SCHAEFFLER



EMO 2015

Press Kit

LuK INA FAG

Contents

00 **Added value through digitalization**

01 **The "PrecisionDesk" app for rolling bearings checks their authenticity**

02 **Added value through digitalization –**
"*Machine tools 4.0*" innovation project

03 **New materials and improved behavior for maximum spindle bearing performance**

04 **Grease or oil - FAG CONCEPT PRECISION for accurate and efficient lubrication of spindle bearings**

05 **Hydrostatic compact guidance system *HLE 4.0* - for active control of axes**

06 **Smart actuators for extremely high load carrying capacity: Innovative screw drive for electromechanical linear actuators**

07 **Plug-and-play linear systems for machine tools and special machines**

08 **Monorail guidance systems 4.0 - Intelligent components for feed spindles**

09 **Benchmark bearing and drive solutions for rotary axes**

10 **Series RIB torque motors - 12% more torque or 30% less power loss**

11 **Proven to be better: INA track rollers now available in X-life quality**

12 **Reduced development times: Online software for designing spindle bearings**

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Added value through digitalization

MILAN/SCHWEINFURT, October *5, 2015.* In recent decades and years, the main aims of "mechatronization" of subsystems and rolling bearings have been high levels of functional integration, high power density, downsizing and reducing the number of components and interfaces. With *Industrie 4.0*, the scope has widened: Communicative products and the digitalization of components which provide completely new additional functions are a new point of focus. Amongst other things, the aim is to have a real time view of production.

The performance and quality of production machines are fundamentally and definitively determined by the bearing supports. Data on the current condition as well as the future behavior of subsystems supported by bearings, such as spindles, guidance systems, rotary and swivel axes etc. are a fundamental basis for the required real time view. In its role as supplier and development partner for technical drive components, Schaeffler is pursuing a digitalization strategy across all product groups with the aim of providing data from the most diverse of processes via sensors, networking and analysis in order to be able to offer customers clear-cut added value. Schaeffler's activities in the field of machine tool digitalization provide the whole sector with the potential to convert opportunities and overcome challenges through close collaboration between manufacturer, supplier and user.

"*Machine tools 4.0*" innovation project

One tangible example of Schaeffler's digitalization strategy which can be seen at EMO 2015 is the "*Machine tools 4.0*" innovation project, a joint project with Deckel Maho Pfronten and other partners. The prototype based on the DMC 80 FD duoBLOCK® mill-turn universal machining center has additional sensors integrated into nearly all the bearing positions relevant to the machining process in order to measure vibration, forces, temperatures and pressures and obtain the best possible information on the condition of the machine. In order to make all data accessible, the machine is provided with an internal network to which all additional sensors, actuators and evaluation units are connected.

***Linear guidance systems 4.0* development project**

At EMO 2015, Schaeffler is presenting an INA linear recirculating roller bearing and guideway assembly with bearing condition monitoring by means of piezoelectric accelerometers and automated lubrication on demand via an innovative lubricator.

A further innovation on display from INA Linear Technology is the completely hydrostatic compact guidance system with integral piezoresistive pressure sensors. The sensors in the pressure pockets of the HLE-A-XL hydrostatic guidance system measure the pressure changes which occur due to changes in the operating forces. The pressure pocket data are used to calculate the three-dimensional machining forces at the working point (3D logging) through calculation algorithms working in the background. The *4.0* functionality allows workpiece machining to be actively controlled using additional integral pressure sensors, increasing machining quality and efficiency.

Rolling bearing app ready for release

At EMO 2015, Schaeffler is launching rolling bearings with a Data Matrix Code. This allows the bearing to be checked using the PrecisionDesk app. Further functionality, such as retrieving information on performance capability and mounting, are also in development.

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Online-press kit and further information:

Please find more information regarding Schaeffler's trade show presence at EMO 2015 at www.schaeffler.de/en/emo

You can download the online press kit via this link:
http://www.schaeffler.de/content.schaeffler.de/en/press/presskits/press_kit_emo/emo.jsp

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The Schaeffler Group is a leading global integrated automotive and industrial supplier. The company stands for the highest quality, outstanding technology and strong innovative ability. The Schaeffler Group makes a decisive contribution to "mobility for tomorrow" with high-precision components and systems in engine, transmission and chassis applications as well as rolling and plain bearing solutions for a large number of industrial applications. The company generated sales of approximately 12.1 billion Euros in 2014. With around 84,000 employees worldwide, Schaeffler is one of Europe's largest technology companies in family ownership. It has a worldwide network of manufacturing locations, research and development facilities and sales companies at approximately 170 locations in 50 countries. The Industrial division supplies components and systems for around 60 industrial sectors via its worldwide organization and its application support service. The range comprises products from miniature bearings only a few millimeters wide to large-size bearings with an outside diameter of several meters.

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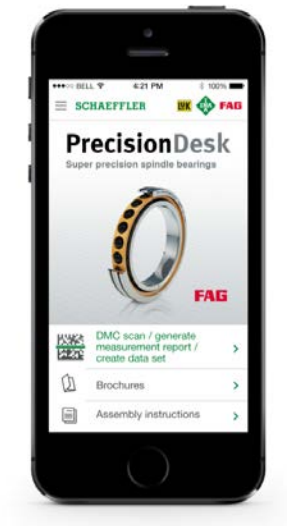
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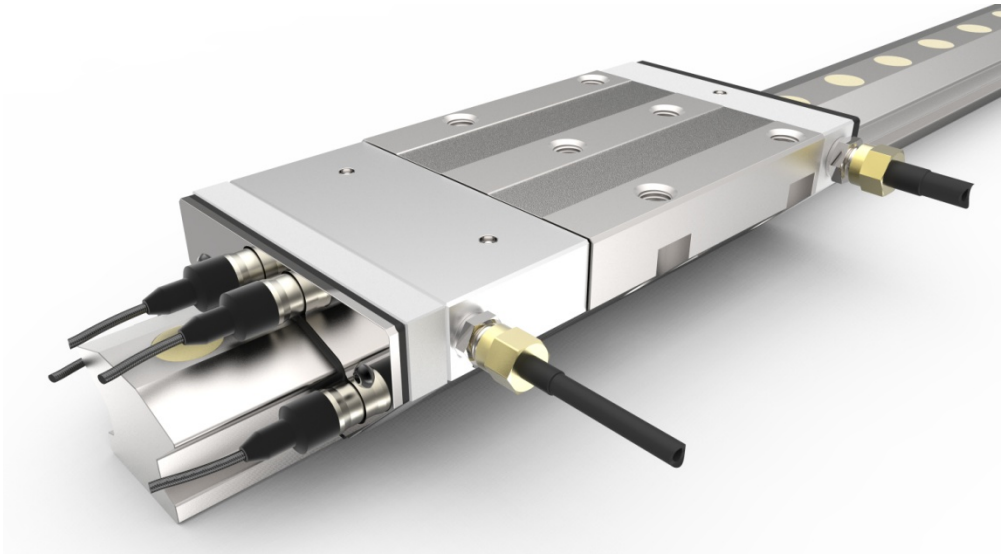
"Machine tools 4.0" innovation project which networks new digitized components with existing technology, from sensors to the cloud, and represents a real step towards digitized production.



Machine 4.0 represents a real step by Schaeffler towards digitized production. The collected data are evaluated both locally and in a Schaeffler cloud in order to feed the results back to the various different site locations.



The app "PrecisionDesk" includes services for high-precision rotary and linear bearings and will be available to coincide with the 2015 EMO.



