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Plain bearings — Thermoplastic bushes — Dimensions and tolerances

Paliers lisses — Bagues thermoplastiques — Dimensions et tolérances

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 7, *Special types of plain bearings*.

This second edition cancels and replaces the first edition (ISO 16287:2005), which has been technically revised. The main changes compared to the previous edition are as follows:

— Clause 3, “Terms and definitions”, has been added;

— Figures 2 and 3 have been revised.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Plain bearings — Thermoplastic bushes — Dimensions and tolerances

1 Scope

This document specifies the dimensions and tolerances for inserted thermoplastic bushes used as plain bearings with or without lubrication grooves in accordance with ISO 12128. These thermoplastic bushes are dimensionally exchangeable to wrapped bushes according to ISO 3547-1.

This document is not applicable to reinforced plastics.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 3547-2, *Plain bearings — Wrapped bushes — Part 2: Test data for outside and inside diameters*

ISO 6691, *Thermoplastics polymers for plain bearings — Classification and designation*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Symbols

B	nominal width of bush
B_{fl}	flange thickness
C_i	inside chamfer
C_o	outside chamfer
D_{fl}	flange diameter
D_H	nominal housing bore diameter
D_i	nominal inside diameter of the bush
$D_{i,ch}$	inside diameter of the bush when inserted in a ring gauge middle H7
D_o	nominal outside diameter of the bush
r	radius for flange bushes

5 Dimensions

The dimensions and tolerances of the thermoplastic bushes are shown in Figures 1 and 2, according to whether cylindrical (type C) or flanged (type F), and given, in millimetres, in Tables 1, 2, 3 and 4. The surface finishes *x* and *y* represented in Figures 1 and 2 are given in Table 5.

For the determination of the IT value (see ISO 286-1) of the coaxiality tolerance, the dimensions of D_o are applicable.

For the determination of the IT value (ISO 286-1) of the axial run-out tolerance, the dimensions of D_{fl} are applicable.

