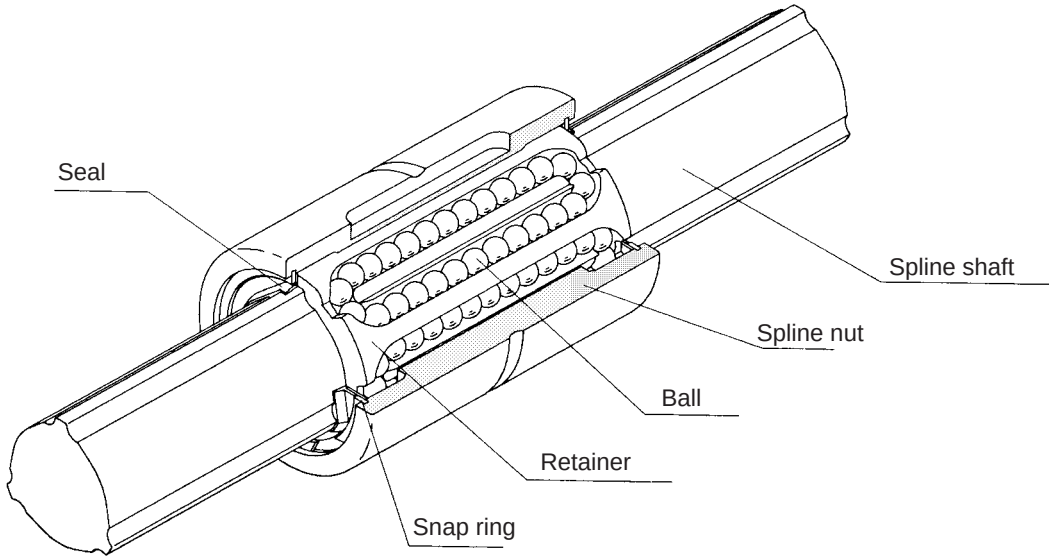


Fig. 1 Construction of Ball Spline Type LBS

Construction and Features

In Ball Spline type LBS, as shown in Fig. 1, the spline shaft has three crests positioned equidistantly at 120°, on both sides of which a total of six trains of load-bearing balls are arranged so as to hold the crests from both sides.

The raceways are precision-ground into R-grooves so as to have a radius approximately the same as the ball radius. When the Ball Spline receives torque from the spline shaft or spline nut, the three trains of balls in the torque loading direction bear equal parts of the load, and as a result the center of rotation is set automatically. With the rotation reversed, the other three trains of balls in the opposite direction bear the load.

As the trains of balls are held in place so that they are caused to circulate in line by the retainer built into the spline-nut interior, the balls do not fall off if the spline shaft is removed.

Zero angular backlash

The construction of type LBS, as described above, can minimize angular backlash (clearance in the rotational direction). Preloading on a spline nut can reduce angular backlash to zero if necessary, thereby increasing rigidity.

Unlike conventional types of Ball Splines designed with a circular-arc or Gothic groove, type LBS has eliminated the need to twist two spline nuts in order to bear a preload, thereby facilitating compact design.

High rigidity and accurate positioning

Type LBS has a wide contact angle and is capable of bearing a preload with a single spline nut. Therefore, the initial displacement is limited, providing the system with high rigidity and high positioning accuracy.

High-speed linear motion and rotation possible

The retainer, with its low friction, superior lubricant-retaining structure, and high rigidity, helps ensure low-maintenance, high-speed linear with grease lubrication alone. Furthermore, as the radial distance to loaded balls and that to free balls are virtually equal, the centrifugal force exerted on the balls is insignificant even during high-speed rotation. These characteristics combine to provide smooth linear motion.

Compact design

In type LBS, free balls do not circulate in the outer tracks as they formerly did in conventional types of Ball Splines, enabling the spline-nut outer diameter to be kept low. The LBS design can therefore be made compact, so that relatively little space is required for installation.

Simple assembly

Even if it is necessary to remove the spline shaft due to special mounting conditions, such as the need to use blind holes or attach a Ball Spline to a complicated structure, the balls will not fall off. As a result, assembly, maintenance, and checking are simple to perform.

A linear bush can be used for heavy loads

The raceways on which balls roll are round-grooved to a radius approximately the same as that of the ball, thereby allowing the balls and raceway to contact each other over a wide range. Type LBS therefore has a high load-bearing capacity against radial and other loads.

