INTERNATIONAL STANDARD

ISO 6524

Second edition
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Plain bearings — Thin-walled half-bearings — Checking of peripheral length

Paliers lisses — Demi-coussinets minces — Contrôle de la longueur développée

Reference number
ISO 6524:1992(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 6524 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Sub-Committee SC 3, *Dimensions, tolerances and construction details.*

This second edition cancels and replaces the first edition (ISO 6524:1983), of which it constitutes a technical revision.

Annexes A, B, C, D and E form an integral part of this International Standard.

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Plain bearings — Thin-walled half-bearings — Checking of peripheral length

1 Scope

This International Standard specifies methods of checking the measuring equipment and gauging tools necessary for measuring the peripheral length (or nip or crush) of thin-walled half-bearings.

Thin-walled half-bearings are flexible and, in the free condition, do not conform to a cylindrical profile. This is one reason why the peripheral length of the half-bearings can only be measured under a constraining load by use of specialized measuring equipment.

Measuring equipment different from that illustrated in this International Standard can be used, providing the measuring accuracy of the equipment is consistent with the specifications given in clause 17.

This International Standard does not include measurement of the joint face taper.

It applies to thin-walled half-bearings, the specifications of which are given in ISO 3548 and ISO 6864.

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

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

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 peripheral length: The circumferential length which runs from one joint face to the other.

3.2 nip; crush: The value, a, by which a half-bearing fitted in a checking block of bore diameter d_{cb} under a predetermined checking load F exceeds the defined peripheral length of the checking block bore (see figure 1).

NOTE 1 In practice, the datum serves as a basis for measuring a (see figure 2).

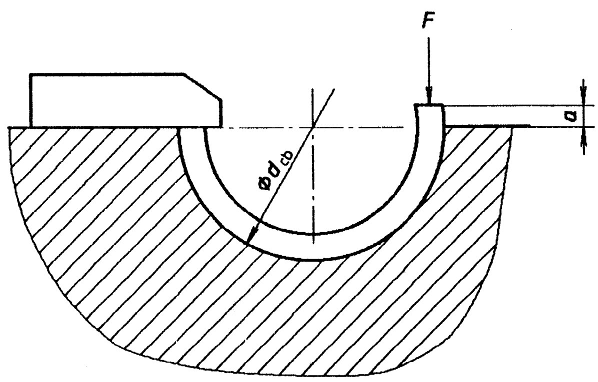


Figure 1 — Nip, a

3.3 repeatability: The closeness of agreement between successive results obtained with the same method on the same test piece, under the same conditions (same operator, same measuring equipment, same checking place and time intervals).

NOTE 2 Repeatability is assessed from the standard deviation of repeatability σ_{Δ}. See annex E.

3.4 reproducibility: The closeness of agreement between individual results obtained with the same method on the same test piece but under different conditions (identical or different operator, measuring equipment, checking place and times).

NOTE 3 For the purposes of this International Standard, reproducibility is the difference between the two averages obtained from two sets of measuring equipment. See annex E.

3.5 comparability: The accuracy in the case of operators working in different checking places at different periods and each of them achieving individual results, one using method A and the other method B, on the same half-bearing in different checking blocks.

NOTE 4 Comparability is assessed from the difference between the two averages obtained from the two methods. See annex E.

4 Symbols

NOTE 5 The characteristic subscripts are as follows:

bs: bearing to be checked

cb: checking block

cbm: master checking block

cbs: series checking block

cs: comparison shell

M: measured

ms: master shell

th: theoretical

a or $a_1 + a_2$	nip, in millimetres
B	width of the half-bearing without flange, in millimetres
B_1	checking block width (construction for flanged half-bearings), in millimetres
B_2	checking block width, in millimetres
B_3	checking block width (construction for half-bearings without flange), in millimetres
B_{ms}	master shell width, in millimetres
d_{cb}	diameter of the checking block bore, in millimetres[1)]
D_{bs}	outside diameter of the half-bearing to be checked, in millimetres
D_{ms}	outside diameter of the master shell, in millimetres[1)]
E	Young's modulus, in newtons per square metre
f	coefficient of friction in calculation of deflection under load
$F = F_1 = F_2$	checking load, in newtons
F_{cor}	correction factor, in millimetres[1)]
h	fillet radius between back and flange on flanged half-bearing, in millimetres
H_{cb}	distance from the bottom of the checking block bore to the datum plane, in millimetres[1)]
ΔH_{cb}	elastic deformation of the height of the checking block under load, in millimetres
K_1	checking block chamfer (construction for half-bearings without flange), in millimetres
K_2	checking block chamfer (construction for flanged half-bearings), in millimetres
l	peripheral length, in millimetres[1)]
Δl	deviation of the actual peripheral length of the checking block, in millimetres
p_E	elastic depression of the toe piece, in millimetres
R_a	surface roughness, in microns
s_{cs}	wall thickness of the comparison shell, in millimetres
s_{ms}	wall thickness of the master shell, in millimetres
s_{tot}	total wall thickness of the half-bearing, in millimetres
u	uncertainty of measurement
w	width of the toe piece contact area, in millimetres
z	distance between flanges of the flanged half-bearing, in millimetres

1) The symbol may be followed by a subscript defining the gauging tool to which the symbol is applied and/or by a subscript indicating an effective measured value or a theoretical value.

δ	empirical correction to compensate for the difference in elastic deflections under load between method A and method B, in millimetres
$\tilde{\delta}$	correction estimated by calculation
σ	standard deviation

5 Purpose of checking

It is necessary to keep to within the nip tolerances of ISO 3548 and ISO 6864 in order to guarantee the designated mounting compression (interference fit) for the half-bearings in the housing bore.

6 Checking methods

6.1 Method A

The checking load, F, is directly applied via the measuring head with a pivoting toe piece to one joint face of the half-bearing whilst the other joint face is in contact with a fixed stop (see figure 2).

6.2 Method B

The checking loads F_1 and F_2 are applied via the measuring head and two toe pieces to both joint faces of the half-bearing (see figure 3).

NOTE 6 In the case of method A, the fixed stop exerts the required counter-force which, in the case of method B, is applied directly by the measuring equipment via two toe pieces.

EXAMPLE

Method A $F = 6\ 000$ N

Method B $\begin{cases} F_1 = 6\ 000 \text{ N} \\ F_2 = 6\ 000 \text{ N} \end{cases}$

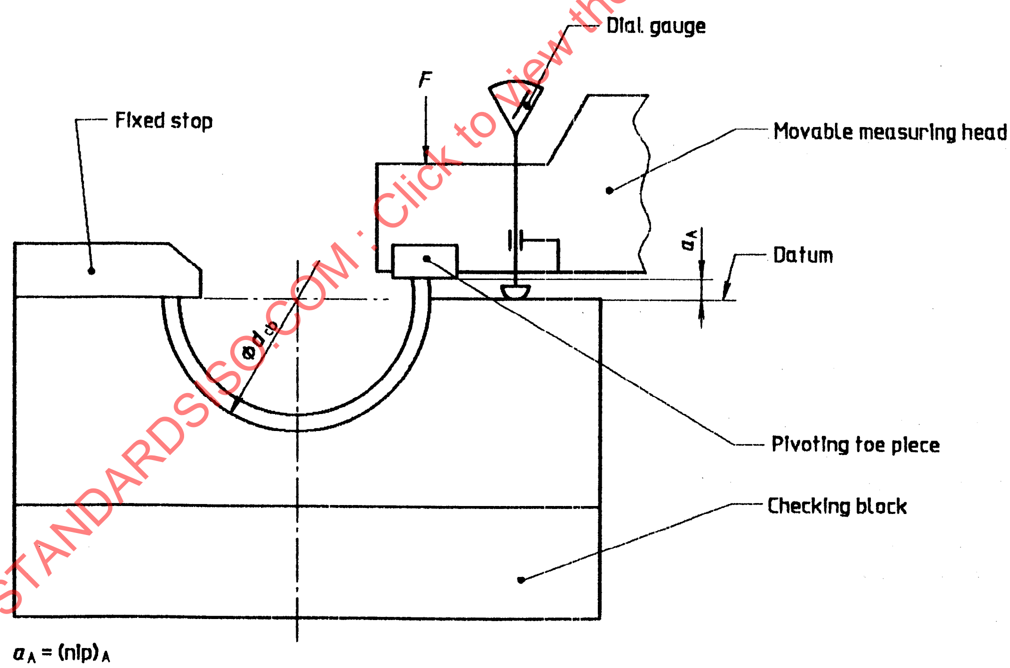
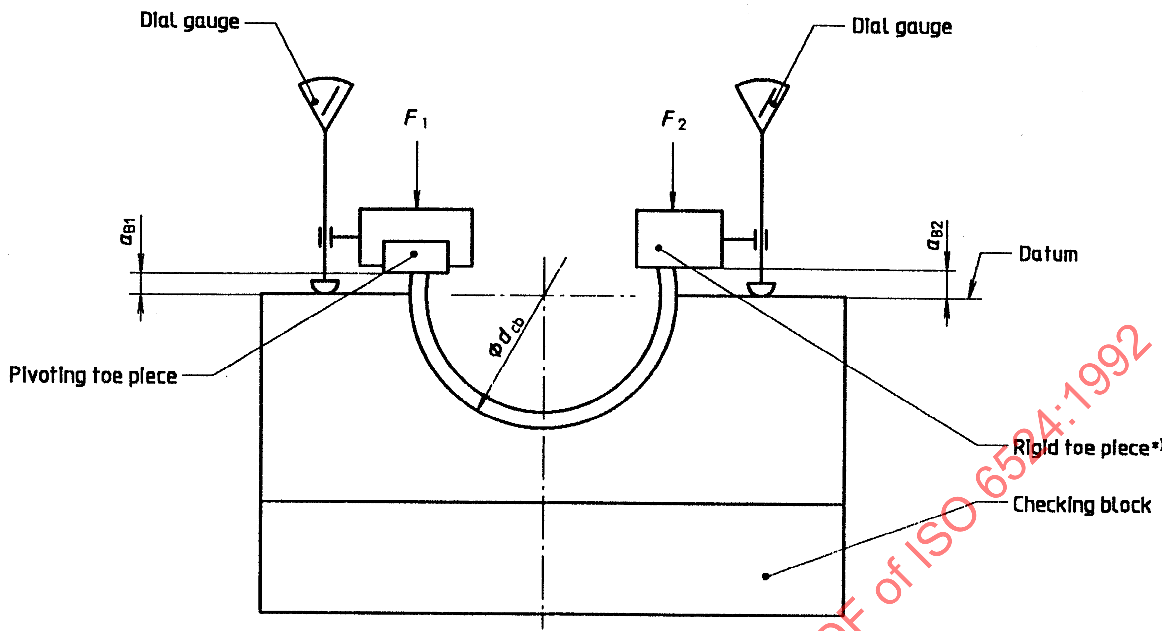


