BALL SCREWS

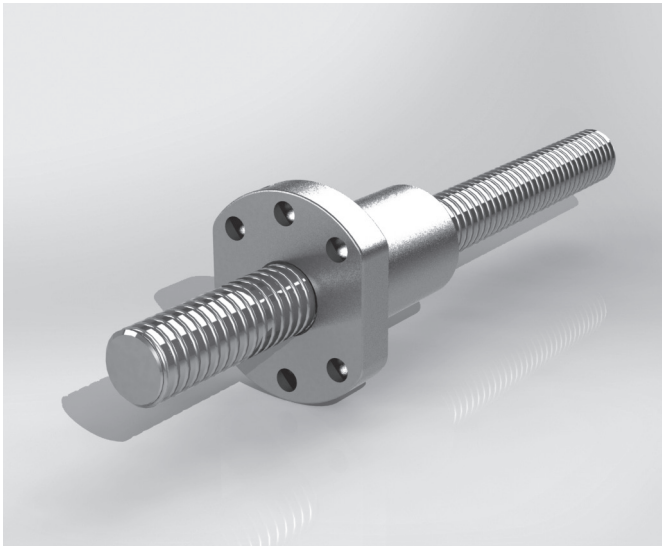
2 TBK BALL SCREW

TBK ball screws are low friction systems capable to convert rotary motion to linear motion thanks to the recirculating ball technology. Ball screw assemblies are able to withstand high loads because the load is distributed all over a large number of ball bearings that travel around a raceway in the ball screw. Thanks to its low friction the efficiency of the system is remarkably high (around 90%).

2.1 Main characteristics/features

The main features of TBK ball screws are:

- High efficiency
- Low friction
- Smooth running
- Low noise
- Easy installation
- Clean operation
- Low maintenance
- Long life
- Different accuracy grades



2.2 Choice of TBK ball screw system

For a proper selection of a TBK ball screw system it is recommended to follow the procedure described below:

1. Determine the desired accuracy according to the machine where the ball screw is going to be installed
2. Determine the loading conditions
3. Pre-select the type, the shaft diameter and the size of the ball screw
4. Calculate the allowable axial load and the reference torque for the unit chosen
5. Check the pre-load required
6. Confirm that the positioning accuracy is the one needed for the equipment

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2.3 Accuracy Selection

In the table below different applications can be found with the recommended accuracy.

	Application	C0	C1	C2	C3	C5	C7
MC Machine tools	Machining Center				●	●	
	Lathe				●	●	
	Milling Machine				●	●	
	Drilling machine					●	●
	Jig Boring machine	●	●				
	Grinding Machine			●	●		
	Electro-discharge Machine (EDM)			●	●	●	
	Punching press				●	●	
	Laser beam machine				●	●	
	Wood Working Machine					●	●
	Wire cutting machine			●	●		

	Application	C0	C1	C2	C3	C5	C7
Robot industrial	Assembling				●	●	
	Others					●	●
Semiconductor Machine	Wire Bonder		●	●			
	Prober		●	●			
	Inserter Machine			●	●	●	
	PBC driller		●	●	●	●	
	Lithography machine	●	●				
	Chemical processing					●	●
Other Machines	Injection Molding Machine					●	●
	Measuring Machine	●	●	●			
	Office machine				●	●	●
	Steel mill					●	●
	Image processing	●	●				
	Fuel rod control				●	●	●
	Mechanical snubber					●	●
	Aircraft				●	●	

From the table below, the values for the representative travel distance error (±E) and the fluctuation (e) can be obtai ned depending on the accuracy grade chosen. The representative travel distance error is the difference between the representative travel and the reference travel distance. The fluctuation is the maximum width between two straight lines parallel to the representative travel distance.

		C0		C1		C2		C3		C5		C7	C10
Travel Length (mm)	Accuracy Grade	±E	e	±E	e	±E	e	±E	e	±E	e	±E/e	±E/e
	≤100	3	3	3.5	5	5	7	8	8	18	18		
	≤200	3.5	3	4.5	5	7	7	10	8	20	18		
	≤315	4	3.5	6	5	8	7	12	8	23	18		
	≤400	5	3.5	7	5	9	7	13	10	25	20		
	≤500	6	4	8	5	10	7	15	10	27	20		
	≤630	6	4	9	6	11	8	16	12	30	23		
	≤800	7	5	10	7	13	9	18	13	35	25		
	≤1000	8	6	11	8	15	10	21	15	40	27		
	≤1250	9	6	13	9	18	11	24	16	46	30	±50 /	±210 /
	≤1600	11	7	15	10	21	13	29	18	54	35	300 mm	300 mm
	≤2000			18	11	25	15	35	21	65	40		
	≤2500			22	13	30	18	41	24	77	46		
	≤3150			26	15	36	21	50	29	93	54		
	≤4000			30	18	44	25	60	35	115	65		
	≤5000					52	30	72	41	140	77		
	≤6300					65	36	90	50	170	93		
	≤8000							110	60	210	115		
	≤10000									260	140		
	≤12500									320	170		

Fluctuation in Thread Length of 300 mm and in One Revolution (permissible value)

Accuracy Grade	Fluctuation /300 (mm)	Fluctuation /2p (mm)
C0	3.5	3
C1	5	4
C2	7	5
C3	8	6
C5	18	8
C7	-	-

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2.4 Preload Selection

The table below can be used as a guidance to properly choose the minimum preload according to the accuracy desired.

