



FAG

**added
competence**



Bearing Solutions for Machine Tools

SCHAEFFLER



added
competence

“added competence” – for your success

With their forward-looking bearing arrangement solutions for feed spindles, main spindles, rotary tables and linear guidance units, INA and FAG have been at the forefront of the world market for decades. However, bearing components alone are often no longer the decisive factor for these machine subsystems.

Indeed, our customers are continuing to benefit directly from significant performance improvements and unique selling points thanks to our “ready-to-fit” products; these compact, ready-to-fit bearings are used in accordance with the simple principle: unpack, screw mount, use. However, in order to optimize the entire machine tool system it is becoming ever more important not simply to support the subsystems but also to integrate important functions such as measuring, sealing, lubrication, braking etc. in the components themselves. This intellectual approach is fulfilled comprehensively by the concept “added competence” in the Business Unit Production Machinery since it attaches central importance to systems solution thinking for the bearing, bearing position and entire system. This gives you access to a product range that can optimally cover all of your applications in the machine tool.

Since direct drives and mechatronic solutions are used ever more frequently in machine tools, we have incorporated a further strong partner in the form of IDAM – INA Drives & Mechatronics – in our spectrum of capabilities. In this way, we can now supply you from a single source with bearing elements and the appropriate drive system to give complete systems that are precisely matched to each other.

This opens up completely new technical and economic design possibilities for your requirements, as well as significant advantages in the time and process chain.

In terms of products, we can offer you a comprehensive, precisely balanced range, precision technology and top product quality. In order to match the pulse of your developments as closely as possible, we also have a worldwide network of engineers and service and sales technicians working for you and ensuring that we maintain close contact with you in your own location.

We are convinced that we will always have the right product for your application.

Just contact us to see what we can do for you.

The right product for any application



Screw drive supports Page 4



Main spindles Page 6



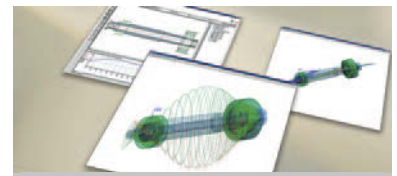
Linear technology Page 8



Direct drives Page 10



Rotary tables Page 12



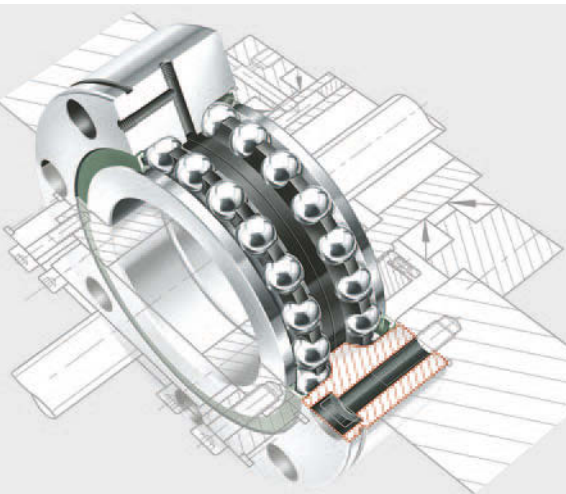
Service Page 14

The right bearing support is a critical factor for the efficiency of a machine tool and the quality of the machined workpieces. For many years, Schaeffler has consistently contributed to the world-leading position of this market sector by means of products under the INA and FAG brands. Through our close partnership, often extending over decades, with the best-known manufacturers of machines, equipment and subsystems in all industrial sectors and our own continuously developed production know-how, we are a world-leading bearing manufacturer and machine tools incorporating the products described in this publication are the obvious choice.

Whether you are interested in dedicated high tech solutions that give unique selling points in the market or in proven standard products that offer long life and ease of mounting, take a look – this is where you will find what you really need, nothing more, nothing less!

On the following pages, you will see a first overview of our product portfolio for machine tools.

Ready-to-fit compact bearing supports



INA screw drive support bearing unit for spindle nuts



ZKLF in a hybrid version for long term, short stroke operation: Our units require only a face milled surface on the adjacent construction. No machining of the bearing bore seat is necessary. During mounting, the bearing unit undergoes self-centering when the spindle nut is moved

Electromechanical drive concepts for machine axes can be realized easily and economically using maintenance-free INA and FAG screw drive support bearings. Based on a deep understanding of details and systems in relation to this bearing position, a product range was developed that led, through the “ready-to-fit” approach, to demonstrable simplifications and savings in the machine tool as an entire system.

Classic components with worldwide acceptance

The reduction in system costs is aided in particular by maintenance-free axial angular contact ball bearing units suitable for direct screw mounting. The classic components in the range are the INA series ZKLN and ZKLF that ensure reliable bearing support for the spindle axis within a small design envelope and without a complex adjacent construction. With their high mounting accuracy and rigidity, low

friction and high torsional strength, these double row axial angular contact ball bearings are in considerable demand worldwide. Seals are already integrated in the bearings.

