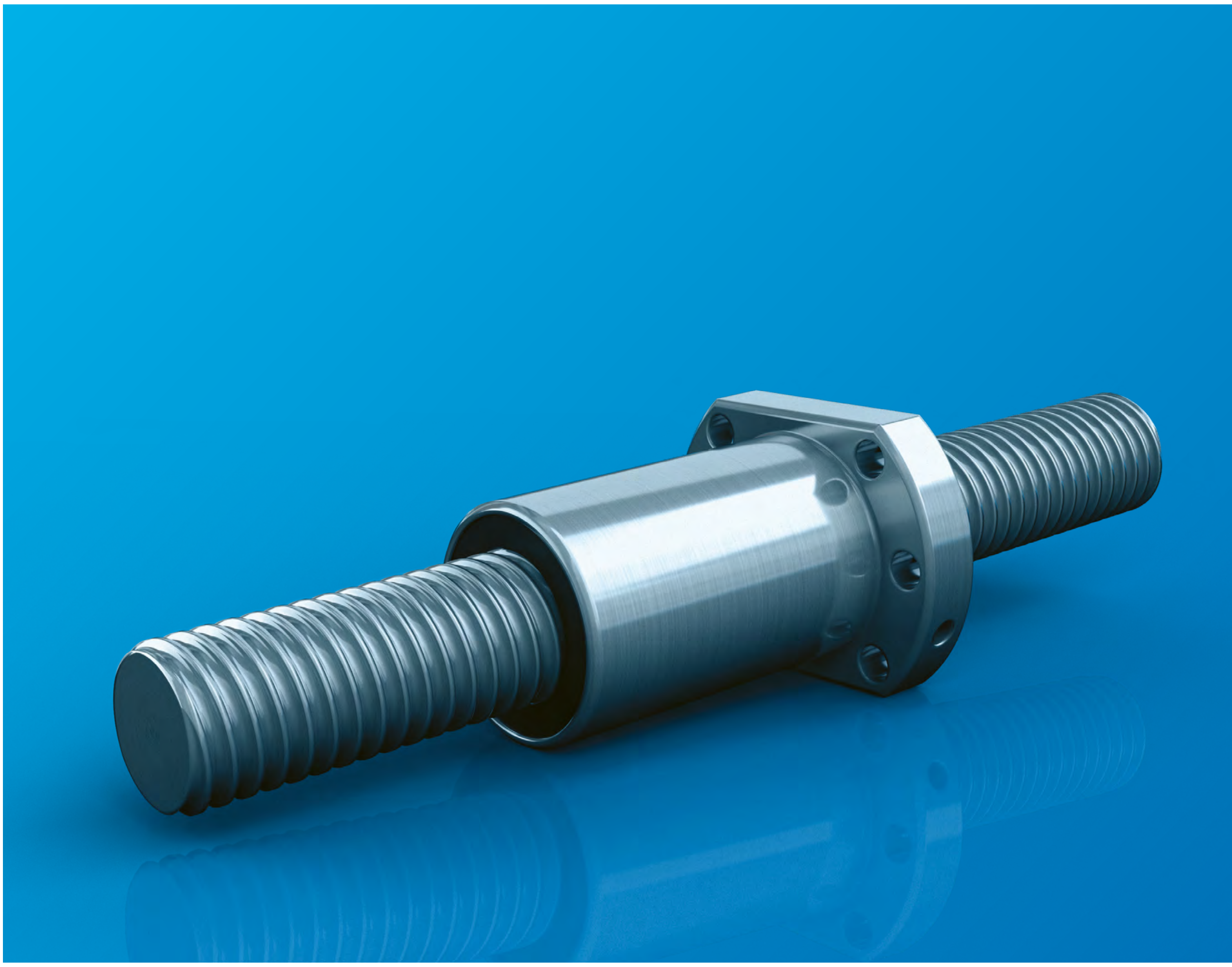
HYPEX

Linear Motion



BALL SCREW DRIVES

O nas
About Us

Podjetje HYPEX d.o.o. je proizvodno-trgovsko podjetje v zasebni lasti, ustanovljeno leta 1990. Pred leti smo zgradili sodoben poslovno proizvodni center v industrijski coni v Lescah, kjer je poleg poslovnih prostorov tudi veleprodajna trgovina, skladišča ter obrat proizvodnje.

Proizvodno-prodajni program smo v zadnjem času razširili, tako da danes nudimo veliko izbiro elementov industrijske avtomatizacije in industrijske opreme za strojegraditelje, vzdrževalce, inštalaterje in obrtnike tako doma kot v tujini.

Kot dobavitelj komponent ali celih sklopov iz lastne proizvodnje nudimo tudi proizvode drugih znanih in manj znanih proizvajalcev, katerih proizvodi morajo po kvaliteti in standardih ustrezati zahtevam sodobnega trga.

HYPEX d.o.o. is a production and trading company founded in 1990 and since then privately owned. Several years ago we built a modern business manufacturing center in the industrial zone in Lesce, where in addition to commercial premises we include wholesale trade, warehouse and manufacturing plant.

Production and sales program was recently expanded, so today we offer a great selection of elements of industrial automation and industrial equipment for engineers, repairers, installers and tradesmen both at home and abroad.

As a supplier of components or entire sets from our own production, we also offer products of other well-known and lesser-known producers whose products have the quality and standards to meet the requirements of the modern market.

Hypex proizvodi po kvaliteti
in standardih ustrezajo zahtevam
sodobnega trga.

Hypex products have the quality and
standards to meet the requirements
of the modern market.

Hypex prodajni program
Hypex Products

UNI-AIR PRIKLJUČKI
UNI-AIR FITTINGS

PROFILNA TEHNIKA
PROFILE TECHNICS

PROCESNA TEHNIKA
FLUID CONTROL

UNI-AIR PNEVMATIKA
UNI-AIR PNEUMATICS

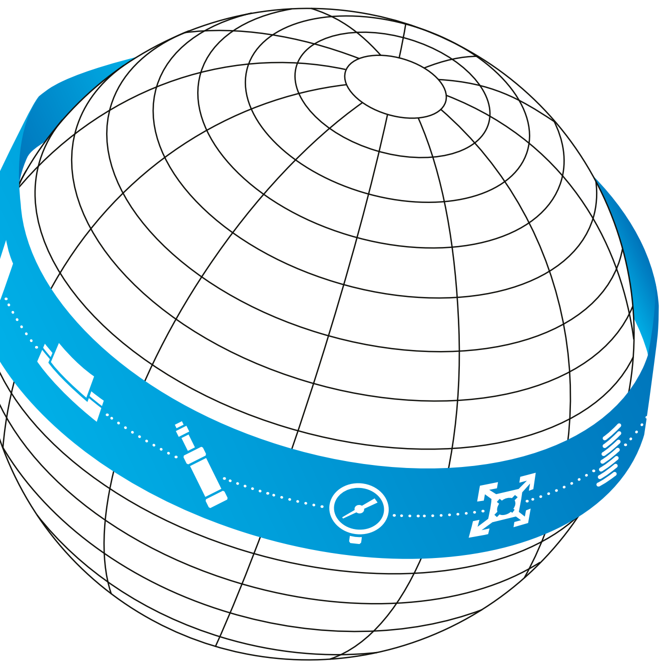
LINEARNA TEHNIKA
LINEAR MOTION TECHNOLOGY

- **TIRNA VODILA**
  LINEAR GUIDES
- **MINI TIRNA VODILA**
  MR MINIATURE LINEAR GUIDE SERIES
- **OKROGLA VODILA**
  ROUND GUIDES
- **VRETENA**
  BALL SCREW DRIVES

UNIMOTION LINEARNE ENOTE
UNIMOTION LINEAR UNITS

UNIMOTION ELEKTRIČNI CILINDRI
UNIMOTION ELECTRIC CYLINDERS

Hypex spletna trgovina
Hypex Online Store



Obiščite našo spletno trgovino: www.hypex.si

Spletna trgovina je jasno urejena in preprosta za uporabo. Vsebuje detajlne informacije, vključno s 3D CAD modeli, posameznih produktov.

Podrobnejše informacije o dostavi in vse ostale informacije so na voljo na spletu.

Visit our online store: www.hypex.si

Online store is clearly arranged and easy to use. It contains detailed product information, including 3D CAD models.

More information about shipping and all other information available on the web.

Kazalo
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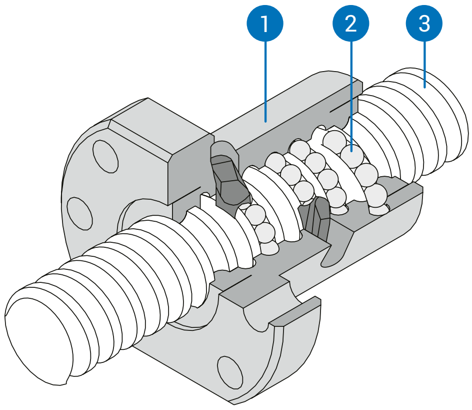
Product overview

BALL SCREW DRIVE

Ball screw drives convert rotary motion into linear motion and vice versa, where loads are transferred from the ball screw shaft to the ball nut through a ball set to maximize the level of efficiency and minimize the friction. Ball screw drive consists of a ball screw shaft, a ball nut and a set of the balls:



1 – Ball nut with recirculation systems
2 – Balls
3 – Ball screw shaft

Features

– High level of efficiency (> 90 %)
– High load capacity
– High positioning accuracy
– Gothic arc profile with contact angle of 45°
– No stick/slip effect
– Conform also to DIN standard 69051
– Not capable of self-locking

Precision rolled ball screws

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Nominal diameter: ø8 ~ 40 mm
Lead: 2 ~ 25 mm
Material: CK55 – 1.1203 (induction surface hardened – 58 ~ 62 HRC)

Ball nuts

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Material: 15CrMo – 1.7262 (carbonized hardened – 58 ~ 62 HRC)

Ball nut types:

– **FSU:** flanged single nut (DIN standard 69051) – diameter of ø16 ~ 40 mm, lead of 5 ~ 10 mm

– **FSC:** flanged single nut (low noise type) – diameter of ø16 ~ 40 mm, lead of 5 ~ 20 mm

– **FSE:** flanged single nut (high lead type) – diameter of ø16 ~ 25 mm, lead of 16 ~ 25 mm

– **FSK:** flanged single nut (miniature type) – diameter of ø8 ~ 10 mm, lead of 2 ~ 4 mm

– **RSK:** cylindrical single nut with threaded nose (miniature type) – diameter of ø12 mm, lead of 4 ~ 5 mm

– **RSY:** cylindrical single nut with key way – diameter of ø12 ~ 32 mm, lead of 5 ~ 20 mm

– **RSU:** cylindrical single nut with threaded nose (DIN standard 69051) – diameter of ø16 mm, lead of 5 mm

ACCESSORIES

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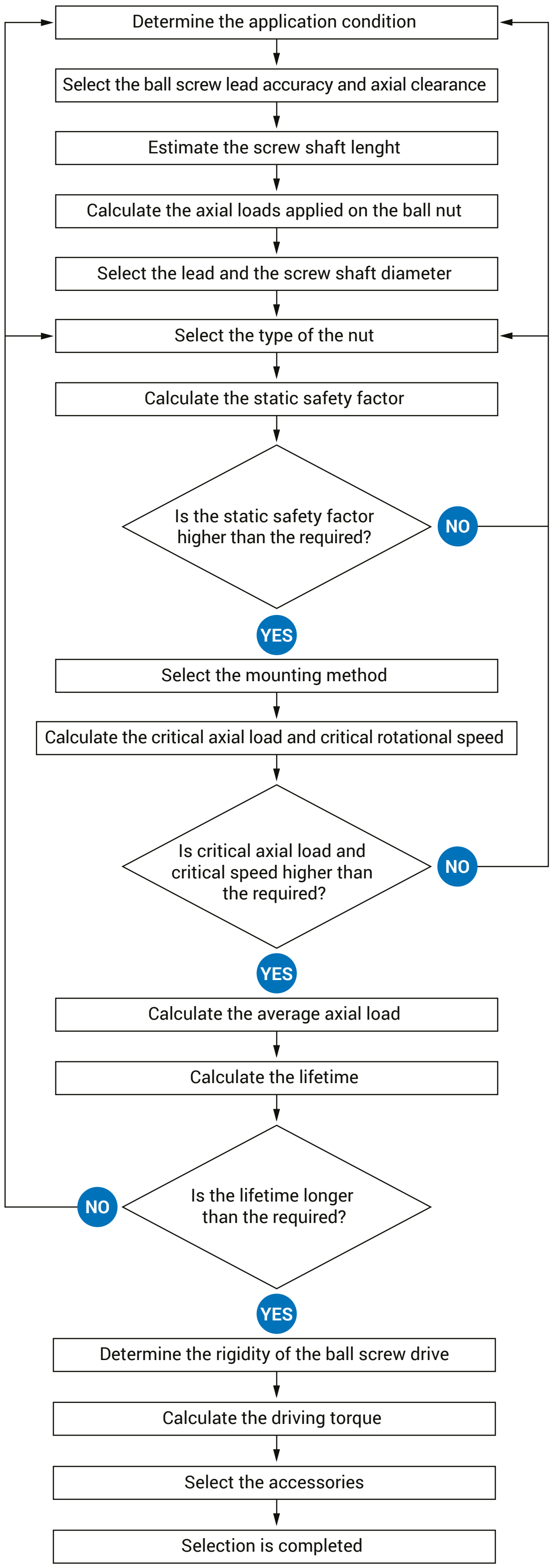
– End machining

– Support units of the ball screw

– Couplings

General information

HOW TO SELECT A BALL SCREW DRIVE



GENERAL TECHNICAL INFORMATION

Operating conditions

Maximum rotational speed	$70000/d_p$	[rpm]
Maximum acceleration	20	[m/s²]
Environmental temperature	−10 ~ + 80	[°C]
Duty cycle	100	[%]

d_p	Ball center-to-center diameter	[mm]

For operating conditions over the stated values in the upper table please contact us.

Basic static load rating C_0

When the ball screw drive is subjected to an excessive axial load, the threaded surfaces and the rolling elements (steel balls) can be permanently deformed. At this point the ball screw drive will no longer operate smoothly. The basic static load rating C_0 is defined as the static axial concentrically acting load which causes a permanent overall deformation of 0,0001 times of the ball diameter. The values of C_0 can be found in the table for the particular type and size of the ball nut.

