BALL SPLINE
ROTARY BALL SPLINE
STROKE BALL SPLINE
BALL SCREW SPLINE

BALL SPLINE

The NB ball spline is a linear motion mechanism utilizing the rolling motion of ball elements that can sustain loads and transfer torque simultaneously. 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), and flange types (SSPF/SSPT). 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 obtain 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 easily machined 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.

LIGHT WEIGHT and COMPACTNESS

The NB ball spline SSP-AM type has a smaller spline-nut diameter compared to the conventional SSP type nut on the same shaft diameter. The SSP-AM type is best suited for the chip-mounter head device and the multiaxial applications. Anti-corrosion type is also available.
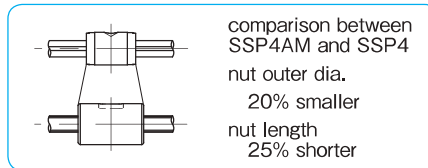
comparison between SSP4AM and SSP4
nut outer dia.
20% smaller
nut length
25% shorter

Figure B-1 Basic Structure of NB Ball Spline

outer cylinder
side ring with side-seal
spline shaft
retainer
ball elements

SSP Type

return cap
seal ring
spline shaft
outer cylinder
steel ball

SSP-AM Type
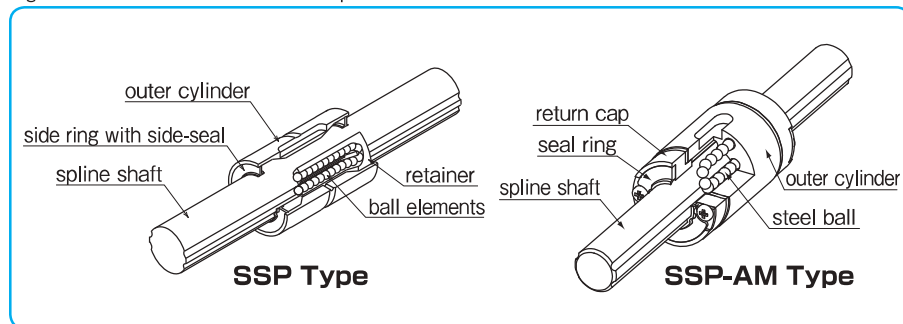
TYPES

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-18
	SSP-AM SSPS-AM	• light and compact nut • countersink for fixing (SSP4AM) • with special key • nominal diameter: 4-10	P.B-20
	SSPM	• cylindrical spline nut without key groove • with two lock plates for fixing • nominal diameter: 6-10	P.B-22
flange type	SSPF SSPFS	• spline nut with flange • nominal diameter: SSPF6-60 : SSPFS6-25	P.B-24
	SSPT	• spline nut with a two side cut flange • nominal diameter: 6-10	P.B-26
	SSPT-AM SSPK-AM SSPTS-AM SSPKS-AM	• light and compact nut with flange • nominal diameter: 4-10	P.B-28

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
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-31)

ACCURACY

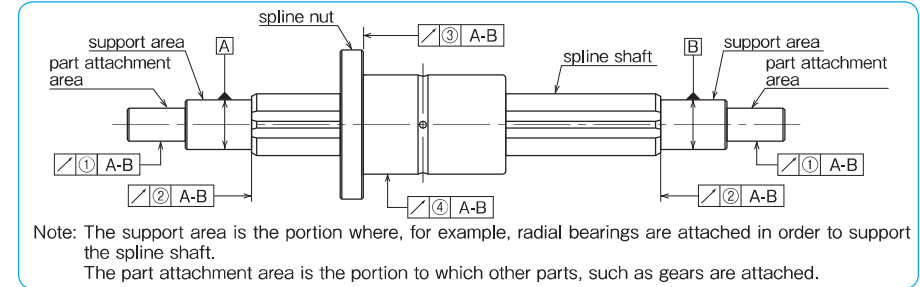The NB ball spline is measured for accuracy at the points shown in Figure B-2 and categorized as either high-grade (blank) or precision-grade (P). Contact NB for accuracy information on the commercial type ball spline.

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.

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-3
Tolerance of Spline Shaft Groove Torsion (Max.)

