INTERNATIONAL STANDARD

ISO 16589-1

Second edition
2011-04-15

Rotary shaft lip-type seals incorporating thermoplastic sealing elements —

Part 1: Nominal dimensions and tolerances

Bagues d'étanchéité à lèvres pour arbres tournants incorporant des éléments d'étanchéité thermoplastiques —

Partie 1: Dimensions nominales et tolérances

Reference number
ISO 16589-1:2011(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16589-1 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 7, *Sealing devices*.

This second edition cancels and replaces the first edition (ISO 16589-1:2001), which has been technically revised.

ISO 16589 consists of the following parts, under the general title *Rotary shaft lip-type seals incorporating thermoplastic sealing elements*:

— *Part 1: Nominal dimensions and tolerances*

— *Part 2: Vocabulary*

— *Part 3: Storage, handling and installation*

— *Part 4: Performance test procedures*

— *Part 5: Identification of visual imperfections*

Introduction

Rotary shaft lip-type seals are used to retain fluid in equipment where the differential pressure is relatively low. Typically, the shaft rotates and the housing is stationary, although in some applications the shaft is stationary and the housing rotates.

Dynamic sealing is normally the result of a designed interference fit between the shaft and a flexible element incorporated in the seal.

Similarly, a designed interference fit between the outside diameter of the seal and the diameter of the housing bore retains the seal and prevents static leakage.

Careful storage and handling and proper installation of all seals are necessary to avoid hazards, both prior to and during installation, which would adversely affect service life.

Rotary shaft lip-type seals incorporating thermoplastic sealing elements —

Part 1: Nominal dimensions and tolerances

1 Scope

ISO 16589 specifies seals utilizing sealing elements manufactured from suitably formulated compounds based on thermoplastic materials, such as polytetrafluoroethylene (PTFE). They are considered suitable for use under low pressure conditions.

This part of ISO 16589 shows seal types and examples. It also specifies the nominal dimensions and tolerance of the seals, shafts and housings, as well as a dimensional identification code.

NOTE ISO 16589 is complementary to ISO 6194, which covers seals incorporating elastomeric sealing elements.

2 Normative references

The following referenced documents are indispensable for the application 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 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 16589-2, *Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 2: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and ISO 16589-2 apply.

4 Symbols

a housing bore depth

b nominal seal width

c housing bore chamfer length

d_m minor diameter at the shaft lead-in chamfer

D_1 nominal diameter of the shaft to be used with the seal

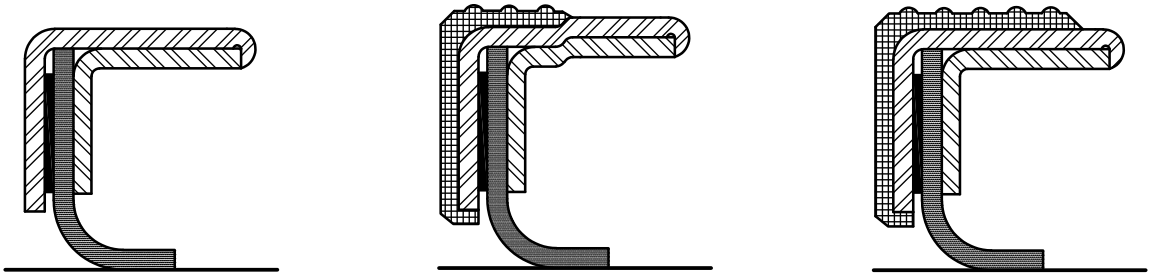
D_2 nominal diameter of the housing bore and of the outer diameter of the seal

r housing bore corner radius

5 Seal types and examples

5.1 Seal outside diameter construction

Figure 1 shows three basic types of seal outside diameter construction.