Hydrostatic compact guidance system HLE-A-XL with integral pressure sensors

Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schaefer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Johanna Katzenberger
Schaeffler Technologies AG & Co. KG
Communications Industrial
Georg-Schaefer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3873
Fax: +49 9721 91-3375
Mobile: +49 151 4066 5844
johanna.katzenberger@schaeffler.com

Press Release

Schaeffler at the 2015 EMO (Hall 03, Booth H08 L07)

The "PrecisionDesk" app for rolling bearings checks their authenticity

MILAN/SCHWENFURT, *October 5, 2015.* Schaeffler is launching its new "PrecisionDesk" app – which includes services for high-precision rotary and linear bearings and is available free of charge – to coincide with the 2015 EMO. This app can be used on mobile end devices with Android, iOS, and Windows operating systems and is designed to help mounting personnel and engineers when selecting bearings and installing components. A new feature of the app is that it allows rolling bearings that are marked with a data matrix code to be checked by simply scanning the data matrix code on the bearing or the bearing packaging. This means that app users can use these data matrix codes to access all of the app's functions, regardless of whether they are using a smartphone or tablet. A web browser-based solution is also being developed that will allow the customer to make use of all the same functions from their PC using a corresponding handheld scanner.

Applications for high-precision rotary and linear bearings include machine tools and textile and printing machinery as well as food and packaging plants. In the future, options such as directly accessing bearing-specific measurement records for spindle and rotary table bearings and storing them for documentation purposes or sending them using the app will be available. For spindle bearings, it is also possible to generate bearing-specific electronic data records and, via suitable interfaces, to utilize these in logistics systems, for example. The app thus offers Schaeffler customers the opportunity to monitor their own bearing inventory and to increase quality levels in the mounting process through the efficient pairing of bearings and shafts/housings. Catalog information, additional product information, and the Schaeffler library can also be directly accessed using the app, which will initially be available in German and English (further languages are also planned at a later date).

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The Industrial division supplies components and systems for around 60 industrial sectors via its worldwide organization with market proximity and its application support service. The range includes miniature bearings only a few millimeters wide through to large-size bearings with an outside diameter of several meters.

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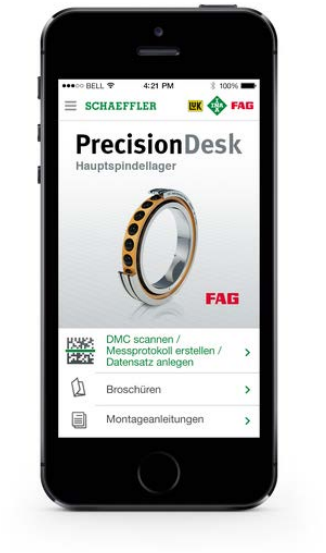
Images: Schaeffler



FAG P4S spindle bearing with data matrix code



Icon of Schaeffler's "PrecisionDesk" app: The app includes services for high-precision rotary and linear bearings and will be available in app stores to coincide with the 2015 EMO.



In the future, options such as directly accessing bearing-specific measurement records for spindle and rotary table bearings and storing them for documentation purposes or sending them using the app will be available.

Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schaefer-Strasse 30
97421 Schweinfurt, Germany
Phone: +49 9721 91-3400
Fax: +49 9721 91-3375
Cell phone: +49 172 8820421
martin.adelhardt@schaeffler.com

Johanna Katzenberger
Schaeffler Technologies AG & Co. KG
Communications Industrial
Georg-Schaefer-Strasse 30
97421 Schweinfurt, Germany
Phone: +49 9721 91-3873
Fax: +49 9721 91-3375
Cell phone: +49 151 4066 5844
johanna.katzenberger@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Added value through digitalization –

"*Machine tools 4.0*" innovation project

MILAN/SCHWEINFURT, October 5*, 2015.* Schaeffler and Deckel Maho Pfronten have developed the "*Machine tools 4.0*" concept based on a specific investment project together with other partners which connects existing technology, from sensors to the cloud, to new digitized components and represents a real step towards digitized production. Two prototypes have been built based on the 4th generation of the DMC 80 FD duoBLOCK® machining center. One will be put into volume production in the precision bearing cell at Schaeffler's plant in Höchstadt. The second prototype can be seen at the DMG MORI booth at EMO 2015. As a leading supplier and development partner for technical drive components in machine tools, Schaeffler is pursuing a specific digitalization strategy with the aim of providing data from the most diverse of processes via sensors, networking and analysis in order to be able to offer customers clear-cut added value. As a user of machine tools, this *Industrie 4.0* initiative has a direct relevance in Schaeffler's own production. Schaeffler's activities in the field of machine tool digitalization provide the whole sector with the potential to convert opportunities and overcome challenges through close collaboration between manufacturer, supplier and user.

Bearing supports as data sources

Bearing supports are decisive components for machine tool performance as they are decisive not only for the functional capacity of the machine but also for the quality of the work piece. Data which can be attributed to the current condition as well as the future behavior of components become an important source of information for the machine operator. Existing sensors can be used or suitable equipment retrofitted. At times, it could advantageous or, in fact, the only sensible option, to integrate the sensor directly into components as this is the only point at which some parameters can be determined.

The prototypes for this innovative project have additional sensors integrated into nearly all the bearing positions relevant to the machining process in order to measure vibration, forces, temperatures and pressures and obtain the best possible information on the condition of the machine. Making a machine ready for "*4.0 production*", means assessing the recorded data, saving them and being able to draw conclusions from them. In order to make all data accessible, the machine is provided with an internal network to which all additional sensors, actuators and

evaluation units are connected. A gateway provides a link to the cloud. In order to ensure data can be exchanged with the machine's control system, Profibus is integrated into the PLC for time-critical and process data and the OPC UA protocol is used for further information from the human machine interface (HMI). The data from the machine are saved locally in the gateway and copied into the Schaeffler cloud. This ensures the machine's data history is available without having to connect to the network. Calculations can be completed in the cloud via web services or apps.

Big data and data analysis

Analysis of large volumes of data has assumed a new significance compared to existing data analysis, which principally has a 1:1 ratio as far as output is concerned. This assumes that, in addition to the actual measured values, patterns occur in a sufficiently large number of measured values/data (big data) which can be correlated with other data. These provide a new level of quality in terms of what they can reveal with respect to, for example, the bearings' condition and therefore machine condition (data-based added value). The patterns can be automatically recognized by suitable algorithms and any necessary recommended actions carried out. Decentralized functional units are required which can operate both autonomously and as an integral part of the network. This allows local intelligence to assess the data locally. Additional evaluations which require more computing power can be retrieved from the cloud. An analytical evaluation based on data from all connected machines is carried out in the cloud and not locally on the machine.

Schaeffler is therefore designing a horizontal network along the value-added chain, similar to the vertical integration of sensors into the cloud, in order to learn how complexity and requirements for products and services can be accommodated in production.

Integration into production

The possibilities offered by digitalization are not limited to manufacturing machines. The manufacturing environment can also benefit from a continuous flow of data. This avoids isolated solutions which could require manual intervention. Vertical integration is also required to connect to the ERP system for automatic order processing.

Manufacturing

An important element in "big data" is an unambiguous identification of individual components. To this end, a marking unit is integrated which gives each component a unique code using a Data Matrix Code. This stays with the components throughout the manufacturing process and forms part of the unit ID. This allows the component's history to be analyzed and provides traceability.

Process

Determining the forces on the tool center point (TCP) allows further optimization of the machine loading as well as the process itself:

Displacement at the TCP due to loads that occur during machining can be determined using a mathematical model and potential correction measures can be fed back to the control system in real time. The actual machining forces occurring can be determined in advance using machining simulations. These form a nominal value which may not deviate outside a predetermined range as this would indicate an unacceptable condition.

Energy

In addition to measuring actual energy usage and assigning this to each machining stage, it is also possible to determine future energy demands through process simulation. When combined with existing data, a more accurate prediction of energy requirements can be produced which allows demand-driven purchasing of energy as well as production planning by minimizing energy peaks across the business.

