C. Other values quoted at 20°C. All values are typical.

* 2. Rated torques are continuous allowable torque values at 40°C with a 250×250×6 (mm) (9.84×9.84×0.24 (in.)) heat sink attached.

* 3. These values are reference values

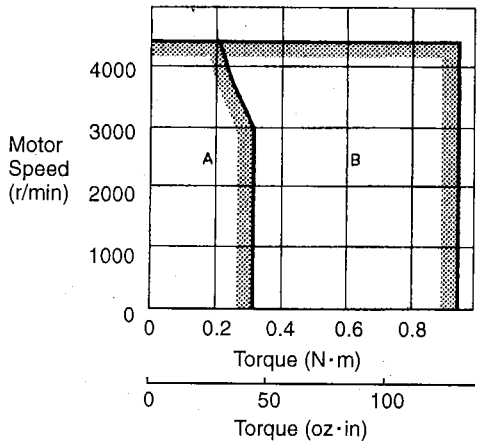
Note 1. When a motor is fitted with a shaft seal, use the following reduction ratings because of the higher friction torque.

2. Holding brakes or 12-bit absolute encoders have larger moments of inertia than incremental encoders. Therefore, the characteristics change slightly.

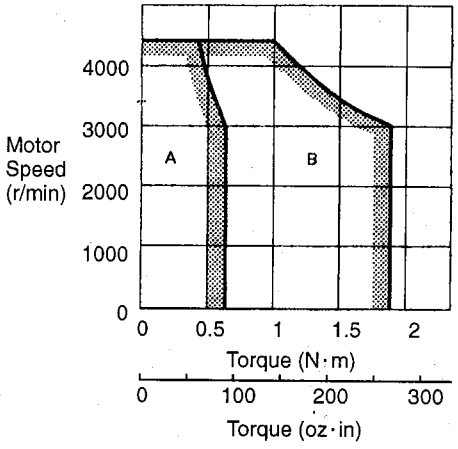
SGMP-	01B	02B	03B
Reduction Rating (%)	90	90	95

■ 100-VAC SGMP Servomotor Torque-Motor Speed Characteristics

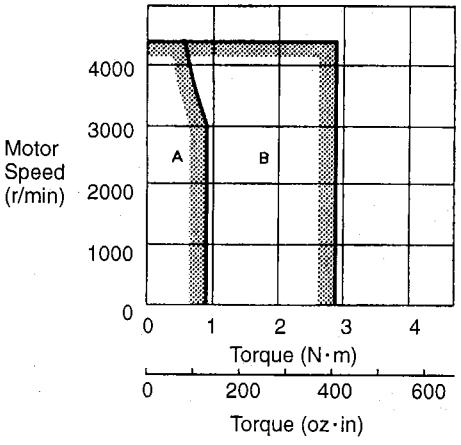
SGMP-01B



SGMP-02B



SGMP-03B



A: Continuous Duty Zone
B: Intermittent Duty Zone

2.5 SERVOPACK Ratings and Specifications

The ratings and specifications for the SGD SERVOPACK are shown below. Refer to them as required when selecting a SERVOPACK. Refer to the specifications listed in the table for combination with the appropriate type of Servomotor.

Table 2.5 SERVOPACK and Applicable Servomotors

Voltage			200 VAC						100 VAC				
SGD SERVOPACK			A3AN	A5AN	01AN	02AN	04AN	08AN	A3BN	A5BN	01BN	02BN	03BN
Max. Applicable Motor Capacity W (HP)			30 (0.04)	50 (0.07)	100 (0.13)	200 (0.27)	400 (0.53)	750 (1.01)	30 (0.04)	50 (0.07)	100 (0.13)	200 (0.27)	300 (0.40)
Combined Specifications	Motor	Type: SGM-	A3A□	A5A□	01A□	02A□	04A□	08A□	A3B□	A5B□	01B□	02B□	03B□
		SGMP	–	–	01A□	02A□	04A□	08A□	–	–	01B□	02B□	03B□
		Motor Capacity W (HP)	30 (0.04)	50 (0.07)	100 (0.13)	200 (0.27)	400 (0.53)	750 (1.01)	30 (0.04)	50 (0.07)	100 (0.13)	200 (0.27)	300 (0.40)
		Rated/ Max. Motor Speed	3000/4500 r/min						3000/4500 r/min				
		Applicable encoder	Incremental encoder 2048 P/R, absolute encoder 1024 P/R										
		Allowable Load Inertia*1 $J_L \times 10^{-4}$ kg·m^2 (oz·in·s^2 × 10^{-3})	0.63 (8.80)	0.78 (11.0)	1.20 (17.0)	3.69 (52.2)	3.82 (54.1)	13.4 (189)	0.63 (8.80)	0.78 (11.0)	1.20 (17.0)	3.69 (52.2)	3.82 (54.1)
	Continuous Output Current A (rms)		0.42	0.6	0.87	2.0	2.6	4.4	0.63	0.90	2.2	2.7	3.7
	Max. Output Current A (rms)		1.3	1.9	2.8	6.0	8.0	13.9	2.0	2.9	7.1	8.4	14.8
Basic Specifications	Power Supply		Single-phase 200 to 230 VAC, +10% to –15%, 50/60 Hz*2						Single-phase 100 to 115 VAC*2, +10% to –15%, 50/60 Hz				
	Control Method		Single-phase, full-wave rectification IGBT-PWM (sine-wave driven)										
	Feedback		Incremental encoder 2048 P/R, absolute encoder 1024 P/R										
	Conditions	Ambient Temp.	0 to 55°C*3										
		Storage Temp.	–20 to +85°C										
		Ambient/ Storage Humidity	90% or less (with no condensation)										
		Vibration/ Shock Resistance	4.9/19.6 m/s^2 (0.5/2G)										
	Configuration		Book (Base-mounted)										
	Approx. Mass kg (lb)		0.9 (1.98)				1.2 (2.65)	1.5 (3.31)	0.9 (1.98)			1.2 (2.65)	1.5 (3.31)
Reference Method	Operation Specifications		Positioning by serial commands										
	Reference Input		MECHATROLINK communication, 4Mbps, 2ms cycle Serial commands: Operation command, move command (position and speed), interpolation command, synchronous command, parameter read, parameter write, monitor output command										

Voltage		200 VAC	100 VAC
Position Control Functions		• Online switching for speed and loop gain: By changing the parameters • Setting for acceleration/deceleration method (linear one–step, linear two-step, exponential, s-curve): By specifying the commands • Conversion between position reference unit and feedback pulse • Setting for feed–forward compensation and bias: By changing user constants • Positioning output and positioning completion output: Read by commands	
Monitoring		Position, speed, position error, torque, SERVOPACK status, and alarm can be monitored using the monitor commands.	
I/O Signals	Sequence Input	Forward overtravel prohibit (P–OT), reverse overtravel prohibit (N–OT), external latch (EXT), zero point return deceleration limit switch (DEC)	
	Sequence Output	Brake interlock (BK), servo alarm (ALM)	
Dynamic Brake (DB)		Operated automatically with power OFF, a servo alarm, or overtravel	
External Regenerative Unit		Required when exceeding the allowable load inertia*1	
Overtravel (OT)		Deceleration to a stop at P-OT, N-OT, or software OT (P–SOT or N–SOT)	
Protective Functions		Overcurrent, grounding, overload, overvoltage, overspeed, overrun prevention, overflow, zero point error, hardware error, encoder error, MECHATROLINK communication error	
Indicators		Alarm, power, and MECHATROLINK communication indicators (LEDs)	
Others		Digital operator and personal computer monitor cannot be used.	

Note 1. Allowable load inertia ranges require no optional External Regenerative Unit. Values are 30 times the moment of inertia for 30 W to 200 W Servomotors, and 20 times for 300-W, 400-W and 750-W Servomotors. If the range is exceeded, some limitation must be provided for use or a Regenerative Unit is required.

2. Supply voltage should not exceed 230 V + 10% (253 V) or 115 V + 10% (127 V). A step-down transformer is required if the voltage should exceed these values.

2.6 Standard Peripheral Device Combinations

The rated current for the external terminal of the SGD SERVOPACK, applicable power supply size, and peripheral equipment are listed in the following table.

Table 2.6 SGM/SGMP Servomotor, SGD SERVOPACK, and Peripheral Device Combinations

Type	SERVOPACK Model SGD-		Applicable Servomotor Model	Power Supply Capacity per SERVOPACK*1 (kVA)	MCCB or Fuse Power Supply Capacity*2 (A)	Applicable Noise Filter (Reference Filter Structure)	Recommended Noise Filter*3		Power ON/OFF Contactor
							Model	Spec.	
200 VAC	30 W	SGD-A3AN	SGM-A3A□	0.25	5	(Applicable)	LF- 205A	Single-phase 200 VAC class, 5 A	Yaskawa HI-15E5 (30 A), or equivalent
	50 W	SGD-A5AN	SGM-A5A□	0.3					
	100 W	SGD-01AN	SGM-01A□	0.5					
			SGMP-01A□						
	200 W	SGD-02AN	SGM-02A□	0.75			LF- 205A	Single-phase 200 VAC class, 5 A	
			SGMP-02A□						
	400 W	SGD-04AN	SGM-04A□	1.2	9		LF- 210	Single-phase 200 VAC class, 10 A	
			SGMP-04A□						
	750 W	SGD-08AN	SGM-08A□	2.2	16		LF- 220	Single-phase 200 VAC class, 20 A	
			SGMP-08A□						
100 VAC	30 W	SGD-A3BN	SGM-A3B□	0.25	5	(Not applicable)	LF- 205A	Single-phase 200 VAC class, 5 A	
	50 W	SGD-A5BN	SGM-A5B□	0.3					
	100 W	SGD-01BN	SGM-01B□	0.5					
			SGMP-01B□						
	200 W	SGD-02BN	SGM-02B□	0.75	8		LF- 210	Single-phase 200 VAC class, 10 A	
			SGMP-02B□						
	300 W	SGD-03BN	SGM-03B□	1.4	15		LF- 220	Single-phase 200 VAC class, 20 A	
			SGMP-03B□						

Note 1. Values for the rated load

2. Shut off characteristics (at 25°C): 200%: 2 s min., 700%: 0.01 s min.

3. A Tokin Corp. noise filter, which is available from Yaskawa Control Co., Ltd., is recommended.

3

Servodrive Characteristics

This chapter provides characteristics of SERVOPACKS and Servomotors.

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3.1 Overload Characteristics

The SERVOPACK has a built-in overload protective function to protect the SERVOPACK and Servomotor from overload. Allowable power for the SERVOPACK is therefore limited by the overload protective function as shown below.

The overload detection level quoted under hot start conditions at a motor ambient temperature of 40°C cannot be modified.

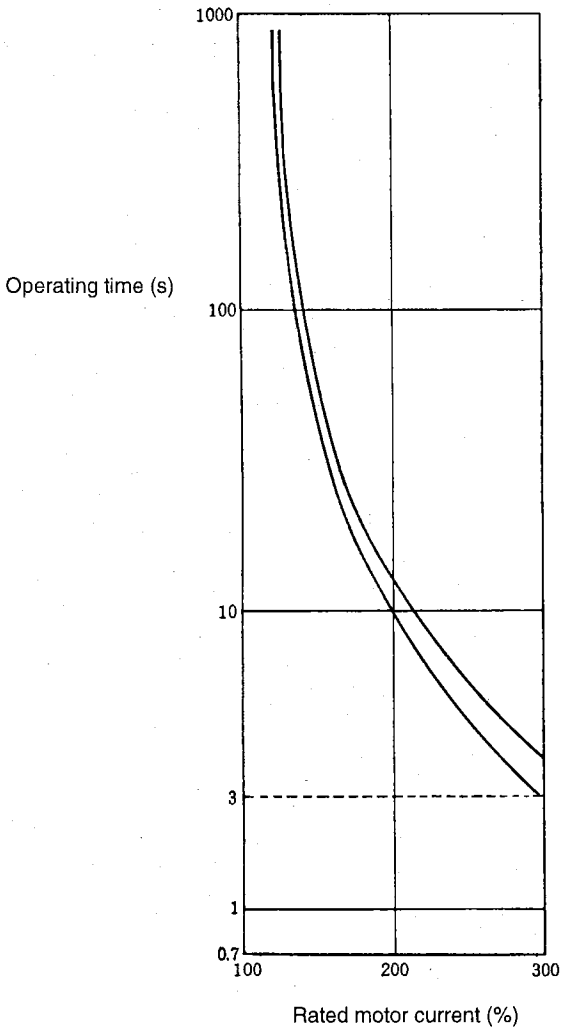


Figure 3.1 Overload Characteristics

3.2 Starting and Stopping Time

The motor starting (*tr*) and stopping time (*tf*) with a constant load are calculated using the following equations. Motor viscous torque and friction torque have been ignored.

$$\text{Starting time: } tr = 104.7 \times \frac{N_R(J_M + J_L)}{Kt \cdot I_R(\alpha-\beta)}[ms]$$

$$\text{Stopping time: } tf = 104.7 \times \frac{N_R(J_M + J_L)}{Kt \cdot I_R(\alpha + \beta)}[ms]$$

N_R: Rated motor speed (r/min)

J_M: Motor moment of inertia ($kg \cdot m^2$)...($GD^2_M/4$)

J_L: Load converted to shaft moment of inertia ($kg \cdot m^2$)...($GD^2_L/4$)

K_t: Motor torque constant ($N \cdot m/A$)

I_R: Rated motor current (A)

$\alpha = I_P/I_R$: Acceleration/deceleration current coefficient

[Where I_P is accel/decel current (accel/decel current is α times the rated motor current) (A)]

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

[Where I_L is the load torque equivalent current (load current is β times the rated motor current) (A)]

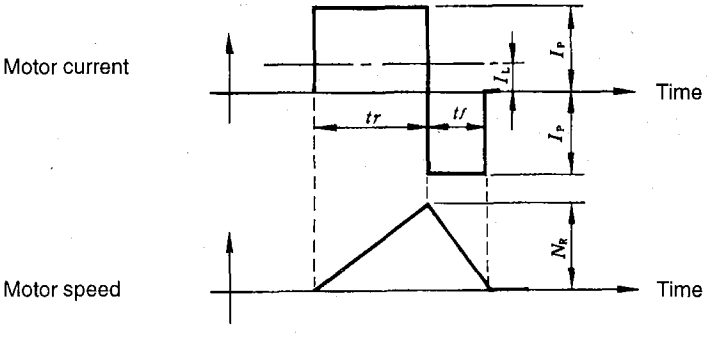


Figure 3.2 Motor Current – Motor Speed Timing Chart

3.3 Allowable Repeatability

The running and stopping frequency is limited by the Servomotor. It is important to ensure that the Servomotor is not started and stopped too frequently.

3.3.1 Allowable Repeatability as Limited by the Servomotor

Running and stopping repeatability vary with motor conditions, such as the load conditions and running time. A typical example is given below (See *Chapter 3.2 "Starting and Stopping Time"* for details on symbols.).

■ With Motor Idling or Stopped

The most common example is the operating cycle shown in Fig. 3.3 where rms frequency for motor armature current is lower than the rated motor current. If we assume that T is the operating cycle, then the range for T will satisfy the following equation.

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

Find I_P, tr, and tf that satisfy the equation above when cycle time (T) is already known.

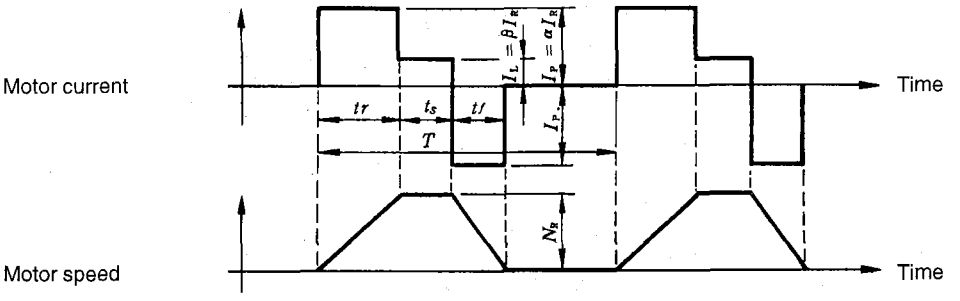


Figure 3.3 Motor Current – Motor Speed Timing Chart

■ With Motor Stopped without Idling Except during Acceleration or Deceleration

The timing chart for motor armature current and motor speed is shown in Fig. 3.4. If we assume that allowable repeatability is n, then n can be found using the equation given below.

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

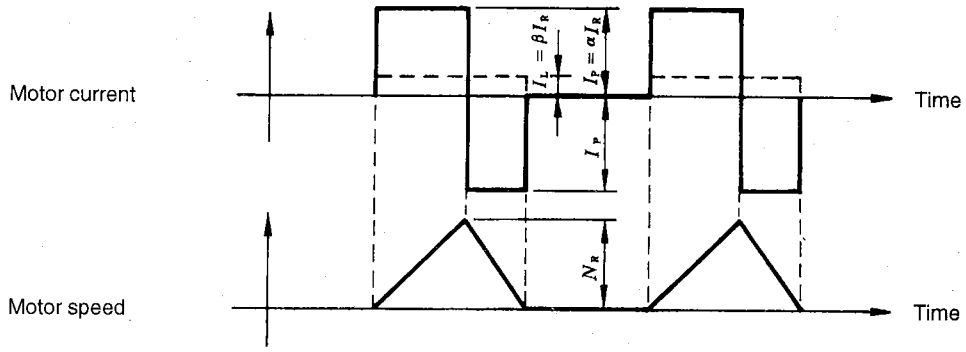


Figure 3.4 Motor Current – Motor Speed Timing Chart

■ With Motor Constantly Cycling through Acceleration, Idling, and Deceleration without Stopping

The timing chart for motor armature current and motor speed is shown in Fig. 3.5. If we assume that allowable repeatability is n (times per minute), then n can be found using the equation given below.

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

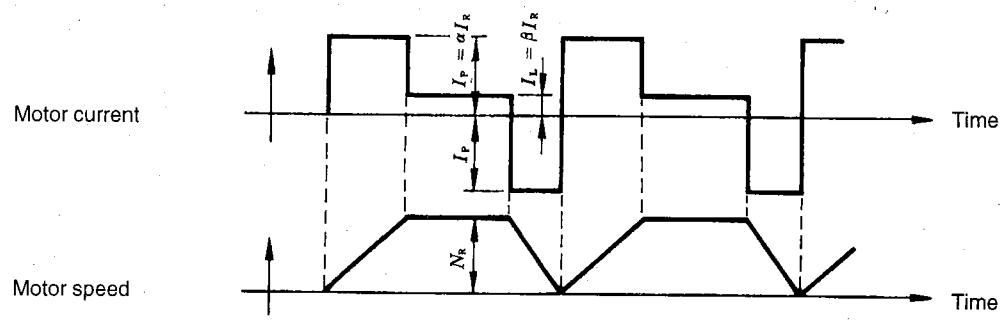


Figure 3.5 Motor Current – Motor Speed Timing Chart

3.4 Large-amplitude Frequency Characteristics

When looking at frequency characteristics with a SERVOPACK and Motor combination, the motor speed amplitude is limited by the peak current through the SERVOPACK. The relationship between motor speed (N) and frequency (f) is expressed using the equation given below.

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

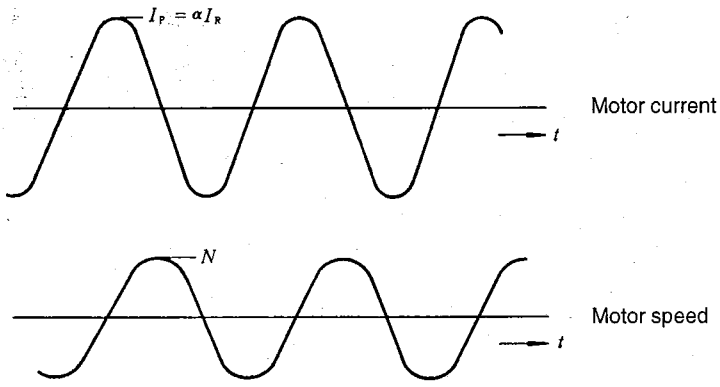


Figure 3.6 Motor Current – Motor Speed Timing Chart

3.5 Mechanical Characteristics

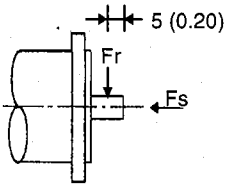
3.5.1 Mechanical Strength

A Servomotor can withstand instantaneous peak torque on the output shaft of up to 300% of the motor rating.

3.5.2 Allowable Radial Load and Allowable Thrust Load

The output shaft allowable loads for SGM and SGMP Servomotors are shown below.

Table 3.1 Allowable Radial Load and Allowable Thrust Load

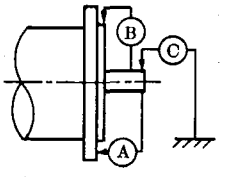
Servomotor Model	Allowable Radial Load Fr [N (lbf)]		Allowable Thrust Load Fs [N (lbf)]		Reference Diagram
	With Incremental Encoder	With Absolute Encoder	With Incremental Encoder	With Absolute Encoder	
SGM-A3	68 (15)	49 (11)	54 (12)	19 (2)	
SGM-A5	68 (15)	68 (15)	54 (12)	19 (2)	
SGM-01	78 (17)	68 (15)	54 (12)	19 (2)	
SGM-02	245 (55)	196 (44)	74 (16)	49 (11)	
SGM-03	245 (55)	196 (44)	74 (16)	68 (15)	
SGM-04	245 (55)	196 (44)	74 (16)	68 (15)	
SGM-08	392 (88)	343 (77)	147 (33)	98 (10)	
SGMP-01	78 (17)	78 (17)	49 (11)	49 (11)	
SGMP-02	245 (55)	245 (55)	68 (15)	49 (11)	
SGMP-03	245 (55)	245 (55)	68 (15)	49 (11)	
SGMP-04	245 (55)	245 (55)	68 (15)	49 (11)	
SGMP-08	392 (88)	392 (88)	147 (33)	49 (11)	

Note Radial and thrust load limit values are the sum of the loads generated by the motor torque and external loads applied to the shaft.

3.5.3 Mechanical Tolerances

Tolerances for Servomotor output shaft and installation are shown in Table 3.2.

Table 3.2 Mechanical Tolerances

Tolerance (T.I.R.)*		Reference Diagram
Perpendicularity between the flange face and output shaft (A)	0.04 mm (0.0016 in)	
Mating concentricity of flange O.D. (B)	0.04 mm (0.0016 in)	
Run-out at the end of the shaft (C)	0.02 mm (0.00079 in)	

* T.I.R. = Total Indicator Reading

3.5.4 Direction of Motor Rotation

AC Servomotor rotation when a positive direction instruction (and direction instruction) is input is counterclockwise as viewed from the load end of the shaft.

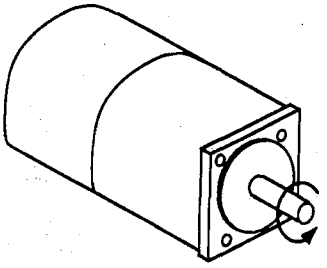
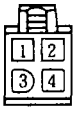


Figure 3.7 Direction of Rotation for Positive Direction Instruction Input

■ Connector Wiring Specifications

Motor Side (Standard)

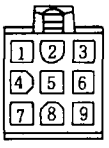


1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG (frame ground)	Green

Motor Side (with Brake)

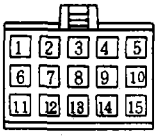
1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG (frame ground)	Green
5	Brake terminal	Black
6	Brake terminal	Black

Encoder Side (Incremental Encoder)



1	Channel A output	Blue
2	Channel $\overline{A}$ output	Blue/Black
3	Channel B output	Yellow
4	Channel $\overline{B}$ output	Yellow/Black
5	Channel Z (C) output	Green
6	Channel $\overline{Z}$ ($\overline{C}$) output	Green/Black
7	0V (power supply)	Gray
8	+5V (power supply)	Red
9	FG (frame ground)	Orange

Encoder Side (Absolute Encoder)



1	Channel A output	Blue
2	Channel $\overline{A}$ output	White/Blue
3	Channel B output	Yellow
4	Channel $\overline{B}$ output	White/Yellow
5	Channel Z (C) output	Green
6	Channel $\overline{Z}$ ($\overline{C}$) output	White/Green
7	0V (power supply)	Black
8	+5V (power supply)	Red
9	FG (frame ground)	Green/Yellow
10	Channel S output	Purple
11	Channel $\overline{S}$ output	White/Purple
(12)*	(Capacitor reset)	(Gray)
13	Reset	White/Gray
14	0 V (battery)	White/Orange
15	3.6 V (battery)	Orange

* Do not use terminal 12; it is used only to discharge the capacitor for shipment.

3.5.5 Impact Resistance

The Servomotor will withstand two vertical impacts at an impact acceleration of 98 m/s^2 (10 G) (See Fig. 3.8.) when the axis of the Servomotor is mounted horizontally.
Since a precision detector is attached to the shaft at the end opposite the load end, do not subject the shaft to direct impact as this may damage the encoder.

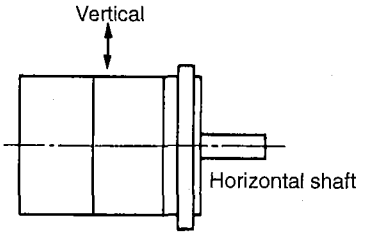


Figure 3.8 Impact Measurement

3.5.6 Vibration Resistance

The Servomotor will withstand a vibration acceleration of 24.5 m/s^2 (2.5 G) in the vertical, transverse, and longitudinal directions (See Fig. 3.9) when the axis of the Servomotor is mounted horizontally.

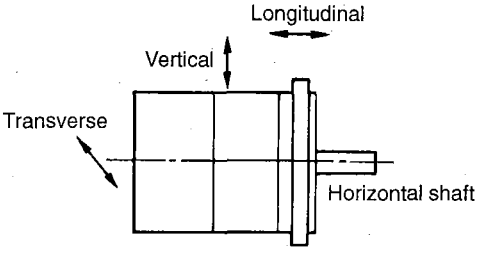


Figure 3.9 Vibration Resistance Measurement

3.5.7 Vibration Class

The vibration class of the Servomotor is 15 μm or below at the rated speed (See Fig. 3.10).

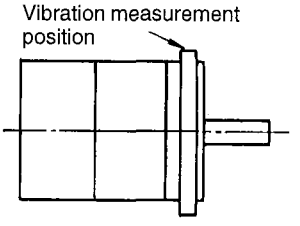


Figure 3.10 Vibration Measurement

4

Configuration and Connections

This chapter provides information on the Servodrives configuration and connections.

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4.1 Internal Connection Diagram

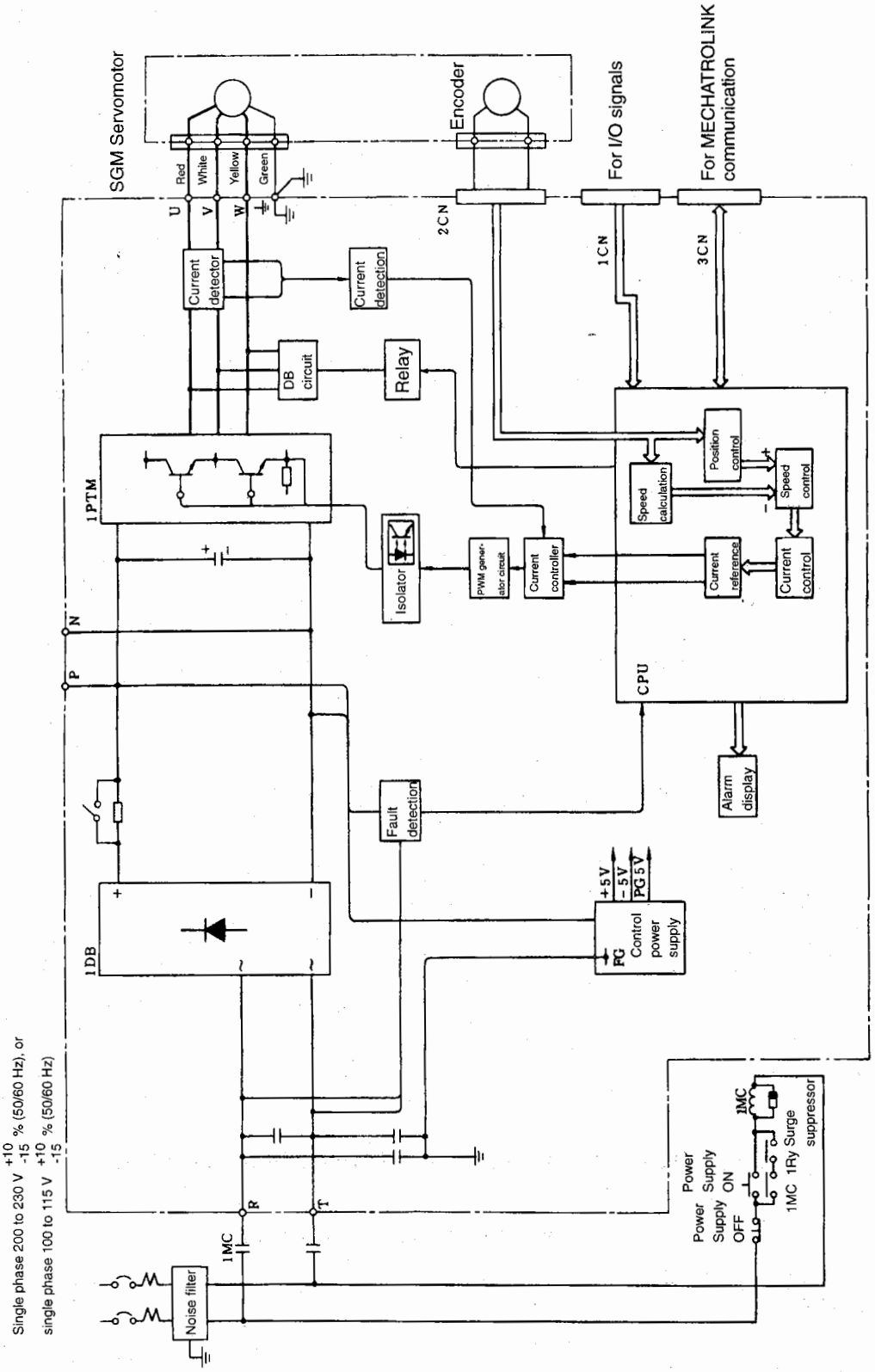


Figure 4.1 Internal Connection Diagram for the SERVOPACK

4.2 Main Circuit Terminals

Table 4.1 Main Circuit Terminals

Terminal Signal	Name	Description
R, T	Power supply input terminal	Single-phase 200 to 230 VAC $^{+10}_{-15}$ %, 50/60 Hz*
U, V, W	Motor terminal	Connect U to the red motor terminal, V to the white motor terminal, and W to the blue motor terminal.
⏚	Ground terminal	Connect to the motor ground terminal (green) for grounding.
P, N	Regenerative Unit terminal	Connect to a Regenerative Unit. (External connection is usually not needed.)

Note For 100 V power supply: Single phase 100 to 115 VAC $^{+10}_{-15}$ %, 50/60 Hz

4.3 Applicable Receptacles

4.3.1 1CN Connector for I/O Signals

Table 4.2 Specifications for Applicable SERVOPACK I/O Signal Receptacles

Specifications for SERVOPACK Connector	Applicable Receptacle Model		
	Solder	Case	Manufacturer
10226-52A2JL (Product of SUMITOMO 3M, Ltd.), 26-pin right angle	10126-3000VE	10326-52A0-008	SUMITOMO 3M, Ltd.

4.3.2 2CN Connector for Encoder

Table 4.3 Applicable Receptacle and Cable Specifications

Specifications for SERVOPACK Connector	Applicable Receptacle Model			Cable Specifications (see note)
	Solder	Case	Manufacturer	
10220-52A2JL (Product of SUMITOMO 3M, Ltd.), 20-pin right angle	10120-3000VE	10320-52A0-008	SUMITOMO 3M, Ltd.	See chapter *9.4 "Cable Specifications"*.

Note This cable is available from Yaskawa. Refer to chapter *9.4 "Cable Specifications"* for more details on cables.

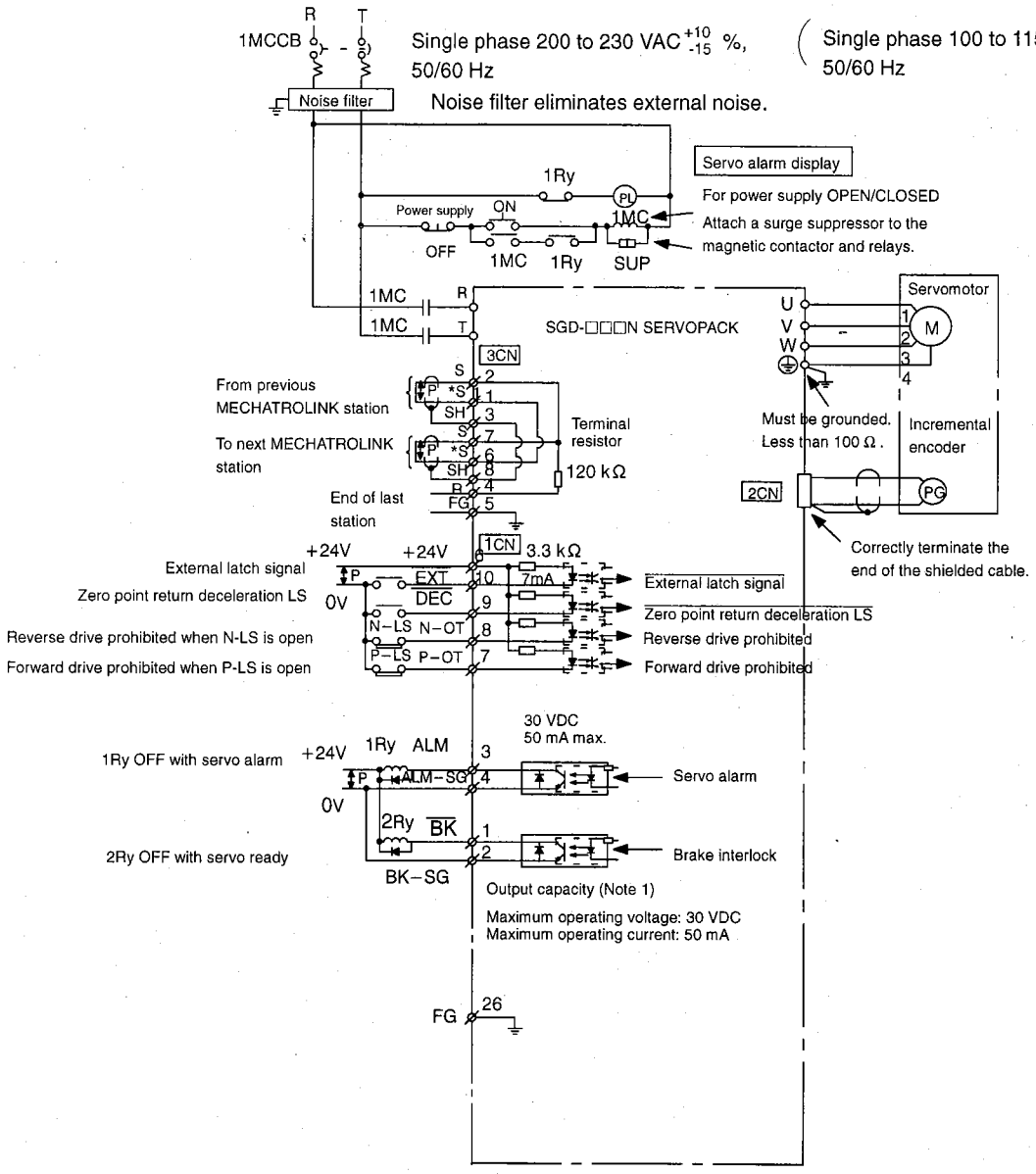
4.3.3 3CN Connector for MECHATROLINK Communication

Table 4.4 Applicable Receptacle

Specifications for SERVOPACK Connector	Applicable Receptacle Model		
	Solder	Case	Manufacturer
MR-8RMD2 (Product of HONDA TSUSHIN INDUSTRY Co., Ltd.), 8-pin right angle	MR-8F	MR-8L	HONDA TSUSHIN INDUSTORY Co., Ltd.

4.4 Connecting an Incremental Encoder

4.4.1 Typical Example



Note 1. Maximum capacity of each output circuit is 50 mA and 30 VDC.

2. Signal output line $\overline{\top}_P$ represents twisted-pair wires.

3. The 24 VDC power (I/O power) supply must be supplied by the user.

4. The power supply must be ON while the servo alarm (1Ry) remains OFF till the communication connection (CONNECT command) is completed after the control power is turned ON.

Figure 4.2 Ex.: SGD-□□□N SERVOPACK Connection to Motor and Peripheral Device

4.4.2 1CN I/O Connector Terminals

■ Terminal Layout

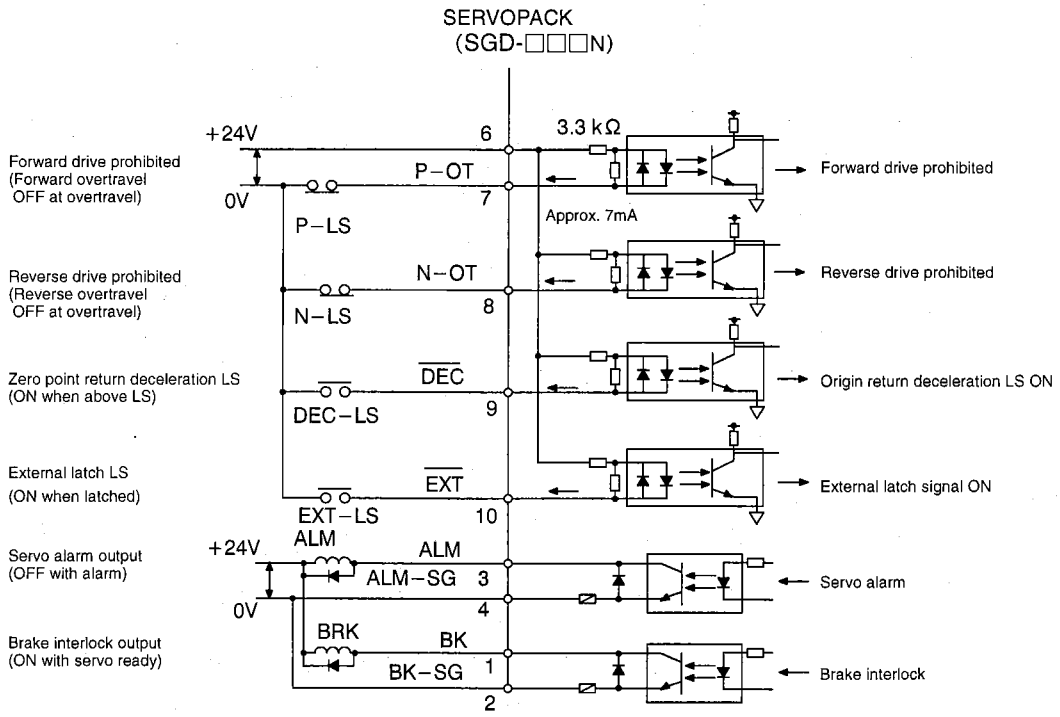
Table 4.5 1CN Terminal Layout

2	4	6	8	10	12	
BK-SG	ALM-SG	+24 V IN	N-OT	$\overline{\text{EXT}}$	–	
Signal ground for brake out	Signal ground for servo alarm	I/O power supply input	Reverse drive prohibited input	External latch signal input	–	
1	3	5	7	9	11	13
$\overline{\text{BK}}$	ALM	–	P-OT	$\overline{\text{DEC}}$	–	–
Brake interlock signal output	Servo alarm output	–	Forward drive prohibited input	Zero point return deceleration LS input	–	–
15	17	19	21	23	25	
–	–	–	–	–	–	
–	–	–	–	–	–	
14	16	18	20	22	24	26
–	–	–	–	–	–	FG
–	–	–	–	–	–	Frame ground

Note 1. Do not connect any terminals marked with "-".

2. Do not use vacant pins for relay or other purposes.

■ I/O Signal Connections and External Signal Processing



Note 1. Maximum capacity of each output circuit is 50 mA and 30 VDC.

2. The 24 VDC power (I/O power) supply must be supplied by the user.

Figure 4.3 1CN I/O Signal Connection and External Signal Processing

■ Input Signals and Their Application

Table 4.6 Input Signals

Signal Name	1CN Pin No.	Description	
N-OT P-OT	8 7	Reverse drive prohibited (Reverse overtravel) Forward drive prohibited (Forward overtravel)	Connect to the appropriate forward or reverse limit switch signal for linear or other types of drive. The signals are CLOSED during normal operation and are OPEN when the limit switch is operated. These functions can be canceled with user constant (Cn-0001 bits 2 and 3). Always $\overline{\text{N-OT}}$ or Always $\overline{\text{P-OT}}$ can also be set.
+24V IN	13	24 V	This is the power supply input for pins 7, 8, 9, and 10 of 1CN (I/O). The user must provide the 24 VDC (50 mA min.) power supply. The 12 V power supply can also be used.
$\overline{\text{DEC}}$	9	Origin return deceleration LS	This signal is the deceleration LS input when the motor returns to the zero point. The signal is CLOSED on the LS. The polarity can be reversed with a user constant (Cn-0014, bit 12). If it is reversed, the signal will be OPEN on the LS.
$\overline{\text{EXT}}$	10	External latch signal	This signal is the latch signal input for external signal. External signal must be latched when this signal is CLOSED.

■ Input Circuits

There are four types of input signals: Forward/reverse drive (overtravel) prohibited, zero point return deceleration LS, and external latch signals. They comprise the input circuits that use the 24 V power supply (see *Fig. 4.4*). The 12 V power supply can be used instead, but the power supply is represented as "24 V" in the following descriptions. (The 12 V power supply provides only half the current of the 24 V power supply.) See *Figure 4.2* for an example of connections.

The user must provide the 24 V power supply: 24 VDC ±1 V, 50 mA min. (about 7 mA per circuit).

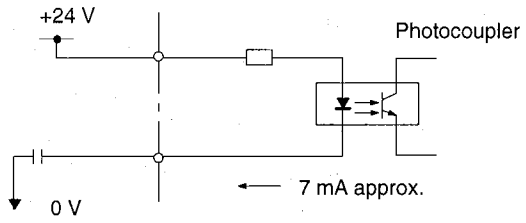


Figure 4.4 Input Circuit Configuration

P-OT and N-OT: Forward and Reverse Drive Prohibited

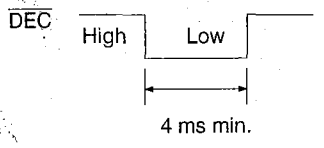
These inputs are used to stop the motor from forward running (counterclockwise viewed from the load coupling side) or reverse running. If drive prohibited (overtravel) is not used, connect 1CN pins 7 and 8 to the external 24 V power supply, or invalidate function by user constant Cn-0001 bit 2, 3.

When overtravel is operated the speed to zero for emergency stop in the internal circuit. When the motor stops, set the clamp to zero. (The motor can also be stopped using user constant Cn-0001, bits 8 and 9.)

Zero Point Return Deceleration LS ($\overline{DEC}$)

The motor decelerates from the zero point return feed speed to zero point return approach speed 1 (Cn–0022) when this signal level changes from high to low during the zero point return operation. When this signal level changes from low to high, the motor moves from the first phase C pulse position to the position set by Cn–0028 (final travel distance) at zero point return approach speed 2 (Cn–0023) . The motor then stops. Refer to the *MECHATROLINK Servo Command User's Manual* for details.

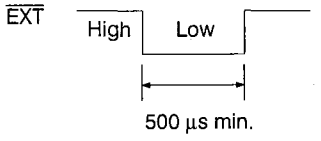
The deceleration LS requires that the low (closed) interval be at least 4 ms. If the interval is too short, reduce the feed speed.



External Latch Signal ($\overline{EXT}$)

The external latch signal is used as a latch input signal for latch command or external position command. Refer to the *MECHATROLINK Servo Command User's Manual* for details.

Latching occurs at the falling edge when the signal level changes from high to low. Make sure that the low signal level (closed) interval is at least 500 µs.



