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# KEYLESS BALL SPLINE

SSPM Type  
SPA Type  
SPA-W Type

Light-weight miniature sizes, 6, 8, and 10.

**Revolutionary Installation Design !**



NB Corporation of America

No.6510U

# KEYLESS BALL SPLINE

**KEYLESS SPLINE NUT  
BLOCK TYPES**

**SSPM  
SPA and SPA-W**

**Miniature Spline Diameters : 6mm, 8mm, and 10mm.**

**NB** Keyless Ball Spline Type is free from troublesome key slot machining by adapting "Lock-Plate" for Spline Nut installation in housing. This installation method greatly contributes to compact designs, ease of installation, and total system cost savings.

**NB** Keyless Ball Spline will of course carry radial loads and torque at the same time like other Ball Splines while still maintaining highly accurate linear motion.

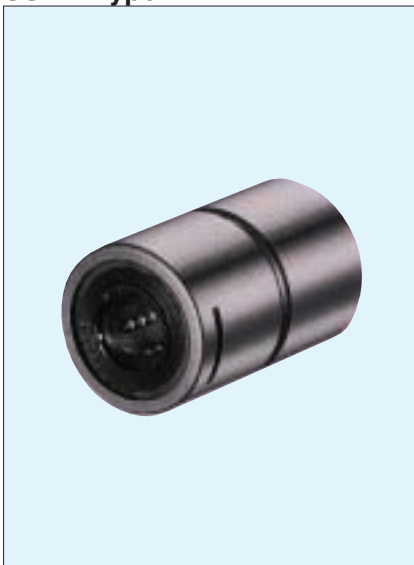
## CONFIGURATIONS AND FEATURES

**NB**'s unique Lock-Plates and Lock-Grooves allow for easy installation of the Keyless Ball Spline to custom housings. For immediate installation, the Block type consists of a highly precision machined housing and factory installed Keyless Spline Nut. For greater moment loads, **NB** also offers the Wide Block type which has two factory installed Keyless Spline Nuts.

**NB** Keyless Ball Spline consists of Nut and Spline Shaft as a set, which has ball groove. Spline Nut has a ball retainer which allows for the Spline Nut to be removed and re-applied to the Spline Shaft without the ball elements falling out. There are four precision ground ball grooves on the Spline Shaft Providing a guarantee of extremely smooth and accurate movement. The feature of optimum angle for ball contacts provide for idealistic preload which enhances the mechanical rigidity by eliminating radial clearance.

## TYPE

**SSPM type**



**SPA type**



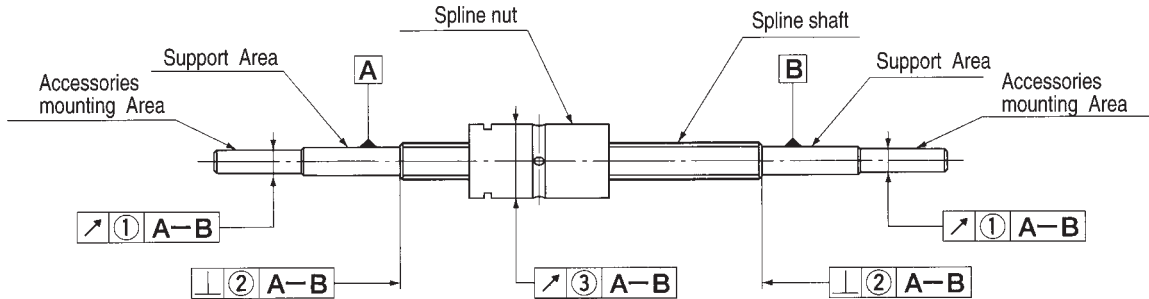
**SPA-W type**





## ACCURACY

Fig.1 Accuracy



### Spline shaft: Allowable groove torsion (maximum)

The groove torsion is indicated for 100mm, arbitrarily set as the effective length of the spline section. When travel rate is under 100mm or exceeds 100mm, the value shown in the table increases or decreases proportionally to travel rate.

