

High Torque Type Ball Spline

Models LBS, LBST, LBF, LBR and LBH

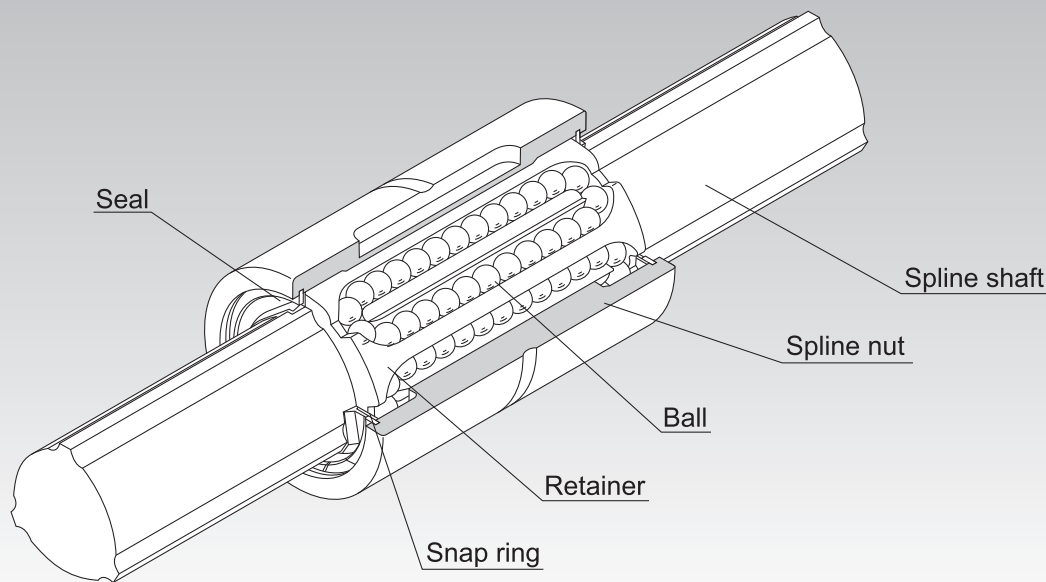


Fig.1 Structure of High Torque Type Ball Spline Model LBS

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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.

[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.


A3-53

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.

A3-54 **THK**

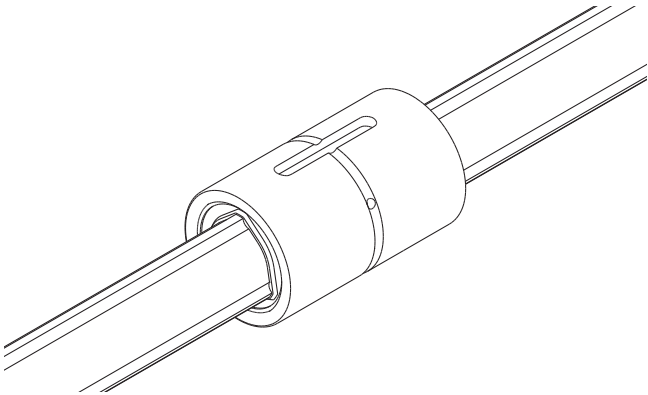
Types and Features

[Types of Spline Nuts]

Cylindrical Type Ball Spline Model LBS (Medium Load Type)

Specification Table⇒ **A3-58**

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

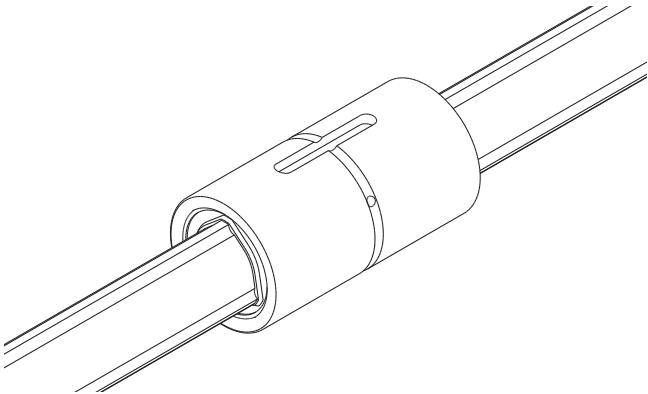


Ball Spline

Cylindrical Type Ball Spline Model LBST (Heavy Load Type)

Specification Table⇒ **A3-60**

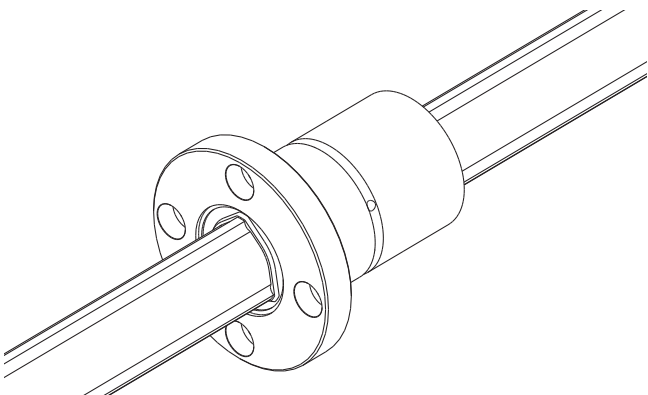
A heavy load type that has the same spline nut diameter as model LBS, but has a longer spline nut length. It is optimal for locations where the space is small, a large torque is applied, and an overhang load or moment load is applied.



