INTERNATIONAL STANDARD

ISO 1132-2

First edition
2001-09-01

Rolling bearings — Tolerances —

Part 2: Measuring and gauging principles and methods

Roulements — Tolérances —

Partie 2: Principes et méthodes de mesurage et de vérification par calibre

Reference number
ISO/FDIS 1132-2:2001(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 part of ISO 1132 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 1132-2 was prepared by Technical Committee ISO/TC 4, *Rolling bearings*.

This first edition of ISO 1132-2 cancels and replaces ISO/TR 9274:1991, in the form of a technical revision thereof.

ISO 1132 consists of the following parts, under the general title *Rolling bearings — Tolerances*:

— *Part 1: Terms and definitions*

— *Part 2: Measuring and gauging principles and methods*

Annex A forms a normative part of this part of ISO 1132.

Rolling bearings — Tolerances —

Part 2:
Measuring and gauging principles and methods

1 Scope

This part of ISO 1132 establishes guidelines for measurement of dimensions, running accuracy and internal clearance of rolling bearings. The purpose is to outline the fundamentals of various measuring and gauging principles which may be used in order to clarify and comply with the definitions of ISO 1132-1 and ISO 5593.

The measuring and gauging methods described in this part of ISO 1132 may differ amongst themselves and do not provide for a unique interpretation. It is recognized that there are other adequate measuring and gauging methods and that technical development may result in even more convenient methods. Therefore, this part of ISO 1132 does not imply any obligation to apply any particular method. However, the methods specified may be referred to in cases of dispute.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 1132. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 1132 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1:1975, *Standard reference temperature for industrial length measurements*.

ISO 76:1987, *Rolling bearings — Static load ratings.*

ISO 104:—[1)], *Rolling bearings — Thrust bearings — Boundary dimensions, general plan*.

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*.

ISO 1132-1:2000, *Rolling bearings — Tolerances — Part 1: Terms and definitions*.

ISO 3030:1996, *Rolling bearings — Radial needle roller and cage assemblies — Dimensions and tolerances*.

ISO 3031:2000, *Rolling bearings — Thrust needle roller and cage assemblies, thrust washers — Boundary dimensions and tolerances*.

ISO 3245:1997, *Rolling bearings — Needle roller bearings, drawn cup without inner rings — Boundary dimensions and tolerances.*

---

1) To be published. (Revision of ISO 104:1994)

ISO 4291:1985, *Methods for the assessment of departure from roundness — Measurement of variations in radius*.

ISO 5593:1997, *Rolling bearings — Vocabulary*.

ISO 15241:2001, *Rolling bearings — Symbols for quantities*.

3 Terms and definitions

For the purpose of this part of ISO 1132, the terms and definitions given in ISO 1132-1 and ISO 5593 apply. The following additional terms and definitions are used throughout this part of ISO 1132. An index of methods with their respective symbols, as specified in ISO 1132-1, is included in annex A.

3.1
measurement
set of operations having the object of determining the dimension(s) or variation of a feature

3.2
gauge
device of defined geometric form and size used to assess the conformance of a feature of a work piece to a dimensional specification.

NOTE The device could give only “GO” and/or “NOT GO” information (e.g. plug gauge).

3.3
gauging
inspection of size and/or form by means of a gauge

3.4
measuring and gauging principle
fundamental geometric basis for the measurement or gauging of the considered geometric characteristic

3.5
measuring and gauging method
practical application of a principle by the use of different types of measuring and gauging equipment and operations

3.6
measuring and gauging equipment
technical device used to perform a specific method of measuring (e.g. calibrated indicator)

3.7
measuring force
force applied by the stylus of an indicator or a recorder to the feature being measured

3.8
measuring load
external force applied to the specimen being measured in order to accomplish the measurement

4 Symbols

For the purposes of this part of ISO 1132, the symbols given in ISO 15241 and the following apply.

The symbols (except those for tolerances) shown in the figures and the values given in the tables denote nominal dimensions unless specified otherwise. Additionally, the drawing symbols given in Table 1 are applied throughout this part of ISO 1132.

