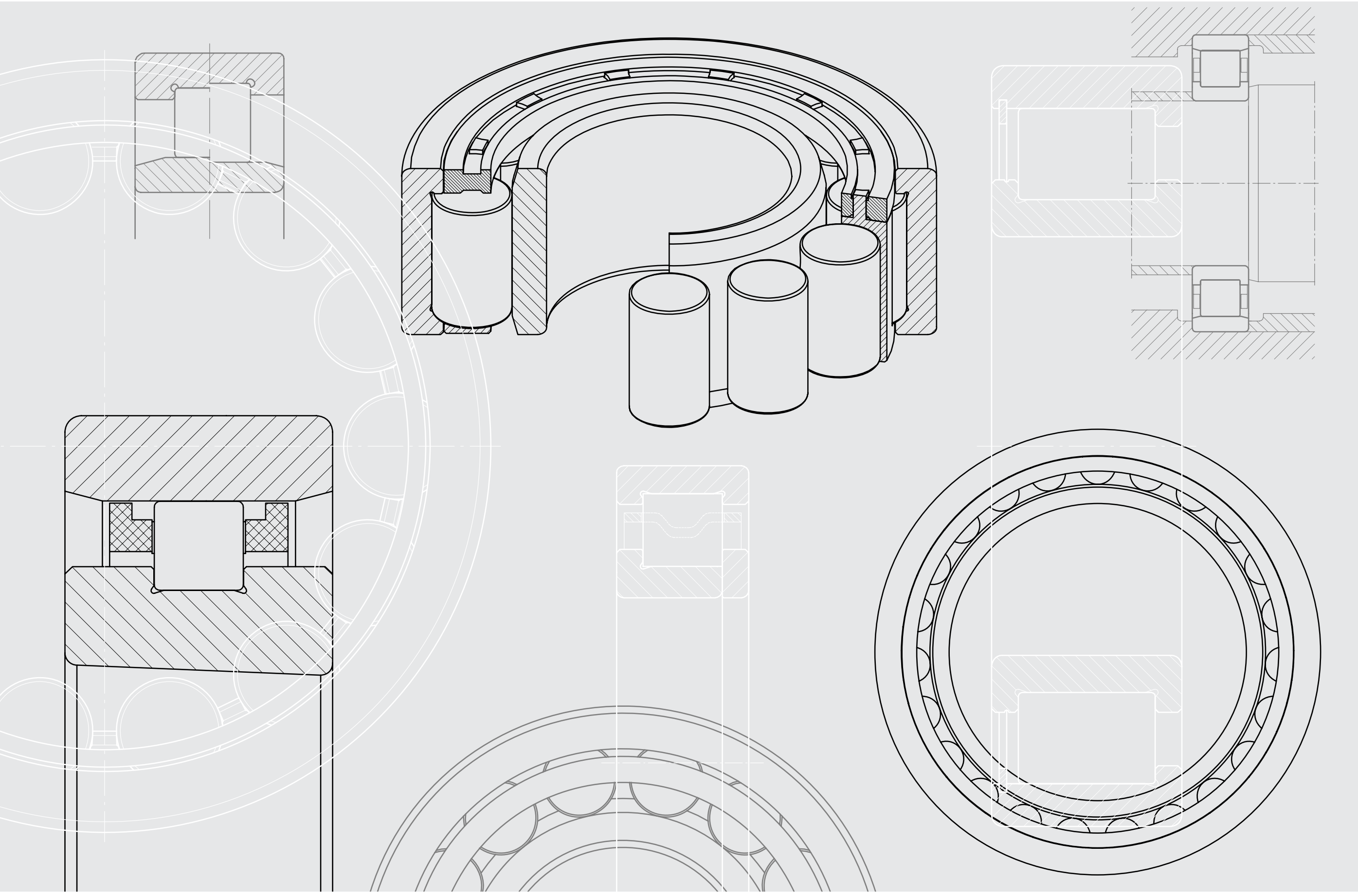


Cylindrical Roller Bearings

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.

Precise logistics secure a maximum in worldwide reliability of delivery

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.

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).

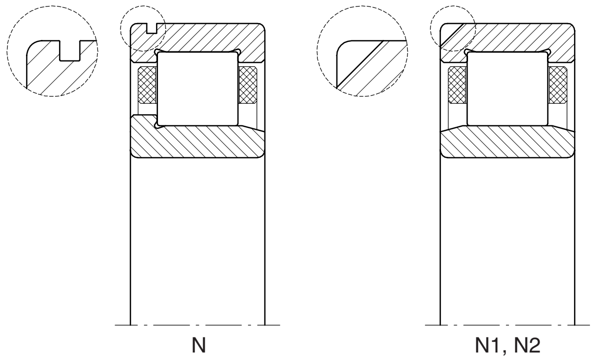
The IBC product range is supplemented by single row cylindrical roller bearings of the design NU without inner ring (designation RNU) as well as by cylindrical roller bearings of the design N without outer ring (designation RN). Cylindrical roller bearings without loose ring are the best choice for bearings 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.



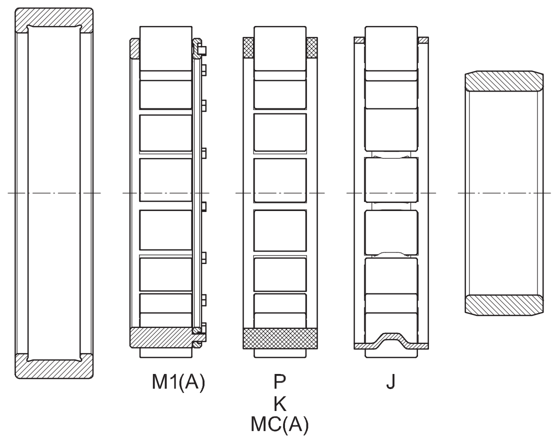
Special designs 46-103

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

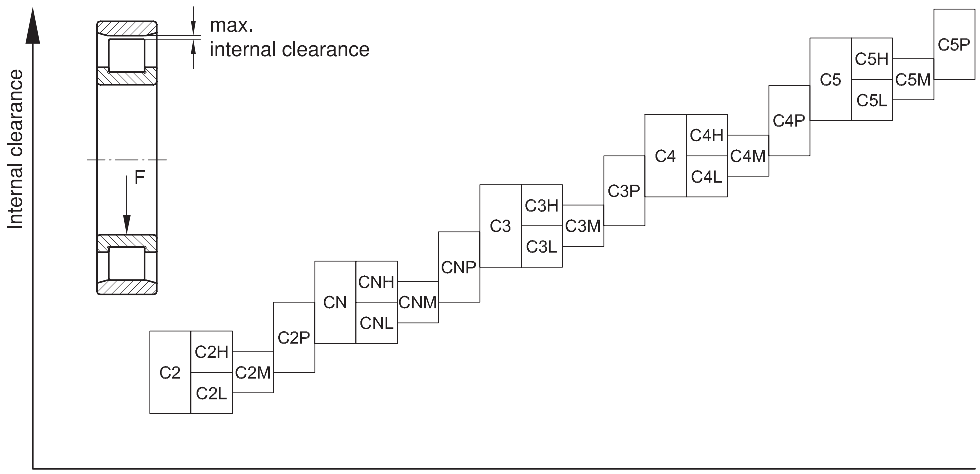
Radial internal clearance
IBC manufactures cylindrical roller bearings as a standard with radial internal clearance Normal (CN) or C3. Some cylindrical roller bearings are available with smaller clearance C2 or with larger clearance C4. Bearings with clearance C5 are available on request. The values 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	Bore diameter [mm], clearance [µm]																				
	over incl.	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	55	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		NUP 2		NUP 22		NUP 3		NUP 23	
Dia-meter [mm]	Bore code –	min. [µm]	max.	min. [µm]	max.	min. [µm]	max.	min. [µm]	max.
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		NJ 2+HJ 2		NJ 22+HJ 22		NJ 3+HJ 3		NJ 23+HJ23	
Dia-meter [mm]	Bore code –	min. [µm]	max.	min. [µm]	max.	min. [µm]	max.	min. [µm]	max.
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 $^2/_3$ 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.