Table 1. Spline shaft : Allowable groove torsion

Accuracy class	Allowable torsion um
High class (None)	13
Precision class (P)	6

Table 2. Allowable tolerances of each section against Spline support area.

unit/5 m

Part No.	1 Radial run-out of part mounting section.		2 Perpendicularity of spline and face.	
	High class	Precision class(P)	High class	Precision class(P)
SSPM/SPA 6	14	8	9	6
SSPM/SPA 8	14	8	9	6
SSPM/SPA 10	17	10	9	6

Table 3. Radial run-out of spline nut against support area.

unit/5 m

Total spline shaft length		Part No.					
		SSPM 6		SSPM 8		SSPM 10	
more	less	High class	Precision class(P)	High class	Precision class(P)	High class	Precision class(P)
7	200	46	26	46	28	36	20
200	315	89	57	89	57	54	32
315	400	126	82	126	82	68	41
400	500	7	7	163	108	82	51
500	630	7	7	7	7	102	65

## PRE-LOAD

**NB** Ball Spline can be pre-loaded by selecting slightly larger balls than the space presented between spline shaft groove and nut groove. Where less vibration and less fluctuation of load / torque are present, standard pre-load is desired to ensure smooth linear movement. Where slight twisting load, alternate moment load, and vibration are present, or more precise motion is required, a light pre-load is desired.

Table 4. Clearance at rotating direction

unit/5 m

Part No.	Normal pre-load	Light pre-load
SSPM/SPA 6	3 242 1	3 643 2
SSPM/SPA 8	3 242 1	3 643 2
SSPM/SPA 10	3 342 1	3 943 3



## LIFE

Under normal operating conditions with radial load and/or torque stresses act on both race ways and rolling elements. Over a period of time these stresses cause a condition known as flaking, which is an indicator of material fatigue. Life of Keyless Ball Spline is defined as the total travel distance from time of initial operation until flaking condition is first discovered.

Though the Keyless Ball Spline of same part number and manufactured under same conditions, when compared the life may vary even under similar operating conditions. To determine a consistent life criteria, the concept of rated life (L) is defined for calculation purpose. This rated life (L) is defined by travel distance, which 90% of Keyless Ball Spline had achieved without flaking, when sufficient number of Keyless Ball Splines had been operated under same condition.

Basic dynamic load rating (C) and basic dynamic torque rating (C<sub>T</sub>) as stated in the dimension table reflect the basic load in radial direction and the basic torque in rotating direction to achieve a rated life of 50 x 10<sup>3</sup> meter.

Life rating can be obtained by the following formulas:

$$\text{In a case of radial load} \quad L = \left( \frac{f_C}{f_W} \cdot \frac{C}{P} \right)^3 \cdot 50$$

$$\text{In a case of torque load} \quad L = \left( \frac{f_C}{f_W} \cdot \frac{C_T}{T} \right)^3 \cdot 50$$

L : Life rating(Km)    f<sub>C</sub> : contact factor    f<sub>W</sub> : load factor

C : basic dynamic load rating (N)    C<sub>T</sub> : basic dynamic torque rating(N·m)    P : working load(N)    T : working torque(N·m)

### Contact factor (f<sub>C</sub>)

In a typical application, Keyless Ball Splines are often used to carry load by more than two pieces of spline nuts on a single spline shaft. To avoid variables such as machining inaccuracies of installation surface, difference of Spline Nut between each other, influence unevenly distributed loads on Spline Nuts. Contact factors (f<sub>C</sub>) as a safety factor generally used are shown in Table 5.

Table 5. Contact factor (f<sub>C</sub>)

Number of the Nuts on a single Keyless Ball Spline Shaft.	Contact factor
1	1.00
2	0.81
3	0.72
4	0.66
5	0.61

### Load factor (f<sub>W</sub>)

In reciprocating linear motion, it is difficult to precisely calculate applied loads due to many factors. To calculate loads, it is necessary to take into consideration factors such as mass, inertia, speed, distance, and frequency of movement. In general, these variables are simplified by using load factor (f<sub>W</sub>) as stated in Table 6.

Table 6. Load factor (f<sub>W</sub>)

Operating conditions		Load factor (f <sub>W</sub> ) .
Load	Speed	
No vibration or shocks	less than 15m/min.	1.04 1.5
No remarkable vibration or shocks	less than 60m/min.	1.54 2.0
Vibration or shocks are present.	more than 60m/min.	2.04 3.5



## LUBRICATION

Through operation lubrication is dispersed, so it is advisable to relubricate periodically based upon application requirement.

