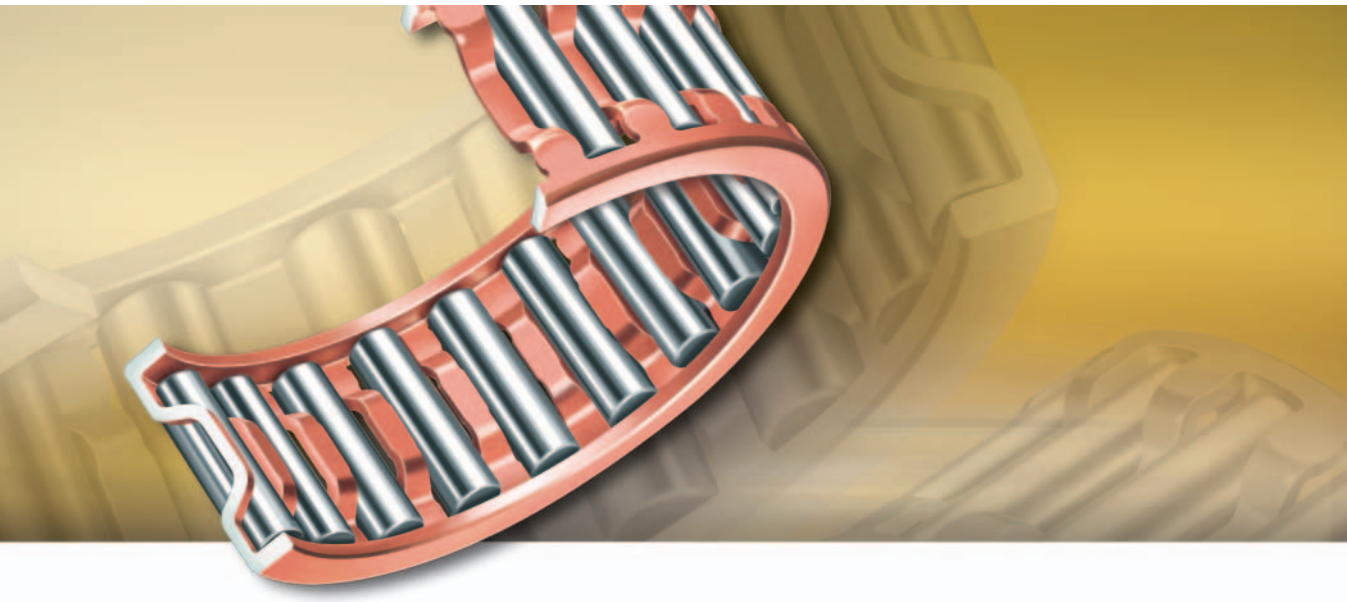


Needle roller and cage assemblies for crank pins and piston pins

SCHAEFFLER

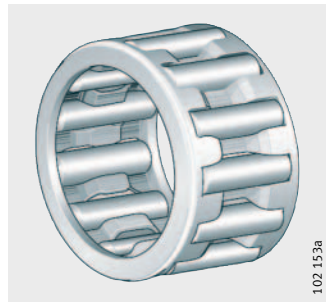
Needle roller and cage assemblies for crank pins and piston pins

Product overview

Needle roller and cage assemblies for crank pins and piston pins

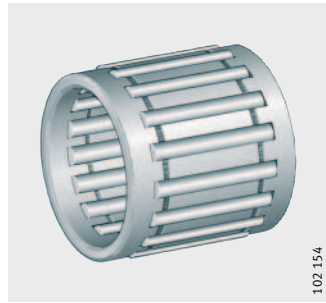
For crank pins

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 roller sort as well as the shaft and housing tolerances and can be adjusted by means of the needle roller sort.

The raceways must be hardened, ground and honed.

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 little 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, undergo little wear, have 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 little clearance. Due to their small radial internal clearance, tilting of the connecting rod is reduced to a minimum.
They 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 low-wear steel cages are case hardened or quenched and tempered and have high strength.