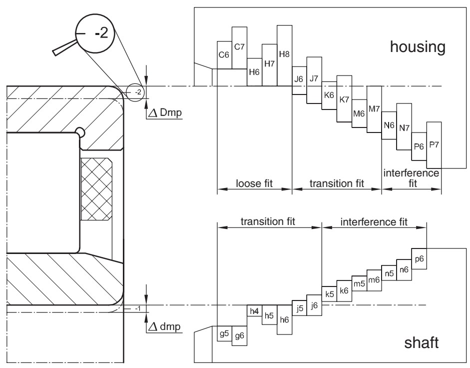
Interference fits and rotational conditions
Because the interference fits considerably influence the clearance or preload, the following information should be noticed. First of all, it should be ascertained which bearing rings take on rotating load and which ones take on static load. The rings with rotating 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 • 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	IR not lightly movable		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:

$S_{reff} = S_o - (S_i + S_T)$	[mm]	[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:

$S_m = S_o - S_i$	[mm]	[1.1]

$S_i = I_i \bullet f_i + I_o \bullet f_o$	[mm]	[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:

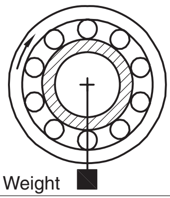
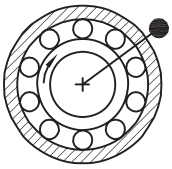
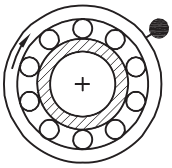
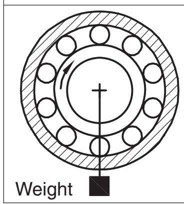
f_i	solid shaft	0.8
f_o	steel or casting housing	0.7
f_i	hollow shaft	0.6
f_o	light metall housing	0.5

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.

$S_T = \alpha \bullet \Delta_T \bullet d_m$	[mm]	[1.3]

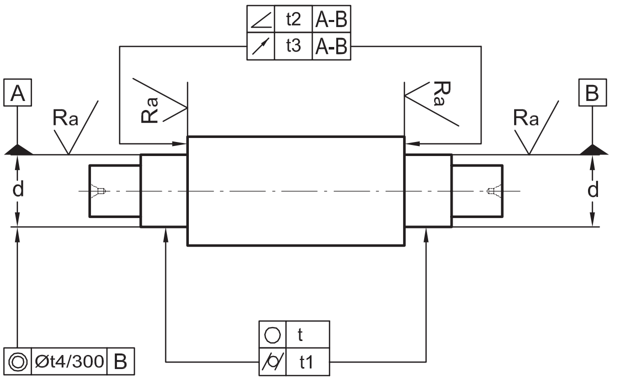
α	coefficient of expansion of bearing steel $12 \bullet 10^{-6}$	[k^{-1}]
Δ_T	difference in temperature from inner ring to outer ring	
d_m	average diameter of bearing $0.5 \bullet (d + D)$	[mm]

	Inner ring	Outer ring
 Weight	**Point load** Inner ring stands still Direction of load unchangeable	**Circumferential load** Outer ring rotates Direction of load unchangeable
 Unbalance	**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
 Unbalance	**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
 Weight	**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

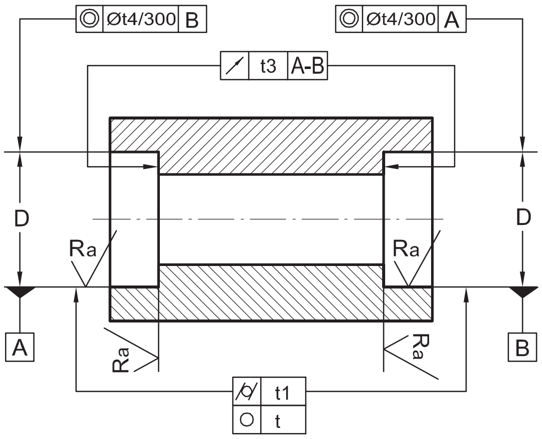
6. Tolerances of connecting parts of cylindrical roller bearings

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	IT5/2	IT4/2	IT3/2	IT2/2
Cylindrical shape	⌭	t1	IT5/2	IT4/2	IT3/2	IT2/2
Squareness	∠	t2	–	–	–	IT3/2
Face runout	↗	t3	IT5	IT4	IT3	IT3
Concentricity	◎	t4	IT6	IT6	IT5	IT4
Roughness R_a						
d ≦ 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	IT5/2	IT4/2	IT3/2	IT2/2
Cylindrical shape	⌭	t1	IT5/2	IT4/2	IT3/2	IT2/2
Face runout	↗	t3	IT5	IT4	IT3	IT3
Concentricity	◎	t4	IT7	IT6	IT5	IT4
Roughness R_a						
D ≦ 80 mm		–	N6	N6	N5	N5
80 < D ≦ 250 mm		–	N7	N7	N6	N6
D < 250 mm		–	N7	N7	N7	N7

Form accuracy of housings *40-308*

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).

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*

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

Roughness R_a of the axial collars of the spindle in the housing and of the rings in between: N6 = 0.8 µm

Roughness values *40-310*

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

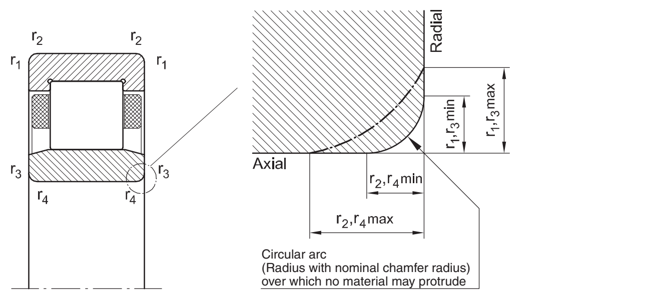
	Inner ring [mm]	Accuracy	Ø 2.5 to 10	10 18	18 30	30 50	50 80	80 120	120 150	150 180	180 250	250 315
Δ_{dmp}	Deviation of the average bore diameter on one level	PN	–8	–8	–10	–12	–15	–20	–25	–25	–30	–35
		P6	–7	–7	–8	–10	–12	–15	–18	–18	–22	–25
		P5	–5	–5	–6	–8	–9	–10	–13	–13	–15	–18
		P4	–4	–4	–5	–6	–7	–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 to 30	30 50	50 80	80 120	120 150	150 180	180 250	250 315	315 400	400 500	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 referrring 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}). Values in µm
The total width tolerance of a bearing set adds up out of the sum of single tolerances.

