

BALL SCREWS

We produce ball screw drives in diameters ranging from 3 to 160 mm. The maximum lead is usually equal to the nominal diameter. Larger leads can be accommodated on an individual basis. Screw lengths up to 7 m are made from a single piece and are standard items. Longer screws are available on request. Screw lengths up to 15 m have already been produced.

Custom leads (including inch leads, etc.) can also be supplied. Our ball screw drives are produced to tolerance grades IT3, IT5, IT7 and IT10 in accordance with DIN 69051/DIN ISO 3408. On request, we can also supply lead logs for ball screws (these come as standard with IT3).

The matching ball nuts can be manufactured in accordance with the DIN standard, company standard or customer drawing. Whether the application requires the use of a single or a double nut for the ball screw is the customer's decision, based on their specific needs. Depending on the lead or load, ball profiles with diameters ranging from 0.5 to 20 mm are used.

We also supply complete assemblies with fixed and floating bearing brackets and nut holders. Alternatively, for long screws, we offer driven nuts including the complete bearing assembly. Our heavy duty "Herkules" range includes ball screw drives for exceptional loads.

For designers, drawings of the nuts can be downloaded from our website in various CAD formats. When you place an order, our engineering department will be happy to provide you with the individual CAD data for your screw drive.

We also offer various wiper systems and full covers for our ball screw drives.



APPLICATIONS



▶ Ball screw drive

Application areas for ball screw drives

- Machine tool building
- Conveying technology
- Aerospace industry
- Reactor technology
- Material handling systems
- Medical engineering
- Defence engineering
- Measurement and testing technology
- Traffic engineering
- Radar and antenna technology
- Linear technology
- Automotive

A distinction is made between a positioning ball screw and a transport ball screw. Positioning ball screws are used in applications with stringent requirements in terms of process properties, for example in machine tool building. Transport ball screws are used in material handling technology and conveying systems. Depending on requirements, the screw thread can be rolled, whirled or ground.



Machine tool building



Conveying technology



Aerospace industry



Reactor technology



Material handling systems

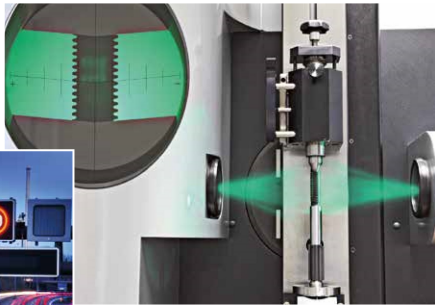


Defence engineering



Medical engineering

Measurement and testing technology



Traffic engineering

Radar and antenna technology



Linear technology



Automotive

Kammerer – a strong partner



QUALITY



► What is checked?

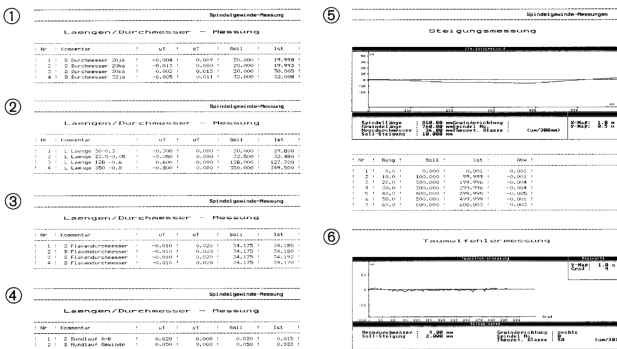
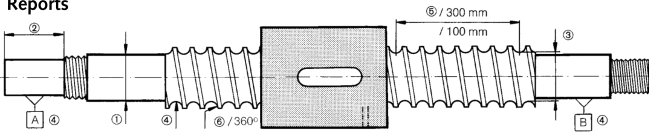
Measurement of the lead accuracy every 300 mm of the ball screw (to DIN 69051)
 the individual pitch of each thread or, for example, every 100 mm
 the wobble error
 the radial runout error at the spindle ends
 the length of the spindle
 the flank diameter (accuracy and radial runout)

Ball screws are drive units that make it possible to position machine components highly accurately, e.g. in machine tools and measuring equipment. To achieve the required accuracy, extensive measurements are also essential between the individual processing phases to check the manufacture.

Check measurements and tests are carried out for the following criteria, whereby some are of course only performed at the customer's request:

- Radial and axial runout
- Parallelism
- Axial play
- Tooth bearing
- Pre-loading
- No-load and load torques
- Rigidity
- Lead variation
- Material
- Thread profile
- Hardness
- Hardening cracks
- Straightness
- Dimensions
- Fit

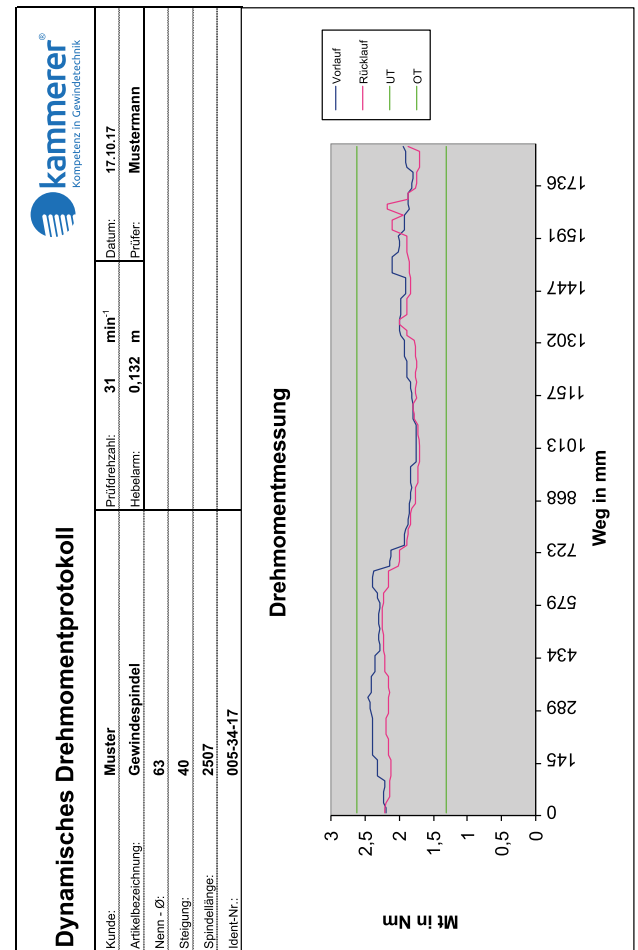
► Reports



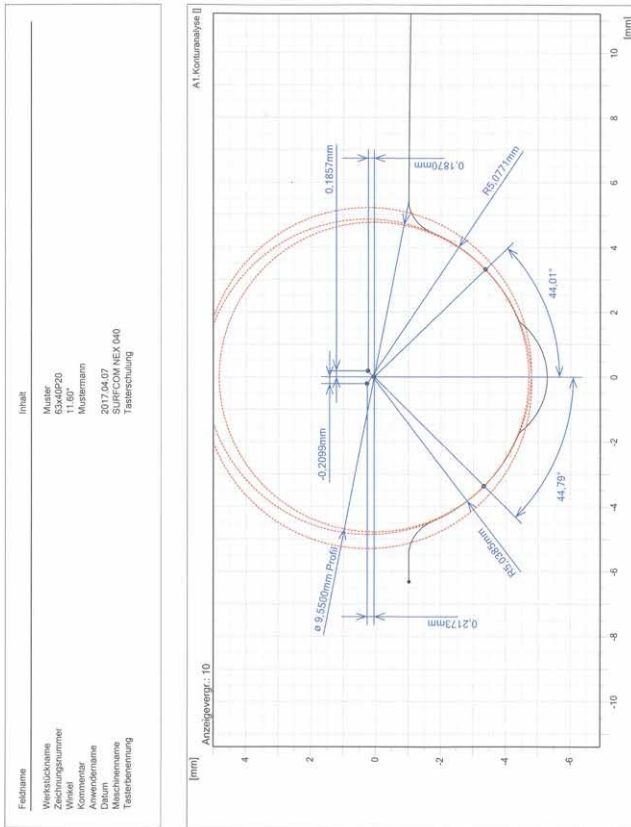
We can make all the necessary measurements on ball screw spindles and nuts on our test machine

with its computer analysed lead and measurement reports. Test reports can be supplied on request.

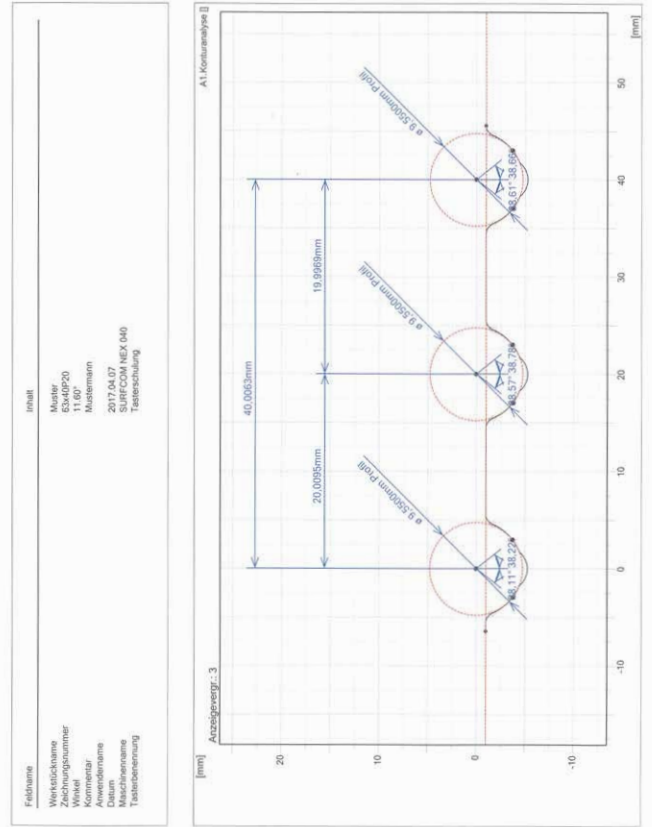
► Dynamic torque protocol



▶ Thread profile protocol



▶ Thread profile protocol



► DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

5 Abnahmeprüfungen

5.1 Allgemein

Die typischen Toleranzklassen für Positionier- und Transport-Kugelgewindetriebe sind in Tabelle 2 angegeben.

Tabelle 2 — Typische Toleranzklassen für Positionier- und Transport-Kugelgewindetriebe

Art des Kugelgewindetriebes	Toleranzklasse
Positionierung	0 – 1 – 3 – 5
Transport	0 – 1 – 3 – 5 – 7 – 10

Abhängig von der Art des betrachteten Kugelgewindetriebs [Positionier- (Typ P) oder Transport- (Typ T) Kugelgewindetrieb] müssen die Prüfungen aus Tabelle 3 angewendet werden.

Das Grundmessprinzip ist in Bild 2 dargestellt.

Tabelle 3 — Prüfungen für die Wegabweichung

Wegabweichungen über eine Referenzlänge	Art des Kugelgewindetriebs	
	Positionier-	Transport-
Wegkompensation, c , für den Nutzweg, l_u	Angabe durch Anwender	C = 0
Toleranz des Sollweges, e_p	E1.1	E1.2
Zulässige Wegschwankung, v_{wg} , über den Nutzweg	E2	–
Zulässige Wegschwankung, v_{300p} , über 300 mm Weg	E3	E3
Zulässige Wegschwankung, $v_{2\pi p}$, über 2π rad	E4	–

Prüfungen und Toleranzen für die Verschiebung der Kugelgewindemutter relativ zur Kugelgewindespindel.

Ein Vermessen der Gewindesteigung kann mit einer Messkugel durchgeführt werden, die den Gewingegang einer nicht in Rotation befindlichen Kugelgewindespindel abtastet. Für die Messintervalle, siehe Tabelle A.2.

Die Wegschwankung, $v_{2\pi}$, innerhalb von 2π rad wird durch neun Messungen ($8 \times 45^\circ$) pro Umdrehung bestimmt oder fortlaufend über einem Gewingegang (am Anfang, in der Mitte und am Ende des Nutzweges), vorausgesetzt, dass dies Bestandteil einer speziellen Vereinbarung war.

5.2 Wegabweichung und Wegschwankung

E 1.1

Prüfobjekt: Positionier-Kugelgewindetrieb

Prüfung der mittleren Wegabweichung, e_{sa} , und e_{0a} über den Nutzweg, l_u :

a) für den Sollweg, l_s ;
b) für den Nennweg, l_0 .

Diagramm

a) Istwegabweichung

b)

Zulässige Abweichungen		Toleranz für den Sollweg e_p [μm]							Beobachtungen und Anmerkungen
		Toleranzklassen							
Nutzweg l_u [mm]		0	1	3	5	7	10		
>	\leq								
0	315	4	6	12	23	–	–	a) $e_{sa} = \text{---} \mu\text{m}$	
315	400	5	7	13	25	–	–		
400	500	6	8	15	27	–	–		
500	630	6	9	16	32	–	–	b) Wegkompensationen c muss vom Anwender angegeben werden	
630	800	7	10	18	36	–	–	$c = \text{---}$	
800	1 000	8	11	21	40	–	–	$e_{0a} = \text{---} \mu\text{m}$	
1 000	1 250	9	13	24	47	–	–		
1 250	1 600	11	15	29	55	–	–		
1 600	2 000	–	18	35	65	–	–		
2 000	2 500	–	22	41	78	–	–		
2 500	3 150	–	26	50	96	–	–		
3 150	4 000	–	32	62	115	–	–		
4 000	5 000	–	–	76	140	–	–		
5 000	6 300	–	–	–	170	–	–		

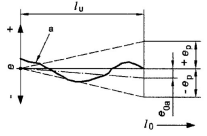
Prüfmittel
Siehe Bild 2

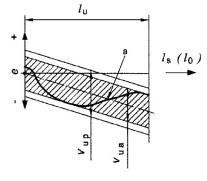
Prüfanleitung
Siehe Bild 2

► DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

Prüfobjekt: Transport-Kugelgewindtrieb Prüfung der mittleren Wegabweichung, e_{0B} , über den Nutzweg, l_U	E 1.2																								
Diagramm 																									
^a Istwegabweichung																									
Zulässige Abweichungen <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td colspan="6">Toleranz für den Sollweg e_p [μm]</td> </tr> <tr> <td colspan="6">Toleranzklassen</td> </tr> <tr> <td>0</td> <td>1</td> <td>3</td> <td>5</td> <td>7</td> <td>10</td> </tr> <tr> <td colspan="6">$e_p = \pm \frac{l_U}{300} \cdot i_{300p}$</td> </tr> </table>	Toleranz für den Sollweg e_p [μm]						Toleranzklassen						0	1	3	5	7	10	$e_p = \pm \frac{l_U}{300} \cdot i_{300p}$						Beobachtungen und Anmerkungen $e_{0B} = \text{_____ } \mu\text{m}$
Toleranz für den Sollweg e_p [μm]																									
Toleranzklassen																									
0	1	3	5	7	10																				
$e_p = \pm \frac{l_U}{300} \cdot i_{300p}$																									
Prüfmittel Siehe Bild 2																									
Prüfanleitung Siehe Bild 2																									

Prüfobjekt: Positionier-Kugelgewindtrieb Prüfung der Wegschwankung, v_{UP} , über den Nutzweg, l_U	E 2																																																																																																																																							
Diagramm 																																																																																																																																								
^a Istwegabweichung																																																																																																																																								
Zulässige Abweichungen <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <th rowspan="2">Nutzweg l_U [mm]</th> <th colspan="7">Wegschwankung v_{UP} [μm]</th> </tr> <tr> <th colspan="7">Toleranzklassen</th> </tr> <tr> <td>></td> <td>≤</td> <td>0</td> <td>1</td> <td>3</td> <td>5</td> <td>7</td> <td>10</td> </tr> <tr> <td>0</td> <td>315</td> <td>3,5</td> <td>6</td> <td>12</td> <td>23</td> <td>-</td> <td>-</td> </tr> <tr> <td>315</td> <td>400</td> <td>3,5</td> <td>6</td> <td>12</td> <td>25</td> <td>-</td> <td>-</td> </tr> <tr> <td>400</td> <td>500</td> <td>4</td> <td>7</td> <td>13</td> <td>26</td> <td>-</td> <td>-</td> </tr> <tr> <td>500</td> <td>630</td> <td>4</td> <td>7</td> <td>14</td> <td>29</td> <td>-</td> <td>-</td> </tr> <tr> <td>630</td> <td>800</td> <td>5</td> <td>8</td> <td>16</td> <td>31</td> <td>-</td> <td>-</td> </tr> <tr> <td>800</td> <td>1 000</td> <td>6</td> <td>9</td> <td>17</td> <td>34</td> <td>-</td> <td>-</td> </tr> <tr> <td>1 000</td> <td>1 250</td> <td>6</td> <td>10</td> <td>19</td> <td>39</td> <td>-</td> <td>-</td> </tr> <tr> <td>1 250</td> <td>1 600</td> <td>7</td> <td>11</td> <td>22</td> <td>44</td> <td>-</td> <td>-</td> </tr> <tr> <td>1 600</td> <td>2 000</td> <td>-</td> <td>13</td> <td>25</td> <td>51</td> <td>-</td> <td>-</td> </tr> <tr> <td>2 000</td> <td>2 500</td> <td>-</td> <td>15</td> <td>29</td> <td>59</td> <td>-</td> <td>-</td> </tr> <tr> <td>2 500</td> <td>3 150</td> <td>-</td> <td>17</td> <td>34</td> <td>69</td> <td>-</td> <td>-</td> </tr> <tr> <td>3 150</td> <td>4 000</td> <td>-</td> <td>21</td> <td>41</td> <td>82</td> <td>-</td> <td>-</td> </tr> <tr> <td>4 000</td> <td>5 000</td> <td>-</td> <td>-</td> <td>49</td> <td>99</td> <td>-</td> <td>-</td> </tr> <tr> <td>5 000</td> <td>6 300</td> <td>-</td> <td>-</td> <td>-</td> <td>119</td> <td>-</td> <td>-</td> </tr> </table>	Nutzweg l_U [mm]	Wegschwankung v_{UP} [μm]							Toleranzklassen							>	≤	0	1	3	5	7	10	0	315	3,5	6	12	23	-	-	315	400	3,5	6	12	25	-	-	400	500	4	7	13	26	-	-	500	630	4	7	14	29	-	-	630	800	5	8	16	31	-	-	800	1 000	6	9	17	34	-	-	1 000	1 250	6	10	19	39	-	-	1 250	1 600	7	11	22	44	-	-	1 600	2 000	-	13	25	51	-	-	2 000	2 500	-	15	29	59	-	-	2 500	3 150	-	17	34	69	-	-	3 150	4 000	-	21	41	82	-	-	4 000	5 000	-	-	49	99	-	-	5 000	6 300	-	-	-	119	-	-	Beobachtungen und Anmerkungen $v_{UP} = \text{_____ } \mu\text{m}$
Nutzweg l_U [mm]		Wegschwankung v_{UP} [μm]																																																																																																																																						
	Toleranzklassen																																																																																																																																							
>	≤	0	1	3	5	7	10																																																																																																																																	
0	315	3,5	6	12	23	-	-																																																																																																																																	
315	400	3,5	6	12	25	-	-																																																																																																																																	
400	500	4	7	13	26	-	-																																																																																																																																	
500	630	4	7	14	29	-	-																																																																																																																																	
630	800	5	8	16	31	-	-																																																																																																																																	
800	1 000	6	9	17	34	-	-																																																																																																																																	
1 000	1 250	6	10	19	39	-	-																																																																																																																																	
1 250	1 600	7	11	22	44	-	-																																																																																																																																	
1 600	2 000	-	13	25	51	-	-																																																																																																																																	
2 000	2 500	-	15	29	59	-	-																																																																																																																																	
2 500	3 150	-	17	34	69	-	-																																																																																																																																	
3 150	4 000	-	21	41	82	-	-																																																																																																																																	
4 000	5 000	-	-	49	99	-	-																																																																																																																																	
5 000	6 300	-	-	-	119	-	-																																																																																																																																	
Prüfmittel Siehe Bild 2																																																																																																																																								
Prüfanleitung Siehe Bild 2 v_{UP} ist der kleinste Abstand, parallel zur Ordinate zwischen zwei Geraden gemessen, die parallel zum mittleren Istweg verlaufen und die Istwegabweichung über den Nutzweg l_U nach oben und unten begrenzen.																																																																																																																																								

► DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

Prüfobjekt: Transport- oder Positionier-Kugelgewindtrieb Prüfung der Wegschwankung, v_{300} , über 300 mm axialen Weg:	E 3																														
Diagramm 																															
^a Istwegabweichung																															
Zulässige Abweichungen <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <th colspan="6">Toleranzklasse</th> </tr> <tr> <td>0</td><td>1</td><td>3</td><td>5</td><td>7</td><td>10</td> </tr> <tr> <td colspan="6">v_{300a} [µm]</td> </tr> <tr> <td>3,5</td><td>6</td><td>12</td><td>23</td><td>52¹⁾</td><td>210¹⁾</td> </tr> <tr> <td colspan="6">¹⁾ nur für Transport-Kugelgewindtriebe</td> </tr> </table>	Toleranzklasse						0	1	3	5	7	10	v_{300a} [µm]						3,5	6	12	23	52 ¹⁾	210 ¹⁾	¹⁾ nur für Transport-Kugelgewindtriebe						Beobachtungen und Anmerkungen $v_{300a \max} = \text{_____ } \mu\text{m}$
Toleranzklasse																															
0	1	3	5	7	10																										
v_{300a} [µm]																															
3,5	6	12	23	52 ¹⁾	210 ¹⁾																										
¹⁾ nur für Transport-Kugelgewindtriebe																															
Prüfmittel Siehe Bild 2																															
Prüfanleitung Siehe Bild 2 v_{300a} ist der kleinste Abstand, der parallel zur Ordinate gemessen wird. Er wird gefunden, wenn man eine Schablone entlang der Istwegabweichung und parallel zur mittleren Istwegabweichung werden die Istwegschwankungen innerhalb der gesamten Länge von 300 mm entlang des Nutweges beinhaltet.																															

Prüfobjekt: Positionier-Kugelgewindtrieb Prüfung der Wegschwankung, $v_{2\pi}$, über 2π rad:	E 4																								
Diagramm 																									
^a Istwegabweichung																									
Zulässige Abweichungen <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <th colspan="6">Toleranzklasse</th> </tr> <tr> <td>0</td><td>1</td><td>3</td><td>5</td><td>7</td><td>10</td> </tr> <tr> <td colspan="6">$v_{2\pi a}$ [µm]</td> </tr> <tr> <td>3</td><td>4</td><td>6</td><td>8</td><td>-</td><td>-</td> </tr> </table>	Toleranzklasse						0	1	3	5	7	10	$v_{2\pi a}$ [µm]						3	4	6	8	-	-	Beobachtungen und Anmerkungen $v_{2\pi a \max} = \text{_____ } \mu\text{m}$
Toleranzklasse																									
0	1	3	5	7	10																				
$v_{2\pi a}$ [µm]																									
3	4	6	8	-	-																				
Prüfmittel Siehe Bild 2																									
Prüfanleitung Siehe Bild 2 $v_{2\pi a}$ ist der kleinste Abstand, der parallel zur Ordinate gemessen wird. Durch Verschieben einer Schablone entlang der Istwegabweichung und parallel zur mittleren Istwegabweichung werden die Istwegschwankungen über jeden Abstand entsprechend einer Umdrehung, beinhaltet z. B. 2π rad über den Nutweg.																									

► DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

5.3 Lauf- und Lageprüfungen

Prüfobjekt: Transport- oder Positionier-Kugelgewindetrieb **E 5**

Messung des Rundlaufs, i_{θ} , des Kugelgewindespindelaußendurchmessers über die Länge l_5 zur Bestimmung der Geradheit bezogen auf AA'.

Nenndurchmesser d_0 [mm]		l_5 [mm]	Toleranzklasse					
>	≤		0	1	3	5	7	10
6	12	80	i_{θ} [µm] für l_5					
12	25							
25	50	16	20	25	32	40	80	
50	100	630						
100	200	1 250						

Nenndurchmesser l_1 / d_0

		$i_{s,max} \theta$ [µm] für $l_1 > 4 \cdot l_5$					
>	≤	32	40	50	64	80	160
-	40	32	40	50	64	80	160
40	60	48	60	75	96	120	240
60	80	80	100	125	160	200	400
80	100	128	160	200	256	320	640

Beobachtungen und Anmerkungen

$i_{\theta} =$ _____ µm

$i_{s,max} \theta =$ _____ µm

Prüfmittel
Feinzeiger und paarige Prüfprismen

Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.612.2
Kugelgewindespindel in identischen Prüfprismen an den Punkten A und A' lagern.
Feinzeiger mit planem Messeinsatz im Abstand l_5 senkrecht zur zylindrischen Oberfläche anstellen.
Kugelgewindespindel langsam drehen und Messungen in den angegebenen Messintervallen vornehmen.
ANMERKUNG 1 Messungen bei Lagerung zwischen Spitzen können nach Vereinbarung ausgeführt werden.
ANMERKUNG 2 Wenn $l_1 < 2 \cdot l_5$ ist, erfolgt die Messung bei $l_1/2$.

Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb **E 6.1**

Messung der Rundlaufabweichung, $i_{\theta,1}$, des Lagersitzes bezogen auf AA' über die Länge l .
Für Länge $l_6 \leq l$ (siehe Tabelle)
Für Länge $l_6 > l$ muss gelten $i_{\theta,1a} \leq i_{\theta,1p} \cdot \frac{l_6}{l}$

Legende
1 Lagersitz

Nenndurchmesser d_0 [mm]		l [mm]	Toleranzklasse				
>	≤		1	3	5	7	10
6	20	80	10	12	20	40	63
20	50	125	12	16	25	50	80
50	125	200	16	20	32	63	100
125	200	315	-	25	40	80	125

Beobachtungen und Anmerkungen

Durchmesser $i_{\theta,1a}$

_____ mm _____ µm

_____ mm _____ µm

_____ mm _____ µm

_____ mm _____ µm

Prüfmittel
Feinzeiger und paarige Prüfprismen

Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.612.2
Kugelgewindespindel an den Punkten A und A' auf Prüfprismen lagern.
Feinzeiger in einem Abstand von l_6 senkrecht zur zylindrischen Oberfläche anstellen.
Kugelgewindespindel langsam drehen und Messwerte vom Feinzeiger aufnehmen.

► DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier- oder Transport-Kugelgewindtrieb		E 6.2
Messung der Rundlaufabweichung, $f_{6,2}$, der Lagersitze bezogen auf die Zentrierlinie des Gewindeabschnitts		
Diagramm		
Legende		
1 Lagersitze		
Zulässige Abweichungen		Beobachtungen und Anmerkungen
Nenndurchmesser d_0 [mm]	Toleranzklasse	$f_{6,2a} = \text{---} \mu\text{m}$
	0 1 3 5 -	
$>$ \leq	$f_{6,1p}$ [μm]	
-	8 3 5 8 10 -	
8	12 4 5 8 11	
12	20 4 6 9 12	
20	32 5 7 10 13	
32	50 6 8 12 15	
50	80 7 9 13 17	
80	125 - 10 15 20	
Prüfmittel		
Feinzeiger und paarige Prüfprismen (Kugelgewindemutter oder spezielle Vorrichtung)		
Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.612.2		
Die Kugelgewindespindel in der Nähe beider Enden des Gewindeabschnitts lagern, unter Verwendung einer größeren Anzahl von Kugeln mit derselben Größe wie bei normalem Einsatz.		
Feinzeiger am Außendurchmesser der Lagersitze der Kugelgewindespindel anstellen.		
Kugelgewindespindel eine Umdrehung drehen und Messwerte des Feinzeigers aufnehmen.		
ANMERKUNG Diese Prüfung kann nach Vereinbarung zwischen Hersteller und Anwender durchgeführt werden. Wenn die Prüfung angewandt wird, so ersetzt sie Prüfung E6.1		

Prüfobjekt: Positionier- oder Transport-Kugelgewindtrieb		E 7.1
Messung der Rundlaufabweichung, $f_{7,1}$, des Endzapfen-Durchmessers bezogen auf den Lagerstuhl, durch Differenzbildung:		
Für die Länge $l_f \leq l$ (l siehe Tabelle)		
Für die Länge $l_f > l$ muss gelten $f_{7,1a} \leq f_{7,1p} \frac{l_f}{l}$		
Diagramm		
Legende		
1 Lagersitz		
Zulässige Abweichungen		Beobachtungen und Anmerkungen
Nenndurchmesser d_0 [mm]	Toleranzklasse	Durchmesser $f_{7,1a}$ ____ mm ____ μm ____ mm ____ μm ____ mm ____ μm ____ mm ____ μm
$>$ \leq	1 3 5 7 10	
	$f_{7,1p}$ [μm] für l	
6 20	80 5 6 8 12 16	
20 50	125 6 8 10 16 20	
50 125	200 8 10 12 20 25	
125 200	315 - 12 16 25 32	
Prüfmittel		
Feinzeiger und paarige Prüfprismen		
Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.612.2		
Kugelgewindtrieb in den Punkten A und A' auf Prüfprismen lagern.		
Feinzeiger im Abstand l_f senkrecht auf der zylindrischen Oberfläche anstellen.		
Kugelgewindespindel langsam drehen und die Messwerte des Feinzeigers aufnehmen.		

► DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

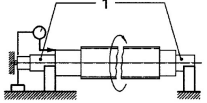
Prüfobjekt: Positionier- oder Transport-Kugelgewindtrieb		E 7.2																																																					
Messung der Rundlaufabweichung, $i_{7,2}$, des Endzapfen-Durchmessers bezogen auf die Zentrierlinie des Lagersitzes:																																																							
Diagramm																																																							
Legende 1 Lagersitze																																																							
Zulässige Abweichungen		Beobachtungen und Anmerkungen:																																																					
<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Nenndurchmesser d_0 [mm]</th> <th colspan="5">Toleranzklasse</th> </tr> <tr> <th>0</th> <th>1</th> <th>3</th> <th>5</th> <th>-</th> </tr> </thead> <tbody> <tr> <td>></td> <td>8</td> <td>3</td> <td>5</td> <td>8</td> <td>10</td> </tr> <tr> <td>≤</td> <td>12</td> <td>4</td> <td>5</td> <td>8</td> <td>11</td> </tr> <tr> <td>12</td> <td>20</td> <td>4</td> <td>6</td> <td>9</td> <td>12</td> </tr> <tr> <td>20</td> <td>32</td> <td>5</td> <td>7</td> <td>10</td> <td>13</td> </tr> <tr> <td>32</td> <td>50</td> <td>6</td> <td>8</td> <td>12</td> <td>15</td> </tr> <tr> <td>50</td> <td>80</td> <td>7</td> <td>9</td> <td>13</td> <td>17</td> </tr> <tr> <td>80</td> <td>125</td> <td>-</td> <td>10</td> <td>15</td> <td>20</td> </tr> </tbody> </table>	Nenndurchmesser d_0 [mm]	Toleranzklasse					0	1	3	5	-	>	8	3	5	8	10	≤	12	4	5	8	11	12	20	4	6	9	12	20	32	5	7	10	13	32	50	6	8	12	15	50	80	7	9	13	17	80	125	-	10	15	20	$i_{7,2\Delta} = \text{---} \mu\text{m}$	
Nenndurchmesser d_0 [mm]		Toleranzklasse																																																					
	0	1	3	5	-																																																		
>	8	3	5	8	10																																																		
≤	12	4	5	8	11																																																		
12	20	4	6	9	12																																																		
20	32	5	7	10	13																																																		
32	50	6	8	12	15																																																		
50	80	7	9	13	17																																																		
80	125	-	10	15	20																																																		
Prüfmittel Feinzeiger und paarige Prüfprismen																																																							
Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.612.2 Lagerung der Kugelgewindspindel horizontal in Prüfprismen auf ihren Lagersitzen. Feinzeiger auf dem Außendurchmesser des Endzapfens anstellen. Kugelgewindspindel eine Umdrehung drehen und die Messwerte des Feinzeigers aufnehmen. ANMERKUNG Diese Prüfung kann nach Vereinbarung zwischen Hersteller und Anwender durchgeführt werden. Wenn die Prüfung angewandt wird, ersetzt sie Prüfung E7.1.																																																							

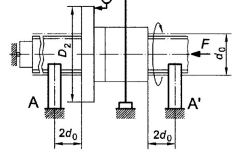
Prüfobjekt: Positionier- oder Transport-Kugelgewindtrieb		E 8.1																													
Messung der Planlaufabweichung, $i_{8,1}$, der Anlagefläche für Lager bezogen auf AA':																															
Diagramm																															
$i_{8,1\Delta} \leq i_{8,1P} - \Delta $ Δ ist die Abweichung der Geradheit																															
Legende 1 Lagersitz																															
Zulässige Abweichung		Beobachtungen und Anmerkungen																													
<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Nenndurchmesser d_0 [mm]</th> <th colspan="5">Toleranzklasse</th> </tr> <tr> <th>1</th> <th>3</th> <th>5</th> <th>7</th> <th>10</th> </tr> </thead> <tbody> <tr> <td>></td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>10</td> </tr> <tr> <td>≤</td> <td>63</td> <td>4</td> <td>5</td> <td>6</td> <td>12</td> </tr> <tr> <td>125</td> <td>-</td> <td>6</td> <td>8</td> <td>10</td> <td>16</td> </tr> </tbody> </table>	Nenndurchmesser d_0 [mm]	Toleranzklasse					1	3	5	7	10	>	3	4	5	6	10	≤	63	4	5	6	12	125	-	6	8	10	16	Durchmesser $i_{8,1\Delta}$ ___ mm ___ μm ___ mm ___ μm ___ mm ___ μm	
Nenndurchmesser d_0 [mm]		Toleranzklasse																													
	1	3	5	7	10																										
>	3	4	5	6	10																										
≤	63	4	5	6	12																										
125	-	6	8	10	16																										
Prüfmittel Feinzeiger und paarige Prüfprismen																															
Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.632 Kugelgewindtrieb auf Prismen in den Punkten A und A' lagern. Kugelgewindspindel in axialer Richtung gegen Versatz sichern (z. B. durch das Platzieren einer Kugel zwischen Zentrierbohrung der Kugelgewindspindel und der Anlagefläche). Feinzeiger senkrecht zur Planfläche der Lagerzapfenschulter und zur Mantelfläche des entsprechenden Lagerzapfens anstellen. Kugelgewindspindel eine Umdrehung drehen und die Messwerte des Feinzeigers aufnehmen.																															

► DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

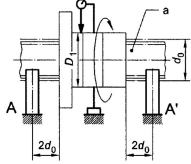
Prüfobjekt: Positionier- oder Transport-Kugelgewindetriebe		E 8.2		
Messung der Planlaufabweichung, f_{s2} , der Anlagefläche für das Lager bezogen auf die Achse der Kugelgewindespindel.				
Diagramm 				
Legende 1 Lagerseite				
Zulässige Abweichungen			Beobachtungen und Anmerkungen $f_{s2a} = \text{_____ } \mu\text{m}$	
Nenndurchmesser d_0 [mm]		Toleranzklasse		
> ≤		0 1 3 5 -		
		f_{s2p} [μm]		
- 8		2 3 4 5		
8 12		2 3 4 5		
12 20		2 3 4 5		
20 32		2 3 4 5		
32 50		2 3 4 5		
50 80		3 4 5 7		
80 125		- 4 6 8		
Prüfmittel Feinzeiger und paarige Prüfprismen				
Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.632 Die Kugelgewindespindel horizontal auf Prismen an den Lagerseiten lagern und gleichzeitig in axialer Richtung gegen Versatz sichern. Feinzeiger senkrecht zur Planfläche des Lagerplatzes anstellen. Kugelgewindespindel eine Umdrehung drehen und die Messwerte des Feinzeigers aufnehmen. ANMERKUNG Diese Prüfung kann nach Vereinbarung zwischen Hersteller und Anwender durchgeführt werden. Wenn die Prüfung angewandt wird, ersetzt sie Prüfung E8.1.				

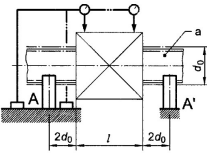
Prüfobjekt: Positionier- oder Transport-Kugelgewindetriebe		E 9		
Messung der Planlaufabweichung, f_{9a} , der Anlagefläche der Kugelgewindemutter bezogen auf AA' (nur für vorgespannte Kugelgewindemuttern).				
Diagramm 				
Zulässige Abweichungen			Beobachtungen und Anmerkungen: $f_{9a \text{ max}} = \text{_____ } \mu\text{m}$	
Flanschdurchmesser D_2 [mm]		Toleranzklasse		
> ≤		0 1 3 5 7 10		
		f_{9a} [μm]		
16 32		8 10 12 16 20 -		
32 63		10 12 16 20 25		
63 125		12 16 20 25 32		
126 250		16 20 25 32 40		
250 500		- - 32 40 50		
Prüfmittel Feinzeiger und paarige Prüfprismen				
Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.632 System vorgespannt. Lagern der Kugelgewindespindel auf Prismen in den Punkten A und A'. Sichern der Kugelgewindespindel gegen axialen Versatz (z. B. Kugel zwischen Zentrierbohrung und Anlagefläche). Feinzeiger senkrecht zur Flanschfläche der Kugelgewindemutter am größten Durchmesser D_2 anstellen. Kugelgewindemutter gegen Verdrehen auf der Kugelgewindespindel sichern. Kugelgewindespindel drehen und Messwerte des Feinzeigers aufnehmen.				

► DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier- oder Transport-Kugelgewindtrieb		E 10																																																																
Messung der Rundlaufabweichung, f_{10} , des Außendurchmessers der Kugelgewindemutter bezogen auf AA' (nur für vorgespannte und drehende Kugelgewindemuttern):																																																																		
Diagramm 																																																																		
^a fixiert																																																																		
Zulässige Abweichungen Außendurchmesser der Kugelgewindemutter D_1 [mm]	<table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <tr> <th colspan="2"></th> <th colspan="6">Toleranzklasse</th> </tr> <tr> <th colspan="2"></th> <th>0</th> <th>1</th> <th>3</th> <th>5</th> <th>7</th> <th>10</th> </tr> <tr> <th style="font-size: small;">></th> <th style="font-size: small;">≤</th> <th colspan="6" style="font-size: small;">f_{10a} [µm]</th> </tr> <tr> <td style="font-size: small;">16</td> <td style="font-size: small;">32</td> <td style="font-size: small;">8</td> <td style="font-size: small;">10</td> <td style="font-size: small;">12</td> <td style="font-size: small;">16</td> <td style="font-size: small;">20</td> <td style="font-size: small;">-</td> </tr> <tr> <td style="font-size: small;">32</td> <td style="font-size: small;">63</td> <td style="font-size: small;">10</td> <td style="font-size: small;">12</td> <td style="font-size: small;">16</td> <td style="font-size: small;">20</td> <td style="font-size: small;">25</td> <td style="font-size: small;">-</td> </tr> <tr> <td style="font-size: small;">63</td> <td style="font-size: small;">125</td> <td style="font-size: small;">12</td> <td style="font-size: small;">16</td> <td style="font-size: small;">20</td> <td style="font-size: small;">25</td> <td style="font-size: small;">32</td> <td style="font-size: small;">-</td> </tr> <tr> <td style="font-size: small;">125</td> <td style="font-size: small;">250</td> <td style="font-size: small;">16</td> <td style="font-size: small;">20</td> <td style="font-size: small;">25</td> <td style="font-size: small;">32</td> <td style="font-size: small;">40</td> <td style="font-size: small;">-</td> </tr> <tr> <td style="font-size: small;">250</td> <td style="font-size: small;">500</td> <td style="font-size: small;">-</td> <td style="font-size: small;">-</td> <td style="font-size: small;">32</td> <td style="font-size: small;">40</td> <td style="font-size: small;">50</td> <td style="font-size: small;">-</td> </tr> </table>			Toleranzklasse								0	1	3	5	7	10	>	≤	f_{10a} [µm]						16	32	8	10	12	16	20	-	32	63	10	12	16	20	25	-	63	125	12	16	20	25	32	-	125	250	16	20	25	32	40	-	250	500	-	-	32	40	50	-	Beobachtungen und Anmerkungen $f_{10a \max} = \dots \mu\text{m}$
		Toleranzklasse																																																																
		0	1	3	5	7	10																																																											
>	≤	f_{10a} [µm]																																																																
16	32	8	10	12	16	20	-																																																											
32	63	10	12	16	20	25	-																																																											
63	125	12	16	20	25	32	-																																																											
125	250	16	20	25	32	40	-																																																											
250	500	-	-	32	40	50	-																																																											
Prüfmittel Feinzeiger und paarige Prüfprismen																																																																		
Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.612.2 System vorgespannt. Lagern der Kugelgewindespindel auf Prismen in den Punkten A und A'. Feinzeiger senkrecht zur zylindrischen Fläche der Kugelgewindemutter am Führungsdurchmesser D_1 anstellen. Sichern der Kugelgewindespindel. Kugelgewindespindel langsam drehen und Messwerte des Feinzeigers aufnehmen.																																																																		

Prüfobjekt: Positionier- oder Transport-Kugelgewindtrieb		E 11																								
Parallelitätsabweichung, f_{11} , einer rechteckigen Kugelgewindemutter bezogen auf AA' (nur für vorgespannte Kugelgewindemuttern):																										
Diagramm 																										
^a fixiert																										
Zulässige Abweichungen	<table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <tr> <th colspan="6">Toleranzklasse</th> </tr> <tr> <th>0</th> <th>1</th> <th>3</th> <th>5</th> <th>7</th> <th>10</th> </tr> <tr> <th colspan="6" style="font-size: small;">f_{11p} [µm] je 100 mm (kumulativ)</th> </tr> <tr> <td style="font-size: small;">14</td> <td style="font-size: small;">16</td> <td style="font-size: small;">20</td> <td style="font-size: small;">25</td> <td style="font-size: small;">32</td> <td style="font-size: small;">-</td> </tr> </table>	Toleranzklasse						0	1	3	5	7	10	f_{11p} [µm] je 100 mm (kumulativ)						14	16	20	25	32	-	Beobachtungen und Anmerkungen $f_{11a} = \dots \mu\text{m}$
Toleranzklasse																										
0	1	3	5	7	10																					
f_{11p} [µm] je 100 mm (kumulativ)																										
14	16	20	25	32	-																					
Prüfmittel Feinzeiger und paarige Prüfprismen																										
Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.412.2 System vorgespannt. Kugelgewindespindel auf Prismen in den Punkten A und A' lagern. Feinzeiger senkrecht zur Prüffläche anstellen und auf dieser parallel zur Achse der Kugelgewindespindel über die Länge / verschieben. Messwerte des Feinzeigers aufnehmen.																										

DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

5.4 Funktionsprüfungen

Prüfobjekt: Positionier- oder Transport-Kugelgewindtrieb
Messung des Leerlaufdrehmoments bei Vorspannung, ΔT_p

E 12

Diagramm

$T_p = F \cdot l$ ohne Abstreifer
 $T_p = F_1 \cdot l$ mit Abstreifer
 l_n = Länge der Kugelgewindemutter
Legende
 X Weg
 Y Leerlaufdrehmoment bei Vorspannung
 1 Kraftmesser

T_{p0} [Nm]		Toleranzklasse					
>	≤	0	1	3	5	7	10
ΔT_{pp} [% von T_{p0}] für $l_u/d_0 \leq 40$; $l_n \leq 4000$ mm							
0,2	0,4	30	35	40	50	-	-
0,4	0,6	25	30	35	40	-	-
0,6	1,0	20	25	30	35	40	-
1,0	2,5	15	20	25	30	35	-
2,5	6,3	10	15	20	25	30	-
6,3	10	-	15	20	30	-	-
ΔT_{pp} [% von T_{p0}] für $40 < l_u/d_0 \leq 60$; $l_n \leq 4000$ mm							
0,2	0,4	40	40	50	60	-	-
0,4	0,6	35	35	40	45	-	-
0,6	1,0	30	30	35	40	45	-
1,0	2,5	25	25	30	35	40	-
2,5	6,3	20	20	25	30	35	-
6,3	10	-	-	20	25	35	-
ΔT_{pp} [% von T_{p0}]; $l_n > 4000$ mm							
-	0,6	Keine Angabe					
0,6	1,0	-	-	40	45	50	-
1,0	2,5	-	-	35	40	45	-
2,5	6,3	-	-	30	35	40	-
6,3	10	-	-	25	30	35	-

Zulässige Abweichungen

Beobachtungen und Anmerkungen

Mit Abstreifer

$l =$ _____ m
 $F =$ _____ N
 $T_{pa} =$ _____ Nm
 $\Delta T_{pa} = \pm$ _____ Nm
 $= \pm$ _____ % von T_{p0}

Ohne Abstreifer

$F_1 =$ _____ N
 $T_{ta} =$ _____ Nm
 $\Delta T_{ta} = \pm$ _____ Nm
 $= \pm$ _____ % von T_{p0}

Prüfmittel
 Prüfbank mit Kraftmeseinrichtung

Prüfanleitung
 System vorgespannt (mit oder ohne Abstreifer). Zur Aufnahme der radialen Vorspannkraft, die Kugelgewindemutter mit der Kraftmeseinrichtung im Abstand l von der Drehachse verbinden. Messungen durch die Kraftmeseinrichtung bei einer Drehzahl von 100 min⁻¹ in beide Drehrichtungen durchführen.¹⁾ Zur Schmierung ist ein Schmieröl der Viskositätsklasse ISO VG 100 zu verwenden.²⁾

1) Andere Drehzahlen, Schmierstoffe und Messeinrichtungen können nach Vereinbarung zwischen Anwender und Hersteller verwendet werden.

Prüfobjekt: Positionier- oder Transport-Kugelgewindtrieb
Messung der axialen Steifigkeit, R_{nu1}

E 13

Diagramm

Legende
 X elastische Verformung, Δl
 Y Belastung, F
 a gegen Verdrehen gesichert
 b axial gesichert

Zulässige Abweichungen
 Keine Angaben

Beobachtungen und Anmerkungen

$F_{pr} =$ _____ N
 $F_1 =$ _____ N
 $F_2 =$ _____ N
 $\Delta l_1 =$ _____ μ m
 $\Delta l_2 =$ _____ μ m
 $R_{nu1} =$ _____ N/ μ m
 $R_{nu2} =$ _____ N/ μ m

Prüfmittel
 Feinzeiger und Prüfvorrichtung

Prüfanleitung
 Vorspannte Kugelgewindemutter in beiden Richtungen gegen axialen Versatz und Kugelgewindespindel gegen Verdrehen gesichert. Stativ der Feinzeiger an der Kugelgewindespindel aufsetzen und die Messastar mit möglichst geringem Abstand parallel zur Achse des Kugelgewindetriebes an der Stirnfläche der Kugelgewindemutter anstellen. Axiale Kraft $F_1 = 0,5 \cdot F_{pr}$ oder $F_2 = 2 \cdot F_{pr}$ in Zug- und Druckrichtung auf die Kugelgewindespindel aufbringen. F_{pr} Vorspannung Δl_1 oder Δl_2 sind elastische Verformungen (Umkehrbereich) durch die jeweiligen axialen Prüflasten $\pm F_1$ und $\pm F_2$.

Steifigkeit im Bereich $\pm F_1$: $R_{nu1} = \frac{2 \cdot F_1}{\Delta l_1} = \frac{F_{pr}}{\Delta l_1}$

Steifigkeit im Bereich $+F_1$ bis $+F_2$ und $-F_1$ bis $-F_2$: $R_{nu2} = \frac{2 \cdot (F_2 - F_1)}{\Delta l_2 - \Delta l_1} = \frac{3 \cdot F_{pr}}{\Delta l_2 - \Delta l_1}$

Andere Prüflasten F können nach Vereinbarung zwischen Hersteller und Anwender verwendet werden.

► DIN extracts

DIN ISO 3408-3:2011-04

DIN ISO 3408-3:2011-04

Anhang A
(normativ)

Ergänzende Tabellen

Tabelle A.1 — Toleranzwerte für Sollweg, e_{pl} , für eine Bandbreite über 300 mm (r_{300}) sowie für eine mittlere Wegabweichung, e , und für Standard-Toleranzklassen nach ISO 286-2:1988

Messlänge [mm]		Toleranzklasse					
		0	1	3	5	7	10
>	≤	Toleranz auf den Sollweg, e_p [μ m]					
–	315	4	6	12	23	52	210
315	400	5	7	13	25	57	230
400	500	6	8	15	27	63	250
500	630	6 ^a	9	16	32	70	280
630	800	7 ^a	10	18	36	80	320
800	1 000	8 ^a	11	21	40	90	360
1 000	1 250	9 ^a	13	24	47	105	420
1 250	1 600	11 ^a	15	29	55	125	500
1 600	2 000	13 ^a	18	35	65	150	600
2 000	2 500	15 ^a	22	41	78	175	700
2 500	3 150	18 ^a	26	50	96	210	860
3 150	4 000		32 ^a	62 ^a	115 ^a	260 ^a	1 050 ^a
4 000	5 000		39 ^a	76 ^a	140 ^a	320 ^a	1 300 ^a
5 000	6 300		48 ^a	92 ^a	170 ^a	390 ^a	1 550 ^a

^a Diese Werte wurden durch lineare Extrapolation der IT-Werte nach ISO 286-2 für Längen über 500 mm bis 3 150 mm errechnet.

Tabelle A.2 — Mindestanzahl von Messungen über 300 mm (Messintervalle)

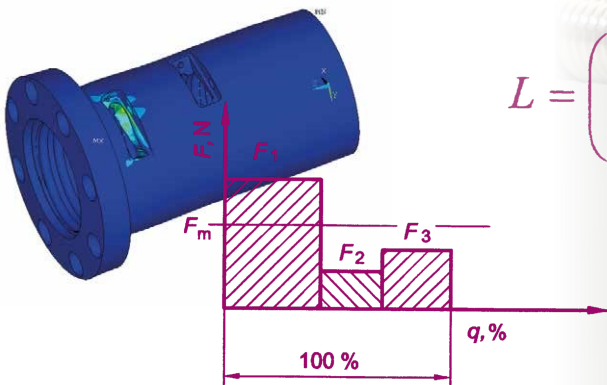
Steigung f_h [mm]	Angegebene Toleranzklasse					
	0	1	3	5	7	10
Mindestanzahl von Messungen						
2,5	20	15	10	6	3	1
5	20	15	10	6	3	1
10	15	10	5	3	1	1
20	6	5	4	3	1	1
40	–	–	2	1	1	1

Tabelle A.3 — Maximaler Überlauf

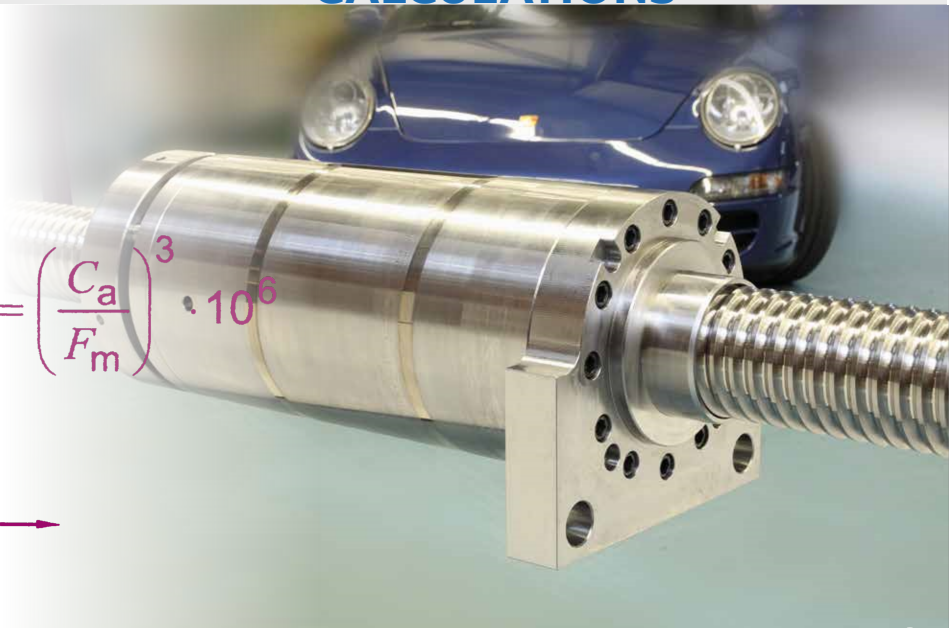
Steigung f_h	Maße in mm				
	2,5	5	10	20	40
Maximaler Überlauf f_{max}	10	20	40	60	100

TECHNOLOGY/ CALCULATIONS

$$\varphi = \arctan\left(\frac{R_h}{\pi \cdot D_{pw}}\right)$$



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

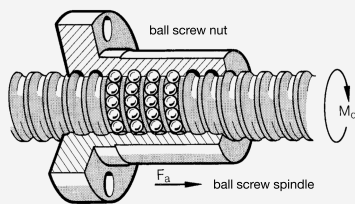


▶ Ball screw technology

The ball screw is a working unit for converting a rotary to a linear movement and vice-versa.

It consists of the spindle, the nut system with ball feedback elements and the balls as anti-friction elements. The balls form the connection between the spindle and the nut by rolling in the appropriate tracks in the spindle and the

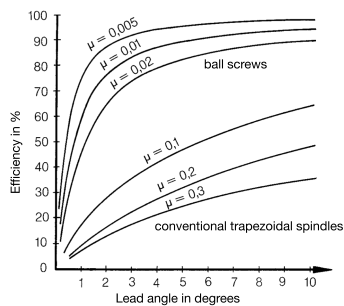
nut. The forces to be transmitted are distributed over a number of balls so that the result is a relatively small specific loading. On account of its rolling friction, the ball screw has an extremely low coefficient of friction.



▶ Efficiency

The efficiency of ball screws is considerably higher than that of conventional trapezoidal screws due to the rolling friction that occurs in this case. Furthermore, there is no slip-stick effect, which makes it possible to traverse even the smallest distances accurately. With ball screws it is fundamentally possible to reverse the motion due to the

low frictional losses even at relatively small lead angles, i.e. to convert a linear movement into a rotary one. Therefore, in installations where self-retardation is required, the appropriate safeguards such as brakes, for example, must be provided.



