



FAG

added
competence



Bearing Solutions for the Electronics Manufacturing Industry

SCHAEFFLER GROUP
INDUSTRIAL

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From front end to finished integrated circuit boards: Highly developed bearing supports for the electronics manufacturing industry

Bearings in semiconductor production: From front end ...

In this kind of environment, bearings are exposed to aggressive media and the increased application of vacuum technology. This is why many of our standard bearings are corrosion resistant. At our customers' request, we also coat our components to protect them against wear, friction and excessive voltage.

... to back end

In bonding operations, bearings are used to support fast, oscillating motions. All handling operations also require a high level of reliability and repeat accuracy. Our four point contact ball bearings that can be mounted in small design spaces and our precise linear guides with high load capacity are just some of the solutions we provide for these applications. Extra-long service life included.

Bearings in circuit board production

All motions occurring in pick-and-place machines for integrated circuits require extremely precise and safe bearing supports. We have developed deflection rollers with particularly small tilting clearance for transport systems. Or flat cage guides with positive cage control that allow high-precision positioning.

Three applications – three requirement profiles – one solution:

Tailor-made bearing technology made by INA and FAG – all available from a single source.

We have the right product for any application: New rolling bearing materials and coatings fight corrosion, and special greases meet increased clean room requirements. All tried and tested.

No job without the right solution!

Your technical vision is our challenge. Look through the next few pages to see what we already have.

And let us work together to develop solutions we may not have for you yet.

We'd like to hear from you.



Front end example: wafer test

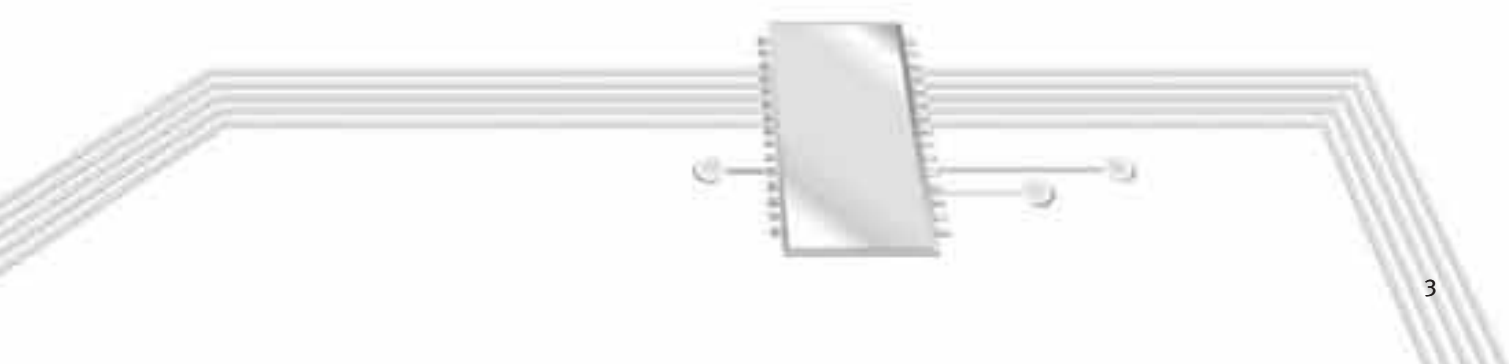


Back end example: die bonding



Example: pick-and-place

Circuit board and semiconductor production



Choose from 1001 bearing designs! For reliable bearing supports for rotary motions ...



We have combined nearly 40,000 different products from an enormous range of rolling bearing components and materials. All of these are standard solutions you can find in our catalog and that you can choose from whenever you need efficient, state-of-the-art bearing supports for your machine components.

Reduced weight with thin-section bearings

Precise and safe handling motions with high repeat accuracy are also based on the right bearing technology. For instance on INA's lightweight and smooth-running thin section bearings. Their extremely small cross section makes them especially suitable for small mounting spaces – such as in wafer handling systems.

Longer service life with INA's track rollers

Optimal lubrication, good angular misalignment behavior and low wear on the outer ring are the outstanding benefits of our stud type track roller (PWKR). In real life, this means that since the grease service life has been increased significantly, our bearings are maintenance free in most applications.



Bearing design made easy: Our electronic product selection and support program **medias**® is a convenient aid for designers

... and for all linear axes

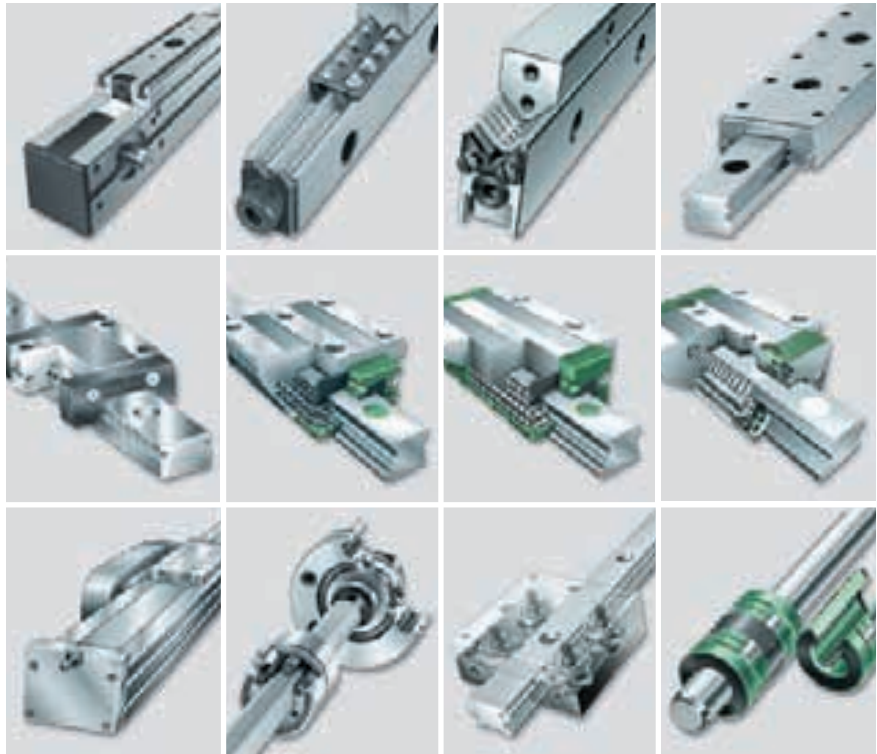
Even under extreme conditions – if lubrication for life is not feasible – relubrication intervals are extended several times over.

