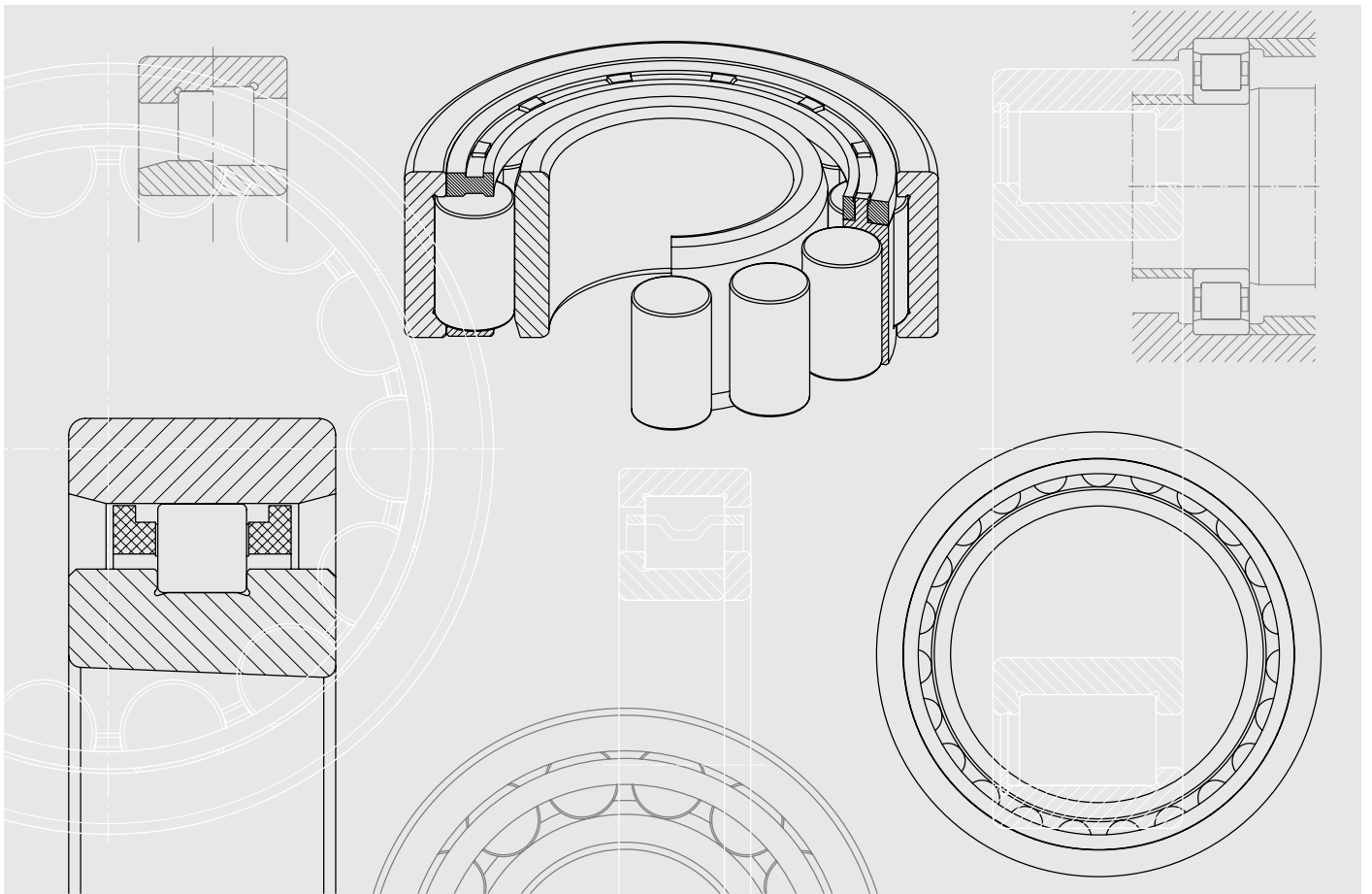
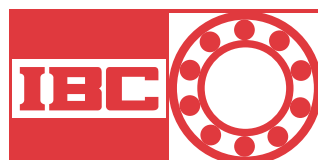


IBC



Cylindrical Roller Bearings

TI-I-4010.0 / E





Headquarters of IBC Wälzlager GmbH in the industrial area of Solms-Oberbiel



Historical Location

The headquarters, with the plants Solms-Oberbiel and Asslar are conveniently situated in the centre of Germany. The immediate connection to major north/south routes as well as to the main routes leading east and west not only forms a central position in Germany, but also within entire Europe. The near airport of Frankfurt a.M. connects us worldwide.



Flexible and reliable

The central computer controlled high shelf warehouse, built in 1996, with more than 2000 pallet parking bays stores semi-manufactured and finished products as well as large bearings. It complements the previous 2-storied computerised service storage, also with more than 2500 storage places. Both storage systems, together with our despatch centre, secure a maximum in precise logistics and in worldwide reliability of delivery.



Precise logistics secure a maximum in worldwide reliability of delivery



The central computer controlled high shelf warehouse



New Plant in Asslar



Präzision mit Zukunft, Precision with future, remains without alternative.

We are future-oriented.
We have the creativity and vision to perform and provide.
This is our exact presentation to solutions with precision.



1. Introduction

A permanent increase in demands concerning quality bearing systems leads to new developments of various technologies and new materials in order to meet high and very specific technical and economical applications. IBC Wälzlager GmbH, Industrial Bearings and Components, meets this fact by continuously increasing the performance of our products and technical processes, as well as expanding our product range.

The new **EXAD** cylindrical roller bearing series stands out with **Extended Capacity and Advanced Application** characteristic features. Due to its optimisation in design, materials and production sequences it unites clear improvement concerning fatigue life, functional safety, higher load capacity and quieter running properties with reduced friction and therefore lower heat build up.

Closer customer contact due to fair customer relationship serve the shared goal definition and consistent pursuit of these goals, so that even special customer requests are realised fast and specifically in economic solutions.

The intensive cooperation with universities and technical colleges is a traditional constituent part of our scientific work, not only on the sector of research and development but also as an interface for education and training.

It is, amongst other things, our great commitment to innovation that is reflected in our intensive activity in research and development. The main areas we focus on are basic research, material technology, tribology, but also the optimisation of manufacturing processes. Thus the material variation of the bearing components contributes decisively to the increase of the productive efficiency of the products.

Apart from serving research, our modern equipment – in the hands of trained, skilled workers – reaches even further than this, thus allowing the production of bearings that comply to the highest standards of quality, ensured for a long period of time.

Permanent quality inspections are integrated in the manufacturing process, thus ensuring the same high quality level of all our products. Our quality management system is implemented and certificated for design, development, production and sales of all types of rolling bearings and linear motion bearings according to DIN EN ISO 9001: 2000.

More detailed information on the different bearing designs, as well as information on the choice of the right bearing and it's correct, safe integration into individual constructions are to be found in the respective product catalogues. For a catalogue overview read the last page of this brochure.

It is this extensive product range of delivery and the worldwide support of our customers on site by our service

department and technical departments that enables us, together with our customers, to find specific and economic bearing solutions for their bearing assignments.

Single row cylindrical roller bearings

Cylindrical roller bearings are used whenever high rotational speed, minimum friction losses, high radial loads as well as changing lengths of surrounding parts due to heat have to be compensated. Single row cylindrical roller bearings with a cage consist of a solid outer ring and an inner ring as well as cylindrical rollers and cage assembly, the rollers are held between both solid ribs at the sides of the inner ring or the outer ring. According to it's design the in each case other ring has two solid ribs or is without rib. Therefore, it is possible to dismantle the bearing ring with solid ribs on both sides and the roller assembly from the bearing ring without rib. This makes installation and removal substantially easier, especially when tight fit is necessary for both bearing rings on account of the load ratios. The cage prevents mutual touching of the cylinder rollers during rolling. The bearings can be lubricated from the front as they are produced without sealing. IBC predominantly manufactures cylindrical roller bearings with cylindrical bores.

Cylindrical roller bearings with cage are suited for holding very high loads in radial direction. Because of the line contact between roller and track they have a high stiffness and are designated for high rotational speed.

Within IBC's product range of bearings there are different and innovative solution principles for ensuring sure loose fit bearing function, supporting bearing function and locating bearing function. Thus, IBC manufactures cylindrical roller bearings in a whole variety of different designs, dimensional series and sizes. The single row cylindrical roller bearings with cage, however, described in this catalogue make out the predominant part. As they enable axial displacements they are predestined for supporting working spindles in machine tools. Furthermore they are used in pumps and compressors. Beside single row cylindrical roller bearings and double-row cylindrical roller bearings with cage the range is complemented for general mechanical engineering by single row full complement cylindrical roller bearings and double-row full complement cylindrical roller bearings.

While cylindrical roller bearings with cage still allow high rotational speed, even with high loads, full complement cylindrical roller bearings are designed for lower rotational speed and wheel movements. They are used in extremely loaded, slowly turning bearings.

Dimensions

The main dimensions of single row IBC cylindrical roller bearing with cage meet the specifications in DIN 5412-1:2000 or ISO 15:1998 or DIN 616:2000.

2. General bearing data

Series

Single row IBC cylindrical roller bearings with cage are available in a large variety of designs. 10, 2, 3, 22, 23. Other variations, such as for example modified internal clearances and tolerances, are available on request.

Designs

Single row IBC cylindrical roller bearings with cage are manufactured in the designs NU, N, NJ and NUP. In addition, single row full complement cylindrical roller bearings of the designs NCF and NJG supplement the product range. Furthermore, double-row precision cylindrical roller bearings with cage are manufactured in the design NN and NNU (see service catalogue).

The IBC product range is supplemented by single row cylindrical roller bearings of the design NU without inner ring (designation RNU) as well as by cylindrical roller bearings of the design N without outer ring (designation RN). Cylindrical roller bearings without loose ring are the best choice for bearings in which the tracks on the shaft or in the housing can be hardened and ground. In RNU type bearings there is no inner ring, thus making the shaft stronger and therefore improving the stiffness. The axial displacement of the shaft in comparison to the housing only depends on the width of the track on the shaft or with cylindrical roller bearings of the RN design on the width of the track in the housing.

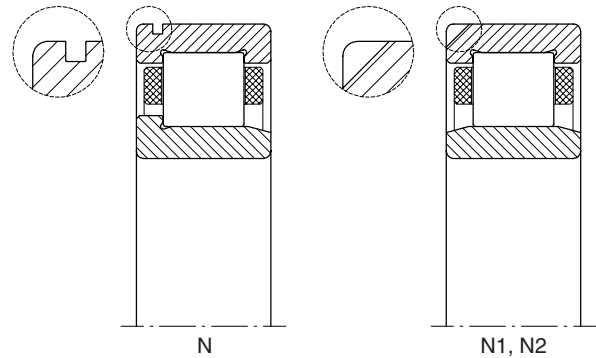
Special designs

Besides designs already mentioned IBC also manufactures a variety of cylindrical roller bearings in special design. In such cases please contact our technical consultation teams. It will be our pleasure to support you in the solution of your specific bearing tasks.

Cylindrical roller bearings with an outer annular snap ring groove in the outer ring are also regarded as bearings of a special design. They are marked with the additional figure N and simplify the construction as they can be fixed easily and in order to save space axially in the housing with a locating snap ring.

With certain bearing types, the cylindrical roller bearings with loose fit have to be mounted in the housing in order to make the installation and removal easier or even to enable this in the first place. The outer ring is kept safe from creeping by partially manufacturing single row cylindrical roller bearings with a locking groove (suffix N1) or with two locking grooves (suffix N2) on the outer ring side that are in a 180° position to each other.

Besides already described bearings with cylindrical bore IBC also manufactures single row cylindrical roller bearings with conical bore on request. The bearings with conical bore carry the additional figure K and have cone 1:12 as well as a slightly larger clearance than the cylindrical roller bearings with cylindrical bore. Apart from this they also enable the adjusting of a certain clearance or preload with the installation.



Special designs

46-103

Bearing materials

Bearing rings and rolling elements are manufactured from bearing steel 100Cr6 (1.3505) according to SAE52100 and SUJ2.

Heat treatment

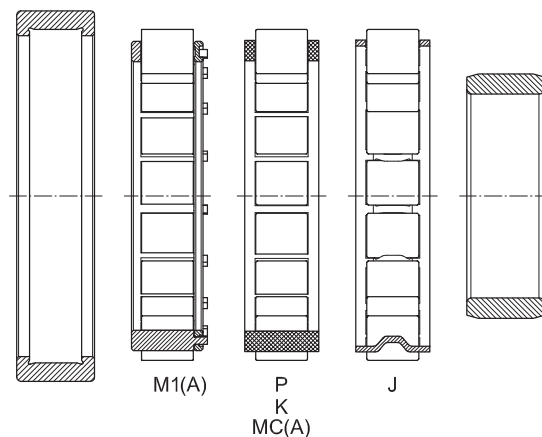
Bearing rings are as standard dimension-stable up to a working temperature of 150 °C. In addition, higher valued heat treatments for higher temperatures are possible on request, provided the bearings are equipped with a metal cage. Bearings for high temperatures carry the suffixes S1, S2, S3 for identification.

Please note that the load-carrying capacity of the bearings is reduced when constantly operating under higher temperatures.

Cages

Various cage designs are available, dependant upon design and size of the bearing:

- P** Window type nylon cage Polyamide 6.6 glass fibre filled, applicable up to 120 °C
- M** Brass cage
- J** Steel sheet cage
- K** PEEK cage, glass fibre filled, applicable up to 200 °C, with high rotational speed up to max.150 °C



Cage designs

46-901

IBC Cylindrical roller bearings are equipped as standard with plastic window cages made out of glass fibre filled polyamide PA6.6 or with different solid brass cages (see designation IBC cylindrical roller bearing p. 19). When dealing with high operating temperatures or with problematic working conditions we recommend the application of steel metal cages, PEEK cages or solid brass cages. These are available on request. These cage variations are suited for operating temperatures up to 150 °C, they are made for high rotational speed, resist aggressive materials and are highly stable in radial acceleration and in axial acceleration. At temperatures higher than 150 °C the bearing rings should have a special heat treatment.

Note

Cylindrical roller bearings with a plastic window cage made of glass fibre filled polyamide PA6.6 are suited for an operating temperature range between -20 °C and + 120 °C, at which the used lubricant has a strong impact on the fatigue life. Hence, when using synthetic greases or lubricants with EP additives, check the chemical resistance of the cage material before use. At higher temperatures the service life of plastic cages can possibly become reduced when using aged oils as well as additives contained in the oil. Therefore oil change periods should absolutely be complied with. Bearings with a polyamide cage shouldn't be applied in ammoniated surroundings or in ambient conditions where Freon is used as a coolant, for example in refrigerating machines.

Coated bearings (Prefix AC)

Besides designs that have already been mentioned, IBC also manufactures special bearings for special installation cases. According to the application an ATCoat thin hard chrome coating may be recommendable. Because of its bonded, thin chrome layer it has a very good wear protection and corrosion prevention at the same rating of bearing and permits higher rotational speed or lower working temperatures. The emergency run properties of bearings are substantially improved by the special topography of the surface. Thus, IBC cylindrical roller bearings with an ATCoat are especially favoured with poor lubrication conditions. Among others, such poor lubrication conditions are given, when

- it is impossible to use a lubricant in certain ambient surroundings.
- it is only possible to use a low viscous lubricant which cannot create a separating film.
- very low rotational speeds occur, at which no elasto-hydrodynamical lubricant film can build up
- the movement is not a complete rotation, where the lubricant film will not remain.
- the bearing is unloaded and starts to slide.
- smearing takes place through sliding of roller assembly by sudden acceleration or braking on account of mass inertia and is unsatisfactory preload.

ATCoat thin dense chromium coated bearings still function as an excellent alternative to corrosion resistant bearings.

Designs

Cylindrical roller bearings are manufactured in many different designs, depending on their individual application and requirements. After the arrangement of the bearing ribs at the inner ring or outer ring the following basic forms are defined:

Loose fit bearings

Cylindrical roller bearings of the design NU and N are loose fit bearings. They can only take on radial forces. They permit a certain amount of axial displacement in both directions within the bearing between shaft and housing. The design NU has two solid ribs on the outer ring and an inner ring without rib, while two solid ribs on the inner ring and an outer ring without rib identify the bearings of the design N.

Supporting bearings

Cylindrical roller bearings of the design NJ are supporting bearings. They are not only able to take on large radial forces, but can also take on axial forces in one direction. This allows the guidance of the shaft in one direction of axial force. In the other direction they function as a loose fit bearing. With the design NJ the outer ring has two solid ribs and the inner ring has one solid rib.

Locating bearings

Cylindrical roller bearings of the design NUP are locating bearings. They guide the shaft in both axial directions, because they are not only able to take on large radial forces but can also take on axial forces. Bearings of the design NUP have two solid ribs on the outer ring, one solid rib and one loose-rib on the inner ring.

Cylindrical roller bearing with L-section rings

For guiding the shaft in one or in both axial directions IBC, on request, also manufactures cylindrical roller bearings of the design NU and NJ with a L-section ring. For this, L-section rings, type HJ, are used. They are manufactured from bearing steel 100Cr6. The application of L-section rings is advantageous for type NUP when the seating surface of the inner ring of cylindrical roller bearings with loose-rib washer is too small to fix the bearing suitable enough for high loads. L-section rings also make the installation and removal of the bearing easier, thus reducing assembly times and shutdown times. Cylindrical roller bearings of the design NU with L-section ring HJ carry out supporting bearing function. They are able to take on axial loads in one direction and can therefore guide the shaft axially in one direction. However, ensure that bearings of the design NU are not installed with combined L-section rings on both bearing sides, as this could bear the danger of clamping.

Bearings of the design NJ when combined with HJ L-section ring become a locating bearing unit which permits shaft guidance in both directions. They have two solid ribs on the outer ring, one rib on the inner ring as well as an additional L-section ring for the side of the inner ring without rib. The dimensions of the L-section rings meet DIN 5412-1:2000 or ISO 246:1995.

3. Radial internal clearance

Radial internal clearance

IBC manufactures cylindrical roller bearings as a standard with radial internal clearance Normal (CN) or C3. Some cylindrical roller bearings are available with smaller clearance C2 or with larger clearance C4. Bearings with clearance C5 are available on request. The values of the

radial internal clearance of single row cylindrical roller bearings with cylindrical bore meet DIN 620-4:1987 or ISO 5753:1991. They are valid for bearings that are not built-in at measuring load zero. With cylindrical roller bearings with standard clearance or with restricted clearance the bearing parts are interchangeable.

