SCHAEFFLER

Needle roller and cage assemblies for crank pins and piston pins

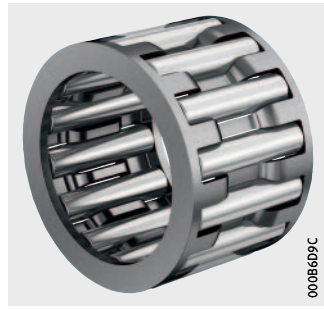
Needle roller and cage assemblies for crank pins and piston pins

Product overview

Needle roller and cage assemblies for crank pins and piston pins

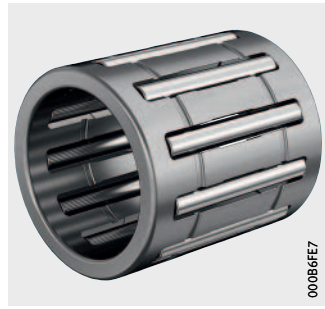
For crank pins

KZK



For piston pins

KBK



Needle roller and cage assemblies for crank pins and piston pins

Features

Needle roller and cage assemblies for connecting rod bearing arrangements are used in the crank mechanisms of 2 and 4 stroke engines as well as in compressors for supporting crank pins and piston pins. They consist of cages equipped with needle rollers, support high centrifugal and acceleration forces and are suitable for high speeds.

They require very little radial space since the radial section height only corresponds to the diameter of the needle rollers. They give bearing arrangements with high runout accuracy which is, however, influenced by the geometrical accuracy of the raceways. The radial internal clearance is dependent on the needle sort as well as the shaft and housing tolerances and can be adjusted by means of the needle roller sort.

Needle roller and cage assemblies for crank pins

Needle roller and cage assemblies for crank pins are externally guided, which means that the connecting rod bore guides the cage radially with defined clearance. The radial movement of the cage in relation to the connecting rod bore and the rolling elements is as small as possible.

The cages are made from quenched and tempered steel, have good wear resistance, exhibit high strength and their large guidance surfaces are designed for optimum lubrication.

Needle roller and cage assemblies for piston pins

Needle roller and cage assemblies for piston pins are internally guided, which means that the piston pin guides the cage radially with defined clearance. Due to their small radial internal clearance, tilting of the connecting rod is reduced to a minimum. The needle roller and cage assemblies support high frequency oscillating loads and are available for the majority of piston pin diameters in various widths, in accordance with the piston boss spacing.

The steel cages are case hardened or quenched and tempered, exhibit good wear resistance and have high strength.

Further information

For further information on needle roller and cage assemblies:

- Catalogue HR 1, Rolling Bearings.

Special designs

Depending on the performance requirements, variants are possible in relation to:

- material
- heat treatment
- coating
- cage profile
- needle roller profile.

Further information

For further information on coatings:

- TPI 186, Higher Performance Capacity Through the Use of Coatings.

Needle roller and cage assemblies for crank pins and piston pins

Design and safety guidelines

Guidance of the connecting rod

Depending on which parts of the crank mechanism are guided laterally by the connecting rod, a distinction is drawn between crank end guidance and piston end guidance.

Crank end guidance

The connecting rod and needle roller and cage assembly KZK are guided axially between the crank webs, *Figure 1*. The connecting rod eye at the crank end must have lubrication pockets and slots to allow the supply of lubricant.

Free lateral movement of the connecting rod and needle roller and cage assembly KBK between the piston bosses must be ensured taking account of all tolerances.

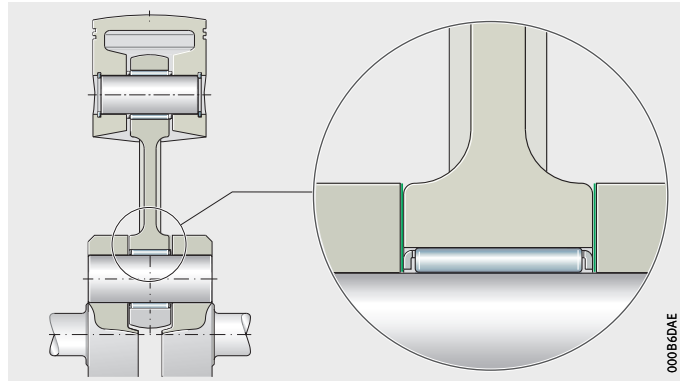


Figure 1
Crank end guidance: Lateral guidance of the connecting rod between the crank webs

Piston end guidance

The connecting rod and needle roller and cage assembly KBK are guided axially between the piston bosses, *Figure 2*.

