BALL SPLINE

ROTARY BALL SPLINE

STROKE BALL SPLINE

BALL SPLINE

The NB ball spline is a linear motion mechanism utilizing the rotational motion of ball elements that can sustain loads and at the same time can transfer torque. It can be used in a wide variety of applications including robotics and transport type equipment.

STRUCTURE AND ADVANTAGES

The NB ball spline consists of a spline shaft with raceway grooves and a spline nut. The spline nut consists of an outer cylinder (main body), retainer, side rings, and ball elements that is designed and manufactured to achieve a reliably smooth motion.

High Load Capacity and Long Travel Life

The raceway grooves are machined to a radius close to that of the ball elements. The large ball contact area results in high load capacity and long travel life.

Wide Variety of Configurations

Spline shaft sizes with diameters from 4mm to 100mm are available. Several types of spline nut are available: cylindrical types (SSP/SSPM), flange types (SSPF/SSPT), and block type (SSPB). Material option of Stainless steel (SUS440C or equivalent) is also available. They can be specified to suit various applications.

High Accuracy Torque Transmission

Due to the effective contact angle between the raceway grooves and the balls, the NB ball spline can transfer large torque. By adjusting preload it is possible to give a higher rigidity and a higher positioning accuracy.
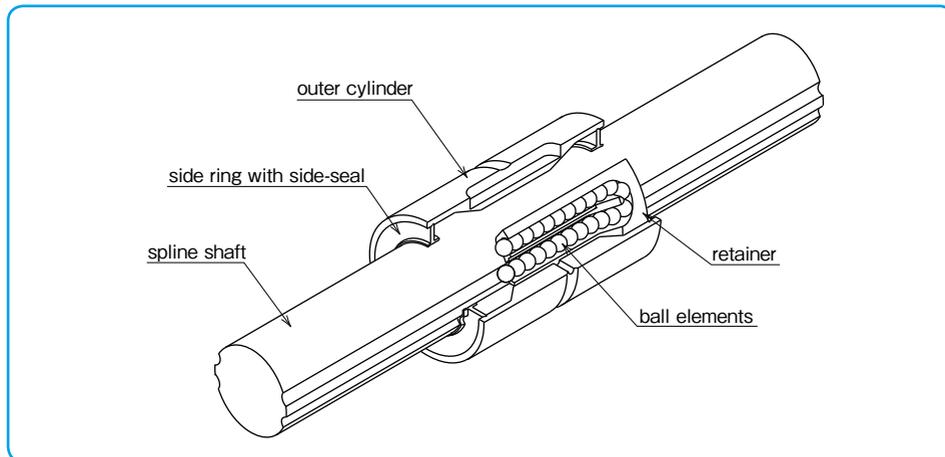
Ease of Additional Custom Machining

Since a round shaft with raceway grooves is used, NB ball spline shafts can be machined easily to customized specifications.

High-Speed Motion and High-Speed Rotation

The outer cylinder is compact and well balanced, resulting in good performance at high speed.
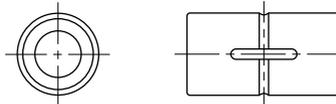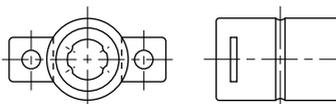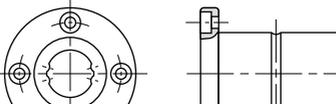
Figure B-1 Basic Structure of NB Ball Spline

TYPES

TYPES OF SPLINE NUT

A wide variety of spline nut designs are available and all spline nuts come with side-seals as a standard feature.

Table B-1 Types of Spline Nut

type of nut		shape and advantage		page
cylindrical type	SSP SSPS		· cylindrical spline nut with key groove · with special key · nominal diameter: SSP4-100 : SSPS4-25	P.B-14
	SSPM		· cylindrical spline nut without key groove · with two lock plates for fixing · nominal diameter: 6-10	P.B-16
flange type	SSPF SSPFS		· spline nut with flange · nominal diameter: SSPF6-60 : SSPFS6-25	P.B-18
	SSPT		· spline nut with a two side cut flange · nominal diameter: 6-10	P.B-20
block type	SSPB		· cast block · spline grooves are machined directly on main body · high rigidity · with grease fitting · nominal diameter: 20-40	P.B-22
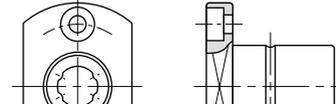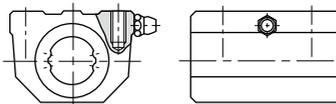
BALL SPLINE

TYPES OF SPLINE SHAFT

Depending on the application requirements, either a ground spline shaft or a non-ground (commercial grade) spline shaft is available.

Table B-2

type of spline shaft	shape and advantage
ground spline shaft	・precision ground and precision machined surface finish ・high precision ・possible to machine ends of spline shaft and surface treatment ・nominal diameter: 4-100
standard spline shaft	・standard dimension and shape ・accuracy grade: high grade ・short lead time ・nominal diameter: 4-60 　(refer to page B-24)
commercial shaft (non-ground)	・for general industrial use ・cost effective ・possible to machine ends of spline shaft and surface treatment ・nominal diameter: 20-50 ・maximum length: 5000mm 　(refer to page B-25)

ACCURACY

The NB ball spline is measured for accuracy at the points shown in Figure B-2 and categorized as either high-grade (blank) or precision-grade (P).
Contact NB for accuracy information on the commercial type ball spline.

Table B-3
Tolerance of Spline Shaft and Groove Torsion

type of shaft	ground shaft	
accuracy grade	high	precision (P)
tolerance	13μm／100mm	6μm／100mm

Figure B-2 Accuracy Measurement Points

Note: The support area is the portion where, for example, radial bearings are attached in order to support the spline shaft.
The part attachment area is the portion to which other parts, such as gears are attached.
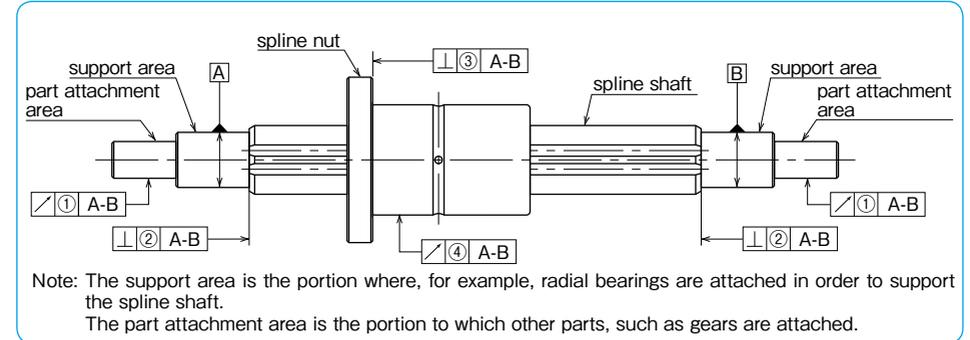
Table B-4 Tolerance Relative to Spline Support Area (Max.)　　　　　　　　　　　　　　　　unit/μm

part number	radial runout of part attachment area ①		perpendicularity of the end of the spline shaft section ②		perpendicularity of the flange ③	
	high-grade	precision-grade	high-grade	precision-grade	high-grade	precision-grade
SSP　4	14	8	9	6	—	—
SSP　6	14	8	9	6	11	8
SSP　8	14	8	9	6	11	8
SSP 10	17	10	9	6	11	8
SSP 13A	19	12	11	8	13	9
SSP 16A	19	12	11	8	13	9
SSP 20A	19	12	11	8	13	9
SSP 25A	22	13	13	9	16	11
SSP 30A	22	13	13	9	16	11
SSP 40A	25	15	16	11	19	13
SSP 50A	25	15	16	11	19	13
SSP 60A	29	17	19	13	22	15
SSP 80	29	17	19	13	22	15
SSP 80L	29	17	19	13	—	—
SSP100	34	20	22	15	—	—
SSP100L	34	20	22	15	—	—
SSP 20	19	12	11	8	13	9
SSP 25	22	13	13	9	16	11
SSP 30	22	13	13	9	16	11
SSP 40	25	15	16	11	19	13
SSP 50	25	15	16	11	19	13
SSP 60	29	17	19	13	22	15

Table B-5 ④Radial Runout of Outer Surface of Spline Nut Relative to Spline Shaft Support Area (Max.)   unit/μm

total length of spline shaft (mm)		SSP4 SSP6 SSP8		SSP10		SSP13A SSP16A		SSP20A・20 SSP25A・25 SSP30A・30		SSP40A・40 SSP50A・50		SSP60A・60 SSP80 SSP80L		SSP100 SSP100L	
greater than	or less	high-grade	precision grade	high-grade	precision grade	high-grade	precision grade	high-grade	precision grade	high-grade	precision grade	high-grade	precision grade	high-grade	precision grade
—	200	46	26	36	20	34	18	32	18	32	16	30	16	30	16
200	315	89	57	54	32	45	25	39	21	36	19	34	17	32	17
315	400	126*	82*	68	41	53	31	44	25	39	21	36	19	34	17
400	500	163*	108*	82	51	62	38	50	29	43	24	38	21	35	19
500	630	—	—	102	65	75	46	57	34	47	27	41	23	37	20
630	800	—	—	—	—	92	58	68	42	54	32	45	26	40	22
800	1,000	—	—	—	—	115	75	83	52	63	38	51	30	43	24
1,000	1,250	—	—	—	—	153	97	102	65	76	47	59	35	48	28
1,250	1,600	—	—	—	—	195*	127*	130	85	93	59	70	43	55	33
1,600	2,000	—	—	—	—	—	—	171	116	118	77	86	54	65	40

★ SSP4 maximum length: 300mm; SSP6 maximum length: 400mm; SSP13A, 16A maximum length: 1500mm
★★ Please contact NB for shaft lengths exceeding 2000mm.

PRELOAD AND CLEARANCE IN ROTATIONAL DIRECTION

Both the clearance and preload are expressed in terms of clearance in the rotational direction. The preload is categorized into three different levels: standard, light (T1), and medium (T2). A preload cannot be specified with the commercial grade spline shaft.

Table B-6 Preload and Clearance in Rotational Direction unit/μm

part number	standard	light (T1)	medium (T2)
SSP 4			
SSP 6	−2~+1	− 6~−2	—
SSP 8			
SSP 10			
SSP 13A	−3~+1	− 8~−3	−13~− 8
SSP 16A			
SSP 20A			
SSP 25A	−4~+2	−12~−4	−20~−12
SSP 30A			
SSP 40A			
SSP 50A			
SSP 60A	−6~+3	−18~−6	−30~−18
SSP 80			
SSP 80L			
SSP100			
SSP100L	−8~+4	−24~−8	−40~−24
SSP 20			
SSP 25	−4~+2	−12~−4	−20~−12
SSP 30			
SSP 40			
SSP 50	−6~+3	−18~−6	−30~−18
SSP 60			

Table B-7 Operating Condition and PreLoad

preload	preload symbol	operating conditions
standard	blank	minute vibration is applied. a precise motion is required. a torque in a given direction is applied.
light	T1	slight vibration is applied. slight torsional load is applied. cyclic torque is applied.
medium	T2	shock/vibration is applied. over-hang load is applied. torsional load is applied.

RATED LIFE

When the ball elements are used as the rolling elements in ball splines, the following equations are used to calculate the life of ball spline.

For radial load

$$L=\left(\frac{f_C}{f_W}\cdot\frac{C}{P}\right)^3\cdot 50$$

For torque load

$$L=\left(\frac{f_C}{f_W}\cdot\frac{C_T}{T}\right)^3\cdot 50$$

L: rated life (km) f_C: contact coefficient f_W: load coefficient
C: basic dynamic load rating (N)   P: applied load (N)
C_T: basic dynamic torque rating (N·m)   T: applied torque (N·m)
* Refer to page Eng-5 for the coefficients
** The load rating of the commercial spline is approximately 70% of the standard ball spline.

$$L_h=\frac{L\cdot 10^3}{2\cdot \ell_S\cdot n_1\cdot 60}$$

L_h: life time (hr) ℓ_S: stroke length (m)
L: rated life (km) n_1: number of cycles per minute (cpm)

OPERATING CONDITIONS

The performance of the ball spline is affected by the operating conditions of the application. The operating conditions should therefore be carefully taken into consideration.