Repetitively accurate pick-and-place operations with INA linear guides

Modern high-speed pick-and-place systems process up to 120,000 components per hour. All motions in this process must have extremely precise and reliable bearing supports. This is true for all axes, such as in the x and y direction with our low-maintenance, four-row ball type profiled rail unit KUBE..B.

Our miniature ball type profiled rail unit KUME..C was also designed with high-precision positioning in mind. Its technical advantages are the same as those of larger profiled rail units: high load capacity, low maintenance, corrosion resistance and compliance with clean room requirements.

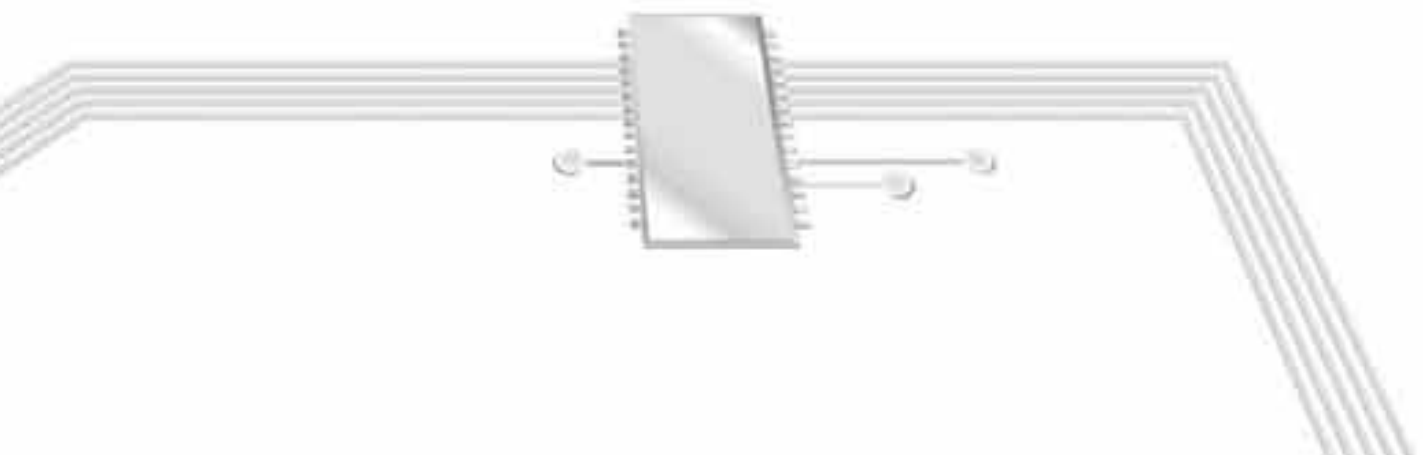
Miniature modules with highly rigid aluminum carrier profiles are an ideal solution due to their integrated functionality:



“guidance” and “drive” in one unit, complete with drive and controls. In addition, we supply actuators equipped with IDAM direct drives (for more information, see pages 8–9). These ready-to-use systems are great for highly dynamic positioning jobs.

System solutions expertise

Cost saving system solutions are our strength. And if you can't find what you are looking for, we would like to work with you to develop a special solution for your application.



Optimize your machine! Special solutions for increased technical requirements



Rapid prototyping: Customers are able to test the product in its future environment as early as the quotation phase



Significant cost benefits: Customized precision tension pulleys

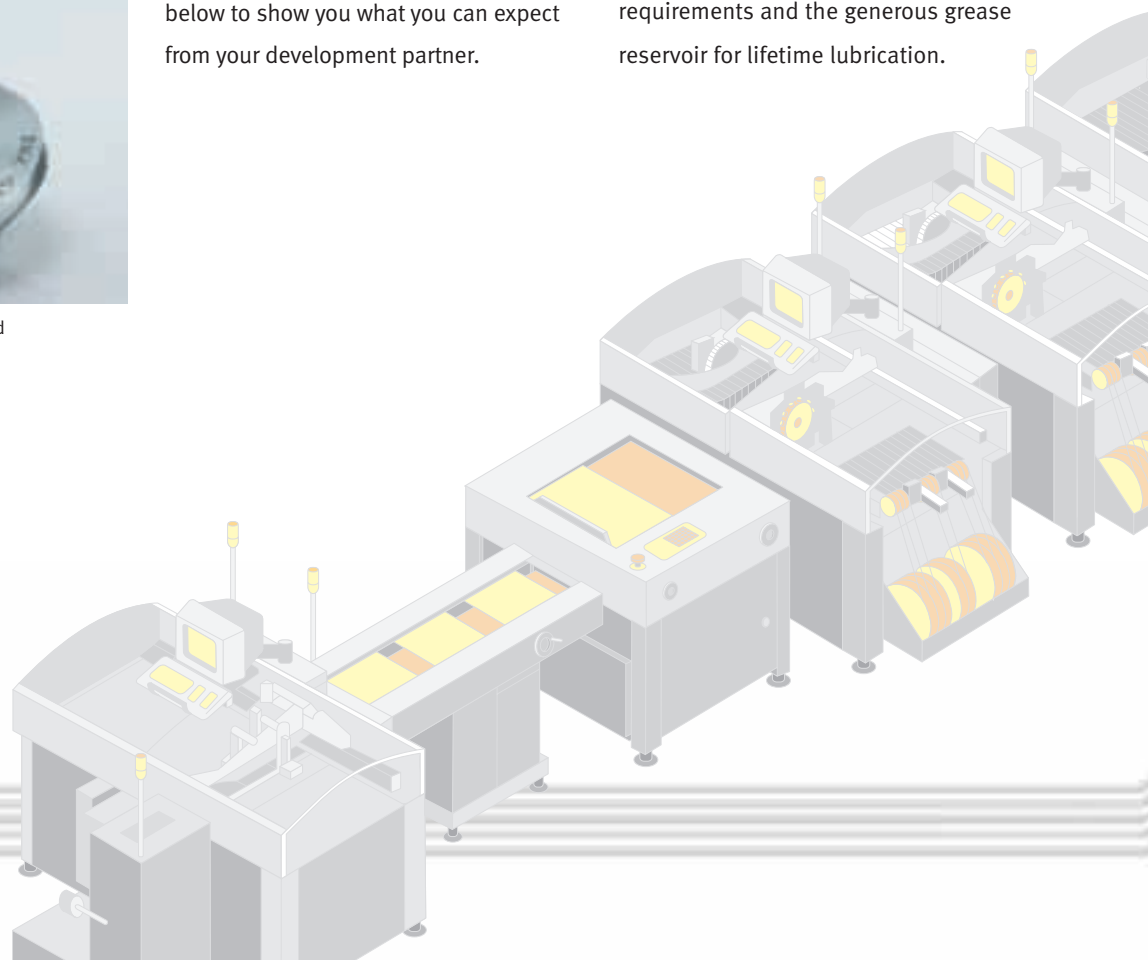
We work closely with users to develop innovative, customized solutions every day. Around 1,000 new products are launched per year and the Schaeffler Group holds the rights to 13,000 patents and patent applications. Creative engineering with often unconventional results characterizes the way our engineers work. They use cutting-edge simulation methods, in-house test facilities and laboratories for physical and chemical analyses. The fact that they have access to the technical resources and know-how an international group of companies has to offer provides a considerable benefit. Research results, product quality and our flexibility in processing orders can all be measured. We have included the three examples below to show you what you can expect from your development partner.

