

High Torque Type Ball Spline

Models LBS, LBF, LBH, LBST and LBR

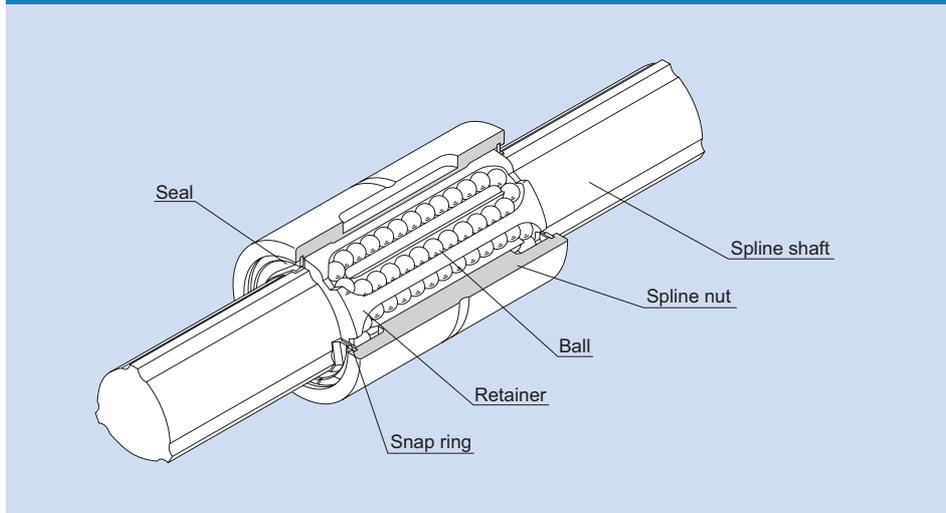


Fig.1 Structure of High Torque Type Ball Spline Model LBS

Structure and Features

With the high torque type Ball Spline, the spline shaft has three crests positioned equidistantly at 120° , and along both sides of each crest, two rows of balls (six rows in total) are arranged so as to hold the crest, as shown in Fig.1.

The raceways are precision ground into R-shaped grooves whose diameters are approximate to the ball diameter. When a torque is generated from the spline shaft or the spline nut, the three rows of balls on the load-bearing side evenly receive the torque, and the center of rotation is automatically determined. When the rotation reverses, the remaining three rows of balls on the unloaded side receive the torque.

The rows of balls are held in a retainer incorporated in the spline nut so that they smoothly roll and circulate. With this design, balls will not fall even if the spline shaft is removed from the nut.

[No Angular Backlash]

With the high torque type Ball Spline, a single spline nut provides a preload to eliminate angular backlash and increase the rigidity.

Unlike conventional ball splines with circular-arc groove or Gothic-arch groove, the high torque type Ball Spline eliminates the need for twisting two spline nuts to provide a preload, thus allowing compact design to be achieved easily.

Features of Each Model

High Torque Type Ball Spline

[High Rigidity and Accurate Positioning]

Since this model has a large contact angle and provides a preload from a single spline nut, the initial displacement is minimal and high rigidity and high positioning accuracy are achieved.

[High-speed Motion, High-speed Rotation]

Adoption of a structure with high grease retention and a rigid retainer enables the ball spline to operate over a long period with grease lubrication even in high-speed straight motion. Since the distance in the radius direction is almost uniform between the loaded balls and the unloaded balls, the balls are little affected by the centrifugal force and smooth straight motion is achieved even during high-speed rotation.

[Compact Design]

Unlike conventional ball splines, unloaded balls do not circulate on the outer surface of the spline nut with this model. As a result, the outer diameter of the spline nut is reduced and a space-saving and compact design is achieved.

[Ball Retaining Type]

Use of a retainer prevents the balls from falling even if the spline shaft is pulled out of the spline nut.

[Can be Used as a Linear Bushing for Heavy Loads]

Since the raceways are machined into R grooves whose diameter is almost equal to the ball diameter, the contact area of the ball is large and the load capacity is large also in the radial direction.

[Double, Parallel Shafts can be Replaced with a Single Shaft]

Since a single shaft is capable of receiving a load in the torque direction and the radial direction, double shafts in parallel configuration can be replaced with a single-shaft configuration. This allows easy installation and achieves space-saving design.

Applications

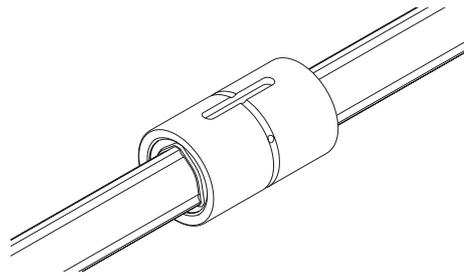
The high torque type Ball Spline is a reliable straight motion system used in a wide array of applications such as the columns and arms of industrial robot, automatic loader, transfer machine, automatic conveyance system, tire forming machine, spindle of spot welding machine, guide shaft of high-speed automatic coating machine, riveting machine, wire winder, work head of electric discharge machine, spindle drive shaft of grinding machine, speed gears and precision indexing shaft.

Types and Features

[Types of Spline Nuts]

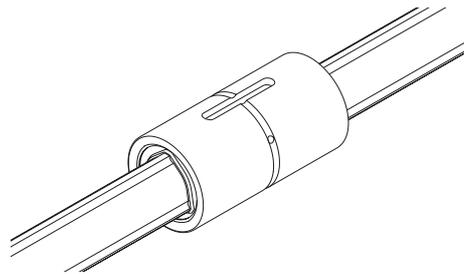
Cylindrical Type Ball Spline Model LBS (Medium Load Type) [Specification Table⇒B-368](#)

The most compact type with a straight cylindrical spline nut. When transmitting a torque, a key is driven into the body. The outer surface of the spline nut is provided with anti-carbonation treatment.



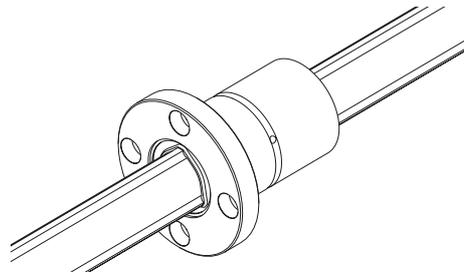
Cylindrical Type Ball Spline Model LBST (Heavy Load Type) [Specification Table⇒B-372](#)

A heavy load type that has the same spline nut diameter as model LBS, but has a longer spline nut length. It is optimal for locations where the space is small, a large torque is applied, and an overhang load or moment load is applied.