Further information

Further information on needle roller and cage assemblies is given in Catalogue HR 1, Rolling Bearings.

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.

The KBK is guided axially between the piston boss abutment surfaces. Free lateral movement of the connecting rod between the piston bosses.

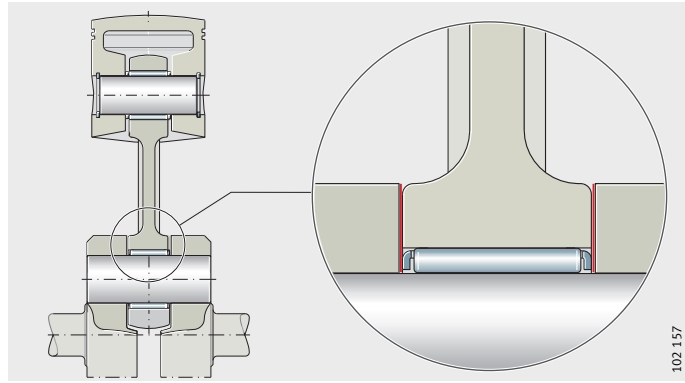


Figure 1
Crank end guidance – lateral guidance of the connecting rod

Piston end guidance

The connecting rod and needle roller and cage assembly KBK are guided axially between the piston bosses, *Figure 2*. As a result, wider piston pin bearing arrangements and longer pistons are generally necessary.

In order to ensure free axial movement of the connecting rod, the crank webs must be turned to give sufficient clearance.

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.

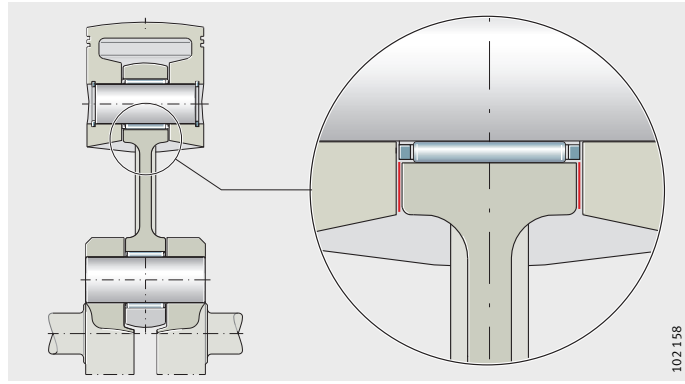


Figure 2
Piston end guidance – lateral guidance of the connecting rod

Design of adjacent parts

The bores and pins for the needle roller and cage assemblies must be produced as rolling bearing raceways. A roughness Rz1 (Ra0,2) must be ensured.

The rolling bearing raceways, thrust surfaces and thrust washers must be as follows:

- case hardened to at least 0,5 mm deep; a surface hardness of at least 700 HV must be ensured.
- The lateral thrust surfaces should be precision machined (Ra2 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.

Materials should be selected in accordance with the following table.

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

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 datasheets, page 13 to page 15, must be completed and returned to us.

Proven enveloping circle diameters for 2 stroke engines

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

In order to determine the crank pin diameter for 4 stroke engines, the technical data of the engine are required, see datasheets, page 13 to page 15.

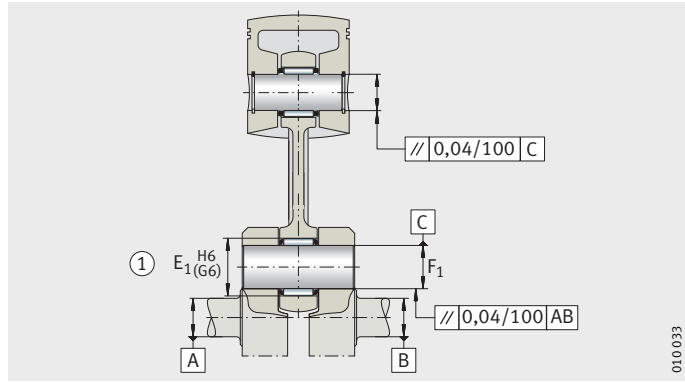
Needle roller and cage assemblies for crank pins and piston pins

Accuracy

The geometrical tolerances of the raceways must be in accordance with the tables and *Figure 3* and *Figure 4*.