Free lateral movement of the piston rod and needle roller and cage assembly KZK between the crank webs must be ensured taking account of all tolerances.

In order to ensure good radial guidance of the needle roller and cage assembly KZK, the large connecting rod eye must be matched to the width of the needle roller and cage assembly KZK.

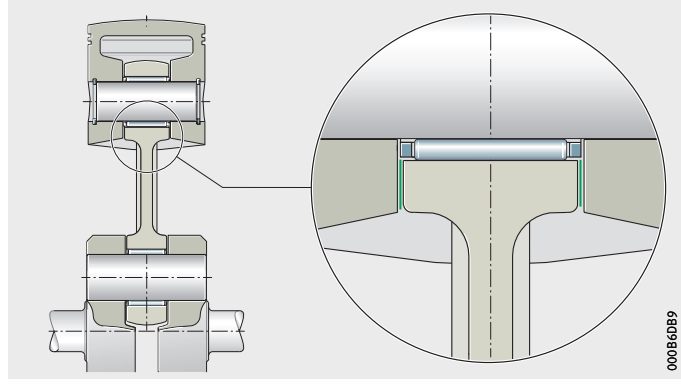


Figure 2
Piston end guidance: Lateral guidance of the connecting rod

Design of adjacent parts

The bores and pins for the needle roller and cage assemblies must be produced as rolling bearing raceways. A roughness Rz 1 (Ra 0,2) must be ensured.

The raceways must be hardened, ground and, depending on the application, honed. The rolling elements and guidance surfaces of the cage must also be supported over their entire length by the raceways.

A minimum case hardening depth of 0,5 mm and a minimum surface hardness of 700 HV must be observed for all raceways and thrust surfaces. In addition, the lateral thrust surfaces should be precision machined (maximum Ra 0,2 recommended) and wear resistant (thrust washers should be fitted if necessary).

For lubrication of the needle roller and cage assemblies, holes or lubrication pockets should be provided, with additional lubrication slots for the crank end guidance.

Proven materials for adjacent parts

Adjacent part	Material
Connecting rod	16MnCr5, 15CrNi6
Crank pin	15Cr3, 17Cr3, 15CrNi6
Piston pin	Ck15, 15Cr3, 17Cr3

Preferred enveloping circle diameter of needle roller and cage assemblies

The dimensions of the needle roller and cage assemblies KZK and KBK are determined by factors including the capacity of the cylinder.

The preferred enveloping circle diameters F_w of needle roller and cage assemblies for proven diameters of crank pins and piston pins are given for 2 stroke engines, see table. Other enveloping circle diameters may be available if sufficient quantities are required.

Proven enveloping circle diameters for 2 stroke engines

Capacity per cylinder		Enveloping circle diameter F_w for			
		KZK		KBK	
cm^3		mm		mm	
over	incl.	from	to	from	to
–	35	8	14	8	12
35	50	12	16	10	12
50	100	16	20	12	14
100	150	18	22	14	16
150	200	22	24	16	18
200	300	24	28	18	22
300	–	28	–	20	–

In order to design needle roller and cage assemblies for a specific engine, the technical data of the engine must be taken into consideration. The design brief for crank mechanism bearing arrangements must therefore be completed. The design brief is available online, see link, page 7.

Needle roller and cage assemblies for crank pins and piston pins

Calculation of rolling bearings in crank mechanisms

The basic rating life and adjusted reference rating life are available for the calculation of rolling bearings in crank mechanisms.
We recommend calculating the adjusted reference rating life in preference.

Fatigue theory as a principle

The rating life calculation standardised in ISO 281 is based on Lundberg and Palmgren's fatigue theory, which always gives a final rating life.

