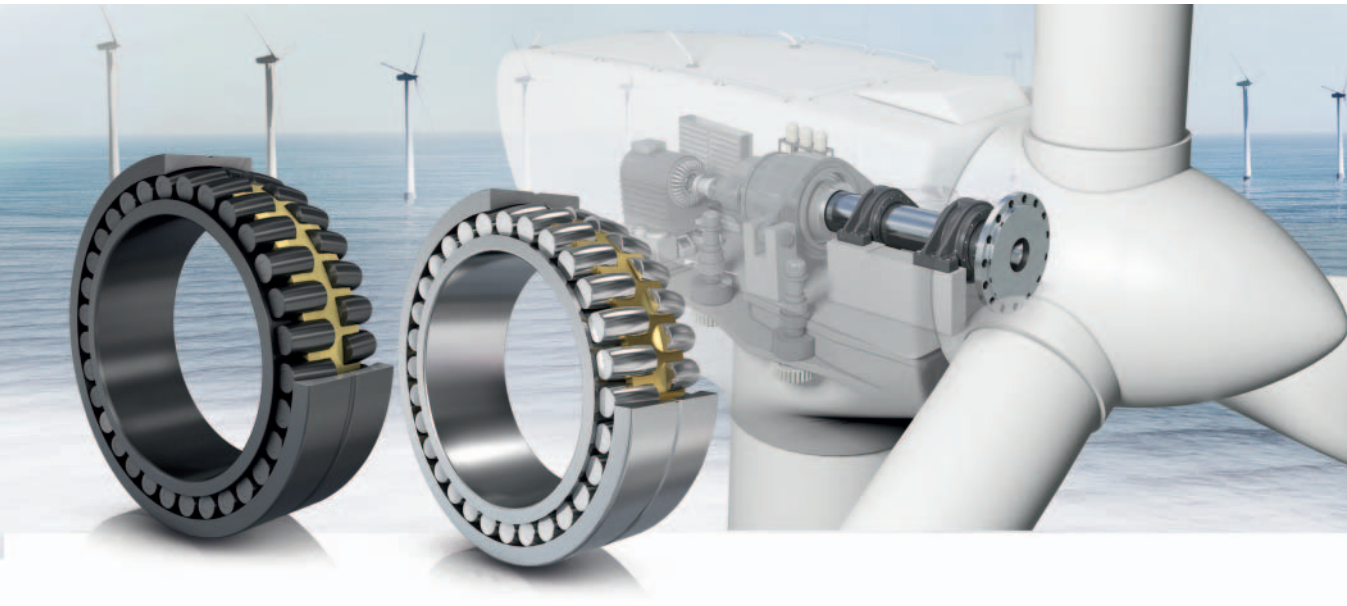
FAG



Spherical Roller Bearings

For rotor bearing arrangements in wind turbines
Locating bearings

SCHAEFFLER

Spherical roller bearings for rotor bearing arrangements in wind turbines

Features

Spherical roller bearings for rotor bearing arrangements

Where locating bearing and non-locating bearings are accommodated in separate housings it is possible that, due to mounting and manufacturing inaccuracies as well as the shaft deflection resulting from operating loads, the only bearing type that can be used is one with an angular adjustment facility. Due to the high loads acting on the rotor bearings, spherical roller bearings are the preferred bearing type here.

Since non-locating bearings are subjected to radial load only, our standard spherical roller bearings can be used in this case.

Locating bearings are subjected to particularly high axial loads as a result of the wind forces. We have therefore optimised our proven standard spherical roller bearings in relation to the specific requirements placed on locating bearings in wind turbines.

This TPI exclusively covers spherical roller bearings that are used as locating bearings for the rotor bearing arrangement in wind turbines.

X-life

X-life is the premium brand that identifies particularly high performance products under the INA and FAG brands. They are characterised by longer rating life and operating life.

This improved performance results from the use of state of the art manufacturing techniques and improved internal constructions. Products identified as the X-life premium brand have an increase in the basic dynamic load rating.

At Schaeffler, the systematic calculation of basic load ratings is compiled in the method “Method to investigate rolling bearing rating life”. This describes all calculation and test methods that are necessary in order to determine all the reference values that influence rating life. This procedure has been certified by Germanischer Lloyd (GL-CER-002-2015), *Figure 1*.