Flanged Type Ball Spline Model LBF

Specification Table⇒ **A3-62**

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.



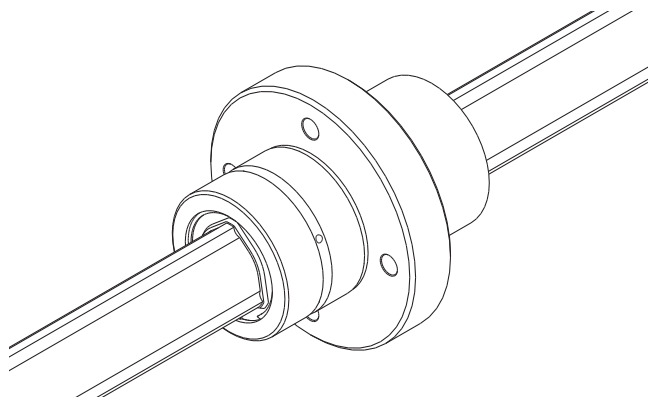
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A3-55

Flanged Type Ball Spline Model LBR

Specification Table⇒ **A3-64**

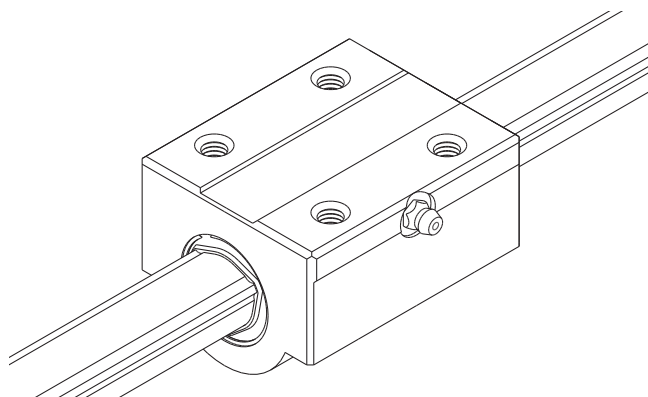
Based on the heavy load type model LBST, this model has a flange in the central area, making itself optimal for locations under a moment load such as arms of industrial robots.



Rectangular Type Ball Spline Model LBH

Specification Table⇒ **A3-66**

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.



A3-56

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[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.



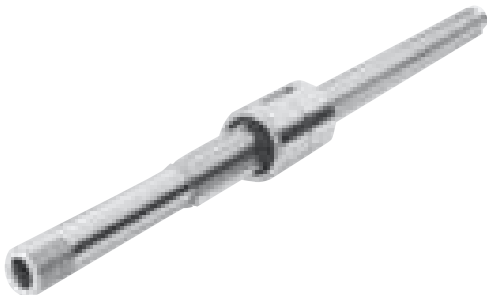
Special Spline Shaft

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.



Ball Spline

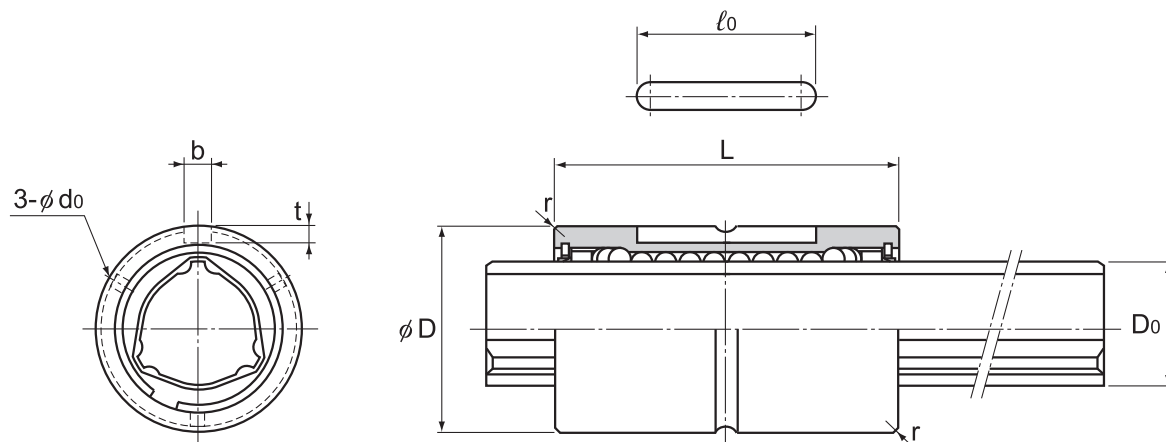
Housing Inner-diameter Tolerance

When fitting the spline nut to the housing, transition fit 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

Model LBS (Medium Load Type)



