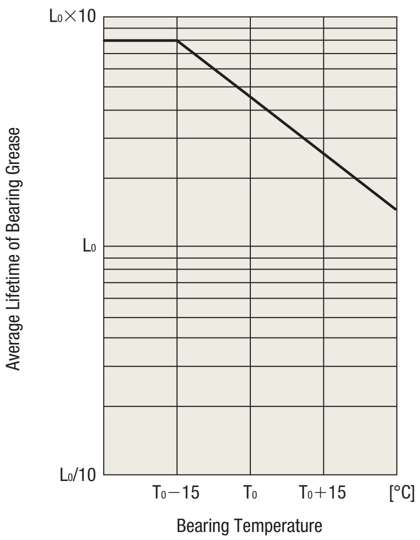
Service Life

The life of Oriental Motor products is an important factor in determining the maintenance and inspection timing of your equipment. This section explains the definition of life for each of our products. Since life is not a guaranteed value, please use it only as a reference for proper maintenance and inspection.

Service Life of a Motor

The service life of a bearing greatly affects the service life of a motor.
The service life of a bearing can be expressed in 2 ways:
① Grease life is affected by grease deterioration due to heat.
② Mechanical life is affected by rolling fatigue.
In most cases, the motor life is estimated based on ① the grease life, since the bearing life is more affected by grease deterioration due to heat generation than the load applied to the bearing.
Temperature is the primary determinant of grease life, meaning that grease life is significantly affected by temperature. A simple representation of this is shown in the graph below.
This graph shows that the life of bearing grease is halved with every 15˚C temperature rise in the bearing.



Taking measures to lower the motor temperature is effective for extending the motor's life.
The table below shows the average bearing grease life for each motor as reference.

Product	Operating Condition	Estimated Average Life of Bearing Grease [h]
Induction Motors	Operation: Continuous, unidirectional Torque: Rated torque Type of Load: Uniform load Speed: Rated speed Ambient Temperature: 30˚C	30,000
Brushless Motors		40,000
Servo Motors Stepper Motors	Surface Temperature of Motor Case Operation at 80˚C	50,000

● Note that the life of bearing grease is greatly affected by operating conditions, such as method of use and environmental conditions.

Standard AC Motors, Brushless Motors and Servo Motors

Use the motor in conditions where the surface temperature of the motor case is 90˚C max.

Stepper Motors

Use the motor in conditions where the surface temperature of the motor case is 100˚C max.
(For the **AZ** Series, use the motor in conditions where the surface temperature of motor case is 80˚C max.)
Because of the effects of operating ambient temperature and operating duty, the lower the motor surface temperature, the longer the motor life becomes.
In rare occasions such as when the motor is subjected to a large radial load, the mechanical life may become shorter than the grease life.

Service Life of a Gearhead

The gearhead life is reached when power can no longer be transmitted because the bearing mechanical life has ended. Therefore, the actual life of a gearhead varies depending on the load, how the load is applied, and the operating speed. Oriental Motor defines life under certain conditions as rated life, based on which the life under actual operation is calculated according to load conditions and other factors. The tooth surface of Oriental Motor's gearheads is lubricated by a grease lubrication mechanism. Separate lubrication is not required.

● Rated Life

Oriental Motor defines the rated life as the life of a gearhead under the following operating conditions:
Conditions
Torque: Permissible torque
Load Type: Uniform load
Input Speed: Reference input speed
Radial Load*: Permissible radial load
Axial Load*: Permissible axial load

*The rated life of the **PS** geared, **PN** geared, or **HPG** geared type motors is the value when either a radial or axial load is applied.

Table 1: Rated Life of Each Gearhead Type

Motor Type	Series	Gearhead Type	Reference Input Speed [r/min]	Rated Life [h]
Standard AC Motors	**KIIS** Series	Right-Angle Gearhead Type	1500	5000
	KII Series	Parallel Shaft Gearhead		10000
	FPW Series	Parallel Shaft Gearhead	1500	5000
Speed Control Motors	**BMU** Series **BLE2** Series	Parallel Shaft Gearhead	3000	10000
	BXII Series **BLH** Series*1	Parallel Shaft Gearhead	3000	10000
		Hollow Shaft Flat Gearhead*2		
	DSC Series	Parallel Shaft Gearhead	1500	10000
Stepper Motors	**AZ** Series	**TS** Geared Type	1500	10000
		PS Geared Type		20000
		HPG Geared Type		20000
		Harmonic Geared Type (□42 mm)		7000
		Harmonic Geared Type (□60 mm, □90 mm)		10000
	AR Series **CRK** Series	**TH** Geared Type	1500	5000
		PS Geared Type		20000
		PN Geared Type		
		Harmonic Geared Type		5000
	RKII Series	**TS** Geared Type	1500	10000
		PS Geared Type		20000
		Harmonic Geared Type (□42 mm)		7000
		Harmonic Geared Type (□60 mm, □90 mm)		10000
	CVK Series	**SH** Geared Type	1500	10000
	1.8°/0.9° **PK** Series	**SH** Geared Type	1500	5000
	1.8°/0.9° **PKP** Series	**SH** Geared Type	1500	10000
		Harmonic Geared Type (ϕ72 mm)		7000
Servo Motors	**NX** Series	**PS** Geared Type	3000	10000

