

Chapter 1: Rolling element bearings

Preamble

The tables and information presented here are taken from the 1994 SKF General Catalogue. This catalogue has almost 1000 pages so it is obviously impractical to reproduce more than a small portion of the catalogue.

Of the 47 types of bearings listed in the SKF catalogue, detailed data for only 4 types have been included here:

- Deep groove ball
- Self-aligning ball
- Cylindrical roller
- Spherical roller (self-aligning roller)

Note : These bearings are all of the open type except the deep groove ball which may be purchased as a pre-sealed and pre-lubricated bearing.

The basic dynamic load rating is in accordance with the methods prescribed by the International Standards Organisation in various standards such as ISO 281: 1977/90 and ISO 76:1987. In the ISO method, the basic rating life of the bearing (L_{10} life) is related to the loads (radial and axial) only on the bearing.

The L_{10} life is defined as the life that 90% of a sufficiently large group of apparently identical bearings can be expected to attain or exceed under the given operating loads. That is to say, 10% of bearings can be expected to have a life less than the L_{10} life, whereas 90% of bearings will exceed it. In fact, the average life is about 5 times the L_{10} life.

Note: The L_{10} life is expressed in millions of revolutions.

There has been a great deal of research and testing done over the years on bearing life and it has been found that three other factors considerably affect the life of a rolling element bearing. These factors are:

- Type of steel used in the bearing
- Lubrication
- Cleanliness

Type of steels

The ISO equations are based upon standardised material specifications. In general, bearing steels in commercial bearings have equal or better life properties than those in the ISO standard. In addition, bearings made of special steels can be ordered.

Lubrication

Lubrication encompasses factors such as:

- type of lubricant used (oil or grease or other)
- whether the lubricant contains additives
- lubricant viscosity
- lubricant temperature
- method of introducing and circulating the lubricant through the bearing
- whether or not the lubricant is changed with fresh lubricant at regular intervals

Note : Viscosity and temperature of lubricants are related and for liquid lubricants the viscosity decreases with temperature. The grease normally used by SKF for pre-lubricated deep groove ball bearings has a viscosity of 100 mm²/s at 40°C.

Cleanliness

Cleanliness encompasses factors such as:

- contaminants in the environment under which the bearing operates
- dirt, dust, metallic particles that can find their way into the bearing
- water or other liquids that can contaminate the lubricant or cause bearing corrosion
- filtration of the lubricant
- method of sealing the bearing

Note: Many of these factors are inter-related, for example if the bearing is well-sealed, contaminants cannot enter the bearing.

In recognition of the factors other than load than can affect bearing life, ISO in 1977 introduced an adjusted rating life, that took into account reliability, material and the lubricant viscosity.

As a result of the research done by SKF, they introduced a 'New SKF life theory' that introduces the concept of a fatigue load limit. This is the load below which fatigue will not occur in a bearing. That is, with correct lubrication and cleanliness any value of the load below the fatigue load limit, the bearing will last indefinitely. This theory also takes into account lubricant viscosity and cleanliness.

To summarise, there are therefore three methods of determining the bearing life.

- The 'traditional' ISO method of determining the basic rating life. This method takes into account only the loads on the bearing.
- The ISO 'adjusted rating life' that takes into account other factors including reliability, type of bearing steel and lubricant viscosity.
- The SKF 'new life theory' that takes into account the other factors included in the ISO adjusted rating life method but also takes into account the fatigue load limit and cleanliness.

As each of these methods can produce a different answer, it is evident that calculation of rolling element bearing life should be regarded an estimate since many factors apart from load can influence bearing life. The more of these factors that are known and the more precisely they are known, the more precisely bearing life can be calculated.

Selection of bearing type

Thirty seven common types of bearings are listed on pages 19 and 20. The selection chart on page 21 can be used to select the most appropriate type of bearing according to the various selection factors such as load direction, shaft speed, accuracy, noise, friction, self-alignment etc.

Selection of bearing size

A step-by-step method of bearing size selection is now detailed for four main types of bearings, namely deep groove ball, self-aligning ball, roller, and self-aligning roller.

Selection of deep groove ball bearings

Method 1 - ISO L_{10} life method

1. Determine the required life of the bearing in operating hours. This depends upon whether the bearings will operate continuously or intermittently and the expected life of the equipment. In mechanical design it is often the case that the bearings should be selected for a life of 10 years.
2. Convert the design life in hours into a design life L expressed in millions of revolutions. The equation is:

$$L = \frac{60 N h}{10^6}$$

Where:

L = design life in millions of revolutions
 N = average operating speed in rev/min
 h = design life in hours

3. Determine the average radial load F_r and axial load F_a on the bearing. In most cases the loads on the bearings are the shaft reaction forces at the bearing.

Note: Where dynamic loads occur, shock factors should be applied to the steady loads.

4. Calculate the ratio F_a/F_r .
5. Knowing the shaft size, use the data tables on pages 26 and 27 to select a bearing from those available for this size of shaft. In the absence of other knowledge, select a bearing around the mid-range of those available. Write down the static load rating C_0 and the dynamic load rating C .
6. Calculate the ratio F_a/C_0 and hence read off the value of e from the graph on page 22 by projecting across to the e line and then down to the e scale.

7. Calculate the equivalent dynamic bearing load P . If:

$Fa/Fr \leq e$ then $P = Fr$

$Fa/Fr > e$ then $P = X Fr + Y Fa$ where $X = 0.56$ and the value of Y can be read off the graph on page 20 by projecting across from the Fa/Co value to the Y line and then down to the Y scale.

Note: this graph has been drawn for normal clearance bearings.

8. For the bearing selected calculate the bearing L_{10} life using the equation:

$$L_{10} = \left(\frac{C}{P} \right)^3$$

9. If $L_{10} < L$, the bearing is too small. Repeat steps 5- 8 using a bearing with a higher load carrying capacity (further down in the table).

If $L_{10} \approx L$ the bearing is OK.

If $L_{10} > L$, the bearing may be too large. Repeat steps 5- 8 using a bearing with a lower load carrying capacity (further up in the table).

10. Calculate the equivalent static bearing load P_o using the equation:

$P_o = 0.6 Fr + 0.5 Fa$ and check that P_o is less than Co . If not another bearing should be selected.

Note: If $P_o < Fr$ then make $P_o = Fr$.

11. Check the minimum radial load on the bearing. For satisfactory operation:

$Fr > 0.01 C$

Note: this is a 'rule of thumb'; more accurate methods of calculating the minimum load based upon lubricant viscosity, operating speeds etc are given in the SKF catalogue.

12. Check that the maximum shaft speed does not exceed the speed rating of the bearing.

Selection of self-aligning ball bearings

Method 1- ISO L_{10} life method

1. Determine the required life of the bearing in operating hours. This depends upon whether the bearings will operate continuously or intermittently and the expected life of the equipment. In mechanical design it is often the case that the bearings should be selected for a life of 10 years.
2. Convert the design life in hours into a design life L expressed in millions of revolutions. The equation is:

$$L = \frac{60 N h}{10^6}$$

Where:

L = design life in millions of revolutions

N = average operating speed in rpm

h = design life in hours

3. Determine the average radial load F_r and axial load F_a on the bearing. In most cases the loads on the bearings are the shaft reaction forces at the bearing.
Note: Where dynamic loads occur, shock factors should be applied to the steady loads.
 4. Calculate the ratio F_a/F_r .
 5. Knowing the shaft size, use the data tables to select a bearing from those available for this size of shaft. Use pages 28 and 29 for bearings without adaptor sleeves and pages 30 and 31 for bearings with adaptor sleeves. In the absence of other knowledge, select a bearing around the mid-range of those available. Write down the dynamic and static load ratings C and C_0 and calculation factors: e , Y_1 , Y_2 , Y_0 .
 6. Calculate the equivalent dynamic bearing load P . If:
 $F_a/F_r \leq e$ then $P = F_r + Y_1 F_a$
 $F_a/F_r > e$ then $P = 0.65F_r + Y_2 F_a$
 7. For the bearing selected calculate the bearing L_{10} life using the equation:
- $$L_{10} = \left(\frac{C}{P} \right)^3$$
8. If $L_{10} < L$, the bearing is too small. Repeat steps 5- 7 using a bearing with a higher load carrying capacity (further down in the table).
If $L_{10} \approx L$ the bearing is OK.
If $L_{10} > L$, the bearing may be too large. Repeat steps 5- 7 using a bearing with a lower load carrying capacity (further up in the table).

9. Calculate the equivalent static bearing load P_o using the equation:

$P_o = F_r + Y_o F_a$ and check that P_o is less than C_o . If not another bearing should be selected.

Note: If $P_o < F_r$ then make $P_o = F_r$.

10. Check the minimum radial load on the bearing. For satisfactory operation:

$$F_r > 0.01 C$$

Note: this is a 'rule of thumb'; more accurate methods of calculating the minimum load based on lubricant viscosity, operating speeds etc are given in the SKF catalogue.

11. Check that the maximum shaft speed does not exceed the speed rating of the bearing.

12. If the bearing has a tapered bore and adaptor sleeve check that the axial load on the bearing does not exceed the permissible load on the adaptor sleeve, that is:

$$F_a < 3 B d$$

Where: F_a = the axial load on the bearing in N

B = the width of the bearing in mm

d = the internal diameter of the bearing in mm

Note: The tables for self-aligning bearings with adaptor sleeve do not list the internal diameter of the bearing. Use the designation of the bearing with adaptor sleeve and go to the tables for the same designation of bearing without adaptor sleeve in order to obtain the internal diameter.

Selection of cylindrical roller bearings

Method 1 - ISO L_{10} life method

1. Determine the required life of the bearing in operating hours. This depends upon whether the bearings will operate continuously or intermittently and the expected life of the equipment. In mechanical design it is often the case that the bearings should be selected for a life of 10 years.
2. Convert the design life in hours into a design life L expressed in millions of revolutions. The equation is:

$$L = \frac{60 N h}{10^6}$$

Where:

L = design life in millions of revolutions
 N = average operating speed in rpm
 h = design life in hours

3. Determine the average radial load F_r and axial load F_a on the bearing. In most cases the loads on the bearings are the shaft reaction forces at the bearing.

Note: Where dynamic loads occur, shock factors should be applied to the steady loads.

4. Calculate the ratio F_a/F_r .

Note: This ratio should not exceed 0.5.

5. Knowing the shaft size, use the data tables (pages 31 to 34) to select a bearing from those available for this size of shaft. In the absence of other knowledge, select a bearing around the mid-range of those available. Write down the static load rating C_0 and the dynamic load rating C .

6. Calculate the equivalent dynamic bearing load P . For bearings without flanges (type NU) :

$$P = F_r$$

For bearings with flanges:

$$F_a/F_r \leq e \text{ then } P = F_r$$

$$F_a/F_r > e \text{ then } P = 0.92 F_r + Y F_a$$

where $e = 0.2$ and $Y = 0.6$ for bearings of series 10, 2, 3 and 4

$e = 0.3$ and $Y = 0.4$ for bearings of series 22 and 23

7. For the bearing selected calculate the bearing L_{10} life using the equation:

$$L_{10} = \left(\frac{C}{P} \right)^{10/3}$$

8. If $L_{10} < L$, the bearing is too small. Repeat steps 5- 7 using a bearing with a higher load carrying capacity (further down in the table).
If $L_{10} \approx L$ the bearing is OK.
If $L_{10} > L$, the bearing may be too large. Repeat steps 5- 8 using a bearing with a lower load carrying capacity (further up in the table).
9. Check that P_o is less than $C_o/1.5$. If not another bearing should be selected.
Note: $P_o = F_r$ for cylindrical roller bearings.
10. Check the minimum radial load on the bearing. For satisfactory operation:
 $F_r > 0.02 C$
Note: this is a 'rule of thumb'; more accurate methods of calculating the minimum load based upon lubricant viscosity, operating speeds etc are given in the SKF catalogue.
11. Check that the maximum shaft speed does not exceed the speed rating of the bearing.

Selection of spherical (self-aligning) roller bearings

Method 1 - ISO L_{10} life method

1. Determine the required life of the bearing in operating hours. This depends upon whether the bearings will operate continuously or intermittently and the expected life of the equipment. In mechanical design it is often the case that the bearings should be selected for a life of 10 years.
2. Convert the design life in hours into a design life L expressed in millions of revolutions. The equation is:

$$L = \frac{60 N h}{10^6}$$

Where:

L = design life in millions of revolutions
 N = average operating speed in rpm
 h = design life in hours

3. Determine the average radial load F_r and axial load F_a on the bearing. In most cases the loads on the bearings are the shaft reaction forces at the bearing.

Note: Where dynamic loads occur, shock factors should be applied to the steady loads.

4. Calculate the ratio F_a/F_r .
5. Knowing the shaft size, use the data tables on page 35 to select a bearing from those available for this size of shaft. In the absence of other knowledge, select a bearing around the mid-range of those available. Write down the static load rating C_0 and the dynamic load rating C , also calculation factors: e , Y_1 , Y_2 , Y_0 .

6. Calculate the equivalent dynamic bearing load P . If:

$F_a/F_r \leq e$ then $P = F_r + Y_1 F_a$

$F_a/F_r > e$ then $P = 0.67F_r + Y_2 F_a$

7. For the bearing selected calculate the bearing L_{10} life using the equation:

$$L_{10} = \left(\frac{C}{P} \right)^{10/3}$$

8. If $L_{10} < L$, the bearing is too small. Repeat steps 5- 7 using a bearing with a higher load carrying capacity (further down in the table).

If $L_{10} \approx L$ the bearing is OK.

If $L_{10} > L$, the bearing may be too large. Repeat steps 5- 8 using a bearing with a lower load carrying capacity (further up in the table).

9. Calculate P_o and check that P_o is less than $C_o/1.5$. If not another bearing should be selected.

Note: $P_o = F_r + Y_0 F_a$ for spherical roller bearings.

10. Check the minimum radial load on the bearing. For satisfactory operation:

$$F_r > 0.02 C$$

Note: this is a 'rule of thumb'; more accurate methods of calculating the minimum load based upon lubricant viscosity, operating speeds etc are given in the SKF catalogue.

11. Check that the maximum shaft speed does not exceed the speed rating of the bearing.

Method 2 ISO Adjusted rating life method

The method is basically the same as already detailed for the various types of bearings. The only difference is that the adjusted rating life L_{na} is used rather than the L_{10} life. The adjusted rating life is calculated using the following formula:

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

Where : a_1 = life adjustment factor for reliability

a_2 = life adjustment factor for material

a_3 = life adjustment factor for operating conditions

Using the generally accepted reliability of 90%, factor a_1 has a value 1. For other reliability values a table in the SKF handbook gives the corresponding value of the reliability factor.

Factor a_2 depends upon the type of steels used in the bearing. For standard steel types (as defined by ISO) this factor has a value of 1.

a_3 is essentially determined by bearing lubrication (provided operating temperatures are not excessive and cleanliness is normal).

SKF claims higher life properties for their steels than the ISO standard and have combined factors a_2 and a_3 into a combined factor a_{23} . So:

$$L_{na} = a_1 a_{23} L_{10}$$

Then if $a_1 = 1$, ('normal' 90% reliability) :

$$L_{na} = a_{23} L_{10}$$

Factor a_{23} can be determined using Diagrams 1 and 3 (on page 23). Diagram 1 gives the required kinematic viscosity v_1 for adequate lubrication at the rotational speed (as a function of the mean diameter of the bearing). Diagram 2 gives the value of factor a_{23} as a function of the viscosity ratio κ , defined as : $\kappa = v/v_1$ where v = actual kinematic viscosity of the lubricant used (at the operating temperature of the bearing).

Notes:

- The shaded area on Diagram 3 is for lubricants with additives.
- The diagrams are valid for mineral oils and greases under conditions of normal cleanliness.
- Since lubricant viscosity depends upon the temperature, it is necessary to estimate the operating temperature of the bearing in order to calculate κ . Operating temperature depends on a number of factors such as the ambient temperature, the load on the bearing, shaft speed, housing design and so on. Temperature measurement of similar bearings under operating conditions is a good method of obtaining this temperature. SKF have a computer program that will calculate operating temperature for a particular application.

