

Ball Screw Spline BNS

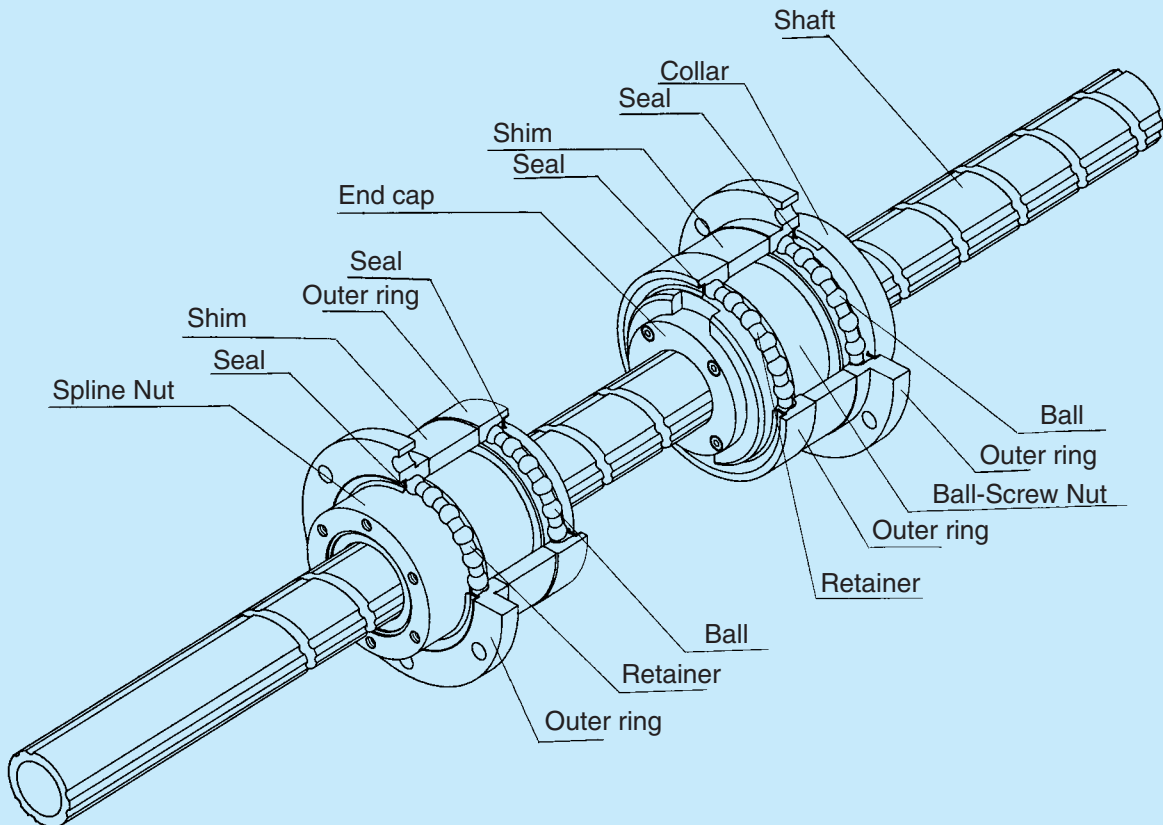


Fig. 1 Construction of the Ball Screw Spline

Construction and Features

The Ball-Screw Spline contains Ball Screw raceways and Ball Spline grooves crossing one another. The Nuts of the Ball Screw and Ball Spline have dedicated support bearings embedded on their exterior. Therefore, the Ball-Screw Spline is a stroke-rotation unit.

The Ball-Screw Spline can simultaneously achieve three modes of motion (rotational, linear and spiral) on a single shaft by rotating and stopping the Ball Screw and Spline Nuts.

The Ball-Screw Spline is best suited for applications in devices requiring both rotational and linear motion in a single unit, including the Z-axis of scalar robots, assembly robots, automatic loaders, and machining-center ATC.

Zero axial clearance

The Ball Spline has an angular-contact structure that causes no backlash in the rotational direction, enabling precise positioning.

Lightweight and compact

The Nut and support bearing are formed into one unit, permitting a high-precision, compact design. Moreover, the low inertia resulting from use of the lightweight Nut enables sensitive response.

Simple installation

The Ball-Spline Nut is designed so that balls do not fall off if the Spline Nut is removed from the shaft, making installation simple.

Bolting to the housing is all that's required. The Rotating Nut system is ready to use. (H7 is the recommended tolerance for the housing inner diameter.)

Smooth movement with low noise

As the Ball Screw is based on an end-cap mechanism, smooth movement can be achieved with low noise.

Highly rigid support bearing

The support bearing on the Ball Screw side is designed to have a contact angle of 60° , ensuring high rigidity in the axial direction, while that on the Ball Spline side is designed to have a contact angle of 30° , ensuring high rigidity in the moment direction. These contact angles provide highly rigid support for the shaft.

The Ball-Screw Spline comes with rubber seals attached as a standard accessory. These seals prevent the entry of foreign matter.

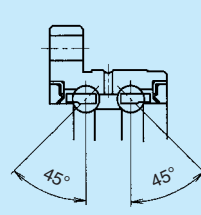


Fig. 2 Construction of the Type BNS-A Support Bearing

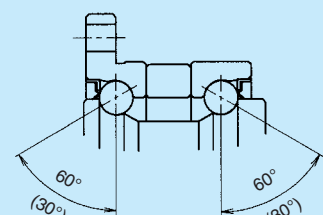


Fig. 3 Construction of the Type BNS Support Bearing

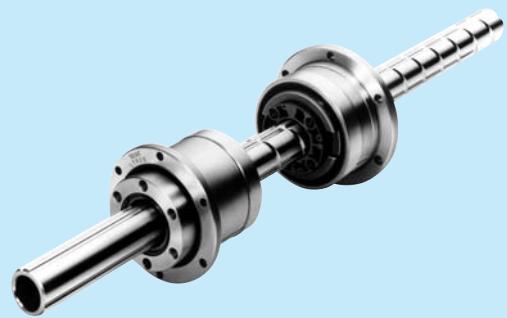
Types

Type BNS-A



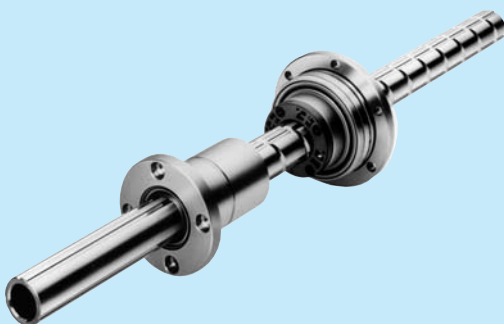
[Compact type: For rotational motion + linear motion]

Type BNS



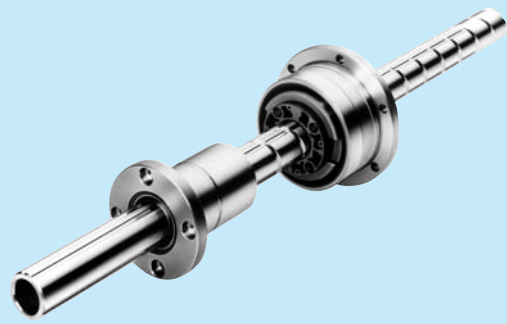
[Heavy-load type: For rotational motion + linear motion]

Type NS-A



[Compact type: For linear motion]

