SCHAEFFLER

Planetary Screw Drives

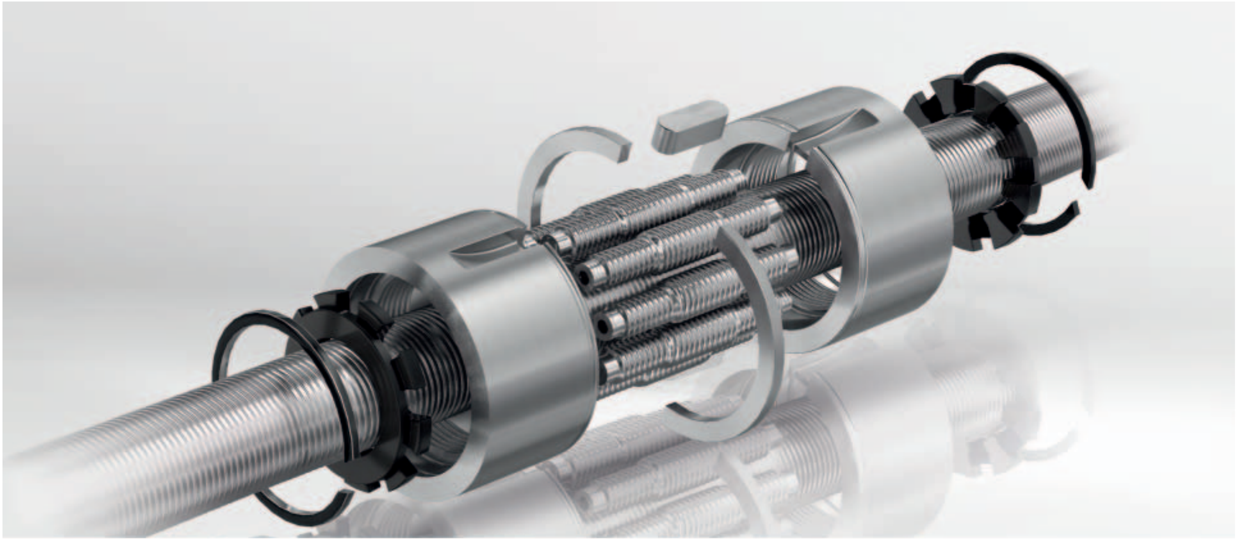
Foreword

Due to the increasing demand for subassemblies and systems, the use of ready-to-fit linear systems as economically innovative machine components is becoming increasingly important.
On this basis, Schaeffler has developed series comprising planetary screw drives and the matching bearing components for the locating and non-locating bearing side of the spindle bearing arrangement.

Planetary screw drives convert a rotational motion into a translational motion. Due to the high performance density and the very high axial load carrying capacity, they are extremely suitable as drives for actuators and open up the possibility of replacing hydraulic or pneumatic drives. As a result, the requirement for energy savings and conservation of resources can be fulfilled by the use of electromechanical drive systems. There is significant potential for savings in this case.

Due to the high conversion ratio of planetary screw drives, high axial forces can be achieved with low drive torques and without a gearbox. In addition to the cost-effective motors possible as a result, the long rating life and low maintenance requirements of the planetary screw drives give a highly economical drive system.

For advice on the selection and application of planetary screw drives and the preparation of design proposals, please contact the skilled personnel in Application Engineering and our engineering service both at home and abroad.



Technical principles

Load carrying capacity and life
Lubrication
Buckling
Critical speeds
Drive and holding torque

Technical principles

Load carrying capacity and life

Requirements

In order to determine the requisite size of a planetary screw drive, the requirements for the following criteria must be taken into consideration:

- load carrying capacity
- rating life
- operational reliability.

The load carrying capacity is indicated in the dimensioning of the planetary screw drive by the basic load ratings given in the dimension tables.

Basic dynamic load rating

The basic dynamic load rating C corresponds to a purely axial, constant load under which 90% of a sufficiently large number of apparently identical planetary screw drives reach or exceed a basic rating life of 1 million revolutions.

Basic static load rating

The basic static load rating C_0 describes the force acting concentrically and constantly in an axial direction under which the Hertzian pressure between the threaded rollers and the spindle at the most heavily loaded point induces a permanent overall deformation of 0,0001 times the flank diameter of a threaded roller. In this case, the Hertzian pressure is 4 200 N/mm^2.

Operating temperature

Planetary screw drives can be used at operating temperatures from –10 °C to +100 °C.

Basic rating life

The basic rating life L_{10} and L_{10h} is reached or exceeded by 90% of a sufficiently large number of apparently identical bearings before the first evidence of rolling fatigue occurs:

$$L_{10} = \left(\frac{C}{P_a}\right)^3$$

$$L_{10h} = \frac{16\,666}{n_m} \cdot \left(\frac{C}{P_a}\right)^3$$

$$L_s = \frac{P}{100} \cdot \left(\frac{C}{P_a}\right)^3$$

$$L_{10h} = \frac{8{,}33 \cdot P}{H \cdot n_{osc}} \cdot \left(\frac{C}{P_a}\right)^3$$

L_{10} 10^6 revolutions
The basic rating life in millions of revolutions that is reached or exceeded by 90% of a sufficiently large number of apparently identical planetary screw drives before the first evidence of rolling fatigue occurs

C N
Basic dynamic load rating

P_a N
Equivalent axial load

L_{10h} h
The basic rating life in operating hours according to the definition for L_{10}

n_m min^{-1}
Equivalent speed

L_s 10^5 m
The basic rating life for a displacement distance of 10^5 m, according to the definition for L_{10}

P mm
System pitch, see dimension table

H m
Single stroke length for oscillating motion

n_{osc} min^{-1}
Frequency of oscillating motion.

In design, it must be ensured that the equivalent axial bearing load does not exceed the value $P_a = 0{,}5 \cdot C$. If it exceeds this value, please consult Schaeffler.

Equivalent load and speed

The equations for calculating the basic rating life assume that the load and speed are constant. Non-constant operating conditions can be taken into consideration by means of equivalent operating values. These have the same effect as the loads occurring in practice.