Table 1 — Drawing symbols

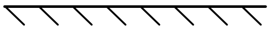
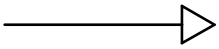
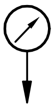
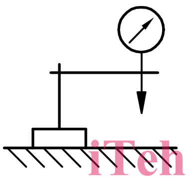
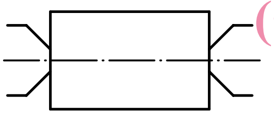
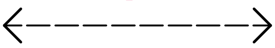
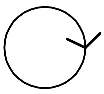
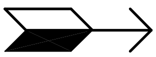
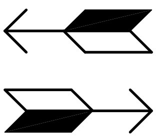
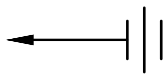
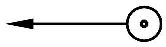
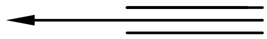
Symbol	Interpretation
	Surface plate (measuring plane)
 (Front view)  (Top view)	Fixed support
	Fixed gauge support
 (Front view)  (Top view)	Indicator or recorder
	Measuring stand with indicator or recorder Symbols for measuring stands can be drawn in different ways in accordance with the measuring equipment used.
	Centred arbor
	Intermittent linear traverse
	Turning against fixed support(s)
	Rotation about centre
	Loading, direction of loading
	Loading alternately in opposite directions

Table 1 — Drawing symbols *(continued)*

Symbol	Interpretation
 (Front view)  (Top view)	Movable support for indicator moving perpendicular to the measured surface
	Movable support for indicator moving parallel to (along) the measured surface

5 General conditions

5.1 Measuring equipment

Measurements of the various dimensions, runouts and clearances can be performed on different types of measuring equipment and with differing degrees of accuracy. The principles described are commonly used by bearing manufacturers and users and generally they provide an accuracy sufficient for practical purposes. It is recommended that the total measuring inaccuracy should not exceed 10 % of the actual tolerance zone. However, the measuring and gauging methods may not always fully check the indicated requirements. Whether or not such methods are sufficient and acceptable depends on the magnitude of the actual deviations from the ideal dimension or form and the inspection circumstances.

Bearing manufacturers frequently use specially designed measuring equipment for individual components, as well as for assemblies, to increase speed and accuracy of measurement. Should the dimensional or geometrical errors appear to exceed those in the relevant specifications, when using equipment as indicated in any of the methods in this part of ISO 1132, the matter should be referred to the bearing manufacturer.

5.2 Masters and indicators

Dimensions are determined by comparing the actual component with appropriate gauge blocks or masters whose calibration is traceable through national standards organizations to the length of the international prototype as defined in ISO 1. For such comparison, a calibrated indicator of appropriate sensitivity is used.

5.3 Arbors

In all cases when the arbor method of measuring runout is used, the rotational accuracy of the arbor shall be determined so that subsequent bearing measurements may be suitably corrected for any appreciable arbor inaccuracy. A precision arbor having a taper of approximately 0,000 2:1 on diameter shall be used.

In cases when an arbor is used to measure the bore diameter of a roller complement, a precision arbor having a taper of approximately 0,000 5:1 on diameter shall be used.

5.4 Temperature

Before any measurements are made, the part to be measured, the measuring equipment and master shall be brought to the temperature of the room in which the measurements are to be made. The recommended room temperature is 20 °C, see ISO 1. Care shall be taken to avoid heat transfer to the component or assembled bearing during measurement.

5.5 Measuring force and radius of measuring stylus

To avoid undue deflection of thin rings, the measuring force shall be minimized. If significant distortion is present, a load deflection factor shall be introduced to correct the measured value to the free unloaded value. The maximum measuring force and minimum radius of the measuring stylus are given in Table 2.

Table 2 — Maximum measuring forces and minimum radii of measuring stylus

Bearing feature	Nominal size range mm		Measuring force [a] N	Stylus radius [b] mm
	>	⩽	max.	min.
Bore diameter *d*	—	10	2	0,8
	10	30	2	2,5
	30	—	2	2,5
Outside diameter *D*	—	30	2	2,5
	30	—	2	2,5

[a] The maximum measuring force is intended to give repeatable measurements without distortion of the specimen. Where distortion occurs, a lower measuring force may be used.

[b] Smaller radii may be used with an appropriate reduction in the measuring force applied.

5.6 Coaxial measuring load

To maintain bearing assemblies in their proper relative positions, the coaxial measuring load given in Tables 3 and 4 should be applied for the methods where specified.

Table 3 — Coaxial measuring loads for radial ball bearings and angular contact ball bearings with contact angles ⩽ 30°

Outside diameter mm		Coaxial load on the bearing N
>	⩽	min.
—	30	5
30	50	10
50	80	20
80	120	35
120	180	70
180	—	140

Table 4 — Coaxial measuring loads for tapered roller bearings, angular contact ball bearings with contact angles > 30° and thrust bearings

Outside diameter mm		Coaxial load on the bearing N
>	⩽	min.
—	30	40
30	50	80
50	80	120
80	120	150
120	—	150

5.7 Measurement zone

The limits for deviations of a bore or an outside diameter are applicable to measurements in radial planes situated at a distance greater than "a" from the side face or flange face of the ring. The values of "a" are given in Table 5.