Type 1

Metal-cased

Type 2

Semi-rubber-covered metal-cased

Type 3

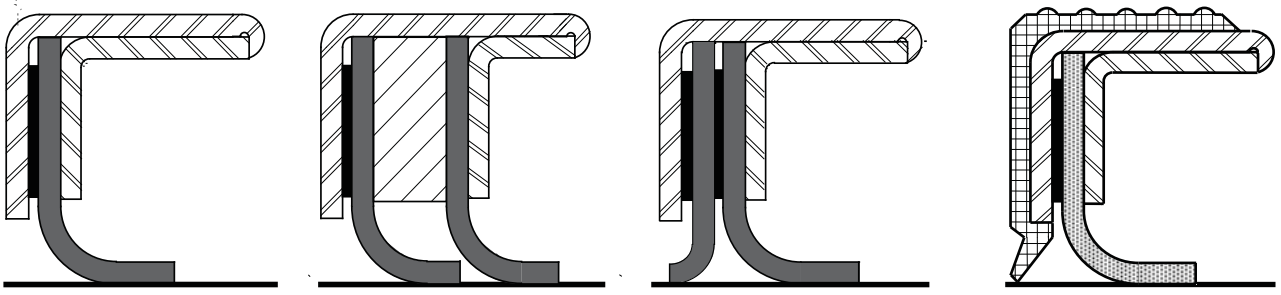
Rubber-covered metal-cased

NOTE Because of some variations in design details, or seals made by different manufacturers, the constructions shown are intended only to be representative of the basic types.

Figure 1 — Three basic types of outside diameter construction

5.2 Sealing lip arrangements

Some examples of sealing lip arrangements are shown in Figure 2.



Example 1

Single lip

Example 2

Double lip in tandem

Example 3

Single lip with thermoplastic protection lip

Example 4

Single lip with elastomeric protection lip

Figure 2 — Sealing lip arrangements

The sealing lip arrangements shown in Figure 2 can be used with each seal outside diameter construction shown in Figure 1.

Hydrodynamic aids on the main lip may be incorporated by some manufacturers in certain applications.

The design of the sealing lip should be agreed between the manufacturer and purchaser.

NOTE Because of variations in design detail, or seals made by different manufacturers, the constructions shown are intended only as representative examples of the basic types.

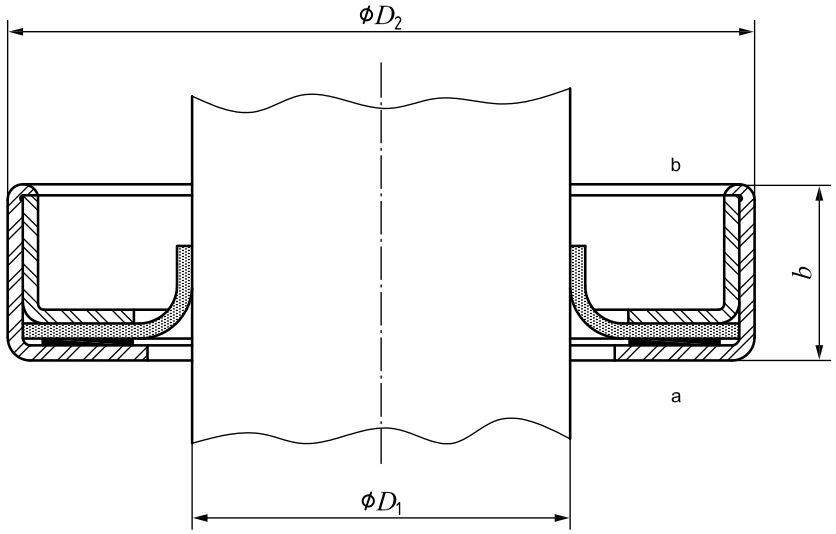
6 Pressure and nominal dimensions

6.1 Pressure

Seals of this type are normally used with atmospheric pressure on the air side, and sealing fluids at pressures from 0 kPa to 30 kPa (0,3 bar) above atmospheric pressure. The user should consult the seal manufacturer regarding use at other pressures.

6.2 Nominal dimensions

The nominal dimensions of the seals are shown in Figure 3 and given in Table 1.



Key

b nominal seal width

D_1 nominal diameter of the shaft to be used with the seal

D_2 nominal diameter of the housing bore and seal outside diameter

a Air side.

b Fluid side.