Advantages:

Long life, which is many times that of the slide screw. The heat developed is considerably less, which means that higher traverse speeds are possible. The higher cost of the ball screw can be compensated for to a great extent by these factors. At the same time, the fact that it is not self-retarding may need to be taken into account.

When sliding friction is combined with low relative speeds (creep), intermittent sliding always occurs, the so-called slip-stick effect, even though a proportionately sized drive and a constant speed are used.

This undesirable slip-stick effect does not occur with rolling friction enabling the same position to be achieved repeatedly.

Installation: Before installation, the ball screw must be cleaned with a cleaning fluid such as benzene, if necessary. Cleaning fluids must not act aggressively on the wiper materials such as nylon or felt. It is not usually necessary to remove the preservative.

Ball screws are protected against corrosion in the factory and must be lubricated (oil and grease) before putting to use.

Materials for ball screws

Spindles

Steel for surface hardening	Cf53
Material No. 1.1213	
Surface hardness	60 + 2 HRC
Tensile strength Rm	600 N/mm ²
Elastic limit Rp	400 N/mm ²
Material No. 1.7225	42 CrMo 4
Surface hardness	60 + 2 HRC
Tensile strength Rm	900 N/mm ²
Elastic limit Rp	600 N/mm ²

Balls

100 Cr 6. Accuracy quality class I – III (highest quality class) to DIN 5401, Hardness 63 ± 3 HRC.

Nuts

Material No. 1.2067	100 Cr 6
Hardness	61 + 2 HRC
Tensile strength Rm	980 N/mm ²
Elastic limit Rp	980 N/mm ²
Hard up to Rm	2100 N/mm ²
Material No. 1.3536	
Hardness	61 + 2 HRC
Tensile strength Rm	690 N/mm ²
Elastic limit Rp	390 N/mm ²
Hard up to Rm	1800 N/mm ²

Material specification for 100Cr6:
Material No. 1.3505, Bezeichnung nach DIN 17 006.
Special materials on request.

▶ Wipers

Ball screws should be basically protected against dirt and impurities. With the KAMMERER's ball screws, this is done by means of standard plastic wipers, which, however, might slightly protrude the nut housing.

We recommend replacing the wipers, as far as possible, after the respective running time of the ball screws. This has a positive effect on the service life. According

to customer requirements, we deliver also plastic wipers offering improved sliding properties.

The best solution however is to completely cover the ball screw using a spiral spring cover, for example.



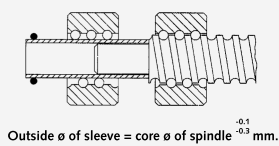
Dismantling the nut:

If possible, the nut and the spindle should not be dismantled. However, if this should be necessary, an assembly sleeve must be used (see sketch).

Slide the sleeve over the end of the spindle as far as the start of the thread and then screw the nut carefully from the thread onto the sleeve. Dismantling must be carried

out without the use of force. Make sure that the nut cannot slip off the sleeve (O-ring or similar). When screwing the nut on to the spindle, the start of the thread must be screwed in carefully.

Note: The balls must not be allowed to get behind the return sections. Cleanliness must be ensured !!!



▶ Track profile

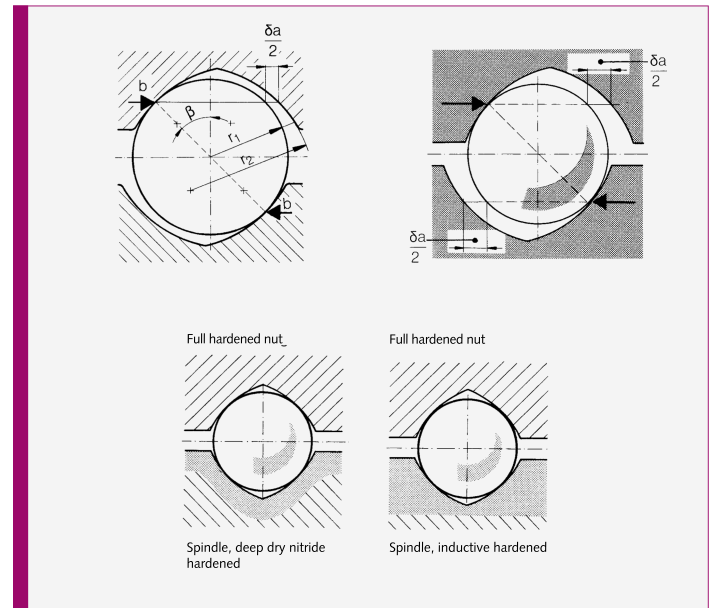
Kammerer ball screws are basically equipped with Gothic track profiles and offer the following advantages:

Good running characteristics, high rigidity and a good contact angle β , of around 45° are aimed for.

- β = contact angle
- δ_a = axial play
- r_1 = ball radius
- r_2 = track radius

This profile with the largest possible load angle β , good lubrication conditions and a ball diameter calculated for the appropriate application brings the following advantages:

- highest ratings and thus long lifetime
- best running characteristics
- efficiency up to 98 %
- maximum rigidity
- almost constant drive torque



▶ Axial play with a single nut

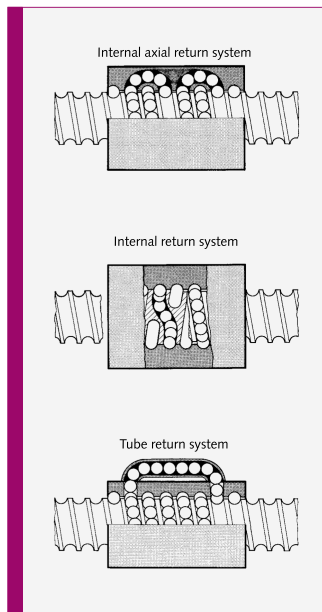
Like the anti-friction bearing, due to its design, the ball screw with a single nut has an axial play of 0.02 to 0.05 mm depending upon its dimensions, which is constant regardless of loading.

Loading causes an elastic deformation of the materials with a hysteresis-like character, which in addition gives rise to an axial displacement (see Page 32, Rigidity).

▶ Ball feedback systems

Internal axial ball feedback with single or multiple returns depending upon the number of turns of the thread, which bear the load. The three-dimensional space curve causes the balls to run softly and with little noise, as these are taken off tangentially to the ball reference circle. The return system is independent of the lead. Leads of 1 x D or a maximum of 2 x D of the spindle are also possible.

This return system is used by Kammerer.



External ball feedback systems (tube returns). Here, the balls are fed back through a return tube fixed to the outside of the ball screw nut.

▶ Pre-loading

In order to achieve the smallest possible relative movement between the nut and the spindle, certain single nuts are tensioned against one another.

- F_b = operating load [N]
- F_p = pre-loading force [N]
- δ_v = deformation due to F_v
- δ_b = axial play
- δ_s = deformation due to F_s
- $2 \cdot \delta_s$ = return distance

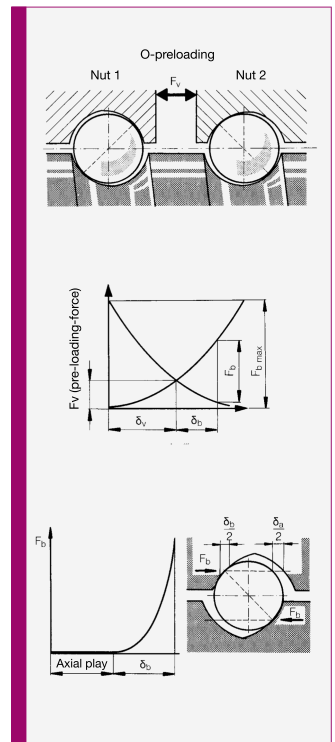
- the pre-loading force amounts $\frac{1}{2,83}$ to of the average operating load.

Loads over and above this cause the balls of the unloaded nut to lose contact and the return distance to increase.

- The average operating load is defined as the load consistent with a life of $20 \cdot 10^6$ revolutions.

- The following relationship can be derived from the above:

$$F_v = \sqrt[3]{\frac{C}{20 \cdot 2,83}} = \frac{C}{7,68} \text{ [N]}$$



► Pre-loading nut systems

In order to eliminate the axial play and to keep the axial displacement due to the material deformation as small as possible, nuts are pre-loaded.

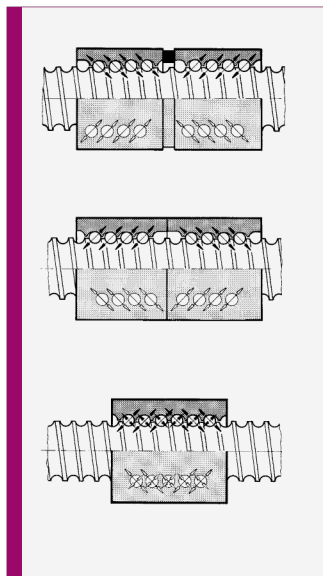
Three types of pre-loading are distinguished:

X-pre-loading:
The forces are directed inwards. The spindle is under compression in the pre-loading range. The pre-loading is increased by forcing the nuts together.

O-pre-loading: The forces are directed outwards. The spindle is under tension in the pre-loading range. The pre-loading is increased by forcing the nuts apart.

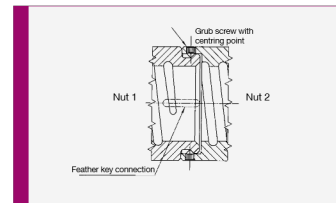
Pre-loading using oversized balls:
The most cost-effective solution, as only half the nut length has to be manufactured, creates the pre-loading by the oversize of the balls (= four point contact) and which is thus finding more frequent usage.

The pre-loading is adjusted by varying the diameter of the balls.



► Pre-loading – Kammerer

Pre-loading No. 1 is the preferred method used by Kammerer.



► Pre-loading of spindles

Spindles are pre-loaded to increase the positioning accuracy. Changes in length due to foreseeable temperature differences are avoided. For this purpose, spindles must be ground with a lead going into the minus range. The necessary variation in the lead (ΔP) over the whole length is given by the following equation:

$$\Delta P = a \cdot l \cdot \Delta t \quad [\text{mm}]$$

a = coefficient of expansion (steel = 0.011 mm/m · degree)
 l = total length of spindle (m)
 Δt = temperature difference (°C)

A temperature difference of ca. 5° can be expected here. The nominal lead is achieved by stretching the spindle during assembly. The axial force necessary for stretching the spindle (F_2) must be produced by the bearings and is calculated from:

$$F_2 = \frac{\Delta P \cdot E \cdot A}{l} \quad [\text{N}]$$

$$A = \frac{d_m^2 \cdot \pi}{4} \quad [\text{mm}^2]$$

ΔP = necessary lead variation from equation
 E = modulus of elasticity (21 x 10⁴ N/mm² for steel)
 A = spindle cross section (mm²), see equation
 l = total length of spindle (mm)
 d_m = average spindle diameter

The speeds can also be increased when a spindle has been put under tension.

► Values for stretching ball screws

- Diameter 32 mm 0,03/1000mm A = 594 mm²
- Diameter 40 mm 0,04/1000mm A = 990 mm²
- Diameter 50 mm 0,05/1000mm A = 1625 mm²
- Diameter 63 mm 0,06/1000mm A = 2552 mm²
- Diameter 80 mm 0,07/1000mm A = 4596 mm²
- Diameter 100 mm 0,07/1000mm A = 7314 mm²

$$\Delta P = (a \cdot l \cdot \Delta t) / 1000 \quad (\text{mm})$$

$$F_2 = (\Delta P \cdot E \cdot A) / l \quad (\text{N})$$

$$A = (d_m^2 \cdot 3,1416) / 4 \quad (\text{mm}^2)$$

P = pitch (mm)
 a = thermal coefficient of expansion (steel = 0.011mm/m* degree)
 l = spindle length in (mm)
 t = temperature difference (degree) max value 5 °C otherwise consultation with Kammerer
 E = modulus of elasticity 210000 N/mm² (steel)
 A = spindle cross sectional area (mm²)

Rigidity

The total rigidity (C_{tot}) of a system is made up of the individual rigidities (ball screw, bearings ...). The effect of all the factors should therefore be taken into account.

For the ball screw:

$$\frac{1}{C_{\text{pos}}} = \frac{1}{C_k} + \frac{1}{C_{m1}} + \frac{1}{C_s} = \frac{1}{C_{\text{ms}}} + \frac{1}{C_s} \quad [\text{N}/\mu\text{m}]$$

Rigidity in the ball area (C_k)

The axial rigidity in the ball area is derived from:

$$C_k = \frac{F_D}{\delta_D} \quad [\text{N}/\mu\text{m}]$$

The rigidities for designs not given in the table can be calculated from the following overview and formulae. For double nuts, assuming the same number of revolutions for each nut and a ratio of

$$\frac{F_D}{F_V} = 2,83$$

$$C_k = 2 \cdot \sqrt[3]{F_D \cdot (k \cdot i)^2} \quad [\text{N}/\mu\text{m}]$$

F_D = operating load [N]
 F_V = pre-loading force [N]
 k = rigidity factor [N/μm^{2/3}]
 i = number of revolutions 3/2

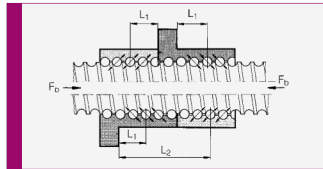
Rigidity of the body of the nut (c_m)

$$c_m = \frac{A \cdot E}{L \cdot 10^3} \quad [\text{N}/\mu\text{m}]$$

A = nut cross sectional area [mm²]
 E = modulus of elasticity $21 \cdot 10^4$ [N/mm²]

Use L1 or L2 according to the direction of the operating load F_D

$L_1 \approx 0,5 \cdot \text{nut length}$
 $L_2 \approx 0,75 \cdot \text{nut length}$



Rigidity of the nut unit (c_{nu})

For an approximate calculation it is sufficient to say:

$$c_{nu} = f_{pm} \cdot c_k \quad [\text{N}/\mu\text{m}]$$

$f_{pm} = 0,55$ (internal pre-loading for single nuts)
 $f_{pm} = 0,70$ (pre-loaded double nut)

Calculation of the total rigidity

1. Rigidity of the ball area

$$c_k = 2 \cdot \sqrt[3]{F_D \cdot (k \cdot i)^2}$$

$$= 2 \cdot \sqrt[3]{25000 \cdot (53 \cdot 51 \cdot 5)^2}$$

$$c_k = 2428 \text{ N} / \mu\text{m}$$

2. Rigidity of the nut area

$$c_m = 0,7 \cdot c_k$$

$$= 0,7 \cdot 2428 = 1700 \text{ N} / \mu\text{m}$$

3. Rigidity of the nut body

$$c_n = \frac{A_2 \cdot E}{l \cdot 10^3} \quad [\text{N} / \mu\text{m}]$$

$$c_n = \frac{1970 \cdot 21 \cdot 10^4}{98 \cdot 10^3}$$

$$c_n = 4221 \text{ N} / \mu\text{m}$$

3. Rigidity of the spindle

3.1 Single-sided fixed bearing

$$c_z = \frac{A_1 \cdot E}{l \cdot 10^3} \quad [\text{N} / \mu\text{m}]$$

$$c_z = \frac{1548 \cdot 21 \cdot 10^4}{1000 \cdot 10^3}$$

$$c_z = 325 \text{ N} / \mu\text{m}$$

3.2 Double-sided fixed bearing

$$c_z = \frac{4 \cdot A_1 \cdot E}{l \cdot 10^3} \quad [\text{N} / \mu\text{m}]$$

$$c_z = 4 \cdot 325 = 1300 \text{ N} / \mu\text{m}$$

4. Total rigidity

$$\frac{1}{c_{\text{tot}}} = \frac{1}{c_k} + \frac{1}{c_m} + \frac{1}{c_z} = \frac{1}{c_{\text{ms}}} + \frac{1}{c_z}$$

Example – Calculation of rigidity

Nut system DIN 69051

Nominal diameter	$d_s = 50 \text{ mm}$	according to dimension sheet
Lead	$P = 10 \text{ mm}$	
Number of revolutions	$i = 5$	
Dynamic rating	$C = 98.400 \text{ N}$	
Operating load max.	$F_D = 25.000 \text{ N}$	
Spindle length between bearings	$l = 1.000 \text{ mm}$	
Rigidity factor	$k = 53,51 \text{ N}/\mu\text{m}^2$	
Spindle cross sectional area	$A_s = 1.548 \text{ mm}^2$	
Nut cross sectional area	$A_2 = 1.970 \text{ mm}^2$	

4.1 Single-sided fixed bearing

$$\frac{1}{c_{\text{tot}}} = \frac{1}{1700} + \frac{1}{325}$$

$$c_{\text{tot}} = 273 \text{ N} / \mu\text{m}$$

4.2 Double-sided fixed bearing

$$\frac{1}{c_{\text{tot}}} = \frac{1}{1700} + \frac{1}{1300}$$

$$c_{\text{tot}} = 737 \text{ N} / \mu\text{m}$$

4.3 Single-sided fixed bearing

$$\frac{1}{c_{\text{tot}}} = \frac{1}{c_k} + \frac{1}{c_m} + \frac{1}{c_z}$$

$$\frac{1}{c_{\text{tot}}} = \frac{1}{2428} + \frac{1}{4221} + \frac{1}{325} = 268 \text{ N} / \mu\text{m}$$

4.4 Double-sided fixed bearing

$$\frac{1}{c_{\text{tot}}} = \frac{1}{2428} + \frac{1}{4221} + \frac{1}{1300} = 705 \text{ N} / \mu\text{m}$$

Rigidity of the spindle between bearings (c_z)

The rigidity of the spindle is dependent upon the type of bearings.

Single-sided fixed bearing, case 1

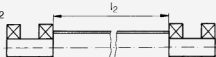
$$c_z = \frac{A \cdot E}{l \cdot 10^3} \quad [\text{N}/\mu\text{m}]$$



E = modulus of elasticity $21 \cdot 10^4$ [N/mm²]
 l = length between bearings or between bearing and nut [mm]
 A = spindle cross sectional area [mm²]
 d_m = average spindle diameter (see table on page 70 (*critical bending speed*)) [mm]

Double-sided fixed bearing, case 2

$$c_z = \frac{4 \cdot A \cdot E}{l \cdot 10^3} \quad [\text{N}/\mu\text{m}]$$



$$A = \frac{d_m^2 \cdot \pi}{4} \quad [\text{mm}^2]$$

► Average loading

Constant speed / varying load

$$F_{Bm} = \sqrt[3]{F_{a1}^3 \cdot \frac{q_1}{100} + F_{a2}^3 \cdot \frac{q_2}{100} + F_{a3}^3 \cdot \frac{q_3}{100} + \dots \text{ etc.}} \quad [\text{N}]$$

Constant speed / linearly varying load

$$F_{Bm} = \frac{F_{b \text{ min}} + 2 F_{b \text{ max}}}{3} \quad [\text{N}]$$

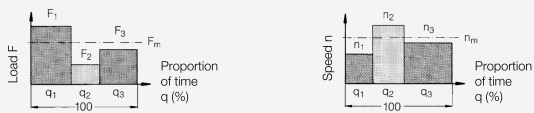
Speed and load varying

$$F_{Bm} = \sqrt[3]{F_{a1}^3 \cdot \frac{n_1}{n_m} \cdot \frac{q_1}{100} + F_{a2}^3 \cdot \frac{n_2}{n_m} \cdot \frac{q_2}{100} + \dots \text{ etc.}} \quad [\text{N}]$$

F_{Bm} = average axial load [N]
 n_m = average speed [min⁻¹]
 q_1 = proportion of time used referred to 100 %
 n_1 = speed values

► Average speed

$$n_m = n_1 \cdot \frac{q_1}{100} + n_2 \cdot \frac{q_2}{100} + n_3 \cdot \frac{q_3}{100} + \dots \text{ etc.} \quad [\text{min}^{-1}]$$



► Drive torque and drive power

If a torque is to be converted to a longitudinal force, then:

$$M_s = \frac{F \cdot P}{2000 \cdot \pi \cdot \eta}$$

When a longitudinal force is converted to a torque (lead angle $\alpha \geq 5^\circ$):

$$M_s = \frac{F \cdot P \cdot \eta'}{2000 \cdot \pi}$$

The drive power is calculated from:

$$P_d = \frac{M_s \cdot n}{9550}$$

F = Force [N]
 M_s = Drive torque [N_m]
 M_o = Output torque [N_m]
 n = Speed [min⁻¹]
 P = Lead [mm]
 P_d = Power [kW]
 η = Efficiency [0,9 – 0,95]

► Efficiency η or η'

$$\tan \alpha = \frac{P}{d_m \cdot \pi}$$

α = lead angle [°]
 P = Lead [mm]
 d_m = ball reference circle [mm]
 ρ = angle of friction [°] = 0,2° to 0,35°

If a torque is to be converted to a longitudinal force, then:

$$\eta \approx \frac{\tan \alpha}{\tan (\alpha + \rho)}$$

When a longitudinal force is converted to a torque:

$$\eta' \approx \frac{\tan (\alpha - \rho)}{\tan \alpha}$$



► Lifetime

The **lifetime** (better, nominal life) is expressed by the number of revolutions (or number of operating hours at constant speed) that 90 % of a sufficiently large number of identical ball screws achieve or exceed before the first signs of material fatigue occur. The nominal lifetime is designated with L or L_h if the figure is expressed in revolutions or hours respectively.

The **dynamic rating C** is to be understood to mean an axial load acting centrally (given in N) of unvarying magnitude and direction under which a sufficiently large number of identical ball screws achieve a nominal life of one million revolutions.

The **static rating C_0** is to be understood to mean an axial load acting centrally (given in N) which causes a total permanent deformation of 0.0001 x the ball diameter between the ball and the ball track.

As ball screws are sensitive to radial and eccentric loads, these should be avoided if possible.

$$F_{0m} \leq F_{0 \max} \leq C_0$$

$$L = \left[\frac{C}{F_{am}} \right]^3 \cdot 10^6$$

$$C = \sqrt[3]{\frac{L \cdot F_{am}^3}{10^6}}$$

$$F_{am} = \sqrt[3]{\frac{C^3 \cdot 10^6}{L}}$$

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

- L = lifetime [revolutions]
- L_h = lifetime [h]
- C_0 = static rating [N]
- C = dynamic rating [N]
- F_{am} = average axial load [N]
- F_{amax} = max. axial load [N]
- n_m = average speed [min⁻¹]
- f_n = utilisation factor

$$f_n = \frac{\text{Duration of use (h)}}{\text{planned utilisation of the machine (h)}}$$

Guide values for machine life:

- 1-shift: 10.000 bis 20.000 h
- 2-shift: 20.000 bis 40.000 h

► Calculation DIN ISO 3408

Load ratings in accordance with DIN ISO 3408-5			
Nominal diameter	d_g	mm	50
Lead	P_h	mm	20
Number of starts	$P_s:P$	-	1
Nominal ball diameter	D_m	mm	7,5
Contact angle	α	°	45
Number of turns	i	-	4
Actual surface hardness		HV10	720
Tolerance class		-	5
Osculation of the screw/nut	f_r	-	0,53
Correction factor for effect of steel smelting	f_m	-	1,44
Modified static axial load rating	C_{stat}	kN	177,1
Modified dynamic axial load rating	C_{dyn}	kN	89,4

► Calculation DIN ISO 3408

Service life in accordance with DIN ISO 3408-5									
Load spectrum	n	Designation	m [kg]	a [m/s ²]	F _j [N]	F _a [N]	v [m/min]	n _j [min-1]	q _j [%]
	1	Acceleration		1.400	10,0	14.000	14.000	20,0	1.000
2	Rapid traverse		1.400	9,8	275	4.618	40,0	2.000	20
3	Processing 1				8.000	9.327	0,2	10	25
4	Processing 2				6.000	8.005	2,0	100	25
5	Standstill				0	0	0	0	22
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Equivalent dynamic axial load	$F_{m1,2}$	N	s.u.
Equivalent speed	n_m	1/min.	508
Preload force	F_{pr}	N	4.471
Preload force of the dynamic axial load rating		%	5
Limit load	F_{lim}	N	12.647
Average preloading across operative service life	f_{sp}	%	100
Actual equivalent dynamic axial load	F_{ms}	N	8.140
Service life in revolutions	L	10 ⁶ revol.	1.325,746
Service life in operating hours	L_h	h	43.538

Reliability		%	95
Correction factor for the effect of reliability	f_r	-	0,62
Nominal service life	L_{10}	10 ⁶ revol.	821,963
Nominal service life in operating hours	L_{10h}	h	26.994
Duty cycle of the ball screw drive	ED_{KGT}	%	100
Actual machine operating hours	L_{hEFF}	h	26.994

► Calculation DIN ISO 3408

Critical parameters				
Screw speed	Screw external diameter	d_{se}	mm	48,0
	Screw core diameter	d_{sc}	mm	41
	Unsupported screw length	l_{sr}	mm	2,065
	Correction factor for bearing 'fixed-fixed'	f_{b1}	-	2,24
	Safety factor		-	0,80
	Critical speed	n_{cr}	1/min	1,134
	Permissible speed	n_{ref}	1/min	2,033
Maximum speed from load spectrum	n_1	1/min	2,000	
Buckling	Nut length	L_2	mm	110
	Unsupported screw length	l_{sr}	mm	2,065
	Correction factor for bearing 'fixed-floating - nut fixed'	f_{b2}	-	4,00
	Theoretical buckling force	F_{th}	N	264.454
	Safety factor		-	0,50
	Permissible buckling force	F_{ref}	N	132.227
Largest effective load	F_{eff}	N	14.000	
Drive	Efficiency	h	-	0,97
	Drive torque	M_d	Nm	46
	Drive power	P_d	kW	10
Rolling element	Ratio of ball to screw diameter	$Üv$		6,47
	Speed factor for lubricant	K		
	Correction factor	f_{ds}		
	Max. screw speed	n_{max}	1/min	
	Speed limit of the rolling elements	n_{Dnmax}	1/min	
Actual speed of the rolling elements	n_{Dnr}	1/min	12,933	