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 from (mm)	to (mm)	Tolerance of the chamfer widths Radial r_1, r_3 min. (mm)	max. (mm)	Axial r_2, r_4 min. (mm)	max. (mm)
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:

$P = F_r$	[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:

$P = F_r$	with $F_a / F_r \leq e$	
$P = 0.92 \cdot F_r + Y \cdot F_a$	with $F_a / F_r > e$	[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:

$P_0 = F_r$	[2.2]

P_0	equivalent static bearing load	[N]

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:

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

$F_{r\,min}$	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 • (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.

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

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.

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

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.

$$a_2 = a_{2b} \bullet a_{2s} \bullet a_{2w} \qquad [2.6]$$

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_3N_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.

$$a_3 = a_{3ts} \bullet a_{3vi} \qquad [2.7]$$

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}.

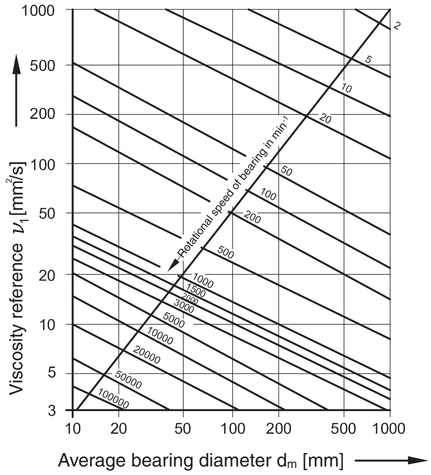
Life cycle coefficient a_{3vi}

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.

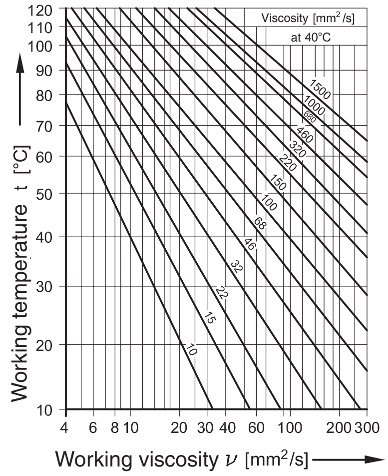
First of all the viscosity reference ν_1 is determined depending on the rotational speed n and on the average diameter of the bearing dm according to diagramme 40-501. Then the actual viscosity ν at operating temperature is taken from diagramme 40-502. The ratio of both values to each other is the κ-value.

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

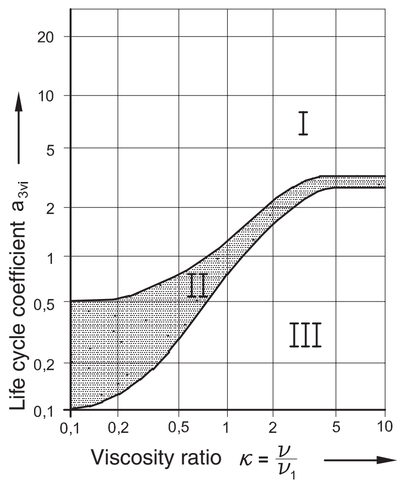
κ	viscosity ratio	
ν	actual kinematic viscosity of the lubricant at working temperature	[mm²/s]
ν_1	necessary kinematic viscosity of the lubricant at working temperature	[mm²/s]



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 φ = 0.9 g/cm³ (mineral oil), then κ has to be corrected by multiplying it with the density ratio of φ / 0.9 g/cm³ (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 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 µm 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 µm sized dust particle of a hardness > 50 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 mW/mm² K referring to the bearing shell surface ($\pi \bullet D \bullet B$) as well as a difference in temperature of 60 °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:

$$F_{a\,max} = \frac{k_1 \bullet C_o \bullet 10^4}{n \bullet (d + D)} - k_2 \bullet F_r \qquad [2.9]$$

$F_{a\,max}$	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 to 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 $F_a = 0.0045 \bullet D^{1.5}$. With all remaining series the $F_a = 0.0023 \bullet D^{1.7}$ 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:	$F_a = 0.013 \bullet D^{1.5}$	
Other series:	$F_a = 0.007 \bullet D^{1.7}$	[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:

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

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 discipated 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_o 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 $\left[\frac{mm}{min}\right]$		
C / P	15	8	4
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:

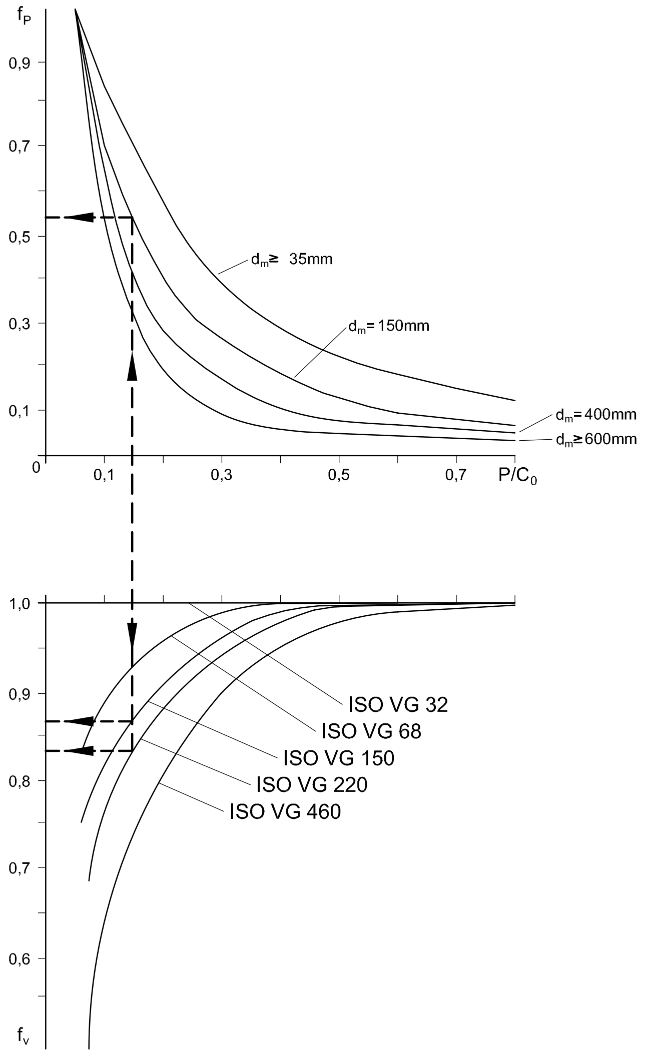
$$n_{max} = f_p \cdot f_v \cdot n_r \qquad [3.2]$$

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:

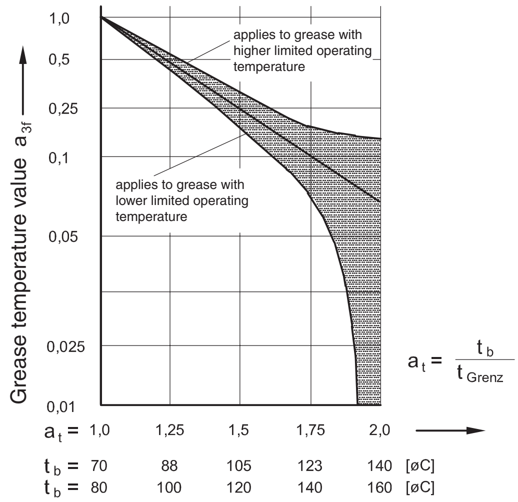
$$n_{max} = f_p \cdot n_r \cdot f_{v\ \text{base oil actual}} / f_{v\ \text{base oil ISO VG 150}} \quad [3.3]$$

Rotational speed higher than reference rotational speed

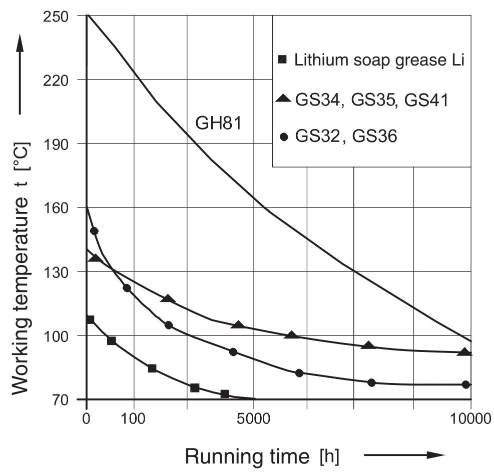
Rotational speed that is higher than the reference rotational speed lead to excessive bearing temperatures, unless corrective actions are undertaken such as heat absorbing oil circulation lubrication, air-cooling or liquid cooling of the inner ring and outer ring. High bearing temperatures reduce the 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

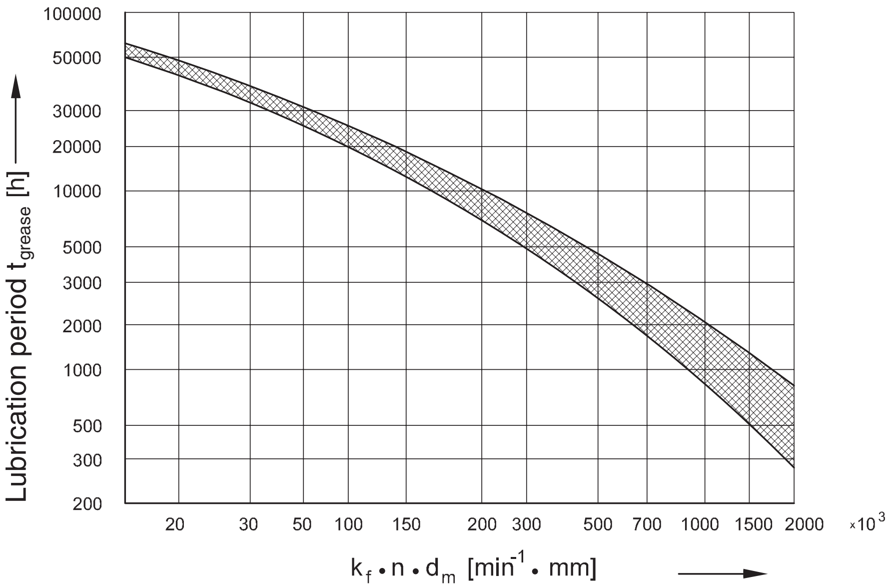
Greases age faster at higher operating temperatures than at operating temperatures of 70 °C. If the working temperature is higher than 70 °C as a result of own heat generation or because of surrounding heat then the complete service life of the bearing could depend on the service life of the grease. 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*

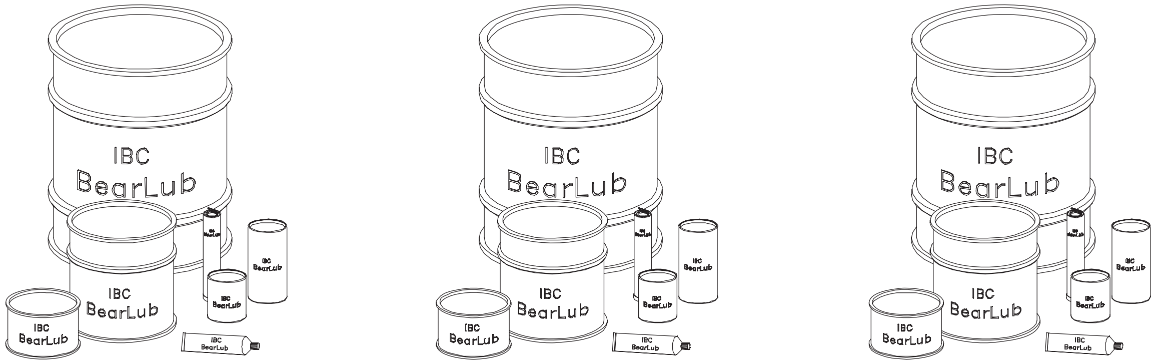
The grease fatigue life ascertained according to picture 40-506 decreases with the grease temperature coefficient a_{3f} according to picture 40-504.
Besides the temperature, further grease service life-reduction factors are also of importance:

– 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 $L_{na\ bearing}$ with $L_{h\ grease}$ 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 °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

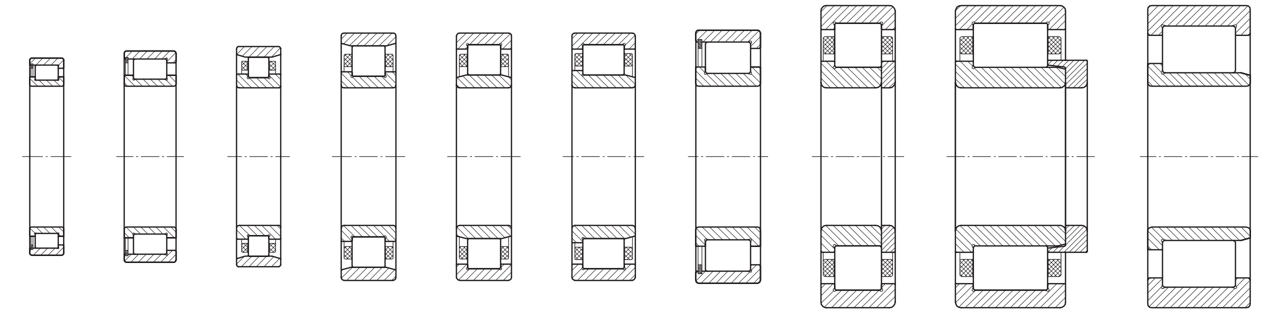
IBC suffix	Rotational figures dm · n	Tempera-ture range	Consistence classification NLGI	Base oil	Viscosity of basic oil		Thickener	Density	Comments
	·10^6 [mm / min]	[°C]			40°C	100°C		[g/cm^3]	
GN 02	0.6	−30/+130	2	Mineral oil	100	10	Li-12 Hydro Stearat	0.9	Standard grease for single row deep groove 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 rotatio-nal 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	Perfluoro-polyether	55	9	PU	1.7	High thermal and chemical resistence, 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



NCF 29.. NCF 30.. N 10.. N 2.. NU 2.. NJ 22.. NCF 22.. NUP 3.. NJ+HJ 23.. NJG 23..