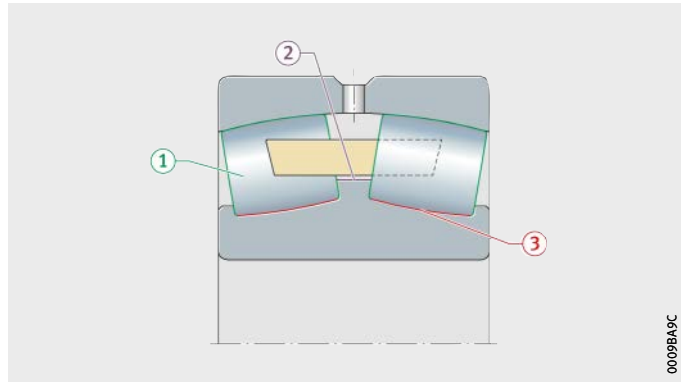
Spherical roller bearings for rotor bearing arrangements in wind turbines are predominantly available, due to their improved macrogeometry and microgeometry, in the X-life design.

Figure 1
Germanischer Lloyd – certificate

Spherical roller bearings for rotor bearing arrangements in wind turbines

Improved geometry

The objective of the changes to the internal bearing geometry is to achieve increased robustness. In both the microgeometry and macrogeometry, modifications were therefore made that reduce fatigue close to the surface. The essential characteristics of the improved geometry are shown in *Figure 2*. Further measures can be implemented for specific customers, see page 4.



① Profiled rolling elements
② Rigid central rib
③ Improved surface

Figure 2
Improved geometry

Macrogeometry

For spherical roller bearings as locating bearings for rotor bearing arrangements, the following macrogeometric optimisations have been made in comparison with catalogue bearings:

- reduced internal clearance tolerances for optimisation of the operating clearance, reduction in the pressures and the axial displacement of the drive train
- rigid central rib to increase the axial rigidity and thus reduce the axial sliding distances in the drive train, *Figure 3*
- asymmetrical contact angle (optional) for even higher axial load carrying capacity and thus reduced friction in the drive train.

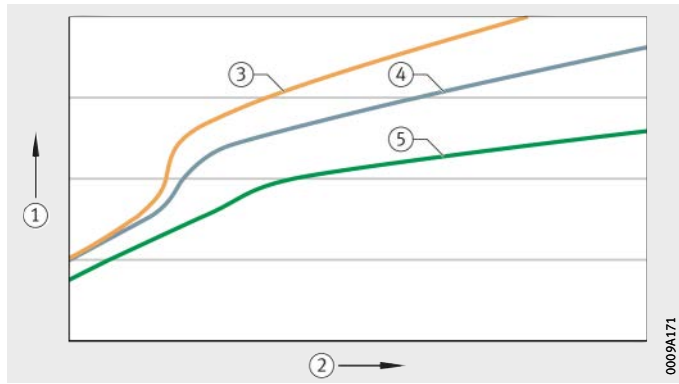
Microgeometry

For spherical roller bearings as locating bearings for rotor bearing arrangements, the following microgeometric optimisations have been made in comparison with catalogue bearings:

- improved surface quality for uniform pressure distribution and reduced bearing friction
- closer osculations to reduce the contact pressures p
- profiled rolling elements to reduce the wear parameter $p \cdot v$[1)], *Figure 4*.

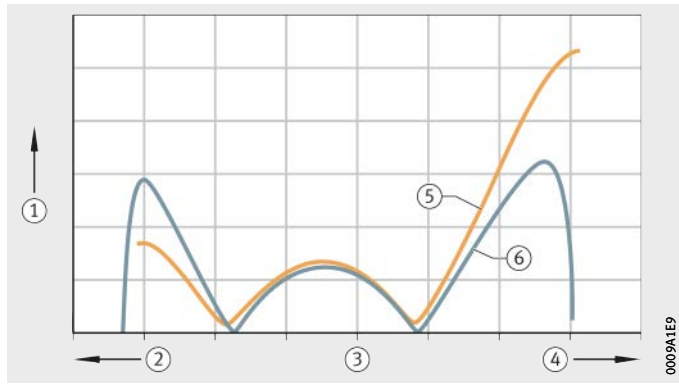
Comparison of the internal constructions

The influence of the contact angle and the central rib as well as the effects of profiled rolling elements are shown in *Figure 3* and *Figure 4*.



① Axial displacement
② Axial force (constant radial load)
③ Symmetrical with loose central rib
④ Symmetrical with fixed central rib
⑤ Asymmetrical with fixed central rib

Figure 3
Axial displacement from bearing centre



① Wear parameter p · v
② Outer roller end
③ Roller centre
④ Inner roller end
⑤ Unprofiled roller and loose central rib
⑥ Profiled roller and fixed central rib

Figure 4
Wear parameter p · v along roller axis under high axial load

1) The wear parameter p · v is the product of the contact pressure p and the normal slippage velocity v for spherical roller bearings. This product is formed along the contact between the ring and roller from the inner to the outer roller end.

