VEXTA STEP.

Stepping Motors

C

Introduction

Motor & Driver Packages	Closed Loop α_{STEP}	AC Input	**AS** Series C-11	AS
			AS PLUS Series C-11	AS PLUS
		DC Input	**ASC** Series C-55	ASC
	5-Phase Microstep	AC Input	**RK** Series C-77	RK
		DC Input	**CFK II** Series C-105	CFK II
	5-Phase Full/Half	DC Input	**CSK** Series C-119	CSK
			PMC Series C-135	PMC
	2-Phase Full/Half	AC Input	**UMK** Series C-149	UMK
		DC Input	**CSK** Series C-161	CSK
2-Phase Stepping Motors C-183	Without Encoder		**PK Series/PV Series** C-196	PK/PV
	With Encoder		**PK** Series C-233	PK
Driver with Indexer			**UI2120G** C-241	UI2120G
Controllers C-251			**EMP** Series C-254	EMP401 EMP402
			SG8030 Series C-266	SG8030J
Low-Speed Synchronous Motors			**SMK** Series C-269	SMK
Accessories			Accessories C-279	
Before Using a Stepping Motor			Before Using a Stepping Motor ... C-295	

Types of Stepping Motors

● Package Products: We offer a wide variety of motors and drivers.

Power Supply Input	AC Input			
	Single-Phase 100-115 VAC, 200-230 VAC, Three-Phase 200-230 VAC		Single-Phase 100-115 VAC, 200-230 VAC	Single-Phase 100/115 VAC
Series	αSTEP **AS** Series		**NanoStep RK** Series	**UMK** Series
	AS	**AS PLUS**		
Features				
	· High reliability due to closed loop control · No gain tuning required · High resolution control due to microstepping	· Controller and driver in one stand alone package · Programmable functions	· High-resolution control is possible by microstepping · Low vibration, low noise due to smooth drive function	· 2-phase stepping motor and compact AC input driver in one package · Driver with built-in pulse generator is available (**UI2120G**)
Motor Type	Closed Loop Control Stepping Motors	Closed Loop Control Stepping Motors	5-Phase Stepping Motors	2-Phase Stepping Motors
Basic Step Angle	0.36° (Resolution Setting: 1000 P/R)	0.36° (Resolution Setting: 1000 P/R)	0.72°	1.8° (Standard Type) 0.9° (High-Resolution Type)
Resolution	Microstep 0.72°, 0.36°, 0.072°, 0.036°	Microstep 0.72°~0.036°	Microstep 0.72°~0.00288° (16 steps)	Full Step/Half Step 1.8° / 0.9° (Standard Type) 0.9° / 0.45° (High-Resolution Type)
Function	Closed loop control Microstepping Resolution switch Pulse input mode switch Automatic current down at standstill Current Setting Speed Filter Protection Function	Closed loop control Microstepping Resolution selectable via software 14 programs · 64 lines/prog. · Conditional statements · IF/ELSE · SMP XX · WHILE/WEND · LOOP/ENDL I/O test Current setting Speed filter Protection function Resolution setting Automatic current down RS232 Control	Smooth drive function Pulse input mode switch Automatic current down Automatic current off Electromagnetic brake switch function (Energy-saving mode) Timing output Overheat output Resolution select All windings off input	Pulse input mode switch Automatic current down Automatic current off Timing output Overheat output Step angle switch All windings off input
Safety Standards	cULus* CE	cULus* CE	cULus* CE	—
Line up — Standard Motor	□1.65 in. (□42 mm), □2.36 in. (□60 mm), □3.35 in. (□85 mm)		□1.65 in. (□42 mm), □2.36 in. (□60 mm), □3.35 in. (□85 mm)	□1.65 in. (□42 mm), □2.22 in. (□56.4 mm)
Line up — Electro-magnetic Brake Motor	□1.65 in. (□42 mm), □2.36 in. (□60 mm), □3.35 in. (□85 mm)		—	—
Line up — Geared Motor	□1.65 in. (□42 mm), □2.36 in. (□60 mm), □3.54 in. (□90 mm)		□1.65 in. (□42 mm), □2.36 in. (□60 mm), □3.54 in. (□90 mm)	—
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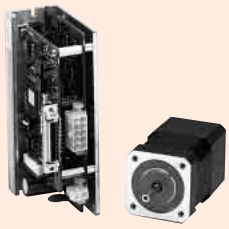
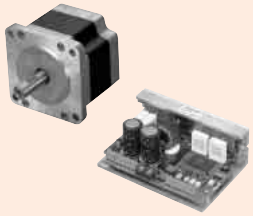
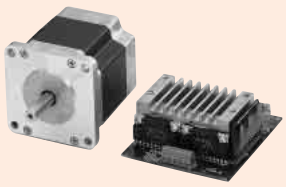
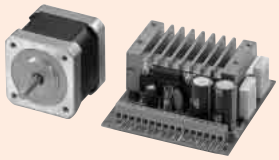
* With motor frame size 1.65 inch (42 mm), only the driver conforms to the CSA standard.