Radial clearance class	over incl.	Bore diameter [mm], clearance [µm]																			
		0 24	24 30	30 40	40 50	50 65	65 80	80 100	100 120	120 140	140 160	160 180	180 200	200 225	225 250	250 280	280 315	315 355	355 400	400 450	450 500
C2	min.	0	0	5	5	10	10	15	15	15	20	25	35	45	45	55	65	65	100	110	110
	max.	25	25	30	35	40	45	50	55	60	70	75	90	105	110	125	130	145	190	210	220
CN	min.	20	20	25	30	40	40	50	50	60	70	75	90	105	110	125	130	145	190	210	220
	max.	45	45	50	60	70	75	85	90	105	120	125	145	165	175	195	205	225	280	310	330
C3	min.	35	35	45	50	60	65	75	85	100	115	120	140	160	170	190	200	225	280	310	330
	max.	60	60	70	80	90	100	110	125	145	165	170	195	220	235	260	275	305	370	410	440
C4	min.	50	50	60	70	80	90	105	125	145	165	170	195	220	235	260	275	305	370	410	440
	max.	75	75	85	100	110	125	140	165	190	215	220	250	280	300	330	350	385	460	510	550
C5	min.	75	75	85	100	110	125	140	165	190	225	250	275	305	330	370	410	455	510	565	625
	max.	100	100	110	130	140	160	175	205	235	275	300	330	365	395	440	485	535	600	665	735

Restricted areas

- C2L lower half clearance area C2
- C2M middle area +/-25% around average value of C2
- C2H upper half clearance area C2

Note

Clearance "Normal" CN or C0: This specification is not mentioned in designations. "Normal" in this context is to be understood in terms of usually applied. In applications with high rotational speed characteristic higher radial clearance classes are also referred to as "normal".

Shifted radial internal clearance

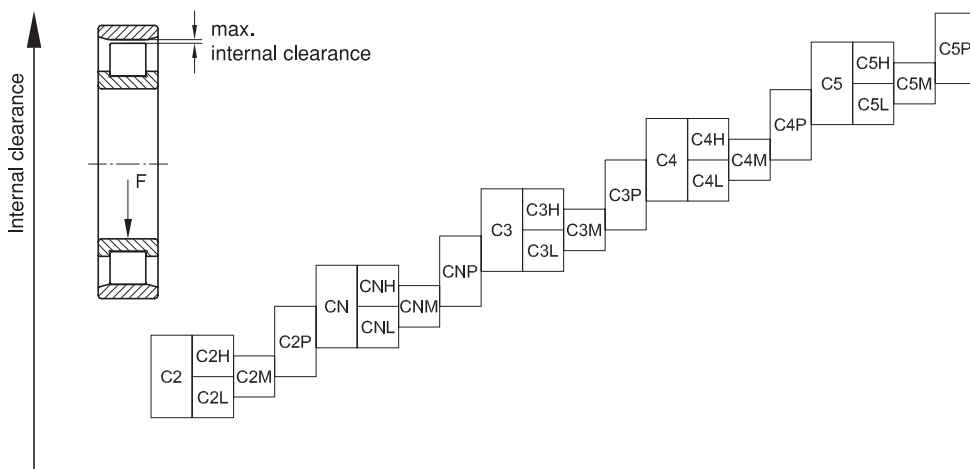
With this, the according adjoining parts of a clearance class (upper half of the nominal area + lower half of the next higher area) overlap.

$$C2P = C2H + CNL$$

$$CNP = CNH + C3L$$

$$C3P = C3H + C4L$$

In special cases the radial internal clearance is named with absolute values: NU 210.EAP.C10-15



46-201

4. Axial clearance

Axial clearance

When functioning as locating bearings, bearings of the design NUP can guide the shaft in both directions. Their axial clearance values are listed in the chart. The values of cylindrical roller bearings of design NJ with L-section ring HJ are to be taken from the right chart below.

The values listed in the charts are approximate values. Please note that the rolling elements may be tilted while measuring the radial internal clearance, which causes an expanding of the axial clearance.

Noise

The noise level rises with increasing radial clearance. If a greater amount of heat up isn't a problem, as it would be with fast-running spindles, then the backlash should be chosen as small as possible for applications where noise matters.

Axial clearance NUP

Bearing bore Dia- meter [mm]	Bore code –	NUP 2		NUP 22		NUP 3		NUP 23	
		min.	max.	min.	max.	min.	max.	min.	max.
		[µm]		[µm]		[µm]		[µm]	
17	03	37	140	37	140	37	140	47	155
20	04	37	140	47	155	37	140	47	155
25	05	37	140	47	155	47	155	47	155
30	06	37	140	47	155	47	155	47	155
35	07	47	155	47	155	47	155	62	180
40	08	47	155	47	155	47	155	62	180
45	09	47	155	47	155	47	155	62	180
50	10	47	155	47	155	47	155	62	180
55	11	47	155	47	155	62	180	62	180
60	12	47	155	62	180	62	180	87	230
65	13	47	155	62	180	62	180	87	230
70	14	47	155	62	180	62	180	87	230
75	15	47	155	62	180	62	180	87	230
80	16	47	155	62	180	62	180	87	230
85	17	62	180	62	180	62	180	87	230
90	18	62	180	62	180	62	180	87	230
95	19	62	180	62	180	62	180	87	230
100	20	62	180	87	230	87	230	120	315
105	21	62	180	87	230	87	230	120	315
110	22	62	180	87	230	87	230	120	315
120	24	62	180	87	230	87	230	120	315
130	26	62	180	87	230	87	230	120	315
140	28	62	180	87	230	87	230	120	315
150	30	62	180	87	230	87	230	120	315

Axial clearance NJ + HJ

Bearing bore Dia- meter [mm]	Bore code –	NJ 2+HJ 2		NJ 22+HJ 22		NJ 3+HJ 3		NJ 23+HJ 23	
		min.	max.	min.	max.	min.	max.	min.	max.
		[µm]		[µm]		[µm]		[µm]	
17	03	42	165	42	165	42	165	52	183
20	04	42	165	52	185	42	165	52	183
25	05	42	165	52	185	52	185	52	183
30	06	42	165	52	185	52	185	52	183
35	07	52	185	52	185	52	185	72	215
40	08	52	185	52	185	52	185	72	215
45	09	52	185	52	185	52	185	72	215
50	10	52	185	52	185	52	185	72	215
55	11	52	185	52	185	72	215	72	215
60	12	52	185	72	215	72	215	102	275
65	13	52	185	72	215	72	215	102	275
70	14	52	185	72	215	72	215	102	275
75	15	52	185	72	215	72	215	102	275
80	16	52	185	72	215	72	215	102	275
85	17	72	215	72	215	72	215	102	275
90	18	72	215	72	215	72	215	102	275
95	19	72	215	72	215	72	215	102	275
100	20	72	215	102	275	102	275	140	375
105	21	72	215	102	275	102	275	140	375
110	22	72	215	102	275	102	275	140	375
120	24	72	215	102	275	102	275	140	375
130	26	72	215	102	275	102	275	140	375
140	28	72	215	102	275	102	275	140	375
150	30	72	215	102	275	102	275	140	375

5. Interference fits and rotational conditions

Skewing

The skewing of the inner ring in comparison to the outer ring that is acceptable without leading to service life reduction is dependent on the load ratio C/P and is limited to a few angular minutes. With a ratio of $C/P \geq 5$ ($P/C \leq 0.2$) the adjustment angle for the bearings of the series 10, 2, 3 may only be max. 4 angular minutes. For cylindrical roller bearings of the series 22 as well as 23 the skewing may be only maximum 3 angular minutes. Please note that the listed approximate values for bearings that are not axially guided have their validity on condition of constant position of the axis of shaft and housing. With cylindrical roller bearings of the series 2 and 3, for example, this approximately fulfils the radial internal clearance and with series 22 and 23 approximately $\frac{2}{3}$ of the radial internal clearance is reached.

Because the ribs are loaded irregularly, given values for skewing may not be used to a full extent with axially guiding bearings, as this results in extended wear. In some cases this may even lead to lip crack. With bearings of the design NUP or NJ with L-section ring HJ, it is possible that internal axial tension occurs, because of the fairly small axial clearance, so that listed maximum skewing values have no validity.

Note

Please note that skewing causes a certain compulsive run from which extended running noise may result and which may also limit service life. Please, contact our technical consultation teams in such cases in which skewing is expected to exceed maximum values.

Axial displacement

In general, the guidance of a shaft consists of a locating bearing and a loose fit bearing. Cylindrical roller bearings of the design NU and N have a loose fit bearing function.

These bearing types are displaceable along the axis and prevent mutual seizure of the bearings. They permit axial displacements within the bearing as a result of thermal expansions between shaft and housing in both directions up to a certain degree. Because the axial displacement takes place within the bearing, it takes place within the rotating bearing virtually without friction. Cylindrical roller bearings of the design NJ allow axial displacements between the rolling elements and one of the tracks in one direction. In this case the installation of inner ring and outer ring is possible with tight fit.

Interference fits and rotational conditions

Because the interference fits considerably influence the clearance or preload, the following information should be noticed. First of all, it should be ascertained which bearing rings take on rotating load and which ones take on static load. The rings with rotating load have to fit firmly, because the rings within the housing have a tendency to also join in rotation in circumferential direction. With the static-loaded rings this is less critical, so that these are usually not fixed so tightly. With this, a certain point of the ring range is always carrying the load. The larger the impact and the load becomes, the more solidly the interference fit has to be selected (picture 40-301).

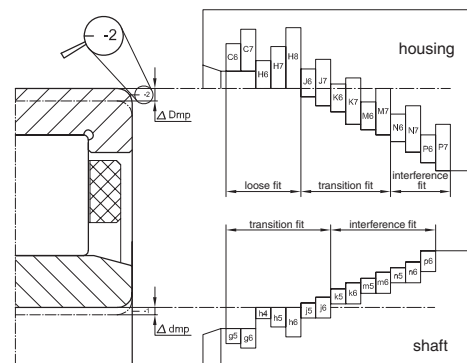
The lighter interference fits in each case apply to low loads up to $0.08 \cdot C$, the tighter interference fits are used for values that are higher. The radial clearance decrease which is caused by tight fit and by a temperature differential from inner ring to outer ring is to be taken into consideration when selecting the clearance.

The interference fit should be tuned according to the desired clearance at operating temperature. However, tighter fits may be selected for hollow shafts and for thin sectional housings.

Accuracy class	Inner Ring IR	Outer Ring AR	Shaft			Housing		
			PN, P6	P5	P4	PN, P6	P5	P4
Static load on the inner ring	IR lightly movable	OR fixed	g6	g5	g4	M7	M6	M5
Rotating load on the outer ring			h6	h5	h4			
Stationary load on the outer ring	IR fixed	OR lightly movable	j6, k6	js5, k5	js4, k4	H7	H6	H5
Rotating load on the inner ring		OR not lightly movable				J7	JS6	JS5
Uncertain load		OR fairly fixed				J7, K7	JS6, K6	JS5, K5

Interference fits for static load and rotating load

40-301



General interference fits

40-314

Reduction of radial internal clearance by interference fits and working conditions

The radial internal clearance becomes reduced to the following reference values:

$$S_{\text{reff}} = S_o - (S_i + S_T) \quad [\text{mm}] \quad [1.0]$$

S_{reff}	effective radial operation clearance
S_o	clearance before installation
S_i	clearance reduced by interference fit
S_T	clearance reduced by temperature differential between inner ring and outer ring

After assembly (S_m) there is following clearance:

$$S_m = S_o - S_i \quad [\text{mm}] \quad [1.1]$$

$$S_i = I_i \cdot f_i + I_o \cdot f_o \quad [\text{mm}] \quad [1.2]$$

I_i	interference inner ring
I_o	interference outer ring
f_i	reduction factor inner ring
f_o	reduction factor outer ring

Approximate values:

f_i	solid shaft	0.8
f_o	steel or casting housing	0.7
f_i	hollow shaft	0.6
f_o	light metall housing	0.5

f_i and f_o depend on the roughness, on the cross section ratios of the bearing rings and on the diameter ratios of the hollow shaft and of the thin section housings.

Because of the limited possibility of loss of heat due to the smaller surface and the more frequent rolling contact by the rolling element, a difference in temperature during operation from inner ring to outer ring of approx. 5–10 °C is usual. This value changes by flow of hot or cold media through hollow shafts.

$$S_T = \alpha \cdot \Delta_T \cdot d_m \quad [\text{mm}] \quad [1.3]$$

α	coefficient of expansion of bearing steel $12 \cdot 10^{-6}$	$[\text{k}^{-1}]$
Δ_T	difference in temperature from inner ring to outer ring	
d_m	average diameter of bearing $0.5 \cdot (d + D)$	

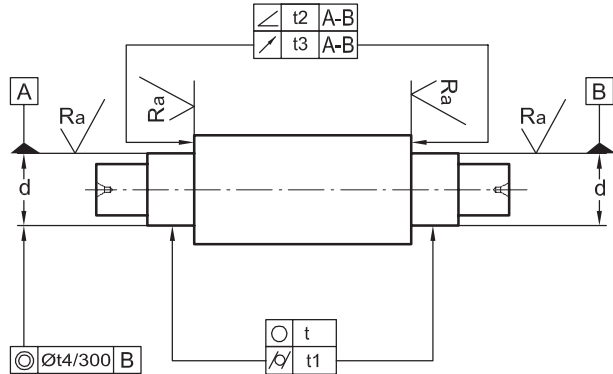
	Inner ring	Outer ring
	Point load Inner ring stands still Direction of load unchangeable	Circumferential load Outer ring rotates Direction of load unchangeable
	Point load Inner ring rotates Direction of load rotates with the inner ring	Circumferential load Outer ring stands still Direction of load rotates with the inner ring
	Circumferential load Inner ring stands still Direction of load rotates with the outer ring	Point load Outer ring rotates Direction of load rotates with the outer ring
	Circumferential load Inner ring rotates Direction of load unchangeable	Point load Outer ring stands still Direction of load unchangeable

Load ratios in bearing rings

40-300

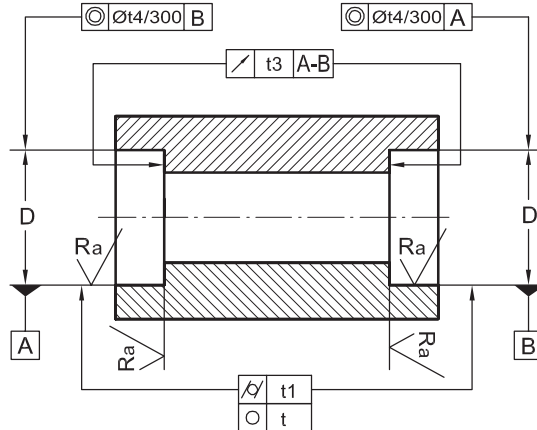
6. Tolerances of connecting parts of cylindrical roller bearings

Form accuracy of shafts



40-305

Form accuracy of housings



40-307

Geometrical property	Tolerance-sign	Tolerance-symbol	Acceptable form deviations Tolerance grade/ roughness class Bearing tolerance class			
			PN	P6	P5	P4
Roundness	○	t	$\frac{IT5}{2}$	$\frac{IT4}{2}$	$\frac{IT3}{2}$	$\frac{IT2}{2}$
Cylindrical shape	∇	t1	$\frac{IT5}{2}$	$\frac{IT4}{2}$	$\frac{IT3}{2}$	$\frac{IT2}{2}$
Squareness	\sphericalangle	t2	-	-	-	$\frac{IT3}{2}$
Face runout	\nearrow	t3	IT5	IT4	IT3	IT3
Concentricity	◎	t4	IT6	IT6	IT5	IT4
Roughness R_a						
$d \leq 80$ mm		-	N6	N5	N4	N4
$d > 80$ mm		-	N7	N6	N5	N5

Form accuracy of shafts

40-306

Geometrical property	Tolerance-sign	Tolerance-symbol	Acceptable form deviations Tolerance grade/ roughness class Bearing tolerance class			
			PN	P6	P5	P4
Roundness	○	t	$\frac{IT5}{2}$	$\frac{IT4}{2}$	$\frac{IT3}{2}$	$\frac{IT2}{2}$
Cylindrical shape	∇	t1	$\frac{IT5}{2}$	$\frac{IT4}{2}$	$\frac{IT3}{2}$	$\frac{IT2}{2}$
Face runout	\nearrow	t3	IT5	IT4	IT3	IT3
Concentricity	◎	t4	IT7	IT6	IT5	IT4
Roughness R_a						
$D \leq 80$ mm		-	N6	N6	N5	N5
$80 < D \leq 250$ mm		-	N7	N7	N6	N6
$D < 250$ mm		-	N7	N7	N7	N7

Form accuracy of housings

40-308

ISO tolerance grades according to DIN 7151									
Diameter Nominal dimension		Tolerance class							
over	incl.	IT0	IT1	IT2	IT3	IT4	IT5	IT6	IT7
mm		μm							
6	10	0.6	1	1.5	2.5	4	6	9	15
10	18	0.8	1.2	2	3	5	8	11	28
18	30	1	1.5	2.5	4	6	9	13	21
30	50	1	1.5	2.5	4	7	11	16	25
50	80	1.2	2	3	5	8	13	19	30
80	120	1.5	2.5	4	6	10	15	22	35
120	180	2	3.5	5	8	12	18	25	40
180	250	3	4.5	7	10	14	20	29	46
250	315	4	6	8	12	16	23	32	52
315	400	5	7	9	13	18	25	36	57
400	500	6	8	10	15	20	27	40	63

Tolerance grades according to DIN 7151

40-309

Design of the connecting parts

The position and form accuracy of the connecting parts ought to be adjusted to meet the requirements for the accuracy of the bearings (picture 40-305, picture 40-307). The bearings with their fairly slim rings adapt to the form deviations of shaft and housing. The chosen interference fits depend on the rotational conditions of the specific bearing rings (picture 40-300, 40-301, 40-314).

Roughness class	Roughness value R_a [μm]
N3	0.1
N4	0.2
N5	0.4
N6	0.8
N7	1.6

Roughness values

40-310

Roughness R_a of the axial collars of the spindle in the housing and of the rings in between: $N6 = 0.8 \mu m$

With bearings of the design RNU when not built-in, the enveloping circle diameter F_w , which is the internal limitation circle of the cylindrical rollers when touching the outer track, is within the tolerance range of F6.