Condition of the machine

The condition of the machine is recorded using classic vibration monitoring processes. The condition of the lubricant is also measured and evaluated at different points. Demand-driven lubrication guarantees functional capacity as well as careful use of resources without influencing machine performance. It is also possible to provide a relative prediction of the further development of the bearing condition.

Maintenance

Load collectives in the machine can be clearly understood by classifying the machining processes. For example, a nominal residual service life of the bearing position can be calculated online using the Schaeffler bearing calculation program BEARINX via a web service. The aim is to use simulations of planned machining tasks and the resultant foreseeable operating life of the individual components to

control production in such a way as to allow essential maintenance to be planned in advance in order to maximize machine availability.

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Images: Schaeffler



Building on a specific investment project, Schaeffler and Deckel Maho Pfronten are developing the "*Machine tool 4.0*" which connects existing technology, from sensors to the cloud, to new digitized components and represents a real step towards digitized production.

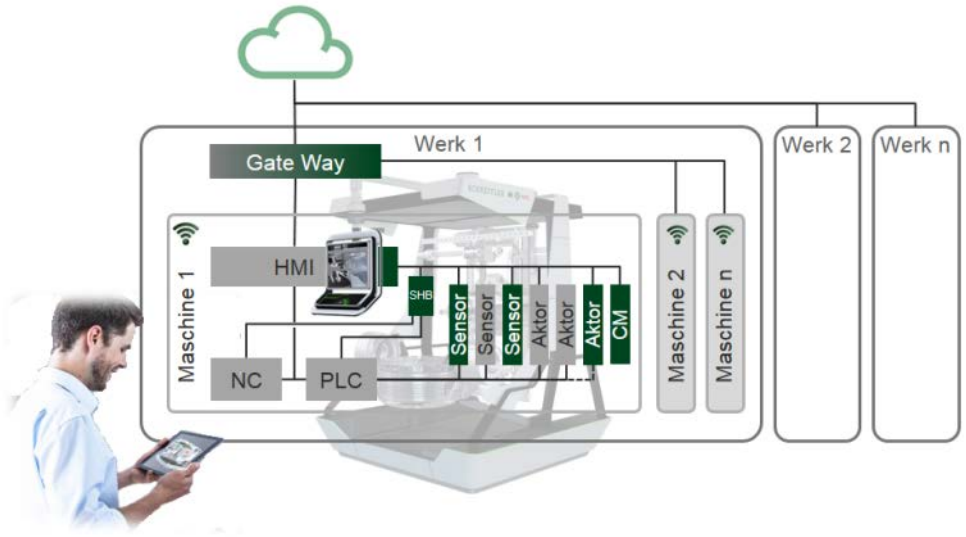




The possibilities offered by digitalization are not limited to manufacturing machines. The production environment also benefits from a continuous flow of data in the value chain.



Machine 4.0 represents a real step by Schaeffler towards digitized production. The collected data are evaluated both locally and in a Schaeffler cloud in order to feed the results back to the various different site locations.



Representation of the system architecture of a digitized machine tool.

Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Johanna Katzenberger
Schaeffler Technologies AG & Co. KG
Communication Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3873
Fax: +49 9721 91-3375
Mobile: +49 151 4066 5844
johanna.katzenberger@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

New materials and improved behavior for maximum spindle bearing performance

MILAN/SCHWEINFURT, *October 5, 2015.* By using new materials and manufacturing methods, Schaeffler has achieved significant increases in the performance of several series of spindle bearings. As a result of these developments, new high-precision bearings, cylindrical roller bearings with plastic cages and the new high performance steel Vacrodur will be presented for the first time at EMO 2015. Increased speeds, higher accuracy, longer operating life and greater load carrying capacity for bearing supports ensure that Schaeffler's customer can develop machine tools in the future which pave the way in terms of both their performance capability and operational safety.

Cylindrical roller bearings in X-life quality with plastic cage

The new generation of X-life products from Schaeffler now includes the proven high accuracy cylindrical roller bearings of series N10 and NN30, with inside diameters from 30 to 120 mm, with an 18 % increase in basic dynamic load ratings. The bearings are fitted with a window cage made from high performance polyphthalamide (PPA) plastic. In tests, these bearings, particularly the double-row bearings, have demonstrated significant improvements in their suitability for high speeds compared to bearings with brass cages. In this comparison, bearings with the new polyamide cage also feature a reduction in temperature of up to 12 K. This reduced heating also allows up to 25 % increase in speeds in limiting speed tests. A further advantage of the lower running temperature of this polyamide cage compared to the brass cage is an increase in the grease operating life. Using the plastic cage, which is lighter and has better damping characteristics, also has a positive influence on the bearing noise - the bearings run more quietly. Considerably higher performance designs can be achieved due to the increased limiting speeds in the new X-life cylindrical roller bearings. This is particularly true when combined with high speed axial bearings of series BAX. Speed parameters of almost 1 million mm/min are possible with minimal oil lubrication.

Vacrodur bearings - peak performance for the future

One way of increasing the load carrying capacity of bearings while retaining their suitability for high speeds is by using superior materials for the inner and outer rings. For years, rolling bearings from Schaeffler with rings made from Cronidur have represented the ultimate with respect to load carrying capacity and grease operating life. In comparison, the new high performance steel Vacrodur offers even greater static and dynamic load ratings together with superior wear behavior. Vacrodur is a high-performance steel made in a powder metallurgy process with a fine, homogeneous structure featuring an excellent combination of hardness and ductility. Tests have shown superior wear behavior under poor lubricating conditions and contamination as the material is harder than most of the contaminant particles. The high surface hardness also leads to lower sensitivity to brinelling. Bearings made from Vacrodur can support higher loads without plastic deformation occurring in the raceway. Compared to 100Cr6, the basic dynamic load rating is 65 % higher with the same internal design. Schaeffler is offering spindle bearings made from Vacrodur as special solutions for bearing positions with very high demands. Other installation areas for this high-performance steel are bearing supports susceptible to mixed friction and contamination as well as high static loading.

Spindle bearings in P4 accuracy

Schaeffler is now offering a range of spindle bearings in P4 running accuracy for simple milling spindles with belt drives or fast-running electric motors. These open individual bearings are fitted with a plastic cage guided on the rolling elements and large steel balls in the diameter range B70. With contact angles of 15 and 25 degrees and a standard preload class of UL, these bearings correspond, at least in terms of their mechanical accuracy, to the well-know P4S spindle bearings, series B70. They are available with inside diameters from 25 to 100 mm. The FAG P4S spindle bearings already have a Data Matrix Code which allows the bearing's authenticity to be checked using the PrecisionDesk app and, in the future, will also provide further functionality such as retrieving information on performance capability and mounting.

* * *

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Images: Schaeffler



FAG P4S spindle bearing with Data Matrix Code



X-life cylindrical roller bearing with plastic cage



BAX – High-speed axial bearings for main spindles

Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Johanna Katzenberger
Schaeffler Technologies AG & Co. KG
Communications Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3873
Fax: +49 9721 91-3375
Mobile: +49 151 4066 5844
johanna.katzenberger@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Grease or oil - FAG CONCEPT PRECISION for accurate and efficient lubrication of spindle bearings

MILAN/SCHWEINFURT, October 5*, 2015.* Extremely accurate and efficient lubrication of spindle bearings is now possible courtesy of the recently developed FAG CONCEPT PRECISION GREASE and FAG CONCEPT PRECISION OIL compact lubrication systems from Schaeffler. As this type of rolling bearing support runs at high speeds, key points of focus in their development are correct supply and removal of lubricant, lubricant quantity, heat dissipation the the lubricant itself.

