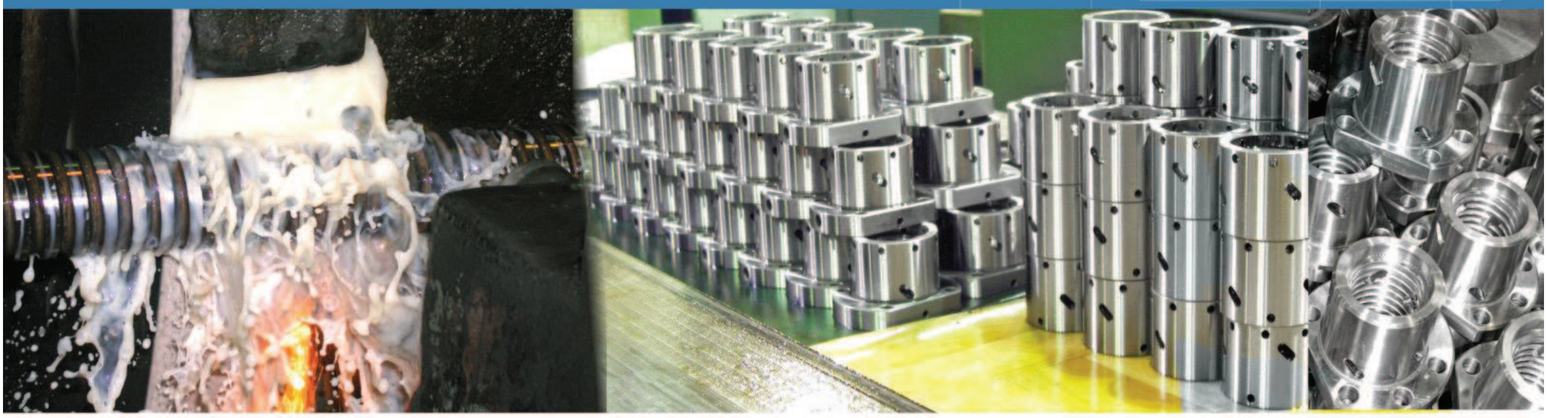
FOP

FABRYKA OBRABIAREK PRECYZYJNYCH

PRECISION GROUND BALLSCREWS



COMPANY PROFILE

Established in 1902 as an engineering company, Fabryka Obrabiarek Precyzyjnych FOP AVIA S.A. have been producing high precision machine tools for over 40 years, And have been producing high precision ballscrews for over 30 years.
Since up to 75%of the production is exported, AVIA is well recognized in Europe and overseas as one of the leading suppliers of these products.
Production of our ballscrews is carried out in an air-conditioned manufacturing facility.
CNC machine tools, including the most modern high precision CNC thread grinders are used there. Custom made inspection machines are used in order to maintain high quality standard.

PRECISION BALLSCREWS

AVIA brand precision ballscrews are mostly installed in modern CNC machine tools and in high precision manual machine tools.

All standard AVIA brand ballscrew are precision ground in three accuracy grades: 1, 3 and 5 acc. To DIN/ISO

The Ballscrew are made out of the wear resistant high grade alloy steel, are induction hardened and precision ground.
Inspection equipment used in the production of ballscrews includes laser interferometric lead measuring machine, special purpose machine measuring drag torque and super precision testing equipment for checking the thread profile.

Standard AVIA brand ballscrews are made with flanged nuts as well cylindrical nuts with fitting keys – in accordance with the customer's preference. The can be made without preload, with single nut preload and with and with double nut preload. This provides the customer with the choice of seven types of nuts.

Metric lead is standard. Imperial lead ballscrews are custom manufactured.
The design of ballscrews is being continuously upgraded in cooperation with our customers. A computer aided design is used for this purpose.

The journals of the screw are made in accordance with the customer's drawings.
In addition to the deliveries of the standard AVIA brand ballscrews, we also offer ballscrew repair and reconditioning services as well as manufacturing of custom made ballscrews, manufactured according to the customer's drawings.

Contents

1 . Introduction

Recirculation ballscrews have been developed from conventional mechanism of feed screw and nut, by utilizing rolling parts (bearing balls) between the screw and the nut. In ballscrews the sliding friction is replaced by rolling friction which gives numerous advantages and makes the ballscrew suitable for broad range of applications that demand:

- high efficiency
- no backlash operation
- high axial rigidity
- long life

In particular, ballscrews are used to provide feed drive and operate as positioning mechanisms in numerically controlled machine tools, in optical and measuring devices, in aircraft sub-assemblies, and in many other industry sectors.

Ballscrews are manufactured from high quality materials. As a result of the rolling motion of the balls along the hardened tracks of the screw and the nut, the wear life of the ballscrew is very long, which eliminates the need of axial play compensation and maintains original lead accuracy during the whole operating period. Implementation of preloaded nut enables backlash-free operation and gives higher stiffness.

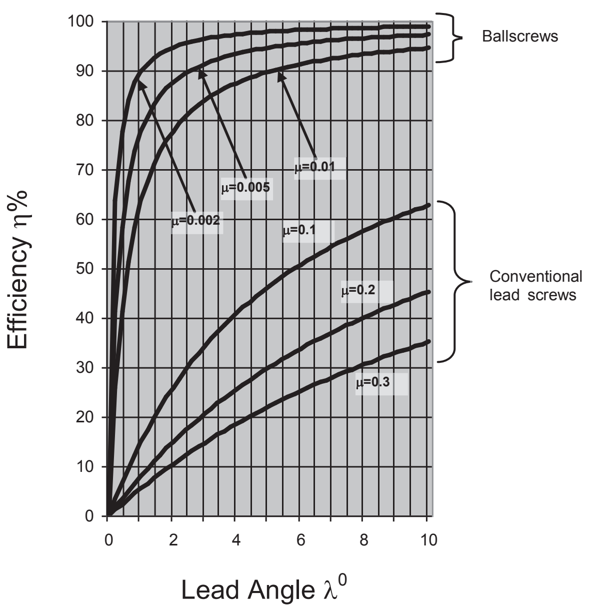


Figure 1.1

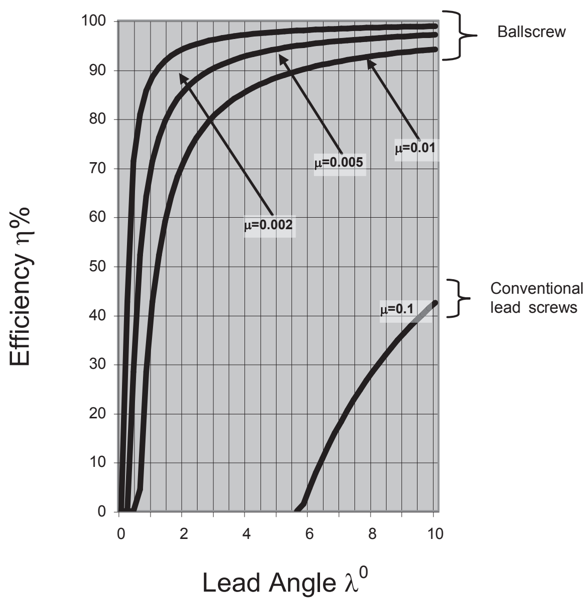


Figure 1.2

High efficiency of the ballscrews makes them suitable for applications, where there is a need for conversion of the rotary motion into the linear motion. Fig. 1.1 shows the relation between efficiency η and lead angle λ, in case of conversion from rotary motion into linear motion, and Fig. 1.2 in case of conversion from linear motion into rotary motion. It should be noted, that the conversion from linear motion into rotary motion is possible only with no preloading ballscrew. If proload is applied, the system becomes self-locking.

AVIA ballscrews have internal recirculation of balls (Fig. 1.3a) and external recirculation of balls (Fig. 1.3b) . Ballscrews from AVIA employ an ogival form ball-track (Gothic arch). Such a profile helps in achieving high stiffness and also in eliminating axial play.
Required ballscrew preload is ensured by the following:

1 Combination of the two half-nuts tightened against each other.
   a) Where the half-nuts are pushed out - tension preloading (Fig. 1.4).
   b) Where the half-nuts are pushed in - compression preloading (Fig. 1.5).

2 Application of preload by selection of interference balls (4-point contact configuration) single nut – see (Fig. 1.6).

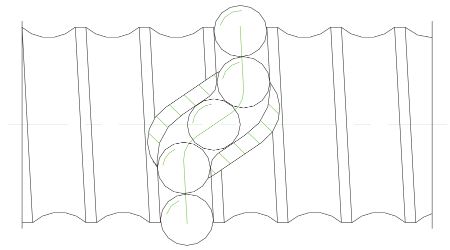


Figure 1.3a

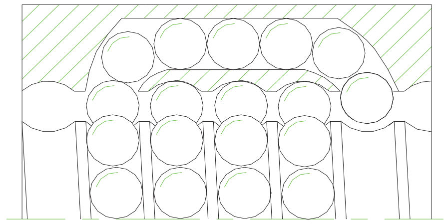


Figure 1.3b

Range of production:

Nominal diameter: 16 ~ 80 mm
Nominal lead (pitch): 4 ~ 20 mm
Standard length: up to 3200 mm

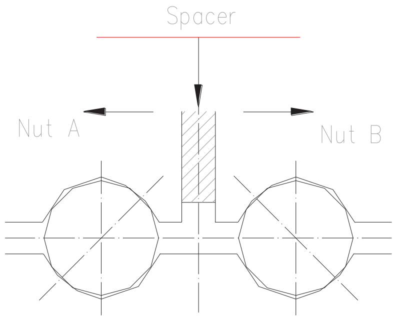


Fig. 1.4 Tension preloading

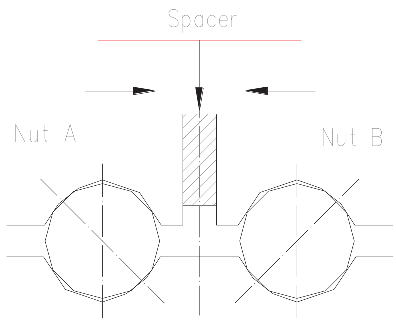


Fig. 1.5 Compression preloading

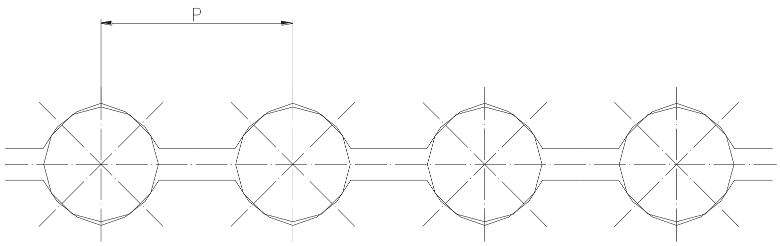


Fig. 1.6 Type "P" (4–point contact of balls)

2. Production range

2.1 Lead accuracy classes

Figure 2.1 shows characteristic dimensions related to the accuracy of a ballscrew.

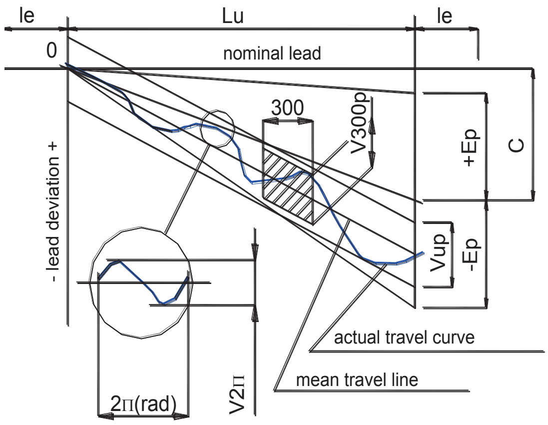


Fig.2.1

Lu - Useful travel, which is the thread length reduced by 'le' distances of non-qualified path.

C - Target deviation of mean lead line from nominal lead within 'Lu' length.

Ep - Maximum deviation of mean lead line from target line.

Vup - Maximum width of lead deviations over the travel length.

V300p - Real width of lead deviations over the length of 300 mm.

V2Π - Real width of lead deviations for one revolution of the screw.

Target deviation **C** should be given in the Purchase Order. Otherwise, C = 0 is assumed.
The lead measurements are taken at temperature 293°K (20°C).
The non-qualified distance $\mathbf{le_{max}}$ is applied as follows:

- for 5 mm lead, le_{max} = 20 mm
- for 10 mm lead, le_{max} = 40 mm
- for 20 mm lead, le_{max} = 60 mm

Target deviation of mean lead line C over Lu length can be determined from the following formula:

$$C = \Delta L_0 \times \frac{L_0}{L_u} \quad \text{where:}$$

$\Delta L_0 = \alpha \times L_0 \times \Delta T$ [mm] - thermal elongation of the screw shaft
L_0 - distance between end journal supports
L_u - ball-thread length
$\alpha = 11 \times 10^{-6}$ [mm/(mm x deg)] - coefficient of thermal expansion for steel
ΔT - temperature variation [deg]

Standard AVIA ballscrews are manufactured in 3 accuracy grades, according to DIN 69051 (ISO 3408): 1, 3 & 5 classes, see Table 2.1 below.

Table 2.1

Class	V300p[µm]	V2πp[µm]
1	6	4
3	12	6
5	23	8

Tab. 2.2. International Standards for Accuracy Classes of Ballscrews.

Unit: [µm]

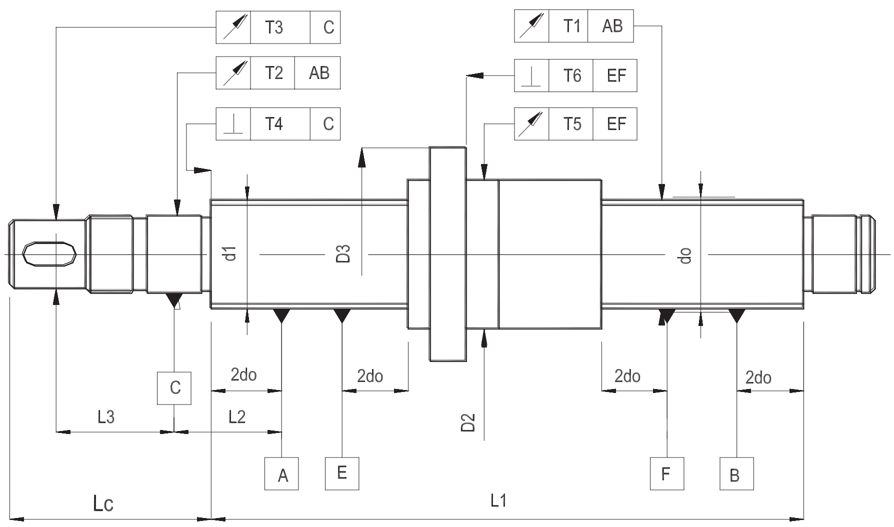
Class		0	1	2	3	4	5	6	7	10
e300 (V300p.)	*ISO,DIN*		6		12		23		52	210
	BSI		6		12	16	23		52	210
	JIS	3.5	5		8		18		50	210
	HIWIN	3.5	5	6	8	12	18	23		

Table 2.3 contains permissible values of **Vup** and **Ep** in relation to the useful length **Lu**, and accuracy classes.

Table 2.3

Lu[mm]		**Ep[μm]**			**Vup[μm]**		
above	*to*	***1***	***3***	***5***	***1***	***3***	***5***
	315	*6*	*12*	*23*	*6*	*12*	*23*
315	*400*	*7*	*13*	*25*	*6*	*12*	*25*
400	*500*	*8*	*15*	*27*	*7*	*13*	*26*
500	*630*	*9*	*16*	*30*	*7*	*14*	*29*
630	*800*	*10*	*18*	*35*	*8*	*16*	*31*
800	*1000*	*11*	*21*	*40*	*9*	*17*	*35*
1000	*1250*	*13*	*24*	*46*	*10*	*19*	*39*
1250	*1600*	*15*	*29*	*54*	*11*	*22*	*44*
1600	*2000*	*18*	*35*	*65*	*13*	*25*	*51*
2000	*2500*	*22*	*41*	*77*	*15*	*29*	*59*
2500	*3150*	*26*	*50*	*93*	*17*	*34*	*69*
3150	*4000*	*30*	*60*	*115*	*21*	*41*	*82*

2.2 Geometrical classification of precision ballscrews



Tab. 2.4

Symbol	Dimension L1		Accuracy Class		
	over	to	1	3	5
T1	L1	500	0.015	0.020	0.025
	500	1000	0.020	0.025	0.035
	1000	2000	0.030	0.035	0.045
	2000			0.045	0.055

Tab. 2.5

Symbol	Dimension L2		Accuracy Class		
	over	to	1	3	5
T2	L2	100	0.010	0.014	0.020
	100	300	0.012	0.017	0.025
	300	500	0.015	0.020	0.030
	500	1000	0.020	0.025	0.040
	1000	2000	0.030	0.035	0.050

Tab.2.6

Symbol	Dimension L3		Accuracy Class		
	over	to	1	3	5
T3	L3	100	0.006	0.008	0.010
	100	300	0.008	0.010	0.012
	300	500	0.011	0.015	0.020
	500	1000	0.017	0.025	0.035

Tab.2.7

Symbol	Dimension d1		Accuracy Class		
	over	to	1	3	5
T4	d1	50	0.003	0.004	0.005
	50	100	0.004	0.005	0.006
	100		0.005	0.006	0.007

Tab.2.8

Symbol	Dimension D2		Accuracy Class		
	over	to	1	3	5
T5	D2	50	0.012	0.016	0.020
	63	100	0.016	0.020	0.025
	100		0.020	0.025	0.032

Tab.2.9

Symbol	Dimension D3		Accuracy Class		
	over	to	1	3	5
T6	D3	100	0.012	0.016	0.020
	100	140	0.016	0.020	0.025
	140		0.020	0.025	0.032

REMARKS:

1. Types T5 and T6 refer to preloaded ballscrews only.
2. For the acceptance tests of a shaft end, the nut should be moved out as close as possible to the A reference (or B reference respectively), however not further than the last 2 thread turns

2.3. Dimensional Ranges

F.O.P. AVIA S.A. manufactures the ballscrews in the following ranges: nominal diameter **d_0 = 16 – 80 mm**, lead **P = 4 - 20 mm**, and total screw length **l_s = 3200 mm**. Nominal diameter is the theoretical diameter of a cylinder created by the ball centers. See Table 2.10 for basic dimensions of ballscrews manufactured at AVIA.

On request, after confirmation by AVIA engineers, longer ballscrews than described in Table 2.10 might be supplied, but total length of not more than 3200 mm. Such cases must be checked for buckling effect and critical speed, according to calculation formulas given in Chapter 3 of this booklet.

Tab. 2.10

		Nominal diameter d_0 (mm)							
		16	20	25	32	40	50	63	80
Lead P(mm)	4	■	■						
	5	■	■	■	■	■	■		
	6		■	■	■	■	■		
	8			■	■	■	■		
	10			■	■	■	■	■	■
	12				■	■	■	■	■
	16					■	■	■	■
	20					■	■	■	■
Class		Maximum screw length l_s (mm)							
3		400	450	600	850	1200	1600	2100	2500
5		800	1000	1500	2500	3000	3200	3200	3200

(grey) - recommended lead

(blue) -- standard value

2.4. Nut selection

Figure 2.2 shows the standard nuts available from F.O.P. AVIA S.A.

