

INTERNATIONAL STANDARD

ISO 3548

Second edition
1999-12-01

Plain bearings — Thin-walled half bearings with or without flange — Tolerances, design features and methods of test

*Paliers lisses — Demi-coussinets minces à ou sans collerette —
Tolérances, caractéristiques de conception et méthodes d'essai*



Reference number
ISO 3548:1999(E)

Foreword

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

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 3548 was prepared by Technical Committee ISO/TC 123 *Plain bearings*, Subcommittee SC 3 *Dimensions, tolerances and construction details*.

This second edition cancels and replaces the first edition (ISO 3548:1978) and also ISO 6864:1984 the technical content of which is now incorporated in this International Standard.

Annex A forms a normative part of this International Standard.

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Printed in Switzerland

Plain bearings — Thin-walled half bearings with or without flange — Tolerances, design features and methods of test

1 Scope

This International Standard specifies tolerances, design features and test methods for thin-walled half bearings with integral flange up to an outside diameter of D_o of 250 mm and without flange up to an outside diameter of D_o of 500 mm. Due to the variety of design it is, however, not possible to standardize the dimensions of the half bearings.

Half bearings according to this International Standard are predominantly used in reciprocating machinery and consist of a steel backing and one or more bearing metal layers on the inside.

In reciprocating machinery, flanged half bearings may be used in connection with half bearings without flange.

Alternatively to serve as a flanged half bearing, it is possible to use a half bearing without flange together with two separate half thrust washers in accordance with ISO 6526; or a half bearing with assembled flanges.

NOTE All dimensions and tolerances are given in millimetres.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard 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.

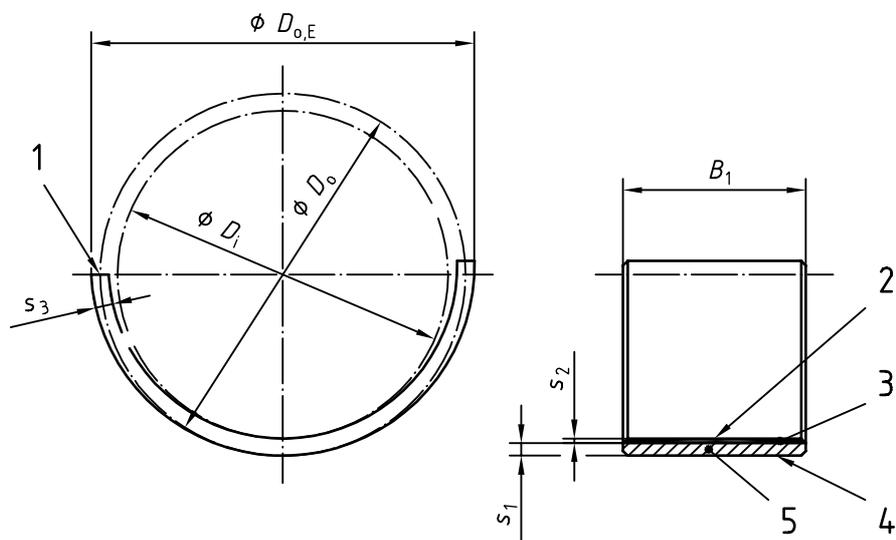
ISO 4288, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture.*

ISO 6524, *Plain bearings — Thin-walled half bearings — Checking of peripheral length.*

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

3 Symbols

See Figures 1 and 2 and Table 1.



Key

- | | |
|-------------------|----------------|
| 1 Joint face | 4 Bearing back |
| 2 Sliding surface | 5 Steel back |
| 3 Bearing metal | |

Figure 1 — Half bearing without flange
(with positive free spread)

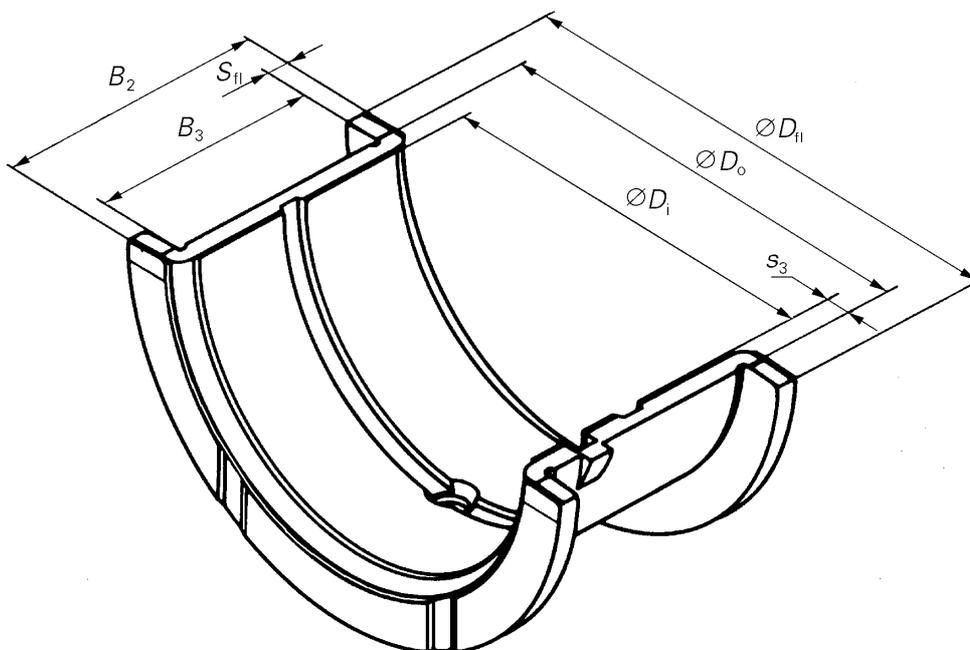


Figure 2 — Flange half bearing
(integral or assembled, excluding free spread)

