

# Ball Screw with Ball Spline

## Miniature Ball Screw with Ball Spline

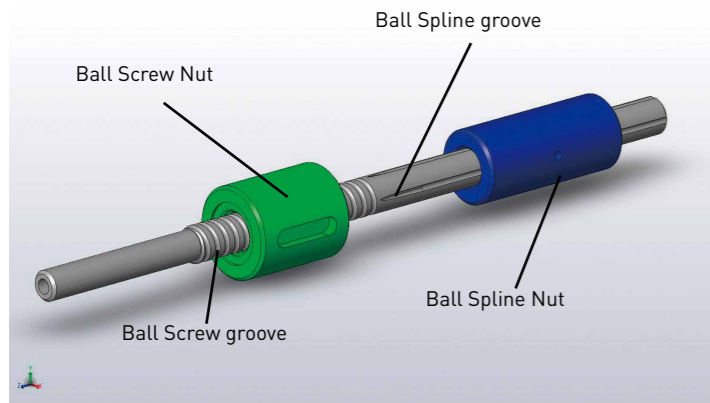
Ball Screw manufacturing company (KSS) and Ball Spline manufacturing company (HEPHAIST) collaborated for developing new product which is focused on Hybrid, Compact and lightweight.

### Features

- This is a combined product which is possible for linear and rotational movement as well as suction at the same time with one unit.
- Achieved developing very compact product as "Overlap type" using Miniature Ball Screws and Miniature Ball Splines .



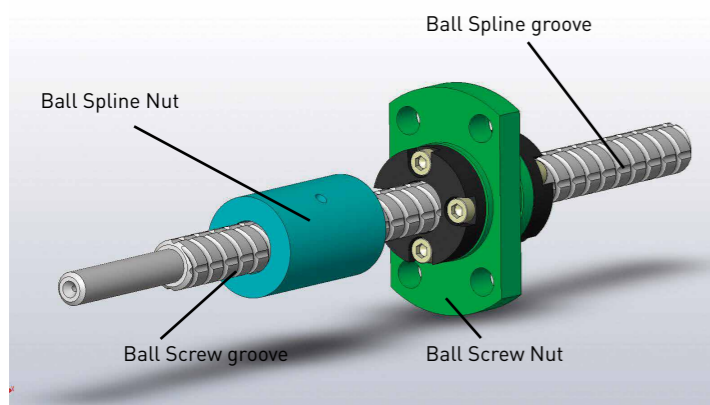
### BSSP Separated type



It's a combined products, which has Ball Screw and Ball Spline processed on the same Shaft.