DC Input			
24 VDC	24 VDC	24 VDC	24/36 VDC
ASC Series	**NanoStep CFK II** Series	5-Phase **CSK** / **PMC** Series	2-Phase **CSK** Series
			
· High reliability due to closed loop control · No gain tuning required · High-resolution control due to microstepping	· 5-phase stepping motor and compact DC input driver in one package · High-resolution control is possibly by microstepping	· 5-phase stepping motor and compact DC input driver in one package	· 2-phase stepping motor and compact DC input driver in one package · Wide variety of frame sizes and types
Closed Loop Control Stepping Motors	5-Phase Stepping Motors	5-Phase Stepping Motors	2-Phase Stepping Motors
0.36° (Resolution Setting: 1000 P/R)	0.72°	0.72°	1.8° (Standard Type), 0.9° (High-Resolution Type)
Microstep 0.72°, 0.36°, 0.072°, 0.036°	Microstep 0.72°~0.00288° (16 steps)	Full Step/Half Step 0.72° / 0.36°	Full Step/Half Step 1.8° / 0.9° (Standard Type) 0.9° / 0.45° (High-Resolution Type)
Closed loop control Microstepping Resolution switch Pulse input mode switch Automatic current down Current Setting Speed Filter Protection Functions	Automatic current down Timing output Step angle switch All windings off input Pulse input mode	Automatic current down Timing output Step angle switch All windings off input	Automatic current down Setting current monitor output Timing signal output Step angle switch Pulse input mode switch Input power supply voltage switch Power LED equipped All windings off input
cULus CE	—	cULus CE (5-Phase **CSK** only)	—
□1.10 in. (□28 mm), □1.65 in. (□42 mm), □2.36 in. (□60 mm)	□0.79 in. (□20 mm), □1.10 in. (□28 mm), □1.65 in. (□42 mm), □2.36 in. (□60 mm), □3.35 in. (□85 mm)	□1.10 in. (□28 mm), □1.65 in. (□42 mm), □2.36 in. (□60 mm), □3.35 in. (□85 mm)	□1.65 in. (□42 mm), □2.22 in. (□56.4 mm), □3.35 in. (□85 mm)
□1.65 in. (□42 mm), □2.36 in. (□60 mm)	—	—	—
□1.10 in. (□28 mm), □1.65 in. (□42 mm), □2.36 in. (□60 mm)	—	□1.10 in. (□28 mm), □1.65 in. (□42 mm), □2.36 in. (□60 mm)	□1.65 in. (□42 mm), □2.36 in. (□60 mm)
Page C-55	Page C-105	5-Phase **CSK**:Page C-119 **PMC**:Page C-135	Page C-161

◆ Controllers for Stepping Motors

These controllers are optimized to control stepping motors.
→Page C-251

◆ αSTEP PLUS

Stand alone closed loop driver/controller

◆ UI2120G

All-In-One Intelligent Driver/Controller for 2-Phase Stepping motors.
→Page C-241