## OPERATING ENVIRONMENT

### Anti-Dust

Invasion of partial contaminant debris will affect mechanical performance and shorten life expectancy. Specially designed seals fitted to the Spline Nut and work effectively under normal operating environments. For extremely contaminated environments it is advisable to protect the Spline assembly with use of covers or bellows.

### OPERATING TEMPERATURE

Recommended maximum operating temperature should not exceed 808 due to use of resin type ball retainer contained within the Spline Nut.

### EXCESSIVE MOMENT

**NB**'s Keyless Ball Spline is designed to carry high load and moment load even with use of one Spline Nut, however, when excessive moment loads exist this may disturb stable movement. Where high accuracy movement is required, it is advisable to use two or more Spline Nuts or double-wide Block to evenly distribute loads.

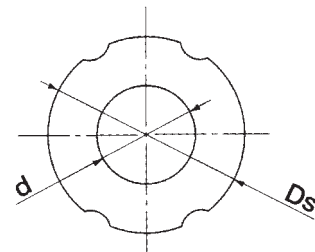
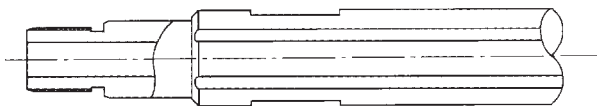
## CUSTOMIZED SPECIFICATIONS

**NB** accepts customized requests such as: Special machining is required at end of the Spline Shafts; Customized configuration of Spline Shafts; Specially requested surface treatment finish, etc,. When these customized requests arise, please contact **NB**. Also offered are Hollow type Spline Shafts. Please refer to the diameters available in Table 7.

Table 7. Hollow Spline Shafts

Part No.	External dia. Ds mm	Internal dia. d mm	Section modulus Z mm <sup>3</sup>	Moment of inertia I mm <sup>4</sup>
SSPM/SPA 6	6	2	19.4	58
SSPM/SPA 8	8	3	46.5	186
SSPM/SPA10	10	4	89.6	448

Fig.2. An example of machining done at end of Spline Shaft.



## NOTES ON ASSEMBLY

### FIT TOLERANCE

**NB** recommends a slip fit for internal housing bore tolerance of H7.

### EASY INSTALLATION

Insert Keyless Ball Spline Nut to the housing. Secure Spline Nut with use of provided Lock-plates. Insert Lock-Plates fully to the bottom of Lock-Plate grooves (located on circumference of Spline Nut) prior to tightening fasteners. This prevents radial movement within housing.

### PRECAUTION

When the Keyless Ball Spline is subjected to vibration, alternating torque, quick acceleration or deceleration movements, it is advisable to apply a bonding agent to external surface of Spline Nut and fasteners. When multiple Spline Nuts are used on the same Spline Shaft, confirm smooth movement while stabilizing Lock-plates.

### INDICATION OF REFERENCE PLANE

Reference planes of SPA and SPA-W type Blocks are at the tapped hole surface and the surface opposite from the **NB** mark.

### INSTALLATION EXAMPLES

Fig. 3. Installation by FP type lock-plate.

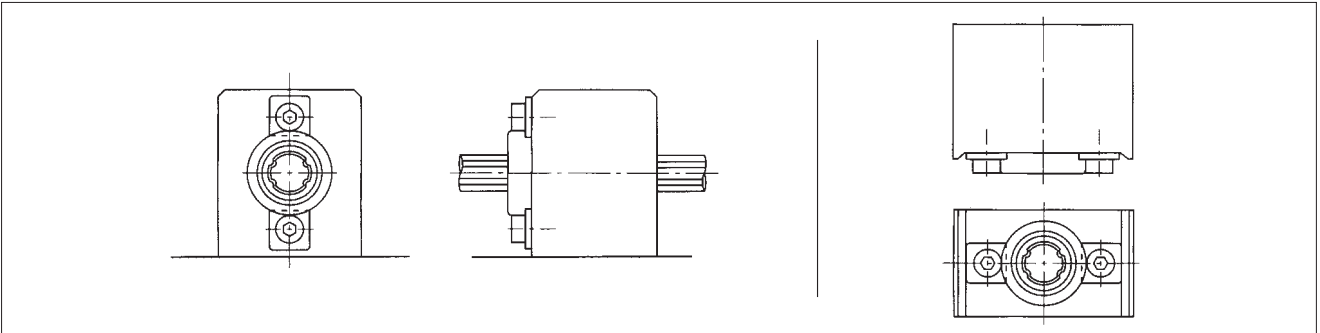


Fig. 4. Installation by LP type lock-plate.

