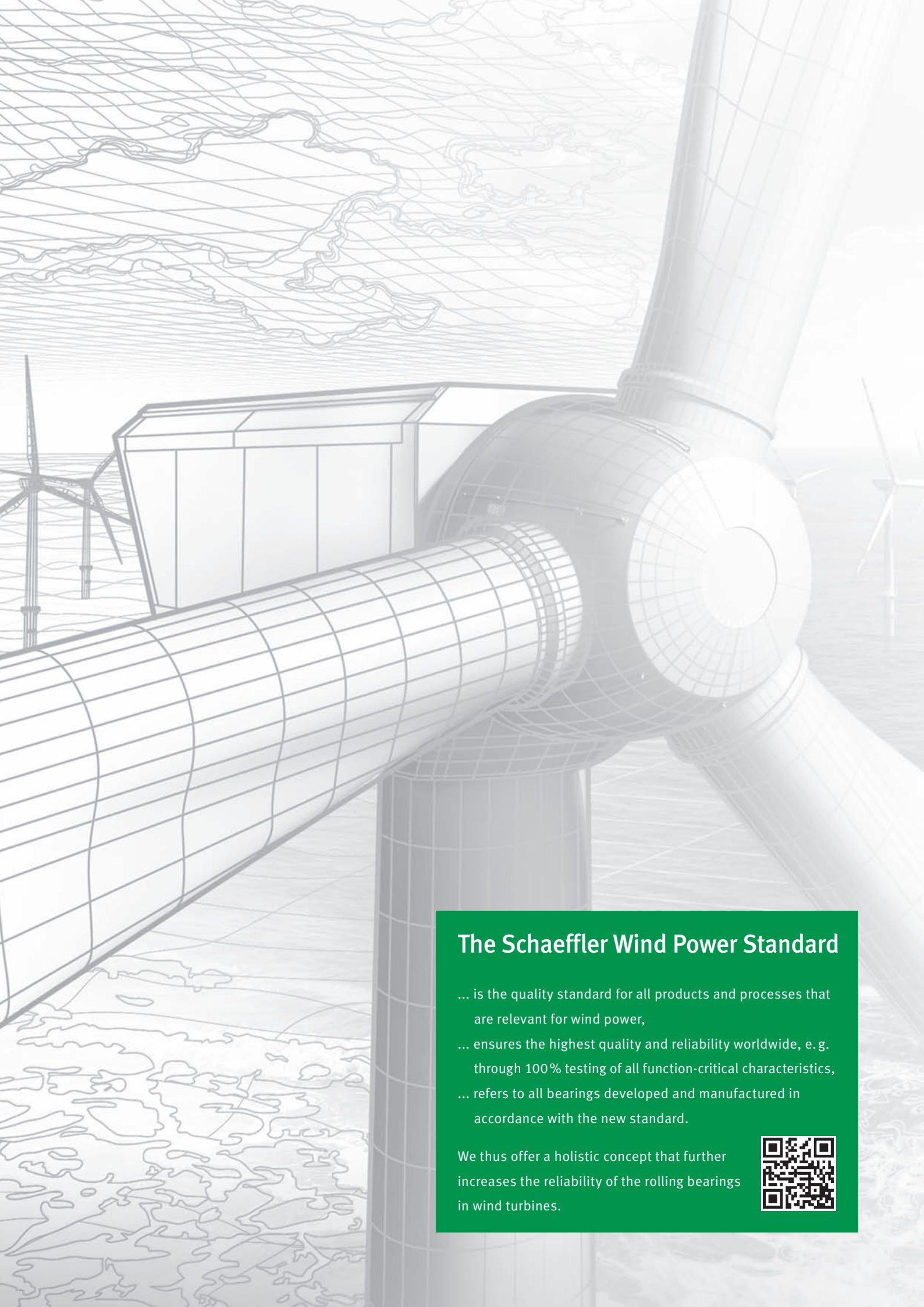
SCHAEFFLER

Bearing Solutions and Service for Wind Turbines

LuK INA FAG



The Schaeffler Wind Power Standard

... is the quality standard for all products and processes that are relevant for wind power,

... ensures the highest quality and reliability worldwide, e. g. through 100 % testing of all function-critical characteristics,

... refers to all bearings developed and manufactured in accordance with the new standard.

We thus offer a holistic concept that further increases the reliability of the rolling bearings in wind turbines.