Flanged Type Ball Spline Model LBF [Specification Table⇒B-374](#)

The spline nut can be attached to the housing via the flange, making assembly simple. It is optimal for locations where the housing may be deformed if a keyway is machined on its surface, and where the housing width is small. Since it allows a dowel pin to be driven into the flange, angular backlash occurring in the fitting can completely be eliminated.



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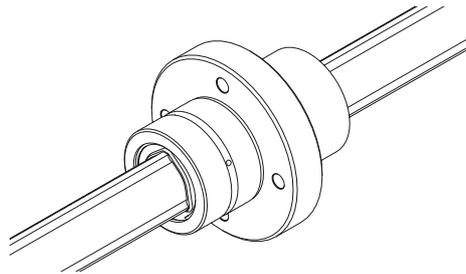
Features of Each Model
High Torque Type Ball Spline

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Flanged Type Ball Spline Model LBR

Specification Table⇒B-376

Based on the heavy load type model LBST, this model has a flange in the central area, making itself optimal for locations under a moment load such as arms of industrial robots.

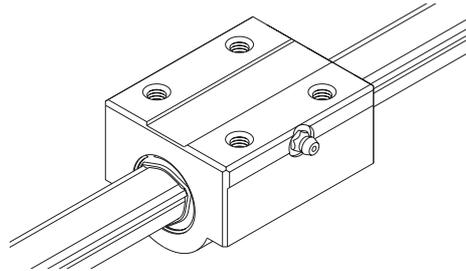


Ball Spline

Rectangular Type Ball Spline Model LBH

Specification Table⇒B-378

Its rigid rectangular spline nut does not require a housing and can be directly mounted on the machine body. Thus, a compact, highly rigid linear guide system is achieved.



[Types of Spline Shafts]

Precision Solid Spline Shaft (Standard Type)

The spline shaft is cold-drawn and its raceway is precision ground. It is used in combination with a spline nut.



Special Spline Shaft

THK manufactures a spline shaft with thicker ends or thicker middle area through special processing at your request.



Hollow Spline Shaft (Type K)

A drawn, hollow spline shaft is available for requirements such as piping, wiring, air-vent and weight reduction.



Service Life

For details, see A-465.

Clearance in the Rotation Direction

For details, see A-481.

Accuracy Standards

For details, see A-482.

Housing Inner-diameter Tolerance

When fitting the Ball Spline with the housing, tight fitting is normally recommended. If the accuracy of the Ball Spline does not need to be very high, clearance fitting is also acceptable.

Table1 Housing Inner-diameter Tolerance

Housing Inner-diameter Tolerance	General conditions	H7
	When clearance needs to be small	J6

Spline Shaft

Spline shafts are divided in shape into precision solid spline shaft, special spline shaft and hollow spline shaft (type K), as described on A-488.

For details, see B-381 to B-383.

Accessories

Ball Spline models LBS and LBST are provided with a standard key.

For detailed dimensions, see B-384.

Medium Torque Type Ball Spline

Models LT and LF

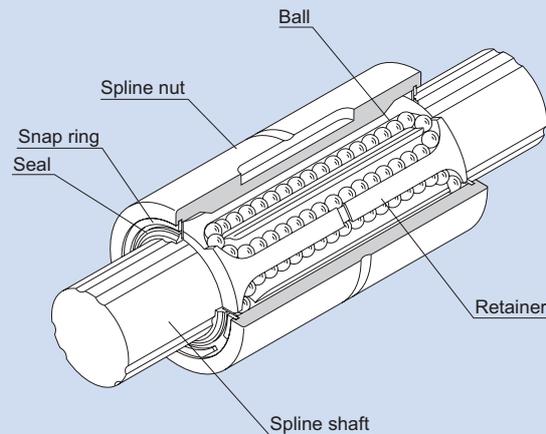


Fig.1 Structure of Medium Torque Type Ball Spline Model LT

Structure and Features

With the medium torque type Ball Spline, the spline shaft has two to three crests on the circumference, and along both sides of each crest, two rows of balls (four or six rows in total) are arranged to hold the crest so that a reasonable preload is applied.

The rows of balls are held in a special resin retainer incorporated in the spline nut so that they smoothly roll and circulate. With this design, balls will not fall even if the nut is removed from the spline shaft.

[Large Load Capacity]

The raceways are formed into circular-arc grooves approximate to the ball curvature and ensure angular contact. Thus, this model has a large load capacity in the radial and torque directions.

[No Angular Backlash]

Two rows of balls facing one another hold a crest, formed on the circumference of the spline nut, at a contact angle of 20° to provide a preload in an angular-contact structure. This eliminates an angular backlash in the rotational direction and increases the rigidity.

Features of Each Model

Medium Torque Type Ball Spline

[High Rigidity]

Since the contact angle is large and an appropriate preload is given, high rigidity against torque and moment is achieved.

[Ball Retaining Type]

Use of a retainer prevents the balls from falling even if the spline shaft is pulled out of the spline nut. (except for models LT4 and 5)



Ball Spline

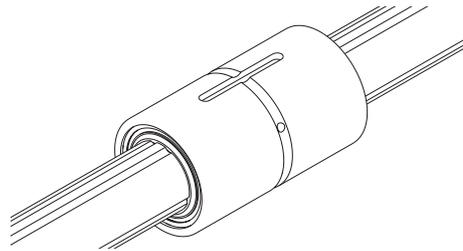
Types and Features

[Types of Spline Nuts]

Cylindrical Type Ball Spline Model LT

Specification Table⇒B-386

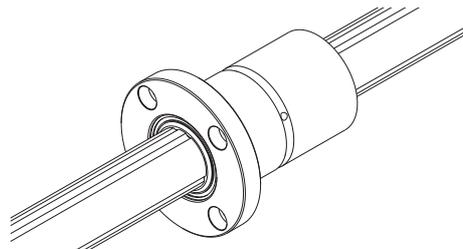
The most compact type with a straight cylindrical spline nut. When transmitting a torque, a key is driven into the body.



Flanged Type Ball Spline Model LF

Specification Table⇒B-388

The spline nut can be attached to the housing via the flange, making assembly simple. It is optimal for locations where the housing may be deformed if a keyway is machined on its surface, and where the housing width is small. Since it allows a dowel pin to be driven into the flange, angular backlash occurring in the fitting can completely be eliminated.



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[Types of Spline Shafts]

Precision Solid Spline Shaft (Standard Type)

The raceway of the spline shaft is precision ground. It is used in combination with a spline nut.