Dust Prevention
Foreign particles or dust in the ball spline nut affects the motion accuracy and shortens the life time. Standard seals will perform well for dust prevention under normal operating conditions, however, in a harsh environment it is necessary to attach bellows or protective covers.
(refer to Figure B-4)

Operating Temperature
The retainer is made of resin, so the operating temperature should never exceed 80℃.

Excessive Moment
One spline nut can sustain high moment, however, excessive moment makes the spline nut unbalanced and unstable in motion. Please use more than one spline nut for high moment or high accuracy applications.

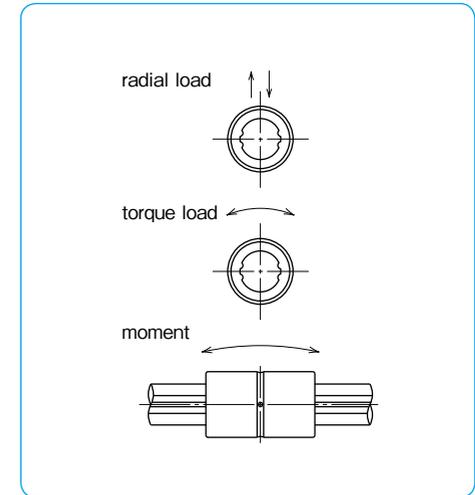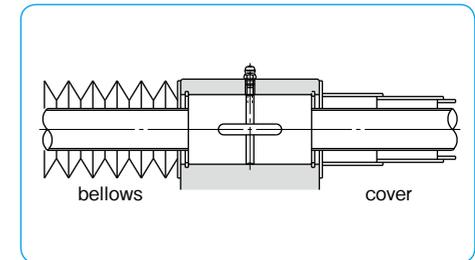Figure B-3 Radial Load and Torque Load

radial load

torque load

moment

Figure B-4 Example of Dust Prevention

bellows   cover

LUBRICATION

The spline nut is prelubricated with lithium soap based grease prior to shipment for immediate use. Please relubricate with a similar type of grease periodically depending on the operating conditions.

Low dust generation grease is available from NB standard grease. (refer to page Eng-39)

The NB spline nut has seals as standard. The seals work well to contain the grease inside the nut especially for the ground shaft, since the seal shape approximates the spline shaft profile.

Figure B-5 Example of Lubrication Mechanism
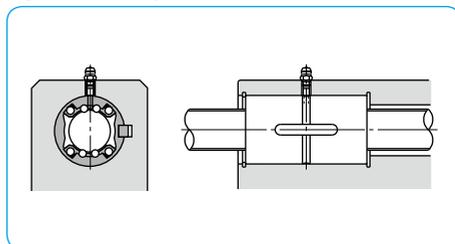
SPECIAL REQUIREMENTS

Based on customer drawings and requirements NB does shaft-end machining, spline nut machining, surface treatment, etc. Please contact NB for special requirements. Table B-8 shows a list of recommended inner diameters for hollow spline shaft.
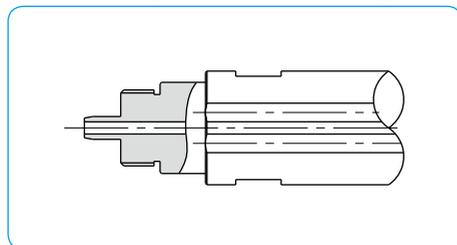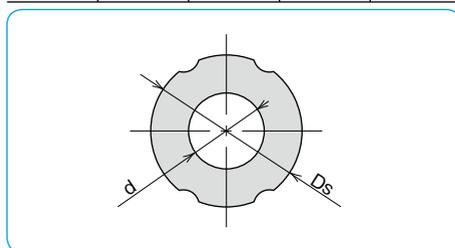
Figure B-6 Example of Shaft-end Machining

Table B-8
Recommended Inner Diameter for Hollow Spline Shaft

part number	shaft diameter Ds mm	inner diameter d mm	cross-sectional coefficient Z mm^3	second moment of inertia I mm^4
SSP 4	4	1.5	5.7	11
SSP 6	6	2	19.4	58
SSP 8	8	3	46.5	186
SSP10	10	4	89.6	448
SSP13A	13	6	193	1,260
SSP16A	16	8	348	2,780
SSP20A	20	10	686	6,860
SSP25A	25	15	1,230	15,400

MOUNTING

Fit

A transition fit is used for the SSP/SSPM-type spline nut and its housing bore to minimize the clearance. If high accuracy is not required, then a clearance fit can be used.

In case of the SSPT/SSPF type spline nut, for a light load and little torque application, a hole slightly larger than the outer diameter of the nut can suffice.

Insertion of Spline Nut

When inserting a spline nut into the housing, use a jig like the one shown in Figure B-7. Carefully insert the nut so as not to hit the side ring and seal.

Table B-10 Recommended Jig Dimensions   unit/mm

part number	D	d	part number	D	d
SSP 4	9.5	3.5	SSP 20	31.5	16.5
SSP 6	13.5	5	SSP 25	36.5	20.5
SSP 8	15.5	7	SSP 30	44.5	25
SSP 10	20.5	8.5	SSP 40	59.5	33
SSP 13A	23.5	12	SSP 50	74	41
SSP 16A	30.5	14.5	SSP 60	89	50
SSP 20A	34.5	18			
SSP 25A	41.5	22.5			
SSP 30A	46.5	27			
SSP 40A	63.5	35.6			
SSP 50A	79	44			
SSP 60A	89	53.5			
SSP 80	119	74			
SSP 80L	119	74			
SSP100	149	92			
SSP100L	149	92			

Insertion of Spline Shaft

When inserting the spline shaft into the spline nut, ensure that the ball elements do not drop out. This is done by aligning the raceway grooves of the shaft with the rows of ball elements and the seal-lip of the nut. Then carefully insert the spline shaft through the spline nut.

Table B-9 Fit for the Spline Nut

type of spline nut	clearance fit	transition fit
SSP	H7	J6
SSPM		

Figure B-7 Insertion of Spline Nut into Housing
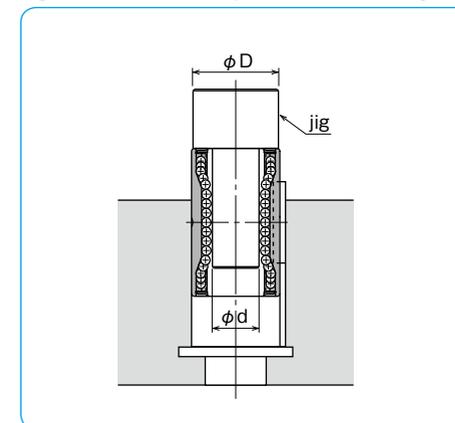
Mounting of SSP Type

Examples of installing the SSP type are shown in Figures B-8 and B-9.

Figure B-8 Using a Retaining Ring
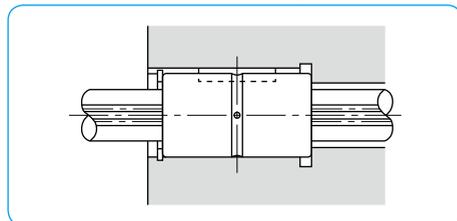
Figure B-9 Using a Push Plate
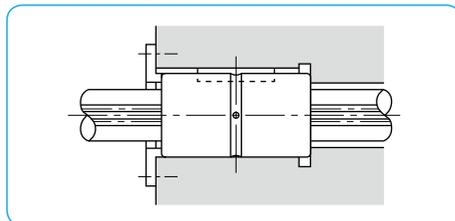
Key

The SSP type spline nut comes with a key shown in Figure B-10.

Figure B-10 Key for SSP Type
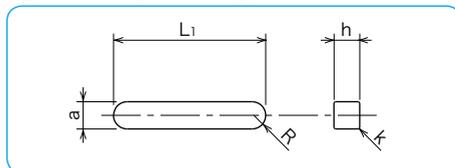
Table B-11 Major Dimensions of Key

part number	a		h		L_1	R	k
	mm	tolerance µm	mm	tolerance µm	mm	mm	mm
SSP 4	2		2		6	1	
SSP 6	2.5	+16 +6	2.5	0 −25	10.5	1.25	
SSP 8	2.5		2.5		10.5	1.25	0.2
SSP 10	3		3		13	1.5	
SSP 13A	3		3		15	1.5	
SSP 16A	3.5		3.5		17.5	1.75	
SSP 20A	4	+24 +12	4	0 −30	29	2	0.5
SSP 25A	4		4		36	2	0.3
SSP 30A	4		4		42	2	0.5
SSP 40A	6		6		52	3	0.5
SSP 50A	8	+30/+15	7		58	4	0.5
SSP 60A	12	+36 +18	8	0 −36	67	6	0.8
SSP 80	16		10		76	8	0.5
SSP 80L					110		
SSP100	20	+43 +22	13	0 −43	110	10	0.8
SSP100L					160		
SSP 20	4	+24 +12	4	0 −30	26	2	0.2
SSP 25	5		5		33	2.5	0.3
SSP 30	7	+30 +15	7	0 −36	41	3.5	0.3
SSP 40	10		8		55	5	0.5
SSP 50	15	+36 +18	10		60	7.5	0.5
SSP 60	18		11	0/−43	68	9	0.5

Mounting of SSPM Type

Examples of installing the SSPM type are shown in Figures B-11 to B-14.

Figure B-11 Using F Type Lock Plates
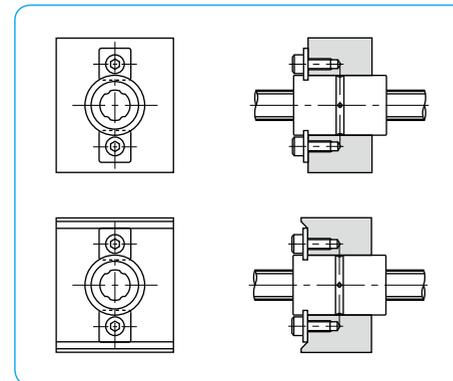
Figure B-12 Using LP Type Lock Plates

Figure B-13 Using Special Lock Plates (1)

Figure B-14 Using Special Lock Plates (2)
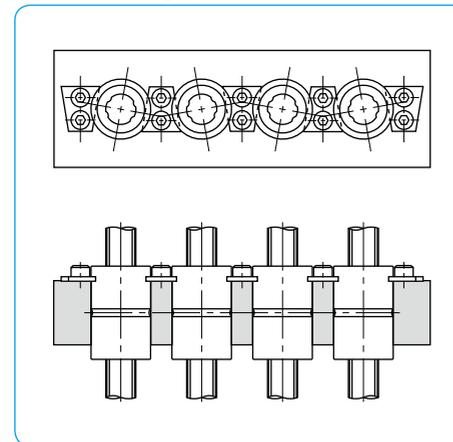
F Type Lock Plate (Standard Plate)

The lock plate shown in Figure B-15 is provided with the SSPM spline nut.

Material: SUS304CSP

Table B-12 F Type Lock Plate

part number	K mm	G mm	t mm	R mm	applicable spline nut
FP 6	6.8	2.9	1.0	0.5	SSPM 6
FP 8	8.5	3.5	1.2	0.5	SSPM 8
FP10	8.5	3.5	1.2	0.5	SSPM10

Figure B-15 F Type Lock Plate
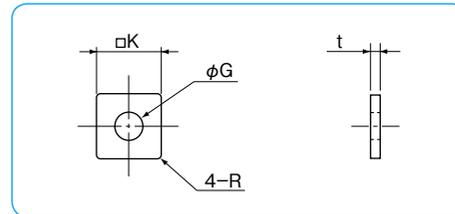
LP Type Lock Plate (Optional Plate)

The LP type lock plate is also available for purchase with the SSPM spline nut.

