



**FAG**



## A Brief Introduction to Rolling Bearings

**SCHAEFFLER GROUP**

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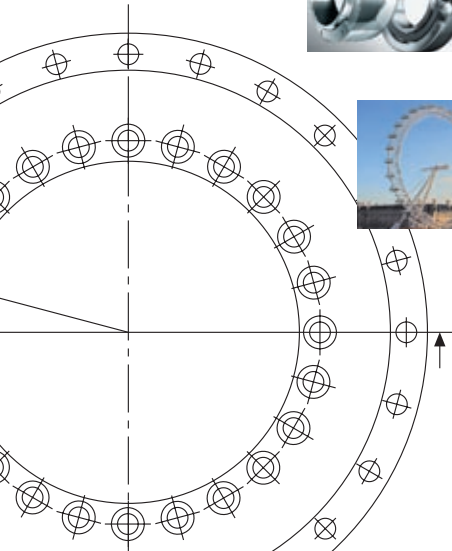
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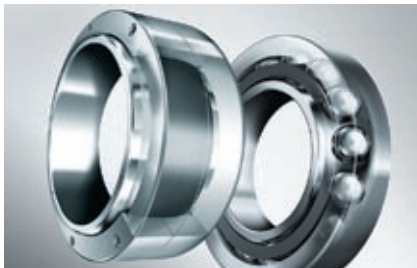
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## What are bearings used for?



Bearings in a passenger car: Ball bearings on the axles ensure that the wheels rotate

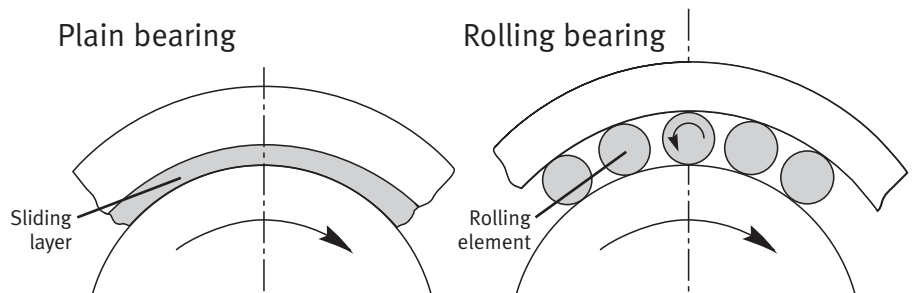


Plain bearings (left) are designed for heavy loads

Bearings are components designed to connect machine parts. Bearings transmit motion and forces. They are usually mounted on axles or shafts and inserted in housings.

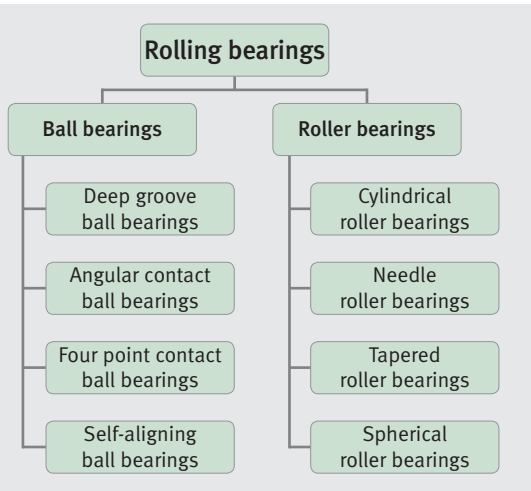
If a bearing transmits rotary motion, it is called a rotary bearing. Linear bearings are used for longitudinal motion. The type of friction involved distinguishes plain bearings from rolling bearings.

**Plain bearings** are components with a sliding layer between two parts. This sliding layer may be a solid layer that is fixed to the bearing, such as plastic or bronze layers. Otherwise, a lubricating film separates the surfaces.



# Rolling Bearings

## Rolling bearing types and components



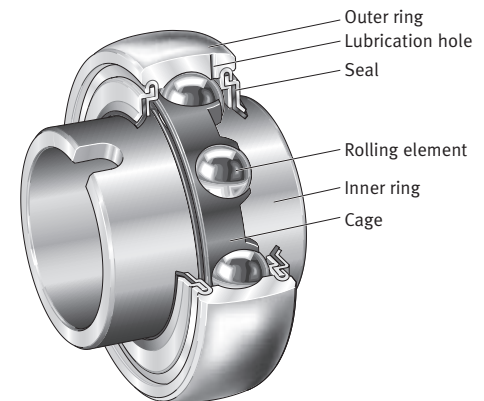
Various bearing types are available for numerous applications

**Rolling bearings** are bearings with two components that move in opposite directions. These parts are the inner and outer ring, and they are separated by rolling elements. The rolling elements roll between the two rings during operation. This occurs on hardened steel surfaces called raceways. The friction generated here is significantly lower compared to plain bearings.

### When should which type be used?

Ball bearings can rotate at high speeds, but cannot support very high loads. This makes them an excellent choice for hand drills.