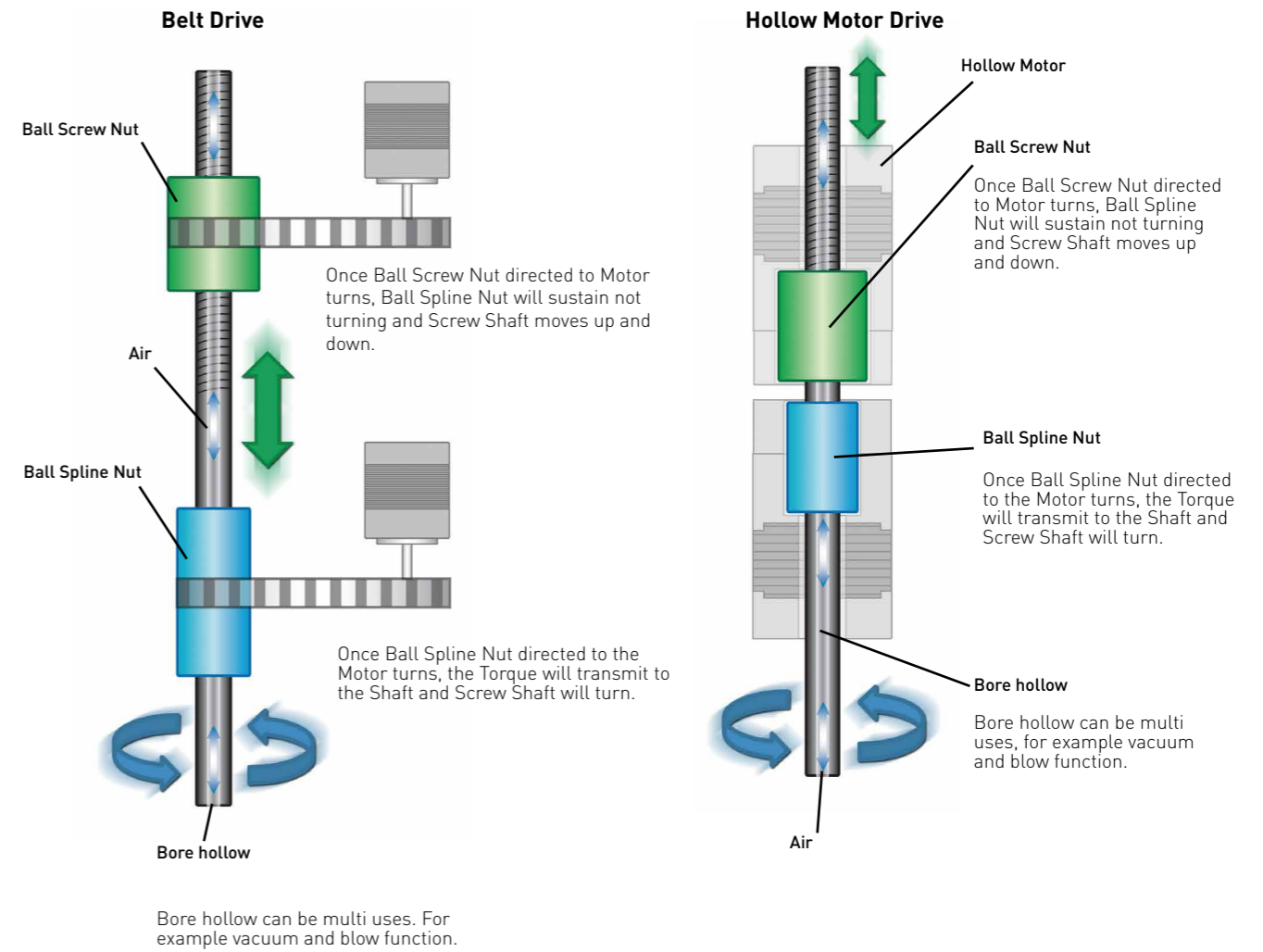
### BSSP Overlap type



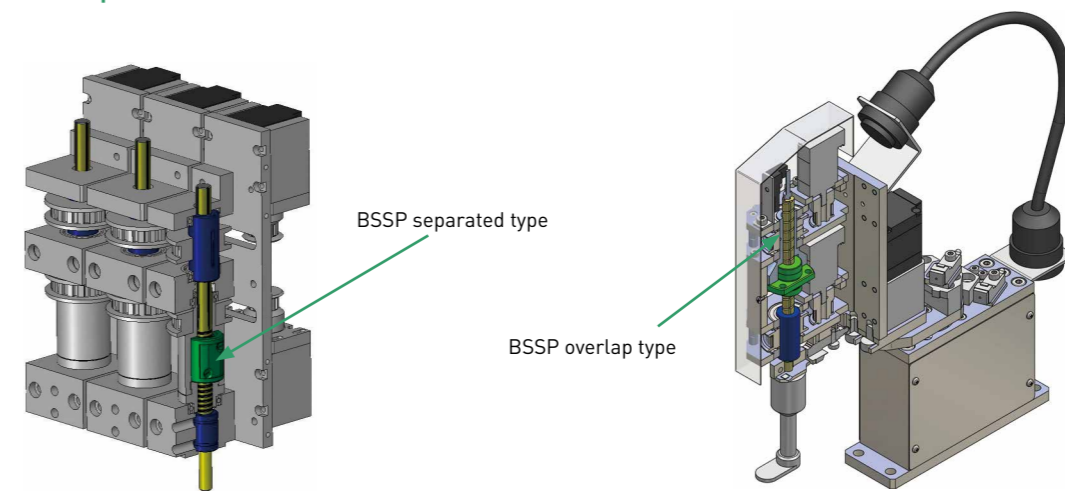
By processing Ball Screw and Ball Spline on the same place makes product have longer travel and compact.



### Usage example



### Application Example



Using "Separated type" of Ball Screw Spline is suitable for downsizing devices and equipment. Suitable for Chip-Mounter application etc.

Using "Overlap type" can save Shaft length and makes device as minimized as possible. For example, suitable for Miniature SCARA Robot, especially for the head part.

**Specifications**

**1) Accuracy Grade & Axial/Radial play**

Accuracy grade and Axial/Radial play for BSSP are shown in Table below.

Unit : mm

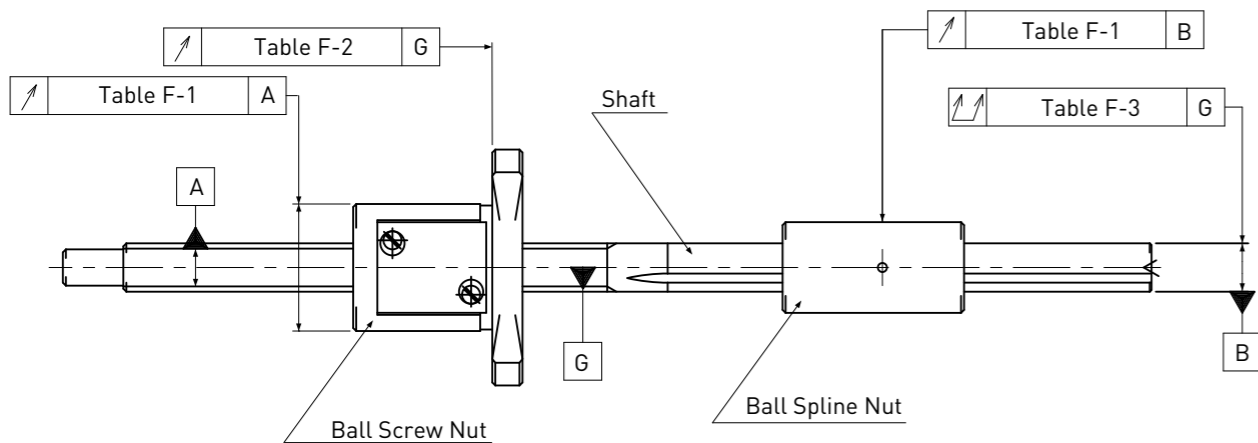
Type	Part	C3 (Maximum)	C5 (Maximum)
Separated type	Ball Screw Axial play	0 or 0.005	0.005
	Ball Spline Radial play	0	
Overlap type	Ball Screw Axial play	0.005	
	Ball Spline Radial play	0.002	