◆ 2-Phase Stepping Motors

Motor Frame Size:
□1.10 in. (□28 mm), □1.38 in. (□35 mm),
□1.65 in. (□42 mm), □2.22 in. (□56.4 mm),
□2.36 in. (□60 mm), □3.35 in. (□85 mm),
□3.54 in. (□90 mm)

Line-Up:
PK Series
High Torque Type
Standard Type (with Encoder also available)
High-Resolution Type (with Encoder also available)
SH Geared Type
PV Series

◆ Low-Speed Synchronous Motors (SMK Series)

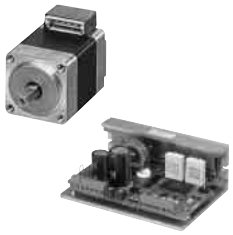
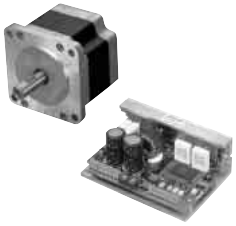
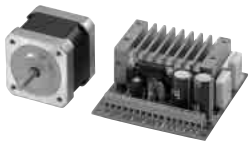
Synchronous motors can instantly switch between forward and reverse operation. They perform synchronous operation at 72 r/min at 60 Hz or 60 r/min at 50 Hz (**SMK014 MA-A** : 36 r/min at 60 Hz or 30 r/min at 50 Hz). They offer highly precise speed regulation and low-speed rotation. Gearheads in 20 gear ratios are available for use with pinion shaft models, offering up to 86 lb-in of torque.
→Page C-269

Introduction of Stepping Motors

αSTEP

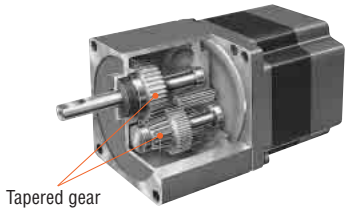
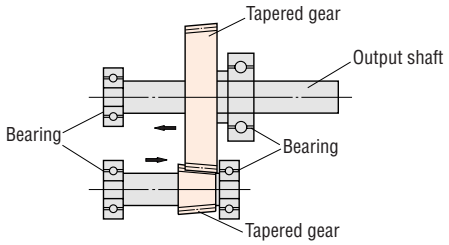
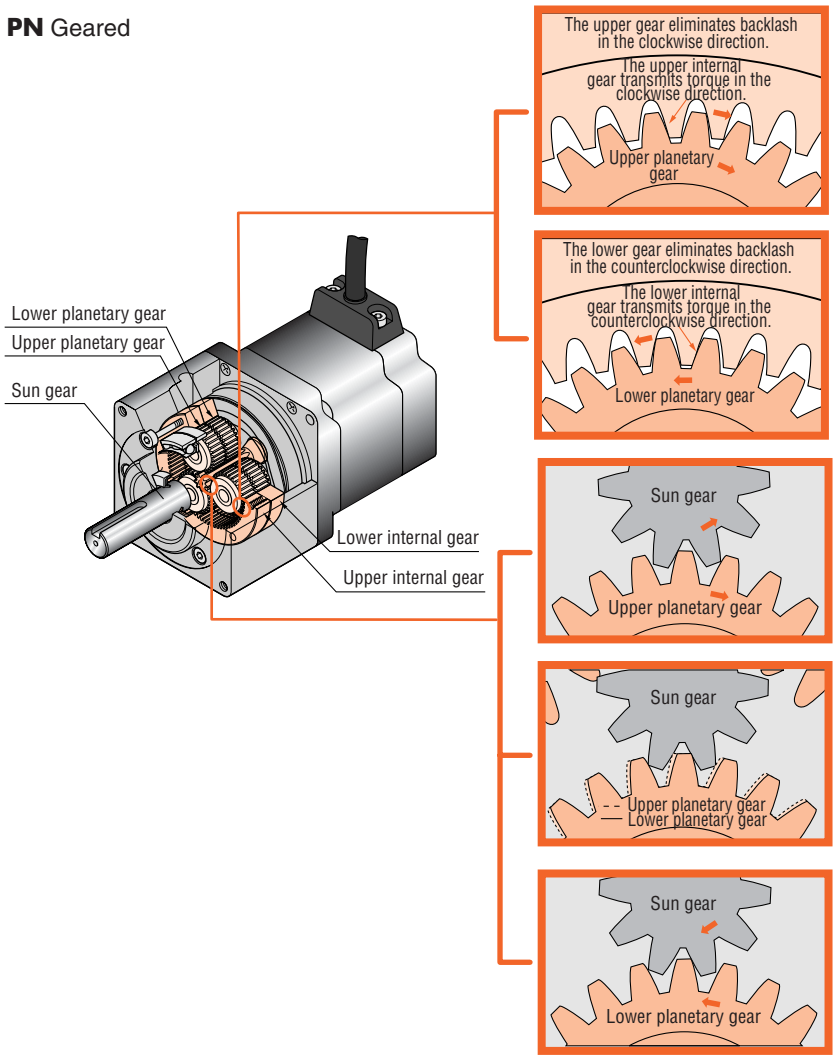
Type	Features	Series
Standard Type 	The standard type combines the base αSTEP motor (round-shaft type) and a driver. The compact, high-response, tuning-free motor is easy to handle and offers excellent performance. The standard type comes in frame sizes from 1.10 inch sq. (28 mm sq.) to 3.35 inch sq. (85 mm sq.).	**AS** Series **ASC** Series
Electromagnetic Brake Type 	The electromagnetic brake type incorporates a non-excitation brake into the motor. Since the brake operates without electrical current, the load can be held in position even in the event of a power failure, thereby preventing physical injury or damage to the equipment. (Some motor models do not offer this option.)	**AS** Series **ASC** Series
Geared Type 	Various gears are available to further improve the performance of αSTEP motors. These models incorporate a highly accurate, non-backlash gear or low-backlash gear. The geared type comes in frame sizes from 1.10 inch sq. (28 mm sq.) to 3.54 inch sq. (90 mm sq.). The geared type generates high torque at low speed, drives a large inertial load and ensures higher resolution, all the while maintaining the high accuracy of the motor.	**AS** Series **ASC** Series

