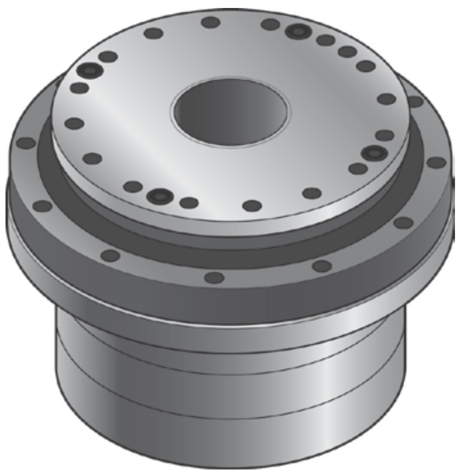
HarmonicDrive®

AC Servo Actuator

SHA-M series manual



ISO14001

ISO9001

Introduction

Thank you for purchasing our SHA-M series AC Servo Actuator.
Wrong handling or use of this product may result in unexpected accidents or shorter life of the product.
Read this document carefully and use the product correctly so that the product can be used safely for many years.
Product specifications are subject to change without notice for improvement purposes.
Keep this manual in a convenient location and refer to it whenever necessary in operating or maintaining the units.
The end user of the actuator should have a copy of this manual.

SAFETY GUIDE

To use this actuator safely and correctly, be sure to read SAFETY GUIDE and other parts of this document carefully and fully understand the information provided herein before using the actuator.

NOTATION

Important safety information you must note is provided herein. Be sure to observe these instructions.

WARNING	Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious personal injury.
CAUTION	Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate personal injury and/or damage to the equipment.
Caution	Indicates what should be performed or avoided to prevent non-operation or malfunction of the product or negative effects on its performance or function.

LIMITATION OF APPLICATIONS

The equipment listed in this document may not be used for the applications listed below:

- Space equipment
- Automobile, automotive parts
- Aircraft, aeronautic equipment
- Amusement equipment, sport equipment, game machines
- Nuclear equipment
- Machine or devices acting directly on the human body
- Household apparatus
- Instruments or devices to transport or carry people
- Vacuum equipment
- Apparatus or devices used in special environments

If the above list includes your intending application for our products, please consult us.

CAUTION

Safety measures are essential to prevent accidents resulting in death, injury or damage of the equipment due to malfunction or faulty operation.

SAFETY NOTE

ITEMS YOU SHOULD NOTE WHEN USING THE ACTUATOR

- **CAUTIONS RELATED TO THE DESIGN**

CAUTION

Always use under followings conditions.

The actuator is designed to be used indoors. Observe the following conditions:

- Ambient temperature: 0℃ to 40℃
- Ambient humidity: 20% to 80%RH (Non-condensation)
- Vibration: Max 25 m/s^2 (Refer to Page 1-38.)
- No contamination by water, oil
- No corrosive or explosive gas

Follow exactly the instructions in the relating manuals to install the actuator in the equipment.

- Ensure exact alignment of the actuator center and the center of the corresponding machine by following the manual.
- Failure to observe this caution may lead to vibration, resulting in damage of output elements.

- **CAUTIONS FOR USAGE**

WARNING

Keep limited torques of the actuator.

- Keep limited torques of the actuator.
- Be aware, that if arms attached to output element hits by accident an solid, the output element may be uncontrollable.

Never connect cables directly to a power supply socket.

- Each actuator must be operated with a proper servo amplifier.
- Failure to observe this caution may lead to injury, fire or damage of the actuator.

Do not apply impacts and shocks

- The actuator directly connects with the encoder so do not use a hammer during installation.
- Failure to observe this caution could damage the encoder and may cause uncontrollable operation.

Avoid handling of actuators by cables.

- Failure to observe this caution may damage the wiring, causing uncontrollable or faulty operation.

ITEMS YOU SHOULD NOTE WHEN USING THE SERVO AMPLIFIER

- **Read the "MR-J4-_B Servo Amplifier Technical Manuals" and ensure safe operation.**

- **Be sure to read the "MELSERVO-J4 SERIES AC SERVO SAFETY GUIDE", which comes together with the servo amplifier, before using this product.**

- **CAUTIONS FOR USAGE**

WARNING

Never change wiring while power is active.
Make sure of power non-active before servicing the products. Failure to observe this caution may result in electric shock or personal injury.

Do not touch terminals or inspect products at least 5 minutes after turning OFF power.

- Otherwise residual electric charges may result in electric shock.
- Make installation of products not easy to touch their inner electric components.

DISPOSAL

CAUTION

All products or parts must be disposed of as industrial waste.
Since the case or the box of drivers have a material indication, classify parts and dispose them separately.

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Related manual

The table below lists related manual. Check each item as necessary.

Title	Document No.	Description
MR-J4-_B SERVO AMPLIFIER INSTRUCTION MANUAL	SH-030106	The specifications and characteristics of the Mitsubishi Electric MR-J4-_B series are explained.
MR-J4-□B-S033 PRODUCT SPECIFICATIONS	BCN-B72000-090 (ENG)	The specifications and characteristics of the MR-J4-□B servo amplifier, which works with SHA-M series, are explained.

Conformance to overseas standards

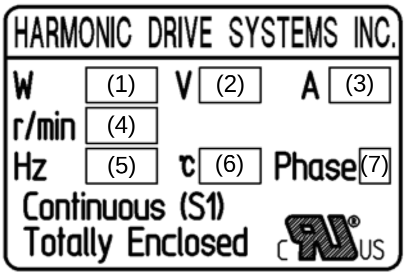
SHA series actuator conforms to following overseas standards.

UL Standard	UL1004-1, UL1004-6（File No. E243316）
CSA Standard	C22.2 No.100
European Low Voltage EC Directives	EN60034-1, EN60034-5

UL nameplate sticker

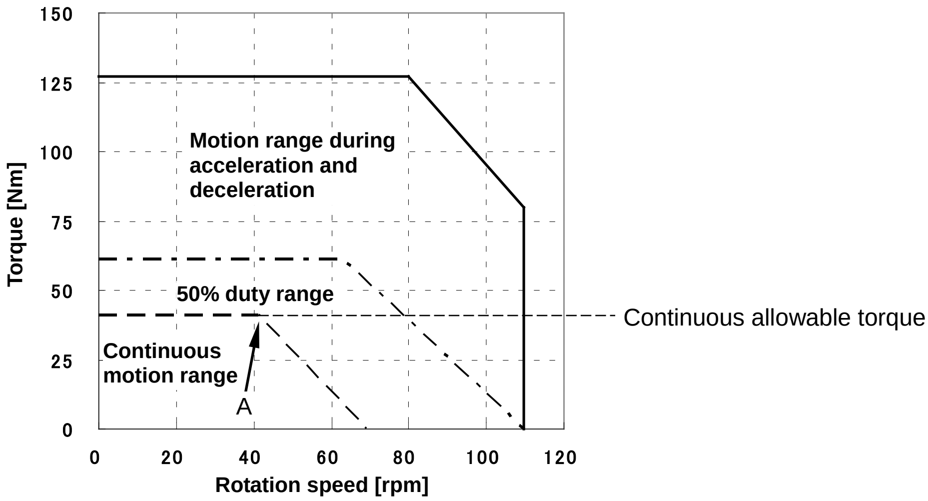
The following specifications of SHA series actuators are shown based on the UL1004-1, UL1004-6 (File No. E243316) standards.

Nameplate field	Explanation
(1)	Output [W] at point A on the graph below
(2)	Voltage [V] between motor wires at point A on the graph below
(3)	Allowable continuous current [A]
(4)	Rotation speed [rpm] at point A on the graph below
(5)	Current fundamental frequency [Hz] at point A on the graph below
(6)	Allowable range temperature [℃]
(7)	Number of phase



UL nameplate sticker

Radiation plate: 350*350*18 [mm]



The nameplate values of various models are shown below.

SG/HP

Item \ Model		SHA25M					
		11	51	81	101	121	161
(1) Output at point A	W	133	175	203	207	178	127
(2) Voltage at point A	V	101	115	122	125	125	120
(3) Allowable continuous current	A	3.0	3.0	3.0	2.9	2.6	2.1
(4) Speed at point A	rpm	141	41	29	24.5	21	15
(5) Frequency at point A	Hz	129	174	196	206	212	201
(6) Allowable range temperature	℃	40					
(7) Number of phase	—	3					

Item \ Model		SHA32M						SHA40M				
		11	51	81	101	121	161	51	81	101	121	161
(1) Output at point A	W	240	328	369	373	308	233	487	564	570	560	480
(2) Voltage at point A	V	97	110	114	118	116	115	109	115	115	116	122
(3) Allowable continuous current	A	6.0	6.0	6.0	5.7	5.0	4.1	9.0	9.0	9.0	8.8	7.2
(4) Speed at point A	rpm	115	34	23	20	16.5	12.5	29	20.5	16.5	14	12
(5) Frequency at point A	Hz	105	145	155	168	166	168	123	138	139	141	161
(6) Allowable range temperature	℃	40										
(7) Number of phase	—	3										

Item \ Model		SHA58M				SHA65M			
		81	101	121	161	81	101	121	161
(1) Output at point A	W	876	908	863	731	964	963	958	802
(2) Voltage at point A	V	100	101	101	107	92	92	96	100
(3) Allowable continuous current	A	17.0	17.0	16.4	13.4	22.0	21.9	20.1	16.3
(4) Speed at point A	rpm	12.3	10.2	8.5	7.2	10	8	7.4	6.2
(5) Frequency at point A	Hz	133	137	137	155	108	108	119	133
(6) Allowable range temperature	℃	40							
(7) Number of phase	—	3							

CG

Item \ Model		SHA25M				
		50	80	100	120	160
(1) Output at point A	W	177	201	204	174	127
(2) Voltage at point A	V	115	121	123	123	119
(3) Allowable continuous current	A	3.0	3.0	3.0	2.6	2.1
(4) Speed at point A	rpm	42	29	24	20.5	15
(5) Frequency at point A	Hz	175	193	200	205	200
(6) Allowable range temperature	℃	40				
(7) Number of phase	—	3				

Item \ Model		SHA32M					SHA40M				
		50	**80**	**100**	**120**	**160**	**50**	**80**	**100**	**120**	**160**
(1) Output at point A	W	321	372	373	308	233	493	558	568	568	488
(2) Voltage at point A	V	109	114	117	116	115	109	114	115	116	123
(3) Allowable continuous current	A	6.0	6.0	5.7	5.0	4.1	9.0	9.0	9.0	8.8	7.2
(4) Speed at point A	rpm	34	23.5	20	16.5	12.5	30	20.5	16.6	14.2	12.2
(5) Frequency at point A	Hz	142	157	167	165	167	125	137	138	142	163
(6) Allowable range temperature	℃	40									
(7) Number of phase	ー	3									

Chapter 1

Outlines

This chapter explains the features, functions and specifications of the actuator.

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1-1 Outlines

SHA-M series AC Servo Actuators provide high torque and highly accurate rotary operation that can be controlled with SSCNETIII/H by combining SHA series with the Mitsubishi Electric AC servo amplifier MELSERVO-J4 series. AC Servo Actuator sizes 25 through 65 comprise HarmonicDrive® speed reducer for precision control combined with a flat AC servo motor. AC Servo Actuator models 25 through 65 comprise a HarmonicDrive® speed reducer for precision control combined with a flat AC servo motor. There are 3 types of speed reducers: SG with SHG series incorporated, HP with HPF series incorporated, and CG with newly added CSG series incorporated. They are an advanced version of current FHA series AC Servo Actuators having a flat, hollow structure. They represent further evolution from the previous flat, hollow FHA series servo actuators.

One key feature of SHA series actuators is their compact size. The outer diameter has been reduced, while the maximum torque/volume ratio is approximately double that of any conventional actuator. The hollow structure maintains the same size as conventional actuators. A through-hole is provided at the center of the actuator, through which wirings, air pipes, and even laser beams can be passed to supply power and give/receive signals to moving parts of machines and devices.

SHA-M series actuators play an important role in driving various factory automation (FA) equipment, such as robot joints, alignment mechanisms for semi-conductor and LCD devices, ATC of metal-cutting machines, printing machine roller drive, etc.

◆ Doubled torque/volume ratio

The incorporation of a SHG series or CSG series HarmonicDrive® speed reducer has achieved approximately 20% smaller external diameter when compared with our conventional products. Accordingly, the maximum torque/volume ratio has increased to approximately double the ratio of any conventional actuator. Based on the maximum torque, you can select a model of one smaller size. Also, output torque at the same volume/weight is very high compared to when a direct drive motor is used. This is another reason why SHA-M series has a great advantage.

◆ More variety in large size

5 models are available for SG including those (#58, #65) accommodating high torque up to 3,400 Nm - the range not heretofore supported. The wide lineup also includes models supporting intermediate reduction ratios of 81:1, 121:1, and so on. CG has 3 models available with 5 reduction ratios of 50:1 to 160:1.

◆ Modular design

The components of SHA-M series, such as speed reducers, output shaft bearing, motor, brake and encoder, are arranged based on modular design. We can also custom-design a model meeting your specific requirements, so please contact your sales representative.

◆ 17-bit magnetic absolute encoder

The newly developed AC servo motors are equipped with HDS's original highly reliable 17-bit magnetic absolute encoder with safety function. The serial communication saves wiring and provides not only a multi revolution counting function which is a must-have feature of actuators with speed reducers, but it also has an internal backup battery to retain absolute positions even when the encoder cable is disconnected briefly.

The encoder also constantly compares two sets of detected angles. If any abnormality is found, the encoder's built-in failsafe function outputs a signal to the host system. This certainly helps you build a safe system.

◆ For high speeds

Also supports high speeds in combination with the HPF hollow shaft planetary gearhead.

◆ Connection with MELSERVO-J4 amplifiers

Combination with Mitsubishi Electric MELSERVO-J4 amplifiers is now available. It can be controlled using the SSCNETIII/H high-speed motion network.

◆ CG with an improved output shaft deflection accuracy is added to the product lineup

After reviewing the output rotary unit structure, the higher accuracy of the surface runout and shaft deflection has been achieved. Together with easy-to-index speed ratios that are divisible, such as 50:1 and 100:1, this is ideal for use with index tables.

1

Outlines

1-2 Combinations with servo amplifier and extension cables

The combinations of SHA-M actuators, MR-J4-_B servo amplifiers, and extension cables are as follows:

		SHA25M	SHA32M	SHA40M	SHA58M	SHA65M
SSCNETⅢ/H type		MR-J4-60B-S033	MR-J4-100B-S033	MR-J4-100B-S033 or MR-J4-200B-S033	MR-J4-350B-S033	MR-J4-500B-S033
Extension cables (option)	Motor wire	EWD-MB**-A06-TMC-M			EWD-MB**-D09-TMC-M1	EWD-MB**-D09-TMC-M2
	Encoder wire Note 1	MR-EKCBL☐M-H (Long flex life product) or MR-EKCBL☐M-L (Standard product)				

** an □ in the extension cable model indicates the cable length. See below for details.
Motor wire : 02 = 2 m, 05 = 5 m, 10 = 10 m
Encoder wire : 2 = 2 m, 5 = 5 m, 10 = 10 m

For details on encoder lines, contact Mitsubishi Electric customer support.

Note 1: When connecting the encoder lines MR-EKCBL□M* and SHA58M/65M, please use the encoder connector converter cable that comes with the actuator.

The MR-J4-_B servo amplifier parameters (PA17: Motor series, PA18: Motor type) are set for the above combination. For parameters not covered in this section, refer to the MR-J4-_B SERVO AMPLIFIER INSTRUCTION MANUAL (SH-030106).

<table>
<tr><th>No.</th><th>Abbreviation (*)</th><th>Name and function</th><th>Default value (units)</th><th>Setting range</th></tr>
<tr><td>PA17</td><td>**MSR</td><td>Servo motor series setting
When driving SHA-M actuator, select the motor type with [Pr.PA17] and [Pr.PA18].
Set at the same time as [Pr.PA18].
For the setting values, refer to the following table.

SG/HP type
<table>
<tr><td>Parameters</td><td>Motor series
SHA☐☐M</td></tr>
<tr><td>[Pr.PA17]
set value</td><td>00E0</td></tr>
</table>
CG type
<table>
<tr><td>Parameters</td><td>Motor series
SHA☐☐M</td></tr>
<tr><td>[Pr.PA17]
set value</td><td>00E2</td></tr>
</table>
</td><td>0000h</td><td>0000h
to
FFFFh</td></tr>
<tr><td>PA18</td><td>**MTY</td><td>Motor type setting
When driving SHA-M actuator, select the motor type with [Pr.PA17] and [Pr.PA18].
Set at the same time as [Pr.PA17].
For the setting values, refer to the following table.
SG/HP type
<table>
<tr><td colspan="8">Parameter [Pr.PA18] set value</td></tr>
<tr><td rowspan="2">Motor series</td><td rowspan="2">Combined servo amplifier</td><td colspan="6">Reduction ratio</td></tr>
<tr><td>11</td><td>51</td><td>81</td><td>101</td><td>121</td><td>161</td></tr>
<tr><td>SHA25M</td><td>MR-J4-60B</td><td>190B</td><td>1933</td><td>1951</td><td>1965</td><td>1979</td><td>19A1</td></tr>
<tr><td>SHA32M</td><td rowspan="2">MR-J4-100B</td><td>200B</td><td>2033</td><td>2051</td><td>2065</td><td>2079</td><td>20A1</td></tr>
<tr><td rowspan="2">SHA40M</td><td></td><td>2933</td><td>2951</td><td>2965</td><td>2979</td><td>29A1</td></tr>
<tr><td>MR-J4-200B</td><td></td><td>2A33</td><td>2A51</td><td>2A65</td><td>2A79</td><td>2AA1</td></tr>
<tr><td>SHA58M</td><td>MR-J4-350B</td><td></td><td></td><td>3A51</td><td>3A65</td><td>3A79</td><td>3AA1</td></tr>
<tr><td>SHA65M</td><td>MR-J4-500B</td><td></td><td></td><td>4151</td><td>4165</td><td>4179</td><td>41A1</td></tr>
</table>
CG type
<table>
<tr><td colspan="7">Parameter [Pr.PA18] set value</td></tr>
<tr><td rowspan="2">Motor series</td><td rowspan="2">Combined servo amplifier</td><td colspan="5">Reduction ratio</td></tr>
<tr><td>50</td><td>80</td><td>100</td><td>120</td><td>160</td></tr>
<tr><td>SHA25M</td><td>MR-J4-60B
-S033</td><td>1932</td><td>1950</td><td>1964</td><td>1978</td><td>19A0</td></tr>
<tr><td>SHA32M</td><td rowspan="2">MR-J4-100B
-S033</td><td>2032</td><td>2050</td><td>2064</td><td>2078</td><td>20A0</td></tr>
<tr><td rowspan="2">SHA40M</td><td>2932</td><td>2950</td><td>2964</td><td>2978</td><td>29A0</td></tr>
<tr><td>MR-J4-200B
-S033</td><td>2A32</td><td>2A50</td><td>2A64</td><td>2A78</td><td>2AA0</td></tr>
</table>
</td><td>0000h</td><td>0000h
to
FFFFh</td></tr>
</table>

Note: Parameters that have * before the parameter abbreviation are enabled under the following condition.
- *: After setting, either switch the servo amplifier power OFF then ON again or reset the controller.
- **: After setting, switch the servo amplifier power OFF then ON again.

1-3 Model Ordering Code

Model Ordering Code
Examples of standard models:

SHA	32	M	101	SG	–	B	12	A	200	–	16	S17b	A	–	C		–	SP
(1)	(2)	(3)	(4)	(5)	–	(6)	(7)	(8)	(9)	–	(10)	(11)	(12)	–	(13)	(14)	–	(15)

(1) Model: AC Servo Actuator SHA series
(2) Size : 25, 32, 40, 58, 65: SG type
25, 32: HP type
25, 32, 40: CG type
(3) Version symbol
(4) Reduction ratio (indicated by R in 1/R format)
Reduction ratio 11 is for the HPF hollow shaft planetary gearhead
Reduction ratios 50 and higher are for HarmonicDrive® speed reducers .

HPF		SHG		CSG	
11	1/11	51	1/51	50	1/50
		81	1/81	80	1/80
		101	1/101	100	1/100
		121	1/121	120	1/120
		161	1/161	160	1/160

(5) Speed reducer

HP	HPF hollow shaft planetary gearhead
SG	SHG series
CG	CSG series

(6) Motor version symbol

A	Size 58, 65
B	Size 25, 32, 40

(7) Motor size

09	Size 25
12	Size 32
15	Size 40
21	Size 58, 65

(8) Brake

A	Without brake
B	With brake

(9) Motor input voltage

100	100V
200	200V

(10) Encoder format

16	Conforming to Mitsubishi format, transmission rate: 2.5 Mbps, 1-on-1 connection

(11) Encoder type, resolution

S17b	17-bit absolute encoder, 131,072 pulses/revolution

(12) Encoder phase angle: Phase difference between induced voltage in motor phase U and absolute origin

A	0 degree

(13) Connector specification

C	With standard connector
N	Without connector

(14) Option symbol

L	With near origin and end limit sensors
V	With stand (CG type only)
Y	Side exit cable

(Please contact us for option-compatible combinations.)

(15) Special specification

No description	Standard product
SP	Special specification product

1-4 Specifications

The specifications of SHA-M series actuators are explained.

SG/HP type

Item		SHA25M 11	SHA25M 51	SHA25M 81	SHA25M 101	SHA25M 121	SHA25M 161
Combined servo amplifier		MR-J4-60B-S033					
Max. torque*1	Nm	26	127	178	204	217	229
	kgf·m	2.7	13	18.2	20.8	22.1	23.4
Allowable continuous torque*1*2	Nm	9.0	41	67	81	81	81
	kgf·m	0.92	4.2	6.8	8.2	8.2	8.2
Max. rotational speed*1	rpm	509.1	109.8	69.1	55.4	46.3	34.8
Torque constant*1	Nm/A	4.2	19	31	39	46	62
	kgf·m/A	0.43	2.0	3.2	4.0	4.7	6.3
Max. current*1	A	8.9	8.6	7.5	7.0	6.3	5.2
Allowable continuous current*1*2	A	3.0	3.0	3.0	2.9	2.6	2.1
MEF constant*3	V/(rpm)	0.47	2.2	3.5	4.3	5.2	6.9
Phase resistance（20℃）	Ω	1.2					
Phase inductance	mH	3					
Inertia moment (without brake) GD^2/4	kg·m^2	0.029	0.56	1.4	2.2	3.2	5.6
Inertia moment (without brake) J	kgf·cm·s^2	0.30	5.7	14	22	32	57
Inertia moment (with brake) GD^2/4	kg·m^2	0.034	0.66	1.7	2.6	3.7	6.6
Inertia moment (with brake) J	kgf·cm·s^2	0.35	6.7	17	26	38	67
Reduction ratio		1:11	1:51	1:81	1:101	1:121	1:161
Permissible moment load	Nm	410	258				
	kgf·m	41.8	26.3				
Moment stiffness	Nm/rad	37.9×10^4	39.2×10^4				
	kgf·m/arc min	11.3	11.6				
One-way positional accuracy	Sec.	120	50	40	40	40	40
Encoder type		Magnetic absolute encoder					
Single motor revolution Encoder resolution		2^{17}（131,072）					
Motor multi revolution counter		2^{16}（65,536）					
Resolution of output shaft	Pulse/rev	1,441,792	6,684,672	10,616,832	13,238,272	15,859,712	21,102,592
Mass (without brake)	kg	5.0	2.95				
Mass (with brake)	kg	5.1	3.1				
Environmental conditions		Operating temperature: 0 to 40℃/Storage temperature: -20 to 60℃ Operating humidity/storage humidity: 20 to 80%RH (no condensation) Resistance to vibration*4:25 m/s^2 (frequency:10 to 400Hz)/Shock resistance*5:300 m/s^2 No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist To be used indoors, no direct sunlight Altitude: less than 1,000 m above sea level					
Motor insulation		Insulation resistance: 100MΩ or more (by DC500V insulation tester) Dielectric strength: AC1,500V/1 min Insulation class: A					
Mounting direction		Can be installed in any direction.					
Protection structure		Totally enclosed self-cooled type (IP54)					

The table shows typical output values of actuators.

*1: This displays representative characteristics for when combined with a standard amplifier (driven using an ideal sine wave).

*2: Value after temperature rise and saturation when the 320 x 320 x 18 [mm] aluminum radiation plate is installed.

*3: Value of phase induced voltage constant multiplied by 3.

*4: Refer to the resistance to vibration (Page 1-38).

*5: Refer to the shock resistance (Page 1-37).

SG/HP type

Item	Unit	SHA32M 11	51	81	101	121	161
Combined servo amplifier		MR-J4-100B-S033					
Max. torque*1	Nm	58	281	395	433	459	484
	kgf·m	5.9	28.7	40.3	44.2	46.8	49.4
Allowable continuous torque*1*2	Nm	20	92	153	178	178	178
	kgf·m	2.1	9.4	15.6	18.2	18.2	18.2
Max. rotational speed*1	rpm	436.4	94.1	59.3	47.5	39.7	29.8
Torque constant*1	Nm/A	4.5	21	33	42	50	66
	kgf·m/A	0.46	2.1	3.4	4.2	5.1	6.8
Max. current*1	A	18	17.3	15.2	13.5	12.2	9.9
Allowable continuous	A	6.0	6.0	6.0	5.7	5.0	4.1
MEF constant*3	V/(rpm)	0.51	2.3	3.7	4.7	5.6	7.4
Phase resistance (20℃)	Ω	0.33					
Phase inductance	mH	1.4					
Inertia moment (without brake) GD^2/4	kg·m^2	0.091	2.0	5.1	8.0	11	20
Inertia moment (without brake) J	kgf·cm·s^2	0.93	21	52	81	117	207
Inertia moment (with brake) GD^2/4	kg·m^2	0.11	2.3	5.9	9.2	13	23
Inertia moment (with brake) J	kgf·cm·s^2	1.1	24	60	94	135	238
Reduction ratio		1:11	1:51	1:81	1:101	1:121	1:161
Permissible moment load	Nm	932	580				
	kgf·m	95	59.1				
Moment stiffness	Nm/rad	86.1×10^4	100×10^4				
	kgf·m/arc min	25.7	29.6				
One-way positional accuracy	Sec.	120	50	40	40	40	40
Encoder type		Magnetic absolute encoder					
Single motor revolution Encoder resolution		2^{17} (131,072)					
Motor multi revolution counter		2^{16} (65,536)					
Resolution of output shaft	Pulse/rev	1,441,792	6,684,672	10,616,832	13,238,272	15,859,712	21,102,592
Mass (without brake)	kg	9.4	5.9				
Mass (with brake)	kg	9.7	6.2				
Environmental conditions		Operating temperature: 0 to 40℃/Storage temperature: -20 to 60℃ Operating humidity/storage humidity: 20 to 80%RH (no condensation) Resistance to vibration*4: 25 m/s^2 (frequency: 10 to 400Hz)/Shock resistance*5: 300 m/s^2 No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist To be used indoors, no direct sunlight Altitude: less than 1,000 m above sea level					
Motor insulation		Insulation resistance: 100MΩ or more (by DC500V insulation tester) Dielectric strength: AC1,500V/1 min Insulation class: A					
Mounting direction		Can be installed in any direction.					
Protection structure		Totally enclosed self-cooled type (IP54)					

The table shows typical output values of actuators.

*1: This displays representative characteristics for when combined with a standard amplifier (driven using an ideal sine wave).

*2: Value after temperature rise and saturation when the 400 x 400 x 20 [mm] aluminum radiation plate is installed.

*3: Value of phase induced voltage constant multiplied by 3.

*4: Refer to the resistance to vibration (Page 1-38).

*5: Refer to the shock resistance (Page 1-37).