Method 3 SKF New Life Method

This is a variant on the ISO Adjusted Life Method. SKF introduce the concept of a fatigue load limit P_u whose value is given in the bearing tables. It represents that load below which fatigue will not occur in the bearing. That is with adequate lubrication and cleanliness, for values of load below P_u the bearing will last indefinitely. The life of the bearing L_{nba} is then related to the ratio P_u/P . The equation is:

$$L_{nba} = a_1 a_{SKF} L_{10}$$

Where:

L_{nba} = adjusted rating life to new life theory

a_1 = life adjustment factor for reliability (as given by the ISO adjusted life method)

a_{SKF} = life adjustment factor based on the new life theory

Assuming 'normal' 90% reliability, $a_1 = 1$ so the equation becomes:

$$L_{SKF} = a_{SKF} L_{10}$$

Values of a_{SKF} can be obtained from Diagram 4 (page 24) for ball bearings and Diagram 5 (page 25) for roller bearings for various values of the viscosity ratio κ (defined in Method 2). The x axis on these diagrams are $\eta_c P_u/P$.

The factor η_c is a factor to take into account contamination. The following table may be used as a guide to the contamination factor η_c :

Condition	η_c
Very clean - debris size the order of the lubricant film thickness	1
Clean - conditions typical of bearings greased for life and sealed	0.8
Normal - conditions typical of bearings greased for life and shielded	0.5
Contaminated - bearings without seals, particle ingress likely from surroundings - 0.1	
Heavily contaminated	0

Example

A 45 mm diameter shaft running at 5000 rpm is fitted with a deep-groove ball bearing number 6309. The radial load on the bearing is 8 kN and there is no axial load. The bearing is to be oil lubricated using oil with viscosity 20 mm²/s at the operating temperature. Reliability is normal (90%). Determine the bearing life using all three methods if conditions are:

- (a) clean
- (b) contaminated with an estimated contamination factor of 0.2.

Solution**(a) Using the ISO L_{10} method**

$$L_{10} = \left(\frac{C}{P} \right)^3$$

From the bearing tables (page 26) for bearing 6309 (45 mm shaft) : $C = 52.7$ kN

Since there is no axial load : $P = F_r = 8$ kN

$$L_{10} = \left(\frac{C}{P} \right)^3 \quad \therefore L_{10} = \left(\frac{52.7}{8} \right)^3 = 286 \text{ million revs}$$

Using the ISO adjusted life method

$$L_{na} = a_1 a_{23} L_{10}$$

For 'normal' (90%) reliability, $a_1 = 1$

For bearing 6309, from the bearing tables (page 26), $D = 100$ mm

Since $d = 45$ mm $d_m = 0.5 \times (45 + 100) = 72.5$ mm

From Diagram 1 (page 23) for 5000 rpm, the required oil viscosity $v_1 = 7$ mm²/s

Since the actual viscosity $v = 20$ mm²/s, $\kappa = v/v_1 = 20/7 = 2.9$

From Diagram 3 (page 23) with $\kappa = 2.9$, $a_{23} = 2$

Therefore $L_{na} = 1 \times 2 \times 286 = 572$ million revs

Note: The longer life is due to the viscosity of the lubricating oil being almost three times higher than that required for adequate lubrication

Using the SKF new life method

$$L_{nna} = a_1 a_{SKF} L_{10}$$

For 'normal' (90%) reliability, $a_1 = 1$

From the bearing tables for 6309 bearing (page 24), $P_u = 1.34 \text{ kN}$

From the table on page 15, for normal cleanliness, $\eta_c = 0.8$

Since $P = 8 \text{ kN}$, $\eta_c P_u/P = 0.8 \times 1.34/8 = 0.134$

Since $\kappa = 2.9$ (calculated above), from Diagram 4 (page 15) $a_{SKF} \approx 8$

Therefore $L_{nna} = 8 \times 286 = 2288 \text{ million revs}$

Note: this is four times higher than the L_{na} life as predicted by the adjusted life method

- (b) Because conditions are contaminated, the only method applicable is the SKF new life method.

Now $\eta_c = 0.2 \therefore \eta_c P_u/P = 0.2 \times 1.34/8 = 0.0335$

Since $\kappa = 2.9$ (calculated above), from Diagram 4 (page 22) $a_{SKF} \approx 1.2$

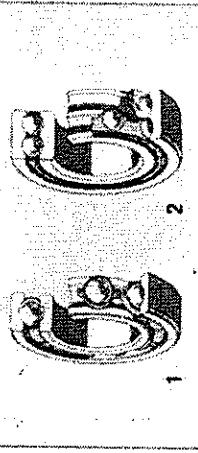
Therefore $L_{nna} = 1.2 \times 286 = 343 \text{ million revs}$

Note : there is a considerable reduction in life due to the contaminated conditions

Radial bearings

Deep groove ball bearings

Single row *) (1)
with shield(s) or seal(s)
with snap ring groove in outer ring
(and snap ring)
double row (2)



*) see also SKF catalogue "Thin section bearings"

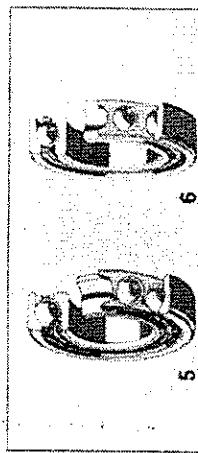
Self-aligning ball bearings
with cylindrical or tapered bore (3)
with seals
with extended inner ring (4)



*) see also SKF catalogue "Thin section bearings"
**) see SKF catalogue "Precision bearings"

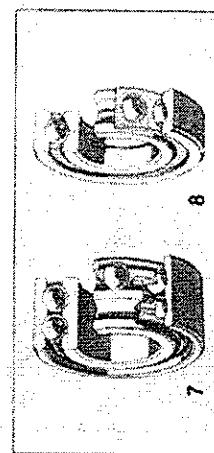
Angular contact ball bearings

Single row *) (5)
for paired mounting
precision bearings *) (6)



*) see also SKF catalogue "Thin section bearings"
**) see SKF catalogue "Precision bearings"

double row (7)
with shields or seals
Four-point contact ball bearings *) (8)

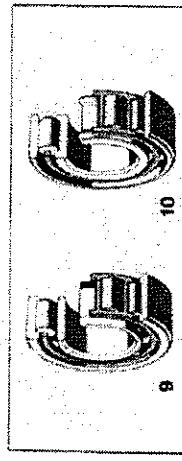


*) see also SKF catalogue "Thin section bearings"

Radial bearings

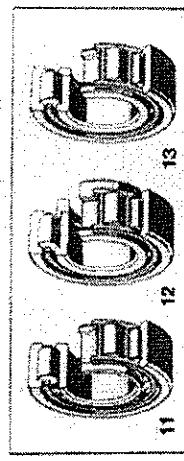
Cylindrical roller bearings

single row
NU type (9)
N type (10)



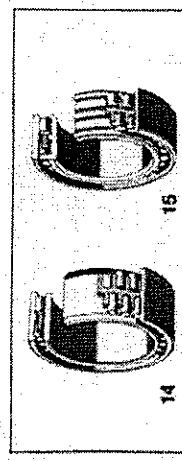
9
10

NJ type (11)
NJ type with HJ angle ring (12)
NUP type (13)



11
12
13

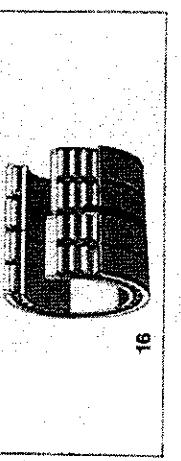
double row*)
NNU type (14)
NN type (15)



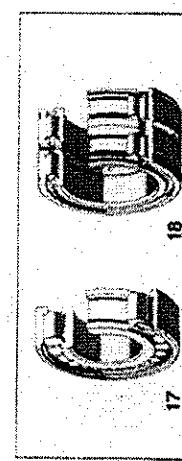
14
15

*) see SKF catalogues "Large bearings" and "Precision bearings"

four-row*)
with cylindrical (16) or tapered bore



16

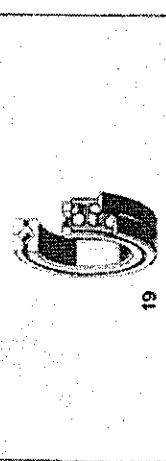


17
18

Full complement cylindrical roller bearings
single row (17)
double row
with (18) or without seals
multi-row*)

*) see SKF catalogue "Large bearings"

Crossed cylindrical roller bearings (19)

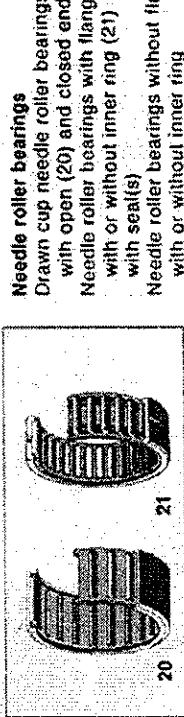


19

Radial bearings**Needle roller bearings**

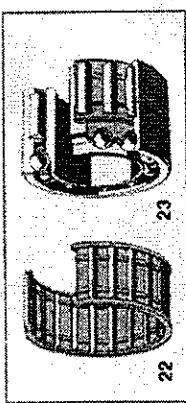
Drawn cup needle roller bearings
with open (20) and closed ends
Needle roller bearings with flanges
with or without inner ring (21)
with seal(s)

Needle roller bearings without flanges
with or without inner ring
¹⁾ see SKF catalogue "Needle roller bearings"

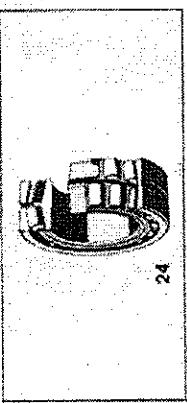


Needle roller and cage assemblies¹⁾ (22)
Combined needle roller bearings¹⁾ (23)
Alignment needle roller bearings¹⁾,

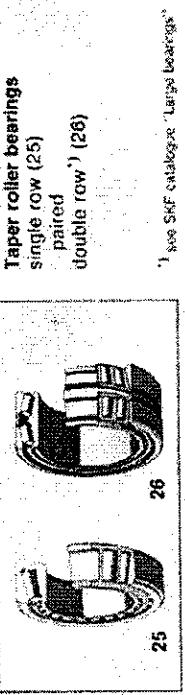
¹⁾ see SKF catalogue "Needle roller bearings"



Spherical roller bearings
with cylindrical (24) or tapered bore

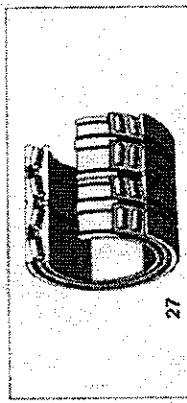
**Taper roller bearings**

single row (25)
paired
double row¹⁾ (26)



¹⁾ see SKF catalogue "Large bearings"

four-row¹⁾ (27)



¹⁾ see SKF catalogue "Large bearings"

Crossed taper roller bearings¹⁾ (28)

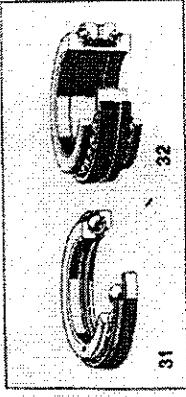
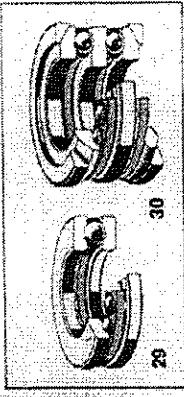
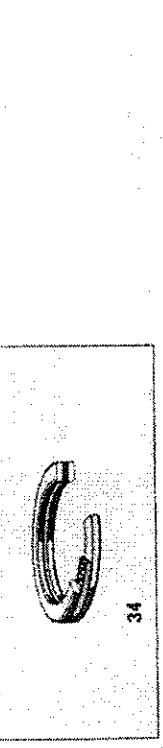
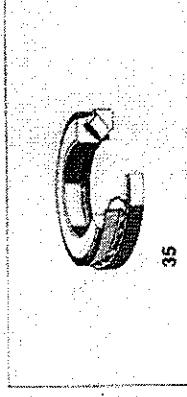


¹⁾ see SKF catalogue "Precision bearings"

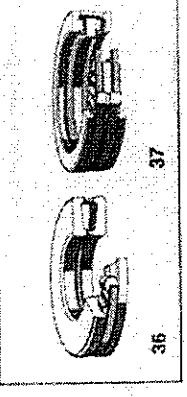
Thrust bearings**Thrust ball bearings**

single direction
with flat housing washer (29)
with spheroid housing washer and sealing ring
double direction
with flat housing washers
with spheroid housing washers and sealing rings (30)

¹⁾ see SKF catalogue "Large bearings" and "Precision bearings"

**Cylindrical roller thrust bearings (33)****Needle roller thrust bearings (34)****Spherical roller thrust bearings (35)**

Taper roller thrust bearings
single direction¹⁾ (36)
double direction¹⁾ (37)



¹⁾ see SKF catalogue "Large bearings"