Ball screw support bearings:

Just bolt them on

Machine builders like them: ready-to-install, complete bearing solutions for ball screw supports. What has been available for large spindles and high load ratings for a long time, we have now customized for our customers in the electronics manufacturing industry: easy-to-mount bearing supports with low friction torques and high accuracy. Angular contact radial ball bearing units ZKLR are supplied for shaft diameters ranging from 6 to 20 mm. The benefit: Just bolt them on – fewer components, less time, fewer mounting errors.

Other advantages are the small space requirements and the generous grease reservoir for lifetime lubrication.



Precision tension pulley:

An integrated unit in a very small space

(Toothed) belts in transport systems for electronic assemblies require extremely precise and consistent guidance. Standard tension pulleys can't do the job here – there are too many different tasks that must be completed at the same time: Thin substrates must not be pinched, and circuit boards must

be transported in a way that minimizes the non-useable board area. A solution developed by INA has put an end to what are often expensive and technically unsophisticated in-house solutions. In a step-by-step process, we have developed tension pulleys with a modular design that leave nothing to be desired even in very small spaces.

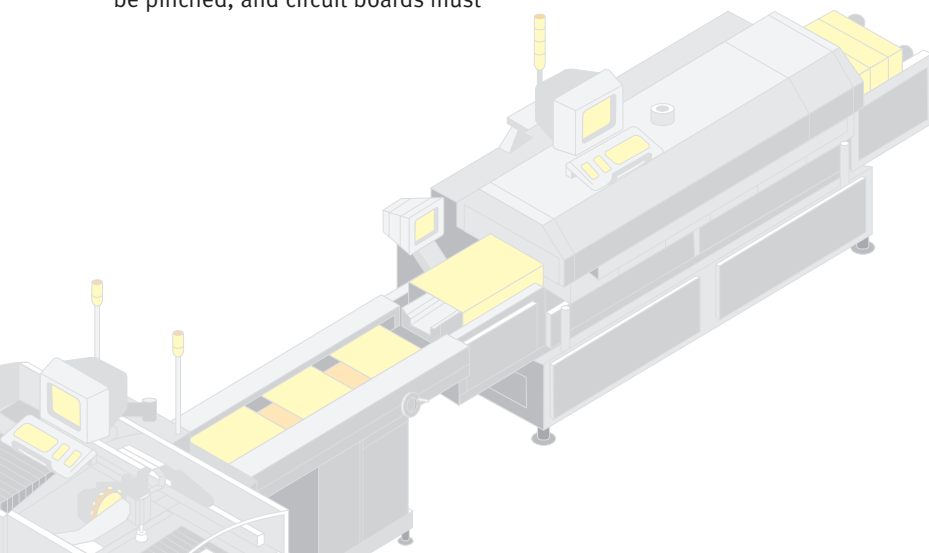
INA linear actuators:

Complete systems for small spaces

For around fifteen years now, our product range has included complete modules with drives and controls, based on various linear guidance systems. These actuators have proven to be great solutions for all positioning jobs: They are lightweight thanks to aluminum profiles, offer various guidance systems (such as profiled rail or track roller guides) and a wide selection of drive designs – from toothed belt drives to lead screws to direct drives.

Development partnerships with our customers lead to many new solutions that are then integrated in catalog products.

What would you like us to develop for you?



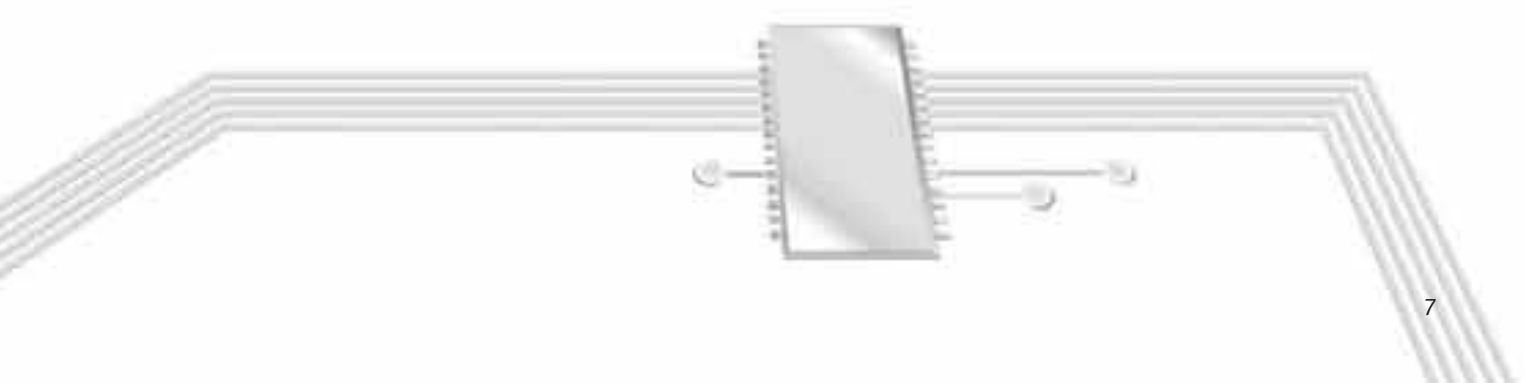
Easy to mount: Angular contact ball bearing unit ZKLR for ball screw supports



For 24/7 operation: Long-life guide roller in stainless steel design



Now with direct drives made by IDAM: Linear actuator MLFI as a complete system



Direct drive innovation. The perfect drive for every application



Pick-and-place: IDAM technology has long had a place in the electronics manufacturing industry

IDAM direct drives provide you with perfect application solutions at the highest technical level. We supply linear, rotary and two-coordinate direct drives in a wide range of sizes and performance as well as all relevant electronics assemblies. Our customized high-performance multi-axis systems and precision rotary positioning tables deserve special attention.