Current high-performance greases allow spindle bearings to be lubricated safely and economically over long periods of time, even when running at very high speeds. For this reason, the majority of main spindles are lubricated with grease. These bearing supports are usually sensitive to over-lubrication which means that solutions are required which provide the correct amount of grease to the correct point on the spindle. Furthermore, high-performance greases tend to harden and separate under pressure. The relubrication facility must take this into consideration.

FAG CONCEPT PRECISION GREASE

Schaeffler's FAG CONCEPT PRECISION GREASE is a lubrication system which has been designed specifically for the demands of main spindles with respect to the volume dispensed on each stroke. Grease-filled hoses are connected to the outlets and form the actual lubricant reservoir for relubrication. The cartridge contains only pressure oil which is pumped into the hoses during lubrication. The grease and pressure medium are kept apart by a ball in the hose. The system provides 0.025 cm^3 per stroke and supply line. The grease is under pressure only during the relubrication process in order to prevent the grease separating in the relubrication unit.

The FAG CONCEPT2 system is another compact lubrication unit from Schaeffler which has either one or two outlets and typically is suitable for relubricating rotary tables. FAG CONCEPT8 has up to eight outlets and can be used for lubricating linear axes in machine tools.

FAG CONCEPT PRECISION OIL – direct oil lubrication without compressed air

If very high speed parameters (> 1,6 million mm/min) are required in an application, the usual solution is pneumatic oil lubrication. The disadvantage of pneumatic oil lubrication is the need for compressed air which is resource-hungry and expensive. The compressed air costs just for relubricating one motor spindle in three-shift operation can be €700 per annum. Insufficiently filtered air or the formation of condensation due to inadequate drying can also lead to premature spindle failure.

The solution: FAG CONCEPT PRECISION OIL provides direct oil lubrication in extremely small doses without the need for compressed air as a carrier. The innovation here is replacing compressed air as the medium for transporting the lubricant into the bearing by a damper/throttle element. This element provides a virtually continuous feed rate to the bearing. The concept has been tested with Weiss Spindeltechnologie GmbH in a prototype motor spindle and has since been proven in practice. A speed-dependent control for the direct oil lubrication system offers further potential for optimization.

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FAG CONCEPT PRECISION GREASE – automatic grease relubrication system



FAG CONCEPT PRECISION OIL – The solution for a direct oil lubrication unit, particularly for high speed spindles without the need for compressed air.

SCHAEFFLER

Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Johanna Katzenberger
Schaeffler Technologies AG & Co. KG
Communications Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3873
Fax: +49 9721 91-3375
Mobile: +49 151 4066 5844
johanna.katzenberger@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Hydrostatic compact guidance system *HLE 4.0* - for active control of axes

MILAN/HOMBURG, October 5*, 2015.* The fully hydrostatic compact guidance system HLE introduces, for the first time, a development project of second generation INA linear technology with integral pressure sensors. The *4.0* functionality allows workpiece machining to be actively controlled, increasing machining quality and efficiency. The pressure pockets of the saddle plate are filled with a sliding material in order to prevent crash situations. In the latest generation HLE-A-XL, this sliding material is replaced with a special bronze coating to ensure very high emergency running characteristics.

Pressure pocket data for active control of the machine tool

Dynamic rigidity and the reduction of vibration play a significant role in machine tools due to increasing dynamics and higher power densities. Schaeffler is offering a fully hydrostatic compact guidance system HLE-A-XL to complement the adaptive damping provided by the RUDS damping carriage in combination with the linear recirculating roller bearing and guideway assembly RUE-E. This ready-to-fit and sealed system with integrated pressure control combines the functions of "guidance" and "damping" within the design envelope of a monorail guidance system. It is thus a substitute for monorail guidance systems. Piezoresistive pressure sensors are used in the *4.0* version of the HLE-A-XL. The sensors measure the pressure changes in the pressure pockets which occur due to changes or variations in the operating forces. The pressure pocket data are used to calculate the three-dimensional machining forces at the working point (3D logging) through calculation algorithms working in the background. This allows the HLE-A-XL to provide active control for the machine tool. By taking the moving masses of the unit into consideration as well, the calculation program can also use the calculation model to determine the residual operating life of all rolling bearing elements.

The addition to the product range of the second generation hydrostatic compact guidance system HLE-A-XL in X-life quality provides machine tool manufacturers with the option of realizing different machine tool performance classes within one machine concept. The HLE-A-XL provides excellent damping characteristics combined with high dynamic rigidity. This means higher cutting rates, improved surface quality and longer tool life for end users. The *4.0* functionality will allow

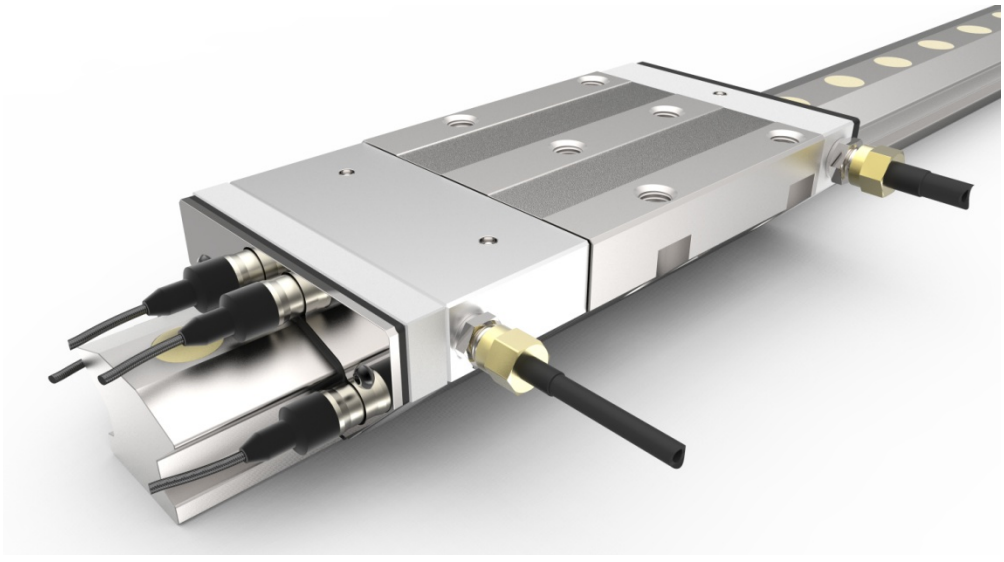
machining to be actively controlled in the future by means of additional integral pressure sensors, thus increasing machining quality and efficiency.

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Image: Schaeffler



Hydrostatic compact guidance system HLE-A-XL with integral pressure sensors

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Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Jürgen Klein
Schaeffler Technologies AG & Co. KG
Head of Marketing, Linear Technology
Berliner Straße 134
66424 Homburg (Saar), Germany
Tel. +49 6841 701-2106
Fax: +49 6841 701-45 2106
Mobile: +49 173 5720510
juergen.klein@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Smart actuators for extremely high load carrying capacity: Innovative screw drive for electromechanical linear actuators

MILAN/HOMBURG, *October 5, 2015.* Schaeffler is expanding its range of spindles through the addition of a screw drive that features a new design and functional principle and delivers both a high load carrying capacity and a high power density. The technical characteristics of the so-called "planetary screw drive" or PWG make it the perfect addition to Schaeffler's range, which includes the ball screw drive (KGT) and roller screw drive (RGT). The high power density of the PWG means that it can also be used as a substitute for hydraulic drives. Schaeffler thus has a complete range of screw drives and can deliver the perfect solution for every application in terms of speed, precision, and load carrying capacity. The planetary screw drive PWG paves the way to a "Smart actuator": An electromechanical linear actuator with extremely high efficiency and minimum space requirements.