7. Tolerances of cylindrical roller bearings

	Inner ring [mm]	Accuracy	Ø 2.5	10	18	30	50	80	120	150	180	250
			to 10	18	30	50	80	120	150	180	250	315
Δ_{dmp}	Deviation of the average bore diameter on one level	PN	-8	-8	-10	-12	-15	-20	-25	-25	-30	-35
		P6	-7	-7	-8	-10	-12	-15	-18	-18	-22	-25
		P5	-5	-5	-6	-8	-9	-10	-13	-13	-15	-18
		P4	-4	-4	-5	-6	-7	-8	-10	-11	-12	-15
K_{ia}	Radial runout of the inner ring on the assembled bearing	PN	10	10	13	15	20	25	30	30	40	50
		P6	6	7	8	10	10	13	18	18	20	25
		P5	4	4	4	5	5	6	8	8	10	13
		P4	2.5	2.5	3	4	4	5	6	6	8	-
S_d	Face runout of the front side, referring to the bore	P5	7	7	8	8	8	9	10	10	11	13
		P4	3	3	4	4	5	5	6	6	7	-
S_{ia}	Face runout of the front side, referring to the track of the inner ring on the assembled bearing	P5	7	7	8	8	8	9	10	10	13	15
		P4	3	3	4	4	5	5	7	7	8	-
Δ_{Bs}	Deviation of a single inner ring width	PN, P6	-120	-120	-120	-120	-150	-200	-250	-250	-300	350
		P5, P4	-40	-80	-100	-120	-150	-200	-250	-250	-300	350
		PN, P6, P5, P4	-250	-250	-250	-250	-250	-380	-380	-380	-500	-500
V_{Bs}	Variation inner ring width	P6	15	20	20	20	25	25	30	30	30	35
		P5	5	5	5	5	6	7	8	8	10	13
		P4	2.5	2.5	2.5	3	4	4	5	5	6	-

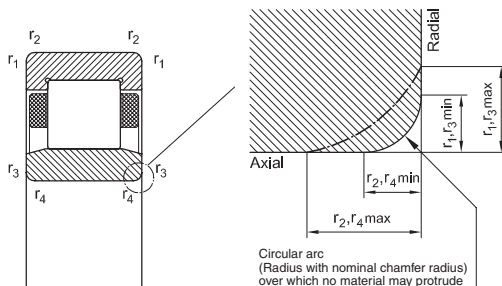
	Outer ring [mm]	Accuracy	Ø 18	30	50	80	120	150	180	250	315	400	500
			to 30	50	80	120	150	180	250	315	400	500	630
Δ_{Dmp}	Max. deviation of the average outer diameter on one level	PN	-9	-11	-13	-15	-18	-25	-30	-35	-40	-45	-50
		P6	-8	-9	-11	-13	-15	-18	-20	-25	-28	-33	-38
		P5	-6	-7	-9	-10	-11	-13	-15	-18	-20	-23	-28
		P4	-5	-6	-7	-8	-9	-10	-11	-13	-15	-18	-22
K_{ea}	Radial runout of the outer ring on the assembled bearing	PN	15	20	25	35	40	45	50	60	70	80	100
		P6	9	10	13	18	20	23	25	30	35	-	-
		P5	6	7	8	10	11	13	15	18	20	-	-
		P4	4	5	5	6	7	8	10	11	13	-	-
S_D	Variation of the surface outline's incline, referring to the referential side surface	P5	8	8	8	9	10	10	11	13	13	-	-
		P4	4	4	4	5	5	5	7	8	10	-	-
S_{ea}	Face runout of the front side referring to the track of the outer ring on the assembled bearing	P5	8	8	10	11	13	14	15	18	20	-	-
		P4	5	5	5	6	7	8	10	10	13	-	-

The width tolerances of the outer ring (Δ_{Cs} , V_{Cs}) are according to those of the inner ring (Δ_{Bs} , V_{Bs}).
The total width tolerance of a bearing set adds up out of the sum of single tolerances.

Values in μm

Tolerances

Beside the standard tolerance PN according to DIN 620-2:1988 or ISO 492-2002 single row cylindrical roller bearings are also available in higher tolerance classes P6 and P5. Bearings in P4 can be manufactured on request. Cylindrical roller bearings with higher accuracy are necessary for bearing arrangements with high runout accuracy or often also with bearings that run at very high rotational speed.



Permissible values for chamfer dimensions according to DIN 620, part 6 40-315

Nominal chamfer radius r_{min}, r_{12}, r_{34} mm	Diameter of bore d		Tolerance of the chamfer widths			
	from	to	Radial r_1, r_3		Axial r_2, r_4	
			min.	max.	min.	max.
0.2	-	-	0.2	0.5	0.2	0.8
0.3	-	40	0.3	0.6	0.3	1.0
	40	-	0.3	0.8	0.3	1.0
0.6	-	40	0.6	1.0	0.6	2.0
	40	-	0.6	1.3	0.6	2.0
1.0	-	50	1.0	1.5	1.0	3.0
	50	-	1.0	1.9	1.0	3.0
1.1	-	120	1.1	2.0	1.1	3.5
	120	-	1.1	2.5	1.1	4.0
1.5	-	120	1.5	2.3	1.5	4.0
	120	-	1.5	3.0	1.5	5.0
2.0	-	80	2.0	3.0	2.0	4.5
	80	220	2.0	3.5	2.0	5.0
2.1	-	280	2.1	4.0	2.1	6.5
2.5	-	100	2.5	3.8	2.5	6.0
	100	280	2.5	4.5	2.5	6.0
3.0	-	280	3.0	5.0	3.0	8.0

Limit values for chamfer dimensions

40-304

8. Determination of the bearing size

Equivalent dynamic bearing load

The following applies for dynamically stressed cylindrical roller bearings that are in use as loose fit bearings:

$$P = F_r \quad [2.0]$$

If cylindrical roller bearings with ribs on the inner ring and outer ring are used for axial guiding of the shaft in one or in both directions, then the equivalent dynamic bearing load can be approximated from:

$$\begin{aligned} P &= F_r && \text{with } F_a / F_r \leq e \\ P &= 0.92 \cdot F_r + Y \cdot F_a && \text{with } F_a / F_r > e \end{aligned} \quad [2.1]$$

P	equivalent dynamic bearing load	[N]
F_r	radial load	[N]
e	limit value	
	0.2 with bearings of the series 10, 2 and 3	
	0.3 with bearings of the series 22 and 23	
Y	axial load factor	
	0.4 with bearings of the series 22 and 23	
	0.6 with bearings of the series 10, 2 and 3	

The ratio of F_a / F_r shouldn't exceed the value of 0.5 with axially loaded single row cylindrical roller bearings as an optimum run is only given with radial load at the same time.

Equivalent static bearing load

The following applies for statically stressed single row cylindrical roller bearings:

$$P_0 = F_r \quad [2.2]$$

$$P_0 \text{ equivalent static bearing load} \quad [N] \quad [2.2]$$

Minimum load

A minimum load is needed to ensure an undisturbed operation, in particular with quick-running bearings and bearings that are used with strong accelerations as well as with quick changing loads. Should the weight of the supported parts not be sufficient, then it is possible to achieve more force by spring preload, therefore avoiding destructive sliding between the rolling elements and the tracks. Use the following formula for approximate calculation of the minimum radial load for single row cylindrical roller bearings:

$$F_{r \min} = k_r \cdot \left(0.6 + 0.4 \cdot \frac{n}{n_r} \right) \cdot d_m^2 \quad [2.3]$$

$F_{r \min}$	minimum radial load	[N]
k_r	radial minimum load factor	
n	service speed	[min ⁻¹]
n_r	reference rotational speed	[min ⁻¹]
d_m	mean diameter of bearing $0.5 \cdot (d + D)$	[mm]

With the application of high viscosity lubricants as well as by cold starting it is possible that higher minimum loads are necessary. In general, the deadweight of the supported parts and the external forces already cause the radial load to be higher than the minimum load is. However, if the ascertained limit value is under-run an additional radial load of the bearings is necessary.

Determination of the bearing's dimensions

While specifying the correct bearing size, it is of great importance to know the service life appropriate to the respective application case. This service life is dependent on different factors, such as type of machine, daily operating hours as well as on the requirements for the operational safety.

According to DIN ISO 281:1993 the nominal service life L_{10} arises from the ratio of the equivalent dynamic bearing load P to the dynamic load rating C.

$$L_{10} = \left(\frac{C}{P} \right)^3 \cdot \frac{10^6}{60 \cdot n} \quad [h] \quad [2.4]$$

L_{10}	nominal service life (90% of the bearings reach this period; 10% may fail)	
C	dynamic load rating	[kN]
P	equivalent dynamic bearing load	[kN]
n	service speed	[min ⁻¹]

Extended service life calculation L_{na}

In the so-called extended service life calculation according to DIN ISO 281/A2:2001 other factors of influence are additionally taken into consideration such as safety needs, special lubrication ratios and in particular the degree of the contamination as well as modified working conditions by mutated materials.

$$L_{na} = a_1 \cdot a_2 \cdot a_3 \cdot L_{10} \quad [h] \quad [2.5]$$

L_{na}	extended service life, hours of operation
a_1	lifetime expectation
a_2	material dependent coefficient $a_2 = a_{2b} \cdot a_{2s} \cdot a_{2w}$
a_3	operating conditions

Lifetime expectation a_1

Lifetime expectation	L_{na}	a_1
90	L_{10a}	1
95	L_{5a}	0.62
96	L_{4a}	0.53
97	L_{3a}	0.44
98	L_{2a}	0.33
99	L_{1a}	0.21

Material dependent coefficient a_2

When using high quality bearing steel 100Cr6 (1.3505) the life cycle coefficient a_2 is usually considered to be 1. However, surface coatings (ATCoat coating), heat stabilisation of the steel and the application of ceramic rolling elements (silicon nitrides) change the coefficient a_2 . Hence, the upgrading with individual factors a_{2b} , a_{2s} and a_{2w} is advisable.

$$a_2 = a_{2b} \cdot a_{2s} \cdot a_{2w} \quad [2.6]$$

Ring-material	a_{2b}	Heat stabilisation	a_{2s}	Rolling element material	a_{2w}
100 Cr6	1	150 °C	1	100Cr6	1
IR ATCoat	1.25	200 °C	0.75	ceramic Si ₃ N ₄	2
OR ATCoat	1.2	250 °C	0.45		
IR+OR ATCoat	1.5				

Life cycle coefficient a_3

Working conditions, such as the propriety of the lubrication at service speed and at operating temperature, absolute cleanness in the lubrication spot or foreign matters have a strong impact on the service life of bearings. The life cycle coefficient a_3 consists of the steel adjustment factor a_{3ts} (provided that this hasn't already been taken into consideration as a temperature stabilising factor a_{2s} , then $a_{3ts} = 1$ also with 150 °C) and the factor a_{3vi} , which also takes the viscosity at operating temperature and impurity into consideration.

$$a_3 = a_{3ts} \cdot a_{3vi} \quad [2.7]$$

a_{3ts} steel temperature coefficient (up to 150 °C)
 a_{3vi} viscosity coefficient

In addition, it is recommended to compare the grease service life with the later estimated bearing service life L_{na} .

Life cycle coefficient a_{3vi}

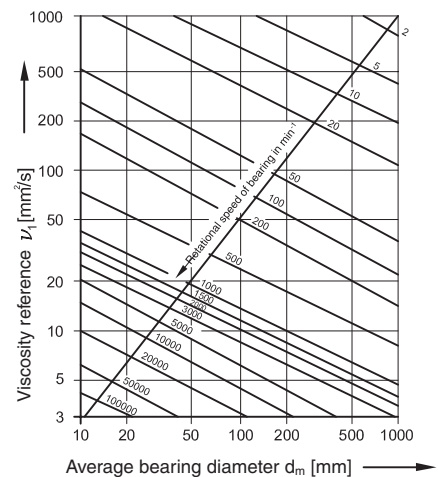
The degree of surface separation at the touching points when in contact with the rollers is decisive for the effectiveness of the lubricant. It is essential that the lubricant has a certain minimum degree of viscosity at operating temperature so that it is able to build up a lubricant film that supports loads sufficiently. Regarding this, the viscosity ratio κ serves as a measure of the effectiveness of the lubricant at operating temperature.

κ marks the ratio of the actual kinematic viscosity ν to the kinematic viscosity ν_1 which is necessary for sufficient lubrication.

First of all the viscosity reference ν_1 is determined depending on the rotational speed n and on the average diameter of the bearing d_m according to diagramme 40-501. Then the actual viscosity ν at operating temperature is taken from diagramme 40-502. The ratio of both values to each other is the κ -value.

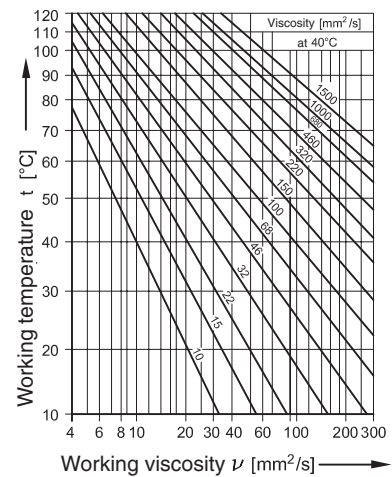
$$\kappa = \nu / \nu_1 \quad [2.8]$$

κ viscosity ratio
 ν actual kinematic viscosity of the lubricant at working temperature [mm²/s]
 ν_1 necessary kinematic viscosity of the lubricant at working temperature [mm²/s]



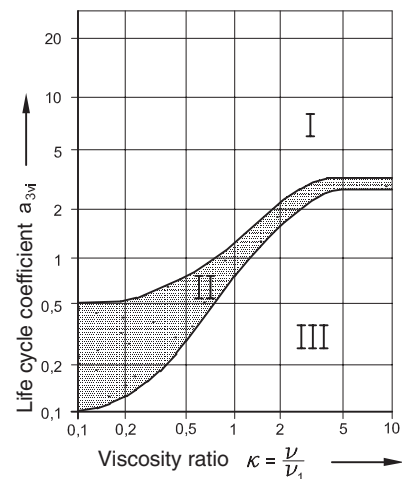
Necessary kinematic viscosity ν_1

40-501



Viscosity ν at working temperature for mineral oil

40-502



Curve a_{3vi} depending on κ

40-503

Once the operating temperature is known or determinable, then the according viscosity at the internationally specified reference temperature of 40 °C can be determined using picture 40-502 or calculated according to DIN EN ISO 3104:1999. The viscosity index 95 forms the basis for this chart and applies to mineral oil. The lubricants that show this viscosity value cover a large part of the requirements within bearing technology.

When a lubricant's density deviates from $\varphi = 0.9 \text{ g/cm}^3$ (mineral oil), then κ has to be corrected by multiplying it with the density ratio of $\varphi / 0.9 \text{ g/cm}^3$ (this is of particular concern with high temperature greases).

With the κ -value the life cycle coefficient a_{3vi} can be determined by means of the range of variation curve as shown in picture 40-503. The continuous curve is valid for regular working conditions and at regular purity degree of the lubricant. Higher values within the range of variation can be achieved by use of suitable additives in the area $\kappa < 1$. Additives such as solid active ingredients, polar active ingredients and polymer active ingredients reduce the wear, help prevent corrosion, reduce friction and improve adhesion of the lubricants in the lubrication gaps. Small loads, high cleanness and suitable additives also enable a_{3vi} factors in the area of 1, in particular with κ -values > 1 .

Influence of the cleanness inside the lubrication gap on the a_{3vi} -value

Depending on the size of the bearings, limit values over the maximum size of the run over particles with the hardness $> 50 \text{ HRC}$ are given for point contact and for line contact. Oil cleanness classes are determined according to ISO 4406 and filter-restraining rates are defined according to ISO 4572 (e.g. $\beta_{6 > 75}$ means that of 75 particles $> 6 \mu\text{m}$ only one may pass the filter). 5 purity standards are determined for the oil purity standards and accompanying filter-backing rates, graded according to average bearing diameter d_m . On this occasion it should be considered that filters that are bigger than $\beta_{25 > 75}$ generally shouldn't be used because of their service life. In special requirements for the running accuracy of spindles one single $5 \mu\text{m}$ sized dust particle of a hardness $> 50 \text{ HRC}$ is already too much for special applications. In these cases highest purity standards should be generally applied.

Accessible a_{3vi} values in picture 40-503:

- > 1 Best conditions: no foreign matter, grease is applied through smallest possible filters (noise-checked grease), highest oil purity standard

Dynamic axial load-carrying capacity

Besides taking on radial loads, bearings with ribs on the inner ring and outer ring are also able to take on axial loads. The axial sliding surfaces of the rollers and ribs decisively determine the axial load capacity, and it predominantly depends on the factors lubrication, operating temperature and heat removal dissipation from the bearing. Usually a viscosity ratio of $\kappa \geq 2$ can be assumed as well as a specific heat removal dissipation of $0.5 \text{ mW/mm}^2 \text{ K}$ referring to the bearing shell surface ($\pi \cdot D \cdot B$) as well as a difference in temperature of $60 \text{ }^\circ\text{C}$ between operating temperature of the bearing and temperature of the installation surroundings, so that the maximum value of the constant axial load can be determined exactly enough by using the following formula:

$$F_{a \max} = \frac{k_1 \cdot C_0 \cdot 10^4}{n \cdot (d + D)} - k_2 \cdot F_r \quad [2.9]$$

$F_{a \max}$	maximum axial load	[kN]
C_0	static load rating	[kN]
F_r	radial component of the load	[kN]
k_1	bearing coefficient	
	1.5 with oil lubrication	
	1.0 with grease lubrication	
k_2	bearing coefficient	
	0.15 with oil lubrication	
	0.10 with grease lubrication	
n	service speed	[min ⁻¹]
d	diameter of bearing bore	[mm]
D	outer diameter of bearing	[mm]
B	bearing width	[mm]

For the actual viscosity with grease lubrication the viscosity of the base oil is to be used. If there is a viscosity ratio of $\kappa < 2$ then both friction and wear increase. With low rotational speed this can be reduced by using e.g. oils with wear protection and suitable EP additives.

For continuing axial loads the application of greases which are distinguished with an oil separation of at least 3% according to DIN 51817 is recommended. Besides, lubrication intervals ought to be reduced. Please notice that the shown maximum axial load value is valid under the circumstance that constant axial load is provided with sufficient lubrication of the contact surfaces. If short period active axial loads or shock impact axial loads appear, then higher limit values are permitted. Nevertheless, it should be seen to the fact that the limit values are not exceeded with regard to the lip crack.

In order to avoid lip crack the limit values concerning rib stress are necessarily to be complied with. With single row cylindrical roller bearings of series 2 the constant axial load shouldn't exceed the value $F_a = 0.0045 \cdot D^{1.5}$. With all remaining series the $F_a = 0.0023 \cdot D^{1.7}$ should be kept. If only an occasional active axial load is given for a short period of time, then following limit values shouldn't be exceeded:

Series 2:	$F_a = 0.013 \cdot D^{1.5}$	
Other series:	$F_a = 0.007 \cdot D^{1.7}$	[2.10]

F_a	permanent or occasional axial load	[kN]
D	outer diameter of bearing	[mm]

The size of the contact surfaces on the counterparts and the axial runout accuracy is also important for a constant rib load as well as for a sufficient runout accuracy of the shaft with axially highly loaded cylindrical roller bearings. Thus, a support of the ribs on the complete height is recommendable. Please notice that with very strong bending of the shaft bending fatigue stresses can appear, caused by the support of the boards.

9. Rotational speed determination

Thus, e.g., the diameter of the shaft shoulder for the board on the inner ring arises as follows:

$$d_{as} = 0.5 \cdot (d_1 + F) \quad [3.1]$$

d_{as}	recommended min. diameter of shaft shoulder	[mm]
d_1	diameter of inner ring shoulder	[mm]
F	diameter of inner ring track	[mm]

If skewing between inner ring and outer ring occurs for more than one angular minute, then this causes an essential change of the force introduction ratios of the shoulders. This may cause loss of the included safety factor, resulting in lower permissible axial loads. In these cases please contact our technical consultation teams.

Reference rotational speed n_r

In general, the rotational speed of bearings is limited by the maximum operating temperature and depends on the used lubricant and the form stability as well as on the load of the used materials. The rotational speed that is to be reached by taking the allowed operating temperature into account is influenced by the heat that is generated in the installation surroundings of the bearing, by the frictional heat originating in the bearing as well as by the heat quantity dissipated by the bearing itself.

The reference rotational speed is a comparative value, with which under fixed defined operational conditions a heat balance is achieved between the heat generated in the bearing and the heat that is dissipated by the lubricant, the shaft and the housing.

According to the load conditions and lubrication conditions that are standardised in ISO 15312 the reference rotational speed (n_r) is the same for oil and grease which refers to a persistent temperature of +70 °C at ambient temperature of 20 °C.