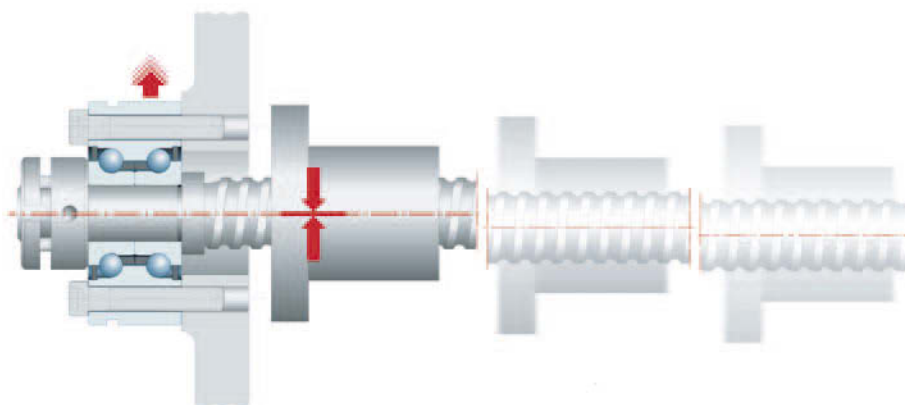
For extreme loads in highly dynamic spindle applications, the series ZKLF is also available as a matched pair of bearings (in a four-row design). These bearings are also provided in the X-life version, giving the following advantages:

- 10% higher basic dynamic load rating
- Up to 33% longer life
- 40% higher limiting speed

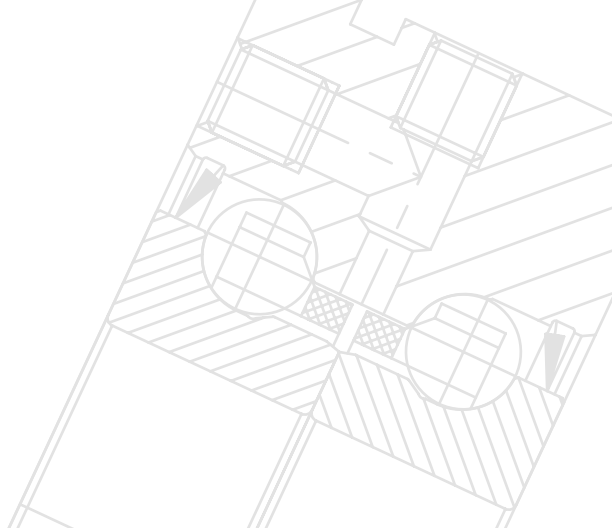
For the concept “driven screw drive bearing”, Schaeffler also has a bearing portfolio that is optimally matched to the requirements.

Attractive solution for vertical axes

For the particular case of locating/ locating screw drive bearing supports, bearings of series DKLFA have been developed. These are an ideal solution in so-called tensioned screw drives,



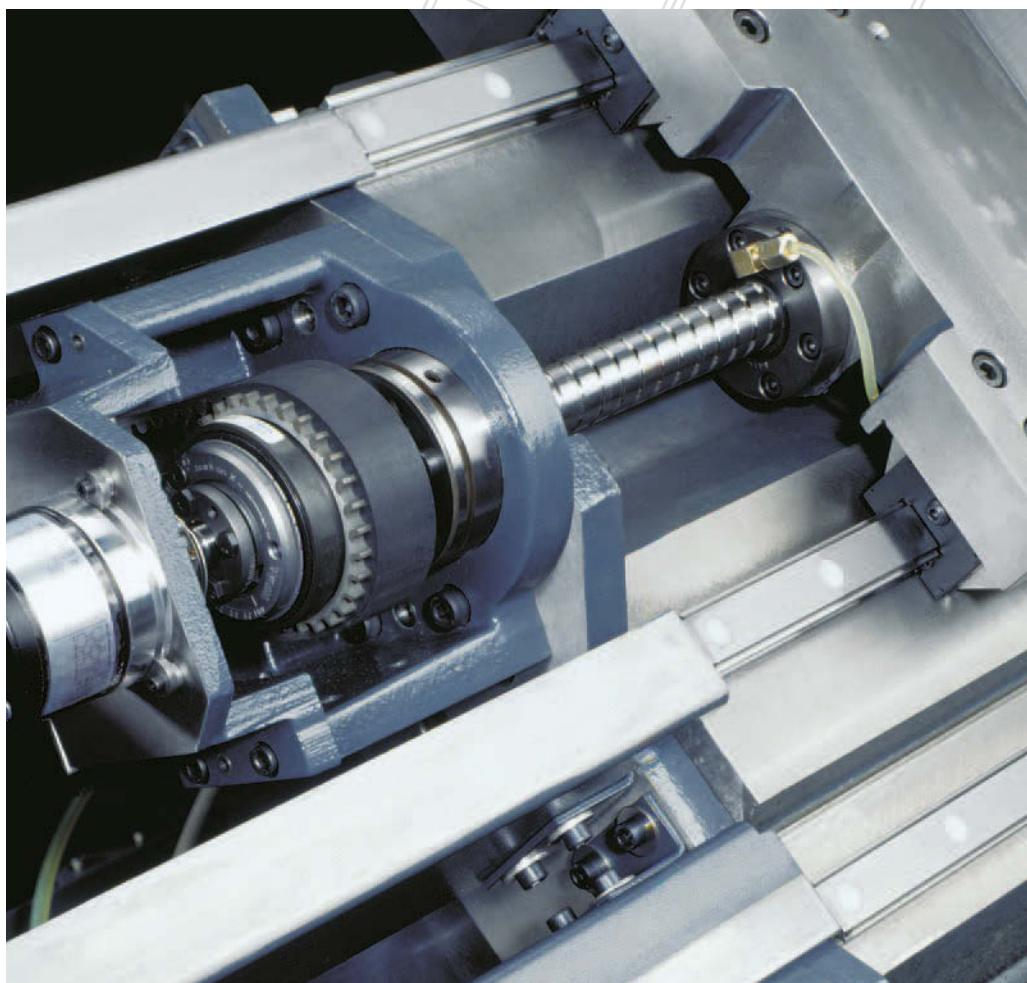
Alignment of bearings by movement of the spindle nut