Figure 2 — Principle of method A



$a_B = a_{B1} + a_{B2} = (\text{nip})_B$

*) Bearings may also be checked using two pivoting toe pieces.

Figure 3 — Principle of method B

7 Choice and designation of checking method

7.1 Choice of checking method

Recommendations for choosing either method A or method B, based on the dimensions of the half-bearings to be checked, are given in table 1.

However, any size of bearing may be tested by either method by agreement between the manufacturer and user. In that case, a correction δ should be applied to compensate for the difference in deflections at joint face(s) under load between method A and method B, and be such that

$$a_A = a_{B1} + a_{B2} + \delta$$

The value of δ shall be determined empirically by actual measurements obtained on the two different types of equipment used. Since the detailed design of the checking feature will vary between different manufacturers, the value of δ established by one manufacturer cannot be transferred to another, who shall determine it separately. See example in annex E.

For general guidance, the value of δ may be derived from the formula used in the mathematical analysis of belt friction, which gives

$$\delta = \frac{d_{cb,M}F}{s_{ms}B_{ms}} \times \frac{1}{2Ef}\left(1 + e^{-f\pi} - 2e^{-f\pi/2}\right)$$

With a value of the friction coefficient $f = 0{,}15$, the formula becomes

$$\tilde{\delta} = 7 \times 10^{-7} \times \frac{d_{cb,M}F}{s_{ms}B_{ms}}$$

(See also 16.5.)

Table 1

D_{bs} mm	Recommended checking method
$D_{bs} \leqslant 200$	A, B
$200 < D_{bs} \leqslant 500$	B

7.2 Designation of checking method

Example of the designation of method B for checking thin-walled half-bearings with an outside diameter, D_{bs}, of 340 mm:

Method ISO 6524-B-340

8 Measuring equipment

Figures 4 and 5 show typical measuring equipment for measuring the nip (crush) by method A and by method B, respectively.

NOTE 7 Figures 4 and 5 show hydraulically operated equipment. Pneumatically or mechanically operated equipment may also be used.

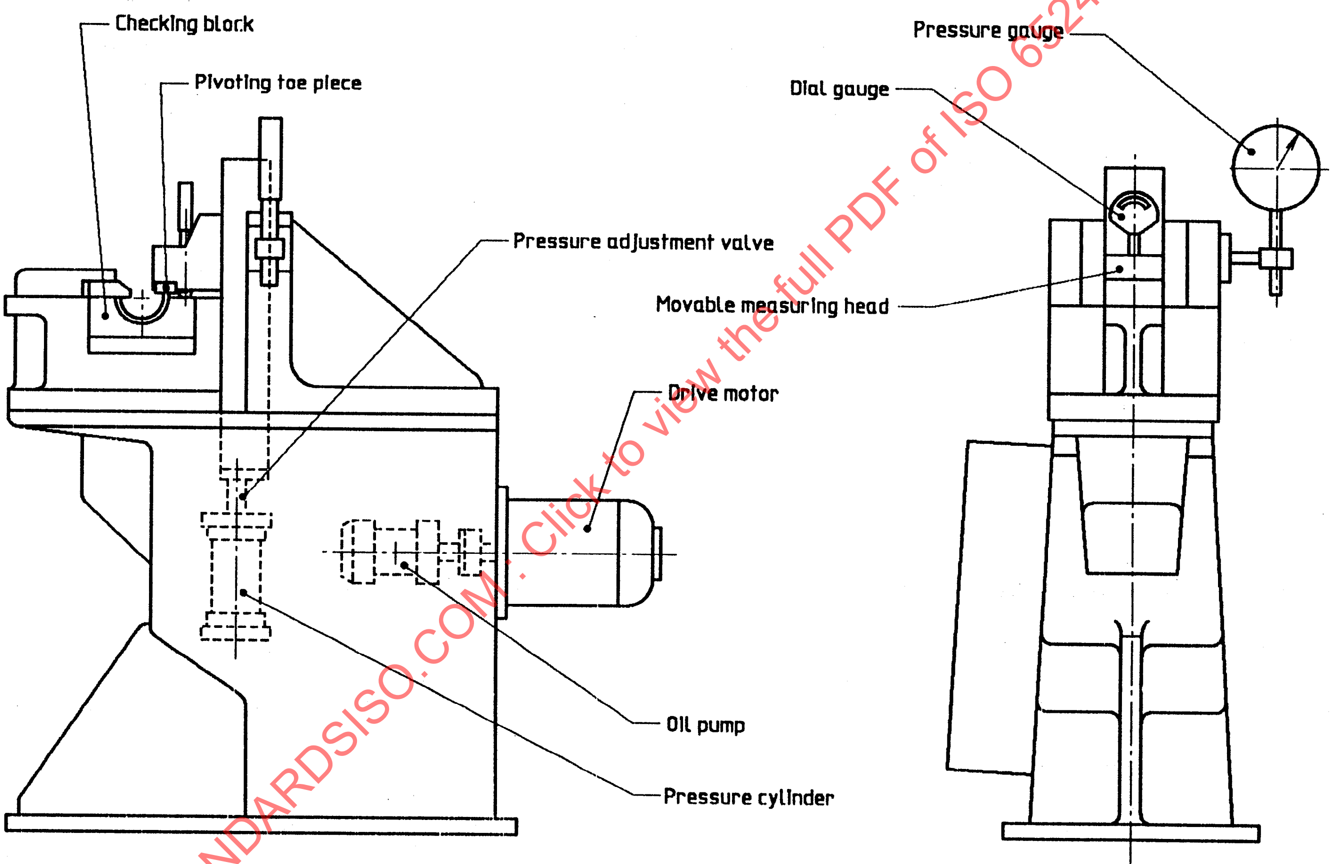
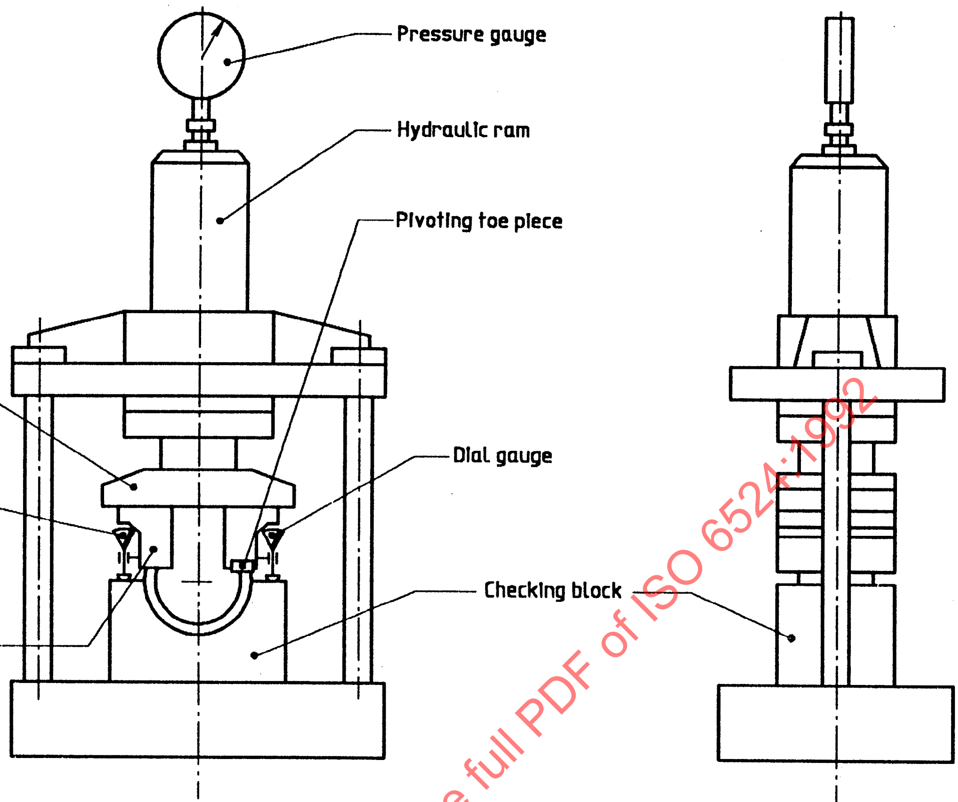