Material: SUS304CSP

Figure B-16 LP Type Lock Plate

When using the LP type lock plate, please machine the housing as shown above.
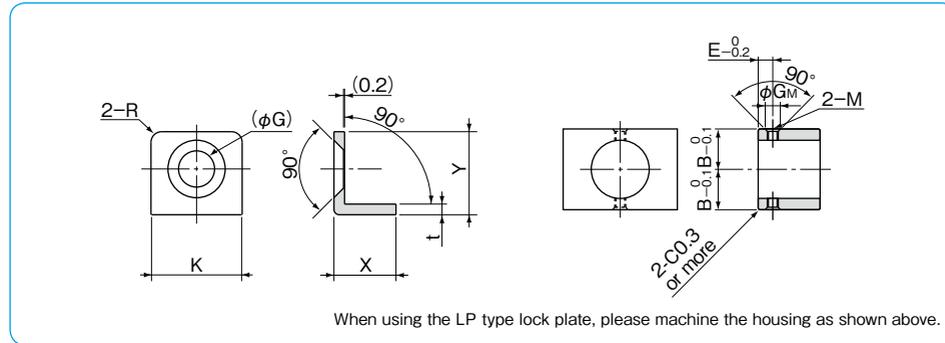
Table B-13 LP Type Lock Plate

part number	lock plate major dimensions						machined housing dimensions				applicable spline nut
	K mm	G mm	t mm	R mm	X mm	Y mm	B mm	E mm	G_M mm	M	
LP 6	8.6	3.8	1.0	1	5.85	7.8	11.1	3.3	3.5	M2.5	SSPM 6
LP 8	9.15	4.5	1.2	1	6.45	9.2	12.3	4.0	4.2	M3	SSPM 8
LP10	9.15	4.5	1.2	1	6.45	9.2	14.8	4.0	4.2	M3	SSPM10

Mounting of SSPF Type

Examples of installing the SSPF type are shown in Figure B-17.

Figure B-17 Examples of installing SSPF Type
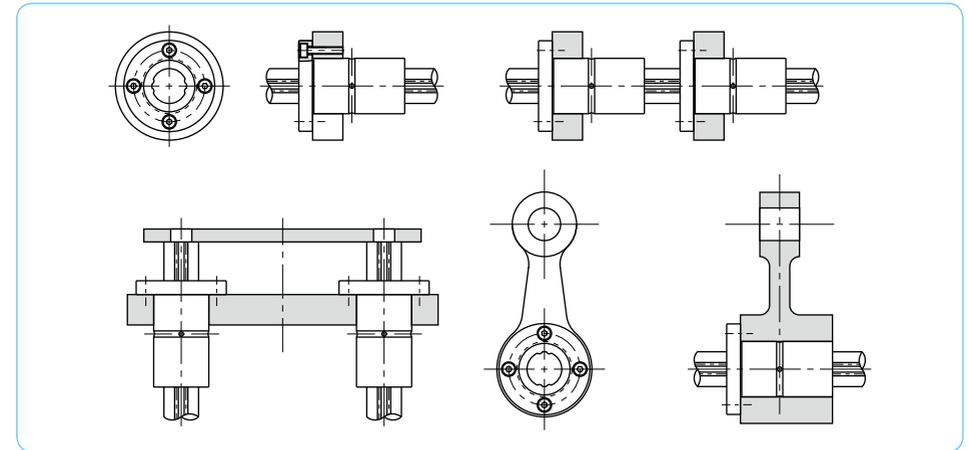
Mounting of SSPT Type

Examples of installing SSPT type are shown in Figure B-18.

Figure B-18 Examples of installing SSPT Type
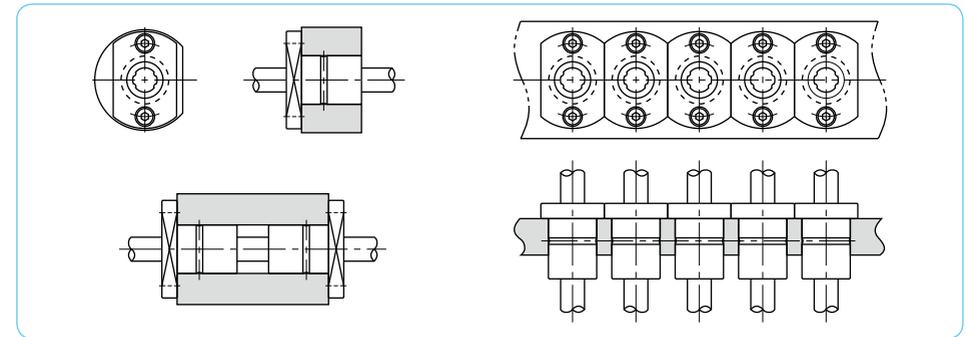
Mounting of SSPB Type

Example of installing SSPB type is shown in Figure B-19.

Figure B-19 Example of installing SSPB Type

SSPB type
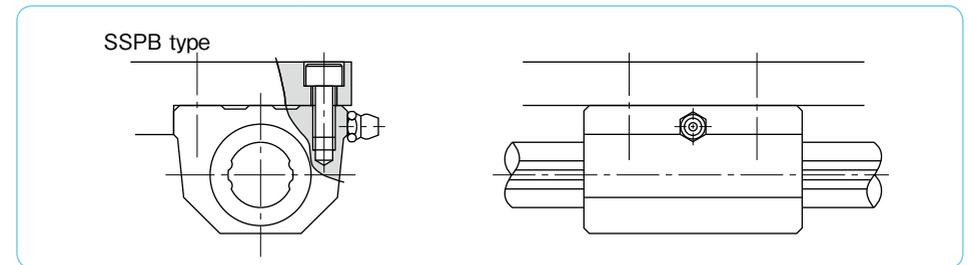
SSP TYPE
— Cylindrical Spline Nut —
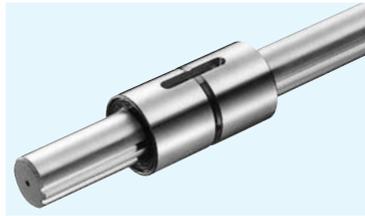
part number structure

example **SSP 80 L - 2 - T1 - 600 - P/CU**

- **specification**
  SSP: standard
  SSPS: anti-corrosion
- **nominal diameter**
- **nut length**
  blank: standard
  L: long
- **number of nuts attached to one shaft**
- **preload symbol**
  blank: standard
  T1: light
  T2: medium
- **spline shaft total length**
- **accuracy grade**
  blank: high
  P: precision
- **with special specification**

Note: retainer material is resin.

M_{O2}

When two spline nuts are used in close contact.

2-d (oil hole)
key groove
t
b
key groove

SSP4~10   SSP13A~60

※SSP4 spline nut does not come with any oil hole.

M_{O1}
L_1
D_s
D
L

key groove
b
t
2-d (oil hole)

SSP80·80L~100·100L

M_{O1}
L_1
D_s
D
B
(L)

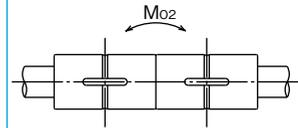| part number		major dimensions															size
		D		L		B	b		t +0.05 0	L_1	d	Ds					
standard	anti-corrosion	mm	tolerance μm	mm	tolerance mm	mm	mm	tolerance μm	mm	mm	mm	mm	tolerance μm				
SSP 4	SSPS 4	10	0/−9	16			2		1.2	6	—	4	0				4
SSP 6	SSPS 6	14	0	25			2.5	+14 0	1.2	10.5	1	6	−12				6
SSP 8	SSPS 8	16	−11	25	0 −0.2		2.5		1.2	10.5	1.5	8	0				8
SSP 10	SSPS10	21	0	33			3		1.5	13	1.5	10	−15				10
SSP 13A	SSPS13A	24	−13	36		—	3		1.5	15	1.5	13	0				13A
SSP 16A	SSPS16A	31		50			3.5	+18 0	2	17.5	2	16	−18				16A
SSP 20A	SSPS20A	35	0	63			4		2.5	29	2	20	0				20A
SSP 25A	SSPS25A	42	−16	71			4		2.5	36	3	25	−21				25A
SSP 30A	—	47		80	0 −0.3		4		2.5	42	3	30					30A
SSP 40A	—	64	0	100			6		3.5	52	4	40	0				40A
SSP 50A	—	80	−19	125			8	+22/0	4	58	4	50	−25				50A
SSP 60A	—	90	0	140			12	+27 0	5	67	4	60	0				60A
SSP 80	—	120	−22	160		118.2	16		6	76	5	80	−30				80
SSP 80L	—	120		217	—	175.2				110							80L
SSP100	—	150	0	185		132.6	20	+33 0	7	110	5	100	0				100
SSP100L	—	150	−25	248		195.6				160			−35				100L
SSP 20	SSPS20	32	0	60	0/−0.2		4	+18 0	2.5	26	2	18.2	0				20
SSP 25	SSPS25	37	−16	70			5		3	33	3	23	−21				25
SSP 30	—	45		80		—	7	+22 0	4	41	3	28					30
SSP 40	—	60	0	100	0 −0.3		10		4.5	55	4	37.4	0				40
SSP 50	—	75	−19	112			15	+27 0	5	60	4	47	−25				50
SSP 60	—	90	0/−22	127			18		6	68	4	56.5	0/−30				60

basic torque rating		basic load rating		allowable static moment		second cross-sectional moment of inertia mm⁴	cross-sectional coefficient mm³	mass		size
dynamic C_T N·m	static C_{OT} N·m	dynamic C kN	static Co kN	M_{O1} N·m	M_{O2} N·m			nut kg	shaft kg/m	
0.74	1.05	0.86	1.22	1.97	10.3	1.18×10	5.90	0.0065	0.10	4
1.5	2.4	1.22	2.28	5.1	40	5.9×10	1.97×10	0.019	0.21	6
2.1	3.7	1.45	2.87	7.4	50	1.9×10^2	4.76×10	0.023	0.38	8
4.4	8.2	2.73	5.07	18.0	116	4.61×10^2	9.22×10	0.054	0.60	10
21	39.2	2.67	4.89	13.7	109	1.38×10^3	2.13×10^2	0.07	1.0	13A
60	110	6.12	11.2	46	299	2.98×10^3	3.73×10^2	0.15	1.5	16A
105	194	8.9	16.3	110	560	7.35×10^3	7.34×10^2	0.22	2.4	20A
189	346	12.8	23.4	171	1,029	1.79×10^4	1.43×10^3	0.33	3.7	25A
307	439	18.6	23.2	181	1,470	3.66×10^4	2.44×10^3	0.36	5.38	30A
674	934	30.8	37.5	358	2,940	1.15×10^5	5.75×10^3	0.95	9.55	40A
1,291	2,955	40.3	64.9	690	4,084	2.83×10^5	1.13×10^4	1.9	15.0	50A
1,577	2,629	47.7	79.5	881	5,473	5.91×10^5	1.97×10^4	2.3	21.6	60A
3,860	6,230	83.1	134	2,000	11,100	1.93×10^6	4.83×10^4	5.1	39	80
5,120	9,340	110	201	4,410	21,100			7.6		80L
6,750	11,570	135	199	3,360	19,300	4.69×10^6	9.38×10^4	9.7	61	100
8,960	17,300	179	298	7,340	37,700			13.9		100L
83	133	7.84	11.3	63	500	5.05×10^3	5.54×10^2	0.2	2.0	20
162	239	12.3	16.1	104	830	1.27×10^4	1.11×10^3	0.22	3.1	25
289	412	18.6	23.2	181	1,470	2.75×10^4	1.96×10^3	0.35	4.8	30
637	882	30.8	37.5	358	2,940	8.73×10^4	4.67×10^3	0.81	8.6	40
1,390	3,180	46.1	74.2	696	4,400	2.16×10^5	9.21×10^3	1.5	13.1	50
2,100	4,800	58.0	127	1,300	8,800	4.51×10^5	1.60×10^4	2.5	19	60

1kN≒102kgf   1N·m≒0.102kgf·m

SSPM TYPE
− Keyless Spline Nut −

part number structure

example **SSPM** **10** **-2** **-T1** **-200** **-P/CU**

with special specification

accuracy grade
blank: high
P: precision

spline shaft total length

SSPM type

nominal diameter

number of nuts attached to one shaft

preload symbol
blank: standard
T1: light

M_{O2}

When two spline nuts are used in close contact.

