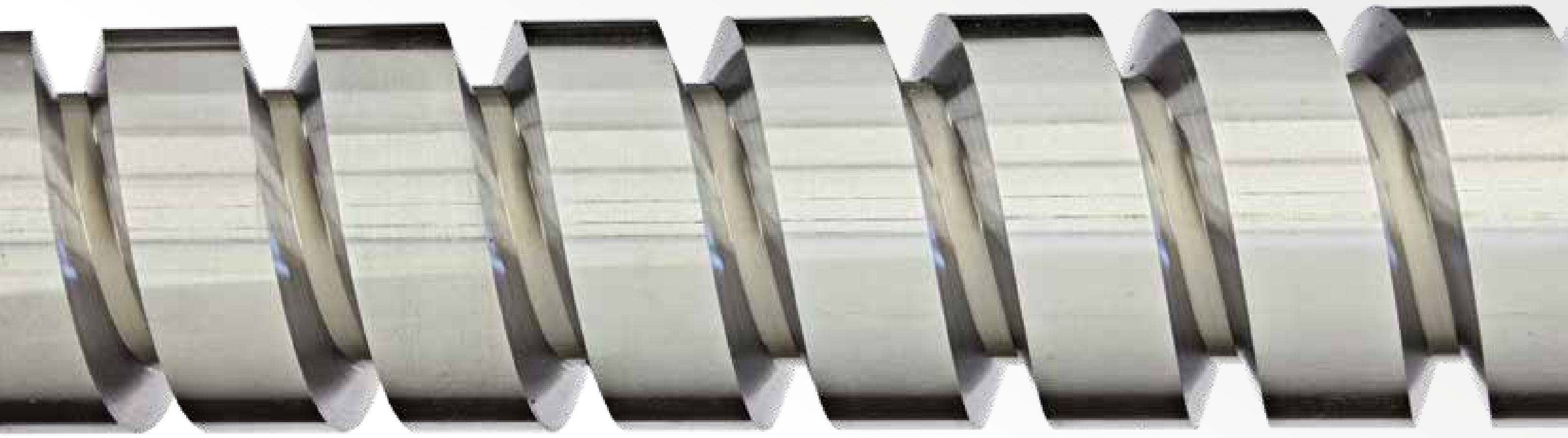
kammerer®
Kompetenz in Gewindetechnik



Ball screw drives
Trapezoidal screw drives

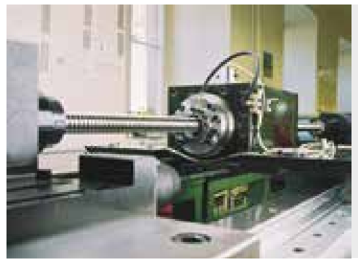
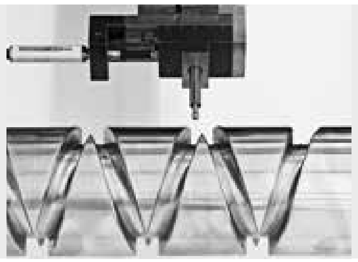
The perfect drive

If you are looking to convert rotational motion into linear motion – or vice-versa – then Kammerer Gewindetechnik GmbH is the perfect partner for you. As a long-standing company with over 75 years of experience and exceptional innovative strength, we offer efficient ball and sliding screw drives as well as custom threads. And all with tailor-made quality, developed and produced at our modern company headquarters in the Black Forest and in use around the world. Kammerer enjoys a successful position on the global market and works for a wide range of sectors, such as automotive engineering, medical technology, machine building, and the packaging industry. All these industries value our problem-solving expertise, which really comes into its own on unusual tasks. Our clever customised solutions provide customers in various countries and sectors with the perfect machine and system drive.

Consistent quality

Whirling, rolling, grinding and milling. Not many companies offer what Kammerer regards as standard: we master all common production methods. And no matter whether it is a batch size of one or large-scale production, each project starts with an expert, in-depth consultation with one of our specialists – after all, when it comes to ball screw drives, a little clarification is often required. Following a targeted analysis and consultation, we draw upon our wealth of expertise and our awareness of the challenges that tomorrow will bring to create customised solutions, developed with the user in mind.

These are produced at our modern Kammerer plant, where we master all the necessary production steps right down to heat and surface treatment. This means smooth processes and premium quality for you, our customers. And our extensive, precision measuring technology guarantees that every single product that leaves our factory is of the very best quality.

Contents










For every challenge

Customisation takes centre stage at Kammerer. Whether it is the design and development of a completely new system or the overhaul and enhancement of existing devices, we develop and produce tailor-made screws for specific challenges. Our product range, which we adapt to suit each customer's individual needs, contains:

1. Ball screw drives
2. Sliding screw drives
3. Sliding screws and nuts
4. Planetary roller screw drives
5. Worms and worm shafts
6. Coarse threads
7. Customer-specific assemblies and complete solutions






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 the 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

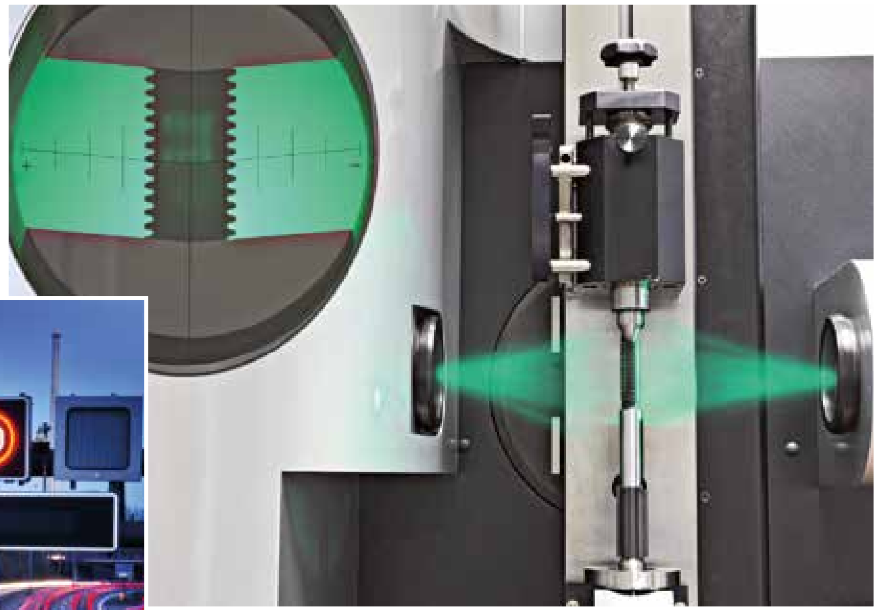
Reactor technology

Material handling systems

Medical engineering

Defence engineering

Measurement and testing technology



Traffic engineering

Radar and antenna technology

Linear technology

Automotive

Kammerer – a strong partner

QUALITY

kammerer

What is checked?

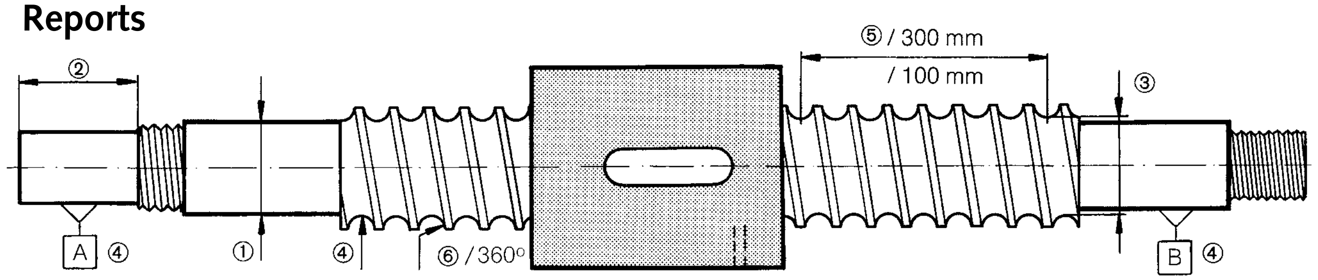
Measurement of the lead accuracy every 300 mm of the ball screw (to DIN 69051)
the individual pitch of each thread or, for example, every 100 mm
the wobble error
the radial runout error at the spindle ends
the length of the spindle
the flank diameter (accuracy and radial runout)

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



①

Spindelgewinde-Messung

Laengen/Durchmesser – Messung

Nr	Kommentar	uT	oT	Soll	Ist
1	D Durchmesser 20j6	-0.004	0.009	20.000	19.998
2	D Durchmesser 20h6	-0.013	0.000	20.000	19.993
3	D Durchmesser 30k6	0.002	0.015	30.000	30.005
4	D Durchmesser 32j6	-0.005	0.011	32.000	32.008

②

Spindelgewinde-Messung

Laengen/Durchmesser – Messung

Nr	Kommentar	uT	oT	Soll	Ist
1	L Laenge 30-0.3	-0.300	0.000	30.000	29.800
2	L Laenge 32.5-0.05	-0.050	0.000	32.500	32.480
3	L Laenge 128 -0.6	0.600	0.000	128.000	127.700
4	L Laenge 350 -0.8	-0.800	0.000	350.000	349.500

③

Spindelgewinde-Messung

Laengen/Durchmesser – Messung

Nr	Kommentar	uT	oT	Soll	Ist
1	D Flakendurchmesser	-0.010	0.020	34.175	34.185
2	D Flakendurchmesser	-0.010	0.020	34.175	34.180
3	D Flakendurchmesser	-0.010	0.020	34.175	34.192
4	D Flakendurchmesser	-0.010	0.020	34.175	34.170

④

Spindelgewinde-Messung

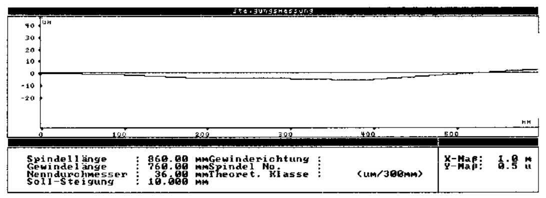
Laengen/Durchmesser – Messung

Nr	Kommentar	uT	oT	Soll	Ist
1	D Rundlauf A-B	0.020	0.000	0.020	0.015
2	D Rundlauf Gewinde	0.050	0.000	0.050	0.030

⑤

Spindelgewinde-Messungen

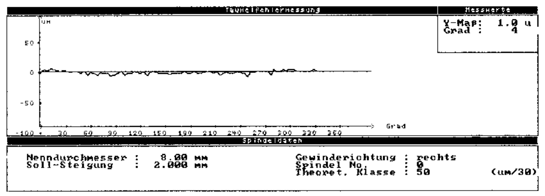
Steigungsmessung



Nr	Gang	Soll	Ist	Abw
1	0.0	0.000	0.001	0.001
2	10.0	100.000	99.999	-0.001
3	20.0	200.000	199.996	-0.004
4	30.0	300.000	299.996	-0.004
5	40.0	400.000	399.995	-0.005
6	50.0	500.000	499.999	-0.001
7	60.0	600.000	600.003	0.003

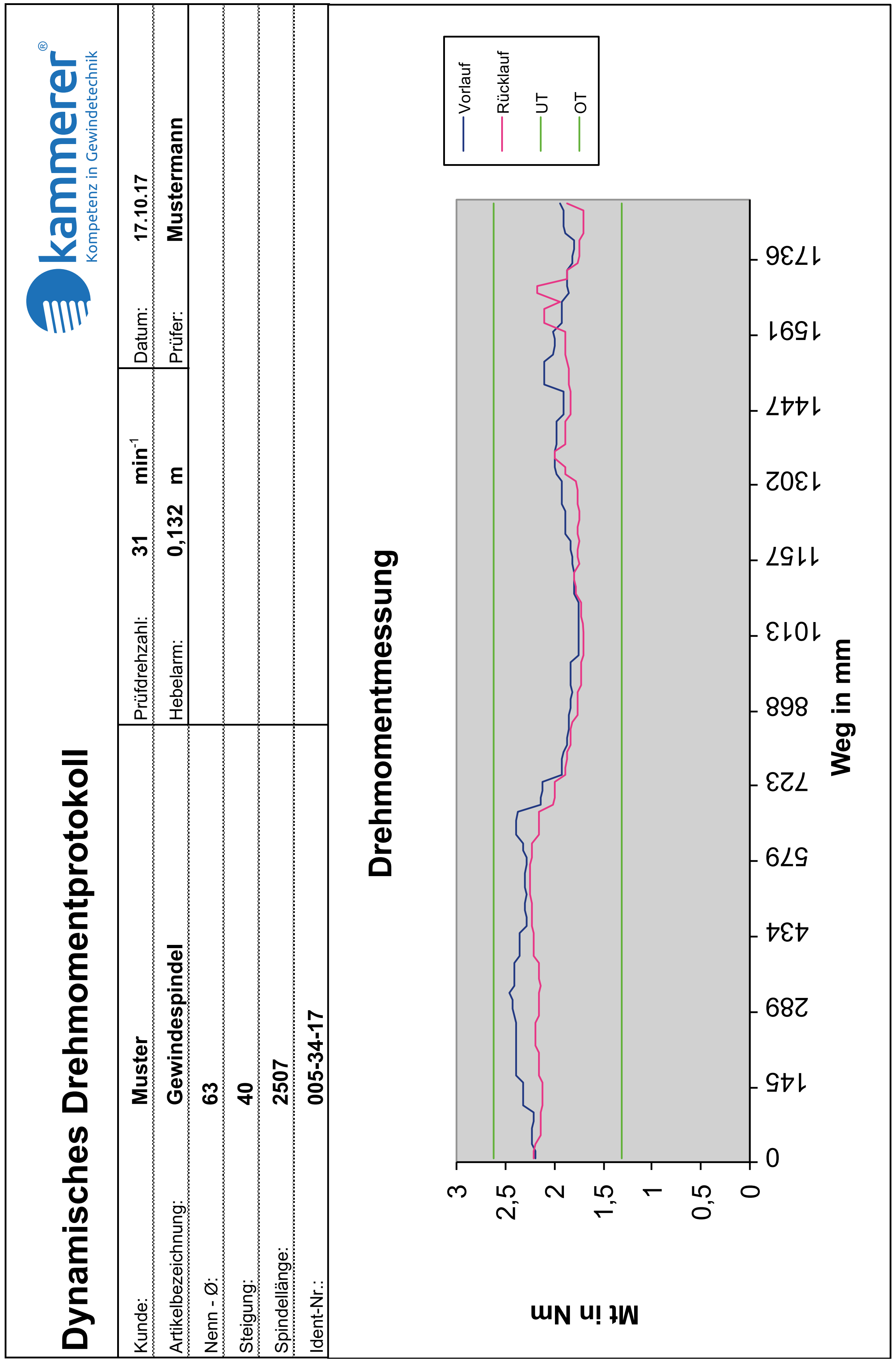
⑥

Taumelfehlermessung



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



Kammerer Gewindetechnik GmbH • In der Hausmatte 3 • 78132 Hornberg/Niederwasser • Tel.: 0 78 33 / 96 06 - 0 • Fax: 0 78 33 / 96 06 - 50 • E-Mail: info@kammerer-gewinde.com

Pitch measurement log (ball thread)

Steigungsprotokoll

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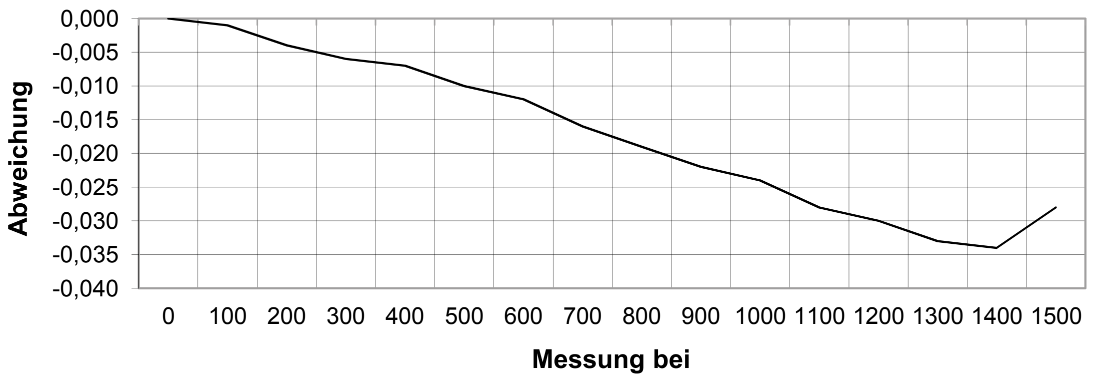
Kunde:	Kammerer	**Prüfer:**	H. Wolber
Artikelbezeichnung:	Kugelgewindespindel	**Messgerät:**	Trimos
Zeichnungsnummer:	1123456	**Abteilung:**	QS
Spindellänge:	1900	**Temperatur:**	20°
Gewindelänge:	1700	**Prüfdatum:**	12.07.2017
Nenndurchmesser:	40		
Sollsteigung:	10		
Spindelnummer:	**001**		
Gewinderichtung:	rechts		
Gangzahl	1		
Toleranzklasse:	0,01 / 300		

Steigungsprotokoll



Sollmaß	Istmaß	Abweichung
0,000	0,000	0,000
100,000	99,999	-0,001
200,000	199,996	-0,004
300,000	299,994	-0,006
400,000	399,993	-0,007
500,000	499,990	-0,010
600,000	599,988	-0,012
700,000	699,984	-0,016
800,000	799,981	-0,019
900,000	899,978	-0,022
1000,000	999,976	-0,024
1100,000	1099,972	-0,028
1200,000	1199,970	-0,030
1300,000	1299,967	-0,033
1400,000	1399,966	-0,034
1500,000	1499,972	-0,028

Sollmaß	Istmaß	Abweichung

Pitch measurement log (ball thread)

kammerer® Kompetenz in Gewindetechnik

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http://www.kammerer-gewinde.com
e-mail adresse: info@kammerer-gewinde.com

Firma: Kammerer

3++ Gewindespindelmessung
Messprotokoll Steigungsmessung (Kugelgewinde)

Bezeichnung: Kugelspindel	
Artikelnummer: 50x12	Spindelnummer: 1
Spindellänge: 2100	Gewinderichtung: rechts
Gewindelänge: 1900	Gangzahl: 1
Nenndurchmesser: 50	Theor. Klasse: 5
Sollsteigung: 12	
Kunde: Kammerer	Messkopf: 2
Messgerät: TESA Laser 3000	WS-Temperatur: 20
Abteilung: QS	Prüfdatum: 12.07.2017
Prüfer: Wolber	Prüfzeit: 09:50

Steigungen

Lfd. Nr.	Soll	Ist	Abweichung
1	0,000	0,000	0,000
2	120,000	120,000	-0,000
3	240,000	240,001	0,001
4	360,000	360,000	0,001
5	480,000	480,003	0,003
6	600,000	600,000	0,000
7	720,000	720,004	0,004
8	840,000	840,003	0,003
9	960,000	960,004	0,004
10	1080,000	1080,007	0,007
11	1200,000	1200,003	0,003
12	1320,000	1320,005	0,005
13	1440,000	1440,007	0,007
14	1560,000	1560,008	0,008
15	1680,000	1680,008	0,008
16	1800,000	1800,009	0,009

EMAS
REG.NR. DE-126-00072
Kammerer Gewindetechnik GmbH

DEKRA
REG.NR. 31196712
Kammerer Gewindetechnik GmbH

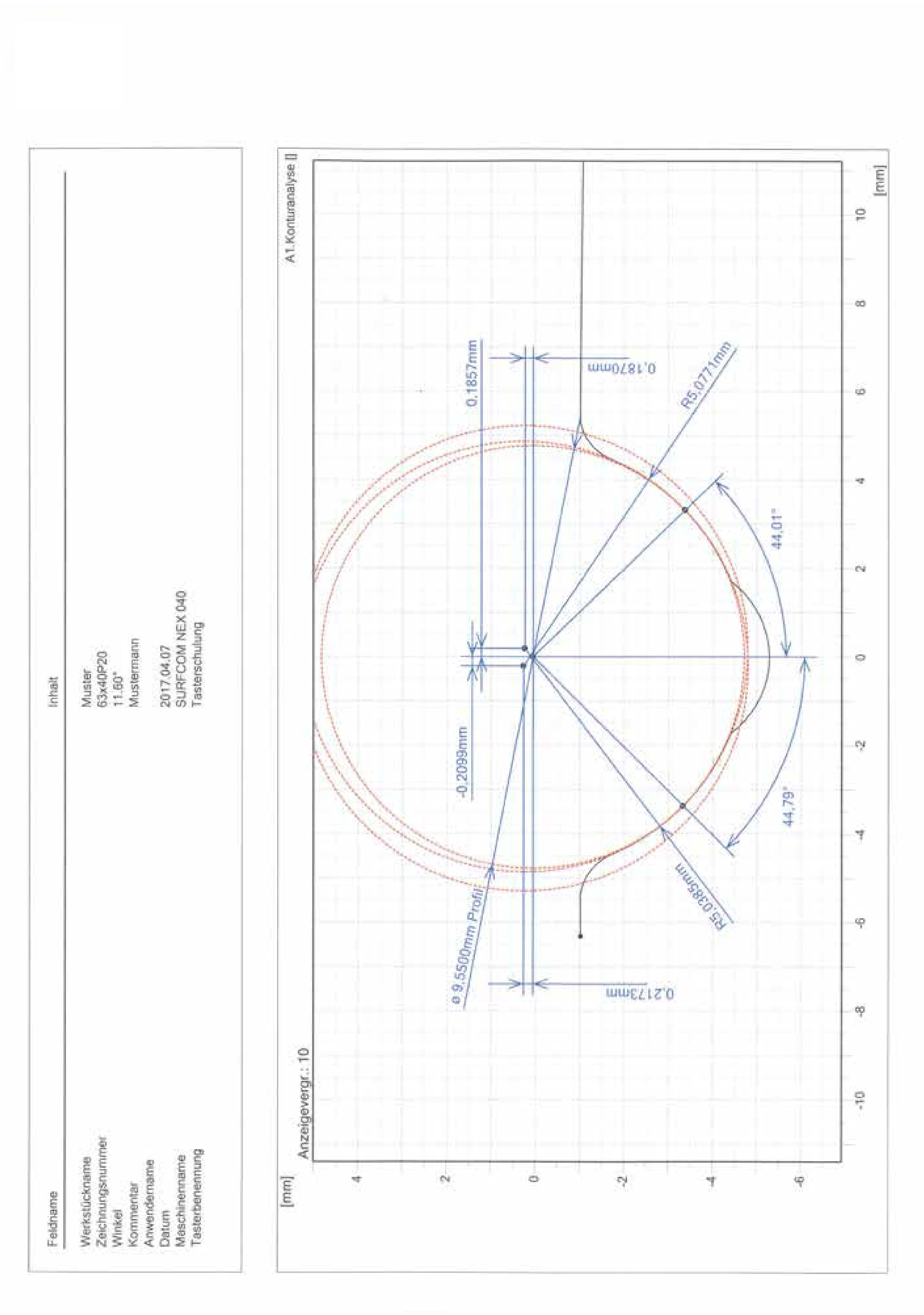
Geschäftsführer:
Achim Kammerer, Peter Kammerer
Handelsregister Freiburg: HRB 680587
Amtsgericht: Freiburg i. Br.

Sparkasse Schwarzwald-Baar
Konto Nr. 200 595 9 (BLZ 694 500 65)
BIC: SOLA DE S1 VSS
IBAN: DE44 6945 0065 0002 0059 59

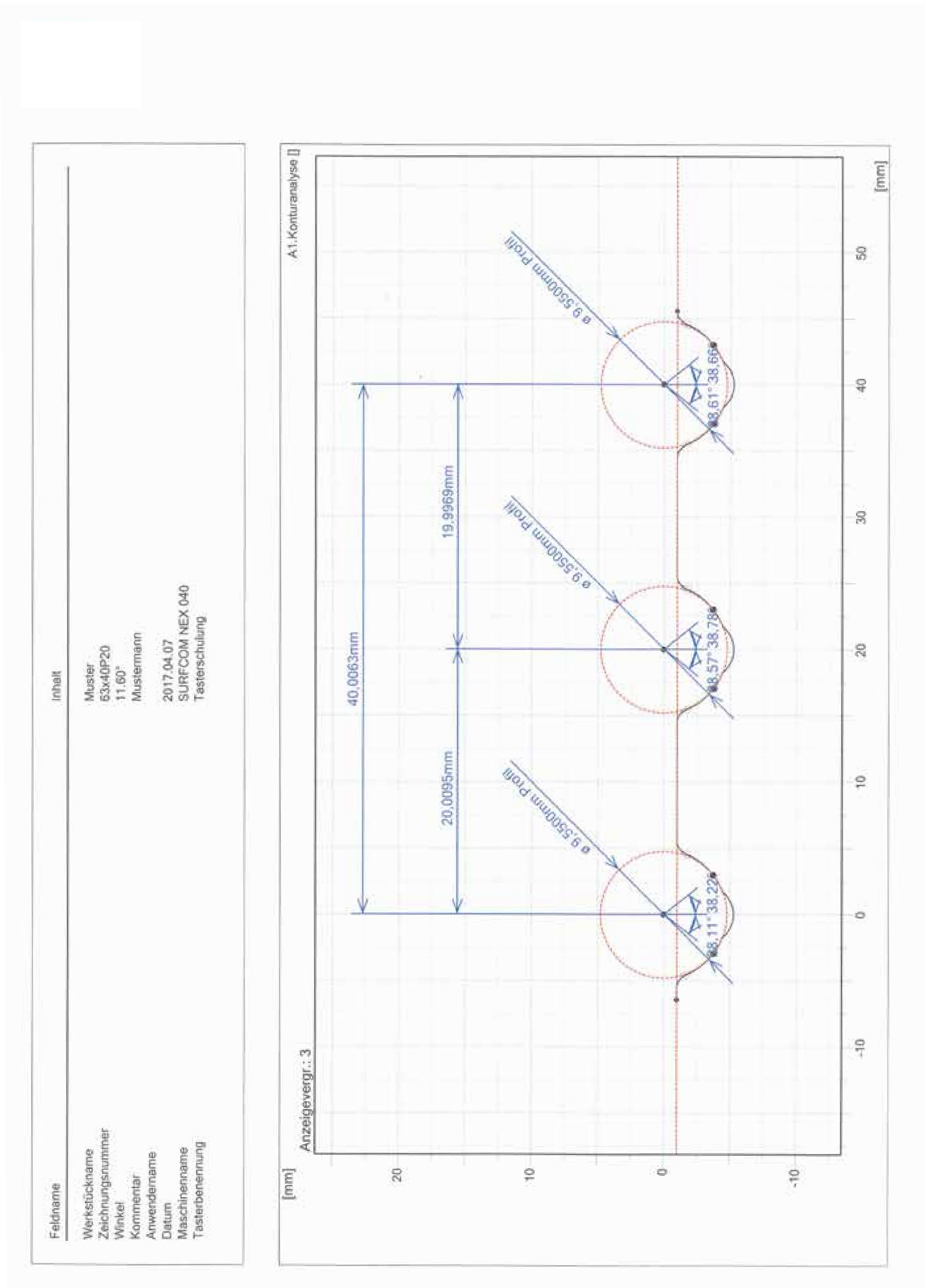
Volksbank Triberg eG
Konto Nr. 80 40 02 (BLZ 694 917 00)
BIC: GENODE61TRI
IBAN: DE72 6949 1700 0000 8040 02

Commerzbank AG Villingen
Konto Nr. 158 0919 (BLZ 694 400 07)
BIC: COBADEFF694
IBAN: DE14 6944 0007 0158 0919 00

Thread profile protocol



Thread profile protocol



DIN extracts

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-
	Prüfung	
Wegkompensation, c, für den Nutzweg, l_u	Angabe durch Anwender	C = 0
Toleranz des Sollweges, e_p	E1.1	E1.2
Zulässige Wegschwankung, v_{up}, 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 Gewindegang 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 × 45°) pro Umdrehung bestimmt oder fortlaufend über einem Gewindegang (am Anfang, in der Mitte und am Ende des Nutzweges), vorausgesetzt, dass dies Bestandteil einer speziellen Vereinbarung war.

DIN ISO 3408-3:2011-04

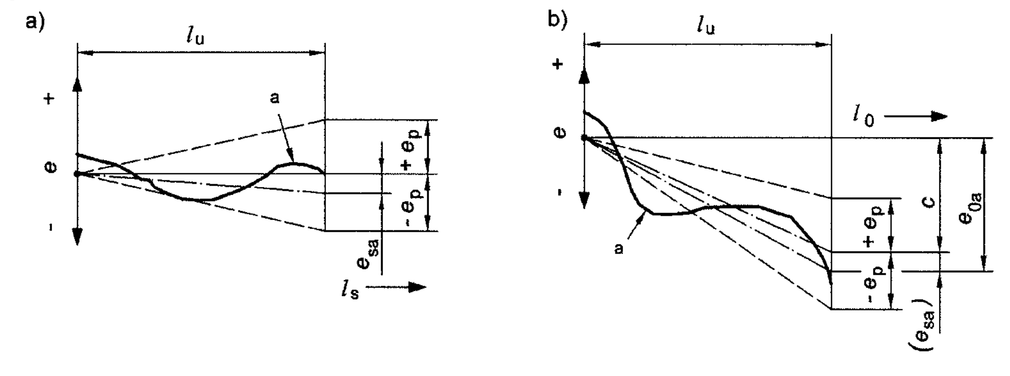
5.2 Wegabweichung und Wegschwankung

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

Zulässige Abweichungen

Nutzweg l_u [mm]		Toleranz für den Sollweg e_p [µm]					
		Toleranzklassen					
>	≤	0	1	3	5	7	10
0	315	4	6	12	23	–	–
315	400	5	7	13	25	–	–
400	500	6	8	15	27	–	–
500	630	6	9	16	32	–	–
630	800	7	10	18	36	–	–
800	1 000	8	11	21	40	–	–
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	–	–

Beobachtungen und Anmerkungen

a)

e_{sa} = ________ µm

b)

Wegkompensationen c muss vom Anwender angegeben werden

c = ________

e_{0a} = ________ µm

Prüfmittel

Siehe Bild 2

Prüfanleitung

Siehe Bild 2

DIN extracts

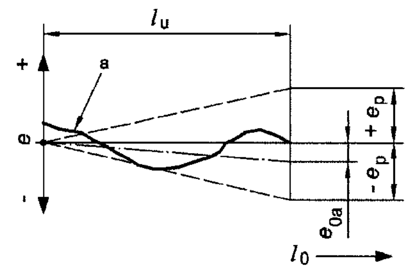
DIN ISO 3408-3:2011-04

Prüfobjekt: Transport-Kugelgewindetrieb

E 1.2

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

Diagramm



a Istwegabweichung

Zulässige Abweichungen

Toleranz für den Sollweg e_p [µm]					
Toleranzklassen					
0	1	3	5	7	10
$e_p = \pm \frac{l_u}{300} \cdot v_{300p}$					

Beobachtungen und Anmerkungen

e_{0a} = ________ µm

Prüfmittel

Siehe Bild 2

Prüfanleitung

Siehe Bild 2

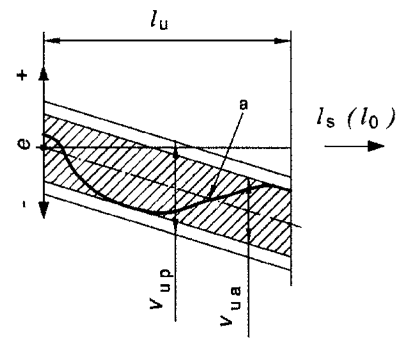
DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier-Kugelgewindetrieb

E 2

Prüfung der Wegschwankung, v_u, über den Nutzweg, l_u:

Diagramm



a Istwegabweichung

Zulässige Abweichungen

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_{ua} = ________ µm

Prüfmittel

Siehe Bild 2

Prüfanleitung

Siehe Bild 2

v_{ua} 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.

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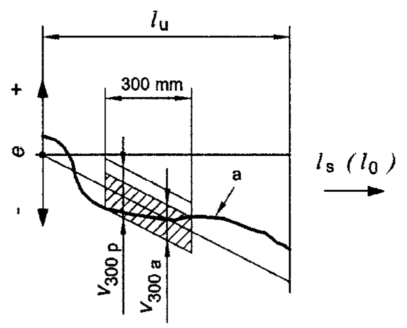
DIN extracts

DIN ISO 3408-3:2011-04

Prüfobjekt: Transport- oder Positionier-Kugelgewindetrieb	**E 3**
Prüfung der Wegschwankung, v_{300}, über 300 mm axialen Weg:	

Diagramm



[a] Istwegabweichung

Zulässige Abweichungen

Toleranzklasse					
0	1	3	5	7	10
v_{300p} [µm]					
3,5	6	12	23	52 [1)]	210 [1)]

[1)] nur für Transport-Kugelgewindetriebe

Beobachtungen und Anmerkungen

$v_{300a\,max}$ = ________ µm

Prüfmittel

Siehe Bild 2

Prüfanleitung

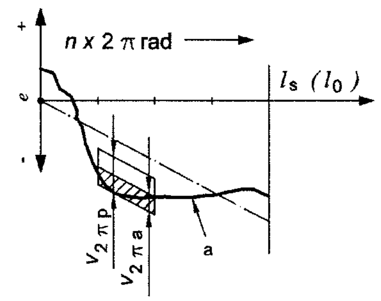
Siehe Bild 2

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 Nutzweges beinhaltet.

DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier-Kugelgewindetrieb	**E 4**
Prüfung der Wegschwankung, $v_{2\pi}$, über 2π rad:	

Diagramm



[a] Istwegabweichung

Zulässige Abweichungen

Toleranzklasse					
0	1	3	5	7	10
$v_{2\pi p}$ [µm]					
3	4	6	8	–	–

Beobachtungen und Anmerkungen

$v_{2\pi a\,max}$ = ________ µm

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 Nutzweg.

DIN extracts

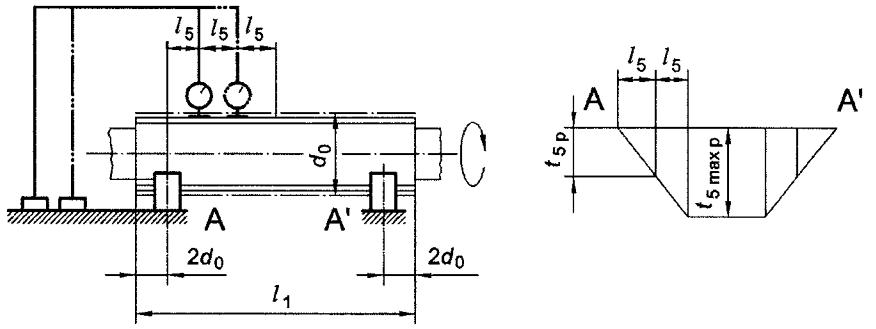
DIN ISO 3408-3:2011-04

5.3 Lauf- und Lageprüfungen

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

Messung des Rundlaufs, t_5, des Kugelgewindespindelaußendurchmessers über die Länge l_5 zur Bestimmung der Geradheit bezogen auf AA':

Diagramm



Zulässige Abweichungen

Nenndurchmesser d_0 [mm] >	≤	l_5 [mm]	Toleranzklasse 0	1	3	5	7	10
			t_{5p} [µm] für l_5					
6	12	80						
12	25	160						
25	50	315	16	20	25	32	40	80
50	100	630						
100	200	1 250						
Nenndurchmesser l_1 / d_0 >	≤		$t_{5max\,p}$ [µm] für $l_1 > 4\,l_5$					
–	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

t_{5a} = ________ µm

$t_{5max\,a}$ = ________ 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 $l_1 < 2 l_5$ ist, erfolgt die Messung bei $l_1/2$.

DIN ISO 3408-3:2011-04

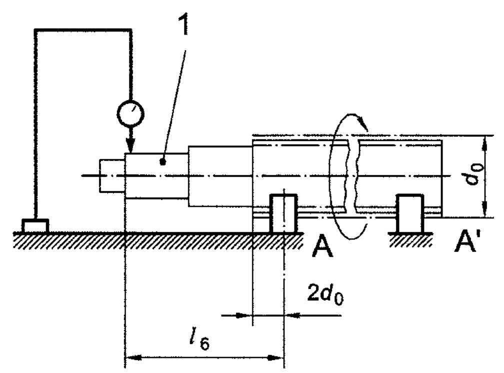
Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb — **E 6.1**

Messung der Rundlaufabweichung, $t_{6.1}$, des Lagersitzes bezogen auf AA' über die Länge l:

Für Länge $l_6 \leq l$ (l siehe Tabelle)

Für Länge $l_6 > l$ muss gelten $t_{6.1a} \leq t_{6.1p} \frac{l_6}{l}$

Diagramm



Legende

1 Lagersitz

Zulässige Abweichungen

Nenndurchmesser d_0 [mm] >	≤	l [mm]	Toleranzklasse 1	3	5	7	10
			$t_{6.1p}$ [µm] für l				
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	$t_{6.1a}$
_____ 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.

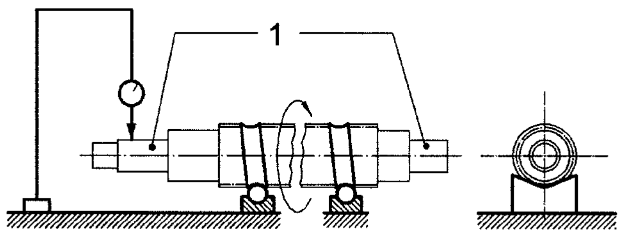
DIN extracts

DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb **E 6.2**

Messung der Rundlaufabweichung, $t_{6.2}$, der Lagersitze bezogen auf die Zentrierlinie des Gewindeabschnitts:

Diagramm



Legende

1 Lagersitze

Zulässige Abweichungen

Nenndurchmesser d_0 [mm]		Toleranzklasse				
		0	1	3	5	–
>	≤	$t_{6.1p}$ [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	

Beobachtungen und Anmerkungen

$t_{6.2a}$ = ________ µm

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.

DIN ISO 3408-3:2011-04

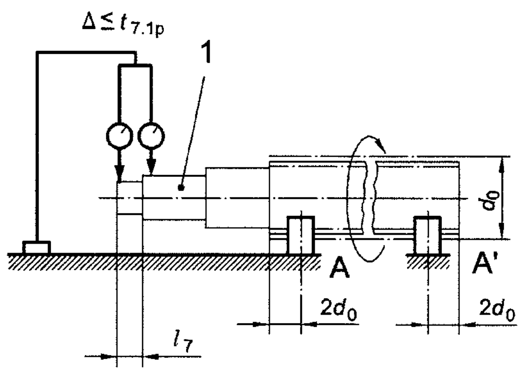
Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb **E 7.1**

Messung der Rundlaufabweichung, $t_{7.1}$, des Endzapfen-Durchmessers bezogen auf den Lagersitz, durch Differenzbildung:

Für die Länge $l_7 \leq l$ (l siehe Tabelle)

Für die Länge $l_7 > l$ muss gelten $t_{7.1a} \leq t_{7.1p} \frac{l_7}{l}$

Diagramm



Legende

1 Lagersitz

Zulässige Abweichungen

Nenndurchmesser d_0 [mm]		l	Toleranzklasse				
			1	3	5	7	10
>	≤	[mm]	$t_{7.1p}$ [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

Beobachtungen und Anmerkungen

Durchmesser	$t_{7.1a}$
_____ mm	_____ µm
_____ mm	_____ µm
_____ mm	_____ µm
_____ mm	_____ µm

Prüfmittel

Feinzeiger und paarige Prüfprismen

Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.612.2

Kugelgewindetrieb in den Punkten A und A' auf Prüfprismen lagern.

Feinzeiger im Abstand l_7 senkrecht auf der zylindrischen Oberfläche anstellen.

Kugelgewindespindel langsam drehen und die Messwerte des Feinzeigers aufnehmen.

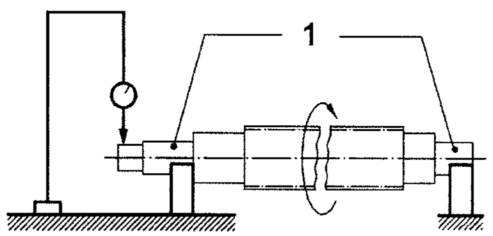
DIN extracts

DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb — **E 7.2**

Messung der Rundlaufabweichung, $t_{7.2}$, des Endzapfen-Durchmessers bezogen auf die Zentrierlinie des Lagersitzes:

Diagramm



Legende

1 Lagersitze

Zulässige Abweichungen

Nenndurchmesser d_0 [mm] >	≤	Toleranzklasse 0	1	3	5	–
		$t_{7.2p}$ [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	

Beobachtungen und Anmerkungen:

$t_{7.2a}$ = __________ µm

Prüfmittel

Feinzeiger und paarige Prüfprismen

Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.612.2

Lagerung der Kugelgewindespindel horizontal in Prüfprismen auf ihren Lagersitzen.

Feinzeiger auf dem Außendurchmesser des Endzapfens 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 E7.1.

DIN ISO 3408-3:2011-04

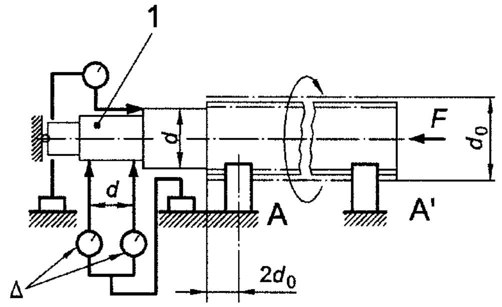
Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb — **E 8.1**

Messung der Planlaufabweichung, $t_{8.1}$, der Anlagefläche für Lager bezogen auf AA':

Diagramm

$t_{8.1a} \leq t_{8.1p} - |\Delta|$

Δ ist die Abweichung der Geradheit



Legende

1 Lagersitz

Zulässige Abweichung

Nenndurchmesser d_0 [mm] >	≤	Toleranzklasse 1	3	5	7	10
		$t_{8.1p}$ [µm]				
6	63	3	4	5	6	10
63	125	4	5	6	8	12
125	200	–	6	8	10	16

Beobachtungen und Anmerkungen

Durchmesser	$t_{8.1a}$
_____ mm	_____ µm
_____ mm	_____ µm
_____ mm	_____ µm

Prüfmittel

Feinzeiger und paarige Prüfprismen

Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.632

Kugelgewindetrieb auf Prismen in den Punkten A und A' lagern.

Kugelgewindespindel in axialer Richtung gegen Versatz sichern (z. B. durch das Platzieren einer Kugel zwischen Zentrierbohrung der Kugelgewindespindel und der Anlagefläche).

Feinzeiger senkrecht zur Planfläche der Lagerzapfenschulter und zur Mantelfläche des entsprechenden Lagerzapfens anstellen.

Kugelgewindespindel eine Umdrehung drehen und die Messwerte des Feinzeigers aufnehmen.

kammerer

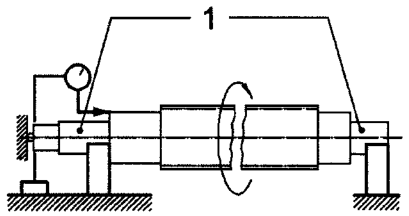
DIN extracts

DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier- oder Transport-Kugelgewindetriebe — **E 8.2**

Messung der Planlaufabweichung, $t_{8.2}$, der Anlagefläche für das Lager bezogen auf die Achse der Kugelgewindespindel:

Diagramm



Legende

1 Lagersitze

Zulässige Abweichungen

Nenndurchmesser d_0 [mm] >	≤	Toleranzklasse 0	1	3	5	–
		$t_{8.2p}$ [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	

Beobachtungen und Anmerkungen

$t_{8.2a}$ = __________ µm

Prüfmittel

Feinzeiger und paarige Prüfprismen

Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.632

Die Kugelgewindespindel horizontal auf Prismen an den Lagersitzen lagern und gleichzeitig in axialer Richtung gegen Versatz sichern.

Feinzeiger senkrecht zur Planfläche des Lagersitzes anstellen.

Kugelgewindespindel eine Umdrehung drehen und die Messwerte des Feinzeigers aufnehmen.

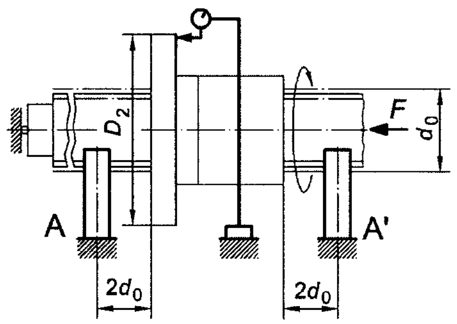
ANMERKUNG Diese Prüfung kann nach Vereinbarung zwischen Hersteller und Anwender durchgeführt werden. Wenn die Prüfung angewandt wird, ersetzt sie Prüfung E8.1.

DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb — **E 9**

Messung der Planlaufabweichung, t_9, der Anlagefläche der Kugelgewindemutter bezogen auf AA' (nur für vorgespannte Kugelgewindemuttern):

Diagramm



Zulässige Abweichungen

Flanschdurch-Messer D_2 [mm] >	≤	Toleranzklasse 0	1	3	5	7	10
		t_{9p} [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	

Beobachtungen und Anmerkungen:

$t_{9a\ max}$ = __________ µm

Prüfmittel

Feinzeiger und paarige Prüfprismen

Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.632

System vorgespannt. Lagern der Kugelgewindespindeln auf Prismen in den Punkten A und A'.

Sichern der Kugelgewindespindel gegen axialen Versatz (z. B. Kugel zwischen Zentrierbohrung und Anlagefläche).

Feinzeiger senkrecht zur Flanschanlagefläche der Kugelgewindemutter am größten Durchmesser D_2 anstellen.

Kugelgewindemutter gegen Verdrehen auf der Kugelgewindespindel sichern.

Kugelgewindespindel drehen und Messwerte des Feinzeigers aufnehmen.

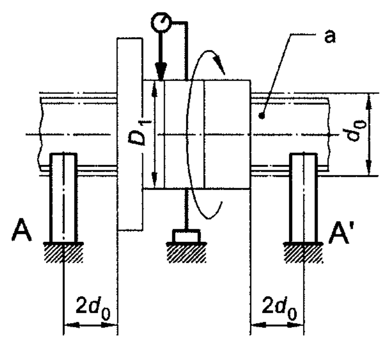
DIN extracts

DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb	**E 10**

Messung der Rundlaufabweichung, t_{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]		Toleranzklasse					
		0	1	3	5	7	10
>	≤	t_{10p} [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

$t_{10a\ max}$ = ________ µm

Prüfmittel

Feinzeiger und paarige Prüfprismen

Prüfanleitung Verweis auf Prüfregeln ISO 230-1:1996, 5.612.2

System vorgespannt. Lagern der Kugelgewindespindeln auf Prismen in den Punkten A und A'.

Feinzeiger senkrecht zur zylindrischen Fläche der Kugelgewindemutter am Führungsdurchmesser D_1 anstellen.

Sichern der Kugelgewindespindel.

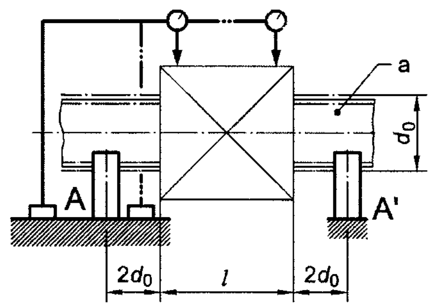
Kugelgewindespindel langsam drehen und Messwerte des Feinzeigers aufnehmen.

DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb	**E 11**

Parallelitätsabweichung, t_{11}, einer rechteckigen Kugelgewindemutter bezogen auf AA' (nur für vorgespannte Kugelgewindemuttern):

Diagramm



[a] fixiert

Zulässige Abweichungen

Toleranzklasse					
0	1	3	5	7	10
t_{11p} [µm] je 100 mm (kumulativ)					
14	16	20	25	32	–

Beobachtungen und Anmerkungen

t_{11a} = ________ µm

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

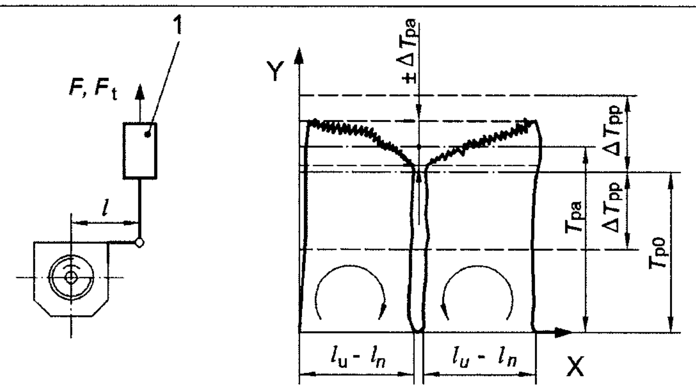
DIN ISO 3408-3:2011-04

5.4 Funktionsprüfungen

Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb **E 12**

Messung des Leerlaufdrehmoments bei Vorspannung, ΔT_p:

Diagramm



$T_p = F \times l$ ohne Abstreifer

$T_t = F_t \times l$ mit Abstreifer

l_n = Länge der Kugelgewindemutter

Legende

X Weg

Y Leerlaufdrehmoment bei Vorspannung

1 Kraftmesser

Zulässige Abweichungen

T_{p0} [Nm]		Toleranzklasse 0	1	3	5	7	10
>	≤	ΔT_{pp} [% von T_{p0}] für $l_u/d_0 \le 40$; $l_u \le 4\,000$ 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 $40 < l_u/d_0 \le 60$; $l_u \le 4\,000$ 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}]; $l_u > 4\,000$ 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	–

Beobachtungen und Anmerkungen

Mit Abstreifer

l = ____________ m

F = ____________ N

T_{pa} = ____________ Nm

ΔT_{pa} = ± __________ Nm

≈ ± __________ % von T_{p0}

Ohne Abstreifer

F_t = ____________ N

T_{ta} = ____________ Nm

ΔT_{ta} = ± __________ Nm

≈ ± __________ % von T_{p0}

Prüfmittel

Prüfbank mit Kraftmesseinrichtung

Prüfanleitung

System vorgespannt (mit oder ohne Abstreifer).
Zur Aufnahme der radialen Vorspannkraft, die Kugelgewindemutter mit der Kraftmesseinrichtung im Abstand l von der Drehachse verbinden.
Messungen durch die Kraftmesseinrichtung bei einer Drehzahl von 100 min^{-1} in beide Drehrichtungen durchführen.[1)]
Zur Schmierung ist ein Schmieröl der Viskositätsklasse ISO VG 100 zu verwenden.[a)]

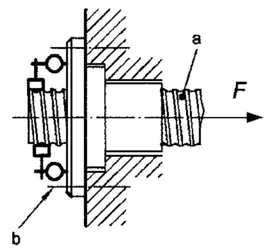
a) Andere Drehzahlen, Schmierstoffe und Messeinrichtungen können nach Vereinbarung zwischen Anwender und Hersteller verwendet werden.

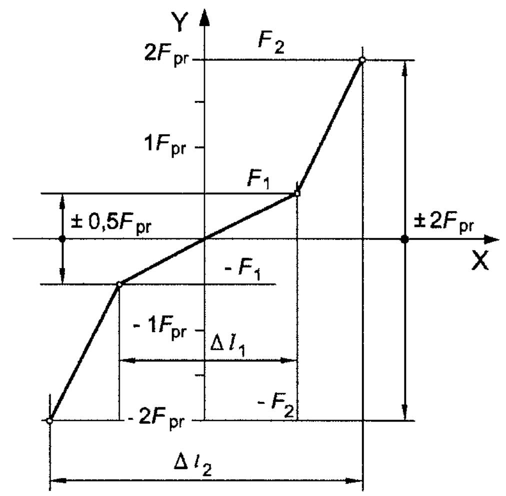
DIN ISO 3408-3:2011-04

Prüfobjekt: Positionier- oder Transport-Kugelgewindetrieb **E 13**

Messung der axialen Steifigkeit, R_{nu}:

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

Δl_1 = ____________ µm

Δl_2 = ____________ µm

R_{nu1} = ____________ N/µm

R_{nu2} = ____________ N/µm

Prüfmittel

Feinzeiger und Prüfvorrichtung

Prüfanleitung

Vorgespannte Kugelgewindemutter in beiden Richtungen gegen axialen Versatz und Kugelgewindespindel gegen Verdrehen gesichert.

Stative der Feinzeiger an der Kugelgewindespindel aufsetzen und die Messtaster mit möglichst geringem Abstand parallel zur Achse des Kugelgewindetriebs 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

Anhang A
(normativ)

Ergänzende Tabellen

Tabelle A.1 — Toleranzwerte für Sollweg, e_p, für eine Bandbreite über 300 mm (v_{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 [µm]					
–	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.

DIN ISO 3408-3:2011-04

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

Steigung P_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

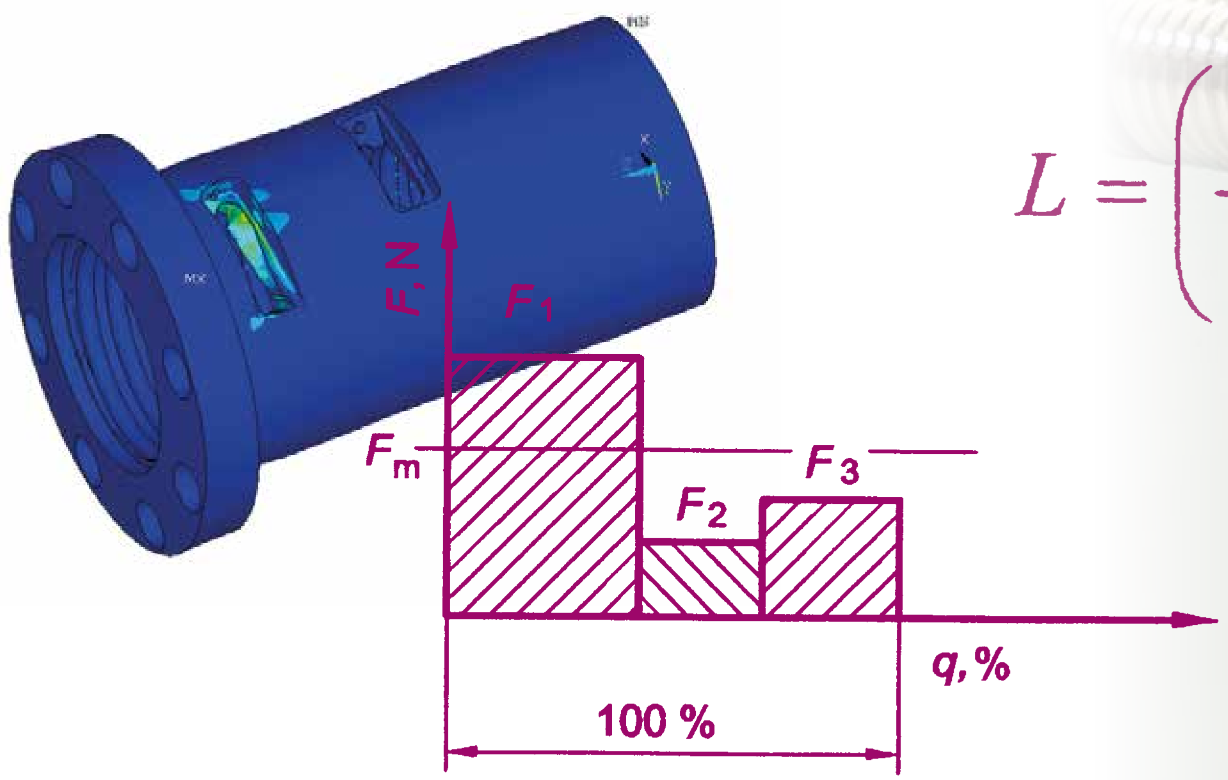
Tabelle A.3 — Maximaler Überlauf

Maße in mm

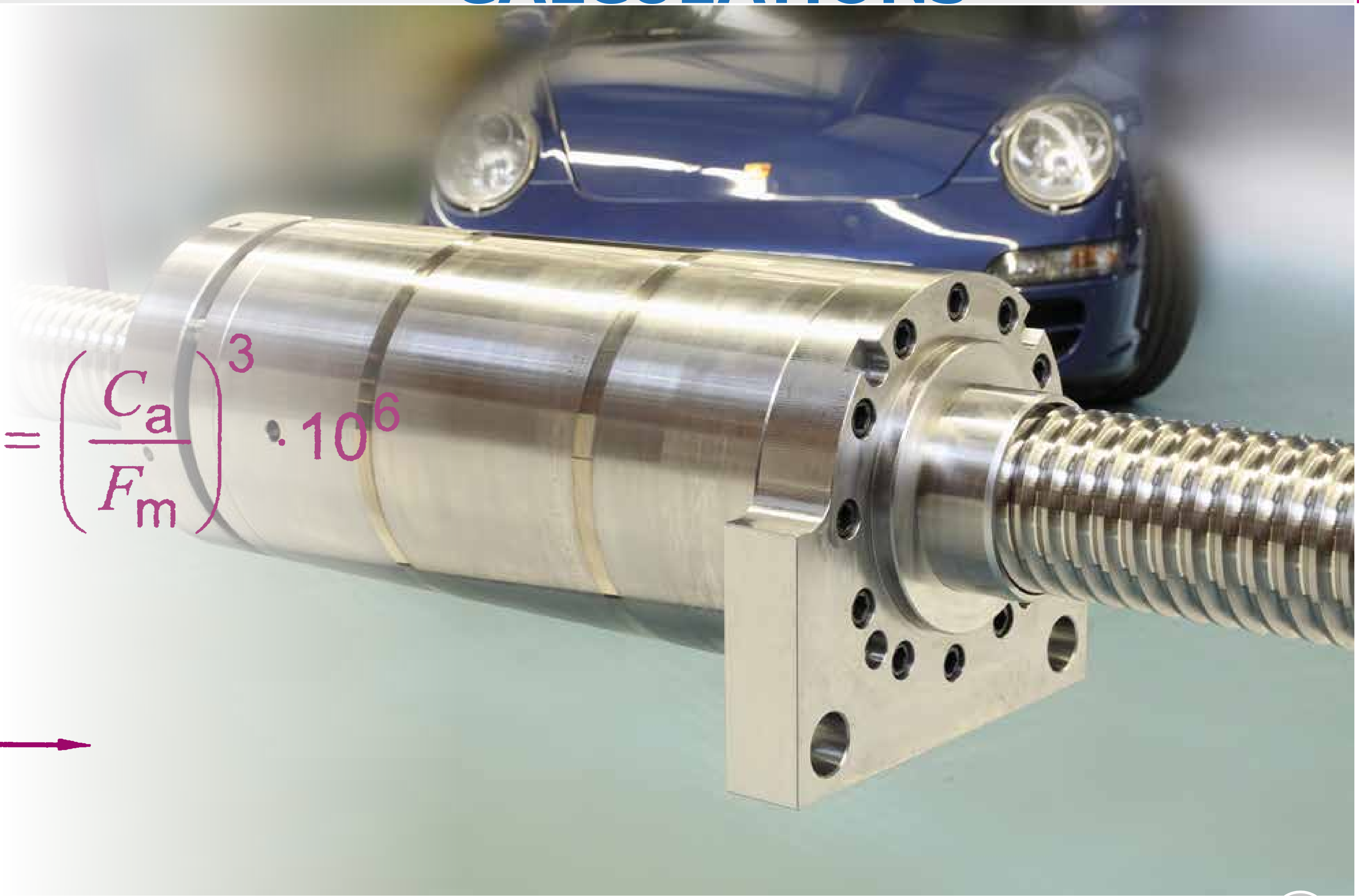
Steigung P_h	2,5	5	10	20	40
Maximaler Überlauf l_{max}	10	20	40	60	100

TECHNOLOGY / CALCULATIONS

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



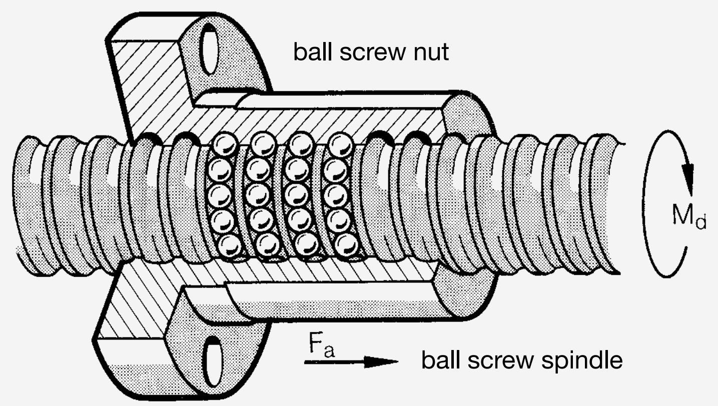
$$L = \left(\frac{C_a}{F_m}\right)^3 \cdot 10^6$$



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 be tween the spindle and the nut by rolling in the ap propri ate 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.



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 compen sated for to a great extent by these factors. At the same time, the fact that it is not self-re-tarding 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.

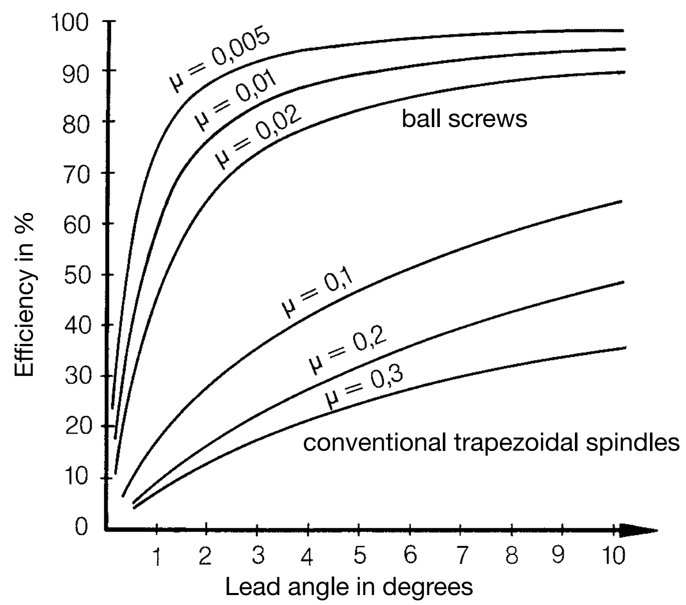
This undesirable slip-stick effect does not occur with rolling friction enabling the same position to be achieved repeatedly.

Installation: Before installation, the ball screw must be clean ed with a cleaning fluid such as benzene, if neces sary. 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.

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 fundament ally 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.



Materials for ball screws

Spindles

Steel for surface hardening	Cf53
Material No. 1.1213	
Surface hardness	60 + 2 HRC
Tensile strength Rm	600 N/mm²
Elastic limit Rp	400 N/mm²
Material No. 1.7225	42 CrMo 4
Surface hardness	60 + 2 HRC
Tensile strength Rm	900 N/mm²
Elastic limit Rp	600 N/mm²

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/mm²
Elastic limit Rp	980 N/mm²
Hard up to Rm	2100 N/mm²
Material No. 1.3536	
Hardness	61 + 2 HRC
Tensile strength Rm	690 N/mm²
Elastic limit Rp	390 N/mm²
Hard up to Rm	1800 N/mm²

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

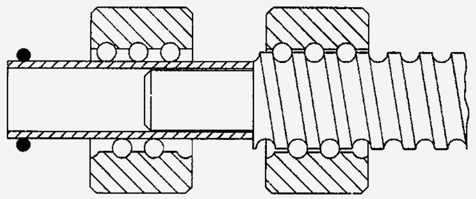
The best solution however is to completely cover the ball screw using a spiral spring cover, for example.

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 !!!



Outside ø of sleeve = core ø of spindle $^{-0.1}_{-0.3}$ mm.

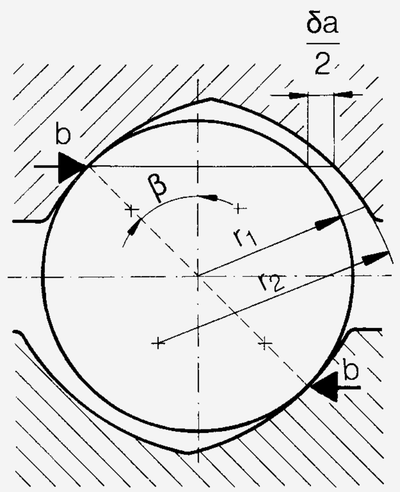
Track profile

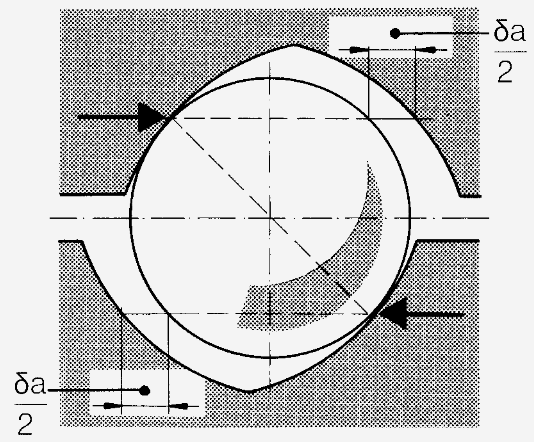
Kammerer ball screws are basically equipped with Gothic track profiles and offer the following advantages:
Good running characteristics, high rigidity and a good contact angle β, of around 45° are aimed for.

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

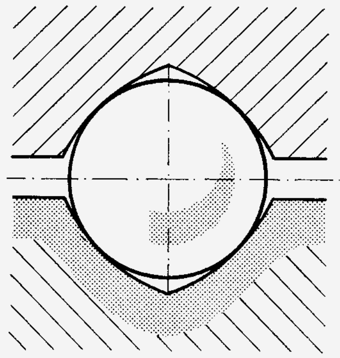
This profile with the largest possible load angle β, good lubrication conditions and a ball diameter calculated for the appropriate application brings the following advantages:

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



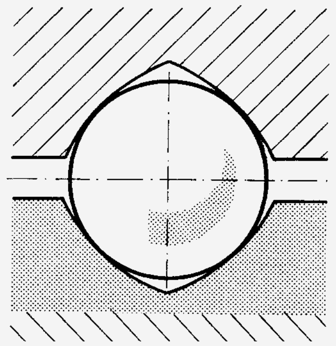


Full hardened nut



Spindle, deep dry nitride hardened

Full hardened nut



Spindle, inductive hardened

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).