Figure 4 — Typical measuring equipment with one column, for method A



*) Bearings may also be checked using two pivoting toe pieces.

Figure 5 — Typical measuring equipment with two columns, for method B

9 Measuring equipment requirements

The most important factors affecting the accuracy of the measuring equipment (and hence the measured nip value) are given below.

9.1 Tolerance on checking load setting

The permissible tolerances are given in table 2.

Table 2

F N	Tolerance on F %
$F \leqslant 2\ 000$	$\pm$ 1,25
$2\ 000 < F \leqslant 5\ 000$	$\pm$ 1
$5\ 000 < F \leqslant 10\ 000$	$\pm$ 0,75
$10\ 000 < F \leqslant 50\ 000$	$\pm$ 0,5
$50\ 000 < F$	$\pm$ 0,25

9.2 Speed of approach of measuring head

The checking load, F, shall be applied to the joint face(s) of the half-bearing so that shock load will not occur. The speed of approach shall be 10 mm/s $\pm$ 2 mm/s.

For devices in which the speed of approach cannot be altered, the load shall be applied, released and applied a second time before the measurement is made.

9.3 Construction of measuring head

The measuring head shall be so constructed that it is accurately guided and moves normal to the datum of the checking block. The deviation from parallelism between the toe piece(s) in the measuring head and the supporting plane of the checking block shall not exceed 0,04 mm per 100 mm in a radial direction.

9.4 Accuracy of the measuring plane of the toe pieces

Specifications on the accuracy of the measuring plane of the toe pieces are given in table 3.

Table 3

Dimensions and tolerances in millimetres
Surface roughness in microns

D_{bs}	Surface roughness R_a	Tolerance on flatness
$D_{bs} \leqslant 160$	0,2	0,001 5
$160 < D_{bs} \leqslant 340$	0,4	0,003
$340 < D_{bs} \leqslant 500$		0,004

9.5 Accuracy of the dial gauge

Uncertainty of measurement $u \leqslant 1,2$ µm ($\pm 2\sigma$) with $\sigma = 0,3$ µm

10 Gauging tools for establishing the datum

The following equipment can be used for carrying out measurements:

- a master checking block (for reference measurements) (see clause 11),
- a series checking block (for series control in production) (see clause 11), or
- a master shell or comparison shell (for series control in production) (see clause 12).

It can be used in three ways (as indicated in 10.1, 10.2 and 10.3) to establish the appropriate datum for setting the dial gauge.

10.1 Master checking block (used alone)

The master checking block is the comparison basis for the other checking blocks used for series control.

10.2 Series checking block used alone

The peripheral length of the bore of this type of checking block is determined by comparison with the master checking block.

It is applied in series control without using a master shell or a comparison shell.

10.3 Series checking block with master shell

The peripheral length of the checking block bore is determined by the master shell or comparison shell, the peripheral length of which was determined in the master checking block.

This combination of gauging tools is applied in series control.

NOTE 8 For series control, a checking block may also be used with a checking master, but this combination of gauging tools is not within the scope of this International Standard.

11 Checking block requirements

A typical checking block is shown in figure 6. The gauging part has a bore diameter d_{cb} and height H_{cb} and holds the half-bearings to be checked.

The checking block should preferably be of hardened steel and of rigid construction so that the requirements of clause 16 are met when the half-bearing is tested under load.

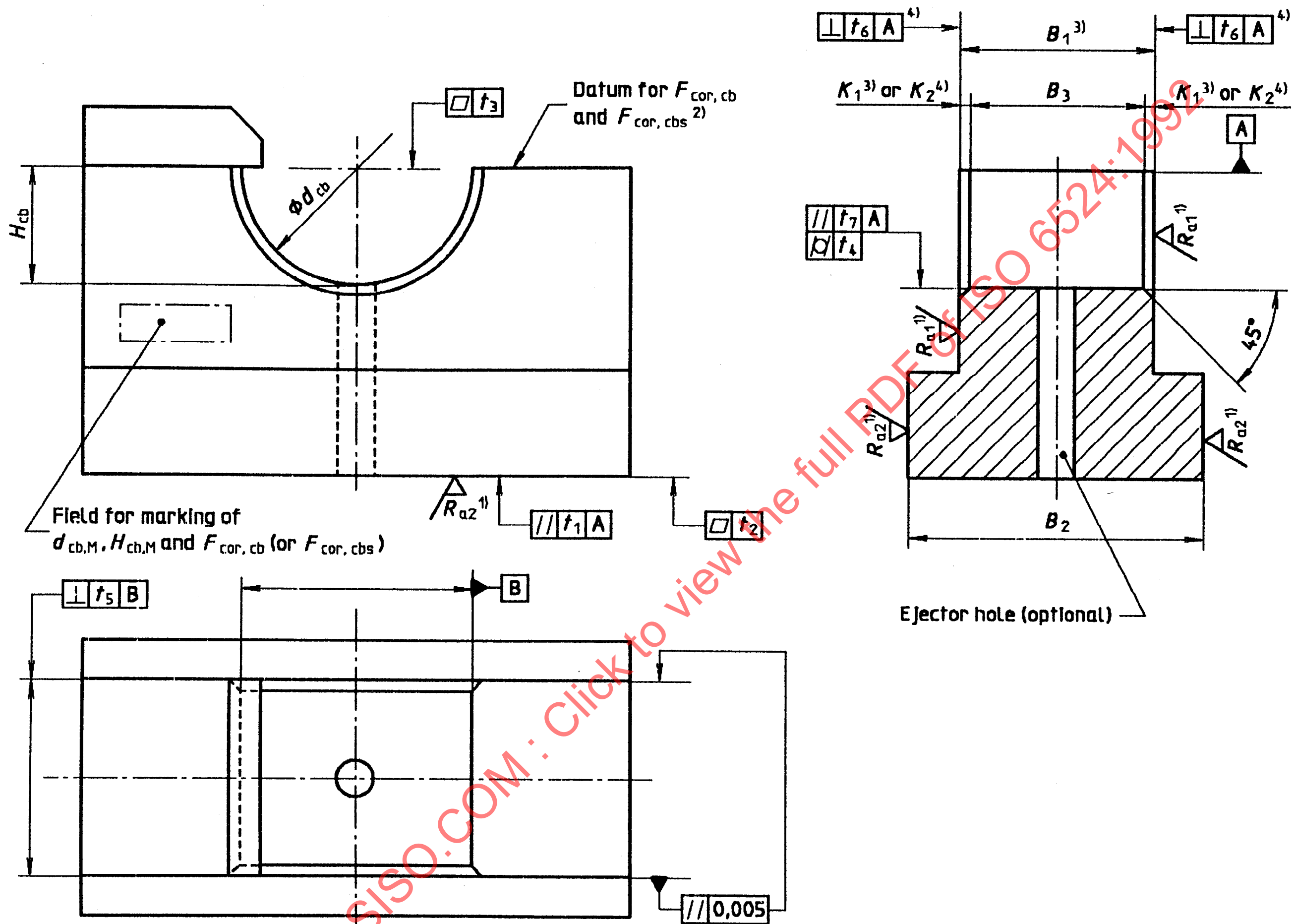
The bore of the checking block shall not be chromium plated.

