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Rolling bearings — Instrument precision bearings —

Part 1: Boundary dimensions, tolerances and characteristics of metric series bearings

Roulements — Roulements de précision pour instruments —

Partie 1: Dimensions d'encombrement, tolérances et caractéristiques, séries métriques

Reference number
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Contents

Page

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 1224-1 was prepared by Technical Committee ISO/TC 4, *Rolling bearings*.

This first edition of ISO 1224-1, together with ISO 1224-2, cancels and replaces ISO 1224:1984, which has been technically revised.

ISO 1224 consists of the following parts, under the general title *Rolling bearings — Instrument precision bearings*:

— *Part 1: Boundary dimensions, tolerances and characteristics of metric series bearings*

— *Part 2: Boundary dimensions, tolerances and characteristics of inch series bearings*

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Rolling bearings — Instrument precision bearings —

Part 1: Boundary dimensions, tolerances and characteristics of metric series bearings

1 Scope

This part of ISO 1224 specifies the characteristics that define instrument precision rolling bearings, metric series, their types, boundary dimensions, tolerances and internal clearance, classifications used for selective assembly, torque definitions and test condition, and limitations of bearing yield rates.

2 Normative references

The following referenced documents are indispensable for the application 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 15, *Rolling bearings — Radial bearings — Boundary dimensions, general plan*

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

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

ISO 5593:1997, *Rolling bearings — Vocabulary*

ISO 15241, *Rolling bearings — Symbols for quantities*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1132-1, ISO 5593 and the following apply.

3.1
perpendicularity of inner ring bore with respect to the face
⟨basically cylindrical surface⟩ total variation of the relative position, in a radial direction parallel with the plane tangential to the reference face of the inner ring, of points on the same generatrix of the bore at a distance from the side faces of the ring equal to 1,2 times the largest axial single chamfer dimension

3.2
axial runout of outer ring flange back face of assembled bearing
⟨radial groove ball bearing⟩ difference between the largest and the smallest of the axial distances between the back face of the outer ring flange, in different angular positions of this ring, at a radial distance from the outer ring axis equal to half the mean diameter of the flange back face, and a point in a fixed position relative to the inner ring

NOTE For a measurement to be valid, the inner and outer ring raceways shall be in contact with all the balls.

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3.3
torque quality
torque quality of an instrument ball bearing is a function of average and maximum torques

NOTE Maximum torque is most frequently specified for slow speed (near zero) applications and for limited arcs of travel. Where considerable rotation is involved, average torque may be the criterion.

3.4
maximum torque
maximum value of torque recorded during any test cycle

3.5
average torque
arithmetic mean value of the torque readings obtained during the test cycle

3.6
test load
specified axial load coincident with the axis of rotation of the bearing

4 Symbols

For the purposes of this document, the symbols given in ISO 15241 and the following apply.

The symbols (except those for tolerances) shown in Figure 1 and the values given in the Tables 1 to 6 denote nominal dimensions unless specified otherwise.

B inner ring width

C outer ring width

C_1 outer ring flange width

D outside diameter of bearing

D_1 outside diameter of outer ring flange

d bore diameter

K_{ea} radial runout of outer ring of assembled bearing

K_{ia} radial runout of inner ring of assembled bearing

r chamfer dimension (except where r_1 is applicable)

$r_{s\,min}$ smallest single chamfer dimension of r

$r_{s\,max}$ largest single chamfer dimension of r

r_1 chamfer dimension of front face of angular contact ball bearing inner and outer rings

$r_{1s\,min}$ smallest single chamfer dimension of r_1

S_D perpendicularity of outer ring outside surface with respect to the face[1)]

S_d perpendicularity of inner ring face with respect to the bore[1)]

S_{dr} perpendicularity of inner ring bore with respect to the face[1)]

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S_{ea} axial runout of outer ring of assembled bearing[1)]

S_{ea1} axial runout of outer ring flange back face of assembled bearing[1)]

S_{ia} axial runout of inner ring of assembled bearing[1)]

V_{Bs} variation of inner ring width

V_{Cs} variation of outer ring width

V_{C1s} variation of outer ring flange width

V_{Dmp} variation of mean outside diameter

V_{Dsp} variation of outside diameter in a single plane

V_{dmp} variation of mean bore diameter

V_{dsp} variation of bore diameter in a single plane

Δ_{Bs} deviation of a single inner ring width

Δ_{Cs} deviation of a single outer ring width

Δ_{C1s} deviation of a single outer ring flange width

Δ_{Dmp} deviation of mean outside diameter in a single plane

Δ_{Ds} deviation of a single outside diameter

Δ_{D1s} deviation of a single outside diameter of outer-ring flange

Δ_{dmp} deviation of mean bore diameter in a single plane

Δ_{ds} deviation of a single bore diameter

1) For angular contact ball bearings, the back face is the reference face.