The interdisciplinary cooperation of INA, FAG and IDAM allows to develop state-of-the-art positioning systems with direct drives. These drives are nearly wear-free and offer the following features:

- Very good dynamics and rigidity
- Very high positioning and repeat accuracy
- High final speeds
- High acceleration and braking capability

Linear drives

Since we produce our own linear AC synchronous and reluctance motors in-house, we are able to cover a large amount of the permanently increasing requirements for precise and dynamic applications. These applications range from “sensitive” and fast Voicecoils for bonding applications all the way down to flexible pick-and-place applications. IDAM linear motors can be combined with mechanical, hydrostatic and aerostatic guides.

Series L1, FSM and ULIM AC synchronous motors are ideal for the electronics manufacturing industry. L1 and FSM motors work precisely and efficiently with only little heat generation. Thanks to their slim design, they are well suited for measuring and feed tasks. Additional benefits of these motor series include small electric time constants (up to 0.2 ms), high dynamics in controlled operation, flat design and low attractive forces.



Linear synchronous motors: Types L1A, L1B, ULIM

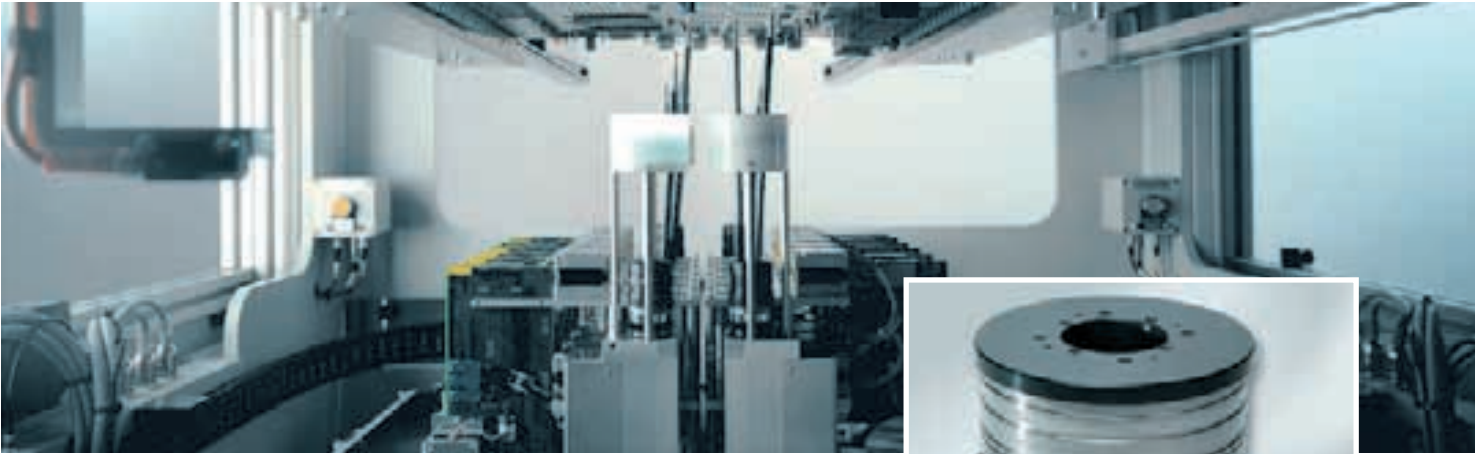
For applications with high speed requirements, L1 and FSM type series are the right choices. The ironless motors used in the ULIM series are characterized by a very good force/mass ratio and their excellent synchronized operation. ULIM series are great solutions for pick-and-place jobs with high dynamics and response times in the ms range as well as tasks where a very high track accuracy or consistent speed is important.

Planar drives

Planar drives with air bearings (surface drives) are perfect for point-to-point positioning that requires precision levels in the micron range. The reluctance principle is used here to generate force. Magnets attract the forcers so strongly to the stator that they cannot be lifted in spite of an air gap (10–15 µm). This is why a planar drive can also be used vertically and overhead. This system becomes efficient when several forcers work on a stator because they make



Rotary synchronous motor: Type RI



Dynamic, precise, maintenance-free: Planar system in flying probe testers



Rotary positioning unit for the electronics manufacturing industry

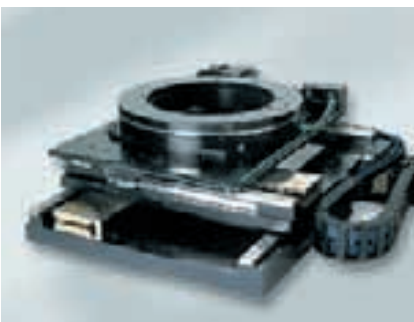
available a large number of additional axes in the work area. Planar drives are ideal for chip card processing technology and for chip card insertion tasks, for laser trimming SMD resistances, sorting components, conveying and reversing memory circuits, pick-and-place jobs and circuit board processing.

Servo drives

IDAM develops extremely compact high-performance servo drives for motor control electronics. This is achieved by using cutting-edge electronic components, efficient connection technology and by implementing modern control structures and interfaces.

