Lead Screw Nut

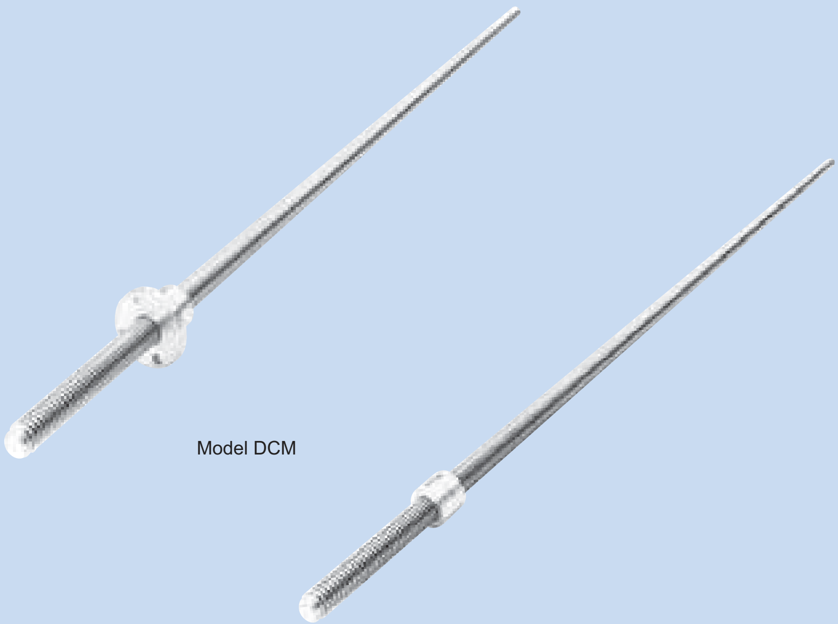
THK General Catalog

A Technical Descriptions of the Products

B Product Specifications (Separate)

* Please see the separate "B Product Specifications".

Features of the Lead Screw Nut



Model DCM

Model DC

Structure and Features

The lead Screw Nut models DCM and DC are manufactured to meet the standards for the 30° trapezoidal threads. They use a special alloy (see A-831) for the nuts and have a precision male thread, formed through die casting, as the core. As a result, these bearings achieve less unevenness in accuracy and higher accuracy and wear resistance than the machined lead screw nuts.
For the screw shafts to be used with this product, the rolled shafts are available as the standard.
In addition, the cut screw shafts and the ground screw shafts are also available according to the application. Contact THK for details.

Features of the Special Rolled Shafts

The dedicated rolled shafts with the standardized lengths are available for the Lead Screw Nut.

[Increased Wear Resistance]
The shaft teeth are formed by cold gear rolling, and the surface of the tooth surface is hardened to over 250 HV and are mirror-finished. As a result, the shafts are highly wear resistant and achieve significantly smooth motion when used in combination with lead screw nuts.

[Improved Mechanical Properties]
Inside the teeth of the rolled shaft, a fiber flow occurs along the contour of the tooth surface of the shaft, making the structure around the teeth roots dense. As a result, the fatigue strength is increased.

[Additional Machining of the Shaft End Support]
Since each shaft is rolled, additional machining of the support bearing of the shaft end can easily be performed by lathing or milling.

High Strength Zinc Alloy

The high strength zinc alloy used in the lead screw nuts is a material that is highly resistant to seizure and the wear and has a high load carrying capacity. Its composition, the mechanical properties, the physical properties and the wear resistance are given below.

[Composition]

Table1 Composition of the High Strength Zinc Alloy

Unit: %

Item	Description
Aℓ	3 to 4
Cu	3 to 4
Mg	0.03 to 0.06
Be	0.02 to 0.06
Ti	0.04 to 0.12
Zn	Remaining portion

[Mechanical Properties]

Item	Description
Tensile strength	275 to 314 N/mm²
Tensile yield strength (0.2%)	216 to 245 N/mm²
Compressive strength	539 to 686 N/mm²
Compressive yield strength (0.2%)	294 to 343 N/mm²
Fatigue strength	132 N/mm² × 10^7 (Schenk bending test)
Charpy impact	0.098 to 0.49 N-m/mm²
Elongation	1 to 5 %
Hardness	120 to 145 HV

[Physical Properties]

Item	Description
Specific gravity	6.8
Specific heat	460 J/ (kg・K)
Melting point	390 ℃
Thermal expansion coefficient	24×10^{-6}

[Wear Resistance]

