Precision Rolled Ball Screw Drives
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Product Description

Ball Screw Assembly KGT
A precision rolled ball screw assembly KGT consists of at least one KGF or KGM nut on a screw shaft KGS.
The thread design is a right hand, gothic arch profile. KGT Ball screw assemblies are available in various metric diameter-lead combinations.

Ball Screw Shaft KGS
Series KGS precision rolled metric ball screw shafts are manufactured from high strength steel, C153 (SAE 1055). The thread surface is induction hardened to 60 HRC (1.5 mm case depth), min.

Lead accuracies of 23μm/300mm and 50μm/300mm are offered.

Single and multi-start thread designs are used. The number of starts is determined by the diameter-lead combination, and is listed in the dimensional chart for each size.

Standard machined end configurations are offered. Screws can also be machined to customer specifications (drawing required).

Operating Limits
The maximum rotational speed for INA ball screw drives is 4500 rpm. Application specific parameters, such as critical speed may further reduce the speed limit; verification is required.

The permissible operating temperature range is from -30° to +80° C, and up to 110° C for short periods. This assumes proper lubrication.

<table>
<thead>
<tr>
<th>Series</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KGT..F</td>
<td>Ball screw assembly, KGS screw with single flanged nut KGF</td>
</tr>
<tr>
<td>KGT..M</td>
<td>Ball screw assembly, KGS screw with single cylindrical nut KGM</td>
</tr>
<tr>
<td>KGT..FM</td>
<td>Ball screw assembly, KGS screw with double preloaded nut unit (1 KGF, 1 KGM)</td>
</tr>
<tr>
<td>KGT..MM</td>
<td>Ball screw assembly, KGS screw with double preloaded nut unit (2 KGM)</td>
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</tbody>
</table>

Table 1 • INA Ball Screw Drive Assemblies

<table>
<thead>
<tr>
<th>Series</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KGS</td>
<td>Ball Screw Shaft</td>
</tr>
<tr>
<td>KGF</td>
<td>Flanged Ball Nut</td>
</tr>
<tr>
<td>KGM</td>
<td>Cylindrical Ball Nut</td>
</tr>
</tbody>
</table>

Table 2 • INA Ball Screw Drive Components

Figure 1
Button-type Segment Ball Return System. Used On Single Start 5 and 10mm leads

Figure 2
Duct-type Ball Return System. Used On Dual Start 10mm Leads

Figure 3
Endcap Ball Return System. Used On High-helix, Multi-start Leads
Ball Nuts

Flanged Ball Nut KGF
Cylindrical Ball Nut KGM
Series KGF and KGM ball nuts are manufactured from high quality bearing steel, 100Cr6 (SAE 52100). After hardening, the locating surfaces and raceways are precision ground in a single setting to assure accuracy.

INA ball nuts use internal ball return systems. The result is an easy to install compact design.

KGF and KGM ball nuts are offered with Nitrile contact seals on each end face (Suffix EE). The end seals prevent the ingress of contamination and escape of lubrication from the nut.

Preloaded Ball Nuts
Due to low friction and high accuracy, INA ball nuts can be preloaded or assembled to reduce backlash. Two methods are employed to reduce backlash or establish preload:

The most cost-effective method is to reduce or eliminate clearance in the ballnut by ball size selection. This method may result in increased friction in the unloaded state due to four-point ball contact. However, as soon as axial load is applied, normal two-point contact conditions are established and the ballnut operates efficiently, without backlash upon load reversal. The standard preload for this method is 2% of the dynamic load rating [C].

For applications demanding optimum stiffness, INA ball nuts can also be combined to create a preloaded double-nut assembly. The preload is achieved by tensioning the two nuts against each other in conjunction with a ground spacer ring. The total nut length can be enlarged up to 10mm as a consequence of the applied pretensioning ring.

The standard preload for a double-nut assembly is 10% of the dynamic load rating [C]. Other preload values, ranging from 0% to 30% C can be provided upon request.

NOTE: Double-nut preloading is only possible with 5mm and 10mm leads. Leads of 20mm, 25mm, 40mm and 50mm can only be set to low backlash or preloaded by ball selection. Please consult INA Engineering to determine the correct preload for your application.