Reliability – made by Schaeffler

Schaeffler is one of the world's leading rolling bearing manufacturers and has been producing bearings for wind turbines for over 30 years. We offer the right solution for every bearing position and a holistic concept that further increases the reliability of the rolling bearings in wind turbines: The **Schaeffler Wind Power Standard (WPOS)**.

In order to ensure that the high standards of the sector are maintained, we work closely with customers and suppliers across the entire process chain all the way up to volume production. In this way, we work together to develop the optimum solution for every bearing position – from the rotor shaft to the gearbox, generator, nacelle, and blade adjustment system. Customer requirements have already been taken into account down to the finest detail in the project planning phase. Sophisticated simulation and calculation methods support the selection of bearings and documentation. And the test phase uses Schaeffler's ASTRAIOS – one of the most modern and powerful large-size bearing test rigs in the world. There, bearings of up to 15 metric tons and an outside diameter of 3.5 meters can be tested under realistic conditions. Special rolling bearing greases and a wide range of services and products for maintenance and equipment condition monitoring round out our program. The follow-up costs for maintenance can thus be reduced and the availability of wind turbines can be increased.

Profitable wind turbines need reliable components.
Let us be your development partner!

FAG and INA products manufactured in accordance with the Schaeffler Wind Power Standard bear the WPOS mark

Everything from a single source

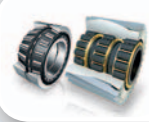
The ideal solution for every bearing position

Animation
http://windpower.schaeffler.com

Our Range of Products

Rotor Shaft

Proven and powerful bearing designs
Tapered roller bearings, spherical roller bearings, cylindrical roller bearings, and bearing housings



Gearbox

Strong and safe for every drive unit
Tapered roller bearings, cylindrical roller bearings with cage, full complement cylindrical roller bearings, deep groove ball bearings, and four-point contact ball bearings

Generator

Longer operating life thanks to current insulation
Deep groove ball bearings and cylindrical roller bearings in a variety of current insulation versions

Pitch and Yaw Systems

Ensure yaw control in the long term
Single and double-row four-point contact bearings with and without gearing, deep groove ball bearings, cylindrical roller bearings, spherical roller bearings, tapered roller bearings, and sealed plain bearings

Condition Monitoring

Reliability through remote monitoring and diagnosis
Service and systems for online condition monitoring, offline individual measurements, lubricant monitoring

Installation & Maintenance

Professional service for all bearing positions
Tools, measuring equipment and accessories for the mounting/dismounting of rolling bearings, worldwide support by specially trained Schaeffler technicians, wide range of training options

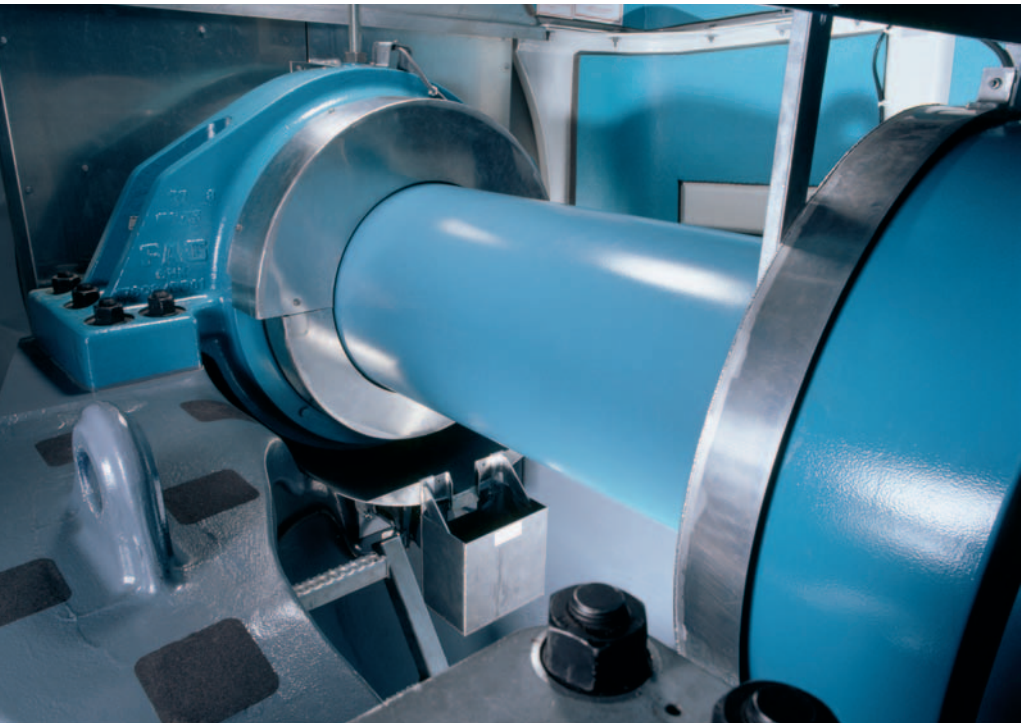
Bearing Design

Modern simulation and calculation programs and realistic tests
From the complete system to the rolling element contact: Comprehensive analysis for the optimum bearing design