Special Spline Shaft

THK manufactures a spline shaft with thicker ends or thicker middle area through special processing at your request.



Hollow Spline Shaft (Type K)

A drawn, hollow spline shaft is available for requirements such as piping, wiring, air-vent and weight reduction.



Thick

Hollow Spline Shaft (Type N)

A drawn, hollow spline shaft is available for requirements such as piping, wiring, air-vent and weight reduction.



Thin

Ball Spline

Service Life

For details, see A-465.

Clearance in the Rotation Direction

For details, see A-481.

Accuracy Standards

For details, see A-482.

Housing Inner-diameter Tolerance

When fitting the Ball Spline with the housing, tight fitting is normally recommended. If the accuracy of the Ball Spline does not need to be very high, clearance fitting is also acceptable.

Table1 Housing Inner-diameter Tolerance

Housing Inner-diameter Tolerance	General conditions	H7
	When clearance needs to be small	J6

Spline Shaft

Spline shafts are divided in shape into precision solid spline shaft, special spline shaft and hollow spline shaft (types K and N), as described on A-493.

For details, see B-391 to B-392.

Accessories

Ball Spline model LT is provided with a standard key.

For detailed dimensions, see B-393.

Features of Each Model
Medium Torque Type Ball Spline



Ball Spline

Rotary Ball Spline With Geared type

Models LBG and LBGT

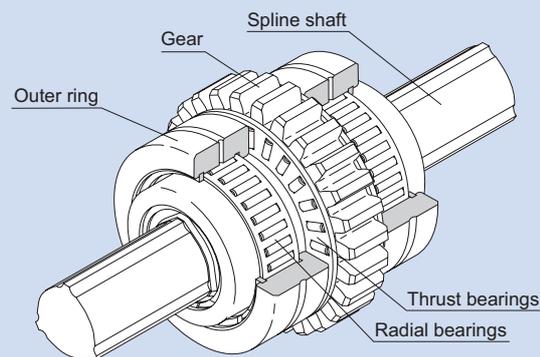


Fig.1 Structure of Rotary Ball Spline Model LBG

Structure and Features

With the Rotary Ball Spline, the spline shaft has three crests, and along both sides of each crest, two rows of balls (six rows in total) are arranged to hold the crest so that a reasonable preload is applied. These models are unit types based on model LBR, but have gear teeth on the flange circumference and radial and thrust bearings on the spline nut, all compactly integrated.

The rows of balls are held in a special resin retainer so that they smoothly roll and circulate. With this design, balls will not fall even if the spline shaft is removed.

[No Angular Backlash]

The spline shaft has three crests positioned equidistantly at 120° and along both sides of each crest, two rows of balls (six rows in total) are arranged so as to hold the crest at a contact angle of 45° and provide a preload. As a result, backlash in the rotational direction is eliminated and the rigidity is increased.

[Compact Design]

The spline nut is compactly integrated with radial and thrust bearings, allowing compact design to be achieved.

Features of Each Model

Rotary Ball Spline

[High Rigidity]

Since the contact angle is large and an appropriate preload is given, high rigidity against torque and moment is achieved.

Use of needle bearings in the support unit achieves a rigid nut support strong against a radial load.

[Optimal for Torque Transmission with Spline Nut Drive]

Since the support bearings allow a rigid nut support, these models are optimal for torque transmission with spline nut drive.



Ball Spline

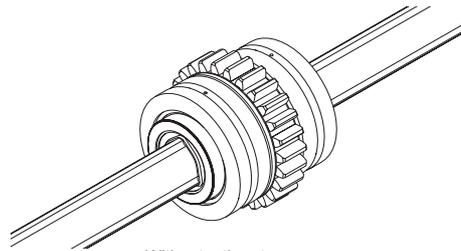
Types and Features

[Types of Spline Nuts]

Ball Spline with Gears Model LBG

Specification Table⇒B-396

These models are unit types based on model LBR, but have gear teeth on the flange circumference and radial and thrust bearings on the spline nut, all compactly integrated. It is optimal for a torque transmission mechanism with spline nut drive.

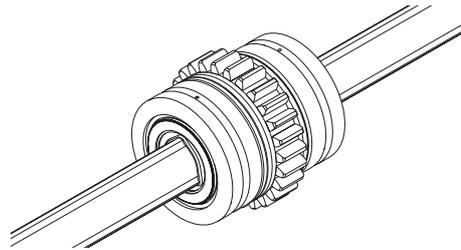


Without a thrust raceway

Ball Spline with Gears Model LBGT

Specification Table⇒B-398

These models are unit types based on model LBR, but have gear teeth on the flange circumference and radial and thrust bearings on the spline nut, all compactly integrated. It is optimal for a torque transmission mechanism with spline nut drive.



With a thrust raceway

[Types of Spline Shafts]

For details, see A-488.

Service Life

For details, see A-465.

Clearance in the Rotation Direction

For details, see A-481.

Accuracy Standards

For details, see A-482.

Housing Inner-diameter Tolerance

Table 1 shows housing inner-diameter tolerance for models LBG and LBGT.

Table 1 Housing Inner-diameter Tolerance

Housing Inner-diameter Tolerance	General conditions	H7
	When clearance needs to be small	J6

Spline Shaft

Spline shafts are divided in shape into precision solid spline shaft, special spline shaft and hollow spline shaft (type K), as described on A-488.

For details, see B-400 to B-401.

Rotary Ball Spline With Support Bearing Type

Models LTR and LTR-A

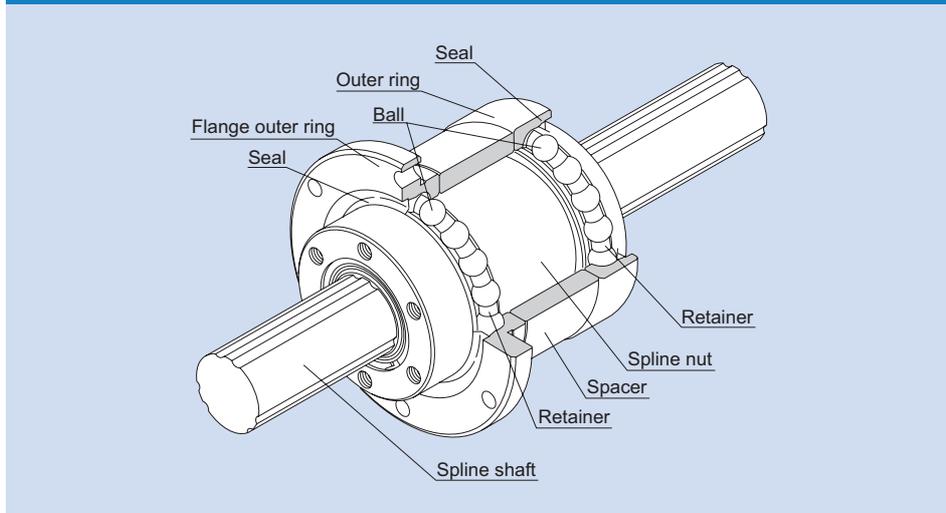


Fig.1 Structure of Rotary Ball Spline Model LTR

Structure and Features

With the Rotary Ball Spline model LTR, the spline shaft has three crests on the circumference, and along both sides of each crest, two rows of balls (six rows in total) are arranged to hold the crest so that a reasonable preload is applied.

