Shipped from Japan in as little as 10 days Semi-custom

LT-X / LF-X

Interchangeable Miniature Ball Spline

Quick Delivery Product
Semi-Custom Order

Interchangeable Compact Ball Spline

LT-X/LF-X

Interchangeable compact ball splines that enable compact, high-speed equipment designs are now available as semi-custom orders.
Products are shipped from Japan in as little as 10 days after ordering.

Order

Machining of shafts and shipping
(Shipped from Japan in as little as 10 days)

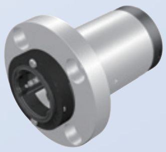
Delivery
(Supporting your short lead times)

Model LT-X Cylindrical Type

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

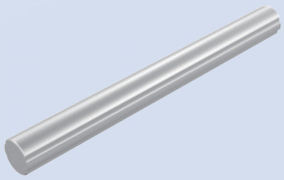
Model LF-X Flanged Type

The spline nut can be bolted to the housing using the flange, making assembly simple. It is suitable for locations where the housing may be deformed if a keyway is machined on its surface, or in locations where the housing width is narrow.



Spline Shaft

Interchangeable spline shaft that can be freely combined with LT-X/LF-X.

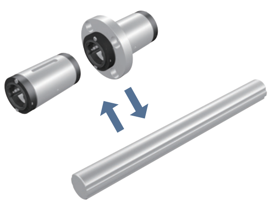


Shipped from Japan in as little as 10 days

Nut and spline shafts can be purchased separately + **Specify overall spline shaft length in 1 mm increments**

1 Reduce Spare Parts Inventory with an Interchangeable Ball Spline

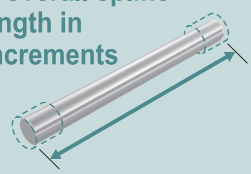
Failure in a single part of a system can result in large losses. In order to carry out repairs as quickly as possible, it is necessary to have numerous spare parts for every system. Interchangeable compact ball splines can be used as common spare parts, reducing the number of spare parts required.



Nuts and spline shafts are offered as single products, enabling easy replacement in case of breakage.

+

2 Specify overall spline shaft length in 1 mm increments



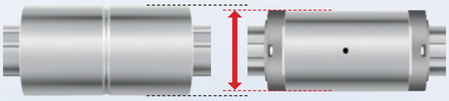
Model No.	Maximum shaft manufacturing length (mm)
LT10X/LT13X	Normal grade: 1000, High accuracy grade: 500
LT16X/LT20X	Normal grade: 1500, High accuracy grade: 750
LT25X/LT30X	Normal grade: 3000, High accuracy grade: 1500

STRONG POINT

Compact Nut Shape

The nut is more compact than the conventional Model LT/LF thanks to the new circulating pathways.

Nut Dimensions Comparison (LT/LT-X)



Outer diameter up to 10% smaller.
(Compared to the conventional model.)
Enables a more compact design of core parts.

High Speed

Optimal ball circulation and high-speed motion thanks to new circulating pathways.

High-Speed Durability Test

Testing Method

Item	Description
Model No.	LT20X
Speed	2 m/s
Acceleration	49 m/s^2
Lubricant	Lithium soap-based grease (AFB-LF Grease)
Stroke	650 mm
Orientation	Horizontal

Test Result

Runs 10,000 km without abnormalities

Smooth Motion

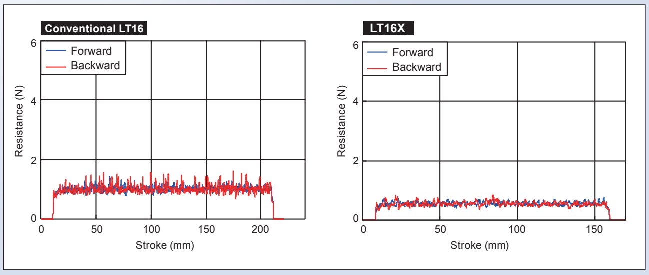
Reduced rolling resistance compared to the conventional Model LT/LF.

Rolling Resistance Test

Testing Method

Item	Description
Model No.	LT16/LT16X
Speed	10 mm/s
Lubricant	Lithium soap-based grease (AFB-LF Grease)
Orientation	Horizontal

Test Result

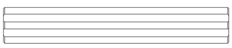


+ Shaft machining shape selection + Grease type selection

*Please contact your local THK branch office separately about express delivery support/exact delivery dates.

Shaft machining shape

Select from three shapes recommended by us.

Shape		Shaft shape
01	Straight full spline	
02	One end center tap	
03	Both ends center tap	

Model No.	Center tap size (coarse) (Select from the following sizes)
LT10X	M3 M4
LT13X	M4 M5
LT16X	M6 M8
LT20X	M8 M10
LT25X	M10 M12
LT30X	M14 M16

3 Grease type

You can select the type of grease according to the application.

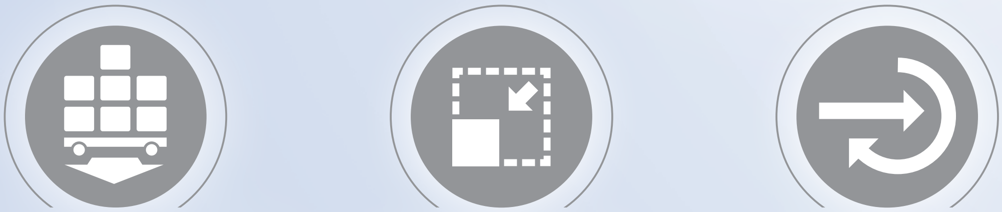
Name of grease	Features
AFA	Low sliding friction
AFB-LF	Universal type — Standard grease
AFC	For fretting corrosion resistance
AFE-CA	For clean environments
AFF	For clean environments
AFG	For preventing heat generation
AFJ	For a wide range of speeds
L100	For clean environments/for high loads
L500	For high loads

*For details about THK Original Grease products, see p. 6.

What Is a Ball Spline?

Ball splines are linear motion guides that transmit torque while the nut moves with smooth linear motion caused by balls rolling along raceways precisely ground into the spline shaft.