Models LBS15 to 100

Model No.	Spline nut dimensions											
	Outer diameter		Length		L ₂	L ₃	D ₂	Keyway dimensions			r	C
	D	Tolerance	L	Tolerance				b H8	t +0.1 0	ℓ ₀		
LBS 15	23	⁰ -0.013	40	⁰ -0.2	—	—	—	3.5	2	20	0.5	—
○● LBS 20	30	⁰ -0.016	50		—	—	—	4	2.5	26	0.5	—
○● LBS 25	37		60	⁰ -0.3	—	—	—	5	3	33	0.5	—
○● LBS 30	45		70		—	—	—	7	4	41	1	—
○● LBS 40	60	90	—		—	—	10	4.5	55	1	—	
○● LBS 50	75	100	—		—	—	15	5	60	1.5	—	
○● LBS 70	100	⁰ -0.019	110		—	—	—	18	6	68	2	—
○● LBS 85	120		140	⁰ -0.022	—	—	—	20	7	80	2.5	—
○● LBS 100	140		160		⁰ -0.025	—	—	—	28	9	93	3

Note) ○: Model numbers able to handle high temperatures (metal retainers: operating temperature up to 100°C)
Compatible model numbers: LBS20 to 100

(Example) LBS20 A CL+500L H

High temperature symbol

●: Model numbers compatible with felt seals. Compatible model numbers: LBS20 to 100
Felt seals cannot be attached to ball spline models using metal retainers.
When equipping felt seals, the length dimensions of the nuts will change.

Model number coding

2 LBS40 UU CL +1000L P K

Model No.

Symbol for clearance
in the rotational direction
(*2)

Accuracy symbol
(*3)

Symbol for spline shaft (*4)

Number of spline nuts
on one shaft
(no symbol for one nut)

Contamination protection
accessory symbol
(*1)

Overall spline shaft length (*5)
(in mm)

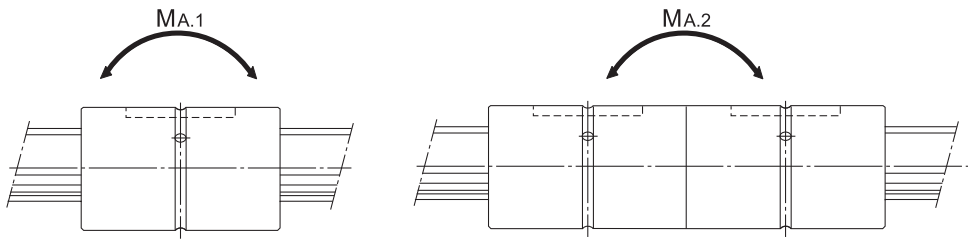
(*1) See **A3-126**. (*2) See **A3-30**. (*3) See **A3-35**. (*4) See **A3-69**. (*5) See **A3-121**.

A 3-58

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Download data by searching for the corresponding model number on the Technical Support site.

<https://tech.thk.com>



Unit: mm

		Spline shaft outer diameter		Basic torque rating		Basic load rating (radial)		Static permissible moment		Mass	
	Greasing hole	D ₀	d ₅	C _T N·m	C _{0T} N·m	C kN	C ₀ kN	M _{A.1} ** N·m	M _{A.2} ** N·m	Spline Nut kg	Spline shaft kg/m
	d ₀										
	2	14.5	—	30.4	74.5	4.4	8.4	25.4	185	0.06	1
	2	19.7	—	74.5	160	7.8	14.9	60.2	408	0.14	1.8
	2	24.5	—	154	307	13	23.5	118	760	0.25	2.7
	3	29.6	—	273	538	19.3	33.8	203	1270	0.44	3.8
	3	39.8	—	599	1140	31.9	53.4	387	2640	1	6.8
	4	49.5	—	1100	1940	46.6	73	594	4050	1.7	10.6
	4	70	—	2190	3800	66.4	102	895	6530	3.1	21.3
	5	84	—	3620	6360	90.5	141	2000	12600	5.5	32
	5	99	—	5190	12600	126	237	3460	20600	9.5	45

Note) **M_{A.1} indicates the permissible moment value in the axial direction when a single spline nut is used.
**M_{A.2} indicates the allowable moment load value in the axial direction when using two spline nuts in contact with each other.
For details on the maximum lengths of ball spline shafts by accuracy, please see **A3-121**.