Accuracy	C10	C7	C5	C3
Minimum Preload	P0	P1	P2	P2

The first two grades of preload imply that a small clearance exist which can be seen in following tables.

PRELOAD P0

Screw Shaft OD	Ball Screw Clearance in axial direction (max)
4mm ~ 14mm 15mm ~ 50mm 50mm ~ 80mm	0.05mm 0.08mm 0.12mm

PRELOAD P1

Screw Shaft OD	Ball Screw Clearance in axial direction (max)
4mm ~ 80mm	0.0 mm

For P2 and P3 grades of preload an internal force appears that results in a reference torque (Tr), which is the one to be overcame to start the operation.

Model	P2 Tr (kgf·cm)	P3 Tr (kgf·cm)
1404-4	0.13	0.34
1604-3	0.17	0.45
1604-4	0.21	0.57
1605-3	0.29	0.79
1605-4	0.3	0.8
1610-3	0.39	1.04
2005-4	0.47	1.26
2504-4	0.33	0.88
2505-4	0.6	1.6
2510-3	1.11	2.95
2510-4	1.47	3.93
3205-4	0.76	2.02
3206-4	1.14	3.03

Model	P2 Tr (kgf·cm)	P3 Tr (kgf·cm)
3210-3	2.02	5.37
3210-4	2.62	6.99
4005-4	0.95	2.53
4006-4	1.25	3.32
4010-3	2.59	6.91
4010-4	3.31	8.84
5010-3	3.29	8.77
5010-4	4.21	11.23
6310-4	5.42	14.46
6320-3	13.08	34.87
8010-4	6.68	17.82
8020-3	16.87	44.98

For higher preloads please consult the technical department of TBK linear guides.

2.5 Driving Torque required

When an external axial load is applied to the system a minimum driving torque has to be applied to the rod. This driving torque can be calculated from the following formulas.

$$T = T_r + 0{,}05 \cdot \frac{Fa \cdot l}{2\pi \cdot \sqrt{\tan\beta}} \quad ; \quad \text{where} \quad \tan\beta = \frac{l}{\pi \cdot d}$$

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2.6 Static Calculation

To calculate the maximum axial load that can be applied to the system the following formula must be used.

$$sf = \frac{Coa}{Fa}$$

The model and size chosen will be appropriate for the system if the following safety factors are achieved.

Machine type	Load condition	Minimum sf
General industry	Without vibrations or impact	1.0 ~ 1.3
	With vibrations or impact	2.0 ~ 3.0
Machine tools	Without vibrations or impact	1.0 ~ 1.5
	With vibrations or impact	2.5 ~ 7.0

2.7 Rated Life (Total number of revolutions)

The service life of a ball screw can be calculated from the following equation where a load factor has to be considered according to the table.

$$L\ (revolutions) = \left(\frac{Ca}{Fa * wf} \right)^3 \cdot 10^6$$

Impacts and vibrations	Speed (v)	Load factor (wf)
Faint	Very low speed v < 0.25m/s	1.0 ~ 1.2
Weak	Low speed 0.25m/s < v < 1m/s	1.2 ~ 1.5
Medium	Moderate speed 1m/s < v < 2m/s	1.5 ~ 2.0
Strong	High speed v > 2m/s	2.0 ~ 3.5

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2.8 Ordering References

The Model Number Coding of Ball Screw

TBK SFT R 025 05 B 2 D G C5 1000 P0

- **TBK SFT** — ***Nut type codes:*** SFU · DFU · SFT · DFT · SFE · SFK
  - **S:** **S** Single nut **D** Double nut
  - **F:** **F** With flange **C** Without flange
  - **T:** **T** Type nut **E** Type nut **K** Type nut **U** Type nut
- **R** — ***Direction of helix***
  R: Right **L:** Left
- **025** — ***Shaft dia. (mm)***
- **05** — ***Lead (mm)***
- **B 2** — ***No. of Turns (Circuits) or Turn x Row:***
  Turn: T:1 T:1.5 (or 1.7) B:2.5 C:3.5 ex: (B2=2.5x2)
- **D** — ***Flange type:*** **N:** No cutting
  S: Single cutting **D:** Double cutting
- **G** — ***Produce code:***
  G: Grinding **F:** Rolled
- **C5** — ***Accuracy code:***
  C0 · C1 · C2 · C3 · C5 · C7 · C10
- **1000** — ***Overall length of sahft (mm)***
- **P0** — ***Axial clearance and preload code***
  P0 · P1 · P2 · P3 · P4