Three Features of Ball Splines



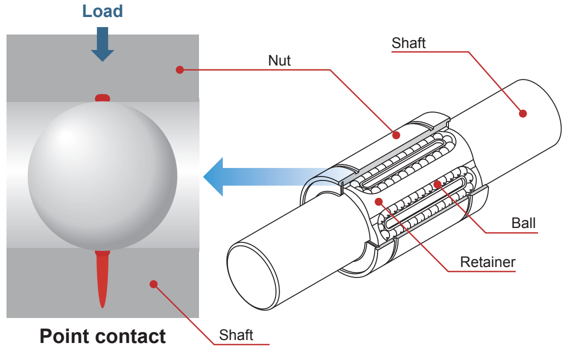
1 High load capacity and long service life

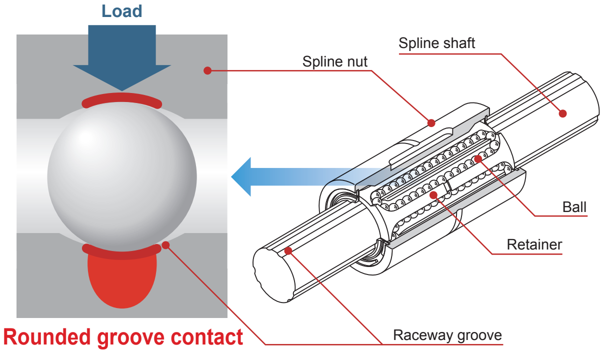
2 Lightweight and compact

3 Linear and rotating mechanism

1 High load capacity and long service life

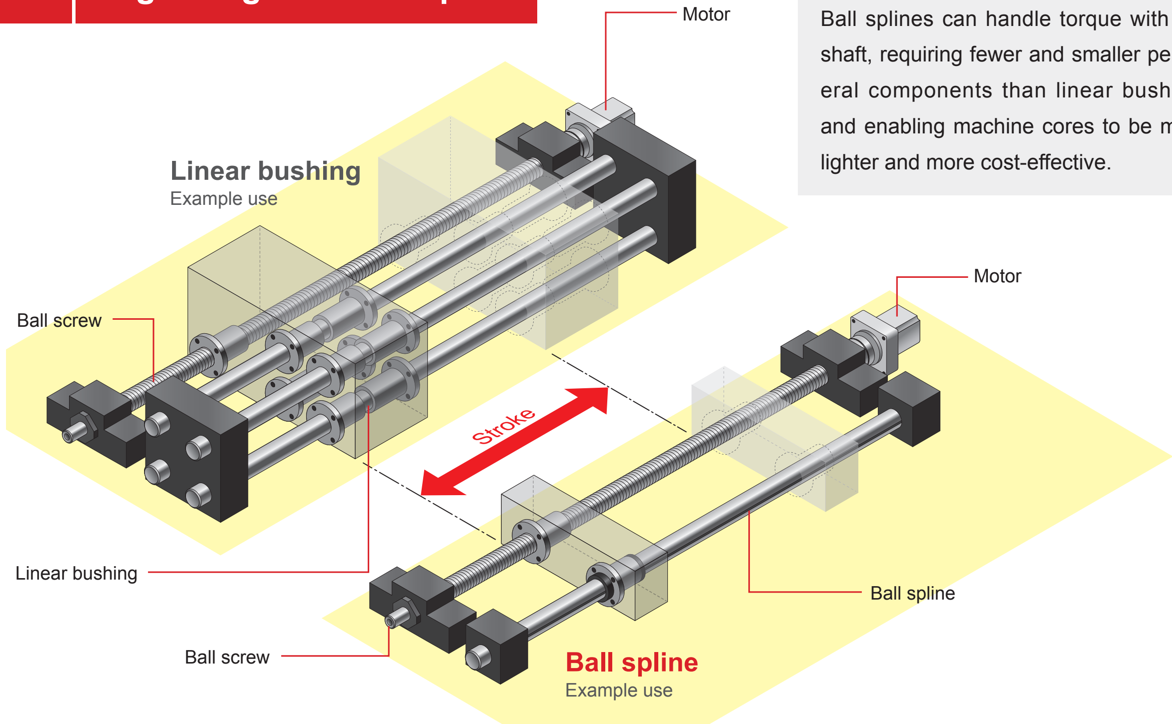
Unlike linear bushings, ball splines possess raceways. The rounded shape of these raceways closely resembles that of the balls, significantly increasing the load the ball spline can handle and enabling a high load capacity and long service life. Compared to linear bushings, the permissible load is 13 times greater, and the service life is 2,200 times greater.





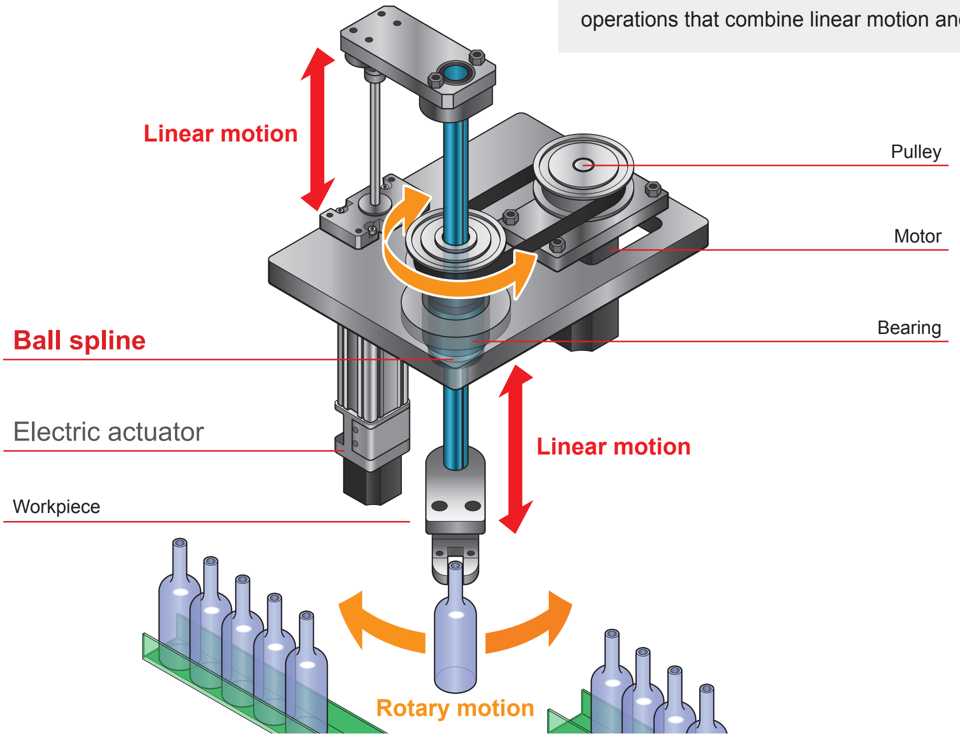
2 Lightweight and compact

Ball splines can handle torque with one shaft, requiring fewer and smaller peripheral components than linear bushings and enabling machine cores to be made lighter and more cost-effective.



3 Linear and rotating mechanism

Ball splines can transmit torque with one shaft, enabling operations that combine linear motion and rotation.



LT-X / LF-X

Interchangeable ball splines that enable compact, high-speed core parts.

*This image is the Model LT-X.