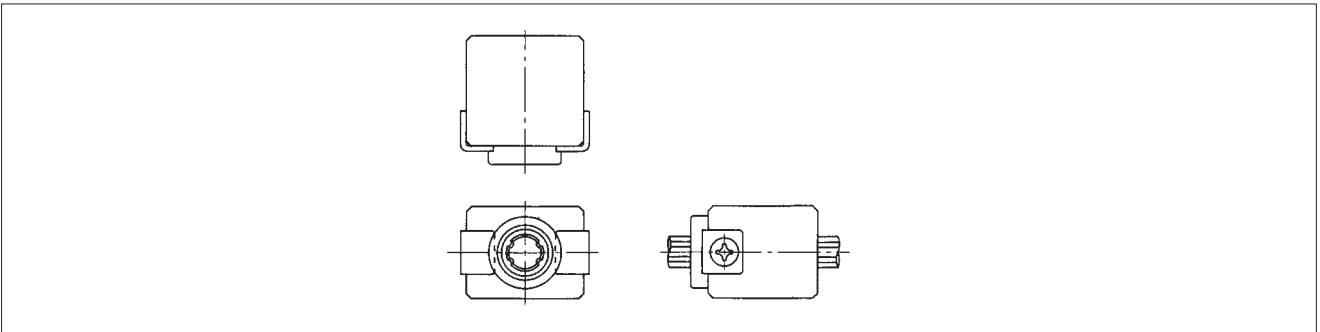
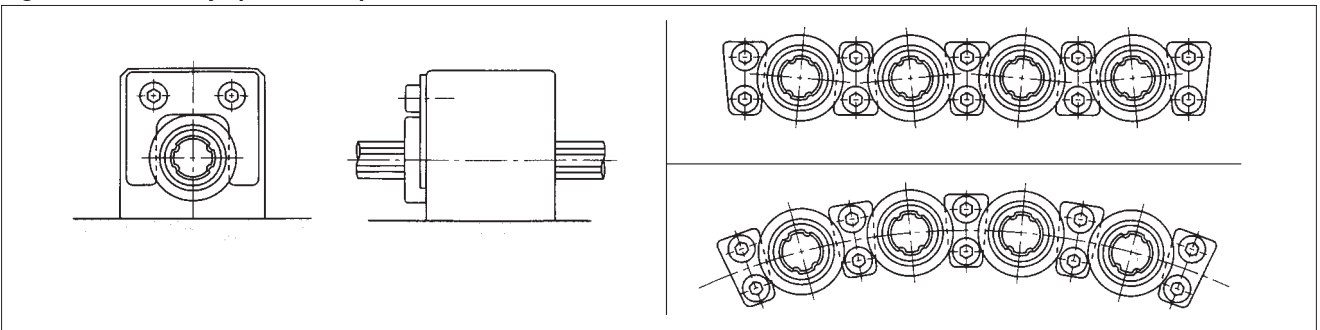


Fig. 5. Installation by special lock-plate.

