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Spherical plain bearings — Spherical plain bearings rod ends for hydraulic fluid power cylinders

Rotules lisses — Embouts à rotule pour vérins hydrauliques

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 4, *Rolling bearings*, Subcommittee SC 7, *Spherical plain bearings*, in collaboration with Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 3, *Cylinders*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a fluid (liquid) under pressure within an enclosed circuit.

One component of such systems is the fluid power cylinder. This is a device that converts power into linear mechanical force and motion. It consists of a moveable element, i.e. a piston and a piston rod, operating within a cylindrical bore.

The spherical plain bearings rod ends are used on piston rods of hydraulic cylinders for mechanical transmitting the cylinder force under oscillatory rotational and tilting movements. The design of the spherical plain bearing rod ends is based on the maximum forces resulting from the specified internal diameter of the cylinders and pressure according to the ISO 6020 series and ISO 6022.

The dimensions and tolerances specified in this document have been selected to permit the design and use of spherical plain bearings rod ends which incorporate radial spherical plain bearings having various sliding material combinations. These spherical plain bearings can be requiring maintenance (steel/steel or steel/bronze), maintenance-free [e.g. steel/polytetrafluoroethylene (PTFE)] and/or sealed.

NOTE Spherical plain bearings rod ends for hydraulic fluid power cylinders can be used for other applications than hydraulic fluid power cylinders as well.

Type D and Type E from this document are in the scope of ISO 8132 and ISO 8133.

Spherical plain bearings — Spherical plain bearings rod ends for hydraulic fluid power cylinders

1 Scope

This document specifies designs, dimensions, tolerances and technical requirements of spherical plain bearings rod ends for hydraulic fluid power cylinders.

The specified tolerance values apply to finished spherical plain bearing rod ends before any coating, plating, ring splitting or fracturing.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 68-1, *ISO general purpose screw threads — Basic profile — Part 1: Metric screw threads*

ISO 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 582:1995, *Rolling bearings — Chamfer dimensions — Maximum values*

ISO 965-1, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data*

ISO 1132-1, *Rolling bearings — Tolerances — Part 1: Terms and definitions*

ISO 4762, *Hexagon socket head cap screws*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 6811, *Spherical plain bearings — Vocabulary*

ISO 8132, *Hydraulic fluid power — Mounting dimensions for accessories for single rod cylinders, 16 MPa (160 bar) medium and 25 MPa (250 bar) series*

ISO 8133, *Hydraulic fluid power — Mounting dimensions for accessories for single rod cylinders, 16 MPa (160 bar) compact series*

ISO 12240-1:1998, *Spherical plain bearings — Part 1: Radial spherical plain bearings*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1132-1, ISO 5598, ISO 6811 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
spherical plain bearings rod end, welded type
spherical plain bearings rod end having a welding chamfer or a welding shank at the bottom for fastening the rod end to the cylinder by welding

3.2
spherical plain bearings rod end, threaded type
spherical plain bearings rod end having an internal thread that is connected to the cylinder by thread, with or without locking device

3.3
angle of tilt of bearing
α
permissible angular displacement of the inner member relative to the outer member of a spherical plain bearing or rod end

Note 1 to entry: See Figure 1.

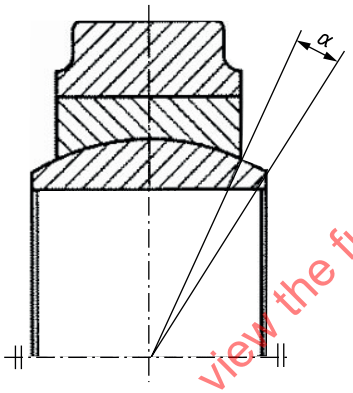


Figure 1 — Angle of tilt of a bearing

Note 2 to entry: Attention is drawn to the fact that after mounting a spherical plain bearing rod end on a shaft, the angle through which the rod end can tilt can be restricted by design of adjacent components.

[SOURCE: ISO 6811:1998, 03.02.01, modified — "of bearing" has been added to the term and, Figure 1 and Note 1 to entry have been added.]

4 Symbols

For the purposes of this document, the symbols in Table 1 apply.

The symbols (except those for tolerances) shown in the Figures 1 to 3 and the values given in Tables 2 to 10 denote nominal dimensions, unless otherwise specified.

Table 1 — Symbols

Symbol	Symbol/identification code according to ISO 6099[a]	Description	Unit
B	*EN*	Inner ring width	mm
b	–	Width of thread connected side of rod end	mm
C_1	*EU*	Width of rod end eye	mm
d	*CN*	Bore diameter of inner ring	mm
d_k	–	Sphere diameter	mm

[a] ISO 6099 covers the identification codes for cylinder mounting dimensions and accessories (see Annex A).

Table 1 *(continued)*

Symbol	Symbol/identification code according to ISO 6099[a]	Description	Unit
d_2	*2EF*	Outside diameter of rod end eye	mm
d_4	*N*	Rod end shank shoulder diameter	mm
d_5	–	Rod end shank diameter for welding end	mm
d_6	–	Locating pin diameter	mm
d_7	–	Diameter of small flange step of rod end	mm
d_8	–	Diameter of large flange step of rod end	mm
d_9	–	Flange diameter for welded end	mm
e	–	Chamfer dimension for welded end	mm
F_n	–	Nominal cylinder force	kN
G	*KK*	Designation of thread	mm
h_1	*CH*	Centre height of threaded rod end	mm
h_2	–	Centre height of welded rod end	mm
L	–	Width of bottom side of threaded rod end	mm
l_3	*AV*	Thread length	mm
l_4	–	Overall length of threaded rod end	mm
l_6	–	Overall length of welded rod end	mm
l_7	*LF*	Length from the bearing bore centre to the stepped surface of shank	mm
l_8	–	Length of locating pin	mm
l_{33}	–	Depth of thread hole	mm
Ra	–	Surface roughness	µm
r_s	–	Single chamfer dimension of inner ring	mm
V_{dmp}	–	Variation of mean bore diameter	µm
V_{dsp}	–	Variation of bore diameter in a single radial plane	µm
α	Z	Angle of tilt of bearing	°
Δ_{Bs}	–	Deviation of a single inner ring width	µm
Δ_{dmp}	–	Deviation of mean bore diameter in a single plane	µm
Δ_{h1s}	–	Deviation of centre height of threaded rod end	mm
Δ_{h2s}	–	Deviation of centre height of welded rod end	mm

[a] ISO 6099 covers the identification codes for cylinder mounting dimensions and accessories (see Annex A).

Annex A shows an application example of the symbols according to this document and the identification codes of ISO 6099.

5 Design

The rod end bearings for hydraulic cylinders comprise a radial spherical plain bearing and a rod end housing. The spherical plain bearing rod end, welded type for hydraulic cylinders is shown in Figure 2, and threaded type is shown in Figure 3.

NOTE 1 The figures only show an example of the design. For example, the design from Figure 3 a) can have two screws on one side. Conformity with the designs illustrated is not required.

Table 2 gives an overview about the different design variants.

NOTE 2 With or without lubricating nipple or lubrication hole. Type and design of lubricating nipple or lubrication hole at manufacturer's discretion.

NOTE 3 The spherical plain bearings can be axially located in the housing by means of retaining rings.

NOTE 4 A suitable thread locking device can be used.

NOTE 5 Differences in shape of the rod end housing depending on the manufacturer's processes can occur.

Table 2 — Overview of rod end designs

Basic type [a]	Type	Dimension series	Remark 1	Remark 2	Figure
Welded type	Rod ends with a cylindrical welding section with locating pin	E	Spherical plain bearing unassisted of retaining rings	–	2 a)
	Rod ends with a welding chamfer	E	Spherical plain bearing located by means of retaining rings [c]	–	2 b)
	Rod ends with a rectangular welding section	E, W		–	2 c)
Threaded type [d]	A [b]	E		Thread locking device by two hexagon socket head cap screws **left and/or right** of the internal thread of the rod end shank	3 a)
	B [b]	E		-	3 b)
	C [b]	E		Thread locking device by two hexagon socket head cap screws **on one side** of the internal thread of the rod end shank	3 c)
	D [b]	W		Thread locking device by two hexagon socket head cap screws **left and/or right** of the internal thread of the rod end shank	3 d)
	E [b]	E	Spherical plain bearing unassisted of retaining rings		3 e)