System solutions

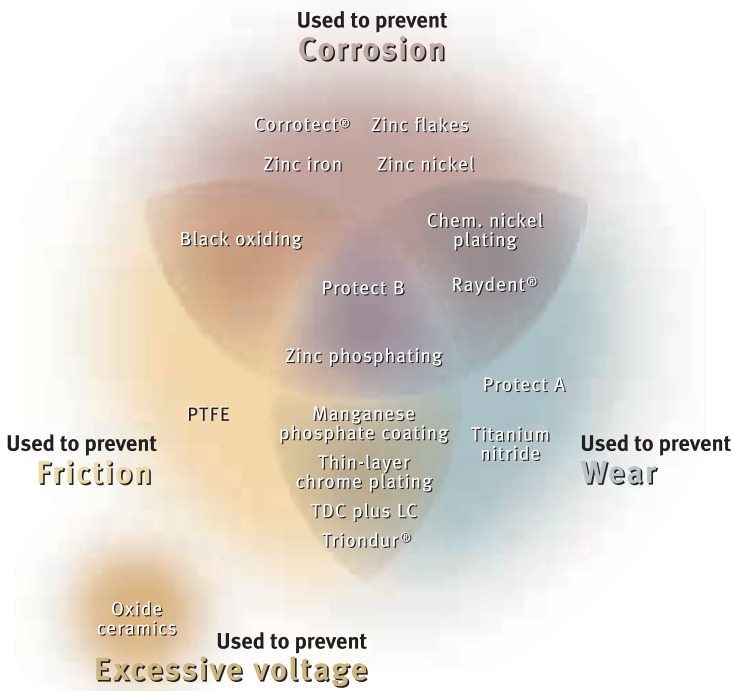
Being a motor specialist, our goal is to generate efficient and successful systems. One example to be mentioned here is our rotary positioning actuators for high-precision, dynamic handling tasks in electronics manufacturing. All rotary tables are equipped with incremental, optical measuring systems. Products supplied by INA, such as crossed roller bearings, ensure smooth synchronized operation.



Highly dynamic positioning system for three coordinates X, Y and Phi with open frame



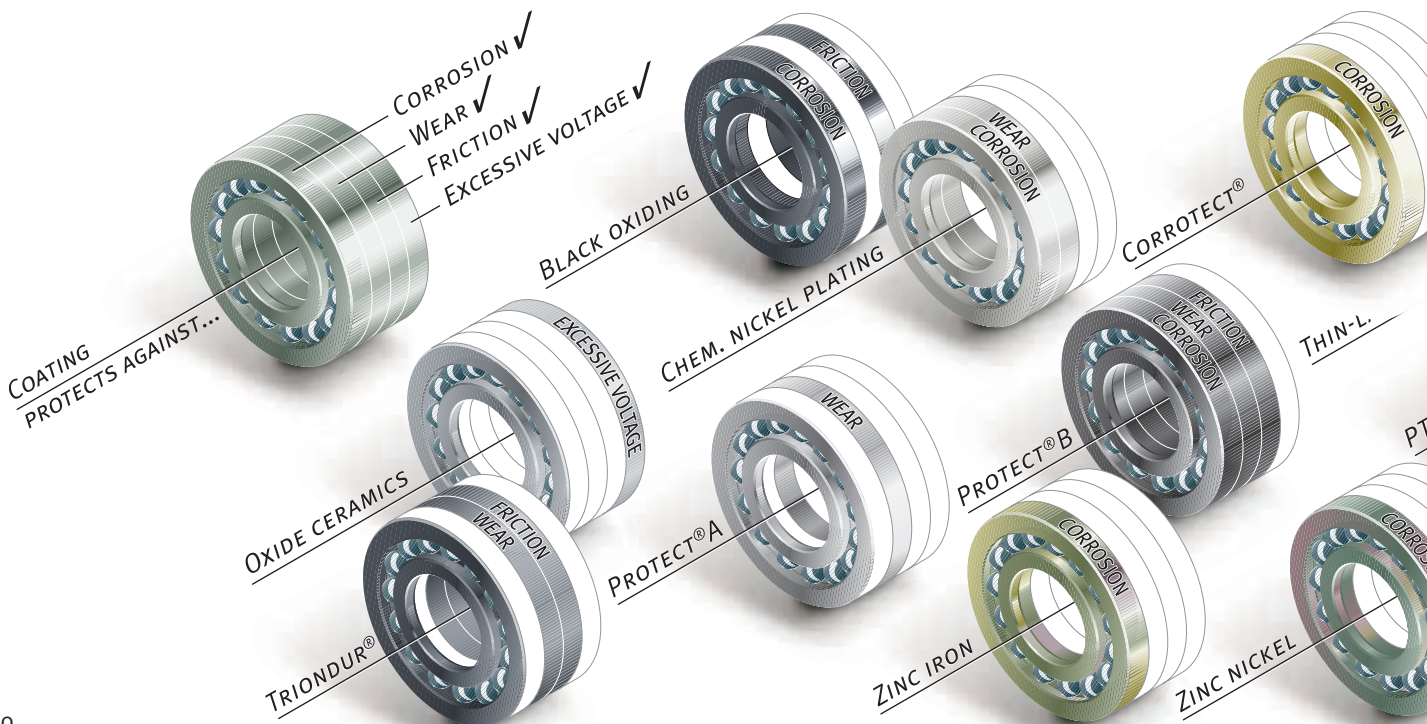
Multi-layered protection: From Corrotect® to TRIONDUR



Coatings are applied to rolling bearings, linear guides or their components to achieve an improvement over the standard product. They affect running-in behavior and emergency running characteristics and optimize anti-corrosion protection as well as wear and friction behavior. In addition, a wide range of coatings is available in the case of lubricant starvation and in environments with aggressive media as well as to protect against false brinelling or excessive voltage.

Patented corrosion protection: Corrotect®

Corrotect® offers the most effective corrosion protection of all special coatings supplied by INA and FAG. It is electro-



deposited on the surface, is extremely thin and is consolidated in the surface roughness profile and partially removed under load. Corroctect® is a low-cost cathodic rust protection solution.