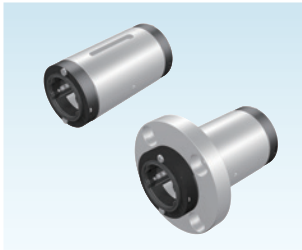
Sample Model Number Configuration

Select an option | Fixed symbol

Spline nut

LF20X UU H (GK) AFA NUT

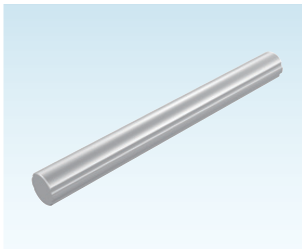
- LF20X — Model No.
  LT-X: Cylindrical type
  LF-X: Flanged type
- UU — Seal symbol
  No symbol: Without seal
  UU: With end seal
- H — Accuracy symbol
  No symbol: Normal grade
  H: High accuracy grade
- (GK) — Interchangeability symbol
- AFA — Grease type
  AFB-LF: Standard (no symbol)
  AFA, AFC, AFE-CA, AFF, AFG, AFJ, L100, L500
- NUT — Spline nut symbol



Spline shaft

LT20X - 500L H - 03 M10 N10 (GK) SHAFT

- LT20X — Model No.
- 500L — Overall spline shaft length (mm)
- H — Accuracy symbol
  No symbol: Normal grade
  H: High accuracy grade
- 03 — Shaft ends
  (Shape 01, 02, 03)
- M10 — Left tap diameter
  (compatible with shapes 02, 03)
- N10 — Right tap diameter
  (compatible with shape 03)
- (GK) — Interchangeability symbol
- SHAFT — Spline shaft symbol

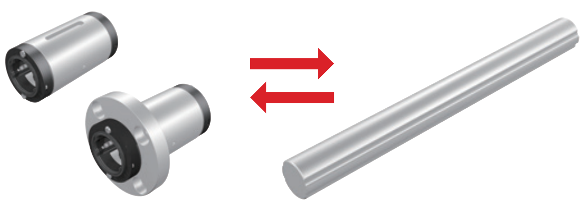


*Use a spline nut and spline shaft with the same accuracy symbol.

Selectable Semi-Custom Orders

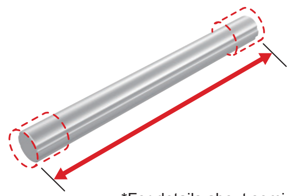
Reduce Spare Parts Inventory with an Interchangeable Ball Spline

Nuts and spline shafts are offered as single products, enabling easy replacement in case of breakage.



Spline Shaft Length Can Be Specified in 1 mm Increments

The overall shaft length can be specified in 1 mm increments. Select from three recommended shaft machining shapes.



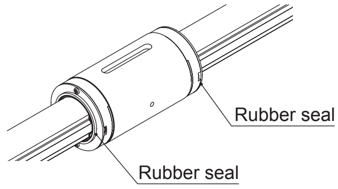
*For details about semi-custom orders, see p. 8.

Contamination Prevention

*Ingress of dust or other foreign material into the spline nut will cause abnormal wear or shorten the service life, so it is necessary to take steps to prevent this from happening. When ingress of dust or other foreign material is a possibility, it is important to select a sealing device or contamination protection option suited to the service conditions. For ball splines, a highly wear-resistant special synthetic rubber seal is available as a contamination protection accessory.

Symbol	Contamination protection accessory
None	Without seal
UU	Rubber seal on both ends of spline nut

*Use the rubber seal at temperatures of 80°C or lower.



Accuracy Standards

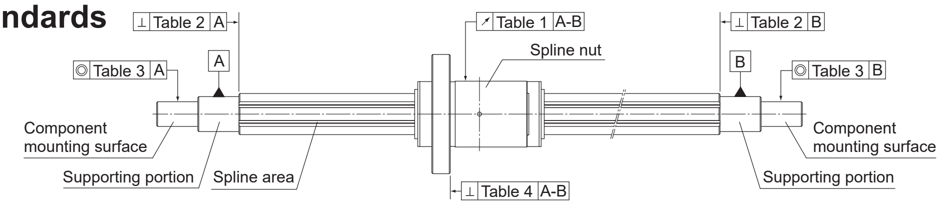


Table 1: Runout of the Spline Nut Outer Diameter in Relation to the Supporting Portion of the Spline Shaft

Accuracy		Runout (max) (μm)					
Nominal shaft diameter		10		13, 16, 20		25, 30	
Overall spline shaft length (mm)		Normal grade (No symbol)	High accuracy grade (H)	Normal grade (No symbol)	High accuracy grade (H)	Normal grade (No symbol)	High accuracy grade (H)
Above	Or less						
-	200	59	36	56	34	53	32
200	315	83	54	71	45	58	39
315	400	103	68	83	53	70	44
400	500	123	82	95	62	78	50
500	630	151	102	112	75	88	57
630	800	190	-	137	92	103	68
800	1000	-	-	170	115	124	83
1000	1250	-	-	-	-	151	102
1250	1600	-	-	-	-	190	130

Table 2: Perpendicularity of the Shaft End Face in Relation to the Supporting Portion of the Shaft

Accuracy	Perpendicularity (max) (μm)	
Nominal shaft diameter	Normal grade (No symbol)	High accuracy grade (H)
10	22	9
13, 16, 20	27	11
25, 30	33	13

Table 3: Concentricity of the Part-Mounting Surface in Relation to the Supporting Portion of the Shaft

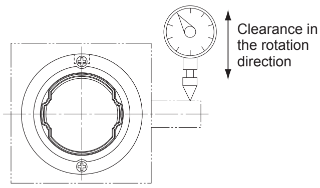
Accuracy	Concentricity (max) (μm)	
Nominal shaft diameter	Normal grade (No symbol)	High accuracy grade (H)
10	41	17
13, 16, 20	46	19
25, 30	53	22

Table 4: Perpendicularity of the Flange-Mounting Surface in Relation to the Supporting Portion of the Shaft

Accuracy	Perpendicularity (max) (μm)	
Nominal shaft diameter	Normal grade (No symbol)	High accuracy grade (H)
10, 13	33	13
16, 20, 25, 30	39	16

Clearance in the Rotation Direction

The sum of clearances in the circumferential direction is standardized as the clearance in the rotation direction.



Nominal shaft diameter	Interchangeability clearance (μm)
10	-4 to +1
13	-4 to +1
16	-5 to +1

Nominal shaft diameter	Interchangeability clearance (μm)
20	-5 to +1
25	-7 to +1
30	-7 to +1

*As this product is an interchangeable model, the clearance in the rotation direction differs from that of a standard product.
For details, use the web-exclusive Optimal Product Selection Tool service, or contact THK.

Standard Grease

Model LT-X/LF-X comes with grade 2 lithium-based grease (AFB-LF) as standard. AFB-LF Grease is a general-purpose grease that provides excellent extreme pressure resistance and mechanical stability through the use of a refined mineral oil base oil and a lithium-based consistency enhancer.