If the load and speed vary in steps over a time period T, *Figure 1*, n_m and P_a are calculated as follows:

$$n_m = \frac{q_1 \cdot n_1 + q_2 \cdot n_2 + \ldots + q_z \cdot n_z}{100}$$

$$P_a = \sqrt[3]{\frac{q_1 \cdot n_1 \cdot F_1^3 + q_2 \cdot n_2 \cdot F_2^3 + \ldots + q_z \cdot n_z \cdot F_z^3}{q_1 \cdot n_1 + q_2 \cdot n_2 + \ldots + q_z \cdot n_z}}$$

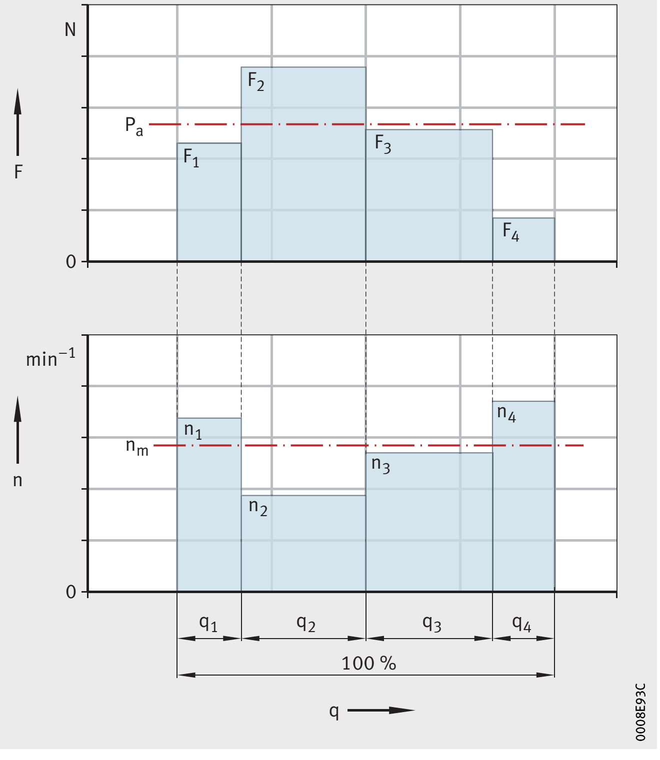
n_m $\min^{-1}$
Equivalent speed

q_i %
Time proportion of an operating mode relative to the total operating period; $q_i = (\Delta t_i / T) \cdot 100$

n_i $\min^{-1}$
Constant speed during the time period i

P_a N
Equivalent axial load

F_i N
Constant load during the time period i.



F_i = constant load during the time period
n_i = constant speed during the time period
q_i = time proportion of the operating mode relative to the total operating period

Figure 1
Load and speed varying in steps

Static load safety factor

The static load safety factor S_0 is the security against permanent deformation at the rolling contact:

$$S_0 = \frac{C_0}{F_0}$$

S_0 –
Static load safety factor

C_0 N
Basic static load rating

F_0 N
Maximum axial force.

The static load safety factor S_0 should not be less than the value 4. If this is the case, however, please consult Schaeffler.

Operating life

The operating life is defined as the life actually achieved by the planetary screw drive. It may differ significantly from the basic, calculated life.

Possible causes of premature failure due to wear or fatigue include:

- excessive loads as a result of misalignments
- contamination
- inadequate lubrication
- oscillating motion with very small swivel angles
- vibration while stationary
- overloading of the planetary screw drive (even for short periods)
- plastic deformation.

Lubrication

Planetary screw drives must be lubricated.

The lubricant operating life or the relubrication interval respectively are essentially dependent on:

- load
- velocity
- stroke length
- environmental conditions.

Initial greasing

Planetary screw drives are supplied with a preservative.
Prior to commissioning, they must be lubricated using the specified initial grease quantity.

Initial grease quantity

The initial grease quantity is made up of several components, see table.

Determining the initial grease quantity

Nominal diameter d_0	Initial grease quantity		
	Static	Moving	
		Base value	Dependent on stroke
mm	g	g	g/100 mm
5	2,8	0,7	0,4
9	3	0,8	0,6
12	4,2	1,1	0,8
15	4,1	1	1
20	4,8	1,2	1,2
25	7,2	1,8	1,6

The lubrication quantities are introduced partially while the nut is static and partially while it is moving.

Since the nut in the planetary screw drive does not have contact seals, a portion of the grease is carried out of the nut over the stroke range. In order to take account of this process, the grease quantity is increased during initial greasing and regreasing by an amount as a function of the stroke.

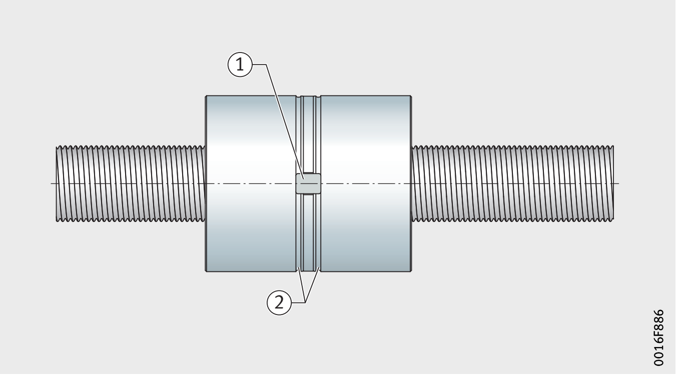
Example

Planetary screw drive PWG09 with a stroke of 100 mm:

- initial grease quantity = 3 g + 0,8 g + 0,6 g = 4,4 g
- Of this amount:
  – 3 g is introduced while the nut is stationary
  – 0,8 g + 0,6 g is introduced while the nut is moved over its complete stroke.

Lubricant feed

Lubricant feed is carried out in the central area of the nut. The lubricant is fed into the interior via the grooves on the circumference of the nut halves, *Figure 1*.



① Position for lubricant feed
② Integrated lubrication grooves

Figure 1
Lubricant feed

The locating bore in the housing must not have a circumferential lubrication groove in the central area of the nut, since this can lead to a positional error of the supplied spacer.

Recommended greases

Since the planetary screw drive is operated in the mixed friction range, we recommend lithium soap or lithium complex soap greases with a mineral oil base, EP additives and solid lubricant components that fulfil the conditions for greases in accordance with DIN 51825-KPF2K–20.

We recommend grease lubrication using greases of NLGI grade 2 and ISO VG 150 for the base oil.