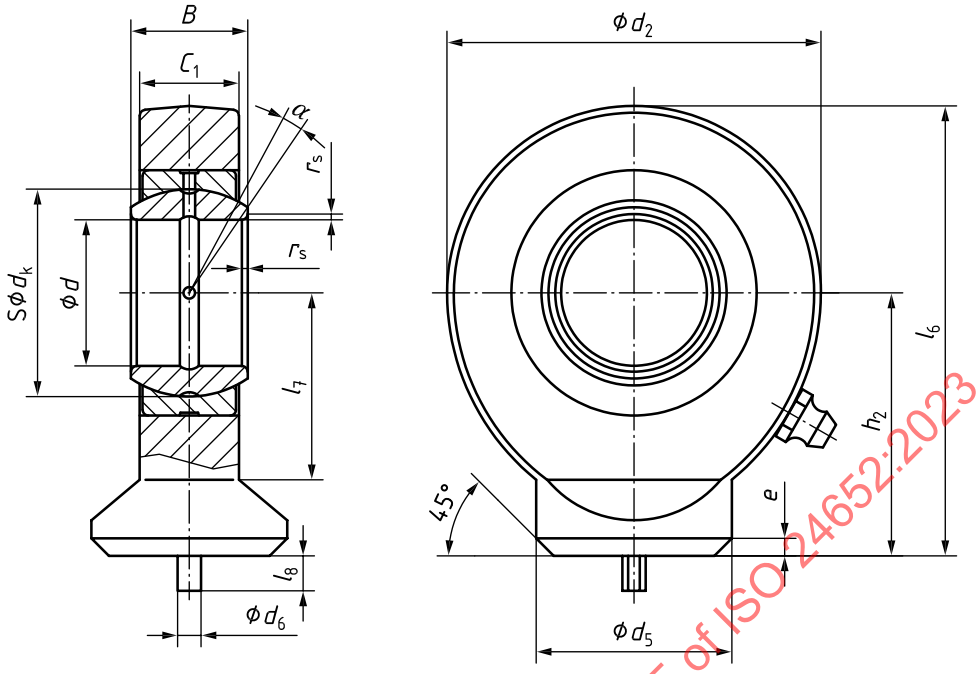
[a] Spherical plain bearing shall be in accordance with ISO 12240-1.

[b] The different stud holes are given for $d \leq 30$ mm and $d > 30$ mm.

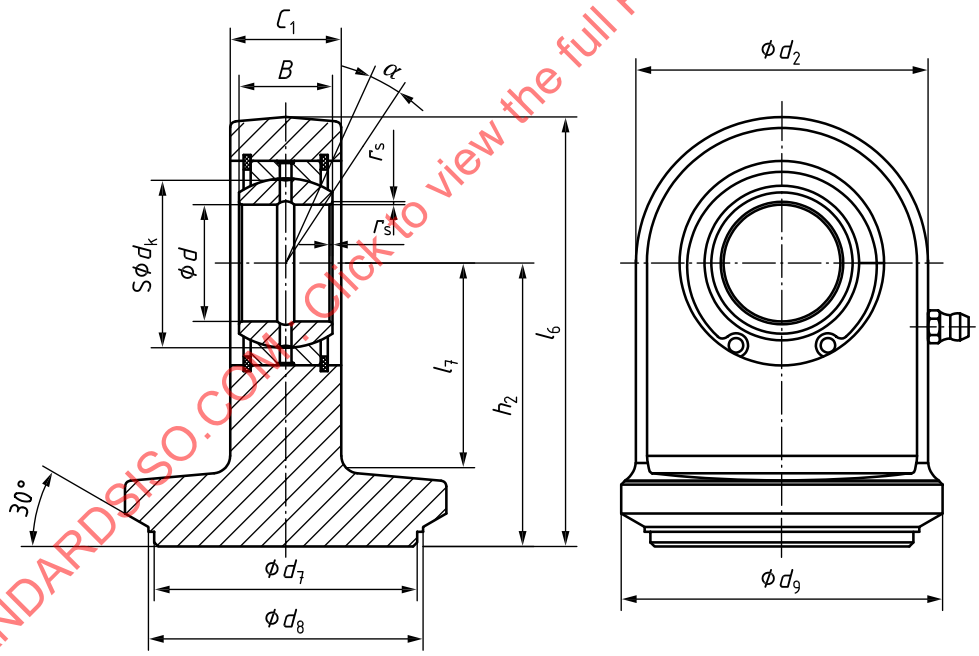
[c] See Annex B.

[d] Threads shall be in accordance with ISO 68-1.

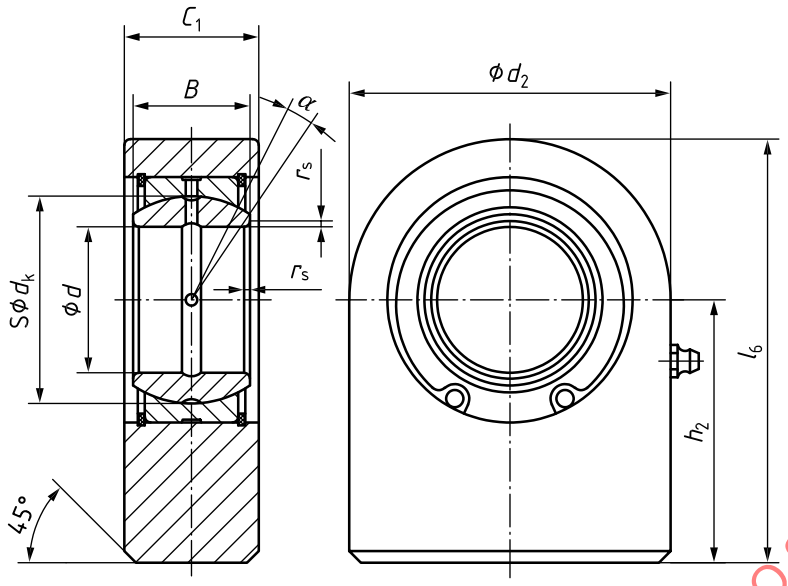
Retaining rings and retaining ring grooves are shown in Annex B. Annex C shows a mounting example of a spherical plain bearing rod end on a hydraulic fluid power cylinder.