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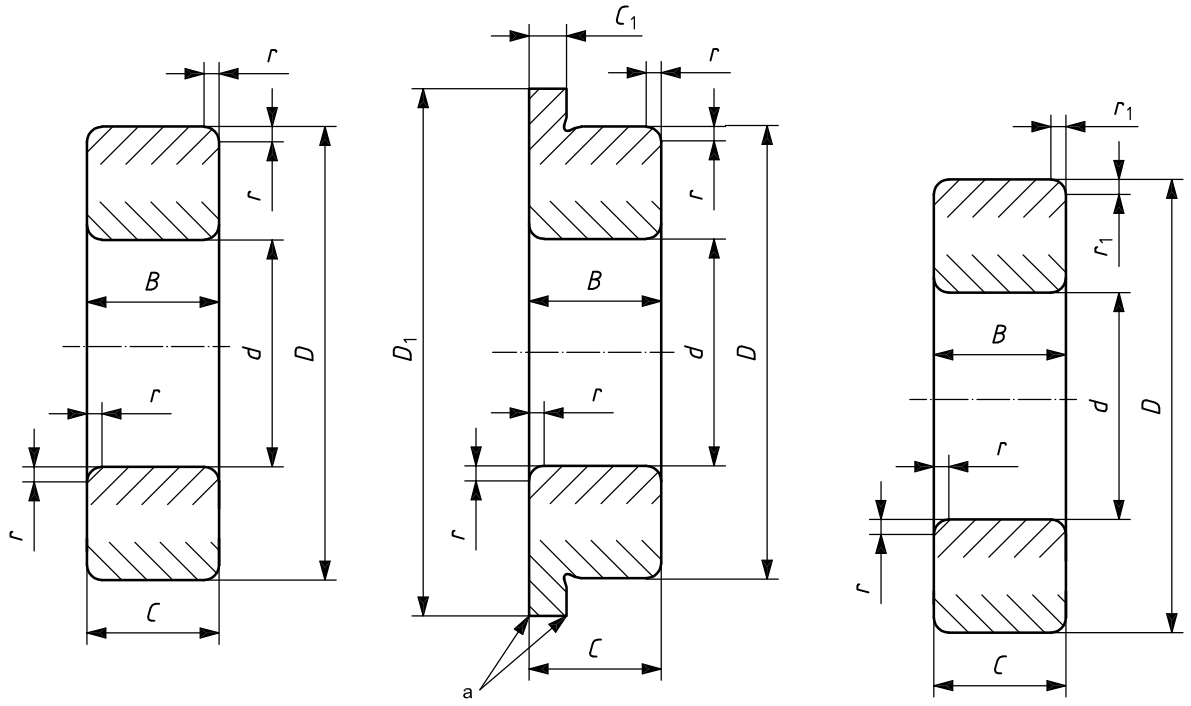

a) Single-row deep groove ball bearings **b) Angular contact ball bearings**

a Broken corner.

Figure 1 — Instrument precision bearing

5 Characteristics

Satisfactory performance of instrument precision bearings necessitates that they be produced to special tolerances, as given in Clause 8. In addition, these bearings shall be particularly free from foreign matter and meet one or more specific requirements in the following categories:

a) low or uniform torque or both, either at starting or in rotation (this requirement does not apply to bearings with seals);

b) smooth running or vibration limitations;

c) limitations of bearing yield rates.

Due to the many specialized requirements that exist in instrument applications, specification of these categories should be established only after full agreement between the manufacturer and the customer.

6 Bearing types

Single-row deep groove ball bearings meet the majority of the requirements and may be open or capped, with or without a flanged outer ring. However, for specific applications, angular contact ball bearings, non-separable or with separable inner ring, may be required.

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7 Boundary dimensions

Boundary dimensions for metric series instrument precision bearings are given in Table 1.