Grease operating life

Since it is not possible to calculate all the influencing factors, the precise grease operating life can only be determined under operating conditions. The approximation equation below, however, can be used to determine a guide value for many applications:

$$t_{fG} = t_f \cdot K_P \cdot K_W \cdot K_U$$

t_{fG} h
Guide value for grease operating life in operating hours

t_f h
Basic lubrication interval in operating hours

K_P, K_W, K_U –
Correction factors for load, stroke and environment.

The grease operating life is restricted, due to the ageing resistance of the grease, to a maximum of 3 years.

Basic lubrication interval

The basic lubrication interval t_f, *Figure 2*, is valid under the following conditions:

- bearing temperature < +70 °C
- load ratio $C_0/P = 20$
- no disruptive environmental influences
- stroke ratio between 10 and 50, see page 12.

t_f = basic lubrication interval
GKW = speed parameter

① Relubrication possible
② Regreasing necessary

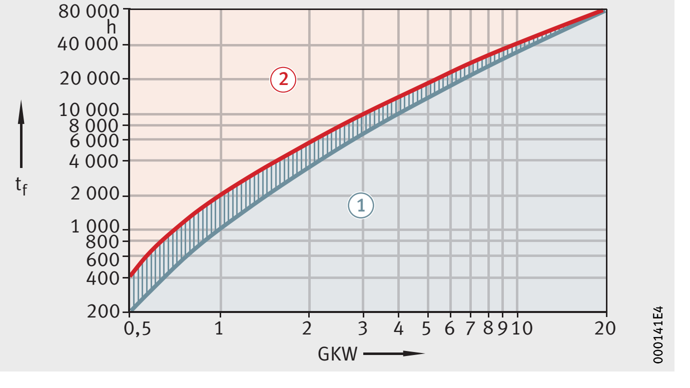


Figure 2
Determining the basic lubrication interval

Speed parameter

In order to determine the basic lubrication interval, the speed parameter must be known.

The speed parameter is calculated as follows:

$$GKW = \frac{60}{\bar{v}} \cdot K_{LF}$$

GKW –
Speed parameter

$\bar{v}$ m/min
Mean travel velocity

K_{LF} –
Bearing factor;
for planetary screw drives: $K_{LF} = 0{,}041$.

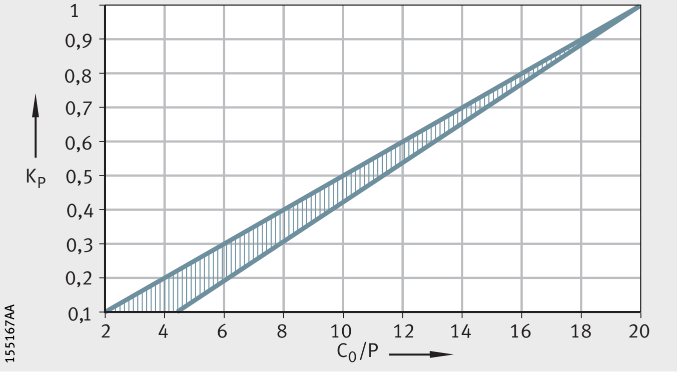
Correction factors

The correction factors take account of the influences of load, stroke and environment on the grease operating life.

Correction factor for load K_P

The correction factor K_P takes account of the strain on the grease at a load ratio of $C_0/P < 20$, *Figure 3*.

The factors are only valid for high quality lithium soap greases.



K_P = correction factor for load
C_0/P = load ratio

Figure 3
Correction factor for load

Correction factor for stroke length K_W

The correction factor K_W takes account of the displacement distance to be lubricated, *Figure 4*. It is dependent on the stroke ratio.

K_W = correction factor for stroke length
H_v = stroke ratio

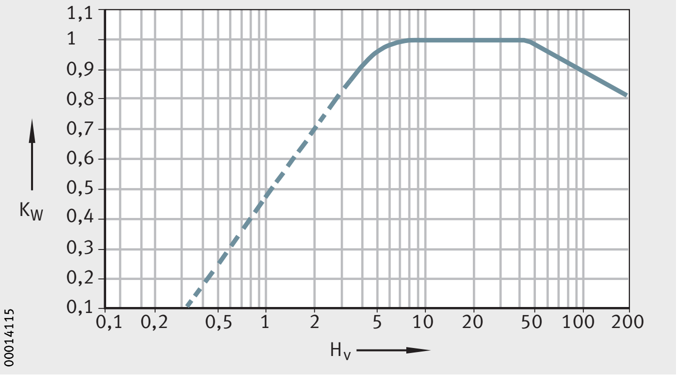


Figure 4
Correction factor for stroke length

Stroke ratio

If the stroke ratio H_V is less than 10 or more than 50, the grease operating life is reduced due to the risk of fretting corrosion or loss of grease.

The stroke ratio is calculated as follows:

$$H_v = \frac{H \cdot 10}{L}$$

H_v –
Stroke ratio
H mm
Stroke length
L mm
Length of threaded nut, see dimension table.

If the stroke length is very short, the grease operating life may be shorter than the calculated guide value. In this case, special greases are recommended; please consult Schaeffler.

Correction factor for environment K_U

The correction factor K_U takes account of shaking forces, vibrations (a cause of fretting corrosion) and shocks, see table.

These influences place an additional strain on the grease.

If cooling lubricant or moisture enters the system, calculation is not possible.

Environmental influence and correction factor

Environmental influence	Correction factor K_U
Slight	1
Moderate	0,8
Heavy	0,5

Relubrication

Lubricating grease

The grease used for relubrication should be the same as that used for initial greasing. If different greases are used, their miscibility and compatibility must be checked first.

Relubrication interval

If the guide value for the grease operating life t_{fG} is less than the required operating duration of the planetary screw drive, relubrication must be carried out.

Relubrication must be carried out at a time when the old grease can still be forced out of the threaded nut by the new grease.

A guide value for the relubrication interval for most applications is:

$$t_{fR} = 0{,}5 \cdot t_{fG}; \; t_{fG} < t_{fE}$$

t_{fR} h
Guide value for relubrication interval in operating hours

t_{fG} h
Guide value for grease operating life in operating hours

t_{fE} h
Required operating duration in hours.

Relubrication quantity

The relubrication quantity is approximately 50% of the initial grease quantity. Relubrication should be carried out wherever possible with several partial quantities at various times instead of the complete quantity at the time of the relubrication interval.

Influence of grease on friction behaviour

During commissioning and relubrication, the coefficient of friction increases temporarily due to the fresh grease. After a short running-in period, however, the coefficient of friction returns to its original lower value.