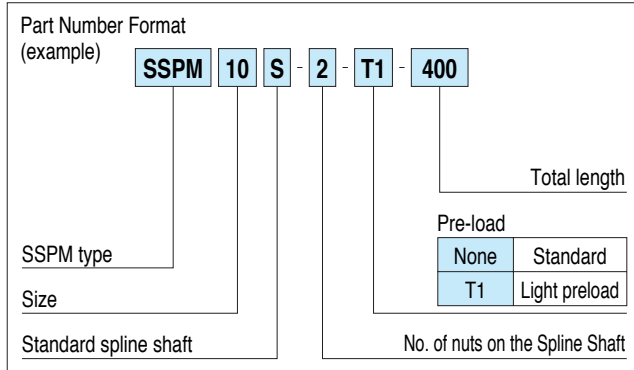




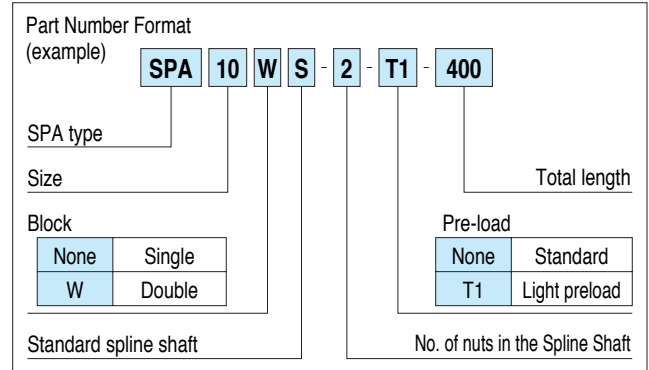
## STANDARD KEYLESS BALL SPLINE

Standard Keyless Ball Splines are available for quick delivery requests. These consist of high class spline Nut(s) and Spline Shaft in standard lengths.

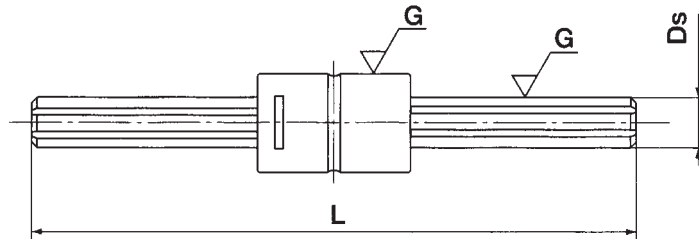
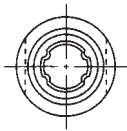
### SSPM type



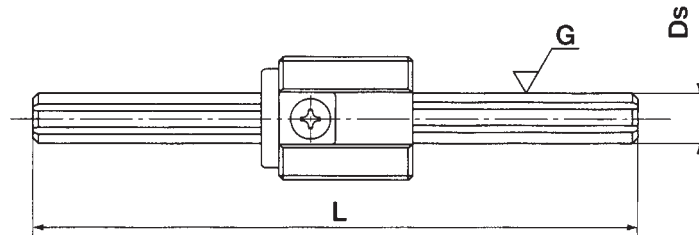
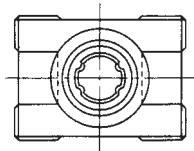
### SPA type



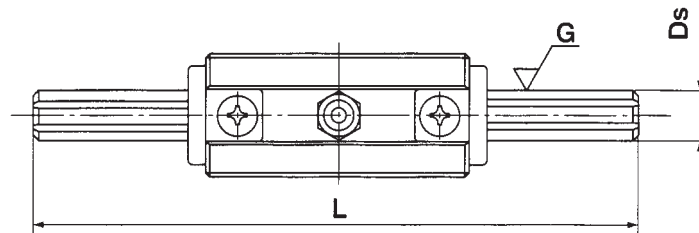
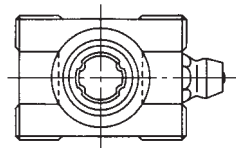
SSPM-S type



SPA-S type

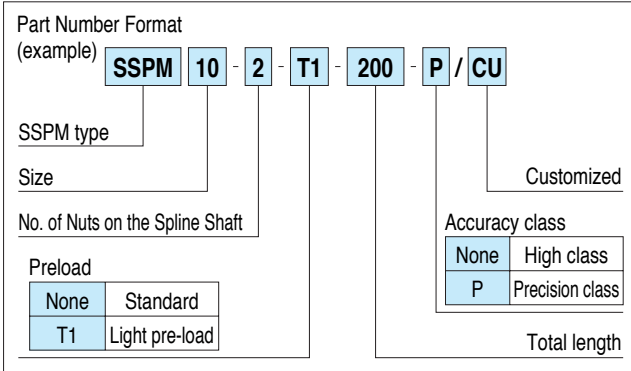


SPA-WS type



Part Number			Dia. Ds (h7) mm	Standard Length				
Keyless spline nut	Single block	Double-wide block		L mm				
SSPM 6S	SPA 6S	SPA 6WS	6	150	200	300	400	7
SSPM 8S	SPA 8S	SPA 8WS	8	150	200	300	400	500
SSPM10S	SPA10S	SPA10WS	10	200	300	400	500	600

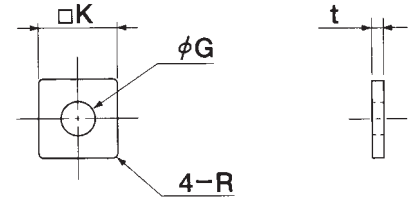
## SSPM type (Keyless Ball Spline Nut)



