PRODUCT CATALOGUE

KULIČKOVÉ ŠROUBY KUŘIM, a.s.

„We always have the right solution“

KSK
PRECISE MOTION

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1. INTRODUCTION

The establishment of the company **KULIČKOVÉ ŠROUBY KUŘIM, a.s.** was closely connected with the machine tools manufacturing facility in Kuřim, the foundations of which were laid in **1924**, in the engineering plant of the former Czechoslovakian gun factory in Brno. At that time, the manufacturing of special machine tools for arms production started in the factory's machine repair shop. In **1929**, the company began to manufacture machine tools for its internal use and shortly afterwards also for the domestic market.

However, the real boom in machine tool manufacturing started in **1932**. By the following year, Zbrojovka milling machines had already penetrated the markets in England, Russia, Switzerland, Italy, the Netherlands, Sweden, South Africa and Finland.

Due to the high demand for precision lathes and high-performance milling machines from Zbrojovka, a new manufacturing plant was founded in Kuřim in **1942**.

The production of CNC machines in the 1960s led to the development of new and more sophisticated machinery components. Low mechanical efficiency of the lead (trapezoidal) screws became a serious barrier to the building of CNC machines. Therefore, these motion components were gradually replaced with ball screws, which have been manufactured in Kuřim since **1967**.

The high efficiency of the ball screws and the possibility to eliminate axial play using them are the basic and significant conditions for the implementation of CNC control systems in machine tools and in other machinery and industrial applications.

Ball screws were produced by the company called TOS KUŘIM until **1996**. Afterwards the company was privatized in **1996** and the limited company TOS KUŘIM–KŠ, s.r.o. was established. In **1997** the name of the company was changed to **KULIČKOVÉ ŠROUBY KUŘIM, s.r.o.** On 1 January 2001 it was transformed into a joint stock company. On 25 July 2005 ALTA a.s., a Czech trading company, became the majority owner of the company.

Since **1 September 2011** the company **KULIČKOVÉ ŠROUBY KUŘIM, a.s.** has changed its majority owner and has become a member of the Swiss holding **OC Schweiz Maschinen Bau AG**, which associates a number of manufacturing facilities that deliver their products to the producers of machine tools, injection moulding and plastics industry, and other industrial sectors.

The company **KULIČKOVÉ ŠROUBY KUŘIM, a.s.** currently manufactures ball screws in the precision classes **IT1**, **IT3**, **IT5**, **T5** and **T7** under the **ISO 3408** and **DIN 69051** standards. Our products meet the most demanding requirements for the design of machine tools, automated lines and single-purpose machines due to their excellent technical parameters such as rigidity, life, high efficiency and smooth run.

The company **KULIČKOVÉ ŠROUBY KUŘIM, a.s.** also manufactures and supplies **ISO** and **ČSN** compliant lead (trapezoidal) screws for conventional machines and many different industrial applications.

The company also produces cylindrical rods for linear guides. They are characterized by high efficiency, accuracy and low passive resistance. Our guide rods are used in combination with linear bushings produced by the world's leading producers.

The high level of the quality management system has been certified annually since **2000** under the **ISO 9001** standard. The currently valid quality management system is in compliance with **EN ISO 9001:2008** and has been certified by **TÜV NORD CERT GmbH**.

KULIČKOVÉ ŠROUBY KUŘIM, a.s. is a member of the following associations:

Association of Engineering Technology

CECIMO

Brno Regional Chamber of Commerce

2.1. General information about ball screws

Ball screws (hereinafter also BS) are structural components (non self-locking) that convert rotary motion into smooth, accurate and reversible linear motion with high efficiency, rigidity, precision and reliability.

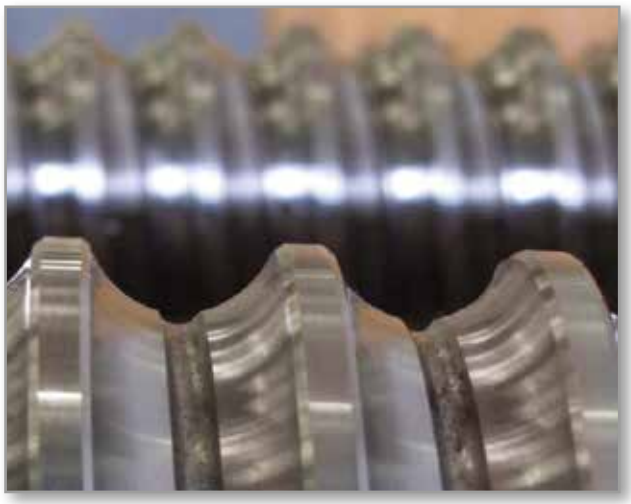
Ball screws require an accurate and rigid mount with precise alignment of the ball screw longitudinal axis and the guiding surfaces within 0.02 mm/1,000 mm. At the same time, the nut position should guarantee its perpendicularity to the longitudinal axis of the ball screw within 0.02 mm/1,000 mm.

The nuts can be loaded only in the axial direction. In the case of long and thin ball screws the unit's design should eliminate the deflection of the shaft due to its own weight.

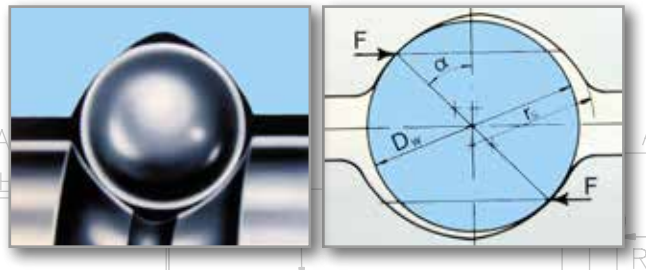
The precise quality of the screw grooves guarantees high endurance against heat generation and wear. Other advantages of the ball screws are low driving torque (even in the case of preloaded nuts) and high linear accuracy.

Ball screws are used in different applications mainly for their high efficiency (given by the low rolling resistance of the balls in the thread shell) during the transition of the rotary to linear motion. Ball screws are mainly used in the following industrial areas:

- machine tools and metal forming machines
- injection moulding machines
- packaging machines
- lifting equipment
- handling and automation technology
- medical equipment
- pharmaceutical industry (medical and laboratory instruments)
- automotive industry, aerospace industry, etc.



The performance of the grooves in the ball screw subcomponents determines the ball screw functional quality; therefore these components are hardened and afterwards, in the case of precision ball screws, also ground in order to guarantee the required two-point contact of the balls in the so-called Gothic (ogival) thread profile.



The ball screws are made of steel with grade **ČSN 14 260**, **CF53** or **42CrMo4** (shafts) and **14 109** or **14 209** (nuts). The nut and the threaded part of the shaft are hardened to **58-60 HRC**. Minimum strength of the core and the non-hardened parts of the shaft is **R_m = 650 MPa**. The resulting quality is verified by long-term life tests and final analysis of the changes in the functional sections of the transmission after reaching the defined wear limits. Based on the obtained results and bearing in mind the operating conditions, we can guarantee the actual service life of the product, or we can offer the best solution based on the specific requirements of the customer.

The selection of the right type and design of a ball screw from our standard product range depends on the required application, technical characteristics and the operating conditions.

The properties of the ball screws are characterized by the following parameters:

- **Nominal thread diameter**
- **Thread pitch**
- **Thread precision class**
- **Load capacity, rigidity and life**
- **Travel speed**
- **Ball recirculation system in the nuts**
- **Other parameters**

Nominal thread diameter

The nominal thread diameter determines the column strength of the ball screw shaft in relation to its length and support. The nominal diameter of the shaft $\mathbf{d_o}$ has been used to derive the relation of its maximum rotational speed $\mathbf{n_{max}}$ towards the recirculation speed of the balls in the used recirculation system and type of lubrication. The product of multiplying the nominal diameter and the rotational speed gives us a characteristic value limiting the application and the function of the ball screw, whereas the following limitations are applied:

Internal ball recirculation with beds:

$$n_{max} = \frac{100.000}{d_0}$$

External ball recirculation with shims:

$$n_{max} = \frac{70.000}{d_0}$$

Recirculation segments and lids:

$$n_{max} = \frac{125.000}{d_0}$$

Thread pitch

The thread pitch (P) determines the dynamic properties of the recirculation system, whilst the precision class determines the resulting working accuracy of positioning. In our standard product range we offer pitches from **3 mm** to **50 mm** depending on the nominal diameters and recirculation types. The pitch size determines the maximum size of the balls and therefore influences the total number of balls in the recirculation system or in the working thread of the nut.

Thread precision class

Our ball screws are offered in several **precision classes** that are in compliance with the definitions of the standards **ISO 3408** and **DIN 69051**.

The precision classes are given in the following table:

Travel deviation per 300 mm thread length (mm)	Ground thread			Whirled thread			Rolled thread	
	IT1	IT3	IT5	IT5	T5	T7	T5	T7
	0.006	0.012	0.023	0.023	0.023	0.052	0.023	0.052

The travel deviations for whirled and rolled ball screws with precision classes **T5** and **T7** are in compliance with the **ISO 3408-3** standard for transport ball screws.

Load capacity, rigidity and basic rating life

Load capacity is another technical parameter which is important for the proper selection of a ball screw which, similarly to the ball bearings, is characterized by the static load capacity $\mathbf{C_o}$ (defined as the load resulting permanent deformation of the functional thread or ball surface with diameter $\mathbf{D_w}$ equalling **0.0001** $\mathbf{D_w}$) and the dynamic load capacity $\mathbf{C_a}$ (corresponding to the load that the ball screw can theoretically endure reaching a basic rating life of one million revolutions $\mathbf{L_{10} = 1 \times 10^6}$).

The determination of the **basic rating life** (which is defined as the value expressing with **90 %** reliability the number of the shaft revolutions, in relation to the nut unit under load **F**, until the first signs of material fatigue or wear of the functional transition elements appear) is done by the following formula:

$$L_{10} = \left(\frac{C_a}{F}\right)^3 \times 10^6 \text{ (revolutions)}$$

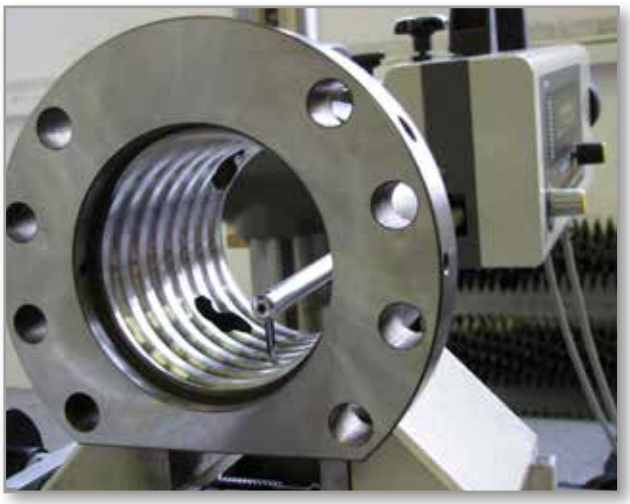
Another important characteristic property of the ball screws is their **rigidity R**, which is defined as a ratio of the external axial load $\mathbf{F_a}$ to the axial travel of the nut **δ** onto the ball screw shaft:

$$R = \frac{F_a}{\delta} \text{ (N/µm)}$$

In order to achieve high rigidity and at the same time to eliminate axial backlash, **preloading force** $\mathbf{F_v}$ is applied in the transmission. For this reason the ratio between the axial force $\mathbf{F_a}$ (at which a backlash still does not occur) and the preload $\mathbf{F_v}$, should meet the following condition:

$$\frac{F_v}{F_a} = 2{,}83$$

The definition of the axial force $\mathbf{F_a}$ and therefore the preload have to be done carefully based on the operating load of the ball screw, because the preload decreases the total life of the assembly.



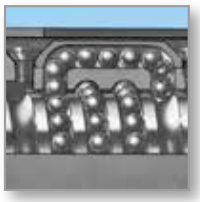
Travel speed

The nut unit must be capable of managing the required speed and changes in speed while ensuring precise positioning and sufficient rigidity. In order to eliminate the undesirable inertial effect, it is recommended to solve the drive of the ball screw through a rotating nut, with a static hollow shaft to cool the assembly. By different combinations of the selected nominal diameter **D_o**, the pitch **P**, the lubrication type and the type of transmission, it is possible to come up with a wide spectrum of attainable travel speed values corresponding to the possibilities of the machine tool support drive. To attain maximum accelerations and minimize undesirable impacts, the most favourable application for medium-sized machining centres proves to be the use of high-speed ball screws **K 40×40** with a rotating nut driven by a motor with a transmission ratio **p = 2:1**. The transmission enables better selection of the electric drive unit according to its performance and acceleration. The technological application of the machine tool significantly influences the ball screw type selection. High-speed ball screws are suitable for HSC (high speed cutting) machining with high-speed feed (up to 80 min^{-1}), while standard ball screws with lower pitch but higher rigidity are used for machines designed for conventional machining with lower spindle rotational speed, lower feeds and a deeper cut.

Ball recirculation system in the nuts

Standard types of nut units are equipped with an internal ball recirculation system done by the so-called recirculation **deflectors**, which return the balls within one pitch of the ball screw, or in a recirculation **rib** containing several recirculation grooves in one body.

Non-standard types of nut units are equipped with an external ball recirculation system in a so-called **shim**, which returns balls within several pitches of the ball screw thread.



Our high speed bball screws (most often two-start) have nut units with special-design nut **caps** or radial **segments** smoothly transitioning the balls from the working area into a longitudinal axial hole in the nut.

The **segments** are also used in the one-start ball screws as a replacement of the deflectors.

Other parameters

Ball screw ends

Ball screw ends are manufactured according to the client's drawing or requirements for the shaft mounting.

Special-design ball screws

Ball screws can be customized for connection of cooling or lubrication through an axial hole in the shaft.

Thread lengths

Based on our technological capabilities and the precision class we recommend the following screw shaft lengths (see table below).

Ball screw lubrication

Ball screws are lubricated by oil or grease. The manner of lubrication and the lubricants are the same as those used for rolling bearings. The basic amount of the lubricant for a particular nut unit can be determined and recommended upon request.

Oil lubrication

In general, for the lubrication of the ball screws the same kind of oils as for the rolling bearings have been used, i.e. transmission mineral oils and bearing mineral oils with a minimum viscosity of **50 mm^2/s** at **40 °C**. The amount of the oil used depends on the operating conditions.

Grease lubrication

Grade 2 greases in accordance with **DIN 51825** are recommended for ball screws. The following types are delivered as a standard:

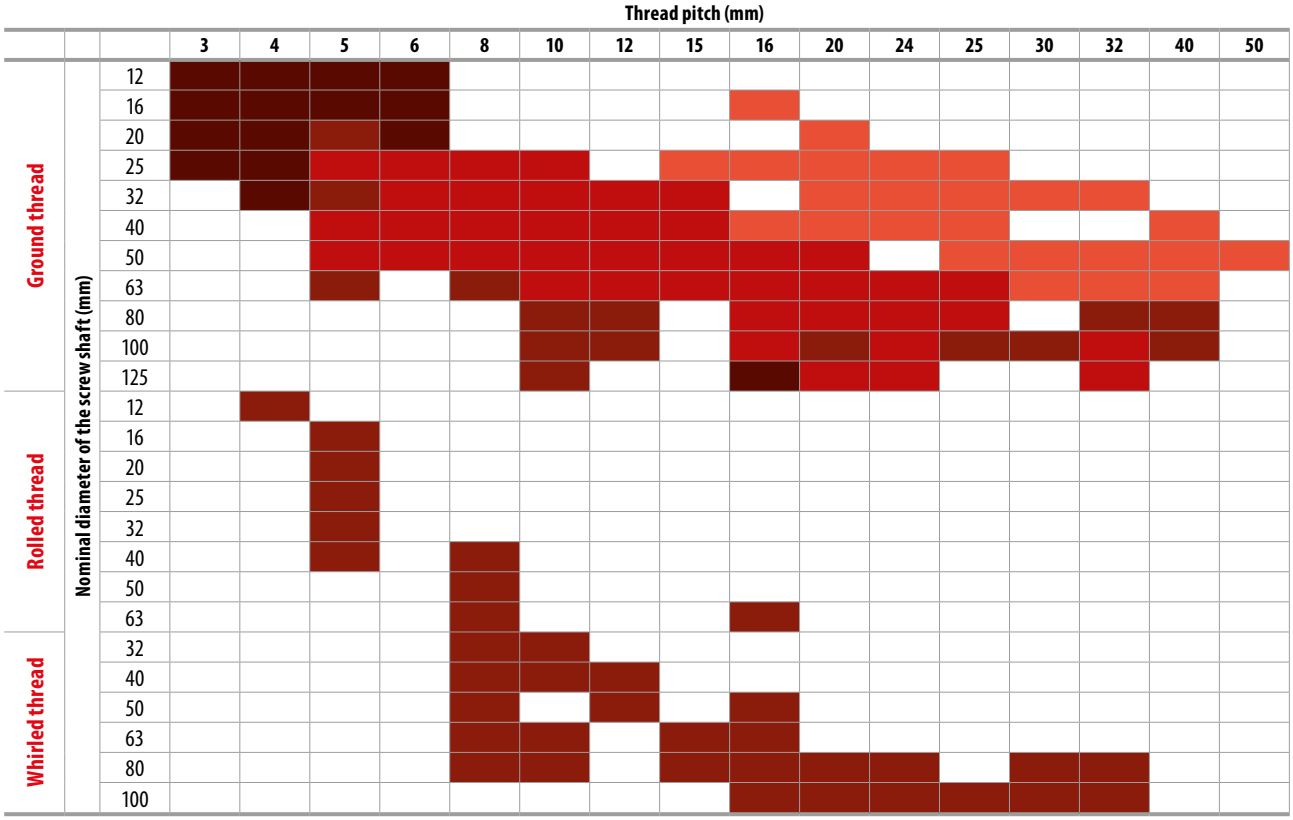
KLÜBER Isoflex NBU 15
OPTIMOL OPTITEMP TT1

For high load applications plastic lubricants can be used.
After setting up of the machine tool the lubricant has to be replenished after 2 to 3 months. In a standard operation period the grease should be replenished once every 6 to 10 months. Greases with different properties should not be mixed during operation.

Recommended thread lengths	nominal diameter of the screw shaft (mm)											
	Precision class	12	16	20	25	32	40	50	63	80	100	125
ground thread	IT1	200	230	250	350	700	1200	1500	2000	2500	2800	3000
	IT3	250	280	300	400	1000	1800	2000	2500	3000	3500	3500
	IT5	300	350	500	800	1500	2500	3500	4000	5000	5500	4000
whirled thread	IT5	-	-	-	-	-	3000	4000	4500	5000	5500	-
	T5	-	-	-	-	-	4000	4500	5000	5500	5800	-
	T7	-	-	-	-	-	5000	5300	5500	5800	6000	-
rolled thread	T5	3000	3000	4000	5000	6000	6000	6000	6000	-	-	-
	T7	3000	3000	4000	5000	6000	6000	6000	6000	-	-	-

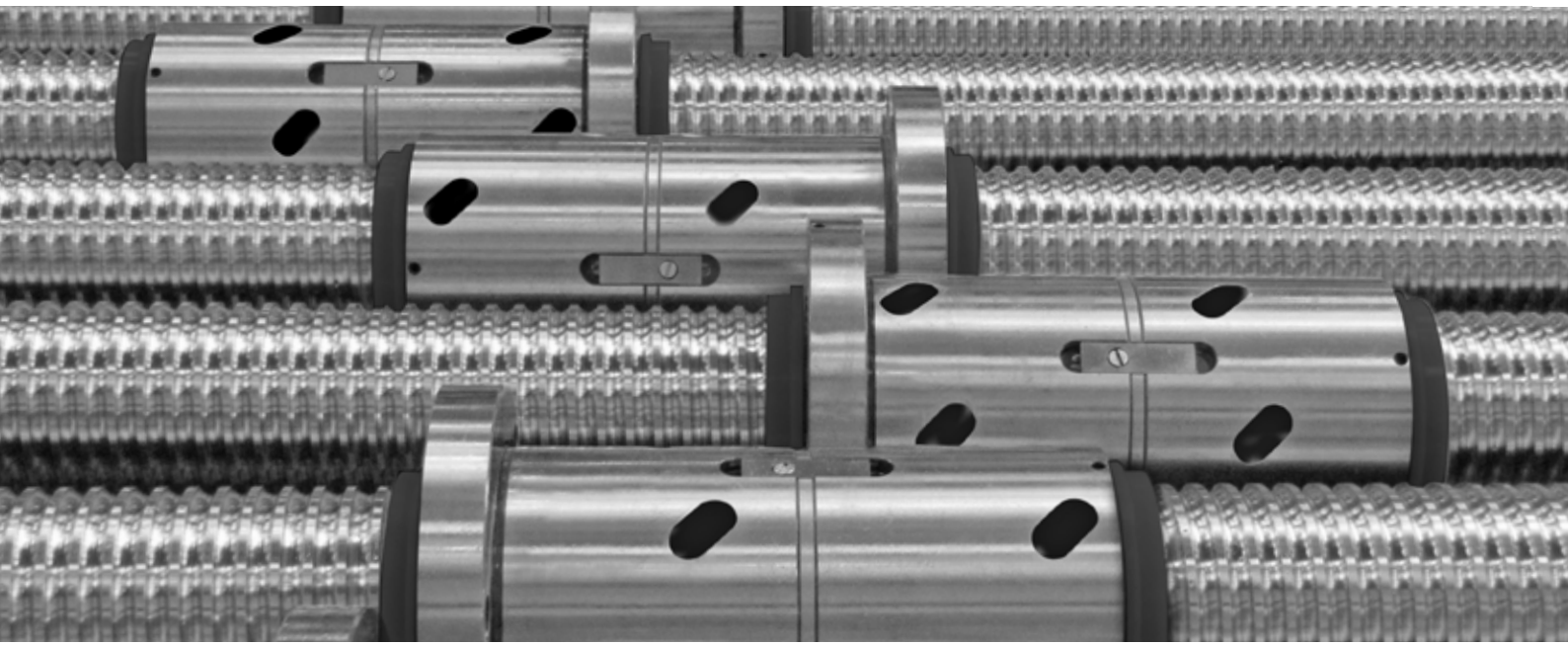
Dimensions other than those mentioned in the overview above (below) we gladly offer after mutual consultation.