Static safety factor f_s

The static safety factor f_s is defined as the ratio between the basic static load rating C_0 (of the ball screw drive) and the maximum axial load applied on the ball nut F_{max}. The static safety factor f_s should never be lower than 1,0 and it is very important when ball screw drive is subjected to the impact loads and vibrations. Recommended static safety factor are presented in the following table.

$$f_s = \frac{C_0}{F_{max}}$$

f_s	Static safety factor	
C_0	Basic static load rating	[N]
F_{max}	Maximum axial load applied on the ball nut	[N]

Recommended static safety factor

Ball screw drive application	Loading condition	Min. f_s
General applications/ industrial machines	Light impact and vibrations	1,0 ~ 1,3
	Heavy impact and vibrations	2,0 ~ 3,0
Machine tools	Light impact and vibrations	1,0 ~ 1,5
	Heavy impact and vibrations	2,5 ~ 7,0

Nominal life L

Suppose a number of ball screw drives of the same type operated individually under the same conditions. After a certain period of time 90 % of them will not fail as a result of signs of fatigue on the contact surfaces, known as flaking. The total number of revolutions at this point is defined as the nominal life L.

Basic dynamic load rating C

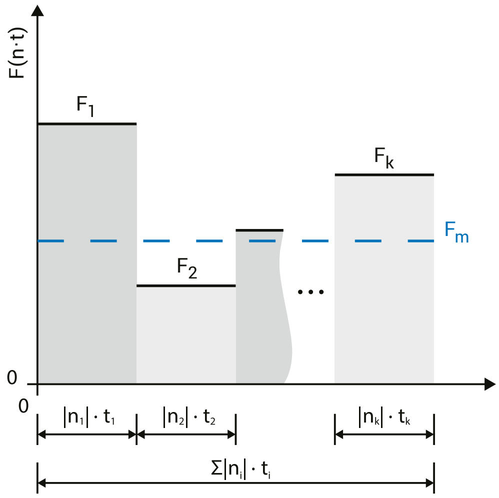
The basic dynamic load rating C is defined as the axial concentrically acting load of constant direction and magnitude at which a ball screw drive achieves a nominal life of one million revolutions.

Average axial load F_m

When the axial load F applied on a ball nut fluctuates, an average axial load F_m which will yield the same lifetime of a ball screw drive as the fluctuating load should be calculated. In the following, three common types of the axial load fluctuation are presented.

Incremental type

When the axial load fluctuates incrementally, the average axial load F_m may be calculated as follows (see figure below):

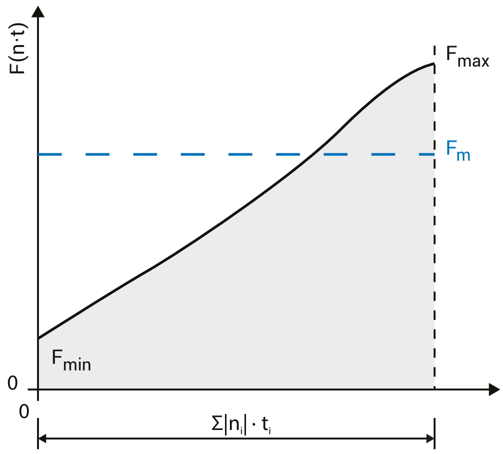


$$F_m = \sqrt[3]{\frac{1}{\Sigma|n_i| \cdot t_i} \cdot \left(F_1^3 \cdot |n_1| \cdot t_1 + F_2^3 \cdot |n_2| \cdot t_2 + \cdots + F_k^3 \cdot |n_k| \cdot t_k\right)}$$

F_m	Average axial load	[N]
F_i	i-th axial load of a given incremental loading regime $F(n \cdot t)$, $i \in \{1, 2, ..., k\}$	[N]
n_i	i-th rotational speed of a given incremental loading regime $F(n \cdot t)$, $i \in \{1, 2, ..., k\}$	[rpm]
t_i	i-th time of a given incremental loading regime $F(n \cdot t)$, $i \in \{1, 2, ..., k\}$	[s]
k	Number of increments	

Linear type

When the axial load fluctuation is almost linear, the average axial load F_m may be calculated as follows (see figure below):



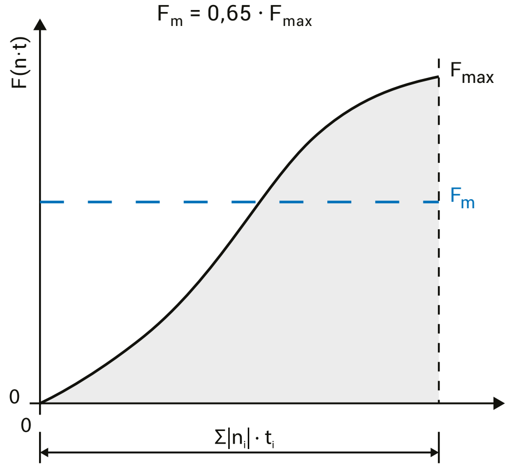
$$F_m = \frac{1}{3} \cdot \left(F_{min} + 2 \cdot F_{max}\right)$$

F_{min}	Minimum value of fluctuating axial load	[N]
F_{max}	Maximum value of fluctuating axial load	[N]

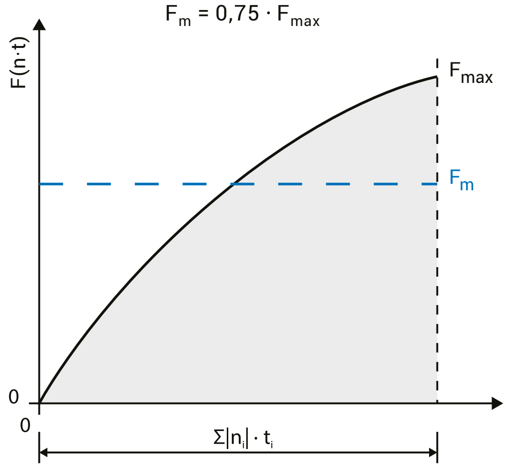
Sinusoidal type

When the axial load fluctuates similar to the sinusoidal wave as it is presented in the figures below, the average axial load F_m may be calculated as follows:

$F_m = 0{,}65 \cdot F_{max}$



$F_m = 0{,}75 \cdot F_{max}$



LIFE TIME CALCULATION

Nominal life L

Nominal life L of the ball screw drive can be calculated by the following equation, where the basic dynamic load rating C, average axial load F_m applied on a ball nut and the load factor f_w are taken into consideration:

$$L = \left(\frac{C}{F_m \cdot f_w}\right)^3 \cdot 10^6$$

L	Nominal life	[rev]
f_w	Load factor	

Lifetime L_h

If the total travel distance s of one cycle (in some cases s = 2 · stroke) and the number of cycles per minute (cycle frequency) are known, the lifetime L_h can be calculated based on the nominal life.

$$L_h = \frac{L \cdot l}{s \cdot n_{cm} \cdot 60}$$

L_h	Lifetime	[h]
l	Ball screw lead	[mm]
n_{cm}	Number of cycles per minute	[cyc/min]
s	Total travel distance of one cycle	[mm]

Lifetime can also be calculated using the average rotational speed n_m:

$$n_m = \frac{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \cdots + |n_k| \cdot t_k}{t_1 + t_2 + \cdots + t_k}$$

$$L_h = \frac{L}{n_m \cdot 60}$$

n_m	Average rotational speed	[rpm]
n_i	i-th rotation speed of a given incremental regime n(t), $i \in \{1, 2, ..., k\}$	[rpm]
t_i	i-th time of a given incremental regime n(t), $i \in \{1, 2, ..., k\}$	[s]

Load factor f_w

Lifetime of the ball screw drive can be reduced significantly if the impacts and vibrations as a result of high speed of a ball screw occur during the operation. The average load F_m must be multiplied by the load factor f_w. Since the effects of impacts and vibrations are difficult to determine, the empirical values of the load factor (according to the table presented below) should be taken into consideration.

Shock and vibrations	Average travel speed v_m	f_w
Weak	Low $v_m \leq 0{,}15$ m/s	1,0 ~ 1,2
Medium	Medium 0,25 m/s < $v_m \leq 1$ m/s	1,2 ~ 1,5
Strong	High $v_m > 1$ m/s	1,5 ~ 3,0

Here the average travel speed v_m is calculated as follows:

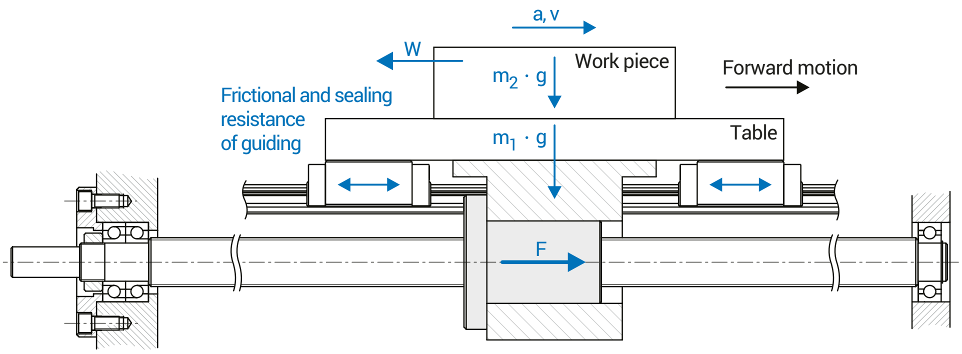
$$v_m = \frac{n_m \cdot l}{60000}$$

v_m	Average travel speed	[m/s]

AXIAL LOAD APPLIED ON THE BALL SCREW DRIVES CALCULATION

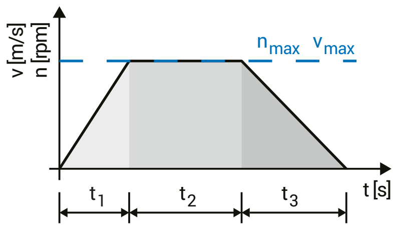
In the following calculations of the axial load F applied on the ball screw drives are presented for some typical examples of the applications. The mass (inertia) of the table and work piece, axial forces and mounting style (orientation position) are taken into consideration.

Example #1



Application conditions:

– Horizontal mounting position
– Mass of the table and work piece
– Working force
– Frictional and sealing resistance force of guiding
– Travel or rotational speed as a function of time v(t) or n(t), respectively:



Loads applied on the ball nut:

Forward motion:

- During the acceleration ($a_1 = v_{max}/t_1 = n_{max} \cdot l/(60000 \cdot t_1)$):

  $F = -(m_1 + m_2) \cdot a_1 - W - (m_1 + m_2) \cdot g \cdot \mu - f_G$

- During the constant travel speed ($a_2 = 0\ m/s^2$):

  $F = -W - (m_1 + m_2) \cdot g \cdot \mu - f_G$

- During the deceleration ($a_3 = -v_{max}/t_3 = -n_{max} \cdot l/(60000 \cdot t_3)$):

  $F = -(m_1 + m_2) \cdot a_3 - W - (m_1 + m_2) \cdot g \cdot \mu - f_G$

Backward motion:

- During the acceleration ($a_1 = -v_{max}/t_1 = -n_{max} \cdot l/(60000 \cdot t_1)$):

  $F = -(m_1 + m_2) \cdot a_1 - W + (m_1 + m_2) \cdot g \cdot \mu + f_G$

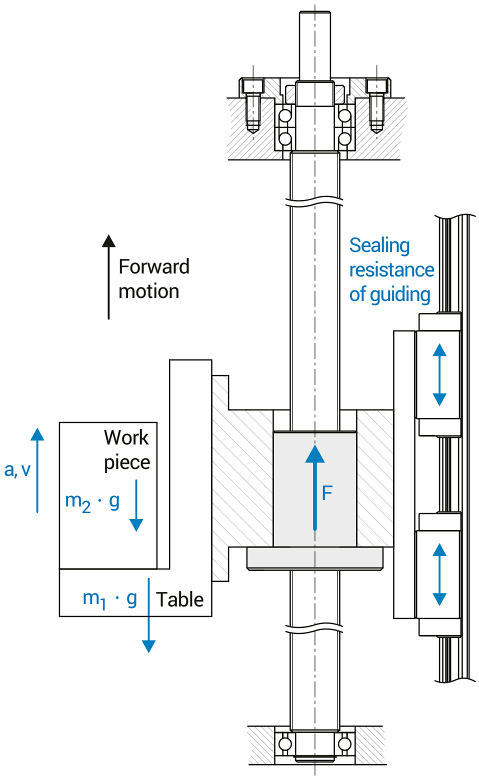
- During the constant travel speed ($a_2 = 0\ m/s^2$):

  $F = -W + (m_1 + m_2) \cdot g \cdot \mu + f_G$

- During the deceleration ($a_3 = v_{max}/t_3 = n_{max} \cdot l/(60000 \cdot t_3)$):

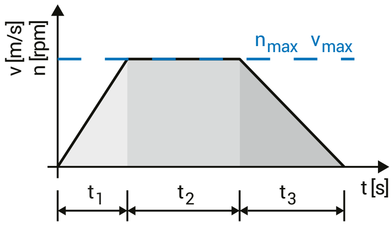
  $F = -(m_1 + m_2) \cdot a_3 - W + (m_1 + m_2) \cdot g \cdot \mu + f_G$

Example #2



Application conditions:

– Vertical mounting position
– Mass of the table and work piece
– Sealing resistance force of guiding
– Travel or rotational speed as a function of time v(t) or n(t), respectively:



Loads applied on the ball nut:

Forward motion:

- During the acceleration ($a_1 = v_{max}/t_1 = n_{max} \cdot l/(60000 \cdot t_1)$):

  $F = -(m_1 + m_2) \cdot (g + a_1) - f_G$

- During the constant travel speed ($a_2 = 0$ m/s^2):

  $F = -(m_1 + m_2) \cdot g - f_G$

- During the deceleration ($a_3 = -v_{max}/t_3 = -n_{max} \cdot l/(60000 \cdot t_3)$):

  $F = -(m_1 + m_2) \cdot (g + a_3) - f_G$

Backward motion:

- During the acceleration ($a_1 = -v_{max}/t_1 = -n_{max} \cdot l/(60000 \cdot t_1)$):

  $F = -(m_1 + m_2) \cdot (g + a_1) + f_G$

- During the constant travel speed ($a_2 = 0$ m/s^2):

  $F = -(m_1 + m_2) \cdot g + f_G$

- During the deceleration ($a_3 = v_{max}/t_3 = n_{max} \cdot l/(60000 \cdot t_3)$):

  $F = -(m_1 + m_2) \cdot (g + a_3) + f_G$

F	Axial load applied on the the ball nut	[N]
m_1, m_2	Mass of the table and work piece	[kg]
W	Working force	[N]
g	Gravity ≈ 9,81	[m/s^2]
f_G	Sealing resistance of guiding	[N]
μ	Coefficient of friction of guiding	
v_{max}	Maximum travel speed	[m/s]
n_{max}	Maximum rotational speed of ball screw	[rpm]
t_i	Duration time of i-th section og a given regime v(t) or n(t)	[s]
a_i	Acceleration of the table within i-th section of a given regime v(t) or n(t)	[m/s^2]
l	Ball screw lead	[mm]

CRITICAL AXIAL LOAD AND CRITICAL ROTATIONAL SPEED

For all applications the critical axial load and critical rotational speed of the ball screw drive must be taken into consideration.