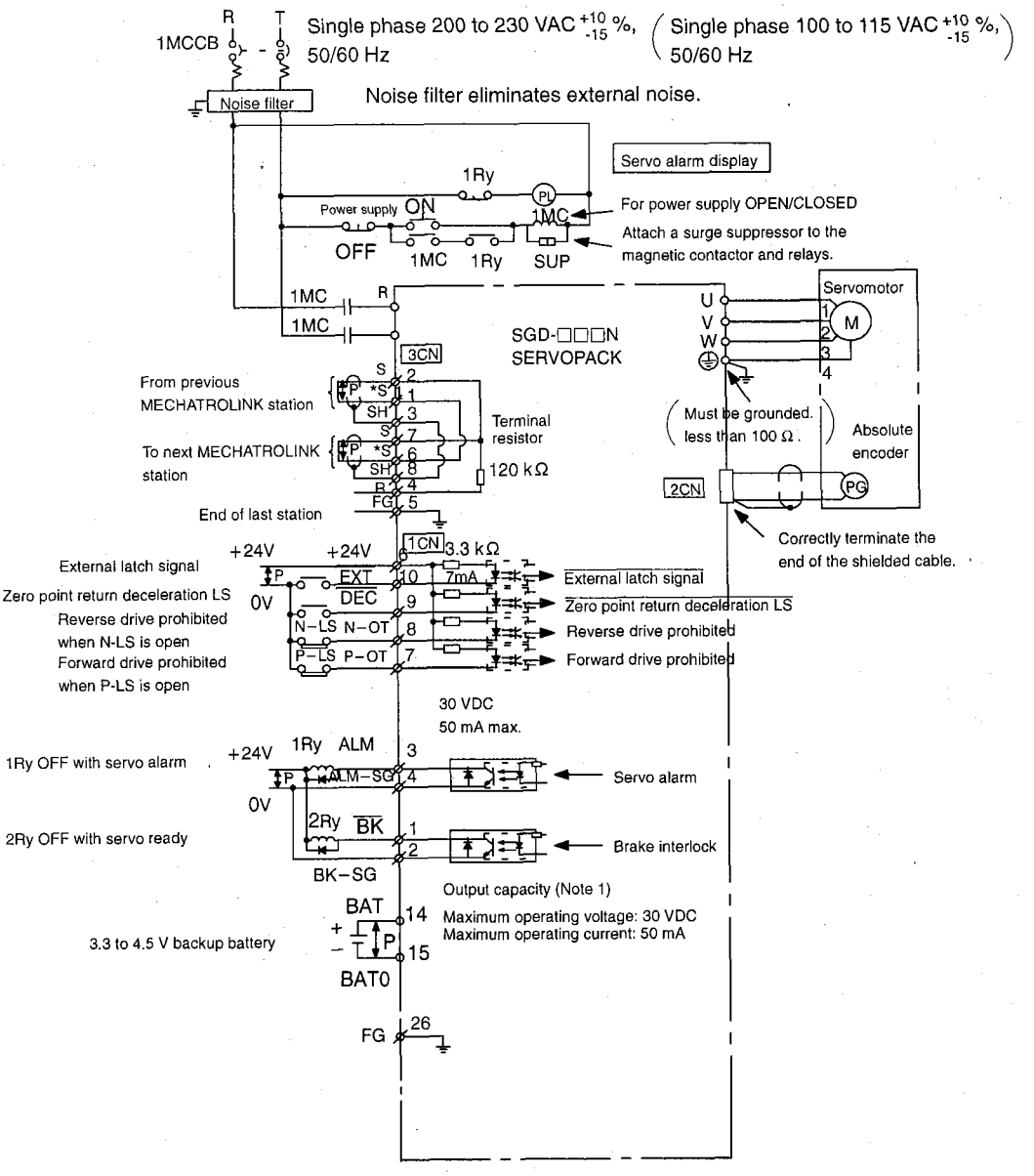
■ Output Signals and Their Application

Table 4.7 Output Signals

Signal Name	1CN pin No.	Description	
ALM	3 (4)	Servo Alarm	Turns OFF when an error is detected. Stays OFF until communication connection completes (CONNECT command) when the power is ON. See chapter *5.4.2 "Error Detection Function"* for further details.
$\overline{BK}$	1 (2)	Brake Interlock Output	Outputs the timing signal for the holding brake signal.

4.5 Connecting an Absolute Encoder

4.5.1 Typical Example



Note 1. Maximum capacity of each output circuit is 50 mA and 30 VDC.

2. Signal output line $\overline{\top}_P$ represents twisted-pair wires.

3. The 24 VDC power (I/O power) supply must be supplied by the user.

4. The power supply must be ON while the servo alarm (1Ry) remains OFF till the communication connection (CONNECT command) is completed after the control power is turned ON.

Figure 4.5 SGD-□□□N SERVOPACK Connection to Motor and Peripheral Device

4.5.2 1CN I/O Connector Terminals

■ Terminal Layout

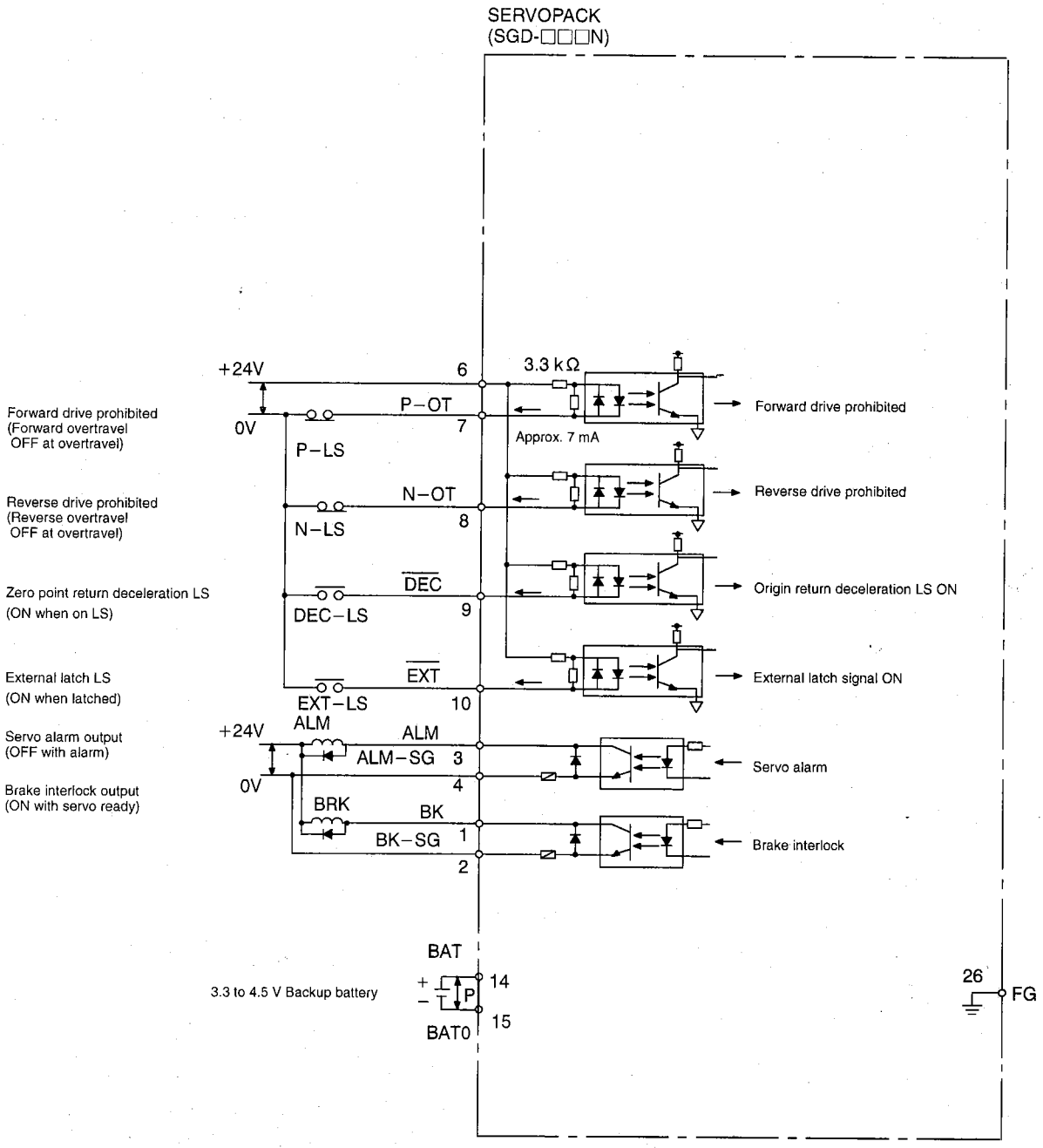
Table 4.8 1CN Terminal Layout

	2	4	6	8	10	12
	BK-SG	ALM-SG	+24 V IN	N-OT	$\overline{\text{EXT}}$	–
	Signal ground for brake out	Signal ground for servo alarm	I/O power supply input	Reverse drive prohibited input	External latch signal input	–
1	3	5	7	9	11	13
$\overline{\text{BK}}$	ALM	–	P-OT	$\overline{\text{DEC}}$	–	–
Brake interlock signal output	Servo alarm output	–	Forward drive prohibited input	Zero point return deceleration LS input	–	–
	15	17	19	21	23	25
	BAT 0	–	–	–	–	–
	Battery input (–)	–	–	–	–	–
14	16	18	20	22	24	26
BAT	–	–	–	–	–	FG
Battery input (+)	–	–	–	–	–	Frame ground

Note 1. Do not connect any terminals marked with "-".

2. Do not use vacant pins for relay or other purposes.

■ I/O Signal Connections and External Signal Processing



Note 1. Maximum capacity of each output circuit is 50 mA and 30 VDC.

2. The 24 VDC power (I/O power) supply must be supplied by the user.

3. Signal input wire $\overline{\overline{\ }}_P$ represents twisted-pair wires.

Figure 4.6 1CN I/O Signal Connection and External Signal Processing

■ Input Signals and Their Application

Table 4.9 Input Signals

Signal Name	1CN Pin No.	Description	
N-OT P-OT	8 7	Reverse drive prohibited (Reverse overtravel) Forward drive prohibited (Forward overtravel)	Connect to the appropriate forward or reverse limit switch signal for linear or other types of drive. The signals are CLOSED during normal operation and are OPEN when the limit switch is operated. This function can be canceled with user constant Cn-0001 bit 2,3. Always $\overline{\text{N-OT}}$ or Always $\overline{\text{P-OT}}$ can also be set.
+24V IN	6	24 V	This is the power supply input for pins 7, 8, 9, and 10 of 1CN (I/O). The user must provide the 24 VDC (50 mA min.) power supply. The 12 V power supply can also be used.
$\overline{\text{DEC}}$	9	Origin return deceleration LS	This signal is the deceleration LS input when the motor returns to the zero point. The signal is CLOSED on the limit switch. The polarity can be reversed with a user constant (CN–0014, bit 12). If it is reversed, the signal will be OPEN on the LS.
$\overline{\text{EXT}}$	10	External latch input	This signal is the latch signal input for external signal. External signal will be latched when this signal is CLOSED.
BAT BAT0	14 15	Backup battery + input Backup battery – input	This terminal connects to the backup battery used when power to the absolute encoder is OFF. The voltage is 3.3 to 4.5 V. (The user must supply the battery.)

■ Input Circuits

The input signals are the same as those for the incremental encoder (See *4.4.2 "1CN I/O Connector Terminals"*).

■ Output Signals and Their Application

Table 4.10 Output Signals

Signal Name	1CN Pin No.	Description	
ALM	3 (4)	Servo Alarm	Turns OFF when an error is detected. Stays OFF until communication connection completes (CONNECT command) when the power is turned ON. See *5.4.2 "Error Detection Function"* for further details.
$\overline{\text{BK}}$	1 (2)	Brake Interlock Output	Outputs the timing signal for the holding brake signal.

4.6 Output Circuits

There are two output signals: Brake interlock and servo alarm. They use non-contract transistor circuits. The voltage and current specifications for these signals are as follows:

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

Output circuits require 24 VDC power supply by the user. We recommend the same 24 V power supply as that used for the input circuits.

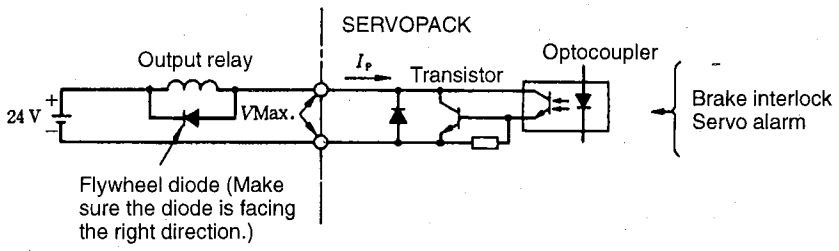
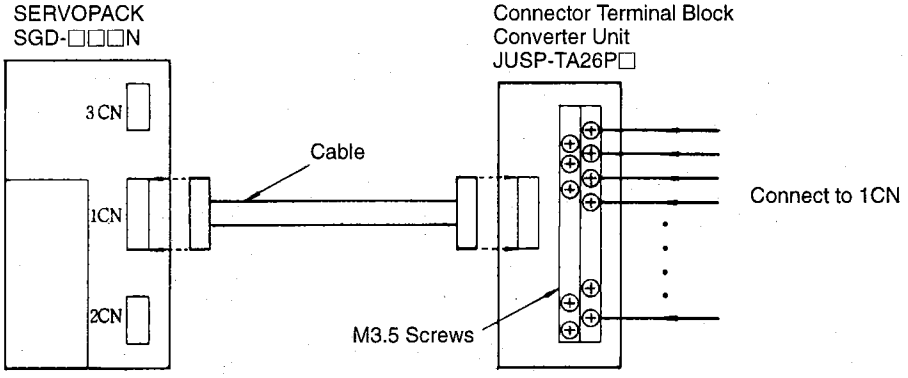


Figure 4.7 Output Circuits

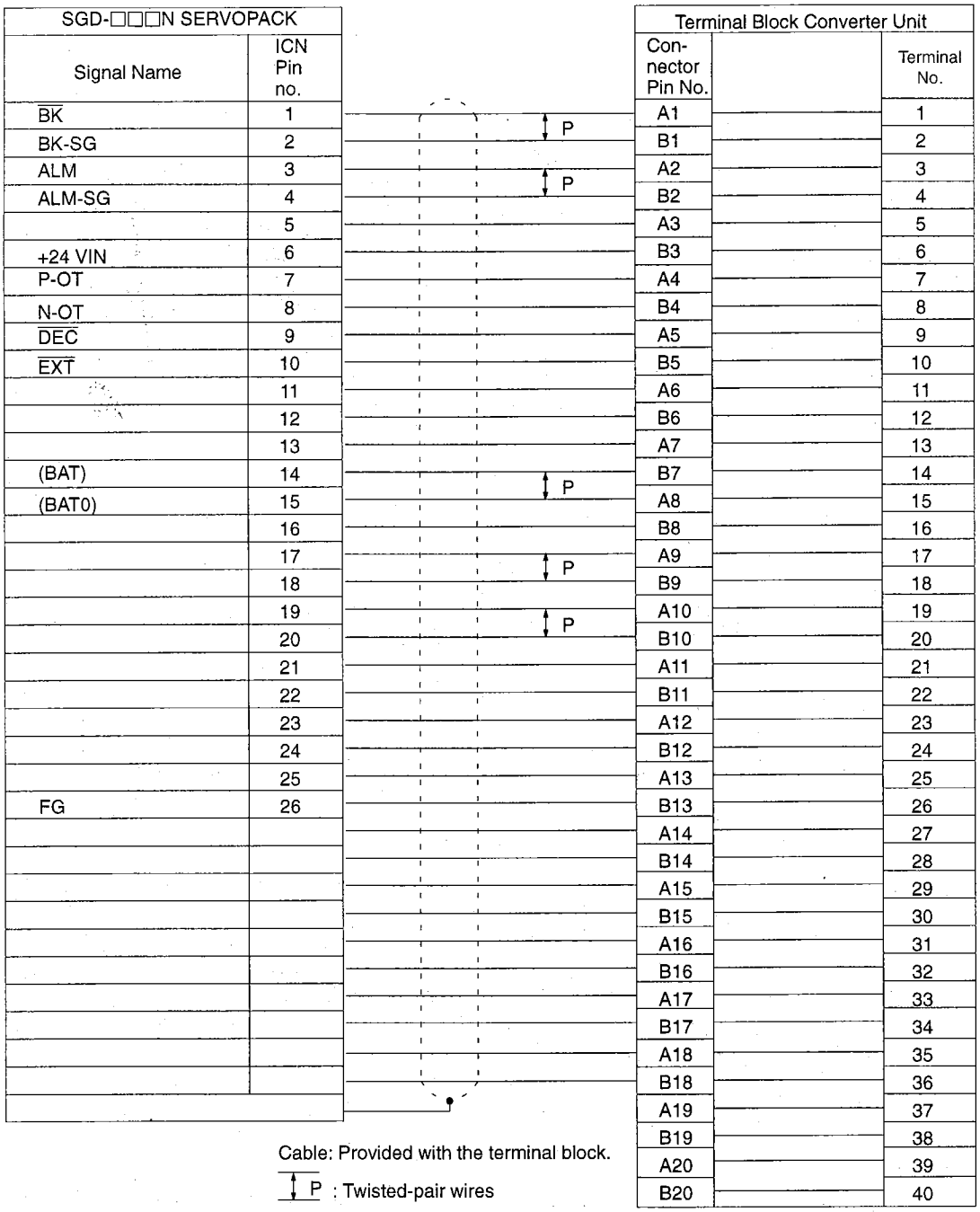
4.7 Connector Terminal Block Converter Unit for 1CN

4.7.1 Application



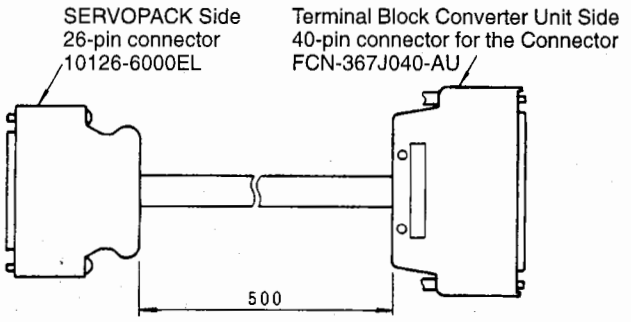
Note There is no connector terminal block converter unit for the 2CN. We provide encoder cables for the 2CN connector. Obtain a cable of suitable length (See chapter *9.4 "Cable Specifications."*)

4.7.2 Connection Specifications



Note Do not use vacant pins.

4.7.3 Cable Specifications (Accessory for Connector Terminal Block Converter Unit)



4.8 2CN Encoder Connector Terminals

4.8.1 2CN Terminal Layout

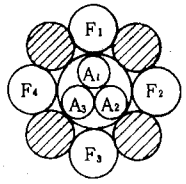
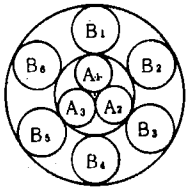
Table 4.11 Terminal Layout (2CN)

2	PG0V	PG power supply 0 V	1	PG0V	PG power supply 0 V	12	BAT+	Battery (+) (for absolute encoder only)	11		
4	PG5V	PG power supply +5 V	3	PG0V		14	PC	PG input phase C	13	BAT–	Battery (–) (for absolute encoder only)
6	PG5V		5	PG5V	PG power supply +5 V	16	PA	PG input phase A	15	*PC	PG input phase C
8	PS	PG input phase S (for absolute encoder only)	7	DIR	Direction	18	PB	PG input phase B	17	*PA	PG input phase A
10			9	*PS	PG input phase S (for absolute encoder only)	20	FG	Frame ground	19	*PB	PG input phase B

4.8.2 Applicable Cables

Yaskawa provides cables with the following specifications. Cables are not provided with the SERVOPACK or servomotor. Order cables in the standard specifications (lengths) as required.

Table 4.12 Applicable Cables

Cable Specifications	Incremental Encoder (Yaskawa Dwg. #B9400064)	Absolute Encoder (Yaskawa Dwg. #DP8409123)
Basic Specifications	Compound KQVV-SW AWG22 × 3C, AWG26 × 4P	Compound KQVV-SW AWG22 × 3C, AWG26 × 6P
Finished Dimension	ϕ7.5 mm (ϕ0.30 in)	ϕ8.0 mm (ϕ0.31 in)
Internal Structure and Lead Colors (DP8409123 standard)	 A_1 Red A_2 Black A_3 Green yellow F_1 Blue/White blue Twisted pair F_2 Yellow/White yellow Twisted pair F_3 Green/White green Twisted pair F_4 Orange/White orange Twisted pair	 A_1 Red A_2 Black A_3 Green yellow B_1 Blue/White blue Twisted pair B_2 Yellow/White yellow Twisted pair B_3 Green/White green Twisted pair B_4 Orange/White orange Twisted pair B_5 Purple/White purple Twisted pair B_6 Gray/White gray Twisted pair
Yaskawa Standard Specifications	Standard lengths: 3 m (9.9 ft), 5 m (16.4 ft), 10 m (32.8 ft), 15 m (49.2 ft), 20 m (65.6 ft) (see note 2)	

Note 1. The maximum allowable wiring distance for applicable cables between the SERVOPACK and the Servomotor (PG) is 20 m (65.6 ft).

2. See *9.4 "Cable Specifications"* for details on cables.

4.8.3 2CN Connection Method

■ Incremental Encoder

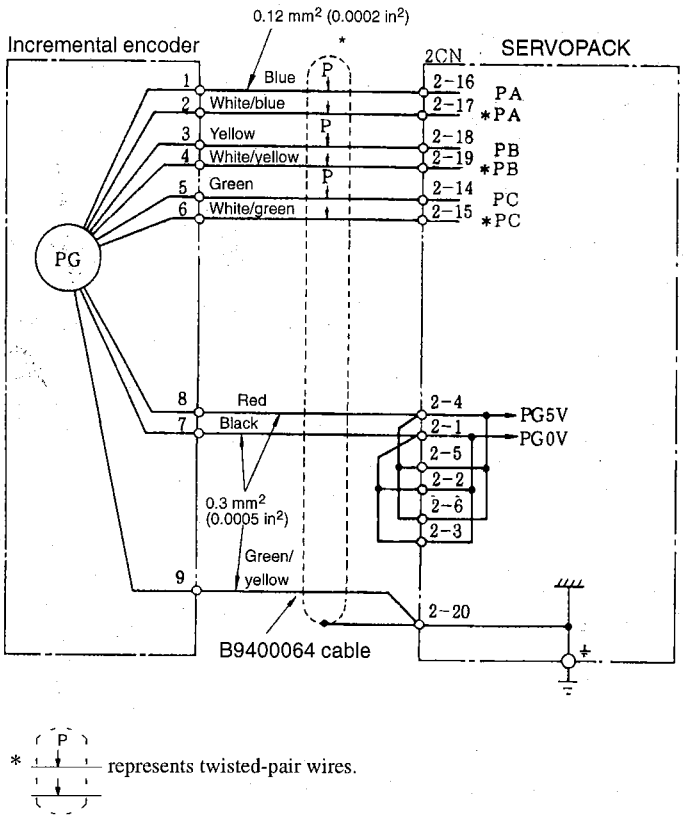


Figure 4.8 2CN Connection Method for an Incremental Encoder (Using a B9400064 Cable for an Incremental Encoder)

■ Absolute Encoder

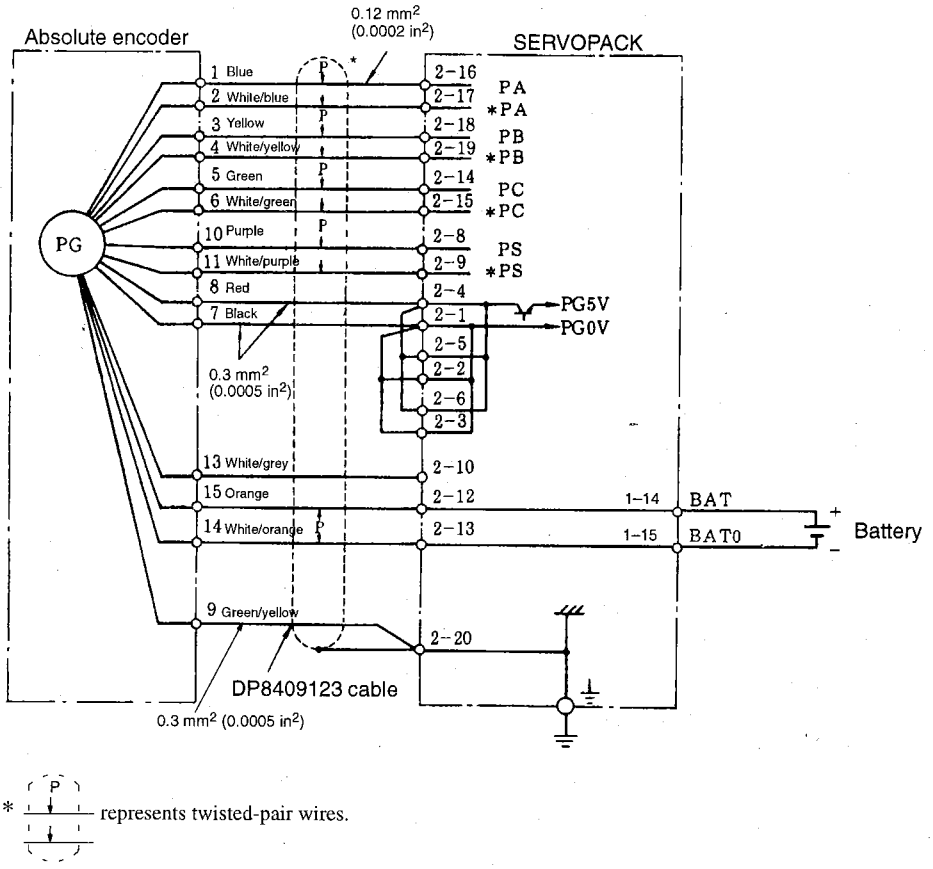


Figure 4.9 2CN Connection Method and 1CN Connection for an Absolute Encoder (Using a DP8409123 Cable for an Absolute Encoder)

4.9 3CN Connector for MECHATROLINK Communication

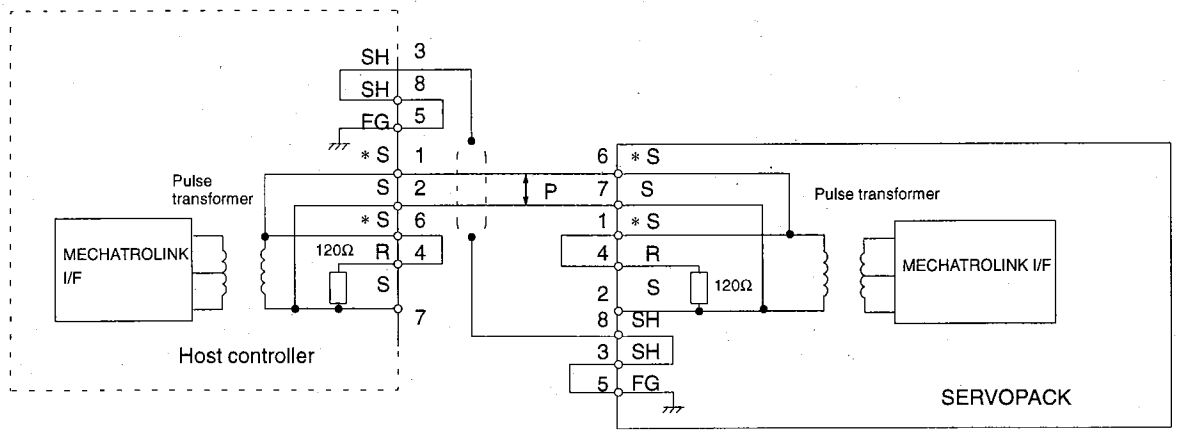
4.9.1 3CN Terminal Layout

Table 4.13 3CN Terminal Layout

1	2	3
*S	S	SH
Serial data		Shield
4	5	
R	FG	
Termination resister	Frame ground	
6	7	8
*S	S	SH
Serial data		Shield

4.9.2 3CN Connection Method

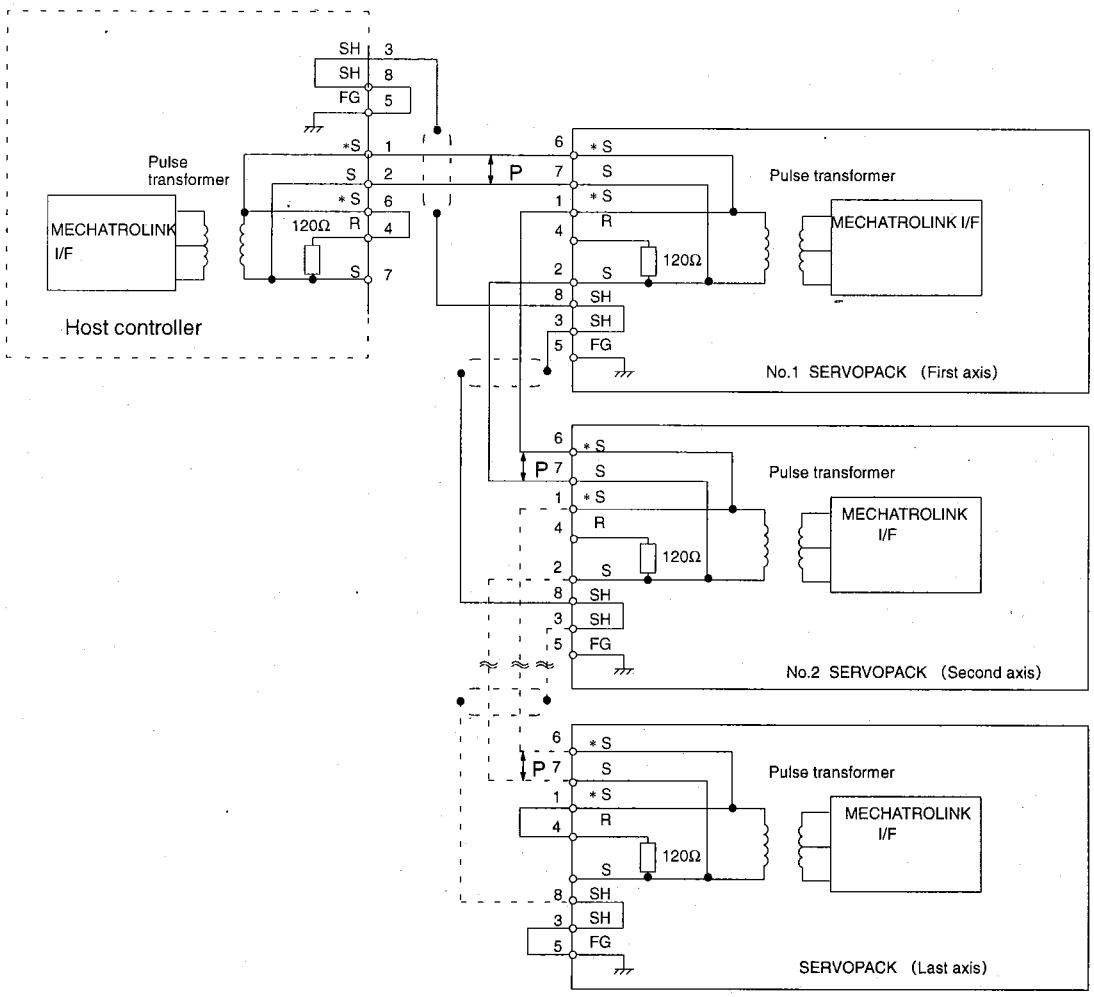
■ Host Controller and SERVOPACK Connection



P represents twisted-pair wires and represents a shield.

■ Multiple Axis Connections

Short 3CN pins 1 and 4, and insert a termination resister at the SERVOPACK for the last axis on the cable. Then, short 3CN pins 3 and 5, and ground the shield to the frame ground. Also, insert a terminal resister (120 Ω) and ground the shield to the frame ground on the host controller.



P represents twisted-pair wires and represents a shield.

5

Application

This chapter describes how to use the Servodrives.

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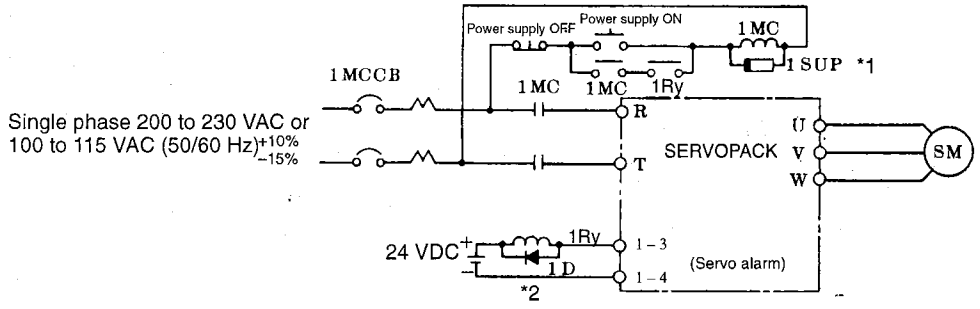
5.1 Turning Power ON/OFF

The figure below shows a typical example of the power ON/OFF sequence.



* 1. CR50500BA surge suppressor (Okaya Electric Industries Co., Ltd.) or the equivalent

* 2. Flywheel diode (to prevent spikes in 5Ry)

Figure 5.1 Example of Power ON/OFF Sequence

IMPORTANT

1. Construct a power ON sequence so the power is turned OFF if a servo alarm signal is output. See chapter *5.4.4 "Handling Protective Circuit Operation"* for more details on handling the alarm signal output.
2. During the power ON/OFF sequence shown in Figure 5.1, it takes up to approx. two seconds until the normal signal is valid once power is turned ON assuming that the connect command has been received. The SERVOPACK outputs a servo alarm signal for up to two seconds when power is turned ON in order to give time to initialize the SERVOPACK.
3. It takes up to approx. two seconds to turn ON the power supply to the control circuit because the SERVOPACK is initialized. The servo alarm signal is output (ON) until processing by the CONNECT command has been completed.
4. The SERVOPACK has a capacitor in the power supply. A high charging current will thus flow for 0.2 seconds when the power is turned ON. Frequently turning the power ON and OFF will cause the main power devices (such as capacitors and fuses) to deteriorate and can result in unexpected problems.
5. Start and stop the Servomotor by SV_ON/SV_OFF commands rather than turning the power supply ON and OFF.
6. A power loss alarm may occur if the SERVOPACK is turned ON immediately after being turned OFF. To prevent this, always wait for the time shown in the table below before turning the power ON again.

SERVOPACK Model SGD-	A3AN A5AN	01AN 02AN 04AN	08AN	200 VAC input
	A3BN	A5BN 01BN 02BN	03BN	100 VAC input
Power Holding Time	6 s	10 s	15 s	Maximum values

7. After turning the power OFF, do not touch the power terminals for at least five minutes because high voltage may remain in the SERVOPACK.

5.2 Position Control

5.2.1 Electronic Gear Function

The electronic gear function enables the motor travel distance per input reference unit to be set to any value. More specifically, the value is set based on the number of encoder pulses, reference unit (minimum unit of position data for moving the load), and machine gear ratio. When the electronic gear ratio is 1/1, the motor will move one reference unit per pulse input.

Setting the Electronic Gear Ratio (B/A)

Determining the Reference Unit

The electronic gear ratio represents the number of encoder pulses per reference unit.
The reference unit is the minimum unit of position data for moving the load, e.g., 0.01 mm, 0.1°, or 0.01 inches.

A 1-pulse input moves the load by 1 reference unit.

Example: Reference Unit = 0.1 μm
If a reference of 50000 pulses is input, the load moves 5 mm
(50000 × 0.1 = 5000 μm = 5 mm).

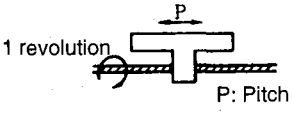
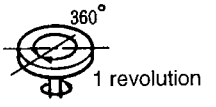
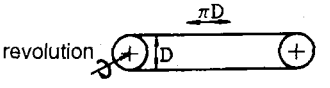
Determine the reference unit based on factors like equipment specifications and positioning precision.

Determining the Load Travel Distance per Load Shaft Revolution in Reference Units

$$\text{Load travel distance per load shaft revolution (in reference units)} = \frac{\text{Load travel distance per load shaft revolution (in distance units)}}{\text{Reference unit}}$$

Table 5.1 shows an example of the load travel distance per load shaft revolution.

Table 5.1 Example of the Load Travel Distance per Load Shaft Revolution

Load Travel Distance per Load Shaft Revolution	Example of the Load Structure	
P	Ball screw	
360°	Disc table	
πD	Belt and pulley	

Example: Load Travel Distance per Load Shaft Revolution= 12 mm (0.47 in), Reference Unit = 0.01 mm (0.0004 in)

Load travel distance per load shaft revolution = 12/0.01 = 1200 (reference units)

Determining the Electronic Gear Ratio (B/A)

B = [(Cn-0011) × 4] × (motor shaft revolution speed)

A = [Load travel distance per load shaft revolution (reference units)] × (load shaft speed)

Reduce the electronic gear ratio (B/A) to the lowest terms so that both A and B are less than 32768, and then set A and B in Cn-0025 and Cn-0024.

■ Motor Shaft and Load Shaft Revolution Speed

The motor shaft and load shaft speeds form the gear ratio for the mechanical system. If the mechanical system is structured so that load shaft makes "ℓ " revolutions when the motor shaft makes "m" revolutions, the gear ratio for the motor shaft and the load shaft is m/ℓ , as shown below.

Motor shaft speed: m [revolutions]

Load shaft speed: ℓ [revolutions]

Figure 5.2 shows a block diagram of the electronic gear function.

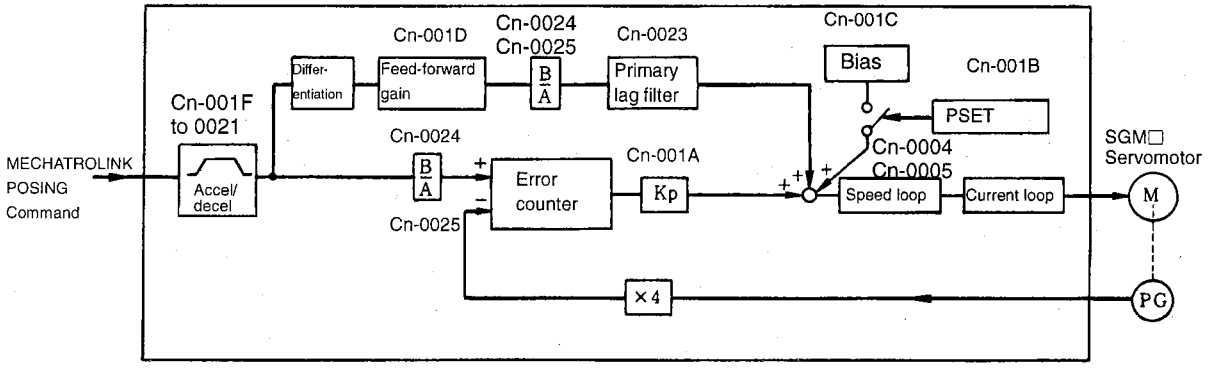


Figure 5.2 Block Diagram of the Electronic Gear Function

5.2.2 Feed-forward Control Function

The feed-forward control function differentiates position reference and add it to speed reference in order to shorten positioning time. Set the amount of feed-forward control (0% to 100%) in Cn-001D, but do not set the level too high, because this may cause overshooting with light loads.

A primary lag filter can be added for the feed-forward reference. If it is added, set the time constant for the primary lag filter in user constant Cn-0027.

5.3 Setting Up an Absolute Encoder

5.3.1 Battery

An absolute encoder requires a battery in order to save position data in the event of a power interruptions.

- We recommend the following battery.
  One lithium battery: ER6VC 3.6 V battery made by Toshiba Battery Co., Ltd.
- Make sure the battery is installed securely so that environmental changes or changes over time will not cause a loss of contact.
- The battery voltage is not monitored inside the SERVOPACK (with 12 bit absolute encoder). Provide a battery voltage monitor circuit as necessary.
  Minimum voltage: 3.3 V
- See *12.1.3 "Replacing the Battery"* for more details on battery replacement.

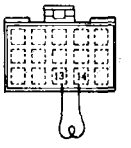
5.3.2 Setup Procedure

The encoder needs to be set up to clear the cumulative rotation number to zero to set up the motor, or when the absolute encoder has been left disconnected from a battery for more than two days.

Internal circuit elements may not function properly if the capacitor in the encoder is not fully charged. Use the setup procedure described below in the following cases.

Note Failure to follow the procedure exactly as written may result in problems.

1. Turning ON SERVOPACK Power
   - Wire the SERVOPACK, motor, and encoder together correctly.
   - Connect the battery and turn ON the SERVOPACK. Send the SENS_ON command by MECHATROLINK communication (encoder power ON). Then leave the SERVOPACK turned ON for at least thirty minutes to sufficiently charge the backup capacitor.
2. Resetting Data
   - Turn OFF the SERVOPACK, and disconnect the encoder connector.
   - Short encoder terminals 13 and 14 together for 1 to 2 seconds.



3. Wiring

   Restore the wiring to the normal status.

4. Turning ON Power

   The setup is complete if there are no errors when the SERVOPACK is turned ON and the SENS_ON command is sent. If alarm code "00" is transferred by MECHATROLINK communication from the SERVOPACK, then repeat the procedure starting from the beginning.

5.4 Protection Functions

The SERVOPACK is equipped with various functions to protect the driver and motor from damage.

5.4.1 Dynamic Brake Function

The SERVOPACK is equipped with a dynamic brake for emergency stops. The brake is operated for any of the following conditions.

- When an alarm occurs (error detection)
- When the servo receives the SV_OFF command
- When power is turned OFF

5.4.2 Error Detection Function

Table 5.2 shows the error detection function for the SERVOPACK. Alarm details can be checked by MECHATROLINK communication and SVALM output.

Table 5.2 Error Detection Function

Alarm Code	SVALM Output	Error Detection Function	Description
0□	OFF	User constant error Absolute data error	An absolute error or parameter (user constant) error.
10	OFF	Overcurrent detection	Overcurrent flowed through the main circuit. The SERVOPACK heat sink overheated.
40	OFF	Overvoltage detection	The main circuit DC voltage exceeded 420 V.
51	OFF	Overspeed detection	Motor speed exceeded the maximum speed.
7□	OFF	Overload detection	The load torque for the motor and SERVOPACK was exceeded.
B□	OFF	Hardware error	The hardware circuit is abnormal.
C□	OFF	Phase error detection Overrun detection Broken PG signal line	An overrun was caused by the motor or the PG wiring incorrect. Noise in encoder wiring.
8□	OFF	Encoder alarm	Absolute encoder alarm.
9□	ON	Warning	A user constant or command error.
D0	OFF	Position error overflow	The number of pulses accumulated in the error counter exceeded the preset value.
E□	OFF	Communication error	A synchronization error or communication error.
F3	OFF	Power loss detection	Power was turned back ON within the allotted power retention time after it was turned OFF.
99	ON	No alarm	–

ON: Output transistor is ON.
OFF: Output transistor is OFF.

5.4.3 Servo Alarm Output (ALM, ALM-SG)

The power drive circuit in the SERVOPACK will turn OFF and the alarm status will be displayed if any error detection function shown in Table 5.2 operates. Details of the alarm will be sent by a MECHATROLINK response message, the red indicator on the SERVOPACK will light, and the alarm output (ALM, ALM-SG) will turn OFF. See *Table 5.2* for more details on alarm codes.

5.4.4 Handling Protection Circuit Operation

An alarm signal output indicates some kind of error. Determine the cause, take appropriate action, and then resume operation.

Check the error data for past occurrences using the alarm-warning history (traceback) of the MECHATROLINK communication, and implement the remedy listed in *Table* 12.6.

5.4.5 Servo Alarm Reset

To reset the SERVOPACK when a servo alarm occurs, send the MECHATROLINK ALM-CLR command, or turn OFF the power and then ON.

5.5 Indications

The following indications are made on the front panel of the SERVOPACK.

- Power ON: Green LED lights.
- Alarm occurred: Red LED lights.
- During MECHATROLINK communication: Green LED lights.

5.6 Precautions

5.6.1 Overhanging Load

Do not allow the motor to be continuously rotated by the load while the regenerative brake is being applied.

Example: Tension control drive
Do not use the motor for lowering objects without a counterweight.