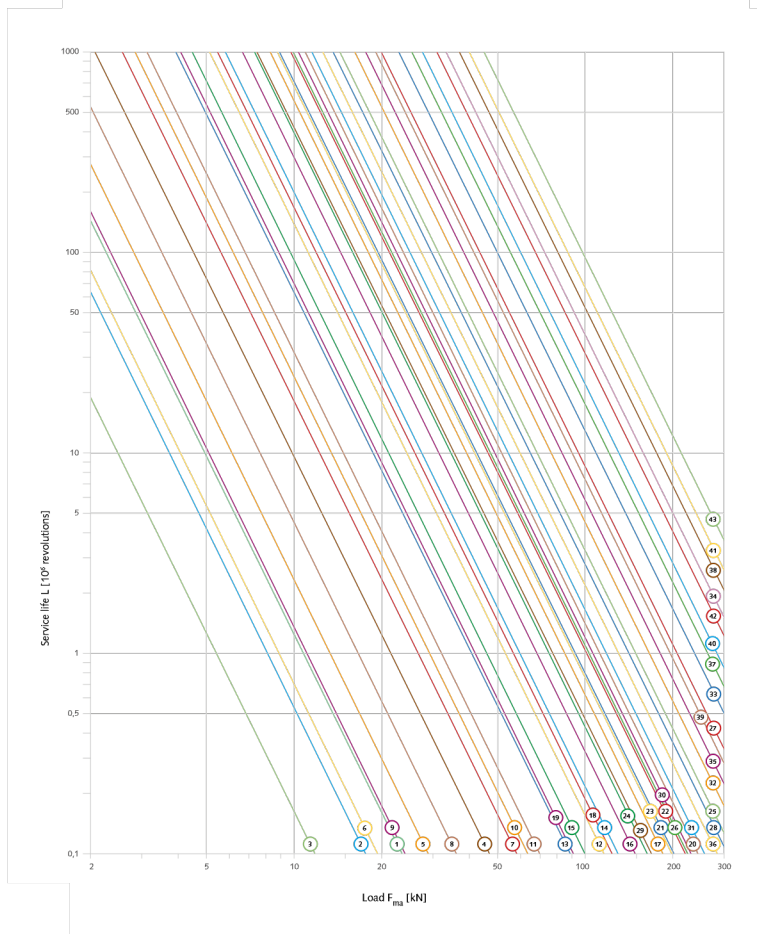
► Calculation DIN ISO 3408

Rigidity in accordance with DIN ISO 3408-4				
Screw	Deep drill hole diameter	d_{so}	mm	
	Static axial rigidity of the ball screw, one-side fixed	R_{s1}	N/µm	149
	Static axial rigidity of the ball screw, both sides fixed	R_{s2}	N/µm	596
Nut	External diameter of the nut	D_1	mm	75
	Selected preload force	F_{pr}	N	4.471
	Static axial rigidity of the ball nut body and the ball screw	$R_{n1,pr}$	N/µm	51.234
	Static axial rigidity in the area of the ball/ball track	$R_{n2,pr}$	N/µm	1.781
	Static axial rigidity of the ball screw nut, 2-point	$R_{n3,pr}$	N/µm	1.721
Static axial rigidity of the ball screw nut, 4-point	$R_{n4,pr}$	N/µm	1.665	
Static axial rigidity of the ball screw/ball screw nut system		$dR_{n,pr}$	N/µm	832
Axial deformation in the area of the balls and track		$dI_{n1,pr}$	µm	7
Static axial rigidity of the ball screw drive, one-side fixed		R_{s1}	N/µm	126
Static axial rigidity of the ball screw drive, both sides fixed		R_{s2}	N/µm	347

Stretching force (fixed bearings on both sides)

Screw length	l_1	mm	2.250
Temperature difference	dt	K	5
Required lead variation	dP	mm	0,12
Safety factor		-	1,5
Required stretching force	F_s	N	26.824

► Service life – diagram
ball screw drive (dia. 16 – dia. 160)



- | | | | |
|-------------------|------------------|------------------|-------------------|
| ① DM16x5-2,38-4 | ⑭ DM32x10-6,35-3 | ⑳ DM50x20-8-4 | ⑳ DM80x20-12,7-6 |
| ② DM16x10-2,38-3 | ⑮ DM32x20-6,35-3 | DM50x30-8-4 | ㉑ DM60x60-12,7-3 |
| ③ DM16x16-2,38-2 | ⑯ DM16x10-2,38-3 | DM50x40-8-4 | ㉒ DM100x10-7,5-6 |
| ④ DM20x5-3,175-5 | ⑰ DM40x20-6,35-3 | DM63x40-7,5-4 | ㉓ DM100x10-6,35-6 |
| ⑤ DM20x10-3,175-3 | DM40x40-8-2 | ㉔ DM50x40-7,5-4 | ㉔ DM100x20-12,7-4 |
| ⑥ DM20x20-3,175-2 | DM63x5-3,5-6 | ㉕ DM50x50x-8-3 | ㉕ DM100x40-12,7-4 |
| ⑦ DM25x5-3,5-5 | DM40x20-8-3 | ㉖ DM63x10-7,5-6 | ㉖ DM100x20-12,7-6 |
| DM32x32-6,35-2 | DM50x50-7,5-3 | ㉗ DM63x20-7,5-4 | ㉗ DM120x10-7,5-6 |
| ⑧ DM25x10-3,5-3 | DM40x20-9,52-3 | ㉘ DM63x20-9,52-6 | ㉘ DM120x20-12,7-4 |
| ⑨ DM25x20-3,5-2 | DM40x40-9,52-2 | ㉙ DM63x40-9,52-4 | ㉙ DM120x40-12,7-4 |
| DM25x25-3,5-2 | DM50x5-3,5-6 | ㉚ DM63x50-7,5-3 | ㉚ DM120x20-12,7-6 |
| ⑩ DM32x5-3,5-5 | DM50x10-7,5-5 | ㉛ DM63x50-9,52-3 | ㉛ DM160x20-12,7-4 |
| ⑪ DM32x10-4,5-4 | DM50x20-7,5-4 | ㉜ DM80x10-6,35-6 | ㉜ DM160x40-12,7-4 |
| DM40x5-3,5-5 | DM50x30-7,5-4 | ㉝ DM80x10-7,5-6 | ㉝ DM160x20-12,7-6 |
| | | ㉞ DM80x20-12,7-4 | |
| | | DM80x40-12,7-4 | |



▶ Example – Calculation of lifetime

Given load and speed values:

Fast speed: $n_1 = 1200$ rpm, $F_{b1} = 7.500$ N, $q_1 = 25$ %
 Roughing work: $n_2 = 60$ rpm, $F_{b2} = 25.000$ N, $q_2 = 40$ %
 Finish machining: $n_3 = 150$ rpm, $F_{b3} = 18.000$ N, $q_3 = 35$ %
 Lifetime of the machine: $L_m = 10.000$ h
 Utilisation factor of the ball screw: $f_n = 0,5$

Required nominal diameter of the ball screw 40 or 50 mm, lead 10 mm.
 (These two diameters are derived from the critical speed and the installation conditions).

1. Calculating the average speed (n_m) [rpm]

$$n_m = n_1 \cdot \frac{q_1}{100} + n_2 \cdot \frac{q_2}{100} + n_3 \cdot \frac{q_3}{100} + \dots \text{ etc.}$$

$$n_m = 1200 \cdot \frac{25}{100} + 60 \cdot \frac{40}{100} + 150 \cdot \frac{35}{100} = 376,5 \text{ rpm}$$

2. Calculating the average load ($F_{m,av}$) [N]

$$F_{m,av} = \sqrt{F_{b1}^3 \cdot \frac{n_1}{n_m} \cdot \frac{q_1}{100} + F_{b2}^3 \cdot \frac{n_2}{n_m} \cdot \frac{q_2}{100} + F_{b3}^3 \cdot \frac{n_3}{n_m} \cdot \frac{q_3}{100} + \dots \text{ etc.}}$$

$$F_{m,av} = \sqrt{7500^3 \cdot \frac{1200}{376,5} \cdot \frac{25}{100} + 25.000^3 \cdot \frac{60}{376,5} \cdot \frac{40}{100} + 18.000^3 \cdot \frac{150}{376,5} \cdot \frac{35}{100}} = 12.897 \text{ N}$$

3. Required lifetime (L): $L = 60 \cdot L_m \cdot n_m \cdot f_n$

$$L = 60 \cdot 10.000 \cdot 376,5 \cdot 0,5 = 112,95 \cdot 10^4 \text{ revolutions}$$

4. Calculation of the required dynamic loading capacity (C)

$$C = F_{m,av} \cdot \sqrt[3]{\frac{L}{10^6}}$$

$$C = 12.897 \cdot \sqrt[3]{\frac{112,95 \cdot 10^4}{10^6}} = 62.342 \text{ N}$$

Here, a ball screw with a nominal diameter of 50 mm, nominal lead = 10 mm and 4 load-bearing threads with a dynamic rating of $C = 98.400$ N is chosen from the dimension sheets.

5. Re-examination of the expected lifetime (L and L_s)

$$L = \left[\frac{C}{F_{m,av}} \right]^3 \cdot 10^6 \text{ revolutions} \quad L_s = \frac{L}{60 \cdot n_m \cdot f_n} \quad [h]$$

$$L = \left[\frac{98.400}{12.897} \right]^3 \cdot 10^6 = 444 \cdot 10^6 \text{ revolutions} \quad L_s = \frac{444 \cdot 10^6}{60 \cdot 376,5 \cdot 0,5} = 39.322 \text{ h}$$

▶ Speed limits referred to the nut system

The maximum speed possible for a ball screw depends above all on the type of construction and the ball feed back system. Furthermore, it is dependent upon the size and type of the lubrication system (oil or grease).

Under the assumption that the ball screw is relatively lightly loaded and that it is well lubricated, the maximum possible speed can be calculated by a formula.

Speed factor for grease lubrication
oil lubrication

$K \approx 60.000 - 100.000$
 $K \approx 90.000 - 200.000$

Depending on diameter +
ratio of ball to screw diameter
= (AD/ball-Ø)

$$n_{max} = \frac{K}{d}$$

n_{max} = max. speed (rpm)
 K = speed factor
 d = spindle diameter (mm)

The maximum possible traverse speed can be calculated from the formula:

$$v_{max} = \frac{K \cdot P}{60 \cdot d}$$

v_{max} = max. possible traverse speed (mm/sec.)
 P = thread lead (mm)

With speed factors above 20,000, the dynamic rating of the ball screw should include a safety margin of at least 20 %.

The same can be achieved by an appropriate tapering off of the load. However, too small a loading should be avoided at maximum traverse speed as otherwise the wear factor (lifetime) will be adversely affected.

These figures are purely for guidance. It should be especially noted that above speeds of 3000 rpm, technical consultation with our engineers is necessary. With ceramic spheres filling = limit speed 30 % higher.

▶ Calculation of critical bending speed

Calculation of the critical bending speed n_{cr}
Take speed limits of the nut system into account

$$n_{cr} = \frac{30}{\pi} \cdot \sqrt{\frac{21 \cdot 10^4 \cdot d_m^4 \cdot 10^4}{0,013 \cdot F \cdot l_s^3 \cdot 20}}$$

$$n_{zul} = 0,8 \cdot n_{cr} \cdot f_k$$

KGT Type	Ball-Ø	d _m Ø	N/m
10x 2	1,58	9,3	5,3
12x 3	2,38	11,0	7,4
12x 5	2,38	11,0	7,4
16x 5	2,38	15,0	13,9
20x 5	3,175	18,6	21,3
25x 5	3,5	22,5	31,3
32x 5	3,5	28,5	49,9
40x 5	3,5	36,5	81,9
50x 5	3,5	46,5	133,0
63x 5	3,5	58,5	210,6
32x10	4,5	28,2	49,0
32x10	6,35	27,5	46,6
40x10	6,35	35,5	77,7
50x10	7,5	44,4	121,5
63x10	7,5	56,4	196,1
80x10	6,35	77,5	370,3
80x10	7,5	76,4	359,9
100x10	7,5	96,4	572,9
120x10	7,5	116,4	835,3
63x20	7,5	56,4	196,1
80x20	12,7	74,8	344,5
100x20	12,7	94,8	553,5
120x20	12,7	114,8	811,8
160x20	12,7	154,8	1476,5

Average thread diameter = d_m
Weight of the spindle/metre = N/m

Correction factor

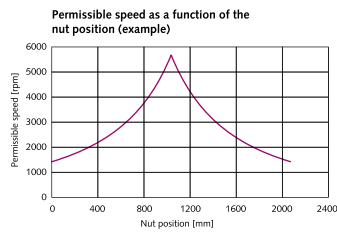
$f_k = 0,32$ case 1

$f_k = 1,0$ case 2

$f_k = 1,55$ case 3

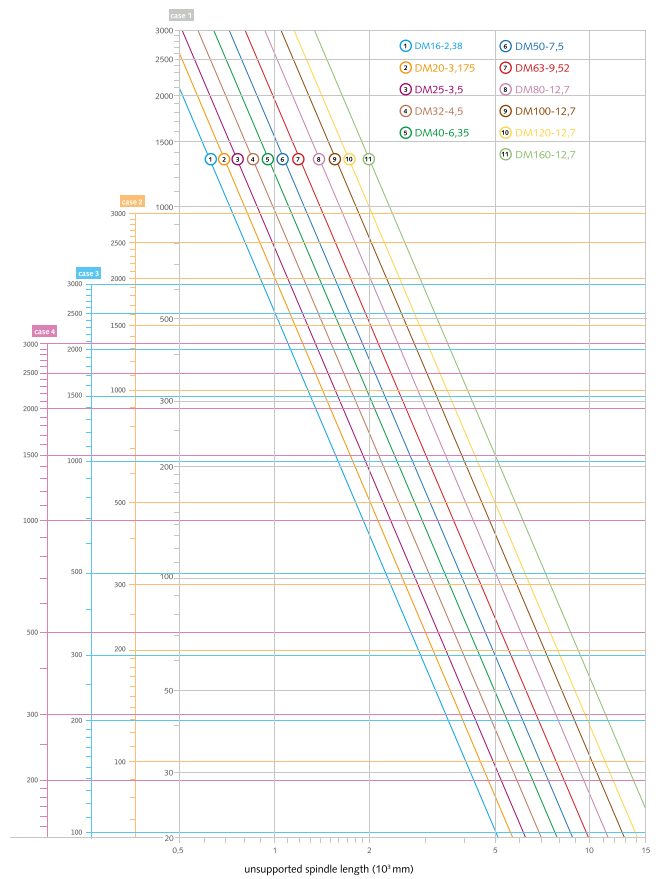
$f_k = 2,24$ case 4

0,8 = safety factor
 n_{cr} = critical speed from the diagram [rpm]
 f_k = correction factor
 d_m = average thread diameter, see table below
 F = weight of the unsupported spindle length in N
 l_s = bearing spacing [mm]
 n_{zul} = permissible speed [rpm]



Fixed and preloaded nuts act like a ball bearing and prevent the screw from swinging up. This leads to a permissible speed for the ball screw drive that depends on the stroke position and can be used in sub-areas for higher traversing speeds with the aid of speed control.

▶ Critical bending speed – diagram



► Buckling

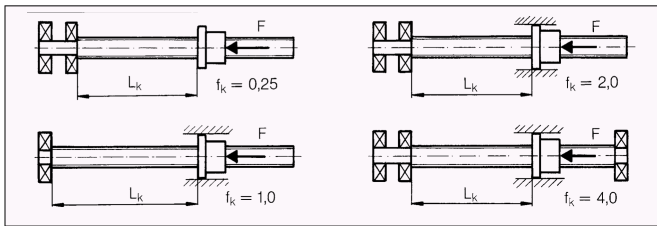
Calculation of the buckling force F_{kn} as a function of the spindle length L_k and the core diameter of the spindle.

$$F_{kn} = \frac{21 \cdot 10^4 \cdot d_k^4 \cdot \pi^3 \cdot f_k}{64 \cdot L_k^3}$$

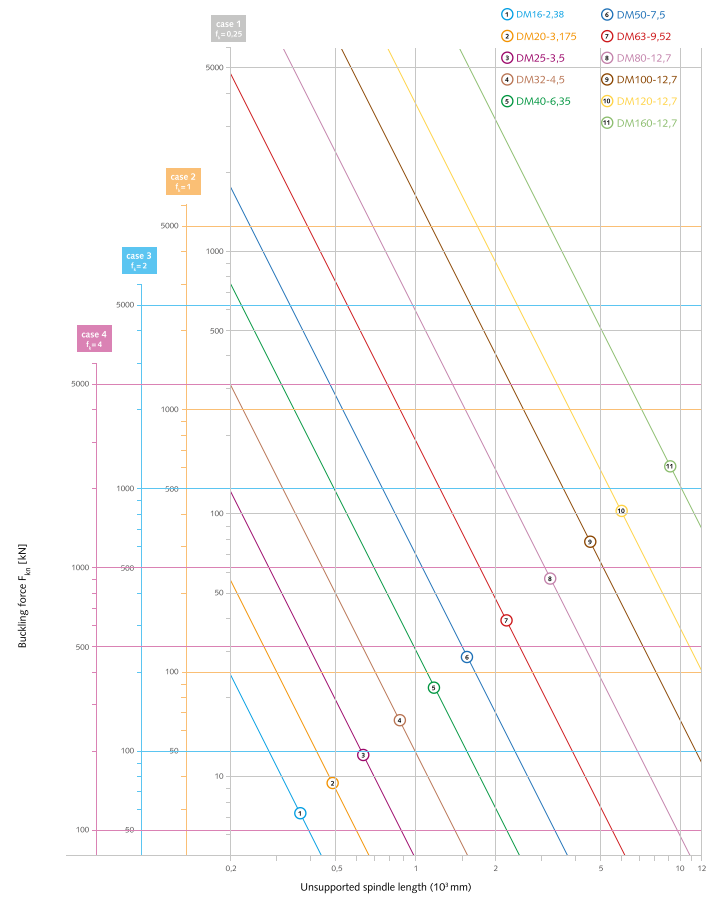
d_k = core diameter of the spindle (mm)
 L_k = unsupported spindle length (mm)
 f_k = correction factor for bearing type

correction factor f_k for taking the type of bearing into account

Core diameter see Nut dimensions tables



► Buckling – diagram



Lubricating ball screw drives

In principle, the same lubricants as for anti-friction bearings can be used for ball screw drives, i.e.: both oil and grease.

In contrast to anti-friction bearings, the maximum operating temperature is of far more importance with ball screw drives, as it affects the accuracy of the ball screw drive due to longitudinal expansion along the axis. A one-off filling of grease for the ball screw drive as lifelong lubrication is not normally adequate, as grease is continually removed due to the screw shaft repeatedly moving in and out of the lubricated area and thus damage could occur in the near term due to lack of lubrication. If grease nipples are specified for re-lubrication purposes, damage may also be expected if the maintenance intervals are not observed or if the ball screw drive is over greased. As central lubrication systems are available for many applications, oil lubrication tends to be used for ball screw drives.

General lubrication

Criteria for selecting a lubricating grease

Operating temperature range

It must correspond to the range of possible temperatures in the ball screw drive.

The possible operating temperatures should not reach the upper or lower limit value:

- The highest operating temperature should be 20°C below the upper limit value
- The lowest operating temperature should be 20°C above the lower limit value.

Grease does not release much base oil at very low temperatures.

This can result in insufficient lubrication.

Type of lubricating grease

The characteristics of a grease depend on the

- Viscosity of the base oil
- Thickener – important for the speed range
- Shear strength – important for the speed range
- Additive

Consistency of the lubricating grease

Lubricating greases are divided into consistency classes – NLGI grades. (DIN 51818). Grades 1, 2, and 3 are preferred for use on ball screw drives.

The greases used should:

- not become too soft (NLGI 1) at high temperatures
 - not become too firm (NLGI 3) at low temperatures.
- Select a lubricating grease according to the speed factor $n \cdot d$ for grease (table) for high-speed ball screw drives or, in the case of a low starting torque, use grease with a high speed factor.

Lubrication and maintenance are important for reliable functioning and ensuring a long service life for the ball screw drives.

The role of lubricant

The lubricant should:

- Form a sufficient load-bearing lubricant film on the contact surfaces
- Dissipate heat (in the case of oil lubrication)
- Also seal the nut externally against solid and liquid contaminants (in the case of grease lubrication)
- Dampen the running noise and protect against corrosion.

Type of lubrication

Ball screw drives can be lubricated with grease or oil.

The type of lubrication and quantity depend on the:

- Operating conditions
- Type of construction and the size of the nuts
- Adjacent construction
- Lubricant supply

Alloyed lubricants

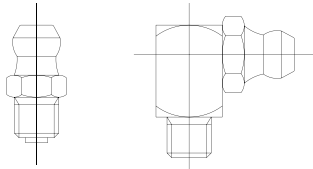
Kammerer uses alloyed lubricants.

These contain:

- Active substances for the consistency to improve ageing resistance
 - Additives which reduce wear in unfavourable lubrication conditions.
- A reaction layer should arise on the surfaces in question to protect them. These additive packages may not be effective in every temperature or load range.

Check the compatibility of the lubricants

- With one another
 - With anti-corrosion agents
 - With plastics (elastomers and thermosetting plastics)
 - With light and non-ferrous metals
 - With coatings, colours and paints
 - With the environment
- Take the toxicity and biodegradability into account.



Grease lubrication

Grease is used to lubricate ball screw drives if a central lubrication unit cannot be installed and the application involves low speeds. Other advantages are improved sealing, dry running prevention and the fact that grease lubrication does not depend on the installation position. The re-lubrication intervals must be agreed with Kammerer for each application in order to avoid damage due to lack of lubrication.

Lubricating greases are divided into NLGI grades according to DIN 51815-1 to 4 according to their worked penetration. In normal cases, ball screw drives are used at operating temperatures from -20°C to +120°C.

Here, class K2k water resistant greases according to DIN 51825 are to be used. In special cases, greases according to NLGI 1 (for very high speeds) or NLGI 3 (for the highest loads or low speeds) are also possible.

The mixing of greases based on different saponifications must be avoided. The manufacturer must be consulted if the operating temperatures lie above or below the given values. The amount of grease to be applied must be such that the cavities are approximately 1/3 full/according to the formula. To avoid unnecessary overheating of the ball screw drive due to over greasing, the design must enable use or excess grease to escape.

Re-lubrication

Conditions: Use the same lubricating grease as for initial lubrication

- In the case of different greases, check the miscibility and compatibility of the greases

Re-lubricate

- With the ball screw drive rotating and at operating temperature
- Before shutdown
- Before a long period of shutdown
- Before long interruptions to operation

Quantity

- Depends on the speed
- 20% to 80% of the initial grease quantity
- Re-lubricate until a fresh collar of grease forms on the sealing gaps
- Old lubricating grease must be able to escape from the ball screw drive unhindered

Re-lubrication quantity after 150 km of operation
 $(\text{Nominal diameter (mm)} \times 0.52 - \text{nominal diameter}^2 (\text{mm}) \times \text{nut length (mm)/1000}) = \text{cm}^3$

Behaviour in regard to water/emulsion

Emulsion in lubricating grease significantly reduces the service life of the bearing: The behaviour of lubricating grease in regard to water is evaluated according to DIN 51 807, the corrosion protection characteristics can be tested according to DIN 51 802 – see the grease manufacturer's data sheets for information.

Compressive strength

For a load-bearing lubricant film, the viscosity must be sufficiently high at operating temperature. Use lubricating grease with EP (Extreme Pressure) properties and high base oil viscosity (KP grease according to DIN 51 502) for high loads.

Grease for ball screw drives

Manufacturer	Chemical composition		Temperature range [°C]		Viscosity of the base oil [mm ² /s]		Speed factor	
	Designation	Oil type	Thickener	from	to	40°C		100°C
Klüber ISOFLIX	TOPAS NCA 52	Synthetic hydrocarbon	Special calcium soap	-50	130	31	5,9	1.000.000
	NBU 15	Combination	Barium complex soap	-40	130	21	4,5	1.600.000

Lubricant technology offers a range of special types of grease which have been designed for specific applications. Get in touch with us to determine the right lubricant for your application.

Oil lubrication

The advantage of oil lubrication by means of a central lubrication system is that an adequate lubricant film can keep on forming and the ball screw drive heating is low due to the improved heat dissipation. Furthermore, any excess oil is removed by the wiper.

Basically, circulating oils with active substances for increasing the corrosion protection and the ageing resistance as per C-L according to DIN 51517 Part 2, like those also used for lubricating anti-friction bearings, are suitable for supplying ball screw drives.

The viscosity of the lubricant to be used depends primarily on the speed and the ambient temperature as well as the load. In order to guarantee an adequate lubricant film at all times and under all operating conditions, it is important to aim for a higher lubricant viscosity.

If speed of the ball screw drive is less than 20 rpm and/or high loading is to be expected, it is advisable to use a circulating oil with active substances to increase the ageing resistance of the corrosion protection as well as additives for increasing the loading capability and improving the protection against wear as per C-LP according to DIN 51517 Part 3.

The amount of oil required for each ball turn is about 3 - 50 drops/min. With splash lubrication, it is sufficient if the oil level is maintained up to the centre of the lowest rolling element when installed horizontally.

Compatibility

Before using the lubricating oil, check its behaviour in regard to:

- Plastics
- Elastomers
- Non-ferrous and light metals.

Test it under dynamic loading and at operating temperature – ask the lubricant manufacturer.

Miscibility

The following can be mixed with one another: lubricating oils based on mineral oils and of the same classification, e.g. HLP

- The viscosities should not differ by more than one ISO VG class.
- Always check the miscibility of synthetic oils – ask the lubricant dealer.

Compressive strength

Use lubricating oils with EP additives: Identification letter P according to DIN 51502.

The load-bearing capacity of known greases may change if EP additives containing lead are removed.

Therefore: check the grease selection

- Ask the grease manufacturer.
- Grease does not dissipate any heat from the bearing.
- The operating temperature should not exceed +70°C.

Here, the

- Thermal load of the lubricant grease is at its lowest
- The service life of the grease is at its longest

Lubricant grease

Lubricant grease K according to DIN 51 825 – 1 to 4 is suitable. Kammerer uses grease in accordance with the table.

This is subject to change due to technical progress.

Heat dissipation due to the lubricant

Lubricating oil dissipates heat from the bearing.

Advantages of oil lubrication

- Good lubrication distribution
- Heat is dissipated out of the bearing
- Affects the operating temperature, the permissible speed and the loading capability of the bearing
- Good lubricant exchange during re-lubrication

Lubricating oils

Ball screw drives are lubricated with lubricating oils based on mineral/synthetic oils.

Operating temperatures:

- Alloyed mineral oils: Continuous operation up to +130°C
 - Synthetic oils: Continuous operation up to +200°C
- The lubricant manufacturer's specifications are decisive.

Selecting a lubricating oil

A load-bearing lubricant film is required in the contact zones between the rolling element and track. Depending on the operating speed, the lubricating oil must have at least a nominal viscosity at operating temperature.

Lubricating methods

- Drip feed lubrication
 - Recirculating oil lubrication
 - Oil-air lubrication
- Oil mist lubrication should be replaced by oil-air lubrication to protect the environment.

Drip feed lubrication

Can be used for: high-speed ball screw drives

The amount of oil required depends on the:

- Nut
- Turns
- Operating speed
- Loading

Guide value:

- Between 3 and 50 drops/min per rolling element track
- One drop weighs approx. 0.025 g
- Excess oil must be able to escape from the nut.

Questionnaire, Part 1

Customer: _____ Customer No: _____
 Address: _____
 Telephone: _____ Telex: _____
 Department: _____ Contact: _____
 New design: Re-design:
 Enquiry dated: _____ Order dated: _____

Order confirmation dated: _____ Order No: _____

Customer drawing No: _____ dated: _____
 No: _____ dated: _____
 No: _____ dated: _____

Standard spindle, type: _____

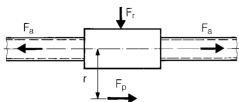
Quantity
 Call-off of: _____ items _____ monthly, yearly _____
 _____ per order, or _____

We would ask you to provide us with as many technical details as possible. Our offer can then be worked out more carefully and appropriately for the application. If possible, please attach an installation drawing or draft sketch of the ball screw to this request.