which are axially preloaded in order to compensate thermal expansion. A third row of balls supports the continuously increased levels of unilateral axial load that arise as a result of the tensioning forces. DKLFA bearings are extremely well suited to heavily loaded vertical axes in machine tools. The two flattened areas on the outer ring facilitate designs with extremely low section height. These are also “ready-to-fit”.

Our range is rounded out by the high precision, single row FAG universal bearings 7602, 7603 and BSB. These can be used in any combination required for the specific operating conditions.

Detailed information on screw drive support bearings can be found in the Schaeffler publication Fasteners TPI 123 “Double Row Axial Angular Contact Ball Bearings for Screw Drives”.



Support of screw drives in accordance with the state of the art



FAG BSB..-2Z



INA ZKLN..-2RS



INA ZKLF..-2Z



INA DKLFA..-2RS

When innovations become standards



Precise workpieces through innovative bearing solutions

For many years, FAG spindle bearings have been setting the standards for reliability, accuracy and very high speeds. The performance capability of spindles and machine tools has been continually pushed forward as a result of innovative products such as hybrid versions, sealed bearings, FD ball type non-locating bearings and X-life ultra premium bearings. They now constitute the standards in this market sector. This success story is rooted in longstanding

experience in applications and intensive partnership in development with leading spindle manufacturers.

A recent new milestone is the high performance bearing series RS. This is characterized by a particularly robust construction and its suitability for very high speeds. The use of these bearings based on large ball sizes and fundamentally with a 20° contact angle provides sustainable cost savings in main spindles – due to significantly longer life and new design options. RS spindle bearings are available, according to requirements, as open bearings or sealed and greased “for life”. Alternatively, they are also offered in the Direct Lube version for pneumatic oil lubrication.

FAG products for the non-locating bearing position

For the non-locating bearing position, we offer our customers a sophisticated performance spectrum. High precision

cylindrical roller bearings are available as single row and double row bearings and also in a hybrid version. These bearings are characterized by their high load carrying capacity, high rigidity and excellent accuracy.

The new high precision cylindrical roller bearing FAG N..TR (Thermally Robust) with a radially elastic outer ring makes it possible, for the first time, to achieve excellent compensation of temperature fluctuations together with very high speed capability on the non-locating bearing position for the motor spindle. The optimized lubricant distribution as well as a lower temperature level in operation provide additional security for the non-locating bearing function. The use of a unilaterally guided cage gives more rapid grease distribution.

Detailed product information can be found in our spindle bearing catalogue SP1.



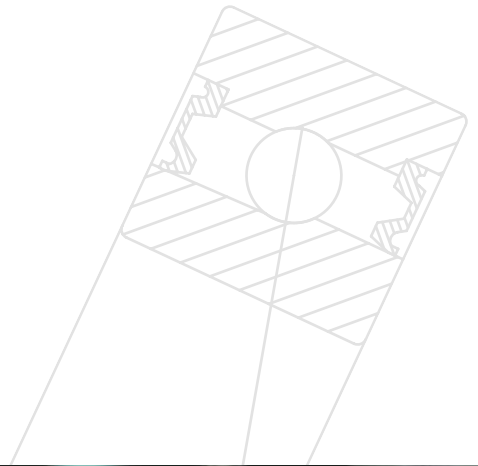
Hybrid bearings for very high spindle speeds: premium products in machine tools



Sealed spindle bearings – greased “for life” with the correct grease in the correct quantity



Direct Lube spindle bearings for pneumatic oil lubrication – for very high speeds



Attractive solution for milling spindles

The new series of high speed axial bearings (BAX) combines high axial load carrying capacity and rigidity with the suitability for high speeds of main spindle bearings. Bearings of this series are dimensionally compatible with spindle bearings of series 70 and have a contact angle of 30° (optionally 40°).

