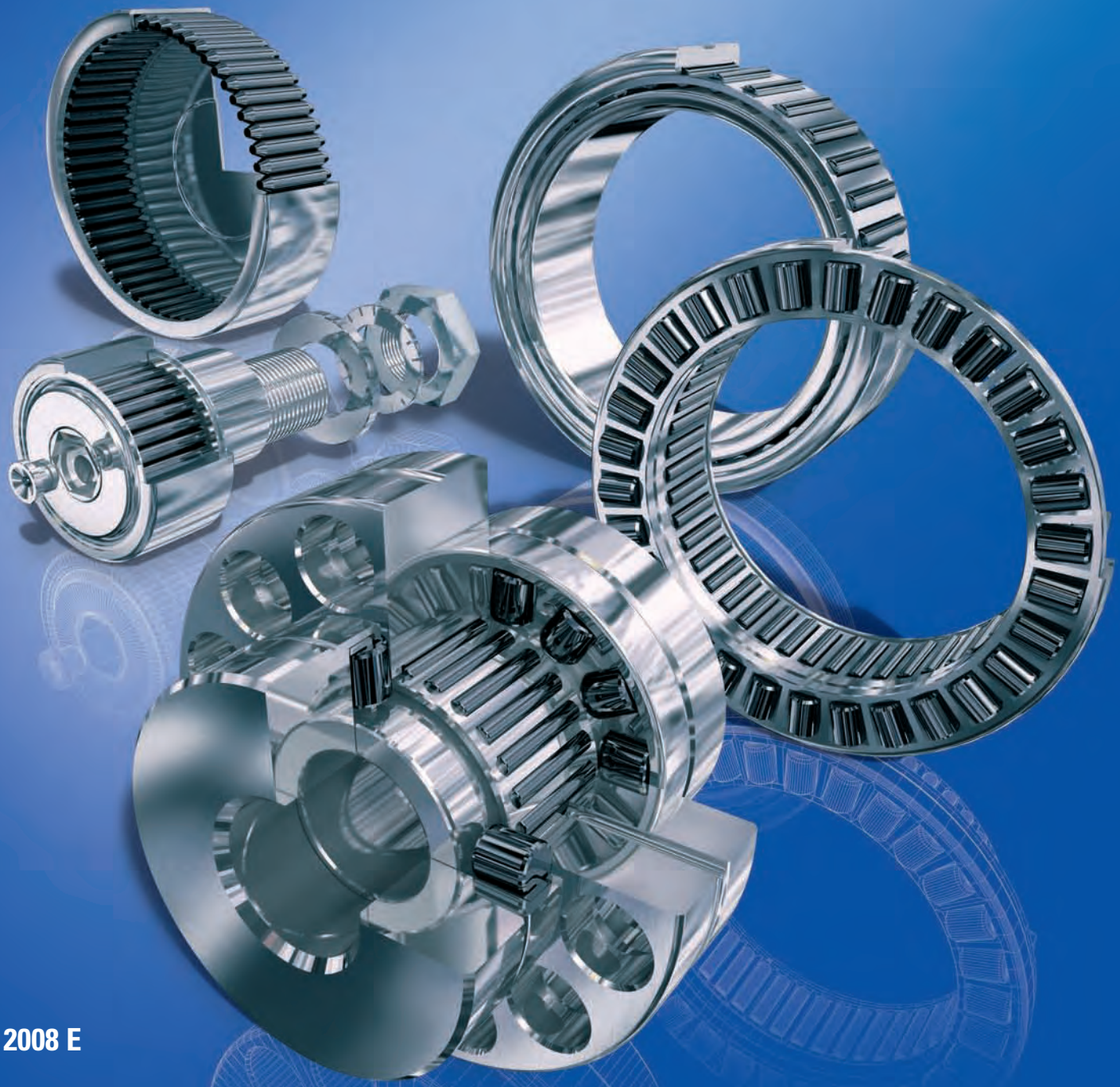
NADELLA

Linear and Motion Solutions

Needle Bearings



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► NEEDLE BEARINGS
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NADELLA
Specialist manufacturer of needle bearings since 1930.
1000 employees
2 manufacturing plants
80 million bearings per annum
4000 million needle rollers.

PRODUCT DEVELOPMENT
NADELLA needle roller products are under continual development both from the point of performance and their adaptability to specific applications. NADELLA have created many special products to meet various complex requirements: The RAX combined radial and axial roller bearings; Deltaflex bearings for steering columns and special bearings for the machine tool and aviation industries.

The design department at NADELLA, who hold an extensive file of successful patents, is in close contact with the market in order to respond rapidly with innovative and competitive solutions to its' customers needs.

QUALITY
NADELLA is committed to achieving "Quality" throughout production and in all departments. This is achieved through continuous research and development into methods and means of production; the use of high powered automatic presses, machines to cut and weld cages and automated machines for grinding and assembly, as well as machines for sorting and grading needle rollers.

RELIABILITY
The reliabililty of NADELLA bearings is maintained on two levels:

- firstly, the suitability of the bearing to satisfy the requirements of the customer
- secondly, manufacturing to zero defects.

These two features are permanently under verification and surveillance, on test rigs, by continual inspection from operators and furthermore, by statistical process control. The reliability of NADELLA products is confirmed every day in standard high volume applications as well as selected sophisticated and complex applications.

SUPPORT
NADELLA's engineers work closely with their customers, both in the design office and the workshop. Through their training and their experience, they can make a positive contribution to the technological evolution of their customer's products.

NADELLA
PRESENT IN ALL INDUSTRIES
From the simple drawn cup needle roller bearings to the sophisticated bearings that articulate the nozzles on the three stages of the Ariane missile, NADELLA is present throughout all industries, both for mass produced volumes and specific applications at the frontiers of technology.

Our engineers, experienced in all types of application, are available to work with you throughout the design and development of your products and any future projects.

A great many industries have already put their confidence in the NADELLA products.

NADELLA BEARINGS – NEW CAPACITIES

Resulting from the significant progress made in the geometry of our bearings and in the quality of the steel used, NADELLA bearings now offer the user increased performance.

The new basic static capacities shown in the present catalogue (ISO standard) take into account this increased performance.

IMPORTANT: The correction factors have been revised to conform with the new specifications. Please don't forget to consult them.

PRINCIPAL UNITS

	S.I.SYSTEM		Multiple or Part		Equivalent
Unit	Title	Symbol	Title	Symbol	
length	metre	**m**	millimetre	**mm**	1 mm = 10^{-3}**m**
			Micrometre or micron	μ**m**	1 μm = 10^{-6}**m**
time	second	**sec**	hour	h	1 h = 3600 sec
			minute	**min**	1 min = 60 sec
speed	metre per second	**m/sec²**			
speed (rotational)	revolutions per minute	**r.p.m.**			
acceleration	metres per second per second	**m/s²**			
mass	kilogramme	**kg**	gramme	**g**	1 g = 10^{-3} **kg**
force	newton	**N**			
moment of force	newton metre	**Nm**			
stress	pascal	**Pa**	Megapascal	**MPa**	1 MPa = 1N/mm²
kinematic viscosity	square metres per second	**m²/s**	square millimetres per second	**mm²/s**	1 mm²/s = **cSt**
temperature	degrees centigrade	°C			

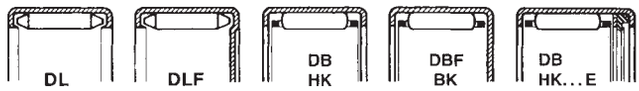
COMMENTS

The information given in this catalogue can be subject to modification and deletions. NADELLA does not accept any responsibility for errors or omissions that may have escaped notice.

Information and advice contained herein may be insufficient given the conditions of individual applications. For further assistance, please consult our Technical Department.

Certain products mentioned in this catalogue involve proprietary rights of manufacture (Trade Marks, Patents, etc.).

NEEDLE BUSHES

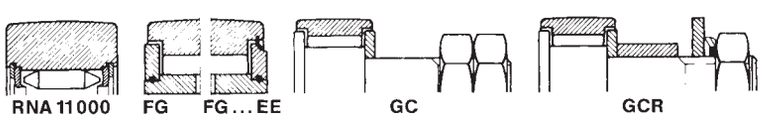


BEARINGS WITH CAGE
GUIDED NEEDLES

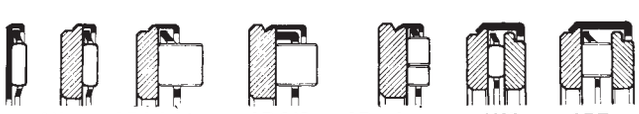
FULL COMPLEMENT NEEDLE BEARINGS

NEEDLE ROLLERS

CAM FOLLOWERS

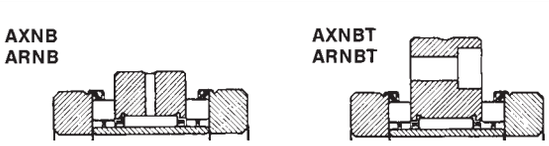


THRUST BEARINGS
WITH NEEDLES
WITH ROLLERS



COMBINED
BEARINGS

PRECISION COMBINED BEARINGS
WITH ADJUSTABLE PRELOAD



SEALING RINGS

SUMMARY TABLE – INNER RINGS
SUMMARY TABLE – THRUST PLATES

BEARING TOLERANCES (ISO 92)
ISO SHAFT AND HOUSING FITS
C/P FACTORS

SYMBOLS AND DESIGNATIONS

TECHNICAL INFORMATION

1. GENERAL

2. CALCULATIONS FOR RADIAL AND THRUST BEARINGS

2.1 DYNAMIC CAPACITY C

2.2. NOMINAL LIFE L_{10}

2.3. MODIFIED LIFE L_{na}

2.3.1. Reliability correction factor a_1
2.3.2. Correction factor a_2 for material and a_3 for lubrication

2.4. EQUIVALENT LOAD AND SPEEDS

2.4.1. Overload factors
2.4.2. Variable loads and speeds
2.4.3. Load varying linearly at constant speed
2.4.4. Oscillating motion

2.5. APPLICATION CRITERIA

2.6. STATIC CAPACITY Co – LIMIT LOAD P_L

2.7. TEMPERATURE EFFECTS

2.8. BEARING RACEWAYS

2.8.1. Hardness
2.8.2. Heat treatment
2.8.3. Surface finish

2.9. COEFFICIENTS OF FRICTION

2.10. LIMITING SPEEDS

2.11. CALCULATION EXAMPLES

3. LUBRICATION

3.1. GREASE LUBRICATION

3.1.1. Principal types of greases
3.1.2. Special greases
3.1.3. Compatibility of greases
3.1.4. Application
3.1.5. Quantity of grease
3.1.6. Re-lubrication

3.2. OIL LUBRICATION

3.2.1. Viscosity
3.2.2. Application
3.2.3. Centralised lubrication

3.3 SUPPLY OF LUBRICANTS – STOCK

4. SEALING

4.1. SEALING USING NARROW PASSAGES

4.2. RUBBING SEALS

4.2.1. Various types
4.2.2. Mounting
4.2.3. NADELLA sealing rings

TECHNICAL INFORMATION

1. GENERAL

The choice of a bearing depends on many factors that need to be examined in order to obtain the most successful results at the lowest cost.

In most cases the selection should be made when the overall design of the machine has been decided. Dimensional limits are then known, also the speeds and loads. At this stage the choice can be made from the many types of bearings offered from the NADELLA standard ranges and the notes given in this section will generally permit one to select the most suitable bearing for each application.

When calculating the cost of the assembly, not only should the price of the bearing be considered but also costs for heat treatment, machining, and handling and fitting of ancilliary items (snap rings, locking devices, tools etc.) and the eventual quantities required. Large economies can be made on these items if the correct bearing is selected. Sometimes it is more advantageous to choose a bearing of slightly higher cost which will however, when all criteria are taken into consideration, provide the most economic solution.

In the studies that are undertaken by NADELLA, the bearings proposed frequently occupy less space and save material, machining and installation costs, which benefit the entire assembly.

As for all other types of bearing, the results obtained with needle bearing products depend to a large extent on the design and method of assembly, loading, and alignment between inner and outer rings.

Bearing alignment depends first of all on the geometry of the parts involved and secondly on the deflection of the shaft under load. The shaft diameter should therefore be sufficient to prevent large deflections. This is easier to achieve using needle bearings because they occupy a small radial area.

2. CALCULATIONS FOR RADIAL AND THRUST BEARINGS

The details following enable one to evaluate radial bearings and thrust bearings and also combined bearings which comprise a radial and a thrust component. These are calculated separately without transforming the axial load into an equivalent radial load.

The calculations for linear bearings and recirculating roller linear bearings are covered in the relevant sections.

The calculation for a radial or thrust bearing must take account of the following principal factors:

- actual supported loads and possible shock loads
- speed of rotation
- operating temperature
- hardness of the bearing raceways.

Other features such as lubrication, sealing and alignment do not enter directly into the life calculations but they must be considered in order to avoid introducing unfavourable factors.

The life calculation of a radial bearing or a thrust bearing under rotation is established from the dynamic capacity C indicated in the tables of dimensions. The static capacity Co enables one to determine the maximum load under certain operating conditions (see table page 11).

IMPORTANT
The correction factors (reliability, material, lubrication, hardness, operating conditions) have been revised to conform with the new basic capacities. Please don't forget to consult them.
In the case where a NADELLA bearing is used with a raceway provided by the customer, our Technical Service is available to your designers to define the correction factors applicable.

2.1. DYNAMIC CAPACITY C

The dynamic capacity of a bearing is the constant radial load which it can support during 1 000 000 revolutions before the first signs of fatigue appear on a ring or rolling element. For a thrust bearing, the capacity for 1 000 000 revolutions assumes a constant axial load centred in line with the axis of rotation.

The dynamic capacity C for caged needle bearings and thrust bearings shown in the tables of dimensions has been established in conformance with the ISO Standard 281/I (French Std. E 22 392 - Dec. 1977). This does not apply to full complement needle bearing products where the dynamic capacity C has been established by NADELLA.

2.2. NOMINAL LIFE L_{10}

The life of a radial bearing or thrust bearing is the number of revolutions (or the number of hours at constant speed) that it will maintain before showing the first signs of material fatigue.

The relationship between the life in millions of revolutions L_{10}, the dynamic capacity C and the supported load P, is given by the formula:

$$L_{10} = \left(\frac{C}{P}\right)^{p}$$

In this expression p is equal to 10/3 for needle or roller bearings. In order to assess the importance of the influence of load on the life expectancy, one should note for example that, if the load on a bearing is doubled, its life is reduced by a factor of 10.

The formula above is independent of speed of rotation which must not exceed the recommended limit in respect of the radial bearing or the thrust bearing used and the method of lubrication.

If the speed of rotation n (r.p.m.) is constant, the life is given in hours by the function:

$$L_{10\,h} = \frac{L_{10} \times 10^6}{60\ n}$$

The life in hours is then inversely proportional to the speed.

To make these calculations the table on page 183 gives the values for the factor C/P for various lives in hours and speeds in r.p.m. For intermediate speeds or lives one can interpolate the figures given.

One can also use the table on page 184 to establish the values for the factor C/P as a function of the product n x h (n speed in r.p.m. and h life in hours). For example for 800 r.p.m. and 6 000 hrs. (800 x 6 000 = 4 800 000) one finds factor C/P = 5.47.

The above formulae will ensure that 90% of the bearings operating under the same conditions will attain at least the calculated L_{10} life, known as the *nominal life* (the figure 10 being the percentage of bearings which may not attain this life). The formulae are based on the use of standard quality bearing steel and assume a satisfactory method of lubrication.

2.3. MODIFIED LIFE L_{na}

In various conditions, a modified life can be determined (in millions of revolutions) following the general formula:

$$L_{na} = a_1\ a_2\ a_3\ L_{10}$$

in which a_1 a_2 and a_3 are correction factors linked respectively to reliability, material and lubrication.

2.3.1. Reliability correction factor a_1

A reliability factor in excess of 90% may be required in certain industries, such as aviation, for reasons of security and to reduce the risk of a very costly immobilisation.

The table below indicates the values of the correction factor a_1 as a function of reliability:

Reliability %	Factor a_1	Corrected life L_{na1}
90	1	L_{10}
95	0.62	L_5
96	0.53	L_4
97	0.44	L_3
98	0.33	L_2
99	0.21	L_1

In order to select as an example a bearing of L_4 life (reliability 96%) it is necessary to consider a theoretical L_{10} life (reliability 90%), equal to $L_4/0.53$ applied in the formula $L_{10} = (C/P)^{10/3}$ using the dynamic capacity C given in this catalogue.

2.3.2. Correction factor a_2 for material and a_3 for lubrication

Modern developments in the manufacture of steel enable one to consider the use of special degassed or vacuum remelted types. The practical life achievable with bearings using these special steels is much greater than with conventional bearings steels, on which are based the load capacities in this catalogue.

The factor a_2 for increase of life due to material must be estimated making allowance for the lubricant properties (factor a_3). These properties must take account of the bearing loads. In cases where lubrication is insufficient (e.g. oil viscosity too low at the operating temperature) one should use a factor $a_3 < 1$. It is therefore recommended that the product of the factors $a_2 \times a_3$ is always considered in its entirety.

The NADELLA Technical Department should be consulted in these special cases.

2.4. EQUIVALENT LOAD AND SPEEDS

2.4.1. Overload factors

The load on a radial or thrust bearing is established from the characteristics of the machine together with the working loads prevailing. However, account should also be taken as far as possible of the supplementary loads which arise due to imperfections in the transmission, etc. or due to overloads, shocks and vibration. For conventional machines and equipment experience is the best guide but in general the coefficients listed below may be applied to determine the equivalent load used in the life calculation:

1.0—1.2 machinery or mechanisms operating smoothly without repeated shocks
1.1—1.3 geared transmissions according to gear quality
1.5—3.0 machinery or equipment operating under repeated shocks or vibration.

As far as belt drive transmissions are concerned, the calculated tangential load should be multiplied by the following coefficients:

2.0—2.5 for vee belts
2.5—5.0 for flat belts according to drive tension.

2.4.2. Variable loads and speeds

When the loads and speeds are variable, the life calculation can only be made by first establishing an assumed constant load and constant speed equivalent in their effect on the fatigue life of the radial bearing or thrust bearing.

This type of operating condition is frequently met and the possible variations although cyclical are numerous. One encounters this feature in particular, in variable speed drives. The equivalent load P and the equivalent speed n are obtained from the following formulae:

$$P = \sqrt[p]{\frac{m_1 n_1 P_1^p + m_2 n_2 P_2^p + \ldots + m_n n_n P_n^p}{m_1 n_1 + m_2 n_2 + \ldots + m_n n_n}}$$

$$n = m_1 n_1 + m_2 n_2 + \ldots + m_n n_n$$

In which:

$m_1, m_2, \ldots, m_n$: Intervals of operating time under constant load and at constant speed (by definition: $m_1 + m_2 + \ldots + m_n = 1$)
$n_1, n_2, \ldots, n_n$: Constant speeds corresponding respectively to intervals of time $m_1, m_2 \ldots m_n$
$P_1, P_2, \ldots, P_n$: Constant loads corresponding respectively to intervals of time $m_1, m_2 \ldots m_n$.

For radial bearings and needle/roller thrust bearings p is equal to 10/3.

2.4.3. Load varying linearly at constant speed

Whilst at constant speed, the load varies linearly during a given time, between a minimum P_{min} and a maximum P_{max}, the equivalent load is given by:

$$P = \frac{P_{min} + 2\,P_{max}}{3}$$

2.4.4. Oscillating motion

In order to calculate the life during oscillating motion it is necessary to determine an equivalent speed in revolutions per minute from the formula:

$$n = \frac{n_{osc}\alpha}{180}$$

n_{osc} = number of oscillations "Forward and Return" per minute.
α = amplitude of oscillation "Forward" in degrees.

However, this formula risks being in error and giving inaccurate lives for oscillations at small amplitudes. It is therefore recommended not to apply it for angles of oscillation below 15°. When the angle of oscillation is very small fretting corrosion is likely to be produced and a suitable lubricant must be chosen in consequence. Experience confirms that full complement needle bearings provide better results under this phenomenon in view of their better load sharing capability.

2.5. APPLICATION CRITERIA

The life calculation may be unreliable when values for speed and load reach the ultimate limits.

A low speed and/or load can yield an extremely long calculated life but this will be limited in practice by other operating factors such as sealing, lubrication and maintenance, all of which have a decisive influence on the life of the product in such cases.

2.6. STATIC CAPACITY Co LIMIT LOAD P_L

The static capacity Co given in the tables of dimensions has been established in conformance with ISO Specification 76. This takes into consideration the maximum admissible contact stress (Hertzian stress). The value currently being adopted in 4000 M.Pa.*.

Since permanent deformation is produced as readily in a bearing rotating as in one that is stationary, the static capacity Co determines the limit load P_L which depends on the type of bearing and the operating conditions (see table below). When the limit load P_L is given within the "min-max" range, the load applied may attain the indicated maximum provided it is applied continuously without sudden repeated variations. Alternatively, in the case of shock loads and vibrations, the load applied should not exceed the minimum value of limit load P_L.

Operating conditions	Limit load P_L for:		
	Needle bushes and radial components of combined bearings RAX or RAXF 700	Axial components of combined bearings type RAX or RAXF 700	Other bearings (1)
Important requirements for smoothness of function, silent operation, or accuracy of rotation	0.2 Co	0.25 Co	0.25 Co – 0.5 Co
General applications	See loading limits in the tables of dimensions		0.5 Co – Co
Slow rotation or oscillatory motion			0.7 Co – 1.2 Co

(1) For studded cam followers the limit load P_L determined as a function of the static capacity of the bearing must not be in excess of the authorised maximum strength of the stud given in the tables of dimensions.

* Previous values corresponded approximately to a total permanent deformation of the raceway from a rolling element, bearing the heaviest load equal to 0.0001 of the diameter of the rolling element.

2.7. TEMPERATURE EFFECTS

Having selected a lubricant appropriate to the temperature conditions, it is still necessary to take into account the permanent reduction in the dynamic capacity of bearings operating above 150°C and in static capacity above 250°C.

Operating temperature (°C)	150	200	250	300
Capacity reduction coefficient:				
● dynamic	1	0.9	0.75	0.6
● static	1	1	1	0.8

When the operating temperature is in excess of 120°C, some permanent dimensional change can occur in large ground bearing rings, which can prejudice their smooth operation. In such cases stabilisation heat treatment of the rings is recommended. The suffix HT is added to the bearing designation in accordance with the following table which also indicates the equivalent hardness of the rings at a temperature of 20°C:

Stabilisation heat treatment	HT1	HT2	HT3	HT4
Max. temperature of operation (°C) Hardness HRC of rings at a temperature of 20°C	150 60	200 58	250 55	300 52

At the maximum operating temperature, the hardness of stabilised rings HT2–HT4 is reduced in accordance with the following table:

Stabilisation heat treatment	HT1	HT2	HT3	HT4
Hardness HRC of stabilised rings at the maximum authorised temperature	60	55	52	49

2.8. BEARING RACEWAYS

2.8.1. Hardness

The load capacities shown in the tables of dimensions apply to raceways with a hardness of between 58 and 64 HRC.

The dynamic and static capacities are reduced when hardness values are lower than 58 and 54 HRC respectively according to the following table:

Hardness	HRC HV	60 697	58 653	56 613	54 577	52 545	50 512	48 485	45 447	40 392	35 346	30 302	25 267
Capacity reduction coefficients	Dyn. Stat.	1 1	1 1	0.93 1	0.84 1	0.73 0.96	0.63 0.86	0.52 0.77	0.43 0.65	0.31 0.50	0.23 0.39	0.15 0.30	0.11 0.25

2.8.2. Heat Treatment

The minimum hardness required to apply the calculations without reducing the basic capacities may be obtained with a through-hardened bearing steel or with a case-hardened and tempered steel. In the latter case, the hardened case must be homogeneous and regular over the entire surface of the raceway. The case thickness "e" is the depth between the surface and the core having a hardness value of Vickers HV1 of 550 (see French Standard A 04 202).

This depth is given in table below as a function of the ratio P/Co (P applied load and Co static capacity):

P/Co	≤0.2	0.35	0.5	0.75	1	1.2
e mini (mm)	0.3	0.5	0.7	0.9	1	1.2

2.8.3. Surface finish

The shafts or housing used directly as raceways for needles must have a surface finish acceptable for the operating conditions and the precision requirements. For general applications under average loads one can accept a surface finish corresponding to the C.L.A. system (centre line average value):

Inner raceway for radial bearings : C.L.A. = 0.35µm
Outer raceway for radial bearings : C.L.A. = 0.4 µm
Raceway for thrust bearings : C.L.A. = 0.5 µm

2.9. COEFFICIENTS OF FRICTION

The power dissipated within a bearing is generally negligible in comparison to the total power losses of the mechanism. However, the design and sensitivity of certain machines sometimes require the assessment of losses attributable to the bearings.

The resistance torque M of a bearing supporting a load P is given by the following relationships:

- radial bearing: $M = f \times P \times \frac{Ci}{2}$ (Ci being the diameter of the inner raceway of the bearing)
- thrust bearing: $M = f \times P \times \frac{dm}{2}$ with $dm = \frac{d_1 + d_2}{2}$ (d_1 and d_2 being the raceway diameters given in table of dimensions).

The coefficient of friction f which appears in these formulae depends on a number of factors, amongst which are:

- type of bearing
- applied load
- speed of rotation
- lubrication
- surface finish and alignment.

The mean values shown below are for oil lubrication and are applicable under favourable mechanical conditions:

f = 0.002 to 0.003 for caged needle bearings
f = 0.003 to 0.004 for full complement bearings and needle thrust bearings
f = 0.004 to 0.005 for roller thrust bearings.

These coefficients are applicable for values of C/P between 2 and 6 approximately. For values less than or in excess of these limits the coefficient of friction f can be increased by 10 to 50%. Under starting conditions from rest, the values of f may be up to 50% higher than those shown above.

To evaluate the losses of the entire bearing assembly, account must also be taken of the friction due to the seals which can be significant, especially during "running-in".

2.10. LIMITING SPEEDS

The limiting speed of a bearing depends principally on the type under consideration, the pitch diameter of the rolling elements and the method of lubrication.

Other factors such as the alignment and geometry of the bearing raceways, functional clearances and dispersion of heat are of greater importance when high speed rotation is considered.

In the case of needle bushes where the thin outer ring is deformed to the shape of the housing, the cylindrical tolerance of this latter element is of prime importance to good function at high speeds.

When satisfactory conditions exist, the speed limits given in the tables of dimensions can be obtained with oil lubrication maintaining a regular flow to the radial or thrust bearing. These speed limits may be exceeded if the flow rate, cooling and recirculation of the oil is specially studied. In such cases it is recommended that the NADELLA Technical Department is consulted with respect to the special characteristics of the particular bearing envisaged.

For needle or roller thrust bearings rotating at high speed, an oil circulatory system or oil mist must be achieved within the thrust bearing in the direction of the centrifugal force created by the effect of rotation. The lubricant can then reach the bearing through its bore. This arrangement is facilitated by using the intermediate thrust plates type PMH which possess radial oil holes connected to an external groove.

The speed limits for caged needle bushes with incorporated seal (type DB...E or HK...E) are shown in the appropriate tables.

When a bearing is mounted incorporating the use of an ET sealing ring, it is the speed limit of the seal that must be taken into consideration.

For combined bearings, it is the thrust component which imposes the maximum permissible speed limits shown in the tables.

If shaft snap rings are to be used to maintain lateral control of inner rings or needle cages, it is recommended that the critical speed of these items be taken into consideration.

The speed limits shown in the tables of dimensions are for oil lubrication. For grease lubrication the following coefficients should be applied according to type:

Types	Coefficient
Sealing rings type ET	0.8
Needle bushes with seal incorporated	0.8
Caged needle bearings and bushes	0.66
Full complement needle bearings and bushes	0.5
Needle or roller thrust bearings and combined bearings	0.5

Since cam followers are normally supplied with a suitable operating grease, their speed limits are shown accordingly in the tables of dimensions. For cam followers without incorporated seals and having oil lubrication, the speed limits shown may be increased by approximately 30% for continuous rotation (50% for intermittent rotation).

2.11. CALCULATION EXAMPLES

Example 1 – Life calculation

What is the probable L_{10} life for a caged needle bearing NBI 25 40 20 supporting a constant radial load P of 4 400 N at a speed of 1 000 r.p.m.?

What is the probable L_5 life (95% reliability)?

Dynamic capacity of bearing (page 50): Cr = 28 000 N.

Factor $Cr/P = \frac{28\,000}{4\,400} = 6.36$

The table on page 183 gives for a speed of 1 000 r.p.m. and a factor Cr/P = 6,37, L_{10} life of 8000 hours.

For L_5 life (95% reliability) the L_{10} life must be multiplied by the coefficient 0.62 according to table on page 9 giving:

$L_5 = 8\,000 \times 0.62 = 4\,900$ hours.

Load as a function of Cor

Static capacity of bearing Cor = 44 500 N

Factor $= \frac{P}{Cor} = \frac{4\,400}{44\,500} = 0.10$ i.e. lower than limits shown on page 11.

Example 2 – Choice of bearing

A bearing is required to support a constant radial load P of 16 000 N at a speed of 750 r.p.m. Life required is 10 000 hours. Gear drive of average precision quality. What bearing is to be selected?

Taking account of the average precision quality of the gearing, one uses a factor of 1.2 from which equivalent load P = 16 000x 1.2 = 19 200 N.

For a life of 10000 hours and a speed of 750 r.p.m. the table on page 183 gives the factor Cr/P = 6.25.

Required capacity Cr = 6.25x P = 6.25x 19 200 = 120 000 N.

One must then select a bearing from the full complement range:

- either the Na 2 095 with capacity Cr = 120 000 N
- or the NA 3 060 with capacity Cr = 123 000 N.

One can then verify that in either case the equivalent load P as a factor of static capacity Cor for these bearings is within the limits shown (page 11).

Example 3 – Calculation of permissible load

Full complement needle bush DL 30 20 rotating at 300 r.p.m. on a shaft of hardness 512 HV. Life to be attained 5 000 hours. What radial load can be permitted?

Dynamic capacity of DL 30 20 (page 28): Cr = 26 000 N.

Reduction of dynamic capacity for hardness of 512 HV (page 12): Crx 0.63 = 16 400 N.

For a life of 5000 hours and a speed of 300 r.p.m. the table on page 183 gives Cr/P = 3.86.

Permissible load on the needle bush: $P = \frac{C_r}{3.86} = \frac{16\,400}{3.86} \approx 4\,200$ N approx.

Control of limit load

For operation without special demands, the limit load is given in the table of dimensions, i.e. 18 000 N for DL 30 20. To take account of the hardness of the shaft 512 HV, the limit load is reduced to 18 000x 0.86 = 15 480 (0.86 being the reduction coefficient for static capacity given on page 12).

The permissible calculated load of 4 200 N can then be applied, being less than the limit load.

Example 4 – Choice of a needle bush

One requires a needle bush on a shaft hardened to 700 HV to support a radial load P of 8000 N at a speed of 40 r.p.m. The intermittent function of the machine permits a life expectancy of only 1000 hours. What needle bush should be chosen?

For a life of 1000 hours and a speed of 40 r.p.m. the table on page 183 gives a factor Cr/P = 1.30.

Dynamic capacity required: Cr = 1.3x P = 1.3x 8 000 = 10 400 N.

One could then select:

- either full complement needle cage DL 20 12 Cr = 10 200 N
- or caged needle bush HK 16 16 Cr = 10 800 N.

Control of limit load

The loading limits for these needle bushes shown in the table of dimensions are 6300 N for DL 20 12 and 5200 N for HK 16 16. These are insufficient to support a load of 8000 N.

One then has a choice:

- either full complement needle bush DL 18 16 (or DL 18 24 16 P) for which the limit load is 9 000 N
- or caged needle bush HK 20 20 for which the limit load is 8 700 N.

Example 5 – Choice of a needle cage for a gear wheel subject to variable loads and speeds.

It is intended to mount a cage with two rows of needles type BB in a precision reduction gear. The bore of the gear and supporting shaft are case hardened and tempered to a hardness of 58 to 64 HRC. The radial load and corresponding speed are variable on the bearings according to the intervals of time in operation as indicated below. The life required is 10 000 hours. What cage is to be selected?

Intervals of time in operation	Speed r.p.m.	Load N
$m_1 = 0.015$	$n_1 = 200$	$P_1 = 32\,000$
$m_2 = 0.025$	$n_2 = 320$	$P_2 = 21\,000$
$m_3 = 0.20$	$n_3 = 540$	$P_3 = 12\,000$
$m_4 = 0.76$	$n_4 = 1\,100$	$P_4 = 5\,000$

Equivalent load (see page 10):

$$P = \sqrt[\frac{10}{3}]{\frac{0.015\times200\times(32\,000)^{\frac{10}{3}}+0.025\times320\times(21\,000)^{\frac{10}{3}}+0.20\times540\times(12\,000)^{\frac{10}{3}}+0.76\times1\,100\times(5\,000)^{\frac{10}{3}}}{0.015\times200+0.025\times320+0.20\times540+0.76\times1\,100}}$$

Therefore P = 8 340 N.

This load of 8 340 N is multiplied by 1.1 to take account of the geared transmission (see page 10) giving an equivalent load P = 8 340x 1.1 = 9 174 N.

Equivalent speed:
n = 0.015x 200 + 0.025x 320 + 0.20x 540 + 0.76x 1 100 = 955 r.p.m.

For this speed and a life of 10 000 hours, the function Cr/P is approximately 6.72 (from the table on page 183).

Dynamic capacity required:
Cr = 6.72x P = 6.72x 9 174 = 61 649 N.

One can then consider the needle cage B 70 78 30, which has a capacity Cr = 69 000 N.

Control of limit load

Since the static capacity of this cage is 155 000 N, the function

$P/Cor = \frac{9\,174}{155\,000} \approx 0.06 =$ is below the limits recommended on page 11.

Thickness of the case hardened and tempered layer

According to the table on page 12, for function P/Cor < 0.2, the hardened case depth should not be less than 0.3 mm after grinding.

Example 6 – Choice of a cam follower

One requires a studded cam follower to support a radial load varying linearly over a given time from P min = 3 000 N to P max = 15 000 N without shock loads and at a constant speed of 30 r.p.m. What is the smallest cam follower to be selected and what will be its life?

The maximum load of 15000 N demands the choice of GC 35, wich has a limit load corresponding to the strength of the stud of 24000 N given in the table of dimensions (page 95).

The ratio of the maximum load to the static capacity of this cam follower (Cor = 33 000 N) is $\frac{15\,000}{33\,000} = 0.45$. This is permissible according to the table on page 11.

Equivalent load

The equivalent load is given by $P = \frac{P_{mini} + 2P_{maxi}}{3}$

therefore $P = \frac{3\,000 + 2 \times 15\,000}{3} = 11\,000$ N.

Since the dynamic capacity Cr of GC 35 is 19 200 N, the function $Cr/P = \frac{19\,200}{11\,000} \simeq 1.75$.

The table on page 184 gives product n x h = 110 000 for a Cr/P ratio = 1.76

The probable life will then be $h = \frac{110\,000}{30} \simeq 3\,650$ hours.

Example 7 – Choice of a needle thrust bearing

One considers using a needle or roller thrust bearing to support a static centred axial load P = 60 000 N with repetitive shock loads. The thrust bearing is required to rotate slowly under the same load but without shock loading. Which is the most suitable type to choose?

To take account of the shock loading one must consider an equivalent static load of 2x 60 000 = 120 000 N (see page 10).

For slow rotation without shock loading one must accept that this load should not exceed Coa (see page 11).

The static capacity will then be Coa = 120 000 N.

The needle thrust bearing AX 55 78 with Coa = 164 000 N is the most suitable solution for this application.

Example 8 – Life of a combined bearing

A combined bearing RAX 735 is required to carry a constant radial load Pr = 4 400 N and a constant centred axial load Pa = 2 500 N at a speed of 750 r.p.m. What is the probable life?

Load capacities and limit loads for RAX 735

Radial			Axial		
Basic capacities		Limit load	Basic capacities		Limit load
Dynamic C_r N	Static C_{or} N	N	Dynamic C_a N	Static C_{oa} N	N
24500	45000	14300	19400	88000	27000

Since the radial load of 4 400 N and axial load of 2 500 N are significantly lower than the limit loads shown, the combined bearing RAX 735 can be used.

Calculation of life of the radial component

The function $\frac{Cr}{Pr} = \frac{24\,500}{4\,400} = 5.57$

For a speed of 750 r.p.m. and a Cr/P ratio of 5.57 (lying between 5.36 and 5.62), the table on page 183 gives a life of 6 800 hours approx.

Calculation of life of the axial acomponent

The function $\frac{Ca}{Pa} = \frac{19\,400}{2\,500} = 7.76$

This is higher than the ratio Cr/Pr for the radial component and would enable a longer life (20 000 hours). Advantage cannot be taken of this since the life of the bearing will be limited by the life of the radial component, i.e. 6 800 hours.

3. LUBRICATION

Our products are protected against oxydation, but normally supplied unlubricated. Please don't forget to lubricate them when mounting.

Lubrication of a bearing provides a viscous film between the rolling elements in order to reduce heat and wear caused by friction.

The lubricant can also assist in preventing corrosion and help to seal the bearing from the introduction of dirt and impurities; it reduces friction between the shaft and seals and lowers the noise level generated within the bearing.

Wherever the operating conditions permit, grease should be chosen in preference to oil, as it is more convenient to use and more economic. Furthermore, it acts as an efficient seal against the effects of dust and humidity. On account of its consistency, grease can improve the effectiveness of sealing rings and can be used on its own as a seal, when it is used to fill grooves or labyrinths provided for this purpose.

Grease is indispensible for the lubrication of bearings in certain machines where any oil seepage is totally unacceptable (machines for the manufacture of textiles, paper, etc.).

Alternatively, oil is necessary for high rotational speeds in excess of the limits advised for grease lubrication (see "limiting speeds" page 13) and in cases where there is a problem of heat dissipation.

Oil lubrication is also necessary where it is used already in the function of the equipment, such as hydraulic motors and pumps, speed variators and gear boxes etc.

Oil and grease lubricants must be free of all impurities which could cause premature failure of the bearing and removal from service. Sand and metal particles are particularly injurious to bearings. Every precaution must be taken to assure the cleanliness of gear casings, pipes, grease nipples, couplings, as well as lubricant containers.

The efficiency of a lubricant decreases in service both by age and by the continuous mixing to which it is submitted. Therefore replenishment must take place at regular intervals, taking account of operating and environmental conditions (humidity, dirt, temperature) except for applications where the bearing has been lubricated for life with a suitable grease.

3.1. GREASE LUBRICATION

Bearing greases offer a high strength lubrication, good mechanical stability, resistance to oxydation and satisfactory anti-rust properties, particularly for equipment mounted in humid conditions or undergoing water spray.

Their consistency, generally grades 1, 2 or 3 in the NLGI scale, must remain as stable as possible within the temperature limitations set according to their composition.

3.1.1. Principal types of greases

Lithium soap greases are particularly suitable for the lubrication of needle or roller, radial and thrust bearings. They can be utilised within the temperature range –30°C to +120°C and even up to 150°C if they are of very good quality. Generally, they are supplied with anti-rust inhibitors and offer good protection against corrosion. NADELLA cam followers are supplied lubricated with a grease of this type.

Sodium soap greases are suitable for lubricating bearings up to 100°C approx. (minimum temperature –30°C) and they assure good sealing against contamination. They can absorb small amounts of water without losing their effectiveness but large amounts will dissolve them and destroy their efficiency.

Calcium soap greases stabilised with water can only be used up to 50 or 60°C. Their mechanical stability and anti-rust properties are poor. They are therefore not recommended for lubricating bearings but can be utilised in labyrinth seals. However, certain calcium greases having better mechanical stability and improved anti-rust properties can be used up to 100°C for lubricating bearings in humid atmospheres.

3.1.2. Special greases

Greases available with an EP (Extreme Pressure) additive can be used when heavy load conditions mean the bearings endure high stress rates. These greases are generally good lubricants with good anti- rust properties, even in the presence of humidity.

Elaborate greases (with gelified inorganic additives and synthetic oils) may be considered for special high temperature applications, providing there is no possibility of interaction with plastic materials or other incompatible materials.

3.1.3. Compatibility of greases

Certain greases are incompatible with others and, if they are mixed, their function will be impaired. With greases considered as compatible, account should be taken of the reduction in their consistency when mixed and the maximum permissible temperature should be reduced accordingly.

3.1.4. Application

Grease can be introduced into the bearing at the time of assembly, care being taken to distribute it around the crown of the needles (see below "Quantity of grease").

The free space found in the bearing which is filled with grease, constitutes a reservoir and a reinforced seal. This method is possible if replenishments of grease are necessary at regular maintenance periods, during the course of which one can dismount the bearings, clean and examine them. Otherwise one has to use a hand pump which forces grease into the bearing by means of valves and replenishes the adjacent reservoir and also the channels and labyrinth seals.

The entry passage for the grease must directly abut the bearing or be in close proximity to it, in order that new fresh grease pushes out the used grease through the seals. For this reason the lip of the sealing ring must be oriented towards the outside of the bearing for it to rise under the force of the grease being ejected. This method has the advantage of removing impurities which could be introduced into the seals, particularly in the case of a highly contaminated atmosphere.

Centralised manual or automatic systems provide for the periodic controlled injection of grease at the various lubrication points.

3.1.5. Quantity of grease

The amount of grease that should be contained in a bearing can be established by considering the relationship of the limiting speed permissible for the grease n_G (see page 14) to the speed of rotation n:

$\frac{n_G}{n} < 1.25$	not filled, the bearing being lightly smeared and the adjacent parts packed with grease
$1.25 < \frac{n_G}{n} < 5$	1/3 to 2/3 of the available volume packed with grease of grade 2. These quantities can be increased slightly for grease of grade 1
$\frac{n_G}{n} > 5$	totally filled with grease.

3.1.6. Re-lubrication

The frequency of grease re-lubrication depends on a number of factors, amongst which are the type of bearing and its dimensions, the speed and load, the temperature and ambient atmospheric conditions (humidity, acidity, pollution), the type of grease and sealing. Only after controlled trials can the re-lubrication period be defined exactly and particular importance should be given to the effects of temperature, speed and humidity.

Under normal conditions of function without unfavourable factors using an appropriate grease with a maximum temperature of 70°C, the re-lubrication interval T_G in hours can be determined approximately from the formula:

$$T_G = \frac{K \times 10^6}{n \times \sqrt{Ci} \times \sqrt[4]{\frac{n}{n_G}}}$$

n : speed of rotation
n_G : permissible speed limit for grease lubrication (see page 13)
Ci : diameter of inner raceway of bearing in mm
K : coefficient according to the type of bearing

K = 32 for caged needle bearings
K = 28 for full complement needle bearings
K = 15 for needle or roller thrust bearings.

For the bearings below, the diameter Ci is replaced by the following dimensions, given in the table of dimensions:

- Cam followers type FG and derivatives: dimension D1
- Cam followers type GC and derivatives: average dimension $\frac{d+M}{2}$
- Needle or roller thrust bearings: dimension d1.

If the operating temperature exceeds 70°C, the interval T_G determined from the formula above should, for each increase of 15°C, be reduced by 50%. However, this adjustment is not applicable beyond 115°C; for temperatures above this level trials should be made to determine the acceptable re-lubrication interval.

In the case of very slow speed rotation, which would give interval T_G in excess of 35,000 hours corresponding to 8 years operation at a rate of 12 hours per day, it is recommended to limit the period to a maximum of 3 years.

For oscillating motion, the speed to be considered is the equivalent speed given by the formula on page 11. For very small amplitudes of oscillation it is recommended to reduce by half the calculated re-lubrication period T_G.

3.2. OIL LUBRICATION

Refined mineral oils offer good chemical stability and resistance to oxydation and are useful for lubrication of bearings up to temperature of 120 to 130°C.

3.2.1. Viscosity

The essential characteristic of an oil is its basic kinematic viscosity in $mm^2/sec.$ at a reference temperature of 40°C according to ISO 3448 (French Std. 60 141). The old reference temperatures of 20 or 50°C are no longer used but their corresponding values appear on diagram 2 following. The base viscosity V_{40} should be increased proportionately as the operating temperature increases but decreased as the speed increases, without however reaching a lower limit below which the film strength of the oil is impaired. For applications under moderate load without shocks up to about 1/5 of the dynamic capacity of the bearing, the viscosity V_F at the operating temperature should not be lower than 12 $mm^2/sec.$ For higher loads greater than 1/5 of the dynamic capacity the min. viscosity V_F can be about 18 $mm^2/sec.$

The variation in viscosity of an oil as a function of temperature is reduced as the number measuring its index of viscosity is increased. A viscosity index of 85 to 95 is generelly satisfactory for the lubrication of bearings.

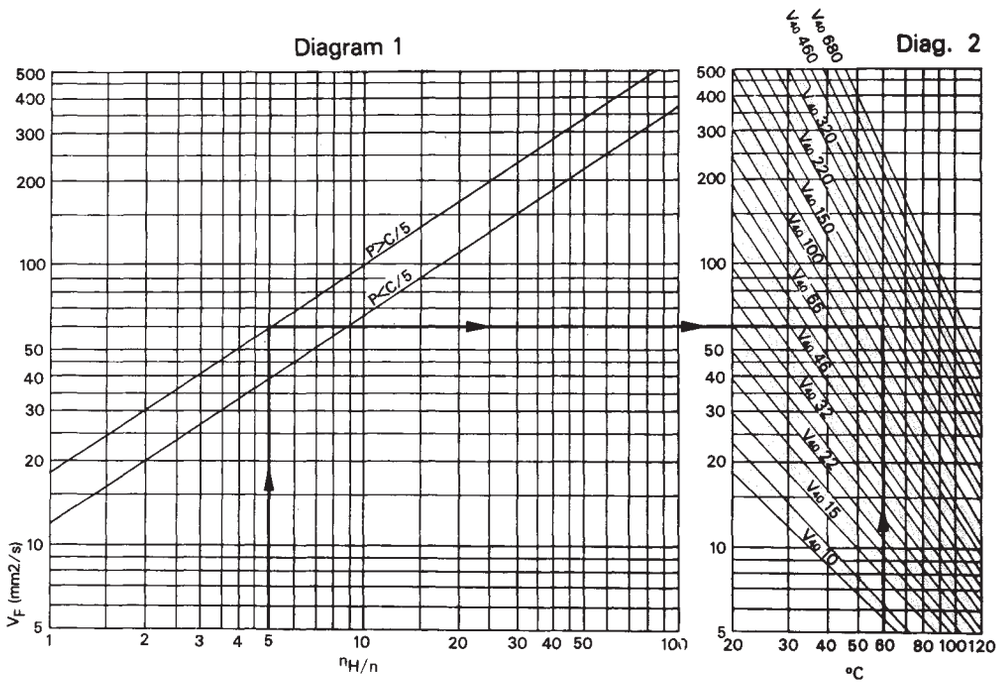
Diagram 1 below gives the viscosity V_F required at the operating temperature from the ratio $\frac{n_H}{n}$ (n_H: permitted speed limit for oil lubrication n: speed rotation).

For the viscosity V_F required in operation, diagram 2 gives the base viscosity V_{40} at the reference temperature of 40°C for an oil of viscosity index 95.

Example: A bearing supporting a load $P > \frac{C}{5}$ and having a speed limit for oil lubrication of 10 000 r.p.m., must rotate at 2 000 r.p.m. at temperature up to 60°C.

The ratio $\frac{n_H}{n} = \frac{10\,000}{2\,000} = 5$ indicates a viscosity in operation $V_F = 60$ mm^2/sec.

(diagram 1). For an operating temperature of 60°C, the horizontal $V_F = 60$ cuts the vertical of 60°C (diagram 2) in the 150 zone, which is therefore the base viscosity required at 40°C.



3.2.2. Application

Oil must be supplied to radial or thrust bearings regularly and in sufficient quantity but not abundantly, otherwise an abnormal increase in temperature can occur.

According to the speed of rotation, the following general lubrication methods can be applied.

Lubrication by *oil bath* is suitable for assemblies with the shaft horizontal and average speeds up to about half the values shown in the tables of dimensions. The level of oil in the bath at rest must reach the lowest point of the inner raceway of the bearing, though the movement of oil caused by the immersion of parts in the oil bath may be sufficient to feed bearings suitated above this level, providing there are pipes and collectors to ensure sufficient oil reserve when starting.

Lubrication by *drip feed* is applicable to bearings possessing a lubrication hole in their outer ring or to an assembly of thrust bearings with intermediate plate type PMH with oil hole. This method is suitable even for high speed applications and permits the application of the optimum quantity of oil, though it is necessary to maintain observation of the oil level in the reservoir.

Lubrication by *oil circulation* under pressure by pump is suitable for high speed applications. It prevents an increase in the operating temperature if adequate quantity is maintained and the pressure does not impede the free expulsion of oil from the bearing.

For thrust bearings, the entry of oil must be ensured if possible at the shaft, in order to utilise the centrifugal force due to rotation. The intermediate thrust plates PMH with oil hole permit this arrangement as they are centred externally allowing entry of oil through the housing.

The method of using an *oil mist* consists of applying to the bearings oil finely atomised in suspension in a current of clean compressed air. The pressure created within the bearing effectively protects it from the introduction of dust, humid vapours and noxious gases. This procedure, which allows a substantial flow from a small quantity of oil, is used particularly for ultra high speed applications in excess of speed limits given in the tables of dimensions.

3.2.3. Centralised lubrication

On individual machines or particular assemblies operating automatically with many positions to be lubricated, it is useful to consider a centralised lubricating system. This may comprise a manual or automatically controlled pump which, via a distribution network, supplies oil to the various lubrication points. The necessary equipment is manufactured by specialised suppliers and offers advantages such as filtration, re-circulation, flow control and metering to each lubrication point.

3.3. LUBRICANTS-SUPPLY/STOCK

With the exception of cam followers types FG, GC, GCR and derivatives which are delivered lubricated with a lithium soap operating grease, all other needle or roller bearing products are supplied without grease, though protected against oxydation by an oil film compatible with most greases and mineral oil lubricants.

Radial and thrust bearings should be stocked in a clean dry environment and retained in their original wrapping until the last moment before assembly. Even when assembling the bearing, care should be taken to prevent contamination from dirt or metallic particles and humidity.

In case of doubt concerning cleanliness of the bearing, it may be necessary to wash it in filtered petroleum (1). In so doing the bearing must be rotated and then suitably drained and dried (avoid the use of compressed air, which may contain water particles). Smear the bearing with a suitable oil or grease to protect it against oxydation at the time of assembly.

(1) The use of trichlorethylene is not recommended on account of its tendency to cause oxydation.

4. SEALING

Sealing is required to prevent the escape of lubricant from the bearings and also the introduction of abrasive or corrosive impurities.

A carefully studied and accurately manufactured seal is of prime importance to the correct operation of a bearing. For studies undertaken by NADELLA Technical Department, the same attention is given to the sealing system as to the choice of bearings.

4.1. SEALING USING NARROW PASSAGES

This technique avoids the use of rubbing seals, which generate heat and induce wear and require a ground surface, usually heat treated.

A small grove or slot (about 0.1 mm) arranged at the end of the shaft is sufficient to ensure satisfactory sealing when operating in a dry clean atmosphere (Figs. 1 and 2). The sealing can be improved if this narrow passage is packed with grease and if further grooves and multiple passages filled with grease can be arranged when operating in abrasive conditions (Figs. 3 and 4).

The grease used in sealing is generally the same as that used for the lubrication of radial bearings but in the case where deflectors or baffles are used it is possible to select a different grease specifically chosen for its resistance to water, dust and any other matter harmful to bearings. It is of course necessary to avoid the sealing grease coming into contact with the bearing grease in case of their incompatibility.

Sealing by narrow passages can also be effected by the use of oil in horizontal assemblies. In this method the rotating shaft has flanges or notches which take up the oil and centrifuge it into channels from where it is returned into the sump (Fig. 5).

4.2. RUBBING SEALS

4.2.1. Various types

Sealing rings of different types provide an effective seal with a light resistance exerted on the surface, though the friction and heat generation which result determine rotational speed and require that the rubbing surface be hardened and of the appropriate finish. The friction is generally highest at the commencement of use but diminishes rapidly during"running-in". The rubbing area must always be lubricated even before starting in order to avoid premature damage to the seal.

The parts that slide into the seal during assembly must be chamfered (to 30° max.) in front of the rubbing surface in order to avoid damage from a sharp edge.

Felt seals can be used successfully with grease lubrication for speeds of 4 or 5 m/sec. and up to a temperature of about 100°C. Before fitting into place, felt seals should be heated in an oil bath at 80°C. Their effectiveness is increased if they are themselves protected by a deflector forming a baffle (Fig. 6).

Sealing Rings in synthetic nitrile rubber are the most frequently used type, for bearings lubricated with oil or grease. They withstand temperatures of −40 to +120°C. The heat generation from the rubbing lip depends not only on the rotational speed but also the eccentricity and alignment of the rubbing surface and the surface finish.

In cases where the sealing has to be particularly effective, it is recommended that the rubbing surface be plunge ground to avoid imperfections from the machine tool.

For speeds above 4 m/sec. a maximum roughness of 0.5 μ is recommended and above 8 m/sec. the rubbing surface must be heat treated and hardened to 60 HRC.

A number of different types of sealing rings are available from specialist manufacturers in respect to shape and material (double lip, rubbing face lip) any of which can be adapted to the particular ambient conditions and temperatures.

The toroidal seals and quadrilobed types, though not normally considered for rotating applications, can be used for oscillating movement or very slow speed applications with grease lubrication but they impose serious friction conditions.

4.2.2. Mounting

When using grease lubrication for bearings, the lip of the seal must be oriented to the outside of the bearing to enable the expulsion of old grease during replenishment.

Alternatively, when the sealing ring is needed to enable the retention of oil, its lip should be oriented towards the inside of the bearing (Fig. 8).

If the atmosphere is abrasive or in the case of water spray conditions, one can use two sealing rings spaced a little apart. The seal on the side adjacent to the bearing has its lip facing to the inside for oil lubrication and facing outside for grease lubrication. The other sealing ring is always oriented with its lip facing outwards. The space separating the two seals must be filled with grease, possibly that used to lubricate the bearings. Alternatively, a special passageway can be provided (Fig. 9) and a special fibrous grease more effective against water and impurities can be used.

4.2.3. NADELLA Sealing Rings

Sealing rings manufactured by NADELLA type ET (see page 161) are designed specially to be mounted with needle bushes of the same internal and external dimensions (Figs. 10 and 12).

Needle bushes type DB...E and HK...E include a seal incorporated on one side (see page 34). They can equally be used with a sealing ring type ET to ensure the retention of grease on the opposite side (Fig. 11).

When a needle bush is used with an inner ring on a shaft which is not heat-treated, this inner ring can be selected wider than the cage to serve as running surface for the sealing ring type ET (Fig. 12).