The ball screw drive and roller screw drive have both become well established on the screw drive market. The ball screw drive's outstanding strengths include high dynamics due to the high spindle pitch, low-friction running, and a high level of positioning and repeat accuracy. For geometrical reasons, however, low spindle pitches cannot be achieved. By comparison, the roller screw drive offers a higher load carrying capacity at spindle pitches from approx. 10 mm and high positioning accuracy.

The missing third element is a design that can support even higher loads at small spindle pitches of less than 5 mm. For this type of application, Schaeffler has developed the so-called planetary screw drive (PWG): This design features planetary gears with v-shaped parallel grooves that roll up and down the spindle. The rotation of the planets or their drive is via the spindle nut. The ends of the planets are located in grooves in the end faces of the two-piece nut. The very high number of rolling contacts means that the PWG achieves a higher load carrying capacity and rigidity than the other two designs. Friction levels remain low thanks to the good internal load distribution and the optimized osculation between the spindle thread flanks and the crowned flanks of the planetary gear grooves. When planetary gears with the correct groove diameter are selected, overall pitches of just 0.75 to 5 mm can be achieved.

The special features of this design include the manufacturing process itself: The spindles and planetary gears are manufactured using forming methods, which makes good material compression possible together with optimum grain flow, the highest possible strength, and therefore a further 15% increase in load rating compared to conventional technologies. This manufacturing method also reduces the costs to a level comparable with that of ball screw drives manufactured using forming methods. Clearance-free, preloaded units can easily be created by adding a spacer washer between the two halves of the spindle nut.

Reduced design envelope, higher power density, and cost savings

The PWG closes the gap between the RGT and KGT in the spindle diameter range between 5 and approximately 30 mm when it comes to very high load carrying capacities and the smallest possible overall pitches. For example, the PWG generates an impressive 2,200 N of axial force from only 40 Ncm with an overall pitch of 0.75 mm. Consequently, very high axial forces can be achieved even with small motors. Schaeffler's planetary screw drive (PWG) thus makes it possible not only for electromotive actuators with a high power density, long rating life, and low maintenance outlay to be developed, but also for low-cost motors to be used. The electric drive can be easily integrated using a feather key connection on the outside diameter of the spindle nut.

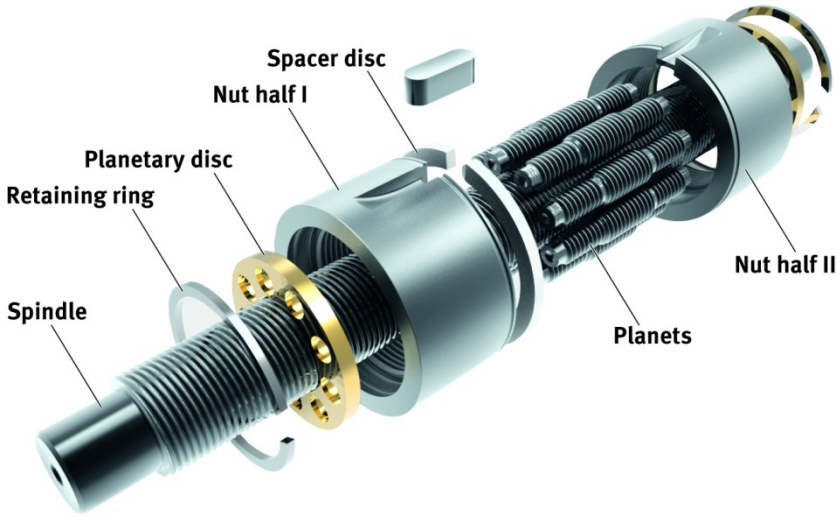
Applications and initial projects can be found in areas such as mirror tracking systems in the solar power sector, azimuth adjustment systems in the wind power sector, feed units for sheet metal forming in the mechanical engineering sector, in sheet metal bending machines, in locking cylinders for plastic injection molding machines, in riveting and cutting devices, and in adhesive metering systems. The PWG is already in volume production in clutch actuators for the automotive industry.

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Design of the planetary screw drive PWG: The spindle and the planetary rollers are manufactured by forming methods



The PWG achieves the highest power density in the range from 5 to 25 mm.

Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Jürgen Klein
Schaeffler Technologies AG & Co. KG
Head of Marketing, Linear Technology
Berliner Strasse 134
66424 Homburg (Saar), Germany
Phone: +49 6841 / 701 2106
E-Mail: juergen.klein@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Plug-and-play linear systems for machine tools and special machines

MILAN/HOMBURG, *October 5, 2015.* In order to be able to meet the very short development times for machine tools and special machines, today's manufacturers expect their linear technology suppliers to offer not just linear components but first and foremost plug-and-play subsystems including engineering, drive technology and other services. This includes final assembly, cabling, setting control parameters and commissioning. The Systems Solutions business unit at Schaeffler Linear Technology in Homburg specializes in just these ready-to-use, project-specific linear systems. An intelligent mix of customizable, high-performance linear system components from the Schaeffler range and mechanical and electrical drive elements from well-known suppliers and partners form the basis of ready-to-use and economical linear systems and system solutions.

Economical solutions by integrating functions

Schaeffler engineers integrate linear guidance systems, toothed belt drives and ball screw drives, planetary screw drives, measuring systems, rotary encoders, carriages, lubrication systems, end switches, covers etc. into Schaeffler's own extruded aluminum profiles which have been developed in-house. In addition to standard components, Schaeffler develops and manufactures customized linear systems. These are optimized to the specific load scenarios using FEM. These linear systems have been developed and manufactured as plug-and-play electrical systems using a range of direct drives, servo motors, controls and sensors. Combined with Schaeffler's comprehensive range of rolling and linear bearings and rolling bearing expertise, this produces innovative solutions with a high level of integration time and again.

Telescopic actuator MTKUSE: More space for machine tools

Compared with standard linear axes, telescopic axes offer significant advantages in that they do not extend over the whole travel distance and therefore can release space for other machines and processes. When used as secondary axes, telescopic modules offer considerably more options for machine tool design. Transfer to areas behind protective walls or into different work spaces also become a possibility.

Schaeffler Lineartechnik has developed the MTKUSE telescopic actuator specifically for secondary axes such as in pick-and-place applications or for tool transfer. Three precision linear ball bearing and guideway assemblies are arranged on top of each other such that the possible travel distance is more than twice that of the basic actuator. The linear unit can extend in both directions. A geared servomotor is mounted on the outside of the aluminum profile and drives the actuator via a rack and pinion drive. On request by the customer, servomotors from a range of manufacturers and suitably prepared, low backlash precision planetary gearboxes can be fitted. End switches and distance measuring systems can be integrated on request. An indirect evaluation of the frictional torque and therefore the bearing condition is possible via the servo controller using current detection and position error monitoring.

High precision linear table LTP: precise, repeatable movement

High precision linear tables, series LTP, are used when tools are moved with precision and high repeat accuracy during machining or inspection. The linear slide is supported in a high precision, machined aluminum plate on high-accuracy linear recirculating ball bearing and guideway assemblies. These assemblies provide the LTP table with smooth, quiet running and a low displacement resistance. The unit is driven by a servomotor and a ball screw drive. A variant with a direct drive is available as an alternative. Distance measuring systems and position switches can be included on customer request. The LTP high precision linear table is available in three sizes with options for a gray cast iron, vibration damping variant. These linear tables can be fitted with bellows or a telescopic metal cover to protect them from foreign objects and liquids. A coupling housing KGEH has been developed as an open interface in order to accommodate customer requests for servomotors from a range of different manufacturers. An indirect evaluation of the condition of the frictional torque and therefore the condition of the bearing or spindle is also possible with linear tables via the servo controller. High precision linear tables are used as secondary axes in machine tools for transferring tools or as a drive for the laser guidance when marking tools and coding.