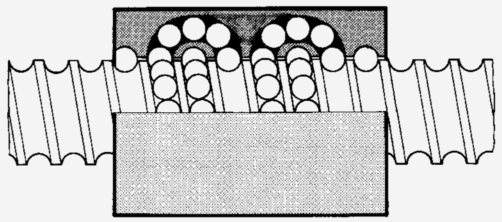
Ball feedback systems

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.

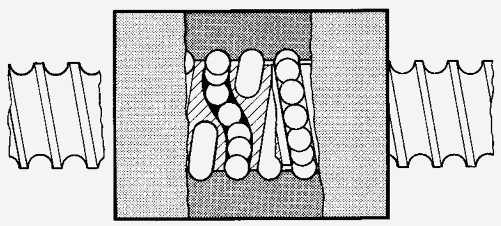
This return system is used by Kammerer.

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.

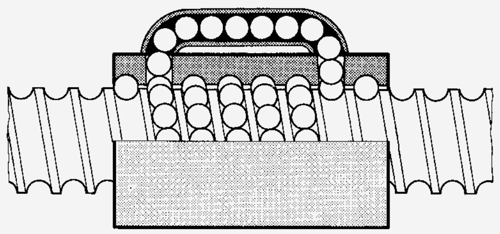
Internal axial return system



Internal return system



Tube return system



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_v = pre-loading force [N]
δ_v = deformation due to F_v
δ_a = axial play
δ_b = deformation due to F_b
$2 \cdot \delta_b$ = return distance

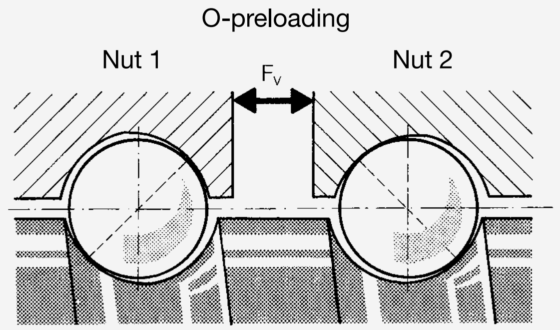
- the pre-loading force amounts $\frac{1}{2,83}$ to of the average operating load.

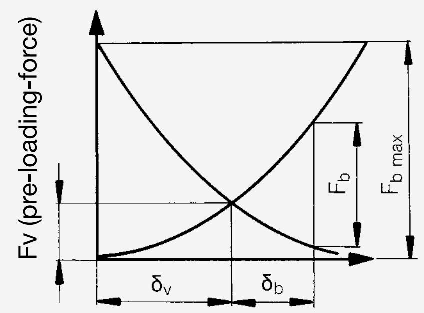
  Loads over and above this cause the balls of the unloaded nut to lose contact and the return distance to increase.

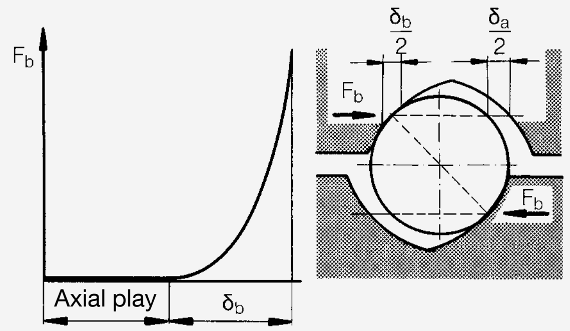
- The average operating load is defined as the load consistent with a life of 20 · 106 revolutions.

- The following relationship can be derived from the above:

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





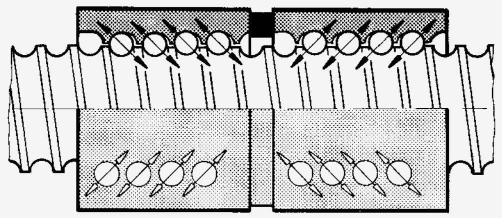


Pre-loading nut systems

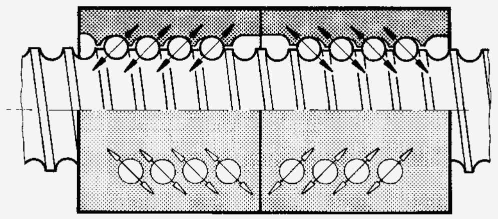
In order to eliminate the axial play and to keep the axial dis placement due to the material deformation as small as pos sible, nuts are pre-loaded.

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.

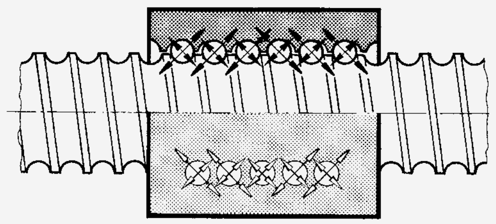


O-pre-loading: The forces are directed outwards. The spindle is under tension in the pre-loading range. The pre-loading is increased by forcing the nuts apart.



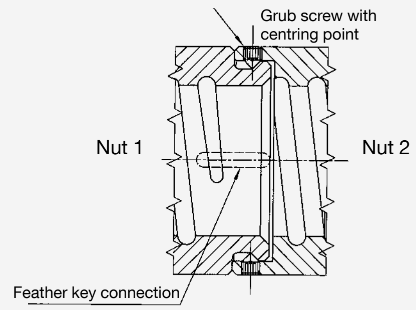
Pre-loading using oversized balls:
The most cost-effective solution, as only half the nut length has to be manufactured, creates the pre-loading by the oversize of the balls (= four point contact) and which is thus finding more frequent usage.

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 (Δ P) 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)
Δ t = 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 (F2) must be produced by the bearings and is calculated from:

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

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

Δ P = necessary lead variation from equation
E = modulus of elasticity (21 x 10^4 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* l* Delta t) /1000 (mm)
F2 = (Delta P * E * A) / l (N)
A = (dm² * 3,1416)/ 4 (mm²)

P = pitch (mm)
a = thermal coefficient of expansion (steel = 0.011mm/m* degrees)
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_{ges}) 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:

$$\frac{1}{C_{ges}} = \frac{1}{C_k} + \frac{1}{C_m} + \frac{1}{C_s} = \frac{1}{C_{me}} + \frac{1}{C_s} \quad [\text{N/µm}]$$

Rigidity in the ball area (C_k)
The axial rigidity in the ball area is derived from:

$$C_k \approx \frac{F_b}{\delta_b} \quad [\text{N/µm}]$$

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

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

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

F_b	= operating load	[N]
F_v	= pre-loading force	[N]
K	= rigidity factor	[N/µm$^{2/3}$]
i	= number of revolutions	3/2

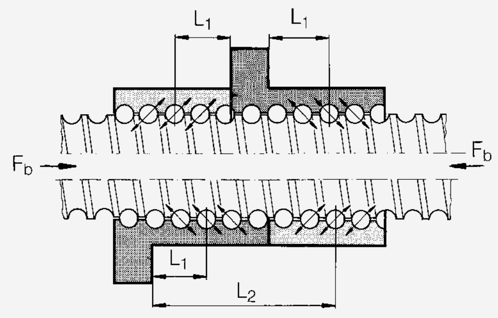
Rigidity of the body of the nut (c_m)

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

A = nut cross sectional area [mm²]
E = modulus of elasticity 21 · 10⁴ [N/mm²]

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

$L_1 \approx$ 0,5 · nut length
$L_2 \approx$ 0,75 · nut length



Rigidity of the nut unit (c_{me})
For an approximate calculation it is sufficient to say:

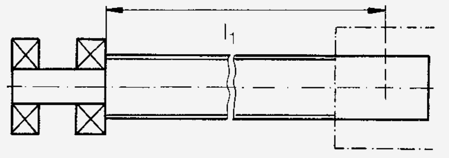
$c_{me} = f_{cm} \cdot c_k$ [N/µm]
f_{cm} = 0.55 (internal pre-loading for single nuts)
f_{cm} = 0.70 (pre-loaded double nut)

Rigidity of the spindle between bearings (c_s)

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

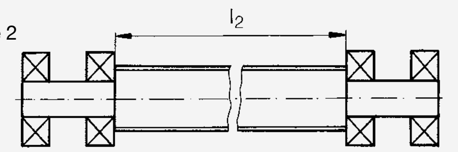
Single-sided fixed bearing, case 1

$$c_s = \frac{A \cdot E}{l_1 \cdot 10^3} \quad [\text{N/µm}]$$



Double-sided fixed bearing, case 2

$$c_s = \frac{4 \cdot A \cdot E}{l_2 \cdot 10^3} \quad [\text{N/µm}]$$



E	= modulus of elasticity 21 · 10⁴	[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]

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

Calculation of the total rigidity

1. Rigidity of the ball area

$$c_k = 2 \cdot \sqrt[3]{F_b \cdot (k \cdot i)^2}$$
$$= 2 \cdot \sqrt[3]{25000 \cdot (53{,}51 \cdot 5)^2}$$
$$c_k = 2428 \ N/\mu m$$

2. Rigidity of the nut area

$$c_{me} \approx 0{,}7 \cdot c_k$$
$$\approx 0{,}7 \cdot 2428 = 1700 \ N/\mu m$$

3. Rigidity of the nut body

$$c_m = \frac{A_2 \cdot E}{l \cdot 10^3} \quad [N/\mu m]$$
$$c_m = \frac{1970 \cdot 21 \cdot 10^4}{98 \cdot 10^3}$$
$$c_m = 4221 \ N/\mu m$$

3. Rigidity of the spindle

3.1 Single-sided fixed bearing

$$c_s = \frac{A_1 \cdot E}{l \cdot 10^3} \quad [N/\mu m]$$
$$c_s = \frac{1548 \cdot 21 \cdot 10^4}{1000 \cdot 10^3}$$
$$c_s = 325 \ N/\mu m$$

3.2 Double-sided fixed bearing

$$c_s = \frac{4 \cdot A_1 \cdot E}{l \cdot 10^3} \quad [N/\mu m]$$
$$c_s = 4 \cdot 325 = 1300 \ N/\mu m$$

4. Total rigidity

$$\frac{1}{c_{ges}} = \frac{1}{c_k} + \frac{1}{c_m} + \frac{1}{c_s} = \frac{1}{c_{me}} + \frac{1}{c_s}$$

Example – Calculation of rigidity

Nut system DIN 69051	according to dimension sheet
Nominal diameter	d_0 = 50 mm
Lead	P = 10 mm
Number of revolutions	i = 5
Dynamic rating	C = 98.400 N
Operating load max.	F_b = 25.000 N
Spindle length between bearings	l = 1.000 mm
Rigidity factor	k = 53,51 N/µm
Spindle cross sectional area	A_1 = 1.548 mm²
Nut cross sectional area	A_2 = 1.970 mm²

4.1 Single-sided fixed bearing

$$\frac{1}{c_{ges}} = \frac{1}{1700} + \frac{1}{325}$$
$$c_{ges} = 273 \ N/\mu m$$

4.2 Double-sided fixed bearing

$$\frac{1}{c_{ges}} = \frac{1}{1700} + \frac{1}{1300}$$
$$c_{ges} = 737 \ N/\mu m$$

4.3 Single-sided fixed bearing

$$\frac{1}{c_{ges}} = \frac{1}{c_k} + \frac{1}{c_m} + \frac{1}{c_s}$$
$$\frac{1}{c_{ges}} = \frac{1}{2428} + \frac{1}{4221} + \frac{1}{325} = 268 \ N/\mu m$$

4.4 Double-sided fixed bearing

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

Average loading

Constant speed / varying load

$$F_{Bm} = \sqrt[3]{F^3_{b1} \cdot \frac{q_1}{100} + F^3_{b2} \cdot \frac{q_2}{100} + F^3_{b3} \cdot \frac{q_3}{100} + \ldots \text{etc.}} \quad [N]$$

Constant speed / linearly varying load

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

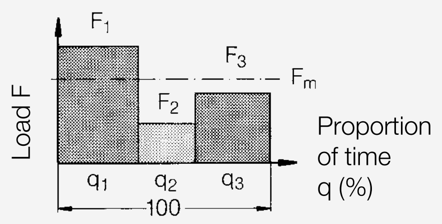
Speed and load varying

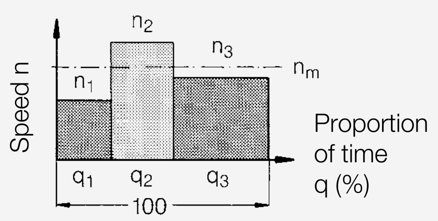
$$F_{Bm} = \sqrt[3]{F^3_{b1} \cdot \frac{n_1}{n_m} \cdot \frac{q_1}{100} + F^3_{b2} \cdot \frac{n_2}{n_m} \cdot \frac{q_2}{100} + \ldots \text{etc.}} \quad [N]$$

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

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





Drive torque and drive power

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

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

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

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

The drive power is calculated from:

$$P_a = \frac{M_a \cdot n}{9550}$$

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

Efficiency η or. η'

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

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 Lh 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_o 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.

$$F_{bm} \leqq F_{b\,max} \leqq C_o$$

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

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

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

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

L = lifetime [revolutions]
L_h = lifetime [h]
C_o = static rating [N]
C = dynamic rating [N]
F_{am} = average axial load [N]
$F_{a\,max}$ = 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_0	mm	50
Lead	P_h	mm	20
Number of starts	P_h:P	-	1
Nominal ball diameter	D_w	mm	7,5
Contact angle	a	°	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_{0am}	kN	177,1
Modified dynamic axial load rating	**C_{am}**	**kN**	**89,4**

Calculation DIN ISO 3408

Service life in accordance with DIN ISO 3408-5

Load spectrum

n	Designation	m [kg]	a [m/s²]	Fj [N]	Fa [N]	v [m/min]	nj [min-1]	qj [%]
1	Acceleration	1.400	10,0	14.000	14.000	20,0	1.000	8
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_{op}	%	100
Actual equivalent dynamic axial load	F_{ma}	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_{ar}	-	0,62
Nominal service life	L_{ar}	10^6 revol.	821,963
Nominal service life in operating hours	L_{har}	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

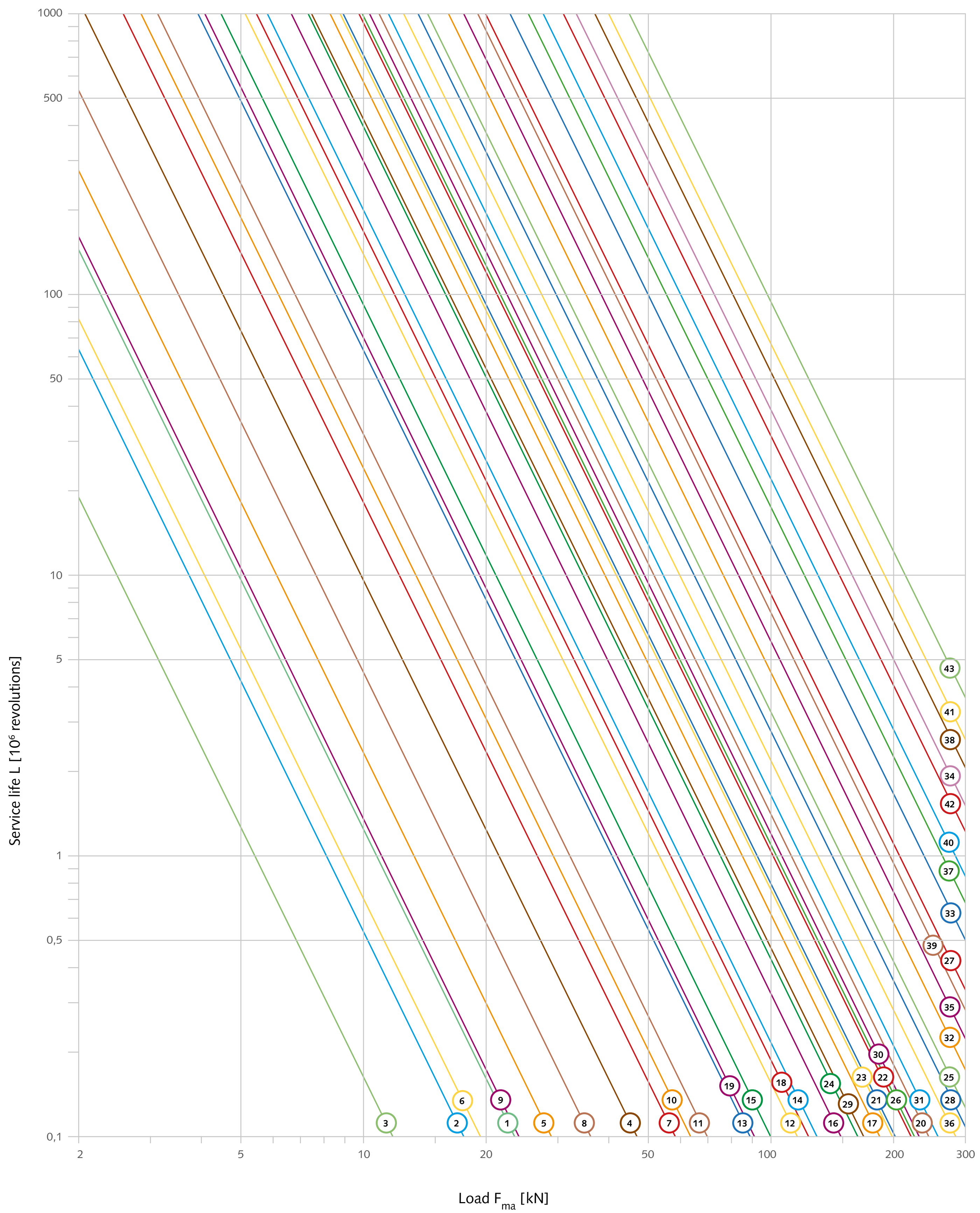
Critical parameters				
Screw speed	Screw external diameter	d_{sa}	mm	48,0
	Screw core diameter	d_{sk}	mm	41
	Unsupported screw length	l_{kr}	mm	2.065
	Correction factor for bearing 'fixed-fixed'	f_{k1}	-	2,24
	Safety factor		-	0,80
	Critical speed	n_{kr}	1/min	1.134
	Permissible speed	n_{zul}	**1/min**	**2.033**
	Maximum speed from load spectrum	n_i	1/min	2.000
Buckling	Nut length	L_2	mm	110
	Unsupported screw length	l_{skr}	mm	2.065
	Correction factor for bearing 'fixed-floating - nut fixed'	f_{k2}	-	4,00
	Theoretical buckling force	F_{kn}	N	264.454
	Safety factor		-	0,50
	Permissible buckling force	F_{zul}	**N**	**132.227**
	Largest effective load	F_{eff}	N	14.000
Drive	Efficiency	h	-	0,97
	Drive torque	M_a	Nm	46
	Drive power	P_a	kW	10
Rolling element	Ratio of ball to screw diameter	Üv		6,47
	Speed factor for lubricant	K		
	Correction factor	f_{dn}		
	Max. screw speed	n_{max}	1/min	
	Speed limit of the rolling elements	n_{Dwmax}	1/min	
	Actual speed of the rolling elements	n_{Dw}	1/min	12.933

Calculation DIN ISO 3408

Rigidity in accordance with DIN ISO 3408-4				
Screw	Deep drill hole diameter	d_{bo}	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	$R_{n/s,pr}$	N/µm	51.234
	Static axial rigidity in the area of the ball/ball track	$R_{b/t,pr}$	N/µm	1.781
	Static axial rigidity of the ball screw nut, 2-point	R_{nu2}	N/µm	1.721
	Static axial rigidity of the ball screw nut, 4-point	R_{nu4}	N/µm	1.665
	Static axial rigidity of the ball screw/ball screw nut system	$dR_{nu,ar}$	**N/µm**	**832**
	Axial deformation in the area of the balls and track	$dl_{b/t,pr}$	µm	7
	Static axial rigidity of the ball screw drive, one-side fixed	R_{bs1}	N/µm	126
	Static axial rigidity of the ball screw drive, both sides fixed	R_{bs2}	N/µm	347

Stretching force (fixed bearings on both sides)			
Screw length	l_s	mm	2.250
Temperature difference	dt	K	5
Required lead variation	dP	mm	0,12
Safety factor		-	1,5
Required stretching force	F_a	**N**	**26.824**

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



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

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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_h = 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_{bm}) [N]

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

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

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

$$L = 60 \cdot 10.000 \cdot 376{,}5 \cdot 0{,}5 = 112{,}95 \cdot 10^6 \text{ revolutions}$$

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

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

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

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_h)

$$L = \left[\frac{C}{F_{bm}}\right]^3 \cdot 10^6 \text{ revolutions} \qquad L_h = \frac{L}{60 \cdot n_m \cdot f_n}\ [h]$$

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

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	K ≈ 60.000 – 100.000	Depending on diameter + ratio of ball to screw diameter = (AD/ball-Ø)
oil lubrication	K ≈ 90.000 – 200.000	

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

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_{kr}
Take speed limits of the nut system into account

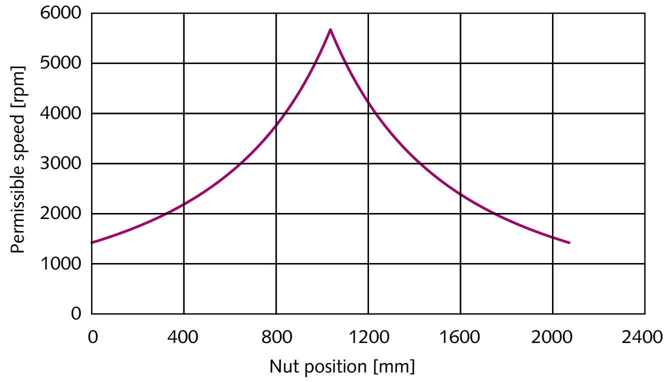
$$n_{kr} = \frac{30}{\pi} \cdot \sqrt{\frac{21 \cdot 10^4 \cdot d_m^4 \cdot 10^4}{0{,}013 \cdot F \cdot l_a^3 \cdot 20}}$$

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

0,8 = safety factor
n_{kr} = 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_a = bearing spacing [mm]
n_{zul} = permissible speed [rpm]

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

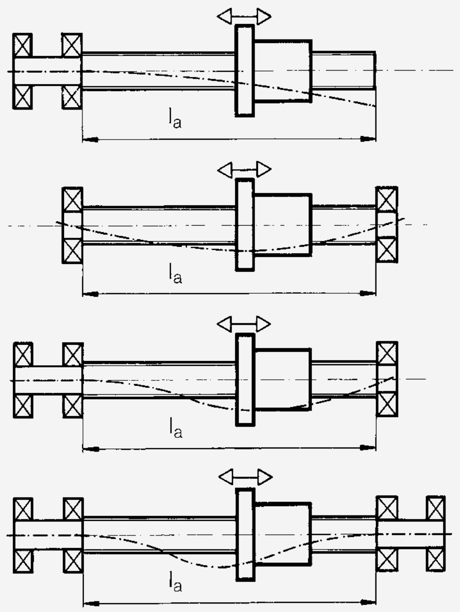
Permissible speed as a function of the nut position (example)



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.

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

Correction factor



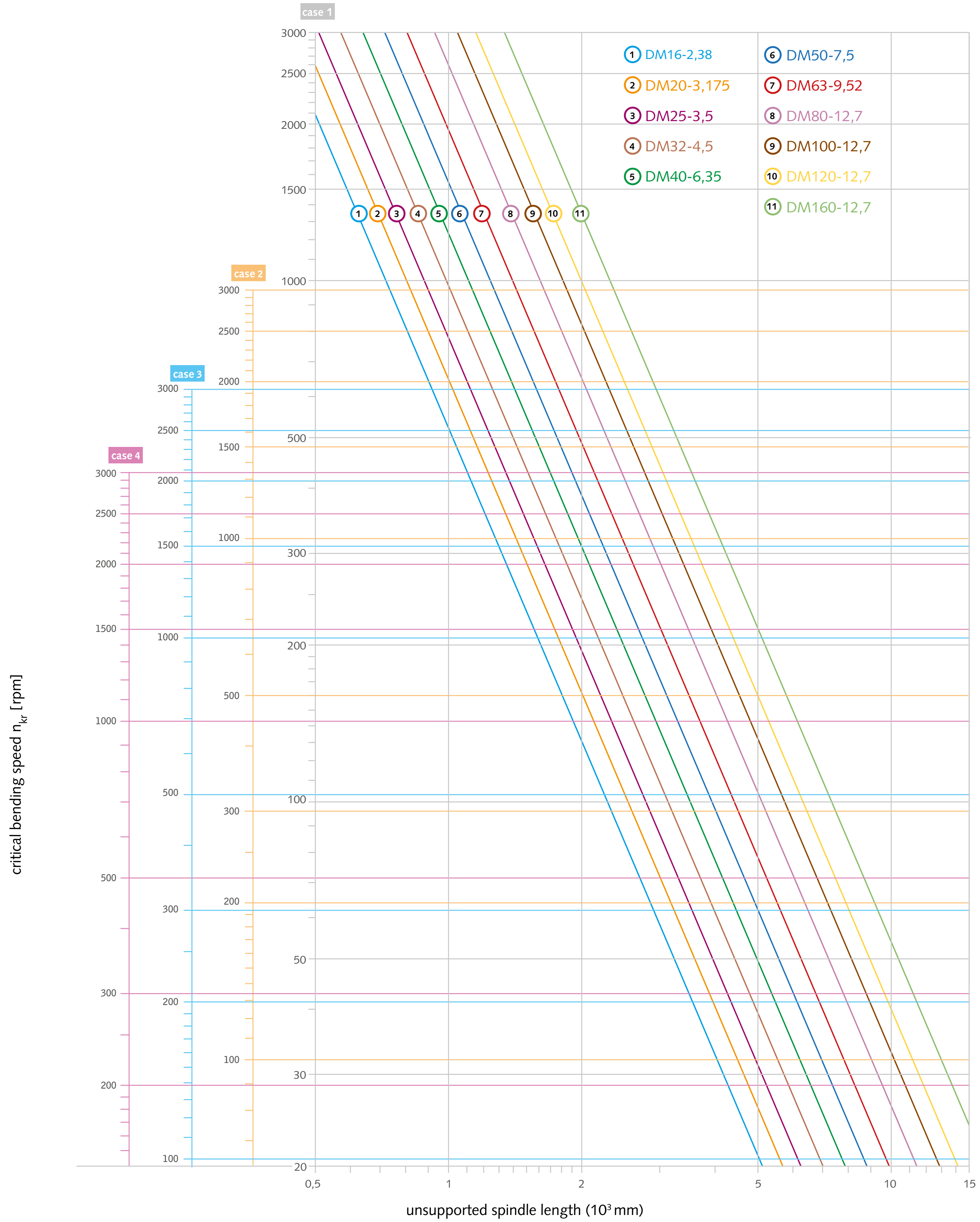
$f_{kr} = 0{,}32$ case 1

$f_{kr} = 1{,}0$ case 2

$f_{kr} = 1{,}55$ case 3

$f_{kr} = 2{,}24$ case 4

Critical bending speed – diagram



Buckling

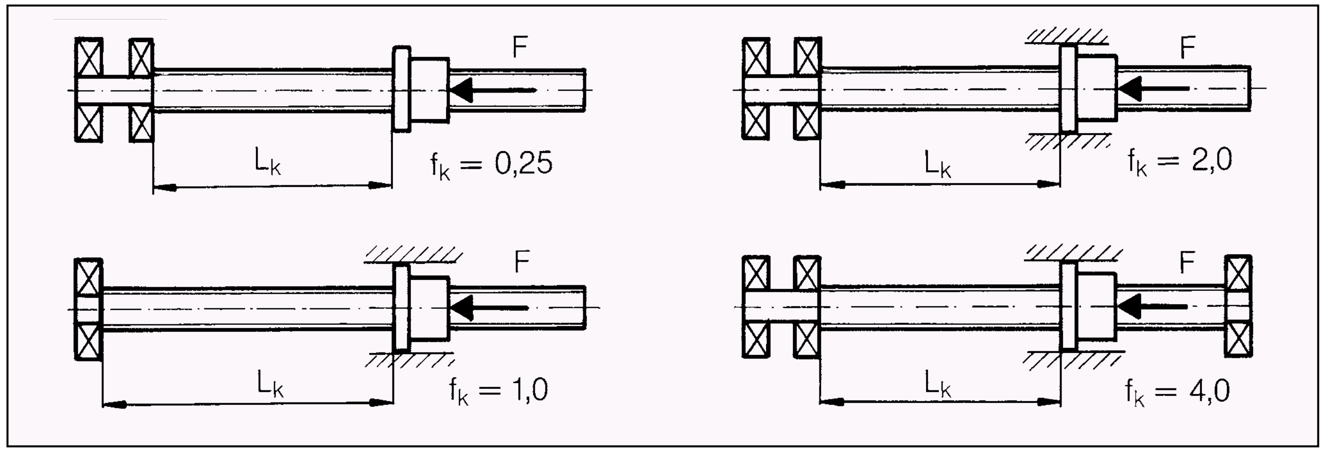
Calculation of the buckling force F_{kn} as a function of the spindle length L_k and the core diameter of the spindle.

$$F_{kn} = \frac{21 \cdot 10^4 \cdot d_k^4 \cdot \pi^3 \cdot f_k}{64 \cdot L_k^2}$$

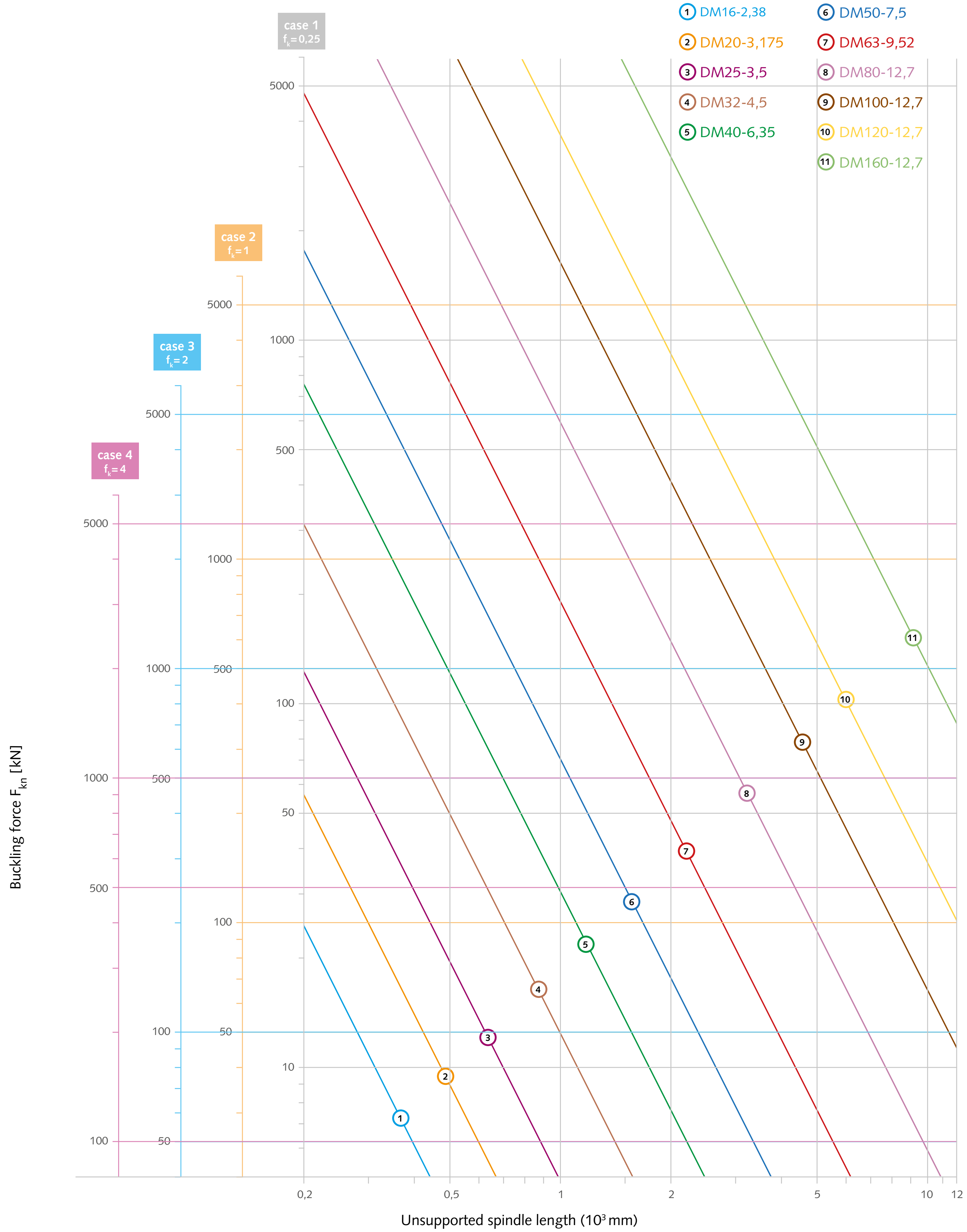
d_k = core diameter of the spindle (mm)
L_k = unsupported spindle length (mm)
f_k = correction factor for bearing type

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 * dM 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.