**2) Run-out and location tolerances for BSSP**

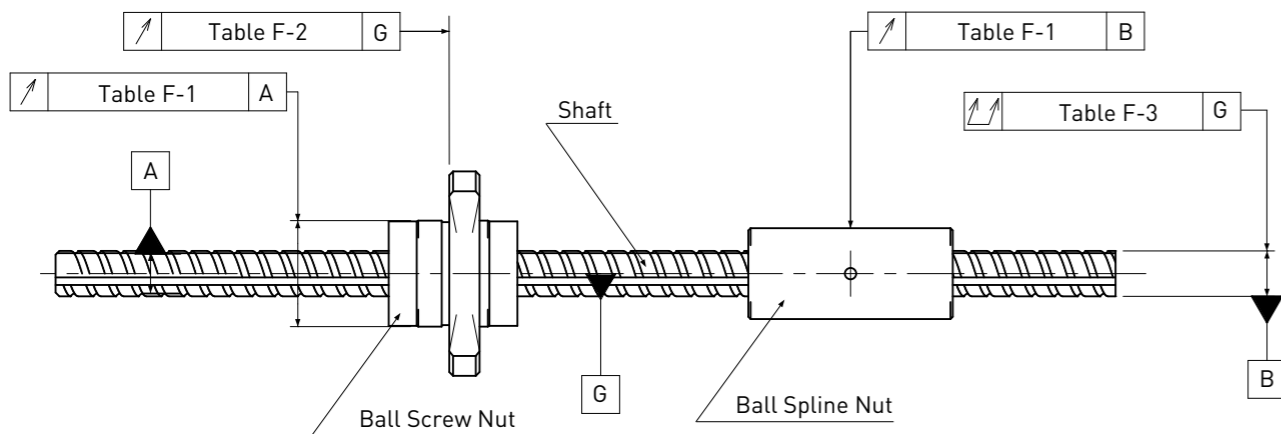
Run-out and location tolerances for BSSP are based on JIS B1192-3(Ball Screw), JIS B1193(Ball Spline) .

Tolerance for each part and description are as follows.

**[Separated type]**



**[Overlap type]**



**Table F-1 : Radial Run-out of Ball Nut location diameter related to the centerline of Screw Shaft**

Unit :  $\mu\text{m}$

Nut outside diameter (mm)		Permissible deviation of Radial Run-out		
Over	Up to	Ball Screw Nut		Ball Spline Nut
		C3	C5	
—	20	9	12	11
20	32	10	12	—

**Table F-2 : Axial Run-out (Perpendicularity) of Ball Nut location face related to the centerline of Screw Shaft**

Unit :  $\mu\text{m}$

Nut outside diameter (mm)		Permissible deviations of Axial Run-out (Perpendicularity)	
Over	Up to	Ball Screw Nut	
		C3	C5
—	20	8	10
20	32	8	10

**Table F-3 : Total Run-out in radial direction of Screw Shaft related to the centerline of Screw Shaft**

Unit :  $\mu\text{m}$

Shaft total length (mm)		Permissible deviations of total Run-out in radial direction	
Over	Up to	C3	C5
—	125	25	35
125	200	35	50
200	315	50	65

**3) Lead accuracy of Ball Screws**

Ball Screw lead accuracy is specified by the tolerance of actual mean travel error ( $\pm e_p$ ) and travel variation ( $V_u$ ) over the Screw Shaft effective length.

Tolerance of each accuracy grades are shown in the Table F-4.

**Table F-4 : Tolerance on Specified travel ( $\pm e_p$ ) and permissible travel variation of Ball Screws.**

Unit :  $\mu\text{m}$

Accuracy Grade	C3		C5	
	$\pm e_p$	$V_u$	$\pm e_p$	$V_u$
Effective screw length (mm)	Over	Up to	$\pm e_p$	$V_u$
	—	100	8	8
	100	200	10	8
	200	315	12	8
			18	18
			20	18
			23	18

#### 4) Material & Heat treatment, Surface hardness

Standard material of BSSP, Heat treatment and Surface hardness are shown in Table F-5. However, they vary depending on profile of Shaft or Nut. Please refer to KSS drawings.

Table F-5 : Material, Heat treatment & Surface hardness

		Material	Heat treatment	Surface hardness
Screw Shaft	Solid Shaft	SCM415	Carburizing and quenching	HRC 58-62
	Hollow Shaft	SUJ2	Induction hardening	
Nut		SCM415	Carburizing and quenching	HRC 58-62

#### 5) Lubrication

In Ball Screw with Ball Spline (BSSP) use, lubricant should be required. If lubricant is not applied with, the problem such as increase of Torque and shortened Life occurs. Applying lubricant can minimize temperature increases, decline of mechanical efficiency due to friction, and deterioration of accuracy caused by wear.