Spherical roller bearings for rotor bearing arrangements in wind turbines

Customer-specific bearings

Spherical roller bearings can be additionally provided with the following features:

- coatings (Durotect B, Durotect CK, Triondur C)
- design in accordance with the Schaeffler Wind Power Standard
- bore diameter with specific modifications.

Durotect B

Durotect B is the black oxide coating developed by Schaeffler. It offers the following advantages:

- better running-in behaviour
- increased protection against White Etching Cracks (WEC).

Durotect CK

Durotect CK is a columnar hard chromium coating. It offers the advantage of high wear resistance (high hardness), particularly for fit surfaces, where fretting corrosion is to be expected.

Triondur C

Triondur C is a carbon-based coating system developed by Schaeffler. This coating system reduces the friction and wear occurring under mixed friction.

Schaeffler Wind Power Standard

The Schaeffler Wind Power Standard is the highest quality standard for all products and processes that are of significance in the field of wind power at Schaeffler. It ensures the highest quality and reliability worldwide.

Modified bore diameter

For reconditioning activities, the inner ring can be matched to the shaft:

- reduction in bore diameter by 1 mm or 2 mm
- no change to operating clearance.

This gives the following advantages:

- cost savings due to reuse of the rotor shaft in overhaul
- no requirement for material deposit on the shaft, thus deleting an additional work step.

Sealing

Spherical roller bearings for rotor bearing arrangements in wind turbines are supplied as standard without seals. Sealed spherical roller bearings are available by agreement.

Lubrication

Spherical roller bearings for rotor bearing arrangements in wind turbines are predominantly lubricated using grease. Schaeffler recommends the use of greases of viscosity class ISO VG 320 or higher, especially Arcanol LOAD400 or Arcanol LOAD460, *Figure 5*.

Further information on lubrication can be found in TPI 176, Lubrication of Rolling Bearings.

Figure 5
Arcanol greases

Cages

Spherical roller bearings for rotor bearing arrangements in wind turbines have single-piece solid brass cages as standard.
Two-piece solid brass cages are available by agreement.

Suffixes

Suffixes for common designs, see table.

Common designs

Suffix	Description
CN/2L	Half the internal clearance of internal clearance group CN (Group N), lower half
C2/2H	Half the internal clearance of internal clearance group C2 (Group 2), upper half
J24BA	Inner ring bore with Durotect CK coating
J30PC	Rings and rolling elements with black oxide coating (Durotect B)
J30PE	Rolling elements with black oxide coating (Durotect B)
J30PG	Inner ring and rolling elements with black oxide coating (Durotect B)
J48BB	Rolling elements with Triondur C coating
H123C	Nominal bore diameter reduced by 1 mm
H123E	Nominal bore diameter reduced by 2 mm

Spherical roller bearings for rotor bearing arrangements in wind turbines

Design and safety guidelines

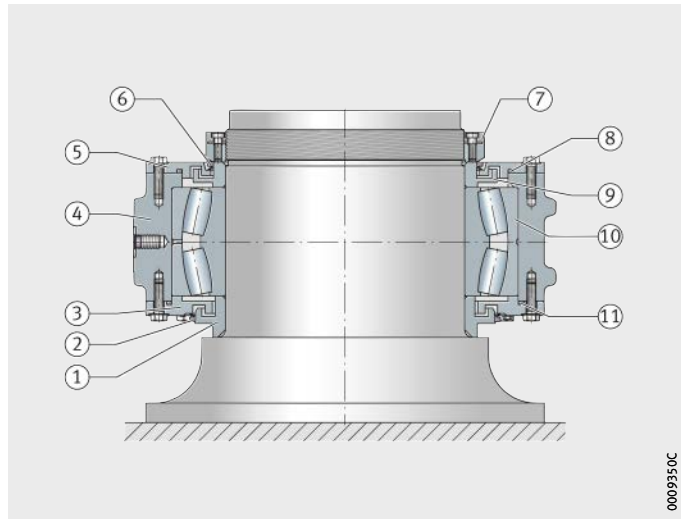
Design and safety guidelines are given in Catalogue HR 1, Rolling Bearings.

Mounting of spherical roller bearings

The mounting of a spherical roller bearing as described here relates to the most frequently used sealing system, *Figure 6*.
In the case of other sealing systems, it may be necessary to adjust the mounting sequence. The temperatures indicated for heating of the components are valid for commonly used fits.

Figure 6 shows the completely mounted bearing unit with all individual components.