When used in combination with modern, high speed cylindrical roller bearings of types N10 and NN30 in particular, it is possible to realize highly robust spindles with high axial and radial load carrying capacity and suitability for very high speeds. They are thus recommended as extremely suitable for applications in milling spindles for machining centers.



For extremely fast and high performance machine tools: FAG spindle bearings set standards



High speed BAX axial bearing for main spindles

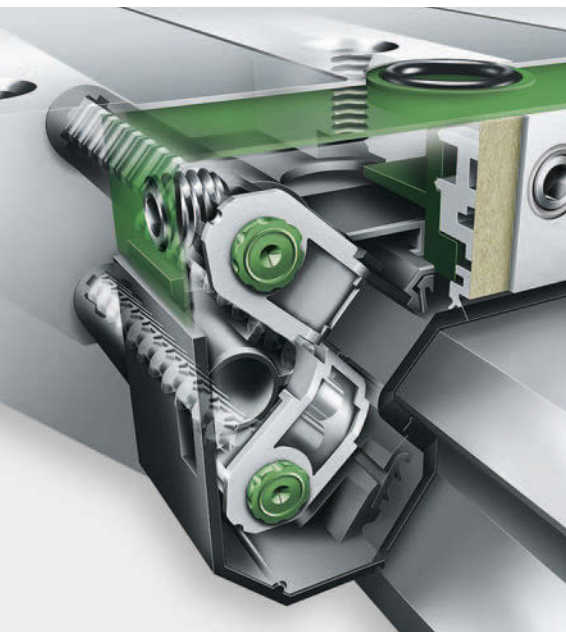


Thermally robust high-speed cylindrical roller bearing TR with elastic outer ring for motor spindles



High precision cylindrical roller bearings – high rigidity, high load carrying capacity

High power in a straight line: From linear guidance systems ...



Under continuous development: We are now offering the 5th generation of linear recirculating roller bearing and guideway assemblies

INA Linear Technology, a wide range with proven quality. This means we can offer you the optimum product, both economically and technically, for any application.

INA monorail guidance systems

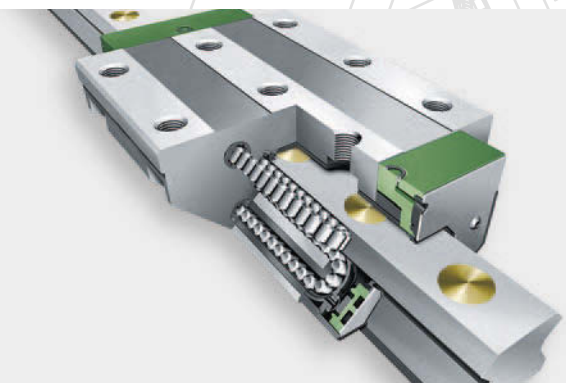
Linear recirculating roller bearing and guideway assemblies of series RUE and linear recirculating ball bearing and guideway assemblies with 2, 4 or 6 rows of balls are among our proven classic products. The widest range of variants is found with the four-row KUVÉ – with sizes from 15 to 55 and 16 different carriage types. Both types of system, whether they are based on balls or rollers, have the same modular concept and are highly integrated in a functional sense. With the lubricant reservoirs integrated directly in the raceways and an optimized lubricant feed system for relubrication in any mounting position, we can achieve long maintenance intervals for the user. INA monorail guidance systems have the widest range of accessories available on the market – allowing versatile and individual configuration to fully match customer requirements.

Hydrostatic compact guidance system

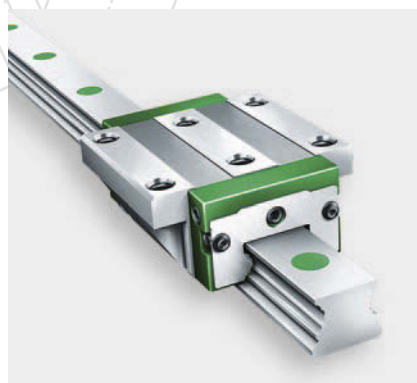
Dynamic rigidity and reductions in vibration are important criteria in the support of linear axes. Linear axes with increased damping capability can give a considerable increase in the effective value of a machine. In addition to adaptive damping by means of the damping carriage RUDS, Schaeffler also offers a fully hydraulic linear guidance system now in its second generation. This is the ready-to-fit, sealed hydraulic compact guidance system HLE with integrated pressure control, matching the design envelope of a monorail guidance system.