However, modern, high-quality bearings can exceed by a considerable margin the values calculated in accordance with standard ISO 281 under favourable operating conditions. Ioannides and Harris have developed a further model of fatigue in rolling contact that expands on the Lundberg and Palmgren theory and gives a better description of the performance capability of modern bearings.

Basic rating life

Our calculation method can be used to calculate the basic rating life L_{10} of the bearings (needle roller and cage assemblies for crank pins and piston pins, main bearings) in the crank mechanism of internal combustion engines on the basis of DIN ISO 281.
In comparison with the standardised calculation to DIN ISO 281, it additionally takes into consideration the influence of internal load distribution in the bearing on the rating life. The calculation method takes account of dynamic loading (gas forces and inertia, external forces acting on the crankshaft) and the movement functions in crank mechanisms.

Simplifications underlying the calculation model are as follows:

- the crankshaft is only subjected to propulsion units of identical load and geometry, articulated connecting rods are not taken into consideration
- statically determinate crankshaft bearing arrangement with two bearings
- no account taken of lubrication influences
- no account taken of geometrical imperfections and deformations of the surrounding parts.

Adjusted reference rating life

It is also possible to calculate the adjusted reference rating life L_{nmr} in accordance with DIN ISO 281, Appendix 4.
This calculation method additionally incorporates the fatigue limit load of the material, the lubrication conditions and the type and size of contamination. Further data is required in this case.
Please contact Schaeffler.

Further information

For detailed information on the calculation methods:

- Catalogue HR 1, Rolling Bearings.

Design brief for crank mechanism bearing arrangements

In order to be able to support you in designing needle roller and cage assemblies for a specific engine, the relevant technical data of the engine is required. The design brief used to record this data is available online via the following link.

http://bit.ly/2qSVKWx

Needle roller and cage assemblies for crank pins and piston pins

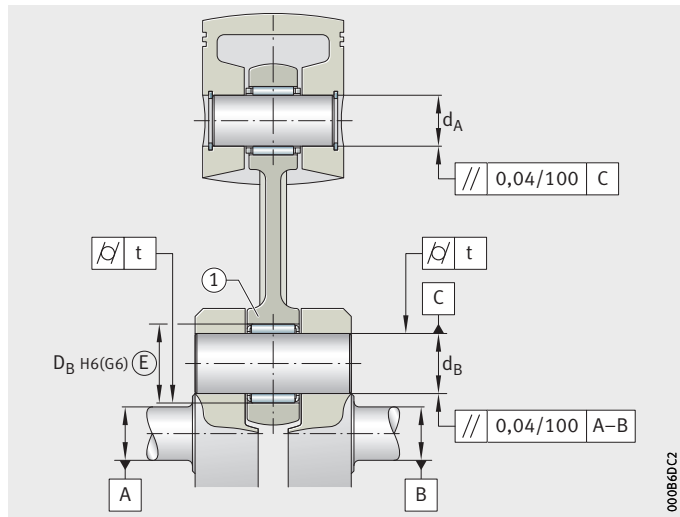
Accuracy

Geometrical tolerances

The geometrical tolerances of the raceways must be observed, see tables, *Figure 3* and *Figure 4*, page *9*.

Permissible geometrical tolerance values for crank pin bearing arrangements

Nominal diameter of the crank pin d_B mm		Tolerance t of cylindricity for	
		d_B (crank pin) µm	D_B (connecting rod bore) µm
over	incl.		
8	14	2	3
14	18	2	3
18	22	3	5
22	25	4	5
25	30	4	7
30	–	4	7