Table 1 — Metric series bearings

Dimensions in millimetres

d	D	B and C	$r_{s\ min}$[a]	$r_{1s\ min}$[a]	Flanged bearings		Applicable types of bearing	Dimension series[b]
					D_1	C_1		
0,6	2	0,8	0,05	0,05	—	—	open	17
1	2,5	1	0,05	0,05	—	—	open	17
1	3	1	0,05	0,05	3,8	0,3	open	18
1	3	1,5	0,05	0,05	3,8	0,45	capped	38
1	4	1,6	0,1	0,05	5	0,5	open	19
1	4	2,3	0,1	0,05	5	0,6	capped	39
1,5	3	1	0,05	0,05	—	—	open	17
1,5	4	1,2	0,05	0,05	5	0,4	open	18
1,5	4	2	0,05	0,05	5	0,6	capped	38
1,5	5	2	0,15	0,08	6,5	0,6	open	19
1,5	5	2,6	0,15	0,08	6,5	0,8	capped	39
2	4	1,2	0,05	0,05	—	—	open	17
2	5	1,5	0,08	0,05	6,1	0,5	open	18
2	5	2,3	0,08	0,05	6,1	0,6	capped	38
2	6	2,3	0,15	0,08	7,5	0,6	open, capped	19
2	6	3	0,15	0,08	7,5	0,8	capped	39
2,5	5	1,5	0,08	0,05	—	—	open	17
2,5	6	1,8	0,08	0,05	7,1	0,5	open	18
2,5	6	2,6	0,08	0,05	7,1	0,8	capped	38
2,5	7	2,5	0,15	0,08	8,5	0,7	open, capped	19
2,5	7	3,5	0,15	0,08	8,5	0,9	capped	39
3	6	2	0,08	0,05	—	—	open	17
3	7	2	0,1	0,05	8,1	0,5	open	18
3	7	3	0,1	0,05	8,1	0,8	capped	38
3	8	3	0,15	0,08	9,5	0,7	open, capped	19
3	8	4	0,15	0,08	9,5	0,9	capped	39
3	10	4	0,15	0,08	11,5	1	open, capped	02
4	7	2	0,08	0,05	—	—	open	17
4	9	2,5	0,1	0,05	10,3	0,6	open	18
4	9	4	0,1	0,05	10,3	1	capped	38
4	11	4	0,15	0,08	12,5	1	open, capped	19
4	13	5	0,2	0,1	15	1	open, capped	0,2

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Table 1 (*continued*)

Dimensions in millimetres

d	D	B and C	$r_{s\ min}$[a]	$r_{1s\ min}$[a]	Flanged bearings		Applicable types of bearing	Dimension series[b]
4	16	5	0,3	0,15	—	—	open, capped	03
5	8	2	0,08	0,05	—	—	open	17
5	11	3	0,15	0,08	12,5	0,8	open	18
5	11	5	0,15	0,08	12,5	1	capped	38
5	13	4	0,2	0,1	15	1	open, capped	19
5	16	5	0,3	0,15	18	1	open, capped	02
5	19	6	0,3	0,15	22	1,5	open, capped	03
6	10	2,5	0,1	0,05	—	—	open	17
6	13	3,5	0,15	0,08	15	1	open	18
6	13	5	0,15	0,08	15	1,1	capped	28
6	15	5	0,2	0,1	17	1,2	open, capped	19
6	19	6	0,3	0,15	22	1,5	open, capped	02
7	11	2,5	0,1	0,05	—	—	open	17
7	14	3,5	0,15	0,08	16	1	open	18
7	14	5	0,15	0,08	16	1,1	capped	28
7	17	5	0,3	0,15	19	1,2	open, capped	19
7	19	6	0,3	0,15	22	1,5	open, capped	10
7	22	7	0,3	0,15	—	—	open, capped	02
8	12	2,5	0,1	0,05	—	—	open	17
8	16	4	0,2	0,1	18	1	open	18
8	16	6	0,2	0,1	18	1,3	capped	38
8	19	6	0,3	0,15	22	1,5	open, capped	19
8	22	7	0,3	0,15	—	—	open, capped	10
8	24	8	0,3	0,15	—	—	open	02
9	14	3	0,1	0,05	—	—	open	17
9	17	4	0,2	0,1	19	1	open	18
9	17	6	0,2	0,1	19	1,3	capped	38
9	20	6	0,3	0,15	—	—	open, capped	19
9	24	7	0,3	0,15	—	—	open, capped	10
9	26	8	0,3	0,15	—	—	open, capped	02
10	15	3	0,1	0,05	—	—	open	17
10	19	5	0,3	0,15	21	1	open	18
10	19	7	0,3	0,15	21	1,5	capped	38
10	22	6	0,3	0,15	—	—	open, capped	19
10	26	8	0,3	0,15	—	—	open, capped	10
10	30	9	0,6	0,3	—	—	open, capped	02

[a] Maximum chamfer dimensions are given in ISO 582.

