Toroidal Roller Bearings

C..-M, C..-M1B, C..-K-M, C..-K-M1B, C..-K30-M1B

Technical Product Information

Foreword

Schaeffler is a leading worldwide supplier of rolling bearings, spherical plain bearings, plain bearings, linear products, accessories specific to bearings and comprehensive maintenance products and services. Schaeffler has in excess of 40000 catalogue products manufactured as standard, providing an extremely wide portfolio that gives secure coverage of applications from all 60 designated industrial market sectors.

The central factors responsible for this success include outstanding strength in innovation, a global focus on local customer proximity, highly developed manufacturing methods, extremely high quality standards in all processes and the ability to transform specific customer requirements quickly and accurately into cost-effective solutions. For these reasons, and thanks to its extensive catalogue range, Schaeffler is a high-performance and customer-focused partner.

Longer rating life and operating life, enhanced performance

The toroidal roller bearing (TORB) is a proven type of rolling bearing developed by Schaeffler. A toroidal roller bearing is a single row rolling bearing with long, slightly crowned rollers. When used as a non-locating bearing, the toroidal roller bearing combines the self-alignment function of a spherical roller bearing with the axial displacement facility of a cylindrical roller bearing.
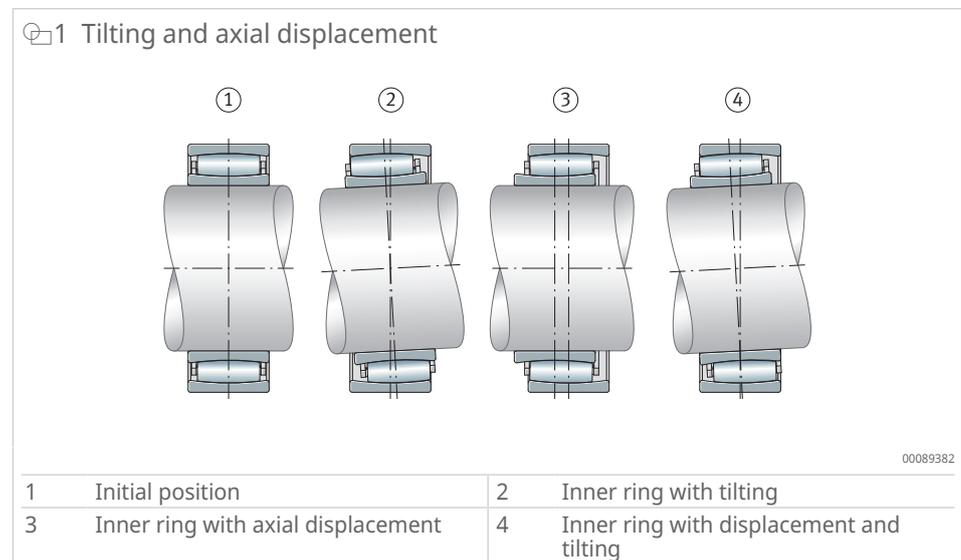
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1 Bearing design

The single row bearings have long, crowned rollers. The concave raceways in the inner ring and outer ring are concentric relative to the centre of the bearing. The raceway profiles are matched to each other and ensure optimum distribution of stresses in the bearing as well as low operating friction. The rollers are self-guiding. They will always automatically adopt the position at which the load is distributed over the length of the roller. This is also the case if the rings are displaced or skewed relative to each other.

The toroidal roller bearing combines the angular adjustment facility of a spherical roller bearing with the unconstrained axial displacement facility of a cylindrical roller bearing. It offers a very high radial load carrying capacity within a small installation space. Toroidal roller bearings offer an ideal and operationally reliable solution to the problem of achieving a locating/non-locating bearing. Since axial displacement is compensated within the toroidal roller bearing, the constraining forces occurring are very slight and can be disregarded.

1 Tilting and axial displacement

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1	Initial position	2	Inner ring with tilting
3	Inner ring with axial displacement	4	Inner ring with displacement and tilting

1.1 X-life

X-life is the premium brand that identifies particularly high-performance products from Schaeffler. These products are characterised by a long rating life and operating life due to the use of cutting-edge manufacturing techniques. These manufacturing techniques lead to better and more uniform surfaces and contact areas and thus optimised load distribution in the bearing.

X-life products offer the following expanded design possibilities:

• With the same load and design envelope, the rating life of X-life bearings is increased, allowing for longer maintenance intervals.

• Conversely, an X-life bearing in the same design envelope and with the same rating life can support higher loads.

• Where the rating life and load remain unchanged, X-life bearings allow higher performance density, facilitating optimisation of the design envelope and reductions in mass.

The expanded design possibilities offered by an X-life bearing make a significant contribution to improving the overall cost-effectiveness of an application in terms of the total cost of ownership (TCO).

⊕2 Key features of X-life

X-life

Indicator of increased rating life and operating life

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Increase in basic dynamic load rating C

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Optimised surfaces and functionally optimum internal construction
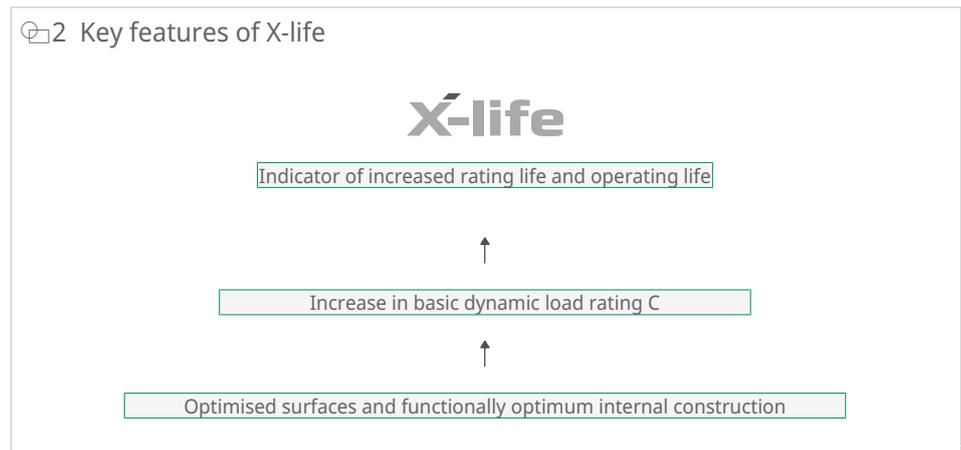
1.2 Ideal non-locating bearing concept

Where a shaft is liable to temperature-induced elongation and misalignment, the non-locating bearing is a particularly important concept. In this case, toroidal roller bearings have proved ideal as non-locating bearings.

Compared to conventional non-locating bearing arrangements, they offer the following advantages:

- substantial axial length changes of the shaft are compensated without constraint between the raceways and the rolling elements within the bearing
- even more considerable axial displacements have no effect on the locating bearing
- there is no axial distortion of the bearing system

⊕3 Locating/non-locating bearing arrangement, angular adjustment facility and axial displacement facility
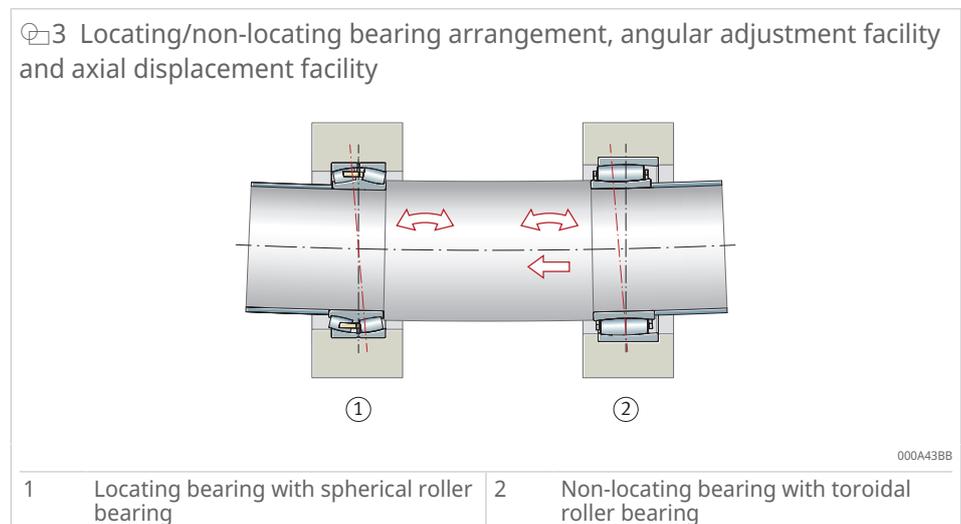
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| 1 | Locating bearing with spherical roller bearing | 2 | Non-locating bearing with toroidal roller bearing |

A primary area of application for toroidal roller bearings is in paper machines.

The following requirements are placed on the bearings in these applications:

- constraint-free non-locating bearing function
- high load carrying capacity
- high operational reliability
- long operating life
- low maintenance requirement
- low operating costs
- compact construction
- high performance capability

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1.3 Product range

The product range of toroidal roller bearings comprises 8 series.

🖻4 Cross-section of available series

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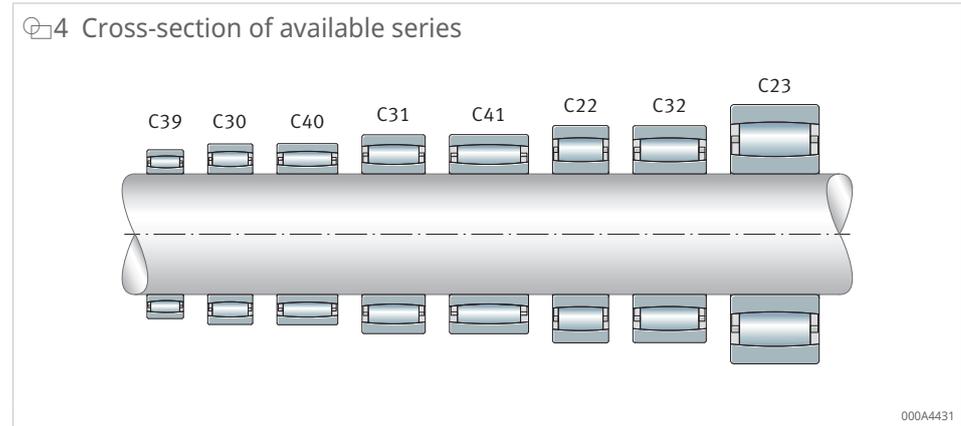
1.4 Axial displacement facility

These bearings can accommodate axial offset and thus compensate thermal expansion or deviations from the required bearing position. The part-specific displacement distance s_1 refers to the maximum possible displacement on both sides, relative to the central position. The displacement distance s_1 applies only to non-tilted bearing rings and is depended on the operating clearance. Axial displacement and tilting alter the position of the rolling elements in the bearing, which in turn changes the operating clearance.