Product range of manufactured ball screws



- Recirculation shims (E – external recirculation)
- Recirculation deflectors (I – internal recirculation)
- Different types of recirculation by shims, segments or deflectors (E – external recirculation by shims, I – internal recirculation or S – segment recirculation)
- Recirculation for high-speed ball screws (V – caps, or S – segments)

Recirculation systems I and S comply with the DIN 69051 standard.



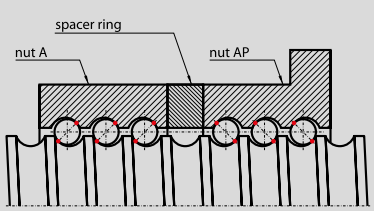
Ball screw nuts are the major components which transfer the axial load and provide smooth recirculation of the balls through the transition elements. The nut units provide elimination of axial play and guarantee the necessary rigidity of the transmission in both directions. They also distribute the lubricant and partially remove heat from the transmission unit. The inner working space of the nuts is protected at both ends against rough contamination by wipers, usually produced from PA6 (polyamide).

Types of nut units

type	designation	description	page.
	**A**	Single, non-preloaded nut without flange	20, 21
	**AP**	Single, non-preloaded nut with flange	22, 23, 25
	**A+A**	Double, preloaded nut without flange	20, 21
	**AP+A**	Double, preloaded nut with flange	22, 23, 28
	**APR**	Single, preloaded nut with flange	22, 23
	**APVR**	Single, high-speed preloaded nut with flange for shafts with two starts	24
	**APQR**	Single, high-speed preloaded nut with flange for shafts with four starts	24
	**APE**	Single, non-preloaded nut with flange for shafts with rolled thread	25
	**B+B+K**	Double preloaded nut in a cube case	26, 27
	**RMV**	Driven nut with inserted bearings	29
	**RMI**	Driven nut with integrated bearings	29

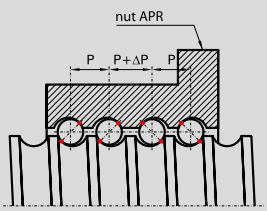
Applied methods of nut unit preload

AP+A



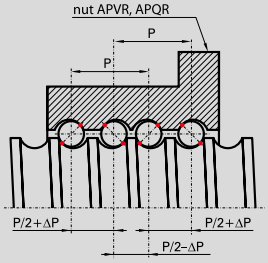
preload by inserted spacer ring

APR



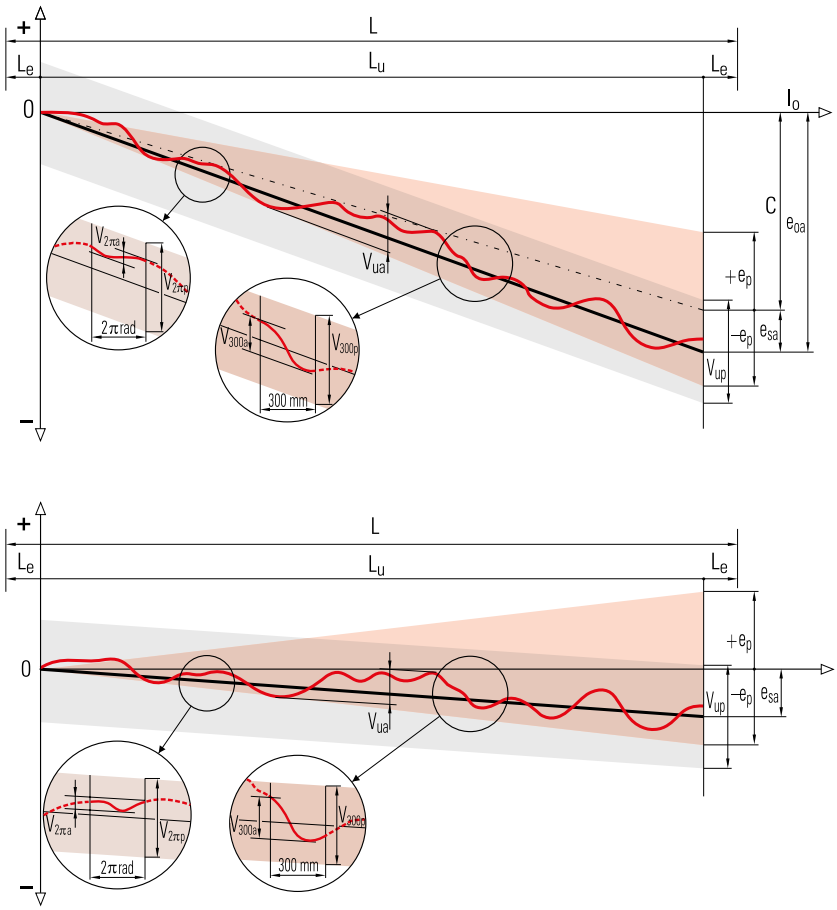
preload by increased difference in thread pitch

APVR, APQR



preload by difference between thread leads

Parameters of geometric accuracy of the ball screw travel

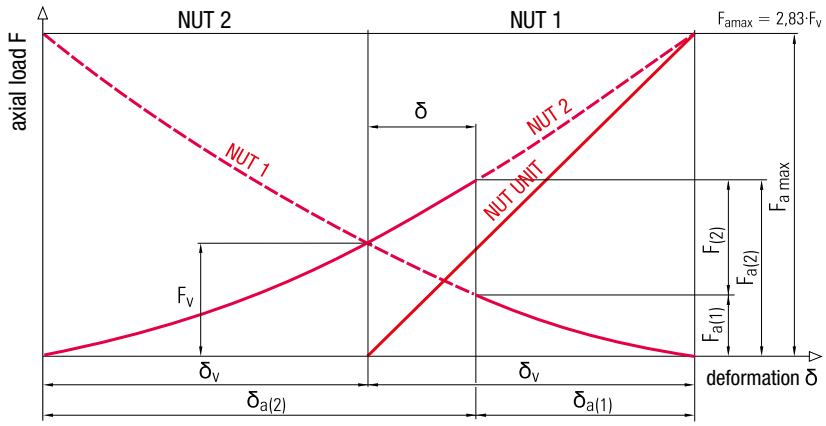


L thread length
L_o nominal travel
L_u useful travel
L_e excess travel
C travel compensation (difference between specified and nominal travel)
e_p tolerance on specified travel (deviation of the actual mean travel)
e_{oa} deviation of the actual mean travel from the nominal travel
e_{sa} deviation of the actual mean travel from the specified travel
V_{300} deviation of travel within the limit of 300 mm of the useful travel
$V_{2\pi rad}$ deviation of travel within the limits of one turn
V_u deviation of travel within the useful travel

tolerance field of the defined mean travel
tolerance field of the useful travel deviations
tolerance field of travel deviations within one revolution
tolerance field of travel deviations within the limits of 300 mm of the useful travel

L_e (mm):
up to pitch **P<20 L_e = 4P**,
for **P>20 L_e = 3P**,
for **P>40 L_e = 2.5P**

Behaviour of forces and deformations in a preloaded nut unit



δ elastic deformation of the nut unit
$δ_v$ deformation resulting from the preload force Fv
$δ_{a(1),(2)}$ deformation resulting from external load on the nut 1 or 2
F_v preload force
$F_{(1),(2)}$ external load on nut 1 or 2
$F_{a(1),(2)}$ internal forces acting in nut 1 or 2

Manufacturing technologies

Rolling of the ball screw thread is a technology of forming the screw (by pressure) on a steel shaft, using rotating dies with the desired thread profile. The result is a semi-product for further processing such as case hardening and polishing of the ball screw thread. The thread pitch provided by rolling differs from the required nominal pitch by a deviation which has been corrected by the subsequent heat treatment. This method is suitable for mass production. The resulting accuracy is significantly influenced by the quality of the material and the conditions of the controlled rolling process. Afterwards it is necessary to select and sort

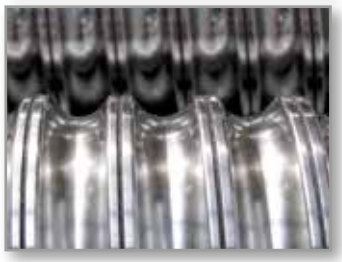
the rolled shafts based on the achieved accuracy. As a standard, rolled ball screws are made in accuracy class **T7 (DIN 69051, ISO 3408)** and lower. Ball screws in **T5** can also be selected. Rolled ball screws are characterized by the specific shape of the non-functional part of the thread profile resulting from the forming process. Due to the technology used, those ball screws have significant inner tension and stresses of the material, usually demonstrated by geometrical inaccuracy, associated with deformations of the shaft axis and slightly increased noise during rolling of the balls within the thread profile.

Rotational milling (whirling) of the ball screw thread is a metal cutting technology using tools with the desired thread profile, which provides machining of the thread already on the hardened surface of the shaft in order to get the final precise lead accuracy and profile of the screw. This technology is suitable for serial and piece production of ball screws. The resulting accuracy is influenced by the accuracy of the machine as well as by the quality of the used cutting tools and their precise adjustment. As a standard, this method is used to produce ball screws in **IT5** (**T5** and **T7**) precision classes. Whirling can also be used for the production of hardened ball nuts without the necessity of subsequent grinding. Final assembly and "matching" of the nut and the screw shaft is then performed by the selection of balls (oversized balls). With regard to the depth of the hardened layer and the shallow thread profile, the whirled ball screws are suitable rather for smaller sizes of balls.

Grinding of the ball screw threads is the traditional technology of ball screw manufacturing, using already machined and hardened shafts, achieving the most precise and accurate thread profile and lead of the screw. The method is suitable for serial and piece production. The resulting accuracy is influenced by the accuracy of the grinding machines and the quality of the used grinding wheels and their continuous profile shaping. This method is usually used to produce ball screws in the **IT1** and **IT3** precision classes. The hardened layer has optimal layout and distribution, copying the thread profile of the ball screw, which is characterised by high geometric accuracy and long operating life. However, this is the most demanding and time-consuming production method.

ground profile

whirled profile



rolled profile

2.2. Standard positioning ball screws (ST)

This type of ball screws is most widely spread in practice thanks to their universal use, excellent technical parameters and wide product range. They have been produced mainly by the technologies of grinding, whirling or a combination of both.

For this type of ball screws the following nut types are available:

- Single and double nuts
- With backlash or preloaded
- With internal or external ball recirculation system
- With or without flange

Characteristics:

- Precise positioning ball screws
- Wide range of sizes and pitches
- Standard geometric and working accuracy, service life and load capacities according to ISO 3408 and DIN 69051
- Delivered with customized preload

Technical parameters:

- Diameters from **12** to **125 mm**
- Pitch from **3** to **50 mm**, lengths up to **6,2 m**
- Accuracy classes from **IT1** to **IT5**
- $\mathbf{D_o \times n = 100{,}000}$ efficiency **94–97 %** (according to the thread pitch and lubricant)
- Shaft material minimum strength $\mathbf{R_m = 650\,MPa}$, functional surfaces of the shaft and nut hardened to **58-60HRC**
- Application temperatures **-40** to **+80 °C** (according to lubricant type)

Applications:

- Machine tools
- Positioning mechanisms
- Automotive and aerospace industries

Example of designation: K80×20 - 4+4/AP+A ST/3 (ball screw with diameter 80 mm, 20 mm right hand pitch, 4 working threads, double preloaded nut type AP+A, with flange type 3)

Technical data are specified in Chapter No. 3 – Technical parameter tables (pages 20, 21, 22, 23, 26).

Universal application, wide product range

2.3. High-load ball screws (HL)

Compared to standard ball screws, high-load (HL) ball screws are characterized by more than twice higher load capacity and rigidity, achieved by changed radius of the thread profile. In the case of long ball screw shafts, this profile can be ground just in the nut. Short ones (up to three times the length of the nut) always have this profile also on the shaft. High load ball screws have lower efficiency and are designed for slow-running applications.

The HL ball screws are usually produced as non-preloaded (single nuts with backlash). In all applications, it is necessary to perform shaft buckling analysis and the nuts must be checked for their flange width in relation to axial load.

Characteristics:

- Precise ball screws for high axial load and long life
- Thread accuracy of the ball screws complies with the **IT1** precision class **(DIN 69051)** with inter-thread deviation less than **2 µm**
- Shaft ends are ground in the tolerance **classes 4** to **6**

Technical parameters:

- Recommended shaft diameters are **63**, **80**, **100** and **125 mm**
- Recommended pitch **20 mm**
- Used material with minimum strength $\mathbf{R_m}$**=720MPa**
- Ball screws, surface-induction hardened to **58-60HRC**
- Ball nuts are designed for high loads

Conditions for use of HL ball screws:

- Transmission efficiency approximately **0.93 – 0.95%**
- Shaft buckling analysis is necessary
- Lubricants for high loads must be used. Recommended lubricants are:
  Klüber Microlube GL 261, **OKS 400**, **Optimol Longtime PD 2**, **Lubcon Turmogrease PHS 1002** (all other greases suitable for high loads).
- Working temperature up to **90°C**

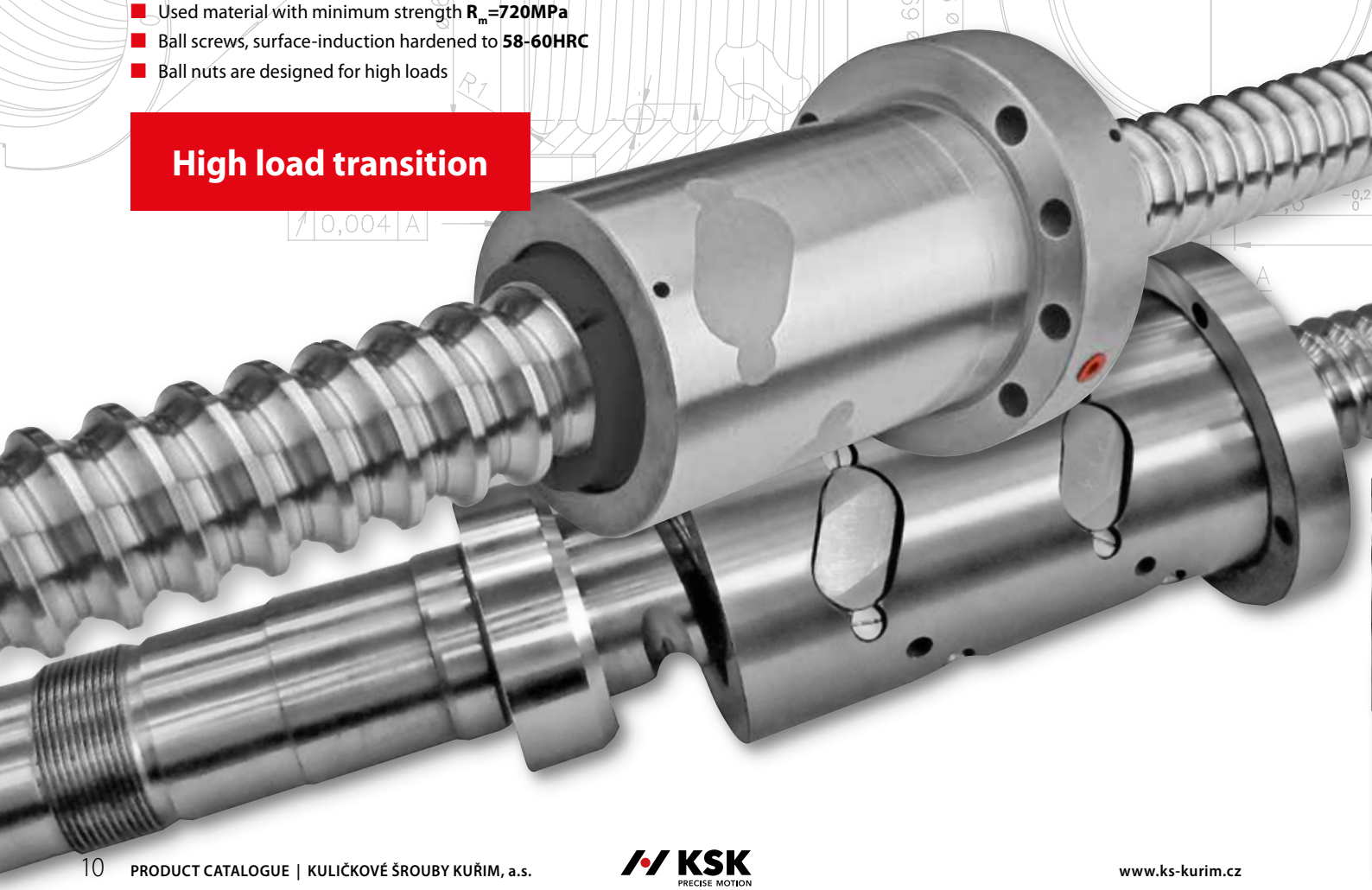
Applications:

- Injection moulding machines
- Transportation mechanisms
- Lifting equipment
- Replacement for hydraulic cylinders

Example of designation: K80×20 - 4/AP HL/3 (ball screw with diameter 80 mm and pitch 20 mm, 4 working threads, single nut with flange, high-load design, flange type 3)

Technical parameters are specified in Chapter No. 3 – Technical parameter tables (page 25).

High load transition



2.4. High-speed ball screws (HS)

New technologies bring essential changes in the requirements for machine tools especially concerning rotational speed of the working spindle (up to **50,000 rpm**), spindle output (**15÷60 kW**), linear working speed (**10÷30 m.min^{-1}**) and linear high-speed (**40÷80 m.min^{-1}**). In order to achieve the above mentioned parameters engineers are forced to use linear motors or high-speed ball screws.

The linear motors have high cost and their high electromagnetic field often causes complications for the machine tool builders. This is why the cheaper and technically sufficient high-speed ball screws are more widely spread. In them the thread pitch **P** equals their diameter **D_o** and they can be run at high rotational speeds **n** (**D_o** multiplied by **n** can be up to **125,000**).

For this type of ball screws the following nut types are available:

- Single preloaded nuts by difference between thread leads
- Nuts with patented external ball recirculation system
- Usually nuts with flange

Characteristics:

- Precise ground positioning screws
- High pitches up to the size equal to their nominal diameter, two-start and four-start screws
- Standard geometric and working accuracy, service life and load capacities according to **ISO3408** and **DIN69051**
- Delivered with customized preload

Technical parameters:

- Diameters from **16** to **50 mm**
- Pitches from **15** to **50 mm**, thread lengths to **2 m**
- Thread lengths over **2 m** can be supplied in single-start design with segments (see table on page 28)
- Accuracy class **IT1** and **IT3**
- **D_o×n = 125,000**, efficiency **94–97%** (according to thread pitch and lubricant)
- Minimum strength of the shaft material **R_m = 650MPa**, functional surfaces of the shaft and nut hardened to **58-60HRC**
- Working temperature **-40** to **+80°C** (according to lubricant type)
- Lubricants with high viscosity are recommended

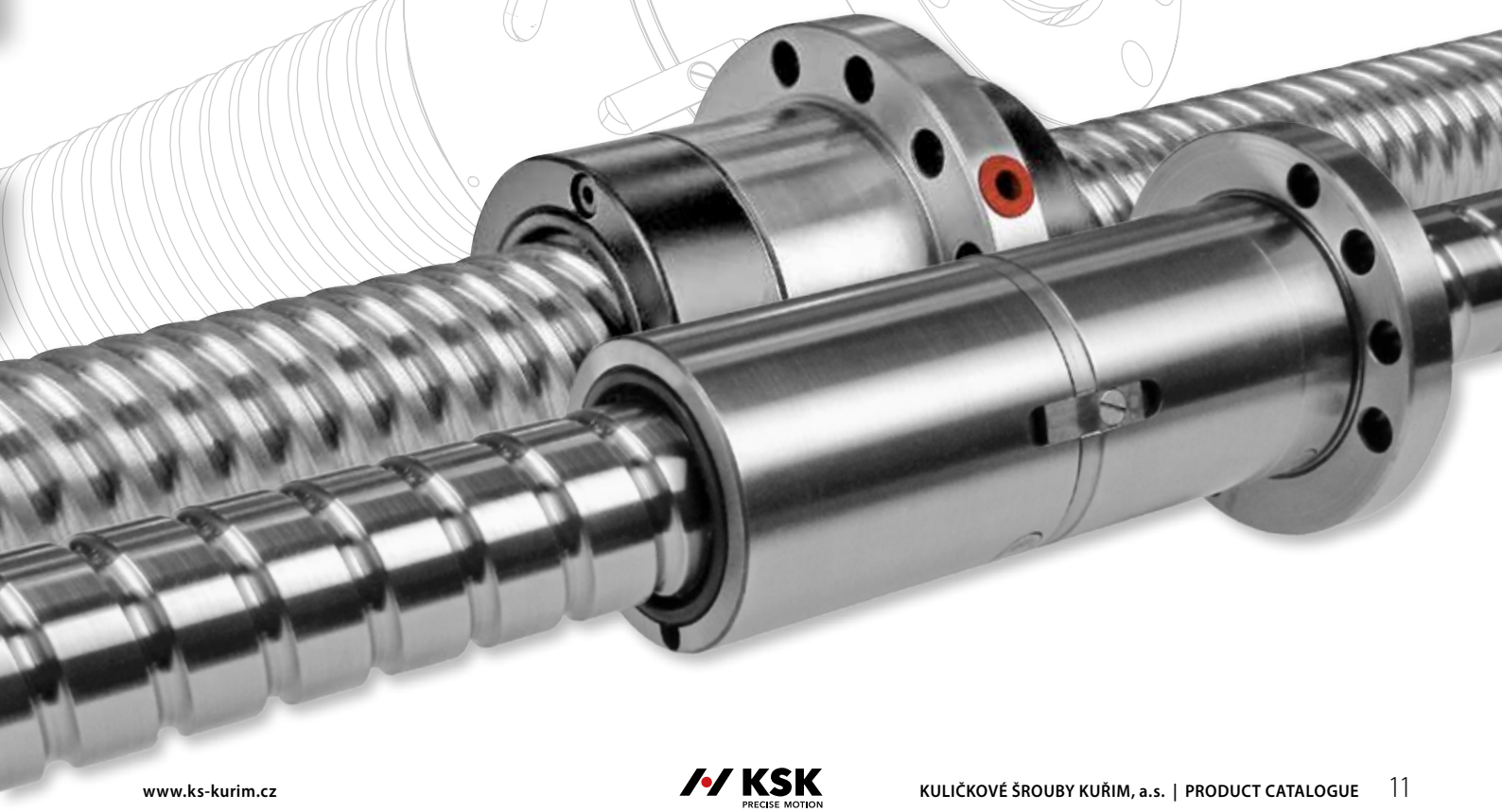
Applications:

- Machine tools
- Positioning mechanisms

Example of designation: K40×40 – 1.5+1.5/APVR HS/3 (ball screw with diameter 40 mm, with right hand two-start pitch 40 mm, with 1.5 working threads, preloaded nut type APVR with flange type 3)

Technical parameters are specified in Chapter No. 3 – Technical parameter tables (pages 24, 28).