Angular-contact ball raceways are machined on the outer surface of the spline nut to constitute support bearings, allowing the whole body to be compactly and lightly designed.

The rows of balls are held in a special resin retainer so that they smoothly roll and circulate. With this design, balls will not fall even if the spline shaft is removed.

In addition, a dedicated seal for preventing foreign material from entering the support bearings is available.

[No Angular Backlash]

Two rows of balls facing one another hold a crest, formed on the circumference of the spline nut, at a contact angle of 20° to provide a preload in an angular-contact structure. This eliminates an angular backlash in the rotational direction and increases the rigidity.

[Compact Design]

The spline nut is integrated with the support bearings, allowing highly accurate, compact design to be achieved.

Features of Each Model

Rotary Ball Spline

[Easy Installation]

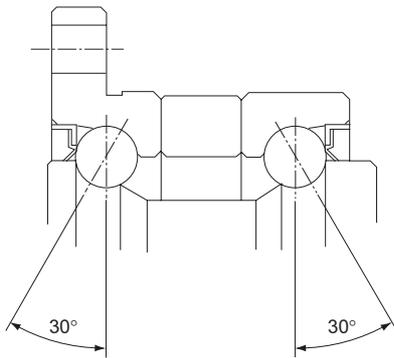
This ball spline can easily be installed by simply securing it to the housing using bolts.

[High Rigidity]

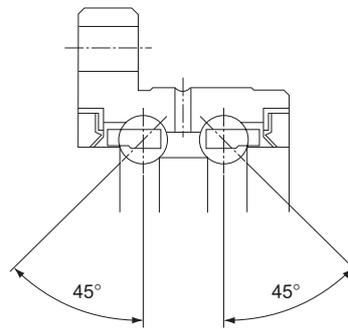
Since the contact angle is large and an appropriate preload is given, high rigidity against torque and moment is achieved.

The support bearing has a contact angle of 30° to secure high rigidity against a moment load, thus to achieve a rigid shaft support.

Model LTR-A, a compact type of LTR, has a contact angle of 45° .



Model LTR



Model LTR-A

Ball Spline

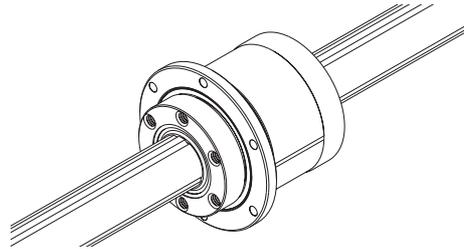
Types and Features

[Types of Spline Nuts]

Ball Spline Model LTR

Specification Table⇒B-406

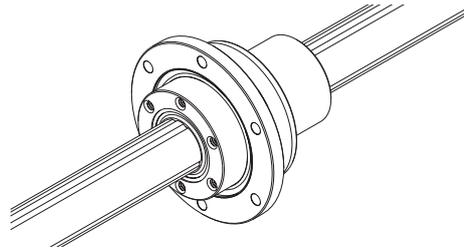
A compact unit type whose support bearings are directly integrated with the outer surface of the spline nut.



Ball Spline Model LTR-A

Specification Table⇒B-404

A compact type even smaller than LTR.



[Types of Spline Shafts]

For details, see A-493.

Features of Each Model

Rotary Ball Spline

Service Life

For details, see A-465.

Clearance in the Rotation Direction

For details, see A-481.

Accuracy Standards

For details, see A-482.

Housing Inner-diameter Tolerance

For the housing inner-diameter tolerance for model LTR, class H7 is recommended.

Spline Shaft

Spline shafts are divided in shape into precision solid spline shaft, special spline shaft and hollow spline shaft (types K and N), as described on A-493.
For details, see B-408 to B-409.

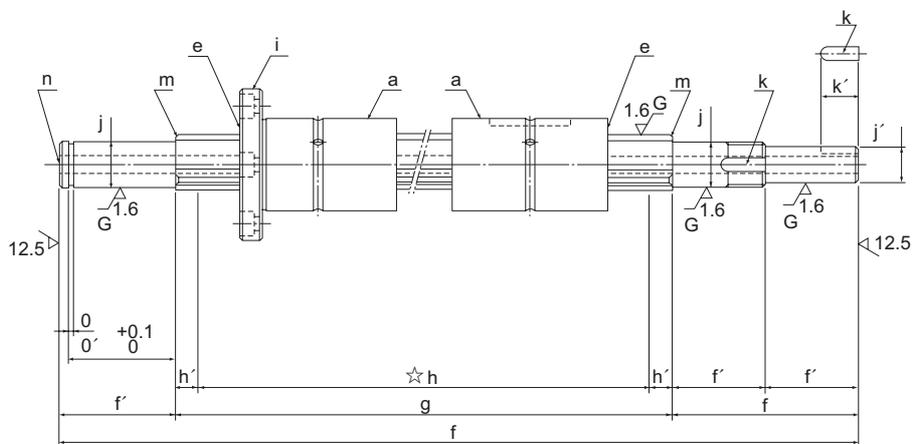


Ball Spline

Checking List for Spline Shaft End Shape

If desiring a ball spline type with its end specially machined, check the following items when placing an order.

The diagram below shows a basic configuration of the Ball Spline.