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

Table B-4 Tolerance Relative to Spline Support Area (Max.)　　　　　　　　unit：μm

part number	radial runout of part attachment area ①		radial runout of the end of the spline shaft section ② (when grinding is requested on the drawing)		radial runout of the flange ③	
	high-grade	precision-grade	high-grade	precision-grade	high-grade	precision-grade
SSP 4·4AM	14	8	9	6	—	—
SSP 5AM	14	8	9	6	—	—
SSP 6·6AM	14	8	9	6	11	8
SSP 8·8AM	14	8	9	6	11	8
SSP 10·10AM	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 80A	29	17	19	13	—	—
SSP 80AL	29	17	19	13	—	—
SSP100A	34	20	22	15	—	—
SSP100AL	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)		size																
		SSP4 SSP4AM		SSP5AM SSP6 SSP6AM		SSP8 SSP8AM		SSP10 SSP10AM		SSP13A SSP16A SSP20A·20		SSP25A·25 SSP30A·30		SSP40A·40 SSP50A·50		SSP60A·60 SSP80A SSP80AL		SSP100A SSP100AL	
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	high-grade	precision grade	high-grade	precision grade
—	200	46	26	46	26	46	26	36	20	34	18	32	18	32	16	30	16	30	16
200	315	89	—	89	57	89	57	54	32	45	25	39	21	36	19	34	17	32	17
315	400	—	—	126	—	126	82	68	41	53	31	44	25	39	21	36	19	34	17
400	500	—	—	—	—	163	—	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	—	—	—	—	—	—	—	—	256*	180*	210	140	175	105	70	43	55	33
1,600	2,000	—	—	—	—	—	—	—	—	394	314	311	241	224	154	179	109	65	40

★ 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 · 4AM			
SSP 5AM			
SSP 6 · 6AM	0～+3	−3～0	—
SSP 8 · 8AM			
SSP 10 · 10AM			
SSP 13A	−3～+1	−8～−3	−13～−8
SSP 16A			
SSP 20A · 20			
SSP 25A · 25	−4～+2	−12～−4	−20～−12
SSP 30A · 30			
SSP 40A · 40			
SSP 50A · 50			
SSP 60A · 60	−6～+3	−18～−6	−30～−18
SSP 80A			
SSP 80AL			
SSP100A	−8～+4	−24～−8	−40～−24
SSP100AL			

Table B-7 Preload and Operating Condition

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.

※Since the contrary relation of preload and dynamic frictional resistance, dynamic frictional resistance will increase when applying preload.

STRENGTH OF SPLINE SHAFT

The ball spline has larger load ratings compared to ball bush. Also, the ball spline can sustain radial load, moment (bending moment) and torque (twisting moment) at the same time. Thus, it is necessary to consider the strength of ball spline shaft.

Using the following equations, select the size of ball spline.

$$\sigma \geqq \frac{M}{Z} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

σ: permissible bending stress of spline shaft (98N/mm²)
M: bending moment onto spline shaft (N·mm)
Z: modulus of section (mm³)
(refer to Table B-8 on page B-8)

Twisting Moment Only

$$\tau_a \geqq \frac{T}{Z_P} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

Ta: permissible twisting stress of spline shaft (49N/mm²)
T: twisting moment onto spline shaft (N·mm)
Zp: polar modulus of section (mm³)
(refer to Table B-8 on page B-8)

Bending Moment and Twisting Moment Combined

Calculate equivalent bending moment (Me) by using equation (3). Then, substitute Me into equation (1) for shaft size selection.

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

Me: equivalent bending moment (N·mm)
M: bending moment onto spline shaft
T: twisting moment onto spline shaft

Rigidity of Spline Shaft

The rigidity of spline shaft is expressed in the torsional angle (θ) caused by twisting moment. For high accuracy smooth motion, it is necessary to keep the torsional angle within 0.25° per 1,000mm.

$$\theta = \frac{T \cdot L}{G \cdot I_P} \cdot \frac{360}{2\pi} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots (4)$$

$$\text{Rigidity} = 0.25° \geqq \frac{1,000}{L}\theta \quad \cdots\cdots\cdots\cdots (5)$$

θ: torsional angle (°)
T: twisting moment onto spline shaft (N·mm)
L: spline shaft length (mm)
G: shearing modulus (SUJ2) 7.9×10⁴ (N/mm²)
　　　　　　　　　　(SUS) 7.69×10⁴ (N/mm²)
Ip: polar moment of inertia of area (mm⁴)
(refer to Table B-8 on page B-8)
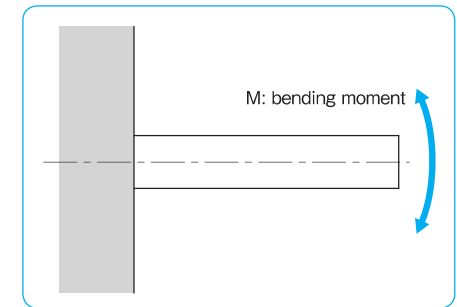
Figure B-3 Bending Moment

M: bending moment
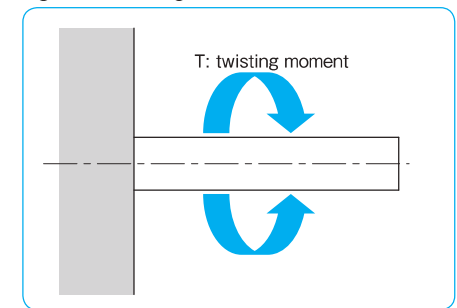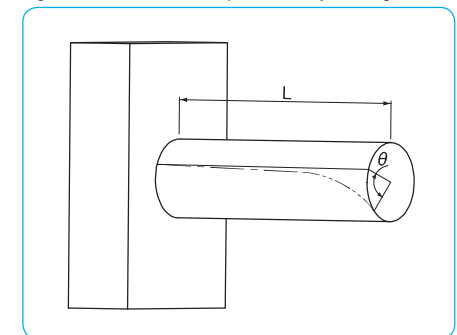
Figure B-4 Twisting Moment