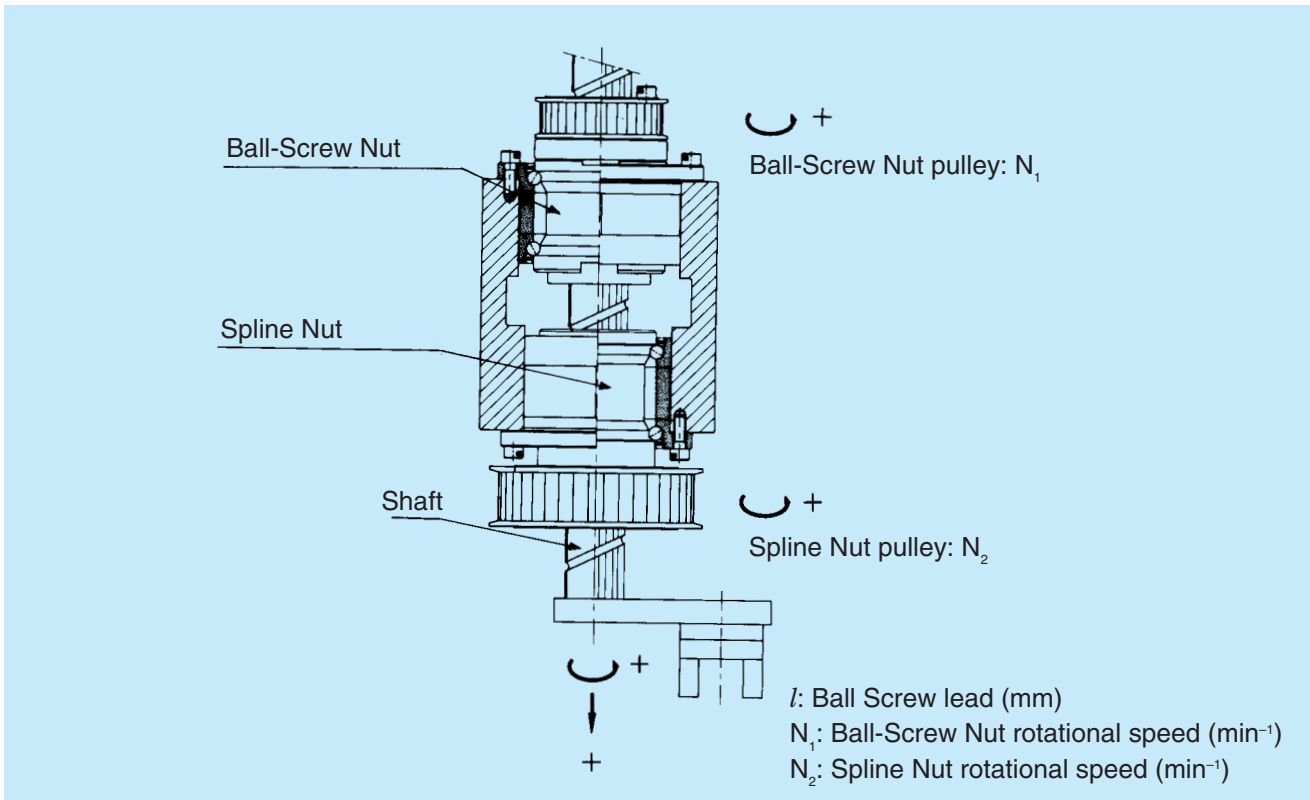
Type NS



[Heavy-load type: For linear motion]

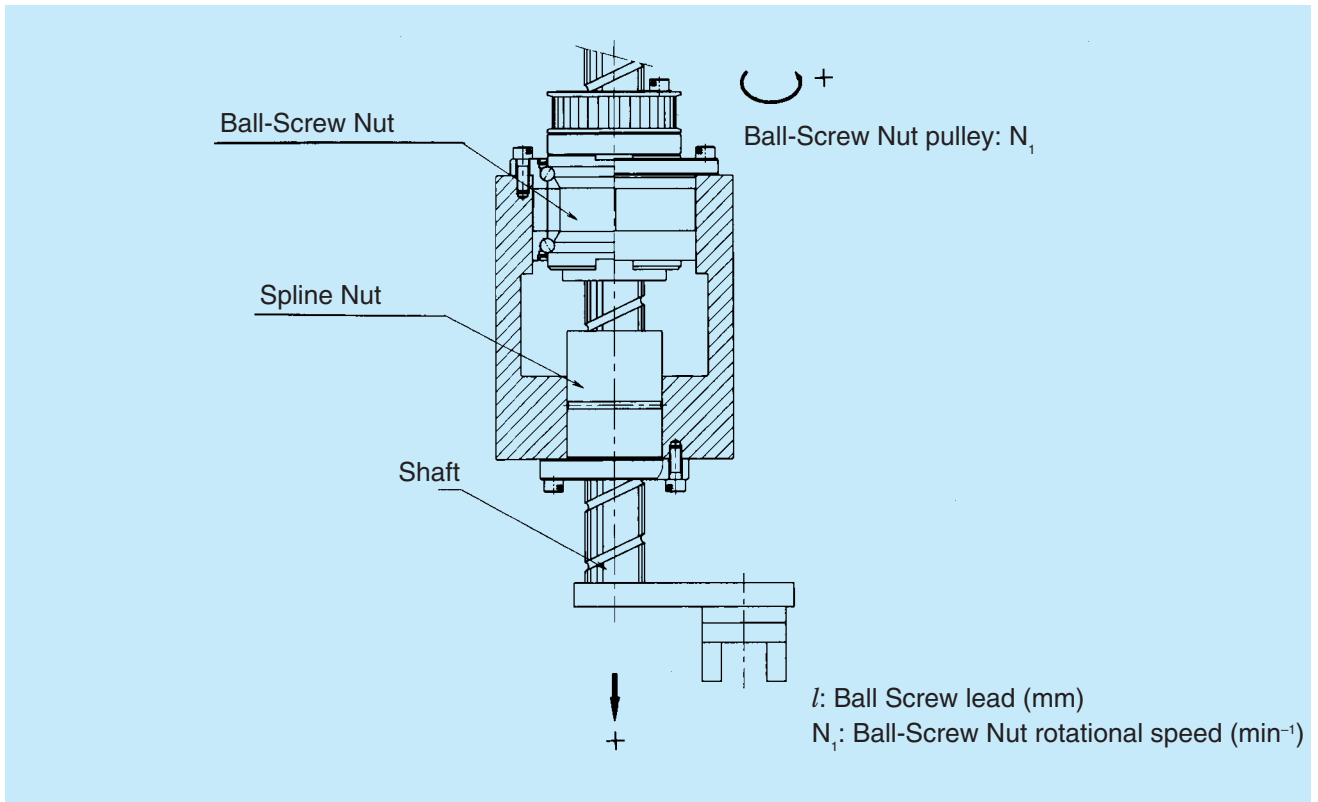
Operation Pattern

1. Type BNS Basic Operation



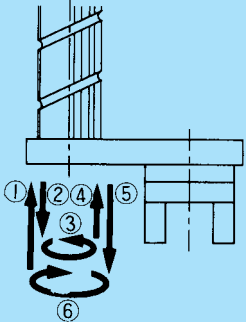
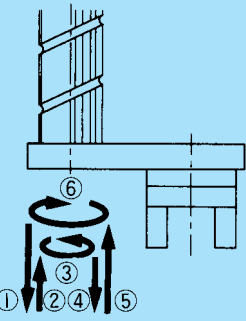
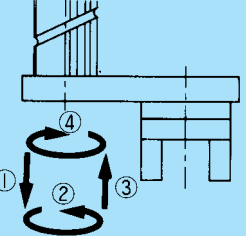
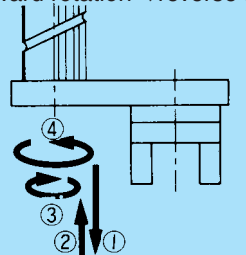
Movement	Moving direction	Input		Shaft movement	
		Ball Screw pulley	Ball Spline pulley	Vertical (speed)	Rotation (speed)
1. Vertical 	① Vertical → downward	N_1 (forward)	0	$V = N_1 \times l$ ($N_1 \neq 0$)	0
	Rotation → 0				
	② Vertical → upward	$-N_1$ (reverse)	0	$V = -N_1 \times l$ ($N_1 \neq 0$)	0
	Rotation → 0				
2. Rotation 	① Vertical → 0	N_1	N_2 (forward)	0	N_2 (forward) ($N_1 = N_2 \neq 0$)
	Rotation → forward				
	② Vertical → 0	$-N_1$	$-N_2$ (reverse)	0	$-N_2$ (reverse) ($-N_1 = N_2 \neq 0$)
	Rotation → reverse				
3. Spiral 	① Vertical → upward	0	N_2 ($N_2 \neq 0$)	$V = N_2 \times l$	N_2 (forward)
	Rotation → forward				
	② Vertical → downward	0	$-N_2$ ($-N_2 \neq 0$)	$V = -N_2 \times l$	$-N_2$ (reverse)
	Rotation → reverse				