Permissible geometrical tolerances for crank pin bearing arrangements

Nominal dimension F_1		Deviation for F_1		E_1	
over mm	incl. mm	Parallelism µm	Roundness µm	Parallelism µm	Roundness µm
8	14	1	1	2	1
14	18	1	1	2	1
18	22	1	2	3	2
22	25	2	2	3	2
25	30	2	2	4	2
30	–	2	2	4	3

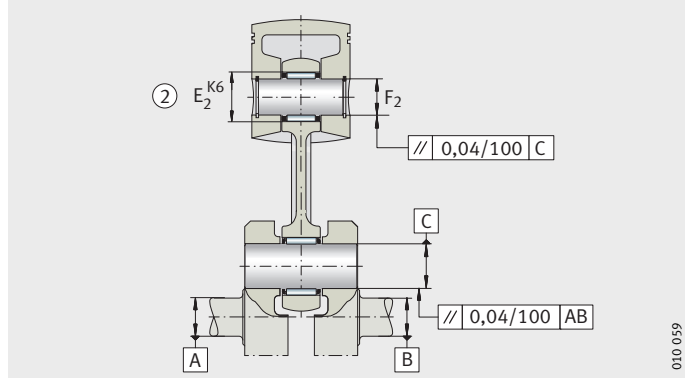


① Crank end guidance

Figure 3
Geometrical tolerances for crank pin bearing arrangements

Permissible geometrical tolerances for piston pin bearing arrangements

Nominal dimension F_2		Deviation for F_2		E_2	
over mm	incl. mm	Parallelism µm	Roundness µm	Parallelism µm	Roundness µm
8	14	1	1	2	1
14	18	1	1	2	1
18	24	2	2	3	2



② Piston end guidance

Figure 4
Geometrical tolerances for piston pin bearing arrangements

Radial internal clearance

The radial internal clearance can be determined by means of the needle roller sort, see table Sort plan for crank pin and piston pin bearing arrangements, page 8. For simplification, the mean values of the needle roller sorts can be used.

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.

For crank pin bearing arrangements

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

Minimum values for the radial internal clearance according to the table Radial internal clearance – minimum values to be achieved.

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

For very high speeds (for example in race engines), please contact us.

For piston pin bearing arrangements

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

Needle roller and cage assemblies for crank pins and piston pins

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

	Bore deviations		
	+7 +11	+11 +15	+15 +20
Crank pin deviation	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		
Needle roller sort	–4 –6/–5 –7	–1 –3/–2 –4	0 –2/–1 –3
Radial internal clearance	18 to 27	18 to 27	20 to 30
Crank pin deviation	–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

	Bore deviations		
	–9 –5	–5 –1	–1 +2
Piston pin deviation	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		
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		
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

Radial internal clearance				
Nominal dimension		Crank pin bearing arrangement		Piston pin bearing arrangement
F_1 mm		2 stroke	4 stroke	
over	incl.	μm	μm	μm
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	–	32	25	–

Special designs

Needle roller and cage assemblies KZK are available by agreement in the following designs:

- split cage, suffix D
- copper plated cage, suffix CU
- silver plated cage, suffix AG
- for high performance machines.

