

SCHAEFFLER



State-of-the-Art Main Bearing Solutions for Wind Turbines

Schaeffler - the wind industry's development partner

Wind + Schaeffler = Wind Power

With our renowned INA and FAG brands and over 30 years of experience producing bearings for the wind industry, Schaeffler has more bearings currently operating inside wind turbines than any other manufacturer. That's unmatched know-how. Our research and development efforts with wind turbine manufacturers and wind farm operators have resulted in a continuous increase in the operational safety and operating life of Schaeffler bearings. As a result, our solutions are helping wind farm owners increase machine availability, thereby greatly impacting the wind farm's overall generating capacity.

Schaeffler offers bearing solutions for the entire wind turbine. As the wind industry's development partner, however, we do far more than just supply all of your bearing needs. We are with you every step of the way, from the inception of the product idea to volume production. In this way, we work together with you to develop the optimum solution for every bearing position, starting with the rotor shaft to the gearbox, generator, nacelle, and blade adjustment system.

Our bearing development process for the wind industry is bolstered by sophisticated simulation and calculation methods. During the product testing phase, we can avail ourselves of Schaeffler's groundbreaking ASTRAIOS test rig, one of the most modern and powerful large-size bearing test rigs in the world. It enables us to test bearings weighing up to 15 metric tons and spanning an outside diameter of 3,5 meters - while they are running under real-world conditions! A comprehensive selection of special rolling bearing greases and a wide range of services and products for maintenance and condition monitoring round out Schaeffler's portfolio of offerings to the wind industry.

For you, the wind-industry professional, this means reduced maintenance costs and increased wind turbine availability. In other words, greater productivity and profitability for wind farm operations.

Partnering with Schaeffler offers you the advantages of:

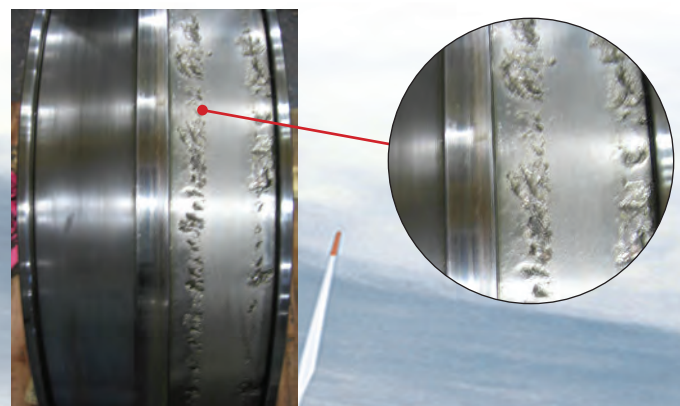
- Expert technical advice from highly experienced engineers
- Optimally matched bearing material and engineered surface technologies
- Product customization options to handle a wide range of operating conditions
- General as well as customer-specific training programs
- Our proprietary BEARINX® bearing calculation software that ensures the best-possible product selection
- Lower operating costs and improved reliability, thanks to Schaeffler's premium X-life products

X-life™ - proven to be better

X-life represents Schaeffler's seal of quality for especially efficient products offered under the INA and FAG brands. X-life bearings can deliver substantially longer operating life, the result of higher dynamic load ratings than were possible under the previous standard. Consequently, X-life products open up completely new design possibilities that, in turn, significantly improve the overall cost-effectiveness of the application in which they are employed. The enhanced performance of X-life bearings is the product of state-of-the-art manufacturing technologies and upgraded internal designs. This leads to better and more uniform surfaces and contact points which, ultimately, result in an optimized load distribution inside the bearing.

The challenge posed by the typical mainshaft support

Inside the wind turbine, the mainshaft supports the main rotor hub and transmits rotational energy in the form of torque from the rotor hub to the gearbox. This bearing position requires high reliability as well as resistance to the high loads generated by the rotor blades. Due to the high levels of thrust generated in this environment, conventional symmetric spherical roller mainshaft support bearings used in wind turbines experience uneven internal load distribution between the roller rows. This causes the rotor-side row to have lower load, while the gearbox-side row is potentially overloaded. Because of the low speed of the rotor shaft, only a minimal grease lubrication film is generated. This produces a metal-to-metal running condition. Occasional roller sliding occurs, which causes damage to the running surfaces. The end result: poor performance and premature bearing failure.



Damage to running surface due to roller sliding.

You choose the Schaeffler solution that best fits your needs

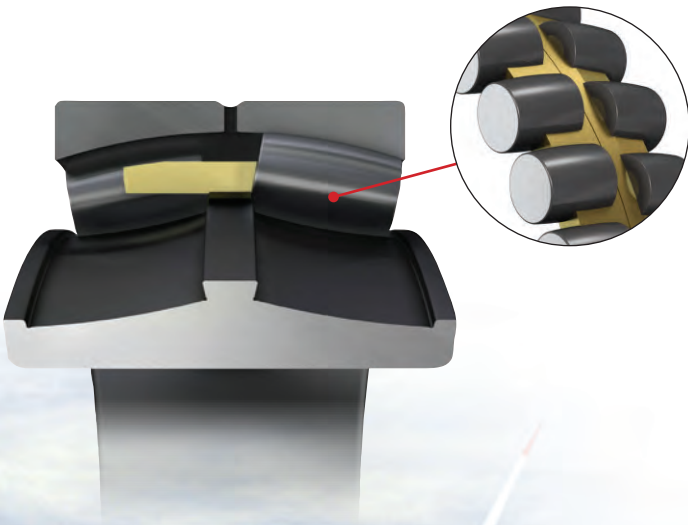
Upgraded Symmetric Spherical Roller Bearing: The superior solution for challenging applications

Looking for improved performance and longer life than standard mainshaft bearings? Schaeffler offers upgraded symmetric spherical roller mainshaft bearings that include optimized roller and raceway profiles, along with a specially designed two-piece brass cage geometry.