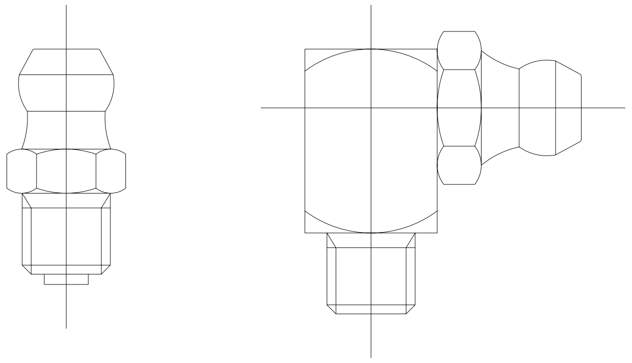
The role of lubricant
The lubricant should:
- Form a sufficient load-bearing lubricant film on the contact surfaces
- Dissipate heat (in the case of oil lubrication)
- Also seal the nut externally against solid and liquid containments (in the case of grease lubrication)
- Dampen the running noise and 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 manufacture 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 used 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
((Nominal diameter (mm)+ 0.5)2 - nominal diameter2 (mm)) x (nut length (mm)/1000) = cm³

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 lubricant grease with EP (Extreme Pressure) properties and high base oil viscosity (KP grease according to DIN 51 502) for high loads.

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.

Grease for ball screw drives

Manufacturer	Chemical composition		Temperature range [°C]		Viscosity of the base oil [mm²/s]		Speed factor
Designation	**Oil type**	**Thickener**	**from**	**to**	**40 °C**	**100 °C**	**dn**
Klüber ISOFLEX TOPAS NCA 52	Synthetic hydrocarbon	Special calcium soap	-50	130	31	5.9	1.000.000
Klüber ISOFLEX 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 classificati on, 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.

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-beating 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: ____________

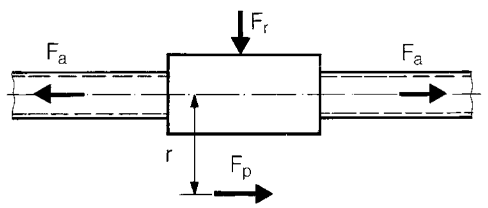
Quantity

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.

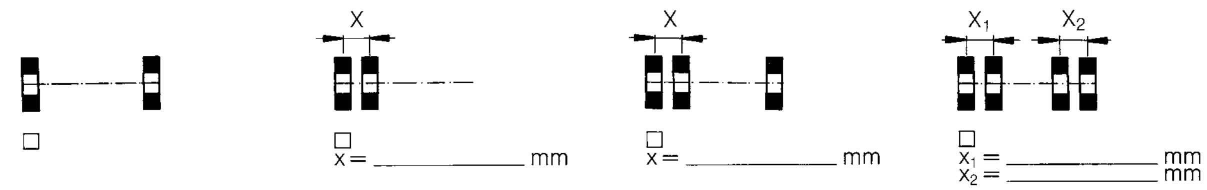
Collective load

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

1.10 Utilisation factor: $f_n = \dfrac{\text{ball screw duty (h)}}{\text{machine duty}}$

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/µm
1.16 Permissible no-load torque: ____________ Nm
1.17 Required life: ____________ operating hours, ____________ x 10^6 revolutions

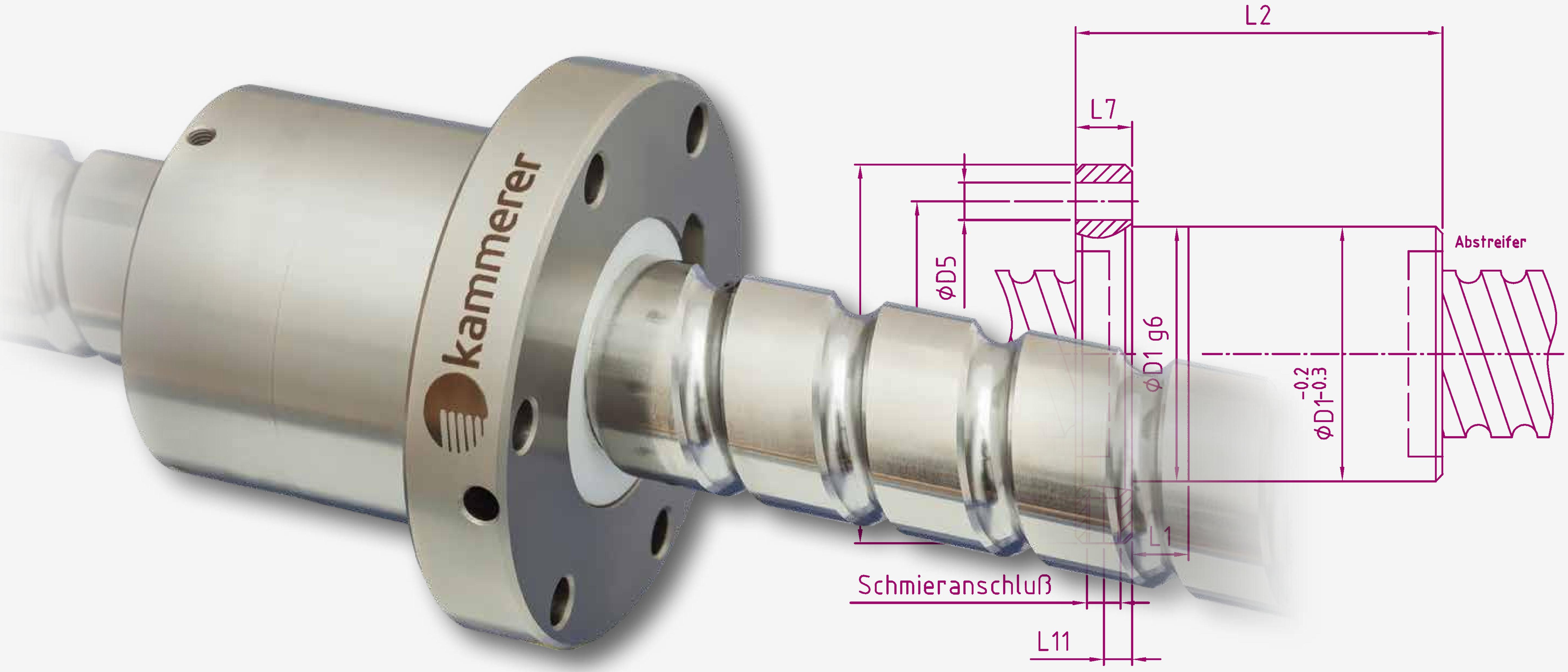
2.0 **Operating conditions**
2.1 Dust/dirt ☐ Moisture ☐ influence of chemicals ☐
2.2 Seal type: Bellows ☐ Telescopic spring ☐ Plastic wiper ☐ Felt wiper ☐
2.3 Operating temperature: ____________ °C, Ambient temperature ____________ °C
2.4 Type of lubrication: ____________
2.5 Unusual operating conditions: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

3.0 **Characteristic data of spindle**
3.1 Required nominal diameter ø A: ____________ mm
3.2 Lead P: ____________ mm
3.3 Lead direction: right-hand ☐ left-hand ☐
3.4 Permissible lead variation Δp/300 mm at 20 °C ____________ µm
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_a: ____________ µm
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 = ____________ µm at F_{va} = ____________ N
4.7 Max. reversal span δu = ____________ µm at F_{va} = ____________ 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: ____________

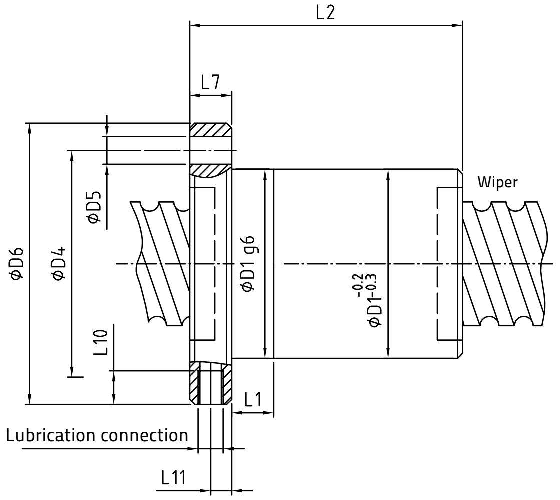
Checked and approved (customer)	Checked (Kammerer)

NUTS / SCREWS

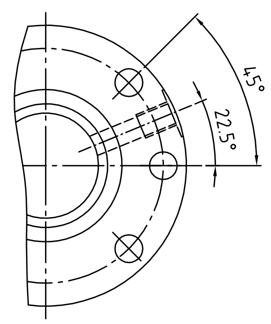

kammerer
L2
L7
ØD5
ØD1 g6
ØD1 $^{-0.2}_{-0.3}$
Abstreifer
L1
Schmieranschluß
L11

kammerer®

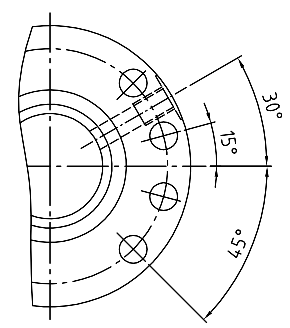
Nut dimension table **EFM** (single flange nut)



Drilling diagram 1

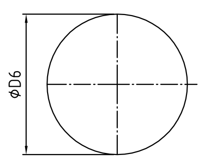


Drilling diagram 2

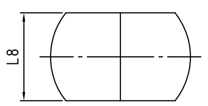


Flange shapes

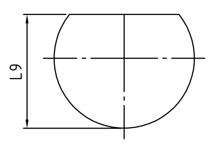
Shape A



Shape B

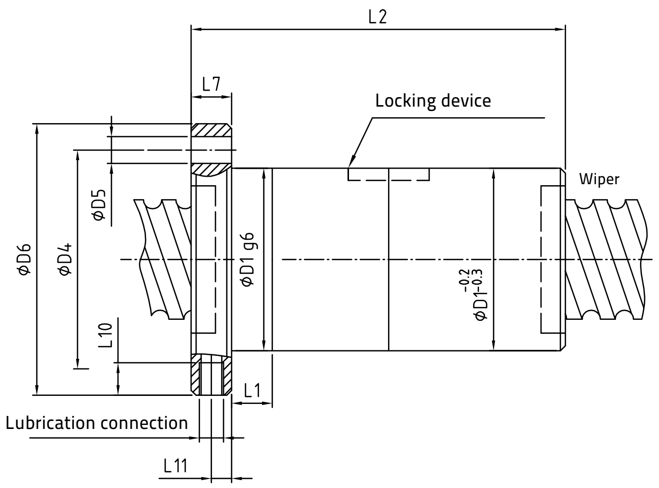


Shape C

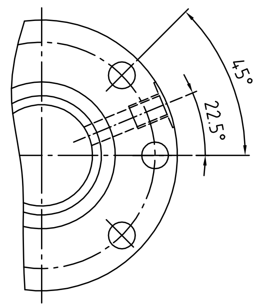


Dimensions	Spindle-Ø h6	D_w Ball-Ø	i Number of turns	Core-Ø Spindle	D_1 g6 Centring-Ø	D_4 Pitch circle-Ø	Drilling diagram	Number of mounting holes	D_5 Hole-Ø	D_6 Flange-Ø	L_1 Fit size length	L_2 Nut length	L_7 Flange width	L_8 Shape B	L_9 Shape C	L_{10} Thread depth	L_{11} Lubrication hole distance	Lubrication connection	Dynamic axial load rating C_{dyn} [kN]	Static axial load rating C_{stat} [kN]	Static axial rigidity $R_{nu,ar}$ with a preload 5% of C_{dyn} [N/μm]
16x5	16	2.38	4	14	28	38	1	6	5.5	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
32x10	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	88.8	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	199.3	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
63x50	60	7.5	3	52.8	90	108	2	8	11	125	25	220	18	95	110	10	9	M8x1	74.8	163.2	757
63x50	60	9.52	3	52.3	95	115	2	8	13.5	135	25	220	20	100	117.5	10	10	M8x1	104.2	211.9	806
80x10	80	6.35	6	75	105	125	2	8	13.5	145	16	125	20	110	127.5	10	10	M8x1	115.8	353.2	1463
80x10	80	7.5	6	72.8	108	128	2	8	13.5	148	16	125	20	113	130.5	10	10	M8x1	162.3	467.9	1641
80x20	80	12.7	4	69.5	125	145	2	8	13.5	165	25	160	25	130	147.5	10	12.5	M8x1	232.1	510.7	1314
80x20	80	12.7	6	69.5	125	145	2	8	13.5	165	25	200	25	130	147.5	10	12.5	M8x1	334.9	789.9	2012
80x40	80	12.7	4	69.5	125	145	2	8	13.5	165	25	240	25	130	147.5	10	12.5	M8x1	230.8	513.0	1414
80x60	80	12.7	3	69.5	125	145	2	8	13.5	165	25	260	25	130	147.5	10	12.5	M8x1	175.4	372.6	1025
100x10	100	6.35	6	95	125	145	2	8	13.5	165	16	125	22	130	148	10	11	M8x1	126.3	441.9	1596
100x10	100	7.5	6	92.8	128	148	2	8	13.5	168	16	125	22	133	150.5	10	11	M8x1	177.6	589.1	1804
100x20	100	12.7	4	89.5	150	176	2	8	17.5	202	25	190	30	155	178.5	10	15	M8x1	256.9	641.5	1559
100x20	100	12.7	6	89.5	150	176	2	8	17.5	202	25	220	30	155	178.5	10	15	M8x1	370.6	993.3	2370
100x40	100	12.7	4	89.5	150	176	2	8	17.5	202	25	250	30	155	178.5	10	15	M8x1	255.9	644.7	1653
120x10	120	7.5	6	112.8	150	176	2	8	17.5	202	25	125	25	155	178.5	10	12.5	M8x1	190.7	707.8	1936
120x20	120	12.7	4	109.5	170	196	2	8	17.5	222	25	180	30	175	198.5	10	15	M8x2	277.6	779.0	1756
120x20	120	12.7	6	109.5	170	196	2	8	17.5	222	25	220	30	175	198.5	10	15	M8x3	400.5	1196.4	2605
120x40	120	12.7	4	109.5	170	196	2	8	17.5	222	25	260	30	175	198.5	10	15	M8x4	276.9	775.9	1901
160x20	160	12.7	4	149.5	210	243	2	8	22	275	25	190	40	215	245	10	20	M8x5	311.9	1040.0	2028
160x20	160	12.7	6	149.5	210	243	2	8	22	275	25	230	40	215	245	10	20	M8x6	449.9	1609.2	3054
160x40	160	12.7	4	149.5	210	243	2	8	22	275	25	270	40	215	245	10	20	M8x7	311.4	1044.6	2284

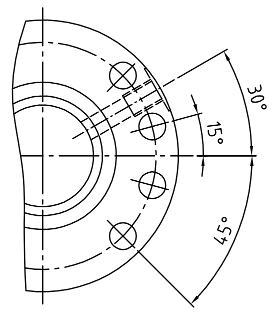
Nut dimension table **DpfM** (double flange nut)



Drilling diagram 1

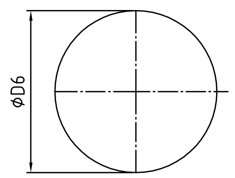


Drilling diagram 2

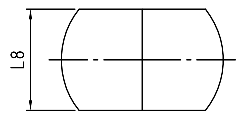


Flange shapes

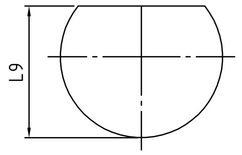
Shape A



Shape B

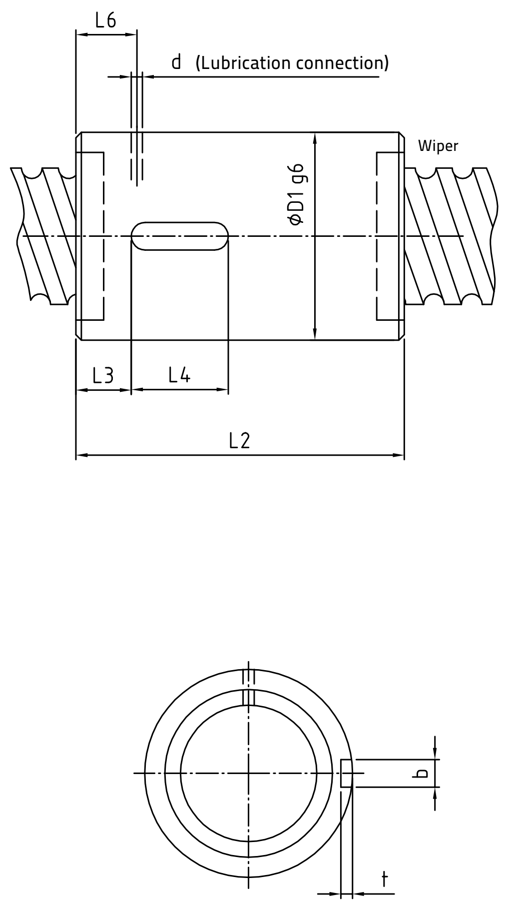


Shape C



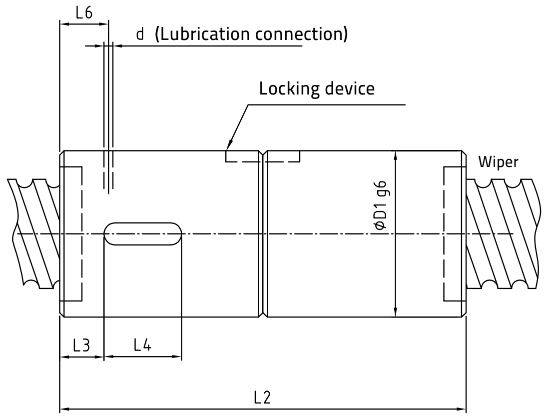
		D_w	i		D_1 g6	D_4			D_5	D_6	L_1	L_2	L_7	L_8	L_9	L_{10}	L_{11}				
Dimensions	Spindle-Ø h6	Ball-Ø	Number of turns	Core-Ø Spindle	Centring-Ø	Pitch circle-Ø	Drilling diagram	Number of mounting holes	Hole-Ø	Flange-Ø	Fit size length	Nut length	Flange width	Shape B	Shape C	Thread depth	Lubrication hole distance	Lubrication connection	Dynamic axial load rating C_{dyn} [kN]	Static axial load rating C_{stat} [kN]	Static axial rigidity $R_{nu,ar}$ with a preload 10% of C_{dyn} [N/μm]
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

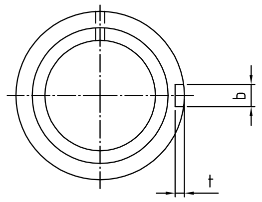
Nut dimension table **EM** (single nut)



Dimensions	Spindle-Ø h6	D_w Ball-Ø	i Number of turns	Core-Ø Spindle	D_1 g6 Centring-Ø	L_2 Nut length	L_3 Groove distance	L_4 Groove length	L_6 Hole distance	d Hole-Ø	b P9 Groove width	t Groove depth	Dynamic axial load rating C_{dyn} [kN]	Static axial load rating C_{stat} [kN]	Static axial rigidity $R_{nu,ar}$ with a preload 5% of C_{dyn} [N/μm]
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	26.9	50	60	13	20	10	4	5	2.9	28.7	58.9	570
32x10	30	4.5	5	26.4	50	80	20	28	12	4	5	2.9	40.4	76.3	629
32x10	30	6.35	4	25	56	75	20	28	12	4	5	2.9	51.8	83.0	523
32x20	30	6.35	3	25	56	95	20	28	12	4	5	2.9	39.4	60.3	398
32x32	30	6.35	2	25	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	52.3	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	1559
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

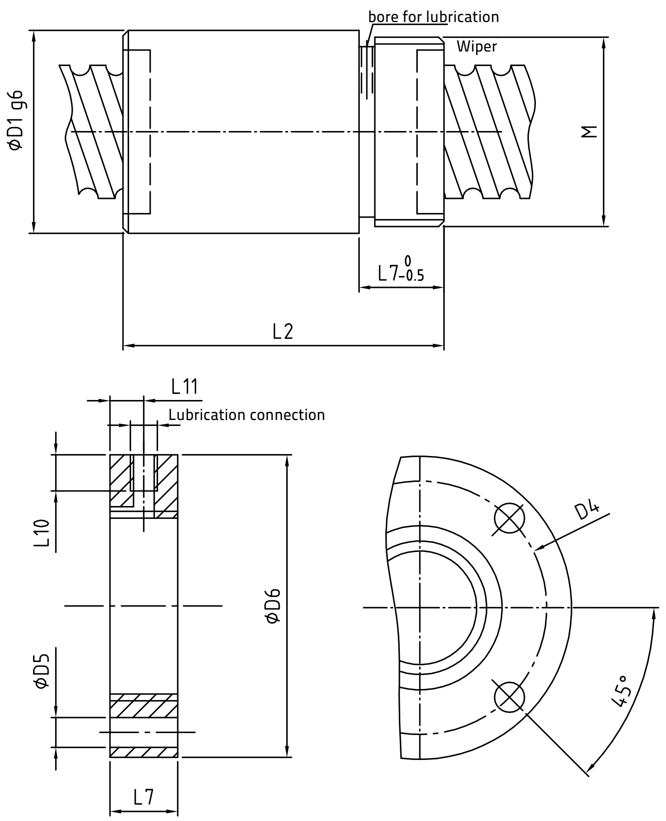
Nut dimension table **DpM** (double nut)





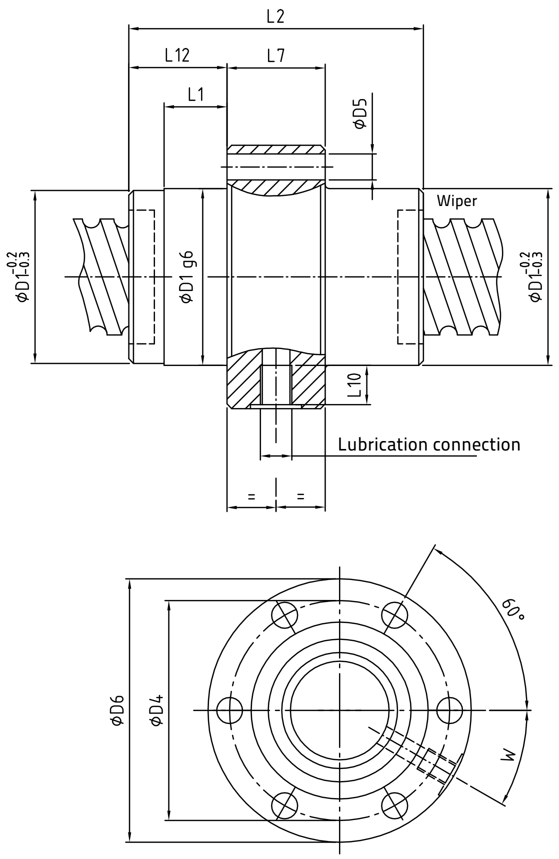
Dimensions	Spindle-Ø h6	D_w	i	Core-Ø Spindle	D_1 g6	L_2	L_3	L_4	L_6	d	b P9	t	Dynamic axial load rating C_{dyn} [kN]	Static axial load rating C_{stat} [kN]	Static axial rigidity $R_{nu,ar}$ with a preload 10% of C_{dyn} [N/µm]
		Ball-Ø	Number of turns		Centring-Ø	Nut length	Groove distance	Groove length	Hole distance	Hole-Ø	Groove width	Groove depth			
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	559
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	3.5	5	26.9	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 **EZM** (screwed inserts)



Dimensions	Spindle-Ø h6	D_w	i		D_1 g6	D_4	Number of mounting holes	D_5	D_6	L_2	L_7	L_{10}	L_{11}	Lubrication connection	M	Dynamic axial load rating C_{dyn} [kN]	Static axial load rating C_{stat} [kN]	Static axial rigidity $R_{nu,ar}$ with a preload 5% of C_{dyn} [N/µm]
		Ball-Ø	Number of turns	Core-Ø Spindle	Centring-Ø	Pitch circle-Ø		Hole-Ø	Flange-Ø	Total length	Flange width	Groove depth	Lubrication distance		Thread			
16x5	16	3.175	3	14	32	45	4	6	60	42	12	8	6	M6	M26x1.5	11.7	16.1	210
20x5	20	3.175	4	17.3	40	55	4	7	70	52	12	8	6	M6	M35X1.5	17.1	27.9	338
20x10	20	4.5	3	16.4	40	55	4	7	70	65	12	8	6	M6	M35x1.5	20.6	28.9	273
25x5	24	3.5	5	20.9	45	65	4	9	84	60	15	8	7.5	M6	M40x1.5	25.9	46.8	490
25x10	24	3.5	3	20.9	45	65	4	9	84	60	12	8	6	M6	M40x1.5	16.2	26.6	299
32x5	30	3.5	5	26.9	52	72	4	9	90	60	15	8	7.5	M6	M48x1.5	28.7	58.9	574
32x10	30	6.35	4	25	56	80	4	11	100	80	15	8	7.5	M6	M52x1.5	51.8	83.0	523
40x5	38	3.5	6	34.9	65	90	4	11	110	70	18	10	9	M8x1	M60x1.5	37.2	91.5	815
40x10	38	6.35	4	33	65	90	4	11	110	88	18	10	9	M8x1	M60x1.5	58.4	106.8	632
40x20	38	6.35	2	33	65	90	4	11	110	88	18	10	9	M8x1	M60x1.5	30.2	48.5	305
40x30	38	6.35	2	33	65	90	4	11	110	100	18	10	9	M8x1	M60x1.5	29.9	49.2	313
50x10	48	7.5	5	40.8	80	110	4	14	135	100	20	10	10	M8x1	M75x1.5	110.0	225.7	1028
50x20	48	7.5	3	40.8	80	110	4	14	135	114	20	10	10	M8x1	M75x1.5	68.6	129.9	633
63x10	60	7.5	6	52.8	95	125	6	14	150	120	20	10	10	M8x1	M90x1.5	143.6	346.6	1441
63x20	60	8	4	53.3	95	125	6	14	150	138	20	10	10	M8x1	M90x1.5	109.1	242.2	1030
63x40	60	8	2	53.3	95	125	6	14	150	138	20	10	10	M8x1	M90x1.5	56.3	109.8	497

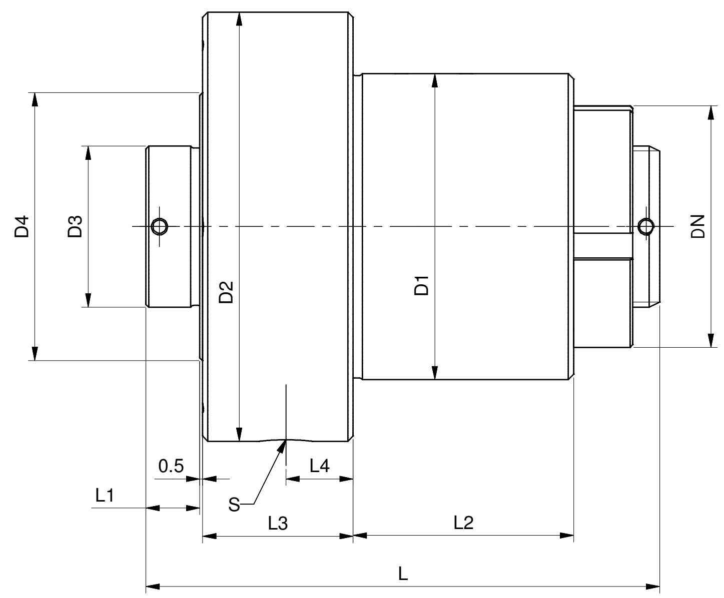
Nut dimension table **MFM** (middle flange nut)

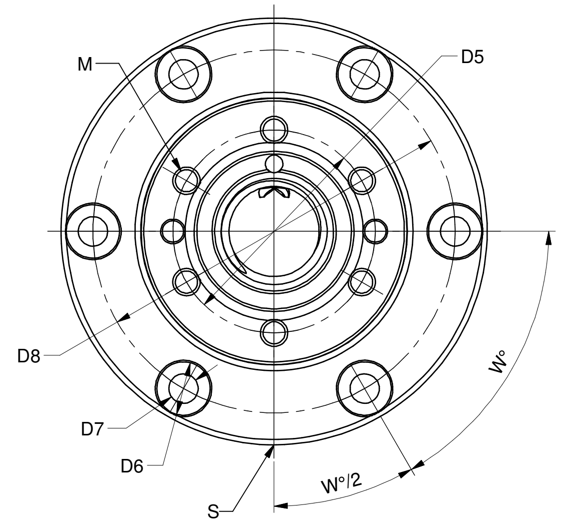


Dimensions	Spindle-Ø h6	D_w	i		D_1 g6	D_4	Number of mounting holes	D_5	D_6	L_1	L_2	L_7	W	L_{10}	L_{12}	Lubrication connection	Dynamic axial load rating C_{dyn} [kN]	Static axial load rating C_{stat} [kN]	Static axial rigidityt $R_{nu,ar}$ with a preload 5% of C_{dyn} [N/µm]
		Ball-Ø	Number of turns	Core-Ø Spindle	Centring-Ø	Pitch circle-Ø		Hole-Ø	Flange-Ø	Fit size length	Total length	Flange width	Angle	Thread depth	Neck length				
16x10	16	2.38	3	14	33	45	6x60°	6.6	58	10	45	15	40	8	15	M6	8.0	12.2	208
16x16	16	2.38	2	14	33	45	6x60°	6.6	58	10	55	15	40	8	20	M6	5.3	7.6	134
20x10	20	3.175	4	17.2	38	50	6x60°	6.6	63	10	64	20	30	8	22	M6	17.0	27.6	345
20x20	20	3.175	2	17.2	38	50	6x60°	6.6	63	10	64	20	30	8	22	M6	8.7	12.8	167
25x20	24	4.5	3	20.4	48	60	6x60°	6.6	73	16	90	25	42	8	32.5	M6	22.4	34.5	318
25x25	24	4.5	2	20.4	48	60	6x60°	6.6	73	16	80	25	42	8	27.5	M6	15.0	21.9	200
32x20	30	6.35	3	25	56	68	6x60°	6.6	80	16	88	20	30	8	34	M6	39.4	60.3	398
32x32	30	6.35	2	25	56	68	6x60°	6.6	80	16	92	20	30	8	36	M6	26.2	37.6	244
40x20	38	6.35	3	33	63	78	6x60°	9	95	16	88	25	30	10	31.5	M8x1	44.5	77.9	472
40x40	38	6.35	2	33	72	90	6x60°	11	110	16	113	40	41	10	36.5	M8x1	29.6	48.2	304
50x20	48	9.52	3	40.3	85	105	6x60°	11	125	16	92	30	30	10	31	M8x1	94.8	165.1	646
50x40	48	9.52	2	40.3	85	105	6x60°	11	125	16	113	30	30	10	41.5	M8x1	63.4	102.6	428
63x40	60	9.52	2	52.3	95	118	6x60°	14	140	16	120	30	20	10	45	M8x1	71.3	131.6	510
63x50	60	9.52	2	52.3	95	118	6x60°	14	140	16	140	30	20	10	55	M8x1	70.8	130.1	503
80x40	80	12.7	2	69.5	125	152	6x60°	18	180	16	133	30	30	10	51.5	M8x1	120.2	236.3	668
80x60	80	12.7	2	69.5	125	152	6x60°	18	180	16	165	30	30	10	67.5	M8x1	119.1	232.9	663

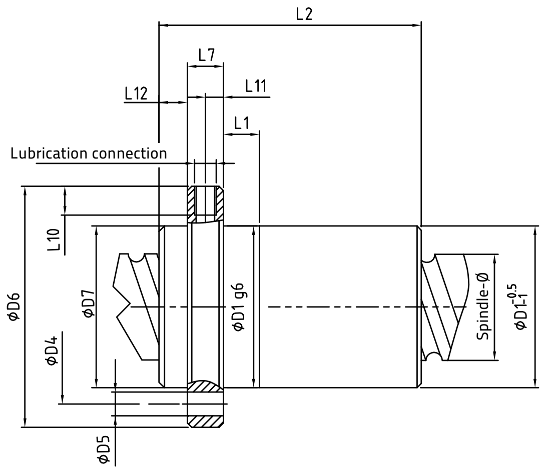
Nut dimension table for **driven nuts**

Dimen-sions	Max. lead	D_w Ball-Ø	i Number of turns	n Limiting speed [rpm]	D1 g6 Cen-tring-Ø	D2	D3 g6	$D4_{-0,2}$	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 $R_{nu,ar}$ with a preload 5% of C_{dyn} [N/µm]
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	3.5	6	3000	70	95	43	65	52	11	6.6	82	58	119	15	50	35	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	723
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	1066
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	2588
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