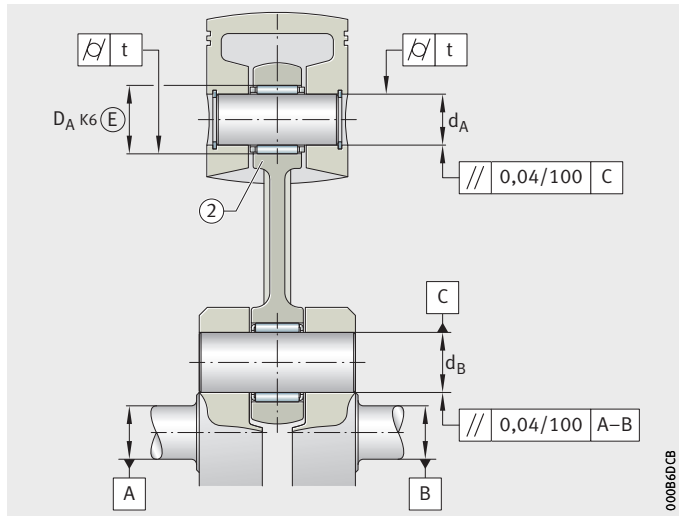


① Crank end guidance

Figure 3
Geometrical tolerances for crank pin bearing arrangements

Permissible geometrical tolerance values for piston pin bearing arrangements

Nominal diameter of the piston pin d_A mm		Tolerance t of cylindricity for	
		d_A (piston pin) µm	D_A (connecting rod bore) µm
over	incl.		
8	14	2	3
14	18	2	3
18	22	4	5



② Piston end guidance

Figure 4
Geometrical tolerances for piston pin bearing arrangements

Needle roller and cage assemblies for crank pins and piston pins

Radial internal clearance

The radial internal clearance can be set using the appropriate needle roller sort; sort plans can be used for this purpose, see tables.

Example of determination of the radial internal clearance using the mean value of the needle roller sort:

- needle roller sort 0 –2, mean value –1.

Crank pin bearing arrangements

The radial internal clearance is dependent on the speed, rigidity and accuracy of the crankshaft parts.

Minimum values for radial internal clearance must be achieved, see table, page 11.

Do not exceed the tolerance range of 0,015 mm.

For very high speeds (for example in racing engines), please contact Schaeffler.

Piston pin bearing arrangements

The radial internal clearance must be at least 0,002 mm and must not exceed 0,012 mm.

Sort plan for crank pin bearing arrangements

Conditions:

- bore tolerance G6 for 18 mm to 30 mm in three groups
- pin tolerance h5 for 14 mm to 18 mm in three groups
- needle roller sort 0 –2 to –5 –7
- radial internal clearance 17 µm to 30 µm.

Sort plan for crank pin bearing arrangements

Characteristics	Bore deviations		
	+7 +11 µm	+11 +15 µm	+15 +20 µm
Crank pin deviation	$^{0}_{-3}$	$^{0}_{-3}$	$^{0}_{-3}$
Needle roller sort	–4 –6; –5 –7	–2 –4; –3 –5	0 –2; –1 –3
Radial internal clearance	17 to 26	17 to 26	17 to 27
Crank pin deviation	$^{-3}_{-6}$	$^{-3}_{-6}$	$^{-3}_{-6}$
Needle roller sort	–4 –6; –5 –7	–1 –3; –2 –4	0 –2; –1 –3
Radial internal clearance	20 to 27	18 to 27	20 to 30
Crank pin deviation	$^{-6}_{-8}$	$^{-6}_{-8}$	$^{-6}_{-8}$
Needle roller sort	–1 –3; –2 –4	0 –2; –1 –3	0 –2
Radial internal clearance	17 to 25	19 to 27	23 to 30

Sort plan for piston pin bearing arrangements

Conditions:

- bore tolerance K6 for 10 mm to 18 mm in three groups
- pin tolerance 0 –6 in three groups
- needle roller sort 0 –2 to –5 –7
- radial internal clearance 3 µm to 12 µm.

Sort plan for piston pin bearing arrangements

Characteristics	Bore deviations		
	–9 –5 µm	–5 –1 µm	–1 +2 µm
Piston pin deviation	$^{0}_{-2}$	$^{0}_{-2}$	$^{0}_{-2}$
Needle roller sort	–5 –7	–3 –5; –4 –6	–1 –3; –2 –4
Radial internal clearance	3 to 9	3 to 11	3 to 10
Piston pin deviation	$^{-2}_{-4}$	$^{-2}_{-4}$	$^{-2}_{-4}$
Needle roller sort	–4 –6; –5 –7	–2 –4; –3 –5	0 –2; –1 –3
Radial internal clearance	3 to 11	3 to 11	3 to 10
Piston pin deviation	$^{-4}_{-6}$	$^{-4}_{-6}$	$^{-4}_{-6}$
Needle roller sort	–3 –5; –4 –6	–1 –3; –2 –4	0 –2; –1 –3
Radial internal clearance	3 to 11	3 to 11	5 to 12