M_{O1}, M_{O2}, $2-F$, $2-W$, K, C, A, B, H, $2-\phi G$, $2-d$ (oil hole), D_S, D, t, L
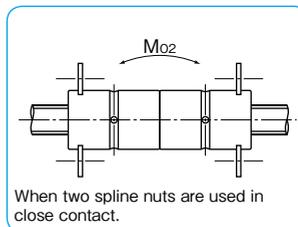
part number	D mm	D tolerance μm	L mm	L tolerance mm	F mm	W mm	C mm	A mm	d mm	B mm	H mm	K mm	G mm
SSPM 6	14	0	25	0	2.2	1.1	1.0	12.0	1	9.4	25.6	6.8	2.9
SSPM 8	16	−11	25	−0.2	2.7	1.3	1.2	13.6	1.5	11	30.6	8.5	3.5
SSPM10	21	0/−13	33		2.7	1.3	1.2	18.6	1.5	13.5	35.6	8.5	3.5

(major dimensions)
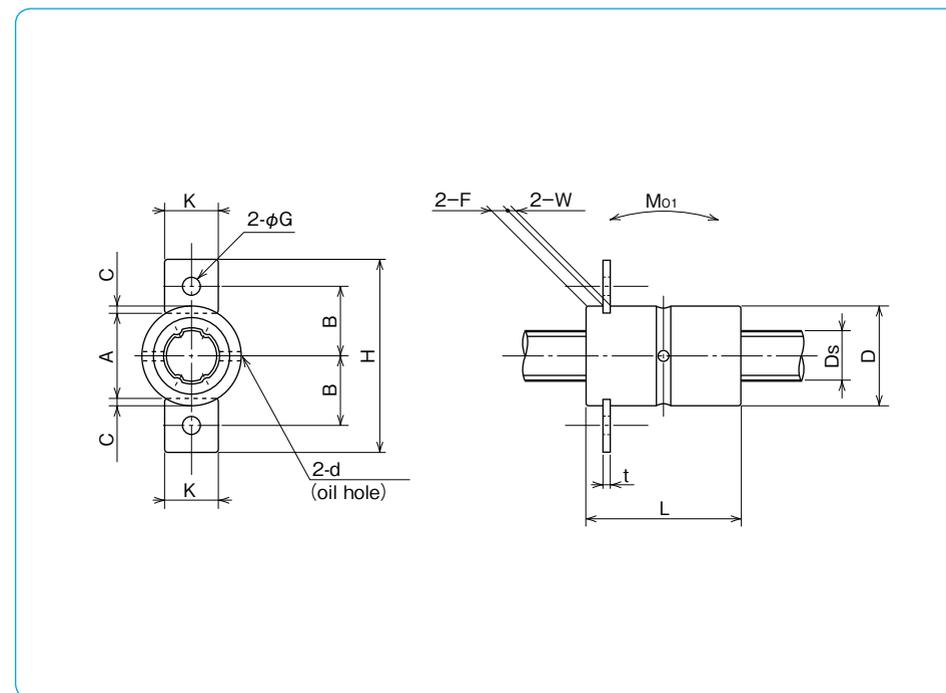
t mm	D_S mm	D_S tolerance μm	basic torque rating dynamic C_T N·m	basic torque rating static C_{OT} N·m	basic load rating dynamic C kN	basic load rating static Co kN	allowable static moment M_{O1} N·m	allowable static moment M_{O2} N·m	second cross-sectional moment of inertia mm⁴	cross-sectional coefficient mm³	mass nut kg	mass shaft kg/m	size
1.0	6	0/−12	1.5	2.4	1.22	2.28	5.1	40	5.9×10	1.97×10	0.019	0.21	6
1.2	8	0	2.1	3.7	1.45	2.87	7.4	50	1.9×10^2	4.76×10	0.023	0.38	8
1.2	10	−15	4.4	8.2	2.73	5.07	18.0	116	4.61×10^2	9.22×10	0.054	0.60	10

1kN≒102kgf   1N·m≒0.102kgf·m

BALL SPLINE

SSPF TYPE
− Flange Type Nut −

part number structure

example **SSPF** - **25** - **2** - **T1** - **436** - **P/CU**

- with special specification
- accuracy grade
  blank: high
  P: precision
- specification
  SSPF: standard
  SSPFS: anti-corrosion
- spline shaft total length
- nominal diameter
- preload symbol
  blank: standard
  T1: light
  T2: medium
- number of nuts attached to one shaft

Note: retainer material is resin.

M_{O2}

When two spline nuts are used in close contact.

mounting hole x 4

M_{O1}

2-φd (oil hole)

SSP6〜10

2-φd (oil hole)

SSP13A〜60
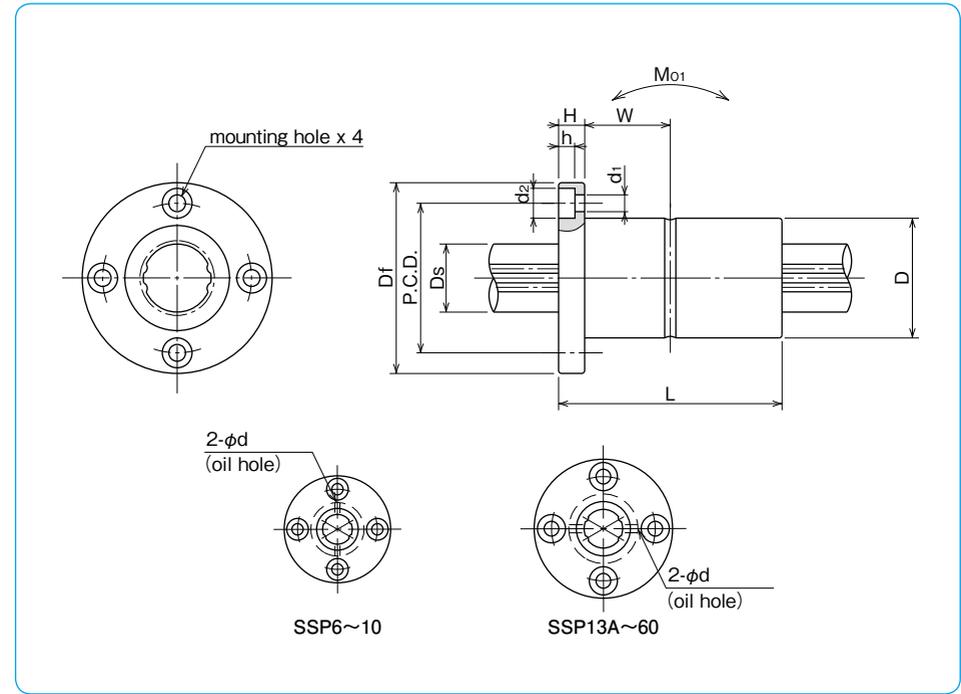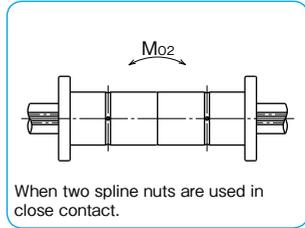
part number		D		L		Df	H	P.C.D.	$d_1 \times d_2 \times h$	W	d	
standard	anti-corrosion	mm	tolerance μm	mm	tolerance mm	mm	mm	mm	mm	mm	mm	
SSPF 6	SSPFS 6	14	0	25		30	5	22	3.4×6.5×3.3	7.5	1	
SSPF 8	SSPFS 8	16	−11	25		32	5	24	3.4×6.5×3.3	7.5	1.5	
SSPF10	SSPFS10	21	0	33	0	42	6	32	4.5×8×4.4	10.5	1.5	
SSPF13A	SSPFS13A	24	−13	36	−0.2	43	7	33	4.5×8×4.4	11	1.5	
SSPF16A	SSPFS16A	31		50		50	7	40	4.5×8×4.4	18	2	
SSPF20A	SSPFS20A	35	0	63		58	9	45	5.5×9.5×5.4	22.5	2	
SSPF25A	SSPFS25A	42	−16	71		65	9	52	5.5×9.5×5.4	26.5	3	
SSPF30A	—	47		80	0	75	10	60	6.6×11×6.5	30	3	
SSPF40A	—	64	0	100	−0.3	100	14	82	9×14×8.6	36	4	
SSPF50A	—	80	−19	125		124	16	102	11×17.5×11	46.5	4	
SSPF60A	—	90	0/−22	140		129	18	107	11×17.5×11	52	4	
SSPF20	SSPFS20	32	0	60	0/−0.2	51	7	40	4.5×8×4.4	23	2	
SSPF25	SSPFS25	37	−16	70		60	9	47	5.5×9.5×5.4	26	3	
SSPF30	—	45		80	0	70	10	54	6.6×11×6.5	30	3	
SSPF40	—	60	0	100	−0.3	90	14	72	9×14×8.6	36	4	
SSPF50	—	75	−19	112		113	16	91	11×17.5×11	40	4	
SSPF60	—	90	0/−22	127		129	18	107	11×17.5×11	45.5	4	

Ds		basic torque rating		basic load rating		allowable static moment		second cross-sectional moment of inertia	cross-sectional coefficient	mass		size
		dynamic C_T	static C_{oT}	dynamic C	static Co	M_{o1}	M_{o2}			nut	shaft	
mm	tolerance μm	N·m	N·m	kN	kN	N·m	N·m	mm⁴	mm³	kg	kg/m	
6	0/−12	1.5	2.4	1.22	2.28	5.1	40	5.9×10	1.97×10	0.037	0.21	**6**
8	0	2.1	3.7	1.45	2.87	7.4	50	1.9×10^2	4.76×10	0.042	0.38	**8**
10	−15	4.4	8.2	2.73	5.07	18.0	116	4.61×10^2	9.22×10	0.094	0.6	**10**
13	0	21	39.2	2.67	4.89	13.7	109	1.38×10^3	2.13×10^2	0.1	1	**13A**
16	−18	60	110	6.12	11.2	46	299	2.98×10^3	3.73×10^2	0.2	1.5	**16A**
20	0	105	194	8.9	16.3	110	560	7.35×10^3	7.34×10^2	0.33	2.4	**20A**
25	−21	189	346	12.8	23.4	171	1,029	1.79×10^4	1.43×10^3	0.45	3.7	**25A**
30		307	439	18.6	23.2	181	1,470	3.66×10^4	2.44×10^3	0.55	5.38	**30A**
40	0	647	934	30.8	37.5	358	2,940	1.15×10^5	5.75×10^3	1.41	9.55	**40A**
50	−25	1,291	2,955	40.3	64.9	690	4,084	2.83×10^5	1.13×10^4	2.73	15.0	**50A**
60	0/−30	1,577	2,629	47.7	79.5	881	5,473	5.91×10^5	1.97×10^4	3.2	21.6	**60A**
18.2	0	83	133	7.84	11.3	63	500	5.05×10^3	5.54×10^2	0.22	2	**20**
23	−21	162	239	12.3	16.1	104	830	1.27×10^4	1.11×10^3	0.32	3.1	**25**
28		289	412	18.6	23.2	181	1,470	2.75×10^4	1.96×10^3	0.51	4.8	**30**
37.4	0	637	882	30.8	37.5	358	2,940	8.73×10^4	4.67×10^3	1.15	8.6	**40**
47	−25	1,390	3,180	46.1	74.2	696	4,400	2.16×10^5	9.21×10^3	2.1	13.1	**50**
56.5	0/−30	2,100	4,800	58.0	127	1,300	8,800	4.51×10^5	1.60×10^4	3.3	19	**60**

1kN≒102kgf   1N·m≒0.102kgf·m

SSPT TYPE
− Two Side Cut Flange Type −

part number structure

example **SSPT** **10** - **2** - **T1** - **436** - **P/CU**

with special specification

accuracy grade
blank: high
P: precision

spline shaft total length

preload symbol
blank: standard
T1: light

SSPT type

nominal diameter

number of nuts attached
to one shaft

M_{O2}

When two spline nuts are used in close contact.

