BS ISO 6624-4:2016

BSI Standards Publication

Internal combustion engines — Piston rings

Part 4: Half keystone rings made of steel

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National foreword

This British Standard is the UK implementation of ISO 6624-4:2016. It supersedes BS ISO 6624-4:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/14/-/10, RIC engines - Cylinders, pistons and rings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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2016-02-15

Internal combustion engines — Piston rings —

Part 4:
Half keystone rings made of steel

Moteurs à combustion interne — Segments de piston —

Partie 4: Segments semi-trapézoïdaux en acier

Reference number
ISO 6624-4:2016(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.

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

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

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 34, *Propulsion, powertrain and powertrain fluids*.

This second edition cancels and replaces the first edition (ISO 6624-4:2003), which has been technically revised.

ISO 6624 consists of the following parts, under the general title *Internal combustion engines — Piston rings*:

— *Part 1: Keystone rings made of cast iron*

— *Part 2: Half keystone rings made of cast iron*

— *Part 3: Keystone rings made of steel*

— *Part 4: Half keystone rings made of steel*

Introduction

ISO 6624 is one of a number of series of International Standards dealing with piston rings for reciprocating internal combustion engines. Others are ISO 6621,[2][3][4][5] ISO 6622,[6],[7] ISO 6623,[8] ISO 6625,[9] ISO 6626,[10][11][12] and ISO 6627.[13]

Internal combustion engines — Piston rings —

Part 4: Half keystone rings made of steel

1 Scope

This part of ISO 6624 specifies the essential dimensional features of half keystone rings made of steel, types HK, HKB and HKBA, having nominal diameters from 50 mm up to, and including, 160 mm, used in reciprocating internal combustion piston engines for road vehicles and other applications.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6621-4, *Internal combustion engines — Piston rings — Part 4: General specifications*

3 Overview

The half keystone ring types are specified in Tables 1 and 2 and Figures 1, 2 and 3. Their common features and the dimensions of those features are specified in Tables 3 to 6 and Figures 4 to 10. Table 7 gives the force factors for the different ring types, while Table 8 gives the dimensions and forces of half keystone rings.

The common features and dimensional tables presented in this part of ISO 6624 constitute a broad range of variables and, in selecting a particular ring type, the designer shall bear in mind the conditions under which it will be required to operate.

It is also essential that the designer refer to the specifications and requirements of ISO 6621-3[4] and ISO 6621-4 before completing selection.

4 Ring types and designation examples

NOTE For the angle of half keystone rings, the same definition and measurement apply as for keystone rings (see ISO 6621–2).

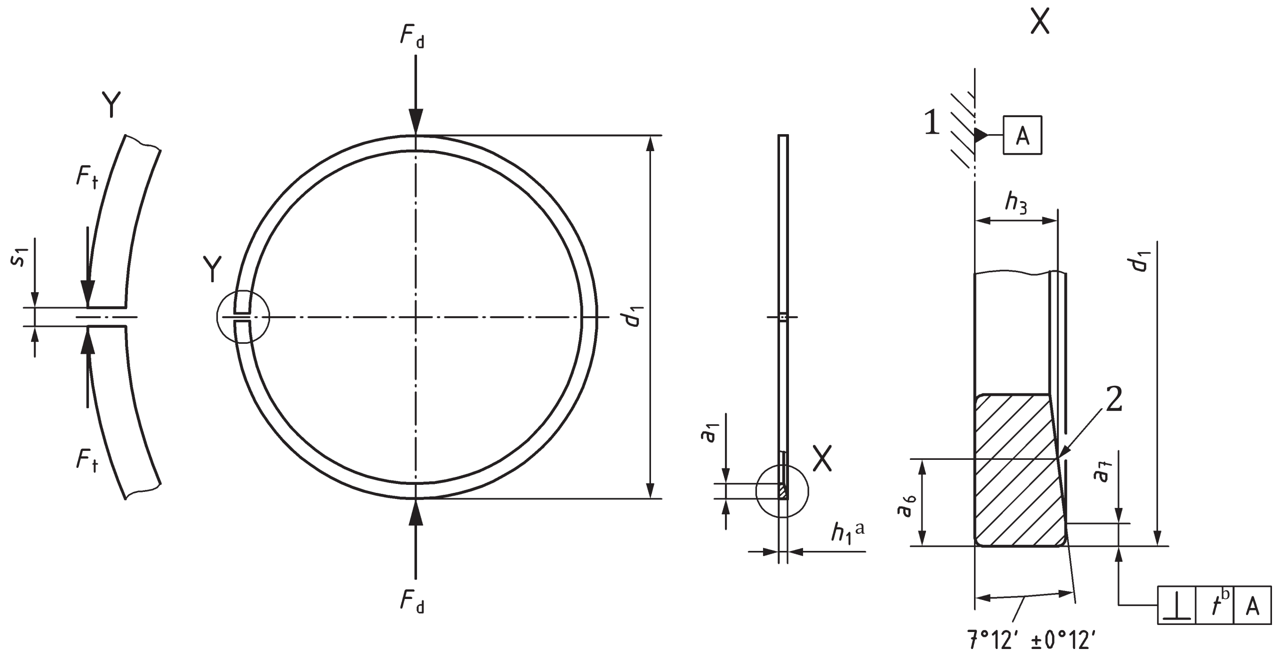
4.1 Type HK — Straight faced half keystone ring 7°

4.1.1 General features

Figure 1 shows the general features of piston ring type HK.