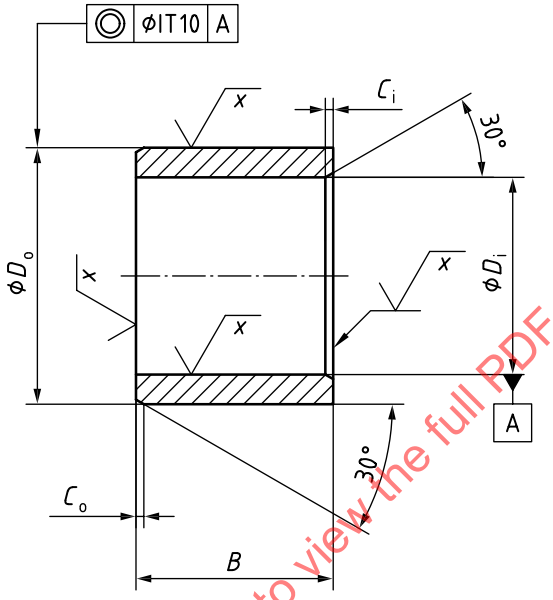

Figure 1 — Cylindrical bush

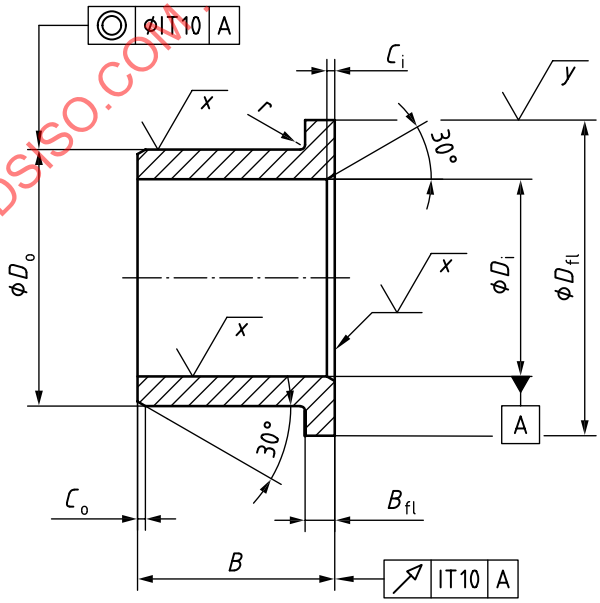

Figure 2 — Flanged bush

Table 1 — Nominal sizes and limits for thick-walled bushes type C and type F

Dimensions in millimetres

D_i[d]	D_o				D_{fl}[e]	B_{fl}	B[a]			C_i[b] C_o[c]	r
			Limits for tolerance group (see Table 5)								
nom.	nom.		A	B	d13	h13	h13			maximum	maximum
6	10	12	+0,21		14	3	6	10	—	0,8	0,5
8	12	14	+0,07		18	3	6	10	15	0,8	0,5
10	14	16	+0,27		20	3	6	10	15	0,8	0,5
12	16	18	+0,09		22	3	10	15	20	0,8	0,8
14	18	20			25	3	10	15	20	0,8	0,8
15	18	21	+0,33		27	3	10	15	20	0,8	0,8
16	20	22	+0,11		28	3	12	15	20	0,8	0,8
18	22	24			30	3	12	20	30	0,8	0,8
20	24	26	+0,45		32	3	15	20	30	1,5	0,8
22	26	28	+0,15		34	3	15	20	30	1,5	0,8
24	28	30			36	3	15	20	30	1,5	0,8
25	30	32			38	4	20	30	40	1,5	0,8
28	34	36	+0,60		42	4	20	30	40	2	0,8
30	36	38	+0,20		44	4	20	30	40	2	0,8
32	38	40		zb11	46	4	20	30	40	2	0,8
35	41	45	+0,69		50	5	30	40	50	2	0,8
38	45	48	+0,23		54	5	30	40	50	2	0,8
40	48	50			58	5	30	40	60	2	0,8
42	50	52	+0,90		60	5	30	40	60	2	0,8
45	53	55	+0,30		63	5	30	40	60	2,5	0,8
48	56	58			66	5	40	50	60	2,5	0,8
50	58	60			68	5	40	50	60	2,5	0,8
55	63	65			73	5	40	50	70	2,5	0,8
60	70	75			83	7,5	40	60	80	2,5	0,8
65	75	80			88	7,5	50	60	80	2,5	2
70	80	85			95	7,5	50	70	90	2,5	2
75	85	90			100	7,5	50	70	90	2,5	2
80	90	95			105	7,5	60	80	100	2,5	2
85	95	100			110	7,5	60	80	100	2,5	2
90	105	110			120	10	60	80	120	2,5	2
95	110	115			125	10	60	100	120	2,5	2
100	115	120			130	10	80	100	120	2,5	2
105	120	125	f		135	10	80	100	120	2,5	2
110	125	130			140	10	80	100	120	2,5	2
120	135	140			150	10	100	120	150	2,5	2
130	145	150			160	10	100	120	150	3	2
140	155	160		za11	170	10	100	150	180	3	2

[a] If it is necessary to use the non-standard width B, then these should be arranged to have a final digit of 0, 2, 5 or 8.

[b] As an alternative to the chamfer C_i, a 45° angle may be used.

[c] As an alternative to the chamfer C_o, a radius may be used.

[d] Depending on the material, the wall thickness shall be rated so that the inside diameter D_i of the fitted bush is within the tolerance classes F10 to D12 respectively.

[e] For D_{fl}, the tolerance class d13 is preferred. Other tolerance class up to h13 are allowable and shall be subject to agreement between the manufacturer and the user.

[f] To be agreed between the manufacturer and the user.

Table 1 *(continued)*

D_i[d] nom.	D_o nom.		Limits for tolerance group (see Table 5) A	B	D_{fl}[e] d13	B_{fl} h13	B[a] h13			C_i[b] C_o[c] maximum	r maximum
150	165	170			180	10	120	150	180	3	2
160	180	185			200	12,5	120	150	180	3	2
170	190	195			210	12,5	120	180	200	3	2
180	200	210			220	15	150	180	250	3	2
190	210	220			230	15	150	180	250	3	2
200	220	230			240	15	180	200	250	3	2

[a] If it is necessary to use the non-standard width B, then these should be arranged to have a final digit of 0, 2, 5 or 8.

[b] As an alternative to the chamfer C_i, a 45° angle may be used.

[c] As an alternative to the chamfer C_o, a radius may be used.

[d] Depending on the material, the wall thickness shall be rated so that the inside diameter D_i of the fitted bush is within the tolerance classes F10 to D12 respectively.

[e] For D_{fl}, the tolerance class d13 is preferred. Other tolerance class up to h13 are allowable and shall be subject to agreement between the manufacturer and the user.

[f] To be agreed between the manufacturer and the user.