Greasing Interval

The greasing interval varies depending on the usage conditions and environment.
In general, it is recommended to re-grease every 100 km traveled (three to six months).
Ultimately, the greasing interval and amount of grease applied should be set using the actual device or machine.

Representative Physical Properties

Item		Representative property	Testing Method
Consistency enhancer		Lithium-based	
Base oil		Refined mineral oil	
Base oil kinematic viscosity mm²/s (40 °C)		170	ISO 2137 ISO 2176 ISO 6743 ISO 11009 ISO 12924
Worked penetration (25°C, 60 W)		275	
Mixing stability (100,000 W)		345	
Dropping point: °C		193	
Evaporation volume: mass% (99°C, 22 h)		0.4	
Oil separation rate: mass% (100°C, 24 h)		0.6	
Copper plate corrosion (B method, 100°C, 24 h)		Passed	
Low temperature torque mN·m (-20°C)	Starting	130	
	Running	51	
4-ball testing (welding load): N		3089	ASTM D2596
Operating temperature range: °C		-15 to 100	
Appearance color		Brownish yellow	

THK Original Grease

THK provides various types of THK Original Grease needed for the lubrication of LM systems. They are available for various conditions and environments. Refer to the table on the right to select the type of grease required for the application of your LM system.

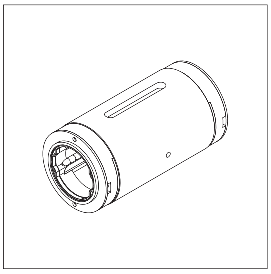
Standard grease

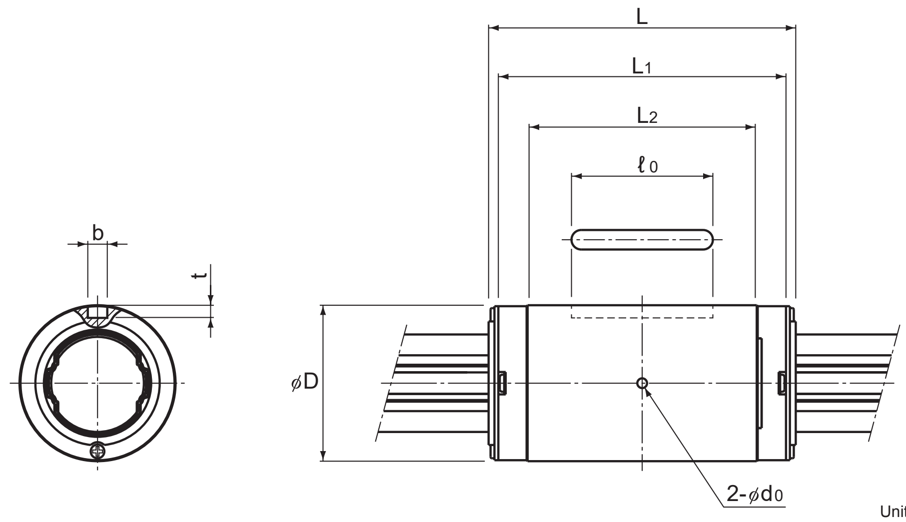
Name of grease		AFA	AFB-LF	AFC	AFE-CA	AFF	AFG	AFJ	L100	L500
Features		Low sliding friction	Universal type	For fretting corrosion resistance	For clean environments	For clean environments	For preventing heat generation	For a wide range of speeds	For clean environments and high loads	For high loads
Base oil		High-grade synthetic oil	Refined mineral oil	High-grade synthetic oil	High-grade synthetic oil	High-grade synthetic oil	High-grade synthetic oil	Refined mineral oil	High-grade synthetic oil	Refined mineral oil
Consistency enhancer		Urea-based	Lithium-based	Urea-based	Urea-based	Lithium-based	Urea-based	Urea-based	Lithium complex-based	Lithium complex-based
Features	Low sliding friction	○					○	○		
	Micro-vibration	○		○		○	○	○		
	High loads		○					○	◎	◎
	Low dust generation (clean environments)				◎	○			○	
	Water resistance	○	○				○			
	Mechanical stability		○	○	○	○		○	○	○

◎: Superior ○: Good

Spline Nut Specification Table

LT-X (Cylindrical Type)



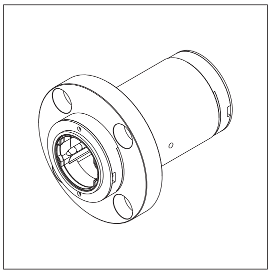


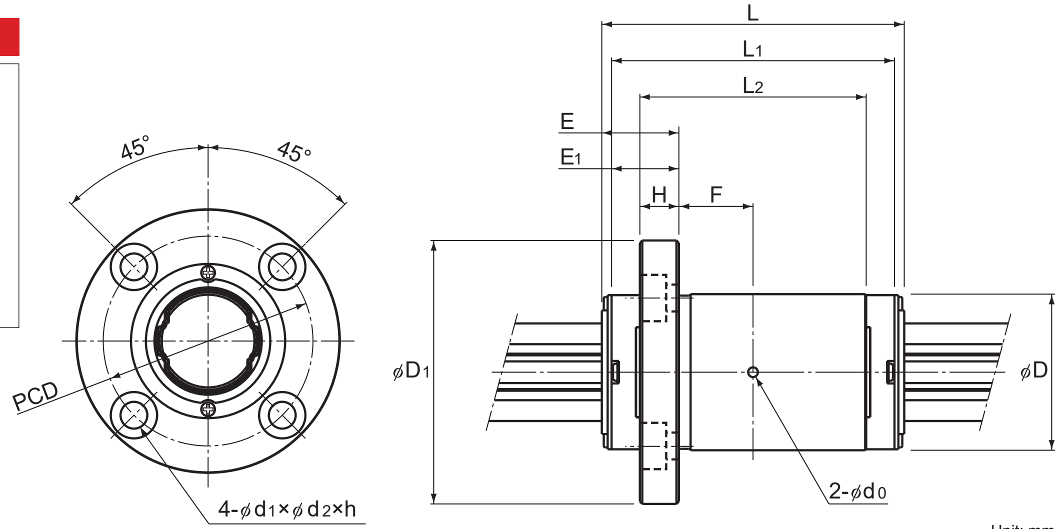
Unit: mm

Model No.	Spline nut dimensions									Spline nut mass
	Nut outer diameter		Length			Keyway dimensions			Greasing hole	
	D	Tolerance	L (With seal)	L_1 (Without seal)	L_2	b H8	t	ℓ_0	d_0	(g)
LT10X	19	0 -0.013	33	30.8	23.9	3	1.5	13	1.5	30
LT13X	23	0 -0.013	36	32.4	24	3	1.5	15	1.5	40
LT16X	28	0 -0.013	50	46.4	35.4	3.5	2	17.5	2	81
LT20X	32	0 -0.016	63	59	47.4	4	2.5	29	2	130
LT25X	40	0 -0.016	71	67	52.6	4	2.5	36	3	235
LT30X	45	0 -0.016	80	75.6	59.6	4	2.5	42	3	295

*The mass of the ball spline nut is the value of the ball spline nut without seals.