Options⇒**A3-126**

THK **A3-59**

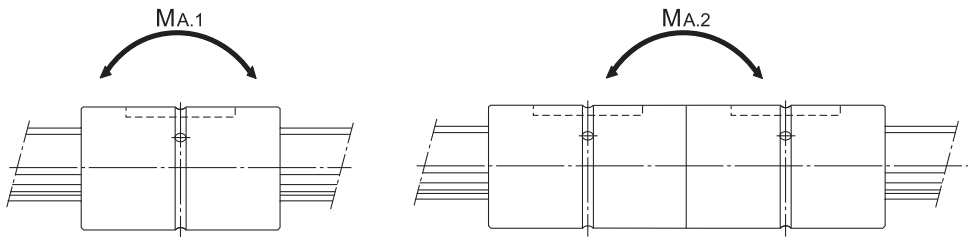


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Unit: mm

	Basic torque rating		Basic load rating (radial)		Static permissible moment		Mass	
	C _T N·m	C _{OT} N·m	C kN	C ₀ kN	M _{A.1} ** N·m	M _{A.2} ** N·m	Spline Nut kg	Spline shaft kg/m
	90.2	213	9.4	20.1	103	632	0.17	1.8
	176	381	14.9	28.7	171	1060	0.29	2.7
	312	657	22.5	41.4	295	1740	0.5	3.8
	696	1420	37.1	66.9	586	3540	1.1	6.8
	1290	2500	55.1	94.1	941	5610	1.9	10.6
	1870	3830	66.2	121	1300	8280	3.3	15.6
	3000	6090	90.8	164	2080	11800	3.8	21.3
	4740	9550	119	213	3180	17300	6.1	32
	6460	14400	137	271	4410	25400	10.4	45
	8380	19400	148	306	5490	32400	12.9	69.5
	13900	32200	196	405	8060	55400	28	116.6

Note) **M_{A.1} indicates the permissible moment value in the axial direction when a single spline nut is used, as shown in the figure above.
**M_{A.2} indicates the permissible moment value in the axial direction when two spline nuts in close contact with each other are used, as shown in the figure above.
For details on the maximum lengths of ball spline shafts by accuracy, please see **A3-121**.

Options⇒**A3-126**

THK **A3-61**

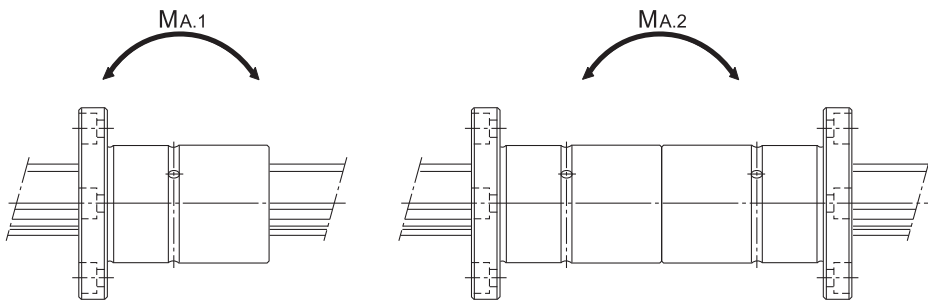


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Unit: mm

		Basic torque rating		Basic load rating (radial)		Static permissible moment		Mass	
	Mounting hole $d_1 \times d_2 \times h$	C_T N·m	C_{0T} N·m	C kN	C_0 kN	$M_{A.1}^{**}$ N·m	$M_{A.2}^{**}$ N·m	Spline Nut kg	Spline shaft kg/m
	4.5×8×4.4	30.4	74.5	4.4	8.4	25.4	185	0.11	1
	4.5×8×4.4	74.5	160	7.8	14.9	60.2	408	0.2	1.8
	5.5×9.5×5.4	154	307	13	23.5	118	760	0.36	2.7
	6.6×11×6.5	273	538	19.3	33.8	203	1270	0.6	3.8
	9×14×8.6	599	1140	31.9	53.4	387	2640	1.2	6.8
	11×17.5×11	1100	1940	46.6	73	594	4050	1.9	10.6
	11×17.5×11	1870	3830	66.2	121	1300	8280	3.5	15.6
	14×20×13	2190	3800	66.4	102	895	6530	3.6	21.3
	16×23×15.2	3620	6360	90.5	141	2000	12600	6.2	32
	18×26×17.5	5910	12600	126	237	3460	20600	11	45

Note) $M_{A.1}$ indicates the permissible moment value in the axial direction when a single spline nut is used, as shown in the figure above.
 $M_{A.2}$ indicates the permissible moment value in the axial direction when two spline nuts in close contact with each other are used, as shown in the figure above.
 For details on the maximum lengths of ball spline shafts by accuracy, please see **A3-121**.