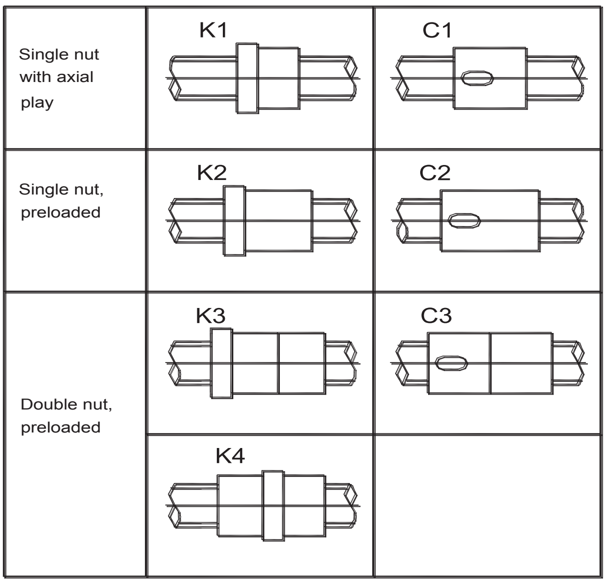
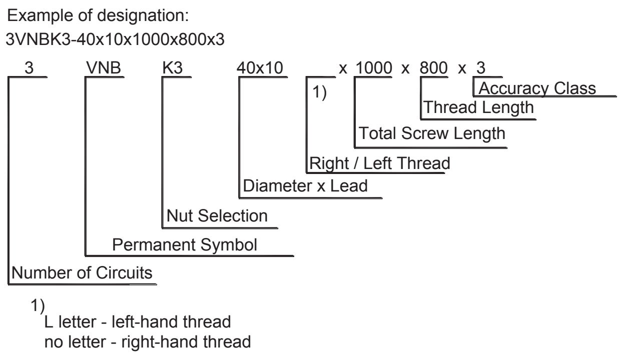


Fig. 2.2

The nuts are normally equipped with plastic wipers.
The diagram below shows the method of designation of AVIA standard ballscrews.



The symbol **3VNBK3-40x10x1000x800x3** designates preloaded double nut, with 3 start turns, nominal diameter 40 mm, right hand thread of 10 mm lead, total screw length of 1000 mm and thread length of 800 mm, accuracy class 3.

2. Materials and heat treatment

Tab. 2.11

Part Name	Material		Heat Treatment	Rockwell Hardness
	PN	DIN		
Screw	ŁH15	100Cr6	High-frequency hardening of thread	58-62
Nut	18HGM	20CrMo5	Carburizing and hardening of thread	58-62
	ŁH15	100Cr6	Hardening of thread	
Balls	ŁH15	100Cr6	-	62-65

Hardness of the screw ends is 170-235 HB (spheroidizing annealing). On special request, after confirmation by AVIA engineers, other materials can be used (with the exception of balls), for example stainless steel for the screw. In such cases the calculations of static load C_0 and dynamic load C ratings should be made with the consideration of surface hardness for the selected material. Calculation formulas are given in Chapter 3 of this booklet..

3. Selection Principles of AVIA Ballscrews

3.1 Overview

Determine the values of the following parameters for your application of a ballscrew:
- ballscrew nominal diameter
- pitch
- maximum pitch deviations (accuracy grade)
- screw length
- nut configuration
- maximum backlash (axial play); VNBK1, VNBC1
- preloading (VNBK2, VNBK3, VNBK4, VNBC2, VNBC3)

Consider selection criteria as follows:
- basic requirements for your application
- target life time under predicted load
- mechanical strength of ballscrew estimated during operation with torsional buckling, running with critical speed and under maximum expected axial forces
- required stiffness.

Basic ballscrew dimensions (i.e. nominal diameter, thread lead, screw length) should be based on general design of a device or machine, where the ballscrew is to be fitted.

Even at the preliminary stage of selection, the values of maximum static load, working load and stiffness recommended in Chapter 5 of this booklet might be a helpful indication.

If the detailed calculations show that the preselected values do not meet the requirements, the parameters should be adjusted as advised below:

1. Static or dynamic loads too low.
   - apply larger nominal diameter
   - increase the number of circuits in the nut
   - if possible introduce larger balls (and increase the lead)
2. Buckling load or critical speed parameters do not comply with the requirements.
   - apply larger nominal diameter
   - improve the mounting method (bearing arrangement)
3. Axial stiffness too low.
   - check the rigidity of ballscrew mounting method

- apply tension preloading
- apply larger nominal diameter
- increase the number of circuits in the nut
- increase the ballscrew preloading (affects the life time).

3.2 Mounting methods

Mounting and journal configurations depend on application (the structure of machine). So, when starting the project, the designer should be aware that the mounting method applied affects the stiffness, critical speed and permissible buckling load.
The four typical methods for mounting of a ballscrew are shown in Table 3.1.

Mounting method	k
2-0	$2.5 * 10^3$
1-1	$10 * 10^3$
2-1	$20 * 10^3$
2-2	$40 * 10^3$

Tab. 3.1

3.3 Permissible buckling load

Such ballscrews which operate under compression loads should be checked for buckling effect. Calculation may be done using Euler's formula (for steel $E = 2.1*10^6$ daN/cm^2):

$$F_{kr} = k \cdot \left(\frac{d_r^2}{l_0} \right)^2$$

where:
F_{kr} - critical force for buckling effect (daN)
d_r - root diameter of screw shaft (mm)
l_0 - theoretical length (mm)
k - factor for different mounting methods (see Table 3.1).

Theoretical length should be calculated as the distance between bearing supports of the screw or in case 2-0, as the distance from the bearing support to the unsupported end of the screw.
Maximum permissible axial load to avoid buckling effect F_{dop} is defined as follows:

$$F_{dop} = x \cdot F_{kr} > C_0$$

where:
x - safety factor (0.5 ÷ 0.8)
F_{kr} – (see Appendix 1, page 46)
C_0 - permissible static load of ballscrew

3.4 Critical speed

To avoid vibrations the ballscrew should be run with the speed lower than the first critical speed. Below is the equation for critical speed calculation of steel material
($E = 2.1 * 10^6$ daN/cm^2, $\gamma = 7.85 * 10^{-3}$ daN/cm^3):

$$n_{kr} = k \cdot \frac{d_r}{l_0^2}$$

where:
n_{kr} - critical speed (r.p.m.)
d_r - root diameter of screw shaft (mm)
l_0 - theoretical length (mm)
k - factor for different mounting methods (see Table 3.2).

Tab. 3.2

Mounting method	k
2-0	$43*10^6$
1-1	$121*10^6$
2-1	$189*10^6$
2-2	$274*10^6$

Permissible ballscrew speed is calculated as follows:

$$n_{dop} = x \cdot n_{kr}$$

where:
x = 0.8 – (safety factor)
n_{kr} – (see Appendix 2, page 47)

3.5 Operation load

Operation load for a ballscrew means the average force, between the screw and nut, applied axially.
The force may be either constant or variable.
In case of variable load there are two categories; F_{max} the maximum value, and F_m the average value, According to the equation below:

$$F_m = \left(\frac{F_1^3 n_1 t_1 + F_2^3 n_2 t_2 + \ldots F_i^3 n_i t_i}{n_1 t_1 + n_2 t_2 + n_i t_1} \right)^{1/3} daN$$

where:
- F_1, F_2 ... F_i [daN] - the loads
- n_1, n_2 ... n_i [r.p.m.] - the speeds
- t_1, t_2 ... t_i [%] - time ratios

The equation:

$$n_z = \frac{n_1 t_1 + n_1 t_1 + \ldots + n_i t_i}{100} \text{ r.p.m.}$$

defines so called equivalent number of revolutions.
In case of static loads it is determinant to compare the maximum load F_m with static load C_0, and in case of variable loads to compare F_m load with C the dynamic load, taking into account also the required life time of the ballscrew.
Notice: Contact our engineers for recommendations if loads other than axial occur.

3.6 Basic static load

Basic static load C_0 is the force causing the ball track deformation which is equal to ball diameter multiplied by 10^{-4}. The relation between maximum static load F_{max} and theoretical parameter C_0 is shown below,

$$f_{ho} \cdot C_0 \geq F_{max} \cdot f_d$$

where:
f_{h0} - conformity factor related to ball track hardness (see Table 3.3)
f_d - conformity factor related to load characteristics (see Table 3.4)

Tab. 3.3

Hardness HRC	≥58	56	54	52
f_{h0}	1	0,92	0,82	0,73
Hardness HRC	50	45	40	30
f_{h0}	0,65	0,47	0,37	0,21

Tab. 3.4

Operating conditions	f_d
Running loads with no vibrations	0.5
Standard working conditions, static loads	1
Variable loads	1.5÷2
Impact loads	>2

The product of f_{ho} * C_0 is the basic static load of a ballscrew, reduced due to real ball track hardness, and the product of F_{max} * F_d is the theoretical maximum static load, reduced due to expected lifetime.

3.7 Basic dynamic load, expected lifetime

The main factor causing wear-out of a ballscrew is metal fatigue. Useful lifetime is the period of time when the contact surfaces of a ballscrew are not worn.
Expected lifetime of a ballscrew is given either as running speed L or as running hours L_h.
Consider the following ratio between lifetime and the load:

$$\frac{L_1}{L_2} = \left(\frac{F_2}{F_1} \right)^3$$

Basic dynamic load C is the constant load which enables the conventional ballscrew to run 1 * 10^6 revolutions. Expected lifetime for such ballscrew loaded with constant force F is:

$$L = \left(\frac{C}{F} \right)^3 \cdot 10^6 \text{revolutions}$$

Select the ballscrew for a specific application using the following formula:

$$C_{red} \geq f_N \cdot F_{red}$$

where:
C_{red} - dynamic load, reduced
F_{red} - force, reduced

$$f_N = \sqrt[3]{\frac{L}{10^6}}$$

f_N - reliability factor conforming the required lifetime (L - revolutions)

If the surface hardness is below 58 HRC, the basic dynamic load should be re-calculated (usually in case of non-standard materials applied).
Factor f_h depends on the ball track hardness, see Table 3.5.

Tab. 3.5

Hardness HRC	≥58	56	54	52
f_h	1	0,87	0,76	0,67
Hardness HRC	50	45	40	30
f_h	0,58	0,43	0,33	0,18

Operation life of a ballscrew is limited mainly by the lifetime of its' ball. In such case the dynamic load should be re-calculated with the use of f_p factor, related to the travel measure, i.e.

$\frac{l_u}{i \cdot P}$ where:
l_u - nut travel
i - number of circuits
P - lead

Tab. 3.6

$\frac{l_u}{i \cdot P}$	>1	to 1.2	to 1.4	to 1.6
f_p	0,77	0,80	0,85	0,88
$\frac{l_u}{i \cdot P}$	do 2,0	do 2.5	do 3,0	>3,0
f_p	0,91	0,94	0,97	1,0

Calibrated static load is:

$$C_{red} = f_h \cdot f_p \cdot C$$

In order to determine the reduced load F_{red} it is necessary to use average load parameter F_m, as calculated in par. 3.5.

If the ballscrew is working under variable loads, shocks or vibrations, it should be taken into account. Factor f_d relates to the operating conditions.

Tab. 3.7

Working conditions	f_d
Uniform loads	1,0÷1,2
Variable loads	1,2÷1,5
Impacts and vibrations	1,5÷3,0

Reduced load F_{red} is:

$$F_{red} = f_d \cdot F_m$$

Finally the basic dynamic load C is related as follows:

$$f_h \cdot f_p \cdot C \geq f_N \cdot f_d \cdot F_m$$

Caution: Expected lifetime calculations (basic dynamic load as well) should be performed for only one direction of forces applied to the screw and the nut. Only special applications may require the consideration of bi-directional forces in full working range. With the assumed lifetime L, you should assign the higher value of the two calculated for dynamic load C. If the dynamic load C is assumed, then the lower value of the two calculated as L parameters should be taken. See below the relation between expected lifetime in number of revolutions (L) and running hours (L_h).

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

where:
n_z - average number of revolutions (r.p.m.) according to par. 3.5.

With the assumed lifetime in hours (L_h), the required dynamic load is:

$$C_{red} \geq F_{red} \sqrt[3]{\frac{L_h \cdot 60 \cdot n_z}{10^6}}$$

and finally,

$$C \geq \frac{f_d}{f_n f_p} \cdot 0.01 \cdot \sqrt[3]{\sum_1^i \left(F_i^3 \cdot n_i \cdot q_i\right) \cdot 0.6 \cdot L_h}$$

3.8 Stiffness

Stiffness (R) is defined as follows,

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

For ballscrews the material deformation δ is basically described as a sum of deformations of screw, nut, screw bearing supports, nut mounting and ball-track contact deflections:

$$\delta = \delta_s + \delta_n + \delta_l + \delta_z + \delta_k$$

Usually the leading component is the screw deformation,

$$\delta_s = \frac{F \cdot l}{E \cdot A}$$

where:
F - axial load
l - working range distance
E - modulus of elasticity
A - cross section

Screw deformation may be considerably reduced by supporting the both ends and applying tension preloading, which is illustrated in Fig. 3.1 (for a given F load):

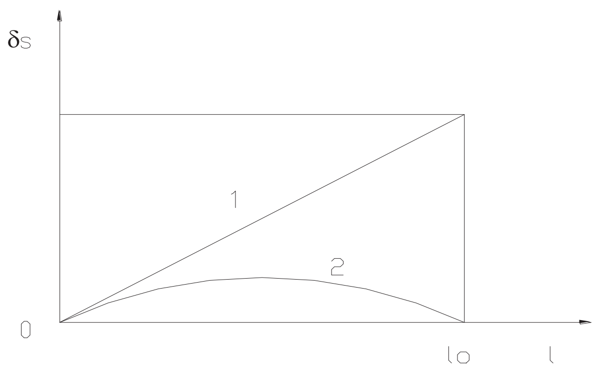


Fig. 3.1 1 - without preloading
2 - with preloading

Here the maximum screw deformation is:

$$\delta_s = \frac{F \cdot l_0}{4 \cdot E \cdot A}$$

Ball-track contact deformation δ_k is usually non-linear function of load F. For the single nut with no preloading, the relationship is as follows:

$$\delta_k = a \cdot F^{2/3}$$

where: a - factor related to various design parameters

Summarizing:

a) Preloading should be only as high as necessary, and as low as possible.
b) Applying working torque not bigger than tripled value of preloading does not eliminate the preload effect completely („zero preload").

The maximum preloading value can be defined as:

$$F_n = 0.15 \cdot C$$

c) where:
C - dynamic load capacity of a ballscrew

For other preloading values F_n‘ the stiffness R' is,

$$R' = \left(\frac{F_n'}{0.1 \cdot C} \right)^{1/3}$$

Stiffness values given in Chapter 5 relate to the ballscrews in accuracy grade 1 and 3. For grade 5 the stiffness value should be reduced by 10%. In addition, the stiffness will be lower if the nut is mounted in a housing.

3.9 Preload drag torque

If the screw of a ballscrew preloaded with F_n force is rotated against the nut with no external axial force, the ballscrew shows some resistance which is defined in torque units (Nm), and is called the preload drag torque T.
See Fig. 3.2 for the real torque curve in relation to the tolerance limits. Table 3.8 shows the permissible torque deviations dT_{p0} against nominal values T_{p0},

in %, which depend on slenderness ratio and accuracy grade of a ballscrew.

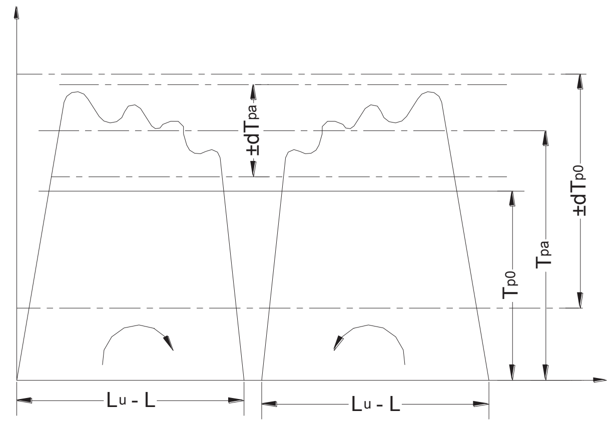


Fig. 3.2

L_u - useful travel of a nut
L - nut length
T_{p0} - basic drag torque
dT_{p0} - permissible variation of basic preload drag torque T_{po}
T_{pa} - mean actual drag torque
DT_{pa} - variation value of actual drag torque

Table 3.8

Basic drag torque		Permissible variation dT_{p0} (%)		
		Accuracy grade		
		1	3	5
T_{p0} (Nm) above	up to	For $\frac{l_u}{d_0} \leq 40$		
	0.4	35	40	50
0.4	0.6	30	35	40
0.6	1.0	25	30	35
1.0	2.5	20	25	30
2.5	6.3	15	20	25
6.3		-	15	20
above	up to	For $\frac{l_u}{d_0} \leq 60$		
	0.4	40	50	60
0.4	0.6	35	40	45
0.6	1.0	30	35	40
1.0	2.5	25	30	35
2.5	6.3	20	25	30
6.3		-	20	25
above	up to	For $\frac{l_u}{d_0} > 60$		
	0.6	n.a.		
0.6	1.0	-	40	45
1.0	2.5	-	35	40
2.5	6.3	-	30	35
6.3		-	25	30

4.0 Recommendations for the user

4.1 Ballscrew selection procedure

To order ballscrews please complete the following questionnaire:

QUESTIONNAIRE
FOR SELECTION OF AVIA BALLSCREWS

1.The buyer (company name, tel., fax).

2.Application field (machine type)

3.Dimensions
Nominal diameter mm
Lead mm
Right-hand/Left-hand thread
Thread length mm
Total length mm

4.Nut selection

5.Required operating parameters
Thread accuracy grade
Required lead deviation
Preload drag torque Nm
Required stiffness daN/um
Permissible axial play mm

6.Supplementary information
Environment contamination
Operating temperature range
Lubricants
Applied load type
Maximum speed r.p.m

7.Special requirements

4.2 Shaft end design

1. Shaft ends are basically made according to customer requirements. However, there are some limitations due to manufacturing and assembly conditions. Recommended shaft end configurations are shown in Fig. 4.1 and in Table 4.1.
2. Standard fine thread is of class 6g. Other grades are available on request. Recommended dimensions of mounting threads for shaft ends are: M15x1, M17x1, M20x1, M25x1.5, M30x1.5, M35x1.5, M40x1.5, M45x1.5, M50x1.5, M55x2, M60x2, M65x2.

