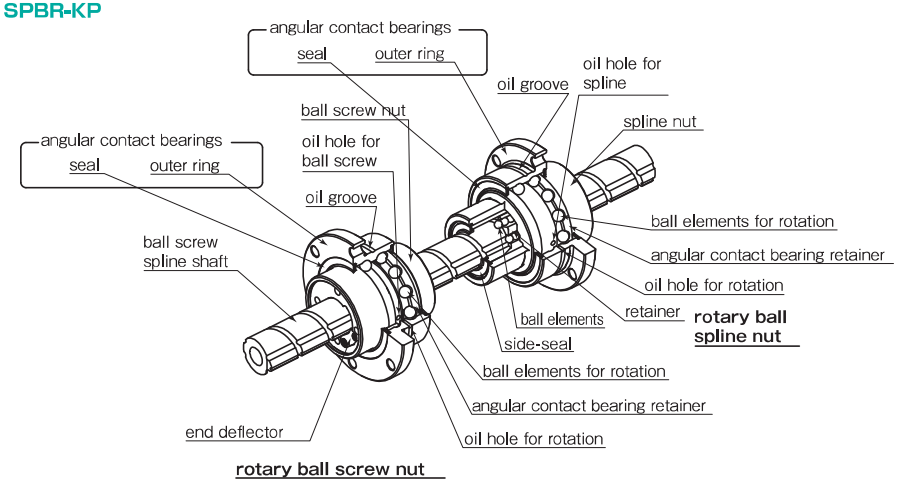
BALL SCREW SPLINE

STRUCTURE AND ADVANTAGES

The NB Ball Screw Spline consists of a highly accurate and highly rigid Ball Screw nut and Ball Spline nut attached to the ball screw spline shaft which has a screw groove and spline grooves.
SPBR type has a Rotary Ball Screw nut and Rotary Ball Spline nut.
Rotary Ball Screw nut is an integration of ball screw nut and angular contact bearings.
Rotary Ball Spline nut is an integration of ball spline nut and angular contact bearings.
SPBF type has a Rotary Ball Screw nut and a Ball Spline nut.
A single axis of the NB Ball Screw Spline can provide positioning, linear and rotary motion as well as combined spiral motion.
The typical applications are SCARA robot, assembly machine, loader, etc.

Figure B-47 Structure of SPBR-KP type, SPBF-KP type

SPBR-KP



SPBF-KP

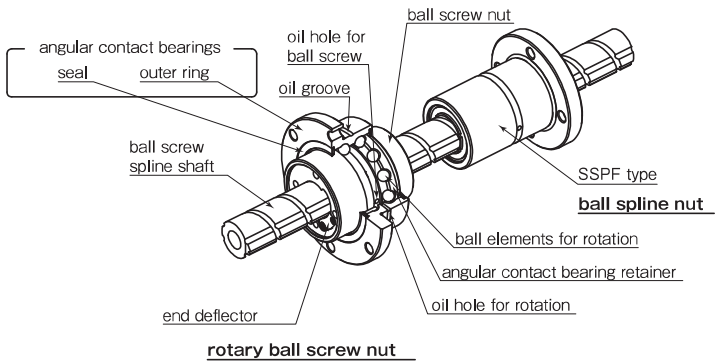
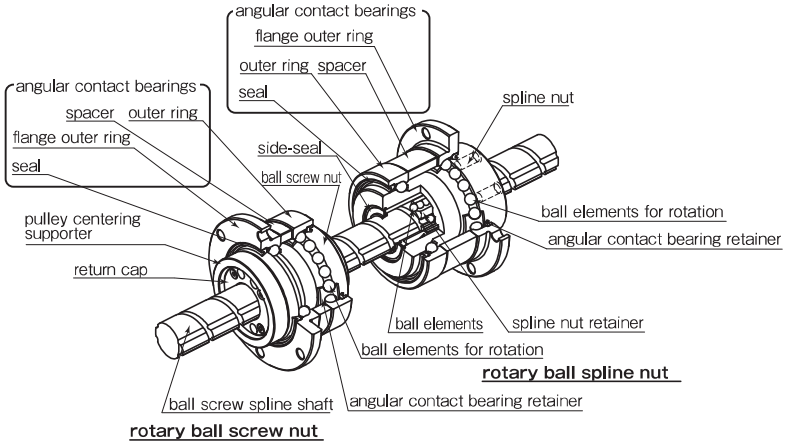
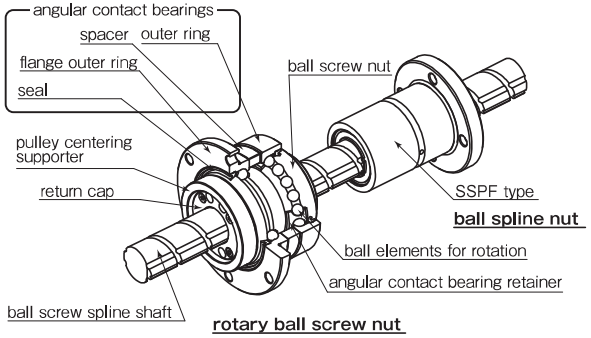


Figure B-48 Structure of SPBR type, SPBF type

SPBR type



SPBF type



SPECIFICATION

Refer to table B-40 for NB ball screw spline material and operating temperature range.