See Table 7 for dimensions and forces.

h_3 values are calculated based on Annex A.



Key

1 reference plane (ring is positioned flat against datum A)

2 top side identification mark

a Nominal.

b $t = 0{,}006 \times h_1$.

Figure 1 — Type HK

4.1.2 Designation

EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624–4, being a 7° half keystone ring made of steel with a straight faced peripheral surface (HK), of nominal diameter d_1 = 60 mm (60), of nominal ring width h_1 = 1,2 mm (1,2), made of CrSi alloyed steel subclass 62 (MC62), and having a chromium plated peripheral surface with a minimum thickness of 0,1 mm (CR2). Parameters in parenthesis are used in the ISO ring designation:

Piston ring ISO 6624-4 HK - 60 × 1,2 - MC62/CR2

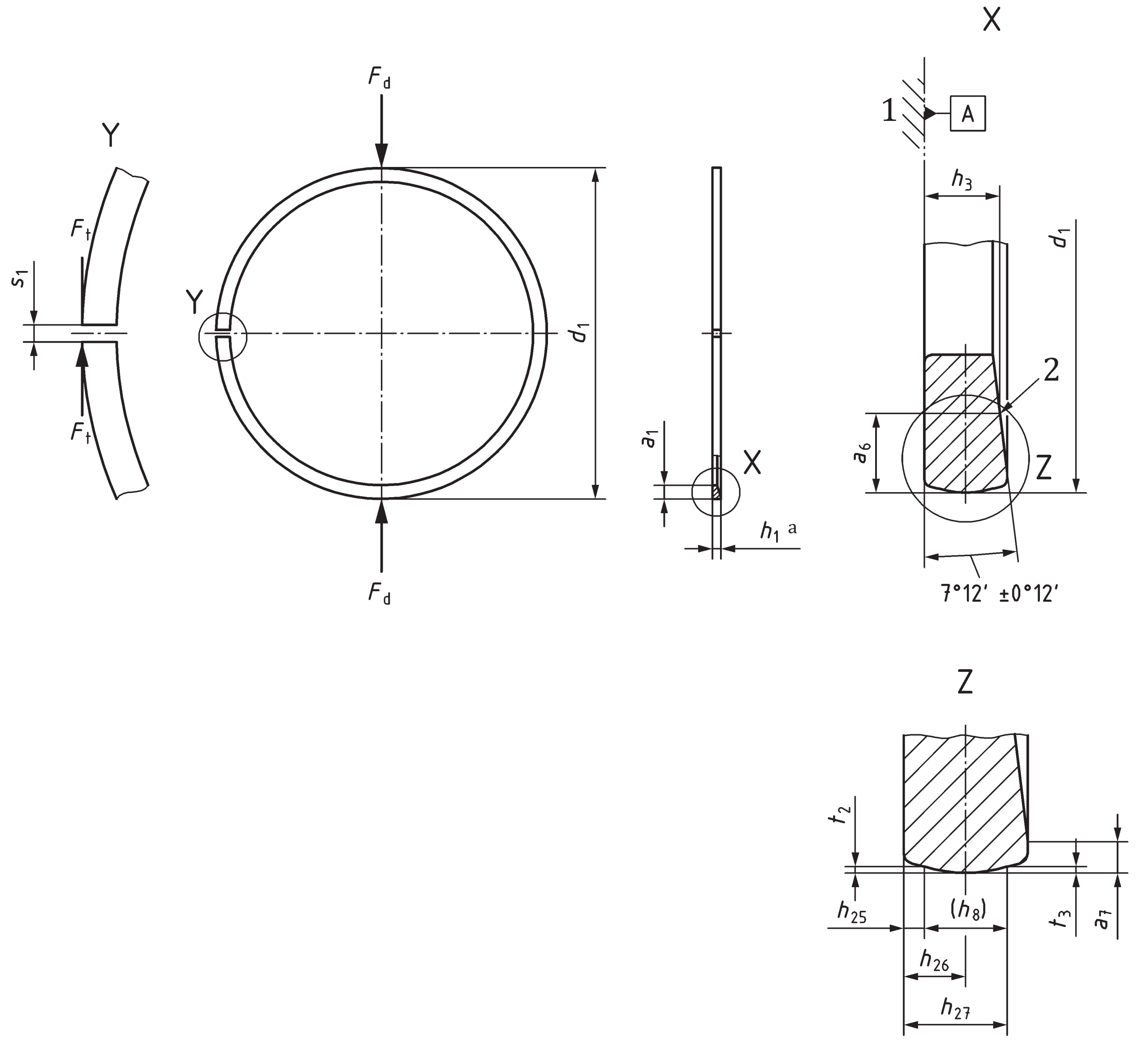
4.2 Type HKB — Barrel faced half keystone ring 7°

4.2.1 General features

Figure 2 shows the general features of piston ring type HKB.