Rolling Bearing Lubrication

Important for a long operating life
Arcanol – rolling bearing-tested grease, relubricating devices

Proven and powerful bearing designs



All of the forces generated by the wind directly affect the bearings on the rotor shaft. Low-friction bearings from Schaeffler operate in the drive trains of modern turbines from 220 kW to the latest multi-megawatt class around the world. Together with our customers, we develop the most efficient bearing for the situation. The results from realistic tests with our large-size bearing test rig ASTRAIOS (see page 13) are incorporated into our bearing designs.

Shaft bearing support

The classic, well-proven solution consists of a locating/non-locating bearing with spherical, cylindrical, or tapered roller bearings.

Hub bearing support

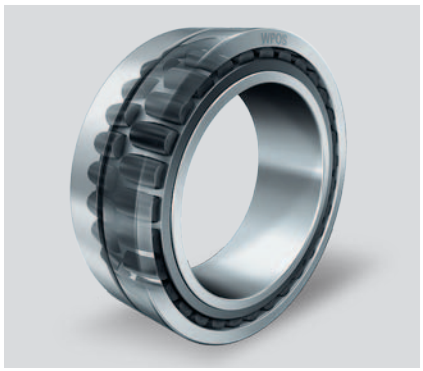
In the adjusted bearing version, two tapered roller bearings are mounted. The alternative locating/non-locating bearing consists of a paired tapered roller bearing and a cylindrical roller bearing.

Single-bearing designs

These designs combine power and torque in one multiple-row bearing. The version of the bearing as a double-row tapered roller bearing is selected in accordance with the operating conditions. The dimensions of the large-size bearing extend to over 400 mm in width and over 3,000 mm in outside diameter. Pre-mounted rotor bearing units with adjacent parts and seal system lower the expense for logistics and installation.

Rotor bearing housings

Bearing housings calculated with the most modern methods ensure the best possible application of force and torque.



Wear-resistant thanks to black oxide-coated rolling elements (Durotect® B): FAG spherical roller bearings

Experience the product interactively!

Strong and safe for every gearbox

Highly dynamic forces with extreme peak and minimum loads, sudden load changes, and strongly varying operating temperatures present great challenges for the bearing technology in wind turbine gearboxes. Bearings with high static safety and safe dynamic design in accordance with international design guidelines such as ISO 81 400 and IEC 61400-4 are the solution here.

New simulation calculations

The deformation of the gearbox housing can also place stress on the bearings. Load peaks also result from braking procedures and other influences from the turbine controls. New simulation calculations of the dynamic behavior of the drive train lead to more precise load formulations and enhance the previous approaches based on analogies and measurements.

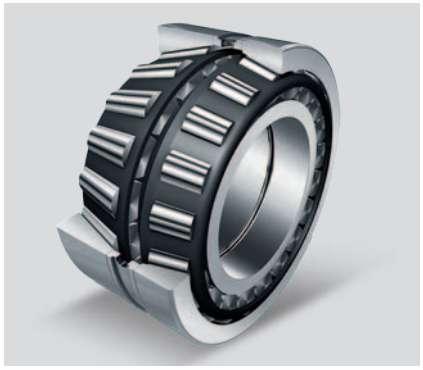
High load ratings – low friction

Thanks to its special cage design, the high-capacity cylindrical roller bearing combines the advantages of full complement bearings with those of cage-type bearings. Depending on the need, a significant increase in load ratings is possible compared to bearings with a standard cage.