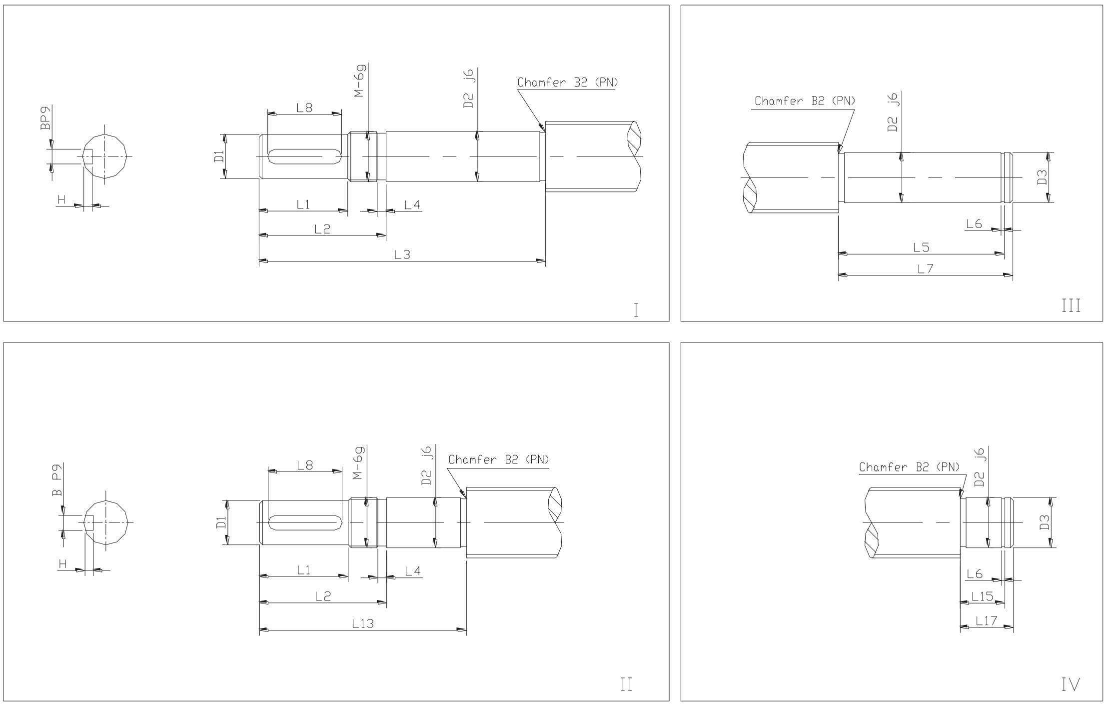


Fig. 4.1

Tab. 4.1

do	D1	D2	D3	M	L1	L2	L3	L13	L4	L5	L15	L6	L7	L17	L8	B(P9)	H
20	10	12	11.5	M12x1.0	25	36	86	59	2	51	12	1.1	55	16	20	4	2.5
25	15	17	16.2	M17x1.0	30	43	97	70	2	52.1	14	1.1	59	18	25	5	3.0
32	15	20	19.0	M20x1.0	40	55	111	84	2	52.1	15	1.3	62	20	28	6	3.5
40	25	30	28.6	M30x1.5	50	70	136	106	3	52.1	19	1.6	75	24	36	8	4.0
50	36	40	37.5	M40x1.5	60	84	175	128	3	52.1	23	1.85	100	30	40	12	5.0
63	40	50	47.0	M50x1.5	70	98	205	150	3	52.1	27	2.15	117	35	50	14	5.5
80	55	60	57.0	M60x2.0	80	109	228	168	4	52.1	31	2.15	130	39	63	18	6.0

4.3 Ballscrew mounting method

Nut mounting method should ensure high axial stiffness. It is recommended to utilize as few carrying elements as possible, which results in higher rigidity of support.
Flanged nuts (VNBK1, VNBK2, VNBK3 and VNBK4) do not require a special mounting. They can be fixed directly to the machine frame, through holes in the flange. Reference surface is either the fitted diameter related with the frame hole (H7/g6) or in case of free mounting in the hole, the face of the frame (see Fig. 4.2).
No-flange nuts (VNBC1, VNBC2 and VNBC3) require a housing with key groove (Fig. 4.3).

Bearing mounting method should ensure rigid support with minimum deflection and maximum vibration resistance. Ballscrews operated at constant ambient temperatures are recommended to be supported at both ends, with preloading applied. See examples shown in Fig. 4.4.

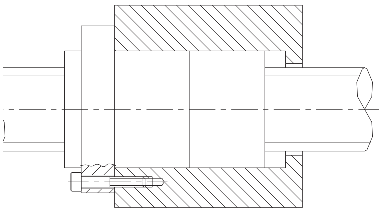


Fig. 4.2

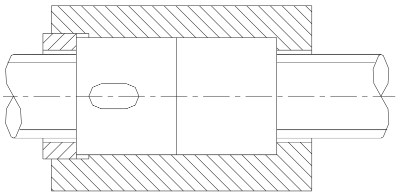


Fig. 4.3

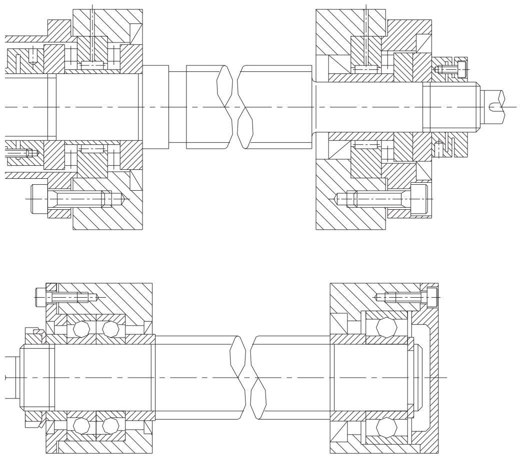


Fig. 4.4

4.4 Dust protection

Ballscrews should be protected during operation against dust or metallic debris. If the ballscrew is mounted inside a machine frame or working conditions are not hazardous, no special means of protection are required.
Under standard circumstances it is usually sufficient to provide wipers touching the screw thread and closing the nut, which however calls for longer nut.
Special applications, where the dust contamination in the air is high and/or corrosive agents exist, require additional protection for the whole ballscrew length, in the form of telescopic or bellow-type covers.

4.5 Assembly

The ballscrew must be assembled completely with the ball-nut by its manufacturer. Disassembly of the ball-nut by a user is forbidden. Over-traveling of the nut is also forbidden, as it results in balls come-out of the nut. Run-out of the ball nut axis and bearing holes must not exceed 0.01 mm.
Permissible out of squarness between screw centerline and mounting surface of the nut is 0.01/100 mm.

Mounting surfaces must be carefully cleaned and the fixing bolts should be tightened uniformly. It is not allowed to hammer the ball nut into the seating hole. It is not allowed to use mounting holes of the nut as a guide for drill. Threaded holes in the frame should have a chamfer.

4.6 Storage

The ballscrews should be stored with anti-rust protection film, originally packed by the manufacturer. Before application at the workshop they should be kept in vertical position to avoid bending.

4.7 Lubrication

Lubrication of a ballscrew is required for all applications to provide thin overlay, separating the running surfaces, in order to minimize the wear-out. The purpose of lubrication is also smooth running, lower friction and better anti-rust protection. The same lubricants may be used for ballscrews as for ball bearings. Take care to apply clean lubricant. The selection of lubrication method and lubricant type depend on the design, rotation speed, loads, ambient and working temperatures, maintenance periods, dust protection, etc.

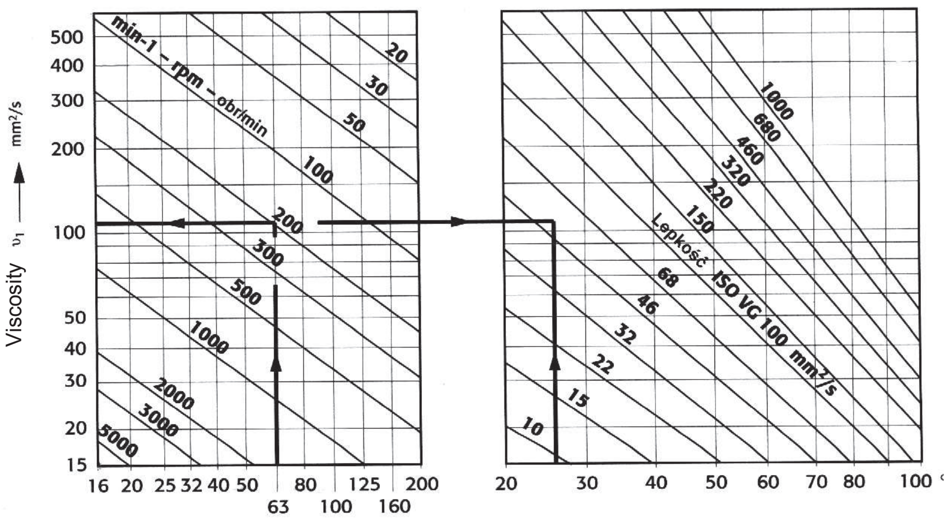
Using grease is convenient as it simplifies the design, and enables the application of simple anti-dust protection, and saves maintenance time. Also it helps in sealing the nut interior and makes the ballscrew running smoother. Thus, it is recommended to apply grease in all cases where the speed and operating temperature are not too high. For heavy loads and low speeds the greases of higher viscosity are required. The grease should fill up 1/3 ÷ 1/2 of internal space of the nut. For most applications it is sufficient to apply grease once or twice a year.
Oil is the best lubricant for ballscrews. It is used when other parts of the machine are also lubricated with oil or if the rotation speed is too high for using grease.

Oil selection for various nominal diameters, speeds and operating temperatures are shown in the chart. In the table below are presented recommended oils. Oil must be free from acid and corrosive agents. It should have anti-foam and anti-aging properties.

4.8 Typical defects of ballscrews

Malfunctions of a ballscrew may be caused by:
- nut come-out of the screw thread
- incorrect assembly
- material defects
- overload
- seizing due to dirt

In any case, the use should never attempt to replace any damaged or worn part of the ballscrew. The only exception is wiper.

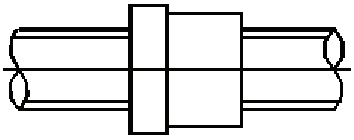
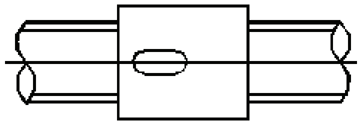
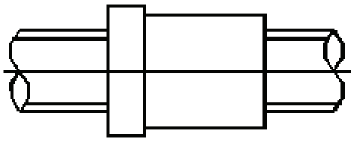
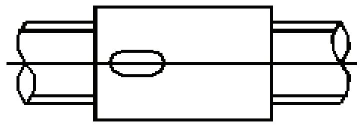
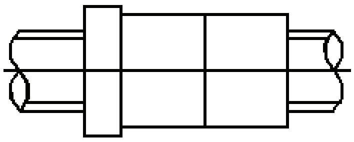
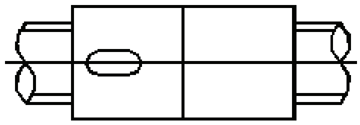
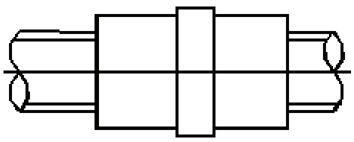


Pitch diameter

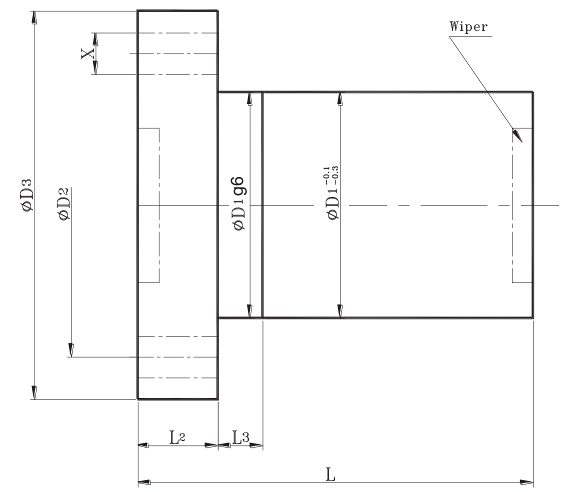
Operating temperature

Viscosity ISO	DIN 1517	CASTROL	ELF	MOBIL
VG 68	CL 68 CLP 68	Hyspin AWS 68 Alpha SP 68	Polytelis 68 Moglia 68	Vactra Oil Heavy Medium Mobilgear 626/ Vactra Oil No.2
VG 100	CI 100 CLP 100	Hyspin AWS 100 Alpha SP 100	Polytelis 100 Moglia 100	Vactra Oil Heavy Mobilgear 627
VG 150	CL 150 CLP 150	Alpha SP 150 Alpha SP 150	Polytelis 150 Moglia 150	Vactra Oil Extra Heavy Mobilgear 627
VG 200	CL 220 CLP 220	Alpha SP 220 Alpha SP 220	Polytelis 220 Moglia 220	Mobil DTE Oil BB Mobilgear 626/ Vactra Oil No.4

5.0 Selection of standard AVIA nuts

Single nut with axial play	K1  page 19 - 22	C1  page 35 - 38
Single nut preloaded	K2  page 23 - 26	C2  page 39 - 42
Double nut preloaded	K3  page 27 - 30	C3  page 43 - 46
	K4  page 31 - 34	

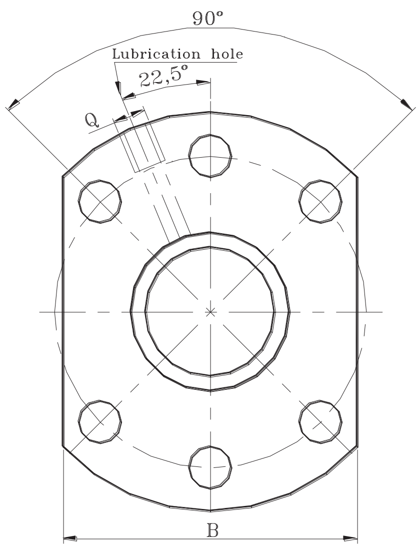
Type K1

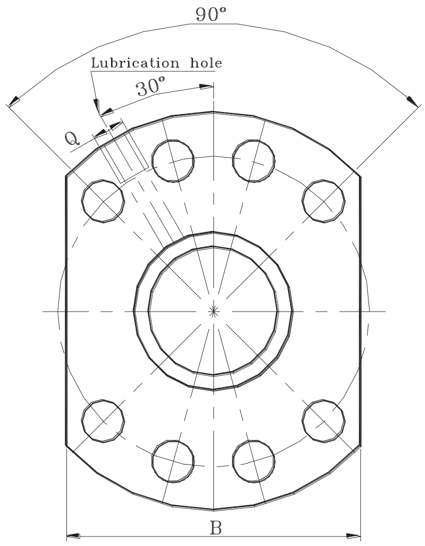


Model	Size		Ball Dia.	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Max. axial play [mm]
	Nominal Dia. d_0	Lead p					
3VNBK1 16x5	16	5	3.175	3	944	1350	0.02
3VNBK1 20x5	20	5	3.175	3	1080	1790	
4VNBK1 20x5				4	1430	2390	
3VNBK1 25x5	25	5	3.175	3	1200	2350	
4VNBK1 25x5				4	1590	3200	
3VNBK1 25x6		6	3.969	3	1320	2820	
4VNBK1 25x6				4	1650	3810	
3VNBK1 25x10		10	3.969	3	1680	3730	
3VNBK1 32x5	32	5	3.175	3	1190	3250	
4VNBK1 32x5				4	1470	4240	
6VNBK1 32x5				6	2150	6240	
3VNBK1 32x6		6	3.969	3	1550	3890	
4VNBK1 32x6				4	1950	5100	
6VNBK1 32x6				6	2770	7800	
3VNBK1 32x8		8	5.556	3	2090	4700	
4VNBK1 32x8				4	2800	6500	
3VNBK1 32x10		10	6.0	3	2420	5200	
4VNBK1 32x10				4	3160	6850	
3VNBK1 32x12		12	6.0	3	2420	5200	
4VNBK1 32x12				4	3160	6850	
4VNBK1 40x5	40	5	3.175	4	1650	5420	
6VNBK1 40x5				6	2350	8050	
4VNBK1 40x6		6	3.969	4	2180	6680	
6VNBK1 40x6				6	3100	9700	
4VNBK1 40x10-Z		10	6.0	4	4320	8600	
6VNBK1 40x10-Z				6	6220	15400	
3VNBK1 40x12-Z		12		3	3700	7950	
4VNBK1 40x12-Z				4	4320	8600	
3VNBK1 40x16-Z		16		3	3780	8040	
3VNBK1 40x20		20		3	2900	7480	

Z - external recirculation of balls

i = 6 for $d_0 \leq 32$; i = 8 for d_0 >32



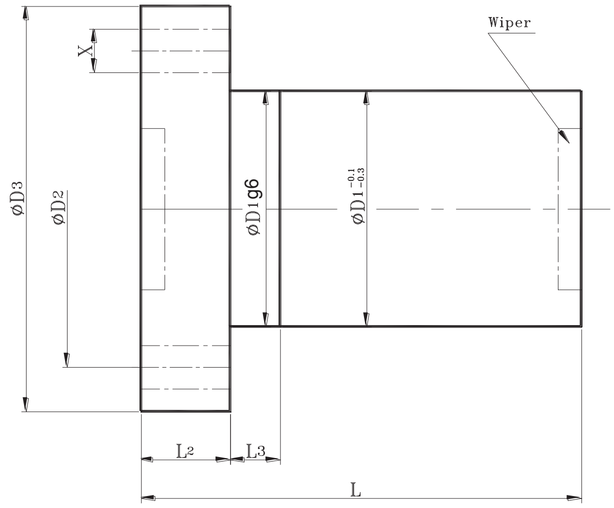


Nut									Model
D1	**D2**	**D3**	**L**	**L2**	**L3**	**i * X**	**B**	**Q**	
36	47	58	43	10	10	6.6	44	M6	3VNBK1 16x5
36	47	58	43	10	10	6.6	44	M6	3VNBK1 20x5
			48						4VNBK1 20x5
40	51	62	44	10	10	6.6	48	M6	3VNBK1 25x5
			49						4VNBK1 25x5
40	51	62	49	10	12	6.6	48	M6	3VNBK1 25x6
			55						4VNBK1 25x6
40	51	62	66	10	12	6.6	48	M6	3VNBK1 25x10
50	65	80	46	12	10	9	62	M6	3VNBK1 32x5
			52						4VNBK1 32x5
			62						6VNBK1 32x5
50	65	80	51	12	12	9	62	M6	3VNBK1 32x6
			57						4VNBK1 32x6
			70						6VNBK1 32x6
50	65	80	60	12	14	9	62	M6	3VNBK1 32x8
			71						4VNBK1 32x8
50	65	80	69	12	16	9	62	M6	3VNBK1 32x10
			80						4VNBK1 32x10
50	65	80	75	12	16	9	62	M6	3VNBK1 32x12
			88						4VNBK1 32x12
63	78	93	55	14	10	9	70	M8x1	4VNBK1 40x5
			65						6VNBK1 40x5
63	78	93	61	14	12	9	70	M8x1	4VNBK1 40x6
			73						6VNBK1 40x6
63	78	93	70	14	14	9	70	M8x1	4VNBK1 40x10-Z
			90						6VNBK1 40x10-Z
63	78	93	66	14	16	9	70	M8x1	3VNBK1 40x12-Z
			78						4VNBK1 40x12-Z
63	78	93	78	14	16	9	70	M8x1	3VNBK1 40x16-Z
63	78	93	105.5	14	16	9	70	M8x1	3VNBK1 40x20