High speed transition



2.5. Ball screws for low speed and precise positioning (PP)

These ball screws are used in applications in which high accuracy and low speed of positioning are required. They are suitable especially for precise machine tools.

The shaft thread is generally ground. These ball screws are only available with double preloaded nuts **AP+A**, or **A+A**. The ball screws are offered in **IT1** precision class and for their maximum thread length the following formula should be kept: $L_z = 20 \times D_o$. The load capacities of these ball screws are reduced to **70%** of the load capacity of standard ball screws due to the reduction of the number of balls in the nuts.

The main advantages of these ball screws are their high accuracy and smooth run. Furthermore their high flexibility allows the production of ball screws exactly according to the customer's needs.

For this type of ball screws the following nut types are available:

- Double preloaded nuts

Characteristics:

- Precise ground positioning screws with **IT1** precision class
- Standard geometric and working accuracy according to **ISO3408** and **DIN 69051**
- Reduced tolerance of T_p values (usually by **10** to **15%** compared to the standard)
- Delivered with customized preload

Technical parameters:

- Diameters from **20** to **80 mm**
- Recommended pitches **5** and **10 mm**, thread lengths to $20 \times D_o$
- Precision class **IT1**
- $D_o \times n = 80{,}000$, efficiency **94–97%** (according to thread pitch and lubricant)
- Minimum strength of the shaft material $R_m = 650$**MPa**, functional surfaces of the shaft and nut hardened to **58-60HRC**
- Working temperature **-20** to **+60°C** (according to lubricant type)
- Lubricants with increased resistance to unstable high pressure are recommended

Applications:

- Precise machine tools - grinding machines, EDM and laser machines

These ball screws do not have a separate technical parameter table and are delivered as customized solutions with respect to the limitations mentioned above. We recommend performance with an internal or external recirculating system, for example a segment type system; see the table on page 28.

Example of designation: K40x5 - 4+4/AP+A PP/2 (ball screw with diameter 40 mm, with pitch 5 mm, 4 working threads, preloaded double nut AP+A, precise positioning design, flange type 2)

Precise positioning and smooth run

2.6. High-efficiency ball screws (HE)

These ball screws are designed for applications requiring high efficiency of the transmission. They are used especially in machine tools and other equipment which meet the requirements for low energy consumption, as well as where high efficiency is required in order to eliminate heat sources or when an optimal ball screw drive is needed.

The high efficiency is achieved by an accurate thread profile ground section, by precise geometry of the groove and alternatively by the use of ceramic balls in the recirculation system.

These ball screws are produced in the precision classes **IT1** to **IT5**.

For this type of ball screws the following nut types are available:

- All types of nuts, non-preloaded nuts with backlash up to **0.05 mm**

Characteristics:

- Application of ceramic balls, special gothic thread profile
- Precise positioning ground ball screws
- Standard geometric and working accuracy according to **ISO3408** and **DIN 69051**
- Reduced $\mathbf{T_p}$ values (usually by **15** to **20%** against the standard)

Technical parameters:

- Diameters from **12** to **63 mm**
- Recommended pitch up to **10 mm**
- Precision classes from **IT1** to **IT5**
- $\mathbf{D_o \times n = 80.000}$, efficiency **96–98%** (according to thread pitch and lubricant)
- Minimum strength of the shaft material $\mathbf{R_m = 650MPa}$, functional surfaces of the shaft and nut hardened to **58–60HRC**
- Working temperature **-20** to **+60°C**
- A lubricant with reduced noise is recommended for a smooth run

Applications:

- Energy saving machine tools
- Laboratory and measuring equipment
- Aerospace industry

These ball screws have no separate technical parameter table and they can be supplied with different nut units (**A**, **AP**, **A+A**, **AP+A**, **APR**). We recommend performance with an internal or external recirculating system, for example a segment type system; see the table on page 28.

Example of designation: K63x10 - 4/AP HE/2 (ball screw with diameter 63 mm and pitch 10 mm, 4 working threads, single non-preloaded nut with flange, high efficiency design, flange type 2)

High efficiency

2.7. Ball screws with a driven nut
(with inserted bearings RMV or integrated bearings RMI)

The ball screw with a driven nut is a construction unit designed for direct mounting into the support of the machine and for connection to the drive through a gearwheel, or a wheel for cogged belts. In the **RMV** variant readymade bearings are inserted between the nut and the housing, whilst in the **RMI** variant the bearing tracks are produced directly on the outer surface of the nut and the balls recirculate between the nut and the housing. The nut is preset for driving gearwheel mounting. The preloaded bearings have been selected with respect to the load-carrying capacity of the nut. The precision class of the bearings also complies with the precision class of the ball screw.

This compact unit is filled with a permanent grease filling and possible additional lubrication of the nut and the bearings is provided manually through a greasing hole, which can be adapted according to the requirements of the customer. This assembly is usually based on a double preloaded nut with segment recirculation system of the balls in a hole drilled lengthwise in the body of the nut above the thread. In the case of a double thread shaft the preload can be done by displacement of the run within each nut, resulting in an extremely compact unit for high speed and acceleration.

This solution provides machine tool builders with an opportunity to use an ecological and energy saving drive alternative in comparison with the standard shaft drive, which negatively influences the power consumption for its own rotation. It reflects the demands of the new European legislation being prepared in this regard.

Characteristics:
- Compact construction unit for direct drive of the nut
- Possibility of nut preload
- Standard geometric and working accuracy according to **ISO3408** and **DIN 69051**

Technical parameters:
- Diameters from **50** to **80 mm**
- Recommended pitch from **20** to **32 mm**
- Precision class from **IT1** to **IT5**
- **D_o×n** = **100,000**, efficiency **95–97%** (according to the thread pitch and lubricant)
- Minimum strength of the shaft material **R_m = 650MPa**, functional surfaces of the shaft and nut hardened to **58–60HRC**
- Working temperature **-20** to **+60°C**

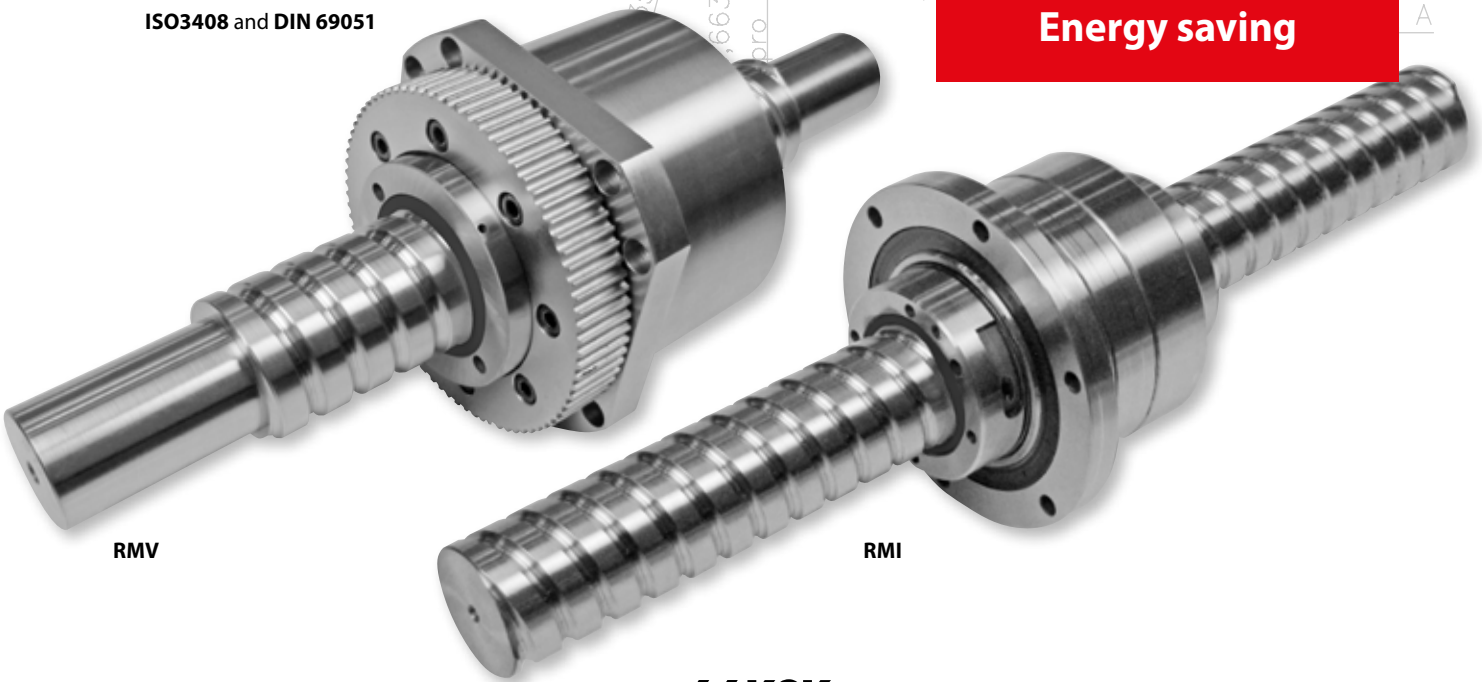
Variants of performance:
- Preloading by the difference between thread leads used in the two-start ball screws allows shortening of the nut
- Use of a single non-preloaded nut also allows shortening of the nut

Application:
- Machine tools
- Transporting mechanisms
- Substitution of racks
- Long actuation assemblies

Example of designation: RMV K50x25 - 4/ (driven nut with inserted bearings for ball screw with diameter 50 mm with pitch 25 mm and 4 working threads), or RMI K50×32 -4/ (driven nut with integrated bearings for ball screw with diameter of 50 mm with pitch 32 mm and 4 working threads).

Technical parameters are specified in Chapter No. 3 – Technical parameter tables (page 29).

Energy saving



RMV **RMI**

2.8. Transport ball screws (TS)

Transport ball screws are used in applications where high accuracy of positioning is not required, such as for example in transporting and lifting devices, wood processing machines, etc.

The screw shaft is produced by rolling or whirling and the shaft ends are machined according to the request of the customer. They are equipped as a standard with an **APE** type of nut, which is a single non-preloaded nut with flange. These ball screws are produced in the **T5** and **T7** precision classes. Their main advantage is a lower price.

Characteristics:

- Productive and quick production of the screw shaft up to the length of **6,2 m**
- Non-preloaded nut with backlash **0.015–0.05 mm** (depending on the ball screw size)
- Standard geometric and working accuracy according to **ISO3408** and **DIN69051** for transport ball screws

Technical parameters:

- Diameters from **12** to **63 mm** – rolled, from **32** to **100 mm** – whirled
- Recommended pitch up to **10 mm** – rolled and up to **30 mm** – whirled
- Precision class **T5**, **T7**
- **D_o×n = 80,000**, efficiency **93–95 %** (according to thread pitch and lubricant)
- Minimum strength of the shaft material **R_m = 650MPa**, functional surfaces of the shaft and nut hardened to **58-60HRC**
- Working temperature **-20** to **+60°C**

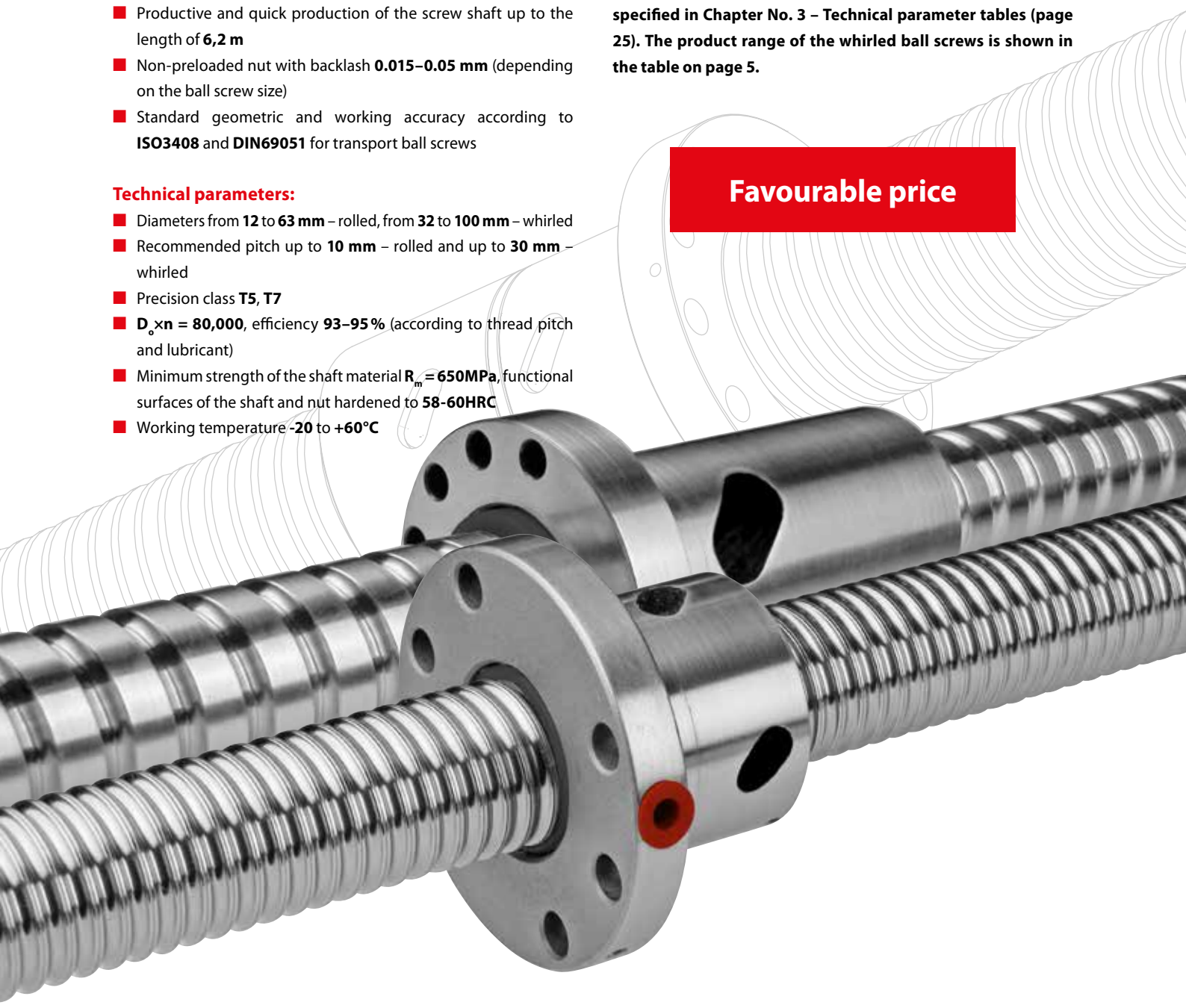
Application:

- Transporting mechanisms
- Wood processing machines
- Substitution of racks
- Long actuation assemblies

Example of designation: K63x10 - 4/APE TS (ball screws with diameter 63 mm and pitch 10 mm, 4 working threads of the APE single nut with flange, transport design, the standard type 3 of the flange is not pointed out).

Technical parameters of the ball screws with rolled shaft are specified in Chapter No. 3 – Technical parameter tables (page 25). The product range of the whirled ball screws is shown in the table on page 5.

Favourable price



2.9. Trapezoidal screws (Tr)

Trapezoidal screws (hereinafter also **Tr** screws) with metric trapezoidal thread (according to **ČSN 014050**) are standard structural components used as self-locking transition of the rotary motion to linear motion with low efficiency, given by the principle of their construction, by the lubrication and by the material of the friction thread surfaces. These lead screws bear only axial load and relevant torque whereas backlash between the screw and the nut should be decreased by special construction.

Trapezoidal screws are supplied as a complex assembly with matched nut or nuts according to the request of the customer. Their material, application, lubrication and adjustment of backlash, which occurs during the operation, are determined by the custom practice of the particular customers and it is not solved by the manufacturer, which provides only consulting and advisory services.

We offer a wide range of trapezoidal screws with metric thread:

- Diameters from **16 mm** to **120 mm**
- Thread pitch from **4 mm** to **14 mm**
- Maximum thread length **12 m** (according to diameter and precision class)

The range is enlarged by the offer of non-standard connecting dimensions of nuts. Both nuts and screws can be manufactured according to the requirements of the customer. The profile of the thread is produced in compliance with the standards **ISO 2901-77**, **ISO 2902-77**, **ISO 2903-77** and **ISO 2904-77** or with the corresponding **ČSN 01 4050**.

Shafts are usually made from steel grade **14260** and **CF53**. The standard performance of the shaft is without heat treatment.

The nuts can be made from cast iron with grade **422425**, from tin bronze **Cu – Sn12**, or from plated steel (steel shell, plated with bronze **Cu – Sn12**). Technical consultation and delivery of the plated steel material is needed in the case of plated nut design.

Self-locking

Precision classes:

Thread shafts and nuts are manufactured in three precision classes:

- **1 – fine** – ground profile of the shaft thread (used in thread grinding machines, CNC boring machines and other machines with higher accuracy),
- **2 – intermediate** (used in cutting machines, lathes, milling machines, horizontal boring machines),
- **3 – rough** (used in machine tools without any special requests regarding accuracy).

The precision of the thread is determined by:

- the system of thread tolerances,
- deviation of thread pitch,
- accuracy of shape and position of the thread,
- thread surface roughness.

Basic characteristics of Tr screws:

- Maximum peripheral speed in the thread is **v = 80m/min** for nuts from **CuSn8**, **CuSn12**. It is specified as the ratio between the speed factor (usually p_v = **400**) and the allowed specific pressure in the thread (usually $p_{allowed}$ = **5N/mm²**).
- Maximum rpm n of the **Tr** screw with nominal diameter **d** are:

$$n = \frac{(v \times 1000)}{(d \times \pi)} \text{ ot./min}$$

- Maximum travel speed s for the pitch **P** in mm is:

$$s = \frac{(n \times P)}{1000} \text{ m/min}$$

- The pressure **p** in the **Tr** thread can be calculated as follows:

$$p = \frac{F}{(0{,}75 \times \pi\, d_s \times (d\text{-}d_s) \times H/P)} \text{ N/mm}^2$$

where **F** is axial force in [**N**], d_s is the mean diameter of the thread, **d** is the nominal diameter of the thread, **H** is the thread length in the nut and **P** is thread pitch, all values in [**mm**]. The allowed pressure is as stated above ($p_{allowed}$ = **5N/mm²**).

Technical parameters are specified in Chapter No. 3 – Technical parameter tables (page 30).

2.10. Other products

Linear actuators

The linear actuator provides drive controlled linear motion within the range of the working stroke, thus replacing hydraulic cylinders. It converts the rotary motion into linear actuation by the use of a ball screw with minimum transition efficiency **95%**, stroke range **150–600 mm** upon axial load from **12.5** to **25kN**.

The actuation speed can be regulated or set by a suitable selection of the pitch of the used ball screw in relation to the used electric motor.

Guide rods

Guide rods are structural components suitable for accurate and highly efficient linear guidance of the moving parts of various mechanisms. They are produced from hardened, ground and straightened circular cross section shafts and can be mounted in clamping bars, sockets and other clamping elements. The guide rods are supplied with a relevant rolling guide according to the required operation load and type of the guide rod. Guide rods that have been properly designed, calculated and applied do not require any special supervision or maintenance. However, they should be protected against dust, water and aggressive environments.
In combination with ball screws and suitable drives they constitute basic construction motion units used in various machines and equipment.
Guide rods are usually produced from steel grades **CF53** or **42CrMo4** and afterwards are induction heat treated to **58 - 60HRC.**

Assembly

Before the start of operation the conservation oil layer should be removed and the guide rods should be cleaned properly. The guide rods are usually implemented with linear bushings. They should be accurately aligned in parallel with the direction of motion of the linear bearings with precision **0.02 mm/1,000 mm**. In the event of any warranty repair the guide rods should be sent to the producer as a complete rolling guide assembly.

Lubrication

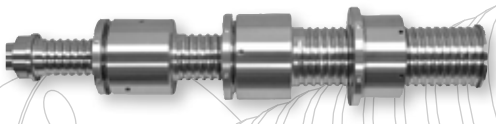
For the lubrication of the guide rods, suitable lubricants include those used for ball bearings as well as relevant plastic lubricants which are applied once on basis of the recommendation of manufacturers of rolling guides.

Technical parameters are specified in Chapter No. 3 – Technical parameter tables (page 31).

Telescopic ball screws

It is a complex assembly of several ball screws screwed in one. Each nut has the additional function of a bearing for the fixation of the next shaft from the assembly of ball screws. The unique construction with mutual bonds of the individual components secures simultaneous turning and actuation of all ball screws at once. In such a way multiplication of the stroke per one revolution of the drive is achieved. The telescopic ball screw replaces hydraulic cylinders, with the advantage of easy control and positioning.

The telescopic ball screw takes advantage of the basic properties of the ball screws, in which the highly efficient rolling of balls in the thread profiles of the screw and the nut is used for the transition of the rotary motion into linear.

