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**Plain bearings — Wrapped bushes —**

**Part 2:**

Test data for outside and inside diameter

*Paliers lisses — Bagues roulées —*

*Partie 2: Données d'essai pour le diamètre extérieur et le diamètre intérieur*



## Foreword

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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 3547-2 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 3, *Dimensions, tolerances and construction details*.

This first edition of ISO 3547-2, together with ISO 3547-1, ISO 3547-3 and ISO 3547-4, cancels and replaces ISO 3547:1976 the technical content of which has been revised and augmented.

ISO 3547 consists of the following parts, under the general title *Plain bearings — Wrapped bushes*:

- *Part 1: Dimensions*
- *Part 2: Test data for outside and inside diameter*
- *Part 3: Lubrication holes, lubrication grooves and lubrication indentations*
- *Part 4: Materials*

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## Introduction

Wrapped bushes are not inherently stable when they are in their free condition. After they have been pressed into the bore of the housing, they tend to take up the shape of this bore due to the interference between the outside diameter of the bush and the bore of the housing. For this reason the outside diameter and the inside diameter of wrapped bushes can only be checked with special gauges and test equipment. Thus special test data are required on the drawing to enable this checking to be done.

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# Plain bearings — Wrapped bushes —

## Part 2:

### Test data for outside and inside diameter

#### 1 Scope

This part of ISO 3547 specifies test data for outside and inside diameters of wrapped bushes made of solid and multilayer bearing material for application as plain bearings. It also specifies test designations.

Since the wall thickness of the bush is measured in the free condition, no special test data are required for this on the drawing (see ISO 12307-1 and ISO 12307-2).

NOTE Depending on the manufacturing method the back of the bushes may show isolated light depressions and similarly bushes with lubrication holes, grooves and bore indentations may show distortion. The wall thickness must therefore be measured away from these areas.

#### 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 3547. 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 3547 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 3547-1:1999, *Plain bearings — Wrapped bushes — Part 1: Dimensions.*

ISO 3547-4:1999, *Plain bearings — Wrapped bushes — Part 4: Materials.*

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

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

ISO 12307-2:<sup>1)</sup>, *Plain bearings — Checking of wrapped bushes — Part 2: Checking the inside diameter.*

ISO 12301, *Plain bearings — Quality control techniques and inspection of geometrical and material quality characteristics.*

ISO 13715, *Technical drawings — Edges of undefined shape — Vocabulary and indication on drawings.*

#### 3 Term and definition

For the purposes of this part of ISO 3547 the definition of a wrapped bush as given in ISO 4378-1 applies.

<sup>1)</sup> To be published.

## 4 Symbols and units

See Table 1 and Figure 1.