Z - external recirculation of balls

i = 6 for $d_0 \le 32$; i = 8 for $d_0 > 32$

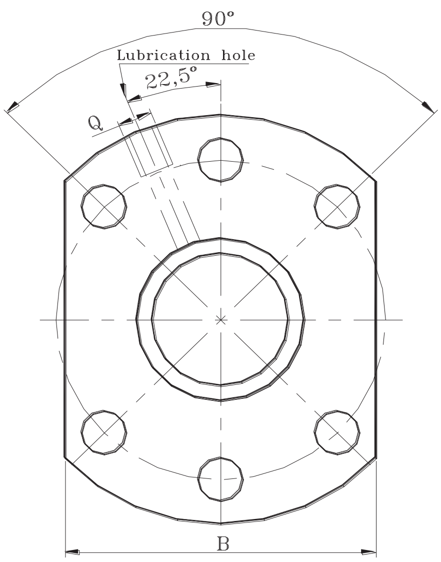
Type K1

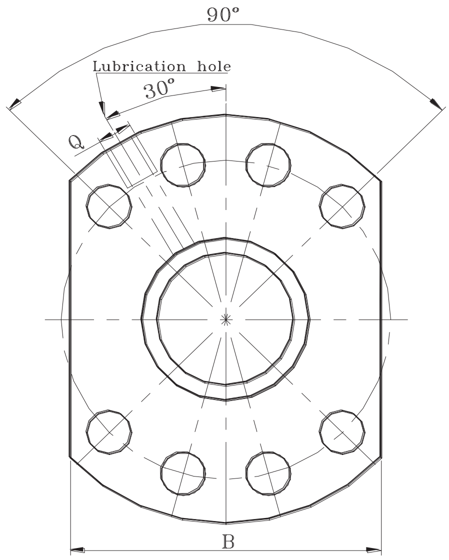


Model	Size: Nominal Dia. d_0	Size: Lead p	Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Max. axial play [mm]
4VNBK1 50x5	50	5	3.175	4	1810	7200	0.02
6VNBK1 50x5				6	2800	11900	
4VNBK1 50x6		6	3.969	4	2680	8450	
6VNBK1 50x6				6	3500	13000	
4VNBK1 50x8		8	5.556	4	3680	11160	
6VNBK1 50x8				6	5690	16850	
3VNBK1 50x10-Z		10	6.0	3	3620	10540	
4VNBK1 50x10-Z				4	4470	13870	
6VNBK1 50x10-Z				6	7500	21510	
3VNBK1 50x12-Z		12	6.0	3	3620	10540	
4VNBK1 50x12-Z				4	4470	13870	
3VNBK1 50x16		16	7.938	3	4510	11290	
3VNBK1 50x20		20	7.938	3	4560	11370	
4VNBK1 63x6	63	6	3.969	4	2660	10800	
6VNBK1 63x6				6	3770	17000	
4VNBK1 63x8		8	5.556	4	3540	13200	
6VNBK1 63x8				6	5400	21860	
4VNBK1 63x10		10	6.0	4	5470	15570	
6VNBK1 63x10				6	6470	23350	
4VNBK1 63x12		12	7.938	4	6640	20100	
6VNBK1 63x12				6	9490	30600	
3VNBK1 63x20		20	9.525	3	8530	23650	
4VNBK1 80x10	80	10	6.0	4	5200	20410	
6VNBK1 80x10				6	7250	30620	
4VNBK1 80x12		12	7.938	4	7550	26120	
6VNBK1 80x12				6	10700	39200	
3VNBK1 80x16		16	9.525	3	7500	27450	
4VNBK1 80x16				4	12850	42600	
3VNBK1 80x20		20	9.525	3	7500	27450	
4VNBK1 80x20				4	12850	42600	

Z - external recirculation of balls

i = 6 for $d_0 \leq 32$; i = 8 for $d_0 > 32$



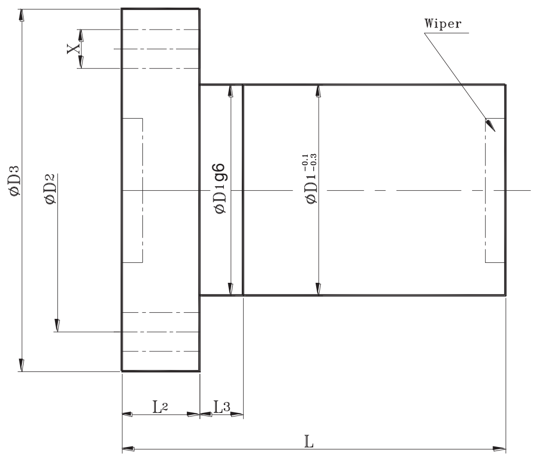


Nut									Model
D1	D2	D3	L	L2	L3	i *X	B	Q	
75	93	110	57	16	10	11	85	M8x1	4VNBK1 50x5
			67						6VNBK1 50x5
75	93	110	63	16	12	11	85	M8x1	4VNBK1 50x6
			75						6VNBK1 50x6
75	93	110	74	16	14	11	85	M8x1	4VNBK1 50x8
			91						6VNBK1 50x8
75	93	110	74	16	16	11	85	M8x1	3VNBK1 50x10-Z
			85						4VNBK1 50x10-Z
			106						6VNBK1 50x10-Z
75	93	110	84	16	18	11	85	M8x1	3VNBK1 50x12-Z
			97						4VNBK1 50x12-Z
75	93	110	100	16	20	11	85	M8x1	3VNBK1 50x16
75	93	110	118	16	20	11	85	M8x1	3VNBK1 50x20
90	108	125	65	18	12	11	95	M8x1	4VNBK1 63x6
			77						6VNBK1 63x6
90	108	125	76	18	14	11	95	M8x1	4VNBK1 63x8
			93						6VNBK1 63x8
90	108	125	87	18	16	11	95	M8x1	4VNBK1 63x10
			108						6VNBK1 63x10
90	108	125	99	18	18	11	95	M8x1	4VNBK1 63x12
			124						6VNBK1 63x12
95	115	135	122	20	25	13.5	100	M8x1	3VNBK1 63x20
105	125	145	89	20	16	13.5	110	M8x1	4VNBK1 80x10
			110						6VNBK1 80x10
105	125	145	101	20	18	13.5	110	M8x1	4VNBK1 80x12
			126						6VNBK1 80x12
125	145	165	117	25	22	13.5	130	M8x1	3VNBK1 80x16
			129						4VNBK1 80x16
125	145	165	129	25	25	13.5	130	M8x1	3VNBK1 80x20
			151						4VNBK1 80x20

Z - external recirculation of balls

i = 6 for $d_0 \leq 32$; i = 8 for $d_0 > 32$

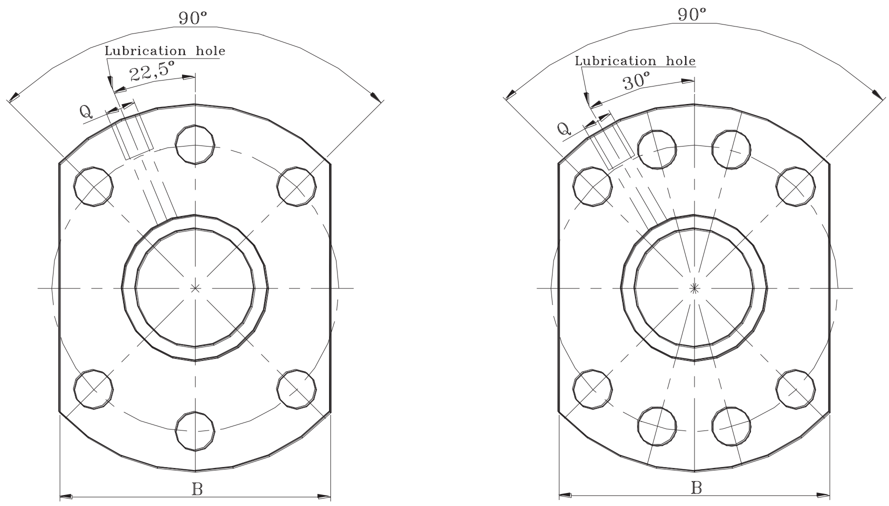
Type K2



Model	Size		Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/μm]
	Nominal Dia. d_0	Lead p					
3VNBK2 16x5	16	5	3.175	3	944	1350	11
3VNBK2 20x5	20	5	3.175	3	1080	1790	20
4VNBK2 20x5				4	1430	2390	27
3VNBK2 25x5	25	5	3.175	3	1200	2350	28
4VNBK2 25x5				4	1590	3200	37
3VNBK2 25x6		6	3.969	3	1320	2820	28
4VNBK2 25x6				4	1650	3810	37
3VNBK2 25x10		10	3.969	3	1680	3730	25
3VNBK2 32x5	32	5	3.175	3	1190	3250	38
4VNBK2 32x5				4	1470	4240	51
6VNBK2 32x5				6	2150	6240	76
3VNBK2 32x6		6	3.969	3	1550	3890	33
4VNBK2 32x6				4	1950	5100	43
6VNBK2 32x6				6	2770	7800	65
3VNBK2 32x8		8	5.556	3	2090	4700	35
4VNBK2 32x8				4	2800	6500	47
3VNBK2 32x10		10	6.0	3	2420	5200	35
4VNBK2 32x10				4	3160	6850	48
3VNBK2 32x12		12	6.0	3	2420	5200	33
4VNBK2 32x12				4	3160	6850	45
4VNBK2 40x5	40	5	3.175	4	1650	5420	50
6VNBK2 40x5				6	2350	8050	74
4VNBK2 40x6		6	3.969	4	2180	6680	50
6VNBK2 40x6				6	3100	9700	74
4VNBK2 40x10-Z		10	6.0	4	4320	8600	72
6VNBK2 40x10-Z				6	6220	15400	108
3VNBK2 40x12-Z		12		3	3700	7950	51
4VNBK2 40x12-Z				4	4320	8600	68
3VNBK2 40x16-Z		16		3	3780	8040	51
3VNBK2 40x20		20		3	2900	7480	47

Z - external recirculation of balls

i = 6 for $d_0 \leq 32$; i = 8 for $d_0 > 32$

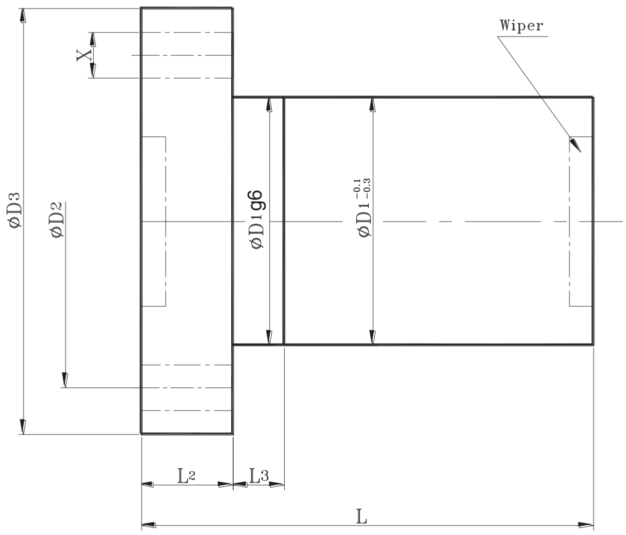


Nut									Model
D1	D2	D3	L	L2	L3	i * X	B	Q	
36	47	58	43	10	10	6.6	44	M6	3VNBK2 16x5
36	47	58	43	10	10	6.6	44	M6	3VNBK2 20x5
			48						4VNBK2 20x5
40	51	62	44	10	10	6.6	48	M6	3VNBK2 25x5
			49						4VNBK2 25x5
40	51	62	49	10	12	6.6	48	M6	3VNBK2 25x6
			55						4VNBK2 25x6
40	51	62	66	10	12	6.6	48	M6	3VNBK2 25x10
50	65	80	46	12	10	9	62	M6	3VNBK2 32x5
			52						4VNBK2 32x5
			62						6VNBK2 32x5
50	65	80	51	12	12	9	62	M6	3VNBK2 32x6
			57						4VNBK2 32x6
			70						6VNBK2 32x6
50	65	80	60	12	14	9	62	M6	3VNBK2 32x8
			71						4VNBK2 32x8
50	65	80	69	12	16	9	62	M6	3VNBK2 32x10
			80						4VNBK2 32x10
50	65	80	75	12	16	9	62	M6	3VNBK2 32x12
			88						4VNBK2 32x12
63	78	93	55	14	10	9	70	M8x1	4VNBK2 40x5
			65						6VNBK2 40x5
63	78	93	61	14	12	9	70	M8x1	4VNBK2 40x6
			73						6VNBK2 40x6
63	78	93	70	14	14	9	70	M8x1	4VNBK2 40x10-Z
			90						6VNBK2 40x10-Z
63	78	93	66	14	16	9	70	M8x1	3VNBK2 40x12-Z
			78						4VNBK2 40x12-Z
63	78	93	78	14	16	9	70	M8x1	3VNBK2 40x16-Z
63	78	93	105.5	14	16	9	70	M8x1	3VNBK2 40x20

Z - external recirculation of balls

i = 6 for $d_0 \leq 32$; i = 8 for $d_0 > 32$

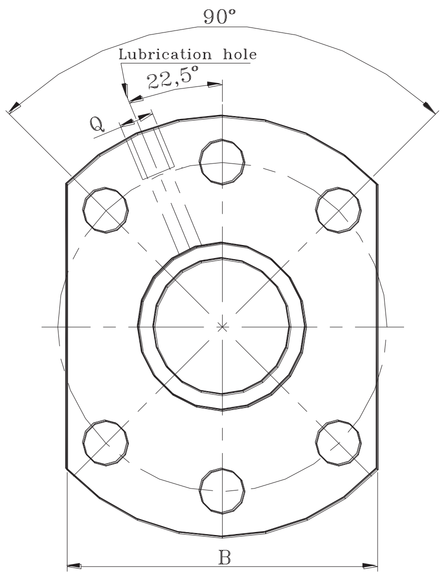
Type K2

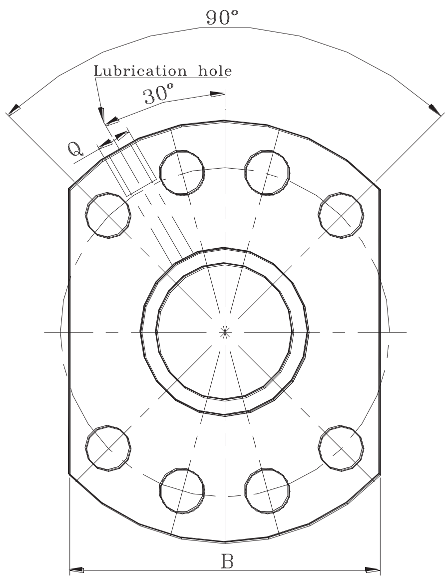


Model	Size		Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/μm]
	Nominal Dia. d_0	Lead p					
4VNBK2 50x5	50	5	3.175	4	1810	7200	62
6VNBK2 50x5				6	2800	11900	91
4VNBK2 50x6		6	3.969	4	2680	8450	62
6VNBK2 50x6				6	3500	13000	93
4VNBK2 50x8		8	5.556	4	3680	11160	62
6VNBK2 50x8				6	5690	16850	92
3VNBK2 50x10-Z		10	6.0	3	3620	10540	50
4VNBK2 50x10-Z				4	4470	13870	63
6VNBK2 50x10-Z				6	7500	21510	94
3VNBK2 50x12-Z		12	6.0	3	3620	10540	50
4VNBK2 50x12-Z				4	4470	13870	63
3VNBK2 50x16		16	7.938	3	4510	11290	49
3VNBK2 50x20		20	7.938	3	4560	11370	47
4VNBK2 63x6	63	6	3.969	4	2660	10800	75
6VNBK2 63x6				6	3770	17000	113
4VNBK2 63x8		8	5.556	4	3540	13200	77
6VNBK2 63x8				6	5400	21860	114
4VNBK2 63x10		10	6.0	4	5470	15570	79
6VNBK2 63x10				6	6470	23350	115
4VNBK2 63x12		12	7.938	4	6640	20100	78
6VNBK2 63x12				6	9490	30600	113
3VNBK2 63x20		20	9.525	3	8530	23650	75
4VNBK2 80x10	80	10	6.0	4	5200	20410	96
6VNBK2 80x10				6	7250	30620	140
4VNBK2 80x12		12	7.938	4	7550	26120	97
6VNBK2 80x12				6	10700	39200	141
3VNBK2 80x16		16	9.525	3	7500	27450	95
4VNBK2 80x16				4	12850	42600	130
3VNBK2 80x20		20	9.525	3	7500	27450	95
4VNBK2 80x20				4	12850	42600	125

Z - external recirculation of balls

i = 6 for $d_0 \leq 32$; i = 8 for $d_0 > 32$



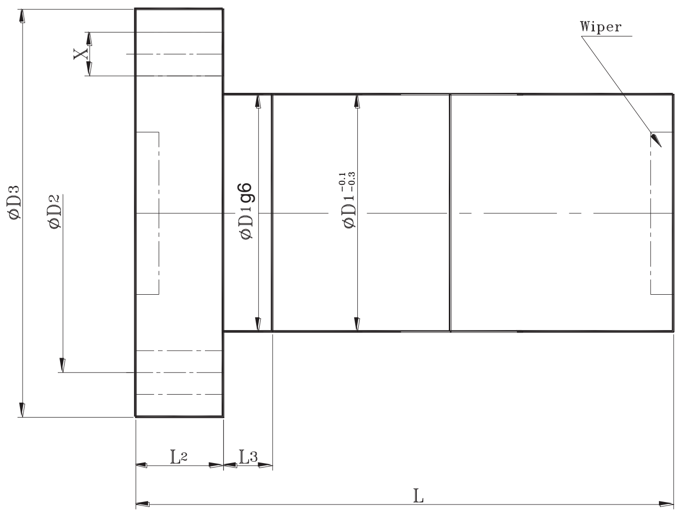


Nut									Model
D1	D2	D3	L	L2	L3	i * X	B	Q	
75	93	110	57	16	10	11	85	M8x1	4VNBK2 50x5
			67						6VNBK2 50x5
75	93	110	63	16	12	11	85	M8x1	4VNBK2 50x6
			75						6VNBK2 50x6
75	93	110	74	16	14	11	85	M8x1	4VNBK2 50x8
			91						6VNBK2 50x8
75	93	110	74	16	16	11	85	M8x1	3VNBK2 50x10-Z
			85						4VNBK2 50x10-Z
			106						6VNBK2 50x10-Z
75	93	110	84	16	18	11	85	M8x1	3VNBK2 50x12-Z
			97						4VNBK2 50x12-Z
75	93	110	100	16	20	11	85	M8x1	3VNBK2 50x16
75	93	110	118	16	20	11	85	M8x1	3VNBK2 50x20
90	108	125	65	18	12	11	95	M8x1	4VNBK2 63x6
			77						6VNBK2 63x6
90	108	125	76	18	14	11	95	M8x1	4VNBK2 63x8
			93						6VNBK2 63x8
90	108	125	87	18	16	11	95	M8x1	4VNBK2 63x10
			108						6VNBK2 63x10
90	108	125	99	18	18	11	95	M8x1	4VNBK2 63x12
			124						6VNBK2 63x12
95	115	135	122	20	25	13.5	100	M8x1	3VNBK2 63x20
105	125	145	89	20	16	13.5	110	M8x1	4VNBK2 80x10
			110						6VNBK2 80x10
105	125	145	101	20	18	13.5	110	M8x1	4VNBK2 80x12
			126						6VNBK2 80x12
125	145	165	117	25	22	13.5	130	M8x1	3VNBK2 80x16
			129						4VNBK2 80x16
125	145	165	129	25	25	13.5	130	M8x1	3VNBK2 80x20
			151						4VNBK2 80x20