Comments (or sketch)

1. Operating data

- 1.1 Drive via spindle shaft nut
- 1.2 Static max. loading, axial (F_a) Tension: _____ N, Compression: _____ N
- 1.3 Dynamic max. loading: Tension: _____ N, Compression: _____ N
- 1.4 Non-axial loading: F_r = _____ N, F_p = _____ N, r = _____ mm



- 1.5 Safety factor in the loading figures: _____
- 1.6 Loading direction: single-sided two-sided
- 1.7 Speed at the stated loads: v = _____ mm/min, n = _____ rpm
- 1.8 Max. speed: n_{max} = _____ rpm
- 1.9 If the loads or speeds should vary, please provide details in the table below.

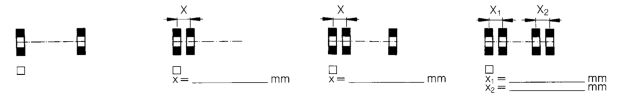
Collective load

Type of load	F_a (N)	n (rpm)	or v (mm/min)	s (mm)	or q (%)

1.10 Utilisation factor: f_n = _____ ball screw duty (h)
 _____ machine duty

Questionnaire, Part 2

1.11 Spindle mounting



- 1.12 Distance between bearings: _____ mm
- 1.13 Installation orientation: vertical horizontal at an angle of _____ degrees
- 1.14 Max. permissible play: _____ mm
- 1.15 Required rigidity: _____ N/ μ m
- 1.16 Permissible no-load torque: _____ Nm
- 1.17 Required life: _____ operating hours, _____ $\times 10^6$ revolutions

2.0 Operating conditions

- 2.1 Dust/dirt Moisture influence of chemicals
- 2.2 Seal type: Bellows Telescopic spring Plastic wiper Felt wiper
- 2.3 Operating temperature: _____ °C, Ambient temperature _____ °C
- 2.4 Type of lubrication: _____
- 2.5 Unusual operating conditions: _____

3.0 Characteristic data of spindle

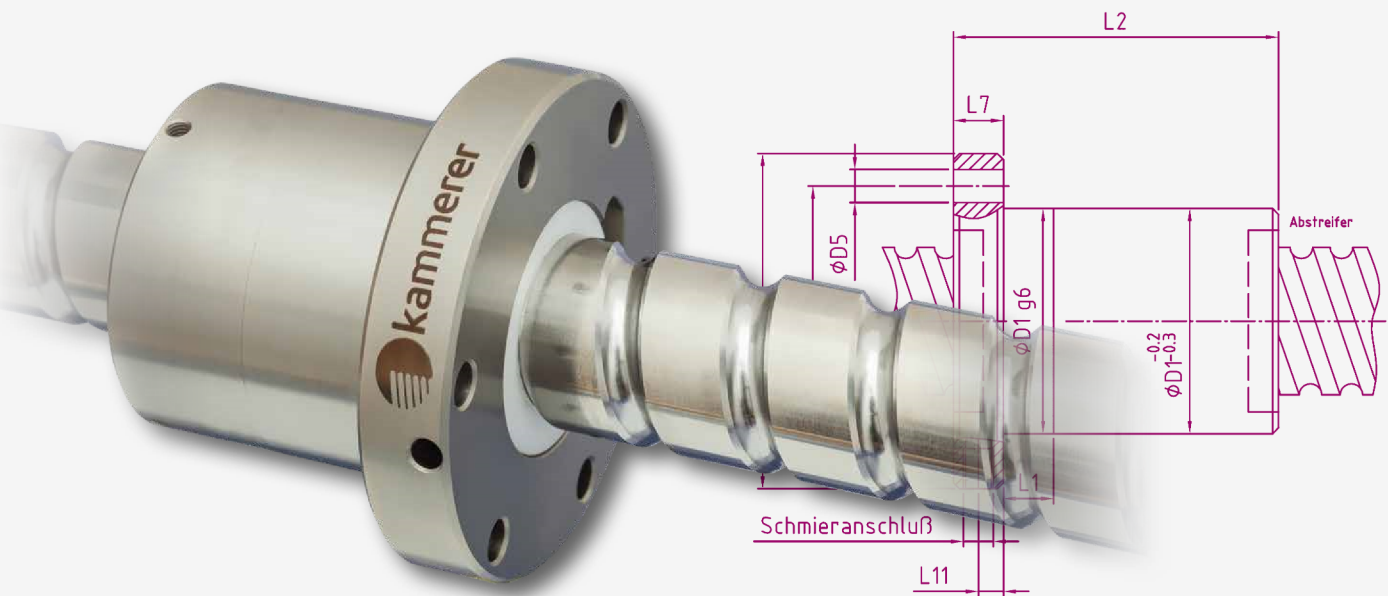
- 3.1 Required nominal diameter ϕA : _____ mm
- 3.2 Lead P : _____ mm
- 3.3 Lead direction: right-hand left-hand
- 3.4 Permissible lead variation $\Delta p/300$ mm at 20 °C _____ μ m
- 3.5 Δp /thread length at 20 °C _____ mm
- 3.6 Permissible lead variation according to drawing No.: _____
- 3.7 Actual lead variation diagram required:
- 3.8 Max. wobble error: _____ mm
- 3.9 Thread length: _____ mm
- 3.10 Total length: _____ mm
- 3.11 Spindle in tension Compression pre-loaded at F_v = _____ N
- 3.12 Material: _____ to ISO, DIN: _____
- 3.13 Material No: _____ Quality norm: _____
- 3.14 Surface treatment: _____
- 3.15 Hardness: _____ Depth of hardening zone: _____
- 3.16 Ball screw surface: _____ Roughness class: _____ Reference roughness value R_s : _____ μ m
- 3.17 Accuracy class: _____

4.0 Characteristic data of nut

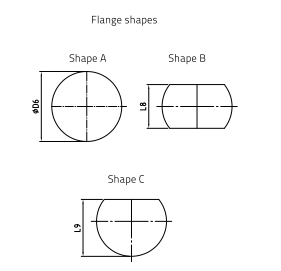
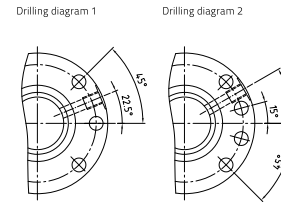
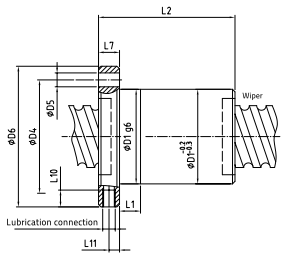
- 4.1 Max. length: _____ mm
- 4.2 Max. diameter: _____ mm
- 4.3 Housing to drawing No: _____
- 4.4 Single nut max. axial play _____
- 4.5 Double nut: Type of construction: _____ pre-loaded at F_v = _____ N
- 4.6 Max. axial displacement δa = _____ μ m at F_{v0} = _____ N
- 4.7 Max. reversal span δu = _____ μ m at F_{v0} = _____ N
- 4.8 Material: _____ to ISO, DIN: _____
- 4.9 Material No: _____ Quality norm: _____
- 4.10 Surface treatment: _____
- 4.11 Hardness: _____ Depth of hardening zone: _____
- 4.12 Ball screw surface: _____
- 4.13 Accuracy class: _____

Checked and approved (customer)	Checked (Kammerer)
---------------------------------	--------------------

NUTS / SCREWS

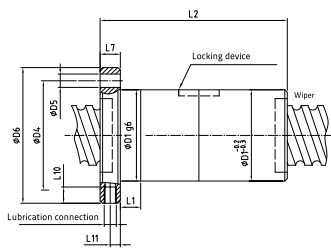


► Nut dimension table EFM (single flange nut)



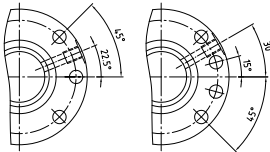
Dimensions	Spindle-Ø h6	D _n Ball-Ø	i Number of turns	Core-Ø Spindle	D _{g6} Centring-Ø	D _h Pitch circle-Ø	Drilling diagram	Number of mounting holes	D _h Hole-Ø	D _h Flange-Ø	Fit size length	Nut length	Flange width	L ₁ Shape B	L ₂ Shape C	L ₃ Thread depth	L ₄ Lubrication hole distance	Lubrication connection	Dynamic axial load rating C _{dyn} [kN]	Static axial load rating C _{stat} [kN]	Static axial rigidity R _{ax} [10 ⁶ N/m] = 1/δ _{ax} (at F _{ax} = 1000 N)
16x5	16	2.38	4	14	28	38	1	6	8.5	48	10	45	10	40	44	8	5	M6	10.5	16.8	280
16x10	16	2.38	3	14	28	38	1	6	5.5	48	10	55	10	40	44	8	5	M6	8.0	12.2	207
16x16	16	2.38	2	14	28	38	1	6	5.5	48	10	60	10	40	44	8	5	M6	5.3	7.6	134
20x5	20	3.175	5	17.2	36	47	1	6	6.6	58	10	52	10	44	51	8	5	M6	20.9	35.3	429
20x10	20	3.175	3	17.2	36	47	1	6	6.6	58	10	60	40	44	51	8	5	M6	13.0	20.3	260
20x20	20	3.175	2	17.2	36	47	1	6	6.6	58	10	70	10	44	51	8	5	M6	8.7	12.8	167
25x5	24	3.5	5	20.9	40	51	1	6	6.6	62	10	60	10	48	55	8	5	M6	25.9	46.8	483
25x10	24	3.5	3	20.9	40	51	1	6	6.6	62	10	70	10	48	55	8	5	M6	16.2	26.6	297
25x20	24	3.5	2	20.9	40	51	1	6	6.6	62	10	70	10	48	55	8	5	M6	10.8	16.8	196
25x25	24	3.5	2	20.9	40	51	1	6	6.6	62	10	85	10	48	55	8	5	M6	10.7	16.9	191
32x5	30	3.5	5	26.9	50	65	1	6	9	80	10	60	12	62	71	8	6	M6	28.7	58.9	570
32x10	30	4.5	4	26.4	50	65	1	6	9	80	10	80	12	62	71	8	6	M6	33.0	59.9	507
32x20	30	6.35	4	25	56	71	1	6	9	86	20	80	14	65	75.5	8	7	M6	51.8	83.0	523
32x20	30	6.35	3	25	56	71	1	6	9	86	20	95	14	65	75.5	8	7	M6	39.4	60.3	398
32x32	30	6.35	2	25	56	71	1	6	9	86	20	105	14	65	75.5	8	7	M6	26.2	37.6	244
40x5	38	3.5	5	34.9	63	78	2	8	9	93	10	70	14	70	81.5	10	7	M8x1	31.6	75.2	679
40x10	38	6.35	4	33	63	78	2	8	9	93	20	88	14	70	81.5	10	7	M8x1	58.4	106.8	629
40x20	38	6.35	3	33	63	78	2	8	9	93	20	95	14	70	81.5	10	7	M8x1	44.5	77.9	472
40x20	38	8	3	31.3	70	85	2	8	9	100	25	110	14	75	87.5	10	7	M8x1	66.7	110.2	545
40x20	38	9.52	3	30.3	75	93	2	8	11	110	25	110	16	85	97.5	10	8	M8x1	83.1	131.8	561
40x40	38	8	2	31.3	70	85	2	8	9	100	25	130	14	75	87.5	10	7	M8x1	44.3	68.3	333
40x40	38	9.52	2	30.3	75	93	2	8	11	110	25	140	16	85	97.5	10	8	M8x1	55.2	81.3	341
50x5	48	3.5	6	44.9	75	93	2	8	11	110	16	70	16	85	97.5	10	8	M8x1	40.9	116.0	946
50x10	48	7.5	5	40.8	75	93	2	8	11	110	16	98	16	85	97.5	10	8	M8x1	110.0	225.7	1013
50x20	48	7.5	4	40.8	75	93	2	8	11	110	20	135	16	85	97.5	10	8	M8x1	89.4	177.1	832
50x20	48	8	4	41.3	82	100	2	8	11	118	25	135	16	92	105	10	8	M8x1	98.3	192.9	882
50x30	48	7.5	4	40.8	75	93	2	8	11	110	20	170	16	85	97.5	10	8	M8x1	88.9	177.6	864
50x30	48	8	4	41.3	82	100	2	8	11	118	25	170	16	92	105	10	8	M8x1	97.7	193.7	884
50x40	48	7.5	4	40.8	75	93	2	8	11	110	20	220	16	85	97.5	10	8	M8x1	88.0	177.4	852
50x40	48	8	4	41.3	82	100	2	8	11	118	25	220	16	92	105	10	8	M8x1	96.8	193.6	871
50x50	48	7.5	3	40.8	75	93	2	8	11	110	20	210	16	85	97.5	10	8	M8x1	66.7	129.0	627
50x50	48	8	3	41.3	82	100	2	8	11	118	25	210	16	92	105	10	8	M8x1	73.4	141.5	642
63x5	60	3.5	6	56.9	90	108	2	8	11	125	16	70	18	95	110	10	9	M8x1	44.6	145.3	1077
63x10	60	7.5	6	52.8	90	108	2	8	11	125	16	120	18	95	110	10	9	M8x1	143.6	346.6	1418
63x20	60	7.5	4	52.8	90	108	2	8	11	125	25	135	18	95	110	10	9	M8x1	99.3	225.3	1002
63x20	60	9.52	6	52.3	95	115	2	8	13.5	135	25	190	20	100	117.5	10	10	M8x1	193.3	446.8	1576
63x40	60	7.5	4	52.8	90	108	2	8	11	125	25	220	18	95	110	10	9	M8x1	98.3	224.1	1015
63x40	60	9.52	4	52.3	95	115	2	8	13.5	135	25	220	20	100	117.5	10	10	M8x1	136.8	289.5	1080

► Nut dimension table DpFM (double flange nut)

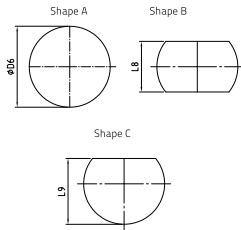


Drilling diagram 1

Drilling diagram 2

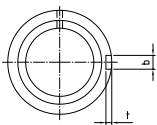
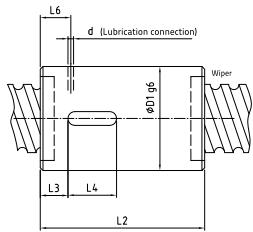


Flange shapes



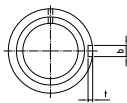
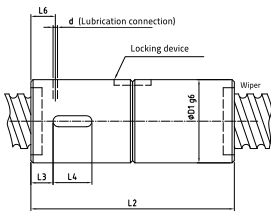
Dimensions	Spindle- Ø h6	D _p Ball-Ø	i Number of turns	Core-Ø Spindle	D _c g6 Centring- Ø	D _s Pitch circle-Ø	Drilling diagram	Number of mounting holes	D _s Hole-Ø	D _c Flange-Ø	L ₁ Fit size length	L ₂ Nut length	L ₃ Flange width	L ₄ Shape B	L ₅ Shape C	L ₆ Thread depth	L ₇ Lubrica- tion hole distance	Lubrica- tion con- nection	Dynamic axial load C _{dyn} (kN)	Static axial load C _{stat} (kN)	Static axial rigidity R _{ax} with a preload C _{ax} (N/mm)
16x5	16	2.38	4	14	28	38	1	6	5.5	48	10	85	10	40	44	8	5	M6	10.5	16.8	362
16x10	16	2.38	3	14	28	38	1	6	5.5	48	10	110	10	40	44	8	5	M6	8.0	12.2	264
16x16	16	2.38	2	14	28	38	1	6	5.5	48	10	115	10	40	44	8	5	M6	5.3	7.6	170
20x5	20	3.175	5	17.2	36	47	1	6	6.6	58	10	95	10	44	51	8	5	M6	20.9	35.3	559
20x10	20	3.175	3	17.2	36	47	1	6	6.6	58	10	110	40	44	51	8	5	M6	13.0	20.3	332
20x20	20	3.175	2	17.2	36	47	1	6	6.6	58	10	135	10	44	51	8	5	M6	8.7	12.8	212
25x5	24	3.5	5	20.9	40	51	1	6	6.6	62	10	95	10	48	55	8	5	M6	25.9	46.8	633
25x10	24	3.5	3	20.9	40	51	1	6	6.6	62	10	110	10	48	55	8	5	M6	16.2	26.6	382
25x20	24	3.5	2	20.9	40	51	1	6	6.6	62	10	135	10	48	55	8	5	M6	10.8	16.8	249
25x25	24	3.5	2	20.9	40	51	1	6	6.6	62	10	155	10	48	55	8	5	M6	10.7	16.9	242
32x5	30	3.5	5	26.9	50	65	1	6	9	80	10	105	12	62	71	8	6	M6	28.7	58.9	752
32x10	30	4.5	4	26.4	50	65	1	6	9	80	10	150	12	62	71	8	6	M6	33.0	59.9	656
32x10	30	6.35	4	25	56	71	1	6	9	86	20	150	14	65	75.5	8	7	M6	51.8	83.0	676
32x20	30	6.35	3	25	56	71	1	6	9	86	20	190	14	65	75.5	8	7	M6	39.4	60.3	508
32x32	30	6.35	2	25	56	71	1	6	9	86	20	200	14	65	75.5	8	7	M6	26.2	37.6	310
40x5	38	3.5	5	34.9	63	78	2	8	9	93	10	110	14	70	81.5	10	7	M8x1	31.6	75.2	903
40x10	38	6.35	4	33	63	78	2	8	9	93	20	160	14	70	81.5	10	7	M8x1	58.4	106.8	820
40x20	38	6.35	3	33	63	78	2	8	9	93	20	192	14	70	81.5	10	7	M8x1	44.5	77.9	605
40x20	38	8	3	31.3	70	85	2	8	9	100	25	210	14	75	87.5	10	7	M8x1	66.7	110.2	699
40x20	38	9.52	3	30.3	75	93	2	8	11	110	25	210	16	85	97.5	10	8	M8x1	83.1	131.8	719
40x40	38	8	2	31.3	70	85	2	8	9	100	25	250	14	75	87.5	10	7	M8x1	44.3	68.3	423
40x40	38	9.52	2	30.3	75	93	2	8	11	110	25	250	16	85	97.5	10	8	M8x1	55.2	81.3	433
50x5	48	3.5	6	44.9	75	93	2	8	11	110	16	130	16	85	97.5	10	8	M8x1	40.9	116.0	1275
50x10	48	7.5	5	40.8	75	93	2	8	11	110	16	185	16	85	97.5	10	8	M8x1	110.0	225.7	1339
50x20	48	7.5	4	40.8	75	93	2	8	11	110	20	240	16	85	97.5	10	8	M8x1	89.4	177.1	1075
50x20	48	8	4	41.3	82	100	2	8	11	118	25	250	16	92	105	10	8	M8x1	98.3	192.9	1137
50x30	48	7.5	4	40.8	75	93	2	8	11	110	20	330	16	85	97.5	10	8	M8x1	88.8	177.6	1107
50x30	48	8	4	41.3	82	100	2	8	11	118	25	330	16	92	105	10	8	M8x1	97.7	193.7	1131
50x40	48	7.5	4	40.8	75	93	2	8	11	110	20	410	16	85	97.5	10	8	M8x1	88.0	177.4	1087
50x40	48	8	4	41.3	82	100	2	8	11	118	25	410	16	92	105	10	8	M8x1	96.8	193.6	1110
50x50	48	7.5	3	40.8	75	93	2	8	11	110	20	400	16	85	97.5	10	8	M8x1	66.7	129.0	798
50x50	48	8	3	41.3	82	100	2	8	11	118	25	400	16	92	105	10	8	M8x1	73.4	141.5	815
63x5	60	3.5	6	56.9	90	108	2	8	11	125	16	130	18	95	110	10	9	M8x1	44.6	145.3	1473
63x10	60	7.5	6	52.8	90	108	2	8	11	125	16	210	18	95	110	10	9	M8x1	143.6	346.6	1894
63x20	60	7.5	4	52.8	90	108	2	8	11	125	25	250	18	95	110	10	9	M8x1	99.3	225.3	1302
63x20	60	9.52	6	52.3	95	115	2	8	13.5	135	25	350	20	100	117.5	10	10	M8x1	199.3	446.8	2049
63x40	60	7.5	4	52.8	90	108	2	8	11	125	25	420	18	95	110	10	9	M8x1	98.3	224.1	1299
63x40	60	9.52	4	52.3	95	115	2	8	13.5	135	25	430	20	100	117.5	10	10	M8x1	136.8	289.5	1383
63x50	60	7.5	3	52.8	90	108	2	8	11	125	25	420	18	95	110	10	9	M8x1	74.8	163.2	965
63x50	60	9.52	3	52.3	95	115	2	8	13.5	135	25	420	20	100	117.5	10	10	M8x1	104.2	211.9	1029
80x10	80	6.35	6	75	105	125	2	8	13.5	145	16	225	20	110	127.5	10	10	M8x1	115.8	353.2	2010
80x10	80	7.5	6	72.8	108	128	2	8	13.5	148	16	225	20	113	130.5	10	10	M8x1	162.3	467.9	2255
80x20	80	12.7	4	69.5	125	145	2	8	13.5	165	25	300	25	130	147.5	10	12.5	M8x1	232.1	510.7	1724
80x20	80	12.7	6	69.5	125	145	2	8	13.5	165	25	350	25	130	147.5	10	12.5	M8x1	334.9	789.9	2642
80x40	80	12.7	4	69.5	125	145	2	8	13.5	165	25	440	25	130	147.5	10	12.5	M8x1	230.8	513.0	1821
80x60	80	12.7	3	69.5	125	145	2	8	13.5	165	25	480	25	130	147.5	10	12.5	M8x1	175.4	372.6	1310
100x10	100	6.35	6	95	125	145	2	8	13.5	165	16	230	22	130	148	10	11	M8x1	126.3	441.9	2249
100x10	100	7.5	6	92.8	128	148	2	8	13.5	168	16	230	22	133	150.5	10	11	M8x1	177.6	589.1	2543
100x20	100	12.7	4	89.5	150	176	2	8	17.5	202	25	300	30	155	178.5	10	15	M8x1	256.9	641.5	2065
100x20	100	12.7	6	89.5	150	176	2	8	17.5	202	25	380	30	155	178.5	10	15	M8x1	370.6	993.3	3142
100x40	100	12.7	4	89.5	150	176	2	8	17.5	202	25	450	30	155	178.5	10	15	M8x1	255.9	644.7	2138
120x10	120	7.5	6	112.8	150	176	2	8	17.5	202	25	235	25	155	178.5	10	12.5	M8x1	190.7	707.8	2778
120x20	120	12.7	4	109.5	170	196	2	8	17.5	222	25	310	30	175	198.5	10	15	M8x2	277.6	779.0	2356
120x20	120	12.7	6	109.5	170	196	2	8	17.5	222	25	390	30	175	198.5	10	15	M8x3	400.5	1196.4	3494
120x40	120	12.7	4	109.5	170	196	2	8	17.5	222	25	470	30	175	198.5	10	15	M8x4	276.9	775.9	2477
160x20	160	12.7	4	149.5	210	243	2	8	22	275	25	320	40	215	245	10	20	M8x5	311.9	1040.0	2794
160x20	160	12.7	6	149.5	210	243	2	8	22	275	25	400	40	215	245	10	20	M8x6	449.9	1609.2	4208
160x40	160	12.7	4	149.5	210	243	2	8	22	275	25	480	40	215	245	10	20	M8x7	311.4	1044.6	3023

► Nut dimension table EM (single nut)



Dimensions	Spindle-Ø h6	D ₂		Core-Ø Spindle	D ₂ g6				d	b P9	t	Dynamic axial load rating C _{dyn} [kN]	Static axial load rating C _{stat} [kN]	Static axial rigidity R _{ax} with a preload F _{ax} of C _{stat} [N/mm]	
		Ball-Ø	Number of turns		Centring-Ø	Nut length	L ₂	L ₃							L ₄
16x5	16	2.38	4	14	28	45	10	16	10	4	4	2.4	10.5	16.8	280
16x10	16	2.38	3	14	28	55	10	16	10	4	4	2.4	8.0	12.2	207
16x16	16	2.38	2	14	28	60	10	16	10	4	4	2.4	5.3	7.6	134
20x5	20	3.175	5	17.2	36	52	11	20	10	4	5	2.9	20.9	35.3	429
20x10	20	3.175	3	17.2	36	55	11	20	10	4	5	2.9	13.0	20.3	260
20x20	20	3.175	2	17.2	36	65	11	20	10	4	5	2.9	8.7	12.8	167
25x5	24	3.5	5	20.9	40	60	12	20	10	4	5	2.9	25.9	46.8	483
25x10	24	3.5	3	20.9	40	60	12	20	10	4	5	2.9	16.2	26.6	297
25x20	24	3.5	2	20.9	40	70	12	20	10	4	5	2.9	10.8	16.8	196
25x25	24	3.5	2	20.9	40	80	12	20	10	4	5	2.9	10.7	16.9	191
32x5	30	3.5	5	26.4	50	60	13	20	10	4	5	2.9	28.7	58.9	570
32x10	30	3.5	3	26.4	50	80	20	28	12	4	5	2.9	40.4	76.3	629
32x20	30	3.5	2	26.4	50	80	20	28	12	4	5	2.9	25.1	51.8	523
32x20	30	6.35	3	29	56	95	20	28	12	4	5	2.9	39.4	60.3	398
32x32	30	6.35	2	29	56	95	20	28	12	4	5	2.9	26.2	37.6	244
40x5	38	3.5	5	34.9	63	70	15	20	12	4	6	3.5	31.6	75.2	679
40x10	38	6.35	4	33	63	88	25	28	12	4	6	3.5	58.4	106.8	629
40x20	38	6.35	3	33	63	90	25	28	12	4	6	3.5	44.5	77.9	472
40x20	38	8	3	31.3	70	105	25	28	12	4	6	3.5	66.7	110.2	545
40x20	38	9.52	3	30.3	75	105	25	28	12	4	6	3.5	83.1	131.8	561
40x40	38	8	2	31.3	70	130	25	28	12	4	6	3.5	44.3	68.3	333
40x40	38	9.52	2	30.3	75	130	25	28	12	4	6	3.5	55.2	81.3	341
50x5	48	3.5	6	44.9	75	90	28	28	12	4	6	3.5	40.9	116.0	946
50x10	48	7.5	5	40.8	75	98	28	28	12	4	6	3.5	110.0	225.7	1013
50x20	48	7.5	4	40.8	75	125	28	28	12	4	6	3.5	89.4	177.1	832
50x20	48	8	4	41.3	82	125	28	28	12	4	6	3.5	98.3	192.9	882
50x30	48	7.5	4	40.8	75	160	28	28	12	4	6	3.5	88.8	177.6	864
50x30	48	8	4	41.3	82	160	28	28	12	4	6	3.5	97.7	193.7	884
50x40	48	7.5	4	40.8	75	210	28	28	12	4	6	3.5	88.0	177.4	852
50x40	48	8	4	41.3	82	210	28	28	12	4	6	3.5	96.8	193.6	871
50x50	48	7.5	3	40.8	75	200	28	28	12	4	6	3.5	66.7	129.0	627
50x50	48	8	3	41.3	82	200	28	28	12	4	6	3.5	73.4	141.5	642
63x5	60	3.5	6	56.9	90	70	28	28	12	4	6	3.5	44.6	145.3	1077
63x10	60	7.5	6	52.8	90	120	32	28	12	4	6	3.5	143.6	346.6	1418
63x20	60	7.5	4	52.8	90	125	40	45	16	4	8	4.1	99.3	225.3	1002
63x20	60	9.52	6	52.8	95	180	40	45	16	4	8	4.1	199.3	446.8	1576
63x40	60	7.5	4	52.8	90	210	40	45	16	4	8	4.1	98.3	224.1	1015
63x40	60	9.52	4	52.3	95	210	40	45	16	4	8	4.1	136.8	289.5	1080
63x50	60	7.5	3	52.8	90	210	40	45	16	4	8	4.1	74.8	163.2	757
63x50	60	9.52	3	52.3	95	210	40	45	16	4	8	4.1	104.2	211.9	806
80x10	80	6.35	6	75	105	125	35	28	14	4	6	3.5	115.8	353.2	1463
80x10	80	7.5	6	72.8	108	125	35	28	14	4	6	3.5	162.3	467.9	1641
80x20	80	12.7	4	69.5	125	150	40	45	16	4	8	4.1	232.1	510.7	1314
80x20	80	12.7	6	69.5	125	190	40	45	16	4	8	4.1	334.9	789.9	2012
80x40	80	12.7	4	69.5	125	220	40	45	16	4	8	4.1	230.8	513.0	1414
80x60	80	12.7	3	69.5	125	240	40	45	16	4	8	4.1	175.4	372.6	1025
100x10	100	6.35	6	95	125	125	40	28	14	4	6	3.5	126.3	441.9	1596
100x10	100	7.5	6	92.8	128	125	40	28	14	4	6	3.5	177.6	589.1	1804
100x20	100	12.7	4	89.5	150	160	50	45	16	4	10	4.7	256.9	641.5	1599
100x20	100	12.7	6	89.5	150	190	50	45	16	4	10	4.7	370.6	993.3	2370
100x40	100	12.7	4	89.5	150	230	50	45	16	4	10	4.7	255.9	644.7	1653
120x10	120	7.5	6	112.8	150	125	40	28	14	4	8	4.1	190.7	707.8	1936
120x20	120	12.7	4	109.5	170	160	50	55	16	4	10	4.7	277.6	779.0	1756
120x20	120	12.7	6	109.5	170	190	50	55	16	4	10	4.7	400.5	1196.4	2605
120x40	120	12.7	4	109.5	170	240	50	55	16	4	10	4.7	276.9	775.9	1901
160x20	160	12.7	4	149.5	210	160	50	55	16	4	10	4.7	311.9	1040.0	2028
160x20	160	12.7	6	149.5	210	190	50	55	16	4	10	4.7	449.9	1609.2	3054
160x40	160	12.7	4	149.5	210	240	50	55	16	4	10	4.7	311.4	1044.6	2284

