

ROTARY BALL SPLINE

The NB rotary ball spline can be used for both rotational motion and linear motion. The applications include SCARA robots, 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 either cross rollers for SPR or balls for SPB.

High Accuracy

Ball Splines transfer torque and achieve accurate positioning in the linear direction. By adding the rotating portion, Rotary Ball Splines can achieve accurate positioning in the linear and rotational directions.

Half the Parts, Reduction in Installation Cost

The Spline nut and rotary bearing are combined in order to significantly reduce the number of parts, compared to conventional system. The combination also reduces the housing thickness to a minimum, resulting in light weight and easy installation.

Figure B-27 Structure of SPR type

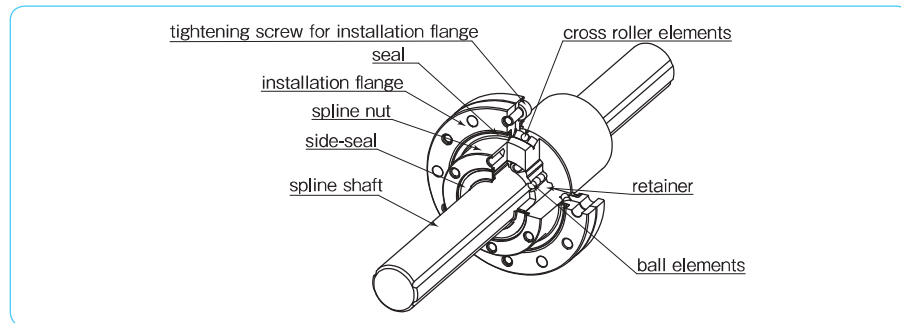
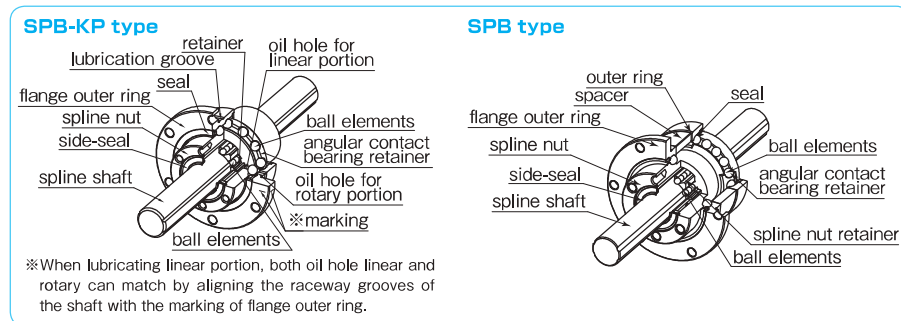


Figure B-28 Structure of SPB-KP type and SPB type



※When lubricating linear portion, both oil hole linear and rotary can match by aligning the raceway grooves of the shaft with the marking of flange outer ring.

Compact and High Rigidity (SPR type)

The cross rollers are directly attached to the ball spline's outer cylinder, resulting in a compact and light design. SPR type has high rigidity despite its compactness. The tool changer is one typical application.

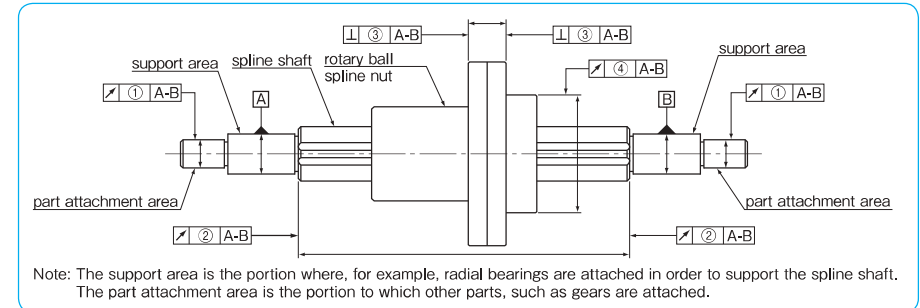
High Rigidity and High Speed (SPB type)

SPB type is a combination of a spline nut and angular contact bearings. The rotary portion is a set of angular contact bearings which are aligned in the back-to-back duplex manner. SPB type can bear radial, axial, and moment loads in a well-balanced way, thus best suited to high speed rotational applications.

ACCURACY OF SPR TYPE

The accuracy of SPR type is measured at the points shown in Figure B-29.

Figure B-29 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 shaft section.

Table B-19 Tolerance of Spline Shaft Groove Torsion (Max.)

tolerance
13 μm/100mm

Table B-20 Tolerance Relative to Spline Support Area (Max.)