*1 The rated life of motors with an output power of 15 W is 5000 [h].
*2 The rated life of hollow shaft flat gearhead, 200 W and 400 W are 5000 [h].

●Estimating Lifetime

Lifetime under actual conditions of use is calculated based on the operating speed, load and load type, using the following formula. The calculated lifetime represents the actual driven hours.

$$L\text{ (Lifetime)} = L_1 \frac{K_1}{(K_2)^3 \cdot f} \text{ [h]}$$

L_1: Rated lifetime [hours]
Refer to Table 1 above to find the applicable rated lifetime for the gearhead.

K_1: Speed coefficient
The speed coefficient K_1 is calculated based on the reference input speed listed in Table 1 above and the actual input speed.

$$K_1 = \frac{\text{Reference Input Speed}}{\text{Actual Input Speed}}$$

K_2: Load factor
The load factor K_2 is calculated based on the actual operating torque and the permissible torque for each gearhead.

$$K_2 = \frac{\text{Operating Torque}}{\text{Permissible Torque}}$$

The average torque may be considered operating torque if the gearhead is subject to load while starting and stopping only, such as when driving an inertial load. The calculation of average torque is explained later in this section.
Permissible torque represents the specification values listed in the product catalogue.

f: Load-type factor
The factor f is determined based on load type, using the following drive examples as a reference:

Load Type	Example	Load Factor f
Uniform Load	· Unidirectional continuous operation · For driving belt conveyors and film reels that are subject to minimal load fluctuation	1.0
Slight Impact	· Frequent starting and stopping · Cam drive and inertial body positioning via stepper motor	1.5
Medium Impact	· Frequent instantaneous bi-directional operation, starting and stopping of reversible motors · Frequent instantaneous stopping by brake pack of AC motors · Frequent instantaneous starting and stopping of brushless motors and servo motors	2.0

Note

Notes Regarding the Effects of Radial Load and Axial Load

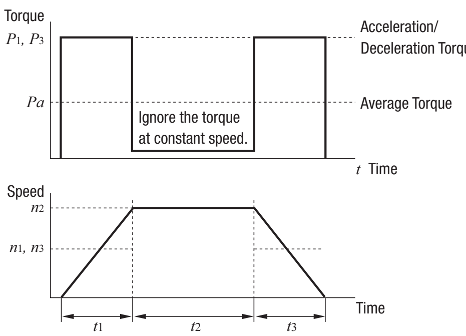
- The above estimated lifetime is calculated according to the radial load and axial load, which are in proportion to a given load factor. For example, if the load factor is 50%, the lifetime is calculated using 50% radial load and axial load.
- The actual life of a gearhead having a low load factor and a large radial load or axial load will be shorter than the value determined through the previous formula.

●How to Obtain the Average Torque

The stepper motor or servo motor is used for intermittent operation of an inertia load, such as driving an index table and arm. In this case, the average torque shall be considered the operating torque, as described below. The load factor for driving an inertia load using a standard AC motor or brushless motor shall be 1.0.

◇Driving an Inertia Load ①

The graph below shows torque generated when driving only an inertial load over a long operating cycle. Frictional load caused by bearings and other parts during constant speed operation is negligible and therefore omitted.