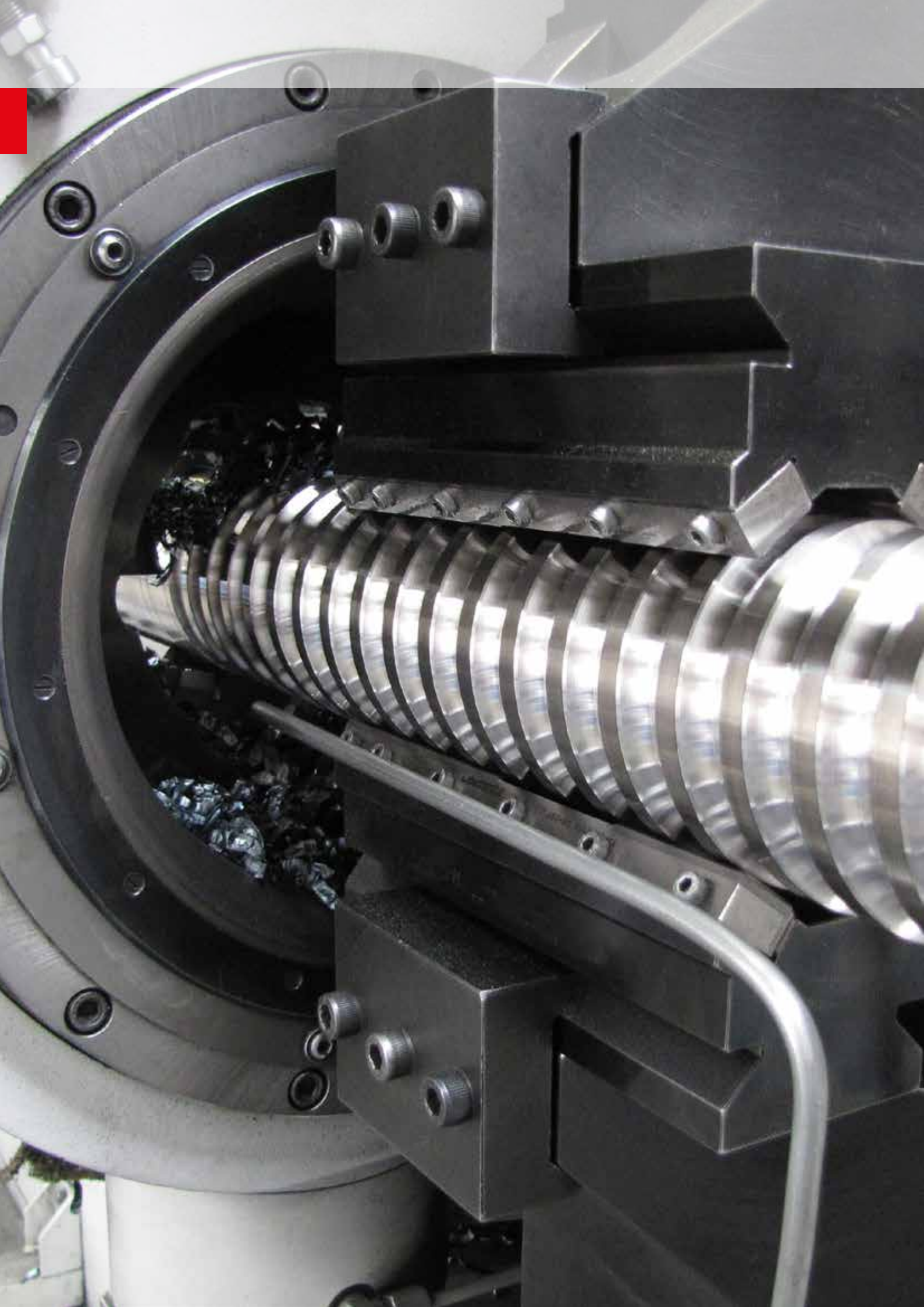


Telescopic ball screws are appreciated for their compact length in comparison with the achieved total actuation. This property can be used at places where it is necessary to solve actuation without the possibility to apply through and long lifting mechanisms, such as for example in the case of various handling platforms. The telescopic ball screw can be used in machine tools with unconventional kinematic structure (hexapods).

Threadless ball screws

The threadless ball screw is designed mainly for handling mechanisms of manipulators and transporting devices, which require effective transition of the rotary motion to linear without the preference of high rigidity and load capacity, but with the requirement for simplicity, easy maintenance and easy production.

Screw thread is produced only in the nut and the transition of the load is provided only through the balls in the nut and the smooth cylindrical surface of the shaft. The principle is based on the elastic deformation of the surface of the hardened and ground shaft caused during the rolling of the preloaded balls guided in the inner screw thread of the nut. In this application it is possible to use the slippage of the nut on the shaft after exceeding certain axial force as a safety element. The nut continues in its motion in the original direction after the decrease of the load, or the current increase causes drive disconnection.



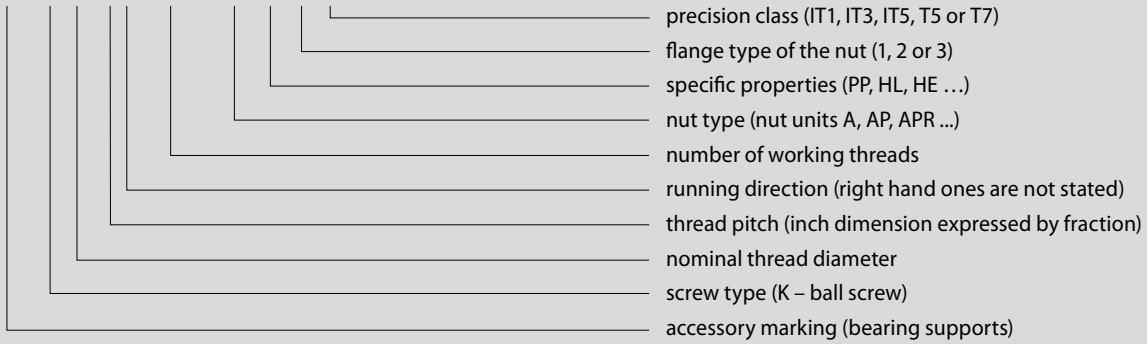
3.1. Description and meaning of used symbols

The individual types of the ball screw nut design are specified in the Technical parameter tables by the following parameters

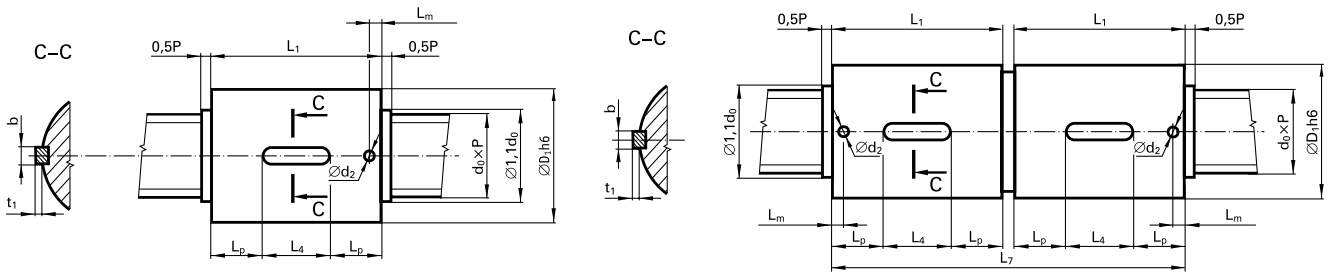
parameter	description
d_o	**nominal diameter** the diameter of the cylinder containing the centres of the balls which are in contact with the screw shaft and the ball nut body at the theoretical contact points
P	**pitch** the axial distance between threads
i	**number of working threads (loaded turns)** number of threads in the nut under load
D_w	**ball diameter** diameter of balls in the nut unit
L, D, t, ...	**dimension values** nominal length and diameter dimensions for nut units
C_o	**basic static load rating** the static centric axial load that corresponds to a total permanent deformation of the ball and ball track at the most heavily stressed point of contact between the ball and the ball track of 0.0001 times the ball diameter
C_a	**basic dynamic axial load rating** the constant centric axial load that a ball screw can theoretically endure for a basic rating life of one million revolutions
k	**rigidity factor** the rigidity level of the ball transmission between the shaft and the nut which is determined by the geometric shape of the thread groove and the material parameters
R	**axial rigidity** the rate of elastic deformation of the nut against the shaft at given load
E	**external type of recirculation** external recirculation of the balls by the means of shims via several working threads
I	**internal type of recirculation** internal recirculation of the balls by means of deflectors, which are separate for each working thread in the nut. Dimensions of nuts with this type of recirculation comply with DIN 69051.
S	**segment type of recirculation** internal recirculation of the balls by means of segments which lead and return the balls through an axial hole in the nut. Dimensions of nuts with this type of recirculation comply with DIN 69051.

3.2. Designation of ball screws

xyz **K 50×10L – 4+4 /AP+A PP/2 IT1**



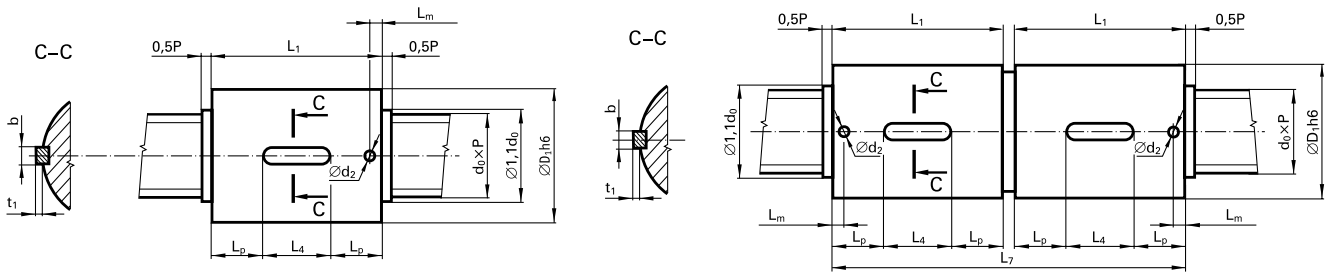
3.3. Nut types A, A+A



Application: Chapters 2.2., 2.5., 2.6., 2.8.

K d_o×P	i	D_w	D_1	L_1±1 (A)	L_4	b	t_1	d_2	L_m	L_p	L_7±2 (A+A)	assy. arbor	C_o	C_a	k	R	recirc. type
-	-	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm$^{3/2}$	N/µm	-
K 12×3	2 3	2,000	22	18 21	10 12	5	1,3	2	4,5	6 6,5	36 42	9,7	4 940 7 410	2 840 4 020	61 92	215 282	E
K 12×4	2 3	2,500	24	23 27	12	5	1,3	2	5	7 7,5	47 55	9,2	6 630 9 950	3 910 5 540	53 79	220 310	E
K 12×5	2	2,500	24	25	12	5	1,3	2	5,5	7,5	50	9,2	6 610	3 900	53	220	E
K 16×3	3 4	2,000	27	21 24	12	5	1,3	2	4,5	6,5	42 48	13,7	10 840 14 500	4 980 6 400	126 168	424 545	E
K 16×4	3 4	2,500	29	27 31	16	5	1,3	3	5	7,5	55 63	13,2	14 100 18 800	6 880 8 800	110 147	422 548	E
K 16×5	2 3	3,175	32	27 32	16	5	1,3	3	5,5	8	57 67	12,5	10 990 16 500	6 150 8 700	63 95	284 418	E
K 20×3	3 4	2,000	36	21 24	12	5	1,3	2	4,5	6,5	42 48	18,1	13 810 18 420	5 600 7 165	161 214	497 674	E
K 20×4	3 4	2,500	36	27 31	16	5	1,3	3	5	7,5	55 63	17,6	18 260 24 350	7 910 10 130	141 188	522 696	E
K 20×5	3 4	3,500	36	35,1 40,6	20	5	1,3	3	5,5	8 10	73,4 85,6	17,2	24 860 33 150	11 920 15 260	115 153	518 695	I
K 25×3	3 4	2,000	40	21 24	12	5	1,3	2	4,5	6,5	42 48	22,7	17 760 23 686	6 270 8 034	204 272	619 825	E
K 25×4	3 4	2,500	40	27 31	16	5	1,3	3	5	7,5	55 63	22,2	23 260 31 018	8 890 11 380	180 239	639 844	E
K 25×5 (R/L)	3 4	3,500	40	35,1 40,6	20	5	1,3	3	5,5	8 10	73,4 85,6	22,0	31 550 42 070	13 600 17 500	148 197	646 855	I
K 25×6	3 4	3,969	44	37 43	18	5	1,3	3	6,5	9,5 12,5	79 91	20,7	34 720 46 290	15 690 20 100	137 182	644 858	E
K 25x8	2 3	5,000	47	38 46	25	6	1,9	3	6,5	6,5 10,5	78 94	19,6	27 240 40 860	13 900 19 700	79 118	424 620	E
K 25×10	3	3,500	40	60	20	5	1,3	3	6,5	20	118	22,0	31 360	13 500	146	643	I
K 32×5	3 4 6	3,500	50	35,1 40,6 51	18	6	1,9	4	5 5,5 5,5	8 11 16,5	73,4 85,6 106	29,2	41 540 55 390 83 080	15 650 20 050 28 400	193 257 386	822 1 082 1 590	I
K 32×6	3 4	3,969	52	37 43	18	8	2,5	3	6,5	10 12,5	79 91	27,6	47 670 63 560	18 700 23 900	179 239	831 1 093	E
K 32×8	3 4	5,000	56	46 54	25	8	2,5	4	-	-	94 110	26,5	57 700 76 950	24 420 31 300	156 208	827 1 088	E
K 32×10	3 4	6,350	50	61,7 72,5	40	8	2,5	4	7	11 16	129 152,5	26,2	65 960 87 940	30 330 38 900	134 179	804 1 057	I
K 32×12	3 4	6,350	50	67 80	40	8	2,5	4	7	13,5 20	137 164	25,6	65 820 87 750	30 250 38 740	134 178	800 1 050	I
K 40×5 (R/L)	4 6	3,500	63	40,6 51	20	8	2,5	4	5,5	10 15,5	85,6 106	36,9	70 900 106 370	22 500 31 850	327 490	1 318 1 900	I
K 40×8	3 4 6	5,000	63	51,3 60 76,7	20 40 40	8	2,5	4	7	15,5 11 18	104,6 124,08 156,7	34,5	74 730 99 600 149 500	28 070 35 950 50 950	200 266 399	1 020 1 340 1 970	I
K 40×10 (R/L)	3 4 6	6,350	63	62,3 73,1 93,9	40	8	2,5	4	7,5	11 16,5 27	129 153,1 193,9	33,1	87 800 117 050 175 600	36 180 46 300 65 650	173 230 345	1 010 1 330 1 950	I
K 40×12	3 4	7,938	76	70 82	40	8	2,5	4	8,5	15 21	142 166	31,5	102 800 137 050	45 230 57 900	150 200	990 1 300	E
K 40×15	2 3 4	7,144	70	68,1 85,6 101,6	40	8	2,5	4	9	14 23 29	143,1 180,6 204	33,6	65 760 98 640 131 520	29 500 41 760 53 500	106 160 213	683 1 005 1 320	I

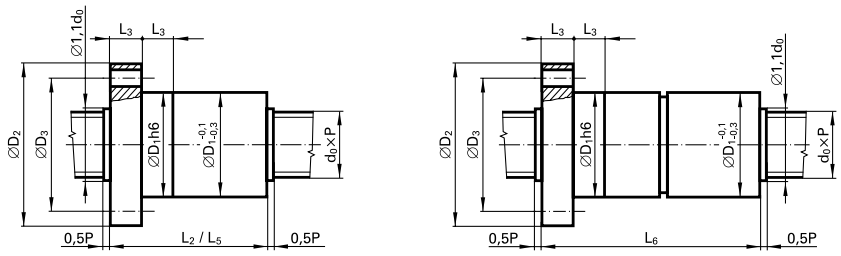
Nut types A, A+A



Application: Chapters 2.2., 2.5., 2.6., 2.8.

K d_0×P	i	D_w	D_1	L_1±1 (A)	L_4	b	t_1	d_2	L_m	L_p	L_7±2 (A+A)	assy. arbor	C_o	C_a	k	R	recirc. type
-	-	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm$^{3/2}$	N/µm	-
K 50×5	4 6	3,500	75	40,6 51	20	8	2,5	4	5,5	10 15,5	85,6 106	47,3	90 870 136 310	25 060 35 520	413 620	1 590 2 350	I
K 50×8	3 4 6	5,000	75	53,3 62 78,7	20 40 40	8	2,5	4	7	16,5 11 19,5	112 126 161,4	44,5	95 200 126 940 190 410	31 500 40 400 57 250	254 339 508	1 240 1 640 2 410	I
K 50×10	3 4 6	6,350	75	62,3 73,1 93,9	40	8	2,5	4	7,5	11 16,5 27	129 153,1 193,9	43,1	115 185 153 580 230 370	42 000 53 780 76 220	221 295 442	1 250 1 640 2 420	I
K 50×12	3 4	7,938	90	70 82	40	10	2,9	4	9	15 21	142 166	41,5	136 820 182 440	53 950 69 100	193 258	1 240 1 630	E
K 50×15	3 4	7,938	75	86,7 105,5	40	8	2,5	4	10	23,5 33	176,7 218	41,5	136 600 182 140	53 830 68 940	193 257	1 240 1 630	I
K 50×20	3 4	7,938	75	99,2 124,2	40	8	2,5	4	10	29,5 42	204,2 254,2	42,1	136 120 181 500	53 570 68 600	192 256	1 230 1 620	I
K 63×8	3 4	5,000	95	46 54	25	10	2,9	4	7,5	11,5 14,5	94 110	57,5	122 500 163 300	35 300 45 215	325 433	1 520 2 000	E
K 63×10	3 4 6	6,350	90	73,1 85,5 93,9	40	10	2,9	5	7,5	16,5 22,7 27	153,1 165 194	56,1	153 500 204 650 306 980	48 570 62 200 88 150	284 378 568	1 550 2 000 3 000	I
K 63×12	4 6	7,938	90	88 113	40	10	2,9	5	9	24 36,5	184 233	54,4	239 400 359 120	80 100 113 500	332 499	2 040 2 990	I
K 63×16	4 6	7,938	90	114 147,3	40	10	2,9	5	11,5	37 53,5	234 302	54,4	249 940 374 900	82 350 116 700	332 498	2 050 3 020	I
K 63×20	3 4	10,319	95	121,7 143,4	40	12	3,5	5	15	40,5 51,5	238,5 293,4	53,0	230 680 307 580	86 560 110 860	212 283	1 540 2 040	I
K 80×10	4 6	7,144	105	72,5 93,9	40	12	3,5	5	9	16 26,5	152,5 193,9	72,0	301 500 452 250	82 990 117 600	457 685	2 540 3 740	I
K 80×12 (R/L)	3 4 6	7,938	110	76 89 114	40	12	3,5	5	9	18 24,5 37	156 185 234	71,4	239 300 319 070 478 600	72 200 92 450 131 030	323 430 645	1 920 2 530 3 700	I
K 80×1/2"	3 4 6	7,938	110	78,3 92 118,5	40	12	3,5	5	9	19 26 39	163 187,2 241,3	71,4	239 270 319 020 478 540	72 170 92 430 131 000	323 430 645	1 920 2 530 3 730	I
K 80×16	3 4 6	7,938	130	92 108 164	50	12	3,5	5	12	21 29 18,5	188 220 332	71,4	239 100 318 790 478 180	72 100 92 330 130 850	322 430 645	1 920 2 530 3 720	I
K 80×20	3 4 6	12,700	125	121,7 143,4 195	70	14	3,5	5	14	25,5 36,5 62,5	248,3 293,4 355	66,6	345 940 461 250 691 900	124 430 159 360 225 800	244 326 488	1 920 2 520 3 250	I
K 80×24	3 4	10,319	150	141 165	80	14	4,5	5	16	30,5 42,5	285 333	70,0	302 820 403 760	100 400 128 580	276 368	1 930 2 550	I
K 100×10	6	7,144	125	93,9	50	14	4,5	5	8,5	22	194	92,0	565 820	129 090	867	4 520	I
K 100×12	3 4	7,938	150	70 82	40	14	4,5	5	10,5	15 21	142 166	91,3	307 740 410 320	80 930 103 650	409 545	2 340 3 080	E
K 100×16	3 4	7,938	150	92 108	50	14	4,5	5	12	21 29	188 220	91,2	307 560 410 090	80 860 103 560	409 545	2 340 3 080	I
K 100×20	4 6	12,700	150	145 186,7	80	14	4,5	5	14	32,5 53	295 380	86,5	605 100 907 650	184 980 262 155	417 625	3 120 4 600	I
K 100×24	3 4	12,700	176	141 165	80	14	4,5	5	16	30,5 42,5	285 333	88,1	453 420 604 560	144 250 184 740	312 416	2 370 3 120	I
K 125×20	4 6	12,700	185	135 205	80	16	4,5	5	14	27,5 23	275 425	111,5	778 250 1167380	209 300 296 620	531 796	3 820 5 600	I

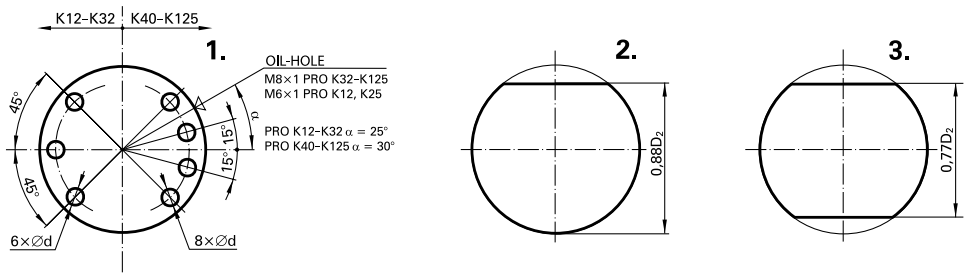
Nut types AP, AP+A, APR



Application: Chapters 2.2., 2.5., 2.6., 2.8.