Ferris wheels turn much more slowly. Here, large roller bearings are used since they can support extremely high loads.



# R o l l i n g   B e a r i n g s



Design of a needle roller bearing with a plastic cage



Ball bearing cages in different designs and materials

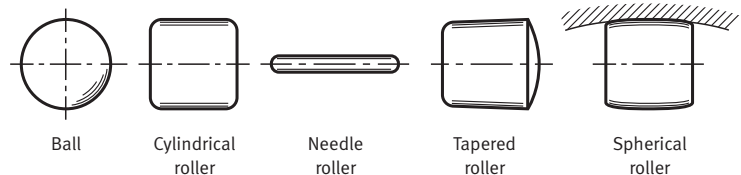
Rolling elements are the most important parts in a bearing, because they carry most of the loads. Rolling elements come in different shapes: balls, cylindrical rollers, needle rollers, tapered rollers or spherical rollers. The names of many bearing types are based on the kind of rolling element used, such as “ball bearing” or “needle roller bearing.”

In modern bearings, a cage is used to provide even spacing for the rolling ele-

ments. This prevents them from contacting each other. Cages can be made from sheet steel, plastic or brass.

Additional components may be sealing shields or seals. Another important part of a bearing is the lubricant. Rolling bearings are lubricated with grease or oil to extend operating life. The seal keeps the lubricant in the bearing and prevents dirt and moisture from entering.

Rolling element types



## Accuracy requirements and quality control



Zero defect production:  
Quality surveillance of each step of production



The highest possible quality in high volume production:  
Measuring probe for the micron range

Rolling bearings have to meet demanding quality requirements. They must be able to support high loads and have a long operating life. Extremely high accuracy is required during bearing manufacture to ensure that bearings run smoothly and save energy in the application. All components must match very precisely. The only permissible deviations are in the micron range.

For this purpose, a safety net is included in every manufacturing operation – integrated quality control. Many machine tools perform inspections automatically during manufacturing, for example by means of camera monitoring. Random

### How small is-a micron?

In engineering, a “micron” refers to a micrometer ( $\mu\text{m}$ ), a millionth of a meter.

It is 40 times smaller than the thinnest human hair.

checks made on machines and in laboratories ensure consistently high quality. Trained machine operators monitor the quality during operation. The necessary measuring instruments are adjusted by lab experts and checked on a regular basis.

## Bearing materials



Large quantities of high-grade steel are required to produce rolling bearings



Ceramic is an excellent material for rolling elements – the bearings have a significantly longer operating life

Bearings are usually manufactured from high-grade 100 CR 6 chromium steel. This tried-and-tested material offers both the required hardness and a high level of purity – ideal conditions for very high load carrying capacity and long operating life.

Special applications require bearings made from stainless steel or ceramics or surface-coated bearings. For some applications, a hybrid bearing type is more suitable. In this kind of bearing, the

rings are made from steel and the rolling elements are ceramic. Since ceramic is a very light material, these bearings can rotate at very high speeds and require only very little lubrication.

Engineering plastic materials are also important for bearings. They do not withstand extremely high temperatures, but they are very lightweight compared to steel. This is why they are used increasingly for cages or seals in the automotive industry. Here, every gram of weight matters.

## Modern manufacturing technology ...



The first step: Forging bearing rings

The network within the Schaeffler Group allows INA and FAG to utilize all modern technologies for rolling bearing manufacture. The bearings can be produced in large quantities in the required quality and accuracy.

For large bearings, the first step is **forging**. The raw material is a piece of bearing steel. How is this made into a bearing ring? The piece of steel is heated to 1200 degrees Celsius, buckled, pierced and milled.



Turning is an important metal cutting operation

Smaller bearing rings are generally cut from tubes or bars and are then **precision machined**, similar to forged parts. The blanks are then turned on multi-spindle lathes where inside and outside dimensions are machined. The material removed during this cutting process is called “chips.” This operation allows the required rolling element raceways and grooves for seals to be obtained.



## ... as a success factor



Protection against premature material fatigue:  
Hardening of inner rings

**Hardening** is a type of heat treatment that makes steel hard and wear-resistant. The parts are heated in a hardening furnace to 800 degrees Celsius and then “quenched,” which means they are immersed in a salt or oil bath for rapid cooling. The steel will then become significantly harder. Without this hardening operation the bearing rings would not be able to withstand the constant pressure of the rolling elements during operation.



As smooth as glass: Honed surfaces increase the performance and life of bearings and mean less noise

**Grinding and honing (fine grinding)** are the next operations. Various grinding media are used to process the rough surfaces. The finer the grinding wheel or the honing stone, the smoother the surface of the ground raceway or the surface of the rolling element. In the finishing operation, deviations must not exceed one half of a micron.