Ordering example and ordering designation

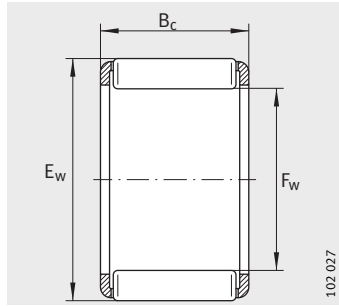
Needle roller and cage assembly KZK for:

- 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

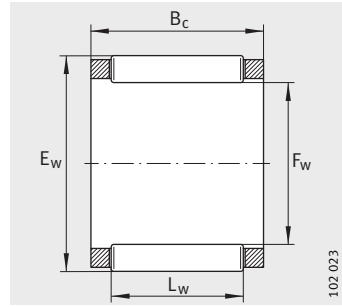
Dimension table · Dimensions in mm

Designation[1) 2)]	Mass	Dimensions			Basic load ratings		Fatigue limit load
	m	F_w	E_w	B_c	dyn. C_r	stat. C_{0r}	P_{ur}
	≈g				N	N	N
KZK8×12×8	2,2	**8**	12	8	3 900	3 400	415
KZK10×14×10	4,6	**10**	14	10	4 150	3 900	485
KZK12×16×10	3,5	**12**	16	10	6 400	7 200	850
KZK12×17×10	5	**12**	17	10	7 400	7 400	890
KZK13×17×10	4	**13**	17	10	6 500	7 300	870
KZK14×18×10	4	**14**	18	10	7 100	8 500	1 020
KZK14,4×20,4×10	6,5	**14,4**	20,4	10	8 100	7 800	930
KZK15×21×11,15	9	**15**	21	11,15	10 100	10 600	1 290
KZK16×21×10	6	**16**	21	10	8 600	9 600	1 080
KZK16×22×10	7,7	**16**	22	10	9 200	9 500	1 140
KZK16×22×12	9,8	**16**	22	12	10 900	11 700	1 460
KZK18×24×12	10	**18**	24	12	11 600	13 100	1 650
KZK18×24×13	12,5	**18**	24	13	12 100	13 800	1 740
KZK19×25×15	15	**19**	25	15	13 000	15 400	1 870
KZK20×28×16	26	**20**	28	16	17 900	19 700	2 350
KZK22×28×13	15	**22**	28	13	13 900	17 500	2 220
KZK22×28×16	18	**22**	28	16	15 600	20 200	2 500
KZK22×29×16	20	**22**	29	16	17 800	21 800	2 650
KZK23,1×28,1×14	11	**23,1**	28,1	14	13 100	18 600	2 250
KZK25×32×16	24,4	**25**	32	16	18 200	23 100	2 800
KZK25,1×30,1×14	13	**25,1**	30,1	14	14 000	20 800	2 500
KZK26×31×16	16	**26**	31	16	17 200	27 500	3 400
KZK26×33×14	23	**26**	33	14	19 100	24 900	3 200
KZK28×33×14	14	**28**	33	14	14 800	23 100	2 800
KZK28×35×17	33	**28**	35	17	21 700	30 000	3 700
KZK28×35×18	27	**28**	35	18	23 400	33 000	4 200
KZK28×36×14	28	**28**	36	14	20 300	25 000	3 950
KZK28×36×16	30	**28**	36	16	23 300	30 000	3 650
KZK30×38×16	32	**30**	38	16	22 800	30 000	3 500
KZK30×38×18	35	**30**	38	18	25 500	35 000	4 250