Figure 3 — Seal

Table 1 — Nominal dimensions

Dimensions in millimetres

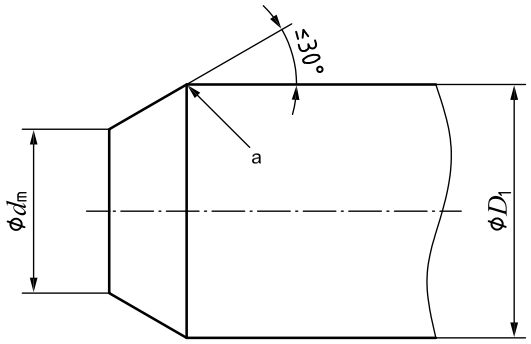
D_1	D_2	b[a]	D_1	D_2	b[a]	D_1	D_2	b[a]	D_1	D_2	b[a]
6	16	7	25	52	7	45	65	8	120	150	12
6	22	7	28	40	7	50	65	8	130	160	12
7	22	7	28	47	7	50	72	8	140	170	15
8	22	7	28	52	7	55	72	8	150	180	15
8	24	7	30	42	7	55	80	8	160	190	15
9	22	7	30	47	7	60	80	8	170	200	15
10	22	7	30	52	7	60	85	8	180	210	15
10	25	7	32	45	8	65	85	10	190	220	15
12	24	7	32	47	8	65	90	10	200	230	15
12	25	7	32	52	8	70	90	10	220	250	15
12	30	7	35	50	8	70	95	10	240	270	20
15	26	7	35	52	8	75	95	10	260	300	20
15	30	7	35	55	8	75	100	10	280	320	20
15	35	7	38	55	8	80	100	10	300	340	20
16	30	7	38	58	8	80	110	10	320	360	20
18	30	7	38	62	8	85	110	12	340	380	20
18	35	7	40	55	8	85	120	12	360	400	20
20	35	7	40	62	8	90	120	12	380	420	20
20	40	7	42	55	8	95	120	12	400	440	20
22	35	7	42	62	8	100	125	12	450	500	25
22	40	7	45	62	8	110	140	12	480	530	25
22	47	7									
25	40	7									
25	47	7									

[a] b may be increased to permit the use of more complex seal configurations.

7 Shafts

7.1 Shaft ends

The end of the shaft shall be provided with a lead-in chamfer as shown in Figure 4 and given in Table 2. It shall be free from burrs, sharp edges and rough machining marks.



Key

d_m minor diameter at the shaft lead-in chamfer

D_1 nominal diameter of the shaft to be used with the seal

a Remove sharp edge.

Figure 4 — Shaft lead-in chamfer

Table 2 — Shaft lead-in chamfer

Dimensions in millimetres

Shaft diameter		Shaft diameter	
D_1	d_m max.	D_1	d_m max.
$D_1 \leqslant 10$	$D_1 - 1{,}5$	$50 < D_1 \leqslant 70$	$D_1 - 4{,}0$
$10 < D_1 \leqslant 20$	$D_1 - 2{,}0$	$70 < D_1 \leqslant 95$	$D_1 - 4{,}5$
$20 < D_1 \leqslant 30$	$D_1 - 2{,}5$	$95 < D_1 \leqslant 130$	$D_1 - 5{,}5$
$30 < D_1 \leqslant 40$	$D_1 - 3{,}0$	$130 < D_1 \leqslant 240$	$D_1 - 7{,}0$
$40 < D_1 \leqslant 50$	$D_1 - 3{,}5$	$240 < D_1 \leqslant 480$	$D_1 - 11{,}0$

Assembly tools are specified in ISO 16589-3 and should be used to ensure that the sealing lip is not damaged.

If a radius is used instead of a lead-in chamfer, its value shall be between 1,8 mm and 3,0 mm.

7.2 Diametral tolerance

The shaft shall have a diametral tolerance not greater than h11, as specified in ISO 286-2.

7.3 Surface roughness and hardness

7.3.1 Surface roughness

The seal contact surface of a ground shaft shall be finished to a surface roughness, measured in the axial direction of between Ra 0,2 µm and Ra 0,5 µm, and between Rz 1,2 µm and Rz 3,0 µm.

Some surface finish processes will not provide roughness values that fall within the limits given in this part of ISO 16589. Surface roughness requirements shall be determined between the manufacturer of the surface and the seal supplier.

The seal contact surface shall normally be free of machining leads.

Ground and polished shafts can require other grades of surface texture, in which case they should be subject to agreement between the manufacturer and user.