This TPI is not a substitute for a comprehensive mounting manual. For actual mounting, the complete mounting manual containing safety guidelines and further information must be used.
Please request the mounting manual from Schaeffler.



① Labyrinth ring for rotor side
② V ring for rotor side
③ Housing cover for rotor side
④ Housing
⑤ Housing cover for gearbox side
⑥ V ring for gearbox side
⑦ Shaft nut
⑧ O ring for gearbox side
⑨ Labyrinth ring for gearbox side
⑩ Bearing
⑪ O ring for rotor side

Figure 6
Mounted spherical roller bearing

Mounting sequence

▶ Move the main shaft to a vertical position (rotor side down), *Figure 7*.

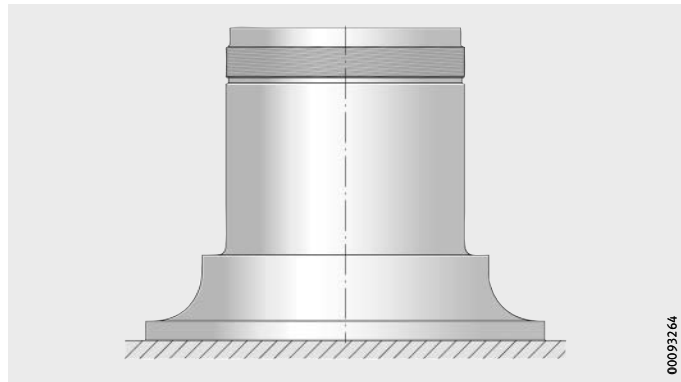
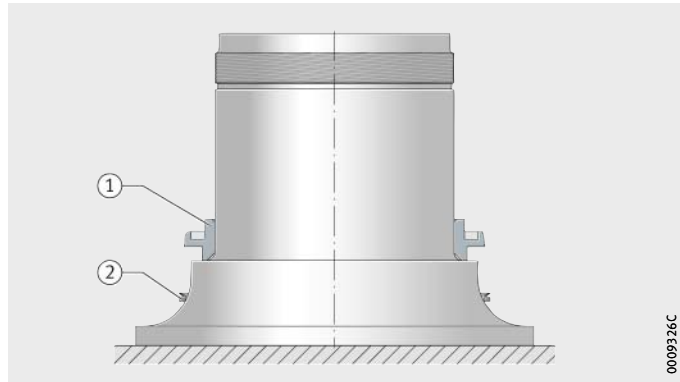


Figure 7
Main shaft in mounting position

- Place the V ring for the rotor side on the shaft, *Figure 8*.
- Heat the labyrinth ring for the rotor side to approx. +50 °C.
- Slide the heated labyrinth ring for the rotor side as far as possible onto the shaft end (rotor side). Observe the correct direction for mounting (labyrinth nose towards the gearbox), *Figure 8*.
- Check the contact of the ring on the flange, *Figure 8*, ①.



① Labyrinth ring for rotor side
② Deposited V ring for rotor side

Figure 8
Mounting of the labyrinth ring for the rotor side

- Allow the labyrinth ring for the rotor side to cool.
- Grease the O ring for the rotor side and insert in the slot on the housing cover for the rotor side, *Figure 9*.
- Fill the inner profile of the housing cover for the rotor side completely with rotor bearing grease.
- Slide the housing cover for the rotor side (with the inserted O ring) onto the shaft and place on the labyrinth ring, *Figure 9*.

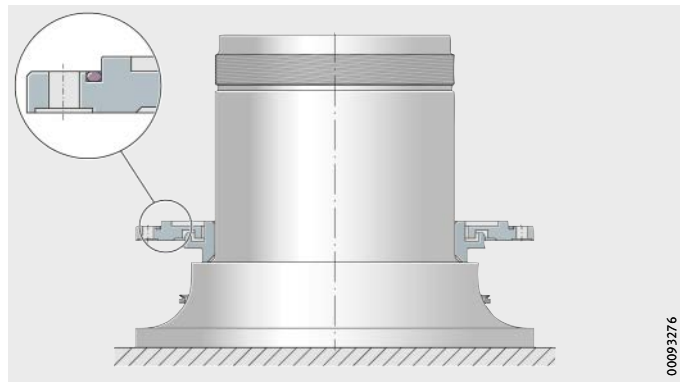


Figure 9
Preliminary positioning of the housing cover for the rotor side with the O ring

- Clean and degrease the inner ring bore of the bearing using a suitable cleaning agent.
- Heat the spherical roller bearing in steps (step size +20 °C) to approx. +100 °C to +110 °C.