Table 1 — Symbols and units

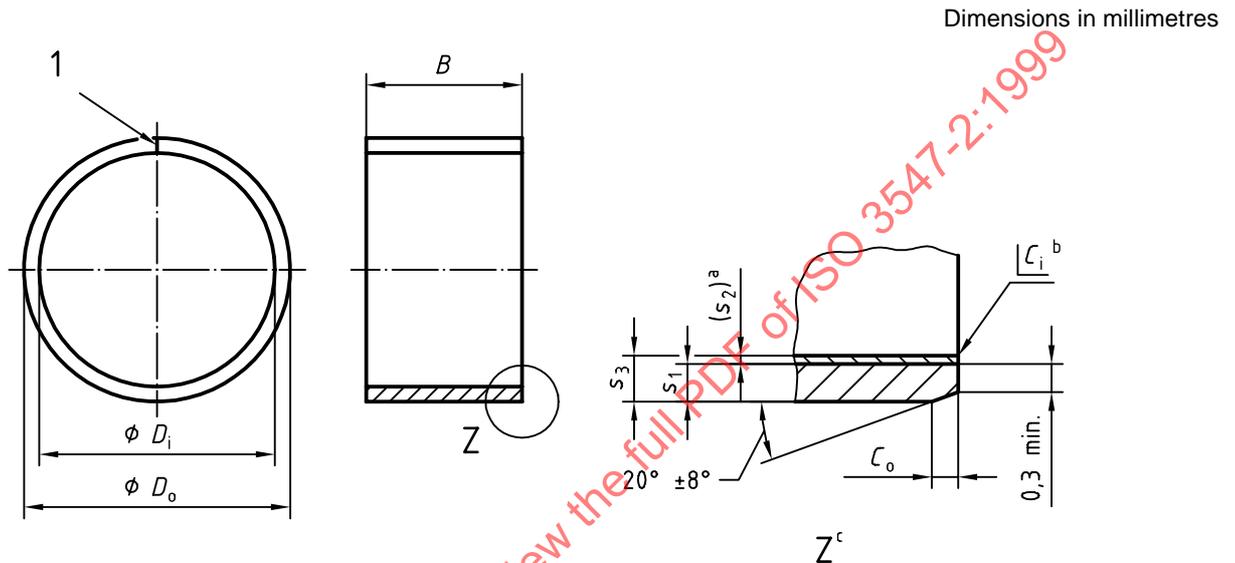
Symbol	Term	Unit
$A_{cal}$	Reduced area of cross section (calculated value) of the bush	mm <sup>2</sup>
$B$	Nominal width of the bush	mm
$C_i$	Inside chamfer	mm
$C_o$	Outside chamfer	mm
$D_i$	Nominal inside diameter of the bush	mm
$D_{i,ch}$	Inside diameter of the bush in the ring gauge	mm
$D_o$	Nominal outside diameter of the bush	mm
$F_{ch}$	Test force	N
$d_{ch}$	Diameter of the checking block $d_{ch,1}$ and setting mandrel $d_{ch,2}$	mm
$s_1$	Thickness of the steel layer <sup>a</sup>	mm
$s_2$	Thickness of the bearing material layer <sup>a</sup>	mm
$s_3$	Wall thickness <sup>a</sup>	mm
$T$	Tolerance of $D_o$	mm
$v$	Elastic reduction of the outside diameter under test force $F_{ch}$	mm
$z$	Distance apart of the halves of the test housing	mm
$\Delta z$	Indicator reading	mm
$\Delta z_D$	Circumference indicator reading for test D	mm
<sup>a</sup>	For bushes which are made of a single material $s_1 = s_3$ or $s_2 = s_3$	

## 5 Notes pertaining to the data shown on the drawing

The drawing should show:

- outside diameter  $D_o$  and wall thickness  $s_3$ , or
- outside diameter  $D_o$  and inside diameter  $D_i$ .

In no case shall the wall thickness  $s_3$  and the inside diameter  $D_i$  both be specified as dimensions that should be checked.



### Key

1 Split

- a Thickness of the bearing material layer: only valid as a basis for calculation in accordance with ISO 3547-1.
- b  $C_i$  can be a radius or a chamfer, in accordance with ISO 13715.
- c Shown on a bush made out of a multilayer material.

Figure 1

## 6 Types of test

### 6.1 Test A

Checking the outside diameter  $D_o$  in a test rig with checking block and setting mandrel as specified in clause 7.

### 6.2 Test B

Checking the outside diameter  $D_o$  with two ring gauges as specified in clause 8.

### 6.3 Test C

Checking the inside diameter  $D_i$  of a bush pressed into a ring gauge as specified in clause 9.

### 6.4 Test D

Checking the outside diameter  $D_o$  by precision measuring tape as specified in clause 10.

## 7 Test A

### 7.1 Description

The test rig consists of a base on which the two parts of the checking block are mounted, see ISO 12307-1.

After the bush has been placed in position with the split at the top, the two halves of the checking block are pressed towards one another using the given test force  $F_{ch}$ . The test force causes the bush to be seated into the bore of the checking block in a satisfactory manner.

During the test the outside diameter of the bush is made smaller by the elastic reduction  $\nu$  (see Table 3), however no permanent reduction of the outside diameter takes place. The setting of the indicating device to the correct distance is achieved using a setting mandrel with test force  $F_{ch}$  applied. This adjusts the distance  $z$  between the two halves of the checking block.

**Table 2 — Maximum difference between the diameters of checking block  $d_{ch,1}$  and setting mandrel  $d_{ch,2}$**

$D_o$		$d_{ch,1} - d_{ch,2}$ max.
$>$	$\leq$	
—	18	0,006
18	50	0,008
50	80	0,01
80	120	0,012
120	180	0,016

After the bush has been inserted the distance  $z$  between the two halves of the checking block changes under the test force  $F_{ch}$  and the distance indicator should read  $\Delta z$ . From this the outside bush diameter  $D_o$  can be calculated:

$$D_o = d_{ch,2} + \nu + \frac{2}{\pi} \cdot \Delta z$$

### 7.2 Calculation basis

#### 7.2.1 Elastic reduction $\nu$ of outside diameter $D_o$

The elastic reduction  $\nu$  of the outside diameter is the difference between the outside diameter  $D_o$  under zero load and that diameter that is present when the test force  $F_{ch}$  is applied. In order to ensure that the bush properly conforms to the surface of the test housing the force  $F_{ch}$  must have a certain value. The test force is so fixed that it produces the given elastic reduction  $\nu$  in the outside diameter that is shown in Table 3.