Exceptional service conditions can necessitate the selection of other grades of surface texture, in which case they should be subject to agreement between the manufacturer and user.

7.3.2 Surface hardness

Unless otherwise agreed between the manufacturer and user, the surface hardness of the shaft should be a minimum of 30 Rockwell C. If the shaft could be subject to damage during handling, this should be increased to 45 Rockwell C.

8 Housings

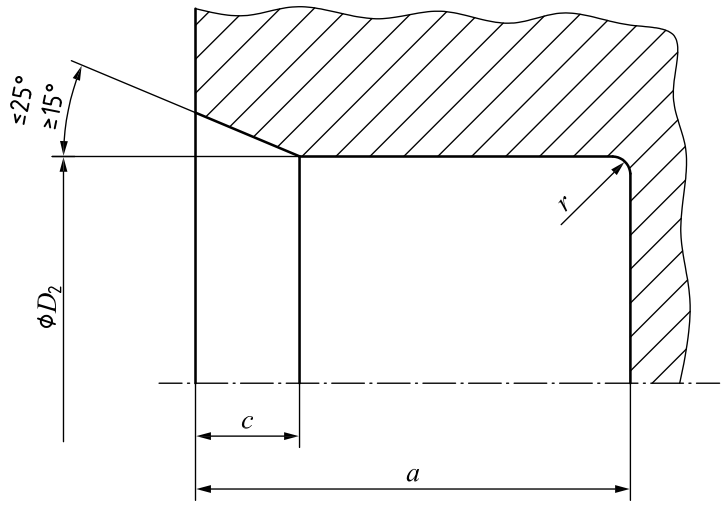
8.1 Dimensions

8.1.1 Where the housing is a rigid fully-machined ferrous part, the housing bore shall conform to 8.2 and 8.3.

8.1.2 The housing bore shall be provided with a lead-in chamfer, free from burrs, as shown in Figure 5 and specified in Table 3.

8.1.3 The housing bore depth and corner radius shall be as shown in Figure 5 and specified in Table 3.

If the housing is not in accordance with 8.1.1 to 8.1.3 (e.g. non-ferrous or non-metallic material, pressing of ferrous or non-ferrous material), the dimensions, tolerances and lead-in configuration should be agreed between the purchaser and manufacturer.



Key

D_2 nominal diameter of the housing bore and seal outside diameter
r housing bore corner radius
a housing bore depth
c housing bore chamfer length

Figure 5 — Housing bore

Table 3 — Housing bore dimensions

Dimensions in millimetres

Nominal seal width b	a min.	c	r max.
$\leqslant 10$	$b + 1{,}2$	0,70 to 1,00	0,50
>10	$b + 1{,}5$	1,00 to 1,30	0,75

8.2 Housing bore tolerance

The housing bore shall have a diametral tolerance not greater than H8, as specified in ISO 286-2.

8.3 Housing bore surface roughness

The surface roughness of the housing bore, measured in the axial direction, shall be between Ra 1,6 µm and Ra 3,2 µm, and between Rz 6,3 µm and Rz 12,5 µm.

There shall be no visible surface imperfections.

The housing bore surface roughness may require lower values when metal-cased seals are used, in which case they should be subject to agreement between the manufacturer and user.

9 Seal tolerances

9.1 Seal width

The recommended seal width tolerances are given in Table 4.

Table 4 — Seal width tolerance

Dimensions in millimetres

Nominal seal width b	Tolerance
$\leqslant 10$	±0,3
$10 < b \leqslant 14$	±0,4
$14 < b \leqslant 18$	±0,5
$18 < b \leqslant 25$	±0,6

9.2 Seal outside diameter

To provide an interference fit between the seal outside surface and the housing bore surface, the tolerances for the outside diameter of the seal shall be as given in Table 5.

The seal outside diameter tolerances in Table 5 shall be used for ferrous housings only. If non-ferrous housing materials are used, the seal manufacturer shall be consulted. The seal manufacturer provides the proper recommendations regarding the interference fit between the seal and the non-ferrous housing.

NOTE Since the interference between the seal outside surface and the housing bore surface is a characteristic related to the design of the seal, it might be necessary for agreement to be reached between the purchaser and manufacturer on the limits to be used. See Annex A for the recommended form.