The customer advantages include:

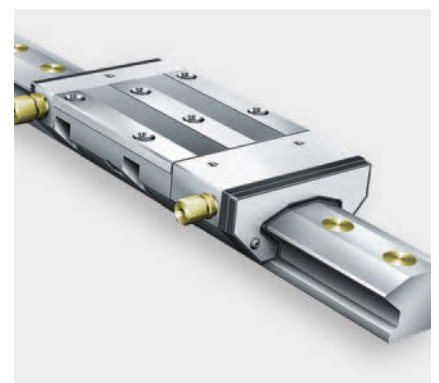
- Functional integration of guidance and damping
- Prevention of leakage by the integrated seals
- Good crash security and excellent emergency running characteristics due to special bronze coating
- Uniform design elements
- Complete advisory process through to the assembly.



Heavy duty sprinter in an XXL format: The linear recirculating roller bearing and guideway assembly RUE100-E-L



Compact: The four-row KUVÉ combines very high load carrying capacity and rigidity with highly dynamic characteristics



Two combined in one: This hydrostatic compact guidance system provides both guidance and damping

... through to the system solution, matching customer requirements

The I-D-E-A-S concept:

Keeping the customer in mind

Literally no other manufacturer can supply all the components for standardized or customer-specific system solutions for automation in manufacturing. Our systems specialists have access to one of the world's most-comprehensive ranges of linear and rotary rolling bearing products. They provide a large variety of mechanical and mechatronic components as well as Schaeffler's entire range of replacement part and after-sales services.

Three options for system solutions

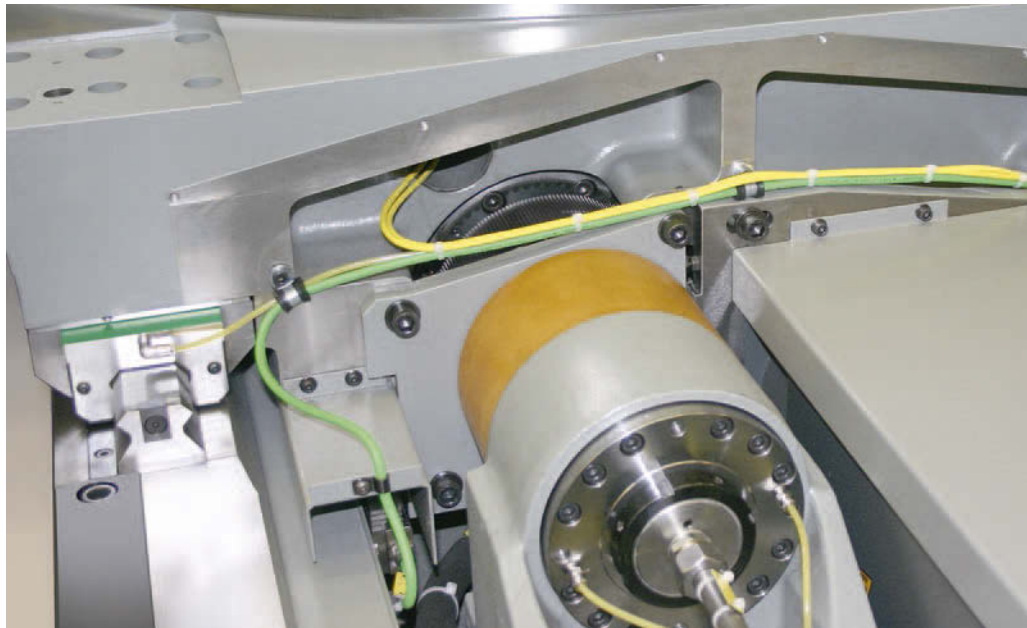
Manufacturing system solutions is one of our Linear Technology sector's core areas of expertise. During this process, we provide support to our customers and sales partners with their requirements, even with very complex tasks.

1. Mechanical systems

This includes the complete range of services related to our catalog products such as linear modules and linear tables.

2. Mechatronic systems

We combine linear actuators and linear tables with perfectly-matched power transmission technology such as motors, gearboxes, control systems and sensors.



Linear recirculating roller bearing and guideway assemblies RUE give reliable guidance of the main axes in machine tools

3. Individual system solutions

In close collaboration with our customers we develop the best possible individual system solution for them – adapted specifically to their needs and the requirements of the task involved.

