INTERNATIONAL STANDARD

ISO 18669-1

First edition
2004-09-01

Internal combustion engines — Piston pins —

Part 1:
General specifications

Moteurs à combustion interne — Axes de pistons —

Partie 1: Spécifications générales

Reference number
ISO 18669-1:2004(E)

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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.

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 18669-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

ISO 18669 consists of the following parts, under the general title *Internal combustion engines — Piston pins*:

Part 1: General specifications

Part 2: Inspection measuring principles

Internal combustion engines — Piston pins —

Part 1:
General specifications

1 Scope

This part of ISO 18669 specifies the essential dimensional characteristics of piston pins of outer diameter from 8 mm up to 100 mm, for reciprocating internal combustion engines. In addition, it establishes a vocabulary, a pin-type classification, material description based on mechanical properties, common features and quality requirements. It may also be used for piston pins of compressors working under analogous conditions.

In certain applications, except road vehicles, and provided that mutual agreement is made between the purchaser and the manufacturer, this part of ISO 18669 may be used with suitable modifications.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1 General

2.1.1
piston pin
precision cylindrical component that connects the piston to the connecting rod and has a smooth hard peripheral surface

2.2 Geometrical and manufacturing features of piston pins

2.2.1 Bore types

2.2.1.1
cylindrical
pin having a straight cylindrical bore

2.2.1.2
centre web
pin inside diameter formed symmetrically from each end leaving a web in the pin centre

NOTE The web is subsequently removed leaving a step as shown in Figure 2.

2.2.1.3
tapered
pin with conical-shaped inside diameter near the ends that reduces the weight of the piston pin

2.2.1.4
machined
pin with inside diameter produced solely by machining

2.2.1.5
seamless drawn tube
hollow steel product which does not contain any line junctures resulting from the method of manufacture

2.2.1.6
end web
pin inner diameter formed from one end leaving a web near the opposite end

NOTE The web is punched out. The pin is then drawn over a mandrel and a forming line may result as shown in Figure 3.

2.2.2 Outside-edge configurations

2.2.2.1
chamfer
outside-edge bevelled feature that is sometimes used to mate with a round retainer ring

NOTE Referred to as "locking chamfer" when a round wire retainer ring is located on the chamfer angle and used to secure the pin in the piston.

2.2.2.2
form angle
δ
region of outside-edge form that provides a smooth transition to the peripheral surface to facilitate ease of assembly

2.2.2.3
drop-off
non-functional machining feature that creates a transition between the outside edge and the peripheral surface

See Figures 6, 7 and 9.

2.2.2.4
inside-edge chamfer
bevelled edge between the bore surface and the end faces of the piston pin

2.2.2.5
gauge point
locating point on the pin outside-edge chamfer from where the gauge diameter (d_5) and gauge length (l_5) are measured

2.2.3 Other features

2.2.3.1
volume change
change detected as a permanent outside-diameter dimensional deviation at reference temperature after being heated to a test temperature for a specified period of time

2.2.3.2
slag lines
linear flaws of non-metallic inclusions

3 Symbols

For the purposes of this part of ISO 18669, the symbols in Table 1 apply.

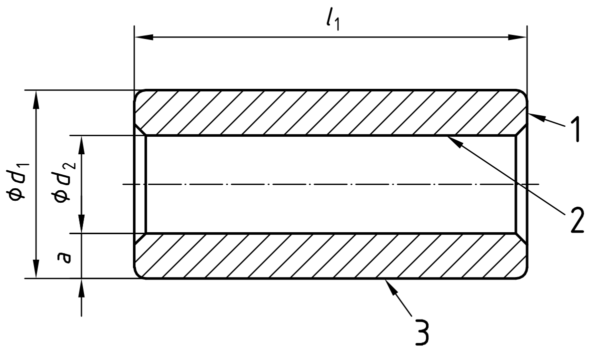
Table 1 — Symbols

Symbol abbreviation	Description
a	Wall thickness
b	Outside-edge drop-off length
c	Outside-edge drop-off height
d_1	Outside diameter
d_2	Inside diameter
d_3	Tapered bore diameter
d_4	Centre-web diameter
d_5	Gauge diameter
f	Outside-edge length
g	Outside-edge chamfer length
l_1	Length
l_3	Tapered bore length
l_4	Centre-web length
l_5	Gauge length
r	Outside-edge radius
R_m	Core strength
s	End face runout
t	Inside-edge chamfer length
α	Tapered bore angle
β	Outside-edge chamfer angle
δ	Outside-edge form angle
H_s	Limit hardness

4 Nomenclature

4.1 Outside, inside and end features

Terms commonly used to describe pins with a cylindrical bore are shown in Figure 1.