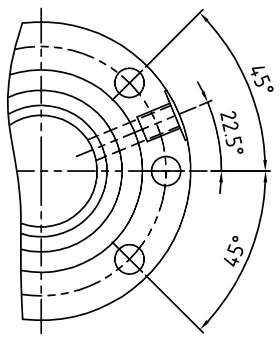


Nut dimension table for **Herkules heavy-duty range**

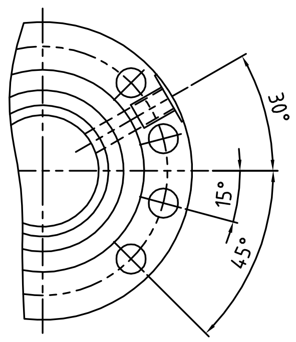


Dimensions	Spindle-Ø h6	D_w Ball-Ø	i Number of turns	Core-Ø Spindle	D_1 g6 Centring-Ø	D_4 Pitch circle-Ø	Drilling diagram	Number of mounting holes	D_5 Hole-Ø	D_6 Flange-Ø	D_7 Diameter behind flange	L_1 Fit size length	L_2 Nut length	L_7 Flange width	L_8 Shape B	L_9 Shape C	L_{10} Thread depth	L_{11} Lubrication hole distance	L_{12} Width behind flange	Lubrication connection	Dynamic axial load rating C_{dyn} [kN]	Static axial load rating C_{stat} [kN]
80x20	80	15	6	68.6	135	155	2	8	13.5	175	0	25	230	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	310	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

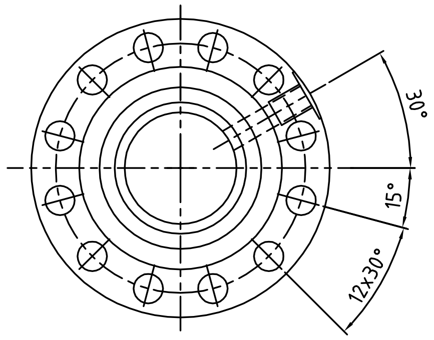
Drilling diagram 1



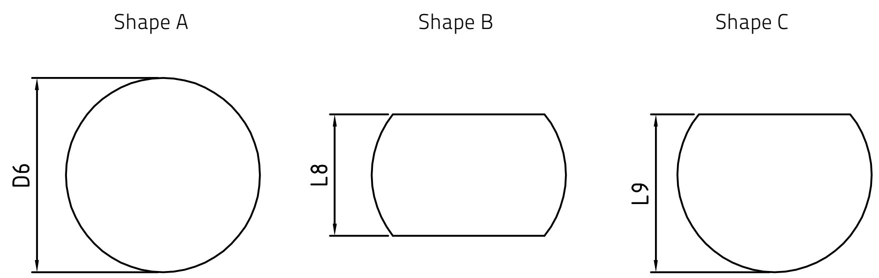
Drilling diagram 2



Drilling diagram 3



Flange shapes



Ground miniature ball screw drives

Spindle type	Dimensions	Figure	D_w Ball-Ø	d_1 Collar-Ø	d_2 Fit-Ø	M-thread	d_3 Fit-Ø	d_4 Fit-Ø	L_1 Collar length	L_2 Neck length	L_3 Journal length	L_4 Journal length	L_5 M-thread start	WAF	WAF length
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

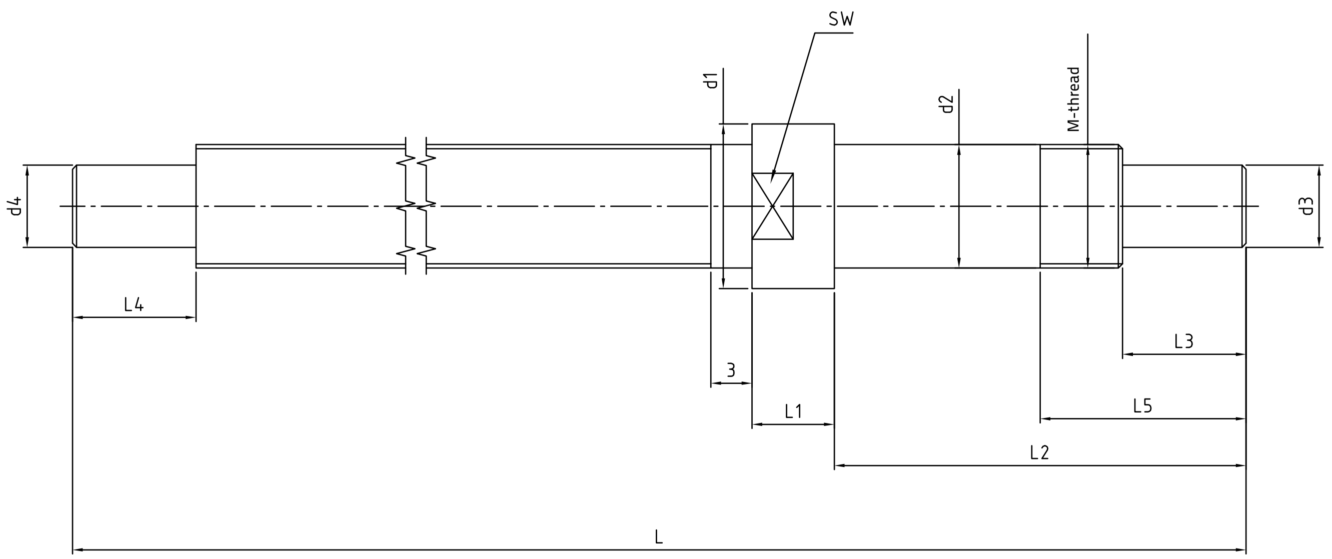
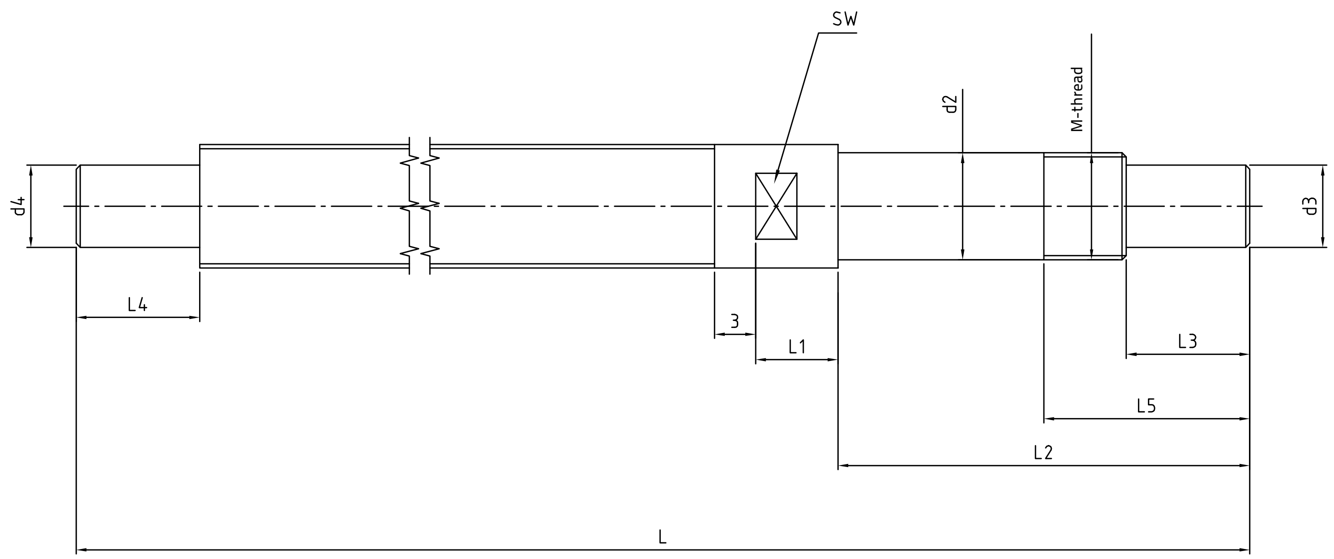
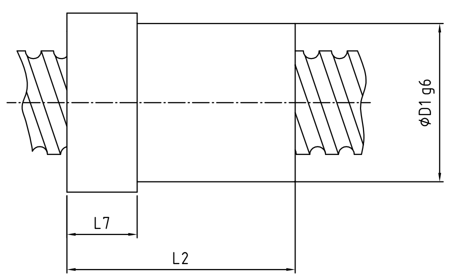
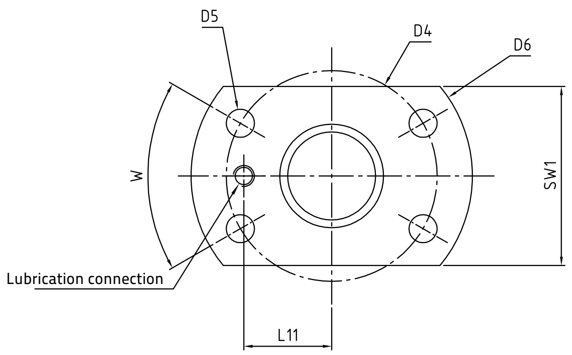


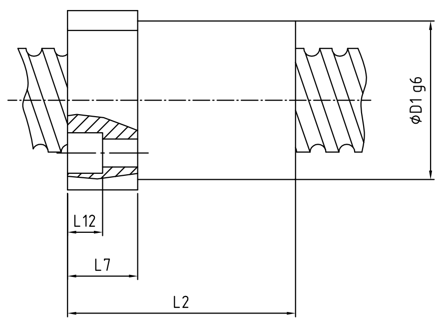
Figure B

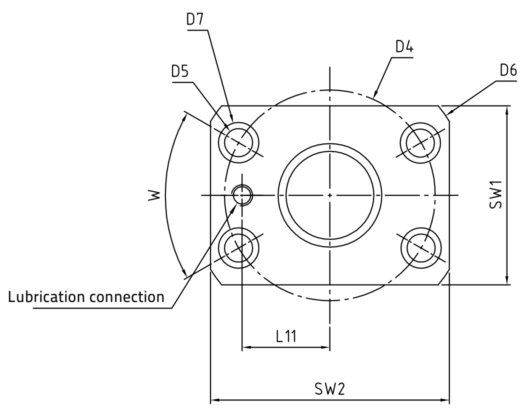


Miniature single flange nuts







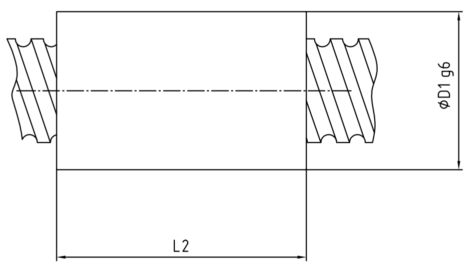


Nut type	Dimensions	D_w Ball-Ø	i Number of turns	D_1 g6 Centring-Ø	L_2 Nut length	L_7 Flange width	D_6 Flange-Ø	SW1	SW2	D_4 Pitch circle-Ø	W Drilling pattern angle [°]	Number of mounting holes	D_5 Hole-Ø	Wiper	Lubrication connection	L_{11} Lubrication connection distance	D_7 Sink diameter	L_{12} Depth of sink	C_{dyn} [N]	C_{stat} [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	28	19	-	22	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



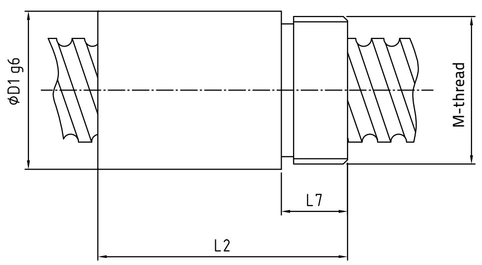
Nut type	Dimensions	D_w	i	D_1 g6	L_2	Wiper	C_{dyn} [N]	C_{stat} [N]	max. speed [rpm]
		Ball-Ø	Number of turns	Centring-Ø	Nut length				
EM-A	3x1	0.8	2	7	7.5	no	230	260	4200
EM-B	3x1	0.8	2	9	7.5	no	230	260	4200
EM-A	4x0.5	0.5	2	7	7	no	125	140	4000
EM-B	4x0.5	0.5	3	7	9	no	150	170	4000
EM-A	4x1	0.8	2	10	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	2230	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_w	i	D_1 g6	L_2	Wiper	C_{dyn} [N]	C_{stat} [N]	max. speed [rpm]
		Ball-Ø	Number of turns	Centring-Ø	Nut length				
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_w	i	D_1 g6	L_2	L_7	M-thread	Wiper	C_{dyn} [N]	C_{stat} [N]	max. speed [rpm]
		Ball-Ø	Number of turns	Centring-Ø	Nut length	Flange width					
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	16x1	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	16x1	no	2000	2300	4500
EZM-A	8x5	1.6	3	16.5	30	8	14x1	no	2000	2230	4000
EZM-B	8x5	1.6	3	17.5	30	8	16x1	no	2000	2230	4000
EZM-A	10x2	1.6	3	18	28.5	7	16x1	yes	2400	2950	4000

Nut type	Dimensions	D_w	i	D_1 g6	L_2	L_7	M-thread	Wiper	C_{dyn} [N]	C_{stat} [N]	max. speed [rpm]
		Ball-Ø	Number of turns	Cen-tring-Ø	Nut length	Flange width					
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	18x1	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	20.5	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

kammerer

Leads – Overview

	Spindle ø	Lead – standard												
KGT 8	8	2	2,5			5								
KGT 10	10	2		3		5		8						
KGT 12	12	2		3	4	5								
KGT 16	16					5			10					
KGT 20	20				4	5	6			20				
KGT 25	24				4	5	6	8	10					
KGT 32	30					5	6	8	10	20	30			
KGT 40	38					5	6	8	10	20		40		
KGT 50	48					5		8	10	20			50	
KGT 63	60							8	10	20		40		60
KGT 80	80								10	20		40		60
KGT 100	100								10	20		40		60
KGT 120	120								10	20		40		60
KGT 160	160								10	20		40		60

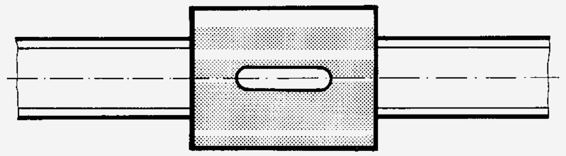
= preferred standard range

We can supply **any lead** on request (maximum lead = 2 x diameter). The spindle length can be up to 6000 mm depending on the diameter. Even special lengths are no problem for us.

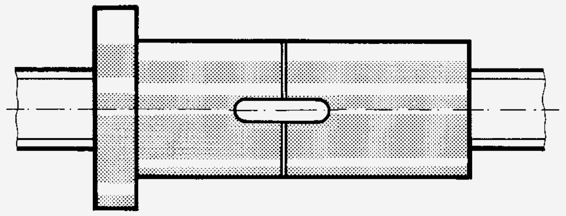
How accurate are the leads and how are they produced? The lead accuracies are in accordance with DIN 69051, Part 3: 3/5/7/10. Test certificates can be provided. Depending on the application, the leads are ground, fine turned or rolled.

Nut systems

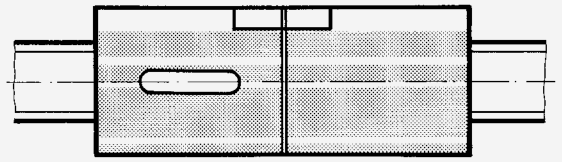
Cylindrical single nut



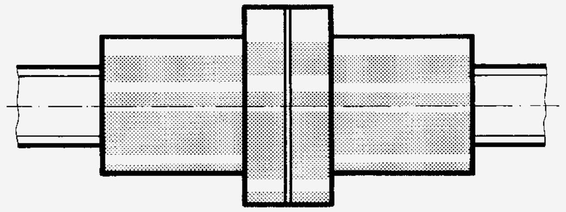
Pre-loaded flanged double nut



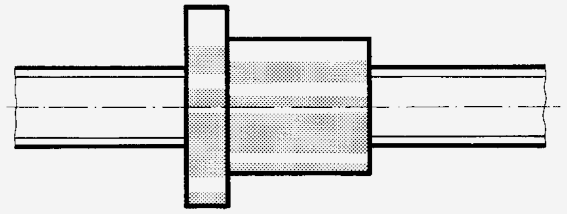
Cylindrical double nut



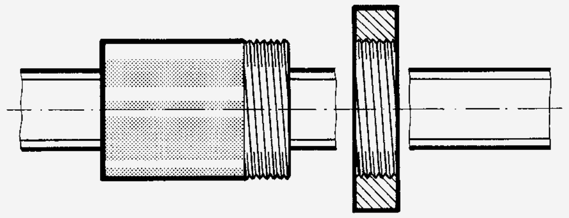
Pre-loaded centre-flanged double nut



Flanged single nut or internally pre-loaded flanged single nut



Single nut with and without screw flange



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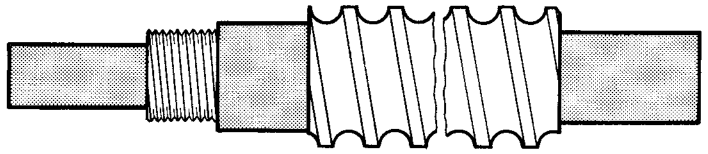
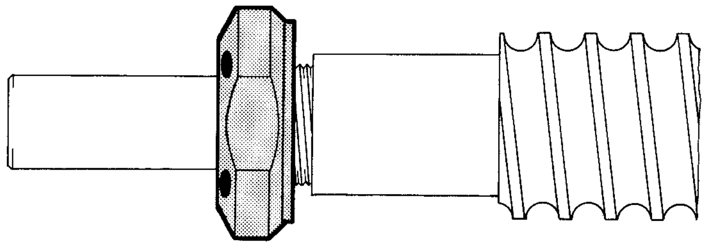
ACCESSORIES

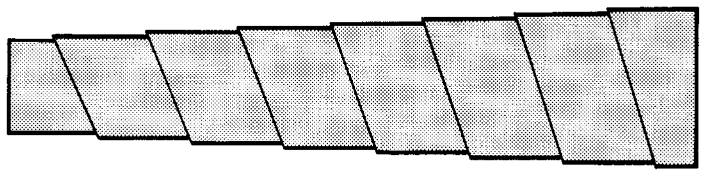
Spindle ends



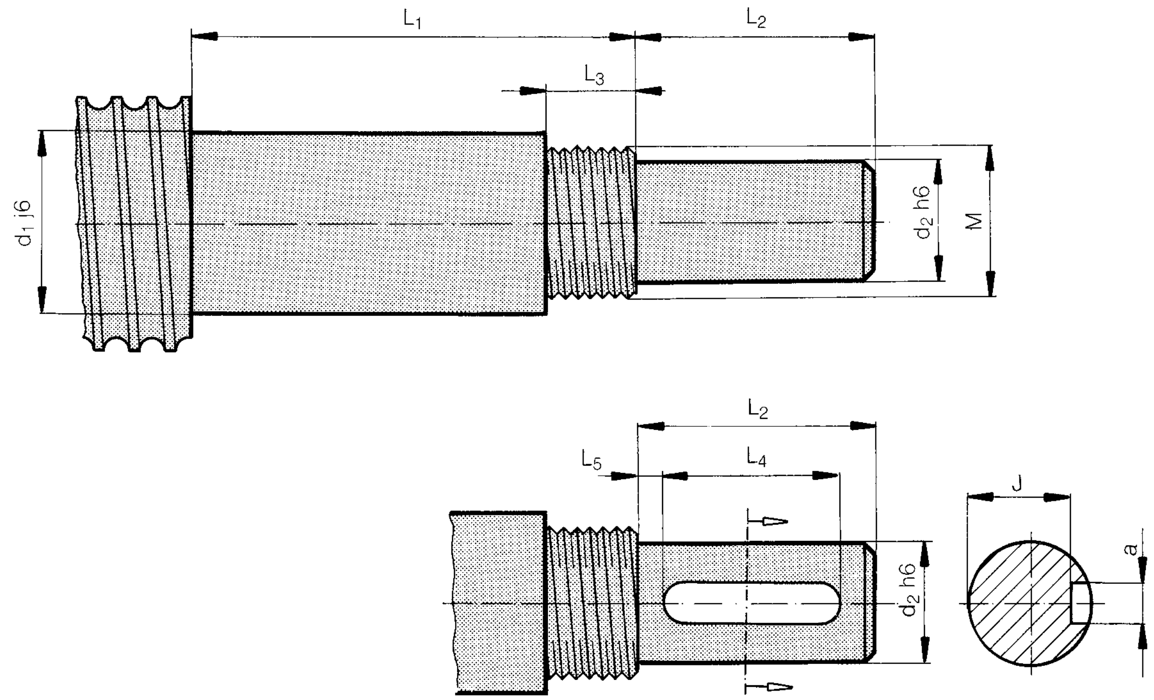
KMT nuts



Spiral spring covers



Standard spindle ends

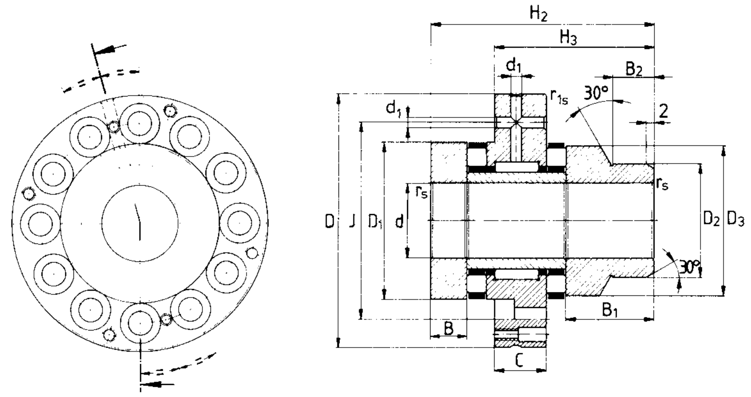


KGT	d_1 j6	d_2 h6	L_1	L_2	L_3	L_4	L_5	M	J	a_{P9}	Bearing ZARF/LTN	Lock nut
25 x 5	15	12	70	25	18	16	3	M 15x1	9,5	4	1560 LTN	KMT 2 M 15x1
32 x 5	20	15	79	30	20	22	4	M 20x1	12,0	5	2068 LTN	KMT 4 M 20x1
32 x 10	20	15	94	30	20	22	4	M 20x1	12,0	5	2080 LTN	KMT 4 M 20x1
40 x 5	25	20	86	40	22	28	5	M 25x1,5	16,5	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

kammerer

Needle axial cylinder roller bearings

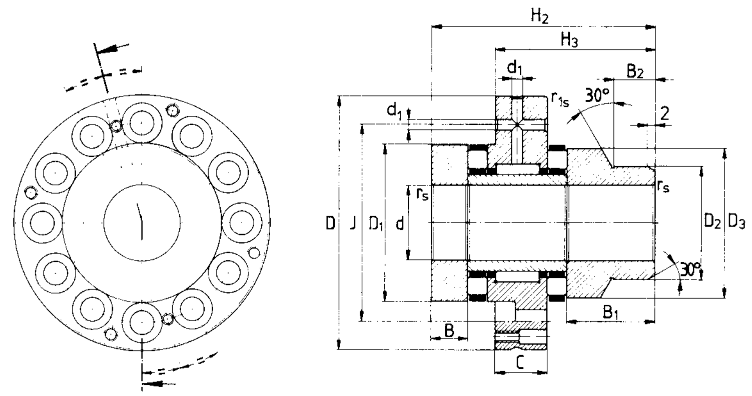
Range ZARF ... L
Light duty range



Shaft diameter	Code	Weight kg	Dimensions																	Fixing screws DIN 912[1] 10.9 Anz.		Ratings				Limiting speed		Axial rigidity c_{al} N/µm
			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 N	stat. C_0 N	radial dyn. C N	stat. C_0 N	n_g oil rpm	n_g 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	2.000	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

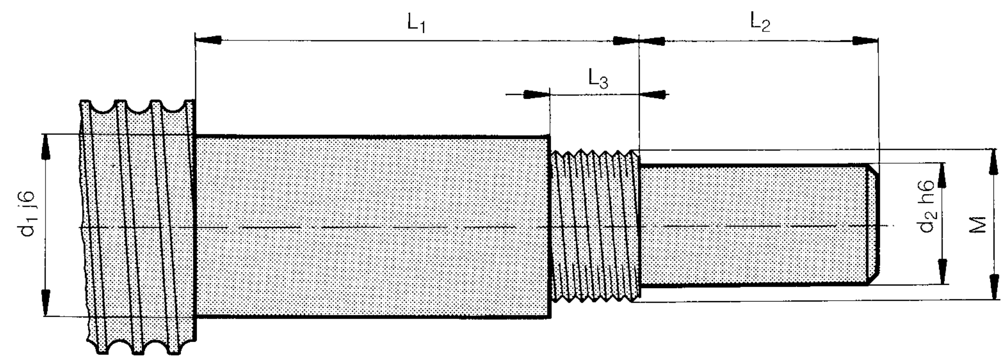
Needle axial cylinder roller bearings

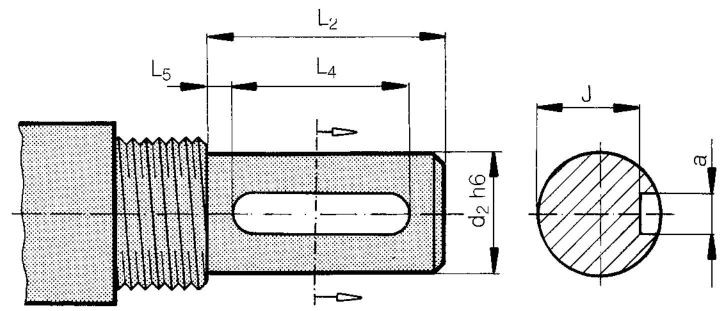
Range ZARF ... L
Heavy duty range



Shaft diameter	Code	Weight kg	Dimensions																	Fixing screws DIN 912[1] 10.9 Anz.		Ratings				Limiting speed		Axial rigidity c_{al} N/µm
			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 N	stat. C_0 N	radial dyn. C N	stat. C_0 N	n_g oil rpm	n_g 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	M6	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	M6	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

Standard spindle ends

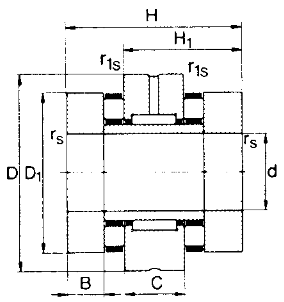




KGT	d_1 j6	d_2 h6	L_1	L_2	L_3	L_4	L_5	M	J	a_{P9}	Bearing ZARF/TN	Lock nut
25 x 5	15	12	57	25	18	16	3	M 15x1	9,5	4	1545 TN	KMT 2 M 15x1
32 x 5	20	15	65	30	20	22	4	M 20x1	12,0	5	2052 TN	KMT 4 M 20x1
32 x 10	20	15	79	30	20	22	4	M 20x1	12,0	5	2062 TN	KMT 4 M 20x1
40 x 5	25	20	71	40	22	28	5	M 25x1,5	16,5	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

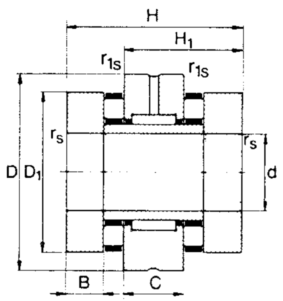
Range ZARN
Light duty range



Shaft diameter	Code	Weight kg	Dimensions 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.	Ratings axial dyn. C N	stat. C_0 N	radial dyn. C N	stat. C_0 N	Limiting speed n_g oil rpm	n_g grease rpm	Axial rigidity c_{al} N/µm
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	46	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

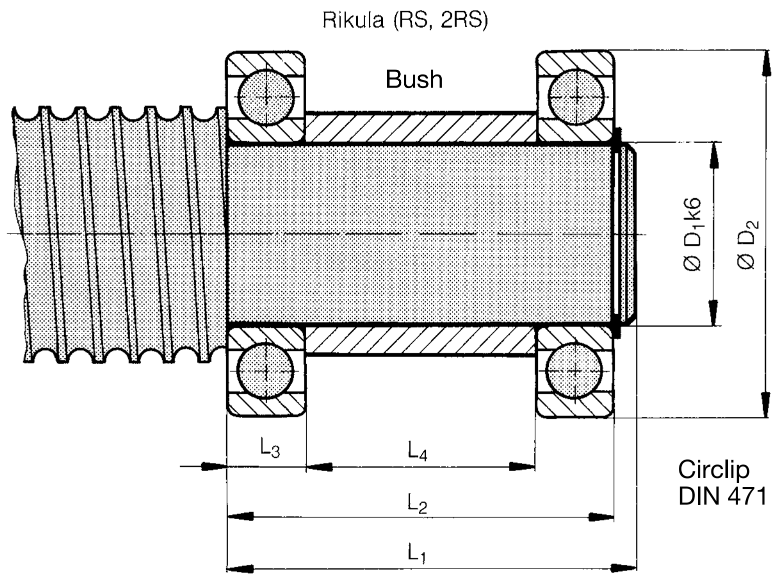
Needle axial cylinder roller bearings

Range ZARN
Heavy duty range



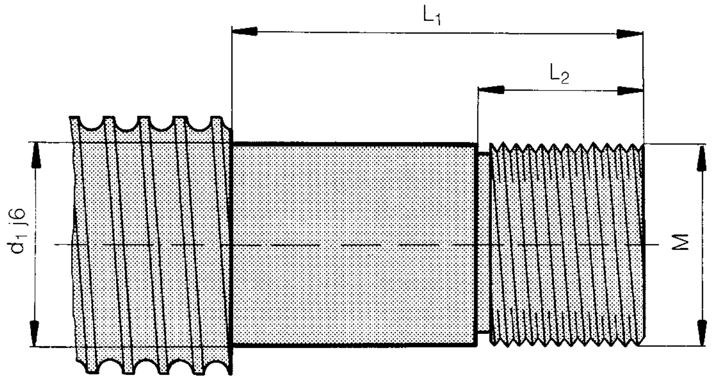
Shaft diameter	Code	Weight kg	Dimensions d	D	H	H_1	H_2	H_3	C	D_1	D_2	D_3	B	B_1	B_2	r_s min.	r_{1s} min.	Ratings axial dyn. C N	stat. C_0 N	radial dyn. C N	stat. C_0 N	Limiting speed n_g oil rpm	n_g grease rpm	Axial rigidity c_{al} N/µm
20	ZARN 2062 TN	0,87	20	62	60	40	–	–	20	52	–	–	12,5	–	–	0,3	0,6	64.000	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	78	–	–	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

Standard spindle ends



KGT	D_1 k6	D_2	L_1	L_2	L_3	L_4	Rikula 2RS Size	Bush ø x ø x L_4	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 j6	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

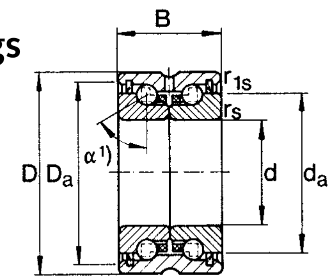
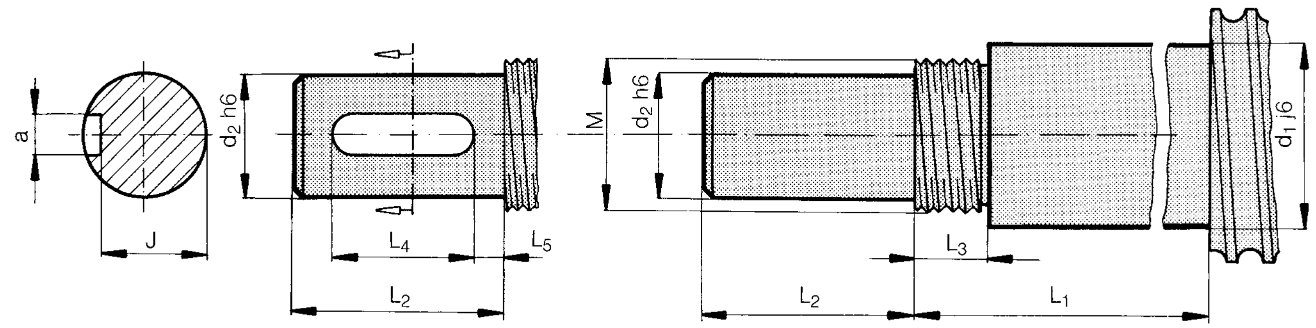


Table of dimensions. Dimensions in mm

Shaft diameter	Code	Weight kg	Dimensions d −0,005	D −0,010	B −0,25	r_s min.	r_{1s} min.	J	d_1	b	l	Connection dimensions D_a max.	d_a min.	Fixing screws DIN 912 10.9 Anz.		Ratings dyn. C N	stat. C_0 M	Limiting speed n_g grease rpm	Axial rigidity c_{al} N/µm
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

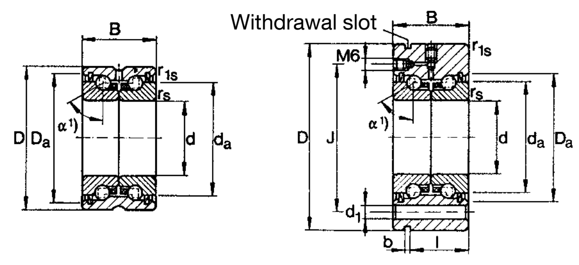


KGT	d_1 j6	d_2 h6	L_1	L_2	L_3	L_4	L_5	M	J	a_{P9}	Bearing ZKLF/2RS	Lock nut
16x5–10	12	10	40	20	16	16	1	M12 x 1	8,2	3	1255	KMT 1 M12 x 1
20x5–20	15	12	42	23	18	16	3	M15 x 1	9,5	4	1560	KMT 2 M15 x 1
25x5–10	20	15	47	30	20	22	3	M20 x 1	12,0	5	2068	KMT 4 M20 x 1
32x5–10	25	20	49	40	22	28	4	M25 x 1,5	16,5	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

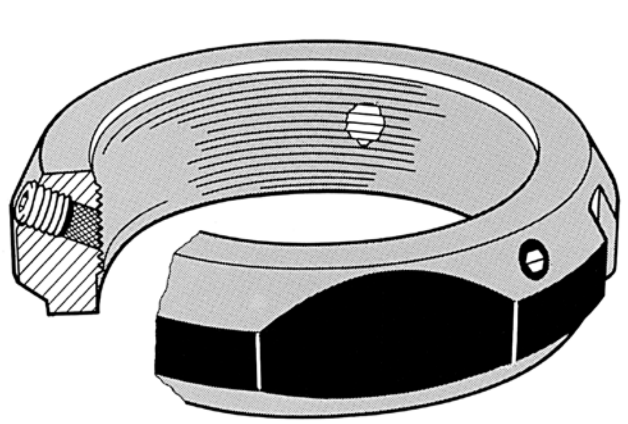


ZKLN...2RS ZKLF...2RS

Table of dimensions. Dimensions in mm

Shaft diameter	Code	Weight kg	Dimensions d −0,005	D −0,010	B −0,25	r_s min.	r_{1s} min.	J	d_1	b	l	Connection dimensions D_a max.	d_a min.	Fixing screws DIN 912 10.9 Anz.		Ratings dyn. C N	stat. C_0 N	Limiting speed n_g grease rpm	Axial rigidity c_{al} N/µm
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 1255.2RS	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	M8	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

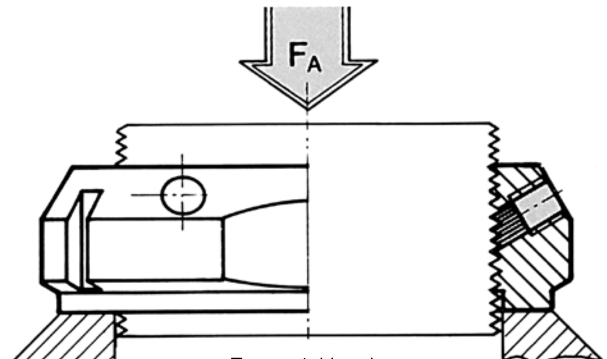
The locking pins are pressed against the shaft thread with the help of adjusting screws.
Axial forces are absorbed by the flanks of the thread and not by the locking pins. Securing the nut against turning is based exclusively on the friction between the pins and the screw thread. As the locking pins 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.