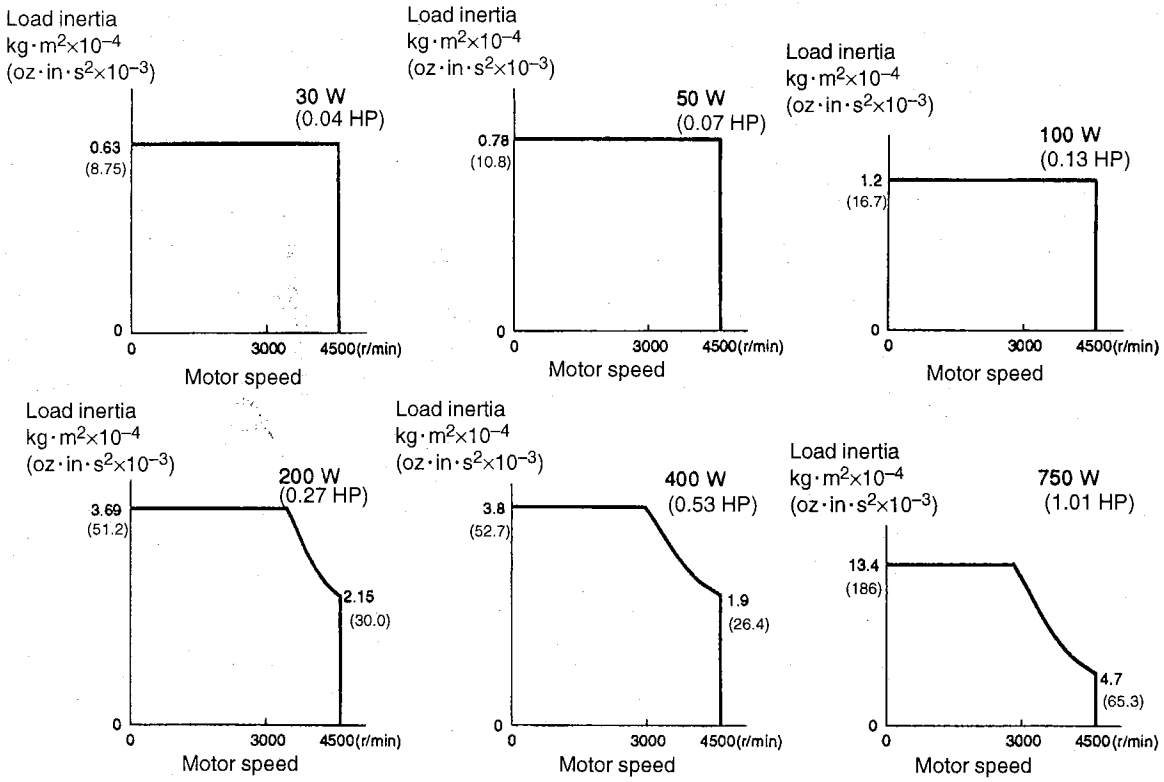
Rated specifications for the regenerative braking capacity of the SERVOPACK is only for brief periods while the motor is stopped. Contact your Yaskawa representative about applications with overhanging load.

5.6.2 Load Inertia J_L

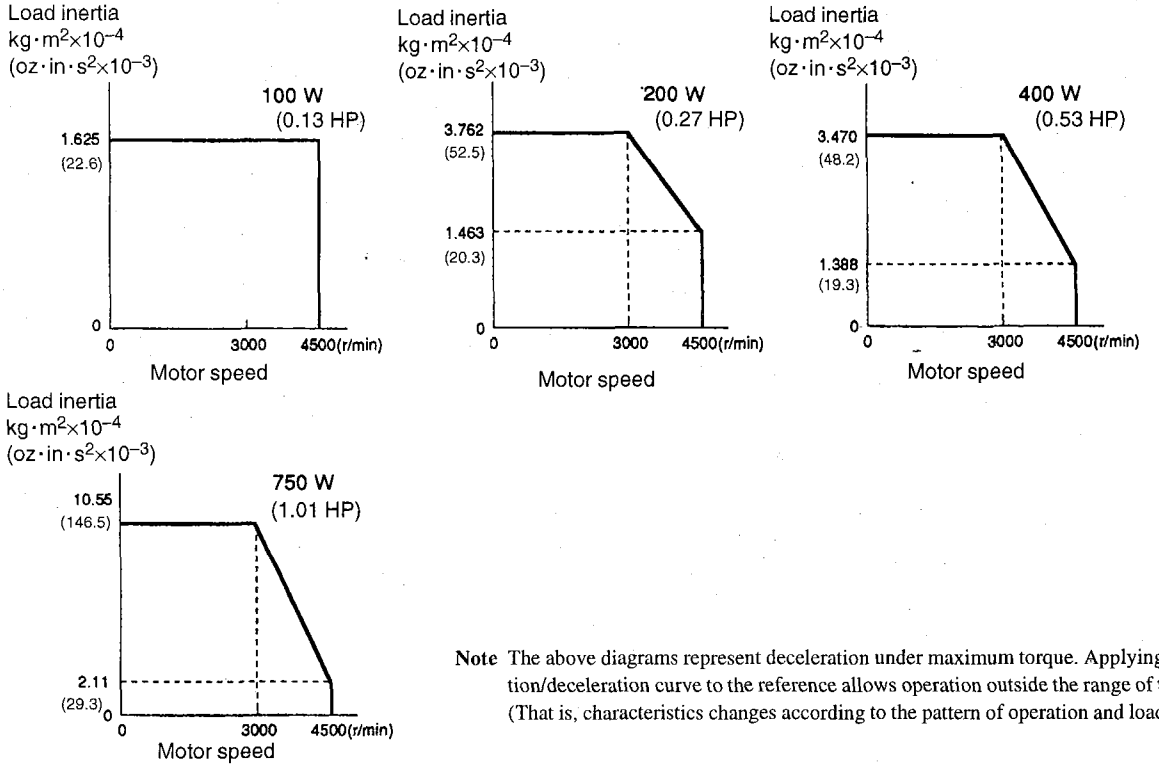
Make sure the allowable load inertia J_L calculated for the motor shaft falls within the range given in *Figure 5.3.* (when using Servomotors with incremental encoders for 200 VAC) An overvoltage alarm will occur during deceleration if the load inertia exceeds the values in the figure. If this occurs, take one of the following actions. For further details, contact your Yaskawa representative.

- Reduce the torque limit.
- Reduce the deceleration rate.
- Reduce the maximum rotation speed.
- Add a Regenerative Unit.

■ Load Inertia for SGM 200 VAC Servomotor with Incremental Encoder



■ Load Inertia for SGMP 200 VAC Servomotor with Incremental Encoder



Note The above diagrams represent deceleration under maximum torque. Applying an acceleration/deceleration curve to the reference allows operation outside the range of the diagrams. (That is, characteristics changes according to the pattern of operation and load conditions.)

Figure 5.3 Allowable Load Inertias

5.6.3 Regenerative Unit

A regenerative unit is used as an SGD SERVOPACK Peripheral Device.

■ Specifications and Ratings

Table 5.3 Regenerative Unit Specifications and Ratings

Item	JUSP-RG08C	Comments
Applicable SERVOPACK	SGD-□□□□	–
Regenerative Working Voltage	380 VDC	–
Regenerative Process Current	8 ADC	Regenerative resistance: 50 Ω, 60 W
Error Detection Functions	Regenerative resistance failure, regenerative transistor failure, overvoltage	–
Alarm Output	Normally closed contact (OPEN when protective function operates)	200 V drives OK
Dimensions mm (in.)	55 × 160 × 130 (2.17×6.30×5.12) W×H×D	–

■ Connecting a Regenerative Unit

The connections of the regenerative unit are shown below.

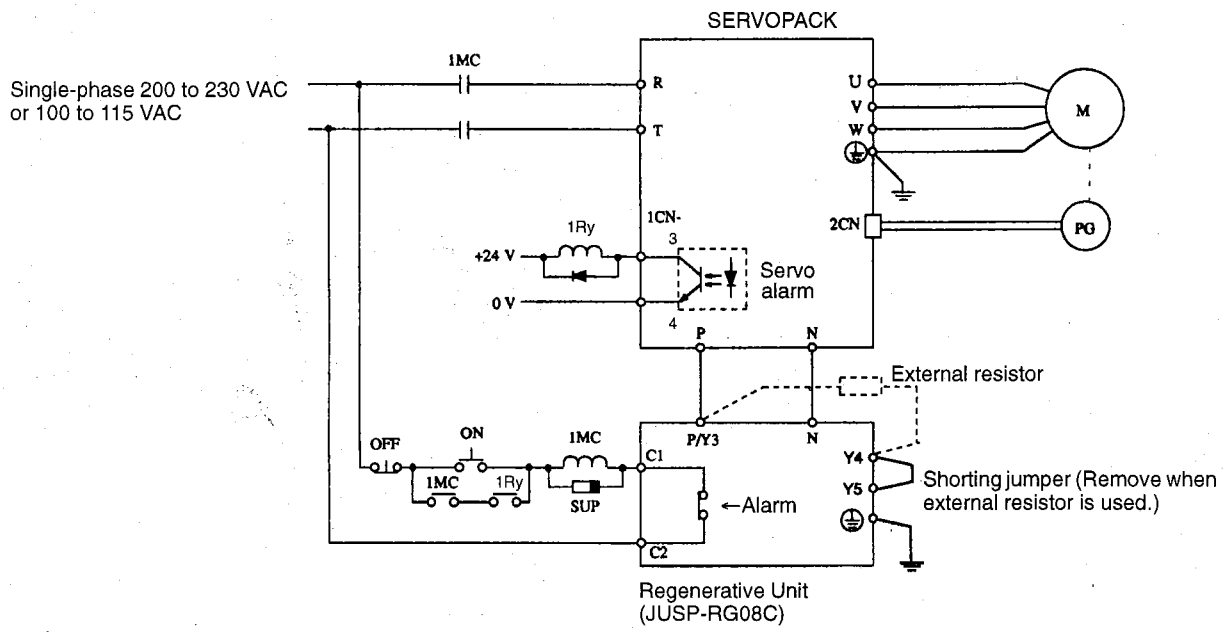


Figure 5.4 Regenerative Unit Connection Diagram

- A Regenerative unit is equipped with the following error detection functions:
  - Detecting disconnection in the regenerative resistor.
  - Detecting a damaged transistor in the regenerative unit.
  - Detecting overvoltage.
- When one of these fault detection functions operates, the internal alarm relay is actuated, and the circuit between output terminals C1 and C2 is opened.
- Form a sequence so that SERVOPACK power turns OFF when the alarm relay is actuated.
- Once the alarm relay is actuated, it takes two or three seconds until the system returns to a normal state. This time is required for the main capacitor inside the SERVOPACK to discharge.
- When using an external resistor, be sure to remove the jumper between Y4 and Y5 and then connect the resistor between P/Y3 and Y4.
- Be sure to use an external resistor with a resistance of at least 50 Ω.

5.6.4 High Voltage Lines

A transformer that will step down three-phase 400/440 V to single-phase 200 V or single-phase 100 V is required when using a 400 V class (400 V, 440 V) power supply. Select an appropriate power transformer using *Table 5.5 MCCB or Fuse for the Power Capacity.*

5.7 Application Precautions

5.7.1 Noise Control

■ Example of Wiring for Noise Control

The SERVOPACK uses high-speed switching elements in the main circuit. "Switching noise" may be generated by these high-speed switching elements if wiring or grounding around the SERVOPACK is not appropriate. To prevent this, always wire and ground the SERVOPACK correctly.

The SERVOPACK also has a built-in microprocessor (CPU). Therefore, install a noise filter to protect the microprocessor from external noise.

The diagram below shows an example of wiring for noise control.

■ Grounding

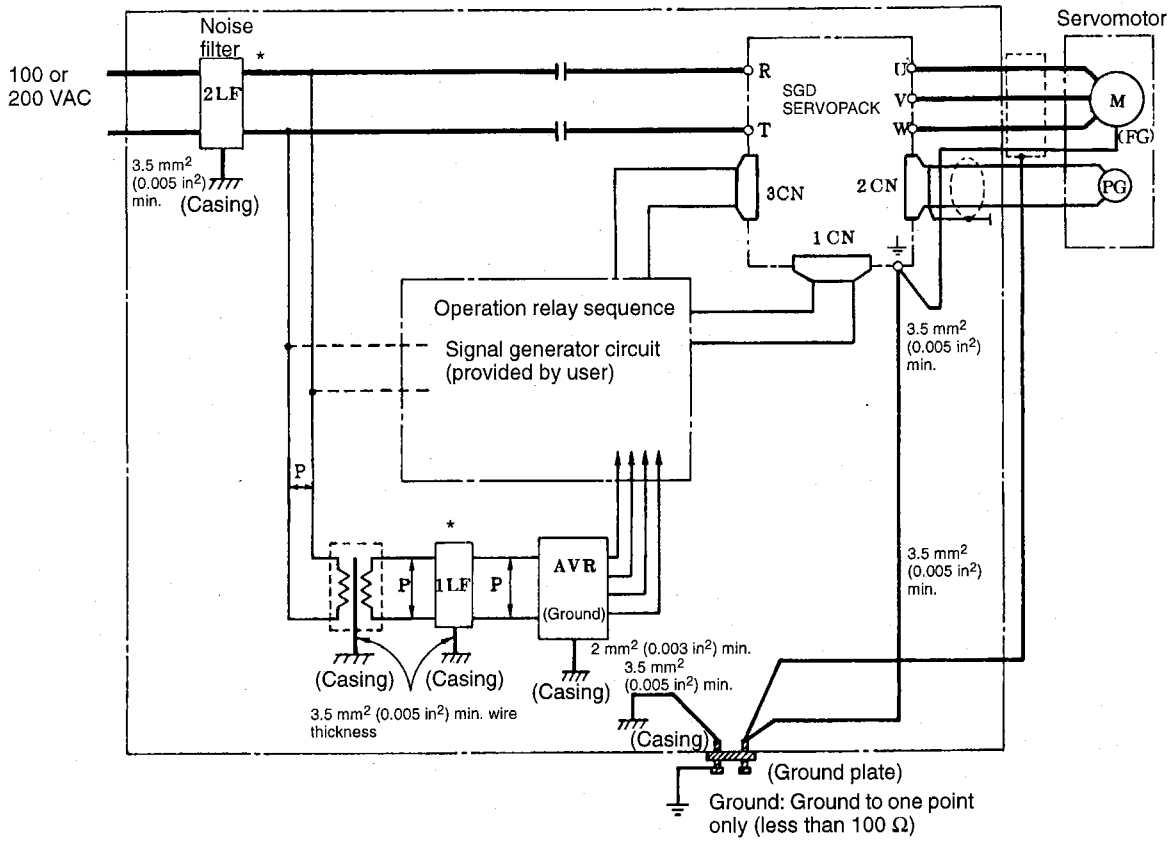


Figure 5.5 Grounding

* When using a noise filter, always observe the wiring instructions given in the next section.

Note 1. Use a wire (preferably a plain stitch copper wire) at least 3.5 mm² (0.005 in²) thick to ground the casing.

2. Use twisted-pair wires whenever possible for wires indicated by P.

- Motor Frame Grounding

If the Servomotor is grounded via the machine, switching noise current (Cf dv/dt) will flow from the SERVOPACK power unit (PWM) through motor stray capacitance. Always connect the Servomotor ground terminal 4 (green) to the SERVOPACK ground terminal to prevent adverse effects from switching noise. Be sure to ground the ground terminal.

- SERVOPACK SG 0 V

If the reference input line receives noise, ground the SG 0 V line. If the main circuit wiring for the motor is accommodated in a metal conduit, ground the conduit as well as the junction box. Always ground using ground to one point only.

■ Using a Noise Filter

Use an inhibit-type noise filter to block noise from the power supply line. *Table 5.4* lists recommended noise filters for each SERVOPACK. Also install a noise filter on the power supply line for peripheral equipment if needed.

IMPORTANT

Always observe the installation and wiring instructions shown in *Figures 5.6* to 5.9. Incorrect use of a noise filter reduces its benefits.

5

Table 5.4 Noise Filter Types

Supply Voltage	SERVOPACK Type		Noise Filter Connection	Recommended Noise Filter*	
				Model	Specifications
200 V	30 W (0.04 HP)	SGD-A3AN	(Correct)  (Incorrect) 	LF-205A	Single-phase 200 VAC, 5 A
	50 W (0.07 HP)	SGD-A5AN			
	100 W (0.13 HP)	SGD-01AN			
	200 W (0.27 HP)	SGD-02AN			
	400 W (0.53 HP)	SGD-04AN		LF-210	Single-phase 200 VAC, 10 A
	750 W (1.01 HP)	SGD-08AN		LF-220	Single-phase 200 VAC, 20 A
100 V	30 W (0.04 HP)	SGD-A3BN		LF-205A	Single-phase 200 VAC, 5 A
	50 W (0.07 HP)	SGD-A5BN			
	100 W (0.13 HP)	SGD-01BN			
	200 W (0.27 HP)	SGD-02BN		LF-210	Single-phase 200 VAC, 10 A
	300 W (0.39 HP)	SGD-03BN		LF-220	Single-phase 200 VAC, 20 A

* These noise filters made by Tokin Corp. are available from Yaskawa. Contact your nearest Yaskawa sales representative for noise filters.

- Separate input lines from output lines. Do not run input and output lines in the same duct or bundle them together.

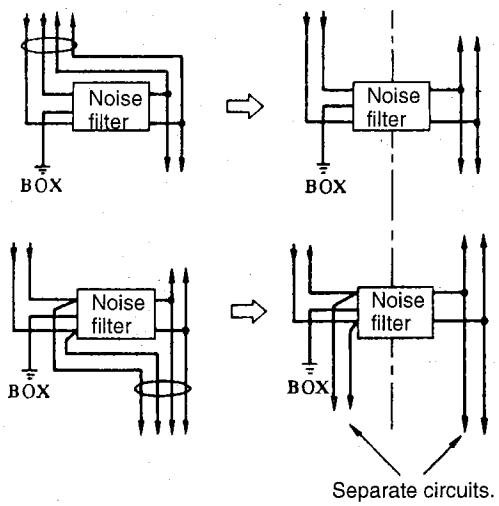


Figure 5.6

- Separate ground wires from noise filter output lines.
  Do not run ground wires, noise filter output lines, and other signal lines in the same duct or bundle them together.

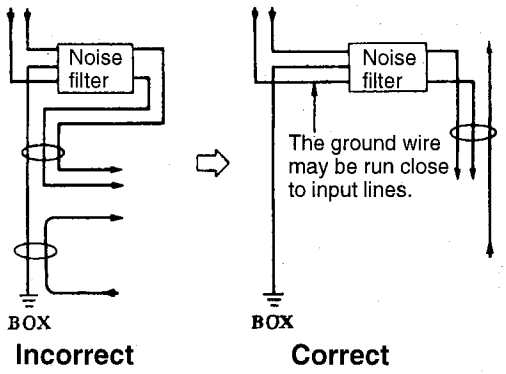


Figure 5.7

- Connect the ground wire directly to the junction box or the ground plate.

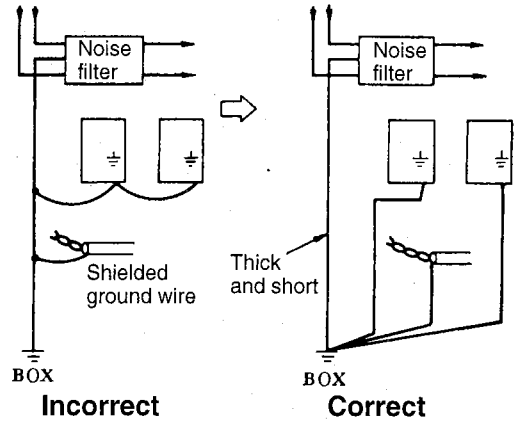


Figure 5.8

- When grounding a noise filter inside a unit, connect the noise filter ground wire and the ground wires for other devices inside the unit to the ground plate of the unit first, and then ground these wires.

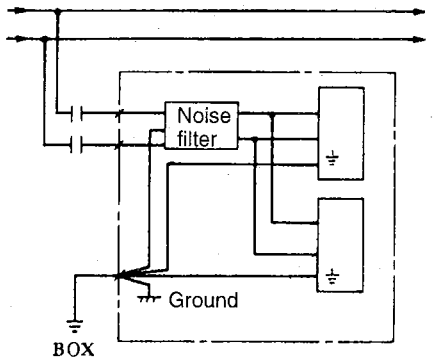


Figure 5.9

5.7.2 Power Supply Line Protection

The SERVOPACK is connected directly to a commercial power supply (200 or 100 V) . Therefore, always use an appropriate molded-case circuit breaker (MCCB) or fuse for each SERVOPACK (see Table 5.5) to protect the power supply line from ground faults or shorting and to prevent fires. A fast-operating fuse cannot be used because the SERVOPACK power supply is a capacitor input type, and a fast-operating fuses may blow out when power is turned ON.

Table 5.5 MCCB or Fuse for the Power Capacity

Supply Voltage	SERVOPACK Model	Power Capacity per SERVOPACK (kVA) *1	Power Capacity per MCCB or Fuse (A) *2
200 V	SGD-A3AN	0.25	5
	SGD-A5AN	0.3	
	SGD-01AN	0.5	
	SGD-02AN	0.75	
	SGD-04AN	1.2	9
	SGD-08AN	2.2	16
100 V	SGD-A3BN	0.2	5
	SGD-A5BN	0.3	
	SGD-01BN	0.5	
	SGD-02BN	0.75	8
	SGD-03BN	1.4	15

* 1. Power capacity at the rated load

* 2. Operating characteristics (25°C): 2 s or more at 200%, 0.01 s or more at 700%

5.8 Appropriate Applications

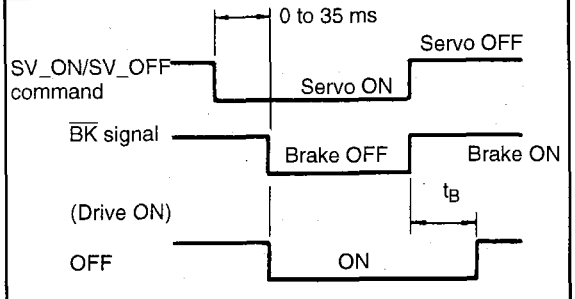
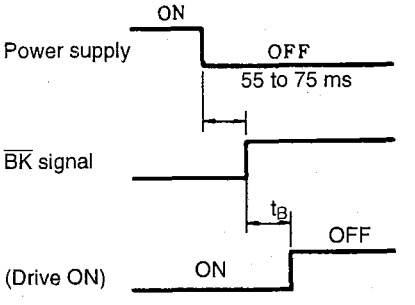
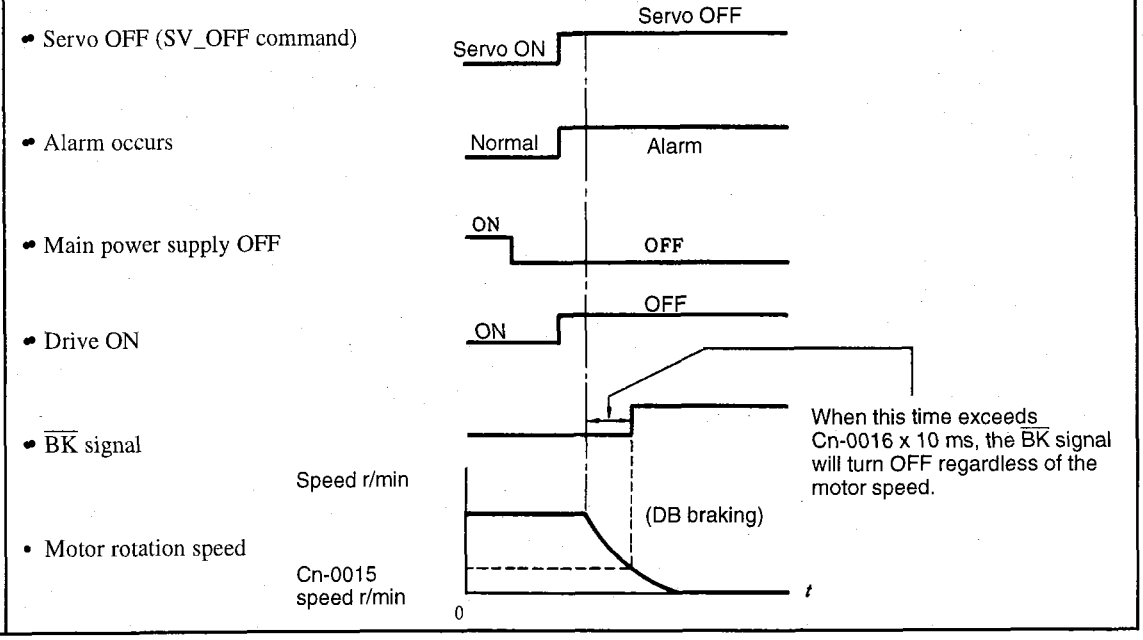
5.8.1 Holding Brake Interlock Signal

This output signal can be output for interlocking motor circuit power status and motor rotation speed.

■ Setup Procedure

The brake signal is output from 1CN-1(2). Delay time t_B (× 10 ms) from when the brake turns ON until the Servomotor turns OFF can be set in user constant Cn-0012. The following shows the Servo ON signal and power supply timing.

Table 5.6 Servo ON Command and Power Supply Timing

<table>
<tr><td rowspan="2">Motor Stopped</td><td>Servo ON Command Timing</td><td>Power Supply Timing</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td colspan="2">t_B: Brake Time (set from 0 to 50 ms in Cn-0012)</td></tr>
<tr><td>Motor Running</td><td colspan="2">Timing with the Servo OFF, main power OFF, and an alarm
 
</td></tr>
</table>

5.9 Adjustments

5.9.1 Servo System Adjustments

Once the load inertia constant (Cn–0003) has been specified, the following user constants (parameters) are used to adjust the servo system.

- Cn-0004: Speed Loop Gain
- Cn-0005: Speed Loop Integration Time Constant
- Cn-0017: Torque Reference Filter Time Constant
- Cn-001A: Position Loop Gain

A simple block diagram of the servo system is shown below.

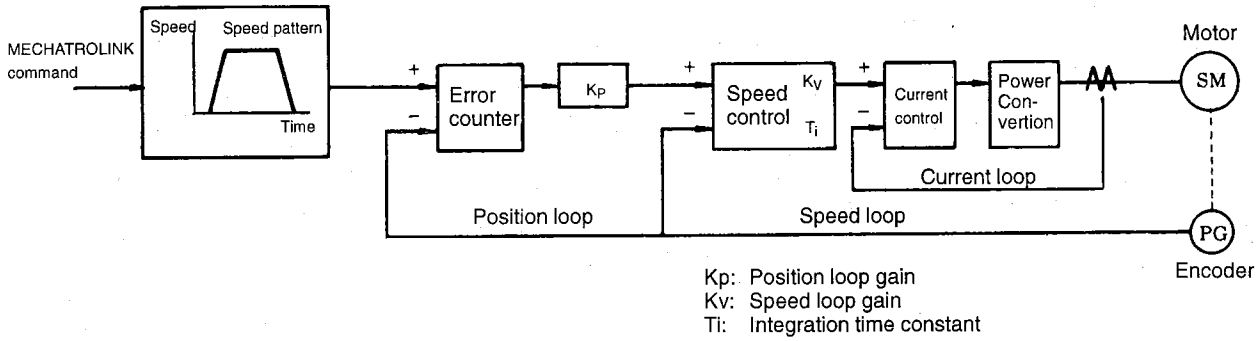


Figure 5.10 Servo System Block Diagram

■ Basic Rules for Gain Adjustment

The servo system is equipped with the following feedback systems.

- Position loop
- Speed loop
- Current loop

The inner loops require better response. Failure to follow this principle will result in poor response and vibration.

The current loop already provides adequate response and cannot be adjusted by the user. The user can adjust the position loop and speed loop gains. The speed loop integration time constant and torque reference filter time constant can also be adjusted by the user.

The responses of the position loop and speed loop must be kept in balance. Increasing the position loop gain alone to improve response will cause the speed reference in the SERVOPACK to vibrate, producing slow or inconsistent positioning times. If the position loop gain is increased, the speed loop gain must be similarly increased.

The mechanical system will start to vibrate at the upper limits for the position and speed loop gain. Do not exceed these limits. Generally position loop gain cannot be increased beyond the characteristic frequency of the mechanical system.

Example: Articulated Robots

Using harmonic gears produces a mechanism with extremely low rigidity.
Characteristic frequency of the mechanical system: 10 to 20 Hz
Allowable position loop gain: 10 to 20 (1/s)

Example: Chip Mounters, IC Bonders, Precision Machine Tools

Characteristic frequency: 70 Hz or more.
Position loop gain: 70 (1/s) or more.

The response of the servo system (Controller, Servodriver, Servomotor, detector, etc.) is crucial to the response requirements, but a highly rigid system is also needed as well.

5.9.2 User Constants

■ Cn–0003: Load Inertia

The load inertia specifies motor axis converted load inertia.
Specify the load inertia as a percentage of the motor rotor inertia (motor inertia = 100%).

■ Cn-0004: Speed Loop Gain

The Speed Loop Gain sets the speed loop response. The response is improved by setting this user constant to the maximum value in a range that does not cause vibrations in the mechanical system.

■ Cn-0005: Speed Loop Integration Time Constant

The speed loop has an integration element that enables response to micro-inputs. Because this integration element can produce a delay in the servo system, positioning set time increases and response slows as the time constants increase. The integration time constant must be increased, however, to prevent machine vibration if the load inertia is large or the mechanical system includes an element prone to vibration. The following equation can be used to calculate a guideline value.

$$T_i \geqq 2.3 \times \frac{1}{2\pi \times K_v}$$

Ti: Integration time constant [s]
Kv:Speed loop gain [Hz]

■ Cn-0017, 0018: Torque Reference Filter Time Constant

When a ball screw is used, torsional resonance may occur that increases the pitch of the vibrating noise. This oscillation can sometimes be overcome by increasing the torque reference filter time constant. The filter, however, will produce a delay in the servo system, just like the integration time constant, and its value should not be increased any more than necessary.

If the secondary torque reference filter time constant (Cn–0018) is set to 0, the torque reference filter switch to the primary filter.

If the vibration cannot be overcome by the torque reference filter time constant (Cn–0017), use the secondary torque reference filter time constant (Cn–0018) to switch the filter to the secondary filter and overcome the vibration.

■ Cn-001A: Position Loop Gain

The position loop gain determines the response of the servo system. The higher it is set, the higher the response and the less time it takes for positioning. As such, the equipment must have higher rigidity and a higher characteristic frequency.

The entire servo system is more susceptible to vibration if position loop gain alone is increased to improve response, and the speed reference output from the position loop will cause vibration. Always increase speed loop gain while checking the response.

Position loop gain K_P is calculated as shown below.

$$K_P = \frac{V_S}{\epsilon}$$

K_P (1/s): Position loop gain
V_S (PPS): Steady speed reference
ε (Pulse): Steady error (The number of pulses in the error counter at constant speed)

■ Adjustment

1. Calculate and set the motor axis converted load inertia.
2. Set the loop gain to a low value and increase speed loop gain within a range that does not cause noise or vibration to occur.
3. Slightly reduce the speed loop gain from the value in step 1, and increase position loop gain within a range that does not cause overshooting or vibration to occur.
4. Determine the speed loop integration time constant by observing the positioning time and vibration in the mechanical system. Positioning time may be increased if the speed loop integration time constant is too large.
5. It is not necessary to change the torque reference filter time constant unless torsional resonance occurs in the equipment shafts. Torsion resonance may be present if there high-frequency vibration noise. In this case, adjust the torque reference filter time constant to reduce the noise.
6. Finally, it is necessary to determine the optimum value for acceleration/deceleration to adjust finely the position and speed loop gain as well as the integration time constant.

■ Monitoring

The MECHATROLINK communications monitoring function can be used to read various monitor items, display the monitor status at the host controller, and make any necessary adjustments.

If monitoring cannot be made at the host controller, use the analog monitor. The analog monitor

can observe load torque or speed overshoot, but is not for monitoring vibration. Therefore, we recommend that monitoring should be made at the host controller.

■ Analog Monitoring

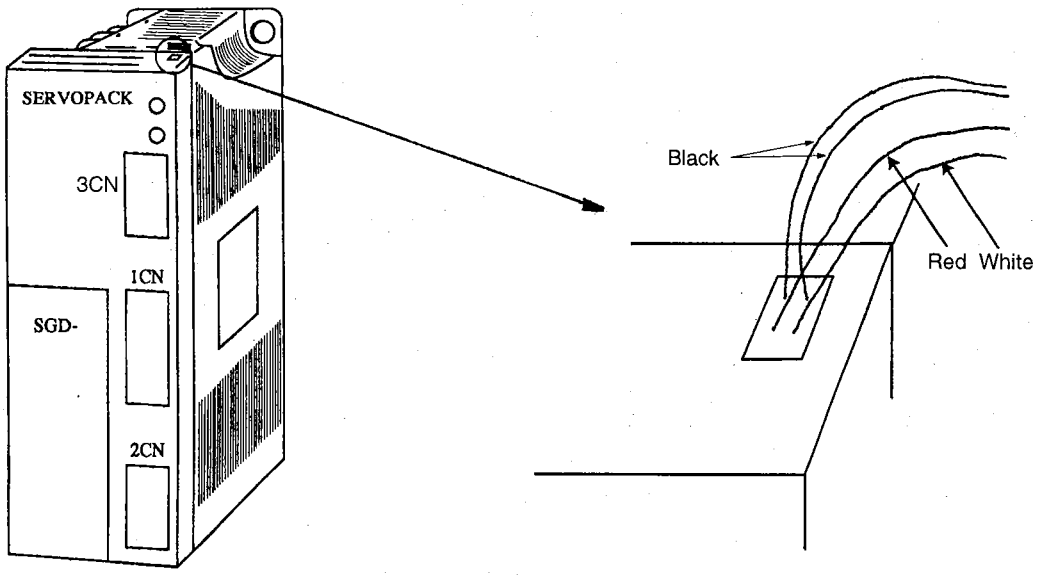
Motor speed and torque can be monitored via an analog signal while adjusting the gain. The cable connections and output signals needed for this are outlined below.

IMPORTANT

The cable is only loosely attached to the SGD SERVOPACK connector, and an external force applied to it may cause it to disconnect. Do not connect meters or other devices to the cable in applications.

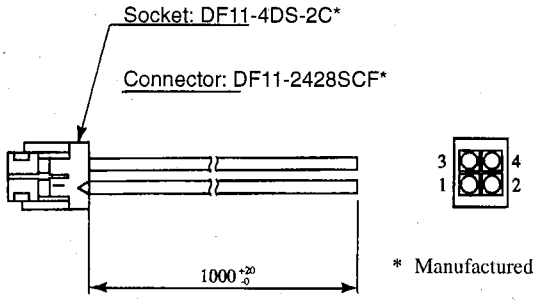
● Connecting Monitoring Cables to an SGD-□□□N SERVOPACK

Use a DE9404559 cable from the connector for analog monitor output.



Insert the cables that will be used for monitoring through the location marked with a circle in the figure above. Make sure the red and white cables insert the front panel of the SERVOPACK.

● Dimension Diagram of the Monitoring Cables (DE9404559)



* Manufactured by Hirose Electric Co., Ltd.

- **Cable Colors and Monitor Signals**

Cable Color	Signal Name	Description
Red	VTG-M	Speed monitor (0.5 V, 1,000 r/min.)
White	TRQ-M	Torque monitor (0.5 V, 100% torque)
Black (2 wires)	GND	GND

5.9.3 Functions that Improve Response

The following functions are provided to improve response.

- Mode switching
- Feed-forward control
- Bias

These functions will not necessarily improve characteristics, and they can even have the opposite effect. Be sure to observe the precautions given below, and monitor the actual response of the characteristics while making adjustments.

■ Mode Switching

Mode switching is used to improve transient characteristics if the torque reference saturates during acceleration and deceleration. In other words, mode switching is a function that automatically switches the speed control mode inside the SERVOPACK from PI (proportional/integral) to P (proportional) control above a certain setting.

■ Feed-forward Control

Feed-forward control generally shortens positioning time, but has no effect on systems where the position loop gain is at its maximum. Adjust the amount of feed-forward control using Cn-001D as outlined below.

1. Adjust the speed and position loop.
2. Gradually increase the amount of feed-forward control set in Cn-001D until the positioning complete status (PSET) is output as quickly possible.

Make sure during adjustment that the position complete status (PSET) is not intermittent (repeatedly turning ON and OFF) and that the speed is not overshoot. Setting the amount of feed-forward control too high will cause a intermittent positioning complete status as well as speed overshooting.

A primary lag filter may be added to the feed-forward line to improve characteristics when the positioning complete signal is intermittent or when speed overshooting occurs due to excessive feed-forward control.

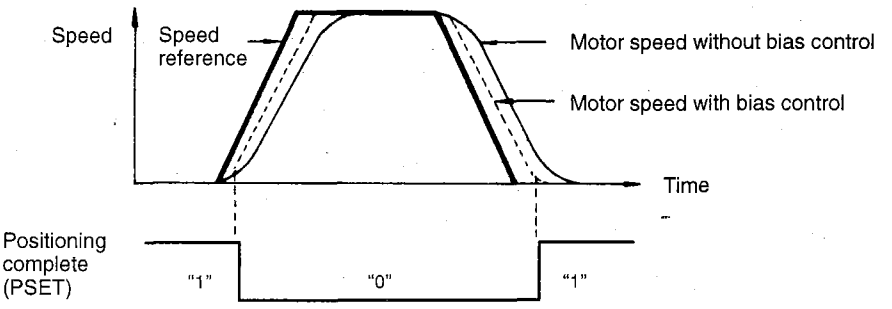
■ Bias Control

When the number of pulses in the error counter exceeds the positioning complete width (Cn-001B), bias (Cn-001C) is added to the error counter output (speed reference) until the

speed reference falls within the positioning complete width. This shortens the positioning time by reducing the number of pulses in the error counter.

Motor operation will become unstable if the bias is set too high. Adjust the bias while monitoring the response because the optimum value will vary with the gain and the positioning complete width.

Set Cn-001C to 0 if bias control will not be used.



5.9.4 Guidelines for Setting the Load Inertia Ratio

Adjustment guidelines are given below based on the rigidity and load inertia of the mechanical system. These values are given as guidelines only, and oscillation or poor response may occur within the given ranges. Monitor the response (waveform) to optimize the adjustment. Higher gain is possible with highly rigid machines.

5

■ Machines with High Rigidity

Machines with high rigidity include ball screws and direct-drive machines.

Examples: Chip Mounters, IC Bonders, Precision Machine Tools

Load Inertia Ratio (GD^2_L/GD^2_M) (Cn-0003) [%]	Position Loop Gain (Cn-001A) [0.01/s]	Speed Loop Gain (Cn-004) [0.1 Hz]	Speed Loop Integration Time Constant (Cn-005) [0.01ms]
1× (100)	5000 to 7000	500 to 700	500 to 2000
3× (300)			
5× (500)			
10× (1000)			
15× (1500)			
20× (2000)			
30× (3000)			

Note 1. For an inertia ratio of 10× or higher, slightly reduce the position loop gain and speed loop gain below the values shown, and set the integration time constant to a higher value before starting the adjustment.

2. Slightly increase the speed loop integration time constant for an inertia ratio of 20× or higher.
3. As the inertia ratio increases, set the position loop gain and speed loop gain to the lower limit of the range of values specified and increase the speed loop integration time constant.

■ Machines with Medium Rigidity

Machines with medium rigidity include machines driven by ball screws through reduction gears. or machines driven directly by long ball screws.

Examples: General Machine Tools, Orthogonal Robots, Conveyors

Load Inertia Ratio (GD^2_L/GD^2_M) (Cn-0003) [%]	Position Loop Gain (Cn-001A) [0.01/s]	Speed Loop Gain (Cn-0004) [0.1 Hz]	Speed Loop Integration Time Constant (Cn-0005) [0.01 ms]
1× (100)	3000 to 5000	300 to 500	1000 to 4000
3× (300)			
5× (500)			
10× (1000)			
15× (1500)			
20× (2000)			
30× (3000)			

Note 1. For an inertia ratio of 10× or higher, slightly reduce the position loop gain and speed loop gain below the values shown, and set the integration time constant to a higher value before starting the adjustment.

2. Slightly increase the speed loop integration time constant for an inertia ratio of 20× or higher.
3. As the inertia ratio increases, set the position loop gain and speed loop gain to the lower limit of the range of values specified, and increase the speed loop integration time constant.

■ Machines with Low Rigidity

Machines with low rigidity include machines driven by timing belts, chains, or harmonic gears.

Example: Conveyors, Articulated Robots

Load Inertia Ratio (GD^2_L/GD^2_M) (Cn-0003) [%]	Position Loop Gain (Cn-001A) [0.01/s]	Speed Loop Gain (Cn-0004) [0.1 Hz]	Speed Loop Integration Time Constant (Cn-0005) [0.01 ms]
1× (100)	1000 to 2000	100 to 200	5000 to 10000
3× (300)			
5× (500)			
10× (1000)			
15× (1500)			
20× (2000)			
30× (3000)			

Note 1. For an inertia ratio of 10× or higher, slightly reduce the position loop gain and speed loop gain below the values shown, and set the integration time constant to a higher value before starting the adjustment.

2. Slightly increase the speed loop integration time constant for an inertia ratio of 20× or higher.
3. As the inertia ratio increases, set the position loop gain and speed loop gain to the lower limit of the range of values specified, and increase the speed loop integration time constant.

6

MECHATROLINK Communication

This chapter describes MECHATROLINK communication specifications, commands and communication sequence and provides a list of alarms/ warning.

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6.1 Specifications and Configuration

6.1.1 Specifications

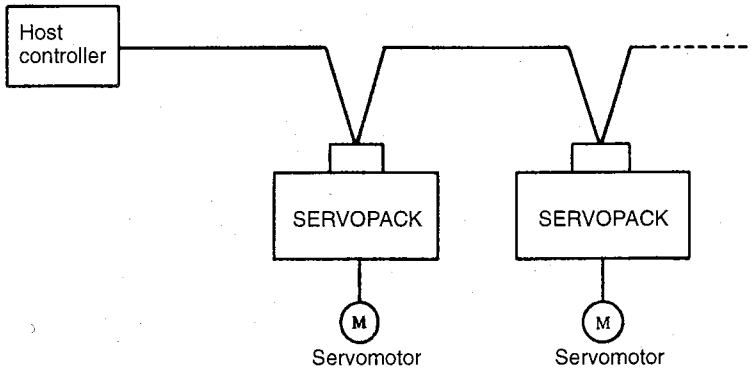
Items that are not described in this chapter conform to the MECHATROLINK application layer. For more details refer to the following manuals.

MECHATROLINK System User's Manual (SIE-S800-26.1)

MECHATROLINK Servo Command User's Manual (SIE-S800-26.2)

6.1.2 Control Structure

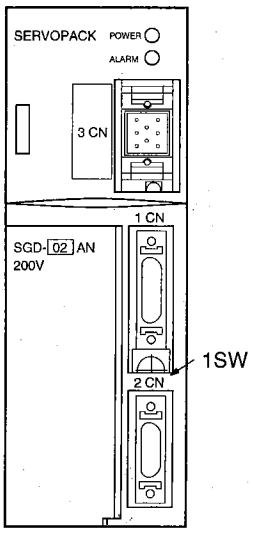
The following illustration shows the control structure. Up to 15 axes can be connected.



6.2 1SW Rotary Switch for MECHATROLINK Station Address Settings

1SW sets the MECHATROLINK station address, and is used to select one of the following SGD-□□□N slave node addresses.

1SW	Station Address
0	Not used (Do not set.)
1	41H (Factory setting)
2	42H
3	43H
4	44H
5	45H
6	46H
7	47H
8	48H
9	49H
A	4AH
B	4BH
C	4CH
D	4DH
E	4EH
F	4FH



Note This switch setting is read only when power is turned ON.
To change settings, turn OFF the power and turn it ON again.

6.3 MECHATROLINK Command List

MECHATROLINK common commands, motion common commands, and servo standard commands are shown in the following tables.