Table 1 — Symbols and units

Symbol	Term	Unit
a_1	Measuring point perpendicular to plane of joint face	mm
A_{cal}	Reduced area of cross section (calculated value) of half bearing	mm ²
b_H	Housing width	mm
B_1	Half bearing width (without flange)	mm
B_2	Flange half bearing width	mm
B_3	Distance between flanges	mm
C_1	Outside chamfer	mm
C_2	Inside chamfer	
d_{Ch}	Diameter of the checking block bore	mm
d_H	Housing diameter	mm
D_{fl}	Outside diameter of flange	mm
D_i	Nominal inside diameter of the half bearing (bearing bore)	mm
D_o	Nominal outside diameter of the half bearing	mm
$D_{o,E}$	Outside diameter of the half bearing in the free state (with free spread)	mm
e_B	Amount of eccentricity	mm
F	Test force	N
F_{ax}	Axial test force for assembled flange bearings	N
h	Nip (crush, overstand), $h = h_1 + h_2$ (in checking method B)	mm
p	Amount of free spread	mm
s_{fl}	Flange thickness	mm
s_1	Thickness of the steel backing	mm
s_2	Bearing metal thickness	mm
s_3	Half bearing wall thickness	mm
s_4	Wall thickness at base of groove	mm
u	Amount of wall thickness reduction for eccentric bearing	mm

4 Dimensions and tolerances

4.1 Housing diameter, half bearing outside diameter and nip

The housing diameter shall be manufactured to tolerance class H6. Thereby the half bearing outside diameter shall be selected with such an oversize that an adequate interference fit is ensured in the housing diameter.

In the case of housings made from materials having a high coefficient of expansion or where other factors such as housing dimensional stability are involved, the housing size may depart from tolerance class H6 but shall always be produced in accordance with a grade 6 tolerance.

The half bearing in a free state is flexible so that its outside diameter cannot be measured directly. Instead of this, its peripheral length is determined by means of special checking fixtures. The peripheral length results from the periphery of the checking block bore and the nip taking into account the reduction under a given checking load per joint face (see clause 6). For the calculation of the effective interference fit of the half bearings in the housing, see [5].

The tolerances given in Table 2 for the nip, apply to half bearings with machined joint faces. Different materials and housing design require different interference fits, therefore tolerances only are given in Table 2.

4.2 Half bearing wall thickness and bearing bore

Nominal dimensions to be preferred for the wall thickness of the bearing are given in Table 2. Particulars of the wall thickness for each application cannot be specified in general, therefore only tolerances can be given for the wall thickness. These tolerances and the surface roughnesses of the bearing back and the sliding surface of half bearings with or without electroplated antifriction layers are given in Table 2.

The tolerance for the half bearing wall thickness depends on whether the bearing bore is subject to a final machining operation (i.e. "as-machined") or whether the bearing bore is electroplated without further machining (i.e. "as-plated").

Slight surface deformations are acceptable on the outside diameter of the bearing provided that they are not numerous. However, the measurement of the wall thickness shall not be carried out in these areas.

The bearing bore in the fitted state results from the housing bore which is elastically enlarged by the press fit, reduced by twice the value of the half bearing wall thickness (see [5]).

NOTE In certain applications it may be necessary to use plain or flange half bearings with eccentric bores, i.e. the wall thickness of the half bearing decreases uniformly from the crown to the joint faces (see Figures 3 and 4).

The eccentricity e_B is characterized in a radial plane by the distance between the centre x_1 of the bearing outside surface and the centre x_2 of the bearing bore. e_B is not dimensioned specifically. The eccentricity is controlled by the specified reduction u which is measured at a vertical distance a_1 from the plane of the joint face. (For guidance of draughtsmen a_1 is generally specified so that the angle α_2 is approximately 25° from the joint face.) It is subject to agreement between user and manufacturer.

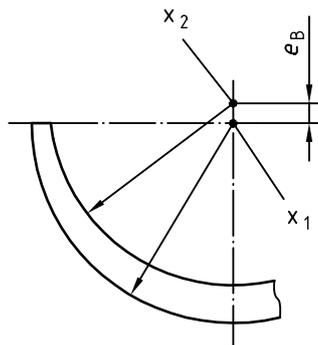


Figure 3 — Eccentric bearing bore of half bearing

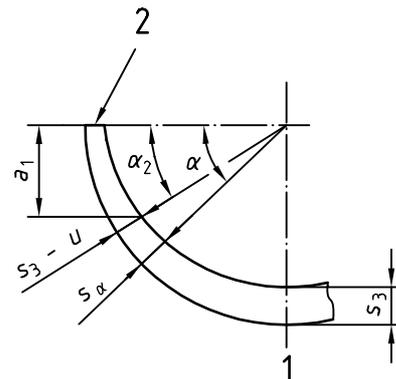


Figure 4 — Example of the wall thickness at different angles

Key
 1 Crown
 2 Joint face

The tolerance limit for the behaviour of wall thickness can be calculated according to the following approximate formula:

$$s_{\alpha,BL} = s_{3,act} - BL_u \times \frac{1 - \sin\alpha}{1 - \sin\alpha_2}$$

$$s_{\alpha,UL} = s_{3,act} - UL_u \times \frac{1 - \sin\alpha}{1 - \sin\alpha_2}$$

where

BL_u	is the bottom Limit of u ;
UL_u	is the upper Limit of u ;
$s_{3,act}$	is the actual value of s_3 ;
$s_{\alpha,BL}$	is the bottom value of s_{α} ;
$s_{\alpha,UL}$	is the upper value of s_{α}

An example of calculation is given in annex A.