Table B-40 Material and Operating Temperature Range

type	nut		spline shaft	operating temperature range
	outer cylinder	return cap /retainer		
SPBR	steel	resin	steel	− 20℃~ 80℃
SPBF				

PRELOAD

The preload is properly adjusted for the ball screw nut, spline nut, and angular contact bearings.
Please contact NB for preload specification.

USE AND HANDLING PRECAUTIONS

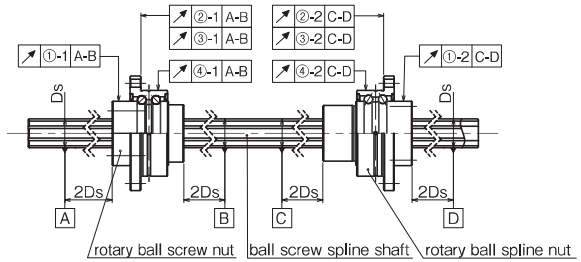
- Please do not adjust the spacer for SPBR and SPBF type. The spacer is adjusted to provide a proper spacing for the best preload condition.
- Please do not remove the Rotary Ball Screw nut from the shaft. There is no ball-retainer in the Rotary Ball Screw nut.
- Please use the pulley centering supporter when attaching the pulley to the return-cap for SPBR and SPBF type.

ACCURACY

The NB Ball Screw Spline is measured for accuracy at the points shown in Figure B-49.

Figure B-49 Accuracy Measurement points

SPBR-KP type



SPBF-KP type

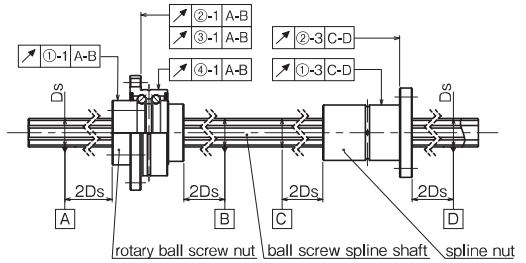


Table B-41 Tolerance of Spline Shaft Groove Torsion (Max.)

tolerance
13μm/100mm

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

Table B-42 Grade of Ball Screw Groove

C5

Applied to lead angle accuracy only

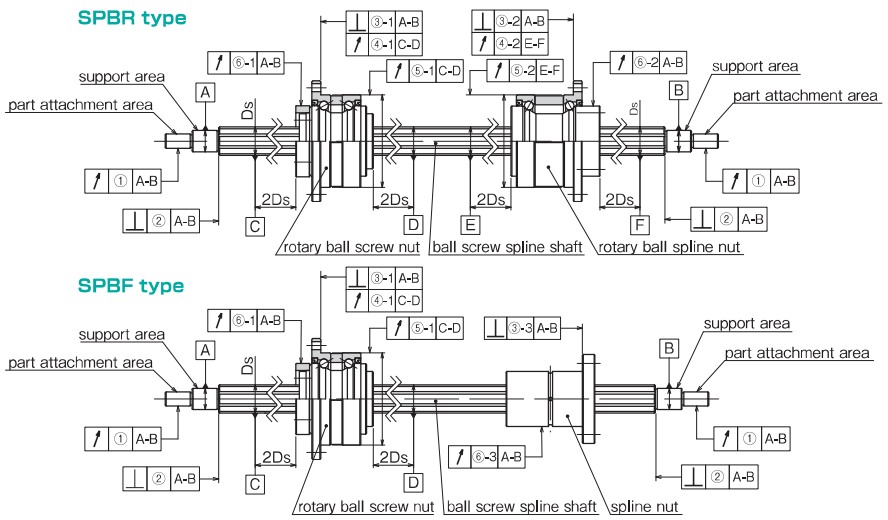
Table B-43 Accuracy tolerance of each component (Max.) unit: μm

part number	① radial runout of the outer surface			② radial runout of flange attachment surface		
	①-1	①-2	①-3	②-1	②-2	②-3
SPBR16KP,SPBF16KP	15	33	33	16	18	13
SPBR20KP,SPBF20KP	19	39	39			
SPBR25KP,SPBF25KP				18	21	16

Table B-44 Accuracy tolerance during rotational movement of angular rotating area (Max.) unit: μm

part number	③ radial runout of flange mounting side		④ radial runout of outer ring	
	③-1	③-2	④-1	④-2
SPBR16KP	8	8	9	9
SPBR20KP			10	10
SPBR25KP				

Figure B-50 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.
④、⑤indicate radial runout of rotational movement of angular rotating area.