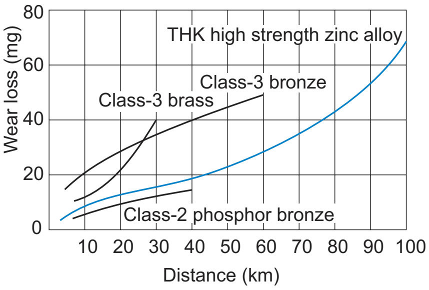


Fig.1 Wear Resistance of the High Strength Zinc Alloy

[Test conditions: Amsler wear-tester]

Item	Description
Test piece rotational speed	185 min^{-1}
Load	392 N
Lubricant	Dynamo oil

Selecting a Lead Screw Nut

[Dynamic Permissible Torque T and Dynamic Permissible Thrust F]

The dynamic permissible torque (T) and the dynamic permissible thrust (F) are the torque and the thrust at which the contact surface pressure on the tooth surface of the bearing is 9.8 N/mm^2. These values are used as a measuring stick for the strength of the lead screw nut.

[pV Value]

With a sliding bearing, a pV value, which is the product of the contact surface pressure (p) and the sliding speed (V), is used as a measuring stick to judge whether the assumed model can be used. Use the corresponding pV value indicated in Fig.1 as a guide for selecting a lead screw nut. The pV value varies also according to the lubrication conditions.

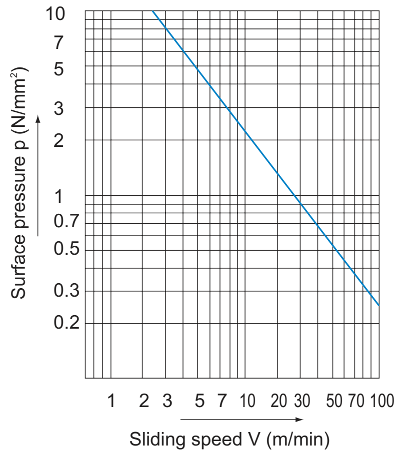


Fig.1 pV Value

● **f_S: Safety Factor**

To calculate a load applied to the lead screw nut, it is necessary to accurately obtain the effect of the inertia that changes with the weight and dynamic speed of an object. In general, with the reciprocating or the rotating machines, it is not easy to accurately obtain all the factors such as the effect of the start and stop, which are always repeated. Therefore, if the actual load cannot be obtained, it is necessary to select a bearing while taking into account the empirically obtained safety factors (f_S) shown in Table1.

Table1 Safety Factor (f_S)

Type of load	Lower limit of f_S
For a static load less frequently used	1 to 2
For an ordinary single-directional load	2 to 3
For a load accompanied by vibrations/impact	4 or greater

● f_T: Temperature Factor

If the temperature of the lead screw nut exceeds the normal temperature range, the seizure resistance of the nut and the strength of the material will decrease. Therefore, it is necessary to multiply the dynamic permissible torque (T) and the dynamic permissible thrust (F) by the corresponding temperature factor indicated in Fig.2.

Accordingly, when selecting a lead screw nut, the following equations need to be met in terms of its strength.

Dynamic permissible torque(T)

$$f_S \leqq \frac{f_T \cdot T}{P_T}$$

Static permissible thrust(F)

$$f_S \leqq \frac{f_T \cdot F}{P_F}$$

f_S : Safety factor (see A-833Table1)
f_T : Temperature factor (see Fig.2)
T : Dynamic permissible torque (N-m)
P_T : Applied torque (N-m)
F : Dynamic permissible thrust (N)
P_F : Axial load (N)

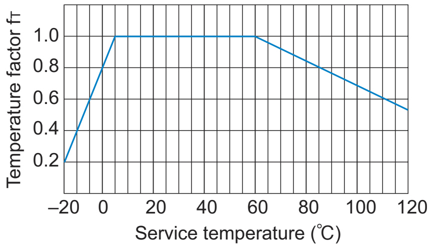


Fig.2 Temperature Factor

● Hardness of the Surface and the Wear Resistance

The hardness of the shaft significantly affects the wear resistance of the lead screw nut. If the hardness is equal to or less than 250 HV, the abrasion loss increases as indicated in Fig.3. The roughness of the surface should preferably be 0.80a or less.

A special rolled shaft achieves the surface hardness of 250 HV or greater, through hardening as a result of rolling, and surface roughness of 0.20a or less. Thererfore, the dedicated rolled shaft is highly wear resistant.