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

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

Needle roller and cage assemblies for piston pins



KBK

Dimension table · Dimensions in mm

Designation[1) 2)]	Mass	Dimensions				Basic load ratings		Fatigue limit load
	m	F_w	E_w	B_c	L_w	dyn. C_r	stat. C_{0r}	P_{ur}
	≈g					N	N	N
KBK8×11×10	3	**8**	11	10	7,3	3 450	3 450	435
KBK9×12×10	4	**9**	12	10	7,3	3 700	3 900	495
KBK9×12×11,7	4	**9**	12	11,7	7,8	4 200	4 600	620
KBK9×13×12,5	4,3	**9**	13	12,5	9,8	6 000	6 100	750
KBK11×14×15	3	**11**	14	15	11,8	6 600	8 600	1 798
KBK10×13×12,5	4	**10**	13	12,5	9,8	5 000	5 900	700
KBK10×13×14,5	4	**10**	13	14,5	11,8	5 400	6 600	790
KBK10×14×10	4,6	**10**	14	10	6,8	4 800	4 700	590
KBK10×14×12,7	5	**10**	14	12,7	9,8	6 500	6 900	850
KBK10×14×13	5,8	**10**	14	13	9,8	6 000	6 200	760
KBK12×15×15	5	**12**	15	15	10,8	6 000	7 900	950
KBK12×15×17,5	6	**12**	15	17,5	13,8	7 800	11 000	1 390
KBK12×16×13	7	**12**	16	13	9,8	6 900	7 800	970
KBK12×16×16	8	**12**	16	16	11,8	8 000	9 500	1 160
KBK12×17×13	8	**12**	17	13	9,8	8 300	8 600	1 000
KBK12×17×14,4	8,5	**12**	17	14,4	11,8	9 600	10 400	1 270
KBK13×16×14	5,5	**13**	16	14	9,8	6 200	8 300	990
KBK13×17×14,5	8	**13**	17	14,5	11,8	8 500	10 400	1 280
KBK13×17×17,5	10	**13**	17	17,5	12,8	9 100	11 300	1 430
KBK14×17×20	8	**14**	17	20	15,8	9 400	14 700	1 910
KBK14×18×17	9	**14**	18	17	11,8	9 100	11 600	1 400
KBK15×19×17	9	**15**	19	17	11,8	8 900	11 500	1 420
KBK15×19×19,5	12,6	**15**	19	19,5	15,8	10 600	14 300	1 860
KBK15×19×20	12,8	**15**	19	20	15,8	11 300	15 500	2 010
KBK15×19×24	11	**15**	19	24	17,8	12 400	17 600	2 300
KBK16×20×20	13	**16**	20	20	15,8	11 800	16 900	2 180
KBK18×22×22	16,9	**18**	22	22	15,8	13 600	21 000	2 700
KBK18×22×24	18	**18**	22	24	17,8	14 100	22 000	2 900
KBK18×23×23,15	22	**18**	23	23	17,8	16 700	23 500	2 900
KBK20×25×22	20	**20**	25	22	16,3	16 200	23 300	2 800
KBK20×25×23,15	28	**20**	25	23,15	17,8	17 400	25 500	3 150
KBK22×27×25	30	**22**	27	25	19,8	20 500	32 500	4 100

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

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

Appendix
Calculation of rolling bearings in crank machines

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 machines.

Simplifications underlying the calculation model:

- the crankshaft is only subjected to power train 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 the Schaeffler engineering service.

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 the 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/Palmgren theory and gives a better description of the performance capability of modern bearings.

The calculation methods are described in detail in Catalogue HR1, Rolling Bearings.

Datasheets, functional diagram

The following datasheets, page 13 to page 15 are used to collect all the data relevant to the calculation.

Datasheet · Needle roller and cage assemblies for crank pins and piston pins

Customer data

Customer _____

_____

_____

Contact _____

Telephone _____

E-mail _____

Date _____

Enquiry data

Proposal deadline _____

Delivery date _____

Annual volume _____

Required rating life _____ h

Engine data

Engine type (e.g. 1 cylinder/ 4 stroke) _____

Capacity _____ cm^2

Application/model (e.g. Enduro, scooter) _____

Cylinder bore D _____ mm

Stroke h _____ mm

Engine power P _____ kW

Design data for connecting rod

Connecting rod length $L^{1)}$ _____ mm

Centre of gravity of connecting rod $L_S{}^{1)}$ _____ mm

Mass of connecting rod m_S _____ kg

Mass of longitudinally guided parts (KBK, piston, pin, rings) m_L _____ kg

Design data for crankshaft main bearing arrangement[2)]

Crank-conrod offset distance $r_{KY}{}^{3)}$ _____ mm

Position of brg. C $x_C{}^{1)}$ _____ mm

Oscillating mass compensation _____ %

Mass of rotating parts m_U _____ kg

Position of brg. D $x_D{}^{1)}$ _____ mm

Bearings for calculation

Bearing $A^{1)}$ (e.g. type, dimensions) _____

Bearing $C^{1)\,2)}$ (e.g. type, dimensions) _____

Bearing $B^{1)}$ (e.g. type, dimensions) _____

Bearing $D^{1)\,2)}$ (e.g. type, dimensions) _____

1) See functional diagram, page 15.