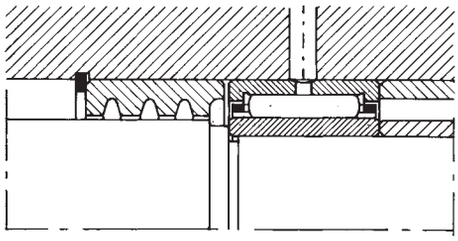


Fig. 1

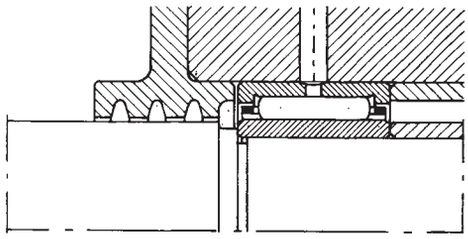


Fig. 2

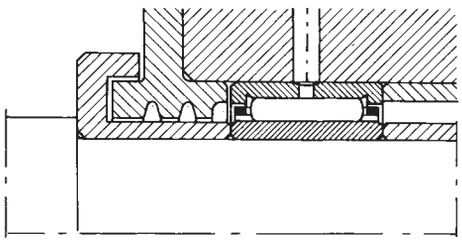


Fig. 3

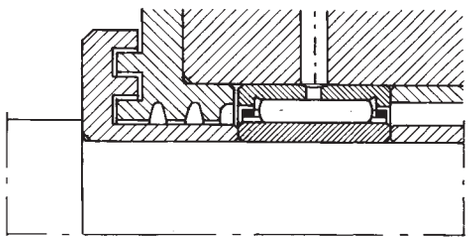


Fig. 4

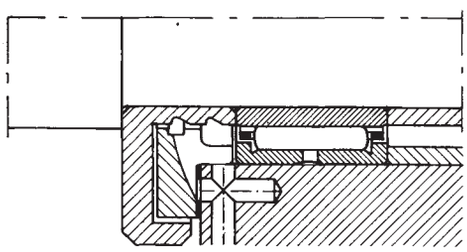


Fig. 5

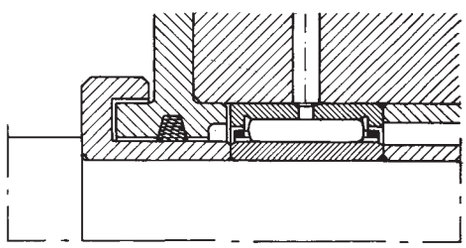


Fig. 6

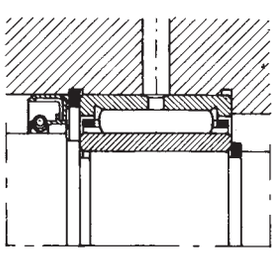


Fig. 7

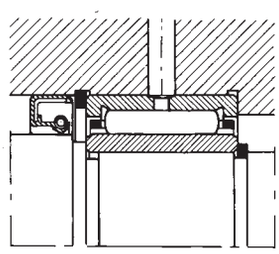


Fig. 8

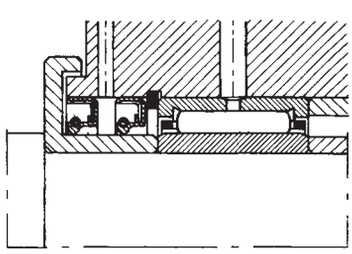


Fig. 9

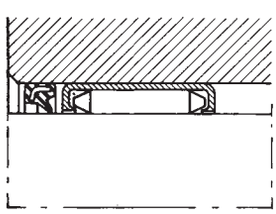


Fig. 10

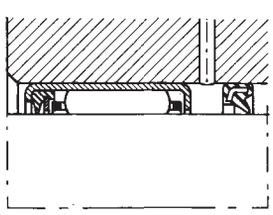


Fig. 11

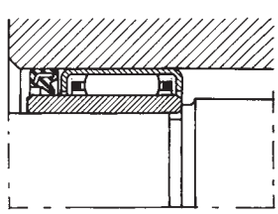


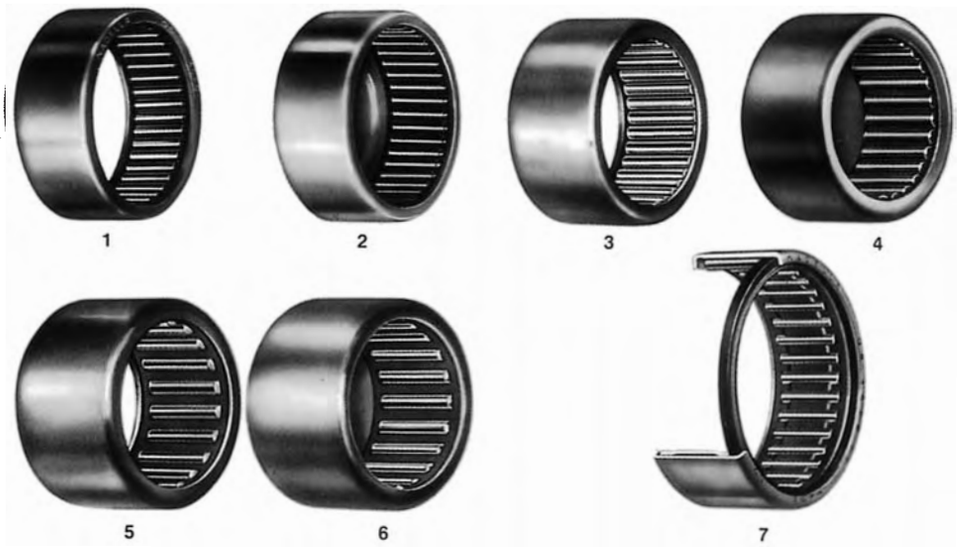
Fig. 12

NEEDLE BUSHES

IMPORTANT

The caged needle bushes manufactured to tolerances conforming to ISO standard 3245 now have new designations:
– HK series, open, formerly DB..P
– BK series, closed-end, formerly DBF..P
– HK..E series, open, with seal, formerly DB..PE

For a limited period, one or the other designations will be supplied in deliveries.



Needle bushes consist of a thin, heat treated outer ring formed from accurately controlled sheet steel encasing a set of needles. Bushes may have a full complement of needles retained in the outer ring by their ends or by grease; others have the needles retained in a cage which is prevented from moving laterally in the outer ring.

These bearings which occupy very little radial space are particularly economical to use and possess a high load capacity, relative to their size. They should be selected in preference to other bearings when conditions of mounting and operation permit.

When needle bushes are used without an inner ring and the needles rotate on a shaft of suitable hardness, they occupy minimum space and therefore provide a very satisfactory solution. Maximum load capacity is obtained with a shaft hardness under the needles of at least 650 HV. A lower hardness is acceptable if loads and required life permit. (See Technical Section.)

Hardened inner rings can be supplied for most NADELLA needle bushes. They remove the necessity to harden the shaft and enable the bearings to accept full load capacity.

All needle bushes are normally supplied unlubricated (except where a special grease has been requested). However, they are coated with a thin film of grease to prevent corrosion.

TYPES OF NEEDLE BUSH – In metric dimensions – Without Oil hole.

Full complement needle bushes				**Caged needle bushes**		
Retained needles		Grease-retained needles*				open with seal
open (fig. 1)	closed end (fig. 2)	open (fig. 3)	closed end (fig. 4)	open (fig. 5)	closed end (fig. 6)	(fig. 7)
DL **DL..P**	**DLF** **DLF..P**	**SL** **SL..P**	**CN, CNS**	**DB** **HK**	**DBF** **BK**	**DB..E** **HK...E**

* Dimensions on request.

Full complement needle bushes in inch dimensions open or with closed end can be supplied on demand.

Needle bushes with oil hole can be supplied where the quantities involed are large. Nevertheless, it may be necessary to supply bushes with oil hole if the standard type is not available.

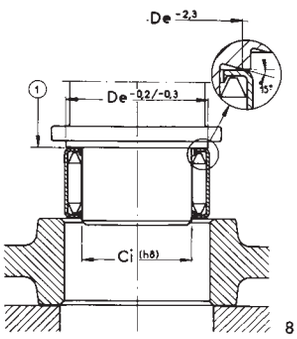
Needle bushes HK, BK, and those with suffix P are manufactured to tolerances conforming to ISO standard 3245 (French standard E 22 372 September 1976).

Housing tolerances recommended for needle bushes without suffix P are identical to those recommended for combined bearings types RAX and RAXF 700.

▶ *The full complement needle bush* with needles retained in the outer ring (Figs. 1 and 2) incorporates the advantages of low price, high load capacity and ease of handling and fitting.

▶ *Full complement needle bushes with grease-retained needles* in the outer ring (Figs. 3 and 4) combine cheapness whilst also providing a high load capacity. This is obtained by the use of flat ended needles having a greater effective length.

Such bearings are useful for applications involving large quantities at very low cost and where the lack of retention of needles cannot constitute a risk, e.g. needles dislodging when the shaft is fitted. Dimensions on request.



8

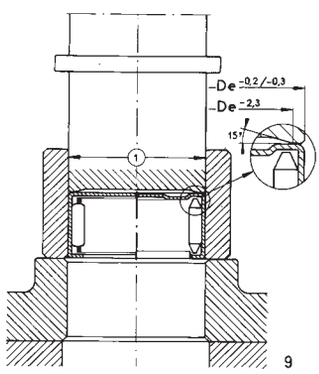
(1) Marked face

▶ *Caged needle bushes* (Figs. 5 and 6) are less susceptible to misalignment between the shaft and housing and are generally preferred in applications involving a vertical shaft under light to medium loads.

The relatively large volume of grease available in these bearings reduces the frequency of re-lubrication and may even permit lubrication for life in certain applications.

▶ *Caged needle bushes type HK...E, DB...E* (Fig. 7) have a seal incorporated, thus dispensing with the need for separate sealing rings.

▶ *Closed-end needle bushes* (Figs. 2, 4, 6) ensure perfect sealing at the end of a shaft and do not necessitate the use of blind housings or end caps. They are also able to support a small axial force transmitted by the shaft. Where a large axial load requires the additional use of a thrust bearing, one may consider the combined bearing with thin outer ring, type RAX 700 (see page 136). The low price and minimal space occupied and the ease of installation of this bearing provide a very acceptable solution in many cases.



9

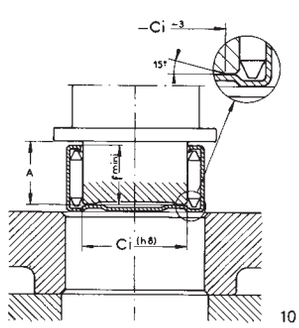
(1) Bore of Ring: $D_e + 0.3$ mm

INSPECTION

Needle bushes are not truly cylindrical in the free state and therefore they can be can be inspected only after they have been fitted in a ring-gauge having sufficient thickness to withstand deformation and with a bore ground truly cylindrical. The sizes of these gauges, together with the dimensions of the "GO" and "NO-GO" plug-gauges are given in the tables of dimensions. For needle bushes with suffix P the inspection dimensions are in conformance with ISO standard 3245 (French standard E 22 372 September 1976) which applies to a ring gauge of tolerance N6. For needle bushes without suffix P the inspection dimensions relate to a ring gauge of tolerance H6.

Because considerable tightening of the needle bush takes place in the ring gauge due to the interference fit, insertion and removal of the bush is likely to make it unsuitable for subsequent use. This method, which is the only valid way of correct inspection, can only be applied therefore to parts set aside for inspection.

INSTALLATION



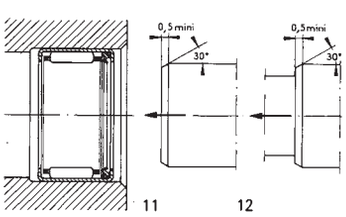
10

$A_{min} = f_{min} + 1$ mm

For needle bushes one must accept that the thin outer ring is interference fitted to the housing bore and will correspond closely to the shape of the housing. A housing with localised imperfections and thickness variations may cause deformation of the bush, which is detrimental to smooth operation. Best results are obtained with a geometrically uniform shape and even load distribution. The force required to insert the needle bush must be applied without shock to the side marked with the bearing part number. Thus it is advisable to use a small press fitted with a suitable mandrel to apply uniform force to the bush centred in the housing (Fig. 8). The axial movement of the mandrel should be limited by a shoulder coming against the face of the housing.

Bushes having one closed end should preferably have the open end presented to the housing bore (Fig. 9). If this is not possible, the force may be applied to the inside face of the closed end in the case of bushes type DLF (Fig. 10). (This must not be done in the case of bushes type DBF or BK.)

CAGED NEEDLE BUSHES INCORPORATING SEALS



11 12

Caged needle bushes type DB..E (or HK..E) have a seal incorporated on the inside of the face marked with the bearing part number. To this face should be applied the force necessary for installation. Thus, after fitting, the seal will normally be situated towards the outside of the bearing to prevent loss of lubricant and the entry of dirt, etc. (Fig. 11). If sealing is also necessary on the opposite side, a separate sealing ring type ET, of the same internal and external diameters as the needle bush may be used. The bearing seal which is made of synthetic rubber permits operation up to 120°C. (Minimum running temperature −20°C.)

The shaft to be introduced into the needle bush on assembly must be chamfered at its end or at its shoulder (Fig. 12). When carrying out this operation the surface passing through the seal must be greased, in order to provide satisfactory sealing at commencement of operation.

INNER RINGS

Inner Rings for needle bushes are normally supplied without oil hole and have a cylindrical needle track (series IM or IM..P). In those infrequent cases where lubrication is provided through the shaft, inner rings can be supplied on request with an oil hole (series IMC). Please consult NADELLA for details.

IM, IM... P

The inner rings with a slightly convex needle track series IM..R6 without oil hole are primarily intended for full complement needle bushes type DL as a means of extending the permissible misalignment tolerance up to 1 in 1 000 for continuous operation (instantaneous maximum: 2 in 1 000). Inner rings type IM..R6 must be correctly centred in relation to the bush (maximum permissible displacement: 5% of width L). For this reason these inner rings cannot be used with closed-end bushes type DLF.

SHAFT TOLERANCES

Operating conditions	Needle bushes without inner ring	Dim. Ci	Needle bushes with inner ring	Dim. Ci
Rotating	All types except CN and CNS	h5 (h6)	All types except CN and CNS	k5 (k6)
Oscillating motion	All types except CN and CNS	j5 (j6)	All types except CN and CNS	m5 (m6)

IMC, IMC... P

HOUSING TOLERANCES

Types of bush	Housing Dimension De	
	Steel or cast iron	Non-ferrous metal (1) or thin casings in steel
DL, DLF – DB, DBF – DB... E	H6 (H7)	M6 (M7)
DL... P, DLF... P HK, BK, HK... E	N6 (N7)	R6 (R7)

(1) If a housing of non-ferrous metal reaches temperatures considerably higher (or lower) than 20°C, account should be taken of the difference in expansion (or contraction) of the bush and suitable adjustments to the fits should be made.

The cylindrical tolerance defined as the difference in radii of two coaxial cylinders (Standard ISO 1101) must normally be less than a quarter of the machining tolerance on the defined diameter. However, for precision applications or high speeds, it is recommended that the cylindrical tolerance is reduced to one eighth of the machining tolerance.

RADIAL PLAY

The fit of a bush in its housing determines to a large extent the dimension under the needles after fitting and consequently the radial play during operation.

The recommended shaft and housing tolerances give a radial play the limits of which are suitable for most normal applications. To obtain a closer clearance, it is possible to match the shaft diameters with the diameters under the needles of the bushes after the latter have been fitted into their housings.

The possible differences in the rigidity of housings and the variations of clamping force resulting from the tolerance build up do not permit one to establish a range of dimensions under the needles for every application. However, for housings of very thick steel, taking into account the probable restraining force, the variations of the dimension under the needles after installation will be within the tolerances given below:

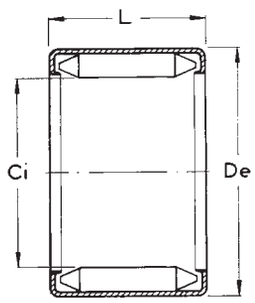
Type of bush	Tolerance of dimension under the needles after fitting	
DL... P, DLF... P HK, BK, HK... E	F8	
DL, DLF DB, DBF, DB... E	Dimension Ci ≤ 22 mm 25 – 44 mm 45 – 55 mm	 + 15/ + 50 µm + 20/ + 60 µm + 20/ + 65 µm

The radial play limits should also take into account the tolerance of the shaft used directly as a raceway or the outer diameter of the inner ring after it has been fitted on to the shaft.

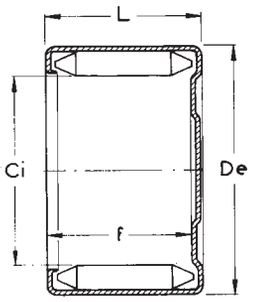
Where an inner ring is used on a shaft of recommended tolerance k5 (k6) or m5 (m6), the minimum play may be slightly lower and the maximum play slightly higher than for the case of an assembly without inner ring on a shaft of h5 (h6) tolerance.

Needle Bushes, full complement, retained

● open series
DL and DL . . . P
● closed
end series
DLF and DLF . . . P



DL, DL...P

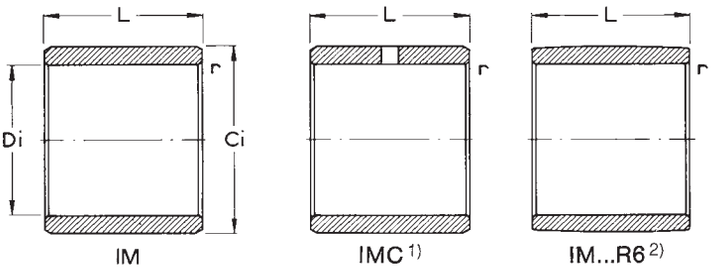


DLF, DLF...P

Limit load: See technical section page 11 and calculation examples pages 14 to 17.

Shaft Dia.	Designations DL, DLF Series	Ci	De	L 0/-0.25	f min	Basic capacities		Limit load	Speed limit	Weight approx.	
	DL...P, DLF...P to ISO tolerances					Dyn. Cr	Stat. Cor			DL	DLF
mm		mm	mm	mm	mm	N	N	N	r.p.m.	g	g
6	**DL, DLF 6 10**	6	12	10	7,7	2 900	3 800	1 450	50 000	4,2	4,4
8	**DL, DLF 8 10**	8	14	10	7,7	4 500	6 500	2 000	37 500	5,3	5,6
9	**DL, DLF 9 14 12**	9	14	12	9,7	6 100	9 200	2 950	33 000	6,1	6,5
10	**DL, DLF 10 12**	10	16	12	9,7	7 000	10 900	3 400	30 000	8	8,5
12	**DL, DLF 12 10**	12	18	10	7,7	6 000	9 700	2 800	25 000	7,6	8,4
	DL, DLF 12 12	12	18	12	9,7	7 000	11 500	4 000	25 000	9,4	10,2
13	**DL, DLF 13 12**	13	19	12	9,7	8 500	14 200	4 200	23 000	9,9	10,9
14	**DL, DLF 14 12**	14	20	12	9,7	7 900	13 500	4 600	21 500	10,5	11,6
15	**DL, DLF 15 12**	15	21	12	9,7	9 400	16 400	4 800	20 000	11	12,2
16	**DL, DLF 16 12**	16	22	12	9,7	8 700	15 500	5 200	18 500	12	13,4
17	**DL, DLF 17 12**	17	23	12	9,7	9 000	16 200	5 400	17 500	13	14,4
	DL, DLF 17 23 12 P	17	23	12	9,7	9 000	16 200	5 400	17 500	13	14,4
18	**DL, DLF 18 12**	18	24	12	9,7	10 700	19 500	5 700	16 500	14	16
	DL, DLF 18 16	18	24	16	13,7	16 000	29 500	9 000	16 500	19	21
	DL,*DLF 18 24 16 P	18	24	16	13,7	16 000	29 500	9 000	16 500	19	21
20	**DL, DLF 20 12**	20	26	12	9,7	10 200	19 500	6 300	15 000	15	17
	DL, DLF 20 16	20	26	16	13,7	16 000	30 500	10 000	15 000	20	22
22	**DL, DLF 22 16**	22	28	16	13,7	17 000	33 000	10 800	13 500	22	25
25	**DL, DLF 25 16**	25	33	16	13,7	16 000	32 500	10 800	12 000	35	39
	DL, DLF 25 20	25	33	20	17,7	22 800	46 000	15 500	12 000	43	47
28	**DL, DLF 28 20**	28	36	20	17,7	24 500	52 000	17 000	11 000	47	51
30	**DL, DLF 30 16**	30	38	16	13,7	21 700	46 500	12 600	10 000	40	45
	DL, DLF 30 20	30	38	20	17,7	26 000	56 000	18 000	10 000	50	55
	DL,*DLF 30 25	30	38	25	22,7	35 500	76 000	25 000	10 000	63	68
35	**DL,*DLF 35 42 16 P**	35	42	16	13,7	21 500	48 000	15 400	8 500	40	46
	DL, DLF 35 16	35	43	16	13,7	24 000	54 000	14 500	8 500	46	53
	DL, DLF 35 20	35	43	20	17,7	29 000	65 000	21 000	8 500	57	64
40	**DL, DLF 40 16**	40	48	16	13,7	26 500	62 000	16 500	7 500	51	61
	DL, DLF 40 20	40	48	20	17,7	36 000	84 000	23 500	7 500	64	74
44	**DL, DLF 44 16**	44	52	16	13,7	23 800	57 000	18 000	6 800	56	66
45	**DL,*DLF 45 52 16 P**	45	52	16	13,7	25 800	63 000	19 800	6 500	48	58
47	**DL,*DLF 47 16**	47	55	16	13,7	25 000	61 000	19 200	6 400	60	71
50	**DL,*DLF 50 12**	50	58	12	9,7	20 000	50 000	15 000	6 000	47	61
	DL,*DLF 50 18	50	58	18	15,7	36 500	92 000	24 500	6 000	71	85
	DL,*DLF 50 20	50	58	20	17,7	37 000	93 000	29 000	6 000	77	91
55	**DL, DLF 55 20**	55	63	20	17,7	39 500	102 000	32 000	5 500	86	102

* on request



1) Inner rings with lubrication hole, type IMC, available on request.
2) Inner rings with convex raceways cannot be used with needle bushes with closed end (Series DLF or DLF...P).

Inspection of bushes

	Ring Gauge Bore mm	Plug Gauge GO mm	Plug Gauge NO-GO mm
	12,000	6,009	6,036
	14,000	8,009	8,036
	14,000	9,009	9,036
	16,000	10,009	10,036
	18,000 18,000	12,009 12,009	12,035 12,035
	19,000	13,009	13,035
	20,000	14,009	14,035
	21,000	15,009	15,035
	22,000	16,009	16,035
	23,000 22,976	17,009 17,016	17,035 17,034
	24,000 24,000 23,976	18,009 18,009 18,016	18,035 18,035 18,034
	26,000 26,000	20,009 20,009	20,035 20,035
	28,000	22,009	22,035
	33,000 33,000	25,015 25,015	25,041 25,041
	36,000	28,015	28,041
	38,000 38,000 38,000	30,015 30,015 30,015	30,041 30,041 30,041
	41,972 43,000 43,000	35,025 35,015 35,015	35,050 35,041 35,041
	48,000 48,000	40,015 40,015	40,041 40,041
	52,000	44,015	44,041
	51,967	45,025	45,050
	55,000	47,015	47,041
	58,000 58,000 58,000	50,015 50,015 50,015	50,041 50,041 50,041
	63,000	55,015	55,041

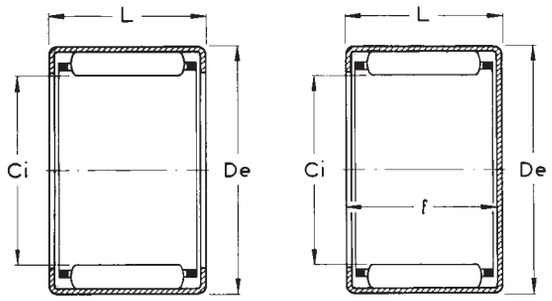
Inner rings

Shaft Dia. mm	Designation IM Series	Di mm	Ci mm	L 0/-0.12 mm	r mini mm	Weight approx. g	Reference Needle bush
8	**IM 8 12 12,4**	8	12	12,4	0,3	5,8	DL, DLF 12 12
9	**IM 9 13 12,4**	9	13	12,4	0,3	6,4	DL, DLF 13 12
10	**IM 10 14 12,4**	10	14	12,4	0,3	7	DL, DLF 14 12
12	**IM 12 15 12,4**	12	15	12,4	0,2	5,8	DL, DLF 15 12
	IM 12 16 12,4	12	16	12,4	0,3	8,1	DL, DLF 16 12
13	**IM 13 17 12,4**	13	17	12,4	0,3	8,7	DL, DLF 17 12
	IM 13 17 12,4	13	17	12,4	0,3	8,7	DL, DLF 17 23 12 P
	IM 13 18 12,4	13	18	12,4	0,35	11,2	DL, DLF 18 12
	IM 13 18 16,4	13	18	16,4	0,35	15	DL, DLF 18 16
	IM 13 18 16,4	13	18	16,4	0,35	15	DL, DLF 18 24 16 P
15	**IM 15 20 12,4**	15	20	12,4	0,35	12,7	DL, DLF 20 12
	IM 15 20 16,4	15	20	16,4	0,35	17	DL, DLF 20 16
17	**IM 17 22 16,4**	17	22	16,4	0,35	18,8	DL, DLF 22 16
20	**IM 20 25 16,4**	20	25	16,4	0,35	21,5	DL, DLF 25 16
	IM 20 25 20,4	20	25	20,4	0,35	27	DL, DLF 25 20
23	**IM 23 28 20,4**	23	28	20,4	0,35	30,5	DL, DLF 28 20
25	**IM 25 30 16,4**	25	30	16,4	0,35	26,5	DL, DLF 30 16
	IM 25 30 20,4	25	30	20,4	0,35	33	DL, DLF 30 20
	IM 25 30 25	25	30	25	0,35	40	DL, DLF 30 25
30	**IM 30 35 16,4**	30	35	16,4	0,35	31	DL, DLF 35 42 16 P
	IM 30 35 16,4	30	35	16,4	0,35	31	DL, DLF 35 16
	IM 30 35 20,4	30	35	20,4	0,35	39	DL, DLF 35 20
35	**IM 35 40 16,4**	35	40	16,4	0,35	36	DL, DLF 40 16
	IM 35 40 20,4	35	40	20,4	0,35	45	DL, DLF 40 20
40	**IM 40 44 16,4**	40	44	16,4	0,3	32	DL, DLF 44 16
	IM 40 45 16,4 P*	40	45	16,4	0,3	32	DL, DLF 45 52 16 P
45	**IM 45 50 20,4**	45	50	20,4	0,6	56	DL, DLF 50 20
50	**IM 50 55 20,4**	50	55	20,4	0,6	62	DL, DLF 55 20

* on request

Caged needle bushes

- open series DB, HK
- closed end series DBF, BK



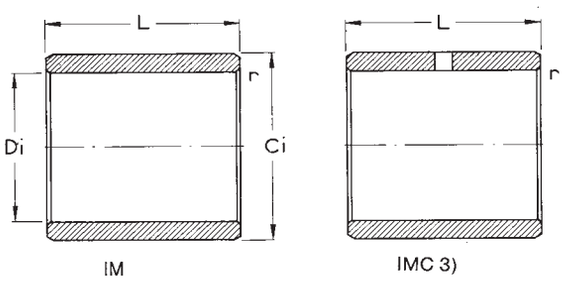
DB, HK DBF, BK

Limit load: See technical section page 11 and calculation examples pages 14 to 17.

Shaft Dia.	Designations		Ci	De	L 0/-0.25	f min	Basic capacities		Limit load	Speed limit	Weight approx.	
	Series HK, BK to ISO tolerances	Series [2] DB, DBF					Dyn. Cr	Stat. Cor			DB	DBF
mm			mm	mm	mm	mm	N	N	N	r.p.m.	g	g
5	HK, BK 5 9		5	9	9	7,9	2 150	1 950	670	80 000	2	2,1
6	HK, BK 6 8		6	10	8	6,9	2 000	1 800	600	67 000	2	2,1
	HK, BK 6 9		6	10	9	7,9	2 390	2 280	760	67 000	2,3	2,4
7	HK, BK 7 9		7	11	9	7,9	2 750	2 850	930	57 000	2,7	2,9
8	HK,*BK 8 8		8	12	8	6,9	2 500	2 580	820	50 000	2,6	2,8
	HK, BK 8 10		8	12	10	8,9	3 500	3 900	1 250	50 000	3,2	3,4
9	HK,*BK 9 10		9	13	10	8,9	3 800	4 500	1 400	44 000	3,5	3,8
10	HK,*BK 10 10		10	14	10	8,9	3 950	4 900	1 500	40 000	3,9	4,2
	HK,*BK 10 12		10	14	12	10,9	5 000	6 600	2 100	40 000	4,7	5
		DB, DBF 10 12	10	16	12	10,5	5 700	6 000	2 200	40 000	7,5	8,2
12	HK, BK 12 10		12	16	10	8,9	4 450	6 000	1 800	33 000	4,5	5
		DB, DBF 12 10	12	18	10	8,5	4 750	5 000	1 800	33 000	7	7,8
	HK,*BK 12 12		12	18	12	10,5	6 300	7 200	2 500	33 000	8,7	9,5
		DB, DBF 12 12	12	18	12	10,5	6 300	7 200	2 500	33 000	8,7	9,5
13	HK, BK 13 12		13	19	12	10,5	6 800	8 000	2 800	31 000	9,2	10
		DB, DBF 13 12	13	19	12	10,5	6 800	8 000	2 800	31 000	9,2	10
14	HK,*BK 14 12		14	20	12	10,5	6 900	8 500	2 900	29 000	9,8	10,7
		DB, DBF 14 12	14	20	12	10,5	6 900	8 500	2 900	29 000	9,8	10,7
	HK,*BK 14 16		14	20	16	14,5	9 900	13 500	4 600	29 000	13	13,9
15	HK,*BK 15 12		15	21	12	10,5	7 400	9 300	3 100	27 000	10,5	11,5
		DB, DBF 15 12	15	21	12	10,5	7 400	9 300	3 100	27 000	10,5	11,5
	HK,*BK 15 22 [1]		15	21	22	20,5	12 700	18 500	6 200	27 000	19,8	20,8
16	HK,*BK 16 12		16	22	12	10,5	7 400	9 800	3 300	25 000	11	12,3
		DB, DBF 16 12	16	22	12	10,5	7 400	9 800	3 300	25 000	11	12,3
	HK,*BK 16 16		16	22	16	14,5	10 800	15 700	5 200	25 000	14,7	16
17	HK,*BK 17 12		17	23	12	10,5	7 900	10 500	3 500	24 000	11,6	13
		DB, DBF 17 12	17	23	12	10,5	7 900	10 500	3 500	24 000	11,6	13
18	HK,*BK 18 12		18	24	12	10,5	7 900	11 000	3 600	22 000	12,7	14,3
	HK, BK 18 16		18	24	16	14,5	11 400	17 500	5 800	22 000	17	18,6
		DB, DBF 18 16	18	24	16	14,5	11 500	17 700	5 800	22 000	17	18,6
20	HK,*BK 20 10		20	26	10	8,5	6 300	8 500	2 800	20 000	11,5	13,5
	HK,*BK 20 12		20	26	12	10,5	8 400	12 300	4 000	20 000	13,8	15,8
		DB, DBF 20 12	20	26	12	10,5	8 400	12 300	4 000	20 000	13,8	15,8
	HK,*BK 20 16		20	26	16	14,5	12 200	19 500	6 400	20 000	18,4	20,4
		DB, DBF 20 16	20	26	16	14,5	12 200	19 500	6 400	20 000	18,4	20,4
	HK,*BK 20 20		20	26	20	18,5	15 500	27 000	8 700	20 000	23	25

* on request
1) Fitted with 2 needle cages.
2) The recommended housing tolerance for those bushes is identical with the appropriate tolerance for combined bearings RAX or RAXF 700 series of equivalent diameters.

IMPORTANT
The caged needle bushes manufactured to tolerances conforming to ISO standard 3245 now have new designations:
– **HK** series, open, formerly DB...P
– **BK** series, closed-end, formerly DBF...P
For a limited period, one or the other designations will be supplied in deliveries.



IM IMC 3)

Inspection of bushes

Ring Gauge Bore mm	Plug Gauge GO mm	Plug Gauge NO-GO mm
8,984	5,010	5,028
9,984	6,010	6,028
9,984	6,010	6,028
10,980	7,013	7,031
11,980	8,013	8,031
11,980	8,013	8,031
12,980	9,013	9,031
13,980	10,013	10,031
13,980	10,013	10,031
16,000	10,009	10,036
15,980	12,016	12,034
18,000	12,009	12,035
17,980	12,016	12,034
18,000	12,009	12,035
18,976	13,016	13,034
19,000	13,009	13,035
19,976	14,016	14,034
20,000	14,009	14,035
19,976	14,016	14,034
20,976	15,016	15,034
21,000	15,009	15,035
20,976	15,016	15,034
21,976	16,016	16,034
22,000	16,009	16,035
21,976	16,016	16,034
22,976	17,016	17,034
23,000	17,009	17,035
23,976	18,016	18,034
23,976	18,016	18,034
24,000	18,009	18,035
25,976	20,020	20,041
25,976	20,020	20,041
26,000	20,009	20,035
25,976	20,020	20,041
26,000	20,009	20,035
25,976	20,020	20,041

Inner rings

3) Inner rings with lubrication hole type IMC, available on request.

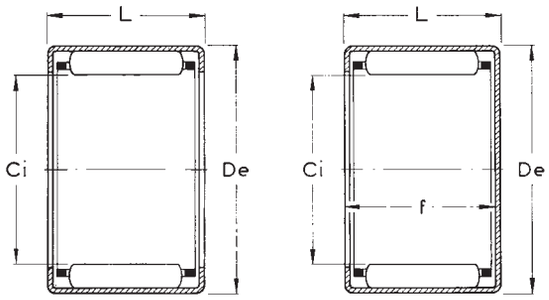
Shaft Dia. mm	Designation IM Series	Di mm	Ci mm	L 0/-0,12 mm	r min mm	Weight approx. g	Reference Needle bush
8	**IM 8 12 10 P**	8	12	10	0,3	4,6	HK, BK 12 10
	IM 8 12 12,4	8	12	12,4	0,3	5,8	HK, BK 12 12
	IM 8 12 12,4	8	12	12,4	0,3	5,8	DB, DBF 12 12
9	**IM 9 13 12,4**	9	13	12,4	0,3	6,4	HK, BK 13 12
	IM 9 13 12,4	9	13	12,4	0,3	6,4	DB, DBF 13 12
10	**IM 10 14 12,4**	10	14	12,4	0,3	7	HK, BK 14 12
	IM 10 14 12,4	10	14	12,4	0,3	7	DB, DBF 14 12
	IM 10 14 16 P	10	14	16	0,3	9	HK, BK 14 16
12	**IM 12 15 12,4**	12	15	12,4	0,2	5,8	HK, BK 15 12
	IM 12 15 12,4	12	15	12,4	0,2	5,8	DB, DBF 15 12
	IM 12 15 22,4*	12	15	22,4	0,2	10,7	HK, BK 15 22
	IM 12 16 12,4	12	16	12,4	0,3	8,1	HK, BK 16 12
	IM 12 16 12,4	12	16	12,4	0,3	8,1	DB, DBF 16 12
	IM 12 16 16 P	12	16	16	0,3	10,5	HK, BK 16 16
13	**IM 13 17 12,4**	13	17	12,4	0,3	8,7	HK, BK 17 12
	IM 13 17 12,4	13	17	12,4	0,3	8,7	DB, DBF 17 12
	IM 13 18 12,4	13	18	12,4	0,35	11,2	HK, BK 18 12
	IM 13 18 12,4	13	18	12,4	0,35	11,2	HK, BK 18 16
	IM 13 18 16 P	13	18	16,4	1,35	15	DB, DBF 18 16
15	**IM 15 20 12,4**	15	20	12,4	0,35	12,7	HK, BK 20 12
	IM 15 20 12,4	15	20	12,4	0,35	12,7	DB, DBF 20 12
	IM 15 20 16 P	15	20	16	0,35	16,5	HK, BK 20 16
	IM 15 20 16,4	15	20	16,4	0,35	17	DB, DBF 20 16
	IM 15 20 20 P	15	20	20	0,35	20,5	HK, BK 20 20

* on request

→ *over*

Caged needle bushes

● open series DB, HK
● closed end series DBF, BK



DB, HK DBF, BK

Limit load: See technical section page 11 and calculation examples pages 14 to 17.

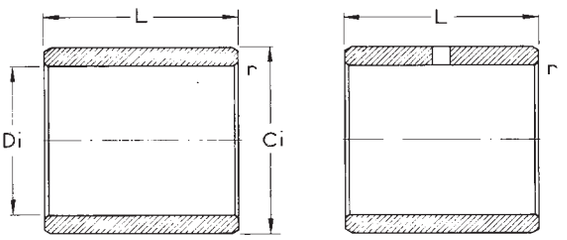
→ over

Shaft Dia.	Designations		Ci	De	L 0/-0.25	f min	Basic capacities		Limit load	Speed limit	Weight approx.	
	Series HK, BK to ISO tolerances	Series[1] DB, DBF					Dyn. Cr	Stat. Cor			DB	DBF
mm			mm	mm	mm	mm	N	N	N	r.p.m.	g	g
22	**HK,*BK 22 12**		22	28	12	10,5	8 900	13 500	4 300	18 000	15	18
	HK,*BK 22 16		22	28	16	14,5	12 800	21 700	7 000	18 000	20	23
		DB, DBF 22 16	22	28	16	14,5	12 800	21 500	7 000	18 000	20	23
25	**HK,*BK 25 12**		25	32	12	10,5	9 300	13 000	4 300	16 000	20	23
	HK,*BK 25 16		25	32	16	14,5	14 400	22 700	7 400	16 000	26	29
	HK, BK 25 20		25	32	20	18,5	18 900	32 000	10 500	16 000	32	35
		DB, DBF 25 16	25	33	16	14,5	15 500	22 300	7 500	16 000	30	34
		DB, DBF 25 20	25	33	20	18,5	20 500	32 000	10 500	16 000	37	41
28	**HK,*BK 28 16**		28	35	16	14,5	15 000	25 000	8 100	14 300	28	32
	HK,*BK 28 20		28	35	20	18,5	19 800	35 500	11 400	14 300	35	39
30	**HK,*BK 30 12**		30	37	12	10,5	10 200	15 500	5 000	13 000	23	27
	HK,*BK 30 16		30	37	16	14,5	15 900	27 300	8 700	13 000	30	34
	HK,*BK 30 20		30	37	20	18,5	20 800	38 500	12 400	13 000	38	42
		DB, DBF 30 20	30	38	20	18,5	22 300	37 500	12 000	13 000	45	50
35	**HK,*BK 35 16**		35	42	16	14,5	17 200	31 800	10 100	11 500	35	41
	HK,*BK 35 20		35	42	20	18,5	22 500	45 000	14 300	11 500	43	49
		DB, DBF 35 20	35	43	20	18,5	24 500	45 000	14 300	11 500	49	56
40	**HK,*BK 40 12**		40	47	12	10,5	11 400	19 500	6 300	10 000	30	37
	***HK,*BK 40 16**		40	47	16	14,5	17 500	34 000	10 700	10 000	39	46
	***HK,*BK 40 20**		40	47	20	18,5	23 000	48 500	15 200	10 000	49	56
		DB, DBF 40 20	40	48	20	18,5	26 200	51 000	16 000	10 000	55	63
45	***HK,*BK 45 16**		45	52	16	14,5	18 800	39 000	12 000	9 000	43	53
	HK, BK 45 20		45	52	20	18,5	24 800	55 000	17 000	9 000	54	64
		DB, DBF 45 20	45	52	20	18,5	24 800	55 000	17 000	9 000	54	64
47		**DB, DBF 47 16**	47	55	16	14,5	21 700	42 000	13 200	8 500	50	61
50	***HK,*BK 50 20**		50	58	20	18,5	29 500	64 000	20 000	8 000	70	83
		DB, DBF 50 20	50	58	20	18,5	29 500	64 000	20 000	8 000	70	83
	***HK,*BK 50 24**		50	58	24	22,5	36 000	83 000	25 500	8 000	84	97
55	***HK,*BK 55 20**		55	63	20	18,5	31 500	72 000	22 000	7 300	76	92
	***HK,*BK 55 24**		55	63	24	22,5	38 500	93 000	28 500	7 300	91	107

* on request

1) The recommended housing tolerance for these needle bearings is identical with the housing tolerance for combined bearings RAX or RAXF 700 series of equivalent diameters.

IMPORTANT
The caged needle bushes manufactured to tolerances conforming to ISO standard 3245 now have new designations:
– **HK** series, open, formerly DB...P
– **BK** series, closed-end, formerly DBF...P
For a limited period, one or the other designations will be supplied in deliveries.



IM IMC 2)

Inspection of bushes

Ring Gauge Bore mm	Plug Gauge GO mm	Plug Gauge NO-GO mm
27,976	22,020	22,041
27,976	22,020	22,041
28,000	22,009	22,035
31,972	25,020	25,041
31,972	25,020	25,041
31,972	25,020	25,041
33,000	25,015	25,041
33,000	25,015	25,041
34,972	28,020	28,041
34,972	28,020	28,041
36,972	30,020	30,041
36,972	30,020	30,041
36,972	30,020	30,041
38,000	30,015	30,041
41,972	35,025	35,050
41,972	35,025	35,050
43,000	35,015	35,041
46,972	40,025	40,050
46,972	40,025	40,050
46,972	40,025	40,050
48,000	40,015	40,041
51,967	45,025	45,050
51,967	45,025	45,050
52,000	45,015	45,041
55,000	47,015	47,041
57,967	50,025	50,050
58,000	50,015	50,041
57,967	50,025	50,050
62,967	55,030	55,060
62,967	55,030	55,060

Inner rings

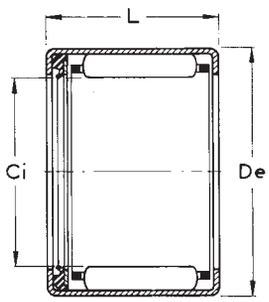
2) Inner rings with lubrication hole type IMC, available on request.

Shaft Dia. mm	Designation IM Series	Di mm	Ci mm	L 0/-0.12 mm	r min mm	Weight approx. g	Reference Needle bush
17	***IM 17 22 13 P**	17	22	13	0,35	14,9	HK, BK 22 12
	IM 17 22 16 P	17	22	16	0,35	18,5	HK, BK 22 16
	IM 17 22 16,4	17	22	16,4	0,35	18,8	DB, DBF 22 16
20	**IM 20 25 16 P**	20	25	16	0,35	21	HK, BK 25 16
	IM 20 25 20 P	20	25	20	0,35	26,5	HK, BK 25 20
	IM 20 25 16,4	20	25	16,4	0,35	21,5	DB, DBF 25 16
	IM 20 25 20,4	20	25	20,4	0,35	27	DB, DBF 25 20
23	**IM 23 28 20 P**	23	28	20	0,35	30	HK, BK 28 20
25	**IM 25 30 12,4 P**	25	30	12,4	0,35	19,7	HK, BK 30 12
	IM 25 30 16,4	25	30	16,4	0,35	26,5	HK, BK 30 16
	IM 25 30 20 P	25	30	20	0,35	32	HK, BK 30 20
	IM 25 30 20,4	25	30	20,4	0,35	33	DB, DBF 30 20
30	**IM 30 35 16,4**	30	35	16,4	0,35	31	HK, BK 35 16
	IM 30 35 20 P	30	35	20	0,35	38	HK, BK 35 20
	IM 30 35 20,4	30	35	20,4	0,35	39	DB, DBF 35 20
35	**IM 35 40 16,4**	35	40	16,4	0,35	36	HK, BK 40 16
	IM 35 40 20 P	35	40	20	0,35	44	HK, BK 40 20
	IM 35 40 20,4	35	40	20,4	0,35	45	DB, DBF 40 20
40	***IM 40 45 16,4 P**	40	45	16,4	0,35	41	HK, BK 45 16
	IM 40 45 20 P	40	45	20	0,35	50	HK, BK 45 20
	IM 40 45 20,4	40	45	20,4	0,35	51	DB, DBF 45 20
45	**IM 45 50 20,4**	45	50	20,4	0,65	56	HK, BK 50 20
	IM 45 50 20,4	45	50	20,4	0,65	56	DB, DBF 50 20
	IM 45 50 25 P	45	50	25	0,65	69	HK, BK 50 24
50	**IM 50 55 20,4**	50	55	20,4	0,65	62	HK, BK 55 20
	IM 50 55 25 P	50	55	25	0,65	76	HK, BK 55 24

* on request

Caged needle bushes with integral seal

● DB...E, HK...E



DB...E, HK...E

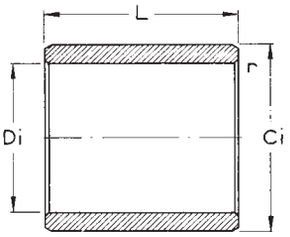
Limit load: See technical section page 11 and calculation examples pages 14 to 17.

Shaft Dia.	Designations		Ci	De	L 0/-0.25	Basic capacities		Limit load	Speed limit	Weight approx.
	Series HK...E to ISO tolerances	Series [2] DB...E				Dyn. Cr	Stat. Cor			
mm			mm	mm	mm	N	N	N	r.p.m.	g
12		**DB 12 14 E**	12	18	14	6 300	7 200	2 500	16 600	9,5
14	***HK 14 14 E**		14	20	14	6 900	8 500	2 900	14 300	10,8
		DB 14 14 E	14	20	14	6 900	8 500	2 900	14 300	10,8
15	**HK 15 14 E**		15	21	14	7 400	9 300	3 100	13 300	11,3
	HK 15 24 E[1]		15	21	24	12 700	18 500	6 200	13 300	20,8
16	**HK 16 14 E**		16	22	14	7 400	9 800	3 300	12 500	12,2
	HK 16 18 E		16	22	18	10 800	15 700	5 200	12 500	16,2
17		**DB 17 14 E**	17	23	14	7 900	10 500	3 500	11 700	12,6
18	***HK 18 14 E**		18	24	14	7 900	11 000	3 600	11 100	13,7
		DB 18 18 E	18	24	18	11 500	17 700	5 800	11 100	18
20	***HK 20 18 E**		20	26	18	12 200	19 500	6 400	10 000	19,8
		DB 20 18 E	20	26	18	12 200	19 500	6 400	10 000	19,8
22	***HK 22 18 E**		22	28	18	12 800	21 700	7 000	9 100	21,6
		DB 22 18 E	22	28	18	12 800	21 500	7 000	9 100	21,6
25	***HK 25 18 E**		25	32	18	14 400	22 700	7 400	8 000	28
		DB 25 22 E	25	33	22	20 500	32 000	10 500	8 000	39
		DB 25 36 E[1]	25	33	36	26 500	44 500	18 000	8 000	63
30	**HK 30 18 E**		30	37	18	15 900	27 300	8 700	6 700	32
		DB 30 22 E	30	38	22	22 300	37 500	12 000	6 700	47
35	***HK 35 18 E**		35	42	18	17 200	31 800	10 100	5 700	39
		DB 35 22 E	35	43	22	24 500	45 000	14 300	5 700	53
40	***HK 40 18 E**		40	47	18	17 500	34 000	10 700	5 000	44
		DB 40 22 E	40	48	22	26 200	51 000	16 000	5 000	60
45	***HK 45 18 E**		45	52	18	18 800	39 000	12 000	4 400	47
	HK 45 22 E		45	52	22	24 800	55 000	17 000	4 400	58
50	***HK 50 22 E**		50	58	22	29 500	64 000	20 000	4 000	76
		DB 50 22 E	50	58	22	29 500	64 000	20 000	4 000	76

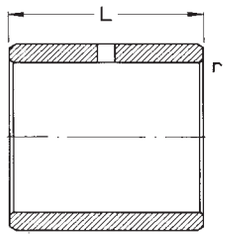
* on request

1) Fitted with 2 needle cages.
2) The recommended housing tolerance for these needle bearings is identical with the housing tolerance for combined bearings RAX or RAXF 700 series of equivalent diameters.

IMPORTANT
The caged needle bushes manufactured to tolerances conforming to ISO standard 3245 now have new designations:
– **HK...E** series, open, with seal, formerly DB...PE
For a limited period, one or the other designations will be supplied in deliveries.



IM



IMC 3)

Inspection of bushes

Ring Gauge Bore mm	Plug Gauge GO mm	Plug Gauge NO-GO mm
18,000	12,009	12,035
19,976 20,000	14,016 14,009	14,034 14,035
20,976 20,976	15,016 15,016	15,034 15,034
21,976 21,976	16,016 16,016	16,034 16,034
23,000	17,009	17,035
23,976 24,000	18,016 18,009	18,034 18,035
25,976 26,000	20,020 20,009	20,041 20,035
27,976 28,000	22,020 22,009	22,041 22,035
31,972 33,000 33,000	25,020 25,015 25,015	25,041 25,041 25,041
36,972 38,000	30,020 30,015	30,041 30,041
41,972 43,000	35,025 35,015	35,050 35,041
46,972 48,000	40,025 40,015	40,050 40,041
51,967 51,967	45,025 45,025	45,050 45,050
57,967 58,000	50,025 50,015	50,050 50,041

Inner rings

3) Inner rings with lubrication hole type IMC, available on request.

Shaft Dia. mm	Designation IM Series	Di mm	Ci mm	L 0/-0.12 mm	r min mm	Weight approx. g	Reference Needle bush
8	***IM 8 12 16**	8	12	16	0,3	7,4	DB 12 14 E
10	**IM 10 14 16 P**	10	14	16	0,3	9	HK 14 14 E
	IM 10 14 16,4	10	14	16,4	0,3	9,2	DB 14 14 E
12	**IM 12 15 16 P**	12	15	16	0,2	7,6	HK 15 14 E
	IM 12 16 16 P	12	16	16	0,3	10,5	HK 16 14 E
	***IM 12 16 20 P**	12	16	20	0,3	13,2	HK 16 18 E
13	**IM 13 17 16,4**	13	17	16,4	0,3	11,5	DB 17 14 E
	IM 13 18 16 P	13	18	16	0,35	14,5	HK 18 14 E
14	**IM 14 18 20,4**	14	18	20,4	0,3	15,5	DB 18 18 E
15	**IM 15 20 20 P**	15	20	20	0,35	20,5	HK 20 18 E
	IM 15 20 20	15	20	20	0,35	20,5	DB 20 18 E
17	**IM 17 22 20 P**	17	22	20	0,35	23	HK 22 18 E
	IM 17 22 20,4	17	22	20,4	0,35	23,5	DB 22 18 E
20	**IM 20 25 20 P**	20	25	20	0,35	26,5	HK 25 18 E
	IM 20 25 25	20	25	25	0,35	33	DB 25 22 E
25	**IM 25 30 20 P**	25	30	20	0,35	32	HK 30 18 E
	IM 25 30 25	25	30	25	0,35	40	DB 30 22 E
30	**IM 30 35 20 P**	30	35	20	0,35	38	HK 35 18 E
	IM 30 35 25	30	35	25	0,35	48	DB 35 22 E
35	**IM 35 40 20 P**	35	40	20	0,35	44	HK 40 18 E
	IM 35 40 25	35	40	25	0,35	55	DB 40 22 E
40	**IM 40 45 20 P**	40	45	20	0,35	50	HK 45 18 E
	***IM 40 45 25 P**	40	45	25	0,35	62	HK 45 22 E
45	**IM 45 50 25 P**	45	50	25	0,65	69	HK 50 22 E
	IM 45 50 25	45	50	25	0,65	69	DB 50 22 E

* on request

BEARINGS WITH CAGE - GUIDED NEEDLES

Caged needle bearings possess an outer ring made from through- hardened bearing steel. The cage, which guides the needles and retains them in the outer ring, is manufactured as explained in the section on needle cages.

The bearings may be used without an inner ring if the shaft journal serving as a raceway is of sufficient hardness and has the correct surface finish. To ensure that the full load capacity of these bearings is achieved, a hardness of 58–64 HRC is required. A lower hardness will entail a reduction in the load capacities (both dynamic and static) as shown in the table of dimensions (see Technical Section).

TYPES OF BEARING

Without inner ring	With inner ring
NB	**NBI**
RNA	**NA**
Dimensions of series 49 in accordance with ISO Standard 1206 (French Standard E 22 370 – DIN 617)	

TOLERANCES OF THE INNER AND OUTER RINGS

The inner and outer rings of caged bearings are manufactured in conformance with the tolerance class of ISO 1206 (French Standard E 22 370).

For high precision applications, bearing rings can be made to closer tolerances corresponding to classes 6, 5 and 4 of ISO Standard 492 (DIN 620) denoted by symbols P6, P5, P4.

SHAFT AND HOUSING TOLERANCES

Type of operation	Load direction	SHAFT without inner ring Ci	SHAFT with inner ring Di (1) ≤ 80	SHAFT with inner ring Di (1) 85–130	HOUSING De (2)
Shaft revolving Housing stationary	Fixed	h5	k5	m5	J6 (J7)
	Revolving at shaft speed	g5	h5	h5	M6 (M7)
	Indeterminate	g5	k5*	m5*	M6 (M7)
Shaft stationary Housing revolving	Fixed	g5	h5	h5	M6 (M7)
	Revolving at housing speed	h5	k5	m5	J6 (J7)
	Indeterminate	g5	k5*	m5*	M6 (M7)
Shaft and housing revolving	Variable	g5	k5*	m5*	M6 (M7)
Oscillatory motion	Variable	h5	k5	k5	M6 (M7)

* class C3 bearing required in these cages

1), 2): see on page 44

The cylindrical tolerance defined as the difference in radii of two coaxial cylinders (ISO Standard 1101) should normally be less than a quarter of the manufacturing tolerance. However, for high precision or high speed applications, it is advisable to restrict this tolerance to one eighth of the manufacturing tolerance.

1) Tolerances shown are valid for solid shafts of steel or cast iron. Tighter fits are required for inner rings mounted on hollow or non-ferrous metal shafts.

2) Tolerances shown are valid for housings of steel or cast iron having rigid walls. Tighter fits are required for outer rings in thin-walled or non-ferrous metal housings.

If shafts or housings are of light alloy and can reach temperatures considerably higher (or lower) than 20°C, allowance should be made for differential expansion (or contraction).

RADIAL PLAY

▶ *Bearings without inner ring*

Radial play results from the difference between the diameter beneath the needles, which is held within tolerance F6 in accordance with ISO 1206 (French Standard E 22 370) and the recommended shaft tolerance (g5 or h5). After installation this clearance may be slightly reduced where the outer ring is a tight fit in the housing of tolerance M6 (or M7). Bearings can be supplied with a dimension beneath the needles selected from the lower half of the tolerance F6 (suffix TB) or from the upper half of the tolerance (suffix TC). See table below:

Nominal dimension Ci mm		Tolerance of diameter under needles		
		normal F6 µm	selected TB µm	selected TC µm
above	to			
3	6	+ 10 + 18	+ 10 + 14	+ 14 + 18
6	10	+ 13 + 22	+ 13 + 18	+ 17 + 22
10	18	+ 16 + 27	+ 16 + 22	+ 21 + 27
18	30	+ 20 + 33	+ 20 + 27	+ 26 + 33
30	50	+ 25 + 41	+ 25 + 33	+ 33 + 41
50	80	+ 30 + 49	+ 30 + 40	+ 39 + 49
80	120	+ 36 + 58	+ 36 + 47	+ 47 + 58
120	180	+ 43 + 68	+ 43 + 56	+ 55 + 68
180	250	+ 50 + 79	+ 50 + 65	+ 64 + 79
Examples of bearing		NB 25 33 20 RNA 4904	NB 25 33 20 TB RNA 4904 TB	NB 25 33 20 TC RNA 4904 TC

Designations for bearings with outer ring that have been manufactured to closer tolerances of classes 6, 5, or 4 include the suffix P6, P5 or P4.

Examples: NB 25 33 20 P6, NB 25 33 20 P6 TB, NB 25 33 20 P6 TC.
RNA 4904 P6, RNA 4904 P6 TB, RNA 4904 P6 TC.

▶ *Bearings with inner ring*

Caged bearings with inner rings of standard manufacture have a radial play in the group according to ISO Standard 5753.

By prior agreement with our Technical Department, such bearings can be supplied as follows:

having a radial play in group 2, smaller than standard (Suffix C2)
having a radial play in groups 3, 4 or 5, larger than standard to allow for expansion of the inner ring (Suffix C3, C4 or C5).

Within each class, bearings can be supplied with a radial play of reduced overall tolerances (Suffix "ZS").

The inner and outer rings of a bearing with reduced radial play "ZS" are matched and if these rings are interchanged with other inner or outer rings, the reduced radial play "ZS" will not be retained. They will, however, remain within the limits of standard play for their class.

Complete bearings of which the inner and outer rings are manufactured to tolerance class P6, P5 or P4, and with radial play in class C2, C3, C4 or C5 have designations with the suffix P. Example: ...P62 refers to a bearing the inner and outer rings of which are manufactured to class P6 and with play in class C2.

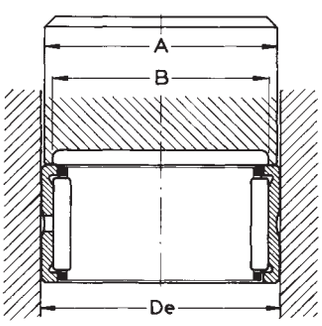
► *Examples of bearing designations:*

Tolerance of inner and outer rings	Normal Radial play		C2 Radial play	
	standard tolerance	reduced tolerance ZS	standard tolerance	reduced tolerance ZS
normal	NBI 20 33 20 NA 4904	NBI 20 33 20 ZS NA 4904 ZS	NBI 20 33 20 C2 NA 4904 C2	NBI 20 33 20 C2 ZS NA 4904 C2 ZS
class P6	NBI 20 33 20 P6 NA 4904 P6	NBI 20 33 20 P6 ZS NA 4904 P6 ZS	NBI 20 33 20 P62 NA 4904 P62	NBI 20 33 20 P62 ZS NA 4904 P62 ZS

► *Radial play for bearings with cage-guided needles with inner ring:*

Inner ring bore Di mm		C2 Play				normal play				C3 Play				C4 Play				C5 Play			
		interval				interval				interval				interval				interval			
		ZS µm		standard µm		ZS µm		standard µm		ZS µm		standard µm		ZS µm		standard µm		ZS µm		standard µm	
Above	To	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
	24	10	20	0	30	20	30	10	40	35	45	25	55	45	55	35	65	65	75	55	85
24	30	10	25	0	30	25	35	10	45	40	50	30	65	50	60	40	70	70	80	60	90
30	40	12	25	0	35	25	40	15	50	45	55	35	70	55	70	45	80	80	95	70	105
40	50	15	30	5	40	30	45	20	55	50	65	40	75	65	80	55	90	95	110	85	120
50	65	15	35	5	45	35	50	20	65	55	75	45	90	75	90	65	105	110	130	100	140
65	80	20	40	5	55	40	60	25	75	70	90	55	105	90	110	75	125	130	150	115	165
80	100	25	45	10	60	45	70	30	80	80	105	65	115	105	125	90	140	155	180	145	195
100	120	25	50	10	65	50	80	35	90	95	120	80	135	120	145	105	160	180	205	165	220
120	140	30	60	10	75	60	90	40	105	105	135	90	155	135	160	115	180	200	230	185	250
140	160	35	65	15	80	65	100	50	115	115	150	100	165	150	180	130	195	225	260	210	275
160	180	35	75	20	85	75	110	60	125	125	165	110	175	165	200	150	215	250	285	235	300
180	200	40	80	25	95	80	120	65	135	140	180	125	195	180	220	165	235	275	315	260	330

In cases where an order separately specifies inner rings for a cage-guided needle bearing it is recommended to make reference to the corresponding bearing complete, e.g. Inner ring for NBI 20 33 20



A = De –0.2 – 0.4

INSTALLATION

► *Outer rings*

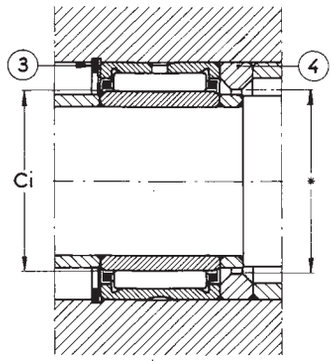
The force applied to the face of the outer ring must be exerted only on the area bounded by the outer diameter De and inner diameter B. Under no circumstances must force be applied to the flanges which retain the needle cage.