The friction behaviour is determined significantly by the characteristics of the grease used. The consistency and base oil viscosity serve as approximate guide values.

Permissible compressive force

If the spindle of the planetary screw drive is subjected to compressive load, the design must be checked in relation to buckling.

The maximum permissible compressive force is dependent on:

- the nominal diameter of the spindle
- the free unsupported length
- the axial operating load.

The permissible compressive force $F_{k\ per}$ that can act in an axial direction on the spindle of the planetary screw drive is calculated as follows:

$$F_{k\ per} = \frac{f_k \cdot d_0^4}{a^2} \cdot 10^4$$

$F_{k\ per}$ N
Permissible compressive force

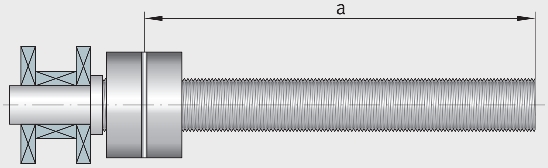
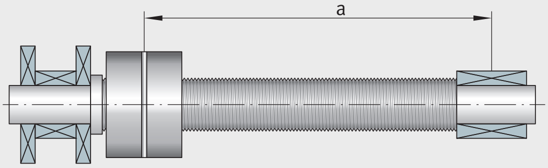
f_k N/mm^2
Bearing factor, see table

d_0 mm
Nominal diameter of spindle

a mm
Free spindle length.

The calculated values are theoretical values. The actual permissible compressive force on the spindle of a planetary screw drive may deviate from the calculated values as a result of component tolerances.

Bearing factor f_k

Type of spindle bearing arrangement	Bearing factor f_k
	2,54
	10,17

Critical speeds

Critical and permissible spindle speed

The rotating spindle causes vibration of the planetary screw drive supported by bearings due to deflection and eccentricities as a result of tolerances. If the excitation frequency reaches the natural frequency of this system, resonance occurs that can cause damage to the planetary screw drive and the surrounding parts.

In order to prevent this, a permissible spindle speed n_{per} is defined that is at least 20% below the natural frequency of the system.

The critical spindle speed n_c corresponds to the natural frequency of the system and is dependent on:

- the free spindle length
- the spindle diameter
- the type of spindle bearing arrangement
- the bearing rigidity.

This critical spindle speed n_c and the permissible spindle speed n_{per} are calculated as follows:

$$n_c = \left(8 \cdot 10^6 \cdot \frac{d_0^{0,95}}{a^{1,73}}\right)^{k_n}$$

$$n_{per} = 0,8 \cdot n_c$$

n_c $\min^{-1}$
Critical spindle speed

k_n $\min^{-1} \cdot \text{mm}$
Factor dependent on the type of spindle bearing arrangement, see table

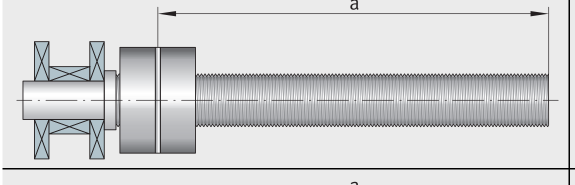
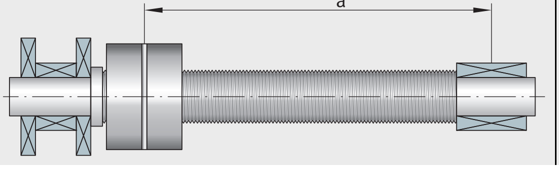
d_0 mm
Nominal diameter of the spindle, see dimension table

a mm
Free spindle length

n_{per} $\min^{-1}$
Maximum permissible spindle speed.

The calculated values are theoretical values. The actual critical and permissible spindle speeds of a planetary screw drive may deviate from the calculated values as a result of component tolerances.

Bearing factor k_n

Type of spindle bearing arrangement	Bearing factor k_n
	1,02
	1,2

Drive and holding torque

The drive torque of the motor is converted to an axial thrust force by the kinematics of the planetary screw drive. The decisive parameters here are the system friction and the system pitch.

Drive torque

The drive torque is calculated as follows:

$$M_a = \frac{F \cdot P}{2 \cdot \pi \cdot \eta} \cdot 10^{-3}$$

M_a Nm
Drive torque (against the load direction)

F N
Axial force

P mm
System pitch, see dimension table

η %
Efficiency of conversion of rotational motion into a longitudinal motion, see dimension table.

Holding torque

Planetary screw drives are not self-locking.
This means that, in order to hold a load at a precise position, a minimum torque known as the holding torque is required.

Planetary screw drives

Planetary screw drives

Planetary screw drives

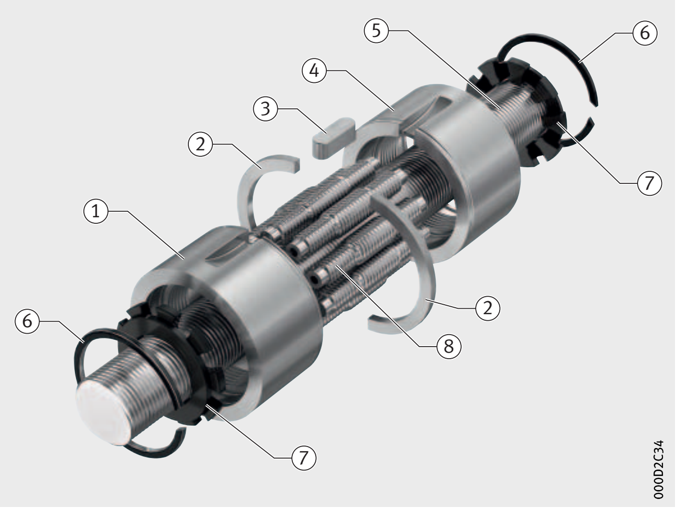
Features

Planetary screw drives convert rotational motion into longitudinal motion. As a result of their internal design, very small pitch values can be achieved, which means that high axial forces can be generated with relatively low drive torques. Due to the large reduction ratios, no additional gearboxes are required and smaller motors can be used.

Planetary screw drives are available in various sizes and optionally with matching Schaeffler bearing KITs.

Design

The main components of a planetary screw drive are a threaded spindle, threaded nut and planet rollers, *Figure 1*.
The threaded nut contains planet rollers arranged parallel to the axis that roll in planetary motion without axial displacement about the threaded spindle during rotation of the threaded spindle and thus give axial displacement of the nut. Due to the rolling conditions, the system pitch is not identical to the pitch of the threaded spindle.