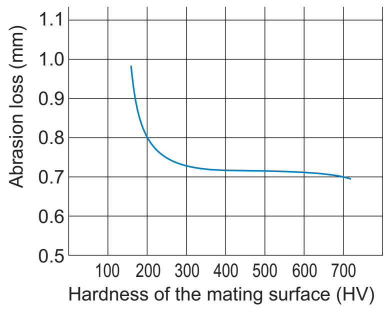


Fig.3 Hardness of the Surface and Wear Resistance

[Calculating the Contact Surface Pressure p]

The value of "p" is obtained as followed.

$$p = \frac{P_F}{F} \times 9.8$$

p : Contact surface pressure on the tooth from an axial load (P_F N) (N/mm²)
F : Dynamic permissible thrust (N)
P_F : Axial load (N)

[Calculating the Sliding Speed V on the Teeth]

The value of "V" is obtained as followed.

$$V = \frac{\pi \cdot Do \cdot n}{\cos\alpha \times 10^3}$$

V : Sliding speed (m/min)
Do : Effective diameter (mm)
(see specification table)
n : Rotation speed per minute (min^{-1})
α : Lead angle (degree)
(see specification table)
R : Lead (mm)

[Example of Calculation]

Assuming that Lead Screw Nut model DCM is used, select a lead screw nut that travels at feed speed S = 3 m/min while receiving an axial load P_F = 1,080 N, which is applied in one direction. First, tentatively select model DCM32 (dynamic permissible thrust F = 21,100 N). Obtain the contact surface pressure (p).

$$p = \frac{P_F}{F} \times 9.8 = \frac{1080}{21100} \times 9.8 \fallingdotseq 0.50\ N/mm^2$$

Obtain the sliding speed (V).

The rotation speed per minute (n) of the screw shaft needed to move it at feed speed S = 3 m/min is calculated as follows.

$$n = \frac{S}{\ell \times 10^{-3}} = \frac{3}{6 \times 10^{-3}} = 500\ min^{-1}$$

$$V = \frac{\pi \cdot Do \cdot 500}{\cos\alpha \times 10^3} = \frac{\pi \times 29 \times 500}{\cos 3°46' \times 10^3} \fallingdotseq 45.6\ m/min$$

From the diagram of pV values (see Fig.1 on A-833), it is judged that there will be no abnormal wear if the sliding speed (V) is 47 m/min or below against the "p" value of 0.50 N/mm². Second, obtain the safety factor (f_S) against the dynamic permissible thrust (F). Given the conditions: temperature factor f_T = 1 and applied load P_F= 1,080 N, the safety factor is calculated as follows.

$$f_S \leqq \frac{f_T \cdot F}{P_F} = \frac{1 \times 21100}{1080} = 19.5$$

Since the required strength will be met if "f_S" is at least 2 because of the type of load, it is appropriate to select model DCM32.

Efficiency and Thrust

The efficiency (η) at which the screw transfers a torque into thrust is obtained from the following equation.

$$\eta = \frac{1 - \mu \tan\alpha}{1 + \mu / \tan\alpha}$$

η : Efficiency
α : Lead angle
μ : Frictional resistance
Fig.4 shows the result of the above equation.
The thrust generated when a torque is applied is obtained from the following equation.

$$Fa = \frac{2 \cdot \pi \cdot \eta \cdot T}{R \times 10^{-3}}$$

Fa : Thrust generated (N)
T : Torque (input) (N-m)
R : Lead (mm)

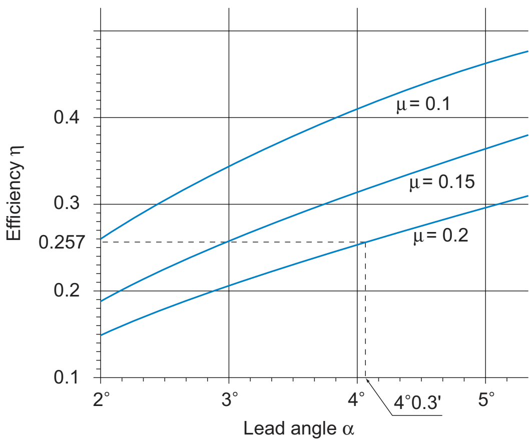


Fig.4 Efficiency

[Example of Calculation]

Assuming that Lead Screw Nut model DCM20 is used and the input torque T = 19.6 N-m, obtain the thrust to be generated.
Calculate the efficiency (η) when μ = 0.2.
The lead angle (α) of model DCM20: 4°03'
From the diagram in Fig.4, the efficiency (η) when the friction coefficient μ = 0.2 is obtained as η = 0.257.
Obtain the thrust generated.

$$Fa = \frac{2 \cdot \pi \cdot \eta \cdot T}{R \times 10^{-3}} = \frac{2 \times \pi \times 0.25 \times 19.6}{4 \times 10^{-3}} \fallingdotseq 7700 \text{ N}$$

Accuracy Standards

Table2 Accuracy of the Screw Shaft of Models DCM and DC

Unit: mm

Shaft symbol	Rolled shaft	Cut shaft	Ground shaft
Accuracy	T[Note]	K[Note]	G[Note]
Single pitch error (max)	±0.020	±0.015	±0.005
Accumulated pitch error (max)	±0.15/300	±0.05/300	±0.015/300

Note) Symbols T, K and G indicate machining methods for the screw shaft. The cut shafts and ground shafts are build-to-order.