Tribological layer systems: Protect®

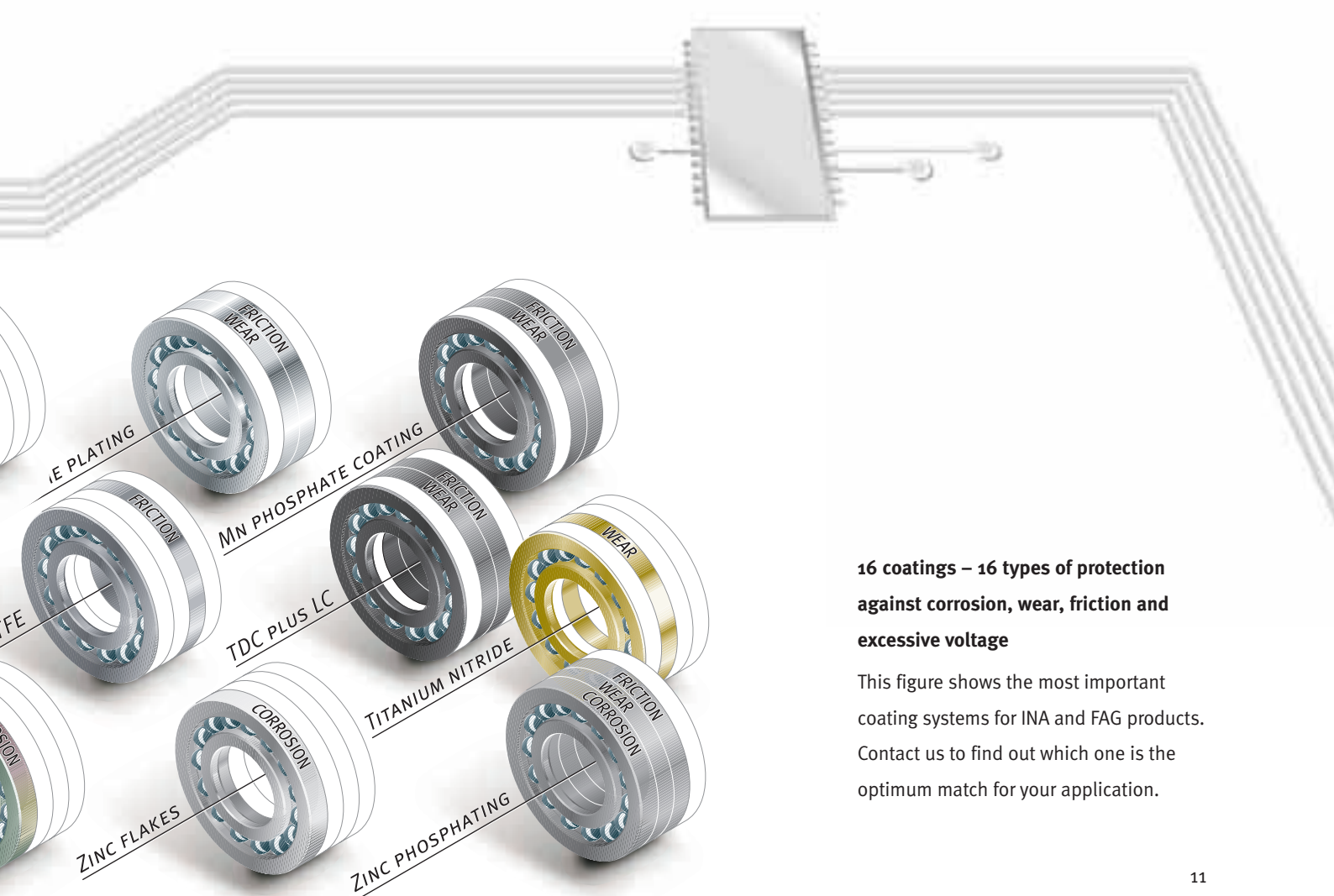
Protect® A is columnar thin-film chromium plating. The structured surface of the chrome layer increases surface hardness and offers effective protection against wear. The gap geometry has a positive

effect on oil pressure buildup, forms lubricant pockets and in this way prevents insufficient lubrication under extreme operating conditions.

If additional corrosion protection requirements are present, then Protect® B is the right solution. It consists of two layers – thin-film chromium plating and an additional chromium oxide layer. The top layer also supports the lubricant and offers reliable corrosion protection for applications in an aggressive environment.

... and Triondur®

Triondur® coating systems are created in a vacuum using the PVD and plasma-based CVD methods. Besides the functional layer, which has a thickness of only a few microns, the base material and the surface to be coated are also considered as a whole so that the positive characteristics can be fully utilized. Triondur® coating systems considerably improve wear resistance and reduce friction. In the long run, they offer protection against tribomechanical stress, insufficient lubrication and oil contamination.



16 coatings – 16 types of protection against corrosion, wear, friction and excessive voltage

This figure shows the most important coating systems for INA and FAG products. Contact us to find out which one is the optimum match for your application.

PEEK, ceramics and Cronidur: The right combination for your success



Ball cages of various designs and materials



PEEK and metal end pieces for profiled rail systems



Bearings made from high-performance plastic materials

PEEK is a **high-performance plastic material** that has proven to be the right solution in numerous special applications in the semiconductor industry, for instance as bearing cage material. This is because PEEK offers very good resistance to media and can be used in a wide range of temperatures. The type and amount of filling material used depends on the intended application for the bearing, and the right combination is what counts here. Varying the percentages of graphite, PTFE and glass fiber allows the cages to be optimized with regard to the following characteristics: dry running behavior, mechanical stability, use in various media.

Cages aren't the only parts where we like to use PEEK. For low-load bearings, for instance, the bearing rings may be made from this high-performance plastic material.

You can also choose between PEEK or metal end pieces for our four-row ball type profiled rail units KUVÉ. The plastic variant can be used for temperatures of up to 300°C and has special advantages: low weight, resistant to chemicals and radiation, amagnetic, no excessive voltage and abrasion resistant. For higher

loads, we recommend that you use **metal** end pieces. This makes the guides very robust and suitable for high speeds. In addition, they can be used in vacuums and clean rooms.

Other combinations become possible when rolling bearings are included in the calculation. **Ceramics** is the perfect material for this – lightweight and durable. Bearings with ceramic balls or rollers (hybrid bearings) have important advantages, such as a significantly longer bearing life, higher speeds, lower bearing temperatures and low lubricant requirements.



Comparison of the media resistance of various steels

Material designation		100Cr6	Cronidur 30	X46Cr13	X90Cr MoV18	X102Cr Mo17
Material number		1.3505		1.4034	1.4112	1.4125
Suitability as rolling bearing steel		++	++	-	+	+
Medium at 20°C	Concentration in %					
Salt water	4	--	++	o	++	-
Hydrochloric acid HCl	0,1	--	++	--	-	--
Sulfuric acid H ₂ SO ₄	10	--	--	--	--	--
Nitric acid HNO ₃	5	--	++	++	++	--
Phosphoric acid H ₃ PO ₄	10	--	++	-	+	+
Citric acid C ₆ H ₈ O ₇	25	--	++	-	+	--
Sulfurous acid H ₂ SO ₃	1	--	++	--	-	--

++ resistant + moderately resistant - barely resistant -- not resistant o not checked

There are large variations in the resistance of various rolling bearing steels to corrosive media. Among these, Cronidur has the best performance in combination with the application-specific requirements. Since corrosion is a system-specific characteristic, the suitability of the materials must be checked on a case-by-case basis. This includes consideration of the component shape, the surface and the media.