T: twisting moment

Figure B-5 Deformation of Spline Shaft by Twisting Moment

BALL SPLINE

Table B-8 Cross-sectional Characteristics of Spline Shaft

part number	I moment of inertia of area mm^4	Z modulus of section mm^3	I$_P$ polar moment of inertia of area mm^4	Z$_P$ polar modulus of section mm^3	C=1/48EI SUJ2 1/N·mm^2	C=1/48EI SUS440C 1/N·mm^2
SSP 4	1.18×10	5.90	2.41×10	1.20×10	8.57×10^{-9}	8.83×10^{-9}
SSP 6	5.91×10	1.97×10	1.21×10^2	4.04×10	1.71×10^{-9}	1.76×10^{-9}
SSP 8	1.90×10^2	4.76×10	3.88×10^2	9.69×10	5.32×10^{-10}	5.47×10^{-10}
SSP 10	4.61×10^2	9.22×10	9.42×10^2	1.88×10^2	2.19×10^{-10}	2.26×10^{-10}
SSP 13A	1.32×10^3	2.03×10^2	2.70×10^3	4.16×10^2	7.66×10^{-11}	7.89×10^{-11}
SSP 16A	2.98×10^3	3.73×10^2	6.15×10^3	7.68×10^2	3.39×10^{-11}	3.49×10^{-11}
SSP 20A	7.35×10^3	7.35×10^2	1.51×10^4	1.51×10^3	1.38×10^{-11}	1.42×10^{-11}
SSP 25A	1.79×10^4	1.43×10^3	3.68×10^4	2.94×10^3	5.65×10^{-12}	5.82×10^{-12}
SSP 30A	3.63×10^4	2.42×10^3	7.57×10^4	5.05×10^3	2.79×10^{-12}	—
SSP 40A	1.15×10^5	5.73×10^3	2.39×10^5	1.20×10^4	8.83×10^{-13}	—
SSP 50A	2.81×10^5	1.12×10^4	5.86×10^5	2.34×10^4	3.60×10^{-13}	—
SSP 60A	5.91×10^5	1.97×10^4	1.22×10^6	4.08×10^4	1.71×10^{-13}	—
SSP 80A / SSP 80AL	1.93×10^6	4.83×10^4	3.92×10^6	9.81×10^4	5.24×10^{-14}	—
SSP100A / SSP100AL	4.69×10^6	9.38×10^4	9.55×10^6	1.91×10^5	2.16×10^{-14}	—
SSP 20	5.03×10^3	5.53×10^2	1.04×10^4	1.14×10^3	2.01×10^{-11}	2.07×10^{-11}
SSP 25	1.27×10^4	1.10×10^3	2.63×10^4	2.29×10^3	7.97×10^{-12}	8.21×10^{-12}
SSP 30	2.74×10^4	1.96×10^3	5.73×10^4	4.10×10^3	3.69×10^{-12}	—
SSP 40	8.71×10^4	4.66×10^3	1.82×10^5	9.75×10^3	1.16×10^{-12}	—
SSP 50	2.16×10^5	9.19×10^3	4.53×10^5	1.93×10^4	4.69×10^{-13}	—
SSP 60	4.50×10^5	1.59×10^4	9.46×10^5	3.35×10^4	2.25×10^{-13}	—
SSP 4AM	1.18×10	6.01	2.44×10	1.23×10	8.56×10^{-9}	8.82×10^{-9}
SSP 5AM	2.77×10	1.11×10	5.77×10	2.31×10	3.65×10^{-9}	3.76×10^{-9}
SSP 6AM	5.89×10^2	1.96×10	1.22×10^2	4.05×10	1.72×10^{-9}	1.77×10^{-9}
SSP 8AM	1.88×10^2	4.71×10	3.86×10^2	9.66×10	5.37×10^{-10}	5.53×10^{-10}
SSP 10AM	4.53×10^2	9.06×10	9.35×10^2	1.87×10^2	2.23×10^{-10}	2.30×10^{-10}

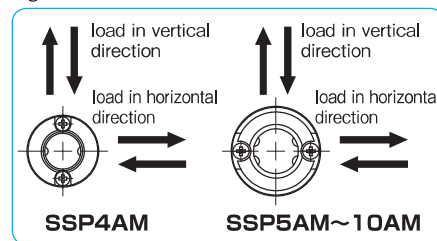## LOAD RATING

The load rating for SSP-AM type depends on the direction of load.

Table B-9　LOAD RATING

		SSP4AM	SSP5AM~10AM
basic dynamic load rating	vertical	C	C
	horizontal	$1.73\times C$	$1.22\times C$
basic static load rating	vertical	C$_0$	C$_0$
	horizontal	$1.73\times C_0$	$1.22\times C_0$

Figure B-6　Load Direction

load in vertical direction　load in horizontal direction

load in vertical direction　load in horizontal direction

SSP4AM　SSP5AM~10AM

CALCULATION OF DEFLECTION AND DEFLECTION ANGLE OF SPLINE SHAFT

The following formulas are used to obtain the deflection and its angle of the ball spline shaft. Typical conditions are listed in Table B-10.