Key

1 end face

2 bore surface

3 peripheral surface

d_1 outside diameter

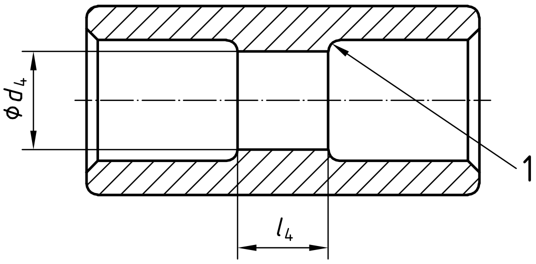
d_2 inside diameter

l_1 length

a Wall thickness.

Figure 1 — Pin with cylindrical bore

Terms commonly used to describe pins with a centre web are shown in Figure 2.



Key

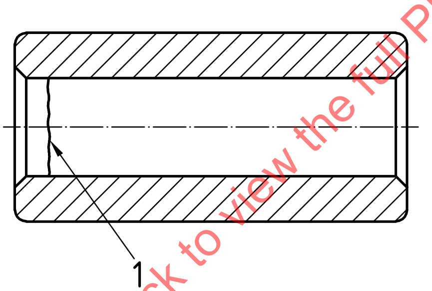
1 centre-web radius

l_4 centre-web length

d_4 centre-web diameter

Figure 2 — Pin with cold-formed centre web

Terms commonly used to describe pins with a cold-formed end-web are shown in Figure 3.

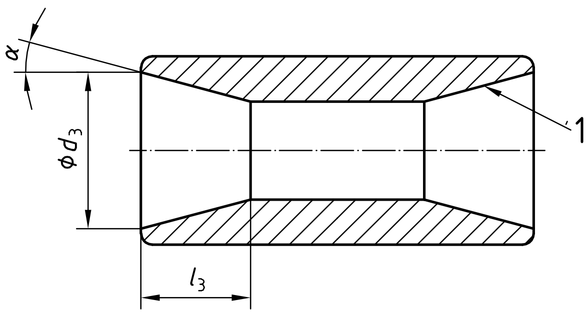


Key

1 end-web forming line

Figure 3 — Pin with cold-formed end web

Terms commonly used to describe pins with a tapered bore are shown in Figure 4.



Key

1 tapered bore surface

d_3 tapered bore diameter

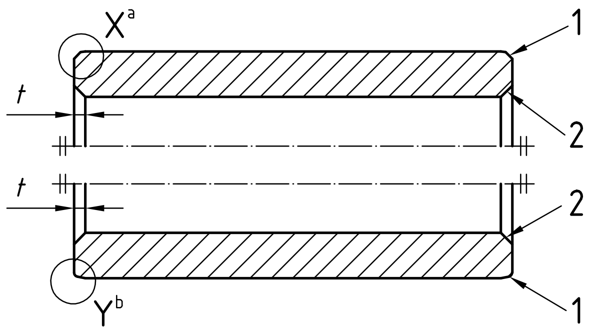
α tapered bore angle

l_3 tapered bore length

Figure 4 — Pin with tapered bore

4.2 Outside edge and inside chamfer configurations

Terms commonly used to describe the outside edge and inside chamfer configurations are shown in Figure 5.