4.3 Width of half bearing, distance between flanges, outside diameter of flange and flange thickness

The nominal dimension for the half bearing width and the distance between flanges depends upon the type of application, the common ratio being $B_1(B_2)/D_1 \leq 0,5$. The tolerances for the half bearing width are given in Table 2. The flange outside diameter should be smaller than the diameter of the shoulder of the shaft.

In most cases the flange thickness is fixed in conformity with the half bearing wall thickness and, in general, a tolerance is fixed only for the flange thickness of the pressure-loaded side in order to ensure that these flanges of the upper and lower half bearing have approximately the same thickness. In this case, the position of these flanges with respect to the locating nicks is fixed.

If the upper and lower half bearings are of the same design, then generally the two flanges of one half bearing must have the same thickness within the tolerance range fixed in Table 2. In that case, the flange thicknesses result from the bearing width and the distance between flanges. Nevertheless some other tolerance may be accepted after agreement between the user and the manufacturer (see clause 7).

4.4 Free spread

Free spread is influenced by factors such as the lining material, its thickness and its physical properties, by the backing material and its properties, and by the operating temperature of the assembly. Since these features are not specified in this International Standard, it is not possible to specify free spread. Free spread must in all circumstances be positive. After operation in the combustion engine at normal conditions, a sufficient amount of free spread remains in the bearing to enable it to be refitted. The actual amount of free spread shall be the subject of agreement between manufacturer and user.

NOTE Half bearings for reciprocating machinery normally have a free spread of 0,2 mm up to 3 mm. For very large thin-walled half bearings the free spread may be greater but it should not be such that the half bearing cannot be fitted into the housing.

Table 2 — Dimensions, tolerances and limit deviations for half bearings with and without flange

Housing diameter	Wall thickness	Tolerance or limit deviation for ^a										Surface ^{b,c} roughness					
		Wall thickness		Flange thickness ^{d,e}	Half bearing width			Flange outside diameter	Distance between flanges ^e	Housing width	Nip ^f	Bearing back	Sliding surface				
		s_3	s_3		B_1	B_2								D_{fl}	B_3	b_H	h
d_H	s_3	without electro-plated anti-friction layer	with electro-plated anti-friction layer ^g	s_{fl}	without flange	integral flange bearing	assembled flange bearing ^h										
>	≤																
—	50	1,5 1,75 2 2,5	— ^a	0 - 0,05	0 - 0,3	0 - 0,05	0 - 0,12	± 1	+ 0,05 0	- 0,02 - 0,07	0,03	0,8	0,8				
50	80	1,75 2 2,5 3	0,008	0 - 0,05	0 - 0,3	0 - 0,05	0 - 0,12	± 1	+ 0,05 0	- 0,02 - 0,07	0,035	0,8	0,8				
80	120	2 2,5 3 3,5	0,01	0 - 0,05	0 - 0,3	0 - 0,07	0 - 0,12	± 1	+ 0,07 0	- 0,02 - 0,07	0,04	0,8	0,8				
120	160	3 3,5 4 5	0,015	0 - 0,05	0 - 0,4	0 - 0,07	0 - 0,2	± 1,5	+ 0,07 0	- 0,02 - 0,1	0,045	1,2	0,8				
160	200	3,5 4 5	0,015	0 - 0,05	0 - 0,4	0 - 0,12	0 - 0,2	± 1,5	+ 0,07 0	- 0,02 - 0,1	0,05	1,2	0,8				
200	250	4 5 6	0,02	0 - 0,05	0 - 0,4	0 - 0,12	0 - 0,2	± 1,5	+ 0,07 0	- 0,02 - 0,1	0,055	1,2	0,8				
250	315	5 6 8	0,02	—	0 - 0,5	—	—	—	—	—	0,06	1,6	1,2				
315	400	6 8 10	0,025	—	0 - 0,5	—	—	—	—	—	0,07	1,6	1,2				
400	500	8 10 12	0,03	—	0 - 0,5	—	—	—	—	—	0,07	1,6	1,2				

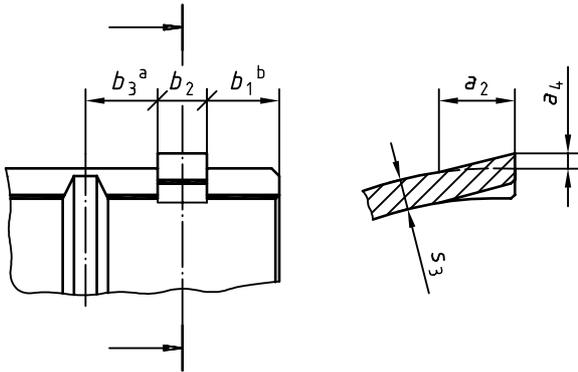
^a Subject to agreement between user and manufacturer.
^b Surface roughness in accordance with ISO 4288.
^c Surface roughness measurements of bearings with an electroplated antifriction layer may be unreliable due to penetration of the soft layer by the stylus of the measuring equipment.
^d On the pressure loaded side.
^e The limit deviations shall not be added.
^f See clause 6, Figures 18 and 19. For nip of bearings with an electroplated antifriction layer and without subsequent machining of the joint faces add 0,01 mm to the tolerance value.
^g For larger half bearings thicker electroplated antifriction layers are often used which require another machining operation. In such cases, the tolerances for sliding surfaces without electroplated antifriction layer apply.
^h Checked as shown in 7.1 and 7.2.

5 Design features

Dimensions are by agreement and tolerances as given in Tables 3 and 4.