Recesses shall be cut into the checking block to accommodate the nick in the half-bearings. They shall be 1 mm wider and deeper and 1,5 mm longer than the locating nicks in the half-bearings.

11.1 Reference tooling: Master checking block

11.1.1 Manufacturing limits

Manufacturing limits and specifications for the master checking block are given in table 4.



1) It is recommended that the values given in tables 5 and 6 be observed.

2) See 13.1 and 13.2.1.

3) Construction for half-bearing without flange:

B_1 may correspond to B_2 or it may be adjusted to the width of the half-bearing, i.e. to B_{max} + 1,2 mm with $K_{1\,max}$ = 0,4 mm

4) Construction for flanged half-bearing:

B_1: see table 5

$K_2 = h_{max}$ + 0,5 mm

Figure 6 — Checking block

Table 4

Dimensions and tolerances in millimetres
Surface roughness in microns

Outside diameter D_{bs}	Tolerance on d_{cbm}	Surface roughness of checking block bore R_a	Tolerance on H_{cbm}	Surface roughness of the datum R_a
$D_{bs} \leqslant 75$	$^{+0,003}_{0}$	0,2	$^{+0,003}_{0}$	0,3
$75 < D_{bs} \leqslant 110$	$^{+0,004}_{0}$		$^{+0,003\,5}_{0}$	
$110 < D_{bs} \leqslant 160$	$^{+0,005}_{0}$		$^{+0,004}_{0}$	
$160 < D_{bs} \leqslant 250$	$^{+0,006}_{0}$	0,4	$^{+0,004\,5}_{0}$	0,6
$250 < D_{bs} \leqslant 340$	$^{+0,007\,5}_{0}$	0,6	$^{+0,005}_{0}$	1
$340 < D_{bs} \leqslant 500$	$^{+0,01}_{0}$		$^{+0,006}_{0}$	

11.1.1.1 Tolerances of form and orientation

It is the responsibility of the manufacturer of the master checking block to achieve high quality regarding tolerances of form and orientation, the values of which are given in tables 5 and 6.

11.1.1.2 Surface roughnesses R_{a1} and R_{a2}

See tables 5 and 6.

11.1.1.3 Specifications for B_1, B_2 and B_3

See tables 5 and 6.

11.1.2 Measuring accuracy of equipment used for establishing $d_{cbm,M}$ and $H_{cbm,M}$

Determination of $d_{cbm,M}$ and $H_{cbm,M}$ shall be carried out using measuring equipment with a tolerance of

$\pm$ 0,001 mm, for $d_{cbm} \leqslant 160$ mm

$\pm$ 0,002 mm, for $d_{cbm} > 160$ mm

These values are necessary for calculating the correction factor $F_{cor,cbm}$ (see 13.1), which is based on the peripheral length, determined from the formula:

$$l_{cbm,M} = d_{cbm,M} \times \frac{\pi}{2} + 2\left(H_{cbm,M} - \frac{d_{cbm,M}}{2} \right)$$

11.1.3 Permissible wearing limit

The tolerance specified in 11.1.1 for the master checking block shall not be exceeded through wear. If wear occurs within the specified tolerance range, then it will be necessary to change the correction factor.

11.2 Series gauging tools

11.2.1 Series checking block used alone

Since the peripheral length of this checking block bore is determined by comparison with the master checking block (11.1), larger tolerances for d_{cbs} and H_{cbs} are acceptable.

11.2.1.1 Manufacturing limits

Manufacturing limits and specifications for the series checking block are given in tables 7 to 9.

11.2.1.2 Correction factor, $F_{cor,cbs}$

See 13.2.1.

Table 5

Dimensions and tolerances in millimetres
Surface roughness in microns

D_{bs}	Bearing without flange $B_{3\,min}$	Flanged bearing $B_{1\,min}$	$B_{1\,max}$	Surface roughness R_{a1}	Tolerances of form and orientation t_1	t_2	t_3	t_4	t_5	t_6
$D_{bs} \leqslant 75$	$B_{max} + 0,4$	$z_{min} - 0,1$	$z_{min} - 0,05$	1,2	0,002	0,002	0,002	0,002	0,002	0,005
$75 < D_{bs} \leqslant 110$										
$110 < D_{bs} \leqslant 160$										
$160 < D_{bs} \leqslant 250$					0,005	0,005	0,005	0,004	0,003	0,006
$250 < D_{bs} \leqslant 340$				1,6						
$340 < D_{bs} \leqslant 500$					0,007		0,007			

Table 6

Dimensions and tolerances in millimetres
Surface roughness in microns

B	B_2 $^{+2}_{0}$	Surface roughness R_{a2}	Tolerance on parallelism t_7
$B \leqslant 55$	60	1,2	0,002
$55 < B \leqslant 80$	85		0,003
$80 < B$	$B + 5$		0,004

Table 7

Dimensions and tolerances in millimetres
Surface roughness in microns

D_{bs}	Tolerance on d_{cbs}	Surface roughness of checking block bore R_a	Tolerance on H_{cbs}	Surface roughness of the datum R_a
$D_{bs} \leqslant 75$	$^{+0,008}_{0}$	0,2	$^{+0,008}_{0}$	0,3
$75 < D_{bs} \leqslant 110$	$^{+0,01}_{0}$		$^{+0,009}_{0}$	
$110 < D_{bs} \leqslant 160$	$^{+0,012}_{0}$		$^{+0,01}_{0}$	
$160 < D_{bs} \leqslant 250$	$^{+0,014}_{0}$	0,4	$^{+0,01}_{0}$	0,6
$250 < D_{bs} \leqslant 340$	$^{+0,017}_{0}$	0,6	$^{+0,011}_{0}$	1
$340 < D_{bs} \leqslant 500$	$^{+0,022}_{0}$		$^{+0,012}_{0}$	

Table 8

Dimensions and tolerances in millimetres
Surface roughness in microns

D_{bs}	Bearing without flange $B_{3\,min}$	Flanged bearing $B_{1\,min}$	$B_{1\,max}$	Surface roughness R_{a1}	Tolerances of form and orientation t_1	t_2	t_3	t_4	t_5	t_6
$D_{bs} \leqslant 75$	$B_{max} + 0{,}4$	$z_{min} - 0{,}1$	$z_{min} - 0{,}05$	1,2	0,004	0,004	0,004	0,004	0,004	0,01
$75 < D_{bs} \leqslant 110$										
$110 < D_{bs} \leqslant 160$										
$160 < D_{bs} \leqslant 250$					0,01	0,01	0,01	0,008	0,006	0,012
$250 < D_{bs} \leqslant 340$				1,6						
$340 < D_{bs} \leqslant 500$					0,014		0,014			

Table 9

Dimensions and tolerances in millimetres
Surface roughness in microns

B	B_2 $^{+2}_{0}$	Surface roughness R_{a2}	Tolerance on parallelism t_7
$B \leqslant 55$	60	1,2	0,004
$55 < B \leqslant 80$	85		0,006
$80 < B$	$B + 5$		0,008

11.2.1.3 Permissible wearing limit

The limit of permissible wear of the series checking block is reached when the difference between the correction factor in original and worn conditions is equal to the values stated in table 10.

Table 10

d_{cbs} mm	Permissible difference $\lvert F_{cor,cbs,new} - F_{cor,cbs,worn} \rvert$ mm
$d_{cbs} \leqslant 75$	0,012
$75 < d_{cbs} \leqslant 110$	0,016
$110 < d_{cbs} \leqslant 160$	0,02
$160 < d_{cbs} \leqslant 250$	0,024
$250 < d_{cbs} \leqslant 340$	0,03
$340 < d_{cbs} \leqslant 500$	0,04

11.2.2 Series checking block with master shell or with comparison shell

11.2.2.1 Manufacturing limits

Manufacturing limits and specifications for the series checking block are given in tables 7 to 9.

11.2.2.2 Correction factor

See 13.2.2.

11.2.2.3 Permissible wearing limit

The limit of permissible wear of the series checking block is reached when the difference between the correction factor in original and worn conditions is equal to the values stated in table 10.