Note! During heating, ensure that the components are of uniform temperature, in order to prevent distortion of the rolling elements (by applying several temperature sensors). The difference in temperature between the components should not exceed +25 °C.

- Slide the heated spherical roller bearing onto the shaft using a suitable lifting device until it reaches the labyrinth ring, *Figure 10*. While it is being moved into place, the inner ring must remain aligned precisely parallel to the shaft, in order to prevent tilting of the inner ring relative to the shaft. If there is a risk of jamming, remove the bearing immediately and heat it again.
- Press the spherical roller bearing (inner ring) against the labyrinth ring until it has cooled.
- Check the contact of the bearing on the labyrinth ring.

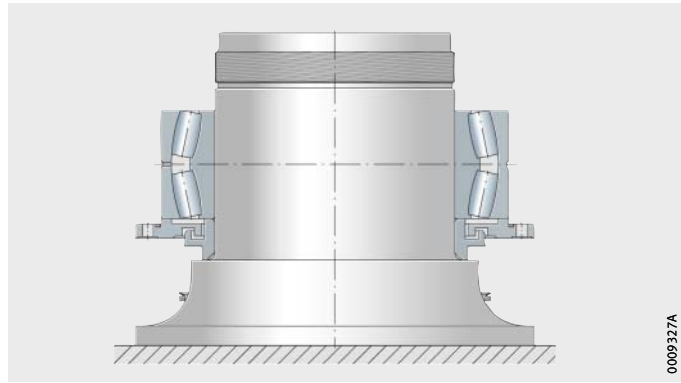


Figure 10
Mounting of the bearing

- Heat the bearing housing to at least +60 °C to +80 °C.
- Slide the heated bearing housing over the cooled spherical roller bearing with coaxial alignment to the shaft, *Figure 11*. Avoid any damage to the housing cover and labyrinth ring.

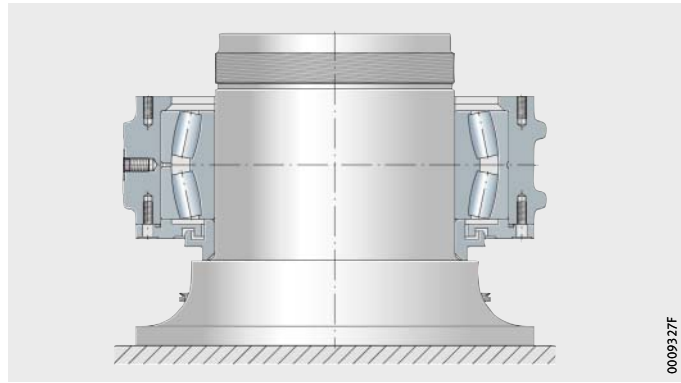


Figure 11
Mounting of the housing

- Fill the bearing spaces completely with rotor bearing grease so that all the rolling elements are coated with grease. For greasing of the bearing, please observe the document “Lubrication advice” and the lubricant quantity calculation method available from Schaeffler.
- Heat the labyrinth ring for the gearbox side to approx. +50 °C.
- Slide the heated labyrinth ring for the gearbox side onto the shaft as far as the bearing inner ring. Observe the correct direction for mounting (labyrinth nose towards the gearbox), *Figure 12*.

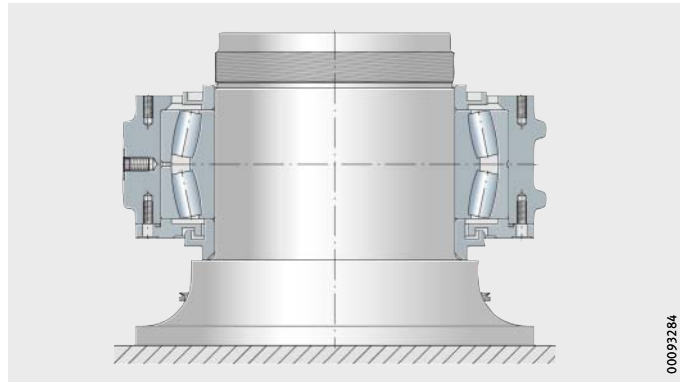


Figure 12
Mounting of the labyrinth ring for the gearbox side

- Allow the labyrinth ring for the gearbox side to cool.
- Grease the O ring for the gearbox side and insert in the slot on the housing cover for the gearbox side, *Figure 13*.
- Fill the inner profile of the housing cover for the gearbox side completely with rotor bearing grease.
- Slide the housing cover for the gearbox side (with the inserted O ring) onto the shaft, *Figure 13*.
- Screw mount the housing covers for the rotor side and gearbox side to the rotor bearing housing.

