INTERNATIONAL STANDARD

**ISO 12301**

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# Plain bearings — Quality control techniques and inspection of geometrical and material quality characteristics



*Paliers lisses — Techniques de contrôle de la qualité et vérifications des caractéristiques de qualité géométriques et des matériaux*



Reference number
ISO 12301 : 1992 (E)

## 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.

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.



International Standard ISO 12301 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Sub-Committee SC 5, *Quality analysis and assurance*.



(The draft International Standard was circulated under the number ISO/DIS 8259.)

Annexes A and B of this International Standard are for information only.



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# Plain bearings — Quality control techniques and inspection of geometrical and material quality characteristics

## 1 Scope

This International Standard specifies quality control techniques and inspection of the geometrical and material quality characteristics of the following types of plain bearing:

— metallic thin-walled half-bearings, as specified in ISO 3548;

— metallic thin-walled flanged bearings, as specified in ISO 6864;

— metallic thick-walled half-bearings (with and without flange) which are manufactured as halves but which are not necessarily interchangeable and have the ratio $s_{tot} : D_o \geqslant 0{,}11$;

— wrapped bushes, as specified in ISO 3547;

— unsplit metallic bushes (with and without flange) made from solid and multilayer materials and with outside diameters up to 230 mm, as specified in ISO 4379;

— thermoplastic bushes (with and without flange) with inside diameters up to and including 200 mm;

— ring-type thrust washers and pressed bimetallic half-thrust washers, as specified in ISO 6525 and ISO 6526, respectively;

— plain bearings made from sintered material, as specified in ISO 2795.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 286-1 : 1988, *ISO system of limits and fits — Part 1: Bases of tolerances, deviations and fits.*

ISO 468 : 1982, *Surface roughness — Parameters, their values and general rules for specifying requirements.*

ISO 1880 : 1979, *Instruments for the measurement of surface roughness by the profile method — Contact (stylus) instruments of progressive profile transformation — Profile recording instruments.*

ISO 2178 : 1982, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method.*

ISO 2795 : 1991, *Plain bearings — Sintered bushes — Dimensions and tolerances.*

ISO 3543 : 1981, *Metallic and non-metallic coatings — Measurement of thickness — Beta backscatter method.*

ISO 3547 : 1976, *Plain bearings — Wrapped bushes — Dimensions, tolerances and methods of checking.*

ISO 3548 : 1978, *Plain bearings — Thin-walled half bearings — Dimensions, tolerances and methods of checking.*

ISO 4378-1 : —[1], *Plain bearings — Terms, definitions and classification — Part 1: Design, bearing materials and their properties.*

ISO 4379 : —[2], *Plain bearings — Copper alloy bushes.*

ISO 4384-1 : 1982, *Plain bearings — Hardness testing of bearing metals — Part 1: Compound materials.*

1) To be published. (Revision of ISO 4378-1 : 1983)

2) To be published. (Revision of ISO 4379 : 1978)

ISO 4384-2 : 1982, *Plain bearings — Hardness testing of bearing metals — Part 2: Solid materials.*

ISO 4386-1 : 1992, *Plain bearings — Metallic multilayer plain bearings — Part 1: Non-destructive ultrasonic testing of bond.*

ISO 4386-2 : 1982, *Plain bearings — Metallic multilayer plain bearings — Part 2: Destructive testing of bond for bearing metal layer thicknesses* ⩾ 2 mm.

ISO 4386-3 : 1992, *Plain bearings — Metallic multilayer plain bearings — Part 3: Non-destructive penetrant testing.*

ISO 6524 : 1983, *Plain bearings — Methods of dimensional control — Peripheral length checking of thin-walled half bearings.*

ISO 6525 : 1983, *Plain bearings — Ring type thrust washers made from strip — Dimensions and tolerances.*

ISO 6526 : 1983, *Plain bearings — Pressed bimetallic half thrust washers — Features and tolerances.*

ISO 6691 : 1989, *Thermoplastics for plain bearings — Classification and designation.*

*ISO 6864 : 1984, Plain bearings — Thin-walled flanged half bearings — Dimensions, tolerances and methods of checking.*

ISO 12306 : —[1], *Plain bearings — Measurement of wall thickness of thin-walled half-bearings and thin-walled unsplit or wrapped bushes.*

ISO 12307 : —[1], *Plain bearings — Checking the outside diameter of wrapped bushes.*

## 3 Definitions

For the purposes of this International Standard, the definitions of technical terms relating to plain bearings given in ISO 4378-1 and the following definitions of terms relating to quality and measurement apply.