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			

Material

	Steel rollers 100Cr6
AC-	Rings ATCoated

Design

NU..	N..
NJ..	NCF..
NUP..	NJG..

Designation of the bearing series

10..	2..
30..	3..
29..	22..
	23..

Designation of the bore diameter

00	10 mm	02	15 mm
01	12 mm	03	17 mm

From number 04 x 5 [mm]

Basic form

EA..	EXAD
V..	Full complement
VH..	Full complement + self retaining of rollers

Coating ATCoat

A11	Inner ring and outer ring coated (IR + OR)
A15	IR + OR coated, rolling elements and cage corrosion resistant
A 21	Inner ring coated
A 31	Outer ring coated

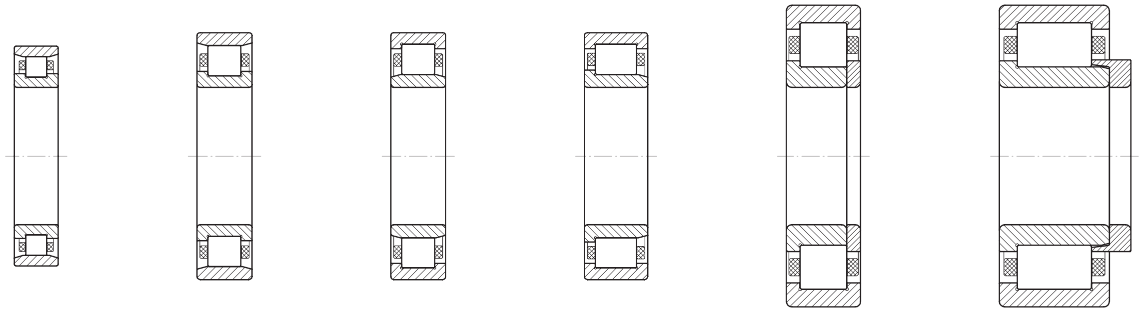
Precision classes and radial clearance

P6, P63, P52, P53 = P5 + C3

Cage

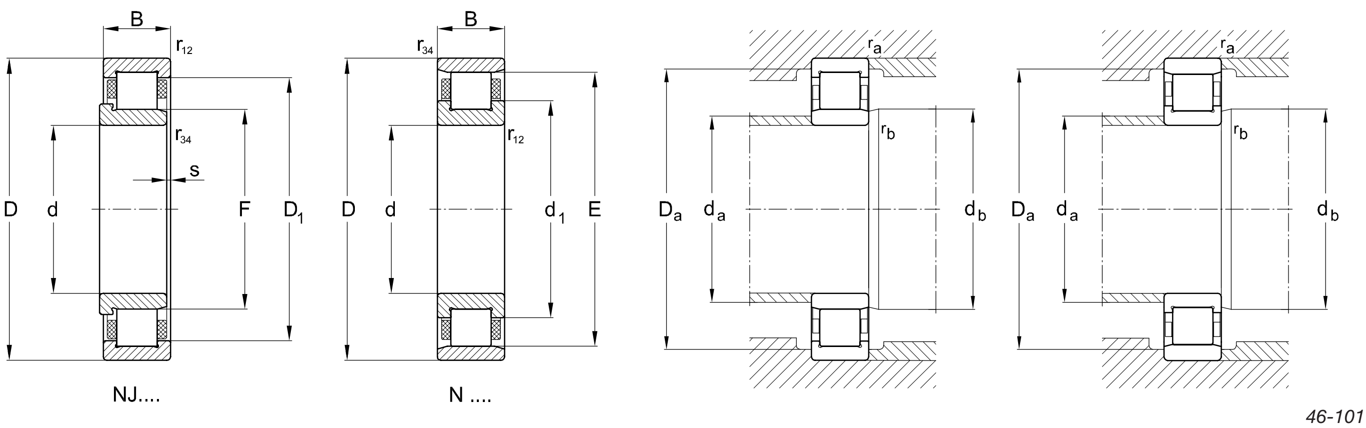
MC	one-piece-machined-brass cage, located on rolling elements
MCA	one-piece-machined-brass cage, located on outer ring
M1	one-piece-machined-brass cage, riveted, located on rolling elements
M1A	one-piece-machined-brass cage, riveted, located on outer ring
P	Polyamid window type cage, glassfibre inforced, located on rolling elements
J	Steel sheet cage
K	PEEK glass fibre reinforced window type cage, located on rolling elements

Designation system *44-106*



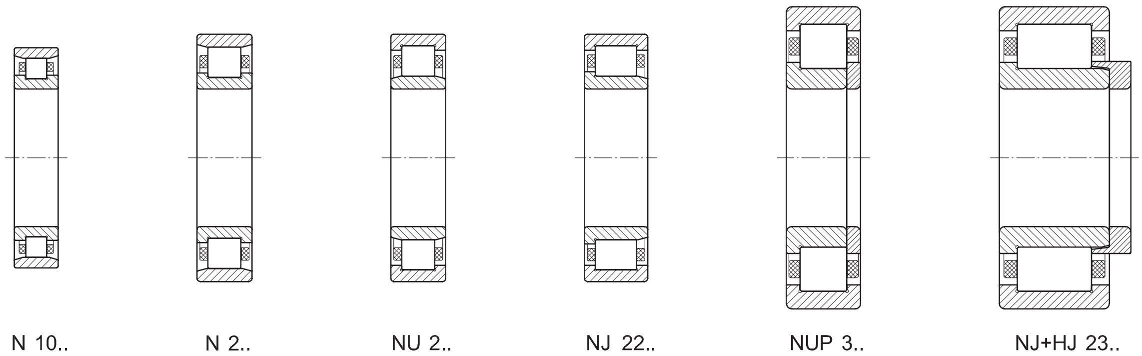
46-101

Basic dimensions			Basic designation	Basic load ratings stat.	dyn.	Fatigue limit load	Minimal load factor	Limiting speed	Reference speed	Weight
d	D	B		C_0	C	P_u (radial)	k_f	n_G	n_R	
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



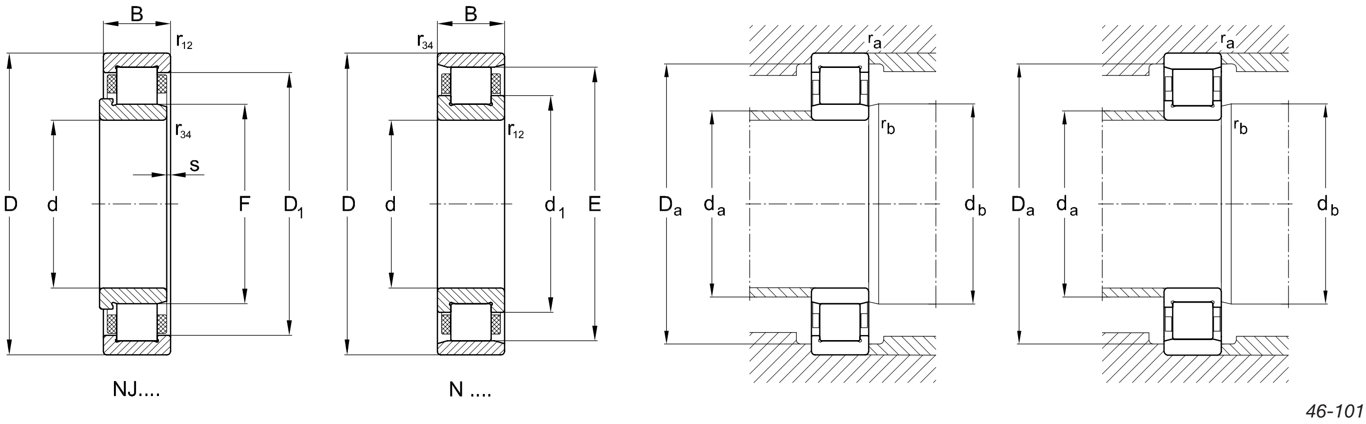
46-101

Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d_1 mm	D_1	r_{12min}	r_{34min}	$d_{a_{min}}$	$D_{a_{max}}$	$D_{b_{max}}$ 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