Z - external recirculation of balls

$i = 6$ for $d_0 \leq 32$; $i = 8$ for $d_0 > 32$

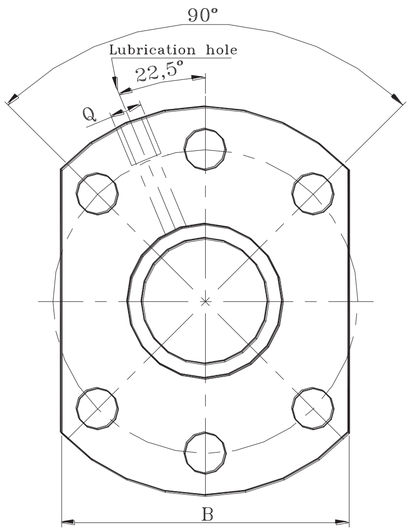
Type K3

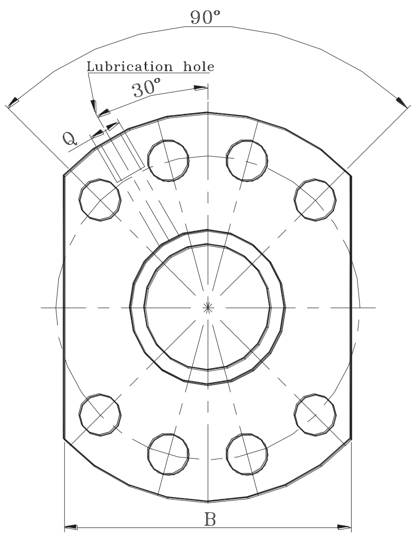


Model	Size: Nominal Dia. d_0	Size: Lead p	Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/μm]
3VNBK3 16x5	16	5	3.175	3	944	1350	20
3VNBK3 20x5	20	5	3.175	3	1080	1790	39
4VNBK3 20x5				4	1430	2390	52
3VNBK3 25x5	25	5	3.175	3	1200	2350	49
4VNBK3 25x5				4	1590	3200	64
3VNBK3 25x6		6	3.969	3	1320	2820	48
4VNBK3 25x6				4	1650	3810	64
3VNBK3 25x10		10	3.969	4	1680	3730	49
3VNBK3 32x5	32	5	3.175	3	1190	3250	61
4VNBK3 32x5				4	1470	4240	80
6VNBK3 32x5				6	2150	6240	118
3VNBK3 32x6		6	3.969	3	1550	3890	62
4VNBK3 32x6				4	1950	5100	82
6VNBK3 32x6				6	2770	7800	121
3VNBK3 32x8		8	5.556	3	2090	4700	60
4VNBK3 32x8				4	2800	6500	79
3VNBK3 32x10		10	6.0	3	2420	5200	60
4VNBK3 32x10				4	3160	6850	79
3VNBK3 32x12		12	6.0	3	2420	5200	58
4VNBK3 32x12				4	3160	6850	75
4VNBK3 40x5	40	5	3.175	4	1650	5420	98
6VNBK3 40x5				6	2350	8050	144
4VNBK3 40x6		6	3.969	4	2180	6680	99
6VNBK3 40x6				6	3100	9700	146
4VNBK3 40x10-Z		10	6.0	4	4320	8600	101
6VNBK3 40x10-Z				6	6220	15400	148
3VNBK3 40x12-Z		12		3	3700	7950	75
4VNBK3 40x12-Z				4	4320	8600	99
3VNBK3 40x16-Z		16		3	3780	8040	75
3VNBK3 40x20		20		3	2900	7480	70

Z - external recirculation of balls

i = 6 for $d_0 \leq 32$; i = 8 for $d_0 > 32$



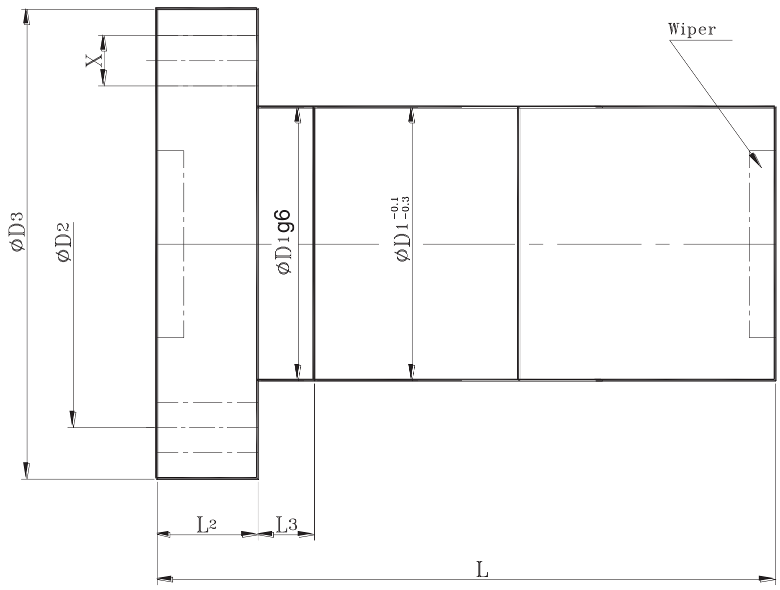


Nut									Model
D1	D2	D3	L	L2	L3	i * X	B	Q	
36	47	58	81	10	10	6.6	44	M6	3VNBK3 16x5
36	47	58	81	10	10	6.6	44	M6	3VNBK3 20x5
			91						4VNBK3 20x5
40	51	62	83	10	10	6.6	48	M6	3VNBK3 25x5
			93						4VNBK3 25x5
40	51	62	93	10	12	6.6	48	M6	3VNBK3 25x6
			106						4VNBK3 25x6
40	51	62	127	10	12	6.6	48	M6	3VNBK3 25x10
50	65	80	86	12	10	9	62	M6	3VNBK3 32x5
			97						4VNBK3 32x5
			118						6VNBK3 32x5
50	65	80	95	12	12	9	62	M6	3VNBK3 32x6
			108						4VNBK3 32x6
			133						6VNBK3 32x6
50	65	80	114	12	14	9	62	M6	3VNBK3 32x8
			133						4VNBK3 32x8
50	65	80	132	12	16	9	62	M6	3VNBK3 32x10
			154						4VNBK3 32x10
50	65	80	145	12	16	9	62	M6	3VNBK3 32x12
			171						4VNBK3 32x12
63	78	93	102	14	10	9	70	M8x1	4VNBK3 40x5
			123						6VNBK3 40x5
63	78	93	114	14	12	9	70	M8x1	4VNBK3 40x6
			138						6VNBK3 40x6
63	78	93	140	14	14	9	70	M8x1	4VNBK3 40x10-Z
			180						6VNBK3 40x10-Z
63	78	93	125	14	16	9	70	M8x1	3VNBK3 40x12-Z
			149						4VNBK3 40x12-Z
63	78	93	149	14	16	9	70	M8x1	3VNBK3 40x16-Z
63	78	93	205,5	14	16	9	70	M8x1	3VNBK3 40x20

Z - external recirculation of balls

i = 6 for $d_0 \le 32$; i = 8 for $d_0 > 32$

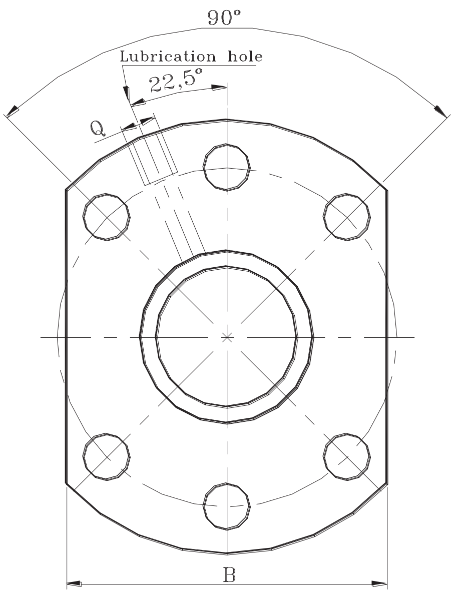
Type K3

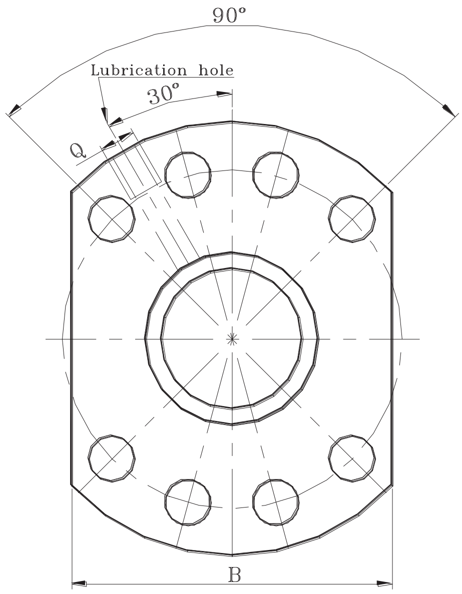


Model	Size: Nominal Dia. d_0	Size: Lead p	Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/μm]
4VNBK3 50x5	50	5	3.175	4	1810	7200	119
6VNBK3 50x5				6	2800	11900	175
4VNBK3 50x6		6	3.969	4	2680	8450	121
6VNBK3 50x6				6	3500	13000	178
4VNBK3 50x8		8	5.556	4	3680	11160	121
6VNBK3 50x8				6	5690	16850	177
3VNBK3 50x10-Z		10	6.0	3	3620	10540	93
4VNBK3 50x10-Z				4	4470	13870	122
6VNBK3 50x10-Z				6	7500	21510	180
3VNBK3 50x12-Z		12	6.0	3	3620	10540	92
4VNBK3 50x12-Z				4	4470	13870	122
3VNBK3 50x16		16	7.938	3	4510	11290	95
3VNBK3 50x20		20	7.938	3	4560	11370	92
4VNBK3 63x6	63	6	3.969	4	2660	10800	146
6VNBK3 63x6				6	3770	17000	215
4VNBK3 63x8		8	5.556	4	3540	13200	149
6VNBK3 63x8				6	5400	21860	220
4VNBK3 63x10		10	6.0	4	5470	15570	154
6VNBK3 63x10				6	6470	23350	226
4VNBK3 63x12		12	7.938	4	6640	20100	151
6VNBK3 63x12				6	9490	30600	222
3VNBK3 63x20		20	9.525	3	8530	23650	147
4VNBK3 80x10	80	10	6.0	4	5200	20410	187
6VNBK3 80x10				6	7250	30620	275
4VNBK3 80x12		12	7.938	4	7550	26120	189
6VNBK3 80x12				6	10700	39200	278
3VNBK3 80x16		16	9.525	3	7500	27450	187
4VNBK3 80x16				4	12850	42600	246
3VNBK3 80x20		20	9.525	3	7500	27450	187
4VNBK3 80x20				4	12850	42600	246

Z - external recirculation of balls

$i = 6$ for $d_0 \le 32$; $i = 8$ for $d_0 > 32$



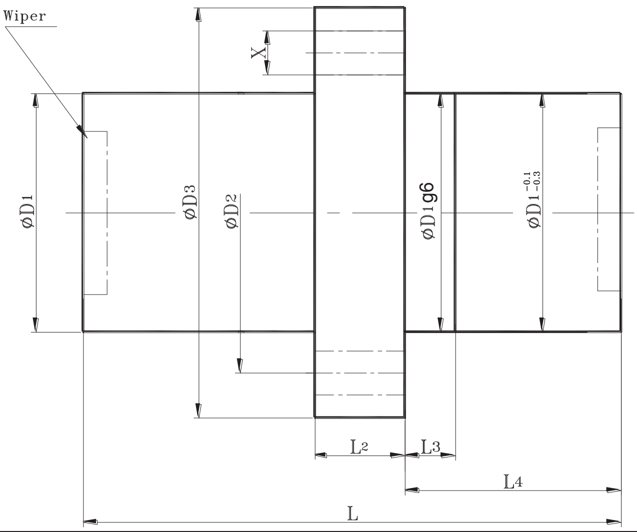


Nut									Model
D1	D2	D3	L	L2	L3	i * X	B	Q	
75	93	110	104	16	10	11	85	M8x1	4VNBK3 50x5
			125						6VNBK3 50x5
75	93	110	116	16	12	11	85	M8x1	4VNBK3 50x6
			140						6VNBK3 50x6
75	93	110	138	16	14	11	85	M8x1	4VNBK3 50x8
			172						6VNBK3 50x8
75	93	110	139	16	16	11	85	M8x1	3VNBK3 50x10-Z
			161						4VNBK3 50x10-Z
			203						6VNBK3 50x10-Z
75	93	110	158	16	18	11	85	M8x1	3VNBK3 50x12-Z
			184						4VNBK3 50x12-Z
75	93	110	194	16	20	11	85	M8x1	3VNBK3 50x16
75	93	110	230	16	20	11	85	M8x1	3VNBK3 50x20
90	108	125	118	18	12	11	95	M8x1	4VNBK3 63x6
			142						6VNBK3 63x6
90	108	125	140	18	14	11	95	M8x1	4VNBK3 63x8
			174						6VNBK3 63x8
90	108	125	163	18	16	11	95	M8x1	4VNBK3 63x10
			205						6VNBK3 63x10
90	108	125	186	18	18	11	95	M8x1	4VNBK3 63x12
			236						6VNBK3 63x12
95	115	135	234	20	25	13.5	100	M8x1	3VNBK3 63x20
105	125	145	165	20	16	13.5	110	M8x1	4VNBK3 80x10
			207						6VNBK3 80x10
105	125	145	188	20	18	13.5	110	M8x1	4VNBK3 80x12
			238						6VNBK3 80x12
125	145	165	215	25	22	13.5	130	M8x1	3VNBK3 80x16
			239						4VNBK3 80x16
125	145	165	241	25	25	13.5	130	M8x1	3VNBK3 80x20
			284						4VNBK3 80x20

Z - external recirculation of balls

$i = 6$ for $d_0 \leq 32$; $i = 8$ for $d_0 > 32$

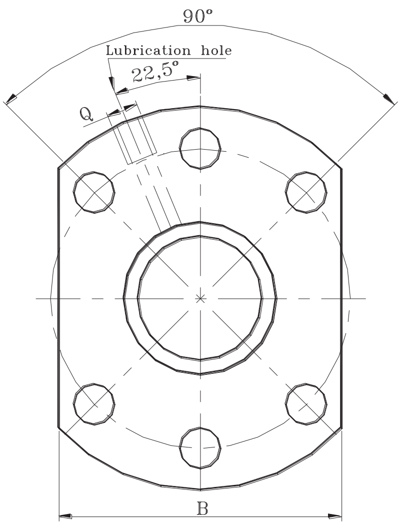
Type K4

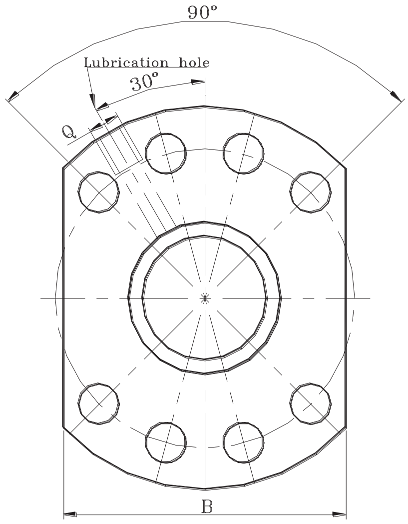


Model	Size: Nominal Dia. d_0	Size: Lead p	Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/μm]
3VNBK4 16x5	16	5	3.175	3	944	1350	20
3VNBK4 20x5	20	5	3.175	3	1080	1790	39
4VNBK4 20x5				4	1430	2390	52
3VNBK4 25x5	25	5	3.175	3	1200	2350	49
4VNBK4 25x5				4	1590	3200	64
3VNBK4 25x6		6	3.969	3	1320	2820	48
4VNBK4 25x6				4	1650	3810	64
3VNBK4 25x10		10	3.969	4	1680	3730	49
3VNBK4 32x5	32	5	3.175	3	1190	3250	61
4VNBK4 32x5				4	1470	4240	80
6VNBK4 32x5				6	2150	6240	118
3VNBK4 32x6		6	3.969	3	1550	3890	62
4VNBK4 32x6				4	1950	5100	82
6VNBK4 32x6				6	2770	7800	121
3VNBK4 32x8		8	5.556	3	2090	4700	60
4VNBK4 32x8				4	2800	6500	79
3VNBK4 32x10		10	6.0	3	2420	5200	60
4VNBK4 32x10				4	3160	6850	79
3VNBK4 32x12		12	6.0	3	2420	5200	58
4VNBK4 32x12				4	3160	6850	75
4VNBK4 40x5	40	5	3.175	4	1650	5420	98
6VNBK4 40x5				6	2350	8050	144
4VNBK4 40x6		6	3.969	4	2180	6680	99
6VNBK4 40x6				6	3100	9700	146
4VNBK4 40x10-Z		10	6.0	4	4320	8600	101
6VNBK4 40x10-Z				6	6220	15400	148
3VNBK4 40x12-Z		12		3	3700	7950	75
4VNBK4 40x12-Z				4	4320	8600	99
3VNBK4 40x16-Z		16		3	3780	8040	75
3VNBK4 40x20		20		3	2900	7480	70

Z - external recirculation of balls

i = 6 for $d_0 \leq 32$; i = 8 for $d_0 > 32$



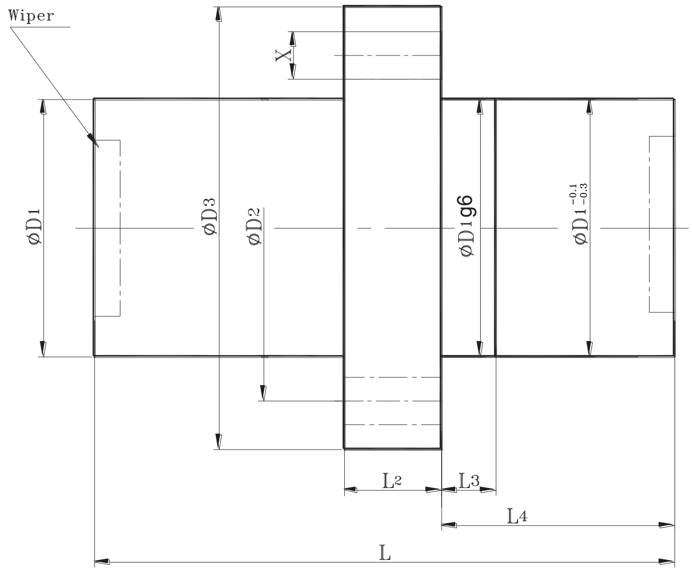


Nut										Model
D1	D2	D3	L	L2	L3	L4	i * X	B	Q	
36	47	58	81	10	10	33	6.6	44	M6	3VNBK4 16x5
36	47	58	81	10	10	33	6.6	44	M6	3VNBK4 20x5
			91			38				4VNBK4 20x5
40	51	62	83	10	10	34	6.6	48	M6	3VNBK4 25x5
			93			39				4VNBK4 25x5
40	51	62	93	10	12	39	6.6	48	M6	3VNBK4 25x6
			106			45				4VNBK4 25x6
40	51	62	127	10	12	56	6.6	48	M6	3VNBK4 25x10
50	65	80	86	12	10	34	9	62	M6	3VNBK4 32x5
			97			40				4VNBK4 32x5
			118			50				6VNBK4 32x5
50	65	80	95	12	12	39	9	62	M6	3VNBK4 32x6
			108			45				4VNBK4 32x6
			133			58				6VNBK4 32x6
50	65	80	114	12	14	48	9	62	M6	3VNBK4 32x8
			133			59				4VNBK4 32x8
50	65	80	132	12	16	57	9	62	M6	3VNBK4 32x10
			154			68				4VNBK4 32x10
50	65	80	145	12	16	63	9	62	M6	3VNBK4 32x12
			171			76				4VNBK4 32x12
63	78	93	102	14	10	41	9	70	M8x1	4VNBK4 40x5
			123			51				6VNBK4 40x5
63	78	93	114	14	12	47	9	70	M8x1	4VNBK4 40x6
			138			59				6VNBK4 40x6
63	78	93	140	14	14	56	9	70	M8x1	4VNBK4 40x10-Z
			180			76				6VNBK4 40x10-Z
63	78	93	132	14	16	52	9	70	M8x1	3VNBK4 40x12-Z
			156			64				4VNBK4 40x12-Z
63	78	93	156	14	16	64	9	70	M8x1	3VNBK4 40x16-Z
63	78	93	205,5	14	16	91,5	9	70	M8x1	3VNBK3 40x20