a) Rod ends with a cylindrical welding section with locating pin

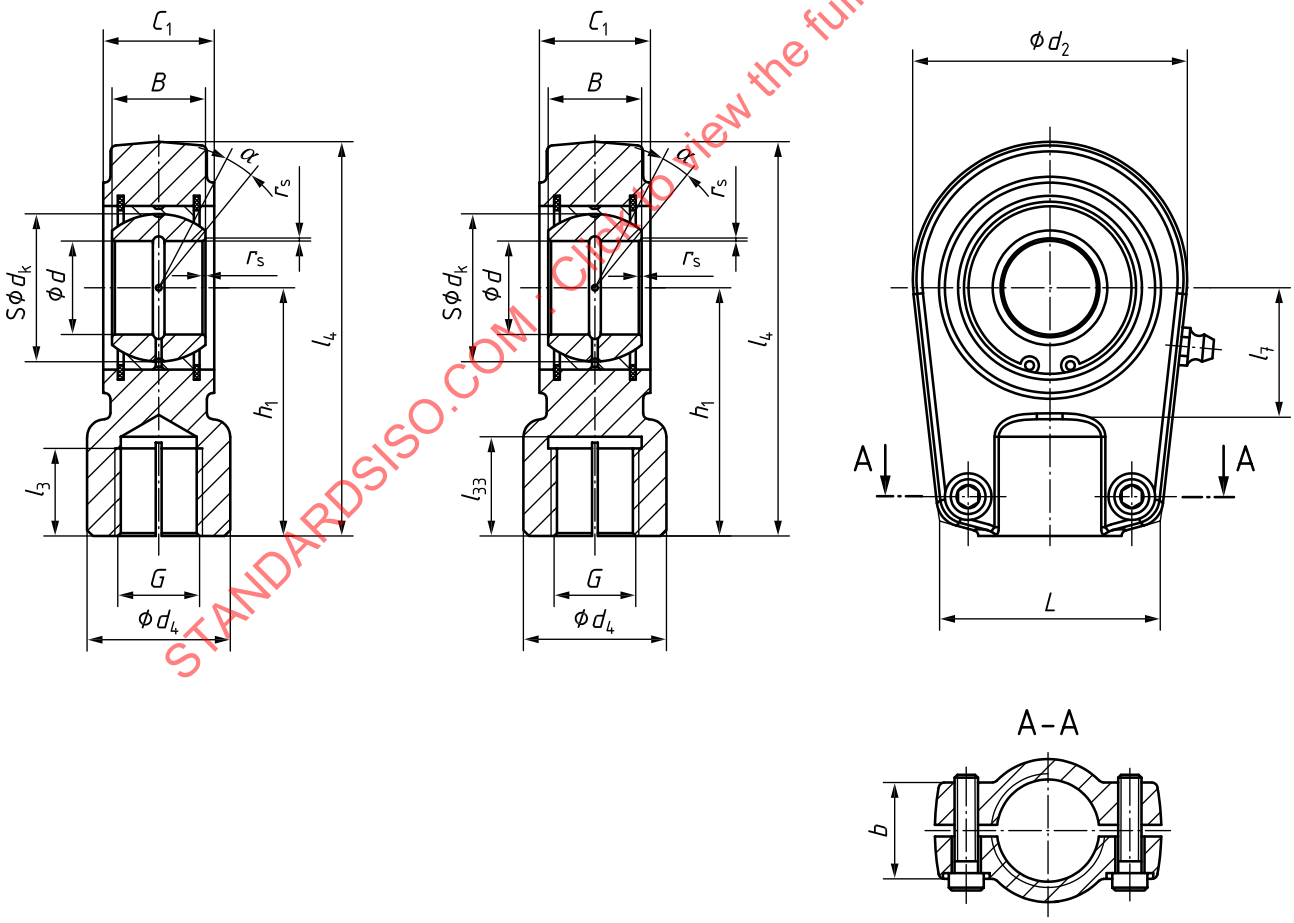


b) Rod ends with a welding chamfer



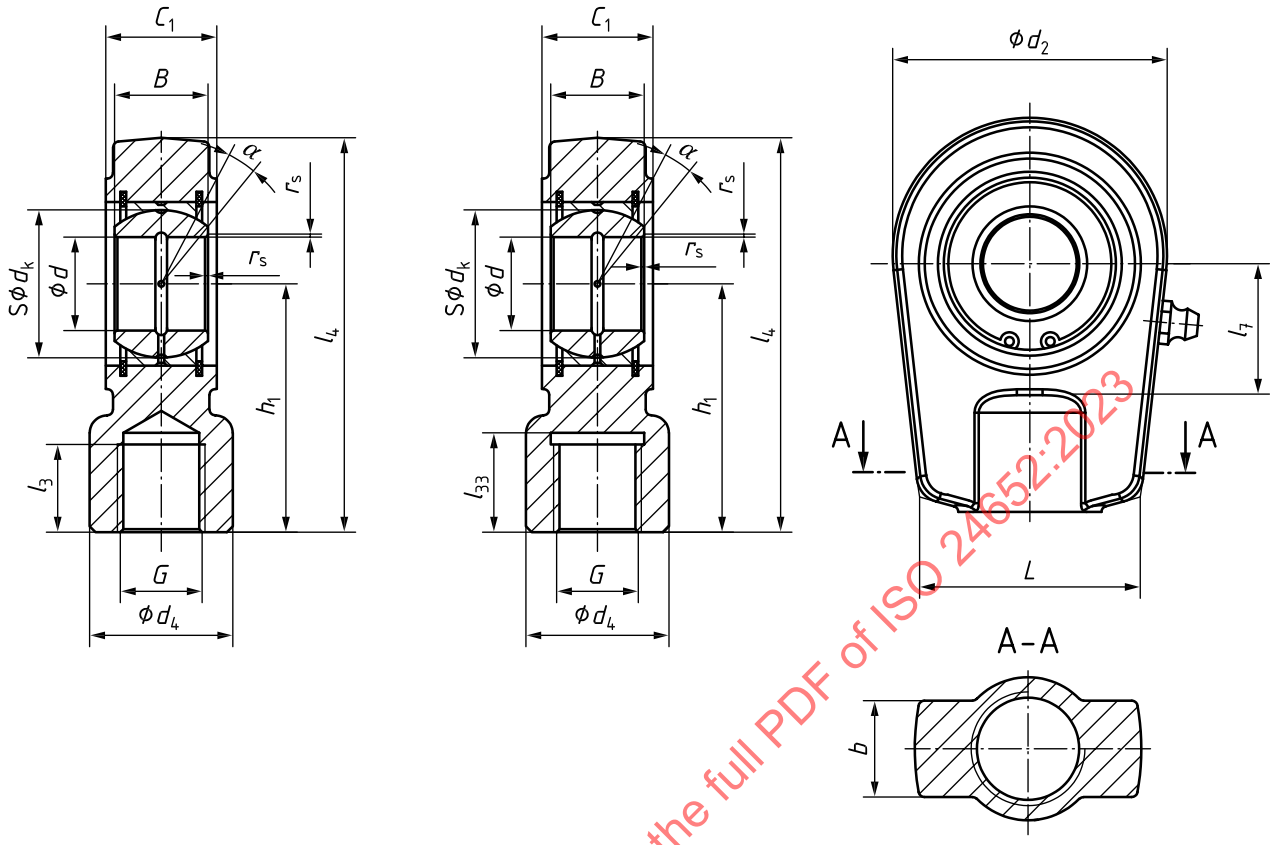
c) Rod ends with a rectangular welding section

