RH Series

The RH series includes compact and high-torque DC servo actuators with a high rotational accuracy combining a speed reducer HarmonicDrive® for precision control and a DC servo motor. A combination with a dedicated servo driver that fully demonstrates the performance of this RH series of implements; compact machines and equipment with a high rotational accuracy.

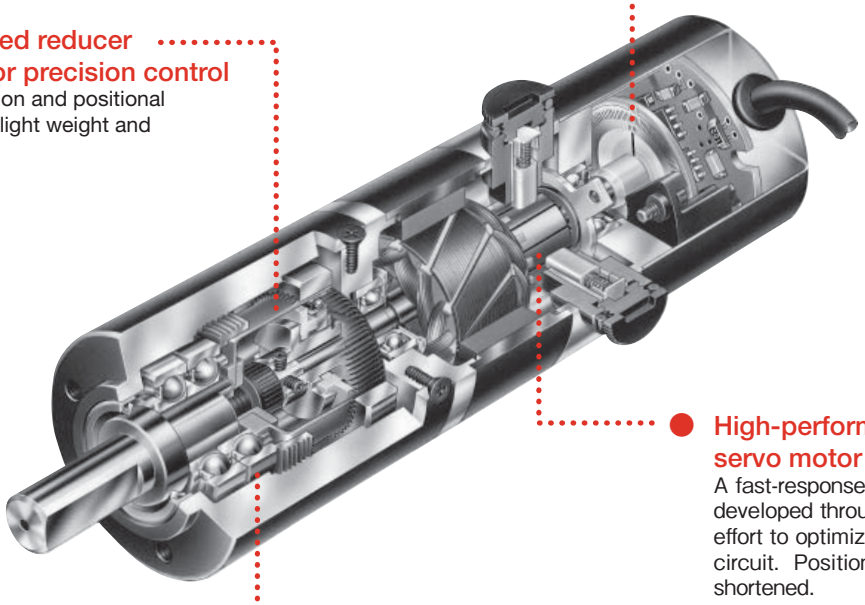
Features

High resolution
High resolution of maximum 400,000 pulses/revolution (0.0009°/pulse) combining a HarmonicDrive®.

High positional accuracy
The HarmonicDrive® eliminates backlash caused by gear play, assuring high-accuracy positioning.

Compact body and high-output torque
High output. 0.69Nm (maximum momentary torque achieved) by the smallest model RH-5A with outside dimensions of ϕ20mm in diameter x 89mm.

Structure



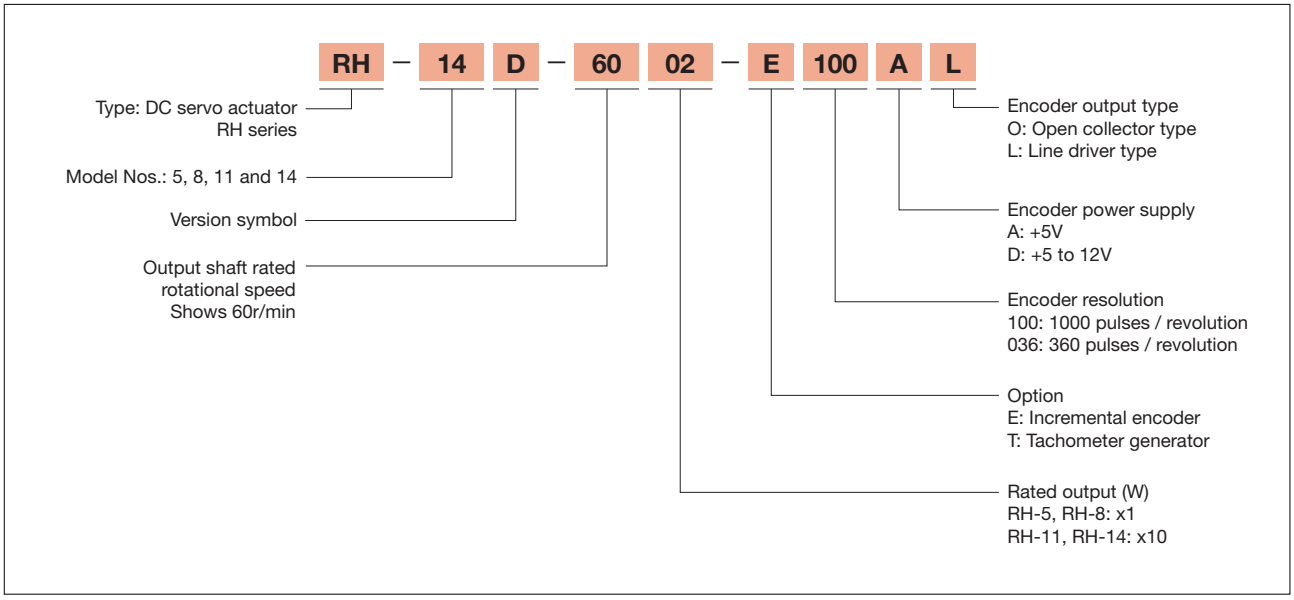
High-precision optical encoder
Rectangular output signal is dissolved up to x 4.

Compact and speed reducer HarmonicDrive® for precision control
Features a high resolution and positional accuracy. Unmatched light weight and compact properties.