Z - external recirculation of balls

i = 6 for $d_0 \le 32$; i = 8 for $d_0 > 32$

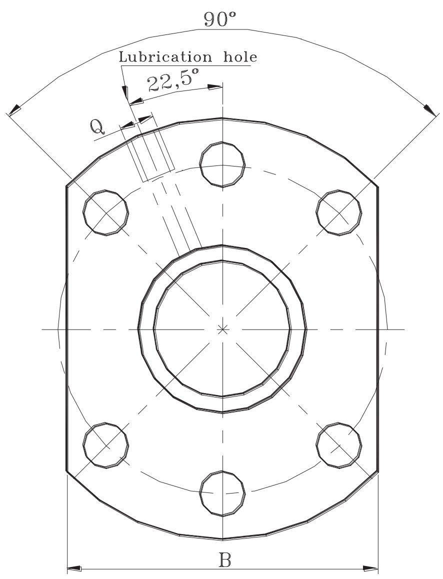
Type K4

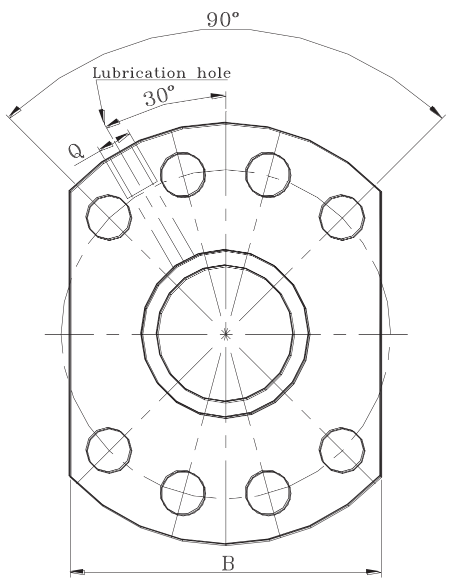


Model	Size		Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/μm]
	Nominal Dia. d_0	Lead p					
4VNBK4 50x5	50	5	3.175	4	1810	7200	119
6VNBK4 50x5				6	2800	11900	175
4VNBK4 50x6		6	3.969	4	2680	8450	121
6VNBK4 50x6				6	3500	13000	178
4VNBK4 50x8		8	5.556	4	3680	11160	121
6VNBK4 50x8				6	5690	16850	177
3VNBK4 50x10-Z		10	6.0	3	3620	10540	93
4VNBK4 50x10-Z				4	4470	13870	122
6VNBK4 50x10-Z				6	7500	21510	180
3VNBK4 50x12-Z		12	6.0	3	3620	10540	92
4VNBK4 50x12-Z				4	4470	13870	122
3VNBK4 50x16		16	7.938	3	4510	11290	95
3VNBK4 50x20		20	7.938	3	4560	11370	92
4VNBK4 63x6	63	6	3.969	4	2660	10800	146
6VNBK4 63x6				6	3770	17000	215
4VNBK4 63x8		8	5.556	4	3540	13200	149
6VNBK4 63x8				6	5400	21860	220
4VNBK4 63x10		10	6.0	4	5470	15570	154
6VNBK4 63x10				6	6470	23350	226
4VNBK4 63x12		12	7.938	4	6640	20100	151
6VNBK4 63x12				6	9490	30600	222
3VNBK4 63x20		20	9.525	3	8530	23650	147
4VNBK4 80x10	80	10	6.0	4	5200	20410	187
6VNBK4 80x10				6	7250	30620	275
4VNBK4 80x12		12	7.938	4	7550	26120	189
6VNBK4 80x12				6	10700	39200	278
3VNBK4 80x16		16	9.525	3	7500	27450	187
4VNBK4 80x16				4	12850	42600	246
3VNBK4 80x20		20	9.525	3	7500	27450	187
4VNBK4 80x20				4	12850	42600	246

Z - external recirculation of balls

i = 6 for $d_0 \leq 32$; i = 8 for $d_0 > 32$



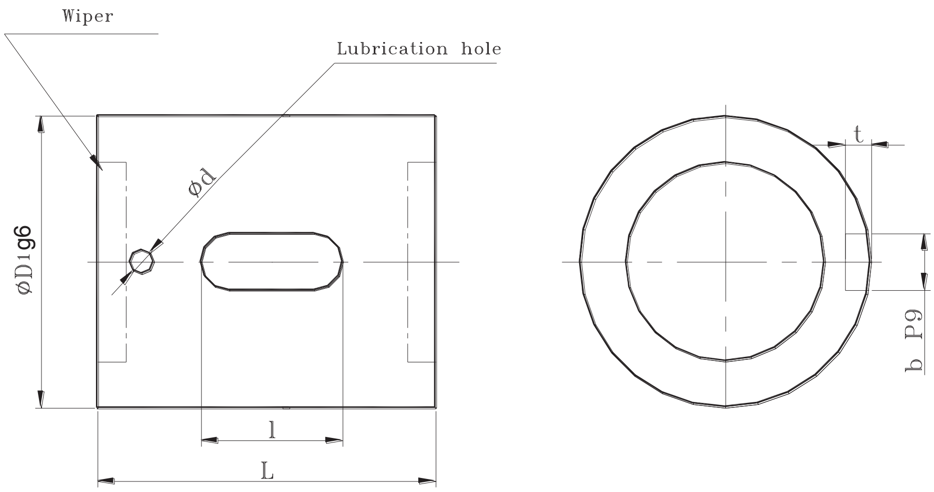


Nut										Model
D1	D2	D3	L	L2	L3	L4	i * X	B	Q	
75	93	110	104	16	10	41	11	85	M8x1	4VNBK4 50x5
			125			51				6VNBK4 50x5
75	93	110	116	16	12	47	11	85	M8x1	4VNBK4 50x6
			140			59				6VNBK4 50x6
75	93	110	138	16	14	58	11	85	M8x1	4VNBK4 50x8
			172			75				6VNBK4 50x8
75	93	110	139	16	16	58	11	85	M8x1	3VNBK4 50x10-Z
			161			69				4VNBK4 50x10-Z
			203			90				6VNBK4 50x10-Z
75	93	110	158	16	18	68	11	85	M8x1	3VNBK4 50x12-Z
			184			81				4VNBK4 50x12-Z
75	93	110	194	16	20	84	11	85	M8x1	3VNBK4 50x16
75	93	110	230	16	20	106	11	85	M8x1	3VNBK4 50x20
90	108	125	118	18	12	47	11	95	M8x1	4VNBK4 63x6
			142			59				6VNBK4 63x6
90	108	125	140	18	14	58	11	95	M8x1	4VNBK4 63x8
			174			75				6VNBK4 63x8
90	108	125	163	18	16	69	11	95	M8x1	4VNBK4 63x10
			205			90				6VNBK4 63x10
90	108	125	186	18	18	81	11	95	M8x1	4VNBK4 63x12
			236			106				6VNBK4 63x12
95	115	135	234	20	25	102	13.5	100	M8x1	3VNBK4 63x20
105	125	145	165	20	16	69	13.5	110	M8x1	4VNBK4 80x10
			207			90				6VNBK4 80x10
105	125	145	188	20	18	81	13.5	110	M8x1	4VNBK4 80x12
			238			106				6VNBK4 80x12
125	145	165	215	25	22	92	13.5	130	M8x1	3VNBK4 80x16
			239			104				4VNBK4 80x16
125	145	165	241	25	25	104	13.5	130	M8x1	3VNBK4 80x20
			284			126				4VNBK4 80x20

Z - external recirculation of balls

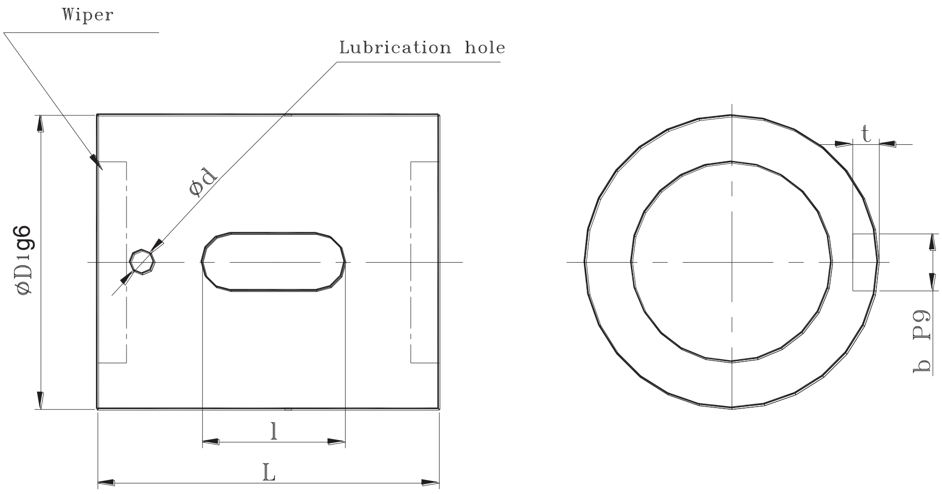
i = 6 for $d_0 \leq 32$; i = 8 for $d_0 > 32$

Type C1



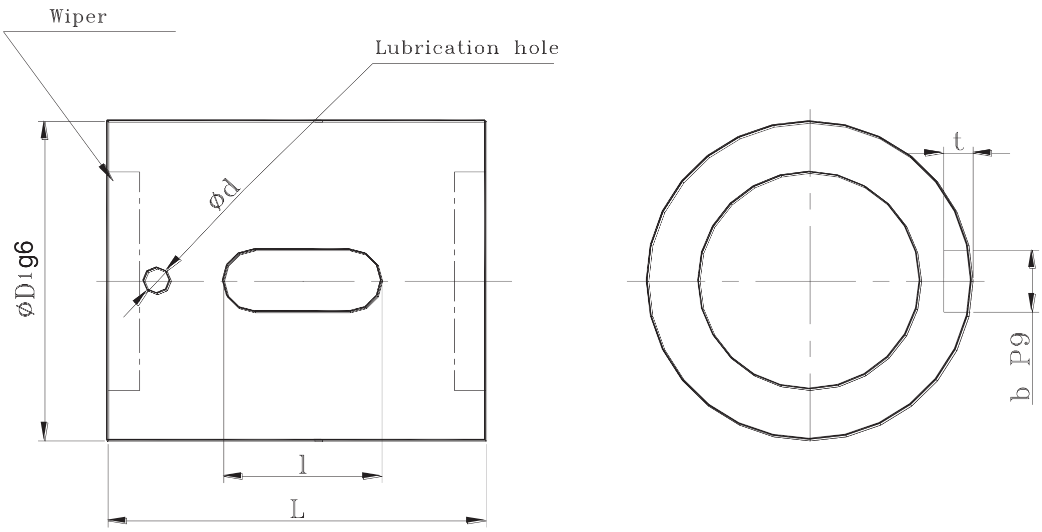
Model	Size		Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Max. axial play [mm]
	Nominal Dia. d_0	Lead p					
3VNBC1 16x5	16	5	3.175	3	944	1350	0.02
3VNBC1 20x5	20	5	3.175	3	1080	1790	
4VNBC1 20x5				4	1430	2390	
3VNBC1 25x5	25	5	3.175	3	1200	2350	
4VNBC1 25x5				4	1590	3200	
3VNBC1 25x6		6	3.969	3	1320	2820	
4VNBC1 25x6				4	1650	3810	
3VNBC1 25x10		10	3.969	4	1680	3730	
3VNBC1 32x5	32	5	3.175	3	1190	3250	
4VNBC1 32x5				4	1470	4240	
6VNBC1 32x5				6	2150	6240	
3VNBC1 32x6		6	3.969	3	1550	3890	
4VNBC1 32x6				4	1950	5100	
6VNBC1 32x6				6	2770	7800	
3VNBC1 32x8		8	5.556	3	2090	4700	
4VNBC1 32x8				4	2800	6500	
3VNBC1 32x10		10	6.0	3	2420	5200	
4VNBC1 32x10				4	3160	6850	
3VNBC1 32x12		12	6.0	3	2420	5200	
4VNBC1 32x12				4	3160	6850	
4VNBC1 40x5	40	5	3.175	4	1650	5420	
6VNBC1 40x5				6	2350	8050	
4VNBC1 40x6		6	3.969	4	2180	6680	
6VNBC1 40x6				6	3100	9700	
4VNBC1 40x10-Z		10	6.0	4	4320	8600	
6VNBC1 40x10-Z				6	6220	15400	
3VNBC1 40x12-Z		12		3	3700	7950	
4VNBC1 40x12-Z				4	4320	8600	
3VNBC1 40x16-Z		16		3	3780	8040	
3VNBC1 40x20		20		3	2900	7480	

Z - external recirculation of balls



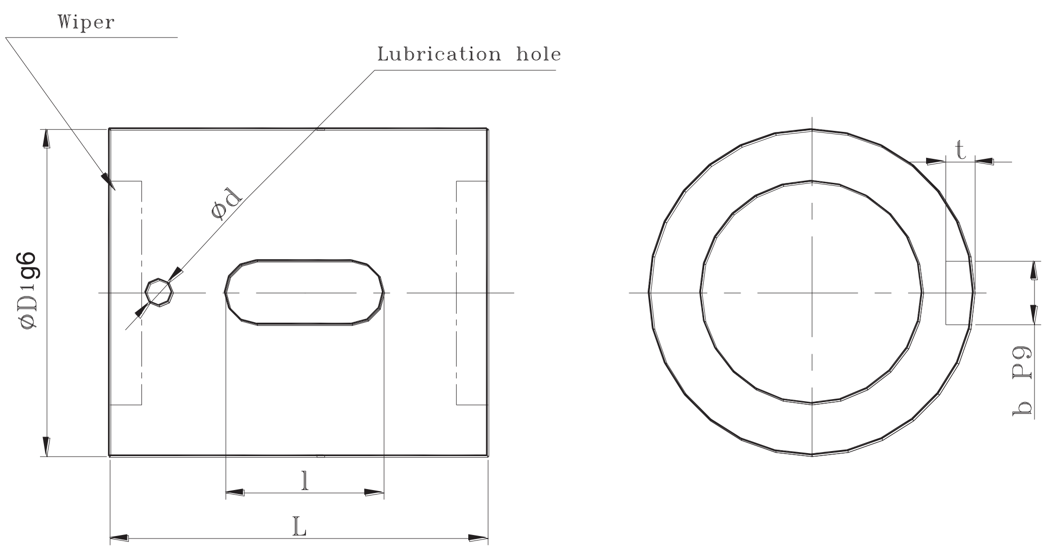
Nut				Model
D1	L	d	b * t * l	
36	38	3	4 * 2.5 * 12	3VNBC1 16x5
36	38	3	4 * 2.5 * 12	3VNBC1 20x5
	43			4VNBC1 20x5
40	39	3	4 * 2.5 * 12	3VNBC1 25x5
	44			4VNBC1 25x5
40	44	3	4 * 2.5 * 12	3VNBC1 25x6
	51			4VNBC1 25x6
40	61	3	4 * 2.5 * 12	3VNBC1 25x10
50	40	4	5 * 3 * 12	3VNBC1 32x5
	45			4VNBC1 32x5
	56			6VNBC1 32x5
50	44	4	5 * 3 * 12	3VNBC1 32x6
	51			4VNBC1 32x6
	63			6VNBC1 32x6
50	54	4	5 * 3 * 20	3VNBC1 32x8
	62			4VNBC1 32x8
50	63	4	5 * 3 * 20	3VNBC1 32x10
	74			4VNBC1 32x10
50	70	4	5 * 3 * 20	3VNBC1 32x12
	83			4VNBC1 32x12
63	47	4	6 * 3.5 * 16	4VNBC1 40x5
	58			6VNBC1 40x5
63	53	4	6 * 3.5 * 16	4VNBC1 40x6
	65			6VNBC1 40x6
63	70	4	6 * 3.5 * 25	4VNBC1 40x10-Z
	90			6VNBC1 40x10-Z
63	66	4	6 * 3.5 * 25	3VNBC1 40x12-Z
	78			4VNBC1 40x12-Z
63	78	4	6 * 3.5 * 25	3VNBC1 40x16-Z
63	100	4	6 * 3.5 * 25	3VNBC1 40x20

Type C1



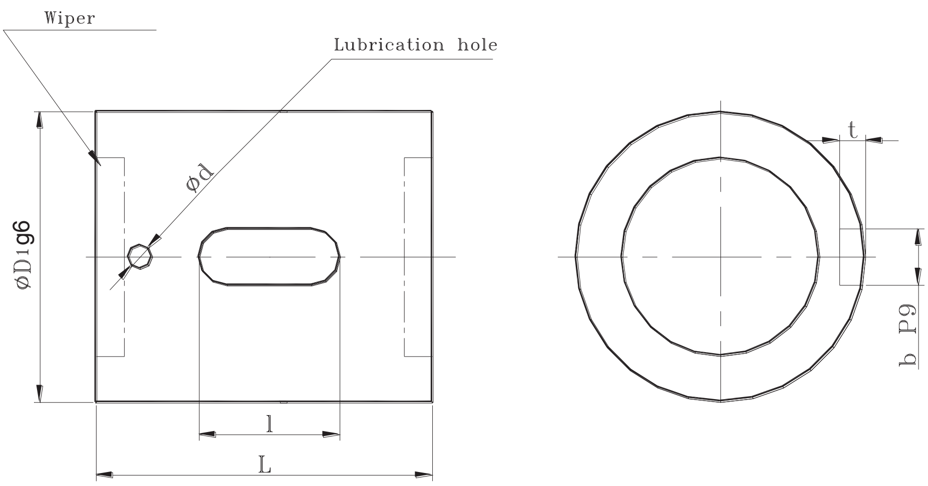
Model	Size		Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Max. axial play [mm]
	Nominal Dia. d_0	Lead p					
4VNBC1 50x5	50	5	3.175	4	1810	7200	0.02
6VNBC1 50x5				6	2800	11900	
4VNBC1 50x6		6	3.969	4	2680	8450	
6VNBC1 50x6				6	3500	13000	
4VNBC1 50x8		8	5.56	4	3680	11160	
6VNBC1 50x8				6	5690	16850	
3VNBC1 50x10-Z		10	6.0	3	3620	10540	
4VNBC1 50x10-Z				4	4470	13870	
6VNBC1 50x10-Z				6	7500	21510	
3VNBC1 50x12-Z		12	6.0	3	3620	10540	
4VNBC1 50x12-Z				4	4470	13870	
3VNBC1 50x16		16	7.938	3	4510	11290	
3VNBC1 50x20		20	7.938	3	4560	11370	
4VNBC1 63x6	63	6	3.969	4	2660	10800	
6VNBC1 63x6				6	3770	17000	
4VNBC1 63x8		8	6.0	4	3540	13200	
6VNBC1 63x8				6	5400	21860	
4VNBC1 63x10		10	6.0	4	5470	15570	
6VNBC1 63x10				6	6470	23350	
4VNBC1 63x12		12	7.938	4	6640	20100	
6VNBC1 63x12				6	9490	30600	
3VNBC1 63x20		20	9.525	3	8530	23650	
4VNBC1 80x10	80	10	6.0	4	5200	20410	
6VNBC1 80x10				6	7250	30620	
4VNBC1 80x12		12	7.938	4	7550	26120	
6VNBC1 80x12				6	10700	39200	
3VNBC1 80x16		16	9.525	3	7500	27450	
4VNBC1 80x16				4	12850	42600	
3VNBC1 80x20		20	9.525	3	7500	27450	
4VNBC1 80x20				4	12850	42600	