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

unit: μm

Table B-21 ④Radial Runout of Outer Surface of Rotary Spline Nut Relative to Spline Support Area (Max.) unit: μm

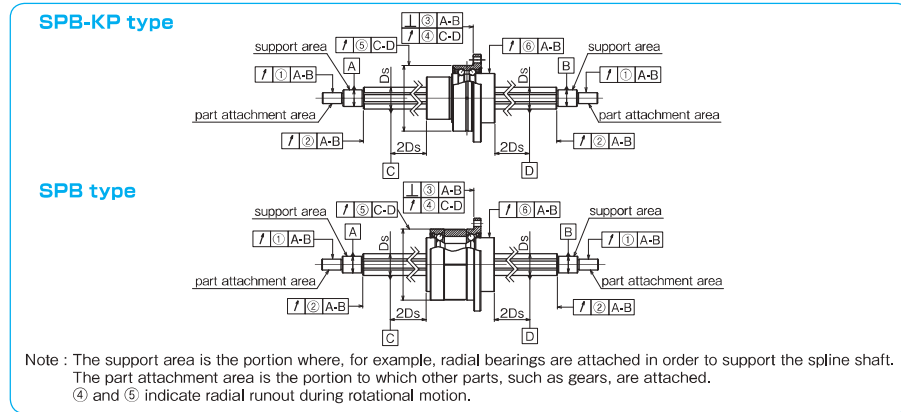
spline shaft total length (mm)	size						
	6, 8	10	13, 16, 20A, 20	25A, 25, 30A, 30	40A, 40, 50A, 50	60A, 60	
—	200	46	36	34	32	32	30
200	315	89	54	45	39	36	34
315	400	126	68	53	44	39	36
400	500	163*	82	62	50	43	38
500	630	—	102	75	57	47	41
630	800	—	—	92	68	54	45
800	1,000	—	—	115	83	63	51
1,000	1,250	—	—	153	102	76	59
1,250	1,600	—	—	256**	210	175	70
1,600	2,000	—	—	394	311	224	179

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

ACCURACY OF SPB TYPE

The accuracy of SPB type is measured at the points shown in Figure B-30.

Figure B-30 Accuracy Measurement Points



Tolerance of Spline Shaft Groove Torsion (Max.)

The groove torsion is indicated per 100mm, arbitrarily set as the effective length of the spline shaft section.

Table B-22 Tolerance of Spline Shaft Groove Torsion (Max.)

accuracy grade	high	precision (P)
tolerance	13 μm/100mm	6 μm/100mm

Table B-23 Tolerance Relative to Spline Support Area (Max.)

unit : μ m

part number	①radial runout of part attachment area		②radial runout of the end of the spline shaft section (when grinding is requested on the drawing)		③perpendicularity of the flange	
	high-grade	precision-grade(P)	high-grade	precision-grade(P)	high-grade	precision-grade(P)
SPB 6KP	14	8	9	6	14	10
SPB 8KP						
SPB10KP						
SPB13KP	19	12	11	8	18	13
SPB16KP,16						
SPB20KP,20						
SPB25KP,25						
SPB25KP,25	22	13	13	9	21	16

Table B-24 Tolerance of Angular Contact Bearing Rotation (Max.) unit : μ m

part number	④runout of flange mounting side		⑤radial runout of outer ring	
	high-grade	precision-grade(P)	high-grade	precision-grade(P)
SPB 6KP	6	6	8	8
SPB 8KP				
SPB10KP				
SPB13KP	8	8	9	9
SPB16KP,16				
SPB20KP,20			10	10
SPB25KP,25				

Table B-25 ⑥Radial Runout of Spline Nut Relative to Spline Support Area(Max.) unit : μ m

spline shaft total length (mm)	size										
	6		8		10		13,16,20		25		
greater than	or less	high-grade	precision-grade(P)	high-grade	precision-grade(P)	high-grade	precision-grade(P)	high-grade	precision-grade(P)	high-grade	precision-grade(P)
—	200	46	26	46	26	36	20	34	18	32	18
200	315	89	57	89	57	54	32	45	25	39	21
315	400	126	—	126	82	68	41	53	31	44	25
400	500	—	—	163	—	82	51	62	38	50	29
500	630	—	—	—	—	102	65	75	46	57	34
630	800	—	—	—	—	—	—	92	58	68	42
800	1,000	—	—	—	—	—	—	115	75	83	52
1,000	1,250	—	—	—	—	—	—	153	97	102	65
1,250	1,600	—	—	—	—	—	—	256	180	210	140
1,600	2,000	—	—	—	—	—	—	394	314	311	241

*SPB16, 13KP, and 16KP shaft maximum length : 1,500mm
 ※Please contact NB for spline shafts exceeding 2,000mm.

PRELOAD AND CLEARANCE

Preload and clearance of linear motion are available with a standard preload(blank), light preload(T1), and medium preload(T2).