SG type

Item	Unit	SHA40M 51	81	101	121	161	51	81	101	121	161
Combined servo amplifier		MR-J4-100B-S033*1					MR-J4-200B-S033				
Max. torque*2	Nm	340	560	686	802	841	523	675	738	802	841
	kgf·m	34.7	57.1	70	81.8	85.8	53.4	68.9	75.3	81.8	85.8
Allowable continuous torque*2*3	Nm	94	158	198	237	317	160	263	330	382	382
	kgf·m	9.6	16.1	20.2	24.2	32.3	16.3	26.8	33.7	39	39
Max. rotational speed*2	rpm	78.4	49.4	39.6	33.1	24.8	78.4	49.4	39.6	33.1	24.8
Torque constant*2	Nm/A	25	41	51	61	81	25	41	51	61	81
	kgf·m/A	2.6	4.1	5.2	6.2	8.2	2.6	4.1	5.2	6.2	8.2
Max. current*2	A	18	18	18	17.9	14.6	26.7	21.8	19.4	17.9	14.6
Allowable continuous current*2*3	A	6.0	6.0	6.0	6.0	6.0	9.0	9.0	9.0	8.8	7.2
MEF constant*4	V/(rpm)	2.9	4.6	5.7	6.8	9.1	2.9	4.6	5.7	6.8	9.1
Phase resistance (20℃)	Ω	0.19									
Phase inductance	mH	1.2									
Inertia moment (without brake) $GD^2/4$	$kg·m^2$	5.0	13	20	28	50	5.0	13	20	28	50
Inertia moment (without brake) J	$kgf·cm·s^2$	51	130	202	290	513	51	130	202	290	513
Inertia moment (with brake) $GD^2/4$	$kg·m^2$	6.1	15	24	34	61	6.1	15	24	34	61
Inertia moment (with brake) J	$kgf·cm·s^2$	62	157	244	350	619	62	157	244	350	619
Reduction ratio		1:51	1:81	1:101	1:121	1:161	1:51	1:81	1:101	1:121	1:161
Permissible moment load	Nm	849									
	kgf·m	86.6									
Moment stiffness	Nm/rad	179×10^4									
	kgf·m/arc min	53.2									
One-way positional accuracy	Sec.	50	40	40	40	40	50	40	40	40	40
Encoder type		Magnetic absolute encoder									
Single motor revolution Encoder resolution		2^{17} (131,072)									
Motor multi revolution counter		2^{16} (65,536)									
Resolution of output shaft	Pulse/rev	6,684,672	10,616,832	13,238,272	15,859,712	21,102,592	6,684,672	10,616,832	13,238,272	15,859,712	21,102,592
Mass (without brake)	kg	9.9									
Mass (with brake)	kg	10.7									
Environmental conditions		Operating temperature: 0 to 40℃/Storage temperature: -20 to 60℃ Operating humidity/storage humidity: 20 to 80%RH (no condensation) Resistance to vibration*5: 25 m/s^2 (frequency: 10 to 400Hz)/Shock resistance*6: 300 m/s^2 No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist To be used indoors, no direct sunlight Altitude: less than 1,000 m above sea level									
Motor insulation		Insulation resistance: 100MΩ or more (by DC500V insulation tester) Dielectric strength: AC1,500V/1 min Insulation class: A									
Mounting direction		Can be installed in any direction.									
Protection structure		Totally enclosed self-cooled type (IP54)									

The table shows typical output values of actuators.

*1: If a MR-J4-100B driver is combined with a SHA40M actuator, the maximum torque and allowable continuous torque are limited.

*2: This displays representative characteristics for when combined with a standard amplifier (driven using an ideal sine wave).

*3: Value after temperature rise and saturation when the 500 x 500 x 25 [mm] aluminum radiation plate is installed.

*4: Value of phase induced voltage constant multiplied by 3.

*5: Refer to the resistance to vibration (Page 1-38).

*6: Refer to the shock resistance (Page 1-37).

SG type

Item	Model	SHA58M				SHA65M			
		81	101	121	161	81	101	121	161
Combined servo amplifier		MR-J4-350B-S033				MR-J4-500B-S033			
Max. torque*1	Nm	1924	2067	2236	2392	2743	2990	3263	3419
	kgf･m	196	211	228	244	279	305	333	349
Allowable continuous torque*1*2	Nm	680	850	969	969	921	1149	1236	1236
	kgf･m	69	86	99	99	94	117	126	126
Max. rotational speed*1	rpm	37.0	29.7	24.8	18.6	34.6	27.7	23.1	17.4
Torque constant*1	Nm/A	54	68	81	108	54	68	81	108
	kgf･m/A	5.5	6.9	8.3	11.0	5.5	6.9	8.3	11.0
Max. current*1	A	45	39	36	30	62	55	51	41
Allowable continuous current*1*2	A	17.0	17.0	16.4	13.4	22.0	21.9	20.1	16.3
MEF constant*3	V/(rpm)	6.1	7.6	9.1	12.1	6.1	7.6	9.1	12.1
Phase resistance (20℃)	Ω	0.028				0.028			
Phase inductance	mH	0.29				0.29			
Inertia moment (without brake) $GD^2/4$	$kg·m^2$	96	149	214	379	110	171	245	433
Inertia moment (without brake) J	$kgf·cm·s^2$	980	1520	2180	3870	1120	1740	2500	4420
Inertia moment (with brake) $GD^2/4$	$kg·m^2$	106	165	237	420	120	187	268	475
Inertia moment (with brake) J	$kgf·cm·s^2$	1090	1690	2420	4290	1230	1910	2740	4850
Reduction ratio		1:81	1:101	1:121	1:161	1:81	1:101	1:121	1:161
Permissible moment load	Nm	2180				2740			
	kgf･m	222				280			
Moment stiffness	Nm/rad	531×10^4				741×10^4			
	kgf･m/arc min	158				220			
One-way positional accuracy	Sec.	40	40	40	40	40	40	40	40
Encoder type		Magnetic absolute encoder							
Single motor revolution Encoder resolution		2^{17} (131,072)							
Motor multi revolution counter		2^{16} (65,536)							
Resolution of output shaft	Pulse/rev	10,616,832	13,238,272	15,859,712	21,102,592	10,616,832	13,238,272	15,859,712	21,102,592
Mass (without brake)	kg	29.5				37.5			
Mass (with brake)	kg	32				40			
Environmental conditions		Operating temperature: 0 to 40℃/Storage temperature: -20 to 60℃ Operating humidity/storage humidity: 20 to 80%RH (no condensation) Resistance to vibration*4: 25 m/s^2 (frequency: 10 to 400Hz)/Shock resistance*5: 300 m/s^2 No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist To be used indoors, no direct sunlight Altitude: less than 1,000 m above sea level							
Motor insulation		Insulation resistance: 100MΩ or more (by DC500V insulation tester) Dielectric strength: AC1,500V/1 min Insulation class: A							
Mounting direction		Can be installed in any direction.							
Protection structure		Totally enclosed self-cooled type (IP54)							

The table shows typical output values of actuators.
*1: This displays representative characteristics for when combined with a standard amplifier (driven using an ideal sine wave).
*2: Value after temperature rise and saturation when the 650 x 650 x 30 [mm] aluminum radiation plate is installed.
*3: Value of phase induced voltage constant multiplied by 3.
*4: Refer to the resistance to vibration (Page 1-38).
*5: Refer to the shock resistance (Page 1-37).

CG type

Item		Model	SHA25M 50	80	100	120	160
Combined servo amplifier			MR-J4-60B-S033				
Max. torque *1		Nm	127	178	204	217	229
		kgf･m	13.0	18.2	20.8	22.1	23.4
Allowable continuous torque *1*2		Nm	40	66	81	81	81
		kgf･m	4.1	6.8	8.2	8.2	8.2
Max. rotational speed*1		rpm	112	70	56	46.7	35
Torque constant*1		Nm/A	19	31	38	46	61
		kgf･m/A	1.9	3.1	3.9	4.7	6.3
Max. current*1		A	8.7	7.6	7.0	6.3	5.2
Allowable continuous current*1*2		A	3.0	3.0	3.0	2.6	2.1
MEF constant*3		V/(rpm)	2.1	3.4	4.3	5.2	6.9
Phase resistance (20℃)		Ω	1.2				
Phase inductance		mH	3.0				
Inertia moment (without brake)	$GD^2/4$	$kg\cdot m^2$	0.50	1.3	2.0	2.9	5.1
	J	$kgf\cdot cm\cdot s^2$	5.1	13	20	29	52
Inertia moment (with brake)	$GD^2/4$	$kg\cdot m^2$	0.60	1.5	2.4	3.4	6.1
	J	$kgf\cdot cm\cdot s^2$	6.1	16	24	35	62
Reduction ratio			1:50	1:80	1:100	1:120	1:160
Permissible moment load		Nm	258				
		kgf･m	26.3				
Moment stiffness		Nm/rad	39.2×10^4				
		kgf･m/arc min	11.6				
One-way positional accuracy		Sec.	50	40	40	40	40
Repeatability		Sec.	±5				
Reverse positional accuracy		Sec.	60	25	25	25	25
Encoder type			Magnetic absolute encoder				
Single motor revolution Encoder resolution			2^{17}（131,072）				
Motor multi revolution counter			2^{16}（65,536）				
Resolution of output shaft		Pulse/rev	6,553,600	10,485,760	13,107,200	15,728,640	20,971,520
Mass (without brake)		kg	3.95				
Mass (with brake)		kg	4.1				
Environmental conditions			Operating temperature: 0 to 40℃/Storage temperature: -20 to 60℃ Operating humidity/storage humidity: 20 to 80%RH (no condensation) Resistance to vibration*4: 25 m/s^2 (frequency: 10 to 400Hz)/Shock resistance*5: 300 m/s^2 No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist To be used indoors, no direct sunlight Altitude: less than 1,000 m above sea level				
Motor insulation			Insulation resistance: 100MΩ or more (by DC500V insulation tester) Dielectric strength: AC1,500V/1 min Insulation class: A				
Mounting direction			Can be installed in any direction.				
Protection structure			Totally enclosed self-cooled type (IP54)				

The table shows typical output values of actuators.
*1: This displays representative characteristics for when combined with a standard amplifier (driven using an ideal sine wave).
*2: Value after temperature rise and saturation when the 650 x 650 x 30 [mm] aluminum radiation plate is installed.
*3: Value of phase induced voltage constant multiplied by 3.
*4: Refer to the resistance to vibration (Page 1-38).
*5: Refer to the shock resistance (Page 1-37).

CG type

Item		Model	SHA32M 50	SHA32M 80	SHA32M 100	SHA32M 120	SHA32M 160
Combined servo amplifier			MR-J4-100B-S033				
Max. torque *1		Nm	281	395	433	459	484
		kgf･m	28.7	40.3	44.2	46.8	49.4
Allowable continuous torque *1*2		Nm	90	151	178	178	178
		kgf･m	9.2	15.4	18.2	18.2	18.2
Max. rotational speed*1		rpm	96	60	48	40	30
Torque constant*1		Nm/A	20	33	41	49	66
		kgf･m/A	2.1	3.4	4.2	5.0	6.7
Max. current*1		A	17.7	15.4	13.7	12.2	10.0
Allowable continuous current*1*2		A	6.0	6.0	5.7	5.0	4.1
MEF constant*3		V/(rpm)	2.3	3.7	4.6	5.5	7.4
Phase resistance (20℃)		Ω	0.33				
Phase inductance		mH	1.4				
Inertia moment (without brake)	$GD^2/4$	$kg･m^2$	1.7	4.3	6.7	9.7	17
	J	$kgf･cm･s^2$	17	44	68	99	175
Inertia moment (with brake)	$GD^2/4$	$kg･m^2$	2.0	5.1	7.9	11	20
	J	$kgf･cm･s^2$	20	52	81	116	207
Reduction ratio			1:50	1:80	1:100	1:120	1:160
Permissible moment load		Nm	580				
		kgf･m	59.2				
Moment stiffness		Nm/rad	100×10^4				
		kgf･m/arc min	29.6				
One-way positional accuracy		Sec.	40	30	30	30	30
Repeatability		Sec.	±4				
Reverse positional accuracy		Sec.	60	25	25	25	25
Encoder type			Magnetic absolute encoder				
Single motor revolution Encoder resolution			2^{17}（131,072）				
Motor multi revolution counter			2^{16}（65,536）				
Resolution of output shaft		Pulse/rev	6,553,600	10,485,760	13,107,200	15,728,640	20,971,520
Mass (without brake)		kg	7.7				
Mass (with brake)		kg	8.0				
Environmental conditions			Operating temperature: 0 to 40℃/Storage temperature: -20 to 60℃ Operating humidity/storage humidity: 20 to 80%RH (no condensation) Resistance to vibration*4: 25 m/s^2 (frequency: 10 to 400Hz)/Shock resistance*5: 300 m/s^2 No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist To be used indoors, no direct sunlight Altitude: less than 1,000 m above sea level				
Motor insulation			Insulation resistance: 100MΩ or more (by DC500V insulation tester) Dielectric strength: AC1,500V/1 min Insulation class: A				
Mounting direction			Can be installed in any direction.				
Protection structure			Totally enclosed self-cooled type (IP54)				

The table shows typical output values of actuators.

*1: This displays representative characteristics for when combined with a standard amplifier (driven using an ideal sine wave).
*2: Value after temperature rise and saturation when the 650 x 650 x 30 [mm] aluminum radiation plate is installed.
*3: Value of phase induced voltage constant multiplied by 3.
*4: Refer to the resistance to vibration (Page 1-38).
*5: Refer to the shock resistance (Page 1-37).

CG type

Item \ Model		SHA40M									
		50	80	100	120	160	50	80	100	120	160
Combined servo amplifier		MR-J4-100B*1					MR-J4-200B				
Max. torque *2	Nm	333	548	686	802	841	523	675	738	802	841
	kgf･m	34.0	55.9	70.0	81.8	85.8	53.4	68.9	75.3	81.8	85.8
Allowable continuous torque *2*3	Nm	92	156	196	235	315	157	260	327	382	382
	kgf･m	9.4	15.9	20.0	24.0	32.1	16.0	26.5	33.3	39.0	39.0
Max. rotational speed*2	rpm	80	50	40	33.3	25	80	50	40	33.3	25
Torque constant*2	Nm/A	25	40	50	60	80	25	40	50	60	80
	kgf･m/A	2.5	4.1	5.1	6.1	8.2	2.5	4.1	5.1	6.1	8.2
Max. current*2	A	18.0	18.0	18.0	17.6	14.3	27.2	22.0	19.6	18.0	14.7
Allowable continuous current*2*3	A	6.0	6.0	6.0	6.0	6.0	9.0	9.0	9.0	8.8	7.2
MEF constant*4	V/(rpm)	2.8	4.5	5.6	6.7	9.0	2.8	4.5	5.6	6.7	9.0
Phase resistance (20℃)	Ω	0.19									
Phase inductance	mH	1.2									
Inertia moment (without brake) GD²/4	kg･m²	4.8	12	19	27	49	4.8	12	19	27	49
Inertia moment (without brake) J	kgf･cm･s²	49	124	194	280	497	49	124	194	280	497
Inertia moment (with brake) GD²/4	kg･m²	5.8	15	23	33	59	5.8	15	23	33	59
Inertia moment (with brake) J	kgf･cm･s²	59	150	235	338	601	59	150	235	338	601
Reduction ratio		1:50	1:80	1:100	1:120	1:160	1:50	1:80	1:100	1:120	1:160
Permissible moment load	**Nm**	849									
	kgf･m	86.6									
Moment stiffness	**Nm/rad**	179×10⁴									
	kgf･m/arc min	53.2									
One-way positional accuracy	**Sec.**	40	30	30	30	30	40	30	30	30	30
Repeatability	**Sec.**	±4									
Reverse positional accuracy	**Sec.**	50	20	20	20	20	50	20	20	20	20
Encoder type		Magnetic absolute encoder									
Single motor revolution Encoder resolution		2¹⁷ (131,072)									
Motor multi revolution counter		2¹⁶ (65,536)									
Resolution of output shaft	**Pulse/rev**	6,553,600	10,485,760	13,107,200	15,728,640	20,971,520	6,553,600	10,485,760	13,107,200	15,728,640	20,971,520
Mass (without brake)	**kg**	13.0									
Mass (with brake)	**kg**	13.8									
Environmental conditions		Operating temperature: 0 to 40℃/Storage temperature: -20 to 60℃ Operating humidity/storage humidity: 20 to 80%RH (no condensation) Resistance to vibration*5: 25 m/s² (frequency: 10 to 400Hz)/Shock resistance*6: 300 m/s² No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist To be used indoors, no direct sunlight Altitude: less than 1,000 m above sea level									
Motor insulation		Insulation resistance: 100MΩ or more (by DC500V insulation tester) Dielectric strength: AC1,500V/1 min Insulation class: A									
Mounting direction		Can be installed in any direction.									
Protection structure		Totally enclosed self-cooled type (IP54)									

The table shows typical output values of actuators.

*1:If a MR-J4-100B-S033 driver is combined with a SHA40M actuator, the maximum torque and allowable continuous torque are limited.

*2: This displays representative characteristics when combined with a standard amplifier (driven using an ideal sine wave).

*3 :Value after temperature rise and saturation when the 500 x 500 x 25 [mm] aluminum radiation plate is installed.

*4: Value of phase induced voltage constant multiplied by 3.

*5: Refer to the resistance to vibration (Page 1-38).

*6: Refer to the shock resistance (Page 1-37).

1 Outlines

1-5 Motor shaft holding brake

The brakes equipped on SHA-M series actuators are used to hold the motor shaft in place when the power is cut off. With small models (SHA25M, 32M), the actuator's built-in circuit controls the voltage supplied to the brake in order to reduce the power consumption while the brake is actuated.
Be sure to use a DC power supply having proper brake excitation voltage and capable of outputting enough current consumption during suction.

Specifications

SG/HP type

Item	Model	SHA25M						SHA32M					
		11	51	81	101	121	161	11	51	81	101	121	161
Type		Dry non-excitation actuation type (with power-saving control)											
Brake excitation voltage	V	DC24V ± 10% (no polarity)*1											
Current consumption during suction (at 20℃)	A	0.8*2						0.8*2					
Current consumption during holding (at 20℃)	A	0.3						0.3					
Holding torque*3	Nm	11	51	81	101	121	161	22	102	162	202	242	322
	kgf·m	1.1	5.2	8.3	10	12	16	2.2	10	17	21	25	33
Inertia moment*3 (Actuator total) (with brake)	(GD²/4) kg·m²	0.034	0.66	1.7	2.6	3.7	6.6	1.7	2.3	5.9	9.2	13	23
	(J) kgf·cm·s²	0.35	6.7	17	26	38	67	17	24	60	94	135	238
Mass (with brake)*4	kg	5.1	3.1					9.7	6.2				
Allowable number of normal brakings*5		100,000 times											
Allowable number of emergency stops*6		200 times											

Item	Model	SHA40M					SHA58M			
		51	81	101	121	161	81	101	121	161
Type		Dry non-excitation actuation type (without power-saving control)								
Brake excitation voltage	V	DC24V ± 10% (no polarity)*1								
Current consumption during suction (at 20℃)	A	0.7					0.9			
Current consumption during holding (at 20℃)	A	Same as current consumption during suction								
Holding torque*3	Nm	204	324	404	484	644	1220	1520	1820	2420
	kgf·m	21	33	41	49	66	124	155	185	246
Inertia moment*3 (Actuator total) (With brake)	(GD²/4) kg·m²	6.1	15	24	34	61	106	165	237	420
	(J) kgf·cm·s²	62	157	244	350	619	1090	1690	2420	4290
Mass (with brake)*4	kg	10.7					32			
Allowable number of normal brakings*5		100,000 times								
Allowable number of emergency stops*6		200 times								

Item		Model SHA65M 81	101	121	161
Type		Dry non-excitation actuation type (without power-saving control)			
Brake excitation voltage	**V**	DC24V ± 10% (no polarity)*1			
Current consumption during suction (at 20℃)	**A**	0.9			
Current consumption during holding (at 20℃)	**A**	Same as current consumption during suction			
Holding torque[*3]	**Nm**	1220	1520	1820	2420
	kgf·m	124	155	185	246
Inertia moment[*3] **(Actuator total) (With brake)**	**(GD²/4) kg·m²**	120	187	268	475
	(J) kgf·cm·s²	1230	1910	2740	4850
Mass (with brake)[*4]	**kg**	40			
Allowable number of normal brakings[*5]		100,000 times			
Allowable number of emergency stops[*6]		200 times			

CG type

Item	Model	SHA25M 50	80	100	120	160	SHA32M 50	80	100	120	160
Type		Dry non-excitation actuation type (with power-saving control)									
Brake excitation voltage	**V**	DC24V ± 10% (no polarity)[*1]									
Current consumption during suction (at 20℃)	**A**	0.8 [*2]					0.8 [*2]				
Current consumption during holding (at 20℃)	**A**	0.3					0.3				
Holding torque[*3]	**Nm**	50	80	100	120	160	100	160	200	240	320
	kgf·m	5.1	8.2	10	12	16	10	16	20	24	33
Inertia moment[*3] **(Actuator total)** (with brake)	**(GD²/4) kg·m²**	0.60	1.5	2.4	3.4	6.1	2.0	5.1	7.9	11	20
	(J) kgf·cm·s²	6.1	16	24	35	62	20	52	81	116	207
Mass (with brake)[*4]	**kg**	4.1					8.0				
Allowable number of normal brakings[*5]		100,000 times									
Allowable number of emergency stops[*6]		200 times									

Item	Model	SHA40M 50	80	100	120	160
Type		Dry non-excitation actuation type (without power-				
Brake excitation voltage	**V**	DC24V ± 10% (no polarity)*1				
Current consumption during suction (at 20℃)	**A**	0.7				
Current consumption during holding (at 20℃)	**A**	Same as current consumption during suction				
Holding torque[*3]	**Nm**	200	320	400	480	640
	kgf·m	20	33	41	49	65
Inertia moment[*3] **(Actuator total)** (With brake)	**(GD²/4) kg·m²**	5.8	15	23	33	59
	(J) kgf·cm·s²	59	150	235	338	601
Mass (with brake)[*4]	**kg**	13.8				
Allowable number of normal brakings[*5]		100,000 times				
Allowable number of emergency stops[*6]		200 times				

*1: Power supply is user’s responsibility. Use a power supply capable of outputting enough current consumption during suction for the brake.
*2: The duration for current consumption during suction is 0.5 second or less for the power supply of DC24V ± 10%.
*3: The values are converted for the output shaft of the actuator.
*4: The values present total mass of the actuator.
*5: The service time for normal holding is assured when the brake activates at motor shaft rotation speed of 150 rpm or less.
*6: The service time for emergency stop is assured when the brake activates at motor speed of 3,000 rpm or less provided the load inertia moment is 3 times of less than that of the actuator.

WARNING

The motor shaft holding brake cannot be used for deceleration.
Do not use the holding brake more than the allowable number of normal brakings (100,000 times at the motor shaft rotation speed of 150 rpm or less) or allowable number of emergency stops (200 times at the motor shaft rotation speed of 3,000 rpm, provided the load inertia moment is 3 times or less than that of the actuator).

Exceeding the allowable number of normal brakings and allowable number of emergency stops may deteriorate holding torque, and may consequently become out of use as a brake.

1-6 External dimensions

The external dimensions of SHA-M series actuators are shown below.

- **SHA25M-HP (Speed reducer: HPF hollow shaft planetary)**

Unit: mm (third angle projection)

Encoder cable
AWG24 x 3 sets + shield
(Cable outer diameter: φ7.7)

Motor brake connector
Housing :350715-1[AMP]
Pin contact (motor U・V・W) :350690-1[AMP]
Pin contact (brake) :350690-1[AMP]
Pin contact (motor PE) :350669-1[AMP]

Encoder connector
Housing :1-172169-9[AMP]
Tab contact :170361-1[AMP]
Clamp :316454-1[AMP]

Motor brake cables
AWG20 x 4-core + AWG24 x 2-core
(Cable outer diameter: φ5.6)

15 or less

Allowable range)

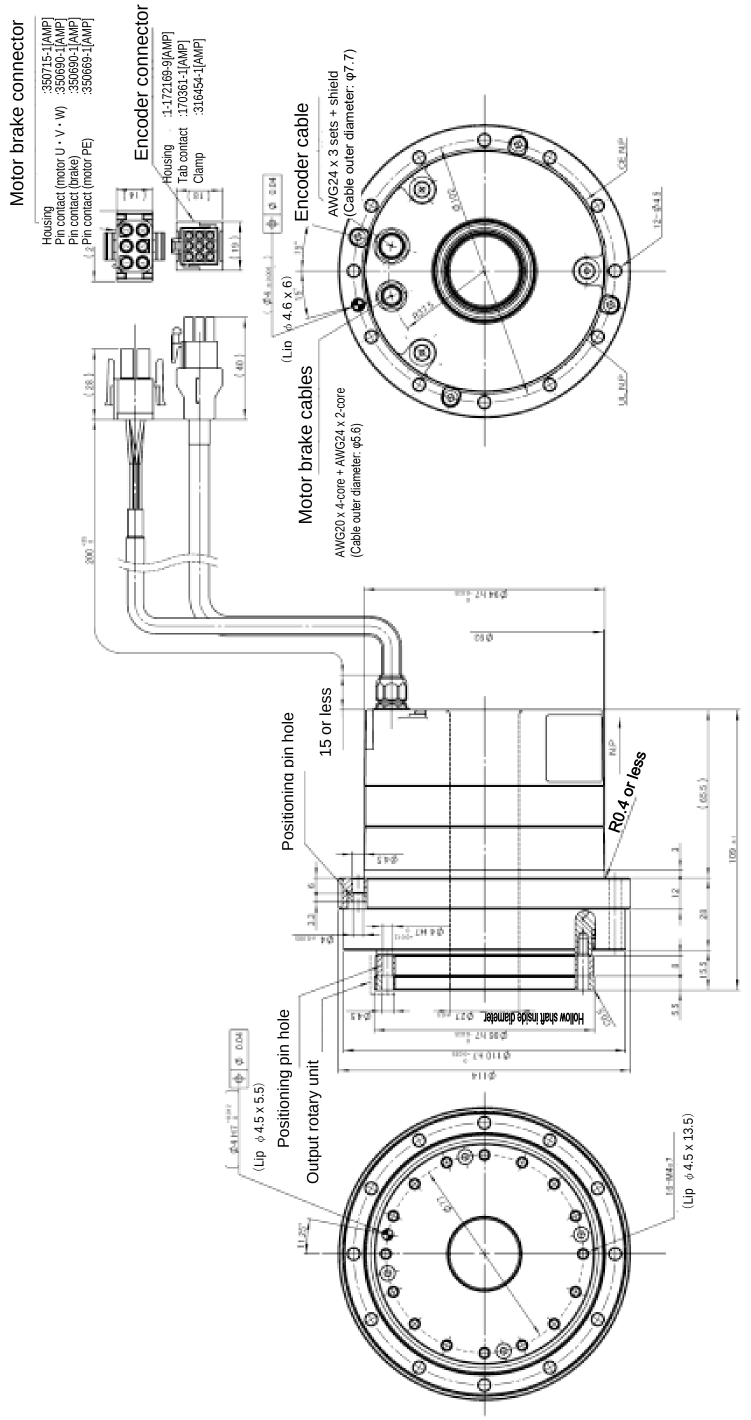
Hollow shaft inside diameter

Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

1 Outlines

- **SHA25M-SG (Speed reducer: SHG series)**

Unit: mm (third angle projection)



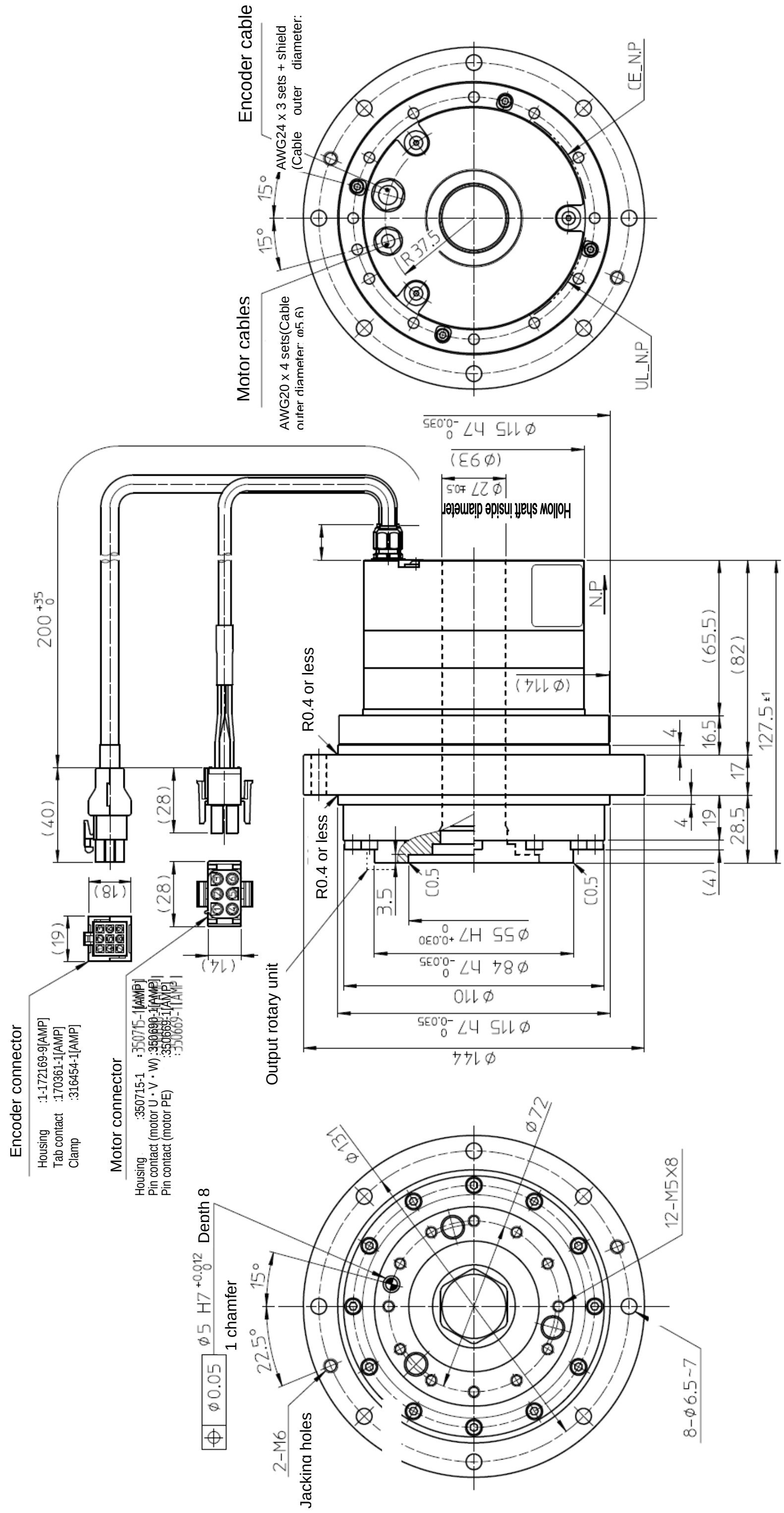
Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

