Schaeffler screw drive range

The function of screw drives

Screw drives comprise a threaded spindle and a threaded nut. Due to the rotation of the spindle, the nut moves in a linear manner on the spindle and thus converts the rotary motion of the drive into linear motion. It is rigidly connected to the adjacent construction and gives axial displacement or positioning of the component.
The main load direction of screw drives is axial, but radial load is not permissible. The screw drive can be subjected to high dynamic axial load.

Threaded nuts

Nuts are available in a flanged or cylindrical design and in the form of single or double nuts. Preloaded nuts (double nuts) facilitate high positional accuracy and rigidity. Flanged nuts are particularly easy to fit, since they are screw mounted on the adjacent construction.

Threaded drives

The thread on the spindles is either rolled or ground. The threaded spindle can be driven by direct or indirect means. It is supported on one or both sides. Support on both sides is normally in the form of a locating/non-locating bearing arrangement. The locating bearing side is preferably realised by means of specially developed double row axial angular contact ball bearings for screw drives that have high rigidity as well as high axial and radial load carrying capacity. In addition to numerous standard designs, the ends of the spindle can be configured in accordance with customer requirements.

Ball screw drives, roller screw drives and planetary screw drives

For a wide range of application areas in machine building and automotive engineering as well as in handling and automation technology, Schaeffler offers a comprehensive portfolio of ball drives, roller screw drives and planetary screw drives, *Figure 1*:

- ball screw drives KGT, see page 2
- roller screw drives RGT, see page 5
- planetary screw drives PWG, see page 9.

① Ball screw drive KGT
② Roller screw drive RGT
③ Planetary screw drive PWG

Figure 1
Screw drives

Schaeffler screw drive range

Selection criteria

The selection criteria for screw drives are essentially the requirements placed on:

- positional accuracy
- rigidity
- freedom from clearance/preload
- load carrying capacity (axial load carrying capacity)
- basic rating life
- speed
- permissible axial spindle load (buckling)
- frictional torque
- smoothness of running (running noise)
- pitch.

For advice on these products as well as the design and calculation of the bearing arrangement, please consult Schaeffler.

Ball screw drives

In ball screw drives KGT, the load is transmitted from the spindle by means of balls to the nut. The nut (cylindrical nut or flanged nut) has a return system for recirculating the rolling elements.

Ball screw drives have the following technical features:

- high load carrying capacity due to the large number of balls
- smooth, uniform running
- reliable function and operational security due to the internal return and recirculation system
- easy-to-fit nut design
- sealed nuts (optional).

Axial deflection, preload

Schaeffler ball screw drives have a contact angle of 45°. External drive forces induce an axial force F_a. This causes axial deflection as a function of the preload.

In the case of preloaded single nuts, the preload is achieved by the introduction of oversize balls. There are then four contact points per rolling element; this means that the rolling elements are in four point contact with the raceways.

Double nuts are preloaded by the introduction of a spacer that sets the nut in an O arrangement. In this case, the rolling elements are in two point contact with the raceways.

Preload classes: see table, page 3.

Preload classes for ball screw drives

Spindle diameter d_w	Preload class		
	V0 Standard Max. axial clearance mm	V1[1] Clearance-free mm	V2[1] Preloaded mm
06, 08, 10, 12, 14	0,05	0	approx. 3% · C[2]
16, 20, 25, 32, 40	0,08		
50, 63, 80	0,12		

1) Available by agreement.

2) C = basic dynamic load rating.

Accuracy

Depending on the operating conditions and the application, different requirements are placed on the accuracy of ball screw drives. Schaeffler ball screw drives have the accuracy class T7, see table. By agreement, class T5 is also available.

Accuracy classes for ball screw drives with rolled spindle

Deviation	Accuracy class	
	T5[3] µm	T7[1] µm
Displacement variation over 300 mm axial displacement[2] in accordance with DIN 69051-3	23	52

1) Standard accuracy class.

2) Other tolerances in accordance with DIN 69051-3 (ISO 3408-3).

3) Available by agreement.

Sealing

With a few exceptions, the threaded nuts are sealed by means of gap or labyrinth seals (depending on the design of the nut) and thus protected against contamination.

Optionally, contact seals can be supplied for certain series.