Only the maximum material size applies outside the measurement zone.

Table 5 — Measurement zone limits

Dimensions in millimetres

$r_{s\ min}$		a
>	⩽	
—	0,6	$r_{s\ max} + 0,5$
0,6	—	$1,2 \times r_{s\ max}$

5.8 Preparation before measuring

Any grease or corrosion inhibitor adhering to the bearing shall be removed if it is likely to affect the measured results. Before measuring, the bearing should be lubricated with a low viscosity oil.

The accuracy of measurements may be adversely affected for pre-lubricated bearings and some designs of sealed and shielded bearings. To eliminate any discrepancy, the measurements shall be made with open bearings, i.e. after removing the seals/shields and/or lubricant.

NOTE Immediately after completion of the measurements, the bearing should be protected with a corrosion inhibitor.

5.9 Reference face for measurements

The reference face is designated by the bearing manufacturer and is usually the datum for measurements.

NOTE The reference face for the measurement of a ring is generally taken as the unmarked face. In the case of symmetrical rings when it is not possible to identify the reference face, the tolerances are deemed to apply relative to either face.

The reference face of a shaft washer and housing washer of a thrust bearing is that face intended to support axial load and is generally opposite the raceway.

In the case of single-row angular contact ball bearing rings and tapered roller bearing rings, the reference face is the “back face” which is intended to support axial load.

For bearings with flanged outer rings, the reference face is the flange face intended to support axial load.

6 Measuring and gauging principles and methods

6.1 General

Principles for measuring and gauging are shown for the applicable definitions in ISO 1132-1. Methods are described as they apply to various bearing types in clauses 7 to 16 of this part of ISO 1132. Where more than one method is shown, a primary method is identified. Many terms in ISO 1132-1 are derivatives of measured features and they are so identified in the comments.

Measurements of geometrical accuracy (e.g. deviation from circular, cylindrical and spherical form) are as specified in ISO 4291.

6.2 Format of clauses

The format of clauses 7 to 16 is arranged in three parts.

a) The title identifying the principle and method including the clause numbering.

b) The left hand column entitled “Method” shows:

— a figure illustrating the method;

— essential characteristics of the method;

— the readings to be taken;

— required repetitions.

c) The right hand column entitled “Comments” is used for supplementary information, e.g.:

— a particular application;

— any restrictions in application;

— any particular sources of error;

— any particular requirements as to equipment;

— examples of equipment;

— treatment of readings obtained.

6.3 Caution

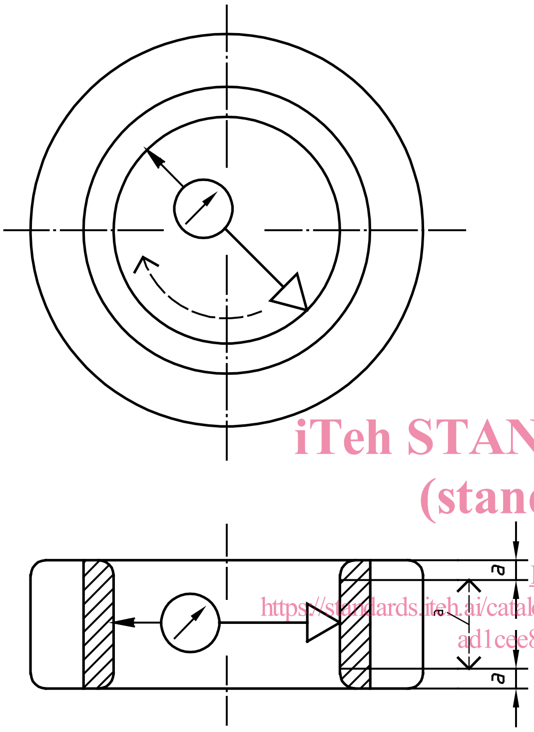
Consideration has not been given to the influence of the accuracy and design of the measuring equipment or to the skill of the operator. These factors sometimes have a significant influence on the resulting measurement or gauged assessment.

The measuring and gauging principles and methods are not illustrated in detail and are not intended for application on end-product drawings.