Where inner or outer rings of small diameter not requiring a tight fit are used, they should be fitted by lightly tapping on a mandrel (see figure). In other cases a press should be used, the force being applied direct on the bearing centre line.

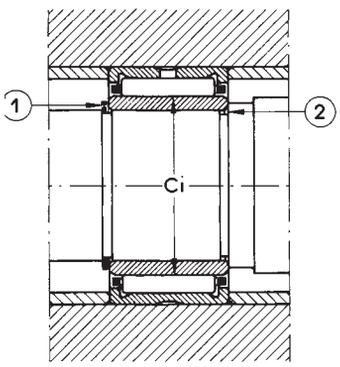
De mm	B mm	De mm	B mm	De mm	B mm	De mm	B mm	De mm	B mm	De mm	B mm
14	12	26	23	37	34	50	46	80	73	110	102
15	13	27	24	38	35	52	48	82	75	115	107
16	14	28	25	39	36	55	51	85	78	120	110
17	15	29	26	40	36	57	53	90	83	125	115
19	17	30	27	42	38	62	56	92	83	130	122
22	19	32	29	45	41	68	61	95	90	140	132
23	20	33	30	47	43	72	66	100	92	150	142
24	21	34	31	48	44	78	71	105	97		

► *Inner Rings*

The smaller sizes of inner rings are installed in a similar manner to that outlined above. Large inner rings having a tight fit should be immersed in an oil bath at 70–80°C to expand them sufficiently to slide easily into position on the shaft.



*Ci + 0,2 maxi



① Snap ring
② Groove for extraction tool
③ Snap ring
④ Guidance ring

AXIAL RETENTION

The outer rings of caged bearings must be retained laterally. This also applies to inner rings if the shaft is of tolerance h5. When the shaft is of tolerance k5, inner rings generally have a sufficiently close fit not to need retention. Any retaining rings used laterally to position the outer ring must have an inside diameter greater than dimension Ci. Similarly, any parts used laterally to position the inner ring must have an outside diameter smaller than dimension Ci.

Such an arrangement prevents any fretting at the faces of the bearings and allows the introduction of the shaft (fitted with inner rings if necessary) through the outer ring, installed in its housing.

The snap-rings must be inspected after positioning in their grooves for correct abutment.

▶ *Retention of outer rings*

Whenever possible, the outer rings should be installed in "through bored" housings as these are easier to manufacture accurately than housings with shoulders. Lateral retention of the rings can then be ensured by snap-rings, or end caps, etc.

If the housing is not through bored, the bottom of the bore should either include a recess groove or possess a radius less than that of the outer ring.

When installing large parts, particularly when the bearings are not readily accessible or difficult to observe, it is advisable to protect the outer ring by means of a collar having an inner diameter slightly greater than dimension Ci with a large chamfer, through which to guide the shaft during mounting.

▶ *Retention of inner rings*

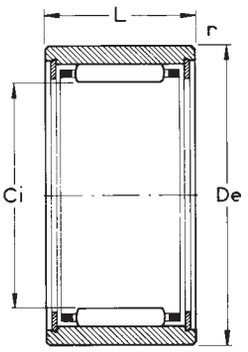
Inner rings may be laterally retained by snap rings. They can also seat against a shoulder on the shaft, provided that the radius between shoulder and shaft is smaller than the chamfer on the rings as shown in the table of dimensions. Whenever possible, an extraction groove should also be provided on the shaft. If, however, to maintain the strength of the shaft, a large radius is to be machined between the shoulder and shaft, a ring having a large chamfer should be placed between the inner ring and the shoulder, thus ensuring accurate face abutment with the inner ring.

Bearings with cage-guided needles without inner ring

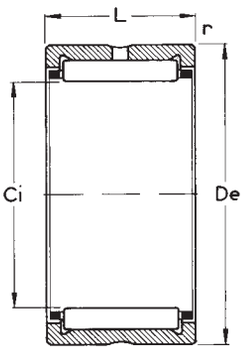
NB, RNA 49 series

All bearings are not necessarily available.

Please consult us for delivery times and for special dimensions.



Up to Ci = 12 mm



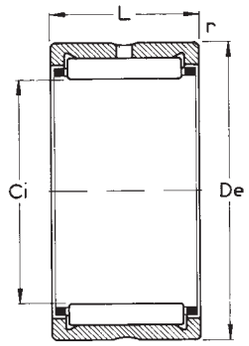
From Ci = 14 mm

Shaft Dia.	Designations		Ci	De	L	r min	Basic capacities		Speed limit	Weight approx.
	NB Series	RNA 49 Series					Dyn. Cr	Stat. Cor		
mm			mm	mm	mm	mm	N	N	r.p.m.	g
7	NB 7 14 12		7	14	12	0,35	3 600	3 400	57 000	8,5
8	NB 8 15 12		8	15	12	0,35	4 500	4 600	50 000	9,4
9	NB 9 16 12		9	16	12	0,35	5 000	5 500	44 000	10,3
	NB 9 16 16		9	16	16	0,35	6 300	7 300	44 000	13,8
10	NB 10 17 12		10	17	12	0,35	4 400	4 750	40 000	11,7
	NB 10 17 16		10	17	16	0,35	6 100	7 200	40 000	15,2
12	NB 12 19 12		12	19	12	0,35	5 050	6 000	33 000	13,3
	NB 12 19 16		12	19	16	0,35	6 600	8 400	33 000	17,5
14		RNA 4900	14	22	13	0,30	10 600	11 600	28 500	17
	NB 14 22 16		14	22	16	0,35	13 100	15 300	28 500	21
15	NB 15 23 16		15	23	16	0,35	13 800	16 500	27 000	22,3
16		RNA 4901	16	24	13	0,30	11 700	13 700	25 000	19
	NB 16 24 16		16	24	16	0,35	14 500	18 000	25 000	23,5
18	NB 18 26 16		18	26	16	0,35	15 700	20 500	22 000	26
19	NB 19 27 16		19	27	16	0,35	15 500	20 800	21 000	27
	NB 19 27 20		19	27	20	0,35	19 400	27 500	21 000	34
20		RNA 4902	20	28	13	0,30	13 100	16 900	20 000	22,5
	NB 20 28 16		20	28	16	0,35	16 200	22 000	20 000	28
	NB 20 28 20		20	28	20	0,35	20 000	29 000	20 000	35,5
21	NB 21 29 16		21	29	16	0,35	16 800	23 500	19 000	29
	NB 21 29 20		21	29	20	0,35	20 800	31 000	19 000	37
22		RNA 4903	22	30	13	0,30	14 000	18 900	18 000	24,5
	NB 22 30 16		22	30	16	0,35	17 400	24 800	18 000	30,5
	NB 22 30 20		22	30	20	0,35	21 500	32 500	18 000	38
24	NB 24 32 16		24	32	16	0,35	18 500	27 500	16 700	33
	NB 24 32 20		24	32	20	0,35	22 800	36 500	16 700	41
25	NB 25 33 16		25	33	16	0,35	19 000	29 000	16 000	34
	NB 25 33 20		25	33	20	0,35	22 500	36 500	16 000	43
		RNA 4904	25	37	17	0,30	25 000	30 000	16 000	56
26	NB 26 34 20		26	34	20	0,35	23 300	38 000	15 400	44
28	NB 28 37 20		28	37	20	0,35	27 500	42 500	14 000	53
		RNA 49/22 17	28	39	17	0,30	27 000	34 500	14 000	54
29	NB 29 38 20		29	38	20	0,35	27 300	42 500	13 800	54
	NB 29 38 30		29	38	30	0,35	41 500	73 000	13 800	82

over →

Bearings with cage-guided needles without inner ring

NB, RNA 49 series



All bearings are not necessarily available.

Please consult us for delivery times and for special dimensions.

Shaft Dia.	Designations		Ci	De	L	r min	Basic capacities		Speed limit	Weight approx.
	NB Series	RNA 49 Series					Dyn. Cr	Stat. Cor		
mm			mm	mm	mm	mm	N	N	r.p.m.	g
30	**NB 30 40 20**		30	40	20	0,35	28 000	44 500	13 000	65
	NB 30 40 30		30	40	30	0,35	41 000	73 000	13 000	98
		RNA 4905	30	42	17	0,30	28 000	36 500	13 000	65
32	**NB 32 42 20**		32	42	20	0,35	28 500	47 000	12 500	68
	NB 32 42 30		32	42	30	0,35	42 000	77 000	12 500	103
35	**NB 35 45 20**		35	45	20	0,35	30 500	53 000	11 000	74
	NB 35 45 30		35	45	30	0,35	44 000	84 000	11 000	112
		RNA 4906	35	47	17	0,30	30 500	43 000	11 000	75
37	**NB 37 47 20**		37	47	20	0,35	31 000	55 000	10 800	78
38	**NB 38 48 20**		38	48	20	0,35	32 000	57 000	10 500	80
40	**NB 40 50 20**		40	50	20	0,35	32 500	59 000	10 000	83
	NB 40 50 30		40	50	30	0,35	47 500	97 000	10 000	125
42	**NB 42 52 20**		42	52	20	0,35	33 500	63 000	9 500	87
		RNA 4907	42	55	20	0,60	40 000	64 000	9 500	115
45	**NB 45 55 20**		45	55	20	0,35	34 500	67 000	9 000	92
	NB 45 55 30		45	55	30	0,35	45 500	95 000	9 000	140
47	**NB 47 57 20**		47	57	20	0,35	35 000	69 000	8 500	95
48		**RNA 4908**	48	62	22	0,60	44 500	77 000	8 500	158
50	**NB 50 62 25**		50	62	25	0,65	44 000	95 000	8 000	162
	NB 50 62 35		50	62	35	0,65	61 000	144 000	8 000	230
52		**RNA 4909**	52	68	22	0,60	47 000	86 000	7 700	205
55	**NB 55 68 25**		55	68	25	0,65	44 000	98 000	7 000	197
	NB 55 68 35		55	68	35	0,65	61 000	148 000	7 000	278
58		**RNA 4910**	58	72	22	0,60	49 500	95 000	6 900	185
60	**NB 60 72 25**		60	72	25	0,65	48 000	113 000	6 700	190
	NB 60 72 35		60	72	35	0,65	66 000	170 000	6 700	270
63		**RNA 4911**	63	80	25	1	64 000	115 000	6 400	283
65	**NB 65 78 25**		65	78	25	0,85	54 000	120 000	6 000	228
	NB 65 78 35		65	78	35	0,85	74 000	180 000	6 000	320
68	**NB 68 82 25**		68	82	25	0,85	54 000	123 000	5 900	253
	NB 68 82 35		68	82	35	0,85	75 000	185 000	5 900	355
		RNA 4912	68	85	25	1	66 000	124 000	5 900	300

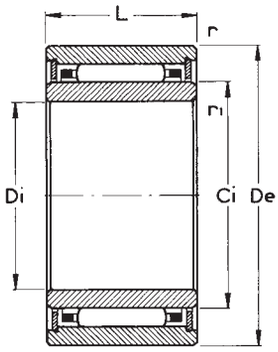
Shaft Dia.	Designations		Ci	De	L	r min	Basic capacities		Speed limit	Weight approx.
	NB Series	RNA 49 Series					Dyn. Cr	Stat. Cor		
mm			mm	mm	mm	mm	N	N	r.p.m.	g
70	**NB 70 85 25**		70	85	25	0,85	56 000	129 000	5 700	285
	NB 70 85 35		70	85	35	0,85	77 000	185 000	5 700	405
73		**RNA 4913**	72	90	25	1	70 000	135 000	5 500	345
	NB 73 90 35		73	90	35	0,85	98 000	210 000	5 500	460
75	**NB 75 92 25**		75	92	25	0,85	64 000	143 000	5 300	350
	NB 75 92 35		75	92	35	0,85	88 000	215 000	5 300	490
80	**NB 80 95 25**		80	95	25	1,35	73 000	148 000	5 000	294
	NB 80 95 35		80	95	35	1,35	103 000	230 000	5 000	410
		RNA 4914	80	100	30	1	100 000	195 000	5 000	500
85		**RNA 4915**	85	105	30	1	103 000	205 000	4 700	530
	NB 85 105 35		85	105	35	1,35	105 000	240 000	4 700	650
90	**NB 90 110 25**		90	110	25	1,35	77 000	165 000	4 400	480
		RNA 4916	90	110	30	1	106 000	219 000	4 400	560
	NB 90 110 35		90	110	35	1,35	108 000	255 000	4 400	680
95	**NB 95 115 26**		95	115	26	1,35	79 000	174 000	4 200	530
	NB 95 115 36		95	115	36	1,35	128 000	280 000	4 200	700
100	**NB100 120 26**		100	120	26	1,35	83 000	185 000	4 000	560
		RNA 4917	100	120	35	1,10	112 000	273 000	4 000	750
	NB100 120 36		100	120	36	1,35	112 000	273 000	4 000	770
105	**NB105 125 26**		105	125	26	1,35	85 000	195 000	3 800	580
107	**NB107 125 32**		107	125	32	1,35	102 000	295 000	3 700	660
110	**NB110 130 30**		110	130	30	1	118 000	268 000	3 600	660

Bearings with cage-guided needles with inner ring

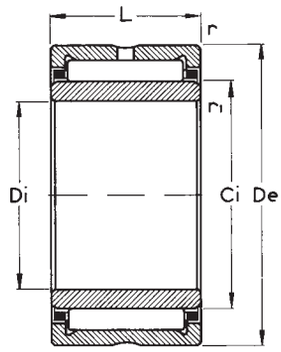
NBI, NA 49 series

All bearings are not necessarily available.

Please consult us for delivery times and for special dimensions.



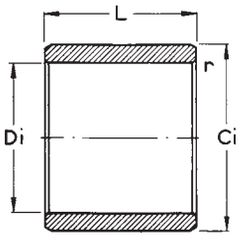
Up to Ci = 12 mm



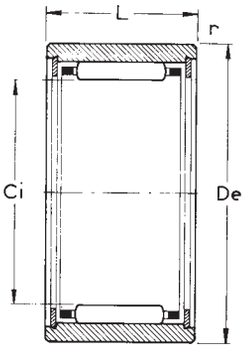
From Ci = 14 mm

Shaft Dia.	Designations		Di	De	L	Ci	r min	r1 min	Basic capacities		Speed limit	Weight approx.
	NBI Series	NA 49 Series							Dyn. Cr	Stat. Cor		
mm			mm	mm	mm	mm	mm	mm	N	N	r.p.m.	g
5	NBI 5 15 12		5	15	12	8	0,35	0,20	4 500	4 600	50 000	12,1
6	NBI 6 16 12		6	16	12	9	0,35	0,20	5 000	5 500	44 000	13,4
	NBI 6 16 16		6	16	16	9	0,35	0,20	6 300	7 300	44 000	18
7	NBI 7 17 12		7	17	12	10	0,35	0,20	4 400	4 750	40 000	15,3
	NBI 7 17 16		7	17	16	10	0,35	0,20	6 100	7 200	40 000	20
9	NBI 9 19 12		9	19	12	12	0,35	0,20	5 050	6 000	33 000	17,7
	NBI 9 19 16		9	19	16	12	0,35	0,20	6 600	8 400	33 000	23,3
10		NA 4900	10	22	13	14	0,30	0,30	10 600	11 600	28 500	24,3
	NBI 10 22 16		10	22	16	14	0,35	0,30	13 100	15 300	28 500	30
12	NBI 12 23 16		12	23	16	15	0,35	0,20	13 800	16 500	27 000	30
		NA 4901	12	24	13	16	0,30	0,30	11 700	13 700	25 000	27,5
	NBI 12 24 16		12	24	16	16	0,35	0,30	14 500	18 000	25 000	34
13	NBI 13 26 16		13	26	16	18	0,35	0,35	15 700	20 500	22 000	40,5
15	NBI 15 27 16		15	27	16	19	0,35	0,30	15 500	20 800	21 000	40
	NBI 15 27 20		15	27	20	19	0,35	0,30	19 400	27 500	21 000	50
		NA 4902	15	28	13	20	0,30	0,30	13 100	16 900	20 000	36
	NBI 15 28 16		15	28	16	20	0,35	0,35	16 200	22 000	20 000	44,5
	NBI 15 28 20		15	28	20	20	0,35	0,35	20 000	29 000	20 000	56
17	NBI 17 29 16		17	29	16	21	0,35	0,30	16 800	23 500	19 000	43,5
	NBI 17 29 20		17	29	20	21	0,35	0,30	20 800	31 000	19 000	55
		NA 4903	17	30	13	22	0,30	0,30	14 000	18 900	18 000	39
	NBI 17 30 16		17	30	16	22	0,35	0,35	17 400	24 800	18 000	49
	NBI 17 30 20		17	30	20	22	0,35	0,35	21 500	32 500	18 000	61
20	NBI 20 32 16		20	32	16	24	0,35	0,30	18 500	27 500	16 700	49
	NBI 20 32 20		20	32	20	24	0,35	0,30	22 800	36 500	16 700	62
	NBI 20 33 16		20	33	16	25	0,35	0,35	19 000	29 000	16 000	55
	NBI 20 33 20		20	33	20	25	0,35	0,35	22 500	36 500	16 000	69
		NA 4904	20	37	17	25	0,30	0,30	25 000	30 000	16 000	79
22	NBI 22 34 20		22	34	20	26	0,35	0,30	23 300	38 000	15 400	67
		NA 49/22 17	22	39	17	28	0,30	0,30	27 000	34 500	14 000	84
23	NBI 23 37 20		23	37	20	28	0,35	0,35	27 500	42 500	14 000	83
25	NBI 25 38 20		25	38	20	29	0,35	0,30	27 300	42 500	13 800	80
	NBI 25 38 30		25	38	30	29	0,35	0,30	41 500	73 000	13 800	120
	NBI 25 40 20		25	40	20	30	0,35	0,35	28 000	44 500	13 000	97
	NBI 25 40 30		25	40	30	30	0,35	0,35	41 000	73 000	13 000	147
		NA 4905	25	42	17	30	0,30	0,30	28 000	36 500	13 000	93
28	NBI 28 42 20		28	42	20	32	0,35	0,30	28 500	47 000	12 500	96
	NBI 28 42 30		28	42	30	32	0,35	0,30	42 000	77 000	12 500	145

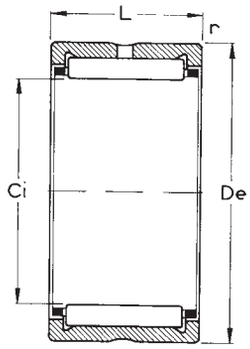
Inner rings



NB, RNA 49 series



Up to Ci = 12 mm



From Ci = 14 mm

Shaft ⌀ Di mm	Designations	Ci mm	L mm	r mini mm	weight approx. g
5	IM 5 8 12 P	8	12	0,2	2,7
6	IM 6 9 12 P IM 6 9 16 P	9 9	12 16	0,2 0,2	3,1 4,2
7	IM 7 10 12 P IM 7 10 16 P	10 10	12 16	0,2 0,2	3,6 4,8
9	IM 9 12 12 P IM 9 12 16 P	12 12	12 16	0,2 0,2	4,4 5,9
10	IM 4 900 IM 10 14 16 P	14 14	13 16	0,35 0,3	7,3 9
12	IM 12 15 16 P IM 4 901 IM 12 16 16 P	15 16 16	16 13 16	0,2 0,35 0,3	7,6 8,5 10,5
13	IM 13 18 16 P	18	16	0,35	14,5
15	IM 15 19 16 P IM 15 19 20 P IM 4 902 IM 15 20 16 P IM 15 20 20 P	19 19 20 20 20	16 20 13 16 20	0,3 0,3 0,35 0,35 0,35	12,8 16 13,3 16,5 20,5
17	IM 17 21 16 P IM 17 21 20 P IM 4 903 IM 17 22 16 P IM 17 22 20 P	21 21 22 22 22	16 20 13 16 20	0,3 0,3 0,35 0,35 0,35	14,3 18 14,9 18,5 23
20	IM 20 24 16 P IM 20 24 20 P IM 20 25 16 P IM 20 25 20 P IM 4 904	24 24 25 25 25	16 20 16 20 17	0,3 0,3 0,35 0,35 0,35	16,5 20,5 21 26,5 22,5
22	IM 22 26 20 P IM 49 /22 17	26 28	20 17	0,3 0,35	22,5 30
23	IM 23 28 20 P	28	20	0,35	30
25	IM 25 29 20 P IM 25 29 30 P IM 25 30 20 P IM 25 30 30 P IM 4 905	29 29 30 30 30	20 30 20 30 17	0,3 0,3 0,35 0,35 0,35	25 38 32 49 27,5
28	IM 28 32 20 P IM 28 32 30 P	32 32	20 30	0,3 0,3	28 42

Designations	
NB Series	RNA 49 Series
NB 8 15 12	
NB 9 16 12 NB 9 16 16	
NB 10 17 12 NB 10 17 16	
NB 12 19 12 NB 12 19 16	
NB 14 22 16	RNA 4 900
NB 15 23 16 NB 16 24 16	RNA 4 901
NB 18 26 16	
NB 19 27 16 NB 19 27 20 NB 20 28 16 NB 20 28 20	RNA 4 902
NB 21 29 16 NB 21 29 20 NB 22 30 16 NB 22 30 20	RNA 4 903
NB 24 32 16 NB 24 32 20 NB 25 33 16 NB 25 33 20	RNA 4 904
NB 26 34 20	RNA 49/ 22 17
NB 28 37 20	
NB 29 38 20 NB 29 38 30 NB 30 40 20 NB 30 40 30	RNA 4 905
NB 32 42 20 NB 32 42 30	

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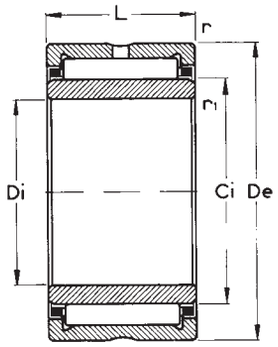
Bearings with cage-guided needles with inner ring

NBI, NA 49 series



All bearings are not necessarily available.
Please consult us for delivery times and for special dimensions.

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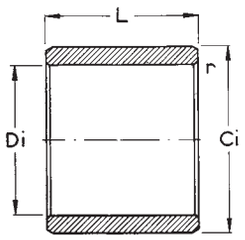
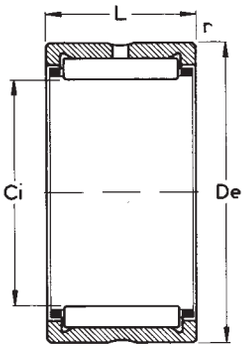
Shaft Dia. mm	Designations NBI Series	Designations NA 49 Series	Di mm	De mm	L mm	Ci mm	r min mm	r1 min mm	Basic capacities Dyn. Cr N	Basic capacities Stat.Cor N	Speed limit r.p.m.	Weight approx. g
30	**NBI 30 45 20**		30	45	20	35	0,35	0,35	30 500	53 000	11 000	112
	NBI 30 45 30		30	45	30	35	0,35	0,35	44 000	84 000	11 000	170
		NA 4906	30	47	17	35	0,30	0,30	30 500	43 000	11 000	107
32	**NBI 32 47 20**		32	47	20	37	0,35	0,35	31 000	55 000	10 800	118
33	**NBI 33 48 20**		33	48	20	38	0,35	0,35	32 000	57 000	10 500	120
35	**NBI 35 50 20**		35	50	20	40	0,35	0,35	32 500	59 000	10 000	127
	NBI 35 50 30		35	50	30	40	0,35	0,35	47 500	97 000	10 000	192
		NA 4907	35	55	20	42	0,60	0,60	40 000	64 000	9 500	178
37	**NBI 37 52 20**		37	52	20	42	0,35	0,35	33 500	53 000	9 500	133
40	**NBI 40 55 20**		40	55	20	45	0,35	0,35	34 500	67 000	9 000	142
	NBI 40 55 30		40	55	30	45	0,35	0,35	45 500	95 000	9 000	215
		NA 4908	40	62	22	48	0,60	0,60	44 500	77 000	8 500	250
42	**NBI 42 57 20**		42	57	20	47	0,35	0,35	35 000	69 000	8 500	148
45	**NBI 45 62 25**		45	62	25	50	0,65	0,65	44 000	95 000	8 000	230
	NBI 45 62 35		45	62	35	50	0,65	0,65	61 000	144 000	8 000	325
		NA 4909	45	68	22	52	0,60	0,60	47 000	86 000	7 700	290
50	**NBI 50 68 25**		50	68	25	55	0,65	0,65	44 000	98 000	7 000	275
	NBI 50 68 35		50	68	35	55	0,65	0,65	61 000	148 000	7 000	385
		NA 4910	50	72	22	58	0,60	0,60	49 500	95 000	6 900	295
55	**NBI 55 72 25**		55	72	25	60	0,65	0,65	48 000	113 000	6 700	275
	NBI 55 72 35		55	72	35	60	0,65	0,65	66 000	170 000	6 700	385
		NA 4911	55	80	25	63	1	1	64 000	115 000	6 400	420
58	**NBI 58 78 25**		58	78	25	65	0,85	0,85	54 000	120 000	6 000	355
	NBI 58 78 35		58	78	35	65	0,85	0,85	74 000	180 000	6 000	500
60	**NBI 60 82 25**		60	82	25	68	0,85	0,85	54 000	123 000	5 900	400
	NBI 60 82 35		60	82	35	68	0,85	0,85	75 000	185 000	5 900	570
		NA 4912	60	85	25	68	1	1	66 000	124 000	5 900	450
62	**NBI 62 85 25**		62	85	25	70	0,85	0,85	56 000	129 000	5 700	440
	NBI 62 85 35		62	85	35	70	0,85	0,85	77 000	185 000	5 700	620
65		**NA 4913**	65	90	25	72	1	1	70 000	135 000	5 500	480
	NBI 65 90 35		65	90	35	73	0,85	0,85	98 000	210 000	5 500	690
67	**NBI 67 92 25**		67	92	25	75	0,85	0,85	64 000	143 000	5 300	520
	NBI 67 92 35		67	92	35	75	0,85	0,85	88 000	215 000	5 300	730
70	**NBI 70 95 25**		70	95	25	80	1,35	1,35	73 000	148 000	5 000	520
	NBI 70 95 35		70	95	35	80	1,35	1,35	103 000	230 000	5 000	720
		NA 4914	70	100	30	80	1	1	100 000	195 000	5 000	760

Inner rings



NB, RNA 49 series



Shaft Ø Di mm	Designations	Ci mm	L mm	r mini mm	weight approx. g
30	**IM 30 35 20 P**	35	20	0,35	38
	IM 30 35 30 P	35	30	0,35	57
	IM 4 906	35	17	0,35	32,5
32	**IM 32 37 20 P**	37	20	0,35	40
33	**IM 33 38 20 P**	38	20	0,35	42
35	**IM 35 40 20 P**	40	20	0,35	44
	IM 35 40 30 P	40	30	0,35	66
	IM 4 907	42	20	0,85	63
37	**IM 37 42 20 P**	42	20	0,35	46
40	**IM 40 45 20 P**	45	20	0,35	50
	IM 40 45 30 P	45	30	0,35	75
	IM 4 908	48	22	0,85	91
42	**IM 42 47 20 P**	47	20	0,35	52
45	**IM 45 50 25 P**	50	25	0,65	69
	IM 45 50 35 P	50	35	0,65	97
	IM 4 909	52	22	0,85	87
50	**IM 50 55 25 P**	55	25	0,65	76
	IM 50 55 35 P	55	35	0,65	107
	IM 4 910	58	22	0,85	111
55	**IM 55 60 25 P**	60	25	0,65	84
	IM 55 60 35 P	60	35	0,35	118
	IM 4 911	63	25	1,35	135
58	**IM 58 65 25 P**	65	25	0,85	125
	IM 58 65 35 P	65	35	0,85	177
60	**IM 60 68 25 P**	68	25	0,85	150
	IM 60 68 35 P	68	35	0,85	210
	IM 4 912	68	25	1,35	148
62	**IM 62 70 25 P**	70	25	0,85	155
	IM 62 70 35 P	70	35	0,85	215
65	**IM 4 913**	72	25	1,35	138
	IM 65 73 35 P	73	35	0,85	225
67	**IM 67 75 25 P**	75	25	0,85	167
	IM 67 75 35 P	75	35	0,85	235
70	**IM 70 80 25 P**	80	25	1,35	222
	IM 70 80 35 P	80	35	1,35	310
	IM 4 914	80	30	1,35	265

Designations	
NB Series	RNA 49 Series
NB 35 45 20	
NB 35 45 30	**RNA 4 906**
NB 37 47 20	
NB 38 48 20	
NB 40 50 20	
NB 40 50 30	**RNA 4 907**
NB 42 52 20	
NB 45 55 20	
NB 45 55 30	**RNA 4 908**
NB 47 57 20	
NB 50 62 25	
NB 50 62 35	**RNA 4 909**
NB 55 68 25	
NB 55 68 35	**RNA 4 910**
NB 60 72 25	
NB 60 72 35	**RNA 4 911**
NB 65 78 25	
NB 65 78 35	
NB 68 82 25	
NB 68 82 35	**RNA 4 912**
NB 70 85 25	
NB 70 85 35	
	RNA 4 913
NB 73 90 35	
NB 75 92 25	
NB 75 92 35	
NB 80 95 25	
NB 80 95 35	**RNA 4 914**

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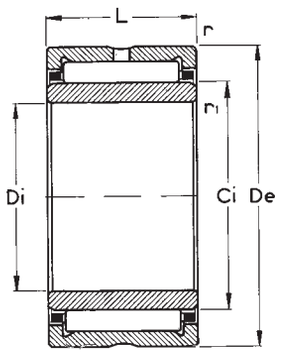
Bearings with cage-guided needles with inner ring

NBI, NA 49 series



All bearings are not necessarily available.
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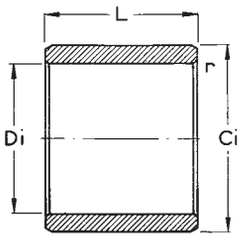
over →

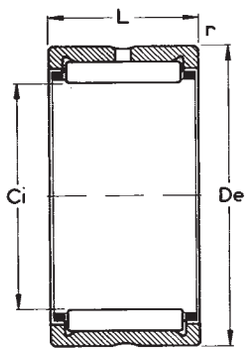
Shaft Dia.	Designations		Di	De	L	Ci	r min	r1 min	Basic capacities		Speed limit	Weight approx.
	NBI Series	NA 49 Series							Dyn. Cr	Stat.Cor		
mm			mm	mm	mm	mm	mm	mm	N	N	r.p.m.	g
75		**NA 4915**	75	105	30	85	1	1	103 000	205 000	4 700	810
	NBI 75105 35		75	105	35	85	1,35	1,35	105 000	240 000	4 700	970
80	**NBI 80110 25**		80	110	25	90	1,35	1,35	77 000	165 000	4 400	730
		NA 4916	80	110	30	90	1	1	106 000	219 000	4 400	850
	NBI 80110 35		80	110	35	90	1,35	1,35	108 000	255 000	4 400	1 030
85	**NBI 85115 26**		85	115	26	95	1,35	1,35	79 000	174 000	4 200	800
	NBI 85115 36		85	115	36	95	1,35	1,35	128 000	280 000	4 200	1 080
		NA 4917	85	122	35	100	1,10	1,10	112 000	273 000	4 000	1 320
90	**NBI 90120 26**		90	120	26	100	1,35	1,35	83 000	185 000	4 000	850
	NBI 90120 36		90	120	36	100	1,35	1,35	112 000	273 000	4 000	1 170
95	**NBI 95125 26**		95	125	26	105	1,35	1,35	85 000	195 000	3 800	880
	NBI 95125 32		95	125	32	107	1,35	1,35	102 000	295 000	3 700	1 120
100	**NBI10013030**		100	130	30	110	1	1,35	118 000	268 000	3 600	1 030

Inner rings



Shaft ∅ Di mm	Designations	Ci mm	L mm	r mini mm	weight approx. g
75	**IM 4 915**	85	30	1,35	280
	IM 75 85 35 P	85	35	1,35	330
80	**IM 80 90 25 P**	90	25	1,35	245
	IM 4 916	90	30	1,35	295
	IM 80 90 35 P	90	35	1,35	350
85	**IM 85 95 26 P**	95	26	1,35	270
	IM 85 95 36 P	95	36	1,35	380
	IM 4 917	100	35	1,85	570
90	**IM 90 100 26 P**	100	26	1,35	290
	IM 90 100 36 P	100	36	1,35	400
95	**IM 95 105 26 P**	105	26	1,35	300
	IM 95 107 32 P	107	32	1,35	450
100	**IM 100 110 30 P**	110	30	1,85	360

NB, RNA 49 series



Designations	
NB Series	RNA 49 Series
NB 85 105 35	**RNA 4915**
NB 90 110 25	**RNA 4916**
NB 90 110 35	
NB 95 115 26	**RNA 4917**
NB 95 115 36	
NB 100 120 26	
NB 100 120 36	
NB 105 125 26	
NB 107 125 32	
NB 110 130 30	

FULL COMPLEMENT NEEDLE BEARINGS

Full complement needle bearings have a through-hardened outer ring which results in high static and dynamic load capacities and an ability to withstand overloading, shocks and vibration.

They are particularly suitable for operations involving oscillating motion but may also accept high speed conditions where good alignment is necessary. This can more easily be achieved using a convex inner ring raceway.

The retention of the needles in the outer ring enables the bearing to be installed easily during assembly.

These bearings are available with or without an inner ring from 12 mm bore size. Standard complete bearings type NA (and special types NA...BIR) have an inner ring with convex raceway form. If extra wide inner rings or rings with lubrication hole are required, they should be ordered separately for use with the corresponding RNA series.

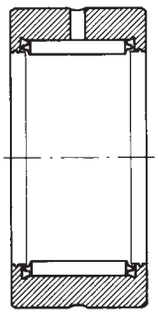
STANDARD TYPES

Bearings without inner ring	Inner rings with cylindrical raceway		
	Same width as bearing (with lubrication hole)	Extra wide inner rings (2) with lubrication hole	Extra wide inner rings (2) without lubrication hole
RNA 1) series 1 000, 2 000, 22 000, 3 000	**BIC** series 1 000, 2 000, 22 000, 3 000	**BICG**	**BIP, BIG, BIK**
Complete bearings with convex inner raceway			
NA series 1 000, 2 000, 22 000, 3 000			

1) Old designation Na.....s/Bi
2) Widths quoted on request.

SPECIAL TYPES

RNA... DER/SGT	Bearings without inner ring. Convex outer ring without lubrication hole or grease groove. Cylindrical inner rings available separately.
NA... BIR	Complete bearings with convex inner ring raceway for misalignment greater than 1 in 1000.



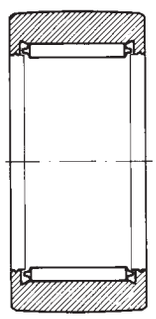
RNA

FULL COMPLEMENT BEARINGS WITHOUT INNER RING

▶ *Standard type RNA*(old designation Na..s/Bi) Series 1 000, 2 000, 22 000, 3 000.

The shaft journal which is used directly as the inner ring raceway of the bearing should have adequate hardness and satisfactory surface finish. A hardness of 58–64 HRC will ensure full load capacity for the bearing. Lower hardness figures will entail a reduction in both static and dynamic capacities as shown in the table of dimensions (see Technical Section).

In cases of misalignment, a convex inner ring raceway can be machined directly at the shaft journal position by grinding, using a concave profile and inclining the diamond impregnated grinding wheel. A convex inner ring raceway calculated to permit misalignment of 1 in 1 000 does not affect bearing load capacity. A larger convex radius is necessary for a greater degree of misalignment but this will reduce the effective bearing load capacity. Further information is available on request.



RNA...DER/SGT

▶ *Special types RNA...DER/SGT*

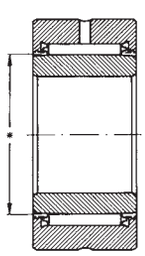
These bearings have a convex outer ring which can swivel in the housing and must be used with a cylindrical bearing raceway. They are manufactured specially on request in the same dimensions as the standard RNA series 1 000, 2 000, 22 000 and 3 000. The convex outer ring radius is normally designed for a maximum misalignment of 10 in 1 000. In special cases a specific radius can be provided on request.

For these bearings the swivelling contact of the outer ring in the housing is improved by the elimination of the lubrication groove and hole (designated by the suffix...SGT).

If the outer ring is to move freely in the cylindrical housing, the latter must be machined to F7 (or F8) tolerance, though this fit is only suitable for operation under a load fixed in relation to the housing to prevent the outer ring slipping. The shoulders at the outer rings (snap rings or abutments) must leave sufficient lateral clearance to permit the ring to move. These bearings must be assembled with a cylindrical inner ring raceway with or without a lubrication hole. Please consult NADELLA Technical Department on each application.

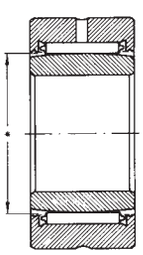
INNER RINGS (TYPE BIR)

Inner rings made from high quality bearing steel heat treated and through-hardened avoid any necessity for heat treatment of the shaft and enable the bearings to operate within their full load capacity (with the exception of special convex inner rings).



NA

** Standard convex inner ring R6*



NA..BIR

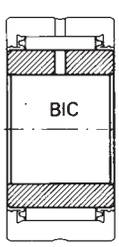
** Special convex inner ring BIR*

▶ *Inner Rings with convex raceway R6*

These inner rings without lubrication hole are of the same width as the outer ring and are supplied with series NA complete, types 1 000, 2 000, 22 000 and 3 000. They can accept a misalignment of 1 in 1 000 in continuous operation and up to 2 in 1 000 temporarily, as in the case of sudden deflection due to overload conditions. The inner and outer rings may be displaced axially from one to the other by up to 5% of the ring width.

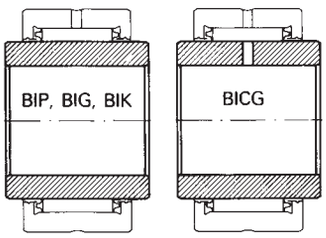
▶ *Inner Rings with convex raceway type BIR.*

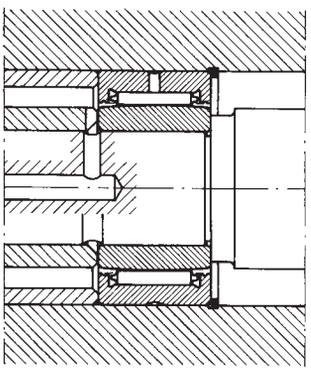
For those applications where the acceptable misalignment required is beyond the limit of convex inner rings R6, the complete NA bearing can be supplied under the designation NA...BIR, with an inner ring possessing a larger radius of convexity. However, the load capacity for these bearings is then reduced. Please consult NADELLA Technical Department if these types are to be specified.



▶ *Inner Rings with cylindrical raceway*

Cylindrical inner rings of the same bore as those with convex raceway may be supplied on request:
– with oil hole permitting lubrication through the shaft.
– wider than corresponding outer ring to enable a displacement in position of one ring relative to the other (e.g. expansion of the shaft) or lateral shaft movement.





In this last case, please consult NADELLA Technical Department.

The use of cylindrical inner rings with standard bearings type RNA series 1 000, 2 000, 22 000 and 3 000 requires that the housing and shaft be correctly aligned at assembly with due regard to the application under load. If it is not essential to use these inner rings, it is always preferable to use complete bearings type NA with convex inner rings type R6, without oil hole, of the same width as the outer ring. In particular cases where lubrication is provided through the shaft, the inner ring with oil hole may be replaced by a lubrication hole at the face of the inner ring (see figure).

Cylindrical inner rings are recommended for use with special bearings type NA...DER with convex outer ring, since using a convex inner ring with these types could create an indeterminate system of alignment.

RING TOLERANCES

Inner and outer rings for full complement standard needle bearings are manufactured in accordance with the tolerance class of ISO Standard 492 (class zero according to DIN 620). Closer tolerances corresponding to classes 6, 5 and 4 may be necessary for special high precision applications (symbols P6, P5, P4).

SHAFT AND HOUSING TOLERANCES

Type of operation	Direction of load	SHAFT					HOUSING 2)
		Bearings without inner ring	Bearings with inner ring 1) Dim Di				
		Dim Ci	≦80	85 –130	140 –220	≧230	Dim De
Shaft rotating housing fixed	Fixed	h5	k5	m5	n6	p6	J6 (J7)
	Rotating with shaft	g5	h5	h5	h6	h6	M6 (M7)
	Unknown	g5	k5*	m5*	n6	p6	M6 (M7)
Shaft fixed housing rotating	Fixed	h5	k5	m5	n6	p6	J6 (J7)
	Rotating with shaft	g5	h5	h5	h6	h6	M6 (M7)
	Unknown	g5	k5*	m5*	n6	p6	M6 (M7)
Shaft and housing rotating	Any direction	g5	k5*	m5*	n6	p6	M6 (M7)
Oscillating motion	Any direction	h5	k5*	k5*	m6	m6	M6 (M7)

** To be used with bearings with selected TC clearance.*

Cylindrical tolerance, defined as the difference in radii of two coaxial cylinders (ISO Standard 1101) must normally be less than a quarter of the manufacturing tolerance. In the case of precision applications or high speed operation it is recommended to reduce this tolerance to one eighth of the manufacturing tolerance.

1) Tolerances applicable for solid shafts in steel or cast iron. Tighter fit of the inner ring should be controlled to closer limits for hollow shafts or shafts of non-ferrous metals.

2) Tolerances applicable for solid shafts in steel or cast iron of rigid wall section. Housing fit at outer ring should be controlled to closer limits for thin wall sections in non-ferrous metals.

If the housing or shaft are manufactured from light alloys and can reach temperatures greatly in excess or below 20°C, it is necessary to allow for differential expansion or contraction with respect to the accompanying bearing and make the necessary adjustments.

RADIAL PLAY

Bearings without inner ring

The radial play of a bearing without inner ring results from the difference in diameter beneath the needles and the size of the shaft. The standard diameter beneath the needles for RNA bearings with the recommended shaft tolerances should provide suitable radial play for most normal applications.

For special applications (high precision, close fits, etc.), NADELLA can offer the diameter beneath the needles selected as follows:
– in the bottom half of the normal tolerance (RNA...TB)
– in the upper half of the normal tolerance (RNA...TC).

Bearings without inner ring tolerance Class TB mounted on a shaft with k5 tolerance will have a reduced radial play suitable for certain applications.

Nominal dimension Ci mm		Tolerance of diameter under needles		
		normal F6 µm	selected TB µm	selected TC µm
above	to			
5	15	+20 + 40	+20 + 31	+ 29 + 40
15	25	+20 + 43	+20 + 33	+ 30 + 43
25	30	+25 + 48	+25 + 38	+ 35 + 48
30	35	+30 + 53	+30 + 43	+ 40 + 53
35	60	+35 + 58	+35 + 48	+ 45 + 58
60	80	+45 + 73	+45 + 60	+ 58 + 73
80	115	+50 + 78	+50 + 65	+ 63 + 78
115	180	+60 + 88	+60 + 75	+ 73 + 88
180	220	+70 +103	+70 + 88	+ 85 +103
220	270	+80 +113	+80 + 98	+ 95 +113
270	350	+90 +128	+90 +110	+108 +128
Examples of bearing		RNA 1020	RNA 1020 TB	RNA 1020 TC

A nominal diameter under the needles further reduced and having a tolerance of 10, 15, or 20 microns according to size, may be required for certain precision applications (Type RNA...TA).

Should a larger clearance than normal be necessary, the shaft diameter must be controlled nearer to the nominal size than the tolerances h5 or g5 would normally provide.

► *Standard complete bearings with inner ring*

Complete bearings type NA are offered with a radial play that is suitable for the majority of applications. They can be supplied if necessary:
– with the radial play selected from the bottom half of the normal tolerance (NA...TB)
– with the radial play selected from the upper half of the normal tolerance (NA...TC).
For bore dimensions Di > 130 mm bearings NA...TB or NA...TC are supplied only on special request.

► *Radial play of full complement bearings with convex inner ring "R6"*

Series 1 000, 2 000, 22 000							
Inner ring bore Di mm		Standard play µm		Selected TB µm		Selected TC µm	
above	to	min	max	min	max	min	max
12	20	20	50	20	35	35	50
20	25	25	60	25	43	42	60
25	30	30	65	30	48	47	65
30	50	35	70	35	53	52	70
50	55	45	85	45	65	65	85
55	65	45	90	45	68	67	90
65	70	45	95	45	70	70	95
70	105	50	100	50	75	75	100
105	125	60	115	60	88	87	115
120	140	80	145	80	113	112	145
140	170	100	165				
170	190	120	185				
190	210	130	200				
210	230	130	205				
230	260	160	235				
260	290	180	260				
290	310	180	265				

Series 3 000							
Inner ring bore Di mm		Standard play µm		Selected TB µm		Selected TC µm	
above	to	min	max	min	max	min	max
30	45	35	70	35	53	52	70
45	55	45	85	45	65	65	85
55	65	45	90	45	68	67	90
65	70	50	95	50	73	72	95
70	100	50	100	50	75	75	100
100	105	60	110	60	85	85	110
105	130	60	115	60	88	87	115
130	140	80	145	80	113	112	145
140	170	100	165				
170	190	120	185				
190	210	130	200				
210	230	130	205				
230	260	160	235				
260	290	180	260				
290	310	180	265				

► *Radial play of full complement bearings with cylindrical inner ring*

Series 1 000, 22 000							
Inner ring bore Di mm		Standard play µm		Selected TB µm		Selected TC µm	
above	to	mini	maxi	mini	maxi	mini	maxi
12	17	20	50	20	35	35	50
17	20	30	60	30	45	45	60
20	25	35	70	35	53	52	70
25	30	40	75	40	58	57	75
30	35	45	80	45	63	62	80
35	50	50	85	50	68	67	85
50	55	60	100	60	80	80	100
55	65	60	105	60	83	82	105
65	70	60	110	60	85	85	110
70	90	65	115	65	90	90	115

Series 2 000							
Inner ring bore Di mm		Standard play µm		Selected TB µm		Selected TC µm	
above	to	mini	maxi	mini	maxi	mini	maxi
15	20	30	60	30	45	45	60
20	25	35	70	35	53	52	70
25	30	40	75	40	58	57	75
30	35	45	80	45	63	62	80
35	50	50	85	50	68	67	85
50	55	60	100	60	80	80	100
55	65	60	105	60	83	82	105
65	70	60	110	60	85	85	110
70	105	65	115	65	90	90	115
105	125	75	130	75	103	102	130
125	140	95	160	95	128	127	160
140	170	125	190				
170	190	145	210				
190	210	160	230				
210	230	160	235				

Series 3 000							
Inner ring bore Di mm		Standard play µm		Selected TB µm		Selected TC µm	
above	to	mini	maxi	mini	maxi	mini	maxi
30	45	50	85	50	68	67	65
45	55	60	100	60	80	80	100
55	65	60	105	60	83	82	105
65	70	65	110	65	88	87	110
70	100	65	115	65	90	90	115
100	105	75	125	75	100	100	125
105	130	75	130	75	103	102	130
130	140	95	160	95	128	127	160
140	170	125	190				
170	190	145	210				
190	210	160	230				
210	230	160	235				
230	260	190	265				
260	290	210	290				
290	310	210	295				

A reduced radial play, in the 10, 15 or 20 micron groups, can be supplied for special precision applications (NA...TA...).

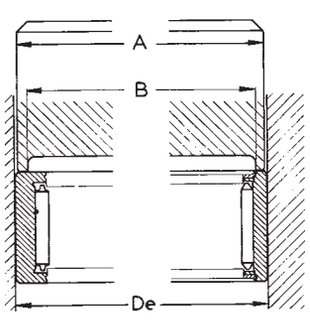
A radial play larger than normal may be necessary for certain applications, for example an inner ring subject to expansion mounted on a shaft running at high temperature (NA...TS...).

INSTALLATION OF RINGS

► *Outer Rings*

The force applied to the face of the ring must be exerted only on the area bounded by outer diameter De and the inner diameter B. The area of a ring with shoulders must not be subjected to loads or shocks.

It is recommended to use a mandrel with which to tap small outer rings lightly into position. Alternatively, a press may be used, providing the load exerted is on the centre line of the ring.



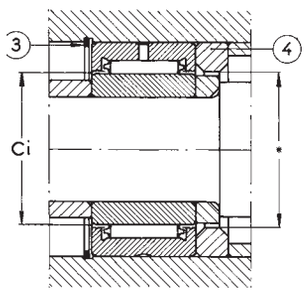
A = De – 0,5 mm

De mm	B mm	De mm	B mm	De mm	B mm	De mm	B mm	De mm	B mm	De mm	B mm
16	13.5	52	46.5	100	90	145	135	205	190	300	280
19	16	58	52	105	95	150	138	215	200	315	295
22	18.5	62	55	110	100	155	143	220	205	325	305
24	21	65	58	115	105	160	148	230	215	340	315
28	24	72	64	120	110	165	153	245	225	350	325
32	27.5	80	71	125	115	170	158	255	235	365	340
35	30.5	85	76	130	120	180	168	265	245	375	350
42	37	90	81	135	125	190	175	280	260	385	360
47	41.5	95	85	140	130	195	180	290	270	395	370

▶ *Inner Rings*

For inner rings of small dimensions one can proceed in the manner described above. For larger sizes where tight fits are required, the rings should first be immersed in an oil bath at a temperature of 70°C to 80°C to enable them to expand and slide more easily up to their correct position on the shaft.

LATERAL RETENTION OF RINGS



*Ci + 0.5 maxi

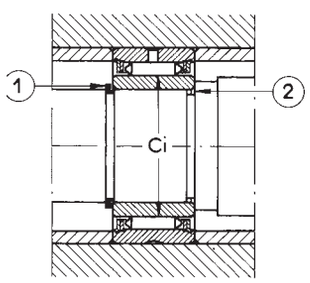
Inner and outer rings for NA bearings must be positioned laterally:
– each lateral abutment for the outer rings must have an inner diameter greater than dimension Ci
– each lateral abutment for the inner rings must have an outer diameter smaller than dimension Ci.

In this way correct fitting is ensured and fretting at the face of the bearing is avoided. NADELLA snap rings provide these conditions. Snap rings from other suppliers must be checked for correct seating in the groove during mounting.

▶ *Fitting of outer rings*

Whenever possible outer rings should be installed in through bored housings, which are easier to manufacture in cylindrical form without taper than housings with shoulders. Lateral retention of rings can then be assured by snap rings, etc.

If the housing cannot be through bored, its base must possess grooves for engaging a bearing extraction tool.



① Snap Ring
② Groove for extraction tool
③ Snap ring
④ Guidance ring for inserting shaft

For those installations using large components and where bearings are inaccessible or difficult to observe, it is advisable to protect the face of the outer ring on the mounting side by a ring having an internal diameter slightly larger than dimension Ci and possessing a chamfer to help guide the shaft into position during installation.

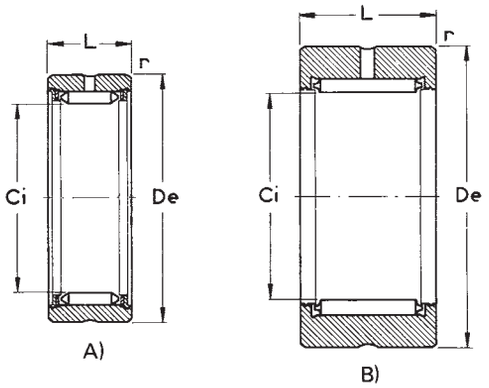
▶ *Fitting of inner rings*

Inner rings may be positioned laterally by snap rings. They may also be supported by a shoulder on the shaft providing that the shoulder radius is smaller than the chamfer on the ring — shown in the table of dimensions. Whenever possible, it is preferable to provide a groove for a bearing extraction tool on the shaft. If it is necessary to provide a large shoulder radius in order to retain the shaft strength, then a ring incorporating a large chamfer may be placed between the shoulder and the inner ring.

Full complement needle bearings without inner ring

RNA 1 000, 2 000, 22 000, 3 000 series

All bearings are not necessarily available.
Please consult us for delivery times and for special dimensions.



RNA 1 005 to RNA 1 017 are not manufactured with a lubrication hole.

Shaft Dia.	Designations 1)		Ci	De	L	r	Basic capacities		Speed limit	Weight approx.
	1 000, 2 000 22 000 Series	3 000 Series				min	Dyn. Cr	Stat. Cor		
mm	(fig. A)	(fig. B)	mm	mm	mm	mm	N	N	r.p.m.	g
7,3	**RNA 1 005**		7,3	16	12	0,35	3 950	4 450	52 000	10
9,7	**RNA 1 007**		9,7	19	12	0,35	4 800	5 900	39 000	13
12,1	**RNA 1 009**		12,1	22	12	0,35	5 600	7 400	31 000	18
14,4	**RNA 1 010**		14,4	24	12	0,35	6 350	8 900	26 000	20
17,6	**RNA 1 012**		17,6	28	15	0,35	11 000	16 500	21 600	34
20,8	**RNA 1 015**		20,8	32	15	0,65	12 400	19 500	18 300	44
22,1	**RNA 2 015**		22,1	35	22	0,65	23 500	37 500	17 200	82
23,9	**RNA 1 017**		23,9	35	15	0,65	13 700	22 500	15 900	47
28,7	**RNA 1 020**		28,7	42	18	0,65	19 300	33 500	13 200	84
	RNA 2 020		28,7	42	22	0,65	28 500	49 000	13 200	104
33,5	**RNA 1 025**		33,5	47	18	0,65	21 500	39 000	11 100	97
	RNA 2 025		33,5	47	22	0,65	33 000	60 000	11 100	122
	RNA 22 025		33,5	47	30	0,65	52 000	94 000	11 100	170
38,2	**RNA 1 030**		38,2	52	18	0,65	23 500	44 500	10 000	107
	RNA 2 030		38,2	52	22	0,65	34 500	66 000	10 000	139
	RNA 22 030		38,2	52	30	0,65	57 000	108 000	10 000	193
44	**RNA 1 035**		44	58	18	0,65	26 000	51 000	8 600	127
	RNA 2 035		44	58	22	0,65	38 000	75 000	8 600	160
	RNA 22 035		44	58	30	0,65	63 000	124 000	8 600	225
		RNA 3 030	44	62	30	0,65	64 000	125 000	8 600	309
49,7	**RNA 1 040**		49,7	65	18	0,85	28 500	58 000	7 600	160
	RNA 2 040		49,7	65	22	0,85	41 500	85 000	7 600	200
	RNA 22 040		49,7	65	30	0,85	68 000	140 000	7 600	278
		RNA 3 035	49,7	72	36	0,65	90 000	183 000	7 600	545
55,4	**RNA 1 045**		55,4	72	18	0,85	30 500	65 000	6 900	193
	RNA 2 045		55,4	72	22	0,85	45 000	95 000	6 900	242
		RNA 3 040	55,4	80	36	0,85	97 000	204 000	6 900	672
62,1	**RNA 1 050**		62,1	80	20	0,85	33 000	73 000	6 100	255
	RNA 2 050		62,1	80	28	0,85	64 000	142 000	6 100	375
		RNA 3 045	62,1	85	38	0,85	105 000	230 000	6 100	710
68,8	**RNA 1 055**		68,8	85	20	0,85	35 500	80 000	5 500	248
	RNA 2 055		68,8	85	28	0,85	69 000	157 000	5 500	361
		RNA 3 050	68,8	90	38	0,85	113 000	255 000	5 500	705
72,6	**RNA 1 060**		72,6	90	20	0,85	37 000	85 000	5 200	283
	RNA 2 060		72,6	90	28	0,85	72 000	165 000	5 200	413
		RNA 3 055	72,6	95	38	0,85	117 000	268 000	5 200	782

1) Old designation Na...s/Bi

over →

Full complement needle bearings without inner ring

RNA 1000, 2000, 3000 series

All bearings are not necessarily available.
Please consult us for delivery times and for special dimensions.