Figure 2 — Spherical plain bearings rod end, welded type



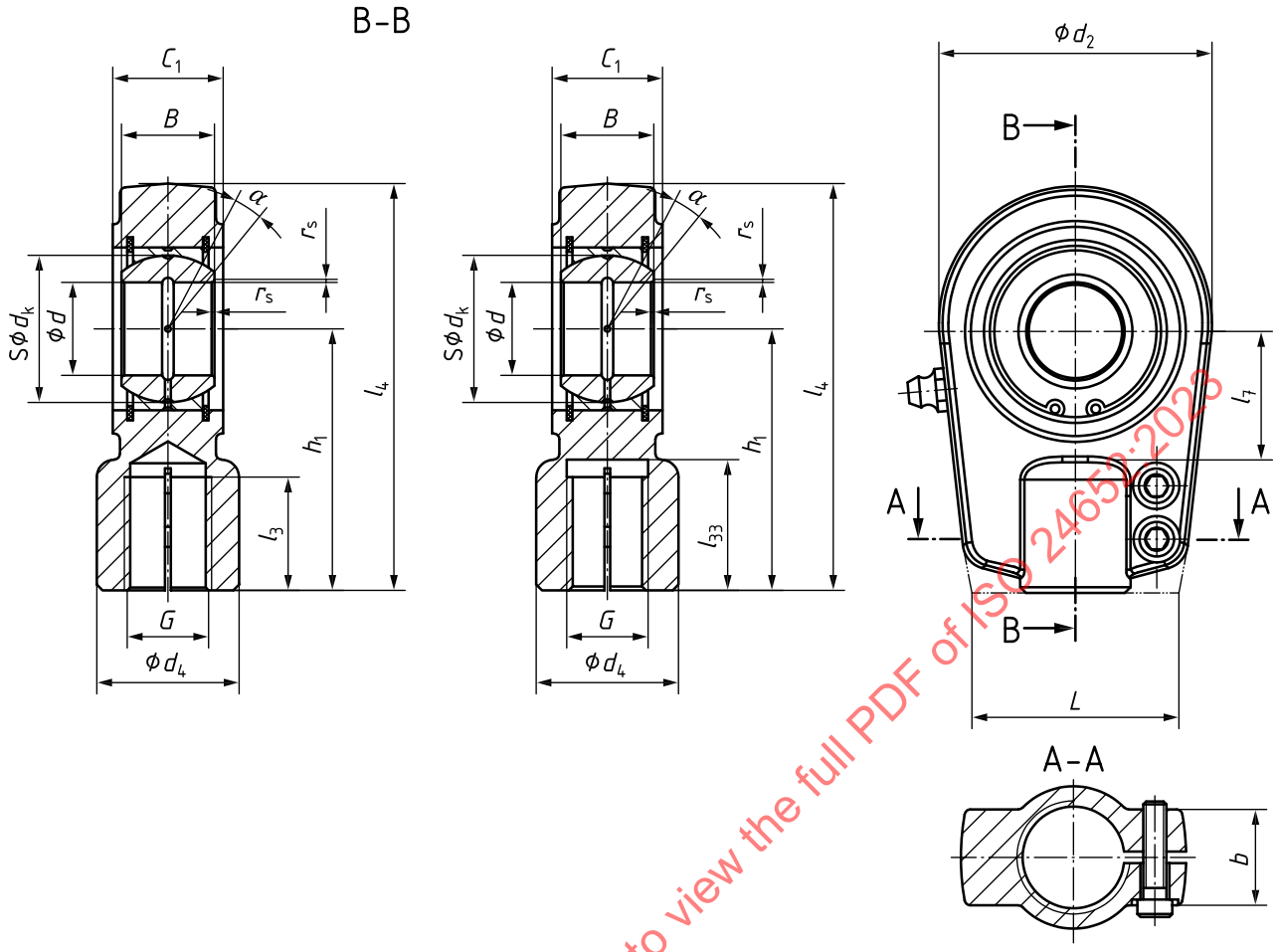
$d \leq 30$ mm $d > 30$ mm

a) Type A



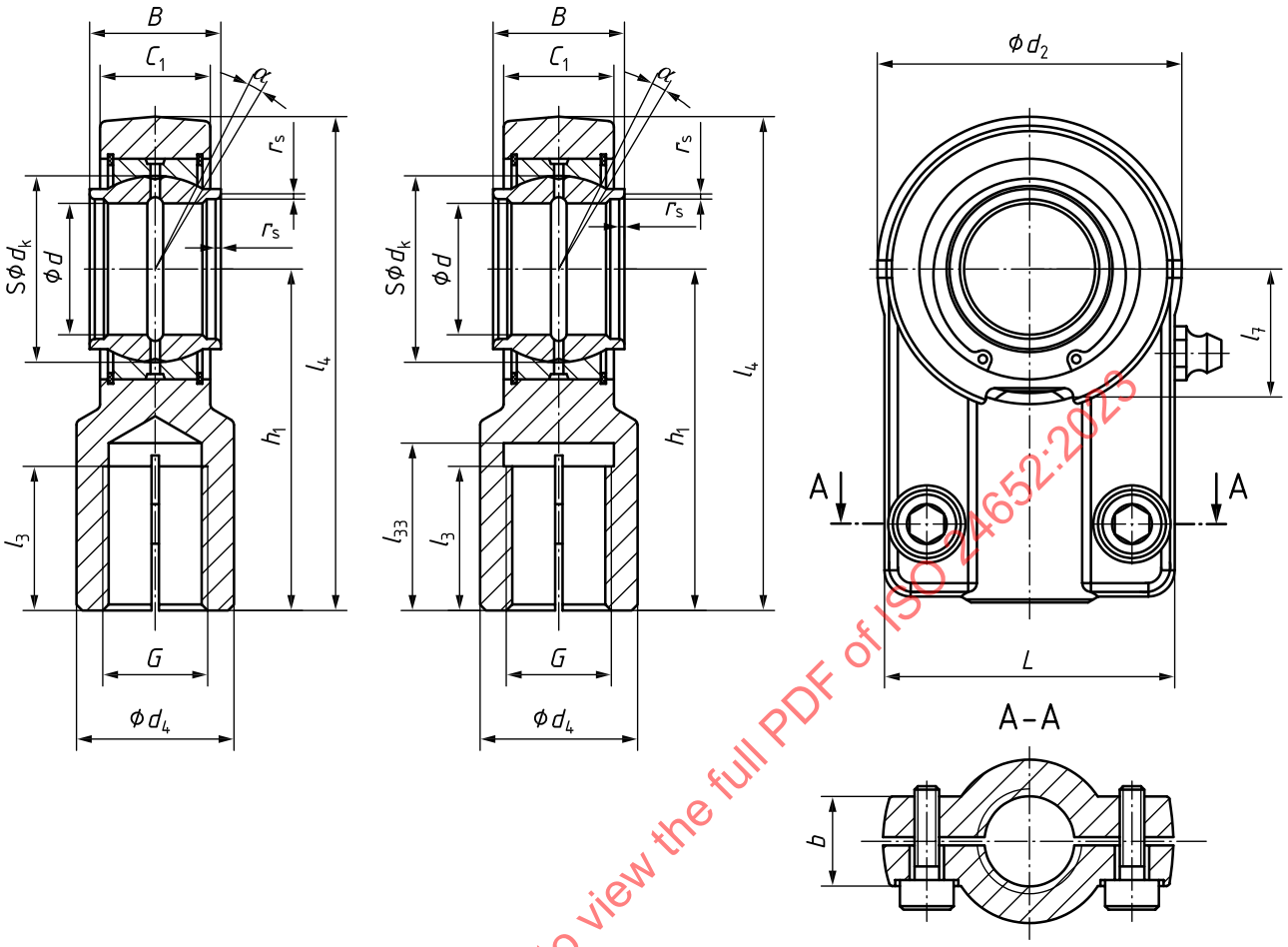
$d \leq 30$ mm $d > 30$ mm

b) Type B



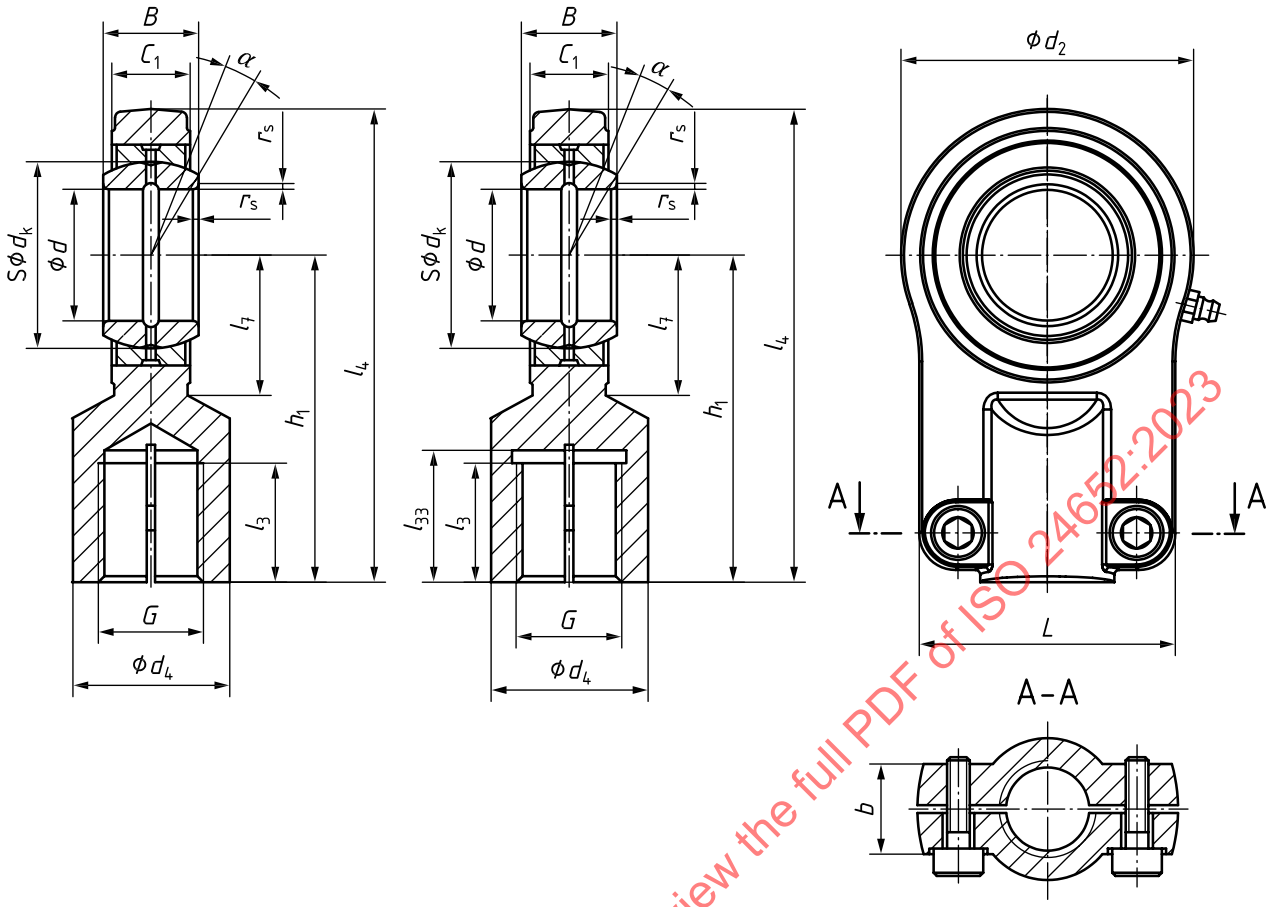
$d \leq 30$ mm $d > 30$ mm

c) Type C



$d \leq 30$ mm $d > 30$ mm

d) Type D



$d \leq 30$ mm $d > 30$ mm

e) Type E

Figure 3 — Spherical plain bearings rod end, threaded type

6 Dimensions

6.1 General

Dimensions shall be as shown in Figures 2 a) to 2 c) and 3 a) to 3 e) and values as given in Tables 3 to 10.

Where "max." is shown in Tables 3 to 10, this indicates that the value is the largest actual value permitted. Where "min." is shown in Tables 3 to 10, this indicates that the value is the smallest actual value permitted.

NOTE For nominal values as well as tolerance values, the manufacturer can be contacted.

The corresponding largest single chamfer dimensions to the r_s dimensions in Tables 3 to 10 shall be as given in ISO 582:1995, Table 1.

Load requirements according to ISO 8132 and ISO 8133 are currently only assigned to spherical plain bearings rod end, threaded type, Type D in Table 9, and Type E in Table 10.

6.2 Spherical plain bearings rod end, welded type

Table 3 — Rod ends with a cylindrical welding section with locating pin

d	B	d_k [a]	C_1 max.	d_2 max.	h_2	l_6	l_7	l_8	d_5	d_6	e min.	e max.	r_s min.	α [b] ≈
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm		mm	°
10	9	16	7,5	30	24	40	15	6	16	3	1	3	0,3	12
12	10	18	8,5	35	27	45	17,5	6	19	3	1	3	0,3	10
15	12	22	10,5	41	31	52	20	6	22	4	1,5	3,5	0,3	8
16 [c]	14	25	11,5	47	35	59	23	6	25	4	1,5	4	0,3	10
17	14	25	11,5	47	35	59	23	6	25	4	1,5	4	0,3	10
20	16	29	13,5	54	38	66	27,5	6	29	4	1,5	4	0,3	9
25	20	35,5 [c]	18	65	45	78	33	6	35	4	2,5	5	0,6	7
30	22	40,7 [c]	20	75	51	89	37,5	6	42	4	2,5	5	0,6	6
35	25	47	22	84	61	104	43	6	49	4	2,5	5	0,6	6
40	28	53	24	94	69	118	48	6	54	4	3	6	0,6	7
45	32	60	28	104	77	132	52	6	60	6	3	6	0,6	7
50	35	66	31	114	88	150	59	6	64	6	3	7	0,6	6
60	44	80	39	137	100	173	72,5	6	72	6	3	10	1	6
70	49	92	43	162	115	199	85,5	6	82	6	4	12	1	6
80	55	105	48	182	141	237	98	6	97	6	4	12	1	6

[a] This value is given for reference only.