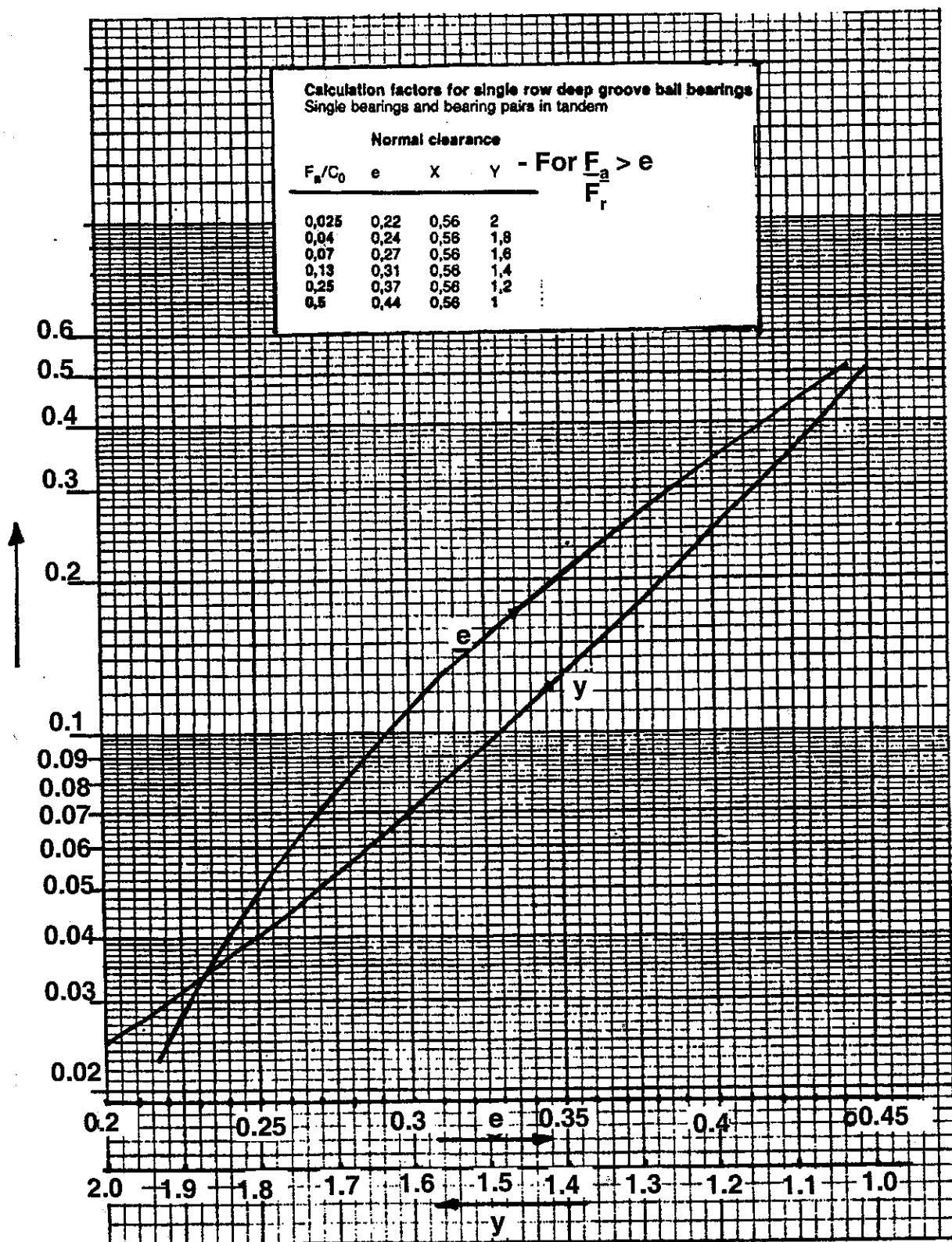
Rolling Element Bearings

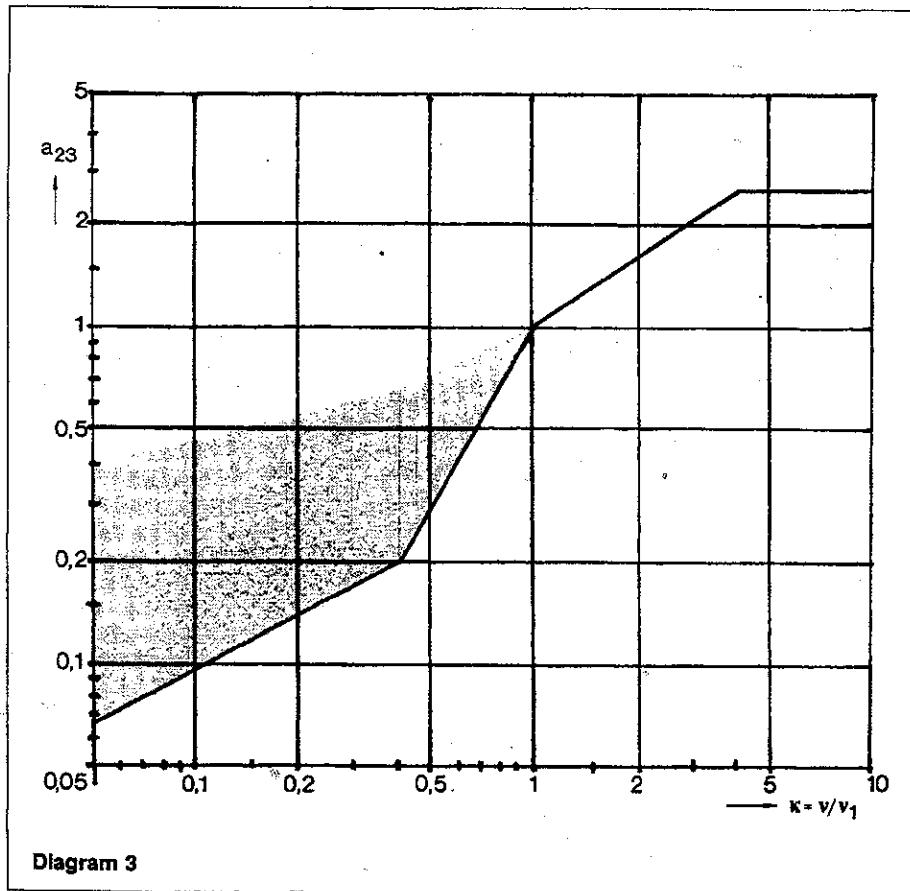
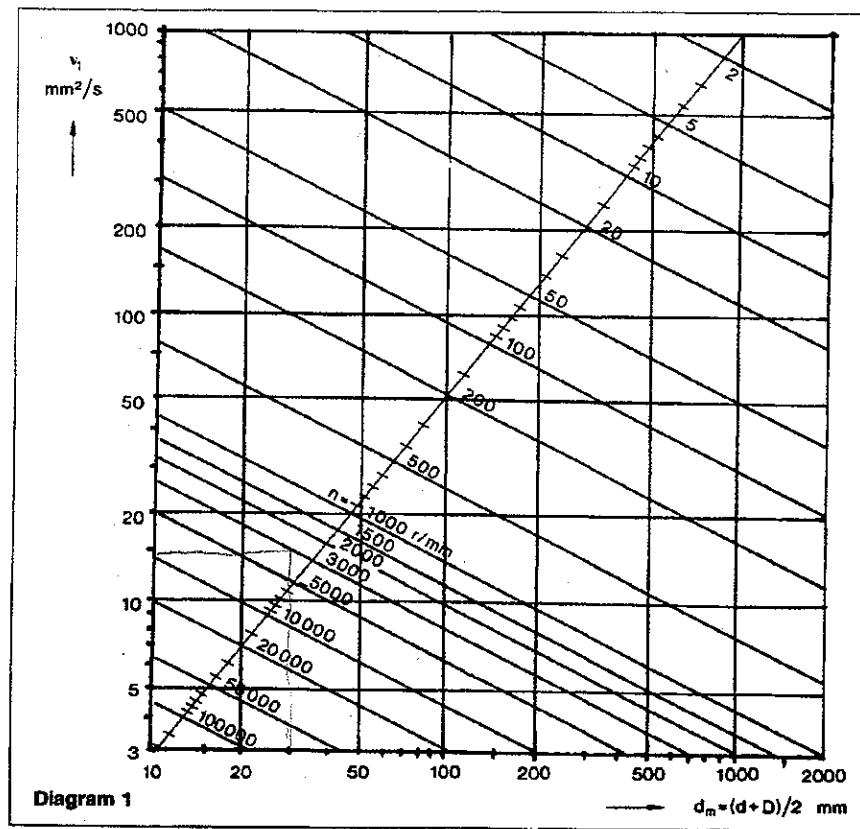
This matrix can only provide a rough guide so that in each individual case it is necessary to make a more qualified selection referring to the information given on the preceding pages or the detailed information in the text preceding each one on this section. If several designs of a bearing type are shown adjacent to each other, the relevant information is indicated by the same small letter used to identify the individual design.

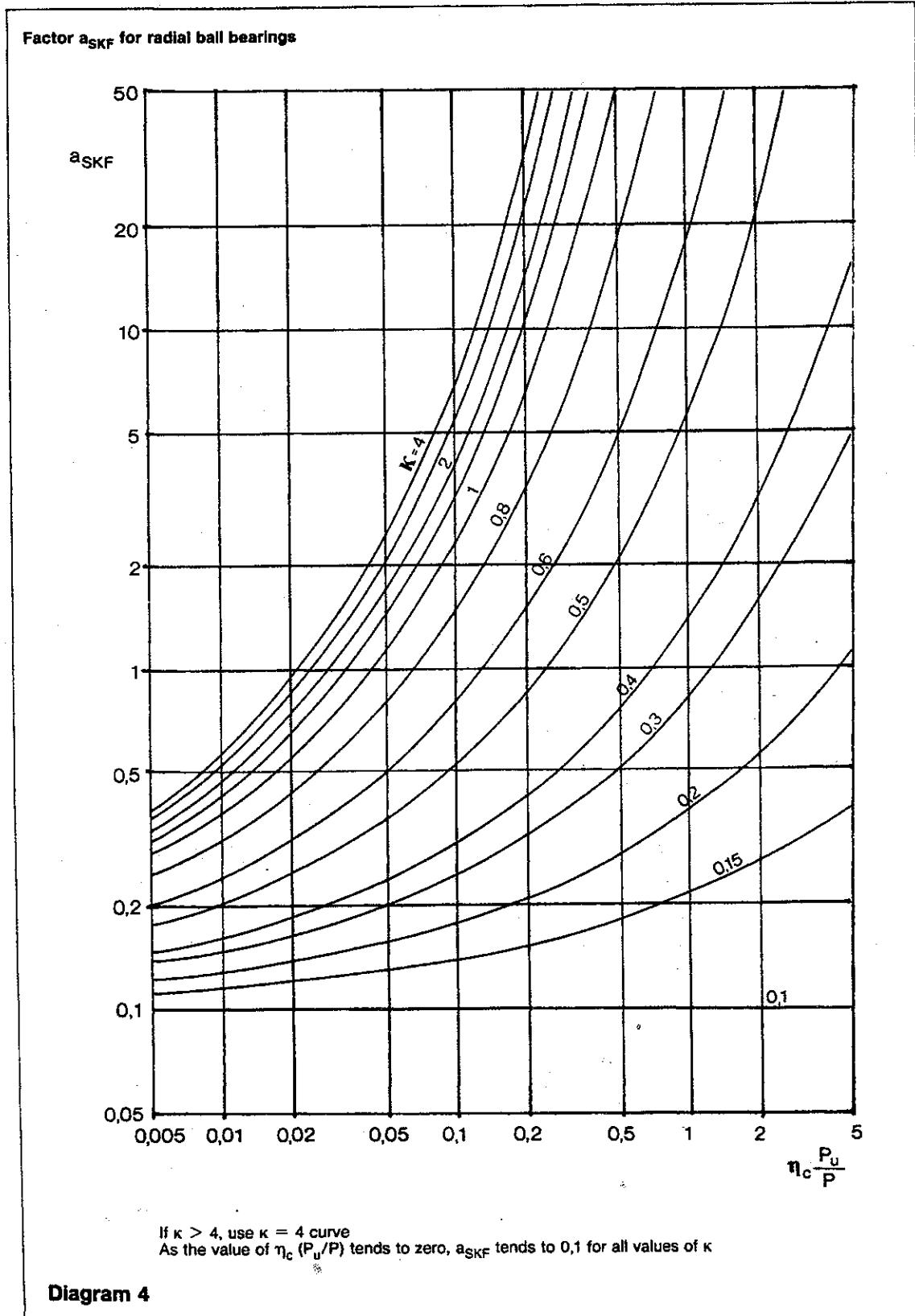
Bearing types - design and characteristics	
Bearing type	Design
Deep groove ball bearings	 Separable
Self-aligning ball bearings	 Non-separable
Angular contact ball bearings (back-to-back)	 Self-aligning
Four-point contact ball bearings	 Tapered bore
Cylindrical roller bearings	 Self-aligning
Full complement cylindrical roller bearings	 Self-aligning
Needle roller bearings	 Self-aligning
Spherical roller bearings	 Self-aligning
Taper roller bearings (face-to-face)	 Separable
Thrust ball bearings	 Separable
Cylindrical roller thrust bearings	 Separable
Needle roller thrust bearings	 Separable
Spherical roller thrust bearings	 Separable

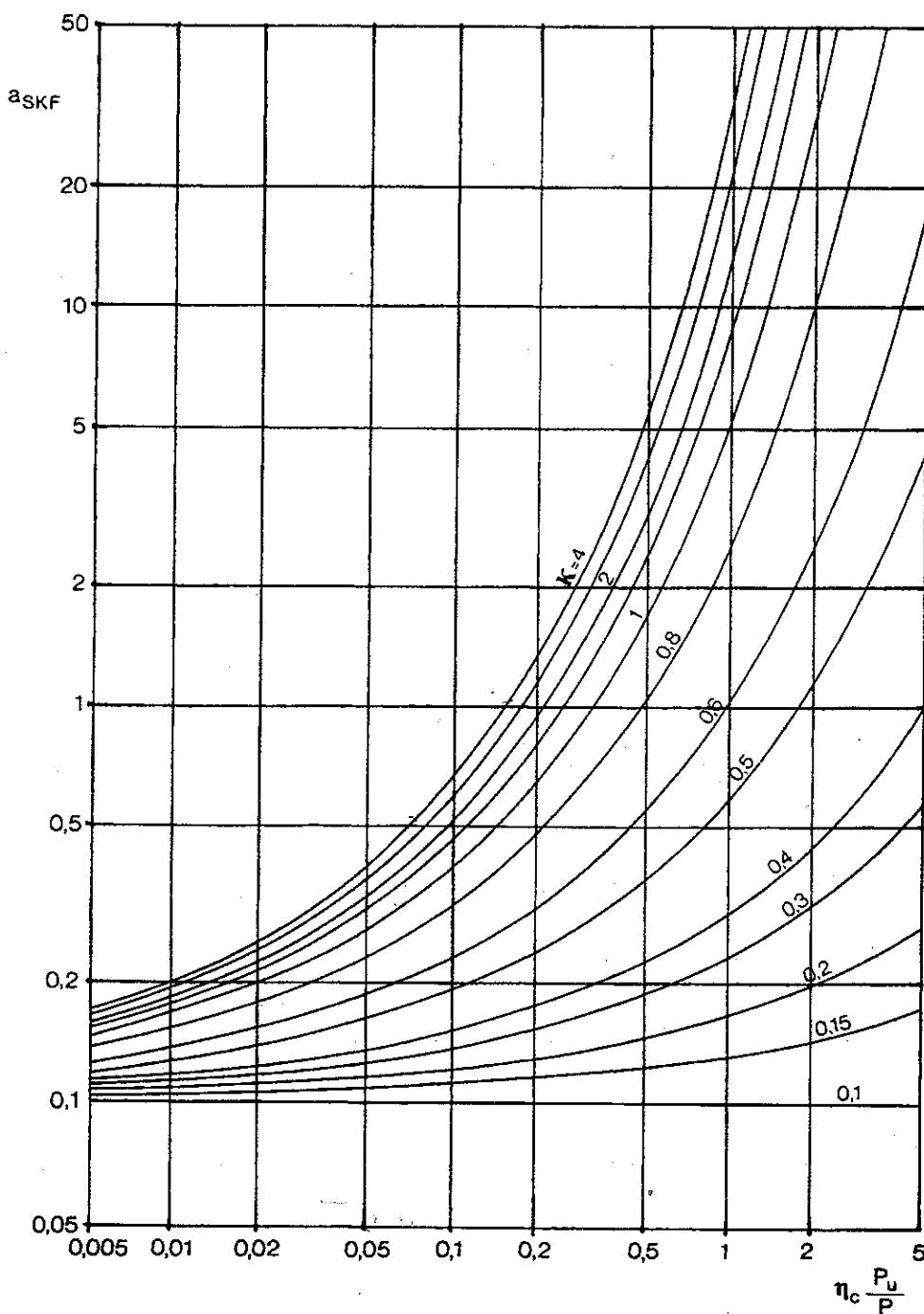
Chapter 1

Mechanical Design Data Manual



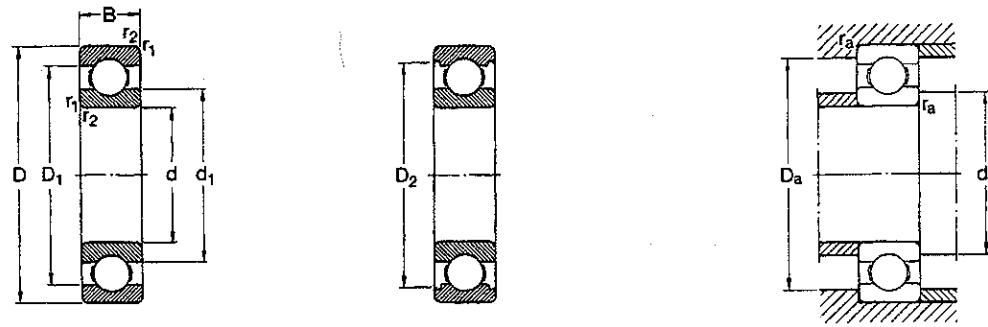




Factor a_{SKF} for radial roller bearings

If $\kappa > 4$, use $\kappa = 4$ curve
 As the value of $\eta_c (P_u/P)$ tends to zero, a_{SKF} tends to 0,1 for all values of κ