5.1 Locating nick and nick recess

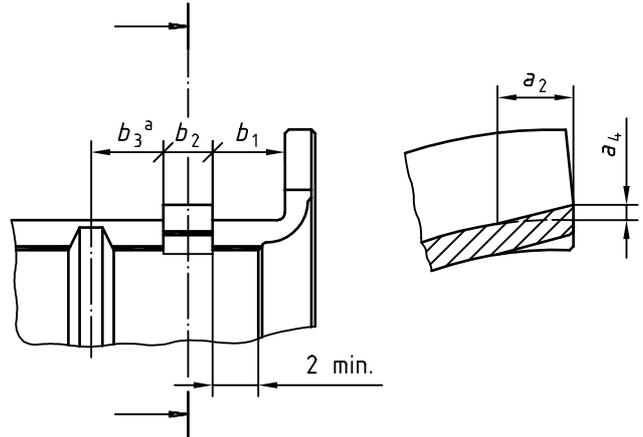
See Figures 5, 6 and 7.



$b_1 \geq 1,5 \times s_3$, but not less than 3 mm

- a If b_3 is less than 2 mm, this area is permitted to be free of bearing metal over a circumferential length a_2 to avoid the breaking of bearing metal when the bearing bore is machined. The locating nick may also break into the oil groove.
- b The nick may also be produced at the end of the half bearing; in this case is $b_1 = 0$.

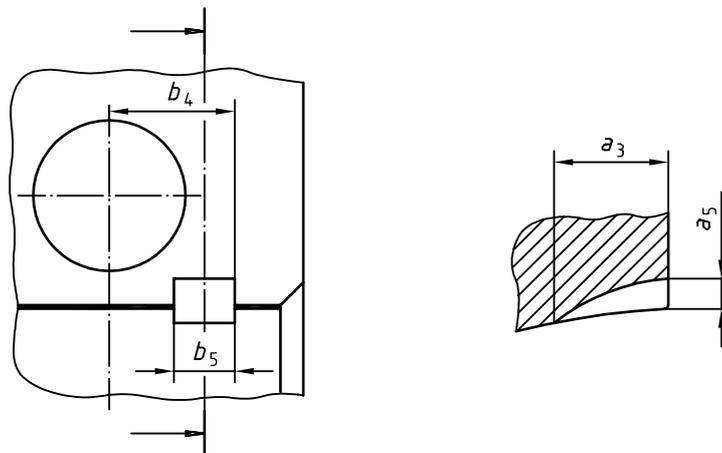
Figure 5 — Locating nick in a half bearing without flange



$b_1 \geq 1,5 \times s_3$, but not less than 3 mm

- a If b_3 is less than 2 mm, this area is permitted to be free of bearing metal over a circumferential length a_2 to avoid the breaking of bearing metal when the bearing bore is machined. The locating nick may also break into the oil groove.

Figure 6 — Locating nick in a flanged half bearing



$$b_4 \approx \frac{B_1(B_2)}{2} - b_1^a$$

- a See Figure 4 or Figure 5.

Figure 7 — Nick recess in the housing

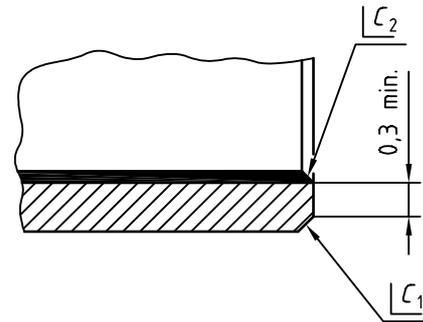
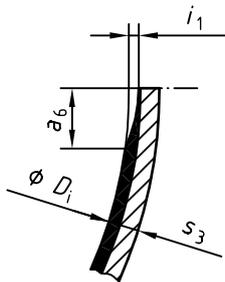
5.2 Reliefs and chamfers

Joint face bore reliefs are normally provided at both sides of the half bearing (with or without flange) on the whole width. For guidance it is suggested that the dimension a_6 be approximately 1/10 of the inside diameter D_i , but the actual value of this dimension will be dependent on the application and is subject to agreement between user and manufacturer (see Figure 8).

Chamfers are provided at both ends of a half bearing without flange (see Figure 9).

Flange reliefs are provided at all joint faces (see Figure 10, section A-A) as well as at the edges of the flange sliding surfaces (see Figure 10, detail X).