Radial internal clearance, minimum values

Nominal dimension d_B mm		Crank pin bearing arrangement		Piston pin bearing arrangement
		2 stroke µm	4 stroke µm	µm
over	incl.			
8	14	14	10	2
14	18	17	12	2
18	22	20	14	2
22	25	24	18	2
25	30	28	20	–
30	–	30	25	–

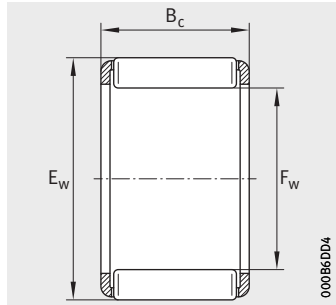
Ordering example, ordering designation

Needle roller and cage assembly KZK for:

- crank pin 16 mm
- connecting rod bore 22 mm
- width 12 mm
- needle roller sorts (sort pair coded blue) –2 –4 and –3 –5
- copper plated cage.

Ordering designation **KZK16×22×12 SORT–2–4/–3–5–CU**

Needle roller and cage assemblies for crank pins



KZK

Dimension table · Dimensions in mm

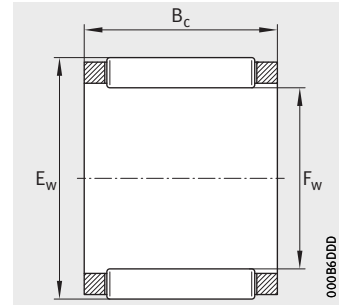
Dimensions			Basic load ratings		Fatigue limit load	Mass	Designation[1)2)]
F_w	E_w	B_C	dyn. C_r	stat. C_{0r}	C_{ur}	m	
			N	N	N	≈ g	
8	12	8	3 900	3 400	415	0,0022	**KZK8×12×8**
10	14	10	4 150	3 900	485	0,0046	**KZK10×14×10**
12	16	10	6 400	7 200	880	0,0035	**KZK12×16×10**
12	17	10	7 400	7 400	980	0,005	**KZK12×17×10**
13	17	10	7 400	7 400	890	0,004	**KZK13×17×10**
14	18	10	7 100	8 500	1 060	0,004	**KZK14×18×10**
14,4	20,4	10	8 100	7 800	930	0,0065	**KZK14,4×20,4×10**
15	21	11,15	10 100	10 600	1 290	0,009	**KZK15×21×11,15**
16	21	10	8 200	9 200	1 210	0,006	**KZK16×21×10**
16	22	10	9 200	9 500	1 140	0,0077	**KZK16×22×10**
16	22	12	11 000	11 900	1 670	0,0098	**KZK16×22×12**
18	24	12	11 600	13 100	1 840	0,01	**KZK18×24×12**
18	24	13	12 100	13 800	1 740	0,0125	**KZK18×24×13**
19	25	15	13 000	15 400	1 870	0,015	**KZK19×25×15**
20	28	16	17 900	19 700	2 350	0,026	**KZK20×28×16**
22	28	13	13 900	17 500	2 490	0,015	**KZK22×28×13**
22	28	16	15 600	20 200	2 500	0,018	**KZK22×28×16**
22	29	16	17 800	21 800	2 850	0,02	**KZK22×29×16**
23,1	28,1	14	13 100	18 600	2 250	0,011	**KZK23,1×28,1×14**
25	32	16	18 200	23 100	3 050	0,0244	**KZK25×32×16**
25,1	30,1	14	14 000	20 800	2 500	0,013	**KZK25,1×30,1×14**
26	31	16	17 200	27 500	3 400	0,016	**KZK26×31×16**
26	33	14	19 100	24 900	3 200	0,023	**KZK26×33×14**
28	33	14	14 800	23 100	2 800	0,014	**KZK28×33×14**
28	35	17	21 700	30 000	3 700	0,033	**KZK28×35×17**
28	35	18	23 400	33 000	4 200	0,027	**KZK28×35×18**
28	36	14	20 300	25 000	3 950	0,028	**KZK28×36×14**
28	36	16	23 300	30 000	3 650	0,03	**KZK28×36×16**
30	38	16	22 800	30 000	3 500	0,032	**KZK30×38×16**
30	38	18	25 500	35 000	4 250	0,035	**KZK30×38×18**

Other dimensions available by agreement.