Table B-10 Formulas for Calculating Deflection and Deflection Angle

support method	specification	formula for deflection	formula for deflection angle
1 support / support		$\delta_{max}=\dfrac{P\ell^3}{48EI}=P\ell^3C$	$i_1=0$ $i_2=\dfrac{P\ell^2}{16EI}=3P\ell^2C$
2 fixed / fixed		$\delta_{max}=\dfrac{P\ell^3}{192EI}=\dfrac{1}{4}P\ell^3C$	$i_1=0$ $i_2=0$
3 support / support	uniformly distributed load p	$\delta_{max}=\dfrac{5p\ell^4}{384EI}=\dfrac{5}{8}p\ell^4C$	$i_2=\dfrac{p\ell^3}{24EI}=2p\ell^3C$
4 fixed / fixed	uniformly distributed load p	$\delta_{max}=\dfrac{p\ell^4}{384EI}=\dfrac{1}{8}p\ell^4C$	$i_2=0$
5 support / support	a b a	$\delta_1=\dfrac{Pa^3}{6EI}\left(2+\dfrac{3b}{a}\right)=8Pa^3\left(2+\dfrac{3b}{a}\right)C$ $\delta_{max}=\dfrac{Pa^3}{24EI}\left(\dfrac{3\ell^2}{a^2}-4\right)=2Pa^3\left(\dfrac{3\ell^2}{a^2}-4\right)C$	$i_1=\dfrac{Pab}{2EI}=24PabC$ $i_2=\dfrac{Pa(a+b)}{2EI}=24Pa(a+b)C$
6 fixed / fixed	a b a	$\delta_1=\dfrac{Pa^3}{6EI}\left(2-\dfrac{3a}{\ell}\right)=8Pa^3\left(2-\dfrac{3a}{\ell}\right)C$ $\delta_{max}=\dfrac{Pa^3}{24EI}\left(2+\dfrac{3b}{a}\right)=2Pa^3\left(2+\dfrac{3b}{a}\right)C$	$i_1=\dfrac{Pa^2b}{2EI\ell}=\dfrac{24Pa^2bC}{\ell}$ $i_2=0$
7 fixed / free		$\delta_{max}=\dfrac{P\ell^3}{3EI}=16P\ell^3C$	$i_1=\dfrac{P\ell^2}{2EI}=24P\ell^2C$ $i_2=0$
8 fixed / free	uniformly distributed load p	$\delta_{max}=\dfrac{p\ell^4}{8EI}=6p\ell^4C$	$i_1=\dfrac{p\ell^3}{6EI}=8p\ell^3C$ $i_2=0$
9 support / support	Mo	$\delta_{max}=\dfrac{\sqrt{3}Mo\ell^2}{216EI}=\dfrac{2\sqrt{3}}{9}Mo\ell^2C$	$i_1=\dfrac{Mo\ell}{12EI}=4Mo\ell C$ $i_2=\dfrac{Mo\ell}{24EI}=2Mo\ell C$
10 fixed / fixed	Mo	$\delta_{max}=\dfrac{Mo\ell^2}{216EI}=\dfrac{2}{9}Mo\ell^2C$	$i_1=\dfrac{Mo\ell}{16EI}=3Mo\ell C$ $i_2=0$

δ_1: deflection at the concentrated load point (mm) δ_{max}: maximum deflection (mm) i_1: deflection angle at the concentrated load point (rad) i_2: deflection angle at the support point (rad) Mo: moment (N·mm) P: concentrated load (N) p: uniformly distributed load (N/mm) a,b: concentrated load point distance (mm) ℓ: span (mm) I: moment of inertia of area (mm^4) (refer to Table B-8 on page B-8) E: modulus of longitudinal elasticity (SUJ2) 2.06×10^5 (N/mm^2) (SUS) 2.0×10^5 (N/mm^2) C: 1/48EI (1/N·mm^2)

ALLOWABLE ROTATIONAL SPEED OF SPLINE SHAFT

When the rotational speed is increased and approaches the spline shaft resonant frequency, the spline shaft is disabled from further operation. This speed is called the critical speed and can be obtained by the following equations. In order to leave a sufficient safety margin, the allowable operating speed should be set at about 80% of the calculated value.