Options⇒**A3-126**

THK **A3-63**

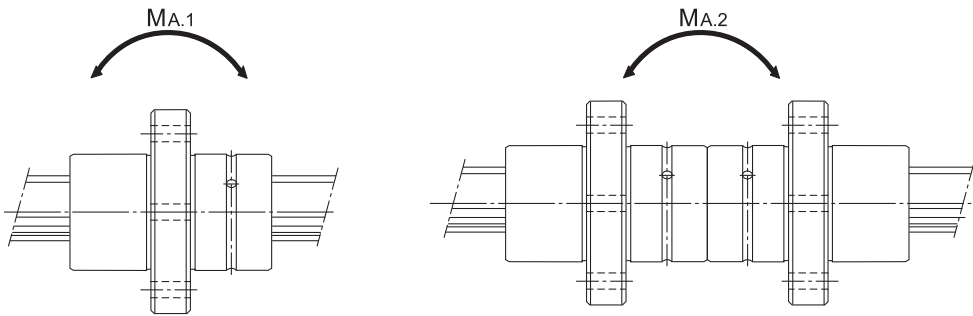


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Unit: mm

				Basic torque rating		Basic load rating (radial)		Static permissible moment		Mass	
	Mounting hole		Greasing hole								
	d ₁	F	d ₀	C _T N·m	C _{0T} N·m	C kN	C ₀ kN	M _{A.1} ** N·m	M _{A.2} ** N·m	Spline Nut kg	Spline shaft kg/m
	4.5	7.5	2	30.4	74.5	4.4	8.4	25.4	185	0.14	1
	5.5	12	2	90.2	213	9.4	20.1	103	632	0.33	1.8
	5.5	14	2	176	381	14.9	28.7	171	1060	0.54	2.7
	6.6	16	3	312	657	22.5	41.4	295	1740	0.9	3.8
	9	20.5	3	696	1420	37.1	66.9	586	3540	1.7	6.8
	11	23	4	1290	2500	55.1	94.1	941	5610	2.7	10.6
	11	26	4	1870	3830	66.2	121	1300	8280	3.7	15.6
	14	27	4	3000	6090	90.8	164	2080	11800	6	21.3
	16	32	5	4740	9550	119	213	3180	17300	8.3	32
	18	35	5	6460	14400	137	271	4410	25400	14.2	45

Note) **M_{A.1} indicates the permissible moment value in the axial direction when a single spline nut is used, as shown in the figure above.
**M_{A.2} indicates the permissible moment value in the axial direction when two spline nuts in close contact with each other are used, as shown in the figure above.
For details on the maximum lengths of ball spline shafts by accuracy, please see **A3-121**.

Options⇒**A3-126**

THK **A3-65**



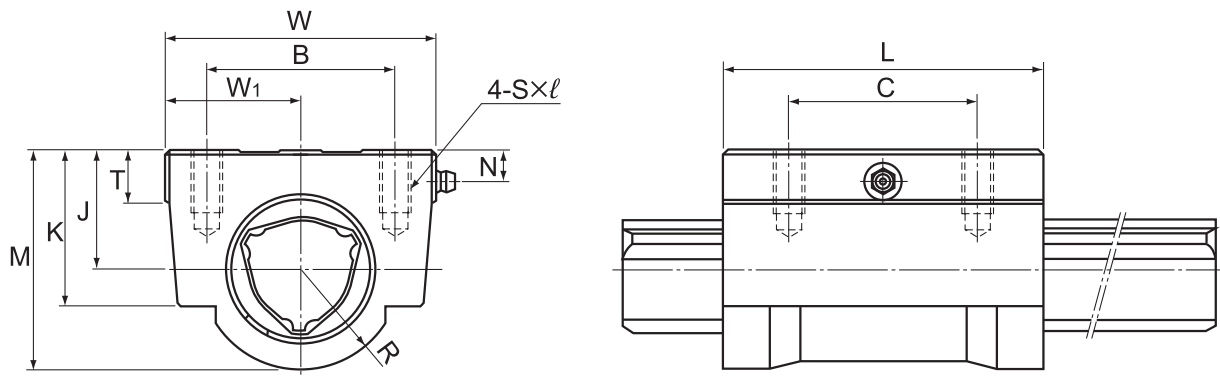
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Model LBH



Model No.	Spline nut dimensions									
	Height	Width	Length				J	W ₁		
	M	W	L	B	C	S×ℓ	±0.15	±0.15	T	K
○ LBH 15	29	34	43	26	26	M4×10	15	17	6	20
○● LBH 20	38	48	62	35	35	M6×12	20	24	7	26
○● LBH 25	47	60	73	40	40	M8×16	25	30	8	33
○● LBH 30	57	70	83	50	50	M8×16	30	35	10	39
○● LBH 40	70	86	102	60	60	M10×20	38	43	15	50
○● LBH 50	88	100	115	75	75	M12×25	48	50	18	63

Note) ○: indicates model numbers for which high temperature types are available (with metal retainer; service temperature: up to 100°C).

(Example) LBH30 A CM+600L H

 High temperature symbol

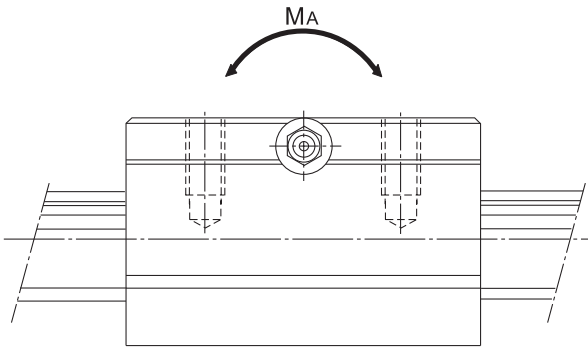
●: indicates model numbers for which felt seal types are available (see **A3-126**).

A felt seal cannot be attached to Ball Spline models using metal retainer.

Model number coding

2	LBH40	UU	CL	+700L	P	K
Model No.		Symbol for clearance in the rotational direction (*2)		Accuracy symbol (*3)	Symbol for spline shaft (*4)	
Number of spline nuts on one shaft (no symbol for one nut)		Contamination protection accessory symbol (*1)		Overall spline shaft length (*5) (in mm)		

(*1) See **A3-126**. (*2) See **A3-30**. (*3) See **A3-35**. (*4) See **A3-69**. (*5) See **A3-121**.