[b] Dimension series quoted are those given in ISO 15 for bearings without flange.

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8 Tolerances

8.1 Tolerance class 5A

See Tables 2 and 3.

Table 2 — Inner ring

Tolerances values in micrometres

d mm		Δ_{dmp}		Δ_{ds}		V_{dsp}	V_{dmp}	Δ_{Bs}[b]		V_{Bs}	K_{ia}	S_{dr}[c]	S_{ia}
>	⩽	high	low	high	low	max.	max.	high	low	max.	max.	max.	max.
0,6 [a]	10	0	−5	0	−5	3	3	0	−25	5	3,5	7	7

[a] This diameter is included in the group.

[b] The tolerance for the total width of the inner rings of a matched pair or a matched stack is 0 to − 200 µm times the number of bearings in the mounting.

[c] Perpendicularity of inner ring face with respect to the bore (S_d) is

$$S_d = S_{dr} \times d_1 / 2\left(B - 2{,}4 r_{s\,max}\right)$$

where S_{dr} is obtained from Table 2 and d_1 is the mean diameter of inner ring face.

Table 3 — Outer ring

Tolerances values in micrometres

D mm		Δ_{Dmp}		Δ_{Ds}				V_{Dsp} and V_{Dmp}		Δ_{Cs}[b]		V_{Cs}	K_{ea}	S_D	S_{ea}	S_{ea1}	Δ_{C1s}		V_{C1s}	Δ_{D1s}	
				open		capped		open	capped												
>	⩽	high	low	high	low	high	low	max.	max.	high	low	max.	max.	max.	max.	max.	high	low	max.	high	low
2 [a]	18	0	−5	0	−5	+1	−6	3	5	0	−25	5	5	8	8	10	0	−50	5	0	−25
18	30	0	−6	0	−6	+1	−7	3	5	0	−25	5	6	8	8	10	0	−50	5	0	−25

[a] This diameter is included in the group.

[b] The tolerance for the total width of the outer rings of a matched pair or a matched stack is 0 to – 200 µm times the number of bearings in the mounting.

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8.2 Tolerance class 4A

See Tables 4 and 5.

Table 4 — Inner ring

Tolerances values in micrometres

d mm		Δ_{dmp}		Δ_{ds}		V_{dsp}	V_{dmp}	Δ_{Bs} [b]		V_{Bs}	K_{ia}	S_{dr} [c]	S_{ia}
>	⩽	high	low	high	low	max.	max.	high	low	max.	max.	max.	max.
0,6 [a]	10	0	−5	0	−5	2,5	2,5	0	−25	2,5	2,5	3	3

[a] This diameter is included in the group.

[b] The tolerance for the total width of the inner rings of a matched pair or a matched stack is 0 to − 200 µm times the number of bearings in the mounting.

[c] Perpendicularity of inner ring face with respect to the bore (S_d) is

$$S_d = S_{dr} \times d_1 / 2\left(B - 2{,}4 r_{s\,max}\right)$$

where S_{dr} is obtained from Table 4 and d_1 is the mean diameter of inner ring face.

Table 5 — Outer ring

Tolerances values in micrometres

D mm		Δ_{Dmp}		Δ_{Ds}				V_{Dsp} and V_{Dmp}		Δ_{Cs} [b]		V_{Cs}	K_{ea}	S_D	S_{ea}	S_{ea1}	Δ_{C1s}		V_{C1s}	Δ_{D1s}	
				open		capped		open	capped												
>	⩽	high	low	high	low	high	low	max.	max.	high	low	max.	max.	max.	max.	max.	high	low	max.	high	low
2 [a]	18	0	−5	0	−5	+1	−6	2,5	5	0	−25	2,5	3,5	4	5	8	0	−50	2,5	0	−25
18	30	0	−5	0	−5	+1	−6	2,5	5	0	−25	2,5	4	4	5	8	0	−50	2,5	0	−25

[a] This diameter is included in the group.

[b] The tolerance for the total width of the outer rings of a matched pair or a matched stack is 0 to − 200 µm times the number of bearings in the mounting.