Using the following equations, select the size of ball spline shaft. First, calculate I_d and A by equation (8) and (9) then, substitute the values into equation (7).

$$N_C = 60 \cdot \frac{\lambda^2}{2\pi \cdot L^2} \cdot \sqrt{\frac{E \cdot I_d \times 10^3}{\gamma \cdot A}} \quad \cdots\cdots\cdots (7)$$

Nc: critical speed (rpm)
L: support distance (mm)
E: modulus of longitudinal elasticity (SUJ2)2.06×10^5 (N/mm²)
　　　　　　　　　　　　　　　(SUS)2.0×10^5 (N/mm²)
γ: density (SUJ2)7.85×10^{-6} (kg/mm³)
　　　　　(SUS)7.75×10^{-6} (kg/mm³)

I_d: Minimum Moment of Inertia of Area (mm⁴)

$$I_d = \frac{\pi \cdot d^4}{64} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots (8)$$

d: maximum machined-down diameter with no spline grooves left (refer to Table B-11)

A: Minimum Cross-sectional Area of the Spline Shaft (mm²)

$$A = \frac{\pi \cdot d^2}{4} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots (9)$$

d: maximum machined-down diameter with no spline grooves left (refer to Table B-11)

λ: coefficient of mounting method
　(refer to Figure B-7)
fixed-free $\lambda = 1.875$
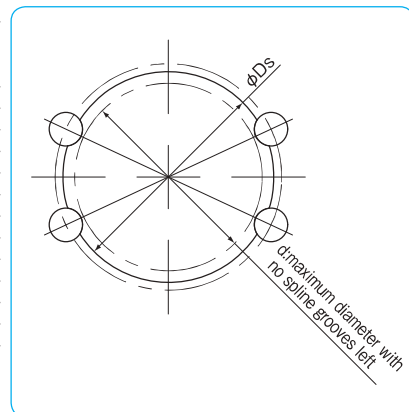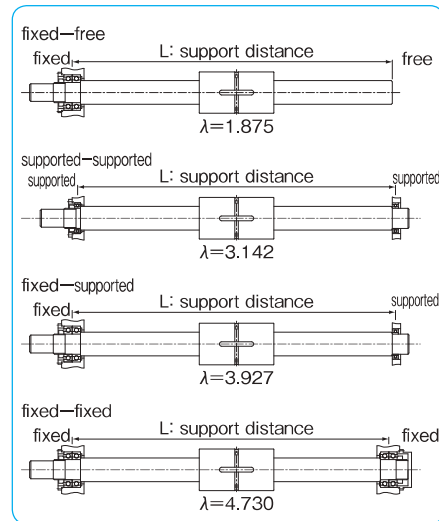supported-supported $\lambda = 3.142$
fixed-supported $\lambda = 3.927$
fixed-fixed $\lambda = 4.730$

Figure B-7 Mounting Method

fixed—free
fixed　　　L: support distance　　　free
$\lambda = 1.875$

supported—supported
supported　　L: support distance　　supported
$\lambda = 3.142$

fixed—supported
fixed　　　L: support distance　　supported
$\lambda = 3.927$

fixed—fixed
fixed　　　L: support distance　　fixed
$\lambda = 4.730$

Table B-11 Spline Shaft Profile

part number	d: maximum diameter with no spline grooves left mm	part number	d: maximum diameter with no spline grooves left mm
SSP 4	3.5	SSP20	16.4
SSP 6	5.3	SSP25	20.6
SSP 8	7.2	SSP30	24.8
SSP 10	9	SSP40	33.1
SSP 13A	11.7	SSP50	41.4
SSP 16A	14.2	SSP60	49.7
SSP 20A	17.9		
SSP 25A	22.4	SSP 4AM	3.4
SSP 30A	26.8	SSP 5AM	4.3
SSP 40A	35.5	SSP 6AM	5.2
SSP 50A	44.6	SSP 8AM	7.1
SSP 60A	54	SSP10AM	8.8
SSP 80A	73.9		
SSP 80AL			
SSP100A	92		
SSP100AL			

The maximum diameter (d) is recommended as the shaft diameter of the support area leaving no spline grooves after end-machining.

φDs

d: maximum diameter with no spline grooves left

RATED LIFE CALCULATION

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)　　fc: contact coefficient　fw: load coefficient
C: basic dynamic load rating (N)　P: applied load (N)
CT: 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.

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

Lh: life time (hr)　ℓ_s: stroke length (m)
L: rated life (km)　n₁: number of cycles per minute (cpm)

Figure B-8 Radial Load and Torque Load

radial load

torque load

moment

MOUNTING

Fit between Spline Nut and Housing

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. Regarding 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. The mounting surface for the flange influences the perpendicularity and parallelism. Please make sure that the accuracy of the mounting surface is correct.

Insertion of Spline Nut

When inserting a spline nut into the housing, use a jig like the one shown in Figure B-9. Carefully insert the nut so as to not hit the side ring and seal.

Table B-12 Fit for the Spline Nut

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

Figure B-9 Insertion of Spline Nut into Housing

φD

jig

φd

Table B-13 Recommended Jig Dimensions　unit：mm

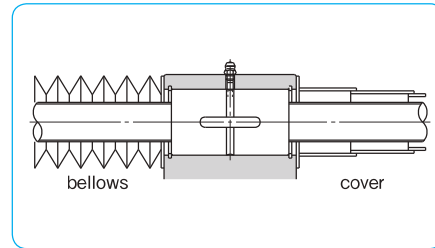| part number	D	d	part number	D	d
SSP 4	9.5	3.5	SSP20	31.5	16.5
SSP 6	13.5	5	SSP25	36.5	20.5
SSP 8	15.5	7	SSP30	44.5	25
SSP 10	20.5	8.5	SSP40	59.5	33
SSP 13A	23.5	12	SSP50	74	41
SSP 16A	30.5	14.5	SSP60	89	50
SSP 20A	34.5	18			
SSP 25A	41.5	22.5	SSP 4AM	7.5	3
SSP 30A	46.5	27	SSP 5AM	9.5	4
SSP 40A	63.5	35.6	SSP 6AM	11.5	5
SSP 50A	79	44	SSP 8AM	14.5	7
SSP 60A	89	53.5	SSP10AM	18.5	8.5
SSP 80A	119	74			
SSP 80AL					
SSP100A	149	92			
SSP100AL					