Unit: mm

				Basic torque rating		Basic load rating (radial)		Static permissible moment	Mass	
	R	N	Grease nipple	C _T N·m	C _{0T} N·m	C kN	C ₀ kN	M _A ^{**} N·m	Spline Nut kg	Spline shaft kg/m
	14	5	φ4 drive Nipple	30.4	74.5	4.4	8.4	25.4	0.23	1
	18	7	A-M6F	90.2	213	9.4	20.1	103	0.58	1.8
	22	6	A-M6F	176	381	14.9	28.7	171	1.1	2.7
	26	8	A-M6F	312	657	22.5	41.4	295	1.73	3.8
	32	10	A-M6F	696	1420	37.1	66.9	586	3.18	6.8
	40	13.5	A-PT1/8	1290	2500	55.1	94.1	941	5.1	10.6

Note) **M_A indicates the permissible moment value in the axial direction when a single spline nut is used, as shown in the figure above.
For details on the maximum lengths of ball spline shafts by accuracy, please see **A3-121**.

Options⇒**A3-126**

THK **A3-67**



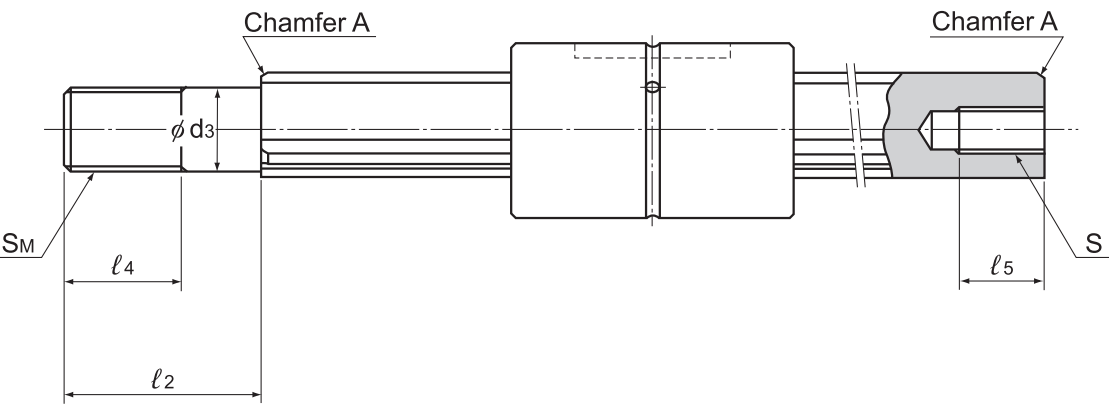
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Model LBS with Recommended Shaft End Shape



Unit: mm

Model No.	d_3	Tolerance	l_2	S_M	l_4	$S \times l_5$
LBS 15	10	$\begin{smallmatrix} 0 \\ -0.015 \end{smallmatrix}$	23	M10×1.25	14	M6×10
LBS 20	14	$\begin{smallmatrix} 0 \\ -0.018 \end{smallmatrix}$	30	M14×1.5	18	M8×15
LBS 25	18		42	M18×1.5	25	M10×18
LBS 30	20	$\begin{smallmatrix} 0 \\ -0.021 \end{smallmatrix}$	46	M20×1.5	27	M12×20
LBS 40	30		70	M30×2	40	M18×30
LBS 50	36	$\begin{smallmatrix} 0 \\ -0.025 \end{smallmatrix}$	80	M36×3	46	M20×35

Note) For details of chamfer A, see **A3-70**.

A3-68

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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 **A3-57**.

Since production of a spline shaft with a specific shape is performed at your request, provide a drawing of the desired shaft shape when asking an estimate or placing an order.

[Sectional Shape of the Spline Shaft]

Table2 shows the sectional shape of a spline shaft. If the spline shaft ends need to be cylindrical, the minor diameter (ϕd) value should not be exceeded if possible.

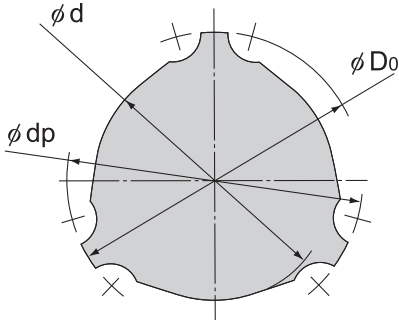


Table2 Sectional Shape of the Spline Shaft

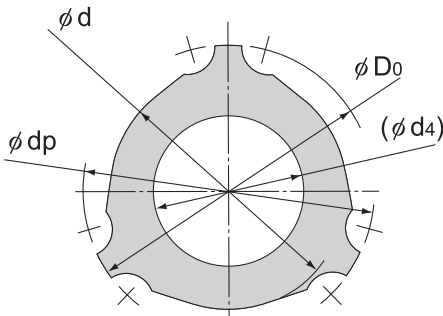
Unit: mm

Nominal shaft diameter	15	20	25	30	40	50	60	70	85	100	120	150
Minor diameter ϕd	11.7	15.3	19.5	22.5	31	39	46.5	54.5	67	81	101	130
Major diameter ϕD_0	14.5	19.7	24.5	29.6	39.8	49.5	60	70	84	99	117	147
Ball center-to-center diameter ϕdp	15	20	25	30	40	50	60	70	85	100	120	150
Mass (kg/m)	1	1.8	2.7	3.8	6.8	10.6	15.6	21.3	32	45	69.5	116.6

*The minor diameter ϕd must be a value at which no groove is left after machining.