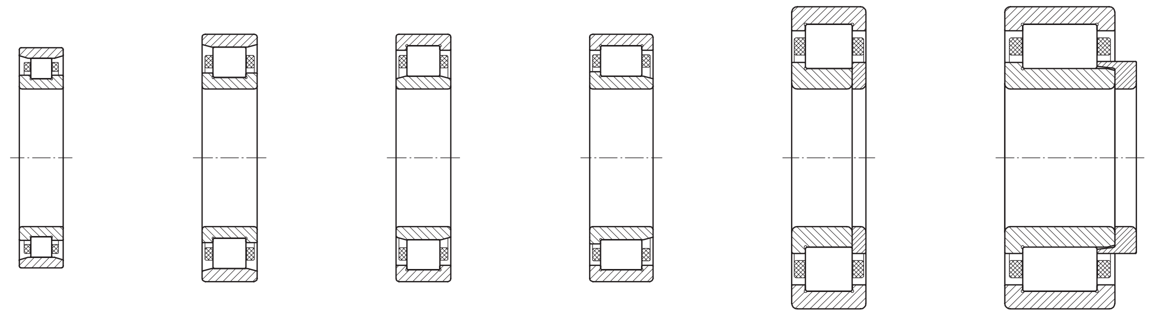


46-101

Basic dimensions			Basic designation	Basic load ratings stat.	dyn.	Fatigue limit load	Minimal load factor	Limiting speed	Reference speed	Weight
d	D	B		C_0	C	P_u (radial)	k_f	n_G	n_R	
mm				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



Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d_1	D_1	r_{12min}	r_{34min}	$d_{a_{min}}$	$D_{a_{max}}$	$D_{b_{max}}$	$r_{a_{max}}$	$r_{b_{max}}$
				mm						mm		
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.. NU 2.. NJ 22.. NUP 3.. NJ+HJ 23..

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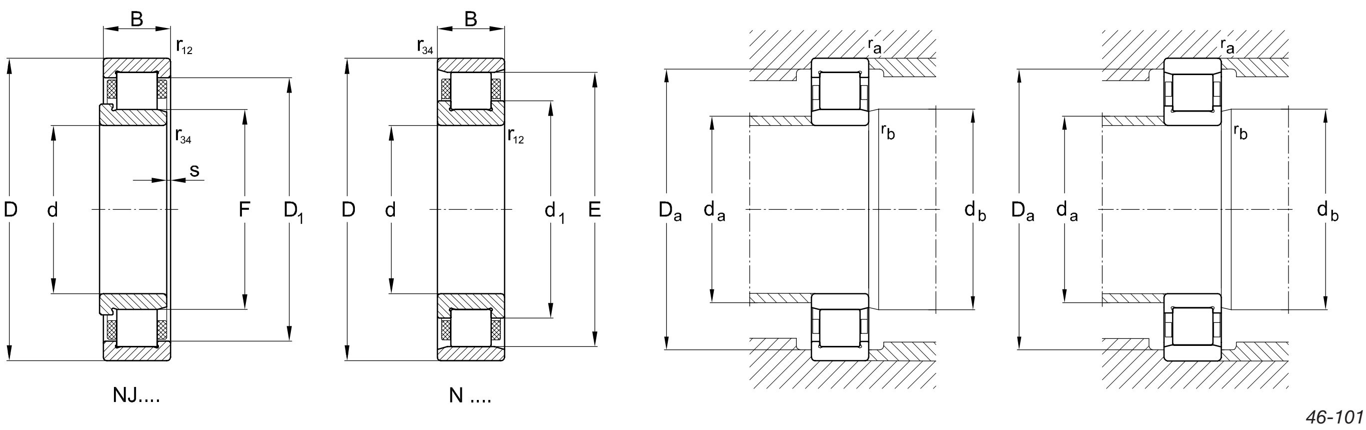
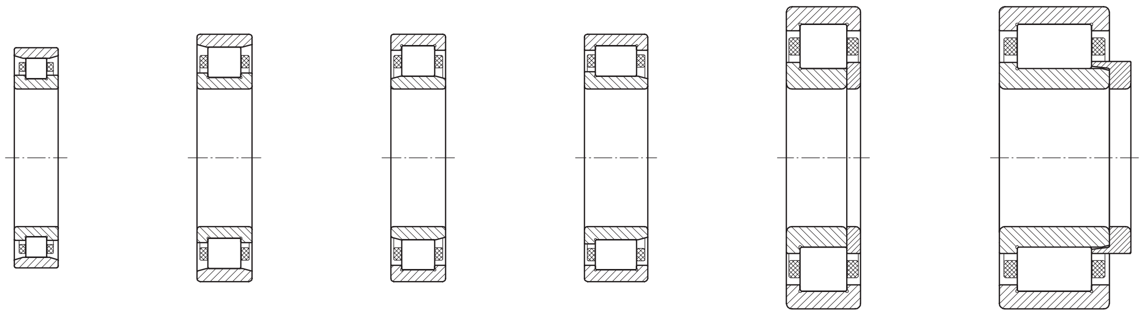
Basic dimensions			Basic designation	Basic load ratings stat.	dyn.	Fatigue limit load	Minimal load factor	Limiting speed	Reference speed	Weight
d	D	B		C_0	C	P_u (radial)	k_f	n_G	n_R	
mm				N		N		min^{-1}		kg
75	115	20	**NU 1015**	82 000	76 000	8 500	0.10	10 000	6 700	0.740
75	130	25	**N 215.EA**	156 000	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	3700	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



Basic designation	Dimensions							Mounting dimensions				
	F	E	s	d_1	D_1	r_{12min}	r_{34min}	$d_{a_{min}}$	$D_{a_{max}}$	$D_{b_{max}}$	$r_{a_{max}}$	$r_{b_{max}}$
				mm						mm		
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