[Check Items]

- | | |
|--|--|
| <ul style="list-style-type: none"> a. Type of the spline nut to be fit b. Number of spline nuts c. Clearance in the rotation direction d. Accuracy e. With/without a seal (for a single seal, check its orientation) f. Overall length (including all dimensions? Total value correct?) g. Effective spline length h. Hardened area (mark the location with symbol ☆ and indicate the purpose of hardening) i. Orientation of the flange (for flanged type) | <ul style="list-style-type: none"> j. Spline shaft end shape (thicker than the minimum spline diameter?) (black, mill scale) k. Positional relationship between the spline nut and the spline shaft end shape (keyway of the spline nut, flange mounting hole) l. Indication of chamfering for each part m. Shape of chamfer on the spline shaft end (see B-382) n. Intended purpose of the though hole in the spline shaft if any o. o'. Snap ring groove p. Maximum length q. Precedented or not |
|--|--|

Housing Inner-diameter Tolerance

When fitting the spline nut with the housing, tight fitting is normally recommended. If the accuracy of the Ball Spline does not need to be very high, clearance fitting is also acceptable.

Table1 Housing Inner-diameter Tolerance

Housing Inner-diameter Tolerance	General conditions	H7
	When clearance needs to be small	J6

Note) For the housing inner-diameter tolerance of Rotary Ball Spline model LTR, H7 is recommended.

Positions of the Spline-nut Keyway and Mounting Holes

The keyways formed on the outer surface of straight nuts for Ball Spline models are positioned where balls under a load are placed as shown in Fig.1.

The flange-mounting holes of the flange types are positioned as shown in Fig.2.

When placing an order, indicate their positions in relation to the keyway or the like to be formed on the spline shaft.

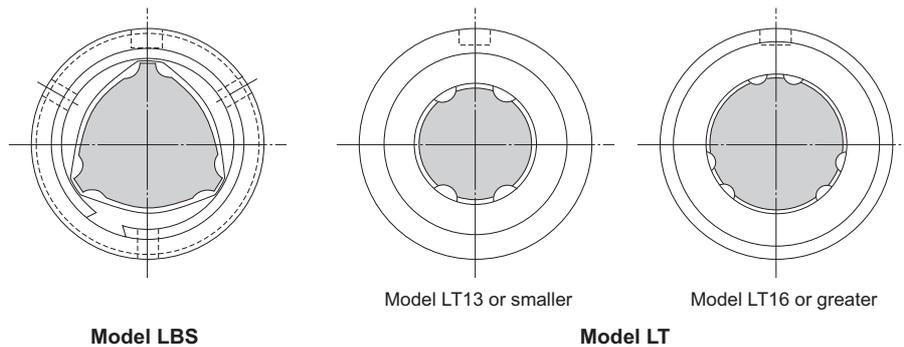


Fig.1 Positions of Keyways

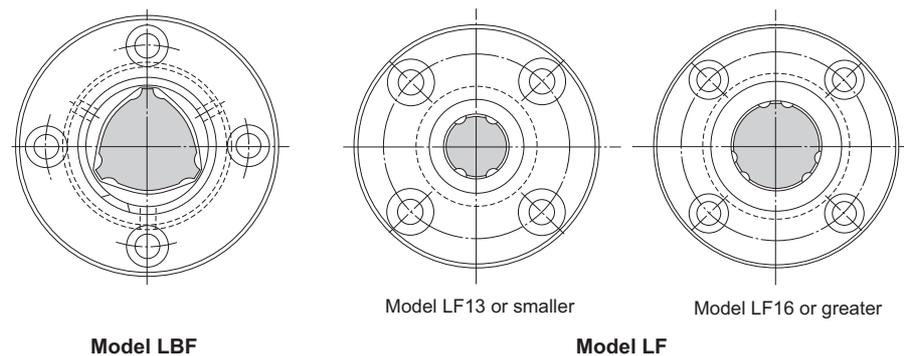


Fig.2 Positions of Flange Mounting Holes

Assembling the Ball Spline

Mounting the Spline

Fig.1 and Fig.2 shows examples of mounting the spline nut. Although the Ball Spline does not require a large strength for securing it in the spline shaft direction, do not support the spline only with driving fitting.

Straight nut type

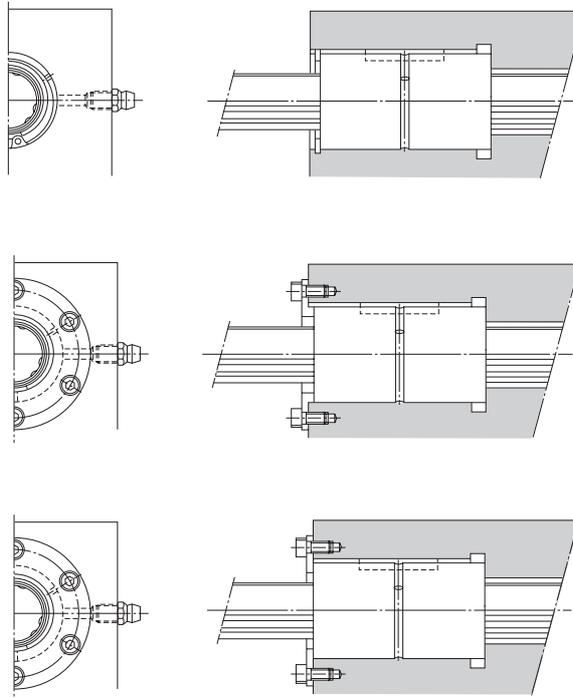
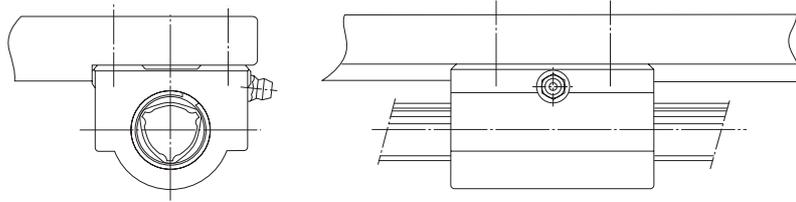


Fig.1 Examples of Fitting the Spline Nut

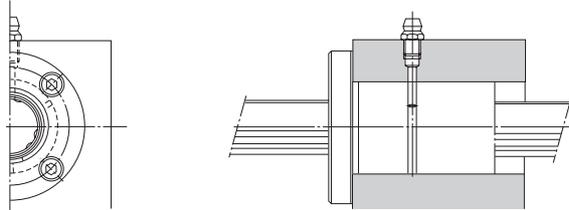
Mounting Procedure and Maintenance
Assembling the Ball Spline

Ball Spline

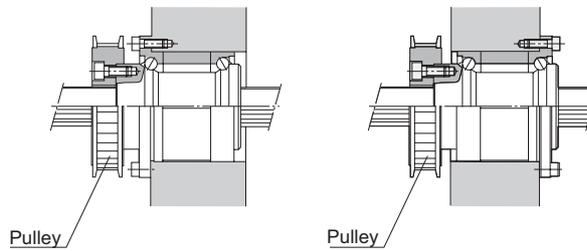
Model LBH



Flanged type



Model LTR



Model LBG

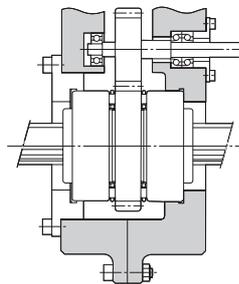


Fig.2 Examples of Fitting the Spline Nut

Installing the Spline Nut

When installing the spline nut into the housing, do not hit the side plate or the seal, but gently insert it using a jig (Fig.3).