Two parallel axes integrated into a one-axis configuration

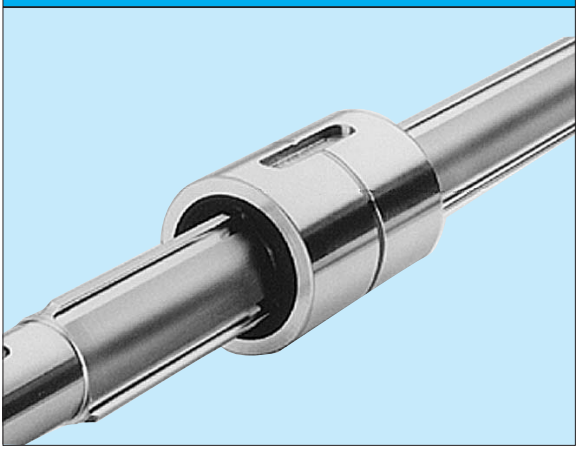
In type LBS, a single axis can bear loads in both the torque-applying and radial directions. Therefore, an installation that formerly required two parallel axes can be configured using only one axis. This simplifies installation procedures and saves space.

Uses

Ball spline LBS is a highly reliable linear motion system applied to:
industrial-robot supporting pole and arm / automatic loader / transfer machine / automatic conveyance system / tire-molding machine / spot-welding-machine spindle / high-speed automatic-painting-machine guide shaft / riveting machine / wire winder / electric-discharge-machine work head / grinding-machine spindle drive shaft / various speed-change gears / precision indexing shaft

Types and Features

Cylindrical Ball Spline Type LBS



Cylindrical Ball Spline Type LBST

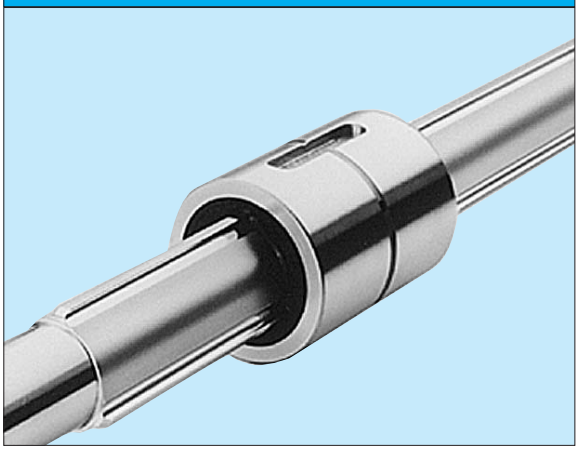


Table 6 LBS and LBST Standard Keys

Unit: mm

Model No.	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 LBST 20	4		4		26		2	
LBS 25 LBST 25	5		5		33	0 −0.250	2.5	
LBS 30 LBST 30	7	+0.030 +0.015	7	0 −0.036	41		3.5	
LBS 40 LBST 40	10		8		55	0 −0.300	5	0.8
LBS 50 LBST 50	15	+0.036 +0.018	10		60		7.5	
LBST 60 LBS 70 LBST 70	18		12	0 −0.043	68		9	1.2
LBS 85 LBST 85	20	+0.043 +0.022	13		80		10	
LBS 100 LBST 100	28		18		93	0 −0.350	14	
LBST 120	28		18		123	0 −0.400	14	
LBST 150	32	+0.051 +0.026	20	0 −0.052	157		16	2

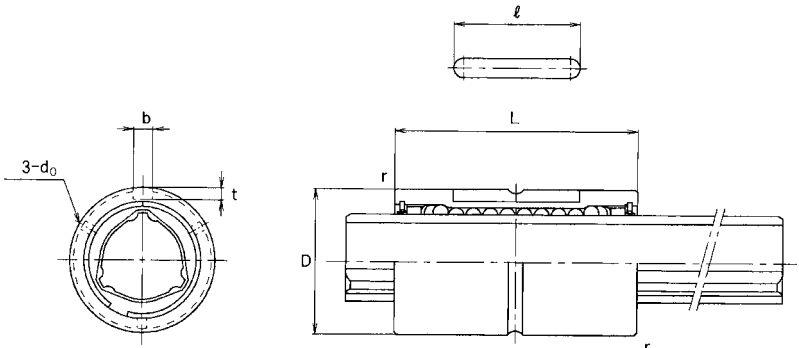
Type LBS

(medium-duty type)