Table B-26 Preload and Clearance of SPR Type unit : μ m

	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	-6~+3	-18~-6	-30~-18
	SPR50A			
	SPR60A			
		SPR20	-4~+2	-12~-4
	SPR25			
	SPR30			
	SPR40			
	SPR50			
	SPR60			

Table B-27 Preload and Clearance of SPB-KP and SPB Type (Linear Motion) unit : μ m

part number	standard	light (T1)	medium (T2)
SPB 6KP	0 ~+3	-3 ~ 0	—
SPB 8KP			
SPB10KP			
SPB13KP	-3 ~+1	-8 ~-3	-13 ~ -8
SPB16KP,16			
SPB20KP,20	-4 ~+2	-12 ~-4	-20 ~-12
SPB25KP,25			

Please contact NB for other than preload standards above.

Table B-28 Preload and Operating Conditions

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.

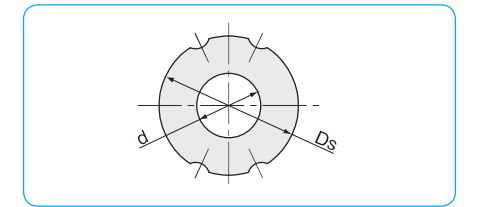
※Frictional resistance may be affected by preload.

HOLLOW SPLINE SHAFT

NB provides hollow shafts. It can be used for running cable, air piping, and weight reduction. Table B-29 shows a list of recommended inner diameter for hollow spline shaft (SUJ2).

Table B-29 Recommended Inner Diameter for Hollow Spline Shaft

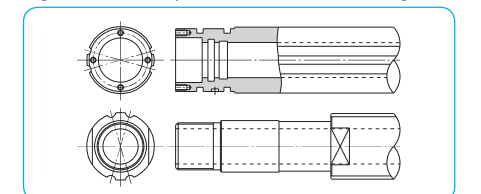
part number	outer diameter D _s mm	inner diameter d mm	second moment of inertia I mm ⁴	cross-sectional coefficient Z mm ³
SPR 6	6	2	58.3	18.9
SPR 8	8	3	186	44.9
SPR10	10	4	448	85.9
SPR13	13	6	1,260	182
SPR16	16	8	2,780	323
SPR20A	20	10	6,860	637
SPR25A	25	15	15,400	1,100



SPECIAL REQUIREMENTS

NB provides customization such as shaft-end machining, spline nut machining, and surface treatment per customer requests. Please contact NB for the inner diameter of SPR20~SPR60.

Figure B-31 Examples of Shaft-end Machining



MOUNTING

The flange attachment screws of SPR type 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. The spacer of SPB type is properly adjusted to produce the best preload condition. Shock loading to the spacer should be avoided as this can change the preload condition and deteriorate the accuracy. Please fix the mounting screws diagonally. The recommended torque values for medium-hardness steel screws are listed in Table B-30.

Table B-30 Recommended Torque unit : N·m

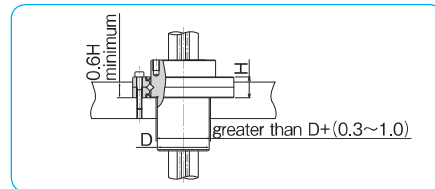
mounting screw	M2	M2.5	M3	M4	M5	M6	M8
recommended torque	0.4	0.9	1.4	3.2	6.6	11.2	27.6

(for alloy steel screw)

SPR Type

When the flange of SPR type is to be used with a faucet joint (as shown in Figure B-32) 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.

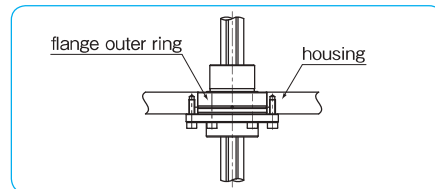
Figure B-32 SPR type Mounting Method



SPB-KP Type

The housing bore for the SPB-KP type should be matched to a tolerance of H7 and keep enough depth (as shown in Figure B-33) so that the outer ring is inside the housing.

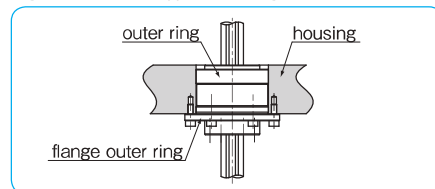
Figure B-33 SPB-KP type Mounting Method



SPB Type

The housing bore for the SPB type should be machined to a tolerance of H7 and contain enough depth so that the outer ring is inside the housing. If not, the outer ring may fall off.

Figure B-34 SPB type Mounting Method



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 seal lip of the nut. Then, carefully insert the spline shaft through the spline nut.

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-40) However, an oil lubricant is recommended for high-speed applications. A grease fitting or machining oil holes is optional (Figure B-35-38), please contact NB for details.

SPR Type

A grease fitting for rotational portion and machining oil hole for spline portion are optional.