For lubrication of BSSP, regular lithium-soap-based Grease and ISO VG32-68 Oil (turbine Oil #1 to #3) are recommended.

BSSP are applied with anti-rust oil for rust prevention, if there is no designation when shipping. Since anti-rust oil is not lubricant, apply Grease or Lubrication oil before using BSSP.

If there is no specific request, KSS would recommend our original grease (MSG No.2) as standard lubricant.

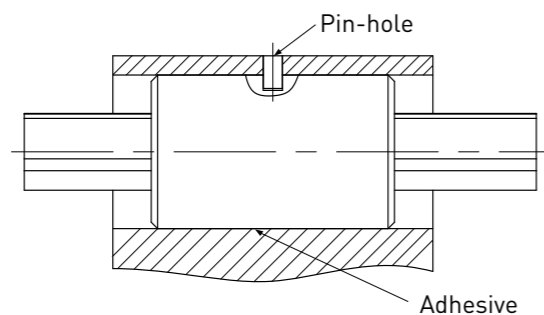
We can apply designated Grease before shipping, please ask KSS representative.

Table F-6 : Recommended lubricants for normal operating conditions

Lubricant	Type	Product name
Grease	Lithium-based Grease	KSS original Grease MSG No.2
Lubricating Oil	Sliding surface Oil or turbine Oil	Super Multi 68

#### 6) Mounting of Ball Spline Nut

Ball Spline Nut should be mounted using pin-hole located on Nut outer, and adhesive. Please make sure that no load would be applied on pin when using pin-hole.

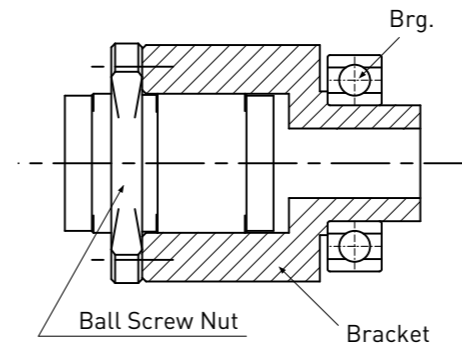


#### 7) Mounting of Ball Screw Nut

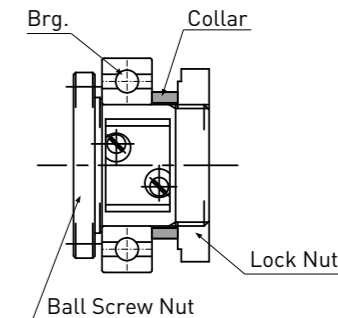
There would be a couple of ways to install Bearings onto Ball Screw Nut, such as using Bracket as Bearing shaft, direct mounting on Ball Screw Nut.

KSS designs special profile of Ball Screw Nut in accordance with customer's mounting request. Please ask KSS representative for further information.

Brg. install with Bracket



Direct install of Brg. onto Nut outer



#### Model number notation

[Separated type]

**BSSP 06 10 / 06 - 080 R 070 S 200 C5 T**

① ② ③ ④ ⑤ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫

[Overlap type]

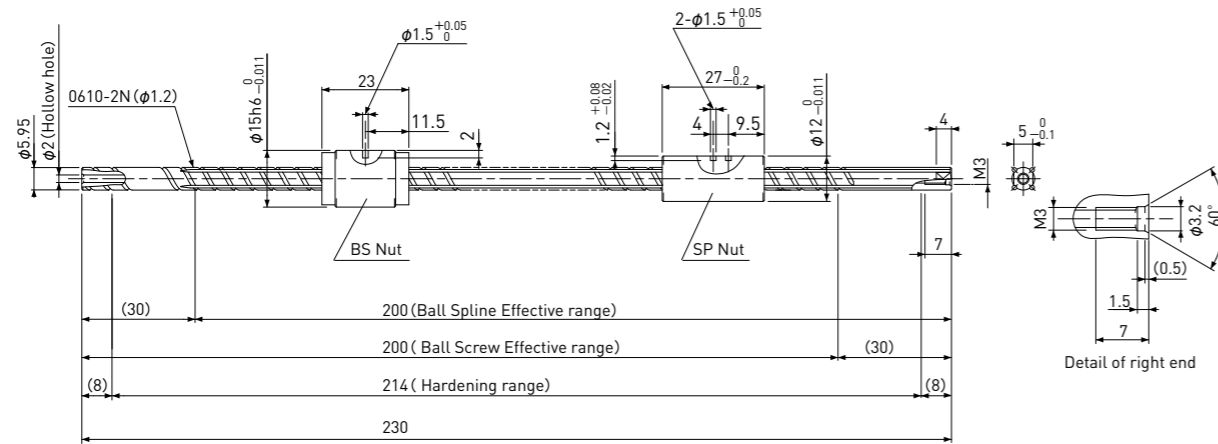
**BSSP 06 10 - 150 R 180 C5 T**

① ② ③ ⑥ ⑦ ⑩ ⑪ ⑫

- ① Ball Screw with Ball Spline series No.  
BSSP : Ball Screw with Ball Spline
- ② Screw Shaft nominal diameter (mm)
- ③ Lead (mm)
- ④ Ball Spline Shaft nominal diameter (mm)
- ⑤ Screw thread length (mm)
- ⑥ Screw thread & Spline length (mm)
- ⑦ Thread direction (R=Right-hand, L=Left-hand)
- ⑧ Spline length (mm)
- ⑨ S means Ball Spline part
- ⑩ Total length (mm)
- ⑪ Accuracy grade
- ⑫ Shaft option : No indication=solid shaft, T=Hollow shaft