Model No.	Spline-nut dimensions								
	Outer diameter D		Length L		Keyway dimensions				Oil hole
		Tolerance		Tolerance	b H8	t +0.05 0	l	r	d_0
LBS 15	23	0 −0.013	40	0 −0.2	3.5	2	20	0.5	2
LBS 20	30	0 −0.016	50		4	2.5	26	0.5	2
LBS 25	37		60	0 −0.3	5	3	33	0.5	2
LBS 30	45		70		7	4	41	1.0	3
LBS 40	60	0 −0.019	90		10	4.5	55	1.0	3
LBS 50	75		100		15	5	60	1.5	4
LBS 70	100	0 −0.022	110		18	6	68	2.0	4
LBS 85	120		140	0 −0.4	20	7	80	2.5	5
LBS 100	140	0 −0.025	160		28	9	93	3.0	5

Notes:

- In model numbers 15 through 70, the spline nut accommodates a retainer made of synthetic resin that generates low noise during operation. If your operating temperature exceeds 80°C, use a model with a metal retainer. When specifying such a model, append an "A" to the model number.
  Please note, however, that there is no high-temperature model for type LBS15.
  [Ex.] LBS20 A CL + 500LH
  High-temperature symbol
- If a model with seals is required, please specify.
- For model-number coding, see page B-56.



Spline nut

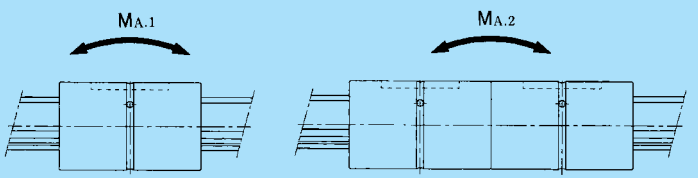
Unit: mm

Basic torque rating		Basic load rating (radial)		Static permissible moment		Mass	
C_T Nm	C_{0T} Nm	C kN	C_0 kN	$M_{A.1}$ 1) Nm	$M_{A.2}$ 2) Nm	Spline nut kg	Spline shaft kg/m
30.4	74.5	4.4	8.4	25.4	185	0.06	1.0
74.5	160	7.8	14.9	60.2	408	0.14	1.8
154	307	13.0	23.5	118	760	0.25	2.7
273	538	19.3	33.8	203	1270	0.44	3.8
599	1140	31.9	53.4	387	2640	1.0	6.8
1100	1940	46.6	73.0	594	4050	1.7	10.6
2190	3800	66.4	102	895	6530	3.1	21.3
3620	6360	90.5	141	2000	12600	5.5	32.0
5910	12600	126	237	3460	20600	9.5	45.0

Notes:

1) $M_{A.1}$ represents the permissible moment in the axial direction when a single spline nut is used, as shown below.

2) $M_{A.2}$ represents the permissible moment in the axial direction when two closely linked spline nuts are used, as shown below.
(As type LBS does not provide sufficiently stable accuracy when used with a single spline nut, we recommend type LBST for single-spline-nut use, or type LBS for closely linked double spline-nut use.)



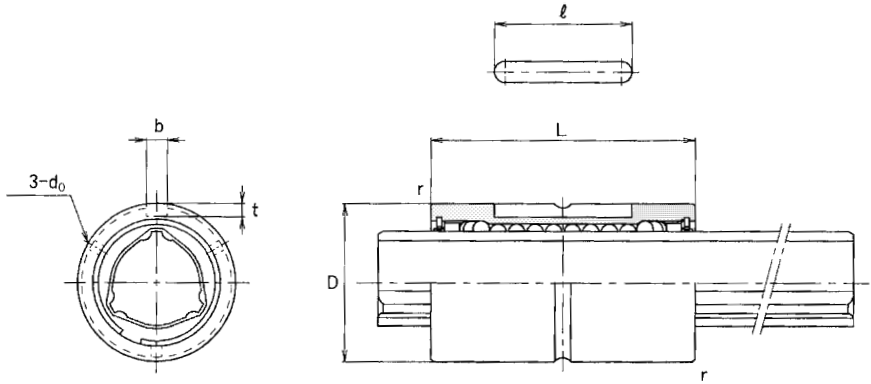
Type LBST

(heavy-duty type)