In the following cases, it is necessary to check during the design phase whether the bearing maintains the required operating clearance:

- axial displacement
- tilting
- axial displacement and tilting

To ensure axial displacement distance, the free space on both sides of the bearing must be maintained.

To ensure proper bearing function, the following 2 cases must be checked during the design phase.

- The axial displacement combined with tilting remains within the permitted displacement distance s_1.
- The application allows for operating clearance, which is reduced by axial displacement and tilting to a residual bearing clearance.

For bearings with an cage M1B, please note: The range for maximum axial displacement begins at 90 % of s_1. The load ratio must not exceed $C_0/P \leq 5$. If values exceed this range, please contact Schaeffler's technical advisory experts.

The resulting bearing clearance can be calculated using the following formula:

𝆑1

$$s_{res} = s_{ini} - \Delta s$$

𝆑2

$$\Delta s = k_\delta \cdot \left(\delta_{ax} + s_\varphi \right)^2$$

f 3

$$s_\varphi = k_\varphi \cdot \varphi$$

f 4

$$s_{res} = s_{ini} - k_\delta \cdot \left(\delta_{ax} + k_\varphi \cdot \varphi\right)^2$$

s_{res}	μm	Resulting bearing clearance after tilting and axial displacement
s_{ini}	μm	Radial internal clearance after mounting
Δs	μm	Reduction in radial bearing clearance
k_δ	–	Operating clearance factor
s_φ	mm	Reduction in axial displacement facility as a result of tilting
k_φ	–	Tilting factor
φ	°	Tilting between inner ring and outer ring (misalignment ± shaft deflection)
δ_{ax}	mm	Axial displacement from central position

⚠ Other influences, such as differences in temperature between the inner ring and outer ring, must also be taken into consideration.

1.4.1 Geometrical restriction of the axial displacement facility

Tilting causes axial displacement of the rollers from the central position. This means that the axial displacement facility of the bearing rings relative to each other is reduced by s_φ.
This reduction in the axial displacement facility due to tilting can be calculated as follows:

f 5

$$s_\varphi = k_\varphi \cdot \varphi$$

s_φ	mm	Reduction in axial displacement facility as a result of tilting
k_φ	–	Tilting factor
φ	°	Tilting between inner ring and outer ring (misalignment ± shaft deflection)

When tilting occurs at the same time, the maximum possible axial displacement facility is calculated as follows:

f 6

$$s_{red} = s_1 - s_\varphi$$

s_{red}	mm	Maximum axial displacement facility under tilting
s_1	mm	Maximum axial displacement facility
s_φ	mm	Reduction in axial displacement facility as a result of tilting

1.4.2 Restriction due to reduction in radial bearing clearance

The bearing clearance is reduced in the following cases:
- axial displacement
- tilting of the bearing from the central position
- axial displacement and tilting of the bearing from the central position

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Depending on the necessary operating clearance, it must be checked whether the required axial displacement is possible under the tilting present.

The reduction in operating clearance is calculated as follows:

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$$\Delta s = k_\delta \cdot \left(\delta_{ax} + k_\varphi \cdot \varphi \right)^2$$

Δs	μm	Reduction in radial bearing clearance
k_δ	–	Operating clearance factor
δ_{ax}	mm	Axial displacement from central position
k_φ	–	Tilting factor
φ	°	Tilting between inner ring and outer ring (misalignment ± shaft deflection)

1.4.3 Example: toroidal roller bearing C3144-XL-K-M-C4

The radial clearance of toroidal roller bearing C3144-XL-K-M-C4 with tapered bore is 410 μm upon delivery. The operating clearance in the central position is only 240 μm due to mounting.

Dryer roll application

In the dryer roll, the misalignment is 0,2° and, in addition, there is thermal expansion of the shaft by 6,3 mm. Is this displacement permissible in addition to the tilting? What is the change in the operating clearance?

⊞1 Initial data

Tilting factor	k_φ = 13,67
Angular misalignment	φ = 0,2°
Displacement facility	s_1 = 22,3 mm

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$$s_\varphi = k_\varphi \cdot \varphi$$

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*ƒ*9

$$s_\varphi = 13,67 \cdot 0,2 \approx 2,73 \text{ mm}$$

s_φ	mm	Reduction in axial displacement facility as a result of tilting
k_φ	–	Tilting factor
φ	°	Tilting between inner ring and outer ring (misalignment ± shaft deflection)

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$$s_{red} = s_1 - s_\varphi$$

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*ƒ*11

$$s_{red} = 22,30 \text{ mm} - 2,73 \text{ mm} = 19,57 \text{ mm}$$

s_{red}	mm	Maximum axial displacement facility under tilting
s_1	mm	Maximum axial displacement facility
s_φ	mm	Reduction in axial displacement facility as a result of tilting
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The axial displacement of 6,3 mm lies within the permissible range of 19,57 mm in combination with tilting of 0,2°. In addition, the application must be checked with regard to the reduction in operating clearance.

⊞2 Initial data

Tilting factor	$k_\delta = 0{,}791$
Axial displacement from central position	$\delta_{ax} = 6{,}30$ mm

∫12

$$s_{res} = s_{ini} - k_\delta \cdot \left(\delta_{ax} + k_\varphi \cdot \varphi\right)^2$$

∫13

$$s_{res} = 240 \ \mu m - 0{,}791 \cdot \left(6{,}3 + 2{,}73\right)^2 \ \mu m \approx 175 \ \mu m$$

s_{res}	μm	Resulting bearing clearance after tilting and axial displacement
s_{ini}	μm	Radial internal clearance after mounting
k_δ	–	Operating clearance factor
δ_{ax}	mm	Axial displacement from central position
k_φ	–	Tilting factor
φ	°	Tilting between inner ring and outer ring (misalignment ± shaft deflection)

The resulting bearing clearance after tilting and axial displacement is 175 μm.

⚠ In principle, the influence of temperature differences between the inner ring and outer ring must also be taken into consideration.

⊕5 Resulting operating clearance of bearing C3144-XL-K-M-C4

φ	
0°	
0,1°	
0,2°	
0,3°	
0,4°	
0,5°	
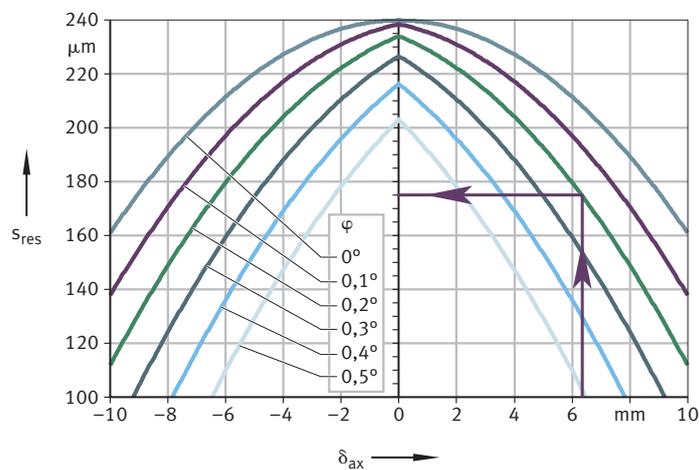
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s_{res}	Operating clearance	δ_{ax}	Axial displacement
φ	Tilting		

1.5 Interchangeability

As standard, toroidal roller bearings use the same ISO dimension series and have the same sizes as other bearing types, such as spherical roller bearings. This standardisation enables full interchangeability with other bearing types.

1.6 Bearing housings

Through the combination of a toroidal roller bearing and FAG bearing housing, it is possible to create non-locating bearing arrangement units that are interchangeable and operationally reliable. As a result, cost-effective and maintenance-friendly designs can be achieved.

⌾ 6 Bearing housing with toroidal roller bearing

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2 Compensation of angular misalignments

The bearings can accommodate angular misalignments of up to $\varphi = 0,5°$ between the central axes of the inner ring and outer ring without negatively impacting function and rating life. A slight geometric deviation of the housing bore or a shaft that is not precisely aligned can therefore be compensated by the bearing without issue.

Depending on the bearing series and size, angular misalignments of $\varphi > 0,5°$ may be possible, but may be associated with a reduction in the rating life. For applications involving greater angular misalignments, Schaeffler offers support to ensure optimal design of the bearing arrangement.

Please direct any questions to your contact at Schaeffler.

3 Lubrication

Open designs can be lubricated with either oil or grease. The lubricant should be introduced from one side and discharged on the opposite side.

4 Speeds

The thermal speed rating given in the bearing tables can be exceeded up to the limiting speed, depending on the operating conditions. The thermally safe operating speed should be used to take account of special operating conditions.

Further information

HR 1 | Rolling Bearings |
https://www.schaeffler.de/std/1D3D ↗

5 Temperature range

The bearings are dimensionally stable up to +200 °C. Bearings with metal cages can be used at operating temperatures ranging from –30 °C to +200 °C.

6 Cages

Depending on the series and bearing size, the following cage designs are available for the bearings as standard:

- roller-guided sheet steel cage, single-piece, no suffix
- roller-guided brass window cage, suffix M
- brass window cage, guided on inner ring, suffix M1B

7 Internal clearance

Axial displacements of the bearing rings relative to each other reduce the internal clearance. This reduction can be calculated.