With constant radial load of 5 % of the static load rating C_0 either an oil bath lubrication reaching up to the middle of the lower rolling element with a mineral oil without EP additives and with a kinematic viscosity of 12 mm²/s at an operating temperature of 70 °C (ISO VG 32) or, alternatively, a grease lubrication based on lithium soap mineral oil with a viscosity of 100 to 200 mm²/s at 40 °C (base oil ISO VG 150) with a grease filling amount of approx. 30% of the space have been considered.

With grease lubrication a temperature persistence of 70 °C can be achieved after a grease distribution run of 10 to 20 hours. With rotational outer ring the values may possibly decrease.

Please note that, in comparison with plastic cages made out of glass fibre filled polyamide PA6.6, the rotational speed has to be reduced for steel metal sheet cages or for solid brass cages.

Cylindrical roller bearing	Speed Parameter d_k [mm]		
	15	8	4
C / P			
Loose fit bearing	450 000	300 000	150 000
Locating bearing without outer axial load or with only light, but alternating axial load	300 000	200 000	100 000
Locating bearing with constant, light axial load	200 000	120 000	60 000

Conversion coefficients for critical rotational speed

Bearing with standard cage	alternative standard cages		
	K, P, J, M1	M1A	MC, MCA
K, P, J, M1	1	1.30	1.45
M1A	0.75	1	1.20
MC, MCA	0.70	0.85	1

Determination of the max. service speed n_{max} depending on load and oil viscosity

The reference rotational speed n_r is only defined for a certain proportional load and under a certain lubrication condition, so that with other loads and oil viscosities the max. service speed n_{max} has to be re-determined with relevant coefficients. At operating temperatures of 70 °C the max. rotational speed can be determined as follows in dependency of the load and the oil viscosity:

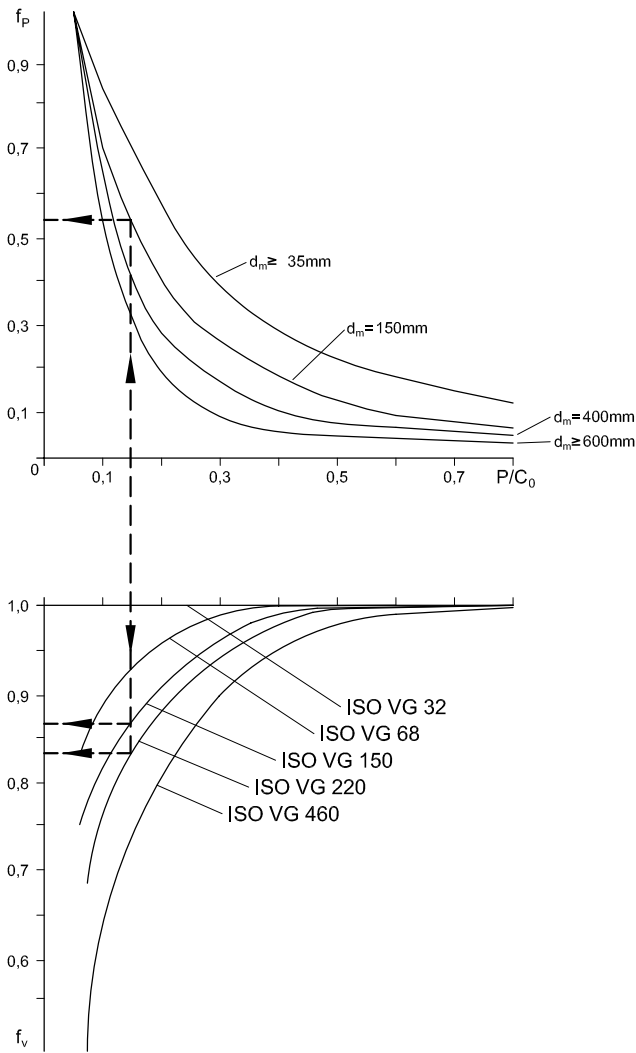
$$n_{max} = f_p \cdot f_v \cdot n_r \quad [3.2]$$

n_{max}	max. service speed	[min ⁻¹]
f_p	correction factor for the bearing load	
f_v	correction factor for the oil viscosity	
n_r	rotational reference speed	[min ⁻¹]

As a function from the ratio of P to C_0 and the average bearing diameter d_m , approximate values for the correction factors f_p and f_v can be determined.

The diagramme in picture 46-501 on page 16 shows approximate values for the f_p -value that is dependent on load and for the f_v -factor for oil lubrication that is dependent on viscosity.

10. Lubrication



Corrections factors f_p and f_v for radial roller bearings

40-501

With grease lubrication two values for f_v are determined out of the diagramme and are calculated as a ratio to each other:

$$n_{\max} = f_p \cdot n_r \cdot f_v \text{ base oil actual} / f_v \text{ base oil ISO VG 150} \quad [3.3]$$

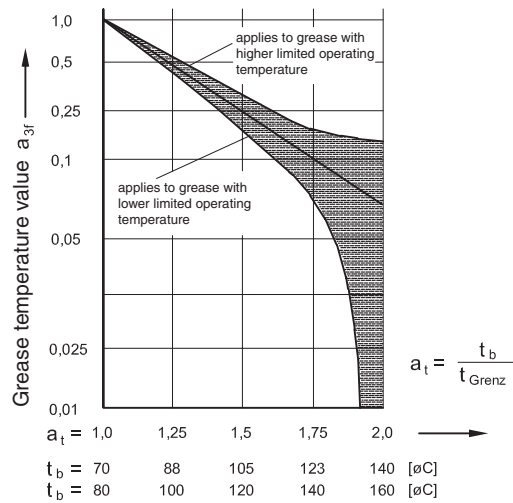
Rotational speed higher than reference rotational speed

Rotational speed that is higher than the reference rotational speed lead to excessive bearing temperatures, unless corrective actions are undertaken such as heat absorbing oil circulation lubrication, air-cooling or liquid cooling of the inner ring and outer ring. High bearing temperatures reduce the lubricant's viscosity, thus perhaps preventing a lubricant film that is sufficient for carrying loads. This results in higher friction causing higher temperature, and, at the same time reducing internal clearance. A seizure of the bearings as a result of extended sliding friction, can result from this.

Grease life

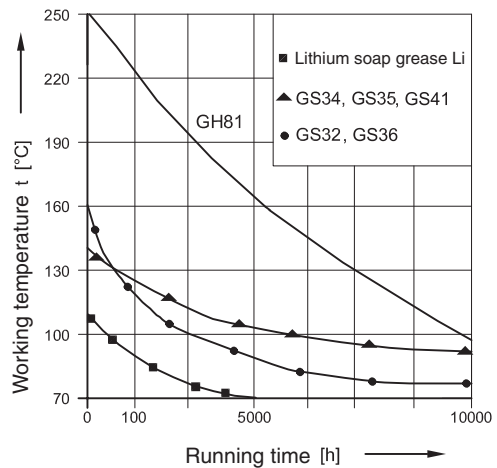
Greases age faster at higher operating temperatures than at operating temperatures of 70 °C. If the working temperature is higher than 70 °C as a result of own heat generation or because of surrounding heat then the complete service life of the bearing could depend on the service life of the grease. We advise to compare the service life of the bearing with the grease service life separately, as the bearing service life is reduced if the thickness of the lubricant film is not sufficient enough to prevent immediate metallic contact between rolling elements, tracks and cage.

For more information on this subject also check picture 40-504, the example after picture 40-506 as well as diagramme 46-502.



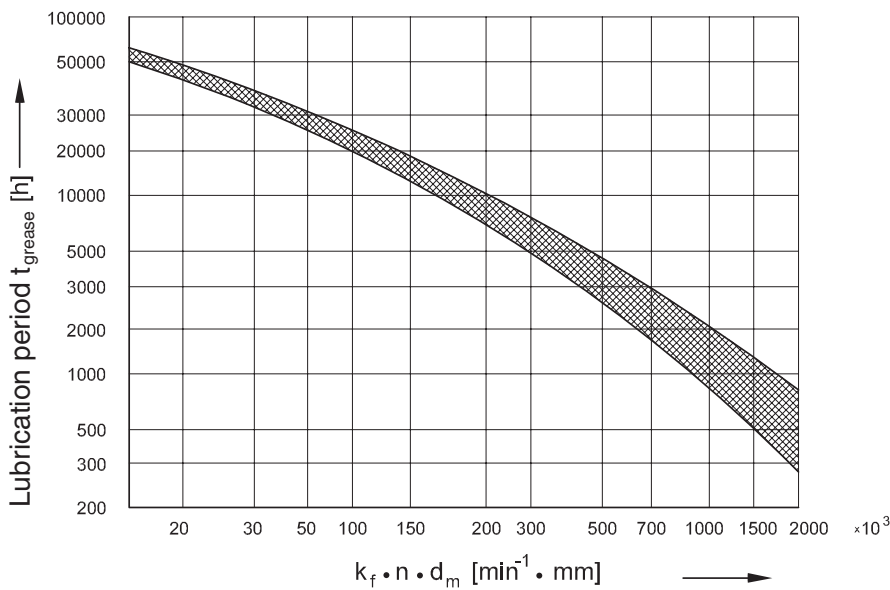
Grease fatigue life

40-504



Grease service life at certain temperatures

40-506



Cylindrical roller bearing design	k_f
single row with cage	3..3,5
full complement	25

Lubrication periods

46-502

The grease fatigue life ascertained according to picture 40-506 decreases with the grease temperature coefficient a_{3f} according to picture 40-504.

Besides the temperature, further grease service life-reduction factors are also of importance:

– vertical shaft	0.5 – 0.7
– rotating outer ring	0.6
– shock impact loads, strong vibrations, oscillations	0.1 – 0.9
– Influence of high loads C/P between 3 and 10	0.1 – 1.0
– Impurity	0.9
– Air flow through the bearing	0.1 – 0.7

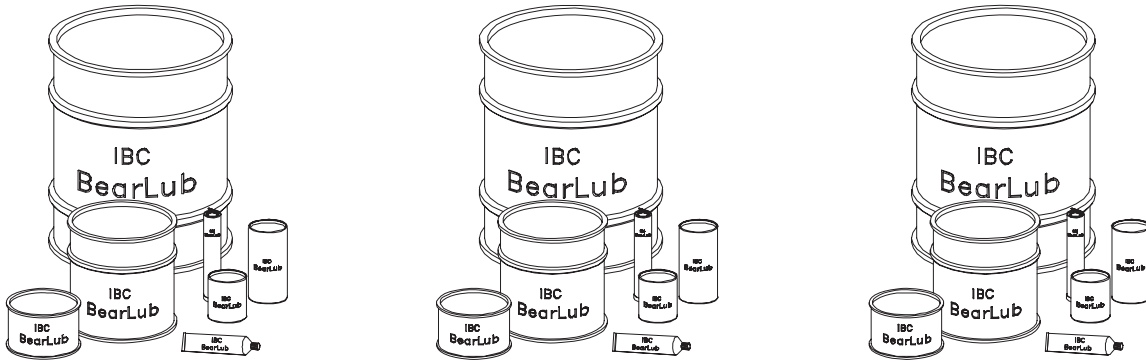
After comparing $L_{na \text{ bearing}}$ with $L_{h \text{ grease}}$ relubrication may seem sensible according to the grease service life. This depends on the ratio at of the grease operating temperature (bearing temperature on the inner ring t_b) to the max. grease temperature t_{limit} . A service life reduction of the grease is reached from t_{limit} on (mostly from $70^\circ\text{C} = 1$, e.g., with lithium soap greases on mineral oil basis; with synthetic products a considerable deviation is possible). (With lasting $a_t = 2$ no considerable grease service life is possible).

With long-term stress at short-term max. limit temperature values as shown by grease manufacturers the grease service life is extremely low.

Note

Changes in lubricant properties are possible, even with the same lubricants and from order to order. Hence, IBC can neither be held responsible for the lubricants themselves nor for their operational steadiness.

11. IBC BearLub greases – choice



14-001

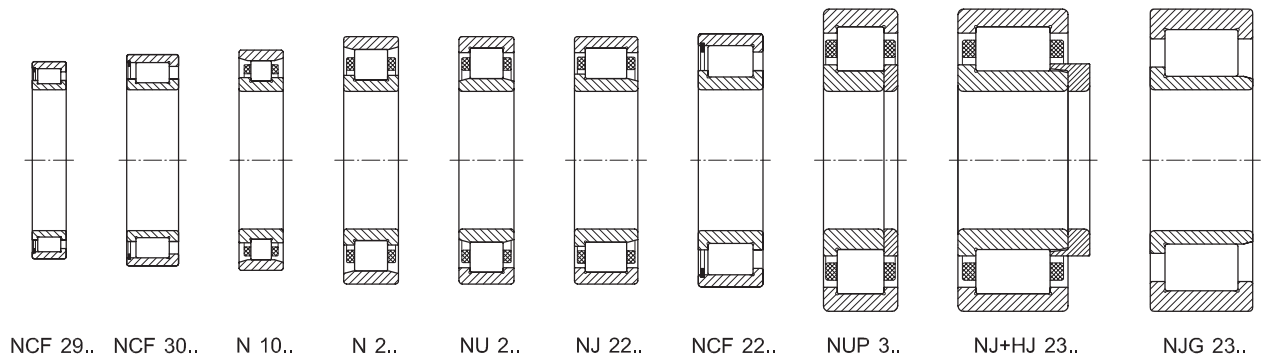
IBC suffix	Rotational figures dm · n [mm / min]	Temperature range [°C]	Consistence classification NLGI	Base oil	Viscosity of basic oil		Thickener	Density [g/cm ³]	Comments
					40°C	100°C			
GN 02	0.6	-30/+130	2	Mineral oil	100	10	Li-12 Hydro Stearat	0.9	Standard grease for single row deep groove ball bearings until D=72, noise reduced
GN 03	0.6	-25/+130	3	Mineral oil	100	10	Li-12 Hydro Stearat	0.9	Standard grese for single row deep groove ball bearings above D=72, noise reduced
GN 21	1.0	-35/+140	2	Mineral oil + EP	82	12.5	Li-12 Hydro Stearat	0.87	Multi purpose heavy duty grease for lubrication of guides and stationary housing applications
GS 32	1.0	-50/+120	2	Mineral oil + Ester oil	15	3.7	Li-soap	0.88	Noise tested grease for high rotational speed and low temperature
GS 34	1.0	-50/+120	2	Mineral oil + Ester oil	21	4.7	Ba-Complex	0.99	High speed and low temperature grease
GS 36	1.8	-40/+120	2/3	PAO Ester	25	6	Li-soap	0.94	Especially for high speed spindle bearings in machine tools
GS 41	1.0	-60/+140	2	SK-Synthetic oil	18	4	Ba-Complex soap	0.96	High speed grease for taper roller bearings
GS 75	>2.0	-50/+120	2	Ester oil + SKW	22	5	Polycarbamide	0.92	Especially for high speed spindle bearings in machine tools
GH 62	0.5	-30/+160	2/3	Ester oil + SKW	150	18	Polycarbamide	0.88	High temperature and long duration
GH 68	1.3	-35/+160	2	Ester oil	55	9	Li-soap	0.975	Grease for high temperature, heavy duty and high speed
GH 70	0.6	-40/+180	2/3	Synthetic	70	9.4	Polycarbamide	0.95	Very low noise, high temperature grease
GH 72	0.7	-40/+180	2/3	Ester oil	100	12	Polycarbamide	0.97	Low noise, life time lubrication, high temperature, corrosion protective
GH 83	0.3	-60/+250	1	Fluoridated Polyester oil	300	85	PTFE	1.94	Highest viscosity during operations under high temperature conditions
GH 88	0.3	-30/+260	2	Perfluoropolyether	55	9	PU	1.7	High thermal and chemical resistance, high performance under pressure, radiation and in vacuum
GH 90	0.6	-50/+260	2	PFPE	190	34	PTFE	1.9	High life time, consistent with most elastomers, good resistance against aggressive chemicals
GA 91	0.3	-75/+260	1/2	Silicon oil			Teflon		Resistance against corrosion and oxidation, used for aircraft industry
GF 20	0.3	-40/+120	1	Mineral oil	230	22	Al-Complex soap	0.9	Good adhesive and wear protection, used for food industry

Table 14-300: Lubrication of bearings – IBC BearLub-Greases

The mentioned speed ratio (medium bearing diameter • speed) of lubricants is a reference value for spring-preloaded bearings of medium diameter. Hybrid bearings allow for higher values (35%), roller bearings and others allow for reduced values.

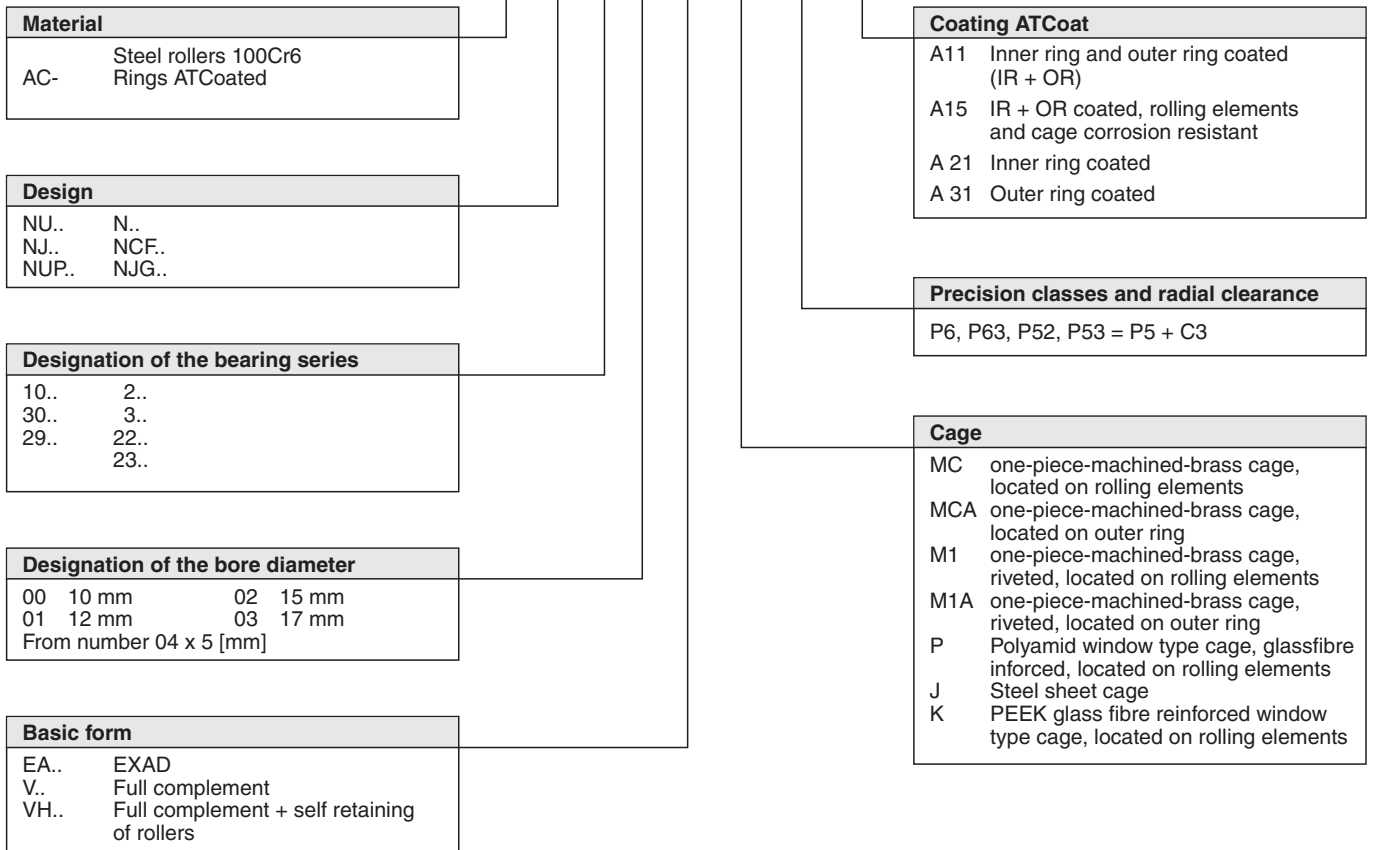
For further lubricants please ask our Technical Department.