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The MTKUSE telescopic actuator combined with an MDKUVE25-KGT linear actuator.



Excerpt from the linear actuator and linear table product portfolio from Schaeffler (from the left): Linear table LTS-KGT, linear actuator MKUVE-KGT, linear actuator MLF-ZR



Individual system solution including connecting elements and drive technology from Schaeffler.

Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Jürgen Klein
Schaeffler Technologies AG & Co. KG
Head of Marketing, Linear Technology
Berliner Straße 134
66424 Homburg (Saar), Germany
Tel. +49 6841 701-2106
Fax: +49 6841 701-45 2106
Mobile: +49 173 5720510
juergen.klein@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Monorail guidance systems 4.0 - Intelligent components for feed spindles

MILAN/HOMBURG, *October 5, 2015.* For the first time, the fifth generation of the INA linear recirculating roller bearing and guideway assembly, series RUE-E, includes sensor units which provide both appropriate lubrication and bearing condition monitoring. Where necessary, the sensors monitoring the lubricant condition send a message to the machine control and initiate automatic relubrication via, for example, the innovative multi-point lubrication system FAG CONCEPT8. In order to monitor the bearing condition, a piezoelectric accelerometer is attached to the steel saddle plate on the carriage. This supplies the vibration velocity, the vibration acceleration and the rolling bearing parameter to the attached signal converter and also monitors limiting values. With this new concept for the RUE-E, Schaeffler is developing a system which provides users with direct feedback and communication with the unit's control system, automated lubrication where necessary and automated maintenance. Manual lubrication is no longer necessary and lubricant usage can be reduced by up to 30%. Automated condition monitoring provides predictive maintenance which, in turn, produces increased availabililty and quality as well as reduced total cost of ownership.

Piezoelectric vibration monitoring

In its delivered condition or when a linear roller bearing and guideway assembly is used in a feed spindle, the guideways are generally in an optimum condition with respect to running characteristics and lubricant condition. This can be observed through the vibration behavior of the saddle plate when the system is in motion. In order to establish variations and deviations from this ideal nominal value, piezoelectric accelerometers have been attached to the steel saddle plate on the carriage. The accelerometers are suitable for use with coolants and in contaminated environments. The permanently connected, two-wire, separately shielded cable is completely encased in polyurethane. The sensor has a sensitivity of 100 mV/g, a resolution of 0.001 g and a frequency range of 5000 to 50 000 Hz for measuring spike energy. The accelerometer supplies the vibration velocity, the vibration acceleration and the rolling bearing parameter to the attached signal converter via the cable and also monitors limiting values. The signals are then separated into different frequency ranges or an energy evaluation of the impulse peaks is carried

out using spike energy (gSE). 4-20mA and 0-10 V signals are passed to the PLC, the Schaeffler Box and the lubrication unit via analog outputs.

This closes the monitoring and automated lubrication loop. An innovative multi-point lubricator, FAG CONCEPT8, is an integral part of the lubrication loop; this is a lubrication system for rolling bearings which ensures optimum lubricant feed to the bearing units without the need of any manual intervention. If the actual evaluated signal values sent back by the signal converter deviate from the nominal values, the FAG CONCEPT8 unit automatically ensures appropriate maintenance measures or relubrication operations are initiated.

X-life screw drive bearings - increased life and productivity through higher limiting speeds

In order to be able to make optimum use of the performance of screw drives in feed spindles, it is vital that they have a bearing support with the corresponding performance, load carrying capacity and dynamics. This is where the advantages of the INA ZKLN and ZKLF double row, preloaded angular contact ball bearing series come to the fore. These bearing series, which have been used successfully for years, are now available in X-life quality.

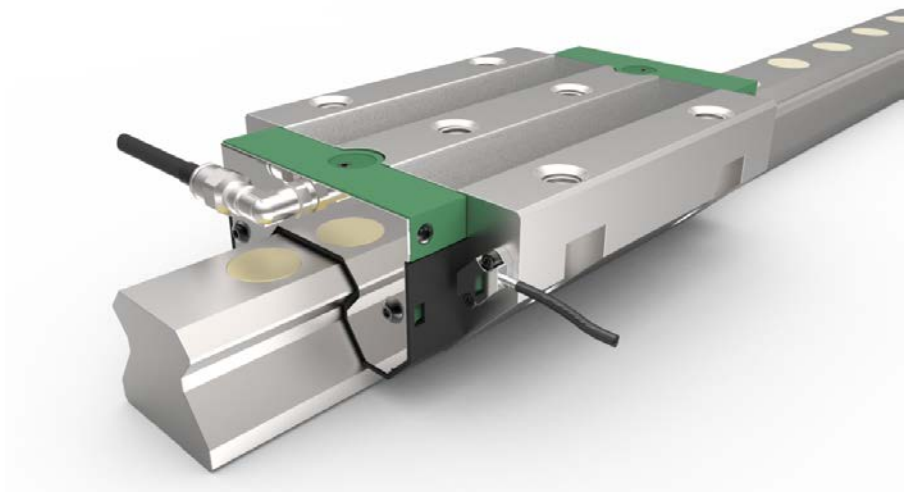
As part of the modified X-life manufacturing process, it was possible to increase the basic dynamic load rating by a further 10 % which corresponds to a 30 % increase in the nominal operating life. Tests have also shown that the limiting speeds can also be increased by up to 60 %. The user benefits from reduced friction and the subsequent reduction in heat generation in the bearing. This leads to greater accuracy, increased dynamics and improved results from machining. At the same time, higher speeds can be achieved during rapid traverse which leads to increased machine efficiency. Behavior during changes in the direction of rotation, such as frequently occur in machine tools during precise positioning, should also not be ignored. Uniform frictional torque during the whole positioning process is vitally important here. Benchmark tests show that the new INA ZKLN and ZKLF bearings have a constant frictional torque at slow changes in the direction of rotation and therefore facilitate extremely accurate positioning.

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Image: Schaeffler



INA linear recirculating roller bearing and guideway assembly RUE-E, 4.0 design, with integral accelerometer

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Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Jürgen Klein
Schaeffler Technologies AG & Co. KG
Head of Marketing, Linear Technology
Berliner Straße 134
66424 Homburg (Saar), Germany
Tel. +49 6841 701-2106
Fax: +49 6841 701-45 2106
Mobile: +49 173 5720510
juergen.klein@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Benchmark bearing and drive solutions for rotary axes

MILAN/SCHWEINFURT, *October 5, 2015.* Schaeffler offers not only a range of bearings for different services but different series optimized to specific prioritized features. We also develop customer-specific solutions. The width and breadth of this offer from an expert partner guarantees the best solution for the customer in both technical and commercial terms. This can be clearly seen in the new solutions for precision rotary axes and rotary tables presented at EMO 2015: Bearings, angular measuring systems and direct drives.

Rotary table bearing series - top performance for all applications

The axial/radial cylindrical roller bearing YRTC leads the technical field in terms of tilting rigidity. The result is extremely high machining accuracy and cutting capacity.

Axial/radial cylindrical roller bearings YRTS have a patented raceway geometry which allows them to attain a previously unachievable low bearing friction for preloaded roller bearings. For example, a standard rotary table bearing with an inside diameter of 325 mm produces a frictional moment of approximately 90 Nm at 100 rpm. Replace this with a YRTS 325 and the frictional moment reduces to a mere 10 Nm. This represents a saving of approximately 800 W or €1000 per annum in 24/7 S1 operation. Users benefit from increased production quality due to lower thermal expansion and reduced operating costs. They are therefore the benchmark for rotary tables with different machining options.

The flange-mounted axial angular contact ball bearings ZKLDF..B are the market leader in rotary tables with extremely high demands in terms of speed. Limiting speeds for rotary tables can be considerably increased if these bearings are combined with RKI torque motors. If the limiting speeds are not exploited to the full, the user still benefits from the extremely low bearing friction and the associated lower build-up of heat in the structure of the machine. This has a positive influence on the machining accuracy.