Preload Variants

KGT-MM
A preloaded nut unit per variation MM consists of two KGM cylindrical nuts and a pretensioning ring.

Figure 4

KGT-FM
A preloaded nut unit per variation FM consists of one KGF flanged nut, one KGM cylindrical nut and a pretensioning ring.

Figure 5
Load Rating And Life

Dynamic Load Rating, \( C \)
The dynamic load Rating, \( C \), is the axial load under which 90% of a significantly large group of apparently identical ball screws will reach or exceed 1,000,000 revolutions before the first evidence of material fatigue occurs.

Static Load Rating, \( C_0 \)
The static load rating, \( C_0 \), is the axial load under which permanent deformation of the raceways or balls occurs in the magnitude of \( 1/10,000 \) of the original ball diameter.

Basic Life Rating
The basic life rating can be calculated by using the following equations:

\[
L_{10} = \left( \frac{C}{P} \right)^3 \cdot 10^6 \quad (1)
\]

\[
L_h = \frac{16,666}{n} \cdot \left( \frac{C}{P} \right)^3 \quad (2)
\]

\( L_{10} \) revolutions
Basic life rating in revolutions

\( L_h \) hours
Basic life rating in operating hours

\( C \) N
Dynamic load rating

\( P \) N
Equivalent axial load

\( n \) rpm
Equivalent speed

Equivalent load and equivalent speed
If ball screws are subject to alternating loads and/or alternating speeds, equivalent values must be calculated for use in the basic life calculation.

The equations for equivalent load and equivalent speed are as follows:

\[
P_a = \sqrt[3]{\frac{q_1 \cdot n_1 \cdot F_1^3 + q_2 \cdot n_2 \cdot F_2^3 + \ldots + q_z \cdot n_z \cdot F_z^3}{q_1 \cdot n_1 + q_2 \cdot n_2 + \ldots + q_z \cdot n_z}} \quad (3)
\]

\[
n = \frac{q_1 \cdot n_1 + q_2 \cdot n_2 + \ldots + q_z \cdot n_z}{100} \quad (4)
\]

\( P \) N
Equivalent axial load

\( F_{1...z} \) N
Constant operating load within a time interval

\( n_{1...z} \) rpm
Constant speed within a time interval

\( q_{1...z} \) %
Duration of time interval

\( N \) rpm
Equivalent speed
Critical Speed
The critical speed of a shaft is the rotational speed at which the shaft becomes dynamically unstable due to resonance of the rotational imbalances with the natural frequency of the shaft. At the critical speed, the shaft can vibrate and deflect in large magnitudes which could result in damage to the shaft and to the machine of which it is part.

It is recommended that the maximum rotational speed of a ball screw be limited to 80% of the critical speed. The equations to calculate critical speed and maximum speed of INA ball screws are as follows:

\[
\begin{align*}
    n_{\text{crit}} &= \frac{k_n \cdot d_2}{L^2} \cdot 10^7 \\
    n_{\text{max}} &= 0.8 \cdot n_{\text{crit}}
\end{align*}
\]

Where:
- \( n_{\text{crit}} \) rpm: Critical speed of screw shaft
- \( k_n \) mm/min\(^{-1}\): Factor from Table 1 for the type of support bearing arrangement
- \( d_2 \) mm: Root diameter of screw shaft listed in dimension table
- \( L \) mm: Unsupported shaft length according to Table 1
- \( n_{\text{max}} \) rpm: Maximum permissible shaft speed

Buckling Load
A shaft under compressive axial load is subject to potential buckling. It is recommended that the maximum axial load on the ball screw be limited to 50% of the buckling load. Limits due to static and dynamic load ratings must be observed as well.