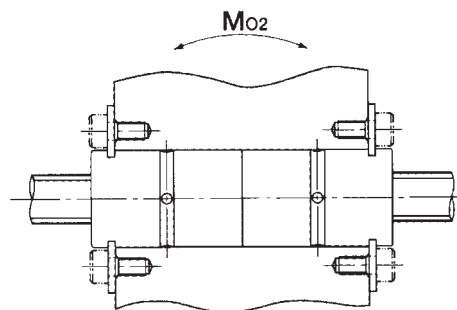
Part No.	Major Dimensions								Dimensions for Installation			
	D		L	F	W	C	A	d	B	H	M	9
	mm	tolerance um										
<b>SSPM 6</b>	14	0	25	2.2	1.1	1.0	12.0	1.0	9.4	25.6	M2.5	4
<b>SSPM 8</b>	16	3 11	25	2.7	1.3	1.2	13.6	1.5	11.0	30.6	M 3	5
<b>SSPM10</b>	21	3 13	33	2.7	1.3	1.2	18.6	1.5	13.5	35.6	M 3	5

### Dimensions of Lock-plate for F type. Material: SUS304CSP (2 plates/Nut)

Part No.	K	G	t	R	Applicable Spline Nut
	mm	mm	mm	mm	
<b>FP 6</b>	6.8	2.9	1.0	0.5	<b>SSPM 6</b>
<b>FP 8</b>	8.5	3.5	1.2	0.5	<b>SSPM 8</b>
<b>FP10</b>	8.5	3.5	1.2	0.5	<b>SSPM10</b>



When using two single blocks in combination



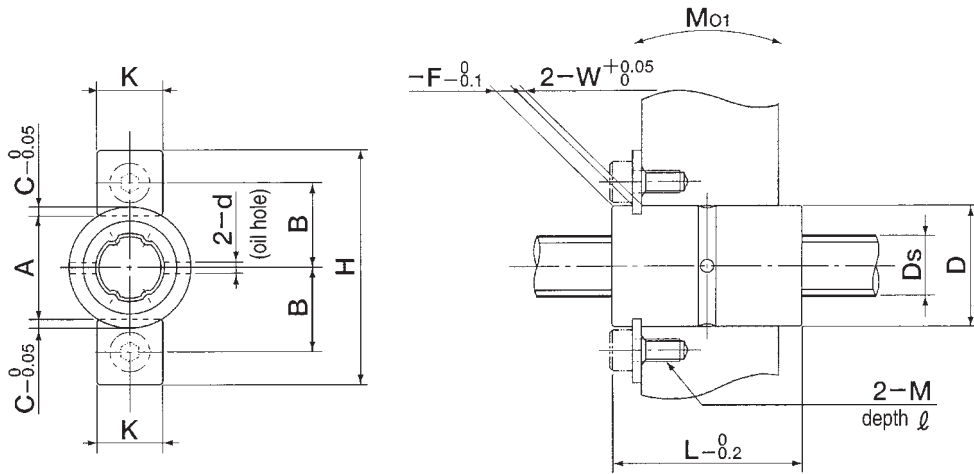
1 Recommended housing bore tolerance: H7



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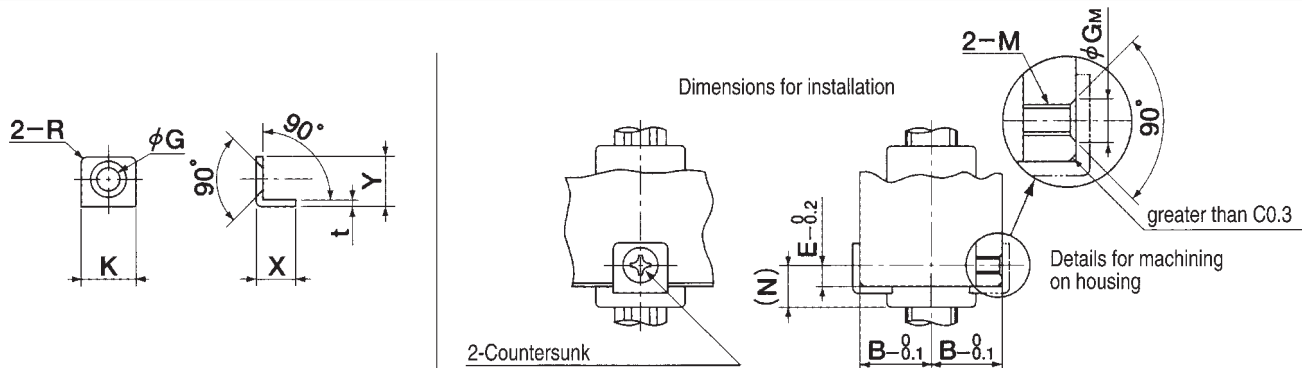
1 Recommended housing bore tolerance: H7