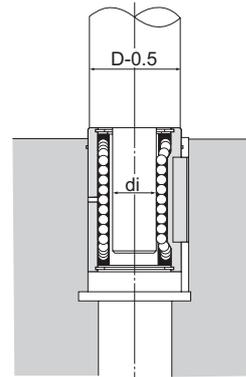


Fig.3

Table1 Dimensions of the Jig for Model LBS

Unit: mm

Nominal shaft diameter	15	20	25	30	40	50	60	70	85	100	120	150
di	12.5	16.1	20.3	24.4	32.4	40.1	47.8	55.9	69.3	83.8	103.8	131.8

Table2 Dimensions of the Jig for Model LT

Unit: mm

Nominal shaft diameter	6	8	10	13	16	20	25	30	40	50	60	80	100
di	5.0	7	8.5	11.5	14.5	18.5	23	28	37.5	46.5	56	75.5	94.5

Installation of the Spline Shaft

When installing the spline shaft into the spline nut, identify the matching marks (Fig.4) on the spline shaft and the spline nut, and then insert the shaft straightforward while checking their relative positions.

Note that forcibly inserting the shaft may cause balls to fall off.

If the spline nut is attached with a seal or given a preload, apply a lubricant to the outer surface of the spline shaft.

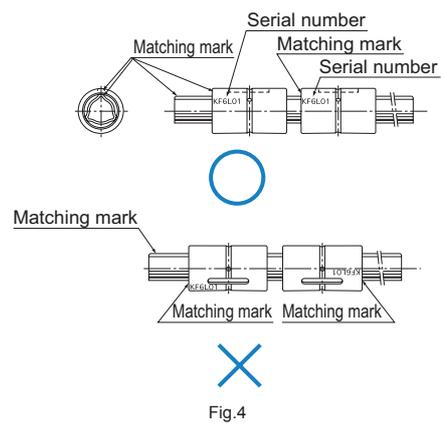


Fig.4

Lubrication

To prevent foreign material from entering the spline nut and the lubricant from leaking, special synthetic resin seals with high wear resistance are available for the Ball Spline.

Spline nuts with seals (seal for both ends type UU, and seal for one end) contain high-quality lithium-soap group grease No. 2. However, if using them at high speed or with a long stroke, replenish grease of the same type through the greasing hole on the spline nut after running in.

Afterward, replenish grease of the same type as necessary according to the service conditions.

The greasing interval differs depending on the conditions. Normally, replenish the lubricant (or replace the product) roughly every 100 km of travel distance (six months to one year) as a rule of thumb.

For a Ball Spline model type without a seal, apply grease to the interior of the spline nut or to the raceways of the spline shaft.

Material and Surface Treatment

Depending on the service environment, the Ball Spline requires anticorrosive treatment or a different material. For details of anticorrosive treatment and material change, contact THK.

Contamination Protection

Entrance of dust or other foreign material into the spline nut will cause abnormal wear or shorten the service life. Therefore, it is necessary to prevent detrimental foreign material from entering the Ball Spline. When entrance of dust or other foreign material is predicted, it is important to select an effective sealing device or dust-control device that meets the environment conditions.

For the Ball Spline, a special synthetic rubber seal that is highly resistant to wear is available as a contamination protection accessory. If desiring a higher contamination protection effect, a felt seal is also available for some types. For details about the felt seal, contact THK.

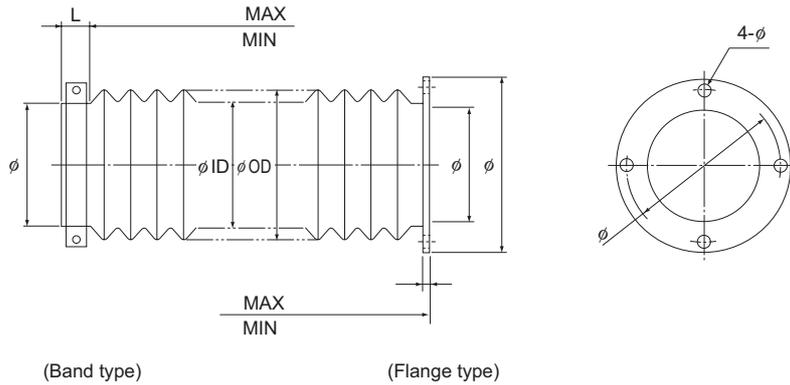
In addition, THK produces round bellows. Contact us for details.

Table1 Contamination protection accessory symbol

Symbol	Contamination protection accessory
No Symbol	Without seal
UU	Rubber seal attached on both ends of spline nut
U	Rubber seal attached on either end of spline nut
DD	Felt seal attached on both ends of spline nut
D	Felt seal attached on either end of spline nut
ZZ	Rubber seal attached on both ends of support bearings
Z	Rubber seal attached on either end of support bearings

Specifications of the Bellows

Bellows are available as a contamination protection accessory. Use this specification sheet.



Specifications of the Bellows

Supported Ball Screw models:

Dimensions of the Bellows

Stroke: () mm MAX: () mm MIN: () mm

Permissible outer diameter: (φ OD) Desired inner diameter: (φ ID)

How It Is Used

Installation direction: (horizontal, vertical, slant) Speed: () mm/sec. min.

Motion: (reciprocation, vibration)

Conditions

Resistance to oil and water: (necessary, unnecessary) Oil name ()

Chemical resistance: Name () × () %

Location: (indoor, outdoor)

Remarks:

Number of Units To Be Manufactured:

[Handling]

- (1) Disassembling components may cause dust to enter the system or degrade mounting accuracy of parts. Do not disassemble the product.
- (2) Tilting a spline nut or spline shaft may cause them to fall by their own weight.
- (3) Dropping or hitting the Ball Spline may damage it. Giving an impact to the product could also cause damage to its function even if the product looks intact.