High-performance DC servo motor
A fast-response DC servo motor developed through constant effort to optimize magnetic circuit. Positioning time is shortened.

Output shaft bearing with high stiffness
The output shaft is supported by a high-precision bearing. A large load is supported directly.

Models and Symbols



Specification (With an Incremental Encoder)

Time rating: Continuous Protection: Totally enclosed self-cooled Ambient temperature: 0 to 40°C Ambient humidity: 35 to 80% RH (Do not expose to condensation.)

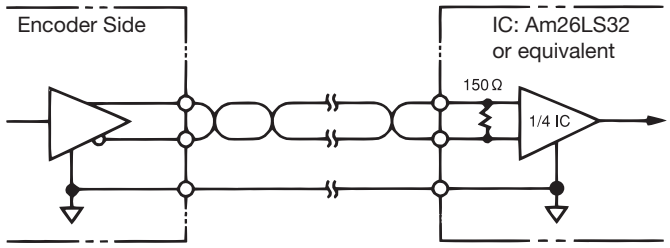
Item		Model	RH-5A			RH-8D		RH-11D		RH-14D	
			8802	5502	4402	6006	3006	6001	3001	6002	3002
Rated Output		W	1.5	1.7	1.4	8.6	6.2	13.6	12.3	20.3	18.5
Rated Voltage		V	12			24		24		24	
Maximum Momentary Torque		Nm	0.39	0.59	0.69	2.7	3.5	4.9	7.8	14	20
		kgfcm	4.0	6.0	7.0	27	36	50	80	140	200
Max. Continuous Stall Torque		Nm	0.24	0.39	0.43	1.5	2.3	2.5	4.4	5.4	7.8
		kgfcm	2.4	4.0	4.4	15	23	25	45	55	80
Rated Torque		Nm	0.16	0.29	0.29	1.4	2.0	2.2	3.9	3.2	5.9
		kgfcm	1.6	3.0	3.0	14	20	22	40	33	60
Max. Rotational Speed		r/min	180	110	90	100	50	100	50	100	50
Rated Rotational Speed		r/min	88	55	44	60	30	60	30	60	30
Maximum Momentary Current		A	0.83	0.78	0.77	1.6	1.1	2.4	2.1	5.4	4.1
Rated Current		A	0.5	0.5	0.5	1.0	0.8	1.3	1.3	1.8	1.8
Torque Constant		Nm/A	0.69	1.11	1.38	2.1	4.2	2.46	4.91	2.92	5.76
		kgfcm/A	7.06	11.3	14.1	21.4	42.9	25.1	50.1	29.8	58.8
Moment of Inertia *5	$GD^2/4$	kgm^2	6.3×10^{-4}	16×10^{-4}	25×10^{-4}	37×10^{-4}	150×10^{-4}	110×10^{-4}	430×10^{-4}	210×10^{-4}	810×10^{-4}
	J	$kgfcm^2$	0.007	0.016	0.026	0.04	0.15	0.11	0.44	0.21	0.83
Permissible Radial Load		N	59			196		245		392	
		kgf	6.0			20		25		40	
Permissible Thrust Load		N	29			98		196		392	
		kgf	3.0			10		20		40	
Reduction Ratio			50	80	100	50	100	50	100	50	100
Mass		kg	0.09			0.3		0.5		0.77	
Combined Driver			HS-360-1A			HS-360-1B		HS-360-1C		HS-360-1D	

*1: Values shown inn the table above indicate representative values on the output shaft.
*2: This is the value when the actuator is combined with the HS-360 driver.
*3: If you use the actuator by combining it with the HS-360 driver, chose an encoder that satisfies the line driver specification.
*4: The actuator specification shows values when the actuator is installed on the following aluminum radiator plates.
RH-5A : 150x150x3 (mm)
RH-8D : 150x150x6 (mm)
RH-11D : 150x150x6 (mm)
RH-14D : 150x150x6 (mm)
*5: The inertia moment is the value converted to the output shaft from the total value of the inertia moments of the motor shaft and the HarmonicDrive®.
*6: The resolution of the detector is the value obtained from ((motor shaft encoder resolution multiplied by 4) X (reduction ratio)).
*7: The brush in DC servo motors requires replacement.
*8: Please check the actuator rotation direction in our technical data sheet.

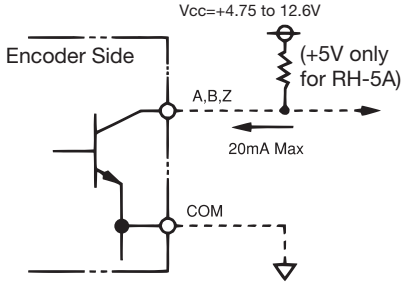
Encoder Specification

Item \ Model	RH-5A		RH-8D,11D,14D	
Output Circuit	Line Driver	Open Collector	Line Driver	Open Collector
Resolution (Pulses / revolution)	360		1000	
Power Supply (V)	DC+5V±5%		DC+5V±5%	DC+4.75 to 12.6V
Current Consumption (mA)	170max.	60max.	170max.	60max.
Response Frequency (kHz)	100		125	