**3.1 quality of plain bearing**: Condition which renders a plain bearing fit to fulfil given requirements. The given requirements are generally dependent upon the intended use.

**3.2 quality control techniques**: The method, equipment and procedure by means of which the quality of a plain bearing is assessed.

**3.3 quality characteristic**: Characteristic by means of which the quality of a plain bearing is judged.

**3.4 inspection**: Checking of one or more quality characteristics of a plain bearing with applicable requirements.

**3.5 uncertainty of measurement**: The uncertainty of measurement, $u$, can be calculated using the following formula:

$$u = \pm t \cdot \sigma$$

where

$t$ is the stochastic variable according to Student's $t$ distribution; $t = 2$ and corresponds to a statistical uncertainty in measurement $P = 95\ \%$, for which the probability of exceeding the value $(1 - P) = 0{,}05$ or 5 %;

$\sigma$ is the standard deviation.

NOTE 1 The uncertainty of measurement is normally included in the tolerance given.

**3.6 measuring points [lines]**: Agreed points [lines] established to facilitate agreement on testing.

NOTE 2 The establishment of measuring points [lines] does not preclude the need to comply with dimensional specifications in other areas.

**3.7 tolerance**: Range of acceptable measurements between the upper specified limit and the lower specified limit.

## 4 Symbols and units

For the purposes of this International Standard, the symbols and units are as given in table 1.



**Table 1**

| Symbol | Parameter | SI Unit |
|---|---|---|
| $a$ | Crush height (nip) | mm |
| $\Delta a$ | Measured change in $a$ | mm |
| $a_c$ | Distance between measuring lines | mm |
| $a_E$ | Distance between gauge faces | mm |
| $a_{fl}$ | Distance between flanges | mm |
| $A_{eff}$ | Effective cross-section | $mm^2$ |
| $B$ | Width | mm |
| $B_\Delta$ | Joint displacement | mm |
| $d_c$ | Diameter of the checking block bore | mm |
| $d_H$ | Housing diameter | mm |
| $D_{fl}$ | Flange diameter | mm |
| $D_{fs}$ | Diameter measured across the joint in the free state; free spread diameter | mm |
| $D_i$ | Inside diameter | mm |
| $D_o$ | Outside diameter | mm |
| $E_{red}$ | Elastic reduction | mm |
| $F_c$ | Checking load | N |
| $F_{pin}$ | Checking load (measuring pin) | N |
| $F_{tan}$ | Tangential load of bearing as fitted | N |
| $h_\Delta$ | Joint face taper | mm |
| $H$ | Height | mm |
| $r$ | Repeatability | µm |
| $s_1$ | Steel thickness | mm |
| $s_2$ | Bearing lining thickness | mm |
| $s_{2,\,red}$ | Bearing lining thickness, reduced | mm |
| $s_{fl}$ | Flange thickness | mm |



1) To be published.

**Table 1** (*concluded*)

| Symbol | Parameter | SI Unit |
|---|---|---|
| $s_{tot}$ | Wall thickness (total) | mm |
| $T$ | Tolerance | mm |
| $u$ | Uncertainty of measurement | mm |
| $x_1, x_2, \ldots, x_i$ | Individual measured values | mm |
| $\varepsilon_{max}$ | Maximum deformation in compression | mm |
| $\varepsilon_{min}$ | Minimum deformation in compression | mm |
| $\sigma_{tan}$ | Tangential strength | $N/mm^2$ |
| $\Phi$ | Stress | $N/mm^2$ |

## 5 Summary of defined quality characteristics

A summary of defined quality characteristics is given in table 2 for the convenience of users of this International Standard, as a guide indicating which defined quality characteristics are relevant to each type of bearing.

The sequence of the characteristics listed in table 2 does not determine their importance. The manufacturer and user shall agree on priorities for the quality characteristics which, from their points of view, are required to assure reliability and lifetime of the product.