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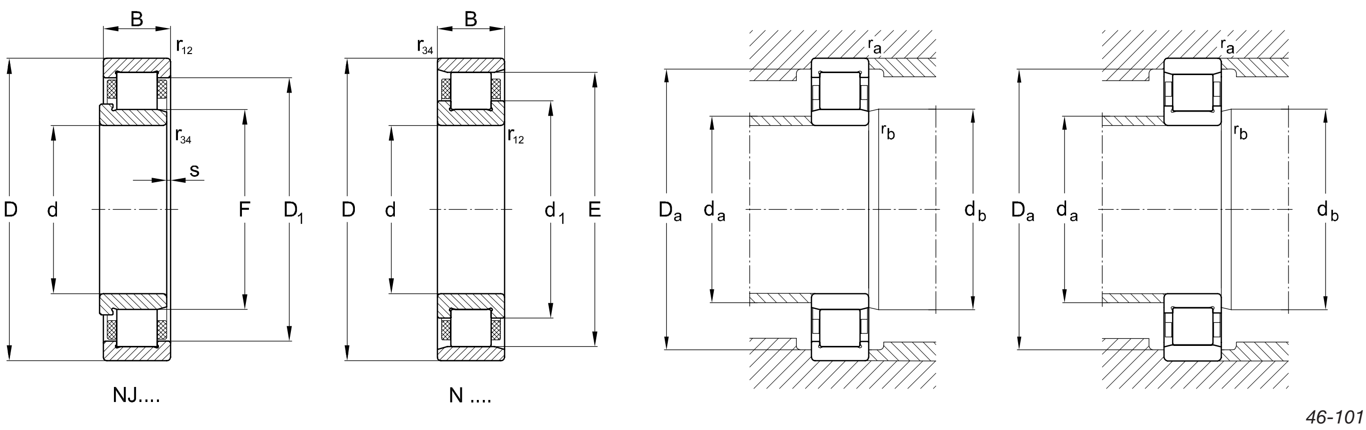
Basic dimensions			Basic designation	Basic load ratings stat.	dyn.	Fatigue limit load	Minimal load factor	Limiting speed	Reference speed	Weight
d	D	B		C_0	C	P_u (radial)	k_f	n_G	n_R	
mm				N		N		min $^{-1}$		kg
105	160	26	**NU 1021**	153 000	131 000	16 000	0.10	7 500	4 800	1.900
105	190	36	**N 221.EA**	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



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:

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

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:

$P = F_r$	bei $F_a / F_r \leq e$	
$P = 0.92 \cdot F_r + Y \cdot F_a$	bei $F_a / F_r > e$	[4.1]

P	equivalent dynamic bearing load	[N]
F_r	radial load	[N]
e	limit value 0.3 with bearings of the series 29, 30, 22 and 23	
Y	axial load factor 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:

$$P_0 = F_r \qquad [4.2]$$

P_0	equivalent static bearing load	[N]

Minimum load
To ensure an 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:

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

$F_{r\,min}$	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 • (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 dissipation from the bearing. Usually a viscosity ratio of $\kappa \geq 2$ can be assumed as well as a specific heat dissipation of 0.5 mW/mm² • K referring to the bearing shell surface (π • D • B) as well as a difference in temperature of 60 °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:

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

$F_{a\,max}$	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 to 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.

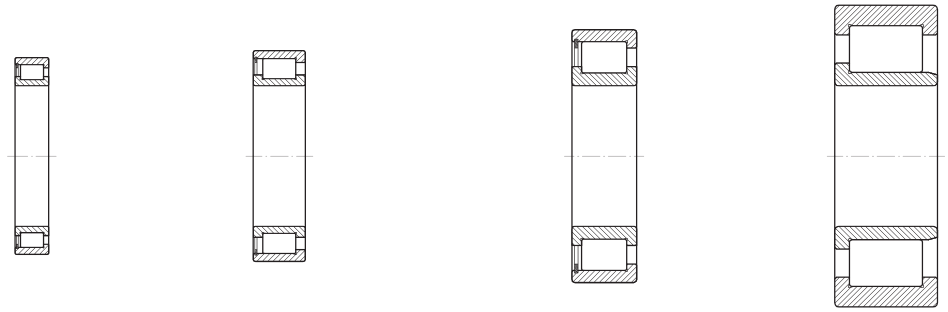
Thus, a support of the ribs on the complete height is recommendable. Please notice that with very strong bending of the shaft bending fatigue stress can appear, caused by the support of the ribs.
Thus, e.g., the diameter of the shaft shoulder arises for the rib on the inner ring as follows:

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

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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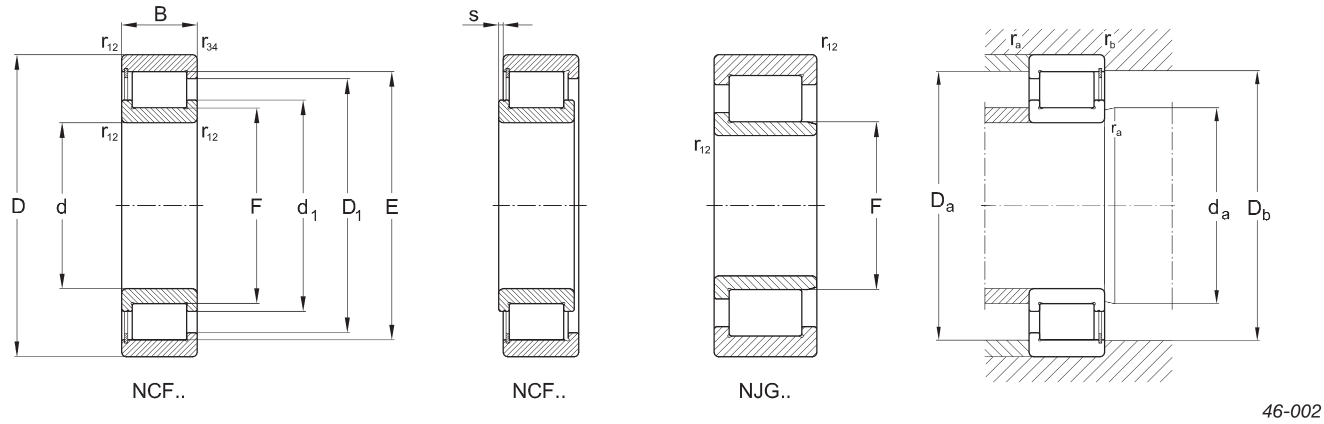
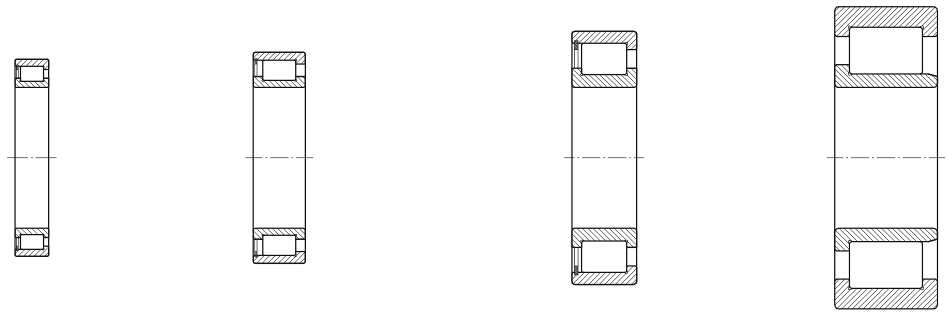
Basic dimensions			Basis designation	Basic load ratings stat.	dyn.	Fatigue limit load	Limiting speed	Reference speed	Weight
d	D	B		C_0	C	P_u (radial)	n_G	n_R	
mm				N		N	min^{-1}		kg
20	42	16	**NCF 3004**	28 500	28 100	3 100	10 000	8 500	0.110
20	47	18	**NCF 2204**	37 500	45 500	6 100	9 700	6 500	0.160
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