Z - external recirculation of balls



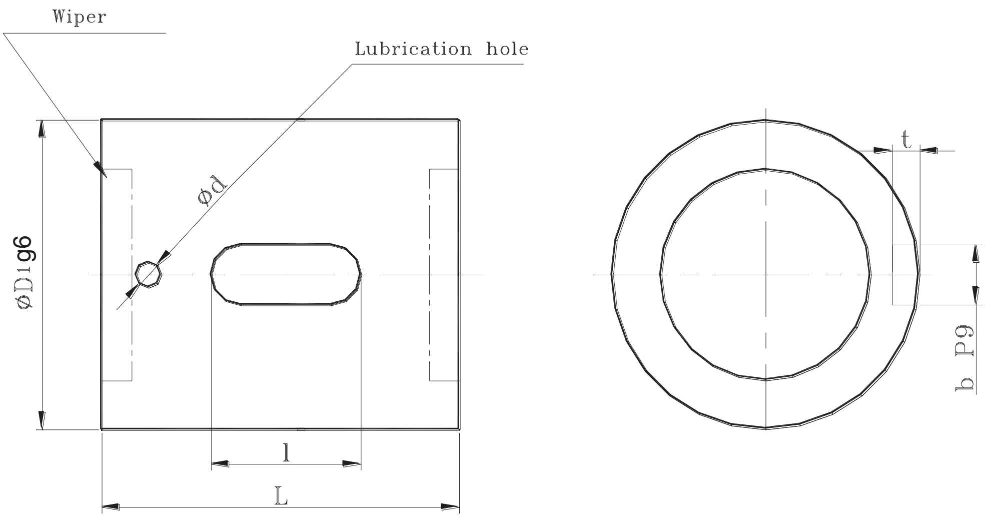
Nut				Model
D1	L	d	b * t * l	
75	47	4	6 * 3.5 * 18	4VNBC1 50x5
	58			6VNBC1 50x5
75	53	4	6 * 3.5 * 18	4VNBC1 50x6
	65			6VNBC1 50x6
75	64	4	6 * 3.5 * 28	4VNBC1 50x8
	81			6VNBC1 50x8
75	65	4	6 * 3.5 * 28	3VNBC1 50x10
	76			4VNBC1 50x10
	97			6VNBC1 50x10
75	74	4	6 * 3.5 * 32	3VNBC1 50x12
	87			4VNBC1 50x12
75	94	4	6 * 3.5 * 32	3VNBC1 50x16
75	112	4	6 * 3.5 * 32	3VNBC1 50x20
90	53	5	8 * 4 * 28	4VNBC1 63x6
	65			6VNBC1 63x6
90	64	5	8 * 4 * 28	4VNBC1 63x8
	81			6VNBC1 63x8
90	76	5	8 * 4 * 28	4VNBC1 63x10
	97			6VNBC1 63x10
90	87	5	8 * 4 * 32	4VNBC1 63x12
	112			6VNBC1 63x12
95	112	5	8 * 4 * 50	3VNBC1 63x20
105	76	5	10 * 4.5 * 28	4VNBC1 80x10
	97			6VNBC1 80x10
105	87	5	10 * 4.5 * 32	4VNBC1 80x12
	112			6VNBC1 80x12
125	98	5	10 * 4.5 * 40	3VNBC1 80x16
	110			4VNBC1 80x16
125	112	5	10 * 4.5 * 50	3VNBC1 80x20
	133			4VNBC1 80x20

Type C2



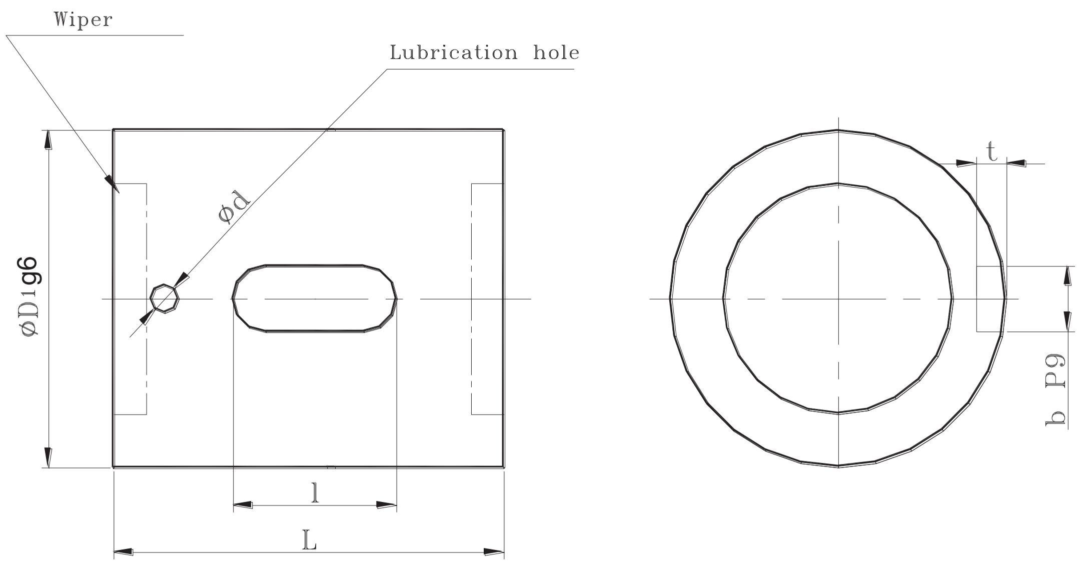
Model	Size		Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/µm]
	Nominal Dia. d_0	Lead p					
3VNBC2 16x5	16	5	3.175	3	944	1350	11
3VNBC2 20x5	20	5	3.175	3	1080	1790	20
4VNBC2 20x5				4	1430	2390	27
3VNBC2 25x5	25	5	3.175	3	1200	2350	28
4VNBC2 25x5				4	1590	3200	37
3VNBC2 25x6		6	3.969	3	1320	2820	28
4VNBC2 25x6				4	1650	3810	37
3VNBC2 25x10		10	3.969	4	1680	3730	25
3VNBC2 32x5	32	5	3.175	3	1190	3250	38
4VNBC2 32x5				4	1470	4240	51
6VNBC2 32x5				6	2150	6240	76
3VNBC2 32x6		6	3.969	3	1550	3890	33
4VNBC2 32x6				4	1950	5100	43
6VNBC2 32x6				6	2770	7800	65
3VNBC2 32x8		8	5.556	3	2090	4700	35
4VNBC2 32x8				4	2800	6500	47
3VNBC2 32x10		10	6.0	3	2420	5200	35
4VNBC2 32x10				4	3160	6850	48
3VNBC2 32x12		12	6.0	3	2420	5200	33
4VNBC2 32x12				4	3160	6850	45
4VNBC2 40x5	40	5	3.175	4	1650	5420	50
6VNBC2 40x5				6	2350	8050	74
4VNBC2 40x6		6	3.969	4	2180	6680	50
6VNBC2 40x6				6	3100	9700	74
4VNBC2 40x10-Z		10	6.0	4	4320	8600	72
6VNBC2 40x10-Z				6	6220	15400	108
3VNBC2 40x12-Z		12		3	3700	7950	51
4VNBC2 40x12-Z				4	4320	8600	68
3VNBC2 40x16-Z		16		3	3780	8040	51
3VNBC2 40x20		20		3	2900	7480	47

Z - external recirculation of balls



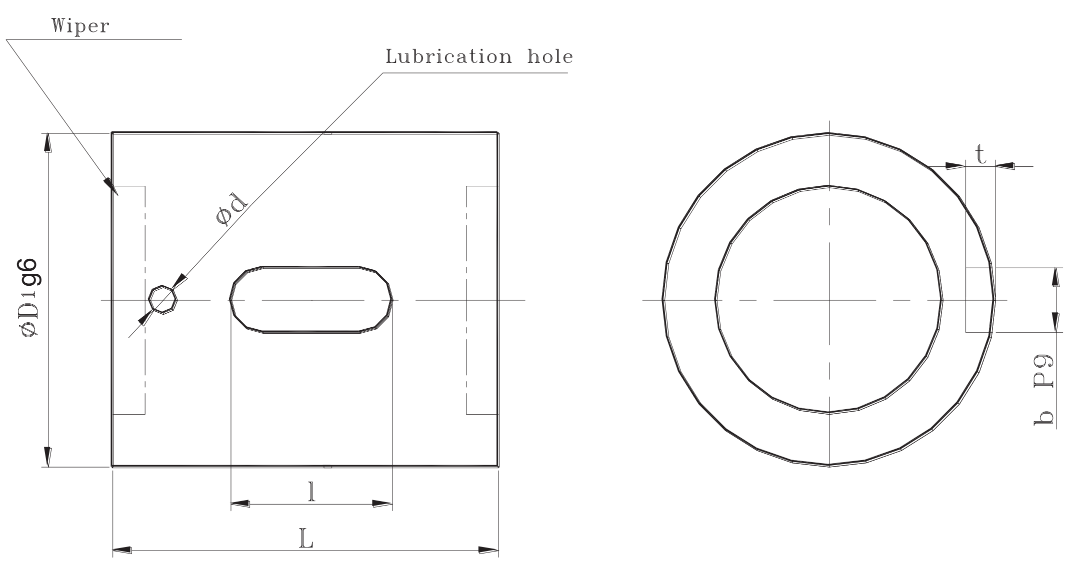
Nut				Model
D1	L	d	b ∗ t ∗ l	
36	38	3	4 ∗ 2.5 ∗ 12	3VNBC2 16x5
36	38	3	4 ∗ 2.5 ∗ 12	3VNBC2 20x5
	43			4VNBC2 20x5
40	39	3	4 ∗ 2.5 ∗ 12	3VNBC2 25x5
	44			4VNBC2 25x5
40	44	3	4 ∗ 2.5 ∗ 12	3VNBC2 25x6
	51			4VNBC2 25x6
40	61	3	4 ∗ 2.5 ∗ 12	3VNBC2 25x10
50	40	4	5 ∗ 3 ∗ 12	3VNBC2 32x5
	45			4VNBC2 32x5
	56			6VNBC2 32x5
50	44	4	5 ∗ 3 ∗ 12	3VNBC2 32x6
	51			4VNBC2 32x6
	63			6VNBC2 32x6
50	54	4	5 ∗ 3 ∗ 20	3VNBC2 32x8
	62			4VNBC2 32x8
50	63	4	5 ∗ 3 ∗ 20	3VNBC2 32x10
	74			4VNBC2 32x10
50	70	4	5 ∗ 3 ∗ 20	3VNBC2 32x12
	83			4VNBC2 32x12
63	47	4	6 ∗ 3.5 ∗ 16	4VNBC2 40x5
	58			6VNBC2 40x5
63	53	4	6 ∗ 3.5 ∗ 16	4VNBC2 40x6
	65			6VNBC2 40x6
63	70	4	6 ∗ 3.5 ∗ 25	4VNBC2 40x10-Z
	90			6VNBC2 40x10-Z
63	66	4	6 ∗ 3.5 ∗ 25	3VNBC2 40x12-Z
	78			4VNBC2 40x12-Z
63	78	4	6 ∗ 3.5 ∗ 25	3VNBC2 40x16-Z
63	100	4	6 ∗ 3.5 ∗ 25	3VNBC2 40x20

Type C2



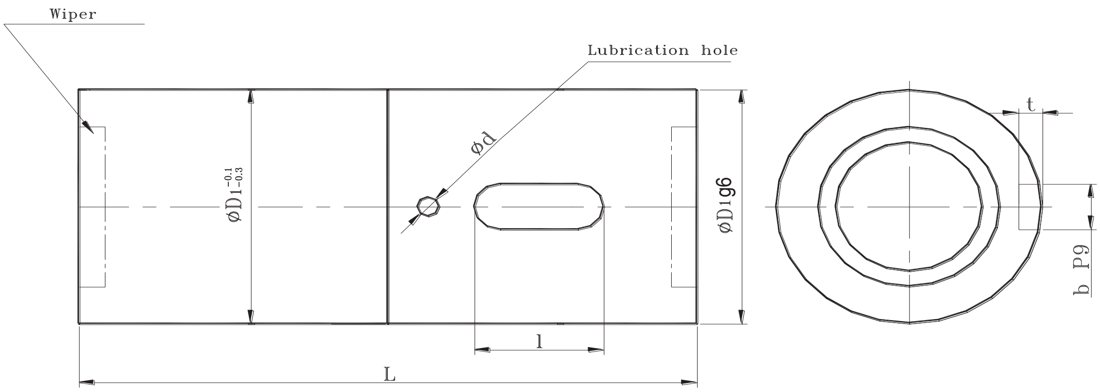
Model	Size		Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/μm]
	Nominal Dia. d_0	Lead p					
4VNBC2 50x5	50	5	3.175	4	1810	7200	62
6VNBC2 50x5				6	2800	11900	91
4VNBC2 50x6		6	3.969	4	2680	8450	62
6VNBC2 50x6				6	3500	13000	93
4VNBC2 50x8		8	5.56	4	3680	11160	62
6VNBC2 50x8				6	5690	16850	92
3VNBC2 50x10-Z		10	6.0	3	3620	10540	50
4VNBC2 50x10-Z				4	4470	13870	63
6VNBC2 50x10-Z				6	7500	21510	94
3VNBC2 50x12-Z		12	6.0	3	3620	10540	50
4VNBC2 50x12-Z				4	4470	13870	63
3VNBC2 50x16		16	7.938	3	4510	11290	49
3VNBC2 50x20		20	7.938	3	4560	11370	47
4VNBC2 63x6	63	6	3.969	4	2660	10800	75
6VNBC2 63x6				6	3770	17000	113
4VNBC2 63x8		8	6.0	4	3540	13200	77
6VNBC2 63x8				6	5400	21860	114
4VNBC2 63x10		10	6.0	4	5470	15570	79
6VNBC2 63x10				6	6470	23350	115
4VNBC2 63x12		12	7.938	4	6640	20100	78
6VNBC2 63x12				6	9490	30600	113
3VNBC2 63x20		20	9.525	3	8530	23650	75
4VNBC2 80x10	80	10	6.0	4	5200	20410	96
6VNBC2 80x10				6	7250	30620	140
4VNBC2 80x12		12	7.938	4	7550	26120	97
6VNBC2 80x12				6	10700	39200	141
3VNBC2 80x16		16	9.525	3	7500	27450	95
4VNBC2 80x16				4	12850	42600	130
3VNBC2 80x20		20	9.525	3	7500	27450	95
4VNBC2 80x20				4	12850	42600	125

Z - external recirculation of balls



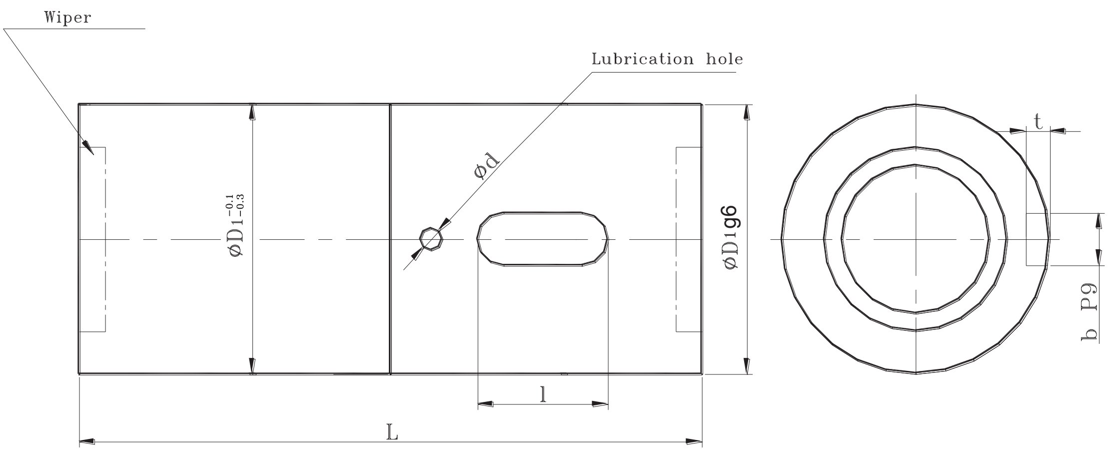
Nut				Model
D1	L	d	b * t * l	
75	47	4	6 * 3.5 * 18	4VNBC2 50x5
	58			6VNBC2 50x5
75	53	4	6 * 3.5 * 18	4VNBC2 50x6
	65			6VNBC2 50x6
75	64	4	6 * 3.5 * 28	4VNBC2 50x8
	81			6VNBC2 50x8
75	65	4	6 * 3.5 * 28	3VNBC2 50x10-Z
	76			4VNBC2 50x10-Z
	97			6VNBC2 50x10-Z
75	74	4	6 * 3.5 * 32	3VNBC2 50x12-Z
	87			4VNBC2 50x12-Z
75	94	4	6 * 3.5 * 32	3VNBC2 50x16
75	112	4	6 * 3.5 * 32	3VNBC2 50x20
90	53	5	8 * 4 * 28	4VNBC2 63x6
	65			6VNBC2 63x6
90	64	5	8 * 4 * 28	4VNBC2 63x8
	81			6VNBC2 63x8
90	76	5	8 * 4 * 28	4VNBC2 63x10
	97			6VNBC2 63x10
90	87	5	8 * 4 * 32	4VNBC2 63x12
	112			6VNBC2 63x12
95	112	5	8 * 4 * 50	3VNBC2 63x20
105	76	5	10 * 4.5 * 28	4VNBC2 80x10
	97			6VNBC2 80x10
105	87	5	10 * 4.5 * 32	4VNBC2 80x12
	112			6VNBC2 80x12
125	98	5	10 * 4.5 * 40	3VNBC2 80x16
	110			4VNBC2 80x16
125	112	5	10 * 4.5 * 50	3VNBC2 80x20
	133			4VNBC2 80x20