2. Type NS Basic Operation

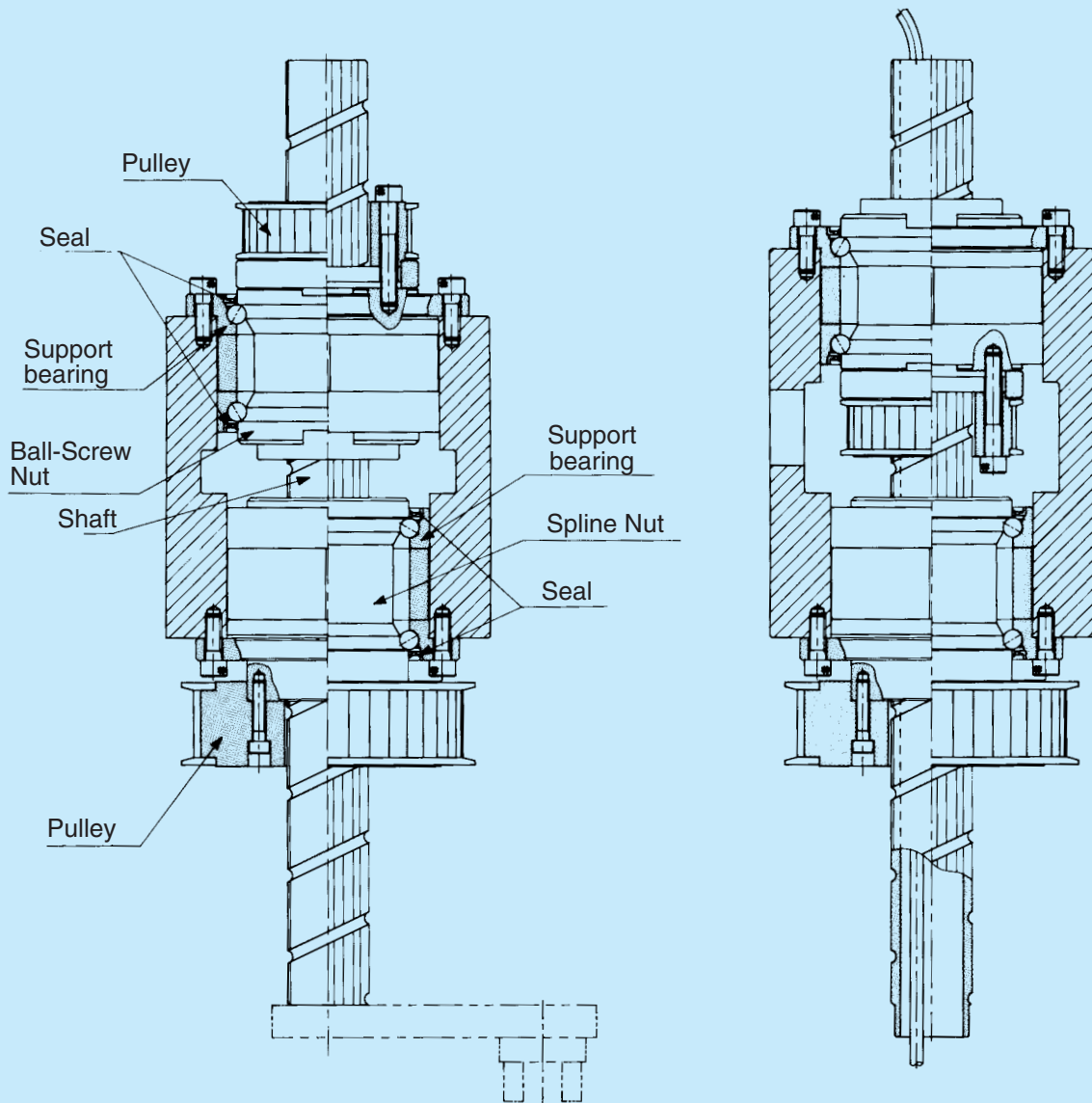


Movement	Moving direction	Input Ball Screw pulley	Shaft movement Vertical (speed)
1. Vertical 	① Vertical→downward	N_1 (forward)	$V = N_1 \times l$ ($N_1 \neq 0$)
	② Vertical→upward	$-N_1$ (reverse)	$V = -N_1 \times l$ ($N_1 \neq 0$)

3. Type BNS Applied Operation

Movement	Moving direction	Input		Shaft movement		
		Ball Screw pulley	Ball Spline pulley	Vertical (speed)	Rotation (speed)	
1. Upward→downward →forward rotation→upward →downward→reverse rotation 	①	Vertical→upward	$-N_1$ (reverse)	0	$V = -N_1 \times l$ ($N_1 \neq 0$)	0
	②	Vertical→downward	N_1 (forward)	0	$V = N_1 \times l$ ($N_1 \neq 0$)	0
	③	Rotation→forward	N_1	N_2 (forward)	0	N_2 (forward) ($N_1=N_2 \neq 0$)
	④	Vertical→upward	$-N_1$	0	$V = -N_1 \times l$ ($N_1 \neq 0$)	0
	⑤	Vertical→downward	N_1	0	$V = N_1 \times l$ ($N_1 \neq 0$)	0
	⑥	Rotation→reverse	$-N_1$	$-N_2$ (reverse)	0	$-N_2$ (reverse) ($-N_1=N_2 \neq 0$)
2. Downward→upward →forward rotation→downward →upward→reverse rotation 	①	Vertical→downward	N_1	0	$V = N_1 \times l$ ($N_1 \neq 0$)	0
	②	Vertical→upward	$-N_1$	0	$V = -N_1 \times l$ ($N_1 \neq 0$)	0
	③	Rotation→forward	N_1	N_2	0	N_2 ($N_1=N_2 \neq 0$)
	④	Vertical→downward	N_1	0	$V = N_1 \times l$ ($N_1 \neq 0$)	0
	⑤	Vertical→upward	$-N_1$	0	$V = -N_1 \times l$ ($N_1 \neq 0$)	0
	⑥	Rotation→reverse	$-N_1$	$-N_2$	0	$-N_2$ ($-N_1=N_2 \neq 0$)
3. Downward→forward rotation →upward→reverse rotation 	①	Vertical→downward	N_1	0	$V = N_1 \times l$ ($N_1 \neq 0$)	0
	②	Rotation→forward	N_1	N_2	0	N_2 ($N_1=N_2 \neq 0$)
	③	Vertical→upward	$-N_1$	0	$V = -N_1 \times l$ ($N_1 \neq 0$)	0
	④	Rotation→reverse	$-N_1$	$-N_2$	0	$-N_2$ ($-N_1=N_2 \neq 0$)
4. Downward→upward →forward rotation→reverse rotation 	①	Vertical→downward	N_1	0	$V = N_1 \times l$ ($N_1 \neq 0$)	0
	②	Vertical→upward	$-N_1$	0	$V = -N_1 \times l$ ($N_1 \neq 0$)	0
	③	Rotation→reverse	$-N_1$	$-N_2$	0	$-N_2$ ($-N_1=N_2 \neq 0$)
	④	Rotation→forward	N_1	N_2	0	N_2 ($N_1=N_2 \neq 0$)