Model No.	Spline-nut dimensions								
	Outer diameter D		Length L		Keyway dimensions				Oil hole
		Tolerance		Tolerance	b H8	t +0.05 0	l	r	d_0
LBST 20	30	0 −0.016	60	0 −0.2	4	2.5	26	0.5	2
LBST 25	37		70	0 −0.3	5	3	33	0.5	2
LBST 30	45		80		7	4	41	1.0	3
LBST 40	60	0 −0.019	100		10	4.5	55	1.0	3
LBST 50	75		112		15	5	60	1.5	4
LBST 60	90	0 −0.022	127		18	6	68	1.5	4
LBST 70	100		135		18	6	68	2.0	4
LBST 85	120		155	0 −0.4	20	7	80	2.5	5
LBST 100	140	0 −0.025	175		28	9	93	3.0	5
LBST 120	160		200	0 −0.5	28	9	123	3.5	6
LBST 150	205	0 −0.029	250		32	10	157	3.5	6

Notes:

- In model numbers 20 through 70, the spline nut accommodates a retainer made of synthetic resin that generates low noise during operation. (There is no high-temperature model for type LBST70 or lower). If your operating temperature exceeds 80°C, use a model of type LBS accommodating a metal retainer (see page B-60).
- If a model with seals is required, please specify.
- For model-number coding, see page B-56.



Spline nut

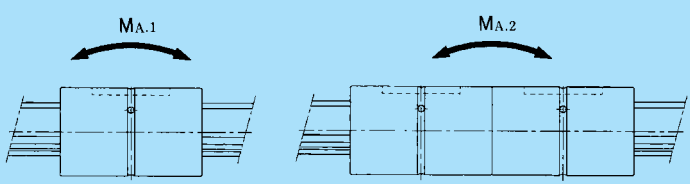
Unit: mm

Basic torque rating		Basic load rating (radial)		Static permissible moment		Mass	
C_T Nm	C_{0T} Nm	C kN	C_0 kN	$M_{A.1}$ 1) Nm	$M_{A.2}$ 2) Nm	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	0.50	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	32.0
6460	14400	137	271	4410	25400	10.4	45.0
8380	19400	148	306	5490	32400	12.9	69.5
13900	32200	196	405	8060	55400	28.0	116.6

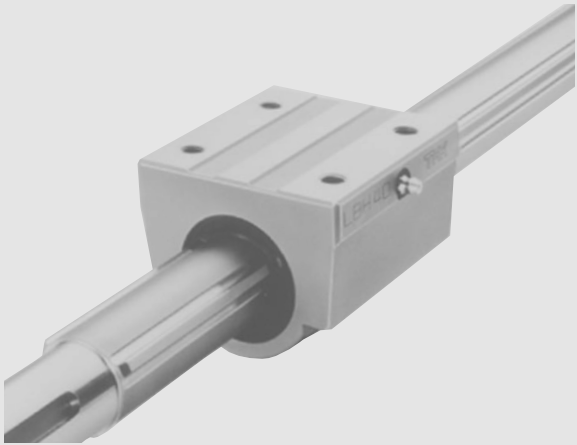
Notes:

1) $M_{A.1}$ represents the permissible moment in the axial direction when a single spline nut is used, as shown below.

2) $M_{A.2}$ represents the permissible moment in the axial direction when two closely linked spline nuts are used, as shown below.



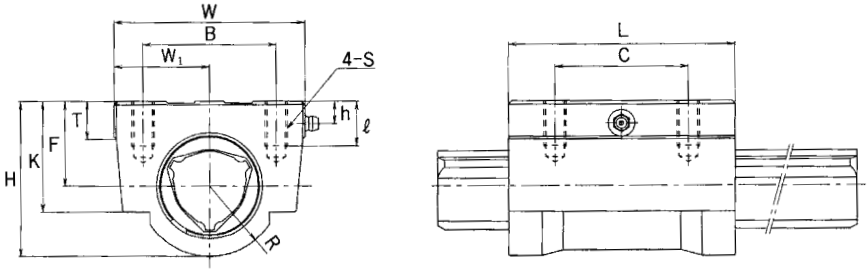
Type LBH



Model No.	Spline-nut dimensions									
	Height H	Width W	Length L	B	C	S × *l*	F ±0.15	W_1 ±0.15	T	K
LBH 15	29	34	43	26	26	M 4 × 10	15	17	6	20
LBH 20	38	48	62	35	35	M 6 × 12	20	24	7	26
LBH 25	47.5	60	73	40	40	M 8 × 16	25	30	8	33
LBH 30	57	70	83	50	50	M 8 × 16	30	35	10	39
LBH 40	70	86	102	60	60	M 10 × 20	38	43	15	50
LBH 50	88	100	115	75	75	M 12 × 25	48	50	18	63

Notes:

- The spline nut accommodates a retainer made of synthetic resin that generates low noise during operation. (There is no high-temperature model for type LBH).
- If a model with seals is required, please specify.
- For model-number coding, see page B-56.