① Nut half I
② Spacers
③ Feather key
④ Nut half II
⑤ Threaded spindle
⑥ Retaining rings
⑦ Planet rings
⑧ Planet rollers

Figure 1
Design of a planetary screw drive

Advantages

With their specific characteristics, planetary screw drives fill the gap between roller screw drives and ball screw drives.
They are thus the ideal solution for numerous applications.

The specific characteristics include:

- very economical drive
- high axial load carrying capacity due to the large number of rolling contacts
- facility for preloading clearance-free
- very small pitch values ($<$ 1 mm)
- very smooth running, due to the lack of rolling element return
- simple, robust design
- very high performance density
- high reliability and operational security.

High performance density and load carrying capacity

Planetary screw drives are characterised by a very high performance density. 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.

Economical drive

Due to the small pitch, it is possible to achieve very high axial forces using low drive torques and without a gearbox. The planetary screw drive from Schaeffler can be used not only to give electrically driven actuators with a high performance density, long operating life and low maintenance requirements but also allows the use of economical motors. Integration of the electric drive can be achieved very easily by means of a feather key connection on the outside diameter of the spindle nut.

Areas of application

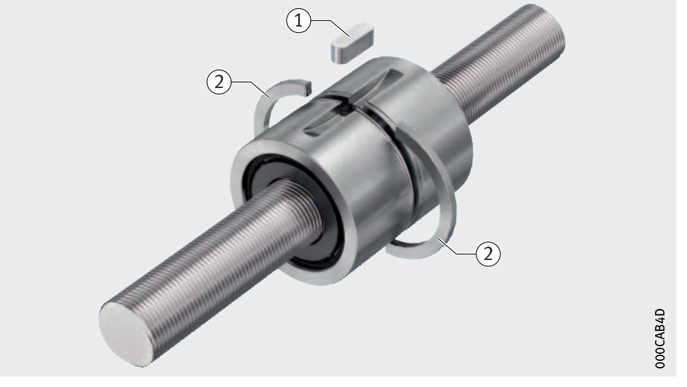
Due to the high performance density, planetary screw drives are extremely suitable as force actuators and offer the potential for replacing hydraulic axes by energy-efficient electromechanical drives.

Possible areas of application can be found in radial pressing tools, in the automation of buildings and processes, as a replacement for hydraulic systems in machine building, in servo table presses and riveting machines, in closing cylinders for plastics injection moulding machines and in the control of maritime drive units. There are also areas of application as actuators in the automotive industry.

Threaded nuts

Planetary screw drives are supplied by Schaeffler with a cylindrical nut, *Figure 2*. The feather key secures the threaded nut against rotation due to the occurring frictional torques in the housing. The spacers limit the preload when axially securing the nut in the adjacent construction and are matched to the use of the threaded spindle supplied.

The threaded spindle and threaded nut are a matched pair and must not be interchanged.



① Feather key
② Spacers

Figure 2
Cylindrical nut

Spindle bearing arrangement

The threaded spindle of a planetary screw drive can be ordered with the following spindle ends:

- spindle ends with bearing seats for locating bearings with drive journals (type A) and non-locating bearings (type M), see dimension table
- without bearing seats, but with the spindle ends cut and chamfered.

Bearing KITs

Bearing KITs can be supplied to match the bearing seat and load carrying capacity of planetary screw drives. All the rolling bearings in the KITs are sealed and greased for life.

The bearing KITs must be ordered specially, see table and page 28.

Designations of locating and non-locating bearing KITs

Size	Locating bearing KIT	Non-locating bearing KIT
PWG05	KIT.PWG05-3200	KIT.PWG05-2100
PWG09	KIT.PWG09-3200	KIT.PWG09-2100
PWG12	KIT.PWG12-3200	KIT.PWG12-2100
PWG15	KIT.PWG15-3200	KIT.PWG15-2100
PWG20	KIT.PWG20-3200	KIT.PWG20-2100
PWG25	KIT.PWG25-3200	KIT.PWG25-2100

!

When using the locating and non-locating bearing KITs , the following restriction on the axial load must be taken into consideration:

- PWG05: $P_a \leqq 0{,}25 \cdot C$
- PWG09: $P_a \leqq 0{,}33 \cdot C$
- PWG12, PWG15, PWG20 and PWG25: $P_a \leqq 0{,}5 \cdot C$

For PWG12 to PWG25, where higher axial forces are present, please consult Schaeffler.

Locating bearing KIT

A locating bearing KIT comprises the following components, *Figure 3*:

- 2 angular contact ball bearings of a tandem design for bracing in an O arrangement
- 1 sleeve matching the diameter
- 1 locknut and 1 thrust washer for preloading the bearing unit.

① Threaded spindle

Components of the locating bearing KIT:
② Sleeve
③ Angular contact ball bearing
④ Thrust washer
⑤ Locknut
⑥ Markings form an "O"

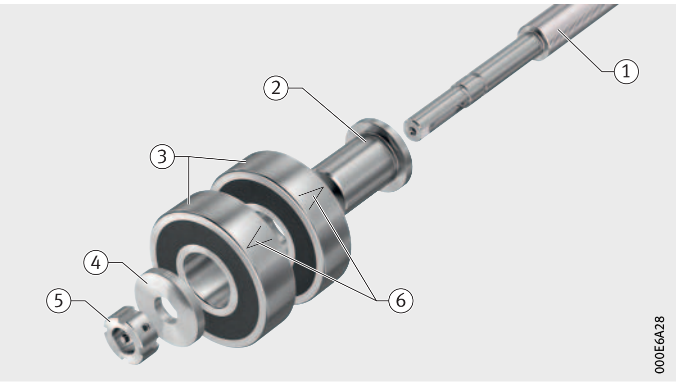


Figure 3
Locating bearing KIT

Mounting

Sequence of work operations in the mounting of a locating bearing KIT:

- The sleeve is mounted on the matching seat on the shaft.
- The two angular contact ball bearings are mounted consecutively on the sleeve such that the markings on the bearing outer rings form an "O".
- The thrust washer is slid onto the shaft.
- The locknut is then screwed into place on the shaft and the retaining pin of the locknut is tightened. The specified tightening torques must be observed, see table.