Table B-45 Tolerance of Spline Shaft Groove Torsion (Max.)

tolerance
13μm/100mm

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

Table B-46 Grade of Ball Screw Groove

C5
Applied to lead angle accuracy only

Table B-47 Tolerance Relative to Spline Support Area (Max.) unit: μm

part number	① radial runout of the component attachment area	② radial runout of the spline shaft surface (Applicable only for ground shaft)	③ radial runout of flange attachment surface		
			③-1	③-2	③-3
SPBR16,SPBF16	19	11	16	18	13
SPBR20,SPBF20					
SPBR25,SPBF25	22	13	18	21	16

Table B-48 Accuracy tolerance during rotational movement of angular rotating area (Max.) unit: μm

part number	④ radial runout of flange mounting side		⑤ radial runout of outer ring	
	④-1	④-2	⑤-1	⑤-2
SPBR16	8	8	9	9
SPBR20			10	10
SPBR25				

Table B-49 Radial Runout of Spline Nut Relative to Spline Support Area (Max.) unit: μm

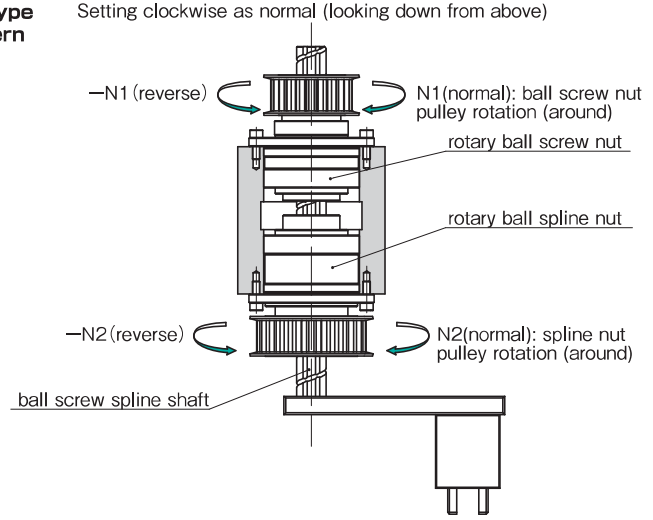
ball screw spline shaft total length (mm)		part number:SPBR,SPBF			
		⑥-1		⑥-2,-3	
greater than	or less	16,20	25	16,20	25
—	200	40	35	18	18
200	315	45	40	25	21
315	400	55	45	31	25
400	500	60	50	38	29
500	630	75	60	46	34
630	800	90	70	58	42
800	1,000	120	85	75	52

SPBR (-KP) TYPE MOTION PATTERN

One set of SPBR(-KP) type can handle linear, rotational, and spiral motion.

SPBR(-KP) type Motion Pattern

Setting clockwise as normal (looking down from above)



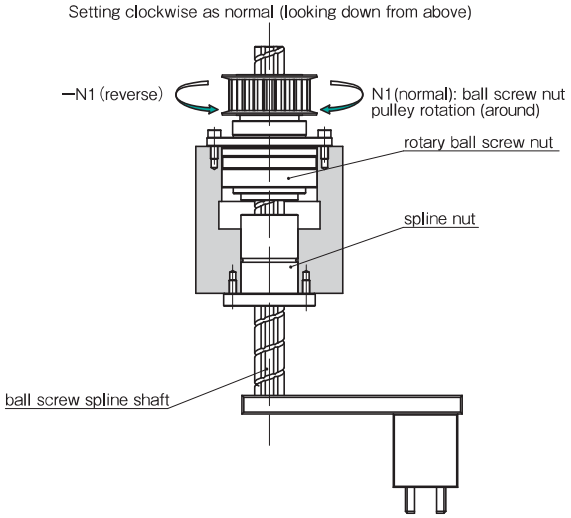
motion	input		output		
	ball screw nut	spline nut	motion direction	travel distance (linear direction)	revolution (rotational direction)
1.up・down	N_1 (normal)	0	①	$L=N_1 \cdot R$ (up)	0
	$-N_1$ (reverse)	0	②	$L=-N_1 \cdot R$ (down)	0
2.rotation	$N_1=N_2$ (normal)	(normal)	①	0	N_2 (normal)
	$-N_1=-N_2$ (reverse)	(reverse)	②	0	$-N_2$ (reverse)
3.spiral	0	N_2 (normal)	①	$L=N_2 \cdot R$ (down)	N_2 (normal)
	0	$-N_2$ (reverse)	②	$L=-N_2 \cdot R$ (up)	$-N_2$ (reverse)
	N_1 (normal) $-N_1$ (reverse)	N_2 (normal)	①	$L=(N_2-(\pm N_1)) \cdot R$ in case of $N_2-(\pm N_1)>0$ (down)	N_2 (normal)
			④	in case of $N_2-(\pm N_1)<0$ (up)	
		$-N_2$ (reverse)	③	$L=(-N_2-(\pm N_1)) \cdot R$ in case of $-N_2-(\pm N_1)>0$ (down)	$-N_2$ (reverse)
			②	in case of $-N_2-(\pm N_1)<0$ (up)	

L : travel distance [mm] R : ball screw lead [mm] N1 : ball screw nut pulley rotation (around) N2 : ball spline nut pulley rotation (around)

SPBF (-KP) TYPE MOTION PATTERN

SPBF(-KP) type can handle linear motion.