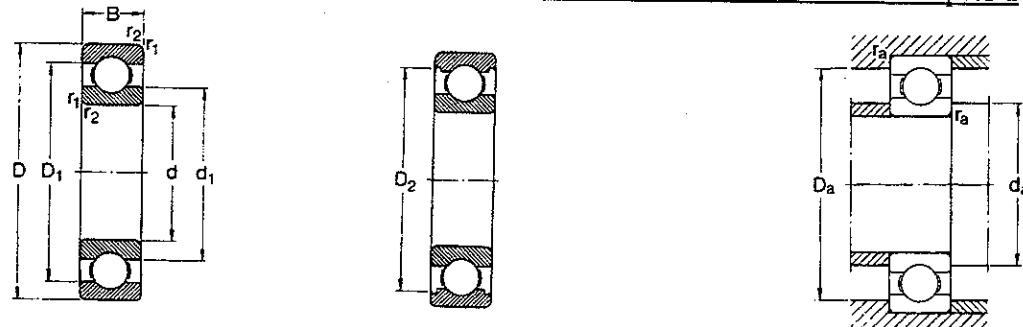
Diagram 5



With full outer ring shoulders

With recessed outer ring shoulders

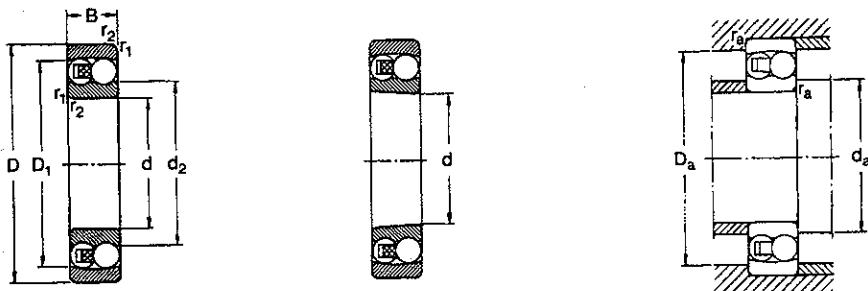
Principal dimensions			Basic load ratings		Fatigue load limit	Speed ratings		Mass	Designation		Dimensions			Abutment and fillet dimensions			
d	D	B	C	C_0	P_u	Lubrication grease	oil	kg			d_1	D_1	D_2	$r_{1,2}$ min	d_a min	D_a max	r_a max
mm			N	N		r/min		-							mm		
15	24	5	1 560	800	34	28 000	34 000	0,0074	61802	17,9	21,1	-	0,3	17	22	0,3	
	28	7	4 030	2 040	85	24 000	30 000	0,016	61902	18,4	24,7	-	0,3	17	26	0,3	
32	8	5 590	2 850	120	22 000	28 000	0,025	16002	20,2	27	28,2	0,3	17	30	0,3		
32	9	5 590	2 850	120	22 000	28 000	0,030	6002	20,2	27	28,2	0,3	17	30	0,3		
35	11	7 800	3 750	160	19 000	24 000	0,045	6202	21,5	29,2	30,4	0,6	19	31	0,6		
42	13	11 400	5 400	228	17 000	20 000	0,082	6302	23,7	33,9	36,3	1	20	37	1		
17	26	5	1 680	930	39	24 000	30 000	0,0082	61803	20,2	23,2	-	0,3	19	24	0,3	
	30	7	4 360	2 320	98	22 000	28 000	0,018	61903	20,4	26,7	-	0,3	19	28	0,3	
35	8	6 050	3 250	137	19 000	24 000	0,032	16003	22,7	29,5	31,2	0,3	19	33	0,3		
35	10	6 050	3 250	137	19 000	24 000	0,039	6003	22,7	29,5	31,2	0,3	19	33	0,3		
40	12	9 560	4 750	200	17 000	20 000	0,065	6203	24,2	32,9	35	0,6	21	36	0,6		
47	14	13 500	6 550	275	16 000	19 000	0,12	6303	26,5	37,6	39,6	1	22	42	1		
	62	17	22 900	10 800	455	12 000	15 000	0,27	6403	32,4	47,4	-	1,1	23,5	55,5	1	
20	32	7	2 700	1 500	63	19 000	24 000	0,018	61804	24	28,3	-	0,3	22	30	0,3	
	37	9	6 370	3 650	156	18 000	22 000	0,038	61904	25,6	31,4	-	0,3	22	35	0,3	
42	8	6 890	4 050	173	17 000	20 000	0,050	16004	27,3	34,6	-	0,3	22	40	0,3		
42	12	9 360	5 000	212	17 000	20 000	0,069	6004	27,2	35,1	37,2	0,6	24	38	0,6		
47	14	12 700	6 550	280	15 000	18 000	0,11	6204	28,5	38,7	40,6	1	25	42	1		
52	15	15 900	7 800	335	13 000	16 000	0,14	6304	30,3	42,1	44,8	1,1	26,5	45,5	1		
	72	19	30 700	15 000	640	10 000	13 000	0,40	6404	37,1	55,6	-	1,1	26,5	65,5	1	
25	37	7	4 360	2 600	125	17 000	20 000	0,022	61805	28,5	33,3	-	0,3	27	35	0,3	
	42	9	6 630	4 000	176	16 000	19 000	0,045	61905	30,2	36,8	-	0,3	27	40	0,3	
47	8	7 610	4 750	212	14 000	17 000	0,060	16005	33,3	40,7	-	0,3	27	45	0,3		
47	12	11 200	6 550	275	15 000	18 000	0,080	6005	32	40,3	42,2	0,6	29	43	0,6		
52	15	14 000	7 800	335	12 000	15 000	0,13	6205	34	44,2	46,3	1	30	47	1		
62	17	22 500	11 600	490	11 000	14 000	0,23	6305	36,6	50,9	52,7	1,1	31,5	55,5	1		
	80	21	35 800	19 300	815	9 000	11 000	0,53	6405	45,4	63,8	-	1,5	33	72	1,5	
30	42	7	4 490	2 900	146	15 000	18 000	0,027	61806	33,7	38,5	-	0,3	32	40	0,3	
	47	9	7 280	4 550	212	14 000	17 000	0,051	61906	35,2	41,8	-	0,3	32	45	0,3	
55	9	11 200	7 350	310	12 000	15 000	0,085	16006	38	47,3	-	0,3	32	53	0,3		
55	13	13 300	8 300	355	12 000	15 000	0,12	6006	38	47,1	49	1	35	50	1		
62	16	19 500	11 200	475	10 000	13 000	0,20	6206	40,3	52,1	54,1	1	35	57	1		
72	19	28 100	16 000	670	9 000	11 000	0,35	6306	44,6	59,9	61,9	1,1	36,5	65,5	1		
	90	23	43 600	23 600	1 000	8 500	10 000	0,74	6406	50,3	70,7	-	1,5	38	82	1,5	
35	47	7	4 750	3 200	166	13 000	16 000	0,030	61807	38,7	43,5	-	0,3	37	45	0,3	
	55	10	9 560	6 200	290	11 000	14 000	0,080	61907	41,6	48,6	-	0,6	39	51	0,6	
62	9	12 400	8 150	375	10 000	13 000	0,11	16007	44	53,3	-	0,3	37	60	0,3		
62	14	15 900	10 200	440	10 000	13 000	0,16	6007	43,7	53,6	55,7	1	40	57	1		
72	17	25 500	15 300	655	9 000	11 000	0,29	6207	46,9	60,6	62,7	1,1	41,5	65,5	1		
80	21	33 200	19 000	815	8 500	10 000	0,46	6307	49,5	66,1	69,2	1,5	43	72	1,5		
100	25	55 300	31 000	1 290	7 000	8 500	0,95	6407	57,4	80,6	-	1,5	43	92	1,5		
40	52	7	4 940	3 450	186	11 000	14 000	0,034	61808	43,7	48,5	-	0,3	42	50	0,3	
	62	12	13 800	9 300	425	10 000	13 000	0,12	61908	47	55,2	-	0,6	44	58	0,6	
68	9	13 300	9 150	440	9 500	12 000	0,13	16008	49,4	57	-	0,3	42	66	0,3		
68	15	16 800	11 600	490	9 500	12 000	0,19	6008	49,2	59,1	61,1	1	45	63	1		
80	18	30 700	19 000	800	8 500	10 000	0,37	6208	52,6	67,9	69,8	1,1	46,5	73,5	1		
90	23	41 000	24 000	1 020	7 500	9 000	0,63	6308	56,1	74,7	77,7	1,5	48	82	1,5		
110	27	63 700	36 500	1 530	6 700	8 000	1,25	6408	62,8	88	-	2	49	101	2		
45	58	7	6 050	4 300	228	9 500	12 000	0,040	61809	48,7	54,5	-	0,3	47	56	0,3	
	68	12	14 000	9 800	465	9 000	11 000	0,14	61909	52,3	60,8	-	0,6	49	64	0,6	
75	10	15 600	10 800	520	9 000	11 000	0,17	16009	55	65,4	-	0,6	49	71	0,6		
75	16	20 800	14 600	640	9 000	11 000	0,25	6009	54,7	65,6	67,8	1	50	70	1		
85	19	33 200	21 600	915%	7 500	9 000	0,41	6209	57,6	72,9	75,2	1,1	51,5	78,5	1		
100	25	52 700	31 500	1 340	6 700	8 000	0,63	6309	62,1	83,7	86,7	1,5	53	92	1,5		
120	29	76 100	45 000	1 900	6 000	7 000	1,55	6409	68,9	96,9	-	2	54	111	2		



With full outer ring shoulders

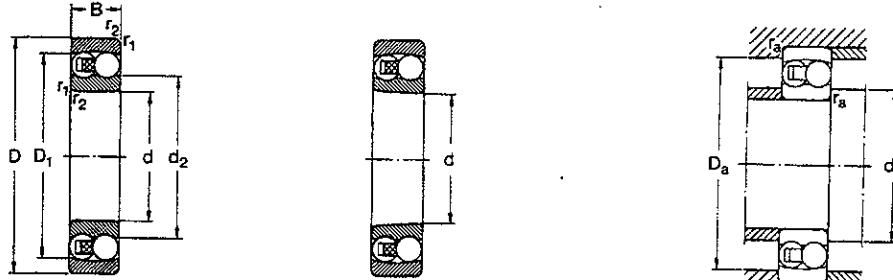
With recessed outer ring shoulders

Principal dimensions			Basic load ratings dynamic static		Fatigue load limit P_u	Speed ratings Lubrication grease oil		Mass	Designation		Dimensions			Abutment and fillet dimensions			
d	D	B	C	C_0		N		r/min	kg		d_1	D_1	D_2	$r_{1,2}$ min	d_a min	D_a max	r_a max
mm																	
50	65	7	6 240	4 750	250	9 000	11 000	0,052	61810	54,7	60,5	-	0,3	52	63	0,3	
72	12	14 600	10 400	500	8 500	10 000	0,14	61910	56,8	65,3	-	0,6	54	68	0,6		
80	10	16 300	11 400	560	8 500	10 000	0,18	16010	60	70,4	-	0,6	54	76	0,6		
80	16	21 600	16 000	710	8 500	10 000	0,26	6010	59,7	70,6	72,8	1	55	75	1		
90	20	35 100	23 200	980	7 000	8 500	0,46	6210	62,5	78,1	81,7	1,1	56,5	83,5	1		
110	27	61 800	38 000	1 600	6 300	7 500	1,05	6310	68,7	92,1	95,2	2	59	101	2		
130	31	87 100	52 000	2 200	5 300	6 300	1,90	6410	75,4	106	-	2,1	61	119	2		
55	72	9	8 840	6 800	360	8 500	10 000	0,083	61811	60,2	67	-	0,3	57	70	0,3	
80	13	15 900	11 400	560	8 000	9 500	0,19	61911	63	72,1	-	1	60	75	1		
90	11	19 500	14 000	695	7 500	9 000	0,26	16011	67	78	-	0,6	59	86	0,6		
90	18	28 100	21 200	900	7 500	9 000	0,39	6011	66,3	79,1	81,5	1,1	61,5	83,5	1		
100	21	43 600	29 000	1 250	6 300	7 500	0,61	6211	69	86,6	89,4	1,5	63	92	1,5		
120	29	71 500	45 000	1 900	5 600	6 700	1,35	6311	75,3	101	104	2	64	111	2		
140	33	99 500	62 000	2 600	5 000	6 000	2,30	6411	81,5	115	-	2,1	66	129	2		
60	78	10	8 710	6 700	365	7 500	9 000	0,11	61812	65,6	72,6	-	0,3	62	76	0,3	
85	13	16 500	12 000	600	7 500	9 000	0,20	61912	68	77,1	-	1	65	80	1		
95	11	19 900	15 000	735	6 700	8 000	0,28	16012	72	83,4	-	0,6	64	91	0,6		
95	18	29 600	23 200	980	6 700	8 000	0,42	6012	71,3	84,1	86,5	1,1	66,5	88,5	1		
110	22	52 700	36 000	1 530	6 000	7 000	0,78	6212	75,5	94,2	97	1,5	68	102	1,5		
130	31	81 900	52 000	2 200	5 000	6 000	1,70	6312	81,8	109	113	2,1	71	119	2		
150	35	108 000	69 500	2 900	4 800	5 600	2,75	6412	88,1	123	-	2,1	71	139	2		
65	85	10	11 900	9 650	510	7 000	8 500	0,13	61813	71,1	79,1	-	0,6	69	81	0,6	
90	13	17 400	13 400	680	6 700	8 000	0,22	61913	73	82,1	-	1	70	85	1		
100	11	21 200	16 600	830	6 300	7 500	0,30	16013	76,5	88,5	-	0,6	69	96	0,6		
100	18	30 700	25 000	1 060	6 300	7 500	0,44	6013	76,3	89,1	91,5	1,1	71,5	93,5	1		
120	23	55 900	40 500	1 730	5 300	6 300	0,99	6213	83,3	103	106	1,5	73	112	1,5		
140	33	92 300	60 000	2 500	4 800	5 600	2,10	6313	88,3	118	122	2,1	76	129	2		
160	37	119 000	78 000	3 150	4 500	5 300	3,30	6413	94	132	-	2,1	76	149	2		
70	90	10	12 100	10 000	540	6 700	8 000	0,14	61814	76,1	84,1	-	0,6	74	86	0,6	
100	16	23 800	18 300	900	6 300	7 500	0,35	61914	79,6	90,6	-	1	75	95	1		
110	13	28 100	25 000	1 060	6 000	7 000	0,43	16014	83,3	97,1	-	0,6	74	106	0,6		
110	20	37 700	31 000	1 320	6 000	7 000	0,60	6014	82,8	97,6	99,9	1,1	76,5	103,5	1		
125	24	60 500	45 000	1 900	5 000	6 000	1,05	6214	87	109	111	1,5	78	117	1,5		
150	35	104 000	68 000	2 750	4 500	5 300	2,50	6314	94,9	126	130	2,1	81	139	2		
180	42	143 000	104 000	3 900	3 800	4 500	4,85	6414	103	147	-	3	83	167	2,5		
75	95	10	12 500	10 800	585	6 300	7 500	0,15	61815	81,1	89,1	-	0,6	79	91	0,6	
105	16	24 200	19 300	965	6 000	7 000	0,37	61915	84,6	95,6	-	1	80	100	1		
115	13	28 600	27 000	1 140	5 600	6 700	0,46	16015	88,3	102	-	0,6	79	111	0,6		
115	20	39 700	33 500	1 430	5 600	6 700	0,64	6015	87,8	103	105	1,1	81,5	108,5	1		
130	25	66 300	49 000	2 040	4 800	5 600	1,20	6215	92	114	117	1,5	83	122	1,5		
160	37	114 000	76 500	3 000	4 300	5 000	3,00	6315	101	135	139	2,1	86	149	2		
190	45	153 000	114 000	4 150	3 600	4 300	6,80	6415	110	156	159	3	88	177	2,5		
80	100	10	12 700	11 200	610	6 000	7 000	0,15	61816	86,1	94,1	-	0,6	84	96	0,6	
110	16	25 100	20 400	1 020	5 600	6 700	0,40	61916	89,6	101	-	1	85	105	1		
125	14	33 200	31 500	1 320	5 300	6 300	0,60	16016	95,3	110	-	0,6	84	121	0,6		
125	22	47 500	40 000	1 660	5 300	6 300	0,85	6016	94,4	112	115	1,1	86,5	118,5	1		
140	26	70 200	55 000	2 200	4 500	5 300	1,40	6216	101	123	127	2	89	131	2		
170	39	124 000	86 500	3 250	3 800	4 500	3,80	6316	108	143	147	2,1	91	159	2		
200	48	163 000	125 000	4 500	3 400	4 000	8,00	6416	116	164	-	3	93	187	2,5		