Idea
Development
Engineering
Application
Service

I-D-E-A-S

The perfect drive system for any application



Thread whirling machine with torque motor (type RI)

IINA – Drives & Mechatronics (IDAM) is the specialist for direct drives. The product portfolio includes linear and rotary motors in a wide range of sizes and power ratings as well as customer-

specific high performance systems. IDAM direct drives are leading technology products and offer the perfect solution for any application. Despite occupying only a very small space,

they develop an extraordinary power density.

These almost wear-free drives have a wide range of positive points including:

- High speed as well as speed variance
- Very good dynamic characteristics and rigidity
- High final speeds
- High acceleration and braking capacity
- Very high positioning and repeat accuracy
- Minimal power loss through heat dissipation

In appropriate applications, IDAM direct drives have major advantages, in terms of energy consumption while achieving very high performance, in comparison with conventional drives.

Linear motors

IDAM linear motors are precise, dynamic assemblies. At the same time, they offer the benefits of a compact



Dynamic and efficient: Linear motors of series L1



Reliable and precise: L2U linear motor

design and a high performance density. For machine tools, the slotted synchronous motors of series L1 and L2U are particularly suitable.

L1 motors operate with high precision and efficiency while developing little heat. Due to their slim design, these linear drives are particularly suitable for measurement and feed tasks.

With the motor series L1C, the development facilities were able to combine high levels of power generation (up to 8,8 N/cm²) with excellent synchronization characteristics and very good efficiency – precisely the characteristics that are in demand in the realization of precision machinery. It has been possible to practically eliminate cogging and load pulsation forces. This gives optimum synchronization, one of the absolute preconditions for high precision machining. The high winding density ensures that heat dissipation into the surrounding machine frame is minimized. This is further reduced by water

cooling and thermal insulation.

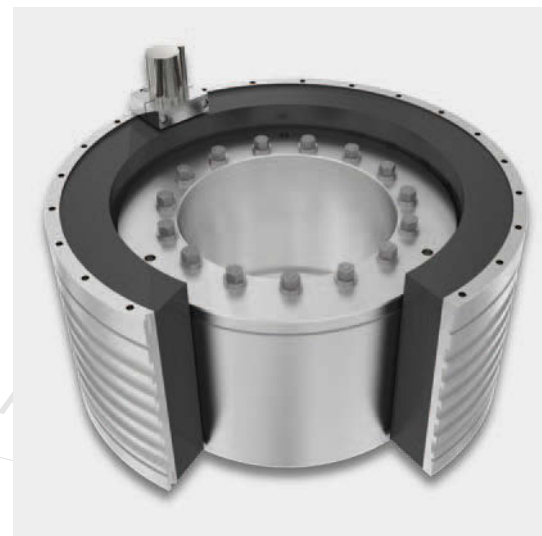
The L2U series is characterized by a very good force/volume ratio and the lack of attraction to the guidance system. As a result, it is particularly conducive to use in dynamic applications requiring high performance levels. Its compact design means that it is easily incorporated in the surrounding structure.

Torque motors

Compact IDAM torque motors – in both internal and external rotor versions – are ideal for applications in machine building where the requirement is for high torque and excellent synchronization behavior. The enormous levels of power generation are ensured by the highly efficient and self-contained cooling system.

With the rotary high performance series RKI, IDAM is moving into new areas of application. The innovative construction leads to optimum values for the motor constant. The drive systems achieve the stated torque values and speeds while generating little heat.

Since volume production solutions do not cover the full spectrum of the possible applications, IDAM manufactures drives matched individually to the specific requirements on the basis of



High performance and economy: RKI torque motor

tested magnet systems. These deliver a winning combination of performance parameters and cost-efficiency. Each segment generates a feed force as a function of its magnet height. The height can be varied in 25 millimeter steps between 25 and 200 mm.

System solutions

In this field, the strength of the “added competence” philosophy takes on particular significance. Development partnerships with our customers and the continuous interdisciplinary cooperation within Schaeffler result in customer-specific high performance systems that are ready-to-fit, perfectly matched and supplied from a single source.



Powerful and compact: RE and RI torque motors

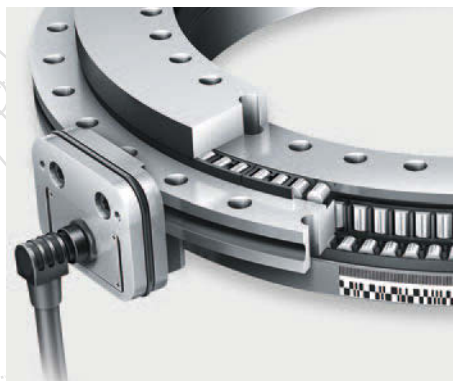
INA/FAG bearing supports – in first place around the world



High precision rotary/swivel table with maximum performance capability due to INA/FAG bearing solutions

Bearing supports for rotary tables in production machinery are one of Schaeffler's most high developed areas of competence. Our range of low-maintenance axial/radial bearings and axial angular contact ball bearings as well as axial needle roller and cage assemblies and axial bearing washers is the widest and most highly developed worldwide for production machinery. For rotary tables, face plates, reversible clamps, milling heads or measuring and inspection equipment – our engineers can provide you with the best technical and economic solution for all requirements.