[b] Attention is drawn to the fact that, after mounting a spherical plain bearing rod end on a shaft, the angle through which the rod end can tilt can be restricted by design of adjacent components.

[c] These values deviate from ISO 12240-1.

Table 4 — Rod ends with a welding chamfer

d	B	d_k [a]	C_1 max.	d_2 max.	h_2	l_7	l_6	d_7	d_8	d_9 ≈	r_s min.	α [b] ≈
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	°
20	16	29	19,2	51	48,5	38	73,5	35	37	45	0,3	9
25	20	35,5	23,2	56	57,5	45	85	50	52	60	0,6	7
30	22	40,7	28,2	66	63,5	51	96	60	62	70	0,6	6
35	25	47	30,2	84,5	73,5	61	115	70	72	80	0,6	6
40	28	53	35,2	101,5	84,5	69	134,5	85	87	100	0,6	7
50	35	66	40,5	125	106,5	88	168	110	112	130	0,6	6
60	44	80	50,5	142	120,5	100	190,5	130	133	150	1	6

[a] This value is given for reference only.

[b] Attention is drawn to the fact that, after mounting a spherical plain bearing rod end on a shaft, the angle through which the rod end can tilt can be restricted by design of adjacent components.

Table 5 — Rod ends with a rectangular welding section

d mm	B mm	d_k [a] mm	Bearing series [b]	C_1 max. mm	d_2 max. mm	h_2 mm	l_6 mm	r_s min. mm	α [c] ≈ °
15	12	22	E	16,2	46	31	53,5	0,3	8
16	14	25	corresponding to E	17,7	49	35	59	0,3	10
16	16	23	W	17,7	49	35	59	0,3	10
17	14	25	E	17,7	49	35	59	0,3	10
20	16	29	E	20	51,5	38	63	0,3	9
20	20	29	W	20	51,5	38	63	0,3	4
25	20	35,5	E	24	56,5	45	72,5	0,6	7
25	25	35,5	W	24	56,5	45	72,5	0,6	4
30	22	40,7	E	29	66,5	51	83,5	0,6	6
32	32	43	W	29	71,5	65	100	0,6	4
35	25	47	E	31	85	61	102,5	0,6	6
40	28	53	E	36,5	102	69	119	0,6	7
40	40	53	W	36,5	102	69	119	0,6	4
45	32	60	E	41,5	112	77	132	0,6	7
50	35	66	E	41,5	125,5	88	149,5	0,6	6
50	50	66	W	41,5	125,5	88	149,5	0,6	4
60	44	80	E	51,5	142,5	100	170	1	6
63	63	83	W	51,5	147	107	179,5	1	4
70	49	92	E	57	166,5	115	197	1	6
70	70	92	corresponding to W	57	166,5	115	197	1	4
80	55	105	E	62	182,5	141	231	1	6
80	80	105	W	62	182,5	141	231	1	4
90	60	115	E	67	228,5	150	263	1	5
90	90	115	corresponding to W	67	228,5	150	263	1	4
100	70	130	E	72	252,5	170	295	1	7
100	100	130	W	72	252,5	170	295	1	4
110	70	140	E	83	298	185	332,5	1	6
110	110	140	corresponding to W	83	298	185	332,5	1	6
120	85	160	E	92,5	363	210	390	1	6

[a] This value is given for reference only.

[b] Bearing series shall be in accordance with ISO 12240-1.

[c] Attention is drawn to the fact that, after mounting a spherical plain bearing rod end on a shaft, the angle through which the rod end can tilt can be restricted by design of adjacent components.

6.3 Spherical plain bearings rod end, threaded type

Table 6 — Type A

d mm	B mm	d_k [a] mm	C_1 max. mm	d_2 max. mm	G	h_1 mm	l_3 min. mm	l_{33} max. mm	l_4 mm	l_7 mm	d_4 mm	L mm	b mm	r_s min. mm	α [b] ≈ °	Screw [c]
20	16	29	19,5	58	M16×1,5	50	17	–	80	25	25	46 41 [d]	20	0,3	9	M8×20
25	20	35,5	23,5	58	M16×1,5	50	17	–	80	25	25	46 41 [d]	21	0,6	7	M8×20
30	22	40,7	28,5	66	M22×1,5	60	23	–	94	30	32	50 46 [d]	26	0,6	6	M8×25
35	25	47	30,5	80	M28×1,5	70	–	29	112	38	40	66 58 [d]	28	0,6	6	M10×30
40	28	53	35,5	96	M35×1,5	85	–	36	135	45	49	76 66 [d]	33	0,6	7	M10×35
50	35	66	40,5	118	M45×1,5	105	–	45	168	55	61	90 88 [d]	37	0,6	6	M12×40
60	44	80	50,5	132	M58×1,5	130	–	59	200	65	75	120 90 [d]	46	1	6	M16×45 M10×45 [d]
70	49	92	55,5	156,5	M65×1,5	150	–	66	232	75	86	130 100 [d]	51	1	6	M16×50 M12×50 [d]
80	55	105	60,5	178,5	M80×2	170	–	81	265	80	105	160 125 [d]	55	1	6	M20×55 M16×50 [d]
90	60	115	65,5	208	M100×2	210	–	101	323	90	124	180 146 [d]	60	1	5	M20×60
100	70	130	70,5	232,5	M110×2	235	–	111	360	105	138	200 166 [d]	65	1	7	M24×65 M20×60 [d]
110	70	140	80,5	269	M120×3	265	–	125	407	115	152	220 190 [d]	74	1	6	M24×80 M20×70 [d]
120	85	160	90,5	343	M130×3	310	–	135	490	140	172	257 217 [d]	84	1	6	M24×80

[a] This value is given for reference only.

[b] Attention is drawn to the fact that, after mounting a spherical plain bearing rod end on a shaft, the angle by which the rod end can tilt may be limited by the design of adjacent components.

[c] Two screws, hexagon socket head cap, in accordance with ISO 4762 shall be used.

[d] For $d \geq 60$ mm, designs may be slotted on one side and have two screws on this one side and in most cases have smaller screws and smaller L.

Table 7 — Type B

d mm	B mm	d_k [a] mm	C_1 max. mm	d_2 max. mm	G	h_1 mm	l_3 min. mm	l_{33} max. mm	l_4 mm	l_7 mm	d_4 mm	L mm	b mm	r_s min. mm	α [b] ≈ °
20	16	29	19,2	57,5	M16×1,5	50	17	–	80	25	25	46	20	0,3	9
25	20	35,5	23,2	57,5	M16×1,5	50	17	–	80	25	25	46	21	0,6	7
30	22	40,7	28,2	66	M22×1,5	60	23	–	94	30	32	50	26	0,6	6
35	25	47	30,2	80	M28×1,5	70	–	29	112	38	40	66	28	0,6	6
40	28	53	35,2	96	M35×1,5	85	–	36	135	45	49	76	33	0,6	7
50	35	66	40,2	118	M45×1,5	105	–	45	168	55	61	90	37	0,6	6
60	44	80	50,3	132	M58×1,5	130	–	59	200	65	75	120	46	1	6
70	49	92	55,3	156	M65×1,5	150	–	66	232	75	86	130	51	1	6
80	55	105	60,3	178,5	M80×2	170	–	81	265	80	105	160	55	1	6
90	60	115	65,3	207,3	M100×2	210	–	101	323	90	124	180	60	1	5
100	70	130	70,3	232,5	M110×2	235	–	111	360	105	138	200	65	1	7
110	70	140	80,3	268	M120×3	265	–	125	407	115	152	220	74	1	6
120	85	160	90,3	341,5	M130×3	310	–	135	490	140	172	257	84	1	6

[a] This value is given for reference only.

[b] Attention is drawn to the fact that, after mounting a spherical plain bearing rod end on a shaft, the angle through which the rod end can tilt can be restricted by design of adjacent components.

Table 8 — Type C

d mm	B mm	d_k [a] mm	C_1 max. mm	d_2 max. mm	G	h_1 mm	l_3 min. mm	l_{33} max. mm	l_4 mm	l_7 mm	d_4 mm	L mm	b mm	r_s min. mm	α [b] ≈ °	Screw [c]
25	20	35,5	23	56	M18×2	65	30	–	95	29	28	48	21	0,6	7	M8×20
30	22	40,7	28	64	M24×2	75	35	–	109	34	34	56	26	0,6	6	M8×25
35	25	47	30	78	M30×2	90	–	46	132	40	45	65	28	0,6	6	M10×30
40	28	53	35	94	M39×3	105	–	56	155	44	56,5	77	33	0,6	7	M12×35
50	35	66	40	116	M50×3	135	–	76	198	55	70	88	36	0,6	6	M12×35
60	44	80	50	130	M64×3	170	–	96	240	65	87	118	46	1	6	M16×45
70	49	92	55	154	M80×3	195	–	112	277	75	110	128	51	1	6	M16×50
80	55	105	60	176	M90×3	210	–	122	305	80	128	156	55	1	6	M20×55
90	60	115	65	210	M100×3	250	–	142	365	90	152	167	60	1	5	M20×60
100	70	130	70	230	M110×4	275	–	150	400	105	170	171	65	1	7	M20×60
110	70	140	80	264	M120×4	300	–	160	442	115	180	187	75	1	6	M24×75
120	85	160	90	340	M150×4	360	–	192	540	140	210	240	85	1	6	M24×85
140	90	180	110	380	M160×4	420	–	210	620	185	230	244	105	1	7	M30×100
160	105	200	110	480	M180×4	460	–	220	710	200	260	268	105	1	8	M30×100

[a] This value is given for reference only.