2) Only required for main bearing calculation.

3) The distance between the centre of gravity of the rotating mass and the crankshaft axis can be y+ or y– in the co-ordinate system.

Load case 1[4)]

Ignition pressure	Pz_1	_____	bar	Time proportion	t_1	_____	%
Speed	n_1	_____	1/min	Gas pressure diagram available[3)]? ❑ yes ❑ no			

Load case 2[4)]

Ignition pressure	Pz_2	_____	bar	Time proportion	t_2	_____	%
Speed	n_2	_____	1/min	Gas pressure diagram available[3)]? ❑ yes ❑ no			

Load case 3[4)]

Ignition pressure	Pz_3	_____	bar	Time proportion	t_3	_____	%
Speed	n_3	_____	1/min	Gas pressure diagram available[3)]? ❑ yes ❑ no			

Load case 4[4)]

Ignition pressure	Pz_4	_____	bar	Time proportion	t_4	_____	%
Speed	n_4	_____	1/min	Gas pressure diagram available[3)]? ❑ yes ❑ no			

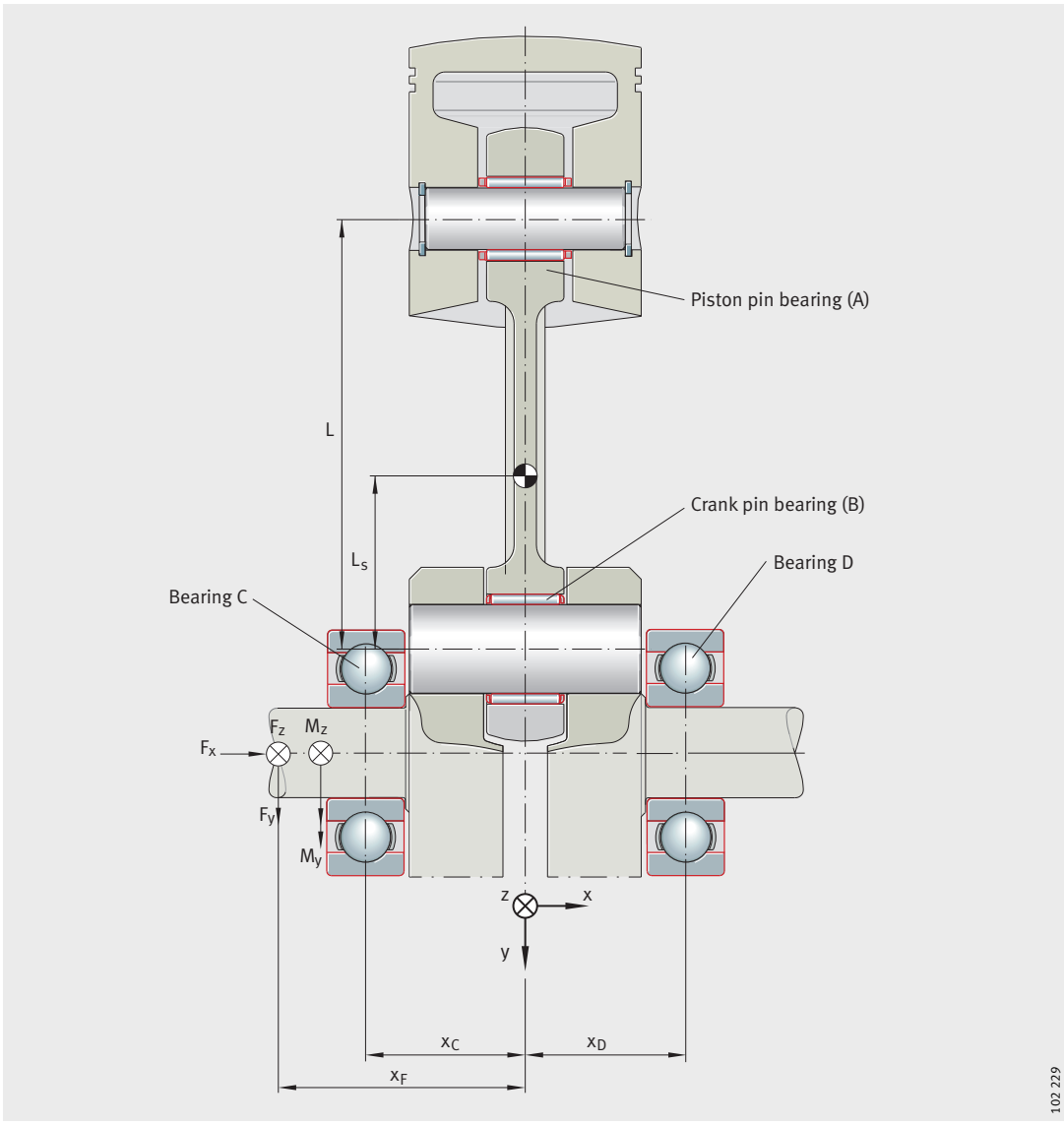
Load case 5[4)]