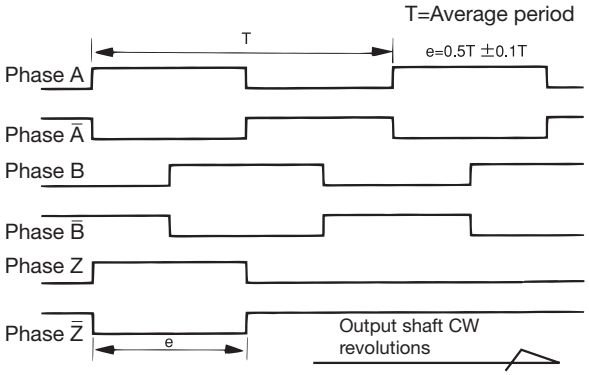
■ Line Driver Output Circuit



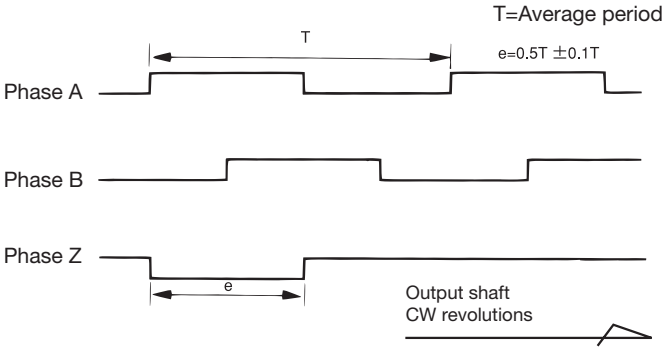
■ Open Collector Output Circuit



■ Line Driver Output Waveform



■ Open Collector Output Waveform



■ Colors of Encoder Cables

Model	RH-5A		RH-8D,11D,14D	
Cable Color	Line Drive	Open Collector	Line Drive	Open Collector
Brown	Signal A	Signal A	Signal A	Signal A
Blue	Signal Ā		Signal Ā	COM
Red	Signal B	Signal B	Signal B	Signal B
Green	Signal B̄		Signal B̄	COM
Yellow	Signal Z	Signal Z	Signal Z	Signal Z
Orange	Signal Z̄		Signal Z̄	COM
White	Power Supply	Power Supply	Power Supply	Power Supply
Black	Ground (COM)	Ground (COM)	Ground (COM)	Ground (COM)
Shield	Floating	Floating	Floating	Floating

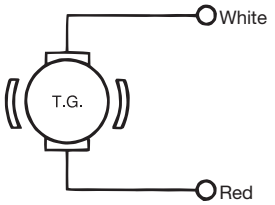
Tachometer Generator Specification

Specification

Item		
Voltage Generated (Note1)	V/1000(r/min)	3±10%
Linearity (Note 1)	%max	±1
Ripple (Note 1)	%max	1(RHS)/3(P-P)
Armature Resistance	Ω	45±10%(20)
Armature Inductance	mH	7±20%
Moment of Inertia (Note 2)	gm²	12×10⁻⁴

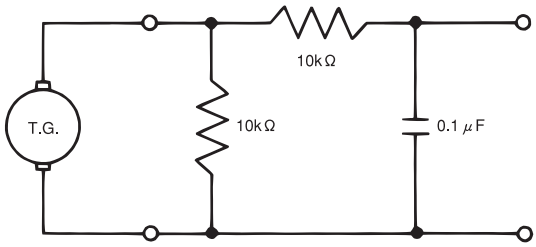
Note 1: Value of tachometer generator only at 200rpm or higher.
Note 2: Moment of inertia on motor shaft. When converted in terms of an actuator output shaft, the moment of inertia can be calculated by multiplying the reduction ratio R of the HarmonicDrive® by the square.

Polarity



(+) and (-) will be output to white and red cables respectively in CW revolutions when viewed from the actuator output shaft.

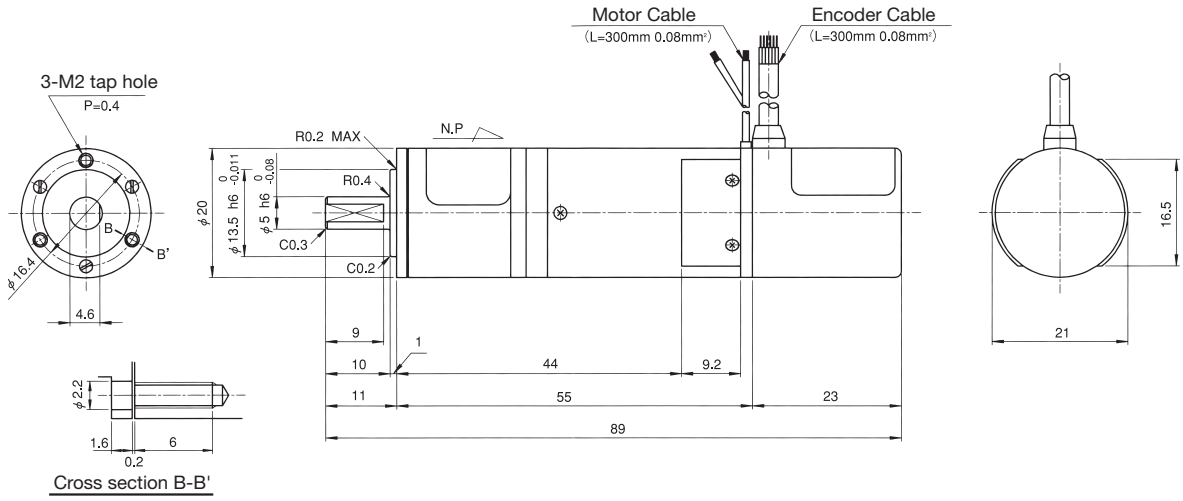
Measurement circuit of generated voltage, linearity and ripple