[b] Attention is drawn to the fact that, after mounting a spherical plain bearing rod end on a shaft, the angle through which the rod end can tilt can be restricted by design of adjacent components.

[c] Two screws, hexagon socket head cap, in accordance with ISO 4762 shall be used.

Table 9 — Type D

d (CN) mm	F_n [a] kN	B (EN) mm	d_k [b] mm	C_1 [c] (EU) max. mm	d_2 (2EF) max. mm	G (KK)	h_1 (CH) mm	l_3 (AV) min. mm	l_{33} max. mm	l_4 mm	l_7 (LF) min. mm	d_4 (N) max. mm	L [d] max. mm	b max. mm	r_s min. mm	α [e] (Z) ≈ °	Screw [f]
12 [g]	8	12	18	11	33	M12×1,25	38	17	–	54	14	19	33	16	0,3	4	M5×16
16 [g]	12,5	16	23	14	41	M14×1,5	44	19	–	64	18	22	41	18	0,3	4	M6×16
20 [g]	20	20	29	17,5	50	M16×1,5	52	23	–	77	22	28	48	20	0,3	4	M8×20
25 [g]	32	25	35,5	22	64	M20×1,5	65	29	–	96	27	31	55	20	0,6	4	M8×20
32 [g]	50	32	44	28	80	M27×2	80	37	42	118,5	32	38	67	23,5	0,6	4	M10×25
40 [g]	80	40	53	34	100	M33×2	97	46	52,5	146	41	47	82	28	0,6	4	M10×25
50 [g]	125	50	66	42	126	M42×2	120	57	63,5	179,5	50	58	98	34	0,6	4	M12×35
63 [g]	200	63	83	53,5	145	M48×2	140	64	72	211	62	70	116	40	1	4	M16×40 M12×35 [h]
70 [i]	250	70	92	58	156	M56×2	160	76	84	245	70	80	135	42	1	4	M16×40
80 [g]	320	80	105	68	184	M64×3	180	86	92,5	270	78	91	150	50	1	4	M20×50 M16×45 [h]
90 [i]	400	90	115	73	186	M72×3	195	91	103	296	85	100	160	52	1	4	M20×55 M16×50 [h]
100 [g]	500	100	130	85,5	228	M80×3	210	96	108	322,5	98	110	180,5	65	1	4	M24×60 M20×60 [h]

[a] Load requirement in accordance with ISO 8132 shall be followed.

[b] This value is given for reference only.

[c] For nominal values as well as tolerance values, the manufacturer can be contacted.

[d] L can be equal to d_2, in special cases, e.g. when made by sheet cutting and machining.

[e] Attention is drawn to the fact that, after mounting a spherical plain bearing rod end on a shaft, the angle through which the rod end can tilt can be restricted by design of adjacent components.

[f] Two screws, hexagon socket head cap, in accordance with ISO 4762 shall be used.

[g] Dimension series W shall be in accordance with ISO 12240-1.

[h] For $d \geq 63$ mm, designs may be slotted on one side and have two screws on one side and in most cases have smaller screws.

[i] These bearings are not defined in ISO 12240-1. But the tolerance values and radial internal clearance values of dimension series W can be applied in these bearings.

Table 9 *(continued)*

d *(CN)* mm	F_n [a] kN	B *(EN)* mm	d_k [b] mm	C_1 [c] *(EU)* max. mm	d_2 *(2EF)* max. mm	G *(KK)*	h_1 *(CH)* mm	l_3 *(AV)* min. mm	l_{33} max. mm	l_4 mm	l_7 *(LF)* min. mm	d_4 *(N)* max. mm	L [d] max. mm	b max. mm	r_s min. mm	α [e] *(Z)* ≈ °	Screw [f]
110 [i]	635	110	140	88	236,5	M90×3	235	106	118	364	105	125	190	65	1	4	M24×60 M20×60[h]
125 [g]	800	125	160	105	320	M100×3	260	113	125	405	120	135	202	75	1	4	M24×70 M20×70[h]
160 [g]	1 250	160	200	133	400	M125×4	310	126	138	488	150	165	252	85	1	4	M24×80
200 [g]	2 000	200	250	165	500	M160×4	390	161	173	620	195	215	323	106	1,1	4	M30×100
250 [g]	3 200	250	350	200	640	M200×4	530	205	217	847	265	300	420	142	1,1	4	M36×140
320 [g]	5 000	320	450	265	750	M250×6	640	260	272	1 015	325	360	520	170	1,1	4	M36×160

[a] Load requirement in accordance with ISO 8132 shall be followed.

[b] This value is given for reference only.

[c] For nominal values as well as tolerance values, the manufacturer can be contacted.

[d] L can be equal to d_2, in special cases, e.g. when made by sheet cutting and machining.

[e] Attention is drawn to the fact that, after mounting a spherical plain bearing rod end on a shaft, the angle through which the rod end can tilt can be restricted by design of adjacent components.

[f] Two screws, hexagon socket head cap, in accordance with ISO 4762 shall be used.

[g] Dimension series W shall be in accordance with ISO 12240-1.

[h] For $d \geq 63$ mm, designs may be slotted on one side and have two screws on one side and in most cases have smaller screws.

[i] These bearings are not defined in ISO 12240-1. But the tolerance values and radial internal clearance values of dimension series W can be applied in these bearings.

Table 10 — Type E

d (CN) mm	F_n [a] kN	B (EN) mm	d_k [b] mm	C_1 [c] (EU) max. mm	d_2 (2EF) max. mm	G (KK)	h_1 (CH) mm	l_3 (AV) min. mm	l_{33} max. mm	l_4 mm	l_7 (LF) min. mm	d_4 (N) max. mm	L [d] max. mm	b max. mm	r_s min. mm	α [e] (Z) ≈ °	Screw [f]
12	8	10	18	8,5	36	M10×1,25	42	15	–	59,5	16	19	36	13	0,3	10	M6×12
16	12,5	14	25	11,5	46	M12×1,25	48	17	–	70,5	20	22	45	13	0,3	10	M6×12
20	20	16	29	13,5	56	M14×1,5	58	19	–	85,5	25	28	55	17	0,3	9	M8×16
25	32	20	35,5	18	66	M16×1,5	68	23	–	100,5	30	31	63	17	0,6	7	M8×16
30	50	22	40,7	20	82	M20×1,5	85	29	–	125	35	37	80	19	0,6	6	M10×20
40	80	28	53	24	102	M27×2	105	37	46	155	45	47	90	23	0,6	7	M10×25
50	125	35	66	31	122	M33×2	130	46	54	190	58	57	105	30	0,6	6	M12×30
60	200	44	80	39	160	M42×2	150	57	65	230	68	69	134	38	1	6	M16×35
80	320	55	105	48	205	M48×2	185	64	75	287,5	92	91	156	47	1	6	M20×45
100	500	70	130	57	240	M64×3	240	86	102	360	116	110	191	57	1	7	M24×55

[a] Load requirement in accordance with ISO 8133 shall be followed.

[b] This value is given for reference only.

[c] For nominal values as well as tolerance values, the manufacturer can be contacted.

[d] L can be equal to d_2, in special cases, e.g. when made by sheet cutting and machining.

[e] Attention is drawn to the fact that, after mounting a spherical plain bearing rod end on a shaft, the angle through which the rod end can tilt can be restricted. by design of adjacent components.

[f] Two screws, hexagon socket head cap, in accordance with ISO 4762 shall be used.

7 Technical requirements

7.1 Material and heat treatment

7.1.1 Inner ring and outer ring

The inner and outer rings of the (steel/steel) bearings are generally made of high quality, hardened bearing steel. The minimum hardness of such bearing rings shall be 54 HRC.

7.1.2 Rod end housing

7.1.2.1 General

The materials given in 7.1.2.2 to 7.1.2.4 should be used.

7.1.2.2 Welded type rod end housing

Welded type rod end housing is generally made of high strength low alloy structural steel, such as steel name (grade) S355B in ISO 630-2.

NOTE Other similar material or material with higher strength can be used.

7.1.2.3 Threaded type rod end housing

Threaded type rod end housing is generally made of high quality, carbon structural steel. The microstructure of the forged rod end housing shall be pearlite and ferrite.