! In order to ensure suitable axial preload of the bearings in an O arrangement, the locknuts must be tightened to the specified tightening torque.

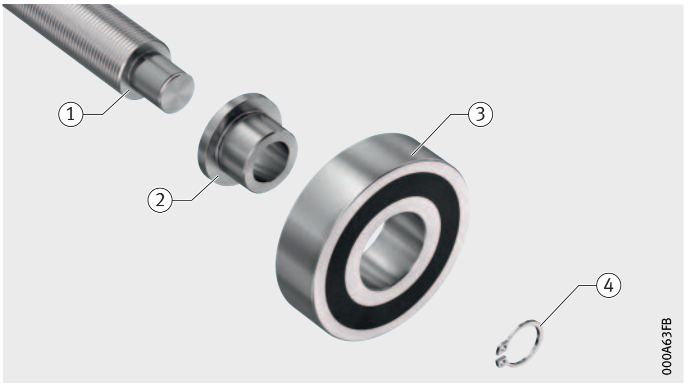
Locknuts and tightening torques

Size	Locknut	Tightening torques	
		Locknut Nm	Retaining pin Nm
PWG05	M5×0,5	2	–
PWG09	ZM06	3	1
PWG12	ZM08	5	1
PWG15	ZM10	8	1
PWG20	ZM12	10	1
PWG25	ZM17	19	3

Non-locating bearing KIT

A non-locating bearing KIT comprises the following components, *Figure 4*:

- 1 deep groove ball bearing
- 1 retaining ring
- 1 sleeve for matching the diameter (only for PWG05).



① Threaded spindle

Components of the non-locating bearing KIT:
② Sleeve (only for PWG05)
③ Deep groove ball bearing
④ Retaining ring

Figure 4
Non-locating bearing KIT

Mounting

Sequence of work operations in the mounting of a non-locating bearing KIT for PWG05:

- There must be a slight interference fit between the sleeve and the shaft and between the bearing inner ring and the sleeve.
- The sleeve is pressed onto the matching seat on the shaft.
- The deep groove ball bearing is pressed onto the sleeve.
- The retaining ring is then mounted in the groove on the end of the shaft.

Sequence of work operations in the mounting of a non-locating bearing KIT for PWG09 to PWG25:

- The deep groove ball bearing is pressed onto the matching seat on the shaft.
- The retaining ring is then mounted in the groove on the end of the shaft.

Setting the preload

Planetary screw drives must be set clearance-free. For this purpose, there is a spacer of a matched width between the two halves of the nut. The system is set clearance-free once it is mounted in the adjacent construction. By means of suitable machine components, both nut halves must be axially pressed against each other with a minimum preload force, see table.

Preload forces for threaded nuts

Size	Preload force N
PWG05	250
PWG09	500
PWG12	550
PWG15	700
PWG20	800
PWG25	900

The axial location of the nut can be carried out, for example, by means of a classic bearing cover, *Figure 5*, or by a bearing cover with a threaded ring, *Figure 6*, page 27. In this case, the threaded ring facilitates easier and more precise setting of the preload.

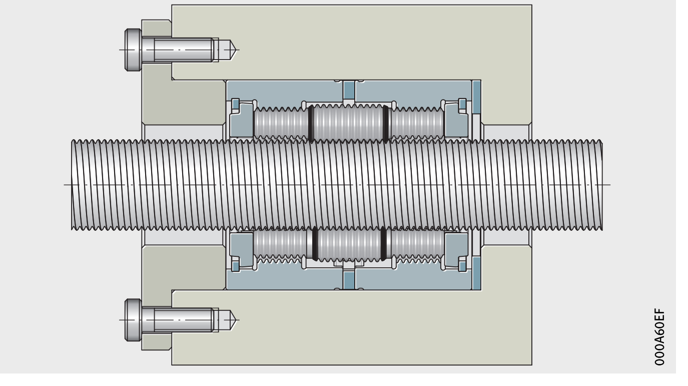


Figure 5
Axial location of the nut by classic bearing cover

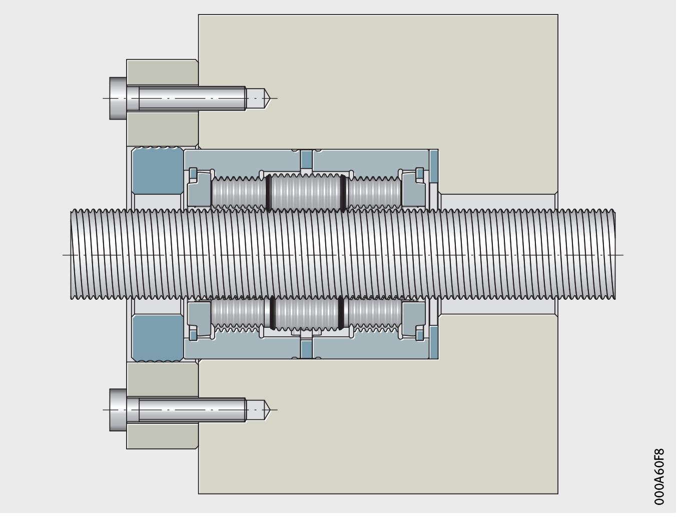
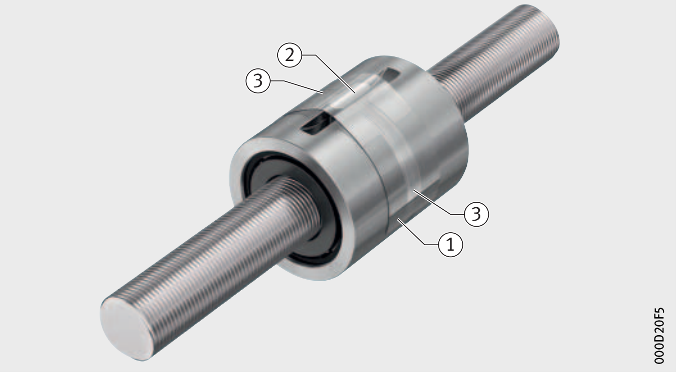


Figure 6
Axial location of the nut
by bearing cover with threaded ring

The feather key and spacers are fixed and held in place in the delivered condition by a transport securing device, *Figure 7*. The transport securing device must be removed before mounting.



① Transport securing device
② Feather key
③ Spacers

Figure 7
Cylindrical nut
in delivered condition

Ordering designation

The structure of the ordering designation is shown in *Figure 8*.