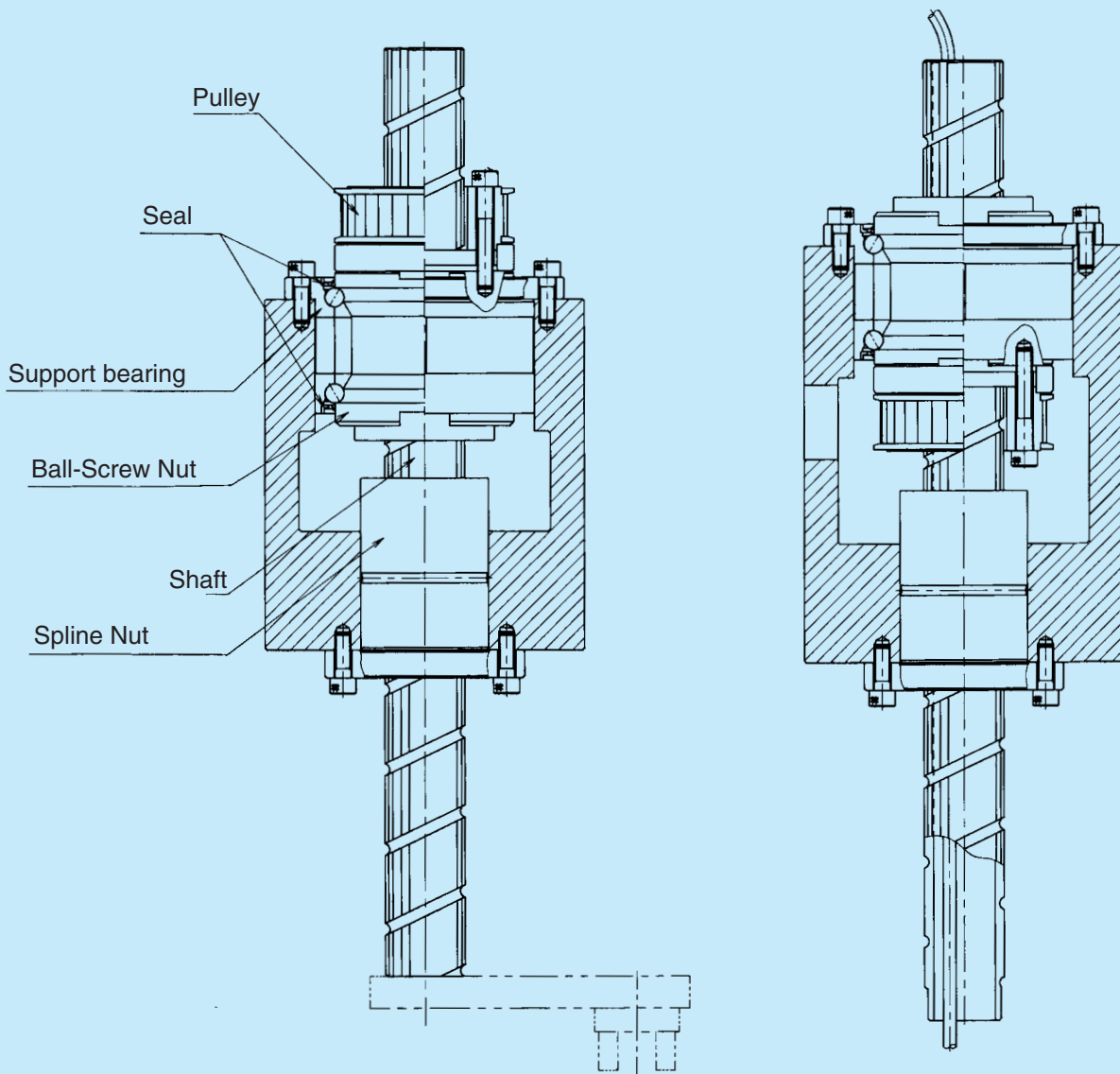
Sample Assembly



An example assembly. The pulleys for the Ball-Screw Nut and Ball-Spline Nut inputs are mounted in the “out/out” mode. The housing length can be minimized.

Assembly in which the Ball-Screw Nut pulley is installed in the housing

Fig. 4 Sample Assembly of Type BNS



Assembly in which the Ball-Screw Nut pulley is installed outside the housing.
The housing length can be minimized.

Assembly in which the Ball-Screw Nut pulley is installed in the housing

Fig. 5 Sample Assembly of Type NS

Accuracy

The Ball-Screw Spline is manufactured to the following specifications.

Ball Screw

Axial clearance : 0 max.

Lead accuracy : C5

(For details on the specifications, see page D-31.)

Ball Spline

Clearance in the rotational direction

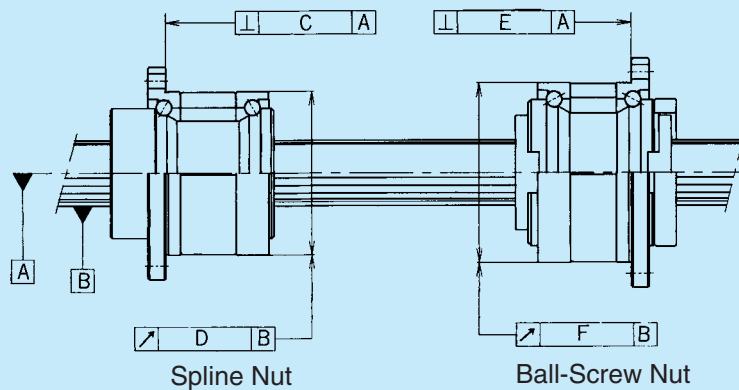
: 0 max. (CL: light preload)

(For details on the specifications, see page B-82 for type BNS and page B-69 for type NS.)

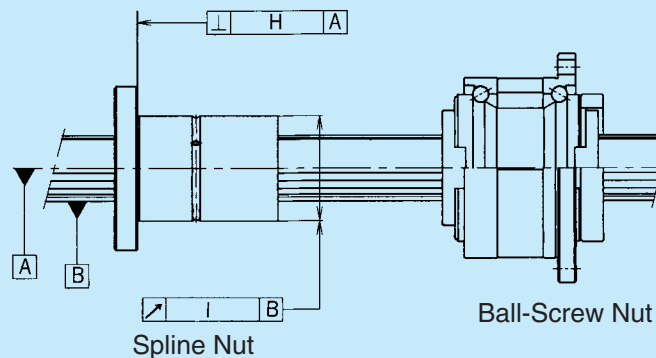
Accuracy grade : H

(For details on the specifications, see page B-33.)

Type BNS



Type NS



Unit: mm

Model No.	C	D	E	F	H	
BNS0812 NS 0812	0.014	0.017	0.014	0.016	0.010	0.013
BNS1015 NS 1015	0.014	0.017	0.014	0.016	0.010	0.013
BNS1616 NS 1616	0.018	0.021	0.016	0.020	0.013	0.016
BNS2020 NS 2020	0.018	0.021	0.016	0.020	0.013	0.016
BNS2525 NS 2525	0.021	0.021	0.018	0.024	0.016	0.016
BNS3232 NS 3232	0.021	0.021	0.018	0.024	0.016	0.016
BNS4040 NS 4040	0.025	0.025	0.021	0.033	0.019	0.019
BNS5050 NS 5050	0.025	0.025	0.021	0.033	0.019	0.019

Lubrication

If grease is to be fed to the Ball-Screw Spline, a greasing plate must be assembled in the housing in advance.