mounting hole x 2

M_{O1}
H
W
h
d_2
d_1
2-d
(oil hole)
Df
P.C.D.
Ds
D
B
L

BALL SPLINE
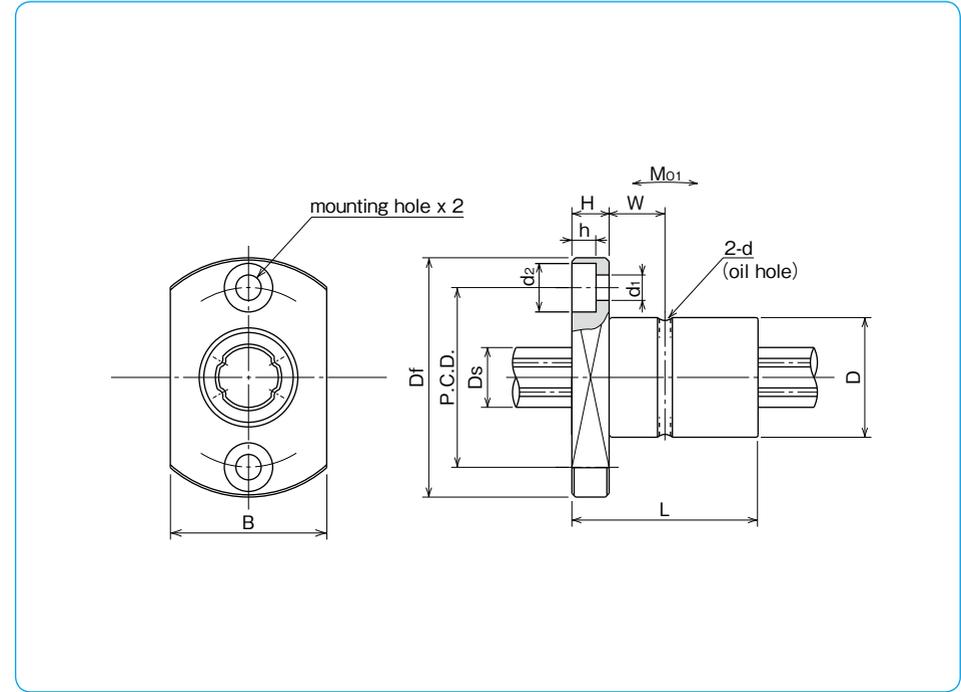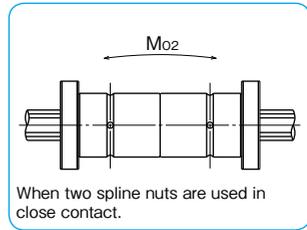
| part number | major dimensions | | | | | | | | | | | size |
| | D | | L | | Df | B | H | P.C.D. | $d_1 \times d_2 \times h$ | W | d | |
	mm	tolerance μm	mm	tolerance mm	mm	mm	mm	mm	mm	mm	mm	
SSPT 6	14	0	25	0 −0.2	30	18	5	22	3.4×6.5×3.3	7.5	1	6
SSPT 8	16	−11	25		32	21	5	24	3.4×6.5×3.3	7.5	1.5	8
SSPT10	21	0/−13	33		42	25	6	32	4.5×8×4.4	10.5	1.5	10

| Ds | | basic torque rating | | basic load rating | | allowable static moment | | second cross-sectional moment of inertia | cross-sectional coefficient | mass | | size |
| | | dynamic C_T | static C_{OT} | dynamic C | static Co | M_{O1} | M_{O2} | | | nut | shaft | |
mm	tolerance μm	N·m	N·m	kN	kN	N·m	N·m	mm^4	mm^3	kg	kg/m	
6	0/−12	1.5	2.4	1.22	2.28	5.1	40	5.9 ×10	1.97×10	0.029	0.21	6
8	0	2.1	3.7	1.45	2.87	7.4	50	1.9 ×10^2	4.76×10	0.035	0.38	8
10	−15	4.4	8.2	2.73	5.07	18.0	116	4.61×10^2	9.22×10	0.075	0.6	10

1kN≒102kgf　1N·m≒0.102kgf·m

SSPB Type
— Block Type —

part number structure

example **SSPB** **25** - **2** - **T1** - **436** - **P**/**CU**

- SSPB type
- nominal diameter
- number of blocks attached to one shaft
- preload symbol
  blank: standard
  T1: light
  T2: medium
- spline shaft total length
- accuracy grade
  blank: high
  P: precision
- with special specification

M_{O2}

When two blocks are used in close contact.

$E^{\pm0.1}$　B　8.5　P_1　4-S　A-M6F　T　ℓ　b　T_1　$h^{\pm0.1}$

M_{O1}　L　P_2　D_S
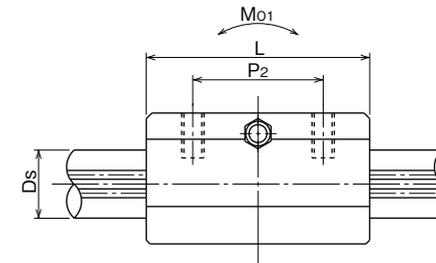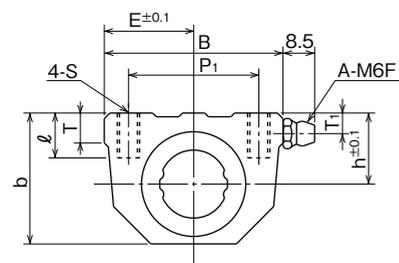
major dimensions

part number	h	B	L	E	b	T	P_1	P_2	S	ℓ	T_1
	mm	mm	mm	mm	mm	mm	mm	mm		mm	mm
SSPB20	19	48	60	24	35	8	35	35	M6	12	5.5
SSPB25	22	60	70	30	41.5	10	40	40	M8	12	6
SSPB30	26	70	80	35	50	12	50	50	M8	12	7
SSPB40	32	86	100	43	63	15	60	60	M10	15	8

D_S		basic torque rating		basic load rating		allowable static moment		second cross-sectional moment of inertia	cross-sectional coefficient	mass		size
	tolerance	dynamic C_T	static C_{OT}	dynamic C	static C_O	M_{O1}	M_{O2}			block	shaft	
mm	μm	N・m	N・m	kN	kN	N・m	N・m	mm⁴	mm³	kg	kg/m	
18.2		83	133	7.84	11.3	63	500	5.05×10^3	5.54×10^2	0.55	2.0	**20**
23	0 −21	162	239	12.3	16.1	104	830	1.27×10^4	1.11×10^3	0.9	3.1	**25**
28		289	412	18.6	23.2	181	1,470	2.75×10^4	1.96×10^3	1.4	4.8	**30**
37.4	0/−25	637	882	30.8	37.5	358	2,940	8.73×10^4	4.67×10^3	2.5	8.6	**40**

1kN≒102kgf　1N・m≒0.102kgf・m

STANDARD BALL SPLINE

part number structure

example **SSP 10 S - 2 - T1 - 400**

- nut shape
  - **SSP**: cylindrical type
  - **SSPM**: keyless type
  - **SSPF**: flange type
  - **SSPT**: two side cut flange type
  - **SSPB**: block type
- nominal diameter
- standard spline shaft
- number of nuts attached to one shaft
- preload symbol
  - **blank**: standard
  - **T1**: light
  - **T2**: medium
- standard length L

SSP4S~10S, 13AS~60AS   SSP20S~60S

heat-treated area   L   ℓ   heat-treated area   L
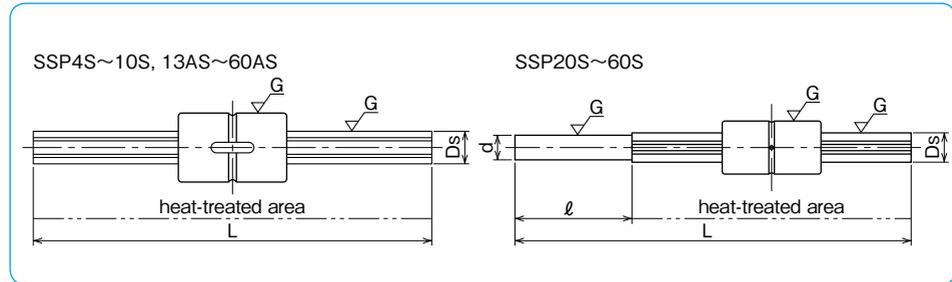
nominal diameter	\multicolumn{10}{c}{major dimensions}	\multicolumn{5}{c}{applicable nut}
	Ds mm	Ds tolerance μm	d mm	d tolerance μm	ℓ mm	\multicolumn{5}{c}{standard length L mm}	SSP	SSPM	SSPF	SSPT	SSPB
4	4	0	–	–	–	100	150	200	300	–	○	–	–	–	–
6	6	−12	–	–	–	150	200	300	400	–	○	○	○	○	–
8	8	0	–	–	–	150	200	300	400	500	○	○	○	○	–
10	10	−15	–	–	–	200	300	400	500	600	○	○	○	○	–
13A	13	0	–	–	–	200	300	400	500	600	○	–	○	–	–
16A	16	−18	–	–	–	200	300	400	500	600	○	–	○	–	–
20A	20	0 / −21	–	–	–	300	400	500	800	1,000	○	–	○	–	–
25A	25		–	–	–	300	400	500	800	1,000	○	–	○	–	–
30A	30		–	–	–	–	500	1,000	1,500	2,000	○	–	○	–	–
40A	40	0 / −25	–	–	–	–	500	1,000	1,500	2,000	○	–	○	–	–
50A	50	−25	–	–	–	–	500	1,000	1,500	2,000	○	–	○	–	–
60A	60	0/−30	–	–	–	–	500	1,000	1,500	2,000	○	–	○	–	–
20	18.2	0 / −21	15	0/−18	150	350	450	550	650	–	○	–	○	–	○
25	23		20	0/−21	150	350	450	550	650	850	○	–	○	–	○
30	28		25		150	450	550	650	750	1,150	○	–	○	–	○
40	37.4	0	30		150	550	750	950	1,150		–	○	–	○	
50	47	−25	40	0 / −25	150	650	850	1,150	1,350		○	–	○	–	–
60	56.5	0/−30	45	−25	150	650	850	1,150	1,350		○	–	○	–	–

· Tolerance of length L for nominal diameter sizes 4 to 10, 13A to 60A: JIS B0405 coarse grade.   ○ yes — none
· Please refer to dimension tables for nut shape and dimensions.

COMMERCIAL BALL SPLINE

part number structure

example **SSPF 25 C - 2 - 436 / CU**

- nut shape
  - **SSP**: cylindrical type
  - **SSPF**: flange type
  - **SSPB**: block type
- commercial spline shaft
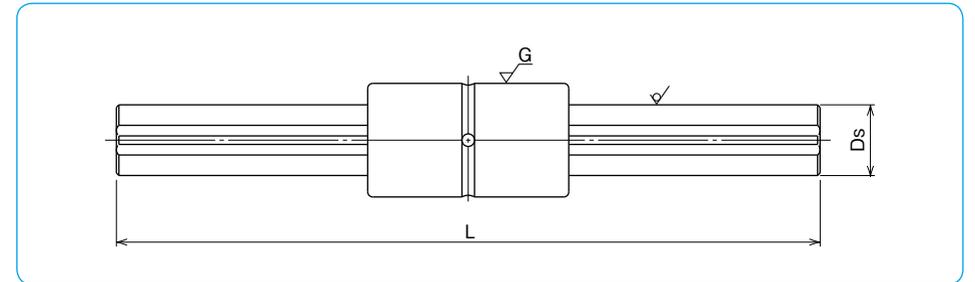- nominal diameter
- number of nuts attached to one shaft
- spline shaft total length
- with special specification

L

nominal diameter	\multicolumn{7}{c}{major dimensions}	\multicolumn{3}{c}{applicable nut}
	Ds mm	\multicolumn{6}{c}{standard length L mm}	SSP	SSPF	SSPB
20	18.2	500	1,000	2,000	3,000	4,000	5,000	○	○	○
25	23	500	1,000	2,000	3,000	4,000	5,000	○	○	○
30	28	500	1,000	2,000	3,000	4,000	5,000	○	○	○
40	37.4	500	1,000	2,000	3,000	4,000	5,000	○	○	○
50	47	500	1,000	2,000	3,000	4,000	5,000	○	○	–

· Tolerance of total length and length of splined portion
  total length up to 4,000: JIS B0405 coarse grade
  total length greater than 4,000: ±5.0mm
  Please specify tolerances when required.   ○ yes — none
· Please refer to dimension tables for nut shape and dimensions.
· When a commercial shaft is used, the load rating of the nut is approximately 70% of indicated rating in the dimension tables.