Principal dimensions			Basic load ratings		Fatigue load limit P_u	Speed ratings		Mass	Designations		Dimensions			Abutment and fillet dimensions		Calculation factors			
d	D	B	C	C_g		Lubrication grease	oil		Bearings with cylindrical bore	d_2	D_1	$r_{1,2}$ min	d_a min	D_a max	r_a max	e	Y_1	Y_2	Y_0
mm		N	N		r/min	kg	-				mm		-						
5	19	6	2 510	480	25	32 000	38 000	0,009	135	10,3	15,4	0,3	7	17	0,3	0,33	1,9	3	2
6	19	6	2 510	480	25	32 000	38 000	0,009	128	10,3	15,4	0,3	8	17	0,3	0,33	1,9	3	2
7	22	7	2 650	560	29	30 000	36 000	0,014	127	12,6	17,6	0,3	9	20	0,3	0,33	1,9	3	2
8	22	7	2 650	560	29	30 000	36 000	0,014	108	12,6	17,6	0,3	10	20	0,3	0,33	1,9	3	2
9	26	8	3 900	815	43	26 000	32 000	0,022	129	14,8	21,1	0,6	13	22	0,6	0,33	1,9	3	2
10	30	9	5 530	1 180	61	24 000	30 000	0,034	1200 E	16,7	24,4	0,6	14	26	0,6	0,33	1,9	3	2
	30	14	8 060	1 730	90	22 000	28 000	0,047	2200 E	15,3	24,3	0,6	14	26	0,6	0,54	1,15	1,8	1,3
12	32	10	6 240	1 430	72	22 000	28 000	0,040	1201 E	18,2	26,4	0,6	16	28	0,6	0,33	1,9	3	2
32	14	8 520	1 900	98	20 000	26 000	0,053	2201 E	17,5	26,5	0,6	16	28	0,6	0,50	1,25	2	1,3	
37	12	9 360	2 160	112	18 000	22 000	0,067	1301 E	20	30,8	1	17	32	1	0,35	1,8	2,8	1,8	
37	17	11 700	2 700	140	17 000	20 000	0,095	2301	16,6	30	1	17	32	1	0,60	1,05	1,6	1,1	
15	35	11	7 410	1 760	90	19 000	24 000	0,049	1202 E	21,2	29,6	0,6	19	31	0,6	0,33	1,9	3	2
35	14	8 710	2 040	104	18 000	22 000	0,060	2202 E	20,9	30,2	0,6	19	31	0,6	0,43	1,5	2,3	1,6	
42	13	10 800	2 600	134	17 000	20 000	0,094	1302 E	23,9	35,3	1	20	37	1	0,31	2	3,1	2,2	
42	17	11 900	2 900	150	15 000	18 000	0,11	2302	23,2	35,2	1	20	37	1	0,52	1,2	1,9	1,3	
17	40	12	8 840	2 200	114	18 000	22 000	0,073	1203 E	24	33,6	0,6	21	36	0,6	0,31	2	3,1	2,2
40	16	10 600	2 550	132	17 000	20 000	0,088	2203 E	23,8	34,1	0,6	21	36	0,6	0,43	1,5	2,3	1,6	
47	14	12 700	3 400	176	14 000	17 000	0,13	1303 E	28,9	41	1	22	42	1	0,30	2,1	3,3	2,2	
47	19	14 800	3 550	183	13 000	16 000	0,16	2303	25,8	39,4	1	22	42	1	0,52	1,2	1,9	1,3	
20	47	14	12 700	3 400	176	15 000	18 000	0,12	1204 E	28,9	41	1	25	42	1	0,30	2,1	3,3	2,2
47	18	16 800	4 150	216	14 000	17 000	0,14	2204 E	27,4	41	1	25	42	1	0,40	1,6	2,4	1,6	
52	15	14 300	4 000	204	12 000	15 000	0,16	1304 E	33,3	45,6	1,1	26,5	45,5	1	0,28	2,2	3,5	2,5	
52	21	18 200	4 750	240	11 000	14 000	0,21	2304	28,8	43,7	1,1	26,5	45,5	1	0,52	1,2	1,9	1,3	
25	52	15	14 300	4 000	204	13 000	16 000	0,14	1205 E	33,3	45,6	1	30	47	1	0,28	2,2	3,5	2,5
52	18	16 800	4 400	228	11 000	14 000	0,16	2205 E	32,3	46,1	1	30	47	1	0,35	1,8	2,8	1,8	
62	17	19 000	5 400	280	9 500	12 000	0,26	1305 E	37,8	52,5	1,1	31,5	55,5	1	0,28	2,2	3,5	2,5	
62	24	24 200	6 550	340	9 500	12 000	0,34	2305	35,2	52,5	1,1	31,5	55,5	1	0,48	1,3	2	1,4	
30	62	16	15 600	4 650	240	10 000	13 000	0,22	1206 E	40,1	53	1	35	57	1	0,25	2,5	3,9	2,5
62	20	23 800	6 700	345	9 500	12 000	0,26	2206 E	38,8	55	1	35	57	1	0,33	1,9	3	2	
72	19	22 500	6 800	355	9 000	11 000	0,39	1306 E	44,9	60,9	1,1	36,5	65,5	1	0,25	2,5	3,9	2,5	
72	27	31 200	8 800	450	8 500	10 000	0,50	2306	41,7	60,9	1,1	36,5	65,5	1	0,44	1,4	2,2	1,4	
90	28	59 200	17 000	865	6 700	8 000	1,00	1406	46,3	75,8	1,5	38	82	1,5	0,40	1,6	2,4	1,6	
35	72	17	19 000	6 000	305	9 000	11 000	0,32	1207 E	47	62,3	1,1	41,5	65,5	1	0,23	2,7	4,2	2,8
72	23	30 700	8 800	455	8 500	10 000	0,40	2207 E	45,3	64,2	1,1	41,5	65,5	1	0,31	2	3,1	2,5	
80	21	26 500	8 500	430	7 500	9 000	0,51	1307 E	51,5	69,5	1,5	43	72	1,5	0,25	2,5	3,9	2,5	
80	31	39 700	11 200	585	7 000	8 500	0,68	2307 E	46,5	68,4	1,5	43	72	1,5	0,46	1,35	2,1	1,4	
100	30	62 400	18 000	930	6 300	7 500	1,30	1407	53,2	83,8	1,5	43	92	1,5	0,37	1,7	2,6	1,8	
40	80	18	19 900	6 950	355	8 500	10 000	0,42	1208 E	53,6	68,8	1,1	46,5	73,5	1	0,22	2,9	4,5	2,8
80	23	31 900	10 000	510	7 500	9 000	0,51	2208 E	52,4	71,6	1,1	46,5	73,5	1	0,28	2,2	3,5	2,8	
90	23	33 800	11 200	570	6 700	8 000	0,72	1308 E	61,5	81,5	1,5	48	82	1,5	0,23	2,7	4,2	2,8	
90	33	54 000	16 000	815	6 300	7 500	0,93	2308 E	53,7	79,2	1,5	48	82	1,5	0,40	1,6	2,4	1,6	
110	33	75 100	23 600	1 200	5 300	6 300	1,70	1408	60	93,4	2	49	101	2	0,35	1,8	2,8	1,8	
45	85	18	22 900	7 800	400	7 500	9 000	0,47	1209 E	57,5	73,7	1,1	51,5	78,5	1	0,21	3	4,6	3,2
85	23	32 500	10 600	540	7 000	8 500	0,55	2209 E	55,3	74,6	1,1	51,5	78,5	1	0,26	2,4	3,7	2,5	
100	25	39 000	13 400	695	6 300	7 500	0,96	1309 E	67,7	88,5	1,5	53	92	1,5	0,23	2,7	4,2	2,8	
100	36	63 700	19 300	1 000	5 600	6 700	1,25	2309 E	60,1	87,4	1,5	53	92	1,5	0,33	1,9	3	2	
120	35	88 400	27 500	1 400	5 000	6 000	2,15	1409	66,4	103	2	54	111	2	0,35	1,8	2,8	1,8	

Note: for bearings with a tapered bore add 'K' to the designation



Cylindrical bore

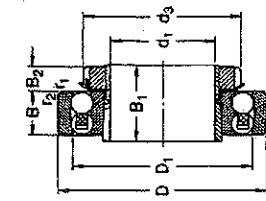
Tapered bore
taper 1:12 on diameter

Principal dimensions			Basic load ratings dynamic static		Fatigue load limit P_u	Speed ratings Lubrication grease oil		Mass	Designations Bearings with cylindrical bore		Dimensions		Abutment and fillet dimensions			Calculation factors			
d	D	B ¹⁾	C	C_0					$d_2 \approx$	$D_1 \approx$	$r_{1,2} \text{ min}$	$d_a \text{ min}$	$D_a \text{ max}$	$r_a \text{ max}$	e	γ_1	γ_2	γ_0	
mm	N	N	N	r/min	kg	-	-	-	-	-	-	mm	-	-	-	-	-	-	
50	90	20	26 500	9 150	475	7 000	8 500	0,53	1210 E	62,3	79,5	1,1	56,5	83,5	1	0,21	3	4,6	3,2
	90	23	33 800	11 200	570	6 300	7 500	0,60	2210 E	61,5	81,5	1,1	56,5	83,5	1	0,23	2,7	4,2	2,8
110	27	43 600	14 000	720	5 600	6 700	1,20	1310 E	70,1	95	2	59	101	2	0,24	2,6	4,1	2,8	
110	40	63 700	20 000	1 040	5 300	6 300	1,65	2310	65,8	94,4	2	59	101	2	0,43	1,5	2,3	1,6	
130	37	101 000	32 000	1 630	4 800	5 600	2,65	1410	71,2	111	2,1	61	119	2	0,35	1,8	2,8	1,8	
55	100	21	27 600	10 600	540	6 300	7 500	0,71	1211 E	70,1	88,4	1,5	63	95	1,5	0,19	3,3	5,1	3,6
100	25	39 000	13 400	895	6 000	7 000	0,81	2211 E	67,7	89,5	1,5	63	92	1,5	0,23	2,7	4,2	2,8	
120	29	50 700	18 000	915	5 000	6 000	1,60	1311 E	77,7	104	2	64	111	2	0,23	2,7	4,2	2,8	
120	43	76 100	24 000	1 250	4 800	5 600	2,10	2311	72	103	2	64	111	2	0,40	1,6	2,4	1,6	
140	40	111 000	36 500	1 860	4 300	5 000	3,25	1411	79,4	120	2,1	66	129	2	0,33	1,9	3	2	
60	110	22	31 200	12 200	620	5 600	6 700	0,90	1212 E	78	97,6	1,5	68	102	1,5	0,19	3,3	5,1	3,6
110	28	48 800	17 000	880	5 300	6 300	1,10	2212 E	74,5	98,6	1,5	68	102	1,5	0,24	2,6	4,1	2,8	
130	31	58 500	22 000	1 120	4 500	5 300	1,95	1312 E	87	115	2,1	71	119	2	0,23	2,7	4,2	2,8	
130	46	87 100	28 500	1 460	4 500	5 300	2,60	2312	76,9	112	2,1	71	119	2	0,33	1,9	3	2	
150	42	125 000	41 500	2 160	3 800	4 500	3,95	1412	85	128	2,1	71	139	2	0,33	1,9	3	2	
65	120	23	35 100	14 000	5 300	6 300	1,15	1213 E	85,3	106	1,5	73	112	1,5	0,18	3,5	5,4	3,6	
120	31	57 200	20 000	1 020	5 000	6 000	1,45	2213 E	80,7	107	1,5	73	112	1,5	0,24	2,6	4,1	2,8	
140	33	65 000	25 500	1 250	4 300	5 000	2,45	1313 E	89	127	2,1	76	129	2	0,22	2,9	4,5	2,8	
140	48	95 600	32 500	1 660	4 000	4 800	3,25	2313	85,5	122	2,1	76	129	2	0,37	1,7	2,6	1,8	
70	125	24	34 500	13 700	710	5 000	6 000	1,25	1214	87,4	109	1,5	78	117	1,5	0,18	3,5	5,4	3,6
125	31	44 200	17 000	880	4 800	5 600	1,50	2214	87,5	111	1,5	78	117	1,5	0,27	2,3	3,6	2,5	
150	35	74 100	27 500	1 340	4 000	4 800	3,00	1314	97,7	129	2,1	81	139	2	0,22	2,9	4,5	2,8	
150	51	111 000	37 500	1 880	3 800	4 500	3,80	2314	91,6	130	2,1	81	139	2	0,37	1,7	2,6	1,8	
75	130	25	39 000	15 600	800	4 800	5 600	1,35	1215	93	116	1,5	83	122	1,5	0,17	3,7	5,7	4
130	31	44 200	18 000	900	4 500	5 300	1,60	2215	93,1	117	1,5	83	122	1,5	0,25	2,5	3,9	2,5	
160	37	79 300	30 000	1 430	3 800	4 500	3,55	1315	104	138	2,1	86	149	2	0,22	2,9	4,5	2,8	
160	55	124 000	43 000	2 040	3 400	4 000	4,70	2315	97,8	139	2,1	86	149	2	0,37	1,7	2,6	1,8	
80	140	26	39 700	17 000	830	4 500	5 300	1,65	1216	101	125	2	88	131	2	0,16	3,9	6,1	4
140	33	65 000	25 500	1 250	4 000	4 800	2,00	2216 E	99	127	2	88	131	2	0,22	2,9	4,5	2,8	
170	39	88 400	33 500	1 500	3 600	4 300	4,20	1316	109	147	2,1	91	159	2	0,22	2,9	4,5	2,8	
170	58	135 000	49 000	2 240	3 200	3 800	6,10	2316	104	148	2,1	91	159	2	0,37	1,7	2,6	1,8	
85	150	28	48 800	20 800	980	4 000	4 800	2,05	1217	107	134	2	94	141	2	0,17	3,7	5,7	4
150	36	58 500	23 600	1 120	3 800	4 500	2,50	2217	105	133	2	94	141	2	0,25	2,5	3,9	2,5	
180	41	97 500	38 000	1 700	3 400	4 000	5,00	1317	117	158	3	98	167	2,5	0,22	2,9	4,5	2,8	
180	60	140 000	51 000	2 280	3 000	3 600	7,05	2317	111	157	3	98	167	2,5	0,37	1,7	2,6	1,8	
90	160	30	57 200	23 600	1 080	3 800	4 500	2,50	1218	112	142	2	99	151	2	0,17	3,7	5,7	4
160	40	70 200	28 500	1 320	3 600	4 300	3,40	2218	112	142	2	99	151	2	0,27	2,3	3,6	2,5	
190	43	117 000	44 000	1 930	3 200	3 800	5,80	1318	122	165	3	103	177	2,5	0,22	2,9	4,5	2,8	
190	64	153 000	57 000	2 500	2 800	3 400	8,45	2318	115	164	3	103	177	2,5	0,37	1,7	2,6	1,8	