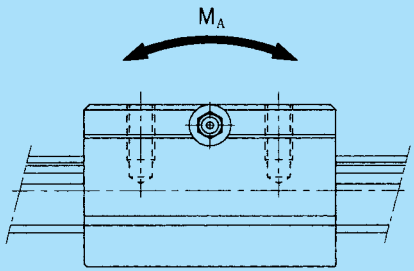


Spline nut

Unit: mm

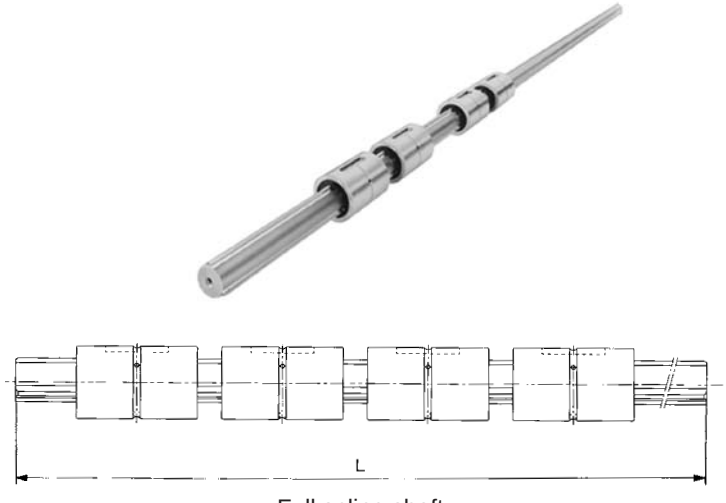
Dimensions			Basic torque rating		Basic load rating (radial)		Static permissible moment	Mass	
l	h	Grease nipple	C_T Nm	C_{OT} Nm	C kN	C_0 kN	M_A 1) Nm	Spline nut kg	Spline shaft kg/m
14	5	4 drive-fit nipple	30.4	74.5	4.4	8.4	25.4	0.23	1.0
18	7	A-M6F	90.2	213	9.4	20.1	103	0.58	1.8
22	6	A-M6F	176	381	14.9	28.7	171	1.10	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	5.10	10.6

Note:
1) M_{A1} represents the permissible moment in the axial direction when a single spline nut is used, as shown below.



Full Spline Type LBS (standard off-the-shelf item)

This type has more than one spline nut attached to a long, straight shaft. The spline-shaft length and the number of spline nuts can be changed freely as required, through reworking. For single-spline-nut use with a short spline-shaft length, a number of spline shafts can be cut from this product. Moreover, the length of each shaft to be cut can be freely determined. Type LBS is therefore highly versatile. Only the normal accuracy and clearance, however, are available with this type.



Full spline shaft

Unit: mm

Model No.	Overall length L	Number of spline nuts
LBS 15	1500	5
LBS 20	1800	6
LBS 25	2500	6
LBS 30	3000	6
LBS 40	3000	4
LBS 50	3000	4

Notes:

- Flanged type LBF is also available.
- For model-number coding, see page B-56.

Reworking spline-shaft ends

The spline shafts of this type are induction-hardened on the surface over their entire length. To rework a shaft, follow the procedures specified below.

1. Using a cutting grinding wheel or the like, cut a shaft to the desired length.
2. Using a burner or the like, anneal a shaft end portion to be reworked (cool the remaining portion during annealing whenever possible).
3. Using the spline outer diameter (crest) as reference (i.e., chucking the shaft on the crests), rough and finish the subject portion with a lathe. When the subject portion is long and grinding is required to perform finishing, provide center holes.
4. If the amount of working that can be performed is limited, it is recommended that the spline-shaft crests be roughed, and then finished with a cylindrical grinding machine.