LF-X (Flanged Type)





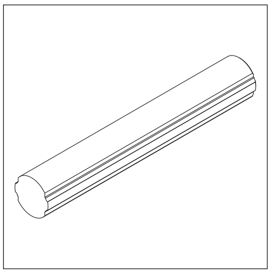
Unit: mm

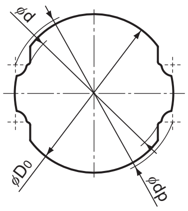
Model No.	Spline nut dimensions													Spline nut mass
	Nut outer diameter		Length			Flange outer diameter					Greasing hole		Mounting hole	
	D	Tolerance	L (With seal)	L_1 (Without seal)	L_2	D_1	H	F	E	E_1	d_0	PCD	$d_1 \times d_2 \times h$	(g)
LF10X	19	0 -0.013	33	30.8	23.9	38	6	5.95	10.55	9.45	1.5	28	4.5 × 8 × 4.4	66
LF13X	23	0 -0.013	36	32.4	24	43	6	6	12	10.2	1.5	33	4.5 × 8 × 4.4	82
LF16X	28	0 -0.013	50	46.4	35.4	48	6	11.7	13.3	11.5	2	38	4.5 × 8 × 4.4	131
LF20X	32	0 -0.016	63	59	47.4	54	8	15.7	15.8	13.8	2	43	5.5 × 9.5 × 5.4	212
LF25X	40	0 -0.016	71	67	52.6	62	8	18.3	17.2	15.2	3	51	5.5 × 9.5 × 5.4	335
LF30X	45	0 -0.016	80	75.6	59.6	74	10	19.8	20.2	18	3	60	6.6 × 11 × 6.5	489

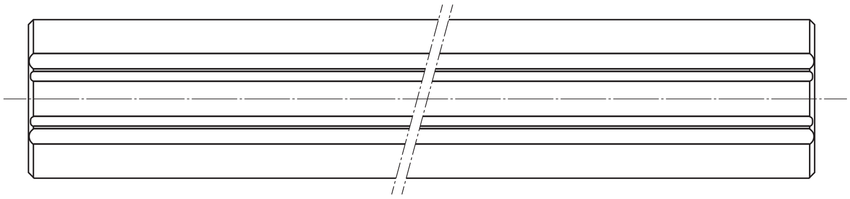
*The mass of the ball spline nut is the value of the ball spline nut without seals.

Spline Shaft Specification Table

Spline Shaft
(Common to LT-X/LF-X)







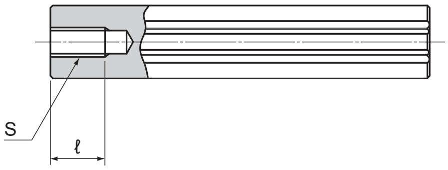
Unit: mm

Model No.	Major diameter ϕD_0	Minor diameter ϕd	Ball center-to-center diameter ϕdp	Maximum shaft manufacturing length		Mass (kg/m)
				Normal grade (No symbol)	High accuracy grade (H)	
LT10X	10	8.6	10.7	1000	500	0.59
LT13X	13	11.3	13.8	1000	500	1.01
LT16X	16	13.9	17.1	1500	750	1.52
LT20X	20	17.9	21.1	1500	750	2.41
LT25X	25	22.4	26.4	3000	1500	3.71
LT30X	30	27	31.6	3000	1500	5.37

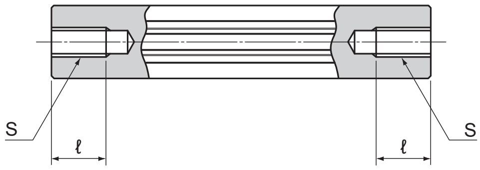
Shaft Machining Shape

Shape 01 (Straight full spline)

Shape 02 (One end center tap)



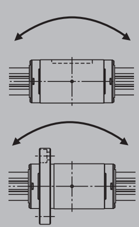
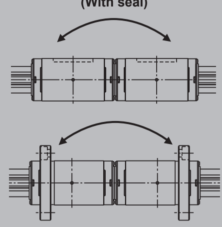
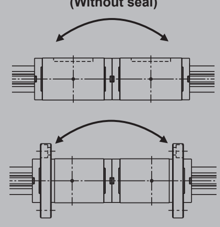
Shape 03 (Both ends center tap)



Unit: mm

Model No.	S × ℓ
LT10X	M3 x 6
	M4 x 8
LT13X	M4 x 8
	M5 x 10
LT16X	M6 x 12
	M8 x 16
LT20X	M8 x 16
	M10 x 20
LT25X	M10 x 20
	M12 x 24
LT30X	M14 x 28
	M16 x 32

Basic Load Rating / Basic Torque Rating / Static Permissible Moment (Common to LT-X/LF-X)

Model No.	Basic load rating		Basic torque rating		Static permissible moment		
	C (kN)	C_0 (kN)	C_T (N·m)	C_{0T} (N·m)	M_{A1}  (N·m)	M_{A2} (With seal)  (N·m)	M_{A2} (Without seal)  (N·m)
LT10X/LF10X	2.94	5.40	9.41	17.3	21.5	114	104
LT13X/LF13X	4.16	6.96	17.1	28.7	28.9	164	149
LT16X/LF16X	8.40	13.4	42.9	68.6	77.4	419	381
LT20X/LF20X	10.5	18.6	66.4	117	144	735	669
LT25X/LF25X	15.9	26.2	125	207	230	1183	1077
LT30X/LF30X	20.8	34.0	196	319	335	1714	1560

Spline Shaft Strength Design

The spline shaft is a compound shaft capable of receiving a radial load and torque. When the load and torque are large, the spline shaft strength must be taken into account.