The use of ceramic rolling elements however results in higher contact pressures on the raceways under higher load. In order to allow the performance potential of the ceramic material to be used to the full, adequate raceway materials are needed. This is where our special steel **Cronidur 30** comes into play. In many applications, the combination of Cronidur 30 and ceramic rolling elements results in a further increase in operating life. Compared to the

proven rolling bearing steel 100 Cr6 or the corrosion-resistant steel X90CrMoV18, Cronidur 30 considerably increases the load capacity, especially under tough operating conditions. This material, which was originally developed for aviation and aerospace applications, extends the life of bearing supports and reduces costs for maintenance and lubrication. In addition, higher power density is made possible in subassemblies. One example here is

very small bearings for speeds of up to 500,000 rpm.

Although the percentage of chromium is fairly small, corrosion resistance is high because the alloy components work together. The key measure here is the passive current density. For Cronidur 30, in sulfuric acid the passive current density is lower by a factor of 100 than for X102CrMo17.



Classification of materials for clean room use. You can rely on our support!

As a result of increasing miniaturization, more and more front-end and back-end processes must be carried out under clean room conditions. Requirements for particle-free air and/or vacuum stages vary depending on the manufacturing process used.

All clean rooms have modern air conditioning technology, airlocks for persons and material and qualified monitoring instruments. All manufacturing systems must comply with clean room conditions.

In line with the requirement for nearly particle-free air, the rolling bearings, linear systems and drives used must be made from low-contamination materials for which no internationally binding specifications have been established. We have accepted this challenge.

Proof of qualification

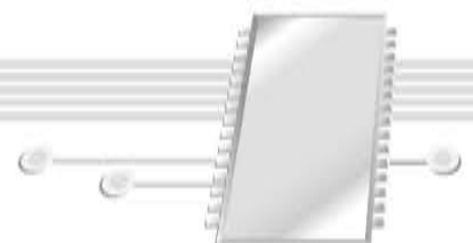
Close cooperation with users leads to the development of an adequate, reliable classification of processes that offers

benefits to the entire market. Schaeffler Group Industrial laboratories work with neutral research institutions to perform intensive, targeted series of tests.

As part of these research projects, products manufactured by the Schaeffler Group are qualified for particle emission per ISO 14644-1. In addition, analyses are performed for outgassing behavior, electrostatic discharge (ESD) and mechanical efficiency.



The design of INA/FAG bearings used in clean rooms is perfectly suited to their future place of installation

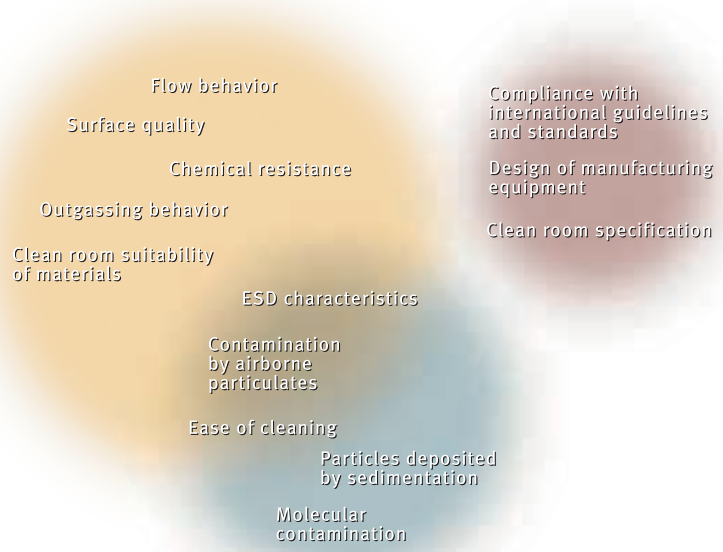


Most of these analyses are carried out in cooperation with the Fraunhofer Institute Manufacturing Engineering and Automation (IPA) in Stuttgart and at the Fraunhofer Institute Integrated Systems and Device Technology (IISB) in Erlangen.

Measurements are performed in clean rooms per ISO class 1. A displacement flow with low vertical turbulence is maintained under consistent operating conditions:

- 0.45 m/s flow speed of initial air
- 22 °C room temperature
- 45% relative humidity

Parameters for clean room suitability



“Class” 10 = ISO class 10?

Comparison of frequently used clean room classes

Maximum limits for particle values ≥ 0,5 µm (rounded)			
Classification	ISO 14644-1		US Fed. Std. 209E*
	per m ³	per cbf	per cbf
ISO class 1	0	0,01	–
ISO class 2	4	0,1	–
“Class” 1	–	–	1
ISO class 3	35	1	–
“Class” 10	–	–	10
ISO class 4	352	10	–
“Class” 100	–	–	100
ISO class 5	3 520	100	–
“Class” 1 000	–	–	1 000
ISO class 6	35 200	1 000	–
“Class” 10 000	–	–	10 000
ISO class 7	352 000	10 000	–

* No longer valid



Manufacturers around the world claim that they supply “Class 10” products. But how do they measure them? For your reassurance: We look at all the standards. You can rely on our support.

The right lubricant for any application – Our service for you



Testing in our in-house lab: Analysis of lubricants for water content



Ultra filtered grease for precision bearings

In addition to well thought-out design and precise production, lubrication plays an important role in determining the reliability and operating life of a bearing. Selection of a suitable grease, the effect of additives, cleanliness in terms of contaminants and compliance with the specified lubrication intervals help to determine the quality of the system.

Decisive criteria

The technical performance of a grease for initial lubrication is tested exhaustively before it is put into operation. This includes determining the particle

generation by measuring the emission of airborne particulates. Grease selection is based on requirements such as

- Protection against wear and corrosion
- Smooth running across the whole temperature range
- Suitability for use in vacuum
- Noise behavior

For high vacuum, special greases based on perfluoropolyether oils (PFPE) with particularly favorable vaporization behavior are used.