Table 6.1 MECHATROLINK Common Command Group

Code	Command	Function	Processing Classification	Synchronization Classification	Remarks
00	NOP	No Operation	N	A	
01	PRM_RD	Read parameter	D	A	
02	PRM_WR	Write parameter	D	A	
03	ID_RD	Read ID	D	A	See note 1.
04	CONFIG	Set up devices	C	A	See note 1.
05	ALM_RD	Read alarm or warning	D	A	See note 1.
06	ALM_CLR	Clear alarm or warning	C	A	See note 1.
07					
08					
09					
0A					
0B					
0C					
0D	SYNC_SET	Start synchronous communication	N	A	
0E	CONNECT	Establish connection	N	A	See note 1.
0F	DISCONNECT	Release connection	N	A	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
1A					
1B	PPRM_RD	Read EEPROM user constants	D	A	
1C	PPRM_WR	Write EEPROM user constants	D	A	
1D					
1E					
1F					

Table 6.2 MECHATROLINK Common Motion Command Group

Code	Command	Function	Processing Classification	Synchronization Classification	Remarks
20	POS_SET	Set coordinates	D	A	
21	BRK_ON	Apply brake	C	A	
22	BRK_OFF	Release brake	C	A	
23	SENS_ON	Turn ON sensor	C	A	
24	SENS_OFF	Turn OFF sensor	C	A	
25	HOLD	Stop motion	M	A	
26					
27					
28					
29					
2A					
2B					
2C					
2D					
2E					
2F					
30	SMON	Status monitoring	D	A	
31	SV_ON	Servo ON	C	A	
32	SV_OFF	Servo OFF	C	A	
33					
34	INTERPOLATE	Interpolation feed	M	S	See note 1.
35	POSING	Positioning	M	A	See note 1.
36	FEED	Manual feed	M	A	See note 1.
37					
38	LATCH	Interpolation feeding with position detection	M	S	See note 1.
39	EX_POSING	External input positioning	M	A	See note 1.
3A	ZRET	Origin return	M	A	See note 1.
3B					
3C					
3D					
3E	ADJ	Adjusting	X	A	See note 2.
3F	SVCTRL	General–purpose servo control	X	A(S)	See note 2.

Note 1. Addition or change unique to SGD-□□□N.
(See *Chapter 6.4.*)

2. Not supported by SGD-□□□N.

The following abbreviations are used for processing and synchronization classifications.

Processing Classifications		Synchronization Classifications	
N	Network command	A	Asynchronous command
D	Data communication command	S	Synchronous command
C	Control command		
M	Motion command		
X	Compound command		

6.4 Special Descriptions

The following sections describes specific items unique to the SGD-□□□N.

6.4.1 Option Field Specifications

1	Command
2	
3	Option
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	Monitor 1/2 type
14	
15	
16	WDT

The third and fourth bytes of the reference data field for motion commands are reserved for options used to add motion command functions for each products.

Option fields are used in the SGD-□□□N for speed loop P/PI control switching and acceleration/deceleration filter selection.

- Appropriate commands for options.
  Followings are appropriate commands for option fields.
  SV_ON, INTERPOLATE, POSING FEED, LATCH, EX_POSING, ZRET

In SGD-□□□N option fields, the third byte is used for acceleration/deceleration filter type selection and the fourth byte is used for speed loop P/PI control switching.

Option	
3	Acceleration/deceleration filter selection
4	Speed loop P/PI control switch

■ Acceleration/Deceleration Filter Selection

	D7	D6	D5	D4	D3	D2	D1	D0
0 3	0	0	0			0	0	0

Acceleration/deceleration filter selection (0 to 2)

Acceleration/Deceleration Filter Selection (D3 and D4)

Three types of acceleration and deceleration can be selected with the SGD-□□□N.

Type	Acceleration/Deceleration Filter Type	Related Parameters
0	Linear acceleration/deceleration (no filter)	–
1	Exponential acceleration/deceleration	Cn-002D, 002E
2	S-curve acceleration/deceleration (running average)	Cn-0026

IMPORTANT

1. All bits except D3 and D4 must be set to 0.
2. Acceleration/deceleration types can only be switched when DEN (acceleration/deceleration filter output complete) is set to 1. Never switch acceleration/deceleration types when DEN is set to 0. Yaskawa cannot guarantee how the SERVOPACK will act if the two items above are not followed exactly.

■ Speed Loop P/PI Control Switching

	D7	D6	D5	D4	D3	D2	D1	D0
04	0	0	0		0	0	0	0

Speed loop P/PI control switching
(1: P control)

Speed Loop P Control Switching (D4)

The SGD-□□□N can switch the speed loop between PI and P control in real time.

D4	Speed Loop Control
0	PI control (switches to P control via mode switch settings)
1	P control

This function suppresses undershooting and shortens positioning complete time when the Servomotor is stopped.

IMPORTANT All bits except D4 must be set to 0, otherwise Yaskawa cannot guarantee how the SERVOPACK will act.

6.4.2 I/O Monitor Specifications

N-OT, P-OT and origin return deceleration limit switch (DEC) can be monitored, but the external latch signal (EXT) cannot be monitored with I/O monitoring by MECHATROLINK communications. N-OT and P-OT are output as a logic OR of the software limits (N-SOT, P-SOT). OT causes overtravel (OT) even at the software limit.

6.4.3 Monitor 1/2 Type Field Specifications

1	Command
2	
3	Option
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	Monitor 1/2 type
14	
15	
16	WDT

The monitor 1/2 type, the thirteenth byte of the reference data field of commands, is reserved to select monitor data that will be returned.

The following types of monitoring are available with the SGD-□□□N.

- Appropriate commands for monitor 1/2 type
  SMON, SV_ON, SV_OFF, INTERPOLATE, POSING, FEED, LATCH, EX_POSING, ZRET

The following table outlines the data (codes) and monitoring contents of monitor 1/2 type.

Name	Code	Description	Units
POS	0	Position in the reference coordinate system	Reference units
MPOS	1	Position in the mechanical coordinate system	Reference units
PERR	2	Position error	Reference units
APOS	3	Absolute position	Reference units
LPOS	4	Counter latch position	Reference units
IPOS	5	Internal position in the reference coordinate system	Reference units
TPOS	6	Final target position	Reference units
–	7	–	–
FSPD	8	Feedback speed	Reference units/s
CSPD	9	Reference speed	Reference units/s
TSPD	A	Final target reference speed	Reference units/s
TRQ	B	Torque reference	Reference units
–	C	–	%
–	D	–	–
–	E	–	–
–	F	–	–

Note 1. The minus (–) sign indicates unused bits. Do not use them.

2. Feed-back speed is approx. 20 [reference unit/s] (factory setting) and reference speed is a resolution of 500 [reference unit/s].

6.4.4 CONFIG Specifications

The following user constants can be reset in CONFIG (equipment setup) command for SGD-□□□N.

Cn-0001	Memory switch 1
Cn-0002	Memory switch 2
Cn-0011	No. of encoder pulses

6.4.5 ALM_RD Specifications

Byte	Command	Response
1	ALM_RD	ALM_RD
2		ALARM
3		STATUS
4		
5	ALM_RD_MODE	ALM_RD_MODE
6		ALM_DATA
7		
8		
9		
10		
11		
12		
13		
14		
15		
16	WDT	RWDT

The ALM_RD_MODE at the fifth byte of ALM_RD (read alarm/warning status) is the field used to select objects that will be read, and it can be specified for each products.

The following table shows the ALM_RD_MODE specifications for the SGD-□□□N.

ALM_RD_MODE	Description
0	Read current alarm/warning status 10 items max. (sixth to fifteenth bytes)
1	Read alarm/warning status history 10 items max. (sixth to fifteenth bytes)

Note Alarm and warning history occurrences are saved on EEPROM, and will not be lost if power turns OFF.

6.4.6 ALM_CLR Specifications

1	ALM_CLR
2	
3	
4	
5	ALM_CLR_MODE
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	WDT

The ALM_CLR_MODE at the fifth byte of ALM_CLR (clear alarm/warning status) is the field used to select objects that will be cleared, and it can be specified for each products.

The following are ALM_CLR_MODE specifications for the SGD-□□□N.

ALM_CLR_MODE	Description
0	Clear current alarm/warning status
1	Clear alarm/warning status history

Note It takes approx. 100 ms to clear. Do not clear alarm/warning status history while the motor is driving.

6.4.7 CONNECT Specifications

1	CONNECT
2	
3	
4	
5	VER
6	COM_MODE
7	COM_TIME
8	
9	
10	
11	
12	
13	
14	
15	
16	WDT

CONNECT (establish connection) is limited in the SGD-□□□N to the following items.

- COM_MODE

D7	D6	D5	D4	D3	D2	D1	D0
				DTMOD		SYNCMOD	EXMOD

DTMOD : Data transfer method
10: Multiple is not supported.

- COM_TIME

Use $2 \leqq$ COM_TIME $\leqq 32$.

6.4.8 INTERPOLATE Specifications

1	INTERPOLATE
2	
3	Option
4	
5	Interpolation position
6	
7	
8	
9	Speed feed forward
10	
11	
12	
13	Monitor type 1/2
14	
15	
16	WDT

The speed feed forward function is not supported in INTERPOLATE (interpolation feed) with the SGD-□□□N.

Always set the speed feed forward field between the ninth and twelfth bytes to 0.

6.4.9 LATCH Specifications

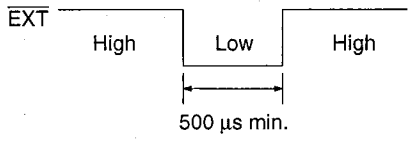
1	LATCH
2	Latch signal select
3	Option
4	
5	Interpolation position
6	
7	
8	
9	Speed feed forward
10	
11	
12	
13	Monitor type 1/2
14	
15	
16	WDT

The speed feed forward function is not supported in LATCH (interpolation feed with position detection) with the SGD-□□□N.

Always set the speed feed forward field between the ninth and twelfth bytes to 0.

Latch Signal Delays
C-phase: Within 1 μs
External signal: Approx. 50 μs (with 24 VDC input)

Set the external signal so that low section will be at least 500 μs as shown below.



6.4.10 POSING Command Specifications

There is a limit to the resolution of the acceleration/deceleration constants and feed speed when positioning with commands like the POSING command. These resolutions are given below. The INTERPOLATE command can be used when higher resolution is required.

- Acceleration/deceleration constants (CN-001F and Cn-0020):
  15625 reference units/s^2 (factory setting)
  This value changes with the number of reference units per revolution.
- If the number of reference units per revolution is 13653 or less, the resolution will be 15625 reference units/s^2. If it exceeds 13653, the resolution will be 250000 reference units/s^2. The acceleration/deceleration time is 8.19s maximum, and it is 1 s maximum with a FEED command.
- Feed speed: Approx. 2 reference units/s
  The feed speed cannot exceed 16383500 reference units/s.

6.4.11 INTERPOLATE Command Specifications

The interpolation feed speed for the INTERPOLATE command and other interpolation commands cannot exceed 16383500 reference units/s when expressing the amount of movement for one reference as a feed speed.

6.4.12 ID_RD Specifications

1	ID_RD
2	
3	
4	
5	DEVICE_CODE
6	OFFSET
7	SIZE
8	
9	
10	
11	
12	
13	
14	
15	
16	WDT

The only DEVICE_CODE available for ID_RD (ID read) is "00H: Main device/Product type" and "02H: Software version" because hardware limits use of the ID_RD function in the SGD-□□□N.

The following IDs can be read.

DEVICE_ CODE	ID Description															
	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
00H	S	G	D	–	*	*	*	N	00	Undefined						
02H	Software version		Undefined													

Note 00 to 07 are ASCII, 08 is 00H, and the software version is binary data.

6.4.13 Unsupported Commands

Do not use the following commands because they are not supported by the SGD-□□□N.

Code	Name	Function
3E	ADJ	Adjustment
3F	SVCTRL	General-purpose servo control

6.5 Power ON Sequence (Communication Sequence)

The following is a typical power ON sequence (communication sequence).

1. Turn ON the control power supply.
   ↓
2. Make communication connection (CONNECT command).

   When communication connection has been completed, confirm the following: COMRDY=1 and SVALM=0. Also confirm the MECHATROLINK version.
   ↓
3. Check device ID, etc.

   Confirm that the ID is "SGD-***N". Also confirm the software version.
   ↓
4. Write required parameters by PRM_WR command. (Set up the equipment (CONFIG command))
   ↓
5. Turn encoder (sensor) power ON (SENS_ON command).

   When the power has been turned ON, confirm the following status: COMRDY=1.
   ↓
6. Main circuit ON (SV_ON command).

   When the main circuit has been turned ON, confirm the following status: SVON=1.
   ↓
7. Operation starts.
   :
8. Main circuit OFF (SV_OFF command).

   When the main circuit has been turned OFF, confirm the following status: SVON=0.
   ↓
9. Communication disconnected (DISCONNECT command)
   ↓
10. Turn control power supply OFF.

    After turning ON the control power, transfer the NOP command or CONNECT command until communication connection has been completed.

The controller always has the required parameters and ensures proper controller operation by transferring the parameters at power ON. We recommend using this method at all times because the controller can then manage the parameters even if the SERVOPACK or motor is replaced.
There is also an alternative method shown on the next page where the SERVOPACK has all parameters (non-volatile parameters).
Non-volatile parameters are saved on EEPROM and cannot be changed very often. Also when absolute encoder is selected, the encoder cannot be changed to an incremental encoder without turning power ON/OFF. (Effect at the next power ON)

First write parameters to the SERVOPACK offline.

1. Turn control power ON.
   ↓
2. Communication connection (CONNECT command)
   ↓
3. Check device ID, etc.
   ↓
4. Write required non–volatile parameters by PPRM_WR command.

   When writing has been completed (ready for next writing), confirm the following status: COMRDY=1.
   ↓
5. Communication disconnected (DISCONNECT command)
   ↓
6. Turn control power OFF.

The following is a typical example (no parameters transferred).

1. Turn control power supply ON.
   ↓
2. Communication connection (CONNECT command)

   When communication connection has been completed, confirm the following status: COMRDY=1 and SVALM=0. Also confirm the MECHATROLINK version.
   ↓
3. Check device ID, etc. (Use the equipment setup (CONFIG command))

   Confirm that ID is "SGD-***N". Also confirm the software version.
   ↓
4. Turn encoder (sensor) power ON (SENS_ON command).

   When the power has been turned ON, confirm the following status: COMRDY=1.
   ↓

5. Main circuits ON (SV_ON command).

   When the main circuit has been turned ON, confirm the following status: SVON=1.

   ↓

6. Operation starts.

   :

7. Main circuit OFF and turn OFF the main power supply.

   ↓

8. Communication disconnected (DISCONNECT command)

   ↓

9. Turn control power supply OFF.

6.6 List of Alarm and Warning Codes

Code	Name	Alarm type
99	Normal	–
94	User constant setting warning	Warning
95	MECHATROLINK command warning	Warning
96	MECHATROLINK communication warning	Warning
00	Absolute encoder data error	Servo alarm
02	Broken user constant	Servo alarm
10	Overcurrent	Servo alarm
11	Ground	Servo alarm
40	Overvoltage	Servo alarm
51	Overspeed	Servo alarm
71	Overload (instantaneous)	Servo alarm
72	Overload (continuous)	Servo alarm
80	Absolute encoder error	Servo alarm
81	Absolute encoder backup error	Servo alarm
82	Absolute encoder checksum error	Servo alarm
83	Absolute encoder battery error	Servo alarm
84	Absolute encoder data error	Servo alarm
85	Absolute encoder overspeed	Servo alarm
B1	Gate array 1 error	Servo alarm
B2	Gate array 2 error	Servo alarm
B3	Phase-U current feedback error	Servo alarm
B4	Phase-V current feedback error	Servo alarm
B5	Watchdog detector error	Servo alarm
C1	Servo overrun	Servo alarm
C2	Encoder phase detection error	Servo alarm
C3	Encoder phase-A and phase-B disconnection	Servo alarm
C4	Encoder phase-C disconnection	Servo alarm
C5	Incremental encoder initial pulse error	Servo alarm
D0	Position error overflow	Servo alarm
E5	MECHATROLINK synchronization error	Communication alarm
E6	MECHATROLINK communication error	Communication alarm
F3	Power loss	Servo alarm

7

User Constants

This chapter describes the contents and settings of user constants (parameters) and memory switches.

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7.1 Setting User Constants

The SERVOPACK has the following user constants (parameters) that can be set or modified to fit the system. It is important to understand what the constants mean before using them.

User constants are set and modified through MECHATROLINK communication.

7.1.1 Gain-related Constants

The following gain-related user constants are available.

■ Cn-0004: Speed Loop Gain

- Sets the proportional gain for the speed controller.
- Allowable setting range: 1 to 20000 [× 0.1 Hz]
- Sets the constant at 40 [Hz] maximum when the motor is running under no-load conditions.

■ Cn-0005: Speed Loop Integration Time Constant

- Sets the integration time constant for the speed controller.
- Allowable setting range: 100 to 65535 [× 0.01 ms]

■ Cn-001A: Position Loop Gain

- Sets the proportional gain for the position controller.
- Allowable setting range: 1 to 50000 [× 0.01/s]

■ Cn-001C: Bias

- Sets the position control bias. This constant is used depending on load conditions to shorten positioning time.
- Allowable setting range: 0 to maximum motor speed [× 100 reference units/s]

■ Cn-001D: Feed Forward Compensation

- Sets the feed forward compensation for the position controller.
- Allowable setting range: 0 to 100 [%]

■ Cn-0027: Feed Forward Reference Filter

- Sets the primary lag filter to add to the feed forward compensation.
- This constant can be used to reduce the impact of feed forward control.
- Allowable setting range: 0 to 64000 [μs]

7.1.2 Torque-related Constants

The following torque-related user constants are available.

■ Cn-0006: Emergency Stop Torque

- Sets the stopping torque (deceleration by emergency stop torque with deceleration constant Cn-0001 bit 8 set to 1) for overtravel.
- Allowable setting range: 0 to maximum torque [%]

■ Cn-0008: Forward Torque Limit

- Sets the motor torque limit for forward rotation (for reverse rotation with reverse rotation mode).
- The motor torque will be controlled within this limit during forward rotation.
- Allowable setting range: 0 to maximum torque [%]

■ Cn-0009: Reverse Torque Limit

- Sets the motor torque limit for reverse rotation.
- The motor torque will be controlled within this limit during reverse rotation.
- Allowable setting range: 0 to maximum torque [%]

■ Cn-0017: Torque Reference Filter Time Constant

- Sets a primary lag filter to add to the reference torque for speed error and speed loop gain.
- This constant is used to prevent vibration due to mechanical resonance.
- Allowable setting range: 0 to 25000 [μs]

■ Cn-0018: Torque Reference Filter Time Constant (Secondary)

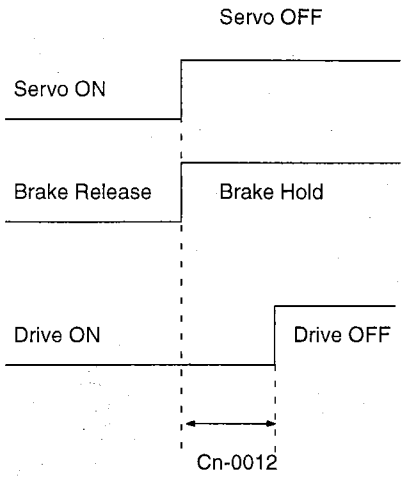
- Sets a secondary lag filter. The filtering effect can be improved by applying a secondary lag filter to the reference torque.
- Specifying a value other than 0 applies a secondary lag filter.
- Allowable setting range: 0 to 25000 [μs]

7.1.3 Sequence-related Constants

The following sequence-related user constants are available.

■ Cn-0012: Time Delay from Brake Reference to Servo OFF

- Sets the time delay from the brake reference output to Servo OFF when a Servomotor with a brake is used.
- Allowable setting range: 0 to 50 [× 10 ms]

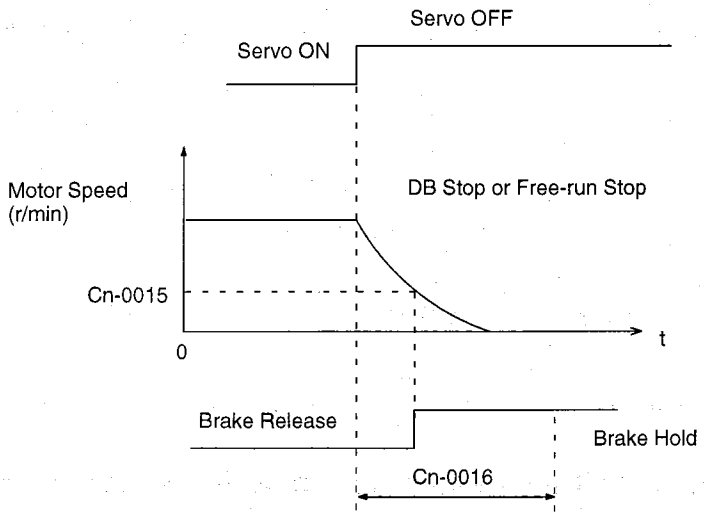


■ Cn-0015: Brake Timing During Motor Running (Motor Speed for Brake ON Reference)

- Sets the motor speed at which a brake reference is turned ON during Servo OFF.
- If the motor speed is faster than this setting speed, the brake will release.
- Allowable setting range: 0 to maximum motor speed [r/min]

■ Cn-0016: Time Delay from Servo OFF to Brake ON During Motor Running

- Sets the time delay from Servo OFF until the brake holds.
- The mechanical brake is not immediately applied while the motor speed is faster than the speed that was set to Cn-0015 after Servo is turned OFF. When the setting time has passed, the brake hold regardless of motor speed.
- Allowable setting range: 10 to 100 [× 10 ms]



7.1.4 Motion-related Constants

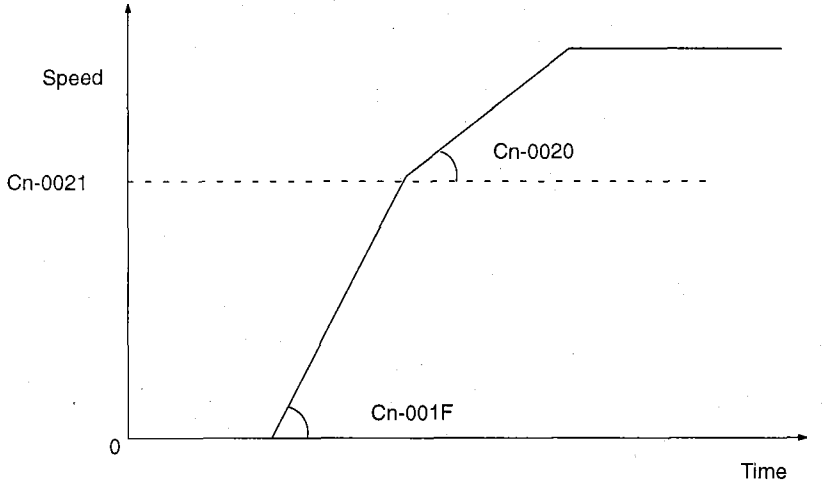
The following motion-related user constants are available.

■ Cn-001F: First-step Linear Acceleration/Deceleration Constant

- Sets the first-step acceleration/deceleration when two-step acceleration/deceleration is used.
- When two-step acceleration/deceleration is not used, set this constant and the acceleration/deceleration constant switching speed (Cn-0021) to 0.
- Allowable setting range: 0 to 65535 [× 10000 reference units/s^2]

■ Cn-0020: Second-step Linear Acceleration/Deceleration Constant

- Sets the second-step acceleration/deceleration.
- Allowable setting range: 0 to 65535 [× 10000 reference units/s^2]



■ Cn-0021: Acceleration/Deceleration Constant Switching Speed

- Sets the speed for switching from the first-step to the second-step acceleration/deceleration in two-step acceleration/deceleration.
- Allowable setting range: 0 to 65535 [× 100 reference units/s]

■ Cn-0026: Running Average Time

- Sets the time of running average for S-curve acceleration/deceleration.
- This constant is used for S-curve acceleration/deceleration.
- Allowable setting range: 0 to 5100 [× 100 μs]
- Running average is not valid when "0" is set.

■ Cn-002D: Exponential Acceleration/Deceleration Bias

- Sets the bias to change linear acceleration/deceleration to exponential acceleration/deceleration.
- Allowable setting range: 0 to 32767 [× 500 reference units/s]

Cn-002E: Exponential Acceleration/Deceleration Time Constant

- Sets the time constant to change linear acceleration/deceleration to exponential acceleration/deceleration.
- Allowable setting range: 0 to 5100 [× 100 μs]
- Exponential acceleration/deceleration is not valid when "0" is set.

Cn-0022: Zero point Return Approach Speed 1

- Sets the approach speed for returning to the zero point after the deceleration limit switch signal turns ON.
- Allowable setting range: 0 to 65535 [× 100 reference units/s]

Cn-0023: Zero point Return Approach Speed 2

- Sets the search speed for the zero point after the deceleration limit switch signal turns ON or OFF.
- Allowable setting range: 0 to 65535 [× 100 reference units/s]

Cn-0028: Final Travel Distance To Return To Zero Point

- Sets the distance from the encoder zero point pulse (phase-C pulse) to the zero point when returning to the zero point.
- Allowable setting range: –2147483648 to +2147483647 [reference units]
- If the setting distance is reverse direction or a short travel distance, the motor will decelerate to a stop and then return to reverse direction.

Cn-002A: Zero Point Width

- Sets the zero point (ZPOINT) detection width.
- Allowable setting range: 0 to 65535 [reference units]

Cn-0033: Absolute Encoder Zero Point Offset

- Sets the difference between the encoder zero point (position 0) and the machine zero point if an absolute encoder is used. For example, set the amount of offset so that the machine zero point is position 0.
- Allowable setting range: –2147483648 to +2147483647 [reference units]

Cn-002B: Final Travel Distance for External Positioning

- Sets the distance from the external signal input during external positioning.
- Allowable setting range: –2147483648 to +2147483647 [reference units]
- If the setting distance is reverse direction or a short travel distance, the motor will decelerate to a stop and then return to reverse direction.

Cn-002F: Forward Software Limit

- Sets the forward software position limit.

- Allowable setting range: –2147483648 to +2147483647 [reference units]
- The positive software limit must be set in combination with the reverse software limit to specify the range of motion. Make sure that the forward software limit is greater than the reverse software limit.

■ Cn-0031: Reverse Software Limit

- Sets the reverse software position limit.
- Allowable setting range: –2147483648 to +2147483647 [reference units]

■ Cn-001B: Positioning Completed Width

- Sets the positioning completed width (PSET).
- Allowable setting range: 0 to 250 [reference units]

■ Cn-0007: Positioning Near Detection Width

- Sets the detection width for positioning completed nearly (NEAR).
- When the motor position moves within the this range for the target position, NEAR is set to 1 regardless of whether command distribution is completed.
- Allowable setting range: 0 to 10000 [reference units]

■ Cn-001E: Position Error Overflow Range

- Sets the overflow detection level of the position error counter.
- Allowable setting range: 1 to 65535 [reference units]
- If the number of reference units per motor revolution (no. of encoder pulses × 4 × A/B) is 8193 or more, the range is the setting × 128. Therefore, the allowable setting range is 1 to 65535 [× 128 reference units].

7.1.5 Pulse-related Constants

The following pulse-related constants are available.

■ Cn-0011: Number of Encoder Pulses

- Sets the number of pulses per encoder revolution.
- The setting can be changed only once after power is turned ON; do not change the setting during operation.
- Sets Cn-0011 to 2048 P/R (SGM-□□□312) or 2000 P/R (SGM-□□□512) for an incremental encoder and to 1024 P/R for an absolute encoder.

■ Cn-0024 (B) and Cn-0025 (A): Electronic Gear Ratio

- The electronic gear ratio $\frac{B}{A}\left(\frac{\text{Cn-0024}}{\text{Cn-0025}}\right)$ represents the number of encoder pulses per reference unit.

For example, consider a system where the reference unit is micrometers in equipment that drives a ball screw with a 5-mm (0.20-in) pitch using a Servomotor with an incremental encoder (8192 pulses). Since 8192 encoder pulses are generated 4 times (unconditionally 4 times) in one motor revolution, the number of pulses generated is 2048 × 4 or 8192 pulses. Here, the Servomotor moves 5 mm (0.20 in) above the 5-mm (0.20-in) pitch ball screw, and this distance expressed as micrometers is 5000 μm. Therefore, set Cn-0024 to 8192 and Cn-0025 to 5000.

- Makes sure that the electronic gear ratio falls within the range $0.01 \leqq B/A \leqq 100$.
- Be sure to recalculate and correct user constants set in reference and speed reference units. Do not change this setting during operation.

7.1.6 Other Constants

The following user constants are available.

■ Cn-0003: Load Inertia

- Sets the load inertia for the moment of inertia ratio on the motor shaft.
- Allowable setting range: 0 to 65535 [%]
- If the load inertia exceeds the allowable range, regenerative brakes and other factors must be reviewed. See Section 6.6.2.

■ Cn-000C: Torque Reference Mode Switch Level

- Sets the torque reference mode switch level.
- This constant is valid only when torque reference mode switch is selected at Cn-0001 bits 12 and 13.
- Allowable setting range: 0 to maximum motor torque [%]

■ Cn-000E: Acceleration Mode Switch Level

- Sets the acceleration mode switch level.
- This constant is valid only when acceleration mode switch is selected at Cn-0001 bits 12 and 13.
- Allowable setting range: 0 to 3000 [× 0.167 r/s^2]

■ Cn-000F: Error Pulse Mode Switch Level

- Sets the mode switch level for switching the mode by error pulses.
- This constant is valid only when error pulse mode switch is selected at Cn-0001 bits 12 and 13.
- Unit: Encoder pulses
- Allowable setting range: 0 to 10000 [pulses]

■ Cn-0035: Speed Loop Compensation Constant

- The speed loop compensation function compensates for a phase shift resulting from speed detection in digital control and is effective in reducing vibration.

- When using this function, set Cn-0035 within a range that does not cause vibration in the servo system or abnormal noise in the mechanical system.
- The speed loop compensation function may not be effective in some cases and vibration may increase as a result. In that case, do not use the function (set Cn-0035 to 0).
- Allowable setting range: 0 to 100 (0: no compensation)

7.1.7 Memory Switches

The settings and functions of the memory switches are described below.

■ Cn-0001 Bit 0: SV_ON Command Mask

- The SV_ON command is disabled when this bit is set to 1 (main circuit operating status).

■ Cn-0001 Bit 0: SENS_ON Command Mask

- The SENS_ON command is disabled when this bit is set to 1 (encoder power ON status).

■ Cn-0001 Bit 2: P-OT Mask

- The P-OT signal is disabled when this bit is set to 1 (P-OT input OFF status).

■ Cn-0001 Bit 3: N-OT Mask

- The N-OT signal is disabled when this bit is set to 1 (N-OT input OFF status).

■ Cn-0001 Bit 5: Power Loss Mask

- Power loss alarm is not detected when this bit is set to 1. (No servo alarm at power loss.)

■ Cn-0001 Bit 6: Base Block Stopping Method

- Sets whether to use the dynamic brake or coasting to stop the motor when the main circuit is not operating (base block).
- Motor coasts to a stop when this bit is set to 1.

■ Cn-0001 Bit 7: Operation After Dynamic Brake (DB) Stop

- Sets whether to continue the dynamic brake after a dynamic brake stops.
- The brake is not continued when this bit is set to 1.

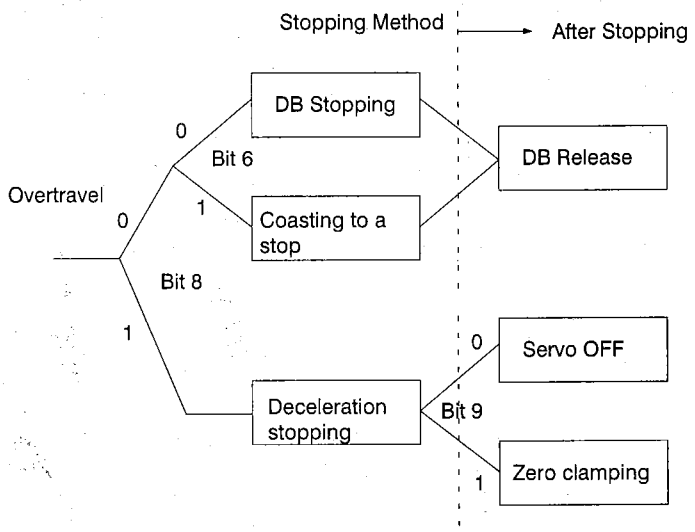
■ Cn-0001 Bit 8: Overtravel (OT) Stoping Method

- Sets how to stop a motor when overtravel occurs.
  Occurs at OT forward/reverse drive prohibit (overtravel) input and software limit.
- The motor will decelerate to a stop with the torque specified in the emergency stop torque constant (Cn-0006) when Cn-0001 bit 8 is set to 1.

■ Cn-0001 Bit 9: Holding Method After An Emergency Torque Deceleration Stop at Overtravel

- Sets the holding method after an emergency torque deceleration stop when overtravel occurs.

- Zero clamping (by position control) after the motor stops when this bit is set to 1. Normally set this to 1.



Stop Sequence in the Overtravel (OT)

■ Cn-0001 Bit 11: Mode Switch Function

- Sets whether or not the mode switch function will be used.
- The function is disabled when this bit is set to 1.

■ Cn-0001 Bits 12 And 13: Mode Switch Selection

- Selects mode switch switching conditions. See Section 5.9.3 for details on the mode switch.

  Bits 13 and 12 = 0, 0: Torque
  Bits 13 and 12 = 0, 1: Nothing (Do not use this setting.)
  Bits 13 and 12 = 1, 0: Acceleration
  Bits 13 and 12 = 1, 1: Error pulse

- The mode switch switching level can be set by Cn-000C to Cn-000F.

■ Cn-0001 Bit 14: Encoder Selection

- Sets Cn-0001 bit 14 to 0 for an incremental encoder and to 1 for an absolute encoder.
- The setting can be changed only once after power is turned ON; do not change the setting during operation.

■ Cn-0002 Bit 0: Motor Rotation Direction

- Sets the motor rotation direction.
- Determines whether Cn-0002 bit 0 or 2CN-7 is the reverse rotation mode with a reverse rotation setting.
- The forward direction is clockwise when Cn-0002 bit 0 is set to 1 (reverse rotation mode).

■ Cn-0002 Bit 1: Pulse Count Check for Absolute Encoder

- Cn-0002 bit 1 is valid only when an absolute encoder is used.

- Cn-0002 bit 1 is used to check whether the number of PG pulses (A and B phase) between origin pulses (C phase) match the number of pulses per revolution when an absolute encoder is used.
- This check is disabled when Cn-0002 bit 1 is set to 1.

Cn-0002 Bit 6: Software Limit Check by Reference

- Cn-0002 bit 6 is used to determine whether the software limit check is enabled when a position reference such as POSING or INTERPOLATE or other is input.
- The software limit check is enabled when Cn-0002 bit 6 is set to 1.

Cn-0002 Bit 8: Servomotor Selection

- Selects an SGM or SGMP Servomotor.
- The setting can be changed only once after power is turned ON; do not change the setting during operation.
- An SGMP Servomotor is selected when Cn-0002 bit 8 is set to 1.

Cn-0013 Bit 10: MECHATROLINK Communication Check Mask

- Cn-0013 bit 10 is used to cancel the communication check for debugging.
- Normally, set Cn-0013 bit 10 to communication check enabled.
- The communication check is canceled when Cn-0013 bit 10 is set to 1.

Cn-0013 Bit 11: WDT Check Mask

- Cn-0013 bit 11 is used to cancel the WDT check for debugging.
- Normally, set Cn-0013 bit 11 to WDT check enabled
- The WDT check is canceled when Cn-0013 bit 11 is set to 1.

Cn-0014 Bit 1: Zero Point Return Direction

- Sets this bit to 0 when zero point return direction is the forward direction (+) .
- Sets this bit to 1 when zero point return direction is the reverse direction (–).

Cn-0014 Bit 2: P-SOT Mask

- Cn-0014 bit 2 is used to disable the positive software limit check.
- The positive software limit check is disabled when Cn-0014 bit 2 is set to 1.

Cn-0014 Bit 3: N-SOT Mask

- Cn-0014 bit 3 is used to disable the reverse software limit check.
- The reverse software limit check is disabled when Cn-0014 bit 3 is set to 1.

Cn-0014 Bit 9: Brake Operation

- Cn-0014 bit 9 is used to set whether the SERVOPACK user constant or the BRK_ON/ BRK_OFF command operates the brake reference.

- The brake reference is operated by the SERVOPACK user constant when Cn-0014 bit 9 is set to 1.

■ Cn-0014 Bit 10: P-OT Signal Logic

- The P-OT signal logic is reversed when Cn-0014 bit 10 is set to 1. Forward drive is prohibited when the P-OT signal is turned OFF (Signal is CLOSED).

■ Cn-0014 Bit 11: N-OT Signal Logic

- The N-OT signal logic is reversed when Cn-0014 bit 11 is set to 1. Reverse drive is prohibited when the N-OT signal is turned OFF (Signal is CLOSED).

■ Cn-0014 Bit 12: DEC Signal Logic

- The DEC signal logic is reversed when Cn-0014 bit 12 is set to 1.
- The motor moves at zero point return approach speed 1 when the DEC signal is turned OFF (Signal is OPEN).
- The motor searches for the origin pulse at zero point return approach speed 2 when the DEC signal is turned ON (Signal is CLOSED).

7.2 List of User Constants

The following is a list of user constants.

IMPORTANT

- Of the user constants listed below, those that are reserved for the system are used internally by the SERVOPACK and cannot as a rule be accessed by the user.
- SERVOPACK behavior cannot be guaranteed if initial values for user constants reserved for the system are changed.
- Encoder and Servomotor factory settings can only be changed once after power is turned ON.
- Do not enter speed or torque values higher than the maximum for the Servomotor.

Table 7.1 List of User Constants

Constant No.	Name	Size	Units	Upper and Lower Limits	Factory Setting
Cn-0001	Memory switches 1	2	bit		0380H
Cn-0002	Memory switches 2	2	bit		0000H
Cn-0003	Load inertia	2	%	0 to 65535	100
Cn-0004	Speed loop gain	2	0.1 Hz	1 to 20000	400
Cn-0005	Speed loop integration time constant	2	0.01 ms	100 to 65535	2000
Cn-0006	Emergency stop torque	2	%	0 to MAX	MAX
Cn-0007	Positioning near detection width	2	Reference units	0 to 10000	10
Cn-0008	Forward torque limit	2	%	0 to MAX	MAX
Cn-0009	Reverse torque limit	2	%	0 to MAX	MAX
Cn-000A	Reserved for system	2	–	–	2048
Cn-000B	Reserved for system	2	–	–	0000H
Cn-000C	Torque reference mode switch level	2	%	0 to MAX	200
Cn-000D	Reserved for system	2	–	–	0000H
Cn-000E	Acceleration mode switch level	2	0.167 r/s^2	0 to 3000	0
Cn-000F	Error pulses mode switch level	2	Pulse	0 to 10000	0
Cn-0010	Reserved for system	2	–	–	500
Cn-0011	Number of encoder pulses	2	P/R	513 to 32767	2048
Cn-0012	Time delay from brake reference to Servo OFF	2	10 ms	0 to 50	0
Cn-0013	Memory switches 3	2	bit		0000H
Cn-0014	Memory switches 4	2	bit		0000H
Cn-0015	Brake timing during motor running (reference output speed)	2	r/min	0 to MAX	100

Constant No.	Name	Size	Units	Upper and Lower Limits	Factory Setting
Cn-0016	Time delay from Servo OFF to brake ON during motor running	2	10 ms	10 to 100	50
Cn-0017	Torque reference filter time constant	2	μs	0 to 25000	400
Cn-0018	Torque reference filter time constant (secondary)	2	μs	0 to 25000	0
Cn-0019	Reserved for system	2	–	–	0000H
Cn-001A	Position loop gain	2	0.01/s	1 to 50000	4000
Cn-001B	Positioning completed width	2	Reference units	0 to 250	7
Cn-001C	Bias	2	100 reference units/s	0 to MAX	0
Cn-001D	Feed forward compensation	2	%	0 to 100	0
Cn-001E	Position error overflow range	2	Reference units	1 to 65535	65535
Cn-001F	First-step linear acceleration/deceleration constant	2	10000 reference units/s^2	0 to 65535	0
Cn-0020	Second-step linear acceleration/deceleration constant	2	10000 reference units/s^2	0 to 65535	100
Cn-0021	Acceleration/deceleration constant switching speed	2	100 reference units/s	0 to 65535	0
Cn-0022	Zero point return approach speed 1	2	100 reference units/s	0 to 65535	50
Cn-0023	Zero point return approach speed 2	2	100 reference units/s	0 to 65535	5
Cn-0024	Electronic gear ratio B (numerator)	2		1 to 32768	4
Cn-0025	Electronic gear ratio A (denominator)	2		1 to 32768	1
Cn-0026	Running average time	2	100 μs	0 to 5100	0
Cn-0027	Feed forward reference filter	2	μs	0 to 64000	0
Cn-0028	Final travel distance to zero point return	4	Reference units	–2147483648 to 2147483647	100
Cn-002A	Origin width	2	Reference units	0 to 65535	10
Cn-002B	Final travel distance with external positioning	4	Reference units	–2147483648 to 2147483647	100
Cn-002D	Exponential acceleration/deceleration bias	2	500 Reference units/s	0 to 32767	0
Cn-002E	Exponential acceleration/deceleration time constant	2	100 μs	0 to 5100	0
Cn-002F	Forward software limit	4	Reference units	–2147483648 to 2147483647	8192 × 99999
Cn-0031	Reverse software limit	4	Reference units	–2147483648 to 2147483647	8192 × 99999
Cn-0033	Absolute encoder origin offset	4	Reference units	–2147483648 to 2147483647	0

Constant No.	Name	Size	Units	Upper and Lower Limits	Factory Setting
Cn-0035	Speed loop compensation constant	2	%	0 to 100	0
Cn-0036	Reserved for system	2	–	–	0000H
Cn-0037	Reserved for system	2	–	–	0000H
Cn-0038	Reserved for system	2	–	–	0000H
Cn-0039	Reserved for system	2	–	–	0000H
Cn-003A	Reserved for system	2	–	–	0000H
Cn-003B	Reserved for system	2	–	–	0000H
Cn-003C	Reserved for system	2	–	–	0000H
Cn-003D	Reserved for system	2	–	–	0000H
Cn-003E	Reserved for system	2	–	–	0000H
Cn-003F	Reserved for system	2	–	–	0000H

Note 1. Non-volatile parameters are saved in EEPROM and cannot be changed very often. It usually takes about 60 ms to overwrite with 2-byte parameter and about 120 ms to overwrite with 4-byte parameter, but response of a command will vary somewhat depending on the status of the buffers.

2. The factory setting for load inertia is an equivalent inertia of the Servomotor. Since vibrations will occur using the factory setting with a small load inertia, always set the load inertia to around 0 prior to operation.

3. Be sure to use an electronic gear ratio (Cn-0024 and 0025) within a range where $0.01 \leqq B(Cn\text{-}0024)/A(Cn\text{-}0025) \leqq 100$.

4. To avoid possible danger, never change parameters such as motor selection, encoder selection and number of encoder pulses while the Servomotor is driving (main circuit ON).

5. Changing parameters like the electronic gear ratio and number of encoder pulses may cause the Servomotor to run at a maximum speed outside the specified Servomotor speed range and may occur alarm code 04 when power is turned ON. If this happens, check the reference units one more time.

6. Be sure to convert all data to hexadecimal before writing it. Convert b15 (MSB) to b0 (LSB) to hexadecimal in 4-bit groups (b15 to b12, b11 to b8, b7 to b4, b3 to b0) for memory switches 1 to 4. Data sent from SERVOPACKS is read in hexadecimal, and note that H in the table is a hexadecimal number. The values specified in Cn-0028, 002B and 002F to 0033 have a sign and are 32-bit twos complements when a minus (–) sign is added.

7.3 Memory Switch Bit Details

The following describes each bit of memory switch (bit-type user constant).