NOTE 3 A key explaining the meaning of signs used in table 2 is provided at the bottom of the table.

**Table 2**

| Relevant clause/ sub-clause No. | Quality characteristic | Type of plain bearing | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Thin-walled half-bearing | Thick-walled half-bearing | Wrapped bush | Unsplit metallic bush | Thermo-plastic bush | Sintered bush | Thrust washer (ring and half) |
| **6** | **Geometrical quality characteristics** | | | | | | | |
| **6.1** | Wall thickness, $s_{tot}$ | | | | | | | |
| **6.1.1** | Line measurement | + | + | + | + | + | − | − |
| **6.1.2** | Point measurement | + | + | + | + | + | + | + |
| **6.2** | Outside diameter, $D_o$ | − | + | + | + | + | + | + |
| **6.3** | Inside diameter, $D_i$ | − | + | + | + | + | + | + |
| **6.4** | Width, $B$ | + | + | + | + | + | + | − |
| **6.5** | Locating features | + | + | + | + | + | − | + |
| **6.6** | Lubricant feed and distibution features | + | + | + | + | + | − | + |
| **6.7** | Surface conditions | + | + | + | + | + | − | + |
| **6.8** | Crush height, $a$ | + | − | − | − | − | − | − |
| **6.9** | Free spread | + | + | − | − | − | − | − |
| **6.10** | Straightness of sliding surface | + | − | − | − | − | − | − |
| **6.11** | Joint face taper, $h_\Delta$ | + | − | − | − | − | − | − |
| **6.12** | Back contact | + | − | − | − | − | − | − |
| **6.13** | Joint displacement, $B_\Delta$ | − | − | + | − | − | − | − |
| **6.14** | Height of thrust half-washer, $H$ | − | − | − | − | − | (+) | + |
| **6.15** | Flatness | − | − | − | − | − | (+) | + |
| **6.16** | Flange diameter, $D_{fl}$ | + | + | + | + | + | + | − |
| **6.17** | Distance between flanges, $a_{fl}$ | + | + | + | + | + | − | − |
| **6.18** | Flange thickness, $s_{fl}$ | + | + | + | + | + | + | − |
| **6.19** | Perpendicularity (squareness) of flange | + | + | + | + | + | (+) | − |
| **6.20** | Geometric deviations | | | | | | | |
| **6.20.1** | Cylindricity | − | (+) | − | + | − | (+) | − |
| **6.20.2** | Run-out of thrust face | − | (+) | − | + | + | (+) | − |
| **6.20.3** | Coaxiality and concentricity | − | + | − | + | + | + | − |

**Table 2** (*concluded*)

| Relevant clause/ sub-clause No. | Quality characteristic | Type of plain bearing | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Thin-walled half-bearing | Thick-walled half-bearing | Wrapped bush | Unsplit metallic bush | Thermo-plastic bush | Sintered bush | Thrust washer (ring and half) |
| **7** | **Material quality characteristics** | | | | | | | |
| **7.1** | Metallic solid material | | | | | | | |
| **7.1.1** | Hardness | – | + | – | + | – | – | – |
| **7.1.2** | Material composition | – | + | – | + | – | – | – |
| **7.1.3** | Material structure | – | + | – | + | – | – | – |
| **7.2** | Multilayer metallic material | | | | | | | |
| **7.2.1** | Overlay properties | + | + | + | – | – | – | + |
| **7.2.2** | Lining properties | + | + | + | – | – | – | + |
| **7.2.3** | Backing properties | + | + | + | – | – | – | + |
| **7.2.4** | Adhesion (bond) of adjacent layers | + | + | + | – | – | – | + |
| **7.3** | Plastic layer material | | | | | | | |
| **7.3.1** | Overlay properties | – | – | + | – | – | – | (+) |
| **7.3.2** | Lining properties | – | – | + | – | – | – | (+) |
| **7.3.3** | Backing properties | – | – | + | – | – | – | (+) |
| **7.3.4** | Adhesion (bond) of adjacent layers | – | – | + | – | – | – | (+) |
| **7.4** | Thermoplastic material (solid) | | | | | | | |
| **7.4.1** | Material composition | – | – | – | – | + | – | – |
| **7.4.2** | Material structure | – | – | – | – | + | – | – |
| **7.5** | Sintered material | | | | | | | |
| **7.5.1** | Material composition | – | – | – | – | – | + | – |
| **7.5.2** | Material structure | – | – | – | – | – | + | – |

**Key**

Plus sign indicates that the characteristic is generally applicable to all types of bearings.