Threaded type rod end housing (d > 50 mm) may also be made of spheroidal graphite cast iron, such as material designation “ISO 1083/JS/450-10/S” in ISO 1083, but the chemical composition is agreed between the manufacturer and the user, and the elongation should be not less than 15 %. The tensile strength and other mechanical properties should be in accordance with ISO 1083. The microstructure of cast iron shall be agreed between the manufacturer and the user.

NOTE Other similar material or material with higher strength can be used.

7.1.2.4 Rod end housings forged

Rod end housings forged are generally unnecessary for heat treatment. It can be quenching and tempering when required.

NOTE Other similar material or material with higher strength can be used.

7.1.3 Hexagon socket head cap screws

Comprising a suitable thread locking device hexagon socket head cap screws shall have at least property class 10.9 in ISO 4762.

7.2 Tolerances

7.2.1 Rod end inner ring

Dimensional tolerances (Δ_{dmp}, Δ_{Bs}, V_{dsp}, V_{dmp}) shall be in accordance with ISO 12240-1:1998, Table 7 for dimension series E, and ISO 12240-1:1998, Table 8 for dimension series W.

NOTE In ISO 12240-1:1998 the outdated symbol V_{dp} is used which has now been replaced with V_{dsp}.

For type D and series W and bearings listed in Table 5 with bearing series corresponding to W, dimensional tolerances shall be in accordance with ISO 12240-1:1998 Table 7 and 8 respectively.

7.2.2 Deviation of centre height Δ_{h1s} and Δ_{h2s}

Tolerance values shall be in accordance with Table 11 except for Types C, D and E.

For Type C, tolerance values shall be in accordance with tolerance class h13 as specified in ISO 286-2.

For Type D, tolerance values shall be in accordance with tolerance class js13 as specified in ISO 286-2, see Table 12.

For Type E, tolerance values shall be in accordance with tolerance class js13 as specified in ISO 286-2, see Table 13.

Table 11 — Deviation limits of centre height except Types C, D and E

Dimensions and deviation limits in millimetres

d		Δ_{h1s} and Δ_{h2s}	
>	≤	U	L
6	20	+0,8	-1,2
20	30	+1,0	-1,7
30	45	+1,4	-2,1
45	60	+1,8	-2,7
60	80	+2,25	-3,4
80	125	+2,7	-3,4

Key

U = upper deviation limit

L = lower deviation limit

Table 12 — Deviation limits of centre height — Threaded type bearings — Type D

Dimensions and deviation limits in millimetres

d		Δ_{h1s}	
>	≤	U	L
-	18	+0,20 [a]	-0,20 [a]
18	32	+0,23	-0,23
32	50	+0,27	-0,27
50	80	+0,32 [a]	-0,32 [a]
80	120	+0,36	-0,36
120	180	+0,41 [a]	-0,41 [a]
180	200	+0,45 [a]	-0,45 [a]
200	250	+0,55	-0,55
250	320	+0,63 [a]	-0,63 [a]

Key

U = upper deviation limit

L = lower deviation limit

[a] Values from ISO 286-2 are rounded up to two significant digits.

Table 13 — Deviation limits of centre height — Threaded type bearings — Type E

Dimensions and deviation limits in millimetres

d		Δ_{h1s}	
>	≤	U	L
-	18	+0,20 [a]	-0,20 [a]
18	25	+0,23	-0,23
25	40	+0,27	-0,27
40	60	+0,32 [a]	-0,32 [a]
60	100	+0,36	-0,36

Key

U = upper deviation limit

L = lower deviation limit

[a] Values from ISO 286-2 are rounded up to two significant digits.

7.2.3 Tolerance class for thread

The thread shall be in accordance with tolerances class 6H specified in ISO 965-1.

7.3 Radial internal clearances

For rod ends with bearings in dimension series E, see Table 14.

For rod ends with bearings in dimension series W, see Table 15.

Table 14 — Radial internal clearances — Dimension series E

Clearance values in micrometres

d mm		Radial internal clearances					
		Group 2		Group N		Group 3	
>	≤	min.	max.	min.	max.	min.	max.
–	12	4	32	16	68	34	104
12	20	5	40	20	82	41	124
20	35	6	50	25	100	50	150
35	60	8	60	30	120	60	180
60	90	9	72	36	142	71	212
90	140	9	85	43	165	83	245
140	200	9	100	50	192	96	284

Table 15 — Radial internal clearances — Dimension series W

Clearance values in micrometres

d mm		Radial internal clearances					
		Group 2		Group N		Group 3	
>	≤	min.	max.	min.	max.	min.	max.
–	12	4	32	16	68	34	104
12	20	5	40	20	82	41	124
20	32	6	50	25	100	50	150
32	50	8	60	30	120	60	180
50	90	9	72	36	142	71	212

Table 15 *(continued)*

d mm		Radial internal clearances					
		Group 2		Group N		Group 3	
>	≤	min.	max.	min.	max.	min.	max.
90	125	9	85	43	165	83	245
125	200	9	100	50	192	96	284
200	250	9	125	63	239	120	353
250	320	9	135	68	261	130	387

7.4 Surface roughness

For values of surface roughness, see Table 16. For definitions of surfaces, see ISO 6811 and Annex D.

Table 16 — Surface roughness

Bearing nominal diameter [a] mm		*Ra* max. µm				
>	≤	Sliding contact surface	Face	Thread surface	Rod end eye bore surface	Other surfaces
–	80	0,8	1,6	3,2	3,2	6,3
80	–	1,6				

[a] Refers to the corresponding bearing bore or outside diameter. For inner ring, bore diameter applies; for outer ring, outside diameter applies.

7.5 Surface treatments

The inner and outer ring surfaces of (steel/steel) bearings shall generally be phosphated (e.g. ISO 9717); the sliding contact surface is treated with molybdenum disulphide (MoS_2) or other lubricant.

Except for shot blasting, the surfaces of the rod end housing are generally not surface-treated. If there are other requirements, consult with manufacturers.

7.6 Rotation and oscillation flexibility

Hold the inner ring stationary, then rotate and oscillate the rod end housing. It shall not be stuck in any direction.

7.7 Load ratings and life

The life of spherical plain bearing rod ends is influenced by many factors. ISO 20015 specifies the method for the calculation of static and dynamic load ratings for spherical plain bearings, however, rod ends are explicitly excluded. As there is no standardized method for determining the load ratings and rating life of spherical plain bearing rod ends for hydraulic cylinders, the manufacturers should be consulted for the methods of calculation.

Annex A
(informative)

Symbols/identification codes

Figure A.1 shows an application example of symbols/identification codes according to this document and ISO 6099, indicated on rod eye spherical, internal thread. The cross reference to symbols of this document can be found in Table 1.

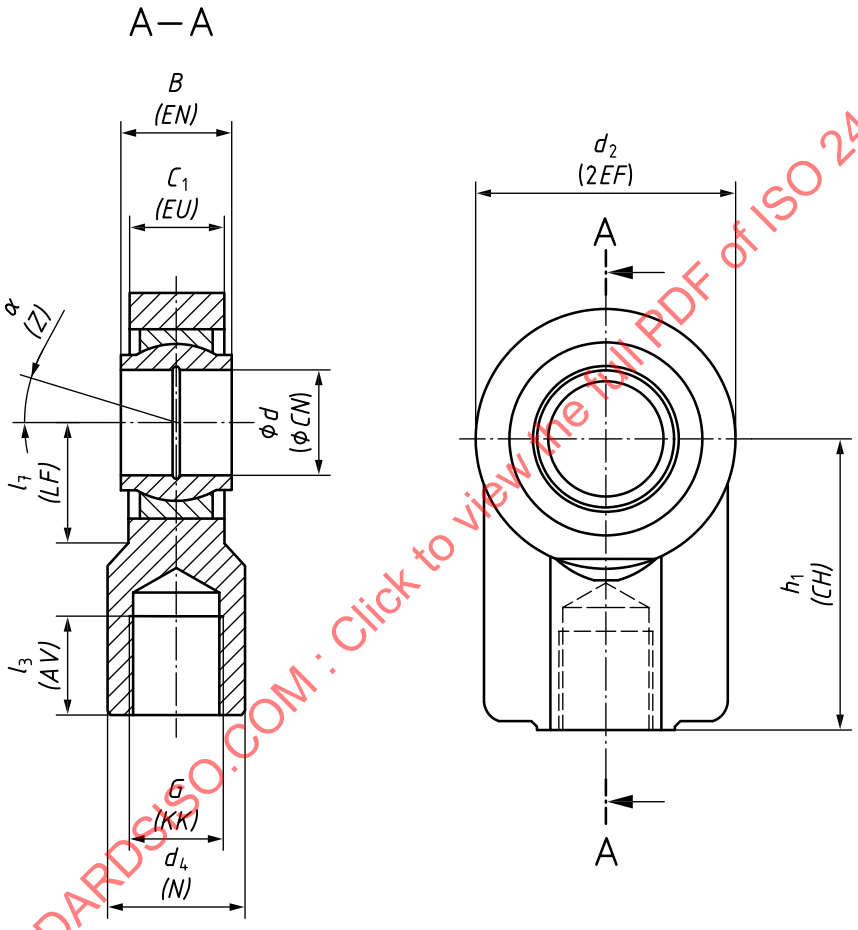


Figure A.1 — Application example of symbols/identification codes according to this document and according to ISO 6099 in brackets

EXAMPLE For inner ring width

B in this document

(EN) in ISO 6099

Annex B
(informative)

Fixation by retaining rings

B.1 General

Manufacturers can use any solutions to keep the bearing well positioned in the rod end housing. As no relevant International Standard exists, in this annex examples with retaining rings and retaining ring grooves are described. Retaining rings with corresponding retaining grooves are a preferred option for fixation.