ROTARY BALL SPLINE

The NB rotary ball spline can be used for both rotational motion and linear motion. The applications include SCARA robots, the vertical shaft of assembly equipment, tool changers, and loaders, etc.

STRUCTURE AND ADVANTAGES

The NB rotary ball spline nut consists of a spline nut and a rotating portion using cross rollers.

Reduced Number of Parts

Because of the single-body construction consisting of the rotating element and the spline element, the number of parts is reduced so that the accumulated errors are also reduced.

Compact and Light

The cross rollers are directly attached to the ball spline's outer cylinder, resulting in a compact and light design.

Substantial Reduction in Installation Cost

The use of cross rollers keeps the housing thickness to a minimum, making the ball spline light and easy to install.
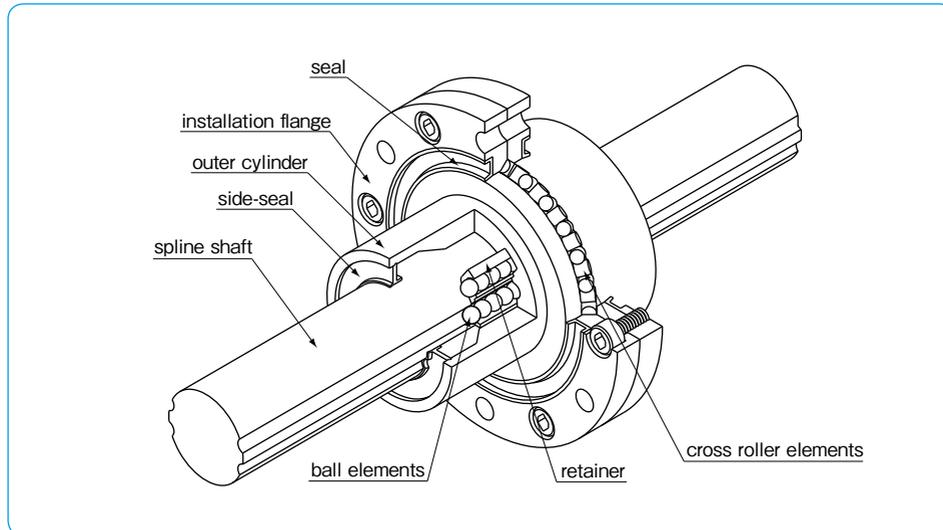
High Rigidity

The use of cross rollers and 4-row ball circuits structure provide high rigidity in spite of the compact design.

High Accuracy

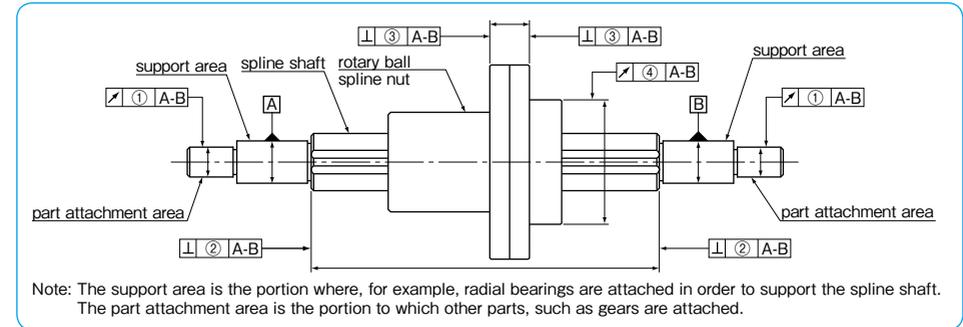The cross rollers ensure accurate positioning in the rotational direction.

Figure B-20 Structure of NB Rotary Ball Spline

ACCURACY

The accuracy of the NB rotary ball spline is measured at the points shown in Figure B-21.

Figure B-21 Accuracy Measurement Points

Note: The support area is the portion where, for example, radial bearings are attached in order to support the spline shaft. The part attachment area is the portion to which other parts, such as gears are attached.

Tolerance of Spline Shaft Groove Torsion (Max.)

The groove torsion is indicated per 100mm, arbitrarily set as the effective length of the spline section. When the spline length is under 100mm or exceeds 100mm, the value shown in Table B-14 decreases or increases proportionally to the spline length.

Table B-14 Tolerance of Spline Shaft Groove Torsion (Max.)

tolerance
13μm/100mm

Table B-15 Tolerance Relative to Spline Support Area (Max.)   unit/μm

part number	①radial runout of part attachment area	②perpendicularity of the end of the spline shaft section	③perpendicularity of the flange
SPR 6	14	9	14
SPR 8	14	9	14
SPR10	17	9	14
SPR13	19	11	18
SPR16	19	11	18
SPR20A	19	11	18
SPR25A	22	13	21
SPR30A	22	13	21
SPR40A	25	16	25
SPR50A	25	16	25
SPR60A	29	19	29
SPR20	19	11	18
SPR25	22	13	21
SPR30	22	13	21
SPR40	25	16	25
SPR50	25	16	25
SPR60	29	19	29

Table B-16 ④Radial Runout of Outer Surface of Rotary Spline Nut Relative to Spline Support Area (Max.)   unit/μm

spline shaft total length (mm) greater than	or less	part number SPR 6、8	SPR 10	SPR 13、16	SPR 20A, 20, 25A, 25, 30A, 30	SPR 40A、40、50A、50	SPR 60A、60
—	200	46	36	34	32	32	30
200	315	89	54	45	39	36	34
315	400	126	68	53	44	39	36
400	500	163*	82	62	50	43	38
500	630	—	102	75	57	47	41
630	800	—	—	92	68	54	45
800	1,000	—	—	115	83	63	51
1,000	1,250	—	—	153	102	76	59
1,250	1,600	—	—	195*	130	93	70
1,600	2,000	—	—	—	171	118	86

※Please contact NB for spline shafts exceeding 2000mm. * SPR6 shaft Max. length: 400mm   SPR13, SPR16 Max.length: 1500mm

PRELOAD AND CLEARANCE

The amount of clearance and preload for the spline portion and the cross roller portion are expressed in terms of the clearance in the rotational direction and the clearance in the radial direction, respectively. Three levels of preload are available: standard, light (T1), and medium (T2).

Table B-17 Preload and Clearance in Rotational and Radial Direction   unit／μm

	part number	standard	light (T1)	medium (T2)
linear motion	SPR 6	−2～+1	− 6～−2	—
	SPR 8			
	SPR10			
	SPR13	−3～+1	− 8～−3	−13～− 8
	SPR16			
	SPR20A	−4～+2	−12～−4	−20～−12
	SPR25A			
	SPR30A			
	SPR40A			
	SPR50A	−6～+3	−18～−6	−30～−18
	SPR60A			
	SPR20	−4～+2	−12～−4	−20～−12
	SPR25			
	SPR30			
	SPR40			
	SPR50	−6～+3	−18～−6	−30～−18
	SPR60			
rotational motion	SPR 6 ～ SPR60	−1～+3		

Table B-18 Operating Conditions and Preload

preload	symbol	operating conditions
standard	blank	minute vibration is applied. a precise motion is required. moment is applied in a given direction.
light	T1	light vibration is applied. light torsional load is applied. cyclic torque is applied.
medium	T2	shock/vibration is applied. over-hang load is applied. torsional load is applied.

SPECIAL REQUIREMENTS

NB provides customization such as shaft-end machining, spline nut machining, and surface treatment per customer requests. Table B-19 shows a list of recommended inner diameters for hollow spline shaft. Please contact NB for the inner diameter of SPR20～SPR60.
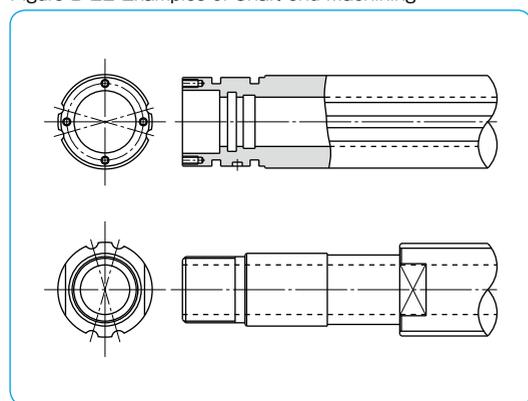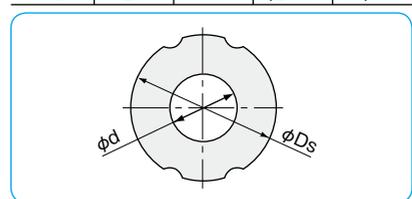
Figure B-22 Examples of Shaft-end Machining

Table B-19 Recommended Inner Diameter for Hollow Spline Shaft

part number	outer diameter Ds mm	inner diameter d mm	cross-sectional coefficient Z mm	second moment of inertia I mm^4
SPR 6	6	2	19.4	58
SPR 8	8	3	46.5	186
SPR10	10	4	89.6	448
SPR13	13	6	193	1,260
SPR16	16	8	348	2,780
SPR20A	20	10	686	6,860
SPR25A	25	15	1,230	15,400

MOUNTING

The flange attachment screws have been pre-adjusted for smooth rotary movement and should never be loosened. Shock loading to the flange assembly should be avoided as this can degrade the accuracy of movement and deteriorate the overall performance.

Mounting of Rotary Ball Spline

When the flange is to be used with a faucet joint (as shown in Figure B-23) the housing bore should be machined to a tolerance of H7 and to a minimum depth of 60% of the flange thickness. If only a light load is applied to the SPR in operation, the flange can be used without a pilot end.
Please fix the mounting screws diagonally in steps with progressively applying more torque at each step. Please use a torque wrench for a uniform torque. The recommended torque values for medium-hardness steel screws are listed in Table B-20.

Insertion of Spline Shaft

When inserting the spline shaft into the rotary ball spline nut, ensure that the ball elements do not drop out. This is done by aligning the raceway grooves of the shaft with the rows of ball elements and the seal-lip of the nut. Then carefully insert the spline shaft through the spline nut.

Figure B-23 Flange Mounting Method

Table B-20 Recommended Torque   unit／N·m

mounting screw	M2	M2.5	M3	M4	M6	M8
recommended torque	0.4	0.9	1.4	3.2	11.2	27.6

(for alloy steel screw)

LUBRICATION

Since NB rotary ball spline nuts are equipped with seals at both the spline portion and the rotational portion, the lubricant is retained for an extended period of time. The spline nut is prelubricated with lithium soap based grease prior to shipment for immediate use. Please relubricate with a similar type of grease periodically depending on the operating conditions.
Low dust generation grease is available from NB standard grease. (refer to page Eng-39)
However, an oil lubricant is recommended for high-speed applications. A grease fitting is optional (Figure B-24), please contact NB for details.
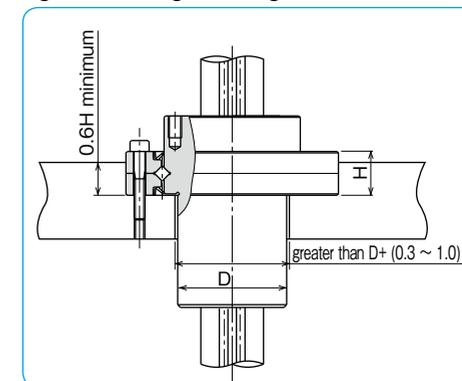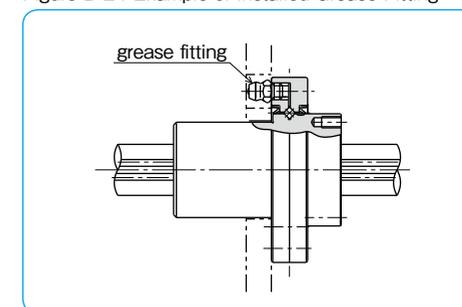
Figure B-24 Example of Installed Grease Fitting

grease fitting

ROTARY BALL SPLINE

OPERATING CONDITIONS

The performance of the rotary ball spline is affected by the operating conditions of the application. The operating conditions should therefore be carefully taken into consideration.