1

Outlines

- **SHA25M-CG (Speed reducer: CSG series)**

Unit: mm (third angle projection)



Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

● SHA32M-HP (Speed reducer: HPF hollow shaft planetary)

Unit: mm (third angle projection)

Encoder cable
AWG24 x 3 sets + shield
(Cable outer diameter: φ7.7)

Motor brake connector
Housing :350715-1[AMP]
Pin contact (motor U・V・W) :350690-1[AMP]
Pin contact (brake) :350690-1[AMP]
Pin contact (motor PE) :350669-1[AMP]

Encoder connector
Housing :1-172169-9[AMP]
Tab contact :170361-1[AMP]
Clamp :316454-1[AMP]

Motor brake cables
AWG18 x 4-core + AWG24 x 2-core
(Cable outer diameter: φ7.7)

15 or less

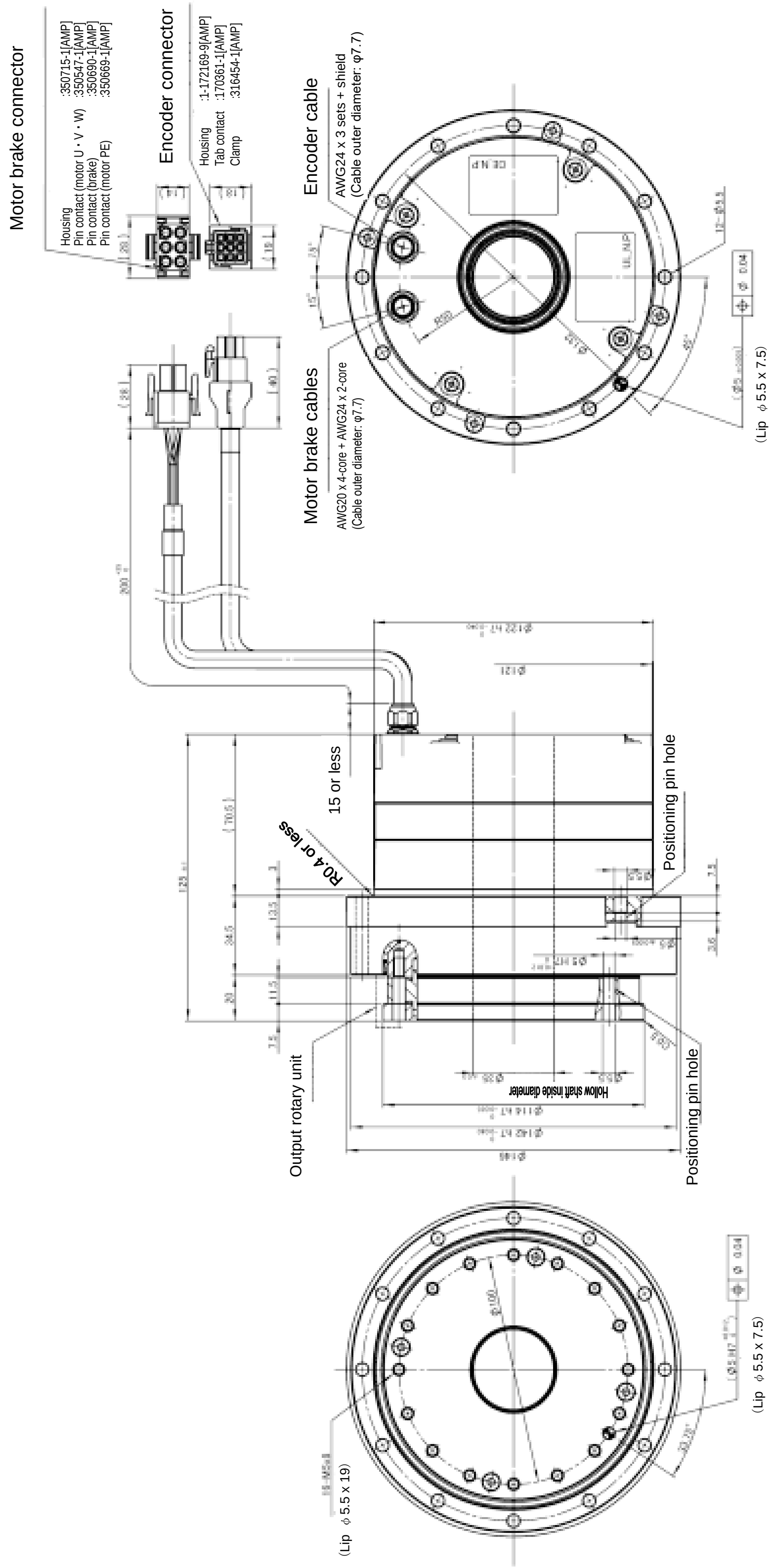
Allowable range)

Hollow shaft inside diameter

Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

- **SHA32M-SG (Speed reducer: SHG series)**

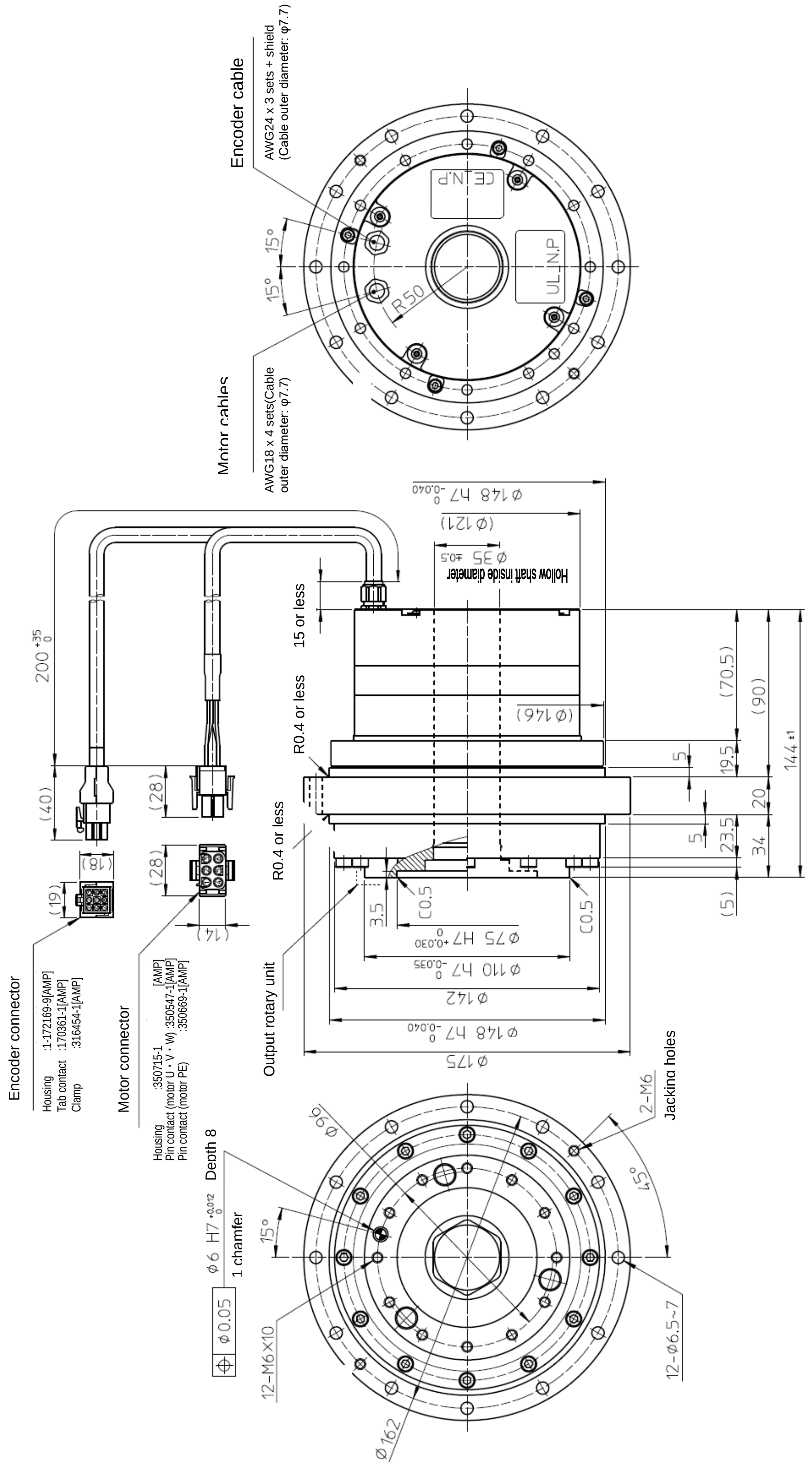
Unit: mm (third angle projection)



Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

● SHA32M-CG (Speed reducer: CSG series)

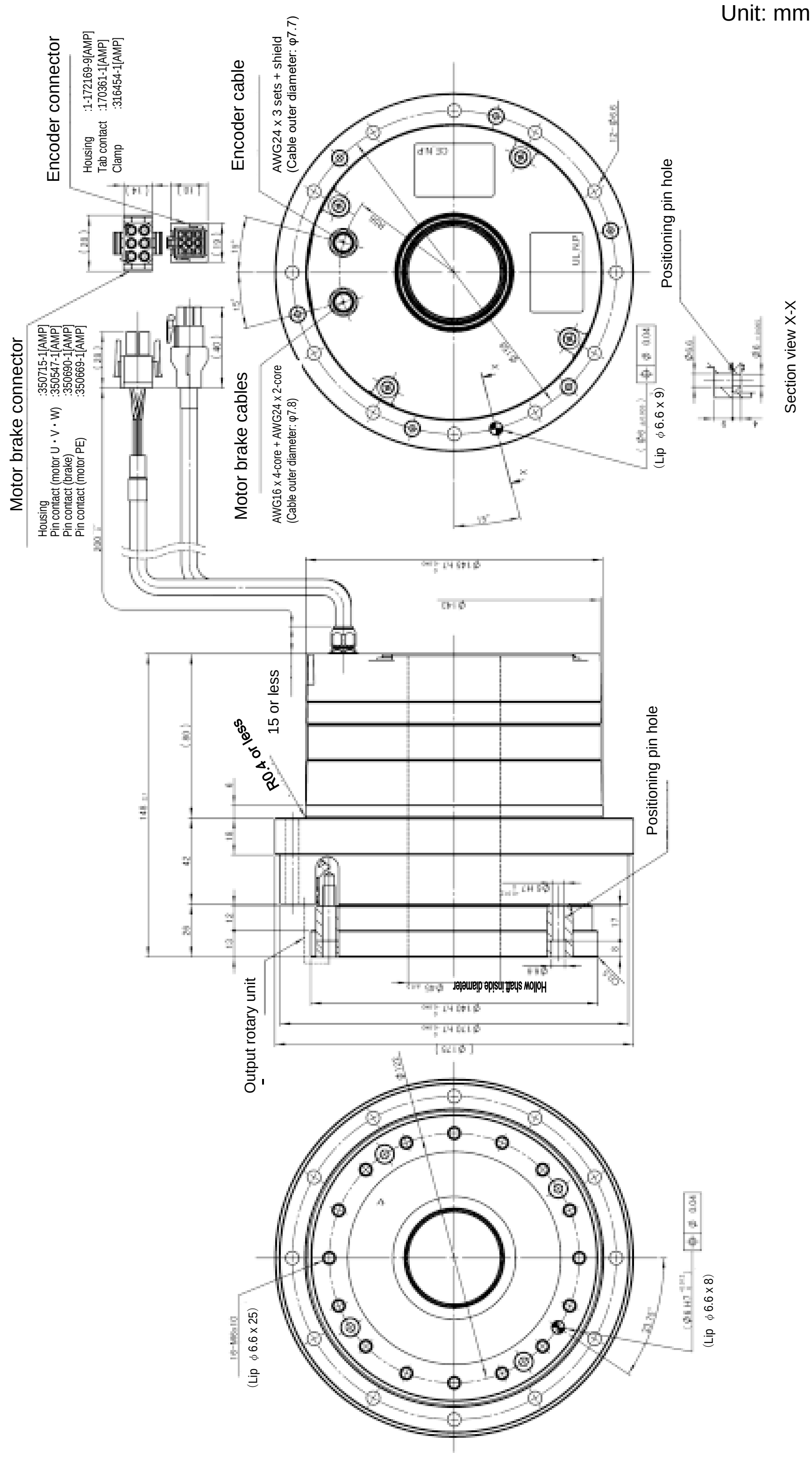
Unit: mm (third angle projection)



Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

- **SHA40M-SG (Speed reducer: SHG series)**

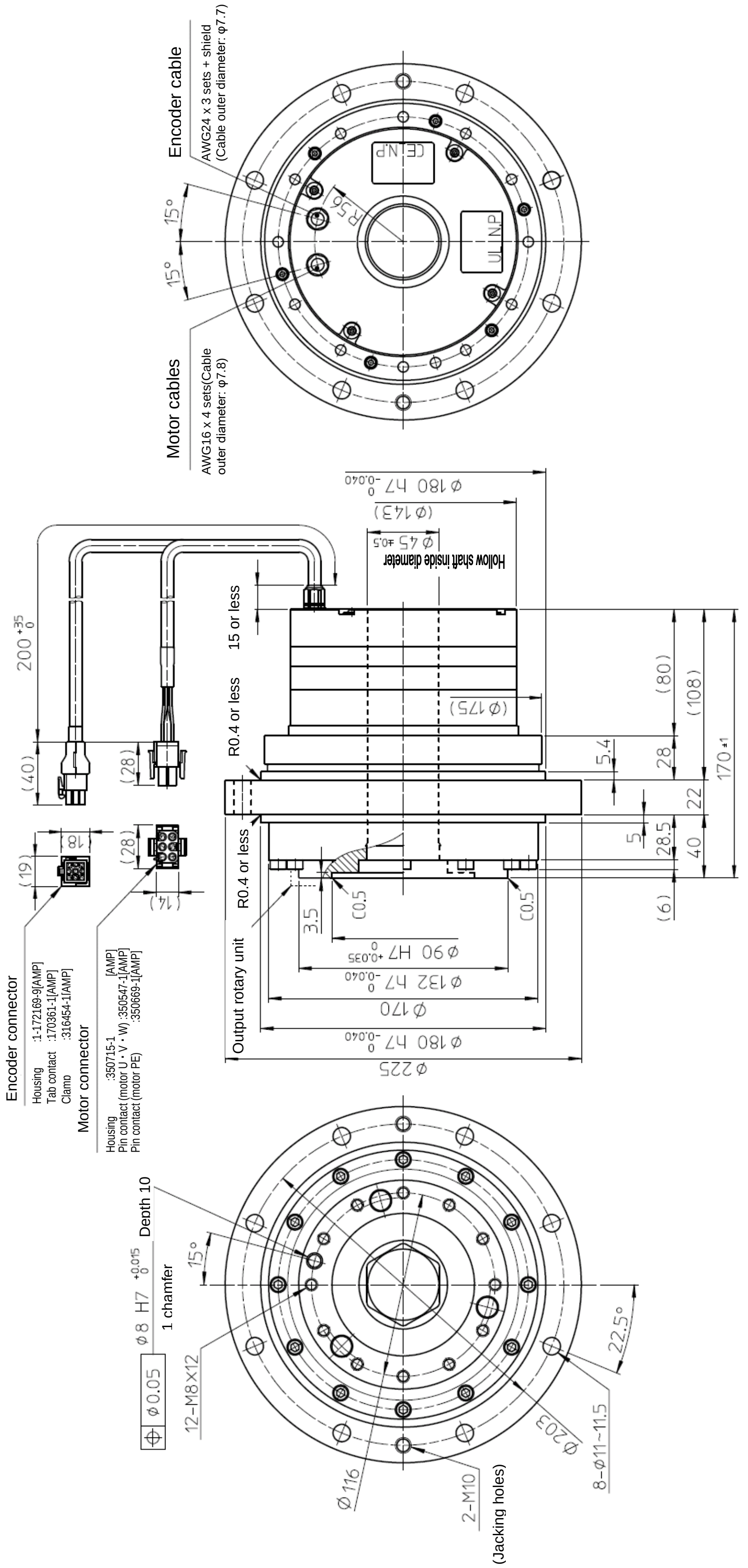
Unit: mm (third angle projection)



Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

● SHA40M-CG (Speed reducer: CSG series)

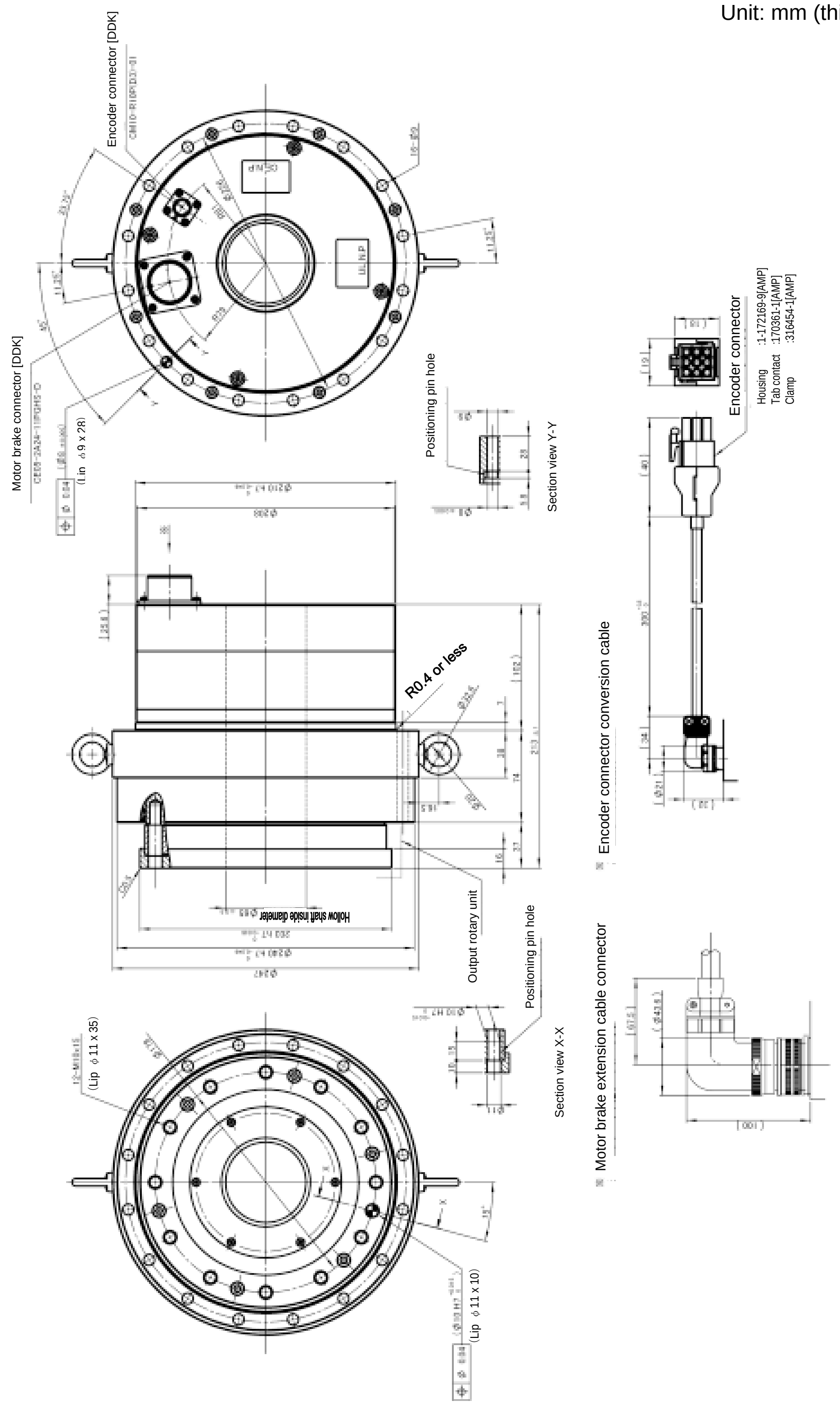
Unit: mm (third angle projection)



Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

- **SHA58M-SG (Speed reducer: SHG series)**

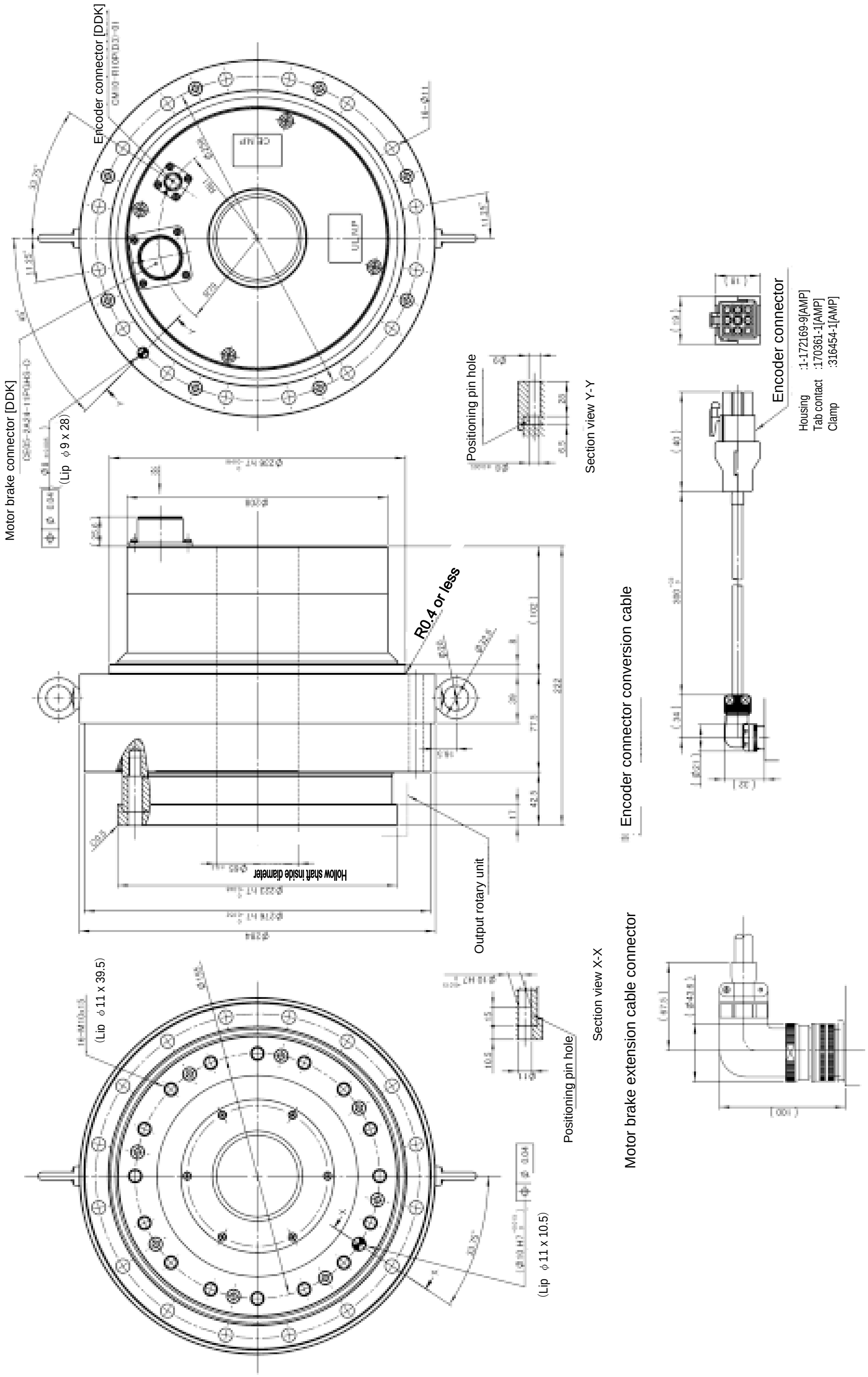
Unit: mm (third angle projection)



Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

- **SHA65M-SG (Speed reducer: SHG series)**

Unit: mm (third angle projection)



Note: For details on external dimensions, check our illustrated specifications.
Tolerances may vary due to product manufacturing method (foundry piece, machine-finished good).
Please contact us for the tolerance when it is not indicated in the dimensions.

1-7 Mechanical accuracy

The mechanical accuracies of the output shaft and mounting flange are shown below for SHA-M series actuators:

SG/HP unit: mm

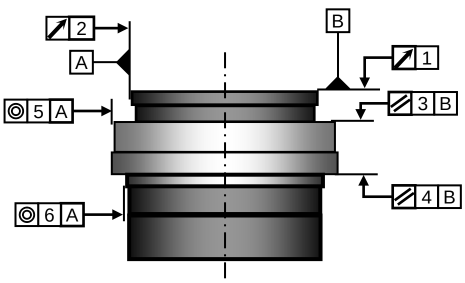
Accuracy items	SHA25M	SHA32M	SHA40M	SHA58M	SHA65M
1. Output shaft surface runout	0.035 (0.020)	0.040 (0.020)	0.045	0.050	0.050
2. Deflection of output shaft	0.035	0.040	0.045	0.050	0.050
3. Parallelism between the output shaft end mounted surface	0.035	0.040	0.045	0.050	0.050
4. Parallelism between the output shaft end mounted surface	0.050	0.055	0.060	0.070	0.070
5. Concentricity between the output shaft and fitting part	0.035	0.040	0.045	0.050	0.050
6. Concentricity between the output shaft and fitting part	0.060	0.065	0.070	0.080	0.080

Note: All values are T.I.R. (Total Indicator Reading).
The values in parenthesis are those combined with the hollow planetary speed reducer HPF series for precision control.

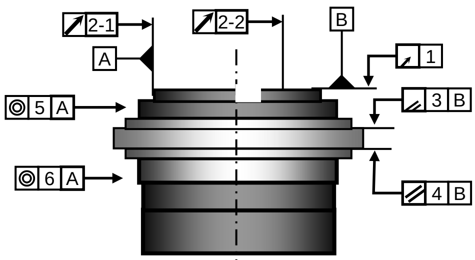
CG unit: mm

Accuracy items	SHA25M	SHA32M	SHA40M
1.Output shaft surface runout	0.010	0.010	0.010
2-1.Deflection of output shaft (Outer faucet joint)	0.010	0.010	0.010
2-2.Parallelism between the output shaft end mounted surface (Inner faucet joint)	0.015	0.015	0.015
3.Parallelism between the output shaft end mounted surface	0.030	0.035	0.035
4.Concentricity between the output shaft and fitting part	0.040	0.045	0.045
5.Concentricity between the output shaft and fitting part	0.050	0.055	0.060
6.Concentricity between the output shaft and fitting part	0.060	0.065	0.070

Note: All values are T.I.R. (Total Indicator Reading).



SG/HP

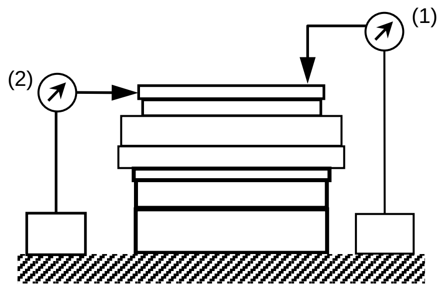


CG

The measuring for the values are as follows:

1 **Output shaft surface runout**

The indicator on the fixed part measures the axial runout (maximum runout width) of the outermost circumference of output shaft of the output rotary unit per revolution.

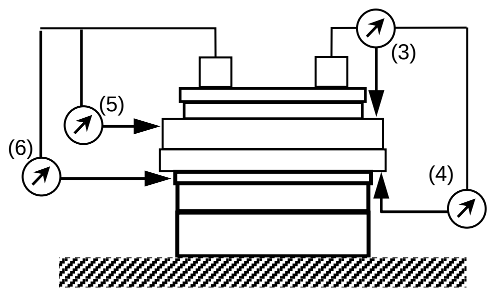


2 **Deflection of output shaft**

The indicator on the fixed part measures the radial runout (maximum runout width) of output shaft of the output rotary unit per revolution.