7.3.1 Cn-0001: Memory Switches 1

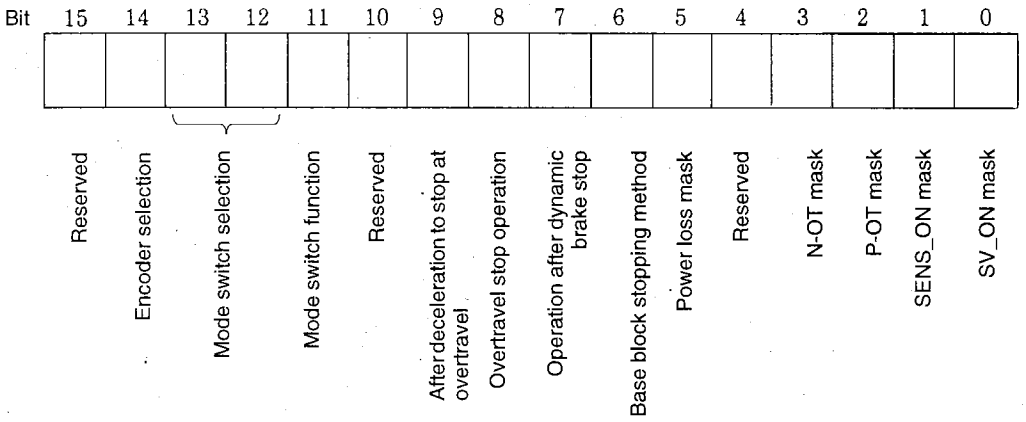
■ Bits b0 to b7

Bits b0 to b7 are described in the following table.

Bit	Description	Factory Setting
b0	SV_ON command mask 0: Enable SV_ON/SV_OFF command. 1: Always send SV_ON command (Servo ON).	0
b1	SENS_ON command mask 0: Enable SENS_ON/SENS_OFF command. 1: Always send SENS_ON command (Encoder power ON).	0
b2	P-OT mask 0: Enable the P-OT signal. 1: Mask (always disable) P-OT signal	0
b3	N-OT mask 0: Enable N-OT signal. 1: Mask (always disable) N-OT signal	0
b4	–	0
b5	Power loss mask 0: Servo alarm at power loss recovery (momentary power loss alarm) 1: Power loss mask (no servo alarm at power loss recovery)	0
b6	Base block stopping method 0: Dynamic brake (DB) stop 1: Coasting to a stop	0
b7	Operation after dynamic brake stop 0: Release dynamic brake. 1: Do not release dynamic brake.	1

Note Never change the factory setting of the bit marked with "–".

Cn-0001



■ Bits b8 to bF

Bits b8 to bF are described in the following table.

Bit	Description	Factory Setting
b8	Overtravel stop method 0: Stopping procedure depends on the setting of bit 6. 1: Decelerate to a stop using emergency stop torque.	1
b9	Operation after deceleration to stop at overtravel 0: Servo turns OFF after deceleration to a stop. 1: Zero clamping after deceleration to a stop (position clamping).	1
bA	–	0
bB	Mode switch function 0: Use the mode switch function (depending on bits 12 and 13). 1: Disable the mode switch function.	0
bC	00: Mode switch selection (use internal torque reference) 01: None(Do not use this setting) 10: Mode switch selection (use acceleration) 11: Mode switch selection (use error pulse)	0
bD		0
bE	Encoder selection 0: Incremental encoder 1: Absolute encoder	0
bF	–	0

Note Never change the factory setting of the bit marked with"–".

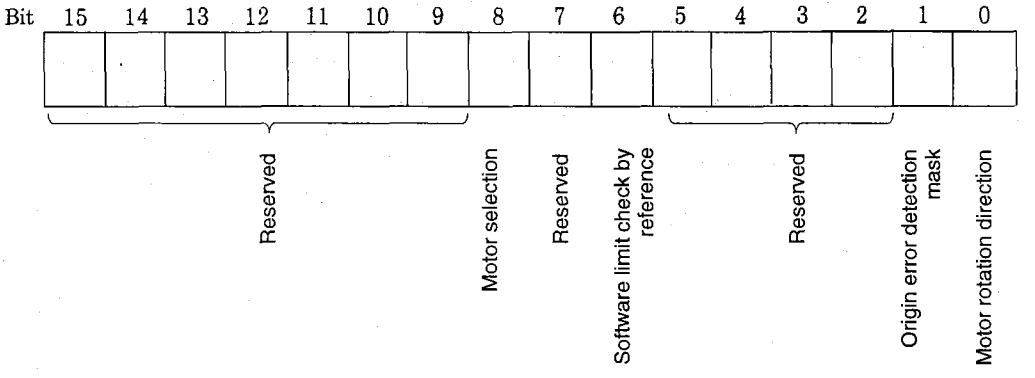
7.3.2 Cn-0002: Memory Switches 2

Cn-0002, memory switch 2, details are described in the following table.

Bit	Description	Factory Setting
b0	Motor rotation direction 0: The forward direction is counterclockwise derection. 1: The forward direction is clockwise derection (reverse rotation mode).	0
b1	Origin error detection mask 0: Detect origin error (only with an absolute encoder) 1: Do not detect zero point errors.	0
b2	–	0
b3	–	0
b4	–	0
b5	–	0
b6	Software limit check by a reference position 0: Do not check. 1: Check.	0
b7	–	0
b8	Motor selection 0: SGM, 1: SGMP motors	0
b9	–	0
bA	–	0
bB	–	0
bC	–	0
bD	–	0
bE	–	0
bF	–	0

Note Never change the factory settings of the bits marked with "–".

Cn-0002

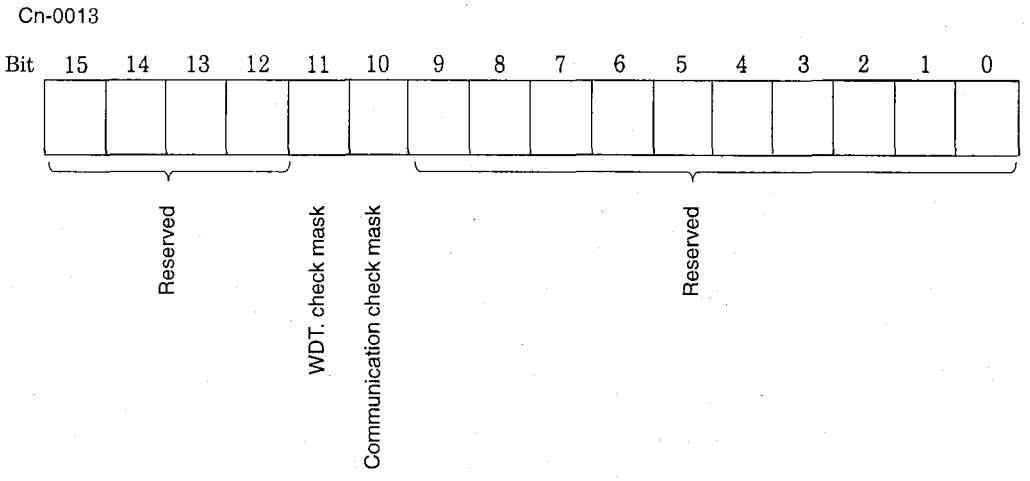


7.3.3 Cn-0013: Memory Switches 3

Cn-0013, memory switches 3, details are described in the following table.

Bit	Description	Factory Setting
b0	–	0
b1	–	0
b2	–	0
b3	–	0
b4	–	0
b5	–	0
b6	–	0
b7	–	0
b8	–	0
b9	–	0
bA	MECHATROLINK communication check mask (for debugging) 0: Communication check 1: Communication check masked	0
bB	WDT check mask (for debugging) 0: Check WDT. 1: Mask WDT.	0
bC	–	0
bD	–	0
bE	–	0
bF	–	0

Note Never change the factory settings of the bits marked with "–".



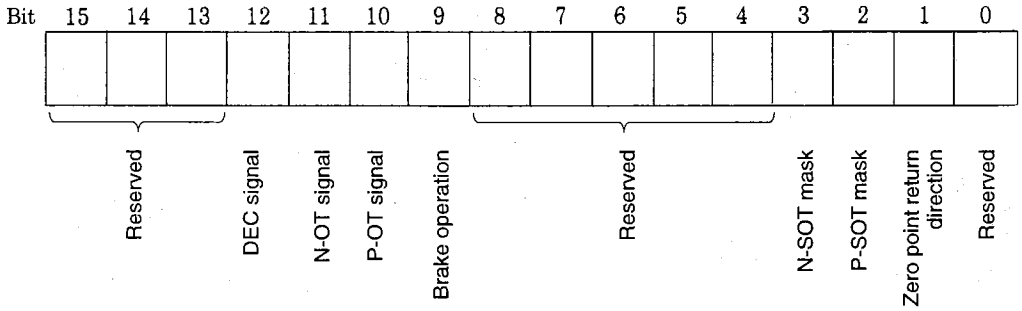
7.3.4 Cn-0014: Memory Switches 4

Cn-0014, memory switch 4, details are described in the following table.

Bit	Description	Factory Setting
b0	–	0
b1	Zero point return direction 0: Forward direction 1: Reverse direction	0
b2	P-SOT mask 0: Enable forward software limit. 1: Mask (always disable) forward software limit.	0
b3	N-SOT mask 0: Enable reverse software limit. 1: Mask (always disable) reverse software limit.	0
b4	–	0
b5	–	0
b6	–	0
b7	–	0
b8	–	0
b9	Brake operation 0: Operate with the BRK_ON/BRK_OFF command. 1: Operate from the SERVOPACK (BRK_ON/BRK_OFF command disabled)	0
bA	P-OT signal 0: Positive logic 1: Negative logic	0
bB	N-OT signal 0: Positive logic 1: Negative logic	0
bC	DEC signal 0: Positive logic 1: Negative logic	0
bD	–	0
bE	–	0
bF	–	0

Note Never change the factory settings of the bits marked with "–".

Cn-0014



7.4 Limits to User Constant Changes

The only user constants that can be changed during motor running are those listed below. Never change any other user constants during motor running.

Number	Name
Cn-0004	Speed loop gain
Cn-0005	Speed loop integration time constant
Cn-0008	Positive torque limit
Cn-0009	Negative torque limit
Cn-0017	Torque reference filter time constant
Cn-0018	Torque reference filter time constant (secondary)
Cn-001A	Position loop gain
Cn-001C	Bias
Cn-001D	Feed forward compensation

7.5 Procedure for Transferring User Constants

The procedure for changing (transferring) user constants (parameters) after power is turned ON is to transfer the Servomotor selection, encoder selection (encoder type and number of pulses), electronic gear ratio, and other user constants in order only. Randomly transferring user constants can cause a user constant setting warning and they may not be received.

Motor selection, encoder selection, and electronic gear ratio parameters can be changed only once after power is turned ON. This must be done prior to executing the SENS_ON command and the motor running.

8

Installation and Wiring

This chapter describes procedures for checking to be performed when the Servomotors and SERVOPACKS are delivered as well as installation and wiring specifications.

8.1 Checking on Delivery ..... 8 - 2
8.2 Installation ..... 8 - 2
8.2.1 Installing Servomotors ..... 8 - 2
8.2.2 Installing SERVOPACKS ..... 8 - 4
8.3 Wiring Specifications ..... 8 - 6
8.3.1 Rated Current and Cable Specifications ..... 8 - 6
8.3.2 Wiring Instructions ..... 8 - 7
8.3.3 Power Loss ..... 8 - 8

8.1 Checking on Delivery

When Σ-Series products are delivered, check the following items:

Check Items	Remarks
Check if the delivered products are the ones you ordered.	Check the model numbers marked on the nameplates of Servomotor and SERVOPACK.
Check for damage.	Check the overall appearance, and check for damage or scratches resulting from transportation.
Check if the motor shaft rotates smoothly.	If the motor shaft can be smoothly turned by hand, it is normal. If the motor has a brake, however, it cannot be turned manually.
Check loose screws.	Check for looseness by using a screwdriver as necessary.

If any of the above items are faulty or incorrect, contact the dealer from which you purchased the products or your nearest sales representative. Be sure to confirm that there are no loose screws, breakage in lead wires, or damage in insulation.

8.2 Installation

8.2.1 Installing Servomotors

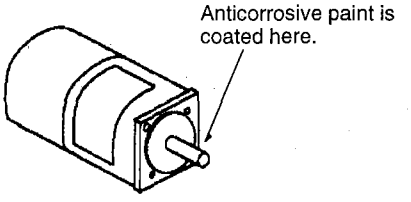
The Servomotor can be installed either horizontally or vertically. If the Servomotor is installed incorrectly or in an inappropriate location, the service life will be shortened or unexpected problems will occur. To prevent this, always observe the installation instructions provided below.

⚠ CAUTION Do not connect the Servomotor directly to a commercial power supply. Doing so will damage the motor.

The Servomotor will not operate unless connected to the proper SERVOPACK.

■ Before Installation

Anticorrosive paint is coated on the edge of the motor shaft to prevent corrosion during storage. Before installation, clean off the anticorrosive paint thoroughly using a cloth moistened with thinner. Avoid getting thinner on other parts of the Servomotor when cleaning the shaft.



■ Installation Site

The Servomotors are designed for indoor use. Install Servomotor in an environment which meets the following conditions:

- Free from corrosive or explosive gases
- Well-ventilated and free from dust and moisture
- Ambient temperature of 0 to 40°C
- Sufficient access for each inspection and cleaning

If the Servomotor is used in a location subject to water or oil mist, install a shield or cover over the Servomotor.

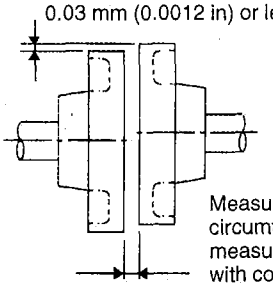
■ Environment Condition

Use the Servomotor in the following environment.

- Temperature range: –20°C to 40°C
- Relative humidity of 20% to 80% (with no condensation)
- Storage temperature: –20°C to 60°C

■ Alignment

Align the shaft of the Servomotor with that of the equipment to be controlled. When connecting couplings, be careful not to apply any impact to the shaft or excessive force on bearings. Install the Servomotor so that alignment accuracy falls within the range shown below. If the shafts are not aligned properly, vibration will occur, resulting in damage to bearings.



■ Allowable Bearing Load

Do not apply any excessive thrust load or radial load to the AC Servomotor. When installing gears, couplings, pulleys, etc., be careful not to apply any impact to the shaft or excessive force on bearings. Mechanical shock to the shaft end must be less than 50 G (490m/s^2).

Design the mechanical system so that thrust load and radial load applied to the servomotor shaft end during operation falls within the range shown in *Table 3.1*.

8.2.2 Installing SERVOPACKS

The SGD-□□□N SERVOPACK is a book-shaped compact servo controller. Install the SERVOPACK according to the following instructions, since faulty installation may cause malfunction.

■ Installation Site

Situation	Precautions
When installed in a control panel	Depending on the size of the panel, the temperature inside the control panel may become higher than the ambient temperature due to heat generated by internal devices. Design the control panel size, unit layout, and cooling method so that the temperature around the SERVOPACK does not exceed 55°C.
When installed near a heating unit	Suppress radiation heat from the heating unit and temperature rise caused by convection so that the temperature around the SERVOPACK does not exceed 55°C.
When installed near a source of vibration	Install a vibration isolator underneath the SERVOPACK to prevent it from receiving vibration.
When installed in a place subject to corrosive gases	Corrosive gases do not immediately affect the SERVOPACK but will eventually cause magnetic contactors or relays in the reference circuits or main circuits to malfunction. Take appropriate action to prevent corrosive gases.
Other locations	Avoid installation in hot or humid places, or where excessive dust or iron powder is present in the air.

■ Orientation

Install the SERVOPACK perpendicular to the wall as shown in the figure.

The SERVOPACK must be orientated as shown in the figure because it is designed to be cooled by natural convection.

- Firmly secure the SERVOPACK through the mounting holes provided.

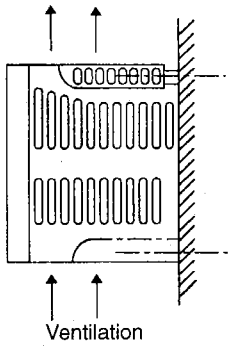
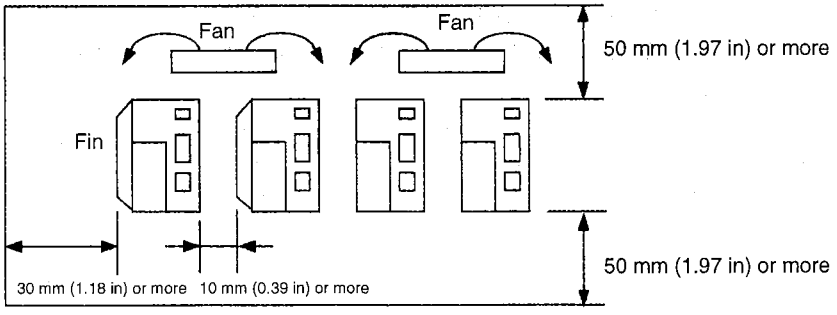


Figure 9.3 Installation Orientation

■ Installation Method



- Install the SERVOPACK perpendicular to the wall so that the front panel faces outward.
- Provide sufficient space around each SERVOPACK to allow cooling by natural convection.
- When installing SERVOPACKS side by side, install cooling fans above the SERVOPACKS to prevent the temperature around each SERVOPACK from increasing excessively and also to maintain an even temperature inside the control panel.
- When installing multiple SERVOPACKS side by side in a control panel, provide at least 10 mm (0.39 in) space between them and at least 50 mm (1.97 in) space above and below them as shown in the figure on the buttom of the previous page and observe the following installation conditions:
  - Ambient temperature for SERVOPACKS: 0 to 55°C
  - Humidity: 90% RH or less
  - Vibration: 0.5G (4.9 m/s^2)
  - Condensation and freezing: None
  - Ambient temperature (or in-panel temperature) to ensure long-term reliability: 45°C or less

8.3 Wiring Specifications

8.3.1 Rated Current and Cable Specifications

The rated current of the SERVOPACK external terminals and cable size are listed in *Tables 8.1* and *8.2*. The cable specifications and sizes must be selected according to the operating environment and current capacity. The cable specifications in these tables were selected under conditions of three cables per bundle at 40° C ambient temperature, with the rated current flowing. *Table 8.3* lists the cable types.

Table 8.1 Rated Current of SGD SERVOPACK External Terminals

Supply voltage	SERVOPACK Model SGD-		Main Circuit Power Input Terminal (R) (T)		Motor Connection Terminals (U) (V) (W) ⏚	
			Rated Current A (rms)	Cable Specifications	Rated Current A (rms)	Cable Specifications
200 V	30 W (0.04HP)	A3AN	1.3	HIV 1.25 min.	0.42	Use Yaskawa cable. See *9.4 Cable Specifications* for details. When using non-Yaskawa cables, check the cable current rating and consider the operating environment. Use cable sizes AWG22 to AWG18 (0.3 to 0.89 mm^2 (0.0005 to 0.001 in^2).
	50 W (0.07HP)	A5AN	1.5		0.6	
	100 W (0.13HP)	01AN	2.5		0.87	
	200 W (0.27HP)	02AN	4.0		2.0	
	400 W (0.53HP)	04AN	6.0	HIV 2.0 min.	2.6	
	750 W (1.01HP)	08AN	11.0		4.4	
100 V	30 W (0.04HP)	A3BN	2.0	HIV 1.25 min.	0.63	
	50 W (0.07HP)	A5BN	2.6		0.7	
	100 W (0.13HP)	01BN	4.5		2.2	
	200 W (0.27HP)	02BN	8.0	HIV 2.0 min.	2.7	
	300 W (0.40HP)	03BN	14.0		3.7	

The appropriate cables for SERVOPACK connectors 1CN and 2CN are shown in the following table.

Table 8.2 Wire Size Example

Control I/O Signal Connector	**1CN**	Cable	Use twisted-pair wires or shielded twisted-pair wires.
		Applicable Cable	AWG24, 26, 28, 30
		Finished Cable Dimensions	ϕ 16.0 mm (ϕ 0.63 in.) max.
		Rated Current A (rms)	100 mA DC max.
PG Signal Connector	**2CN**	Cable	Use Yaskawa cable. See *9.4 Cable Specifications* for details. Use shielded twisted-pair wires if a Yaskawa cable is not used.
		Applicable Cable	Applicable cable sizes: AWG24, 26, 28, 30. Use AWG22 (0.32 mm^2) for encoder power supply and FG lines. Use AWG26 (0.12 mm^2) for other signals. These connections permit wiring distances up to 20 m (65.6 ft.).
		Finished Cable Dimensions	ϕ 11.6 (ϕ 0.46 in.) mm max.
		Rated Current A (rms)	100 mA DC max. (500 mA DC max. for power supply line)

Note Cable selection conditions: three cables per bundle at 40 °C ambient temperature with the rated current flowing.

Table 8.3 Cable Types

Cable Type		Conductor Allowable Temperature [°C]
Symbol	**Name**	
PVC	Normal vinyl cable	–
IV	600-V vinyl cable	60
HIV	Temperature-resistant vinyl cable	75

Note 1. Use cable with 600 V min. withstand voltage for main circuits.

2. Consider allowable current reduction ratio if cables are bundled in PVC or metal ducts.

3. Use temperature-resistant cable under high ambient or panel temperatures where normal vinyl cables rapidly deteriorate.

8

8.3.2 Wiring Instructions

To ensure safe and stable operation, always refer to the following wiring instructions.

- For signal lines and PG feedback lines, use twisted-pair wires and multicore shielded twisted-pair wires (Yaskawa Drawing No. B9400064 or DE8400093).
  The maximum allowable wiring length is as follows: 50 m (164.04 ft) for I/O lines (at 24 V power supply), 20 m (65.62ft) for PG feedback lines, and 50 m (164.04 ft) for MECHATROLINK communication line. Cut off the excess portion of the cable to minimize the cable length.
- For a ground wire, use as thick a cable as possible. At least grounding to less than 100 Ω is recommended. Always ground one point only.

If the motor is insulated from the machine, ground the motor directly.

- To prevent malfunction due to noise, take the following actions:
  - Position the input reference device and noise filter as close to the SERVOPACK as possible.
  - Always install a surge absorber circuit in the relay, solenoid and magnetic contactor coils.
  - The distance between a power line (such as a power supply line or motor cable) and a signal line must be at least 30 cm (12 in). Do not put the power and signal lines in the same duct or bundle them together.
  - Do not share the power supply with an electric welder or electrical discharge machine. When the SERVOPACK is placed near a high-frequency oscillator, install a noise filter on the input side of the power supply line.
  - The SERVOPACK uses high-speed switching elements, which may cause noise on signal lines. To prevent this, always take the above actions.
- Prevention of Radio Frequency Interference (RFI)
- Since the SERVOPACKS are designed for industrial use, no measures are provided against radio frequency interference. Use a noise filter in the power input line when using the SERVOPACKS near residential areas or where they are prone to radio frequency interference.
- Do not bend or apply tension to cables.

Since the conductor of a signal cable is very thin [0.1 to 0.3 mm^2 (0.0002 to 0.0005 in^2)], handle it with adequate care.

8.3.3 Power Loss

The power loss of the SERVOPACKS is as shown in the following table.

Table 8.4 Power Loss during Rated Output

SERVOPACK Model SGD-	Supply Voltage	Capacity W	Output Current A (rms)	Power Loss W
A3AN	200 VAC	30	0.42	15
A5AN		50	0.60	18
01AN		100	0.87	20
02AN		200	2.0	35
04AN		400	2.6	45
08AN		750	4.4	60
A3BN	100 VAC	30	0.63	17
A5BN		50	0.90	20
01BN		100	2.2	30
02BN		200	2.7	47
03BN		300	3.7	70

9

Servodrives Dimensional Drawings

This chapter presents dimensional drawings of the Servomotors, SERVOPACKS, and peripheral devices.

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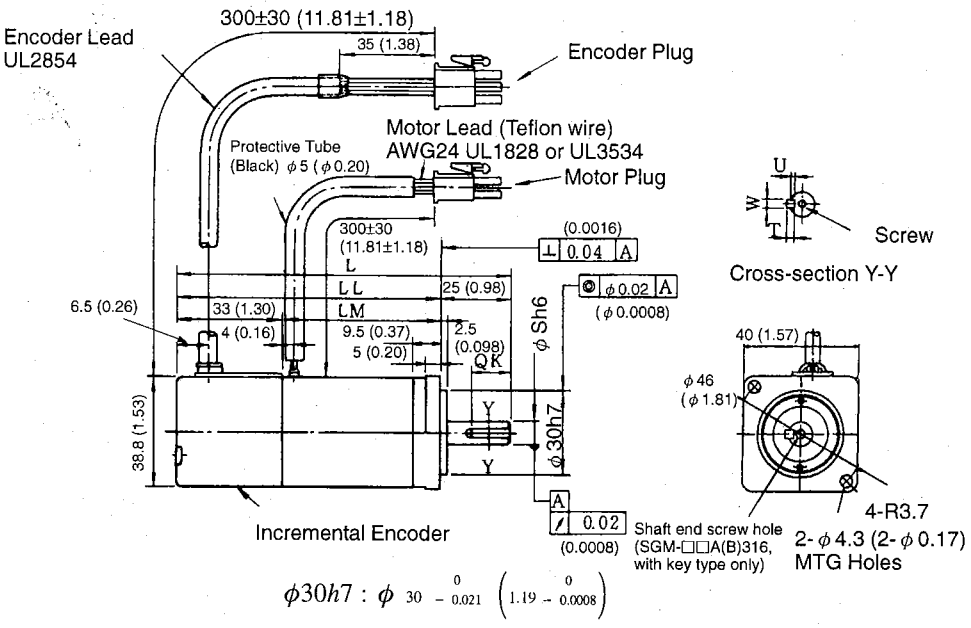
9.1 Servomotor Dimensional Drawings

9.1.1 SGM Servomotors

■ SGM Servomotors with Incremental Encoders, No Brakes

30 W (0.04 HP), 50 W (0.07 HP), 100 W (0.13 HP)



$$\phi 30h7 : \phi\ 30\ {}^{0}_{-0.021}\ \left(1.19\ {}^{0}_{-0.0008}\right)$$

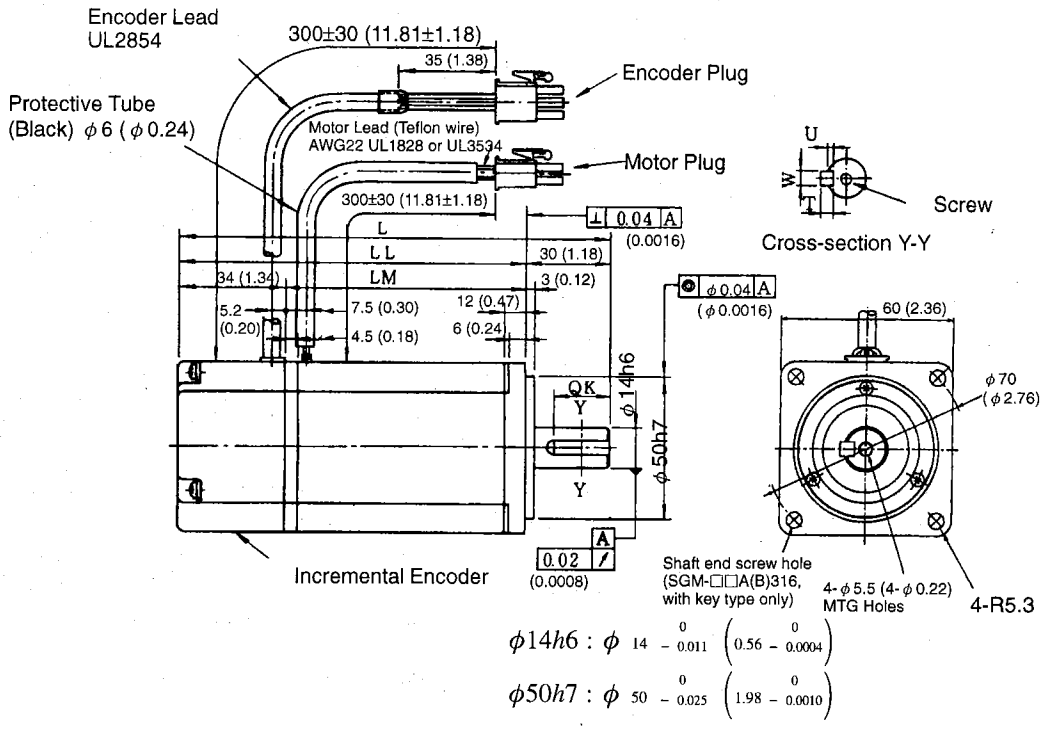
Model SGM-	L	LL	LM	S	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
A3A□12	94.5 (3.72)	69.5 (2.74)	36.5 (1.44)	6 (0.24)	No key				–	30 (0.04)	0.3 (0.66)	68 (15)	54 (12)
A3B□12													
A3A□14					14 (0.55)	1.2 (0.05)	2 (0.08)	2 (0.08)					
A3B□14													
A3A□16									M2.5, depth 5 (0.20)				
A3B□16													
A5A□12	102.0 (4.02)	77.0 (3.03)	44.0 (1.73)	6 (0.24)	No key				–	50 (0.07)	0.4 (0.88)	68 (15)	54 (12)
A5B□12													
A5A□14					14 (0.55)	1.2 (0.05)	2 (0.08)	2 (0.08)					
A5B□14													
A5A□16									M2.5, depth 5 (0.20)				
A5B□16													
01A□12	119.5 (4.70)	94.5 (3.72)	61.5 (2.42)	8 (0.31)	No key				–	100 (0.13)	0.5 (1.10)	78 (17)	54 (12)
01B□12													
01A□14					14 (0.55)	1.8 (0.07)	3 (0.12)	3 (0.12)					
01B□14													
01A□16									M3, depth 6 (0.24)				
01B□16													

Note 1. The encoder is an incremental encoder.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

3. The symbol "□" in the model number indicates the number of encoder pulses (3: 2048P/R, 5: 2000P/R).

200 W (0.27 HP), 300 W (0.04 HP), 400 W (0.53 HP)



$$\phi 14h6 : \phi\ 14\ {}^{0}_{-0.011}\ \left(0.56\ {}^{0}_{-0.0004}\right)$$

$$\phi 50h7 : \phi\ 50\ {}^{0}_{-0.025}\ \left(1.98\ {}^{0}_{-0.0010}\right)$$

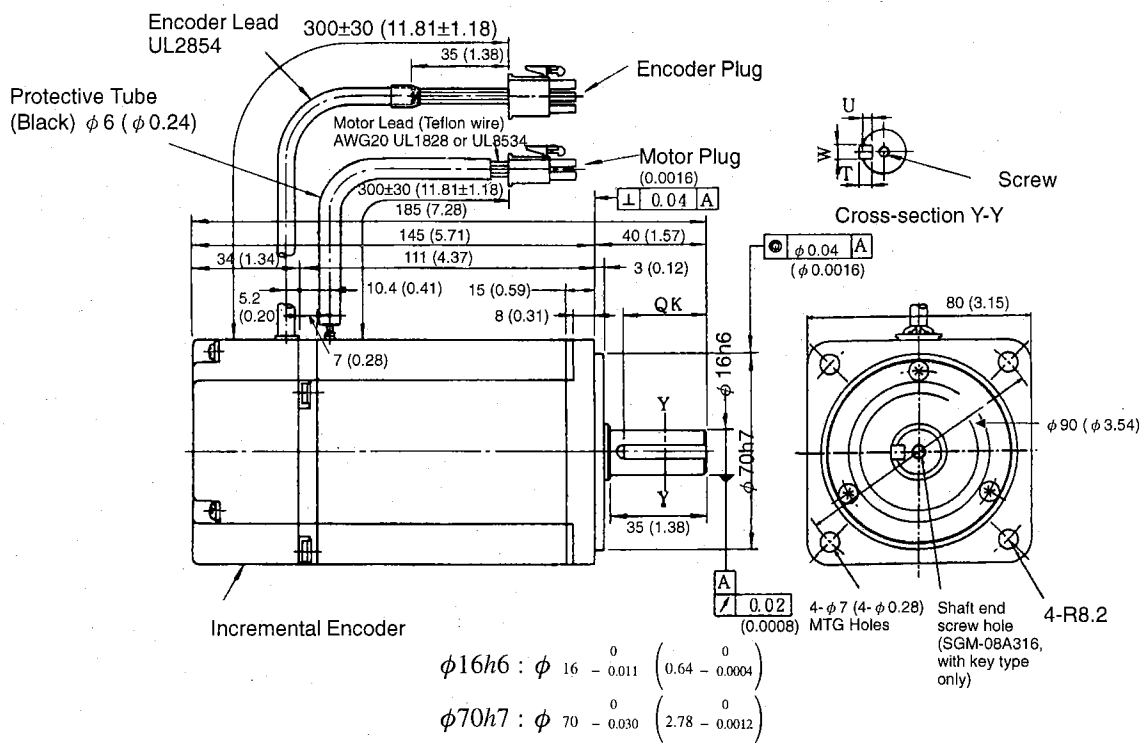
Model SGM-	L	LL	LM	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
02A□12	126.5 (4.98)	96.5 (3.80)	62.5 (2.46)	No key				–	200 (0.27)	1.1 (2.43)	245 (55)	74 (16)
02B□12												
02A□14				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
02B□14												
02A□16								M5, depth 8 (0.31)				
02B□16												
03B□12	154.5 (6.08)	124.5 (4.90)	90.5 (3.56)	No key				–	300 (0.40)	1.7 (3.75)	245 (55)	74 (16)
03B□14				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
03B□16								M5, depth 8 (0.31)				
04A□12	154.5 (6.08)	124.5 (4.90)	90.5 (3.56)	No key				–	400 (0.53)	1.7 (3.75)	245 (55)	74 (16)
04A□14				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
04A□16								M5, depth 8 (0.31)				

Note 1. The encoder is an incremental encoder.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

3. The symbol "□" in the model number indicates the number of encoder pulses (3: 2048P/R, 5: 2000P/R).

750 W (1.01 HP)



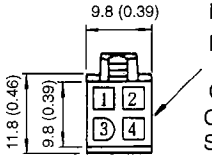
Model SGM-	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
08A□12	No key				–	750 (1.01)	3.4 (7.50)	392 (88)	147 (33)
08A□14	30 (1.18)	3 (0.12)	5 (0.20)	5 (0.20)					
08A□16					M5, depth 8 (0.31)				

Note 1. The encoder is an incremental encoder.

2. "A" in the model number indicates 200 V specifications.
3. The symbol "□" in the model number indicates the number of encoder pulses (3: 2048P/R, 5: 2000P/R).

Servomotor and Encoder Plugs (For 30 W (0.04 HP) to 750 W (1.01 HP))

Motor Plug



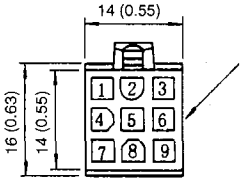
Plug: 172167-1 (AMP)
Pin: 170360-1 or 170364-1

Connected to
Cap: 172159-1
Socket: 170362-1 or 170366-1

Motor Wiring Specifications

1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG	Green

Encoder Plug



Plug: 172169-1 (AMP)
Pin: 170359-1 or 170363-1

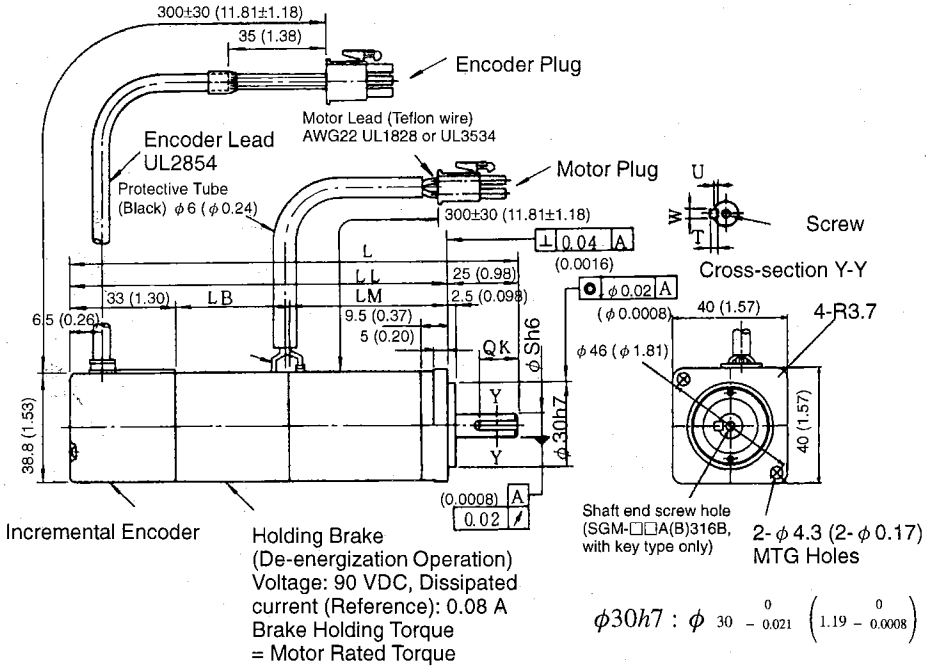
Connected to
Cap: 172161-1
Socket: 170361-1 or 170365-1

Incremental Encoder Wiring Specifications

1	A channel output	Blue
2	$\overline{A}$ channel output	Blue, Black
3	B channel output	Yellow
4	$\overline{B}$ channel output	Yellow, Black
5	C channel output	Green
6	$\overline{C}$ channel output	Green, Black
7	0 V (power supply)	Gray
8	+5 V (power supply)	Red
9	FG (Frame Ground)	Orange

■ SGM Servomotors with Incremental Encoders and Brakes

30 W (0.04 HP), 50 W (0.07 HP), 100 W (0.13 HP)



Model SGM-	L	LL	LM	LB	S	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
A3A□12B	126.0 (4.96)	101.0 (3.98)	36.5 (1.44)	31.5 (1.24)	6 (0.24)	No key					30 (0.04)	0.6 (1.32)	68 (15)	54 (12)
A3B□12B														
A3A□14B						14 (0.55)	1.2 (0.05)	2 (0.08)	2 (0.08)					
A3B□14B														
A3A□16B										M2.5, depth 5 (0.20)				
A3B□16B														
A5A□12B	133.5 (5.26)	108.5 (4.27)	44.0 (1.73)	31.5 (1.24)	6 (0.24)	No key				–	50 (0.07)	0.7 (1.54)	68 (15)	54 (12)
A5B□12B														
A5A□14B						14 (0.55)	1.2 (0.05)	2 (0.08)	2 (0.08)					
A5B□14B														
A5A□16B										M2.5, depth 5 (0.20)				
A5B□16B														
01A□12B	160.0 (6.30)	135.0 (5.31)	61.5 (2.42)	40.5 (1.59)	8 (0.31)	No key				–	100 (0.13)	0.8 (1.76)	78 (17)	54 (12)
01B□12B														
01A□14B						14 (0.55)	1.8 (0.07)	3 (0.12)	3 (0.12)					
01B□14B														
01A□16B										M3. depth 6 (0.24)				
01B□16B														

Note 1. The encoder is an incremental encoder.

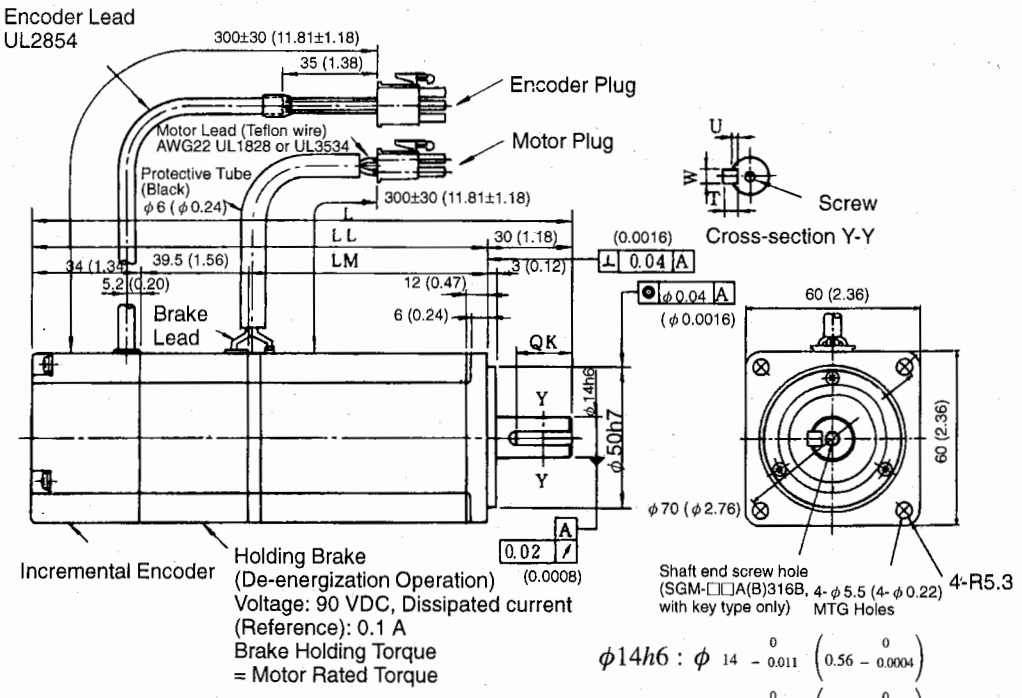
2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

3. The symbol "□" in the model number indicates the number of encoder pulses (3: 2048P/R, 5: 2000P/R).

Dimensional Tolerances

Model SGM-	Shaft-end Dimensions [mm (in)]
	S
A3A□12B	$6\ {}^{0}_{-0.008}\ \left(0.24\ {}^{0}_{-0.0003}\right)$
A3B□12B	
A3A□14B	
A3B□14B	
A5A□12B	$6\ {}^{0}_{-0.008}\ \left(0.24\ {}^{0}_{-0.0003}\right)$
A5B□12B	
A5A□14B	
A5B□14B	
01A□12B	$8\ {}^{0}_{-0.009}\ \left(0.32\ {}^{0}_{-0.0004}\right)$
01B□12B	
01A□14B	
01B□14B	

200 W (0.53 HP), 300 W (0.40 HP), 400 W (0.27 HP)



$\phi 14h6 : \phi\ 14\ {}^{0}_{-0.011}\ \left(0.56\ {}^{0}_{-0.0004}\right)$

$\phi 50h7 : \phi\ 50\ {}^{0}_{-0.025}\ \left(1.98\ {}^{0}_{-0.0010}\right)$

9

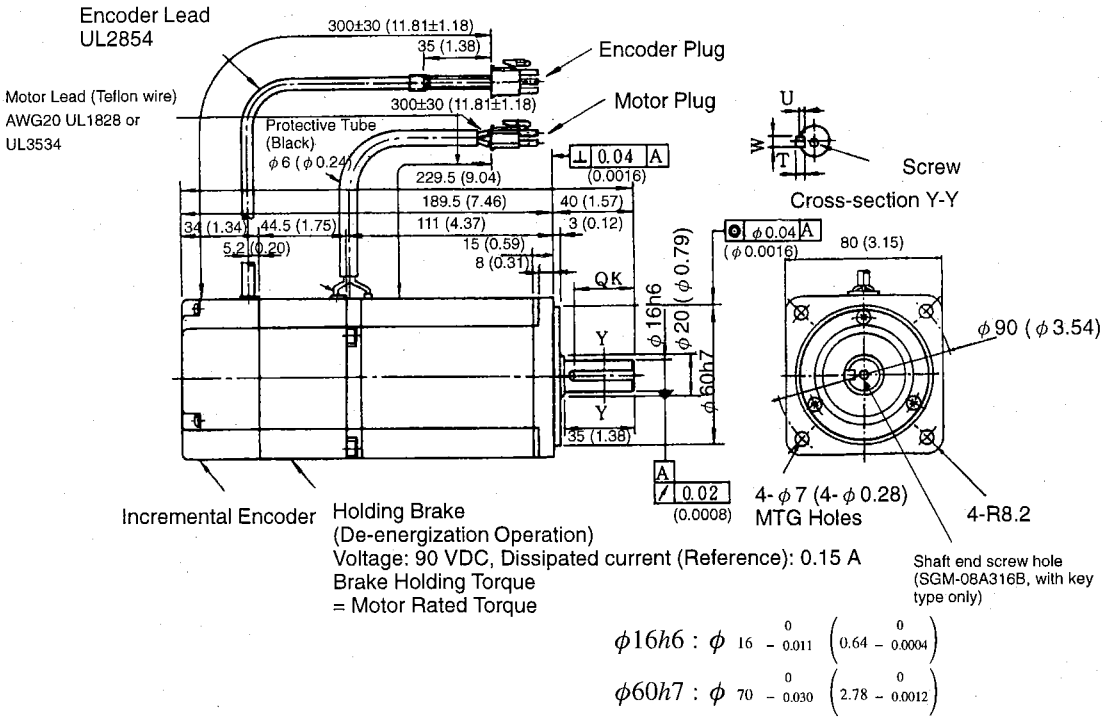
Model SGM-	L	LL	LM	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
02A□12B	166.0 (6.54)	136.0 (5.35)	62.5 (2.46)	No key				–	200 (0.27)	1.6 (3.53)	245 (55)	74 (16)
02B□12B												
02A□14B				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
02A□14B												
02A□16B								M5, depth 8 (0.31)				
02A□16B												
03B□12B	194.0 (7.64)	164.0 (6.46)	90.5 (3.56)	No key				–	300 (0.40)	2.2 (4.85)	245 (55)	74 (16)
03B□14B				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
03B□16B								M5, depth 8 (0.31)				
04A□12B				No key				–	400 (0.53)	2.2 (4.85)	245 (55)	74 (16)
04A□14B				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
04A□16B								M5, depth 8 (0.31)				

Note 1. The encoder is an incremental encoder.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

3. The symbol "□" in the model number indicates the number of encoder pulses (3: 2048P/R, 5: 2000P/R).

750 W (1.01 HP)



$$\phi 16h6 : \phi\ 16\ {}^{0}_{-0.011}\ \left(0.64\ {}^{0}_{-0.0004}\right)$$

$$\phi 60h7 : \phi\ 70\ {}^{0}_{-0.030}\ \left(2.78\ {}^{0}_{-0.0012}\right)$$

Model SGM-	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
08A□12B	No key				–	750 (1.01)	4.3 (9.48)	392 (88)	147 (33)
08A□14B	30 (1.18)	3 (0.12)	5 (0.20)	5 (0.20)					
08A□16B					M5 depth 8 (0.31)				

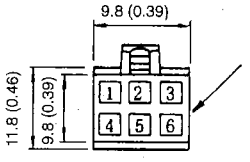
Note 1. The encoder is an incremental encoder.