Critical axial load F_{cr}

Regarding the buckling

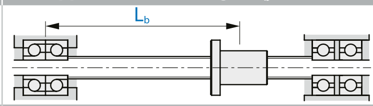
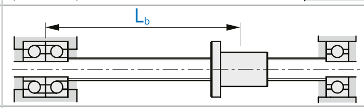
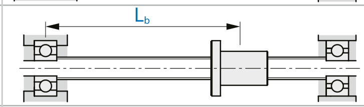
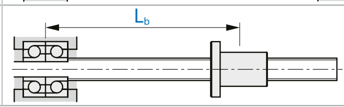
For the case of compressively loaded ball screw shaft in the axial direction, the problem of the buckling may occurred. Critical buckling load F_b can be calculated as follows:

$$F_b = \lambda_b \cdot \frac{d_2^4}{L_b^2} \cdot 10^4$$

F_b	Critical buckling load	[N]
λ_b	Mounting method buckling factor	[N/mm²]
d_2	Screw shaft root diameter	[mm]
L_b	Compressively stressed unsupported screw length	[mm]

It should be noted that the mounting method buckling factor λ_b takes into account the safety factor of 0,5.

Mounting method buckling factor λ_b and unsupported screw length L_b:

Mounting method	Mounting method buckling factor λ_b [N/mm²]	Unsupported screw length L_b
Fixed – Fixed	20,3	
Fixed – Simple	10,2	
Simple – Simple	5,1	
Fixed – Free	1,3	

The most common mounting methods for the screw drives are presented on page 33.

Regarding the permissible tensile and compressive stress

Permissible tensile and compressive load F_p related to the yielding stress in the screw shaft can be calculated using the equation below.

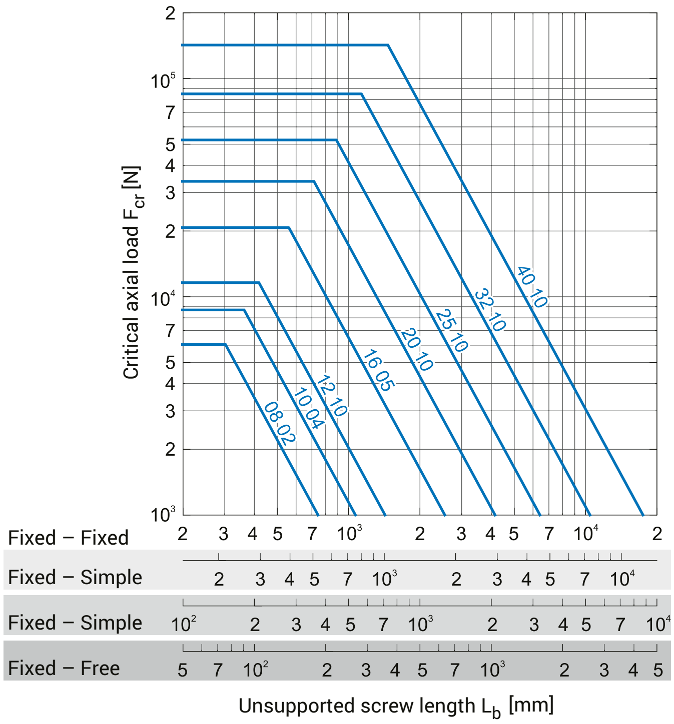
$$F_p = 116 \cdot d_2^2$$

F_p	Permissible tensile and compressive load	[N]

Finally, critical axial load F_{cr} is defined as a minimum between critical buckling load F_b and permissible tensile and compressive load F_p:

$$F_{cr} = \min(F_b, F_p)$$

The critical axial load F_{cr} for different screw diameters and mounting methods can also be obtained based on the following diagram.



Critical rotational speed n_{cr}

Regarding the mounting method

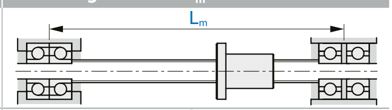
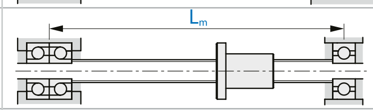
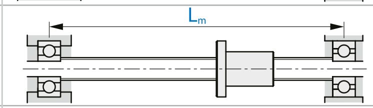
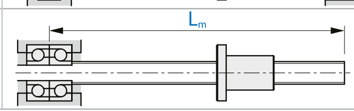
For all the application there is always a risk of resonant vibrations when the rotational frequency of the screw shaft is near its first natural frequency. To avoid this kind of vibrations the rotational speed should be lower than the rotational frequency, which can be calculated as follows:

$$n_s = \lambda_s \cdot \frac{d_2}{L_m^2} \cdot 10^7$$

n_s	Critical rotational speed regarding the mounting method	[rpm]
λ_s	Mounting method speed factor	[rpm · mm]
d_2	Screw shaft root diameter	[mm]
L_m	Mounting distance	[mm]

It should be noted that the mounting method speed factor λ_s takes into account the safety factor of 0,8.

Mounting method speed factor λ_s and mounting distance L_m:

Mounting method	Mounting method speed factor λ_s	Mounting distance L_m
Fixed – Fixed	21,9	
Fixed – Simple	15,1	
Simple – Simple	9,7	
Fixed – Free	3,4	

The most common mounting methods for the screw drives are presented on page 33.

Regarding the recirculation system

The permissible rotational speed n_p is the limiting speed of the recirculation system of the ball nut. It can be calculated based on the product of the permissible rotational speed and the ball center-to-center diameter.

$$d_p \cdot n_p \leq 70.000$$

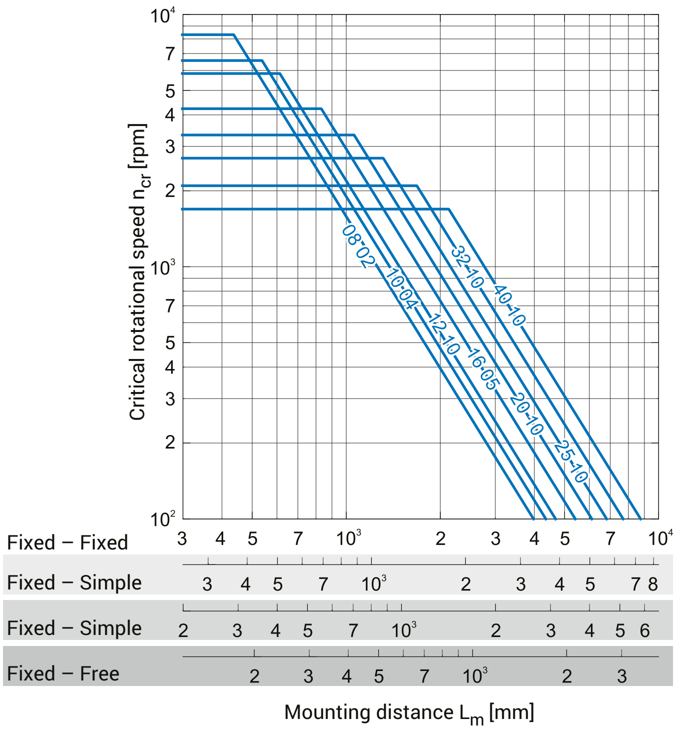
n_p	Permissible rotational speed	[rpm]
d_p	Ball center-to-center diameter	[mm]

For rotational speed exceeding the permissible one please contact us.

Finally, critical rotational speed n_{cr} is defined as a minimum between the critical rotational speed n_s and the permissible rotational speed n_p:

$$n_{cr} = \min(n_s, n_p)$$

The critical rotational speed n_{cr} for different screw diameters and mounting methods can also be obtained based on the following diagram.



DRIVING TORQUE AND MOMENT OF INERTIA CALCULATIONS

Driving torque required to convert rotary motion of the ball screw shaft into linear motion can be calculated by the following equation:

- During the acceleration:

$T_d = T_l + T_f + T_J$

- During the constant travel speed

$T_d = T_l + T_f$

- During the deceleration

$T_d = T_l + T_f - T_J$

T_d	Driving torque	[Nm]
T_l	Load torque during constant travel speed	[Nm]
T_f	Frictional torque	[Nm]
T_J	Inertial torque	[Nm]

Load torque during constant travel speed T_l

$$T_l = \frac{|F| \cdot l}{2\pi \cdot \eta \cdot 10^3} \cdot \left(\frac{N_m}{N_{bs}}\right)$$

F	Axial load applied on the the ball nut during constant travel speed	[N]
l	Ball screw lead	[mm]
η	Ball screw efficiency ≈ 0,9	
N_m	Number of teeth of the motor gear	
N_{bs}	Number of teeth of the ball screw gear	

If there is no reduction presented in the application, ratio $\left(\frac{N_m}{N_{bs}}\right)$ is set to be 1 in all equations.

Frictional torque T_f

$$T_f = (T_{bn} + T_o) \cdot \left(\frac{N_m}{N_{bs}}\right)$$

T_{bn}	No load torque of the ball nut	[Nm]
T_o	Other no load torques presented in the application (support bearings, additional seals, …)	[Nm]

It should be noted that T_{bn} varies according to the viscosity and amount of the lubricant in the ball nut. For more information about T_{bn} please contact us.

Inertial torque T_J

$$T_J = J \cdot \alpha \cdot \left(\frac{N_m}{N_{bs}}\right)^{-1}$$

J	Total moment of inertia	[kg · m²]
α	Angular acceleration of the ball screw	[rad/s²]

$$J = (J_M + J_{bs} + J_{rs}) \cdot \left(\frac{N_m}{N_{bs}}\right)^2 + J_{rm}$$

J_M	Moment of inetria of the moving objects	[kg · m²]
J_{bs}	Moment of inetria of the screw shaft (see technical data table)	[kg · m²]
J_{rs}	Moment of inetria of the rotating objects attached to the screw shaft (gears, couplings, …)	[kg · m²]
J_{rm}	Moment of inetria of the rotating objects attached to the motor shaft (gears, couplings, …)	[kg · m²]

$$J_M = \frac{M}{4} \cdot \left(\frac{l}{\pi \cdot 10^3}\right)^2$$

M	Linearly moved mass of all objects	[kg]
l	Ball screw lead	[mm]

$$\alpha = \frac{|a| \cdot 2\pi \cdot 10^3}{l} = \frac{|\Delta n| \cdot \pi}{30 \cdot \Delta t}$$

a	Acceleration of the ball nut (moved mass)	[m/s²]
l	Ball screw lead	[mm]
Δn	Change of the rotational speed of the ball screw during acceleration or deceleration	[rpm]
Δt	Acclereration time	[s]

ACCURACY, BACKLASH AND RIGIDITY

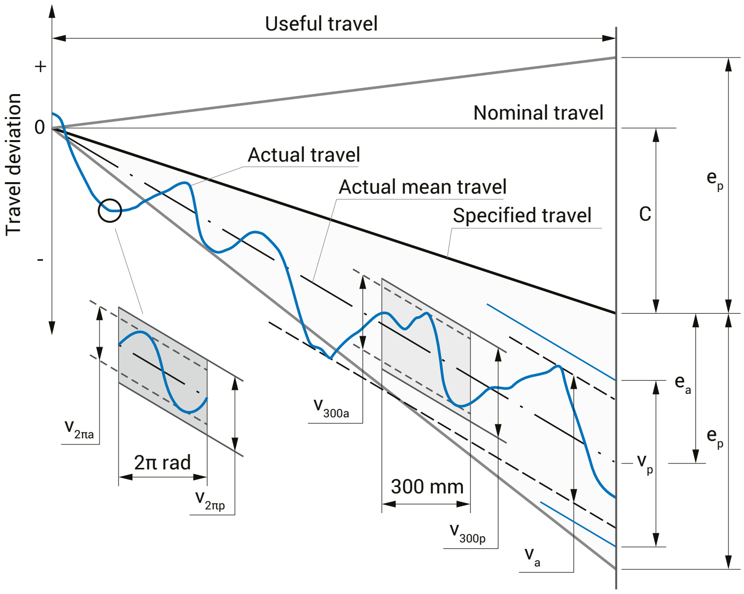
Lead accuracy

Lead or travel accuracy of the ball screws (accuracy grade C5) is specified by:

– tolerance on specified travel e_p
– permissible travel variation within useful travel v_p
– permissible travel variation within 300 mm travel v_{300p}
– permissible travel variation within 1 revolution $v_{2\pi p}$

For the case of accuracy grade C7 the lead or travel accuracy of the ball screws is defined only by tolerance on specified travel e_p and permissible travel variation within 300 mm travel v_{300p}, see the following figure and tables.

ⓘ The accuracy of the ball screw is controlled in accordance with JIS B 1192 Standard.



e_p	Tolerance on specified travel
e_a	Actual mean travel deviation
v_p	Permissible travel variation within useful travel
v_a	Actual travel variation within useful travel
v_{300p}	Permissible travel variation within 300 mm travel
v_{300a}	Actual travel variation within 300 mm travel
$v_{2\pi p}$	Permissible travel variation within 1 revolution
$v_{2\pi a}$	Actual travel variation within 1 revolution
C	Travel compensation for useful travel

Table: Tolerance on specific travel and permissible travel variation within useful travel

Accuracy grade		C5		C7
Useful travel [mm]		e_p [µm]	v_p [µm]	e_p [µm]
Over	Incl.			
-	100	18	18	$\frac{\text{Useful travel [mm]}}{300} \cdot v_{300p}$ [µm]
100	200	20	18	
200	315	23	18	
315	400	25	20	
400	500	27	20	
500	630	30	23	
630	800	35	25	
800	1000	40	27	
1000	1250	46	30	
1250	1600	54	35	
1600	2000	65	40	
2000	2500	77	46	
2500	3150	93	54	
3150	4000	115	65	
4000	5000	140	77	
5000	6300	170	93	

Table: Permissible travel variation within 300 mm travel and 1 revolution

Accuracy grade	C5	C7
v_{300p} [µm]	18	50
$v_{2\pi p}$ [µm]	8	-

Axial backlash

Axial backlash (clearance or play) is defined as the total free axial displacement between the ball nut and the ball screw shaft when there is no rotation between them. The maximum standard and reduced axial backlash is presented in the table below.

Nominal diameter of ball screws shaft [mm]	Standard backlach [mm]	Reduced backlash [mm]
ø8 ~ 12	0,05	0,02
ø16 ~ 40	0,08	0,04

Axial rigidity

In order to get a good positioning accuracy, the axial rigidity of the ball screw drive should be taken into consideration. The axial rigidity of the ball screw drive is determined by the screw shaft rigidity and ball nut rigidity. When the ball screw drive is a part of the feed system (machine), the rigidity of the support bearing together with the rigidity of the nut bracket and the support bearing bracket should also be considered.