Plus sign in parentheses indicates that this characteristic is not always applicable.

Minus sign indicates that the characteristic is not relevant for the corresponding type of bearing.



## 6 Geometrical quality characteristics

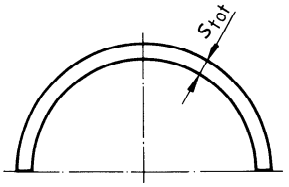
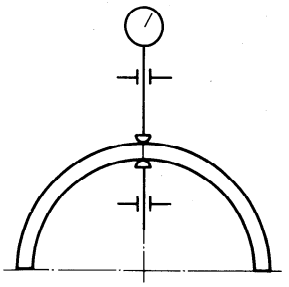
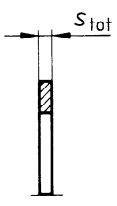
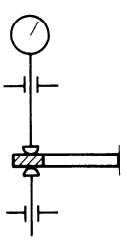
In order to assess plain bearing quality, important dimensional quality characteristics are specified in this clause.

Unless otherwise stated, the dimensions in the tables and figures are given in millimetres.

### 6.1 Wall thickness, $s_{tot}$

See table 3.

**Table 3**

| Applicability | Definition of geometrical characteristic to be measured | Test method/measuring principle | Test equipment |
|---|---|---|---|
| **Metallic thin-walled half-bearing** | See figure 1 and ISO 12306.<br>  <br><br>**Figure 1** | In accordance with ISO 12306. (See figure 2.)<br>NOTE — This test method is also applicable when measuring joint face bore relief.<br>  <br>**Figure 2** | Device for measuring wall thickness (see also ISO 12306). |
| **Metallic thick-walled half-bearing** | See figure 1 and ISO 12306. | Measured normal to the back surface in the radial direction using the spherical faces of the measuring pins, in accordance with ISO 12306. (See figure 2.) | Device for measuring wall thickness. |
| **Wrapped bush** | See figure 1 and ISO 12306. | In accordance with ISO 12306. (See figure 2.)<br>NOTE — Depending on the manufacturing process, the back of the wrapped bush may show slight hollows. The wall thickness shall, therefore, be measured outside these hollows, i.e. on the "bearing areas" (see ISO 3547).<br>In the cases $D_i < 8$ or $D_i > 150$, the test method shall be subject to agreement between the manufacturer and user. | Device for measuring wall thickness (see also ISO 12306). |
| **Unsplit metallic bush** | See figure 1 and ISO 12306. | In accordance with ISO 12306. (See figure 2.)<br>NOTE — The wall thickness may also be determined by obtaining the difference between the outside and inside diameters ($D_o - D_i$) (see 6.2 and 6.3). | Device for measuring wall thickness (see also ISO 12306). |
| **Thermoplastic bush** | See figure 1 and ISO 12306. | In accordance with ISO 12306. (See figure 2.) | Device for measuring wall thickness. |
| **Sintered bush** | See figure 1 and ISO 12306. | In accordance with ISO 12306. (See figure 2.) | Device for measuring wall thickness (see also ISO 12306). |
| **Thrust washer** | Axial distance between the two faces of the washer (see figure 3).<br>  <br><br>**Figure 3** | Measured parallel to the axial direction using the spherical faces of the measuring pins (see figure 4).<br>  <br>**Figure 4** | Device for measuring wall thickness. |

### 6.1.1 Line measurement (wall thickness)

See table 4.