If there is a risk that dust or foreign particles can penetrate the threaded nut, additional sealing measures must be taken.

Lubrication

Ball screw drives must be lubricated. Technical, economic and ecological factors will determine whether oil or grease should be used for lubrication.

The threaded nut is pregreased with a high quality lubricant. For relubrication, the use of lithium or lithium complex soap greases with a mineral oil base is recommended. The base oil viscosity should be between ISO VG 68 and ISO VG 100.

If ball screw drives are to be relubricated using oil, please contact us for further advice.

Operating temperature

Ball screw drives can be used at operating temperatures from –10 °C to +80 °C. For brief periods, a maximum operating temperature of +100 °C is possible and this should be measured on the outside cylindrical surface of the threaded nut.

Schaeffler screw drive range

Pitch values

Available pitch values P for threaded spindles are shown in the table; d_w = spindle diameter, l_w = spindle length.

Pitch of threaded spindles

Designation	Dimensions in mm		Mass	Pitch P				
	d_w	l_w max.	m kg/m	1	2	2,5	3	4
KGS06 to **KGS80**	06	900	0,22	●	–	–	–	–
	08	1 200	0,39	●	●	●	–	–
	10	1 200	0,62	–	●	–	●	●
	12	3 000	0,89	–	●	–	–	–
	14	3 000	1,21	–	●	–	–	–
	16	3 000	1,58	–	–	–	–	–
	20	3 000	2,47	–	–	–	–	–
	25	6 000	3,85	–	–	–	–	●
	32	6 000	6,31	–	–	–	–	–
	40	6 000	9,86	–	–	–	–	–
	50	6 000	15,41	–	–	–	–	–
	63	7 200	24,47	–	–	–	–	–
	80	7 600	39,46	–	–	–	–	–

● Right hand thread.

Pitch of threaded spindles (continued)

Designation	Dimensions d_w mm	Pitch P							
		5	6	10	16	20	25	32	40
KGS06 to **KGS80**	06	–	–	–	–	–	–	–	–
	08	–	–	–	–	–	–	–	–
	10	–	–	–	–	–	–	–	–
	12	●	–	–	–	–	–	–	–
	14	–	–	–	–	–	–	–	–
	16	●, ■	–	●	●	–	–	–	–
	20	●, ■	–	–	–	●	–	–	–
	25	●, ■	–	▲, ●[1)]	–	–	●	–	–
	32	●, ■	–	●	–	●	–	●	
	40	●, ■	●	●	–	●	–		
	50	–	–	●	–	●	–		
	63	–	–	●	–	●	–		
	80	–	–	●	–	●	–		

● Right hand thread.
■ Optionally with left hand thread.
▲ Ball diameter 3,5 mm, suitable for threaded nut KGM25×10-2D3.

1) Standard ball diameter 4,762 mm

Roller screw drives RGT

In roller screw drives RGT, force is transmitted via the thread flanks of the rollers. Since the number of contact surfaces here is significantly higher than in ball screw drives, roller screw drives have significantly higher load carrying capacity.

Roller screw drives have significantly smaller pitch values than ball screw drives. Since there is no recirculation of balls, in contrast to KGT, very quiet running is achieved.

In the case of preloaded double threaded nuts, the load carrying capacity is lower due to the load-bearing length of the threaded rollers – smaller pitch – than for single preloaded nuts.

Design of roller screw drives

Roller screw drives comprise, as in the case of ball screw drives, a threaded spindle and a threaded nut. However, the threaded nut contains threaded rollers arranged parallel to the axis.
As the threaded spindle rotates, the threaded rollers rotate in planetary motion about the threaded spindle without axial displacement. The rotational motion of the nut and planets is synchronised by means of gear rings in order to prevent axial displacement.
As a result, a high positional accuracy is achieved.

Schaeffler roller screw drives are available, in various series and with corresponding bearing components, as ready-to-fit units. Roller screw drives differ essentially in terms of the threaded nut design.

Characteristics

Roller screw drives are characterised by:

- high axial load carrying capacity
- high axial rigidity
- small thread pitch values
- low running noise
- simple mounting and dismounting of the spindle nut
- high operational security
- high positional accuracy.