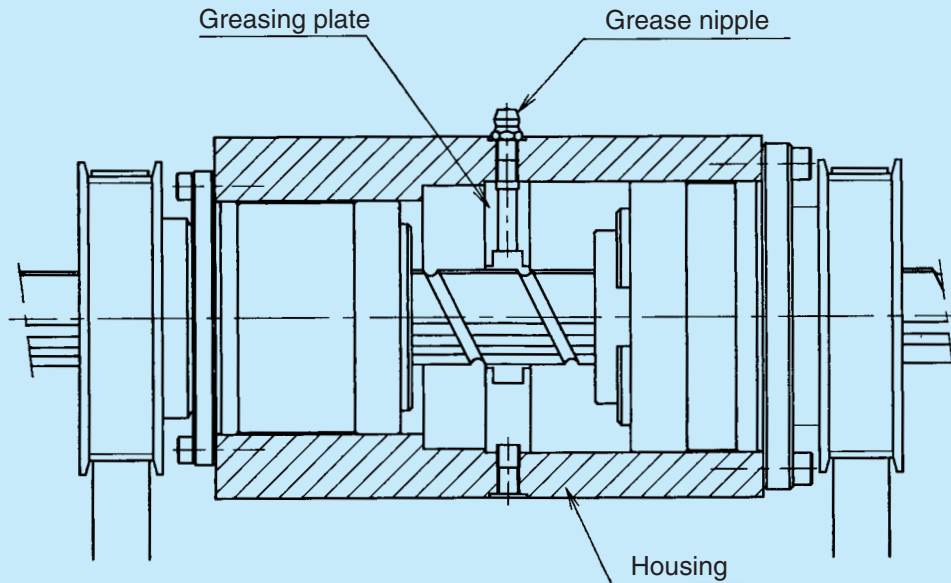


Fig. 6 Lubrication Method

Model-Number Coding

The chief specifications of the Ball-Screw Spline are indicated in the model number. When contacting us to receive a price quote or order a product, or for any other reason, specify the desired model number (given below) and provide any relevant drawings to ensure a prompt reply.

- Ball-Screw Spline
 $\frac{\text{BNS2020}}{(1)} + \frac{400\text{L}}{(2)}$

- (1) Model number
 (2) Shaft overall length (mm)

Table 1 BNS Screw-Shaft Inertial Moment

Model No.	J kgcm ² /mm
BNS 1616	3.92×10^{-4}
BNS 2020	9.37×10^{-4}
BNS 2525	2.20×10^{-3}
BNS 3232	5.92×10^{-3}
BNS 4040	1.43×10^{-2}
BNS 5050	3.52×10^{-2}

Application Example

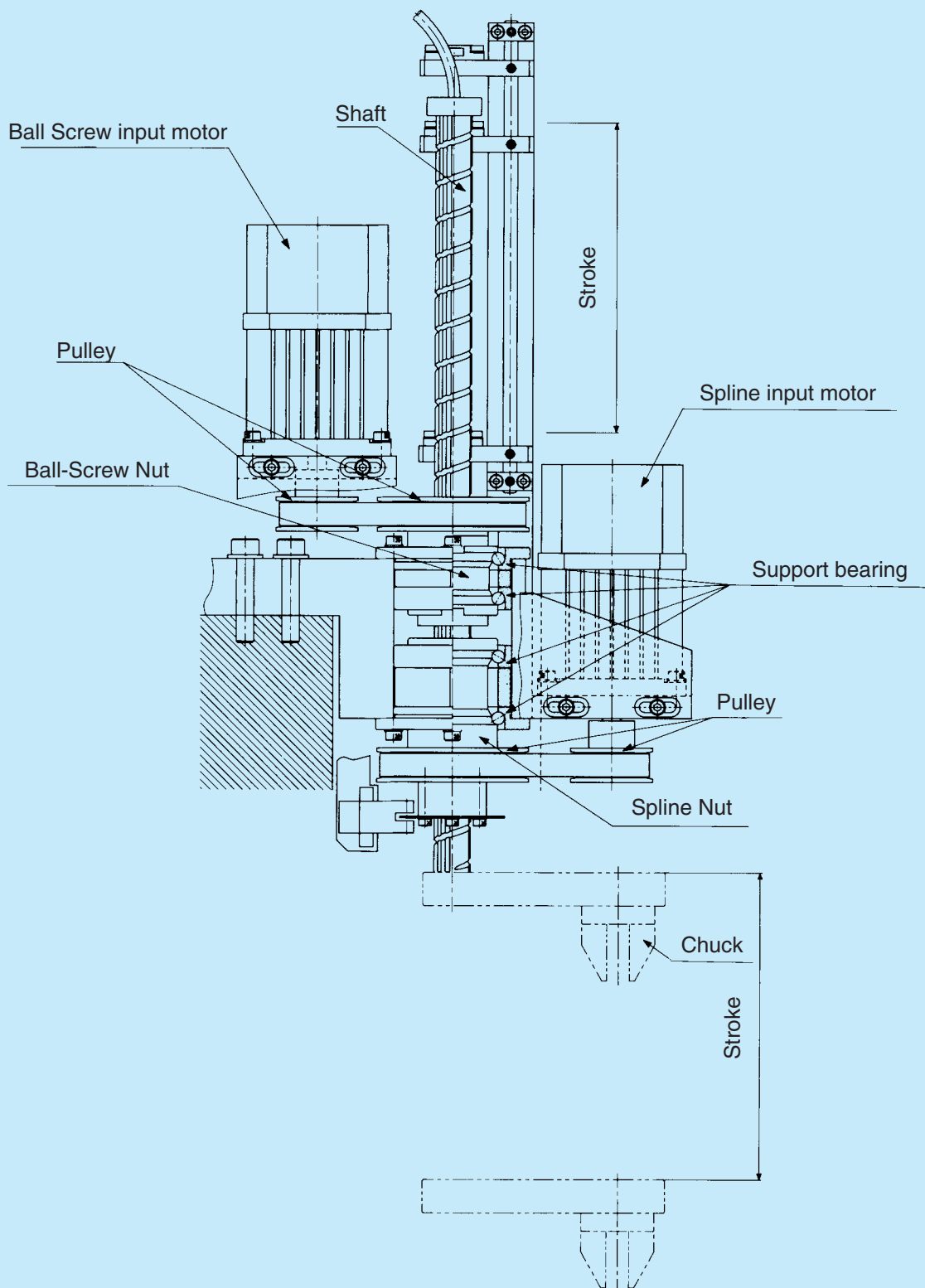
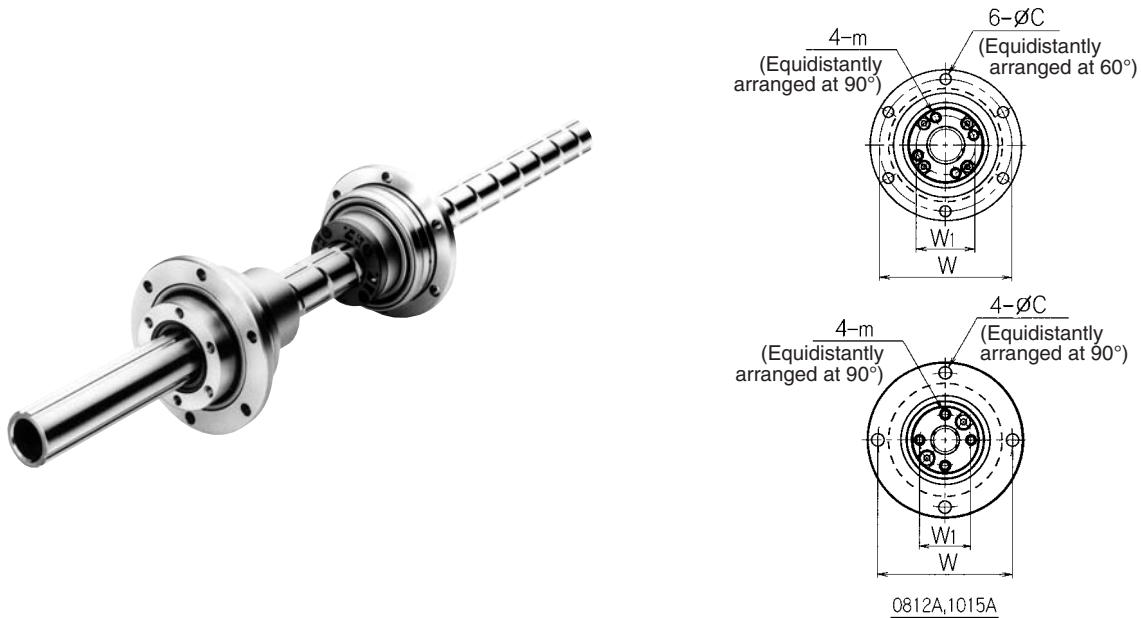


Fig. 7 Application Example of Type BNS

Type BNS-A (Compact Type: For Rotational Motion + Linear Motion)