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 against dust prevention under normal operating conditions; however, in a harsh environment, it is necessary to attach bellows or protective covers.
(refer to Figure B-10)

Operating Temperature

Since the retainer is made of resin, the operating temperature should never exceed 80℃.

Figure B-10 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-40)
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-11 Example of Lubrication Mechanism

HOLLOW SPLINE SHAFT

NB provides hollow shafts. It can be used for running cable, air piping, and weight reduction. Table B-12 shows a list of recommended inner diameter for hollow spline shaft (SUJ2).

Table B-14
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	11.5	5.6
SSP 6	6	2	58.3	18.9
SSP 8	8	3	186	44.9
SSP10	10	4	448	85.9
SSP13A	13	6	1,260	182
SSP16A	16	8	2,780	323
SSP20A	20	10	6,860	637
SSP25A	25	15	15,400	1,100
SSP 4AM	4	1.5	11.6	5.7
SSP 5AM	5	2	26.9	10.3
SSP 6AM	6	2	58.1	18.8
SSP 8AM	8	3	184	44.4
SSP10AM	10	4	440	84.2

SPECIAL REQUIREMENTS

Based on customer drawings and requirements NB offers shaft-end machining, spline nut machining, surface treatment, etc. Please contact NB for special requirements.
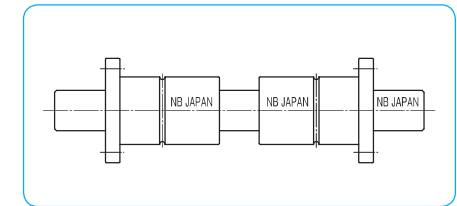
Figure B-12 Example of Shaft-end Machining
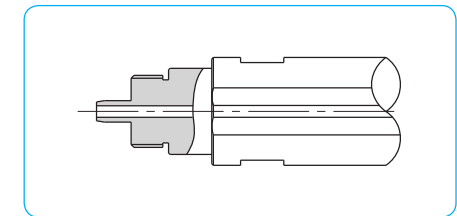
NUT ORIENTATION

Unless otherwise specified, the orientation of two NB ball spline nuts SSPM, SSPF, SSPT and SSPT(K)-AM type is shown in Figure B-13. In other cases please specify the orientation of nut(s) with shaft.

Figure B-13   Nut Orientation and NB mark
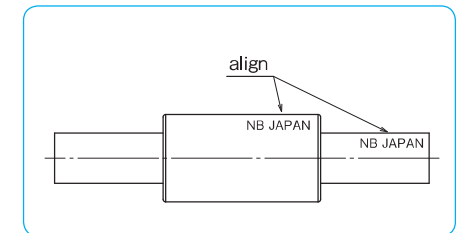

USE AND HANDLING PRECAUTIONS

NB ball spline must be handled with care as it is a precise component. Please note the following points.

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-12. Please make sure to align the NB marks when reinserting the 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. In case that the nut is preloaded, please exercise additional care.
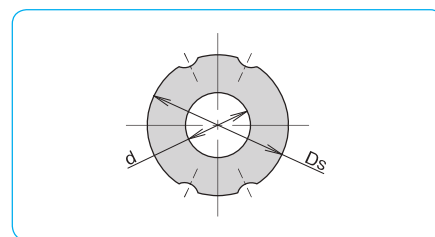
Excessive Moment

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

Figure B-14 NB mark Alignment

align

NB JAPAN   NB JAPAN

MOUNTING

Mounting of SSP Type

Examples of installing the SSP type are shown in Figures B-15 and B-16.
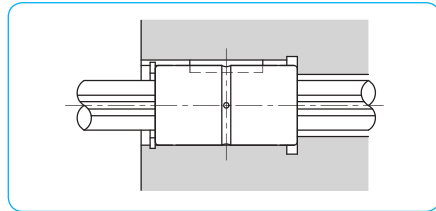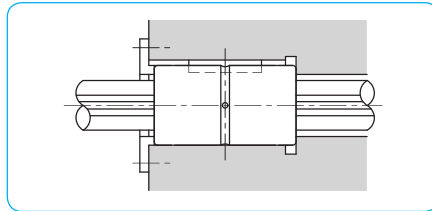
Figure B-15 Using a Retaining Ring