SPBF(-KP) type Motion Pattern



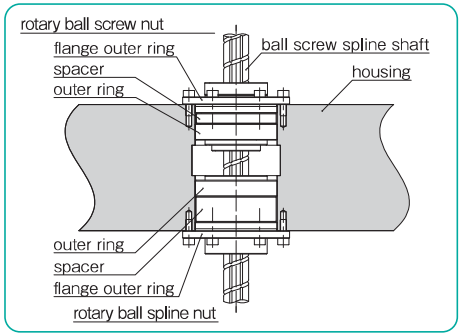
motion	input	output	
	ball screw nut	motion direction	travel distance (linear direction)
1.up・down ② ①	N_1 (normal)	①	$L=N_1 \cdot R$ (up)
	$-N_1$ (reverse)	②	$L=-N_1 \cdot R$ (down)

L : travel distance [mm]　R : ball screw lead [mm]　N1 : ball screw nut pulley rotation (around)

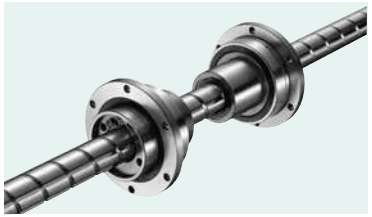
MOUNTING

For SPBR and SPBF types, please finish the holes of the housing with H7 tolerance as shown in Figure B-51 and ensure that both the flange outer ring and outer ring are inserted into the housing. If the flange is not inserted deeply, it may not be able to receive the load properly, or if only the flange outer ring is inserted deeply, the spacer may slip out, which may reduce the accuracy and make it unusable.

Figure B-51　Mounting of SPBR type



SPBR-KP TYPE

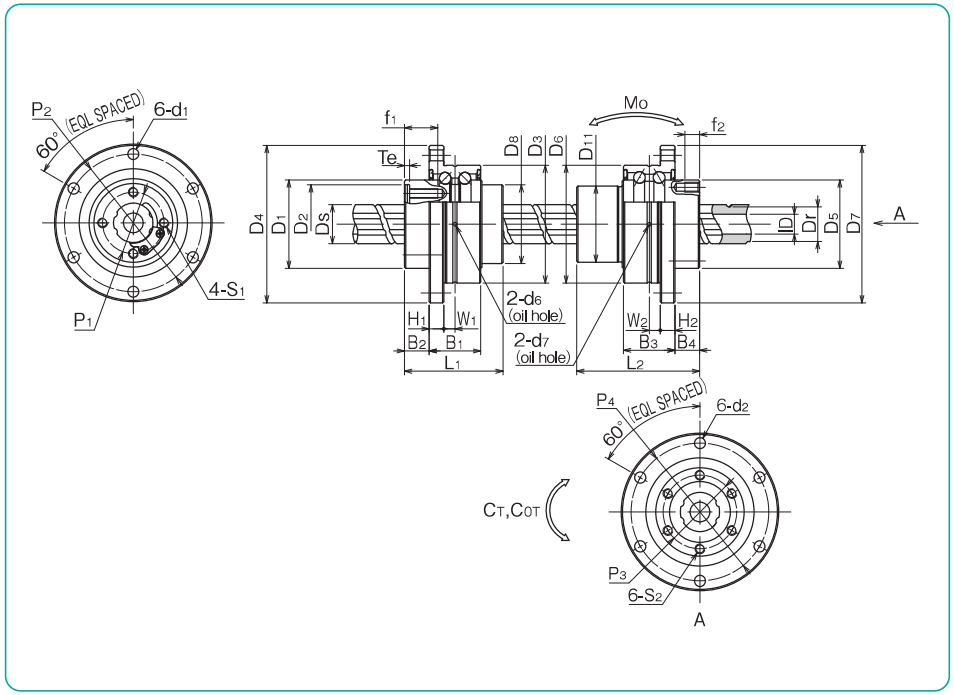


part number structure

example **SPBR 20 KP- 450 T -LB -KGLA /CU**

- SPBR-KP type
- nominal diameter
- ball screw spline shaft total length
- hollow shaft
- with low temperature black chrome treatment
- grease symbol (refer to page Eng-51)
  blank: standard grease
  -KGLA: lithium-based low dust generation grease
  -KGU: urea-based low dust generation grease
  -KGF: anti-fretting grease
- with special specification

Note : Hollow shaft is used for standard type.



ROTARY BALL SCREW NUT

part number	major dimensions										major dimensions of angular contact bearings						
	D1 h7	tolerance	D2 H7	tolerance	D8	L1	P1 P.C.D.	S1	f1	Te	D3 g6	tolerance	D4	H1	B1	B2	P2 P.C.D.	d1
	mm	μm	mm	μm	mm	mm	mm		mm	mm	mm	μm	mm	mm	mm	mm	mm	mm
SPBR16KP	36	0 −25	32	+25 0	32	40	25	M4	13.5	2	48	-9/-25	64	6	21	10	56	4.5
SPBR20KP	43.5		39		39	48	31	M5	16.5	2.5	56	-10 -29	72	6	21	11	64	4.5
SPBR25KP	52	0/-30	47		47	58	38	M6	20	3	66		86	7	25	13	75	5.5