Dia.	Basic torque rating		Basic load rating		Allowable static moment		Moment of inertia	Section modulus	Weight		Part No.	
	Ds	dyn.	stat.	dyn.	stat.	Mo1			Mo2	Nut		Shaft
		tol.	C <sub>r</sub>	C <sub>or</sub>	C	C <sub>o</sub>			N·m			
6	0 3 12	1.5	2.4	1.22	2.28	5.1	40	59	19.7	19	0.21	<b>SSPM 6</b>
8	0 3 15	2.1	3.7	1.45	2.87	7.4	50	190	47.6	23	0.38	<b>SSPM 8</b>
10	0 3 15	4.4	8.2	2.73	5.07	18.0	116	461	92.2	54	0.60	<b>SSPM10</b>

1kN6 102kgf 1N·m6 0.102kgf·m

**LP type [L type Lock-plate (Sold separately)] Material : SUS304CSP**

Part No.	Major Dimensions						Dimensions for installation					Applicable Spline Nut
	K	G	t	R	X	Y	B	E	N	G <sub>m</sub>	M	
LP 6	8.6	4.3	1.0	1	5.85	7.8	11.1	3.3	6.8	3.5	M2.5	<b>SSPM 6</b>
LP 8	9.15	5.0	1.2	1	6.45	9.2	12.3	4.0	8.2	4.0	M 3	<b>SSPM 8</b>
LP10	9.15	5.0	1.2	1	6.45	9.2	14.8	4.0	8.2	4.0	M 3	<b>SSPM10</b>



1 Recommended housing bore tolerance: H7

## SPA/SPA-W type (Block type)

Part Number Format (example)

**SPA 10 W - 2 - T1 - 200 / CU**

SPA type

Size

Block

None	Single
W	Double

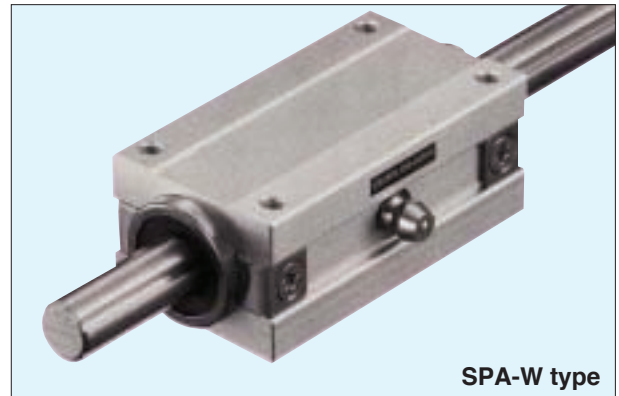
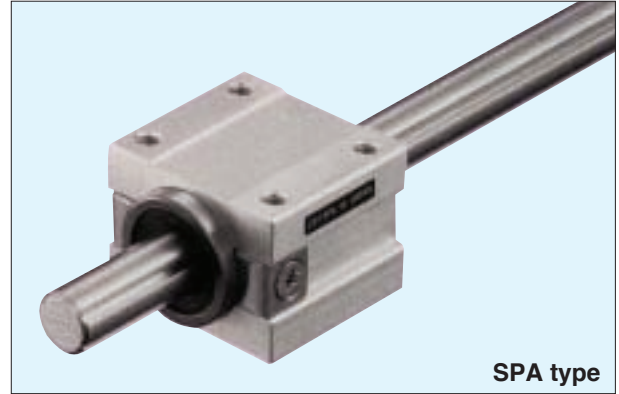
No. of Nuts on the Spline Shaft