7.1 Radial internal clearance for bearings with cylindrical bore

The values for radial internal clearance correspond to DIN 620-4:2004 (ISO 5753-1:2009). The values are valid for bearings which are free from load and measurement forces, i.e. without elastic deformation.

⊞3 Radial internal clearance

d		C2 (Group 2)		CN (Group N)		C3 (Group 3)		C4 (Group 4)		C5 (Group 5)	
mm		µm		µm		µm		µm		µm	
>	≤	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
18	24	15	30	25	40	35	55	50	65	65	85
24	30	15	35	30	50	45	60	60	80	75	95
30	40	20	40	35	55	55	75	70	95	90	120
40	50	25	45	45	65	65	85	85	110	105	140
50	65	30	55	50	80	75	105	100	140	135	175
65	80	40	70	65	100	95	125	120	165	160	210
80	100	50	85	80	120	120	160	155	210	205	260
100	120	60	100	100	145	140	190	185	245	240	310
120	140	75	120	115	170	165	215	215	280	280	350
140	160	85	140	135	195	195	250	250	325	320	400
160	180	95	155	150	220	215	280	280	365	360	450
180	200	105	175	170	240	235	310	305	395	390	495
200	225	115	190	185	265	260	340	335	435	430	545
225	250	125	205	200	285	280	370	365	480	475	605
250	280	135	225	220	310	305	410	405	520	515	655
280	315	150	240	235	330	330	435	430	570	570	715
315	355	160	260	255	360	360	485	480	620	620	790
355	400	175	280	280	395	395	530	525	675	675	850
400	450	190	310	305	435	435	580	575	745	745	930
450	500	205	335	335	475	475	635	630	815	810	1015
500	560	220	360	360	520	510	690	680	890	890	1110
560	630	240	400	390	570	560	760	750	980	970	1220
630	710	260	440	430	620	610	840	830	1080	1070	1340
710	800	300	500	490	680	680	920	920	1200	1200	1480
800	900	320	540	530	760	750	1020	1010	1330	1320	1660
900	1000	370	600	590	830	830	1120	1120	1460	1460	1830
1000	1120	410	660	660	930	930	1260	1260	1640	1640	2040
1120	1250	450	720	720	1020	1020	1380	1380	1800	1800	2240
1250	1400	490	800	800	1130	1130	1510	1510	1970	1970	2460
1400	1600	570	890	890	1250	1250	1680	1680	2200	2200	2740
1600	1800	650	1010	1010	1390	1390	1870	1870	2430	2430	3000

d	mm	Nominal bore diameter

7.2 Radial internal clearance for bearings with tapered bore

The values for radial internal clearance correspond to DIN 620-4:2004 (ISO 5753-1:2009). The values are valid for bearings which are free from load and measurement forces, i.e. without elastic deformation.

▦4 Radial internal clearance

d		C2 (Group 2)		CN (Group N)		C3 (Group 3)		C4 (Group 4)		C5 (Group 5)	
mm		µm		µm		µm		µm		µm	
>	≤	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
18	24	15	35	30	45	40	55	55	70	65	85
24	30	20	40	35	55	50	65	65	85	80	100
30	40	25	50	45	65	60	80	80	100	100	125
40	50	30	55	50	75	70	95	90	120	115	145
50	65	40	65	60	90	85	115	110	150	145	185
65	80	50	80	75	110	105	140	135	180	175	220
80	100	60	100	95	135	130	175	170	220	215	275
100	120	75	115	115	155	155	205	200	255	255	325
120	140	90	135	135	180	180	235	230	295	290	365
140	160	100	155	155	215	210	270	265	340	335	415
160	180	115	175	170	240	235	305	300	385	380	470
180	200	130	195	190	260	260	330	325	420	415	520
200	225	140	215	210	290	285	365	360	460	460	575
225	250	160	235	235	315	315	405	400	515	510	635
250	280	170	260	255	345	340	445	440	560	555	695
280	315	195	285	280	380	375	485	480	620	615	765
315	355	220	320	315	420	415	545	540	680	675	850
355	400	250	350	350	475	470	600	595	755	755	920
400	450	280	385	380	525	525	655	650	835	835	1005
450	500	305	435	435	575	575	735	730	915	910	1115
500	560	330	480	470	640	630	810	800	1010	1000	1230
560	630	380	530	530	710	700	890	880	1110	1110	1350
630	710	420	590	590	780	770	990	980	1230	1230	1490
710	800	480	680	670	860	860	1100	1100	1380	1380	1660
800	900	520	740	730	960	950	1220	1210	1530	1520	1860
900	1000	580	820	810	1040	1040	1340	1340	1670	1670	2050
1000	1120	640	900	890	1170	1160	1500	1490	1880	1870	2280
1120	1250	700	980	970	1280	1270	1640	1630	2060	2050	2500
1250	1400	770	1080	1080	1410	1410	1790	1780	2250	2250	2740
1400	1600	870	1200	1200	1550	1550	1990	1990	2500	2500	3050
1600	1800	950	1320	1320	1690	1690	2180	2180	2730	2730	3310

d	mm	Nominal bore diameter

8 Dimensions, tolerances

The main dimensions of the bearings listed in the product tables match the data in DIN 616 or ISO 15.

8.1 Tolerances

Bearings with a cylindrical bore and tapered bore have normal tolerances in accordance with DIN 620-2 or ISO 492.

The running accuracy of the inner ring and outer ring corresponds to tolerance class 5.

9 Suffixes

▦5 Available designs

Suffix	Description
XL	X-life quality
K	Tapered bore, taper ratio 1:12
K30	Tapered bore, taper ratio 1:30
C2	Radial internal clearance group 2 (C2), smaller than CN
C3	Radial internal clearance group 3 (C3), larger than CN
C4	Radial internal clearance group 4 (C4), larger than C3
C5	Radial internal clearance group 5 (C5), larger than C4
M	Brass window cage, guided by rollers
M1B	Brass window cage, guided on inner ring
W209B	Inner ring made from case hardening steel

10 Dimensioning

10.1 Dynamic and static equivalent bearing load

The bearings are designed to support radial loads only. Therefore, the following applies:
$P = P_0 = F_r$.

Permissible dynamic bearing load

In principle, the permissible dynamic bearing load is determined by $P \leq 0{,}33 \cdot C_r$.

For bearings up to a bore diameter d = 200 mm, the dynamic load is determined by $P \leq 0{,}18 \cdot C_{0r}$.

For applications involving higher dynamic loads, the rating life must be calculated in greater detail. In such cases, please contact Schaeffler's technical advisory experts.

11 Minimum load

To ensure slippage-free operation, the bearings must be subjected to a minimum radial load $F_{r\,min}$. This is particularly important for high-speed bearings, as the absence of sufficient radial load can lead to damaging sliding movements between the rolling elements and raceways.

The requisite minimum radial load $F_{r\,min}$ is defined as follows:

✒14		
$$F_{r\,min} = 0{,}0135 \cdot C_0$$		
$F_{r\,min}$	kN	Minimum radial load
C_0	kN	Basic static load rating

If oil lubrication is used, the requisite minimum load is reduced as a function of the bearing type and speed. To calculate the minimum load, the ancillary value k_r must first be calculated as follows:

✒15		
$$k_r = k_\delta \cdot d_M$$		
k_r	mm	Ancillary value
k_δ	–	Operating clearance factor
d_M	mm	Mean bearing diameter (d + D)/2

With the aid of this ancillary value and the ratio $n/n_{\vartheta r}$, the requisite minimum load can be read off relative to the basic static load rating C_0.

⊕7 Minimum load with oil lubrication

$F_{r\,min}$	Minimum radial load		C_0	Basic static load rating
n	Speed		$n_{\vartheta r}$	Thermal speed rating
k_r	Ancillary value			
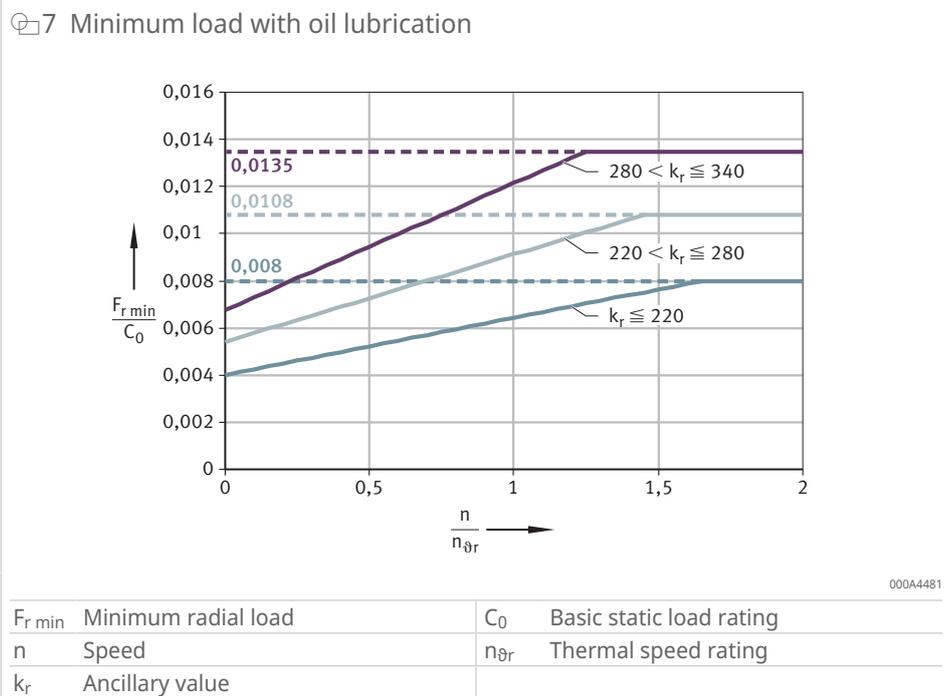
Alternatively, the requisite minimum load can also be calculated.

Depending on the value of k_r, the factors for calculating the minimum load should be selected as follows.