3,4 **Parallelism between the output shaft and mounted surface**

The indicator on the output rotary unit measures the axial runout (maximum runout width) of the outermost circumference of the mounting surface (both on the output shaft side and opposite side) of the output rotary unit per revolution.



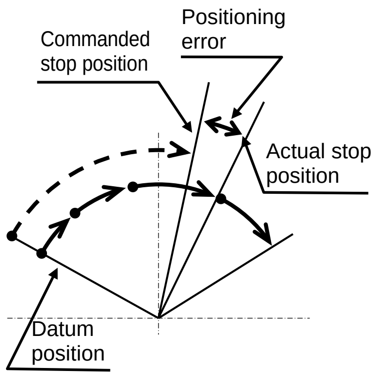
5,6 **Concentricity between the output shaft and fitting part**

The indicator on the output rotary unit measures the radial runout (maximum runout width) of the fitting part (both on the output shaft side and opposite side) of the output rotary unit per revolution.

1-8 Positional accuracy

One-way positional accuracy

The One-way positional accuracy means the maximum positional difference between the actual rotated angle from the datum position and its theoretical rotational angle in one revolution when series of positioning are performed in the same rotation direction. (Refer to JIS B-6201-1987.)
SHA-M series actuators house HarmonicDrive® speed reducer for precision control or HPF, so the positioning error of the motor shaft is compressed by the reduction ratio.



The One-way positional accuracy is shown in the table below:
SG/HP

(Unit: Second)

Model / Reduction ratio	SHA 25M	SHA32M	SHA40M	SHA58M	SHA65M
11:1	120	120	–	–	–
51:1	50	50	50	–	–
81:1 or more	40	40	40	40	40

CG

(Unit: Second)

Model / Reduction ratio	SHA25M	SHA32M	SHA40M
50:1	50	40	40
80:1 or more	40	30	30

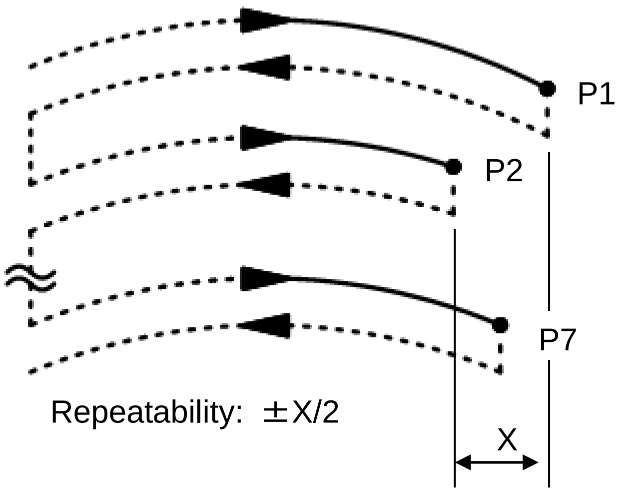
Repeatability (CG)

For the "repeatability", the output shaft stop position is measured by performing positioning at a position 7 times in the same direction. This measurement is performed at 4 locations on the output shaft and the maximum error is found. The measurement value is expressed as an angle which is 1/2 the maximum error with ± attached. (JIS B 6201-1987)

CG

(Unit: Second)

Model / Reduction ratio	SHA 25M	SHA32M	SHA40M
Ratio to full speed	±5	±4	±4



*P1 to P7: Stop position
X: Maximum error

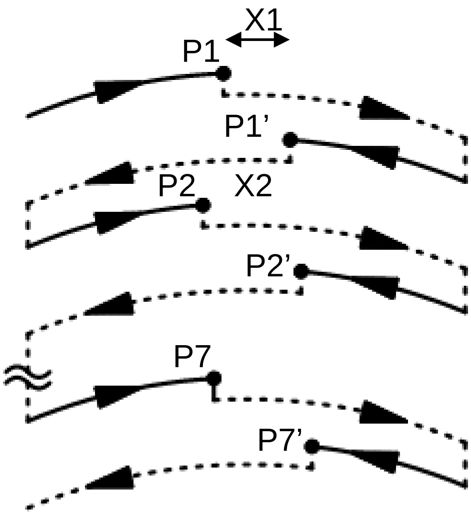
Reverse positional accuracy (CG type)

For the "reverse positional accuracy", the shaft is rotated beforehand in the forward (or reverse) direction and the stop position for that rotation is set as the reference position. An instruction is given to rotate the shaft in the same direction and from the stopped position, the same instruction is given in the reverse (or forward) direction and the difference between the stop position after this rotation and the reference position is measured.
The average value from repeating this 7 times in each direction is shown and the maximum value measured at the 4 locations on the output shaft is shown. (JIS B 6201-1987)

CG

(Unit: Second)

Model / Reduction ratio	SHA 25M	SHA32M	SHA40M
50:1	60	60	50
80:1 or more	25	25	20



＊P1 to P7 : Stop position after forward rotation
P1' to P7' : Stop position after reverse rotation
X1 to X7 : Difference between the stop positions after forward and reverse rotations

Reverse positional accuracy: |X1+X2+….+X7|/7

1 Outlines

1-9 Detector specifications (Absolute encoder)

Absolute encoders installed in SHA-M series are multi turn-type magnetic absolute encoders. This encoder consists of a detector (17 bits) for detecting the position per motor shaft revolution, and a cumulative counter (16 bits) for detecting the number of revolutions.
This encoder constantly detects the absolute output position and stores it by means of the backup battery, regardless of whether the power supply for the servo amplifier or external controller is turned ON/OFF. Accordingly, once the origin is detected when the machine is installed, originating is not required after subsequent power ON operations. This facilitates the recovery operation after a power failure or breakdown.
In addition, while the power is ON, the cumulative counter portion that detects the single revolution absolute position and the number of revolutions is a dual-redundant system in which a matching check is always performed on data, and this highly reliable design allows for encoder errors to be self-detected should they occur.
In addition, a backup capacitor is installed in the encoder to retain absolute positions even when the servo amplifier-encoder extension cable is disconnected for the purpose of maintenance, etc. (Internal backup)
Switch OFF everything but the control circuit power when replacing the MELSERVO-J4 servo amplifier permanent battery. If the battery is replaced with the control circuit power ON, the absolute position data is not lost.

Specifications

Type	Magnetic sensor/electronic battery backup type
Encoder resolution (Resolution per motor revolution)	17 bits (2^{17}: 131,072 pulses)
Motor multi revolution counter (Maximum cumulative motor shaft revolutions)	16 bits (2^{16}: 65,536 revolutions cumulatively)
Maximum permissible motor shaft rotational speed	7000 rpm *1
Safety/redundancy	・Check method in which two identical single revolution detectors are compared ・Check method in which two identical cumulative revolution counters are compared
Backup time by external battery	Approx. 14,000 hours (when power is not supplied, ambient temperature of 20℃)
Backup time by internal battery	30 minutes (after 3 hours of charge, ambient temperature of 20℃, axis stopped) (For backup while the encoder and servo amplifier are disconnected briefly)

Note 1) This is the rotation speed limit of the encoder and is different from the rotation speed that the motor can drive.

Resolution of output shaft

Encoder resolution		17bits (2^{17}: 131,072 pulses)					
Reduction ratio		1:11	1:51	1:81	1:101	1:121	1:161
Resolution of output shaft	Pulse/rev	1,441,792	6,684,672	10,616,832	13,238,272	15,859,712	21,102,592
Resolvable angle per pulse (approximate value)	Sec.	Approx. 0.9	Approx. 0.2	Approx. 0.1	Approx. 0.097	Approx. 0.082	Approx. 0.061
Reduction ratio		1:50	1:80	1:100	1:120	1:160	
Resolution of output shaft	Pulse/rev	6,553,600	10,485,760	13,107,200	15,728,640	20,971,520	
Resolvable angle per pulse (approximate value)	Sec.	Approx. 0.2	Approx. 0.12	Approx.0.1	Approx. 0.082	Approx. 0.062	

Absolute position data

[Absolute position] indicates the absolute position within one motor shaft revolution, while [multi revolution] indicates the number of motor revolutions. The position of the actuator output shaft is obtained by the following formula:
Position of actuator output shaft = (Absolute position + Multi revolution data x Encoder resolution) / Reduction ratio

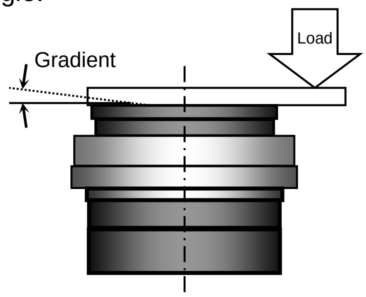
Transfer of encoder data

Data is transferred via bi-directional communication in a normal condition while power is supplied. When the servo amplifier control power supply is turned OFF and the driver enters the battery backup mode, communication stops.

1-10 Rigidity

Moment stiffness

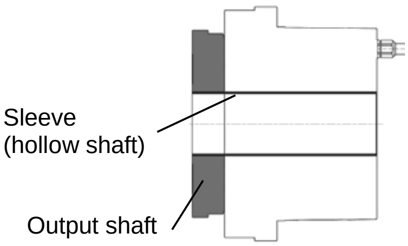
The moment stiffness refers to the torsional stiffness when a moment load is applied to the output shaft of the actuator (shown in the figure).
For example, when a load is applied to the end of an arm attached on the output shaft of the actuator, the face of the output shaft of the actuator tilts in proportion to the moment load. The moment stiffness is expressed as the load/gradient angle.



Item \ Model		SHA25M		SHA32M		SHA40M	SHA58M	SHA65M
Reduction ratio		11:1	50:1 or more	11:1	50:1 or more	50:1 or more	81:1 or more	81:1 or more
Moment stiffness	Nm/rad	37.9×10^4	39.2×10^4	86.1×10^4	100×10^4	179×10^4	531×10^4	741×10^4
	kgf･m/rad	38.7×10^3	40×10^3	87.9×10^3	102×10^3	183×10^3	542×10^3	756×10^3
	kgf･m/arc-min	11.3	11.6	25.7	29.6	53.2	158	220

CAUTION

Do not apply torque, load or thrust to the sleeve (hollow shaft) directly.
The sleeve (hollow shaft) is adhered to the output rotary shaft. Accordingly, the adhered sleeve may be detached from the output rotary shaft if a torque or load is applied to the sleeve (hollow shaft).
Do not apply any torque, moment load or thrust load directly to the sleeve (hollow shaft).



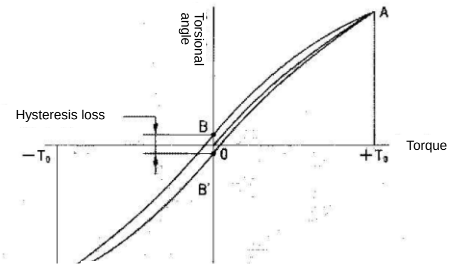
Torsional stiffness (Ratio 50:1 or more)

Caution

- The speed reducer uses (1) speed ratio 50 or more for the HarmonicDrive® gear and (2) speed ratio 11 for the HPF hollow shaft planetary gearhead. The structures of the speed reducer are different, so their rotation direction torsional stiffness are different. Refer to individual characteristics shown on the graphs and tables.

If a torque is applied to the output shaft of the actuator with the servo locked, the output shaft generates a torsional stress roughly in proportion to the torque.

The upper right figure shows the torsional angle of the output shaft when a torque starting from zero and increased to positive side [+T_0] and negative side [–T_0] is applied to the output shaft. This is called [torque vs. torsional angle] diagram, which typically follows a loop 0→A→B→A'→B'→A. The torsional rigidity of SHA series actuator is expressed by the gradient of this [torque vs. torsional angle diagram] representing a spring constant (unit: Nm/rad).

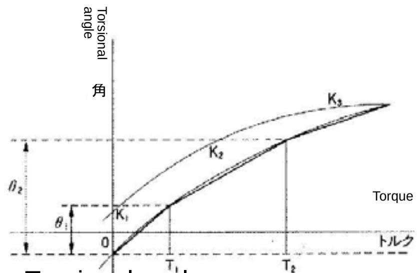


As shown by lower right figure, this [torque vs. torsional angle] diagram is divided into three regions and the spring constants in these regions are expressed by K_1, K_2, and K_3, respectively.

K_1 : Spring constant for torque region 0 to T_1

K_2 : Spring constant for torque region T_1 to T_2

K_3 : Spring constant for torque region over T_2



* φ: Torsional angle

The torsional angle for each region is expressed as follows:

- Range where torque T is T_1 or below: $\varphi = \frac{T}{K_1}$
- Range where torque T is T_1 to T_2: $\varphi = \theta_1 + \frac{T - T_1}{K_2}$
- Range where torque T is T_2 to T_3: $\varphi = \theta_2 + \frac{T - T_2}{K_3}$

The table below shows the averages of T_1 to T_3, K_1 to K_3, and θ_1 to θ_2 for each actuator.

Model		SHA25M		SHA32M		SHA40M		SHA58M	SHA65M
Reduction ratio		50:1	80:1 or more	50:1	80:1 or more	50:1	80:1 or more	80:1 or more	80:1 or more
T_1	Nm	14		29		54		168	235
	kgf·m	1.4		3.0		5.5		17	24
K_1	x10^4 Nm/rad	2.5	3.1	5.4	6.7	10	13	40	54
	kgf·m/arc min	0.74	0.92	1.6	2.0	3.0	3.8	12	16
θ_1	x10^-4 rad	5.5	4.4	5.5	4.4	5.2	4.1	4.1	4.4
	arc min	1.9	1.5	1.9	1.5	1.8	1.4	1.4	1.5
T_2	Nm	48		108		196		598	843
	kgf·m	4.9		11		20		61	86
K_2	X10^4 Nm/rad	3.4	5.0	7.8	11	14	20	61	88
	kgf·m/arc min	1.0	1.5	2.3	3.2	4.2	6.0	18	26
θ_2	x10^-4 rad	15.7	11.1	15.7	11.6	15.4	11.1	11.1	11.3
	arc min	5.4	3.8	5.4	4.0	5.3	3.8	3.8	3.9
K_3	x10^4 Nm/rad	4.4	5.7	9.8	12	18	23	71	98
	kgf·m/arc min	1.3	1.7	2.9	3.7	5.3	6.8	21	29

The table below shows reference torque values calculated for different torsional angle. (Unit: N･m)

Model	SHA25M		SHA32M		SHA40M		SHA58M	SHA65M
Reduction ratio	1:50 1:51	1:80 or more	1:50 1:51	1:80 or more	1:50 1:51	1:80 or more	1:80 or more	1:80 or more
2 arc min	15	21	31	45	63	88	273	360
4 arc min	35	51	77	108	144	208	636	876
6 arc min	56	84	125	178	233	342	1050	1450

Torsional stiffness
(Speed ratio 11: HPF hollow shaft planetary gearhead)

If a torque is applied to the output unit with the input and casing of the speed reducer are locked, the output unit generates a torsion in proportion to the torque. When the values for torque are gradually changed in sequence from (1) Rated output torque in the positive rotation direction→(2) zero→(3) Rated output torque in the negative rotation direction→(4) zero→(5) Rated output torque in the positive rotation direction, the values follow a loop (1)→(2)→(3)→(4)→(5) (returns to (1)) shown in Fig.1 [torque vs. torsional angle diagram].
The gradient of the region [Rated output torque] from [0.15 x rated output torque] is small, and the torsional stiffness of the HPG series is the average of this gradient. The gradient of the region [0.15 x rated output torque] from [zero torque] is large. This gradient is caused by semi-partial contact in the meshing region and uneven load distribution from light loads and so forth on the planet gears.

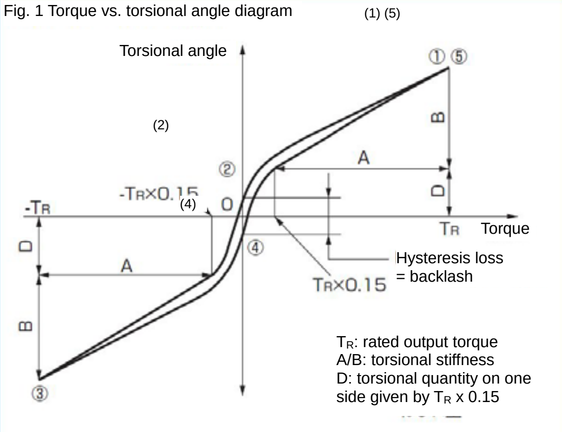
An explanation is provided below on how to calculate the total torsional quantity on one side from a no-load state after a load has been applied by the speed reducer.

$$\theta = D + \frac{T - TL}{\frac{A}{B}}$$

θ : total torsional quantity
D: torsional quantity on one side given by rated output torque x 0.15 torque
T: load torque
TL: rated output torque x 0.15 torque (= T_R x 0.15)
A/B: torsional stiffness

The zero torque part widths of (2) and (4) in the figure on the right [torque vs. torsional angle diagram] is called the hysteresis loss. For the HPG series, backlash is defined as hysteresis loss [rated output torque in the negative rotation direction] from [rated output torque in the positive rotation direction]. The HPG series has a backlash of less than 3 minutes (less than 1 minute with special products) with factory settings.

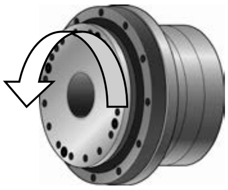
Fig. 1 Torque vs. torsional angle diagram



Item		Model / ratio SHA25M 11	SHA32M 11
Backlash	arc-min	3	3
	10^{-4}rad	8.7	8.7
Rated torque (T_R)	Nm	21	44
Torsional quantity on one side given by T_R x 0.15 (D)	arc-min	2.0	1.7
	10^{-4}rad	5.8	4.9
Torsional stiffness (A/B)	kgf･m/arc-min	1.7	3.5
	x10^{-4}Nm/rad	5.70	11.7

1-11 Rotation direction

SG type
With the factory settings, the rotation direction is defined as counter-clockwise (CCW) as viewed from the output shaft when a pulse train is applied from the MELSERVO-J4 servo amplifier in the direction of rising position addresses.
This rotation direction can be switched with the MELSERVO-J4 servo amplifier "Basic setting parameters ('Pr.PA_ _')" -> "PA14: Rotation direction selection".



CCW (counterclockwise) rotation direction

"PA14: Rotation direction selection" setting

Set value	Actuator rotation direction		Setting
	FWD pulse input	REV pulse input	
0	CCW (counterclockwise) direction	CW (clockwise) direction	Default
1	CW (clockwise) direction	CCW (counterclockwise) direction	

CG
With the factory settings, the rotation direction is defined as clockwise (CW) as viewed from the output shaft when a pulse train is applied from the MELSERVO-J4 servo amplifier in the direction of rising position addresses.
This rotation direction can be switched with the MELSERVO-J4 servo amplifier "Basic setting parameters ([Pr.PA_ _]) " -> "PA14: Rotation direction selection".

"PA14: Rotation direction selection" setting

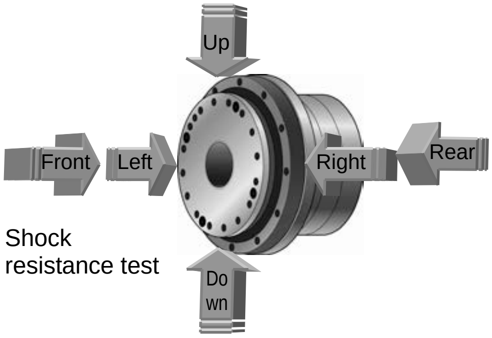
Set value	Actuator rotation direction		Setting
	FWD pulse input	REV pulse input	
0	CW (clockwise) direction	CCW (counterclockwise) direction	Default
1	CCW (counterclockwise) direction	CW (clockwise) direction	

1-12 Shock resistance

The shock resistance of the actuator is as follows, and this value is the same in up/down, left/right and front/rear directions:

Impact acceleration: 300 m/s^2

In our shock resistance test, the actuator is tested 3 times in each direction. Actuator operation is not guaranteed in applications where impact exceeding the above value is constantly applied.

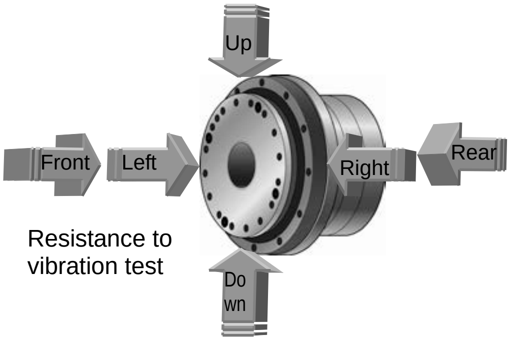


1-13 Resistance to vibration

The resistance to vibration of the actuator is as follows, and this value is the same in up/down, left/right and front/rear directions:

Vibration acceleration: 25 m/s^2 (frequency: 10 to 400Hz)

In our test, the actuator is tested for 2 hours in each direction at a vibration frequency sweep period of 10 minutes.



Resistance to vibration test

1-14 Operable range

The graph on the next page indicates the operable range when SHA-M series actuator (Combination with MELSERVO-J4 servo amplifier) is selected. For details, refer to [Chapter 2 SHA-M series selection].

1. Continuous motion range

The range allows continuous operation for the actuator.

2. 50% duty motion range

This range indicates the torque rotation speed which is operable in the 50% duty operation (the ratio of operating time and delay time is 50:50).

3. Motion range during acceleration and deceleration

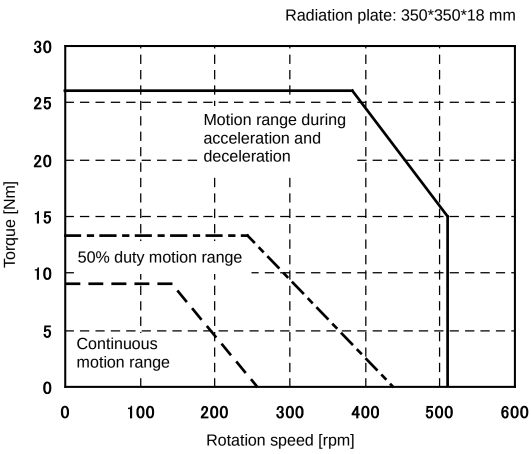
This range indicates the torque rotation speed which is operable momentarily. The range allows instantaneous operation like acceleration and deceleration, usually.
The continuous and 50% duty motion ranges in each graph are measured on the condition where the radiation plate specified in the graph is installed.

Caution

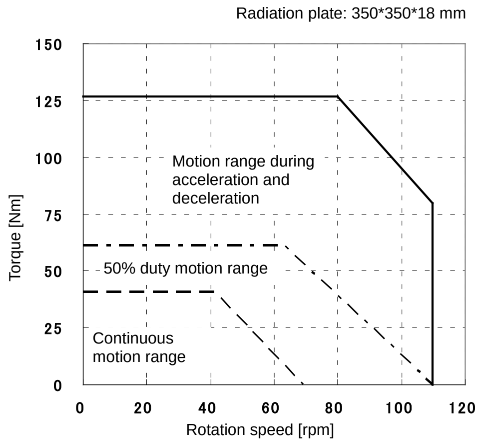
- When the SHA-M-CG is operated at a constant speed (motor shaft speed of 1,000 rpm or less) in the same direction under a constant load torque in a condition where the output shaft is facing up (output shaft is facing down with CG type), improper lubrication of the built-in speed reducer may cause abnormal sound or wear, leading to a shorter life. Improper lubrication can be prevented by changing the speed in the operation pattern, such as by periodically stopping the actuator. However, the HPF planetary speed reducer model (11:1) is not included.