External Dimensions

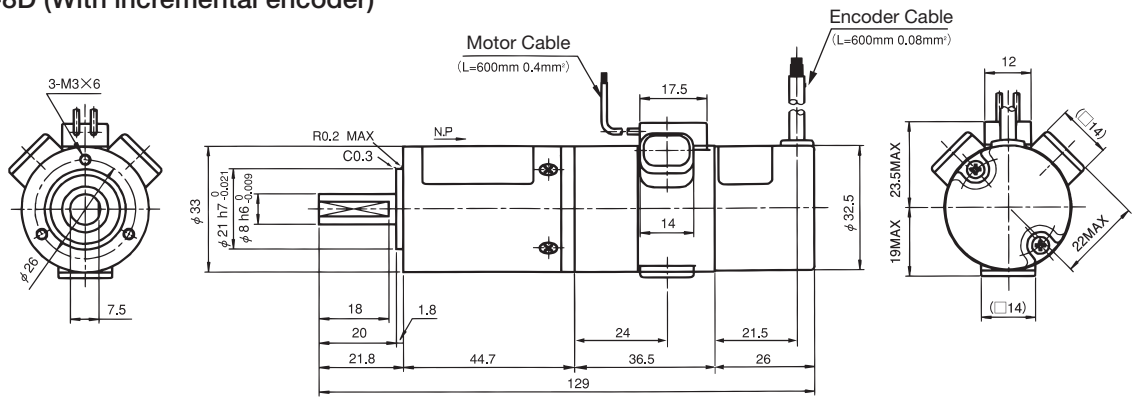
RH-5A (With incremental encoder)

Unit: mm



RH-8D (With incremental encoder)

Unit: mm

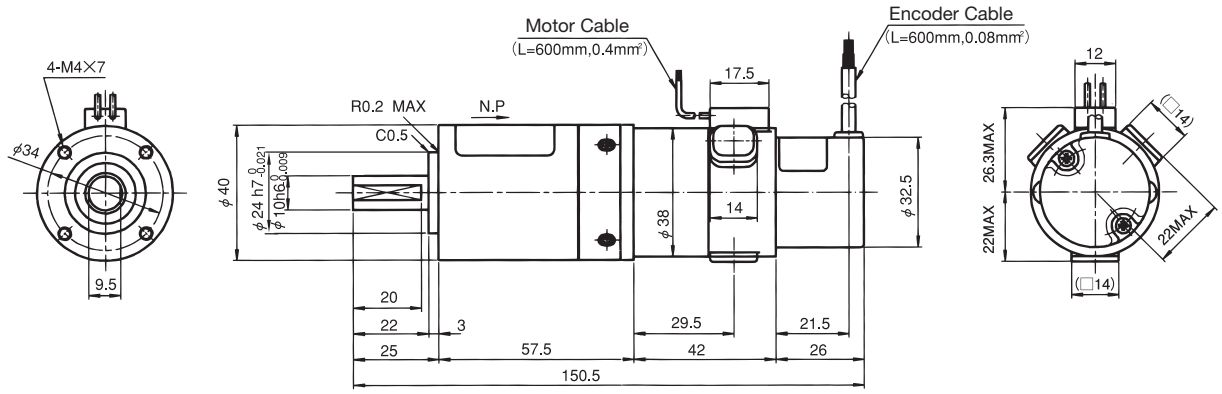


* Please confirm dimensions and shape against the illustrated specifications issued by us accompanying the delivered product. The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles). Contact us for the differential range of the size that is not described.

External Dimensions

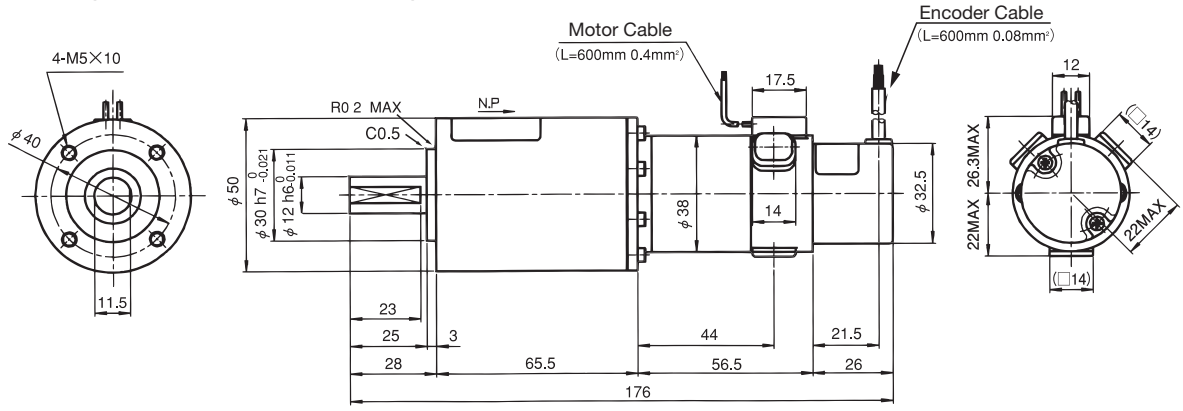
■RH-11D (With incremental encoder)