**Table 3 — Elastic reduction  $v$  of the outside diameter  $D_o$  under test force  $F_{ch}$**

$D_o$		$v$
$>$	$\leq$	
—	6	0,003
6	12	0,006
12	80	0,013
80	180	0,025

### 7.2.2 Diameter of the checking block $d_{ch,1}$ and test force $F_{ch}$

The diameter of the checking block can be calculated from the specified upper limit of the outside diameter from the equation:

$$d_{ch,1} = D_{o, \max} - v$$

By using the figures in Table 3 the values for  $d_{ch,1}$  and  $F_{ch}$  given in Table 4 are obtained.

**Table 4 — Formulae for  $d_{ch,1}$  and  $F_{ch}$**

$D_o$	$D_o \leq 6$	$6 < D_o \leq 12$	$12 < D_o \leq 80$	$80 < D_o \leq 180$
$d_{ch,1}$	$D_{o, \max} - 0,003$	$D_{o, \max} - 0,006$	$D_{o, \max} - 0,013$	$D_{o, \max} - 0,025$
$F_{ch}$	$1500 \times \frac{A_{cal}}{d_{ch,1}}$ (rounded up to 100 N)	$3000 \times \frac{A_{cal}}{d_{ch,1}}$ (rounded up to 250 N)	$6000 \times \frac{A_{cal}}{d_{ch,1}}$ (rounded up to 500 N)	$12000 \times \frac{A_{cal}}{d_{ch,1}}$ (rounded up to 500 N)

NOTE When calculating  $F_{ch}$  the factors 1 500, 3 000, 6 000 or 12 000 have the unit N/mm.

### 7.2.3 Reduced cross section area $A_{cal}$

The nominal size for  $B$ ,  $s_1$  and  $s_2$  should be put into the following equations.

$$A_{cal} = B \times s_1 \quad \text{for steel, steel/lead alloy, steel/tin alloy and steel/plastic}$$

$$A_{cal} = B \times \left( s_1 + \frac{s_2}{2} \right) \quad \text{for steel/copper alloy}$$

$$A_{cal} = B \times \frac{s_2}{2} \quad \text{for copper alloy}$$

$$A_{cal} = B \times \left( s_1 + \frac{s_2}{3} \right) \quad \text{for steel/aluminium alloy}$$

Lubrication grooves can reduce the cross sectional area  $A_{cal}$  depending upon their shape, position and method of manufacture. If the proportion is over 10 % this must be considered in the calculation.

NOTE For bushes which are not made in accordance with ISO 3547-1 the arithmetic average of the two limiting dimensions rounded up to the nearest 0,1 mm should be used for  $B$ ,  $s_1$  and  $s_2$ .

**7.2.4 Limits for  $\Delta z$** 

Upper limit: 0

Lower limit:  $-\frac{\pi}{2} \times T$  (rounded up to the nearest 0,005 mm)**7.2.5 Example for the calculation of the details on the drawing****Given:**

Bush ISO 3547 - 30A 34 × 30 - S3

Outside diameter:  $D_o = (34^{+0,085}_{+0,045})$  mmWall thickness:  $s_3 = (2^{0}_{-0,015})$  mmThickness of the steel layer:  $s_1 = 1,55$  mm  $\pm$  0,2 mmWidth of the bush:  $B = 30$  mm  $\pm$  0,5 mm

Material: steel/copper alloy S3 (in accordance with ISO 3547-4:1999).

**Results:**From 7.2.2:  $d_{ch,1} = D_{o, \max} - v = 34,085$  mm  $-$  0,013 mm

$$d_{ch,1} = 34,072$$
 mm

From 7.2.3:  $A_{cal} = B \times \left( s_1 + \frac{s_2}{2} \right) = 30 \times \left( 1,55 + \frac{0,45}{2} \right)$  mm<sup>2</sup>

$$A_{cal} = 53,25$$
 mm<sup>2</sup>

NOTE  $s_2 = s_3 - s_1 = 2$  mm  $-$  1,55 mm  $=$  0,45 mmFrom 7.2.2:  $F_{ch} = 6\,000 \times \frac{A_{cal}}{d_{ch,1}} = 6\,000 \times \frac{53,25}{34,072} = 9\,377$  N

$$F_{ch} = 9\,500$$
 N (rounded up to the nearest 500 N)