[Lubrication]

- (1) Thoroughly remove anti-rust oil and feed lubricant before using the product.
- (2) Do not mix lubricants of different physical properties.
- (3) In locations exposed to constant vibrations or in special environments such as clean rooms, vacuum and low/high temperature, normal lubricants may not be used. Contact THK for details.
- (4) When planning to use a special lubricant, contact THK before using it.
- (5) When adopting oil lubrication, the lubricant may not be distributed throughout the product depending on the mounting orientation of the system. Contact THK for details.
- (6) Lubrication interval varies according to the conditions. Contact THK for details.

[Precautions on Use]

- (1) Entrance of foreign material may cause damage to the ball circulating component or functional loss. Prevent foreign material, such as dust or cutting chips, from entering the system.
- (2) Contact THK if you desire to use the product at a temperature of 80°C or higher.
- (3) When planning to use the product in an environment where the coolant penetrates the spline nut, it may cause trouble to product functions depending on the type of the coolant. Contact THK for details.
- (4) If foreign material adheres to the product, replenish the lubricant after cleaning the product.
- (5) When using the product in locations exposed to constant vibrations or in special environments such as clean rooms, vacuum and low/high temperature, contact THK in advance.
- (6) Do not remove the spline nut from the spline shaft unnecessarily. If you inevitably reassemble the product, check the relative positions of the spline nut and the spline shaft by identifying the matching marks on them. Be sure not to twist the spline nut and the spline shaft when inserting the shaft into the nut. Forcibly inserting it may cause balls to fall. For a type equipped with seals, apply a lubricant to the circumference of the shaft.
- (7) When installing the spline shaft into the housing, do not hit the seal section or the stop ring section. Doing so may cause malfunction.
- (8) Giving a shock to the product may cause a functional loss. Do not drop the product or hit it with a tool.
- (9) Take care not to let the spline nut run on the incomplete spline section. Doing so may cause malfunction.

[Storage]

When storing the Ball Spline, enclose it in a package designated by THK and store it in a horizontal orientation while avoiding high temperature, low temperature and high humidity. If the product is stored in an inappropriate position, the spline shaft could bend.

[Other]

If you have any trouble or question when handling the product, contact THK.



Spline Nut

THK General Catalog

A Technical Descriptions of the Products

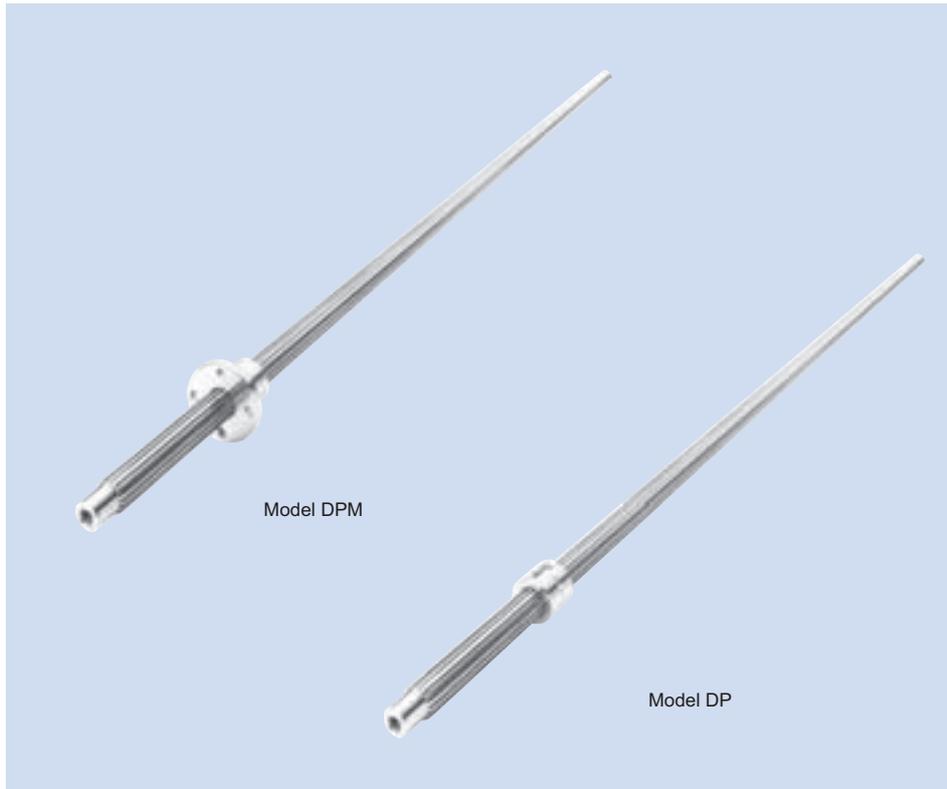
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* Please see the separate "B Product Specifications".

Features of the Spline Nut



Structure and Features

Spline Nut models DPM and DP are low price bearings that are made of a special alloy (see A-515) formed by die casting and use highly accurate spline shafts as the core. Unlike conventional machined spline nuts, the sliding surface of these models maintains a chill layer formed in the rolling process, thus achieving high wear resistance.

The surface of the spline shafts to be used in combination with the nuts is hardened through rolling and is mirror-finished. Accordingly, smooth sliding motion is achieved.

The specially designed teeth of the spline have large contact areas, as well as concentricity, which enable the shaft to automatically establish the center as a torque is applied. Therefore, the teeth demonstrate stable performance in transmitting a torque.

Features of the Special Rolled Shafts

Dedicated rolled shafts with standardized lengths are available for the Spline 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 mirror-finished. As a result, the shafts are highly wear resistant and achieve significantly smooth motion when used in combination with 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 spline nuts is a material that is highly resistant to seizure and wear and has a high load carrying capacity. Its composition, mechanical properties, physical properties and 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/mm ²
Tensile yield strength (0.2%)	216 to 245 N/mm ²
Compressive strength	539 to 686 N/mm ²
Compressive yield strength (0.2%)	294 to 343 N/mm ²
Fatigue strength	132 N/mm ² × 10 ⁷ (Schenk bending test)
Charpy impact	0.098 to 0.49 N-m/mm ²
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 °C
Thermal expansion coefficient	24 × 10 ⁻⁶

[Wear Resistance]

[Test conditions: Amsler wear-tester]

Item	Description
Test piece rotational speed	185 min ⁻¹
Load	392 N
Lubricant	Dynamo oil