Spline Shaft Receiving a Bending Load

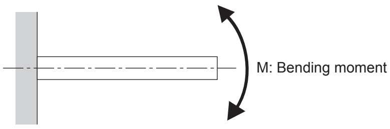
When a bending load is applied to the spline shaft, the spline shaft diameter is obtained by using formula (1).

$$\mathbf{M = \sigma \cdot Z \text{ and } Z = \frac{M}{\sigma}} \quad \cdots\cdots(1)$$

M: Maximum bending moment acting on the spline shaft (N·mm)
σ: Permissible bending stress of the spline shaft (98 N/mm²)
Z: Section modulus of the spline shaft (mm³)
(Refer to the "Cross-sectional Characteristics of the Spline Shaft" table on p. 10)

For reference: Calculating the section modulus for one section of a circular shaft

$$Z = \frac{\pi \cdot d^3}{32}$$



Z: Section modulus (mm³)
d: Shaft outer diameter (mm)

Spline Shaft Receiving a Torsion Load

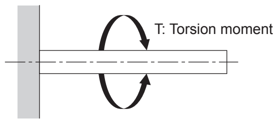
When a torsion load is applied on the spline shaft, the spline shaft diameter is obtained using formula (2).

$$\mathbf{T = \tau_a \cdot Z_P \text{ and } Z_P = \frac{T}{\tau_a}} \quad \cdots\cdots(2)$$

T: Maximum torsion moment (N·mm)
τ_a: Permissible torsion stress of the spline shaft (49 N/mm²)
Z_P: Polar section modulus of the spline shaft (mm³)
(Refer to the "Cross-sectional Characteristics of the Spline Shaft" table on p. 10)

For reference: Calculating the polar section modulus for one section of a circular shaft

$$Z_P = \frac{\pi \cdot d^3}{16}$$



Z_P: Polar section modulus (mm³)
d: Shaft outer diameter (mm)

When the Spline Shaft Simultaneously Receives a Bending Load and a Torsion Load

When the spline shaft receives a bending load and a torsion load simultaneously, calculate two separate spline shaft diameters: one for the equivalent bending moment (M_e) and the other for the equivalent torsion moment (T_e). Then, use the greater value as the spline shaft diameter.

Equivalent bending moment

$$\mathbf{M_e = \frac{M + \sqrt{M^2 + T^2}}{2} = \frac{M}{2}\left\{1 + \sqrt{1 + \left(\frac{T}{M}\right)^2}\right\}} \quad \cdots\cdots(3)$$

$M_e = \sigma \cdot Z$

Equivalent torsion moment

$$\mathbf{T_e = \sqrt{M^2 + T^2} = M \cdot \sqrt{1 + \left(\frac{T}{M}\right)^2}} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(4)$$

$T_e = \tau_a \cdot Z_P$

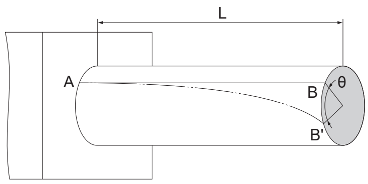
Torsional Rigidity of the Spline Shaft

The torsional rigidity of the spline shaft is expressed as the torsion angle per meter of shaft length. Its value should be limited to within 1°/4.

$$\theta = 57.3 \times \frac{T \cdot L}{G \cdot I_P} \quad \cdots\cdots\cdots\cdots\cdots\cdots(5)$$

$$\text{Rigidity of shaft} = \frac{\text{Torsion angle}}{\text{Unit length}} = \frac{\theta \cdot \ell}{L} < \frac{1°}{4}$$

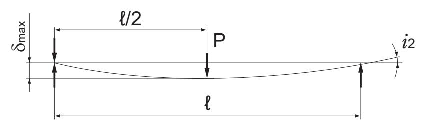
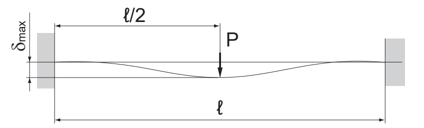
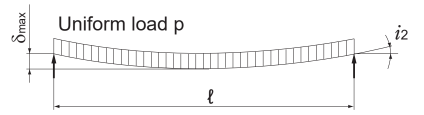
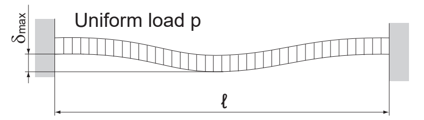
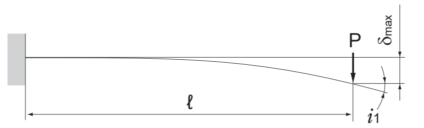
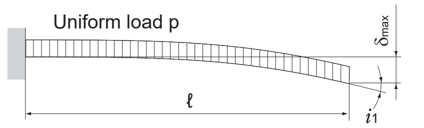
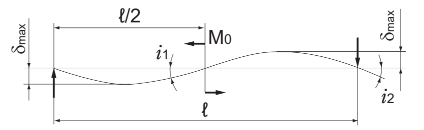
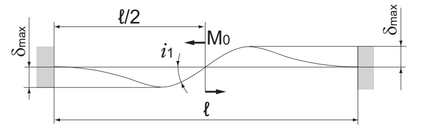
θ: Torsion angle (°)
L: Spline shaft length (mm)
G: Transverse elastic modulus (7.9 × 10⁴ N/mm²)
ℓ: Unit length (1000 mm)
I_P: Polar moment of inertia (mm⁴)
(Refer to the "Cross-sectional Characteristics of the Spline Shaft" table on p. 10)



Deflection and Deflection Angle of the Spline Shaft

The deflection and deflection angle of the spline shaft need to be calculated using formulas that meet the relevant conditions. The formulas that correspond to each condition are shown below.

Deflection and Deflection Angle Formulas

Support method	Usage conditions	Deflection formula	Deflection angle formula
Both ends free		$\delta_{max} = \dfrac{P\ell^3}{48EI}$	$i_1 = 0$ $i_2 = \dfrac{P\ell^2}{16EI}$
Both ends fixed		$\delta_{max} = \dfrac{P\ell^3}{192EI}$	$i_1 = 0$ $i_2 = 0$
Both ends free		$\delta_{max} = \dfrac{5p\ell^4}{384EI}$	$i_2 = \dfrac{p\ell^3}{24EI}$
Both ends fixed		$\delta_{max} = \dfrac{p\ell^4}{384EI}$	$i_2 = 0$
One end fixed		$\delta_{max} = \dfrac{P\ell^3}{3EI}$	$i_1 = \dfrac{P\ell^2}{2EI}$ $i_2 = 0$
One end fixed		$\delta_{max} = \dfrac{p\ell^4}{8EI}$	$i_1 = \dfrac{p\ell^3}{6EI}$ $i_2 = 0$
Both ends free		$\delta_{max} = \dfrac{\sqrt{3}M_0\ell^2}{216EI}$	$i_1 = \dfrac{M_0\ell}{12EI}$ $i_2 = \dfrac{M_0\ell}{24EI}$
Both ends fixed		$\delta_{max} = \dfrac{M_0\ell^2}{216EI}$	$i_1 = \dfrac{M_0\ell}{16EI}$ $i_2 = 0$

δ_{max}: Maximum deflection (mm)
M_0: Moment (N·mm)
ℓ: Span (mm)
I: Geometrical moment of inertia (mm^4)
(Refer to the "Cross-sectional Characteristics of the Spline Shaft" table below)
i_1: Deflection angle at loading point
i_2: Deflection angle at supporting point
P: Concentrated load (N)
p: Uniform load (N/mm)
E: Modulus of longitudinal elasticity 2.06×10^5 (N/mm^2)

The spline shaft section modulus (Z), polar section modulus (Z_P), polar moment of inertia (I_P), and geometrical moment of inertia (I) are shown below.