Key

1 outside-edge radius or chamfer (see Figures 6 and 7)

2 inside-edge chamfer

t inside-edge chamfer length

a See Figure 6

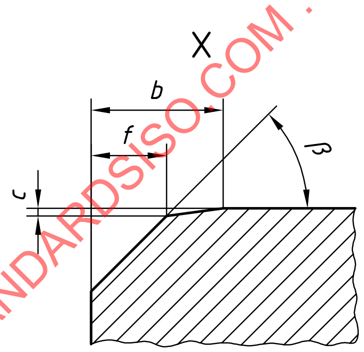
b See Figure 7

NOTE This may be used with either a round or rectangular retainer ring.

Figure 5 — Outside-edge configuration

Terms commonly used to describe the chamfered outside-edge configuration and outside-edge drop-off are shown in Figure 6a).

Terms commonly used to describe double-chamfered outside-edge configurations are shown in Figure 6b).



Key

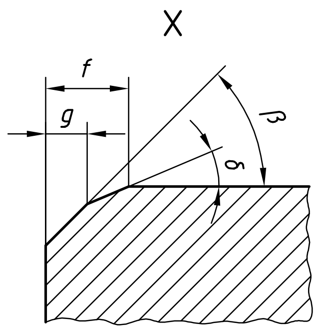
b outside-edge drop-off length

f outside-edge length

c outside-edge drop-off height

β outside-edge chamfer angle

a) Chamfer and drop-off



Key

f outside-edge length

g outside-edge chamfer length

δ outside-edge form angle

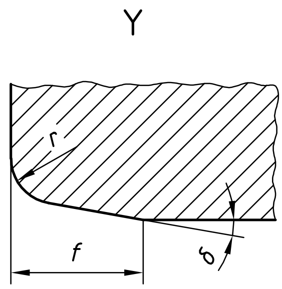
β outside-edge chamfer angle

b) Double-chamfered edge

NOTE Outside-edge drop-off may be used with chamfered, double-chamfered, or radiused outside-edge configurations.

Figure 6 — Detail X of Figure 5

Terms commonly used to describe radiused outside-edge configurations are shown in Figure 7.



Key

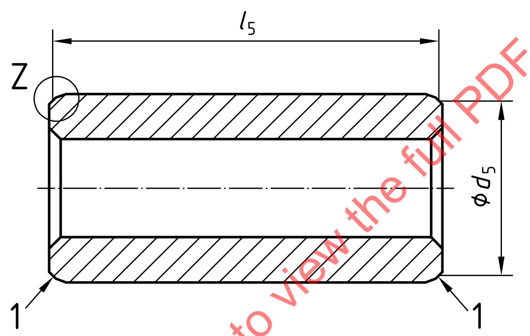
r outside-edge radius

f outside-edge length

δ outside-edge form angle

Figure 7 — Detail Y of Figure 5

Terms commonly used to describe chamfer-locking outside-edge configurations are shown in Figures 8 and 9.



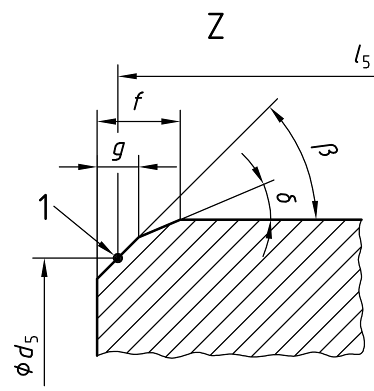
Key

1 gauge points

l_5 gauge length

d_5 gauge diameter

Figure 8 — Chamfer-locking outside edge for round retainer ring



Key

1 gauge point

d_5 gauge diameter

f outside-edge length

g outside-edge chamfer length

l_5 gauge length

Figure 9 — Detail Z of Figure 8

5 Codes

Codes used for piston pins shall be as given in Table 2 with their explanatory descriptions.