# BSSP0610 | Shaft dia. $\phi 6$ Lead 10mm

## C5



Ball Screw Specifications	
Accuracy Grade	JIS C5
Ball size	$\phi 1.2\text{mm}$
Number of thread	2
Thread direction	Right
Pitch circle dia.	6.30mm
Number of circuit	1.2×2
Basic Load Rating Dynamic : Ca	(650N)
Basic Load Rating Static : Coa	(900N)
Axial Play	Max 0.005 mm

Ball Spline Specifications	
Accuracy Grade	JIS C5
Basic Load Rating Dynamic : Cr	(750N)
Basic Load Rating Static : Cor	(1200N)
Basic Torque Rating Dynamic : Ct	(1.9 Nm)
Basic Torque Rating Static : Cot	(1.3 Nm)
Radial Play	Max 0.002 mm

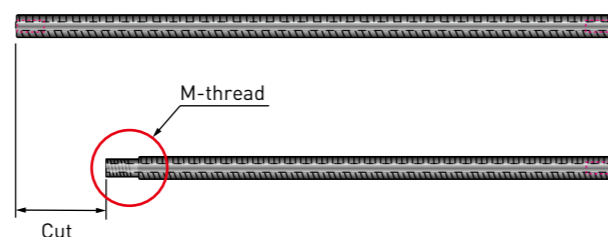
Common Specifications		
Material	Shaft	SUJ2
	Nut	SCM415
Anti-rust treatment		Anti-rust Oil

Note 1) The detail will be provided by drawing.  
 Note 2) Female thread on left end journal is not available.

### [Re-works on Shaft-end]

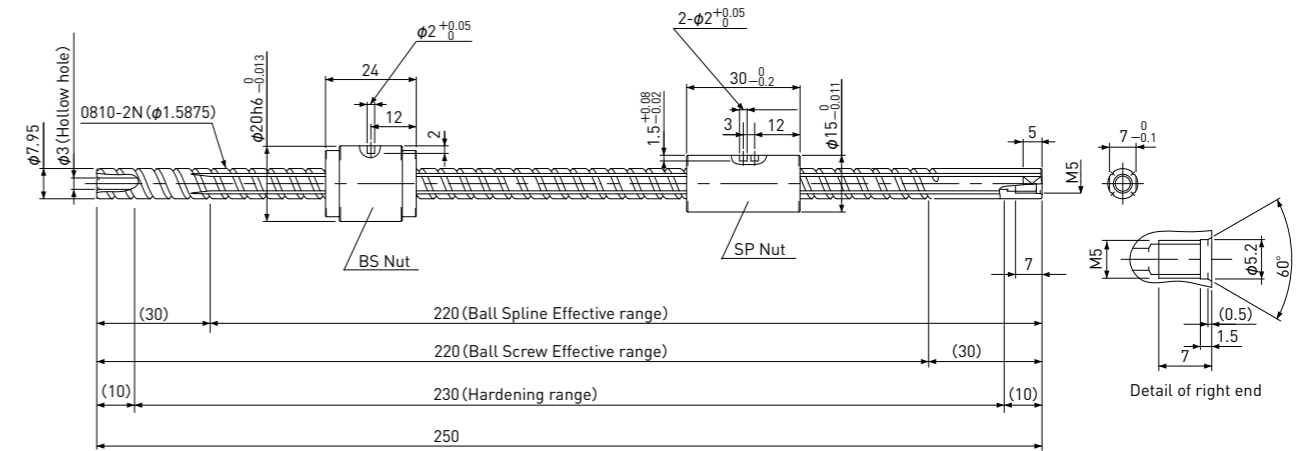
Other parts can be attached by re-working the end journal, such as turning down, or male thread.

### Re-works Example



# BSSP0810 | Shaft dia. $\phi 8$ Lead 10mm

## C5



Ball Screw Specifications	
Accuracy Grade	JIS C5
Ball size	$\phi 1.5875\text{mm}$
Number of thread	2
Thread direction	Right 右
Pitch circle dia.	8.40mm
Number of circuit	1.65×2
Basic Load Rating Dynamic : Ca	(1400N)
Basic Load Rating Static : Coa	(2000N)
Axial Play	Max 0.005 mm

Ball Spline Specifications	
Accuracy Grade	JIS C5
Basic Load Rating Dynamic : Cr	(1000N)
Basic Load Rating Static : Cor	(1450N)
Basic Torque Rating Dynamic : Ct	(3.4Nm)
Basic Torque Rating Static : Cot	(2.4Nm)
Radial Play	Max 0.002 mm