Upgraded symmetric features include:

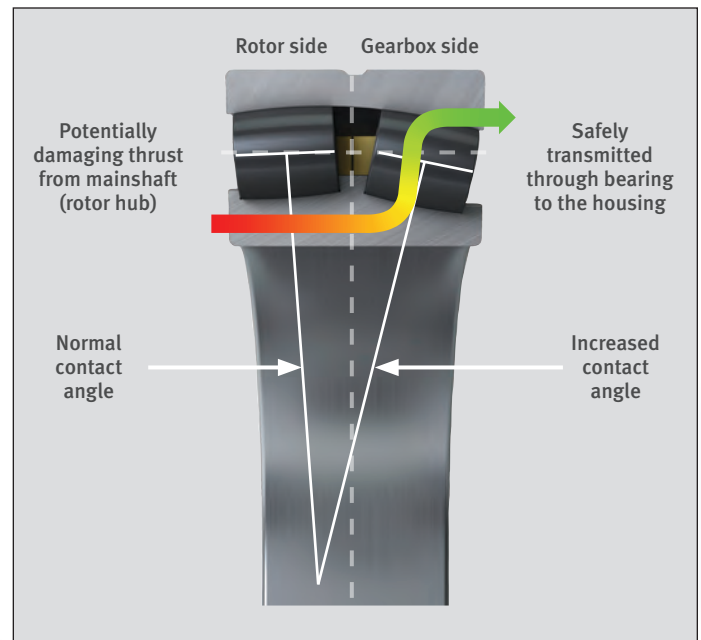
- X-life premium product quality
- Triondur® C-coated rollers that reduce friction and minimize damage from sliding
- Available lifting holes

Although some sliding may still be present when using symmetric spherical roller bearings, rollers finished with Schaeffler's proprietary Triondur C coating significantly reduce sliding friction and minimize damage from sliding. To further mitigate the potential for sliding, these advanced bearings utilize a two-piece brass cage that enables each row to operate independently.



Asymmetric Mainshaft Bearing: The ultimate solution for high-thrust applications

Schaeffler specifically designed its new, state-of-the-art Asymmetric Mainshaft Support Bearing for extreme applications where the bearing is threatened by high thrust forces. While the rotor side of the bearing is designed to carry the normal radial load present in the application, the gearbox side of the bearing is optimized with an increased contact angle to accommodate the high thrust. During operation, the potentially damaging thrust is safely transferred through the bearing and transmitted to the housing support. The bearing's ingenious asymmetric design ensures a more even internal load distribution, which provides improved rolling motion while minimizing sliding. The result: lower torque, less friction and less heat. Plus, the axial displacement of the bearing is also reduced. Bottom line: the overall efficiency of the system is improved, which allows for increased power generation of the wind turbine.



Asymmetric features include:

- X-life premium product quality
- Two-piece brass cage
- Triondur C-coated rollers designed to reduce friction and minimize damage from sliding
- Lifting holes pre-drilled into the outer ring (gearbox side)
- Lifting eye bolt included as standard equipment with bearing
- Durotect® CK thin dense chrome-coated inner ring designed to reduce or even eliminate costly fretting and galling damage to the mainshaft mounting surface

Schaeffler solutions for all major wind turbine platforms

Application Challenge	Schaeffler Solution	Mainshaft Bearing Option		Customer Benefit
		Upgraded Symmetric	Advanced Asymmetric	
Reduced bearing life	X-life premium quality	✓	✓	Longer bearing life
Sliding and smearing damage	Triondur C-coated rollers, 2-piece brass cage	✓	✓	Reduced adhesive wear damage
Poor lubrication	Triondur C-coated rollers, 2-piece brass cage	✓	✓	Longer grease life
Uneven internal load distribution	Asymmetric bearing geometry		✓	Longer bearing life
Excessive axial bearing displacement	Asymmetric bearing geometry		✓	Protects the gearbox from thrust
Absence of threaded holes in bearing for lifting & handling	Threaded lifting holes in outer ring	Optional	✓	Ease of maintenance during replacement
Fretting / galling of mainshaft bearing seat	Durotect CK-coated bearing bore		✓	Lower mainshaft repair costs
Reduced bearing efficiency (friction / heat generation)	Asymmetric bearing geometry		✓	Lower torque, less heat, less friction

Rating (MW)	Rotor Hub Diameter (m)	Single ¹ / UW ² / DW ³	Bearing Size (ISO)	Mainshaft Bearing Option	
				Upgraded Symmetric	Advanced Asymmetric
1.5	70.5	Single	230/600	230/600-E1A-XL-MB1-J48BB-R220-290	F-615587.PRL-WPOS
1.5	77, 82.5	Single	240/600	F-611526.PRL-WPOS	F-608828.PRL-WPOS
1.6	77, 82.5, 87	Single	240/710	F-616705.PRL-WPOS	F-616322.PRL-WPOS
1.65	82	Single	240/630	F-611527.PRL-WPOS	F-615588.PRL-WPOS
1.8 / 2.0	80, 90, 100	UW	230/630	F-607477.PRL-WPOS-J48BB	--
		DW	24188	F-607476.PRL-WPOS-J48BB	F-616355.PRL-WPOS
2.3	93, 103, 108	Single	230/800	F-607299.PRL-WPOS-J48BB	F-608831.PRL-WPOS

¹Single mainshaft configuration, single support bearing

²For 2 bearing mainshaft configurations, denotes the upwind (rotor-side) mainshaft bearing location

³For 2 bearing mainshaft configurations, denotes the downwind (gearbox-side) mainshaft bearing location

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