Table 2 — Codes and descriptions

Code	Description	Relevant ISO 18669-1 clause
P1…P6	Pin-type classification according to manufacturing method of the pin bore	7.1
X	Piston pins in combination with needle bearing	8.3
F1, F2	Outside-edge configuration tolerance class	7.2.4
K	Carburising steel class K	8.1 / 8.2
S	Carburising steel class S	8.1 / 8.2
L	Carburising steel class L	8.1 / 8.2
M	Carburising steel class M	8.1 / 8.2
N	Nitriding steel class N	8.1 / 8.2
V	Piston pins with limited volume change	8.3 / 8.4 / 8.5
R1, R2	Peripheral surface roughness class	9.1.1
G	Chamfer-locking outside-edge configuration (gauge point)	6.2 / 7.2.4
R	Outside-edge radiused	7.2.4 / 6.1.2
C1	Outside-edge chamfered	7.2.4
C2	Outside-edge double chamfered	7.2.4
LA, LB	Length tolerance class	7.2.3
MM	Manufacturer's mark	9.2
TC	Piston pins with bore surface cold formed	7.2.6

6 Designation of piston pins

6.1 Designation elements and order

To designate piston pins, the following details shall be given, in the order shown below. The codes given in Table 2 shall be used.

6.1.1 Mandatory elements

The following mandatory elements shall constitute the designation of a piston pin:

— designation, i.e., piston pin;

— number of International Standard: ISO 18669;

— type of piston pin, e.g. P1;

— hyphen;

— size of piston pin, $d_1 \times d_2 \times l_1$ or $d_1 / d_3 - \alpha \times d_2 \times l_1$ for a pin with tapered bore;

— hyphen;

— material code, e.g. L.

6.1.2 Additional elements

The following optional elements may be added to the designation of a piston pin; in this case they shall be separated from the mandatory elements by a slash (/):

— code for outside-edge configuration, e.g. R, C1, C2, G;

— size of chamfer-locking gauge dimensions, $d_5 \times l_5 \times \beta$ when code G is specified;

— code for limited volume change, V;

— code for surface roughness, R1, R2.

6.2 Designation examples

The following are examples of piston pin designation in accordance with this part of ISO 18669.

EXAMPLE 1 Designation of a piston pin complying with the requirements of ISO 18669-1, manufacturing type P5 (P5) of outside diameter $d_1 = 20$ mm (20), inside diameter $d_2 = 11$ mm (11) and length $l_1 = 50$ mm (50) made of carburising steel, class L (L) with double chamfered outside-edge configuration (C2), selected chamfer-locking outside-edge configuration (G) of gauge diameter $d_5 = 18{,}9$ mm (18,9), gauge length $l_5 = 49$ mm (49) and outside-edge chamfer angle $\beta = 45°$ (45), limited volume change (V) and Class 1 roughness on peripheral surface (R1):

Piston pin ISO 18669 P5-20 × 11 × 50 L / C2 G-18,9 × 49 × 45 V R1

EXAMPLE 2 Designation of a piston pin complying with the requirements of ISO 18669-1, manufacturing type P2 (P2) of outside diameter $d_1 = 22$ mm (22), tapered bore diameter $d_3 = 18$ mm (18), tapered bore angle $\alpha = 20^{\circ}$ (20), inside diameter $d_2 = 12$ mm (12) and length $l_1 = 60$ mm (60) made of nitriding steel, class (N):

Piston pin ISO 18669 P2-22/18-20 × 12 × 60 N

7 Piston pin types, dimensions and tolerances

7.1 Manufacturing types

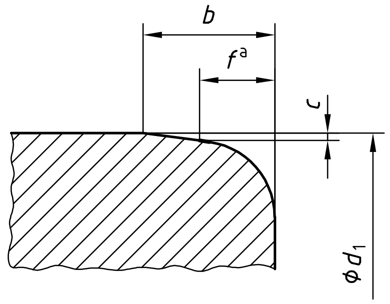
Table 3 — Piston pin manufacturing types

Manufacturing code	Permissible manufacturing methods			
	machined	cold-formed	cold-formed centre web	seamless drawn tube
P1	x	x	x	x
P2	x	x	x	no
P3	no	x	x	no
P4	x	x	no	no
P5	no	x	no	no
P6	x	no	no	no

7.2 Dimensions and tolerances

7.2.1 Outside diameter and form and location tolerances

The edge drop-off at the peripheral surface as shown in Figure 10 is relevant for all outside-edge configurations.



Key

a See Figure 11.

Figure 10 — Edge drop-off

Table 4 shows the outside diameter tolerances and the permissible cylindricity, circularity and edge drop-off.