K d$_o$×P	i	D$_w$	D$_1$	D$_2$	D$_3$	L$_2$±1 (AP)	L$_3$	d	L$_6$±2 (AP+A)	L$_5$±1 (APR)	assy. arbor	C$_o$	C$_a$	k	R	recirc. type
-	-	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm$^{3/2}$	N/µm	-
K 12×3	2 3	2,000	22	37	29	27 30	10	4,5	47 53	-	9,7	4 940 7 410	2 840 4 020	61 92	215 282	E
K 12×4	2 3	2,500	24	39	31	32 36	10	4,5	56 64	-	9,2	6 630 9 950	3 910 5 540	53 79	220 310	E
K 12×5	2	2,500	24	39	31	34	10	4,5	59	-	9,2	6 610	3 900	53	220	E
K 16×3	3 4	2,000	27	46	36	30 33	10	6,4	53 58	-	13,7	10 840 14 500	4 980 6 400	126 168	424 545	E
K 16×4	3 4	2,500	29	49	39	36 40	10	6,4	64 72	-	13,2	14 100 18 800	6 880 8 800	110 147	422 548	E
K 16×5	2 3	3,175	32	58	45	37 42	10	6,4	64 74	-	12,5	10 990 16 500	6 150 8 700	63 95	284 418	E
K 20×3	3 4	2,000	36	58	47	30 33	10	6,4	55 59	-	18,1	13 810 18 420	5 600 7 165	161 214	497 674	E
K 20×4	3 4	2,500	36	58	47	36 40	10	6,4	64 72	-	17,6	18 260 24 350	7 910 10130	141 188	522 696	E
K 20×5	3 4	3,500	36	58	47	42 46	10	6,4	81 90	-	17,2	24 860 33 150	11 920 15 260	115 153	518 695	I
K 25×3	3 4	2,000	40	62	51	32 35	12	6,4	57 62	-	22,7	17 760 23 686	6 270 8 034	204 272	619 825	E
K 25×4	3 4	2,500	40	62	51	38 42	12	6,4	66 74	-	22,2	23 260 31 018	8 890 11 380	180 239	639 844	E
K 25×5 (R/L)	3 4	3,500	40	62	51	44 50	12	6,4	83 95	63 -	22,0	31 550 42 070	13 600 17 500	148 197	646 855	I
K 25×6	3 4	3,969	44	67	55	49 55	12	6,4	91 103	-	20,7	34 720 46 290	15 690 20 100	137 182	644 858	E
K 25×8	2 3	5,000	47	71	59	50 58	12	6,4	90 106	-	19,6	27 240 40 860	13 900 19 700	79 118	424 620	E
K 25×10	3	3,500	40	62	51	63	12	6,4	122	-	22,0	31 360	13 500	146	643	I
K 32×5	3 4 6	3,500	50	80	65	44 50 60	12	8,4	83 94 114	63 75 -	29,2	41 540 55 390 83 080	15 650 20 050 28 400	193 257 386	822 1 082 1 590	I
K 32×6	3 4	3,969	52	76	64	49 55	12	8,4	91 103	-	27,6	47 670 63 560	18 700 23 900	179 239	831 1 093	E
K 32×8	3 4	5,000	56	85	71	58 66	12	8,4	106 122	-	26,5	57 700 76 950	24 420 31 300	156 208	827 1 088	E
K 32×10	3 4	6,350	50	80	65	69 80	12	8,4	138 157	108 -	26,2	65 960 87 940	30 330 38 900	134 179	804 1 057	I
K 32×12	3 4	6,350	50	80	65	74 87	12	8,4	144 171	-	25,6	65 820 87 750	30 250 38 740	134 178	800 1 050	I
K 40×5 (R/L)	4 6	3,500	63	93	78	52 62	14	8,4	96 116	82 89	36,9	70 900 106 370	22 500 31 850	327 490	1 318 1 900	I
K 40×8	3 4 6	5,000	63	93	78	60 69 86	14	8,4	115 133 167	- - -	34,5	74 730 99 600 149 500	28 070 35 950 50 950	200 266 399	1 020 1 340 1 970	I
K 40×10 (R/L)	3 4 6	6,350	63	93	78	72 83 102	14	8,4	141 161 200	111 134	33,1	87 800 117 050 175 600	36 180 46 300 65 650	173 230 345	1 010 1 330 1 950	I
K 40×12	3 4	7,938	76	110	92	84 96	14	8,4	156 180	-	31,5	102 800 137 050	45 230 57 900	150 200	990 1 300	E
K 40×15	2 3 4	7,144	70	100	85	74 95 112	14	8,4	146 190 210	- - -	33,6	65 760 98 640 131 520	29 500 41 760 53 500	106 160 213	683 1 005 1 320	I

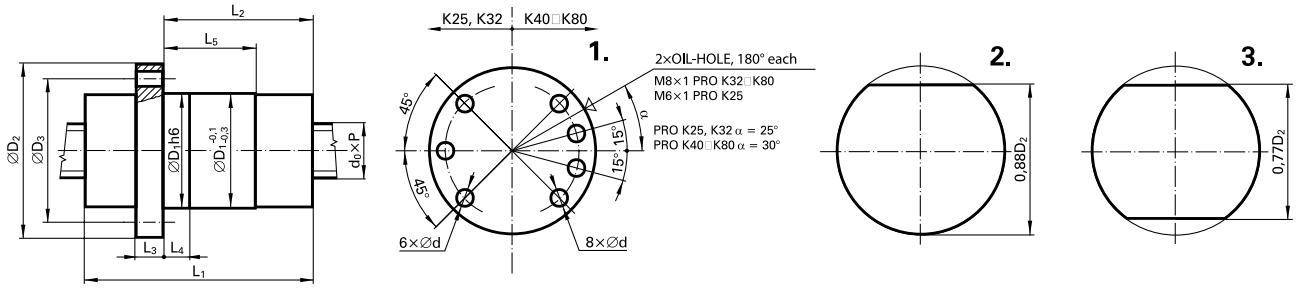
Nut types AP, AP+A, APR



Application: Chapters 2.2., 2.5., 2.6., 2.8.

K d_o×P	i	D_w	D_1	D_2	D_3	L_2±1 (AP)	L_3	d	L_6±2 (AP+A)	L_5±1 (APR)	assy. arbor	C_o	C_a	k	R	recirc. type
-	-	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm$^{3/2}$	N/µm	-
K 50×5	4	3,500	75	110	93	54	16	10,5	98	80	47,3	90 870	25 060	413	1 590	I
	6					64			118	102		136 310	35 520	620	2 350	
K 50×8	3	5,000	75	110	93	62	16	10,5	121	-	44,5	95 200	31 500	254	1 240	I
	4					71			137			126 940	40 400	339	1 640	
	6					91			174			190 410	57 250	508	2 410	
K 50×10	3	6,350	75	110	93	74	16	10,5	142	113	43,1	115 185	42 000	221	1 250	I
	4					85			163	140		153 580	53 780	295	1 640	
	6					106			204	-		230 370	76 220	442	2 420	
K 50×12	3	7,938	89	132	110	86	16	10,5	158	-	41,5	136 820	53 950	193	1 240	E
	4					98			182			182 440	69 100	258	1 630	
K 50×15	3	7,938	75	110	93	98	16	10,5	188	-	41,5	136 600	53 830	193	1 240	I
	4					113			222			182 140	68 940	257	1 630	
K 50×20	3	7,938	75	110	93	110	16	10,5	215	195	42,1	136 120	53 570	192	1 230	I
	4					135			265	-		181 500	68 600	256	1 620	
K 63×8	3	5,000	95	137	115	64	18	10,5	112	-	57,5	122 500	35 300	325	1 520	E
	4					72			128			163 300	45 215	433	2 000	
K 63×10	3	6,350	90	125	108	-	18	10,5	-	115	56,1	153 500	48 570	284	1 550	I
	4					89			167	138		204 650	62 200	378	2 000	
	6					110			209	-		306 980	88 150	568	3 000	
K 63×12	4	7,938	90	125	108	97	18	10,5	192	-	54,4	239 400	80 100	332	2 040	I
	6					124			242			359 120	113 500	499	2 990	
K 63×16	4	7,938	90	125	108	125	20	10,5	245	-	54,4	249 940	82 350	332	2 050	I
	6					159			311			374 900	116 700	498	3 020	
K 63×20	3	10,319	95	135	115	129	20	13	240	200	53,0	230 680	86 560	212	1 540	I
	4					150			285	-		307 580	110 860	283	2 040	
K 80×10	4	7,144	105	145	125	87	20	13	169	-	72,0	301 500	82 990	457	2 540	I
	6					112			210			452 250	117 600	685	3 740	
K 80×12 (R/L)	3	7,938	110	150	130	90	20	13	172	-	71,4	239 300	72 200	323	1 920	I
	4					100			194			319 070	92 450	430	2 530	
	6					128			247			478 600	131 030	645	3 700	
K 80×1/2"	3	7,938	110	150	130	94	20	13	176	-	71,4	239 270	72 170	323	1 920	I
	4					108			203			319 020	92 430	430	2 530	
	6					134			257			478 540	131 000	645	3 730	
K 80×16	3	7,938	126	172	148	112	20	13	208	-	71,4	239 100	72 100	322	1 920	I
	4					128			240			318 790	92 330	430	2 530	
	6					184			352			478 180	130 850	645	3 720	
K 80×20	3	12,700	125	165	145	138	25	13	265	-	66,6	345 940	124 430	244	1 920	I
	4					160			315			461 250	159 360	326	2 520	
	6					200			397			691 900	225 800	488	3 250	
K 80×24	3	10,319	150	210	178	166	25	13	310	-	70,0	302 820	100 400	276	1 930	I
	4					190			358			403 760	128 580	368	2 550	
K 100×10	6	7,144	125	165	145	114	22	13	213	-	92,0	565 820	129 090	867	4 520	I
K 100×12	3	7,938	150	210	178	95	25	13	167	-	91,3	307 740	80 930	409	2 340	E
	4					107			191			410 320	103 650	545	3 080	
K 100×16	3	7,938	150	210	178	117	25	13	213	-	91,2	307 560	80 860	409	2 340	I
	4					133			245			410 090	103 560	545	3 080	
K 100×20	4	12,700	150	202	176	167	30	17	322	-	86,5	605 100	184 980	417	3 120	I
	6					205			402			907 650	262 155	625	4 600	
K 100×24	3	12,700	176	237	199	171	30	17	315	-	88,1	453 420	144 250	312	2 370	I
	4					195			363			604 560	184 740	416	3 120	
K 125×20	4	12,700	185	238	212	165	30	17	305	-	111,5	778 250	209 300	531	3 820	I
	6					235			400			1167 380	296 620	796	5 600	

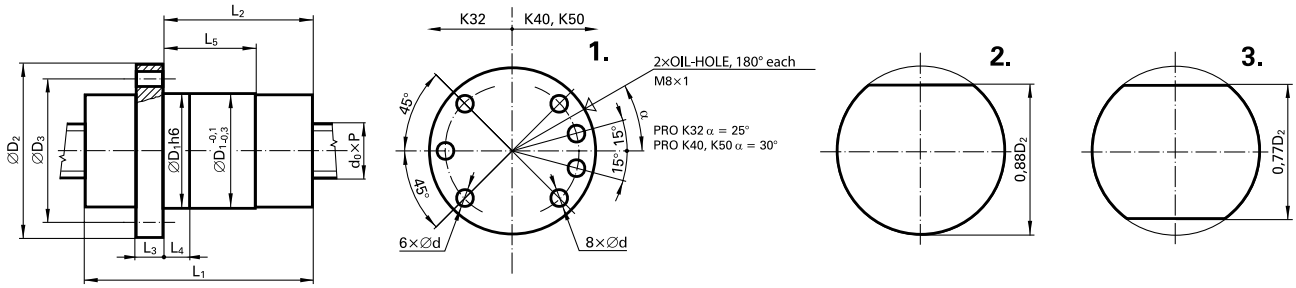
Nut type APVR



Application: Chapter 2.4.

K d_0×P	i	D_w	D_1	D_2	D_3	d	L_1±2 (APVR)	L_2	L_3	L_4	L_5	assy. arbor	C_o	C_a	k	R (for Fv=0,1Ca)
-	-	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm$^{3/2}$	N/µm
K 16×16	1,5	2,500	28	49	39	6,4	46	24	10	12	12	13,2	7 860	3 950	57	231
K 20×20	1,5	3,500	36	58	47	6,4	56	30	10	14	14	16,3	13 370	6 690	60	286
K 25×15	2,2	3,969	45	70	58	6,4	61	33	10	15	15	21,1	29 510	13 110	109	529
K 25×20	1,4	3,969	45	70	58	6,4	55	27	10	9	9		18 530	8 730	68	337
K 25×25	1,5	3,969	45	70	58	6,4	66	37	10	18	18		19 520	9 050	71	351
K 32×20	2,4	3,969	56	85	71	8,4	79	47	12	12	27	28	40730	15 890	152	704
K 32×25	2,5	3,969	56	85	71	8,4	93	61	12	12	41		43 660	16 640	156	727
K 32×32	1,5	3,969	56	85	71	8,4	80	48	12	12	28		25 720	10 440	91	435
K 40×20	4,1	6,350	70	100	85	8,4	122	83	14	14	58	34,2	139 860	52 070	259	1 490
K 40×25	3,3	6,350	70	100	85	8,4	119	80	14	14	55	34,2	111 790	42 790	206	1 200
K 40×32	2,4	6,350	70	100	85	8,4	113	74	14	14	49	34,2	80 335	32 010	147	871
K 40×40	1,5	6,350	70	100	85	8,4	95	56	14	14	31	33,1	49 370	20 874	90	543
K 50×32	3,3	7,144	85	120	103	10,5	153	110	16	16	77	43,1	159 295	56 560	243	1 460
K 50×40	2,4	7,144	85	120	103	10,5	143	97	16	16	67	43,1	114 570	42 340	174	1 060
K 50×50	2,1	7,144	85	120	103	10,5	141	100	16	16	75	42,3	103 060	37 960	148	926
K 63×32	3,3	7,938	100	145	125	13	155	106	18	18	75	55,2	221 980	72 760	293	1 810
K 63×40	2,4	7,938	100	145	125	13	145	96	18	18	65		160 290	54 760	211	1 320
K 80×32	4,2	10,319	125	165	145	13	190	127	25	25	89	70	355 670	99 760	477	2 780
K 80×40	3,3	10,319	125	165	145	13	188	125	25	25	87		360 500	114 160	327	2 260

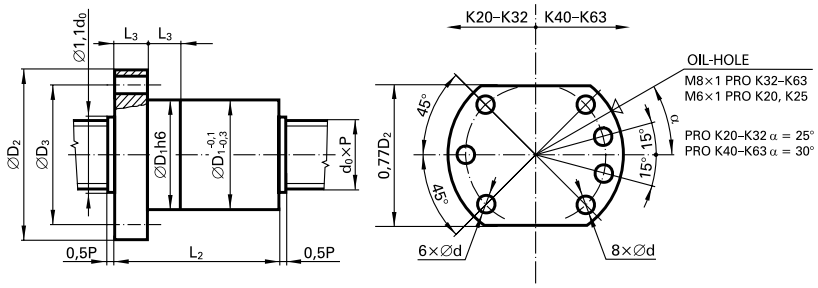
Nut type APQR



Application: Chapter 2.4.

K d_0×P	i	D_w	D_1	D_2	D_3	d	L_1±2 (APQR)	L_2	L_3	L_4	L_5	assy. arbor	C_o	C_a	k	R (for Fv=0,1Ca)
-	-	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm$^{3/2}$	N/µm
K 32×32	1,5	3,969	56	85	71	8,4	80	48	12	12	28	28	51 440	18 950	182	840
K 40×40	1,5	6,350	70	100	85	8,4	98	60	14	14	36	33,1	98 740	37 880	179	1 050
K 50×50	2,1	7,144	85	120	103	10,5	141	100	16	16	75	42,3	206 120	68 900	296	1 790

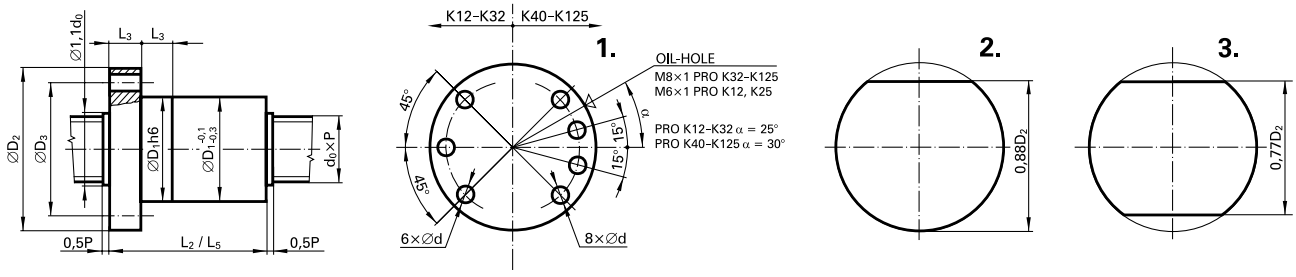
Nut type APE



Application: Chapter 2.8.

K d$_o$×P	i	D$_w$	D$_1$	D$_2$	D$_3$	L$_2$±2 (APE)	L$_3$	d	assy. arbor	C$_o$	C$_a$	k	recirc. type
-	-	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm$^{3/2}$	-
K 12×4	3	2,000	22	37	29	34	10	4,5	9,7	7 390	4 005	92	I
K 16×5	3	3,500	28	49	39	40	10	6,4	12,7	18 280	9 760	89	I
K 20×5	3	3,500	36	58	47	42	10	6,4	16,7	24 860	11 920	115	I
K 25×5	3 4	3,500	40	62	51	44 50	12	6,4	21,7	31 550 42 070	13 620 17 450	148 197	I
K 32×5	4 6	3,500	50	80	65	50 60	12	8,4	28,7	55 390 83 080	20 050 28 420	257 386	I
K 40×5	4 6	3,500	63	93	78	52 62	14	8,4	36,7	70 920 106 370	22 480 31 860	327 490	I
K 40×10	4 6	7,144	63	93	78	83 104	14	8,4	34	132 030 198 050	53 750 76 190	214 321	I
K 50×10	4 6	7,144	75	110	93	85 106	16	10,5	43,8	178 780 268 160	64 260 91 080	275 412	I
K 63×10	4 6	7,144	90	125	108	89 108	18	10,5	56,9	226 220 339 320	72 240 102 370	354 531	I
K 63×20	3 5	7,144	95	135	115	105 145	20	13	56,9	169 020 281 700	56 090 87 030	264 440	S

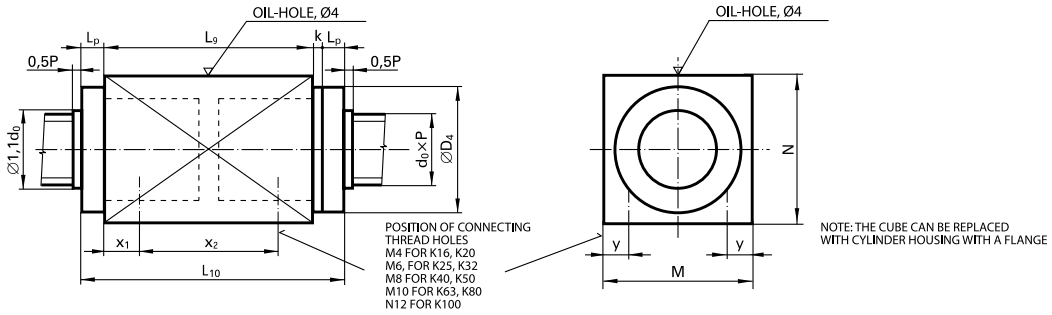
Nut type AP for high-load ball screws



Application: Chapter 2.3.

D$_o$×P	i	D$_w$	D$_1$	D$_2$	D$_3$	L$_2$±2 (AP)	L3	d	assy. arbor	C$_o$	C$_a$	recirc. type
-	-	mm	mm	mm	mm	mm	mm	mm	mm	kN	kN	-
K 63×20	6	15,875	105	145	125	220	25	13	46,2	800	300	I
K 63×24	5	15,875	105	145	125	220	25	13	46,2	670	250	I
K 80×20	7	15,875	125	165	145	230	30	13	63,2	1400	440	I
K 80×24	6	15,875	125	165	145	230	30	13	63,2	1200	390	I
K 100×20	7	15,875	150	202	176	232	32	17	83,2	1850	530	I
K 100×24	6	15,875	150	202	176	232	32	17	83,2	1600	460	I
K 125×20	7	15,875	185	238	212	245	35	17	108,2	2300	600	I
K 125×24	6	15,875	185	238	212	245	35	17	108,2	2000	520	I
K 125×32	5	20,638	185	238	212	245	35	17	106,4	2100	620	I

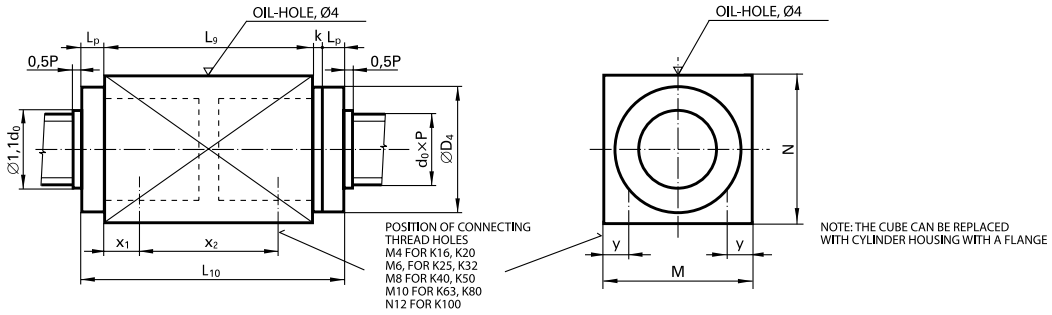
Nut type B+B+K



Application: Chapter 2.2.