Note: for bearings with a tapered bore add 'K' to the designation

Rolling Element Bearings

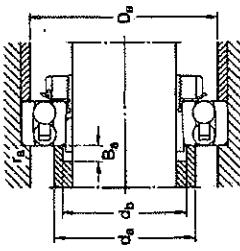
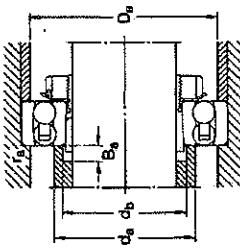
**Self-aligning ball bearings
with adapter sleeve
 $d_1 = 17-55 \text{ mm}$**



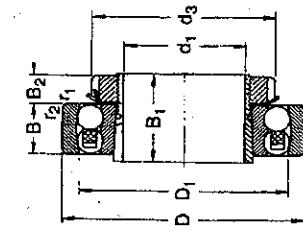
Chapter 1

Mechanical Design Data Manual

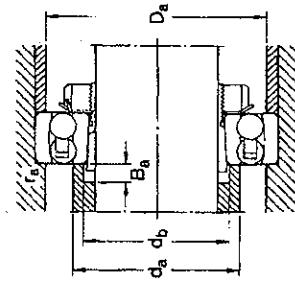
30
TABLE



Principal dimensions d_1 D B C C_0	Basic load ratings dynamic static N	Fatigue load limit P_u	Speed ratings Lubrication oil r/min	Masses Bearing Adapter sleeve kg	Designations Bearing Adapter sleeve	Dimensions d_1 d_2 d_3 D_1 B_1 B_2 r_{12} mm	Abutment and fillet dimensions			Calculation factors														
							d_1	d_2	d_3	D_1	B_1	B_2	d_{\min}	d_{\max}	D_{\min}	D_{\max}								
17 47	14 12 700	3 400	176	15 000	18 000	0.12	0.036	1204 EK	H 204	17	32	41	24	7	1	28.5	23	45.5	5	1	0.30	2.1	3.3	2.2
17 52	15 14 300	4 000	204	12 000	14 000	0.16	0.040	1304 EK	H 304	17	32	45.6	29	7	1.1	33	23	45.5	5	1	0.29	2.2	3.5	2.6
20 52	16 14 300	4 000	204	13 000	16 000	0.14	0.064	1205 EK	H 205	20	36	45.6	26	8	1	33	28	47	5	1	0.28	2.2	3.5	2.5
20 52	18 16 800	4 400	228	11 000	14 000	0.16	0.071	2205 EK	H 305	20	36	45.6	29	8	1.1	32	28	55.5	6	1	0.35	1.8	2.6	1.8
62 62	17 18 000	5 400	280	9 500	12 000	0.26	0.071	1305 EK	H 205	36	62.5	56	25	8	1.1	37	28	55.5	5	1	0.26	1.8	2.6	1.4
62 62	17 24 200	6 550	340	8 500	12 000	0.34	0.095	2305 K	H 2305	36	62.5	56	25	8	1.1	35	30	55.5	5	1	0.48	1.3	2	2.4
25 62	18 15 600	6 650	240	10 000	13 000	0.22	0.086	1206 EK	H 206	25	45	53	27	9	1	40	33	57	5	1	0.26	2.5	3.9	2.6
25 62	18 23 800	6 700	345	9 500	12 000	0.26	0.095	2206 EK	H 306	45	60.9	51	31	8	1.1	44	33	65.5	6	1	0.33	1.9	3	2.5
72 72	18 22 500	6 800	355	9 500	11 000	0.39	0.095	1306 EK	H 2306	45	60.9	51	31	8	1.1	41	35	65.5	5	1	0.25	2.5	3.9	2.5
72 72	18 31 200	8 800	450	6 500	10 000	0.50	0.11	2306 K	H 2306	45	60.9	51	31	8	1.1	41	35	65.5	5	1	0.44	1.4	2.2	1.4
30 30	17 18 000	6 000	305	9 000	11 000	0.32	0.12	1207 EK	H 207	30	52	62.3	29	9	1.1	47	38	65.5	5	1	0.23	2.7	4.2	2.8
30 30	17 23 700	8 800	455	6 500	10 000	0.40	0.14	2207 EK	H 307	32	60.2	56	35	9	1.1	45	39	65.5	5	1	0.31	2.1	3.1	2.2
80 80	21 26 500	6 500	430	7 500	9 000	0.51	0.14	1307 EK	H 207	32	60.2	56	35	9	1.5	51	39	72	7	1.6	0.25	2.6	3.8	2.5
80 80	21 39 700	11 200	585	7 000	8 500	0.58	0.16	2307 EK	H 2307	32	60.2	56	35	9	1.5	48	40	72	7	1.6	0.46	1.95	2.1	1.4
35 35	18 19 900	6 950	355	8 500	10 000	0.42	0.16	1208 EK	H 208	35	58	69.8	31	10	1.1	53	43	73.5	6	1	0.22	2.9	4.5	2.8
35 35	18 31 900	10 000	510	7 500	9 000	0.51	0.17	2208 EK	H 308	58	71.6	36	10	1.1	52	44	73.5	6	1	0.28	2.2	3.5	2.5	
90 90	23 31 800	11 200	570	7 000	9 000	0.72	0.17	1308 EK	H 2308	58	70.2	46	10	1.5	63	44	62	6	1.5	0.23	2.7	4.2	2.8	
90 90	23 34 000	16 000	815	6 300	7 500	0.83	0.22	2308 EK	H 2308	58	70.2	46	10	1.5	53	45	62	6	1.5	0.40	1.6	2.4	1.8	
40 40	19 22 800	7 600	400	7 500	9 000	0.47	0.17	1209 EK	H 209	40	65	73.7	33	11	1.1	57	48	78.5	6	1	0.21	3	4.8	3.2
40 40	19 23 300	10 500	540	7 000	9 500	0.56	0.21	2209 EK	H 309	65	74.8	36	11	1.1	55	50	78.5	6	1	0.26	2.4	3.7	2.8	
100 100	21 39 000	13 400	695	6 300	7 500	0.96	0.23	1309 EK	H 2309	65	89.5	39	11	1.5	67	50	92	6	1.5	0.23	2.7	4.2	2.8	
100 100	21 39 300	19 300	1 000	5 600	7 000	1.25	0.27	2309 EK	H 2309	65	87.4	50	1.5	60	50	92	6	1.5	0.30	1.8	3	2		
45 45	20 26 500	9 150	475	7 000	9 000	0.53	0.24	1210 EK	H 210	45	70	79.5	35	12	1.1	62	53	83.5	6	1	0.21	3	4.6	3.2
45 45	20 33 800	11 200	570	6 200	7 500	0.59	0.27	2210 EK	H 310	45	70	81.5	42	12	1.1	61	55	83.5	10	1	0.23	2.7	4.2	2.8
110 110	21 43 600	14 600	720	5 800	6 500	1.05	0.34	1310 EK	H 2310	70	91.4	55	12	2	65	55	101	6	2	0.45	1.5	2.3	1.6	
110 110	21 43 600	20 000	1 040	5 300	6 000	1.05	0.34	2310 EK	H 2310	70	91.4	55	12	2	65	55	101	6	2	0.45	1.5	2.3	1.6	
50 50	19 27 600	10 500	540	6 300	7 500	0.71	0.26	1211 EK	H 211	50	76	88.4	37	12.5	1.5	70	60	92	7	1.5	0.19	3.3	5.1	3.6
50 50	19 30 000	13 400	695	5 600	6 000	1.05	0.32	2211 EK	H 311	75	103.5	45	12.5	2	72	61	111	7	2	0.40	1.6	2.4	1.6	
120 120	23 29 700	18 200	1 250	4 800	5 600	2.01	0.33	1311 EK	H 2311	75	103.5	45	12.5	2	72	61	111	7	2	0.40	1.6	2.4	1.6	
55 55	19 31 200	12 200	620	5 600	6 700	0.90	0.31	1212 EK	H 212	65	80	97.6	39	13	1.5	78	64	102	7	1.5	0.19	3.3	5.1	3.6
55 55	19 31 200	17 500	690	5 300	6 300	1.10	0.36	2212 EK	H 312	80	80	98.6	47	13	2.1	87	65	119	7	2.1	0.23	2.6	4.1	2.6
130 130	23 29 500	21 000	1 230	4 500	5 600	1.05	0.35	1312 EK	H 2312	80	112	62	13	2.1	76	65	119	7	2	0.35	1.9	3	2	
130 130	23 29 500	26 500	1 460	4 500	5 600	2.00	0.45	2312 EK	H 2312	80	112	62	13	2.1	76	65	119	7	2	0.35	1.9	3	2	



**Self-aligning ball bearings
with adapter sleeve
 $d_1 = 60\text{--}95 \text{ mm}$**



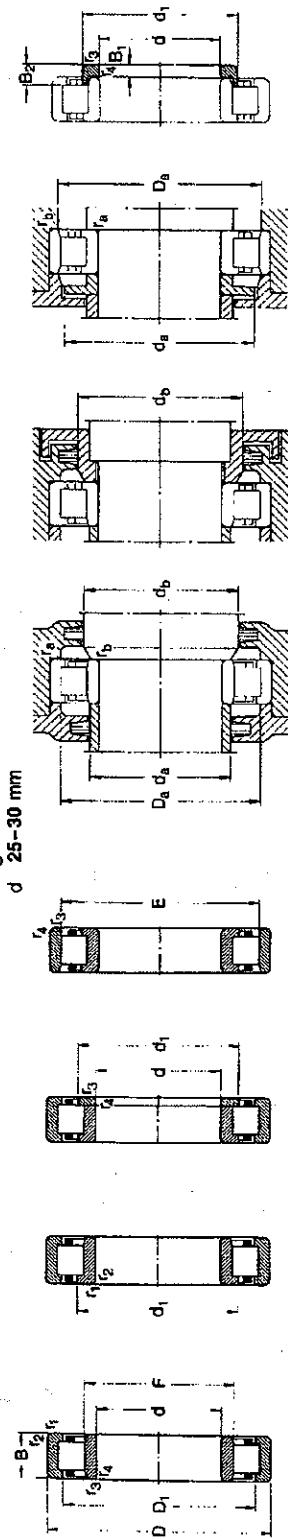
¹⁾ The balls of bearings 1318 K to 1320 K, inclusive, protrude from the side faces, see table on page 260

Principal dimensions d_1 D $B^{(1)}$ C C_0	Basic load ratings dynamic static P_u	Fatigue load limit P_u	Speed ratings Lubrication oil grease	Masses Bearing Adapter sleeve	Designations Bearings Adapter sleeve	Dimensions				Abutment and fillet dimensions				Calculation factors								
						d_1	d_3	D_1	\bar{d}_1	B_1	B_2	$r_{a,2}^2$ min	d_a max	D_a min	B_a min	e	Y_1	Y_2	Y_6			
60 120 23	35 100	14 000	720	5 300	6 300	1.15	0.36	1213 EK	H 213	60	85	106	40	14	1.5	85	70	112	7	1.5	0.16	3.6
60 120 31	57 200	20 050	1 020	5 000	6 000	1.45	0.42	2213 EK	H 313	60	85	107	50	14	1.5	80	70	112	9	1.5	0.24	2.8
60 140 33	65 000	25 500	1 250	5 000	5 000	2.45	0.42	1313 EK	H 313	65	127	50	14	2.1	89	70	129	7	2	0.22	2.9	
60 140 48	95 600	32 500	1 660	4 000	4 800	3.25	0.52	2313 K	H 2313	65	122	65	14	2.1	85	72	129	7	2	0.37	1.7	
65 130 25	39 000	15 600	800	4 800	5 800	1.35	0.66	1215 K	H 215	65	98	116	43	15	1.5	93	80	122	7	1.5	0.17	3.7
65 130 31	44 200	18 000	900	4 500	5 300	1.60	0.78	2215 K	H 315	98	117	55	15	1.5	93	80	122	13	1.5	0.25	2.5	
65 160 37	79 300	30 000	1 430	3 800	4 500	3.55	0.78	1315 K	H 315	98	136	55	15	2.1	104	80	148	7	2	0.32	2.9	
65 160 55	124 000	43 000	2 040	3 400	4 000	4.70	1.10	2315 K	H 2315	98	139	73	15	2.1	97	82	149	7	2	0.37	1.7	
70 140 26	39 700	17 000	830	4 500	5 300	1.65	0.81	1216 K	H 216	70	105	125	46	17	2	101	86	131	7	2	0.16	3.8
70 140 33	65 000	25 500	1 250	4 000	4 800	2.00	0.95	2216 EK	H 316	105	127	59	17	2	99	85	131	13	2	0.22	2.9	
70 170 39	88 400	33 500	1 500	3 600	4 300	4.20	0.95	1316 K	H 316	105	147	59	17	2.1	109	85	159	7	2	0.32	2.8	
70 170 58	135 000	49 200	2 240	3 800	4 600	6.10	1.20	2316 K	H 2316	105	148	78	17	2.1	104	88	159	7	2	0.37	1.7	
75 150 28	49 800	20 300	980	4 000	4 800	2.05	0.94	1217 K	H 217	75	110	134	50	18	2	107	90	141	8	2	0.17	3.7
75 150 36	58 500	23 600	1 120	3 800	4 600	2.50	1.10	2217 K	H 317	75	110	133	63	18	2	105	91	141	13	2	0.25	2.5
75 180 41	97 500	38 000	1 700	3 400	4 000	5.00	1.10	1317 K	H 317	110	110	133	63	18	3	117	91	167	8	2	0.22	2.9
75 180 60	140 000	51 000	2 280	3 000	3 600	7.05	1.35	2317 K	H 2317	110	157	82	18	3	117	91	167	8	2	0.37	1.7	
80 160 30	57 200	23 500	1 080	3 800	4 500	2.50	1.10	1218 K	H 218	80	120	142	52	18	2	112	96	151	8	2	0.17	3.7
80 160 40	70 200	28 500	1 320	3 600	4 300	3.40	1.30	2218 K	H 318	80	120	142	65	18	2	112	96	151	11	2	0.27	2.3
80 190 43	117 000	44 000	1 830	3 200	3 800	5.80	1.30	1318 K	H 318	120	165	65	18	3	122	96	177	8	2	0.32	2.9	
80 190 64	153 000	57 000	2 500	2 800	3 400	8.46	1.60	2318 K	H 2318	120	164	86	18	3	115	100	177	8	2	0.37	1.7	
85 170 32	63 700	27 000	1 200	3 600	4 300	3.10	1.25	1219 K	H 219	85	125	151	55	19	2.1	127	106	169	8	2	0.17	3.7
85 170 43	83 200	34 500	1 530	3 400	4 000	4.10	1.40	2219 K	H 319	125	151	68	19	2.1	118	102	169	10	2	0.27	2.8	
85 200 45	133 000	51 000	2 160	3 000	3 600	6.70	1.40	1319 K	H 319	125	174	68	19	3	127	102	187	8	2	0.32	2.7	
85 200 67	165 000	64 000	2 750	2 600	3 200	9.80	1.80	2319 K	H 2319	125	172	90	19	3	121	105	187	8	2	0.37	1.7	
90 180 34	68 900	30 000	1 290	3 400	4 000	3.70	1.40	1220 K	H 220	90	130	159	58	20	2.1	127	106	169	8	2	0.17	3.7
90 180 46	97 500	40 500	1 760	3 200	3 500	5.00	1.60	2220 K	H 320	130	160	71	20	2.1	124	102	169	9	2	0.27	2.3	
90 215 47	145 000	57 000	2 380	2 800	3 400	8.30	1.60	1320 K	H 320	130	185	71	20	3	136	106	202	8	2	0.37	2.7	
90 215 73	190 600	80 000	3 250	2 400	3 000	12.5	2.00	2320 K	H 2320	130	186	97	20	3	130	110	202	8	2	0.37	2.6	
95 190 36	74 100	32 500	1 370	3 200	3 800	4.36	1.60	1221 K	H 221	95	140	167	60	20	2.1	134	111	179	8	2	0.17	3.7
95 190 50	108 000	45 000	1 900	3 000	3 600	6.10	1.85	2221 K	H 321	140	168	74	20	2.1	131	113	179	8	2	0.26	2.2	