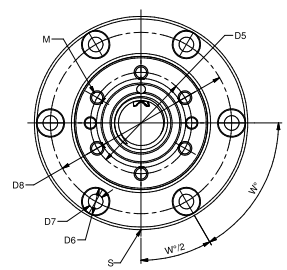
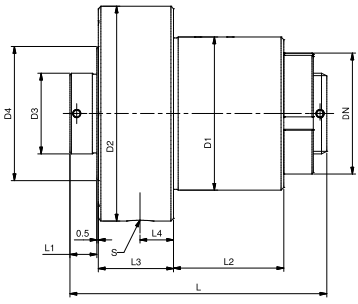
► Nut dimension table DpM (double nut)



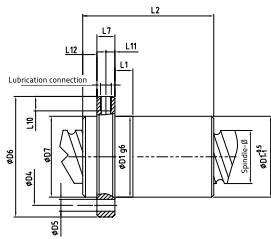
Dimensions	Spindle-Ø h6	D ₂		Core-Ø Spindle	D ₁ g6					d	b P9		Dynamic axial load rating C _{dyn} [kN]	Static axial load rating C _{stat} [kN]	Static axial rigidity R _{ax} with 1 preloaded 100% of C _{dyn} [N/mm]
		Ball-Ø	i		Centring-Ø	Nut length	Groove distance	Groove length	Hole distance		Hole-Ø	Groove width			
16x5	16	2.38	4	14	28	80	10	16	10	4	4	2.4	10.5	16.8	362
16x10	16	2.38	3	14	28	110	10	16	10	4	4	2.4	8.0	12.2	264
16x16	16	2.38	2	14	28	110	10	16	10	4	4	2.4	5.3	7.6	170
20x5	20	3.175	5	17.2	36	90	11	20	10	4	5	2.9	20.9	35.3	599
20x10	20	3.175	3	17.2	36	105	12	20	10	4	5	2.9	13.0	20.3	332
20x20	20	3.175	2	17.2	36	130	12	20	10	4	5	2.9	8.7	12.8	212
25x5	24	3.5	5	20.9	40	90	12	20	10	4	5	2.9	25.9	46.8	633
25x10	24	3.5	3	20.9	40	105	12	20	10	4	5	2.9	16.2	26.6	382
25x20	24	3.5	2	20.9	40	130	12	20	10	4	5	2.9	10.8	16.8	249
25x25	24	3.5	2	20.9	40	150	12	20	10	4	5	2.9	10.7	16.9	242
32x5	30	4.5	5	26.4	50	100	13	20	10	4	5	2.9	28.7	58.9	752
32x10	30	4.5	5	26.4	50	140	20	28	12	4	5	2.9	40.4	76.3	814
32x10	30	6.35	4	25	56	140	20	28	12	4	6	3.5	51.8	83.0	676
32x20	30	6.35	3	25	56	180	20	28	12	4	6	3.5	39.4	60.3	508
32x32	30	6.35	2	25	56	190	20	28	12	4	6	3.5	26.2	37.6	310
40x5	38	3.5	5	34.9	63	108	15	20	12	4	6	3.5	31.6	75.2	903
40x10	38	6.35	4	33	63	150	25	28	12	4	6	3.5	58.4	106.8	820
40x20	38	6.35	3	33	63	175	25	28	12	4	6	3.5	44.5	77.9	605
40x20	38	8	3	31.3	75	200	25	28	12	4	6	3.5	66.7	110.2	700
40x20	38	9.52	3	30.3	75	200	25	28	12	4	6	3.5	83.1	131.8	719
40x40	38	8	2	31.3	70	240	25	28	12	4	6	3.5	44.3	68.3	423
40x40	38	9.52	2	30.3	75	240	25	28	12	4	6	3.5	55.2	81.3	433
50x5	48	3.5	6	44.9	75	150	28	28	12	4	6	3.5	40.9	116.0	1275
50x10	48	7.5	5	40.8	75	170	28	28	12	4	6	3.5	110.0	225.7	1339
50x20	48	7.5	4	40.8	75	230	28	28	12	4	6	3.5	89.4	177.1	1075
50x20	48	8	4	41.3	82	240	28	28	12	4	6	3.5	98.3	192.9	1137
50x30	48	7.5	4	40.8	75	320	28	28	12	4	6	3.5	88.8	177.6	1107
50x30	48	8	4	41.3	82	320	28	28	12	4	6	3.5	97.7	193.7	1131
50x40	48	7.5	4	40.8	75	400	28	28	12	4	6	3.5	88.0	177.4	1087
50x40	48	8	4	41.3	82	400	28	28	12	4	6	3.5	96.8	193.6	1110
50x50	48	7.5	3	40.8	75	390	28	28	12	4	6	3.5	66.7	129.0	798
50x50	48	8	3	41.3	82	390	28	28	12	4	6	3.5	73.4	141.5	815
63x5	60	3.5	6	56.9	90	120	28	28	12	4	6	3.5	44.6	145.3	1473
63x10	60	7.5	6	52.8	90	190	32	28	12	4	6	3.5	143.6	346.6	1894
63x20	60	7.5	4	52.8	90	240	40	45	16	4	8	4.1	99.3	225.3	1302
63x20	60	9.52	6	52.3	95	330	40	45	16	4	8	4.1	199.3	446.8	2049
63x40	60	7.5	4	52.8	90	410	40	45	16	4	8	4.1	98.3	224.1	1299
63x40	60	9.52	4	52.3	95	420	40	45	16	4	8	4.1	136.8	289.5	1383
63x50	60	7.5	3	52.8	90	400	40	45	16	4	8	4.1	74.8	163.2	965
63x50	60	9.52	3	52.3	95	400	40	45	16	4	8	4.1	104.2	211.9	1029
80x10	80	6.35	6	75	105	200	35	28	14	4	6	3.5	115.8	353.2	2010
80x10	80	7.5	6	72.8	108	200	35	28	14	4	6	3.5	162.3	467.9	2255
80x20	80	12.7	4	69.5	125	285	40	45	16	4	8	4.1	232.1	510.7	1724
80x20	80	12.7	6	69.5	125	330	40	45	16	4	8	4.1	334.9	789.9	2642
80x40	80	12.7	4	69.5	125	420	40	45	16	4	8	4.1	230.8	513.0	1821
80x60	80	12.7	3	69.5	125	460	40	45	16	4	8	4.1	175.4	372.6	1310
100x10	100	6.35	6	95	125	210	40	28	14	4	6	4.1	126.3	441.9	2249
100x10	100	7.5	6	92.8	128	210	40	28	14	4	6	4.1	177.6	589.1	2543
100x20	100	12.7	4	89.5	150	280	50	45	16	4	10	4.7	256.9	641.5	2065
100x20	100	12.7	6	89.5	150	360	50	45	16	4	10	4.7	370.6	993.3	3142
100x40	100	12.7	4	89.5	150	430	50	45	16	4	10	4.7	255.9	644.7	2138
120x10	120	7.5	6	112.8	150	215	40	28	14	4	8	4.1	190.7	707.8	2778
120x20	120	12.7	4	109.5	170	290	50	55	16	4	10	4.7	277.6	779.0	2356
120x20	120	12.7	6	109.5	170	370	50	55	16	4	10	4.7	400.5	1196.4	3494
120x40	120	12.7	4	109.5	170	450	50	55	16	4	10	4.7	276.9	775.9	2477
160x20	160	12.7	4	149.5	210	300	50	55	16	4	10	4.7	311.9	1040.0	2794
160x20	160	12.7	6	149.5	210	380	50	55	16	4	10	4.7	449.9	1609.2	4208
160x40	160	12.7	4	149.5	210	460	50	55	16	4	10	4.7	311.4	1044.6	3023

► Nut dimension table for driven nuts

Dimensions	Max. lead	D _w	i	n	D1 g6	D2	D3 g6	D4 d2	D5	D6	D7	D8 +/-0,2	DN	L	L1	L2	L3	L4	Lx	M	W	S	Dynamic axial load rating C _{dyn} [kN]	Static axial load rating C _{stat} [kN]	Static axial rigidity R _{ax} with a preload of 5% of C _{dyn} [N/mm]
16x5	16	3.175	5	3000	57	80	30	50	38	10	5.5	68	45	95.5	10	41	28	12.5	0.5	6xM5/10	6x60°	M6	18.7	28.2	366
20x5	20	3.175	5	3000	60	80	35	55	43	10	5.5	68	52	108.5	10	56	28	12	0.5	6xM5/10	6x60°	M6	20.9	35.3	441
20x10	20	3.175	5	3000	60	80	35	55	43	10	5.5	68	52	118.5	10	66	28	12	0.5	6xM5/10	6x60°	M6	20.8	35.4	448
25x5	25	3.6	6	3000	70	95	43	65	52	11	6.6	82	58	119	15	50	36	13	0.5	6xM6/13	6x60°	M6	30.6	56.8	599
25x6	25	4.5	5	3000	70	95	43	65	52	11	6.6	82	58	119	15	50	35	13	0.5	6xM6/13	6x60°	M6	36.4	60.7	530
32x5	10	3.5	6	3000	75	110	49	75	60	15	9	93	65	131.5	15	67.5	35	13	0.5	6xM6/13	6x60°	M6	33.8	71.7	725
32x6	20	4.5	5	3000	75	110	49	75	60	15	9	93	65	131.5	15	67.5	35	13	0.5	6xM6/13	6x60°	M6	40.5	75.8	627
32x10	32	6.35	4	3000	85	120	55	78	63	15	9	100	70	139.5	15	68	40	17	0.5	6xM6/13	6x60°	M6	51.8	83.0	533
40x5	40	3.5	6	3000	90	125	54	85	68	15	9	105	75	136.5	15	61	40	16.5	0.5	6xM8/15	6x60°	M8x1	37.2	91.5	843
40x10	40	6.35	6	3000	95	130	62	90	73	15	9	110	80	155.5	15	79	40	16	0.5	6xM8/15	8x45°	M8x1	84.3	164.7	962
40x20	40	9.52	4	3000	105	140	73	105	86	15	9	122	85	187	15	103	45	20.5	0.5	8xM8/15	8x45°	M8x1	108.3	179.4	751
40x40	40	9.52	2	3000	105	140	73	105	86	15	9	122	85	190.5	15	106.5	45	20.5	0.5	8xM8/15	8x45°	M8x1	55.2	81.3	343
50x5	10	3.5	6	3000	105	140	65	100	82	15	9	122	92	163.5	15	78	47	17.5	0.5	6xM8/16	6x60°	M8x1	40.9	116.0	998
50x10	50	7.5	5	3000	120	155	72	110	90	15	9	136	105	171	15	92	47	17.5	0.5	6xM8/16	8x45°	M8x1	110.0	225.7	1065
50x20	50	9.52	3	3000	120	155	83	115	95	15	9	136	105	192.5	15	112	47	17.5	0.5	6xM8/16	8x45°	M8x1	94.8	165.1	657
63x10	60	6.35	5	3000	120	170	85	115	96	18	11	145	105	183.5	15	102	45	20	0.5	8xM8/15.5	8x45°	M8x1	87.6	217.4	1119
63x20	60	9.52	5	2450	140	190	95	135	110	20	13.5	165	110	204.5	15	112	55	27.5	0.5	8xM8/15.5	8x45°	M8x1	169.2	366.6	1364
80x20	60	12.7	6	2000	190	270	125	170	144	26	17.5	230	155	252	20	138	70	35	0.5	8xM10/20.5	12x30°	M8x1	334.9	789.9	2103
100x20	100	12.7	6	1600	220	300	135	200	166	33	22	260	195	282	30	158	70	28.5	0.5	8xM12/23	8x45°	M8x1	370.6	993.3	2504
100x40	100	12.7	6	1600	220	300	135	200	166	33	22	260	195	400	30	276	70	28.5	0.5	8xM12/23	8x45°	M8x1	369.2	994.4	2585
120x20	100	12.7	6	1500	250	330	170	225	190	33	22	290	220	280	30	156	70	28	0.5	8xM16/23	12x30°	M8x1	400.5	1196.4	2810



► Nut dimension table for **Herkules heavy-duty range**

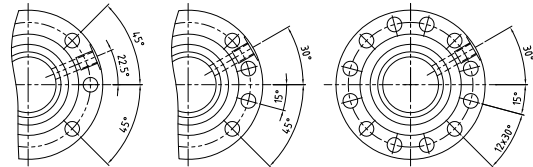


Dimensions	Spindle-Ø hé	D _w		i	D _g G6			Drilling diagram	Number of mounting holes	D ₂	D ₃	D ₇	L ₁	L ₂	L ₇	L ₈	L ₉	L ₁₀	L ₁₁	L ₁₂	Lubrica- tion con- nection	Dynamic axial load rating C ₀₄ [kN]	Static axial load rating C ₀₄ [kN]
		Ball-Ø	Number of turns		Core-Ø Spindle	Centring- Ø	Pitch circle-Ø																
80x20	80	15	6	68.6	135	155	2	8	13.5	175	0	25	310	40	140	157.5	10	20	0	M8x1	419	941	
80x20	80	15	8	68.6	135	155	2	8	13.5	175	0	25	350	40	140	157.5	10	20	0	M8x1	542	1270	
80x20	80	15	10	68.6	135	155	2	8	13.5	175	0	25	350	40	140	157.5	10	20	0	M8x1	660	1609	
80x40P20	80	15	6	68.6	135	155	2	8	13.5	175	0	25	350	40	140	157.5	10	20	0	M8x1	667	942	
100x20	100	15	6	88.6	160	186	2	8	17.5	212	0	40	232	40	165	188.5	10	20	0	M8x1	466	1184	
100x20	100	15	8	88.6	160	186	2	8	17.5	212	0	40	302	40	165	188.5	10	20	0	M8x1	603	1604	
100x20	100	15	10	88.6	160	186	2	8	17.5	212	0	40	342	40	165	188.5	10	20	0	M8x1	734	2014	
100x25	100	20	6	85	180	206	2	8	17.5	232	0	40	290	60	185	208.5	10	20	0	M8x1	682	1565	
100x25	100	20	8	85	180	206	2	8	17.5	232	0	40	375	60	185	208.5	10	20	0	M8x1	881	2115	
100x25	100	20	10	85	180	206	2	8	17.5	232	0	40	435	60	185	208.5	10	20	0	M8x1	1073	2681	
100x50P25	100	20	5	85	180	206	2	8	17.5	232	0	40	390	60	185	208.5	10	20	0	M8x1	921	1288	
120x20	120	15	6	108.6	200	233	2	8	22	265	155	40	286	65	205	235	10	25	16	M8x1	506	1427	
120x20	120	15	8	108.6	200	233	2	8	22	265	155	40	366	65	205	235	10	25	16	M8x1	653	1928	
120x20	120	15	10	108.6	200	233	2	8	22	265	155	40	406	65	205	235	10	25	16	M8x1	795	2429	
120x25	120	20	6	105	200	233	2	8	22	265	180	40	405	80	205	235	10	25	30	M8x1	746	1889	
120x25	120	20	8	105	200	233	2	8	22	265	180	40	470	80	205	235	10	25	30	M8x1	964	2564	
120x25	120	20	10	105	200	233	2	8	22	265	180	40	520	80	205	235	10	25	30	M8x1	1174	3222	
120x50P25	120	20	5	105	200	233	2	8	22	265	180	40	505	80	205	235	10	25	30	M8x1	1009	1559	
160x20	160	15	6	148.6	260	300	2	8	22	340	200	40	315	75	265	302.5	10	27.5	15	M8x1	570	1902	
160x20	160	15	8	148.6	260	300	2	8	22	340	200	40	365	75	265	302.5	10	27.5	15	M8x1	736	2575	
160x20	160	15	10	148.6	260	300	2	8	22	340	200	40	405	75	265	302.5	10	27.5	15	M8x1	896	3248	
160x25	160	20	6	145	260	300	2	8	22	340	210	40	425	95	265	302.5	10	27.5	15	M8x1	849	2537	
160x25	160	20	8	145	260	300	2	8	22	340	210	40	480	95	265	302.5	10	27.5	15	M8x1	1097	3428	
160x25	160	20	10	145	260	300	2	8	22	340	210	40	530	95	265	302.5	10	27.5	15	M8x1	1336	4319	
160x50P25	160	20	5	145	260	300	2	8	22	340	210	40	525	95	265	302.5	10	27.5	15	M8x1	1151	2084	

Drilling diagram 1

Drilling diagram 2

Drilling diagram 3

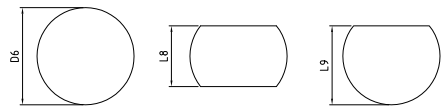


Flange shapes

Shape A

Shape B

Shape C



► Ground miniature ball screw drives

Spindle type	Dimensions	Figure	D _e			M-thread	d ₁		L ₁	L ₂	L ₃	L ₄	L ₅	WAF	WAF length
			Ball-Ø	Collar-Ø	Fit-Ø		Fit-Ø	Fit-Ø							
SP-3-1	3x1	A	0.8	9.5	6g6	M6x0.5	4.5h6	-	6	30	7.5	-	14.5	-	-
SP-4-0.5	4x0.5	A	0.5	9.5	6g6	M6x0.5	4.5h6	-	6	30	7.5	-	14.5	-	-
SP-4-1	4x1	A	0.8	9.5	6g6	M6x0.5	4.5h6	-	6	30	7.5	-	14.5	8	3
SP-6-1	6x1	A	0.8	9.5	6g6	M6x0.5	5g6	5g6	6	37	10	5	19	8	3
SP-6-2	6x2	A	0.8	9.5	6g6	M6x0.5	5g6	5g6	6	37	10	5	19	8	3
SP-8-1	8x1	B	0.8	-	6g6	M6x0.5	5g6	6g6	8	37	10	9	19	6	4
SP-8-2	8x2	B	1.6	-	6g6	M6x0.5	5g6	6g6	8	37	10	9	19	6	4
SP-8-2.5	8x2.5	B	1.6	-	6g6	M6x0.5	5g6	6g6	8	37	10	9	19	6	4
SP-8-3	8x3	B	1.6	-	6g6	M6x0.5	5g6	6g6	8	37	10	9	19	6	4
SP-8-4	8x4	B	1.6	-	6g6	M6x0.5	5g6	6g6	8	37	10	9	19	6	4
SP-8-5	8x5	B	1.6	-	6g6	M6x0.5	5g6	6g6	8	37	10	9	19	6	4
SP-10-2	10x2	B	1.6	-	8g6	M8x1	6g6	6g6	8	37	10	10	19	8	4
SP-10-2.5	10x2.5	B	1.6	-	8g6	M8x1	6g6	6g6	8	37	10	10	19	8	4
SP-10-4	10x4	B	2	-	8g6	M8x1	6g6	6g6	8	37	10	10	19	8	4
SP-12-1	12x1	B	0.8	-	10g6	M10x1	8h6	8g6	10	45	15	10	25	10	5
SP-12-2	12x2	B	1.6	-	10g6	M10x1	8h6	8g6	10	45	15	10	25	10	5
SP-12-2.5	12x2.5	B	1.6	-	10g6	M10x1	8h6	8g6	10	45	15	10	25	10	5
SP-12-3	12x3	B	1.6	-	10g6	M10x1	8h6	8g6	10	45	15	10	25	10	5
SP-12-4	12x4	B	2	-	10g6	M10x1	8h6	8g6	10	45	15	10	25	10	5
SP-12-5	12x5	B	2	-	10g6	M10x1	8h6	8g6	10	45	15	10	25	10	5
SP-12-10	12x10	B	2	-	10g6	M10x1	8h6	8g6	10	45	15	10	25	10	5
SP-16-2	16x2	B	1.6	-	12g6	M12x1	10h6	10g6	10	45	15	22	25	12	5
SP-16-2.5	16x2.5	B	1.6	-	12g6	M12x1	10h6	10g6	10	45	15	22	25	12	5
SP-16-4	16x4	B	2.5	-	12g6	M12x1	10h6	10g6	10	45	15	22	25	12	5

Please specify:
 - Spindle type
 - Nut type
 - Total screw length
 - Tolerance grades IT1-7
 - Nut in play-free design or with 0.01 mm play

Example:
 SP-4-1/EZM-B/150/IT5/Play-free

Figure A

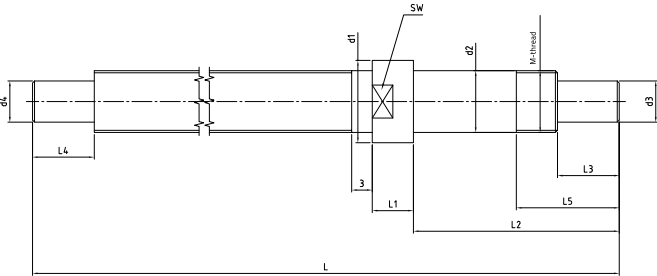
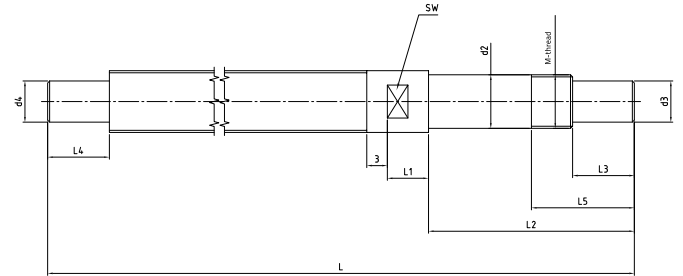
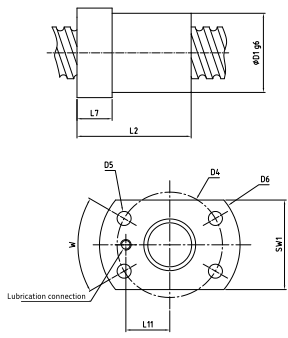