2. "A" in the model number indicates 200 V specifications.

3. The symbol "□" in the model number indicates the number of encoder pulses (3: 2048P/R, 5: 2000P/R).

Servomotor and Encoder Plugs (For 30 W (0.04 HP) to 750 W (1.01 HP))

Motor Plug



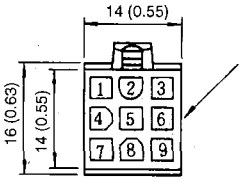
Plug: 172168-1 (AMP)
Pin: 170360-1 or 170364-1

Connected to
Cap: 172160-1
Socket: 170362 -1 or 170366-1

Motor Wiring Specifications

1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG	Green
5	Brake terminal	Red
6	Brake terminal	Black

Encoder Plug



Plug: 172169-1 (AMP)
Pin: 170359-1 or 170363-1

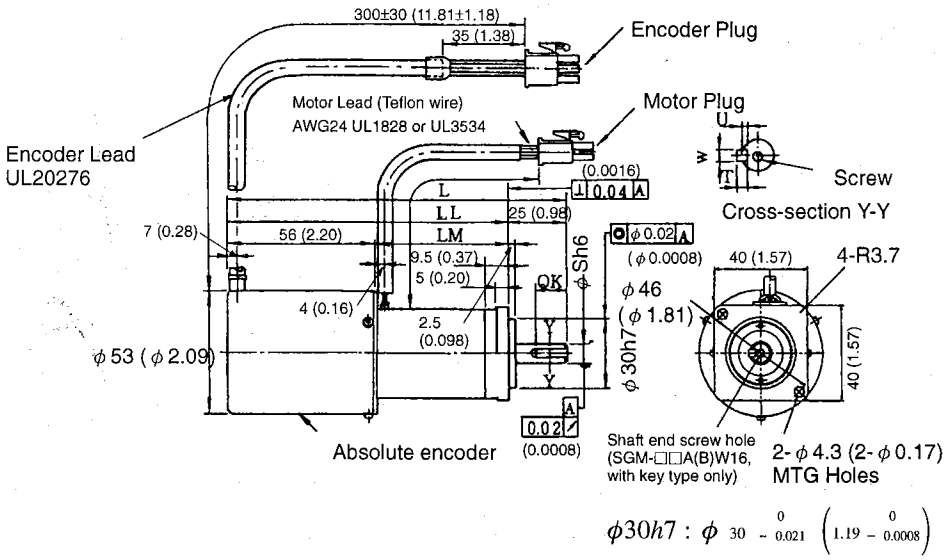
Connected to
Cap: 172161-1
Socket: 170361-1 or 170365-1

Incremental Encoder Wiring Specifications

1	A channel output	Blue
2	$\overline{A}$ channel output	Blue, Black
3	B channel output	Yellow
4	$\overline{B}$ channel output	Yellow, Black
5	Z (C) channel output	Green
6	$\overline{Z}$ ($\overline{C}$) channel output	Green, Black
7	0 V (power supply)	Gray
8	+5 V (power supply)	Red
9	FG (Frame Ground)	Orange

■ SGM Servomotors with Absolute Encoders, No Brakes

30 W (0.04 HP), 50 W (0.07 HP), 100 W (0.13 HP)



Model SGM-	L	LL	LM	S	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
A3AW12	117.5 (4.63)	92.5 (3.64)	36.5 (1.44)	6 (0.24)	No key				–	30 (0.04)	0.45 (0.99)	68 (15)	54 (12)
A3BW12													
A3AW14					14 (0.55)	1.2 (0.05)	2 (0.08)	2 (0.08)					
A3BW14													
A3AW16									M2.5, depth 5 (0.20)				
A3BW16													
A5AW12	125.0 (4.92)	100.0 (3.94)	44.0 (1.73)	6 (0.24)	No key				–	50 (0.07)	0.55 (1.21)	68 (15)	54 (12)
A5BW12													
A5AW14					14 (0.55)	1.2 (0.05)	2 (0.08)	2 (0.08)					
A5BW14													
A5AW16									M2.5, depth 5 (0.20)				
A5BW16													
01AW12	142.5 (5.61)	117.5 (4.63)	61.5 (2.42)	8 (0.31)	No key				–	100 (0.13)	0.65 (1.43)	78 (17)	54 (12)
01BW12													
01AW14					14 (0.55)	1.8 (0.07)	3 (0.12)	3 (0.12)					
01BW14													
01AW16									M3, depth 6 (0.24)				
01BW16													

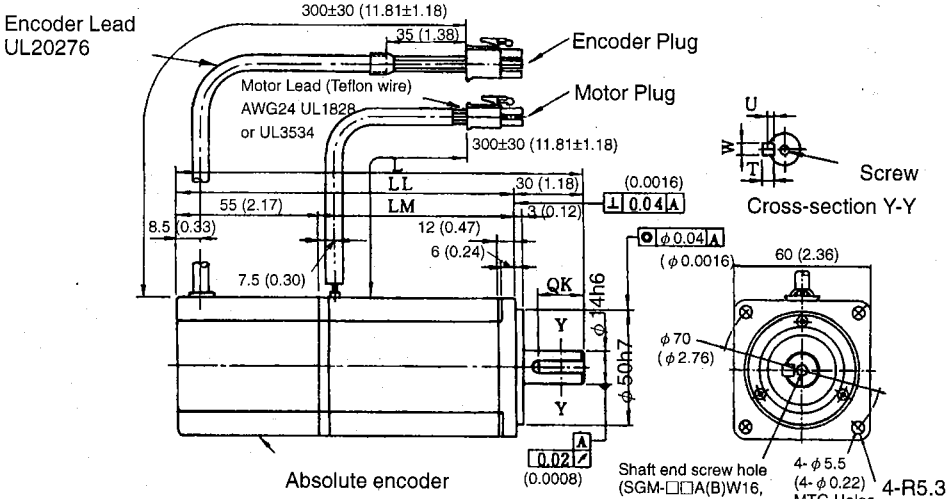
Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V-specifications, and "B" indicates 100 V-specifications.

Dimensional Tolerances

Model SGM-	Shaft-end Dimensions [mm (in)]
	S
A3AW12	$6\ {}^{0}_{-0.008}\ \left(0.24\ {}^{0}_{-0.0003}\right)$
A3BW12	
A3AW14	
A3BW14	
A5AW12	$6\ {}^{0}_{-0.008}\ \left(0.24\ {}^{0}_{-0.0003}\right)$
A5BW12	
A5AW14	
A5BW14	
01AW12	$8\ {}^{0}_{-0.009}\ \left(0.32\ {}^{0}_{-0.0004}\right)$
01BW12	
01AW14	
01BW14	

200 W (0.27 HP), 300 W (0.40 HP) (100 V Only), 400 W (0.53 HP) (200 V Only)



$$\phi 14h6 : \phi\ 14\ {}^{0}_{-0.011}\ \left(0.56\ {}^{0}_{-0.0004}\right)$$

$$\phi 50h7 : \phi\ 50\ {}^{0}_{-0.025}\ \left(1.98\ {}^{0}_{-0.0010}\right)$$

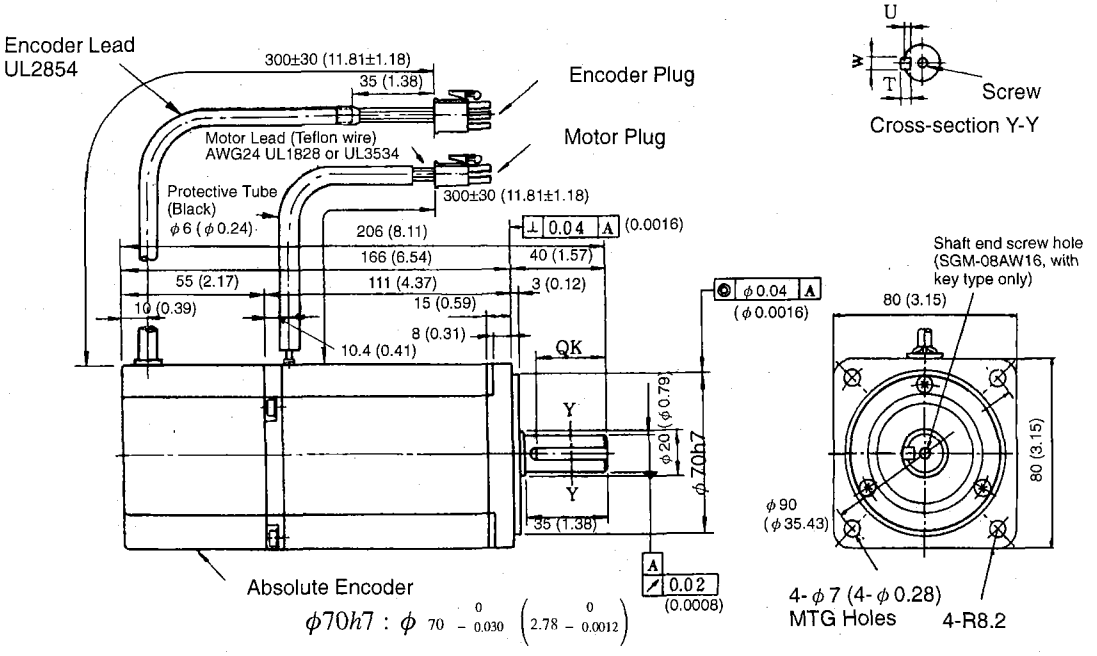
9

Model SGM-	L	LL	LM	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
02AW12	147.5 (5.81)	117.5 (4.63)	62.5 (2.46)	No key				–	200 (0.27)	1.2 (2.65)	245 (55.1)	74 (17)
02BW12												
02AW14				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
02BW14												
02AW16								M5, depth 8 (0.31)				
02BW16												
03AW12	175.5 (6.91)	145.5 (5.73)	90.5 (3.56)	No key				–	300 (0.40)	1.8 (3.97)	245 (55.1)	74 (17)
03BW12												
03AW14				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
03BW14												
03AW16								M5, depth 8 (0.31)				
03BW16												
04AW12	175.5 (6.91)	145.5 (5.73)	90.5 (3.56)	No key				–	400 (0.53)	1.8 (3.97)	245 (55.1)	74 (17)
04AW14				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
04AW16								M5, depth 8 (0.31)				

Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

750 W (1.01 HP)



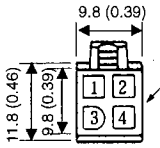
Model SGM-	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
08AW12	No key				–	750 (1.01)	3.5 (7.72)	392 (88)	147 (33)
08AW14	30 (1.18)	3 (0.12)	5 (0.20)	5 (0.20)					
08AW16					M5, depth 8 (0.31)				

Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V specifications.

Servomotor and Encoder Plugs (For 30 W (0.04 HP) to 750 W (1.01 HP))

Motor Plug

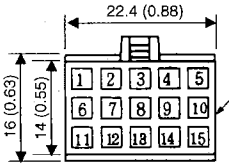


Plug: 172167-1 (AMP)

Pin: 170360-1 or 170364-1

Connected to
Cap: 172159-1
Socket: 170362 -1 or 170366-1

Encoder Plug



Plug: 172171-1 (AMP)
Pin: 170359-1 or 170363-1

Connected to
Cap: 172163-1
Socket: 170361-1 or 170365-1

Motor Wiring Specifications

1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG	Green

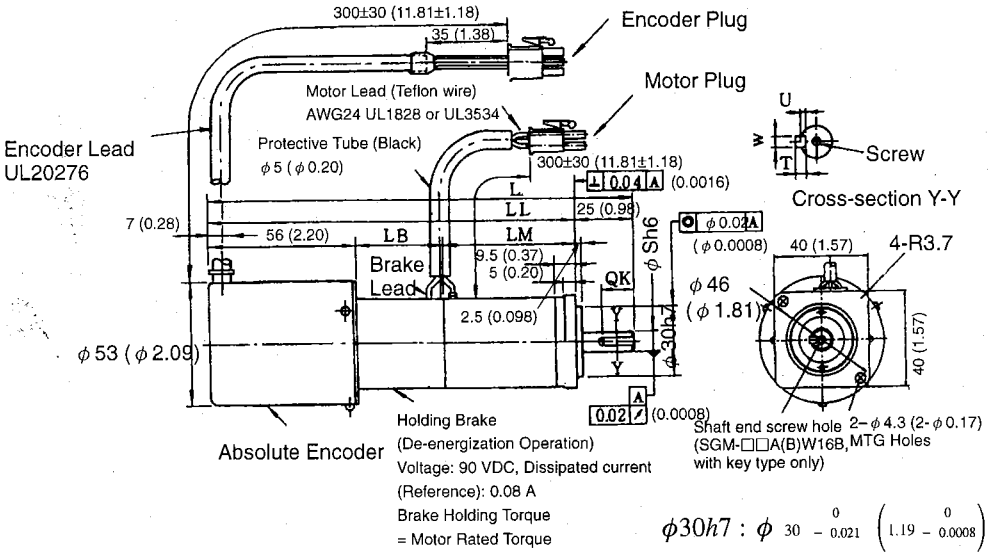
Absolute Encoder Wiring Specifications

1	A channel output	Blue
2	$\overline{A}$ channel output	White, Blue
3	B channel output	Yellow
4	$\overline{B}$ channel output	White, Yellow
5	Z (C) channel output	Green
6	$\overline{Z}$ ($\overline{C}$) channel output	White, Green
7	0 V (power supply)	Black
8	+5 V (power supply)	Red
9	FG (Frame Ground)	Green, Yellow
10	S channel output	Purple
11	$\overline{S}$ channel output	White, Purple
(12)*	(Capacitor reset)	(Gray)
13	Reset	White, Gray
14	0 V (battery)	White, Orange
15	3.6 V (battery)	Orange

* Terminal to discharge capacitor before shipment. Do not use.

■ SGM Servomotors with Absolute Encoders and Brakes

30 W (0.04 HP), 50 W (0.07 HP), 100 W (0.13 HP)



Model SGM-	L	LL	LM	LB	S	QK	U	W	T	Screw Dimensions	Output W (HP)	Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
A3AW12B	149.0 (5.87)	124.0 (4.88)	36.5 (1.44)	31.5 (1.24)	6 (0.24)	No key				–	30 (0.04)	0.75 (1.65)	68 (15)	54 (12)
A3BW12B														
A3AW14B						14 (0.55)	1.2 (0.05)	2 (0.08)	2 (0.08)					
A3BW14B														
A3AW16B										M2.5, depth 5 (0.20)				
A3BW16B														
A5AW12B	156.5 (6.16)	131.5 (5.18)	44.0 (1.73)	31.5 (1.24)	6 (0.24)	No key				–	50 (0.07)	0.85 (1.87)	68 (15)	54 (12)
A5BW12B														
A5AW14B						14 (0.55)	1.2 (0.05)	2 (0.08)	2 (0.08)					
A5BW14B														
A5AW16B										M2.5, depth 5 (0.20)				
A5BW16B														
01AW12B	183.0 (7.20)	158.0 (6.22)	61.5 (2.42)	40.5 (1.59)	8 (0.31)	No key				–	100 (0.13)	0.95 (2.09)	78 (17)	54 (12)
01BW12B														
01AW14B						14 (0.55)	1.8 (0.07)	3 (0.12)	3 (0.12)					
01BW14B														
01AW16B										M3, depth 6 (0.24)				
01BW16B														

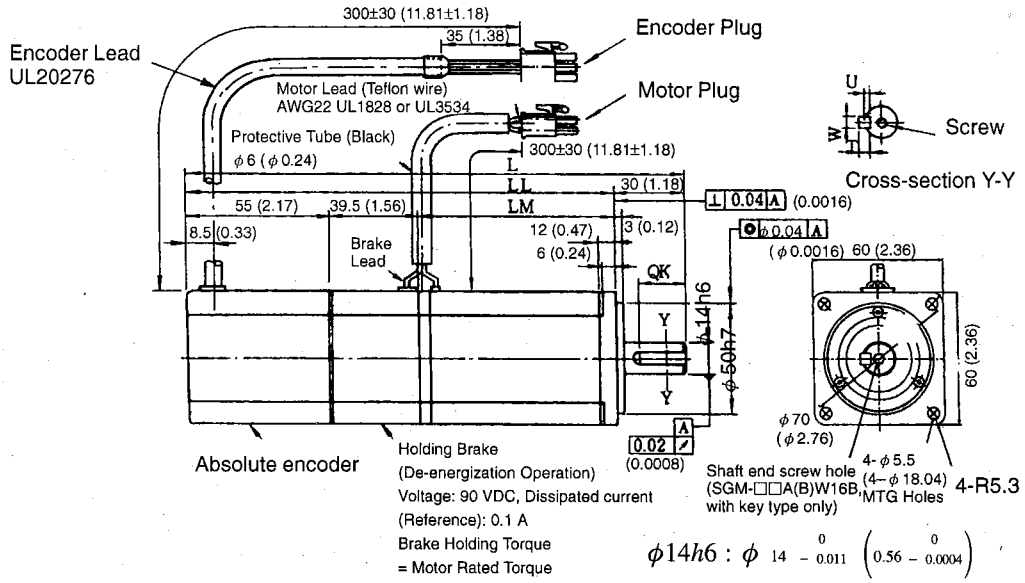
Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

Dimensional Tolerances

Model SGM-	Shaft-end Dimensions [mm (in)]
	S
A3AW12B	$6\ {}^{0}_{-0.008}\ \left(0.24\ {}^{0}_{-0.0003}\right)$
A3BW12B	
A3AW14B	
A3BW14B	
A5AW12B	$6\ {}^{0}_{-0.008}\ \left(0.24\ {}^{0}_{-0.0003}\right)$
A5BW12B	
A5AW14B	
A5BW14B	
01AW12B	$8\ {}^{0}_{-0.009}\ \left(0.32\ {}^{0}_{-0.0004}\right)$
01BW12B	
01AW14B	
01BW14B	

200 W (0.27 HP), 300 W (0.40 HP) (100 V Only), 400 W (0.53 HP) (200 V Only)



$\phi 14h6 : \phi\ 14\ {}^{0}_{-0.011}\ \left(0.56\ {}^{0}_{-0.0004}\right)$

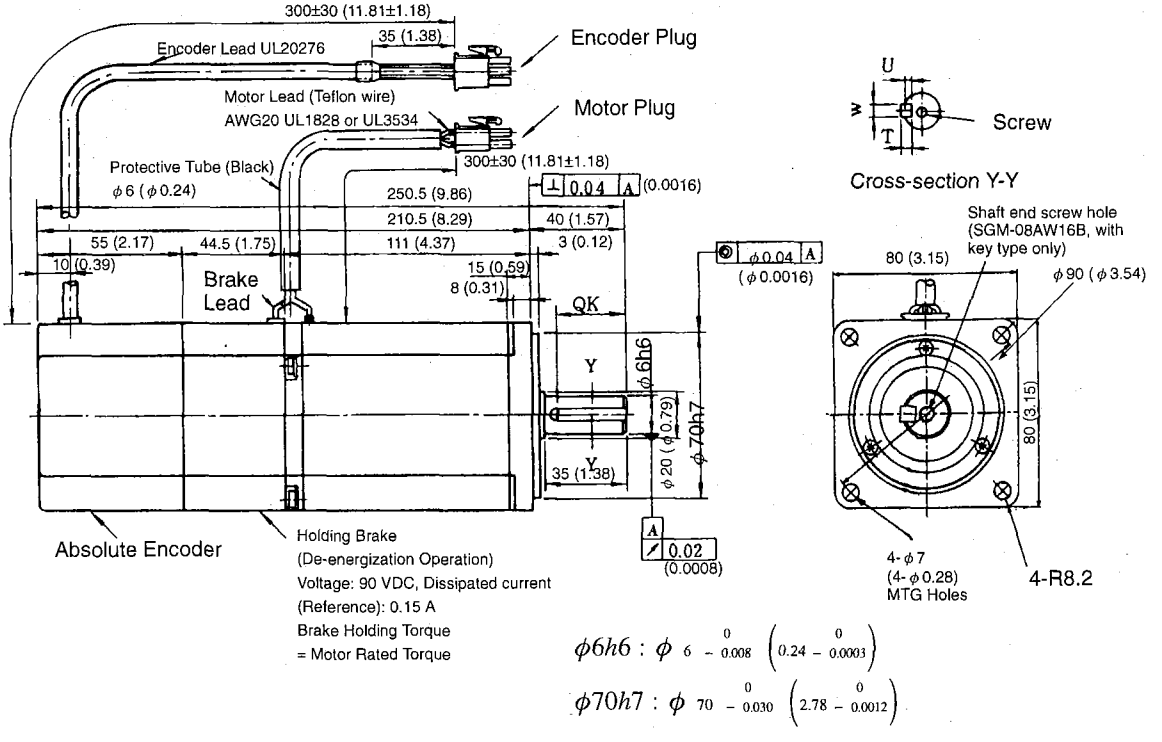
$\phi 50h7 : \phi\ 50\ {}^{0}_{-0.025}\ \left(1.98\ {}^{0}_{-0.0010}\right)$

Model SGM-	L	LL	LM	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
02AW12B	187.0 (7.36)	157.0 (6.18)	62.5 (2.46)	No key				–	200 (0.27)	1.7 (3.75)	245 (55.1)	74 (17)
02BW12B												
02AW14B				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
02BW14B												
02AW16B								M5, depth 8 (0.31)				
02BW16B												
03BW12B	215.0 (8.46)	185.0 (7.28)	90.5 (3.56)	No key				---	300 (0.40)	2.3 (5.07)	245 (55.1)	74 (17)
03BW14B				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)					
03BW16B								M5, depth 8 (0.31)				
04AW12B				No key				---	400 (0.53)	2.3 (5.07)	245 (55.1)	74 (17)
04AW14B				20 (0.79)	3 (0.12)	5 (0.20)	5 (0.20)	M5, depth 8 (0.31)				
04AW16B												

Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

750 W (1.01 HP)



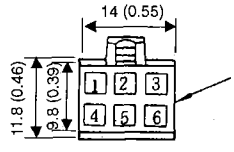
Model SGM-	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
08AW12B	No key				–	750 (1.01)	4.5 (9.92)	392 (88)	147 (33)
08AW14B	30 (1.18)	3 (0.12)	5 (0.20)	5 (0.20)					
08AW16B					M5, depth 8 (0.31)				

Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V specifications.

Servomotor and Encoder Plugs (For 30 W (0.04 HP) to 750 W (1.01 HP))

Motor Plug



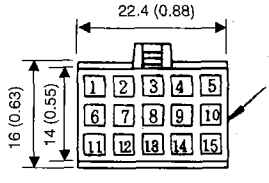
Plug: 172168-1 (AMP)
Pin: 170360-1 or 170364-1

Connected to
Cap: 172160-1
Socket: 170362 -1 or 170366-1

Motor Wiring Specifications

1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG	Green
5	Brake terminal	Red
6	Brake terminal	Black

Encoder Plug



Plug: 172171-1 (AMP)
Pin: 170359-1 or 170363-1

Connected to
Cap: 172163-1
Socket: 170361-1 or 170365-1

Incremental Encoder Wiring Specifications

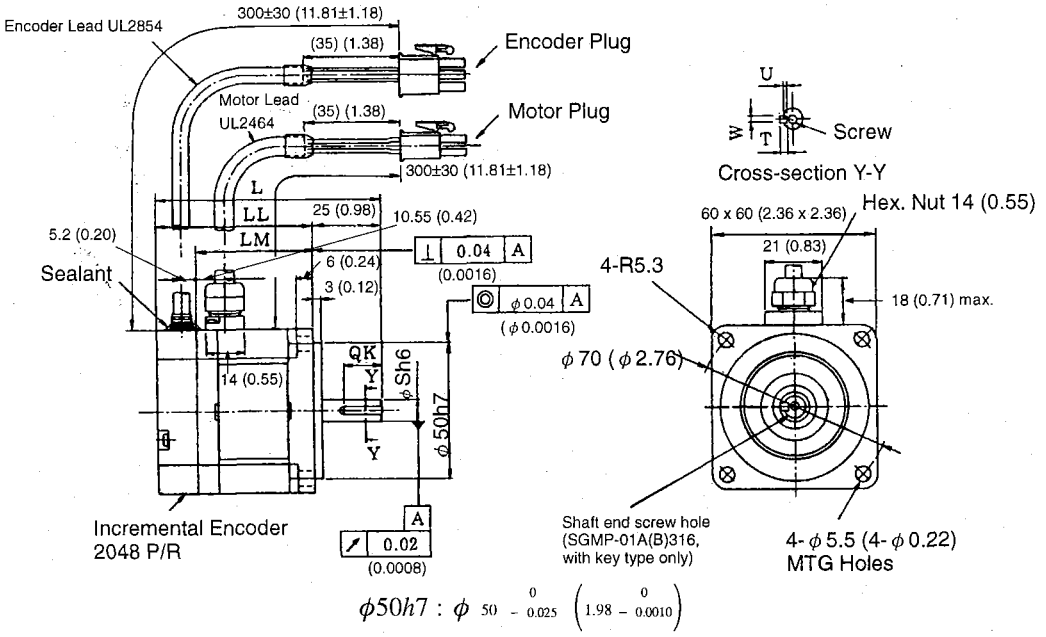
1	A channel output	Blue
2	$\overline{A}$ channel output	White, Blue
3	B channel output	Yellow
4	$\overline{B}$ channel output	White, Yellow
5	Z (C) channel output	Green
6	$\overline{Z}$ ($\overline{C}$) channel output	White, Green
7	0 V (power supply)	Black
8	+5 V (power supply)	Red
9	FG (Frame Ground)	Green, Yellow
10	S channel output	Purple
11	$\overline{S}$ channel output	White, Purple
(12)*	(Capacitor reset)	(Gray)
13	Reset	White, Gray
14	0 V (battery)	White, Orange
15	3.6 V (battery)	Orange

* Terminal to discharge capacitor before shipment. Do not use.

9.1.2 SGMP Servomotors

■ SGMP Servomotors with Incremental Encoders, No Brakes

100 W (0.13 HP)



$\phi 50h7 : \phi\ 50\ {}^{0}_{-0.025}\ \left(1.98\ {}^{0}_{-0.0010}\right)$

Model SGMP-	L	LL	LM	S	QK	U	W	T	Screw dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
01A312	82 (3.23)	57 (2.24)	42.5 (1.67)	8 (0.31)	No key				–	100 (0.13)	0.7 (1.54)	78 (17)	49 (11)
01B312													
01A314					14 (0.55)	1.8 (0.07)	3 (0.12)	3 (0.12)					
01B314													
01A316									M3, depth 6 (0.24)				
01B316													

Note 1. The encoder is an incremental encoder 2048 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

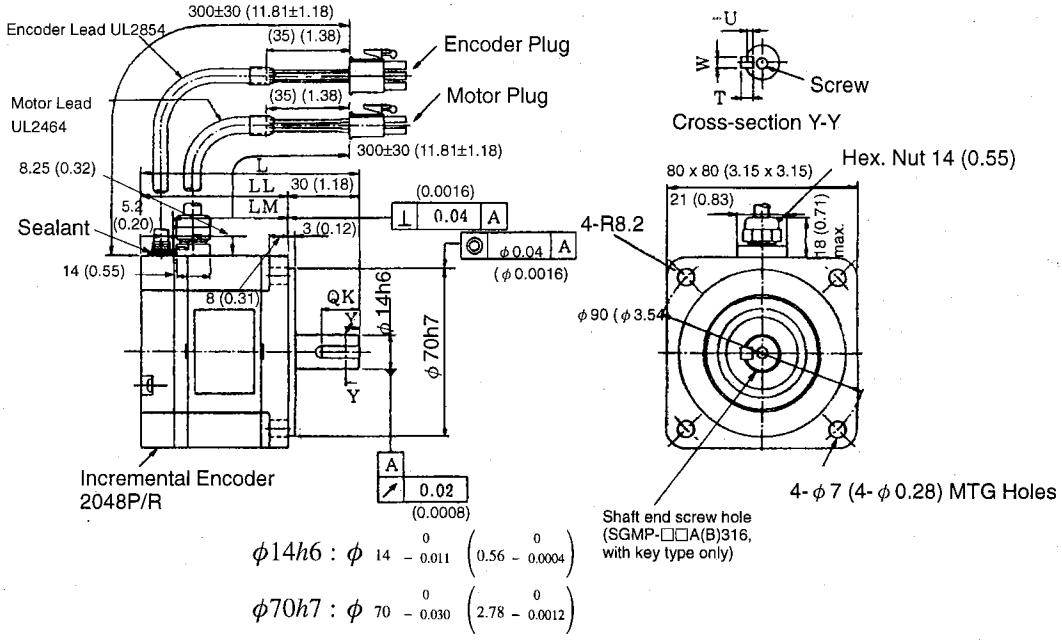
3. The quoted allowable radial load is the value at a position 20 mm (0.79 in.) from the motor mounting surface.

4. Conforms to "IP55" protective structure (except connector and output shaft faces).

Dimensional Tolerances

Model SGMP-	Shaft-end Dimensions [mm (in)]
	S
01A312	$8\ {}^{0}_{-0.009}\ \left(0.32\ {}^{0}_{-0.0004}\right)$
01B312	
01A314	
01B314	
01A316	
01B316	

200 W (0.27 HP), 300 W (0.40 HP) (100 V Only), 400 W (0.53 HP) (200 V Only)



$\phi 14h6 : \phi\ 14\ {}^{0}_{-0.011}\ \left(0.56\ {}^{0}_{-0.0004}\right)$

$\phi 70h7 : \phi\ 70\ {}^{0}_{-0.030}\ \left(2.78\ {}^{0}_{-0.0012}\right)$

9

Model SGMP-	L	LL	LM	QK	U	W	T	Screw dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
02A312	92 (3.62)	62 (2.44)	48.1 (1.89)	No key				–	200 (0.27)	1.4 (3.09)	245 (55)	68 (15)
02B312												
02A314				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
02B314												
02A316								M5, depth 8 (0.31)				
02B316												
03B312	112 (4.41)	82 (3.23)	68.1 (2.68)	No key				–	300 (0.40)	2.1 (4.63)		
03B314				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
03B316								M5, depth 8 (0.31)				
04A312				No key				–	400 (0.53)			
04A314				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
04A316								M5, depth 8 (0.31)				

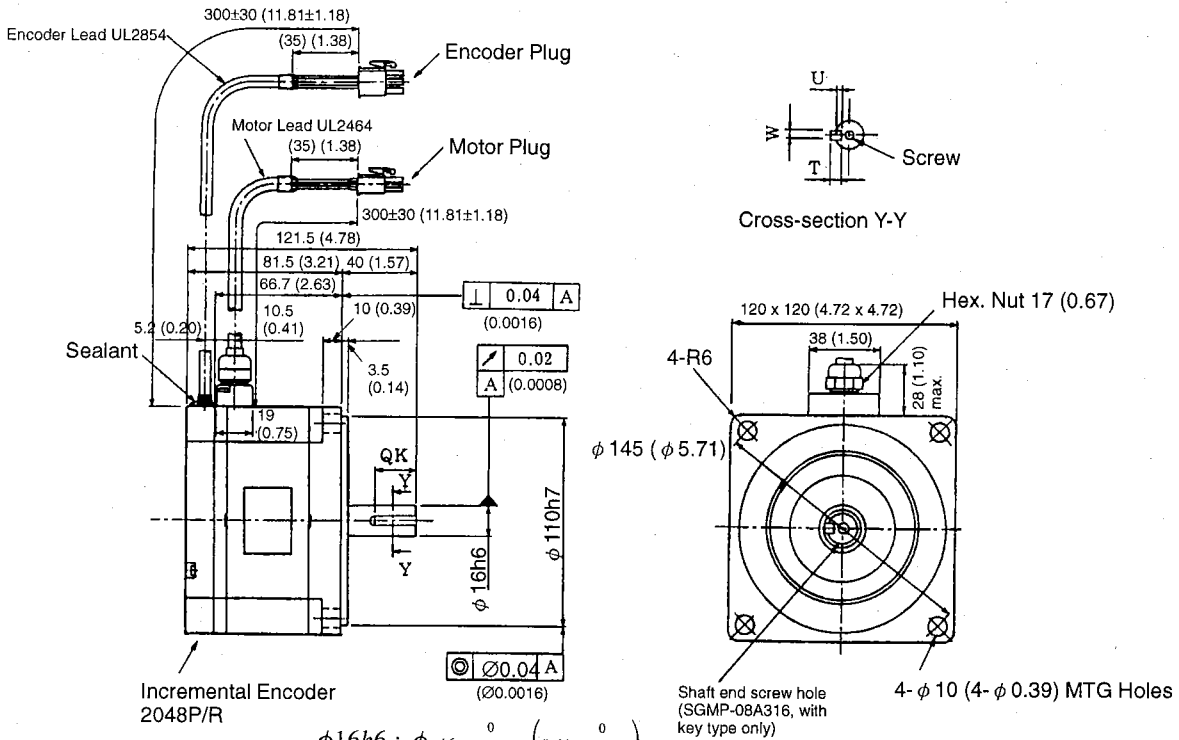
Note 1. The encoder is an incremental encoder 2048 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

3. The quoted allowable radial load is the value at a position 25 mm (0.98in.) from the motor mounting surface.

4. Conforms to "IP55" protective structure (except connector and output shaft faces).

750 W (1.01 HP)



$$\phi 16h6 : \phi\ 16\ {}^{0}_{-0.011}\ \left(0.64\ {}^{0}_{-0.0004}\right)$$

$$\phi 110h7 : \phi\ 110\ {}^{0}_{-0.035}\ \left(4.37\ {}^{0}_{-0.0014}\right)$$

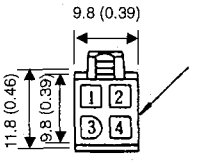
Model SGMP-	QK	U	W	T	Screw dimensions	Output W (HP)	Approx. Mass kg(lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
08A312	No key				–	750 (1.01)	4.6 (10.14)	392 (80)	147 (33)
08A314	22 (0.87)	3 (0.12)	5 (0.20)	5 (0.20)					
08A316					M5, depth 8 (0.31)				

Note 1. The encoder is an incremental encoder for 2048 P/R.

2. "A" in the model number indicates 200 V specifications.
3. The quoted allowable radial load is the value at a position 35 mm (1.38 in.) from the motor mounting surface.
4. Conforms to IP55 protective structure (except connector and output shaft faces).

Servomotor and Encoder Plugs (For 100 W (0.13HP) to 750 W (1.01HP))

Motor Plug



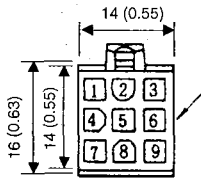
Plug: 172167-1 (AMP Co., Ltd.)
Pin: 170360-1 or 170364-1

Connected to
Cap: 172159-1
Socket: 170362 -1 or 170366-1

Motor Wiring Specifications

1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG	Green Yellow

Encoder Plug



Plug: 172169-1 (AMP Co., Ltd.)
Pin: 170359-1 or 170363-1

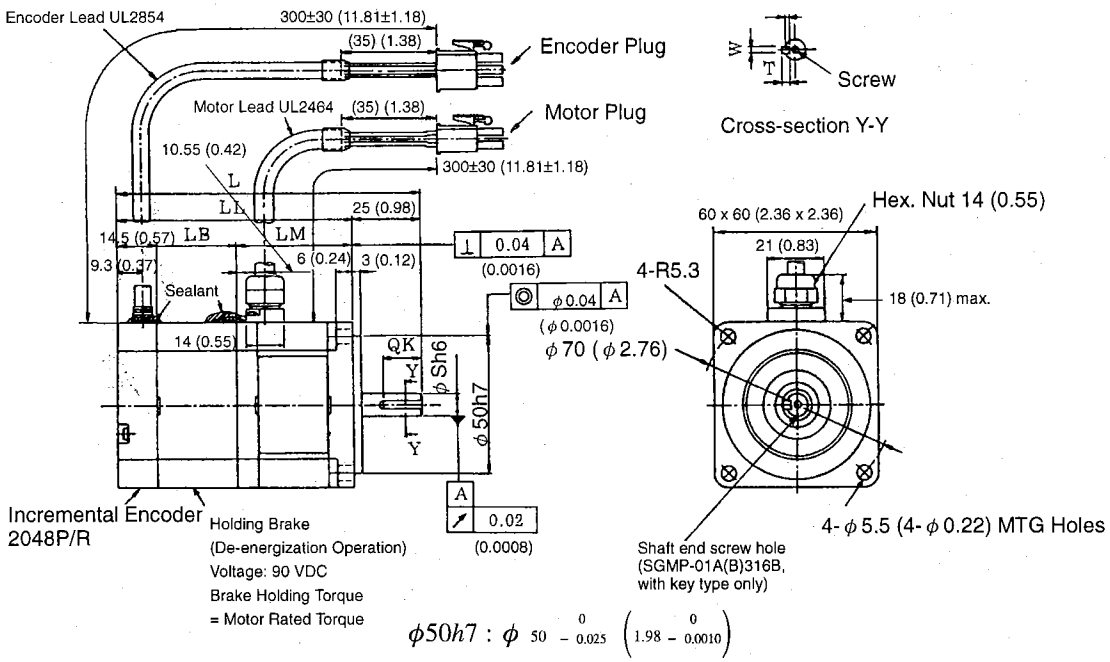
Connected to
Cap: 172161-1
Socket: 170361-1 or 170365-1

Incremental Encoder Wiring Specifications

1	A channel output	Blue
2	$\overline{A}$ channel output	Blue, Black
3	B channel output	Yellow
4	$\overline{B}$ channel output	Yellow, Black
5	C channel output	Green
6	$\overline{C}$ channel output	Green, Black
7	0 V (power supply)	Gray
8	+5 V (power supply)	Red
9	FG (Frame Ground)	Orange

■ SGMP Servomotors with Incremental Encoders and Brakes

100 W (0.13HP)



Model SGMP-	L	LL	LM	LB	S	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lb)	Allowable Thrust Load N (lb)
01A312B	111 (4.37)	86 (3.39)	42.5 (1.67)	29 (1.14)	8 (0.31)	No key				–	100 (0.13)	0.9 (1.98)	78 (17)	49 (11)
01A314B						14 (0.55)	1.8 (0.07)	3 (0.12)	3 (0.12)	M3, depth 6 (0.24)				
01A316B														

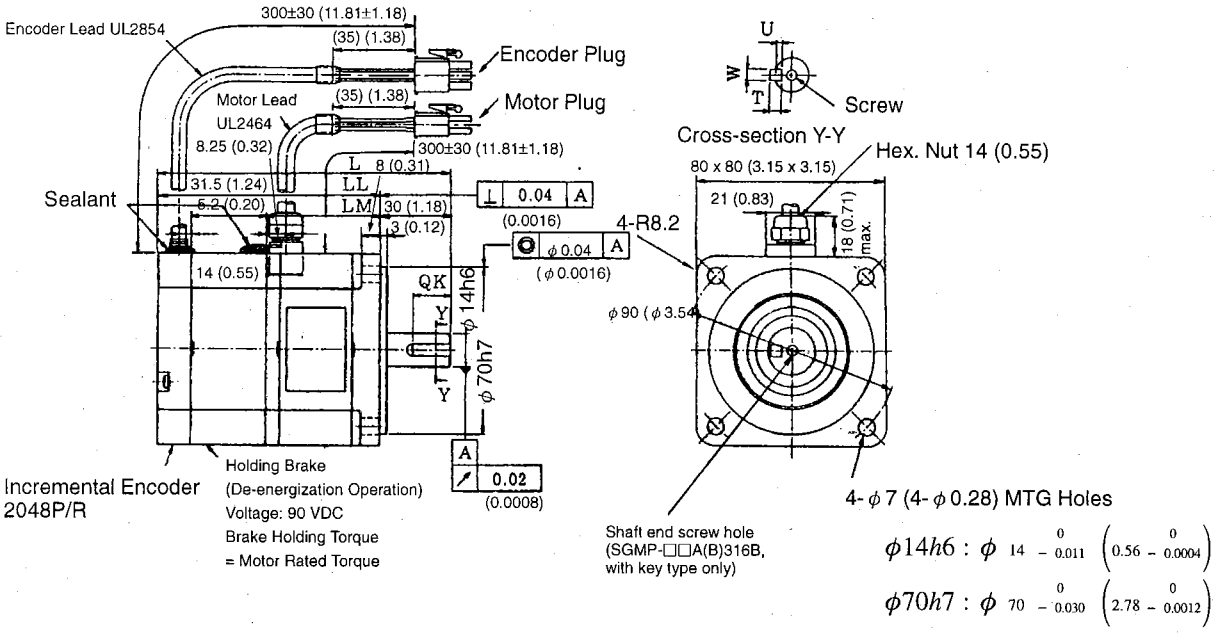
Note 1. The encoder is an incremental encoder 2048 P/R.

2. "A" in the model number indicates 200 V specifications.