Table 2 — Nominal sizes and limits for thin-walled cylindrical bushes type C

Dimensions in millimetres

D_i[d] nom.	D_o nom.	Limits for tolerance group (see Table 5) A	B	B[a] h13						C_i[b] C_o[c] maximum
6	8	+0,21		4	6	8	10	—	—	0,8
8	10	+0,07		6	8	10	12	15	—	0,8
10	12	+0,27		6	8	10	12	15	20	0,8
12	14	+0,09		8	10	12	15	20	25	0,8
14	16			10	12	15	20	25	—	0,8
15	17	+0,33		10	12	15	20	25	—	0,8
16	18	+0,11		10	12	15	20	25	—	0,8
18	20			10	15	20	25	—	—	0,8
20	23	+0,45		10	15	20	25	30	—	1,5
22	25	+0,15		—	15	20	25	30	—	1,5
24	27			—	15	20	25	30	—	1,5
25	28			—	15	20	25	30	50	1,5
28	32	+0.60		—	15	20	25	30	—	2
30	34	+0,20	zb11	10	15	20	25	30	40	2
32	36			20	30	40	—	—	—	2
35	39	+0,69		20	30	35	40	50	—	2
38	42	+0,23		20	30	40	—	—	—	2
40	44			20	30	40	50	—	—	2

[a] If it is necessary to use the non-standard width B, then these should be arranged to have a final digit of 0, 2, 5 or 8.

[b] As an alternative to the chamfer C_i, a 45° angle may be used.

[c] As an alternative to the chamfer C_o, a radius may be used.

[d] Depending on the material, the wall thickness shall be rated so that the inside diameter D_i of the fitted bush is within the tolerance classes F10 to D12 respectively.

[e] To be agreed between the manufacturer and the user.

Table 2 *(continued)*

D_i[d]	D_o		B[a]						C_i[b] C_o[c]
		Limits for tolerance group (see Table 5)							
nom.	nom.	A	B	h13					maximum
45	50	+0,90 +0,30		20	30	40	45	50	—	2,5
50	55			20	30	40	50	60	—	2,5
55	60			20	30	40	50	60	—	2,5
60	65			20	30	40	50	60	70	2,5
65	70			30	50	70	—	—	—	2,5
70	75			30	40	50	70	—	—	2,5
75	80			—	40	60	80	—	—	2,5
80	85			—	40	60	80	100	—	2,5
85	90			30	40	60	80	100	—	2,5
90	95		za11	40	60	100	—	—	—	2,5
95	100			—	60	100	—	—	—	2,5
100	105	e		50	60	100	115	—	—	2,5
105	110			60	100	105	—	—	—	2,5
110	115			60	100	115	—	—	—	2,5
115	120			60	100	—	—	—	—	2,5
120	125			60	100	—	—	—	—	2,5
125	130			60	100	—	—	—	—	2,5
130	135			60	100	—	—	—	—	3
135	140			60	100	—	—	—	—	3
140	145			60	100	—	—	—	—	3
150	155			60	100	—	—	—	—	3

[a] If it is necessary to use the non-standard width B, then these should be arranged to have a final digit of 0, 2, 5 or 8.

[b] As an alternative to the chamfer C_i, a 45° angle may be used.

[c] As an alternative to the chamfer C_o, a radius may be used.

[d] Depending on the material, the wall thickness shall be rated so that the inside diameter D_i of the fitted bush is within the tolerance classes F10 to D12 respectively.

[e] To be agreed between the manufacturer and the user.

Table 3 — Nominal sizes and limits for thin-walled flanged bushes type F

Dimensions in millimetres

D_i[d]	D_o	Limits for tolerance group (see Table 5)		D_{fl}[e]	B_{fl}	B[a]			C_i[b] C_o[c]	r
nom.	nom.	A	B	d13	h13	h13			maximum	maximum
6	8	+0,21 +0,07	zb11	12	1	6	10	—	0,8	0,5
8	10			15	1	6	10	15	0,8	0,5
10	12	+0,27 +0,09		18	1	6	10	15	0,8	0,5
12	14			20	1	10	15	20	0,8	0,8
14	16			22	1	10	15	20	0,8	0,8
15	17	+0,33 +0,11		23	1	10	15	20	0,8	0,8
16	18			24	1	12	15	20	0,8	0,8
18	20			26	1	12	20	30	0,8	0,8
20	23	+0,45 +0,15		30	1,5	15	20	30	1,5	0,8
22	25			31	1,5	15	20	30	1,5	0,8
24	27			34	1,5	15	20	30	1,5	0,8
25	28			35	1,5	20	30	40	1,5	0,8
28	32	+0,60 +0,20		39	2	20	30	40	2	0,8
30	34			42	2	20	30	40	2	0,8
32	36			44	2	20	30	40	2	0,8
35	39	+0,69 +0,23		47	2	30	40	50	2	0,8
38	42			50	2	30	40	50	2	0,8
40	44			53	2	30	40	60	2	0,8
42	47	+0,90 +0,30		55	2,5	30	40	60	2	0,8
45	50			58	2,5	30	40	60	2,5	0,8
48	53			62	2,5	40	50	60	2,5	0,8
50	55			65	2,5	40	50	60	2,5	0,8
55	60			70	2,5	40	50	70	2,5	0,8
60	65	f		75	2,5	40	60	80	2,5	0,8
65	70			80	2,5	50	60	80	2,5	2
70	75			85	2,5	50	70	90	2,5	2
75	80			90	2,5	50	70	90	2,5	2
80	85			95	2,5	60	80	100	2,5	2
85	90			100	2,5	60	80	100	2,5	2
90	95			110	2,5	60	80	120	2,5	2
95	100			115	2,5	60	100	—	2,5	2
100	105			120	2,5	80	100	120	2,5	2