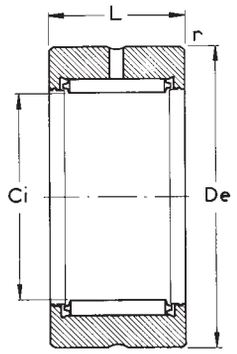
over →

Shaft Dia.	Designations (1)		Ci	De	L	r	Basic capacities		Speed limit	Weight approx.
	1000, 2000 Series	3000 Series				min	Dyn. Cr	Stat. Cor		
mm			mm	mm	mm	mm	N	N	r.p.m.	g
78,3	**RNA 1 065**		78,3	95	20	0,85	41 500	97 000	4 900	306
	RNA 2 065		78,3	95	28	0,85	78 000	184 000	4 900	433
		RNA 3 060	78,3	100	38	0,85	123 000	290 000	4 900	810
83,1	**RNA 1 070**		83,1	100	20	0,85	43 000	103 000	4 500	322
	RNA 2 070		83,1	100	28	0,85	81 000	195 000	4 500	470
		RNA 3 065	83,1	105	38	0,85	129 000	308 000	4 500	865
88	**RNA 1 075**		88	110	24	0,85	64 000	155 000	4 300	577
	RNA 2 075		88	110	32	0,85	104 000	253 000	4 300	767
		RNA 3 070	88	110	38	0,85	134 000	325 000	4 300	906
96	**RNA 1 080**		96	115	24	0,85	68 000	170 000	4 000	510
	RNA 2 080		96	115	32	0,85	110 000	275 000	4 000	694
		RNA 3 075	96	120	38	0,85	142 000	355 000	4 000	1 098
99,5	**RNA 2 085**		99,5	120	32	1,35	113 000	285 000	3 800	787
		RNA 3 080	99,5	125	38	0,85	145 000	365 000	3 800	1 220
104,7	**RNA 2 090**		104,7	125	32	1,35	117 000	300 000	3 600	837
		RNA 3 085	104,7	130	38	1,35	150 000	390 000	3 600	1 252
109,1	**RNA 2 095**		109,1	130	32	1,35	120 000	315 000	3 500	882
		RNA 3 090	109,1	135	43	1,35	185 000	480 000	3 500	1 522
114,7	**RNA 2 100**		114,7	135	32	1,35	125 000	330 000	3 300	677
		RNA 3 095	114,7	140	43	1,35	190 000	505 000	3 300	1 551
119,2	**RNA 2 105**		119,2	140	32	1,35	129 000	340 000	3 200	941
		RNA 3 100	119,2	145	43	1,35	195 000	520 000	3 200	1 645
124,7	**RNA 2 110**		124,7	145	34	1,35	133 000	360 000	3 000	1 015
		RNA 3 105	124,7	150	45	1,35	203 000	550 000	3 000	1 762
132,5	**RNA 2 115**		132,5	155	34	1,35	139 000	380 000	2 900	1 205
		RNA 3 110	132,5	160	45	1,35	210 000	580 000	2 900	2 037
137	**RNA 2 120**		137	160	34	1,35	142 000	395 000	2 800	1 265
		RNA 3 115	137	165	45	1,35	215 000	600 000	2 800	2 140
143,5	**RNA 2 125**		143,5	165	34	1,35	145 000	410 000	2 700	1 218
		RNA 3 120	143,5	170	45	1,35	224 000	630 000	2 700	2 107
148	**RNA 2 130**		148	170	34	1,35	150 000	425 000	2 600	1 292
158	**RNA 2 140**		158	180	36	1,35	157 000	455 000	2 400	1 478
		RNA 3130	158	190	52	1,35	275 000	790 000	2 400	3 285
170,5	**RNA 2 150**		170,5	195	36	1,35	165 000	490 000	2 200	1 790
		RNA 3 140	170,5	205	52	1,35	290 000	860 000	2 200	3 840
179,3	**RNA 2 160**		179,3	205	36	1,35	170 000	515 000	2 100	1 970
		RNA 3 150	179,3	215	52	1,35	300 000	900 000	2 100	4 185

1) Old designation NA...s/Bi

Full complement needle bearings without inner ring

RNA 2 000 and
3 000 series



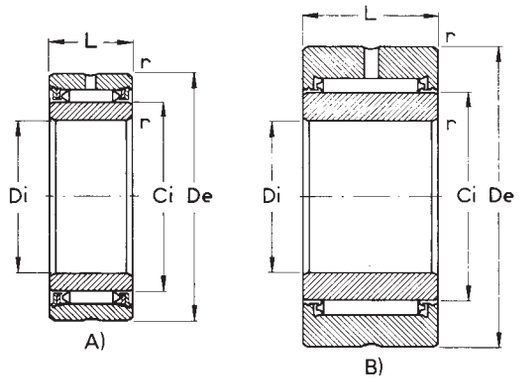
Shaft Dia.	Designations (1)		Ci	De	L	r mini	Basic capacities		Speed limit	Weight approx.
	2 000 Series	3 000 Series					Dyn. Cr	Stat. Cor		
mm			mm	mm	mm	mm	N	N	r.p.m.	g
193,8	**RNA 2 170**		193,8	220	42	1,85	233 000	720 000	2 000	2 570
		RNA 3 160	193,8	230	57	1,35	360 000	1 110 000	2 000	4 955
202,6	**RNA 2 180**		202,6	230	42	1,85	240 000	750 000	1 900	2 835
		RNA 3 170	202,6	245	57	1,85	370 000	1 150 000	1 900	6 235
216	**RNA 2 190**		216	245	42	1,85	250 000	800 000	1 800	3 210
		RNA 3 180	216	255	57	1,85	385 000	1 240 000	1 800	6 040
224,1	**RNA 2 200**		224,1	255	42	1,85	257 000	830 000	1 700	3 560
		RNA 3 190	224,1	265	57	1,85	395 000	1 290 000	1 700	6 650
236		**RNA 3 200**	236	280	57	1,85	410 000	1 350 000	1 600	7 530
248,4	**RNA 2 220**		284,4	280	49	1,85	330 000	1 090 000	1 500	4 620
258,4		**RNA 3 220**	258,4	300	64	1,85	490 000	1 650 000	1 500	8 570
269,6	**RNA 2 240**		269,6	300	49	1,85	345 000	1 190 000	1 400	4 985
281,9		**RNA 3 240**	281,9	325	64	1,85	520 000	1 800 000	1 300	9 480
290,5	**RNA 2 260**		290,5	325	54	1,85	420 000	1 450 000	1 300	6 400
302		**RNA 3 260**	302	350	74	1,85	670 000	2 380 000	1 300	13 400
313,5	**RNA 2 280**		313,5	350	54	1,85	440 000	1 580 000	1 200	7 500
325		**RNA 3 280**	325	375	74	1,85	710 000	2 550 000	1 200	15 400
335	**RNA 2 300**		335	375	54	1,85	460 000	1 690 000	1 100	8 600
344		**RNA 3 300**	344	395	74	1,85	740 000	2 700 000	1 100	16 500

1) Old designation NA...s/Bi

Full complement needle bearings without inner ring

NA 1 000, 2 000, 22 000, 3 000 series

All bearings are not necessarily available.
Please consult us for delivery times and for special dimensions.

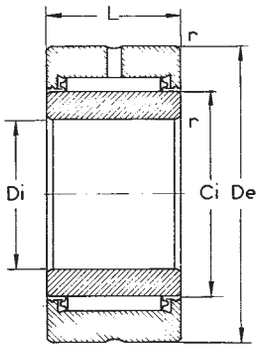


NA 1 012, NA 1 015, NA 1 017 are not manufactured with a lubrication hole.

Shaft Dia.	Designations		Di	De	L	Ci	r mini	Basic capacities		Speed limit	Weight approx.
	1 000, 2 000 – 22 000 Series fig. (A) up to 60 mm fig. (B) above	3 000 Series fig. (B)						Dyn. Cr	Stat. Cor		
mm			mm	mm	mm	mm	mm	N	N	r.p.m.	g
12	NA 1 012		12	28	15	17,6	0,35	11 000	16 500	21 600	50
15	NA 1 015		15	32	15	20,8	0,65	12 400	19 500	18 300	62
	NA 2 015		15	35	22	22,1	0,65	23 500	37 500	17 200	117
17	NA 1 017		17	35	15	23,9	0,65	13 700	22 500	15 900	73
20	NA 1 020		20	42	18	28,7	0,65	19 300	33 500	13 200	130
	NA 2 020		20	42	22	28,7	0,65	28 500	49 000	13 200	160
25	NA 1 025		25	47	18	33,5	0,65	21 500	39 000	11 100	151
	NA 2 025		25	47	22	33,5	0,65	33 000	60 000	11 100	187
	NA 22 025		25	47	30	33,5	0,65	52 000	94 000	11 100	259
30	NA 1 030		30	52	18	38,2	0,65	23 500	44 500	10 000	167
	NA 2 030		30	52	22	38,2	0,65	34 500	66 000	10 000	213
	NA 22 030		30	52	30	38,2	0,65	57 000	108 000	10 000	293
		NA 3 030	30	62	30	44	0,65	64 000	125 000	8 600	497
35	NA 1 035		35	58	18	44	0,65	26 000	51 000	8 600	204
	NA 2 035		35	58	22	44	0,65	38 000	75 000	8 600	253
	NA 22 035		35	58	30	44	0,65	63 000	124 000	8 600	352
		NA 3 035	35	72	36	49,7	0,65	90 000	183 000	7 600	815
40	NA 1 040		40	65	18	49,7	0,85	28 500	58 000	7 600	254
	NA 2 040		40	65	22	49,7	0,85	41 500	85 000	7 600	315
	NA 22 040		40	65	30	49,7	0,85	68 000	140 000	7 600	434
		NA 3 040	40	80	36	55,4	0,85	97 000	204 000	6 900	993
45	NA 1 045		45	72	18	55,4	0,85	30 500	65 000	6 900	306
	NA 2 045		45	72	22	55,4	0,85	45 000	95 000	6 900	381
		NA 3 045	45	85	38	62,1	0,85	105 000	230 000	6 100	1 132
50	NA 1 050		50	80	20	62,1	0,85	33 000	73 000	6 100	418
	NA 2 050		50	80	28	62,1	0,85	64 000	142 000	6 100	603
		NA 3 050	50	90	38	68,8	0,85	113 000	255 000	5 500	1 220
55	NA 1 055		55	85	20	68,8	0,85	35 500	80 000	5 500	453
	NA 2 055		55	85	28	68,8	0,85	69 000	157 000	5 500	649
		NA 3 055	55	95	38	72,6	0,85	117 000	268 000	5 200	1 307
60	NA 1 060		60	90	20	72,6	0,85	37 000	85 000	5 200	485
	NA 2 060		60	90	28	72,6	0,85	72 000	165 000	5 200	695
		NA 3 060	60	100	38	78,3	0,85	123 000	290 000	4 900	1 393
65	NA 1 065		65	95	20	78,3	0,85	41 500	97 000	4 900	536
	NA 2 065		65	95	28	78,3	0,85	78 000	184 000	4 900	757
		NA 3 065	65	105	38	83,1	0,85	129 000	308 000	4 500	1 488
70	NA 1 070		70	100	20	83,1	0,85	43 000	103 000	4 500	567
	NA 2 070		70	100	28	83,1	0,85	81 000	195 000	4 500	805
		NA 3 070	70	110	38	88	0,85	134 000	325 000	4 300	1 568
75	NA 1 075		75	110	24	88	0,85	64 000	155 000	4 300	882
	NA 2 075		75	110	32	88	0,85	104 000	253 000	4 300	1 177
		NA 3 075	75	120	38	96	0,85	142 000	355 000	4 000	1 923

Full complement needle bearings with inner ring

NA 1000, 2000 and 3000 series



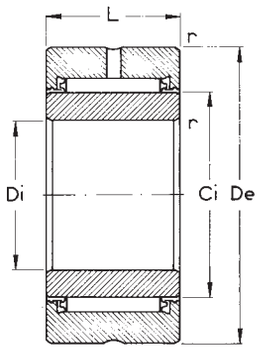
Shaft Dia. mm	Designations 1000 and 2000 Series	Designations 3000 Series	Di mm	De mm	L mm	Ci mm	r mini mm	Basic capacities Dyn. Cr N	Basic capacities Stat. Cor N	Speed limit r.p.m.	Weight approx. g
80	**NA 1080**		80	115	24	96	0,85	68 000	170 000	4 000	920
	NA 2080		80	115	32	96	0,85	110 000	275 000	4 000	1 239
		NA 3080	80	125	38	99,5	0,85	145 000	365 000	3 800	2 025
85	**NA 2085**		85	120	32	99,5	1,35	113 000	285 000	3 800	1 302
		NA 3085	85	130	38	104,7	1,35	150 000	390 000	3 600	2 117
90	**NA 2090**		90	125	32	104,7	1,35	117 000	300 000	3 600	1 368
		NA 3090	90	135	43	109,7	1,35	185 000	480 000	3 500	2 512
95	**NA 2095**		95	130	32	109,1	1,35	120 000	315 000	3 500	1 430
		NA 3095	95	140	43	114,7	1,35	190 000	505 000	3 300	2 626
100	**NA 2100**		100	135	32	114,7	1,35	125 000	330 000	3 300	1 497
		NA 3100	100	145	43	119,2	1,35	195 000	520 000	3 200	2 735
105	**NA 2105**		105	140	32	119,2	1,35	129 000	340 000	3 200	1 556
		NA 3105	105	150	45	124,7	1,35	203 000	550 000	3 000	2 987
110	**NA 2110**		110	145	34	124,7	1,35	133 000	360 000	3 000	1 720
		NA 3110	110	160	45	132,5	1,35	210 000	580 000	2 900	3 532
115	**NA 2115**		115	155	34	132,5	1,35	139 000	380 000	2 900	2 100
		NA 3115	115	165	45	137	1,35	215 000	600 000	2 800	3 660
120	**NA 2120**		120	160	34	137	1,35	142 000	395 000	2 800	2 167
		NA 3120	120	170	45	143,5	1,35	224 000	630 000	2 700	3 792
125	**NA 2125**		125	165	34	143,5	1,35	145 000	410 000	2 700	2 240
130	**NA 2130**		130	170	34	148	1,35	150 000	425 000	2 600	2 325
		NA 3130	130	190	52	158	1,35	275 000	790 000	2 400	5 815
140	**NA 2140**		140	180	36	158	1,35	157 000	455 000	2 400	2 643
		NA 3140	140	205	52	170,5	1,35	290 000	860 000	2 200	6 840
150	**NA 2150**		150	195	36	170,5	1,35	165 000	490 000	2 200	3 230
		NA 3150	150	215	52	179,3	1,35	300 000	900 000	2 100	7 230
160	**NA 2160**		160	205	36	179,3	1,35	170 000	515 000	2 100	3 400
		NA 3160	160	230	57	193,8	1,35	360 000	1 110 000	2 000	9 070
170	**NA 2170**		170	220	42	193,8	1,85	233 000	720 000	2 000	4 770
		NA 3170	170	245	57	202,6	1,85	370 000	1 150 000	1 900	10 420
180	**NA 2180**		180	230	42	202,6	1,85	240 000	750 000	1 900	5 010
		NA 3180	180	255	57	216	1,85	385 000	1 240 000	1 800	10 940
190	**NA 2190**		190	245	42	216	1,85	250 000	800 000	1 800	5 890
		NA 3190	190	265	57	224,1	1,85	395 000	1 290 000	1 700	11 450

over →

Full complement needle bearings with inner ring

NA 1000, 2000 and 3000 series

All bearings are not necessarily available.
Please consult us for delivery times and for special dimensions.



Shaft Dia.	Designations		Di	De	L	Ci	r mini	Basic capacities		Speed limit	Weight approx.
	1000 and 2000 Series	3000 Series						Dyn. Cr	Stat. Cor		
mm			mm	mm	mm	mm	mm	N	N	r.p.m.	g
200	**NA 2200**		200	255	42	224,1	1,85	257 000	830 000	1 700	6 150
		NA 3200	200	280	57	236	1,85	410 000	1 350 000	1 600	12 940
220	**NA 2220**		220	280	49	248,4	1,85	330 000	1 090 000	1 500	8 620
		NA 3220	220	300	64	258,4	1,85	490 000	1 650 000	1 500	15 750
240	**NA 2240**		240	300	49	269,6	1,85	345 000	1 190 000	1 400	9 400
		NA 3240	240	325	64	281,9	1,85	520 000	1 800 000	1 300	18 280
260	**NA 2260**		260	325	54	290,5	1,85	420 000	1 450 000	1 300	11 800
		NA 3260	260	350	74	302	1,85	670 000	2 380 000	1 300	24 100
280	**NA 2280**		280	350	54	313,5	1,85	440 000	1 580 000	1 200	13 850
		NA 3280	280	375	74	325	1,85	710 000	2 550 000	1 200	27 800
300	**NA 2300**		300	375	54	335	1,85	460 000	1 690 000	1 100	16 100
		NA 3300	300	395	74	344	1,85	740 000	2 700 000	1 100	29 300

NEEDLE ROLLERS

In certain applications, the limited amount of space available for bearings and the loads to be supported require the use of a full complement of needles independent of any system of retention. The length of the needle is determined in relation to the load capacity required.

The needles are placed directly between shaft and housing without the use of inner or outer rings. Thus a shaft of maximum diameter is permissible to increase rigidity and load capacity.

In rotating applications where the load capacity requires the use of needles that are long in relation to the shaft diameter, it is preferable to employ two rows of needles of equal length separated by a spacer ring. In such cases, the needles must be selected with diameters in the same tolerance class. This arrangement is particularly recommended for mounting parts such as long idler wheels, especially where they are subjected to rotational torque.

RACEWAYS

Maximum load capacity is obtained with hardened inner and outer raceways of surface hardness 58–64 HRC. Parts used for the lateral retention of needles at their ends should be of equivalent hardness.

The inner and outer raceways should both be aligned on installation and before operation under load. In the case of parts fitted with a single row of needles, the inner raceway may be ground convex to allow misalignment. A convexity permitting misalignment of 1 in 1 000 (or up to 2 in 1 000 in cases of instantaneous overloading) does not reduce the calculated load capacity. This convexity, which also depends on the length of the needles, may be produced on a separate inner ring or directly on the shaft journal using a grinding wheel with concave profile obtained by inclining the diamond impregnated cutting wheel. Further technical information is available on request.

TYPES AND DIMENSIONS

The standard needle type BR has rounded ends. On request, NADELLA can also supply needles with flat ends, type BP.

The standard dimensions of the BR type needles are given in the table following. Needles of special dimensions may be manufactured on request where quantities are sufficiently large.

CHARACTERISTICS

NADELLA standard needles are made in through-hardened bearing steel of hardness 58–65 HRC. Needles in heat treated corrosion resistant steel (hardness 57–62 HRC) may be produced on request, the preferred diameters being 1.5, 2, 2.5, 3 and 4 mm.

The surface finish is ≦ 0.2 µm C.L.A.

The profile of a needle is not cylindrical along its whole length as there is a very slight tape towards the ends. Therefore, precise measurement of the diameter can only be carried out in the central area of the needle. Needles having a greater taper at the ends may be supplied on request (suffix...DTN).

MANUFACTURING TOLERANCES

In general, the diameter of standard needles with rounded ends type BR and with flat ends type BP is produced to a tolerance up to –10 µm from the nominal dimension. However, the maximum variation on any one production lot is 5 µm according to one of the classes of grade 5 in the table. On request, a variation of 3 µm may be obtained according to the classes of grade 3, and a variation of 2 µm according to the classes of grade 2.

Unless specified otherwise, quantities supplied are divided by NADELLA into different classes of each grade 2, 3 or 5. However, with automatic selection, diameters at 2 µm are generally available in grade 2 according to the classes printed in bold type. The colour codes shown for these classes are only used by agreement.

The length of needles type BR and BP is kept within tolerance h13.

TOLERANCES ON NEEDLE DIAMETER

Grade G	Variation in diameter of one lot µm	Standard classes µm	Deviation from true circularity µm
2	2	**0-2 -1-3 -2-4 -3-5 -4-6** -5-7 -6-8 -7-9 -8-10	1
3	3	0-3 -1.5-4.5 -3-6 -4.5-7.5 -6-9 -7-10	1.5
5	5	0-5 -3-8 -5-10	2.5

Example: Needle 2.5x 15.8 BR/G2–2–4

COLOUR CODES FOR THE CLASSES OF GRADE 2

0-2	-1-3	-2-4	-3-5	-4-6	-5-7	-6-8	-7-9	-8-10
red	pink	blue	sky blue	white	grey	green	orange	yellow

These colour codes are only used by prior agreement.

SHAFT AND HOUSING TOLERANCES

Operating conditions	Shaft Ci	Housing Ce	Housing B 1)
Rotation on a convex inner raceway	j 5	F 6	H 12
Rotation on a cylindrical inner raceway	h 5	F 6	
Oscillatory motion	h 5	G 6	

1) Nominal dimension B = length of needle L + 0.2 mm

The cylindrical tolerance, defined as the difference in radii of two coaxial cylinders (ISO Standard 1101), should normally be less than a quarter of the manufacturing tolerance. However, for high precision or high speed applications, it is recommended to restrict this tolerance to one-eighth of the manufacturing tolerance.

LIMITING SPEED

With effective oil lubrication and good alignment, limiting speed may reach:

$n(r.p.m.) = \frac{380\,000}{Ci}$ (Ci: diameter of inner raceway in mm) up to a maximum speed of 70 000 r.p.m. For grease lubrication, use approximately half these values.

DYNAMIC AND STATIC CAPACITIES

The basic dynamic capacity Cr, in newtons (N), is given by the formula:

1) $$Cr = K\,Lu^{7/9}$$

K: variable factor relating to diameter of inner raceway Ci,

Lu (mm): effective needle length, as shown in the table of dimensions.

The basic static capacity Cor in newton (N), is given by the formula:

2) $$Cor = 44\left(1 - \frac{d}{Ci + d}\right) i\,d\,L_u\,Z.$$

d (mm): diameter of needles

Lu (mm): effective needle length, as shown in the table of dimenions.

Z: number of needles

Ci: number of needle rows.

NUMBER OF NEEDLES – CIRCUMFERENTIAL PLAY

The number of needles Z is given, as a function of the proposed shaft diameter Ci and the needle diameter d, by the formula:

3) $$Z = \frac{\pi\,(Ci + d)}{d}$$

adjusted to the nearest whole number.

To ensure the circumferential play jc, which should normally be between 0.3 and 1 mm, the following formula should be used:

4) $$Ci = \gamma d + \frac{jc}{\pi}$$

where γ is a variable factor shown in the tables on pages 68 and 69 in respect to the number of needles Z.

Example:
needles of diameter d = 2.5 mm on a shaft of diameter Ci = approx. 30 mm

Number of needles $Z = \frac{\pi\,(30 + 2{,}5)}{2{,}5}$

or Z = 41 needles (adjusted up)

To ensure circumferential play jc = 0.3 mm, use formula 4) with $\gamma = 12.06$ for 41 needles thus:

$Ci = 12{,}06 \times 2{,}5 + \frac{0{,}3}{\pi} = 30{,}25$ mm (adjusted up).

The shaft diameter Ci can therefore be designed at the nominal dimension adjusted up to 30.3 mm to take 41 needles of diameter 2.5 mm, with a circumferential play of approx. 0.3 mm.

Note: Having established the number of needles Z, reference may then be made to the table on page 82 giving the corresponding Ci dimensions according to needle diameter d and for a circumferential play between 0.3 and 0.6 mm. Thus, for 41 needles of diameter 2.5 mm, diameter Ci is 30.3 mm.

INSTALLATION

Because of the large number of shaft diameters possible, depending on the number of needles chosen and their diameter, needles cannot be packed in rings ready for installation.

The needles, which are supplied loose, should therefore be arranged in a ring around the inner or outer raceway, which must be pregreased to ensure their retention during installation of the parts that will retain them.

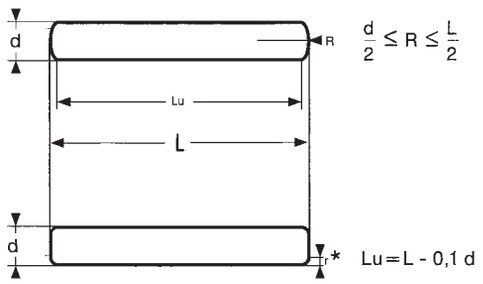
In cases where the shaft has to be introduced blind into a ring of needles (e.g. an idler wheel fitted on a yoke), it may be useful to retain the needles in their housing by means of a mounting shaft of the same length as the needles. This can then be withdrawn when the shaft is introduced.

Arrangement of the needles in a ring may be carried out by hand where the number of installations is small. Where it is relatively high, a simple and effective method is to use a manual appliance which, in a single movement, permits the assembly on a rotating mandrel of a set of needles ready for installation (information on request).

The use of automatic machines with high-speed rotary loading should be considered only for production quantities large enough to ensure that the high cost of investment can be absorbed.

Standard needles with rounded ends type BR

Example of designation:
AIG 3 x 23,8 BR



Needles with flat ends type BP

AIG 3 x 23,8 BP

d	BP	BR		Weight approx. per 1 000
	L	L	Lu	
mm	mm	mm	mm	g
1		5,8	5	34
		7,8	7	46
1,5	5,8	5,8	4,9	76
	6,8	6,8	5,9	90
		7,8	6,9	103
	9,8	9,8	8,9	130
		11,8	10,9	157
		13,8	12,9	185
		15,8	14,9	210
2		3,8	2,8	87
		5,8	4,8	135
	7,8	7,8	6,8	182
	8,8			
	9,8	9,8	8,8	230
		11,8	10,8	280
	12,8			
	13,8	13,8	12,8	325
	15,8	15,8	14,8	375
		17,8	16,8	420
	19,8	19,8	18,8	470
2,5	7,8	7,8	6,7	285
		9,8	8,7	360
		11,8	10,7	430
		13,8	12,7	510
	14			
	15,8	15,8	14,7	580
		17,8	16,7	660
		19,8	18,7	730
		21,8	20,7	800
		23,8	22,7	880
	27,8			
3	9,8	9,8	8,5	510
	11,8	11,8	10,5	620
	12,8			
	13,8	13,8	12,5	730
	15,8	15,8	14,5	840
	17,8	17,8	16,5	940
	19,8	19,8	18,5	1 050
	21,8	21,8	20,5	1 150
	23,8	23,8	22,5	1 260
	25,4			
	25,8	25,8	24,5	1 370
	26,8			
	27,8	27,8	26,5	1 480
	29,8	29,8	28,5	1 600

*

d		in mm	
>	≤	*r* min.	*r* max.
-	1	0,1	0,3
1	3	0,1	0,4
3	5	0,1	0,6

d	BP	BR		Weight approx. per 1 000
mm	L mm	L mm	Lu mm	g
3,5	8,8	11,8	10,3	840
		13,8	12,3	990
		15,8	14,3	1 130
		17,8	16,3	1 280
		19,8	18,3	1 430
		21,8	20,3	1 510
		23,8	22,3	1 720
		25,8	24,3	1 850
		27,8	26,3	2 000
		29,8	28,3	2 150
		34,8	33,3	2 500
4	8,8	13,8	12,1	1 280
		15,8	14,1	1 480
		17,8	16,1	1 650
		19,8	18,1	1 850
		21,8	20,1	2 050
		23,8	22,1	2 250
		25,8	24,1	2 450
		27,8	26,1	2 600
		29,8	28,1	2 800
		34,8	33,1	3 300
		39,8	38,1	3 800
		44,8	43,1	4 200
5	8,8	19,8	17,5	2 900
		21,8	19,5	3 200
		23,8	21,5	3 500
		25,8	23,5	3 800
		27,8	25,5	4 100
		29,8	27,5	4 400
		34,8	32,5	5 100
		39,8	37,5	5 900
		49,8	47,5	7 400
				Unit Weight g
6		29,8	27,6	6,3
		39,8	37,6	8,4
		59,8	57,2	12,7
7		69,8	66,9	20,2
8		79,8	76,7	30

Shaft diameter Ci for Z needles of diameter d and a circumferential clearance jc between 0.3 and 0.6 mm

Coeffizient γ
for formula 4) page 65
Coeffizient K
for formula 1) page 65

d → mm		1		1,5		2		2,5		3		3,5		4		5	
Z	γ	Ci mm	K	Ci mm	K	Ci mm	K	Ci mm	K	Ci mm	K	Ci mm	K	Ci mm	K	Ci mm	K
10	2,24	2,3	531	3,5	823	4,6	1 119	5,7	1 420	6,9	1 730	8,0	2 040	9,1	2 351	11,3	2 985
11	2,55	2,7	586	4	905	5,2	1 228	6,5	1 561	7,8	1 898	9,1	2 241	10,3	2 583	12,9	3 283
12	2,86	3	635	4,4	978	5,9	1 334	7,3	1 693	8,7	2 058	10,2	2 429	11,6	2 803	14,5	3 562
13	3,18	3,3	680	4,9	1 050	6,5	1 430	8,1	1 817	9,7	2 210	11,3	2 608	12,9	3 010	16	3 822
14	3,49	3,6	723	5,4	1 118	7,1	1 522	8,9	1 935	10,6	2 352	12,4	2 776	14,1	3 203	17,6	4 070
15	3,81	3,9	765	5,9	1 182	7,8	1 609	9,7	2 045	11,6	2 488	13,5	2 936	15,4	3 388	19,2	4 306
16	4,13	4,2	804	6,3	1 242	8,4	1 693	10,5	2 151	12,5	2 617	14,6	3 088	16,6	3 564	20,8	4 530
17	4,44	4,5	841	6,8	1 301	9	1 772	11,2	2 253	13,5	2 740	15,7	3 233	17,9	3 732	22,3	4 743
18	4,76	4,9	878	7,3	1 356	9,7	1 849	12,0	2 349	14,4	2 858	16,8	3 372	19,2	3 893	23,9	4 948
19	5,08	5,2	913	7,8	1 411	10,3	1 921	12,8	2 443	15,4	2 971	17,9	3 507	20,4	4 048	25,5	5 144
20	5,39	5,5	945	8,2	1 463	10,9	1 992	13,6	2 532	16,3	3 080	19	3 635	21,7	4 196	27,1	5 333
21	5,71	5,8	978	8,7	1 512	11,6	2 059	14,4	2 618	17,3	3 185	20,1	3 758	23	4 339	28,7	5 515
22	6,03	6,1	1 010	9,2	1 560	12,2	2 125	15,2	2 701	18,2	3 286	21,2	3 879	24,3	4 477	30,3	5 690
23	6,34	6,4	1 039	9,6	1 607	12,8	2 189	16	2 783	19,2	3 385	22,3	3 996	25,5	4 611	31,8	5 861
24	6,66	6,8	1 067	10,1	1 652	13,5	2 250	16,8	2 861	20,1	3 481	23,4	4 107	26,8	4 741	33,4	6 026
25	6,98	7,1	1 097	10,6	1 695	14,1	2 311	17,6	2 936	21,1	3 572	24,6	4 216	28,1	4 866	35	6 187
26	7,30	7,4	1 124	11,1	1 738	14,7	2 369	18,4	3 011	22	3 664	25,7	4 322	29,3	4 991	36,6	6 342
27	7,61	7,7	1 151	11,6	1 779	15,4	2 425	19,2	3 082	23	3 751	26,8	4 426	30,6	5 109	38,2	6 494
28	7,93	8	1 178	12	1 822	16	2 481	20	3 153	23,9	3 836	27,9	4 528	31,9	5 225	39,8	6 642
29	8,25	8,4	1 202	12,5	1 860	16,6	2 535	20,8	3 221	24,9	3 919	29	4 626	33,1	5 341	41,4	6786
30	8,57	8,7	1 228	13	1 898	17,3	2 587	21,6	3 289	25,8	4 002	30,1	4 723	34,4	5 451	43	6927
31	8,88	9	1 252	13,5	1 936	17,9	2 639	22,3	3 356	26,8	4 081	31,2	4 818	35,7	5 560	44,5	7 069
32	9,20	9,3	1 277	13,9	1 975	18,5	2 691	23,1	3 420	27,7	4 161	32,3	4 910	36,9	5 668	46,1	7 204
33	9,52	9,6	1 301	14,4	2 011	19,2	2 739	23,9	3 483	28,7	4 236	33,5	4 998	38,2	5 772	47,7	7 336
34	9,84	9,9	1 325	14,9	2 046	19,8	2 788	24,7	3 545	29,7	4 311	34,6	5 088	39,5	5 874	49,3	7 466
35	10,16	10,3	1 345	15,4	2 081	20,5	2 835	25,5	3 606	30,6	4 386	35,7	5 176	40,8	5 974	50,9	7 595
36	10,47	10,6	1 368	15,8	2 118	21,1	2 883	26,3	3 666	31,5	4 460	36,8	5 262	42	6 075	52,5	7 720
37	10,79	10,9	1 390	16,3	2 150	21,7	2 930	27,1	3 725	32,5	4 530	37,9	5 346	43,3	6 172	54,1	7 843
38	11,11	11,2	1 413	16,8	2 183	22,4	2 974	27,9	3 782	33,5	4 600	39	5 430	44,6	6 267	55,7	7 965
39	11,43	11,5	1 434	17,3	2 216	23	3 020	28,7	3 839	34,4	4 670	40,1	5 512	45,9	6 360	57,3	8 085
40	11,75	11,9	1 453	17,8	2 247	23,6	3 065	29,5	3 895	35,4	4 738	41,3	5 590	47,1	6 455	58,9	8 202
41	12,06					24,3	3 107	30,3	3 949	36,3	4 805	42,3	5 673	48,4	6 546	60,4	8 321
42	12,38					24,9	3 150	31,1	4 005	37,3	4 871	43,5	5 748	49,7	6 635	62	8 435
43	12,70					25,5	3 194	31,9	4 058	38,2	4 938	44,6	5 826	50,9	6 726	63,6	8 548
44	13,02					26,2	3 233	32,7	4 111	39,2	5 001	45,7	5 902	52,2	6 813	65,2	8 660
45	13,34					26,8	3 275	33,5	4 163	40,2	5 064	46,8	5 978	53,5	6 899	66,8	8 769
46	13,65					27,4	3 317	34,3	4 215	41,1	5 127	47,9	6 052	54,7	6 986	68,4	8 879
47	13,97					28,1	3 356	35,1	4 266	42	5 190	49	6 126	56	7 071	70	8 986
48	14,29					28,7	3 396	35,9	4 316	43	5 251	50,2	6 197	57,3	7 153	71,6	9 091
49	14,61					29,4	3 434	36,7	4 366	44	5 311	51,3	6 286	58,6	7 236	73,2	9 196
50	14,93					30	3 474	37,5	4 415	44,9	5 372	52,4	6 339	59,9	7 317	74,8	9 300
51	15,24					30,6	3 513	38,2	4 465	45,9	5 430	53,5	6 409	61,1	7 399	76,3	9 405
52	15,56					31,3	3 550	39	4 514	46,8	5 490	54,6	6 479	62,4	7 479	77,9	9 506
53	15,88					31,9	3 588	39,8	4 561	47,8	5 547	55,7	6 548	63,7	7 556	79,5	9 606
54	16,20					32,5	3 626	40,6	4 609	48,7	5 606	56,8	6 616	64,9	7 637	81,1	9 706
55	16,52					33,2	3 661	41,4	4 655	49,7	5 661	58	6 681	66,2	7 713	82,7	9 804

d → mm		2		2,5		3		3,5		4		5	
Z	γ	Ci mm	K	Ci mm	K	Ci mm	K	Ci mm	K	Ci mm	K	Ci mm	K
56	16,83	33,8	3 699	42,2	4 701	50,6	5 719	59	6 750	67,5	7 789	84,3	9 901
57	17,15	34,4	3 736	43	4 747	51,6	5 774	60,2	6 814	68,7	7 867	85,9	9 997
58	17,47	35,1	3 770	43,8	4 793	52,5	5 831	61,3	6 880	70	7 942	87,5	10 093
59	17,79	35,7	3 806	44,6	4 837	53,5	5 884	62,4	6 944	71,3	8 016	89,1	10 188
60	18,11	36,4	3 840	45,4	4 882	54,5	5 938	63,5	7 009	72,6	8 090	90,7	10 282
61	18,43			46,2	4 926	55,4	5 992	64,6	7 073	73,9	8 162	92,3	10 374
62	18,74			47	4 970	56,4	6 045	65,7	7 136	75,1	8 236	93,8	10 468
63	19,06			47,8	5 013	57,3	6 100	66,8	7 198	76,4	8 307	95,4	10 559
64	19,38			48,6	5 056	58,3	6 150	68	7 258	77,7	8 379	97	10 651
65	19,70			49,4	5 099	59,2	6 204	69,1	7 320	78,9	8 451	98,6	10 740
66	20,02			50,2	5 141	60,2	6 254	70,2	7 381	80,2	8 521	100,2	10 829
67	20,33			51	5 184	61,1	6 306	71,3	7 442	81,5	8 590	101,8	10 917
68	20,65			51,8	5 225	62,1	6 357	72,4	7 502	82,7	8 660	103,4	11 005
69	20,97			52,6	5 266	63	6 408	73,5	7 562	84	8 729	105	11 092
70	21,29			53,4	5 308	64	6 458	74,7	7 620	85,3	8 796	106,6	11 179
71	21,61			54,2	5 349	65	6 506	75,8	7 678	86,6	8 863	108,2	11 265
72	21,93			55	5 389	65,9	6 557	76,9	7 737	87,9	8 930	109,8	11 350
73	22,24			55,7	5 431	66,9	6 604	78	7 795	89,1	8 998	111,3	11 437
74	22,56			56,5	5 471	67,8	6 654	79,1	7 852	90,4	9 064	112,9	11 520
75	22,88			57,3	5 510	68,8	6 702	80,2	7 910	91,7	9 129	114,5	11 604
76	23,20			58,1	5 550	69,7	6 751	81,3	7 966	92,9	9 195	116,1	11 686
77	23,52			58,9	5 589	70,7	6 798	82,5	8 022	94,2	9 260	117,7	11 769
78	23,83			59,7	5 628	71,6	6 846	83,5	8 079	95,5	9 324	119,3	11 851
79	24,15			60,5	5 666	72,6	6 892	84,7	8 134	96,7	9 389	120,9	11 933
80	24,47			61,3	5 704	73,5	6 940	85,8	8 189	98	9 453	122,5	12 013
81	24,79					74,5	6 985	86,9	8 243	99,3	9 516	124,1	12 093
82	25,11					75,5	7 030	88	8 298	100,6	9 578	125,7	12 173
83	25,43					76,4	7 078	89,1	8 353	101,9	9 640	127,3	12 252
84	25,74					77,4	7 123	90,2	8 407	103,1	9 703	128,8	12 332
85	26,06					78,3	7 169	91,3	8 461	104,4	9 764	130,4	12 410
86	26,38					79,3	7 213	92,5	8 512	105,7	9 825	132	12 488
87	26,70					80,2	7 258	93,6	8 565	106,9	9 887	133,6	12 566
88	27,07					81,2	7 302	94,7	8 618	108,2	9 947	135,2	12 643
89	27,34					82,2	7 345	95,8	8 670	109,5	10 007	136,8	12 720
90	27,65					83,1	7 390	96,9	8 723	110,7	10 069	138,4	12 796
91	27,97					84	7 436	98	8 775	112	10 128	140	12 871
92	28,29					85	7 479	99,2	8 825	113,3	10 187	141,6	12 947
93	28,61					86	7 520	100,3	8 876	114,6	10 245	143,2	13 021
94	28,93					86,9	7 565	101,4	8 927	115,9	10 303	144,8	13 096
95	29,24					87,9	7 607	102,5	8 978	117,1	10 363	146,3	13 172
96	29,56					88,8	7 650	103,6	9 028	118,4	10 420	147,9	13 245
97	29,88					89,8	7 692	104,7	9 079	119,7	10 478	149,5	13 318
98	30,20					90,7	7 735	105,8	9 129	120,9	10 537	151,1	13 391
99	30,52					91,7	7 777	107	9 177	122,2	10 593	152,7	13 464
100	30,84					92,7	7 817	108,1	9 227	123,5	10 650	154,3	13 536

CAM FOLLOWERS

NADELLA cam followers are designed to run directly on various types of surface such as cams, ramps and slideways.

In order to satisfy the operating conditions imposed on this type of bearing – heavy radial loads usually accompanied by substantial and repeated shocks, the various NADELLA cam followers have these common advantages:

- heavy section outer ring of high strength steel hardened to 58–61.5 HRC
- outer ring possessing no oil hole or lubrication groove, thus preventing the introduction of impurities into the bearing and scaling and galling of the bearing track
- convex outer ring tolerating out-of-parallelism of contact surfaces
- oil holes situated under the needles enabling lubricant replenishment through the shaft
- full complement of needles providing maximum dynamic and static load capacities.

Although the use of a convex outer ring is advisable in many cases, cam followers are also available with cylindrical outer ring for special applications or for use as radial bearings.

For the use of cam followers with convex outer ring as bearings, please consult NADELLA Technical Department.

TYPES OF CAM FOLLOWER

Convex outer ring			Cylindrical outer ring		
without seals	with seals		without seals	with seals	
	plastic	metal		plastic	metal
FG... FP... GC... GCR... RNA 11 000B6 RNAB 11 000	FG...EE GC...EE GCR...EE	FG...EEM FGU...MM GC...MM GCR...EEM GCU...MM GCUR...MM	FGL... FPL... GCL... GCRL... RNAL 11 000	FGL...EE GCL...EE GCRL...EE	FGL...EEM FGUL...MM GCL...EEM GCRL...EEM GCUL...MM GCURL...MM

TO USE AS FOLLOWER

▶ *Dynamic capacity Cg NADELLA:* It is the constant radial load which a follower can support during 1 000 000 revolutions before the first signs of fatigue appear on a ring or rolling element.

This dynamic capacity enables to calculate the life of a cam follower.

LIMIT LOADS

▶ *Dynamic limit load F:* It is the load which should not be exceeded when follower is subject to repeated torques.

▶ *Static limit load Fo:* It is the maximum strength limit that the follower can exceptionally support.

OPERATING CONDITIONS

▶ *Full complement needle followers types GC, FG, FP*

These followers are recommended under following conditions:
– Intermediate speeds,
– High radial loads,
– Oscillating motions.

▶ *Full complement roller followers types GCU, FGU (light series)*

Their installation is especially recommended for:
– High speeds (increased grease content)
– Limited and intermittent axial loads,
– Heavy radial loads.

▶ *Full complement roller followers type FGU (heavy series)*

This type differs from the light series in that the outer ring is thicker, hence a larger outer diameter and thus can accept heavier loads.

▶ *Cam followers types GCR, GCUR*

Derivatives of GC and GCU, this type has an eccentric collar, which is tightly fitted on the stud enabling the mounting position to be adjusted. The position of the stud can vary ± k (see table of dimensions) relative to the centre of the hole in the mating member.

▶ *Full complement needle followers type RNA 11 000*

These followers may be used without an inner ring on a hardened shaft. Inner rings can be supplied with inner ring for shaft diameters of 12 mm and above. This type is recommended under the following conditions:
– Intermediate speeds,
– High radial loads,
– Oscillating motions.

MISALIGNMENT TOLERANCES

Followers with a convex outer ring permit displacement in relation to the track surface up to a maximum slope of:

1.5 in 1 000 for RNA 11 000 B6
15.0 in 1 000 for RNAB 11 000
7.0 in 1 000 for FG, GC and GCR.

TOLERANCES ON OUTER DIAMETER

For all types of follower:

- convex outer ring h9 on dim. De
- cylindrical outer ring h7 on dim. De
- out of roundness: in accordance ISO Standard 492 (class zero according to DIN 620).

SHAFT TOLERANCES

For RNA 11 000 fitted with inner ring, FG and derivatives	Dim. Di
Load fixed in relation to the inner ring	h5
Load rotating in relation to the inner ring	k5
For RNA 11 000 without inner ring	Dim. Ci h5

The cylindrical tolerance, defined as the difference in radii of two coaxial cylinders (ISO Standard 1101), should normally be less than a quarter of the manufacturing tolerance. However, for high precision or high speed applications it is advised to restrict this tolerance to one eighth of the manufacturing tolerance.

Where followers are used as bearings, please consult NADELLA Technical Department for shaft and housing tolerances.

RACEWAY STRENGTH

The stress capacity of the raceway on which the follower rotates depends on several factors such as load and speed, possibility of shock and width of follower. In the case of high loads, raceway stress may be calculated approximately by the formula:

$$R \geq 45 \frac{P}{De \times L}$$ where:

R in megapascals 1)	= raceway stress
P in newtons	= applied load on follower
De in mm	= outer diameter of follower
L in mm	= width of follower

1) 1 megapascal (MPa) = 1 newton (N) per mm^2

RIGIDITY CONCEPT

The design of NADELLA full complement needle or roller followers provides applications with the high degree of rigidity necessary for precise motion.

This is essentially due to the rigidity of the stud and the rolling elements, to the bending under load of the outer ring, to the rigid contact between the outer ring and the cam, and above all to the thickness of the outer ring.

Owing to their inner design, the full complement followers types GC, FG... limit the load on the rolling elements and consequently the load on the outer ring.

For K values, please see table of dimensions.

ADVICE ON ASSEMBLY

▶ *Positioning of the radial lubrication hole*

In cases where the follower is subjected to high loads, shock or vibration, the lubrication hole situated under the needles should be positioned outside the loaded zone. The lubrication hole which is not visible on the cam follower with threaded stud is parallel to the screwdriver slot in the head of the stud. (The GC 13 does not possess a lubrication hole.) Where the head of the stud has a hexagonal socket, the position of the lubrication hole is indicated by the marking NA.

▶ *Lateral support of FG type followers*

Shoulders on the shaft or other parts serving to retain the follower on the faces of the inner ring should have an outer diameter not less than dimensions D1. Where there is considerable axial load or operation is subject to vibration, this outer diameter should be equal to dimension M.

▶ *Mounting cam followers with threaded studs type GC, GCR, and derivatives*

The stud should fit easily into the hole in the mating member having a bore of tolerance H7. To ensure contact over the entire surface area of the yoke, the supporting face of the mating member should have a diameter of at least equal to dimension M. The locking torque applied to the nuts, as shown in the table of dimensions, is calculated to provide effective fixing of the followers.

ACCESSORIES FOR FOLLOWERS GC AND GCR

Cam followers GC and GCR with threaded studs are supplied with the parts:

Type GC	Type GCR
two nuts	one nut one lock washer one flat washer
one grease nipple for followers up to De = 28 mm (except GC 10 to 15)	
one grease nipple and one plug for followers from De = 30 mm	

The stud of GC 10 to 15 has no axial hole. The stud of types GC and GCR up to De = 28 mm inclusive has a single threaded hole at its top end for a grease nipple. If this grease nipple is not used, an additional plug can be supplied on request as a substitute.

From De = 30 mm upwards the stud of the followers has a hole at each end for a grease nipple. Having fitted the grease nipple into one of the holes, the other should be blanked by means of the plug supplied. If greasing is effected by means of the hole at right angles to the stud, the arrangement described still applies as the grease nipple will act as a plug in this case. However, if obstruction results from the protruding head of the grease nipple, this can be replaced by a second plug available on request.

Cam followers with threaded stud types GC and GCR have a screwdriver slot at the top end. From D = 30 mm up to 52 mm, these types may either have a screwdriver slot or a hexagonal socket at the discretion of NADELLA, unless a specific type is requested.

LUBRICATION – OPERATING TEMPERATURE

Type RNA 11 000 followers are supplied with a coating of protective grease compatible with a lithium base grease.

Types FG, GC, GCR and derivatives with or without seals are supplied with a coating of lithium soap grease permitting operation in temperatures from –20 to +120°C. On request, these followers can be supplied without grease (but protected) in case where lubrication is to be effected by oil or a special lubricant.

Type of follower	Lubrication	Operating temperature
Followers without seals type RNA 11 000	Protective grease	according to lubricant used for operation (see section on lubrication)
Followers without seals type FG (FGL), GC (GCL) and GCR (GCRL)	Lithium soap grease	–20 to +120°C limits permitted by lithium soap grease
Followers with plastic seals ... EE		–20 to +100°C limits permitted by plastic seals
Followers with metal seals ... EEM		–20 to +120°C [1] limits permitted by lithium soap grease

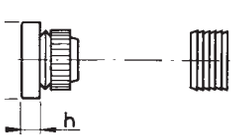
▶ At temperatures of 150°C and above, cam followers must be specially heat treated and calculation of life should take account of reduced load capacity (see page 12).

▶ Use of a special grease for high temperatures may reduce the limiting speeds shown in the tables of dimentions.

1) The metal seal...EEM enables operation up to 200°C with a suitable lubricant.

ACCESSORY DETAILS FOR FOLLOWERS GC AND GCR

The nuts, grease nipples and plugs provided with GC and GCR type followers can be supplied separately. The references and principal dimensions of these accessories are shown in the table below:



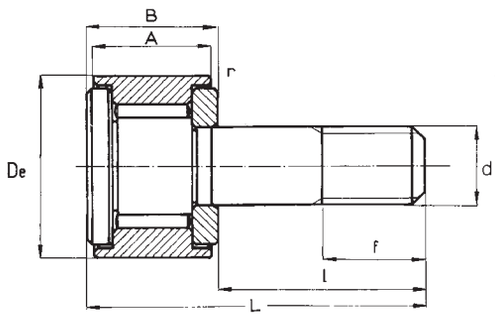
For Follower no.	NUTS Reference	NUTS h mm	GREASE NIPPLES Ref.	GREASE NIPPLES g mm	GREASE NIPPLES h mm	PLUGS Ref.	PLUGS ø mm
10	Hm 4 x 0.7	2.2					
11	Hm 4 x 0.7	2.2					
12	Hm 5 x 0.8	2.7					
13	Hm 5 x 0.8	2.7					
14	Hm 6 x 1.0	3.2					
15	Hm 6 x 1.0	3.2					
16	Hm 6 x 1.0	3.2					
19	Hm 8 x 1.25	4					
22	Hm 10 x 1.25*	5	GN 4	6	2.5 to 3 mm max.	OB 4	4
24	Hm 10 x 1.25*	5					
26	Hm 10 x 1.25*	5					
28	Hm 10 x 1.25*	5					
30	Hm 12 x 1.5	6	**			**	
32	Hm 12 x 1.5	6	**			**	
35	Hm 16 x 1.5	8					
40	Hm 18 x 1.5	9	GN 6	8		OB 6	6
47	Hm 20 x 1.5	10					
52	Hm 20 x 1.5	10					
62	Hm 24 x 1.5	12					
72	Hm 24 x 1.5	12					
80	Hm 30 x 1.5	15	GN 8	10		OB 8	8
85	Hm 30 x 1.5	15					
90	Hm 30 x 1.5	15					

* These threads may be supplied with the old pitch of 1 mm.
** For followers of De 30 and 32 mm with screwdriver slot: grease nipple GN 6 and plug OB 6.
For followers of De 30 and 32 mm with hexagonal socket: grease nipple GN 4 and plug OB 4.

Small cam followers with threaded stud

GC: convex outer ring
GCL: cylindrical outer ring

GC series: without seals



Outer Dia. De	Designations 1)	A	B maxi	d	L maxi	l maxi	f	Pitch	r mini	M 7)	
mm	GC	mm	mm	mm	mm	mm	mm	mm	mm	mm	
10	**10**	8	8,5	4	19,5	11	6	0,7	0,2	8,4	
11	**11**	8	8,5	4	19,5	11	6	0,7	0,2	8,4	
12	**12**	9	9,5	5	22,5	13	7	0,8	0,2	10,3	
13	**13**	9	9,5	5	22,5	13	7	0,8	0,2	10,3	
14	**14**	9	10	6	26	16	8	1	0,3	11,8	
15	**15**	9	10	6	26	16	8	1	0,3	11,8	

Basic capacities when used as a bearing 2)		Basic capacities when used as a follower 3)		Limit loads 4)		Speed limits grease lubrication 5)	Clamping torque 6)	Designations
Dyn. C ISO N	Dyn. C NADELLA N	Stat. Co N	Dyn. Cg N	Dyn. F N	Stat. Fo N	r.p.m.	Nm	GC
2 380	2 700	2 800	2 130	520	960	13 800	0,9	**10**
2 380	2 700	2 800	2 480	520	960	13 800	0,9	**11**
3 200	3 650	4 400	2 980	900	1 680	11 400	1,8	**12**
3 200	3 650	4 400	3 350	900	1 680	11 400	1,8	**13**
3 500	3 950	5 050	3 500	1 480	2 750	10 100	3	**14**
3 500	3 950	5 050	3 750	1 480	2 750	10 100	3	**15**

1) For followers with cylindrical outer ring, designation:GCL.

2) These capacities are to be used only for followers GCL, when the cylindrical outer ring is mounted in a housing.

3) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

4) The load shown is limited by the strengths of the stud or outer ring.
With oil lubrication of followers without seals GC or GCL types, these speeds can be increased by 30% for continuous rotation or, up to 50% momentarily.

5) With oil lubrication of followers, these speeds can be increased by 30% for continuous rotation or, up to 50% momentarily.

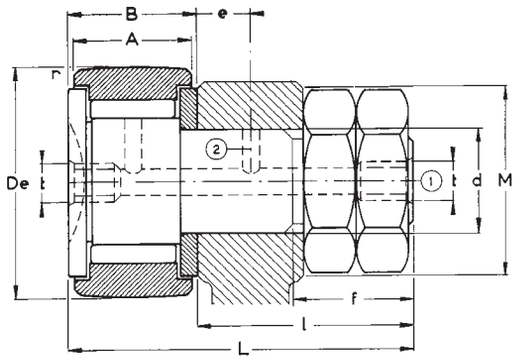
6) These torques are shown for dry threads. For lubricated threads, take 0,7 to 0,8 of these values.

7) Minimum recommended abutment diameter.

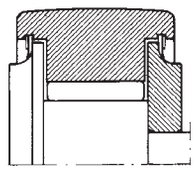
Cam followers with threaded stud

convex outer ring GC
cylindrical outer ring GCL

GC...series:
without seals
GC...EE series:
with plastic seals
GC...EEM series:
with metal seals



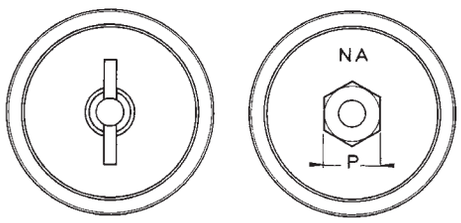
GC



GC..EE, GC..EEM

Outer Dia. De mm	Designations 1) GC... GC...EE GC...EEM	A mm	B maxi mm	d mm	L maxi mm	l maxi mm	f mm	Pitch mm	r mini mm	t mm	e mm	M 7) mm	P 2) mm
16	**16**	11	12,2	6	28,7	16,5	8	1	0,3	4		13,3	
19	**19**	11	12,2	8	32,7	20,5	10	1,25	0,3	4		15,3	
22	**22**	12	13,2	10	36,7	23,5	12	1,25*	0,3	4		18,2	
24	**24**	12	13,2	10	36,7	23,5	12	1,25*	0,3	4		18,2	
26	**26**	12	13,2	10	36,7	23,5	12	1,25*	0,3	4		20,8	
28	**28**	12	13,2	10	36,7	23,5	12	1,25*	0,3	4		20,8	
30	**30**	14	15,2	12	40,7	25,5	13	1,5	0,6	**	6	24,8	8
32	**32**	14	15,2	12	40,7	25,5	13	1,5	0,6	**	6	24,8	8
35	**35**	18	19,6	16	52,6	33	17	1,5	0,6	6	8	28,8	10
40	**40**	20	21,6	18	58,6	37	19	1,5	1	6	8	33,8	12
47	**47**	24	25,6	20	66,6	41	21	1,5	1	6	9	38,7	14
52	**52**	24	25,6	20	66,6	41	21	1,5	1	6	9	38,7	14
62	**62**	29	30,6	24	80,6	50	25	1,5	1	6	11	52	12
72	**72**	29	30,6	24	80,6	50	25	1,5	1	6	11	52	12
80	**80**	35	37	30	100,5	63,5	32	1,5	1	8	15	68	14
85	**85**	35	37	30	100,5	63,5	32	1,5	1	8	15	68	14
90	**90**	35	37	30	100,5	63,5	32	1,5	1	8	15	68	14

* These threads may be supplied with the old pitch of 1 mm (clamping torque 13 Nm).
** t=6 mm for followers 30 and 32 with screw driver slot.
t=4 mm for followers 30 and 32 with hexagonal socket.