Figure B



▶ Miniature single flange nuts

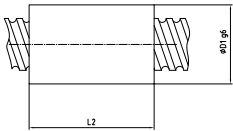


Nut type	Dimen- sions	D _w Ball-Ø	i Number of turns	D ₁ g6 Centring- Ø	L ₁ Nut length	L ₂ Flange width	D ₂ Flange- Ø	SW1	SW2	D ₃ n ₁ pitch circle-Ø	W Drilling pattern angle f1	Number of mount- ing holes	D ₄ Hole-Ø	Wiper	Lubrica- tion con- nection	L ₁₁ Lubrica- tion con- nection distance	D ₅ Sink diameter	L ₁₂ Depth of sink	C ₉₀ [N]	C ₁₀₀ [N]	max. speed [rpm]
EFM-A	3x1	0.8	2	8	15	5	22	14	-	15	60	4	3.2	no	-	-	-	-	230	260	4200
EFM-B	3x1	0.8	2	10	15	5	22	14	-	15	60	4	3.2	no	-	-	-	-	230	260	4200
EFM-A	4x0.5	0.5	2	8	15	5	22	14	-	15	60	4	3.2	no	-	-	-	-	125	140	4000
EFM-B	4x0.5	0.5	2	10	12	3	20	14	-	15	60	4	3.2	no	-	-	-	-	125	140	4000
EFM-A	4x1	0.8	2	10	12	3	20	14	-	15	60	4	3.3	no	-	-	-	-	320	400	4500
EFM-B	4x1	0.8	3	10	14	3	20	14	-	15	60	4	3.3	no	-	-	-	-	480	560	4500
EFM-A	6x1	0.8	3	12	15	3.5	24	16	-	18	60	4	3.4	no	-	-	-	-	730	850	4500
EFM-B	6x1	0.8	4	12	16	3.5	24	16	-	18	60	4	3.4	no	-	-	-	-	940	1130	4500
EFM-A	6x2	0.8	2	12	18	4	24	16	-	18	60	4	3.4	no	-	-	-	-	510	560	4500
EFM-B	6x2	0.8	3	12	18	4	24	16	-	18	60	4	3.4	no	-	-	-	-	730	840	4500
EFM-A	8x1	0.8	3	14	16	4	27	18	-	21	60	4	3.4	no	-	-	-	-	850	1150	3200
EFM-B	8x1	0.8	3	16	23	6	28	19	-	21	60	4	3.4	no	-	-	-	-	850	1150	3200
EFM-A	8x2	1.6	2	14	16	4	27	18	-	21	60	4	3.4	no	-	-	-	-	1450	1550	4500
EFM-B	8x2	1.6	3	16	26	5	29	20	-	23	60	4	3.4	yes	-	-	-	-	2050	2320	4500
EFM-A	8x2.5	1.6	3	16	26	4	29	20	-	23	60	4	3.4	yes	-	-	-	-	2050	2320	4500
EFM-B	8x2.5	1.6	3	16	30	6	28	19	-	22	60	4	3.4	yes	-	-	-	-	2050	2320	4500
EFM-A	8x3	1.6	3	16	26	4	29	20	-	23	60	4	3.4	yes	-	-	-	-	2050	2330	4500
EFM-B	8x3	1.6	3	16	28	6	28	19	-	22	60	4	3.4	yes	-	-	-	-	2050	2330	4500
EFM-A	8x4	1.6	3	16	31	4	29	20	-	23	60	4	3.4	yes	-	-	-	-	2000	2300	4500
EFM-B	8x4	1.6	3	16	33	6	28	19	-	22	60	4	3.4	yes	-	-	-	-	2000	2300	4500
EFM-A	8x5	1.6	3	16	32	6	29	20	-	23	60	4	3.4	yes	-	-	-	-	2000	2230	4000
EFM-B	8x5	1.6	3	16	32	6	29	20	-	23	60	4	3.4	yes	-	-	-	-	2000	2230	4000
EFM-A	8x5	1.6	3	16	32	6	29	20	-	23	60	4	3.4	yes	-	-	-	-	2000	2230	4000
EFM-B	8x5	1.6	3	16	32	6	29	20	-	23	60	4	3.4	yes	-	-	-	-	2000	2230	4000
EFM-A	10x2	1.6	3	18	28	5	35	22	-	27	60	4	4.5	yes	-	-	-	-	2400	2950	4000
EFM-B	10x2	1.6	3	18	28	5	37	24	-	29	60	4	4.5	yes	-	-	-	-	2400	2950	4000
EFM-A	10x2.5	1.6	3	18	28	5	35	22	-	27	60	4	4.5	yes	-	-	-	-	2400	3000	4000
EFM-B	10x2.5	1.6	3	20	28	5	37	24	-	29	60	4	4.5	yes	-	-	-	-	2400	3000	4000
EFM-A	10x4	2	3	22	36	8	37	24	-	29	60	4	4.5	yes	-	-	-	-	2800	3200	4500
EFM-B	10x4	2	3	26	34	10	46	28	42	36	60	4	4.5	yes	M6	14	8	4	2800	3200	4500
EFM-A	12x1	0.8	3	20	25	8	37	24	-	29	60	4	4.5	yes	-	-	-	-	1050	1800	1800
EFM-B	12x1	0.8	3	18	22	5	35	22	-	27	60	4	4.5	yes	-	-	-	-	1050	1800	1800
EFM-A	12x2	1.6	3	20	28	5	37	24	-	29	60	4	4.5	yes	-	-	-	-	2670	3650	3600
EFM-B	12x2	1.6	3	22	31	8	37	24	-	29	60	4	4.5	yes	-	-	-	-	2670	3650	3600
EFM-A	12x2.5	1.6	3	21	32	5	38	25	-	30	60	4	4.5	yes	-	-	-	-	2670	3650	3800
EFM-B	12x2.5	1.6	3	21	34	5	38	25	-	30	60	4	4.5	yes	-	-	-	-	2670	3650	3800
EFM-A	12x3	1.6	3	22	37	8	37	24	-	29	60	4	4.5	yes	-	-	-	-	2670	3650	4000
EFM-B	12x3	1.6	3	21	34	5	38	25	-	30	60	4	4.5	yes	-	-	-	-	2670	3650	4000
EFM-A	12x4	2	3	22	36	8	37	24	-	29	60	4	4.5	yes	-	-	-	-	3100	3800	4300
EFM-B	12x4	2	3	21	33	5	38	25	-	30	60	4	4.5	yes	-	-	-	-	3100	3800	4300
EFM-A	12x5	2	3	22	35	6	38	25	-	30	60	4	4.5	yes	-	-	-	-	3100	3900	4300
EFM-B	12x5	2	2	30	40	10	50	32	45	40	60	4	4.5	yes	M6	15	8	4	2400	2800	4300
EFM-A	12x10	2	2	30	50	10	50	32	45	40	60	4	4.5	yes	M6	15	8	4	2300	2900	4300
EFM-B	12x10	2	3	30	50	10	50	32	45	40	60	4	4.5	yes	M6	15	8	4	3300	4300	4300
EFM-A	16x2	1.6	4	25	40	10	44	29	-	35	60	4	5.5	yes	M6	16	-	-	4000	6500	3000
EFM-B	16x2	1.6	3	25	32	10	44	29	-	35	60	4	5.5	yes	M6	-	-	-	3100	4900	3000
EFM-A	16x2.5	1.6	4	25	44	10	44	29	-	35	60	4	5.5	yes	-	-	-	-	3800	6600	3500
EFM-B	16x2.5	1.6	3	25	40	10	44	29	-	35	60	4	5.5	yes	-	-	-	-	3100	4900	3500
EFM-A	16x4	2.5	4	28	42	10	48	29	-	35	60	4	5.5	yes	M6	16	-	-	8700	13100	4000
EFM-B	16x4	2.5	3	28	42	10	48	29	-	35	60	4	5.5	yes	M6	16	-	-	6800	9800	4000

Please specify:
 - Spindle type
 - Nut type
 - Total screw length
 - Tolerance grades IT1-7
 - Nut in play-free design or with 0.01 mm play

Example:
 SP-4-1/EZM-B/150/IT5/Play-free

▶ Miniature single nuts



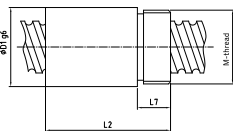
Nut type	Dimensions	D ₂		i	D ₂ g6	L ₂	Wiper	C _{dyn} [N]	C _{stat} [N]	max. speed [rpm]
		Ball-Ø	Number of turns							
EM-A	3x1	0.8	2	7	7.5	no	230	260	4200	
EM-B	3x1	0.8	2	9	7.5	no	230	260	4200	
EM-A	4x0.5	0.5	2	7	7	no	125	140	4000	
EM-B	4x0.5	0.5	3	7	9	no	150	170	4000	
EM-A	4x1	0.8	2	10	10	no	320	400	4500	
EM-B	4x1	0.8	3	10	12	no	480	560	4500	
EM-A	6x1	0.8	3	12	11	no	730	850	4500	
EM-B	6x1	0.8	4	12	15	no	940	1130	4500	
EM-A	6x2	0.8	2	12	13	no	510	560	4500	
EM-B	6x2	0.8	3	12	16	no	730	840	4500	
EM-A	8x1	0.8	3	14	12	no	850	1150	3200	
EM-B	8x1	0.8	3	15	14	no	850	1150	3200	
EM-A	8x2	1.6	2	14	13	no	1450	1550	4500	
EM-B	8x2	1.6	3	14	18	no	2050	2320	4500	
EM-A	8x2.5	1.6	3	16	25	yes	2050	2320	4500	
EM-B	8x2.5	1.6	3	15	21	no	2050	2320	4500	
EM-A	8x3	1.6	3	16	25	yes	2050	2330	4500	
EM-B	8x3	1.6	3	15	21	no	2050	2330	4500	
EM-A	8x4	1.6	3	16	28	yes	2000	2300	4500	
EM-B	8x4	1.6	3	15	22	no	2000	2300	4500	
EM-A	8x5	1.6	3	16	28.5	yes	2000	2320	4000	
EM-B	8x5	1.6	3	15	22.5	no	2000	2230	4000	
EM-A	10x2	1.6	3	18	23	yes	2400	2950	4000	

Nut type	Dimensions	D ₂		i	D ₂ g6	L ₂	Wiper	C _{dyn} [N]	C _{stat} [N]	max. speed [rpm]
		Ball-Ø	Number of turns							
EM-B	10x2	1.6	3	20	23	yes	2400	2950	4000	
EM-A	10x2.5	1.6	3	18	24	yes	2400	3000	4000	
EM-B	10x2.5	1.6	3	20	24	yes	2400	3000	4000	
EM-A	10x4	2	3	20	26	yes	2800	3200	4500	
EM-B	10x4	2	3	26	34	yes	2800	3200	4500	
EM-A	12x1	0.8	3	18	14	no	1050	1800	1800	
EM-B	12x1	0.8	3	20	17	yes	1050	1800	1800	
EM-A	12x2	1.6	3	20	17	no	2670	3650	3600	
EM-B	12x2	1.6	3	22	23	yes	2670	3650	3600	
EM-A	12x2.5	1.6	3	20	28	yes	2670	3650	3800	
EM-B	12x2.5	1.6	3	22	28	yes	2670	3650	3800	
EM-A	12x3	1.6	3	20	23	yes	2670	3650	4000	
EM-B	12x3	1.6	3	22	23	yes	2670	3650	4000	
EM-A	12x4	2	3	20	30	yes	3100	3800	4300	
EM-B	12x4	2	3	22	30	yes	3100	3800	4300	
EM-A	12x5	2	3	24	32	yes	3100	3900	4300	
EM-B	12x5	2	3	20	24	no	3100	3900	4300	
EM-A	12x10	2	2	28	35	yes	2300	2900	4300	
EM-B	12x10	2	3	28	45	yes	3300	4300	4300	
EM-A	16x2	1.6	4	25	30	yes	4000	6500	3000	
EM-B	16x2	1.6	3	25	30	yes	3100	4900	3000	
EM-A	16x2.5	1.6	4	25	30	yes	3800	6600	3500	
EM-B	16x2.5	1.6	3	25	30	yes	3100	4900	3500	

Please specify:
 - Spindle type
 - Nut type
 - Total screw length
 - Tolerance grades IT1-7
 - Nut in play-free design or with 0.01 mm play

Example:
 SP-4-1/EZM-B/150/IT5/Play-free

▶ Miniature screwed inserts



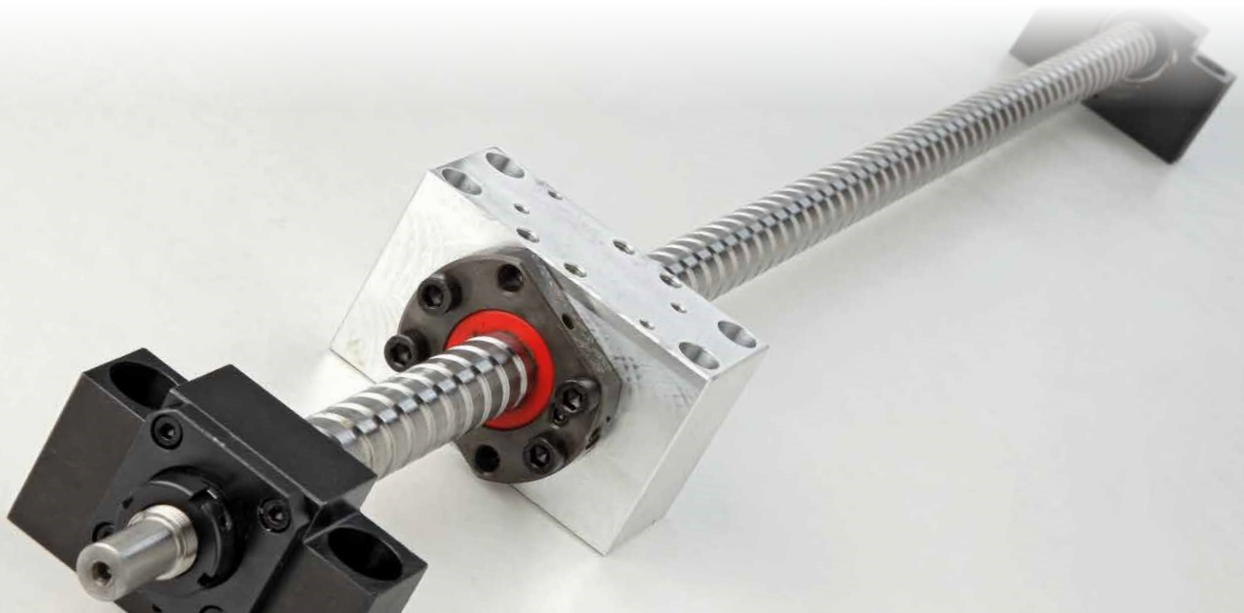
Nut type	Dimensions	D ₂		i	D ₂ g6	L ₂	L ₁	M-thread	Wiper	C _{dyn} [N]	C _{stat} [N]	max. speed [rpm]
		Ball-Ø	Number of turns									
EZM-A	3x1	0.8	2	8.5	15	5	6x0.5	no	230	260	4200	
EZM-B	3x1	0.8	2	10	15	5	6x0.5	no	230	260	4200	
EZM-A	4x0.5	0.5	2	8.5	15	5	6x0.5	no	125	140	4000	
EZM-B	4x0.5	0.5	3	8.5	15	5	6x0.5	no	150	170	4000	
EZM-A	4x1	0.8	2	12	15	5	8x0.75	no	320	400	4500	
EZM-B	4x1	0.8	3	12	17	5	8x0.75	no	480	560	4500	
EZM-A	6x1	0.8	3	12.5	17	6	10x1	no	730	850	4500	
EZM-B	6x1	0.8	4	12.5	21	6	10x1	no	940	1130	4500	
EZM-A	6x2	0.8	2	12.5	20	6	10x1	no	510	560	4500	
EZM-B	6x2	0.8	3	12.5	20	6	10x1	no	730	840	4500	
EZM-A	8x1	0.8	3	16.5	22	8	14x1	no	850	1150	3200	
EZM-B	8x1	0.8	3	17.5	22	8	14x1	no	850	1150	3200	
EZM-A	8x2	1.6	3	16.5	27	8	14x1	no	2050	2320	4500	
EZM-B	8x2	1.6	3	17.5	27	8	14x1	no	2050	2320	4500	
EZM-A	8x2.5	1.6	3	16.5	29	8	14x1	no	2050	2320	4500	
EZM-B	8x2.5	1.6	3	17.5	29	8	14x1	no	2050	2320	4500	
EZM-A	8x3	1.6	2	16	22	8	14x1	no	1470	1550	4500	
EZM-B	8x3	1.6	3	17.5	27	8	14x1	no	2050	2330	4500	
EZM-A	8x4	1.6	3	16.5	30	8	14x1	no	2000	2300	4500	
EZM-B	8x4	1.6	3	17.5	30	8	14x1	no	2000	2300	4500	
EZM-A	8x5	1.6	3	16.5	30	8	14x1	no	2000	2320	4000	
EZM-B	8x5	1.6	3	17.5	30	8	14x1	no	2000	2230	4000	
EZM-A	10x2	1.6	3	18	28.5	7	16x1	yes	2400	2950	4000	

Nut type	Dimensions	D ₂		i	D ₂ g6	L ₂	L ₁	M-thread	Wiper	C _{dyn} [N]	C _{stat} [N]	max. speed [rpm]
		Ball-Ø	Number of turns									
EZM-B	10x2	1.6	3	20.5	28.5	7	18x1	yes	2400	2950	4000	
EZM-A	10x2.5	1.6	3	18	28.5	7	16x1	yes	2400	3000	4000	
EZM-B	10x2.5	1.6	3	20.5	28.5	7	18x1	yes	2400	3000	4000	
EZM-A	10x4	2	3	22.5	36	10	20x1	no	2800	3200	4500	
EZM-B	10x4	2	3	26	36	10	20x1	yes	2800	3200	4500	
EZM-A	12x1	0.8	3	20.5	24	10	18x1	no	1050	1800	1800	
EZM-B	12x1	0.8	3	22.5	27	10	20x1	yes	1050	1800	1800	
EZM-A	12x2	1.6	3	20.5	29	10	18x1	yes	2670	3650	3600	
EZM-B	12x2	1.6	3	22.5	29	10	20x1	yes	2670	3650	3600	
EZM-A	12x2.5	1.6	3	22.5	36	10	20x1	no	2670	3650	3800	
EZM-B	12x2.5	1.6	3	22.5	36	10	20x1	yes	2670	3650	3800	
EZM-A	12x3	1.6	3	20.5	36	10	18x1	no	2670	3650	4000	
EZM-B	12x3	1.6	3	22.5	36	10	20x1	yes	2670	3650	4000	
EZM-A	12x4	2	3	22.5	33	10	18x1	no	3100	3800	4300	
EZM-B	12x4	2	3	25	36	10	20x1	yes	3100	3800	4300	
EZM-A	12x5	2	3	22.5	36	10	18x1	no	3100	3900	4300	
EZM-B	12x5	2	3	25	39	10	20x1	yes	3100	3900	4300	
EZM-A	16x2	1.6	3	25.5	29	10	22x1	no	3100	4900	3000	
EZM-B	16x2	1.6	3	25.5	32	10	24x1.5	yes	3100	4900	3000	
EZM-A	16x3	1.6	3	25.5	44	14	22x1	no	3100	4900	3500	
EZM-B	16x3	1.6	3	25.5	44	14	24x1.5	yes	3100	4900	3500	
EZM-A	16x4	2.5	3	28.5	38	10	22x1	no	6800	9800	4000	
EZM-B	16x4	2.5	3	28.5	38	10	26x1.5	no	6800	9800	4000	

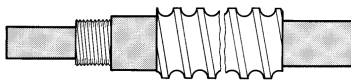
Please specify:
 - Spindle type
 - Nut type
 - Total screw length
 - Tolerance grades IT1-7
 - Nut in play-free design or with 0.01 mm play

Example:
 SP-4-1/EZM-B/150/IT5/Play-free

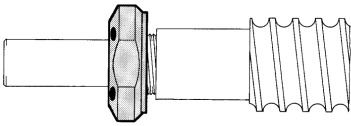
ACCESSORIES



▶ Spindle ends



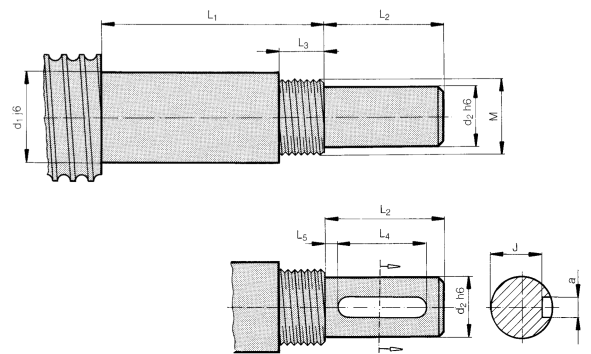
▶ KMT nuts



▶ Spiral spring covers



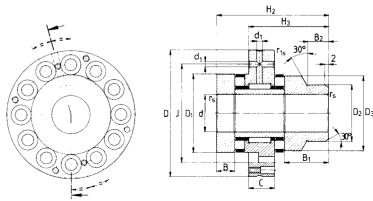
▶ Standard spindle ends



KGT	d ₁ j6	d ₂ h6	L ₁	L ₂	L ₃	L ₄	L ₅	M	J	a ₅₀	Bearing ZARF/LTN	Lock nut
25 x 5	15	12	70	25	18	16	3	M 15x1	9,5	4	1560 LTN	KMT 2 M 15x1
32 x 5	20	15	79	30	20	22	4	M 20x1	12,0	5	2068 LTN	KMT 4 M 20x1
32 x 10	20	15	94	30	20	22	4	M 20x1	12,0	5	2080 LTN	KMT 4 M 20x1
40 x 5	25	20	86	40	22	28	5	M 25x1,5	16,5	6	2575 LTN	KMT 5 M 25x1,5
40 x 10	25	20	86	40	22	28	5	M 25x1,5	16,5	6	2590 LTN	KMT 5 M 25x1,5
50 x 10	35	25	105	60	24	40	8	M 35x1,5	20,8	8	35110 LTN	KMT 7 M 35x1,5
63 x 10	40	30	115	80	24	63	8	M 40x1,5	25,0	10	40115 LTN	KMT 8 M 40x1,5
80 x 10	55	40	128	110	27	90	8	M 55x2	34,5	14	55145 LTN	KMT 11 M 55x2

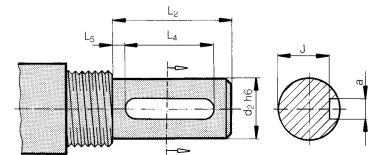
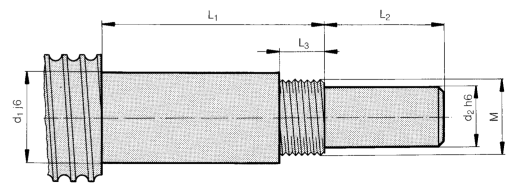
► Needle axial cylinder roller bearings

Range ZARF ... L
Light duty range



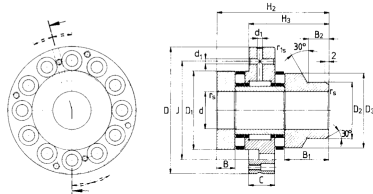
Shaft diameter	Code	Weight kg	Dimensions													Flange screws DIN 913/103 A2-70				Ratings				Limiting speed		Axial rigidity k_a N/mm		
			d	D	H	H ₁	H ₂	H ₃	C	D ₁	D ₂	D ₃	B	B ₁	B ₂	r _s min.	r _{1s} min.	d ₁	J	axial dyn. C ₁₀ N	stat. C ₁₀ N	radial dyn. C ₁₀ N	stat. C ₁₀ N	n _{oil} rpm	n _{grease} rpm			
15	ZARF 1560 LTN	0,45	15	60	-	-	53	39	14	35	24	34	7,5	20,5	11	0,3	0,6	3,2	46	M6	6	24.900	53.000	13.000	17.500	8.500	2.200	1.400
20	ZARF 2068 LTN	0,61	20	68	-	-	60	43	14	42	30	40	10	24	11	0,3	0,6	3,2	53	M6	8	33.500	76.000	14.900	22.400	7.000	2.300	1.800
25	ZARF 2575 LTN	0,84	25	75	-	-	65	48	18	47	36	45	10	25	11	0,3	0,6	3,2	58	M6	8	35.500	86.000	22.600	36.000	6.000	1.900	1.900

► Standard spindle ends



► Needle axial cylinder roller bearings

Range ZARF ... L
Heavy duty range

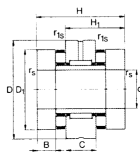


Shaft diameter	Code	Weight kg	Dimensions													Flange screws DIN 913/103 A2-70				Ratings				Limiting speed		Axial rigidity k_a N/mm		
			d	D	H	H ₁	H ₂	H ₃	C	D ₁	D ₂	D ₃	B	B ₁	B ₂	r _s min.	r _{1s} min.	d ₁	J	axial dyn. C ₁₀ N	stat. C ₁₀ N	radial dyn. C ₁₀ N	stat. C ₁₀ N	n _{oil} rpm	n _{grease} rpm			
20	ZARF 2080 LTN	1,22	20	80	-	-	75	53	18	52	40	50	12,5	27,5	11	0,3	0,6	3,2	63	M8	12	64.000	141.000	22.600	36.000	6.000	1.500	2.300
25	ZARF 2590 LTN	1,75	25	90	-	-	75	53	18	62	48	60	12,5	27,5	11	0,3	0,6	3,2	73	M8	12	80.000	199.000	24.300	41.500	4.900	1.400	3.000
35	ZARF 35110 LTN	1,85	35	110	-	-	82	57	18	73	60	73	14	30	12	0,3	0,6	3,2	88	M8	12	110.000	285.000	27.500	53.000	4.000	1.250	3.500
40	ZARF 40115 LTN	3	40	115	-	-	93	65,5	22,5	78	60	78	16	34	12	0,3	0,6	6	94	M8	12	117.000	315.000	38.000	74.000	3.700	1.200	3.800
55	ZARF 55145 LTN	5	55	145	-	-	103	72	22,5	100	80	98	17,5	38,5	14	0,3	0,6	6	118	M10	12	177.000	500.000	44.000	98.000	2.900	1.000	4.900

KGT	d ₁ j6	d ₂ h6	L ₁	L ₂	L ₃	L ₄	L ₅	M	J	a _{sp}	Bearing ZARF/TN	Lock nut
25 x 5	15	12	57	25	18	16	3	M 15x1	9,5	4	1545 TN	KMT 2 M 15x1
32 x 5	20	15	65	30	20	22	4	M 20x1	12,0	5	2052 TN	KMT 4 M 20x1
32 x 10	20	15	79	30	20	22	4	M 20x1	12,0	5	2062 TN	KMT 4 M 20x1
40 x 5	25	20	71	40	22	28	5	M 25x1,5	16,5	6	2557 TN	KMT 5 M 25x1,5
40 x 10	25	20	81	40	22	28	5	M 25x1,5	16,5	6	2572 TN	KMT 5 M 25x1,5
50 x 10	35	25	89	60	24	40	8	M 35x1,5	20,8	8	3585 TN	KMT 7 M 35x1,5
63 x 10	40	30	98	80	24	63	8	M 40x1,5	25,0	10	4090 TN	KMT 8 M 40x1,5
80 x 10	55	40	108	110	27	90	8	M 55x2	34,5	14	55115 TN	KMT 11 M 55x2

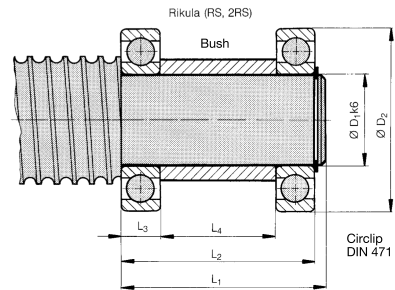
► Needle axial cylinder roller bearings

Range ZARN
Light duty range



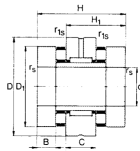
Shaft diameter	Code	Weight kg	Dimensions													Ranges				Limiting speed		Axial rigidity C_a N/mm		
			d	D	H	H ₁	H ₂	C	D ₁	D ₂	B	B ₁	B ₂	r ₁ min.	r _{1s} min.	axial dyn. C N	stat. C ₀ N	radial dyn. C N	stat. C ₀ N	n ₁ of rpm	n _{1, grease} rpm			
15	ZARN 1545 TN	0,34	15	45	40	28	-	-	16	35	-	-	7,5	-	-	0,3	0,6	24.900	53.000	13.000	17.500	8.500	2.200	1.400
20	ZARN 2052 TN	0,41	20	52	48	31	-	-	16	42	-	-	10	-	-	0,3	0,6	33.500	76.000	14.900	22.400	7.000	2.000	1.800
25	ZARN 2557 TN	0,53	25	57	50	35	-	-	20	47	-	-	10	-	-	0,3	0,6	35.500	86.000	22.600	36.000	6.000	1.900	1.900

► Standard spindle ends



► Needle axial cylinder roller bearings

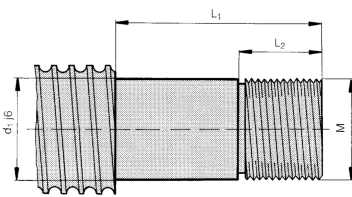
Range ZARN
Heavy duty range



Shaft diameter	Code	Weight kg	Dimensions													Ranges				Limiting speed		Axial rigidity C_a N/mm		
			d	D	H	H ₁	H ₂	C	D ₁	D ₂	B	B ₁	B ₂	r ₁ min.	r _{1s} min.	axial dyn. C N	stat. C ₀ N	radial dyn. C N	stat. C ₀ N	n ₁ of rpm	n _{1, grease} rpm			
20	ZARN 2062 TN	0,87	20	62	60	40	-	-	20	52	-	-	12,5	-	-	0,3	0,6	64.000	141.000	22.600	36.000	6.000	1.500	2.300
25	ZARN 2572 TN	1,17	25	72	60	40	-	-	20	62	-	-	12,5	-	-	0,3	0,6	80.000	199.000	24.300	41.500	4.900	1.400	3.000
35	ZARN 3585 TN	1,65	35	85	66	43	-	-	20	73	-	-	14	-	-	0,3	0,6	110.000	285.000	27.500	53.000	4.000	1.250	3.500
40	ZARN 4090 TN	2,09	40	90	75	50	-	-	25	76	-	-	16	-	-	0,3	0,6	117.000	315.000	38.000	74.000	3.700	1.200	3.800
55	ZARN 55115 TN	3,5	55	115	82	53,5	-	-	25	100	-	-	17,5	-	-	0,3	0,6	177.000	500.000	44.000	98.000	2.900	1.000	4.900