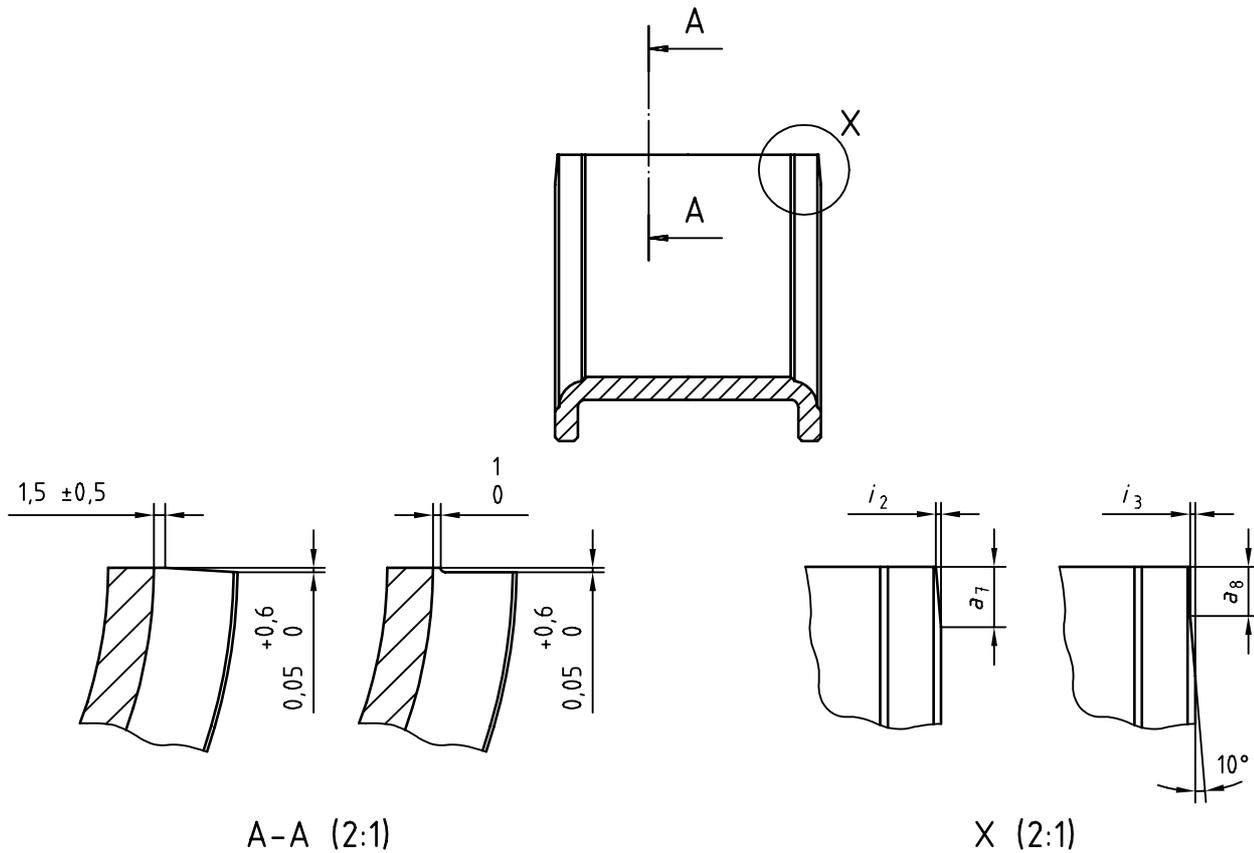
For dimensions and limit deviations see Table 3.



$$a_6 \approx \frac{D_i}{10}$$

Figure 8 — Bearing bore relief

Figure 9 — Chamfers



a) Joint face relief

b) Sliding surface relief for flange bearing.
Sliding surface relief for assembled flange bearing to be in accordance with ISO 6526.

Figure 10 — Flange reliefs
(design at the option of the manufacturer)

5.3 Transition between radial part and flange

Figure 11 shows typical examples of the transition region, the actual form used being dependent upon the manufacturing method and the ratio between wall thickness and flange thickness.

The transition between the radial part and flange shall comply with dimension a_9 in order to avoid cracking.

The transition geometry shall be adapted to the form of the shaft in order to avoid fouling of the fillet radius and of the housing inside diameter.

Figure 12 shows an example of the transition region between half bearing and the flange of an assembled flange bearing.

For assembled flange bearings the preferred dimensions of transition to maximise material for flange attachment are indicated in Figure 12.

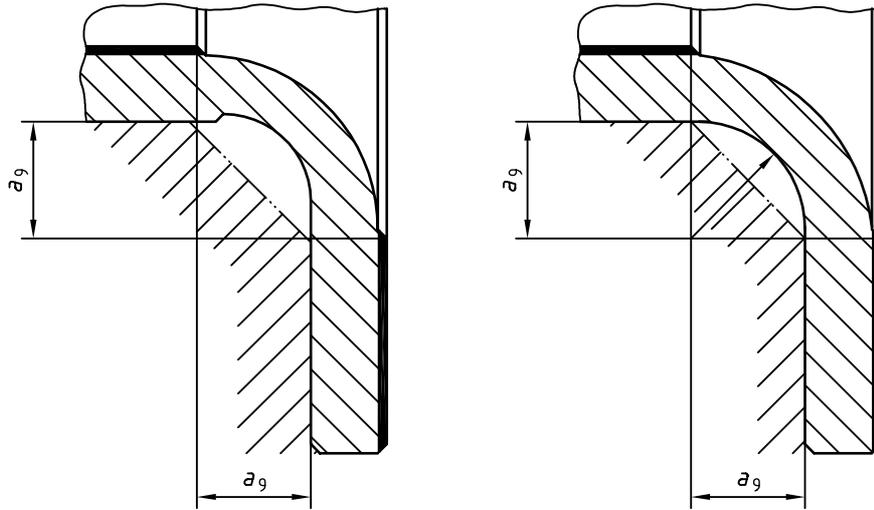


Figure 11 — Types of transition between radial parts of the flange

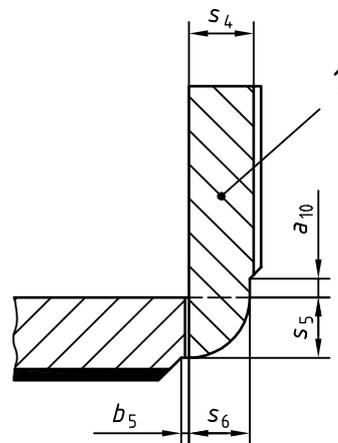
$s_5 \geq$ No less than 66 % of half bearing wall thickness

$s_6 \geq$ No less than 50 % of flange thickness but $< s_4$;
corner profile should always overlap flange and half bearing thickness as follows:

$$a_{10} = 0,5 \text{ mm min.}$$

$$b_5 = 0,25 \text{ mm min.}$$

Oil groove depth must be clear of half bearing maximum profile.