Reliable and economical

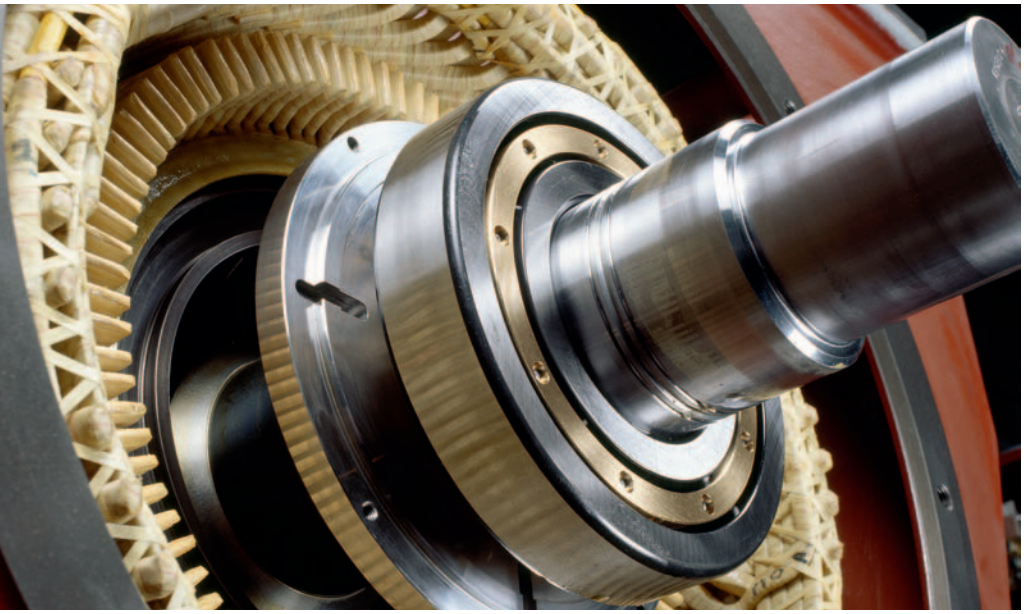
Ready-to-fit, optimally designed tapered roller bearing units for fast gearbox shafts are easy to install and lower logistics expenses. The internal clearance is attuned using adjusted intermediate rings. The load distribution and the friction can be optimized through the effect of varying contact angles of the two bearing series.

High load capacity and low friction: FAG high-capacity cylindrical roller bearings for planetary gears



Ready-to-fit: FAG tapered roller bearings for fast gearbox shafts

Longer operating life thanks to current insulation



Generators in wind turbines are exposed to high vibrational stresses. This additional long-term stress has an especially negative effect on rolling bearing cages and places demands on the lubricant. The bearings are also exposed to high speeds and temperatures as well as the risk of current passing through them.

Current insulation of generator bearings

The passage of current can cause severe damage to the raceways of the bearing rings (craters caused by melting, false brinelling), leading to extremely high maintenance costs. This should already be prevented in the planning phase. In many cases, it is enough to install electrically insulated bearings. Schaeffler offers a variety of solutions for this:

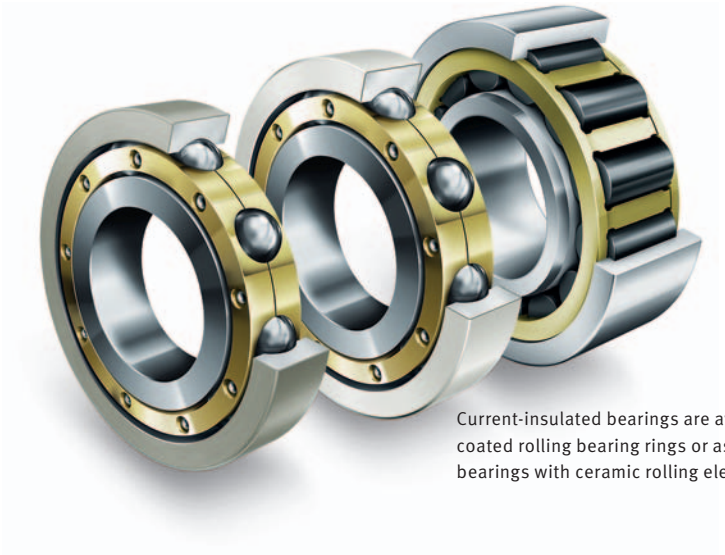
Coated bearings

Insutect®, our highly wear-resistant coating made from aluminum oxide ceramic, can withstand a disruptive voltage of up to 3,000 volts, even in damp environments. And Insutect® E, the glass-fiber reinforced plastic coating, insulates against high-frequency currents with a coating thickness of over 1 mm.

Hybrid bearings

Hybrid bearings with ceramic rolling elements offer maximum protection against current passage. In addition, hybrid bearings have a longer grease operating life. They are suitable for high speeds and have good emergency operation characteristics. All current-insulated bearings have the same dimensions and load ratings as non-insulated bearings and can be installed as a 1-to-1 replacement.