Areas of application

Due to their high rigidity and axial load carrying capacity, roller screw drives are used particularly in high precision machine tools, measuring machinery, industrial robots as well as in electronic component manufacture and precision engineering.

Schaeffler screw drive range

Threaded spindles

Threaded spindles are available in standard or special design. The material used is a surface-hardened steel. The thread is ground and has multiple starts.

Threaded rollers

Threaded rollers have journals at both ends. The journals support the threaded rollers parallel to the axis in the holes in the guide discs. The geared ends of the threaded rollers mesh in the internal gearing of the geared rings in the threaded nut. The thread on the threaded rollers has a single start and crowned flanks.

The threaded rollers roll without slippage in the threaded nut. They are not axially displaced relative to the threaded nut, since the axial displacement components of the contact points of both elements are identical.

Threaded nuts

Schaeffler supplies cylindrical threaded nuts and flanged nuts. Geared rings with internal gearing are fitted in the ends of the nuts. The gearing of the geared rings meshes in the gearing of the threaded rollers. Guide discs in the geared rings support the journals of the threaded rollers and maintain the spacing between these. The guide discs rotate in the threaded nut and prevent the ingress of coarse contamination into the nut. The discs are located by means of retaining rings. The thread of the nuts is identical with the thread of the spindles and has multiple starts.

Threaded nuts are supplied with preload set at the factory. The preload already set must not be changed.

Accuracy classes

Roller screw drives are available in the accuracy class KL 10 or, by agreement, in the higher accuracy class KL 5, see table.

Accuracy classes

Accuracy class	Pitch tolerance[1)] mm
KL 10 (standard)	±0,01
KL 5[2)]	±0,005

1) Deviation over 315 mm thread length.

2) Available by agreement.

Pitch accuracy

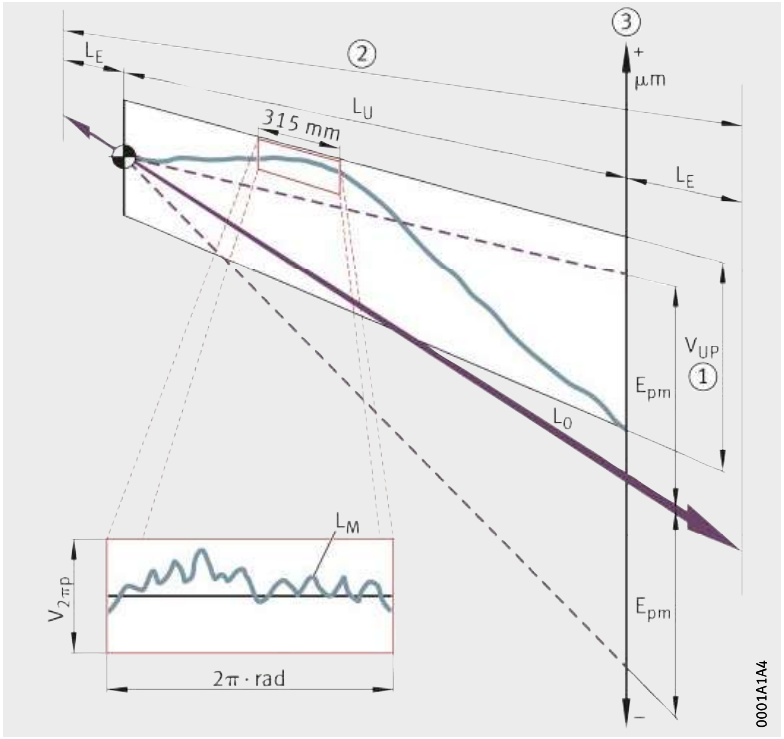
The threaded spindles for roller screw drives have a high pitch accuracy, *Figure 2*. This is achieved by measures including special manufacturing processes.

The maximum values for the pitch deviation E_{pm} and the spread of the pitch deviation V_{UP} are shown in the table. They are valid only for reference lengths up to 1 800 mm.

Pitch accuracy

Effective thread length and reference length L_U[1) mm		Accuracy class			
		KL 5 µm		KL 10 µm	
over	incl.	E_{pm}	V_{UP}	E_{pm}	V_{UP}
0	315	5	5	10	10
315	400	6	5	11	10
400	500	7	6	13	11
500	630	8	6	14	12
630	800	9	7	18	14
800	1 000	10	8	19	15
1 000	1 250	12	9	22	17
1 250	1 600	14	10	27	20
1 600	1 800	17	12	34	23

1) L_U in mm (effective thread length and reference length for measurement of the pitch accuracy).