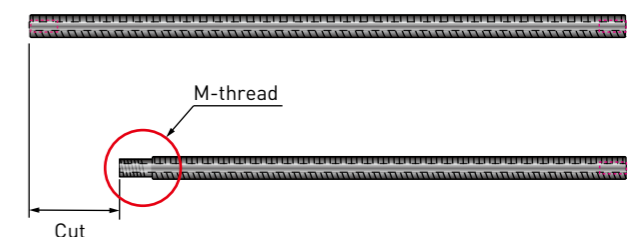
Common Specifications		
Material	Shaft	SUJ2
	Nut	SCM415
Anti-rust treatment		Anti-rust Oil

Note 1) The detail will be provided by drawing.  
 Note 2) Female thread on left end journal is not available..

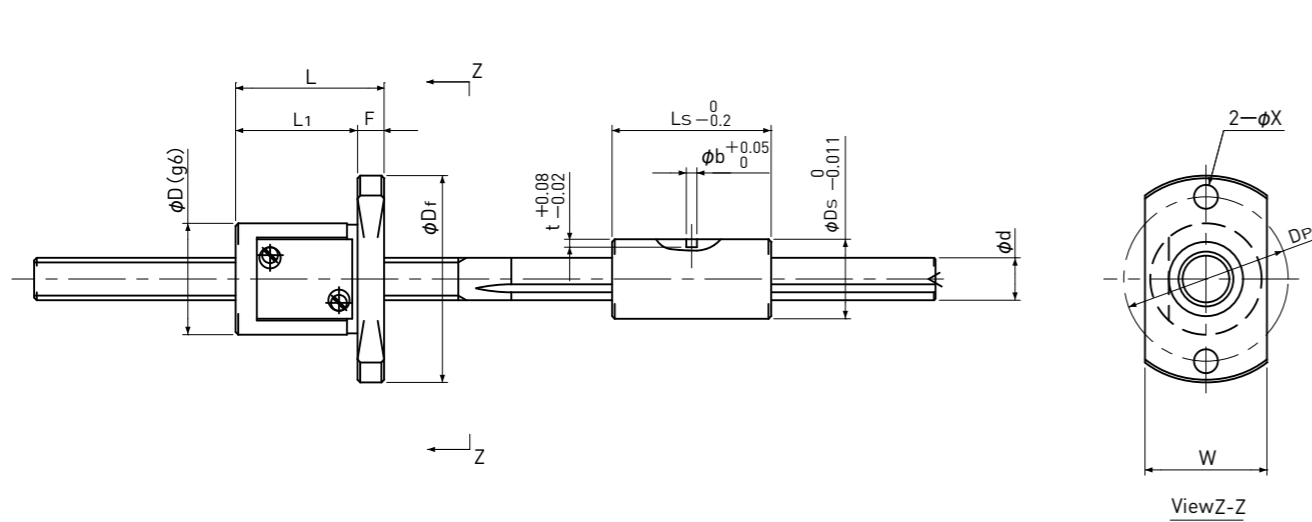
### [Re-works on Shaft-end]

Other parts can be attached by re-working the end journal, such as turning down, or male thread.

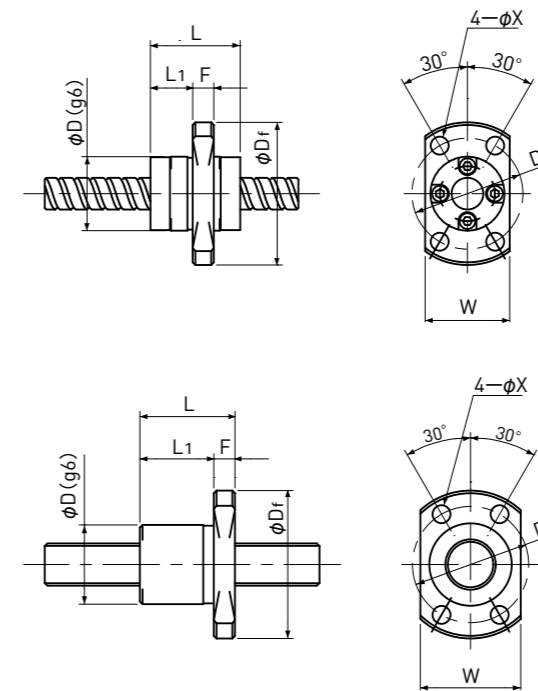
### Re-works Example



## Separated type



Type-1 : Return-plate type (Ball Screw Nut)



Type-2 : End-cap type (Ball Screw Nut)