K d_o×P	i	D_w	M	N	L_9	L_{10}±2 (B+B+K)	L_p	k	x_1	x_2	y	D_4	C_o	C_a	k	R	recirc. type
-	-	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm³/²	N/µm	-
K 16×3	3 4	2,000	38	36	38 44	52 58	6	3	8	22 28	6	30	10 800 14 500	4980 6380	126 168	423 556	E
K 16×4	3 4	2,500	38	36	50 58	65 73	6	3	10	30 38	5	33	14 100 18 800	6880 8800	110 147	431 566	E
K 20×3	3 4	2,000	42	40	38 44	54 60	7	3	8	22 28	6	34	13 800 18 420	5590 7160	161 214	516 679	E
K 20×4	3 4	2,500	42	40	50 58	67 75	7	3	10	30 38	6	37	18 260 24 350	7910 10130	141 188	532 690	E
K 20×5	3 4	3,175	46	44	62 72	82 92	8	4	12	38 48	6	40	21 950 29 270	10400 13300	122 163	529 695	E
K 25×3	3 4	2,000	48	46	38 44	56 62	8	2	8	22 28	6	42	17 760 23 690	6270 8030	204 272	628 827	E
K 25×4	3 4	2,500	48	46	50 58	69 77	8	3	10	30 38	6	42	23 260 31 020	8890 11380	180 239	649 854	E
K 25×5	3 4	3,500	52	50	63 73	82 92	8	3	12	39 49	7	48	31 550 42070	13620 17450	148 197	656 863	I
K 25×6	3 4	3,969	56	54	74 86	95 107	8	5	12	50 62	6	49	34720 46290	15690 20090	137 182	653 860	E
K 25×8	2 3	5,000	56	54	76 92	94 110	8	2	12	52 68	6	50	27240 40860	13910 19720	79 118	434 639	E
K 25×10	3	3,500	52	50	115	134	8	3	20	75	7	48	31360	13500	146	651	I
K 32×5	3 4 6	3,500	62	60	63 73 108	86 96 131	10	3	12 12 20	39 49 88	6	53	41540 55390 83080	15650 20050 28410	193 257 386	822 1082 1592	I
K 32×6	3 4	3,969	62	60	74 86	99 111	10	5	12	50 62	6	56	47670 63560	18690 23930	179 239	831 1093	E
K 32×8	3 4	5,000	66	64	92 108	114 130	10	2	12	68 84	7	60	57700 76950	24420 31270	156 208	827 1088	E
K 32×10	3 4	6,350	70	68	115 135	138 158	10	3	20 25	75 85	10	60	65960 87940	30330 38840	134 179	804 1057	I
K 40×5	4 6	3,500	80	78	73 108	100 135	12	3	12 20	49 88	10	75	70920 106370	22480 31860	327 490	1318 1940	I
K 40×6(L)	3 4 6	3,969	70	68	74 86 128	103 115 157	12	5	12	50 62 104	9	64	60720 80970 121450	20990 26880 38090	228 304 456	1014 1330 1906	E
K 40×8	3 4 6	5,000	80	78	93 109 164	120 136 191	12	3	20 20 30	53 69 104	10	75	74730 99650 149470	28070 35950 50950	200 266 399	1021 1344 1978	I
K 40×10	3 4 6	6,350	80	78	115 135 170	142 162 197	12	3	20 25 30	75 85 110	10	75	87800 117070 175600	36170 46330 65670	173 230 345	1009 1328 1955	I
K 40×12	3 4	7,938	88	86	140 164	166 190	12	2	12	116 140	9	82	102800 137060	45240 57930	150 200	990 1300	E
K 40×20	2	6,350	88	86	150	178	12	4	14	112	9	82	61400	26180	114	686	E
K 50×5	4 6	3,500	90	88	71 91	98 118	12	3	12 12	47 94	8	85	90880 136310	25060 35520	413 620	1598 2350	I

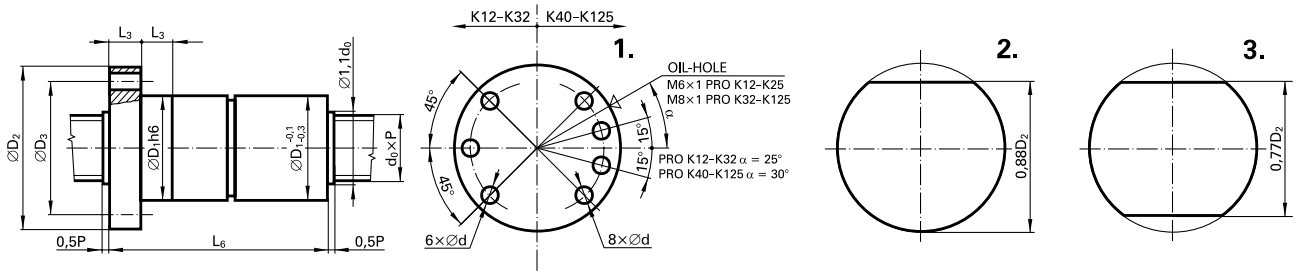
Nut type B+B+K



Application: Chapter 2.2.

K d_o×P	i	D_w	M	N	L_9	L_{10}±2 (B+B+K)	L_p	k	x_1	x_2	y	D_4	C_o	C_a	k	R	recirc. type
-	-	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm$^{3/2}$	N/µm	-
K 50×8	3 4 6	5,000	90	88	93 109 185	120 136 212	12	3	20 20 30	53 69 125	8	85	95 200 126 940 190 410	31540 40390 57250	254 339 508	1247 1640 2414	I
K 50×10	3 4 6	6,350	95	90	115 135 205	142 162 232	12	3	20 25 35	75 85 135	10	85	115 180 153 580 230 370	41990 53780 76220	220 295 442	1250 1645 2421	I
K 50×12	3 4	7,938	105	100	140 164	170 194	14	2	12	116 140	10	95	136820 182430	53950 69100	193 258	1243 1635	E
K 63×8	3 4	5,000	110	105	92 108	122 138	14	2	14	64 80	10	100	122480 163310	35300 45210	325 443	1525 2000	E
K 63×10	4 6	6,35	115	110	130 205	161 236	14	3	20 35	75 135	12,5	105	197600 296400	60760 86115	354 531	2050 3020	I
K 63×12	4 6	7,938	115	110	165 227	202 264	16	5	30 40	105 147	12,5	105	239400 359120	80110 113530	332 499	2040 2995	I
K 80×10	4 6	7,144	135	130	135 205	174 244	18	3	25 35	85 135	12,5	125	301500 452260	82990 117610	457 685	2545 3747	I
K 80×12	3 4 6	7,938	135	130	142 166 230	183 207 271	18	5	25 30 40	92 106 150	12,5	125	239300 319070 478610	72190 92450 131030	323 430 645	1928 2536 3733	I
K 80×1/2"	3 4 6	7,938	135	130	157 185 237	198 226 278	18	5	30 30 40	97 125 157	12,5	125	239270 319030 478540	72170 92440 131000	323 430 645	1927 2536 3732	I
K 80×16	3 4 6	10,319	145	140	184 216 328	224 256 368	18	4	18	148 180 292	14	135	303590 404780 607170	100760 129050 182890	277 369 554	1946 2560 3768	E
K 80×24	3 4 6	15,875	170	165	282 330 598	325 373 641	20	3	18	246 294 562	15	160	413920 551890 827840	158380 202830 287460	212 283 424	1893 2490 3665	E
K 100×12	3 4	7,938	170	165	140 164	186 210	22	2	18	104 128	14	160	307740 410320	80930 103650	409 545	2345 3086	E
K 100×16	3 4	10,319	170	165	184 216	232 264	22	4	20	144 176	14	160	390520 520700	114105 146130	353 470	2383 3135	E
K 100×24	3 4 6	12,700	195	190	282 330 598	335 383 651	25	3	20	242 290 558	16	185	453420 604560 906850	144250 184740 261820	312 416 624	2375 3124 4550	E

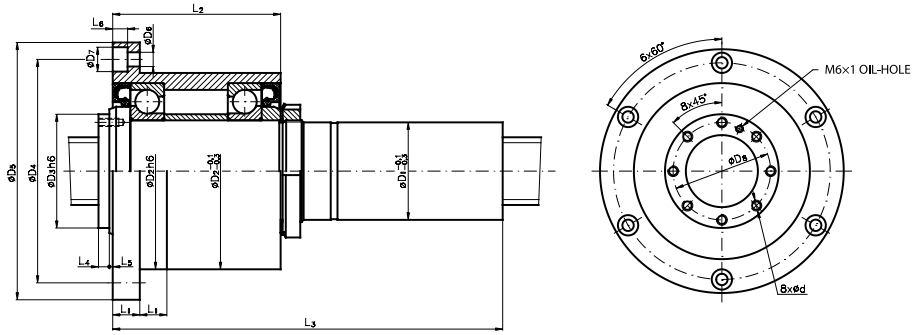
Nut type AP+A for balls screws with segment recirculation (selected types)



Application: Chapters 2.2., 2.5., 2.6.

K d_o×P	i	D_w	D_1	D_2	D_3	L_3	d	L_6±2 (AP+A)	assy. arbor	C_o	C_a	k	R (pro Fv=0,1Ca)	recirc. type
-	-	mm	mm	mm	mm	mm	mm	mm	mm	N	N	N/µm$^{3/2}$	N/µm	-
K 25×5	2,8 3,8 5,8	3,500	40	62	51	12	6,4	70 80 116	21,5	32 400 43 960 67 100	13 700 17 800 25 600	151 285 313	670 890 1 330	S
K 25×10	2,8 3,8 4,8	3,500	40	62	51	12	6,4	102 125 147	21,5	32 200 43 700 55 200	13 600 17640 21600	150 203 257	660 886 1 100	S
K 25×15	2,8	3,500	40	62	51	12	6,4	132	21,5	31 890	13 400	148	650	S
K 25×25	1,8	3,500	40	62	51	12	6,4	118	21,5	20 800	9 000	91	410	S
K 32×6	2,8 4,8	3,969	50	80	65	12	8,4	79 98	28,0	48 400 82 900	18 600 29 600	182 311	830 1 390	S
K 32×20	1,8 3,8	3,969	50	80	65	12	8,4	138 206	28,0	30 550 64 500	12 400 23 600	114 240	530 1 050	S
K 32×32	1,8	3,969	50	80	65	12	8,4	166	28,0	30 900	12 200	109	510	S
K 40×10	3,8 5,8	6,350	63	93	78	14	8,4	126 166	33,2	124 300 189 700	47 700 68 700	243 370	1 350 2 050	S
K 40×20	2,8 3,8	6,350	63	93	78	14	8,4	175 230	33,2	95 500 129 600	37 500 48 750	177 240	1 020 1 350	S
K 50×10	3,8 4,8	6,350	75	110	93	16	10,5	145 165	43,7	159 160 201 000	54 540 66 650	304 385	1 650 2 100	S
K 50×20	3,8 4,8	6,350	75	110	93	16	10,5	208 248	43,7	158 200 199 850	54 050 66 090	302 381	1 650 2 050	S
K 50×40	1,8 2,8	6,350	75	110	93	16	10,5	212 292	43,7	76 260 118 600	28 240 41 300	138 215	800 1 200	S
K 63×20	2,8 4,8	7,938	95	135	115	20	13	203 266	55,2	189 800 325 400	63 890 101 550	252 431	1 550 2 600	S
K 63×40	1,8 2,8	10,319	105	145	125	20	13	239 312	53,4	152 400 237 000	58 870 86 080	139 216	1 020 1 550	S
K 80×16	3,8 5,8	10,319	125	165	145	20	13	215 279	70,0	419 500 640 300	130 850 188 240	382 583	2 600 3 900	S
K 80×25	2,8 3,8	10,319	125	165	145	25	13	240 290	70,0	308 200 418 290	100 210 130 300	280 381	1 930 2 600	S

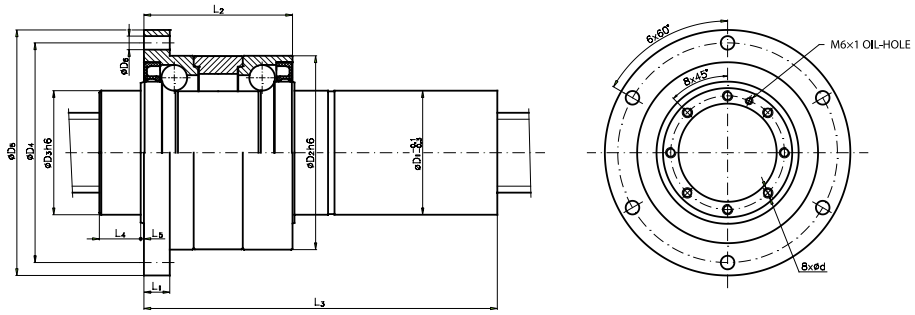
Nut type RMV (with inserted bearings)



Application: Chapter 2.7.

$d_0 \times P$	i	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	d	L_1	L_2	$L_3 \pm 2$ (RMV)	L_4	L_5	L_6	C_o	C_a
	-	mm	mm	mm	mm	mm	mm	mm	mm	-	mm	mm	mm	mm	mm	mm	kN	kN
K 50×20	4	75	145	84	165	190	10,5	18	72	M8	20	124	288	8	1	11	182	68
K 50×25	4	77	155	94	175	200	10,5	18	76	M8	20	113	306	8	1	11	173	58
	5											88	256				216	70
K 63×20	4	92	190	118	210	240	13	20	100	M8	22	148	352	8	2	13	308	110
	5											125	306				385	134
K 80×20	4	127	255	175	280	310	13	20	130	M10	25	148	358	12	3	13	462	159
	5											125	312				578	192

Nut type RMI (with integrated bearings)

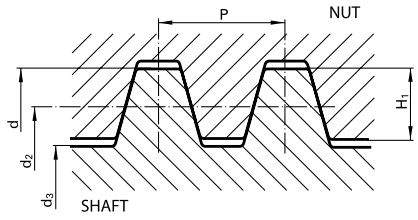


Application: Chapter 2.7.

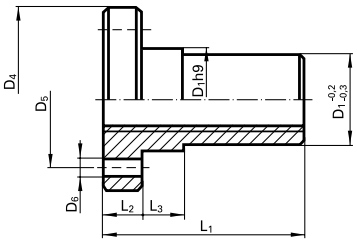
$d_0 \times P$	i	D_1	D_2	D_3	D_4	D_5	D_6	D_7	d	L_1	L_2	$L_3 \pm 2$ (RMI)	L_4	L_5	C_o	C_a
	-	mm	mm	mm	mm	mm	mm	mm	-	mm	mm	mm	mm	mm	kN	kN
K 50×20	5	80	115	80	130	145	8,4	68	M6	14	78	228	22	1,5	208	68
K 50×25	4	80	115	80	130	145	8,4	69	M6	14	78	230	23	1,5	164	55
K 50×32	3	80	115	80	130	145	8,4	69	M6	14	78	220	23	1,5	120	42
	4										78	284			163	55
K 63×20	5	96	150	100	170	190	10,5	88	M8	20	115	275	33	1,5	326	101
K 63×25	4	105	160	105	180	200	10,5	92	M8	20	115	282	38	1,5	326	114
K 63×32	3	105	160	105	180	200	10,5	92	M8	20	115	276	34	1,5	239	87

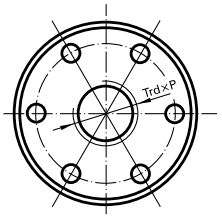
Trapezoidal screws

TRAPEZOIDAL THREAD

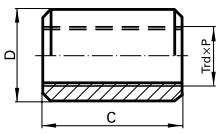


FLANGE NUT





CYLINDER NUT



Application: Chapter 2.9.

	TRAPEZOIDAL THREAD UNDER ČSN 01 4050 (mm)						NUT WITH FLANGE (mm)							CYLINDRICAL NUT (mm)	
Tr d×P	d	P	d_2	d_3	H_1	L_{MAX}	D_1	D_4	D_5	$6×D_6$	L_1	L_2	L_3	D	C
Tr 16×4	16	4	14,0	11,5	2,0	500	28	48	38	6	44	12	8	36	24
Tr 18×4	18	4	16,0	13,5	2,0	500	28	48	38	6	44	12	8	45	30
Tr 20×4	20	4	18,0	15,5	2,0	800	32	55	45	7	44	12	8	45	30
Tr 22×5	22	5	19,5	16,5	2,5	800	32	55	45	7	44	12	8	45	33
Tr 24×5	24	5	21,5	18,5	2,5	1 250	32	55	45	7	44	12	8	50	36
Tr 26×5	26	5	23,5	20,5	2,5	1 250	35	55	45	7	44	12	8	50	39
Tr 28×5	28	5	25,5	22,5	2,5	1 250	38	62	48	7	46	14	8	60	42
Tr 30×6	30	6	27,0	23,0	3,0	1 250	38	62	50	7	46	14	8	60	45
Tr 32×6	32	6	29,0	25,0	3,0	1 250	40	64	54	7	50	16	10	60	48
Tr 36×6	36	6	33,0	29,0	3,0	2 000	45	70	58	7	59	16	10	75	54
Tr 40×7	40	7	36,5	32,0	3,5	2 000	63	95	78	9	73	16	10	80	60
Tr 44×7	44	7	40,5	36,0	3,5	3 150	72	110	93	11	73	16	10	80	66
Tr 48×8	48	8	44,0	39,0	4,0	3 150	75	110	93	11	97	16	10	90	72
Tr 50×8	50	8	46,0	41,0	4,0	4 000	75	110	93	11	97	18	10	90	75
Tr 50×12	50	12	44,0	37,0	6,0	4 000	75	110	93	11	130	18	10	90	125
Tr 60×9	60	9	55,5	50,0	4,5	4 000	90	125	108	11	100	18	12	100	90
Tr 70×10	70	10	65,0	59,0	5,0	5 000	105	145	125	13	120	20	14	110	105
Tr 80×10	80	10	75,0	69,0	5,0	5 000	105	145	125	13	120	20	14	120	120

RECOMMENDED MATERIAL
ČSN 414260 (67SiCr5)
R_m min = 700 MPa

RECOMMENDED MATERIAL
ČSN 423018 (CuSn8) bar material
ČSN 423123 (CuSn12) castings
ČSN 422425 cast iron

PRECISION CLASSES

Thread shafts and nuts are manufactured in three precision classes:

1 – fine (thread grinding machines, CNC boring machines and other machines with higher accuracy),

2 – intermediate (cutting machines, lathes, milling machines, horizontal boring machines) - standard

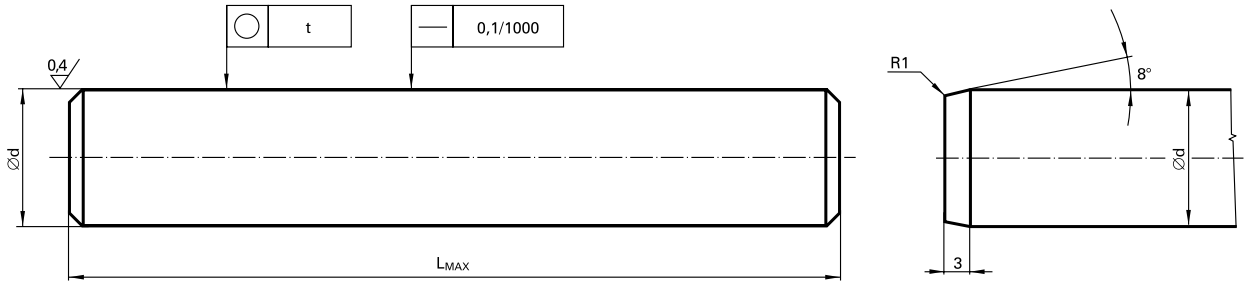
3 – rough (machines without any special requests regarding accuracy)

	PRECISION CLASS		
	1	2	3
TRAVEL DEVIATION PER 300mm THREAD LENGTH [mm]	0,024	0,052	0,081

Thread length

NOMINAL DIAMETER [mm]	PRECISION CLASS		
	1	2	3
16–18	-	500	1 250
20–22	320	800	2 000
24–32	500	1 250	3 150
33–36	800	2 000	4 000
40–44	1 250	3 150	5 000
48–50	2 000	4 000	5 000
60–70	3 150	5 000	5 000
80	4 000	5 000	5 000

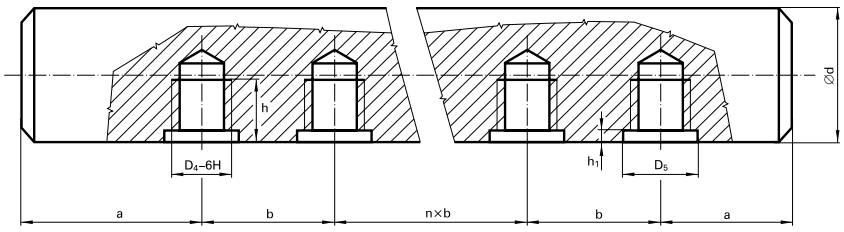
Guide rods



Application: Chapter 2.10.

NOMINAL DIAMETER d	MAXIMUM LENGTH L_{MAX}	LOWER LIMIT DEVIATION h6	t	LOWER LIMIT DEVIATION h7	t	WEIGHT
mm	mm	µm	µm	µm	µm	kg×m^{-1}
16	1 000	-11	5	-18	9	1,58
20	1 500	-13	6	-21	10	2,47
25	2 000	-13	6	-21	10	3,85
30	3 000	-13	6	-21	10	5,55
40	3 500	-16	8	-25	12	9,87
50	4 500	-16	8	-25	12	16,50
60	5 250	-19	9	-30	15	22,20
80	5 250	-19	9	-30	15	39,50

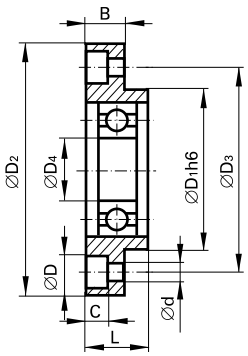
Example of radial clamping holes

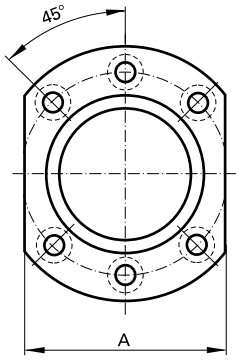


d	D_4–6H	D_5	h	h_1	a	b
mm	-	mm	mm	mm	mm	mm
16	M6	8	9	1,5	60	80
20	M8	10	10	2,0	80	100
25	M10	12	10	2,0	100	120
30	M10	14	16	3,0	120	160
40	M12	18	16	3,0	140	200
50	M16	24	20	4,0	160	240
60	M20	24	25	3,5	180	280
80	M24	28	25	3,5	200	340

LPA bearing supports for shaft ends mounting

LPA is the brand for axial bearing support with a radial ball bearing for mounting of shaft ends. It is delivered with the grease filling as a standard.

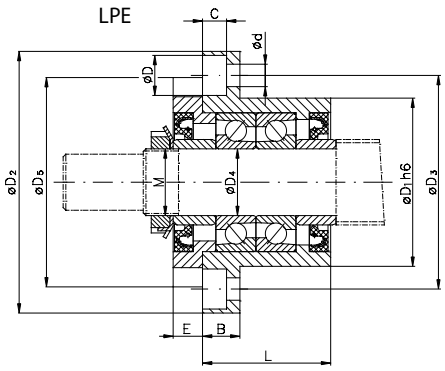


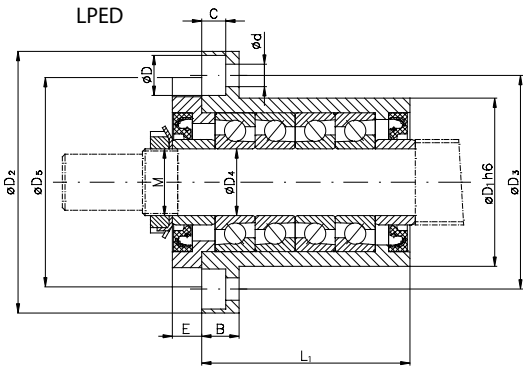


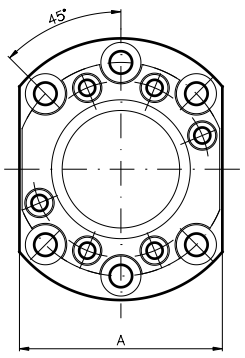
brand type	basic dimensions (mm)										bearing type
	D_1	D_2	D_3	D_4	A	B	C	D	d	L	-
LPA 15	44	70	56	15	54	8,5	5,7	10	5,3	18	6 202
LPA 17	50	78	63	17	60	9,5	6,8	11	6,4	20	6 203
LPA 20	58	94	75	20	72	12,0	9,0	15	8,4	22	6 204
LPA 25	63	98	80	25	76	14,0	9,0	15	8,4	24	6 205
LPA 30	75	118	95	30	90	16,0	11,0	18	10,5	26	6 206
LPA 35	85	138	115	35	105	18,0	11,0	18	10,5	28	6 207
LPA 40	95	156	130	40	118	18,0	13,0	20	13,0	30	6 208

LPE (LPED) bearing supports for shaft ends mounting

LPE (LPED) is the brand for axial bearing support with a ball bearing with angular contact for mounting of driven shaft ends – it substitutes the former non-preloaded support brand LPB.