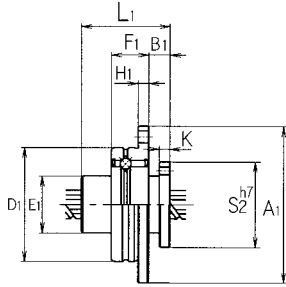
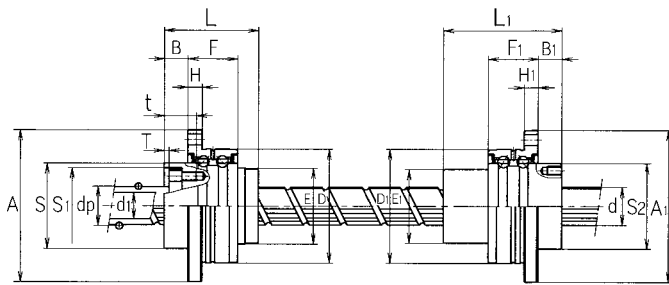


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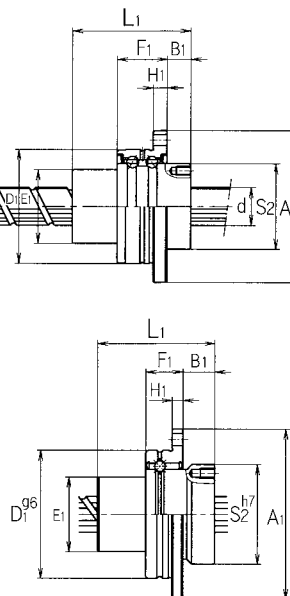
Model No.	Screw shaft OD d	Screw shaft ID d ₁	Lead l	Ball Screw dimensions							
				Basic load rating		Ball center-to-center diameter dp	OD D ^{g6}	Flange diameter A	Overall length L	S ^{h7}	S ₁ ^{h7}
C _a kN	C _{0a} kN										
BNS 0812A	8	-	12	1.1	1.8	8.4	32	44	28.5	22	19
BNS 1015A	10	-	15	1.7	2.7	10.5	36	48	34.5	26	23
BNS 1616A	16	11	16	3.9	7.2	16.65	48	64	40	36	32
BNS 2020A	20	14	20	6.1	12.3	20.75	56	72	48	43.5	39
BNS 2525A	25	18	25	9.1	19.3	26.0	66	86	58	52	47
BNS 3232A	32	23	32	13.0	29.8	33.25	78	103	72	63	58
BNS 4040A	40	29	40	21.4	49.7	41.75	100	130	88	79.5	73

Model No.	Ball Spline dimensions									
	Basic load rating		Static permissible moment M _A Nm	Basic torque rating		OD D ₁ ^{g6}	Flange diameter A ₁	Overall length L ₁	S ₂ ^{h7}	E ₁
C kN	C ₀ kN	C _T Nm		C _{0T} Nm						
BNS 0812A	1.5	2.6	5.9	2.0	2.9	32	44	25	24	16
BNS 1015A	2.7	4.9	15.7	3.9	7.8	36	48	33	28	21
BNS 1616A	7.1	12.6	67.6	31.3	34.3	48	64	50	36	31
BNS 2020A	10.2	17.8	118	56.8	55.8	56	72	63	43.5	35
BNS 2525A	15.2	25.8	210	105	103	66	86	71	52	42
BNS 3232A	20.5	34.0	290	180	157	78	103	80	63	52
BNS 4040A	37.8	60.4	687	418	377	100	130	100	79.5	64

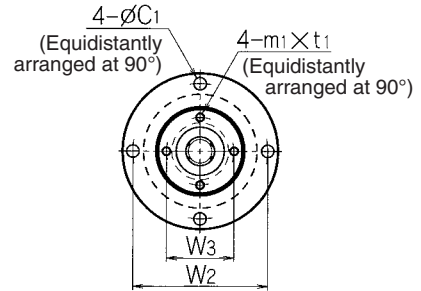
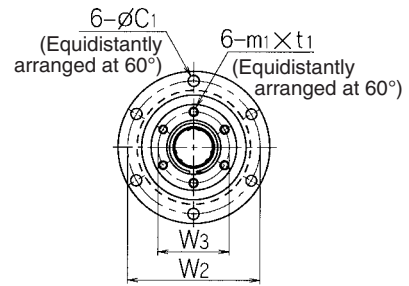
Note: • For model-number coding, see page D-256.



BNS0812A



BNS1015A

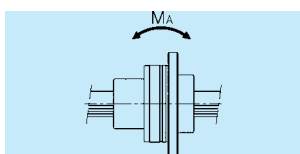


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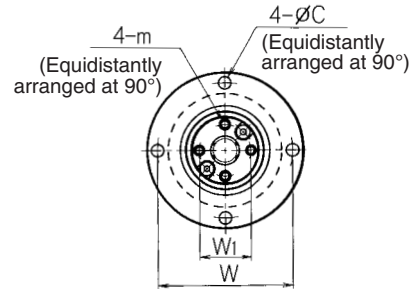
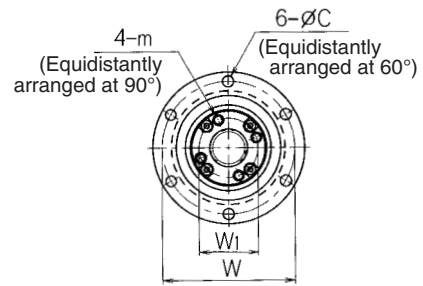
Unit: mm

E	H	F	B	T	W	W ₁	m	t	C	Support-bearing basic load rating		Nut inertial moment kgcm ²
										C _a kN	C _{0a} kN	
19	3	10.5	7	1.5	38	14.5	M2.6	10	3.4	0.8	0.5	0.03
23	3	10.5	8	1.5	42	18	M3 × 0.5	11.5	3.4	0.9	0.7	0.08
32	6	21	10	2	56	25	M4 × 0.7	13.5	4.5	8.7	10.5	0.35
39	6	21	11	2.5	64	31	M5 × 0.8	16.5	4.5	9.7	13.4	0.85
47	7	25	13	3	75	38	M6	20	5.5	12.7	18.2	2.12
58	8	25	14	3	89	48	M6	21	6.6	13.6	22.3	5.42
73	10	33	16.5	3	113	61	M8	24.5	9	21.5	36.8	17.2

H ₁	F ₁	B ₁	K	W ₂	W ₃	m ₁ × t ₁	C ₁	Support-bearing basic load rating		Spline Nut inertial moment kgcm ²
								C _a kN	C _{0a} kN	
3	10.5	6	3	38	19	M2.6 × 3	3.4	0.6	0.2	0.03
3	10.5	9	-	42	23	M3 × 0.5 × 4	3.4	0.8	0.3	0.08
6	21	10	-	56	30	M4 × 0.7 × 6	4.5	6.7	6.4	0.44
6	21	12	-	64	36	M5 × 0.8 × 8	4.5	7.4	7.8	0.99
7	25	13	-	75	44	M5 × 0.8 × 8	5.5	9.7	10.6	2.20
8	25	17	-	89	54	M6 × 10	6.6	10.5	12.5	5.17
10	33	20	-	113	68	M6 × 10	9	16.5	20.7	16.1



Type NS-A (Compact Type: For Linear Motion)