See note 2)

Basic capacities 3) Dyn. Cg NADELLA N	Limit loads 4) Dyn. F N	Stat. Fo N	Speed limits grease lubrication 5) r.p.m.	Clamping torque 6) Nm	Weight with nuts (approx.) g	Designations GC... GC...EE GC...EEM
5 050	1 180	2 200	9 300	3	21	**16**
5 750	2 830	5 200	7 600	8	34	**19**
6 300	4 900	8 100	6 300	20	58	**22**
6 900	5 200	9 200	6 300	20	67	**24**
8 900	5 200	9 600	5 500	20	72	**26**
9 600	5 200	9 600	5 500	20	80	**28**
12 900	7 700	14 300	4 800	26	115	**30**
13 800	7 700	14 300	4 800	26	120	**32**
19 200	11 400	24 000	3 850	64	208	**35**
20 000	14 200	27 000	3 150	90	301	**40**
28 300	21 400	40 000	2 700	120	477	**47**
34 000	21 400	40 000	2 700	120	542	**52**
42 000	31 000	57 500	2 330	220	944	**62**
44 000	31 000	57 500	2 330	220	1 165	**72**
60 000	50 000	93 000	1 700	450	1 915	**80**
64 000	50 000	93 000	1 700	450	2 096	**85**
65 000	50 000	93 000	1 700	450	2 287	**90**

1) Under the suffix ...AK, NADELLA can supply on request followers with cylindrical outer ring GCL, GCL...EE, GCL...EEM, possessing a screw driver slot at the threaded end of the stud.

2) Followers with outer diameter up to 28 mm possess a screw driver slot.
Followers with outer diameter 30 to 52 mm possess a screw driver slot or hexagonal socket at the discretion of NADELLA, except where one or other type has been specifically requested.
Followers with outer diameter above 52 mm possess an hexagonal socket.

3) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

4) The load shown is limited by the strengths of the stud or outer ring.

5) With oil lubrication of followers without seals GC or GCL types, these speeds can be increased by 30% for continuous rotation or, up to 50% momentarily.

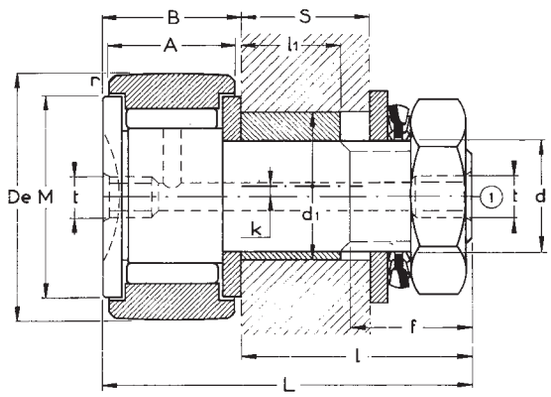
6) These torques are shown for dry threads. For lubricated threads, take 0,7 to 0,8 of these values.

7) Minimum recommended abutment diameter.

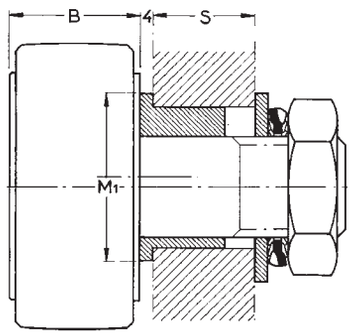
Eccentric cam followers with threaded stud

GCR: convex outer ring
GCRL 1): cylindrical outer ring

GCR... series: without seals
GCR...EE series: with plastic seals
GCR...EEM series: with metal seals



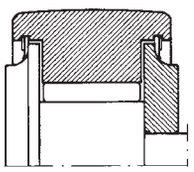
GCR 16 – 52

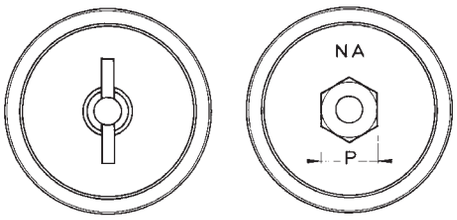


GCR 62 – 90

Outer Dia. De mm	Designations 1) GCR... GCR...EE GCR...EEM	A mm	d1 7) mm	k mm	B maxi mm	L maxi mm	l maxi mm	f mm	d mm	Pitch mm	r mini mm	t mm	M 8) mm	M1 mm	P 2) mm	l_1 mm	S mini mm	S maxi mm
16	**16**	11	9	0,5	12,2	28,7	16,5	8	6	1	0,3	4	13,3			8	8,5	10
19	**19**	11	11	0,5	12,2	32,7	20,5	10	8	1,25	0,3	4	15,3			10	10,5	13
22	**22**	12	14	1	13,2	36,7	23,5	12	10	1,25*	0,3	4	18,2			11	11,5	14
24	**24**	12	14	1	13,2	36,7	23,5	12	10	1,25*	0,3	4	18,2			11	11,5	14
26	**26**	12	14	1	13,2	36,7	23,5	12	10	1,25*	0,3	4	20,8			11	11,5	14
28	**28**	12	14	1	13,2	36,7	23,5	12	10	1,25*	0,3	4	20,8			11	11,5	14
30	**30**	14	16	1	15,2	40,7	25,5	13	12	1,5	0,6	**	24,8		8	11	11,5	14,5
32	**32**	14	16	1	15,2	40,7	25,5	13	12	1,5	0,6	**	24,8		8	11	11,5	14,5
35	**35**	18	21	1,5	19,6	52,6	33	17	16	1,5	0,6	6	28,8		10	14	14,5	19
40	**40**	20	24	1,5	21,6	58,6	37	19	18	1,5	1	6	33,8		12	16	16,5	22
47	**47**	24	27	2	25,6	66,6	41	21	20	1,5	1	6	38,7		14	17,5	18	25
52	**52**	24	27	2	25,6	66,6	41	21	20	1,5	1	6	38,7		14	17,5	18	25
62	**62**	29	36	3	30,6	80,6	50	25	24	1,5	1	8	52	44	12	18	18,5	25,5
72	**72**	29	36	3	30,6	80,6	50	25	24	1,5	1	8	52	44	12	18	18,5	25,5
80	**80**	35	42	3	37	100,5	63,5	32	30	1,5	1	8	68	50	14	27	27,5	36
85	**85**	35	42	3	37	100,5	63,5	32	30	1,5	1	8	68	50	14	27	27,5	36
90	**90**	35	42	3	37	100,5	63,5	32	30	1,5	1	8	68	50	14	27	27,5	36

* These threads may be supplied with the old pitch of 1 mm (clamping torque 13 Nm).
** t=6 mm for followers 30 and 32 with screw driver slot.
t=4 mm for followers 30 and 32 with hexagonal socket.





GCR..EE, GCR..EEM

See note 2)

Basic capacities 3) Dyn. Cg NADELLA N	Limit loads 4) Dyn. F N	Stat. Fo N	Speed limits grease lubrication 5) r.p.m.	Clamping torque 6) Nm	Weight with nuts (approx.) g	Designations GCR... GCR...EE GCR...EEM
5 050	1 180	2 000	9 300	2	24	**16**
5 750	2 830	4 500	7 600	5	39	**19**
6 300	4 900	5 600	6 300	16	57	**22**
6 900	5 200	5 600	6 300	16	72	**24**
8 900	5 200	6 100	5 500	16	80	**26**
9 600	5 200	6 100	5 500	16	88	**28**
12 900	7 700	10 400	4 800	22	118	**30**
13 800	7 700	10 400	4 800	22	126	**32**
19 200	11 000	11 000	3 850	55	220	**35**
20 000	12 300	12 300	3 150	75	321	**40**
28 300	21 400	23 700	2 700	100	500	**47**
34 000	21 400	23 700	2 700	100	568	**52**
42 000	28 800	28 800	2 330	180	1 035	**62**
44 000	28 800	28 800	2 330	180	1 278	**72**
60 000	50 000	54 000	1 700	370	2 074	**80**
64 000	50 000	54 000	1 700	370	2 235	**85**
65 000	50 000	54 000	1 700	370	2 435	**90**

1) Under the suffix ...AK, NADELLA can supply on request followers with cylindrical outer ring GCL, GCL...EE, GCL...EEM, possessing a screw driver slot at the threaded end of the stud.

2) Followers with outer diameter up to 28 mm possess a screw driver slot.
Followers with outer diameter 30 to 52 mm possess a screw driver slot or hexagonal socket at the discretion of NADELLA, except where one or other type has been specifically requested.
Followers with outer diameter above 52 mm possess an hexagonal socket.

3) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

4) The load shown is limited by the strengths of the stud or outer ring.

5) With oil lubrication of followers without seals GC or GCL types, these speeds can be increased by 30% for continuous rotation or, up to 50% momentarily.

6) These torques are shown for dry threads. For lubricated threads, take 0,7 to 0,8 of these values.

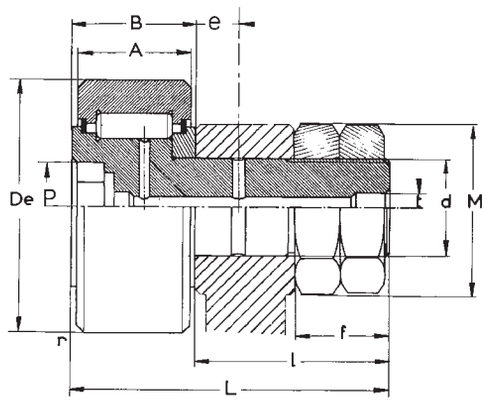
7) The eccentric collar is tightly fitted on the stud.

8) Minimum recommended abutment diameter.

Roller cam followers with threaded stud

GCU: convex outer ring
GCUL: cylindrical outer ring

GCU...MM series: with metal seals [5].



Outer Dia. De	Designations 1)	A	B maxi	d	L maxi	l maxi	f	Pitch	r mini	t	e	M 6)	P wrench size	
mm	GCU...MM	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	
35	**35**	18	19,7	16	52,5	32,8	17	1,5	0,6	6	8	26	10	
40	**40**	20	21,7	18	58,5	36,8	19	1,5	1	6	8	28,6	12	
47	**47**	24	25,7	20	66,5	40,8	21	1,5	1	6	9	33,6	14	
52	**52**	24	25,7	20	66,5	40,8	21	1,5	1	6	9	33,6	14	
62	**62**	29	30,7	24	80,5	49,8	25	1,5	1	6	11	38,9	12	
72	**72**	29	30,7	24	80,5	49,8	25	1,5	1,1	6	11	38,9	12	
80	**80**	35	37,2	30	100,5	63,3	32	1,5	1,1	8	15	51,8	14	
85	**85**	35	37,2	30	100,5	63,3	32	1,5	1,1	8	15	51,8	14	
90	**90**	35	37,2	30	100,5	63,3	32	1,5	1,1	8	15	51,8	14	
100	**100**	40	42,2	36	117,5	75,3	38	3	2	8	20	61	17	
110	**110**	40	42,2	36	117,5	75,3	38	3	2	8	20	61	17	
120	**120**	46	48,2	42	136,5	88,3	44	3	2	8	24	71	19	
130	**130**	46	48,2	42	136,5	88,3	44	3	2	8	24	71	19	

		Basic capacities 2) Dyn. Cg NADELLA N	Limit loads 3) Dyn. F N	Limit loads 3) Stat. Fo N	Speed limits grease lubrication r.p.m.	Clamping torque 4) Nm	Designations GCU...MM
		17 000	7 800	17 200	5 700	64	**35**
		20 000	11 500	22 000	5 200	90	**40**
		29 500	15 500	33 000	4 350	120	**47**
		36 500	21 500	40 000	4 350	120	**52**
		52 000	31 000	58 000	3 650	220	**62**
		63 000	31 000	58 000	3 650	220	**72**
		76 000	48 000	93 000	2 730	450	**80**
		86 000	50 000	93 000	2 730	450	**85**
		94 000	50 000	93 000	2 730	450	**90**
		115 000	76 000	142 000	2 300	740	**100**
		129 000	76 000	142 000	2 300	740	**110**
		150 000	120 000	200 00	1 990	1 200	**120**
		163 000	121 000	223 000	1 990	1 200	**130**

1) Under the suffix ...AK, NADELLA can supply on request followers with cylindrical outer ring GCUL...MM, possessing a screw driver slot at the threaded end of the stud.

2) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

3) The load shown is limited by the strengths of the stud or outer ring.

4) These torques are shown for dry threads. For lubricated threads, take 0,7 to 0,8 of these values.

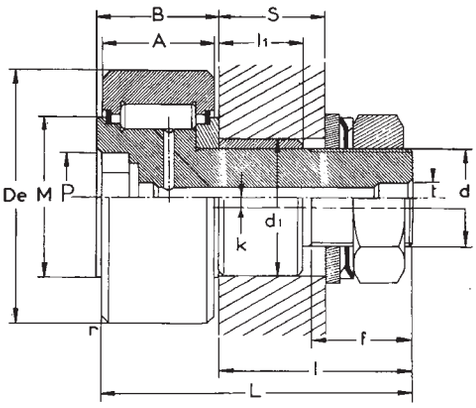
5) Roller followers without seals are available on request by cancelling the suffix ...MM on the designation.

6) Minimum recommended abutment diameter.

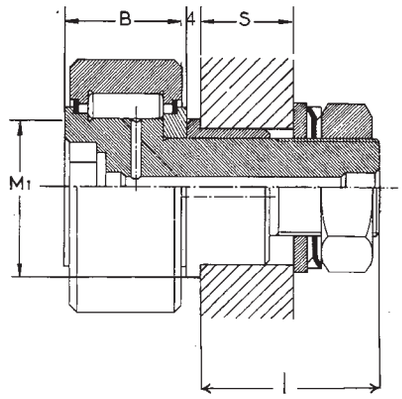
Eccentric roller cam followers with threaded stud

GCUR: convex outer ring
GCURL: cylindrical outer ring

GCUR...MM series: with metal seals. 6)



GCUR 35 – 52



GCUR 62 – 130

Outer Dia.	Designations 1)	A	d1 5)	k	B maxi	L maxi	l maxi	f	d	Pitch	r mini	t	M 7)	M1	P wrench size	l_1	S mini	S maxi	
mm	GCUR...MM	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	
35	**35**	18	21	1,5	19,7	52,5	32,8	17	16	1,5	0,6	6	26		10	14	14,5	19	
40	**40**	20	24	1,5	21,7	58,5	36,8	19	18	1,5	1	6	28,6		12	16	16,5	22	
47	**47**	24	27	2	25,7	66,5	40,8	21	20	1,5	1	6	33,6		14	17,5	18	25	
52	**52**	24	27	2	25,7	66,5	40,8	21	20	1,5	1	6	33,6		14	17,5	18	25	
62	**62**	29	36	3	30,7	80,5	49,8	25	24	1,5	1	6	38,9	44	12	18	18,5	25,5	
72	**72**	29	36	3	30,7	80,5	49,8	25	24	1,5	1,1	6	38,9	44	12	18	18,5	25,5	
80	**80**	35	42	3	37,2	100,5	63,3	32	30	1,5	1,1	8	51,8	50	14	27	27,5	36	
85	**85**	35	42	3	37,2	100,5	63,3	32	30	1,5	1,1	8	51,8	50	14	27	27,5	36	
90	**90**	35	42	3	37,2	100,5	63,3	32	30	1,5	1,1	8	51,8	50	14	27	27,5	36	
100	**100**	40	48	3	42,2	117,5	75,3	38	36	3	2	8	61	56	17	32	32,5	41	
110	**110**	40	48	3	42,2	117,5	75,3	38	36	3	2	8	61	56	17	32	32,5	41	
120	**120**	46	54	3	48,2	136,5	88,3	44	42	3	2	8	71	62	19	39	39,5	48	
130	**130**	46	54	3	48,2	136,5	88,3	44	42	3	2	8	71	62	19	39	39,5	48	

		Basic capacities 2)	Limit loads 3)		Speed limits grease lubrication	Clamping torque 4)	Designations
		Dyn. Cg NADELLA	Dyn. F	Stat. Fo			
		N	N	N	r.p.m.	Nm	GCUR...MM
		17 000	7 800	10 000	5 700	55	**35**
		20 000	10 900	10 900	5 200	75	**40**
		29 500	15 500	21 300	4 350	100	**47**
		36 500	21 300	21 300	4 350	100	**52**
		52 000	28 800	28 800	3 650	180	**62**
		63 000	28 800	28 800	3 650	180	**72**
		76 000	48 000	54 000	2 730	370	**80**
		86 000	50 000	54 000	2 730	370	**90**
		94 000	50 000	54 000	2 730	370	**90**
		115 000	76 000	83 000	2 300	610	**100**
		129 000	76 000	83 000	2 300	610	**110**
		150 000	120 000	130 000	1 990	1 000	**120**
		163 000	121 000	130 000	1 990	1 000	**130**

1) Under the suffix ...AK, NADELLA can supply on request followers with cylindrical outer ring GCURL...MM, possessing a screw driver slot at the threaded end of the stud.

2) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

3) The load shown is limited by the strengths of the stud or outer ring.

4) These torques are shown for dry threads. For lubricated threads, take 0,7 to 0,8 of these values.

5) The eccentric collar is tightly fitted on the stud.

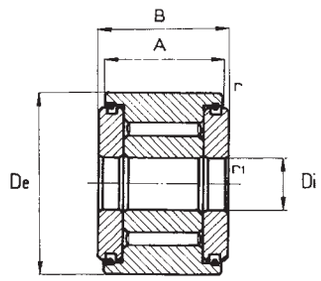
6) Roller followers without seals are available on request by cancelling the suffix ...MM on the designation.

7) Minimum recommended abutment diameter.

Small cam followers

(non separable inner and outer rings)
FP: convex outer ring
FPL: cylindrical outer ring

FP series: without seals



Outer Dia. De mm	Designations 1) FP	Di mm	A mm	B maxi mm	r mini mm	rl mini mm	M 2) mini mm	
10	**3 10**	3	8	8,7	0,2	0,15	8,4	
11	**3 11**	3	8	8,7	0,2	0,15	8,4	
12	**4 12**	4	9	9,7	0,2	0,15	10,3	
13	**4 13**	4	9	9,7	0,2	0,15	10,3	
14	**4 14**	4	9	10,2	0,3	0,15	11,8	
15	**4 15**	4	9	10,2	0,3	0,15	11,8	

	Basic capacities for bearings 3)		for followers 4)		Limit loads 5)		Speed limits grease lubrication 6)	Designations
	Dyn. C ISO N	Dyn. C NADELLA N	Stat. Co N	Dyn. Cg N	Dyn. F N	Stat. Fo N	r.p.m.	FP
	2 380	2 700	2 800	2 130	1 160	2 050	13 800	**3 10**
	2 380	2 700	2 800	2 480	1 680	2 520	13 800	**3 11**
	3 200	3 650	4 400	2 980	1 820	3 350	11 400	**4 12**
	3 200	3 650	4 400	3 350	2 450	3 950	11 400	**4 13**
	3 500	3 950	5 050	3 500	2 550	4 350	10 100	**4 14**
	3 500	3 950	5 050	3 750	3 200	4 750	10 100	**4 15**

1) For followers with cylindrical outer ring, designation: FPL.

2) Minimum recommended abutment diameter.

3) These capacities are to be used only for followers FPL, when the cylindrical outer ring is mounted in a housing.

4) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

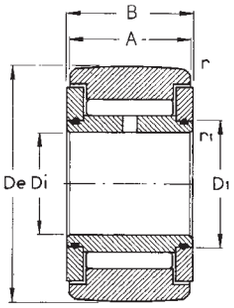
5) The load shown is limited by the strength of the outer ring when mounted in a housing.

6) With oil lubrication of followers without seals FP or FPL types, these speeds can be increased by 30% for continuous rotation or, up to 50% momentarily.

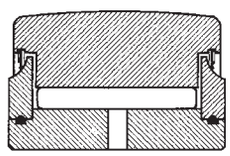
Cam followers

(non separable inner and outer rings)

FG, FG...EE, FG...EEM series:
convex outer ring
FGL, FGL...EE, FGL...EEM series:
cylindrical outer ring



FG



FG...EE. FG...EEM

Outer Dia. mm	Designations followers with convex outer ring 1) without seals FG Series	with plastic seals FG...EE Series	with metal seals FG...EEM Series	Di mm	A mm	B maxi mm	D1 mm	M 2) mini mm	r mini mm	r1 mini mm
16	5 16	5 16	5 16	5	11	12	7,1	10	0,3	0,3
19	6 19	6 19	6 19	6	11	12	8,5	12	0,3	0,3
24	8 24 6)	8 24		8	12	13	10,8	14,5	0,3	0,3
24	8 24 15	8 24 15	8 24 15	8	14	15	10,8	14,5	0,3	0,3
30	10 30	10 30	10 30	10	14	15	13,8	19,5	0,6	0,3
32	12 32	12 32	12 32	12	14	15	16	21,5	0,6	0,3
35	15 35	15 35	15 35	15	18	19	18,7	24	0,6	0,3
40	17 40	17 40	17 40	17	20	21	22	28	0,6	0,3
47	20 47	20 47	20 47	20	24	25	25,7	32,5	1	0,3
52	25 52	25 52	25 52	25	24	25	30,5	37	1	0,3
62	30 62	30 62	30 62	30	28	29	35,2	44	1	0,3
72	35 72	35 72	35 72	35	28	29	41	50	1	0,6
80	40 80	40 80	40 80	40	30	32	46,7	56	1	0,6
85	45 85	45 85	45 85	45	30	32	52,4	62	1	0,6
90	50 90	50 90	50 90	50	30	32	59,1	69	1	0,6
100	55 100		55 100	55	34	36	65	75	1,5	0,6
110	60 110		60 110	60	34	36,2	70	82	1,5	0,6
120	65 120		65 120	65	40	42	74	90	1,5	0,6
125	70 125		70 125	70	40	42	79	92	1,5	0,6
130	75 130*		75 130*	75	40	42	84	96	1,5	0,6
140	80 140		80 140	80	46	48	92	105	2	1
150	85 150*		85 150*	85	46	48	99	112	2	1
160	90 160		90 160	90	52	54	105	120	2	1
170	95 170*		95 170*	95	52	54	110	125	2	1
180	100 180		100 180	100	63	65	116	135	2	1,5
200	110 200*		110 200*	110	63	65	128	150	2	1,5
215	120 215		120 215	120	63	65	138	160	2	1,5
230	130 230*		130 230*	130	75	78	147	170	3	1,5
250	140 250		140 250	140	75	78	158	180	3	1,5
270	150 270*		150 270*	150	75	78	170	195	3	1,5

* on request

		Basic capacities 3) Dyn. Cg NADELLA N	limit loads 4) Dyn. F N	Stat. Fo N	Speed limits grease lubrication 5) r.p.m.	Weight approx. g	Designations FG... FG...EE FG...EEM
		5 050	3 250	5 400	9 300	16	**5 16**
		5 800	4 050	6 700	7 600	19	**6 19**
		6 900	6 600	9 200	6 300	37	**8 24 6)**
		8 700	8 500	12 300	6 300	44	**8 24 15**
		12 900	8 500	15 500	4 800	66	**10 30**
		12 900	8 300	16 200	4 200	77	**12 32**
		18 000	12 200	25 600	3 750	103	**15 35**
		22 300	14 200	31 000	3 150	155	**17 40**
		28 300	21 400	44 500	2 700	295	**20 47**
		29 000	23 600	48 000	2 330	310	**25 52**
		38 500	38 000	73 000	2 050	490	**30 62**
		43 500	49 000	90 000	1 800	670	**35 72**
		54 000	66 000	123 000	1 620	890	**40 80**
		53 000	69 000	125 000	1 450	970	**45 85**
		51 000	74 000	123 000	1 300	1 040	**50 90**
		60 000	88 000	142 000	1 150	1 350	**55 100**
		67 000	102 000	168 000	1 090	1 650	**60 110**
		83 000	135 000	223 000	1 020	2 350	**65 120**
		83 000	144 000	228 000	960	2 500	**70 125**
		84 000	155 000	234 000	910	2 650	**75 130***
		99 000	197 000	275 000	820	3 400	**80 140**
		105 000	220 000	300 000	770	4 000	**85 150***
		120 000	288 000	370 000	710	5 300	**90 160**
		129 000	302 000	410 000	690	6 000	**95 170***
		175 000	353 000	530 000	650	8 050	**100 180**
		189 000	420 000	600 000	590	10 000	**110 200***
		199 000	486 000	660 000	550	11 500	**120 215**
		255 000	560 000	820 000	510	15 500	**130 230***
		280 000	630 000	930 000	480	18 500	**140 250**
		290 000	710 000	1 020 000	440	22 000	**150 270***

1) For followers with cylindrical outer ring, designation: FGL...EE, FGL..EEM.

2) Minimum recommended abutment diameter.

3) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

4) The load shown is limited by the strength of the outer ring when mounted in a housing.

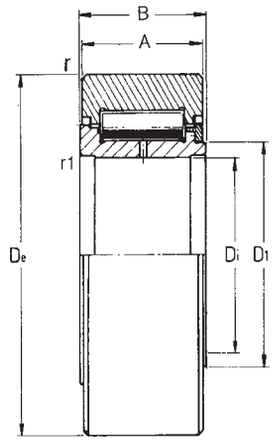
5) With oil lubrication of followers without seals FG, FGL types, these speeds can be increased by 30% for continuous rotation or, up to 50% momentarily.

6) Special followers, for replacement only. For new applications, use the FG 8 24 15.

Roller cam followers

(non separable inner and outer rings)
FGU: convex outer ring
FGUL: cylindrical outer ring

Light series
FGU...MM series:
with metal seals



Outer Dia.	Designations 1)	Di	A	B maxi	D1 mini	M 2) mini	r mini	r1 mini	
mm	FGU...MM	mm	mm	mm	mm	mm	mm	mm	
35	**15 35**	15	18	19	19	25,4	0,6	0,3	
40	**17 40**	17	20	21	22	28	0,6	0,3	
47	**20 47**	20	24	25	25,8	33,5	1	0,3	
52	**25 52**	25	24	25	30	38,2	1	0,3	
62	**30 62**	30	28	29	36,8	45,9	1	0,3	
72	**35 72**	35	28	29	44	53,6	1	0,6	
80	**40 80**	40	30	32	49,5	59,3	1	0,6	
85	**45 85**	45	30	32	54	63,1	1	0,6	
90	**50 90**	50	30	32	59,5	68,8	1	0,6	
100	**55 100**	55	34	36	64	75,8	1,5	0,6	
110	**60 110**	60	34	36	69,5	81,5	1,5	0,6	
120	**65 120**	65	40	42	74,5	86,7	1,5	0,6	
125	**70 125**	70	40	42	79,6	91,8	1,5	0,6	
130	**75 130**	75	40	42	84	97	1,5	0,6	
140	**80 140**	80	46	48	90	102	2	1	
150	**85 150**	85	46	48	94	108,5	2	1	
160	**90 160**	90	52	54	100	114,7	2	1	
170	**95 170**	95	52	54	106,7	121,2	2	1	
180	**100 180**	100	63	65	113	127,6	2	1,5	
200	**110 200**	110	63	65	122	137	2	1,5	
215	**120 215**	120	63	65	132	149,3	2	1,5	
230	**130 230**	130	75	78	143	160,6	3	1,5	
250	**140 250**	140	75	78	151	168	3	1,5	
270	**150 270**	150	75	78	162	179,5	3	1,5	

		Basic capacities 3) Dyn. Cg NADELLA N	limit loads 4) Dyn. F N	Stat. Fo N	Speed limits grease lubrication r.p.m.	Designations FGU...MM
		17 000	7 800	17 000	5 700	**15 35**
		20 000	11 500	21 500	5 200	**17 40**
		29 500	15 500	32 300	4 350	**20 47**
		31 500	17 300	36 000	3 800	**25 52**
		44 500	24 500	540 000	3 150	**30 62**
		50 000	31 300	66 000	2 700	**35 72**
		59 000	40 600	84 000	2 440	**40 80**
		62 000	45 000	91 000	2 290	**45 85**
		62 000	49 000	94 000	2 100	**50 90**
		79 000	53 400	109 000	1 900	**55 100**
		88 000	64 000	129 000	1 770	**60 110**
		110 000	89 000	174 000	1 650	**65 120**
		110 000	93 000	180 000	1 570	**70 125**
		112 000	97 000	185 000	1 480	**75 130**
		138 000	130 000	250 000	1 400	**80 140**
		158 000	130 000	258 000	1 330	**85 150**
		188 000	166 000	327 000	1 250	**90 160**
		198 000	184 000	356 000	1 190	**95 170**
		250 000	250 000	490 000	1 130	**100 180**
		280 000	310 000	590 000	1 050	**110 200**
		310 000	310 000	600 000	960	**120 215**
		375 000	406 000	790 000	890	**130 230**
		420 000	490 000	920 000	850	**140 250**
		445 000	560 000	1 030 000	800	**150 270**

1) For followers with cylindrical outer ring, designation: FGUL...MM.

2) Minimum recommended abutment diameter.

3) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

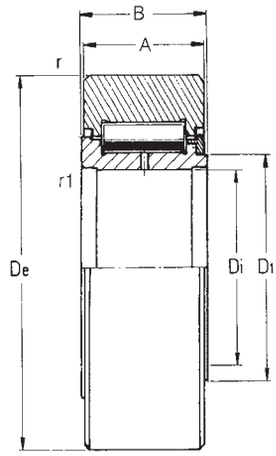
4) The load shown is limited by the strength of the outer ring when mounted in a housing.

Roller cam followers

(non separable inner and outer rings)

FGU: convex outer ring
FGUL: cylindrical outer ring

Heavy series
FGU...MM series: with metal seals



Outer Dia.	Designations 1)	Di	A	B maxi	D1 mini	M 2) mini	r mini	r1 mini	
mm	FGU...MM	mm	mm	mm	mm	mm	mm	mm	
42	**15 42**	15	18	19	19	25,4	1	0,3	
47	**17 47**	17	20	21	22	28	1	0,3	
52	**20 52**	20	24	25	25,8	33,5	1	0,3	
62	**25 62**	25	24	25	30	38,2	1	0,3	
72	**30 72**	30	28	29	36,8	45,9	1	0,3	
80	**35 80**	35	28	29	44	53,6	1	0,6	
90	**40 90**	40	30	32	49,5	59,3	1	0,6	
100	**45 100**	45	30	32	54	63,1	1,5	0,6	
110	**50 110**	50	30	32	59,5	68,8	1,5	0,6	
120	**55 120**	55	34	36	64	75,8	1,5	0,6	
130	**60 130**	60	34	36	69,5	81,5	1,5	0,6	
140	**65 140**	65	40	42	74,5	86,7	2	0,6	
150	**70 150**	70	40	42	79,6	91,8	2	0,6	
160	**75 160**	75	40	42	84	97	2	0,6	
170	**80 170**	80	46	48	90	102	2	1	
180	**85 180**	85	46	48	94	108,5	2	1	
190	**90 190**	90	52	54	100	114,7	2	1	
200	**95 200**	95	52	54	106,7	121,2	2	1	
215	**100 215**	100	63	65	113	127,6	2	1,5	
240	**110 240**	110	63	65	122	137	3	1,5	
260	**120 260**	120	63	65	132	149,3	3	1,5	
280	**130 280**	130	75	78	143	160,6	3	1,5	
300	**140 300**	140	75	78	151	168	3	1,5	
320	**150 320**	150	75	78	162	179,5	3	1,5	

		Basic capacities 3) Dyn. Cg NADELLA N	Limit loads 4) Dyn. F N	Stat. Fo N	Speed limits grease lubrication r.p.m.	Designations FGU...MM
		24 000	16 500	27 000	5 700	**15 42**
		26 700	22 000	32 000	5 200	**17 47**
		36 500	23 700	42 500	4 350	**20 52**
		44 000	34 400	57 000	3 800	**25 62**
		60 000	43 400	80 000	3 150	**30 72**
		62 000	45 600	88 000	2 700	**35 80**
		75 000	61 000	116 000	2 440	**40 90**
		85 000	78 000	138 000	2 290	**45 100**
		91 000	91 000	157 000	2 100	**50 110**
		113 000	98 000	176 000	1 900	**55 120**
		121 000	114 000	197 000	1 770	**60 130**
		145 000	153 000	254 000	1 650	**65 140**
		153 000	172 000	277 000	1 570	**70 150**
		160 000	193 000	300 000	1 480	**75 160**
		190 000	247 000	380 000	1 400	**80 170**
		215 000	243 000	390 000	1 330	**85 180**
		250 000	297 000	480 000	1 250	**90 190**
		259 000	317 000	510 000	1 190	**95 200**
		325 000	446 000	700 000	1 130	**100 215**
		345 000	550 000	770 000	1 050	**110 240**
		395 000	570 000	830 000	960	**120 260**
		480 000	760 000	1 100 000	890	**130 280**
		500 000	860 000	1 160 000	850	**140 300**
		515 000	940 000	1 250 000	800	**150 320**

1) For followers with cylindrical outer ring, designation: FGUL...MM.

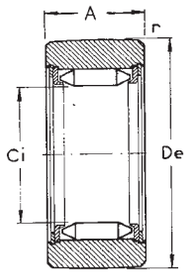
2) Minimum recommended abutment diameter.

3) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

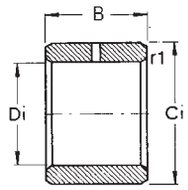
4) The load shown is limited by the strength of the outer ring when mounted in a housing.

Cam followers without inner ring

RNA...B6, RNAB, RNAL Series: without seals



RNA...B6



BIC

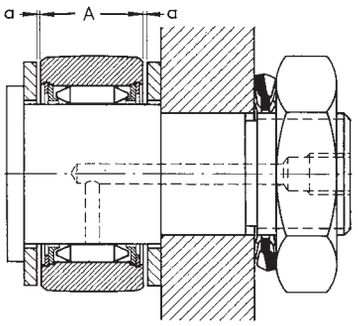
Outer Dia.	Designations			Ci	De	A		r		Basic capacities 1) Dyn. Cg NADELLA
						nom.	tol.	mini		
mm	RNA...B6 Series	RNAB Series	RNAL Series	mm	mm	mm	mm	mm		N
19	**11 005 B6**	**11 005**	**11 005**	7,3	19	12	0 - 0,10	0,35	19	5 100
22	**11 007 B6**	**11 007**	**11 007**	9,7	22	12	0 - 0,10	0,35	25	6 000
24	**14 601 B6**	**14 601**	**14 601**	12,1	24	12	0 - 0,10	0,35	27	6 200
28	**11 009 B6**	**11 009**	**11 009**	12,1	28	12	0 - 0,10	0,35	42	7 400
32	**11 012 B6**	**11 012**	**11 012**	17,6	32	15	- 0,20 - 0,30	0,35	57	10 800
35	**11 015 B6**	**11 015**	**11 015**	20,8	35	15	- 0,20 - 0,30	0,65	62	10 800
42	**11 017 B6**	**11 017**	**11 017**	23,9	42	15	- 0,20 - 0,30	0,65	98	13 400
47	**11 020 B6**	**11 020**	**11 020**	28,7	47	18	- 0,20 - 0,30	0,65	133	16 800
52	**11 025 B6**	**11 025**	**11 025**	33,5	52	18	- 0,20 - 0,30	0,65	152	17 200
62	**11 030 B6**	**11 030**	**11 030**	38,2	62	22	- 0,20 - 0,30	0,65	275	28 500
72	**11 035 B6**	**11 035**		44	72	22	- 0,22 - 0,34	0,65	370	32 000
80	**11 040 B6**	**11 040**		49,7	80	22	- 0,22 - 0,34	0,85	450	34 000
85	**11 045 B6**	**11 045**		55,4	85	22	- 0,22 - 0,34	0,85	480	33 500
90	**11 050 B6**	**11 050**		62,1	90	24	- 0,22 - 0,34	0,85	540	32 500

RNA...B6: Convex outer ring to maximum slope of 0.15%. Tolerance h9 on dim. DE.

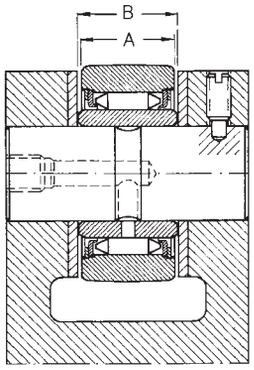
RNAB: Convex outer ring to maximum slope of 1.5%. Tolerance h9 on dim. DE.

RNAL: Cylindrical outer ring. Tolerance h7 on dim. DE.

Example of mounting*



Total axial play: 2a=0.2 mm. approx.



Example of mounting*

Inner rings

Limit loads 2) Dyn. F N	Limit loads 2) Stat. Fo N	Speed limits grease lubrication 3) r.p.m.		Shaft Dia. mm	Designation BIC	Di mm	Ci mm	B nom. mm	B tol. mm	r1 mini mm		For follower
4 050	4 050	8 700										
5 100	5 200	7 000										
4 700	5 600	5 800										
7 100	7 100	5 800										
9 100	12 700	4 200		**12**	**BIC 1012**	12	17,6	15	$^{0}_{-0,10}$	0,35	16	11 012
9 100	13 400	3 650		**15**	**BIC 1015**	15	20,8	15	$^{0}_{-0,10}$	0,65	18	11 015
13 900	18 500	3 200		**17**	**BIC 1017**	17	23,9	15	$^{0}_{-0,10}$	0,65	26	11 017
15 400	23 000	2 700		**20**	**BIC 2020**	20	28,7	18	$^{0}_{-0,10}$	0,65	46	11 020
16 500	24 700	2 330		**25**	**BIC 1025**	25	33,5	18	$^{-0}_{-0,10}$	0,65	54	11 025
31 500	49 500	2 050		**30**	**BIC 2030**	30	38,2	22	$^{-0}_{-0,10}$	0,65	74	11 030
41 000	61 000	1 800		**35**	**BIC 2035**	35	44	22	$^{-0}_{-0,12}$	0,65	93	11 035
47 000	68 000	1 620		**40**	**BIC 2040**	40	49,7	22	$^{-0}_{-0,12}$	0,85	115	11 040
47 500	69 000	1 450		**45**	**BIC 2045**	45	55,4	22	$^{-0}_{-0,12}$	0,85	139	11 045
51 000	68 000	1 300		**50**	**BIC 11 050**	50	62,1	24	$^{-0}_{-0,12}$	0,85	196	11 050

1) These capacities are to be used for all types when the cylindrical or convex outer ring rotates directly on a cam. They take account of the repetitive loads on the follower and consequent elastic deformation of the outer ring.

2) The load shown is limited by the strength of the outer ring when mounted in a housing.

3) With oil lubrication of followers, these speeds can be increased by 30% for continuous rotation or, up to 50% momentarily.

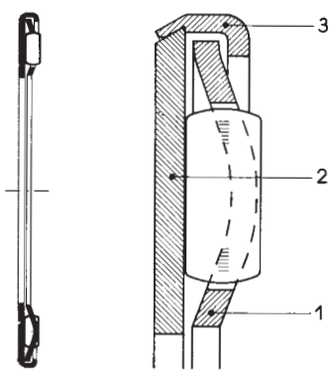
* Stud not delivered by NADELLA.

NEEDLE THRUST BEARINGS-
ROLLER THRUST BEARINGS

AX + CP AR + CPR AXZ ARZ

The rolling elements of a thrust bearing are retained and guided in radial pockets within the cage (1). The latter is itself retained in relation to the plate (2) by means of a steel ring (3). This assembly of parts is easy to handle and install and provides a high axial load capacity whilst occupying minimal space.

The design of NADELLA thrust bearings serves to reduce to a minimum the friction between the rolling elements and the cage that guides them. Given correct installation and adequate oil lubrication, the coefficient of friction will be between 0.003 and 0.004 for needle thrust bearings and between 0.004 and 0.005 for roller thrust bearings.

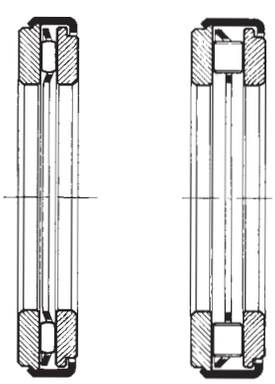


This result is due principally to the design of the one-piece steel cage (1) which has a special curvature that guides the rolling elements by their ends along their centre-lines. Thus, the loads imposed on the cage by the rollers cannot create components parallel to the axis of rotation and therefore no increase in internal friction is generated, and correct operation without wear or overheating is ensured. In addition, this special curvature gives the steel cage great rigidity and being relatively thin provides maximum space for the lubricant.

THRUST PLATES

The plate incorporated in the thrust bearing is made from hardened bearing steel and forms one of the raceways for the rolling elements. The opposing raceway is generally provided by a separate thrust plate of similar design supplied by NADELLA. When the thrust bearing is centred by the revolving part, the thrust plate must be centred by the stationary part and *vice versa*. If the revolving part and the stationary part are noticeably eccentric to each other, the thrust bearing with integral plate must without exception be centred by the revolving part.

The second raceway for the rolling elements may also be formed by the face of a shoulder or an inserted ring, provided these have the correct geometrical dimensions and hardness.



AXZ ARZ

THRUST BEARINGS WITH TWO THRUST PLATES

Thrust bearings type AXZ and ARZ have two thrust plates retained by a steel ring giving protection against the entry of dirt and metal particles whilst at the same time assisting retention of the lubricant.

INTERMEDIATE PLATES

To ensure correct axial positioning in both directions, needle thrust bearings or roller thrust bearings may be mounted as a pair in a bearing arrangement on either side of a common intermediate plate, each face of which forms the second raceway for one of the thrust bearings. NADELLA manufactures two series of intermediate plates in hardened bearing-steel. One series to match needle thrust bearings type AX (both thick or thin) and the other to match roller thrust bearings type AR (light series).

The intermediate plates in the PM series may be used under normal loads without risk of excessive deflection. They can be centred on the shaft, the thrust bearings being centred in the housing, or *vice versa.*

Where heavy loads are involved, particularly when using roller thrust bearings type AR (light series), it is advisable to employ intermediate plates of the PMH series. The thickness and deep supporting surface of this plate gives better axial rigidity. PMH series plates are intended to be centred in the housing. They have radial holes (linked by an exterior groove) allowing oil to reach the bore of the thrust bearings, thereby ensuring effective circulation of lubricant by centrifugal force.

OPERATION

When the ring of rolling elements begins to rotate, it is automatically centred in relation to the shaft axis. Thus the thrust bearing does not need to be precisely centred by the incorporated plate. Hence it is possible to align the bearing (on the shaft or in the housing) allowing wide tolerances to be used and without surface hardening. This enables costs to be reduced. The same feature applies to centring of the thrust plate.

TYPES OF THRUST BEARING

<table>
<tr><th>Thrust bearings with incorporated plate</th><th>Separate thrust plates</th><th>Intermediate plates</th><th>Thrust bearings with two thrust plates</th></tr>
<tr><td>Needle thrust bearings
AX – Thin Series
AX – Thick Series</td><td rowspan="2">CP – Thin Series
CP – Thick Series</td><td rowspan="2">PM without oil hole

PMH with oil hole</td><td>Needle thrust bearings
AXZ Thick Series</td></tr>
<tr><td>Roller thrust bearings
AR – Light Series</td><td rowspan="2">Roller thrust bearings
ARZ Light Series
ARZ Heavy Series</td></tr>
<tr><td>AR 812 Series
AR – Heavy Series</td><td>CPR 812 Series
CPR – Heavy Series</td><td></td></tr>
</table>

Needle thrust bearings with a thin plate are of minimal thickness and are particularly economic to use. They should be considered whenever the degree of support and rotational accuracy permits.

Standard needle thrust bearings with a thick plate and standard roller thrust bearings provide rotational accuracy and axial run-out equal to or better than class 6 according to ISO Standard 199 for ball thrust bearings. They can be supplied in High Precision "HP" quality providing a precision grade superior to that of class 5.

THICKNESS AND AXIAL RUN-OUT TOLERANCES

	Bore Di mm	Thickness tolerance µm	Axial run-out µm		
Needle thrust bearings (thin)	Di ≤ 60	+ 30 /- 40 [1]	20 [1]		
	60 < Di ≤ 90	+ 50 /- 60 [2]	25 [2]		
	90 < Di ≤ 120	+ 50 /- 60 [2]	30 [2]		
Needle thrust bearings (thick) Roller thrust bearings	Di ≤ 60	+ 30 /- 30 [1]	20 [1]	Quality	
	60 < Di ≤ 90	+ 50 /- 50 [2]	25 [2]		
	90 < Di ≤ 120	+ 50 /- 50 [2]	30 [2]	HP	HSP
Thrust plates (thin)	Di ≤ 120	+ 50 /- 60	5*	2	1
	120 < Di ≤ 180	+ 50 /- 110	7*	3	1,5
	180 < Di ≤ 250	+ 50 /- 160	10*	4	2
Thrust plates (thick) Intermediate plates	Di ≤ 120	+ 50 /- 50	5*	2	1
	120 < Di ≤ 180	+ 50 /- 100	7*	3	1,5
	180 < Di ≤ 250	+ 50 /- 150	10*	4	2

* HP quality

1) Under min. load of 150 N

2) Under min. load of 250 N

SUPPORTING FACES

For smooth running operation of needle or roller thrust bearings, it is necessary that their supporting faces should be parallel.

For a thrust bearing with intermediate thrust plate, the permissible degree of deviation from true parallelism between the two supporting faces should be no more than 1 min. (or approx. 0.3 per 1 000).

For a thrust bearing without intermediate thrust plate, the deviation must be no more than 1 min 30. sec. (or approx. 0.45 per 1 000).

Thin needle thrust bearings and thin thrust plates must be supported on a flat, rigid and continuous face throughout the area of circulation of the needles bounded by dimensions d_1 and d_2.

Thick needle thrust bearings and thick thrust plates can be supported on a more restricted or discontinuous shoulder, provided that the deflection of the plate under load does not endanger the smooth operation of the thrust bearing or the axial run-out required.

Since roller thrust bearings generally run under considerable loads, their incorporated plate and thrust plate should be supported on a shoulder covering the whole area of circulation of the rollers bounded by dimensions d_1 and d_2.

Where an application does not involve the use of a thrust plate, the surface forming the second raceway must:
– extend at least across the whole area of circulation of the rolling elements between dimensions d_1 and d_2; and,
– possess a suitable surface finish (≦ 0.5 µm C.L.A.) and sufficient hardness in relation to the load to be supported. A hardness of 58–64 HRC enables thrust bearings to carry their full load capacity. Lower hardness values reduce the capacities shown in the tables of dimensions (see Technical Section).

TOLERANCES FOR CENTRING SUPPORTS

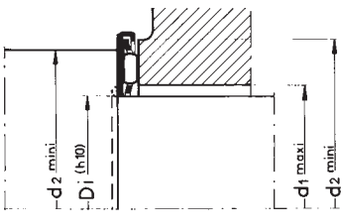
▶ *Centring on the shaft:* h10 on dimensions Di for thrust bearings or thrust plates or dimension d for intermediate plates.

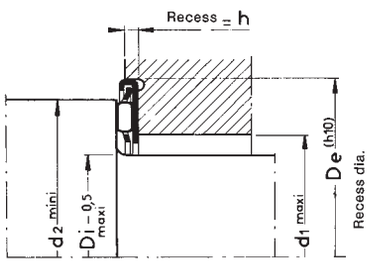
▶ *Centring in the housing:* H10 on dimension De for thrust bearings or dimension B for thrust plates and dimension D for intermediate plates.

MOUNTING ARRANGEMENTS

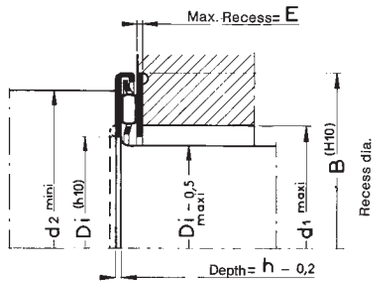
Needle thrust bearings with incorporated thin plate

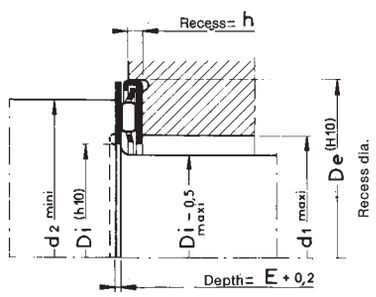
without thrust plate



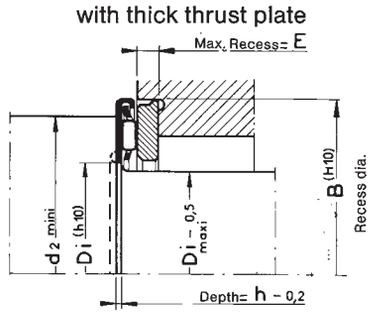


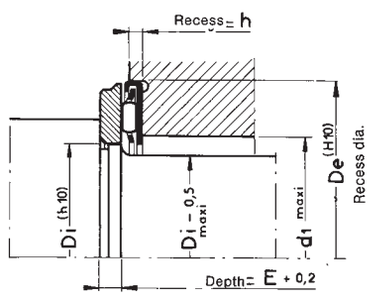
with thin thrust plate





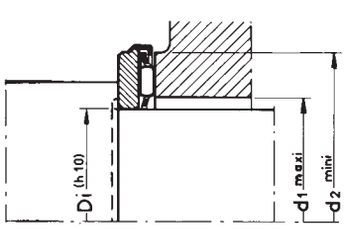
with thick thrust plate

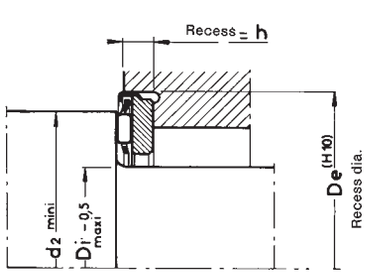




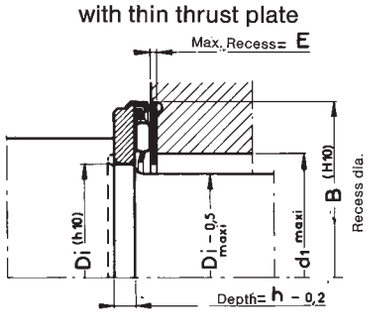
Needle thrust bearings with thin plate or light series roller thrust bearings

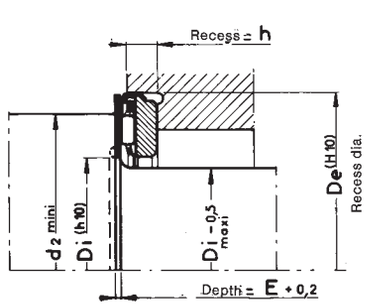
without thrust plate



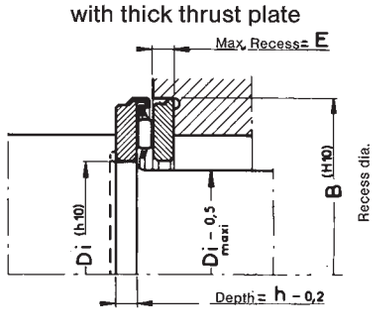


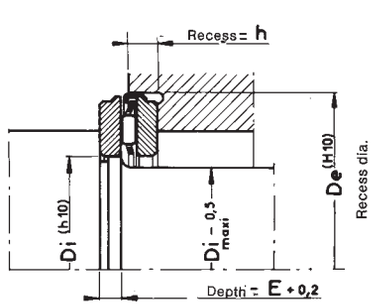
with thin thrust plate



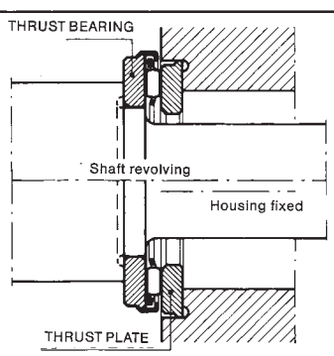


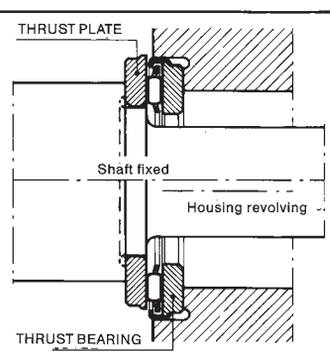
with thick thrust plate





Mounting for eccentric operation

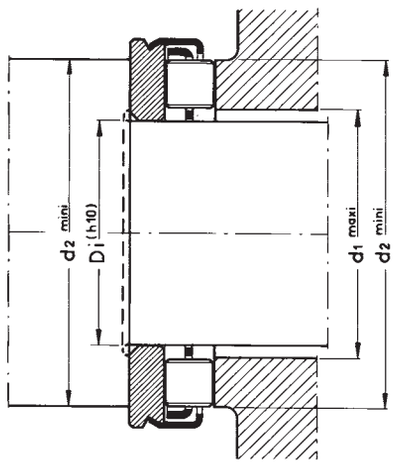


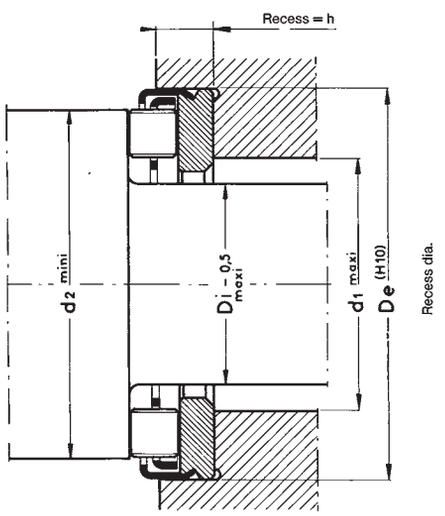


MOUNTING ARRANGEMENTS

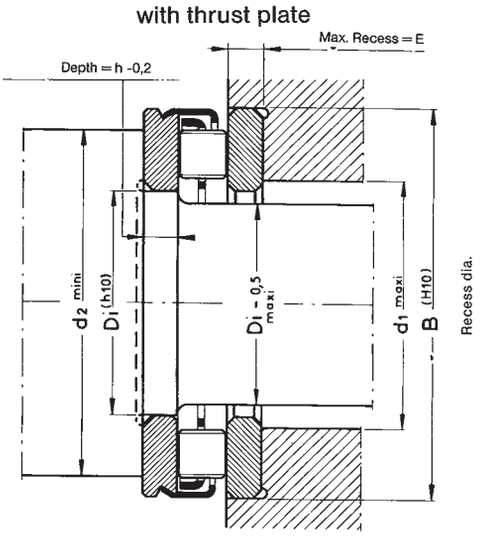
Roller thrust bearings AR 812 and heavy series

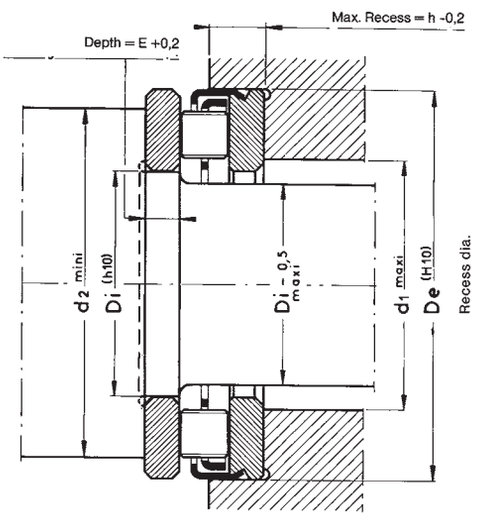
without thrust plate





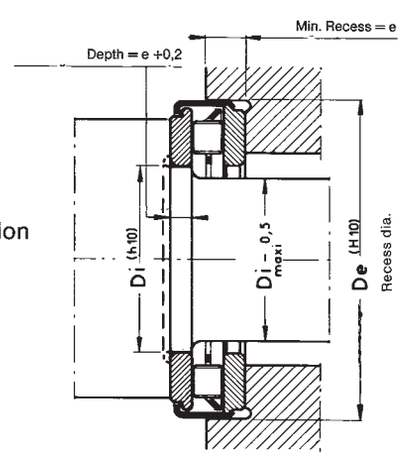
with thrust plate

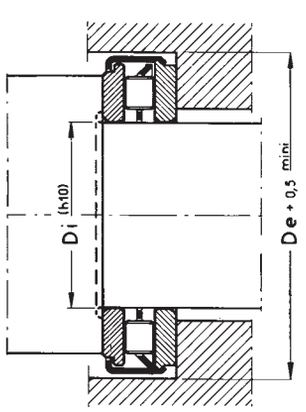




Needle thrust bearings AXZ or roller thrust bearings ARZ

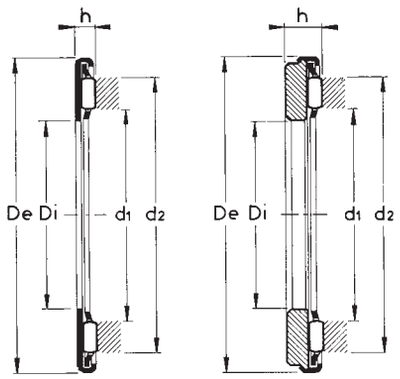
Mounting for high speed rotation





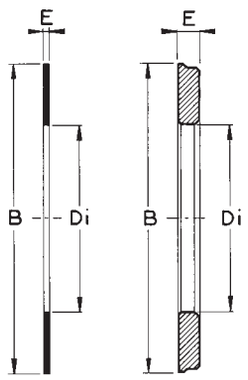
Mounting for slow speed rotation or oscillating motion