Table 5 — Seal outside diameter tolerances

Dimensions in millimetres

Nominal seal outside diameter D_2	Diametral tolerance		Roundness tolerance[a]	
	Metal-cased	Rubber-covered[bc]	Metal-cased	Rubber-covered
$\leqslant 50$	+0,20 +0,08	+0,30 +0,15	0,18	0,25
$50 < D_2 \leqslant 80$	+0,23 +0,09	+0,35 +0,20	0,25	0,35
$80 < D_2 \leqslant 120$	+0,25 +0,10	+0,35 +0,20	0,30	0,50
$120 < D_2 \leqslant 180$	+0,28 +0,12	+0,45 +0,25	0,40	0,65
$180 < D_2 \leqslant 300$	+0,35 +0,15	+0,45 +0,25	0,25 % of outside diameter	0,80
$300 < D_2 \leqslant 530$	+0,45 +0,20	+0,55 +0,30	0,25 % of outside diameter	1,00

[a] The roundness tolerance is equal to the difference between the maximum diameter and the minimum diameter derived from three of more equally spaced measurements.

[b] Rubber-covered and semi-rubber-covered seals having a wave-profile outside surface are acceptable but will require different tolerances, to be agreed between the manufacturer and purchaser.

[c] Rubber-covered and semi-rubber-covered seals employing certain materials other than nitrile can require different tolerances, to be agreed between the manufacturer and purchaser.

10 Size identification code

The size identification code shall consist of the nominal dimensions of the shaft and housing, as given in Table 1.

Examples of the size identification code are given in Table 6.

Table 6 — Examples of size identification code

Dimensions in millimetres

D_1	D_2	**Size code**
6	16	006016
70	90	070090
400	440	400440

11 Identification statement (Reference to this part of ISO 16589)

Manufacturers are strongly recommended to use the following statement in test reports, catalogues and sales literature when electing to comply with this part of ISO 16589:

"The nominal dimensions and tolerances of the seals, shafts and housings conform to ISO 16589-1, *Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 1: Nominal dimensions and tolerances*."

Annex A
(informative)

Seal specification

A.1 For the convenience of both the purchaser and manufacturer, it is recommended that the purchaser complete a form such as the one given in Table A.1, to supply the necessary information to the manufacturer to ensure the supply of a seal suitable for the application.

A.2 It is also recommended that the manufacturer complete a form such as the one given in Table A.2, to supply the purchaser with the necessary information to ensure that the seal is in accordance with the equipment design and application requirements, to enable the purchaser to carry out inspection or quality control on the seals supplied by the manufacturer.

Table A.1 — Purchaser's information

Purchaser: **Reference**

Application: **Assembly drawing:**

1 Shaft information

a) Diameter (D_1) .....mm max. ..... mm min.

b) Material .....

c) Surface roughness Ra ..... µm Rz ..... µm

d) Type of finish .....

e) Hardness ..... Rockwell C

f) Chamfer information .....

g) Rotation

1) Direction of rotation[a]

— Clockwise .....

— Anti-clockwise .....

— Bi-directional .....

2) Rotation speed ..... min^{-1}

3) Rotation cycles (Time on ..... Time off .....)

h) Other shaft motion (if applicable)

1) Axial reciprocation

— Length of stroke ..... mm

— Cycles per minute . .....

— Reciprocation cycles (Time on ..... Time off .....)

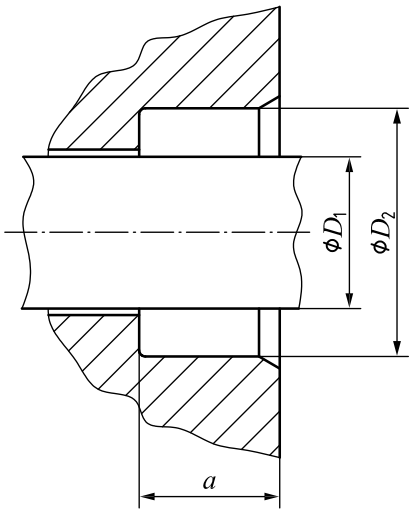
2) Circumferential oscillation

— Magnitude of oscillation ..... degrees

— Cycles per minute .....