PWG09×0,75×900 -M-N-ETO
PWG09×0,75×900-A/M-M-J

Type	
PWG	Planetary screw drive
Size	
05 to 25	Nominal diameter of spindle
System pitch	
0,72 to 2,88	System pitch
Total spindle length	
500 to 1 500	Total spindle length including shaft ends
Spindle end on locating bearing side	
A	Type A
X	Cut
Z	Cut and chamfered
Spindle end on non-locating bearing side	
M	Type M
X	Cut
Z	Cut and chamfered
Threaded nut	
M	Cylindrical nut
Bearing KITs	
J	With locating and non-locating bearing KIT
N	Without bearing KIT
Customer-specific design	
ETO	Spindle ends as specified by customer

000D2030

Figure 8
Ordering designation

Design and safety guidelines

Design of the adjacent construction

Planetary screw drives are designed for the support of high axial loads. Transverse forces and tilting moments increase the internal forces in the nut and thereby lead to a significant reduction in operating life. In order to prevent transverse forces and tilting moments, it is essential that the following specifications are observed in the design of the adjacent construction.

Support and loading

The end faces of the nut in the planetary screw drive must be fully supported. When determining the locating diameter, the inside diameter D_i of the nut must be observed, see dimension table.

In order to utilise the full performance capability of the planetary screw drives, we recommend that ground steel washers are used with light metal or cast housings. The steel washers improve the application and distribution of forces in the housing.

Planetary screw drives are suitable for the transmission of axial forces only. Radial force components must be supported and must not be directed through the nut.

If the threaded spindle is subjected to compressive load, it must be ensured that the maximum permissible compressive force is not exceeded, see page 14. Otherwise, buckling of the spindle may occur. In case of doubt, tensile load must be applied instead.

Alignment

Misalignments of any sort must be avoided, since they induce internal forces that apply load to the rolling contact in addition to the axial force and thus reduce the operating life.

The geometrical and positional tolerances of the locating bore as well as the running accuracy of the nut housing relative to the spindle axis must be checked, see page 30.

Sealing

Dust draws the base oil out of the grease and liquid media wash out the grease. As a result, these contribute to a reduction in operating life, due also to their abrasive and aggressive behaviour respectively.

! Under adverse environmental conditions such as dust or liquid media, planetary screw drives must be protected against the ingress of contamination by means of a cover. Bellows or telescopic tubes are suitable as covers.

Cleanliness

Check the holes and locating edges for burrs. Any burrs present must be removed.

! The adjacent construction must be clean. Contamination will impair the accuracy and operating life of the planetary screw drive.

Accuracy

Tolerances of the adjacent construction

When designing the adjacent construction of a planetary screw drive, it is absolutely essential that the tolerance specifications for the complete system, for the adjacent construction of the threaded nut and for the bearing seating surfaces are observed.

Complete system

The complete system is subject to tolerance specifications for perpendicularity and parallelism, *Figure 9*. The tolerance specifications for parallelism are particularly valid in conjunction with guideways.

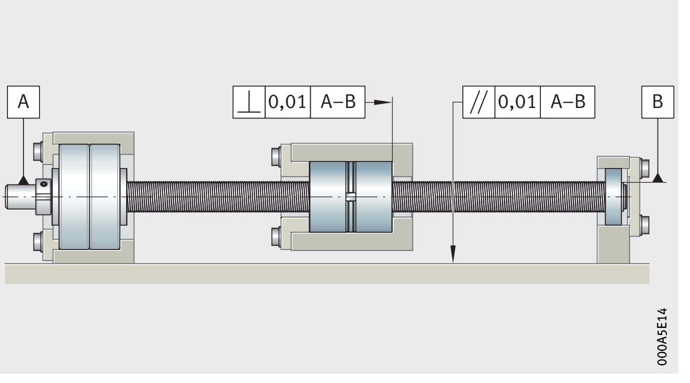


Figure 9
Tolerances
of complete system

! The nut must never be braced in the travel range near the bearing positions.

Adjacent construction of the threaded nut

The adjacent construction of cylindrical nuts is subject to tolerance and surface specifications, *Figure 10*.

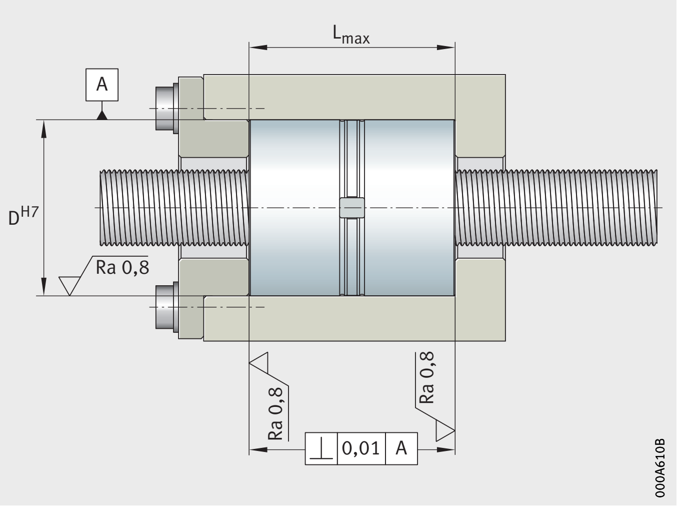


Figure 10
Tolerances
of adjacent construction
of cylindrical nut

Bearing seating surfaces for locating bearing arrangement

For the accuracy of the bearing seating surfaces in a locating bearing arrangement, geometrical and positional tolerances must be observed, *Figure 11* and table.

t_1 = roundness
t_2 = parallelism
t_3 = axial runout of abutment shoulders

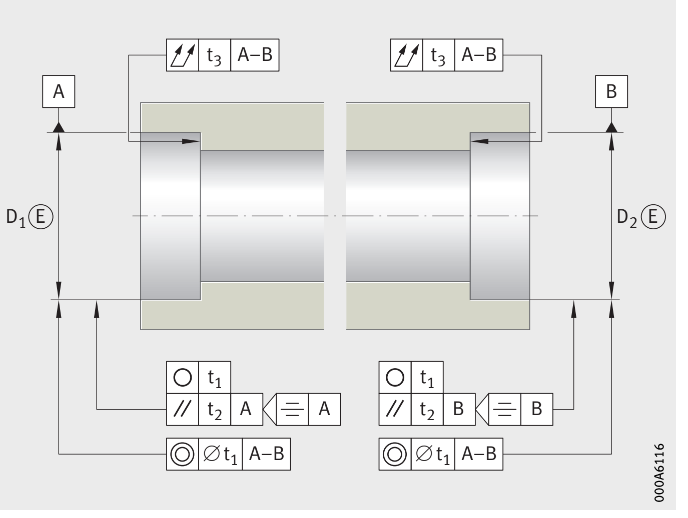


Figure 11
Tolerances of bearing seating surfaces for locating bearing arrangement