3. The quoted allowable radial load is the value at a position 20 mm (0.79in.) from the motor mounting surface.

4. Conforms to IP55 protective structure (except connector and output shaft faces).

200 W (0.27 HP), 300 W (0.40 HP) (100 V Only), 400 W (0.53 HP) (200 V Only)



Model SGMP-	L	LL	LM	QK	U	W	T	Screw Di-mensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
02A312B	123.5 (4.86)	93.5 (3.68)	48.1 (1.89)	No key				–	200 (0.27)	1.9 (4.19)	245 (55)	68 (15)
02B312B												
02A314B				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
02B314B												
02A316B								M5, depth 8 (0.31)				
02B316B												
03B312B	143.5 (5.65)	113.5 (4.47)	68.1 (2.68)	No key				–	400 (0.53)	2.6 (0.10)		
03B314B				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
03B316B								M5, depth 8 (0.31)				
04A312B				No key				–				
04A314B				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
04A316B								M5, depth 8 (0.31)				

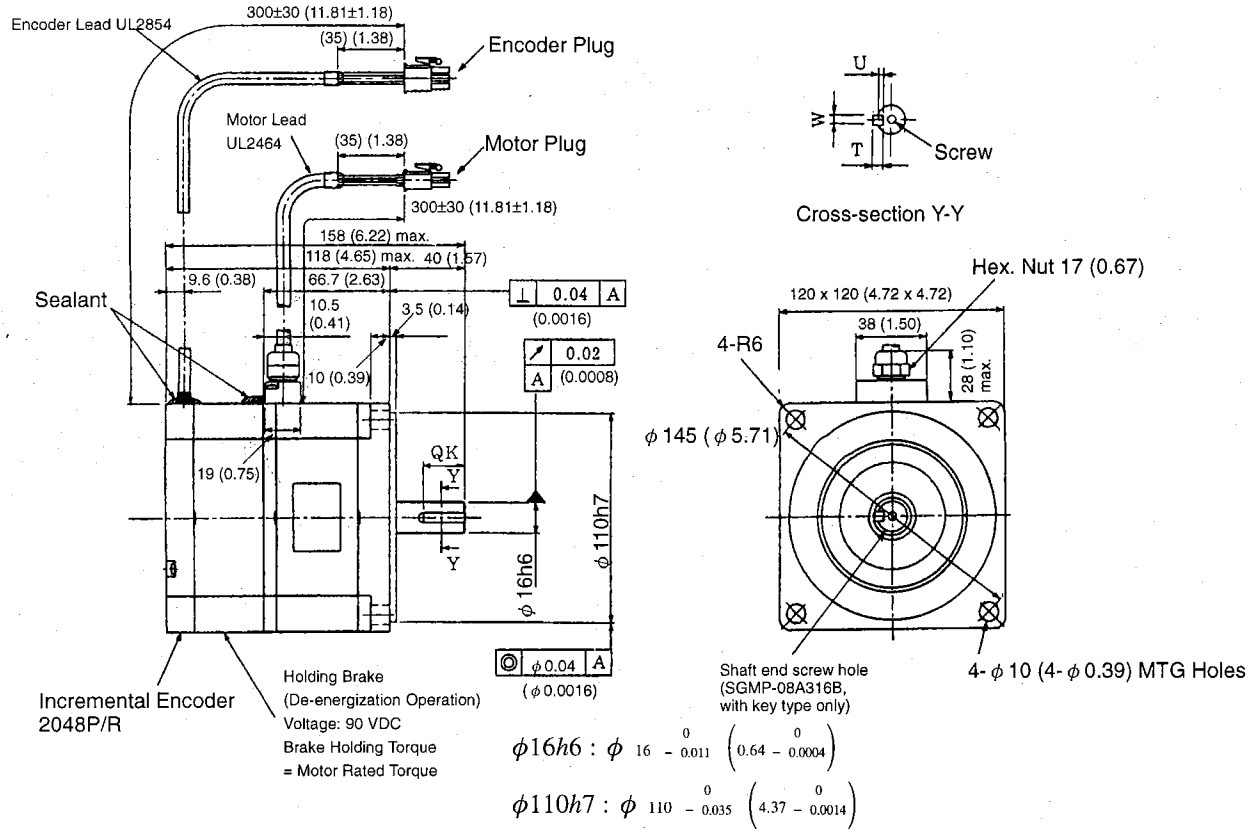
Note 1. The encoder is an incremental encoder 2048 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

3. The quoted allowable radial load is the value at a position 25 mm (0.98in.) from the motor mounting surface.

4. Conforms to IP55 protective structure (except connector and output shaft faces).

750 W (1.01HP)



Model SGMP-	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
08A312B	No key				–	750 (1.01)	5.7 (12.566)	392 (88)	147 (33)
08A314B	22 (0.87)	3 (0.12)	5 (0.20)	5 (0.20)					
08A316B					M5, depth 8 (0.31)				

Note 1. The encoder is an incremental encoder 2048 P/R.

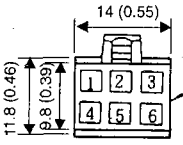
2. "A" in the model number indicates 200 V specifications.

3. The quoted allowable radial load is the value at a position 35 mm (1.38 in.) from the motor mounting surface.

4. Conforms to IP55 protective structure (except connector and output shaft faces).

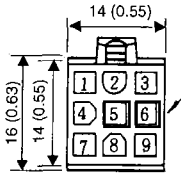
Servomotor and Encoder Plugs (For 100 W (0.13 HP) to 750 W (1.01 HP))

Motor Plug



Plug: 172168-1 (AMP)
Pin: 170360-1 or 170364-1
Connected to
Cap: 172160-1
Socket: 170362 -1 or 170366-1

Encoder Plug



Plug: 172169-1 (AMP)
Pin: 170359-1 or 170363-1
Connected to
Cap: 172161-1
Socket: 170361-1 or 170365-1

Motor Wiring Specifications

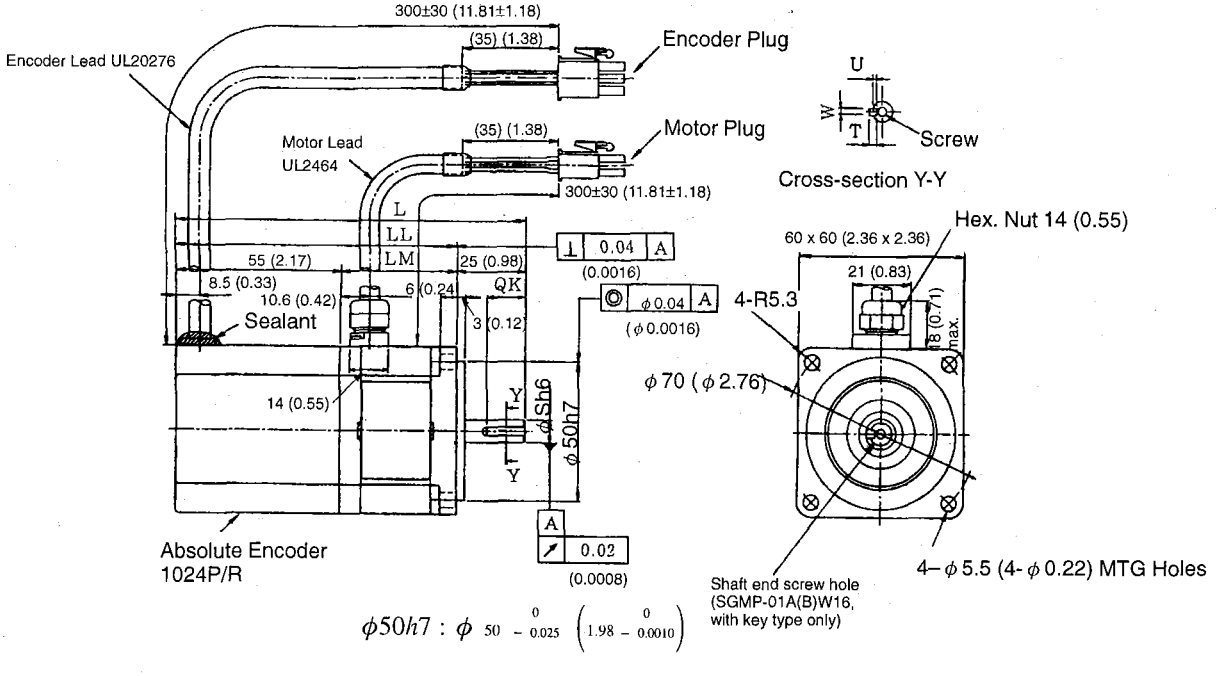
1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG	Green, Yellow
5	Brake	Black
6	Brake	Black

Incremental Encoder Wiring Specifications

1	A channel output	Blue
2	$\overline{A}$ channel output	Blue, Black
3	B channel output	Yellow
4	$\overline{B}$ channel output	Yellow, Black
5	C channel output	Green
6	$\overline{C}$ channel output	Green, Black
7	0 V (power supply)	Gray
8	+5 V (power supply)	Red
9	FG (Frame Ground)	Orange

■ SGMP Servomotors with Absolute Encoders, No Brakes

100 W (0.13HP)



$$\phi 50h7 : \phi\ 50\ {}^{0}_{-0.025}\ \left(1.98\ {}^{0}_{-0.0010}\right)$$

9

Model SGMP-	L	LL	LM	S	QK	U	W	T	Screw dimensions	Output W (HP)	Approx. Mass kg(lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
01AW12	122.5	97.5	42.5 (1.67)	8 (0.31)	No key				–	100 (0.13)	0.95 (2.094)	78 (17)	49 (11)
01BW12													
01AW14					14 (0.55)	1.8 (0.07)	3 (0.12)	3 (0.12)					
01BW14													
01AW16									M3, depth 6 (0.24)				
01BW16													

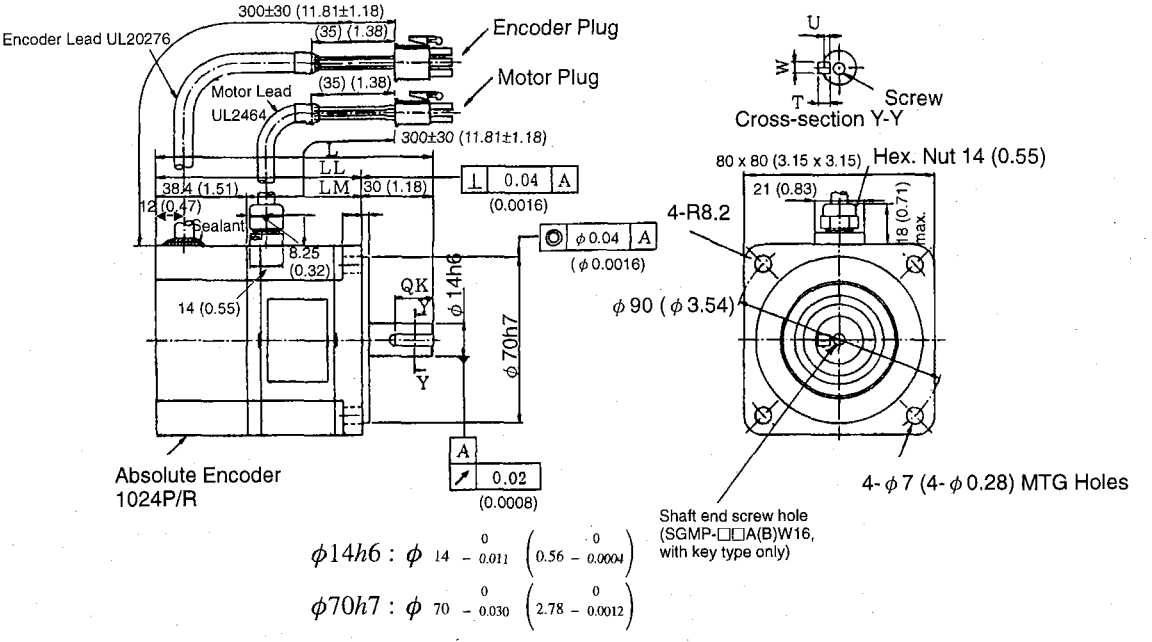
Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V-specifications.

3. The quoted allowable radial load is the value at a position 20 mm (0.79 in.) from the motor mounting surface.

4. Conforms to IP55 protective structure (except connector and output shaft faces).

200 W (0.27 HP), 300 W (0.40 HP) (100 V only), 400 W (0.53HP) (200 V only)



$$\phi 14h6 : \phi\ 14\ {}^{0}_{-0.011}\ \left(0.56\ {}^{0}_{-0.0004}\right)$$

$$\phi 70h7 : \phi\ 70\ {}^{0}_{-0.030}\ \left(2.78\ {}^{0}_{-0.0012}\right)$$

Model SGMP-	L	LL	LM	QK	U	W	T	Screw dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
02AW12	116.5 (4.59)	86.5 (3.41)	48.1 (1.89)	No key				–	200 (0.27)	1.6 (3.53)	245 (55)	68 (15)
02BW12												
02AW14				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
02BW14												
02AW16								M5, depth 8 (0.31)				
02BW16												
03BW12	136.5 (5.37)	106.5 (4.19)	68.1 (2.68)	No key				–	300 (0.40)	2.3 (5.07)		
03BW14				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
03BW16								M5, depth 8 (0.31)				
04AW12				No key				–	400 (0.53)			
04AW14				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
04AW16								M5, depth 8 (0.31)				

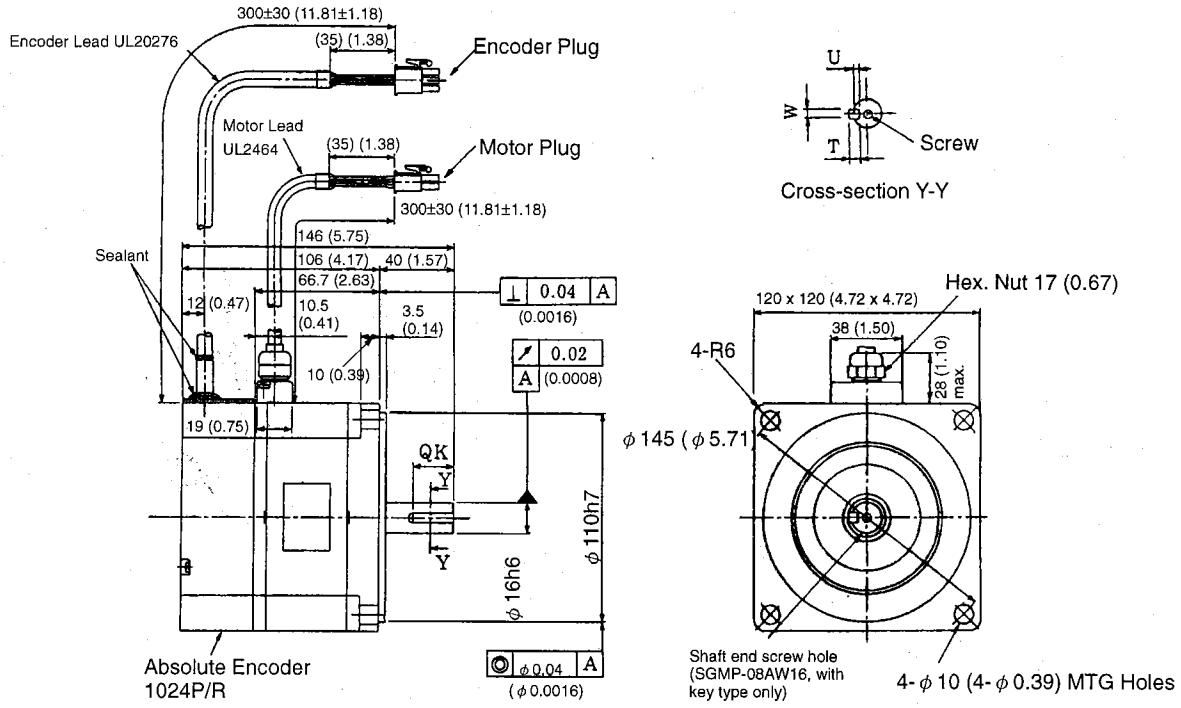
Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V-specifications.

3. The quoted allowable radial load is the value at a position 25 mm (0.98 in.) from the motor mounting surface.

4. Conforms to IP55 protective structure (except connector and output shaft faces).

750 W (1.01HP)



$$\phi 16h6 : \phi\ 16\ {}^{0}_{-0.011}\ \left(0.64\ {}^{0}_{-0.0004}\right)$$

$$\phi 110h7 : \phi\ 110\ {}^{0}_{-0.035}\ \left(4.37\ {}^{0}_{-0.0014}\right)$$

Model SGMP-	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
08AW12	No key				–	750 (1.01)	4.8 (10.58)	392 (88)	147 (33)
08AW14	22 (0.87)	3 (0.12)	5 (0.20)	5 (0.20)					
08AW16					M5 depth 8 (0.31)				

Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

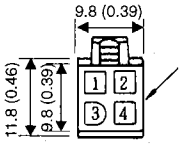
2. "A" in the model number indicates 200 V specifications.

3. The quoted allowable radial load is the value at a position 35 mm (1.38 in.) from the motor mounting surface.

4. Conforms to IP55 protective structure (except connector and output shaft faces).

Servomotor and Encoder Plugs (For 100 W (0.13 HP) to 750 W (1.01 HP))

Motor Plug

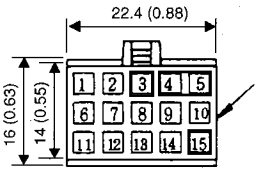


Plug: 172167-1 (AMP)
Pin: 170360-1 or 170364-1
Connected to
Cap: 172159-1
Socket: 170362 -1 or 170366-1

Motor Wiring Specifications

1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG	Green, Yellow

Encoder Plug



Plug: 172171-1 (AMP)
Pin: 170359-1 or 170363-1
Connected to
Cap: 172163-1
Socket: 170361-1 or 170365-1

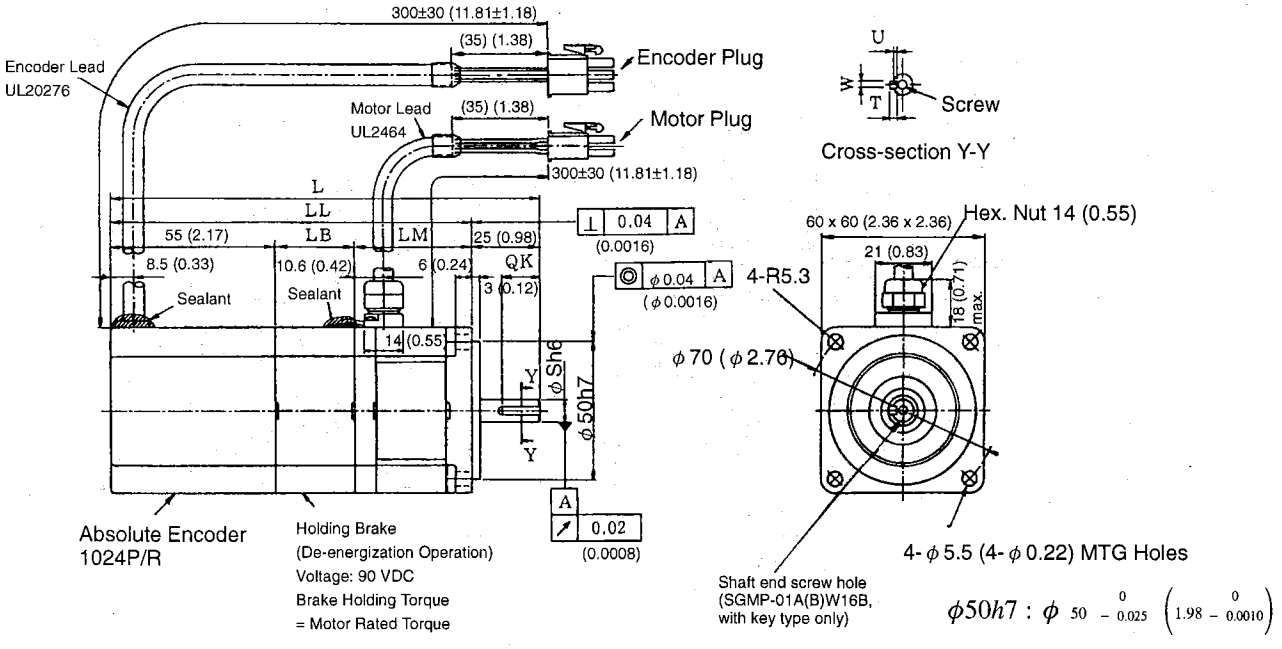
Absolute Encoder Wiring Specifications

1	A channel output	Blue
2	$\overline{A}$ channel output	White, Blue
3	B channel output	Yellow
4	$\overline{B}$ channel output	White, Yellow
5	Z (C) channel output	Green
6	$\overline{Z}$ ($\overline{C}$) channel output	White, Green
7	0 V (power supply)	Black
8	+5 V(power supply)	Red
9	FG (Frame Ground)	Green, Yellow
10	S channel output	Purple
11	$\overline{S}$ channel output	White, Purple
(12)*	(Capacitor reset)	(Gray)
13	Reset	White, Gray
14	0 V(battery)	White, Orange
15	3.6V(battery)	Orange

* Terminal to discharge capacitor before shipment. Do not use.

■ SGMP Servomotors with Absolute Encoders and Brakes

100 W (0.13 HP)



Model SGMP-	L	LL	LM	LB	S	QK	U	W	T	Screw dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable radial load N (lbf)	Allowable thrust load N (lbf)
01AW12B	151.5	126.5	42.5 (1.67)	29 (1.14)	8 (0.31)	No key				–	100 (0.13)	1.2 (2.65)	78 (17)	49 (11)
01BW12B														
01AW14B						14 (0.55)	1.8 (0.07)	3 (0.12)	3 (0.12)					
01BW14B														
01AW16B										M3, depth 6 (0.24)				
01BW16B														

Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

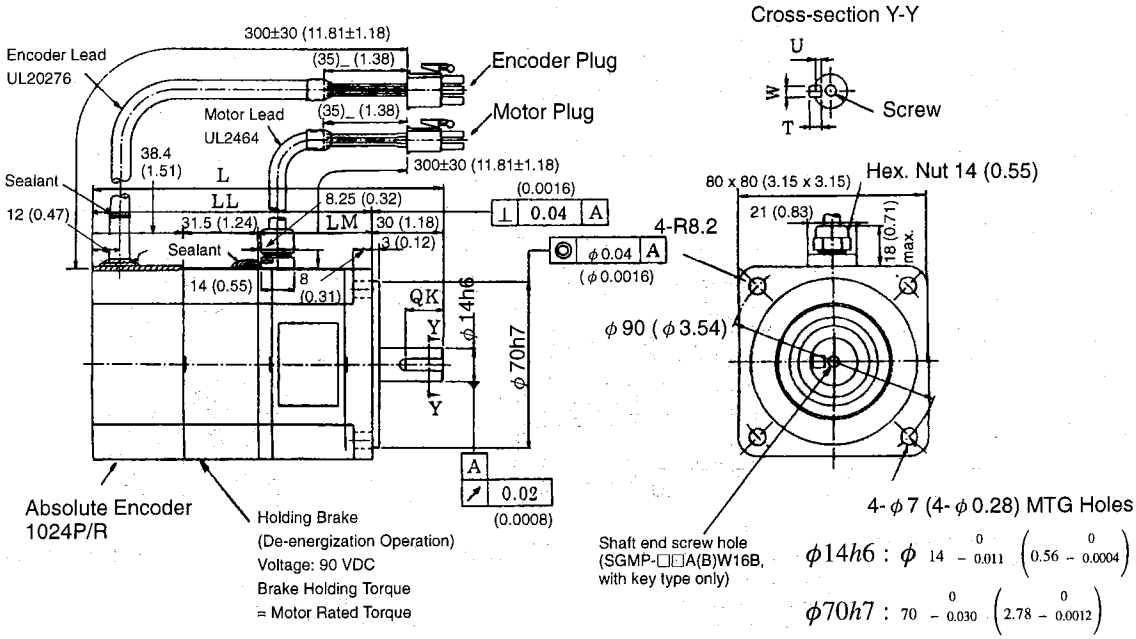
3. The quoted allowable radial load is the value at a position 20 mm (0.79 in.) from the motor mounting surface.

4. Conforms to IP55 protective structure (except connector and output shaft faces).

Dimensional Tolerances

Model SGMP-	Shaft-end Dimensions [mm (in)]
	S
01AW12B	$8\ {}^{0}_{-0.009}\ \left(0.32\ {}^{0}_{-0.0004}\right)$
01BW12B	
01AW14B	
01BW14B	
01AW16B	
01BW16B	

200 W (0.27 HP), 300 W (0.40 HP) (100 V Only), 400 W (0.53 HP) (200 V Only)



Model SGMP-	L	LL	LM	QK	U	W	T	Screw dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
02AW12B	148 (5.83)	118 (4.65)	48.1 (1.89)	No key				–	200 (0.27)	2.1 (4.63)	245 (55)	68 (15)
02BW12B												
02AW14B				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
02BW14B												
02AW16B								M5, depth 8 (0.31)				
02BW16B												
03BW12B	168 (6.61)	138 (5.43)	68.1 (2.68)	No key				–	300 (0.40)	2.8 (6.17)		
03BW14B				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
03BW16B								M5, depth 8 (0.31)				
04AW12B				No key				–	400 (0.53)			
04AW14B				16 (0.63)	3 (0.12)	5 (0.20)	5 (0.20)					
04AW16B								M5, depth 8 (0.31)				

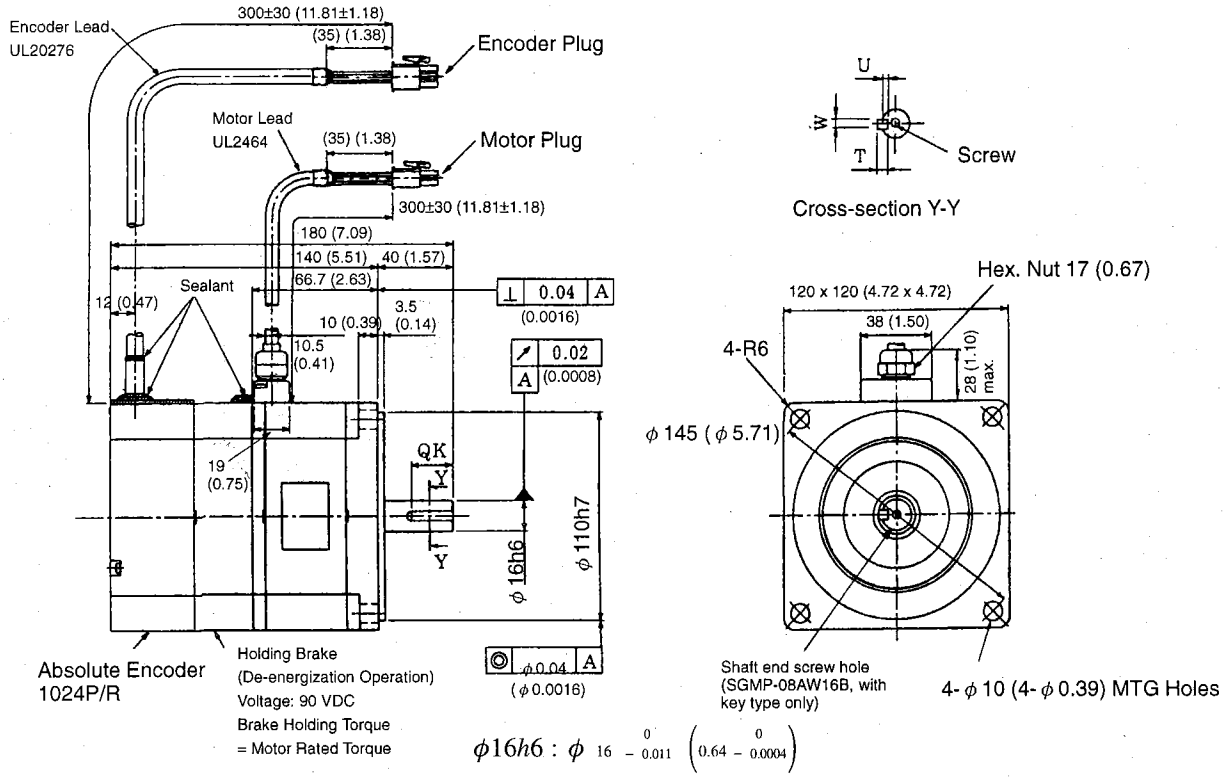
Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

2. "A" in the model number indicates 200 V specifications, and "B" indicates 100 V specifications.

3. The quoted allowable radial load is the value at a position 25 mm (0.98 in.) from the motor mounting surface.

4. Conforms to IP55 protective structure (except connector and output shaft faces).

750 W (1.01 HP)



$$\phi 16h6 : \phi\ 16\ {}^{0}_{-0.011}\ \left(0.64\ {}^{0}_{-0.0004}\right)$$

$$\phi 110h7 : \phi\ 110\ {}^{0}_{-0.035}\ \left(4.37\ {}^{0}_{-0.0014}\right)$$

Model SGMP-	QK	U	W	T	Screw Dimensions	Output W (HP)	Approx. Mass kg (lb)	Allowable Radial Load N (lbf)	Allowable Thrust Load N (lbf)
08AW12B	No key				–	750 (1.01)	6.2 (13.67)	392 (88)	147 (33)
08AW14B	22 (0.87)	3 (0.12)	5 (0.20)	5 (0.20)					
08AW16B					M5, depth 8 (0.31)				

Note 1. The encoder is a 12-bit absolute encoder 1024 P/R.

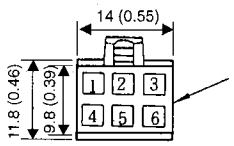
2. "A" in the model number indicates 200 V specifications.

3. The quoted allowable radial load is the value at a position 35 mm (1.38 in) from the motor mounting surface.

4. Conforms to IP55 protective structure (except connector and output shaft faces).

Motor and Encoder Plugs (For 100 W (0.13 HP) to 750 W (1.01 HP))

Motor Plug

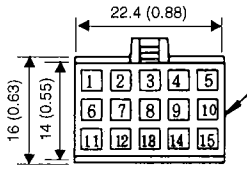


Plug: 172168-1 (AMP)
Pin: 170360-1 or 170364-1 (1 to 4 pins)
170359-1 or 170363-1 (5, 6 pins)
(170360-1 or 170364-1: 750 W only)
Connected to
Cap: 172160-1
Socket: 170362 -1 or 170366-1

Motor Wiring Specifications

1	Phase U	Red
2	Phase V	White
3	Phase W	Blue
4	FG	Green, Yellow
5	Brake terminal	Black
6	Brake terminal	Black

Encoder Plug



Plug: 172171-1 (AMP)
Pin: 170359-1 or 170363-1
Connected to
Cap: 172163-1
Socket: 170361-1 or 170365-1

Absolute Encoder Wiring Specifications

1	A channel output	Blue
2	$\overline{A}$ channel output	White, Blue
3	B channel output	Yellow
4	$\overline{B}$ channel output	White, Yellow
5	Z (C) channel output	Green
6	$\overline{Z}$ ($\overline{C}$) channel output	White, Green
7	0 V (power supply)	Black
8	+5 V (power supply)	Red
9	FG (Frame Ground)	Green, Yellow
10	S channel output	Purple
11	$\overline{S}$ channel output	White, Purple
(12)*	(Capacitor reset)	(Gray)
13	Reset	White, Gray
14	0 V (battery)	White, Orange
15	3.6 V (battery)	Orange

* Terminal to discharge capacitor before shipment. Do not use.

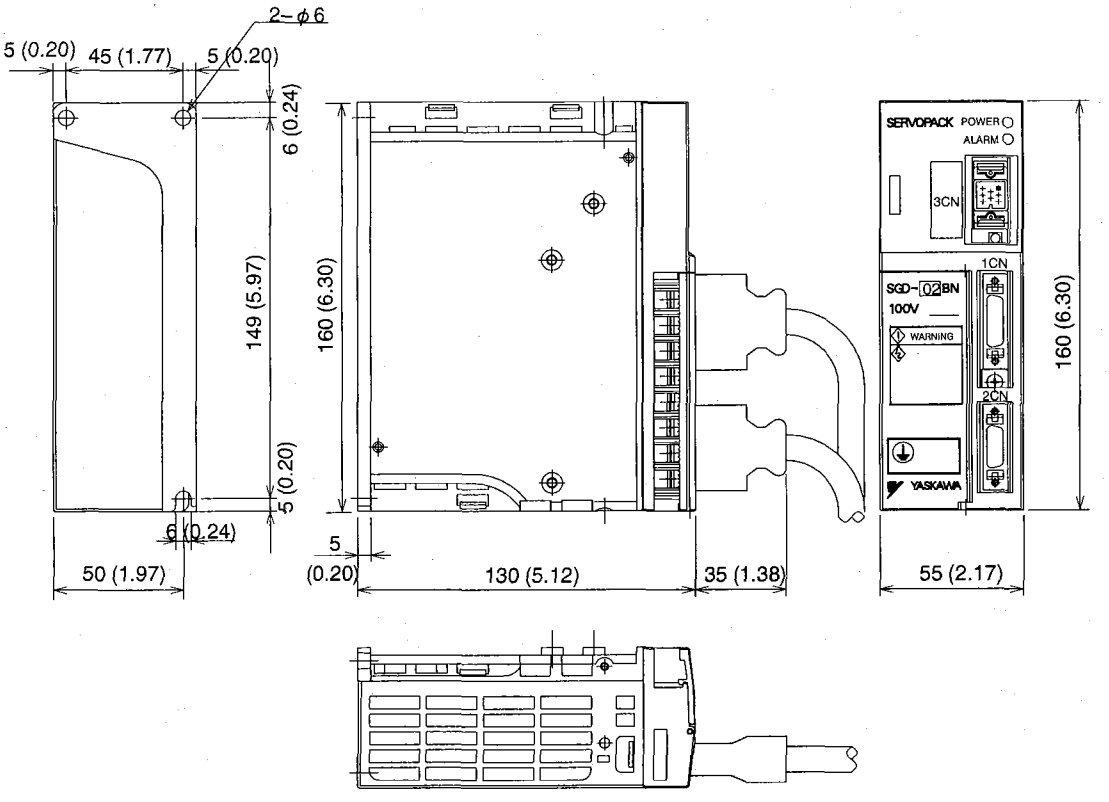
9

9.2 SERVOPACK Dimensional Drawings

The dimension drawings of the SGD SERVOPACK are broadly grouped according to capacity into the following three categories.

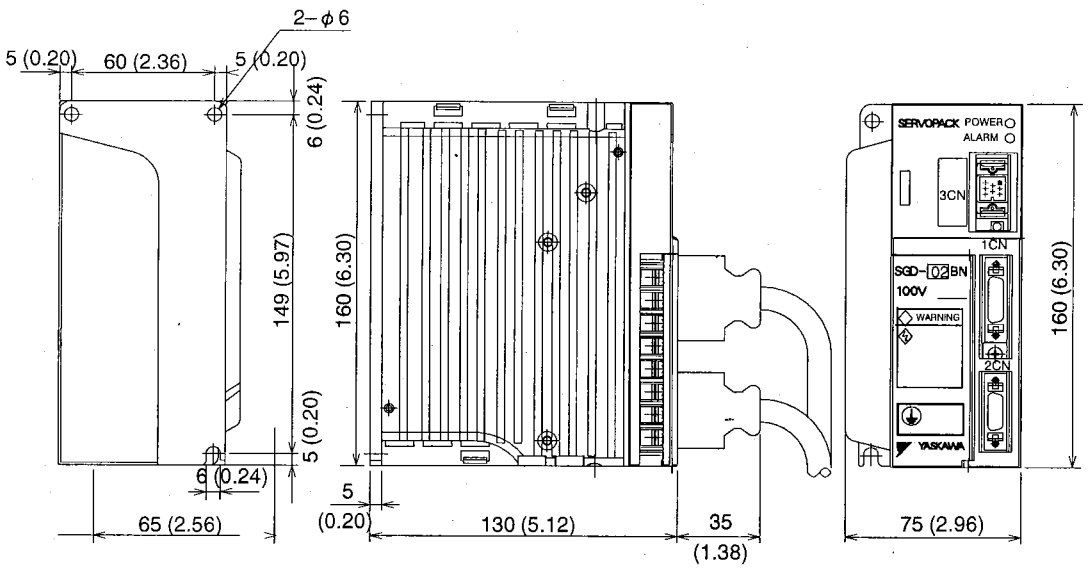
- 200 V, 30 W (0.04 HP) to 200 W (0.27 HP) (Model: SGD-A3AN to 02AN)
  100 V, 30 W (0.04 HP) to 100 W (0.13 HP) (Model: SGD-A3BN to 01BN)
- 200 V, 400 W (0.53 HP) (Model: SGD-04AN)
  100 V, 200 W (0.27 HP) (Model: SGD-02BN)
- 200 V, 750 W (1.01 HP) (Model: SGD-08AN)
  100 V, 300 W (0.40 HP) (Model: SGD-03BN)

9.2.1 SGD-A3AN to 02AN, SGD-A3BN to 01BN

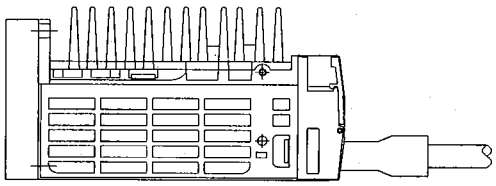


Approx. Mass: 0.9 kg (1.98 lb)

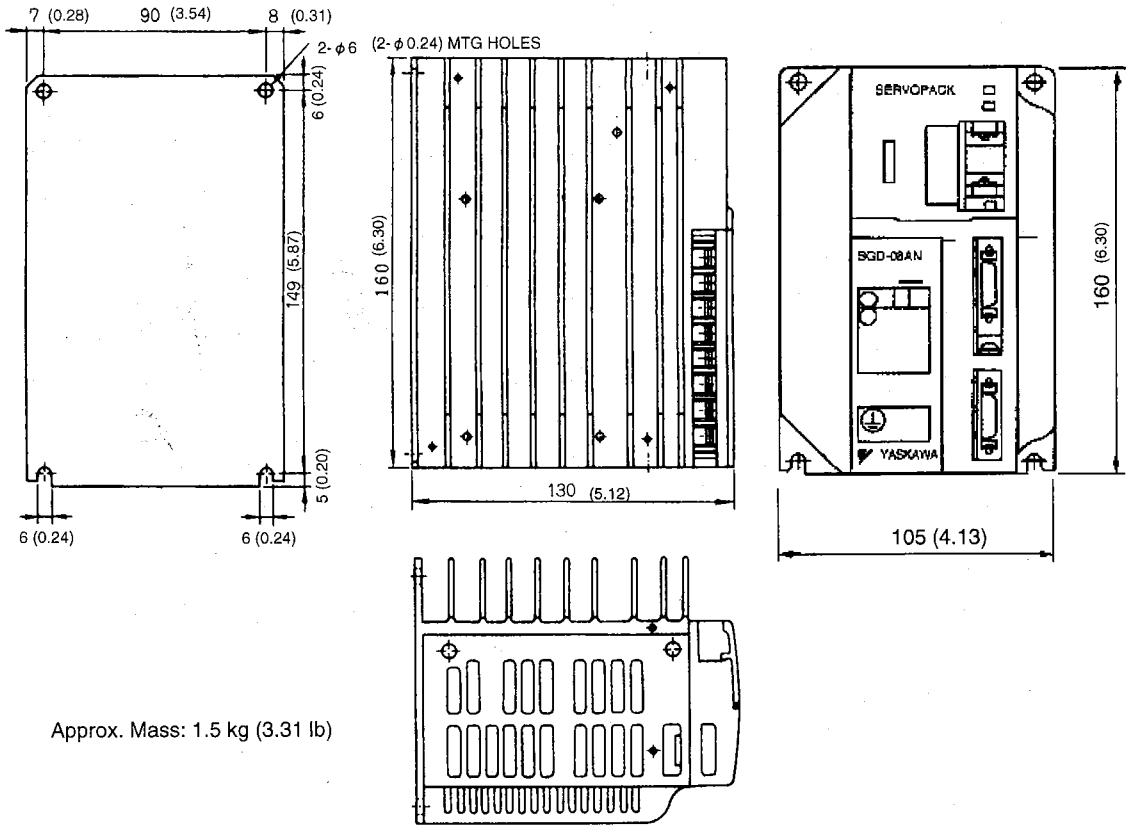
9.2.2 SGD-04AN, SGD-02BN



Approx. Mass: 1.2 kg (2.65 lb)



9.2.3 SGD-08AN, SGD-03BN

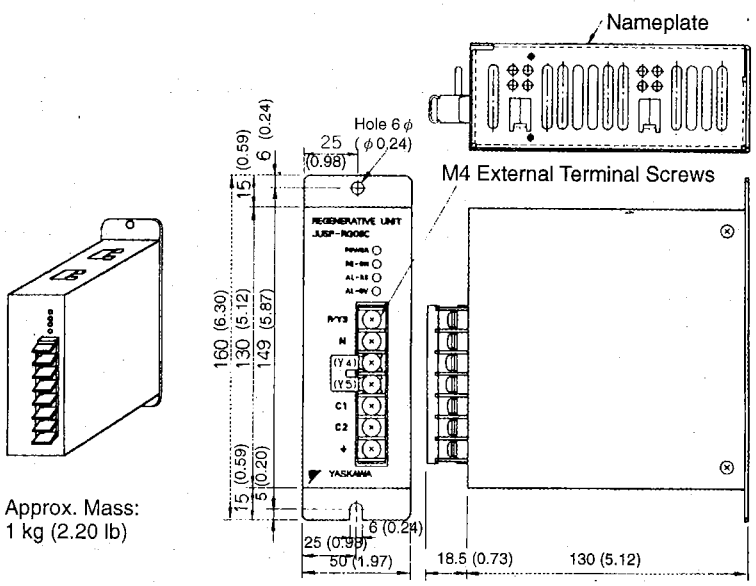


Approx. Mass: 1.5 kg (3.31 lb)

9.3 Regenerative Resistor Unit Dimensional Drawings

The dimensional drawings of the Regenerative Resistor Unit are as shown below.