⊞6 Factors for calculation of minimum load

Ancillary value		Factor due to influence of load	Speed parameter
k_r		f_F	n_K
>	≤		
–	220	0,0080	1,65
220	280	0,0108	1,45
280	340	0,0135	1,25

This method is only valid for $k_r ≤ 340$. For cases where $k_r > 340$, use the formula for the requisite minimum radial load $F_{r\,min}$.

The factor for determining the influence of speed relative to the thermal speed rating $n_{\vartheta r}$ when using oil lubrication is defined as follows:

⌐16 factor f_n, if $n < n_K \cdot n_{\vartheta r}$

$$f_n = 0,5 \cdot \left(1 + \frac{n}{n_{\vartheta r} \cdot n_K} \right)$$

⌐17 factor f_n, if $n ≥ n_K \cdot n_{\vartheta r}$

$$f_n = 1$$

n	min^{-1}	Speed
n_K	–	Speed parameter
$n_{\vartheta r}$	min^{-1}	Thermal speed rating

⌐18

$$F_{r\,min} = f_F \cdot f_n \cdot C_0$$

$F_{r\,min}$	kN	Minimum radial load
C_0	kN	Basic static load rating
f_F	–	Factor due to influence of load
f_n	–	Factor due to influence of speed

Higher minimum loads may be necessary under certain conditions when starting up at low temperature, when using greases with a high base oil viscosity and where bearings have been regreased.

11.1 Example 1: Determining the minimum radial load using the diagram

Determine the minimum radial load at an operating speed of 260 min^{-1} using the diagram.

𝟏19

$$k_r = k_\delta \cdot d_M$$

𝟏20

$$k_\delta = 0{,}791$$

𝟏21

$$d_M = \frac{220 \text{ mm} + 370 \text{ mm}}{2} = 295 \text{ mm}$$

𝟏22

$$k_r = 0{,}791 \cdot 295 \text{ mm} = 233{,}345 \text{ mm} \approx 233 \text{ mm}$$

𝟏23

$$\frac{n}{n_{\vartheta r}} = \frac{260 \text{ min}^{-1}}{960 \text{ min}^{-1}} = 0{,}27$$

Since k_r = 233 mm, the corresponding graph in the diagram is selected.
$n/n_{\vartheta r}$ = 0,27 for $F_{r\,min}/C_0$ = 0,0064.

⊞8 Minimum load with oil lubrication
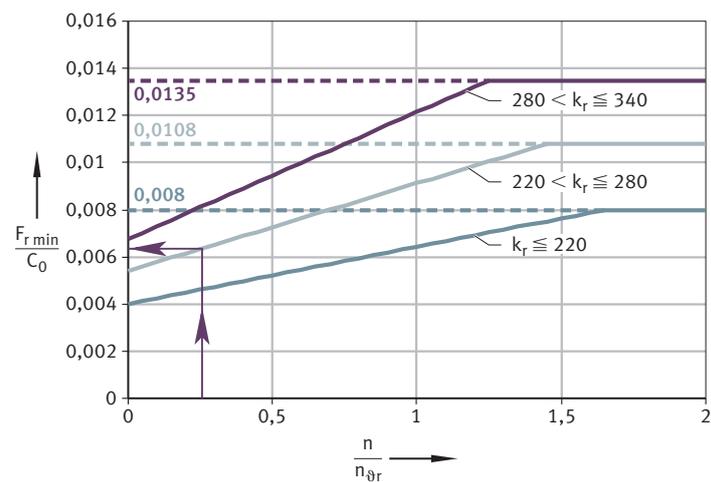
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$F_{r\,min}$	Minimum radial load	C_0	Basic static load rating
n	Speed	$n_{\vartheta r}$	Thermal speed rating
k_r	Ancillary value		

𝟏24

$$F_{r\,min} = 0{,}0064 \cdot 2900 \text{ kN} = 18{,}6 \text{ kN}$$

11.2 Example 2: Calculating the minimum radial load

Determine the minimum radial load at an operating speed of 260 min^{-1} and with oil lubrication using the table ▶24 | ⊞6.

With $k_r \approx 233$ mm from Example 1, the following values are read off:

- $n_K = 1{,}45$
- $f_F = 0{,}0108$

From $n_{\vartheta r} \cdot n_K = 960 \cdot 1{,}45 = 1392 > 260$, it follows that:

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$$f_n = 0{,}5 \cdot \left(1 + \frac{n}{n_{\vartheta r} \cdot n_K} \right)$$

〰26

$$f_n = 0{,}5 \cdot \left(1 + \frac{260 \text{ min}^{-1}}{960 \text{ min}^{-1} \cdot 1{,}45} \right) = 0{,}593$$

〰27

$$F_{r\ min} = f_F \cdot f_n \cdot C_0$$

〰28

$$F_{r\ min} = 0{,}0108 \cdot 0{,}593 \cdot 2900 \text{ kN} \approx 18{,}6 \text{ kN}$$

12 Design of the bearing arrangement

When designing the bearing arrangement, the following functions must be checked:

- axial location of the bearings
- fits
- accuracy of the mating parts
- free space

12.1 Axial location of bearings

The outer ring and inner ring must be axially secured on both sides on the shaft and in the housing. Schaeffler recommends mounting the bearing rings such that one side rests against a shoulder on the shaft or in the housing.

The other side of the inner ring can be axially secured using the following components:

- shaft nut
- retaining ring
- screw mounted end washer on the end of the shaft

The outer rings are generally axially secured and retained in the housing bore by the end cover.

9 Retention by means of retaining nut

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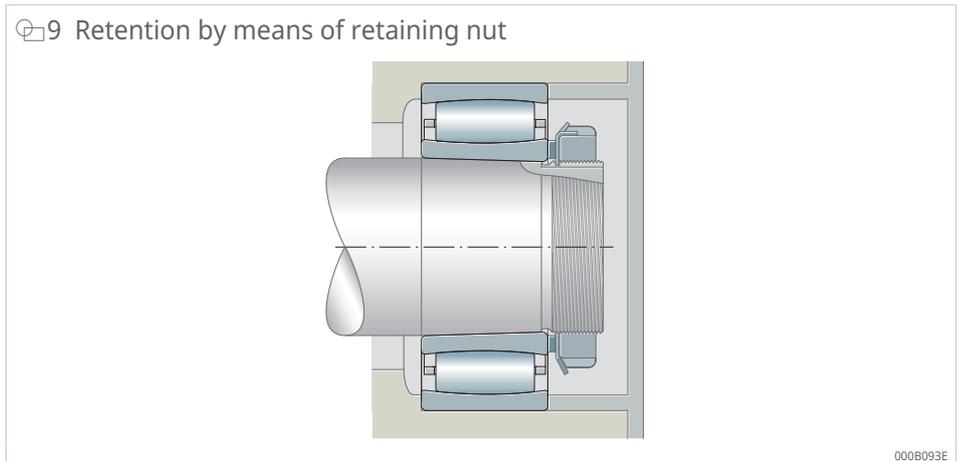
12.2 Fits

Further information is available on the relevant shaft and housing fits.

Further information

HR 1 | Rolling Bearings |
https://www.schaeffler.de/std/1D3D⧉

12.3 Accuracy of the adjacent construction

The accuracy of the cylindrical bearing seats on shafts and in housings should match the accuracy of the bearings used. Further information is available on the relevant tolerances. Alternatively, special application-specific recommendations apply.

Further information

HR 1 | Rolling Bearings |
https://www.schaeffler.de/std/1D3D↗

12.4 Free space

The bearings can compensate for thermally induced length changes of the shaft relative to the housing. To ensure proper function of the bearing, free space must be provided at both end faces of the bearings.

⨍ 29		
$$C_{a\,req} = C_a + 0{,}5 \cdot \left(\delta_{ax} + s_\varphi \right)$$		
$C_{a\,req}$	mm	Requisite value for the depth of the free space
C_a	mm	Minimum value for depth of free space in the case of bearing rings without offset
δ_{ax}	mm	Axial displacement from central position
s_φ	mm	Reduction in axial displacement facility as a result of tilting

🗗 10 Free space in the housing
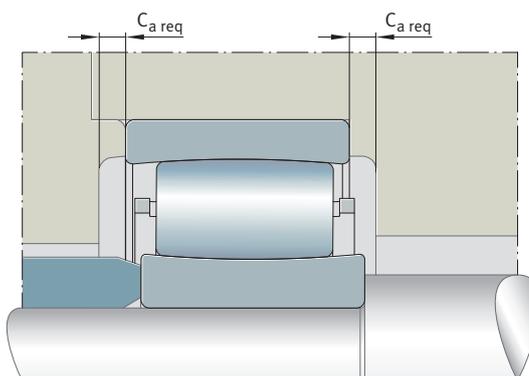
In standard mounting, the bearing rings are fitted concentrically in relation to each other. If significant changes in length occur in one direction in the application due to heat, the inner ring can be fitted with an offset. This is achieved by shifting the inner ring in the opposite direction to the outer ring, up to the maximum permissible axial displacement. This measure significantly increases the potential axial displacement.

Toroidal roller bearings can be axially secured using KML or KM shaft nuts and MBL-T or MB-T tab washers. For bearings with a bore diameter greater than 200 mm, Schaeffler recommends HM30 locknuts with MS30 retaining brackets.

⚠ When axially securing the bearings with retaining nuts, it must be ensured that the cage of the bearing does not graze the retaining nut or tab washer if the shaft undergoes axial displacement. The outside diameter of the retaining nut must always be smaller than the mounting dimension $d_{a\,max}$ given in the product table.

If the required free space is not compatible with the retaining elements, an intermediate ring can be arranged between the bearing and the retaining element, and the thread on the shaft can be extended by the width of the intermediate ring.

13 Mounting and dismounting

Bearings with a cylindrical bore and smaller bearings with a tapered bore should be mounted and dismounted in accordance with the guidance provided in the relevant additional information under the section Mounting and dismounting. For mounting and dismounting larger bearings on tapered journals or sleeves, Schaeffler recommends the hydraulic method.