SG/HP
SHA25M

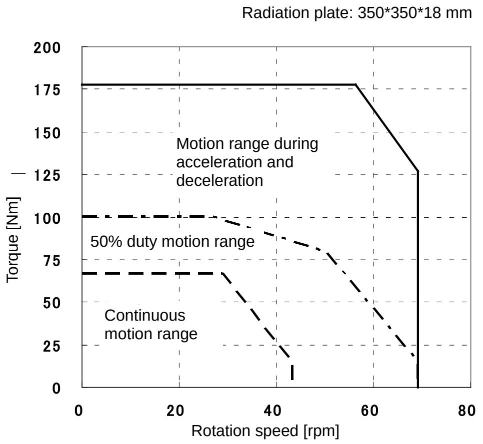
■SHA25M11HP



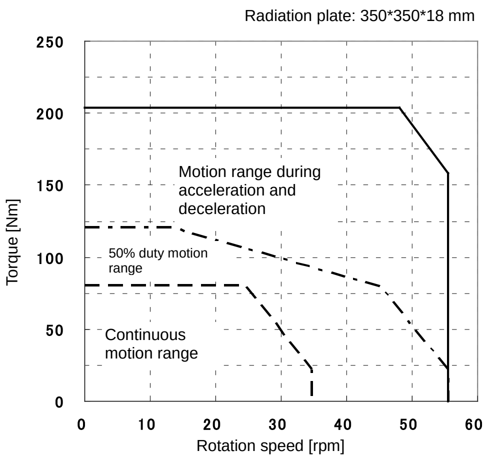
■SHA25M51



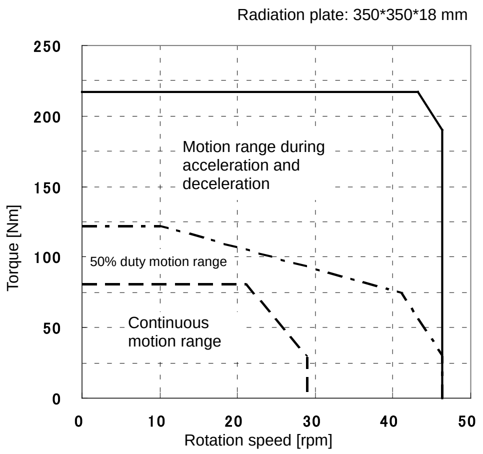
■SHA25M81



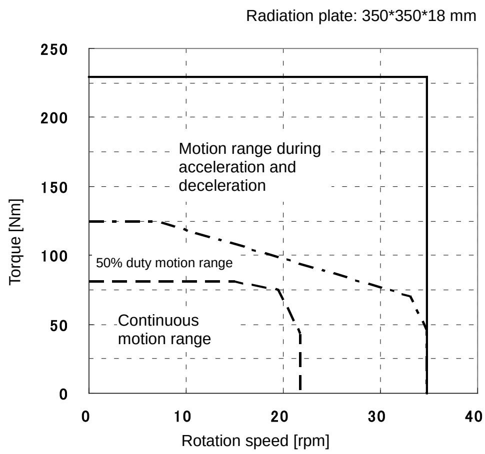
■SHA25M101



■SHA25M121



■SHA25M161

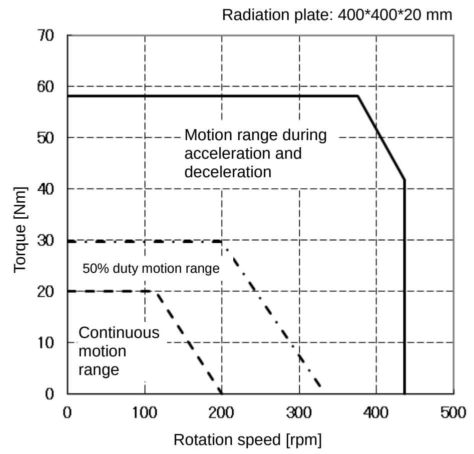


1

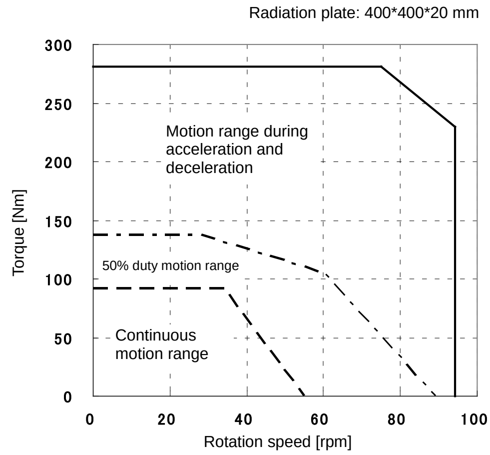
Outlines

SG/HP
SHA32M

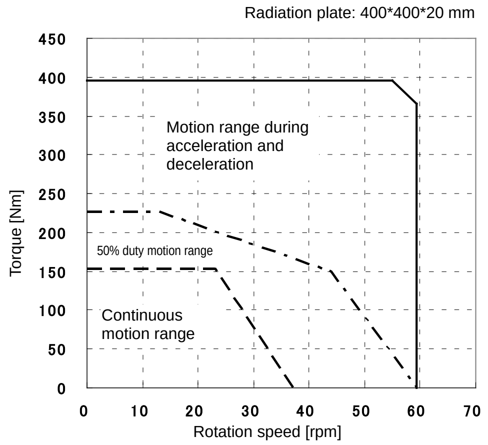
■SHA32M11HP



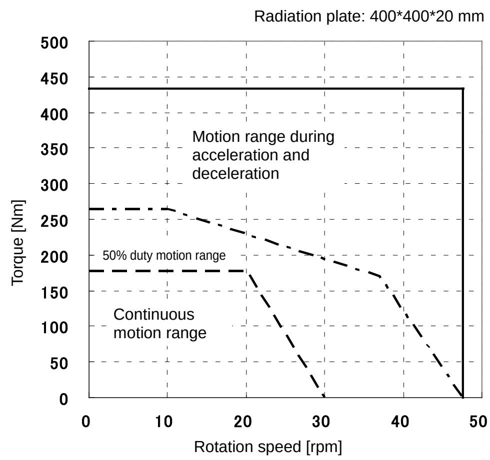
■SHA32M51



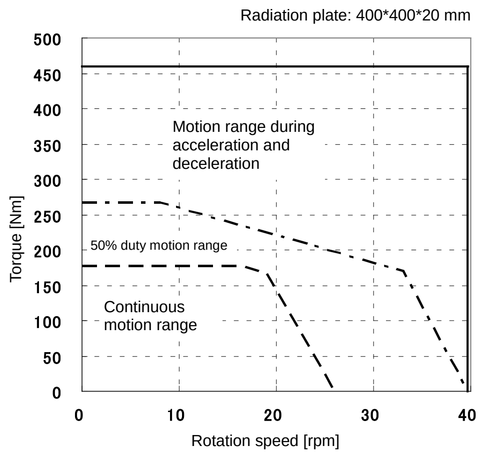
■SHA32M81



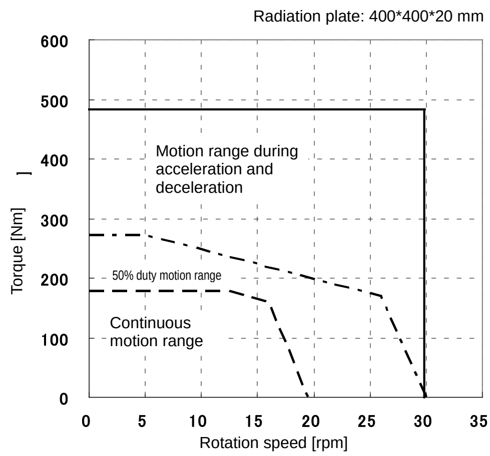
■SHA32M101



■SHA32M121



■SHA32M161

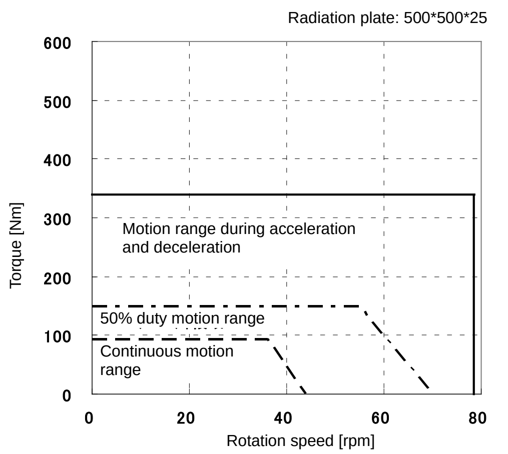


1

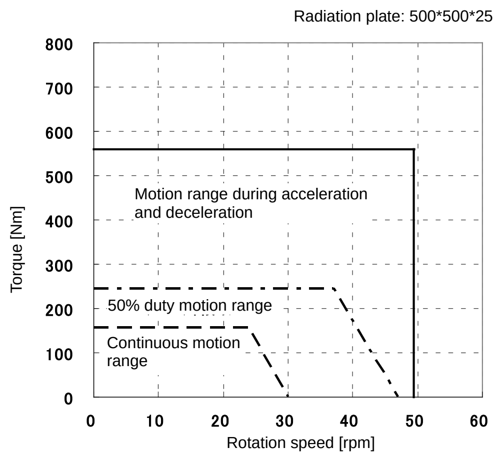
Outlines

SG
SHA40M

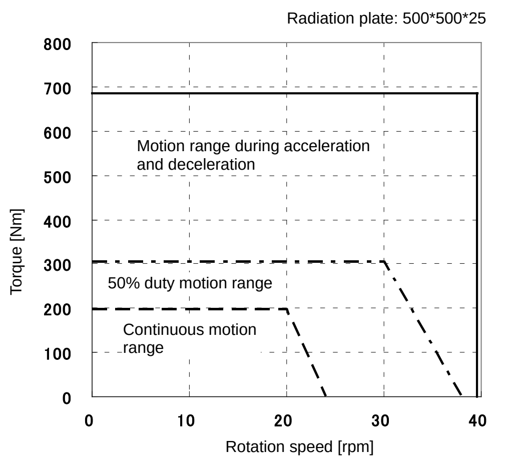
■SHA40M51/MR-J4-100B



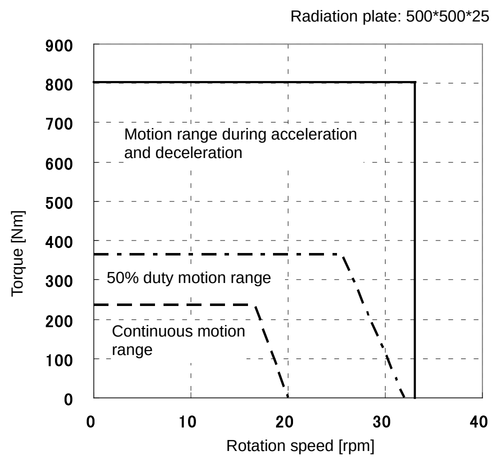
■SHA40M81/ MR-J4-100B



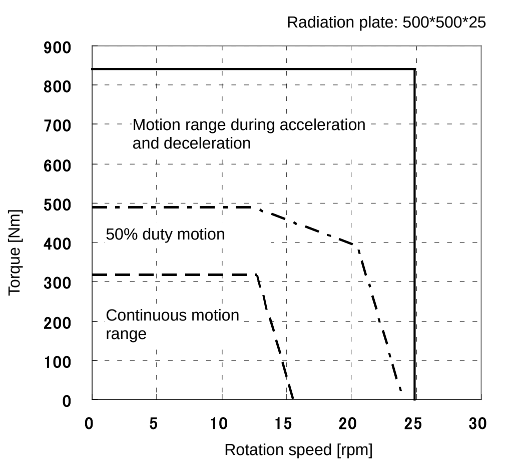
■SHA40M101/ MR-J4-100B



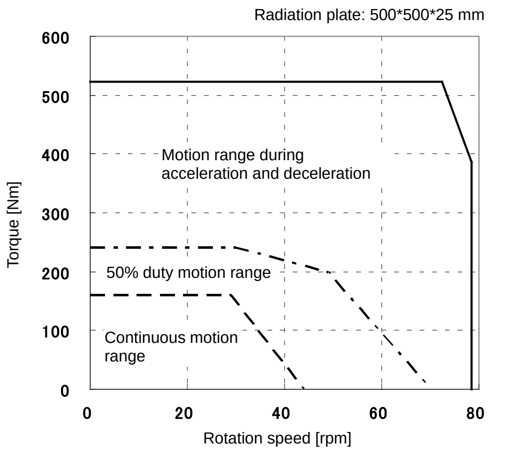
■SHA40M121/ MR-J4-100B



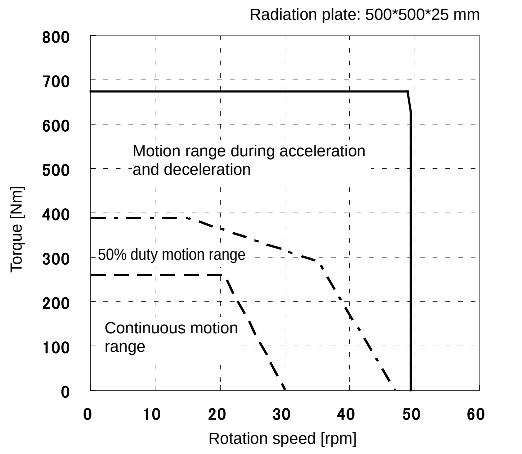
■SHA40M161/ MR-J4-100B



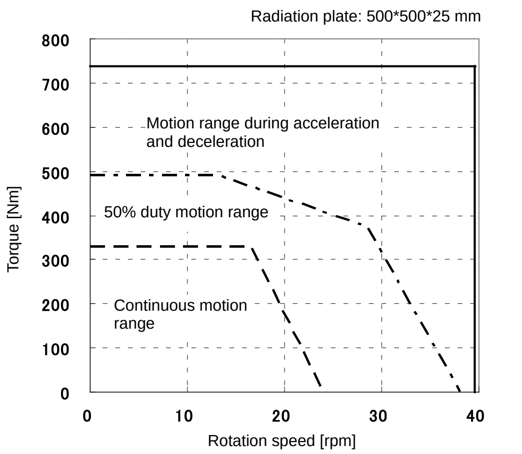
■SHA40M51/ MR-J4-200B



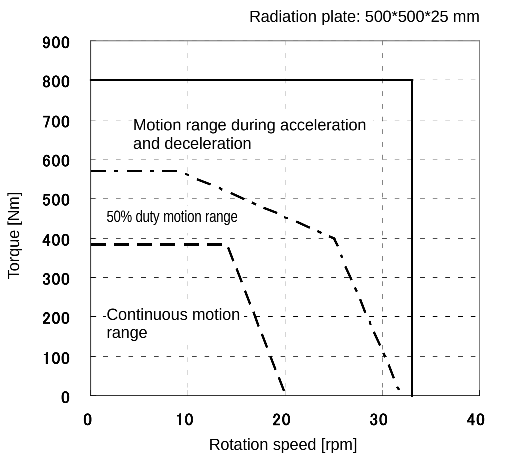
■SHA40M81/ MR-J4-200B



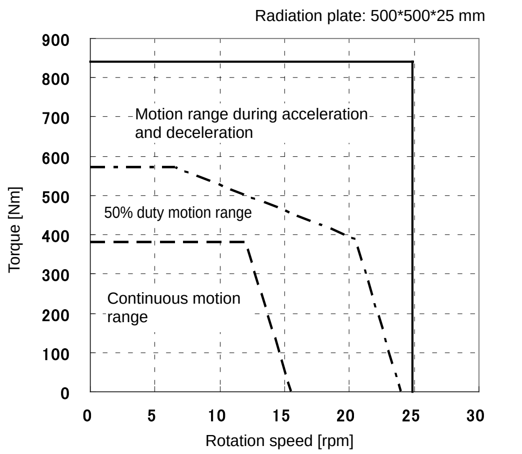
■SHA40M101/ MR-J4-200B



■SHA40M121/ MR-J4-200B



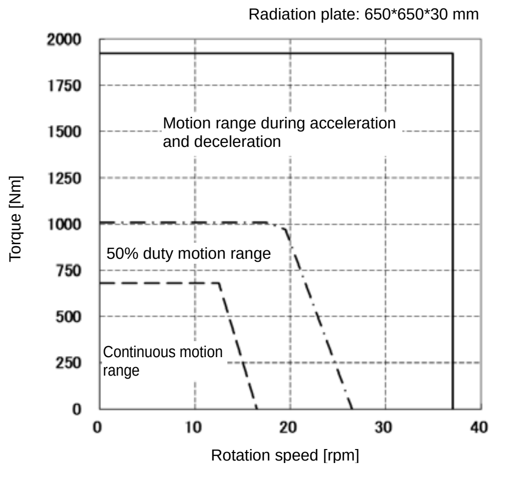
■SHA40M161/ MR-J4-200B



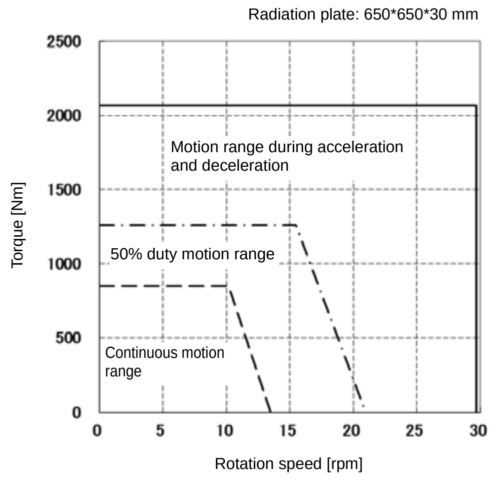
SG

SHA58M

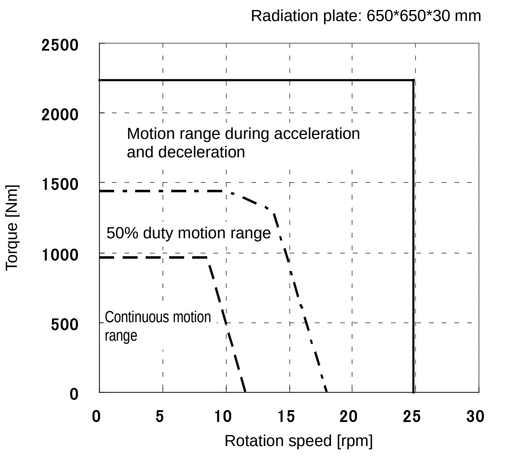
■SHA58M81



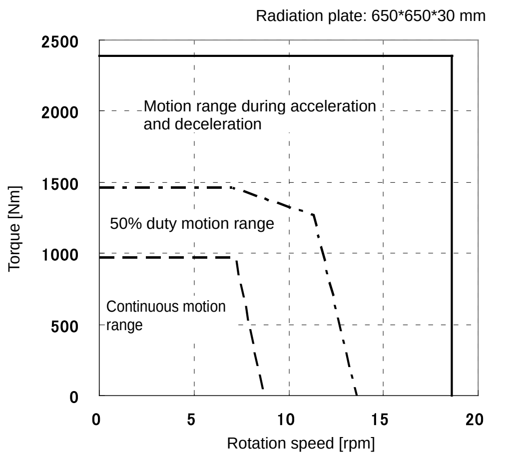
■SHA58M101



■SHA58M121

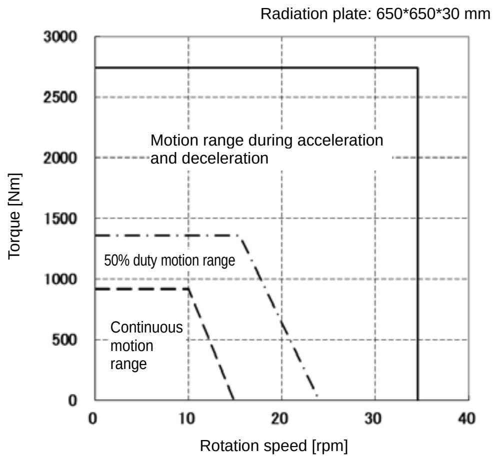


■SHA58M161

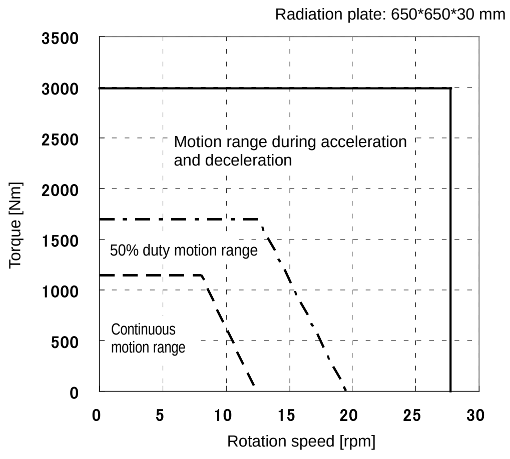


SG
SHA65M

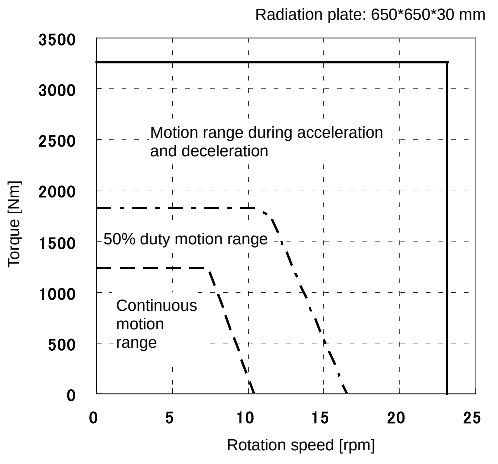
■SHA65M81



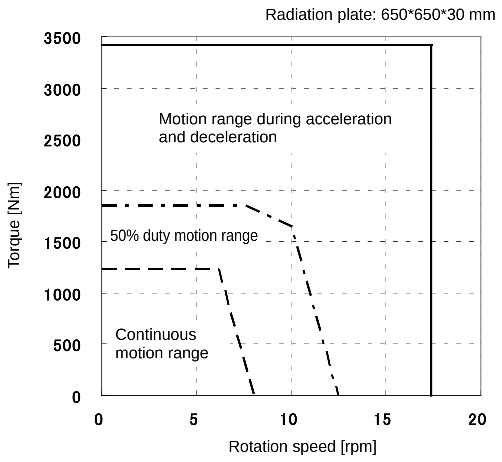
■SHA65M101



■SHA65M121

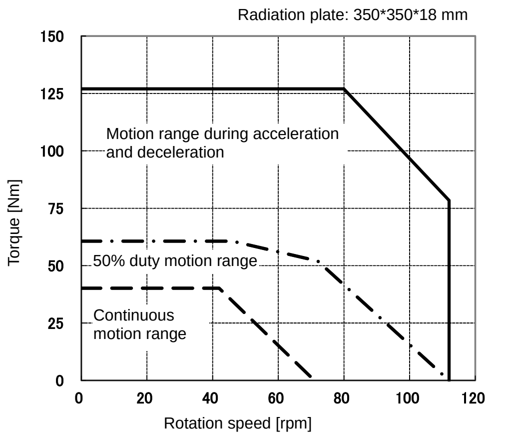


■SHA65M161

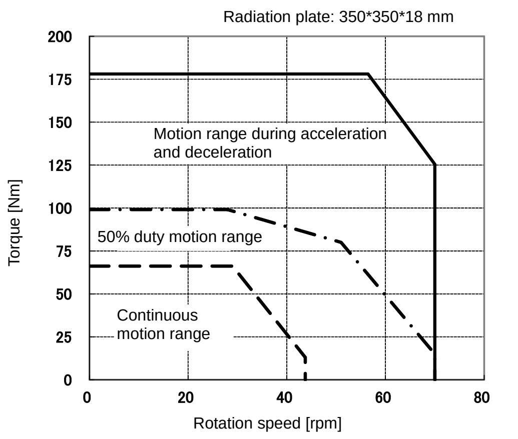


CG
SHA25M

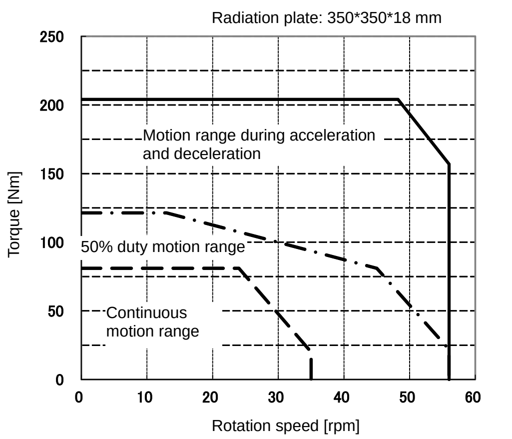
■SHA25M50CG



■SHA25M80CG



■SHA25M100CG



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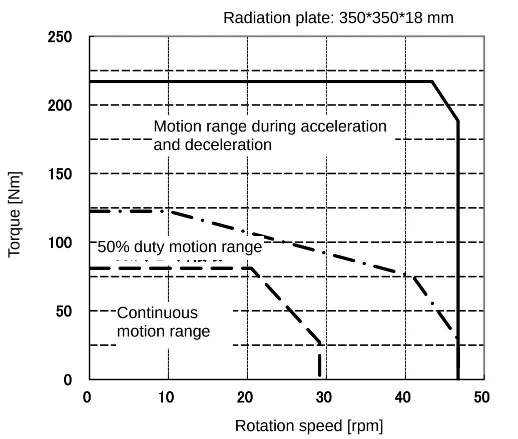
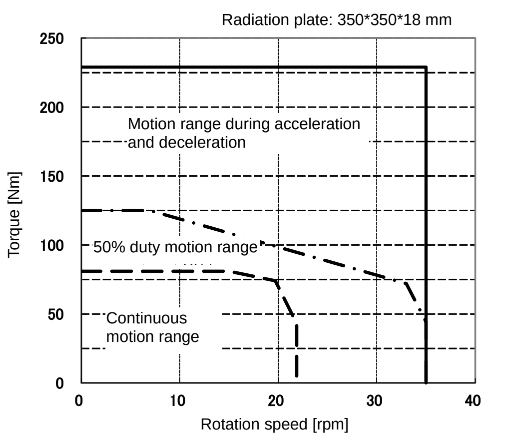
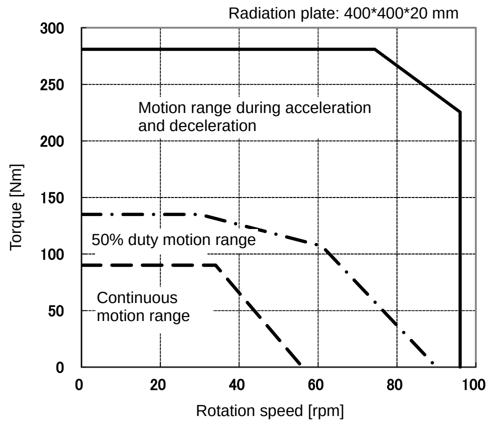


■SHA25M160CG

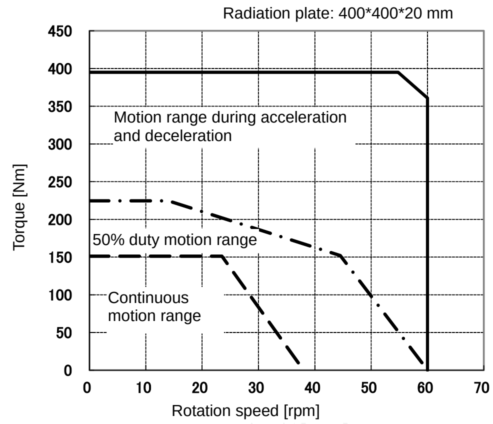


CG
SHA32M

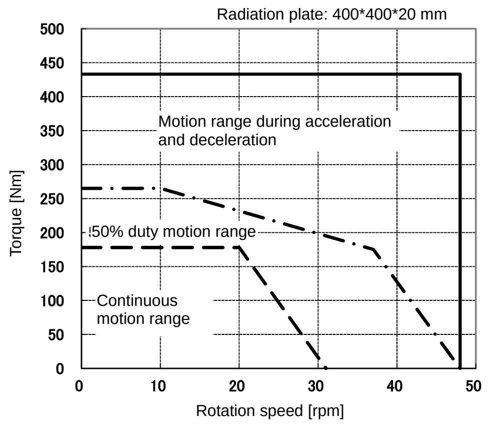
■SHA32M50CG



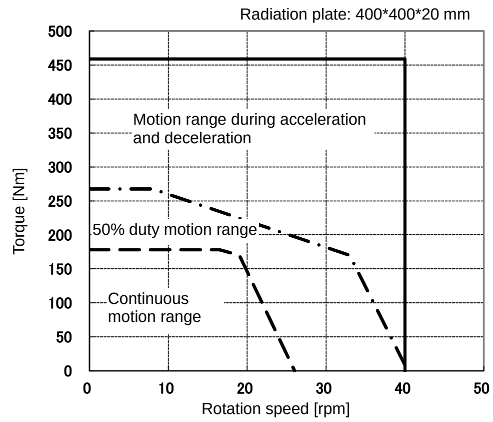
■SHA32M80CG



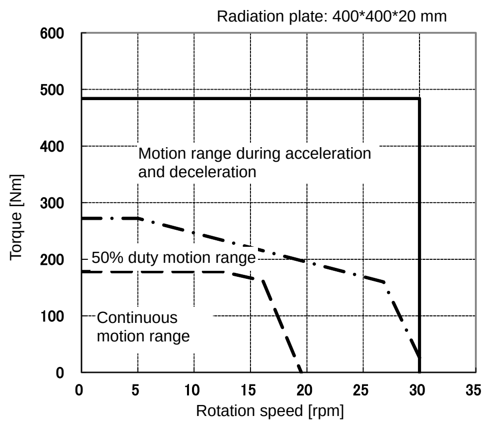
■SHA32M100CG



■SHA32M120CG

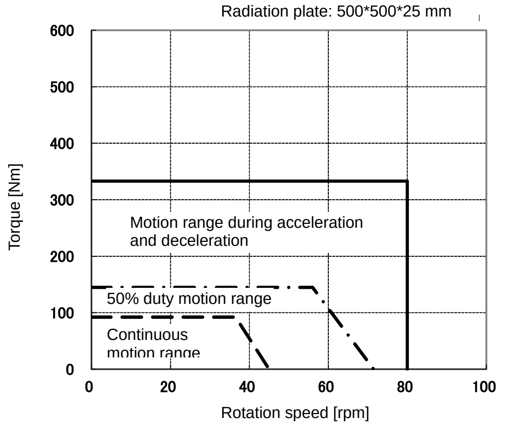


■SHA32M160CG

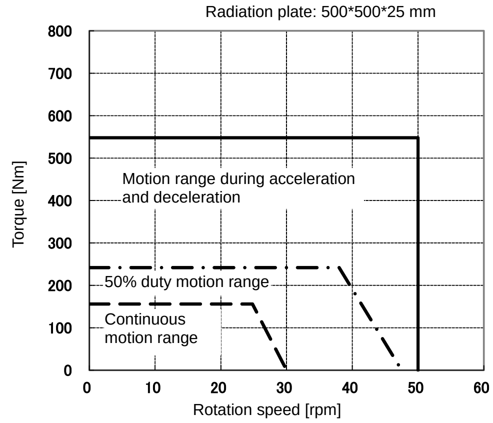


CG
SHA40M

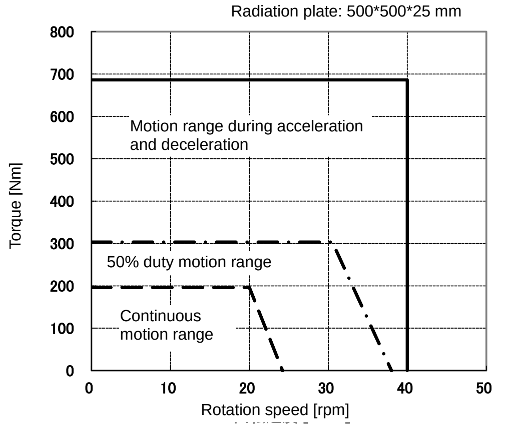
■SHA40M50CG/MR-J4-100B-S033



■SHA40M80CG/ MR-J4-100B-S033



■SHA40M100CG/ MR-J4-100B-S033



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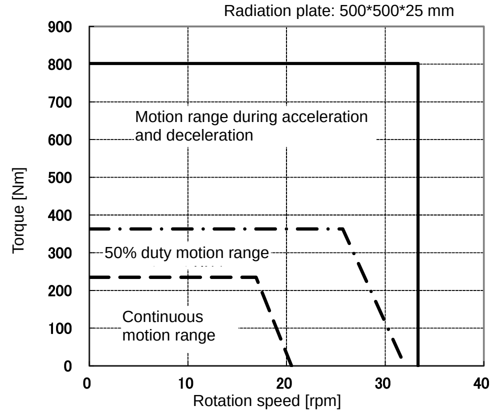
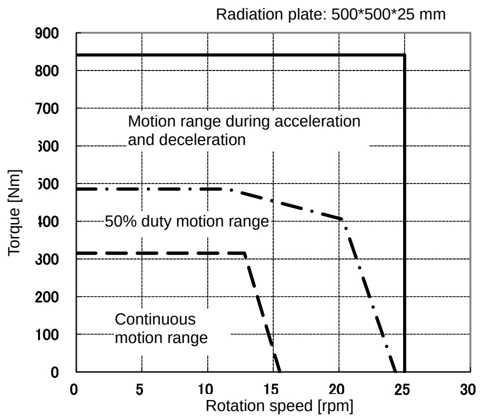


■SHA40M160CG/ MR-J4-100B-S033



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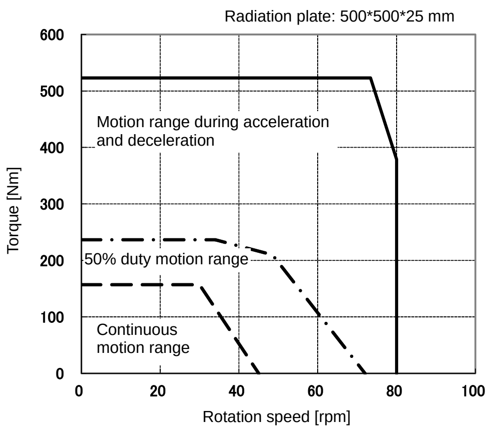
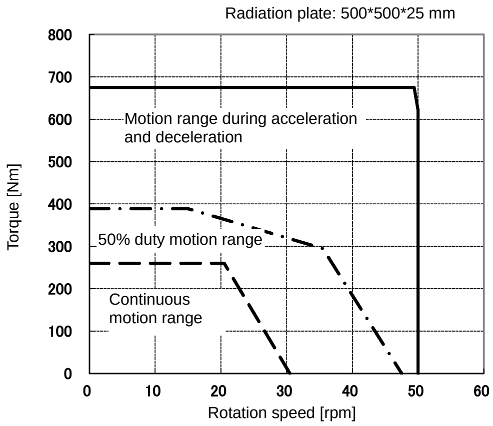
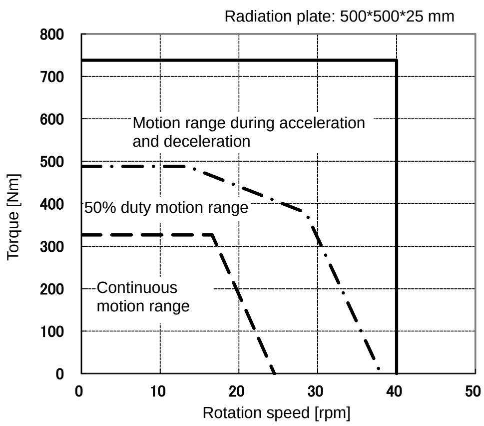


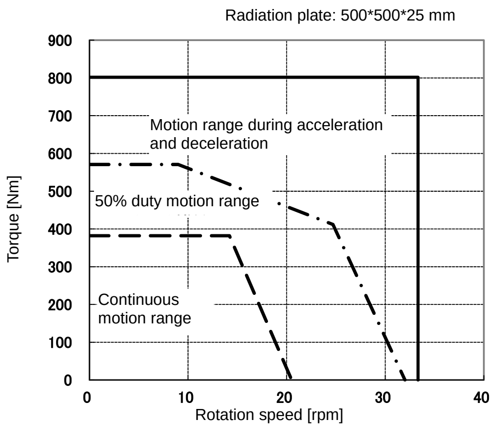
■SHA40M80CG/ MR-J4-200B-S033



■SHA40M100CG/ MR-J4-200B-S033



■SHA40M120CG/ MR-J4-200B-S033



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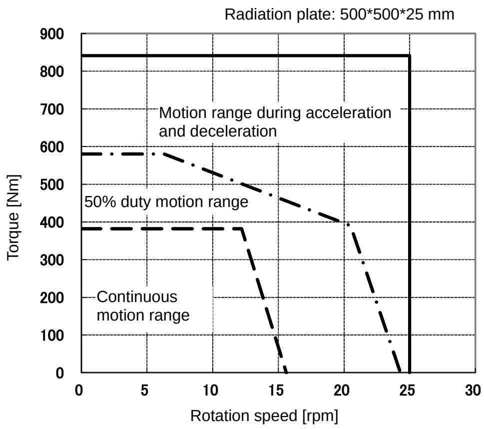


1-15 Cable specifications

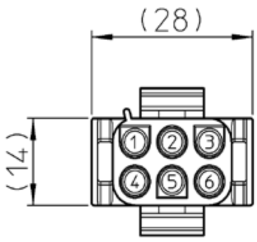
The following tables show specifications of the motor and encoder cables of SHA-M series actuators.