12. Designation IBC cylindrical roller bearings



46-104

N	10	13	.	.	M1
AC-	NU	2	10	. EA	P . P52 . A15
	NJ	3	08	. EA	. MCA . C3
	NUP	22	05	. EA	. M1A . P6
	NCF	29	14	. V	
	NJG	23	24	. VH	



Designation system

44-106



N 10..



N 2..



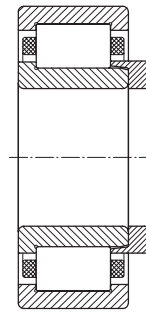
NU 2..



NJ 22..



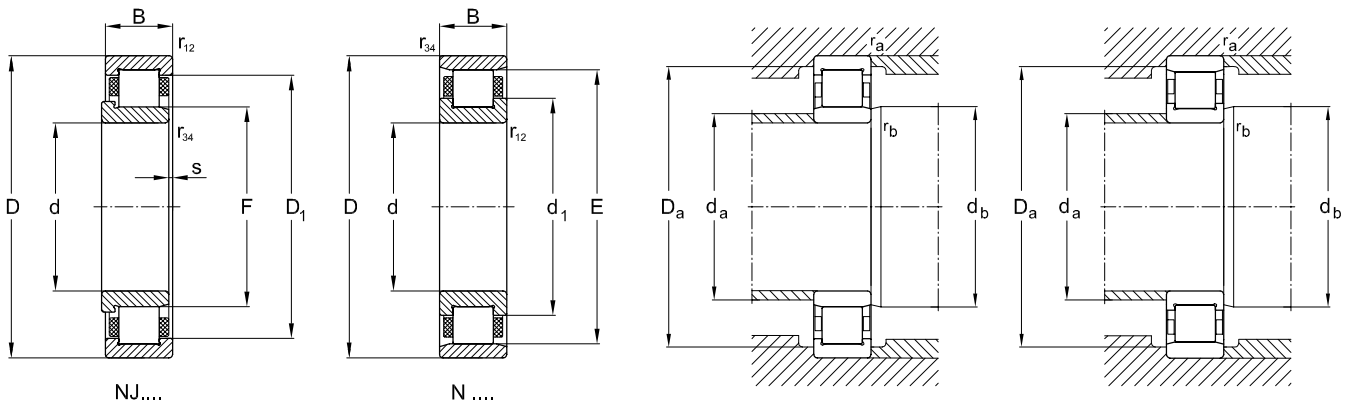
NUP 3..



NJ+HJ 23..

46-101

Basic dimensions			Basic designation	Basic load ratings		Fatigue limit load	Minimal load factor	Limiting speed	Reference speed		Weight
d	D	B		C ₀	C				P _u (radial)	k _f	
mm			N		N			min ⁻¹		kg	
15	35	11	N 202.EA	10 400	15 100	1 470	0.15	22 000	17 600	0.047	
15	35	11	NU 202.EA	10 400	13 800	1 220	0.15	24 000	19 800	0.050	
17	40	12	N 203.EA	14 600	19 000	1 730	0.15	20 000	17 200	0.070	
17	40	12	NU 203.EA	14 600	19 000	1 730	0.15	20 000	17 200	0.070	
17	40	16	NU 2203.EA	21 900	26 200	2 650	0.20	20 000	16 200	0.090	
17	47	14	NU 303.EA	21 200	27 300	2 550	0.15	17 000	14 400	0.120	
20	47	14	N 204.EA	24 700	28 800	2 750	0.15	17 500	14 500	0.130	
20	47	14	NU 204.EA	24 700	28 800	2 750	0.15	17 500	14 500	0.130	
20	47	18	NU 2204.EA	31 000	34 100	3 450	0.20	17 500	13 700	0.140	
20	52	15	NU 304.EA	26 000	36 000	3 250	0.15	16 000	13 500	0.160	
20	52	21	NU 2304.EA	38 000	48 000	4 800	0.29	16 000	11 900	0.220	
25	47	12	NU 1005	12 900	16 700	1 400	0.10	18 000	18 000	0.080	
25	52	15	N 205.EA	27 500	31 600	3 350	0.15	15 500	12 900	0.140	
25	52	15	NU 205.EA	27 500	31 600	3 350	0.15	15 500	12 900	0.140	
25	52	18	NU 2205.EA	34 500	37 800	4 250	0.20	15 500	11 900	0.170	
25	62	17	NU 305.EA	36 500	47 300	4 550	0.15	13 500	11 100	0.250	
25	62	24	NU 2305.EA	55 000	65 000	6 950	0.25	13 500	10 200	0.350	
30	55	13	NU 1006	19 300	22 900	1 860	0.10	15 000	14 000	0.130	
30	62	16	N 206.EA	36 000	44 500	4 550	0.15	13 000	11 400	0.210	
30	62	16	NU 206.EA	36 000	44 500	4 550	0.15	13 000	11 400	0.210	
30	62	20	NU 2206.EA	48 500	56 000	6 100	0.20	13 000	10 600	0.270	
30	72	19	NU 306.EA	48 000	59 800	6 200	0.15	11 000	10 000	0.370	
30	72	27	NU 2306.EA	75 000	84 500	9 650	0.25	11 000	9 100	0.530	
35	62	14	NU 1007	26 000	29 000	4 550	0.10	13 000	12 000	0.180	
35	72	17	N 207.EA	48 500	57 000	6 100	0.15	11 000	9 600	0.310	
35	72	17	NU 207.EA	48 500	57 000	6 100	0.15	11 000	9 600	0.310	
35	72	23	NU 2207.EA	64 000	70 700	8 150	0.20	11 000	9 100	0.410	
35	80	21	NU 307.EA	63 000	75 500	8 150	0.15	10 000	8 800	0.490	
35	80	31	NU 2307.EA	98 000	107 000	12 700	0.25	10 000	8 100	0.730	
40	68	15	NU 1008	30 500	33 500	3 000	0.10	18 000	11 000	0.230	
40	80	18	N 208.EA	53 000	62 500	6 700	0.15	10 000	8 500	0.380	
40	80	18	NU 208.EA	53 000	62 500	6 700	0.15	10 000	8 500	0.380	
40	80	23	NU 2208.EA	75 000	82 200	9 650	0.20	10 000	7 900	0.500	
40	90	23	NU 308.EA	78 000	94 000	10 200	0.15	8 500	7 600	0.660	
40	90	33	NU 2308.EA	119 000	130 500	15 300	0.25	8 500	7 000	0.960	



46-101

Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d ₁ mm	D ₁	r ₁₂ min	r ₃₄ min	d _a min	D _a max	D _b max mm	r _a max	r _b max
N 202.EA	–	30.3	0.5	21.6	–	0.6	0.3	17.4	32.6	31.0	0.6	0.3
NU 202.EA	19.3	–	1	22.0	28.0	0.6	0.3	17.4	30.8	23.0	0.6	0.3
N 203.EA	–	35.1	1	25.2	–	0.6	0.3	21.2	37.6	37.0	0.6	0.3
NU 203.EA	22.1	–	1	25.2	32.5	0.6	0.3	19.4	35.8	24.0	0.6	0.3
NU 2203.EA	22.1	–	1.5	25.2	32.5	0.6	0.3	19.4	35.8	24.0	0.6	0.3
NU 303.EA	24.2	–	1.5	27.7	37.1	1.0	0.6	21.2	41.4	26.0	1.0	0.6
N 204.EA	–	41.5	1	29.9	–	1.0	0.6	25.6	42.8	43.0	1.0	0.6
NU 204.EA	26.5	–	1	29.9	38.8	1.0	0.6	24.2	41.4	31.0	1.0	0.6
NU 2204.EA	26.5	–	2	29.9	38.8	1.0	0.6	24.2	41.4	31.0	1.0	0.6
NU 304.EA	27.5	–	0.9	31.4	42.4	1.1	0.6	24.2	45.0	29.0	1.0	0.6
NU 2304.EA	27.5	–	1.9	31.8	42.4	1.1	0.6	24.2	45.0	29.0	1.0	0.6
NU 1005	30.5	–	2	32.7	39.3	0.6	0.3	27.0	43.8	32.0	0.6	0.3
N 205.EA	–	46.5	1.3	34.9	–	1.0	0.6	30.6	46.4	33.0	1.0	0.6
NU 205.EA	31.5	–	1.3	34.9	43.8	1.0	0.6	29.2	47.8	48.0	1.0	0.6
NU 2205.EA	31.5	–	1.8	34.9	43.8	1.0	0.6	29.2	46.4	33.0	1.0	0.6
NU 305.EA	34	–	1.3	38.3	50.7	1.1	1.1	32.0	55.0	36.0	1.0	1.0
NU 2305.EA	34	–	2.3	38.3	50.7	1.1	1.1	32.0	55.0	36.0	1.0	1.0
NU 1006	36.5	–	2.1	38.9	46.1	1.0	0.6	33.2	50.4	38.0	1.0	0.6
N 206.EA	–	55.5	1.3	41.4	–	1.0	0.6	35.6	57.8	57.0	1.0	0.6
NU 206.EA	37.5	–	1.3	41.4	52.5	1.0	0.6	34.2	56.4	39.0	1.0	0.6
NU 2206.EA	37.5	–	1.8	41.4	52.5	1.0	0.6	34.0	57.0	39.0	1.0	0.6
NU 306.EA	40.5	–	1.4	45.1	59.2	1.1	1.1	37.0	65.0	42.0	1.0	1.0
NU 2306.EA	40.5	–	2.4	45.1	59.2	1.1	1.1	37.0	65.0	42.0	1.0	1.0
NU 1007	42	–	1	44.6	52.4	1.0	0.6	38.2	56.0	44.0	1.0	0.6
N 207.EA	–	64	1.3	48.3	–	1.1	0.6	42.0	67.8	66.0	1.0	0.6
NU 207.EA	44	–	1.3	48.3	61.0	1.1	0.6	39.2	65.0	46.0	1.0	0.6
NU 2207.EA	44	–	2.8	48.3	61.0	1.1	0.6	39.2	65.0	46.0	1.0	0.6
NU 307.EA	46.2	–	1.2	51.2	66.6	1.5	1.1	42.0	71.0	48.0	1.5	1.0
NU 2307.EA	46.2	–	2.7	51.2	66.6	1.5	1.1	42.0	71.0	48.0	1.5	1.0
NU 1008	47	–	2.4	49.8	58.2	1.0	0.6	43.2	63.4	49.0	1.0	0.6
N 208.EA	–	71.5	1.4	54.1	–	1.1	1.1	47.0	73.0	73.0	1.0	1.0
NU 208.EA	49.5	–	1.4	54.1	68.3	1.1	1.1	47.0	73.0	51.0	1.0	1.0
NU 2208.EA	49.5	–	1.9	54.1	68.3	1.1	1.1	47.0	73.0	51.0	1.0	1.0
NU 308.EA	52	–	1.4	57.7	75.9	1.5	1.5	49.0	81.0	54.0	1.5	1.5
NU 2308.EA	52	–	2.9	57.7	75.9	1.5	1.5	49.0	81.0	54.0	1.5	1.5



N 10..



N 2..



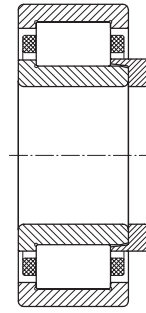
NU 2..



NJ 22..



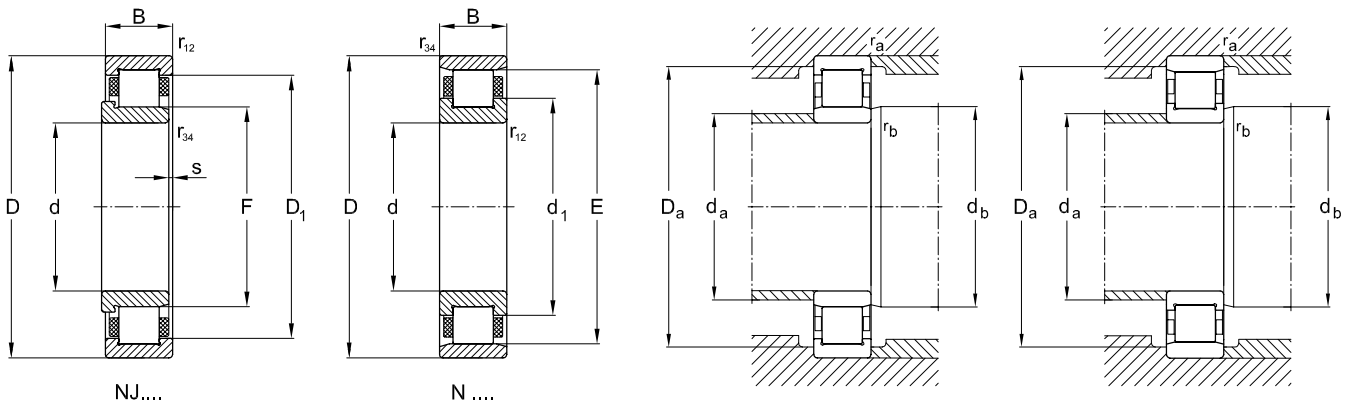
NUP 3..



NJ+HJ 23..

46-101

Basic dimensions			Basic designation	Basic load ratings		Fatigue limit load	Minimal load factor	Limiting speed		Reference speed	Weight
d	D	B		C ₀	C			P _u (radial)	k _f		
mm				N	N	N		min ⁻¹		kg	
45	75	16	NU 1009	37 500	40 000	6 300	0.10	11 000	9 500	0.290	
45	85	19	N 209.EA	63 000	70 700	8 150	0.15	9 000	8 000	0.440	
45	85	19	NU 209.EA	63 000	70 700	8 150	0.15	9 000	8 000	0.440	
45	85	23	NU 2209.EA	82 000	86 000	10 600	0.20	9 000	7 400	0.540	
45	100	25	NU 309.EA	98 000	113 500	12 900	0.15	7 600	7 000	0.890	
45	100	36	NU 2309.EA	153 000	161 000	20 000	0.25	7 600	6 400	1.300	
50	80	16	NU 1010	41 500	42 500	6 700	0.10	9 500	9 000	0.310	
50	90	20	N 210.EA	69 000	74 000	8 800	0.15	8 500	7 600	0.490	
50	90	20	NU 210.EA	69 000	74 000	8 800	0.15	8 500	7 600	0.490	
50	90	23	NU 2210.EA	88 000	91 000	11 400	0.20	8 500	6 900	0.570	
50	110	27	NU 310.EA	113 000	128 500	15 000	0.15	7 100	6 400	1.150	
50	110	40	NU 2310.EA	187 000	189 000	24 500	0.25	7 100	5 800	1.800	
55	90	18	NU 1011	62 000	53 000	8 300	0.10	8 500	8 000	0.450	
55	100	21	N 211.EA	95 000	98 000	12 200	0.15	7 500	6 600	0.660	
55	100	21	NU 211.EA	95 000	98 000	12 200	0.15	7 500	6 600	0.660	
55	100	25	NU 2211.EA	118 000	115 500	15 300	0.20	7 500	6 100	0.790	
55	120	29	NU 311.EA	139 000	157 500	18 600	0.15	6 300	5 800	1.500	
55	120	43	NU 2311.EA	230 000	233 500	30 500	0.25	6 300	5 300	2.200	
60	95	18	NU 1012	55 000	52 000	5 300	0.10	11 000	8 000	0.480	
60	110	22	N 212.EA	102 000	110 000	13 400	0.15	6 900	6 000	0.830	
60	110	22	NU 212.EA	102 000	110 000	13 400	0.15	6 900	6 000	0.830	
60	110	28	NU 2212.EA	152 000	149 000	20 000	0.20	6 900	5 500	1.100	
60	130	31	NU 312.EA	157 000	175 000	20 800	0.15	5 800	5 400	1.850	
60	130	46	NU 2312.EA	260 000	263 000	34 500	0.25	5 800	4 900	2.800	
65	100	18	NU 1013	58 000	53 000	9 800	0.10	7 500	7 000	0.510	
65	120	23	N 213.EA	119 000	124 500	15 600	0.15	6 300	5 600	1.050	
65	120	23	NU 213.EA	119 000	124 500	15 600	0.15	6 300	5 600	1.050	
65	120	31	NU 2213.EA	181 000	173 000	24 000	0.20	6 100	5 200	1.450	
65	140	33	NU 313.EA	191 000	213 000	25 500	0.15	5 400	5 100	2.300	
65	140	48	NU 2313.EA	285 000	290 000	38 000	0.25	5 400	4 600	3.350	
70	110	20	NU 1014	78 000	75 000	12 000	0.10	7 000	6 300	0.700	
70	125	24	N 214.EA	137 000	138 500	18 000	0.15	5 800	5 300	1.150	
70	125	24	NU 214.EA	137 000	138 500	18 000	0.15	5 800	5 300	1.150	
70	125	31	NU 2214.EA	194 000	182 000	25 500	0.20	5 800	4 900	1.550	
70	150	35	NU 314.EA	222 000	239 000	29 000	0.15	5 000	4 600	2.800	
70	150	51	NU 2314.EA	325 000	320 000	41 500	0.25	5 000	4 300	4.000	