— Oscillation cycles (Time on ..... Time off .....)

i) Additional information (i.e. splines, holes, keyways, shaft lead, etc.)



2 Housing information

a) Bore diameter (D_2) ..... mm max. ..... mm min.

b) Bore depth (a) .... mm min.

c) Material .....

d) Surface roughness Ra ..... µm Rz ..... µm

e) Chamfer information .....

f) Housing rotation (if applicable)

1) Direction of rotation[a]

— Clockwise .....

— Anti-clockwise .....

— Bi-directional .....

2) Rotation speed ..... min^{-1}

3 Contained fluid information

a) Type of fluid ..... Grades .....

b) Fluid temperature Normal .....°C Max. .....°C Min. .....°C

c) Temperature cycles .....

d) Fluid level .....

e) Fluid pressure .....kPa ..... bar

f) Pressure cycle .....

4 Alignment

a) Housing bore eccentricity .....mm

b) Shaft runout (TIR) .....mm

5 External conditions

a) External pressure.....kPa ..... bar

b) Materials to be excluded (i.e. dust, mud, water, etc.) .....

.....

[a] Direction of rotation viewed from the air side.

Table A.2 — Manufacturer's information

Manufacturer: ..... Part no. .....

Issue no. ..... Date .....

Seal specification:

Type: ..... Nominal shaft diameter (D_1): .....

Outside diameter (D_2): ..... mm max. .....mm min.

Seal width (b): ..... mm max. .....mm min.

Inner case diameter (d): ..... mm max. .....mm min.

Sealing lip description (delete where not applicable):

Plain Lip incorporating hydrodynamic aids

Clockwise Anti-clockwise Bi-directional

Sealing lip material .....

Case specifications:

Outer case material ..... Inner case material .....

Outer case thickness ..... Inner case thickness .....

Gasket material (if incorporate) .....

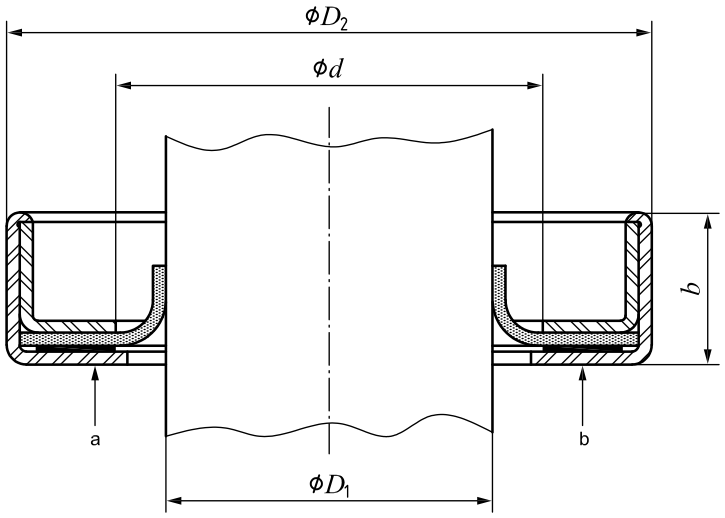
Rubber-covered outside material (if incorporate) .....

Spring material (if incorporate) .....

Optional information .....

Test specification: .....

Example drawing



Key

D_1 nominal diameter of the shaft to be used with the seal

D_2 nominal diameter of the housing bore and seal outside diameter

d nominal diameter of the inner case

b nominal seal width

a Preferred identification location.

b Direction of rotation indicator viewed from air side.

Bibliography

[1] ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

[2] ISO 1629, *Rubber and latices — Nomenclature*

[3] ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

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

[5] ISO 6194-1, *Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 1: Nominal dimensions and tolerances*

[6] ISO 6194-2, *Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 2: Vocabulary*

[7] ISO 6194-3, *Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 3: Storage, handling and installation*

[8] ISO 6194-4, *Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 4: Performance test procedures*

[9] ISO 6194-5, *Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 5: Identification of visual imperfections*

[10] ISO 16589-3, *Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 3: Storage, handling and installation*

[11] ISO 16589-4, *Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 4: Performance test procedures*

[12] ISO 16589-5, *Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 5: Identification of visual imperfections*

ICS 23.100.60; 83.140.50

Price based on 13 pages