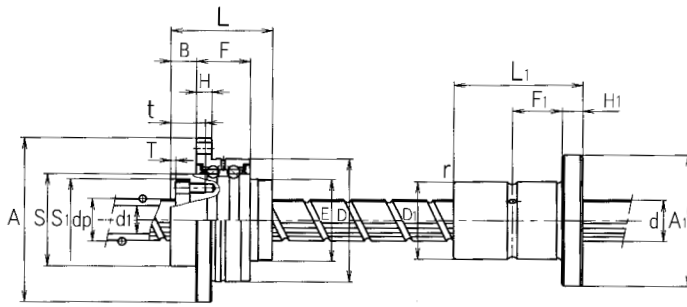


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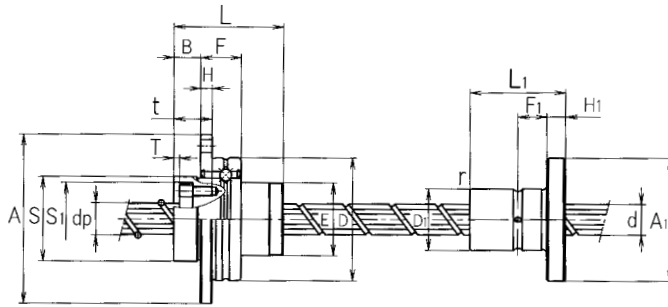
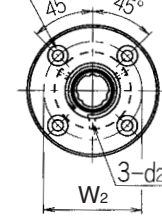
Model No.	Screw shaft OD d	Screw shaft ID d ₁	Lead l	Ball Spline dimensions							
				Basic load rating		Ball center-to-center diameter dp	OD D ^{g6}	Flange diameter A	Overall length L	S ^{h7}	S ₁ ^{h7}
C _a kN	C _{0a} kN	C _a kN	C _{0a} kN	C _a kN	C _{0a} kN						
NS 0812A	8	-	12	1.1	1.8	8.4	32	44	28.5	22	19
NS 1015A	10	-	15	1.7	2.7	10.5	36	48	34.5	26	23
NS 1616A	16	11	16	3.9	7.2	16.65	48	64	40	36	32
NS 2020A	20	14	20	6.1	12.3	20.75	56	72	48	43.5	39
NS 2525A	25	18	25	9.1	19.3	26.0	66	86	58	52	47
NS 3232A	32	23	32	13.0	29.8	33.25	78	103	72	63	58
NS 4040A	40	29	40	21.4	49.7	41.75	100	130	88	79.5	73

Model No.	Ball Spline dimensions							
	Basic load rating		Static permissible moment M _A Nm	Basic torque rating		OD D ₁	Flange diameter A ₁ ^{0.2}	
C kN	C ₀ kN	C _T Nm		C _{0T} Nm				
NS 0812A	1.5	2.6	5.9	2.0	2.9	16 ⁰ _{-0.011}	32	
NS 1015A	2.8	4.9	15.7	3.9	7.8	21 ⁰ _{-0.013}	42	
NS 1616A	7.1	12.6	67.6	31.4	34.3	31 ⁰ _{-0.013}	51	
NS 2020A	10.2	17.8	118	56.8	55.8	35 ⁰ _{-0.016}	58	
NS 2525A	15.2	25.8	210	105	103	42 ⁰ _{-0.016}	65	
NS 3232A	20.5	34.0	290	180	157	49 ⁰ _{-0.016}	77	
NS 4040A	37.8	60.4	687	418	377	64 ⁰ _{-0.019}	100	

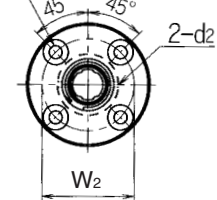
Note: • For model-number coding, see page D-256.



4-X drill ϕY counter bore depth Z
(Equidistantly arranged at 90°)



4-X drill ϕY counter bore depth Z
(Equidistantly arranged at 90°)

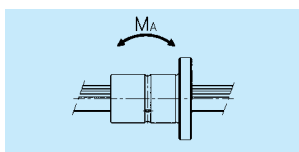


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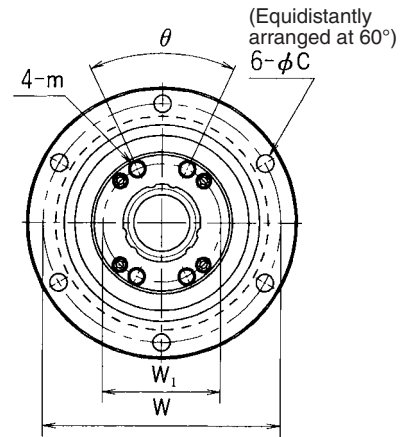
Unit: mm

E	H	F	B	T	W	W ₁	m	t	C	Support-bearing basic load rating		Nut inertial moment kgcm ²
										Ca kN	Coa kN	
19	3	10.5	7	1.5	38	14.5	M2.6	10	3.4	0.8	0.5	0.03
23	3	10.5	8	1.5	42	18	M3 × 0.5	11.5	3.4	0.9	0.7	0.08
32	6	21	10	2	56	25	M4 × 0.7	13.5	4.5	8.7	10.5	0.35
39	6	21	11	2.5	64	31	M5 × 0.8	16.5	4.5	9.7	13.4	0.85
47	7	25	13	3	75	38	M6	20	5.5	12.7	18.2	2.12
58	8	25	14	3	89	48	M6	21	6.6	13.6	22.3	5.42
73	10	33	16.5	3	113	61	M8	24.5	9	21.5	36.8	17.2

Overall length L ₁	H ₁	F ₁	r	d ₂	W ₂	Mounting hole		
						X	Y	Z
25	5	7.5	0.5	1.5	24	3.4	6.5	3.3
33	6	10.5	0.5	1.5	32	4.5	8	4.4
50 ⁰ _{-0.2}	7	18	0.5	2	40	4.5	8	4.4
63 ⁰ _{-0.2}	9	22.5	0.5	2	45	5.5	9.5	5.4
71 ⁰ _{-0.3}	9	26.5	0.5	3	52	5.5	9.5	5.4
80 ⁰ _{-0.3}	10	30	0.5	3	62	6.6	11	6.5
100 ⁰ _{-0.3}	14	36	0.5	4	82	9	14	8.6



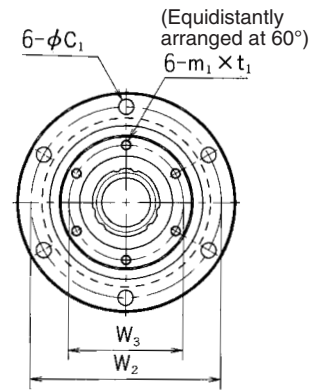
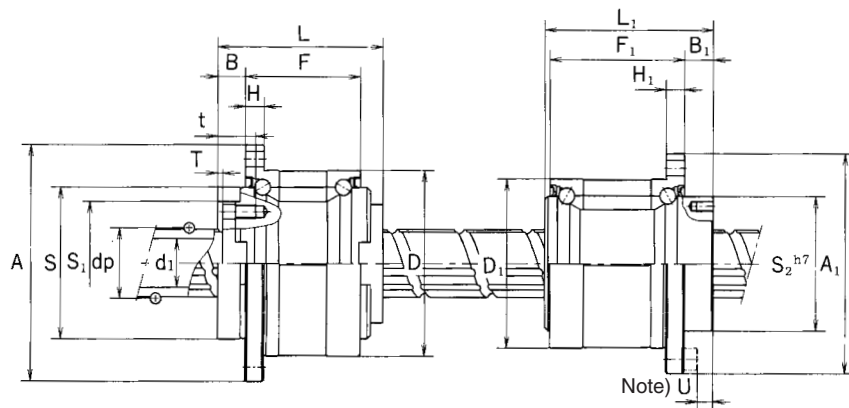
Type BNS (Heavy-Load Type: For Rotational Motion + Linear Motion)



Model No.	Screw shaft OD d	Screw-shaft ID d ₁	Lead l	Basic load rating		Ball center-to-center diameter dp	Ball Spline dimensions			
				C _a kN	C _{0a} kN		OD D	Flange diameter A	Overall length L	S ^{h7}
BNS 1616	16	11	16	3.9	7.2	16.65	52 ⁰ _{-0.007}	68	43.5	40
BNS 2020	20	14	20	6.1	12.3	20.75	62 ⁰ _{-0.007}	78	54	50
BNS 2525	25	18	25	9.1	19.3	26.0	72 ⁰ _{-0.007}	92	65	58
BNS 3232	32	23	32	13.0	29.8	33.25	80 ⁰ _{-0.007}	105	80	66
BNS 4040	40	29	40	21.4	49.7	41.75	110 ⁰ _{-0.008}	140	98	90
BNS 5050	50	36	50	31.8	77.6	52.2	120 ⁰ _{-0.008}	156	126	100