Preload symbol

None	Standards
T1	Light prelaod

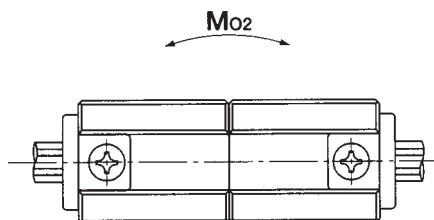
Customized

Total length



Part No.	Major Dimensions								Dimensions for installation				
	h	E	W	L	F	L1	T	Gw	B	C	S	9	D
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm		mm	mm
SPA 6 6W	9.0	12.5	25	25	18	22.5	4.2	7	18	16	M3	5	14
				50		45		6.5		35			
SPA 8 8W	10.0	14.0	28	25	20	22	5	7	20	16	M3	5	16
				50		44		6.5		34			
SPA 10 10W	12.5	16.5	33	33	25	30	7.5	7	25	20	M4	6	21
				66		60		6.5		50			

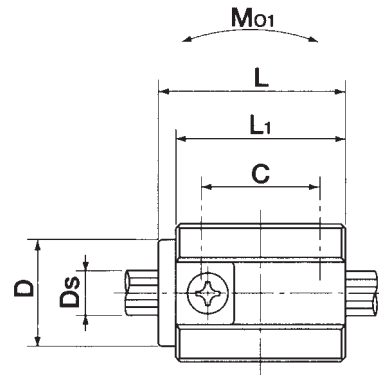
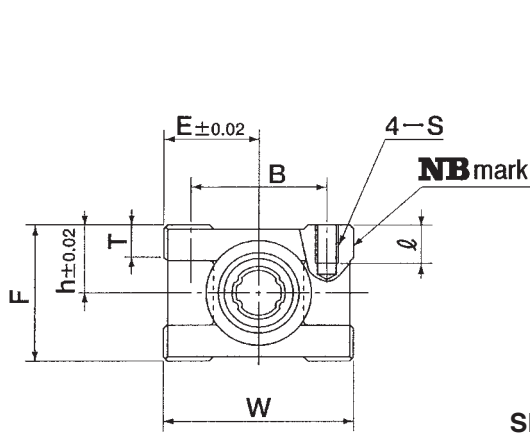
When using two single blocks in combination.



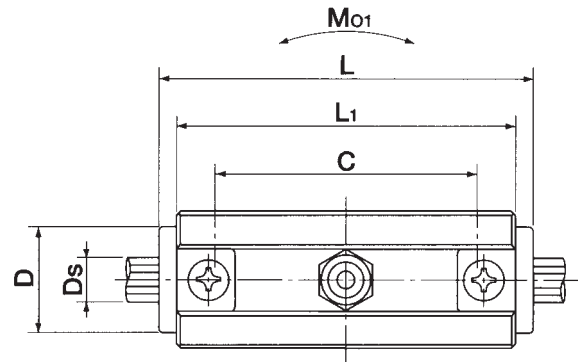
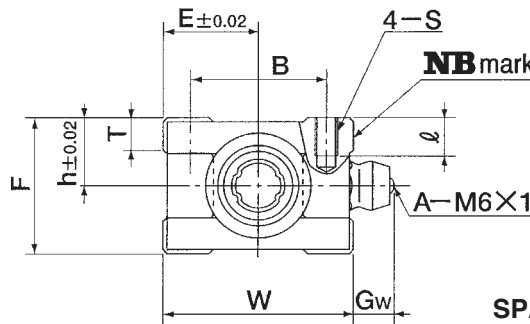
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SPA type



SPA-W type

Dia.	Basic torque rating		Basic load rating		Allowable static moment		Moment of inertia	Section modulus	Weight		Part No.	
	Ds	dyn.	stat.	dyn.	stat.	Mo 1			Mo 2	Block		Shaft
		tol.	Cr	Cor	C	Co			N·m			
6	0	1.5	2.4	1.22	2.28	5.1	40	59	19.7	35	0.21	SPA 6 6W
	3 12	3.0	4.8	1.98	4.56	40	7			72		
8	0	2.1	3.7	1.45	2.87	7.4	50	190	47.6	42	0.38	SPA 8 8W
		4.2	7.4	2.35	5.78	50	7			85		
10	3 15	4.4	8.2	2.73	5.07	18.0	116	461	92.2	88	0.60	SPA 10 10W
		8.8	16.4	4.42	10.14	116	7			179		

1kN6 102kgf    1N·m6 0.102kgf·m