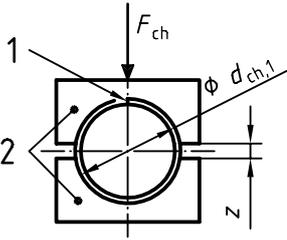
From 7.2.4:  $\Delta z$ 

Upper limit: 0

Lower limit:  $-\frac{\pi}{2} \times T = -\frac{\pi}{2} \times 0,040$  mm  $=$   $-0,062\,8$  mm  $=$   $-0,065$  mm

(rounded up to the nearest 0,005 mm)

### 7.2.6 Example of how the data should be put on the drawing

 <p><b>Key</b>  1 Position of the split  2 Checking block</p>	<p><b>Test A of ISO 3547-2</b></p> <p>Checking block and setting mandrel <math>d_{ch,1} = d_{ch,2} = 34,072</math> mm</p> <p>Test force <math>F_{ch} = 9\,500</math> N</p> <p>Limit for <math>\Delta z = 0</math> and <math>-0,065</math> mm</p> <p>Outside diameter <math>D_o = 34,045</math> to <math>34,085</math> mm</p>
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## 8 Test B

### 8.1 Description

The test is carried out with two ring gauges, a GO ring gauge and a NO GO ring gauge whose diameters shall be chosen empirically from with Table 6 of ISO 3547-1:1999 and agreed upon.

It shall be possible to press the bushes into the GO ring gauge and then push them through with hand pressure (maximum force 250 N). On the other hand with the same force it shall not be possible for them to go into the NO GO ring gauge (see ISO 12307-1).

NOTE In some cases the accuracy of the check may be affected, e.g., by the out of roundness of the bush or by butt joints which are not closed. For this reason Test A is preferred.

### 8.2 Example of how the data to be put on the drawing is obtained

#### Given:

Bush ISO 3547 - 30A 34 × 30 - S3

Outside diameter:  $D_o = (34^{+0,085}_{+0,045})$  mm

Material: steel/copper alloy S3 (in accordance with ISO 3547-4:1999)

GO gauge diameter = 34,095 mm  
NO GO gauge diameter = 34,045 mm } found empirically

### 8.3 Example of how the data should be put on the drawing

<b>Test B of ISO 3547-2</b>	
GO gauge diameter = 34,095 mm	
NO GO gauge diameter = 34,045 mm	

## 9 Test C

### 9.1 Description

To check the inside diameter  $D_{i,ch}$  the bush is to be pressed into a ring gauge, whose nominal diameter corresponds to the dimension specified in Table 5 of ISO 3547-1:1999. Other details of the ring gauge should comply with ISO 12307-2.

The inside diameter  $D_{i,ch}$  shall be measured with a 3-point measuring instrument (see ISO 12301) or checked with a GO and NO GO plug gauge.

The diameters of the GO and NO GO plug gauges  $d_{ch,2}$  are in accordance with the tolerances of the inside diameter  $D_{i,ch}$  of the bush in the ring gauge given in Table 4 of ISO 3547-1:1999.

The GO plug gauge shall be inserted by a minimum effort; the NO GO plug gauge shall not be inserted by manual pressure (maximum force 250 N).

When the bush is pressed into the ring gauge it is possible that there will be a permanent reduction in the outside diameter.

NOTE In order to enable the manufacturer and the customer to compare results of this test it should be agreed whether results should be obtained by measuring or by gauging.

### 9.2 Example of how the data to be put on the drawing is obtained

#### Given:

Bush ISO 3547 - 30W 34 × 30 - Y1

Material: copper-tin-alloy Y1 (in accordance with ISO 3547-4:1999)

Housing bore:  $\begin{matrix} 4H \\ 0 \end{matrix} = (34^{+0,025}) \text{ mm}$

Inside diameter:  $D_{i,ch} = (30^{+0,052}) \text{ mm}$ , of the bush in the ring gauge, gauging test (Table 4 of ISO 3547-1:1999)

Ring gauge inside diameter:  $= (34,013^{+0,003}) \text{ mm}$  (Table 5 of ISO 3547-1:1999 and Table 2 of ISO 12307-2:—)

Outside diameter of the GO plug gauge:  $= (30,000_{-0,003}^0) \text{ mm}$

Outside diameter of the NO GO plug gauge:  $= (30,052_{-0,003}^0) \text{ mm}$  (Table 4 of ISO 3547-1:1999 and Table 2 of ISO 12307-2:—)