The equations to calculate buckling load and permissible axial load of INA ball screws are as follows:

\[
F_{\text{buckling}} = \frac{k_k \cdot d_r^4}{L^2} \cdot 10^4
\]

\[
F_{\text{perm}} = 0.5 \cdot F_{\text{buckling}}
\]

Where:
- \( F_{\text{buckling}} \) N: Buckling load of screw shaft
- \( k_k \) N/mm\(^2\): Factor from Table 1 for the type of support bearing arrangement
- \( d_r \) mm: Root diameter of screw shaft listed in dimension table
- \( L \) mm: Unsupported shaft length according to Table 1

Table 3 • Coefficients \( k_n \) and \( k_k \)

<table>
<thead>
<tr>
<th>Of Support Bearing Arrangement</th>
<th>Critical Speed Factor ( k_n )</th>
<th>Buckling Load Factor ( k_k )</th>
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<tbody>
<tr>
<td>Fixed-Free</td>
<td>3.5</td>
<td>0.84</td>
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<tr>
<td>Fixed-Supported</td>
<td>15.3</td>
<td>7</td>
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<tr>
<td>Fixed-Fixed</td>
<td>22.3</td>
<td>13.7</td>
</tr>
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</table>
Ordering Designations

BALL NUTS

**SERIES**
- KGF: Flanged Ball Nut
- KGM: Cylindrical Ball Nut

**KGF**
- N: 20
- 05
- -
- EE

**DESIGN**
- D: Per DIN 69051
- N: Per INA Standard

**NOMINAL PITCH DIA.**
- In Millimeters

**LEAD**
- In Millimeters

**SEALS**
- Blank: Without End Seals
- EE: With End Seals

BALL SCREW SHAFT

**SERIES**
- KGS: Ball Screw Shaft

**KGS**
- 20
- 05
- -
- 050
- -
- DW
- / 1250

**NOMINAL PITCH DIA.**
- In Millimeters

**LEAD ACCURACY**
- 023: 23 Micron/300 mm
- 050: 50 Micron/300 mm

**LEAD**
- In Millimeters

**END MACHINING OPTIONS**
- Blank: Form Z & Form Z
- DW: Form D & Form W
- DN: Form D & Form N
- DZ: Form D & Form Z
- CS: per customer specification

**OVERALL SHAFT LENGTH**
- In Millimeters

BALL SCREW ASSEMBLY

**SERIES**
- KGT: Ball Screw Assembly

**KGT**
- N
- 20
- 05
- -
- 050
- FM
- EE
- -
- DW
- / 1250

**NOMINAL PITCH DIA.**
- In Millimeters

**LEAD ACCURACY**
- 023: 23 Micron/300 mm
- 050: 50 Micron/300 mm

**LEAD**
- In Millimeters

**NUT SEAL SUFFIX**
- Blank: Without End Seals
- EE: With End Seals

**NUT CONFIGURATION**
- F: Single Flanged Nut (1 KGF)
- M: Single Cylindrical Nut (1 KGM)
- FM: Double Preloaded Nut Unit (1 KGF 1 KGM)
- MM: Double Preloaded Nut Unit (2 KGM)

**END MACHINING OPTIONS**
- Blank: Form Z & Form Z
- DW: Form D & Form W
- DN: Form D & Form N
- DZ: Form D & Form Z
- CS: per customer specification
# Rolled Ball Screws
## Series KGS

![KGS Rolled Ball Screw](image)

<table>
<thead>
<tr>
<th>Nominal Pitch Diameter $d_0$</th>
<th>Designation</th>
<th>Accuracy Class (μm/300 mm)</th>
<th>Dimensions in (mm)</th>
<th>Mass (kg/m)</th>
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<td>Lead $P$</td>
<td>$d_1$ (h11)</td>
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<td>KGS 1610</td>
<td>16</td>
<td>10</td>
<td>15.4</td>
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<tr>
<td>20</td>
<td>KGS 2005</td>
<td>20</td>
<td>5</td>
<td>19.5</td>
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<td>KGS 2020</td>
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<td>20</td>
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<td>KGS 6310</td>
<td>63</td>
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<td>62.5</td>
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</tbody>
</table>

**Notes**

1. For 5600 mm, delivered length is 6000 mm with both ends soft-annealed over a length of 200 mm.
## Flanged Ball Nuts
### Series KGF