Figure B-35 Example of Installed Grease Fitting

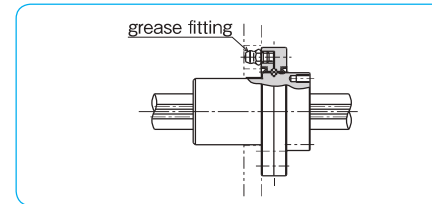
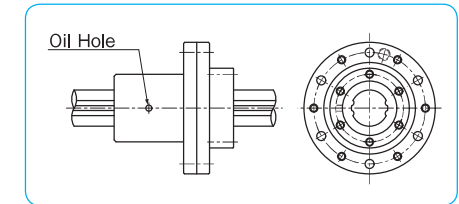


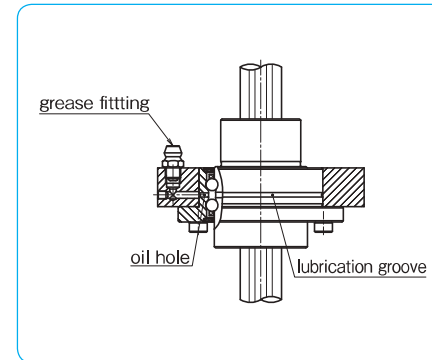
Figure B-36 SPR type Oil Hole



SPB-KP Type

Lubrication is done through oil hole on the outer ring. It is applied the spline portion and the cross roller portion simultaneously.

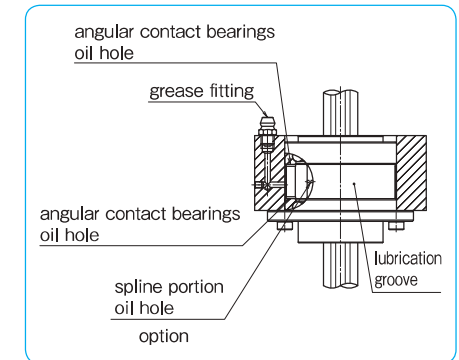
Figure B-37 SPB-KP type Oil Hole



SPB Type

Rotational portion has an oil hole as a standard. For lubrication, it is recommended to mount a grease fitting or oil hole to housing. Machining oil hole for spline portion is available. Please contact NB.

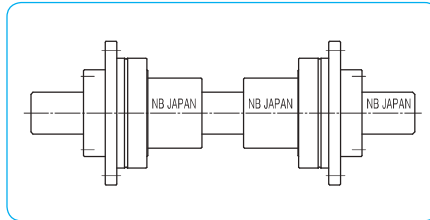
Figure B-38 SPB type Oil Hole



NUT ORIENTATION

Unless otherwise specified, the orientation of two nuts SPR, SPB-KP and SPB type is shown in Figure B-39. In other cases please specify the orientation of nut(s) with shaft.

Figure B-39 Nut Orientation and NB mark



OPERATING CONDITIONS

A Set of Spline Nut and Spline Shaft

The ball spline's accuracy and preload is guaranteed when spline nut and shaft are aligned as shown in Figure B-40. Please make sure to align the NB marks when reinserting the shaft.

At this time, both NB marks on the nut and shaft should be aligned in the same direction as when delivered.

When inserting the spline shaft into the spline nut, ensure that the ball elements do not drop out. This is done by aligning the reaway 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. In case that the nut is preloaded, please exercise additional care. And also, do not disassemble the spline nut.

SPR Type

Please do not loosen the fastening screws for installation flange. The fastening screws are properly adjusted. Please handle with great care, the accuracy is affected if an excessive impact is applied.

SPB Type

Please do not adjust the spacer. The spacer is adjusted to provide a proper spacing for the best preload condition. Please handle with great care, the accuracy is affected if the spacer is slipped by an impact, etc..

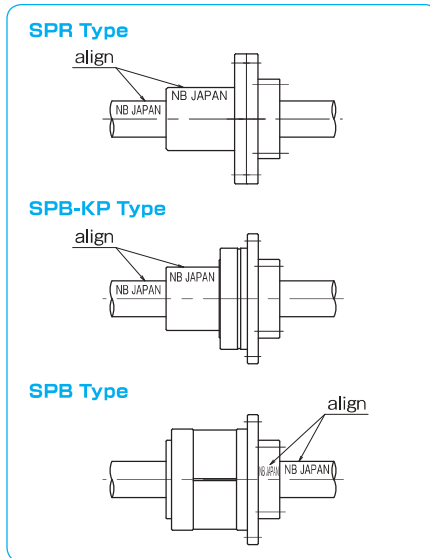
Operating Temperature

Resin retainers are used in the rotary ball spline, since the operating temperature should never exceed 80°C.

Dust Prevention

Foreign particles or dust in the rotary ball spline nut affect the motion accuracy and shorten the lifetime. 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.

Figure B-40 NB mark Alignment



APPLICATION EXAMPLES