See Table 7 for dimensions and forces.

h_3 values are calculated based on Annex A.



Key

1 reference plane (ring is positioned flat against datum A)

2 top side identification mark

a Nominal.

Figure 2 — Type HKB

Table 1 — Symmetrical barrel dimensions and gauge width (h_8)

Dimensions in millimetres

<table>
<tr><th>h_1</th><th>h_{25}</th><th>h_{26}</th><th>h_{26} tol.</th><th>h_{27}</th><th>t_2, t_3</th><th>h_8[a]</th></tr>
<tr><td>1,2</td><td>0,30</td><td>0,60</td><td>±0,20</td><td>0,90</td><td>0,002...0,012</td><td>0,60</td></tr>
<tr><td>1,5</td><td>0,35</td><td>0,75</td><td>±0,25</td><td>1,15</td><td rowspan="4">0,003...0,015</td><td>0,80</td></tr>
<tr><td>1,75</td><td>0,35</td><td>0,85</td><td>±0,30</td><td>1,35</td><td>1,00</td></tr>
<tr><td>2,0</td><td>0,40</td><td>1,00</td><td>±0,30</td><td>1,60</td><td>1,20</td></tr>
<tr><td>2,5</td><td>0,45</td><td>1,25</td><td>±0,40</td><td>2,05</td><td>1,60</td></tr>
<tr><td>3,0</td><td>0,50</td><td>1,50</td><td>±0,50</td><td>2,50</td><td rowspan="2">0,005...0,020</td><td>2,00</td></tr>
<tr><td>3,5</td><td>0,55</td><td>1,75</td><td>±0,50</td><td>2,95</td><td>2,40</td></tr>
<tr><td colspan="7">[a] Gauge width (h_8) only informative; may be used only if agreed between manufacturer and customer.</td></tr>
</table>

4.2.2 Designation

EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624–4, being a half keystone ring made of steel with a barrel faced peripheral surface (HKB), of nominal diameter d_1 = 60 mm (60), of nominal ring width h_1 = 1,5 mm (1,5), made of martensitic steel 11 %Cr (min.) subclass 65 (MC65), and nitrided on the peripheral surface and side faces (NT) to a depth of 0,050 mm min. on the peripheral surface (050), with an associated side face depth of 0,015 mm min. Parameters in parenthesis are used in the ISO ring designation:

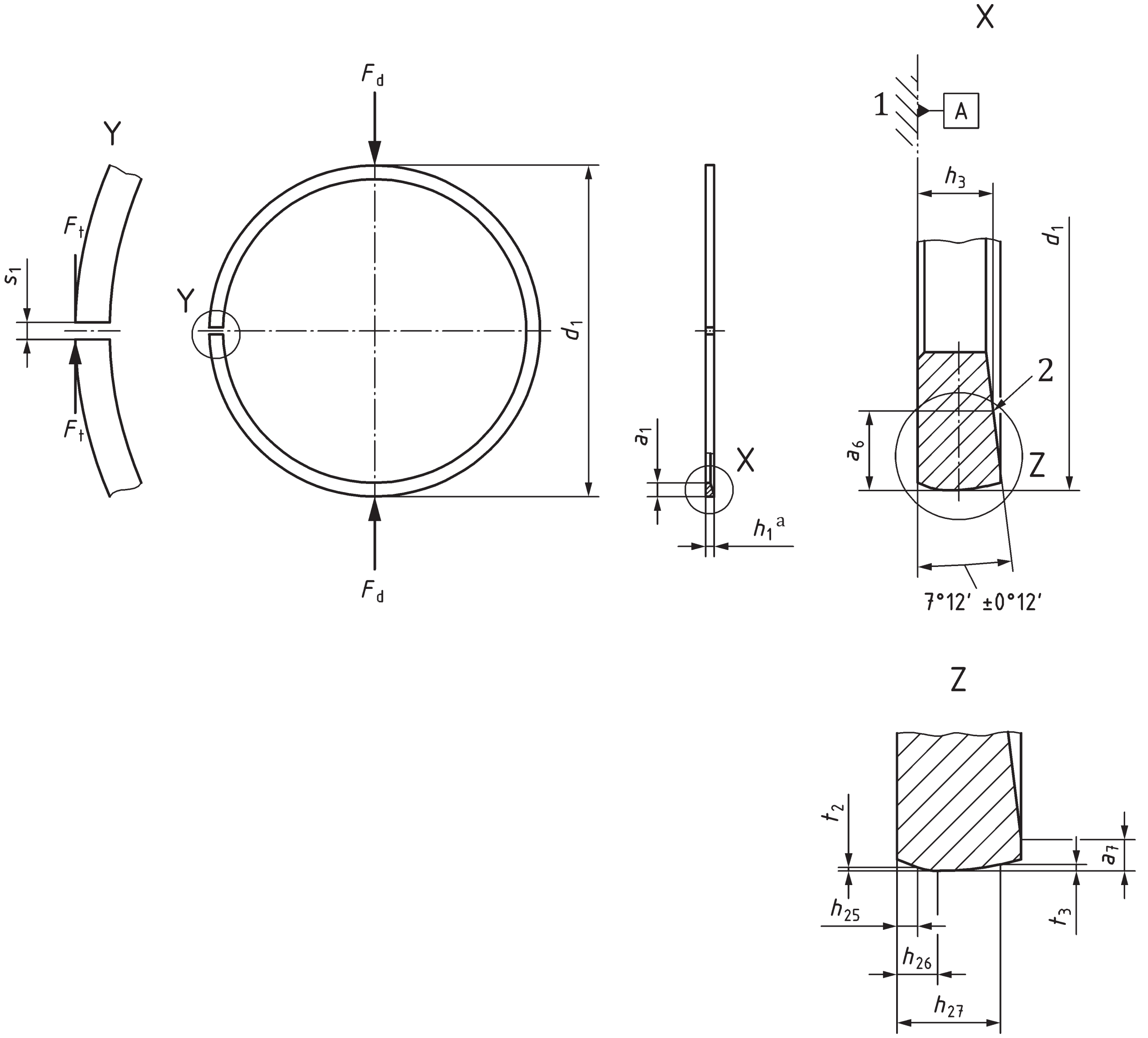
Piston ring ISO 6624-4 HKB - 60 × 1,5 - MC65/NT050