12 Master shell and comparison shell requirements

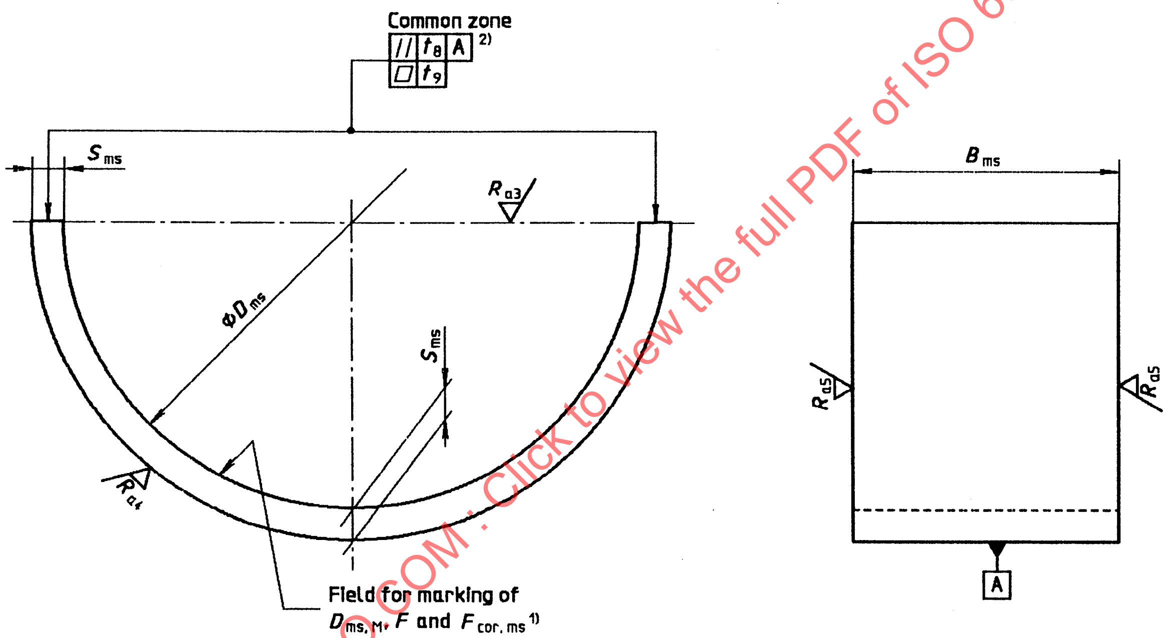
12.1 Master shell requirements

The basic dimensions of the master shell shall correspond to those of the half-bearings to be checked (see figure 7). The master shell shall have similar behaviour to the half-bearing when it is fitted into the checking block.

NOTE 9 This cylindrical master shell is also used for checking flanged half-bearings.

Master shells shall be made from hardened steel (58 HRC min.). Normally master shells are only used up to 200 mm diameter.

In order that a single master may be used for a group of parts down to 1 mm undersize, s_{ms} shall be equal to the total wall thickness s_{tot} of the standard half-bearing to be checked plus 0,125 mm.



$S_{ms} = S_{tot} + 0{,}125$ mm

1) See 13.2.3.

2) Tolerances on parallelism f_8 and flatness f_9 apply when the master shell is fitted in the checking block (zero free spread) under the checking load.

Figure 7 — Master shell

The master shell shall be of similar geometry to that of the bearing being checked. Masters of a different geometry from that of the shell shall not be used since friction and elastic deformation will differ significantly from those of the bearing. See figure 8.

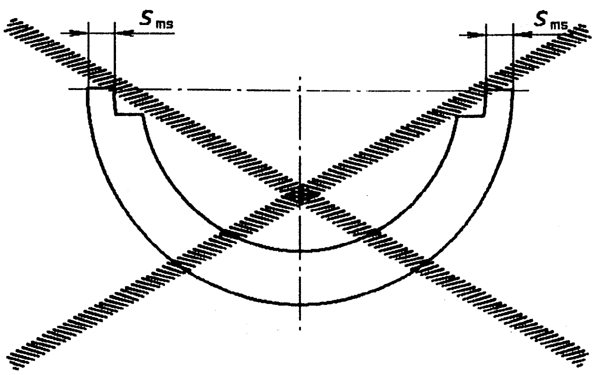


Figure 8 — Stepped master shell not suitable for checking bearings of uniform wall thickness

12.1.1 Manufacturing limits

Manufacturing limits and specifications for the master shell are given in tables 11 and 12.

12.1.2 Correction factor, $F_{cor,ms}$

See 13.2.3.

12.1.3 Permissible wearing limit

The limit of the permissible wear of the master shell is reached when the difference between the correction factor in original and worn conditions is equal to the values stated in table 13.

Table 11

Dimensions and tolerances in millimetres
Surface roughness in microns

D_{ms}	Tolerance on B_{ms}	Tolerance on s_{ms}	Surface roughness R_{a3}	Surface roughness R_{a5}
$D_{ms} \leqslant 160$	$\pm$ 0,1	$\pm$ 0,015	0,2	2
$160 < D_{ms} \leqslant 200$	$\pm$ 0,15	$\pm$ 0,02		

Table 12

Dimensions and tolerances in millimetres
Surface roughness in microns

D_{ms}	Surface roughness R_{a4}	Tolerance on parallelism t_8	Spread	Tolerance on flatness t_9
$D_{ms} \leqslant 160$	0,3	0,004	Within the limits of the half-bearing to be checked	0,003
$160 < D_{ms} \leqslant 200$	0,5	0,006		

Table 13

D_{ms} mm	Permissible difference $\lvert F_{cor,ms,new} - F_{cor,ms,worn} \rvert$ mm
$D_{ms} \leqslant 160$	0,03
$160 < D_{ms} \leqslant 200$	0,035

12.2 Comparison shell requirements

For economic reasons, the nip of the half bearings may be determined using comparison shells rather than master shells.

Comparison shells shall be made from stainless steel or cold or hot worked tool steel. In special cases, a normal production bearing may also be used.

The relative manufacturing limits shall be agreed upon between manufacturer and customer.

13 Correction factors

13.1 Reference tooling: Master checking block correction factor, $F_{cor,cbm}$

The measured peripheral length of the master checking block bore, $l_{cbm,M}$, is given by the following equation (see 11.1.2):

$$l_{cbm,M} = d_{cbm,M} \times \frac{\pi}{2} + 2\left(H_{cbm,M} - \frac{d_{cbm,M}}{2}\right)$$

The theoretical peripheral length of the master checking block bore, $l_{cbm,th}$, is given by the following equation (see 11.1.2):

$$l_{cbm,th} = d_{cbm,th} \times \frac{\pi}{2}$$

The correction factor of the master checking block is therefore

$$F_{cor,cbm} = l_{cbm,M} - l_{cbm,th}$$

The other factors to be taken into consideration, their determination and calculation are given in annex A (for method A) and annex B (for method B).

The basis for the correction factor $F_{cor,cbm}$ is the datum of the master checking block (see figures 2 and 3).

13.2 Series control tooling

13.2.1 Correction factor for series checking block used alone, $F_{cor,cbs}$

The correction factor $F_{cor,cbs}$ is the difference between the nip of a half-bearing measured in a master checking block (a_{cbm}) and in a series checking block (a_{cbs}) under equal checking conditions (see annex C):

$$F_{cor,cbs} = a_{cbm,M} - a_{cbs,M}$$

When setting the dial gauge, the correction factor $F_{cor,cbs}$ of the series checking block only shall be taken into consideration.

The basis for the correction factor $F_{cor,cbs}$ is the datum of the series checking block.

13.2.2 Correction factor for series checking block with master shell

The correction factor $F_{cor,cbs}$ of the series checking block should not be taken into consideration when carrying out measurements; it is only to check the wearing limit of the series checking block.

When setting the dial gauge, the correction factor $F_{cor,ms}$ of the master shell only (see 13.2.3) shall be taken into consideration.

13.2.3 Master shell correction factor, $F_{cor,ms}$

The correction factor $F_{cor,ms}$ is the amount by which a master shell fitted in a master checking block bore, under a predetermined checking load, deviates from the theoretical peripheral length of the master checking block bore.

For detemining the correction factor $F_{cor,ms}$, see annex D.

When setting the dial gauge, the correction factor of the master shell ($F_{cor,ms}$) shall be taken into consideration.

The basis for the correction factor $F_{cor,ms}$ is the joint face of the master shell, the peripheral length of which shall be measured in a master checking block, in accordance with 13.1.

NOTE 10 The correction factor $F_{cor,ms}$ is equal to zero when the master shell is exactly adjusted to the peripheral length of the master checking block bore, the bore diameter d_{cbm} of which corresponds to the outside diameter D_{bs} of the half-bearing to be checked.

13.2.4 Comparison shell correction factor, $F_{cor,cs}$

The correction factor $F_{cor,cs}$ is the amount by which a comparison shell fitted in a master checking block bore, under a predetermined checking load, deviates from the theoretical peripheral length of the master checking block bore.