46-101

Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d ₁ mm	D ₁	r _{12min}	r _{34min}	d _a min	D _a max	D _b max mm	r _a max	r _b max
NU 1009	52.5	—	0.9	55.5	64.5	1.0	0.6	48.2	70.4	54.0	1.0	0.6
N 209.EA	—	76.5	1.2	59.1	—	1.1	1.1	52.0	78.0	78.0	1.0	1.0
NU 209.EA	54.5	—	1.2	59.1	73.3	1.1	1.1	52.0	78.0	56.0	1.0	1.0
NU 2209.EA	54.5	—	1.7	59.1	73.3	1.1	1.1	52.0	78.0	56.0	1.0	1.0
NU 309.EA	58.5	—	1.7	64.6	84.1	1.5	1.5	54.0	91.0	61.0	1.5	1.5
NU 2309.EA	58.5	—	3.2	64.6	84.1	1.5	1.5	54.0	91.0	61.0	1.5	1.5
NU 1010	57.5	—	1	60.5	69.5	1.0	0.6	53.2	75.4	60.0	1.0	0,
N 210.EA	—	81.5	1.5	64.6	—	1.1	1.1	57.0	83.0	83.0	1.0	1.0
NU 210.EA	59.5	—	1.5	64.6	78.3	1.1	1.1	57.0	83.0	62.0	1.0	1.0
NU 2210.EA	59.5	—	1.5	64.6	78.3	1.1	1.1	57.0	83.0	62.0	1.0	1.0
NU 310.EA	65	—	1.9	71.4	92.5	2.0	2.0	61.0	99.0	67.0	2.0	2.0
NU 2310.EA	65	—	3.4	71.4	92.5	2.0	2.0	61.0	99.0	67.0	2.0	2.0
NU 1011	64.5	—	0.5	67.7	79.2	1.1	1.0	59.6	84.0	67.0	1.0	1.0
N 211.EA	—	90	1	71.0	—	1.5	1.1	64.0	93.0	92.0	1.5	1.0
NU 211.EA	66	—	1	71.0	86.6	1.5	1.1	62.0	91.0	68.0	1.5	1.0
NU 2211.EA	66	—	1.5	71.0	86.6	1.5	1.1	62.0	91.0	68.0	1.5	1.0
NU 311.EA	70.5	—	2	77.7	101.4	2.0	2.0	66.0	109.0	73.0	2.0	2.0
NU 2311.EA	70.5	—	3.5	77.7	101.4	2.0	2.0	66.0	109.0	73.0	2.0	2.0
NU 1012	69.5	—	2.9	72.7	82.3	1.1	1.0	64.6	89.0	72.0	1.0	1.0
N 212.EA	—	100	1.4	77.7	—	1.5	1.5	69.0	101.0	101.0	1.5	1.5
NU 212.EA	72	—	1.4	77.7	96.1	1.5	1.5	69.0	101.0	74.0	1.5	1.5
NU 2212.EA	72	—	1.4	77.7	96.1	1.5	1.5	69.0	101.0	74.0	1.5	1.5
NU 312.EA	77	—	2.1	84.5	109.6	2.1	2.1	72.0	118.0	79.0	2.0	2.0
NU 2312.EA	77	—	3.6	84.5	109.6	2.1	2.1	72.0	118.0	79.0	2.0	2.0
NU 1013	74.5	—	1	77.7	87.3	1.1	1	69.6	94.0	77.0	1.0	1.0
N 213.EA	—	108.5	1.4	84.6	—	1.5	1.5	74.0	111.0	111.0	1.5	1.5
NU 213.EA	78.5	—	1.4	84.6	104.3	1.5	1.5	74.0	111.0	81.0	1.5	1.5
NU 2213.EA	78.5	—	1.9	84.6	104.3	1.5	1.5	74.0	111.0	81.0	1.5	1.5
NU 313.EA	82.5	—	2.2	90.7	118.6	2.1	2.1	77.0	128.0	85.0	2.0	2.0
NU 2313.EA	82.5	—	4.7	90.7	118.6	2.1	2.1	77.0	128.0	85.0	2.0	2.0
NU 1014	80	—	1.3	84.0	96.0	1.1	1.0	74.6	104.0	82.0	1.0	1.0
N 214.EA	—	113.5	1.2	89.6	—	1.5	1.5	79.0	116.0	116.0	1.5	1.5
NU 214.EA	83.5	—	1.2	89.6	109.4	1.5	1.5	79.0	116.0	86.0	1.5	1.5
NU 2214.EA	83.5	—	1.7	89.6	109.4	1.5	1.5	79.0	116.0	86.0	1.5	1.5
NU 314.EA	89	—	1.8	97.5	126.8	2.1	2.1	82.0	138.0	91.0	2.0	2.0
NU 2314.EA	89	—	4.8	97.5	126.8	2.1	2.1	82.0	138.0	91.0	2.0	2.0



N 10..



N 2..



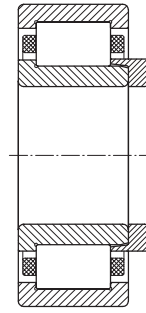
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NJ 22..



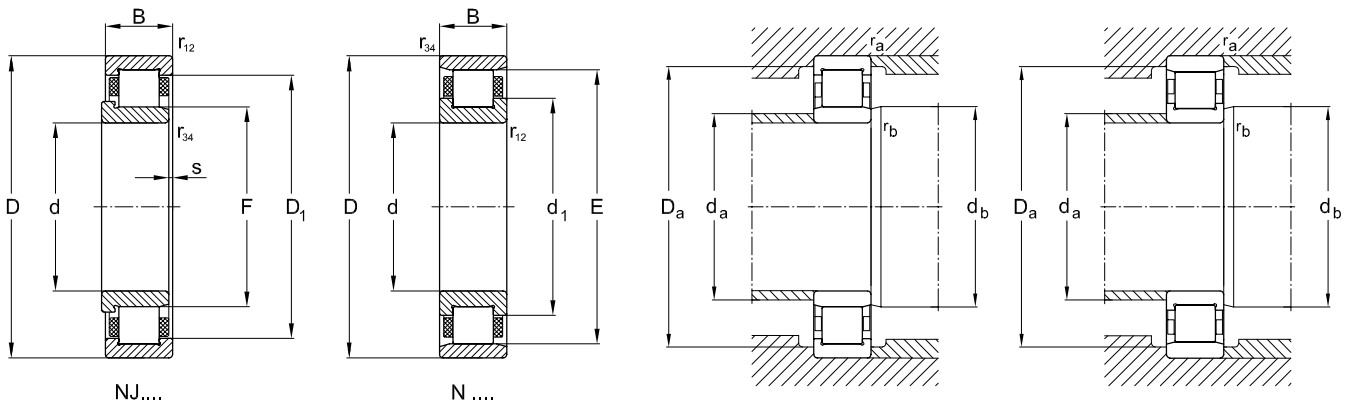
NUP 3..



NJ+HJ 23..

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Basic dimensions			Basic designation	Basic load ratings stat.		Fatigue limit load	Minimal load factor	Limiting speed		Reference speed	Weight
d	D	B		C ₀	C			P _u (radial)	k _f		
mm				N	N	N		min ⁻¹		kg	
75	115	20	NU 1015	82 000	76 000	8 500	0.10	10 000	6 700	0.740	
75	130	25	N 215.EA	156 000	152 000	20 400	0.15	5 600	5 000	1.300	
75	130	25	NU 215.EA	156 000	152 000	20 400	0.15	5 600	5 000	1.300	
75	130	31	NU 2215.EA	207 000	188 500	27 000	0.20	5 600	4 600	1.600	
75	160	37	NU 315.EA	265 000	282 500	33 500	0.15	4 600	4 300	3.400	
75	160	55	NU 2315.EA	395 000	385 000	50 000	0.25	4 600	4 000	5.000	
80	125	22	NU 1016	99 000	91 000	10 400	0.10	6 300	6 300	0.990	
80	140	26	N 216.EA	167 000	162 000	21 200	0.15	5 200	4 700	1.550	
80	140	26	NU 216.EA	167 000	162 000	21 200	0.15	5 200	4 700	1.550	
80	140	33	NU 2216.EA	243 000	216 000	31 000	0.20	5 200	4 300	2.100	
80	170	39	NU 316.EA	275 000	300 000	36 000	0.15	4 400	4 200	4.000	
80	170	58	NU 2316.EA	425 000	417 000	55 000	0.25	4 400	3 900	6.000	
85	130	22	NU 1017	103 000	93 000	10 800	0.10	9 000	6 000	1.100	
85	150	28	N 217.EA	194 000	192 000	24 500	0.15	4 900	4 450	1.900	
85	150	28	NU 217.EA	194 000	192 000	24 500	0.15	4 900	4 450	1.900	
85	150	36	NU 2217.EA	275 000	253 000	34 500	0.20	4 900	4 000	2.500	
85	180	41	NU 317.EA	300 000	320 000	34 500	0.15	4 200	4 000	5.000	
85	180	60	NU 2317.EA	445 000	435 000	60 000	0.25	4 200	3 600	7.000	
90	140	24	NU 1018	124 000	110 000	12 700	0.10	8 500	5 600	1.350	
90	160	30	N 218.EA	217 000	212 000	27 000	0.15	4 600	4 200	2.400	
90	160	30	NU 218.EA	217 000	212 000	27 000	0.15	4 600	4 200	2.400	
90	160	40	NU 2218.EA	315 000	282 000	39 000	0.20	4 600	3 900	3.200	
90	190	43	NU 318.EA	350 000	367 000	43 000	0.15	4 900	3 750	5.900	
90	190	64	NU 2318.EA	530 000	505 000	65 500	0.25	3 900	3 400	8.000	
95	145	24	NU 1019	130 000	113 000	13 200	0.10	8 000	5 300	1.400	
95	170	32	N 219.EA	265 000	257 000	32 500	0.15	4 300	4 000	2.900	
95	170	32	NU 219.EA	265 000	257 000	32 500	0.15	4 300	4 000	2.900	
95	170	43	NU 2219.EA	370 000	330 000	45 000	0.20	4 300	3 700	3.900	
95	200	45	NU 319.EA	380 000	390 000	46 500	0.15	3 800	3 600	6.500	
95	200	67	NU 2319.EA	580 000	535 000	69 500	0.25	3 800	3 200	9.500	
100	150	24	NU 1020	135 000	116 000	13 700	0.10	7 500	5 000	1.500	
100	180	34	N 220.EA	305 000	288 000	36 500	0.15	4 100	3 750	3.500	
100	180	34	NU 220.EA	305 000	288 000	36 500	0.15	4 100	3 750	3.500	
100	180	46	NU 2220.EA	445 000	388 000	54 000	0.20	4 100	3 450	4.800	
100	215	47	NU 320.EA	425 000	450 000	51 000	0.15	3 500	3 200	8.000	
100	215	73	NU 2320.EA	720 000	675 000	85 000	0.25	3 500	2 800	12.000	



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Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d ₁ mm	D ₁	r _{12min}	r _{34min}	d _a min	D _a max	D _b max mm	r _a max	r _b max
NU 1015	85	—	3	89.0	101.7	1.1	1.0	79.6	109.0	87.0	1.0	1.0
N 215.EA	—	118.5	1.2	94.5	—	1.5	1.5	84.0	121.0	121.0	1.5	1.5
NU 215.EA	88.5	—	1.2	94.5	114.4	1.5	1.5	84.0	121.0	91.0	1.5	1.5
NU 2215.EA	88.5	—	1.7	94.5	114.4	1.5	1.5	84.0	121.0	91.0	1.5	1.5
NU 315.EA	95	—	1.8	104.3	136.2	2.1	2.1	87.0	148.0	97.0	2.0	2.0
NU 2315.EA	95	—	4.8	104.3	136.2	2.1	2.1	87.0	148.0	97.0	2.0	2.0
NU 1016	91.5	—	3.3	95.9	109.8	1.1	1.0	86.0	119.0	94.0	1.0	1.0
N 216.EA	—	127.3	1.4	101.7	—	2.0	2.0	91.0	129.0	129.0	2.0	2.0
NU 216.EA	95.3	—	1.4	101.7	122.9	2.0	2.0	91.0	129.0	98.0	2.0	2.0
NU 2216.EA	95.3	—	1.4	101.7	122.9	2.0	2.0	91.0	129.0	98.0	2.0	2.0
NU 316.EA	101	—	2.1	110.6	143.9	2.1	2.1	92.0	158.0	104.0	2.0	2.0
NU 2316.EA	101	—	5.1	110.6	143.9	2.1	2.1	92.0	158.0	104.0	2.0	2.0
NU 1017	95.5	—	3.3	100.9	114.8	1.1	1.0	89.6	124.0	99.0	1.0	1.0
N 217.EA	—	136.5	1.5	107.6	—	2.0	2.0	96.0	139.0	139.0	2.0	2.0
NU 217.EA	100.5	—	1.5	107.6	131.5	2.0	2.0	96.0	139.0	103.0	2.0	2.0
NU 2217.EA	100.5	—	2	107.6	131.5	2.0	2.0	96.0	139.0	103.0	2.0	2.0
NU 317.EA	108	—	2.3	118.0	152.7	3.0	3.0	99.0	166.0	111.0	2.5	2.5
NU 2317.EA	108	—	5.8	118.0	152.7	3.0	3.0	99.0	166.0	111.0	2.5	2.5
NU 1018	103	—	3.5	107.8	122.9	1.5	1.1	96.0	133.0	106.0	1.5	1.0
N 218.EA	—	145	1.8	114.5	—	2.0	2.0	101.0	149.0	148.0	2.0	2.0
NU 218.EA	107	—	1.8	114.5	139.7	2.0	2.0	101.0	149.0	110.0	2.0	2.0
NU 2218.EA	107	—	2.6	114.5	139.7	2.0	2.0	101.0	149.0	110.0	2.0	2.0
NU 318.EA	113.5	—	2.5	124.2	161.6	3.0	3.0	104.0	176.0	116.0	2.5	2.5
NU 2318.EA	113.5	—	6	124.2	161.6	3.0	3.0	104.0	176.0	116.0	2.5	2.5
NU 1019	108	—	3.5	112.8	127.9	1.5	1.1	101.0	138.0	111.0	1.5	1.0
N 219.EA	—	154.5	1.7	120.7	—	2.1	2.1	107.0	158.0	157.0	2.0	2.0
NU 219.EA	112.5	—	1.7	120.7	148.6	2.1	2.1	107.0	158.0	115.0	2.0	2.0
NU 2219.EA	112.5	—	3	120.7	148.6	2.1	2.1	107.0	158.0	115.0	2.0	2.0
NU 319.EA	121.5	—	2.9	132.2	169.6	3.0	3.0	109.0	186.0	124.0	2.5	2.5
NU 2319.EA	121.5	—	6.9	132.2	169.6	3.0	3.0	109.0	186.0	124.0	2.5	2.5
NU 1020	113	—	3.5	117.8	132.9	1.5	1.1	106.0	143.0	116.0	1.5	1.0
N 220.EA	—	163	1.7	127.5	—	2.1	2.1	112.0	168.0	166.0	2.0	2.0
NU 220.EA	119	—	1.7	127.5	156.9	2.1	2.1	112.0	168.0	122.0	2.0	2.0
NU 2220.EA	119	—	2.5	127.5	156.9	2.1	2.1	112.0	168.0	122.0	2.0	2.0
NU 320.EA	127.5	—	2.9	139.6	182.0	3.0	3.0	114.0	201.0	130.0	2.5	2.5
NU 2320.EA	127.5	—	5.9	139.6	182.0	3.0	3.0	114.0	201.0	130.0	2.5	2.5



N 10..



N 2..



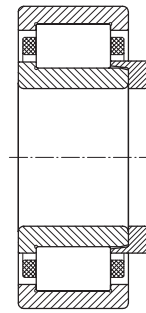
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NJ 22..



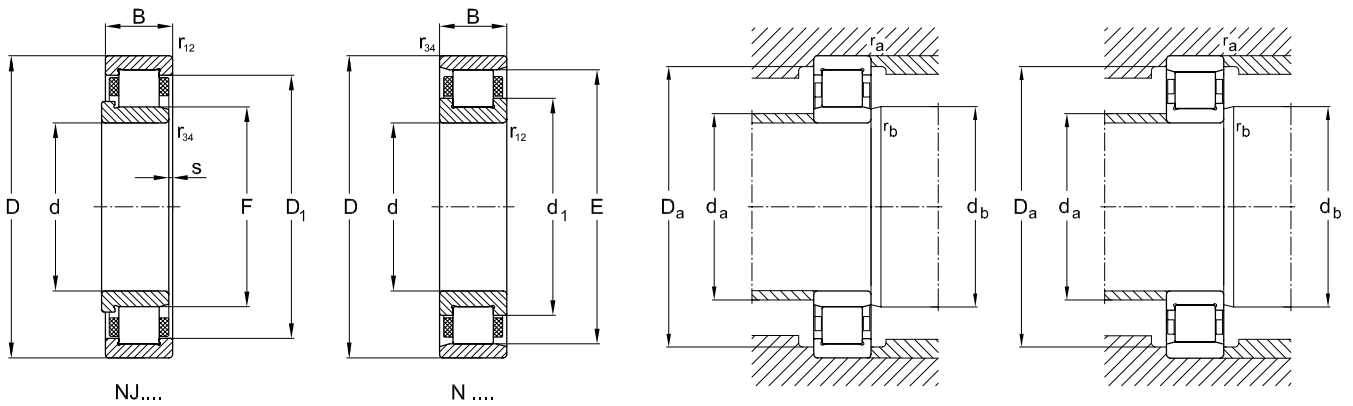
NUP 3..



NJ+HJ 23..

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Basic dimensions			Basic designation	Basic load ratings		Fatigue limit load	Minimal load factor	Limiting speed		Reference speed	Weight
d	D	B		stat.	dyn.			P_u (radial)	n_G		
mm	mm	mm		C_0	C	N	k_f	min ⁻¹	min ⁻¹	kg	
105	160	26	NU 1021	153 000	131 000	16 000	0.10	7 500	4 800	1.900	
105	190	36	N 221.EA	320 000	305 000	36 500	0.15	4 300	3 800	3.950	
105	190	36	NU 221.EA	320 000	305 000	36 500	0.15	3 900	3 600	4.000	
105	225	49	NU 321.EA	500 000	500 000	57 000	0.15	3 800	3 200	8.800	
110	170	28	NU 1022	190 000	166 000	19 300	0.10	7 000	4 500	2.300	
110	200	38	N 222.EA	365 000	340 000	42 500	0.15	3 700	3 400	4.900	
110	200	38	NU 222.EA	365 000	340 000	42 500	0.15	3 700	3 400	4.900	
110	200	53	NU 2222.EA	520 000	448 000	61 000	0.20	3 700	3 200	6.800	
110	240	50	NU 322.EA	475 000	495 000	61 000	0.15	3 200	3 050	11.500	
110	240	80	NU 2322.EA	800 000	750 000	102 000	0.25	3 100	2 600	17.000	
120	180	28	NU 1024	207 000	174 000	20 800	0.10	6 300	4 000	2.500	
120	215	40	N 224.EA	415 000	390 000	49 000	0.15	3 400	3 200	5.800	
120	215	40	NU 224.EA	415 000	390 000	49 000	0.15	3 400	3 200	5.800	
120	215	58	NU 2224.EA	610 000	525 000	72 000	0.20	3 400	2 900	8.400	
120	260	55	NU 324.EA	600 000	610 000	69 500	0.15	3 000	2 750	15.000	
120	260	86	NU 2324.EA	1 010 000	922 000	116 000	0.25	4 300	2 800	24.000	
130	200	33	NU 1026	250 000	212 000	25 000	0.10	5 600	3 800	3.800	
130	230	40	N 226.EA	445 000	420 000	51 000	0.15	3 200	3 000	6.500	
130	230	40	NU 226.EA	445 000	420 000	51 000	0.15	3 200	3 000	6.500	
130	230	64	NU 2226.EA	730 000	615 000	83 000	0.20	3 200	2 700	10.500	
130	280	58	NU 326.EA	670 000	680 000	81 500	0.15	2 800	2 430	18.500	
130	280	93	NU 2326.EA	1 220 000	1 070 000	137 000	0.25	3 000	2 400	30.000	
140	210	33	NU 1028	265 000	216 000	27 000	0.10	5 300	3 600	4.000	
140	250	42	N 228.EA	510 000	455 000	57 000	0.15	3 200	2 800	9.000	
140	250	42	NU 228.EA	510 000	455 000	57 000	0.15	3 200	2 800	9.000	
140	250	68	NU 2228.EA	830 000	662 000	93 000	0.20	4 800	2 800	14.700	
140	300	62	NU 328.EA	800 000	785 000	88 000	0.15	2 600	2 300	22.500	
140	300	102	NU 2328.EA	1 390 000	1 210 000	150 000	0.25	3 600	2 400	38.000	
150	225	35	NU 1030	310 000	248 000	30 000	0.10	5 000	3 200	4.900	
150	270	45	N 230.EA	590 000	520 000	64 000	0.15	2 800	2 600	11.400	
150	270	45	NU 230.EA	590 000	520 000	64 000	0.15	2 800	2 600	11.400	
150	270	73	NU 2230.EA	970 000	760 000	100 000	0.20	2 800	2 600	19.000	
150	320	65	NU 330.EA	930 000	900 000	100 000	0.15	2 600	2 200	27.500	
150	320	108	NU 2330.EA	1 600 000	1 375 000	166 000	0.25	3 400	2 200	45.000	