Economical: Insutect® E coating permanently insulates large-size bearings against current passage



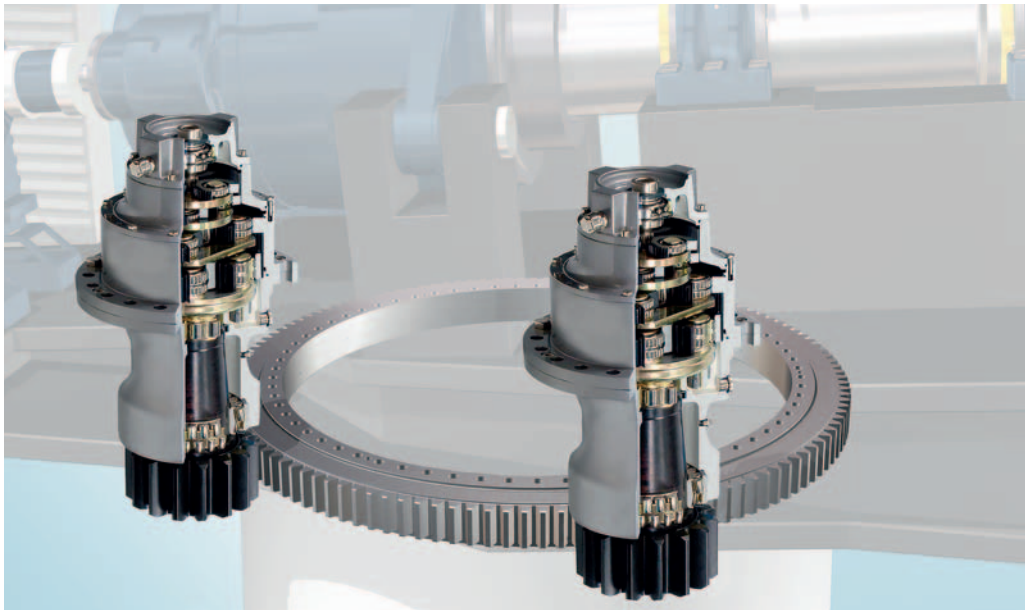
Current-insulated bearings are available with coated rolling bearing rings or as hybrid bearings with ceramic rolling elements

Ensure yaw control in the long term

Pitch bearings

The blade angle is always optimally adjusted to the wind speed via the pitch bearing in order to control the performance of the wind turbine. The high loads from the dynamic stresses on the rotor blades must be safely dissipated into the rotor hub via the raceways and the screw connections. Single or double-row four-point contact ball bearings with cages are used, with internal or external gearing or without gearing, depending on the drive design.

As an essential component of the turbine safety design, pitch bearings must ensure that the blades can be reliably and consistently adjusted under all operating conditions. A long operating life and high reliability are achieved thanks to the optimized dimensioning of the bearings and a maintenance concept tailored to the turbine and the operating conditions.



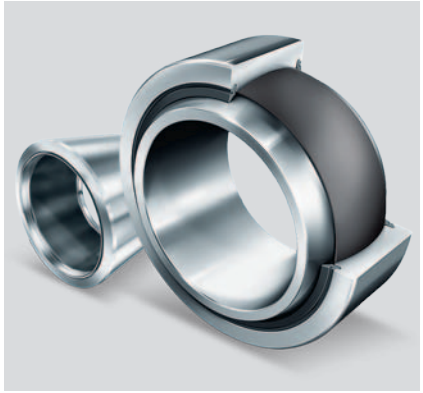
Azimuth bearings

A robust slewing ring is necessary to adjust the position of the nacelle to the wind direction as well as possible.
The wind force and the dynamic inertial forces are dissipated safely and reliably into the tower head via the raceways and screw connections. Single or double-row four-point contact bearings with cages are used, with internal or external gearing.

Azimuth and pitch drive units

Wind turbines are automatically controlled by active systems. Schaeffler offers bearings for slewing gears for nacelle positioning and blade angle positioning from a single source:

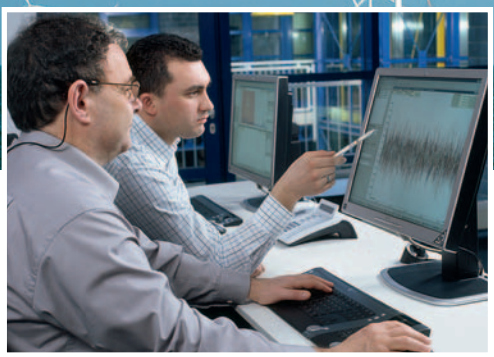
- Drive shaft – deep groove ball bearings
- Planetary gears – full complement cylindrical roller bearings
- Output shaft – cylindrical roller bearings, spherical roller bearings, tapered roller bearings.