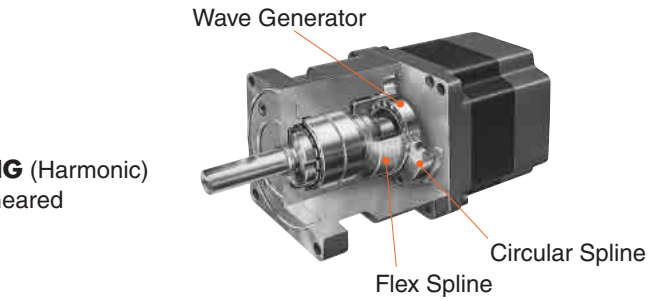
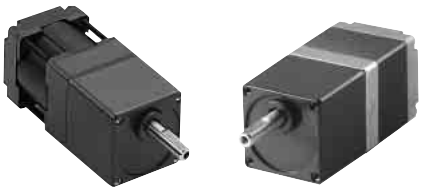
Stepping Motors

Type	Features	Series
Standard Type 	The standard type combines the base motor (round-shaft type) and a driver. Designed to reduce heat generation and power consumption in the motor and driver, these models are easy to use yet provide the required performance. The standard type comes in frame sizes from 0.79 inch sq. (20 mm sq.) to 3.35 inch sq. (85 mm sq.).	5-Phase **RK** Series 2-Phase **UMK** Series 5-Phase **CSK** Series 5-Phase **CFK II** Series 5-Phase **PMC** Series 2-Phase **CSK** Series 2-Phase **PK** Series
High-Torque Type 	High-Torque type, newly-designed motors with high torque, offers an easy-handling connection.	5-Phase **CFK II** Series 2-Phase **PK** Series
High-Speed Type 	The high-speed type is ideal for driving a load not only at low speeds but also at high speeds. The higher rated current and enhanced high-speed characteristics of the motor are complemented by a larger drive capacity.	5-Phase **CFK II** Series
High-Resolution Type 	The motor's basic step angle is reduced to half that of the standard type. These motors achieve high resolution, low vibration and improved stopping accuracy. * All of the high-resolution models currently available use 2-phase motors.	2-Phase **CSK** Series 2-Phase **PK** Series
PV Series (High-Inertia Capability) 	Having a larger rotor inertia than the standard motors, the high-torque motors are designed to drive large inertial loads with outstanding efficiency. These motors also generate higher torque.	2-Phase **PV** Series
Geared Type 	The geared-type motors combine a variety of gears that make the most of the high controllability afforded by a stepping motor. These models incorporate a highly accurate, non-backlash gear or low-backlash gear. The geared type drives a high friction load or large inertial load and ensures higher resolution, all the while maintaining the high accuracy of the motor.	5-Phase **RK** Series 5-Phase **CSK** Series 5-Phase **PMC** Series 2-Phase **CSK** Series 2-Phase **PK** Series