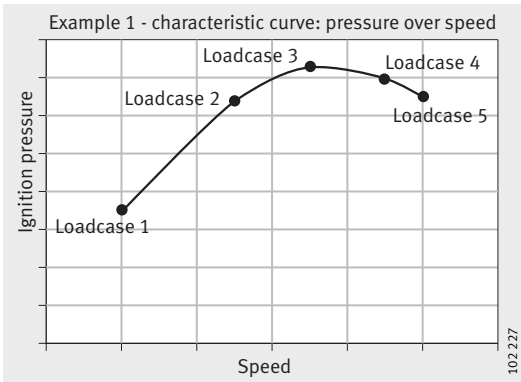
Ignition pressure	Pz_5	_____	bar	Time proportion	t_5	_____	%
Speed	n_5	_____	1/min	Gas pressure diagram available[3)]? ❑ yes ❑ no			

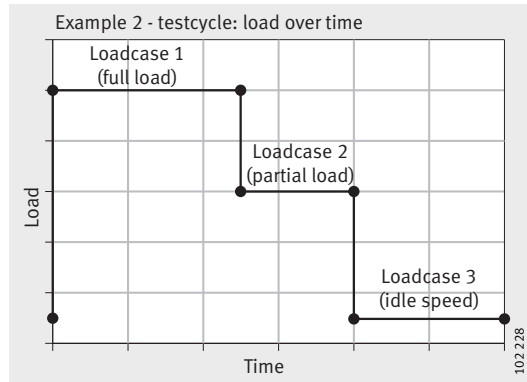
Static forces and moments acting on crankshaft[2)]

Axial point load in "x"	F_x[1)]	_____	N	Position of radial forces in "x"	x_F[1)]	_____	mm
Radial point load in "y"	F_y[1)]	_____	N	Radial point load in "z"	F_z[1)]	_____	N
Static moment about "y"	M_y[1)]	_____	Nm	Static moment about "z"	M_z[1)]	_____	Nm

1) See functional diagram, page 15.
2) Only required for main bearing calculation.
3) Please include the working diagram with the datasheet.
4) See examples, page 15.


Piston pin bearing (A)
L
Crank pin bearing (B)
L_s
Bearing D
Bearing C
F_z
M_z
F_x
F_y
M_y
z
x
y
x_C
x_D
x_F
102 229


Example 1 - characteristic curve: pressure over speed
Loadcase 3
Loadcase 4
Loadcase 2
Loadcase 5
Loadcase 1
Ignition pressure
Speed
102 227


Example 2 - testcycle: load over time
Loadcase 1
(full load)
Loadcase 2
(partial load)
Loadcase 3
(idle speed)
Load
Time
102 228

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