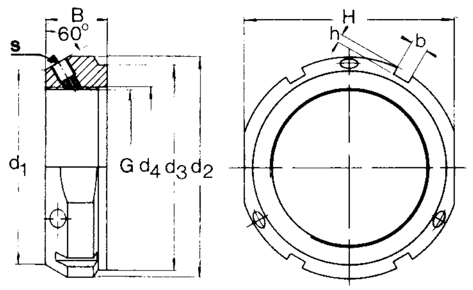


F_A = axial load

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 releas ed 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								–	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

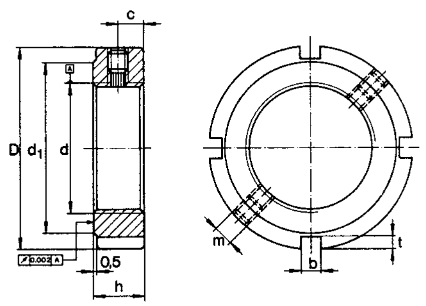


Table of dimensions. Dimensions in mm

Thread d	Code	Weight kg	Dimensions									Axial breaking load F F_{aB}
			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	16.600
M 8 x 0,75	ZM 08	0,01	16	8	3	2	12	–	–	4	M4	23.300

Spiral spring covers

… protect shafts, spindles, columns and screws against con ta mination and damage and reduce the risk of accident in this area.
… can be used in all swarf-producing and swarfless ma chines, 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 the diameters and installation lengths shown below. Different strip widths guarantee faultless operation for the different stroke lengths.
… 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 accomodate 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_a 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.

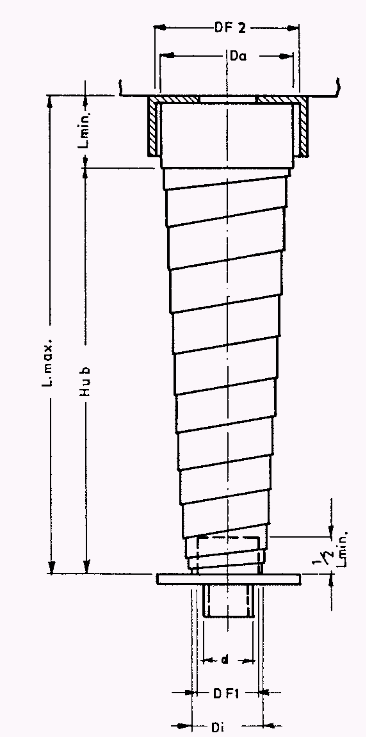
Explanation of drawing::

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

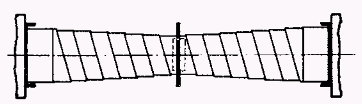
DF_1 = outside diameter of the centring flange (D_1 – 2 mm)
DF_2 = inside diameter of the centring flange (D_a + 4 mm)
Stroke = largest possible travel

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.



Can be fitted horizontally and vertically



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

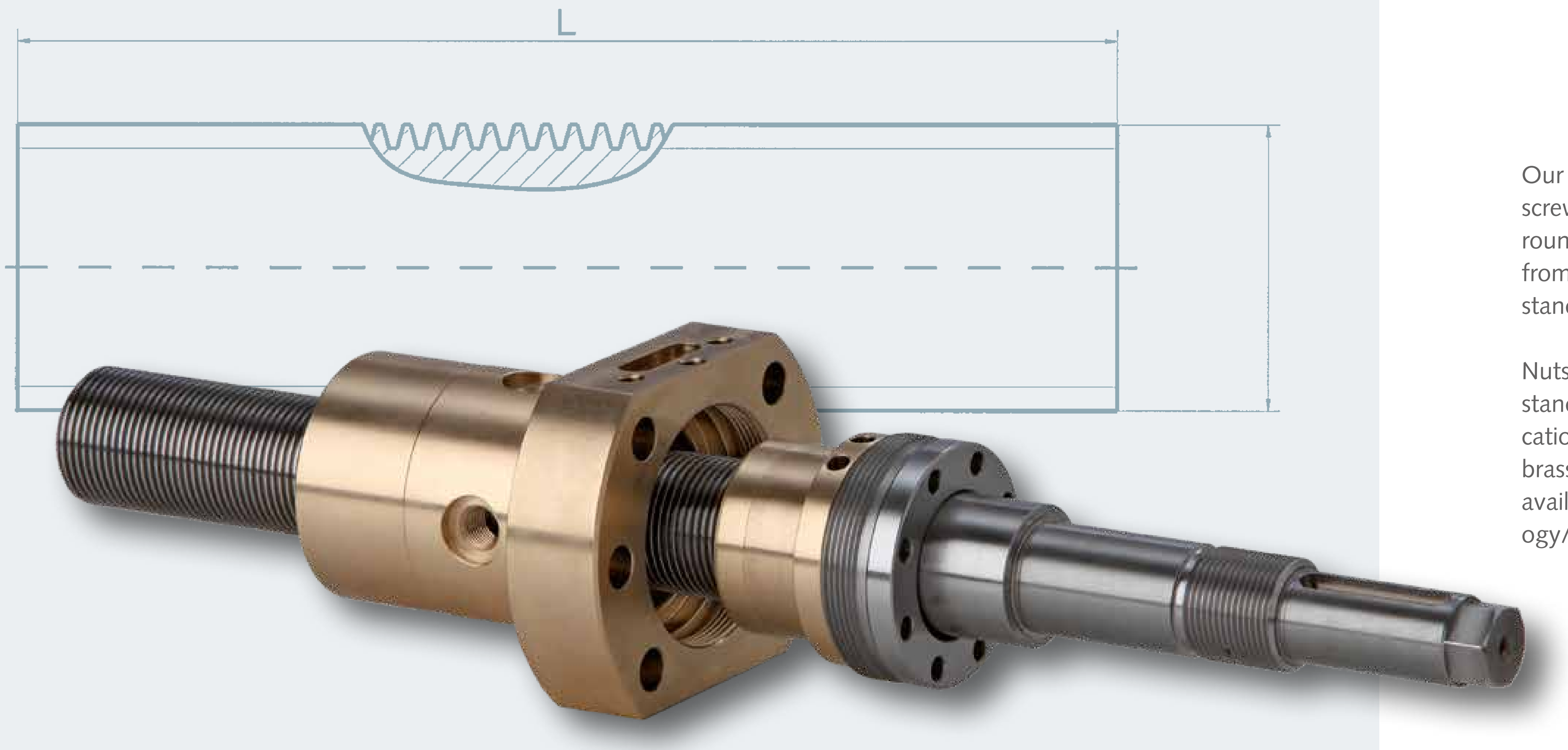
All dimensions in mm

Type	D_1 ± 1 mm	D_a ± 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 30/250/30	30	44	250	30
SF 30/350/30	30	49	350	30
SF 30/450/40	30	53	450	40
SF 30/550/40	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 40/250/30	40	56	250	30
SF 40/350/30	40	60	350	30
SF 40/450/40	40	63	450	40
SF 40/550/40	40	68	550	40
SF 40/350/50	40	55	350	50
SF 40/450/50	40	58	450	50
SF 40/550/50	40	61	550	50
SF 40/650/50	40	65	650	50
SF 40/750/50	40	69	750	50
SF 40/450/60	40	55	450	60
SF 40/550/60	40	58	550	60
SF 40/650/60	40	62	650	60
SF 40/750/60	40	66	750	60
SF 40/900/60	40	70	900	60
SF 40/650/75	40	62	650	75
SF 40/750/75	40	66	750	75
SF 40/900/75	40	72	900	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	66	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 50/250/30	50	68	250	30
SF 50/250/50	50	62	250	50
SF 50/350/50	50	66	350	50
SF 50/450/50	50	70	450	50
SF 50/550/50	50	73	550	50
SF 50/550/60	50	68	550	60
SF 50/650/60	50	72	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 ± 1 mm	D_a ± 2 mm	L max.	L min.
SF 50/1700/120	50	91	1700	120
SF 50/1900/120	50	95	1900	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 55/250/50	55	66	250	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 65/1800/100	65	117	1800	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	136	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 75/650/75	75	99	650	75
SF 75/750/75	75	104	750	75
SF 75/900/75	75	111	900	75
SF 75/1100/100	75	108	1100	100
SF 75/1300/100	75	112	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 90/150/50	90	112	150	50
SF 90/250/50	90	116	250	50
SF 90/350/50	90	121	350	50
SF 90/350/60	90	112	350	60
SF 90/450/60	90	114	450	60
SF 90/450/75	90	114	450	75
SF 90/550/75	90	119	550	75
SF 90/650/75	90	124	650	75
SF 90/750/100	90	115	750	100
SF 90/900/100	90	120	900	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	149	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 110/350/75	110	130	350	75
SF 110/450/75	110	135	450	75
SF 110/600/75	110	140	600	75
SF 110/650/100	110	129	650	100
SF 110/750/100	110	133	750	100
SF 110/900/100	110	138	900	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
SF 110/2800/200	110	172	2800	200

TRAPEZOIDAL / SLIDING SCREWS



Our sliding screws product group includes classic trapezoidal screws and also metric threads, saw-tooth threads, ACME and round threads. We produce all of these with diameters ranging from 6 to 160 mm. Screw lengths up to 6 m are available as standard and screws up to 12 m can be produced on request.

Nuts are available in flange or round versions as our in-house standard or we can produce them according to your specifications. Sliding screw nuts are usually made of bronze or red brass, other materials, such as steel, plastic and cast iron are also available. Our in-house standard is explained in the "Technology/calculations" section. Stainless versions are also possible.

APPLICATIONS

Trapezoidal/sliding screw applications

Our sliding screws are used in numerous sectors. We supply the market leaders in a range of industries. The majority of screws are used in lifting applications, packaging machines, linear applications and medical technology systems.

Here are a few examples:

Linear drive

Printing and colour adjustment

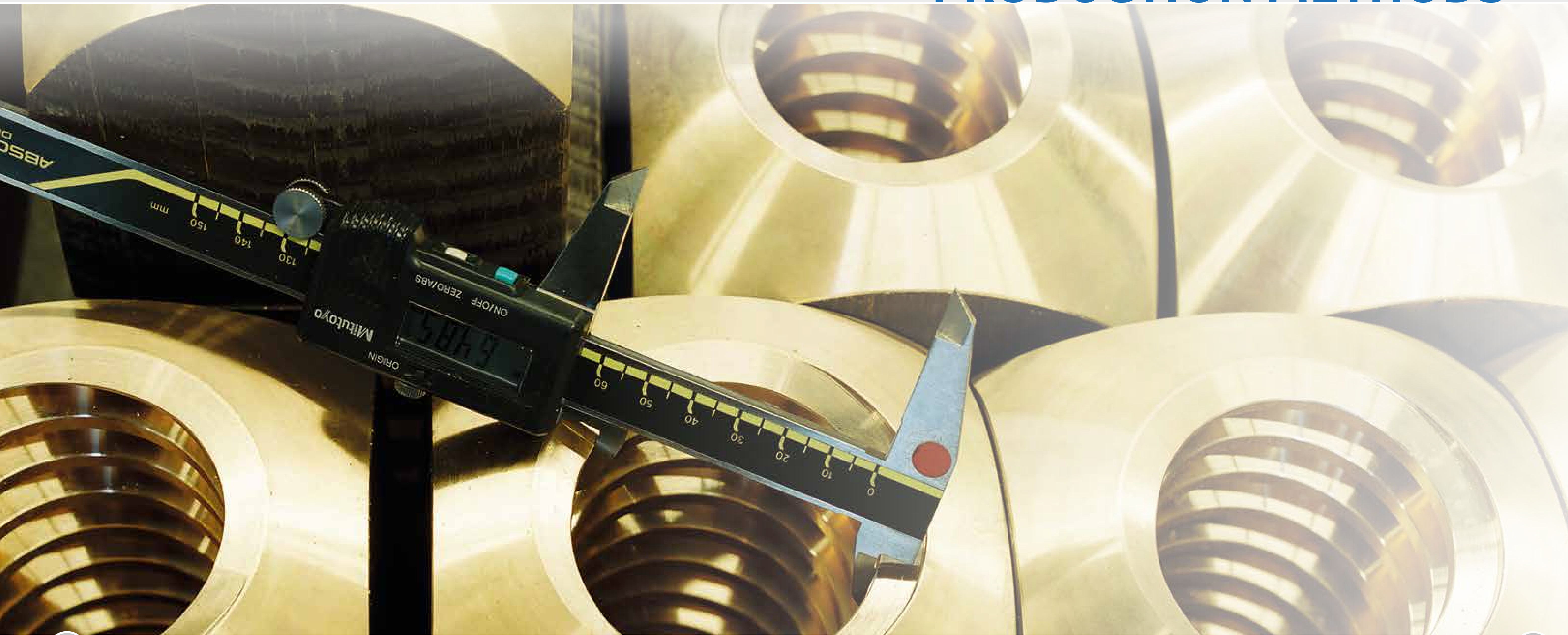
Computed tomography

Lifting jack

We offer all production methods for manufacturing motion threads. This means we can offer whirled, rolled and ground screws and hobbing or thread chasing is still in use too.

The nut thread is normally turned. In this way, the axial play between the screw and nut can be adjusted.

PRODUCTION METHODS



Thread whirling

Screws that are required in small numbers are produced by whirling. This is a machining process in which a rotary tool rotates around the bar stock. As it turns, the rotary tool is pushed out of the axis centre, thereby cutting a chip out of the raw material. If the rotary tool is then provided with an axial feed, a thread is created.

Advantages of the whirling method:

- The same tools can be used for different diameters, profiles and leads.
- Low tooling costs
- Cost effective for small batch sizes
- Hard machining of inductively hardened material is possible
- Hard-to-machine materials can be processed

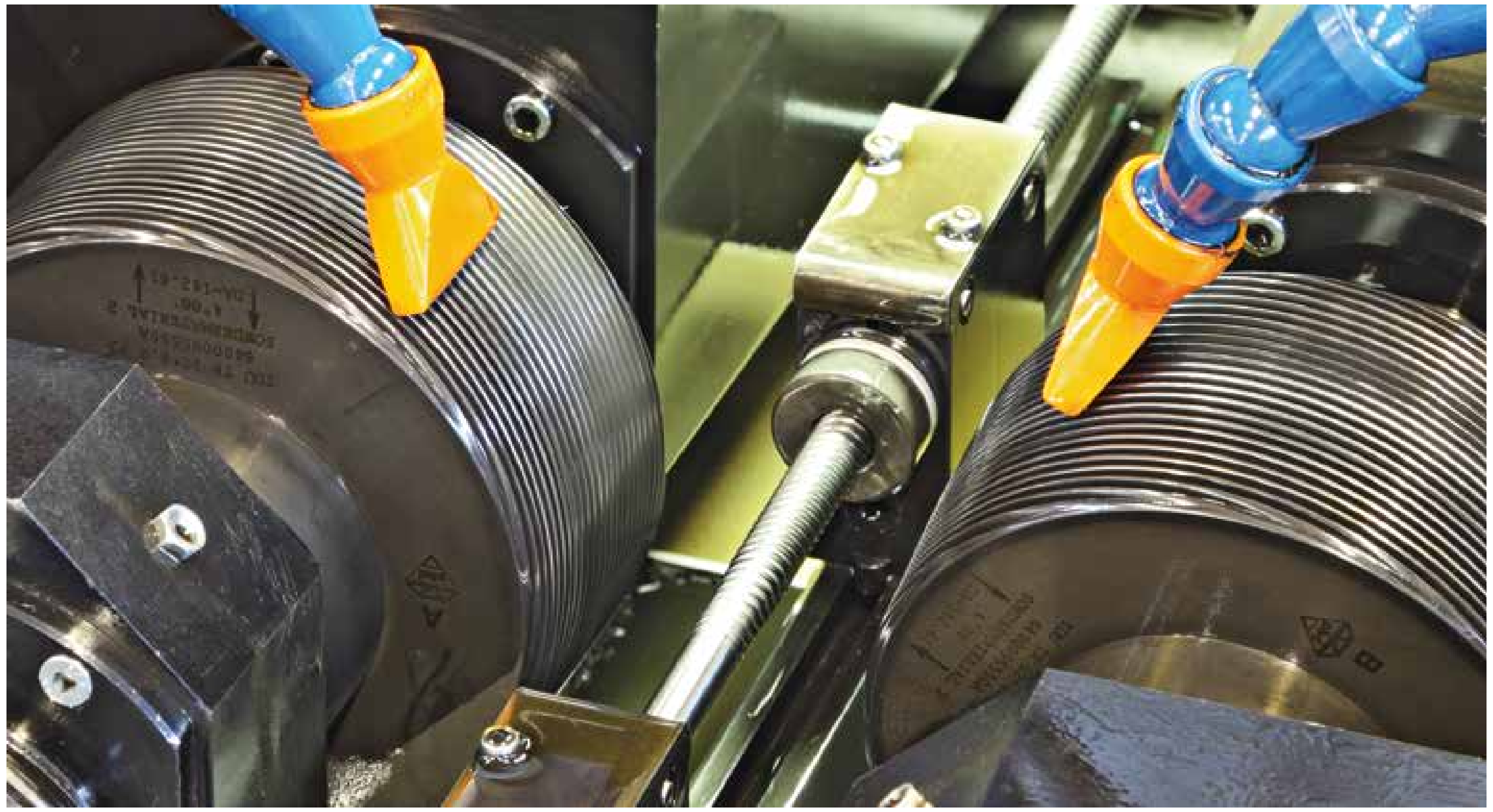
Thread rolling

Thread rolling is a cost-effective production method for larger quantities or for standard threads. However, this method is often not economically viable for small quantities, because of the relatively high tooling costs. Based on chipless cold forming, it has a positive effect on the raw material's properties. In contrast to machining methods, such as thread whirling, cutting, milling and grinding, the material's natural grain orientation is not destroyed.

Thread rolling has a positive influence on the following physical and technical properties:

- Higher wear resistance, tensile strength and bending strength
- Higher surface quality of the burnished thread flanks
- Lower corrosion
- High profile accuracy of thread depending on the rolling tool quality
- High accuracy of flank diameter (parallelism) through high base material tolerance

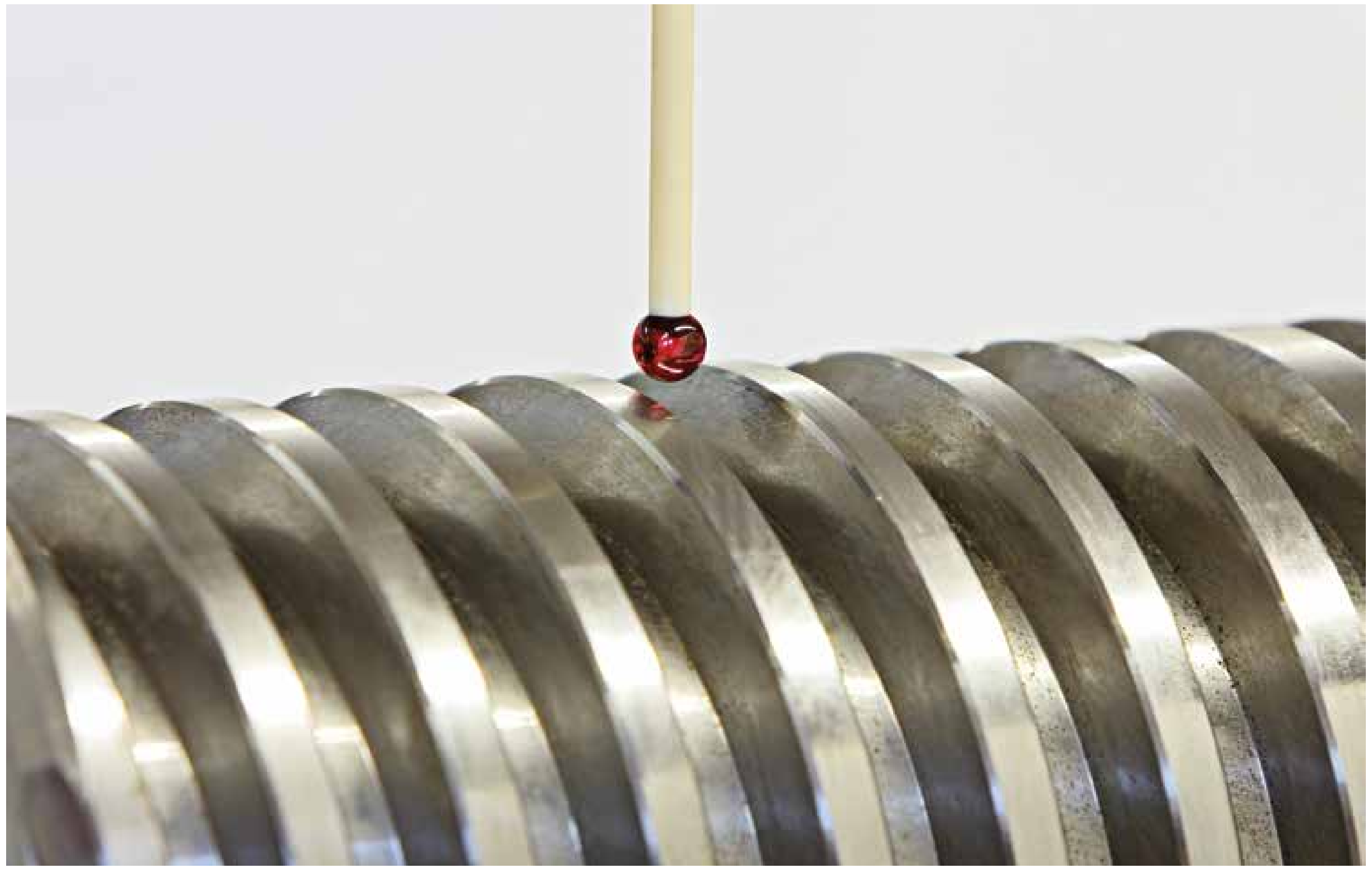
Plastic nuts are particularly well suited for rolled threads. The high flank surface quality of rolled threads and the low coefficient of friction of plastics result in a higher efficiency for the finished screw drive. Note that, according to DIN 103, the core diameter of rolled trapezoidal screws can be up to 0.15 x P smaller than that of machined trapezoidal screws (required flow radius on thread rolling tool). Rolled threads can contain a "closing fold" (groove) on the outer diameter of the thread. However, this does not affect the quality or function of the screw.



Thread grinding

Thread grinding is a chip-forming method that uses geometrically undefined cutting. Due to the long processing times, however, this method is expensive and is only used at Kammerer for the following specifications:

- Multi-start threads
- Screws with a thread length over 4.8 m
- Custom thread profiles
- Screws with greater precision requirements
- Manufacturing screws for hydrostatic screw drives

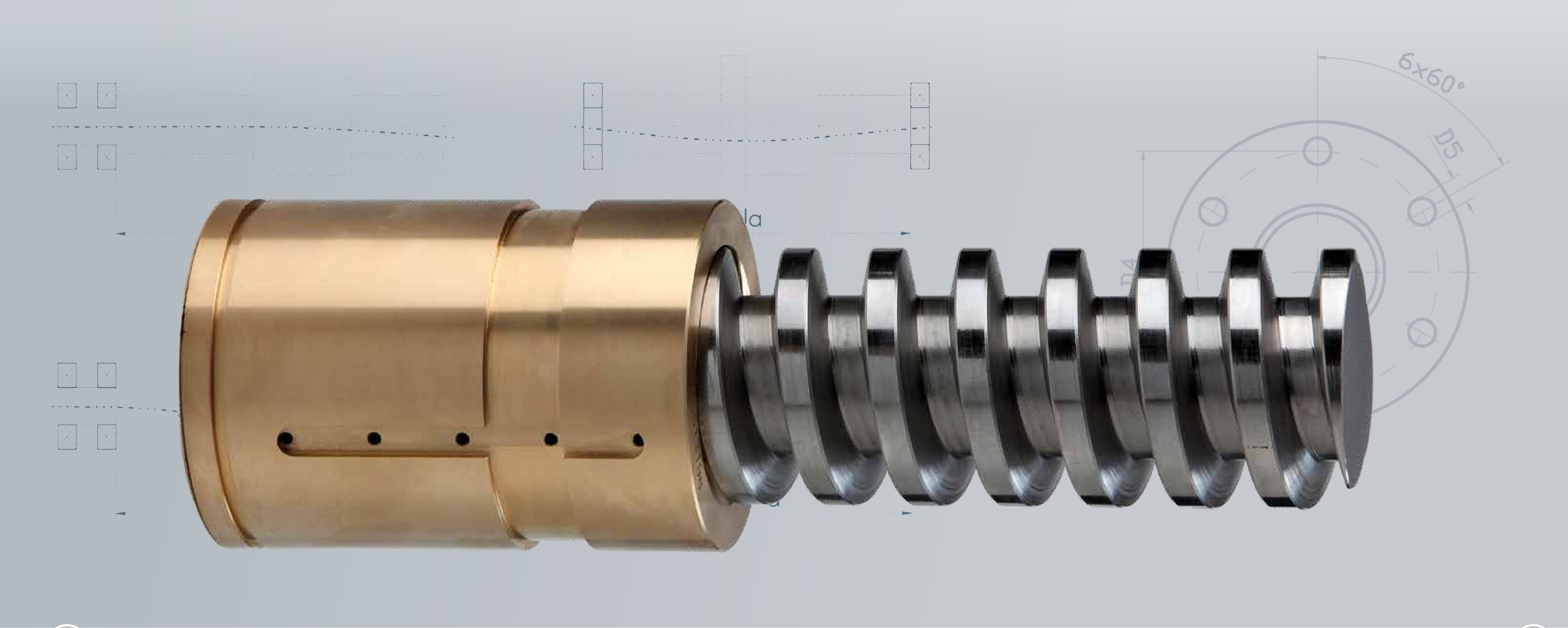


Thread milling

A variety of tools are used for thread milling: end milling, side milling and also hob cutters can all be used to machine a thread.

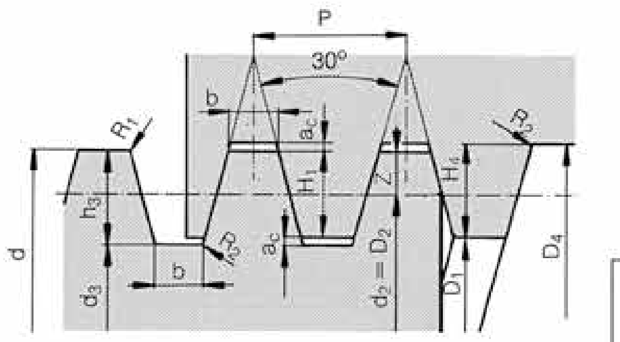
Milling is used for large thread profiles with a high lead angle and for multi-start threads and custom profiles. The thread dimension is always dependent on the milling tool.

TECHNOLOGY / CALCULATIONS



Technical data

Metric ISO trapezoidal thread to DIN 103

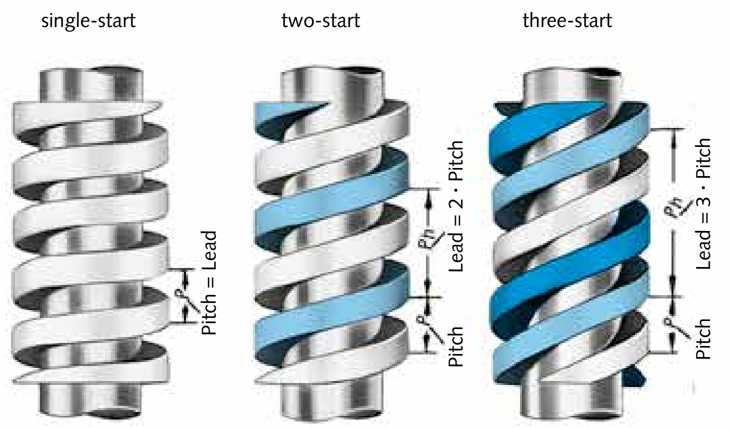


Dim.	for lead P in mm			
	1	2…5	6…12	14…44
a_c	0,15	0,25	0,5	1
R_1	0,075	0,125	0,25	0,5
R_2	0,15	0,25	0,5	1

Nominal- Ø . . . . d
Lead for single start threads and
Pitch for multi-start threads . . . . P
Lead for multi-start threads . . . . P_h
Number of starts. . . . . $n = P_h : P$
Core Ø of bolt thread . . . . $d_3 = d - (P+2 \cdot a_c)$
Outside Ø of nut thread . . . . $D_4 = d + 2 \cdot a_c$
Core Ø of nut thread . . . . $D_1 = d - P$
Thread flank Ø . . . . $d_2 = D_2 = d - 0{,}5 \cdot P$
Depth of bolt
and nut threads. . . . . $h_3 = H_4 = 0{,}5 \cdot P + a_c$
Flank overlap . . . . $H_1 = 0{,}5 \cdot P$
Height of tooth tip . . . . $z = 0{,}25 \cdot P$
Tip clearance . . . . a_c
Rounding . . . . R_1 und R_2
Three chisel width. . . . . $b = 0{,}366 \cdot P - 0{,}54 \cdot a_c$
Flank angle . . . . $\alpha = 30°$

Thread designation	Thread dimensions in mm				
	Flank-ø	Core-ø		Outside-ø	Thread-depth
d x P	$d_2 = D_2$	Bolt d_3	Nut D_1	D_4	$h_3 = H_4$
Tr 8×1,5	7,25	6,2	6,5	8,3	0,9
Tr 9×2	8	6,5	7	9,5	1,25
Tr 10×2	9	7,5	8	10,5	1,25
Tr 12×3	10,5	8,5	9	12,5	1,75
Tr 14×3	12,5	10,5	11	14,5	1,75
Tr 16×4	14	11,5	12	16,5	2,25
Tr 18×4	16	13,5	14	18,5	2,25
Tr 20×4	18	15,5	16	20,5	2,25
Tr 22×5	19,5	16,5	17	22,5	2,75
Tr 24×5	21,5	18,5	19	24,5	2,75
Tr 28×5	25,5	22,5	23	28,5	2,75
Tr 30×6	27	23	24	31	3,5
Tr 32×6	29	25	26	33	3,5
Tr 36×6	33	29	30	37	3,5
Tr 40×7	36,5	32	33	41	4
Tr 44×7	40,5	36	37	45	4
Tr 48×8	44	39	40	49	4,5
Tr 52×8	48	43	44	53	4,5
Tr 60×9	55,5	50	51	61	5
Tr 70×10	65	59	60	71	5,5
Tr 80×10	75	69	70	81	5,5
Tr 90×12	84	77	78	91	6,5
Tr 100×12	94	87	88	101	6,5
Tr 120×14	113	104	106	122	8
Tr 140×14	132,5	124	126	142	8
Tr 160×16	151,5	142	144	162	9

Single and multi-start threads



P_h Lead: Distance along the line of the flank diameter be tween adjacent flanks of the same orientation of the same thread.