[a] If it is necessary to use the non-standard width B, then these should be arranged to have a final digit of 0, 2, 5 or 8.

[b] As an alternative to the chamfer C_i, a 45° angle may be used.

[c] As an alternative to the chamfer C_o, a radius may be used.

[d] Depending on the material, the wall thickness shall be rated so that the inside diameter D_i of the fitted bush is within the tolerance classes F10 to D12 respectively.

[e] For D_{fl}, the tolerance class d13 is preferred. Other tolerance class up to h13 are allowable and shall be subject to agreement between manufacturer and user.

[f] To be agreed between manufacturer and user.

Table 3 *(continued)*

D_i[d]	D_o			D_{fl}[e]	B_{fl}	B[a]			C_i[b] C_o[c]	r
		Limits for tolerance group (see Table 5)								
nom.	nom.	A	B	d13	h13	h13			maximum	maximum
105	110		za11	125	2,5	80	100	—	2,5	2
110	115			130	2,5	80	100	120	2,5	2
120	125			140	2,5	100	—	—	2,5	2
130	135			150	2,5	100	—	—	3	2
140	145			160	2,5	100	—	—	3	2
150	155			170	2,5	100	—	—	3	2

[a] If it is necessary to use the non-standard width B, then these should be arranged to have a final digit of 0, 2, 5 or 8.

[b] As an alternative to the chamfer C_i, a 45° angle may be used.

[c] As an alternative to the chamfer C_o, a radius may be used.

[d] Depending on the material, the wall thickness shall be rated so that the inside diameter D_i of the fitted bush is within the tolerance classes F10 to D12 respectively.

[e] For D_{fl}, the tolerance class d13 is preferred. Other tolerance class up to h13 are allowable and shall be subject to agreement between manufacturer and user.

[f] To be agreed between manufacturer and user.

Table 4 — Nominal sizes and limits for thin-walled flanged bushes type F with widths *B* from ISO 3547-1

Dimensions in millimetres

D_i[c]	D_o		D_{fl}[d]	B_{fl}	B				C_i[a] C_o[b]	r
		Limits for tolerance group (see Table 5)								
nom.	nom.	A	B	d13	h13	h13				maximum	maximum
6	8	+0,21 +0,07	zb11	12	1	4	8	—	—	0,8	0,5
8	10			15	1	5,5	7,5	9,5	—	0,8	0,5
10	12	+0,27 +0,09		18	1	7	9	12	17	0,8	0,5
12	14			20	1	7	9	12	17	0,8	0,8
14	16			22	1	12	17	—	—	0,8	0,8
15	17	+0,33 +0,11		23	1	9	12	17		0,8	0,8
16	18			24	1	12	17	—	—	0,8	0,8
18	20			26	1	12	17	22	—	0,8	0,8
20	23	+0,45 +0,15		30	1,5	11,5	16,5	21,5	—	1,5	0,8
25	28			35	1,5	11,5	16,5	21,5	—	1,5	0,8
30	34	+0,60 +0,20		42	2	16	26	—	—	2	0,8
35	39	+0,69 +0,23		47	2	16	26	—	—	2	0,8
40	44			53	2	16	26	—	—	2	0,8
45	50	+0,90 +0,30		58	2,5	16	26	—	—	2,5	0,8

[a] As an alternative to the chamfer C_i, a 45° angle may be used.

[b] As an alternative to the chamfer C_o, a radius may be used.

[c] Depending on the material, the wall thickness shall be rated so that the inside diameter D_i of the fitted bush is within the tolerance classes F10 to D12 respectively.

[d] For D_{fl}, the tolerance class d13 is preferred. Other tolerance class up to h13 are allowable and shall be subject to agreement between manufacturer and user.

6 Material

Thermoplastics shall be in accordance with ISO 6691, e.g. PA, PET, PE, POM.