4.3 Type HKBA — Asymmetrical Barrel faced half keystone ring 7° (not recommended for nitrided rings of code NT)

4.3.1 General features

See Table 7 for dimensions and forces.

h_3 values are calculated based on Annex A.



Key

1 reference plane (ring is positioned flat against datum A)

2 top side identification mark

a Nominal.

Figure 3 — Type HKBA

Table 2 — Asymmetrical barrel dimensions

Dimensions in millimetres

h_1	h_{25} [a]	h_{26}	h_{26} tol.	h_{27}	t_2 [b]	t_3 [b]
1,75	0,35	0,55	±0,20	1,35	0...0,007	0,008...0,025
2,0	0,40	0,60		1,50		0,009...0,030
2,5	0,45	0,70	±0,25	1,80	0...0,008	0,011...0,035
3,0	0,55	0,80		2,10		0,012...0,038
3,5	0,60	0,90	±0,30	2,40	0...0,009	0,012...0,040

a h_{25} may be lowered for rings with reduced edge dimensions.

b t_2 and/or t_3 may be varied as agreed between manufacturer and customer.

4.3.2 Designation

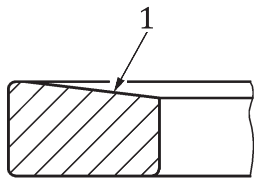
EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624–4, being a half keystone ring made of steel with an asymmetrical barrel faced peripheral surface (HKBA), of nominal diameter d_1 = 80 mm (80), of nominal ring width h_1 = 2,0 mm (2,0), made of martensitic steel 11 %Cr min. subclass 65 (MC65), and PVD on the peripheral surface (PC) to a depth of 0,010 mm min. on the peripheral surface (010). Parameters in parenthesis are used in the ISO ring designation:

Piston ring ISO 6624-4 HKBA - 80 × 2,0 - MC65/PC010

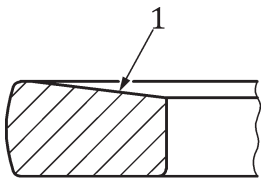
5 Common features

5.1 Type HK, HKB and HKBA — Half keystone rings

5.1.1 Nitrided rings (not recommended for HKBA rings with Nitrided code NT)



a) Type HK



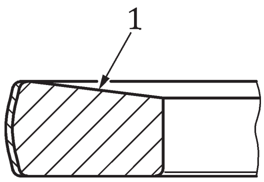
b) Type HKB

Key

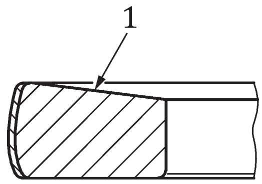
1 top side identification mark

Figure 4 — Nitrided rings

5.1.2 PVD rings



a) Type HKB



b) Type HKBA

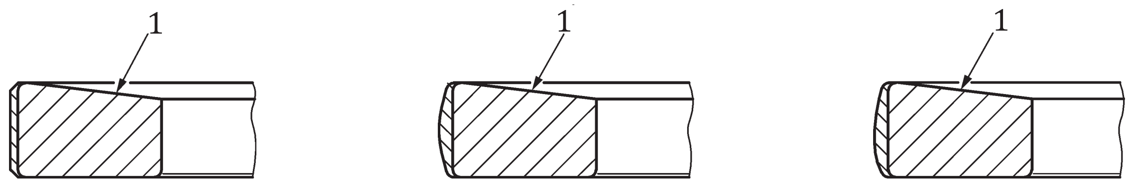
Key

1 top side identification mark

Figure 5 — PVD rings

5.1.3 Chromium plated or spray coated rings

5.1.3.1 Fully faced



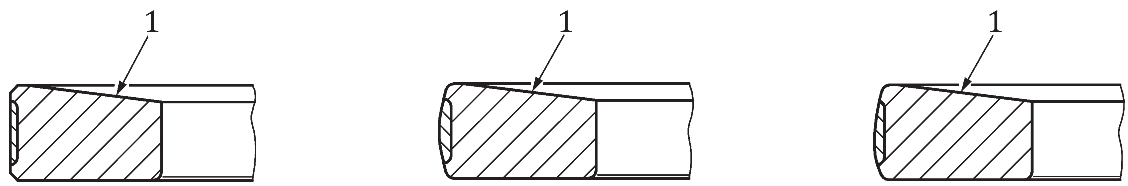
a) Type HK b) Type HKB c) Type HKBA

Key

1 top side identification mark

Figure 6 — Fully faced rings

5.1.3.2 Inlaid (not recommended for chromium plated rings)



a) Type HK b) Type HKB c) Type HKBA

Key

1 top side identification mark

Figure 7 — Inlaid rings

5.2 Type HK, HKB and HKBA rings — Outside and inside rounded edges

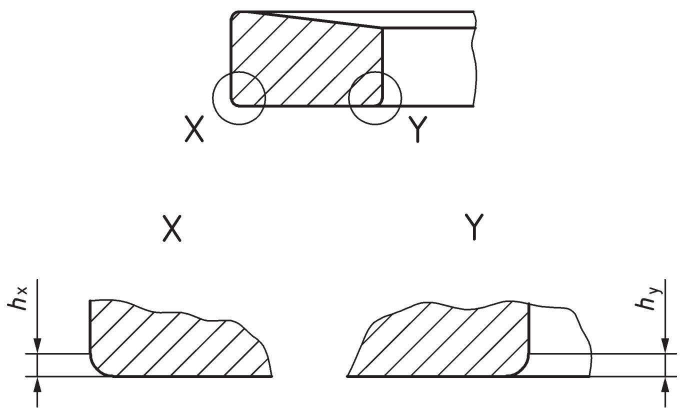


Figure 8 — Outside and inside rounded edges

Table 3 — h_x and h_y dimensions

Dimensions in millimetres

h_1	h_x max.	h_y max.
1,2	0,25	0,3
1,5	0,3	0,35
1,75		
2,0	0,3	0,4
2,5		
3,0		
3,5		

5.3 Type HK, HKB and HKBA rings (fully faced and inlaid) — Plating/coating thickness

a) Fully faced   b) Inlaid

Figure 9 — Plating/coating thickness

Table 4 — Chromium plating/spray coating thickness

Dimensions in millimetres

Chromium plating code	Spray coating code	Thickness min.
CRF	—	0,005
CR1	**SC1**	0,05
CR2	**SC2**	0,10
CR3[a]	**SC3**[a]	0,15
CR4[a]	**SC4**[a]	0,20
[a] Not recommended for rings $h_1 \leq 1,5$.		

Table 5 — PVD coating thickness

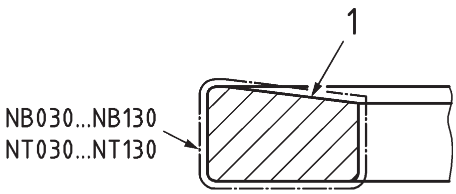
Dimensions in millimetres

Code	Peripheral surface min.
PC001	0,001
PC003	0,003
PC005	0,005
[a] not typical for Diamond Like Carbon coatings (DLC)	

Table 5 *(continued)*

Code	Peripheral surface min.
PC010[a]	0,010
PC020[a]	0,020
PC030[a]	0,030
PC040[a]	0,040
PC050[a]	0,050
[a] not typical for Diamond Like Carbon coatings (DLC)	

5.4 Type HK, HKB and HKBA rings — Nitrided case depth



Key

1 top side identification mark

Figure 10 — Nitrided case depth

Table 6 — Nitrided case depth of peripheral surface and bottom side face

Dimensions in millimetres

Code	Nitrided case depth min.	
	Peripheral surface	Bottom side face
NB030	0,03	0,010
NB050	0,05	0,015
NB070	0,07	0,020
NB090	0,09	0,020
NB110	0,11	0,030
NB130	0,13	0,030
NOTE Nitrided case depth on top side face and on inside surface not specified.		

Table 7 — Nitrided case depth of peripheral surface and side faces (not recommended for HKBA rings)

Dimensions in millimetres

Code	Nitrided case depth min.	
	Peripheral surface	Side faces
NT030	0,03	0,010
NT050	0,05	0,015
NT070	0,07	0,020
NT090	0,09	0,020
NT110	0,11	0,030
NOTE Nitrided case depth on inside surface not specified.		

Table 7 *(continued)*

Code	Nitrided case depth min.	
	Peripheral surface	Side faces
NT130	0,13	0,030
NOTE Nitrided case depth on inside surface not specified.		

6 Force factors

The tangential and diametral forces given in Table 9 shall be corrected when additional features are being used.

For common features, multiplier correction factors given in Table 8 shall be used. The force correction factors for the ratio $m/(d_1 - a_1)$, specified in ISO 6621-4, shall be used.