① Spread for total measurement distance
② Thread length
③ Pitch deviation

Figure 2
Diagram of pitch deviation

Schaeffler screw drive range

Preload

Roller screw drives are supplied with preload set at the factory. Preload increases the rigidity and positional accuracy of the screw drive; it also, however, influences the frictional torque of the nut and thus the drive torque and life of the planetary screw drive.

Rigidity

The rigidity of a roller screw drive is influenced by:

- the preload on the threaded nut
- the number of bearing positions
- the type and size of bearings
- the spacing of the bearings
- the bearing preload
- the length of the threaded spindle
- the housing dimensions.

The total rigidity of a roller screw drive increases with the preload on the threaded nut. If an operating load acts on the roller screw drive, elastic deformations occur on all elements transmitting load. The total deformation is essentially calculated from the deflection values of the threaded nut, the threaded spindle and the screw drive bearing arrangement.

Speed

Schaeffler roller screw drives can be used in applications with high speeds.

The permissible speed for roller screw drives is dependent on:

- the nominal diameter and the free spindle length
- the type of spindle bearing arrangement
- the lubrication.

In the case of a rotating threaded spindle, the critical whirling speed must be taken into consideration as the upper limit for the permissible speed range.

If roller screw drives are operated at speeds that are higher than the maximum permissible spindle speed, the smooth running and life of the spindle will be impaired.

Lubrication

Roller screw drives can be lubricated with oil or grease and run almost exclusively in the mixed friction range. If other machine elements are lubricated with oil, the screw drives should preferably be connected to the existing oil supply system.

Roller screw drives are greased using a low-noise barium complex soap grease with a diester oil base KPE2K–30 in accordance with DIN 51825.

By agreement, screw drives can also be supplied dry or with an oil-based preservative. The oil used is compatible with oils and greases having a diester or mineral oil base. If greases with polycarbamide thickeners are used, please consult us.

At very high loads ($C_0/P \leqq 1,5$), continuous relubrication is necessary.

Operating temperature

Roller screw drives are suitable for operating temperatures from –40 °C to +130 °C.

Further information on roller screw drives

The roller screw drives presented here are described in detail in Publication RGT.

Planetary screw drives PWG

Planetary screw drives PWG are a new addition to the Schaeffler range, *Figure 3*. These screw drives are characterised by a very high performance density.

In these planetary screw drives, force is transmitted via the flanks of the rollers, spindle and nut. Due to the large number of contact points, a very high axial load carrying capacity is achieved.
Due to the very small pitch values, high axial operating forces can be achieved with small drive units (without a gearbox).

Figure 3
Planetary screw drive PWG

Design of planetary screw drives PWG

Planetary screw drives PWG comprise a threaded spindle and a cylindrical nut or flanged nut. The cylindrical nut and flanged nut differ only in the method by which they are attached to the table.

The nut contains planets arranged parallel to the axis. The planets roll uniformly on the threaded spindle and the nut.

The planetary screw drive is designed for temperatures from –10 °C to +80 °C.

Schaeffler screw drive range

Transmission of forces

At the rolling contacts between the spindle, planets and nut, force is transmitted in a circumferential direction purely by means of force locking, on a basis comparable to a friction gear transmission. This method of force transmission is subject to slippage. The slippage is essentially dependent on the axial force and the spindle pitch.

Pitch

Due to the slippage, the overall pitch of the planetary screw drive does not correspond to the pitch of the spindle. In positioning, attention must be paid to the difference between the overall pitch and the spindle pitch.

Ready-to-fit

The nut is supplied in a ready-to-fit form. For fitting, the cylindrical nut is slid into the bore in the table and located by means of a bearing cover. The nut is secured against rotation in the table by means of a feather key.

The flanged nut is mounted on the table via the flange bore by means of fixing screws.

Preset free from clearance

The nut is set free from clearance. It is not necessary to set the preload during or after mounting.