**Table 4**

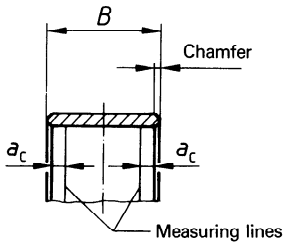
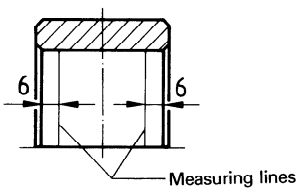
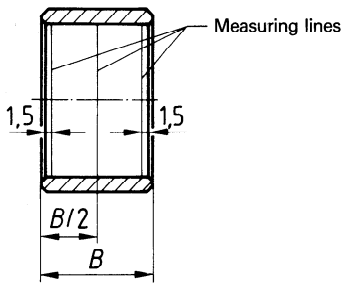
| Applicability | Definition of geometrical characteristic to be measured | Test method/measuring principle | Test equipment |
|---|---|---|---|
| **Metallic thin-walled half-bearing; wrapped bush; unsplit metallic bush** | See figure 5 and ISO 12306.<br><br>NOTE — The distance $a_c$ between the measuring lines is measured from the edge of the sliding surface.<br><br>  <br><br>**Figure 5** | The thickness of the half-bearing or bush is measured continuously on one, two or three predetermined or agreed measuring lines, in accordance with ISO 12306. (See figure 5.)<br><br>NOTE — The defined position of the measuring lines may have to be modified to avoid design features such as grooves, etc. | Device for measuring wall thickness (see also ISO 12306). |
| **Metallic thick-walled half-bearing** | See figure 6 and ISO 12306.<br><br>NOTE — The distance $a_c$ between the measuring lines ($a_c$ = 6) is measured from the edge of the sliding surface.<br><br>  <br><br>**Figure 6** | The thickness of the half-bearing is measured continuously on two predetermined or agreed measuring lines, in accordance with ISO 12306. (See figure 6.)<br><br>NOTES<br><br>1 In the case where $s_{tot}$ > 25, the test method shall be subject to agreement between the manufacturer and user.<br><br>2 The defined position of the measuring lines may have to be modified to avoid design features such as grooves, etc. | Device for measuring wall thickness; for details see the following table.<br><br>**Wall thickness $s_{tot}$** / **Checking load (measuring pin) $F_{pin}$ N** / **Uncertainty of measurement** / **Radius of measuring anvil**<br><br>$s_{tot} \leqslant 10$ — $0{,}8 < F_{pin} \leqslant 1{,}5$ — ±0,001 5 — 3 ± 0,2<br><br>$10 < s_{tot} \leqslant 25$ — $1{,}5 < F_{pin} \leqslant 2{,}5$ — ±0,002 |

**Table 4** (*concluded*)

<table>
<tr><th>Applicability</th><th>Definition of geometrical characteristic to be measured</th><th>Test method/measuring principle</th><th>Test equipment</th></tr>
<tr><td>Thermoplastic bush</td><td>See figure 7 and ISO 12306.<br><br>NOTE — The distance $a_c$ between the measuring lines ($a_c$ = 1,5) is measured from the edge of the sliding surface.<br><br> 

<br>Figure 7</td><td>The thickness of the bush is measured continuously on one, two or three predetermined or agreed measuring lines, in accordance with ISO 12306. (See figure 7.)<br><br>NOTE — The defined position of the measuring lines may have to be modified to avoid design features such as grooves, etc.</td><td>Device for measuring wall thickness; for details see the following table.<br><br>
<table>
<tr><th>Outside diameter $D_o$</th><th>Checking load (measuring pin) $F_{pin}$ N</th><th>Radius of measuring anvil</th><th>Uncertainty of measurement</th></tr>
<tr><td>$D_o \leqslant 150$</td><td>$0,8 \leqslant F_{pin} \leqslant 1,5$</td><td>3 ± 0,2</td><td rowspan="2">±0,005</td></tr>
<tr><td>$150 < D_o \leqslant 300$</td><td>$1,5 < F_{pin} \leqslant 2,5$</td><td>5 ± 0,2</td></tr>
</table>
</td></tr>
</table>



### 6.1.2 **Point measurement** (wall thickness)

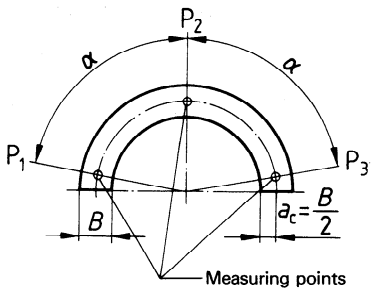
See table 5.