Table 8 — Force correction factors for chromium plated, spray coated, PVD coated and nitrided HK, HKB and HKBA rings

d_1 mm	Factor						
	CRF / PC001 … PC030	**CR1 / PC040**	**CR2/SC1**	**CR3/SC2**	**CR4/SC3**	**SC4**	**NB030…NB130 NT030…NT130**
$50 \leq d_1 < 75$	1	0,87	0,81	0,75	0,69	0,64	1,03
$75 \leq d_1 < 100$	1	0,91	0,86	0,82	0,78	0,74	1,03
$100 \leq d_1 < 125$	1	0,93	0,89	0,86	0,82	0,79	1,03
$125 \leq d_1 \leq 160$	1	0,94	0,91	0,89	0,86	0,83	1,03

7 Dimensions and forces

See Table 9.

Table 9 — Dimensions and forces of HK, HKB and HKBA half keystone

Dimensions in millimetres

Nominal diameter	Radial wall thickness		Nominal value of ring width								Method A							Method B						Measured value[b]	
d_1	a_1		h_1						a_6	a_7	Measured value, h_3[a,b]							h_3 (ref.)						a_6	
		Tolerance	Column						Ref.		For h_1 shown in column							Column							
			1	2	3	4	5	6			1	2	3	4	5	6	Tol.	1	2	3	4	5	6		Tolerance
50	1,7																								
51																									
52																									
53	1,9																	1,11	1,41					1,10	
54										0,5 max.	1,118	1,418													
55																									
56																									
57																									
58					—	—			1,0				—	—			+0,01/-0,024 For Phosphated PO surface 0/-0,024			—	—				+0,08/-0,19 For phosphated PO surface 0/-0,19
59	2,1																								
60		±0,15 Within a ring: 0,15 max.	1,2	1,5			—	—							—	—						—	—		
61																									
62																									
63																									
64	2,3																								
65										0,6 max.	1,116	1,416						1,10	1,40					1,09	
66																									
67																									
68																									
69																									
70																									
71	2,5																								
72					1,75	2,0			1,5	0,7 max.	1,053	1,353	1,603	1,853				1,04	1,34	1,59	1,84			1,60	
73																									

Table 9 — *(continued)*

Closed gap s_1	Closed gap Tolerance	Tangential force F_t N, for h_1 shown in column 1	2	3	4	5	6	Tol.	Diametral force F_d N, for h_1 shown in column 1	2	3	4	5	6	Tolerance	Nominal diameter d_1
0,15	$^{+0,2}_{0}$	4,2	5,3	—	—	—	—	±30 % if F_t < 10 N ±20 % if F_t ≥ 10 N	9,0	11,4	—	—	—	—	±30 % if F_d < 21,5 N ±20 % if F_d ≥ 21,5 N	50
		4,8	6,1						10,3	13,1						51
		4,8	6,1						10,3	13,1						52
		4,7	6,0						10,1	12,9						53
		4,7	6,0						10,1	12,9						54
		4,7	6,0						10,1	12,9						55
		4,6	5,9						9,9	12,7						56
		5,3	6,8						11,4	14,6						57
		5,2	6,7						11,2	14,4						58
		5,2	6,6						11,2	14,2						59
0,2		5,1	6,5						11,0	14,0						60
		5,0	6,4						10,8	13,8						61
		5,7	7,3						12,3	15,7						62
		5,6	7,2						12,0	15,5						63
		5,6	7,2						12,0	15,5						64
		5,5	7,1						11,8	15,3						65
		5,5	7,0						11,8	15,1						66
		5,4	6,9						11,6	14,8						67
		6,2	7,9						13,3	17,0						68
		6,1	7,8						13,1	16,8						69
		6,0	7,7	9,2	10,6				12,9	16,6	19,8	22,8				70
		6,0	7,7	9,1	10,5				12,9	16,6	19,6	22,5				71
		5,9	7,6	9,0	10,4				12,7	16,3	19,4	22,3				72
		5,8	7,5	8,9	10,2				12,5	16,1	19,1	22,0				73

Table 9 — ***(continued)***

Nominal diameter d_1	Radial wall thickness a_1	a_1 Tolerance	Nominal value of ring width h_1 Column 1	h_1 2	h_1 3	h_1 4	h_1 5	h_1 6	a_6 Ref.	a_7	Method A Measured value, h_3 [ab] For h_1 shown in column 1	A 2	A 3	A 4	A 5	A 6	A Tol.	Method B h_3 (ref.) Column 1	B 2	B 3	B 4	B 5	B 6	Measured value[b] a_6	a_6 Tolerance
74																									
75																									
76	2,7																								
77																									
78																									
79																									
80																									
81																									
82	2,9		1,2	1,5	1,75	2,0		—	1,5		1,053	1,353	1,603	1,853				1,04	1,34	1,59	1,84			1,60	
83																									
84																	+0,01/ -0,024 For phosphated PO surface: 0/-0,024								+0,08/ -0,19 For phosphated PO surface 0/-0,19
85																									
86																									
87	3,1	±0,15 Within a ring: 0,15 max.					—								—										
88																									
89																									
90																									
91																									
92										0,7 max.						—									
93	3,3																								
94																									
95			1,5								1,289							1,28							
96																									
97																									
98	3,5																								
99																									
100				1,75	2,0	2,5			2,0			1,539	1,789	2,289					1,53	1,78	2,28			2,07	
101																									
102		±0,20 Within a ring: 0,20 max.															0/-0,029 For phosphated PO surface: +0,01/ -0,029								0/-0,23 For phosphated PO surface: +0,08/ -0,23
103																									
104																									
105	3,7		—				3,0				—				2,789			—				2,78			
106																									
107																									
108																									
109	3,9																								