Unit: mm



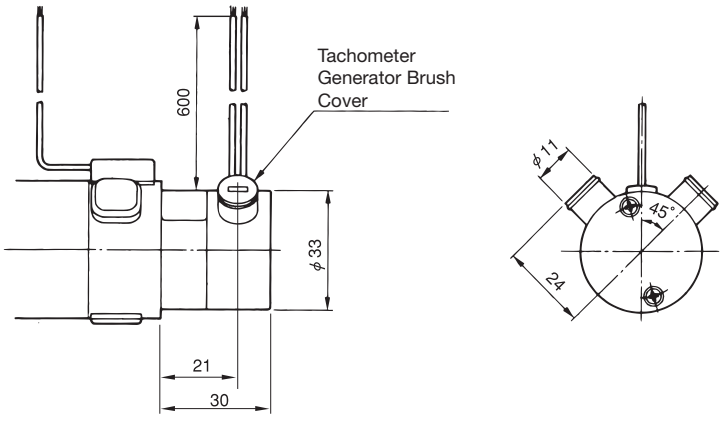
■RH-14D (With incremental encoder)

Unit: mm



■RH-8D, RH-11D, RH-14D (With tachometer generator)

Unit: mm



* Please confirm dimensions and shape against the illustrated specifications issued by us accompanying the delivered product.
The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

Positional Accuracy

The “uni-directional positional accuracy,” “repeatability” and “reverse positional accuracy” are shown below.
The following values represent typical values. (Source: JIS [Japanese Industrial Standards] B-6201-1987).

The RH series contains a speed reducer HarmonicDrive® for precision control and positioning errors of the motor shaft are therefore compressed to 1/50 or 1/100 by speed reduction. In reality, angular transmission errors of the speed reducer determine the positional accuracy. The measured values of angular transmission errors of the speed reducer are therefore shown as the positional accuracies of the RH Series. The accuracies of the individual models are shown below.

Item \ Model		RH-5A	RH-8D	RH-11D	RH-14D
Uni-directional Positional Accuracy	arc sec	290	150	120	120
	rad	1.31×10^{-3}	7.27×10^{-4}	5.82×10^{-4}	5.82×10^{-4}
Repeatability	arc sec	±90	±60	±60	±60
	rad	$\pm4.36\times10^{-4}$	$\pm2.91\times10^{-4}$	$\pm2.91\times10^{-4}$	$\pm2.91\times10^{-4}$
Reverse Positional Accuracy	arc sec	150	60	60	60
	rad	7.27×10^{-4}	2.91×10^{-4}	2.91×10^{-4}	2.91×10^{-4}

<Measurement conditions, Load: no load, rotational speed: rated value>

Mechanical Accuracy

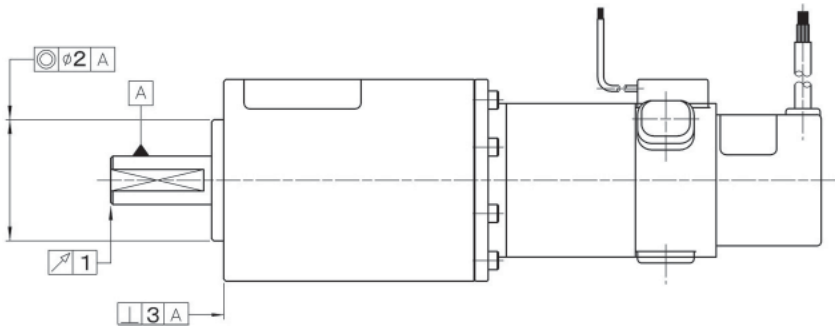
The mechanical accuracies of the output shaft and mounting flange of the RH series are as follows.

Mechanical Accuracy

Unit: mm

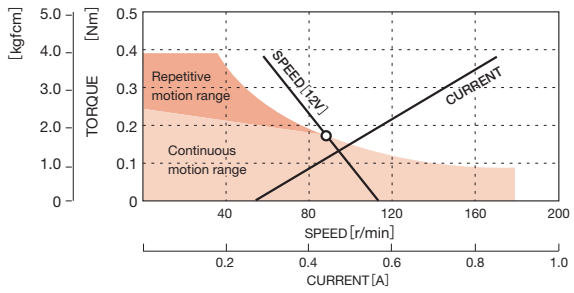
Accuracy Item	RH-5A	RH-8D	RH-11D	RH-14D
1 Output shaft surface runout	0.03	0.03	0.03	0.03
2 Concentricity of output shaft and fitting part	0.04	0.04	0.04	0.04
3 Perpendicularity between the output shaft and mounting surface	0.04	0.04	0.04	0.04

Note: The aforementioned values are TIR (total indicator reading) values.