Rolling Element Bearings

Chapter 1

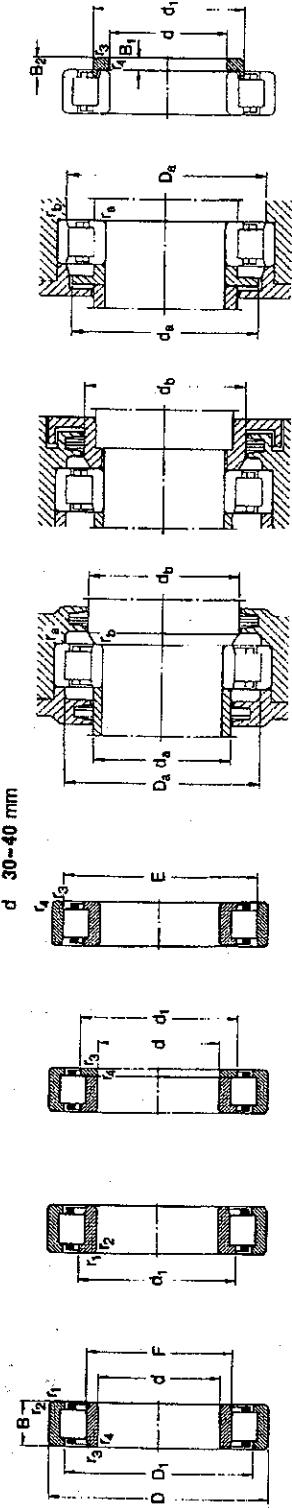
Cylindrical roller bearings single row $d \leq 30$ mm



Type NU Type N Type NUP Type N

Principal dimensions d - D B C	Basic load ratings dynamic static	Fatigue load limit P_{fu}	Speed ratings Lubrication grease	Mass kg	Designation	Dimensions			Abutment andillet dimensions			Angle ring Designation	Mass	Dimensions B ₁ B ₂ mm											
						d	d ₁	d ₂	F, E	r ₁₂ min	r ₃₄ max	d _a min	d _a max	D _a min	D _a max	f _a min	f _a max								
25 47	12	14 200	13 200	1 400	15 000	18 000	0.084	NU 1005	25	-	36.8	30.5	0.6	0.3	2	27	29	32	43	-	0.6	0.3			
52 15	15	28 600	27 000	3 350	11 000	14 000	0.13	NJ 205 EC	34.7	43.8	31.5	1	0.6	1.3	29	30	33	47	-	1	0.6	HJ 2205 EC	0.014	3	6
52 15	15	28 600	27 000	3 350	11 000	14 000	0.14	NJP 205 EC	34.7	43.8	31.5	1	0.6	1.3	29	30	36	47	-	1	0.6	HJ 2205 EC	0.014	3	6
52 15	15	28 600	27 000	3 350	11 000	14 000	0.13	N 205 EC	34.7	45.5	1	0.6	1.3	30	45	48	48	-	1	0.6	-	-	-		
52 15	15	28 600	27 000	3 350	11 000	14 000	0.17	NU 2205 EC	34.7	43.8	31.5	1	0.6	1.8	29	30	39	47	-	1	0.6	HJ 2205 EC	0.014	3	6.5
52 15	15	28 600	27 000	3 350	11 000	14 000	0.17	NJ 2205 EC	34.7	43.8	31.5	1	0.6	-	29	30	36	47	-	1	0.6	HJ 2205 EC	0.014	3	6.5
52 15	15	28 600	27 000	3 350	11 000	14 000	0.13	NJP 2205 EC	34.7	45.5	1	0.6	-	-	-	-	-	-	-	-	-	-	-		
52 18	18	34 100	34 000	4 250	11 000	14 000	0.16	NU 2205 EC	34.7	43.8	31.5	1	0.6	1.8	29	30	39	47	-	1	0.6	HJ 2205 EC	0.014	3	6.5
52 18	18	34 100	34 000	4 250	11 000	14 000	0.17	NJ 2205 EC	34.7	43.8	31.5	1	0.6	-	29	30	36	47	-	1	0.6	-	-	-	
52 18	18	34 100	34 000	4 250	11 000	14 000	0.17	NJP 2205 EC	34.7	43.8	31.5	1	0.6	-	29	30	36	47	-	1	0.6	-	-	-	
62 17	17	40 200	36 500	4 550	9 500	12 000	0.24	N 305 EC	36.1	50.7	34	1.1	1.3	31.5	32	36	55.5	-	1	1	HJ 305 EC	0.023	4	7	
62 17	17	40 200	36 500	4 550	9 500	12 000	0.25	NJ 305 EC	36.1	50.7	34	1.1	1.3	31.5	32	40	55.5	-	1	1	HJ 305 EC	0.023	4	7	
62 17	17	40 200	36 500	4 550	9 500	12 000	0.25	NJP 305 EC	36.1	50.7	34	1.1	1.3	31.5	32	40	55.5	-	1	1	HJ 305 EC	0.023	4	7	
62 17	17	40 200	36 500	4 550	9 500	12 000	0.24	N 305 EC	36.1	50.7	34	1.1	1.3	31.5	32	40	55.5	-	1	1	HJ 305 EC	0.023	4	7	
62 24	24	56 100	55 000	6 950	9 000	11 000	0.35	NJ 2305 EC	36.1	50.7	34	1.1	1.1	23	31.5	32	36	55.5	-	1	1	HJ 2305 EC	0.025	4	8
62 24	24	56 100	55 000	6 950	9 000	11 000	0.36	NJP 2305 EC	36.1	50.7	34	1.1	1.1	23	31.5	32	40	55.5	-	1	1	HJ 2305 EC	0.025	4	8
62 24	24	56 100	55 000	6 950	9 000	11 000	0.38	N 2305 EC	36.1	50.7	34	1.1	1.1	23	31.5	32	40	55.5	-	1	1	HJ 2305 EC	0.025	4	8
30 55	13	17 900	17 300	1 860	12 000	15 000	0.12	NU 1006	30	-	45.6	36.1	0.6	2.1	34	36	38	50	-	1	0.6	-	-	-	
62 16	16	38 000	36 500	4 650	9 500	12 000	0.20	NU 206 EC	41.2	52.5	37.5	1	0.6	1.3	34	36	39	57	-	1	0.6	HJ 206 EC	0.025	4	7
62 16	16	38 000	36 500	4 650	9 500	12 000	0.21	NJ 206 EC	41.2	52.5	37.5	1	0.6	1.3	34	36	43	57	-	1	0.6	HJ 206 EC	0.025	4	7
62 16	16	38 000	36 500	4 650	9 500	12 000	0.22	NJP 206 EC	41.2	52.5	37.5	1	0.6	1.3	34	36	43	57	-	1	0.6	-	-	-	
62 16	16	38 000	36 500	4 650	9 500	12 000	0.20	N 206 EC	41.2	52.5	37.5	1	0.6	1.3	35	54	55	57	-	1	0.6	-	-	-	
62 20	20	48 400	49 000	6 100	9 500	12 000	0.26	NU 2206 EC	41.2	52.5	37.5	1	0.6	1.8	34	36	39	57	-	1	0.6	HJ 2206 EC	0.025	4	7.5
62 20	20	48 400	49 000	6 100	9 500	12 000	0.27	NJ 2206 EC	41.2	52.5	37.5	1	0.6	1.8	34	36	43	57	-	1	0.6	HJ 2206 EC	0.025	4	7.5
62 20	20	48 400	49 000	6 100	9 500	12 000	0.27	NJP 2206 EC	41.2	52.5	37.5	1	0.6	1.8	34	36	43	57	-	1	0.6	-	-	-	
62 20	20	48 400	49 000	6 100	9 500	12 000	0.26	N 2206 EC	41.2	52.5	37.5	1	0.6	1.8	34	36	43	57	-	1	0.6	-	-	-	
72 19	19	51 200	48 000	6 200	9 000	11 000	0.36	NJ 306 EC	45	58.9	40.5	1.1	1.1	1.4	36.5	39	42	65.5	-	1	1	HJ 306 EC	0.040	6	8.5
72 19	19	51 200	48 000	6 200	9 000	11 000	0.37	NJP 306 EC	45	58.9	40.5	1.1	1.1	1.4	36.5	39	42	65.5	-	1	1	HJ 306 EC	0.040	6	8.5
72 19	19	51 200	48 000	6 200	9 000	11 000	0.36	N 306 EC	45	58.9	40.5	1.1	1.1	1.4	36.5	39	42	65.5	-	1	1	HJ 306 EC	0.040	6	8.5
72 19	19	51 200	48 000	6 200	9 000	11 000	0.36	N 306 EC	45	58.9	40.5	1.1	1.1	1.4	36.5	39	42	65.5	-	1	1	HJ 306 EC	0.040	6	8.5
72 27	27	73 700	75 000	9 650	9 000	9 500	0.53	NJ 2206 EC	45	58.9	40.5	1.1	1.1	2.4	36.5	39	42	65.5	-	1	1	HJ 2206 EC	0.042	5	9.5
72 27	27	73 700	75 000	9 650	9 000	9 500	0.54	NJP 2206 EC	45	58.9	40.5	1.1	1.1	2.4	36.5	39	42	65.5	-	1	1	HJ 2206 EC	0.042	5	9.5
72 27	27	73 700	75 000	9 650	9 000	9 500	0.55	N 2206 EC	45	58.9	40.5	1.1	1.1	2.4	36.5	39	42	65.5	-	1	1	HJ 2206 EC	0.042	5	9.5

¹⁾ Permissible axial displacement from normal position of one bearing ring in relation to the other

Cylindrical roller bearings
single row
 $d = 30\text{--}40 \text{ mm}$ 

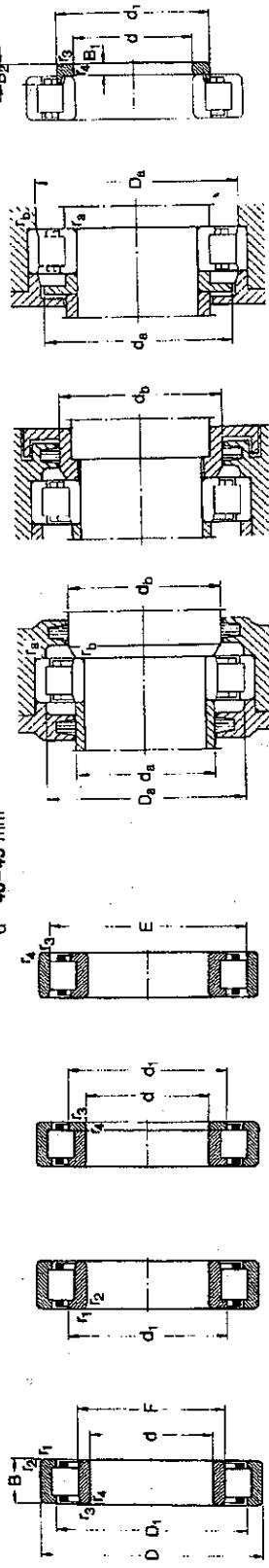
Type NU Type NUP Type N

Practical dimensions d D B C C ₀	Basic load ratings dynamic static		Fatigue load ratings lubrication oil	Speed ratings N/min	Mass kg	Designation	Dimensions						Abutment and fillet dimensions mm	Angle ring designation	Mass kg	Dimensions B ₁ B ₂
	N	N					d	d ₁	ε	D ₁	F _E	f_{d4} min max	d_4 min max			
30 (cont.) 90 23 60 500 53 000 6 800 7 500 9 000 0.75 NU 406 NA 103 30 50.5 66.6 45 1.5 1.5 1.6 38 - 43 47 82 - 1.5 1.5 HJ 406 HJ 406 0.081 7 11.5																
35 62 14 35 800 4 550 10 000 13 000 0.16 NU 1007 EC 35 - 54.5 42 1 0.6 1 39 41 44 57 - 1 0.6 -																
72 17 48 450 48 000 6 100 9 500 10 000 0.30 NU 207 EC 48.1 60.7 44 1.1 0.6 1.3 39 42 46 65.5 - 1 0.6 HJ 207 EC 0.033 4 7																
72 17 48 450 48 000 6 100 9 500 10 000 0.31 NU 207 EC 48.1 60.7 44 1.1 0.6 1.3 39 42 46 65.5 - 1 0.6 HJ 207 EC 0.033 4 7																
72 17 48 400 48 000 6 100 9 500 10 000 0.31 NU 207 EC 48.1 60.7 44 1.1 0.6 1.3 39 42 46 65.5 - 1 0.6 HJ 207 EC 0.033 4 7																
72 23 59 400 63 000 8 150 8 500 10 000 0.40 NU 2207 EC 48.1 60.7 44 1.1 0.6 2.8 39 42 46 65.5 - 1 0.6 HJ 2207 EC 0.036 4 8.5																
72 23 59 400 63 000 8 150 8 500 10 000 0.41 NU 2207 EC 48.1 60.7 44 1.1 0.6 2.8 39 42 46 65.5 - 1 0.6 HJ 2207 EC 0.036 4 8.5																
72 23 59 400 63 000 8 150 8 500 10 000 0.42 NU 2207 EC 48.1 60.7 44 1.1 0.6 2.8 39 42 46 65.5 - 1 0.6 HJ 2207 EC 0.036 4 8.5																
80 21 64 400 63 000 8 150 8 500 10 000 0.40 NU 307 EC 51 66.3 46.2 1.5 1.1 1.2 41.5 44 48 72 - 1.5 1 HJ 307 EC 0.058 6 9.5																
80 21 64 400 63 000 8 150 8 500 10 000 0.48 NU 307 EC 51 66.3 46.2 1.5 1.1 1.2 41.5 44 48 72 - 1.5 1 HJ 307 EC 0.058 6 9.5																
80 21 64 450 63 000 8 150 8 500 10 000 0.46 NU 307 EC 51 66.3 46.2 1.5 1.1 1.2 41.5 44 48 72 - 1.5 1 HJ 307 EC 0.058 6 9.5																
80 31 91 350 98 000 12 700 12 700 8 500 0.72 NU 2307 EC 51 66.3 46.2 1.5 1.1 2.7 41.5 44 48 72 - 1.5 1 HJ 2307 EC 0.062 6 11																
80 31 91 350 98 000 12 700 12 700 8 500 0.73 NU 2307 EC 51 66.3 46.2 1.5 1.1 2.7 41.5 44 48 72 - 1.5 1 HJ 2307 EC 0.062 6 11																
100 25 78 500 69 500 9 000 6 700 8 000 1.00 NU 407 59 78.1 53 1.5 1.5 1.7 43 50 56 92 - 1.5 1.5 HJ 407 0.13 8 13																
100 25 78 500 69 500 9 000 6 700 8 000 1.05 NU 407 59 78.1 53 1.5 1.5 1.7 43 50 56 92 - 1.5 1.5 HJ 407 0.13 8 13																
40 68 15 25 100 26 000 3 000 9 500 12 000 0.22 NU 1006 40 - 57.6 47 1 0.6 2.4 44 45 49 63 - 1 0.6 -																
80 18 53 800 53 000 6 700 7 500 9 000 0.37 NU 208 EC 54 67.8 49.5 1.1 1.1 1.4 46.5 49 51 73.5 - 1 1 HJ 208 EC 0.047 5 8.5																
80 18 53 800 53 000 6 700 7 500 9 000 0.38 NU 208 EC 54 67.8 49.5 1.1 1.1 1.4 46.5 49 51 73.5 - 1 1 HJ 208 EC 0.047 5 8.5																
80 18 53 800 53 000 6 700 7 500 9 000 0.40 NU 208 EC 54 67.8 49.5 1.1 1.1 1.4 46.5 49 51 73.5 - 1 1 HJ 208 EC 0.047 5 8.5																
80 23 76 400 75 000 9 650 7 500 8 500 0.49 NU 2208 EC 54 67.9 49.5 1.1 1.1 1.4 46.5 49 51 73.5 - 1 1 HJ 2208 EC 0.046 5 9																
80 23 76 400 75 000 9 650 7 500 8 500 0.50 NU 2208 EC 54 67.9 49.5 1.1 1.1 1.4 46.5 49 51 73.5 - 1 1 HJ 2208 EC 0.046 5 9																
80 23 76 400 75 000 9 650 7 500 8 500 0.51 NU 2208 EC 54 67.9 49.5 1.1 1.1 1.4 46.5 49 51 73.5 - 1 1 HJ 2208 EC 0.046 5 9																
80 23 76 400 75 000 9 650 7 500 8 500 0.48 NU 2208 EC 54 67.9 49.5 1.1 1.1 1.4 46.5 49 51 73.5 - 1 1 HJ 2208 EC 0.046 5 9																

¹⁾ Permissible axial displacement from normal position of one bearing ring in relation to the other.