part number	W1	d6	ball screw spline shaft Ds	shaft inner diameter ID	lead	root diameter Dr	ball screw basic load rating dynamic Ca	ball screw basic load rating static Coa	angular contact bearings basic load rating dynamic CaR	angular contact bearings basic load rating static CoaR	angular contact bearings ※ maximum revolutions	moment of inertia for the nut	moment of inertia for the ball screw shaft	mass nut	mass shaft	ball screw nut maximum revolutions based on Dm·N	size
	mm	mm	mm	mm	mm	mm	kN	kN	kN	kN	rpm	kg·cm²	kg·cm²/mm	kg	kg/m	rpm	
SPBR16KP	4.5	1.5	16	8	16	13.7	4.3	6.5	7.30	11.3	4,400	0.43	4.19×10^{-4}	0.36	1.10	4,210	16
SPBR20KP	4.5	1.5	20	10	20	17.5	5.7	9.4	7.69	13.3	3,700	1.01	1.05×10^{-3}	0.53	1.73	3,360	20
SPBR25KP	5.5	1.5	25	15	25	21.7	8.5	14.6	10.5	19.4	3,100	2.49	2.35×10^{-3}	0.90	2.27	2,710	25

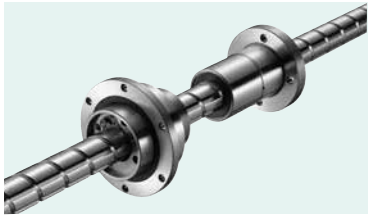
ROTARY BALL SPLINE NUT

part number	major dimensions							major dimensions of angular contact bearings							
	D5 h7	tolerance	D11	L2	P3 P.C.D.	S2	f2	D6 g6	tolerance	D7	H2	B3	B4	P4 P.C.D.	d2
	mm	μm	mm	mm	mm		mm	mm	μm	mm	mm	mm	mm	mm	mm
SPBR16KP	36	0 −25	31	50	30	M4	6	48	-9/-25	64	6	21	10	56	4.5
SPBR20KP	43.5		35	63	36	M5	8	56	-10 -29	72	6	21	12	64	4.5
SPBR25KP	52	0/-30	42	71	44	M5	8	66		86	7	25	13	75	5.5

part number	W2	d7	ball spline basic torque rating dynamic CT	ball spline basic torque rating static COT	ball spline basic load rating dynamic C	ball spline basic load rating static Co	angular contact bearings basic load rating dynamic CR	angular contact bearings basic load rating static COR	angular contact bearings ※ maximum revolutions	allowable static moment Mo	moment of inertia	mass nut	size
	mm	mm	N·m	N·m	kN	kN	kN	kN	rpm	N·m	kg·cm²	kg	
SPBR16KP	4.5	1.5	60	110	6.12	11.2	10.2	8.56	4,200	46	0.43	0.37	16
SPBR20KP	4.5	1.5	105	194	8.9	16.3	10.9	10.1	3,600	110	1.00	0.55	20
SPBR25KP	5.5	1.5	189	346	12.8	23.4	13.7	12.9	3,100	171	2.22	0.84	25

- Please select the smallest maximum revolutions (rpm) in case that more than one portion rotate at the same time.
- ※Maximum revolutions with grease lubrication.
- Moment of inertia is calculated excluding the angular contact bearings.
- Maximum length of ball screw spline shaft : 600mm

SPBF-KP TYPE

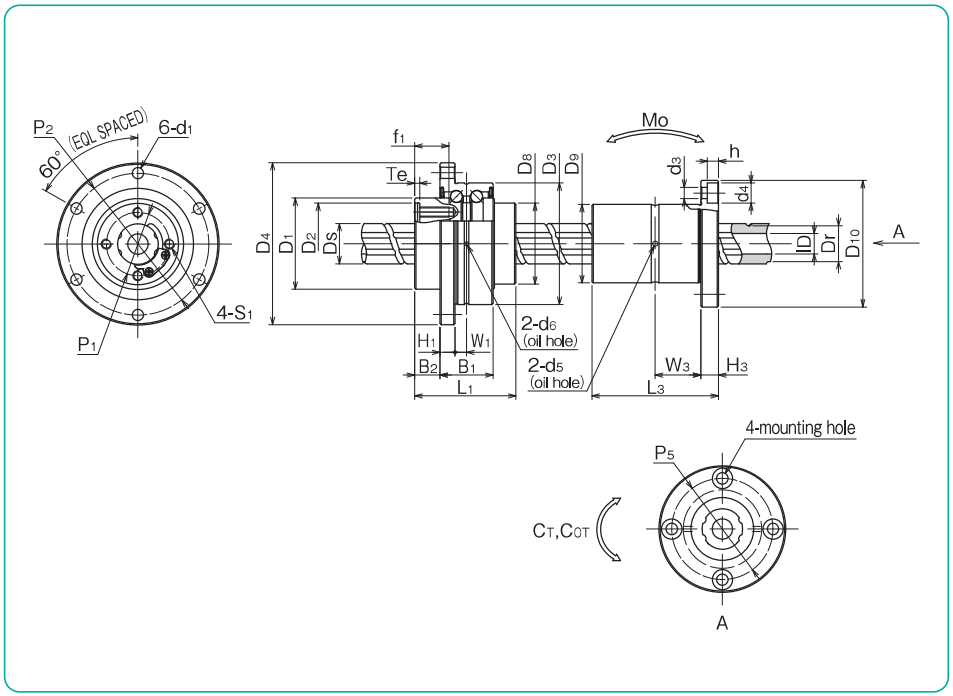


part number structure

example **SPBF 20 KP-450 T -LB -KGLA /CU**

- SPBF-KP type
- nominal diameter
- ball screw spline shaft total length
- hollow shaft
- grease symbol (refer to page Eng-51)
  - **blank**: standard grease
  - -KGLA: lithium-based low dust generation grease
  - -KGU: urea-based low dust generation grease
  - -KGF: anti-fretting grease
- with low temperature black chrome treatment
- with special specification

Note : Hollow shaft is used for standard type.