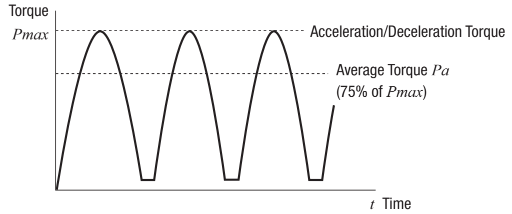


$$P_a = \sqrt[3]{\frac{(P_1{}^3 \times n_1 \times t_1) + (P_3{}^3 \times n_3 \times t_3)}{(n_1 \times t_1) + (n_2 \times t_2) + (n_3 \times t_3)}}$$

n_1 and n_3 represent an average speed in the t_1 and t_3 area.
In the above example: $n_1 = n_3 = \frac{1}{2} n_2$

◇Driving an Inertia Load ②: Using an Arm or Similar Object

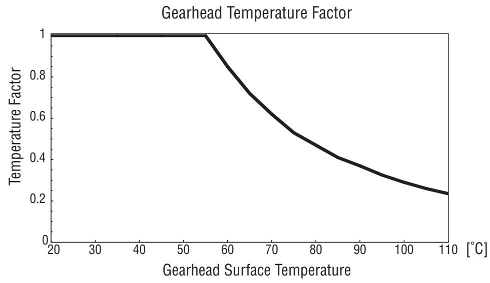
When driving an arm or similar object, the gearhead may be subjected to load fluctuation as shown in the following graph. For example, such load fluctuation will occur when driving a double-joint arm or moving an arm in the vertical direction. In such an application, the average torque shall be 75% of the max. acceleration/deceleration torque, as shown in the following formula.



$$Pa = Pmax \times 0.75$$

●Operating Temperature

An increase in gearhead temperature affects the lubrication of the bearing. However, the effect of temperature on gearhead life varies according to the condition of the load applied to the gearhead bearings, frame size and many other factors. Therefore, it is difficult to include the temperature effect in the previous formula to estimate the lifetime.
The following graph shows the temperature effect on the gearhead bearings. The gearhead life is affected when the gearhead's surface temperature is 55˚C min.

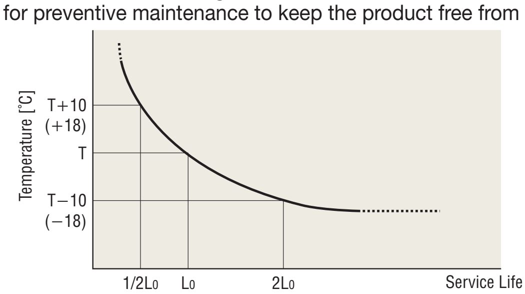


●Note

In some cases, a lifetime of several tens of thousands of hours may be obtained from the calculation under certain conditions. Use the estimated life as a reference only.
The above life estimation is based on the bearing life.
An application in excess of the specification values may adversely affect parts other than the bearings. Use the product within the range of specified values listed in the product catalogue.

■Service Life of a Circuit Product

The life of each of Oriental Motor's circuit products is determined by the aluminum electrolytic capacitor inside the product. Our circuit products are designed so that their useful life will be reached after 5 years min. when the product is used continuously under an ambient temperature of 40˚C. (Excluding certain products.)
In addition, an aluminum electrolytic capacitor generally exhibits the characteristics according to the "Arrhenius equation." Specifically, as shown in the figure below, a temperature rise of 10˚C reduces the life of an aluminum electrolytic capacitor to half, while a temperature drop of 10˚C will extend the life to twice as long.
Since the lifetime of a circuit product varies depending on the operating environment and conditions, Oriental Motor recommends that the curve shown in the figure below be used to determine the need for preventive maintenance to keep the product free from failure.



Service Life of Aluminum Electrolytic Capacitor

Service Life of an Electric Linear Actuator

The life of an electric linear slide and electric cylinder is generally affected by the rolling fatigue life of its ball screw, guide and ball bearing. When stress is applied repeatedly to the raceways and the rolling ball, flaking (a phenomenon in which the metal surface turns into small scale-like pieces and separate from the base metal) occurs due to material rolling fatigue. The rolling fatigue life refers to the time until the flaking occurs.
An expected life is calculated for each product based on its max. ratings (max. transportable mass, max. speed, load moment, etc.) as a reference for calculating the product's life.

Estimated Service Life of Each Series

Series	Lead 3 mm	Lead 6 mm	Lead 12 mm
EAS series	1500 km	3000 km	5000 km
EZS Series	–	3000 km	5000 km
EAC Series	1500 km	3000 km	5000 km

For electric linear slide/cylinder guide, reference life is designed for each series. If the calculation of the load moment of the guide reveals that the load factor with respect to the dynamic permissible moment is 1 more, the reference life becomes below the expected life distance. The expected life distance can be checked with the formula below.
Refer to the following pages for the load moment calculations.

- Electric Linear Slides ➜ H-19
- Electric Cylinders ➜ H-21
- Compact Linear Actuators ➜ H-24

$$\text{Expected Life (km)} = 5000\ \text{km}^{*} \times \left(\frac{1}{\frac{|\Delta M_P|}{M_P} + \frac{|\Delta M_Y|}{M_Y} + \frac{|\Delta M_R|}{M_R}} \right)^3$$

✽The expected life of **EAS2**, **EAC2** is 3000 km.