Operating Temperature

Resin retainers are used in the rotary ball spline, so the operating temperature should never exceed 80℃.

Dust Prevention

Foreign particles or dust in the rotary ball spline nut affects the motion accuracy and shortens the life time. Standard seals will perform well for dust prevention under normal operating conditions, however, in a harsh environment it is necessary to attach bellows or protective covers.

APPLICATION EXAMPLES

ball screw

NB SPR

ball screw

NB SPR

NB SPR

air cylinder

rotary actuator

SPR TYPE

part number structure

example **SPR** **25** - **2** - **T1** - **436** / **CU**

- SPR type
- nominal diameter
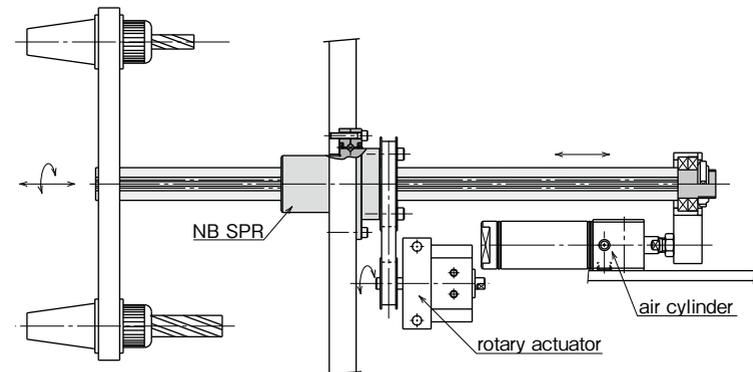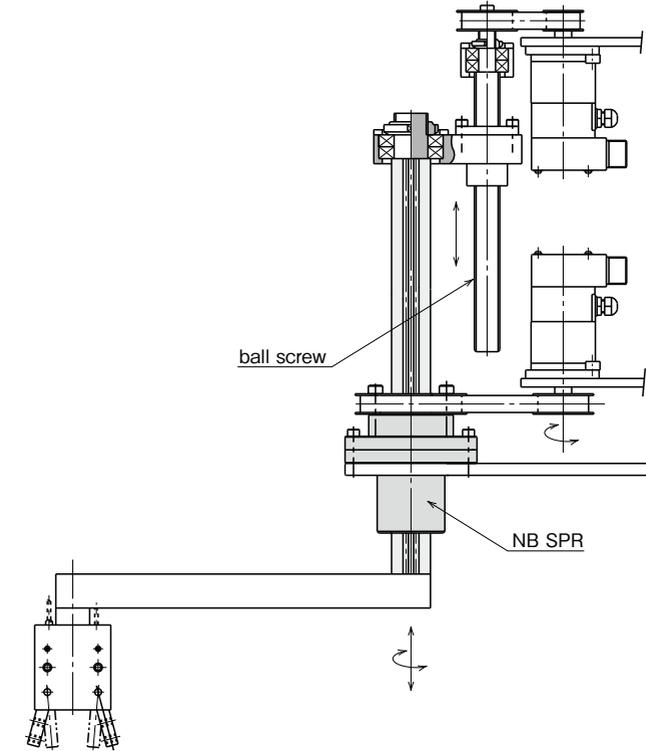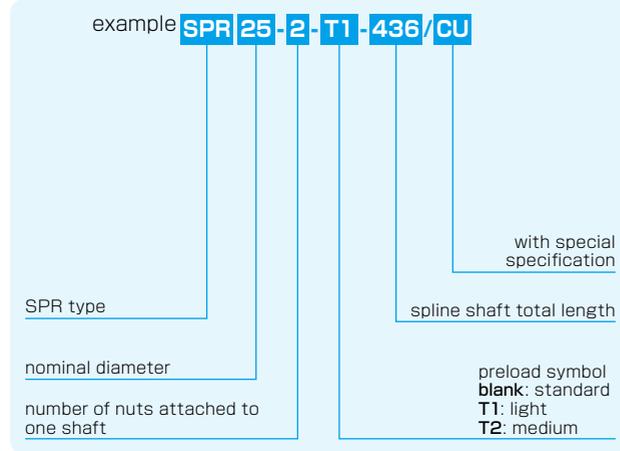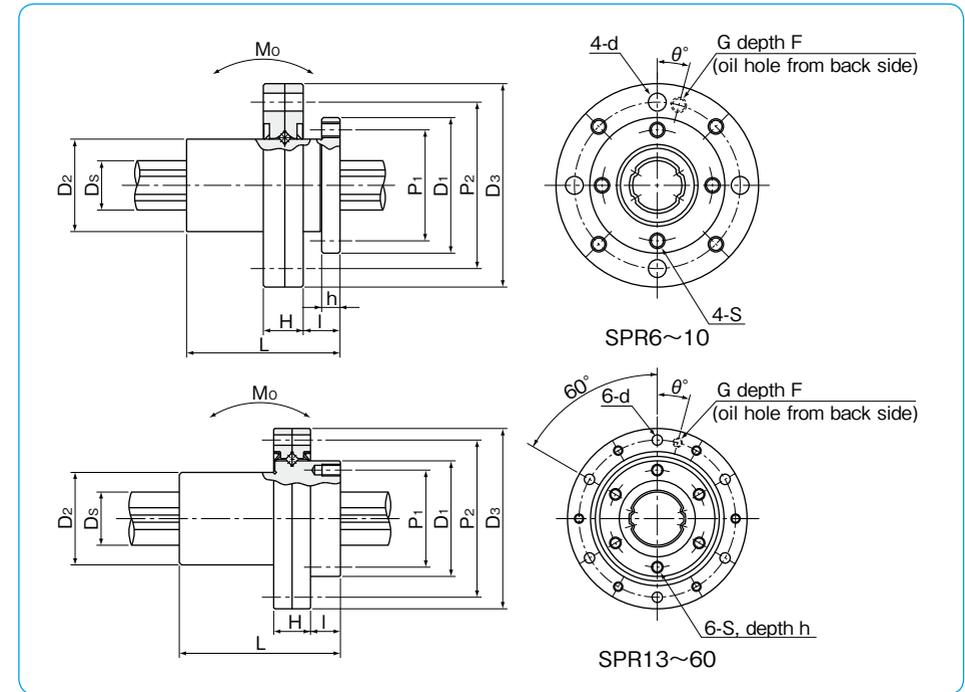- number of nuts attached to one shaft
- preload symbol
  blank: standard
  T1: light
  T2: medium
- spline shaft total length
- with special specification

SPR6~10

SPR13~60

part number	major dimensions D1 mm	D1 tolerance μm	D2 mm	L mm	L tolerance mm	P1 P.C.D. mm	S	h mm	I mm	H mm	D3 mm	D3 tolerance μm	P2 P.C.D. mm	d mm	G	F mm	θ
SPR 6	20		13	25		16	M2	2.5	5	6.5	30	0/-21	24	2.4	M3	2.6	20°
SPR 8	22	0	15	25		18	M2.5	3	6	6.5	33		27	2.9	M3	2.6	20°
SPR10	27	-21	19	33	0	22	M3	4	8	7	40	0/-25	33	3.4	M3	2.8	20°
SPR13	29		24	36	-0.2	24	M3	5	8	9	50		42	3.4	M3	3.6	15°
SPR16	36	0	31	50		30	M4	6	10	11	60		50	4.5	M3	4.4	15°
SPR20A	44		35	63		38	M4	7	12	13	72	0/-30	62	4.5	M6×0.75	5.2	15°
SPR25A	55	-25	42	71		47	M5	8	13	16	82		72	4.5	M6×0.75	6.4	15°
SPR30A	61	0	47	80		52	M6	10	17	17	100	0	86	6.6	M6×0.75	6.8	15°
SPR40A	76	-30	64	100	0	66	M6	10	23	20	120	-35	104	9	M6×0.75	8	15°
SPR50A	92	0	80	125		80	M8	13	24	22	134	0	118	9	M6×0.75	8.8	15°
SPR60A	107	-35	90	140		95	M8	13	25	25	155	-40	137	9	M6×0.75	10	15°
SPR20	40	0	34	60	0/-0.2	34	M4	7	12	13	66	0	56	4.5	M6×0.75	5.2	15°
SPR25	50	-25	40	70		42	M5	8	13	16	78	-30	68	4.5	M6×0.75	6.4	15°
SPR30	61	0	47	80		52	M6	10	17	17	100	0	86	6.6	M6×0.75	6.8	15°
SPR40	76	-30	62	100	0	64	M6	10	23	20	120	-35	104	9	M6×0.75	8	15°
SPR50	88	0	75	112		77	M8	13	24	22	130	0	114	9	M6×0.75	8.8	15°
SPR60	102	-35	90	127	-0.3	90	M8	13	25	25	150	-40	132	9	M6×0.75	10	15°

※Please contact NB for the grease fitting and relubrication method.

spline shaft D_S mm	tolerance μm	rotary ball spline basic torque rating dynamic C_T N·m	static C_{0T} N·m	basic load rating dynamic C kN	static C_0 kN	cross roller bearing basic load rating dynamic C_R kN	static C_{0R} kN	allowable static moment M_0 N·m	second cross-sectional moment of inertia mm^4	cross-sectional coefficient mm^3	mass nut kg	shaft kg/m	※maximum revolutions rpm	size
6	0/-12	1.5	2.4	1.22	2.28	0.6	0.5	5.1	5.9×10	1.97×10	0.04	0.21	2,940	6
8	0	2.1	3.7	1.45	2.87	1.2	1.10	7.4	1.9×10^2	4.76×10	0.05	0.38	2,580	8
10	-15	4.4	8.2	2.73	5.07	2.4	2.45	18.0	4.61×10^2	9.22×10	0.09	0.60	2,060	10
13	0	21	39.2	2.67	4.89	2.9	3.70	13.7	1.38×10^3	2.13×10^2	0.17	1.0	1,350	13
16	-18	60	110	6.12	11.2	5.6	6.70	46	2.98×10^3	3.73×10^2	0.33	1.5	1,080	16
20	0	105	194	8.9	16.3	6.55	8.79	63	7.35×10^3	7.34×10^2	0.57	2.4	890	20A
25	-21	189	346	12.8	23.4	9.63	12.7	171	1.79×10^4	1.43×10^3	0.81	3.7	700	25A
30		307	439	18.6	23.2	11.8	17.1	181	3.66×10^4	2.44×10^3	1.19	5.38	640	30A
40	0	674	934	30.8	37.5	23.0	32.3	358	1.15×10^5	5.75×10^3	2.25	9.55	510	40A
50	-25	1,291	2,955	40.3	64.9	27.8	44.0	690	2.83×10^5	1.13×10^4	3.57	15.0	430	50A
60	0/-30	1,577	2,629	47.7	79.5	29.0	48.8	881	5.91×10^5	1.97×10^4	5.03	21.6	370	60A
18.2	0	83	133	7.84	11.3	5.90	7.35	63	5.05×10^3	5.54×10^2	0.45	2.0	980	20
23	-21	162	239	12.3	16.1	9.11	11.5	104	1.27×10^4	1.11×10^3	0.75	3.1	770	25
28		289	412	18.6	23.2	11.8	17.1	181	2.75×10^4	1.96×10^3	1.25	4.8	640	30
37.4	0	637	882	30.8	37.5	22.8	32.3	358	8.73×10^4	4.67×10^3	2.30	8.6	510	40
47	-25	1,390	3,180	46.1	74.2	27.2	42.1	696	2.16×10^5	9.21×10^3	3.10	13.1	450	50
56.5	0/-30	2,100	4,800	58.0	127.4	26.5	42.6	1,300	4.51×10^5	1.60×10^4	4.70	19	400	60

※Maximum revolutions for grease lubrication.
 Contact NB for further information in case oil lubrication is required.

1kN≒102kgf 1N·m≒0.102kgf·m

STROKE BALL SPLINE

The NB stroke ball spine SPLFS type is a high accuracy linear motion bearing with a limited stroke, to which both radial load and torque can be applied at the same time. It operates with extremely small dynamic friction.