Lubrication and sealing

The nut of a planetary screw drive PWG is pregreased and the end faces are sealed by means of gap seals. The cylindrical nut is relubricated via the threaded spindle. The flanged nut has a relubrication hole that facilitates lubrication via the adjacent construction.

Basic rating life

The basic rating life L_{10} is calculated using the general rating equation for rolling bearing technology.

$$L_{10} = \left(\frac{C}{P}\right)^{p}$$

L_{10} 10^6 revolutions
The basic rating life in millions of revolutions is the life reached or exceeded by 90% of a sufficiently large group of apparently identical bearings before the first evidence of material fatigue develops

C N
Basic dynamic load rating

P N
Equivalent dynamic bearing load for radial and axial bearings

p –
Life exponent; for planetary screw drives: p = 3.

Advantages

The features of these planetary screw drives are:

- very economical drive
- high load carrying capacity due to the large number of rolling contacts
- high axial rigidity
- preloaded clearance-free
- very small pitch values (< 1 mm)
- very quiet running (no rotating rolling elements)
- simple, robust design
- very high performance density
- High reliability and operational security.

Expanded area of application

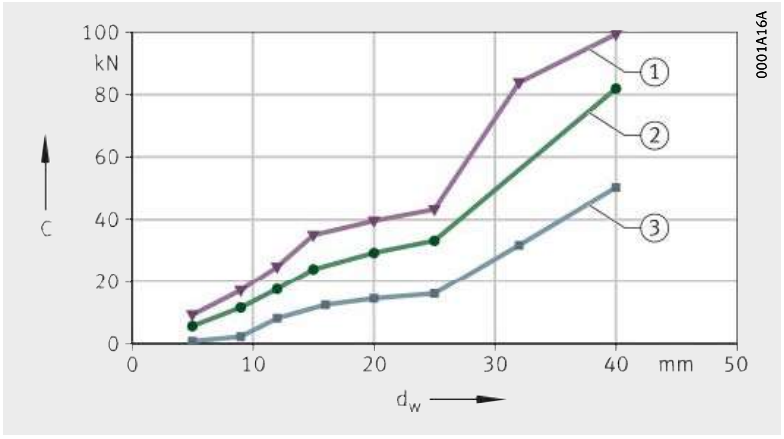
Due to the high performance density, these planetary screw drives are extremely suitable as force actuators and offer the potential for replacing hydraulic axes by energy-efficient electromechanical drives.

Downsizing possible due to high load carrying capacity

The dynamic load carrying capacity C of PWG is almost three times as high as that of KGT (example: nominal diameter of spindle d_W = 63 mm, length of nut L = 200 mm), *Figure 4*.
On the basis of its load carrying capacity, the planetary screw drive can replace a significantly larger ball screw drive.
As a result, it is possible to design the adjacent construction with smaller dimensions.

Comparison of basic load ratings PWG, RGT, KGT

Figure 4 shows a comparison of the dynamic load carrying capacity C between ball screw drives, roller screw drives and planetary screw drives against the different spindle diameters d_W. This shows clearly the significantly higher load carrying capacity of the PWG.



C = dynamic load carrying capacity
d_W = spindle diameter

① Planetary screw drive PWG
② Roller screw drive RGT
③ Ball screw drive KGT

Figure 4
Dynamic load carrying capacity – PWG, RGT, KGT

Bearing unit

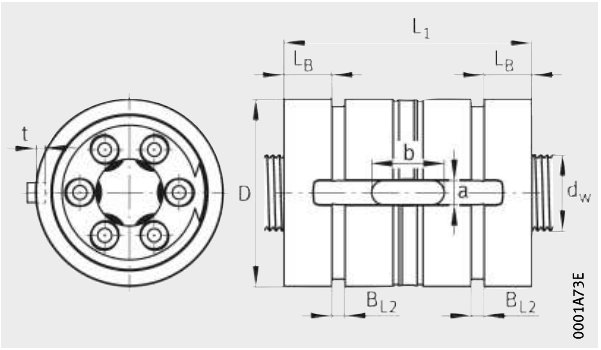
Due to the high performance density of a planetary screw drive, high axial forces occur. In this case, it is advantageous to use two angular contact ball bearings in an O arrangement as a locating bearing. For the non-locating bearing, a needle roller bearing is suitable.

The drive stud of the planetary screw drive is equipped with a slot for a feather key.