**Figure 7** • KGF Flanged Ball Nuts

<table>
<thead>
<tr>
<th>Nominal Pitch Diameter d0</th>
<th>Designation</th>
<th>Lead</th>
<th>Seal</th>
<th>Form</th>
<th>Hole Pattern</th>
<th>Dimensions in (mm)</th>
<th>Lube Hole G</th>
<th>Axial Backlash Max</th>
<th>Load Rating</th>
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<td>Dyn C (kN)</td>
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<td>E</td>
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<td>28 38 55 48 10 42 - 10 40 10 5</td>
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<td>12.0</td>
<td>12.7</td>
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<tr>
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<td>E</td>
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<td>28 38 55 48 10 55 - 10 40 10 5</td>
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<tr>
<td>20</td>
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<td>EE</td>
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<td>3</td>
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<td>15.0</td>
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<td>40 51 6.6 62 16 55 - 10 48 10 5</td>
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<td>17.5</td>
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**Notes**
1) Round flange.

**Figure 8** • Hole Pattern 1

**Figure 9** • Hole Pattern 2

**Figure 10** • Hole Pattern 3
# Cylindrical Ball Nuts

Series KGM

## Table of Dimensions

<table>
<thead>
<tr>
<th>Nominal Pitch Diameter $d_0$</th>
<th>Designation</th>
<th>Seal Suffix</th>
<th>Form</th>
<th>$D_1$</th>
<th>$D_8$</th>
<th>$L_2$</th>
<th>$L_8$</th>
<th>$L_9$</th>
<th>$L_{10}$</th>
<th>BxT</th>
<th>Axial Backlash Max</th>
<th>Dyn $C$ (kN)</th>
<th>Stat $C_0$ (kN)</th>
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</thead>
<tbody>
<tr>
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**Notes**

1) Position of lubrication hole not defined on circumference.
2) $D_1$ - 0.2/-0.8 is $D_1$ -1/-1.5

---

Figure 11 • KGM Cylindrical Ball Nuts

---

Schaeffler Group Industrial
## Standard Screw Ends

**Form D**

![Figure 12 • Standard Screw End - Form D](image)

### Notes

Bearings and locknut must be ordered separately. For more information, see INA publication TPI 123 Bearings For Screw Drives

### Dimensions in (mm)

<table>
<thead>
<tr>
<th>Nominal Pitch Diameter $d_0$</th>
<th>$D_4$</th>
<th>$D_5$</th>
<th>$D_6$</th>
<th>$D_7$</th>
<th>$L_6$</th>
<th>$L_7$</th>
<th>$N \times S$</th>
<th>Bearing</th>
<th>Locknut</th>
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<tbody>
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<td>42</td>
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### Keyway to DIN 6885

$w \times \text{depth} \times L_6$

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### Diagrams

- [Figure 13 • Standard Screw End - Form D With ZKLF & ZM](image)
- [Figure 14 • Standard Screw End - Form D With ZKLN & ZM](image)
Standard Screw Ends
Forms W, N and Z

**Form W**

<table>
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**Notes**
- Bearings must be ordered separately. For more information, see INA publication 901.
- Shaft rings not included.

**Form N**

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**Notes**
- Bearings must be ordered separately. For more information, see INA publication 901.
- Shaft rings not included.
INA manufactures a complete line of ball screw support bearings and precision lock nuts. INA ball screws can be machined to accommodate numerous bearing arrangements.

For more information see publication TPI123, Bearings For Screw Drives.
Corporate Offices
Schaeffler Group USA Inc.
308 Springhill Farm Road
Fort Mill, South Carolina 29715
Telephone: 803-548-8500
Fax: 803-548-8599

Regional Sales Offices

CHARLOTTE
377 Rubin Center Dr., Suite 115
Fort Mill, South Carolina 29708
Telephone: 803-547-7970
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Fax: 630-955-9365

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Fax: 972-221-5373

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Fax: 937-433-6814

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Telephone: 262-544-8270 x 224
Fax: 262-544-8271

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12 Terry Drive, Suite 205
Langhorne, PA 18940
Telephone: 267-364-5401
Fax: 267-364-5416