1) The needle roller and cage assemblies are available by agreement only (subject to availability). Production is dependent on economically viable quantities.

2) The designation describes the dimensions only. For a precise ordering designation, please contact Schaeffler.

Needle roller and cage assemblies for piston pins



KBK

Dimension table · Dimensions in mm

Dimensions			Basic load ratings		Fatigue limit load	Mass	Designation[1)2)]
F_W	E_W	B_C	dyn. C_r	stat. C_{0r}	C_{ur}	m	
			N	N	N	≈ g	
8	11	10	3 450	3 450	435	3	**KBK8×11×10**
9	12	10	3 700	3 900	495	4	**KBK9×12×10**
9	12	11,7	4 200	4 600	620	4	**KBK9×12×11,7**
9	13	12,5	6 000	6 100	780	4,3	**KBK9×13×12,5**
10	13	12,5	5 000	5 900	700	4	**KBK10×13×12,5**
10	13	14,5	5 400	6 600	900	4	**KBK10×13×14,5**
10	14	10	4 800	4 700	590	4,6	**KBK10×14×10**
10	14	12,7	6 500	6 900	850	5	**KBK10×14×12,7**
10	14	13	6 000	6 200	760	5,8	**KBK10×14×13**
11	14	15	6 600	8 600	1 798	3	**KBK11×14×15**
12	15	15	6 000	7 900	1 090	5	**KBK12×15×15**
12	15	17,5	7 800	11 000	1 580	6	**KBK12×15×17,5**
12	16	13	6 900	7 800	1 010	7	**KBK12×16×13**
12	16	16	8 000	9 500	1 180	8	**KBK12×16×16**
12	17	13	7 600	7 700	950	8	**KBK12×17×13**
12	17	14,4	9 600	10 400	1 280	8,5	**KBK12×17×14,4**
13	16	14	6 200	8 300	990	5,5	**KBK13×16×14**
13	17	14,5	8 500	10 400	1 280	8	**KBK13×17×14,5**
13	17	17,5	9 100	11 300	1 430	10	**KBK13×17×17,5**
14	17	20	9 400	14 700	1 910	8	**KBK14×17×20**
14	18	17	9 100	11 600	1 400	9	**KBK14×18×17**
15	19	17	8 900	11 500	1 440	9	**KBK15×19×17**
15	19	19,5	10 600	14 600	1 860	12,6	**KBK15×19×19,5**
15	19	20	11 300	15 500	2 100	12,8	**KBK15×19×20**
15	19	24	12 400	17 600	2 300	11	**KBK15×19×24**
16	20	20	11 800	16 900	2 280	13	**KBK16×20×20**
18	22	22	13 500	20 700	2 800	16,9	**KBK18×22×22**
18	22	24	14 100	22 000	3 050	18	**KBK18×22×24**
18	23	23,15	16 700	23 500	2 900	22	**KBK18×23×23,15**
20	25	22	16 200	23 300	3 050	20	**KBK20×25×22**
20	25	23,15	17 400	25 500	3 150	28	**KBK20×25×23,15**
22	27	25	20 500	32 500	4 100	30	**KBK22×27×25**

Other dimensions available by agreement.

1) The needle roller and cage assemblies are available by agreement only (subject to availability). Production is dependent on economically viable quantities.

2) The designation describes the dimensions only. For a precise ordering designation, please contact Schaeffler.

MATNR 006984290-0000 / TPI 94 / 01 / GB-D / 202009 / pdf only

Schaeffler Technologies
AG & Co. KG

Industriestraße 1–3
91074 Herzogenaurach
Germany
Internet www.schaeffler.de/en
E-mail info.de@schaeffler.com

In Germany:
Phone 0180 5003872
Fax 0180 5003873

From other countries:
Phone +49 9132 82-0
Fax +49 9132 82-4950

Issued: 2020, September

TPI 94 GB-D