The optimized axial/radial cylindrical roller bearing of series YRTS is without equal in the market for applications requiring very high limiting speeds and maximum rigidity. It also exhibits extremely low and consistent frictional torque characteristics as well as increased levels of tilting rigidity. The reductions in friction give consistently low bearing temperatures, which exerts a positive influence on the accuracy of the entire machine subassembly. As a



INA YRTSMA – High precision rotary table bearing with integrated absolute value angular measuring system



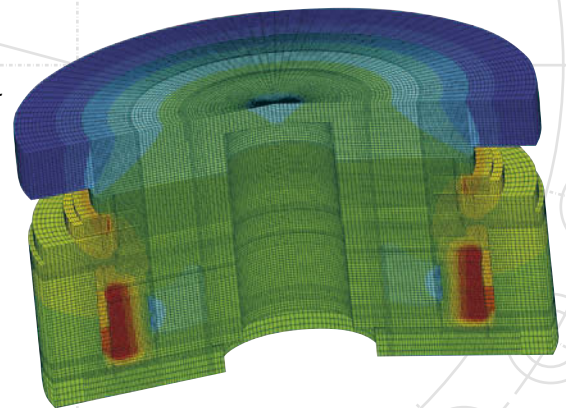
INA YRT – The leading rotary table bearing in the world market for decades

result, YRTS bearings for highly dynamic accelerations are an ideal partner in direct drive rotary tables, in order to make effective use of the potential performance of direct drives. These bearings can optionally be equipped with an angular measuring system incorporating pitch-coded reference marks (YRTM, YRTSM).

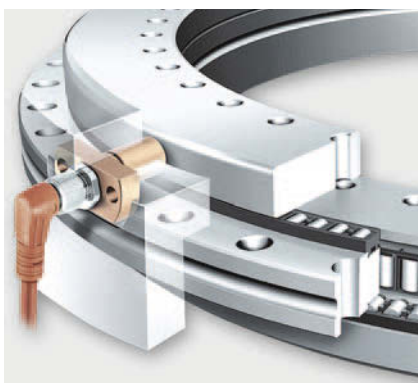
With its YRTSMA, Schaeffler is the first manufacturer in the world to develop a high precision rotary table bearing that has a directly integrated absolute value angular measuring system. This gives a considerable reduction in the mounting work required. In addition, the free space in the centre of the axis opens up completely new design options. The electronic measuring system and IDAM direct drives complement each other extremely well. Since the system components are connected to the adjacent construction by a method that is resistant to vibrations, the influence of vibrations due to machining is substantially prevented.

Very high speeds, high axial and radial load carrying capacity, long operating times – a suitable case for axial angular contact ball bearings of series ZKLDF. This double direction axial angular contact ball bearing with a contact angle of 60° is available as a low-friction, ready-to-fit and greased bearing unit. It provides both security and accuracy in the movement of combined loads.

For standard applications, the proven INA series YRT ranks number 1 worldwide. Its acknowledged reliability, accuracy, cost-efficiency and ongoing development were and remain the guarantors of success. The dimensioning of all bearings for rotary tables has been defined so that they are interchangeable with each other. This gives increased flexibility in the design of a machine tool. Where compact designs with a restricted section height are involved, axial needle roller and cage assemblies of series AXK are available.



Low bearing temperatures give a positive influence on machine accuracy



INA YRTSM – High speed rotary table bearing with incremental measuring system



INA ZKLDF – Low friction, greased “for life” and ready to fit



INA AXK/ASS – flat axial needle roller and cage assemblies, ideal for restricted section height

Effective bearing calculation – freely available



Higher operational security – shorter development times: In bearing design, we carry out modeling of actual operating conditions

With BEARINX®, Schaeffler has developed one of the world's leading programs for rolling bearing calculation. It facilitates the detailed analysis of rolling bearing supports, starting from the individual bearing component and progressing via complex shaft systems to the simulation of operating conditions.

The BEARINX®-online modules based closely on applications allow calculation of the specific bearing loads in machine tools taking account of specific operating and environmental loads as well as the fatigue life in accordance with DIN ISO 281 and numerous other elements for the selection of the correct bearing solution.

User-friendly interface

The self-explanatory menu system will guide you through the inputs for the model structure, bearing selection and load case data. The geometrical and calculation data for INA and FAG rolling bearings are loaded from an integrated database. The results of the calculation can be generated in a user friendly form as a PDF file for ease of documentation.