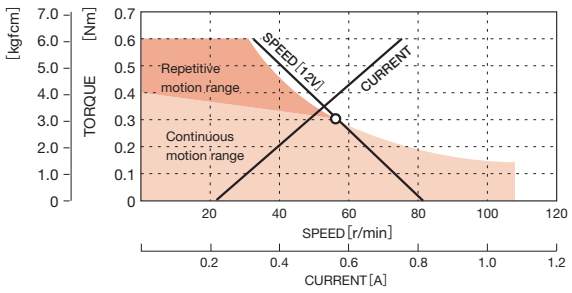


Operable Range

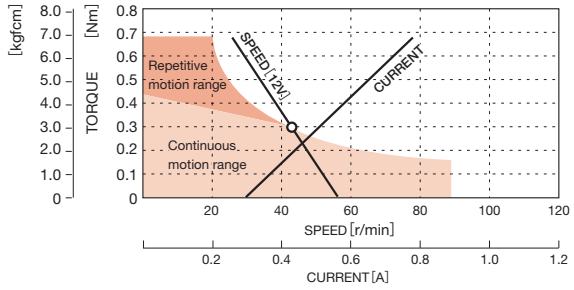
RH-5A-8802



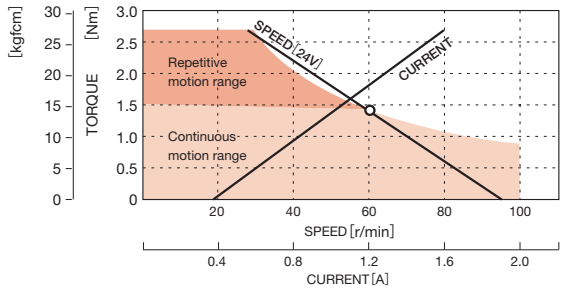
RH-5A-5502



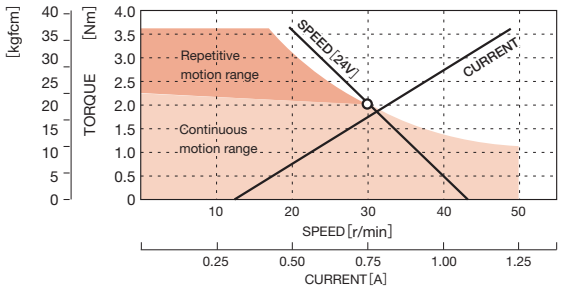
RH-5A-4402



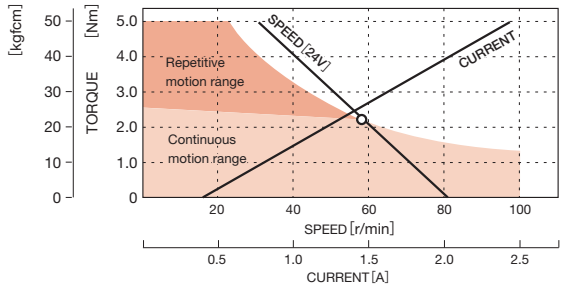
RH-8D-6006



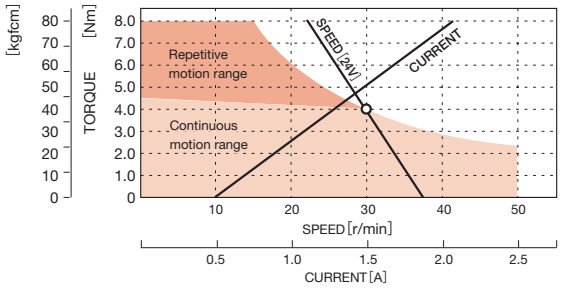
RH-8D-3006



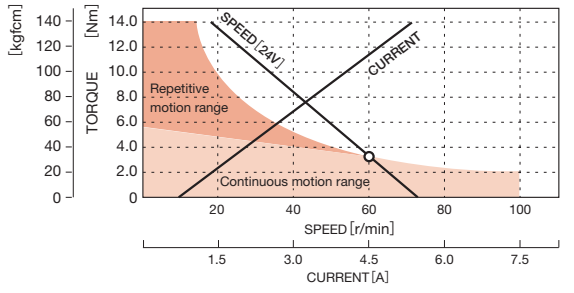
RH-11D-6001



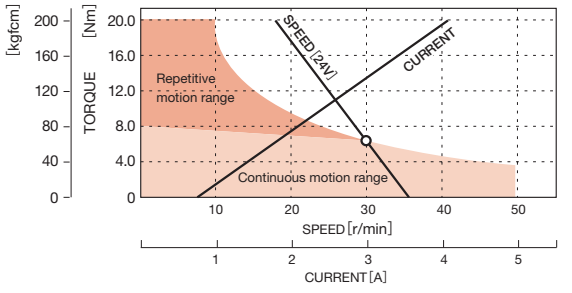
RH-11D-3001



RH-14D-6002



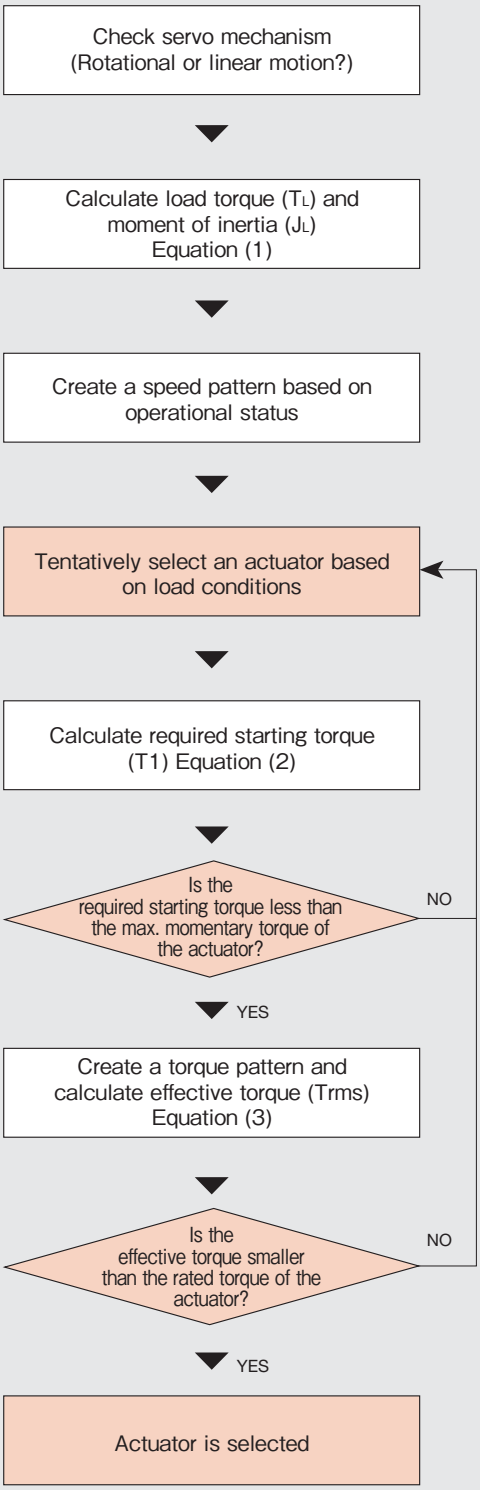
RH-14D-3002



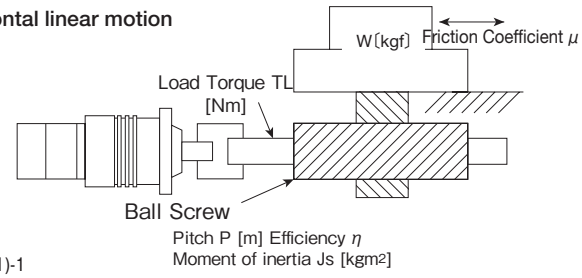
Tips for Selecting the Rotary Actuator

Select an actuator after checking the detailed specifications in the technical information of actuators and drivers.

Flowchart for Actuator Selection



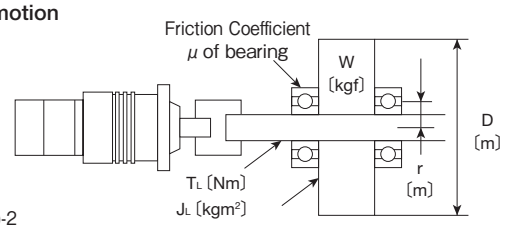
● For horizontal linear motion



Equation (1)-1

$$J_L = J_S + w\left(\frac{P}{2\pi}\right)^2 〔kgm^2〕 \qquad T_L = \frac{\mu W \cdot P}{2\pi \cdot \eta} 〔Nm〕$$