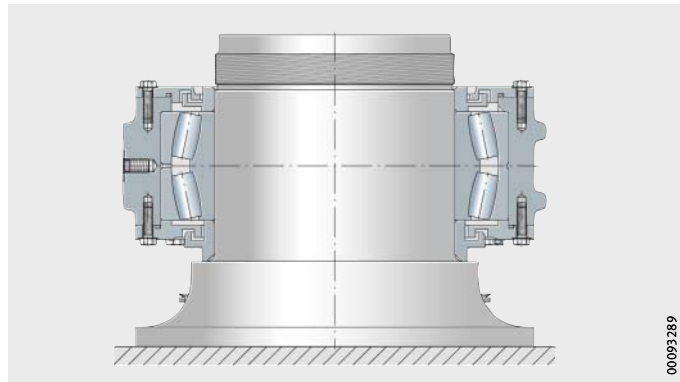


Figure 13
Mounting of the housing covers

- Apply the grease with the aid of a brush or a grease pump to the contact surfaces of the V rings and the housing covers.
- Align the V rings correctly to the labyrinth rings (seal lip towards the housing), *Figure 14*.

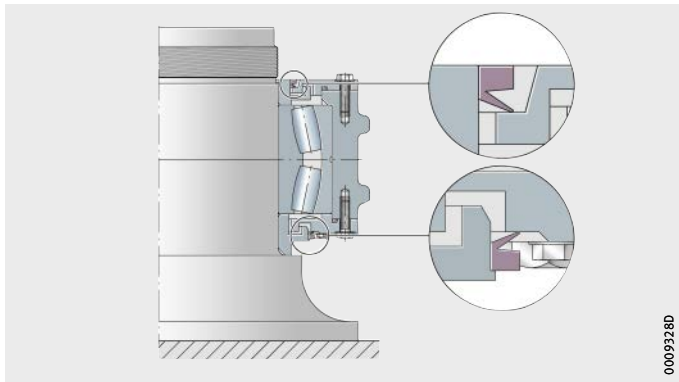


Figure 14
Positioning of the V rings

- Mount the shaft nut in accordance with the manufacturer's mounting manual and secure against loosening, *Figure 15*.

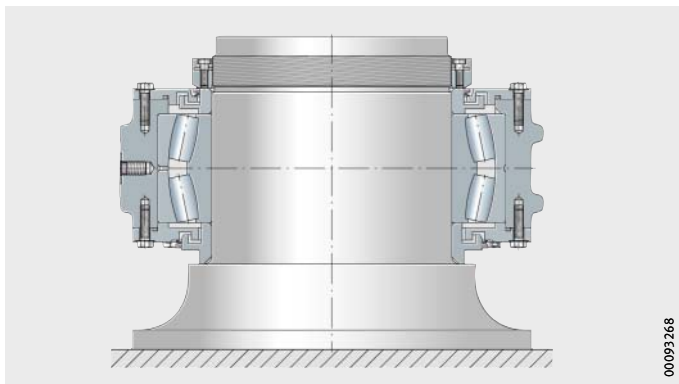


Figure 15
Mounting of the shaft nut

- Grease the bearing under slow rotational motion until grease escapes at the two labyrinth seals.

Note!

Once mounting has been completed, we recommend that any paintwork damage should be repaired and all screws and support washers should additionally be coated with housing colour, in order to ensure optimum protection against rust. Paintwork damage should also be repaired after torsion testing and maintenance work.

Further information

Further information is given in our
Catalogue IS 1, Mounting and Maintenance of Rolling Bearings and TPI 200, FAG Heating Devices for Mounting of Rolling Bearings.

Accuracy

Radial internal clearance

The radial internal bearing clearance corresponds as standard to half the radial internal clearance in internal clearance group CN (Group N) to DIN 620-4 (ISO 5753), where the lower half of the internal clearance is used.

Optionally, the bearings can be supplied with half the radial internal bearing clearance in internal clearance group C2 (Group 2) to DIN 620-4 (ISO 5753), where the upper half of the internal clearance is used.