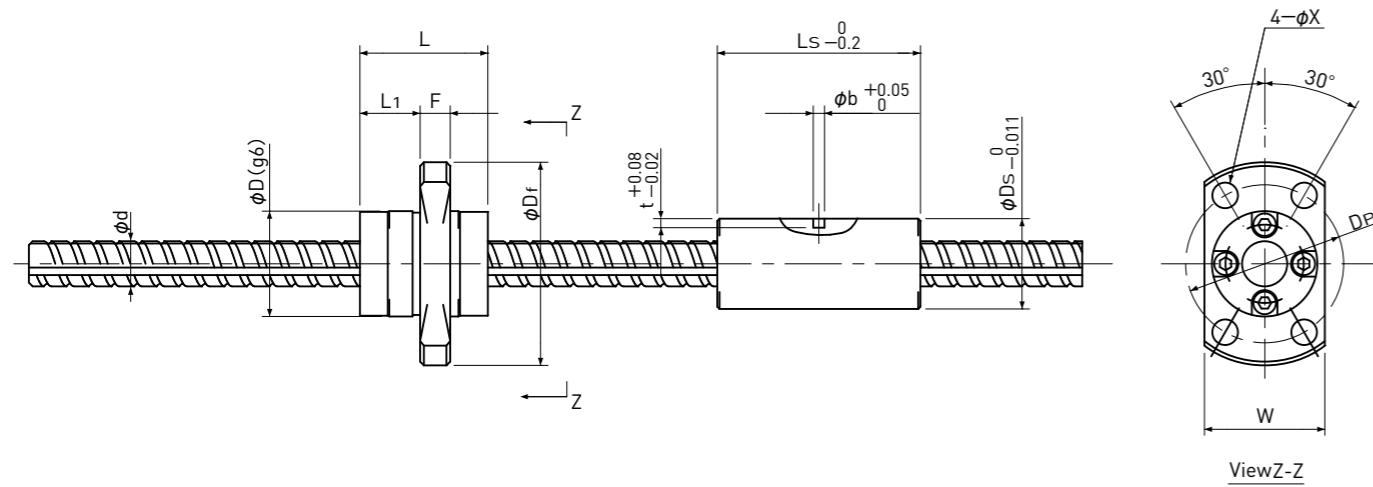
Type-3 : Internal-deflector type (Ball Screw Nut)

Unit:mm

Ball Nut Model number	Shaft nominal dia. d	Ball Screw part													Ball Spline part					Bore hollow	Shaft Inertia Kgmm <sup>2</sup> /mm	Ball Nut Model number					
		Lead	Basic Load Rating (Reference)		Nut dimension										Basic Load Rating (Reference)		Basic Torque Rating (Reference)		Permissible Moment (Ref.) Mo				Nut dimension				
			Ca	Coa	Nut type	Nut mass g	D	Dr	L	L1	F	W	Dp	Bolt Hole X	Cr	Cor	Ct	Cot					Nut mass g	OD. Ds	Length Ls	Pin hole	
			N	N																						b	t
BSSP 0602/06	6	2	(750)	(1200)	1	25	15	29	17	13	4	17	23	3.4	(860)	(1400)	(2.2)	(1.6)	(3.0)	14	12	27	1.5	1.2	2	9.99 × 10 <sup>-10</sup>	BSSP 0602/06
BSSP 0606/06		6	(870)	(1450)	2	20	14	27	17	8	4	16	21	3.4													BSSP 0606/06
BSSP 0610/06		10	(950)	(1600)	2	20	14	27	23	11.5	4	16	21	3.4													BSSP 0610/06
BSSP 0802/08(1)	8	2	(850)	(1600)	1	25	16	30	17	13	4	18	24	3.4	(1200)	(1900)	(4.1)	(3.1)	(4.1)	22	15	30	2.0	1.5	3	31.6 × 10 <sup>-10</sup>	BSSP 0802/08(1)
BSSP 0802/08(2)		2	(2400)	(4000)	1	60	20	38	24	19	5	22	30	4.5													BSSP 0802/08(2)
BSSP 0802/08(3)		2	(1300)	(2300)	3	25	15	28	18	14	4	17	22	3.4													BSSP 0802/08(3)
BSSP 0804/08		4	(2600)	(4200)	1	75	21	39	28	23	5	23	31	4.5													BSSP 0804/08
BSSP 0812/08		12	(2200)	(4000)	2	40	18	31	27	17	4	20	25	3.4													BSSP 0812/08

- Note 1) Please note that Bore hollow is an option, not a standard. In some cases Bore hollow is not available due to Shaft length.
- Note 2) If special profile of Ball Screw Nut / Ball Spline Nut, please ask KSS representative.
- Note 3) Basic Load Rating, Basic Torque Rating and Permissible Moment are theoretical number based on effective number of Balls. They may vary drastically depending on operating condition. Please consider them just reference.
- Note 4) It is difficult to estimate theoretical life, because of combined products with Ball Spline which withstands Radial Load and Ball Screw for Axial Load. We would recommend that final decision should be based on your evaluation on actual machine or our experimental data.
- Note 5) Maximum limit of Shaft length is 150mm (for φ6), 200mm (for φ8). Please ask KSS in case of exceeding limit length.

