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(JBIA)

**Rolling bearings—Tolerances—
Part 2 : Measuring and gauging
principles and methods**

ICS 21.100.20

Reference number : JIS B 1515-2 : 2006 (E)

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from The Japan Bearing Industrial Association (JBIA), with a draft of Industrial Standard based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

Consequently, **JIS B 1515**:1988 is withdrawn and replaced with this Standard and **JIS B 1515-1**.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

JIS B 1515 series consists of the following two parts, under the general title “*Rolling bearings—Tolerances*”:

Part 1 : Terms and definitions

Part 2 : Measuring and gauging principles and methods

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Rolling bearings—Tolerances— Part 2 : Measuring and gauging principles and methods

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **ISO 1132-2** *Rolling bearings—Tolerances—Part 2 : Measuring and gauging principles and methods* published in 2001 without modifying the technical contents.

The portions underlined with dots are the matters not included in the original International Standard.

1 Scope This part of **JIS B 1515** 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 **JIS B 0104** and **JIS B 1515-1**.

If it is found that there are other adequate measuring and gauging methods or that technical development have resulted in even more convenient methods, the producer and the user may consider a measuring and gauging method other than that specified in this part of **JIS B 1515**.

NOTE : The International Standard corresponding to this part of **JIS B 1515** is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 1132-2:2001 *Rolling bearings—Tolerances—Part 2 : Measuring and gauging principles and methods* (IDT)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this part of **JIS B 1515**. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0023 *Technical drawings—Geometrical tolerancing—Maximum material requirement and least material requirement*

JIS B 0104 *Rolling bearings—Vocabulary*

NOTE : **ISO 5593**:1997 *Rolling bearings—Vocabulary* is equivalent to the said standard.

JIS B 0124 *Rolling bearings—Symbols for quantities*

NOTE : **ISO 15241**:2001 *Rolling bearings—Symbols for quantities* is equivalent to the said standard.

JIS B 0401-2 *ISO system of limits and fits—Part 2 : Tables of standard tolerance grades and limit deviations for holes and shafts*

NOTE : **ISO 286-2**:1988 *ISO system of limits and fits—Part 2 : Tables of standard tolerance grades and limit deviations for holes and shafts* is identical with the said standard.

JIS B 1512 *Rolling bearings—Boundary dimensions*

NOTE : **ISO 104**:2002 *Rolling bearings—Thrust bearings—Boundary dimensions, general plan* is equivalent to the said standard.

JIS B 1515-1 *Rolling bearings—Tolerances—Part 1 : Terms and definitions*

NOTE : **ISO 1132-1**:2000 *Rolling bearings—Tolerances—Part 1 : Terms and definitions* is identical with the said standard.

JIS B 1519 *Static load ratings for rolling bearings*

NOTE : **ISO 76**:1987 *Rolling bearings—Static load ratings* is equivalent to the said standard.

JIS B 1536 *Rolling bearings—Needle roller bearings—Dimensions and tolerances*

NOTE : **ISO 3030**:1996 *Rolling bearings—Radial needle roller and cage assemblies—Dimensions and tolerances* is equivalent to the said standard.

NOTE : **ISO 3031**:2000 *Rolling bearings—Thrust needle roller and cage assemblies, thrust washers—Boundary dimensions and tolerances* is equivalent to the said standard.

NOTE : **ISO 3245**:1997 *Rolling bearings—Needle roller bearings, drawn cup without inner rings—Boundary dimensions and tolerances* is equivalent to the said standard.

JIS B 7451 *Instruments for the assessment of departure from roundness—Measurement of variations in radius*

NOTE : **ISO 4291**:1985 *Methods for the assessment of departure from roundness—Measurement of variations in radius* is equivalent to the said standard.

ISO 1 *Geometrical Product Specifications (GPS)—Standard reference temperature for geometrical product specification and verification*

3 Terms and definitions For the purpose of this part of **JIS B 1515**, the terms and definitions given in **JIS B 0104** and **JIS B 1515-1** apply. The following additional terms and definitions are used throughout this part of **JIS B 1515**. An index of methods with their respective symbols, as specified in **JIS B 1515-1**, 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 toleranced 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)

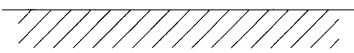
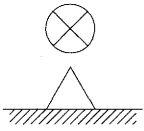
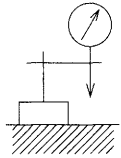
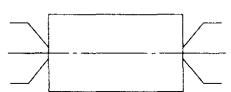
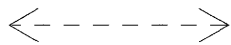
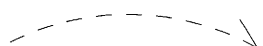
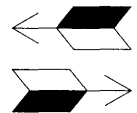
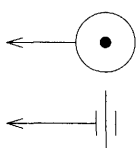
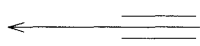
3.7 measuring force force applied by the stylus of an indicator or a recorder to the feature being measured

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

4 Symbols for quantities and drawing symbols For the purposes of this part of **JIS B 1515**, the symbols for quantities given in **JIS B 0124** and the drawing symbols given in table 1 apply.