Key

1 Flange

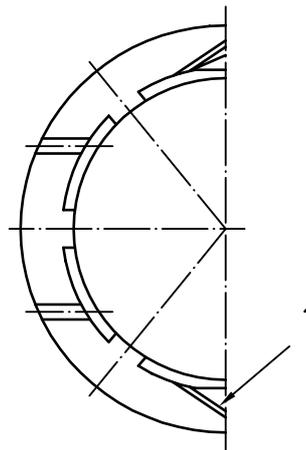
Figure 12 — Type of transition between half bearing and flange of a assembled flange bearing

Table 3 — Minimum height (and width) of transition and relief of the flanges

Housing diameter		a_7	a_8	a_9	i_2	i_3
$>$	$d_H \leq$	± 2	$\pm 0,5$	min.	$+ 0,2$ 0	$+ 0,3$ 0
—	120	5,5	3	2	0,1	0,3
120	250	8	3	3	0,2	0,3

5.4 Assembled flange scalloped toes

This feature is used to improve material utilisation and should be shown optional, see Figure 13.



Key

1 Thrust washer

NOTE Scalloped toe optional at joints to facilitate maximum material utilisation in accordance with ISO 6526.

Figure 13 — Assembled flange scalloped toes

5.5 Oil grooves and holes

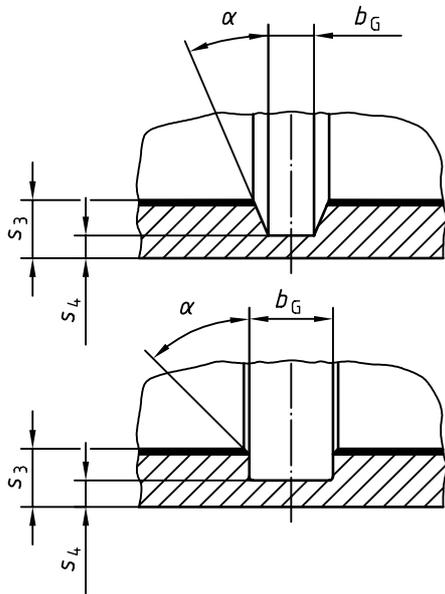
See Figure 14, 15, 16 and 17.

The sizes of oil grooves, pockets and holes are determined by functional requirements and are not specified in this International Standard.

For preferred groove forms in the radial part see Figure 14.

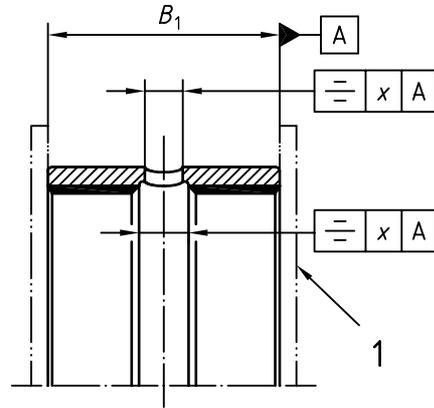
Oil grooves and oil pockets on the flange faces are preferably cut up to the steel backing in the bearing metal and are normally provided up to $D_{fl} = 160$ mm flange outside diameter. Above this size other shapes of grooves or pockets may be provided.

Oil holes can be drilled or pierced. In both cases the sharp edges of the oil holes must be free of burrs, except at the transition to the oil groove. If a chamfer is provided, its form is at the option of the manufacturer. A chamfer is necessary on the sliding surface.



$\alpha = 30^\circ$ or 45° are usual;
 $s_4 \approx 0,35s_3$, but $\geq 0,7$ mm.

Figure 14 — Types of oil grooves



Key

1 Profile of flange bearing

NOTE For tolerance x , see Table 4.

Figure 15 — Position of the oil groove and oil hole

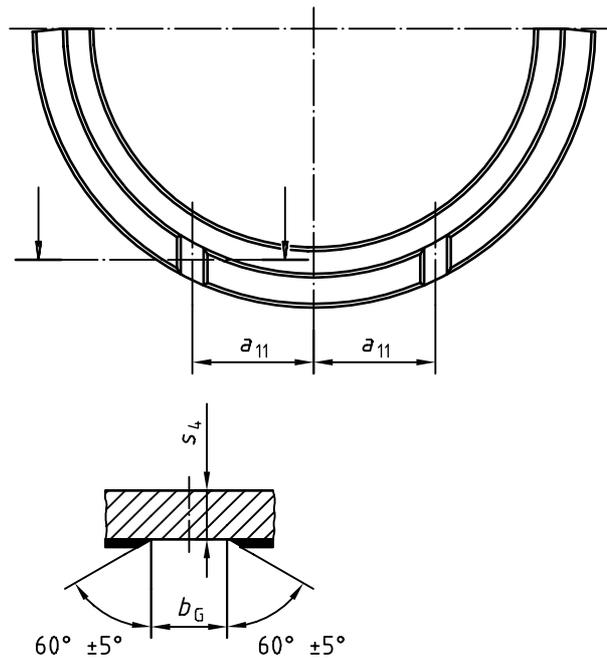
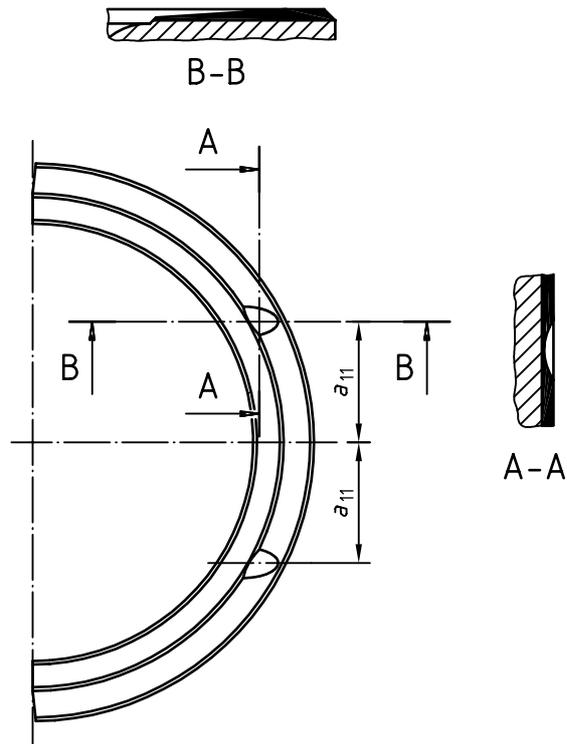


Figure 16 — Groove form on the flange face



NOTE Pocket may be closed or open to the outer flange diameter.