Table 4 — Outside diameter (d_1) and form and location tolerances

Dimensions in millimetres

Outside diameter d_1	Outside diameter tolerance	Cylindricity max.	Circularity max.	Edge drop-off b max.	Edge drop-off c max.
8 to 16	0 to − 0,004	0,001 5	0,001	$0,12 \times d_1$	0,001
> 16 to 30	0 to − 0,005	0,002	0,001 5		
> 30 to 60	0 to − 0,006	0,002 5	0,002		
> 60 to 100	0 to − 0,008	0,003	0,002 5	$0,08 \times d_1$	0,001 5

7.2.2 Inside diameter tolerance

The tolerances of inside diameter (d_2) and concentricity (permissible wall difference) are shown in Table 5.

Table 5 — Inside diameter tolerance and concentricity at wall thickness a

Dimensions in millimetres

Inside diameter d_2	Inside diameter tolerance	Concentricity $a \leqslant 3$ max.	Concentricity $3 < a \leqslant 5$ max.	Concentricity $a > 5$ max.
$\leqslant$ 30	+ 0,1 / − 0,2	0,3	0,4	0,5 / 0,6 [a]
> 30	+ 0,2 / − 0,4	—		

a Only when piston pins are manufactured from seamless tube.

7.2.3 Length (l_1) and gauge length (l_5) tolerances

Table 6 shows the length tolerances and the permissible runout for end face.

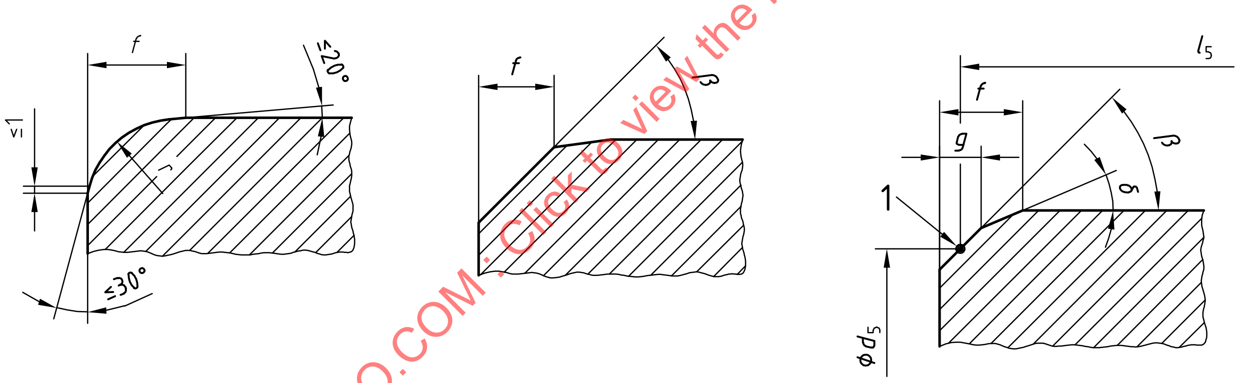
Table 6 — Length tolerances and runout end face

Dimensions in millimetres

Outside diameter d_1	Length l_1 tolerance class 1 code: LA	Length l_1 tolerance class 2 code: LB	Gauge length l_5 tolerance	End face runout s max.
8 to 16	0 to – 0,25	0 to – 0,6	± 0,125	0,12
> 16 to 35	0 to – 0,3		± 0,15	0,15
> 35 to 60	0 to – 0,4		± 0,2	0,15
> 60 to 100	0 to – 0,5		± 0,25	0,25

7.2.4 Outside-edge form

The outside-edge configuration is shown in Figure 11.



Key

1 gauge point

a) Radiused

Code: R

b) Chamfered

Code: C1

c) Double chamfered

Code: C2

NOTE Chamfer-locking outside-edge configurations (gauge point, code: G) are possible with a chamfered or double chamfered outside edge. The values for the gauge point l_5 and d_5 and for the angles β and δ shall be given in the designation of the piston pins.

Figure 11 — Outside-edge configuration

The radiused outside-edge dimensions are given in Table 7.