ROTARY BALL SCREW NUT

part number	major dimensions										major dimensions of angular contact bearings						
	D1 h7	tolerance	D2 H7	tolerance	D8	L1	P1 P.C.D.	S1	f1	Te	D3 g6	tolerance	D4	H1	B1	B2	P2 P.C.D.	d1
	mm	μm	mm	μm	mm	mm	mm		mm	mm	mm	μm	mm	mm	mm	mm	mm	mm
SPBF16KP	36	0 −25	32	+25 0	32	40	25	M4	13.5	2	48	-9/-25	64	6	21	10	56	4.5
SPBF20KP	43.5		39		39	48	31	M5	16.5	2.5	56	-10 -29	72	6	21	11	64	4.5
SPBF25KP	52	0/-30	47		47	58	38	M6	20	3	66		86	7	25	13	75	5.5

part number	W1	d6	ball screw spline shaft Ds	shaft inner diameter ID	lead	root diameter Dr	ball screw basic load rating dynamic Ca	ball screw basic load rating static Coa	angular contact bearings basic load rating dynamic CaR	angular contact bearings basic load rating static CoaR	※ maximum revolutions	moment of inertia for the nut	moment of inertia for the ball screw shaft	mass nut	mass shaft	ball screw nut maximum revolutions based on Dm·N	size
	mm	mm	mm	mm	mm	mm	kN	kN	kN	kN	rpm	kg·cm²	kg·cm²/mm	kg	kg/m	rpm	
SPBF16KP	4.5	1.5	16	8	16	13.7	4.3	6.5	7.30	11.3	4,400	0.43	4.19×10^{-4}	0.36	1.10	4,210	16
SPBF20KP	4.5	1.5	20	10	20	17.5	5.7	9.4	7.69	13.3	3,700	1.01	1.05×10^{-3}	0.53	1.73	3,360	20
SPBF25KP	5.5	1.5	25	15	25	21.7	8.5	14.6	10.5	19.4	3,100	2.49	2.35×10^{-3}	0.90	2.27	2,710	25

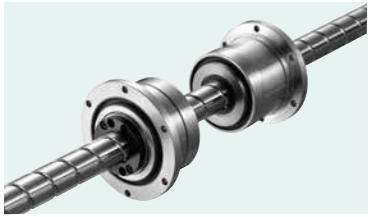
BALL SPLINE NUT

part number	major dimensions							
	D9 h6	tolerance	L3	tolerance	D10	H3	P5 P.C.D.	d3×d4×h
	mm	μm	mm	mm	mm	mm	mm	mm
SPBF16KP	31	0 −16	50	0 −0.2	50	7	40	4.5×8×4.4
SPBF20KP	35		63		58	9	45	5.5×9.5×5.4
SPBF25KP	42		71	0/−0.3	65	9	52	5.5×9.5×5.4

part number	W3	d5	basic torque rating dynamic CT	basic torque rating static COT	basic load rating dynamic C	basic load rating static Co	allowable static moment Mo	moment of inertia	mass nut	size
	mm	mm	N·m	N·m	kN	kN	N·m	kg·cm²	kg	
SPBF16KP	18	2	60	110	6.12	11.2	46	0.43	0.2	16
SPBF20KP	22.5	2	105	194	8.9	16.3	110	1.00	0.33	20
SPBF25KP	26.5	3	189	346	12.8	23.4	171	2.22	0.45	25

- Please select the smallest maximum revolutions (rpm) in case that more than one portion rotate at the same time.
- ※Maximum revolutions with grease lubrication.
- Moment of inertia is calculated excluding the angular contact bearings.
- Maximum length of ball screw spline shaft : 600mm