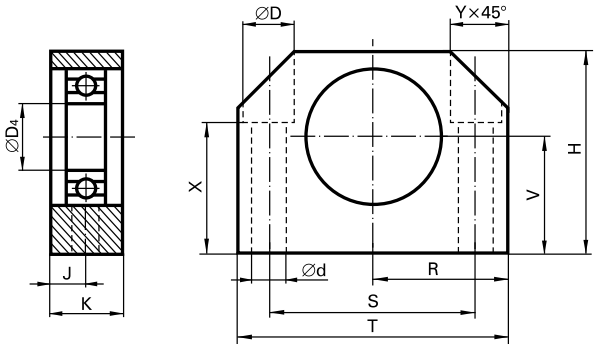




brand type	basic dimensions (mm)														bearing type
	D_1	D_2	D_3	D_4	D_5	A	B	C	D	d	E	L	L_1	M	-
LPE 15, LPED 15	44	70	56	15	56	54	9	5,7	10	5,3	10	37	59	M15×1	7 202
LPE 17, LPED 17	50	78	63	17	65	60	10	6,8	11	6,4	10	39	63	M17×1	7 203
LPE 20, LPED 20	58	94	75	20	74	72	12	9	15	8,4	10	44	72	M20×1	7204
LPE 25, LPED 25	63	98	80	25	80	76	14	9	15	8,4	11	48	78	M25×1,5	7 205
LPE 30, LPED 30	75	118	95	30	92	90	18	11	18	10,5	12	50	82	M30×1,5	7 206
LPE 35, LPED 35	85	138	115	35	110	105	20	11	18	10,5	14	54	88	M35×1,5	7 207
LPE 40, LPED 40	95	156	130	40	120	118	22	13	20	13	14	56	91	M40×1,5	7 208

LPC bearing supports for shaft ends mounting

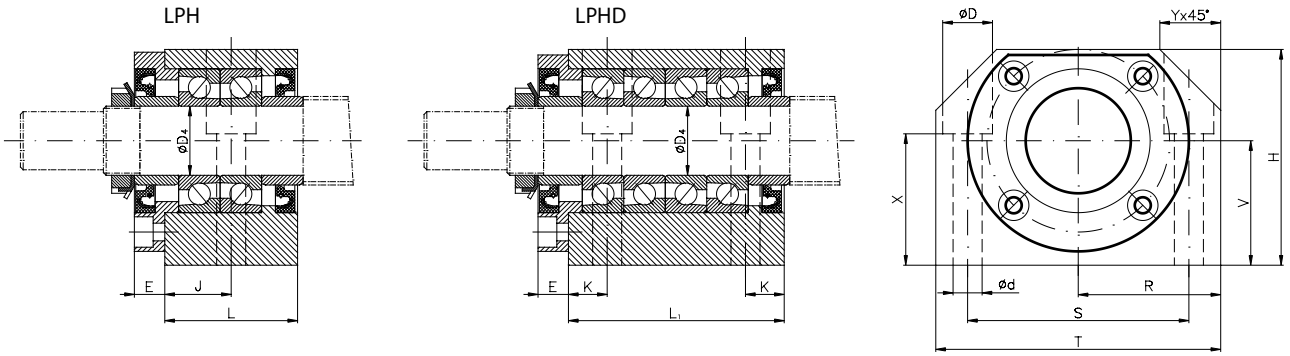
LPC is the brand for radial bearing support with a radial ball bearing for mounting of shaft ends. It is delivered with the grease filling as a standard.



brand type	basic dimensions (mm)												bearing type
	D_4	D	d	H	J	K	R	S	T	V	X	Y	-
LPC 15	15	15	8,4	56	12,0	24	41,0	60	82	30	32,5	18	6 202
LPC 17	17	18	10,5	63	13,5	27	46,0	68	92	35	37,0	18	6 203
LPC 20	20	18	10,5	72	13,5	27	49,0	75	98	40	42,5	20	6 204
LPC 25	25	18	10,5	78	13,5	27	51,5	80	103	45	47,5	22	6 205
LPC 30	30	20	13,0	88	13,5	31	59,0	90	118	50	53,0	26	6 206
LPC 35	35	20	13,0	100	17,5	35	65,0	100	130	55	66,0	26	6 207
LPC 40	40	26	17,0	110	18,0	36	75,0	118	150	60	65,0	30	6 208

LPH (LPHD) bearing supports for shaft ends mounting

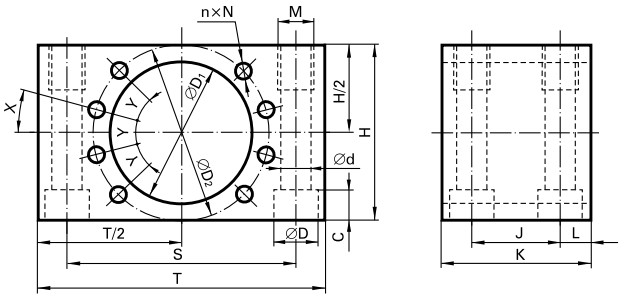
LPH (LPHD) is the brand for radial bearing support with a ball bearing with angular contact for mounting of driven shaft ends – it substitutes the former non-preloaded support brand LPD.



brand type	basic dimensions (mm)															bearing type
	D_4	D	d	E	H	J	K	L	L_1	R	S	T	V	X	Y	-
LPH 15, LPHD 15	15	15	8,4	10	56	18,5	12	37	59	41	60	82	30	32,5	18	7 202
LPH 17, LPHD 17	17	18	10,5	10	63	19,5	14	39	63	46	68	92	35	37	18	7 203
LPH 20, LPHD 20	20	18	10,5	10	72	22	14	44	72	49	75	98	40	42,5	20	7 204
LPH 25, LPHD 25	25	18	10,5	11	78	24	14	48	78	51,5	80	103	45	47,5	22	7 205
LPH 30, LPHD 30	30	20	13	12	88	25	15	50	82	59,0	90	118	50	53	26	7 206
LPH 35, LPHD 35	35	20	13	14	100	27	15	54	88	65,0	100	130	55	66	26	7 207
LPH 40, LPHD 40	40	26	17	14	110	28	20	56	91	75,0	118	150	60	65	30	7 208

MK housing for nut mounting

MK is the brand for a housing used to mount nuts with flange AP, AP+A, APR, APE.



brand type	basic dimensions (mm)															
	C	d	D	D_1	D_2	H	J	K	L	M	n	N	S	T	X	Y
MK 3236	9,0	8,4	15	36	47	50	30	50	10	M10	6	M6	68	88	0	45
MK 2040	9,0	8,4	15	40	51	52	34	54	10	M10	6	M6	72	92	0	45
MK 2545	9,0	8,4	15	45	58	58	34	54	10	M10	6	M6	80	100	0	45
MK 2550	11,0	10,5	18	50	65	66	38	60	11	M12	6	M8	90	112	0	45
MK 3256	11,0	10,5	18	56	71	70	38	60	11	M12	6	M8	95	118	0	45
MK 4063	13,0	13,0	20	63	78	78	40	66	13	M16	8	M8	102	128	15	30
MK 4070	13,0	13,0	20	70	85	80	40	66	13	M16	8	M8	108	134	15	30
MK 5075	17,5	17,0	26	75	93	90	48	80	16	M20	8	M10	124	156	15	30
MK 5085	17,5	17,0	26	85	103	96	48	80	16	M20	8	M10	132	164	15	30

4.1. Ball screw life

CALCULATION OF EQUIVALENT ROTATIONAL SPEED AND LOAD

In case of variable rotational speed and variable load, the parameters $\mathbf{n_m}$ and $\mathbf{F_{ma}}$ are used for the life calculation under **ISO 3408**, where $\mathbf{n_m}$ **(min^{-1})** is the mean rotational speed and $\mathbf{F_{ma}}$ **(N)** is the mean inner axial load (i.e. a mean load which is formed by the external axial load and the preload).

$$n_m = \sum_{j=1}^{n} \frac{q_j}{100} \times n_j$$

$$F_{ma(1),(2)} = \sqrt[3]{\sum_{j=1}^{n} F_{a(1),(2)j}^3 \times \frac{n_j}{n_m} \times \frac{q_j}{100}}$$

where **q** is the average action time in %

and for constant rotation speed

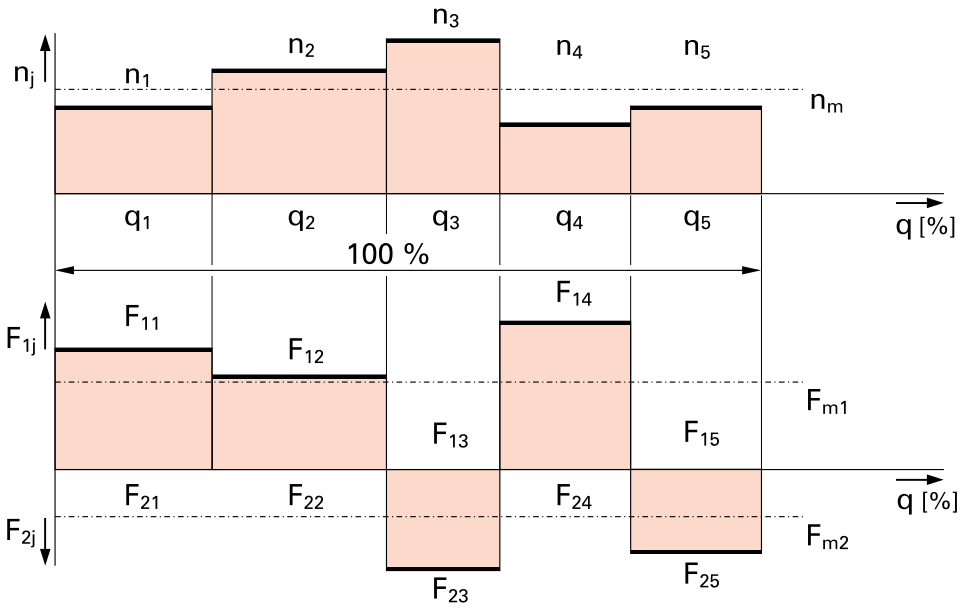
$$F_{ma(1),(2)} = \sqrt[3]{\sum_{j=1}^{n} F_{a(1),(2)j}^3 \times \frac{q_j}{100}}$$

$$F_{a(1),(2)} = F_v \times \left(1 + \frac{F_{1,2j}}{2{,}83 \times F_v}\right)^{3/2}$$

where $\mathbf{F_a}$ is the inner axial load which is calculated according to:

where $\mathbf{F_v}$ is the preload (as a standard $\mathbf{F_v=0.1\times C_a}$), **F** is the force from the external axial load, indexes 1 resp. 2 determine the direction of load and indexes (1) resp. (2) determine relation to the nut 1 or nut 2

Note: If $\mathbf{F_{1,2j} \geq 2.83 \times F_v}$, then $\mathbf{F_{a(1),(2)j} = F_{1,2j}}$



LIFE

in revolutions:

$$L_{1,2} = \left(\frac{C_a \times f_m}{F_{ma(1),(2)}} \right)^3 \times 10^6$$

in hours:

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

Where $\mathbf{C_a}$ is the basic dynamic axial load rating (**N**), corresponding to the permanent constant load, which the ball screw can theoretically transfer within 1 million revolutions, $\mathbf{f_m}$ is the coefficient of quality impact and material status (as a standard $\mathbf{f_m = 1.25}$).

Note: The previous calculation supposes a preloaded nut. In the case of a nut with backlash the mean external load $\mathbf{F_{m12}}$ is used instead of the mean inner load $\mathbf{F_{ma(1),(2)}}$ in the formula for calculation of $\mathbf{L_{1,2}}$.

for variable rotational speed:

$$F_{m1,2} = \sqrt[3]{\sum_{j=1}^{n} F_{1,2j}^3 \times \frac{n_j}{n_m} \times \frac{q_j}{100}}$$

for constant rotational speed:

$$F_{m1,2} = \sqrt[3]{\sum_{j=1}^{n} F_{1,2j}^3 \times \frac{q_j}{100}}$$

RESULTING LIFE

The resulting life of a both sides loaded ball screw with a preloaded nut, or with non-preloaded nut is:

in revolutions:

$$L = \left(L_{(1)}^{\frac{10}{9}} + L_{(2)}^{\frac{10}{9}} \right)^{\frac{9}{10}}$$

in hours:

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

LIFE CORRECTION WITH RESPECT TO THE REQUIRED RELIABILITY

in revolutions:

$$L_a = L \times f_{a1}$$

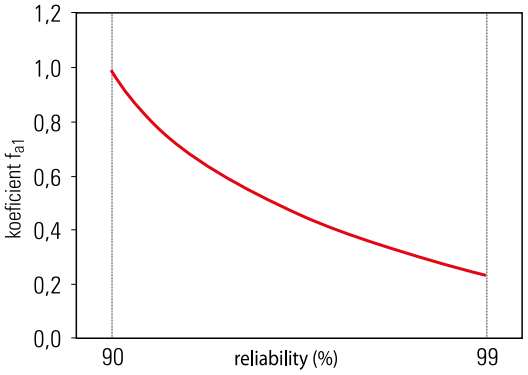
in hours

$$L_{ha} = L_h \times f_{a1}$$

reliability factor $\mathbf{f_{a1}}$

reliability (%)	f_{a1}
90	1.00
95	0.62
96	0.53
97	0.44
98	0.33
99	0.21

reliability of determined life



4.2. Ball screw limit values determination

CALCULATION OF MAXIMUM ROTATIONAL SPEED OF THE BALL SCREW SHAFT

The following relation for maximum permitted rotational speed $\mathbf{n}_{max}$ of the ball screw shaft is valid:

$$n_{max} = 0{,}8 \times n_{kr} \qquad n_{kr} = \frac{1 \times 10^7 \times f_n \times d_0}{L_8^2}$$

Where $\mathbf{n}_{kr}$ is the critical rotational speed determined by the shaft material properties, its mounting and length, $\mathbf{d}_o$ is the nominal diameter of the ball screw, $\mathbf{L}_s$ is the distance between shaft supports and $\mathbf{f}_n$ is a coefficient based on the shaft mounting.

CALCULATION OF MAXIMUM AXIAL LOAD WITH RESPECT TO THE COLUMN STRENGTH OF THE BALL SCREW SHAFT

The following relation for determination of the maximum axial load $\mathbf{F}_{(a)max}$ with respect to the buckling rigidity of the ball screw shaft is valid:

$$F_{(a)max} = 0{,}33 \times Q_{kr} \qquad Q_{kr} = \frac{\pi^3 \times 500 \times d_0^4}{f_v \times L_8^2}$$

Where $\mathbf{Q}_{kr}$ is the critical loading axial force derived from the material properties of the ball screw shaft, its mounting and length, $\mathbf{d}_0$ is the nominal diameter of the ball screw, $\mathbf{L}_s$ is the distance between shaft supports and $\mathbf{f}_v$ is a coefficient according to the shaft mounting.

Determination of the coefficients f_v and f_n

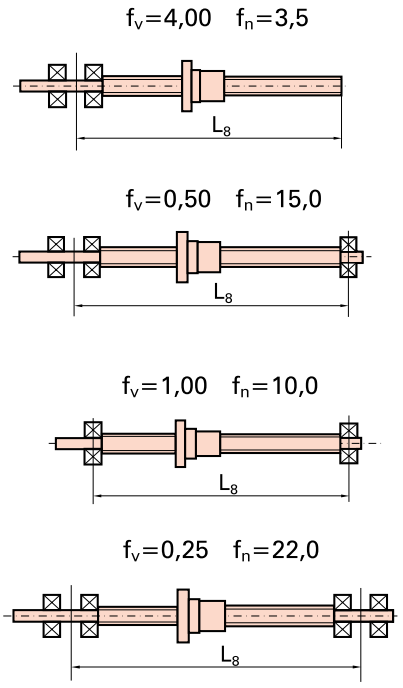
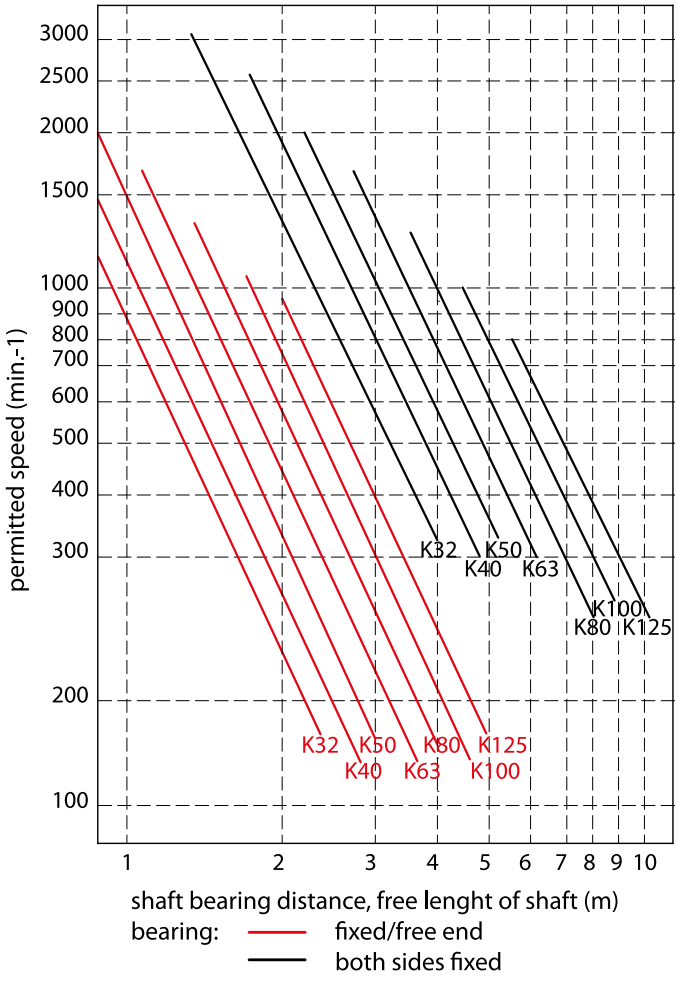


Diagram of maximum permitted rotation speed



5.1. Quality

Customer satisfaction is the main motto of our business activities and the basic element of the strategy of our Company. Our quality management system is based on our long-term tradition and experience in the area of precise engineering. Our quality management system is set and implemented in compliance with the corporate quality policy and objectives.

Our quality management system is in compliance with the **ISO 9001** standard. It is organized and managed in such a way that the Company has absolute insurance and a documented overview of the perfect functioning of all internal processes influencing the product quality in all phases of the production process.

In the area of purchasing of material, components and services our Company focuses on selected long-term reliable qualified sub-suppliers from which we have the guarantee of perfect quality and reliability of deliveries.

Verification of the product quality in the manufacturing process is based on the principle of personal responsibility of each employee for the quality of the of the operation that he provides. Above that there is systematic quality control supervision of the production managers and of designated specialists from the quality control department.

During the final inspection and testing of the readymade assemblies qualified personnel work in a separate air conditioned laboratory equipped with testing equipment whose parameters correspond to the demanding requirements of the standards for verification and testing of ball screws.

The Company's products are released for shipment only after passing all strict and demanding tests (for example by means of laser interferometer, on a special test bench for evaluation of the passive resistance, by digital profilometer and surface profiler, etc.).

The management of the Company pays close attention to the quality of our products not only in the course of their regular meetings, but also by complete and comprehensive support of the process of improvement of the quality management system in compliance with the **EN ISO 9001** standards.

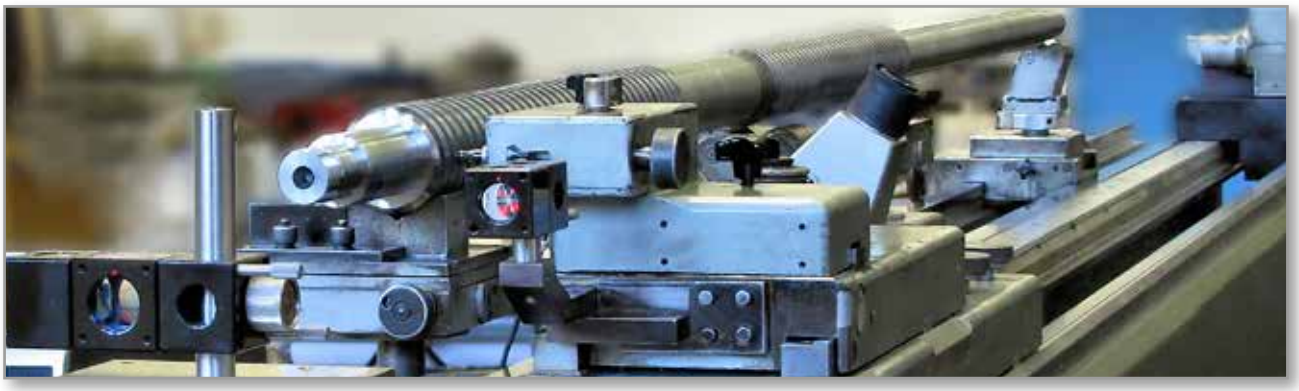

CERTIFICATE TÜV NORD

Management system as per
EN ISO 9001 : 2008

KSK
KULIČKOVÉ ŠROUBY KUŘIM, a.s.
Blanenská 1277
664 34 Kuřim
Czech Republic

Design, development, production and service of ball screws, trapezoidal screws, production of linear guide bars.