Table 7 — Radiused outside-edge dimensions

Dimensions in millimetres

Outside diameter d_1	f and r class 1 code: F1	f and r class 2 code: F2
8 to 16	0,15 to 0,3	0,3 to 0,6
> 16 to 25	0,2 to 0,5	0,4 to 0,8
> 25 to 32	0,3 to 0,6	
> 32 to 60	0,4 to 0,8	0,5 to 1,0
> 60 to 100	0,5 to 1,0	0,8 to 1,5

The chamfered outside-edge dimensions are given in Table 8.

Table 8 — Chamfered outside-edge dimensions

Dimensions in millimetres

Outside diameter d_1	Chamfered C1		Double chamfered C2	
	f class 1 code: F1	f class 2 code: F2	g [a]	f [a]
8 to 16	0,15 to 0,3	0,35 to 1,05	0,35 to 1,05	1,25 to 2,15
> 16 to 25	0,2 to 0,5	0,5 to 1,2	0,5 to 1,2	1,25 to 2,4
> 25 to 32	0,3 to 0,6			
> 32 to 60	0,4 to 0,8			
> 60 to 100	0,5 to 1,0	0,8 to 1,5	0,8 to 1,5	—

[a] $g \leqslant f - 0{,}25$

7.2.5 Inside-edge profile

The inside chamfer configuration is shown in Figure 12.

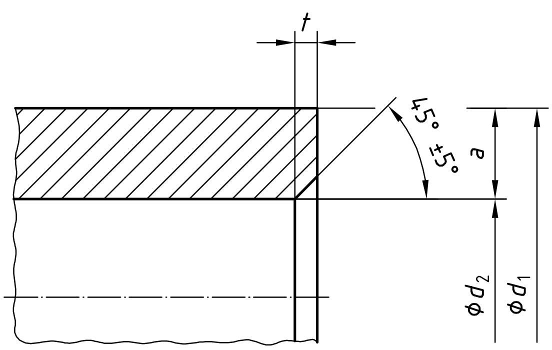


Figure 12 — Inside chamfer configuration

The inside chamfer dimensions are given in Table 9.

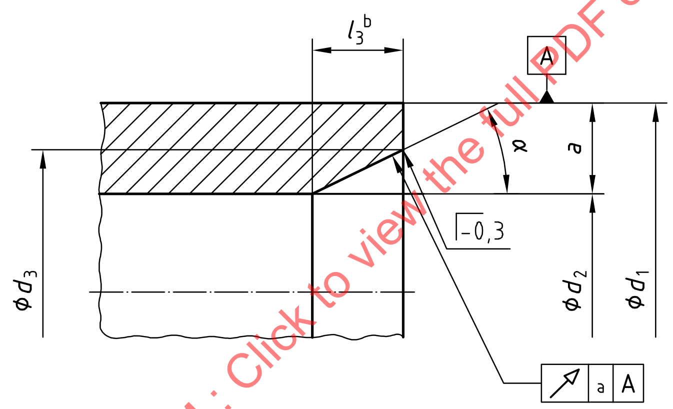
Table 9 — Inside chamfer dimensions

Dimensions in millimetres

Wall thickness a	Inside-edge chamfer length t
1,5 to 3	0,1 to 0,5
> 3 to 5	0,3 to 0,8
> 5 to 8	0,3 to 1,3
> 8 to 12	0,5 to 2
> 12	1 to 3

7.2.6 Tapered bore dimensions

Figure 13 shows the tapered bore configurations.



Key

a Runout, see Table 11.

b Relevant for design and calculations.

Figure 13 — Tapered bore configurations

Table 10 gives the tolerances on tapered bore angle and diameter.