This bearing unit is available fully preassembled from Schaeffler, see dimension table.

Planetary screw drives

With cylindrical nut
With flanged nut

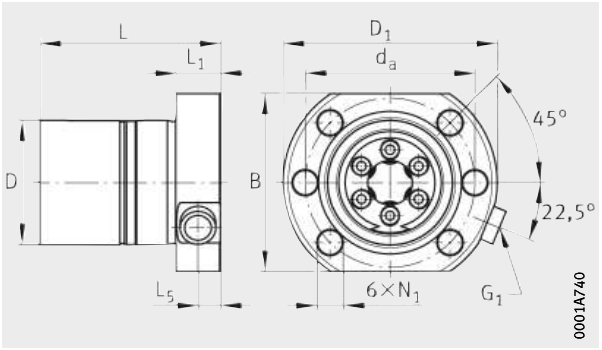


Cylindrical nut

Dimension table · Dimensions in mm

Cylindrical nut									Flanged nut					
Desig-nation	Mass	Dimen-sions		Mounting dimensions					Desig-nation	Mass	Dimensions			
	m ≈ g	∅D	L	b	a	t	L_B	B_{L2}		m ≈ g	∅D	$∅D_1$	L	B
PWM09	192	28	41	14	3	1,95	6	2,15	**PWMF09**	267	28	48	41	40
PWM12	214	30	41	12	4	2,55	6	2,15	**PWMF12**	290	30	52	41	40
PWM15	249	35	41	12	4	2,55	6	2,15	**PWMF15**	327	35	58	41	44

1) Lubrication connector in accordance with DIN 3405-D.

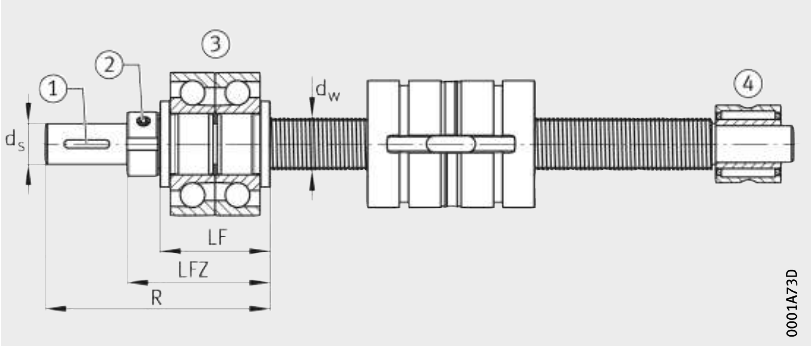


Flanged nut

Mounting dimensions					Spindle diameter	System pitch	Performance data with cylindrical and flanged nut			
							Basic load ratings		Efficiency	Slippage
							dyn.	stat.		
d_a	N_1	L_1	L_5	G_1 [1)]	d_w	p	C N	C_0 N	η %	%
38	6	10	5	5,9	9,35	0,75	16 000	18 000	57	0,1
						2,25			80	0,59
42	6	10	5	5,9	12,67	0,72	25 000	28 000	52	0,08
						2,86			83	0,59
47	6,6	10	5	5,9	14,97	2,11	34 000	38 000	71	0,26

Planetary screw drives

With spindle bearing units



Preassembled bearing unit[1)]

Dimension table · Dimensions in mm

Designation	Planetary screw drive				Spindle bearing arrangement (minimum requirement)						
	Overall pitch P	d_w	Maximum drive torque Nm	Nut Limiting speed n_G min^{-1}	Non-locating bearing	Locating bearing Angular contact ball bearings in O arrangement	Lock-nut	Mounting dimensions			
								d_s	LF	LFZ	R ≈
PWG09	0,75 / 2,25	9,35	9,24	5 000	NKI7/16	2×7202-B-TVP	ZM6	5	27	35	62
PWG12	0,72 / 2,86	12,67	17,24	5 000	NKI7/16	2×7301-50-TVP	ZM8	7	29	37	69
PWG15	2,11	14,97	27,41	5 000	NKI9/16	2×7303-60-TVP	ZM10	9	32	40	75

1) ① Feather key slot on drive stud
② Locknut
③ Locating bearing arrangement
④ Non-locating bearing arrangement

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