100 % maintenance-free: INA plain bearings with ELGOGLIDE® in hydraulic systems for blade angle positioning

Robust and reliable: Pitch bearings with corrosion protection system (zinc and color coating)

Dependable thanks to remote monitoring and diagnosis



The permanent monitoring of wind turbine bearings is a basic prerequisite for better profitability. At Schaeffler, the experts from Industrial Aftermarket (IAM) take on this task.

Online condition monitoring with WiPro

WiPro s is a system tailored to the needs of the wind power producer. It primarily measures the vibrations and selectively monitors torque, temperature, oil quality, and other measurements. The arrangement of the sensors on critical points in the nacelle is based on the individual conditions of the turbine. If predefined threshold values are reached, an alarm is triggered, and the data are automatically sent to the service center by landline, wireless, or satellite modem. Following detailed analysis, we suggest concrete measures to the customer that can be used to avoid unplanned downtimes and expensive secondary damage. Planning security is increased and component replacements can be scheduled in advance.

Offline individual measurements

As an alternative introduction to system monitoring, we offer sophisticated solutions based on portable devices and individual measurement of vibration and temperature data.

Lubricant monitoring

The use of oil and grease sensors contributes to increased system availability. As a grease sensor, Schaeffler recommends the FAG GreaseCheck. Its special feature: Relubrication can be carried out based on condition, i.e. independently of time intervals, which prevents overgreasing. For monitoring the oil, we use the Wear Debris Check oil sensor. This can detect wear and damage to bearings early on through the abrasion particles.

Onshore and offshore: Schaeffler offers variable systems for the online monitoring of wind farms

Professional service for all bearing positions

The installation service from Schaeffler offers support worldwide – quickly and reliably. Extensive bearing knowledge and expertise in renewable energy allow professional service for all bearing positions in a wind turbine. This optimizes installation and deinstallation processes and helps to avoid unscheduled downtimes and to reduce maintenance costs.

A broad range of suitable tools, measuring instruments, and lubricants simplifies the installation and maintenance work and contributes to the prevention of possible damage to bearings. The devices can be leased for a fee.

Schaeffler is always a competent partner for customer-oriented solutions. Individual service strategies and practical training support you in handling bearings, thus making a crucial contribution to increasing operating life.

Professional installation = lower costs + higher system availability

FAG mid-frequency heating devices for heating large-size bearings and components for mounting and dismounting

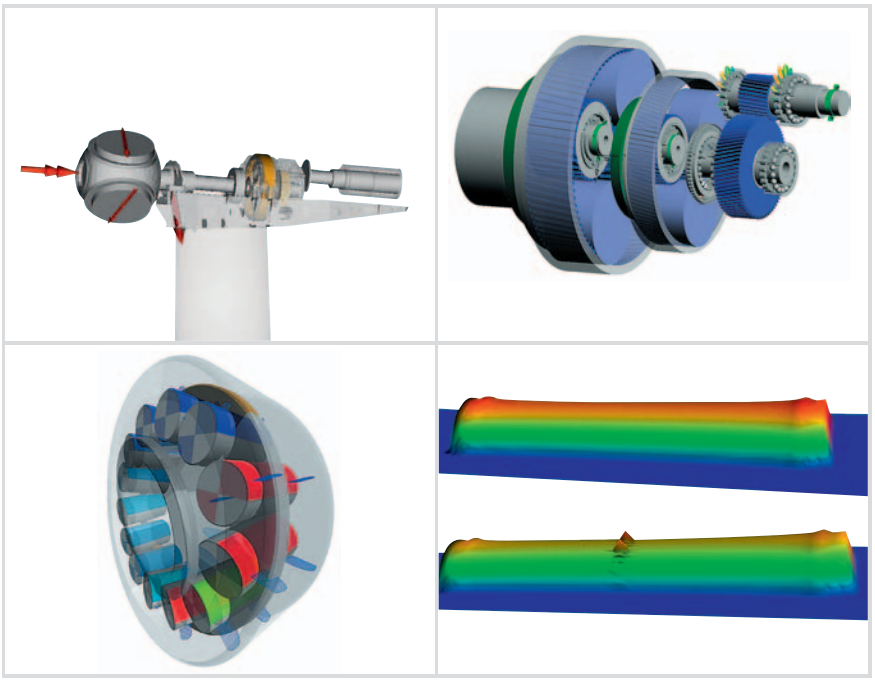
Modern simulation and calculation programs

From complete systems to the rolling contact

Downtimes in a wind turbine are associated with high costs. All factors must therefore be taken into account as well as possible during planning and design. We work with the most up-to-date simulation and calculation programs in order to ensure the optimum selection of products.