Table 10 — Tolerances on tapered bore angle (α) and diameter (d_3)

Dimensions in millimetres

Tapered bore angle α α degrees	Tolerance machined	Tolerance cold-formed code: TC	Tolerance d_3 machined	Tolerance d_3 cold-formed code: TC
< 8	± 15'	± 1°	± 0,10	± 0,20
⩾ 8 to < 25	± 30'		± 0,15	± 0,25
⩾ 25 to < 45	± 1°	± 2°	± 0,25	± 0,30
⩾ 45 to 60			± 0,30	± 0,35

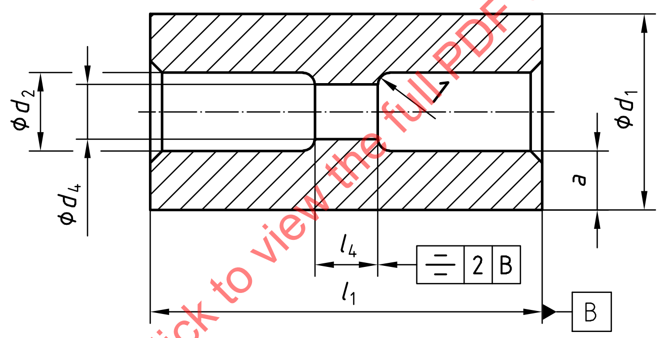
Table 11 gives the runout tolerance on tapered bore diameter.

Table 11 — Runout tolerance on tapered bore diameter

Dimensions in millimetres

Outside diameter d_1	Runout max.	
	machined	cold-formed
8 to $\leqslant$ 16	0,2	0,3
$>$ 16 to $\leqslant$ 25	0,3	0,4
$>$ 25 to $\leqslant$ 32	0,4	0,5
$>$ 32 to 100	0,5	0,6

7.2.7 Centre-web dimensions (see Figure 14)



Key

1 radiused

Figure 14 — Centre-web dimensions

7.2.7.1 Centre-web length (l_4)

Centre-web length (l_4) can be determined using the formula:

$$l_4 = 1{,}3 \times a + 2{,}5 \text{ mm}$$

The common tolerance for the centre-web length (l_4) is $\pm$ 1 mm.

7.2.7.2 Centre-web diameter (d_4)

Centre-web diameter (d_4) can be determined using the formula:

$$d_4 = 0{,}94 \times d_2 - 0{,}7 \text{ mm}$$

The common tolerance for the centre-web diameter (d_4) is $\pm$ 0,5 mm.

8 Material and heat treatment

8.1 Type of material

See Table 12.

Table 12 — Chemical composition, mechanical and physical properties

Feature	**Material**				
Chemical composition (% by weight)	**Class K carburising steel** **code: K**	**Class S carburising steel** **code: S**	**Class L carburising steel** **code: L**	**Class M carburising steel** **code: M**	**Class N nitriding steel** **code: N**
C	0,13 to 0,20	0,13 to 0,25	0,12 to 0,22	0,14 to 0,19	0,26 to 0,34
Si	—	0,15 to 0,35	≤ 0,40	0,15 to 0,40	0,15 to 0,35
Mn	0,60 to 1,00	0,60 to 0,95	0,55 to 0,90	1,00 to 1,30	0,40 to 0,70
P	≤ 0,040	≤ 0,035	≤ 0,035	≤ 0,035	≤ 0,025
S	≤ 0,050	≤ 0,040	≤ 0,040	≤ 0,035	≤ 0,025
Cr	—	0,35 to 0,65	0,70 to 1,25	0,80 to 1,10	2,3 to 2,7
Mo	—	0,15 to 0,30	—	—	0,15 to 0,25
V	—	—	—	—	0,10 to 0,20
Ni	—	0,35 to 0,75	—	—	—
Modulus of Elasticity MPa or N/mm^2	195 000	206 000	210 000	210 000	210 000
Examples	SAE 1016[d]	SAE 8620[e] SNCM 220H[a]	SAE 5120[e] 17Cr3[b] SCr 415H[a]	16MnCr5[b]	31CrMoV9[c]

NOTE Only for calculation: specific gravity 7,8 g/cm^3.

[a] Material designation as specified in JIS G 4052 (see Bibliography).
[b] Material designation as specified in EN 10084 (see Bibliography).
[c] Material designation as specified in EN 10085 (see Bibliography).
[d] Material designation as specified in SAE J403 (see Bibliography).
[e] Material designation as specified in SAE J404 (see Bibliography).

8.2 Core hardness / core strength

See Table 13.