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Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d ₁ mm	D ₁	r _{12min}	r _{34min}	d _a min	D _a max	D _b max mm	r _a max	r _b max
NU 1021	119.5	–	3.8	124.7	141.0	2.0	1.1	111.0	151.0	122.0	2.0	1.0
N 221.EA	–	173	2	134.0	–	2.1	2.1	117.0	178.0	176.0	2.0	2.0
NU 221.EA	125	–	2	134.0	165.1	2.1	2.1	117.0	178.0	128.0	2.0	2.0
NU 321.EA	133	–	3.4	146.5	190.0	3.0	3.0	119.0	211.0	136.0	2.5	2.5
NU 1022	125	–	3.8	131.0	149.7	2.0	1.1	116.0	161.0	128.0	2.0	1.0
N 222.EA	–	180.5	2.1	141.8	–	2.1	2.1	122.0	188.0	183.0	2.0	2.0
NU 222.EA	132.5	–	2.1	141.8	173.8	2.1	2.1	122.0	188.0	135.0	2.0	2.0
NU 2222.EA	132.5	–	3.7	141.8	173.8	2.1	2.1	122.0	188.0	135.0	2.0	2.0
NU 322.EA	143	–	3	155.9	200.9	3.0	3.0	124.0	226.0	146.0	2.5	2.5
NU 2322.EA	143	–	7.5	155.9	200.9	3.0	3.0	124.0	226.0	146.0	2.5	2.5
NU 1024	135	–	3.8	141.0	159.7	2.0	1.1	126.0	171.0	138.0	2.0	1.0
N 224.EA	–	195.5	1.9	153.5	–	2.1	2.1	132.0	203.0	199.0	2.0	2.0
NU 224.EA	143.5	–	1.9	153.5	187.8	2.1	2.1	132.0	203.0	146.0	2.0	2.0
NU 2224.EA	143.5	–	3.8	153.5	187.8	2.1	2.1	132.0	203.0	146.0	2.0	2.0
NU 324.EA	154	–	3.7	168.7	218.7	3.0	3.0	134.0	246.0	157.0	2.5	2.5
NU 2324.EA	154	–	7.2	168.7	218.7	3.0	3.0	134.0	246.0	157.0	2.5	2.5
NU 1026	148	–	4.7	154.8	175.9	2.0	1.1	136.0	191.0	151.0	2.0	1.0
N 226.EA	–	209.5	2.1	164.2	–	3.0	3.0	144.0	216.0	213.0	2.5	2.5
NU 226.EA	153.5	–	2.1	164.2	201.2	3.0	3.0	144.0	216.0	156.0	2.5	2.5
NU 2226.EA	153.5	–	4.3	164.2	201.2	3.0	3.0	144.0	216.0	156.0	2.5	2.5
NU 326.EA	167	–	3.7	182.3	235.2	4.0	4.0	147.0	263.0	170.0	3.0	3.0
NU 2326.EA	167	–	8.7	182.3	235.2	4.0	4.0	147.0	263.0	170.0	3.0	3.0
NU 1028	158	–	4.4	164.8	185.9	2.0	1.1	146.0	201.0	161.0	2.0	1.0
N 228.EA	–	225	2.5	180.0	–	3.0	3.0	154.0	236.0	172.0	2.5	2.5
NU 228.EA	169	–	2.5	180.0	216.7	3.0	3.0	154.0	236.0	172.0	2.5	2.5
NU 2228.EA	169	–	4.4	180.0	216.7	3.0	3.0	154.0	236.0	172.0	2.5	2.5
NU 328.EA	180	–	3.7	196.0	251.7	4.0	4.0	157.0	283.0	183.0	3.0	3.0
NU 2328.EA	180	–	9.7	196.0	251.7	4.0	4.0	157.0	283.0	183.0	3.0	3.0
NU 1030	169.5	–	4.9	176.7	199.0	2.1	1.5	157.0	215.0	173.0	2.0	1.5
N 230.EA	–	242	2.5	193.7	–	3.0	3.0	163.0	256.0	185.0	2.5	2.5
NU 230.EA	182	–	2.5	193.7	233.2	3.0	3.0	163.0	256.0	185.0	2.5	2.5
NU 2230.EA	182	–	4.9	193.7	233.2	3.0	3.0	164.0	256.0	185.0	2.5	2.5
NU 330.EA	193	–	4	210.1	269.8	4.0	4.0	167.0	303.0	196.0	3.0	3.0
NU 2330.EA	193	–	10.5	210.1	269.8	4.0	4.0	167.0	303.0	196.0	3.0	3.0

13. Single row full complement cylindrical roller bearings

Beside single row cylindrical roller bearings with cage the product range is complemented by IBC single row full complement cylindrical roller bearings. These have solid inner rings and outer rings as well as rib-guided cylindrical rollers. As they are equipped with the largest possible number of rolling elements they have a high load-carrying capacity, they are very stiff and are especially suited for application in space-saving constructions. Nevertheless, it has to be considered that on account of the kinematic ratios they are not able to achieve such a high rotational speed as single row cylindrical roller bearings with cage.

Dimensions

The main dimensions of single row full complement IBC cylindrical roller bearings are correspondent with the specifications in DIN 616:2000 or ISO 15:1998.

Series

Single row full complement cylindrical roller bearings are not only available as a slim series 29 but also in broader versions in the designs 30, 22 and 23. Other variations are available on request.

Designs

Single row full complement cylindrical roller bearings are manufactured in the designs NCF and NJG. The full complement cylindrical roller bearings are neither sealed nor greased. They can be oil lubricated or grease lubricated at the front.

Bearings of the series NCF have an inner ring with two solid ribs and an outer ring with one solid rib that is able to guide the shaft axially in one direction. Besides, a snap ring on the side of the outer ring without rib holds the bearing together. They are able to take on axial loads in one direction and are manufactured in the series 29, 30 and 22.

Single row full complement cylindrical roller bearings of the design NJG have a self-retaining roller set. Thus the outer ring with two solid ribs and the roller assembly can be dismantled from the inner ring with a solid rib. No special safety device is necessary for preventing the rollers against falling out which makes the installation and removal substantially easier. They are also able to take on axial loads in one direction. Bearings of the design NJG are designed for slowly turning applications with especially highly loads and are manufactured in the heavy series 23.

With bearing series NCF as well as with NJG the inner ring can be displaced in one direction axially by the distance s (see table). The maximum axial movement from the central position (s) is designed in such a manner that low axial displacements can be compensated, e.g., as a result of thermal expansion of the shaft compared with the housing.

Bearing materials

Bearing rings and rolling elements are manufactured from bearing steel 100Cr6 (1.3505) according to SAE52100 and SUJ2.

Heat treatment

Single row full complement IBC cylindrical roller bearings are usually dimension-stable up to an operating temperature of 120 °C. In addition and on request, higher valued heat treatment is available for higher temperatures. The bearings for high temperatures are marked with the additional figures S1, S2, and S3.

Please note that the load-carrying capacities of the bearings that are constantly exposed to higher operating temperatures are reduced.

Radial internal clearance

IBC manufactures single row full complement cylindrical roller bearings as a standard with radial internal clearance normal (CN) or C3. Some cylindrical roller bearings are available with the smaller clearance C2 or with the larger clearance C4. Bearings with clearance C5 are available on request.

The values of the radial internal clearance of single row full complement cylindrical roller bearings comply to DIN 620-4:1987 or ISO 5753:1991. They are valid for not built-in bearings with measuring load zero. In addition, these bearings are also available with „internal radial preload“ as a special design.

Skewing

The skewing of the inner ring towards the outer ring that is allowed without reducing the service life of single row full complement cylindrical roller bearings is dependent on the load ratio C/P and is limited to a few angular minutes. For the cylindrical roller bearings of the narrow series 29 the skewing is 4 angular minutes while it is 3 angular minutes for the broader bearing series (30, 22 and 23). Please note that the listed approximate values for bearings that are not axially guided have their validity on condition of constant position of the axis of shaft and housing.

Note

Please note that skewing causes a certain compulsive running from which extended running noise may result and which may also limit service life. Please, contact our technical consultation teams in such cases in which skewing is expected to exceed the permitted values.

Tolerances

Beside the standard tolerance PN according to DIN 620-2:1988 or ISO 492-2002 single row full complement cylindrical roller bearings are also available in the higher tolerance classes P6 and P5.

Equivalent dynamic bearing load

The following applies for dynamically stressed full complement cylindrical roller bearings that are in use as loose fit bearings:

$$P = F_r \quad [4.0]$$

If the cylindrical roller bearings are also used as an axial guidance of the shaft, then the equivalent dynamic bearing load can be approximated from:

$P = F_r$ $P = 0.92 \cdot F_r + Y \cdot F_a$	bei $F_a / F_r \leq e$ bei $F_a / F_r > e$	[4.1]
P	equivalent dynamic bearing load	[N]
F_r	radial load	[N]
e	limit value	
Y	axial load factor	
	0.3 with bearings of the series 29, 30, 22 and 23	
	0.4 with bearings of the series 29, 30, 22 and 23	

The ratio of F_a / F_r shouldn't exceed the value of 0.5 with axially loaded single row full complement cylindrical roller bearings as an optimum run is only given with radial load at the same time.

Equivalent static bearing load

The following applies for statically stressed single row full complement cylindrical roller bearings:

$P_0 = F_r$	[4.2]
P_0	equivalent static bearing load [N]

Minimum load

To ensure a trouble free operation, in particular with fairly quick-rotating bearings ($n > 0.5$ times the reference rotational speed) in which the weight forces of the rolling elements as well as the friction within the lubricant can influence the rolling characteristics in the cylindrical roller bearings negatively and in which damaging sliding between the rolling elements and the tracks can appear there ought to be a minimum load. This also applies to bearings that are subjected to quick stress cycles.

Use the following formula for approximate calculation of the minimum radial load for single row full complement cylindrical roller bearings:

$$F_{r \min} = k_r \cdot \left(0.6 + 0.4 \cdot \frac{n}{n_r} \right) \cdot d_m^2 \quad [4.3]$$

$F_{r \min}$	minimum radial load	[N]
k_r	radial minimum load factor	
n	service speed	[min ⁻¹]
n_r	reference rotational speed	[min ⁻¹]
d_m	mean diameter of bearing $0.5 \cdot (d + D)$	[mm]

With the application of high viscosity lubricants as well as with cold starting it is possible that higher minimum loads are necessary. In general, the dead weight of the supported parts and the external forces already cause the radial load to be higher than the minimum load is. However, if the ascertained limit value is under-run an additional radial load of the bearings is necessary.

Dynamic axial load-carrying capacity

Besides taking on radial loads, bearings with ribs on the inner ring and outer ring are also able to take on axial loads. The load-carrying capacity of the axial sliding surfaces at the rib and of the rollers decisively determine the axial load capacity, so that it predominantly depends on the factors lubrication, operating temperature and heat dis-

sipation from the bearing. Usually a viscosity ratio of $\kappa \geq 2$ can be assumed as well as a specific heat dissipation of $0.5 \text{ mW/mm}^2 \cdot \text{K}$ referring to the bearing shell surface ($\pi \cdot D \cdot B$) as well as a difference in temperature of $60 \text{ }^\circ\text{C}$ between operating temperature of the bearing and temperature of the installation surroundings, so that the maximum value of the constant axial load can be determined exactly enough by using the following formula:

$$F_{a \max} = \frac{k_1 \cdot C_o \cdot 10^4}{n \cdot (d + D)} - k_2 \cdot F_r \quad [4.4]$$

$F_{a \max}$	maximum axial load	[kN]
C_o	static load rating	[kN]
F_r	radial load	[kN]
k_1	bearing coefficient	
	1.00 with oil lubrication	
	0.50 with grease lubrication	
k_2	bearing factor	
	0.30 with oil lubrication	
	0.15 with grease lubrication	
n	service speed	[min ⁻¹]
d	diameter of bearing bore	[mm]
D	outer diameter of bearing	[mm]

For the actual viscosity with grease lubrication the viscosity of the base oil is to be used. If there is a viscosity ratio of $\kappa < 2$ then both friction and wear increase. With low rotational speed this can be reduced by using e.g. oils with wear protection and suitable EP additives.

For continuing axial loads the application of greases which are distinguished with an oil separation of at least 3% according to DIN 51817 is recommended. Besides, lubrication intervals ought to be reduced. Please notice that the shown maximum axial load value is valid under the circumstance that constant axial load is provided with sufficient lubrication of the contact surfaces. If short period active axial loads or shock impact axial loads appear, then higher limit values are permitted. Nevertheless, it should be seen to the fact that the limit values are not exceeded with regard to the lip crack.

In order to avoid lip crack the limit values concerning rib stress are necessarily to be complied with. With single row full complement cylindrical roller bearings the constant axial load shouldn't exceed the value $F_a = 0.0023 \cdot D^{1.7}$. With only short stresses which only appear now and then the value $F_a = 0.007 \cdot D^{1.7}$ should be kept.

F_a	permanent or occasional axial load	[kN]
D	outer diameter of bearing	[mm]

The size of the contact surfaces on the counterparts and the axial runout accuracy is also important for a constant rib load as well as for a sufficient runout accuracy of the shaft with axially highly loaded cylindrical roller bearings.

Thus, a support of the ribs on the complete height is commendable. Please notice that with very strong bending of the shaft bending fatigue stress can appear, caused by the support of the ribs.

Thus, e.g., the diameter of the shaft shoulder arises for the rib on the inner ring as follows:

$$d_{as} = 0.5 \cdot (d_1 + F) \quad [4.5]$$

d_{as}	recommended diameter of shaft shoulder	[mm]
d_1	diameter of inner ring rib	[mm]
F	diameter of inner ring track	[mm]

If skewing between inner ring and outer ring occurs for more than one angular minute, then this causes an essential change of the force introduction ratios of the ribs. This may cause loss of the included safety factor, resulting in lower axial loads than permitted. In these cases please contact our technical consultation teams.

Notes



NCF 29..



NCF 30..



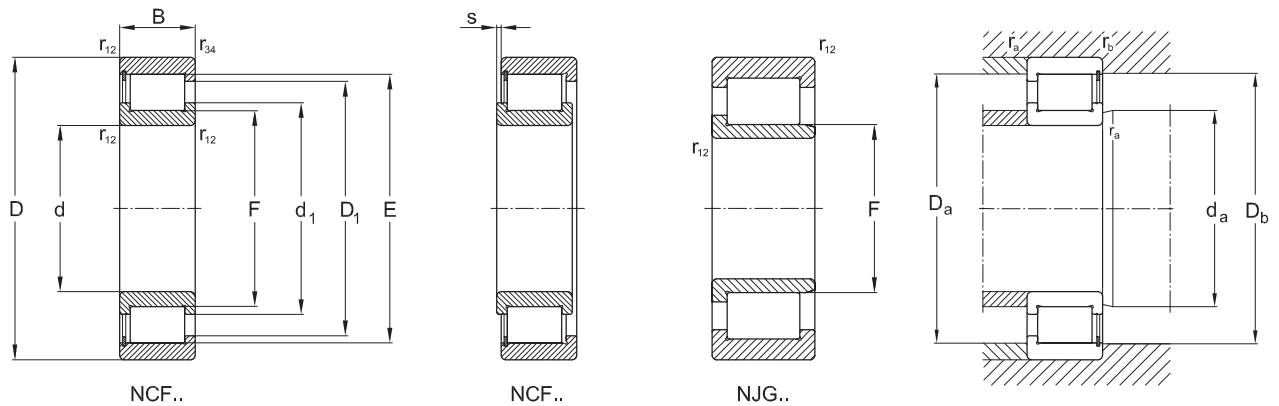
NCF 22..



NJG 23..