[Hole Shape of the Standard Hollow Type Spline Shaft]

Table3 shows the hole shape of the standard hollow type spline shaft. Use this table when a requirement such as piping, wiring, air-vent or weight reduction needs to be met.



Type K

Table3 Sectional Shape of the Standard Hollow Type Spline Shaft

Unit: mm

Nominal shaft diameter	20	25	30	40	50	60	70	85	100	120	150
Minor diameter ϕd	15.3	19.5	22.5	31	39	46.5	54.5	67	81	101	130
Major diameter ϕD_0	19.7	24.5	29.6	39.8	49.5	60	70	84	99	117	147
Ball center-to-center diameter ϕdp	20	25	30	40	50	60	70	85	100	120	150
Hole diameter (ϕd_4)	6	8	12	18	24	30	35	45	56	60	80
Mass (kg/m)	1.6	2.3	2.9	4.9	7	10	13.7	19.5	25.7	47.3	77.1

*The minor diameter ϕd must be a value at which no groove is left after machining.

[Chamfering of the Spline Shaft Ends]

To facilitate the insertion of the spline shaft into a spline nut, the shaft ends are normally chamfered with the dimensions indicated below unless otherwise specified.

● Chamfer A

If the spline shaft ends are stepped, tapped, or drilled as in Fig. 2, they are machined with the Chamfer A dimensions indicated in Table 4.

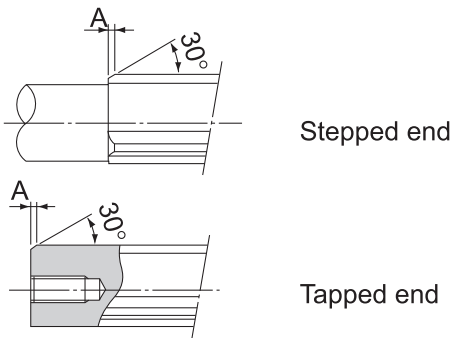


Fig. 2 Chamfer A

● Chamfer B

If either end of the spline shaft is not used, such as for cantilever support, it is machined with the chamfer B dimensions indicated in Table 4.

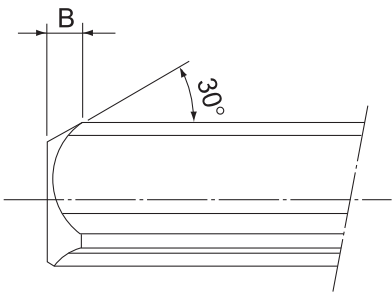


Fig. 3 Chamfer B

Table 4 Chamfer Dimensions of Spline Shaft Ends Unit: mm

Nominal shaft diameter	15	20	25	30	40	50	60	70	85	100	120	150
Chamfer A	1	1	1.5	2.5	3	3.5	5	6.5	7	7	7.5	8
Chamfer B	3.5	4.5	5.5	7	8.5	10	13	15	16	17	17	18

Note) Spline shafts with nominal diameters 6, 8, and 10 are chamfered to C0.5.

[Length of Imperfect Area of a Special Spline Shaft]

If the middle area or the end of a spline shaft is to be thicker than the minor diameter (ϕd), an imperfect spline area is required to secure a recess for grinding. Table5 shows the relationship between the length of the incomplete section (S) and the flange diameter (ϕdf).

(This table does not apply to overall length of 1,500 mm or greater. Contact THK for details.)