Further information

HR 1 | Rolling Bearings |
https://www.schaeffler.de/std/1D3D⧉

MH 1 | Mounting Handbook |
https://www.schaeffler.de/std/1D53⧉

Toroidal roller bearings on adapter sleeve or withdrawal sleeve

Bearings with a tapered bore can be mounted on smooth or stepped shafts using adapter sleeves or withdrawal sleeves. In the case of greater axial displacements, it must be ensured that displacement always occurs in the direction of the sleeve nut. Schaeffler offers adapter sleeves that have been adapted specifically for toroidal roller bearings in order to fulfil the particular requirements of this design. For toroidal bearings, use adapter sleeves with the suffix T, e.g. H24026-T. Further information is available describing the mounting of rolling bearings on adapter and withdrawal sleeves.

⊡11 Toroidal roller bearing on adapter sleeve

000A866E
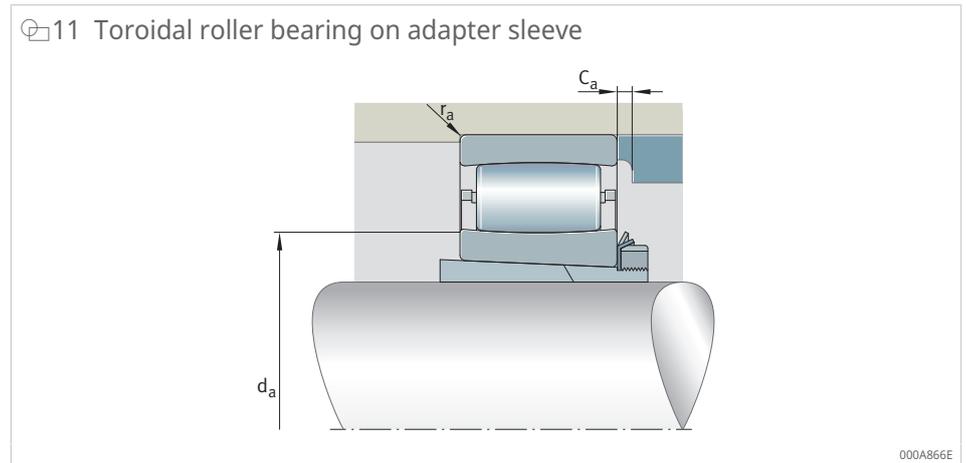
Reduced radial internal clearance in mounting

When bearings with a tapered bore are mounted, there is a reduction in the radial internal clearance. The specified values guarantee a secure seat on the shaft.

⊞7 Reduction in radial internal clearance of bearings with tapered bore

d		Radial internal clearance before mounting						Reduction in radial internal clearance	
		CN (Group N)		C3 (Group 3)		C4 (Group 4)			
>	≤	min.	max.	min.	max.	min.	max.	min.	max.
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
24	30	0,035	0,055	0,050	0,065	0,065	0,085	0,010	0,017
30	40	0,045	0,065	0,060	0,080	0,080	0,100	0,014	0,021
40	50	0,050	0,075	0,070	0,095	0,090	0,120	0,018	0,028
50	65	0,060	0,090	0,085	0,115	0,110	0,150	0,024	0,035

d		Radial internal clearance before mounting						Reduction in radial internal clearance	
		CN (Group N)		C3 (Group 3)		C4 (Group 4)			
>	≤	min.	max.	min.	max.	min.	max.	min.	max.
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
65	80	0,075	0,110	0,105	0,140	0,135	0,180	0,030	0,046
80	100	0,095	0,135	0,130	0,175	0,170	0,220	0,040	0,056
100	120	0,115	0,155	0,155	0,205	0,200	0,255	0,049	0,069
120	140	0,135	0,180	0,180	0,235	0,230	0,295	0,060	0,083
140	160	0,155	0,215	0,210	0,270	0,265	0,340	0,072	0,095
160	180	0,170	0,240	0,235	0,305	0,300	0,385	0,081	0,107
180	200	0,190	0,260	0,260	0,330	0,325	0,420	0,090	0,121
200	225	0,210	0,290	0,285	0,365	0,360	0,460	0,101	0,134
225	250	0,235	0,315	0,315	0,405	0,400	0,515	0,113	0,151
250	280	0,255	0,345	0,340	0,445	0,440	0,560	0,126	0,168
280	315	0,280	0,380	0,375	0,485	0,480	0,620	0,142	0,188
315	355	0,315	0,420	0,415	0,545	0,540	0,680	0,160	0,211
355	400	0,350	0,475	0,470	0,600	0,595	0,755	0,180	0,238
400	450	0,380	0,525	0,525	0,655	0,650	0,835	0,203	0,268
450	500	0,435	0,575	0,575	0,735	0,730	0,915	0,225	0,300
500	560	0,470	0,640	0,630	0,810	0,800	1,010	0,250	0,335
560	630	0,530	0,710	0,700	0,890	0,880	1,110	0,285	0,375
630	710	0,590	0,780	0,770	0,990	0,980	1,230	0,320	0,420
710	800	0,670	0,860	0,860	1,100	1,100	1,380	0,360	0,475
800	900	0,730	0,960	0,950	1,220	1,210	1,530	0,405	0,535
900	1000	0,810	1,040	1,040	1,340	1,340	1,670	0,450	0,605
1000	1120	0,890	1,170	1,160	1,500	1,490	1,880	0,505	0,670
1120	1250	0,970	1,280	1,270	1,640	1,630	2,060	0,565	0,750
1250	1400	1,080	1,410	1,410	1,790	1,780	2,250	0,630	0,840
1400	1600	1,200	1,550	1,550	1,990	1,990	2,500	0,720	0,940
1600	1800	1,320	1,690	1,690	2,180	2,180	2,730	0,810	1,070

d   mm   Nominal bore diameter

⊞8 Axial drive-up distance of the inner ring on the shaft

d		Drive-up distance				Control value for radial internal clearance after mounting		
		Taper 1:12		Taper 1:30		CN (Group N)	C3 (Group 3)	C4 (Group 4)
>	≤	min.	max.	min.	max.	min.	min.	min.
mm	mm	mm	mm	mm	mm	mm	mm	mm
24	30	0,24	0,29	0,61	0,72	0,025	0,035	0,048
30	40	0,30	0,34	0,76	0,84	0,031	0,041	0,059
40	50	0,37	0,42	0,91	1,04	0,033	0,046	0,062
50	65	0,46	0,50	1,14	1,24	0,036	0,054	0,075
65	80	0,55	0,61	1,37	1,53	0,045	0,065	0,090
80	100	0,67	0,73	1,68	1,83	0,056	0,080	0,114
100	120	0,79	0,89	1,98	2,23	0,066	0,093	0,131
120	140	0,91	1,05	2,29	2,62	0,075	0,105	0,147
140	160	1,04	1,21	2,59	3,02	0,083	0,123	0,170
160	180	1,16	1,36	2,90	3,41	0,089	0,137	0,193
180	200	1,28	1,52	3,20	3,81	0,100	0,150	0,204
200	225	1,43	1,68	3,58	4,20	0,109	0,162	0,226
225	250	1,59	1,88	3,96	4,69	0,123	0,177	0,249
250	280	1,77	2,08	4,42	5,19	0,129	0,186	0,273
280	315	1,98	2,31	4,95	5,78	0,138	0,203	0,292
315	355	2,23	2,59	5,56	6,47	0,155	0,221	0,329
355	400	2,50	2,90	6,25	7,26	0,170	0,251	0,357

d		Drive-up distance				Control value for radial internal clearance after mounting		
		Taper 1:12		Taper 1:30		CN (Group N)	C3 (Group 3)	C4 (Group 4)
>	≤	min.	max.	min.	max.	min.	min.	min.
mm	mm	mm	mm	mm	mm	mm	mm	mm
400	450	2,81	3,26	7,01	8,15	0,178	0,279	0,382
450	500	3,11	3,66	7,78	9,14	0,210	0,300	0,430
500	560	3,48	4,05	8,69	10,13	0,220	0,325	0,465
560	630	3,90	4,52	9,76	11,31	0,245	0,355	0,505
630	710	4,39	5,08	10,98	12,69	0,270	0,380	0,560
710	800	4,94	5,71	12,35	14,27	0,310	0,425	0,625
800	900	5,55	6,42	13,88	16,05	0,325	0,460	0,675
900	1000	6,16	7,21	15,40	18,03	0,360	0,490	0,735
1000	1120	6,89	8,00	17,23	20,00	0,385	0,545	0,820
1120	1250	7,69	8,95	19,21	22,37	0,410	0,580	0,880
1250	1400	8,60	9,98	21,50	24,94	0,450	0,640	0,940
1400	1600	9,82	11,16	24,55	27,90	0,480	0,685	1,050
1600	1800	11,04	12,74	27,60	31,85	0,510	0,705	1,110

d   mm   Nominal bore diameter

13

14 Further information

14.1 Products for mounting, maintenance and monitoring

To fully utilise the high performance capability of the bearings, it is important to observe the handling instructions for mounting, dismounting, lubrication, and sealing.

Further information from Schaeffler provides detailed descriptions of the methods required for mounting and dismounting the bearings. In cases where a production stoppage can incur high costs, monitoring of rolling bearings is both advisable and cost-effective. An overview of suitable tools, measuring equipment and diagnostic devices is available in medias.

12 Mounting a toroidal roller bearing

000B0248

Further information

MH 1 | Mounting Handbook |
https://www.schaeffler.de/std/1D53

medias | Product catalogue |
medias.schaeffler.com

14.2 Application example: Paper industry

In the dryer section of a paper machine, steam-heated rolls guide the still-moist paper web through the final drying process. The bearings in these dryer rolls run under high ambient temperatures in housings with recirculating oil lubrication.