The elastic displacement in the axial direction can be obtained using the equation presented below.

$$\delta = \frac{F}{K}$$

δ	Elastic displacement in the axial direction	[µm]
F	Applied axial load	[N]
K	Axial rigidity of the feed system	[N/µm]

The axial rigidity of the feed system can be calculated as follows:

$$\frac{1}{K} = \frac{1}{K_s} + \frac{1}{K_n} + \frac{1}{K_B} + \frac{1}{K_H}$$

K_s	Axial rigidity of the screw shaft	[N/µm]
K_n	Axial rigidity of the ball nut	[N/µm]
K_B	Axial rigidity of the support bearing	[N/µm]
K_H	Axial rigidity of the nut bracket and the support bearing bracket	[N/µm]

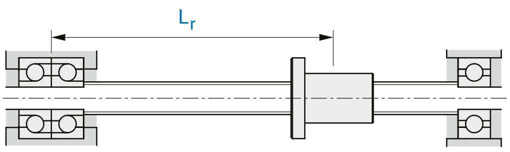
Axial rigidity of the screw shaft K_s

The axial rigidity of a screw shaft depends on the mounting method of the ball screw drive.

In the case of one axially fixed bearing:

$$K_s = \frac{A \cdot E}{L_r \cdot 10^3}$$

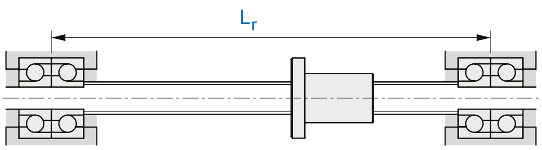
A	Cross-sectional area of the screw shaft = $A = \pi \cdot d_2^2/4$	[mm²]
d_2	Screw shaft root diameter	[mm]
E	Elastic modulus ≈ $2,1 \cdot 10^5$	[N/mm²]
L_r	Stressed screw length	[mm]



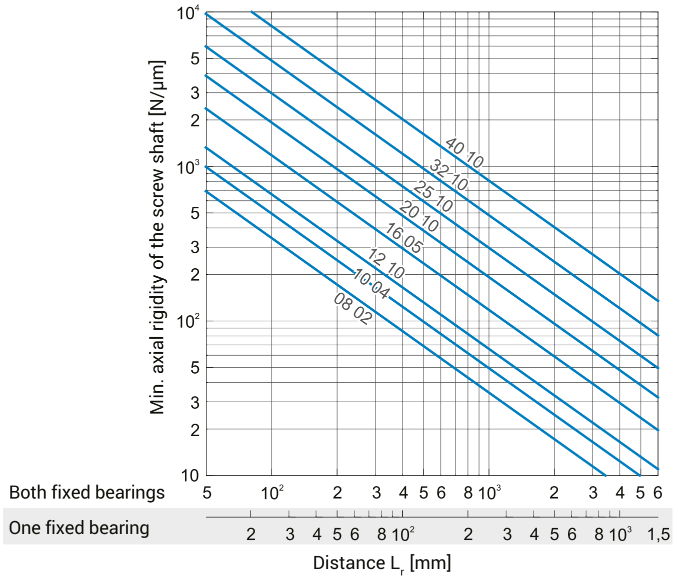
In the case of axially fixed bearing on both sides:

$$K_s = \frac{4 \cdot A \cdot E}{L_r \cdot 10^3}$$

L_r	Mounting distance	[mm]



The minimum axial rigidity of the screw shaft for different screw diameters and mounting methods can also be obtained based on the following diagram.



Axial rigidity of the ball nut K_n

In the case of ball nut with axial backlash the rigidity is calculated based on the following equation:

$$K_n = 0{,}8 \cdot K_{n0} \cdot \left(\frac{F}{0{,}28 \cdot C}\right)^{1/3}$$

K_{n0}	Basic axial rigidity of the ball nut	[N/µm]
F	Applied axial load	[N]
C	Basic dynamic load rating	[N]

Values of K_{n0} and C for particular size and type of the ball nut can be found in the product tables.

Thermal expansion

Thermal expansion plays an important role in positioning accuracy. If the ball screw shaft temperature changes during the operation, the change of the temperature axially deforms the screw shaft. This thermal expansion can be calculated as follows:

$$\Delta L = \alpha_T \cdot \Delta T \cdot L_0$$

ΔL	Thermal expansion	[mm]
α_T	Thermal expansion coefficient For steel: $\alpha_T = 12 \cdot 10^{-6}$ 1/°C	[1/°C]
ΔT	Temperature change	[°C]
L_0	Initial length of the screw shaft	[mm]

Where high positioning accuracy is required the following solutions can be taken into consideration to avoid the thermal expansion problems:

– Select appropriate lubricant
– Select higher lead of the ball screw and decrease the rotational speed
– Lubrication medium or cooling air can be used to cool down external surface of the ball screw
– Warm up the machine to the stable machine's operating temperature

LUBRICATION

Ball nut needs a sufficient amount of the lubricant (both grease and oil can be used), which is essential for optimal operating. The lubricant ensures a lubricating film between the steel balls and the track surfaces to reduce wear and friction. Furthermore, the lubricant protects the metallic surfaces against corrosion and contamination, reduces the noise and heating and lubricant's properties extend the lifetime of the ball screw drive. Ball nuts and screws are pre-lubricated before shipment only to ensure the corrosion resistance. The lubricant can be supplied to the ball nut through the lubrication port.

Lubricant

Recommended grease for the lubrication: Lubcon TURMOGREASE LC 802 EP (K HC P 2/3 N -30).

Do not use the lubricant which contains any solid parts!

Lubrication quantities and intervals

In the following table both initial lubrication (lubrication for initial operation) and re-lubrication amounts of the lubricant that have to be supplied to ball nut are presented.

Grease lubrication
It is recommended to re-lubricate after 50 · 10^6 revolutions or after 500 operating hours. It depends on which value is reached first.

Re-lubrication interval defined in kilometers of traveled distance = 50,0 · l

Oil lubrication
It is recommended to re-lubricate after 1 · 10^6 revolutions or after 1 operating hour. It depends on which value is reached first.

Re-lubrication interval defined in kilometers of traveled distance = 1,0 · l

l	Ball screw lead	[mm]

Ball nut type	Size (d x l)	Grease lubrication		Oil lubrication	
		Initial lubrication [cm^3]	Re-lubrication [cm^3]	Initial lubrication [ml]	Re-lubrication [ml]
FSU	1605	1,2	0,8	0,64	0,16
	1610	1,6	1,1	0,64	0,16
	2005	1,6	1,0	0,80	0,20
	2505	1,9	1,2	1,00	0,25
	2510	5,6	3,6	1,00	0,25
	3205	2,4	1,6	1,28	0,32
	3210	11,5	7,5	1,28	0,32
	4005	3,0	2,0	1,60	0,40
	4010	14,4	9,3	1,60	0,40
FSE	1616	1,1	0,7	0,64	0,16
	2020	1,6	1,0	0,80	0,20
	2525	2,7	1,8	1,00	0,25
FSK	0802	0,2	0,1	0,32	0,08
	1002	0,2	0,2	0,40	0,10
	1004	0,5	0,3	0,40	0,10
RSK	1204	0,5	0,3	0,48	0,12
	1205	0,6	0,4	0,48	0,12
FSC	1610	1,0	0,7	0,64	0,16
	3220	4,1	2,7	1,28	0,32
	4020	10,4	6,8	1,60	0,40
RSY	1205	0,6	0,4	0,48	0,12
	1210	0,6	0,4	0,48	0,12
	1605	1,2	0,8	0,64	0,16
	1610	1,1	0,7	0,64	0,16
	1616	1,1	0,7	0,64	0,16
	2005	1,5	1,0	0,80	0,20
	2010	2,2	1,5	0,80	0,20
	2020	1,6	1,0	0,80	0,20
	2505	1,9	1,2	1,00	0,25
	2510	2,0	1,3	1,00	0,25
	3205	2,4	1,6	1,28	0,32
	3220	4,1	2,7	1,28	0,32
RSU	1605	1,4	0,9	0,64	0,16

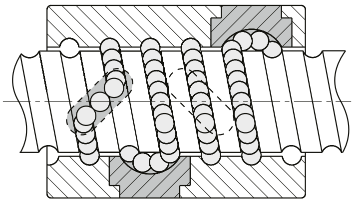
BALL RECIRCULATION SYSTEMS AND DUST PROTECTION

Ball recirculation system guiding the balls from the point where balls have left the loaded turns back to the defined point of the ball nut body or ball screw shaft from where they have enter the loaded turns again. Here, number of circuits represent total number of turns on which the balls are in contact with threaded surface of the ball nut.

Recirculation type

With internal deflectors

To complete an infinite motion, the ball change their traveling direction with a deflector, pass over the circumference of the screw shaft and return to their original positions.

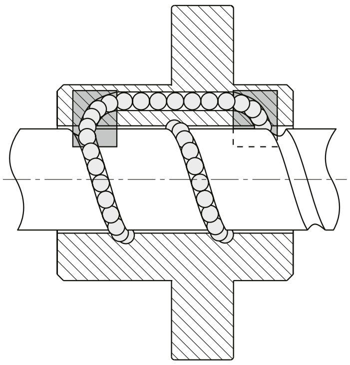


Features:

– Compact type
– Number of turns per recirculation system = 1

With end deflectors

To complete an infinite motion, the balls are picked up with an end deflector, pass through the hole in the nut and return to their original positions.



Features:

– Suitable for high speed
– Number of turns per recirculation system ≥ 1
– Smaller ball nut outside diameter

Number of turns per recirculation system

T: 1 turn
A: 1,8 turns

Number of circuits

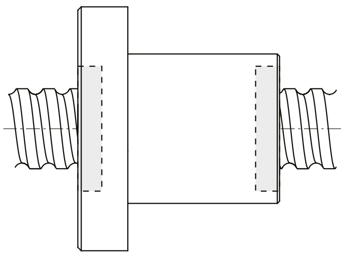
Number of circuits represents number of turns per recirculation system multiplied by the number of recirculation systems.

Example	Number of circuits = A2 ⟶ 1,8 × 2
	Number of turns per recirculation system = A ⟶ 1,8
	Number of recirculation systems = 2

Please see the product tables and ordering code

Dust protection

Most of the ball nuts have the wiper seals attached to the ball nut body. These closure elements are in sliding or non-sliding contact with the ball screw shaft such that foreign objects are inhibited from entering the ball nut. Partial retention of the lubricant is provided.



Product data

PRECISION ROLLED BALL SCREWS

Diameter: ø8 ~ 40 mm
Lead: 2 ~ 25 mm
Thread direction: Right hand thread
Material: CK55 – 1.1203 (induction surface hardened – 58 ~ 62 HRC)
Accuracy grade: C5, C7

Ball screws of nominal diameter ø10 available only in C7 accuracy grade

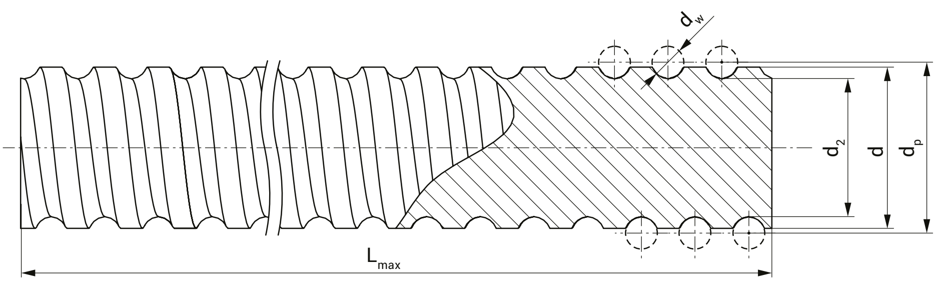
Maximum length:

Nominal diameter d [mm]	Maximum length [mm]
8	1200
10	1200
12	3000
16	3000
20	3000
25	6000
32	6000
40	6000

Ball screw size list:

	Lead [mm]						
Nominal diameter d [mm]	2	4	5	10	16	20	25
8	•						
10	•	•					
12		•	•				
16			•	•	•		
20			•	•		•	
25			•	•			•
32			•	•		•	
40			•	•		•	

Dimensions:



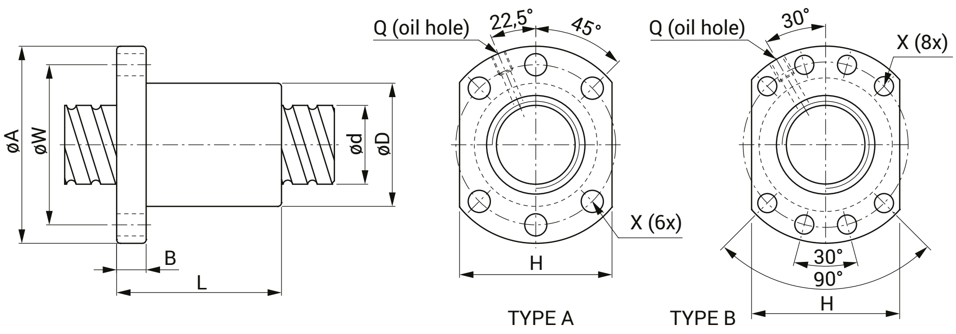
d	Nominal diameter	[mm]
d_2	Root diameter	[mm]
d_p	Ball center-to-center diameter	[mm]
d_w	Ball diameter	[mm]
L_{max}	Maximum length of the ball screw shaft	[mm]

Ball screw d × l	d [mm]	l [mm]	Ball size d_w [mm]	d_2 [mm]	d_p [mm]	Maximum length L_{max} [mm]	Mass [kg/m]	Planar moment of inertia [mm^4]	Mass moment of inertia [$kg \cdot cm^2/m$]
8x2	8	2	1,2	7,2	8,4	1200	0,37	133	0,03
10x2	10	2	1,2	9,2	10,4	1200	0,58	355	0,07
10x4	10	4	2	8,7	10,7	1200	0,56	276	0,06
12x4	12	4	2,381	10,2	12,6	3000	0,80	527	0,13
12x5	12	5	2	10,3	12,3	3000	0,81	561	0,13
12x10	12	10	2	10,0	12,0	3000	0,79	491	0,13
16x5	16	5	3,175	13,4	16,5	3000	1,41	1569	0,40
16x10	16	10	3,175	13,4	16,6	3000	1,41	1597	0,41
16x16	16	16	3,175	13,4	16,6	3000	1,41	1597	0,41
20x5	20	5	3,175	17,4	20,6	3000	2,26	4510	1,03
20x10	20	10	3,969	17,1	21,0	3000	2,23	4163	1,01
20x20	20	20	3,175	17,4	20,6	3000	2,26	4531	1,03
25x5	25	5	3,175	22,4	25,6	6000	3,59	12403	2,62
25x10	25	10	3,5	22,0	25,5	6000	3,55	11499	2,56
25x10	25	10	4,762	21,2	26,0	6000	3,48	9964	2,45
25x25	25	25	3,969	21,8	25,7	6000	3,53	11009	2,52
32x5	32	5	3,175	29,4	32,6	6000	5,98	36674	7,24
32x10	32	10	6,35	27,1	33,4	6000	5,68	26359	6,54
32x20	32	20	3,969	28,7	32,7	6000	5,89	33360	7,03
40x5	40	5	3,175	37,4	40,6	6000	9,44	96041	18,07
40x10	40	10	6,35	35,0	41,4	6000	9,06	73830	16,65
40x20	40	20	5,556	35,8	41,4	6000	9,19	81028	17,13