Maintenance

This section describes the maintenance needed to safely and efficiently operate linear and rotary actuators.

●Check Items and Time Period

If linear and rotary actuators are operated for 8 hours a day, check and maintain them for each time period shown in the table below. If the operating ratio is high or is operated continuously day and night, shorten the maintenance period according to the conditions.

List of Maintenance Periods (Reference)

Product Name	Check Time		Check Period
EAS Series	At startup	6 months after startup	Every 6 months thereafter
EZS Series	At startup	6 months after startup	Every 6 months thereafter
EAC Series	At startup	6 months after startup	Every 6 months thereafter
DRS2 Series	At startup	1 week after startup	Every month thereafter
DRLⅡ Series	At startup	1 week after startup	Every month thereafter

●Checking the Grease Conditions of Traveling Surface and Sliding Surface

The grease conditions of the traveling surface and sliding surface of linear actuators are checked visually. Check the items listed in the table.
Even if the grease has changed color, good lubrication is maintained as long as the traveling surface appears shiny.

List of Visual Confirmation Items

Item	Check Details	Action
Ball Screw Shaft	Attachment of dust or other foreign object?	Remove foreign objects, if any.
	Does the grease look dull? Has the amount of grease decreased?	Clean the screw shaft using a soft cloth and then apply grease to the nut raceway grooves.
Guide Rail (Rod, Shaft Guide)	Attachment of dust or other foreign object?	Remove foreign objects, if any.
	Does the grease look dull? Has the amount of grease decreased?	Clean the ball raceway grooves on both sides of the guide rail using a soft cloth and then apply grease to the ball raceway grooves.

Grease List

Series	Ball Screw	Guide Rail/Rod
EAS series	AFF (Manufactured by THK)	AFF (Manufactured by THK)
EZS Series	AFF (Manufactured by THK)	AFF (Manufactured by THK)
EZS Series For Cleanroom Use	AFE-CA (Manufactured by THK)	AFF (Manufactured by THK)
EAC Series	–	Marutemp SRL (Manufactured by Kyodo Yushi)
DRS2 Series	AFC (Manufactured by THK)	AFC (Manufactured by THK)
DRLⅡ Series Type with a Guide/ Type without a Guide	AFC (Manufactured by THK)	Marutemp PS No.2 (Manufactured by Kyodo Yushi)
DRLⅡ Series Type with a Table	AFE-CA (Manufactured by THK)	AFE-CA (Manufactured by THK)

●Maintenance-Free for Long-Term Performance

The **EAS** Series, **EZS** Series and **EAC** Series come with the lubrication system QZ (manufactured by THK) for the ball screw nut and employ a ball retainer guide (manufactured by THK), so the grease maintenance period can be greatly extended.

We have confirmed in running tests that Oriental Motor electric linear slides and electric cylinders do not experience any problems with omission of maintenance up to their expected life. However, grease deterioration varies depending on the operating conditions and operating environment. Perform maintenance based on the table above in actual use.

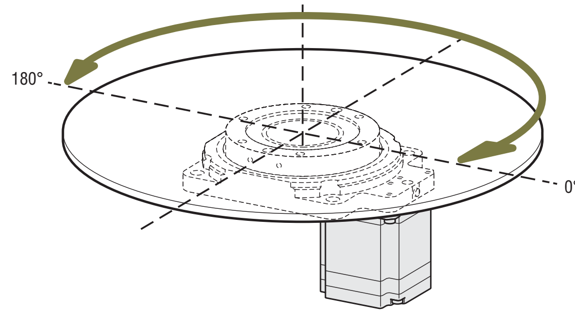
Service Life of Hollow Rotary Actuators

We have confirmed via testing that our hollow rotary actuators operate properly for 10 million 2-way rotations. 10 million rotations is a reference value and is not guaranteed. The expected life varies depending on the ambient temperature and operating conditions.

Actual Test Conditions

- Back-and-forth operation at 180 degrees when an inertial load is installed
- Number of back-and-forth rotations: 10 million
- Torque: the max. permissible torque (safety factor times 1)

✽The safety factor of the torque must be 1.5 to 2 times greater (reference values). The safety factor (times 1) is used for Oriental Motor's actual test.



Service Life of a Cooling Fan

Cooling fan life represents the condition in which the fan's capability to generate air flow has deteriorated due to continuous operation over a certain period of time, or the fan can no longer be used due to significant noise.