For determining the correction factor $F_{cor,cs}$, see annex D.

When setting the dial gauge, the correction factor of the comparison shell $F_{cor,cs}$ shall be taken into consideration.

The basis for the correction factor $F_{cor,cs}$ is the joint face of the comparison shell, the peripheral length of which shall be measured in a master checking block, in accordance with 13.1.

NOTE 11 The correction factor $F_{cor,cs}$ is equal to zero when the comparison shell is exactly adjusted to the peripheral length of the master checking block bore, the bore diameter d_{cbm} of which corresponds to the outside diameter D_{bs} of the half-bearing to be checked.

13.3 Marking

The correction factor calculated shall be engraved on each of the gauging tools.

13.4 Reference setting

In cases of dispute, the setting shall be made in accordance with the determined correction factor in a master checking block (see 13.1). The method shall be agreed between the manufacturer and customer.

14 Typical checking procedure

14.1 Place the checking block in the measuring equipment, line it up and secure it against lateral movement.

14.2 Set the checking load in accordance with specifications.

14.3 Under the specified checking load, lower the pivoting toe piece (for method A) or the toe pieces (for method B) vertically onto the datum of the checking block or onto the joint face of the master shell, or of the comparison shell.

In the case of method A, adjust the dial gauge to the full value of the correction factor engraved on either the checking block ($F_{cor,cb}$ or $F_{cor,cbs}$), the master shell ($F_{cor,ms}$) or the comparison shell ($F_{cor,cs}$).

In the case of method B, adjust both dial gauges to one-half of the correction factor (see figure 3).

14.4 Place the half-bearing to be checked (see also clause 15) in the checking block and apply the checking load via the measuring head.

14.5 Determine the nip variation of the half-bearing, in the case of method A, by reading off the dial gauge directly or, in the case of method B, by adding the partial nip variations recorded on the two dial gauges.

14.6 The measuring temperature shall be between 20 °C and 25 °C when using the master block, but series checking may take place at room temperature if both the measuring equipment and the half-bearings being checked are at the same temperature.

14.7 When carrying out reference measurements, the value of the nip is the average of three measurements taken at a temperature of 20 °C.

15 Condition of the half-bearings to be checked

The joint and back faces of the half-bearing shall be free of foreign matter, grease and any damage, and shall be at the same temperature as the checking block being used.

16 Measuring errors

16.1 Errors due to the measuring equipment

These errors are due to

— an incorrect position of the checking block (longitudinal or transverse direction);

— the checking block being incorrectly fixed in the measuring equipment;

— an incorrect setting of the checking load;

— an excessive speed of approach of the load;

— the pivoting toe piece being too tight or having too much clearance;

— damage or wear of the toe piece(s).

16.2 Errors due to the checking block

These errors are due to

— the difference in temperature between the half-bearing and checking block;

— damage or wear of the checking block;

— the recess for locating nicks being too large;

— the locating nick fouling the notch in the checking block;

— the bore of the checking block being chromium plated;

— the fixed stop (for method A) not covering the total joint face of the bearing;

— the fixed stop (for method A) deflecting too much and/or being poorly attached;

— damage or wear of the fixed stop;

— the checking block width B_3 being smaller than the bearing width in the case of bearings without flange;

— the checking block width B_1 or B_3 for flanged bearings being too large, so that bearings are in contact with the checking block at the fillet radius between back and flange (K_1 or K_2 incorrect).

16.3 Errors due to the correction factor

These errors are due to

— an incorrect reading-off when measuring $d_{cb,M}$ and $H_{cb,M}$;

— an error in calculating the correction factor.

16.4 Errors due to the half-bearing

These errors are due to

— grease, dirt or damage on the outside diameter or joint face;

— joint face taper being excessive.

16.5 Error due to the choice of checking method

An error may arise if the correction δ is not considered when the half-bearing is tested by a method other than the method specified on the bearing drawing (see 7.1 and E.3).

17 Accuracy of methods used

This clause gives a statistical approach to evaluating the accuracy of the methods used by determining the repeatability and the reproducibility of the measurement results and by comparing results obtained with methods A and B.

17.1 Checking conditions

See table 14.

17.2 Limits

The values given in table 15 are a basis for interpreting the test results.

17.3 Calculation

Details of the methods of calculation and the interpretation of the test results of repeatability, reproducibility and comparability are given in annex E.

18 Specifications on bearing drawings

The following should be specified in the drawing, represented graphically or otherwise, for the measurement of the nip:

a) the recommended checking method (A or B) (see clause 7);

b) the checking load;

c) the nip (crush);

d) diameter $d_{cb,th}$ and the distance from the bottom of the checking block to the datum plane, $H_{cb,th}$.

19 Specifications for the control of the checking means

19.1 The gauging tools shall be checked regularly, significant damage made good and any dimensional changes to the gauging tools engraved on them.

19.2 The measuring equipment shall be checked as to its accuracy, at specified time intervals (with regard to statistical methods).

Table 14

Datum	Repeatability	Reproducibility		Comparability
		Case 1[1)]	Case 2[2)]	
Half-bearings	S	S	S	S
Measuring equipment	S	S or I	I or S	D
Checking block	S	S	I or D	D
Operator	S	S or D	D	D
Checking place	S	S or D	D	D
Checking time	Short period	D	D	D

Key

S: Same = physically the same.

I: Identical = in accordance with this International Standard, made to the same design, drawings and specifications.

D: Different = in accordance with this International Standard but made to different designs, drawings and specifications.

1) The same half-bearings are checked in the same checking block with the same checking equipment, or with an identical one (in which the checking block can be mounted), by a single operator or different operators working in the same or in different places at different times.

2) The same half-bearings are checked in identical or in different checking blocks, with identical or different checking equipment by operators working in different places at different times.

Table 15

D_{bs} mm	Repeatability $\sigma_{\Delta B}$ µm	Reproducibility $\lvert\bar{x}_1 - \bar{x}_2\rvert$ max. µm		Comparability[1)] $\lvert\bar{x}_A - \bar{x}_B\rvert$ max. µm
		Case 1[2)]	Case 2[3)]	
$D_{bs} \leqslant 75$	1,1	3	8	10
$75 < D_{bs} \leqslant 160$	1,4	4	9	14
$160 < D_{bs} \leqslant 340$	2,2	6	16	24
$340 < D_{bs} \leqslant 500$	2,8	8	18	30

1) In order to achieve these values, especially for thicker bearings, a good contact between the toe piece (fixed stop) and the bearing joint faces is of prime importance.

2) The same half-bearings are checked in the same checking block with the same checking equipment, or with an identical one (in which the checking block can be mounted), by a single operator or different operators working in the same or in different places at different times.

3) The same half-bearings are checked in identical or in different checking blocks, with identical or different checking equipment by operators working in different places at different times.

Annex A
(normative)

Determination of the correction factor of the master checking block — Method A

A.1 Calculation form

Firm	Number of drawing	Type of bearing
$d_{cbm, th}$ = ______ mm	s_{tot} = ______ mm	B_{max} = ______ mm
F = ______ N		B_{cbm1} or $B_{cbm3, min}$ = ______ mm

1 Actual peripheral length before correction (see figure A.1)

$d_{cbm, M} \times \frac{\pi}{2}$ = ______ × 1,570 8 = ⟶ ______ mm

2 Deviations Δl_{cbm1} and Δl_{cbm2} (take signs into account, see note under figure A.1)

Δl_{cbm1} = [−] ______ mm

Δl_{cbm2} = [+] ______ mm

$\Sigma \Delta l_{cbm}$ = [−] ______ mm ⟶ [−] ______ mm

3 Elastic variation of $H_{cbm, th}$ (see figure A.2)

$\Delta H_{cbm} = \frac{H_{cbm, th}\,F}{5 \times 10^5 \times w\,B_{cbm1}} = \frac{\_\_\_\_ \times \_\_\_\_}{500\,000 \times \_\_\_\_}$ = [−] ______ mm

4 Elastic depressions at the fixed stop and toe piece (see figure A.3)

$p_{E1} + p_{E2} = \frac{0{,}000\,03\,F}{s_{tot}\,B} = \frac{0{,}000\,03 \times \_\_\_\_}{\_\_\_\_ \times \_\_\_\_}$ = [+] ______ mm