SPBR TYPE

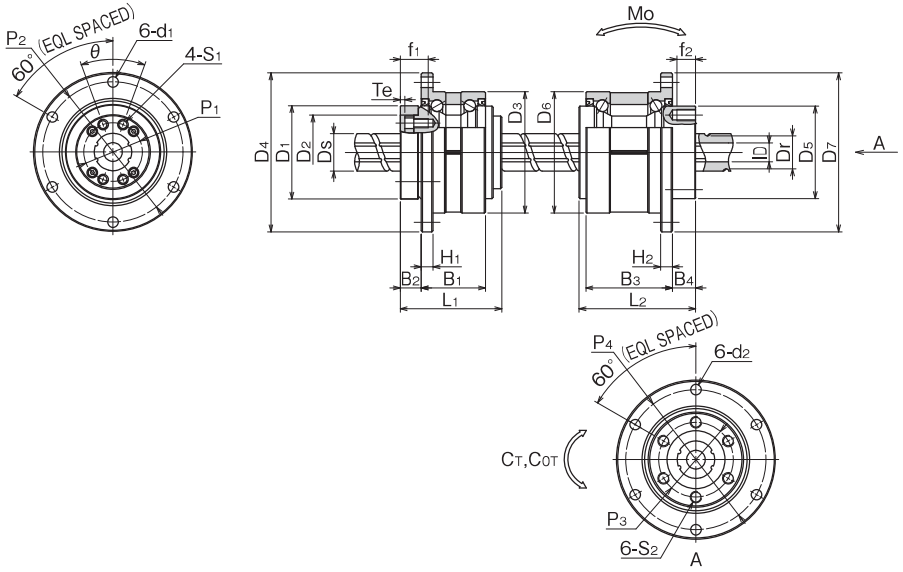


part number structure

example **SPBR 20 - 450 T -LB -KGLA /CU**

- SPBR type
- nominal diameter
- ball screw spline shaft total length
- hollow spline shaft
  blank: standard shaft
  T: standard hollow shaft※
- grease symbol (refer to page Eng-51)
  blank: standard grease
  -KGLA: lithium-based low dust generation grease
  -KGU: urea-based low dust generation grease
  -KGF: anti-fretting grease
- with low temperature black chrome treatment
- with special specification

※For standard hollow shafts, refer to P.B-40 for specifications.



ROTARY BALL SCREW NUT

part number	major dimensions										major dimensions of angular contact bearings							
	D_1 h7	tolerance	D_2 H7	tolerance	L_1	P_1 P.C.D.	θ	S_1	f_1	Te	D_3	tolerance	D_4	H_1	B_1	B_2	P_2 P.C.D.	d_1
	mm	μm	mm	μm	mm	mm			mm	mm	mm	μm	mm	mm	mm	mm	mm	mm
SPBR16	40	0 −25	32	+25 0	43.5	25	40°	M4	12	2	52	0 −7	68	5	27.5	9	60	4.5
SPBR20	50		39		54	31	40°	M5	16	2	62		78	6	34	11	70	4.5
SPBR25	58	0/−30	47		65	38	40°	M6	19	3	72		92	8	43	12.5	81	5.5

part number	ball screw spline shaft Ds	ID (inner diameter)	lead	root diameter Dr	ball screw basic load rating dynamic Ca	ball screw basic load rating static Coa	angular contact bearings basic load rating dynamic C_{aR}	angular contact bearings basic load rating static C_{oaR}	※ maximum revolutions	moment of inertia for the nut	moment of inertia for the ball screw shaft	mass nut	mass shaft	ball screw nut maximum revolutions based on Dm·N	size
	mm	mm	mm	mm	kN	kN	kN	kN	rpm	kg·cm²	kg·cm²/mm	kg	kg/m	rpm	
SPBR16	16	8	16	13.4	4.62	8.59	11.1	22.2	4,000	0.60	4.43×10^{-4}	0.45	1.47	4,170	16
SPBR20	20	10	20	17.2	5.77	12.2	14.4	30.5	3,200	1.75	1.12×10^{-3}	0.76	2.33	3,410	20
SPBR25	25	15	25	21.9	8.62	19.2	18.2	39.8	2,800	3.86	2.74×10^{-3}	1.26	3.65	2,690	25

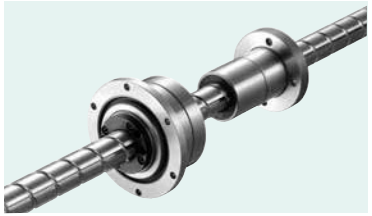
ROTARY BALL SPLINE NUT

part number	major dimensions						major dimensions of angular contact bearings							
	D_5 h7	tolerance	L_2	P_3 P.C.D.	S_2	f_2	D_6	tolerance	D_7	H_2	B_3	B_4	P_4 P.C.D.	d_2
	mm	μm	mm	mm		mm	mm	μm	mm	mm	mm	mm	mm	mm
SPBR16	39.5	0 −25	50	32	M5	8	52	0 −7	68	5	37	10	60	4.5
SPBR20	43.5		63	36	M5	8	56		72	6	48	12	64	4.5
SPBR25	53	0/−30	71	45	M6	8	62		78	6	55	13	70	4.5

ball spline basic torque rating dynamic C_T	ball spline basic torque rating static C_{OT}	ball spline basic load rating dynamic C	ball spline basic load rating static Co	angular contact bearings basic load rating dynamic C_R	angular contact bearings basic load rating static C_{OR}	※ maximum revolutions	allowable static moment Mo	moment of inertia	mass nut
N·m	N·m	kN	kN	kN	kN	rpm	N·m	kg·cm²	kg
60	110	6.12	11.2	13.0	12.8	4,000	46	0.59	0.54
105	194	8.9	16.3	17.4	17.2	3,600	110	1.01	0.70
189	346	12.8	23.4	22.1	22.5	3,200	171	2.00	0.92

・Please select the smallest maximum revolutions (rpm) in case that more than one portion rotate at the same time.
※Maximum revolutions with grease lubrication.
・Moment of inertia is calculated excluding the angular contact bearings.
・Maximum length of ball screw spline shaft : 1,000mm