Service Life of a Cooling Fan

① Rotation life – Life as defined by certain deterioration in fan rotation

② Sound life – Life as defined by certain increase in noise

The rotation life in ① can be easily measured, and the factors involved can be clearly specified numerically. This is usually what is meant when referring to life.
Sound life in ②, on the other hand, is defined by an increase in decibel level, while determining exactly what amount of increase marks the end of sound life is determined by the user's judgment. Moreover, fans can still meet the operating conditions even after reaching the predetermined increase level in noise. In short, there are generally no specific references or lifetime.
Oriental Motor defines life by ① rotation life; a fan is judged to have reached the end of its life when speed drops to 70% of the rated speed.

●Cooling Fan Bearing Life

Cooling fans use a ball bearing. The following explanation applies to the life of a ball bearing. Since the load applied to cooling fan's bearings is negligible, life of a cooling fan is determined by the deterioration of the grease in the bearings.
Since the cooling fan's operating and starting torques are already smaller than those of a power motor, lack of lubrication due to grease deterioration will cause the starting and dynamic torques of the bearing to increase excessively, which may prevent the fan from starting. Deterioration of grease also increases the noise generated by the bearings, further affecting the life of a cooling fan.
Grease life is given by the following formula:

$$\log t = K_1 - K_2 \frac{n}{Nmax} - \left(K_3 - K_4 \frac{n}{Nmax}\right) T$$

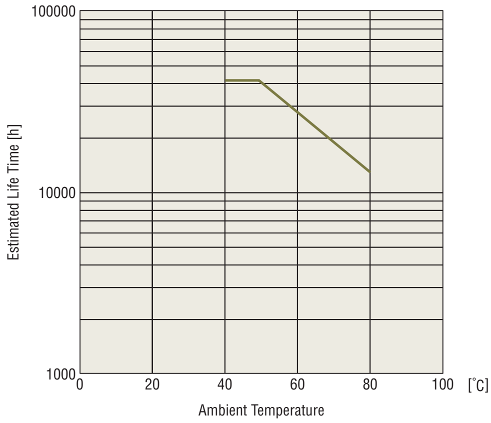
t: Average grease life
K_1, K_2, K_3, K_4: Constants determined by grease
$Nmax$: Max. rotation allowed by grease lubrication
n: Speed of bearings
T: Operating temperature of bearings

As indicated by the above formula, $Nmax$ is predetermined by the bearings, so grease life depends on the temperature and speed of bearings. However, Oriental Motor's products are designed so that the bearing life is only minimally affected by the speed of bearings. Thus, the average grease life is determined by temperature since $\frac{n}{Nmax}$ is a constant value.

●Estimated Life Characteristics

The figure below gives the estimated life characteristics of a cooling fan.
These characteristics are those of the small AC cooling fan **MU1238A**.

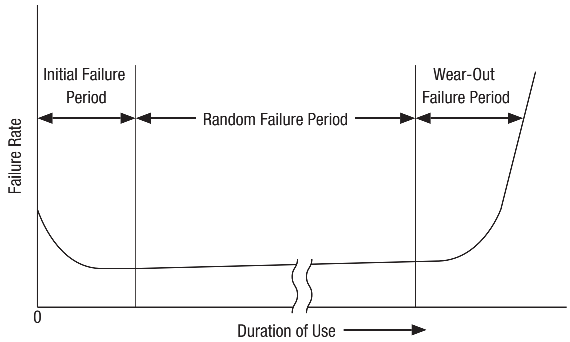
This graph estimates the service life of the bearing using the formula for estimating the life of bearings based on actual measurements of temperature rise at the rated voltage.



Estimated Life Characteristics

Relationship between the Duration of Use and Failure Rate

Generally, the failure rate of parts relative to the duration of use fits the pattern of 3 states: initial failure, random failure and wear-out failure, as shown in the figure below.



Relationship between the Duration of Use and Failure Rate

The risks of initial failures are eliminated in the manufacturing and inspection processes, but random failures are sudden failures that occur randomly and unexpectedly during the durable life of the product before wear progresses. Therefore, it is difficult to provide technical measures against random failures, and the only measure available presently is to predict occurrences based on statistical data.
Wear-out failures occur towards the end of the product's durable life as a result of deterioration and wear. The rate of wear-out failure increases dramatically after a certain period. Replacing certain parts at this point will provide an effective means for preventive maintenance.
(Excerpt from "Recommendation for Periodic Inspection of General-Purpose Inverters" by the Japan Electrical Manufacturers' Association)