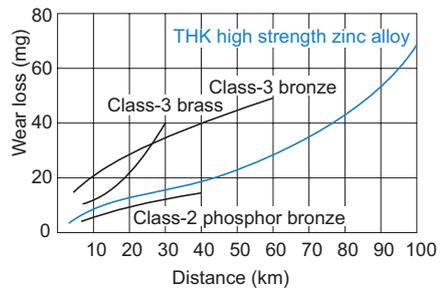


Fig.1 Wear Resistance of the High Strength Zinc Alloy

Clearance in the Rotation Direction

Clearance in the rotational direction: $\alpha \leq 20'$ MAX

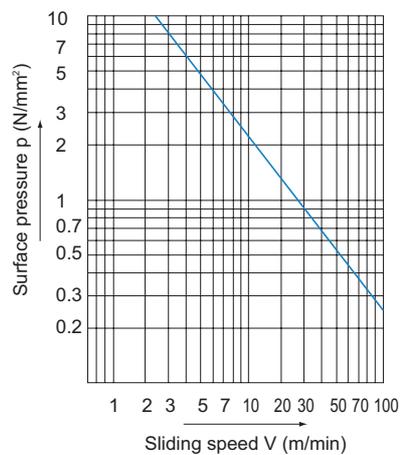
Selecting a Spline Nut

[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/mm². These values are used as a measuring stick for the strength of the spline 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 spline nut. The pV value also varies according to the lubrication conditions.



Spline Nut

● fs: Safety Factor

To calculate a load applied to the spline 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 reciprocating or 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 (fs) shown in Table1.

Fig.1 pV Value

Table1 Safety Factor (fs)

Type of load	Lower limit of fs
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_r:Temperature Factor**

If the temperature of the spline 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 spline nut, the following equations need to be met in terms of its strength.

Dynamic permissible torque (T)

$$f_s \leq \frac{f_r \cdot T}{P_T}$$

Static permissible thrust (F)

$$f_s \leq \frac{f_r \cdot F}{P_F}$$

- f_s : Static safety factor
(see Table1 on A-517)
- f_r : 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)

● **Hardness of the Surface and Wear Resistance**

The hardness of the shaft significantly affects the wear resistance of the spline 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 specially rolled shaft achieves surface hardness of 250 HV or greater, through hardening as a result of rolling, and a surface roughness of 0.20a or less. Thus, the dedicated rolled shaft is highly wear resistant.

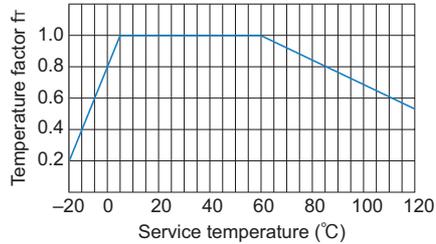


Fig.2 Temperature factor

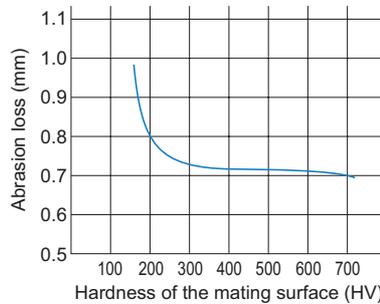


Fig.3 Hardness of the Surface and Wear Resistance

[Calculating the Contact Surface Pressure p]

$$p = \frac{P_T}{T} \times 9.8$$

- p : Contact surface pressure on the tooth under a load torque (P_T) (N/mm²)
- T : Dynamic permissible torque (N-m)
- P_T : Applied torque (N-m)

Point of Selection

Selecting a Spline Nut

[Calculating the Sliding Speed]

With splines, the sliding speed of the tooth surface is equal to the feeding speed.

V : Sliding speed of the tooth (m/min)

[Example of calculation]

Use Spline Nut DPM and reciprocate it at a speed in the axial direction of 5 m/min while transmitting a load torque of 78 N-m. Since the applied torque is not consistent in direction, it is important to select a spline nut that can be used in locations accompanied by vibrations and impact.

First, select a nut that has a dynamic permissible torque (T) at which it can be used.

$$T \geq \frac{f_s \cdot P_T}{f_t} = \frac{4 \times 78}{1} = 312 \text{ N} \cdot \text{m}$$

Safety factor (f_s) = 4
Temperature factor (f_t) = 1
Applied torque (P_T) = 78 N-m

Select Spline Nut model DPM3560 (dynamic permissible torque $T = 443$ N-m), which satisfies the dynamic permissible torque (T) above.

Obtain the pV value.

Obtain the contact surface pressure (p).

$$p = \frac{P_T}{T} \times 9.8 = \frac{78}{443} \times 9.8 \doteq 1.73 \text{ N/mm}^2$$

Obtain the sliding speed (V).

$$V = 5 \text{ m/min}$$

From the diagram of pV values (see Fig.1 on A-517), it is judged that there will be no abnormal wear if the sliding speed (V) is 13.5 m/min or below against the " p " value of 1.73 N/mm². Therefore, it is appropriate to select model DPM3560.

Fit

For the fitting between the spline nut circumference and the housing, we recommend loose fitting or 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 spline nut, the corner is machined to have an R shape. Therefore, it is necessary to chamfer the inner edge of the housing's mouth.

Table1 Chamfer of the Housing's Mouth

Unit: mm

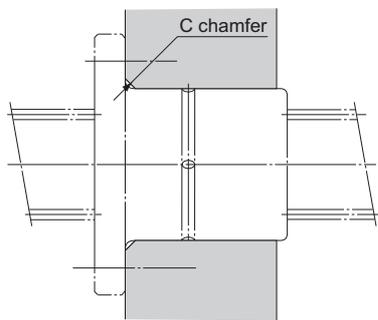


Fig.1

Model No.	Chamfer of the mouth C (Min.)
DPM	
12	2
15	
17	
20	
25	2.5
30	
35	3
40	
45	
50	

Spline Nut

Lubrication

Select a lubrication method according to the conditions of the spline nut.

[Oil Lubrication]

For the lubrication of the spline nut, oil lubrication is recommended. Specifically, oil-bath lubrication or drop lubrication is particularly effective. Oil-bath lubrication is the most appropriate method since it meets harsh conditions such as high speed, heavy load or external heat transmission, and it cools the spline nut. Drop lubrication suits 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
Low speed, light load, low temperature	Low-viscosity sliding surface oil or turbine oil

[Grease Lubrication]

In 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 spline nut. We recommend using lithium-soap group grease No. 2.