BALL NUTS

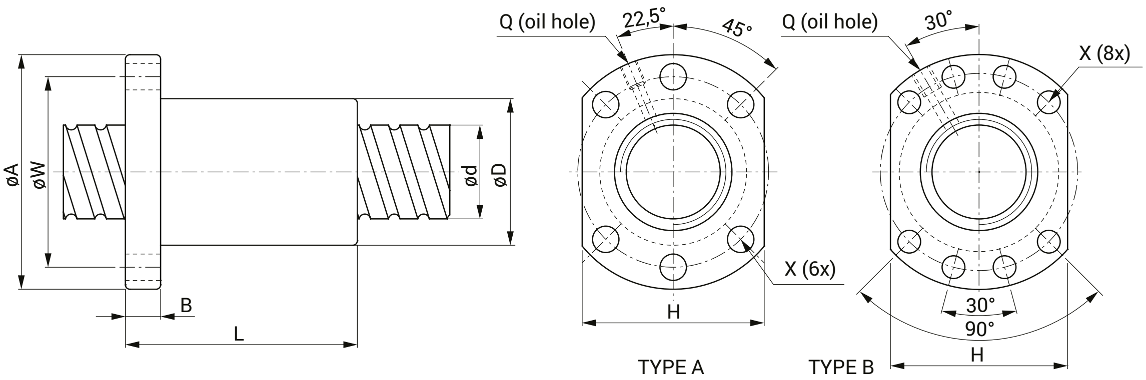
Material: 15CrMo – 1.7262 (carbonized hardened – 58 ~ 62 HRC)

FSU: flanged single nut (DIN standard 69051)



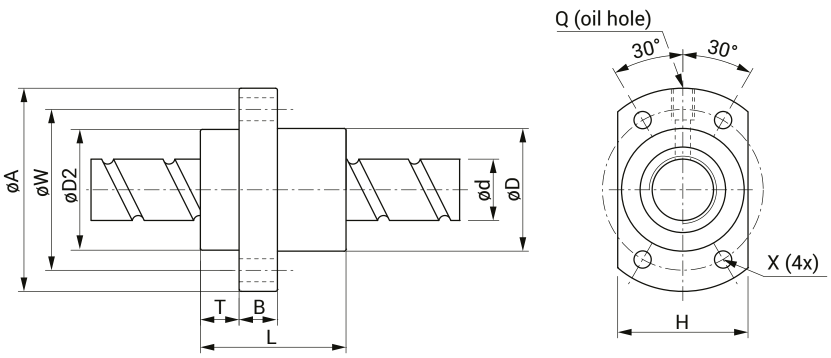
Model	Dimensions [mm]											Type	Number of circuits	Basic dynamic load rating [kN]	Basic static load rating [kN]	Basic rigidity [N/µm]	Mass [kg]
	d	l	d_w	D (g6)	A	B	L	W	X	H	Q			C	C_0	K_{n0}	
FSU 1605 T4	16	5	3,175	28	48	10	50	38	5,5	40	M6x8	A	T4	13,2	15,0	230	0,180
FSU 1610 T3	16	10	3,175	28	48	12	65	38	5,5	40	M6x8	A	T3	10,6	12,1	230	0,245
FSU 2005 T4	20	5	3,175	36	58	10	53	47	6,6	44	M6x8	A	T4	14,8	19,6	280	0,310
FSU 2505 T4	25	5	3,175	40	62	10	53	51	6,6	48	M6x8	A	T4	16,7	25,3	330	0,340
FSU 2510 T4	25	10	4,762	40	62	12	85	51	6,6	48	M6x8	A	T4	28,3	36,3	350	0,480
FSU 3205 T4	32	5	3,175	50	80	12	53	65	9,0	62	M6x8	A	T4	18,9	33,4	410	0,600
FSU 3210 T4	32	10	6,35	50	80	16	90	65	9,0	62	M6x8	A	T4	47,4	76,9	430	0,900
FSU 4005 T4	40	5	3,175	63	93	16	56	78	9,0	70	M8x10	B	T4	21,0	42,6	490	1,000
FSU 4010 T4	40	10	6,35	63	93	18	93	78	9,0	70	M8x10	B	T4	53,0	98,8	530	1,450

FSC: flanged single nut (low noise type)



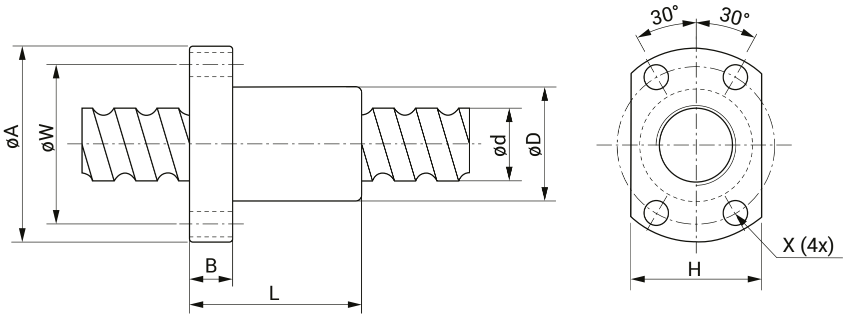
Model	Dimensions [mm]											Type	Number of circuits	Basic dynamic load rating [kN]	Basic static load rating [kN]	Basic rigidity [N/μm]	Mass [kg]
	d	l	d_w	D (g6)	A	B	L	W	X	H	Q			C	C_0	K_{n0}	
FSC 1610 T3	16	10	3,175	28	48	12	43	38	5,5	40	M6x8	A	T3	11,6	14,7	270	0,180
FSC 3220 T3	32	20	3,969	50	80	13	78	65	9,0	62	M6x8	A	T3	21,0	35,1	540	1,000
FSC 4020 T3	40	20	5,556	63	93	15	83	78	9,0	70	M8x10	B	T3	37,1	63,5	820	1,300

FSE: flanged single nut (high lead type)



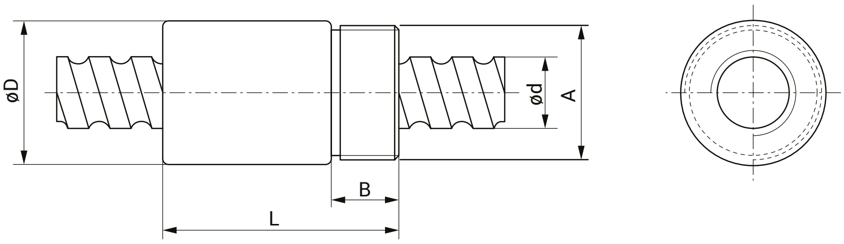
Model	Dimensions [mm]													Number of circuits	Basic dynamic load rating [kN]	Basic static load rating [kN]	Basic rigidity [N/μm]	Mass [kg]
	d	l	d_w	D (g6)	D2 (0/-0,3)	A	B	L	W	X	T	H	Q		C	C_0	K_{n0}	
FSE 1616 A2	16	16	3,175	32	32	53	10	48	42	4,5	10,5	38	M6x8	A2	14,8	19,6	180	0,250
FSE 2020 A2	20	20	3,175	39	39	62	10	55	50	5,5	10,8	46	M6x8	A2	16,3	24,2	290	0,400
FSE 2525 A2	25	25	3,969	47	47	74	12	67	60	6,6	11,2	56	M6x8	A2	24,3	37,8	350	0,730

FSK: flanged single nut (miniature type)



Model	Dimensions [mm]										Number of circuits	Basic dynamic load rating [kN]	Basic static load rating [kN]	Basic rigidity [N/µm]	Mass [kg]
	d	l	d_w	D (g6)	A	B	L	W	X	H		C	C_0	K_{n0}	
FSK 0802 T3	8	2	1,2	16	29	4	26	23	3,4	20	T3	2,1	2,3	60	0,030
FSK 1002 T3	10	2	1,2	18	35	5	28	27	4,5	22	T3	2,4	3,0	80	0,045
FSK 1004 T3	10	4	2	26	46	10	35	36	4,5	28	T3	4,6	4,8	100	0,150

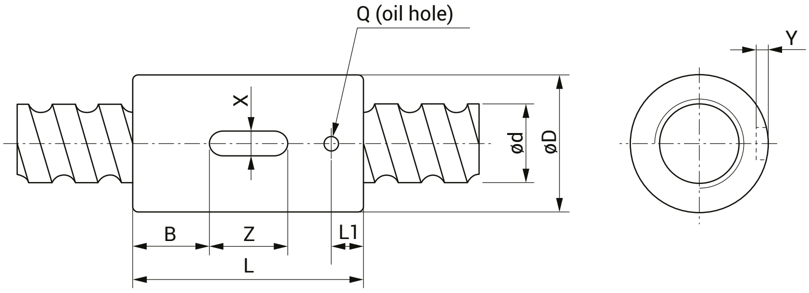
RSK: cylindrical single nut with threaded nose (miniature type)



Without wiper seals

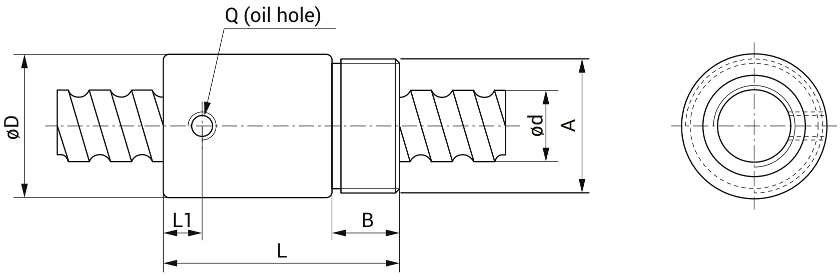
Model	Dimensions [mm]							Number of circuits	Basic dynamic load rating [kN]	Basic static load rating [kN]	Basic rigidity [N/µm]	Mass [kg]
	d	l	d_w	D (g6)	A	B	L		C	C_0	K_{n0}	
RSK 1204 T3	12	4	2,381	25,5	M20x1	10	34	T3	6,3	6,8	90	0,070
RSK 1205 T3	12	5	2	25,5	M20x1	10	39	T3	5,0	5,8	100	0,090

RSY: cylindrical single nut with key way



Model	Dimensions [mm]											Number of circuits	Basic dynamic load rating [kN]	Basic static load rating [kN]	Basic rigidity [N/μm]	Mass [kg]
	d	l	d_w	D (g6)	L	B (±0,1)	X (+0,02/ -0,04)	Y (+0,2/ 0)	Z (+0,2/ 0)	L1	Q		C	C_0	K_{n0}	
RSY 1205 T3	12	5	2	24	40	14,0	3	1,5	12	5	Ø3	T3	5,0	5,8	100	0,085
RSY 1210 T2	12	10	2	24	40	14,0	3	1,5	12	5	Ø3	T2	3,8	4,6	90	0,080
RSY 1605 T4	16	5	3,175	28	50	15,0	5	2,0	20	7	Ø3	T4	13,2	15,0	230	0,120
RSY 1610 T3	16	10	3,175	28	45	12,5	5	2,0	20	7	Ø3	T3	11,6	14,7	230	0,110
RSY 1616 T2	16	16	3,175	28	45	12,5	5	2,0	20	7	Ø3	T2	8,2	9,8	180	0,110
RSY 2005 T4	20	5	3,175	36	53	16,5	5	2,0	20	7	Ø3	T4	14,8	19,6	280	0,230
RSY 2010 T3	20	10	3,969	36	54	17,0	5	2,0	20	7	Ø3	T3	17,3	22,9	250	0,240
RSY 2020 T4	20	20	3,175	36	55	17,5	5	2,0	20	7	Ø3	T4	16,3	24,2	270	0,240
RSY 2505 T4	25	5	3,175	40	53	16,5	5	2,0	20	7	Ø3	T4	16,7	25,3	330	0,270
RSY 2510 T3	25	10	3,5	40	54	17,0	5	2,0	20	7	Ø3	T3	15,8	24,1	320	0,260
RSY 3205 T4	32	5	3,175	50	53	11,5	6	2,5	30	7	Ø3	T4	18,9	33,4	410	0,430
RSY 3210 T3	32	10	6,35	50	70	20	6	2,5	30	7	Ø3	T3	37,0	57,7	330	0,510
RSY 3220 T3	32	20	3,969	50	78	24,0	6	2,5	30	7	Ø3	T3	21,0	35,1	400	0,670

RSU: cylindrical single nut with threaded nose (DIN standard 69051)



Model	Dimensions [mm]									Number of circuits	Basic dynamic load rating [kN]	Basic static load rating [kN]	Basic rigidity [N/μm]	Mass [kg]
	d	l	d_w	D (g6)	A	B	L	L1	Q		C	C_0	K_{n0}	
RSU 1605 T4	16	5	3,175	32	M30x1,5	16	56	6,5	M6x8	T4	13,2	15,0	230	0,210

How to order

HOW TO ORDER

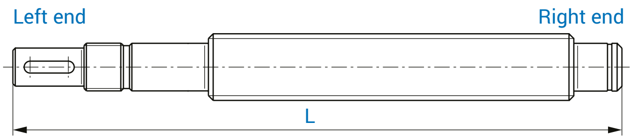
SCR - 16 - 05 - 710,5 - C5 - 03BK10Z - 05BF10 - FSU T4 - P0

Ball screw (SCR)

Nominal diameter [mm] (16)

Lead [mm] (05)

Total length of ball screw shaft [mm] (710,5)



Accuracy grade: (C5)
- **C5**
- **C7**

Left shaft end machining (see end machining coding below) (03BK10Z)

Right shaft end machining (see end machining coding below) (05BF10)

Left and right end machining coding:

03 BK10 Z

Form: (03)
- **03, 04:** For fixed support
- **05, 06:** For simple support
- **0:** Without machining – cut to size
- **C:** End with chamfer
- **A:** End annealed
  (specified the lenght in the additional text)
- **SA:** End according to the customer's drawing

Support unit type (BK10)
Only for Form 03, 04, 05, 06

Option (machining of end face) (Z)
- **Z:** End face with centering hole
- **Leave blank:** Without, Form 04, 06, SA

Ball nut type (with number of circuits) (FSU T4)

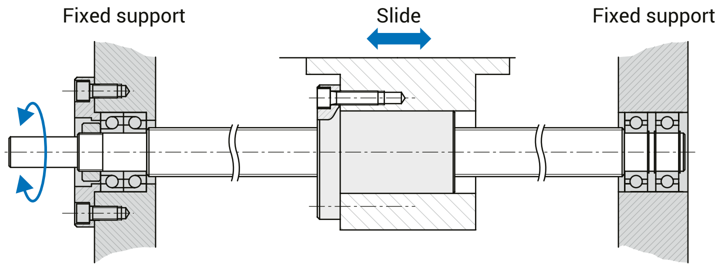
Axial backlash (P0)
- **P0:** Standard backlash
- **PR:** Reduced backlash

Mounting of the ball screw drive

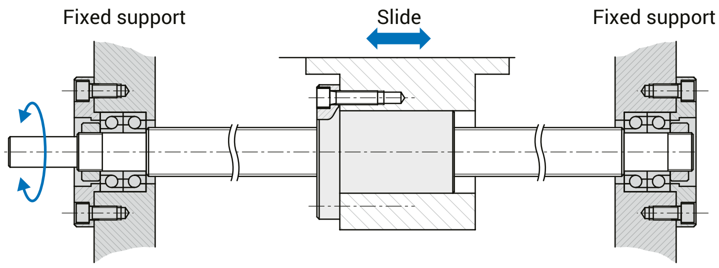
MOUNTING METHODS

The mounting method and the unsupported length of the screw shaft affect the critical speed and the buckling load. In the following the most common mounting methods for the screw drives are presented.