13 Dryer roll in a paper machine

000894E4

Requirements

Ensure that the bearing arrangement meets the following requirements:

- constraint-free compensation in the non-locating bearing of substantial changes in the axial length of the roll
- compensation of possible angular misalignments in the locating bearing and non-locating bearing
- resistance to substantial differences in temperature
- very high operational reliability of the bearing arrangement ($L_{hmn} > 100000$ h)

Design solution

A spherical roller bearing is used as the locating bearing on the drive side. A toroidal roller bearing is used as the non-locating bearing. Both bearings are suitable for supporting potential angular misalignments. Due to the robust design and load carrying capacity of these bearings, the required calculated rating life is easily achieved. The bearing sizes are in some cases determined by the hollow journals of the rolls. Both bearing types are fitted with metal cages, which meet the requirements of the paper industry. With the resulting bearing size, the toroidal roller bearing on the non-locating side is then capable of supporting axial thermal expansion of the roll of up to 15 mm. Due to this length compensation, almost no axial forces occur, which supports low-vibration running of the roll. Both bearing types are mounted directly onto tapered journals, ensuring high running accuracy. The bearings are axially secured using an HMZ locknut. The very high heating temperatures during the heating phase require radial internal clearance to Group 4 and case-hardened inner rings (W209B). The bearing combination shown, with the characteristics described, optimally fulfils the specified requirements.

14 Optimum bearing combination

00089509

| 1 | Locating bearing with spherical roller bearing | 2 | Non-locating bearing with toroidal roller bearing |
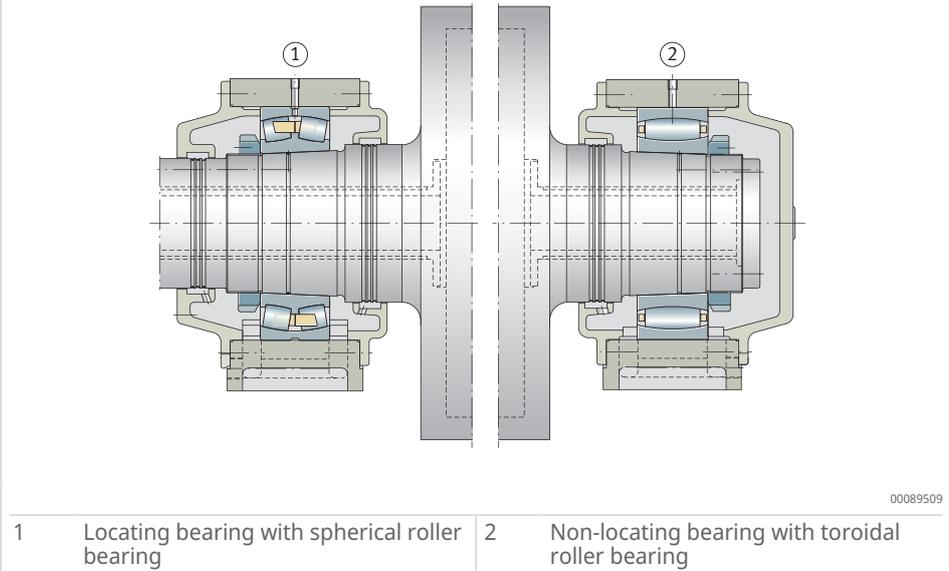
Products used

The following products are available for the application shown:

- toroidal roller bearing C31..-XL-K-M-W209B-C4
  with bore code: 44, 48, 52, 56
- spherical roller bearing 231..-BE-XL-K-W209B-C4
  with bore code: 44, 48, 52, 56
- shaft nut HM30 with bore code: 44, 48, 52, 56
- shaft nut HMZ30 with bore code: 44, 48, 52, 56

Further information

Schaeffler offers housings tailored to this application and its specific require-ments. Further information about the housings is available from Schaeffler on request.

GK 1 | Bearing Housings |
https://www.schaeffler.de/std/1FC0

15 Product tables

15.1 Explanations of the product tables

B	mm	Width
C_{0r}	N	Basic static load rating, radial
C_a	mm	Minimum value for depth of free space in the case of bearing rings without offset
C_r	N	Basic dynamic load rating, radial
C_{ur}	N	Fatigue limit load, radial
d	mm	Inside diameter
D	mm	Outside diameter
D_1	mm	Shoulder diameter of outer ring
d_2	mm	Shoulder diameter of inner ring
d_a	mm	Mounting dimension
D_a	mm	Mounting dimension
k_δ	–	Operating clearance factor
k_φ	–	Tilting factor
m	kg	Mass
n_G	min^{-1}	Limiting speed
$n_{\vartheta r}$	min^{-1}	Thermal speed rating
r	mm	Chamfer dimension
r_a	mm	Undercut radius
s_1	mm	Axial displacement

15
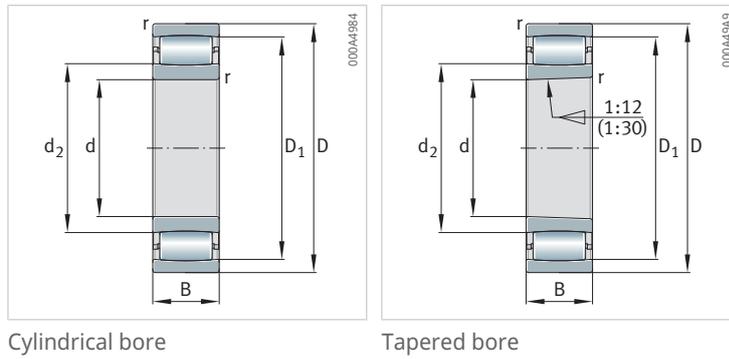
15.2 Toroidal roller bearings

Cage made from brass (M)

Cylindrical bore

Tapered bore

Designation	d	D	B	r	D_1	d_2	s_1	C_r	C_{0r}	C_{ur}
–	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
C2315-XL-K-M	75	160	55	2,1	136,5	99	13,1	430000	470000	56000
C2315-XL-M	75	160	55	2,1	136,5	99	13,1	430000	470000	56000
C2316-XL-K-M	80	170	58	2,1	145,5	103,5	10,1	510000	550000	62000
C2316-XL-M	80	170	58	2,1	145,5	103,5	10,1	510000	550000	62000
C2317-XL-K-M	85	180	60	3	153,9	111,1	12,1	550000	610000	68000
C2317-XL-M	85	180	60	3	153,9	111,1	12,1	550000	610000	68000
C2218-XL-K-M	90	160	40	2	143,9	112,1	9,5	330000	380000	55000
C2218-XL-M	90	160	40	2	143,9	112,1	9,5	330000	380000	55000
C2318-XL-K-M	90	190	64	3	167,4	119,6	9,6	650000	740000	77000
C2318-XL-M	90	190	64	3	167,4	119,6	9,6	650000	740000	77000
C2219-XL-K-M	95	170	43	2,1	149,7	112,3	10,5	370000	405000	61000
C2219-XL-M	95	170	43	2,1	149,7	112,3	10,5	370000	405000	61000
C2319-XL-K-M	95	200	67	3	167,6	120,4	12,6	660000	750000	78000
C2319-XL-M	95	200	67	3	167,6	120,4	12,6	660000	750000	78000
C2220-XL-K-M	100	180	46	2,1	159	120,2	10,1	475000	550000	68000
C2220-XL-M	100	180	46	2,1	156,9	118,1	10,1	420000	470000	68000
C2320-XL-K-M	100	215	73	3	186,1	126,9	11,2	830000	890000	97000
C2320-XL-M	100	215	73	3	184	129	11,2	820000	920000	97000
C2222-XL-K-M	110	200	53	2,1	178,5	135,9	11,1	550000	650000	89000
C2222-XL-M	110	200	53	2,1	178,5	135,9	11,1	550000	650000	89000
C2224-XL-K-M	120	215	58	2,1	190,2	144,8	13	630000	740000	101000
C2224-XL-M	120	215	58	2,1	190,2	144,8	13	630000	740000	101000
C3224-XL-K-M	120	215	76	2,1	190	149	17,1	760000	1000000	92000
C3224-XL-M	120	215	76	2,1	190	149	17,1	760000	1000000	92000
C2226-XL-K-M	130	230	64	3	199,3	151,7	9,6	770000	950000	119000
C2226-XL-M	130	230	64	3	199,3	151,7	9,6	760000	970000	119000
C2228-XL-K-M	140	250	68	3	221,4	174,6	13,7	830000	1080000	126000
C2228-XL-M	140	250	68	3	221,4	174,6	13,7	830000	1080000	126000
C3132-XL-K-M1B	160	270	86	2,1	238,2	191,8	10,3	1010000	1410000	147000
C3132-XL-M1B	160	270	86	2,1	238,2	191,8	10,3	1010000	1410000	147000
C3036-XL-K-M	180	280	74	2,1	236,1	208,9	15,1	900000	1360000	150000
C3036-XL-M	180	280	74	2,1	251	208,9	15,1	900000	1360000	150000
C3136-XL-K-M	180	300	96	3	270,8	215,2	23,2	1300000	1780000	216000
C3136-XL-M	180	300	96	3	270,8	215,2	23,2	1300000	1780000	216000
C3040-XL-K-M	200	310	82	2,1	285,2	234,8	15,2	1170000	1760000	181000
C3040-XL-M	200	310	82	2,1	285,2	234,8	15,2	1170000	1760000	181000
C3140-XL-K-M	200	340	112	3	304,4	245,6	27,3	1600000	2300000	265000
C3140-XL-M	200	340	112	3	304,4	245,6	27,3	1600000	2330000	265000