Type C3



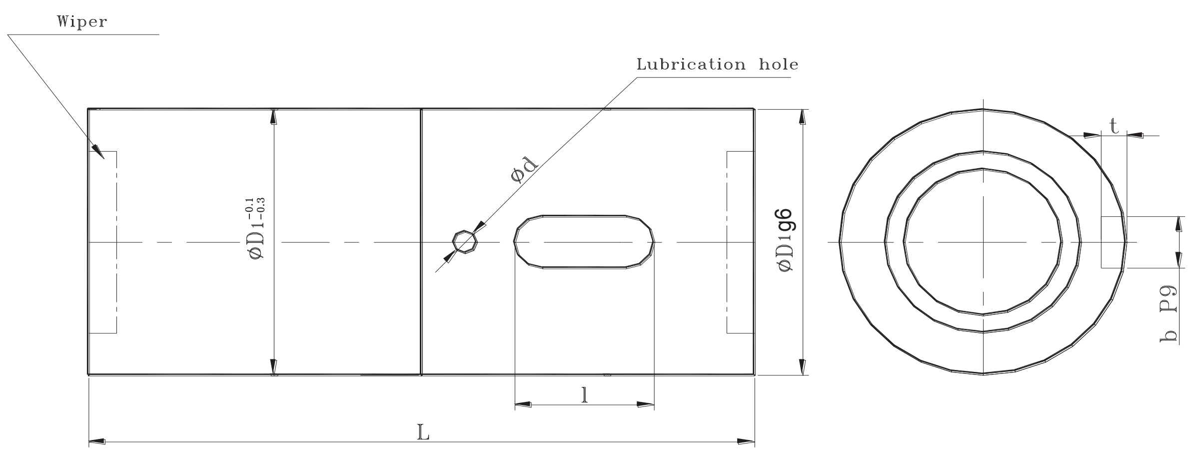
Model	Size		Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/μm]
	Nominal Dia. d_0	Lead p					
3VNBC3 16x5	16	5	3.175	3	944	1350	20
3VNBC3 20x5	20	5	3.175	3	1080	1790	39
4VNBC3 20x5				4	1430	2390	52
3VNBC3 25x5	25	5	3.175	3	1200	2350	49
4VNBC3 25x5				4	1590	3200	64
3VNBC3 25x6		6	3.969	3	1320	2820	48
4VNBC3 25x6				4	1650	3810	64
3VNBC3 25x10		10	3.969	4	1680	3730	49
3VNBC3 32x5	32	5	3.175	3	1190	3250	61
4VNBC3 32x5				4	1470	4240	80
6VNBC3 32x5				6	2150	6240	118
3VNBC3 32x6		6	3.969	3	1550	3890	62
4VNBC3 32x6				4	1950	5100	82
6VNBC3 32x6				6	2770	7800	121
3VNBC3 32x8		8	5.556	3	2090	4700	60
4VNBC3 32x8				4	2800	6500	79
3VNBC3 32x10		10	6.0	3	2420	5200	60
4VNBC3 32x10				4	3160	6850	79
3VNBC3 32x12		12	6.0	3	2420	5200	58
4VNBC3 32x12				4	3160	6850	75
4VNBC3 40x5	40	5	3.175	4	1650	5420	98
6VNBC3 40x5				6	2350	8050	144
4VNBC3 40x6		6	3.969	4	2180	6680	99
6VNBC3 40x6				6	3100	9700	146
4VNBC3 40x10-Z		10	6.0	4	4320	8600	101
6VNBC3 40x10-Z				6	6220	15400	148
3VNBC3 40x12-Z		12		3	3700	7950	75
4VNBC3 40x12-Z				4	4320	8600	99
3VNBC3 40x16-Z		16		3	3780	8040	75
3VNBC3 40x20		20		3	2900	7480	70

Z - external recirculation of balls



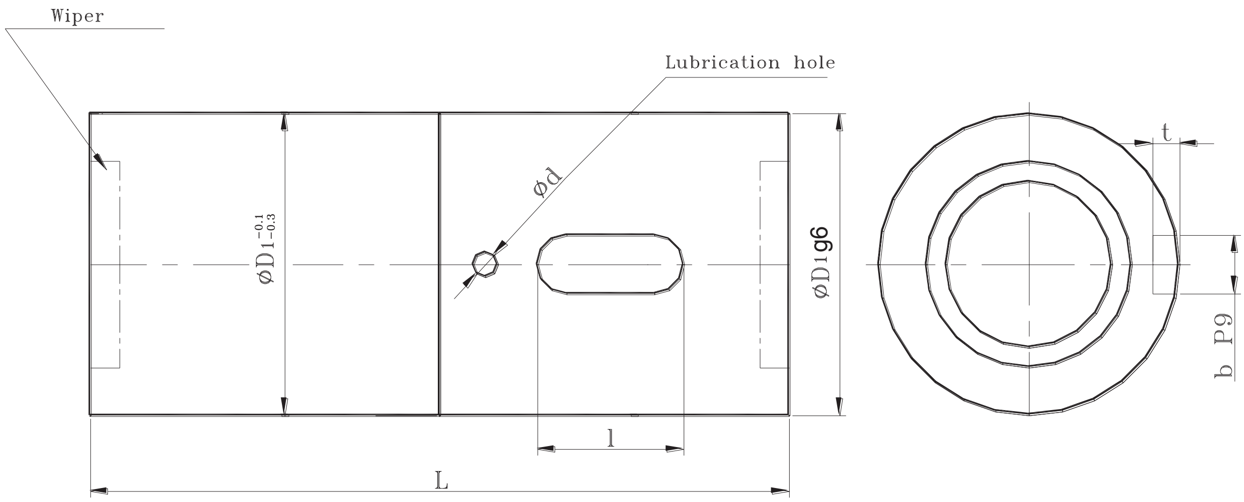
Nut				Model
D1	L	d	b * t * l	
36	76	3	4 * 2.5 * 12	3VNBC3 16x5
36	76	3	4 * 2.5 * 12	3VNBC3 20x5
	86			4VNBC3 20x5
40	78	3	4 * 2.5 * 12	3VNBC3 25x5
	88			4VNBC3 25x5
40	88	3	4 * 2.5 * 12	3VNBC3 25x6
	102			4VNBC3 25x6
40	122	3	4 * 2.5 * 12	3VNBC3 25x10
50	80	4	5 * 3 * 12	3VNBC3 32x5
	90			4VNBC3 32x5
	112			6VNBC3 32x5
50	88	4	5 * 3 * 12	3VNBC3 32x6
	102			4VNBC3 32x6
	126			6VNBC3 32x6
50	108	4	5 * 3 * 20	3VNBC3 32x8
	124			4VNBC3 32x8
50	126	4	5 * 3 * 20	3VNBC3 32x10
	148			4VNBC3 32x10
50	140	4	5 * 3 * 20	3VNBC3 32x12
	166			4VNBC3 32x12
63	94	4	6 * 3.5 * 16	4VNBC3 40x5
	116			6VNBC3 40x5
63	106	4	6 * 3.5 * 16	4VNBC3 40x6
	130			6VNBC3 40x6
63	140	4	6 * 3.5 * 25	4VNBC3 40x10-Z
	180			6VNBC3 40x10-Z
63	125	4	6 * 3.5 * 25	3VNBC3 40x12-Z
	149			4VNBC3 40x12-Z
63	149	4	6 * 3.5 * 25	3VNBC3 40x16-Z
63	200	4	6 * 3.5 * 25	3VNBC3 40x20

Type C3

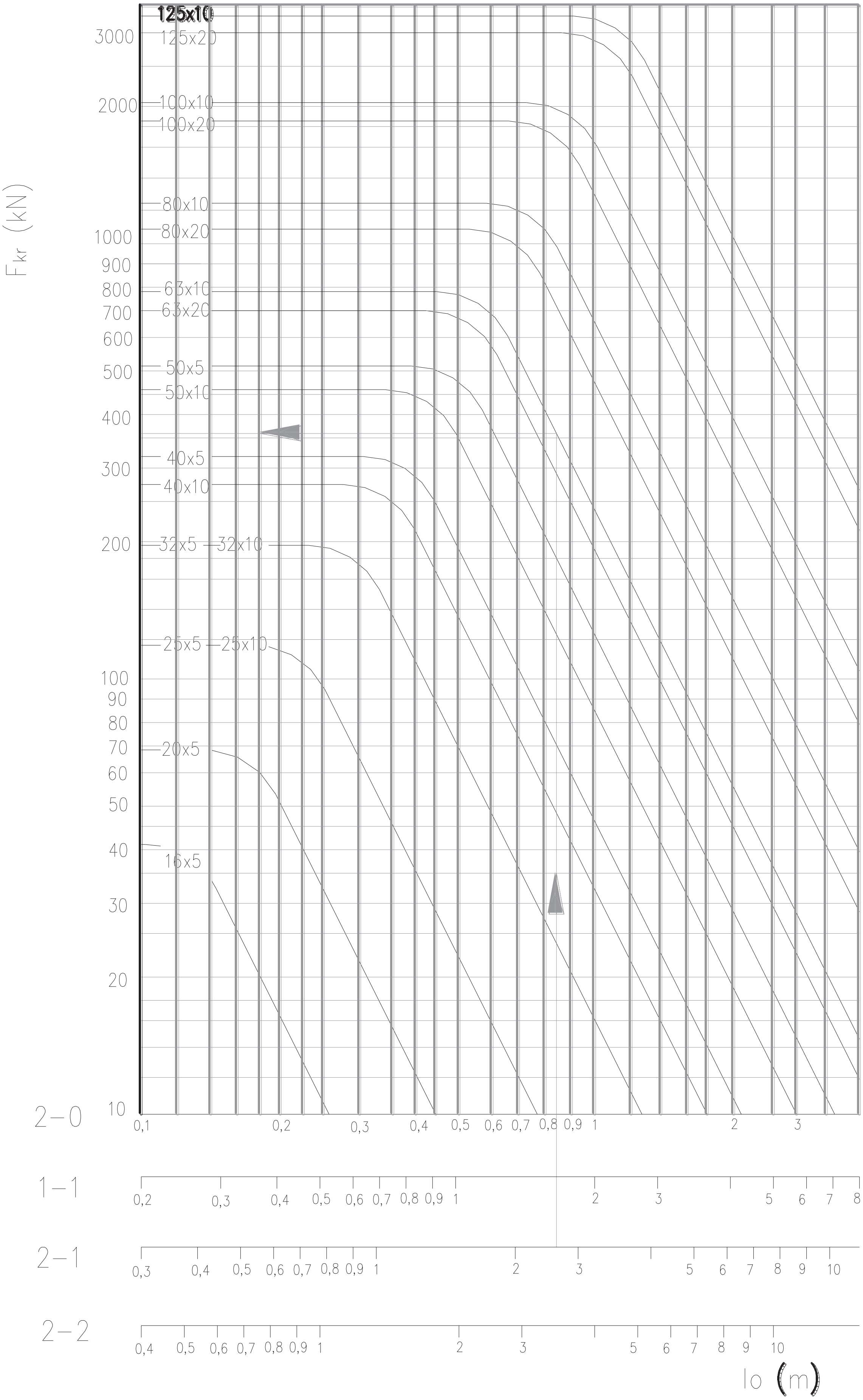


Model	Size		Ball Dia. D_k	Circuits	Dynamic Load C[daN]	Static Load Co[daN]	Stiffness R[daN/μm]
	Nominal Dia. d_0	Lead p					
4VNBC3 50x5	50	5	3.175	4	1810	7200	119
6VNBC3 50x5				6	2800	11900	175
4VNBC3 50x6		6	3.969	4	2680	8450	121
6VNBC3 50x6				6	3500	13000	178
4VNBC3 50x8		8	5.56	4	3680	11160	121
6VNBC3 50x8				6	5690	16850	177
3VNBC3 50x10-Z		10	6.0	3	3620	10540	93
4VNBC3 50x10-Z				4	4470	13870	122
6VNBC3 50x10-Z				6	7500	21510	180
3VNBC3 50x12-Z		12	6.0	3	3620	10540	92
4VNBC3 50x12-Z				4	4470	13870	122
3VNBC3 50x16		16	7.938	3	4510	11290	95
3VNBC3 50x20		20	7.938	3	4560	11370	92
4VNBC3 63x6	63	6	3.969	4	2660	10800	146
6VNBC3 63x6				6	3770	17000	215
4VNBC3 63x8		8	6.0	4	3540	13200	149
6VNBC3 63x8				6	5400	21860	220
4VNBC3 63x10		10	6.0	4	5470	15570	154
6VNBC3 63x10				6	6470	23350	226
4VNBC3 63x12		12	7.938	4	6640	20100	151
6VNBC3 63x12				6	9490	30600	222
3VNBC3 63x20		20	9.525	3	8530	23650	147
4VNBC3 80x10	80	10	6.0	4	5200	20410	187
6VNBC3 80x10				6	7250	30620	275
4VNBC3 80x12		12	7.938	4	7550	26120	189
6VNBC3 80x12				6	10700	39200	278
3VNBC3 80x16		16	9.525	3	7500	27450	187
4VNBC3 80x16				4	12850	42600	246
3VNBC3 80x20		20	9.525	3	7500	27450	187
4VNBC3 80x20				4	12850	42600	246

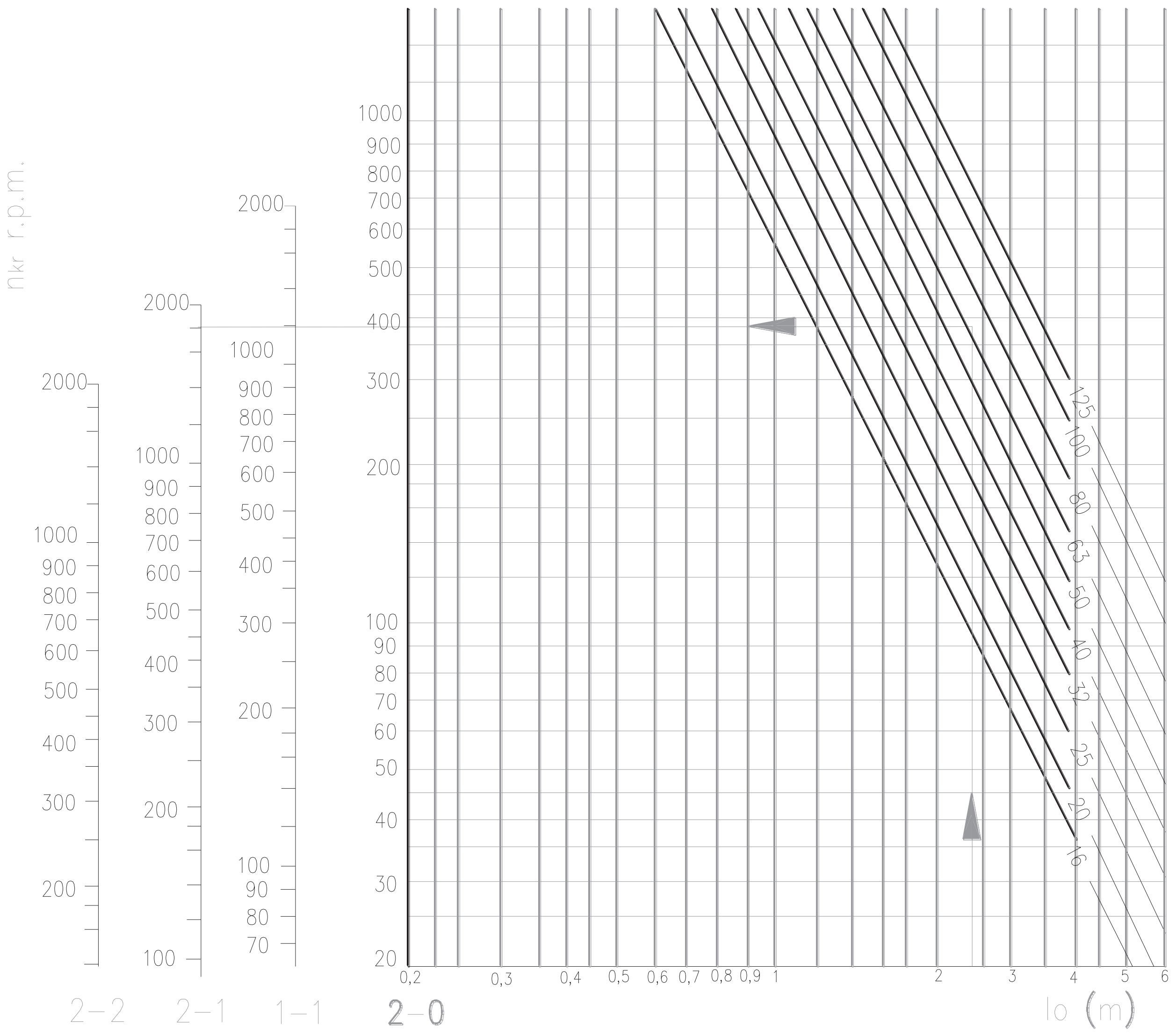
Z - external recirculation of balls



Nut				Model
D1	L	d	b * t * l	
75	94	4	6 * 3.5 * 18	4VNBC3 50x5
	116			6VNBC3 50x5
75	106	4	6 * 3.5 * 18	4VNBC3 50x6
	130			6VNBC3 50x6
75	128	4	6 * 3.5 * 28	4VNBC3 50x8
	162			6VNBC3 50x8
75	130	4	6 * 3.5 * 28	3VNBC3 50x10-Z
	152			4VNBC3 50x10-Z
	194			6VNBC3 50x10-Z
75	148	4	6 * 3.5 * 32	3VNBC3 50x12-Z
	174			4VNBC3 50x12-Z
75	188	4	6 * 3.5 * 32	3VNBC3 50x16
75	224	4	6 * 3.5 * 32	3VNBC3 50x20
90	106	5	8 * 4 * 28	4VNBC3 63x6
	130			6VNBC3 63x6
90	128	5	8 * 4 * 28	4VNBC3 63x8
	162			6VNBC3 63x8
90	152	5	8 * 4 * 28	4VNBC3 63x10
	194			6VNBC3 63x10
90	174	5	8 * 4 * 32	4VNBC3 63x12
	224			6VNBC3 63x12
95	224	5	8 * 4 * 50	3VNBC3 63x20
105	152	5	10 * 4.5 * 28	4VNBC3 80x10
	194			6VNBC3 80x10
105	174	5	10 * 4.5 * 32	4VNBC3 80x12
	224			6VNBC3 80x12
125	196	5	10 * 4.5 * 40	3VNBC3 80x16
	220			4VNBC3 80x16
125	224	5	10 * 4.5 * 50	3VNBC3 80x20
	266			4VNBC3 80x20



Fkr (kN)
125x10
125x20
100x10
100x20
80x10
80x20
63x10
63x20
50x5
50x10
40x5
40x10
32x5
32x10
25x5
25x10
20x5
16x5
3000
2000
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
2–0
0,1 0,2 0,3 0,4 0,5 0,6 0,7 0,8 0,9 1 2 3
1–1
0,2 0,3 0,4 0,5 0,6 0,7 0,8 0,9 1 2 3 5 6 7 8
2–1
0,3 0,4 0,5 0,6 0,7 0,8 0,9 1 2 3 5 6 7 8 9 10
2–2
0,4 0,5 0,6 0,7 0,8 0,9 1 2 3 5 6 7 8 9 10
lo (m)



Example:

Nominal Dia. = 63 mm

Theoretical length of screw = 2,4 m.

Bearing configuration - 2-1

n_{kr}= 1850 r.p.m

n_{dop}= 1850 * 0,8= 1480 r.p.m.