■ Model JUSP-RG08C



Approx. Mass:
1 kg (2.20 lb)

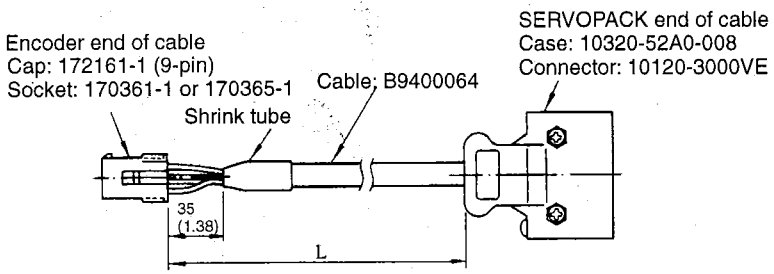
9

9.4 Cable Specifications

9.4.1 Cables from Yaskawa

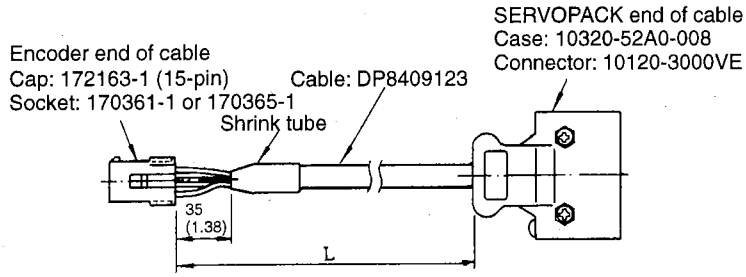
■ Encoder Cables

For Incremental Encoders (Connectors at Both Ends)



Model	L mm (feet)
DP9320089-1	3000^{+100}_{0} ($10^{+0.33}_{0}$)
DP9320089-2	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
DP9320089-3	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
DP9320089-4	15000^{+500}_{0} ($50^{+1.67}_{0}$)
DP9320089-5	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

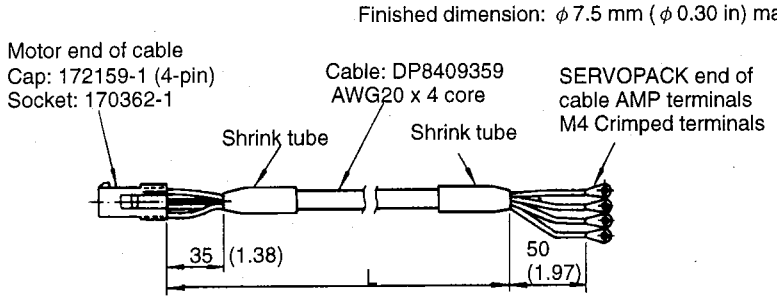
For Absolute Encoders (Connectors at Both Ends)



Model	L mm (feet)
DP9320088-1	3000^{+100}_{0} ($10^{+0.33}_{0}$)
DP9320088-2	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
DP9320088-3	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
DP9320088-4	15000^{+500}_{0} ($50^{+1.67}_{0}$)
DP9320088-5	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

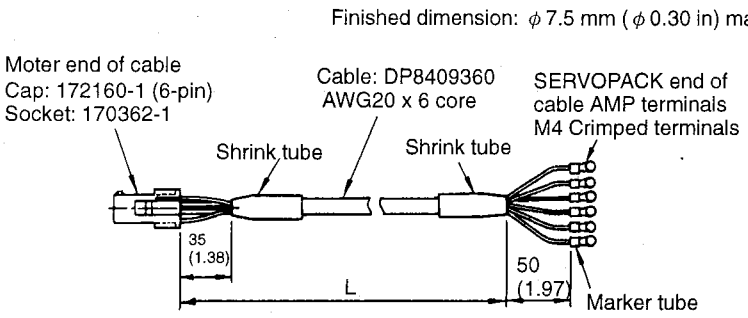
■ Motor Cables

For Motors without Brakes (with Connector and AMP Terminals)



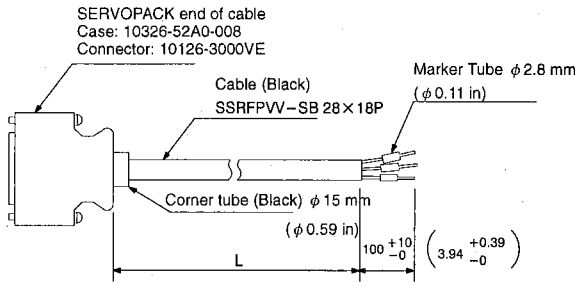
Model	L mm (feet)
DP9320081-1	3000^{+100}_{0} ($10^{+0.33}_{0}$)
DP9320081-2	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
DP9320081-3	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
DP9320081-4	15000^{+500}_{0} ($50^{+1.67}_{0}$)
DP9320081-5	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

For Motors with Brakes (with Connector and AMP Terminals)



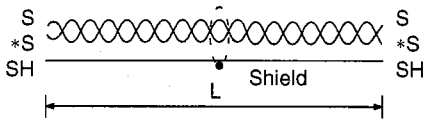
Model	L mm (feet)
DP9320083-1	3000^{+100}_{0} $(10^{+0.33}_{0})$
DP9320083-2	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
DP9320083-3	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
DP9320083-4	15000^{+500}_{0} $(50^{+1.67}_{0})$
DP9320083-5	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

■ I/O Signal Cables



Model	L mm (feet)
DE9411355-1	1000^{+30}_{0} $(3.28^{+0.098}_{0})$
DE9411355-2	2000^{+50}_{0} $(6.56^{+0.16}_{0})$
DE9411355-3	3000^{+50}_{0} $(10^{+0.16}_{0})$

■ MECHATROLINK Communication Cables

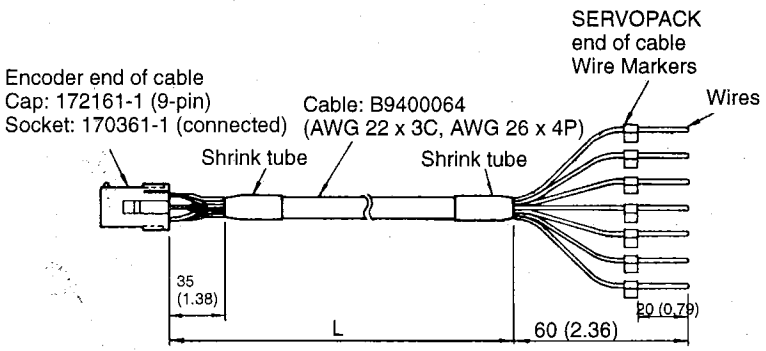


Model	L m (feet)
DE9411358-1	10 (32.8)
DE9411358-2	20 (65.6)
DE9411358-3	30 (98.4)
DE9411358-4	50 (164)
DE9411358-5	100 (328)
DE9411358-6	200 (656)
DE9411358-7	300 (984)
DE9411358-8	500 (1640)
DE9411358-9	1000 (3281)

9.4.2 Cables without SERVOPACK Connectors (PG Cables Only)

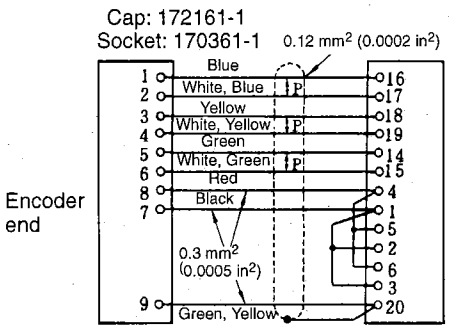
Cables for Incremental Encoders (with Connector on Motor End)

Lead Specifications



Wire Marker	Lead Color
1	Black
4	Red
14	Green
15	White, green
16	Blue
17	White, blue
18	Yellow
19	White, yellow
20	Green, yellow

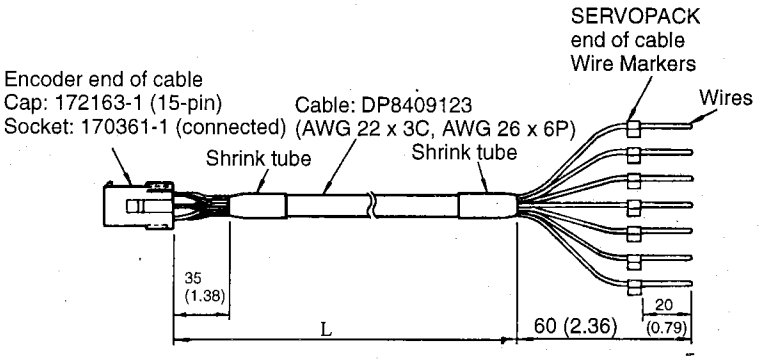
- Connections



Model	L mm (feet)
DP9320086-1	3000^{+100}_{0} ($10^{+0.33}_{0}$)
DP9320086-2	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
DP9320086-3	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
DP9320086-4	15000^{+500}_{0} ($50^{+1.67}_{0}$)
DP9320086-5	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

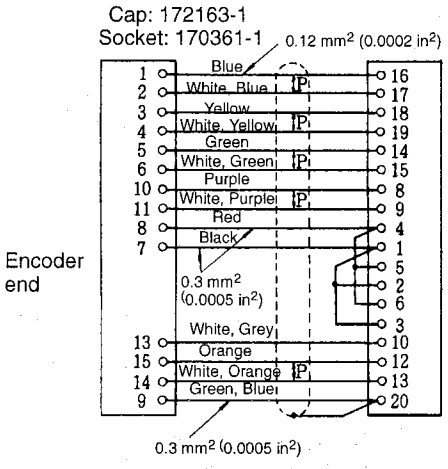
Cables for Absolute Encoders (with Connector on Motor End)

Lead Specifications



Wire Marker	Lead Color
1	Black
4	Red
8	Purple
9	White, purple
10	White, gray
12	Orange
13	White, orange
14	Green
15	White, green
16	Blue
17	White, blue
18	Yellow
19	White, yellow
20	Green, yellow

- Connections



SERVOPACK end (2CN)
To be provided by user

Case: 10320-52A0-008
(Manufactured by SUMITOMO 3M, Ltd.)
Connector: 10120-3000VE
(Manufactured by SUMITOMO 3M, Ltd.)

P: Shielded twisted-pair wires

Model	L mm (feet)
DP9320085-1	3000^{+100}_{0} ($10^{+0.33}_{0}$)
DP9320085-2	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
DP9320085-3	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
DP9320085-4	15000^{+500}_{0} ($50^{+1.67}_{0}$)
DP9320085-5	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

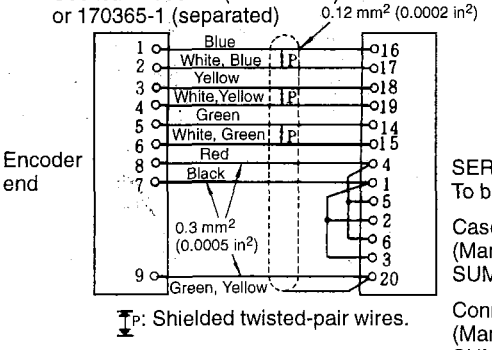
9

9.4.3 Cables Only

■ PG Cables

Cables for Incremental Encoders

To be provided by user
Cap: 172161-1
Socket: 170361-1 (Connected)
or 170365-1 (separated)



SERVOPACK end (2CN)
To be provided by user

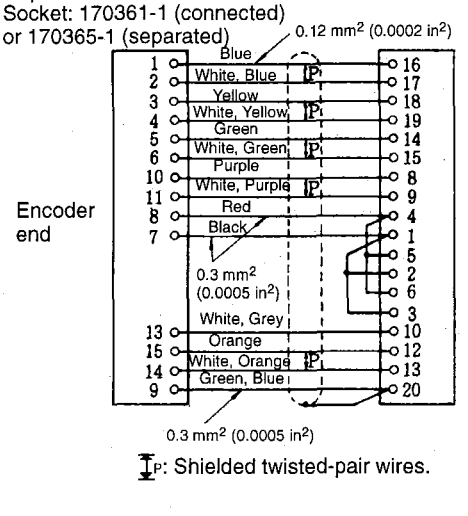
Case: 10320-52A0-008
(Manufactured by SUMITOMO 3M, Ltd.)

Connector: 10120-3000VE
(Manufactured by SUMITOMO 3M, Ltd.)

Model	L mm (feet)
DP9400064-1	3000^{+100}_{0} ($10^{+0.33}_{0}$)
DP9400064-2	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
DP9400064-3	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
DP9400064-4	15000^{+500}_{0} ($50^{+1.67}_{0}$)
DP9400064-5	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

Cables for Absolute Encoders

To be provided by user
Cap: 172163-1
Socket: 170361-1 (connected)
or 170365-1 (separated)



SERVOPACK end (2CN)
To be provided by user

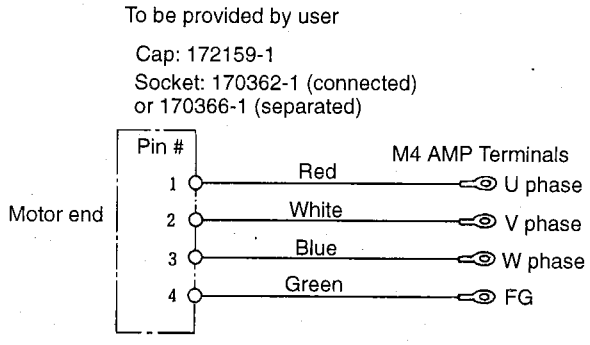
Case: 10320-52A0-008
(Manufactured by SUMITOMO 3M, Ltd.)

Connector: 10120-3000VE
(Manufactured by SUMITOMO 3M, Ltd.)

Model	L mm (feet)
DP8409123-1	3000^{+100}_{0} ($10^{+0.33}_{0}$)
DP8409123-2	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
DP8409123-3	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
DP8409123-4	15000^{+500}_{0} ($50^{+1.67}_{0}$)
DP8409123-5	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

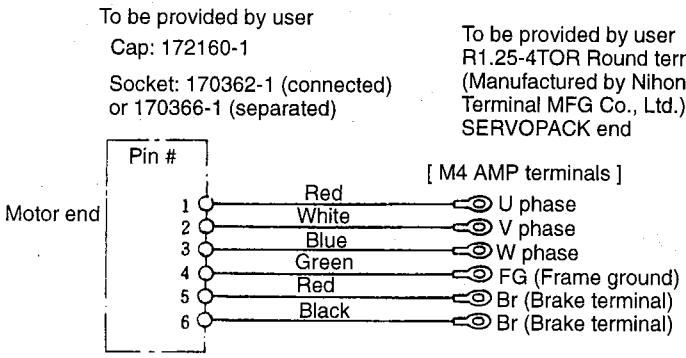
■ Servomotor Cables

Cables for Servomotors without Brakes



Model	L mm (feet)
DP8409359-1	3000^{+100}_{0} ($10^{+0.33}_{0}$)
DP8409359-2	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
DP8409359-3	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
DP8409359-4	15000^{+500}_{0} ($50^{+1.67}_{0}$)
DP8409359-5	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

Cables for Servomotors with Brakes



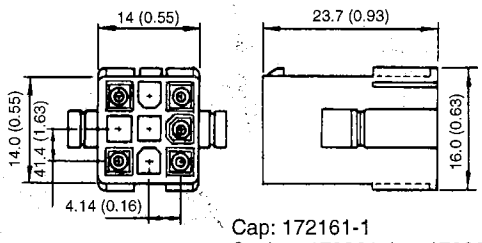
Model	L mm (feet)
DP8409360-1	3000^{+100}_{0} ($10^{+0.33}_{0}$)
DP8409360-2	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
DP8409360-3	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
DP8409360-4	15000^{+500}_{0} ($50^{+1.67}_{0}$)
DP8409360-5	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

Note Each connector is available as a connector kit. However, it is not an accessory of the SERVOPACKS or motors. Refer to *9.5* for details on *Connector Kits*.

9.5 Connector Kits

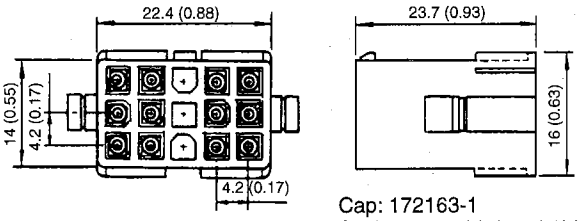
9.5.1 Encoder Cable Connectors

For Incremental Encoders



Cap: 172161-1
Socket: 170361-1 or 170365-1

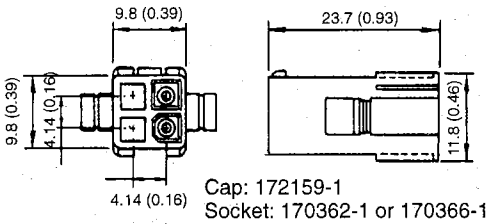
For Absolute Encoders



Cap: 172163-1
Socket: 170361-1 or 170365-1

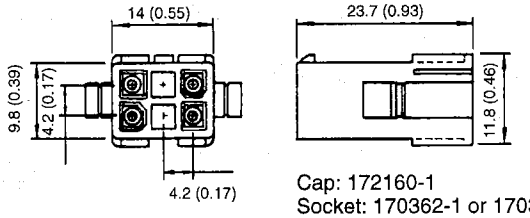
9.5.2 Motor Cable Connectors

Motors without Brakes



Cap: 172159-1
Socket: 170362-1 or 170366-1

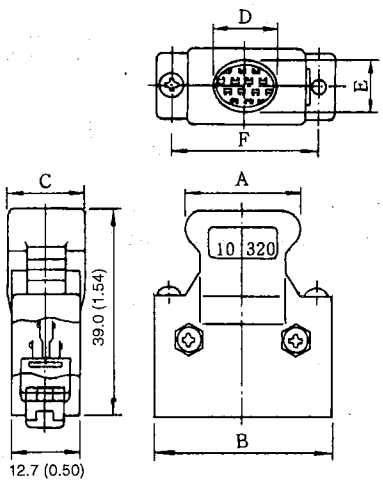
Motors with Brakes



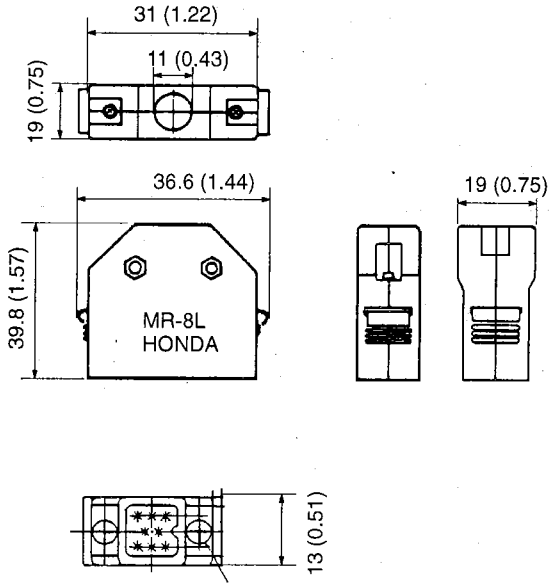
Cap: 172160-1
Socket: 170362-1 or 170366-1

9.5.3 SERVOPACK Connectors

1CN, 2CN Connectors



3CN Connectors



[mm (in)]

SERVOPACK	Connector	Case	A	B	C	D	E	F
1CN	10126-3000VE	10326-52A0-008	25.8 (1.02)	37.2 (1.46)	14.0 (0.55)	12.0 (0.47)	10.0 (0.39)	31.3 (1.23)
2CN	10120-3000VE	10320-52A0-008	22.0 (0.87)	33.3 (1.31)	14.0 (0.55)	12.0 (0.47)	10.0 (0.39)	27.4 (1.08)

The connector kit models are shown below.

Connector Kit Model Number	Application		Connector Kit Part List											
	Encoder/Motor Cable		For Encoder Cable								For Motor Cable			
			Encoder End				SERVOPACK End							
	Encoder Type	Motor Brake	Cap		Socket		Connector		Case		Cap		Socket	
			Model	Qty	Model	Qty	Model	Qty	Model	Qty	Model	Qty	Model	Qty
DP9420006-1	Incremental encoder	Without	172161-1 *1	1	170365-1 *1	10 *3	10120-3000VE *2	1	10320-52A0-008 *2	1	172159-1 *1	1	170366-1 *1	5 *3
DP9420006-2	Incremental encoder	With									172160-1 *1	1		7 *3
DP9420006-3	Absolute encoder	Without	172163-1 *1	1		16 *3					172159-1 *1	1		5 *3
DP9420006-4	Absolute encoder	With									172160-1 *1	1		7 *3

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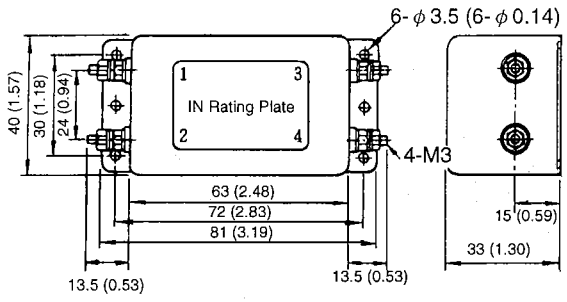
Connector Model	Application	Connector Part List			
		Connector		Case	
		Model	Qty	Model	Qty
DP9411354	1CN connector for I/O	10136-3000VE*2	1	10336-52A0-008*2	1
DE9411357	3CN for MECHATROLINK communication connector	MR-8F*4	1	MR-8L*4	1

* **1.** Manufactured by AMP.
* **2.** Manufactured by SUMITOMO 3M, Ltd.
* **3.** Including one spare.
* **4.** Manufactured by HONDA TSUSHIN INDUSTORY Co., Ltd.

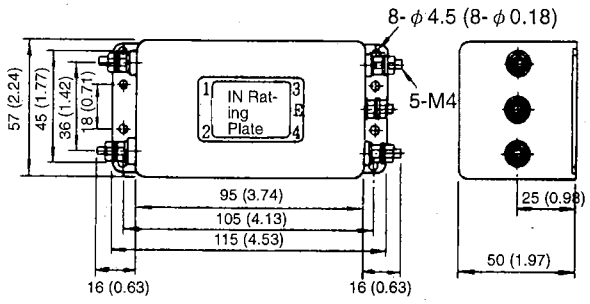
9.6 Noise Filters

9.6.1 Dimensional Diagram

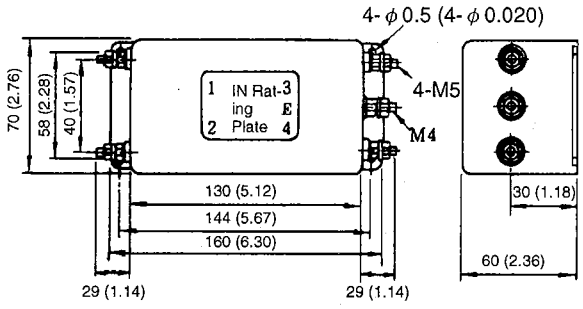
- LF-205A (Single-phase 200-VAC Class, 5 A)



- LF-210 (Single-phase 200-VAC Class, 10 A)



- LF-220 (Single-phase 200-VAC Class, 20 A)



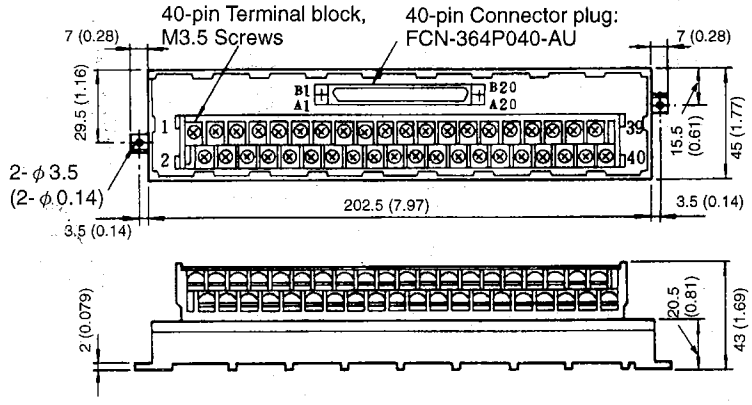
Manufactured by Tokin Co., Ltd.

9

9.7 Peripheral Devices

9.7.1 Connector Terminal Block Converter Unit

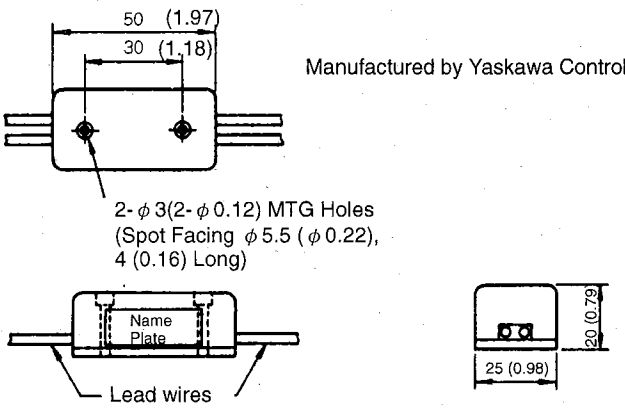
■ JUSP-TA26P



9.7.2 Brake Power Supply

Brake power supplies are available for 100 V and 200 V inputs. Select an appropriate model depending on the power supply voltage.

- 200 VAC Input: 90 VDC (LPSE-2H01)
- 100 VAC Input: 90 VDC (LPDE-1H01)

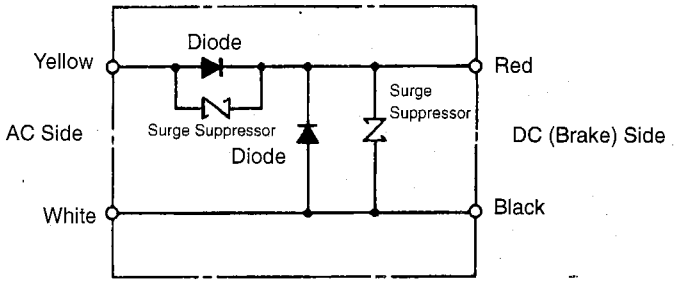


- Lead Wire Length: 500 mm each (19.69 in.)
- Max. Ambient Temperature: 60°C
- Lead Wires: Color coded

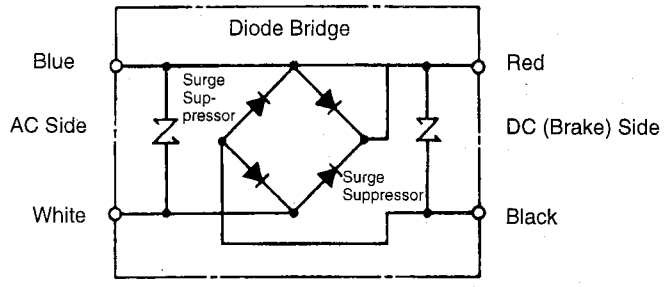
AC Input		Brake
100 V	200 V	
Blue, White	Yellow, White	Red, Black

While it is possible to switch either the AC or DC side of the brake power supply, it is normally safer to switch the AC side. If the DC side is to be switched, install a surge suppressor near the brake coil to prevent the surge voltages due to switching the DC side from damaging the brake coil.

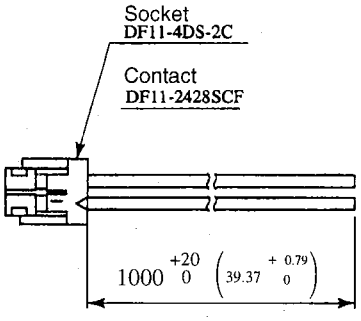
- **Internal Circuit for 200-VAC Input (LPDE-2H01)**



- **Internal Circuit for 100-VAC Input (LPDE-1H01)**



9.7.3 Analog Monitor Cables



Model	L mm (in.)
DE9404559	1000 +20 0 (39.37 + 0.79 0)

9

10

Trial Operation

This chapter describes how to conduct a full trial operation.

10.1 Check Items before Trial Operation ..... 10 -2

10.1.1 Servomotors ..... 10 -2

10.1.2 SERVOPACKS ..... 10 -2

10.2 Trial Operation Procedure ..... 10 -3

10.2.1 Preparation for Trial Operation ..... 10 -3

10.2.2 Operation ..... 10 -3

10.2.3 Trial Operation Inspection ..... 10 -4

10.1 Check Items before Trial Operation

Inspect the following items before conducting trial operation. Also conduct the inspections according to *Chapter 12 "Maintenance and Inspection"* if conducting trial operation on Servomotors that have been stored for a long period of time.

10.1.1 Servomotors

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

10.1.2 SERVOPACKS

- User constants are properly set for the applicable Servomotor and specifications.
- Terminal connections and wiring leads are tightened securely. Connectors are inserted securely.
- The power supply is turned OFF if a servo alarm occurs.
- Voltage supplied to SGD SERVOPACK is 200 to 230 V $^{+10}_{-15}$ % (100 to 115 V $^{+10}_{-15}$ %). (When using a power supply that is not 200 V (100 V), a transformer that steps down to 200 V (100 V) must be installed separately.)

Take appropriate action immediately if an alarm occurs or one of the items above is incorrect.

10.2 Trial Operation Procedure

10.2.1 Preparation for Trial Operation

IMPORTANT

To prevent accidents, initially conduct trial operation with no load connected to the Servomotor. If the trial operation must be conducted while connected to equipment, confirm that the driven system is ready for an emergency stop at any time.

Prepare operation according to the following procedure.

1. Turn the power ON.
   If the power supply ON sequence is correct as shown in *Chapter 5,* press the ON switch to turn ON power. Press and hold the switch for about two seconds in *Figure 5.1* of *Chapter 5.*
2. If the power is supplied normally, the power-ON indicator LED (green) will light. After the CONNECT (establish connection) command is transferred, the alarm LED (red) will go OFF. Use the SMON (status monitoring) command to check SERVOPACK status. The data returned from the SERVOPACK is alarm code 99.
3. Use the ID_RD (read ID) command to check the SERVOPACK type. The SERVOPACK returns "SGD-***N."
4. Transfer the parameters required for trial operation (such as motor selection, encoder type, and encoder pulses) by PRM_WR (write parameter) command.
5. Transfer a SENS_ON (encoder power ON) command and verify that no alarm has occurred. Position data is also received with an absolute encoder.
6. When the SV_ON (Servo ON) command transfer, the power circuit in the SERVOPACK is activated and the Servomotor is ready to drive. If the SMON command is transfer, status SVON = 1 (base driving) will be returned.

* As factory settings the motor is set to an SGM motor and the encoder is set to an incremental encoder (2048 P/R). When using any other motors, the parameters must be changed.

10.2.2 Operation

Driving a Servomotor is possible only when the main circuit is in active base driving. Run the Servomotor at low speed.

■ Command Transmission Example

POSING (rapid traverse positioning) command

Option = 0

Positioning setting = 10000 (current position + 10000 with absolute encoder)

Rapid traverse speed = 400

Make sure the Servomotor is running in the proper direction according to the reference.

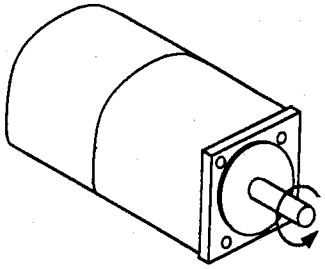


Figure 10.1 Servomotor Forward Running

10.2.3 Trial Operation Inspection

Inspect for the following items during the trial operation.

- Abnormal vibration
- Abnormal noise
- Abnormal temperature rise

Take actions according to *Chapter 12 "Maintenance and Inspection"* if any abnormality is found. During trial operation, the load and machine may not fit well at first and result in an overload.

11

Settings

This chapter describes characteristics at the factory before shipping and Servo performance adjustment.

11.1 Characteristics at the Factory ..... 11 -2

11.2 Resetting ..... 11 -2

11.3 Adjusting Servo Performance ..... 11 -3

11.3.1 Setting User Constants ..... 11 -3

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11.1 Characteristics at the Factory

The speed reference (feed speed) characteristics at the factory are shown below.

Speed Reference – Motor Speed Characteristics

Conditions: No load

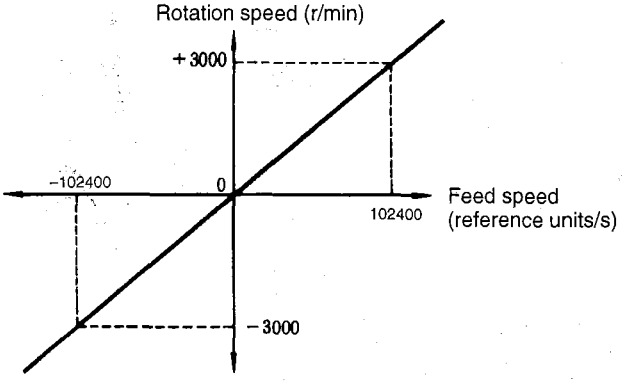


Figure 11.1 Speed Reference – Motor Speed Characteristics

11.2 Resetting

If settings must be reset because of application or usage conditions, reset them according to *Chapter 6 "MECHATROLINK Communication"*.

11.3 Adjusting Servo Performance

11.3.1 Setting User Constants

■ Position Loop Gain (Cn-001A)

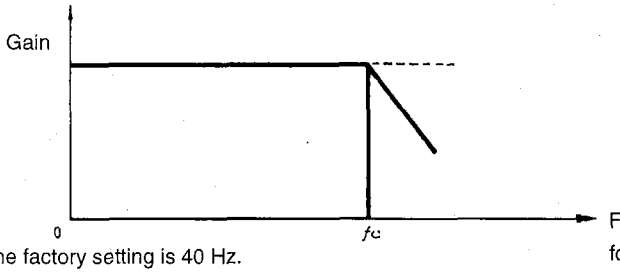
Position loop gain is ideally determined by the specifications of the equipment, but initially set a level lower than the desired value. (The factory setting is 40 (1/s).)

■ Load Inertia (Cn-0003)

Set the load inertia for the moment of inertia ratio on the motor shaft. (This constant is factory-set to 100 (%), which is equivalent to the motor inertia.)

■ Speed Loop Gain (Cn-0004)

The setting (Hz) of Cn-0004 expresses the speed loop gain characteristics, and is the cutoff frequency "fc" for the response characteristics of a system with balanced inertia. The value fc may vary even with the same speed loop gain setting due to fluctuations in load inertia.



* The factory setting is 40 Hz.

Note Set load inertia (Cn-0003) to 0 (%) so that the speed loop gain (Cn-0004) will be 40 (Hz) or less if the Servomotor is running under no-load conditions.

■ Speed Loop Integration Time constant (Cn-0005)

Set Cn-0005 to 20 (ms). (Factory setting)

11.3.2 Setting Optimum Position and Speed Loop Gain

■ Speed Overshooting and Vibration

- Incrementally decrease the position loop gain (Cn-001A).
- Incrementally increase the speed loop gain. If the situation worsens when the speed loop gain is increased, incrementally decrease the gain.
- A certain amount of position loop gain is necessary, so set the acceleration/deceleration time (Cn-001F to 0021) high if the application cannot handle overshoot.

When Response Tracking Worsens

- Incrementally increase the position loop gain (Cn-0001A).
- If the position loop gain cannot be increased any higher because of vibration, incrementally increase the speed loop gain (Cn-0004). If increasing the speed loop gain causes vibration, then tracking performance including that for the mechanical system is at its limit.

12

Maintenance and Inspection

This chapter describes Servodrive maintenance, inspection, and trouble-shooting.

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12.1 Servodrive Maintenance and Inspection of Servodrives

12.1.1 Servomotor

Simple daily inspections are all that are needed to maintain the Servomotor because it is brushless. The inspection and maintenance frequencies given in the following table are only guidelines, and may be increased or decreased to suit driving conditions and environment.

IMPORTANT

Do not disassemble the Servomotor during inspection and maintenance, but rather contact your Yaskawa representative if the Servomotor must be disassembled.

Table 12.1 Inspection Items

Item	Frequency	Procedure	Comments
Vibration and Noise	Daily	Touch and listen.	The degree of vibration and noise must not be any higher than normal.
Appearance and Cleaning	According to the degree of dirt	Clean with a cloth or compressed air.	–
Insulation resistance measurement	Yearly	Disconnect the SERVOPACK and test insulation resistance at 500 V. Must exceed 10 MΩ	Contact your Yaskawa representative if insulation resistance is below 10 MΩ.
Overhaul	Every 20,000 hours or 5 years	Remove the Servomotor, replace consumable parts and perform any necessary repairs.	Contact your Yaskawa representative for the overhaul.
Oil seal replacement (for Motors equipped with oil seals)	Every 5,000 hours	Remove the Servomotor and replace the oil seal.	–

■ Guidelines for Replacing Parts

The following parts are subject to mechanical wear or deterioration over time. To avoid failure, replace these parts periodically as indicated below.

Table 12.2 Parts Replacement

Part	Standard Replacement Period	Replacement Method
Bearings	20,000 operating hours	Disassemble the Servomotor and replace the bearings if necessary.
Oil Seal	About 5,000 hours	Replace with a new oil seal.

12.1.2 SERVOPACK Inspection

The SERVOPACK contains highly reliable parts and does not require daily inspection. Always inspection the SERVOPACK at least once a year. Be sure to check user settings prior to operation because we reset user constants to standard settings when we ship overhauled SERVOPACKS.

Table 12.3 Inspection Items

Item	Frequency	Procedure	Remedy
Clean unit interior and circuit boards	Yearly	Check for dust, dirt, and oil on surfaces.	Clean with a cloth or compressed air.
Loose screws	Yearly	Check for loose terminal block and connector screws.	Tighten any loose screws.
Defective parts in unit or on circuit boards	Yearly	Check for discoloration, damage or broken wires due to heat.	Contact your Yaskawa representative.

■ Guidelines for Replacing Parts

The following parts are subject to mechanical wear or deterioration over time. To avoid failure, replace these parts at the frequency indicated in the following table.

Table 12.4 Parts Replacement

Part	Standard Replacement Period	Replacement Method
Smoothing capacitor	7 to 8 years	Test and replace with a new capacitor if necessary.
Relays	–	Test and replace if necessary.
Fuse	10 years	Replace with a new fuse.

Note Operating conditions

Ambient temperature: Annual average of 30°C
Load factor: 80% max.
Operation rate: 20 hours/day max.

Be sure to check user settings prior to operation because Yaskawa resets user constants to factory settings when shipping overhauled SERVOPACKS.

12.1.3 Replacing Battery for Absolute Encoder

Replace the absolute encoder battery (purchased by the customer) as outlined below. With an ER 6-V C-type lithium battery manufactured by Toshiba Battery Co., Ltd. the estimated life is about 10 years.

1. Turn ON the control power supply of the SERVOPACK and wait at least 30 minutes after the SENS_ON command is transmitted until the capacitor inside the encoder is charged.
2. Replace the battery. The SERVOPACK power supply may be ON or OFF when the battery is replaced.

Encoder multi-turn data will not be lost if the battery is replaced following the instructions given above. After completing step 1, above, the absolute encoder will function normally for up to 2 days without a battery.

IMPORTANT

When replacing the battery with the multi-turn data remaining, leave the encoder power supply for at least 30 minutes (SENS_ON command transfer).

12.2 Troubleshooting

12.2.1 Servomotor

Refer to the *Table 12.5* for the appropriate action when a problem occurs during operation, and be sure to turn OFF the servo system power supply before commencing the procedures that are shaded. Contact your Yaskawa representative immediately if the problem cannot be resolved by using the described procedures.

Table 12.5 Causes, Inspection Areas, and Remedies

Symptom	Cause	Inspection	Remedy
Servomotor does not run	Overloaded	Try running with no load	Reduce the load or replace with a larger capacity Servomotor.
	Loose connection	Check connector terminals (1CN, 2CN)	Tighten any loose parts. (See the Note.)
	External connector wiring incorrect	Check external connector (1CN) wiring	Refer to the connection diagram and correct the wiring.
Unstable Servomotor rotation	Faulty connection	Check the Phase-U, -V and -W lead terminals as well as feedback pulse connection.	Reconnect the wiring.
Servomotor overheated	Ambient temperature too high	Check to see if the ambient temperature is below 40°C.	Reduce the ambient temperature to below 40°C.
	Servomotor surface dirty	Check visually.	Clean dust and oil from the motor surface.
	Overloaded	Try operating with no load	Reduce the load or replace with a larger capacity Servomotor.
Abnormal noise	Mechanical mounting incorrect	• Loose Servomotor mounting screws? • Coupling not centered? • Coupling unbalanced?	• Tighten mounting screws. • Center or balance the coupling.
	Bearing defective	Check for noise and vibration near the bearing.	Contact your Yaskawa representative if defective.
	Vibration caused by the equipment	Foreign objects, damage, or deformation of sliding parts.	Contact the equipment manufacturer.

Note Be sure to turn OFF the power supply when performing the inspection or remedy in the shaded boxes.

12.2.2 SERVOPACK

■ Troubleshooting Using MECHATROLINK Communication Data

Table 12.6 shows examples of troubleshooting problems with MECHATROLINK communications data (alarm code).

Table 12.6 Troubleshooting with MECHATROLINK Communications Data

Alarm Code (Alarm/Warning History)	Status When Lit	Cause	Remedy
"10" Overcurrent	Lit at power ON	Circuit board (1PWB) defective	Replace SERVOPACK.
	Lit at power ON and servo ON	Current feedback circuit or power transistor defective. Dynamic brake circuit.	Replace SERVOPACK.
	Lit during driving Lit at power ON after turning the power OFF SERVOPACK operates when it is reset after a while.	Ambient temperature exceeds 55 ℃.	Reduce the ambient temperature to below 55 ℃.
"40" Overvoltage	Lit with normal running or deceleration	GD^2 load too large.	Check the load inertia for the moment of inertia on the motor shaft
		Circuit board (1PWB) defective.	Replace SERVOPACK.
"51" Overspeed	Lit with high-speed Servomotor rotation after reference input	Servomotor wiring incorrect. Encoder wiring incorrect.	• Check and correct Servomotor wiring. • Check to see if the Phase-A, -B and -C pulses are correct at 2CN, and repair (disconnection, short, no power supply, defective circuit board.) if necessary.
"D0" Overflow	No feedback pulse after moving reference input	• Servomotor wiring incorrect • Encoder wiring incorrect	
		Control board (1PWB) defective	Replace SERVOPACK.
	Overflow during high-speed running	• Servomotor wiring incorrect • Encoder wiring incorrect	• Check and correct Servomotor wiring. • Check to see if the Phase-A, -B and -C pulses are correct at 2CN, and repair (disconnection, short, no power supply, defective circuit board.) if necessary.
		Control board (1PWB) defective	Replace SERVOPACK.
	Normal running by overflow with large move reference input	SERVOPACK adjustment incorrect	Increase speed loop gain (Cn-0004).
		Load capacity too large	Review the load. (overload or load inertia)
		Feed speed too large	Decrease the feed speed.
"71" Instantaneous overload	Lit during driving Operation resumes after turning power OFF and ON.	Load greatly exceeds the rated torque from several seconds to tens seconds.	Review the load. (overload)

Alarm Code (Alarm/Warning History)	Status When Lit	Cause	Remedy
"72" Continuous overload	Lit during operation Operation resumes after turning power OFF and ON.	Load greatly exceeds the rated torque from tens seconds to hundreds second.	Review the load. (overload)
"80" Absolute encoder error	Lit during driving	Faulty absolute encoder wiring or connection	Check to see if the Phase-A, -B and -C pulse wiring is correct at 2CN, and repair if necessary.
		SERVOPACK miscounted pulses	• Turn power OFF, reset and turn power ON. • Separate encoder wiring from main wiring circuits.
		Number of encoder pulses setting incorrect.	Reset the number of encoder pulses correctly.
"81" Backup error	Lit several seconds after power ON	Absolute encoder backup voltage dropped	Follow the absolute encoder setup procedures.
"82" Checksum error	Lit several seconds after power ON	Absolute encoder memory data check failed	Follow the absolute encoder setup procedures.
"83" Battery error	Lit several seconds after power ON	Absolute encoder battery voltage dropped	Replace the battery and turn power ON twice.
"84" Absolute encoder data error	At power ON	Absolute encoder malfunctioned	Replace the Servomotor if the error occurs frequently.
"85" Overspeed	Lit several seconds after power ON	Servomotor rotated at power ON.	Turn power ON with the Servomotor stopped.
"C1" Servo overrun	Lit soon after Servomotor started to run	Servomotor wiring incorrect or disconnected	Check wiring and connectors at the Servomotor.
		Encoder wiring incorrect or disconnected	Check wiring and connectors at the encoder.
"C2" Phase error detection	Lit 1 to 3 seconds after power ON.	Faulty encoder wiring or connection	Check wiring and connectors at the encoder.
		Noise in encoder wiring	Separate encoder wiring from main wiring circuits.
		Encoder defective	Replace Servomotor.
	Lit during driving	Faulty encoder wiring or connection	Check wiring and connectors at the encoder.
		Noise in encoder wiring	Separate encoder wiring from main wiring circuits.
		Encoder defective	Replace Servomotor.
"C3" Broken encoder PA-, PB-phase wire	Lit soon after Servomotor started to run	Faulty encoder wiring (PA, PB) or connection	Check wiring and connectors at the encoder.
"C4" Broken encoder PC-phase wire	Lit soon after Servomotor started to run	Faulty encoder wiring (PC) or connection	Check wiring and connectors at the encoder.
"C5" Initial pulse error	At the SENS_ON or CONFIG command transfer	Incorrect encoder type setting	Reset the encoder type.
		Faulty encoder	Replace the encoder.
		Faulty control board (1PWB)	Replace SERVOPACK.

Alarm Code (Alarm/Warning History)	Status When Lit	Cause	Remedy
"F3" Power loss error	Lit at power ON	Time between turning power OFF and back ON was shorter than the power holding time.	After turning power OFF, wait longer than the power holding time before turning power back ON.
"00" Absolute encoder data error	Lit several seconds after power ON	• Absolute encoder malfunctioned	• Turn power back ON. • Follow the absolute encoder setup procedures.
		• Absolute encoder wiring incorrect	Check and correct absolute encoder wiring.
"02" Broken user constant	Lit at power ON	Circuit board (1PWB) defective	Replace SERVOPACK.
"94" User constant setting warning	Lit at power ON	An user constant was set out of range via MECHATROLINK communication or the setting order was incorrect.	Set the correct setting and review the exact setting order.
"95" Command warning	At command transfer	The CONNECT command has not been transferred.	Transfer the CONNECT command.
	At the SV_ON command tranfer	The CONNECT or SENS–ON command has not been transferred.	Transfer the CONNECT or SENS_ON command.
		Main power supply not turn ON.	Turn ON the main power supply. (Check the sequence.)
	At the synchronous command (SYNC_SET) transfer	Communication phase 3 has not been reached.	Establish a sync by CONNECT command (normal, synchronum) or the SYNC–SET command.
"E5" Synchronization error	At command transfer	WDT data does not match.	Update the WDT data at each communication cycle.
"E6" Communication error	At power supply turn ON	Faulty contact between cable and connector.	Correct the connector wiring.
		Malfunction due to noise	Take action to eliminate noise.
"B□" Hardware error	At power supply turn ON	Control board (1PWB) defective.	Replace SERVOPACK.

Note The alarm code "00" is reset by turning OFF the encoder power supply (by transferring SENS_OFF command) and by transferring ALM_CLR command.

■ Problems due to Defective Wiring or Parts

Table 12.7 Problems Caused by Defective Wiring or Parts

Symptom	Check Areas and Items	Remedy
Motor will not run with reference input	• Check voltage between R and T. • Make sure the alarm indicator is not lit. • Check the N-OT, P-OT, and signals. • Use the SMON command (statsu monitor) to check SERVOPACK status.	• Check the AC power supply circuit. • Look for a cause if an indicator is lit.

■ Problems due to Setting Errors

Table 12.8 Problems due to Setting Errors

Symptom	Cause	Remedy
Poor servo tracking performance	Position loop gain too low	Increase the position loop gain (Cn-001A). Decrease the speed loop gain (Cn-0004) when increasing position loop gain causes hunting. **Note** Do not increase the position loop gain any higher once hunting occurs. This is the tracking performance limit.

■ Troubleshooting: No Alarm or Warning Displayed but Motor Does Not Run

Table 12.9 Troubleshooting with no Alarm or Warning Displays

Symptom	Cause	Conditions	Remedy
Servomotor does not run	SENS_ON command not transfer	Bits 0 and 1 of Cn-0001 set to 0	Transfer the SENS_ON command.
	Encoder to Servomotor wiring disconnected	–	Reconnect the wiring.
	P-OT and N-OT inputs are turned OFF	Bits 2 and 3 of Cn-0001 set to 0	Turn ON the P-OT and N-OT inputs.
Servomotor moves instantaneously, then stops	Number of encoder pulses differs from the user constant setting (Cn-0011).	–	Set the user constant (Cn-0011) to match the number of encoder pulses if necessary.
	Servomotor or encoder wiring incorrect	–	Correct the wiring.

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USER'S MANUAL

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