The table on page 17 provides a selection of the types of factory prelubrication that best meet these requirements.

Arcanol

The Arcanol grease range ensures functional reliability of bearing supports in all conditions. These greases, developed in partnership with renowned lubricant manufacturers, are subjected to comprehensive tests before release and checked subsequently too – batch after batch – before bulk filling. The range is complemented by the Motion Guard series of lubricators that automatically supply the correct quantity of fresh grease to the bearing positions.



Precision is our profession: Like lubricant, like bearing performance



DSC analysis: Temperature behavior of lubricants, analyzed using the latest methods

	low particle emission	high vacuum	low noise operation	low operating temperatures	high operating temperatures	wear protection	smooth operation
greases for initial greasing (selection)							
L 285			■				
L 057						■	
L 271						■	
L 235	■			■			■
L 430	■			■	■		
L 077	■	■			■		

Not all greases are created equal: We lubricate our bearings just right for your application

Expertise close to the customer: The Schaeffler Group has a long tradition of good service



High operational safety – short development times:
We use BEARINX® to design our bearings and model
future operating conditions

Specialists working in engineering teams worldwide provide support from the start. Use our engineers' experience and expertise to your advantage! We always use cutting-edge technology.

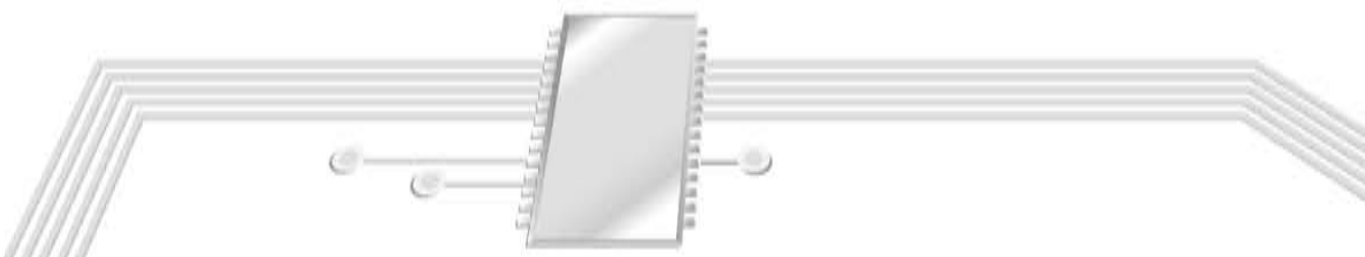
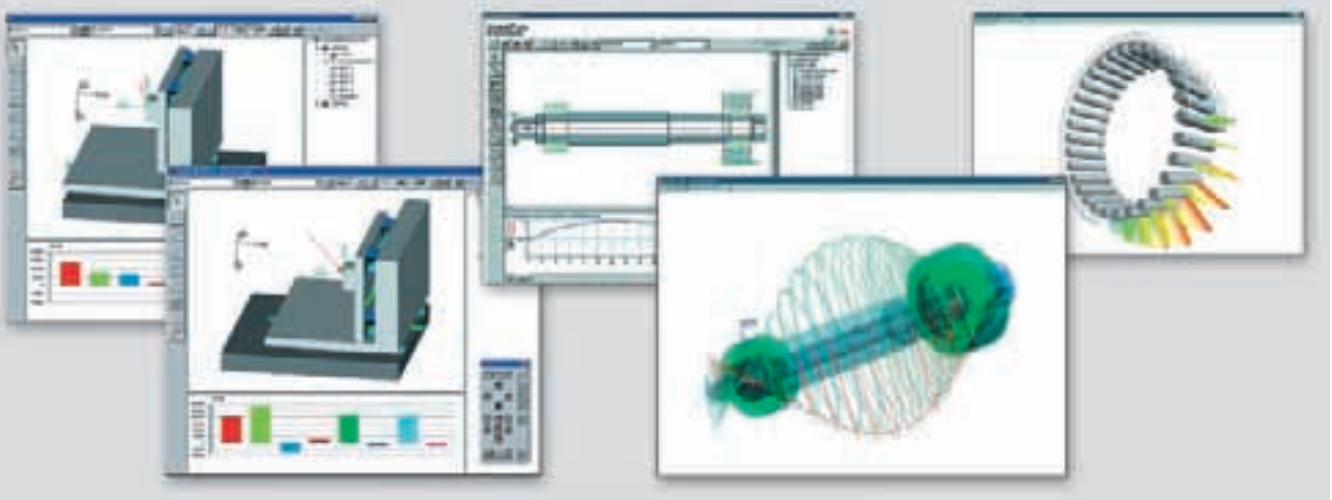
Design. Customized bearing supports and components are typical for the INA and FAG brands. Of course we use state-of-the-art tools like CAE.

Selection/calculation. BEARINX® is one of the leading rolling bearing calculation programs, allowing the detailed analysis of all INA/FAG rolling bearings – from individual components all the way down to complex shaft systems. Internal loads can be calculated for every single rolling bearing contact and can be represented as a graph or table. BEARINX® then uses the loads for each contact point to calculate the life of the bearing.

Simulation. In the design and modeling phase, we work with state-of-the-art methods such as dynamic simulation

and FE analysis. The “rapid prototyping” method allows us to provide customers with precise artificial resin models that let them test the product position in the application.

Testing. Only after these optimization steps have been completed does the new product go to the test lab. At the customer's request, we analyze customer prototypes in one of our modern R&D centers by considering any possible situation and all functions: from wear behavior to emissions and noise. It isn't until stringent practical series of tests have been completed that volume production starts.





Schaeffler Group Industrial – a global sales and support network. One of our locations is close to you.
We'd like to hear from you!

Schaeffler Group Industrial is one of the leading rolling bearing manufacturers worldwide. With its strong brands INA and FAG and its affiliated subsidiary, direct drive specialist IDAM, Schaeffler Group Industrial is active in more than 60 industrial sectors, including several decades in the electronics manufacturing industry. Customers can choose from an exceptionally high-quality and comprehensive portfolio of components and system solutions. The Group's product range includes nearly 40,000 standard products and a large number of special solutions. More than 180 plants and subsidiaries around the world ensure local application support, short delivery times and flexible order processing.



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