Figure B-16 Using a Push Plate

Key

The SSP and SSP-AM type spline nut come with a key shown in Figure B-17.
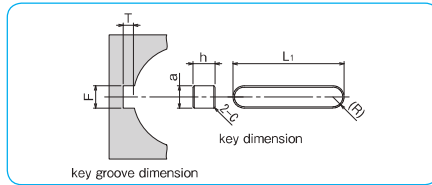
Figure B-17　Key for SSP Type

key dimension

key groove dimension

Table B-15 Major Dimensions of Key and Key Groove

part number	key dimensions						recommended key groove dimensions			
	a		h		L_1	C	F		T	
	mm	tolerance μm	mm	tolerance μm	mm	mm	mm	tolerance μm	mm	tolerance mm
SSP　4	2	+16 + 6	2	0 −25	6	0.2	2	+21 +11	1	+0.1 0
SSP　6	2.5		2.5		10.5		2.5		1.5	
SSP　8	2.5		2.5		10.5		2.5		1.5	
SSP 10	3		3		13		3		1.7	
SSP 13A	3		3		15		3		1.7	
SSP 16A	3.5		3.5		17.5		3.5		1.8	
SSP 20A	4	+24 +12	4	0 −30	29	0.5	4	+30 +18	1.8	
SSP 25A	4		4		36	0.3	4		1.8	
SSP 30A	4		4		42	0.5	4		1.8	
SSP 40A	6		6		52	0.5	6		2.8	
SSP 50A	8	+30/+15	7		58	0.5	8	+37.5/+22.5	3.3	
SSP 60A	12	+36 +18	8	0 −36	67	0.8	12	+45 +27	3.3	+0.2 0
SSP 80A	16		10		76	0.5	16		4.3	
SSP 80AL	16		10		110		16		4.3	
SSP100A	20	+43 +22	13	0 −43	110	0.8	20	+53.5 +32.5	6.4	
SSP100AL	20		13		160		20		6.4	
SSP 20	4	+24 +12	4	0 −30	26	0.2	4	+30 +18	1.8	+0.1 0
SSP 25	5		5		33	0.3	5		2.3	
SSP 30	7	+30 +15	7	0 −36	41	0.3	7	+37.5 +22.5	3.3	+0.2 0
SSP 40	10		8		55	0.5	10		3.8	
SSP 50	15	+36 +18	10		60	0.5	15	+45 +27	5.3	
SSP 60	18		11	0/−43	68	0.5	18		5.4	
SSP 5AM	2	+16 + 6	2	0 −25	6	0.2	2	+21 +11	1	+0.1 0
SSP 6AM	2		2		8		2		1	
SSP 8AM	2.5		2.5		8.5		2.5		1.5	
SSP10AM	3		3		11		3		1.7	

For SSPS and SSP-AM type, the material of key is stainless steel.

Mounting of SSP4AM Type

Example of installing the SSP4AM type are shown in Figure B-18. M2 screw is used for mounting. In process of mounting, please be careful with spline nut.
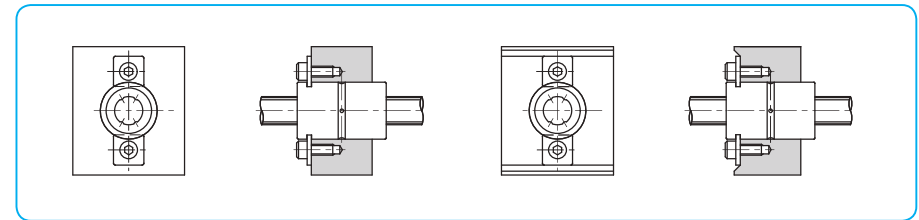
Figure B-18 Mounting of SSP4AM Type
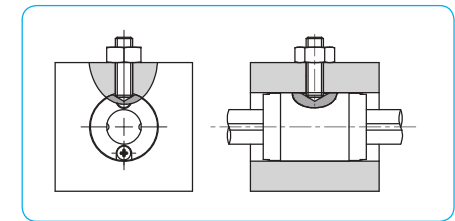
Mounting of SSPM Type

Examples of installing the SSPM type are shown in Figures B-19～24.

Figure B-19 Using F Type Lock Plates

F Type Lock Plate (Standard Plate)

The lock plate shown in Figure B-20 is provided with the SSPM spline nut.
Material: SUS304CSP

Table B-16 F Type Lock Plate

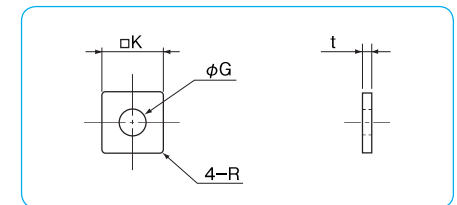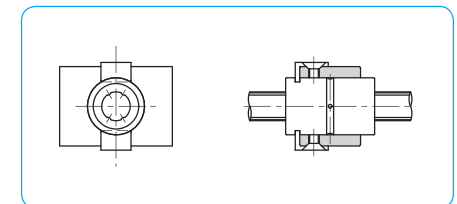| part number	K mm	G mm	t mm	R mm	applicable spline nut
FP 6	6.8	2.9	1.0	0.5	SSPM 6
FP 8	8.5	3.5	1.2	0.5	SSPM 8
FP10	8.5	3.5	1.2	0.5	SSPM10