Cutting edge angular measuring systems - absolute angular measuring system YRTMA, ready for production

If the aim is to achieve the greatest possible positioning accuracy with rotary tables, an integrated dimensional scale must be included in the bearing arrangement. The "zero point" is vital here, i.e. the point at which the deformations and deflections from the machining forces are at their smallest, the diameter for the dimensional scale is

large and the dimensional scale can be achieved with raceway accuracy. Best use is made of the scale on the measuring system by integrating a non-sensitive measuring system into a large bearing in terms of its diameter. The Schaeffler range now includes magnetoresistive measuring systems with pitch-coded reference marks as well as absolute inductive systems. Systems with reference marks have the advantage that the 1Vss electrical interface is compatible with nearly all standard machine tool controls. This is of particular benefit to machine tool manufacturers who have to integrate a vast range of different control systems into their machines. In absolute measuring systems, there is no reference travel after switching the machine on. The control system therefore immediately recognizes the torque motors' pole position. In the event of a loss of power, tools that have been left in the workpiece can therefore be released in a controlled manner.

The inductive absolute angular measuring system YRTMA with single-head technology presented at EMO 2013 has now been released for volume production. In practice, the new single-head system has achieved positioning accuracies of just 2 angular seconds. This value had previously not been achieved anywhere in the world and exceeded even the company's own expectations. This level of performance was confirmed in practical rotary table and milling head applications and has been fully accepted by key customers. A patent has been applied for the measuring head which is designed such that the measuring gap is set automatically when the head is mounted on the bearing. Further adjustment is not necessary. Particularly easy to use: The measuring head is freely and easily accessible from the outside. The system is available with the following standard interfaces: SSI+ 1 Vss, Siemens Drive-CliQ, Fanuc alpha and Heidenhain EnDat2.2 (in development).

Four torque motor series - direct drive series RIB shown for the first time

The new series of torque motors RIB is being shown for first time at EMO 2015. In terms of "extremely high moments with low power losses", this direct drive represents the peak of performance. It is ideally suited for use in rotary tables, pivot axes for oscillating rotary tables and milling heads for highly dynamic, powerful milling, positioning, cycling and swiveling. (Further details are available in the separate RIB motors press release.)

The state-of-the-art RKI series of torque motors shown at EMO 2013 combines extremely high moments and speeds with low power loss. Ideally suited for use in rotary tables with different machining options, e.g. for combined operation

(milling/turning/hard turning or grinding). This product has proven itself over time on the market in the highest quality units from leading manufacturers.

The HSRV/SRV series of torque motors are the ultimate in the terms of extremely high speeds and synchronism. These drives are particularly suitable for very high speed rotary tables (>2 000 rpm), tool or headstock spindles or as a direct drive for ball screw drives in feed axes.

Preferred application areas for series RMF/RMK torque motors are rotary tables for ultra-high accuracy machining e.g. in gear grinding machines, measuring machines, preparing optical lenses and ultra-high accuracy machining to <1µm. They are used in the most accurate machines in the world, including in the OptoTech UPG2000 8-axis ultra-high accuracy grinding and polishing center.

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YRTC – market leader with the best tilting rigidity



ZKLDF – market leader for rotary tables with extremely high speeds



Limiting speeds for rotary tables can be considerably increased if these bearings are combined with RKI torque motors.



The inductive absolute angular measuring system YRTMA with single-head technology presented at EMO 2013 has now been released for volume production. In practice, the new single-head system has achieved positioning accuracies of just 2 angular seconds.

Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Johanna Katzenberger
Schaeffler Technologies AG & Co. KG
Communications Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3873
Fax: +49 9721 91-3375
Mobile: +49 151 4066 5844
johanna.katzenberger@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Series RIB torque motors - 12% more torque or 30% less power loss

MILAN/SUHL, *October 5, 2015.* The new torque motors, series RIB from INA - Drives & Mechatronics AG & Co. KG (IDAM), the Schaeffler Group direct drive specialists, are thermally optimized direct drives for increased productivity and lower energy consumption in machine tools. Due to improvements in heat transfer, the recently developed Series RIB IDAM torque motors can be operated with a 12% increase in maximum torque or at 30% less heat loss compared to the RI Series, dependent on how they are used. The motors are interchangeable with their corresponding RI predecessors and largely compatible with common motor sizes. The active magnet length can be adjusted in 25 mm increments to suit the application and space gained put to optimum use. As with all IDAM motors, latching forces are optimized and they can be used with the majority of control systems. RIB motors are available as individual units and will be in volume production at the end of 2015. In the meantime, the functional principle of RIB motors is being applied to a new linear motor. The first L7 prototype motors have a considerably higher drive force or correspondingly lower power loss.

Optimized heat management is the key

The two different ways of operating electric motors i.e. "running hot" or "running cold" are of particular interest when designing and operating machine tools. The terms "hot" and "cold" are derived from the target temperature when the drive in a machine is running under thermally stable conditions. "Running hot" is used in large volume production, when the relevant axis represents a bottleneck in production. As far as the manufacturing process is concerned, the drive is designed to ensure that maximum use is made of available space and to provide the maximum power appropriate for the process. In subsequent continuous operation, the motor runs close to its performance limit and therefore close to its thermal limit. When "running cold", however, the motor is deliberately over-specified. The benefits are clear: Motor temperatures or heat losses in the motor are demonstrably lower, system accuracy increases and outlines can be followed more precisely due to the increased torques, e.g. in 5-axis machining. This results in increased surface quality and dimensional stability. The disadvantage with this option is an increase in price.

If it is possible to reduce heat transfer resistance in the motor significantly, the result is not only a considerably cooler motor but also a more thermally robust system. The maximum possible power increases as a result of cooling the motor. In practical terms, this means that motors can run at greater output levels ("running hot") or reserve capacity can be deliberately used to improve efficiency ("running cold").

Linear motor concept L7 – more drive force and less power loss

A completely new generation of motors has been created by transferring the optimizations in heat transfer from the rotary RIB motor to a linear motor. This has come to fruition in the L7 linear motor concept. Currently, initial calculations and tests have returned increases in drive forces of approx. 7 % and reductions in heat losses of up to 40 %.

"Precision cooling" of the motor is not required. The magnetic circuit has been optimized to provide the best synchronization. Options such as variants with three cable outlets, thermal motor decoupling and secondary cooling complete the range.

Proof that investing in these new RIB and L7 product ranges not only increases manufacturing accuracy but is also financially beneficial can be found in the example of a five-axis milling machine with direct drives. If all the linear and torque motors are replaced with the new IDAM RIB and L7 concept motors, the heat losses in the main feed axes fall from 17 to 11.5 Kw during 30 % utilization in three shift operation. This corresponds to a saving of 7.2 t of CO_2 per annum or 14.4 MWh per annum which equates to €2,160 per annum at 15 ct/kWh.

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The new torque motors, series RIB from INA Drives & Mechatronics AG & Co. KG (IDAM) are thermally optimized direct drives for increased productivity and lower energy consumption in machine tools.

Contact:

Martin Adelhardt
Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
Fax: +49 9721 91-3375
Mobile: +49 172 8820421
martin.adelhardt@schaeffler.com

Johanna Katzenberger
Schaeffler Technologies AG & Co. KG
Communications Industrial
Georg-Schäfer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3873
Fax: +49 9721 91-3375
Mobile: +49 151 4066 5844
johanna.katzenberger@schaeffler.com

Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Proven to be better: INA track rollers now available in X-life quality

MILAN/SCHWEINFURT, *October 5, 2015*. INA track rollers are the newest addition to Schaeffler's X-life product family. The redesigned LR52 and LR53 series now deliver a significantly higher load carrying capacity and longer rating life than their predecessors. A dynamic load rating increase of 15% compared to competitors' products together with a speed limit increase means that they are currently the most high-performance track rollers on the market. From this fall, both series will be available exclusively in X-life quality. Because the external dimensions have remained the same, these can be used as a direct replacement for existing track rollers without requiring any modifications to the customer's application.