P Pitch: Distance along the line of the flank diameter be tween adjacent flanks of the same orientation.

Multi-start (n-start) threads have the same profile as single-start threads where the lead P_h = the pitch P.

Only the permissible values for the lead P (equal to the pitch P) of the single-start thread may be selected for the pitch P of the multi-start thread. A multiple of the pitch P of the multi-start thread does not however have to correspond to a permissible lead value for a single-start thread.

Thread diameters and leads

Nominal thread diameter			Leads P of the single-start trapezoidal screw																					
Series 1	Series 2	Series 3	44	40	36	32	28	24	22	20	18	16	14	12	10	9	8	7	6	5	4	3	2	1,5
8																								1,5
	9																						2	1,5
10																							2	1,5
	11																					3	2	
12																						3	2	
	14																					3	2	
16																					4		2	
	18																				4		2	
20																					4		2	
	22																8			5		3		
24																	8			5		3		
	26																8			5		3		
28																	8			5		3		
	30														10				6			3		
32															10				6			3		
	34														10				6			3		
36															10				6			3		
	38														10			7				3		
40															10			7				3		
	42														10			7				3		
44														12				7				3		
	46													12			8					3		
48														12			8					3		
	50													12			8					3		
52														12			8					3		
	55												14			9						3		
60													14			9						3		
	65											16			10						4			
70												16			10						4			
	75											16			10						4			
80												16			10						4			
	85										18			12							4			
90											18			12							4			
	95										18			12							4			
100										20				12							4			
		105								20				12							4			
	110									20				12							4			
		115							22				14											
120									22				14											
		125							22				14											
	130								22				14											
		135						24					14											
140								24					14											
		145						24					14											
	150							24				16												
		155						24				16												
160							28					16												
		165					28					16												

Dimensions in mm

A pre-selection of the trapezoidal screw dimensions can be found in the table above.

Priority should be given to the series 1 diameters. Then the matching lead according to DIN 103 can be selected. We can also produce custom leads to suit your needs.

kammerer

Calculations

Carrying capacity:
The ratings of trapezoidal screws are influenced by many factors. The most important factors are material pairings, surface quality, surface compression, duty, lubrication and temperature.
Select a screw according to your requirements (required feed speed, fitting space, etc.) and calculate the necessary length of nut for your application.

Arithmetical determination of the nut length

[01]
$$L_m = \frac{F \times P}{p_{zul.} \times d_2 \times \pi \times H_1 \times z}$$

L_m = nut length required [mm]
F = xial loading force [N]
P = thread lead [mm]
$p_{zul.}$ = permissible surface compression [N/mm²]
d_2 = flank diameter [mm]
H_1 = thread bearing depth [mm] (0.5 x P)
z = number of starts

The permissible surface compression is dependent upon the sliding speed and the material used for the nut. A value of 10 N/mm2 can be taken as a rough estimate. Approximate values for common materials can be found in the table below.

Existing surface compression depending on nut selected

[02]
$$p_{vorh.} = \frac{F \times P}{L_m \times d_2 \times \pi \times H_1 \times z}$$

$p_{vorh.}$ = existing surface compression [N/mm²]
F = axial loading force [N]
P = thread lead [mm]
L_m = nut length required [mm]
d_2 = flank diameter [mm]
H_1 = thread bearing depth [mm] (0,5 x P)
z = number of starts

Sliding speed

[03]
$$v_g = \frac{n \times d_2 \times \pi}{60000}$$

v_g = sliding speed [m/s]
n = rotational speed [rpm]
d_2 = flank diameter [mm]

Screw feed speed

[04]
$$s = \frac{n \times P}{1000}$$

s = feed speed [m/min]
n = rotational speed [rpm]
P = lead [mm]

Material:	Sliding speed	$p_{zul.}$
	[m/s]	N/mm²
Steel	1,5	10
CuSn alloy	1,5	10
CuAl alloy	1,5	10
Plastic PA	0,6	1

Approximate values for the permissible surface compression for sliding screws. Exact particulars can be requested from the material manufacturers.

Berechnungen

Drive torque

[05]
$$M_{ta} = \frac{F \times P}{2000 \times \pi \times \eta}$$

[06]
$$M_{te} = \frac{F \times P \times \eta'}{2000 \times \pi}$$

M_{ta} = drive torque [Nm] when converting a rotary to a linear movement
M_{te} = drive torque [Nm] when converting a linear to a rotary movement
F = axial loading force [N]
P = thread lead [mm]
η = efficiency
η' = efficiency

Efficiency

[07]
$$\eta = \frac{\tan\alpha}{\tan(\alpha + \rho)}$$

[08]
$$\eta' = \frac{\tan(\alpha - \rho)}{\tan\alpha}$$

η = efficiency (torque to linear force)
η' = efficiency (linear force to torque)
α = lead angle [°]
ρ = friction angle [°]

Lead angle

[09]
$$\tan\alpha = \frac{P}{d_2 \times \pi}$$

α = lead angle [°]
P = thread lead [mm]
d_2 = flank diameter [mm]

Friction angle

[10]
$$\tan\rho = \mu G$$

ρ = friction angle [°]
μG = see table below

The thread is self-locking if pitch angle < friction angle

Drive power

[11]
$$P_a = \frac{M_{ta} \times n}{9550}$$

P_a = drive power [kW]
M_{ta} = drive torque [Nm]
n = rotational speed [rpm]

Nut made from:	μG	
	dry	lubricated
Cast iron GG	0,18	0,1
Steel	0,15	0,1
Bronze CuSn	0,1	0,05
Plastic	0,1	0,05

Friction values for common nut materials.

These values can be affected by lubrication, roughness, loading, etc.

Calculations

Critical bending speed

[12] $$n_{kr.} = \frac{30}{\pi} \times \sqrt{\frac{21\times10^4 \times d_2^{\,4} \times 10^4}{0{,}013\times F \times l_a^{\,3} \times 20}}$$

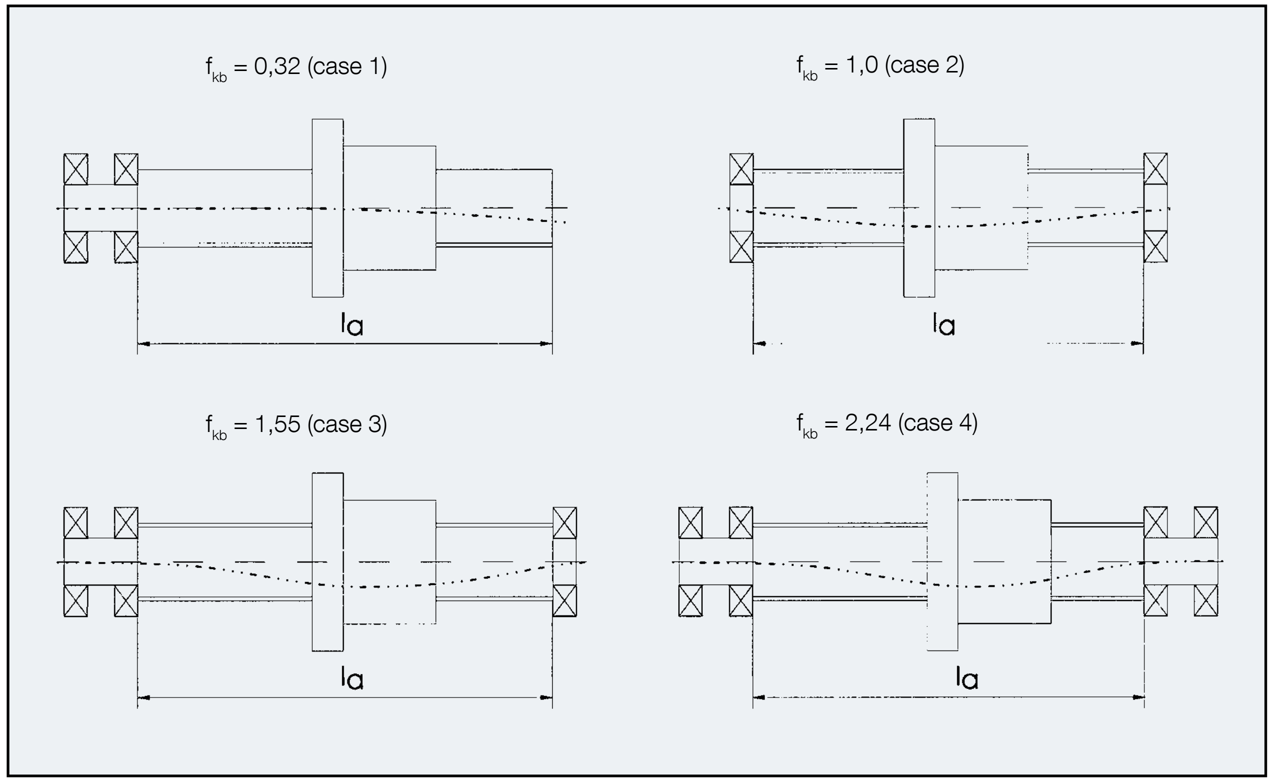
n_{kr} = critical speed due to weight and length of spindle [rpm]
d_2 = flank diameter of thread [mm]
F = weight of the unsupported spindle length [N]
l_a = distance between bearings [mm]

The critical bending speed is dependent upon the deflection of the spindle and thus upon the diameter and the distance between the bearings. The permissible speed can now be calculated from the way in which the spindle is mounted and from a safety factor.

Permissible speed

[13] $$n_{zul.} = 0.8 \times n_{kr.} \times f_{kb.}$$

$n_{zul.}$ = permissible speed [rpm]
n_{kr} = critical speed due to weight and length of spindle [rpm]
f_{kb} = correction factor for deflection
0.8 = safety factor



Correction factor f_{kb} for calculating the permissible speed

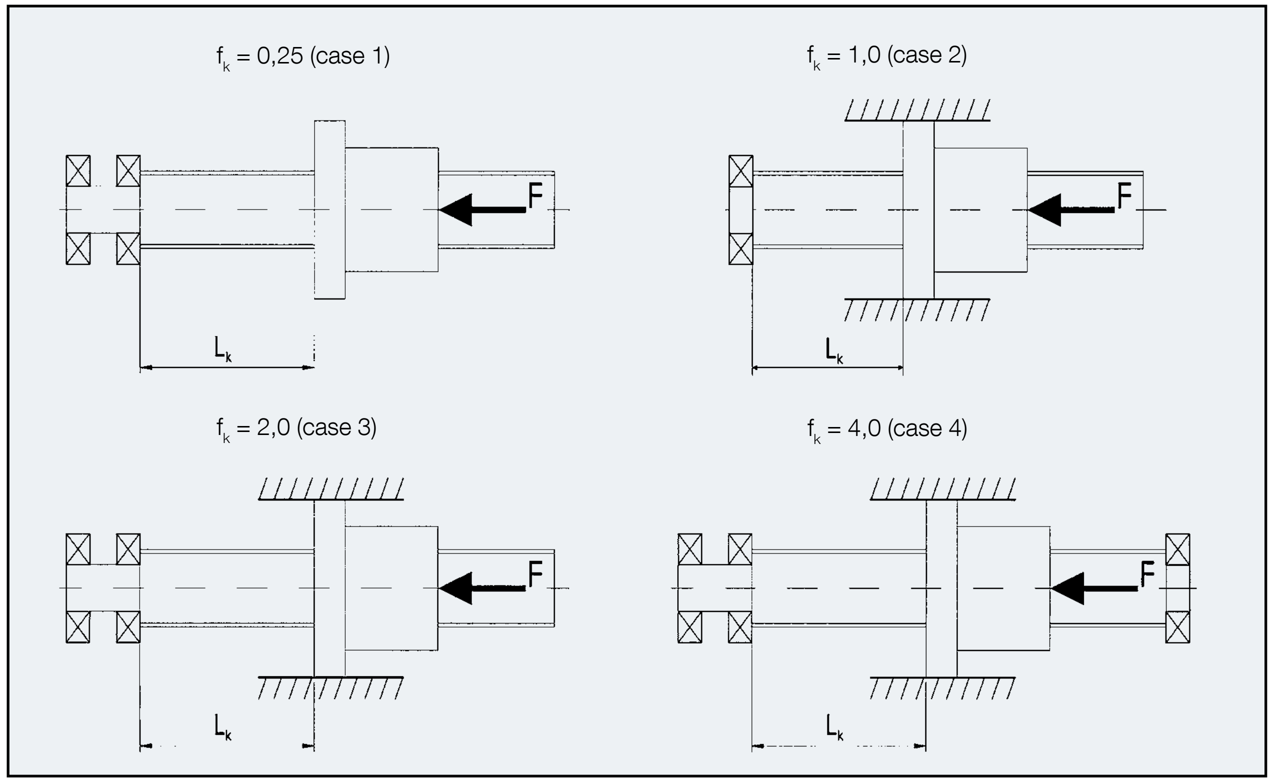
Calculations

Calculating the buckling force

[14] $$F_{Kn.} = \frac{21\times10^4 \times d_3^{\,4} \times \pi^3 \times f_k}{64\times L_k^{\,2}}$$

F_{Kn} = buckling force for the spindle [N]
d_3 = spindle core diameter [mm]
f_k = correction factor for type of mounting
L_K = unsupported spindle length [mm]

The buckling force of the screw spindle is dependent upon the unsupported spindle length and the core diameter of the spindle.



Correction factor f_k for taking into account the type of mounting

Permissible sliding speeds (guide values):

Material	CuSn- und CuAl-alloy/steel	Cast iron	GS, GTW
Sliding speed in m/s in relation to flank diameter	Permissible surface pressure in N/mm²		
0,1	19,3	5,8	9,7
0,2	18,6	5,6	9,3
0,3	18,0	5,4	9,0
0,4	17,3	5,2	8,7
0,5	16,6	5,0	8,3
0,6	16,0	4,8	8,0
0,7	15,3	4,6	7,7
0,8	14,6	4,4	7,3
0,9	14,0	4,2	7,0
1,0	13,3	4,0	6,7
1,1	12,6	3,8	6,3
1,2	12,0	3,6	6,0
1,3	11,3	3,4	5,7
1,4	10,6	3,2	5,3
1,5	10,0	3,0	5,0
1,6	9,3	2,8	4,7
1,7	8,6	2,6	4,3
1,8	8,0	2,4	4,0
1,9	7,3	2,2	3,7
2,0	6,6	2,0	3,3
2,1	6,0	1,8	3,0
2,2	5,3	1,6	2,7
2,3	4,6	1,4	2,3
2,4	4,0	1,2	2,0
2,5	3,3	1,0	1,7
2,6	2,6	0,8	1,3
2,7	2,0	0,6	1,0
2,8	1,3	0,4	0,7
2,9	0,6	0,2	0,3

The permissible surface pressure on the thread flank depends on the sliding speed. The slower the drive runs, the more loading it can take.

As a rule of thumb: At a speed of 1.5 m/sec, the permissible surface pressure for bronze nuts is 10 N/mm²

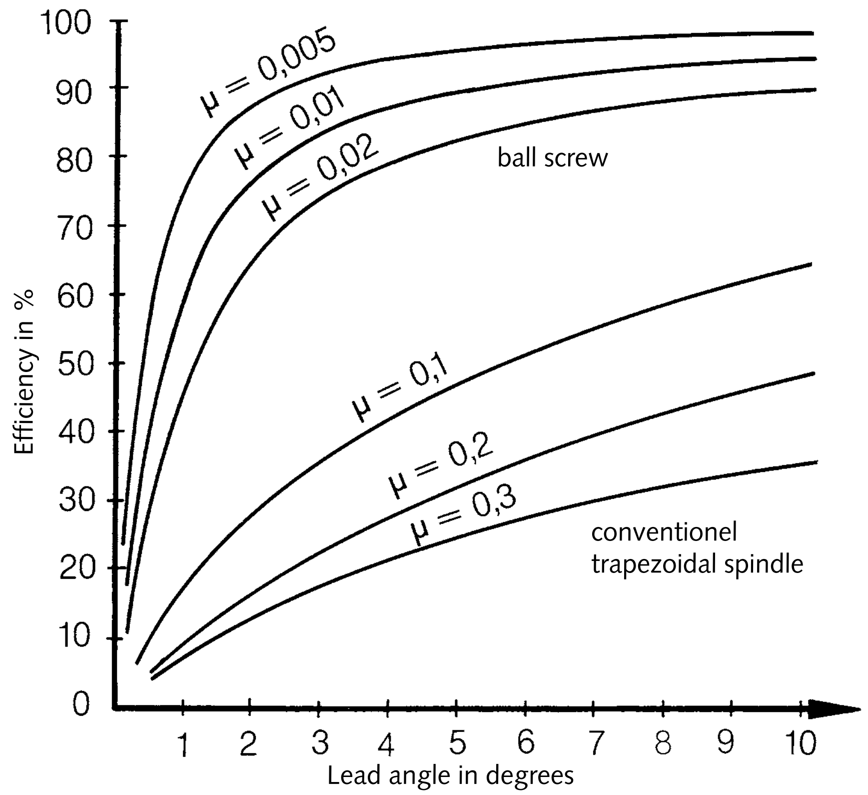
There are a wide range of lubrication options for sliding screws. These must be adapted for the application in question and tested.

We can only provide recommendations on the basis of completed projects. Therefore, we recommend that you contact the lubricant manufacturer.

Efficiency of trapezoidal spindles:

The efficiency of trapezoidal spindles is significantly less than that of ball screw spindles due to the sliding friction.

However, the trapezoidal screw is technically simpler and less expensive. A holding device (e.g. brake) is only required in rare cases due to the self-braking action of the trapezoidal screw spindle.



Graph showing the efficiency as a function of the coefficient of friction

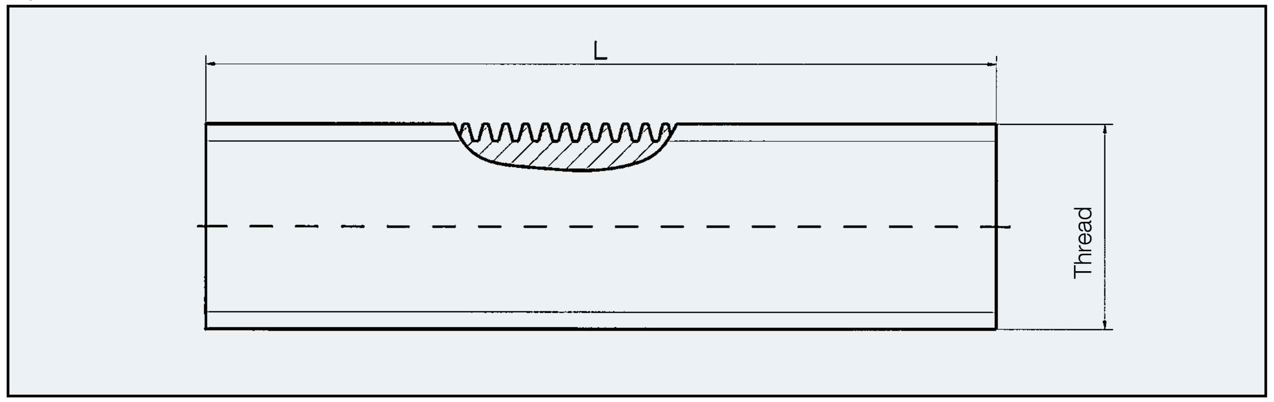
Coefficients of friction for common nut materials

Nuts made of:	μG	
	dry	lubricated
Cast iron GG	0,18	0,1
Steel	0,15	0,1
Bronze CuSn	0,1	0,05
Plastic	0,1	0,05

THREADS ACCORDING TO DIN 103

Trapezoidal screws, whirled

Sold by the meter, whirled



Advantages of whirled screws
- Low tool and set-up costs
- Suitable for single item and small series production
- Material properties only have a minor influence on the lead accuracy
- Ideal for grease lubrication due to the flank surface quality created during whirling
- Tool can be used for different leads

Our selection:
- Trapezoidal screw according to DIN 103, tolerance grade 7e and other required tolerance grades
- The standard lengths are 1 m, 1.5 m, 2 m, 3 m, 6 m
- Other lengths are available on request
- The materials below are standard at Kammerer
- Two quality classes available (see table below)
- All dimensions can also be supplied as a left-hand thread

	Quality classes	
	GK 1	**GK 2**
Lead variation	0,05 / 300mm	0,15 / 300mm
Straightness	0,3 / 1000mm	0,8 / 1000mm
External Ø tolerance	h9	h11

Non-alloy steels	C45 / 11SMn30
Nitriding steels	42CrMo4 + Qt / 31CrMoV9 / ETG 25 / 88 / 100
Stainless steel	VA (1.4305) V2A (1.4301 / 1.4021) V4A (1.4571 / 1.4404)
Special steels	Available on request

Further dimensions on request

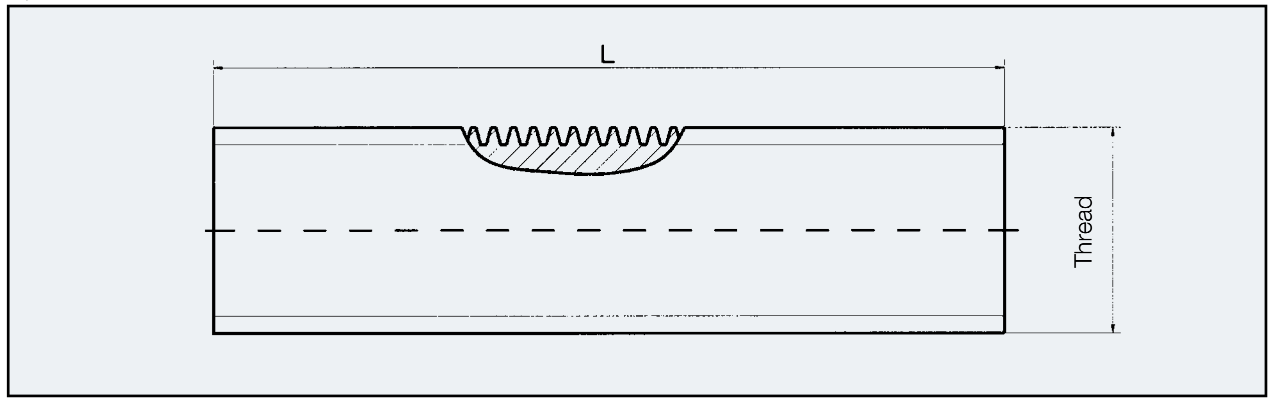
Order example:
Screw Tr70 x 10 x 2 m long, lead left, whirled GK2

Thread				
Tr 8x1,5	Tr 16x4	Tr 30x6	Tr 55x9	Tr 100x12
Tr 10x2	Tr 18x4	Tr 32x6	Tr 60x9	Tr 110x12
Tr 10x3	Tr 20x4	Tr 36x6	Tr 65x10	Tr 120x14
Tr 12x2	Tr 22x5	Tr 40x7	Tr 70x10	Tr 130x14
Tr 12x3	Tr 24x5	Tr 44x7	Tr 75x10	Tr 140x14
Tr 14x3	Tr 26x5	Tr 50x8	Tr 80x10	Tr 150x16
Tr 14x4	Tr 28x5	Tr 52x8	Tr 90x12	Tr 160x16

Quality classes according to Kammerer standard, other accuracies available on request.

Trapezoidal screws, rolled

Sold by the meter, rolled



Advantages of rolled screws:
- The grain orientation of the material is not affected
- Greater resistance to wear and higher tensile and bending strength due to cold forming
- Better surface quality on the thread flanks
- Lower tendency to corrode
- High profile accuracy
- Low coefficient of friction when used with plastic nuts

Our selection:
- Trapezoidal screw according to DIN 103, tolerance grade 7e and other required tolerance grades
- The standard lengths are 1 m, 1.5 m, 2 m, 3 m
- Other lengths are available on request
- The materials below are standard at Kammerer
- Two quality classes available (see table below)

	Quality classes	
	GK 1	**GK 2**
Lead variation	0,1 / 300mm	0,3 / 300mm
Straightness	0,8 / 1000mm	1,5 / 1000mm
Flaking	impermissible	permissible

Non-alloy steels	C15
Nitriding steels	42CrMo4 ETG 25
Stainless steel	VA (1.4305) V2A (1.4301 / 1.4021)

Further dimensions on request

Order example:
Screw Tr20 x 4 x 2 m long, lead right, rolled GK1

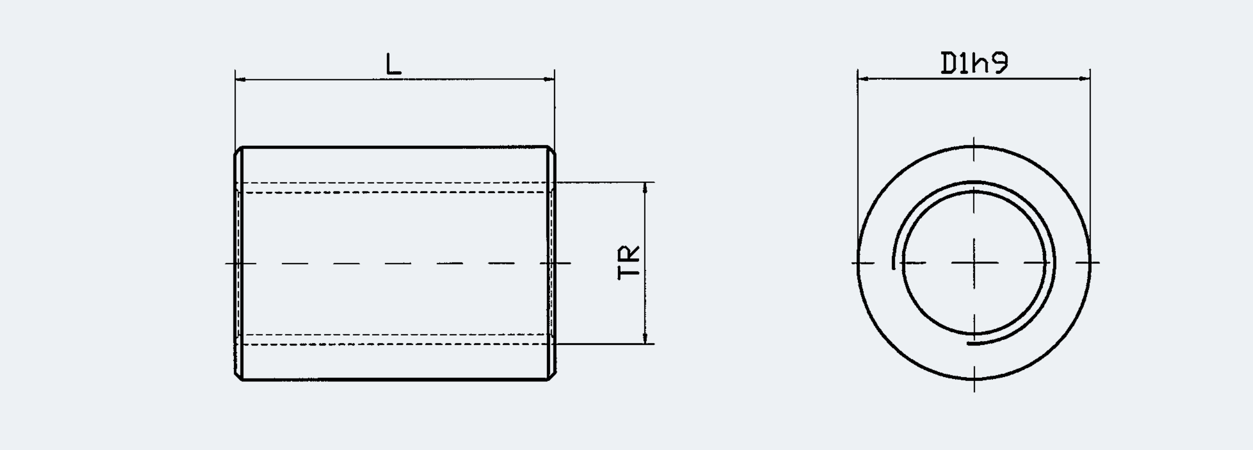
Thread	right	left
Tr 8 x 1,5	X	X
Tr 10 x 2	X	X
Tr 10 x 3	X	X
Tr 12 x 2	X	X
Tr 12 x 3	X	X
Tr 14 x 3	X	X
Tr 14 x 4	X	X
Tr 16 x 4	X	X
Tr 18 x 4	X	X
Tr 20 x 4	X	X
Tr 22 x 5	X	X
Tr 24 x 5	X	X

Thread	right	left
Tr 26 x 5	X	X
Tr 28 x 5	X	X
Tr 30 x 6	X	X
Tr 32 x 6	X	X
Tr 36 x 6	X	X
Tr 40 x 7	X	X
Tr 44 x 7	X	X
Tr 50 x 8	X	X
Tr 52 x 8	X	X
Tr 60 x 9	X	

According to DIN 103, the core diameter of rolled trapezoidal screws can be 0.15 x P smaller than that of machined trapezoidal screws (flow radius required on the thread-rolling tool). Rolled threads may have a "closing fold" (groove) on the outside diameter of the thread turn. This does not affect the quality or function of the thread. It is merely a criterion for assessing the rolling technology.

Round nuts

Round nut, short or long



- Trapezoidal thread to DIN 103, tolerance class 7H
- These nuts are provided in the adjacent materials
- Other materials and tolerances on request
- Short design: L = 1.5 x nominal diameter
- Long design: L = 2 x nominal diameter

- C15
- C45
- CuSn12
- RG7
- GGC-25
- Plastic

Ordering example:
Round nut Tr 44x7, left-hand, made from CuSn12, short, in accordance with Kammerer catalogue

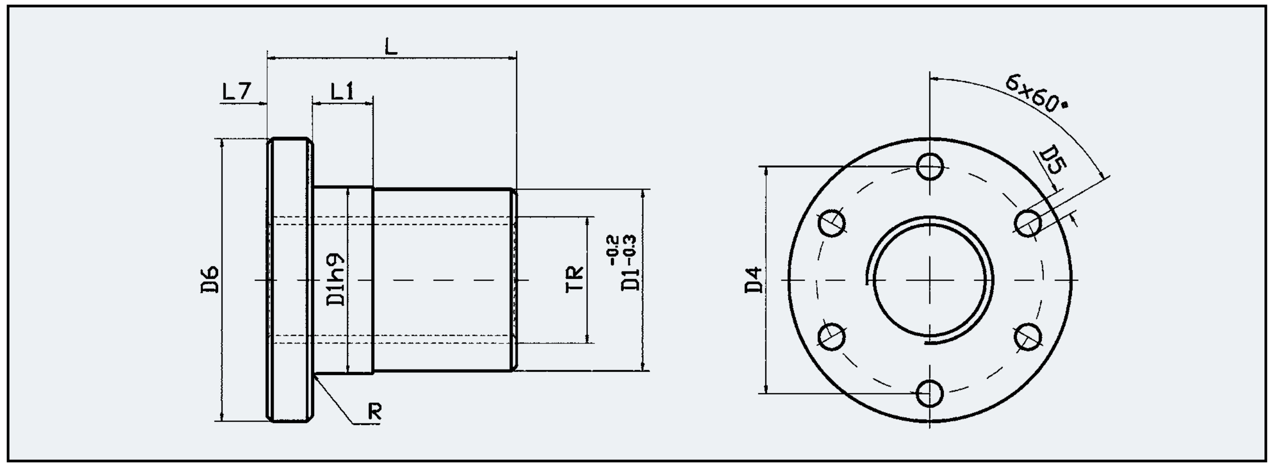
Short design		
Thread	**D1**	**L**
Tr 8 x 1,5	18	12
Tr 10 x 2	22	15
Tr 10 x 3	22	15
Tr 12 x 3	26	18
Tr 14 x 4	30	21
Tr 16 x 4	36	24
Tr 18 x 4	45	27
Tr 20 x 4	45	30
Tr 22 x 5	50	33
Tr 24 x 5	50	36
Tr 26 x 5	60	39
Tr 28 x 5	60	42
Tr 30 x 6	60	45
Tr 32 x 6	60	48
Tr 36 x 6	75	54
Tr 40 x 7	80	60
Tr 44 x 7	80	66
Tr 48 x 8	90	72
Tr 50 x 8	90	75
Tr 60 x 9	100	90
Tr 70 x 10	110	105
Tr 80 x 10	120	120
Tr 90 x 12	130	135

Long design		
Thread	**D1**	**L**
Tr 8 x 1,5	18	16
Tr 10 x 2	22	20
Tr 10 x 3	22	20
Tr 12 x 3	26	24
Tr 14 x 4	30	28
Tr 16 x 4	36	32
Tr 18 x 4	45	36
Tr 20 x 4	45	40
Tr 22 x 5	50	44
Tr 24 x 5	50	48
Tr 26 x 5	60	52
Tr 28 x 5	60	56
Tr 30 x 6	60	60
Tr 32 x 6	60	64
Tr 36 x 6	75	72
Tr 40 x 7	80	80
Tr 44 x 7	80	88
Tr 48 x 8	90	96
Tr 50 x 8	90	100
Tr 60 x 9	100	120
Tr 70 x 10	110	140
Tr 80 x 10	120	160
Tr 90 x 12	130	180

Catalogue nuts in standard dimensions are only produced upon customer request.
Not available from stock.