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	$r_{a_{max}}$	$r_{b_{max}}$
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	–



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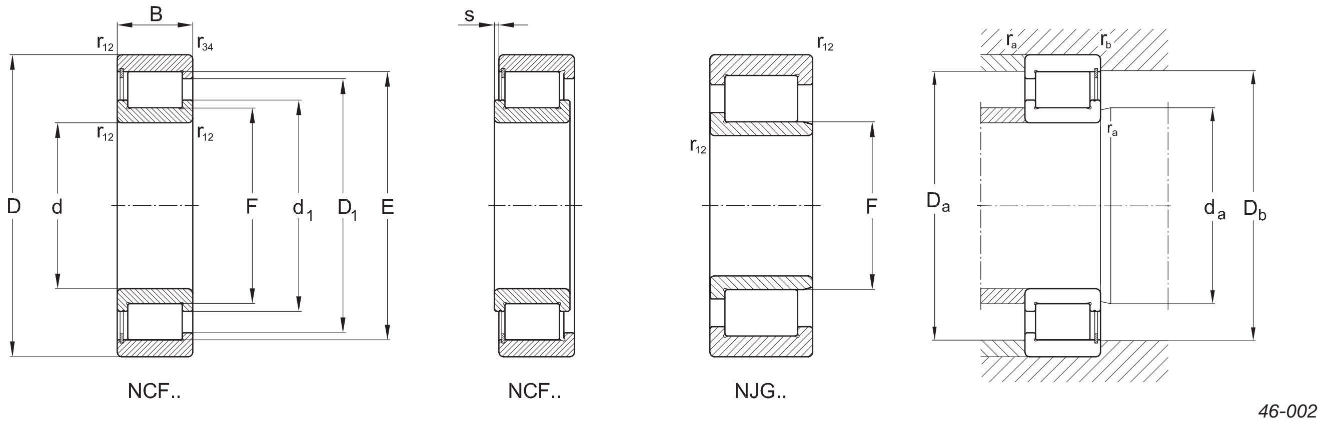
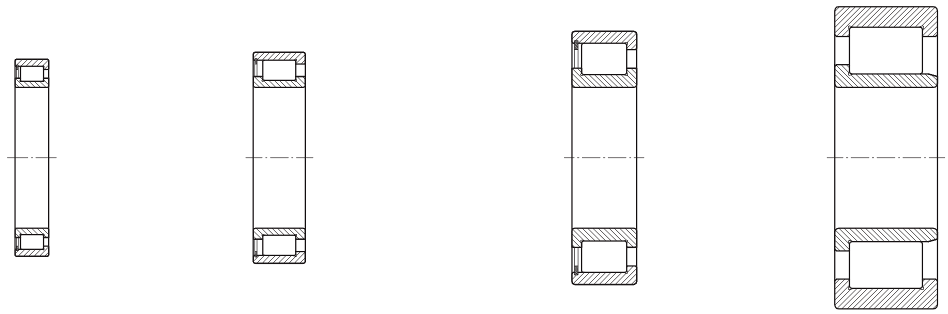
Basic dimensions			Basis designation	Basic load ratings stat.	dyn.	Fatigue limit load	Limiting speed	Reference speed	Weight
d	D	B		C_0	C	P_u (radial)	n_G	n_R	
mm				N		N	min^{-1}		kg
70	100	19	**NCF 2914**	116 000	76 500	13 700	3 800	3 000	0.490
70	110	30	**NCF 3014**	173 000	128 000	22 400	3 600	2 800	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



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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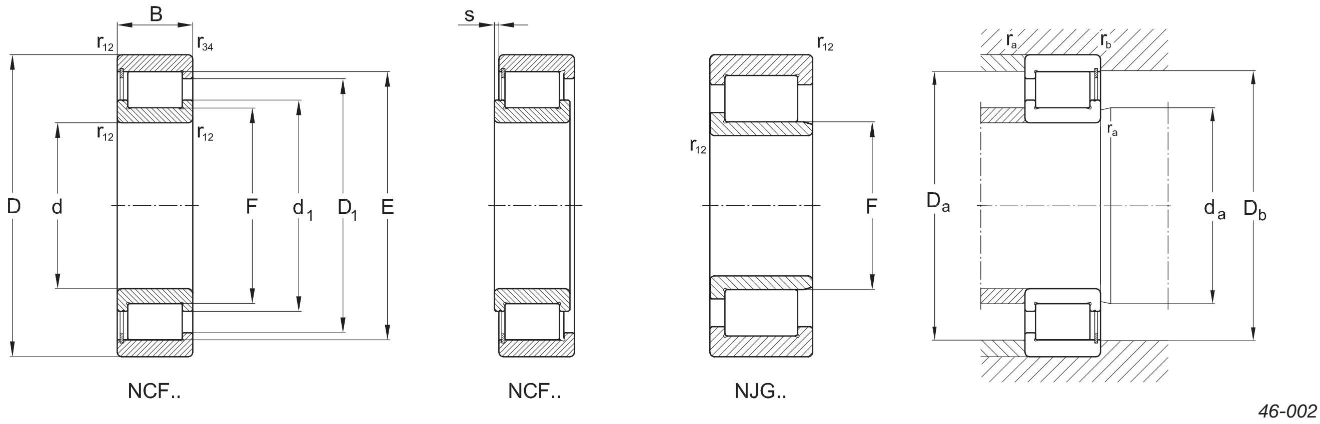
Basic dimensions			Basis designation	Basic load ratings stat.	dyn.	Fatigue limit load	Limiting speed	Reference speed	Weight
d	D	B		C_0	C	P_u (radial)	n_G	n_R	
mm				N		N	min^{-1}		kg
120	165	27	**NCF 2924**	290 000	172 000	34 500	2 200	1 800	1.730
120	180	46	**NCF 3024**	440 000	292 000	52 000	2 000	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



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	$r_{a_{max}}$	$r_{b_{max}}$
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	–

Notes

More of IBC . . .

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

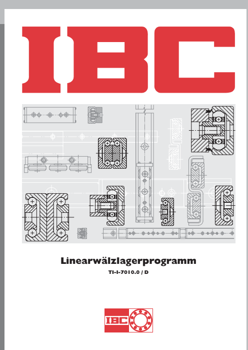
Cylindrical Roller Bearings
TI-I-4010.0 / D (German)
TI-I-4010.0 / E (English)

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)
TI-I-5020.0 / E (English)

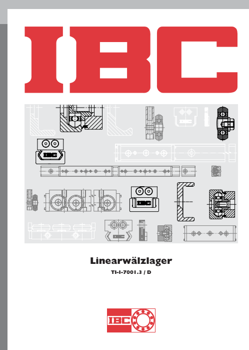
Ball Screw Support Bearings
TI-I-5010.2 / D (German)
TI-I-5010.2 / E (English)

Super Precision Bearings Service Catalog
TI-I-5003.1 / D (German)
TI-I-5003.2 / E (English)



Product Range
Linear Motion Bearings
TI-I-7010.0 / D (German)
TI-I-7010.0 / E (English)

Telescopic-Rails
TI-I-7005.1 / D (German)



Linear Motion Bearings
TI-I-7001.3 / D (German)
TI-I-7001.3 / E (English)

ATCoated Bearings
TI-I-5010.2 / D (German)

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