STRUCTURE AND ADVANTAGES

The NB stroke ball spline consists of a nut and a shaft both with raceway grooves. The flanged spline nut consists of an outer cylinder, a retainer, side-rings, and ball elements.
Since the retainer in the nut is equipped with ball pockets, the ball elements do not contact each other, which allows for a smooth linear motion. The stroke is limited since the retainer is a non-circulating type. For normal operation, it is recommended to consider 80% of the maximum stroke shown in the dimension table as an actual stroke length.

Extremely Small Dynamic Friction and Low Noise

The rolling elements are separated by the ball pockets so that they do not contact each other. The stroke length is limited, but extremely small dynamic friction and low noise are realized because the rolling elements do not circulate.

Compact-Size

With the nut about 20% smaller than conventional ball splines, it contributes to space saving.

All Stainless Steel Type

Since all the components are made of stainless steel, this stroke ball spline has an excellent corrosion resistance and heat resistance (operating temperature: −20 to 140℃). It is ideal for clean room or vacuum applications.

Lubrication

A lubricant groove and two lubrication holes are provided on the outer surface of the nut, which allow for an easy designing of lubricant replenishment.
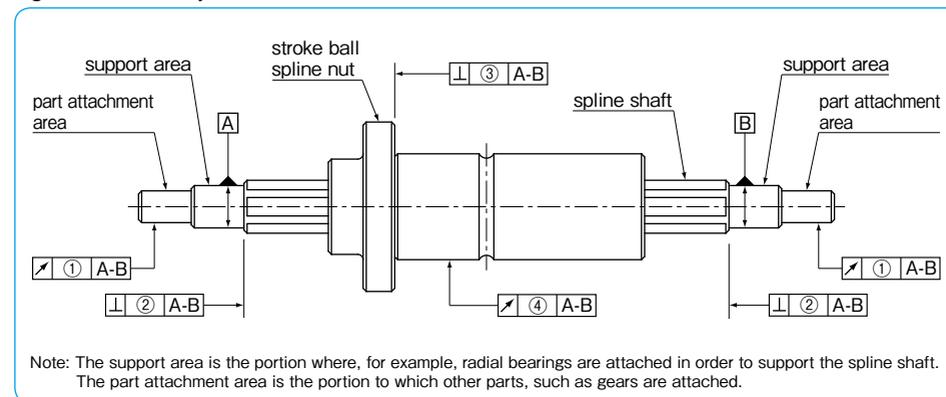
Figure B-25 Structure of SPLFS type
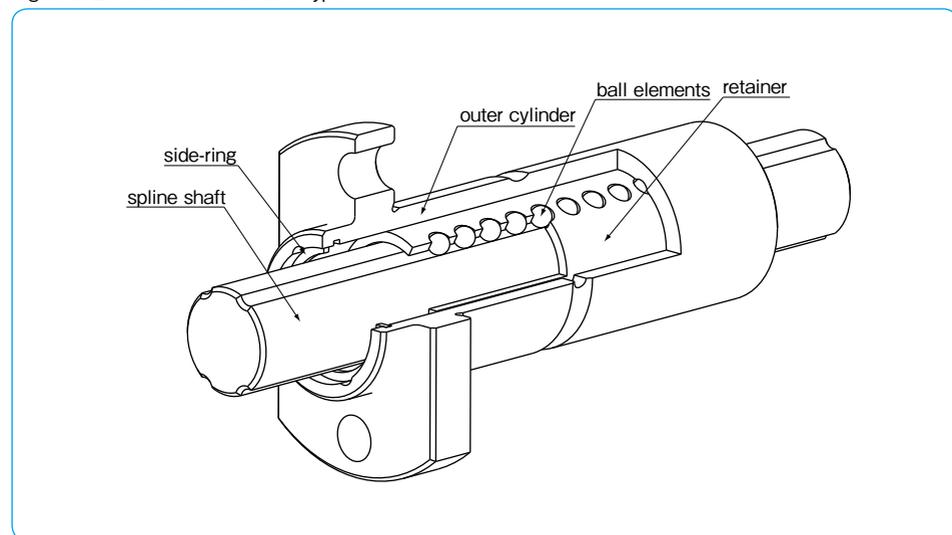
ACCURACY

The accuracy of the NB stroke ball spline is measured at the points shown in Figure B-26.

Figure B-26 Accuracy Measurement Points

Note: The support area is the portion where, for example, radial bearings are attached in order to support the spline shaft. The part attachment area is the portion to which other parts, such as gears are attached.

Tolerance of Spline Shaft Groove Torsion (Max.)

The groove torsion is indicated per 100mm, arbitrarily set as the effective length of the spline section. When the spline length is under 100mm or exceeds 100mm, the value shown in Table B-21 decreases or increases proportionally to the spline length.

Table B-21 Tolerance of Spline Shaft Groove Torsion (Max.)

tolerance
13μm/100mm

Table B-22 Tolerance Relative to Spline Support Area (Max.)　　　　unit／μm

part number	① radial runout of part attachment area	② perpendicularity of the end of the spline shaft section	③ perpendicularity of the flange
SPLFS 6	14	9	11
SPLFS 8	14	9	11
SPLFS10	17	9	13
SPLFS13	19	11	13
SPLFS16	19	11	13

Table B-23 ④Radial Runout of Outer Surface of Spline Nut Relative to Spline Support Area (Max.)   unit／μm

spline shaft total length（mm）		part number		
greater than	or less	SPLFS6、8	SPLFS10	SPLFS13、16
−	200	46	36	34
200	315	89	54	45
315	400	126*	68	53
400	500	163*	82	62
500	630	−	102	75
630	800	−	−	92
800	1,000	−	−	115
1,000	1,250	−	−	153
1,250	1,500	−	−	195

* SPLFS6 maximum shaft length: 400 mm

PRELOAD AND CLEARANCE

Preload and clearance are expressed in terms of clearance in the rotational direction. For the SPLFS type, only the standard preload is available as shown in Table B-24. Please contact NB if a special preload is required.

Table B-24 Preload and Clearance in Rotational
Direction　　　　　　　　　　　　unit／μm

part number	standard
SPLFS 6	−4〜0
SPLFS 8	−4〜0
SPLFS10	−4〜0
SPLFS13	−4〜0
SPLFS16	−4〜0

COMPARISON OF DYNAMIC FRICTIONAL RESISTANCE

Figure B-27　Comparison of Dynamic Friction
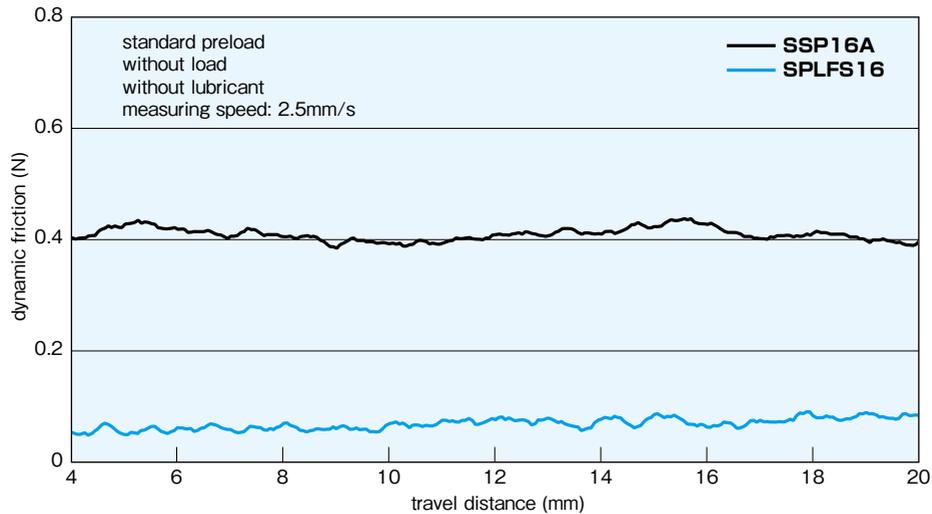
NOTES ON USE

Dust Prevention

Since the stroke ball spline is designed and manufactured for operation with an extremely small dynamic frictional resistance, seals that increase frictional resistance are not equipped as a standard feature. Please contact NB for a special requirement of seals. For use under harsh conditions, the stroke ball spline should be protected using bellows and protective covers.

Retainer Slippage

If the stroke ball spline is used at a high speed or with a vertical shaft, or under an asymmetric load or oscillation, a retainer slippage may occur. For general operation, it is recommended to consider 80% of the maximum stroke length shown in the dimension table as a stroke length.

To prevent the retainer slippage, it is recommended to do a full-stroke movement of the nut whenever necessary in order for the retainer to be relocated to the center.

STROKE BALL SPLINE

SPLFS TYPE
− Two Side Cut Flange Type −

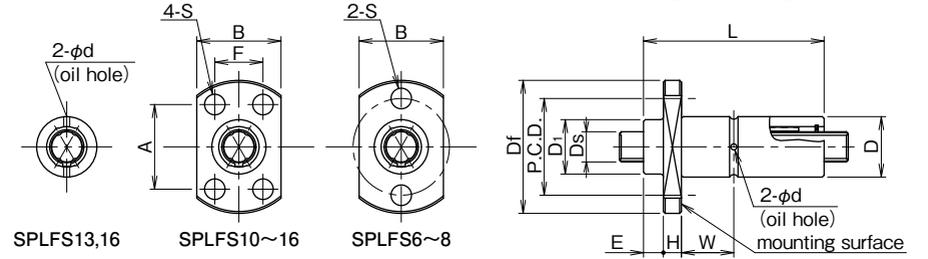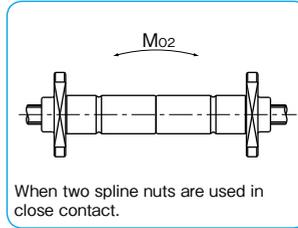### part number structure

example **SPLFS** **16** - **2** - **200** / **CU**

- SPLFS type
- nominal diameter
- number of nuts attached to one shaft
- spline shaft total length
- with special specification

M02

When two spline nuts are used in close contact.

2-φd (oil hole)

4-S

2-S

SPLFS13,16   SPLFS10〜16   SPLFS6〜8

M01

2-φd (oil hole)
mounting surface

major dimensions

part number	maximum stroke	D	D tolerance	D₁	L	L tolerance	E	Df	H	B	P.C.D.	A	F	S	size
	mm	mm	μm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	
SPLFS 6	22	11	0/−8	10	40	0/−0.2	3.3	23	4	14	17	−	−	3.4	**6**
SPLFS 8	20	13	0/−8	12.5	40	0/−0.2	3.3	25.5	4	16	19.5	−	−	3.4	**8**
SPLFS10	28	16	0/−8	15.5	50	0/−0.2	3.3	28.5	5	20	−	18	13	3.4	**10**
SPLFS13	24	20	0/−9	19.5	50	0/−0.2	4.8	36	5	25	−	22	17	3.4	**13**
SPLFS16	26	24	0/−9	23.5	60	0/−0.2	4.8	40	7	29	−	25	19	4.5	**16**

W	d	Ds	Ds tolerance	basic torque rating dynamic C_T	basic torque rating static Co_T	basic load rating dynamic C	basic load rating static Co	allowable static moment M01	allowable static moment M02	second cross-sectional moment of inertia	cross-sectional coefficient	mass nut	mass shaft	size
mm	mm	mm	μm	N·m	N·m	kN	kN	N·m	N·m	mm⁴	mm³	g	kg/m	
12.7	1.2	6	0/−12	2.3	3.8	1.8	3.0	11.2	45	5.9 ×10	1.97×10	21.5	0.21	**6**
12.7	1.2	8	0	3.3	5.5	2.02	3.37	13.1	52	1.9 ×10²	4.76×10	27.0	0.38	**8**
16.7	1.5	10	−15	6.5	10.9	3.21	5.35	25.6	102	4.61×10²	9.22×10	47.7	0.6	**10**
15.2	1.5	13	0	27.6	50.7	4.15	7.6	38.8	155	1.38×10³	2.13×10²	75.3	1.0	**13**
18.2	2.0	16	−18	62.8	115	7.66	14	88.3	353	2.98×10³	3.73×10²	123.5	1.5	**16**

1kN≒102kgf   1N·m≒0.102kgf·m