Needle thrust bearings
AX thin and thick series



Shaft Dia. mm	Designations AX Thin Series	Designations AX Thick Series	Di nom. mm	De max. mm	h mm	d1 mm	d2 mm	Basic capacities Dyn. Ca N	Basic capacities Stat. Coa N	Speed limit r.p.m.	Weight approx. g
5	AX 5 13		5	13	2,3	6,3	10,9	3 000	5 700	25 000	1,3
		AX 3,5 5 13	5	13	3,5	6,3	10,9	3 000	5 700	25 000	2,3
6	AX 6 14		6	14	2,3	7,3	11,9	3 150	6 350	22 000	1,4
		AX 3,5 6 14	6	14	3,5	7,3	11,9	3 150	6 350	22 000	2,4
7	AX 7 15		7	15	2,3	8,3	12,9	3 550	7 600	22 000	1,7
		AX 3,5 7 15	7	15	3,5	8,3	12,9	3 550	7 600	22 000	2,9
8	AX 8 16		8	16	2,3	9,3	13,9	3 700	8 300	22 000	1,7
		AX 3,5 8 16	8	16	3,5	9,3	13,9	3 700	8 300	22 000	3
9	AX 9 17		9	17	2,3	10,3	14,9	4 050	9 500	19 000	2,1
		AX 3,5 9 17	9	17	3,5	10,3	14,9	4 050	9 500	19 000	3,6
10	AX 10 22		10	22	2,8	12	18,6	5 000	10 900	15 500	4
		AX 4 10 22	10	22	4	12	18,6	5 000	10 900	15 500	6,6
12	AX 12 26		12	26	2,8	15	22,6	6 900	17 700	13 000	6
		AX 4 12 26	12	26	4	15	22,6	6 900	17 700	13 000	10
13	AX 13 26		13	26	2,8	15	22,6	6 900	17 700	13 000	6
		AX 4 13 26	13	26	4	15	22,6	6 900	17 700	13 000	9,8
15	AX 15 28		15	28	2,8	17	24,6	7 400	20 000	11 500	6,9
		AX 4 15 28	15	28	4	17	24,6	7 400	20 000	11 500	9
17	AX 17 30		17	30	2,8	19	26,6	7 800	22 000	10 500	7,6
		AX 4 17 30	17	30	4	19	26,6	7 800	22 000	10 500	10
19	AX 19 32		19	32	2,8	21	28,6	8 000	23 300	10 000	8,6
		AX 4 19 32	19	32	4	21	28,6	8 000	23 300	10 000	13
20	AX 20 35		20	35	2,8	22	31,6	11 800	39 000	9 000	10,2
		AX 5 20 35	20	35	5	22	31,6	11 800	39 000	9 000	18
25	AX 25 42		25	42	2,8	27,7	37,4	13 300	49 000	7 500	11,5
		AX 5 25 42	25	42	5	27,7	37,4	13 300	49 000	7 500	25
27	AX 27 44		27	44	2,8	30	39,6	13 700	52 000	7 200	12,1
30	AX 30 47		30	47	2,8	32,7	42,4	14 500	57 000	6 500	13,7
		AX 5 30 47	30	47	5	32,7	42,4	14 500	57 000	6 500	29
35	AX 35 52		35	52	2,8	37,2	49	18 900	84 000	5 500	18,5
		AX 5 35 52	35	52	5	37,2	49	18 900	84 000	5 500	35
	AX 35 53		35	53	2,8	37,2	49	18 900	84 000	5 500	19,3
		AX 5 35 53	35	53	5	37,2	49	18 900	84 000	5 500	36
40	AX 40 60		40	60	2,8	43	54,9	20 400	96 000	5 000	23,9
		AX 5 40 60	40	60	5	43	54,9	20 400	96 000	5 000	46
45	AX 45 65		45	65	2,8	48	59,9	21 800	109 000	4 500	24,7
		AX 5 45 65	45	65	5	48	59,9	21 800	109 000	4 500	50

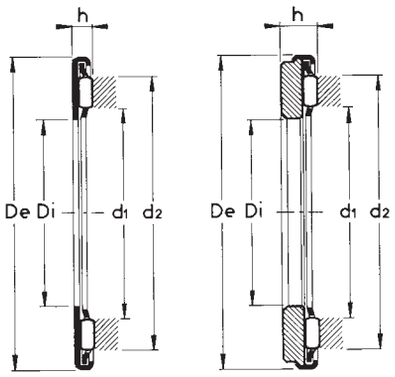
Thrust plates
CP thin and thick series



Shaft Dia.	Designations		Di nom.	B max.	E	Weight approx.	Thrust bearings	
mm	CP Thin Series	CP Thick Series	mm	mm	mm	g	AX Thin Series	AX Thick Series
5	CP 5 13	CP 2 5 13	5 5	12,4 12,4	0,8 2	0,6 1,6	AX 5 13	AX 3,5 5 13
6	CP 6 14	CP 2 6 14	6 6	13,4 13,4	0,8 2	0,7 1,7	AX 6 14	AX 3,5 6 14
7	CP 7 15	CP 2 7 15	7 7	14,4 14,4	0,8 2	0,8 2	AX 7 15	AX 3,5 7 15
8	CP 8 16	CP 2 8 16	8 8	15,4 15,4	0,8 2	0,8 2,1	AX 8 16	AX 3,5 8 16
9	CP 9 17	CP 2 9 17	9 9	16,4 16,4	0,8 2	0,9 2,3	AX 9 17	AX 3,5 9 17
10	CP 10 22	CP 2 10 22	10 10	21,5 21,5	0,8 2	1,7 4,3	AX 10 22	AX 4 10 22
12	CP 12 26	CP 2 12 26	12 12	25,5 25,5	0,8 2	2,5 6,2	AX 12 26	AX 4 12 26
13	CP 13 26	CP 2 13 26	13 13	25,5 25,5	0,8 2	2,4 5,9	AX 13 26	AX 4 13 26
15	CP 15 28	CP 2 15 28	15 15	27,5 27,5	0,8 2	2,5 6	AX 15 28	AX 4 15 28
17	CP 17 30	CP 2 17 30	17 17	29,5 29,5	0,8 2	2,8 7	AX 17 30	AX 4 17 30
19	CP 19 32	CP 2 19 32	19 19	31,5 31,5	0,8 2	3,5 9	AX 19 32	AX 4 19 32
20	CP 20 35	CP 3 20 35	20 20	34,5 34,5	0,8 3	3,8 13	AX 20 35	AX 5 20 35
25	CP 25 42	CP 3 25 42	25 25	41,5 41,5	0,8 3	5,3 19	AX 25 42	AX 5 25 42
27	CP 27 44		27	43,7	0,8	5,8	AX 27 44	
30	CP 30 47	CP 3 30 47	30 30	46,5 46,5	0,8 3	6 22	AX 30 47	AX 5 30 47
35	CP 35 52	CP 3 35 52	35 35	51,5 51,5	0,8 3	7 26	AX 35 52	AX 5 35 52
	CP 35 53	CP 3 35 53	35 35	52,5 52,5	0,8 3	7,4 27	AX 35 53	AX 5 35 53
40	CP 40 60	CP 3 40 60	40 40	59,5 59,5	0,8 3	9,3 34	AX 40 60	AX 5 40 60
45	CP 45 65	CP 3 45 65	45 45	64,4 64,4	0,8 3	10 37	AX 45 65	AX 5 45 65

over →

Needle thrust bearings
AX thin and thick series



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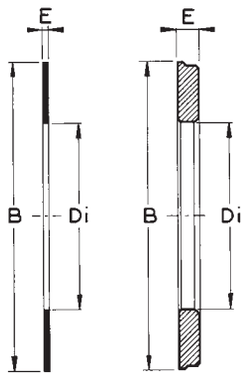
Shaft Dia.	Designations		Di nom.	De max.	h	d1	d2	Basic capacities		Speed limit	Weight approx.
mm	AX Thin Series	AX Thick Series	mm	mm	mm	mm	mm	Dyn. Ca N	Stat. Coa N	r.p.m.	g
50	AX 50 70	AX 5 50 70	50 50	70 70	2,8 5	53,3 53,3	65,7 65,7	22 500 22 500	118 000 118 000	4 000 4 000	25,5 55
55	AX 55 78	AX 6 55 78	55 55	78 78	2,8 6	58,4 58,4	72,5 72,5	28 500 28 500	164 000 164 000	3 800 3 800	34 89
60	AX 60 85	AX 6 60 85	60 60	85 85	2,8 6	63,5 63,5	79,2 79,2	31 500 31 500	193 000 193 000	3 500 3 500	40 106
65	AX 3,5 65 90	AX 6 65 90	65 65	90 90	3,5 6	68,5 68,5	84,2 84,2	33 500 33 500	210 000 210 000	3 200 3 200	59 114
70	AX 3,5 70 95	AX 6 70 95	70 70	95 95	3,5 6	73,5 73,5	89,2 89,2	34 500 34 500	223 000 223 000	3 000 3 000	61 120
75	AX 3,5 75 100	AX 6 75 100	75 75	100 100	3,5 6	78,5 78,5	94,2 94,2	36 000 36 000	240 000 240 000	2 900 2 900	65 127
80	AX 3,5 80 105	AX 6 80 105	80 80	105 105	3,5 6	83,5 83,5	99,2 99,2	36 500 36 500	253 000 253 000	2 700 2 700	69 134
85	AX 3,5 85 110	AX 6 85 110	85 85	110 110	3,5 6	88,5 88,5	104,2 104,2	38 000 38 000	270 000 270 000	2 600 2 600	78 142
90	AX 4,5 90 120	AX 8 90 120	90 90	120 120	4,5 8	94,2 94,2	112,9 112,9	59 000 59 000	360 000 360 000	2 400 2 400	117 238
100	AX 4,5 100 135	AX 9 100 135	100 100	135 135	4,5 9	104,2 104,2	127,3 127,3	73 000 73 000	490 000 490 000	2 100 2 100	155 364
110	AX 4,5 110 145	AX 9 110 145	110 110	145 145	4,5 9	114,2 114,2	137,3 137,3	77 000 77 000	550 000 550 000	2 000 2 000	168 393
120	AX 4,5 120 155	AX 9 120 155	120 120	155 155	4,5 9	124,2 124,2	147,3 147,3	80 000 80 000	590 000 590 000	1 800 1 800	182 424
130		AX 11 130 170	130	170	11	135	161	106 000	710 000	1 700	660
140		AX 11 140 180	140	180	11	145	171	111 000	770 000	1 600	670
150		AX 11 150 190	150	190	11	155	181	115 000	830 000	1 500	710
160		AX 11 160 200	160	200	11	165	191	118 000	870 000	14 000	760
170		AX 12 170 215	170	215	12	175	207	165 000	1 160 000	1 300	1 000
180		AX 12 180 225	180	225	12	185	217	173 000	1 250 000	1 200	1 050
190		AX 14 190 240	190	240	14	196	232	230 000	1 650 000	1 200	1 400
200		AX 14 200 250	200	250	14	206	242	239 000	1 730 000	1 100	1 500
220		AX 14 220 270	220	270	14	226	262	248 000	1 850 000	1 000	1 600
240		AX 15 240 300	240	300	15	246	286	280 000	2 240 000	900	2 300

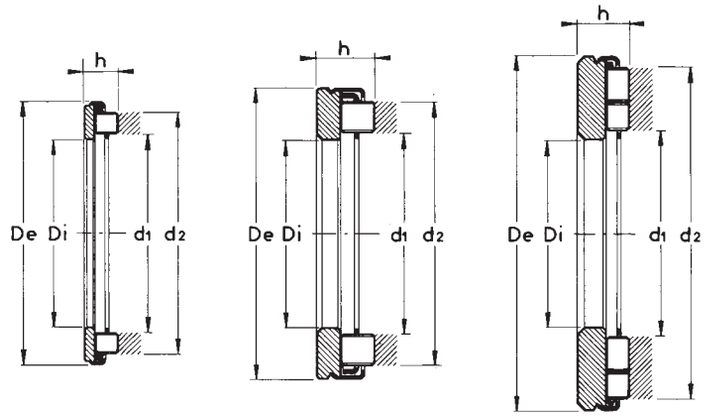
Thrust plates
CP thin and thick series



Shaft Dia.	Designations		Di nom.	B max.	E	Weight approx.	Thrust bearings	
mm	CP Thin Series	CP Thick Series	mm	mm	mm	g	AX Thin Series	AX Thick Series
50	**CP 50 70**	**CP 3 50 70**	50 50	69,4 69,4	0,8 3	11 40	AX 50 70	AX 5 50 70
55	**CP 55 78**	**CP 4 55 78**	55 55	77,4 77,4	0,8 4	14 69	AX 55 78	AX 6 55 78
60	**CP 60 85**	**CP 4 60 85**	60 60	84,3 84,3	0,8 4	16,6 83	AX 60 85	AX 6 60 85
65	**CP 1,5 65 90**	**CP 4 65 90**	65 65	89,3 89,3	1,5 4	33 88	AX 3,5 65 90	AX 6 65 90
70	**CP 1,5 70 95**	**CP 4 70 95**	70 70	94,3 94,3	1,5 4	34,4 93	AX 3,5 70 95	AX 6 70 95
75	**CP 1,5 75 100**	**CP 4 75 100**	75 75	99,3 99,3	1,5 4	37 99	AX 3,5 75 100	AX 6 75 100
80	**CP 1,5 80 105**	**CP 4 80 105**	80 80	104,3 104,3	1,5 4	39 104	AX 3,5 80 105	AX 6 80 105
85	**CP 1,5 85 110**	**CP 4 85 110**	85 85	109,3 109,3	1,5 4	46,6 111	AX 3,5 85 110	AX 6 85 110
90	**CP 1,5 90 120**	**CP 5 90 120**	90 90	118,8 118,8	1,5 5	52 173	AX 4,5 90 120	AX 8 90 120
100	**CP 1,5 100 135**	**CP 6 100 135**	100 100	133,8 133,8	1,5 6	68 277	AX 4,5 100 135	AX 9 100 135
110	**CP 1,5 110 145**	**CP 6 110 145**	110 110	143,8 143,8	1,5 6	75 300	AX 4,5 110 145	AX 9 110 145
120	**CP 1,5 120 155**	**CP 6 120 155**	120 120	153,8 153,8	1,5 6	81 323	AX 4,5 120 155	AX 9 120 155
130		**CP 7 130 170**	130	168,7	7	480		AX 11 130 170
140		**CP 7 140 180**	140	178,7	7	500		AX 11 140 180
150		**CP 7 150 190**	150	188,7	7	530		AX 11 150 190
160		**CP 7 160 200**	160	198,7	7	560		AX 11 160 200
170		**CP 7 170 215**	170	213,5	7	700		AX 12 170 215
180		**CP 7 180 225**	180	223,5	7	735		AX 12 180 225
190		**CP 8 190 240**	190	238,3	8	950		AX 14 190 240
200		**CP 8 200 250**	200	248,3	8	1 000		AX 14 200 250
220		**CP 8 220 270**	220	268,5	8	1 100		AX 14 220 270
240		**CP 9 240 300**	240	298,5	9	1 600		AX 15 240 300

Roller thrust bearings

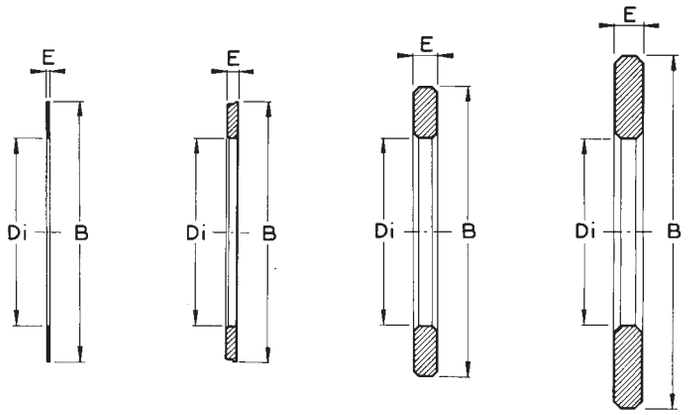
AR light series,
812 series and heavy series



Shaft Dia.	Designations			Di nom	De max	h	d1	d2	Basic capacities		Speed limit	Weight approx.
mm	AR Light Series	AR 812 Series	AR Heavy Series	mm	mm	mm	mm	mm	Dyn. Ca N	Stat. Coa N	r.p.m.	g
10	AR 4,5 10 22			10	22	4,5	12,2	18,5	8 200	17 900	15 500	7,3
12	AR 5 12 26			12	26	5	14,8	22,9	12 700	29 500	13 000	11
15	AR 5 15 28			15	28	5	16,8	24,9	14 000	34 000	11 500	11
17	AR 5 17 30			17	30	5	18,8	26,9	15 000	39 000	10 500	12,5
20	AR 7 20 35			20	35	7	22	31,6	22 000	54 000	9 000	22
25	AR 7 25 42			25	42	7	27,7	37,3	25 500	70 000	7 500	31
			AR 7 25 52	25	52	7	29	47	32 500	122 000	6 500	70
30	AR 7 30 47			30	47	7	32,7	42,3	26 500	77 000	6 500	36
		AR 8 12 06		30	52	11,75	32,8	47	49 000	117 000	6 300	85
			AR 9 30 60	30	60	9	33,5	53,5	46 000	162 000	5 600	113
35	AR 8 35 53,4			35	53,4	8	37,8	47,8	33 800	94 000	5 500	52
		AR 8 12 07		35	62	12,75	38,6	54,8	66 000	165 000	5 300	132
			AR 9 35 68	35	68	9	39	60,6	51 000	194 000	4 900	144
40	AR 9 40 60,4			40	60,4	9	42,8	54 ,8	46 000	129 000	5 000	70
		AR 8 12 08		40	68	14	43,6	61,8	82 000	209 000	4 800	169
			AR 11 40 78	40	78	11	44	70	71 000	265 000	4 200	225
45	AR 9 45 65,4			45	65,4	9	47,8	59 ,8	49 000	143 000	4 500	77
		AR 8 12 09		45	73	14,5	48,6	66,8	85 000	225 000	4 300	197
			AR 14 45 85	45	85	14	49	77	92 000	340 000	3 800	350
50	AR 9 50 70,4			50	70,4	9	52,8	64,8	51 000	157 000	4 000	82
		AR 8 12 10		50	78	15,5	53,6	71,8	93 000	255 000	4 000	234
			AR 14 50 95	50	95	14	54	86	108 000	430 000	3 400	448
55	AR 10 55 78,4			55	78,4	10	58,5	72,5	61 000	203 000	3 800	125
		AR 8 12 11		55	90	18	59,8	82	124 000	335 000	3 600	381
			AR 14 55 105	55	105	14	60,2	96,2	125 000	530 000	3 100	537

Thrust plates

CP thin and thick series,
CPR 812 series and
heavy series



Shaft Dia. mm	Designations CP Thin Series	CP Thick Series	CP 812 Series	CP Heavy Series	Di nom mm	B max mm	E mm	Weight approx. g
10	CP 10 22				10	21,5	0,8	1,7
		CP 2 10 22			10	21,5	2	4,3
12	CP 12 26				12	25,5	0,8	2,5
		CP 2 12 26			12	25,5	2	6,2
15	CP 15 28				15	27,5	0,8	2,5
		CP 2 15 28			15	27,5	2	6
17	CP 17 30				17	29,5	0,8	2,8
		CP 2 17 30			17	29,5	2	7
20	CP 20 35				20	34,5	0,8	3,8
		CP 3 20 35			20	34,5	3	13
25	CP 25 42				25	41,5	0,8	5,3
		CP 3 25 42			25	41,5	3	19
				CPR 4 25 52	25	52	4	52
30	CP 30 47				30	46,5	0,8	6
		CP 3 30 47			30	46,5	3	22
			CPR 812 06		30	52	4,25	42
				CPR 5 30 60	30	60	5	83
35	CP 35 52				35	51,5	0,8	7
		CP 3 35 52			35	51,5	3	26
			CPR 812 07		35	62	5,25	78
				CPR 5 35 68	35	68	5	102
40	CP 40 60				40	59,5	0,8	9,3
		CP 3 40 60			40	59,5	3	34
			CPR 812 08		40	68	5	86
				CPR 6 40 78	40	78	6	162
45	CP 45 65				45	64,4	0,8	10
		CP 3 45 65			45	64,4	3	37
			CPR 812 09		45	73	5,5	104
				CPR 8 45 85	45	85	8	245
50	CP 50 70				50	69,4	0,8	11
		CP 3 50 70			50	69,4	3	40
			CPR 812 10		50	78	6,5	131
				CPR 8 50 95	50	95	8	308
55	CP 55 78				55	77,4	0,8	14
		CP 4 55 78			55	77,4	4	69
			CPR 812 11		55	90	7	206
				CPR 8 55 105	55	105	8	380

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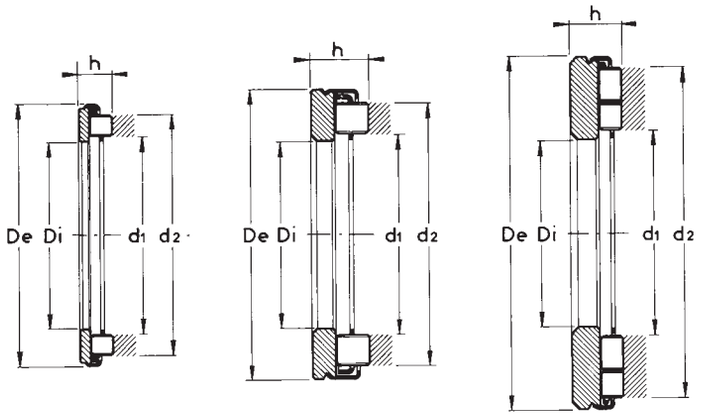
Roller thrust bearings

AR light series,
812 series and
heavy series



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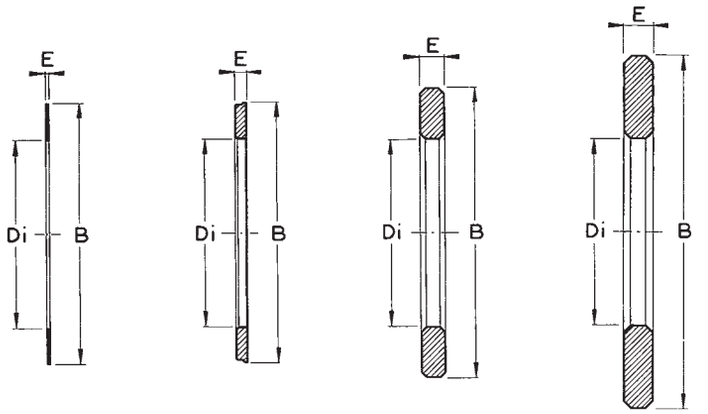
Shaft Dia.	Designations			Di nom	De max	h	d1	d2	Basic capacities		Speed limit	Weight approx.
mm	AR Light Series	AR 812 Series	AR Heavy Series	mm	mm	mm	mm	mm	Dyn. Ca N	Stat. Coa N	r.p.m.	g
60	AR 10 60 85,4			60	85,4	10	63,5	79,5	71 000	255 000	3 500	150
		AR 812 12		60	95	18,5	64,8	87	128 000	360 000	3 300	419
			AR 14 60 110	60	110	14	65,2	101,2	130 000	580 000	2 900	572
65	AR 10 65 90,4			65	90,4	10	68,5	84,5	74 000	275 000	3 200	160
		AR 812 13		65	100	19	69,8	92	133 000	385 000	3 100	461
			AR 14 65 115	65	115	14	70,2	106,2	135 000	620 000	2 800	610
70	AR 10 70 95,4			70	95,4	10	73,5	89,5	77 000	295 000	3 000	170
		AR 812 14		70	105	19	74,8	97	143 000	430 000	2 900	493
			AR 16 70 125	70	125	16	76	116	174 000	710 000	2 600	775
75	AR 10 75 100,4			75	100,4	10	78,5	94,5	80 000	313 000	2 800	180
		AR 812 15		75	110	19	79,8	102	147 000	455 000	2 800	521
			AR 16 75 135	75	135	16	82	126	198 000	860 000	2 400	893
80	AR 10 80 105,4			80	105,4	10	83,5	99,5	82 000	330 000	2 700	190
		AR 812 16		80	115	19,5	84,8	107	150 000	480 000	2 600	574
			AR 16 80 140	80	140	16	87	131	208 000	940 000	2 300	960
85		AR 812 17		85	125	21,5	90,8	115	178 000	570 000	2 400	785
			AR 18 85 150	85	150	18	92	138	230 000	1 010 000	2 100	1 256
90		AR 812 18		90	135	24,5	95,8	124	223 000	700 000	2 300	1 062
			AR 18 90 155	90	155	18	97	143	245 000	1 090 000	2 000	1 330
100		AR 812 20		100	150	26,5	107,8	138	260 000	850 000	2 000	1 400
			AR 20 100 170	100	170	20	109	157	280 000	1 250 000	1 800	1 740
110		AR 812 22		110	160	26,5	117,8	148	275 000	940 000	1 900	1 538
			AR 24 110 190	110	190	24	118	178	365 000	1 600 000	1 700	2 500
120			AR 24 120 210	120	210	24	127	199	470 000	2 300 000	1 500	3 200
130			AR 24 130 225	130	225	24	138	214	510 000	2 640 000	1 400	3 600
140			AR 28 140 240	140	240	28	149	229	600 000	2 980 000	1 300	4 800
150			AR 28 150 250	150	250	28	159	239	630 000	3 200 000	1 250	5 000
160			AR 30 160 270	160	270	30	170	258	730 000	3 800 000	1 150	6 400
170			AR 30 170 280	170	280	30	180	268	760 000	4 050 000	1 100	6 700

Thrust plates

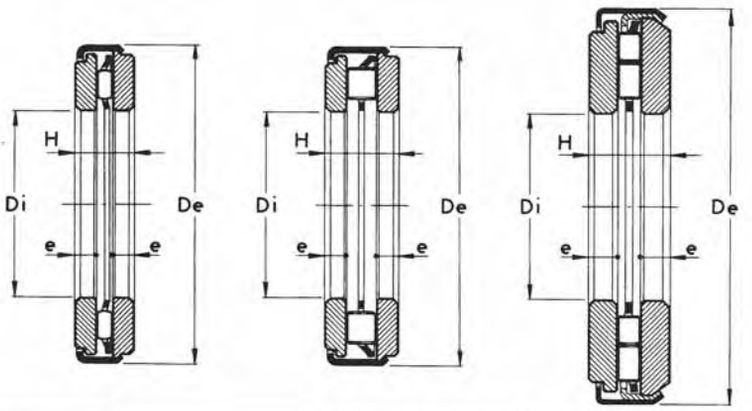
CP thin and thick series,
CPR 812 series and
heavy series



Shaft Dia.	Designations				Di nom	B max	E	Weight approx.
mm	CP Thin Series	CP Thick Series	CP 812 Series	CP Heavy Series	mm	mm	mm	g
60	CP 60 85	CP 4 60 85			60 60	84,3 84,3	0,8 4	16,6 83
			CPR 812 12	CPR 8 60 110	60 60	95 110	7,5 8	228 405
65	CP 1,5 65 90	CP 4 65 90			65 65	89,3 89,3	1,5 4	33 88
			CPR 812 13	CPR 8 75 115	65 65	100 115	8 8	267 430
70	CP 1,5 70 95	CP 4 70 95			70 70	94,3 94,3	1,5 4	34,4 93
			CPR 812 14	CPR 8 70 125	70 70	105 125	8 8	277 510
75	CP 1,5 75 100	CP 4 75 100			75 75	99,3 99,3	1,5 4	37 99
			CPR 812 15	CPR 8 75 135	75 75	110 135	8 8	295 595
80	CP 1,5 80 105	CP 4 80 105			80 80	104,3 104,3	1,5 4	39 104
			CPR 812 16	CPR 8 80 140	80 80	115 140	8,5 8	336 630
85			CPR 812 17	CPR 9 85 150	85 85	125 150	9,5 9	464 815
90			CPR 812 18	CPR 9 90 155	90 90	135 155	10,5 9	624 840
100			CPR 812 20	CPR10 100 170	100 100	150 170	11,5 10	825 1 130
110			CPR 812 22	CPR12 110 190	110 110	160 190	11,5 12	895 1 700
120				CPR12 120 210	120	210	12	2 100
130				CPR12 130 225	130	225	12	2 400
140				CPR14 140 240	140	240	14	3 200
150				CPR14 150 250	150	250	14	3 300
160				CPR15 160 270	160	270	15	4 200
170				CPR15 170 280	170	280	15	4 400

Needle or roller thrust bearings

two plates incorporated AXZ, ARZ, light and heavy series



Shaft Dia.	Designations			Di nom	De nom	H	e	Basic capacities		Speed limit	Weight approx.
	AXZ	ARZ Light Series	ARZ Heavy Series					Dyn. C	Stat. Co		
mm				mm	mm	mm	mm	N	N	r.p.m.	g
5	AXZ 5,5 5 13			5	13	5,5	2	3 000	5 700	25 000	3,64
6	AXZ 5,5 6 14			6	14	5,5	2	3 150	6 350	22 000	4,20
7	AXZ 5,5 7 15			7	15	5,5	2	3 550	7 600	22 000	4,69
8	AXZ 5,5 8 16			8	16	5,5	2	3 700	8 300	22 000	5,09
9	AXZ 5,5 5 13			9	17	5,5	2	4 050	9 500	19 000	5,34
10	AXZ 6 10 22,4	ARZ 6,5 10 22,4		10 10	22,4 22,4	6 6,5	2 2	5 000 8 200	10 900 17 900	15 500 15 500	11,4 12
12	AXZ 6 12 26,4	ARZ 7 12 26,4		12 12	26,4 26,4	6 7	2 2	6 900 12 700	17 700 29 500	13 000 13 000	16,7 17
15	AXZ 6 15 28,4	ARZ 7 15 28,4		15 15	28,4 28,4	6 7	2 2	7 400 14 000	20 000 34 000	11 500 11 500	15,5 19
17	AXZ 6 17 30,4	ARZ 7 17 30,4		17 17	30,4 30,4	6 7	2 2	7 800 15 000	22 000 39 000	10 500 10 500	17,5 22
20	AXZ 8 20 35,4	ARZ 10 20 35,4		20 20	35,4 35,4	8 10	3 3	11 800 22 000	39 000 54 000	9 000 9 000	32,5 38
25	AXZ 8 25 43	ARZ 10 25 43	ARZ 11 25 53	25 25 25	43 43 53	8 10 11	3 3 4	13 300 25 500 32 500	49 000 70 000 122 000	7 500 7 500 6 500	47 57 122
30	AXZ 8 30 48	ARZ 10 30 48	ARZ 14 30 61	30 30 30	48 48 61	8 10 14	3 3 5	14 500 26 500 46 000	57 000 77 000 162 000	6 500 6 500 5 600	54 65 196
35	AXZ 8 35 54	ARZ 11 35 54	ARZ 14 35 69	35 35 35	54 54 69	8 11 14	3 3 5	18 900 33 800 51 000	84 000 94 000 194 000	5 500 5 500 4 900	66 87 246
40	AXZ 8 40 61	ARZ 12 40 61	ARZ 17 40 79	40 40 40	61 61 79	8 12 17	3 3 6	20 400 46 000 71 000	96 000 129 000 265 000	5 000 5 000 4 200	84 114 387
45	AXZ 8 45 66	ARZ 12 45 66	ARZ 22 45 86	45 45 45	66 66 86	8 12 22	3 3 8	21 800 49 000 92 000	109 000 143 000 340 000	4 500 4 500 3 800	92 126 595
50	AXZ 8 50 71	ARZ 12 50 71	ARZ 22 50 96	50 50 50	71 71 96	8 12 22	3 3 8	22 500 51 000 108 000	118 000 157 000 430 000	4 000 4 000 3 400	100 137 756
55			ARZ 22 55 106	55	106	22	8	125 000	530 000	3 100	917
60	AXZ 10 60 86	ARZ 14 60 86	ARZ 22 60 111	60 60 60	86 86 111	10 14 22	4 4 8	31 500 71 000 130 000	193 000 255 000 580 000	3 500 3 500 2 900	194 246 977
65			ARZ 22 65 116	65	116	22	8	135 000	620 000	2 800	1 040
70	AXZ 10 70 96	ARZ 14 70 96		70 70	96 96	10 14	4 4	34 500 77 000	223 000 295 000	3 000 3 000	220 279
80	AXZ 10 80 106	ARZ 14 80 106		80 80	106 106	10 14	4 4	36 500 82 000	253 000 330 000	2 700 2 700	256 312

COMBINED BEARINGS

NADELLA combined needle bearings type RAX and derivatives are designed to support simultaneously both a radial and an axial load.

They comprise a needle thrust bearing (or roller thrust bearing) and needle cage retained in a common outer ring.

The technical characteristics of the thrust bearing and the needle cage are set out in the appropriate sections.

These bearings form one integral unit permitting easy storage, handling and fitting. Their high radial and axial load capacities and small space requirement enable cost effective solutions to be achieved.

Calculations for combined bearings are carried out taking the axial component and the radial component separately without transforming the axial load into an equivalent radial load.

The operation of the thrust bearing and the needle cage independent of one another precludes any interaction harmful to precise axial and radial rotation. Axial expansion of the shaft, for example, will have no effect on the accuracy of the radial component.

The bearings can be used without inner rings or thrust plates, if the shaft journals serving as raceways are of sufficient hardness and possess a suitable surface finish. Hardness of 58–64 HRC will ensure that the full capacity of these bearings is attained. Lower hardness figures will entail a reduction in the static and dynamic capacities (both axial and radial) as shown in the tables of dimensions (see Technical Section).

TYPES OF COMBINED BEARINGS

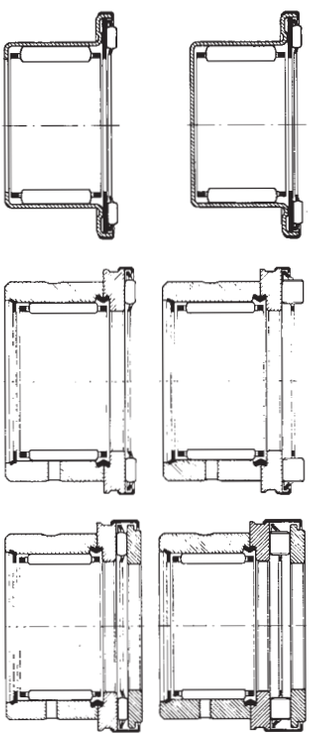
Standard Series

	With needle thrust bearing				With roller thrust bearing	
	Thin outer ring		Thick outer ring		Thick outer ring	
	open	closed-end	without retained thrust plate	with retained thrust plate	without retained thrust plate	with retained thrust plate
Bearings	**RAX 700**	**RAXF 700**	**RAX 400**	**RAXPZ 400**	**RAX 500**	**RAXZ 500**
Separate thrust plates	**CP** thick or thin		**CP** thick or thin		**CP** thick or thin	
Inner rings 1)	**IM**		**IM...P**		**IM...P**	

1) Inner rings with oil hole type IMC on request.

Machine-tool quality

	With needle thrust bearing		With roller thrust bearing	
	without thrust plate	with retained thrust plate	without thrust plate	with retained thrust plate
Bearings	**RAXN 400**	**RAXNPZ 400**	**RAXN 500**	**RAXNZ 500**
Separate thrust plates	**CPN**		**CPN**	
Inner rings	**IM 19000 IM 20600**		**IM 20600**	



Combined bearings type RAX 700 and RAXF 700

Combined bearings type *RAX 700* possess a one-piece outer ring formed from thin sheet steel accurately controlled and hardened by suitable heat treatment. The shape of this outer ring prevents weakness in the area between the axial component and the radial component, even after the latter has been tightly fitted into a housing.

This type of combined bearing is inexpensive and occupies little space, thus providing a very economical solution. Because they are easy to use and can be fitted rapidly, they are often employed in preference to an arrangement with two separate needle bearings. Closed-end combined bearings type *RAXF 700* ensure perfect sealing at the end of a shaft and do not require the use of blind housings or end caps.

Standard combined bearings type RAX 400 and RAX 500

Combined needle bearings type *RAX 400* and *RAX 500* comprise a thrust plate and an outer ring machined separately and joined by a strong metal insert. This arrangement prevents localised stresses and weakness in the area between the two components, thus eliminating the risk of damage during mounting or operation.

Although combined bearings type RAX 700 should be considered first on grounds of economy, combined bearings with thick outer ring type RAX 400 or RAX 500 should be used when operating conditions require higher limit loads or greater rotational accuracy. Moreover, they can be supplied in machine-tool quality type RAXN (see below).

Standard combined bearings type RAXPZ 400 and RAXZ 500

These bearings have an incorporated plate retained by a steel ring set on the thrust plate. They are better protected against the introduction of dust and metal particles and are therefore recommended for spindles of drilling machines, etc.

Machine-tool quality combined bearings types RAXN 400, RAXN 500, and derivatives

The combined bearings in the *RAXN 400* and *RAXN 500* series are manufactured to the same dimensions as the RAX 400 and RAX 500 series in higher precision with respect to out-of- roundness and thickness of the rings and axial run-out of the thrust bearing. These bearings, which are also available with retained thrust plate *RAXNPZ 400* and *RAXNPZ 500*, are particularly recommended for use in drilling machine spindles.

TOLERANCES OF COMBINED BEARINGS

Combined bearings types RAX 700 and RAXF 700

Because types RAX 700 and RAXF 700 have an outer ring formed from thin sheet steel, the radial component of these bearings can only be inspected using a ring-gauge having sufficient thickness to withstand deformation and with a bore ground with great accuracy. The diameters of the ring-gauge and the "GO" and "NO-GO" plug-gauges are identical to those given on pages 26 and 27 in the inspection table for caged needle bushes type DB (without suffix P), having identical inner and outer diameters.

Thickness tolerance of the axial component h: ± 0.1 mm.

Standard combined bearings type RAX 400, RAX 500 and derivatives

▶ *Radial component*

Diameter under the needles Ci: tolerance F6 (ISO Standard 1206).

Width l: –0.1/–0.2 mm

Outer diameter D1
Out-of-roundness
Inner rings IM...P

} Normal tolerance class according to ISO Standard 1206 (French Standard F 22 370).

▶ *Axial component*

Thickness h: +0.05/–0.06 mm

Axial run-out: 0.010 mm

▶ *Thrust plates*

Tolerance	Thin thrust plates		Thick thrust plates
	Bore A ⩽ 60 mm	Bore A > 60 mm	mm
Thickness	E ± 0.030 [1]	E ± 0.050 [2]	E ± 0.050
Axial run-out	0.020 [1]	0.025 [2]	0.005

1) Under minimum load of 150 N
2) Under minimum load of 250 N

Machine-tool quality combined bearings types RAXN 400, RAXN 500 and derivatives

▶ *Radial component*

Diameter under the needles Ci: tolerance F5 (ISO Standard 1206).

Width l: –0.1/–0.2 mm.

Outer diameter D1: Normal tolerance class according to ISO Standard 1206 (French Standard E 22 370).

Out-of-roundness: Precision class 5 according to ISO Recommendation 492 (DIN 620).

Inner rings IM 19 000 and IM 20 600:

inner diameter Di: 0/–0.010 mm
outer diameter Ci: 0/–0.005 mm
width L1: 0/–0.130 mm up to Di = 40 mm
0/–0.160 mm for Di > 40 mm

out-of-roundness: 0.005 mm.

▶ *Axial component*

Thickness h: 0/–0.012 mm
Axial run-out: 0.005 mm

▶ *Thrust plates*

Thickness E: selected to obtain tolerance h8 on total thickness E + h.
Axial run-out: 0.005 mm.

RADIAL PLAY

Combined bearings types RAX 700, RAXF 700

The fit of a combined bearing with thin outer ring in the housing determines, to a large extent, the dimension under the needles and consequently the radial play during operation.

The recommended shaft and housing tolerances give a radial play whose limits are suitable for most normal applications. To obtain a closer clearance, it is possible to match the shaft diameters with the diameters under the needles of the bearings, after the latter have been fitted into their housings.

The possible differences in the stiffness of housings and the variations of clamping force resulting from the tolerance build up do not permit NADELLA to establish a range of dimensions under the needles for every application.

However, for housings of very thick steel, taking into account the probable restraining force, the variations of the dimensions under the needles after installation will be within the tolerances given below:

+15/+50 µm up to Ci = 20 mm
+20/+60 µm Ci = 25 to 40 mm
+20/+65 µm Ci = 45 mm.

The limits of radial play should also take into account the tolerance of the shaft used directly as a raceway or of the outer diameter of the inner ring after it has been fitted on to the shaft.

Where an inner ring is used on a shaft of recommended tolerance k5 (or m5), the minimum play may be slightly lower and the maximum play slightly higher than for the case of an assembly without inner ring on a shaft with tolerance h5.

Standard combined bearings type RAX 400, 500 and derivatives

► *Bearings without inner ring*

The radial play of these bearings when used without inner rings is the difference between the diameter under the needles, which is kept within tolerance F6, and the diameter of the shaft which is machined to the tolerances recommended for dimensions Ci according to the table below.

This type of combined bearing without inner ring can be supplied having a diameter under the needles selected in the lower half of tolerance F6 (suffix TB) or in the upper half (suffix TC).

Nominal dimension Ci mm	Tolerance of diameter under the needles		
	Normal F6 µm	TB µm	TC µm
Above To			
6 – 10	+ 13/+ 22	+ 13/+ 18	+ 17/+ 22
10 – 18	+ 16/+ 27	+ 16/+ 22	+ 21/+ 27
18 – 30	+ 20/+ 33	+ 20/+ 27	+ 26/+ 33
30 – 50	+ 25/+ 41	+ 25/+ 33	+ 33/+ 41
50 – 80	+ 30/+ 49	+ 30/+ 40	+ 39/+ 49

► *Bearings with inner ring*

The radial play prior to installation of standard combined bearings with inner ring is in conformance with the normal group of ISO Standard 5753. The closely controlled play provided by this standard can be provided on request (symbol ZS according to table for bearings with cage guided needles).

Machine-tool quality combined bearings types RAXN 400, RAXN 500 and derivatives

► *Bearings without inner ring*

The radial play prior to installation of machine-tool quality combined bearings results from tolerance F5 on the diameter under the needles and tolerances k5 on the diameter of the shaft.

Nominal dimension Ci mm	Tolerance of diameter under the needles F5 µm
Above To	
6 – 10	+ 13/+ 19
10 – 18	+ 16/+ 24
18 – 30	+ 20/+ 29
30 – 50	+ 25/+ 36
50 – 80	+ 30/+ 43

► *Bearings with inner ring*

The radial play prior to installation of machine-tool quality combined bearings results from tolerance F5 on the diameter under the needles and tolerance 0/—0.005 mm on the outer diameter Ci of inner ring IM 19 000 or IM 20 600.

SHAFT AND HOUSING TOLERANCES

Combined bearings	SHAFT				HOUSING	
	Dimension Ci for bearings without inner ring		Dimension Di for bearings with inner ring		Dimension D1	
	Rotation	Oscillation	Rotation	Oscillation	Steel or cast-iron	Non-ferrous metal 1) or thin castings in steel
RAX, RAXF 700	h5 (h6)	j5 (j6)	k5 (k6)	m5 (m6)	H6 (H7)	M6 (M7)
RAX, RAXPZ, RAXZ Series 400 to 500	h5	j5	k5	m5	K6	M6
RAXN, RAXNPZ, RAXNZ, Series 400 to 500	k5	k5	k5	m5	K6	M6

The cylindrical tolerance defined as the difference in radii of two coaxial cylinders (ISO Standard 1101) should normally be less than a quarter of the manufacturing tolerance. However, for high precision or high speed applications, it is advisable to restrict this tolerance to the one-eighth of the manufacturing tolerance.

1) If a housing of non-ferrous metal reaches temperatures considerably higher (or lower) than 20°C, account should be taken of the difference in expansion (or contraction) of the outer race of the bearing and suitable adjustments to the fits should be made.

SUPPORTING FACES – RACEWAYS

The bearing shoulder must be a flat face at right angles to the housing axis, otherwise axial precision will be affected and the smooth running characteristics of the thrust bearing will be diminished.

Similarly, the shaft shoulder, on which the needles of the thrust bearing rotate or on which the thrust plate is supported, must be flat and square to the axis.

The deviation from true parallelism between the two supporting faces must be no more than:

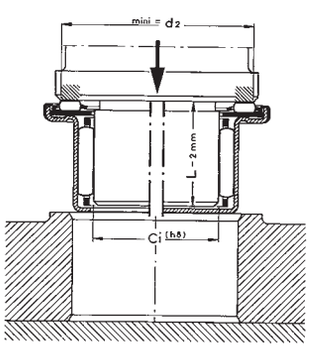
- 1 minute for a combined bearing with thrust plate (or approx. 0.3 in 1 000).
- 1 minute 30 seconds for a combined bearing without thrust plate (or approx. 0.45 in 1 000).

In the case of an assembly where neither thrust plate nor inner ring is used, the shaft journal on which the needle rotate must have sufficient hardness, i. e. 58–64 HRC to ensure maximum load capacities are attained.

If the shaft shoulder is used directly as a raceway for the needles of the thrust bearing or, if it supports a thin thrust plate (thickness 0.8 or 1.5 mm), it must be rigid and continuous throughout the area of circulation of the needles bounded by dimensions d1 and d2. A thick thrust plate can be supported on a smaller shaft shoulder or on one that is discontinuous (as in the case of splines), provided the deflection of the plate does not affect the smooth running or required accuracy of the thrust bearing.

INSTALLATION

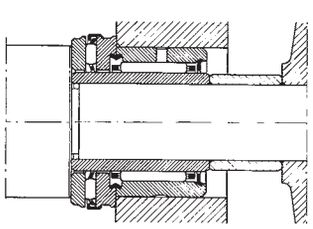
The bearing must be correctly aligned with the housing. It is wise to use a small press fitted with a mandrel having a supporting face square to the axis and covering the whole area bounded by dimensions d1 and d2. This method prevents the thrust component from undergoing shock load which might damage the bearing. When RAX or RAXF 700 bearings are placed in position during installation care must be taken to ensure that the force exerted by the press does not exceed the axial limit load shown in the table of dimensions.



The fitting of inner rings on shafts manufactured to the recommended tolerances is usually sufficient to render the use of retaining rings unnecessary. However, if it is necessary to employ a ring to support an adjacent pinion, this ring must have an outer diameter slightly smaller than dimension Ci to enable it to pass smoothly into the bearing when the shaft is introduced.

TYPICAL ARRANGEMENTS USING COMBINED BEARINGS

RAX and RAXF 700.



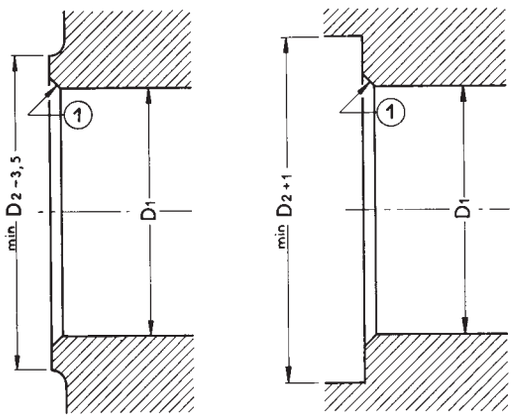
RAX 400 (or 500) and RAXPZ 400 (or RAXZ 500).

RAXN 400 (or 500) and RAXNPZ 400 (or RAXNZ 500): the typical applications for these machine-tool quality combined bearings used without inner ring and with or without thick thrust plate are identical to those for the corresponding standard combined bearings.

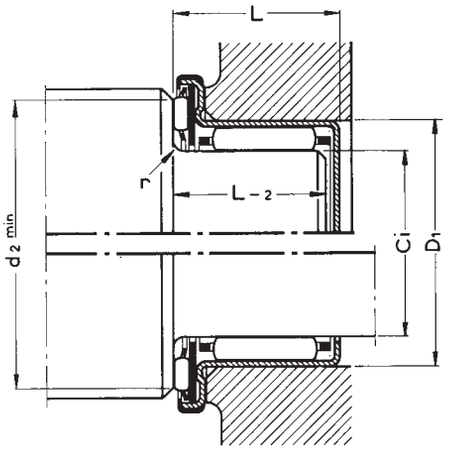
The special inner rings (series 19 000 or 20 600) designed for machine-tool quality combined bearings are of sufficient width to permit centring of the thrust plate and thus eliminate the need for a shaft shoulder (see diagram opposite).

METHODS OF INSTALLATION FOR COMBINED BEARINGS RAX and RAXF 700

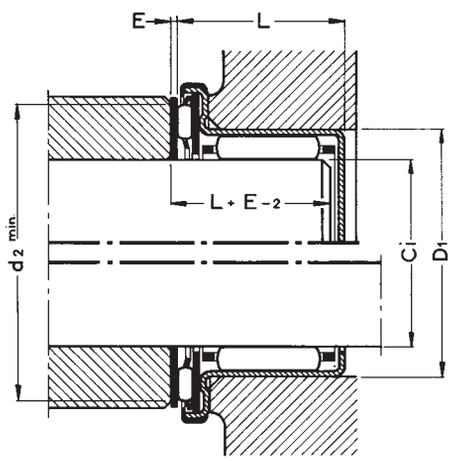
MOUNTING FACES OF HOUSING

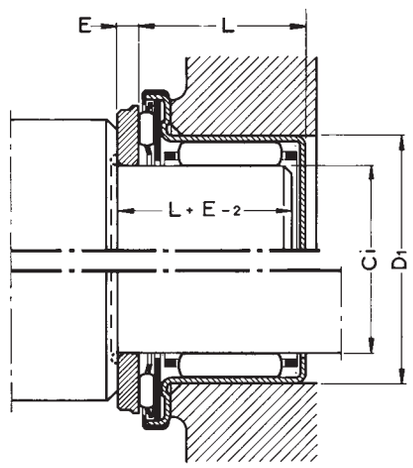


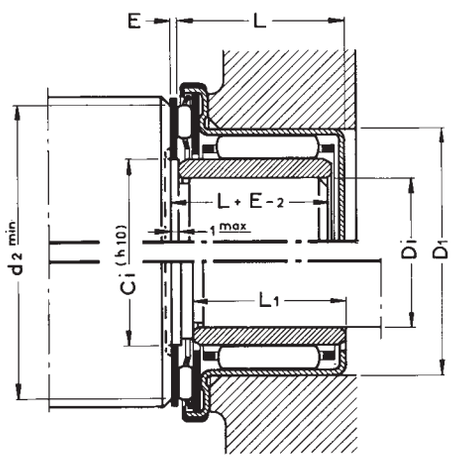
(1) Chamfer: 0,5 to 1 mm up to RAX (or RAFX) 720
0,7 to 1,5 mm from RAX (or RAFX) 725

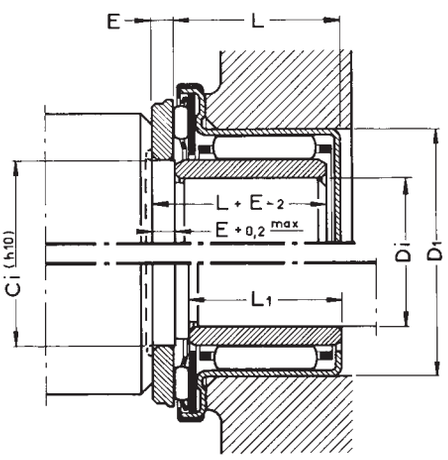


RAX RAXF	712	714	715	718	720	725	730	735	740	745
r max mm	0,75	1	1,8	1	0,5	1,8	1,8	1,8	0,5	0,5

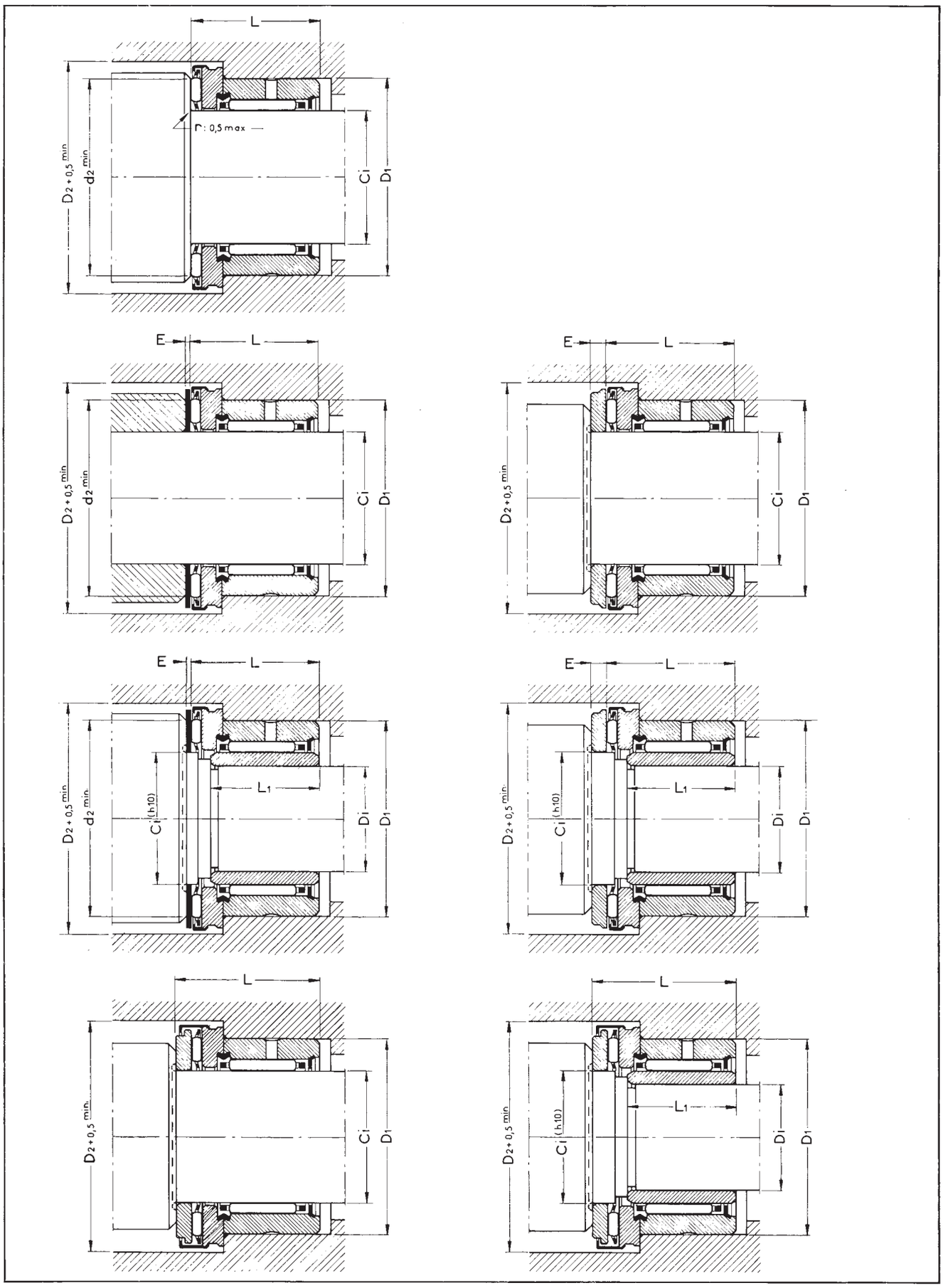






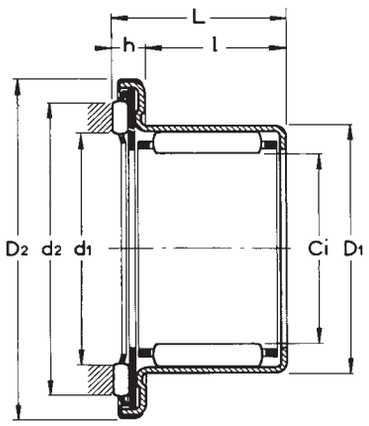


METHODS OF INSTALLATION FOR COMBINED BEARINGS RAX 400 (or 500) RAXPZ 400 (or RAXZ 500)

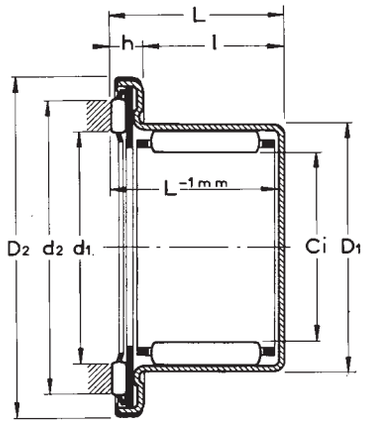


Combined bearings

- open RAX 700 series
- closed-end RAXF 700 series



RAX 700



RAXF 700

Shaft Dia.	Designations		Ci	D1	D2 max	l	H	L	d1	d2	Weight approx.	
	RAX 700 Series	RAXF 700 Series									RAX	RAXF
mm			mm	mm	mm	mm	mm	mm	mm	mm	g	g
5	**RAX 705**			9	15,5	7,7	3,3	11	7,2	11,2	4,5	
12	**RAX 712**	**RAXF 712**	12	18	27,5	10	4,2	14,2	15	22,6	16,5	17,5
14	**RAX 714**	**RAXF 714**	14	20	29,5	10	4,2	14,2	17	24,6	18	20
15	**RAX 715**	**RAXF 715**	15	21	31,5	10	4,2	14,2	19	26,6	20	22
18	**RAX 718**	**RAXF 718**	18	24	33,5	14	4,2	18,2	21	28,6	27	30
20	**RAX 720**	**RAXF 720**	20	26	36,5	14	4,2	18,2	22	31,6	31	35
25	**RAX 725**	**RAXF 725**	25	33	45,5	18	4,2	22,2	30	39,6	55	60
30	**RAX 730**	**RAXF 730**	30	38	50,5	18	4,2	22,2	35	44,7	63	70
35	**RAX 735**	**RAXF 735**	35	43	56,5	18	4,2	22,2	39	50,9	75	84
40	**RAX 740**	**RAXF 740**	40	48	61,5	18	4,2	22,2	43	54,9	86	96
45	**RAX 745**	**RAXF 745**	45	52	66,5	18	4,2	22,2	48	59,9	88	99

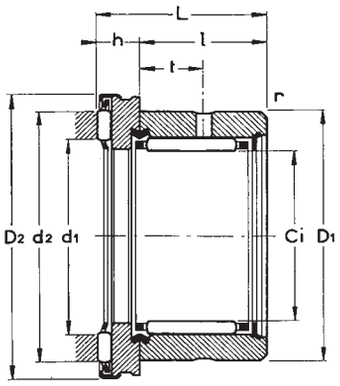
Thrust plates and inner rings
see pages 142 & 143

Limit loads: See Technical Section page 11 and calculation examples page 14 to 17.