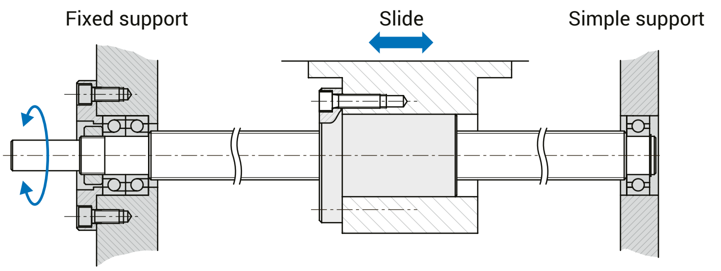
Fixed – fixed method



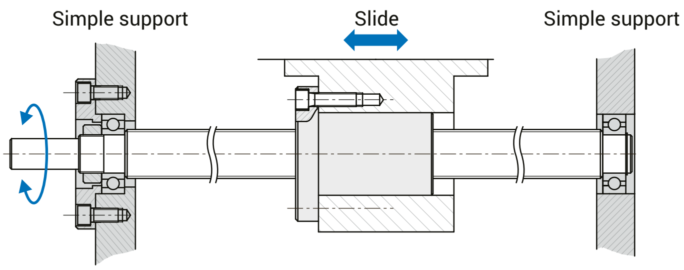
Axially fixed bearings on both sides:



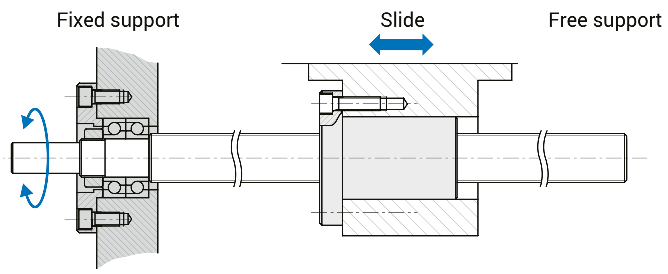
Fixed – simple method



Simple – simple method



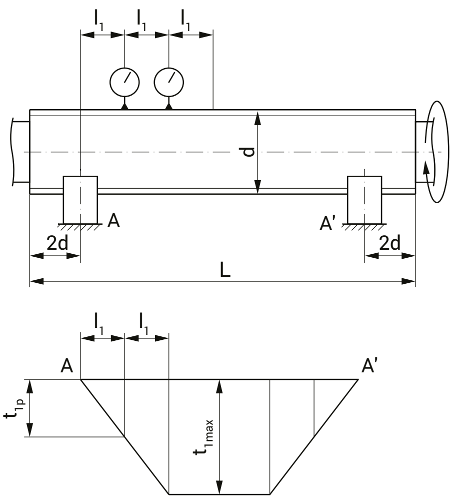
Fixed – free method



GEOMETRICAL TOLERANCE AND ACCEPTANCE CONDITIONS OF THE BALL SCREWS

1. Radial run-out t_1 of the outer diameter of the screw shaft over the length l_1 relative to AA'

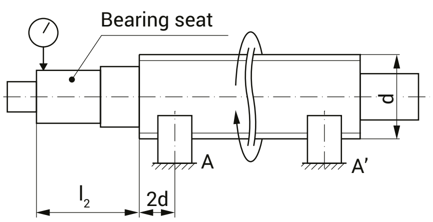
According to DIN 69051 and JIS B 1192



d [mm]		l_1 [mm]	t_{1p} [µm] for l_1 for accuracy grade	
Over	Up to		5	7
6	12	80		
12	25	160	32	40
25	50	315		

L/d		$t_{1\,max}$ [µm] for $L \geq 4 \cdot l_1$ for accuracy grade	
Over	Up to	5	7
	40	64	80
40	60	96	120
60	80	160	200
80	100	256	320

2. Radial run-out t_2 of the bearing journal in relation to AA'

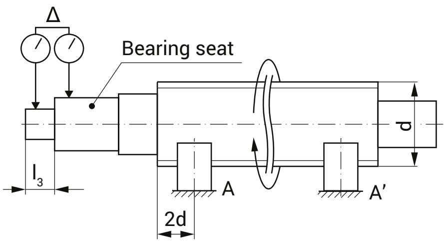


For the case of $l_2 > l_r$:

$$t_{2a} \leq t_{2p} \cdot \frac{l_2}{l_r}$$

d [mm]		Reference length l_r [mm]	t_{2p} [µm] for $l_2 \leq l_r$ for accuracy grade	
Over	Up to		5	7
6	20	80	20	40
20	50	125	25	50

3. Radial run-out deviation t_3 between the journal diameter of the ball screw and the bearing diameter in relation to AA'



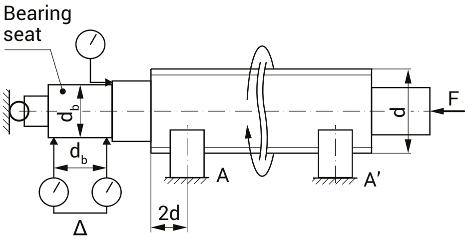
$\Delta \leq t_{3p}$

For the case of $l_3 > l_r$:

$\Delta \leq t_{3p} \cdot \frac{l_3}{l_r}$

d [mm]		Reference length l_r [mm]	t_{3p} [µm] for $l_3 \leq l_r$ for accuracy grade	
Over	Up to		5	7
6	20	80	8	12
20	50	125	10	16

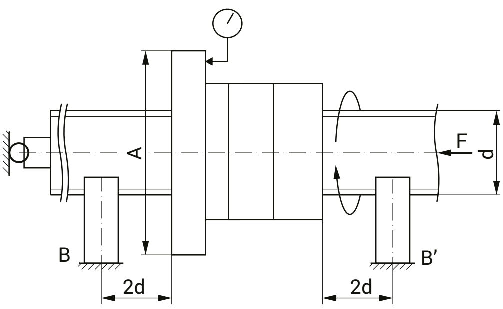
4. Axial run-out t_4 of the bearing end shoulder in relation to AA'



$t_{4a} + |\Delta| \leq t_{4p}$

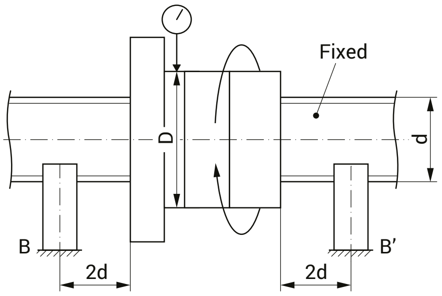
d [mm]		t_{4p} [µm] for accuracy grade	
Over	Up to	5	7
6	63	5	6

5. Axial run-out t_5 of the ball nut mouting face in relation to BB'



A [mm]		t_{5p} [µm] for accuracy grade	
Over	Up to	5	7
16	32	16	20
32	63	20	25
63	125	25	32

6. Radial run-out t_6 of the ball nut outer diameter in relation to BB'



D [mm]		t_{6p} [µm] for accuracy grade	
Over	Up to	5	7
16	32	16	20
32	63	20	25
63	125	25	32

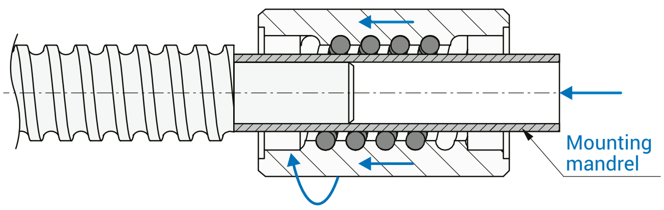
ASSEMBLING THE BALL NUT ONTO THE SCREW SHAFT

Assembling procedure

1. Ball nut together with the mounting mandrel must be pushed to the start of the thread.

It should be noted that the mounting mandrel must be axially in contact with the face of the start of the thread.

2. The nut should be carefully turned onto the thread using slightly axial load.
3. During the assembling process (until the ball nut is not located completely on the screw thread) the mounting mandrel must not be removed to prevent the balls from falling off the nut.

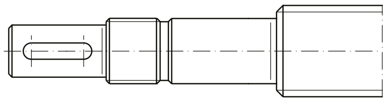
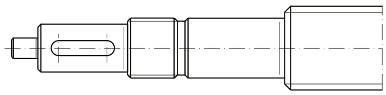
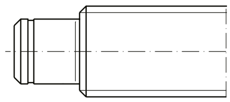
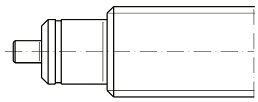
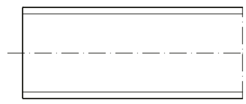
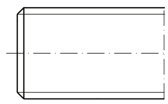
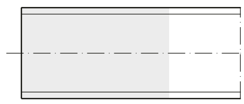
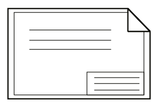


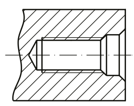
In the case, when the ball nut must be removed from the ball screw shaft, the mounting mandrel must to be used again to prevent the balls from falling off the nut.

Accessories

END MACHINING

Overview

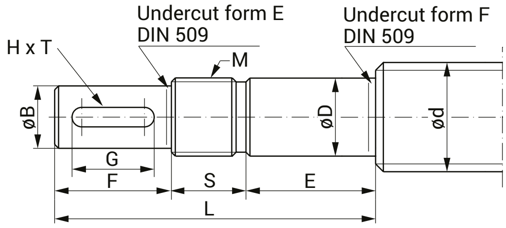
Form	Description	Presentation
03	Fixed side (for fixed support)	
04	Fixed side (for fixed support)	
05	Supported side (for simple support)	
06	Supported side (for simple support)	
0	Without end machining – cut to size	
C	End with chamfer	
A	End annealed	
SA	End machining according to the customer's drawing	

Option	Description	Presentation
Z	End face with centering hole	

We also offer straightening of the screw shaft according to the customer's specification.

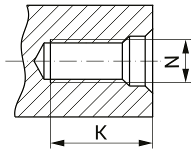
Form 03, 04 – fixed side

03



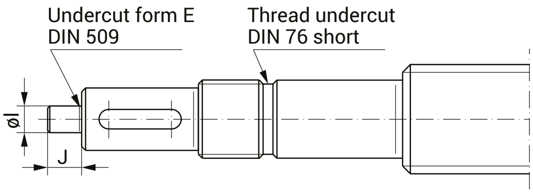
Option

Z



Only for form 03

04

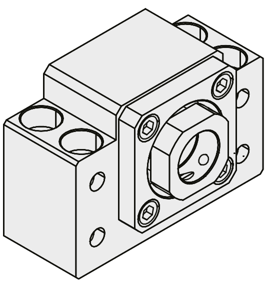


Support type	Dimensions [mm]													
	d	M	D	B (h7)	E	F	S	L	G	H (P9)	T	I	J	N	K
BK10	16	M10x1	10 (−0,005/−0,012)	8	20	20	16	56	14	2	1,2	4	10	-	-
BK12	16/20	M12x1	12 (−0,005/−0,012)	10	22	23	14	59	16	3	1,8	4	10	-	-
BK15	20	M15x1	15 (−0,005/−0,014)	12	28	30	12	70	20	4	2,5	6	15	M5	12
BK17	25	M17x1	17 (−0,005/−0,014)	15	36	30	17	83	20	5	3,0	6	15	M5	12
BK20	32	M20x1	20 (−0,005/−0,014)	17	38	30	15	83	20	5	3,0	6	15	M5	12
BK25	40	M25x1,5	25 (−0,005/−0,014)	20	47	50	18	115	36	6	3,5	6	15	M6	16
BK30	40	M30x1,5	30 (−0,005/−0,015)	25	47	60	25	132	45	8	4,0	6	15	M8	19

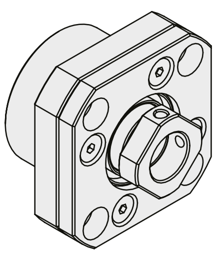
Support type	Dimensions [mm]													
	d	M	D	B (h7)	E	F	S	L	G	H (P9)	T	I	J	N	K
EK06	8	M6x0,75	6 (−0,008/−0,015)	4	20	8	8	36	-	-	-	4	10	-	-
EK08	10/12	M8x1	8 (−0,008/−0,015)	6	22	9	10	41	6	2	1,2	4	10	-	-
FK10	16	M10x1	10 (−0,008/−0,015)	8	25	20	11	56	14	2	1,2	4	10	-	-
FK12	16/20	M12x1	12 (−0,008/−0,017)	10	25	23	11	59	16	3	1,8	4	10	-	-
FK15	20	M15x1	15 (−0,008/−0,017)	12	34	30	13	77	20	4	2,5	6	15	M5	12
FK17	25	M17x1	17 (−0,008/−0,017)	15	43	30	15	88	20	5	3,0	6	15	M5	12
FK20	32	M20x1	20 (−0,010/−0,020)	17	45	30	17	92	20	5	3,0	6	15	M5	12
FK25	40	M25x1,5	25 (−0,010/−0,020)	20	56	50	20	126	36	6	3,5	6	15	M6	16
FK30	40	M30x1,5	30 (−0,010/−0,020)	25	47	60	25	132	45	8	4,0	6	15	M8	19

Support types – fixed side (fixed bearings)