**Table 5**

| Applicability | Definition of geometrical characteristic to be measured | Test method/measuring principle | Test equipment |
|---|---|---|---|
| **Metallic thin-walled half-bearing; wrapped bush; unsplit metallic bush** | Wall thickness measured at determined measuring points (see ISO 12306). | In accordance with ISO 12306.<br><br>NOTE — The defined position of the measuring points may have to be modified to avoid design features such as grooves, etc. | Device for measuring wall thickness (see also ISO 12306). |
| **Metallic thick-walled half-bearing** | Wall thickness measured at determined measuring points which are subject to agreement between the manufacturer and user. | In accordance with ISO 12306.<br><br>NOTE — The defined position of the measuring points may have to be modified to avoid design features such as grooves, etc. | External micrometer with dial indicator. |
| **Thermoplastic bush; sintered bush** | Wall thickness measured at determined measuring points (see ISO 12306). | In accordance with ISO 12306.<br><br>NOTE — The defined position of the measuring points may have to be modified to avoid design features such as grooves, etc. | External micrometer with dial indicator.<br><br>Device for measuring wall thickness (see also ISO 12306). |

**Table 5** (*concluded*)

| Applicability | Definition of geometrical characteristic to be measured | Test method/measuring principle | Test equipment |
|---|---|---|---|
| **Thrust washer** | Wall thickness measured at determined measuring points (P) on measuring lines at a distance $a_c$ from the inside diameter of the washers, as shown in figure 8.<br>  <br><br>Thrust half-washers: $\alpha = 80°$<br>Thrust washers: $\alpha = 120°$<br>**Figure 8** | The thrust washer is measured at measuring points positioned as shown in figure 8.<br>NOTE — The defined position of the measuring points may have to be modified to avoid design features such as grooves, etc. | External micrometer with dial indicator.<br>Device for measuring wall thickness; for details see the following table.<br>**Checking load (measuring pin) $F_{pin}$ N** / **Radius of measuring anvil** / **Uncertainty of measurement**<br>$0,8 \leqslant F_{pin} \leqslant 1,5$ / 3 ±0,2 / ±10 % of tolerance |



## 6.2 Outside diameter, $D_o$

See table 6.



**Table 6**

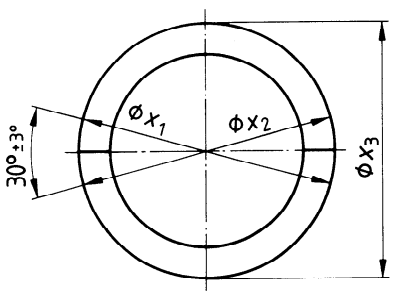
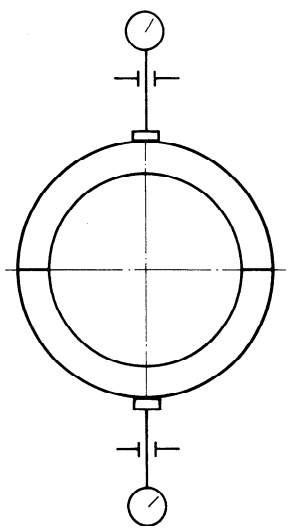
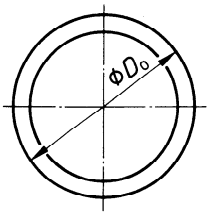
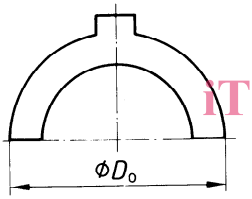
| Applicability | Definition of geometrical characteristic to be measured | Test method/measuring principle | Test equipment |
|---|---|---|---|
| **Metallic thick-walled half-bearing** | Outside diameter of a metallic thick-walled half-bearing measured as a pair in the free condition, determined using the following formula:<br>$D_o = \frac{x_3 + 0,5(x_1 + x_2)}{2}$<br>  <br><br>**Figure 9** | Measured in the radial direction between two flat parallel faces of the measuring device (see figure 10).<br>  <br>**Figure 10** | Measuring device.<br>Holding device.<br>Uncertainty of measurement: ±10 % of the tolerance on outside diameter. |
| **Wrapped bush** | See ISO 12307. | In accordance with ISO 12307. | In accordance with ISO 12307. |