Fit

For the fitting between the lead screw nut circumference and the housing, we recommend a loose fitting or a tight fitting.
Housing inner-diameter tolerance: H8 or J8

Installation

[About Chamfer of the Housing's Mouth]

To increase the strength of the root of the flange of the lead screw nut, the corner is machined to have an R shape. Therefore, it is necessary to chamfer the inner edge of the housing's mouth.

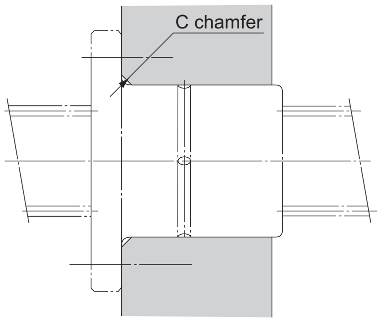


Fig.1

Table1 Chamfer of the Housing's Mouth

Unit: mm

Model No. DCM	Chamfer of the mouth C (Min.)
12	2
14	
16	
18	
20	
22	2.5
25	
28	
32	
36	3
40	
45	
50	

[Recommended Mounting Orientation]

When vertically conveying a heavy object using the screw shaft, it is safe to mount the screw as shown in Fig.2 where supports are provided on the mounting holes to prevent the moving object from falling even if the lead screw nut is broken due to an overload or an impact.

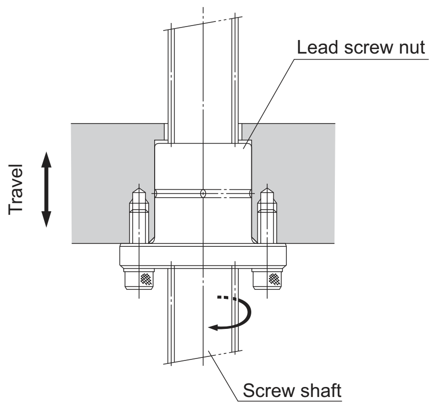


Fig.2 Recommended Mounting Orientation

[Example of Installation]

Fig.3 shows examples of mounting the lead screw nuts. When mounting a lead screw nut, secure sufficient tightening strength in the axial direction. For the housing inner-diameter tolerance, see the section concerning fitting on A-838.

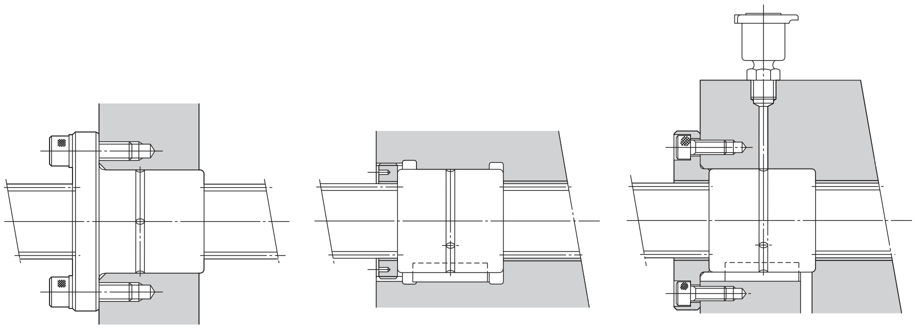


Fig.3 Examples of Installing the Lead Screw Nut

Lubrication

Select a lubrication method according to the conditions of the lead screw nut.

[Oil Lubrication]

For a lubrication of the lead screw nut, an oil lubrication is recommended. Specifically, an oil-bath lubrication or drop the lubrication is particularly effective. An oil-bath lubrication is the most appropriate method since it meets harsh conditions such as high speed, a heavy load or an external heat transmission and it cools the lead screw nut. The drop lubrication is appropriate for low to medium speed and a light to medium load. Select a lubricant according to the conditions as indicated in Table2.

Table2 Selection of a Lubricant

Condition	Types of Lubricants
Low speed, high load, high temperature	High-viscosity sliding surface oil or turbine oil
High speed, light load, low temperature	Low-viscosity sliding surface oil or turbine oil

[Grease Lubrication]

In the low-speed feed, which occurs less frequently, the user can lubricate the slide system by manually applying grease to the shaft on a regular basis or using the greasing hole on the lead screw nut. We recommend using lithium-soap group grease No. 2.