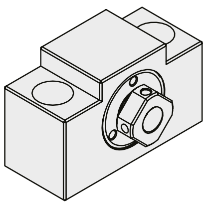
Type BK



Type FK

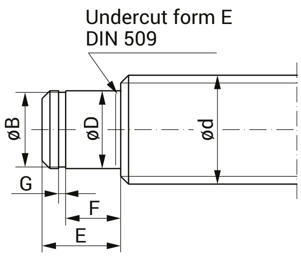


Type EK



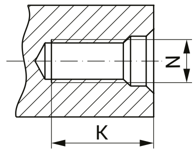
Form 05, 06 – supported side

05



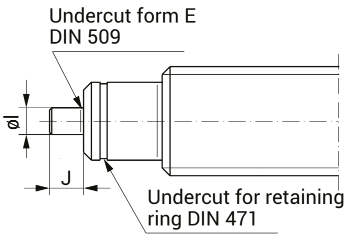
Option

Z



ℹ Only for form 05

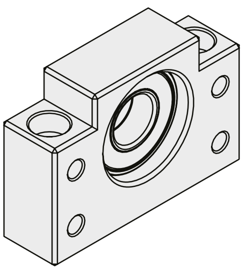
06



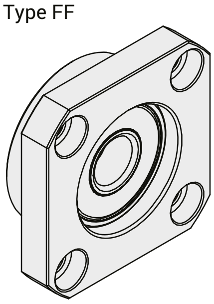
Support type	Dimensions [mm]									
	d	D	B (0/-0,2)	E	F (+0,2/0)	G (H13)	I	J	N	K
EF06	8	6 (−0,005/−0,012)	5,7	9	6,8	0,8	4	10	-	-
EF08	10/12	6 (−0,005/−0,012)	5,7	9	6,8	0,8	4	10	-	-
BF/FF10	16	8 (−0,005/−0,012)	7,6	10	7	1,1	4	10	-	-
BF/FF12	16/20	10 (−0,005/−0,012)	9,6	11	8	1,1	4	10	M4	10
BF/FF15	20	15 (−0,005/−0,014)	14,3	13	9	1,1	6	15	M5	12
BF/FF17	25	17 (−0,005/−0,014)	16,2	16	12	1,1	6	15	M6	16
(BF)/FF20	32	20 (−0,005/−0,014)	19,0	(16)/19	(12)/14	1,3	6	15	M6	16
BF/FF25	40	25 (−0,005/−0,014)	23,9	20	15	1,3	6	15	M10	22
BF/FF30	40	30 (−0,005/−0,015)	28,6	21	16	1,6	6	15	M10	22

Support types – supported side (floating bearings)

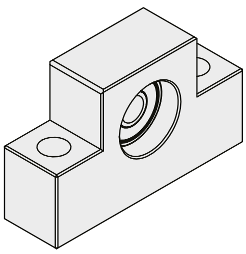
Type BF



Type FF

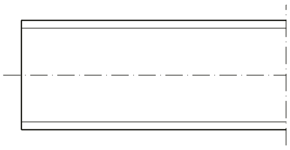


Type EF



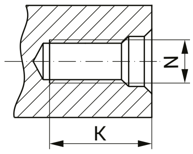
Form 0 – without (cut to size)

0



Option

Z

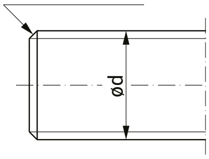


Dimensions [mm]		
d	N	K
8	-	-
10	-	-
12	-	-
16	-	-
20	M5	12
25	M6	16
32	M6	16
40	M10	22

Table is valid for forms 0, C and A

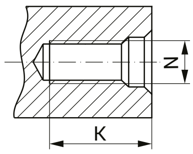
Form C – end with chamfer

C



Option

Z

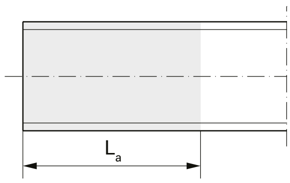


Dimensions can be found at form 0

<table>
<tr><th colspan="2">Dimensions [mm]</th></tr>
<tr><th>d</th><th>C</th></tr>
<tr><td>8</td><td rowspan="2">1</td></tr>
<tr><td>10</td></tr>
<tr><td>12</td><td rowspan="4">2</td></tr>
<tr><td>16</td></tr>
<tr><td>20</td></tr>
<tr><td>25</td></tr>
<tr><td>32</td><td rowspan="2">3</td></tr>
<tr><td>40</td></tr>
</table>

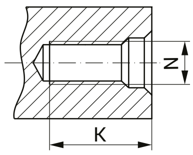
Form A – end annealed

A



Option

Z



Dimensions can be found at form 0

The length of annealing L_a [mm] must be specified in the additional text.

Form SA – according to the customer's drawing

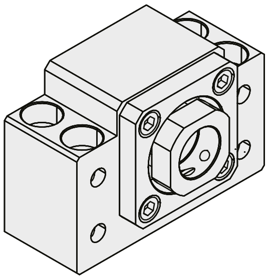
End machining according to an individual customer's drawing.

SUPPORT UNITS OF THE BALL SCREW

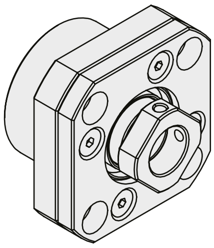
Support units technical data

Fixed side support units

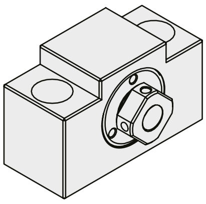
Type BK



Type FK



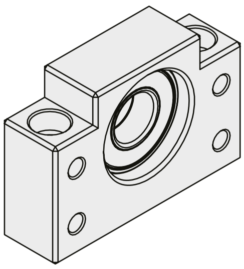
Type EK



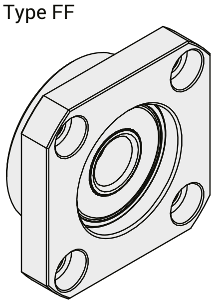
Support unit type	Bearing designation	Basic dynamic axial load rating [KN]	Basic static axial load rating [KN]	Max. starting load [N · cm]	Inner diameter d1 [mm]	Ball screw diameter d [mm]
EK06	706A DF	1,38	1,73	0,5	6	8
EK08	708A DF	2,42	3,35	0,9	8	10/12
BK10/FK10	7000A DF	7,06	7,88	1,9	10	16
BK12/FK12	7001A DF	7,58	9,02	2,1	12	16/20
BK15/FK15	7002A DF	8,02	10,38	2,3	15	20
BK17/FK17	7203A DF	14,20	18,18	3,7	17	25
BK20	7004A DF	14,20	20,00	3,8	20	32
FK20	7204A DF	18,95	25,15	5,5	20	32
BK25/FK25	7205A DF	21,21	31,06	7,3	25	40
BK30/FK30	7206A DF	29,44	44,70	10,5	30	40

Supported side support units

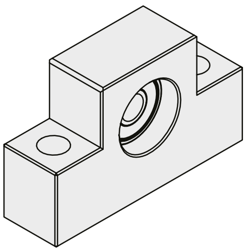
Type BF



Type FF

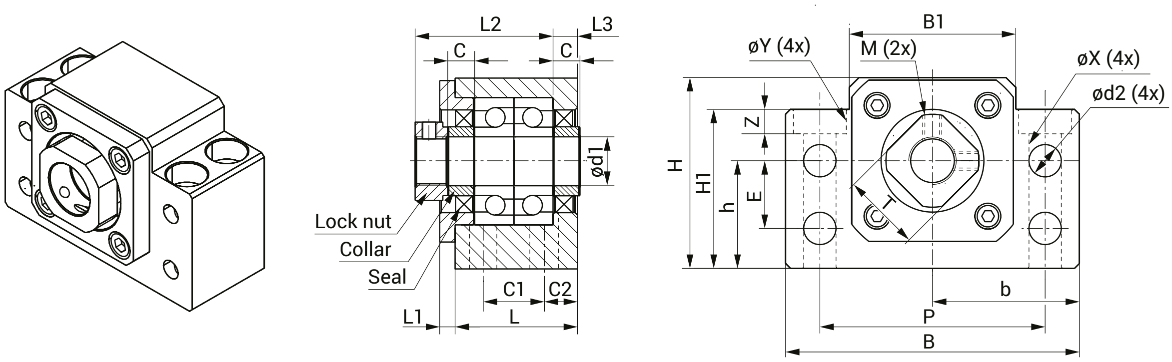


Type EF



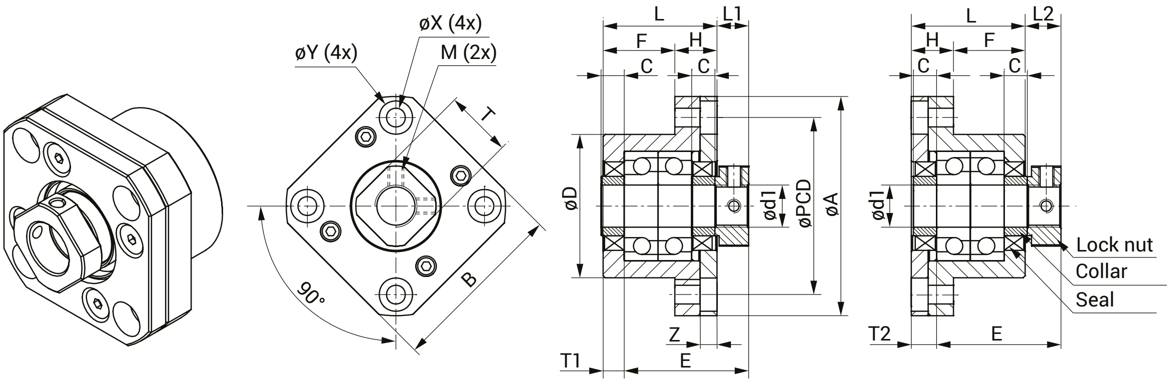
Support unit type	Bearing designation	Basic dynamic radial load rating [KN]	Basic static radial load rating [KN]	Inner diameter d1 [mm]	Ball screw diameter d [mm]
EF06	606 ZZ	2,26	0,84	6	8
EF08	606 ZZ	2,26	0,84	6	10/12
BF10/FF10	608 ZZ	3,30	1,37	8	16
BF12/FF12	6000 ZZ	4,55	1,97	10	16/20
BF15/FF15	6002 ZZ	5,60	2,83	15	20
BF17/FF17	6203 ZZ	9,55	4,80	17	25
BF20	6004 ZZ	9,40	5,00	20	32
FF20	6204 ZZ	12,80	6,60	20	32
BF25/FF25	6205 ZZ	14,00	7,85	25	40
BF30/FF30	6206 ZZ	19,50	11,30	30	40

Support unit BK – fixed side, rectangular type



Type	Dimensions [mm]																					Mass [kg]
	d1	L	L1	L2	L3	C1	C2	B	H	b (±0,02)	h (±0,02)	B1	H1	E	P	d2	X	Y	Z	M	T	C	
BK10	10	25	5	29,5	5	13	6	60	39	30	22	34	32,5	15	46	5,5	6,6	10,8	5,0	M3	16	5,5	0,40
BK12	12	25	5	29,5	5	13	6	60	43	30	25	34	32,5	18	46	5,5	6,6	10,8	1,5	M4	19	5,5	0,41
BK15	15	27	6	32,0	6	15	6	70	48	35	28	40	38	18	54	5,5	6,6	11,0	6,5	M4	22	6,0	0,58
BK17	17	35	9	44,0	7	19	8	86	64	43	39	50	55	28	68	6,6	9,0	14,0	8,5	M4	24	7,0	1,30
BK20	20	35	8	43,0	8	19	8	88	60	44	34	52	50	22	70	6,6	9,0	14,0	8,5	M4	30	8,0	1,20
BK25	25	42	12	54,0	9	22	10	106	80	53	48	64	70	33	85	9,0	11,0	17,0	11,0	M6	35	9,0	2,35
BK30	30	45	14	61,0	9	23	11	128	89	64	51	76	78	33	102	11,0	14,0	20,0	13,0	M6	40	9,0	3,33

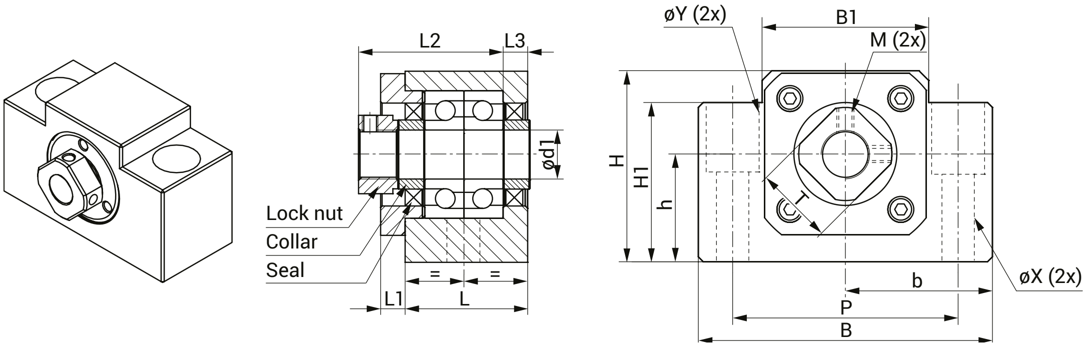
Support unit FK – fixed side, round type



MOUTING METHOD A MOUTING METHOD B

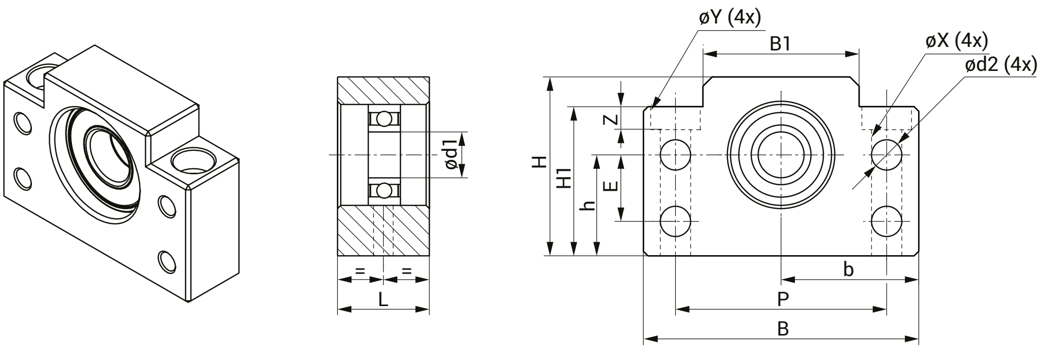
Type	Dimensions [mm]																		Mass [kg]
	d1	L	H	F	E	D (g6)	A	PCD	B	L1	T1	L2	T2	X	Y	Z	M	T	C	
FK10	10	27	10	17	29,5	34	52	42	42	7,5	5	8,5	6	4,5	8,0	4	M3	16	5,5	0,23
FK12	12	27	10	17	29,5	36	54	44	44	7,5	5	8,5	6	4,5	8,0	4	M4	19	5,5	0,25
FK15	15	32	15	17	36,0	40	63	50	52	10	6	12	8	5,5	9,5	6	M4	22	10,0	0,39
FK17	17	45	22	23	47,0	50	77	62	61	11	9	14	12	6,6	11,0	10	M4	24	10,0	0,81
FK20	20	52	22	30	50,0	57	85	70	68	8	10	12	14	6,6	11,0	10	M4	30	11,0	1,02
FK25	25	57	27	30	59,0	63	98	80	79	13	10	20	17	9,0	15,0	13	M5	35	15,0	1,48
FK30	30	62	30	32	61,0	75	117	95	93	11	12	17	18	11,0	17,5	15	M6	40	9,0	2,32