Multi-body simulation

With the hybrid multi-body simulation (MBS), the dynamic behavior of the entire wind turbine is displayed. Based on the model, individual components of the drive train and the entire turbine design can be improved as early as the development phase.



From complete systems to bearing contacts: Comprehensive analyses for optimum bearing design

BEARINX®

With the BEARINX® software, all bearing types, complex shafts, and shaft systems through to complete drive units can be modeled and calculated. The support reactions, the internal stresses of the bearings, the comparative stress of the shafts, and the most important parameters are calculated and can be displayed graphically or in a table. Naturally, the internal load distribution in the bearing is also calculated exactly – up to the contact compression, taking into account the rolling bearing profile. Analogous to the stress on the individual rolling contacts, BEARINX® determines the calculated operating life more precisely than was previously possible.

With BEARINX® online, we offer our customers the opportunity to perform the calculation of complex, multiple-bearing shaft systems from their workplace.

FEM

For even more detailed analyses, FEM calculations can determine the influence of the adjacent construction on the bearings and vice-versa.

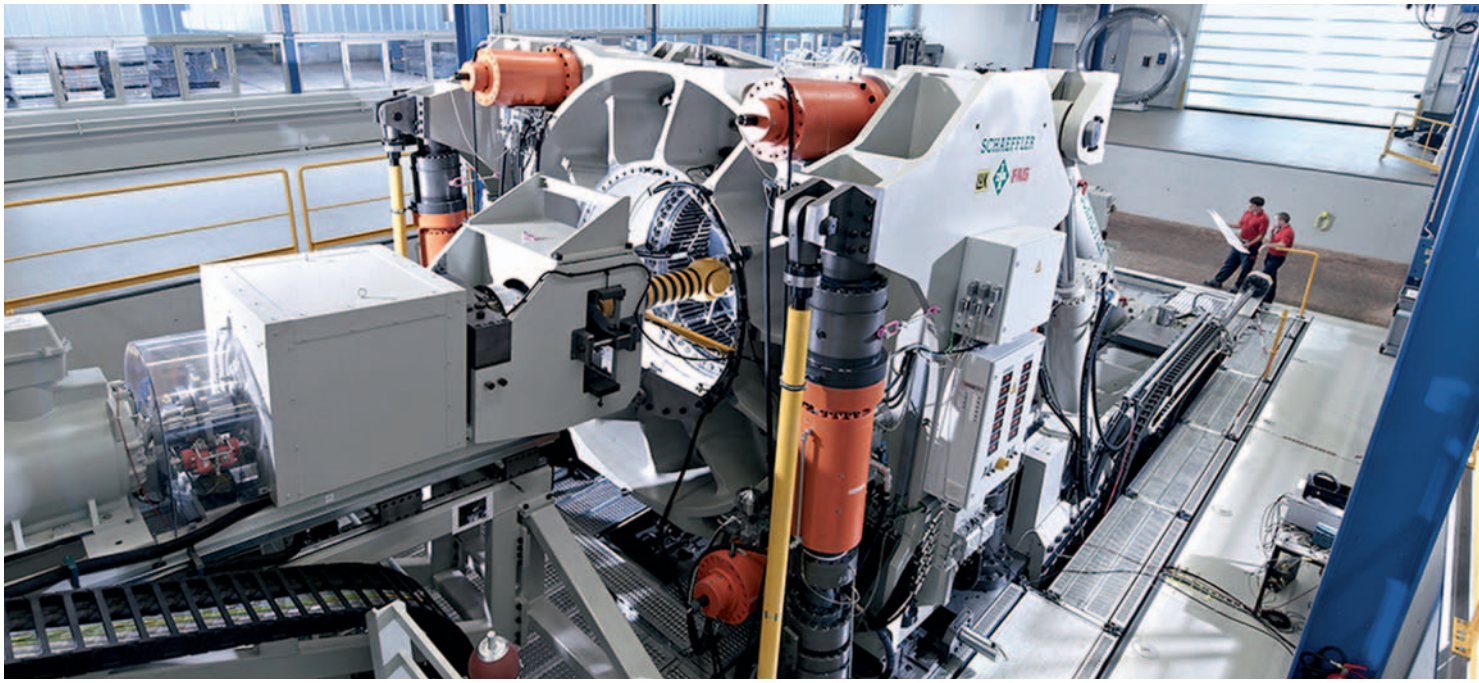
CABA

The CABA3D MBS software allows the dynamic analysis of rolling bearings. Taking into account all degrees of freedom, the force and movement curves of the bearings and rings are defined, which are then used as the basis for determining results (e.g. friction) for every time increment. With CABA3D, it is thus possible to calculate, among other things, the transmitted friction and the acceleration behavior of the bearings when entering the load zone.

Telos

The Telos 3D simulation program examines the individual rolling contacts. Any rolling contact can be analyzed under general lubrication conditions and a distinction can be made between coated and uncoated bearing components.

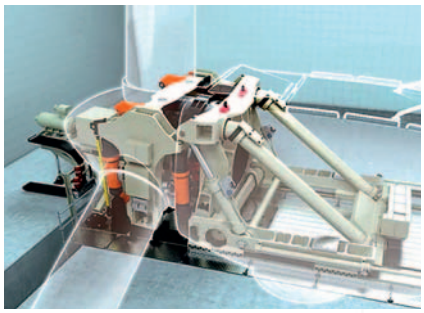
Realistic tests on Schaeffler's ASTRAIOS



ASTRAIOS is one of the most modern, largest, and most high-performance large-size bearing test rigs in the world. Large-size bearings of up to 15 metric tons and a 3.5 meter outside diameter can be tested under practical conditions using a broad simulation program. With ASTRAIOS, Schaeffler makes a significant contribution to the quick and reliable design of wind turbines and increases their profitability and safety.

ASTRAIOS simulates the real loads and moments which occur in a wind turbine – for rotor bearings and slewing rings in wind turbines of up to 6 MW. All rotor bearing designs can be tested.