Figure 17 — Pocket form on the flange face

Table 4 — Tolerances and limit deviations for design features ^a

Housing diameter d_H		Tolerance and limit deviation												
		for												
>	≤	a_2	a_3	a_4	a_5	a_6	a_{11}	b_2	b_5	b_G	C_1, C_2	i_1	s_4	x
—	50	0	+1,5	0	+0,25	0	±1,5	0	+0,15	±0,25	-0,1	0	+0,3	0,6
		-1,5	0	-0,3	0	-3		-0,15	0		-0,6	-0,015	0	
50	80	0	+1,5	0	+0,4	0	±1,5	0 - 0,15	+0,15	±0,25	-0,1	0	+0,3	
		-2	0	-0,4	0	-3			0		-0,6	-0,020	0	
80	120	0	+2	0	+0,6	0	±2,5	0	+0,15	±0,25	-0,1	0	+0,4	
		-2	0	-0,4	0	-4		-0,15	0		-0,6	-0,020	0	
120	160	0	+3	0	+0,75	0	±2,5	0	+0,15	±0,25	-0,4	0	+0,4	
		-2	0	-0,4	0	-4		-0,15	0		-1,2	-0,020	0	
160	200	0	+3,5	0	+1	0	±2,5	0	+0,15	±0,25	-0,4	0	+0,4	
		-2,5	0	-0,5	0	-5		-0,15	0		-1,2	-0,020	0	
200	250	0	+5	0	+1,2	0	±2,5	0	+0,15	±0,25	-0,4	0	+0,4	
		-2,5	0	-0,5	0	-6		-0,15	0		-1,2	-0,025	0	
250	315	0	+5	0	+1,2	0	±2,5	0	+0,15	±0,25	-1	0	+0,5	
		-2,5	0	-0,5	0	-6		-0,15	0		-2	-0,025	0	
315	400	0	+5	0	+1,5	0	±2,5	0	+0,2	±0,25	-1	0	+0,5	
		-3	0	-0,5	0	-8		-0,2	0		-2	-0,030	0	
400	500	0	+5	0	+1,5	0	±2,5	0	+0,25	±0,25	-1,5	0	+0,6	
		-3	0	-0,6	0	-8		-0,25	0		-2,5	-0,035	0	

^a Closer tolerances are subject to agreement between user and manufacturer.

6 Test data for determining the peripheral length

6.1 Calculation of test force F

For half bearings with steel backing, the test force F , in newtons, per joint face for determining the nip h in a checking block with an inside diameter d_{Ch} (normally equal to the maximum housing diameter) is calculated as follows:

$$F = 100 \times A_{cal} \quad (\text{rounded to the nearest 500 N, but limited to a maximum of 100 000 N})$$

The reduced cross sectional area A_{cal} (calculated value) of the half bearing in square millimetres is calculated according to the following equations:

$$A_{cal} = (B_1 \text{ ou } B_2) \times s_1 \quad \text{for steel/lead alloy, steel/tin alloy} \tag{1}$$

$$A_{cal} = (B_1 \text{ ou } B_2) \times \left(s_1 + \frac{s_2}{2} \right) \quad \text{for steel/copper alloy} \tag{2}$$

$$A_{cal} = (B_1 \text{ ou } B_2) \times \left(s_1 + \frac{s_2}{3} \right) \quad \text{for steel/aluminium alloy} \tag{3}$$

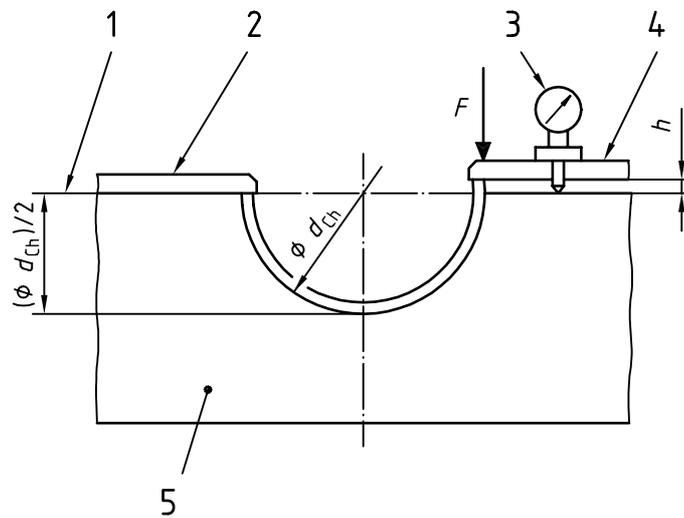
Depending on form, position and type of manufacture, oil grooves can diminish the reduced cross sectional area A_{cal} . If the proportion is above 10 %, this is to be taken into account in the calculation.

NOTE Depending on the size of the half bearing outside diameter, it is recommended to use either checking method A (see Figure 18) or checking method B (see Figure 19) as specified in ISO 6524.

When checking method B is used, a test force F is to be applied to each joint face (see Figure 19). The total force to be applied is $2 F$.

6.2 Checking method A

When using checking method A, the following is to be indicated in the drawing in accordance with ISO 6524.