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9 Radial internal clearance

The radial internal clearance of single-row radial contact groove ball bearings is given in Table 6.

Table 6 — Radial internal clearance of single-row radial contact groove ball bearings

Clearance values in micrometres

d mm		Group 2		Group N		Group 3	
>	⩽	min.	max.	min.	max.	min.	max.
0,6[a]	10	0	6	4	11	10	20

[a] This diameter is included in the group.

10 Bore and outside diameter classification

When required for selective assembly to shafts or housings, instrument precision rolling bearings may be classified into specific size groupings in accordance with the following provisions.

a) method for size determination:

— outside diameter: the largest diameter measured;

— bore diameter: the smallest diameter measured.

b) two equal range groups for each basic diameter, unless agreed otherwise.

c) due to difficulties in gauge correlation between the manufacturer and the customer, the classifications shall be considered only as guides for selective assembly and not as absolute size segregations in borderline cases.

d) unless special arrangement is made with the manufacturer, random and not specific quantities of size groupings shall be supplied.

11 Torque test conditions

11.1 General

Torque of ball bearings may be specified as “running torque” or “starting torque” as defined in ISO 5593:1997, 06.01.02 and 06.01.01, respectively.

The standard unit of torque is the micronewton metre. Convenient multiples thereof may be also used.

The axis position of the bearing should be vertical unless specified otherwise.

11.2 Test conditions

11.2.1 Ambient conditions

Testing should be carried out in a controlled atmosphere, in clean surroundings and on a vibration-free base. Temperature range should be from 20 °C to 25 °C and relative humidity should be maintained below 55 %.

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11.2.2 Pre-test condition of bearings

Before testing, bearing should be demagnetized and cleaned thoroughly with suitably filtered, clean mineral solvent. Bearings should be lubricated with the specified quantity and quality of lubricant. Bearings should be rotated slowly to distribute the lubricant.

11.2.3 Test load

The axial load (see 3.6) should be as follows:

— for bearings having an outside diameter less than or equal to 8 mm: 0,75 N;

— for bearings having an outside diameter over 8 mm: 1,5 N or 4 N as agreed.

11.2.4 Extent of testing

Tests should be conducted in such a manner as to ensure compliance within specified torque limits in both directions of rotation and in both directions of loading on single-row, non-filling slot bearings. For angular contact ball bearings and others that support axial loading in one direction only, torque specifications should apply only under the normal direction of loading.

11.2.4.1 Running torque

The test should be conducted with at least 720° of rotation of the specified rotating ring of the bearing.

11.2.4.2 Starting torque

The test should be conducted with a specified minimum number of starts, each start to be defined with a specified minimum arc of travel.

11.2.4.3 Retest provisions

Bearings that fail to pass the specified test should be demagnetized, cleaned, lubricated and retested. Bearing failing the second test should again be demagnetized, cleaned, lubricated and retested. All bearings failing to pass the third test should be considered as failing the test.

11.3 Correlation of test results on different types of test equipment

Since the average torque values (see 3.5) and maximum torque values (see 3.4) of any two rolling bearings are never exactly identical and, furthermore, since different types of test equipment exhibit different degrees of extent and exaggeration of peak torque values, correlation of measurement between different types of test equipment can prove difficult to resolve. The specification of torque values should, therefore, be agreed between the manufacturer and the customer on the basis of a particular type and design of test equipment, unless the correlation of test results on different test equipment is well established and understood.

12 Limitations of bearing yield rates

Special requirements for accurate positional control of a rotating member in relation to its support may necessitate limitations of bearing yield rates. These yield-rate limitations are governed by specialized control of bearing contact angles and/or preload.

The contact angle is established by the magnitude of the bearing radial internal clearance, internal design and applied axial preload and largely governs the magnitudes of the axial and radial yield rates. When tolerances on contact angle are specified, normal radial internal clearance standards do not apply.

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Axial preload is established by axially loading one bearing against another either by an adjustment system external to the bearings or by the use of axially preloaded matched pairs of bearings, which, when the appropriate rings are clamped together, establishes the required magnitude of axial loading within the pair. In such cases, the normal tolerances that apply to the individual ring width may be exceeded.

Due to many specialized requirements that exist in this field of application and since axial preloading and contact-angle controls affect endurance life and restraining torques, specifications should be established only after full agreement between the manufacturer and the customer.

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