Flange nuts

Flanged nut, short or long



- Trapezoidal thread to DIN 103, tolerance class 7H and other requested tolerance classes
- These nuts are provided in the adjacent materials
- Other materials and tolerances on request
- Two designs (long or short), with or without fixing holes

- C15
- C45
- CuSn12
- RG7
- GGC-25
- Plastic

Ordering example:
Flanged nut Tr 20x4, right-hand, made from RG7, short, in accordance with Kammerer catalogue

Thread	D1	D4	D5	D6	L (short)	L (long)	L1	L7
Tr 8 x 1,5	22	32	4	40	12	16	4	8
Tr 10 x 2	25	34	5	42	15	20	5	10
Tr 10 x 3	25	34	5	42	15	20	5	10
Tr 12 x 3	28	38	6	48	18	24	6	12
Tr 14 x 4	28	38	6	48	21	28	9	12
Tr 16 x 4	28	38	6	48	24	32	12	12
Tr 18 x 4	28	38	6	48	27	36	15	12
Tr 20 x 4	32	45	7	55	30	40	8	12
Tr 22 x 5	32	45	7	55	33	44	8	12
Tr 24 x 5	32	45	7	55	36	48	8	12
Tr 26 x 5	38	50	7	62	39	52	8	14
Tr 28 x 5	38	50	7	62	42	56	8	14
Tr 30 x 6	38	50	7	62	45	60	8	14
Tr 32 x 6	45	58	7	70	48	64	10	16
Tr 36 x 6	45	58	7	70	54	72	10	16
Tr 40 x 7	63	78	9	95	60	80	12	16
Tr 44 x 7	63	78	9	95	66	88	12	16
Tr 48 x 8	72	90	11	110	72	96	14	18
Tr 50 x 8	72	90	11	110	75	100	14	18
Tr 60 x 9	88	110	13	130	90	120	16	20
Tr 70 x 10	88	110	13	130	105	140	16	20
Tr 80 x 10	118	140	15	163	120	160	18	22
Tr 90 x 12	118	140	15	163	135	180	18	22

Further dimensions on request
Catalogue nuts in standard dimensions are only produced upon customer request.
Not available from stock.

CUSTOM THREADS

Custom threads

We can make tools for producing custom threads and profiles. Your specific requirements always come first: on request, we produce custom profiles with non-standard thread depth, shape and dimensions. We can usually handle custom leads too.

The custom threads are made exactly to your specifications. We produce custom threads, screws and nuts from a wide range of materials, such as steel, stainless steel, cast iron, bronze, plastic, aluminium and titanium.

Coarse thread screw with nut

Spiral core for circulating liquid

Various custom profiles

Screw conveyor

Blanks for custom threads

We can produce the following non-standard products:

- Rolled precision worm shafts
- Screw conveyors
- Milled coarse threads (e.g. Tr 32x200)
- Round threads
- Saw-tooth threads
- Diamond threads
- ACME threads

Should you require a custom design or a thread with custom dimensions, please ask our experienced engineers.

Please feel free to use the contact form on our website **www.kammerer-gewinde.de** to get in touch.

LARGE SCALE PRODUCTION / AUTOMOTIVE

Beyond boundaries

The organisation, planning and implementation for large-scale production, particularly when it comes to projects for the automotive industry, is extremely different to that required for single orders. In 2014, production of series parts was moved to Plant 2 in order to keep the two completely separate. This plant is located at the same location as our main plant, just 200 m away. Here, we produce parts according to instructions provided by automotive suppliers, although not all parts are supplied to this industry sector. Our screw drives support you in many area of your day-to-day life.

Kammerer Plant 2 – series production

Automotive

Our products are working away behind the scenes for you in many areas of your life. Take your car, for instance. Here you are highly likely to come across one of our screw drives. Electric seat or steering wheel adjusters, boot lid openers, retractable tow bars and, last but not least, electromechanical rear axle steering. Kammerer screw drives can be found in all of these applications.

Packaging industry

Our products are also used in areas other than the automotive industry, such as in the furniture, electronics or packaging industry, where our screw drives are often used to produce the required adjustment movements. For example, we supply screws for adjusting the height of desks, for force transmission for blind rivet devices or forklift trucks.

Furniture / electronics industry

Medical engineering

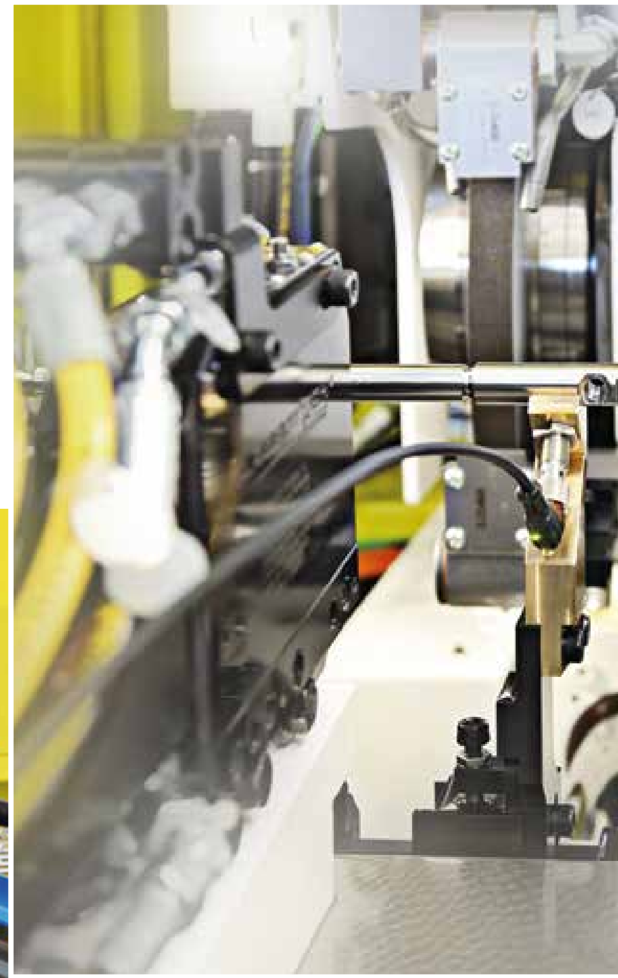
The health industry is a sector that continues to grow. Our screws are used for electric adjustment of hospital beds, lifting patients out of beds or baths and they are even used on the operating table. They can also be found in various applications in the dental industry too.

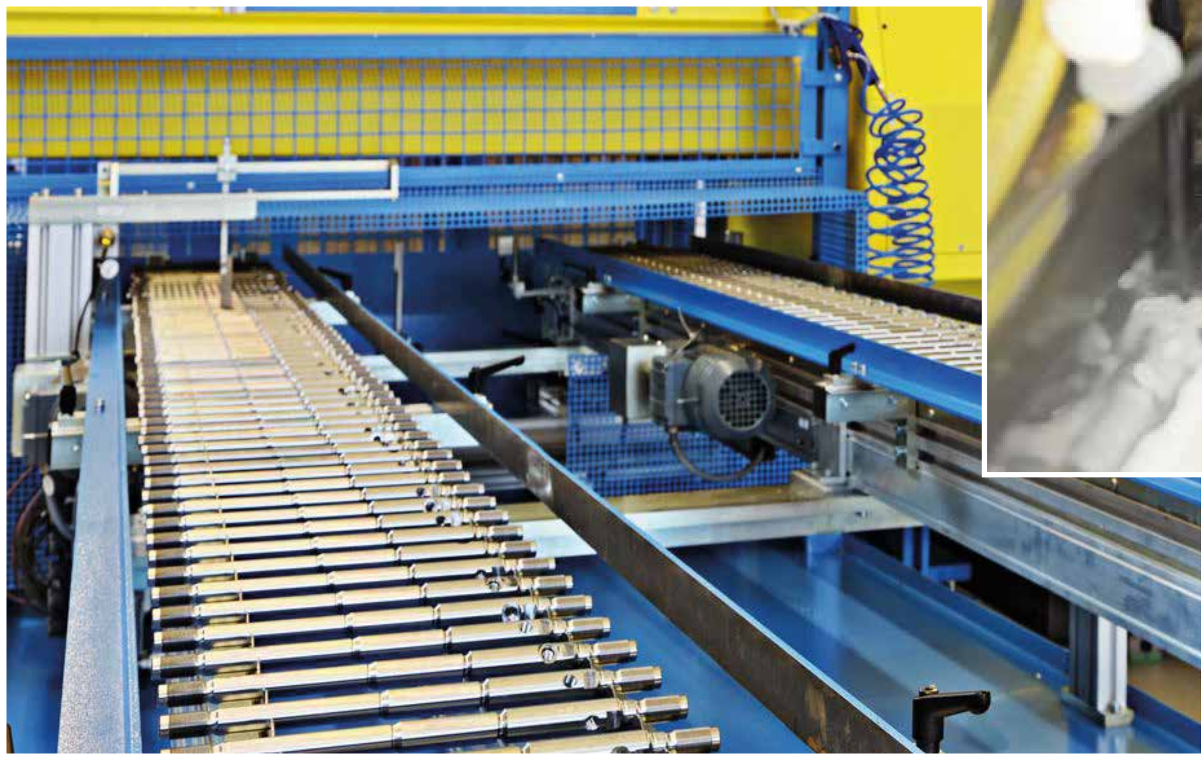
Packaging and logistics

Logistics are a key factor when it comes to series production. Kammerer has used parts-specific packaging and transport protection right from the start.

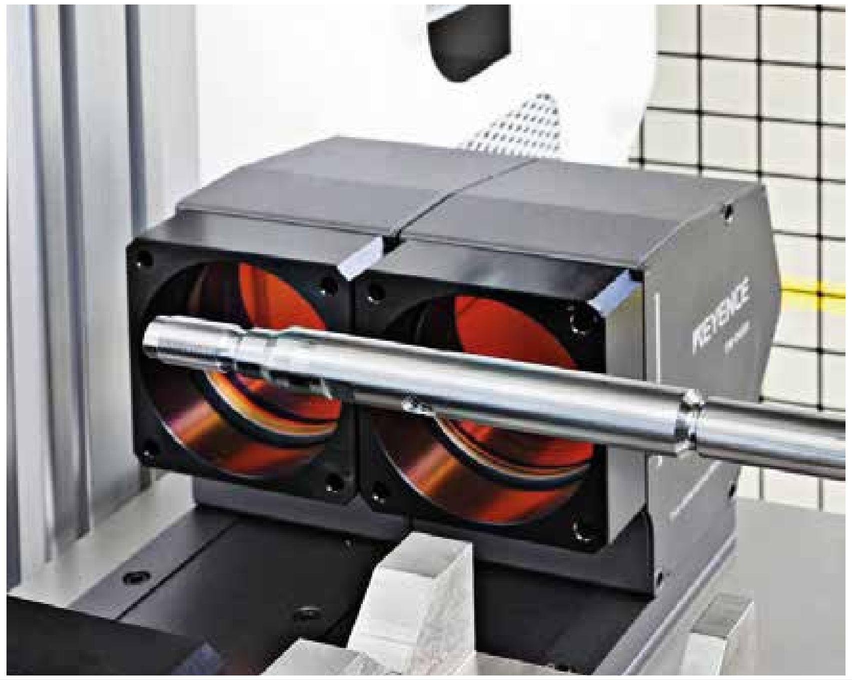
Supply and discharge during grinding

The production processes in series production are normally fully or partially automated. Using robots to supply and discharge the parts is already a matter of course, allowing a single employee to monitor several processes and systems. This helps us to maintain a competitive production facility here in Germany.



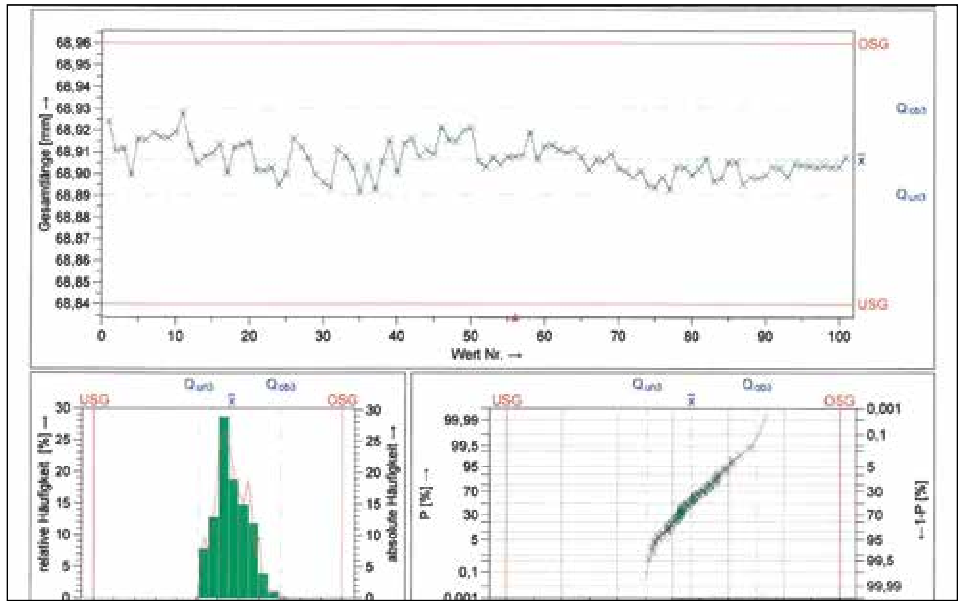


Automatic checking of rotating parts

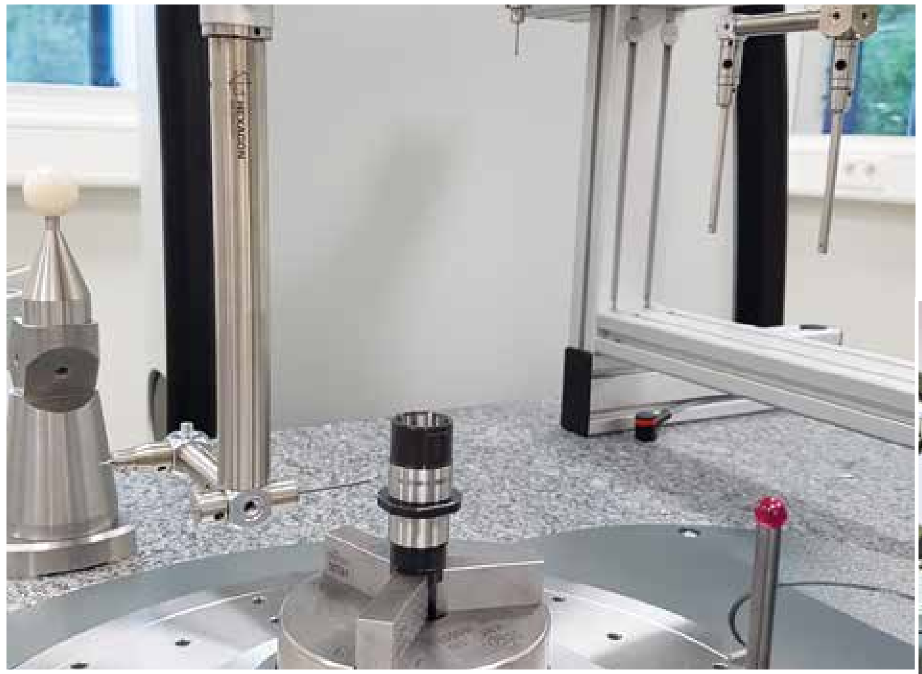


Optical measurement of screw blanks is integrated into the turning process, thereby increasing reliability during machining.

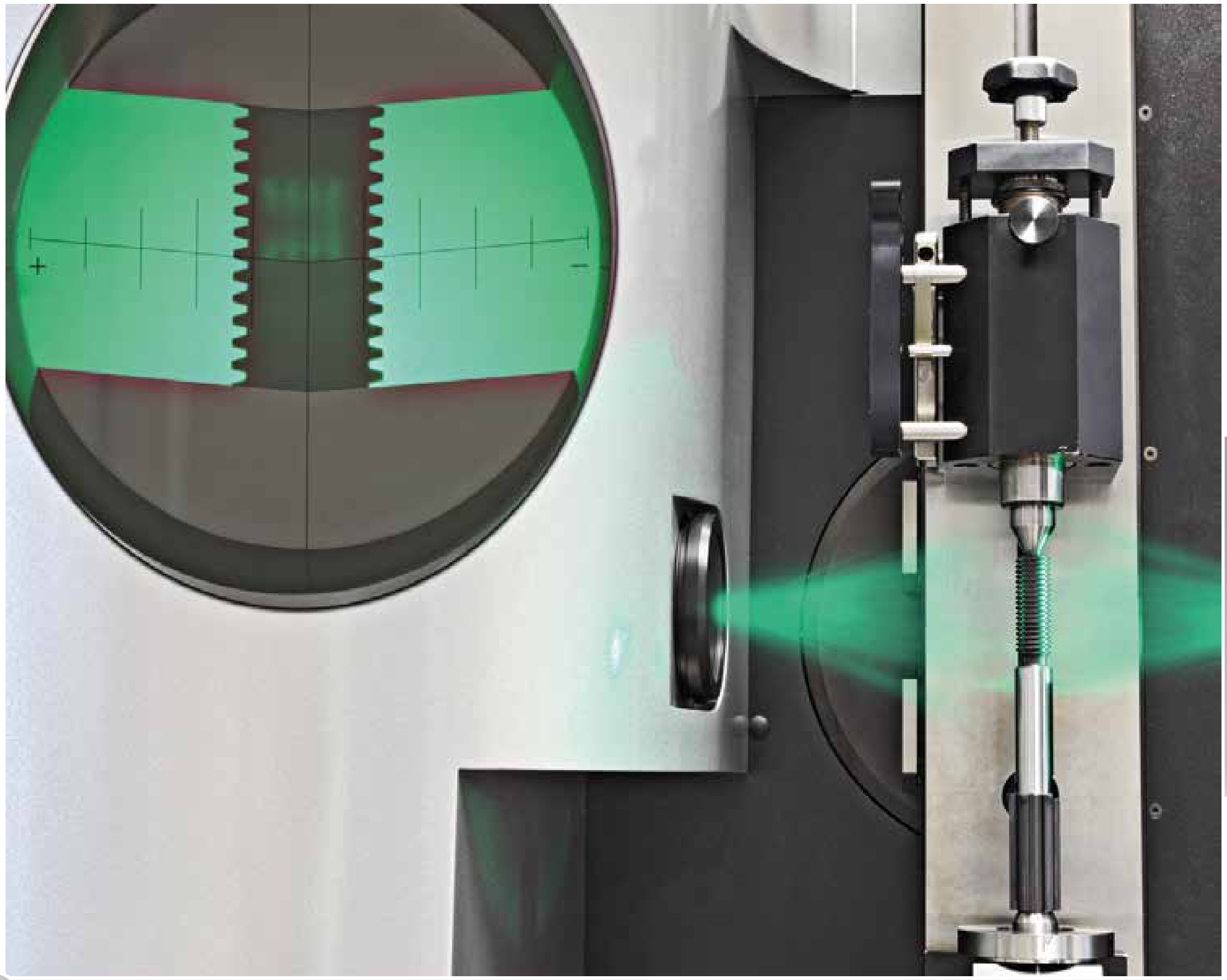
Measurement / testing technology



Statistical evaluations, measuring equipment and process analyses are now standard features in production processes for automotive suppliers.



Optical measurement of the thread



Optical measurement of the thread

We use a variety of methods for measuring our threads, including optical and tactile measuring processes. Our motto is basically to be able to measure everything that we are able to manufacture. This includes the thread profile, the lead, the surfaces and the shape and position tolerances.

kammerer

QUALITY

Ready to go!

Kammerer's customers don't need to carry out incoming goods inspections. They know that they will receive only ready-to-use products from us which can be installed and put into operation right away. We have all the facilities needed to meticulously check the quality of our products.
It goes without saying that this level of reliability and quality is certified: according to DIN ISO 9001:2008. And our "EMAS" environmental certificate verifies our commitment to the environment.


DEKRA

ZERTIFIKAT

kammerer

ISO 9001:2008

DEKRA Certification GmbH bescheinigt hiermit, dass das Unternehmen

Kammerer Gewindetechnik GmbH

Zertifizierter Bereich:
Entwicklung, Herstellung und Vertrieb von Gewindegetrieben

Zertifizierter Standort:
D-78132 Hornberg-Niederwasser, In der Hausmatte 3

ein Qualitätsmanagementsystem entsprechend der oben genannten Norm eingeführt hat und aufrechterhält. Der Nachweis wurde mit Auditbericht-Nr. A12041382 / 2015 erbracht.
Dieses Zertifikat ist gültig vom 28.07.2015 bis 04.07.2018
Zertifikats-Registrier-Nr.: 31196712/6

Lothar Werhofen
DEKRA Certification GmbH Stuttgart, 28.07.2015

IAF DAkkS


Registrierungsurkunde

EMAS
GEPRÜFTES UMWELTMANAGEMENT

Kammerer Gewindetechnik GmbH

In der Hausmatte 3
78132 Hornberg

Register- Nr.: DE 126 00072
Eintragung am 26. Juli 2007

Diese Organisation wendet zur kontinuierlichen Verbesserung der Umweltleistung ein Umweltmanagementsystem nach der EG-Verordnung 1221/2009 an, veröffentlicht regelmäßig eine Umwelterklärung, lässt das Umweltmanagementsystem und die Umwelterklärung von einem zugelassenen, unabhängigen Umweltgutachter begutachten, ist eingetragen im EMAS-Register und deshalb berechtigt das EMAS-Logo zu verwenden.

IHK

Freiburg, den 26. Juli 2011

Andreas Kempff
Hauptgeschäftsführer

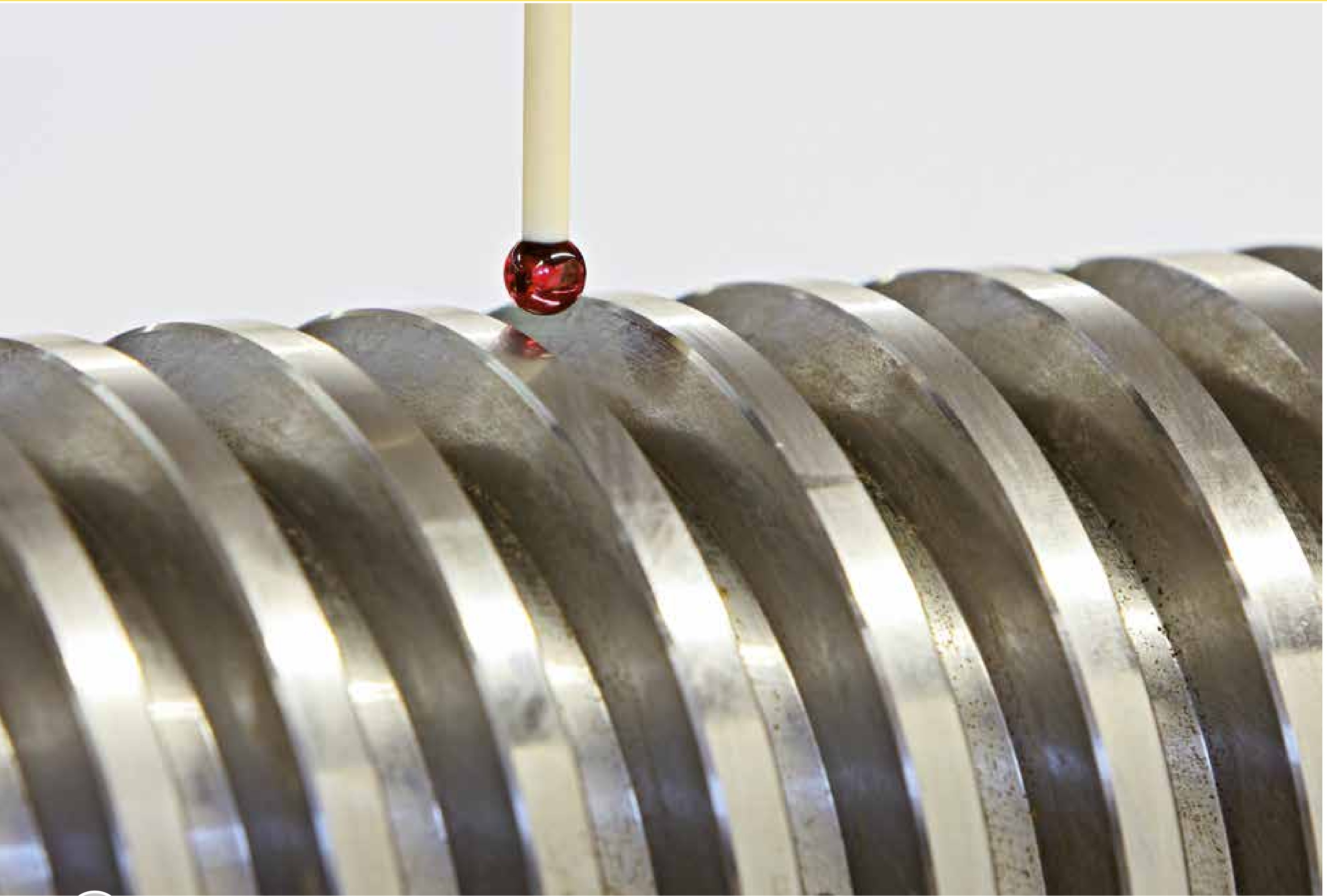
Top left: EMO 2005
Top right: EMO 2011
To the left and below: EMO 2017

Kammerer regularly exhibits at large trade fairs so that visitors can take a look at our high-quality product range.

Quality without compromise

At Kammerer, all key aspects are meticulously certified.

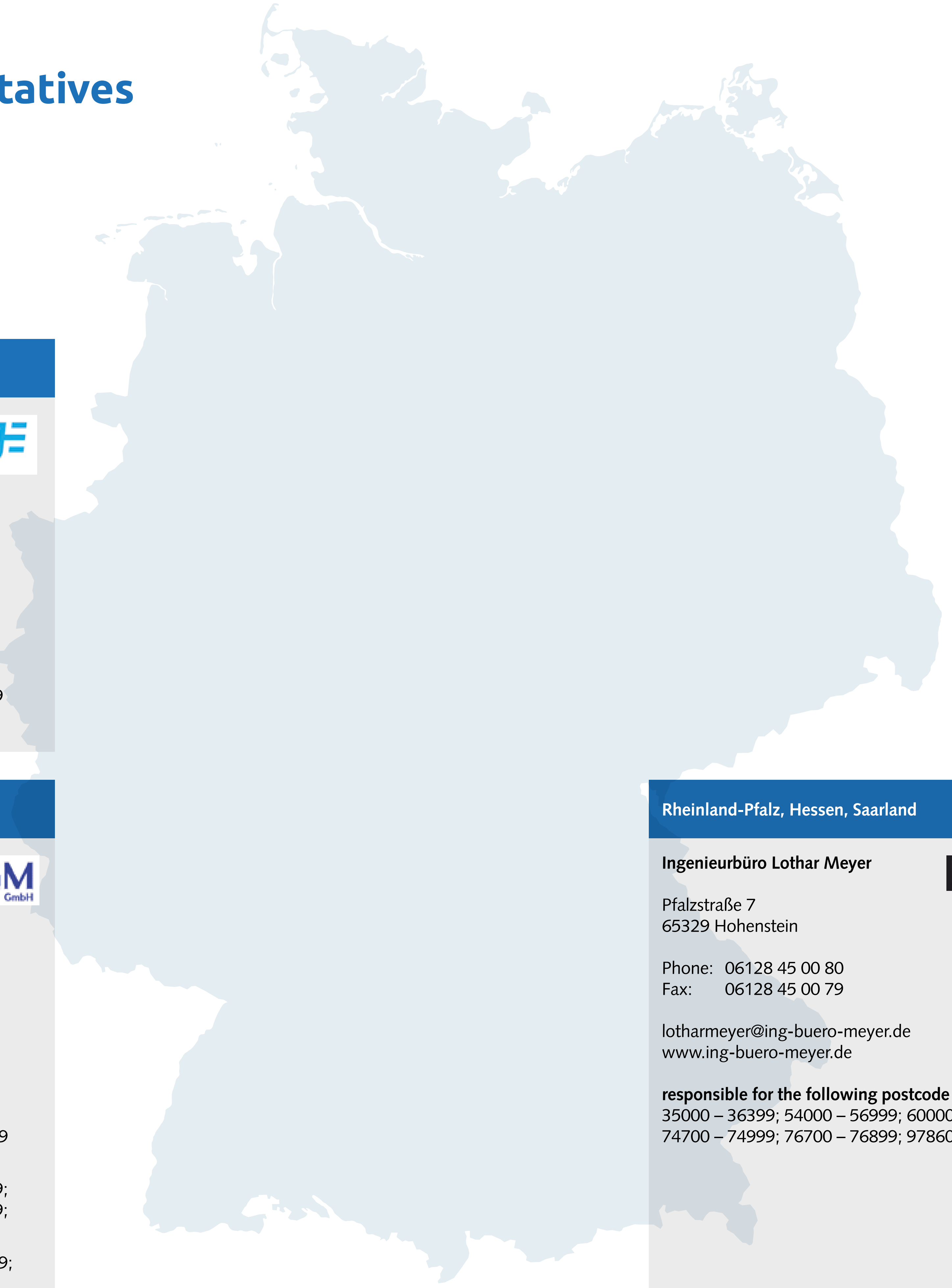
CONTACT



We are here to assist

We appreciate all queries and suggestions. As a customer-focused company, we value open communication with our business partners based on mutual trust.
Whether it be a new project, the feasibility of technical projects or specific questions – we look forward to hearing from you and will gladly provide in-depth advice.

Our area representatives in Germany



Baden-Württemberg

Junghans Engineering GmbH

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Phone: 07681 / 492 23 31
Mobile: 0170 / 900 58 99

contact@junghans-engineering.de
www.junghans-engineering.de

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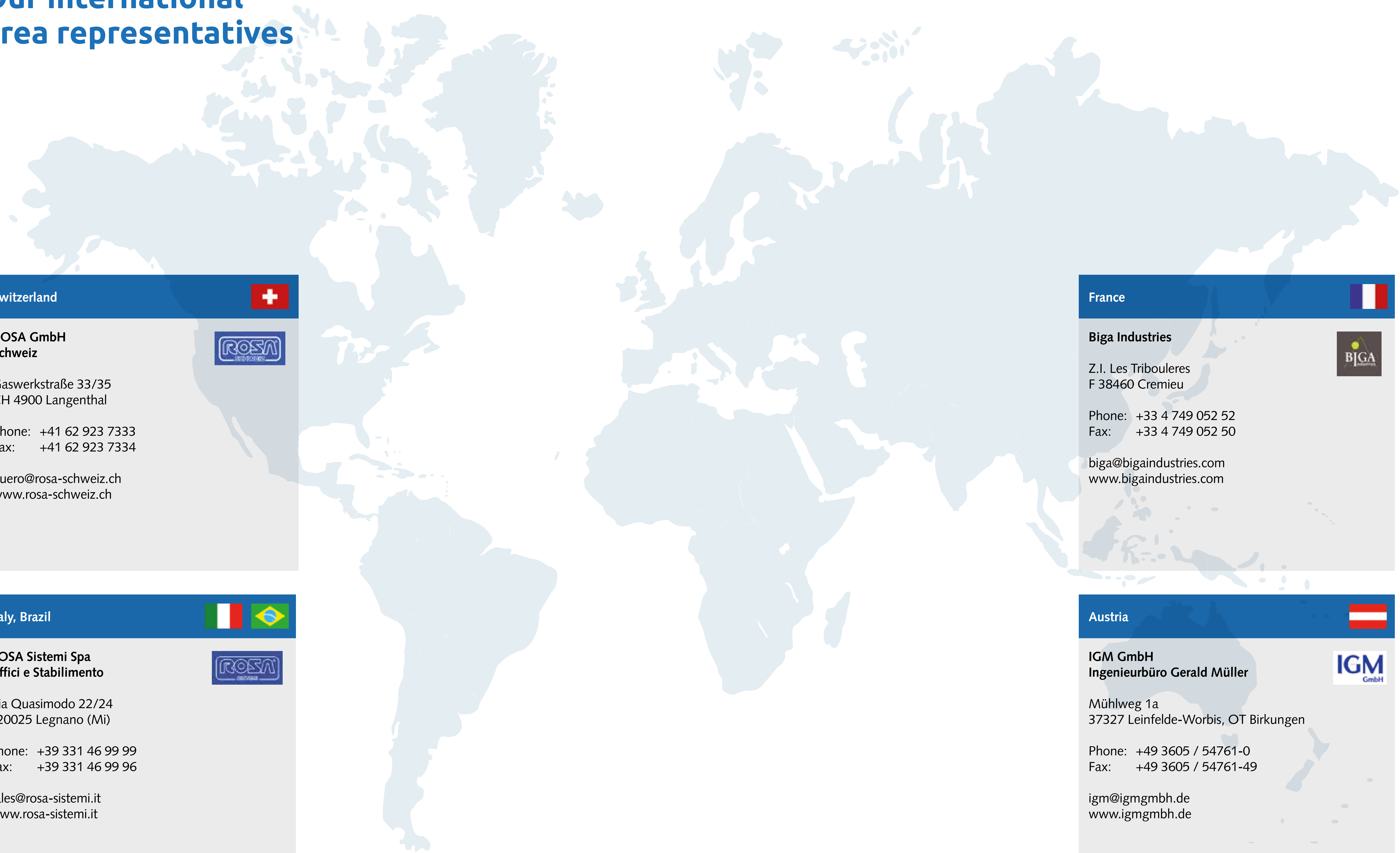
Our international area representatives



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NOTES

NOTES

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