Motor cable specifications

- Size 25, 32, 40

Pin number	Color	Name	
		Without brake	With brake
1	Red	Motor phase-U	Motor phase-U
2	White	Motor phase-V	Motor phase-V
3	Black	Motor phase-W	Motor phase-W
4	Green/yellow	PE	PE
5	Blue	No connection	Brake
6	Yellow	No connection	Brake

- Connector pin layout



Connector model: 350715-1
Pin model:

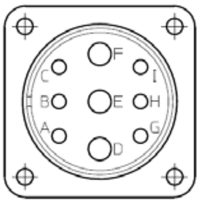
	Size 25	Size 32, 40
Motor UVW	350690-1	350547-1
Brake	350690-1	350690-1
Motor PE	350669-1	350669-1

by AMP

- Size 58, 65

Pin number	Name		Color (Extension cables)
	Without brake	With brake	
A	No connection	Brake	Blue
B	No connection	Brake	Yellow
C	No connection	No connection	–
D	Motor phase-U	Motor phase-U	Red
E	Motor phase-V	Motor phase-V	White
F	Motor phase-W	Motor phase-W	Black
G	PE	PE	Green/yellow
H	PE	PE	–
I	No connection	No connection	–

- Connector pin layout



Connector model: CE05-2A24-11PGHS-D (by DDK)

1

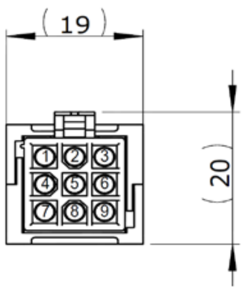
Outlines

Encoder cable specifications

- Size 25, 32, 40

Pin number	Color	Signal name	Remarks
1	Yellow	MR	Serial signal differential output (+)
2	Blue	MRR	Serial signal differential output (-)
3	Orange	BAT	Battery +
4	—	No connection	
5	—	No connection	
6	—	No connection	
7	Red	P5	Power supply input +5V
8	Black	LG	Power supply input 0V (GND)
9	Shield	SD	

- Connector pin layout

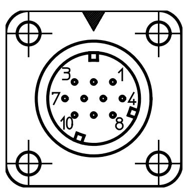


Connector model: 1-172169-9
Clamp model: 316454-1
Pin model: 170361-1
by AMP

- Model 58, 65

Pin number	Signal name	Remarks
1	Vbat	Battery +
2	GND(bat)	Battery - (GND)
3	No connection	
4	Vcc	Power supply input +5V
5	GND(Vcc)	Power supply input 0V (GND)
6	No connection	
7	No connection	
8	SD+	Serial signal differential output (+)
9	SD-	Serial signal differential output (-)
10	FG	

- Connector pin layout



Connector model: CM10-R10P (D3)-01 (by DDK)

For Size Numbers 58 and 65, connecting the encoder connector converter cable that comes with the model gives the same connector pin layout as for Size Numbers 25, 32, and 40.

Chapter 2

Selection guidelines

This chapter explains how to select a proper SHA-M series actuator.

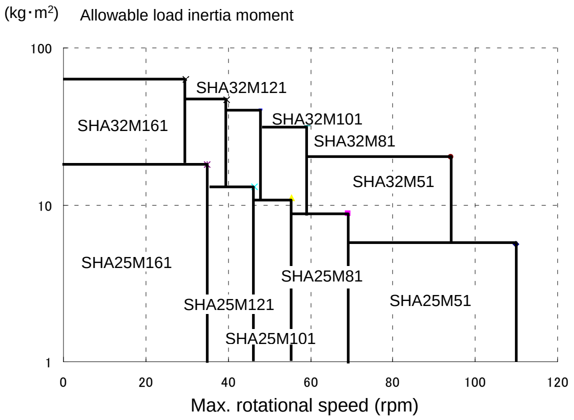
2-1 SHA-M series selection ·· 2-1
2-2 Change in load inertia moment ······························ 2-5
2-3 Verifying and examining load weights ······················ 2-6
2-4 Verifying operating conditions ······························ 2-10

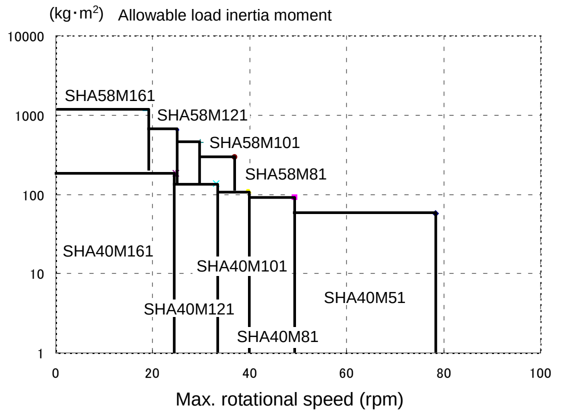
2-1 SHA-M series selection

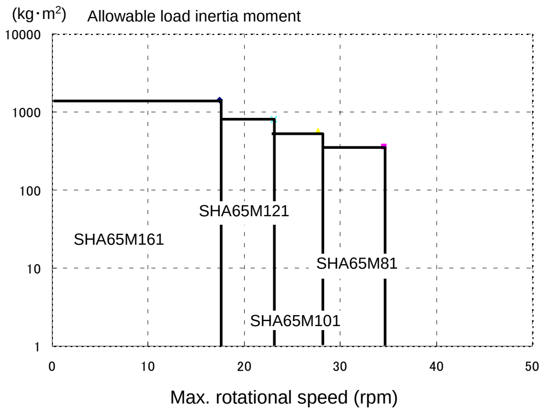
Allowable load inertia moment

To achieve high accuracy and performance, select SHA-M series actuator where the allowable load inertia moment specified for the applicable size is not exceeded.
Note that the allowable values in the table below should be referenced if you wish to shorten the transient vibration period during positioning or operate the actuator at a constant speed in a stable manner.
The operation is possible with the allowable value exceeded if the actuator is accelerated/decelerated gradually, commands given from the host to the servo amplifier are adjusted, or the servo amplifier's vibration suppression function is used.

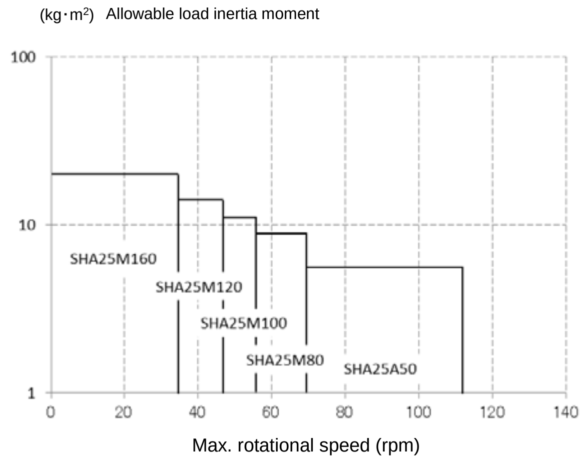
Refer to [A-2 Calculating inertia moment] (P3) for the calculation of inertia moment.

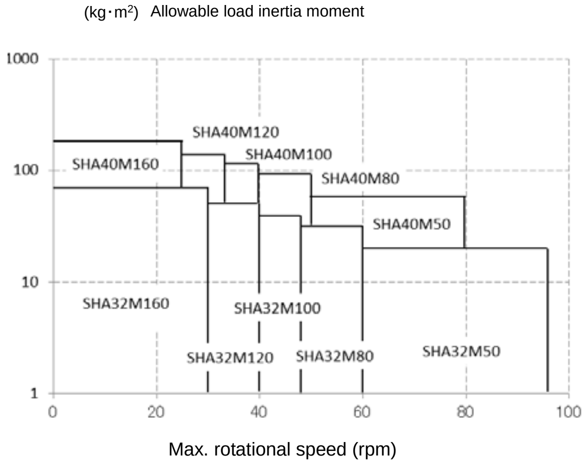






CG





When temporarily selecting an actuator, make certain that the inertia moment and max. rotational speed do not exceed the allowable values shown in the table on the following page.
When a load generating a large inertia moment is operated frequently, a greater regenerative energy will be produced during braking. If the regenerative energy produced exceeds the absorption capacity of the built-in regenerative resistor of the servo amplifier, an additional regenerative resistor must be connected externally to the servo amplifier. For details, refer to the manual of your servo amplifier.

2

Selection guidelines

SG/HP

Actuator model		SHA25M 11	51	81	101	121	161
Reduction ratio		1:11	1:51	1:81	1:101	1:121	1:161
Max. rotational speed	rpm	509.1	109.8	69.1	55.4	46.3	34.8
Actuator inertia moment (without brake)	kg·m²	0.029	0.56	1.4	2.2	3.2	5.6
	kgf·cm·s²	0.30	5.7	14	22	32	57
Actuator inertia moment (with brake)	kg·m²	0.034	0.66	1.7	2.6	3.7	6.6
	kgf·cm·s²	0.35	6.7	17	26	38	67
Allowable load inertia moment	kg·m²	0.32	5.6	8.8	11	14	20
	kgf·cm·s²	3.3	57	90	112	144	201

Actuator model		SHA32M 11	51	81	101	121	161
Reduction ratio		1:11	1:51	1:81	1:101	1:121	1:161
Max. rotational speed	rpm	436.4	94.1	59.3	47.5	39.7	29.8
Actuator inertia moment (without brake)	kg·m²	0.091	2.0	5.1	8.0	11	20
	kgf·cm·s²	0.93	21	52	81	117	207
Actuator inertia moment (with brake)	kg·m²	0.11	2.3	5.9	9.2	13	23
	kgf·cm·s²	1.1	24	60	94	135	238
Allowable load inertia moment	kg·m²	0.99	20	32	40	50	70
	kgf·cm·s²	10	200	320	400	510	710

Actuator model		SHA40M 51	81	101	121	161	SHA58M 81	101	121	161
Reduction ratio		1:51	1:81	1:101	1:121	1:161	1:81	1:101	1:121	1:161
Max. rotational speed	rpm	78.4	49.4	39.6	33.1	24.8	37.0	29.7	24.8	18.6
Actuator inertia moment (without brake)	kg·m²	5.0	13	20	28	50	96	149	214	379
	kgf·cm·s²	51	130	202	290	513	980	1520	2180	3870
Actuator inertia moment (with brake)	kg·m²	6.1	15	24	34	61	106	165	237	420
	kgf·cm·s²	62	157	244	350	619	1090	1690	2420	4290
Allowable load inertia moment	kg·m²	58	92	114	137	182	290	450	640	1140
	kgf·cm·s²	590	930	1170	1400	1860	2900	4600	6500	11600

Actuator model		SHA65M 81	101	121	161
Reduction ratio		1:81	1:101	1:121	1:161
Max. rotational speed	rpm	34.6	27.7	23.1	17.4
Actuator inertia moment (without brake)	kg·m²	110	171	245	433
	kgf·cm·s²	1120	1740	2500	4420
Actuator inertia moment (with brake)	kg·m²	120	187	268	475
	kgf·cm·s²	1230	1910	2740	4850
Allowable load inertia moment	kg·m²	360	560	810	1420
	kgf·cm·s²	3700	5700	8200	14500

CG

Actuator model		SHA25M				
		50	80	100	120	160
Reduction ratio		1:50	1:80	1:100	1:120	1:160
Max. rotational speed	rpm	112	70	56	46.7	35
Actuator inertia moment (without brake)	kg·m^2	0.50	1.3	2.0	2.9	5.1
	kgf·cm·s^2	5.1	13	20	29	52
Actuator inertia moment (with brake)	kg·m^2	0.60	1.5	2.4	3.4	6.1
	kgf·cm·s^2	6.1	16	24	35	62
Allowable load inertia moment	kg·m^2	5.6	8.8	11	14	20
	kgf·cm·s^2	57	90	112	144	201

Actuator model		SHA32M				
		50	80	100	120	160
Reduction ratio		1:50	1:80	1:100	1:120	1:160
Max. rotational speed	rpm	96	60	48	40	30
Actuator inertia moment (without brake)	kg·m^2	1.7	4.3	6.7	9.7	17
	kgf·cm·s^2	17	44	68	99	175
Actuator inertia moment (with brake)	kg·m^2	2.0	5.1	7.9	11	20
	kgf·cm·s^2	20	52	81	116	207
Allowable load inertia moment	kg·m^2	20	32	40	50	70
	kgf·cm·s^2	200	320	400	510	710

Actuator model		SHA40M				
		50	80	100	120	160
Reduction ratio		1:50	1:80	1:100	1:120	1:160
Max. rotational speed	rpm	80	50	40	33.3	25
Actuator inertia moment (without brake)	kg·m^2	4.8	12	19	27	49
	kgf·cm·s^2	49	124	194	280	497
Actuator inertia moment (with brake)	kg·m^2	5.8	15	23	33	59
	kgf·cm·s^2	59	150	235	338	601
Allowable load inertia moment	kg·m^2	58	92	114	137	182
	kgf·cm·s^2	590	930	1170	1400	1860

2

Selection guidelines

2-2 Change in load inertia moment

For SHA series combined with the high reduction ratio of the HarmonicDrive® gear the effects of change in load inertia moment on the servo performance are minimal. In comparison to direct servo drive mechanisms, therefore, this benefit allows the load to be driven with a better servo response.
For example, assume that the load inertia moment increases to N-times. The total inertia moment converted to motor shaft which has an effect on servo response is as follows:
The symbols in the formulas are:

J_S: Total inertia moment converted to motor shaft
J_M: Inertia moment of motor
R: Reduction ratio of SHA series actuator
L: Ratio of load inertia moment to inertia moment of motor
N: Rate of change in load inertia moment

- Direct drive

Before: $Js = J_M(1+L)$ After: $Js' = J_M(1+NL)$ Ratio: $Js'/Js = \frac{1+NL}{1+L}$

- Driven by SHA series

Before: $Js = J_M\left(1+\frac{L}{R^2}\right)$ After: $Js' = J_M\left(1+\frac{NL}{R^2}\right)$ Ratio: $Js'/Js = \frac{1+NL/R^2}{1+L/R^2}$

With SHA series, the value of R increases from 51 to 161, which means that the value increases substantially from R^2 = 2,601 to R^2 = 25,921. Then the ratio is $Js'/Js \fallingdotseq 1$. This means that SHA drive systems are hardly affected by the load variation.
Therefore, it is not necessary to take change in load inertia moment into consideration when selecting SHA series actuator or setting up the initial servo amplifier parameters.

2-3 Verifying and examining load weights

The SHA series actuator incorporates a precise cross roller bearing for directly supporting an external load (output flange). To demonstrate the full ability of the actuator, verify the maximum load moment load as well as the life and static safety coefficient of the cross roller bearing.

Checking procedure

1 Verifying the maximum load moment load (Mmax)

Calculating the maximum load moment load (M_{max})
↓
Verifying the maximum load moment load (M_{max}) is less than or equal to the permissible moment load (Mc)

2 Verifying life

Calculate the average radial load (Fr_{av}) and average axial load (Fa_{av}).
↓
Calculate the radial load coefficient (X) and the axial load coefficient (Y).
↓
Calculate the life of the bearing and verify the life is allowable.

3 Verifying the static safety coefficient

Calculate the static equivalent radial load (Po).
↓
Verify the static safety coefficient (fs).

Specifications of the main roller bearing

The following table shows the specifications of the main roller bearings built in SHA actuators.

Table 1: Specifications of the main roller bearings

Item / Model	Circular pitch of the roller (dp)	Offset amount (R)	Basic dynamic rated load (C)	Basic static rated load (Co)	Permissible moment load (Mc)	Moment stiffness (Km)
	mm	mm	kN	kN	Nm	$\times 10^4$ Nm/rad
SHA25M-SG	85	27.6	21.8	35.8	258	39.2
SHA25M-CG	85	21.6	21.8	35.8	258	39.2
SHA25M-HP	85	15.3	11.4	20.3	410	37.9
SHA32M-SG	111	34.9	38.2	65.4	580	100
SHA32M-CG	111	25.4	38.2	65.4	580	100
SHA32M-HP	111.5	15	22.5	39.9	932	86.1
SHA40M-SG	133	44	43.3	81.6	849	179
SHA40M-CG	133	29.5	43.3	81.6	849	179
SHA58M-SG	195	62.2	87.4	171	2180	531
SHA65M-SG	218	69	130	223	2740	741

2

Selection guidelines

Maximum load moment load

The formula below shows how to calculate the maximum load moment load (M*max*).
Verify that the maximum load moment load (M*max*) is less than or equal to the permissible moment load (Mc).

◆ **Formula (1): Maximum load moment load**

$$M\ max = \frac{Fr\,max \cdot (Lr + R) + Fa\,max \cdot La}{1000}$$

Symbols used in the formula

M*max*	Maximum load moment load	Nm	
Fr*max*	Max. radial load	N	Refer to Fig.1.
Fa*max*	Max. axial load	N	Refer to Fig.1.
Lr ,La	————	mm	Refer to Fig.1.
R	Offset amount	mm	Refer to Fig.1 and Table 1.

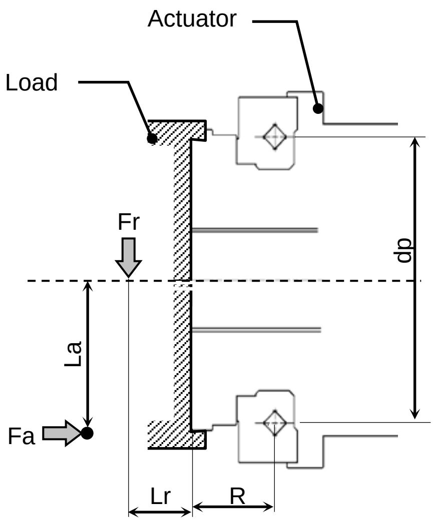


Fig. 1: External load action

Verifying life

Calculating average loads (average radial and axial loads, average output rotational speed)

When the radial and/or axial loads vary during motion, calculate and verify the life of the cross roller bearing converting the loads to their average values.

◆ **Formula (2): Average radial load (Fr*av*)**

$$Fr_{av} = \sqrt[10/3]{\frac{n_1 t_1 |Fr_1|^{10/3} + n_2 t_2 |Fr_2|^{10/3} \cdots n_n t_n |Fr_n|^{10/3}}{n_1 t_1 + n_2 t_2 + \cdots + n_n t_n}}$$

The maximum radial load in section t_1 is given by Fr_1, while the maximum radial load in section t_3 is given by Fr_3.

◆ **Formula (3): Average axial load (Fa*av*)**

$$Fa_{av} = \sqrt[10/3]{\frac{n_1 t_1 |Fa_1|^{10/3} + n_2 t_2 |Fa_2|^{10/3} \cdots n_n t_n |Fa_n|^{10/3}}{n_1 t_1 + n_2 t_2 + \cdots + n_n t_n}}$$

The maximum axial load in section t_1 is given by Fa_1, while the maximum axial load in section t_3 is given by Fa_3.

◆ **Formula (4): Average output rotational speed (N*av*)**

$$N_{av} = \frac{n_1 t_1 + n_2 t_2 + \cdots + n_n t_n}{t_1 + t_2 + \cdots + t_n}$$

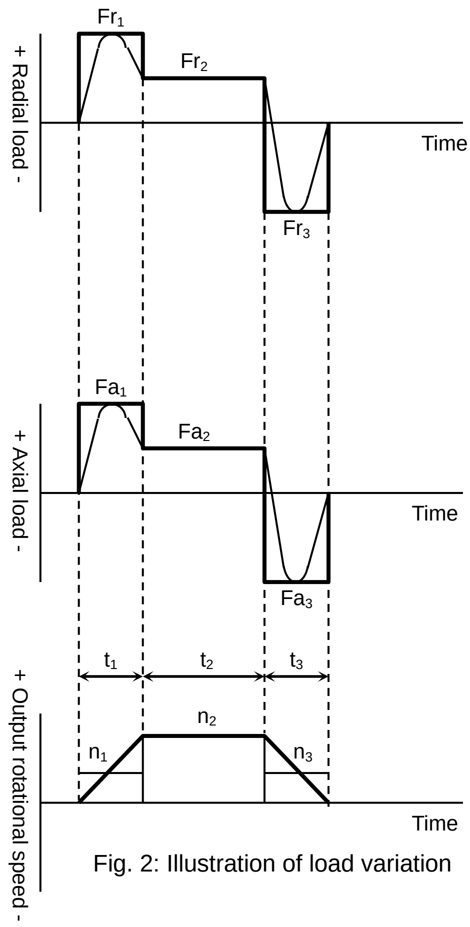


Fig. 2: Illustration of load variation

Radial load coefficient and axial load coefficient

Determine the values of radial load coefficient (X) and axial load coefficient (Y) based on conditional judgment according to formula (5).

Table 2: Radial load coefficient (X), axial load coefficient (Y)

◆ **Formula (5)**	X	Y
$\frac{Fa_{av}}{Fr_{av}+2(Fr_{av}(Lr+R)+Fa_{av}\cdot La)/dp} \leq 1.5$	1	0.45
$\frac{Fa_{av}}{Fr_{av}+2(Fr_{av}(Lr+R)+Fa_{av}\cdot La)/dp} > 1.5$	0.67	0.67

Symbols used in the formulas

Fr_{av}	Average radial load	N	Refer to the average load.
Fa_{av}	Average axial load	N	Refer to the average load.
Lr ,La	————	mm	Refer to Fig.1.
R	Offset amount	mm	Refer to Fig.1 and Table 1.
dp	Pitch circle diameter of a roller	mm	Refer to Fig.1 and Table 1.

Dynamic equivalent radial load

◆ **Formula (6): Dynamic equivalent radial load**

$$Pc = X\cdot\left(Fr_{av}+\frac{2(Fr_{av}(Lr+R)+Fa_{av}\cdot La)}{dp}\right)+Y\cdot Fa_{av}$$

Symbols used in the formulas

Pc	Dynamic equivalent radial load	N	
Fr_{av}	Average radial load	N	Obtained by formula (2).
Fa_{av}	Average axial load	N	Obtained by formula (3).
dp	Pitch circle diameter of a roller	mm	Refer to Table 1.
X	Radial load coefficient	—	Refer to Table 2.
Y	Axial load coefficient	—	Refer to Table 2.
Lr, La	—	mm	Refer to Fig.1.
R	Offset amount	mm	Refer to Fig.1 and Table 1.

Life of cross roller bearing

Calculate the life of cross roller bearing with the formula (7):

◆ **Formula (7): Cross roller bearing life**

$$L_{B-10}=\frac{10^6}{60\times N_{av}}\times\left(\frac{C}{fw\cdot Pc}\right)^{10/3}$$

Symbols used in the formulas

L_{B-10}	Life	hour	—
N_{av}	Average output rotational speed	rpm	Obtained by formula (4).
C	Basic dynamic rated load	N	Refer to Table 1.
Pc	Dynamic equivalent radial load	N	Obtained by formula (6).
fw	Load coefficient	—	Refer to Table 3.

Table 3: Load coefficient

Loaded state	fw
Smooth operation free from impact/vibration	1 to 1.2
Normal operation	1.2 to 1.5
Operation subject to impact/vibration	1.5 to 3

Cross roller bearing life based on oscillating movement

Use formula (8) to calculate the cross roller bearing life against oscillating movement.

◆ **Formula (8): Cross roller bearing life (oscillating)**

$$Loc = \frac{10^6}{60 \times n_1} \times \frac{90}{\theta} \times \left(\frac{C}{fw \cdot Pc}\right)^{10/3}$$

Symbols used in the formulas

Loc	Life	hour	—
n_1	Number of reciprocating oscillation per min.	cpm	—
C	Basic dynamic rated load	N	Refer to Table 1.
Pc	Dynamic equivalent radial load	N	Obtained by formula (6).
fw	Load coefficient	−	Refer to Table 3.
θ	oscillating angle/2	−	Refer to Fig.3.

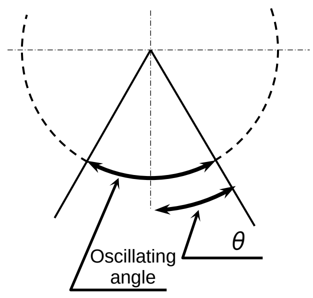


Fig. 3: Oscillating movement

If the oscillating angle is 5° or less, fretting wear may occur because oil film does not form effectively on the contact surface between the race and rolling element of the cross roller bearing. In such cases, consult HDS.

Verifying static safety coefficients

Static equivalent radial load

◆ **Formula (9): Static equivalent radial load**

$$Po = Fr_{max} + \frac{2M_{max}}{dp} + 0.44Fa_{max}$$

Symbols used in the formulas

Fr_{max}	Max. radial load	N	Refer to Fig.1.
Fa_{max}	Max. axial load	N	Refer to Fig.1.
M_{max}	Max. moment load	Nm	Refer to the maximum load weight calculation methods.
dp	Pitch circle diameter of a roller	mm	Refer to Table 1.

Static safety coefficient

Generally, the static equivalent load is limited by the basic static rated load(Co). However, the specific limit should be calculated according to the using conditions and required conditions. In this case, calculate the static safety coefficient (fs) by formula (10).
Table 4 shows general values representing using conditions. Calculate the static equivalent radial load (Po) by formula (9).

◆ **Formula (10): Static safety coefficient**

$$fs = \frac{Co}{Po}$$

Symbols used in the formulas

fs	Static safety coefficient	−	Refer to Table 4.
Co	Basic static rated load	N	Refer to Table 1.
Po	Static equivalent radial load	N	Obtained by formula (9).