Cylindrical roller bearings

single row
d 40-45 mm



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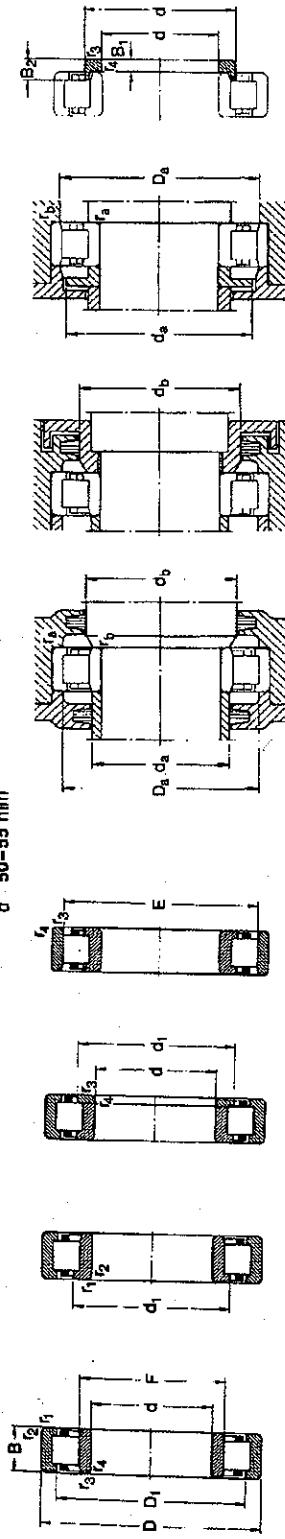
Rolling Element Bearings

Chapter 1

Mechanical Design Data Manual

TABLE I

Cylindrical roller bearings
single row
 $d = 50\text{--}55 \text{ mm}$



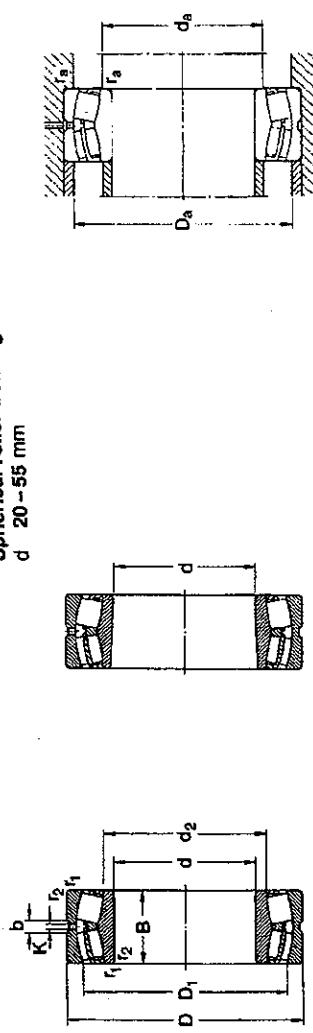
Type NU Type N Type NUP Type N

Angle ring

Principal dimensions	d	D	B	C	$\bullet C_0$	Basic load ratings static dynamic	Fatigue load limit P_u	Speed ratings Lubrication grease oil	Mass	Designation	Dimensions						Angle ring designation	Mass	Dimensions										
											d	d_1	d_2	F, E	r_{12}	r_{14}	r_{16}	d_4	d_5	D_4	D_5	r_{14} max	b_{max}	B_1	B_2				
50	80	16	30	800	34 500	4 000	8 500	10 000	0.31	NU 1010	50	-	68.9	57.5	1	0.6	2.5	54	56	60	75	-	1	0.6	-	HJ 210 EC	0.058	5	9
50	90	20	64	400	69 500	6 300	7 500	0.48	NU 210 EC	64	78	59.5	1.1	1.1	1.5	56.5	57	62	83.5	-	1	1	HJ 210 EC	0.058	5	9			
50	90	20	64	400	69 500	6 300	7 500	0.48	NUP 210 EC	64	78	59.5	1.1	1.1	1.5	56.5	57	66	83.5	-	1	1	-	HJ 210 EC	0.058	5	9		
50	90	20	64	400	69 500	6 300	7 500	0.48	N 210 EC	64	-	B1.5	1.1	1.5	56.5	79	-	83.5	84	1	1	-	HJ 210 EC	0.058	5	9			
50	90	20	64	400	69 500	8 800	8 800	0.48	NU 2210 EC	64	78	59.5	1.1	1.1	1.5	56.5	57	66	83.5	-	1	1	-	HJ 210 EC	0.058	5	9		
50	90	20	64	400	69 500	8 800	8 800	0.48	NUP 2210 EC	64	78	59.5	1.1	1.1	1.5	56.5	57	66	83.5	-	1	1	-	HJ 210 EC	0.058	5	9		
50	90	23	78	100	88 000	11 400	11 400	0.56	NU 2210 EC	64	78	59.5	1.1	1.1	1.5	56.5	57	66	83.5	-	1	1	-	HJ 210 EC	0.058	5	9		
50	90	23	78	100	88 000	88 000	88 000	0.56	NJ 2210 EC	64	78	59.5	1.1	1.1	1.5	56.5	57	66	83.5	-	1	1	-	HJ 210 EC	0.058	5	9		
50	90	23	78	100	88 000	11 400	11 400	0.56	NJP 2210 EC	64	78	59.5	1.1	1.1	1.5	56.5	57	66	83.5	-	1	1	-	HJ 210 EC	0.058	5	9		
50	110	27	110	000	112 000	15 000	15 000	1.15	NU 310 EC	71.2	82.1	65	2	2	1.8	59	63	63	77	101	-	2	2	HJ 310 EC	0.14	8	13		
50	110	27	110	000	112 000	15 000	15 000	1.15	NL 310 EC	71.2	82.1	65	2	2	1.9	59	63	63	77	101	-	2	2	HJ 310 EC	0.14	8	13		
50	110	27	110	000	112 000	15 000	15 000	1.15	NUP 310 EC	71.2	82.1	65	2	2	1.9	59	63	63	77	101	-	2	2	-	HJ 310 EC	0.14	8	13	
50	110	40	161	000	186 000	24 500	24 500	1.70	NU 2310 EC	71.2	92.1	65	2	2	3.4	59	63	63	77	101	-	2	2	HJ 2310 EC	0.15	8	14.5		
50	110	40	161	000	186 000	24 500	24 500	1.70	NJ 2310 EC	71.2	92.1	65	2	2	3.4	59	63	63	77	101	-	2	2	HJ 2310 EC	0.15	8	14.5		
50	110	40	161	000	186 000	24 500	24 500	1.70	NJP 2310 EC	71.2	92.1	65	2	2	3.4	59	63	63	77	101	-	2	2	-	HJ 2310 EC	0.15	8	14.5	
130	31	130	000	127 000	18 600	5 000	5 000	2.00	NU 410	78.8	102	70.8	2.1	2.1	2.6	61	88	81	119	-	2	2	HJ 410	0.23	9	14.5			
130	31	130	000	127 000	18 600	5 000	5 000	2.05	NJ 410	78.8	102	70.8	2.1	2.1	2.6	61	88	81	119	-	2	2	HJ 410	0.23	9	14.5			
55	80	18	57	240	68 500	8 300	8 300	0.40	NU 1011 EC	55	-	79	64.5	1.1	1	0.5	60	63	67	83.5	-	1	1	-	HJ 211 EC	0.083	6	9.5	
55	80	18	57	240	68 500	8 300	8 300	0.40	NU 211 EC	70.8	85.3	66	1.5	1.1	1	61.5	64	68	92	-	1.5	1	-	HJ 211 EC	0.083	6	9.5		
100	100	21	84	200	95 000	12 200	6 000	0.56	NU 211 EC	70.8	85.3	66	1.5	1.1	1	61.5	64	68	92	-	1.5	1	-	HJ 211 EC	0.083	6	9.5		
100	100	21	84	200	95 000	12 200	6 000	0.56	NUP 211 EC	70.8	85.3	66	1.5	1.1	1	61.5	64	68	92	-	1.5	1	-	HJ 211 EC	0.083	6	9.5		
100	100	21	84	200	95 000	12 200	6 000	0.56	N 211 EC	70.8	85.3	66	1.5	1.1	1	61.5	64	68	92	-	1.5	1	-	HJ 211 EC	0.083	6	9.5		
100	100	25	99	000	116 000	15 300	6 000	0.79	NU 2211 EC	70.8	86.3	66	1.5	1.1	1.5	61.5	64	68	92	-	1.5	1	-	HJ 2211 EC	0.085	6	10		
100	100	25	99	000	116 000	15 300	6 000	0.79	NJ 2211 EC	70.8	86.3	66	1.5	1.1	1.5	61.5	64	68	92	-	1.5	1	-	HJ 2211 EC	0.085	6	10		
100	100	25	99	000	116 000	15 300	6 000	0.79	NJP 2211 EC	70.8	86.3	66	1.5	1.1	1.5	61.5	64	68	92	-	1.5	1	-	HJ 2211 EC	0.085	6	10		
120	120	26	138 000	143 000	18 600	4 600	4 600	1.45	NU 311 EC	77.5	101	70.5	2	2	2	64	88	73	111	-	2	2	HJ 311 EC	0.19	9	14			
120	120	26	138 000	143 000	18 600	4 600	4 600	1.45	NJ 311 EC	77.5	101	70.5	2	2	2	64	88	73	111	-	2	2	HJ 311 EC	0.19	9	14			
120	120	26	138 000	143 000	18 600	4 600	4 600	1.45	NJP 311 EC	77.5	101	70.5	2	2	2	64	88	73	111	-	2	2	HJ 311 EC	0.19	9	14			

¹⁾ Permissible axial displacement from normal position of one bearing ring in relation to the other.

Spherical roller bearings
d = 20–55 mm



Cylindrical bore

Tapered bore

Principal dimensions d D B C	Basic load ratings dynamic static C ₀	Fatigue load limit P _u	Speed rating Lubrication grease oil	Mass kg	Designations Bearings with cylindrical bore	Dimensions tapered bore d	Dimensions			Abutment and fillet dimensions			Calculation factors									
							d ₁	d ₂	D ₁	r _{1,2} mm	b	K	d _{ab} mm	D _a mm	r _a mm							
20 52	15	30 500	3 400	8 000	10 000	0.18	21304 CC	—	20	28.5	42.5	1.1	—	—	27	45	1	0.30	2.3	3.4	2.2	
25 52	18	35 700	35 700	3 900	8 500	11 000	0.18	22205 CC	25	31.8	44.1	1	—	—	31	46	1	0.35	1.8	2.9	1.6	
25 52	18	43 100	44 000	4 750	9 000	11 000	0.18	22205 EK	—	30.6	44.1	1	—	—	32	46	1	0.35	1.9	2.9	1.6	
62	62	17	41 400	41 500	4 550	6 700	8 500	0.125	21305 CC	—	35.3	51.1	1.1	—	—	32	55	1	0.30	2.3	3.4	2.2
30	62	20	48 900	52 000	5 400	7 500	8 500	0.28	22206 CC	30	37.7	52.8	1	—	—	36	56	1	0.33	2	3	2.2
30	62	20	61 000	64 000	6 950	7 500	8 500	0.23	22206 EK	—	36.8	53.7	1	5.5	3	37	56	1	0.31	2.2	3.6	2.5
72	72	19	55 200	61 000	6 800	6 000	7 500	0.38	21306 CC	—	41.7	59.2	1.1	—	—	37	65	1	0.27	2.5	3.7	2.5
35	72	23	67 300	73 500	8 000	8 000	0.43	22207 CC	35	44.4	61.4	1.1	—	—	42	65	1	0.31	2.2	3.3	2.2	
80	80	21	65 600	79 900	8 500	9 300	8 000	0.43	22207 EK	—	43	62	1.1	5.5	3	42	65	1	0.31	2.2	3.3	2.2
40	80	23	73 600	81 500	9 150	6 000	7 500	0.52	22208 CC	40	49.7	68.8	1.1	—	—	44	71	1.5	0.28	2.4	3.6	2.5
90	90	23	82 800	98 000	9 800	11 000	10 600	0.52	22208 EK	—	49.1	70.3	1.1	5.5	3	47	73	1	0.28	2.4	3.6	2.5
90	90	33	115 000	122 000	12 200	14 500	13 200	0.71	21308 CC	—	54	74.8	1.5	—	—	49	81	1.5	0.26	2.6	3.6	2.5
90	90	33	127 000	137 000	14 600	14 600	13 200	0.71	22308 CC	—	50.4	74.6	1.5	—	—	49	81	1.5	0.37	1.8	2.7	1.6
45	85	23	77 100	88 000	8 500	5 300	6 700	0.56	22209 CC	45	54.9	74	1.1	—	—	52	78	1	0.26	2.6	3.9	2.5
100	100	25	101 000	114 000	11 400	5 300	6 700	0.66	22209 EK	—	54.9	75.6	1.1	5.5	3	52	78	1	0.26	2.6	3.9	2.5
100	100	36	138 000	160 000	114 000	12 800	11 000	0.95	21309 CC	—	60.4	83.8	1.5	—	—	54	91	1.5	0.37	1.6	2.7	1.6
100	100	36	164 000	183 000	19 300	3 800	4 800	1.35	22309 CC	—	84.6	92.5	1.5	—	—	54	91	1.5	0.37	1.6	2.7	1.6
50	90	23	64 500	100 000	11 000	5 000	6 300	0.60	22210 CC	50	60	79.2	1.1	—	—	67	83	1	0.24	2.6	4.2	2.8
110	110	27	120 000	148 000	12 800	5 000	6 300	1.20	21310 CC	—	60.6	81.5	1.1	5.5	3	60	100	2	0.26	2.6	3.9	2.5
110	110	40	176 000	200 000	21 600	3 600	4 800	1.20	21310 CC	—	66.9	92.4	2	—	—	60	100	2	0.25	2.7	4	2.5
110	110	40	199 000	224 000	3 400	4 300	1.85	22310 EK	—	63.1	92	2	5.5	3	60	100	2	0.37	1.6	2.7	1.6	
55	100	25	99 500	118 000	12 800	4 500	5 600	0.62	22211 CC	55	66	89.1	1.5	—	—	64	91	1.5	0.24	2.8	4.2	2.8
100	100	25	115 000	137 000	15 000	4 500	5 600	0.82	22211 EK	—	65.3	89.7	1.5	5.5	3	64	91	1.5	0.24	2.8	4.2	2.8
120	120	43	138 000	163 000	18 600	3 400	4 300	1.60	21311 CC	—	102	100	2	—	—	65	110	2	0.25	2.7	4	2.5
120	120	43	199 000	232 000	3 200	4 000	2 300	2.35	22311 CC	—	68.3	100	2	5.5	3	65	110	2	0.35	1.9	2.8	1.6
120	120	43	235 000	280 000	3 200	4 000	2.35	22311 EK	—	103	70.1	—	—	—	65	110	2	0.35	1.9	2.9	1.6	