5 Flexibility of the fixed stop under checking load Δl_{cbm} (see figure A.4)

[+] ______ mm

6 Measured peripheral length (after correction)

$l_{cbm, M} = \Sigma$ (1 to 5) = [+] ______ mm

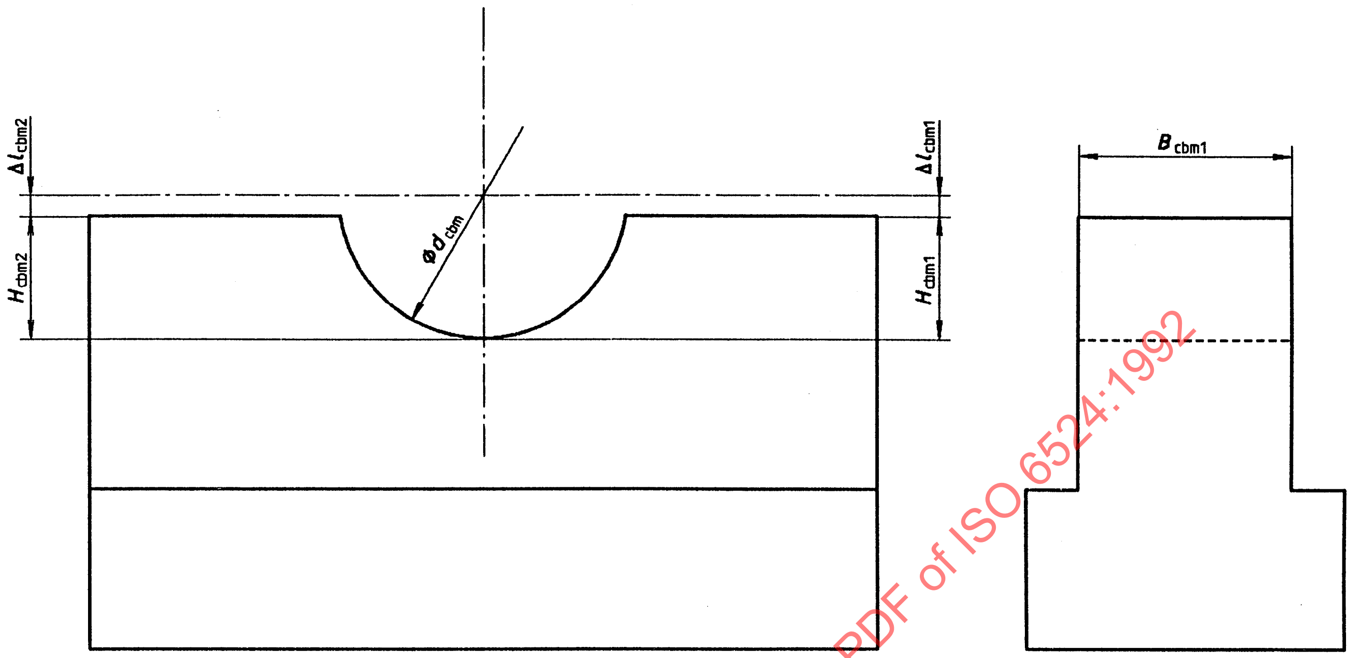
7 Theoretical peripheral length

$l_{cbm, th} = d_{cbm, th} \times \frac{\pi}{2}$ = ______ × 1,570 8 = ⟶ [−] ______ mm

8 Correction factor for master checking block

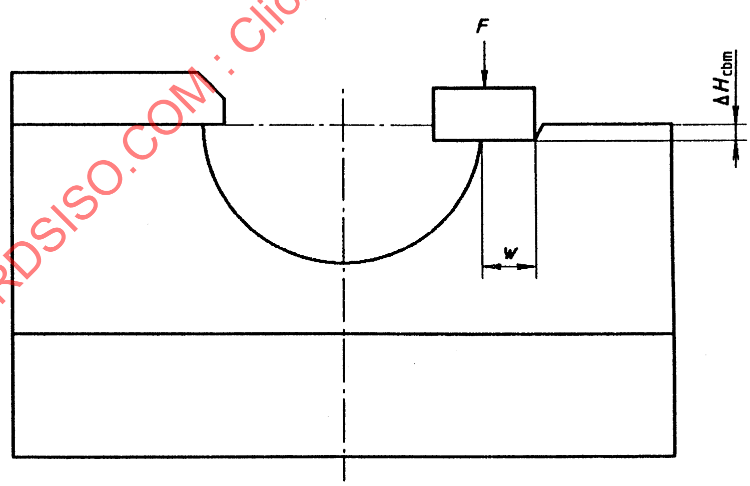
$F_{cor, cbm}$ = [+] ______ mm ⟵ [+] ______ mm

Determine steps 1, 2 and 5 by measurement.



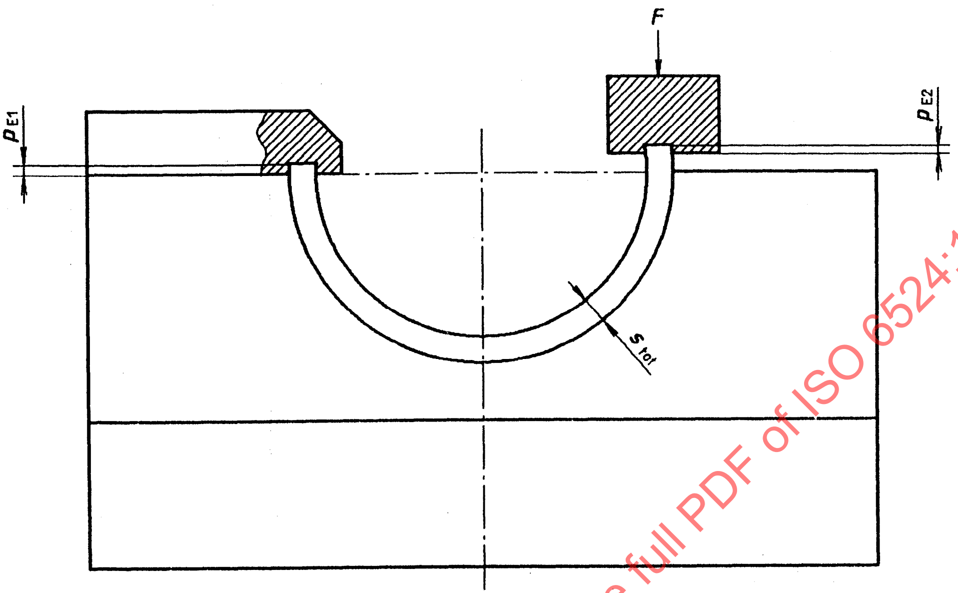
NOTE — $\Delta l_{\text{cbm1}} = H_{\text{cbm1,M}} - \dfrac{d_{\text{cbm,M}}}{2}$ and $\Delta l_{\text{cbm2}} = H_{\text{cbm2,M}} - \dfrac{d_{\text{cbm,M}}}{2}$

Figure A.1



NOTE — w is the width of the toe piece contact area, in millimetres.

Figure A.2



NOTE — p_{E1} and p_{E2} are negligible if the measuring planes of the toe piece and the fixed stop are coated with hard carbide.

Figure A.3

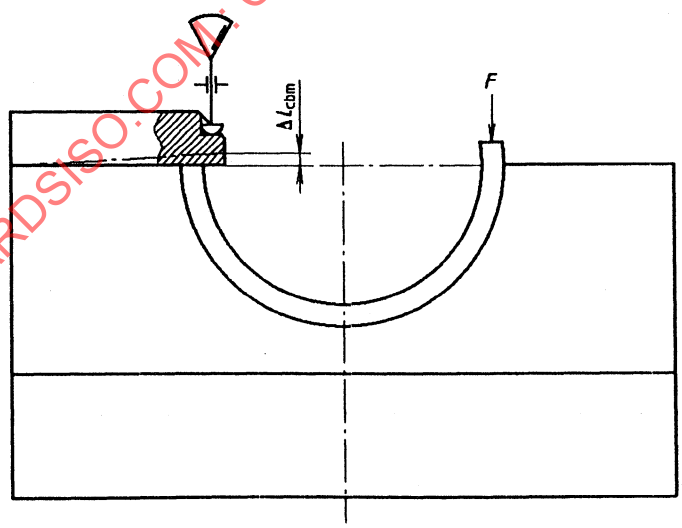


Figure A.4

A.2 Numerical example

Firm	Number of drawing	Type of bearing

$d_{cbm,\,th}$ = 54,521 mm $\qquad s_{tot}$ = 1,950 mm $\qquad B_{max}$ = 35,00 mm