● Rotation motion

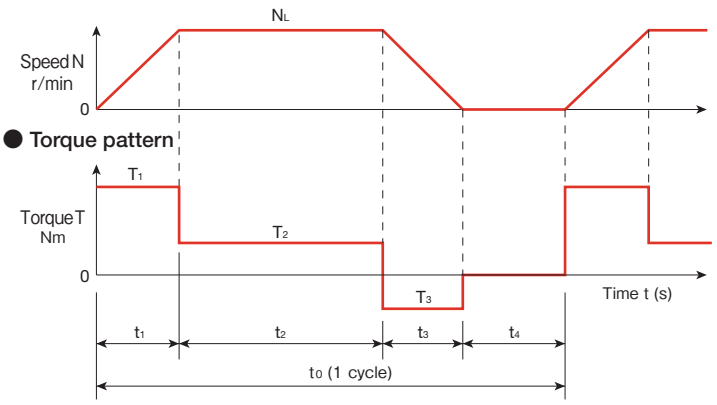


Equation (1)-2

$$J_L = J_S + \frac{w}{8} D^2 〔kgm^2〕 \qquad T_L = \mu W \cdot r 〔Nm〕$$

● Speed pattern

● Torque pattern



Note: t_1 is assumed to be equal to t_3

● Tentative selection conditions

Load Condition	Check	Catalog Value	Unit
Load torque T_L		Rated torque TR	Nm
Max. rotational speed of load N_L		Rated rotational speed NR	r/min
Moment of inertia of load J_L	$3J_A$*	Moment of inertia JA	kgm²

* $J_1 \leq J_A$ is desirable for a system requiring high servo stiffness (fast response and high precision)

Equation (2)

$$T_1 = T_L + \frac{2\pi}{60} \cdot \frac{(J_A + J_L) \cdot N_L}{t_1}$$

Equation (3)

$$T_2 = T_L$$

$$T_3 = T_L - (T_1 - T_L)$$

$$T_{rms} = \sqrt{\frac{T_1^2 \cdot t_1 + T_2^2 \cdot t_2 + T_3^2 \cdot t_3}{t0}}$$

Actuator Selection Example

An example of the actuator selection is shown below.