Over 300 sensors in the test bearings provide information to be evaluated for a variety of analyses. The measurement and control technology are provided by SARA, the automation system for R&D applications from Schaeffler. Our experts evaluate the data and improve the calculation models through comparison with the test results.



Realistic simulation of a wind turbine

See video

Important for a long operating life

Lubrication has an enormous influence on the reliability and operating life of a bearing. The right grease, the performance of the oil, the effect of the additives, the cleanliness, and the adherence to the lubrication intervals determine the operating life of the system.

Grease lubrication

Main bearings in wind turbines are provided with special Arcanol greases, which undergo extensive testing before being approved. Arcanol greases thus always have consistently high quality. Typical greases for main bearings are Arcanol LOAD400 and, for low temperatures, Arcanol LOAD460. For a longer rolling bearing operating life, the raceways and gearing of pitch and azimuth bearings are lubricated with Arcanol MOTION2.

Relubricating devices

Our range includes a variety of lubricators which automatically introduce fresh grease in the right quantity to the bearing positions. Relubricating devices can be individually designed in individual cases for main bearings. The FAG CONCEPT8 can be used for the automatic relubrication of pitch and azimuth bearings and the associated open gearing. The special feature is that the individual pump bodies in the CONCEPT8 can be controlled separately. It is thus possible to completely do away with additional sub-distributors which would mechanically stress the grease during pumping. Installation is easy and economical. Heatable pump elements allow use at low temperatures. The build-up of pressure up to 70 bar ensures a reliable grease supply for the bearing. The open gearing can also be protected from high wear with suitable lubrication pinions.

By the way, Schaeffler also has solutions for oil lubrication.
Talk to our experts!

X-life. Measurably better

X-life is the quality seal for especially efficient products under the INA and FAG brands.

X-life products offer a longer operating life – the result of higher dynamic load ratings than the previous standard. They thus open up completely new design options and provide a significant contribution to the improvement of the overall cost-effectiveness of the application.

The reasons for this improved performance are the most up-to-date manufacturing technology and improved internal designs. This leads to better and more uniform surfaces and contact points and thus an optimized load distribution in the bearing.

www.schaeffler.de/windpower
is your link for more information on Schaeffler's activities
in the field of wind power.
All products, applications, and services.

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Issued: 2014, February

MATNR 036794570-0000 / PWE / US-D / 20140222 / Printed in Germany by kraus