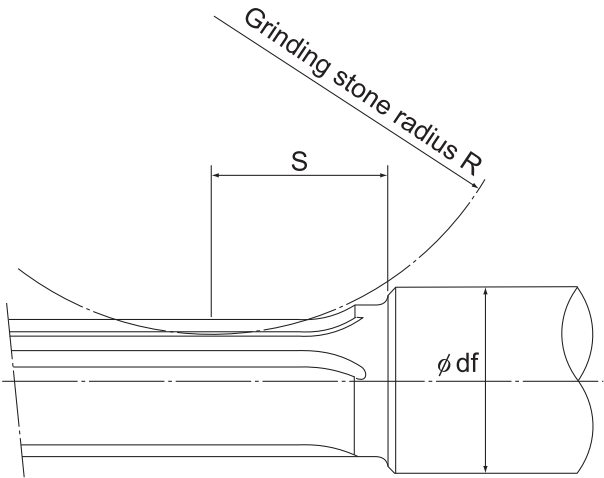


Table5 Length of Imperfect Spline Area: S Unit: mm

Flange diameter ϕdf	15	20	25	30	35	40	50	60	80	100	120	140	160	180	200
Nominal shaft diameter	15	20	25	30	35	40	50	60	80	100	120	140	160	180	200
15	32	42	49	55	60	—	—	—	—	—	—	—	—	—	—
20	—	35	43	51	57	62	—	—	—	—	—	—	—	—	—
25	—	—	51	64	74	82	97	—	—	—	—	—	—	—	—
30	—	—	—	54	67	76	92	105	—	—	—	—	—	—	—
40	—	—	—	—	—	59	80	95	119	—	—	—	—	—	—
50	—	—	—	—	—	—	63	83	110	131	—	—	—	—	—
60	—	—	—	—	—	—	—	66	100	123	140	—	—	—	—
70	—	—	—	—	—	—	—	—	89	115	134	150	—	—	—
85	—	—	—	—	—	—	—	—	61	98	122	140	—	—	—
100	—	—	—	—	—	—	—	—	—	78	108	130	147	—	—
120	—	—	—	—	—	—	—	—	—	—	81	111	133	150	—
150	—	—	—	—	—	—	—	—	—	—	—	64	101	125	144

*This table does not apply to overall length of 1,500 mm or greater. Contact THK for details.

Accessories

Ball Spline models LBS and LBST are provided with a standard key as indicated in Table6.

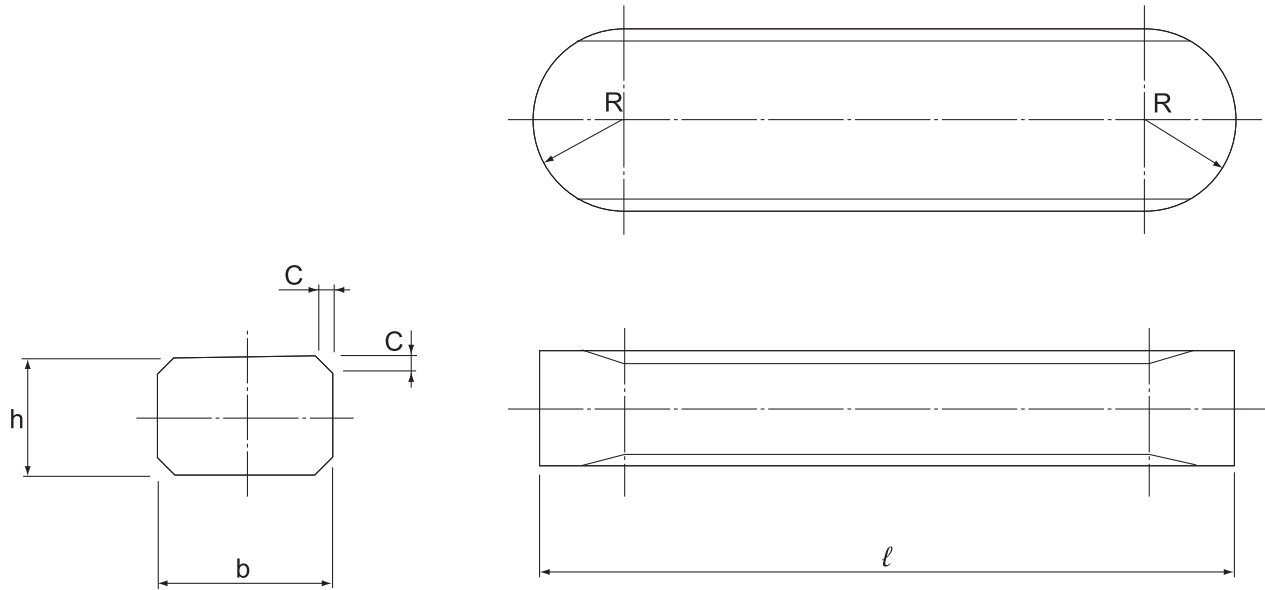


Table6 Standard Keys for Models LBS and LBST Unit: mm

Nominal shaft diameter	Width b		Height h		Length ℓ		R	C
		Tolerance(p7)		Tolerance(h9)		Tolerance(h12)		
LBS 15	3.5	+0.024 +0.012	3.5	0 −0.030	20	0 −0.210	1.75	0.5
LBS 20	4		4		26		2	
LBST 20								
LBS 25	5	+0.030 +0.015	5	0 −0.036	33	0 −0.250	2.5	0.8
LBST 25								
LBS 30	7		7		41		3.5	
LBST 30		+0.036 +0.018	8	0 −0.043	55	0 −0.300	5	1.2
LBS 40	10							
LBST 40								
LBS 50	15	+0.043 +0.022	10	0 −0.052	60	0 −0.350	7.5	2
LBST 50								
LBST 60								
LBS 70	18	+0.051 +0.026	12	0 −0.052	68	0 −0.400	9	
LBST 70								
LBS 85	20	+0.051 +0.026	13	0 −0.052	80	0 −0.400	14	
LBST 85								
LBS 100	28	+0.051 +0.026	18	0 −0.052	93	0 −0.400	14	
LBST 100								
LBST 120	28	+0.051 +0.026	18	0 −0.052	123	0 −0.400	14	
LBST 150	32	+0.051 +0.026	20	0 −0.052	157	0 −0.400	16	



Ball Spline

THK A3-73



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