The symbols (except those for tolerances) shown in the figures and the values given in the tables denote nominal dimensions unless specified otherwise.

Table 1 Drawing symbols

Symbol	Interpretation
	Surface plate (measuring plane)
 (Front view) (Top view)	Fixed support
	Fixed gauge support
	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
 (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 **JIS B 1515**, 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 1 : 5 000 on diameter shall be used.

In cases when an arbor is used to measure the bore diameter of a roller component, a precision arbor having a taper of approximately 1 : 2 000 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 ⁽¹⁾ N	Stylus radius ⁽²⁾ mm
	>	≤	max.	min.
Bore diameter <i>d</i>	— 10 30	10 30 —	2 2 2	0.8 2.5 2.5
Outside diameter <i>D</i>	— 30	30 —	2 2	2.5 2.5

Notes (1) 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.

(2) 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⁽³⁾ applies outside the measurement zone.

Note ⁽³⁾ Maximum limit of size as defined in **JIS B 0023**.

Table 5 Measurement zone limits

Unit: mm

$r_{s \min}$		a
$>$	$\leq$	
—	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 **JIS B 1515-1**. Methods are described as they apply to various bearing types in clauses 7 to 16 of this part of **JIS B 1515**. Where more than one method is shown, a primary method is identified. Many terms in **JIS B 1515-1** 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 of steel ball) are as specified in **JIS B 7451**.

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

- a) **Title** The title identifying the principle and method including the clause numbering.
- b) **Method** 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) **Comments** 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.

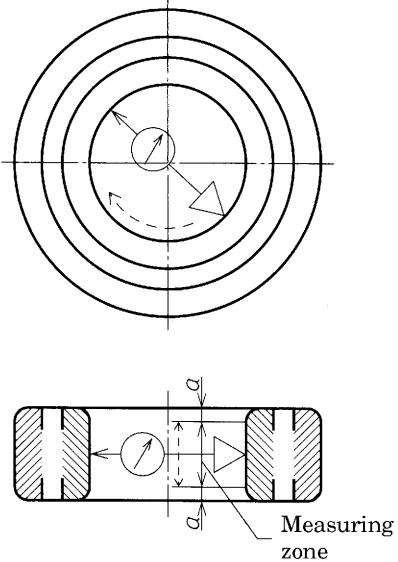
6.3 Caution Consideration has not been given to the influence of the accuracy and design of the measuring equipment or to the skill of the operator. These factors sometimes have a significant influence on the resulting measurement or gauged assessment.

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

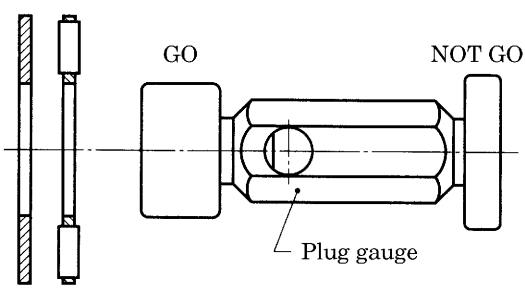
The order of presentation of measuring and gauging principles and methods shall not be regarded as a classification of priority within the prescribed type of measurements.

7 Principles of measuring bore diameter

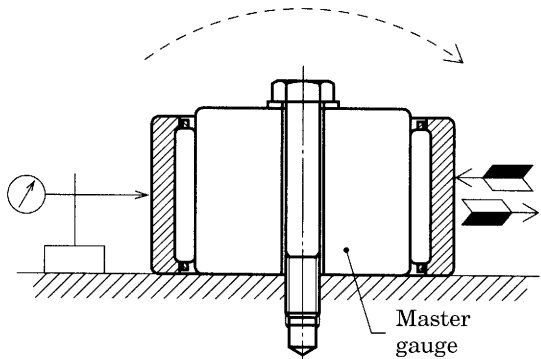
7.1 Measurement of single bore diameter

Method	Comments
 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.

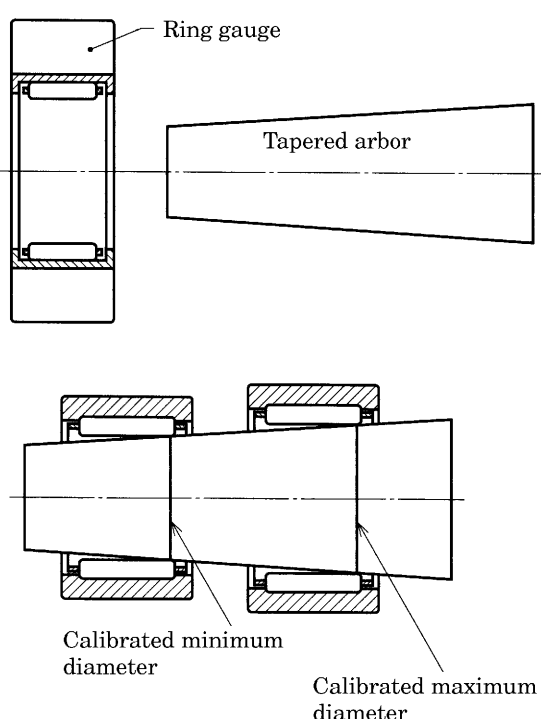
7.2 Functional gauging of smallest single bore diameter of thrust needle roller and cage assembly and thrust washer