Cross-sectional Characteristics of the Spline Shaft

Nominal shaft diameter	Section modulus Z (mm^3)	Polar section modulus Z_P (mm^3)	Polar moment of inertia I_P (mm^4)	Geometrical moment of inertia I (mm^4)
10	86.5	183.8	896.9	422.3
13	191.3	405.3	2574.6	1215.3
16	350.8	749.7	5844.5	2734.3
20	716.5	1498.5	14731.7	7043.9
25	1404.2	2932.9	36067.4	17268.2
30	2444.1	5086.3	75160.0	36115.8

Critical Speed of the Spline Shaft

When a ball spline shaft is used to transmit power while rotating, the rotation cycle nears the natural frequency of the spline shaft as the rotational speed of the shaft increases. This may cause resonance and eventually result in an inability to operate. Therefore, the maximum rotational speed of the shaft must be limited to a speed that is below the critical speed and does not cause resonance.

The critical speed of the spline shaft is obtained using formula (6). (It is multiplied by a safety factor of 0.8.)

If the shaft's rotation cycle exceeds or nears the resonance point during operation, reconsider the spline shaft diameter.

Critical Speed

$$N_c = \frac{60\lambda^2}{2\pi \cdot \ell_b^2} \cdot \sqrt{\frac{E \times 10^3 \cdot I}{\gamma \cdot A}} \times 0.8 \quad \cdots\cdots\cdots\cdots (6)$$

N_c: Critical speed (min^{-1})

ℓ_b: Distance between two mounting surfaces (mm)

E: Young's modulus (2.06 × 10^5 N/mm^2)

I: Minimum geometrical moment of inertia of the shaft (mm^4)

$$I = \frac{\pi}{64} d^4 \qquad \text{d: Minor diameter (mm)}$$

γ: Density (specific gravity) (7.85 × 10^{-6} kg/mm^3)

$$A = \frac{\pi}{4} d^2 \qquad \text{d: Minor diameter (mm)}$$

A: Spline shaft cross-sectional area (mm^2)

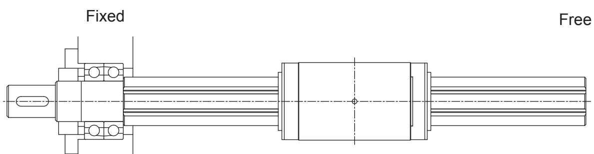
λ: Factor according to the mounting method

(1) Fixed-free: λ = 1.875

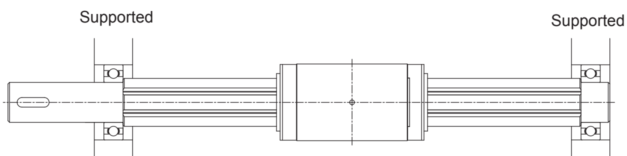
(2) Supported-supported: λ = 3.142

(3) Fixed-supported: λ = 3.927

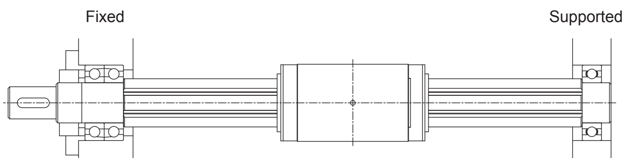
(4) Fixed-fixed: λ = 4.73



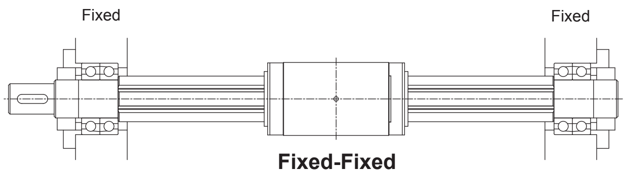
Fixed-Free



Supported-Supported



Fixed-Supported



Fixed-Fixed

Predicting the Service Life

Calculating the Static Safety Factor

To calculate the load applied to the ball spline, you must first obtain the average load required to determine the service life and the maximum load needed to determine the static safety factor. In particular, if the system starts and stops frequently, if an impact load acts on the system, or if a large moment or torque caused by an overhung load is applied, it may experience an unexpectedly large load. When selecting a model number, it is necessary to confirm that the desired model is capable of supporting the required maximum load (whether stationary or in motion). The reference values for the static safety factor are shown in the table below.

$$f_s = \frac{f_T \cdot f_C \cdot C_0}{P_{max}} \quad \cdots\cdots\cdots\cdots (7)$$

f_S: Static safety factor

C_0: Basic static load rating* (N)

P_{max}: Maximum applied load (N)

f_T: Temperature factor**

f_C: Contact factor**

Static Safety Factor Standard Values (f_S)

Machine type	Load conditions	Lower limit of f_s
General industrial machinery	Without vibrations or impacts	3.0 to 6.0
	With vibrations or impacts	4.0 to 7.0
	With vibrations or impacts under combined loads	5.0 to 8.0

*The basic static load rating is a static load of a defined direction and size where the sum of the permanent deformation of the ball and that of the raceway at the contact area under maximum stress is 0.0001 times the ball diameter.

**See the catalog for details of each factor.

*The standard values of the static safety factor may vary depending on usage conditions such as environment, lubrication status, mounting surface accuracy, and/or rigidity.

Nominal Life

The service life of the ball spline varies from unit to unit even if they are manufactured the same way and used in the same operating conditions. Therefore, the nominal life defined here is typically used as a guideline for obtaining the service life of a ball spline.
The nominal life is the total travel distance that 90% of a group of units can achieve without flaking (scale-like pieces on a metal surface) after individually running under the same conditions.

Calculating the Nominal Life

The nominal life of a ball spline varies with the type of load applied during operation: torque load, radial load, or moment load. The corresponding nominal life values are obtained using formulas (8) to (12) below. (The basic load ratings in these loading directions are indicated in the specification table for the corresponding model number.)

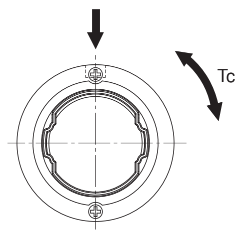
When a Torque Load Is Applied

$$L = \left(\frac{f_T \cdot f_C}{f_W} \cdot \frac{C_T}{T_C} \right)^3 \times 50 \quad \cdots\cdots(8)$$

When a Radial Load Is Applied

$$L = \left(\frac{f_T \cdot f_C}{f_W} \cdot \frac{C}{P_C} \right)^3 \times 50 \quad \cdots\cdots(9)$$

L: Nominal life (km)
C_T: Basic dynamic torque rating (N·m)
T_C: Calculated load torque (N·m)
C: Basic dynamic load rating (N)
P_C: Calculated radial load (N)
f_T: Temperature factor
f_C: Contact factor
f_W: Load factor
*See the general catalog for details of each factor.