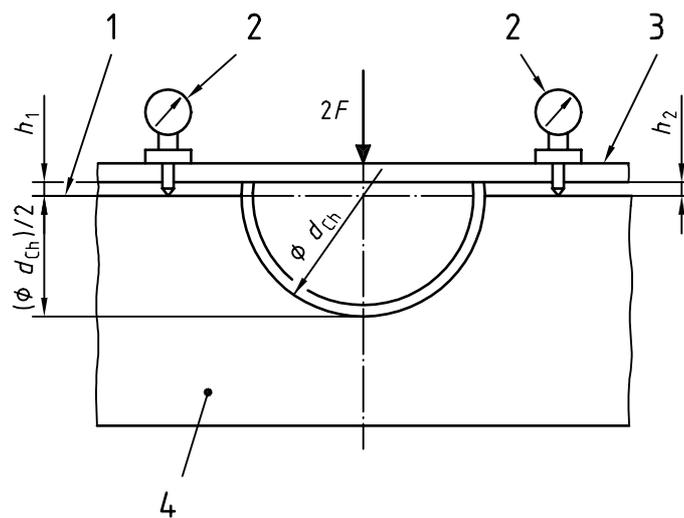
Key

- 1 Datum
- 2 Fixed stop
- 3 Dial gauge
- 4 Pressure plate
- 5 Checking block

Figure 18 — Example of checking method A for test force $F = 6\ 000\ \text{N}$

6.3 Checking method B

When using checking method B, the following is to be indicated in the drawing in accordance with ISO 6524.



Key

- 1 Datum
- 2 Dial gauge
- 3 Pressure plate
- 4 Checking block

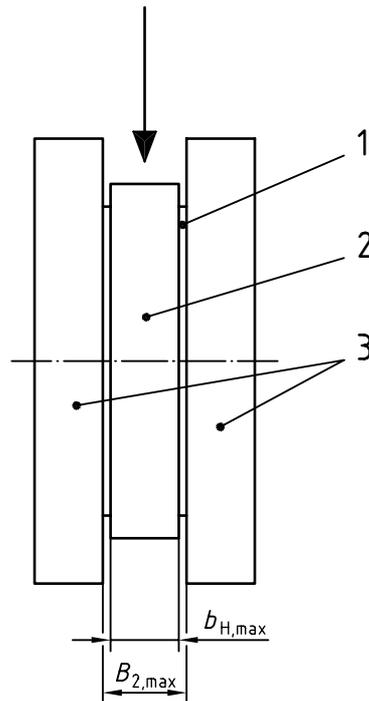
Figure 19 — Example of checking method B for test force $F = 6\ 000\ \text{N}$ (total force $2F = 12\ 000\ \text{N}$)

7 Test data for determining axial width B_2 of flange bearings

The method of checking and test force (if relevant) shall be agreed between manufacturer and user.

7.1 Go between two parallel plates

With a gauge block inserted between the flanges of an integral or assembled flange bearing the bearing must pass freely between two static plates, see Figure 20.



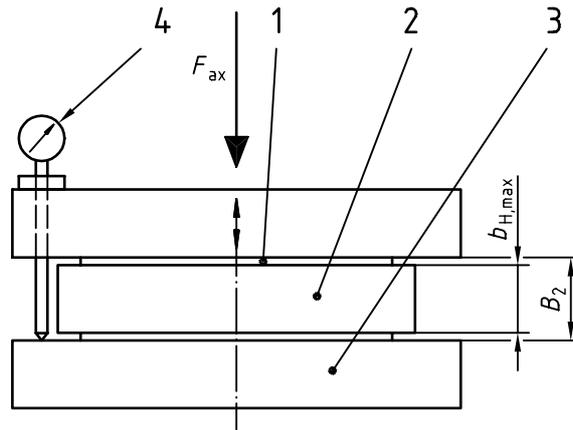
Key

- 1 Integral or assembled flange bearing
- 2 Gauge block
- 3 Static plate

Figure 20 — Freestate reference check for integral or assembled flange bearings

7.2 Axial width B_2 checked under force

With a gauge block inserted between the flanges of an assembled flange bearing the bearing axial length is checked under an axial force F_{ax} , see Figure 21.

**Key**

- 1 Assembled flange bearing
- 2 Gauge block
- 3 Fixed plate of the equipment test
- 4 Dial gauge

NOTE $F_{ax} = \text{Face area of flange} \times 1 \text{ N/mm}^2$

Figure 21 — Example for a test equipment

Annex A (normative)

Example of calculation

Drawing details:

$$BL_u = 0,012 \text{ mm}, UL_u = 0,004 \text{ mm}$$

$$\alpha = 45^\circ, \alpha_2 = 25^\circ, s_{3, \text{act}} = 2,260 \text{ mm}$$

Upper and lower limits of the wall thickness shall be calculated for $\alpha = 45^\circ$

$$s_{\alpha, \text{BL}} = s_{3, \text{act}} - BL_u \times \frac{1 - \sin \alpha}{1 - \sin \alpha_2} = 2,260 - 0,012 \times \frac{0,292 \ 89}{0,577 \ 38} = 2,253 \ 92$$

$$s_{\alpha, \text{BL}} \approx 2,254 \text{ mm (rounded)}$$

$$s_{\alpha, \text{UL}} = s_{3, \text{act}} - UL_u \times \frac{1 - \sin \alpha}{1 - \sin \alpha_2} = 2,260 - 0,004 \times \frac{0,292 \ 89}{0,577 \ 38} = 2,257 \ 97$$

$$s_{\alpha, \text{UL}} \approx 2,258 \text{ mm (rounded)}$$

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- [1] ISO 4383, *Plain bearings — Multilayer materials for thin-walled plain bearings.*
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ICS 21.100.10

Price based on 19 pages