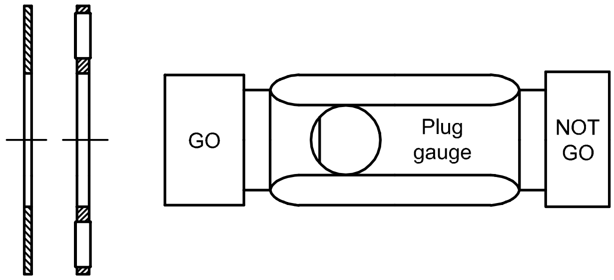
The order of presentation of measuring and gauging principles and methods shall not be regarded as a classification of priority within the prescribed type of measurements.

7 Principles of measuring bore diameter

7.1 Measurement of single bore diameter

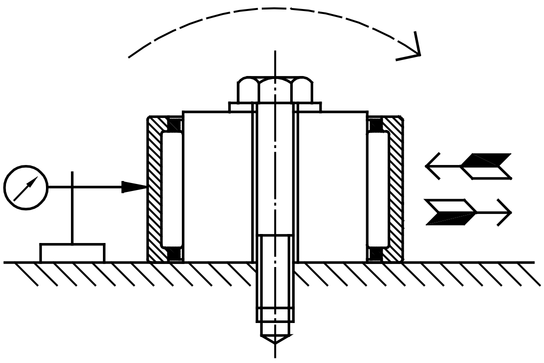
Method	Comments
 a Measuring zone Zero the gauge indicator to the appropriate size using gauge blocks or a master ring. In several angular directions and in a single radial plane, measure and record the largest and the smallest single bore diameters, $d_{sp\,max}$ and $d_{sp\,min}$, within the measuring zone as specified in 5.7. Repeat angular measurements and recordings in several radial planes to determine the largest and the smallest single bore diameter of an individual ring, $d_{s\,max}$ and $d_{s\,min}$.	This method is applicable to all types of rolling bearing rings, shaft washers and central washers. The single bore diameter, d_{sp} or d_s, is measured directly from the indicator. This method is also applicable in measuring a separable cylindrical or needle roller bearing outer ring bore diameter, providing the gauge point clear the raceway lead-in chamfers. The bearing ring or washer shall be placed with the axis in a vertical position in order to avoid the influences of gravity. The following are arithmetically based on the measurements of $d_{sp\,max}$ and $d_{sp\,min}$: d_{mp} mean bore diameter in a single plane; Δ_{dmp} deviation of mean bore diameter in a single plane; V_{dsp} variation of bore diameter in a single plane; V_{dmp} variation of mean bore diameter. The following are arithmetically based on the measurements of d_s, $d_{s\,max}$ and $d_{s\,min}$: d_m mean bore diameter; Δ_{dm} deviation of mean bore diameter; Δ_{ds} deviation of a single bore diameter; V_{ds} variation of bore diameter.

7.2 Functional gauging of smallest single bore diameter of thrust needle roller and cage assembly and thrust washer

Method	Comments
 The bore diameter of a free thrust needle roller and cage assembly or free thrust washer is gauged with GO and NOT GO plug gauges. The GO plug gauge size is the thrust needle roller and cage assembly or thrust washer minimum bore diameter, $d_{\text{cs min}}$ or $d_{\text{s min}}$, respectively, as specified in ISO 3031. The NOT GO plug gauge size is the thrust needle roller and cage assembly or thrust washer maximum bore diameter specified in ISO 3031.	This method is applicable to thrust needle roller and cage assemblies and thrust washers specified in ISO 3031. This method may also be used to gauge the smallest bore diameter of housing washers, $D_{\text{1s min}}$, specified in ISO 104. The assembly or washer shall fall freely from the GO plug gauge under its own weight. The NOT GO plug gauge should not enter the bore of the assembly or washer. Where the NOT GO plug gauge can be forced through the bore, the assembly or washer shall not fall from the gauge under its own weight. Plug gauges are used to verify the limits of size and do not directly measure the bore diameter. NOTE The thrust needle roller and cage assembly and corresponding thrust washer require different plug gauges due to their respective tolerances.

7.3 Measurement of single bore diameter of rolling element complement

Method



Fasten the master gauge to a surface plate.

Bearings with machined rings are measured in the free state.

For drawn cup needle roller bearings, first press the bearing into a hardened steel ring gauge of bore diameter specified in ISO 3245. The minimum radial cross-section of the ring gauge is shown in the adjacent table.

Position the bearing on the master gauge and apply the indicator in the radial direction to the approximate middle of the width on the ring outside surface.

Measure the amount of movement of the outer ring in the radial direction by applying sufficient load on the outer ring in the same radial direction as that of the indicator and in the opposite radial direction. The radial load to be applied is shown in the adjacent table.