Support unit EK – fixed side, rectangular type



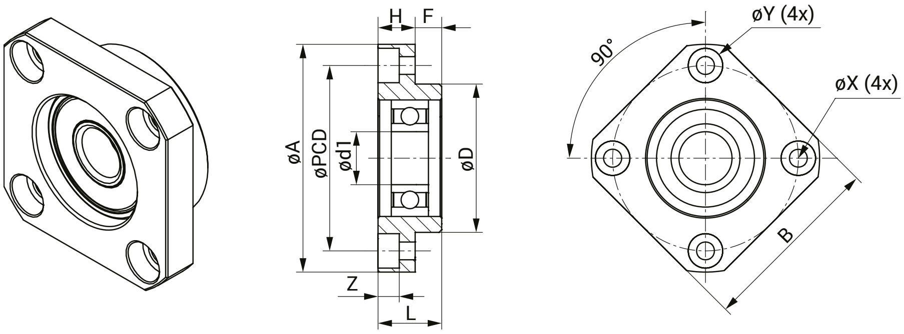
Type	Dimensions [mm]																Mass [kg]
	d1	L	L1	L2	L3	H	B	b (±0,02)	h (±0,02)	B1	H1	P	X	Y	Z	M	T	
EK06	6	20	5,5	22	3,5	25	42	21	13	18	20	30	5,5	9,5	11	M3	12	0,15
EK08	8	23	7,0	26	4,0	32	52	26	17	25	26	38	6,6	11,0	12	M3	14	0,26

Support unit BF – supported side, rectangular type



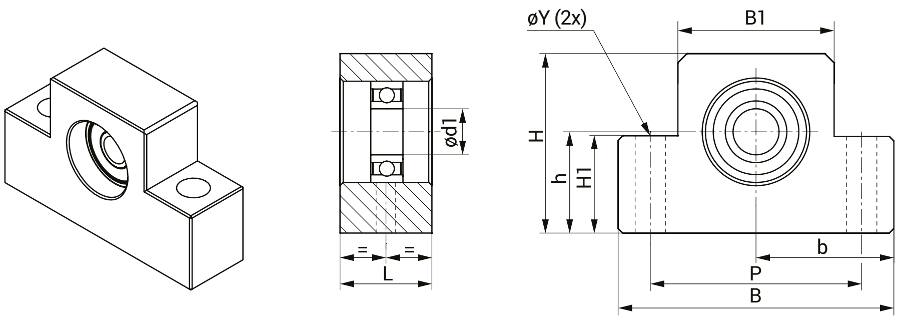
Type	Dimensions [mm]													Mass [kg]
	d1	L	B	H	b (±0,02)	h (±0,02)	B1	H1	E	P	d2	X	Y	Z	
BF10	8	20	60	39	30	22	34	32,5	15	46	5,5	6,6	10,8	5,0	0,30
BF12	10	20	60	43	30	25	34	32,5	18	46	5,5	6,6	10,8	1,5	0,30
BF15	15	20	70	48	35	28	40	38,0	18	54	5,5	6,6	11,0	6,5	0,40
BF17	17	23	86	64	43	39	50	55,0	28	68	6,6	9,0	14,0	8,5	0,75
BF20	20	26	88	60	44	34	52	50,0	22	70	6,6	9,0	14,0	8,5	0,76
BF25	25	30	106	80	53	48	64	70,0	33	85	9,0	11,0	17,0	11,0	1,43
BF30	30	32	128	89	64	51	76	78,0	33	102	11,0	14,0	20,0	13,0	1,94

Support unit FF – fixed side, round type



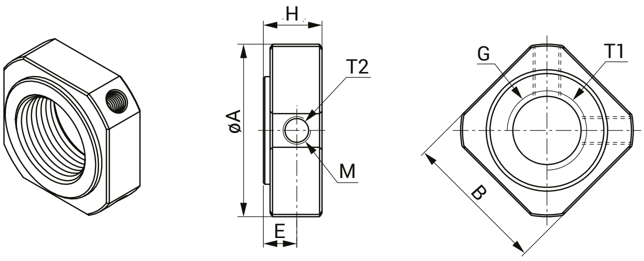
Type	Dimensions [mm]											Mass [kg]
	d1	L	H	F	D (g6)	A	PCD	B	X	Y	Z	
FF10	8	12	7	5	28	43	35	35	3,4	6,5	4,0	0,10
FF12	10	15	7	8	34	52	42	42	4,5	8,0	4,0	0,13
FF15	15	17	9	8	40	63	50	52	5,5	9,5	5,5	0,20
FF17	17	20	11	9	50	77	62	61	6,6	11,0	6,5	0,33
FF20	20	20	11	9	57	85	70	68	6,6	11,0	6,5	0,43
FF25	25	24	14	10	63	98	80	79	9,0	14,0	8,5	0,66
FF30	30	27	18	9	75	117	95	93	11,0	17,0	11,0	1,03

Support unit EF – supported side, rectangular type



Type	Dimensions [mm]											Mass [kg]
	d1	L	B	H	b (±0,02)	h (±0,02)	B1	H1	P	X	Y	Z	
EF06	6	12	42	25	21	13	18	20	30	5,5	9,5	11	0,10
EF08	6	14	52	32	26	17	25	26	38	6,6	11,0	12	0,15

Precision lock nut

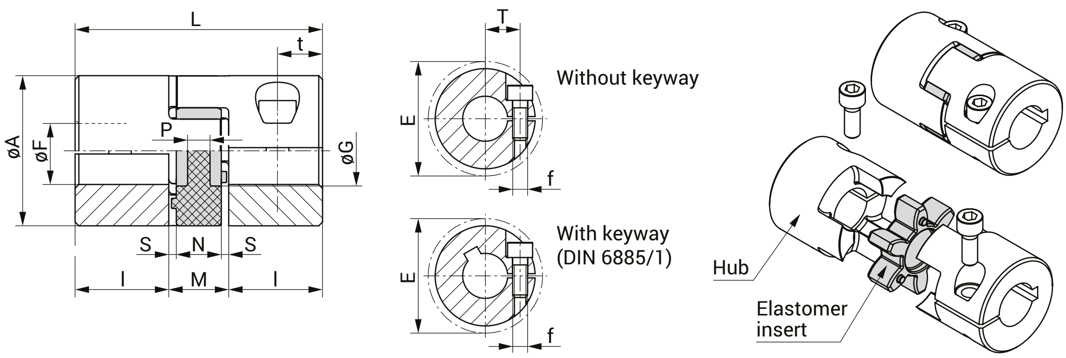


Type	Dimensions [mm]						Tightening torque [Nm]		Weight [g]
	A	H	G	B	E	M	T1	T2	
M10x1	19,0	8	M10x1,0	16	5,5	M3	3,0	0,6	8
M12x1	22,8	8	M12x1,0	19	5,5	M4	6,5	1,5	14
M15x1	25,8	8	M15x1,0	22	4,75	M4	8,0	1,5	16
M17x1	29,0	13	M17x1,0	24	9,0	M4	9,5	1,5	24
M20x1	35,0	11	M20x1,0	30	7,0	M4	17,0	1,5	34
M25x1,5	43,0	15	M25x1,5	35	10,0	M6	21,0	5,0	54
M30x1,5	48,0	20	M30x1,5	40	14,0	M6	32,0	5,0	76

COUPLINGS

Zero backlash couplings

Hub material: aluminum



Size	T_{KN} [Nm]	T_{Kmax} [Nm]	F (F7)		f	M_S [Nm]	Hub		n_{max} [min^{-1}]	A [mm]	G [mm]	L [mm]	I [mm]	M [mm]	N [mm]	S [mm]	P [mm]	t [mm]	T [mm]	E [mm]	Misalignments		
			min [mm]	max [mm]			Mass [kg]	J [10^{-6}·kg·m^2]													ΔK_a [mm]	ΔK_r [mm]	ΔK_w [°]
7	2	4	3	7	M2	0,35	0,003	0,085	40000	14	-	22	7	8	6	1,0	6	4	5,25	15,0	0,6	±0,10	±1,0
9	5	10	4	9	M2,5	0,75	0,007	0,42	28000	20	7,2	30	10	10	8	1,0	2	5	7,25	23,4	0,8	±0,10	±1,0
14	12,5	25	6	16	M3	1,4	0,018	2,6	19000	30	10,5	35	11	13	10	1,5	2	5,5	11,25	32,2	1,0	±0,09	±0,9
19/24	17	34	10	20	M6	11	0,071	18,1	14000	40	18	66	25	16	12	2,0	3,5	12	15,00	45,7	1,2	±0,06	±0,9
24/28	60	120	10	32	M6	11	0,156	74,9	10600	55	27	78	30	18	14	2,0	4	12	20,75	56,4	1,4	±0,10	±0,9
28/38	160	320	14	35	M8	25	0,240	163,9	8500	65	30	90	35	20	15	2,5	5,2	13,5	25,00	72,6	1,5	±0,11	±0,9
38/45	325	650	19	45	M8	25	0,440	465,5	7100	80	38	114	45	24	18	3,0	5,6	16	31,25	83,3	1,8	±0,12	±0,9

T_{KN}	Coupling nominal torque
T_{Kmax}	Coupling maximum torque
M_S	Screw tightening torque
J	Moment of inertia of coupling hub
n_{max}	Maximum rotational speed
ΔK_a	Maximum axial misalignment
ΔK_r	Maximum radial misalignment
ΔK_w	Maximum angular misalignment

In the case of coupling hub without keyway, the maximum transmissible torque is a lower value between the coupling maximum torque T_{Kmax} and the transmissible torque, which can be found in the following table.

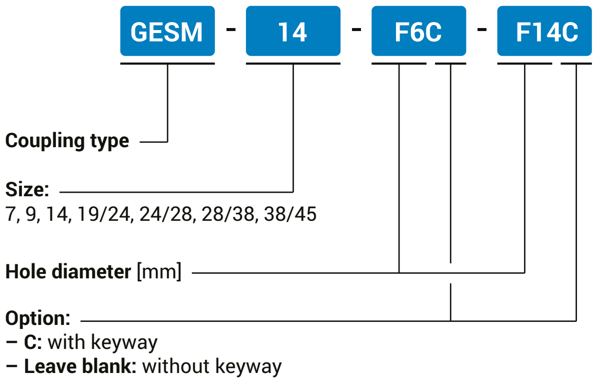
Recommended coupling bore diameter F [mm] and transmissible torque [Nm], valid for shaft tolerances k6:

Size	Ø 4	Ø 5	Ø 6	Ø 7	Ø 8	Ø 9	Ø 10	Ø 11	Ø 12	Ø 14	Ø 15	Ø 16	Ø 19	Ø 20	Ø 22	Ø 24	Ø 25	Ø 28	Ø 30	Ø 32	Ø 35	Ø 38	Ø 40	Ø 42	Ø 45
7	0,7	0,8	1	1,1																					
9	1,1	1,4	1,7	1,9	2,2	2,5																			
14			2,5	2,9	3,3	3,7	4,1	4,6	5	5,8	6,2	6,6													
19/24							23	25	27	32	34	36	43	45											
24/28							23	25	27	32	34	36	43	45	50	54	57	63							
28/38										58	62	66	79	83	91	100	104	116	124	133	145				
38/45													79	83	91	100	104	116	124	133	145	158	166	174	187

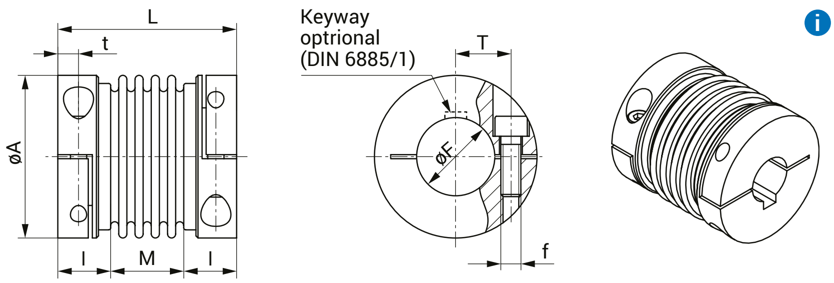
Operating conditions

Operating temeprature	−30 ~ +90	[°C]

How to order



Bellow couplings



ⓘ Hub material: aluminum (size 150 – hub material: steel)

Size	T_{KN} [Nm]	T_{Kmax}* [Nm]	F (F7)		f	M_S [Nm]	Coupling		A [mm]	L [mm]	l [mm]	M [mm]	t [mm]	T [mm]	Misalignments		
			min [mm]	max [mm]			Mass [kg]	J [10^{-3}·kg·m²]							ΔK_a [mm]	ΔK_r [mm]	ΔK_w [°]
2	2	3	4	12,7	M3	2,3	0,02	0,002	25	30	10,5	9	4,0	8	± 0,5	± 0,2	± 1
4,5	4,5	7	6	16	M4	4	0,05	0,007	32	40	13,0	14	5,0	11	± 1,0	± 0,2	± 1
10	10	15	6	24	M4	4,5	0,06	0,016	40	44	13,0	18	5,0	14	± 1,0	± 0,2	± 1
15	15	23	8	28	M5	8	0,16	0,065	49	58	21,5	15	6,5	17	± 1,0	± 0,2	± 1
30	30	45	10	32	M5	15	0,25	0,120	56	68	26,0	16	7,5	20	± 1,0	± 0,2	± 1
60	60	90	14	35	M6	40	0,40	0,300	66	79	28,0	23	9,5	23	± 1,5	± 0,2	± 1
80	80	120	16	42	M8	70	0,70	0,750	82	92	32,5	27	11,0	27	± 2,0	± 0,2	± 1
150	150	225	19	42	M10	85	1,70	1,800	82	92	32,5	27	11,0	27	± 2,0	± 0,2	± 1

* ≈ 1,5 × TKN. Brief overloads of up to 1,5 × the rated (nominal) torque are acceptable.

T_{KN}	Coupling nominal torque
T_{Kmax}	Coupling maximum torque
M_S	Screw tightening torque
J	Moment of inertia of coupling
ΔK_a	Maximum axial misalignment
ΔK_r	Maximum radial misalignment
ΔK_w	Maximum angular misalignment

Operating conditions

Operating temeprature	–30 ~ +100	[°C]
Max. rotational speed	Up to 10000	[min⁻¹]

How to order

BKL - **10** - **11** - **14PFN**

Coupling type

Size:
2, 4, 5, 10, 15, 30, 60, 80, 150

Bore diameter F [mm]

Option:
– **PFN:** with keyway
– **Leave blank:** without keyway

BELEŽKA / NOTES

BELEŽKA / NOTES

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