**Table 6** (*concluded*)

| Applicability | Definition of geometrical characteristic to be measured | Test method/measuring principle | Test equipment |
|---|---|---|---|
| **Unsplit metallic bush; thermoplastic bush; sintered bush** | Outside diameter of a bush measured in the free condition, determined as the arithmetic mean of at least two measurements (see figure 11).<br>  <br>**Figure 11** | Measured in the radial direction between two flat parallel faces of the measuring device (see figure 10).<br>NOTE — In cases where the wall thickness outside diameter ratio is such that the bush may be considered to be flexible, $D_0$ may be measured in accordance with method A specified in ISO 12307 for wrapped bushes. | Measuring device.<br>External micrometer with dial indicator.<br>Holding device.<br>Uncertainty of measurement: ± 10 % of tolerance on outside diameter. |
| **Thrust washer** | Outside diameter of a thrust washer measured in the free condition over the outside end faces (see figure 12).<br>  <br>**Figure 12** | Measured in the radial direction between two flat parallel faces of the measuring device.<br>NOTE — Measuring method should take account of design features such as chamfers. | Standard test equipment.<br>Uncertainty of measurement: ± 10 % of tolerance on outside diameter. |



## 6.3 Inside diameter, $D_i$

See table 7.

**Table 7**

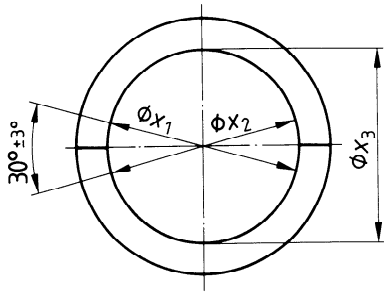
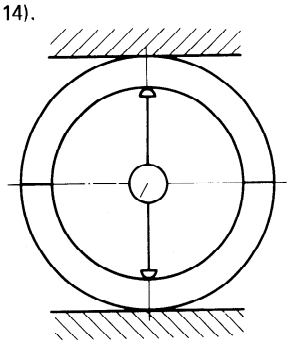
| Applicability | Definition of geometrical characteristic to be measured | Test method/measuring principle | Test equipment |
|---|---|---|---|
| **Metallic thick-walled half-bearing** | Inside diameter of a metallic thick-walled half-bearing with cylindrical bore measured as a pair in the free condition, determined using the following formula:<br>$D_i = \frac{x_3 + 0{,}5(x_1 + x_2)}{2}$<br>  <br>**Figure 13** | Measured in the radial direction using the spherical faces of the measuring pins (see figure 14).<br>  <br>**Figure 14**<br>NOTES<br>1 The inside diameter may also be determined by calculating the difference between the outside diameter and the wall thickness ($D_o - s_{tot}$) (see 6.1 and 6.2).<br>2 The defined position of the measuring areas may have to be modified to avoid design features such as oil pockets, etc. | Measuring device, such as an internal two-point contact measuring instrument with a contact radius of 3 ± 0,2.<br>Holding device.<br>Uncertainty of measurement: ± 10 % of the tolerance on inside diameter. |