Introduction of Geared Type

Geared Motors using dedicated gears for control motors.

Type	Principle and Structure	Series
TH Geared   Structure of **TH** gear's final stage	In **TH**-type gears, tapered gears are used for the spur gear's speed-reduction mechanism and the meshing gear. The tapered gear is produced through continuous profile shifting toward the shaft. The tapered gears are adjusted in the direction of the arrows, as shown in the figure, to reduce backlash.	**AS** Series **ASC** Series 5-Phase **RK** Series 5-Phase **CSK** Series
PN Geared 	The **PN** gear employs a planetary-gear speed-reduction mechanism. The **PN** gear achieves the specified backlash of three arc minutes through the improved accuracy of its components and the backlash-elimination mechanism. That mechanism is comprised of two sets of internal and planetary gears on the upper and lower levels with the internal gear teeth twisted in the circumferential direction. The upper-level internal gears and planetary gears reduce clockwise backlash; the lower-level internal gears and planetary gear reduce counterclockwise backlash.	**AS** Series **ASC** Series 5-Phase **RK** Series

Type	Principle and Structure	Series
HG (Harmonic) Geared  Combines three basic parts. The flex spline is bent into an oval shape by the wave generator. The teeth at the long axis of the oval mesh with the circular spline, while the teeth at the short axis of the oval are completely separate from it. Rotating the wave generator (input) clockwise while keeping the circular spline fixed in position will subject the flex spline to elastic deformation, causing a gradual shift in the point of engagement between the circular spline and flex spline. When the wave generator completes one revolution, the flex spline has rotated two fewer teeth than the circular spline has, resulting in the movement of flex spline for the difference in the tooth count (two teeth) in the opposite direction of the wave generator's rotation (i.e., counterclockwise). This movement translates into output, thereby reducing the speed.	The **HG** (harmonic) gear offers unparalleled precision in positioning and features a simple construction utilizing the metal's elastomechanical property, comprising just three basic components: a wave generator, flex spline and circular spline.	**AS** Series **ASC** Series 5-Phase **RK** Series 5-Phase **PMC** Series
MG Geared **SH** Geared  **MG** Geared **SH** Geared	**MG** geared · **SH** geared type are for stepping motors with spur gear's speed reduction mechanism. Backlash value is 1° to 2°.	5-Phase **PMC** Series 2-Phase **CSK** Series 2-Phase **PK** Series

Characteristics Comparison for Geared Motors

Notes:

- Note that the values shown below must be used as reference. These values vary depending on the series, frame size and gear ratio.
- Maximum holding torque, maximum backlash, minimum resolution and maximum output shaft speed listed here are representative values of the following series:
  TH Geared Type, **PN** Geared Type, **HG** Geared Type: α_{STEP} **AS** Series
  MG Geared Type: **PMC** Series
  SH Geared Type: 2-Phase **CSK** Series