Guide values for the geometrical and positional tolerances of bearing seating surfaces

Bearing tolerance class		Bearing seating surface	Fundamental tolerance grades [1]			
To ISO 492	To DIN 620		Diameter tolerance	Roundness tolerance t_1	Parallelism tolerance t_2	Total axial runout tolerance of abutment shoulder t_3
Normal 6X	PN (P0) P6X	Housing	IT7 (IT6)	Circumfer-ential load IT5/2	Circumfer-ential load IT5	IT5
				Point load IT6/2	Point load IT6	

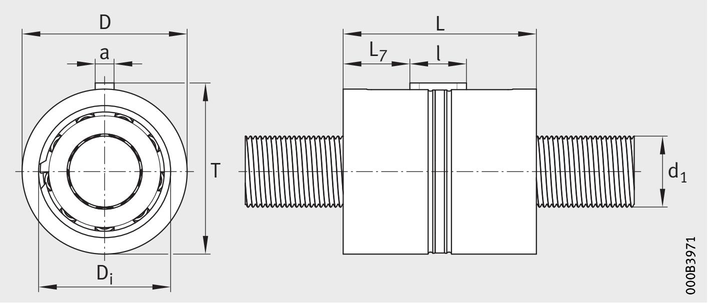
[1] ISO fundamental tolerances (IT grades) in accordance with DIN ISO 286.

Planetary screw drives

Dimension table · Dimensions in mm

System	Spindle						Cylindrical nut	
Designation	Designation	Mass m ≈ g/100 mm	Nominal diameter d_0	Outside diameter d_1	Max. spindle length[1]	System pitch P	Designation	Mass (excluding spindle) m ≈ g
PWG05×0,80	**PWS05**	15,5	5	5,6	500	0,8	**PWM05**	65
PWG09×0,75	**PWS09**	47,2	9	9,4	900	0,75	**PWM09**	119
PWG09×2,25		47,4				2,25		
PWG12×0,72	**PWS12**	89,6	12	12,7	1 200	0,72	**PWM12**	126
PWG12×2,16		91				2,16		
PWG15×2,11	**PWS15**	128,3	15	15,2	1 500	2,11	**PWM15**	178
PWG20×1,35	**PWS20**	230,4	20	20	1 500	1,35	**PWM20**	173
PWG25×1,31	**PWS25**	385,7	25	25,7	1 500	1,31	**PWM25**	417

1) Longer threaded spindles available by agreement.



Cylindrical nut

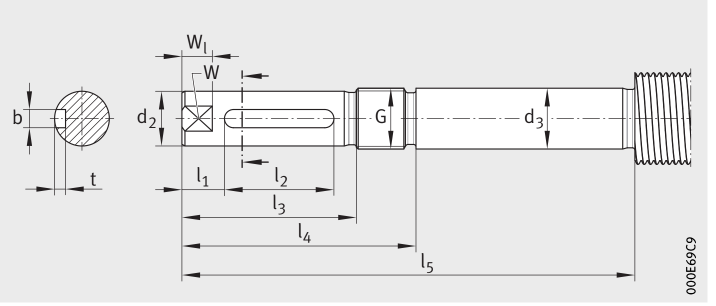
							Performance data			
Dimensions				Mounting dimensions			Limiting speed	Basic load ratings		Efficiency
D h6	D_i	L $^{+0,2}_{-0,35}$	T	l	a	L_7	n_G min^{-1}	dyn. C kN	stat. C_0 kN	η %
22	18	41	23,2	10	3	15,5	5 000	8	10	64
28	23	41	29,3	14	3	13,5	5 000	16	18	61
								14,4		82
31	26	41	32,9	12	4	14,5	5 000	25	28	54
										83
35	28	41	36,3	12	4	14,5	5 000	34	38	69
40	34	41	41,3	12	4	14,5	5 000	39	44	63
53	39	41	55,5	22	6	9,5	5 000	43	50	59

Threaded spindles

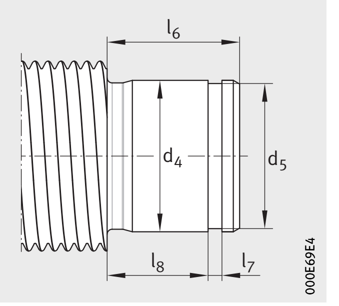
Ends of spindle

Dimension table								
Designation	Locating bearing Type A							
	d_2 h8	W	W_l	l_1	l_2 $^{+0,2}_{-0,2}$	b N9	t $^{+0,1}_{0}$	l_3 $^{+0,2}_{-0,2}$
PWS05	3	2,5	4	5,5	16	2	1,2	24,5
PWS09	5	4	4	5,5	16	2	1,2	24
PWS12	6,9	6	5	7	16	3	1,8	27
PWS15	9	8	5	7	18	3	1,8	28,1
PWS20	10	9	5	7,3	16	3	1,8	26,5
PWS25	15	13	5	7,5	10	5	3	22,8

When using planetary screw drives in combination with the locating and non-locating bearing KITs, the restriction on the axial load must be taken into consideration, see page 23.



Locating bearing (type A)



Non-locating bearing (type M)

				Non-locating bearing Type M				
G DIN 13	l_4 0 −0,2	d_3 h8	l_5 +0,3 0	d_4 h8	d_5	l_6 +0,3 0	l_7 +0,2 0	l_8 +0,1 −0,1
M4×0,5	35,5	4	59,5	3	2,8	13	0,5	11
M6×0,5	35,3	6,1	61	7	6,7	9	0,9	7
M8×0,75	39	8	72,5	10	9,6	10	1,1	8
M10×1	40,2	10	74,5	12	11,5	10,5	1,1	8
M12×1	38,1	12	72,5	17	16,2	12,5	1,1	10
M17×1	36,8	17	76	20	19	15	1,3	12

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