Table 13 — Core hardness

<table>
<tr><th rowspan="2">Wall thickness
a
mm</th><th colspan="5">Core hardness Vickers HV 30
(Core strength, N/mm^2)[a]</th></tr>
<tr><th>Class K</th><th>Class S</th><th>Class L</th><th>Class M</th><th>Class N</th></tr>
<tr><td>1,5 to 2</td><td rowspan="4">240 to 450
(780 to 1450)</td><td>—</td><td>310 to 515
(1000 to 1650)</td><td rowspan="2">310 to 470
(1000 to 1500)</td><td rowspan="5">310 to 470
(1000 to 1500)</td></tr>
<tr><td>$>$ 2 to 5</td><td rowspan="2">270 to 485
(870 to 1560)</td><td>280 to 470
(900 to 1500)</td></tr>
<tr><td>$>$ 5 to 10</td><td>270 to 470
(850 to 1500)</td><td rowspan="3">280 to 470
(900 to 1500)</td></tr>
<tr><td>$>$ 10 to 15</td><td rowspan="2">240 to 450
(780 to 1450)</td><td>250 to 470
(800 to 1500)</td></tr>
<tr><td>$>$ 15</td><td>—</td><td>235 to 470
(750 to 1500)</td></tr>
<tr><td colspan="6">[a] Core strength values R_m are given for reference only and are determined from the core hardness HV by conversion with factor 3,2.</td></tr>
</table>

8.3 Carburised and nitrided case depth

See Table 14.

Table 14 — Case depth

Dimensions in millimetres

<table>
<tr><th rowspan="3">Wall thickness
a</th><th colspan="5">Carburised depth</th><th colspan="2">Nitrided depth</th></tr>
<tr><th colspan="2">outside</th><th rowspan="2">inside
min.</th><th colspan="2">outside and inside together</th><th rowspan="2">outside
min.</th><th rowspan="2">inside
min.</th></tr>
<tr><th>min.</th><th>code: X
min.</th><th>max.</th><th>code: X
max.</th></tr>
<tr><td>1,5 to $<$ 2</td><td>—</td><td>0,4</td><td rowspan="2">0,1</td><td rowspan="2">0,65 × a</td><td rowspan="2">0,80 × a</td><td rowspan="5">0,3</td><td rowspan="5">0,2</td></tr>
<tr><td>2 to 3</td><td>0,3</td><td>0,5</td></tr>
<tr><td>$>$ 3 to 5</td><td>0,4</td><td>0,6</td><td>0,2</td><td>0,50 × a</td><td>0,65 × a</td></tr>
<tr><td>$>$ 5 to 15</td><td>0,6</td><td>—</td><td>0,4</td><td>0,35 × a</td><td>—</td></tr>
<tr><td>$>$ 15</td><td>0,8</td><td>—</td><td>0,6</td><td>0,35 × a</td><td>—</td></tr>
<tr><td colspan="8">NOTE 1 For determination of the case depth, the limit hardness Hs is 550 HV.
NOTE 2 For piston pins with limited volume change code V, the limit hardness Hs is 500 HV.</td></tr>
</table>

8.4 Surface hardness

See Table 15.

Table 15 — Surface hardness

Hardness-measuring method	Surface hardness		
	carburised steel		nitrided steel
	non-limited volume change	limited volume change code: V	
Vickers HV 10	675 min.	635 min.	690 min.
Rockwell HRC [a]	59 min.	57 min.	—

[a] Case depth min. 0,7 mm.

8.5 Volume change

See Table 16.

Table 16 — Outside diameter change Δd_1 after thermal stability test

Dimensions in millimetres

Test conditions	Outside diameter d_1	max.increase Δd_1		
		carburised steel		nitrided steel
		non-limited volume change	limited volume change code: V	
after 4 h at 180 °C	$\leqslant 50$	$+\,0{,}006$	0	0
	> 50 to $\leqslant 60$	$+\,0{,}008$	0	
	> 60 to 100	$+\,0{,}012$	0	
after 4 h at 220 °C	$\leqslant 50$	—	$+\,0{,}006$	
	> 50 to $\leqslant 60$	—	$+\,0{,}008$	
	> 60 to 100	—	$+\,0{,}012$	