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, $d_{es\ min}$ or $d_{s\ min}$, respectively, as specified in JIS B 1536. The NOT GO plug gauge size is the thrust needle roller and cage assembly or thrust washer maximum bore diameter specified in JIS B 1536.	This method is applicable to thrust needle roller and cage assemblies and thrust washers specified in JIS B 1536. This method may also be used to gauge the smallest bore diameter of housing washers, $D_{ls\ min}$, specified in JIS B 1512. 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	Comments																																													
 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 JIS B 1536. The minimum radial cross-section of the ring gauge is shown in table 6. 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 table 7. 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 $F_{ws\ min}$.	This method is applicable to: • radial cylindrical roller bearings without inner ring; • needle roller bearings without inner ring; • 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; ΔF_{wm} deviation of mean bore diameter of rolling element complement. Table 6 Minimum radial cross-section of ring gauges for drawn cup needle roller bearings Unit: mm <table><tr><th colspan="2">Nominal ring gauge bore diameter</th><th>Ring gauge radial cross-section</th></tr><tr><th>></th><th>≤</th><th>min. ⁽⁴⁾</th></tr><tr><td>6</td><td>10</td><td>10</td></tr><tr><td>10</td><td>18</td><td>12</td></tr><tr><td>18</td><td>30</td><td>15</td></tr><tr><td>30</td><td>50</td><td>18</td></tr><tr><td>50</td><td>80</td><td>20</td></tr><tr><td>80</td><td>120</td><td>25</td></tr><tr><td>120</td><td>150</td><td>30</td></tr></table> Note ⁽⁴⁾ Larger ring gauge radial cross-sections may be used to assure accurate measurement. Table 7 Radial measuring loads <table><tr><th colspan="2">F_w mm</th><th>Measuring load N</th></tr><tr><th>></th><th>≤</th><th>min.</th></tr><tr><td>—</td><td>30</td><td>50</td></tr><tr><td>30</td><td>50</td><td>60</td></tr><tr><td>50</td><td>80</td><td>70</td></tr><tr><td>80</td><td>—</td><td>80</td></tr></table>	Nominal ring gauge bore diameter		Ring gauge radial cross-section	>	≤	min. ⁽⁴⁾	6	10	10	10	18	12	18	30	15	30	50	18	50	80	20	80	120	25	120	150	30	F_w mm		Measuring load N	>	≤	min.	—	30	50	30	50	60	50	80	70	80	—	80
Nominal ring gauge bore diameter		Ring gauge radial cross-section																																												
>	≤	min. ⁽⁴⁾																																												
6	10	10																																												
10	18	12																																												
18	30	15																																												
30	50	18																																												
50	80	20																																												
80	120	25																																												
120	150	30																																												
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	Comments																																													
 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 1 : 2 000. 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 JIS B 1536. The minimum radial cross-section of the ring gauge is shown in table 8. 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 table 9. 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.	This method is applicable to the following rolling bearings with the nominal bore diameter of the rolling element complement $F_w \leq 150$ mm: - radial cylindrical roller rolling bearings without inner ring; - needle roller rolling bearings without inner ring; - drawn cup needle rolling bearings without inner ring. 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. Table 8 Minimum radial cross-section of ring gauges for drawn cup needle roller bearings Unit: mm <table><tr><th colspan="2">Nominal ring gauge bore diameter</th><th>Ring gauge radial cross-section</th></tr><tr><th>></th><th>≤</th><th>min. ⁽⁵⁾</th></tr><tr><td>6</td><td>10</td><td>10</td></tr><tr><td>10</td><td>18</td><td>12</td></tr><tr><td>18</td><td>30</td><td>15</td></tr><tr><td>30</td><td>50</td><td>18</td></tr><tr><td>50</td><td>80</td><td>20</td></tr><tr><td>80</td><td>120</td><td>25</td></tr><tr><td>120</td><td>150</td><td>30</td></tr></table> Note ⁽⁵⁾ Larger ring gauge radial cross-sections may be used to assure accurate measurement. Table 9 Axial seating loads for measuring with tapered arbor <table><tr><th colspan="2">F_w mm</th><th>Axial load ⁽⁶⁾ N</th></tr><tr><th>></th><th>≤</th><th></th></tr><tr><td>8</td><td>15</td><td>10</td></tr><tr><td>15</td><td>30</td><td>15</td></tr><tr><td>30</td><td>80</td><td>30</td></tr><tr><td>80</td><td>150</td><td>50</td></tr></table> Note ⁽⁶⁾ Heavier loads may be used provided the measurement is not influenced.	Nominal ring gauge bore diameter		Ring gauge radial cross-section	>	≤	min. ⁽⁵⁾	6	10	10	10	18	12	18	30	15	30	50	18	50	80	20	80	120	25	120	150	30	F_w mm		Axial load ⁽⁶⁾ N	>	≤		8	15	10	15	30	15	30	80	30	80	150	50
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