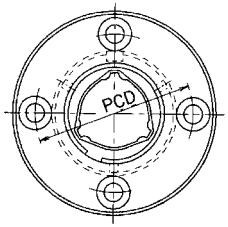
Type LBF

(medium-duty type)

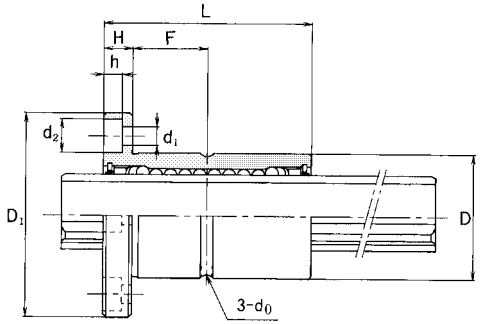
Model No.	Spline-nut dimensions									
	Outer diameter D		Length L		Flange diameter D_1		H	F	Oil hole d_0	PCD
		Tolerance		Tolerance		Tolerance				
LBF 15	23	0 −0.013	40	0 −0.2	43	0 −0.2	7	13	2	32
LBF 20	30	0 −0.016	50		49		7	18	2	38
LBF 25	37		60	0 −0.3	60		9	21	2	47
LBF 30	45		70		70		10	25	3	54
LBF 40	57	0 −0.019	90		90		14	31	3	70
LBF 50	70		100		108	0 −0.3	16	34	4	86
LBF 60	85		127		124		18	45.5	4	102
LBF 70	95	0 −0.022	110		142		20	35	4	117
LBF 85	115		140	0 −0.4	168		22	48	5	138
LBF 100	135	0 −0.025	160		195	0 −0.4	25	55	5	162

Notes:

- In model numbers 15 through 70, the spline nut accommodates a retainer made of synthetic resin that generates low noise during operation. If your operating temperature exceeds 80°C, use a model with a metal retainer. When specifying such a model, append an "A" to the model number.
  Please note, however, that there is no high-temperature model for types LBF15 and LBF60.
  [Ex.] LBF20 A CL + 500LH
  High-temperature symbol
- If a model with seals is required, please specify.
- For model-number coding, see page B-56.



Spline nut



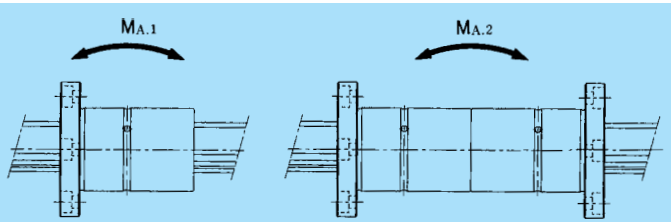
Unit: mm

Mounting hole $d_1 \times d_2 \times h$	Basic torque rating		Basic load rating (radial)		Static permissible moment		Mass	
	C_T Nm	C_{0T} Nm	C kN	C_0 kN	$M_{A.1}$ 1) Nm	$M_{A.2}$ 2) Nm	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	1.0
4.5 × 8 × 4.4	74.5	160	7.8	14.9	60.2	408	0.20	1.8
5.5 × 9.5 × 5.4	154	307	13.0	23.5	118	760	0.36	2.7
6.6 × 11 × 6.5	273	538	19.3	33.8	203	1270	0.60	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	73.0	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	11.0	45

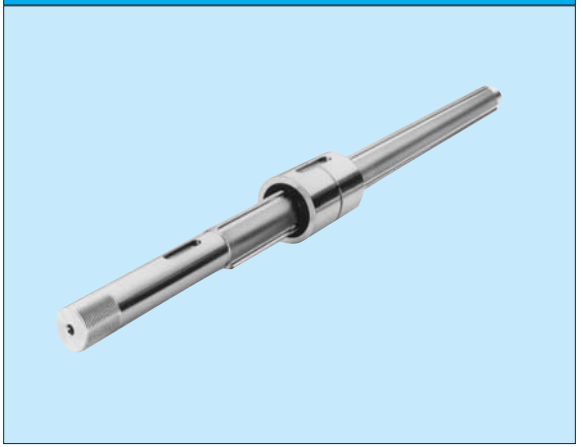
Notes:

1) $M_{A.1}$ represents the permissible moment in the axial direction when a single spline nut is used, as shown below.