Table 4: Static safety coefficients

Using conditions	fs
High rotational accuracy is required, etc.	≧3
Operation subject to impact/vibration	≧2
Normal operation	≧1.5

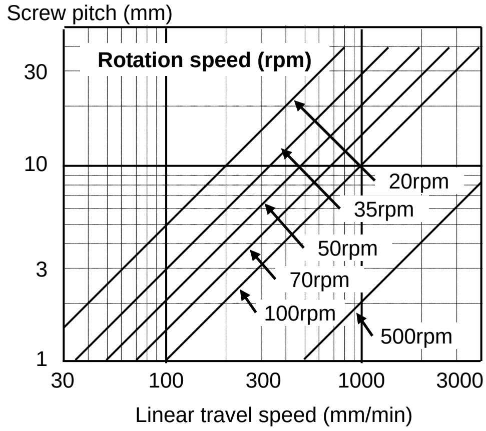
2-4 Verifying operating conditions

The actuator generates heat if started/stopped repeatedly or operated continuously at high speed. Accordingly, examine whether or not the generated heat can be accommodated.
The study is as follows:

Examining actuator rotation speed

Calculate the required rotation speed (rpm) of the load driven by SHA-M series.
For linear operation, use the rotation speed conversion formula below:

$$\text{Rotation speed (r/min)} = \frac{\text{Linear travel speed (mm/min)}}{\text{Screw feed pitch (mm)}}$$



Select an appropriate reduction ratio from 11, 50, 51, 80, 81, 100, 101, 120, 121, 160 and 161 so that the calculated rotation speed does not exceed the maximum rotational speed of SHA-M series actuator.

Calculating and examining load inertia moment

Calculate the load inertia moment of the load driven by SHA-M series actuator.
Refer to [A-2 Calculating inertia moment] (P3) for the calculation.
Based on the calculated result, tentatively select SHA-M series actuator by referring to [Allowable load inertia moment] (P2-1).

Load torque calculation

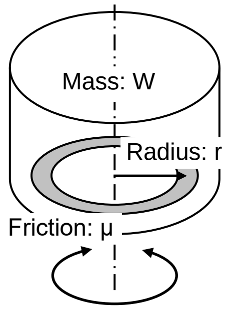
Calculate the load torque as follows:

- Rotary motion

The rotary torque for the rotating mass W on the ring of radius r from the center of rotation is shown in the figure to the right.

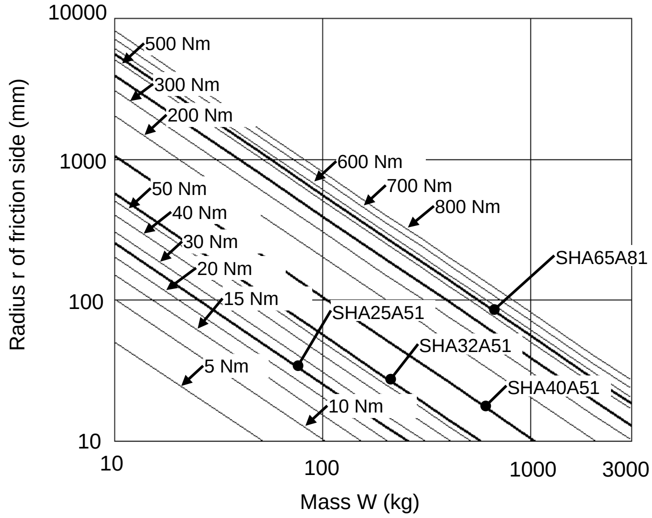
$$T = 9.8 \times \mu \times W \times r$$

T : Rotary torque (Nm)
μ : Friction coefficient
W : Mass (kg)
r : Average radius of friction side (m)



The right graph gives a calculation example when the friction coefficient μ is assumed as 0.1 and the horizontal axis and vertical axis represent mass and rotational radius of friction side, respectively. The actuator toque value shown in the graph indicates 20% of the maximum torque.

Example of rotary torque calculation (friction coefficient = 0.1)
SHA: 20% torque of maximum torque is shown.

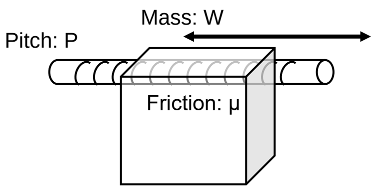


- Linear operation (horizontal operation)

The rotary torque when the mass W moves horizontally due to the screw of pitch P is shown below.

$$T = 9.8 \times \mu \times W \times \frac{P}{2 \times \pi}$$

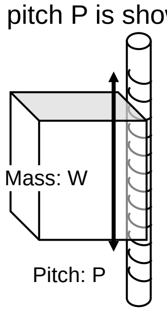
T : Rotary torque (Nm)
μ : friction coefficient
W : mass (kg)
P : Screw feed pitch (m)



- Linear operation (vertical operation)

The rotary torque when the mass W moves vertically due to the screw of pitch P is shown below.

$$T = 9.8 \times W \times \frac{P}{2 \times \pi}$$

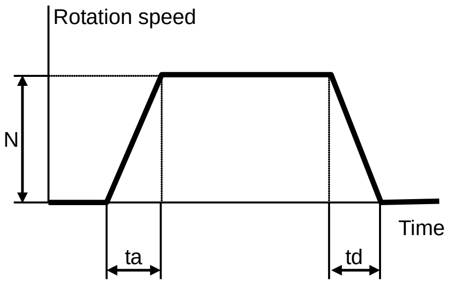


Acceleration time and deceleration time

Calculate acceleration and deceleration times for the selected actuator.

Acceleration time: $t_a = k \times (J_A + J_L) \times \frac{2 \times \pi}{60} \times \frac{N}{T_M - T_L}$

Deceleration time: $t_d = k \times (J_A + J_L) \times \frac{2 \times \pi}{60} \times \frac{N}{T_M + 2 \times T_F + T_L}$



t_a: Acceleration time (s)
t_d: Deceleration time (s)
k: Acceleration reduction coefficient 1 to 1.5
The total positioning time may become shorter if the acceleration is lowered for the purpose of reducing the settling time after positioning.
J_A: Actuator inertia moment (kg·m^2)
J_L: Load inertia moment (kg·m^2)
N: Actuator rotation speed (rpm)
T_M: Maximum actuator torque (Nm)
T_F: Actuator friction torque (Nm)

$T_F = K_T \times I_R - T_R$
K_T: Torque constant (Nm/A)
T_R: Allowable continuous torque (Nm)
I_R: Allowable continuous current (A)

T_L: Load torque (Nm); The polarity is positive (+) when the torque is applied in the rotation direction, or negative (-) when it is applied in the opposite direction.

- **Calculation example 1**

Select an actuator that best suits the following operating conditions:
・Rotation speed: 80 rpm
・Load inertia moment: 1.5 kg·m^2
・Since the load mechanism is mainly inertia, the load torque is negligibly small.

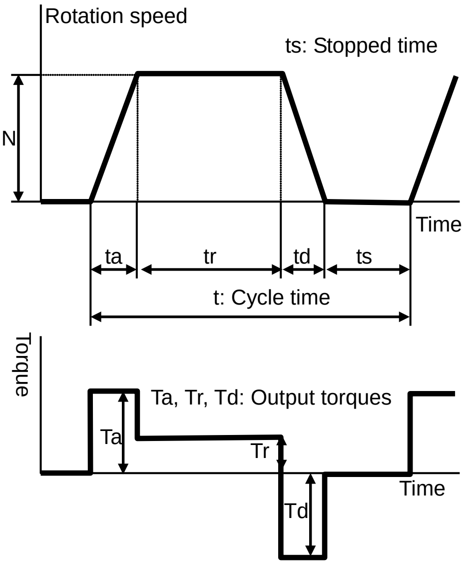
(1) After applying these conditions to the graph in [2-1], SHA25M51SG-B09A200 is tentatively selected.
(2) From the rated table, the following values are obtained: J_A = 0.56 kg·m^2, T_M = 127 Nm, T_R = 41 Nm, K_T = 19 Nm/A, I_R = 3A.
(3) Based on the above formula, the actuator's friction torque T_F is calculated as 19 x 3 - 41 = 16 Nm.
(4) If k = 1.3, the acceleration time and deceleration time can be obtained as follows from the above formulas:
t_a = 1.3 x (0.56+1.5) x 2 x π/60 x 80/127 = 0.177 s
t_d = 1.3 x (0.56+1.5) x 2 x π/60 x 80/(127+2 x 16) = 0.141 s
(5) If the calculated acceleration/deceleration times are too long, correct the situation by:
・Reducing load inertia moment
・Selecting an actuator with a larger frame size

Examining effective torque and average rotation speed

One way to check if the heat generated from the actuator during operation would present a problem is to determine if the point of operation, determined by the effective torque and average rotation speed, is inside the continuous motion range explained in [1-14 Operable range].
Using the following formula, calculate the effective torque T_m and average rotation speed N_{av} when the actuator is operated repeatedly in the drive pattern shown to the right.

$$T_m = \sqrt{\frac{T_a^2 \times t_a + T_r^2 \times t_r + T_d^2 \times t_d}{t}}$$

$$N_{av} = \frac{N/2 \times t_a + N \times t_r + N/2 \times t_d}{t}$$



- t_a : Acceleration time from speed 0 to N (s)
- t_d : Deceleration time from speed N to 0 (s)
- t_r : Operation time at constant speed N (s)
- t : Cycle time (s)
- T_m : Effective torque (Nm)
- T_a : Torque during acceleration (Nm)
- T_r : Torque at constant speed (Nm)
- T_d : Torque during deceleration (Nm)
- N_{av} : Average rotation speed (rpm)
- N : Rotation speed at constant speed (rpm)

- **Calculation example 2**

An example of SHA25M51SG-B09A200 is explained.
Operating conditions: Accelerate an inertia load and then let it move at a constant speed, followed by deceleration, based on conditions similar to those used in calculation example 1. The travel angle per cycle is 120° and the cycle time is 1 second.

(1) The travel angle is calculated from the area of the rotation speed vs. time diagram shown above. In other words, the travel angle is calculated as follows:

$\theta = (N / 60) \times \{t_r + (t_a + t_d) / 2\} \times 360$

Accordingly, $t_r = \theta / (6 \times N) - (t_a + t_d) / 2$

When $\theta = 120°$, and $t_a = 0.177$ (s), $t_d = 0.141$ (s), N = 80 (rpm) in calculation example 1, are applied to this formula, t_r is calculated as 0.091 (s).

(2) Next, calculate the torque during acceleration and torque during deceleration. Based on the acceleration/deceleration time formulas in the preceding section, the relational expressions for torque during acceleration and torque during deceleration if k = 1 are as follows:

$T_a = (J_a+J_L) \times 2 \times \pi / 60 \times N / t_a + T_L$

$T_d = (J_a+J_L) \times 2 \times \pi / 60 \times N / t_d - 2 \times T_F - T_L$

When the values in calculation example 1 are applied to this formula, T_a = 98 (Nm) and T_d = 90 (Nm) are obtained.

(3) Calculate the effective torque. Apply the values in (1) and (2), and T_r = 0 (Nm) and t = 1 (s), to the above formulas.

$$T_m = \sqrt{\frac{98^2 \times 0.177 + 0^2 \times 0.091 + 90^2 \times 0.141}{1}} = 53\ Nm$$

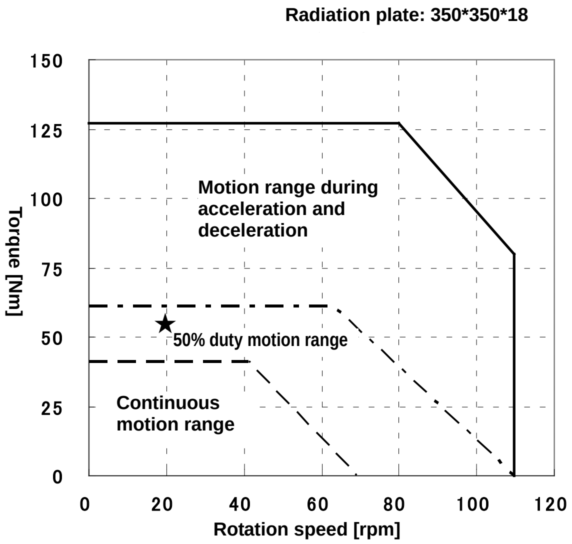
(4) Calculate the average rotation speed. Apply the values in (1), and N = 80 (rpm) and t = 1 (s), to the above formulas.

$$N_{av} = \frac{80/2 \times 0.177 + 80 \times 0.091 + 80/2 \times 0.141}{1} = 20\ r/min$$

(5) The figure on the right shows the points of operation determined by the effective torque and average rotation speed calculated above, plotted on the graph of operable range of SHA25M51, exceeding the continuous motion range. The conclusion is that this actuator cannot be operated continuously under these conditions. Accordingly,

- ◆the operation pattern
- ◆load (possible reduction)
- ◆actuator size

etc., must be reexamined



Operable range of SHA25M51

The following formula is a modified version of the formula for effective torque. By applying the value of allowable continuous torque to T_m in this formula, the allowable cycle time can be calculated.

$$t = \frac{T_a^{\,2} \times t_a + T_r^{\,2} \times t_r + T_d^{\,2} \times t_d}{T_m^{\,2}}$$

Apply the following: T_a = 98 Nm, T_r = 0 Nm, T_d = 90 Nm, T_m =41 Nm, t_a = 0.177 s, t_r = 0.091 s, t_d = 0.141 s Then, the following equation is obtained:

$t = (98^2 \times 0.177 + 90^2 \times 0.141)/ 41^2 = 1.69$ s

Based on the result, setting the cycle time to 1.7 seconds or more to provide a longer stopped time gives T_m = 41 Nm or less, thereby permitting continuous operation within the allowable continuous torque.

Caution

- The aforementioned continuous motion range represents an allowable range where the actuator installed on a specified aluminum radiation plate is operated under natural air cooling. If the radiation area of the mounting member is small or heat conduction of the material is poor, adjust the operating conditions to keep the rise in the actuator's ambient temperature to 40 K or less as a guide.

Chapter 3

Installing SHA actuator

The following explains the installation procedures of the actuators.

3-1 Product Verification 3-1
3-2 Notices on handling 3-2
3-3 Location and installation 3-6

3-1 Product Verification

Check the following items after unpacking the package.

Verification steps

1 Check the items thoroughly for damage sustained during transportation.

If any item is damaged, immediately contact the dealer.

2 Check if the actuator is what you ordered.

The nameplate is found on the rear face of SHA series actuator. Check the TYPE field on the nameplate to confirm that it is indeed the model you have ordered. If any item is wrong, immediately contact the dealer.
Refer to the section 1-2 in this manual for the detail of the model codes.

3 Check if the servo amplifier combinations are correct.

Check that this is the model combination given in this document in Chapter 1 Section 2 “Combinations with servo amplifier and extension cables” column.

4 Check if the driver input voltages being input are correct.

The value of the power voltage input is shown in the servo amplifier nameplate “INPUT” column. If the voltage to be supplied is different from the label voltage, immediately contact the dealer it was purchased from.

WARNING

Do not combine with an actuator other than the one given in this document.

The characteristics of the servo amplifier have been adjusted according to the actuator. A wrong combination of “servo amplifier” and “actuator” may cause inadequate torque or overcurrent that may cause burn damage to the actuator, injury or fire.

Do not connect a supply voltage other than the voltage specified on the servo amplifier’s nameplate.

Connecting a power supply not matching the input voltage specified on the nameplate may result in damage to the servo amplifier, injury or fire.

3-2 Notices on handling

Handle SHA series actuator carefully by observing the notices specified below.

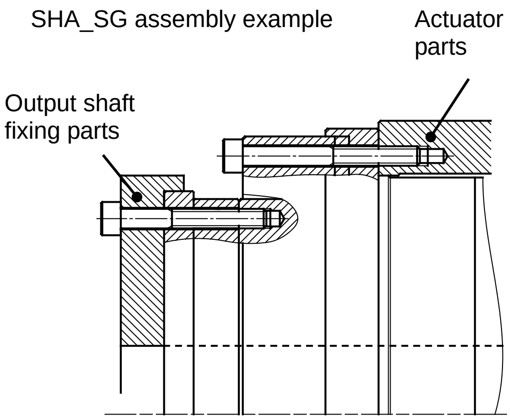
CAUTION

(1) **Do not apply any excessive force or impact, especially to the actuator's output shaft.**
(2) **Do not put SHA series actuator on a table, shelf, etc., where the actuator could easily fall.**
(3) **Do not connect the actuator terminals directly to the power supply. The actuator may burn and cause fire or electric shock.**
(4) **The allowable storage temperature is -20 to +60℃. Do not expose the actuator to direct sunlight for long periods of time or store it in areas in low or high temperature.**
(5) **The allowable relative storage humidity is 80% or less. Do not store the actuator in a very humid place or in areas where temperatures are likely to fluctuate greatly during day and night.**
(6) **Do not use or store the actuator in locations subject to flammable or corrosive gases or dust particles.**
(7) **The large sizes (SHA58, SHA65) are heavy. Handling these sizes may cause lower back pain, or injury if the actuator drops or topples and you get pinned underneath. Handle your actuator with due care by wearing safety shoes or take other proper precaution and also by using supporting jigs.**

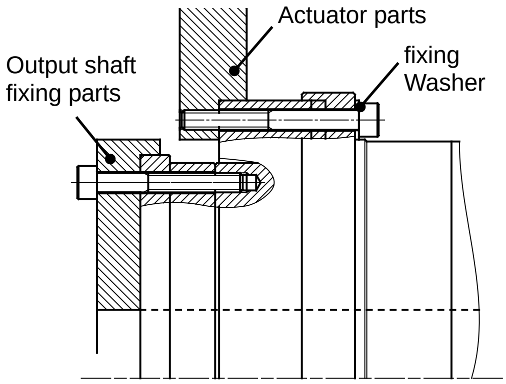
Installation and transmission torque

Examples of actuator assembly are shown below. Assembly examples 1 and 2 are for SHA_SG, 3 and 4 are for SHA_CG. Use high-tension bolts and tighten them with a torque wrench to control the tightening torque. In assembly example 2, use flat washers because the tightening torque is high and the actuator flange is made of aluminum.

SHA_SG assembly example

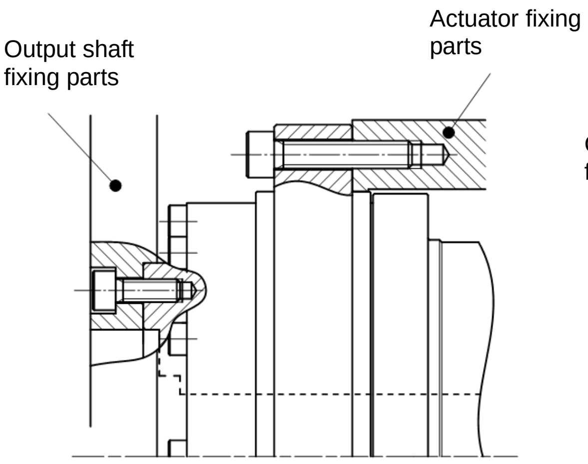


Assembly example 1

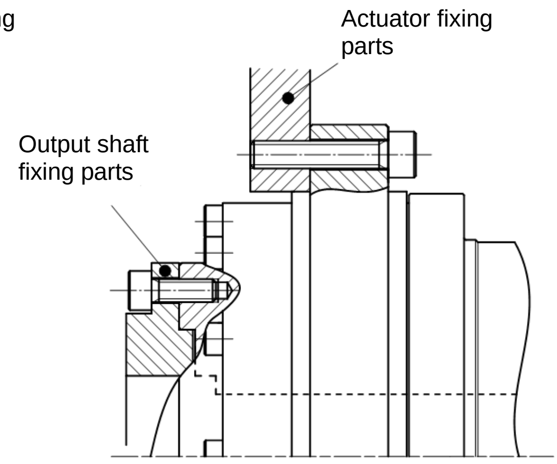


Assembly example 2

SHA-CG assembly example



Assembly example 3



Assembly example 4

● Recommended tightening torque and transmission torque

SG/HP

Item \ Model		SHA25M		SHA32M		SHA40M	
		Output shaft	Actuator	Output shaft	Actuator	Output shaft	Actuator
Number of bolts, size		16-M4 (12-M4)	12-M4	16-M5 (12-M5)	12-M5	16-M6	12-M6
Bolt installation P.C.D.	mm	77	102 (127)	100	132 (157)	122	158
Tightening torque	Nm	4.5	4.5 (3.2)	9	9 (6.4)	15.3	15.3
	Kgf･m	0.46	0.46 (0.33)	0.92	0.92 (0.65)	1.56	1.56
Transmission torque	Nm	433 (325)	430 (381)	900 (675)	891 (754)	1560	1510
	kgf･m	44 (33.2)	44 (38.9)	92 (68.9)	91 (76.9)	159	154

The values in parenthesis are those combined with the hollow planetary speed reducer HPF series for precision control.

Item \ Model		SHA58M		SHA65M	
		Output shaft	Actuator	Output shaft	Actuator
Number of bolts, size		12-M10	16-M8	16-M10	16-M10
Bolt installation P.C.D.	mm	178	226	195	258
Tightening torque Notes 1, 2	Nm	74	37	74	74
	Kgf･m	7.5	3.8	7.5	7.5
Transmission torque Note 3	Nm	4940	5230	7210	9550
	kgf･m	504	533	735	974

CG

Item \ Model		SHA25M		SHA32M		SHA40M	
		Output shaft	Actuator	Output shaft	Actuator	Output shaft	Actuator
Number of bolts, size		12-M5	8-M6	12-M6	12-M6	12-M8	12-M10
Bolt installation P.C.D.	**mm**	72	131	96	162	116	203
Tightening torque	**Nm**	9	11	15.3	11	37	52
	kgf·m	0.92	1.1	1.6	1.1	3.8	5.3
Transmission torque	**Nm**	486	600	918	1114	2012	2639
	kgf·m	50	61	94	114	205	269

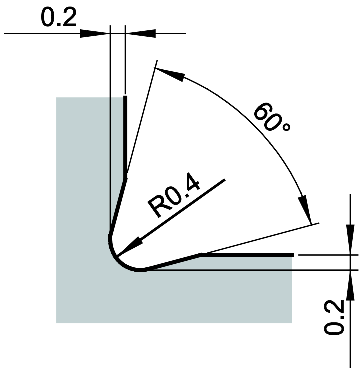
Note 1) The female thread material is premised to withstand the bolt tightening torque
2) Recommended bolt: Hexagonal bolt per JIS B 1176 Intensity category: JIS B 1051 12.9 or higher
3) Calculation conditions Torque efficiency: 0.2 Tightening efficiency: 1.4 Tightening friction coefficient: 0.15

Precautions on installation

When designing the assembly, take note that application of any abnormal or excessive force that causes deformation of the installation surface may result in performance drop. To demonstrate the excellent performance of SHA-M series actuator fully, take note of the following points:

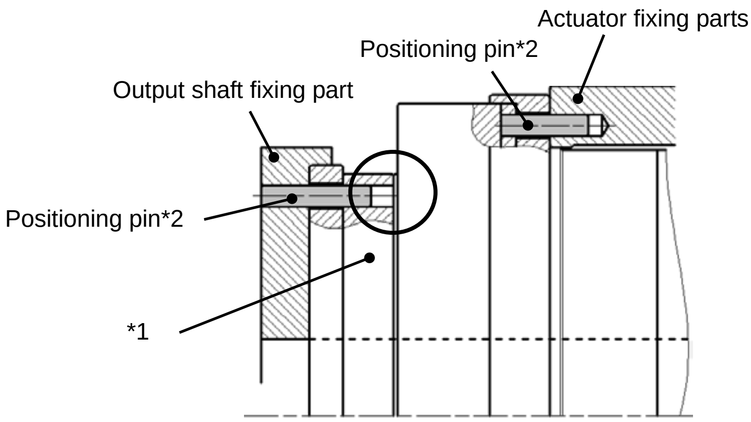
- Warp and deformation on the mounting surface
- Blocking of foreign matter
- Burrs, rising and abnormal position accuracy around tapped mounting holes
- Insufficient chamfering of mounting faucet joint
- Abnormal circularity of mounting faucet joint

When the installation method is as shown in assembly example 2 on the previous page, the recessing shown to the right is recommended for the fixing part mounting faucet joint corner section.



Use of positioning pins

The SHA-M series SG type has positioning pin holes in the output rotary unit and flange fixed to the actuator. The SHA-M series CG type has positioning pin holes only in the output rotary unit. Use these pins as necessary. For details, refer to [1-6 External dimensions] (P1-16) or the illustrated specifications.



Example of use of positioning pins

*1. Do not drive positioning pins into the output rotary unit, but keep proper fitting clearances to the actuator parts. Failure to do so may result in lower positional accuracy.
*2. The hollow planetary speed reducer model is not equipped with a positioning pin.

Surface treatments

Standard SHA-M series actuators are given the following surface treatments:

SG/HP

Location	Surface treatments
Housing	No treatment (aluminum material is exposed)
Output shaft bearing	Raydent treatment
Speed reducer rotating part	Chrome plating
Output flange	Nickel plating or Raydent treatment
Hollow shaft (sleeve)	Nickel plating
Bolt	Chrome plating

CG

Location	Surface treatments
Housing	No treatment (aluminum material is exposed)
Output shaft bearing	Low temperature, black chrome plating
Speed reducer rotating part	Low temperature, black chrome plating
Output flange	Nickel plating or Raydent treatment
Hollow shaft (sleeve)	Nickel plating
Bolt	Chrome plating

The surface treatments given to SHA-M series actuators do not fully prevent rust.

3-3 Location and installation

Installing environment

The environmental conditions of the installation location for SHA-M series actuators must be as follows. Determine an appropriate installation location by observing these conditions without fail.

- ◆ Operating temperature: 0 to 40℃
  The temperature in the cabinet may be higher than the atmosphere depending on the power loss of housed devices and size of the cabinet. Plan the cabinet size, cooling system, and device locations so the ambient temperature of the actuator is kept 40℃ or below.
- ◆ Operating humidity: Relative humidity of 20 to 80%.
  Make sure no condensation occurs. Take note that condensation is likely to occur in a place where there is a large temperature change between day and night or when the actuator is started/stopped frequently.
- ◆ Vibration: 25 m/s^2 (10 to 400Hz) or less (Refer to [1-13 Resistance to vibration] (P1-38))
- ◆ Impact: 300 m/s^2 or less (Refer to [1-12 Shock resistance] (P1-37))
- ◆ Use environment: Free from condensation, metal powder, corrosive gases, water, oil mist, flammable gases, etc.
- ◆ Protection class: Standard products are structurally designed to meet the IP-54 requirements.

  The protection class against water entry is as follows:
  4: Protected against water splashed from all directions.

  The protection class against contact and entry of foreign matter is as follows:
  5: Protected against entry of dust/dirt. Entry of water or foreign matter caused by incomplete protection must not affect the operation of the system.

  However, rotating and sliding areas (oil seal areas) and connectors of SHA25M, 32M and 40M are not IP-54-compliant. Also, when an SHA58M or 65M encoder connector converter cable is used, the actuator side is protected in fitted conditions, but this does not apply to the connector at the servo amplifier side.
  SHA58M and 65M motor connector sections are protected in fitted conditions.
- ◆ Locate the driver indoors or within an enclosure. Do not expose it to the sunlight.
- ◆ Altitude: lower than 1,000 m above sea level
- ◆ The oil seals in rotating and sliding areas do not fully prevent leakage of lubricant. If the actuator is used in a clean room, etc., provide additional oil leakage prevention measures.

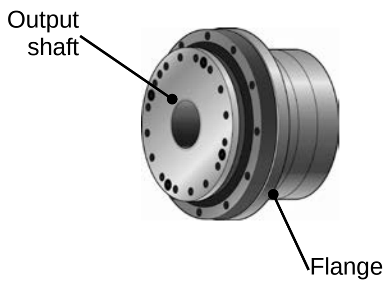
Installation

The SHA series actuator drives mechanical load system at high accuracy.
When installing the actuator, pay attention to precision and do not tap the actuator output part with a hammer, etc. The actuator houses an encoder. Excessive impact may damage the encoder.

Installation procedure

1 Align the axis of rotation of the actuator and the load mechanism precisely.

Note 1: Perform this alignment carefully, especially when a rigid coupling is used. Even slight misalignment may cause the permissible load of the actuator to be exceeded, resulting in damage to the output shaft.



2 Connect the servo amplifier and wiring.

An extension cable is provided. Use it when wiring the driver. For details on wiring, refer to [1-15 Cable specifications] (P1-50) and the manual of your MELSERVO-J4 servo amplifier.

3 Wire the motor cable and encoder cable.

Do not pull the cables with a strong force. The connection points may be damaged. Install the cable with slack not to apply tension to the actuator. Provide a sufficient bending radius (at least 6 times the cable diameter), especially when the cable flexes.