Record indicator readings at the extreme radial positions of the outer ring. Rotate the bearing and repeat the measurement in several different angular positions to determine the largest and the smallest readings, $F_{ws\ max}$ and $F_{ws\ min}$.

Comments

This method is applicable to all radial cylindrical roller, needle roller and drawn cup needle roller bearings without inner ring.

The single bore diameter of rolling element complement, F_{ws}, is equal to the measurement taken plus the master gauge diameter.

The following are arithmetically based on $F_{ws\ max}$ and $F_{ws\ min}$:

- F_{wm} mean bore diameter of rolling element complement;
- Δ_{Fwm} deviation of mean bore diameter of rolling element complement.

Minimum radial cross-section of ring gauges for drawn cup needle roller bearings

Nominal ring gauge bore diameter mm >	 ⩽	Ring gauge radial cross-section mm min. [a]
6	10	10
10	18	12
18	30	15
30	50	18
50	80	20
80	120	25
120	150	30

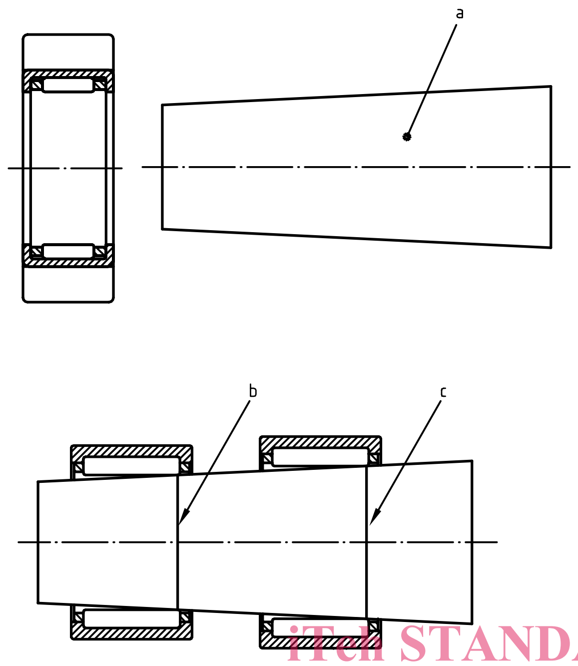
[a] Larger ring gauge radial cross-sections may be used to assure accurate measurement.

Radial measuring loads

F_w mm >	 ⩽	Measuring load N min.
—	30	50
30	50	60
50	80	70
80	—	80

7.4 Measurement of smallest single bore diameter of rolling element complement

Method



a Tapered arbor

b Calibrated minimum diameter

c Calibrated maximum diameter

The bore diameter of the rolling element complement is measured with a full circular, calibrated tapered arbor spanning the range of the bore size and having a taper of approximately 0,000 5:1.

Bearings with machined rings are measured in the free state.

For drawn cup needle roller bearings, first press the bearing into a hardened steel ring gauge of bore diameter specified in ISO 3245. The minimum radial cross-section of the ring gauge is shown in the adjacent table.

Seat the tapered arbor in the bearing bore with a slight oscillating motion so as to remove the radial clearance and align the rollers while not expanding the bearing. An axial load for seating the arbor is shown in the adjacent table. Withdraw the arbor and measure its diameter at the location where the roller complement rested against the largest arbor diameter.

NOTE A thin coating of preserving agent applied to the bearing before measurement will indicate the precise stopping point of the rolling elements on the arbor.

Comments

This method is applicable to all radial cylindrical roller, needle roller and drawn cup needle roller bearings without inner ring and with $F_w \leqslant 150$ mm.

This method is used to measure the smallest single bore diameter of rolling element complement, $F_{ws\ min}$. The single bore diameter of rolling element complement, F_{ws}, is not directly measured.

This method may be used as a gauging technique. The arbor is marked on the diameter at the limits of the tolerance range of the bearing bore diameter. The tolerance limits of the bore diameter of a rolling element complement are met if the diameter of the arbor at the contact location of the roller complement exceeds the minimum diameter calibration marking and does not exceed the maximum diameter calibration marking.

Minimum radial cross-section of ring gauges for drawn cup needle roller bearings

Nominal ring gauge bore diameter mm		Ring gauge radial cross-section mm
>	⩽	min. [a]
6	10	10
10	18	12
18	30	15
30	50	18
50	80	20
80	120	25
120	150	30

a Larger ring gauge radial cross-sections may be used to assure accurate measurement.

Axial seating loads for measuring with tapered arbor

F_w mm		Axial load [a] N
>	⩽	
8	15	10
15	30	15
30	80	30
80	150	50

a Heavier loads may be used provided the measurement is not influenced.