	Geared Type	Features	Maximum Holding Torque lb-in (N·m)	Maximum Backlash [Arc min] (Reference Value)	Minimum Resolution [°/step]	Maximum Output Shaft Speed [r/min]
Low backlash	 **TH** Geared (Parallel Shaft)	• A wide variety of low gear ratio, high-speed operation • Gear ratio : 3.6:1, 7.2:1, 10:1, 20:1, 30:1	106 (12)	45	0.012	500
Non-backlash	 **PN** Geared (Planetary)	• High speed (low gear ratio), high positioning precision • High permissible/maximum torque • Wide variety of gear ratios for selecting the desired step angle. (resolution) • Centered output shaft • Gear ratio : 5:1, 7.2:1, 10:1, 25:1, 36:1, 50:1	Maximum Torque 530 (60) Permissible Torque 320 (37)	3	0.0072	600
	 Harmonic Geared (Harmonic Drive)	• High positioning precision • High permissible/maximum torque • High gear ratio, high resolution • Centered output shaft • Gear ratio : 50:1, 100:1	Maximum Torque 480 (55) Permissible Torque 320 (37)	0	0.0036	70
For compact motors	 **MG** Geared (Parallel Shaft)	• A wide variety of low gear ratio, high-speed operation • Gear ratio : 3.6:1, 7.2:1, 10:1, 20:1, 30:1	4.5 (0.51)	Approx. 1~2°	0.024	833
	 **SH** Geared (Parallel Shaft)	• A wide variety of low gear ratio, high-speed operation • Gear ratio : 3.6:1, 7.2:1, 9:1, 10:1, 18:1, 36:1	35 (4)	Approx. 1~2°	0.05	500

How to Read Specifications Table

	Model	Single-Phase 100-115 VAC	Single Shaft / Double Shaft	RK544AA-N5 / RK544BA-N5	RK544AA-N7.2 / RK544BA-N7.2	RK544AA-N10 / RK544BA-N10
①	Maximum Holding Torque		lb-in (N·m)	7 (0.8)	10.6 (1.2)	13.2 (1.5)
②	Rotor Inertia J		oz-in^2 (kg·m^2)	0.30 (54×10^{-7})		
③	Rated Current		A/Phase	0.75		
④	Basic Step Angle			0.144°	0.1°	0.072°
⑤	Gear Ratio			5 : 1	7.2 : 1	10 : 1
⑥	Permissible Torque		lb-in. (N·m)	7 (0.8)	10.6 (1.2)	13.2 (1.5)
⑦	Maximum Torque		lb-in. (N·m)	13.2 (1.5)	17.7 (2)	17.7 (2)
⑧	Backlash		arc minute (degrees)	2 (0.034°)		
	Angle Error		arc minute (degrees)	6 (0.1°)		
⑨	Permissible Speed Range		r/min	0～600	0～416	0～300
⑩	Power Source Input			Single-Phase 100-115 VAC ±15% 50/60 Hz 1 A		
⑪	Excitation Mode			Microstep: Basic Angle/n * (/Step)		
	Weight	Motor	lb. (kg)	1.2 (0.56)		
		Driver	lb. (kg)	0.88 (0.4)		
	Dimension No.	Motor		7		
		Driver		13		

① **Maximum Holding Torque**
The holding torque (5-Phase : 5-Phase Excitation, 2-Phase: 2-Phase Excitation) is the maximum holding power (torque) the stepping motor has when power (rated current) is being supplied but the motor is not rotating (with consideration given to the permissible strength of the gear when applicable). At motor standstill, the driver's "Automatic Current Cutback" function reduces the maximum holding torque by approximately 50% (approximately 40% for **UMK** and 2-phase **CSK** series).

② **Rotor Inertia**
This refers to the inertia of rotor inside the motor. This is necessary when the required torque (acceleration torque) for the motor needs is calculated.

③ **Rated Current**
The rated current is determined by motor temperature rise. It is the current value that can flow to the motor coils continuously at motor standstill. As a general rule, the current must be set to the rated current.

④ **Basic Step Angle**
The step angle is the angular distance (in degrees) that the motor moves at the input of one pulse from the driver. It differs depending on the motor structure and excitation system.

⑤ **Gear Ratio**
This is the ratio in rotation speed between the input speed from the motor and the speed of the gear output shaft. For example, the gear ratio 10:1 is that when the input speed from the motor is 10 r/min, the gear output shaft is 1 r/min.