## Modern manufacturing technology ...



Economically produced: Deep drawn parts at various manufacturing stages



Lightweight: Plastic coated bearings used as belt tension pulleys for passenger cars

**Deep drawing** is a forming process and represents one of the Schaeffler Group's core technologies. It allows the economic manufacture of large volumes of bearing parts. First, a blank is punched from a strip of steel. It is then deep drawn in several steps to the required shape – it may be a drawn cup needle roller bearing or a modern sheet-metal ball bearing cage. Deep drawing is carried out on large transfer presses with high pressure and without heating the sheet metal.

Plastic parts for bearings are produced using **injection molding** machines. These products include cages of all sizes and designs as well as seals for a wide range of applications. For some applications, complete rolling bearings are injection molded to give them a pre-defined shape.

## ... for the highest quality in volume production



Say good-bye to rust: Corrosion protection with Corroprotect® coating (comparison after salt spray test)

**Surface coating** is an important process for increasing the resistance of bearings during operation. The bearings are better protected from wear, excessive voltage and environmental influences, and they have a longer life. Various chemical and physical procedures are used to apply the layers to the steel. INA's Corroprotect® coating offers protection against a bearing's number one enemy – rust. Triondur®, a thin ceramic-like coating is used against particularly aggressive wear mechanisms.



Fully automatic: A complete bearing is manufactured with inner ring, outer ring, balls, cage and grease

Rolling bearings **assembly** is typically performed on assembly lines. These highly automated production lines have a large amount of integrated quality control. Using assembly lines enables cost-efficient and precise high volume production. Most of these lines are designed and built by specialists in our in-house special-machine tool department.

# Rolling Bearing Range

40,000 bearing designs...



Rolling bearing components and materials can be combined in numerous ways to produce a wide range of bearing designs. INA and FAG offer approximately 40,000 standard products, covering any conceivable application requirements.

Special bearings are designed for special applications that are tailor-made for the customer's specific needs. Examples include bearings with several rings for very high loads, combined ball and roller bearings, wheel bearings with built-in measuring systems or high temperature bearings for aviation and aerospace applications.

... for thousands of uses



An unrivaled wide range of rolling bearings is available for more than 60 industrial sectors.

The products range from miniature bearings only a few millimeters wide, e.g. for dental drills, to large bearings with an outside diameter of many meters, e.g. for wind turbines. Bearings from the brands INA and FAG are also used in textile machinery and machine tools, railways, inline skates and bicycles, drills, bridges and in mining.

INA and FAG combined are number 2 in the rolling bearing industry worldwide.

## INA and FAG in the Schaeffler Group network



The headquarters of the Schaeffler Group and the INA manufacturing plant in Herzogenaurach



FAG plant in Schweinfurt. One of the world's largest bearing forges for producing milled rings is located here

The Schaeffler Group and its brands, INA, FAG, and LuK, is one of the world's leading rolling bearing manufacturers and suppliers to the automotive industry.

As a rolling bearings manufacturer, the Schaeffler Group and its brands INA and FAG has an extremely wide range of products and services of the highest quality. This range includes nearly 225,000 various items that are supplied to more than 60 sectors of industry.

With the INA brand, the Schaeffler Group develops and supplies needle roller bearings and engine components to the automotive industry and wheel bearings for passenger cars and trucks with the FAG brand. LuK is the world's fourth largest clutch manufacturer and also supplies dual mass flywheels and transmission components.

The Schaeffler Group's companies are represented in all major industrial countries of the world. It has 66,000 employees in 180 locations in 50 countries.

This global network ensures the required customer proximity. Close collaboration during the development of new products and short delivery times are thereby ensured. Most of our industrial customers are from the mechanical and plant engineering sectors as well as equipment engineering and precision mechanics.

## Training and starting your career at the Schaeffler Group



Great perspectives: Schaeffler KG is the largest provider of training in North Bavaria, Germany



The Schaeffler Group on an international level:  
The best career prospects

**Vocational training** at the Schaeffler Group is a worthwhile investment in the future. We offer training for technical as well as commercial careers and training for high school graduates at universities of applied science or vocational academies in co-op training programs. You can find more detailed information about the various training options available at the Schaeffler Group at [www.schaeffler.com](http://www.schaeffler.com) → [Careers](#) → [Your introduction to the Schaeffler Group](#)

You can call us on +49 (0)9132 82-2327 with questions regarding training at INA or on +49 (0)9721 91-2694 for FAG locations.

There are various options available for **starting your career** at the Schaeffler Group:

- For undergraduates: Internships and theses
- For graduates: Direct entry through on-the-job training or the TrainING program for the manufacturing and application engineering sectors as well as our trainee program in our finance sector
- For those with work experience: Direct entry through on-the-job training

Sectors: Development, design, application engineering, manufacturing, sales, materials engineering, quality control, mechatronics, purchasing, IT, finance, logistics, controlling, marketing, HR.

Applications to [bewerbung.ina@schaeffler.com](mailto:bewerbung.ina@schaeffler.com) or [bewerbung.fag@schaeffler.com](mailto:bewerbung.fag@schaeffler.com)  
Find out more at: [www.schaeffler-group.com](http://www.schaeffler-group.com)

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