The following modules are available:

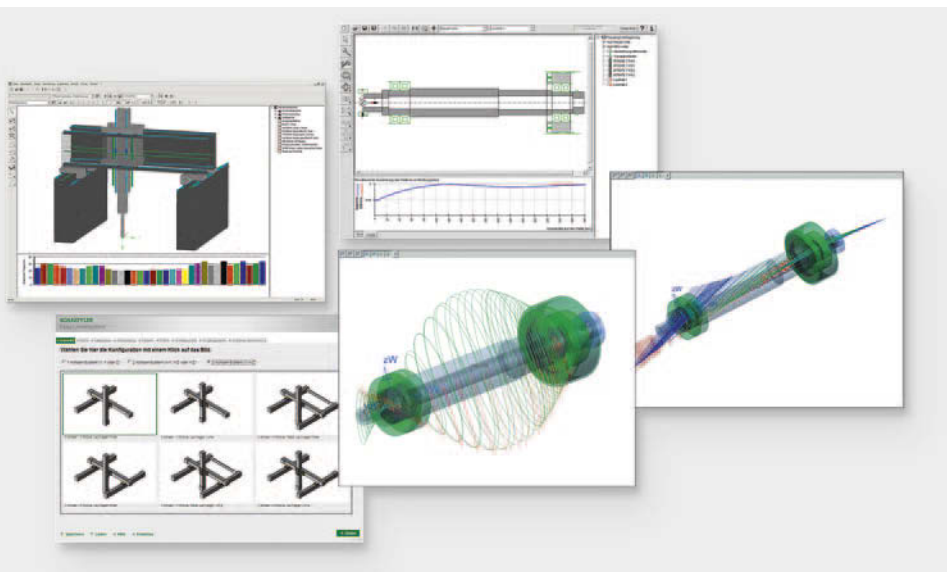
- BEARINX®-online Shaft calculation
- BEARINX®-online Spindle calculation
- BEARINX®-online Linear calculation

Available online: the Easy series

- BEARINX®-online Easy Linear
- BEARINX®-online Easy Linearsystem
- BEARINX®-online Easy Ballscrew

The calculation programs of the “Easy series” are available exclusively online and can be used free of charge without restriction. After initial registration, which takes very little time, you can start immediately on your calculation work.

Other modules are available to customers, sales partners and colleges on the basis of a user agreement.



Your direct access to BEARINX®:
www.schaeffler.com/calculation



Secured productivity, higher machine availability

As a cooperative development partner, we do not simply offer products that are appropriate in terms of practice and performance and the professional design of bearing positions for machine tools. Our service goes beyond this to include modal analysis – the assessment of machinery in relation to dynamics, geometry, noise etc. Our offering is rounded out by other services such as tools and lubricants for operation and the maintenance of machinery.

For many years, Schaeffler has been developing Condition Monitoring systems for components used in all industrial sectors. Of particular interest for machine tool building is the offline or online monitoring of main spindles. Through frequency-selective assessment of the vibration pattern, it is possible to detect indications of changes in spindle bearing condition at an early

stage. In addition, we offer mounting services. In the case of larger plant, direct support by our mounting personnel can be requested.

Furthermore, we regularly hold training sessions covering theory and practice relating to spindle bearings, which can take place either in our own training centre or on site at the customer's location if required.

The Industrial Division of Schaeffler thus has a well-balanced product range – from individual components to matched bearing support systems. Through a combination of application advice and technical service, the customer always receives the most favorable solution in both technical and economic terms.

A complete package, from a single source!



Spindle monitoring



Machinery monitoring by means of FAG SmartCheck



Further information



System solutions for machine tools

www.schaeffler.com/machine-Tools



IDAM direct drives

www.schaeffler.com/direct-drives

idam@schaeffler.com



System solutions for linear axes

www.schaeffler.com/linear-solutions



Services from Industrial Aftermarket

www.schaeffler-iam.com



Schaeffler Technologies AG & Co. KG

Industriestrasse 1 – 3
91074 Herzogenaurach
Germany

Internet www.ina.com

E-Mail info@schaeffler.com

In Germany:

Phone 0180 5003872

Fax 0180 5003873

From other countries:

Phone +49 9132 82-0

Fax +49 9132 82-4950

FAG

Schaeffler Technologies AG & Co. KG

Georg-Schäfer-Strasse 30
97421 Schweinfurt
Germany

Internet www.fag.com

E-Mail FAGinfo@schaeffler.com

In Germany:

Phone 0180 5003872

Fax 0180 5003873

From other countries:

Phone +49 9721 91-0

Fax +49 9721 91-3435

Every care has been taken to ensure the correctness of the information contained in this publication but no liability can be accepted for any errors or omissions. We reserve the right to make technical changes.

© Schaeffler Technologies AG & Co. KG

Issued: 2013, September

This publication or parts thereof may not be reproduced without our permission.