Table 9 — *(continued)*

Closed gap		Tangential force F_t N							Diametral force F_d N							Nominal diameter
s_1	Toler ance	For h_1 shown in column						Tolerance	For h_1 shown in column						Tolerance	d_1
		1	2	3	4	5	6		1	2	3	4	5	6		
0,2	$^{+0,2}_{0}$	6,6	8,5	10,1	11,7				14,2	18,3	21,7	25,1				74
		6,5	8,4	9,9	11,5				14,0	18,1	21,3	24,7				75
		6,4	8,2	9,8	11,3				13,8	17,6	21,1	24,2				76
		6,3	8,1	9,6	11,1				13,5	17,4	20,6	23,8				77
		6,1	7,9	9,4	10,9				13,1	17,0	20,2	23,3				78
		7,0	9,0	10,7	12,4				15,1	19,4	23,0	26,6				79
		6,9	8,9	10,6	12,2				14,8	19,1	22,8	26,2				80
		6,8	8,8	10,4	12,1				14,6	18,9	22,4	26,0				81
0,25		6,7	8,7	10,3	11,9				14,4	18,7	22,1	25,6				82
		6,6	8,6	10,2	11,8				14,2	18,5	21,9	25,4				83
		6,5	8,4	10,0	11,6	—			14,0	18,1	21,5	24,9	—			84
		7,4	9,6	11,4	13,2				15,9	20,6	24,5	28,4				85
		7,3	9,5	11,3	13,0				15,7	20,4	24,3	28,0				86
		7,2	9,3	11,1	12,9				15,5	20,0	23,9	27,7				87
		7,1	9,2	11,0	12,7				15,3	19,8	23,7	27,3				88
		7,0	9,1	10,8	12,5		—		15,1	19,6	23,2	26,9		—		89
		9,0	10,6	12,3	15,7			±30 % if F_t < 10 N	19,2	22,8	26,4	33,8			±30 % if F_d < 21,5 N	90
		10,1	12,1	14,0	17,9				21,8	26,0	30,1	38,5				91
	$^{+0,25}_{0}$	10,0	11,9	13,8	17,6			±20 % if F_t ≥ 10 N	21,4	25,6	29,7	37,8			±20 % if F_d ≥ 21,5 N	92
		9,8	11,6	13,5	17,2				21,0	24,9	29,0	37,0				93
		9,6	11,4	13,2	16,9				20,5	24,5	24,5	36,3				94
		9,3	11,1	12,9	16,5				20,1	23,9	27,7	35,5				95
		10,6	12,6	14,7	18,8				22,8	27,1	31,6	40,4				96
		10,4	12,5	14,5	18,5				22,5	26,9	31,2	39,9				97
		10,3	12,3	14,3	18,3				22,1	26,4	30,7	39,3				98
		10,2	12,1	14,1	18,0				21,8	26,0	30,3	38,7				99
0,3			17,7	13,9	17,7	21,6				38,1	29,8	38,1	46,4			100
			17,4	13,6	17,4	21,2				37,5	29,3	37,5	45,7			101
			19,8	15,5	19,8	24,2				42,7	33,3	42,7	52,0			102
			19,6	15,3	19,6	23,9				42,1	32,8	42,1	51,3			103
		—	19,3	15,1	19,3	23,5			—	41,5	32,4	41,5	50,5			104
			19,0	14,8	19,0	23,1				40,8	31,9	40,8	49,8			105
			18,7	14,6	18,7	22,8				40,2	31,4	40,2	49,0			106
			18,4	14,3	18,4	22,4				39,5	30,8	39,5	48,1			107
			20,9	16,3	20,9	25,5				44,9	35,0	44,9	54,8			108
			20,5	15,9	20,5	25,0				44,0	34,3	44,0	53,7			109