Calculating the Service Life Time

Once the nominal life (L) has been obtained with the formula above, the service life time can be obtained using formula (10) if the stroke length and the number of reciprocations per minute are constant.

$$L_h = \frac{L \times 10^3}{2 \times \ell_S \times n_1 \times 60} \quad \cdots\cdots(10)$$

L_h: Service life time (h)
ℓ_S: Stroke length (m)
n_1: Number of reciprocations per minute (min^{-1})

When a Torque Load and a Radial Load are Applied Simultaneously

When a torque load and a radial load are applied simultaneously, calculate the nominal life by obtaining the equivalent radial load using formula (11) below.

$$P_E = P_C + \frac{4 \cdot T_C \times 10^3}{i \cdot dp \cdot \cos\alpha} \quad \cdots\cdots(11)$$

P_E: Equivalent radial load (N)
$\cos\alpha$: Contact angle $\alpha = 65°$
i = Number of rows of balls under a load $i = 2$
dp: Ball center-to-center diameter (mm)

When a Moment Load is Applied to a Single Nut or Two Nuts in Close Contact with Each Other

Calculate the nominal life by obtaining the equivalent radial load using formula (12) below.

$$P_u = K \cdot M \quad \cdots\cdots(12)$$

P_u: Equivalent radial load (N) (with a moment applied)
K: Equivalent factor
M: Load moment (N·mm)
Refer to the Static Permissible Moment table on p. 8.

When a Moment Load and a Radial Load are Simultaneously Applied

Calculate the nominal life from the sum of the radial load and the equivalent radial load.

Equivalent Moment Factor

Equivalent Moment Factor

Model No.	Equivalent factor: K		
	Single nut	Two nuts in close contact with each other Without seal	Two nuts in close contact with each other With seal
LT/LF10X	0.251	0.0517	0.0470
LT/LF13X	0.241	0.0462	0.0420
LT/LF16X	0.173	0.0352	0.0320
LT/LF20X	0.129	0.0275	0.0250
LT/LF25X	0.114	0.0242	0.0220
LT/LF30X	0.101	0.0220	0.0200

Precautions on Use

Handling

- Use at least two people to move any product weighing 20 kg or more, or use a cart or another method of conveyance. Otherwise, it may cause injury or damage the unit.
- Do not disassemble the parts. This may result in loss of functionality.
- Tilting a spline nut or spline shaft may cause it to fall by its own weight.
- Take care not to drop or strike the ball spline. Otherwise, it may cause injury or damage the unit. Even if there is no outward indication of damage, a sudden impact could prevent the unit from functioning properly.
- Wear appropriate safety gear, such as protective gloves and safety shoes, when handling the product.

Precautions on Use

- Prevent foreign materials, such as cutting chips or coolant, from getting inside the product. Failure to do so could damage the product.
- Prevent foreign materials, such as cutting chips, coolant, corrosive solvents, or water, from getting in the product by using a bellows or cover when the product is used in an environment where such a thing is likely.
- Do not use this product if the external temperature exceeds 80°C. This may deform or damage the resin or rubber parts.
- If foreign materials such as cutting chips adhere to the product, replenish the lubricant after washing the product.
- Very small strokes can inhibit the formation of an oil film between the raceways and the area of contact for the balls, resulting in fretting. Therefore, be sure to use a type of grease with high fretting resistance properties if the stroke will be small. We recommend periodically allowing the spline nut to stroke a distance roughly equal to its length to help ensure that a film forms between the raceway and balls.
- Do not forcibly drive a pin, key, or any other positioning device into the product. This could create indentations in the raceways and impair the product's function.
- Skewing or misalignment of the spline nut and the element that supports the spline shaft can drastically reduce the service life. Inspect the components carefully and make sure they are mounted correctly.
- When inserting the spline shaft into the spline nut, line up the spline shaft and the spline nut, and then put the shaft straight in while checking their relative positions. Note that forcibly inserting the shaft may cause balls to fall out. If the spline nut has seals or a preload, apply a lubricant to the outer surface of the spline shaft.
- Inserting and using the spline nut on the spline shaft while balls are missing could lead to premature failure of the product.
- If any balls fall out of the nut, contact THK. Do not use the product in that condition.
- When installing the spline nut into the housing, gently insert it using a jig so that you do not hit the side plates, end caps, or seals.
- Insufficient rigidity or accuracy of the mounting surface could cause an unexpected load to act on the ball spline, which could lead to a premature failure of the product. Therefore, give sufficient consideration to the rigidity and accuracy of the housing and base.
- If you want to have a flanged-type ball spline undergo additional machining, such as adding a dowel pin hole, contact THK.

Lubrication

- Thoroughly remove anti-rust oil and apply lubricant before using the product.
- Do not mix different lubricants. Even grease containing the same type of thickening agent may, if mixed, interact negatively due to disparate additives or other ingredients.
- When using the product in locations exposed to constant vibrations or in special environments such as in clean rooms, vacuums, and low/high temperatures, use a lubricant suitable for its use/environment.
- When lubricating products that do not feature a grease nipple or oil hole, directly coat the raceways with lubricant and perform several warm-up strokes to ensure that the grease permeates the interior.
- Grease viscosity can vary depending on the temperature. Keep in mind that the ball spline's sliding resistance and torque may be affected by changes in viscosity.
- Following greasing, stirring resistance of the grease can cause the ball spline to exhibit increased sliding resistance and torque. Before commencing operations, be sure to run the unit through several warm-up cycles to ensure that the grease is adequately integrated and dispersed.
- Excess grease may spatter after lubrication. Wipe off spattered grease as necessary.
- Grease deteriorates over time, which decreases the lubricity. Perform regular grease inspections and replenish grease based on frequency of use.
- The greasing interval varies depending on the usage conditions and environment. Grease the system approximately every 100 km of travel distance (3 to 6 months). The final greasing interval/amount should be set at the actual machine.
- When lubricating with oil, the lubricant may not get distributed throughout the ball spline depending on the mounting orientation. Contact THK for details.

Storage

When storing the ball spline, enclose it in the package designated by THK, and store it indoors and in a horizontal orientation while avoiding high temperatures, low temperatures, and high levels of humidity.
Please note that if the product has been kept in storage for an extended period, the lubricant inside may have deteriorated. Please ensure that you replenish the lubricant before using.

Disposal

The product should be treated as industrial waste and disposed of appropriately.

Shipped from Japan in as little as 10 days - Semi-custom - LT-X/LF-X

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