KGT	D ₁ k6	D ₂	L ₁	L ₂	L ₃	L ₄	Rikula 2RS Size	Bush $\phi \times \phi \times L_s$	Circlip DIN 471
8 x 2-5	6	19	28	24	6	12	626	9 x 6,1 x 12	6 x 0,7
10 x 2-8	8	22	32	28	7	14	608	11 x 8,1 x 14	8 x 0,8
12 x 2-8	10	26	36	32	8	16	6000	13 x 10,1 x 16	10 x 1,0
16 x 5	12	28	45	40	8	24	6001	18 x 12,1 x 24	12 x 1,0
20 x 5 20 x 20	15	32	51	46	9	28	6002	21 x 15,1 x 28	15 x 1,0
25 x 5	20	42	58	53	12	29	6004	27 x 20,1 x 29	20 x 1,2
32 x 5 32 x 10 32 x 40	25	52	58	53	15	23	6205	32 x 25,1 x 23	25 x 1,2
40 x 5 40 x 10	30	62	68	60	16	28	6206	40 x 30,1 x 28	30 x 1,5
50 x 10	40	80	88	80	18	44	6208	50 x 40,1 x 44	40 x 1,75
63 x 10	55	100	110	102	21	60	6211	65 x 55,1 x 60	55 x 2,0
80 x 10	70	125	130	122	24	74	6214	80 x 70,1 x 74	70 x 2,5

► Standard spindle ends



D x P	d ₁ h6	L ₁	L ₂	M	Bearing ZKLN/RS	KMT Shaft nuts
8 x 2-5	6	24	10	M 6 x 0,5	0624 2RS	INA ZM 06
10 x 2-8	6	24	10	M 6 x 0,5	0624 2RS	INA ZM 06
12 x 2-5	8	29	10	M 8 x 0,75	0832 2RS	INA ZM 08
16 x 5	12	40	16	M12 x 1,0	1242 2RS	SKF KMT 1
20 x 5	15	42	18	M15 x 1,0	1545 2RS	SKF KMT 2
25 x 5	17	44	20	M17 x 1,0	1747 2RS	SKF KMT 3
32 x 5	25	49	22	M25 x 1,5	2557 2RS	SKF KMT 5
40 x 5	30	49	22	M30 x 1,5	3062 2RS	SKF KMT 6
50 x 5	40	57	24	M40 x 1,5	4075 2RS	SKF KMT 8
32 x 10	25	49	22	M25 x 1,5	2557 2RS	SKF KMT 5
40 x 10	30	49	22	M30 x 1,5	3080 2RS	SKF KMT 6
50 x 10	40	56	24	M40 x 1,5	4075 2RS	SKF KMT 8
63 x 10	50	60	28	M50 x 1,5	5090 2RS	SKF KMT 10

► Axial angular-contact ball bearings

Double-sided action
Range ZKLN ... 2RS

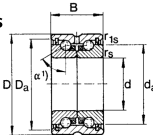
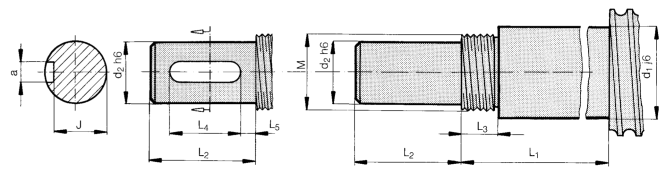


Table of dimensions. Dimensions in mm

Shaft diameter	Code	Weight kg	Dimensions										Connection dimensions		Rating		Limiting speed v _{lim} [rpm]	Axial rigidity c _a [N/mm]	
			d	D	B	r _s	r _{1s}	J	d ₁	b	l	D _a	d _a	d _{yn} C ₁₀ N	stat C ₀ M				
6	ZKLN 0624 2RS	–	6	24	15	0,3	0,6	–	–	–	–	19	9	–	–	5.600	4.800	6.800	200
8	ZKLN 0832 2RS	0,09	8	32	20	0,3	0,6	–	–	–	–	26	12	–	–	10.100	9.200	5.100	250
10	ZKLN 1034 2RS	0,10	10	34	20	0,3	0,6	–	–	–	–	28	14	–	–	10.800	10.600	4.600	325
12	ZKLN 1242 2RS	0,20	12	42	25	0,3	0,6	–	–	–	–	33	16	–	–	13.600	13.900	3.800	375
15	ZKLN 1545 2RS	0,21	15	45	25	0,3	0,6	–	–	–	–	35	20	–	–	14.400	15.800	3.500	400
17	ZKLN 1747 2RS	0,22	17	47	25	0,3	0,6	–	–	–	–	37	23	–	–	15.100	17.600	3.300	450
20	ZKLN 2052 2RS	0,31	20	52	28	0,3	0,6	–	–	–	–	43	25	–	–	20.800	26.500	3.000	650
25	ZKLN 2557 2RS	0,34	25	57	28	0,3	0,6	–	–	–	–	48	32	–	–	22.100	31.000	2.600	750
30	ZKLN 3062 2RS	0,39	30	62	28	0,3	0,6	–	–	–	–	53	40	–	–	23.400	36.000	2.200	850
40	ZKLN 4075 2RS	0,61	40	75	34	0,3	0,6	–	–	–	–	67	50	–	–	34.500	57.000	1.800	1.000
50	ZKLN 5090 2RS	0,88	50	90	34	0,3	0,6	–	–	–	–	81	63	–	–	37.500	71.000	1.500	1.250

► Standard spindle ends



KGT	d ₁ h6	d ₂ h6	L ₁	L ₂	L ₃	L ₄	L ₅	M	J	ap _g	Bearing ZKLF/2RS	Lock nut
16x5-10	12	10	40	20	16	16	1	M12 x 1	8,2	3	1255	KMT 1 M12 x 1
20x5-20	15	12	42	23	18	16	3	M15 x 1	9,5	4	1560	KMT 2 M15 x 1
25x5-10	20	15	47	30	20	22	3	M20 x 1	12,0	5	2068	KMT 4 M20 x 1
32x5-10	25	20	49	40	22	28	4	M25 x 1,5	16,5	6	2575	KMT 5 M25 x 1,5
40x5	30	25	49	50	22	36	6	M30 x 1,5	21,0	8	3080	KMT 6 M30 x 1,5
50x5	40	30	57	55	24	40	7	M40 x 1,5	26,0	8	40100	KMT 8 M40 x 1,5
ZKLN/2RS												
8 x 2-5	6	5	24	10	10	–	–	M 6 x 0,5	–	–	0624	INA ZM06
10 x 2-8	6	5	24	10	10	–	–	M 6 x 0,5	–	–	0624	INA ZM06
12 x 2-5	8	6	29	12	10	–	–	M 8 x 0,75	–	–	0832	INA ZM08

► Axial angular-contact ball bearings

Double-sided action
Range ZKLN ... 2RS

Double-sided action, screw fixing
Range ZKLF ... 2RS

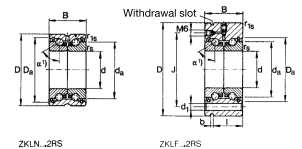
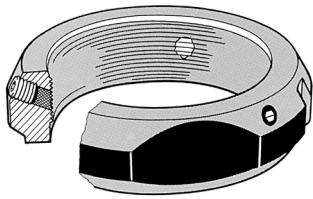


Table of dimensions. Dimensions in mm

Shaft diameter	Code	Weight kg	Dimensions										Connection dimensions		Rating		Limiting speed v _{lim} [rpm]	Axial rigidity c _a [N/mm]	
			d	D	B	r _s	r _{1s}	J	d ₁	b	l	D _a	d _a	d _{yn} C ₁₀ N	stat C ₀ M				
6	ZKLN 0624 2RS	–	6	24	15	0,3	0,6	–	–	–	–	19	9	–	–	5.600	4.800	6.800	200
8	ZKLN 0832 2RS	0,09	8	32	20	0,3	0,6	–	–	–	–	26	12	–	–	10.100	9.200	5.100	250
12	ZKLF 1252 2RS	0,37	12	55	25	0,3	0,6	42	6,5	3	17	33	16	M6	3	13.600	13.900	3.800	375
15	ZKLF 1560 2RS	0,43	15	60	25	0,3	0,6	46	6,5	3	17	35	20	M6	3	14.400	15.800	3.500	400
20	ZKLF 2068 2RS	0,61	20	68	28	0,3	0,6	53	6,5	3	19	43	25	M6	4	20.800	26.500	3.000	650
25	ZKLF 2575 2RS	0,72	25	75	28	0,3	0,6	58	6,5	3	19	48	32	M6	4	22.100	31.000	2.600	750
30	ZKLF 3080 2RS	0,78	30	80	28	0,3	0,6	63	6,5	3	19	53	40	M6	6	23.400	36.000	2.200	850
40	ZKLF 40100 2RS	1,46	40	100	34	0,3	0,6	80	8,5	3	25	67	50	M6	4	34.500	57.000	1.800	1.000

Wellenmutter KMT



Material: High-strength steel (similar to StE47)
 Surface treatment: phosphatised, oiled
 Locking pins: hard drawn brass
 Adjusting screws: P6SS (ISO 2343/DIN 913),
 hardness class 12.9 – 14.9
 Nut thread tolerance: 5 H (ISO 965/3)
 Tolerance 6G is recommended for the shaft thread

The KMT shaft nut secures without damaging the shaft

The KMT nut is secured with three brass locking pins distributed equally around the circumference and which are set into the nut at an angle. The slope angle of the pins is equal to the flank angle of the nut thread, which is also cut into the end surfaces of the locking pins in one continuous process.

The KMT shaft nut does not need a keyway

As a result, the shaft diameter can be made smaller. Costs for the manufacture of the keyway and the key can be avoided.

The KMT shaft nut locking system does not suffer from material fatigue

The locking pins are pressed against the shaft thread with the help of adjusting screws. Axial forces are absorbed by the flanks of the thread and not by the locking pins. Securing the nut against turning is based exclusively on the friction between the pins and the screw thread. As the locking pins do not become distorted, KMT shaft nuts can be used as often as required with the same high accuracy.

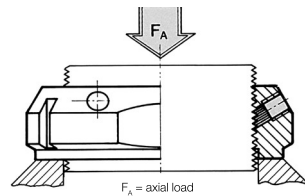
The KMT shaft nut locking system is reliable

Even when the generously sized adjusting screws are only gently tightened, a high locking force is achieved. The force applied by the adjusting screws is used exclusively for locking the nut, i.e.

- load is not taken off the flanks of the nut thread
- the nut is not distorted.

The KMT shaft nut is adjustable

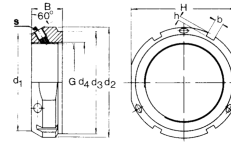
When securing the KMT nut, the three locking pins arranged equally around the circumference enable an exact right-angled adjustment to be made. Variations or inaccuracies of other components sitting on the shaft can be compensated for by means of the KMT nut.



Shaft nut KMT/KMTA Code	Permissible axial load F_A KMT/KMTA	Tightening torque for adjusting screws, max. KMT	Breakaway torque ¹⁾ KMT/KMTA
—	N	Nm	Nm
0	35.000	4,5	15
1	40.000	4,5	18
2	60.000	4,5	20
3	80.000	8	25
4	90.000	8	35
5	130.000	8	45
6	160.000	8	55
7	190.000	8	65
8	210.000	8	80
9	240.000	8	95
10	300.000	8	115
11	340.000	18	225
12	380.000	18	245
13	460.000	18	265
14	490.000	18	285
15	520.000	18	305
16	620.000	18	325
17	650.000	35	660
18	680.000	35	720
19	710.000	35	780
20	740.000	35	840
22	800.000	35	960
24	860.000	35	1080

¹⁾ Applies for adjusting screws tightened to max. tightening torque.

Shaft nuts KMT – Data



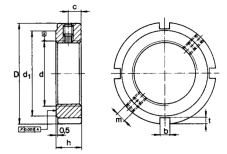
KMT nuts are to be used where simple fitting and reliable locking with high accuracy are required. They can be tightened and released using simple tools such as open-ended spanners, adjustable spanners, hooked spanners or impact spanners.

Shaft nut thread	Code	Dimensions									Weight	Suitable hook spanner Code
		d ₁	d ₂	d ₃	d ₄	B	H	b	h	S		
mm	—	mm	mm	mm	mm	mm	mm	mm	mm	mm	kg	—
M 10 x 0,75	KMT 0	21	28	23	11	14	24	4	2	M 5	0,045	HN 2/ 3
M 12 x 1	KMT 1	23	30	25	13	14	27	4	2	M 5	0,050	HN 3
M 15 x 1	KMT 2	26	33	28	16	16	30	4	2	M 5	0,075	HN 4
M 17 x 1	KMT 3	29	37	33	18	18	34	5	2	M 6	0,10	HN 4
M 20 x 1	KMT 4	32	40	35	21	18	36	5	2	M 6	0,11	HN 5
M 25 x 1,5	KMT 5	36	44	39	26	20	41	5	2	M 6	0,13	HN 5
M 30 x 1,5	KMT 6	41	49	44	32	20	46	5	2	M 6	0,16	HN 6
M 35 x 1,5	KMT 7	46	54	49	38	22	50	5	2	M 6	0,19	HN 7
M 40 x 1,5	KMT 8	56	65	59	42	22	60	6	2,5	M 6	0,30	HN 8/ 9
M 45 x 1,5	KMT 9	61	70	64	48	22	65	6	2,5	M 6	0,33	HN 9/10
M 50 x 1,5	KMT 10	65	75	68	52	25	70	7	3	M 6	0,40	HN10/11
M 55 x 2	KMT 11	74	85	78	58	25	80	7	3	M 8	0,54	HN12/13
M 60 x 2	KMT 12	78	90	82	62	26	85	8	3,5	M 8	0,61	HN13
M 65 x 2	KMT 13	83	95	87	68	28	90	8	3,5	M 8	0,71	HN14
M 70 x 2	KMT 14	88	100	92	72	28	95	8	3,5	M 8	0,75	HN15
M 75 x 2	KMT 15	93	105	97	77	28	100	8	3,5	M 8	0,80	HN15/16
M 80 x 2	KMT 16	98	110	100	83	32	—	8	3,5	M 8	0,90	HN16/17
M 85 x 2	KMT 17	107	120	110	88	32	—	10	4	M10	1,15	HN17/18
M 90 x 2	KMT 18	112	125	115	93	32	—	10	4	M10	1,20	HN18/19
M 95 x 2	KMT 19	117	130	120	98	32	—	10	4	M10	1,25	HN19/20
M100 x 2	KMT 20	122	135	125	103	32	—	10	4	M10	1,30	HN20
M110 x 2	KMT 22	132	145	134	112	32	—	10	4	M10	1,45	HN22
M120 x 2	KMT 24	142	155	144	122	32	—	10	4	M10	1,60	—

Slotted nuts

Table of dimensions. Dimensions in mm

Thread d	Code	Weight kg	Dimensions								Axial crushing load ¹⁾ F_{cr}	
			D	h	b	t	d ₁	d ₂	d ₃	c		m
M 6 x 0,5	ZM 06	0,01	16	8	3	2	12	—	—	4	M4	16.500
M 8 x 0,75	ZM 08	0,01	16	9	3	2	12	—	—	4	M4	23.200



Spiral spring covers

... protect shafts, spindles, columns and screws against contamination and damage and reduce the risk of accident in this area.

... can be used in all swarf-producing and swarfless machines, etc.

... are made of high-quality, hardened spring steel and have optimum characteristics due to their special method of manufacture.

... are designed in a spiral shape and are manufactured in any position. Simple centring flanges are all that are required for mounting the springs, as shown adjacent. The flanges must however accommodate the rotary movements of the spring that occur. The centring flanges are not included in the scope of supply.

... achieve very good sealing between the individual turns in any position. Simple centring flanges are all that are required for mounting the springs, as shown adjacent. The flanges must however accommodate the rotary movements of the spring that occur. The centring flanges are not included in the scope of supply.

When installing vertically, it is recommended that the large diameter is fitted at the top and when installing horizontally it is fitted towards the accumulation of swarf.

No maintenance is necessary. However, it is recommended that cleaning be carried out depending upon the degree of contamination and that a light film of oil be subsequently applied.

For functional reasons it is necessary when enquiring or ordering to state whether the HEMA spiral springs are to be fitted horizontally or vertically. When fitted horizontally, the dimension D_1 is increased by ca. 3–5 mm.

HEMA spiral springs help to maintain the precision of your machines and also increase their life.

Design: spring steel, blued, stainless on request.

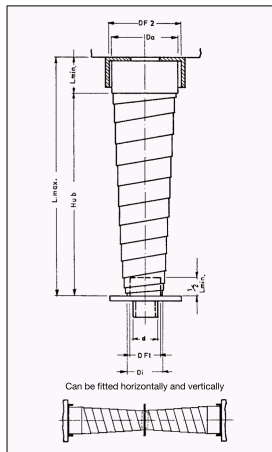
Explanation of drawing::

- d = max. diameter of the part to be covered
- D_1 = inside diameter of spring
- D_2 = outside diameter of spring
- L_{min} = minimum installation length
- L_{max} = maximum installation length

- DF_1 = outside diameter of the centring flange ($D_1 + 2$ mm)
- DF_2 = inside diameter of the centring flange ($D_2 + 4$ mm)
- Stroke = largest possible travel

All dimensions in mm

As ball screws are sensitive to dirt and swarf, they must fundamentally be protected by sealed covers such as bellows or telescopic springs.



Spiral spring cover	for KGT-Type
SF 20	KGT- 12
SF 25	KGT- 16
SF 30	KGT- 20 und KGT- 25
SF 40	KGT- 32/5
SF 50	KGT- 32/10
SF 55	KGT- 40/5+10
SF 65	KGT- 50/5+10
SF 75	KGT- 63/10+20
SF 90	KGT- 80/10+20
SF 110	KGT-100/10+20

All dimensions in mm

Type	$D_1 \pm 1$ mm	$D_2 \pm 2$ mm	L max.	L min.
SF 20/100/20	20	31	100	20
SF 20/150/20	20	34	150	20
SF 20/200/20	20	36	200	20
SF 20/250/20	20	40	250	20
SF 20/300/30	20	39	300	30
SF 20/350/30	20	42	350	30
SF 20/400/30	20	45	400	30
SF 25/100/20	25	35	100	20
SF 25/150/20	25	38	150	20
SF 25/200/20	25	40	200	20
SF 25/250/20	25	44	250	20
SF 25/300/30	25	43	300	30
SF 25/350/30	25	46	350	30
SF 25/400/30	25	49	400	30
SF 25/450/40	25	48	450	40
SF 25/500/40	25	51	500	40
SF 30/150/30	30	39	150	30
SF 30/200/30	30	44	200	30
SF 30/300/30	30	49	300	30
SF 30/450/40	30	53	450	40
SF 30/500/40	30	58	550	40
SF 30/650/50	30	55	650	50
SF 30/750/50	30	59	750	50
SF 40/150/30	40	51	150	30
SF 40/200/30	40	55	200	30
SF 40/300/30	40	60	300	30
SF 40/450/40	40	63	450	40
SF 40/550/40	40	68	550	40
SF 40/650/50	40	65	650	50
SF 40/750/50	40	69	750	50
SF 40/850/60	40	75	850	60
SF 40/950/60	40	82	950	60
SF 40/1000/75	40	86	1000	75
SF 40/1100/75	40	78	1100	75
SF 40/1300/75	40	84	1300	75
SF 40/1500/75	40	90	1500	75
SF 40/1000/100	40	86	1000	100
SF 40/1200/100	40	70	1200	100
SF 40/1500/100	40	78	1500	100
SF 40/1800/100	40	82	1800	100
SF 40/1800/120	40	82	1800	120
SF 40/2000/120	40	86	2000	120
SF 40/2200/120	40	91	2200	120
SF 50/150/30	50	63	150	30
SF 50/200/30	50	68	200	30
SF 50/250/30	50	62	250	30
SF 50/350/50	50	65	350	50
SF 50/450/50	50	70	450	50
SF 50/550/50	50	73	550	50
SF 50/650/60	50	68	650	60
SF 50/750/60	50	76	750	60
SF 50/750/75	50	78	750	75
SF 50/900/75	50	84	900	75
SF 50/1100/75	50	90	1100	75
SF 50/1100/100	50	75	1100	100
SF 50/1300/100	50	79	1300	100
SF 50/1500/100	50	86	1500	100
SF 50/1800/100	50	94	1800	100
SF 50/1700/120	50	91	1700	120

Type	$D_1 \pm 1$ mm	$D_2 \pm 2$ mm	L max.	L min.
SF 50/1700/120	50	91	1700	120
SF 50/1800/120	50	95	1800	120
SF 50/2100/120	50	100	2100	120
SF 50/2300/120	50	105	2300	120
SF 50/2500/120	50	111	2500	120
SF 50/2800/120	50	118	2800	120
SF 50/2800/150	50	118	2800	150
SF 50/3000/150	50	123	3000	150
SF 50/3000/180	50	123	3000	180
SF 50/3250/180	50	128	3250	180
SF 50/3250/200	50	128	3250	200
SF 50/3500/200	50	134	3500	200
SF 55/150/30	55	68	150	30
SF 55/250/30	55	73	250	30
SF 55/350/50	55	66	350	50
SF 55/350/50	55	71	350	50
SF 55/450/50	55	74	450	50
SF 55/550/50	55	77	550	50
SF 55/550/60	55	75	550	60
SF 55/650/60	55	79	650	60
SF 55/750/60	55	83	750	60
SF 55/750/75	55	83	750	75
SF 55/900/75	55	89	900	75
SF 55/1100/75	55	94	1100	75
SF 55/1100/100	55	83	1100	100
SF 55/1300/100	55	87	1300	100
SF 55/1500/100	55	94	1500	100
SF 55/1800/100	55	102	1800	100
SF 55/1700/120	55	96	1700	120
SF 55/1900/120	55	100	1900	120
SF 55/2100/120	55	105	2100	120
SF 55/2300/120	55	110	2300	120
SF 55/2500/120	55	116	2500	120
SF 55/2800/120	55	123	2800	120
SF 55/2800/150	55	121	2800	150
SF 55/3000/150	55	126	3000	150
SF 55/3000/180	55	126	3000	180
SF 55/3250/180	55	130	3250	180
SF 55/3250/200	55	130	3250	200
SF 55/3500/200	55	137	3500	200
SF 65/150/30	65	78	150	30
SF 65/250/30	65	85	250	30
SF 65/250/50	65	76	250	50
SF 65/350/50	65	83	350	50
SF 65/450/50	65	88	450	50
SF 65/550/60	65	88	550	60
SF 65/650/60	65	92	650	60
SF 65/750/60	65	95	750	60
SF 65/750/75	65	93	750	75
SF 65/900/75	65	99	900	75
SF 65/1100/75	65	107	1100	75
SF 65/1100/100	65	95	1100	100
SF 65/1300/100	65	99	1300	100
SF 65/1500/100	65	108	1500	100
SF 65/1600/100	65	117	1600	100
SF 65/1700/120	65	106	1700	120
SF 65/1900/120	65	109	1900	120
SF 65/2100/120	65	113	2100	120
SF 65/2300/120	65	118	2300	120
SF 65/2500/120	65	123	2500	120
SF 65/2800/120	65	128	2800	120
SF 65/2800/150	65	132	2800	150
SF 65/3000/150	65	142	3000	150
SF 65/3000/180	65	138	3000	180
SF 65/3250/180	65	145	3250	180
SF 65/3250/200	65	138	3250	200
SF 65/3500/200	65	148	3500	200
SF 75/150/30	75	92	150	30
SF 75/250/30	75	99	250	30

SF 75/250/50	75	89	250	50
SF 75/350/50	75	94	350	50
SF 75/450/50	75	101	450	50
SF 75/550/60	75	99	550	60
SF 75/650/60	75	103	650	60
SF 75/750/60	75	108	750	60
SF 75/850/75	75	99	850	75
SF 75/900/75	75	104	900	75
SF 75/1100/100	75	111	1100	100
SF 75/1100/100	75	108	1100	100
SF 75/1300/100	75	117	1300	100
SF 75/1500/100	75	120	1500	100
SF 75/1700/100	75	126	1700	100
SF 75/1500/120	75	115	1500	120
SF 75/1800/120	75	122	1800	120
SF 75/2000/120	75	127	2000	120
SF 75/2200/120	75	132	2200	120
SF 75/2000/150	75	135	2000	150
SF 75/2400/150	75	141	2400	150
SF 75/2800/150	75	145	2800	150
SF 75/2800/180	75	142	2800	180
SF 75/3000/180	75	148	3000	180
SF 75/3250/180	75	156	3250	180
SF 75/3250/200	75	148	3250	200
SF 75/3500/200	75	158	3500	200
SF 90/150/30	90	112	150	30
SF 90/250/50	90	116	250	50
SF 90/350/50	90	121	350	50
SF 90/450/60	90	112	450	60
SF 90/550/60	90	114	550	60
SF 90/650/75	90	119	650	75
SF 90/850/75	90	124	850	75
SF 90/900/100	90	115	900	100
SF 90/1000/100	90	120	1000	100
SF 90/1100/100	90	126	1100	100
SF 90/1300/100	90	132	1300	100
SF 90/1300/120	90	125	1300	120
SF 90/1500/120	90	131	1500	120
SF 90/1800/120	90	138	1800	120
SF 90/1800/150	90	144	1800	150
SF 90/2000/150	90	146	2000	150
SF 90/2300/150	90	154	2300	150
SF 90/2600/150	90	159	2600	150
SF 90/2600/180	90	152	2600	180
SF 90/2800/180	90	158	2800	180
SF 90/3000/180	90	164	3000	180
SF 90/3000/200	90	162	3000	200
SF 90/3250/200	90	166	3250	200
SF 90/3500/200	90	170	3500	200
SF 110/250/60	110	131	250	60
SF 110/350/60	110	135	350	60
SF 110/450/60	110	139	450	60
SF 110/550/75	110	130	550	75
SF 110/650/75	110	135	650	75
SF 110/800/75	110	140	800	75
SF 110/950/100	110	129	950	100
SF 110/750/100	110	133	750	100
SF 110/500/100	110	138	500	100
SF 110/1100/120	110	139	1100	120
SF 110/1300/120	110	145	1300	120
SF 110/1500/150	110	155	1500	150
SF 110/1800/150	110	159	1800	150
SF 110/2000/150	110	165	2000	150
SF 110/2000/180	110	159	2000	180
SF 110/2200/180	110	165	2200	180
SF 110/2400/180	110	170	2400	180
SF 110/2400/200	110	162	2400	200
SF 110/2600/200	110	166	2600	200