**Table 7** (*continued*)

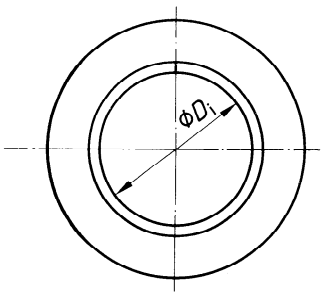
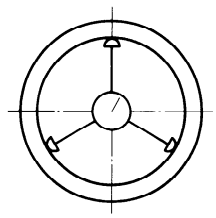
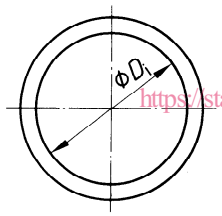
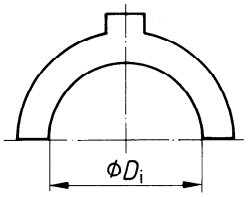
<table>
<tr><th>Applicability</th><th>Definition of geometrical characteristic to be measured</th><th>Test method/measuring principle</th><th>Test equipment</th></tr>
<tr><td>Wrapped bush</td><td>Inside diameter of a wrapped bush measured in pressed-in position (see figure 15).<br>  <br><br>Figure 15</td><td>Measured in the radial direction using the spherical faces of the measuring pins (see figure 16).<br>NOTE — The inside diameter may also be determined by calculating the difference between the outside diameter and the wall thickness ($D_o - s_{tot}$) (see 6.1 and 6.2).<br>  <br>Figure 16</td><td>Bore gauge (two- or three-point contact) with setting gauge.<br>Air gauge with setting gauge.<br>Measuring device in accordance with ISO 12306 and ISO 12307.<br>For details of the measuring device, see the following table.<br><table><tr><th>Inside diameter $D_i$</th><th>Radius for contact method</th><th>Uncertainty of measurement</th></tr><tr><td>$D_i \leqslant 15$</td><td>To be agreed</td><td rowspan="2">± 10 % of tolerance on inside diameter</td></tr><tr><td>$15 < D_i \leqslant 200$</td><td>3 ± 0,2</td></tr></table></td></tr>
<tr><td>Unsplit metallic bush; sintered bush</td><td>Inside diameter of a bush measured in the free condition, determined as the arithmetic mean of at least two measurements (see figure 17).<br>  <br><br>Figure 17</td><td>Measured in the radial direction using the spherical faces of the measuring pins (see figure 16).</td><td>Bore gauge (two- or three-point contact) with setting gauge.<br>Air gauge with setting gauge.<br>Plug gauge.<br>For details of the measuring device, see table for wrapped bush.</td></tr>
<tr><td>Thermoplastic bush</td><td>Inside diameter of a bush measured in the pressed-in condition, determined as the arithmetic mean of at least two measurements (see figure 15).</td><td>Measured in the radial direction using the spherical faces of the measuring pins (see figure 16).<br>NOTES<br>1 The bush is pressed into two ring gauges in succession, one of which corresponds to the maximum dimension and the other to the minimum dimension of the agreed tolerance zone of the location hole. When pressed into the ring gauge with the minimum dimension, the inner diameter of the bush shall not be less than the lower limit. When pressed into the ring gauge with the maximum dimension, the inner diameter of the bush shall not exceed the upper limit.<br>2 In the case of bushes with two flanges, the measurement is carried out, for example, by using split-ring gauges.</td><td>Bore gauge (two- or three-point contact) with setting gauge.<br>Air gauge with setting gauge.<br>Ring gauge.<br>For details of the measuring device, see table for wrapped bush.<br>NOTE — The use of measuring instruments which are also capable of measuring shapes of bush bores which deviate from the cylindrical shape is recommended. The width of the ring gauges shall be greater than the width of the bush; the permissible deviations for the ring gauges amount to ±1/2 IT3, in accordance with ISO 286-1.</td></tr>
</table>

**Table 7** (*concluded*)

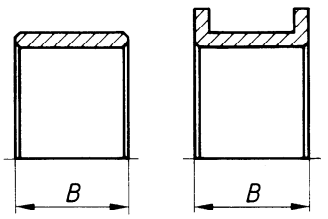
| Applicability | Definition of geometrical characteristic to be measured | Test method/measuring principle | Test equipment |
|---|---|---|---|
| **Thrust washer** | Inside diameter of a thrust washer measured in the free condition between the inside end faces (see figure 18).<br>  <br>**Figure 18** | Measured in the radial direction.<br>NOTE — Measuring method should take account of design features such as chamfers. | Standard test equipment.<br>Uncertainty of measurement: ± 10 % of tolerance on inside diameter. |

## 6.4 Width, $B$

See table 8.



**Table 8**

| Applicability | Definition of geometrical characteristic to be measured | Test method/measuring principle | Test equipment |
|---|---|---|---|
| **Thin-walled and thick-walled half-bearing; wrapped bush; unsplit metallic bush; thermoplastic bush; sintered bush** | Width between the end faces measured at any point in the axial direction (see figure 19).<br>  <br>**Figure 19** | Measured between two flat parallel faces of a measuring device.<br>NOTE — Flanged bearings may also be manufactured from plain journal bearings and thrust washers, in which case an appropriate checking method should be agreed between the manufacturer and user. | Measuring device.<br>Standard test equipment.<br>Uncertainty of measurement: ± 10 % of tolerance on length. |