For modified or other materials, details shall be subject to agreement between the supplier and the purchaser.

NOTE Thermoplastics have a higher coefficient of linear thermal expansion than metals. PA absorbs more moisture than the other materials given and thus, in addition, will alter in volume.

With the tolerance zones and fits specified in this document, these properties are taken into account under the following conditions:

a) the bearing clearance is designed for an operating temperature of the bush of –10 °C to +50 °C and a relative ambient humidity of 20 % to 95 %;

b) interference fit in the housing is achieved by the insertion interference (limit deviation of D_o) and is also maintained at operating temperatures of –10 °C to +50 °C;

c) Tables 1, 2, 3 and 4 are based upon shaft and housing having coefficients of linear thermal expansion of $10 \cdot 10^{-6} \cdot K^{-1}$ to $12 \cdot 10^{-6}$ K^{-1}.

For other operating conditions than those given above, the bearing clearance and the type of fixing shall be reviewed and validated. The tolerances are applicable in the conditioned state of the bushes, i.e. they shall have the temperature (23 °C) and the moisture content (50 %) resulting at a standard atmosphere in accordance with ISO 554 (23/50).

To maintain their dimensions, bushes made of PA shall be stored in the above given standard atmosphere or in a suitable hermetically sealed condition.

7 Design

The surface finish and tolerance classes shall be in accordance with Table 5, for group A or B.

Table 5 — Surface finish and limits

Tolerance group	Method of manufacture	Surface finish of bush µm				Tolerance class for D_i resulting after insertion into the housing bore	Tolerance class of housing bore diameter D_H	Tolerance class of shaft
		x^a		y^a				
		Rz	*Ra*	*Rz*	*Ra*			
A	moulded	16	2,5	100	25	F10 to D12	H7	h7 to h9
B	machined	25	6,3			C11		
[a] *Rz* or *Ra* on agreement.								

The edges shall be free from flash or burrs.

Due to the large insertion interference, the leading edge of the housing bore shall be suitably chamfered or rounded in order to avoid damage during insertion (see Figure 3 in Clause 9).

The standard bearings (type C and type F) shall have a minimum of one outside diameter chamfer and one inside diameter chamfer at opposite ends. By agreement, additional chamfers may be provided.

8 Testing

8.1 General

The dimensions of the bush shall be tested in the conditioned state (see also the Note in Clause 6).

8.2 Outside diameter, D_o

a) Check the outside bush diameter with two ring gauges.

The GO ring corresponds to the maximum D_o size limit and the NO GO ring to the minimum D_o size limit according to Tables 1 to 4 or supplier specification for special thermoplastic compounds.

b) Measure the outside diameter in free condition, determined as the arithmetic mean of at least two measurements (see ISO 12301).

8.3 Inside diameter, D_i

a) Check the inside bush diameter with two ring gauges.

Insert the bush successively into two gauging rings, one corresponding to the maximum size limit and the other to the minimum size limit of the housing tolerance class H7.

The inside bush diameter shall not exceed the bottom limit of the specified tolerance class according to Table 5, when inserted into the gauging ring having the minimum housing tolerance limit.

The inside bush diameter shall not exceed the upper limit of the specified tolerance class when inserted into the gauging ring having the maximum housing tolerance limit.

The inside maximum and minimum bush diameter shall be checked with a GO and NO GO plug gauge or measured with a 3-point measuring instrument.

b) Check the inside bush diameter with one ring gauge, in accordance with ISO 3547-2, test C for wrapped bushes

Press the bush into a ring gauge, the size of which is made up of D_o and the rounded average value of the tolerance class H7.

The inside diameter of the bush when it is pressed into the ring gauge $D_{i,ch}$ shall be checked with a GO and NO GO plug gauge or measured with a 3-point measuring instrument.

The width of the gauging ring shall be greater than the width of the bush.

There are tolerance differences between checking the inside diameter of the bush in two ring gauges corresponding to the H7 limit sizes [see 8.3, a)] and checking the inside bush diameter in one ring gauge with the average value of H7 [see 8.3, b)]. There are further tolerance differences between gauging and measuring the inside bush diameter. Therefore, checking details shall be subject to agreement between the supplier and the purchaser.

9 Assembling

A cylindrical or flange bush should be assembled into its housing with the aid of a stepped mandrel, preferably made from case-hardened mild steel.

A 45° lead-in chamfer should be machined in the housing to assist assembly. For flanged bushes, the minimum chamfer shall be r_{max} × 45° (to allow for the radius behind the flange).

The bush, mandrel and housing shall be correctly aligned during assembly.

Mandrel and chamfer dimensions should be as shown in Figure 3.