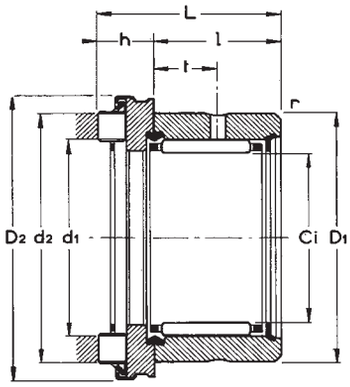
Basic capacities				Limit loads		Speed limit	Bearing designations	
Radial		Axial		Radial	Axial			
Dyn. Cr N	Stat. Cor N	Dyn. Ca N	Stat. Coa N	N	N	r.p.m.	Series RAX 700	Series RAXF 700
2 150	1 950	3 150	6 350	740	3 500	25 000	**RAX 705**	
6 300	7 200	6 900	17 700	2 500	11 000	13 000	**RAX 712**	**RAXF 712**
6 900	8 500	7 400	20 000	2 900	12 500	11 500	**RAX 714**	**RAXF 714**
7 400	9 300	7 800	22 000	3 100	14 000	10 500	**RAX 715**	**RAXF 715**
11 500	17 700	8 000	23 000	5 800	16 000	10 000	**RAX 718**	**RAXF 718**
12 200	19 500	11 800	39 000	6 400	18 000	9 000	**RAX 720**	**RAXF 720**
20 500	32 000	13 700	52 000	10 500	22 000	7 200	**RAX 725**	**RAXF 725**
22 300	37 500	14 900	60 000	12 000	25 000	6 300	**RAX 730**	**RAXF 730**
24 500	45 000	19 400	88 000	14 300	27 000	5 500	**RAX 735**	**RAXF 735**
26 200	51 000	20 400	96 000	16 000	30 000	5 000	**RAX 740**	**RAXF 740**
24 800	55 000	21 800	109 000	17 000	32 000	4 500	**RAX 745**	**RAXF 745**

Combined bearings

RAX 400, RAX 500 series precision bearings in machine tool quality
RAXN 400, RAXN 500 series



RAX 400



RAX 500

Shaft Dia.	Designations		Ci	D1	D2 maxi	l	h	L	t	r mini
mm	RAX 400 Series	RAX 500 Series	mm	mm	mm	mm	mm	mm	mm	mm
10	**RAX 410**	**RAX 510**	10 10	19 19	22 22	14 14	5 5,5	19 19,5	6 6	0,35 0,35
12	**RAX 412**	**RAX 512**	12 12	21 21	26 26	14 14	5 6	19 20	6 6	0,35 0,35
15	**RAX 415**	**RAX 515**	15 15	24 24	28 28	14 14	5 6	19 20	6 6	0,35 0,35
17	**RAX 417**	**RAX 517**	17 17	26 26	30 30	16 16	5 6	21 22	8 8	0,65 0,65
20	**RAX 420**	**RAX 520**	20 20	30 30	35 35	18 18	6 8	24 26	9 9	0,85 0,85
25	**RAX 425**	**RAX 525**	25 25	37 37	42 42	18 18	6 8	24 26	9 9	0,85 0,85
30	**RAX 430**	**RAX 530**	30 30	42 42	47 47	18 18	6 8	24 26	9 9	0,85 0,85
35	**RAX 435**	**RAX 535**	35 35	47 47	53 53,4	18 18	6 9	24 27	9 9	0,85 0,85
40	**RAX 440**	**RAX 540**	40 40	52 52	60 60,4	18 18	6 10	24 28	9 9	0,85 0,85
45	**RAX 445**	**RAX 545**	45 45	58 58	65 65,4	18 18	6 10	24 28	9 9	0,85 0,85
50	**RAX 450**	**RAX 550**	50 50	62 62	70 70,4	21 21	6 10	27 31	11 11	1,3 1,3
60	**RAX 460**	**RAX 560**	60 60	72 72	85 85,4	21 21	7 11	28 32	11 11	1,3 1,3
70	**RAX 470**	**RAX 570**	70 70	85 85	95 95,4	21 21	7 11	28 32	11 11	1,3 1,3

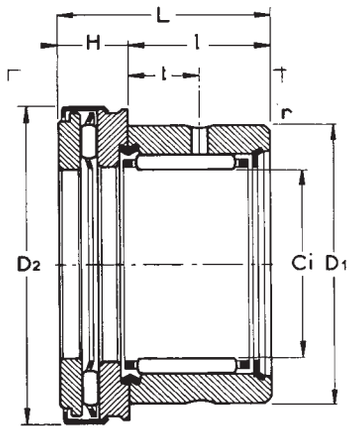
Thrust plates and inner rings

for combined bearings RAX 400 & RAX 500 series: see pages 142 & 143,
for precision combined bearings in machine tool quality RAXN 400 & RAXN 500 series: see pages 144 & 145.

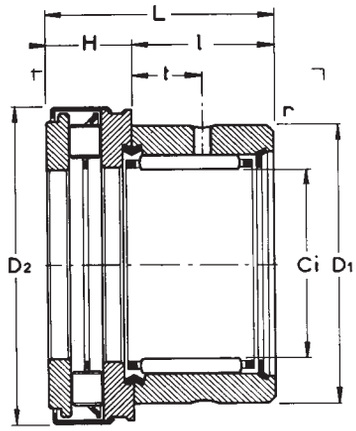
d1	d2	Basic capacities				Speed limit	Weight approx.	Bearing designations
		Radial		Axial				
mm	mm	Dyn. Cr N	Stat. Cor N	Dyn. Ca N	Stat. Coa N	r.p.m.	g	
12	18,6	6 100	7 200	5 000	10 900	15 500	25	**RAX 410**
12,2	18,5	6 100	7 200	8 200	17 900	15 500	26	**RAX 510**
15	22,6	6 600	8 400	7 100	18 500	13 000	32	**RAX 412**
14,8	22,9	6 600	8 400	12 700	29 500	13 000	33	**RAX 512**
17	24,6	9 400	11 700	7 600	20 800	11 500	34	**RAX 415**
16,8	24,9	9 400	11 700	14 000	34 000	11 500	36	**RAX 515**
19	26,6	11 800	16 300	8 100	23 000	10 500	41	**RAX 417**
18,8	26,9	11 800	16 300	15 000	39 000	10 500	44	**RAX 517**
22	31,6	14 700	22 800	11 800	39 000	9 000	66	**RAX 420**
22	31,6	14 700	22 800	22 000	54 000	9 000	70	**RAX 520**
27,7	37,4	16 000	27 500	13 300	49 000	7 500	99	**RAX 425**
27,7	37,4	16 000	27 500	25 500	70 000	7 500	105	**RAX 525**
32,7	42,4	20 500	34 000	14 500	57 000	6 500	111	**RAX 430**
32,7	42,3	20 500	34 000	26 500	77 000	6 500	118	**RAX 530**
37,2	49	22 000	39 500	18 900	84 000	5 500	130	**RAX 435**
37,8	47,8	22 000	39 500	33 800	94 000	5 500	146	**RAX 535**
43	54,9	23 800	45 000	20 400	96 000	5 000	150	**RAX 440**
42,8	54,8	23 800	45 000	46 000	129 000	5 000	174	**RAX 540**
48	59,9	25 300	51 000	21 800	109 000	4 500	179	**RAX 445**
47,8	59,8	25 300	51 000	49 000	143 000	4 500	206	**RAX 545**
53,3	65,7	28 300	61 000	22 500	118 000	4 000	205	**RAX 450**
52,8	64,8	23 800	61 000	51 000	157 000	4 000	232	**RAX 550**
63,5	79,2	31 000	72 000	31 500	193 000	3 500	282	**RAX 460**
63,5	79,5	31 000	72 000	71 000	255 000	3 500	327	**RAX 560**
73,5	89,2	37 500	86 000	34 500	223 000	3 000	386	**RAX 470**
73,5	89,5	37 500	86 000	77 000	295 000	3 000	435	**RAX 570**

Combined bearings with incorporated thrust plate

RAXPZ 400 & RAXZ 500 series
machine tool quality
RAXNPZ 400 &
RAXNZ 500 series



RAXPZ 400



RAXZ 500

Shaft Dia.	Designations		Ci	D1	D2 maxi	l	H	L	t	r mini
mm	RAXPZ 400 Series	RAXZ 500 Series	mm	mm	mm	mm	mm	mm	mm	mm
10	**RAXPZ 410**	**RAXZ 510**	10 10	19 19	22,4 22,4	14 14	7 7,5	21 21,5	6 6	0,35 0,35
12	**RAXPZ 412**	**RAXZ 512**	12 12	21 21	26,4 26,4	14 14	7 8	21 22	6 6	0,35 0,35
15	**RAXPZ 415**	**RAXZ 515**	15 15	24 24	28,4 28,4	14 14	7 8	21 22	6 6	0,35 0,35
17	**RAXPZ 417**	**RAXZ 517**	17 17	26 26	30,4 30,4	16 16	7 8	23 24	8 8	0,65 0,65
20	**RAXPZ 420**	**RAXZ 520**	20 20	30 30	35,4 35,4	18 18	9 11	27 29	9 9	0,85 0,85
25	**RAXPZ 425**	**RAXZ 525**	25 25	37 37	43 43	18 18	9 11	27 29	9 9	0,85 0,85
30	**RAXPZ 430**	**RAXZ 530**	30 30	42 42	48 48	18 18	9 11	27 29	9 9	0,85 0,85
35	**RAXPZ 435**	**RAXZ 535**	35 35	47 47	54 54	18 18	9 12	27 30	9 9	0,85 0,85
40	**RAXPZ 440**	**RAXZ 540**	40 40	52 52	61 61	18 18	9 13	27 31	9 9	0,85 0,85
45	**RAXPZ 445**	**RAXZ 545**	45 45	58 58	66 66	18 18	9 13	27 31	9 9	0,85 0,85
50	**RAXPZ 450**	**RAXZ 550**	50 50	62 62	71 71	21 21	9 13	30 34	11 11	1,3 1,3
60	**RAXPZ 460**	**RAXZ 560**	60 60	72 72	86 86	21 21	11 15	32 36	11 11	1,3 1,3
70	**RAXPZ 470**	**RAXZ 570**	70 70	85 85	96 96	21 21	11 15	32 36	11 11	1,3 1,3

Inner rings

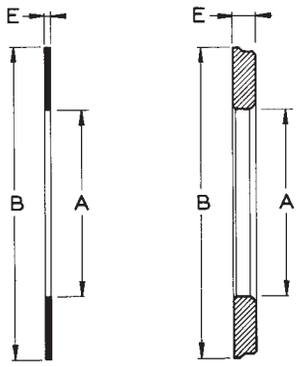
for combined bearings RAXPZ 400 & RAXZ 500 series: see page 143,
for precision combined bearings in machine tool quality RAXNPZ 400 & RAXNZ 500: see page 145.

Combined bearings with retained, overthick thrust plate Type RAXTZ 400
Consult our Technical Department for details.

Basic capacities Radial		Axial		Speed limit	Weight approx.	Bearing designations
Dyn. Cr N	Stat. Cor N	Dyn. Ca N	Stat. Coa N	r.p.m.	g	
6 100	7 200	5 000	10 900	15 500	29	**RAXPZ 410**
6 100	7 200	8 200	17 900	15 500	31	**RAXZ 510**
6 600	8 400	7 100	18 500	13 000	38	**RAXPZ 412**
6 600	8 400	12 700	29 500	13 000	39	**RAXZ 512**
9 400	11 700	7 600	20 800	11 500	40	**RAXPZ 415**
9 400	11 700	14 000	34 000	11 500	44	**RAXZ 515**
11 800	16 300	8 100	23 000	10 500	48	**RAXPZ 417**
11 800	16 300	15 000	39 000	10 500	53	**RAXZ 517**
14 700	22 800	11 800	39 000	9 000	79	**RAXPZ 420**
14 700	22 800	22 000	54 000	9 000	86	**RAXZ 520**
16 000	27 500	13 300	49 000	7 500	118	**RAXPZ 425**
16 000	27 500	25 500	70 000	7 500	131	**RAXZ 525**
20 500	34 000	14 500	57 000	6 500	133	**RAXPZ 430**
20 500	34 000	26 500	77 000	6 500	147	**RAXZ 530**
22 000	39 500	18 900	84 000	5 500	157	**RAXPZ 435**
22 000	39 500	33 800	94 000	5 500	181	**RAXZ 535**
23 800	45 000	20 400	96 000	5 000	184	**RAXPZ 440**
23 800	45 000	46 000	129 000	5 000	218	**RAXZ 540**
25 300	51 000	21 800	109 000	4 500	216	**RAXPZ 445**
25 300	51 000	49 000	143 000	4 500	255	**RAXZ 545**
28 300	61 000	22 500	118 000	4 000	245	**RAXPZ 450**
28 300	61 000	51 000	157 000	4 000	287	**RAXZ 550**
31 000	72 000	31 500	193 000	3 500	365	**RAXPZ 460**
31 000	72 000	71 000	255 000	3 500	423	**RAXZ 560**
37 500	86 000	34 500	223 000	3 000	479	**RAXPZ 470**
37 500	86 000	77 000	295 000	3 000	545	**RAXZ 570**

Thrust plates for standard combined bearings

CP thin and thick series thrust plates for precision bearings in machine tool quality: see page 126.



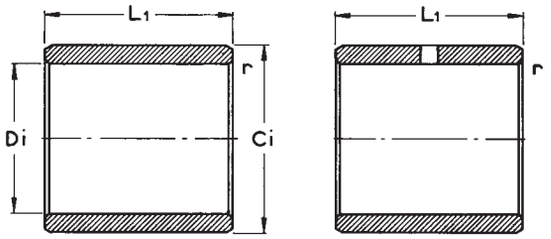
CP thin

CP thick

Bore Dia.	Designations		A nom	B max	E	Weight approx.	For combined bearings		
mm	CP Thin Series	CP Thick Series	mm	mm	mm	g	RAX 700 RAXF 700	RAX 400	RAX 500
10	**CP 10 22**	**CP 2 10 22**	10 10	21,5 21,5	0,8 2	1,7 4,3		RAX 410	RAX 510
12	**CP 12 26**	**CP 2 12 26**	12 12	25,5 25,5	0,8 2	2,5 6,2	RAX, RAXF 712	RAX 412	RAX 512
14	**CP 14 26**	**CP 2 14 26**	14 14	25,5 25,5	0,8 2	2,3 5,6	RAX, RAXF 714		
15	**CP 15 28**	**CP 2 15 28**	15 15	27,5 27,5	0,8 2	2,8 6	RAX, RAXF 715	RAX 415	RAX 515
17	**CP 17 30**	**CP 2 17 30**	17 17	29,5 29,5	0,8 2	2,5 7		RAX 417	RAX 517
18	**CP 18 30**	**CP 2 18 30**	18 18	29,5 29,5	0,8 2	2,3 5,7	RAX, RAXF 718		
20	**CP 20 35**	**CP 3 20 35**	20 20	34,5 34,5	0,8 3	3,8 13	RAX, RAXF 720	RAX 420	RAX 520
25	**CP 25 42**	**CP 3 25 42**	25 25	41,5 41,5	0,8 3	5,3 19	RAX, RAXF 725	RAX 425	RAX 525
30	**CP 30 47**	**CP 3 30 47**	30 30	46,5 46,5	0,8 3	6 22	RAX, RAXF 730	RAX 430	RAX 530
35	**CP 35 52**	**CP 3 35 52**	35 35	51,5 51,5	0,8 3	7 26	RAX, RAXF 735	RAX 435	RAX 535
40	**CP 40 60**	**CP 3 40 60**	40 40	59,5 59,5	0,8 3	9,3 34	RAX, RAXF 740	RAX 440	RAX 540
45	**CP 45 65**	**CP 3 45 65**	45 45	64,4 64,4	0,8 3	10 37	RAX, RAXF 745	RAX 445	RAX 545
50	**CP 50 70**	**CP 3 50 70**	50 50	69,4 69,4	0,8 3	11 40		RAX 450	RAX 550
60	**CP 60 85**	**CP 4 60 85**	60 60	84,3 84,3	0,8 4	17 83		RAX 460	RAX 560
70	**CP 1,5 70 95**	**CP 4 70 95**	70 70	94,3 94,3	1,5 4	32 93		RAX 470	RAX 570

Inner rings for standard combined bearings

IM and IM...P series inner rings for precision bearings in machine tool quality: see page 127.



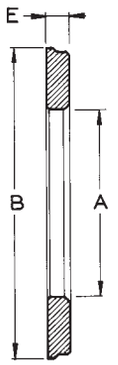
IM, IM...P IMC, IMC...P 1)

1) Inner rings with lubrication hole, type IMC & IMC...P available on request

Shaft Dia.	Designations		Di nom.	Ci maxi	L1	r	Weight approx.	For combined bearings		
	IM Series	IM...P Series						RAX 700 RAXF 700	RAX 400 RAXPZ 400	RAX 500 RAXZ 500
mm			mm	mm	mm	mm	g	Nr.	Nr.	Nr.
7		IM 7 10 16 P	7	10	16	0,2	4,8		410	510
8	IM 8 12 12,4		8	12	12,4	0,3	5,8	712		
9		IM 9 12 16 P	9	12	16	0,2	5,9		412	512
10	IM 10 14 12,4		10	14	12,4	0,3	7	714		
12	IM 12 15 12,4		12	15	12,4	0,2	5,8	715		
		IM 15 12 16 P	12	15	16	0,2	7,6		415	515
13	IM 13 18 16,4		13	18	16,4	0,35	15	718		
14		IM 14 17 17 P	14	17	17	0,2	9,3		417	517
15	IM 15 20 16,4		15	20	16,4	0,35	17	720		
		IM 15 20 20 P	15	20	20	0,35	20,5		420	520
20	IM 20 25 20,4	IM 20 25 20 P	20	25	20	0,35	26,5		425	525
			20	25	20,4	0,35	27	725		
25	IM 25 30 20,4	IM 25 30 20 P	25	30	20	0,35	32		430	530
			25	30	20,4	0,35	33	730		
30	IM 30 35 20,4	IM 30 35 20 P	30	35	20	0,35	38		435	535
			30	35	20,4	0,35	39	735		
35	IM 35 40 20,4	IM 35 40 20 P	35	40	20	0,35	44		440	540
			35	40	20,4	0,35	45	740		
40	IM 40 45 20,4	IM 40 45 20 P	40	45	20	0,35	50		445	545
			40	45	20,4	0,35	51	745		
45		IM 45 50 25 P	45	50	25	0,65	69		450	550
55		IM 55 60 25 P	55	60	25	0,65	84		460	560
60		IM 60 70 25 P	60	70	25	0,85	190		470	570
62		IM 62 70 25 P	62	70	25	0,85	155			

Thrust plates for precision combined bearings in machine tool quality

CPN series

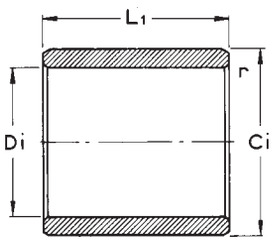


CPN thick

Centred On shaft Dia. mm	Centred On inner ring Ci mm	Designations Standard CPN Series	Designations Supplementary CPN Series	A nom mm	B max mm	E mm	Weight approx. g
10		CPN 2 10 22		10	21,5	2	4,3
			CPN 2,510 22	10	21,7	2,5	5
			CPN 4 10 22	10	21,7	4	9
12		CPN 2 12 26		12	25,5	2	6,2
			CPN 3 12 26	12	25,7	3	9,5
			CPN 4 12 26	12	25,7	4	12
15		CPN 2 15 28		15	27,5	2	6
			CPN 4 15 28	15	27,7	4	13
			CPN 7 15 28	15	27,7	7	24
17		CPN 2 17 30		17	29,5	2	7
			CPN 4 17 30	17	29,7	4	14
			CPN 7 17 30	17	29,7	7	25
	20	CPN 3 20 35		20	34,5	3	13
			CPN 5 20 35	20	34,7	5	24
	25	CPN 3 25 42		25	41,5	3	19
			CPN 5 25 42	25	41,77	5	33
	30	CPN 3 30 47		30	46,5	3	22
			CPN 5 30 47	30	46,7	5	37
	35	CPN 3 35 52		35	51,5	3	26
			CPN 4 35 52	35	52	4	34
	40	CPN 3 40 60		40	59,5	3	34
	45	CPN 3 45 65		45	64,4	3	37
	50	CPN 2 50 70		50	69,4	3	40
	60	CPN 4 60 85		60	84,3	4	83
	70	CPN 4 70 95		70	94,3	4	93

Inner rings for precision combined bearings in machine tool quality

IM 19 000 & IM 20 600 series

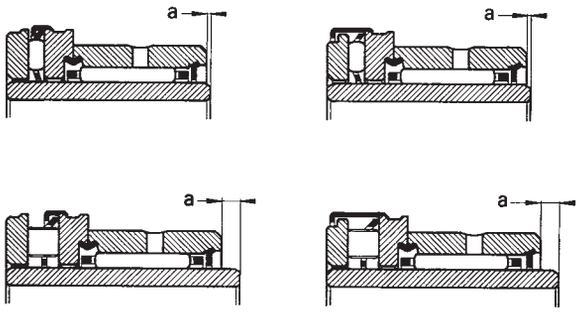


IM, IM...P

r mm { 0,2 for Di = 17 ; 0,5 for Di > 17

Shaft Dia. mm	Designations IM 19 000 Series	Designations IM 20 600 Series	Di mm	Ci mm	L1 mm	Weight approx. g
17	IM 19 017	IM 20 617	17 17	20 20	27,5 31,5	19 21
20	IM 19 020	IM 20 620	20 20	25 25	27,5 31,5	38 44
25	IM 19 025	IM 20 625	25 25	30 30	27,5 31,5	42 48
30	IM 19 030	IM 20 630	30 30	35 35	27,5 31,5	55 63
35	IM 19 035	IM 20 635	35 35	40 40	27,5 31,5	63 72
40	IM 19 040	IM 20 640	40 40	45 45	27,5 31,5	69 80
45	IM 19 045	IM 20 645	45 45	50 50	30,5 34,5	85 96
50	IM 19 050	IM 20 650	50 50	60 60	32,5 38,5	208 250
60	IM 19 060	IM 20 660	60 60	70 70	32,5 39,5	247 300

Bearing assemblies
combined bearings
thrust plates inner rings
● machine tool quality



For combined bearings with retained, over-thick thrust plate, Type RAXNTZ 400, use only the IM rings of the 20 000 series.

Combined bearings and separate thrust plates	Combined bearings with retained thrust plate	Inner rings	a mm
RAXN 420 + CPN 3 20 35	RAXNPZ 420	IM 19 017 IM 20 617	0,5 4,5
RAXN 420 + CPN 5 20 35		IM 20 617	2,5
RAXN 520 + CPN 3 20 35 RAXN 520 + CPN 5 20 35	RAXNZ 520	IM 20 617 IM 20 617	2,5 0,5
RAXN 425 + CPN 3 25 42	RAXNPZ 425	IM 19 020 IM 20 620	0,5 4,5
RAXN 425 + CPN 5 25 42		IM 20 620	2,5
RAXN 525 + CPN 3 25 42 RAXN 525 + CPN 5 25 42	RAXNZ 525	IM 20 620 IM 20 620	2,5 0,5
RAXN 430 + CPN 3 30 47	RAXNPZ 430	IM 19 025 IM 20 625	0,5 4,5
RAXN 430 + CPN 5 30 47		IM 20 625	2,5
RAXN 530 + CPN 3 30 47 RAXN 530 + CPN 5 30 47	RAXNZ 530	IM 20 625 IM 20 625	2,5 0,5
RAXN 435 + CPN 3 35 52	RAXNPZ 435	IM 19 030 IM 20 630	0,5 4,5
RAXN 435 + CPN 4 35 52		IM 20 630	3,5
RAXN 535 + CPN 3 35 52 RAXN 535 + CPN 4 35 52	RAXNZ 535	IM 20 630 IM 20 630	1,5 0,5
RAXN 440 + CPN 3 40 60	RAXNPZ 440	IM 19 035 IM 20 635	0,5 4,5
RAXN 540 + CPN 3 40 60	RAXNZ 540	IM 20 635	0,5
RAXN 445 + CPN 3 45 65	RAXNPZ 445	IM 19 040 IM 20 640	0,5 4,5
RAXN 545 + CPN 3 45 65	RAXNZ 545	IM 20 640	0,5
RAXN 450 + CPN 3 50 70	RAXNPZ 450	IM 19 045 IM 20 645	0,4 4,5
RAXN 550 + CPN 3 50 70	RAXNZ 550	IM 20 645	0,5
RAXN 460 + CPN 4 60 85	RAXNPZ 460	IM 19 050 IM 20 650	0,5 6,5
RAXN 560 + CPN 4 60 85	RAXNZ 560	IM 20 650	2,5
RAXN 470 + CPN 4 70 95	RAXNPZ 470	IM 19 060 IM 20 660	0,5 7,5
RAXN 570 + CPN 4 70 95	RAXNZ 570	IM 20 660	3,5

PRECISION COMBINED BEARINGS, WITH ADJUSTABLE AXIAL PRELOAD.

Types AXNA, AXNB and ARNB combined bearings and their derivatives consist of a needle bearing with or without a cage, in an outer race, with a high radial thickness, each face of which acts as a raceway for a needle or roller thrust bearing. The inner ring, secured laterally between the thrust plates, acts as the inner radial raceway.

These bearings which take up very little space, are particularly recommended for shafts requiring very precise axial positioning, operating under load, such as leading spindles, ballscrews for numerically-controlled machine tools, drive shafts on control apparatus, etc.

SERIES TYPE				
	With attachment holes	Radial caged bearing	Thrust bearing	
			needle	roller
AXNA			●	
AXNAT	●		●	
AXNB		●	●	
AXNBT	●	●	●	
ARNB		●		●
ARNBT	●	●		●

SELECTION OF BEARING TYPE

Subject to calculations made for each application, the following general classifications can be made:

AXNA, AXNAT and AXNB, AXNBT bearings for slow speed assemblies with low operating loads: the particularly high axial rigidity of needle thrust bearings, together with the advantages of preloading, ensure a very high axial precision and satisfactory working life.

For example: displacement drive shafts on control apparatus.

ARNB and ARNBT, series 1 and 2 bearings generally enable preloading to be chosen which suit the precision and working life required of production machine tools.

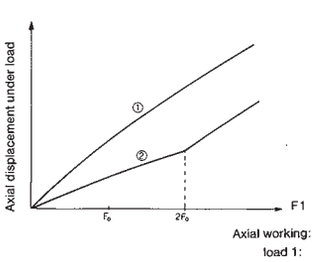
ARNB series 3 bearings for machine tools, machining units or special equipment requiring very high axial rigidity with high loads and slow speeds.

PRELOAD

This technique consists in subjecting the thrust bearings to controlled preload during assembly, using an adjusting nut, in order to eliminate play and reduce the axial displacement caused by the operating stress regardless of the direction or the axial load.

NADELLA has always made the inner ring slightly longer than the space between the thrust plates before adjustment. This means that when the nut is tightened, the inner ring is compressed between the thrust plates and exerts a stress, by reaction, on the internal thread of the screw. This prevents it from being loosened and loss of adjustment occurring.

In an assembly with an axial preload of Fo, an operating stress F1 overloads one of the thrust bearings and frees the other of a load approximately equal to F1/2. In an assembly without preload, the loaded thrust bearing must carry the entire stress F1.



(1) Thrust bearings without preload.
(2) Thrust bearings under a preload Fo.

In a preloaded assembly, the axial rigidity is therefore approximately twice that of an assembly without preload. This result is obtained as long as the operating stress F1 remains less than about twice the preload stress Fo. When F1 > 2 Fo, one of the thrust bearings is total freed and the other thrust bearing completely carries the load F1; in this case, the axial run-out remains less than it would have been for an assembly without preload (see figure).

DETERMINING OF PRELOAD

Preload should be determined according to the axial precision required under maximum load and the working life required.

The working life of the thrust bearing carrying the greater load depends on the resulting stress applied, i.e. Fo + F1/2 when F1 < 2 Fo or when F1 > 2 Fo. Since these two cases can both occur on the same machine according to the type of machining carried out, the calculations must take into account the running time ratios under the various loads and speeds.

For more usual assemblies, a preload stress Fo of 5 to 10% of the dynamical load carrying capacity C of the thrust bearing, is usually suitable.

For certain applications, with slow rotating speeds, for example, the preload stress can be increased to allow for a higher operating load while remaining within the limit of the preload effect, and achieving a satisfactory working life.

ADJUSTMENT OF PRELOAD

For a given assembly, the shaft torque is defined first, which corresponds to the preload required. Series adjustments can then be made on each machine by simply checking the torque. If, as a result of assembly, this is not possible, the nut tightening torque needed to obtain preload is determined separately on the test assemblies. The torque must then be respected for series adjustments. The torque must be measured after starting up the thrust bearing, since it can be up to 50% higher at the beginning of rotation.

BEARING TOLERANCES

The outer and inner rings of the combined bearings are manufactured with class 5 tolerances according to ISO Standard 492 (class P6 of standard DIN 620).

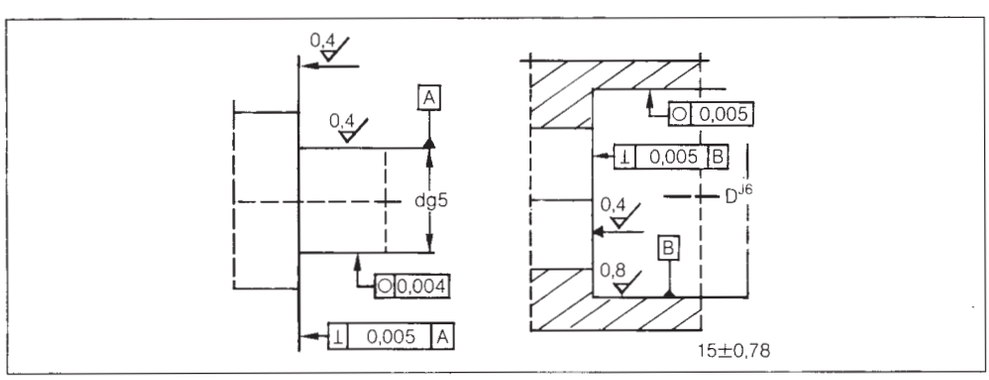
The radial play before assembly is kept within the limits of group 2 given for inner and outer paired rings according to ISO Standard 5753 (class C2 "paired rings" of standard DIN 620). See table page 45 (play C2ZS).

The axial run-out of the thrust bearing plates is in accordance with tolerance class 4 according to ISO Standard 199 (class P4 of standard DIN 620).

ASSEMBLY RECOMMENDATIONS

Shaft tolerance: g5 on dimension Di.
Tolerance of outer ring housing: J6 on dimension De.

The bearing parts of the thrust bearings must be rigid, with plane faces, perpendicular to the rotation axis and of very good surface quality to avoid caulking during use as this decreases the preloading. Their outside diameter must be at least equal to the average diameter of the race, dimension Dm.



The outer ring of the combined bearings should be blocked against a shoulder in order to avoid any axial displacement under load.

In type AXNA, AXNB and ARNB bearings, they are usually blocked by a spacer positioned lengthways during assembly. A flange attached by screws to the frame is located against the spacer.

The outer ring of type AXNAT, AXNBT and ARNBT bearings has three attachment screw holes for direct attachment to the frame.

Apart from watertight bearings (AXNBT.../2 or ARNBT.../2) or the use of long plates (AXNB (T).../1 or ARNB (T).../1), friction of joints on the outside diameter of the thrust bearing plates (dimension A) can be envisaged. In this case, please consult us for positioning.

NADELLA's technical services will supply any further information concerning the choice or assembly of these bearings, on request, together with calculation and adjustment of the axial preload.

LUBRICATION

The oil used to lubricate the other parts of the assembly is generally suitable for combined bearings whose outer ring has three 120° holes connected by a groove. Grease can generally be used if the rotating speed is in the order of 50% of the maximum speeds given in the dimensional tables. However, special top quality greases enable higher speeds to be reached. By way of information, oils with viscosities of 30 to 150 cSt are recommended.

EXAMPLES OF CALCULATIONS

▶ *Choice of bearing*

P: stress under which precision is needed.

$P < 2 \times$ Preloading.

In this field of preloading, the axial rigidity is equal to 2K.

The interference is $\frac{1}{2K} P$

Example: If P = 7000 N, ARNB 50 90 will be chosen, since the preloading value is 3800 N and

$2 \times 3800 = 7600 \text{ N} > P$.

Rigidity in this field $k = 2K = 3900$ N/µm.

Under P, the interference will be

$\frac{1}{3900} \times 7000 = 1{,}79$ µm.

▶ *Working life*

The hypotheses given in the table below enable the equivalent speed and an equivalent load to be determined according to the maximum load and maximum speed, which enables a rapid calculation of the theoretical working life to be made under average operating conditions.

	1	2	3	4
Loads	Pmax	0,8 x Pmax	0,5 x Pmax	0,2 x Pmax
Speeds	0,05 x Vmax	0,2 x Vmax	0,5 x Vmax	Vmax
Fraction of time	0,15	0,40	0,30	0,15

▶ *Calculation of equivalent speed:*

$V_{éq.} = (0{,}15 \times 0{,}05 + 0{,}40 \times 0{,}2 + 0{,}30 \times 0{,}5 + 0{,}15)\, V_{max} \approx 0{,}39 \times V_{max}$

Calculation of equivalent load:

$$P_{eq} \approx \sqrt[P]{\frac{P^P_{max} \times n_{max} (0{,}0075 + 0{,}08 \times 0{,}8^P + 0{,}15 \times 0{,}5^P + 0{,}15 \times 0{,}2^P)}{0{,}39 \times V_{max}}}$$

$P_{éq} \approx 0{,}575 \times P_{max}$

$p = 10/3$

This comparative method can be used for traverse mechanisms on conventional machine tools.

For special machines and control apparatus, the breakdown of loads and speeds can be different and the formula must be applied with caution.

Note: in this rapid calculation, preload is not taken into consideration; its influence on the working life of the bearings is actually very low for most applications if the adjustment conditions given in the literature are respected: preload between 5 and 10% of the dynamic capacity of the thrust bearings.

Example: for a maximum load P of 14 000 N and a maximum speed of 1000 r.p.m.

Equivalent speed: 0.39 x 1000 = 390 r.p.m.

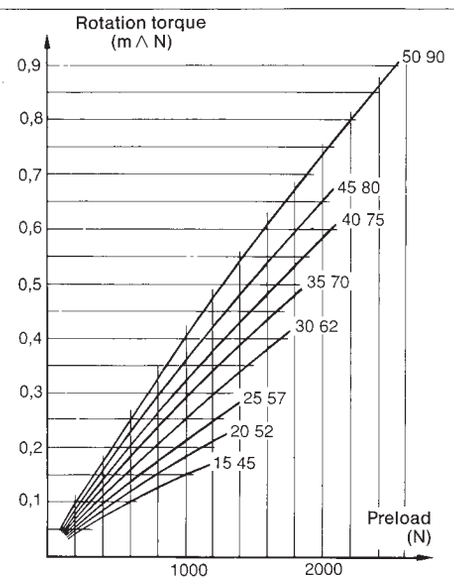
Equivalent load: 0.575 x 14 000 = 8050 N.

Theoretical working life of ARNB 50 90:

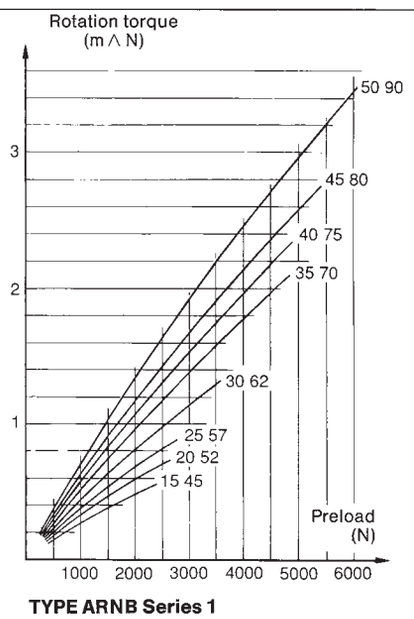
$$\frac{\left(\frac{C}{P}\right)^{\frac{10}{3}} \times 10^6}{60n} = \frac{\left(\frac{60.000}{8050}\right)^{\frac{10}{3}} \times 10^6}{60 \times 390} = 34\,600 \text{ hours}$$

In this example, it is assumed that the time fraction n° 2 is a time fraction when precision machining is not required.

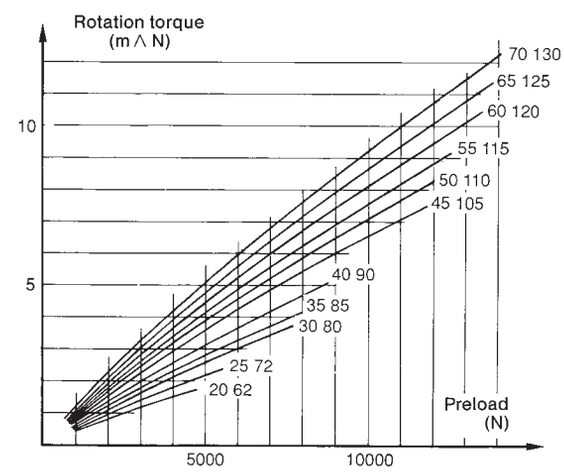
ROTATION TORQUE AS A FUNCTION OF THE PRELOAD



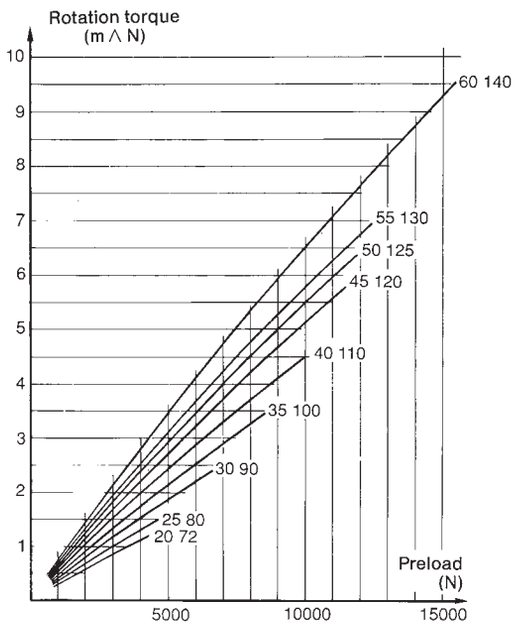
TYPE AXNB



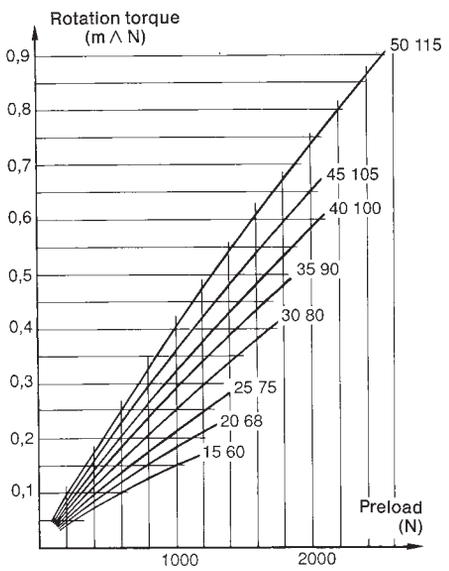
TYPE ARNB Series 1



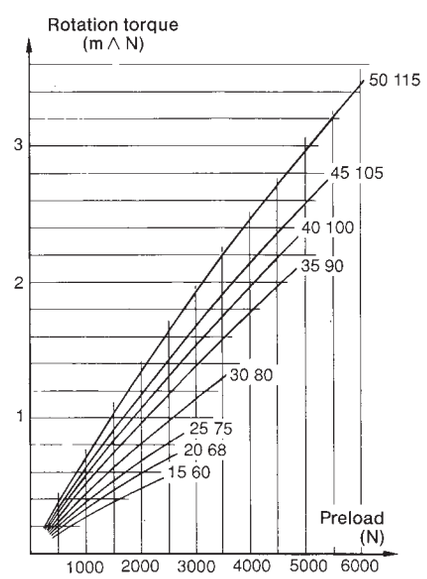
TYPE ARNB Series 2



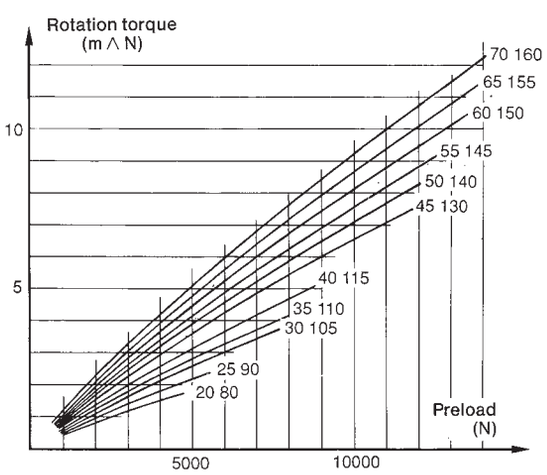
TYPE ARNB Series 3



TYPE AXNBT



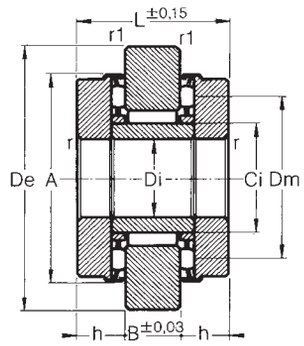
TYPE ARNBT Series 1



TYPE ARNBT Series 2

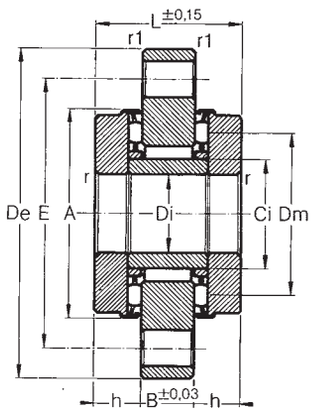
Precision combined bearings with adjustable axial preload.

AXNA and AXNAT series



AXNA

Shaft ∅ mm	Designation AXNA	AXNAT	Dimensions in mm Di	De	Ci	A	Dm	L	B	h	r mini	r1 mini	Attachment CHC screw grade (M)	N° of screws	E mm	Torque Nm
5	5 22		5	22	7,3	17	12,5	12	4	4	0,35	0,35				
		5 32	5	32	7,3	17	12,5	12	4	4	0,35	0,35	3 x 10	4	24	1,4
6	6 28		6	28	8,7	22	15,3	16	6	5	0,35	0,35				
		6 38	6	38	8,7	22	15,3	16	6	5	0,35	0,35	4 x 12	4	30	3
7	7 32		7	32	11,1	26	18,8	18	6	6	0,35	0,35				
		7 42	7	42	11,1	26	18,8	18	6	6	0,35	0,35	4 x 12	6	34	3
8	8 32		8	32	11,1	26	18,8	18	6	6	0,35	0,35				
		8 42	8	42	11,1	26	18,8	18	6	6	0,35	0,35	4 x 12	6	34	3
9	9 35		9	35	12,8	28	20,8	20	8	6	0,35	0,35				
		9 45	9	45	12,8	28	20,8	20	8	6	0,35	0,35	4 x 16	6	37	3
10	10 37		10	37	14,1	30	22,8	22	8	7	0,35	0,35				
		10 48	10	48	14,1	30	22,8	22	8	7	0,35	0,35	5 x 16	6	39	6
12	12 40		12	40	16,6	32	24,8	22	8	7	0,35	0,35				
		12 50	12	50	16,6	32	24,8	22	8	7	0,35	0,35	5 x 16	6	41	6



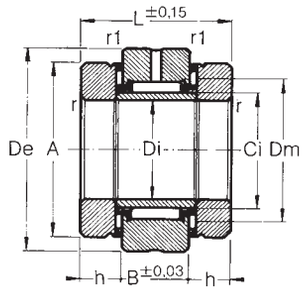
AXNAT

	Basic loads (N)				Maximum speed	Preload 1)	Residual torque 2)	Rigidity K 3)	Threading (M)	Bearing reference
	radial		axial							
	Dyn. Cr	Stat. Cor	Dyn. Ca	Stat. Coa	r.p.m.	N	Nmm	N/µm	(M)	
	2 350	2 650	4 000	9 400	19 000	252	55	32	5 x 0,8	AXNA 5 22
	2 350	2 650	4 000	9 400	19 000	252	55	32	5 x 0,8	AXNAT 5 32
	4 900	5 800	7 200	17 500	15 500	340	70	50	6 x 1	AXNA 6 28
	4 900	5 800	7 200	17 500	15 500	340	70	50	6 x 1	AXNAT 6 38
	5 800	7 400	7 900	21 000	13 000	469	130	100	7 x 1	AXNA 7 32
	5 800	7 400	7 900	21 000	13 000	469	130	100	7 x 1	AXNAT 7 42
	5 800	7 400	7 900	21 000	13 000	469	130	100	8 x 1	AXNA 8 32
	5 800	7 400	7 900	21 000	13 000	469	130	100	8 x 1	AXNAT 8 42
	9 000	11 900	8 500	23 800	11 500	497	190	116	9 x 1	AXNA 9 35
	9 000	11 900	8 500	23 800	11 500	497	190	116	9 x 1	AXNAT 9 45
	9 700	13 100	9 000	26 500	10 500	525	180	119	10 x 1	AXNA 10 37
	9 700	13 100	9 000	26 500	10 500	525	180	119	10 x 1	AXNAT 10 48
	10 900	15 500	9 200	27 800	10 000	532	220	120	12 x 1,5	AXNA 12 40
	10 900	15 500	9 200	27 800	10 000	532	220	120	12 x 1,5	AXNAT 12 50

1) 6% ≈ of basic dynamic axial load.
2) With axial load equal to preload.
3) Rigidity of a single thrust bearing with load equal to preload.

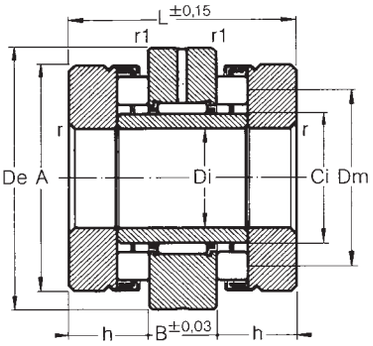
Precision combined bearings with adjustable axial preload

AXNB and ARNB series



AXNB

Shaft Ø mm	Designation				Dimensions in mm									
	AXNB	ARNB Series 1	ARNB Series 2	ARNB Series 3	Di	De	Ci	A	Dm	L	B	h	r mini.	r1 mini.
15	15 45	15 45			15 15	45 45	20 20	35 35	26,8 26,8	40 46	16 16	12 15	0,85 0,85	0,85 0,85
20	20 52	20 52	20 62	20 72	20 20 20 20	52 52 62 72	25 25 30 30	42 42 52 60	32,5 32,5 39,9 43,5	40 46 60 60	16 16 20 20	12 15 20 20	0,85 0,85 1,3 1,3	0,85 0,85 0,85 0,85
25	25 57	25 57	25 72	25 80	25 25 25 25	57 57 72 80	30 30 35 35	47 47 62 68	37,5 37,5 46,7 49,8	44 50 60 60	20 20 20 20	12 15 20 20	0,85 0,85 1,3 1,3	0,85 0,85 0,85 0,85
30	30 62	30 62	30 80	30 90	30 30 30 30	62 62 80 90	35 35 40 40	53 53,4 68 78	43,1 42,8 52,7 57	44 50 66 66	20 20 20 20	12 15 23 23	0,85 0,85 1,3 1,3	0,85 0,85 0,85 0,85
35	35 70	35 70	35 85	35 100	35 35 35 35	70 70 85 100	40 40 45 45	60 60,4 73 85	48,9 48,8 57,7 63	48 54 66 66	20 20 20 20	14 17 23 23	1,3 1,3 1,3 1,3	0,85 0,85 0,85 0,85
40	40 75	40 75	40 90	40 110	40 40 40 40	75 75 90 110	45 45 50 50	65 65,4 78 95	53,9 53,8 62,7 70	48 54 75 75	20 20 25 25	14 17 25 25	1,3 1,3 1,3 1,3	0,85 0,85 0,85 0,85
45	45 80	45 80	45 105	45 120	45 45 45 45	80 80 105 120	50 50 55 55	70 70,4 90 105	59,5 58,8 70,9 78,2	54 60 82 82	25 25 25 25	14,5 17,5 28,5 28,5	1,3 1,3 1,3 1,3	0,85 0,85 0,85 0,85
50	50 90	50 90	50 110	50 125	50 50 50 50	90 90 110 125	55 55 60 60	78 78,4 95 110	65,5 65,5 75,9 83,2	54 60 82 82	25 25 25 25	14,5 17,5 28,5 28,5	1,3 1,3 1,75 1,75	0,85 0,85 0,85 0,85
55			55 115	55 130	55 55	115 130	65 65	100 115	80,9 88,2	82 82	25 25	28,5 28,5	1,75 1,75	0,85 0,85
60			60 120	60 140	60 60	120 140	70 70	105 125	85,9 96	82 82	25 25	28,5 28,5	1,75 1,75	0,85 0,85
65			65 125		65	125	75	110	90,9	82	25	28,5	1,75	0,85
70			70 130		70	130	80	115	95,9	82	25	28,5	1,75	0,85
75			75 155		75	155	90	135	109,9	100	30	35	1,75	0,85
90			90 180		90	180	110	160	132,9	110	35	37,5	1,75	0,85



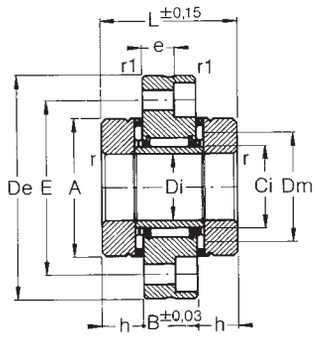
ARNB

Basic loads (N)				Maximum speed	Preload 1)	Residual torque 2)	Rigidity K 3)	Mass	Bearing reference
radial		axial							
Dyn. Cr	Stat. Cor	Dyn. Ca	Stat. Coa	r.p.m.	N	Nmm	N/µm	g	
16 200	22 000	12 000	40 000	9 000	735	120	1 250	296	**AXNB 15 45**
16 200	22 000	20 500	49 000	9 000	1 340	350	780	316	**ARNB 15 45**
18 900	28 800	13 500	50 000	7 500	820	160	1 480	392	**AXNB 20 52**
18 900	28 800	23 500	63 000	7 500	1 550	500	950	418	**ARNB 20 52**
28 000	44 500	48 000	115 000	6 300	3 010	1 200	1 130	875	**ARNB 20 62**
28 000	44 500	42 500	148 000	5 600	2 765	800	1 700	1 300	**ARNB 20 72**
28 000	44 500	14 800	58 500	6 500	880	200	1 780	515	**AXNB 25 57**
28 000	44 500	24 800	70 000	6 500	1 620	550	1 090	543	**ARNB 25 57**
30 500	53 000	66 000	165 000	5 300	4 130	1 900	1 270	1 180	**ARNB 25 72**
30 500	53 000	48 000	179 000	4 900	3 060	1 000	1 900	1 565	**ARNB 25 80**
30 500	53 000	19 000	85 000	5 500	1 130	300	1 880	585	**AXNB 30 62**
30 500	53 000	32 000	88 000	5 500	2 100	850	1 070	620	**ARNB 30 62**
32 500	59 000	83 000	210 000	4 800	5 040	2 600	1 450	1 520	**ARNB 30 80**
32 500	59 000	68 000	250 000	4 200	4 340	1 600	2 300	2 145	**ARNB 30 90**
32 500	59 000	20 500	97 000	5 000	1 210	350	2 250	787	**AXNB 35 70**
32 500	59 000	45 000	124 000	5 000	2 910	1 350	1 300	815	**ARNB 35 70**
34 500	67 000	86 000	228 000	4 300	5 250	2 900	1 520	1 642	**ARNB 35 85**
34 500	67 000	90 000	328 000	3 800	5 770	2 400	2 500	2 535	**ARNB 35 100**
34 500	67 000	22 000	110 000	4 500	1 300	400	2 630	860	**AXNB 40 75**
34 500	67 000	47 500	138 000	4 500	3 070	1 550	1 470	908	**ARNB 40 75**
44 000	95 000	93 000	260 000	4 000	5 740	3 500	1 620	2 110	**ARNB 40 90**
44 000	95 000	106 000	420 000	3 400	6 750	3 200	3 000	3 570	**ARNB 40 110**
44 000	95 000	22 700	119 000	4 000	1 340	450	2 980	1 100	**AXNB 45 80**
44 000	95 000	50 000	150 000	4 000	3 230	1 750	1 480	1 232	**ARNB 45 80**
44 000	98 000	127 000	345 000	3 600	7 770	5 300	1 930	3 060	**ARNB 45 105**
44 000	98 000	122 000	520 000	3 100	7 700	4 100	3 400	4 700	**ARNB 45 120**
44 000	98 000	28 500	164 000	3 800	1 680	650	3 500	1 385	**AXNB 50 90**
44 000	98 000	60 000	197 000	3 800	3 800	2 350	1 950	1 440	**ARNB 50 90**
48 000	113 000	131 000	370 000	3 300	8 120	5 900	2 020	3 320	**ARNB 50 110**
48 000	113 000	128 000	560 000	2 900	8 050	4 600	3 450	4 945	**ARNB 50 125**
53 500	119 000	135 000	395 000	3 100	8 400	6 500	2 170	3 535	**ARNB 55 115**
53 500	119 000	134 000	610 000	2 800	8 330	4 900	3 750	5 256	**ARNB 55 130**
56 000	128 000	147 000	445 000	2 900	9 100	7 500	2 500	3 717	**ARNB 60 120**
56 000	128 000	174 000	710 000	2 600	10 640	6 800	4 100	5 976	**ARNB 60 140**
64 000	143 000	150 000	470 000	2 800	9 310	8 100	2 550	3 960	**ARNB 65 125**
73 000	148 000	155 000	495 000	2 600	9 520	8 800	2 720	4 136	**ARNB 70 130**
77 000	165 000	230 000	730 000	2 300	14 140	14 800	3 050	7 700	**ARNB 75 155**
118 000	268 000	288 00	990 000	1 900	17 640	22 200	3 700	11 654	**ARNB 90 180**

1) 6% ≈ of basic dynamic axial load.
2) With axial load equal to preload.
3) Rigidity of a single thrust bearing with load equal to preload.