The retaining rings and retaining ring grooves specified in this annex only can be applied to rod end bearings for hydraulic cylinders of d_0 = 22 mm to 520 mm.

B.2 Symbols

The symbols are shown in Table B.1

The symbols in the Figures B.1 to B.4 and the values given in Tables B.3 and B.4 denote nominal dimensions unless otherwise specified.

Table B.1 — Symbols

Dimensions in millimetres

Symbol	Description
a	Width of clamp ear ring
D	Outer diameter of retaining ring
d_0	Bore diameter of rod end eye
d_{10}	Diameter of clamp hole
d_{11}	Diameter of retaining ring groove
g	Gap distance of retaining ring without clamp holes
m	Width of retaining ring groove
n	Width of retaining ring
R	Radius of clamp holes centre position
S	Thickness of retaining ring
t	Deviation of retaining ring centre

B.3 Designs

B.3.1 Retaining rings

B.3.1.1 General

The type of retaining ring is selected depending on the bore diameter of the rod end eye, d_0, shown in Figure B.4; see Table B.2.

Table B.2 — Type of retaining rings

d_0 mm		Type of retaining ring	Figure
≥	<		
-	62	Without clamp holes	B.1
62	200	With clamp holes	B.2
200	-	With clamp holes	B.3

B.3.1.2 Retaining ring without clamp holes

See Figure B.1.

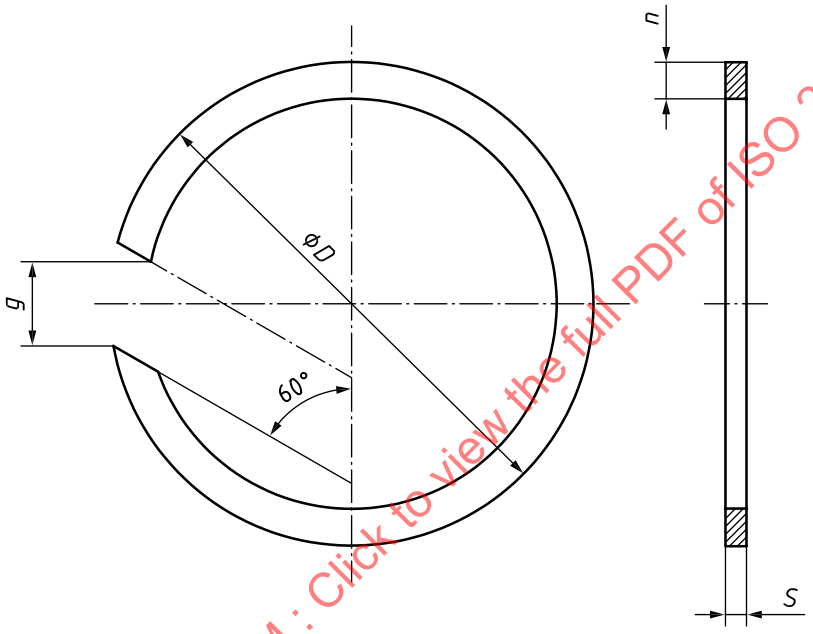


Figure B.1 — Retaining ring without clamp holes

B.3.1.3 Retaining ring with clamp holes

Depending on the size, two different designs are in use, see Figure B.2 and Figure B.3.

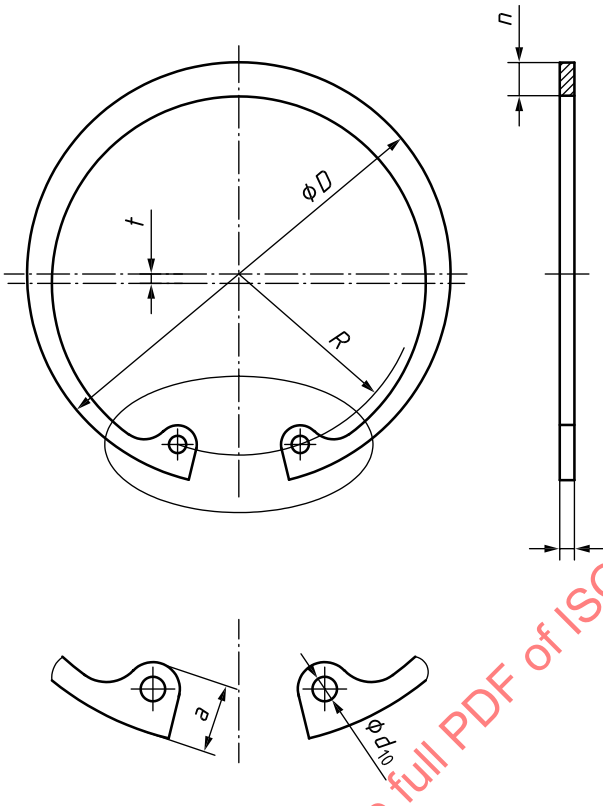


Figure B.2 — Retaining ring with clamp holes $d_0 \leq 200$ mm

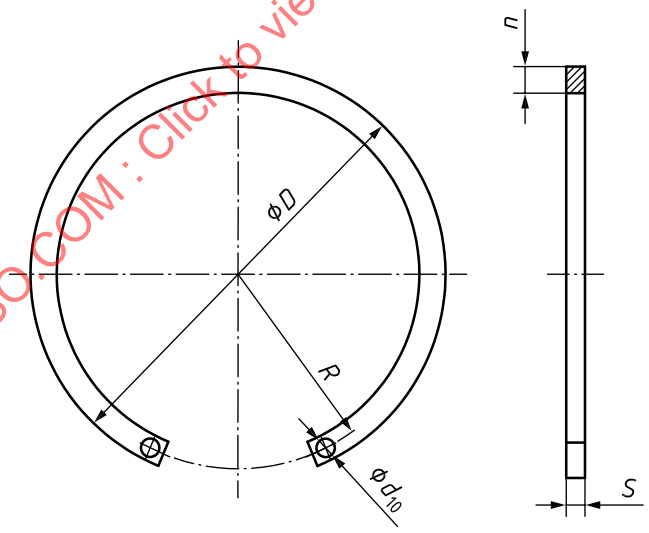


Figure B.3 — Retaining ring with clamp holes $d_0 > 200$ mm

B.3.2 Retaining ring grooves

See Figure B.4.

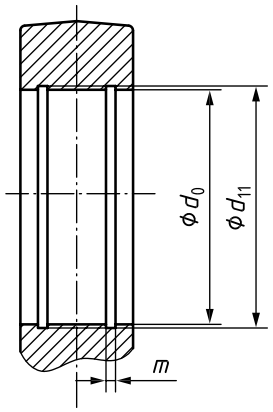


Figure B.4 — Retaining ring groove

B.4 Dimensions

The dimensions of retaining rings and retaining ring groove are given in Table B.3 and Table B.4.

Table B.3 — Dimensions of retaining ring without clamp holes and retaining ring groove

Dimensions in millimetres

d_0	Retaining ring				Retaining ring groove	
	D	S	g	n max.	d_{11}	m
22	23	1,2	4	1,75	23	1,3
26	27,2	1,2	5	1,75	27	1,3
28	29,2	1,2	6	1,75	28,8	1,3
35	36,4	1,5	7	2,3	36	1,6
42	43,8	1,5	8	2,3	43,2	1,6
47	48,8	1,5	9	2,3	48,2	1,6
52	54,3	1,5	10	2,3	53,5	1,6
55	57,3	1,5	11	2,3	56,5	1,6

Table B.4 — Dimensions of retaining ring with clamp holes and retaining ring groove

Dimensions in millimetres

d_0	Retaining ring							Retaining ring groove	
	D	S	a max.	R	t	d_{10}	n	d_{11}	m
62	66,2	2,1	7,35	29,3	1,3	3	5,2[a]	65	2,15
68	72,5	2,5	7,8	32	1,4	3	5,7[a]	71	2,65
75	79,5	2,5	6,8	36,8	1,6	3	6,3[a]	78	2,65
90	95,5	3	8,6	42,7	1,8	3	7,3[a]	93,5	3,15
95	100,5	3	9,7	45,2	1,9	3	7,7[a]	98,5	3,15
105	112	4	11,25	50,4	2,0	4	8,1[a]	109	4,15
120	127	4	11,45	57,8	2,3	4	9,3[a]	124	4,15
130	137	4	11,45	62,8	2,7	4	10,7[a]	134	4,15

[a] For retaining rings according to Figure B.2, n is not constant.