Axial displacement
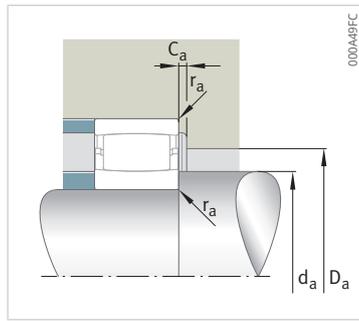
Mounting dimensions

n_G	$n_{\vartheta r}$	m	D_a		d_a		C_a	r_a	k_φ	k_δ
			max.	min.	max.	min.	min.	max.		
mm	mm	kg	mm	mm	mm	mm	mm	mm	–	–
5600	3200	5,3	148	127	111	87	2,2	2	5,53	1,941
5600	3200	5,3	148	127	111	87	1,5	2	5,53	1,941
5100	3050	6,11	158	135	117	92	2,4	2	6,094	1,745
5100	3050	6,3	158	135	117	92	1,7	2	6,094	1,745
4800	2850	7,1	166	143	125	99	1,72	2,5	6,144	1,752
4800	2850	7,29	166	143	125	99	1,72	2,5	6,144	1,752
5300	2650	3,23	149	137	122	101	1,4	2	4,103	2,924
5300	2650	3,38	149	137	122	101	1,3	2	4,103	2,924
4350	2500	8,4	176	154	136	104	1,9	2,5	6,754	1,589
4350	2500	8,65	176	154	136	104	1,9	2,5	6,754	1,589
5000	2750	4,01	158	140	125	107	1,5	2	4,75	2,42
5000	2750	4,12	158	140	125	107	1,5	2	4,75	2,42
4350	2600	9,75	186	155	137	109	1,9	2,5	6,758	1,589
4350	2600	10	186	155	137	109	1,9	2,5	6,758	1,589
4700	2700	4,72	168	149	133	112	0,9	2	4,867	2,393
4700	2700	4,97	168	147	131	112	1,6	2	4,849	2,393
3850	2290	12,6	201	170	147	114	1,5	2,5	8,512	1,223
3850	2290	12,8	201	169	148	114	2,2	2,5	8,026	1,312
4050	2330	7,1	188	168	150	122	1,9	2	5,866	1,941
4050	2330	7,14	188	168	150	122	2	2	5,866	1,941
3700	2200	8,68	203	178	160	132	1,9	2	6,372	1,778
3700	2200	8,91	203	178	160	132	1,9	2	6,372	1,778
3700	1960	11,3	203	180	162	132	1,5	2	7,65	1,423
3700	1960	11,7	203	180	162	132	1,5	2	7,65	1,423
3550	2040	11,2	216	188	168	144	1,1	2,5	6,983	1,602
3550	2040	11,1	216	188	167	144	2	2,5	6,983	1,602
3050	1750	13,7	236	210	190	154	1,9	2,5	7,191	1,598
3050	1750	14,1	236	210	190	154	1,9	2,5	7,191	1,598
2800	1550	19,1	258	227	189	172	1,73	2	9,469	1,15
2800	1550	19,6	258	227	189	172	1,73	2	9,469	1,15
2650	1420	16,5	269	241	223	191	1,5	2	9,696	1,135
2650	1420	16,4	269	241	223	191	1,4	2	9,696	1,136
2380	1310	25,9	286	257	234	194	1,25	2,5	9,634	1,162
2380	1310	26,7	286	257	234	194	2,1	2,5	9,634	1,162
2250	1180	21,9	299	272	252	211	1,8	2	10,083	1,117
2250	1180	22,2	299	272	252	211	1,6	2	10,083	1,117
2060	1120	40,3	326	290	265	214	1,25	2,5	11,848	0,924
2060	1120	40,8	326	290	265	214	2,1	2,5	11,861	0,923

15.2 Toroidal roller bearings
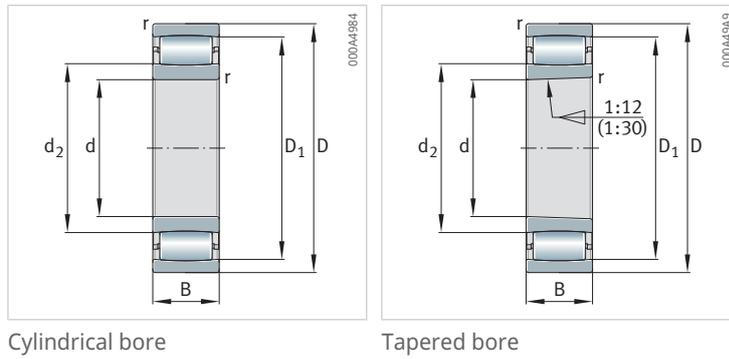
Cage made from brass (M)

Cylindrical bore

Tapered bore

Designation	d	D	B	r	D_1	d_2	s_1	C_r	C_{0r}	C_{ur}
–	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
C3044-XL-K-M	220	340	90	3	310,3	256,7	17,2	1370000	2130000	221000
C3044-XL-M	220	340	90	3	310,3	256,7	17,2	1370000	2130000	221000
C3144-XL-K-M	220	370	120	4	333,1	269,2	22,3	1930000	2900000	280000
C3144-XL-M	220	370	120	4	333,1	269,2	22,3	1930000	2900000	280000
C3048-XL-K-M	240	360	92	3	329,2	275,8	19,2	1400000	2230000	228000
C3048-XL-M	240	360	92	3	329,2	275,8	19,2	1400000	2230000	228000
C3148-XL-K-M	240	400	128	4	356,8	281,2	20,4	2380000	3500000	370000
C3148-XL-M	240	400	128	4	356,8	281,2	20,4	2380000	3500000	370000
C3052-XL-K-M	260	400	104	4	366,2	305,8	19,3	1830000	2950000	280000
C3052-XL-M	260	400	104	4	366,1	305,8	19,3	1830000	2950000	280000
C3152-XL-K-M	260	440	144	4	397,3	318,9	26,4	2750000	4250000	435000
C3152-XL-M	260	440	144	4	397	318,9	26,4	2750000	4250000	435000
C3056-XL-K-M	280	420	106	4	388,5	328,5	21,3	1870000	3100000	290000
C3056-XL-M	280	420	106	4	388,5	328,5	21,3	1870000	3100000	290000
C3156-XL-K-M	280	460	146	5	415	337	28,4	2850000	4500000	465000
C3156-XL-M	280	460	146	5	415	337	28,4	2850000	4500000	455000
C3060-XL-K-M	300	460	118	4	439,4	352,4	20	2260000	3850000	330000
C3060-XL-M	300	460	118	4	439,4	352,4	20	2260000	3850000	330000
C3160-XL-K-M	300	500	160	5	447,6	362,4	30,5	3300000	5200000	510000
C3160-XL-M	300	500	160	5	447,6	362,4	30,5	3350000	5300000	510000
C3164-XL-K-M	320	540	176	5	475,3	372,7	26,7	4150000	6300000	610000
C3164-XL-M	320	540	176	5	475,3	372,7	26,7	4150000	6300000	610000
C3168-XL-K-M	340	580	190	5	518,9	403,1	25,9	4900000	7500000	710000
C3168-XL-M	340	580	190	5	518,9	403,1	25,9	4900000	7500000	710000
C3172-XL-K-M	360	600	192	5	542,7	427,2	27,9	5100000	8000000	750000
C3172-XL-M	360	600	192	5	542,7	427,2	27,9	5100000	8000000	750000
C3176-XL-K-M	380	620	194	5	548,6	448,4	25,4	4950000	8200000	720000
C3176-XL-M	380	620	194	5	548,6	448,4	25,4	5000000	8500000	720000
C3180-XL-K-M	400	650	200	6	587,4	489,6	50,7	4800000	8300000	750000
C3180-XL-M	400	650	200	6	587,4	489,6	50,7	4800000	8300000	750000
C3184-XL-K-M	420	700	224	6	615,7	510,3	34,8	6000000	10600000	890000
C3184-XL-M	420	700	224	6	615,7	510,3	34,8	6000000	10600000	890000
C3188-XL-K-M1B	440	720	226	6	646,2	521,1	16	6900000	11600000	960000
C3188-XL-M1B	440	720	226	6	646,2	521,1	16	6900000	11600000	960000
C3192-XL-K-M	460	760	240	7,5	679,2	558,8	51	7000000	12000000	1010000
C3192-XL-M	460	760	240	7,5	679,2	558,8	51	6800000	12000000	1010000
C4192-XL-K30-M1B	460	760	300	7,5	668,3	539,6	23,3	8700000	14900000	1190000
C4192-XL-M1B	460	760	300	7,5	668,3	539,6	23,3	8700000	14900000	1190000

Axial displacement
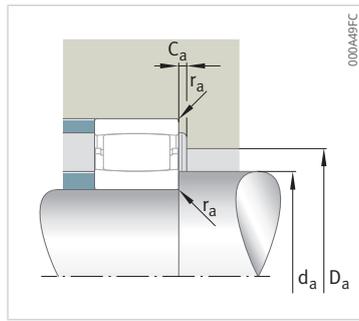
Mounting dimensions

n_G	$n_{\vartheta r}$	m	D_a		d_a		C_a	r_a	k_φ	k_δ
			max.	min.	max.	min.	min.	max.		
mm	mm	kg	mm	mm	mm	mm	mm	mm	–	–
2030	1050	29,2	327	297	274	233	1,86	2,5	11,851	0,931
2030	1050	28,4	327	297	274	233	1,86	2,5	11,851	0,931
1850	960	50,9	353	316	291	237	0,86	3	13,663	0,791
1850	960	52,5	353	316	291	237	0,86	3	13,663	0,791
1880	980	30,7	347	316	293	253	1,86	2,5	12,016	0,931
1880	980	30,7	347	316	293	253	1,86	2,5	12,016	0,931
1690	870	63	383	337	307	257	1,64	3	14,548	0,742
1690	870	64,9	383	337	307	257	1,64	3	14,548	0,742
1650	830	45,5	385	351	326	275	2,1	3	12,452	0,917
1650	830	46,4	385	351	326	275	1,9	3	12,381	0,924
1480	740	86,8	423	377	346	277	1,1	3	16,222	0,667
1480	740	87,5	423	377	346	277	1,7	3	16,223	0,667
1530	770	48,5	405	374	348	295	2,1	3	12,647	0,917
1530	770	50,1	405	374	348	295	1,9	3	12,577	0,924
1400	700	91,4	440	394	359,9	300	1,04	4	16,38	0,667
1400	700	93,8	440	394	364	300	1,7	4	16,385	0,666
1400	690	70,3	445	400	369	315	1,78	3	14,391	0,791
1400	690	72,4	445	400	369	315	1,78	3	14,391	0,791
1280	630	123,3	480	426	391	320	1,13	4	17,019	0,647
1280	630	124	480	426	391	320	1,9	4	17,019	0,647
1180	590	158,9	520	445	403	340	1,42	4	19,632	0,548
1180	590	163,9	520	445	403	340	1,42	4	19,632	0,548
1060	510	201	560	485	437	360	1,55	4	25,687	0,403
1060	510	207,7	560	485	437	360	1,55	4	25,687	0,403
1020	485	210,5	560	509	461	380	1,53	4	25,896	0,403
1020	485	217,3	560	509	461	380	1,53	4	25,896	0,403
990	455	243	600	523	474	400	1,26	4	20,41	0,544
990	455	225	600	523	474	400	2,1	4	20,403	0,544
910	435	253,2	624	563	514	426	1,18	5	20,631	0,548
910	435	261,3	624	563	514	426	1,18	5	20,631	0,548
860	390	349	674	587	539	446	1,13	5	25,009	0,434
860	390	339	674	587	539	446	1,9	5	24,992	0,435
810	360	345	694	615	518	466	6,3	5	25,092	0,347
810	360	354	694	615	518	466	6,3	5	25,092	0,347
760	350	428	728	649	592	492	1,43	6	25,198	0,441
760	350	424	728	649	589	492	2,1	6	25,204	0,441
770	280	516	728	634	588	477	6,9	6	32,219	0,324
770	280	530	728	634	588	477	6,9	6	32,219	0,324