IAF



5.2. General terms & conditions

I. BASIC PROVISIONS

These "Terms&Conditions" form integral parts of the Purchase Contract. In the event of deviation from the Terms & Conditions in the Purchase Contract, the General Terms&Conditions shall become supportive, especially for issues not expressly agreed to in the provisions in deviation therefrom. Contractual relationship between a seller and a buyer shall be established by virtue of making a Purchase Contract (hereafter only the "Contract"). A statement sent through fax or e-mail shall have the same effect as a written statement.

II. MAKING A CONTRACT AND CONTRACT CONTENTS

All deliveries, including the future ones, shall be carried out exclusively under these "Terms&Conditions". This excludes application of the Buyer's (customer's) purchase conditions, unless expressly accepted by the Seller.

Silence on a seller' side to respond to the delivery of terms and conditions of purchase to the Seller (even if delivered repeatedly) shall not be considered as the acceptance thereof.

Oral or written arrangements made prior to the Contract being signed by both parties, relating to a transaction under the Contract to be concluded later, become null and void if not included in the Contract or if not in compliance with these Terms&Conditions.

III. DELIVERY, TERM OF DELIVERY, DELIVERY DELAY

The term of delivery shall start running from the date following the one in which the Contract has been signed by both contracting parties. If the Contract is signed by both parties on different dates, the date decisive for the term of delivery shall always be the later date.

The term of delivery shall be deemed observed if prior to its expiration the subject of delivery is placed at the buyer's disposal for acceptance in a destination specified in the Contract. The Buyer shall not be entitled to accept the goods without prior goods receipt notification sent by the Seller at least 48 hours before the date of delivery of the goods. The Buyer shall be obliged to render to the Seller all the assistance necessary for the goods acceptance. In case the Buyer does not take delivery of goods without undue delay within a specified time after obtaining the seller's goods receipt notification, the goods shall be deemed delivered once the Seller has sent the above notification, and thus the entire purchase price shall become due and the Seller shall have the right to issue immediately an invoice for payment of the purchase price. The Buyer shall be obliged to pay to the Seller, in addition to the purchase price, a consideration for the goods storage of 1.5 % of the purchase price for every commenced month pursuant to the Contract. In case the Buyer does not take delivery of goods within 6 months from the goods receipt notification, he shall have the right to withdraw from the Contract. Partial deliveries are permitted, if not agreed otherwise.

The risk of damage to the goods shall pass to the Buyer on delivery of the goods to the Buyer or when acceptance of goods is delayed by the Buyer. The Buyer shall acquire an ownership right to the goods upon paying a full purchase price as well as all other monetary claims pursuant to the Contract.

The Seller shall not be obliged to deliver the goods pursuant to the Contract in case he has any pending claims due against the Buyer (including debts for contractual penalties, interests on late payments or damage compensations).

The date of delivery shall be postponed by the time the Buyer is late on payment of the purchase price or any other due payment claims of the Seller or of advances for the purchase price, or is in delay with delivery of the drawing documentation or potentially of other manufacturing or transport arrangements, the delivery of which has been agreed to between the Buyer and the Seller, or the delivery of which is indispensable for due performance of the Contract from the Seller's side.

The term of delivery may be appropriately extended, especially during strikes or closures as well as in the creation of unpredictable obstacles that have originated independent of the Seller's will, if these obstacles have clearly significant influence on completion or delivery of the subject of delivery. In case the term of delivery has already expired, a new reasonable term of delivery shall be determined. The Seller will inform the Buyer about beginning and end of the obstacles as soon as possible. In instances when the Seller bears responsibility for extension of the term of delivery or for any its agreed prolongation, he shall be obliged to do his best to shorten the delay as much as possible.

IV. PRICE AND PAYMENT CONDITIONS

The purchase price of goods pursuant to the Contract is fixed. The Buyer shall be liable to pay to the Seller, in addition to the agreed purchase price, VAT at its currently valid rate.

If not agreed otherwise in the Contract, the goods shall be delivered on the basis of EXW term of delivery from Blanenská 1277, Kurim, postal code 664 34, Czech Republic, under the INCOTERMS 2000. The purchase price does not include transport packaging, packing costs, loading of goods to a means of transport, nor costs related to other charges, such as taxes, customs duty, insurance, etc. All these costs shall be borne by the Buyer. The used transport packaging and fixing material will be returned only if specifically requested and agreed.

Holding back payments or setoff of mutual debts due to the Buyer's counterclaims is not permitted.

If not agreed otherwise, the price of goods shall be payable prior to delivery.

The Seller shall be entitled to shorten maturity period of issued invoices for 14 days if the Buyer is repeatedly late in payment of his liabilities or the Buyer's financial circumstances have significantly worsened. In such instances the Seller may withhold any unperformed deliveries arising from all Purchase Contracts without violating the Contract or the right to withdraw therefrom.

V. WARRANTY CONDITIONS

At ordering the goods, the Buyer shall specify exactly the requirements on the goods, i.e. quantity, mode of delivery, characteristics, qualitative parameters, preservation, package, and the mode and form of demonstration of compliance with the specified requirements. The goods must have the quality according to the Buyer's requirement stated in the validly concluded Agreement, otherwise according to the relevant technical standard, or the characteristics common for the relevant article, respectively. The warranty period on new products shall amount to 12 months and on the services provided (repairs, cooperation production, etc.) to 6 months, provided that the Operating Conditions for Transport, Handling, Assembly and Operation of Engineering Products of KULICKOVÉ ŠROUBY KURIM, a.s. are observed.

The warranty period shall start running as from the day of handover of the goods to the Buyer or the forwarder, i.e. from the date

of dispatch. The Buyer may complain about obvious defects of the goods not later than at the inspection of the goods performed immediately after the reception of the goods. Any hidden defects and defects that are found after the delivery of the goods to the Buyer must be complained about by the Buyer without unnecessary delay after the detection of the defect. The Buyer may complain about any defects of the goods only if the Buyer demonstrates that such defects did not emerge in consequence of inexpert handling or inexpert use of the goods, and that they were not caused by outer circumstances that the Buyer was not to anticipate. Any complaint shall be filed in time if it has been delivered to the Seller in written form, with exact specification of the defect and of the claims from liability for defects, not later than by the last day of the warranty period. In case of any complaint filed duly and in time, the Seller shall repair or replace the defective parts.

VI. WITHDRAWAL FROM CONTRACT

The Seller has the right to withdraw from the Contract, in particular if the Buyer is late on payment of the purchase price or any other due payment claims of the Seller and in case of major breach of the Contract from the Buyer's side.

In the event of withdrawal from the Contract by either the Seller or the Buyer for reasons set forth in the Contract or in these delivery terms and conditions or by virtue of law, the Buyer shall be obliged to return the goods to the Seller within 3 days from notification of withdrawal and, at the same time, to pay to the Seller all costs incurred to him in relation to the Contract performance. In addition, the Buyer shall be obliged to compensate any damage to the goods and wear-out that have occurred after goods delivery to the Buyer. The Seller shall be obliged to return to the Buyer the purchase price already paid up, however with the right to deduct the costs incurred in relation to the Contract performance as well as damage compensation covering potential goods damages and wear-out. The Seller shall be obliged to return to the Buyer the above specified part of purchase price within 14 days upon returning the goods.

Withdrawal from the Contract does not affect the penalty claims agreed to in the Contract. These claims do not extinguish as a result of termination of the contractual relationship due to withdrawal from the Contract.

VII. PENALTIES FOR CONTRACT BREACH

From the moment when the Buyer falls into default in the payment of purchase price for the goods, the Buyer can be charged, under reservation of other rights, a contractual penalty of 0.1% of the sum outstanding on a daily basis.

In the event of Buyer's withdrawal from the Contact for other reasons than those specified in Clause VI hereof, the Buyer shall be obliged to pay to the Seller a contractual penalty of 50% of the purchase price. In case the Buyer gets in default in returning the goods as a result of termination of the Contract due to withdrawal of either party, the Buyer shall pay to the Seller a contractual penalty of 0.1 % of the goods purchase price for every commenced day of the default in returning the goods.

If the delivery of goods has been provably delayed through the fault of the Seller and the delay is longer than 20 working days, and the delayed delivery has caused provable damages to the Buyer, for such a delay the Buyer, with exclusion of other claims, shall be entitled to claim a contractual penalty of 0.1 % from the delayed goods value for every day of delay, however up to the maximum of 50 % of the value of delayed goods.

In the event defects in goods that prevent from or make more difficult using such goods or jeopardize safety cause damages to the Buyer, the Buyer shall have the right to claim, during the entire warranty period, a contractual penalty of 0.1% of the price of defective goods for every day of existence of the defects. The highest cumulative contractual penalty or penalties, in accordance with the above specified, is 50% of the defective goods price.

VIII. FORCE MAJEUR

In the event of circumstances that cannot be foreseen in signing the Contract and will create an obstacle for the Seller in the fulfilment of his contractual obligations, the Seller shall be entitled to postpone fulfilment of obligations by a period for which the obstacle prevailed as well as a time necessary for reassuming normal activity.

In all cases of circumstances excluding responsibility (including accidental delay of sub-deliveries, transport corporate breakdowns and similar acts of Force Majeur that will affect fulfilment of the Seller's contractual obligations), the Seller shall have the right to terminate the Contract without indemnifying the ordering party.

The Buyer may ask the Seller for a statement whether or not he is to terminate the Contract, or whether he is prepared to continue in the contract performance in a reasonable alternative time for delivery. If the Seller fails to express himself forthwith, the Buyer shall have the right to terminate the Contract. The Buyer cannot refuse partial fulfilment so far completed.

IX. APPLICABLE LAW FOR SETTLING DISPUTES

Both parties will seek to reach an agreement in all issues that may arise from this Contract. All potential disputes will be settled in compliance with the law of the Czech Republic. The parties agree that any potential dispute originated between them on the basis of legal relations arising from the Contract or in connection therewith shall be adjudicated in arbitration proceedings by the Court of Arbitration attached to the Economic Chamber of the Czech Republic and Agricultural Chamber of the Czech Republic in accordance with its Rules of Procedure by three arbiters, where either party shall appoint one arbiter and they will then elect the presiding arbiter. In the event that either of the parties fails to appoint an arbiter, the President of the Court of Arbitration in compliance with its Rules of Procedure shall appoint the arbiter for that particular party. The language of procedure shall be Czech. Both parities undertake to accept, without reservation, decisions of the Court of Arbitration.

X. FINAL STIPULATIONS

Any amendment and alterations to contracts between the Seller and the Buyer shall only be valid in writing. Legal relations not regulated by these Terms&Conditions or by the Contract shall follow the Czech law and provisions of the Act No. 513/1991 of Coll., the Commercial Code, and regulations relating to the UN Convention on Contracts for the International Sale of Goods (Vienna Convention of 1980). By this express declaration made in compliance with Section 401 of the Commercial Code, the Buyer extends the limitation period of the creditor's rights (the Seller) arising from the Contract or these Terms&Conditions for a period of 10 years. If one or more parts of these Terms&Conditions or of the Contract become legally unenforceable, the parties commit to replace them with new provisions that will follow economic objectives of these Terms&Conditions or the Contract. Other unaffected provisions of these Terms&Conditions or of the Contract shall henceforth remain in force. The parties are obliged to keep confidential all information ascertained in connection with the Contract, not to disclose the information without prior written consent of the other party nor to use such information for their own benefit or for benefit of others during the entire term of these contracts a well as after their termination. The Terms&Conditions shall enter in force and become effective as of December 1st, 2011.

5.3. Operating conditions

A. BALL SCREW AND PRODUCTS DERIVED FROM IT
The ball screw (hereinafter referred to only as "BS") requires, similarly to ball bearing, working conditions and principles corresponding to its accuracy and design, divided into the following categories:

A.I. TRANSPORT AND HANDLING
- During transport and handling, the anticorrosive package must be protected against breach or wear
- Protection against impacts must be provided (the nut body must not be strained by impacts and radial load)
- Handling – the handling points are identified by pictograms on the packages
- During handling, the shaft must be maintained with minimum bending from own weight; the distances between the supports during storage must correspond maximally to 1/4 of the shaft length; vertical suspension of BSs with pre-tensioned nuts is allowed
- Any inclination of non-pre-tensioned ball screws may cause unscrewing of the screw or the nut
- BS stacking (putting on each other) in cardboard boxes or without solid wooden packages is not allowed
- After removing the protective anticorrosive package consisting of Cortec VpCI-126 foil, the product must not be exposed to corrosive environment; environment C1 according to CSN ISO 9223 is allowed for the indispensable period before assembly into the equipment; otherwise, the product surface must be adequately preserved

A.II. ASSEMBLY
- It is forbidden to disassemble the nut from the ball screw shaft or interfere in the product in other way
- The positioning of the shaft axis must be in accuracy up to 0,02mm/m to the guide plain; the perpendicularity of the area of contact for the face of the nut flange must be up to 0,02mm/m to the longitudinal axis
- The thread surface must be protected against dirt, liquids and damage
- Before filling with grease and actual operation, the shaft must be cleaned
- The nut must not be subject to impacts, tilting moment and radial load

A.III. OPERATION
- The BS must be operated in non-aggressive environment without dirt, liquids and dust, unless the BS is intended for such environment
- The nut may be strained only in axial direction
- Bending from own weight must be suitably eliminated in long and thin screws
- The BS must be lubricated in operation (bearing greases according to degree 2 of DIN51825 and oils with minimum viscosity of 50mm2/s at 40°C); standard lubrication is loss-making without filtration and reuse; losses of lubricant in operation must be compensated by additional lubrication with stress on verification of compatibility of lubricants from different manufacturers
- The BS operating temperature is from -30 to +90°C and it is further limited by the lubricant applied
- The maximum revolutions are limited by the gear design (so called revolution factor) and the lubricant applied and they must not be exceeded
- The operating load must correspond to the specification for which the product was designed (load spectrum, Ca, Co), while respecting the strength of the material of the screw shaft (min. strength - Rm=600MPa) and of the nut condition (through-hardened to 60HRc)
- The BS must be protected against dynamic impacts and overloads over the Co value
- During operation, only the useful path of the shaft thread according to DIN69051 may be used for load

A.IV. OTHER PROVISIONS
The manufacturer shall not be liable for any damage caused by inexpert transport, handling, assembly and operation of the BS or by use of the BS for other purpose that it was designed for.

B. TRAPEZOIDAL SCREW AND PRODUCTS DERIVED FROM IT
The trapezoidal screw (hereinafter referred to only as "Tr") requires working conditions and principles corresponding to its accuracy, function and design, divided into the following categories:

B.I. TRANSPORT AND HANDLING
- During transport and handling, the anticorrosive package must be protected against breach or wear
- Protection against impacts must be provided for (the shaft and nut surfaces are soft)
- Handling – the handling points are identified by pictograms on the packages
- During handling, the shaft must be maintained with minimum bending from own weight; the distances between the supports during storage must correspond maximally to 1/4 of the shaft length; vertical suspension is allowed
- Stacking (putting on each other) in cardboard boxes or without solid wooden packages is not allowed
- After removing the protective anticorrosive package consisting of Cortec VpCI-126 foil, the product must not be exposed to corrosive environment; environment C1 according to CSN ISO 9223 is allowed for the indispensable period before assembly into the equipment; otherwise, the product surface must be adequately preserved

B.II. ASSEMBLY
- It is forbidden to interfere in the product
- The positioning of the nut must be provided in accuracy of 0,05 to 0,02 mm/m (according to the Tr screw model) to the longitudinal axis of the shaft
- The thread surface must be protected against dirt, liquids and damage
- Before filling with grease and actual operation, the shaft must be cleaned
- The nut must not be subject to tilting moment and radial load

B.III. OPERATION

- The Tr screw must be operated in non-aggressive environment without dirt, liquids and dust, unless the screw is intended for such environment
- The nut may be strained only in axial direction and it must be guided coaxially to the shaft
- Bending from own weight must be suitably eliminated in long and thin screws
- The Tr screw must be lubricated in operation with a lubricant non-aggressive against the materials used (greases or pastes for sliding guides and gear or sliding oils); standard lubrication is loss-making without filtration and reuse; the losses of lubricant in operation must be compensated by additional lubrication with stress on verification of compatibility of lubricants from different manufacturers
- The operating temperature is from -30 to +90°C and it is further restricted by the lubricant applied and by the nut material
- The maximum revolutions and the maximum sliding speed must not be exceeded
- The safe buckling strength of the shaft of the Tr screw and the bearing power of the nut must not be exceeded
- The operating load must correspond to the specification for which the product was designed, while respecting the strength of the material of the screw shaft (min. strength - Rm=600MPa) and of the nut (usually CuSn8 or CuSn12)

B.IV. OTHER PROVISIONS

The manufacturer shall not be liable for any damage caused by inexpert transport, handling, assembly and operation or by use of the Tr screw for other purpose that it was designed for.

C. GUIDE RODS AND OTHER PRODUCTS

The guide rods of circular section (hereinafter referred to only as "GR") require working conditions and principles corresponding to their accuracy, function and design, divided into the following categories:

C.I. TRANSPORT AND HANDLING

- During transport and handling of GRs and OPs, the package must be protected against breach or wear
- During handling, the GRs must be maintained with minimum bending from own weight; the distances between the supports during storage must correspond maximally to 1/4 of the shaft length; vertical suspension is allowed
- Stacking (putting on each other) in cardboard boxes or without solid wooden packages is not allowed
- After removing the protective anticorrosive package consisting of Cortec VpCI-126 foil, the product must not be exposed to corrosive environment; environment C1 according to CSN ISO 9223 is allowed for the indispensable period before assembly into the equipment; otherwise, the product surface must be adequately preserved

C.II. ASSEMBLY

- It is forbidden to interfere in the product
- The positioning of the GRs must be provided for in required accuracy according to the guide used and the relevant purpose
- The product surface must be protected against dirt, liquids and damage

C.III. OPERATION

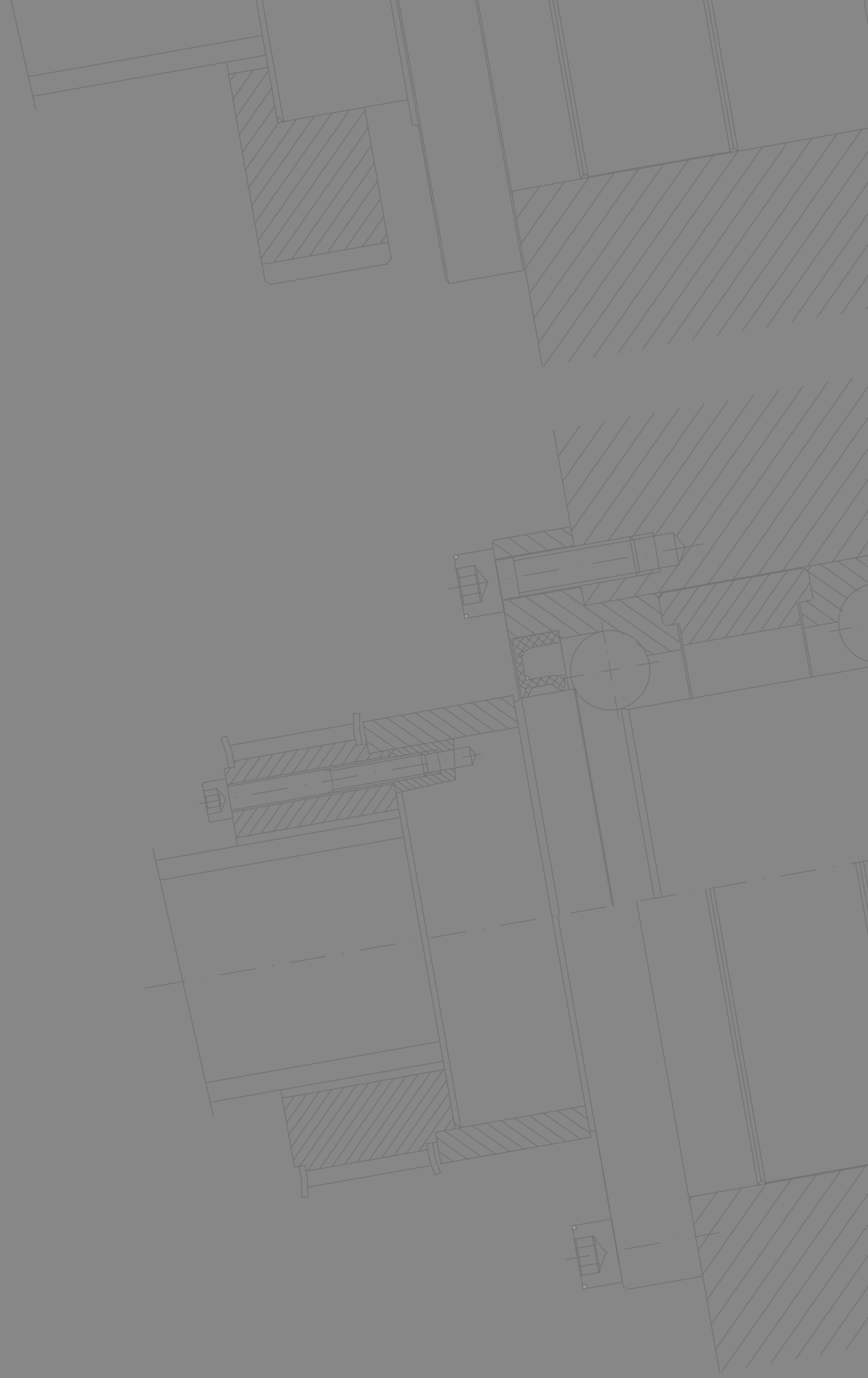
- The GRs and OPs screw must be operated in nonaggressive environment without dirt, liquids and dust, unless they are intended for such environment
- Bending from own weight must be suitably eliminated in long and thin GRs (radial fixation of the rods)
- The rolling friction guides used for GRs must be suitably lubricated during operation
- The GR operating temperature is limited by the lubricant and the rolling friction guide used
- The operating load must correspond to the specification for which the product was designed, while respecting the strength of the material of the GR (min. strength - Rm=600MPa)

C.IV. OTHER PROVISIONS

The manufacturer shall not be liable for any damage caused by inexpert transport, handling, assembly and operation or by use of the GRs or OPs for other purpose that they were designed for.

D. CONCLUDING PROVISIONS

The Operating Conditions come into force and effect as from 1/7/2010.



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