Improved internal construction – new sealing concept

The internal construction was the area most affected by the upgrade to X-life. The LR52 and LR53 series feature a range of design details that increase the dynamic load rating by up to 10% and the static load rating by up to 15%. This also significantly increases the rating life. Both series are offered with DEHP-free HRS seals as standard, but both are also available with improved steel sealing shields (Z) as an option. When it comes to the cage, customers can choose between an optimized polyamide cage and a rigid, robust steel cage.

What is a track roller?

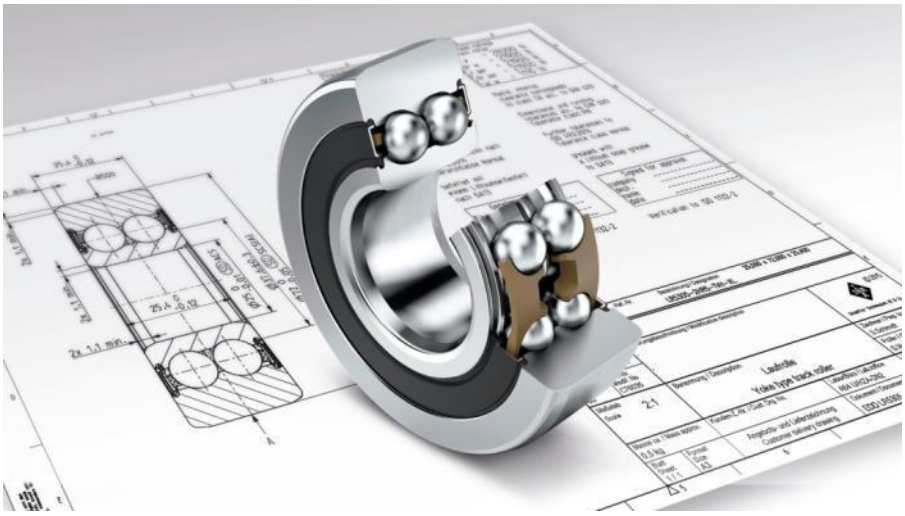
Track rollers are self-retaining double-row units with particularly thick-walled outer rings. In addition to high radial forces, these bearings can also support axial forces in both directions. The outer rings have a crowned or cylindrical outside surface. Designs with a crowned outside surface are used where they are inclined in relation to the mating track and edge stresses must be avoided.

* * *

The Schaeffler Group is a leading global integrated automotive and industrial supplier. The company stands for the highest quality, outstanding technology, and strong innovative ability. The Schaeffler Group makes a decisive contribution to "mobility for tomorrow" with high-precision components and systems in engine, transmission, and chassis applications as well as rolling and plain bearing solutions for a large number of industrial applications. The company generated sales of approximately 12.1 billion euros in 2014. With around 84,000 employees worldwide, Schaeffler is one of the world's largest technology companies in family ownership and, with approximately 170 locations in 50 countries, has a worldwide network of manufacturing locations, research and development facilities, and sales companies. The Industrial division supplies components and systems for around 60 industrial sectors via its worldwide organization with market proximity and its application support service. The range includes miniature bearings only a few millimeters wide through to large-size bearings with an outside diameter of several meters.

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Images: Schaeffler



INA LR52 and LR53 track rollers in X-life quality are characterized by an optimized internal construction that allows them to achieve a longer rating life.



INA LR52 and LR53 X-life track rollers are self-retaining, double-row units with particularly thick-walled outer rings that transfer high radial loads.



X-life is the seal of quality for Schaeffler products that are characterized by a significantly longer rating and operating life based on higher dynamic load ratings under the same load conditions and with the same design envelope.

Contact:

Martin Adelhardt
Schaeffler AG
Senior Vice President, Communications & Marketing
Schaeffler Industrial
Georg-Schaefer-Strasse 30
97421 Schweinfurt, Germany
Phone: +49 9721 91-3400
Cell phone: +49 172 8820421
martin.adelhardt@schaeffler.com

Johanna Katzenberger
Schaeffler Technologies AG & Co. KG
Communication - Schaeffler Industrial
Georg-Schaefer-Strasse 30
97421 Schweinfurt, Germany
Phone: +49 9721 91-3873
Fax: +49 9721 91-3375
Cell phone: +49 151 4066 5844
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Press Release

Schaeffler at EMO 2015 (Hall 03, Booth H08 L07)

Reduced development times: Online software for designing spindle bearings

MILAN/SCHWEINFURT, *October 5, 2015.* In order to find the optimum bearing solution for a main spindle early in the design process, Schaeffler is offering its customers Bearinx®-online - a detailed spindle calculation tool. This provides designers with a virtual environment in which they can "test out" different spindle variants themselves at an early stage, for example based on mounting sequences or bearing sizes, and if necessary have these checked by the Schaeffler Engineering Service in the full version. The results of the Bearinx®-online spindle calculation will be exactly the same as if the calculation had been completed by a Schaeffler engineer due to the identical master data set and calculation unit.

Due to the special kinematics of spindle bearings, tilting effects and other influences, only a minimum amount of training is required. The two-day training courses can take place either at Schaeffler's training center or on the customer's premises. Using examples, participants become familiar with how to operate the program, the design of the model used for the shaft system, entering the load, operational and lubrication data as well as producing the results. A separate summary is provided of the results for the main spindle bearing support. These include the grease operating life, the bearing kinematics, permissible pressures and the modified reference rating life to DIN 26281 or ISO/TS 16281.

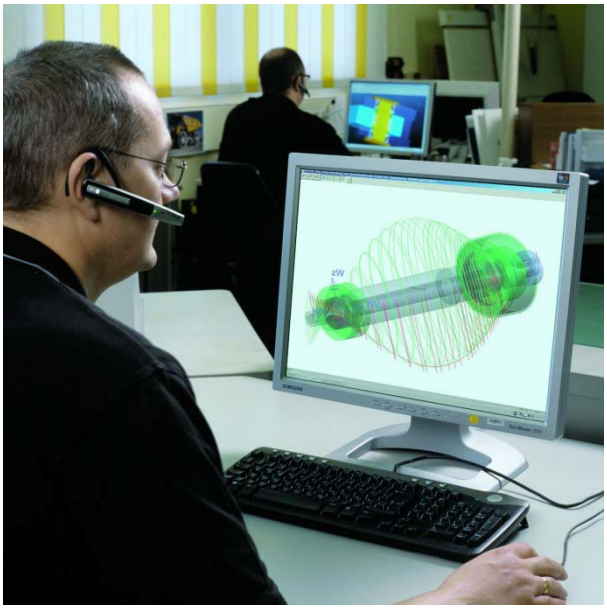
Schaeffler organizes approximately 20 training sessions each year on its own premises, at universities and with customers at home and abroad. Participants in these training sessions leave not only with the ability to complete professional spindle calculations but also with a deeper understanding of the dynamic interplay between the rolling bearing, spindle shaft and tool which they can put to immediate use in their projects.

* * *

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Images: Schaeffler



Bearinx-online simulation of a high frequency motor milling spindle with rotor and clamped tool

Contact:

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Schaeffler AG
Vice President Communications & Marketing Industrial
Georg-Schaefer-Strasse 30
97421 Schweinfurt, Germany
Tel.: +49 9721 91-3400
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Communications Industrial
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Fax: +49 9721 91-3375
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