Tentatively select an actuator based on the load conditions. RSF-11B-100 satisfies the tentative selection conditions based on catalog values (page 50: Specification)

$T_L = 2Nm \quad < T_R = 4.0Nm$
$N_L = 25r/min \quad < T_R = 30r/min$
$J_L = 0.02kgm^2 < J_A = 0.02kgm^2$

▼

Calculate required starting torque (T1)
Equation (1)

$$T_1 = 2 + \frac{2\pi}{60} \cdot \frac{(0.02+0.02) \times 25}{0.1}$$
$$= 3.0Nm$$

▼

Check if the required starting torque is smaller than the maximum momentary torque of the actuator.
$T_1 = 3.0Nm < T_p = 11Nm$ will result. Yes

▼

Calculate effective torque (T_{rms}) Equation
~~$T_1 = 3.0Nm$~~ (3)
$T_2 = T_L = 2Nm$
$T_3 = T_L - (T_1 - T_L) = 1Nm$

$$T_{rms} = \sqrt{\frac{3^2 \times 0.1 + 2^2 \times 0.2 + 1^2 \times 0.1}{1}}$$
$$= 1.3Nm$$

▼

Check if the effective torque is smaller than the rated actuator torque.
$T_{rms} = 1.3Nm < T_R = 4.0Nm$ will result. Yes

▼

Therefore, the actuator model is decided to be RSF-11B-100

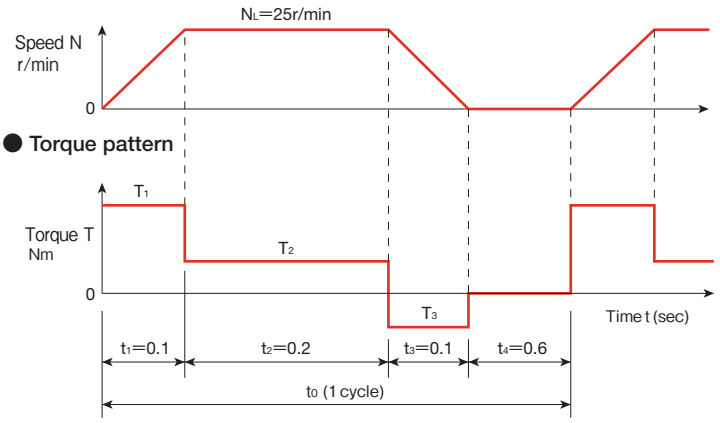
● Load Conditions

Preconditions: The servo mechanism involves horizontal linear motion and the actuator is of a shaft type (RSF series)

Load rotational speed	N_L	:25r/min
Load torque	T_L	:2Nm
Moment of load inertia	J_L	:0.02kgm^2
Speed pattern	$t_1 = t_3$	:0.1sec
	t_2	:0.2sec
	t_4	:0.6sec

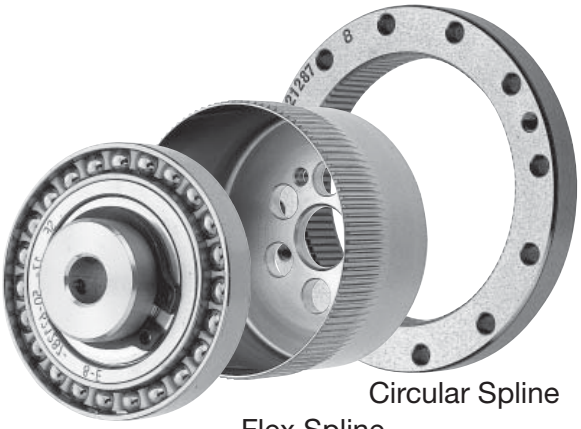
Note: Use characteristic values that are converted into those for the actuator output shaft.

● Speed pattern



● Torque pattern

Structure of HarmonicDrive®

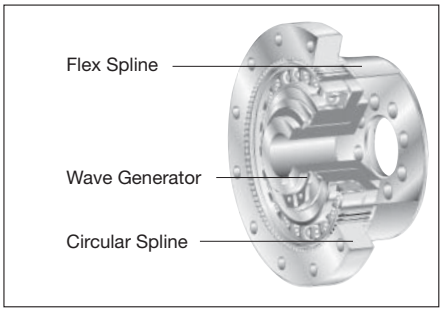


- **Wave Generator:**
  A ball bearing with thin-walled construction is fitted onto the outer circumference of an oval cam. The entire structure is oval. The inner ring of the bearing is fixed onto the oval cam and the outer ring elastically deforms through a ball. The wave generator can be mounted on a motor shaft.

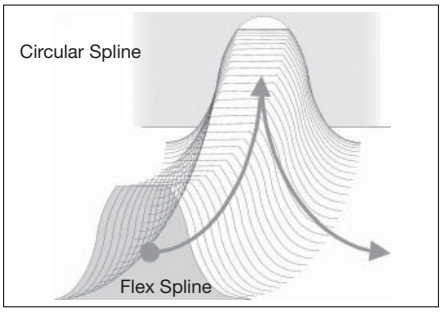
- **Flex Spline:**
  A cup-like elastic metal part with thin wall thickness. Teeth are cut into the outer circumference of the opening of the cup, from where the output is usually extracted.

- **Circular Spline:**
  The inner gear of the rigid body, with teeth of equivalent size to those on the flex spline cut into the inner circumference. The circular spline has two more teeth than the flex spline and is normally fixed onto the gear casing.

Three basic components are assembled



Teeth meshing



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