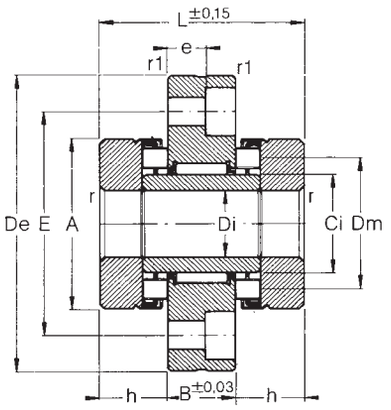
Precision combined bearings with adjustable axial preload

AXNBT and
ARNBT series



AXNBT

Shaft ∅ mm	Designation AXNBT	ARNBT Series 1	ARNBT Series 2	Dimensions in mm Di	De	Ci	A	Dm	L	B	h	r mini	r1 mini	Attachment CHC screw grade (M)	N° of screws	E mm	e mm	Torque Nm
15	15 60			15	60	20	35	26,8	40	16	12	0,85	0,85	6 x 20	6	46	9	10
		15 60		15	60	20	35	26,8	46	16	15	0,85	0,85	6 x 20	6	46	9	10
20	20 68			20	68	25	42	32,5	40	16	12	0,85	0,85	6 x 20	8	53	9	10
		20 68		20	68	25	42	32,5	46	16	15	0,85	0,85	6 x 20	8	53	9	10
			20 80	20	80	30	52	39,9	60	20	20	1,30	0,85	6 x 25	12	63	13	10
25	25 75			25	75	30	47	37,5	44	20	12	0,85	0,85	6 x 25	8	58	13	10
		25 75		25	75	30	47	37,5	50	20	15	0,85	0,85	6 x 25	8	58	13	10
			25 90	25	90	35	62	46,7	60	20	20	1,30	0,85	6 x 25	12	73	13	10
30	30 80			30	80	35	53	43,1	44	20	12	0,85	0,85	6 x 25	12	63	13	10
		30 80		30	80	35	53,4	42,8	50	20	15	0,85	0,85	6 x 25	12	63	13	10
			30 105	30	105	40	68	52,7	66	20	23	1,30	0,85	8 x 25	12	85	11	24
35	35 90			35	90	40	60	48,9	48	20	14	1,30	0,85	6 x 25	12	73	13	10
		35 90		35	90	40	60,4	48,8	54	20	17	1,30	0,85	6 x 25	12	73	13	10
			35 110	35	110	45	73	57,7	66	20	23	1,30	0,85	8 x 25	12	88	11	24
40	40 100			40	100	45	65	53,9	48	20	14	1,30	0,85	8 x 25	8	80	11	24
		40 100		40	100	45	65,4	53,8	54	20	17	1,30	0,85	8 x 25	8	80	11	24
			40 115	40	115	50	78	62,7	75	25	25	1,30	0,85	8 x 30	12	94	16	24
45	45 105			45	105	50	70	59,5	54	25	14,5	1,30	0,85	8 x 30	8	85	16	24
		45 105		45	105	50	70,4	58,8	60	25	17,5	1,30	0,85	8 x 30	8	85	16	24
			45 130	45	130	55	90	70,9	82	25	28,5	1,30	0,85	8 x 30	12	105	16	24
50	50 115			50	115	55	78	65,5	54	25	14,5	1,30	0,85	8 x 30	12	94	16	24
		50 115		50	115	55	78,4	65,5	60	25	17,5	1,30	0,85	8 x 30	12	94	16	24
			50 140	50	140	60	95	75,9	82	25	28,5	1,75	0,85	10 x 30	12	113	14	48
55			55 145	55	145	65	100	80,9	82	25	28,5	1,75	0,85	10 x 30	12	118	14	48
60			60 150	60	150	70	105	85,9	82	25	28,5	1,75	0,85	10 x 30	12	123	14	48
65			65 155	65	155	75	110	90,9	82	25	28,5	1,75	0,85	10 x 30	12	128	14	48
70			70 160	70	160	80	115	95,9	82	25	28,5	1,75	0,85	10 x 30	12	133	14	48
75			75 185	75	185	90	135	109,9	100	30	35	1,75	1,30	12 x 35	12	155	17	80
90			90 210	90	210	110	160	132,9	110	35	37,5	1,75	1,30	12 x 40	16	180	22	80



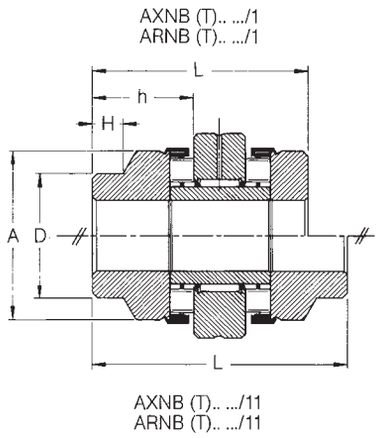
ARNBT

Basic loads (N)				Maximum speed	Preload 1)	Residual torque 2)	Rigidity K 3)	Mass	Bearing reference
radial		axial							
Dyn. Cr	Stat. Cor	Dyn. Ca	Stat. Coa	r.p.m.	N	Nmm	N/µm	g	
16 200	22 000	12 000	40 000	9 000	735	120	1 250	406	**AXNBT 15 60**
16 200	22 000	20 500	49 000	9 000	1 340	350	780	427	**ARNBT 15 60**
18 900	28 800	13 500	50 000	7 500	820	160	1 480	521	**AXNBT 20 68**
18 900	28 800	23 500	63 000	7 500	1 550	500	950	548	**ARNBT 20 68**
28 000	44 500	48 000	115 000	6 300	3 010	1 200	1 130	1 088	**ARNBT 20 80**
28 000	44 500	14 800	58 500	6 500	880	200	1 780	740	**AXNBT 25 75**
28 000	44 500	24 800	70 000	6 500	1 620	550	1 090	768	**ARNBT 25 75**
30 500	53 000	66 000	165 000	5 300	4 130	1 900	1 270	1 438	**ARNBT 25 90**
30 500	53 000	19 000	85 000	5 500	1 130	300	1 880	798	**AXNBT 30 80**
30 500	53 000	32 000	88 000	5 500	2 100	850	1 070	833	**ARNBT 30 80**
32 500	59 000	83 000	210 000	4 800	5 040	2 600	1 450	1 876	**ARNBT 30 105**
32 500	59 000	20 500	97 000	5 000	1 210	350	2 250	1 079	**AXNBT 35 90**
32 500	59 000	45 000	124 000	5 000	2 910	1 350	1 300	1 108	**ARNBT 35 90**
34 500	67 000	86 000	228 000	4 300	5 250	2 900	1 520	2 029	**ARNBT 35 110**
34 500	67 000	22 000	110 000	4 500	1 300	400	2 630	1 257	**AXNBT 40 100**
34 500	67 000	47 500	138 000	4 500	3 070	1 550	1 470	1 306	**ARNBT 40 100**
44 000	95 000	93 000	260 000	4 000	5 740	3 500	1 620	2 657	**ARNBT 40 115**
44 000	95 000	22 700	119 000	4 000	1 340	450	2 980	1 652	**AXNBT 45 105**
44 000	95 000	50 000	150 000	4 000	3 230	1 750	1 480	1 684	**ARNBT 45 105**
44 000	98 000	127 000	345 000	3 600	7 770	5 300	1 930	3 723	**ARNBT 45 130**
44 000	98 000	28 500	164 000	3 800	1 680	650	3 500	1 932	**AXNBT 50 115**
44 000	98 000	60 000	197 000	3 800	3 800	2 350	1 950	1 987	**ARNBT 50 115**
48 000	113 000	131 000	370 000	3 300	8 120	5 900	2 020	4 091	**ARNBT 50 140**
53 500	119 000	135 000	395 000	3 100	8 400	6 500	2 170	4 353	**ARNBT 55 145**
56 000	128 000	147 000	445 000	2 900	9 100	7 500	2 500	4 581	**ARNBT 60 150**
64 000	143 000	150 000	470 000	2 800	9 310	8 100	2 550	4 871	**ARNBT 65 155**
73 000	148 000	155 000	495 000	2 600	9 520	8 800	2 720	5 093	**ARNBT 70 160**
77 000	165 000	230 000	730 000	2 300	14 140	14 800	3 050	8 915	**ARNBT 75 185**
118 000	268 000	288 000	990 000	1 900	17 640	22 200	3 700	13 200	**ARNBT 90 210**

1) 6% ≈ of basic dynamic axial load.
2) With axial load equal to preload.
3) Rigidity of a single thrust bearing with load equal to preload.

Precision combined bearings with adjustable axial preload and thick plates for tight mounting

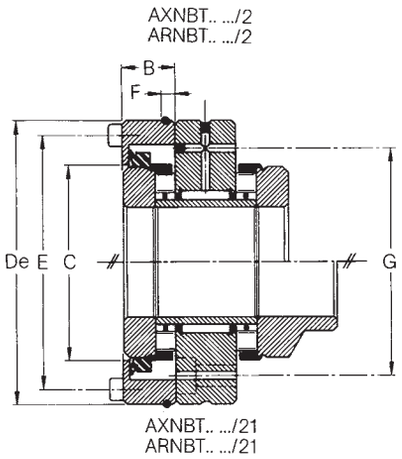
AXNB (T) and
ARNB (T).. .../1
or 11 series

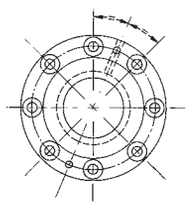


Shaft ∅ mm	Designation AXNB .. .../1 .. .../11	AXNBT .. .../1 .. .../11	ARNB .. .../1 .. .../11 Series 1	ARNBT .. .../1 .. .../11 Series 1	ARNB .. .../1 .. .../11 Series 2	ARNBT .. .../1 .. .../11 Series 2	A mm	D mm	H mm	h mm	L (suffix) .. .../1 mm	L (suffix) .. .../1 mm
15	15 45	15 60	15 45	15 60			35 35	25 25	11 11	27 29	55 60	70 74
20	20 52	20 68	20 52	20 68	20 62	20 80	42 42 52	30 30 40	11 11 11	27 29 35	55 60 75	70 74 90
25	25 57	25 75	25 57	25 75	25 72	25 90	47 47 62	35 35 45	11 11 11	28 30 35	60 65 75	76 80 90
30	30 62	30 80	30 62	30 80	30 80	30 105	53 53,4 68	40 40 50	12 12 11	27 30 39	59 65 82	74 80 98
35	35 70	35 90	35 70	35 90	35 85	35 110	60 60,4 73	45 45 60	12 12 12	29 33 39	63 70 82	78 86 98
40	40 75	40 100	40 75	40 100	40 90	40 115	65 65,4 78	50 50 60	12 12 12	29 33 43	63 70 93	78 86 111
45	45 80	45 105	45 80	45 105	45 105	45 130	70 70,4 90	55 55 70	12 12 15	28,5 32,5 49,5	68 75 103	82 90 124
50	50 90	50 115	50 90	50 115	50 110	50 140	78 78,4 95	60 60 75	12 12 15	31,5 35,5 49,5	71 78 103	88 96 124
55					55 115	55 145	100	80	15	49,5	103	124
60					60 120	60 150	105	90	16	49,5	103	124
65					65 125	65 155	110	90	16	49,5	103	124
70					70 130	70 160	115	100	16	49,5	103	124
75					75 155	75 185	135	110	16	60	125	150
90					90 180	90 210	160	130	16	62,5	135	160

Tight precision combined bearings with adjustable axial preload

AXNBT and
ARNBT.. .../2 or
21 series

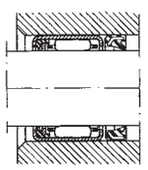




Position of
lubricating holes.

Shaft ∅ mm	Designation AXNBT .. .../2 .. .../21	Designation ARNBT .. .../2 .. .../21	De mm	B mm	G mm	C mm	F mm	Attachment 4 x CHC screws (M)	Attachment E mm
15	**15 60**		60	12	46	36	3,9	3 x 16	52,5
		15 60	60	14	46	36	3,9	3 x 18	52,5
20	**20 68**		68	13	53	43	3,9	3 x 18	61
		20 68	68	15	53	43	3,9	3 x 20	61
		20 80	80	18	63	53	3,9	3 x 25	73
25	**25 75**		75	13	58	48	3,9	3 x 18	67,5
		25 75	75	15	58	48	3,9	3 x 20	67,5
		25 90	90	19	73	63	3,9	3 x 25	82
30	**30 80**		80	13	63	54,5	3,9	3 x 18	73
		30 80	80	16	63	54,5	3,9	3 x 20	73
		30 105	105	20,5	85	69	3,9	3 x 25	93
35	**35 90**		90	13	73	61,5	3,9	4 x 20	81,5
		35 90	90	17	73	61,5	3,9	4 x 25	81,5
		35 110	110	22,5	88	74	3,9	4 x 35	101,5
40	**40 100**		100	13	80	66,5	3,9	4 x 20	89
		40 100	100	17	80	66,5	3,9	4 x 25	89
		40 15	115	22,5	94	79	3,9	4 x 35	106,5
45	**45 105**		105	15	85	71,5	3,9	4 x 20	95,5
		45 105	105	19	85	71,5	3,9	4 x 25	95,5
		45 130	130	25	105	91,5	7,9	5 x 35	117,5
50	**50 115**		115	15	94	79,5	3,9	4x 20	106,5
		50 115	115	19	94	79,5	3,9	4x 25	106,5
		50 140	140	25	113	96,5	7,9	5 x 35	124
55		**55 145**	145	25	118	101,5	7,9	5 x 35	129
60		**60 150**	150	25	123	106,5	7,9	5 x 35	134
65		**65 155**	155	26,5	128	111,5	7,9	5 x 35	140,5
70		**70 160**	160	26,5	133	116,5	7,9	6 x 35	145,5
75		**70 185**	185	30	155	136,5	7,9	5 x 40	170
90		**20 210**	210	32,5	180	161,5	7,9	5 x 40	194,5

SEALING RINGS



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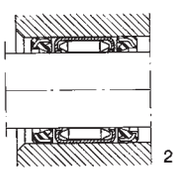

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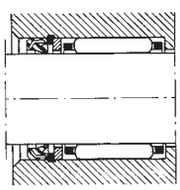
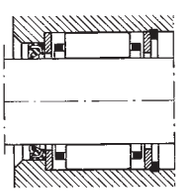
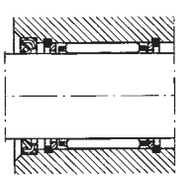


3



4



5

NADELLA sealing rings type ET, made in synthetic rubber and incorporating a metal insert, have the same inner and outer dimensions as NADELLA needle bushes and the radial portion of the combined bearings type RAX 700. The recommended housing and shaft tolerances for these bearings ensure a tight fit of the sealing ring in the housing bore and the optimum friction between lip and shaft. The simple installation of this low-cost seal, requiring no special machining, provides a very economical seal within a minimum space. A caged needle bush, type DB...E (or HK...E) incorporating a sealing ring at one end, may also be used with a type ET sealing ring installed adjoining the other end of the bearing, thus creating a completely sealed bearing (Fig. 1).

In the case of grease lubrication, the seal should be installed with the lip facing away from the bearing (Fig. 1) to enable expulsion of old grease when replenishing by means of a pump. For oil lubrication, installation the opposite way is recommended (Fig. 2). If the prevailing conditions are particularly dirty, it may be necessary to protect the seal additionally by means of a labyrinth.

ET sealing rings may also be used with NADELLA needle cages having the same shaft and housing diameters (Fig. 3) or with those having larger or smaller housing diameters than that of the seal (Fig. 4 and Fig. 5).

The hardness and surface finish required for the raceway on the shaft enable these sealing rings to operate at circumferential speeds of 10–12 m/s, providing lubrication is adequate (for higher speeds – please consult NADELLA Technical Department).

Standard type ET sealing rings will operate satisfactorily at temperatures from –20°C to +120°C. For conditions outside this temperature range, please consult NADELLA.

INSTALLATION

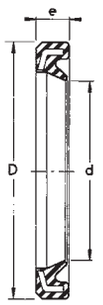
Type ET sealing rings should be smeared with grease before mounting – on the outside diameter (to facilitate assembly and avoid damage) and on the inside (to prevent dry operation when starting from rest).

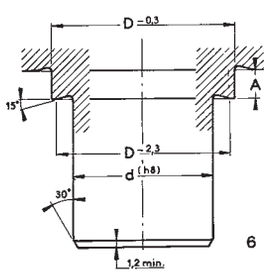
The edge of the housing bore should be chamfered to prevent damage to the seal and to facilitate assembly. A small press should be used for this purpose – such as that used to install needle bushes, in order to guide the sealing ring parallel to the axis of the housing bore.

The needle bush and the sealing ring must be installed separately in two distinct operations. The same mandrel (Fig. 6) may be used for both operations: the seal installation being effected by limiting the mandrel stroke with a spacer (Fig. 7).

In order to prevent the risk of damage to the seal lip, the shaft end must be chamfered.

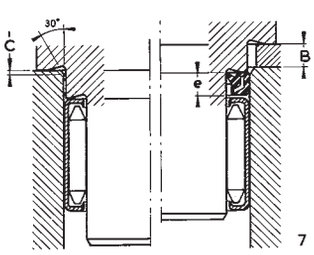
SEALING RINGS





6

A = e + 1,2 – 1,4



7

B = e + 0,3 – 0,5
C = 0,5 – 0,7

Shaft Dia. mm	Designation	d mm	D mm	e mm	Speed limit r.p.m.	Weight approx. g
5	**ET 5 9**	5	9	2	45 000	0,37
6	**ET 6 10**	6	10	2	37 500	0,43
	ET 6 12	6	12	3	37 500	0,67
7	**ET 7 11**	7	11	2	32 000	0,45
8	**ET 8 12**	8	12	3	28 000	0,70
	ET 8 14	8	14	3	28 000	0,80
9	**ET 9 13**	9	13	3	25 000	0,85
	ET 9 14	9	14	3	25 000	1,15
10	**ET 10 14**	10	14	3	22 500	0,90
	ET 10 16	10	16	3	22 500	0,95
12	**ET 12 16**	12	16	3	19 000	1,06
	ET 12 18	12	18	3	19 000	1,12
13	**ET 13 19**	13	19	3	17 500	1,20
14	**ET 14 20**	14	20	3	16 000	1,25
15	**ET 15 21**	15	21	4	15 000	1,70
16	**ET 16 22**	16	22	3	14 000	1,40
17	**ET 17 23**	17	23	3	13 200	1,50
18	**ET 18 24**	18	24	4	12 500	1,80
20	**ET 20 26**	20	26	4	11 200	2,10
	ET 20 28	20	28	4	11 200	2,90
22	**ET 22 28**	22	28	4	10 200	2,20
24	**ET 24 32**	24	32	4	9 400	3,25
25	**ET 25 32**	25	32	4	9 000	2,95
	ET 25 33	25	33	4	9 000	3,30
28	**ET 28 35**	28	35	4	8 000	3,30
	ET 28 36	28	36	4	8 000	3,80
30	**ET 30 37**	30	37	4	7 500	3,40
	ET 30 38	30	38	4	7 500	3,90
35	**ET 35 42**	35	42	4	6 500	4,90
	ET 34 43	55	43	4	6 500	5,40
40	**ET 40 47**	40	47	4	5 600	5,30
	ET 40 48	40	48	4	5 600	6,05
44	**ET 44 52**	44	52	4	5 100	6,55
45	**ET 45 52**	45	52	4	5 000	5,80
50	**ET 50 58**	50	58	4	4 500	7,50
55	**ET 55 63**	55	63	4	4 000	8,40

INNER RINGS IM

The following summary tables list the recommended inner rings for bushes, caged needle bearings and combined bearings.

Inner rings may also be supplied with oil hole (designation IMC). Please consult NADELLA Technical Department with regard to specific requirements.

For a bearing with a given internal diameter, there is a choice of inner rings with the same diameter Ci but of different widths. Normally, the width of the inner ring should never be less than that of the bearing. Alternatively, a cylindrical inner ring wider than the bearing may be used to permit the fitting of a sealing ring, which would locate on the extended portion at one end of the bearing. In this case, if the inner ring has an oil hole, care should be taken to ensure that the hole does not coincide with the ends of the needles.

Inner rings having the suffix...P, inner rings series 49 and inner rings series 19 000 and 20 600 are not to be used (without first consulting NADELLA Technical Department) with needle bushes other than BK, HK, HK...E, and not having the suffix...P, nor with the combined bearings RAX (or RAXF) 700.

The inner rings indicated by an asterisk may be produced with a convex outer diameter under the designation IM...R6. Inner rings IM...R6 are intended principally for use with DL series full complement needle bushes, to increase the allowable misalignment tolerance (see page 27) and must always be positioned immediately below the needle bush, the maximum axial displacement being 5% of the bearing width.

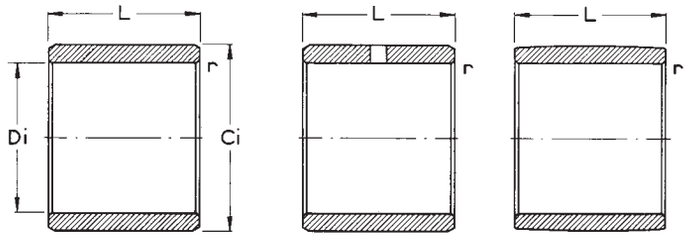
MANUFACTURING TOLERANCES

Inner ring types		Nom dia Di mm	Tolerances			
			Bore Di µm	Width L µm	Out of round µm	Outer dia Ci
Inner rings listed under their three dimensions	with suffix...P	to ISO 1206 (NFE 22370) or ISO 492 Std (DIN 620-0)				h5
	without suffix...P	8 to 25 30 to 45 50	0/-12 0/-15 0/-15	0/-120 0/-120 0/-120	10 15 18	g5
Inner Rings Series 49		to ISO 1206 (NFE 22370) or ISO 492 Std (DIN 620-0)				1)
Inner Rings Series IM 19 000 and IM 20 600		17 to 40 45 to 60	0/-10 0/-10	0/-130 0/-160	5 5	µm 0/-5 0/-5

1) Please consult NADELLA Technical Department.

Table of inner rings

Summary



IM, IM...P IMC 1) IM...R6

1) For inner rings with lubrication hole, IMC series, please consult NADELLA
* These inner rings are also available with convex raceway on Ci diameter – designation IM...R6.

Shaft Dia. Di mm	Designation	Ci mm	L mm	r mini mm	Weight approx. g
5	**IM 5 8 12 P**	8	12	0,2	2,7
6	**IM 6 9 12 P**	9	12	0,2	3,1
	IM 6 9 16 P	9	16	0,2	4,2
7	**IM 7 10 12 P**	10	12	0,2	3,6
	IM 7 10 16 P	10	16	0,2	4,8
8	**IM 8 12 10 P**	12	10	0,3	4,6
	IM 8 12 12,4*	12	12,4	0,3	5,8
	IM 8 12 16	12	16	0,3	7,4
9	**IM 9 12 12 P**	12	12	0,2	4,4
	IM 9 12 16 P	12	16	0,2	5,9
	IM 9 13 12,4*	13	12,4	0,3	6,4
10	**IM10 14 12,4***	14	12,4	0,3	7
	IM 4 900	14	13	0,35	7,3
	IM10 14 16 P	14	16	0,3	9
	IM10 14 16,4	14	16,4	0,3	9,2
12	**IM12 15 12,4***	15	12,4	0,2	5,8
	IM12 15 16 P	15	16	0,2	7,6
	IM12 15 22,4 P	15	22,4	0,2	10,7
	IM12 16 12,4*	16	12,4	0,3	8,1
	IM 4 901	16	13	0,35	8,5
	IM12 16 16 P	16	16	0,3	10,5
	IM12 16 20 P	16	20	0,3	13,2
13	**IM13 17 12,4***	17	12,4	0,3	8,7
	IM13 17 16,4	17	16,4	0,3	11,5
	IM13 18 12,4*	18	12,4	0,35	11,2
	IM13 18 16 P	18	16	0,35	14,5
	IM13 18 16,4*	18	16,4	0,35	15
14	**IM14 17 17 P**	17	17	0,2	9,3
	IM14 18 20,4	18	20,4	0,3	15,5
15	**IM15 19 16 P**	19	16	0,3	12,8
	IM15 19 20 P	19	20	0,3	16
	IM15 20 12,4*	20	12,4	0,35	12,7
	IM 4 902	20	13	0,35	13,3
	IM15 20 16 P	20	16	0,35	16,5
	IM15 20 16,4*	20	16,4	0,35	17
	IM15 20 20 P	20	20	0,35	20,5
	IM15 20 20	20	20	0,35	20,5

Shaft Dia. Di mm	Designation	Ci mm	L mm	r mini mm	Weight approx. g
17	**IM 19 017**	20	27,5	0,2	19
	IM 20 617	20	31,5	0,2	21
	IM 17 21 16 P	21	16	0,3	14,3
	IM 17 21 20 P	21	20	0,3	18
	IM 4 903	22	13	0,35	14,9
	IM 17 22 13 P	22	13	0,35	14,9
	IM 17 22 16 P	22	16	0,35	18,5
	IM 17 22 16,4*	22	16,4	0,35	18,8
	IM 17 22 20 P	22	20	0,35	23
	IM 17 22 20,4	22	20,4	0,35	23,5
20	**IM 20 24 16 P**	24	16	0,3	16,5
	IM 20 24 20 P	24	20	0,3	20,5
	IM 20 25 16 P	25	16	0,35	21
	IM 20 25 16,4*	25	16,4	0,35	21,5
	IM 4 904	25	17	0,35	22,5
	IM 20 25 20 P	25	20	0,35	26,5
	IM 20 25 20,4*	25	20,4	0,35	27
	IM 20 25 25	25	25	0,35	33
	IM 19 020	25	27,5	0,35	38
	IM 20 620	25	31,5	0,35	44
22	**IM 22 26 20 P**	26	20	0,3	22,5
	IM 49/ 22 17	28	17	0,35	30
23	**IM 23 28 20 P**	28	20	0,35	30
	IM 23 20,4*	28	20,4	0,35	30,5
25	**IM 25 29 20 P**	29	20	0,3	25
	IM 25 29 30 P	29	30	0,3	38
	IM 25 30 12,4 P	30	12,4	0,35	19,7
	IM 25 30 16,4*	30	16,4	0,35	26,5
	IM 4 905	30	17	0,35	27,5
	IM 25 30 20 P	30	20	0,35	32
	IM 25 30 20,4*	30	20,4	0,35	33
	IM 25 30 25*	30	25	0,35	40
	IM 19 025	30	27,5	0,35	42
	IM 25 30 30 P	30	30	0,35	49
	IM 20 625	30	31,5	0,35	52
28	**IM 28 32 20 P**	32	20	0,3	28
	IM 28 32 30 P	32	30	0,3	42

Shaft Dia. Di mm	Designation	Ci mm	L mm	r mini mm	Weight approx. g
30	**IM 30 35 16,4***	35	16,4	0,35	31
	IM 4 906	35	17	0,35	32,5
	IM 30 35 20 P	35	20	0,35	38
	IM 30 35 20,4*	35	20,4	0,35	39
	IM 30 35 25	35	25	0,35	48
	IM 19 030	35	27,5	0,35	53
	IM 30 35 30 P	35	30	0,35	57
	IM 20 630	35	31,5	0,35	61
32	**IM 32 37 20 P**	37	20	0,35	40
33	**IM 33 38 20 P**	38	20	0,35	42
35	**IM 35 40 16,4***	40	16,4	0,35	36
	IM 35 40 20 P	40	20	0,35	44
	IM 35 40 20,4*	40	20,4	0,35	45
	IM 35 40 25	40	25	0,35	55
	IM 19 035	40	27,5	0,35	63
	IM 35 40 30 P	40	30	0,35	66
	IM 20 635	40	31,5	0,35	72
	IM 4 907	42	20	0,85	63
37	**IM 37 42 20 P**	42	20	0,35	46
40	**IM 40 44 16,4***	44	16,4	0,3	32
	IM 40 45 16,4 P*	45	16,4	0,35	41
	IM 40 45 20 P	45	20	0,35	50
	IM 40 45 20,4	45	20,4	0,35	51
	IM 40 45 25 P	45	25	0,35	62
	IM 19 040	45	27,5	0,35	69
	IM 40 45 30 P	45	30	0,35	75
	IM 20 640	45	31,5	0,35	80
	IM 4 908	48	22	0,85	91
42	**IM 42 47 20 P**	47	20	0,35	52
45	**IM 45 50 20,4***	50	20,4	0,65	56
	IM 45 50 25 P	50	25	0,65	69
	IM 45 50 25	50	25	0,65	69
	IM 19 045	50	30,5	0,65	85
	IM 20 645	50	34,5	0,65	96
	IM 45 50 35 P	50	35	0,65	97
	IM 4 909	52	22	0,85	87

Shaft Dia. Di mm	Designation	Ci mm	L mm	r mini mm	Weight approx. g
50	**IM 50 55 20,4***	55	20,4	0,65	62
	IM 50 55 25 P	55	25	0,65	76
	IM 50 55 35 P	55	35	0,65	107
	IM 4 910	58	22	0,85	111
	IM 19 050	60	32,5	0,65	208
	IM 20 650	60	38,5	0,65	250
55	**IM 55 60 25 P**	60	25	0,65	84
	IM 55 60 35 P	60	35	0,65	118
	IM 4 911	63	25	1,35	135
58	**IM 58 65 25 P**	65	25	0,85	125
	IM 58 65 35 P	65	35	0,85	177
60	**IM 4 912**	68	25	1,35	148
	IM 60 68 25 P	68	25	0,85	150
	IM 60 68 35 P	68	35	0,85	210
	IM 60 70 25 P	70	25	0,85	190
	IM 19 060	70	32,5	0,85	247
	IM 20 660	70	39,5	0,85	300
62	**IM 62 70 25 P**	70	25	0,85	155
	IM 62 70 35 P	70	35	0,85	215
65	**IM 4 913**	72	25	1,35	138
	IM 65 73 35 P	73	35	0,85	225
67	**IM 67 75 25 P**	75	25	0,85	167
	IM 67 75 35 P	75	35	0,85	235
70	**IM 4 914**	80	30	1,35	265
	IM 70 80 25 P	80	25	1,35	222
75	**IM 4 915**	85	30	1,35	280
	IM 75 85 35 P	85	35	1,35	330
80	**IM 80 90 25 P**	90	25	1,35	245
	IM 4 916	90	30	1,35	295
	IM 80 90 35 P	90	35	1,35	350
85	**IM 85 95 26 P**	95	26	1,35	270
	IM 85 95 36 P	95	36	1,35	380
	IM 4 917	100	35	1,85	570
90	**IM 90 100 26 P**	100	26	1,35	290
	IM 90 100 36 P	100	36	1,35	400
95	**IM 95 105 26 P**	105	26	1,35	300
	IM 95 107 32 P	107	32	1,35	450
100	**IM 100 110 30 P**	110	30	1,85	360

INNER RINGS
— WITH OIL HOLES
— EXTRA WIDE

for bearings type RNA
BIC, BIP, BIG, BICG

Inner rings having oil holes enable oil to be supplied from the shaft directly below the needles.

Inner rings which are wider than the outer rings allow an axial displacement of the shaft with or without simultaneous rotational movement (please consult the NADELLA Technical Department on these special applications).

All the inner rings with oil holes and those of width wider than the outer rings, have a cylindrical needle track (o/dia). For this reason, the housings and shaft seatings must be well aligned when mounting and while functioning under load. Whenever possible, complete bearings, type Na, should be used. These have inner and outer rings of the same width and the convex needle track formed on the inner rings ensures good running (see page 52).

When lubricant is being supplied through the shaft, the use of an inner ring having an oil hole can usually be avoided by putting the oil outlet hole at the side of the ring.

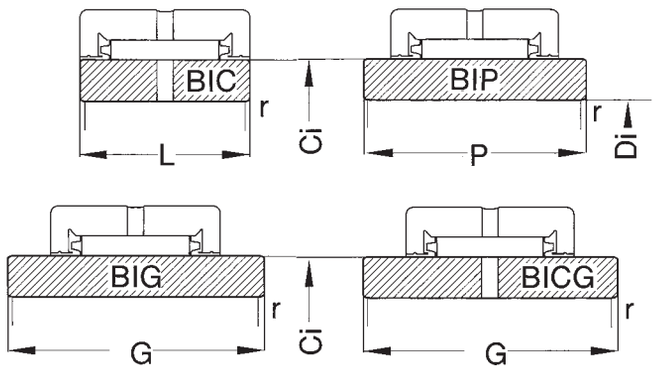
For complete bearings consisting of an outer ring RNA and a wide inner ring (or one with oil hole), the shaft and housing tolerances are given in table 1 on page 53. The fit of the rings must also be considered when choosing a bearing.

Installation and lateral retention of inner rings: see page 55.

Inner rings extra wide
Inner rings with oil holes

for bearings

Type RNA



Code	Common dimensions			Width				Tolerance on	Approx. weight		
	D_i	C_i	r	BIC L	BIP P	BIG G	BICG G	L, P, G	BIC	BIP	BIG BICG
	mm	mm	mm	mm	mm	mm	mm	mm	g	g	g
BIC, BIP 1012	12	17,6	1	15	20				16	20	
BIC, BIP 1015	15	20,6	1	15	20				18	25	
BIC, BIG 2015	15	22,1	1	22		32			35		52
BIC, BIP 1017	17	23,9	1	15	20				26	35	
BIC, BIP 1020	20	28,7	1	18	22			0	46	56	
BIC, BIG 2020	20	28,	1	22		32		-0,10	56		80
BIC, BIP 1025	25	33,5	1	18	22				54	65	
BIC, BIG 2025	25	33,5	1	22		32			65		95
BIC, BIP 1030	30	38,2	1	18	22				60	74	
BIC, BIG 2030	30	38,2	1	22		32			74		108
BIC, BIG, BICG 3030	30	44	1	30		40	40		188		247
BIC, BIP 1035	35	44	1	18	22				77	93	
BIC, BIG 2035	35	44	1	22		32			93		135
BIC, BIG, BICG 3035	35	49,7	1	36		46	46		270		345
BIC, BIP 1040	40	49,7	1,5	18	22				94	115	
BIC, BIG 2040	40	49,7	1,5	22		32			115		170
BIC, BIG, BICG 3040	40	55,4	1,5	36		46	46	0	321		408
BIC, BIP 1045	45	55,4	1,5	18	22			- 0,12	113	139	
BIC, BIG 2045	45	55,4	1,5	22		32			139		210
BIC, BIG, BICG 3045	45	62,1	1,5	38		48	48		422		530
BIC, BIP 1050	50	62,1	2	20	28				163	228	
BIC, BIG, BICG 2050	50	62,1	2	28		38	38		228		312
BIC, BIG, BICG 3050	50	68,8	2	38		48	48		515		650
BIC, BIP 1055	55	68,8	2	20	28				205	288	
BIC, BIG, BICG 2055	55	68,8	2	28		38	38		288		390
BIC, BIG, BICG 3055	55	72,6	2	38		48	48		525		660
BIC, BIP 1060	60	72,6	2	20	28				202	282	
BIC, BIG, BICG 2060	60	72,6	2	28		38	38		282		385
BIC, BIG, BICG 3060	60	78,3	2	38		48	48		583		768
BIC, BIP 1065	65	78,3	2	20	28				230	324	
BIC, BIG, BICG 2065	65	78,3	2	28		38	38		324		437
BIC, BIG, BICG 3065	65	83,1	2	38		48	48		623		785
BIC, BIP 1070	70	83,1	2	20	28			0	245	335	
BIC, BIG, BICG 2070	70	83,1	2	28		38	38	-0,15	335		456
BIC, BIG, BICG 3070	70	88	2	38		48	48		662		820
BIC, BIP 1075	75	88	2	24	32				305	410	
BIC, BIG, BICG 2075	75	88	2	32		42	42		410		538
BIC, BIG, BICG 3075	75	96	2	38		48	48		825		1 040
BIC, BIP 1080	80	96	2	24	32				410	545	
BIC, BIG, BICG 2080	80	96	2	32		42	42		545		714
BIC, BIG, BICG 3080	80	99,5	2	38		48	48		805		1 035

Specially wide inner rings BIK can be supplied if required. K = G + 10 mm.

These inner rings are normally intended for RNA bearings having the same number. For example:

– BIP 1 012 for RNA 1 012
– BIC 2 020 for RNA 2 020
– BIG 3 030 for RNA 3 030.

Inner rings BIG 2000 (except BIG 2015) may also be used with outer rings of series 1000. For example, BIG 2020 could go with RNA 1020. Numerous other combinations are possible of bearings without inner rings and inner rings of different numbers if the C_i dimension is common. For these cases, the agreement of the NADELLA Technical Department should be obtained.

Codes	Common dimensions			Width		Tolerance on L and G	Approx. weight	
	D_i	C_i	r	BIC L	BIG BICG G		BIC	BIG BICG
	mm	mm	mm	mm	mm	mm	g	g
BIC, BIG, BICG 2085	85	99,5	2	32	42		515	685
BIC, BIG, BICG 3085	85	104,7	2	38	48		865	1 085
BIC, BIG, BICG 2090	90	104,7	2	32	42		531	735
BIC, BIG, BICG 3090	90	109,1	2	43	53		990	1 220
BIC, BIG, BICG 2095	95	109,1	2	32	42		548	740
BIC, BIG, BICG 3095	95	114,7	2	43	53		1 075	1 325
BIC, BIG, BICG 2100	100	114,7	2	32	42	0	620	800
BIC, BIG, BICG 3100	100	119,2	2	43	53	-0,20	1 090	1 348
BIC, BIG, BICG 2105	105	119,2	2	32	42		615	810
BIC, BIG, BICG 3105	105	124,7	2	45	55		1 225	1 505
BIC, BIG, BICG 2110	110	124,7	2	34	44		705	920
BIC, BIG, BICG 3110	110	132,5	2	45	55		1 495	1 800
BIC, BIG, BICG 2115	115	132,5	2	34	44		895	1 150
BIC, BIG, BICG 3115	115	137	2	45	55		1 520	1 850
BIC, BIG, BICG 2120	120	137	2	34	44		902	1 165
BIC, BIG, BICG 3120	120	143,5	2	45	55		1 685	2 060
BIC, BIG, BICG 3125	125	143,5	2	34	44		1 022	1 325
BIC, BIG, BICG 2130	130	148	2	34	44		1 033	1 340
BIC, BIG, BICG 3130	130	158	2	52	62		2 530	3 035
BIC, BIG, BICG 2140	140	158	2	36	46		1 165	1 490
BIC, BIG, BICG 3140	140	170,5	2	52	62		3 000	3 560
BIC, BIG, BICG 2150	150	170,5	2	36	46	0	1 440	1 835
BIC, BIG, BICG 3150	150	179,3	2	52	62	-0,25	3 045	3 615
BIC, BIG, BICG 2160	160	179,3	2	36	46		1 430	1 820
BIC, BIG, BICG 3160	160	193,8	3	57	67		4 115	4 820
BIC, BIG, BICG 2170	170	193,8	3	42	52		2 200	2 940
BIC, BIG, BICG 3170	170	202,6	3	57	67		4 185	4 935
BIC, BIG, BICG 2180	180	202,6	3	42	52		2 175	2 720
BIC, BIG, BICG 3180	180	216	3	57	67		4 900	5 750
BIC, BIG, BICG 2190	190	216	3	42	52		2 680	3 300
BIC, BIG, BICG 3190	190	224,1	3	57	67		4 800	5 650
BIC, BIG, BICG 2200	200	224,1	3	42	52		2 590	3 225
BIC, BIG, BICG 3200	200	236	3	57	67		5 410	6 370
BIC, BIG, BICG 2220	220	248,4	3	49	59	0	4 000	5 000
BIC, BIG, BICG 3220	220	258,4	3	64	74	-0,30	7 180	8 300
BIC, BIG, BICG 2240	240	269,6	3	49	59		4 415	5 450
BIC, BIG, BICG 3240	240	281,9	3	64	74		8 800	10 200
BIC, BIG, BICG 2260	260	290,5	3	54	64		5 400	6 400
BIC, BIG, BICG 3260	260	302	3	74	84		10 700	12 100
BIC, BIG, BICG 2280	280	313,5	3	54	64	0	6 350	7 600
BIC, BIG, BICG 3280	280	325	3	74	84	-0,35	12 400	14 000
BIC, BIG, BICG 2300	300	335	3	64	64		7 500	8 900
BIC, BIG, BICG 3300	300	344	3	84	84		12 800	14 600

MANUFACTURING TOLERANCES OF BEARING RINGS

Standard tolerance class[1)]

Inner rings

Bore nominal Di mm from	to	Di_m $\left(\frac{Di\ min + Di\ max}{2}\right)$ µm max	min	Out of round µm max	Width Tolerance µm max	min	Max variation on a ring µm max
2,5	10	0	- 8	10	0	- 120	15
10	18	0	- 8	10	0	- 120	20
18	30	0	- 10	13	0	- 120	20
30	50	0	- 12	15	0	- 120	20
50	80	0	- 15	20	0	- 150	25
80	120	0	- 20	25	0	- 200	25
120	180	0	- 25	30	0	- 250	30
180	250	0	- 30	40	0	- 300	30
250	315	0	- 35	50	0	- 350	35
315	400	0	- 40	60	0	- 400	40

Outer rings

External diameter nominal De* mm from	to	De_m $\left(\frac{De\ min + De\ max}{2}\right)$ µm max	min	Out of round µm max	Width
6	18	0	- 8	15	Tolerance variations on a ring are identical to those of the inner ring for the corresponding bearing
18	30	0	- 9	15	
30	50	0	- 11	20	
50	80	0	- 13	25	
80	120	0	- 15	35	
120	150	0	- 18	40	
150	180	0	- 25	45	
180	250	0	- 30	50	
250	315	0	- 35	60	
315	400	0	- 40	70	

1) According to ISO Norm. 1206 (French Std. E 22 370) or ISO 492 (DIN 620 Class zero).
* Or Dim D1 for combined bearings RAX and RAXN 400 or 500.

Tolerance class 6[1)]

Inner rings

Bore nominal Di mm from	to	Di_m $\left(\frac{Di\ min + Di\ max}{2}\right)$ µm max	min	Out of round µm max	Width Tolerance µm max	min	Max variation on a ring µm max
2,5	10	0	- 7	6	0	- 120	15
10	18	0	- 7	7	0	- 120	20
18	30	0	- 8	8	0	- 120	20
30	50	0	- 10	10	0	- 120	20
50	80	0	- 12	10	0	- 150	25
80	120	0	- 15	13	0	- 200	25
120	180	0	- 18	18	0	- 250	30
180	250	0	- 22	20	0	- 300	30
250	315	0	- 25	25	0	- 350	35
315	400	0	- 30	30	0	- 400	40

Outer rings

External diameter nominal De* mm from	to	De_m $\left(\frac{De\ min + De\ max}{2}\right)$ µm max	min	Out of round µm max	Width
6	18	0	- 7	8	Tolerance variations on a ring are identical to those of the inner ring for the corresponding bearing
18	30	0	- 8	9	
30	50	0	- 9	10	
50	80	0	- 11	13	
80	120	0	- 13	18	
120	150	0	- 15	20	
150	180	0	- 18	23	
180	250	0	- 20	25	
250	315	0	- 25	30	
315	400	0	- 28	35	

Tolerance class 5[1)]

Inner rings

2,5	10	0	- 5	3,5	0	- 40	5
10	18	0	- 5	3,5	0	- 80	5
18	30	0	- 6	4	0	- 120	5
30	50	0	- 8	5	0	- 120	5
50	80	0	- 9	5	0	- 150	6
80	120	0	- 10	6	0	- 200	7
120	180	0	- 13	8	0	- 250	8
180	250	0	- 15	10	0	- 300	10
250	315	0	- 18	13	0	- 350	13
315	400	0	- 23	15	0	- 400	15

Outer rings

6	18	0	- 5	5	Tolerance variations on a ring are identical to those of the inner ring for the corresponding bearing
18	30	0	- 6	6	
30	50	0	- 7	7	
50	80	0	- 9	8	
80	120	0	- 10	10	
120	150	0	- 11	11	
150	180	0	- 13	13	
180	250	0	- 15	15	
250	315	0	- 18	18	
315	400	0	- 20	20	

1) According to Norm. ISO 492 (DIN 620). For tolerances of Class 4 please consult Nadella.

NOTE – For the particular tolerances of a bearing type, please consult the corresponding chapter. In view of the relative thinness of inner and outer rings of needle bearings, their circularity (or ovality) is of little significance, because it is influenced by the shape of the appropriate shafts and housings after installation. This characteristic does not figure in the tables above.

ISO HOUSING TOLERANCES in µm (.001mm)

		F			G	H						J			K	M		N			P	R	
		F6	F7	F8	G6	H6	H7	H8	H10	H11	H12	J6	J7	Js12	K6	M6	M7	N6	N7	N11	P7	R6	R7
6	10	+22 +13	+28 +13	+35 +13	+14 +5	+9 0	+15 0	+22 0	+58 0	+90 0	+150 0	+5 -4	+8 -7	±75	+2 -7	-3 -12	0 -15	-7 -16	-4 -19	0 -90	-9 -24	-16 -25	-13 -28
10	18	+27 +16	+34 +16	+43 +16	+17 +6	+11 0	+18 0	+27 0	+70 0	+110 0	+180 0	+6 -5	+10 -8	±90	+2 -9	-4 -15	0 -18	-9 -20	-5 -23	0 -110	-11 -29	-20 -31	-16 -34
18	30	+33 +20	+41 +20	+53 +20	+20 +7	+13 0	+21 0	+33 0	+84 0	+130 0	+210 0	+8 -5	+12 -9	±105	+2 -11	-4 -17	0 -21	-11 -24	-7 -28	0 -130	-14 -35	-24 -37	-20 -41
30	50	+41 +25	+50 +25	+64 +25	+25 +9	+16 0	+25 0	+39 0	+100 0	+160 0	+250 0	+10 -6	+14 -11	±125	+3 -13	-4 -20	0 -25	-12 -28	-8 -33	0 -160	-17 -42	-29 -45	-25 -50
50	65	+49 +30	+60 +30	+76 +30	+29 +10	+19 0	+30 0	+46 0	+120 0	+190 0	+300 0	+13 -6	+18 -12	±150	+4 -15	-5 -24	0 -30	-14 -33	-9 -39	0 -190	-21 -51	-35 -54	-30 -60
65	80	+49 +30	+60 +30	+76 +30	+29 +10	+19 0	+30 0	+46 0	+120 0	+190 0	+300 0	+13 -6	+18 -12	±150	+4 -15	-5 -24	0 -30	-14 -33	-9 -39	0 -190	-21 -51	-37 -56	-32 -62
80	100	+58 +36	+71 +36	+90 +36	+34 +12	+22 0	+35 0	+54 0	+140 0	+220 0	+350 0	+16 -6	+22 -13	±175	+4 -18	-6 -28	0 -35	-16 -38	-10 -45	0 -220	-24 -59	-44 -66	-38 -73
100	120	+58 +36	+71 +36	+90 +36	+34 +12	+22 0	+35 0	+54 0	+140 0	+220 0	+350 0	+16 -6	+22 -13	±175	+4 -18	-6 -28	0 -35	-16 -38	-10 -45	0 -220	-24 -59	-47 -69	-41 -76
120	140	+68 +43	+83 +43	+106 +43	+39 +14	+25 0	+40 0	+63 0	+160 0	+250 0	+400 0	+18 -7	+26 -14	±200	+4 -21	-8 -33	0 -40	-20 -45	-12 -52	0 -250	-28 -68	-56 -81	-48 -88
140	160	+68 +43	+83 +43	+106 +43	+39 +14	+25 0	+40 0	+63 0	+160 0	+250 0	+400 0	+18 -7	+26 -14	±200	+4 -21	-8 -33	0 -40	-20 -45	-12 -52	0 -250	-28 -68	-58 -83	-50 -90
160	180	+68 +43	+83 +43	+106 +43	+39 +14	+25 0	+40 0	+63 0	+160 0	+250 0	+400 0	+18 -7	+26 -14	±200	+4 -21	-8 -33	0 -40	-20 -45	-12 -52	0 -250	-28 -68	-61 -86	-53 -93
180	200	+79 +50	+96 +50	+122 +50	+44 +15	+29 0	+46 0	+72 0	+185 0	+290 0	+460 0	+22 -7	+30 -16	±230	+5 -24	-8 -37	0 -46	-22 -51	-14 -60	0 -290	-33 -79	-68 -97	-60 -106
200	225	+79 +50	+96 +50	+122 +50	+44 +15	+29 0	+46 0	+72 0	+185 0	+290 0	+460 0	+22 -7	+30 -16	±230	+5 -24	-8 -37	0 -46	-22 -51	-14 -60	0 -290	-33 -79	-71 -100	-63 -109
225	250	+79 +50	+96 +50	+122 +50	+44 +15	+29 0	+46 0	+72 0	+185 0	+290 0	+460 0	+22 -7	+30 -16	±230	+5 -24	-8 -37	0 -46	-22 -51	-14 -60	0 -290	-33 -79	-75 -104	-67 -113
250	280	+88 +56	+108 +56	+137 +56	+49 +17	+32 0	+52 0	+81 0	+210 0	+320 0	+520 0	+25 -7	+36 -16	±260	+5 -27	-9 -41	0 -52	-25 -57	-14 -66	0 -320	-36 -88	-85 -117	-74 -126
280	315	+88 +56	+108 +56	+137 +56	+49 +17	+32 0	+52 0	+81 0	+210 0	+320 0	+520 0	+25 -7	+36 -16	±260	+5 -27	-9 -41	0 -52	-25 -57	-14 -66	0 -320	-36 -88	-89 -121	-78 -130
315	355	+98 +62	+119 +62	+151 +62	+54 +18	+36 0	+57 0	+89 0	+230 0	+360 0	+570 0	+29 -7	+39 -18	±285	+7 -29	-10 -46	0 -57	-26 -62	-16 -73	0 -360	-41 -98	-97 -133	-87 -144
355	400	+98 +62	+119 +62	+151 +62	+54 +18	+36 0	+57 0	+89 0	+230 0	+360 0	+570 0	+29 -7	+39 -18	±285	+7 -29	-10 -46	0 -57	-26 -62	-16 -73	0 -360	-41 -98	-103 -139	-93 -150

ISO SHAFT TOLERANCES in µm (.001mm)

		f	g		h						j		k		m		n	p
		f6	g5	g6	h5	h6	h7	h8	h10	h13	j5	j6	k5	k6	m5	m6	n6	p6
3	6	-10 -18	-4 -9	-4 -12	0 -5	0 -8	0 -12	0 -18	0 -48	0 -180	+3 -2	+6 -2	+6 +1	+9 +1	+9 +4	+12 +4	+16 +8	+20 +12
6	10	-13 -22	-5 -11	-5 -14	0 -6	0 -9	0 -15	0 -22	0 -58	0 -220	+4 -2	+7 -2	+7 +1	+10 +1	+12 +6	+15 +6	+19 +10	+24 +15
10	18	-16 -27	-6 -14	-6 -17	0 -8	0 -11	0 -18	0 -27	0 -70	0 -270	+5 -3	+8 -3	+9 +1	+12 +1	+15 +7	+18 +7	+23 +12	+29 +18
18	30	-20 -33	-7 -16	-7 -20	0 -9	0 -13	0 -21	0 -33	0 -84	0 -330	+5 -4	+9 -4	+11 +2	+15 +2	+17 +8	+21 +8	+28 +15	+35 +22
30	50	-25 -41	-9 -20	-9 -25	0 -11	0 -16	0 -25	0 -39	0 -100	0 -390	+6 -5	+11 -5	+13 +2	+18 +2	+20 +9	+25 +9	+33 +17	+42 +26
50	80	-30 -49	-10 -23	-10 -29	0 -13	0 -19	0 -30	0 -46	0 -120	0 -460	+6 -7	+12 -7	+15 +2	+21 +2	+24 +11	+30 +11	+39 +20	+51 +32
80	120	-36 -58	-12 -27	-12 -34	0 -15	0 -22	0 -35	0 -54	0 -140	0 -540	+6 -9	+13 -9	+18 +3	+25 +3	+28 +13	+35 +13	+45 +23	+59 +37
120	180	-43 -68	-14 -32	-14 -39	0 -18	0 -25	0 -40	0 -63	0 -160	0 -630	+7 -11	+14 -11	+21 +3	+28 +3	+33 +15	+40 +15	+52 +27	+68 +43
180	250	-50 -79	-15 -35	-15 -44	0 -20	0 -29	0 -46	0 -72	0 -185	0 -720	+7 -13	+16 -13	+24 +4	+33 +4	+37 +17	+46 +17	+60 +31	+79 +50
250	315	-56 -88	-17 -40	-17 -49	0 -23	0 -32	0 -52	0 -81	0 -210	0 -810	+7 -16	+16 -16	+27 +4	+36 +4	+43 +20	+52 +20	+66 +34	+88 +56
315	400	-62 -98	-18 -43	-18 -54	0 -25	0 -36	0 -57	0 -89	0 -230	0 -890	+7 -18	+18 -18	+29 +4	+40 +4	+46 +21	+57 +21	+73 +37	+98 +62

SYMBOLS

A

		Page
AIG	Needle.	63
AR	Roller thrust bearing - one retained plate.	97
ARNB	Precision combined bearing with adjustable preload using roller thrust bearings.	129
ARNBT	Combined bearing ARNB with screw locations.	129
ARZ	Roller thrust bearing - two retained plates.	97
AX	Needle thrust bearing - one retained plate.	97
AXJ	Special needle thrust bearing for high speed.	98
AXNA	Precision combined bearing with adjustable preload using needle thrust bearings	129
AXNAT	Combined bearing AXNA with screw locations.	129
AXNB	Precision combined bearing with adjustable preload using needle thrust bearings.	129
AXNBT	Combined bearing AXNB with screw locations.	129
AXZ	Needle thrust bearing -two retained plates.	97

B

B	Needle cage, one-piece with one row of needles.	-
BB	Needle cage, one-piece with two rows of needles.	-
...B6	Convex outer diameter for RNA 11 000 series cam followers.	71
BIC	Cylindrical inner ring with lubrication holes for full complement needle bearings type RNA.	149
BICG	Wide cylindrical inner ring with lubrication holes for full complement needle bearings type RNA 1000, 2000 and 3000 series.	149
BIG-BIK	Wide cylindrical inner ring without lubrication hole for full complement needle bearings type RNA 1000, 2000 and 3000 series.	149
BIP	Wide cylindrical inner ring without lubrication hole for full complement needle bearings type RNA 1000 series.	149
...BIR	Full complement needle bearing type NA with special convex inner ring.	52
BK	Caged needle bush, closed-end, according to ISO tolerances.	25
...BP	Needle roller with flat ends.	63
...BR	Needle roller with round ends.	63

C

... C2, C3, C4, C5	Radial play groups for complete bearings with inner rings.	38
CN, CNS	Needle bush closed-end with full complement grease retained needles.	25
CP	Plate for needle thrust bearing, roller thrust bearing (light series) and combined bearing.	-
CPN	Plate, machine-tool quality.	-
CPR	Plate for roller thrust bearing (heavy series) and 812 series.	-
CPT	Overthick thrust plate.	-

D

DB	Caged needle bush, open.	25
DBF	Caged needle bush, closed-end.	25
DBFH	Needle bush DBF with lubrication hole.	25
DBH	Needle bush DB with lubrication hole.	25
... DELTA	High precision needle roller bearing with adjustable play.	-
... DER	Needle roller bearing with convex outer ring.	51
DG, DGX®	Deltaflex bearing for steering column.	-
DL	Full complement needle bush, open.	25
DLF	Full complement needle bush, closed-end.	25
DLFH	Needle bush DLF with lubrication hole.	25
DLH	Needle bush DL with lubrication hole.	25

E

... E	Seal incorporated one side.	25
... EE	Seals incorporated on two sides	71
... EEM	Metal seals incorporated on two sides	71
ET	Sealing ring.	143

F

		Page
FG	Cam follower with non-separable outer and inner rings. Convex outer ring.	71
FGL	Cam follower with non-separable outer and inner rings. Cylindrical outer ring.	71
FGU ...FGUL	Roller cam follower.	71

G

GC	Cam follower with stud. Convex outer ring.	71
GCL	Cam follower with stud. Cylindrical outer ring.	71
GCR	Eccentric cam follower with stud. Convex outer ring.	71
GCRL	Eccentric cam follower with stud. Cylindrical outer ring.	71
GCU-GCUL	Roller cam follower.	71
GCUR	Eccentric roller cam follower with stud. Convex Outer Ring	71
GCURL	Eccentric roller cam follower with stud. Cylindrical Outer Ring	71
GN	Grease nipple for cam follower with stud.	74

H

HK	Caged needle bush, open, according to ISO tolerances.	25
Hm	Nut for cam follower with stud.	74
... HT 1, 2, 3, 4	Stabilisation heat treatment for high temperature.	12

I

IM	Cylindrical inner ring.	145
IMC	Cylindrical inner ring with lubrication hole.	145

J

JL	Full complement needle bushes, open, inch dimensions.	25
JLF	Full complement needle bush, closed-end, inch dimensions.	25
JLFH	Needle bush JLF with lubrication hole.	25
JLH	Needle bush FL with lubrication hole.	25

M

MB	Needle cage two-piece with one row of needles.	-
MBB	Needle cage two-piece with two rows of needles.	-

N

NA	Full complement or caged needle bearing with inner ring.	51
NAR	Full complement self-aligning needle roller bearing, with inner ring.	–
NAW	Full complement inverted bearing.	-
NB	Caged needle bearing without inner ring.	37
NBI	Caged needle bearing with inner ring.	37
NE	Special product, deep drawn raceway.	–
NG	Special product, tooled race~ay.	–
NH	Special product, both types raceway.	–

O

OB	Plug for cam follower with stud.	74

P

... P	Needle bush DB, DL and derivatives, or inner rings 1M and IMC, according to ISO tolerances.	25
... P6, P5, P4	Precision tolerance codes for inner and outer rings.	38
PM	Intermediate plate for needle or roller thrust bearing, light series.	-
PMH	Intermediate plate with lubrication hole for needle or roller thrust bearing, light series.	-

R

S

T

Z

Notice

Nadella GmbH
Tränkestraße 7
D-70597 Stuttgart
Tel. +49 (0)711 720 63-0
Fax +49 (0)711 720 63-25
Internet: www.nadella.de
e-Mail: info@nadella.de

Nadella S.p.a.
Via Melette 16
I-20128 Milano
Tel. +39 02.27.093.297
Fax +39 02.25.51.768
Internet: www.nadella.it
e-Mail: customer-service@nadella.it

NADELLA

Linear and Motion Solutions

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