F = 5800 N $\qquad B_{cbm1}$ or $B_{cbm3,\,min}$ = 35,00 mm

1 Actual peripheral length before correction (see figure A.1)

$d_{cbm,\,M} \times \frac{\pi}{2}$ = 54,522 × 1,570 8 = → 85,6429 mm

2 Deviations Δl_{cbm1} and Δl_{cbm2} (take signs into account, see note under figure A.1)

Δl_{cbm1} = − 0,001 mm

Δl_{cbm2} = + 0,000 mm

$\Sigma\,\Delta l_{cbm}$ = − 0,001 mm → − 0,0010 mm

3 Elastic variation of $H_{cbm,\,th}$ (see figure A.2)

$\Delta H_{cbm} = \frac{H_{cbm,\,th}\,F}{5 \times 10^5 \times w\,B_{cbm1}} = \frac{27,260 \times 5800}{500\,000 \times 10 \times 35,00}$ = − 0,0009 mm

4 Elastic depressions at the fixed stop and toe piece (see figure A.3)

$p_{E1} + p_{E2} = \frac{0,000\,03\,F}{s_{tot}\,B} = \frac{0,000\,03 \times 5800}{1,950 \times 35,00}$ = + 0,0025 mm

5 Flexibility of the fixed stop under checking load Δl_{cbm} (see figure A.4) + 0,002 mm

6 Measured peripheral length (after correction)

$l_{cbm,\,M} = \Sigma$ (1 to 5) = + 85,6455 mm

7 Theoretical peripheral length

$l_{cbm,\,th} = d_{cbm,\,th} \times \frac{\pi}{2}$ = 54,521 × 1,570 8 = → − 85,6413 mm

8 Correction factor for master checking block

$F_{cor,\,cbm}$ = + 0,004 mm ← + 0,0042 mm

Determine steps 1, 2 and 5 by measurement.

Annex B
(normative)

Determination of the correction factor of the master checking block — Method B

B.1 Calculation form

Firm	Number of drawing	Type of bearing
$d_{cbm, th}$ = ☐☐☐☐☐☐ mm	s_{tot} = ☐☐☐☐☐ mm	B_{max} = ☐☐☐☐☐ mm
F = ☐☐☐☐☐☐ N		B_{cbm1} or $B_{cbm3, min}$ = ☐☐☐☐☐ mm

1 Actual peripheral length before correction (see figure B.1)

$d_{cbm, M} \times \frac{\pi}{2}$ = ☐☐☐☐☐☐ × 1,570 8 = → ☐☐☐☐☐☐☐☐ mm

2 Deviations Δl_{cbm1} and Δl_{cbm2} (take signs into account, see note under figure B.1)

Δl_{cbm1} = [−] ☐☐☐☐ mm

Δl_{cbm2} = [+] ☐ ☐☐☐☐ mm

$\Sigma \Delta l_{cbm}$ = [−] ☐☐☐☐ mm → [−] ☐☐☐☐☐ mm

3 Elastic variation: $\Delta H_{cbm} = \Delta H_{cbm1} + \Delta H_{cbm2}$ (see figure B.2)

$\Delta H_{cbm} = \frac{H_{cbm, th} F}{2,5 \times 10^5 \times w B_{cbm1}}$ = (☐☐☐☐☐☐ × ☐☐☐☐☐☐) / (250 000 × ☐☐ × ☐☐☐☐☐) = [−] ☐☐☐☐☐☐☐☐ mm

4 Elastic depressions at both toe pieces (see figure B.3)

$p_{E1} + p_{E2} = \frac{0,000\,03 F}{s_{tot} B}$ = (0,000 03 × ☐☐☐☐☐☐) / (☐☐☐☐☐ × ☐☐☐☐☐) = [+] ☐☐☐☐☐☐☐☐ mm

5 Measured peripheral length (after correction)

$l_{cbm, M} = \Sigma$ (1 to 4) = [+] ☐☐☐☐☐☐☐☐ mm

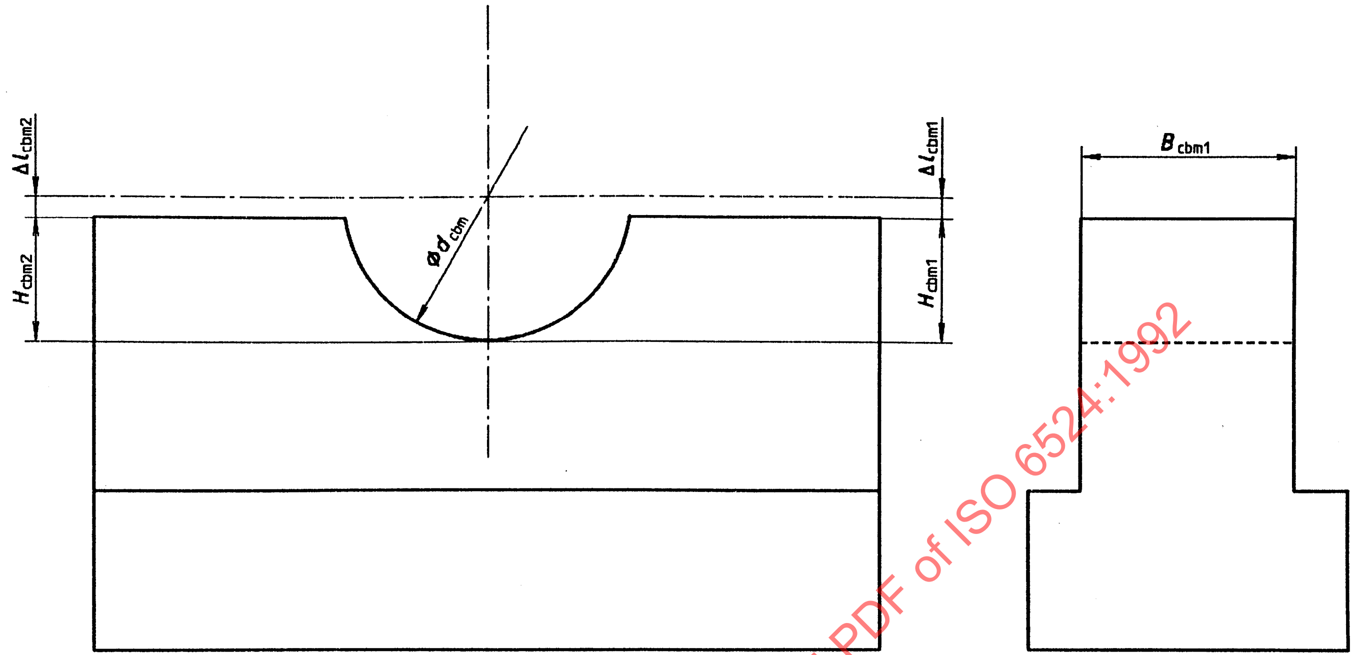
6 Theoretical peripheral length

$l_{cbm, th} = d_{cbm, th} \times \frac{\pi}{2}$ = ☐☐☐☐☐☐ × 1,570 8 = → [−] ☐☐☐☐☐☐☐☐ mm

7 Correction factor for master checking block

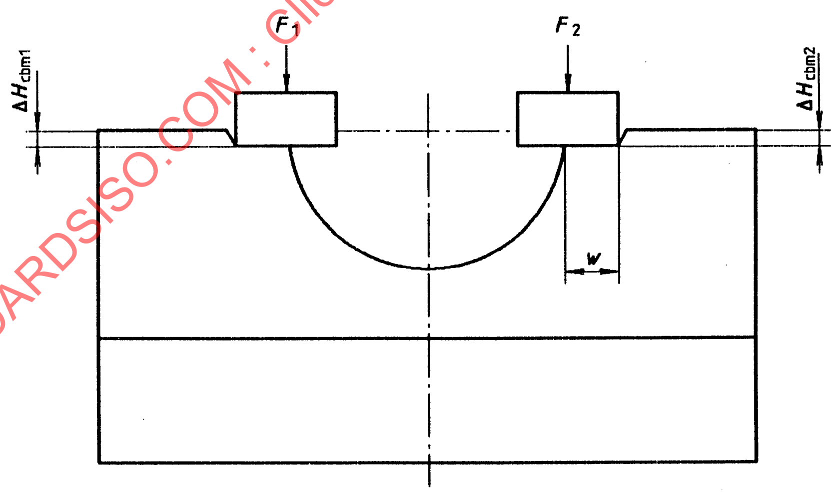
$F_{cor, cbm}$ = [+] ☐☐☐☐ mm ← [+] ☐☐☐☐☐☐ mm

Determine steps 1 and 2 by measurement.



NOTE — $\Delta l_{\text{cbm1}} = H_{\text{cbm1,M}} - \frac{d_{\text{cbm,M}}}{2}$ and $\Delta l_{\text{cbm2}} = H_{\text{cbm2,M}} - \frac{d_{\text{cbm,M}}}{2}$

Figure B.1



NOTE — w is the width of the toe piece contact area, in millimetres.

Figure B.2