Figure B-20 F Type Lock Plate

Figure B-21 Using LP Type Lock Plates

BALL SPLINE

LP Type Lock Plate (Optional Plate)

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

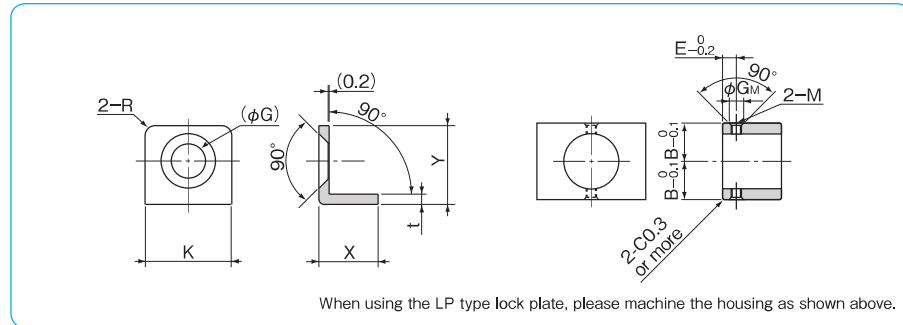### Material: SUS304CSP

Figure B-22 LP Type Lock Plate

When using the LP type lock plate, please machine the housing as shown above.

Table B-17 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

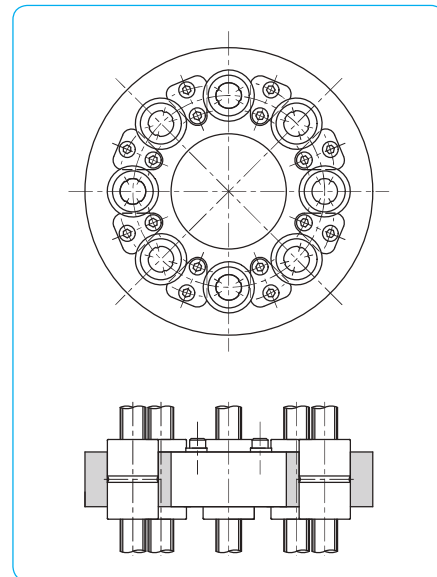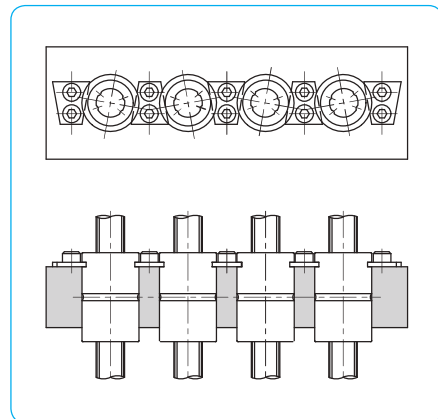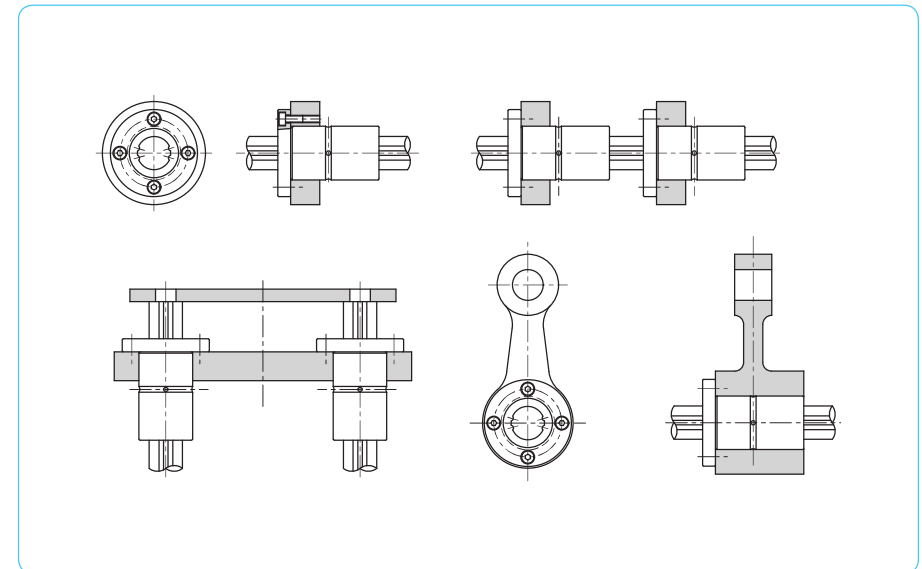Figure B-23 Using Special Lock Plates (1)

Figure B-24 Using Special Lock Plates (2)

Mounting of SSPF Type

Examples of installing the SSPF type are shown in Figure B-25.

Figure B-25 Examples of installing SSPF Type

Mounting of SSPT Type

Examples of installing SSPT type are shown in Figure B-26.

Figure B-26 Examples of installing SSPT Type