Radial internal clearance CN/2L and C2/2H

Bore d mm		Radial internal clearance			
		CN/2L (Group N/2L) µm		C2/2H (Group 2/2L) µm	
over	incl.	min.	max.	min.	max.
400	450	240	305	190	240
450	500	260	335	200	260
500	560	280	360	215	280
560	630	310	395	240	310
630	710	350	440	270	350
710	800	390	485	300	390
800	900	430	540	330	430
900	1 000	480	595	370	480
1 000	1 120	530	650	410	530
1 120	1 250	580	710	450	580
1 250	1 400	630	770	490	630
1 400	1 600	700	860	540	700
1 600	1 800	780	960	600	780
1 800	2 000	860	1 060	660	860
2 000	2 250	950	1 175	725	950
2 250	2 500	1 050	1 300	800	1 050

Spherical roller bearings for rotor bearing arrangements in wind turbines

Ordering examples

New design

The bearing arrangement of a rotor is to be designed using two spherical roller bearings. For new designs, spherical roller bearings 240 should be used in preference as locating bearings. The design of the turbine results in a shaft diameter of 630 mm. Accordingly, the preferred bearing is a spherical roller bearing 240/630 with the designation F-623424.PRL, see dimension table. Due to the mounting situation and the fits derived as a result, the internal clearance is defined as CN/2L. For improved operating behaviour, the rolling elements are to have a black oxide coating.

Bearing type	Spherical roller bearing
Series	240
Shaft diameter	630 mm
Rolling elements with black oxide coating	J30PE
Internal clearance	CN/2L

Ordering designation **F-623424.PRL-J30PE-CN/2L**

Bearing replacement

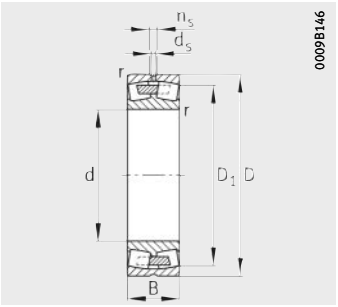
In a turbine, a spherical roller bearing 230/800 (locating bearing) is to be replaced. The basis bearing is accordingly F-607299.PRL, see dimension table. This is to be optimised in relation to internal clearance (CN/2L). The bearing is to be designed in accordance with the Schaeffler Wind Power Standard. The rolling elements of the bearing are to be coated with Triondur C. Finally, the shaft is to be specifically ground down by 2 mm and the bearing bore made correspondingly smaller.

Bearing type	Spherical roller bearing
Series	230
Original shaft diameter	800 mm
Schaeffler Wind Power Standard	WPOS
Shaft diameter reduced by 2 mm	H123E
Rolling elements with Triondur C coating	J48BB
Internal clearance	CN/2L

Ordering designation **F-607299.PRL-WPOS-H123E-J48BB-CN/2L**

Spherical roller bearings

for rotor bearing arrangements in wind turbines



Dimensions

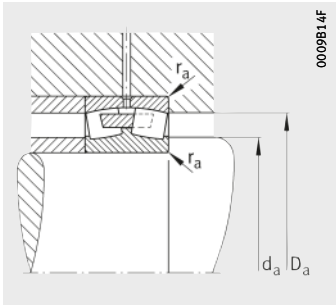
X-life

Dimension table · Dimensions in mm

Designation			Mass	Dimensions						
Standard	Schaeffler designation	X-life	m ≈ kg	d	D	B	r min.	D_1	d_s	n_s
24188	**F-623389.PRL**	**XL**	446,2	**440**	720	280	6	614,3	12,5	23,5
230/500	**F-623400.PRL**	**XL**	229,8	**500**	720	167	6	657,1	12,5	23,5
240/500	**F-623420.PRL**	**XL**	293,7	**500**	720	218	6	647,3	12,5	23,5
241/500	**F-623440.PRL**	**XL**	701,9	**500**	830	325	7,5	705,2	12,5	23,5
230/530	**F-623401.PRL**	**XL**	311	**530**	780	185	6	708,2	12,5	23,5
240/530	**F-623421.PRL**	**XL**	409,7	**530**	780	250	6	694,2	12,5	23,5
241/530	**F-623441.PRL**	**XL**	789,5	**530**	870	335	7,5	742,9	12,5	23,5
230/560	**F-623402.PRL**	**XL**	360,7	**560**	820	195	6	745	12,5	23,5
240/560	**F-623422.PRL**	**XL**	465,6	**560**	820	258	6	732,1	12,5	23,5
230/600	**F-623403.PRL**	**XL**	409,8	**600**	870	200	6	793,3	12,5	23,5
240/600	**F-623423.PRL**	**XL**	544,5	**600**	870	272	6	778,4	12,5	23,5
230/630	**F-623404.PRL**	**XL**	489,6	**630**	920	212	7,5	837,8	12,5	23,5
240/630	**F-623424.PRL**	**XL**	655,2	**630**	920	290	7,5	821,5	12,5	23,5
230/710	**F-623405.PRL**	**XL**	679,4	**710**	1 030	236	7,5	939,1	12,5	23,5
240/710	**F-623425.PRL**	**XL**	889	**710**	1 030	315	7,5	922	12,5	23,5
230/750	**F-623406.PRL**	**XL**	803,8	**750**	1 090	250	7,5	993,4	12,5	23,5
240/750	**F-623426.PRL**	**XL**	1 064,1	**750**	1 090	335	7,5	974,8	12,5	23,5
230/800	**F-607299.PRL**	**XL**	907,8	**800**	1 150	258	7,5	1 051,3	12,5	23,5
240/800	**F-623427.PRL**	**XL**	1 198,1	**800**	1 150	345	7,5	1 033	12,5	23,5
230/850	**F-623408.PRL**	**XL**	1 079,3	**850**	1 220	272	7,5	1 115,9	12,5	23,5
240/850	**F-623428.PRL**	**XL**	1 421,1	**850**	1 220	365	7,5	1 096,4	12,5	23,5
230/900	**F-623409.PRL**	**XL**	1 195	**900**	1 280	280	7,5	1 173,7	12,5	23,5
240/900	**F-623429.PRL**	**XL**	1 583,7	**900**	1 280	375	7,5	1 154,4	12,5	23,5
240/950	**F-623430.PRL**	**XL**	1 983,4	**950**	1 360	412	7,5	1 220,8	12,5	23,5
240/1120	**F-623433.PRL**	**XL**	2 921,4	**1 120**	1 580	462	9,5	1 426,8	12,5	23,5
240/1180	**F-623434.PRL**	**XL**	3 297,2	**1 180**	1 660	475	9,5	1 503	12,5	23,5