SPBF TYPE

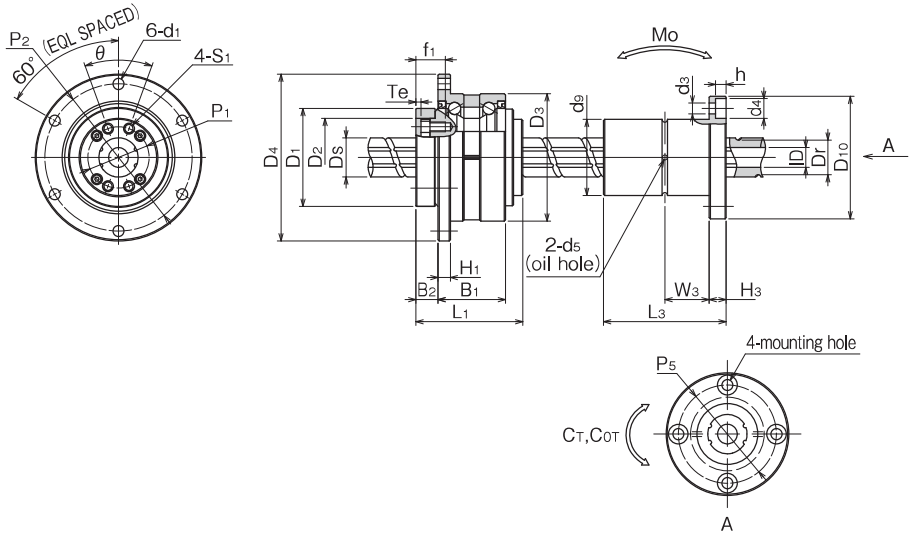


part number structure

example **SPBF 20 - 450 T -LB -KGLA /CU**

- SPBF type
- nominal diameter
- ball screw spline shaft total length
- hollow spline shaft
  blank: standard shaft
  T: standard hollow shaft※
- with low temperature black chrome treatment
- grease symbol (refer to page Eng-51)
  blank: standard grease
  -KGLA: lithium-based low dust generation grease
  -KGU: urea-based low dust generation grease
  -KGF: anti-fretting grease
- with special specification

※For standard hollow shafts, refer to P.B-40 for specifications.



ROTARY BALL SCREW NUT

part number	major dimensions										major dimensions of angular contact bearings							
	D1 h7	tolerance	D2 H7	tolerance	L1	P1 P.C.D.	θ	S1	f1	Te	D3	tolerance	D4	H1	B1	B2	P2 P.C.D.	d1
	mm	μm	mm	μm	mm	mm			mm	mm	mm	μm	mm	mm	mm	mm	mm	mm
SPBF16	40	0 −25	32	+25 0	43.5	25	40°	M4	12	2	52	0 −7	68	5	27.5	9	60	4.5
SPBF20	50		39		54	31	40°	M5	16	2	62		78	6	34	11	70	4.5
SPBF25	58	0/−30	47		65	38	40°	M6	19	3	72		92	8	43	12.5	81	5.5

ball screw spline shaft Ds	ID (inner diameter)	lead	root diameter Dr	ball screw basic load rating dynamic Ca	ball screw basic load rating static Coa	angular contact bearings basic load rating dynamic CaR	angular contact bearings basic load rating static CoaR	※ maximum revolutions	moment of inertia for the nut	moment of inertia for the ball screw shaft	mass nut	mass shaft	ball screw nut maximum revolutions based on Dm·N	size
mm	mm	mm	mm	kN	kN	kN	kN	rpm	kg·cm²	kg·cm²/mm	kg	kg/m	rpm	
16	8	16	13.4	4.62	8.59	11.1	22.2	4,000	0.60	4.43×10^{-4}	0.46	1.47	4,170	16
20	10	20	17.2	5.77	12.2	14.4	30.5	3,200	1.75	1.12×10^{-3}	0.76	2.33	3,410	20
25	15	25	21.9	8.62	19.2	18.2	39.8	2,800	3.86	2.74×10^{-3}	1.26	3.65	2,690	25

BALL SPLINE NUT

part number	major dimensions							
	D9 h6	tolerance	L3	tolerance	D10	H3	P5 P.C.D.	d3×d4×h
	mm	μm	mm	mm	mm		mm	mm
SPBF16	31	0 −16	50	0 −0.2	50	7	40	4.5×8×4.4
SPBF20	35		63		58	9	45	5.5×9.5×5.4
SPBF25	42		71	0/−0.3	65	9	52	5.5×9.5×5.4

W	d5	basic torque rating dynamic CT	basic torque rating static COT	basic load rating dynamic C	basic load rating static Co	allowable static moment Mo	moment of inertia	mass nut
mm	mm	N·m	N·m	kN	kN	N·m	kg·cm²	kg
18	2	60	110	6.12	11.2	46	0.59	0.2
22.5	2	105	194	8.9	16.3	110	1.01	0.33
26.5	3	189	346	12.8	23.4	171	2.00	0.45

・Please select the smallest maximum revolutions (rpm) in case that more than one portion rotate at the same time.
※Maximum revolutions with grease lubrication.
・Moment of inertia is calculated excluding the angular contact bearings.
・Maximum length of ball screw spline shaft : 1,000mm