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Basic dimensions			Basis designation	Basic load ratings		Fatigue limit load	Limiting speed	Reference speed		Weight
d	D	B		stat.	dyn.			n_G	n_R	
mm	mm	mm		C_0	C	P_u (radial) N	min^{-1}		kg	
20	42	16	NCF 3004	28 500	28 100	3 100	10 000	8 500	0.110	
20	47	18	NCF 2204	37 500	45 500	6 100	9 700	6 500	0.160	
25	47	16	NCF 3005	35 500	31 900	3 800	9 000	7 000	0.120	
25	52	18	NCF 2205	45 000	51 000	7 400	8 400	5 500	0.180	
25	62	24	NJG 2305	68 000	68 200	8 500	5 600	4 500	0.380	
30	55	19	NCF 3006	44 000	39 600	5 000	7 500	6 000	0.20	
30	62	20	NCF 2206	65 000	70 000	10 200	7 000	4 550	0.300	
30	72	27	NJG 2306	86 500	84 200	11 000	4 800	4 000	0.560	
35	62	20	NCF 3007	56 000	48 400	6 550	6 700	5 300	0.260	
35	72	23	NCF 2207	79 000	88 000	12 700	6 100	4 200	0.440	
35	80	31	NJG 2307	114 000	108 000	14 300	4 300	3 400	0.750	
40	68	21	NCF 3008	69 500	57 200	8 150	6 000	4 800	0.310	
40	80	23	NCF 2208	93 000	97 000	14 900	5 400	3 600	0.550	
40	90	33	NJG 2308	156 000	145 000	20 000	3 600	3 000	1.000	
45	75	23	NCF 3009	78 000	60 500	9 150	5 300	4 300	0.400	
45	85	23	NCF 2209	99 000	101 000	16 000	5 000	3 300	0.590	
45	100	36	NJG 2309	196 000	172 000	25 500	3 400	2 800	1.450	
50	80	23	NCF 3010	98 000	76 500	11 800	5 000	4 000	0.430	
50	90	23	NCF 2210	113 000	109 000	18 100	4 650	3 000	0.640	
50	110	40	NJG 2310	219 000	232 000	38 500	4 050	2 750	1.810	
55	90	26	NCF 3011	140 000	105 000	17 300	4 300	3 400	0.640	
55	100	25	NCF 2211	150 000	140 000	25 000	4 200	2 650	0.870	
55	120	43	NJG 2311	260 000	233 000	33 500	2 800	2 200	2.300	
60	85	16	NCF 2912	80 000	55 000	9 150	4 500	3 600	0.290	
60	95	26	NCF 3012	146 000	106 000	18 300	4 000	3 400	0.690	
60	110	28	NCF 2212	180 000	169 000	31 000	3 800	2 550	1.180	
60	130	46	NJG 2312	280 000	285 000	50 000	3 400	2 450	2.880	
65	90	16	NCF 2913	88 000	58 300	10 200	4 000	3 200	0.310	
65	100	26	NCF 3013	163 000	112 000	20 000	3 800	3 000	0.730	
65	120	31	NCF 2213	214 000	198 000	37 000	3 500	2 410	1.570	
65	140	48	NJG 2313	360 000	303 000	46 500	2 400	1 900	3.550	



46-002

Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d ₁ mm	D ₁	r _{12min}	r _{34min}	d _a min	D _a max	D _b max mm	r _a max	r _b max
NCF 3004	–	36.8	1.5	29.0	33.0	0.6	0.6	24.0	38.0	40.0	0.6	0.6
NCF 2204	–	41.47	1	30.3	36.9	0.6	0.6	–	–	–	–	–
NCF 3005	–	42.5	1.5	34.0	39.0	0.6	0.6	29.0	43.0	45.0	0.6	0.6
NCF 2205	–	46.5	1	35.3	41.9	1.0	1.0	–	–	–	–	–
NJG 2305	31.74	–	1.7	40.0	45.0	1.1	–	35.0	50.0	–	1.0	–
NCF 3006	–	49.6	2	40.0	45.0	1.0	1.0	35.0	50.0	52.0	1.0	1.0
NCF 2206	–	55.19	1	42.0	50.6	1.0	1.0	–	–	–	–	–
NJG 2306	38.36	–	1.8	43.2	56.4	1.1	–	37.0	65.0	–	1.0	–
NCF 3007	–	55.5	2	45.0	51.0	1.0	1.0	40.0	57.0	59.0	1.0	1.0
NCF 2207	–	63.9	1	47.0	59.3	1.1	1.1	–	–	–	–	–
NJG 2307	44.75	–	2	50.4	65.8	1.5	–	44.0	71.0	–	1.5	–
NCF 3008	–	61.7	2	50.0	58.0	1.0	1.0	45.0	63.0	65.0	1.0	1.0
NCF 2208	–	70.94	1	54.0	66.3	1.1	1.1	–	–	–	–	–
NJG 2308	51.15	–	2.4	57.6	75.2	1.5	–	49.0	81.0	–	1.5	–
NCF 3009	–	66.9	2	55.0	62.0	1.0	1.0	50.0	70.0	72.0	1.0	1.0
NCF 2209	–	74.43	1	57.5	69.8	1.1	1.1	–	–	–	–	–
NJG 2309	56.14	–	2.4	62.5	80.1	1.5	–	54.0	91.0	–	1.5	–
NCF 3010	–	72.3	2	59.0	68.0	1.0	1.0	55.0	75.0	77.0	1.0	1.0
NCF 2210	–	81.4	1	64.4	76.7	1.1	1.1	–	–	–	–	–
NJG 2310	60.72	–	3	68.3	89.7	2.0	2.0	59.0	102.0	–	2.0	–
NCF 3011	–	83.5	2	68.0	79.0	1.1	1.1	61.0	84.0	86.0	1.0	1.0
NCF 2211	–	88.81	1	70.0	84.1	1.5	1.5	–	–	–	–	–
NJG 2311	67.14	–	2.6	75.5	98.6	2.0	–	66.0	109.0	–	2.0	–
NCF 2912	–	78.5	1	69.0	75.0	1.0	1.0	65.0	80.0	80.0	1.0	1.0
NCF 3012	–	86.7	2	71.0	82.0	1.1	1.1	66.0	89.0	91.0	1.0	1.0
NCF 2212	–	99.17	1.5	76.8	93.9	1.5	1.5	–	–	–	–	–
NJG 2312	73.62	–	3	82.0	105.8	2.1	–	71.0	117.0	–	2.0	–
NCF 2913	–	85	1	75	81	1	1	70	85	85	1	1
NCF 3013	–	93.1	2	78	88	1.1	1.1	71	94	96	1	1
NCF 2213	–	106.25	1.5	82.3	100.7	1.5	1.5	–	–	–	–	–
NJG 2313	80.71	–	3	89.9	116.0	2.1	–	77.0	128.0	–	2.0	–



NCF 29..



NCF 30..



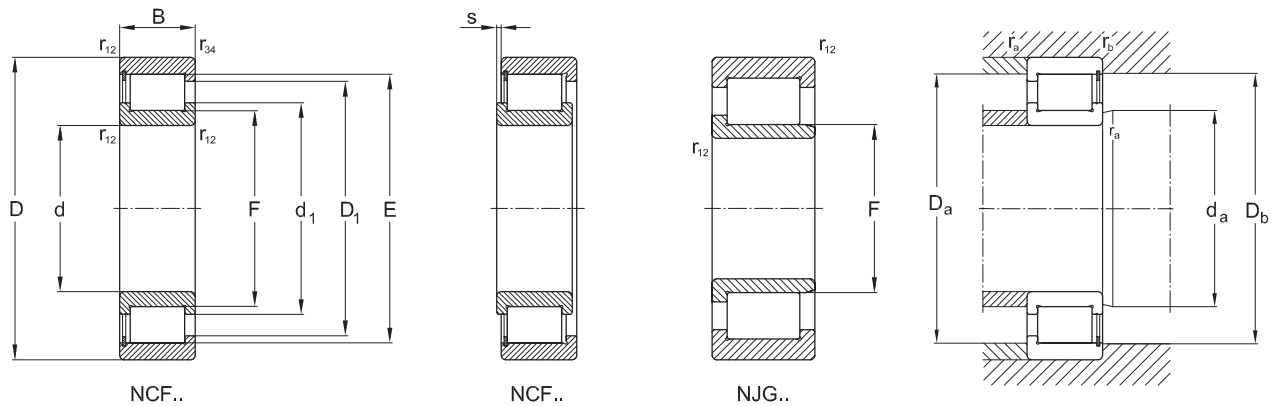
NCF 22..



NJG 23..

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Basic dimensions			Basis designation	Basic load ratings		Fatigue limit load	Limiting speed	Reference speed	Weight
d	D	B		stat.	dyn.				
mm				C_0	C	N	min^{-1}		kg
70	100	19	NCF 2914	116 000	76 500	13 700	3 800	3 000	0.490
70	110	30	NCF 3014	173 000	128 000	22 400	3 600	2 800	1.020
70	125	31	NCF 2214	184 000	227 000	32 000	3 300	2 270	1.660
70	150	51	NJG 2314	400 000	336 000	50 000	2 200	1 800	4.400
75	105	19	NCF 2915	125 000	79 200	14 600	3 600	2 800	0.520
75	115	30	NCF 3015	190 000	134 000	24 500	3 200	2 600	1.060
75	130	31	NCF 2215	241 000	190 000	33 500	3 150	2 140	1.750
75	160	55	NJG 2315	480 000	396 000	60 000	2 000	1 600	5.350
80	110	19	NCF 2916	132 000	80 900	15 600	3 400	2 600	0.550
80	125	34	NCF 3016	228 000	165 000	29 000	3 000	2 400	1.430
80	140	33	NCF 2216	285 000	226 000	38 500	2 950	2 000	2.150
80	170	58	NJG 2316	570 000	457 000	71 000	1 900	1 500	6.400
85	120	22	NCF 2917	166 000	102 000	20 000	3 200	2 600	0.810
85	130	34	NCF 3017	236 000	172 000	30 000	3 000	2 400	1.510
85	150	36	NCF 2217	325 000	255 000	44 500	2 750	1 930	2.740
85	180	60	NJG 2317	620 000	484 000	76 500	1 800	1 400	7.400
90	120	22	NCF 2918	176 000	106 000	20 800	3 000	2 400	0.840
90	140	37	NCF 3018	280 000	198 000	35 500	2 800	2 200	1.970
90	160	40	NCF 2218	370 000	290 000	51 000	2 600	1 900	3.480
90	190	64	NJG 2318	670 000	528 000	81 500	1 800	1 400	8.750
95	170	43	NCF 2219	435 000	340 000	58 000	2 450	1 800	4.170
95	200	67	NJG 2319	720 000	650 000	120 000	2 200	1 560	10.200
100	140	24	NCF 2920	200 000	128 000	24 500	2 600	2 200	1.140
100	150	37	NCF 3020	310 000	209 000	37 500	2 600	2 000	2.150
100	180	46	NCF 2220	520 000	395 000	70 000	2 310	1 700	5.130
100	215	73	NJG 2320	865 000	682 000	104 000	1 500	1 200	13.000
110	150	24	NCF 2922	220 000	134 000	26 000	2 400	1 900	1.230
110	170	45	NCF 3022	400 000	275 000	47 500	2 200	1 800	3.500
110	200	53	NCF 2222	590 000	455 000	78 000	2 090	1 660	7.240
110	240	80	NJG 2322	1 060 000	858 000	122 000	1 300	1 100	17.500



46-002

Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d ₁ mm	D ₁	r _{12min}	r _{34min}	d _a min	D _a max	D _b max mm	r _a max	r _b max
NCF 2914	–	92.3	1	81.0	88.0	1.0	1.0	75.0	95.0	95.0	1.0	1.0
NCF 3014	–	100.3	3	81.0	95.0	1.0	1.0	76.0	104.0	106.0	1.0	1.0
NCF 2214	–	111.45	1.5	87.0	105.2	1.5	1.5	–	–	–	–	–
NJG 2314	84.22	–	3	93.8	121.0	2.1	–	82.0	138.0	–	2.0	–
NCF 2915	–	97.5	1	86.0	93.0	1.0	1.0	80.0	100.0	100.0	1.0	1.0
NCF 3015	–	107.9	3	89.0	103.0	1.1	1.1	81.0	109.0	111.0	1.0	1.0
NCF 2215	–	116.2	1.5	91.8	110.0	1.5	1.5	–	–	–	–	–
NJG 2315	91.24	–	3	101.0	131.0	2.1	–	87.0	148.0	–	2.0	–
NCF 2916	–	102.5	1	91.0	98.0	1.0	1.0	85.0	105.0	105.0	1.0	1.0
NCF 3016	–	117	4	95.0	111.0	1.1	1.1	86.0	119.0	121.0	1.0	1.0
NCF 2216	–	126.3	1.5	98.6	119.3	2.0	2.0	–	–	–	–	–
NJG 2316	98.26	–	4	109.0	141.0	4.0	–	92.0	158.0	–	2.0	–
NCF 2917	–	109.5	1	96.0	105.0	1.1	1.1	91.0	114.0	114.0	1.0	1.0
NCF 3017	–	121.4	4	99.0	116.0	1.1	1.1	91.0	124.0	126.0	1.0	1.0
NCF 2217	–	133.75	1.5	104.4	126.3	2.0	2.0	–	–	–	–	–
NJG 2317	107	–	4	118.0	149.0	3.0	–	99.0	166.0	–	2.5	–
NCF 2918	–	115.3	1	102.0	111.0	1.1	1.1	96.0	119.0	119.0	1.0	1.0
NCF 3018	–	130.1	4	106.0	124.0	1.5	1.5	97.0	133.0	135.0	1.5	1.5
NCF 2218	–	141.15	2.5	110.2	133.3	2.0	2.0	–	–	–	–	–
NJG 2318	105.3	–	4	117.0	152.0	3.0	–	104.0	176.0	–	2.5	–
NCF 2219	–	155.95	2.5	122.0	147.3	2.1	2.1	–	–	–	–	–
NJG 2319	114.65	–	4	126.6	161.9	3.0	3.0	110.0	187.5	–	2.5	–
NCF 2920	–	130.5	1.5	114.0	126.0	1.1	1.1	106.0	134.0	134.0	1.0	1.0
NCF 3020	–	139.7	4	115.0	134.0	1.5	1.5	107.0	143.0	145.0	1.5	1.5
NCF 2220	–	163.35	2.5	127.5	154.3	2.1	2.1	–	–	–	–	–
NJG 2320	119.3	–	4	133.0	173.0	3.0	–	114.0	201.0	–	2.5	–
NCF 2922	–	141	1.5	124.0	136.0	1.1	1.1	116.0	144.0	144.0	1.0	1.0
NCF 3022	–	156.1	5.5	127.0	149.0	2.0	2.0	120.0	160.0	165.0	2.0	2.0
NCF 2222	–	177.6	4	137.0	168.0	2.1	2.1	–	–	–	–	–
NJG 2322	134.3	–	5	151.0	198.0	3.0	–	124.0	226.0	–	2.5	–



NCF 29..



NCF 30..



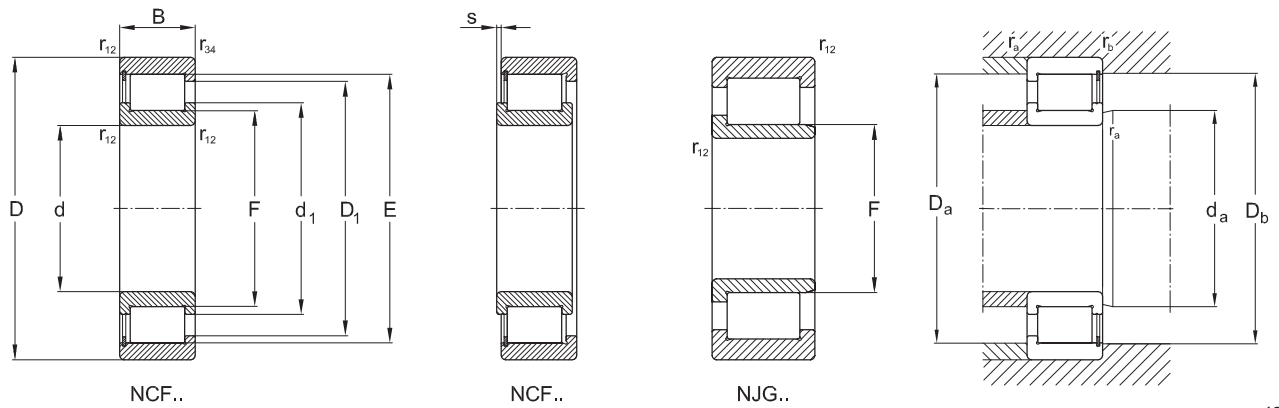
NCF 22..



NJG 23..

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Basic dimensions			Basis designation	Basic load ratings		Fatigue limit load	Limiting speed	Reference speed	Weight
d	D	B		stat.	dyn.				
mm				C_0	C	N	min^{-1}		kg
120	165	27	NCF 2924	290 000	172 000	34 500	2 200	1 800	1.730
120	180	46	NCF 3024	440 000	292 000	52 000	2 000	1 700	3.800
120	215	58	NCF 2224	735 000	512 000	85 000	1 700	1 400	9.050
120	260	86	NJG 2324	1 250 000	952 000	140 000	1 200	1 000	22.500
130	180	30	NCF 2926	360 000	205 000	40 500	2 000	1 600	2.330
130	200	52	NCF 3026	620 000	413 000	72 000	1 900	1 500	5.800
130	230	64	NCF 2226	630 000	860 000	110 000	1 960	1 590	11.250
130	280	93	NJG 2326	1 430 000	1 080 000	156 000	1 200	950	28.000
140	190	30	NCF 2928	390 000	220 000	43 000	1 900	1 500	2.420
140	210	53	NCF 3028	680 000	440 000	78 000	1 800	1 400	6.100
140	250	68	NCF 2228	1 020 000	693 000	114 000	1 500	1 200	14.500
140	300	102	NJG 2328	1 600 000	1 210 000	173 000	1 100	850	35.500
150	210	36	NCF 2930	490 000	292 000	55 000	1 700	1 400	3.770
150	225	56	NCF 3030	710 000	457 000	80 000	1 600	1 300	7.500
150	270	73	NCF 2230	1 180 000	792 000	132 000	1 400	1 100	18.400
150	320	108	NJG 2330	1 930 000	1 450 000	196 000	1 000	800	42.500



46-002

Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d ₁ mm	D ₁	r _{12min}	r _{34min}	d _a min	D _a max	D _b max mm	r _a max	r _b max
NCF 2924	–	153.8	1.5	135.0	149.0	1.1	1.1	126.0	159.0	159.0	1.0	1.0
NCF 3024	–	167.6	5.5	139.0	160.0	2.0	2.0	130.0	170.0	175.0	2.0	2.0
NCF 2224	–	192.32	4	150.0	184.0	2.1	2.1	131.0	204.0	204.0	2.0	2.0
NJG 2324	147.4	–	5	164.0	213.0	3.0	–	134.0	246.0	–	2.5	–
NCF 2926	–	166.5	2	146.0	151.0	1.5	1.5	137.0	173.0	173.0	1.5	1.5
NCF 3026	–	183	5.5	149.0	175.0	2.0	1.0	140.0	190.0	195.0	2.0	1.0
NCF 2226	–	207.25	5	162.3	197.0	2.1	2.1	141.0	218.0	220.0	2.5	2.5
NJG 2326	157.9	–	6	175.0	226.0	4.0	–	147.0	263.0	–	3.0	–
NCF 2928	–	179.3	2	157.0	174.0	1.5	1.5	147.0	183.0	1830.0	1.5	1.5
NCF 3028	–	197	5.5	163.0	189.0	2.0	1.0	150.0	200.0	205.0	2.0	1.0
NCF 2228	–	221.9	5	173.0	212.0	3.0	3.0	143.0	127.0	127.0	2.5	2.5
NJG 2328	168.5	–	6.5	187.0	245.0	4.0	–	157.0	283.0	–	3.0	–
NCF 2930	–	196	2.5	169.0	189.0	2.0	2.0	160.0	200.0	200.0	2.0	2.0
NCF 3030	–	206	7	170.0	198.0	2.1	1.1	161.0	214.0	234.0	2.0	1.0
NCF 2230	–	236.7	6	184.0	227.0	3.0	3.0	153.0	137.0	137.0	2.5	2.5
NJG 2330	182.5	–	6.5	202.0	261.0	4.0	–	167.0	303.0	–	3.0	–

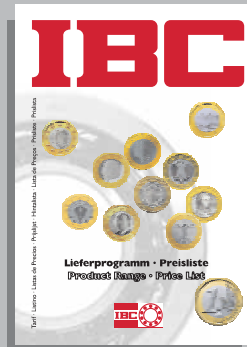
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Company Profile



Product Range
Super Precision Bearings
TI-I-5000.0 / D (German)
TI-I-5000.0 / E (English)
TI-I-5000.0 / I (Italian)



Product Range
Price List



Cylindrical Roller
Bearings
TI-I-4010.0 / D (German)
TI-I-4010.0 / E (English)



Angular Contact Ball
Bearings 40°
TI-I-4044.0 / D (German)
TI-I-4044.0 / E (English)



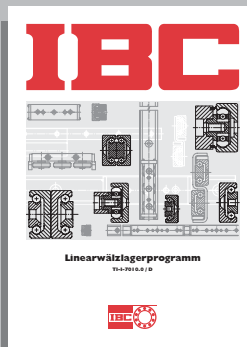
Precision Locknuts
TI-I-5020.0 / D (German)
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Ball Screw Support
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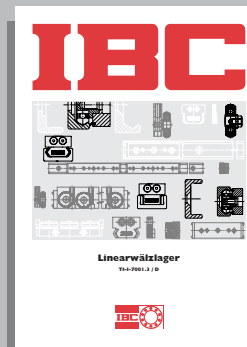
Super Precision Bearings
Service Catalog
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TI-I-5003.2 / E (English)



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Telescopic-Rails
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Linear Motion Bearings
TI-I-7001.3 / D (German)
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ATCoated Bearings
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