## Overlap type



Type-2 : End-cap type (Ball Screw Nut)

Unit: mm

Ball Nut Model number	Shaft nominal dia. d	Ball Screw part													Ball Spline part										Bore hollow	Shaft Inertia Kg <sup>m</sup> ²/mm	Ball Nut Model number	
		Lead	Basic Load Rating (Reference)		Nut dimension										Basic Load Rating (Reference)		Basic Torque Rating (Reference)		Permissible Moment (Ref.) Mo Nm	Nut dimension								
			Ca	Coa	Nut type	Nut mass	D	Dr	L	L1	F	W	DP	Bolt Hole X	Cr	Cor	Ct	Cot		Nut mass	OD. Ds	Length Ls	Pin hole					
															N	N	Nm	Nm		g			b	t				
BSSP 0606	6	6	(600)	(900)	2	20	14	27	17	8	4	16	21	3.4		(650)	(1000)	(1.7)	(1.2)	(2.2)	14	12	27	1.5	1.2	2	9.99 × 10 <sup>-10</sup>	BSSP 0606
BSSP 0610		10	(650)	(900)	2	20	14	27	23	11.5	4	16	21	3.4		(750)	(1200)	(1.9)	(1.3)	(2.4)								BSSP 0610
BSSP 0812	8	12	(1400)	(2000)	2	40	18	31	27	17	4	20	25	3.4		(1100)	(1700)	(3.8)	(2.8)	(2.7)	22	15	30	2.0	1.5	3	31.6 × 10 <sup>-10</sup>	BSSP 0812

Note 1) Please note that Bore hollow is an option, not a standard.

In some cases Bore hollow is not available due to Shaft length.

Note 2) If special profile of Ball Screw Nut / Ball Spline Nut, please ask KSS representative.

Note 3) Basic Load Rating, Basic Torque Rating and Permissible Moment are theoretical number based on effective number of Balls. They may vary drastically depending on operating condition. Please consider them just reference.

Note 4) It is difficult to estimate theoretical life, because of combined products with Ball Spline which withstands Radial Load and Ball Screw for Axial Load. We would recommend that final decision should be based on your evaluation on actual machine or our experimental data.

Note 5) Maximum Load Capacity should be considered 10N.

Note 6) Maximum limit of Shaft length is 150mm (for φ6), 200mm (for φ8).

Please ask KSS in case of exceeding limit length.

## ●Precaution of storage, handling and operating

### • Precaution for handling

BSSP is precision components, and must be handled carefully in accordance with the instruction below.

#### Storage

BSSP should be stored unopened in their original KSS packaging. Avoid opening the package or breaking the inner package unnecessarily. This may result in contamination or rusting, and may degrade operating performance.

Please store BSSP under  $-20^{\circ}\text{C} \sim 80^{\circ}\text{C}$ , less than 80%RH humidity without any dew condensation.

#### Handling

1. Never disassemble BSSP. This will cause contamination, reduce accuracy, and lead to accidents.
2. Customers should not attempt to reassemble BSSP. Incorrect reassembly can easily result in malfunction. BSSP should be returned to KSS, where it will be repaired and reassembled with charge.
3. Take care to avoid injuries due to falling BSSP Shaft or Nut.
4. Dropping BSSP may cause scratching or impact damage to recirculating components, Shaft outside diameters, Balls, or Screw & Spline grooves, which may cause malfunction, such as incorrect rotation. If dropped, BSSP must be inspected by KSS with charge. Please make sure you return dropped Shaft or Nut.

### • Precaution for operating

#### Dust proof

Ball Screws must be used in a clean environment. They should be used with a dustproof cover to prevent contamination from dust or swarf. Dust or swarf contamination due to insufficient dust protection may reduce the BSSP performance, cause damage to recirculating components, which lead to locking.

#### Lubrication

Check lubrication before use. Insufficient lubrication will rapidly deteriorate the operating performance of BSSP.

Since anti-rust oil is not lubricant (Grease / Oil), Anti-rust oil on BSSP should be washed off with clean Kerosene and apply lubricant before using BSSP.

Please check the lubricant condition every 2 to 3months. If Grease is contaminated, remove old Grease, and replace with new Grease.

#### Critical speed and Permissible Axial load

BSSP has the maximum limit of speed and Axial load depending on its size, material, mounting method etc. When design BSSP, KSS would recommend that you consult with KSS engineering about the operating condition and model selection.

#### Over-run

Allowing Nuts to overrun may result in malfunctioning due to Balls escaping, damage to recirculation components, and indentation of the Ball grooves. Continued use in this state will lead to rapid wear and damage to recirculation components. Ball Screw Nut and Ball Spline Nut must therefore never be allowed to overrun. If overrunning occurs, contact KSS for an inspection with charge.

#### Temperature

BSSP should be used under the temperature of  $-20^{\circ}\text{C} \sim 80^{\circ}\text{C}$ , and humidity of less than 80%RH.

Avoid use BSSP under lower / higher temperatures and higher humidity.

This may result in the following problems.

- Reduced performance of Ball recirculation, and smooth movement.
- Damage to recirculation components.
- Reduced hardness of heat treated components.
- Rust on BSSP components.

If it is necessary to work beyond the recommended temperatures, please consult with KSS first as we may be able to provide a solution.

#### Moment load or Radial load

Ball Screw Nut primarily generate thrusts in the axial direction, and are not designed to withstand Radial loads and Moment loads. Care must be taken not to apply Radial loads and Moment loads to the Ball Screw Nut. If these kinds of loads act on the Ball Screws, Ball load uniformity is lost, and the life of Ball Screws is drastically reduced.