Model No.	Basic load rating		Static permissible moment M _A Nm	Basic torque rating		OD D ₁	Flange diameter A ₁	Overall length L ₁
	C kN	C ₀ kN		C _T Nm	C _{0T} Nm			
BNS 1616	7.1	12.6	67.6	31.3	34.3	52 ⁰ _{-0.007}	68	50
BNS 2020	10.2	17.8	118	56.8	55.8	56 ⁰ _{-0.007}	72	63
BNS 2525	15.2	25.8	210	105	103	62 ⁰ _{-0.007}	78	71
BNS 3232	20.5	34.0	290	180	157	80 ⁰ _{-0.007}	105	80
BNS 4040	37.8	60.4	687	418	377	100 ⁰ _{-0.008}	130	100
BNS 5050	60.8	94.5	1340	842	768	120 ⁰ _{-0.008}	156	125

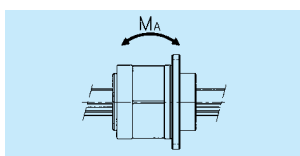
- Notes:
- Dimension U refers to the distance from the head of the hexagon socket button head screw to the Nut end face.
 - For model-number coding, see page D-256.



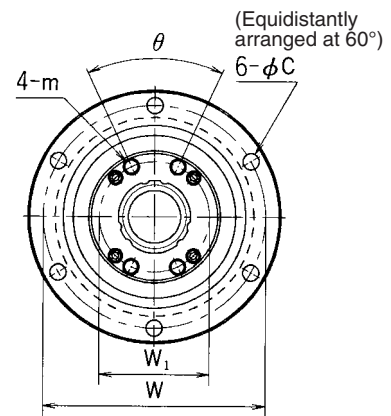
Unit: mm

S_1^{H7}	H	F	B	T	W	W_1	m	t	C	θ°	Support-bearing basic load rating		Nut inertial moment
											C_a kN	C_{oa} kN	kgcm ²
32	5	27.5	9	2	60	25	M4 × 0.7	12	4.5	40	19.4	19.2	0.48
39	6	34	11	2	70	31	M5 × 0.8	16	4.5	40	26.8	29.3	1.44
47	8	43	12.5	3	81	38	M 6	19	5.5	40	28.2	33.3	3.23
58	9	55	14	3	91	48	M 6	19	6.6	40	30.0	39.0	6.74
73	11	68	16.5	3	123	61	M 8	22	9	50	59.3	74.1	27.9
90	12	80	25	4	136	75	M10	28	11	50	62.2	83.0	58.2

S_2^{H7}	H_1	F_1	B_1	W_2	W_3	$m_1 \times t_1$	C_1	U	Support-bearing basic load rating		Nut inertial moment
									C kN	C_o kN	kgcm ²
39.5	5	37	10	60	32	M 5 × 8	4.5	5	12.7	11.8	0.52
43.5	6	48	12	64	36	M 5 × 8	4.5	7	16.2	15.5	0.87
53	6	55	13	70	45	M 6 × 8	4.5	8	17.6	18.0	1.72
65.5	9	60	17	91	55	M 6 × 10	6.6	10	20.1	24.0	5.61
79.5	11	74	23	113	68	M 6 × 10	9	13	37.2	42.5	14.7
99.5	12	97	25	136	85	M10 × 15	11	13	41.6	54.1	62.5

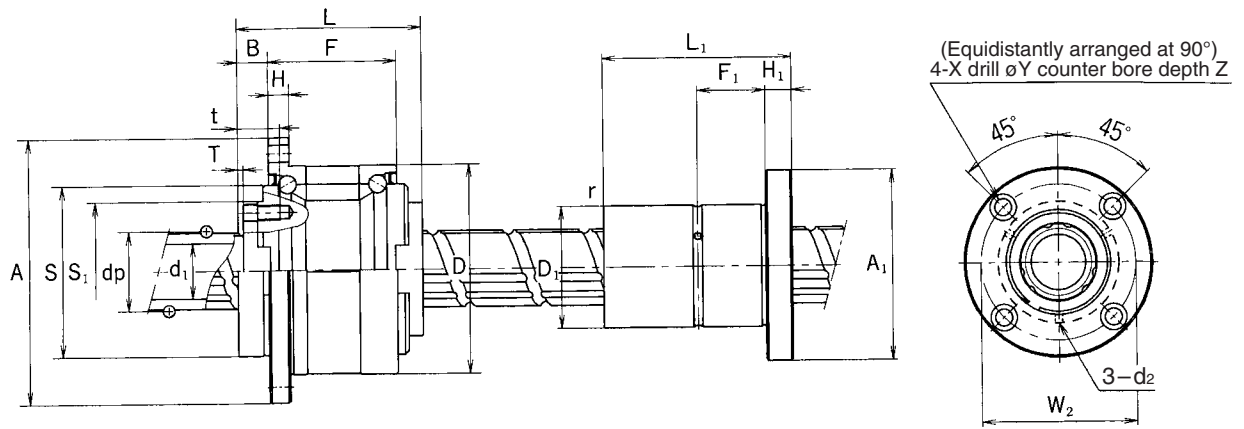


Type NS (Heavy-Load Type: For Linear Motion)



Movement	Moving direction	Input		Shaft movement	
		Ball Screw pulley	Ball Spline pulley	Vertical (speed)	Rotation (speed)
1. Vertical	① Vertical→ downward	N_1 (forward)	0	$V = N_1 \times l$ ($N_1 \neq 0$)	0
	Rotation→0				
	② Vertical→ upward	$-N_1$ (reverse)	0	$V = -N_1 \times l$ ($N_1 \neq 0$)	0
	Rotation→0				
2. Rotation	① Vertical→0	N_1	N_2 (forward)	0	N_2 (forward) ($N_1=N_2 \neq 0$)
	Rotation→ forward				
	② Vertical→0	$-N_1$	$-N_2$ (reverse)	0	$-N_2$ (reverse) ($-N_1=N_2 \neq 0$)
	Rotation→ reverse				
3. Spiral	① Vertical→ upward	0	N_2 ($N_2 \neq 0$)	$V = N_2 \times l$	N_2 (forward)
	Rotation→ forward				
	② Vertical→ downward	0	$-N_2$ ($-N_2 \neq 0$)	$V = -N_2 \times l$	$-N_2$ (reverse)
	Rotation→ reverse				

Note: • For model-number coding, see page D-256.



Unit: mm

S_1^{H7}	H	F	B	T	W	W_1	m	t	C	θ°	Support-bearing basic load rating		Nut inertial moment kgcm ²
											C_a kN	C_{oa} kN	
32	5	27.5	9	2	60	25	M4	12	4.5	40	19.4	19.2	0.48
39	6	34	11	2	70	31	M5	16	4.5	40	26.8	29.3	1.44
47	8	43	12.5	3	81	38	M6	19	5.5	40	28.2	33.3	3.23
58	9	55	14	3	91	48	M6	19	6.6	40	30.0	39.0	6.74
73	11	68	16.5	3	123	61	M8	22	9	50	59.3	74.1	27.9
90	12	80	25	4	136	75	M10	28	11	50	62.2	83.0	58.2

Flange diameter A_1	Overall length L_1	H_1	F_1	r	d_2	W_2	Mounting hole		
							X	Y	Z
51	$50_{-0.2}^0$	7	18	0.5	2	40	4.5	8	4.4
58	$63_{-0.2}^0$	9	22.5	0.5	2	45	5.5	9.5	5.4
65	$71_{-0.3}^0$	9	26.5	0.5	3	52	5.5	9.5	5.4
77	$80_{-0.3}^0$	10	30	0.5	3	62	6.9	11	6.5
100	$100_{-0.3}^0$	14	36	0.5	4	82	9	14	8.6
124	$125_{-0.3}^0$	16	46.5	1	4	102	11	17.5	11