Caution

- Do not bring strong magnetic items (magnet chucks, permanent magnets, etc.) near the rear cover of the actuator. Encoder abnormality may result.
- This encoder retains absolute positions by means of the servo amplifier's battery or its own built-in capacitor when the power is switched OFF. If the encoder cable is disconnected for maintenance, etc., turn on the servo amplifier power and charge the backup capacitor first. After 3 hours of charge, the encoder cable can be disconnected for 30 minutes, provided that the axis is stopped and ambient temperature is 25℃. However, when the backup capacitor is deteriorated, the absolute positions may not be retained.

WARNING

Do not disassemble/reassemble the actuator.
The actuator uses many precision parts. If the actuator is disassembled/reassembled by the customer, it may cause burn damage or uncontrollable operation of the actuator, resulting in fire or injury.

Chapter 4

Options

This chapter explains the options available for SHA series actuator.

4-1 Options··· 4-1

4-1 Options

With near origin and end limit sensors (option code: L)

Revolution sensors are directly connected to the output shaft on the counter-output side of the actuator. Use this option if the mechanical origin is needed (when the virtual origin of the absolute encoder does not do the job) or you want to define an operation range as a safety measure. SHA20A is not compatible.

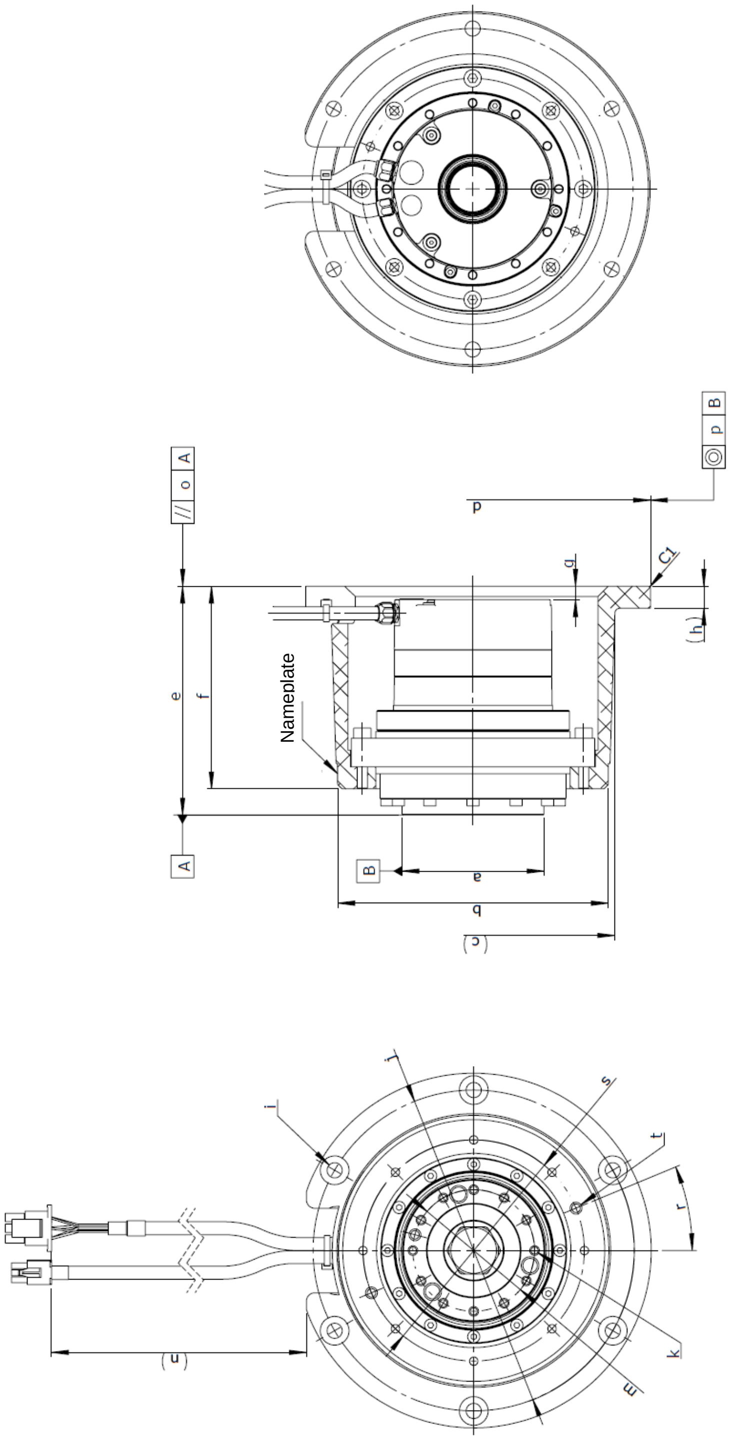
Side exiting cable (option code: Y)

The cables (motor and encoder wires) exit from the side face of the actuator.
Use this option if the actuator is housed in a system and there is not enough space at the rear of the housing.
This option is not available with the SHA58M and SHA65M.
For details on cable exiting from side face, contact our sales office.

With stand (CG type, option code: V)

The model with an optional stand is available for purchase to use the CG type for table drive. In this case, the cable is taken out from the side of the actuator (option code: Y). The models with near home & end limit sensors (option code: L) are not supported.

●Outline drawing of the actuator with an optional stand



●Dimensions and installation specifications of the actuator with an optional stand

Item	Unit	SHA20	SHA25	SHA32	SHA40
a	mm	ϕ69 h7 0/-0.030	ϕ84 h7 0/-0.035	ϕ110 h7 0/-0.035	ϕ132 h7 0/-0.040
b	mm	ϕ135	ϕ160	ϕ198	ϕ248
c	mm	ϕ143	ϕ168	ϕ208	ϕ258
d	mm	ϕ177 h7 0/-0.040	ϕ210 h7 0/-0.046	ϕ260 h7 0/-0.052	ϕ316 h7 0/-0.057
e	mm	133±0.3	135.5±0.3	152±0.3	180±0.3
f	mm	118	120	133	163
g	mm	7.5	8	8	10
h	mm	11	13	13	20
i	mm	6-ϕ6.6 counterbore ϕ13 depth 1	6-ϕ9 counterbore ϕ17 depth 1	6-ϕ11 counterbore ϕ21 depth 1	6-ϕ13 counterbore ϕ25 depth 1
j	mm	ϕ161	ϕ190	ϕ234	ϕ288
k	-	12-M4×7	12-M5×8	12-M6×10	12-M8×12
m	mm	ϕ60	ϕ72	ϕ96	ϕ116
n	mm	170	160	150	130
o Note1)	mm	0.050	0.055	0.060	0.070
p Note1)	mm	ϕ0.080	ϕ0.080	ϕ0.090	ϕ0.100
r	°	60	22.5	45	90
s	mm	ϕ107	ϕ131	ϕ162	ϕ203
t	mm	2-M6 depth 11	2-M8 depth 13	2-M8 depth 15	2-M12 depth 23
Mass Note2)	kg	4.4（4.5）	6.1（6.2）	11.6（11.9）	20（21）
Section i Note 5: Bolts used	-	6-M6	6-M8	6-M10	6-M12
Section i Recommended tightening torque	Nm	11	26	52	90

Note 1) All values are T.I.R. (Total Indicator Reading).
2) The values in parentheses are for models with a brake.
3) For detailed dimensions and specifications of the actuator, refer to the illustrated specifications.
4) Cast aluminum is used for the material of the stand. No surface treatment has been applied.
5) Use flat washers when installing the product.

Extension cables

These extension cables are used to connect SHA-M series actuators and MELSERVO-J4 servo amplifiers.
Two types of extension cables are available for motor (including brake wire) and absolute encoder.
You must use an extension cable to connect your SHA-M series actuator and MELSERVO-J4 servo amplifier.

Motor extension cable:

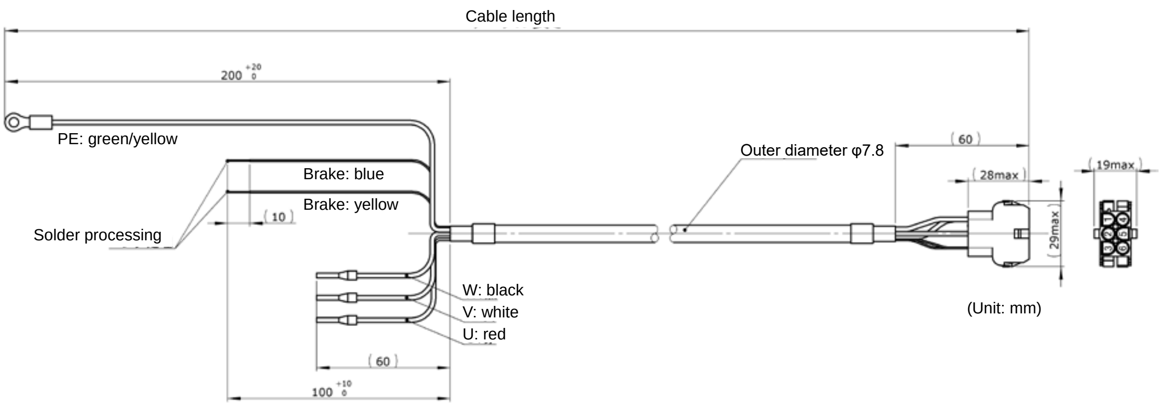
- **Actuator size Nos 25, 32, 40**

EWD-MB**-A06-TMC-M

Cable length (02 = 2m, 05 = 5m, 10 = 10m)

(** in the model code indicates the cable length (02 = 2m, 05 = 5m, 10 = 10m).)

[Servo amplifier side] [Actuator side]



- **Actuator size No. 58**

EWD-MB**-D09-TMC-M1

Cable length (02 = 2m, 05 = 5m, 10 = 10m)

[Actuator side] [Servo amplifier side]

Cable length

PE: green/yellow
U: red
V: white
W: black
Brake: blue
Brake: yellow
Solder processing
Outer diameter φ13.4

(Unit: mm)

- **Actuator size 65**

EWD-MB**-D09-TMC-M2

** : Cable length (02 = 2m, 05 = 5m, 10 = 10m)

[Actuator side]

[Servo amplifier side]

Cable length

PE: green/yellow

U: red

V: white

W: black

Brake: blue

Brake: yellow

Solder processing

Outer diameter φ13.4

(Unit: mm)

Encoder extension cable:

- **Actuator size 25, 32, 40, 58, 65**

MR-EKCBL**M-*

* : H: Long flex life product, L: Standard product

** : Cable length (2 = 2m, 5 = 5m, 10 = 10m)

For details on encoder relay cable, contact Mitsubishi Electric customer support.

Appendix

A-1 Unit conversion ········· A-1
A-2 Calculating inertia moment ········· A-3

A-1 Unit conversion

This manual employs SI system for units. Conversion factors between the SI system and other systems are as follows:

(1) Length

SI system	m	
	↓	
Unit	ft.	in.
Factor	3.281	39.37

Unit	ft.	in.
Factor	0.3048	0.0254
	↓	
SI system	m	

(2) Linear speed

SI system	m/s			
	↓			
Unit	m/min	ft./min	ft./s	in/s
Factor	60	196.9	3.281	39.37

Unit	m/min	ft./min	ft./s	in/s
Factor	0.0167	5.08×10^{-3}	0.3048	0.0254
	↓			
SI system	m/s			

(3) Linear acceleration

SI system	m/s^2			
	↓			
Unit	m/min^2	$ft./min^2$	$ft./s^2$	in/s^2
Factor	3600	1.18×10^4	3.281	39.37

Unit	m/min^2	$ft./min^2$	$ft./s^2$	in/s^2
Factor	2.78×10^{-4}	8.47×10^{-5}	0.3048	0.0254
	↓			
SI system	m/s^2			

(4) Force

SI system	N		
	↓		
Unit	kgf	lb (force)	oz (force)
Factor	0.102	0.225	4.386

Unit	kgf	lb (force)	oz (force)
Factor	9.81	4.45	0.278
	↓		
SI system	N		

(5) Mass

SI system	kg	
	↓	
Unit	lb.	oz.
Factor	2.205	35.27

Unit	lb.	oz.
Factor	0.4535	0.02835
	↓	
SI system	kg	

(6) Angle

SI system	rad		
	↓		
Unit	deg.	min.	sec.
Factor	57.3	3.44×10^3	2.06×10^5

Unit	deg.	min.	sec.
Factor	0.01755	2.93×10^{-4}	4.88×10^{-6}
	↓		
SI system	rad		

(7) Angular speed

SI system	rad/s			
	↓			
Unit	deg/s	deg/min	r/s	rpm
Factor	57.3	3.44×10^3	0.1592	9.55

Unit	deg/s	deg/min	r/s	rpm
Factor	0.01755	2.93×10^{-4}	6.28	0.1047
	↓			
SI system	rad/s			

(8) Angular acceleration

SI system	rad/s²	
↓		
Unit	deg/s²	deg/min²
Factor	57.3	3.44×10^{3}

Unit	deg/s²	deg/min²
Factor	0.01755	2.93×10^{-4}
↓		
SI system	rad/s²	

(9) Torque

SI system	N·m			
↓				
Unit	kgf·m	lb·ft	lb·in	oz·in
Factor	0.102	0.738	8.85	141.6

Unit	kgf·m	lb·ft	lb·in	oz·in
Factor	9.81	1.356	0.1130	7.06×10^{-3}
↓				
SI system	N·m			

(10) Inertia moment

SI system	kg·m²							
↓								
Unit	kgf·m·s²	kgf·cm·s²	lb·ft²	lb·ft·s²	lb·in²	lb·in·s²	oz·in²	oz·in·s²
Factor	0.102	10.2	23.73	0.7376	3.42×10^{3}	8.85	5.47×10^{4}	141.6

Unit	kgf·m·s²	kgf·cm·s²	lb·ft²	lb·ft·s²	lb·in²	lb·in·s²	oz·in²	oz·in·s²
Factor	9.81	0.0981	0.0421	1.356	2.93×10^{-4}	0.113	1.829×10^{-5}	7.06×10^{-3}
↓								
SI system	kg·m²							

(11) Torsional spring constant, moment stiffness

SI system	N·m/rad				
↓					
Unit	kgf·m/rad	kgf·m/arc min	kgf·m/ deg	lb·ft/ deg	lb·in/ deg
Factor	0.102	2.97×10^{-5}	1.78×10^{-3}	0.0129	0.1546

Unit	kgf·m/rad	kgf·m/arc min	kgf·m/ deg	lb·ft/ deg	lb·in/ deg
Factor	9.81	3.37×10^{4}	562	77.6	6.47
↓					
SI system	N·m/rad				

A-2 Calculating inertia moment

Formula of mass and inertia moment

(1) Both centerlines of rotation and gravity are the same:

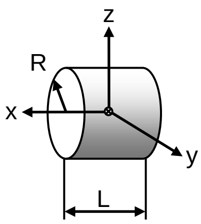
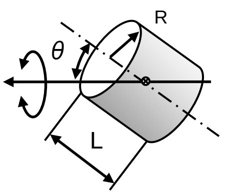
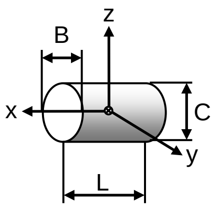
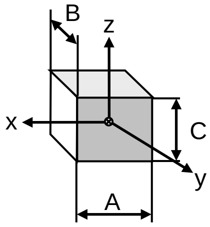
The following table includes formulas to calculate mass and inertia moment.

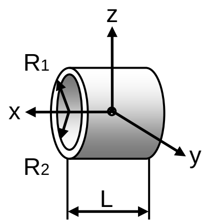
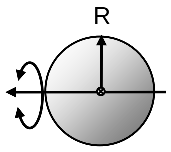
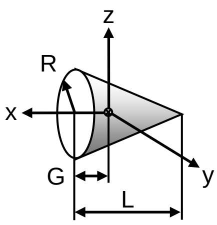
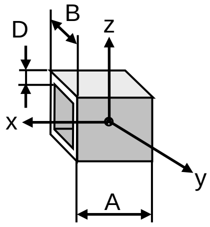
m : mass (kg), Ix, Iy, Iz: inertia moments which rotates around x-, y-, z-axes respectively ($kg \cdot m^2$)

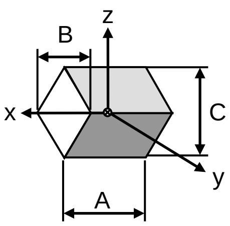
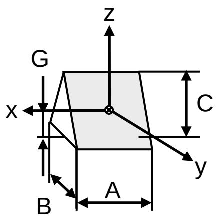
G : distance from end face of gravity center (m)

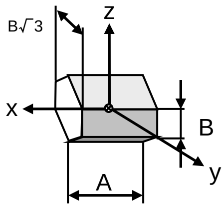
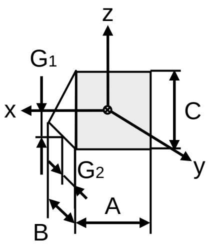
ρ : specific gravity

Unit Length: m, Mass: kg, Inertia moment: $kg \cdot m^2$

Object form	Mass, inertia, gravity center
Cylinder 	$m = \pi R^2 L \rho$ $Ix = \frac{1}{2} m R^2$ $Iy = \frac{1}{4} m \left(R^2 + \frac{L^2}{3} \right)$ $Iz = \frac{1}{4} m \left(R^2 + \frac{L^2}{3} \right)$
Slanted cylinder 	$m = \pi R^2 L \rho$ $I_\theta = \frac{1}{12} m$ $\times \left\{ 3R^2 \left(1 + \cos^2\theta \right) + L^2 \sin^2\theta \right\}$
Ellipsoidal cylinder 	$m = \frac{1}{4} BCL\rho$ $Ix = \frac{1}{16} m \left(B^2 + C^2 \right)$ $Iy = \frac{1}{4} m \left(\frac{C^2}{4} + \frac{L^2}{3} \right)$ $Iz = \frac{1}{4} m \left(\frac{B^2}{4} + \frac{L^2}{3} \right)$
Rectangular pillar 	$m = ABC\rho$ $Ix = \frac{1}{12} m \left(B^2 + C^2 \right)$ $Iy = \frac{1}{12} m \left(C^2 + A^2 \right)$ $Iz = \frac{1}{12} m \left(A^2 + B^2 \right)$

Object form	Mass, inertia, gravity center
Circular pipe  R_1: Outer diameter R_2: Inner diameter	$m = \pi \left(R_1^2 - R_2^2 \right) L \rho$ $Ix = \frac{1}{2} m \left(R_1^2 + R_2^2 \right)$ $Iy = \frac{1}{4} m \left\{ \left(R_1^2 + R_2^2 \right) + \frac{L^2}{3} \right\}$ $Iz = \frac{1}{4} m \left\{ \left(R_1^2 + R_2^2 \right) + \frac{L^2}{3} \right\}$
Ball 	$m = \frac{4}{3} \pi R^3 \rho$ $I = \frac{2}{5} m R^2$
Cone 	$m = \frac{1}{3} \pi R^2 L \rho$ $Ix = \frac{3}{10} m R^2$ $Iy = \frac{3}{80} m \left(4R^2 + L^2 \right)$ $Iz = \frac{3}{80} m \left(4R^2 + L^2 \right)$ $G = \frac{L}{4}$
Square pipe 	$m = 4AD(B-D)\rho$ $Ix = \frac{1}{3} m \left\{ (B-D)^2 + D^2 \right\}$ $Iy = \frac{1}{6} m \left\{ \frac{A^2}{2} + (B-D)^2 + D^2 \right\}$ $Iz = \frac{1}{6} m \left\{ \frac{A^2}{2} + (B-D)^2 + D^2 \right\}$

Object form	Mass, inertia, gravity center
Rhombus pillar 	$m=\frac{1}{2}ABC\rho$ $Ix=\frac{1}{24}m\left(B^2+C^2\right)$ $Iy=\frac{1}{24}m\left(C^2+2A^2\right)$ $Iz=\frac{1}{24}m\left(B^2+2A^2\right)$
Isosceles triangle pillar 	$m=\frac{1}{2}ABC\rho$ $Ix=\frac{1}{12}m\left(\frac{B^2}{2}+\frac{2}{3}C^2\right)$ $Iy=\frac{1}{12}m\left(A^2+\frac{2}{3}C^2\right)$ $Iz=\frac{1}{12}m\left(A^2+\frac{B^2}{2}\right)$ $G=\frac{C}{3}$

Object form	Mass, inertia, gravity center
Hexagonal pillar 	$m=\frac{3\sqrt{3}}{2}AB^2\rho$ $Ix=\frac{5}{12}mB^2$ $Iy=\frac{1}{12}m\left(A^2+\frac{5}{2}B^2\right)$ $Iz=\frac{1}{12}m\left(A^2+\frac{5}{2}B^2\right)$
Right triangle pillar 	$m=\frac{1}{2}ABC\rho$ $Ix=\frac{1}{36}m\left(B^2+C^2\right)$ $Iy=\frac{1}{12}m\left(A^2+\frac{2}{3}C^2\right)$ $Iz=\frac{1}{12}m\left(A^2+\frac{2}{3}B^2\right)$ $G_1=\frac{C}{3}$ $G_2=\frac{B}{3}$

- **Example of specific gravity**

The following tables show references of specific gravity. Confirm the specific gravity for the material of the drive load.

Material	Specific gravity
SUS304	7.93
S45C	7.86
SS400	7.85
Cast iron	7.19
Copper	8.92
Brass	8.50

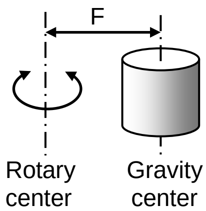
Material	Specific gravity
Aluminum	2.70
Duralumin	2.80
Silicon	2.30
Quartz glass	2.20
Teflon	2.20
Fluorocarbon resin	2.20

Material	Specific gravity
Epoxy resin	1.90
ABS	1.10
Silicon resin	1.80
Polyurethane rubber	1.25

(2) Both centerlines of rotation and gravity are not the same:

The following formula calculates the inertia moment when the rotary center is different from the gravity center.

$$I=Ig+mF^2$$



I: Inertia moment when the gravity center axis does not match the rotational axis (kg·m²)

I_g: Inertia moment when the gravity center axis matches the rotational axis (kg·m²)
Calculate according to the shape by using formula (1).

m: mass (kg)

F: Distance between rotary center and gravity center (m)

(3) Inertia moment of linear operation objects

The inertia moment, converted to actuator axis, of a linear motion object driven by a screw, etc., is calculated using the formula below.

$$I=m\left(\frac{P}{2\pi}\right)^2$$

I: Inertia moment of a linear operation object converted to actuator axis (kg·m²)

m: mass (kg)

P: Linear travel per actuator one revolution (m/rev)

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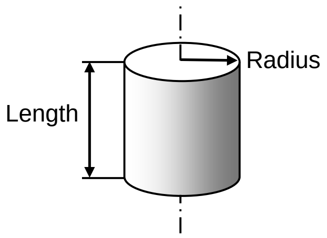
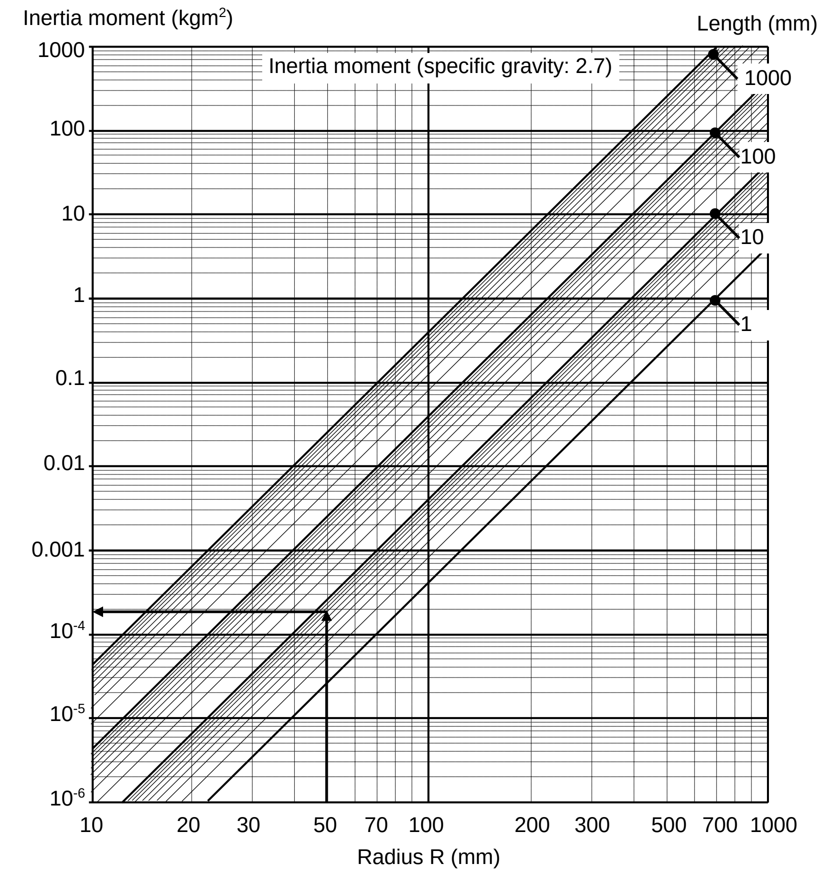
Inertia moment of cylinder

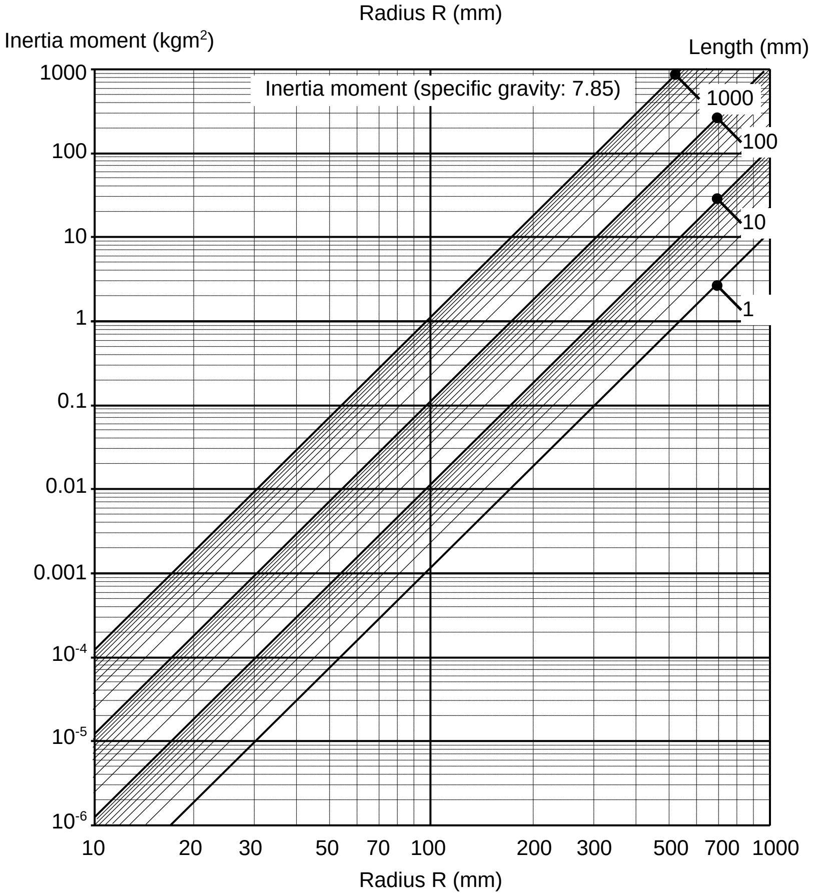
The inertia moment of a cylinder may be obtained from the graphs to the right.



Apply the top graph to aluminum materials (specific gravity: 2.7) and bottom graph to steel materials (specific gravity: 7.85).

(Example)
Material: Aluminum
Outer diameter: 100mm
Length: 7mm
Shape: Column
Since the outer diameter is 100mm, the radius is 50mm. Therefore, the above graph gives the inertia moment as follows:
Approx. 1.9 x 10^{-4} kg・m^2
(Calculated value: 0.000186 kg・m^2)





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Warranty Period and Terms

The equipment listed in this document is warranted as follows:

■Warranty period

Under the condition that the actuator are handled, used and maintained properly followed each item of the documents and the manuals, all the applicable products are warranted against defects in workmanship and materials for the shorter period of either one year after delivery or 2,000 hours of operation time.

■Warranty terms

All the applicable products are warranted against defects in workmanship and materials for the warranted period. This limited warranty does not apply to any product that has been subject to:

(1) user's misapplication, improper installation, inadequate maintenance, or misuse.
(2) disassembling, modification or repair by others than Harmonic Drive Systems, Inc.
(3) imperfection caused by a non-applicable product.
(4) disaster or others that does not belong to the responsibility of Harmonic Drive Systems, Inc.

Our liability shall be limited exclusively to repairing or replacing the product only found by Harmonic Drive Systems, Inc. to be defective. Harmonic Drive Systems, Inc. shall not be liable for consequential damages of other equipment caused by the defective products, and shall not be liable for the incidental and consequential expenses and the labor costs for detaching and installing to the equipment.

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All specifications and dimensions in this manual subject to change without notice.

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