⑥ **Permissible Torque**
The permissible torque represents the torque value limited by the mechanical strength of the gear. For **TH** geared type, the total torque including acceleration/deceleration torque should not exceed this value. For the **PN** & **HG** geared types, the torque not including the acceleration/deceleration torque should not exceed this value.

⑦ **Maximum Torque (PN Geared, Harmonic Geared Type only)**
This is the maximum torque that can be used instantaneously (for a short time). During acceleration/deceleration, the motor can be operated up to this value.

⑧ **Backlash**
The play of gear output shaft when the motor shaft is fixed. When positioning in bi-direction, the positioning accuracy is affected.

⑨ **Permissible Speed Range**
This is the rotation speed that the motor can be operated at with the gear output shaft.

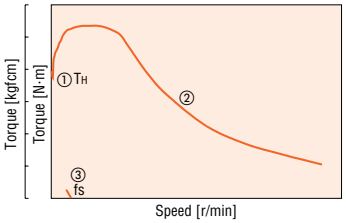
⑩ **Power Source**
The current value of the power input is the maximum input current value. (The input current varies according to the rotation speed.)

⑪ **Excitation Mode**
The driver has a function that can change the motor's step angle. Shown in the table is the step angle value at which the motor can be operated.

Static Friction Torque (α_{STEP}, AS Series, ASC Series Only)
The electromagnetic brake specifications. This is the maximum holding torque at which the electromagnetic brake can hold the position.

How to Read Speed—Torque Characteristics

The graph below is the characteristics that indicate the relationship between the speed and torque when a stepping motor is driven. The required speed and torque is always used when selecting a stepping motor. On the graph, the horizontal axis expresses the speed at motor output shaft while the vertical axis expresses the torque.



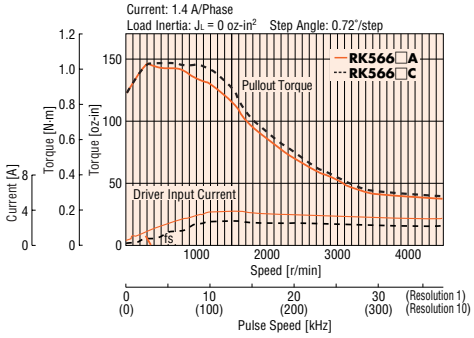
The speed-torque characteristics are determined by the motor and driver, so they vary greatly based upon the type of the driver used.

① **Maximum Holding Torque**
The holding torque (5-Phase : 5-Phase Excitation, 2-Phase : 2-Phase Excitation) is the maximum holding power (torque) the stepping motor has when power is being supplied but the motor shaft is not rotating (rated current). At motor standstill, the driver's "Automatic Current Cutback" function reduces the maximum holding torque by approximately 50% (approximately 40% for **UMK** and 2-phase **CSK** series).

② **Pullout Torque**
Pullout torque is the maximum torque that can be output at a given speed. When selecting a motor, be sure the required torque falls within this curve.

③ **Maximum Starting Frequency (fs)**
This is the maximum pulse speed at which the motor can start or stop instantly (without an acceleration or deceleration period) when the frictional load and inertial load of the stepping motor are 0. Driving the motor at greater than this pulse speed requires gradual acceleration or deceleration. This frequency drops when there is a load inertia on the motor. (Refer to Load Inertia-Maximum Starting Frequency Characteristics in Technical Reference → Page F-32)

The following figure shows the speed-torque characteristics of the 5-phase stepping motor/driver package **RK566BA**.



- Pay attention to heat dissipation from the motor and driver. The motor will produce a considerable amount of heat under certain conditions. Be sure to keep the temperature of the motor case under 212°F (100°C). (Under 167°F (75°C) is required to comply with UL or CSA standards.)
- In order to prevent fatigue of the gear grease in the harmonic gear, keep the temperature of the gear case under 158°F (70°C).

Notes on characteristics diagrams:
- The actual characteristics will vary depending on the driver used. Please use these diagrams only for reference purposes when selecting a motor. You must also conduct a thorough evaluation with the actual driver to be used.