15.2 Toroidal roller bearings
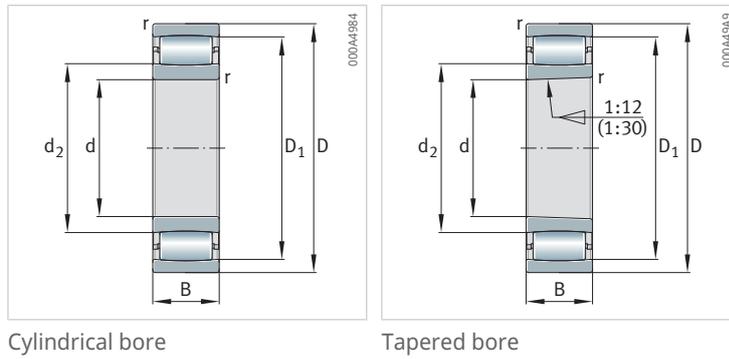
Cage made from brass (M)

Cylindrical bore

Tapered bore

Designation	d	D	B	r	D_1	d_2	s_1	C_r	C_{0r}	C_{ur}
–	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
C30/500-XL-K-M	500	720	167	6	655,8	572,2	37,5	4300000	8300000	700000
C30/500-XL-M	500	720	167	6	655,8	572,2	37,5	4300000	8300000	700000
C31/500-XL-K-M	500	830	264	7,5	734,2	608,8	75,3	7500000	12900000	1090000
C31/500-XL-M	500	830	264	7,5	734,2	608,8	75,3	7500000	12900000	1090000
C39/500-XL-K-M	500	670	128	5	634,6	552,4	20,4	3350000	6500000	620000
C39/500-XL-M	500	670	128	5	634,6	552,4	20,4	3350000	6500000	620000
C41/500-XL-K30-M1B	500	830	325	7,5	740,2	597,2	23	10200000	17800000	1410000
C41/500-XL-M1B	500	830	325	7,5	739,2	598,7	15	10700000	19100000	1410000
C30/530-XL-K-M	530	780	185	6	702,9	602,1	35,7	5200000	9700000	790000
C30/530-XL-M	530	780	185	6	702,9	602,1	35,7	5200000	9700000	790000
C31/530-XL-K-M	530	870	272	7,5	779,2	636,8	44,4	9100000	16100000	1310000
C31/530-XL-M	530	870	272	7,5	779,2	636,8	44,4	9100000	16100000	1310000
C30/560-XL-K-M	560	820	195	6	758,9	662,1	45,7	5700000	11200000	890000
C30/560-XL-M	560	820	195	6	758,9	662,1	45,7	5700000	11200000	890000
C31/560-XL-K-M1B	560	920	280	7,5	805,2	663,4	28	9600000	17400000	1350000
C31/560-XL-M1B	560	920	280	7,5	805,2	663,4	28	9600000	17400000	1350000
C39/560-XL-K-M	560	750	140	5	701,7	621,3	32,4	3650000	7500000	700000
C39/560-XL-M	560	750	140	5	701,7	621,3	32,4	3650000	7500000	700000
C30/600-XL-K-M	600	870	200	6	805,6	691,4	35,9	6300000	12200000	970000
C30/600-XL-M	600	870	200	6	805,6	691,4	35,9	6300000	12200000	970000
C31/600-XL-K-M1B	600	980	300	7,5	869,9	702,9	26,1	11100000	19100000	1490000
C31/600-XL-M1B	600	980	300	7,5	869,9	702,9	26,1	11100000	19100000	1490000
C39/600-XL-K-M	600	800	150	5	745,3	664,7	32,4	4100000	8800000	790000
C39/600-XL-M	600	800	150	5	745,3	664,7	32,4	4100000	8800000	790000
C41/600-XL-K30-M1B	600	980	375	7,5	864,7	701,2	24,6	13600000	24500000	1780000
C41/600-XL-M1B	600	980	375	7,5	864,7	701,2	24,6	13600000	24500000	1780000
C30/630-XL-K-M	630	920	212	6	841,7	715,2	48,1	6900000	12900000	1050000
C30/630-XL-M	630	920	212	7,5	841,7	715,2	48,1	6900000	12900000	1050000
C31/630-XL-K-M1B	630	1030	315	7,5	910,9	743,4	23,8	12200000	22000000	1660000
C31/630-XL-M1B	630	1030	315	7,5	910,9	743,4	23,8	12200000	22000000	1660000
C30/670-XL-K-M	670	980	230	6	904,1	774,8	41,1	8300000	16500000	1250000
C30/670-XL-M	670	980	230	7,5	902,3	776,7	41,1	8300000	16500000	1250000
C31/670-XL-K-M1B	670	1090	336	7,5	963,7	786	41	12600000	22300000	1740000
C31/670-XL-M1B	670	1090	336	7,5	963,7	786	41	12600000	22300000	1740000
C30/750-XL-K-M1B	750	1090	250	7,5	991,7	856,3	25	9500000	19300000	1430000
C30/750-XL-M1B	750	1090	250	7,5	991,7	856,3	25	9500000	19300000	1430000
C39/750-XL-K-M	750	1000	185	6	933,5	829,5	35,7	6400000	14000000	1120000
C39/750-XL-M	750	1000	185	6	933,5	829,5	35,7	6400000	14000000	1120000
C39/850-XL-K-M	850	1120	200	6	1056,9	936,1	35,9	7800000	17000000	1390000
C39/850-XL-M	850	1120	200	6	1056,9	936,1	35,9	7800000	17000000	1390000

Schaeffler

Axial displacement
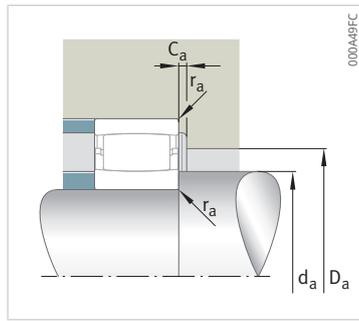
Mounting dimensions

n_G	$n_{\vartheta r}$	m	D_a		d_a		C_a	r_a	k_φ	k_δ
			max.	min.	max.	min.	min.	max.		
mm	mm	kg	mm	mm	mm	mm	mm	mm	–	–
790	370	211	697	635	593	523	2,1	5	18,843	0,647
790	370	216	697	635	593	523	2,1	5	18,843	0,647
680	330	555	798	702	641	532	2,38	6	25,64	0,441
680	330	559	798	702	641	532	4,4	6	25,64	0,441
830	375	120	652	615	573	518	3,1	4	19,736	0,6
830	375	123	652	615	573	518	3,1	4	19,736	0,6
680	225	34,3	798	709	645	532	7,28	6	36,221	0,287
680	225	688	798	708	594	532	7,5	6	36,213	0,287
730	340	296,1	757	677	628	553	2,7	5	21,626	0,548
730	340	292	757	677	628	553	2,5	5	21,626	0,548
640	280	608	838	738	678	562	1,68	6	30,734	0,356
640	280	625	838	738	678	562	3	6	30,734	0,356
660	295	329	793	735	686	583	2,4	5	22,141	0,548
660	295	338	793	735	686	583	2,4	5	22,141	0,548
610	265	701	888	778	660	592	7,3	6	30,983	0,355
610	265	720	888	778	660	592	7,3	6	30,983	0,355
730	335	164	732	683	650	578	2,9	4	20,33	0,6
730	335	168	732	683	650	578	2,9	4	20,33	0,6
620	275	379,3	847	773	724	623	2,15	5	28,196	0,403
620	275	390	847	773	724	623	2,15	5	28,196	0,403
550	247	923,9	948	837	700	632	8,77	6	30,953	0,362
550	247	869	948	837	699	632	8,8	6	30,953	0,363
680	305	197	782	726	685	618	1,7	4	21,712	0,561
680	305	203	782	726	685	618	1,7	4	21,712	0,561
560	186	1058	948	828	695	632	9	6	40,44	0,26
560	186	1086	948	828	695	632	9	6	40,44	0,26
580	270	448	892	809	748	658	4,1	6	29,154	0,39
580	270	460	892	809	748	658	3,9	6	29,154	0,39
520	222	983	998	878	739	662	8,8	6	34,168	0,324
520	222	1009	998	878	739	662	8,8	6	34,168	0,324
530	226	573,9	952	870	809	698	3,33	6	31,149	0,367
530	226	568	952	870	809	698	3,1	6	27,163	0,44
490	220	1167	1058	930	782	702	12	6	34,543	0,325
490	220	1198	1058	930	782	702	12	6	34,543	0,325
475	201	735	1062	965	852	778	6,9	6	29,669	0,404
475	201	755	1062	965	852	778	6,9	6	29,669	0,404
510	216	380	977	906	869	773	3,8	5	25,91	0,479
510	216	391	977	906	869	773	3,8	5	25,91	0,479
440	182	500	1097	1027	981	873	4,5	5	30,626	0,398
440	182	513	1097	1027	981	873	4,5	5	30,626	0,398

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