The spherical roller bearings listed here are intended as locating bearings;
see standard range for non-locating bearings.

For new designs, spherical roller bearings of series 240 should be used in preference.



Mounting dimensions

Mounting dimensions			Basic load ratings		Calculation factors				Fatigue limit load	Limiting speed	Reference speed
d_a	D_a	r_a	dyn. C	stat. C_0	e	Y_1	Y_2	Y_0	C_{ur}	n_G	n_B
			N	N					N	min^{-1}	min^{-1}
466	694	5	7 600	12 900	0,38	1,78	2,65	1,74	1 130	710	260
523	697	5	4 700	8 700	0,21	3,24	4,82	3,16	820	890	510
523	697	5	5 700	11 100	0,27	2,51	3,74	2,45	1 060	750	370
532	798	6	10 000	17 300	0,38	1,78	2,65	1,74	1 450	600	209
553	757	5	5 600	10 100	0,22	3,1	4,62	3,03	950	820	475
553	757	5	7 000	13 500	0,29	2,33	3,47	2,28	1 240	670	335
562	838	6	10 700	19 100	0,37	1,83	2,72	1,79	1 570	560	190
583	797	5	6 100	11 200	0,22	3,1	4,62	3,03	1 030	760	440
583	797	5	7 500	14 600	0,28	2,39	3,56	2,34	1 330	630	315
623	847	5	6 600	12 300	0,21	3,24	4,82	3,16	1 120	710	405
623	847	5	8 300	16 600	0,28	2,41	3,59	2,35	1 480	580	285
658	892	6	7 400	13 700	0,21	3,24	4,82	3,16	1 230	670	380
658	892	6	9 400	18 600	0,28	2,39	3,56	2,34	1 630	550	265
738	1 002	6	9 000	17 300	0,21	3,24	4,82	3,16	1 500	580	320
738	1 002	6	11 000	22 500	0,28	2,43	3,61	2,37	1 940	485	225
778	1 062	6	10 100	19 300	0,21	3,24	4,82	3,16	1 650	550	300
778	1 062	6	12 300	25 500	0,28	2,41	3,59	2,35	2 140	450	207
828	1 122	6	10 900	21 200	0,2	3,31	4,92	3,23	1 790	520	275
828	1 122	6	13 300	28 000	0,27	2,49	3,71	2,43	2 330	420	189
878	1 192	6	11 900	24 000	0,2	3,34	4,98	3,27	1 980	475	255
878	1 192	6	14 800	31 500	0,27	2,51	3,74	2,45	2 600	390	173
928	1 252	6	12 800	25 500	0,2	3,42	5,09	3,34	2 050	455	239
928	1 252	6	15 900	34 500	0,26	2,57	3,83	2,52	2 800	370	160
978	1 332	6	18 400	40 000	0,27	2,47	3,67	2,41	3 150	340	147
1 154	1 546	8	23 500	53 000	0,26	2,57	3,83	2,52	4 000	285	116
1 214	1 626	8	25 500	57 000	0,26	2,64	3,93	2,58	4 300	270	108

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