2) $M_{A.2}$ represents the permissible moment in the axial direction when two closely linked spline nuts are used, as shown below.
(Due to insufficient stability in accuracy, we recommend the use of closely linked double spline nuts.)

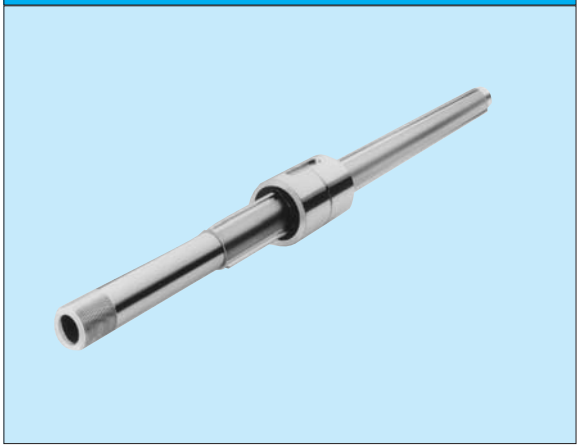


Precision Solid Spline Shaft (standard type)



The spline shaft is formed by cold drawing, and the raceways are cut into the shaft to a high degree of precision. A spline nut is attached to the resulting spline shaft.

Hollow Spline Shaft (type K)



This type is made hollow through cold drawing, to enable it to accommodate pipes and wires and vent air, or to reduce its weight.

Special Spline Shaft

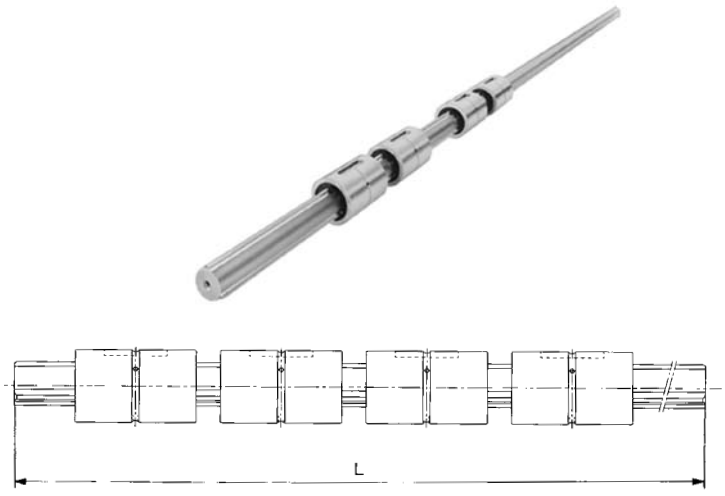
A shaft with a greater diameter at its ends or mid-point can be produced upon request, by machining it to the required spline shape.

Full Spline (standard off-the-shelf item)

Full Spline Type LBS features more than one spline nut attached to a long, straight shaft. The spline-shaft length and the number of spline nuts can be changed freely as required through reworking.

Full Spline Type LBS (standard off-the-shelf item)

This type has more than one spline nut attached to a long, straight shaft. The spline-shaft length and the number of spline nuts can be changed freely as required, through reworking. For single-spline-nut use with a short spline-shaft length, a number of spline shafts can be cut from this product. Moreover, the length of each shaft to be cut can be freely determined. Type LBS is therefore highly versatile. Only the normal accuracy and clearance, however, are available with this type.



Full spline shaft

Unit: mm

Model No.	Overall length L	Number of spline nuts
LBS 15	1500	5
LBS 20	1800	6
LBS 25	2500	6
LBS 30	3000	6
LBS 40	3000	4
LBS 50	3000	4

Notes:

- Flanged type LBF is also available.
- For model-number coding, see page B-56.

Reworking spline-shaft ends

The spline shafts of this type are induction-hardened on the surface over their entire length. To rework a shaft, follow the procedures specified below.

1. Using a cutting grinding wheel or the like, cut a shaft to the desired length.
2. Using a burner or the like, anneal a shaft end portion to be reworked (cool the remaining portion during annealing whenever possible).
3. Using the spline outer diameter (crest) as reference (i.e., chucking the shaft on the crests), rough and finish the subject portion with a lathe. When the subject portion is long and grinding is required to perform finishing, provide center holes.
4. If the amount of working that can be performed is limited, it is recommended that the spline-shaft crests be roughed, and then finished with a cylindrical grinding machine.