Table 9 — *(continued)*

d_1	Radial wall thickness a_1	Radial wall thickness Tolerance	Nominal value of ring width h_1 Column 1	2	3	4	5	6	a_6 Ref.	a_7	Method A Measured value, h_3[a, b] For h_1 shown in column 1	2	3	4	5	6	Tol.	Method B h_3 (ref.) Column 1	2	3	4	5	6	Measured value[b] a_6	Tolerance
110																									
111	3,9																								
112																									
113																									
114																									
115	4,1																								
116																									
117																									
118																									
119																									
120					2,0								1,789							1,78					
121																									
122	4,3																								
123		±0,20 Within a ring: 0,20 max.															0/-0,029 For phos phated PO surface: +0,01/ -0,029								0/-0,23 For phos phated PO surface: +0,08/ -0,23
124																									
125																									
126																									
127	4,5																								
128			—	—		2,5	3,0	3,5	2,0	0,7 max.	—	—		2,289	2,789	3,289		—	—		2,28	2,78	3,28	2,07	
129																									
130																									
131																									
132																									
133	4,7																								
134																									
135																									
136																									
137					—								—							—					
138																									
139	4,9																								
140																									
141																									
142																									
143	5,1																								
144																									
145																									

Table 9 — *(continued)*

Closed gap		Tangential force F_t N							Diametral force F_d N							Nominal diameter
s_1	Tolerance	For h_1 shown in column						Tolerance	For h_1 shown in column						Tolerance	d_1
		1	2	3	4	5	6		1	2	3	4	5	6		
0,35	$^{+0,25}_{0}$	—	—	19,1	19,6	20,0	20,3	±30 % if F_t < 10 N ±20 % if F_t ≥ 10 N	—	—	41,0	42,2	43,0	43,6	±30 % if F_d < 21,5 N ±20 % if F_d ≥ 21,5 N	110
				18,6	19,2	19,6	19,8				40,1	41,3	42,0	42,6		111
				18,2	18,7	19,1	19,3				39,1	40,3	41,1	41,6		112
				20,6	21,3	21,7	22,0				44,4	45,8	46,7	47,4		113
				20,3	21,0	21,4	21,7				43,7	45,1	46,0	46,7		114
				20,0	20,7	21,1	21,4				43,0	44,4	45,3	45,9		115
				19,7	20,3	20,7	21,0				42,3	43,7	44,6	45,2		116
				19,4	20,0	20,4	20,7				41,6	42,9	43,8	44,4		117
				19,0	19,6	20,0	20,3				40,9	42,2	43,0	43,6		118
				21,6	22,3	22,8	23,1				46,4	47,9	49,0	49,7		119
				21,2	22,0	22,4	22,8				45,7	47,2	48,2	48,9		120
				20,9	21,6	22,1	22,4				44,9	46,4	47,4	48,1		121
				20,6	21,2	21,7	22,0				44,2	45,7	46,6	47,3		122
				20,2	20,9	21,3	21,6				43,4	44,9	45,8	46,5		123
				19,8	20,5	20,9	21,2				42,6	44,1	45,0	45,7		124
				22,5	23,3	23,8	24,2				48,3	50,0	51,2	52,0		125
				22,0	22,8	23,3	23,6				47,3	49,0	50,1	50,8		126
				21,5	22,3	22,8	23,1				46,2	47,9	48,9	49,7		127
				21,0	21,7	22,2	22,6				45,1	46,7	47,8	48,5		128
				20,5	21,2	21,7	22,0				44,0	45,6	46,6	47,3		129
0,4				—	24,1	24,6	25,0				—	51,7	52,9	53,8		130
					23,7	24,2	24,6					50,9	52,0	53,0		131
					23,3	23,8	24,2					50,0	51,2	52,1		132
					22,9	23,4	23,8					49,2	50,3	51,2		133
					22,5	23,0	23,4					48,3	49,5	50,3		134
					22,0	22,6	22,9					47,4	48,6	49,3		135
					25,0	25,6	26,1					53,8	55,0	56,1		136
					24,6	25,2	25,7					52,9	54,2	55,2		137
					24,2	24,8	25,2					52,0	53,3	54,2		138
					23,8	24,4	24,8					51,1	52,5	53,3		139
					23,3	23,9	24,3					50,1	51,4	52,3		140
					22,9	23,5	23,9					49,2	50,5	51,3		141
					25,9	26,6	27,1					55,8	57,2	58,3		142
					25,5	26,2	26,7					54,9	56,3	57,3		143
					25,1	25,7	26,2					53,9	55,3	56,3		144
					24,6	25,3	25,7					52,9	54,4	55,3		145

Table 9 — *(continued)*

Nominal diameter	**Radial wall thickness**		**Nominal value of ring width**								**Method A**							**Method B**						**Measured value** [b]	
d_1	a_1		h_1						a_6	a_7	**Measured value**, h_3 [ab]							h_3 (ref.)						a_6	
			Column						Ref.		For h_1 shown in column							Column							
		Tolerance	1	2	3	4	5	6			1	2	3	4	5	6	Tolerance	1	2	3	4	5	6		Tolerance
146	5,1																								
147																									
148						2,5								2,289							2,28				
149																									
150	5,3																0/-0,029 For phosphated PO surface: +0,01/-0,029								0/-0,23 For phosphated PO surface: +0,08/-0,23
151																									
152															2,789										
153		±0,20 Within a ring: 0,20 max.	—	—	—		3,0	3,5	2,0	0,7 max.	—	—	—			3,289				—	—			2,07	
154																									
155						—								—								2,78	3,28		
156	5,5																								
157																									
158																									
159																									
160	5,7																								

Table 9 — *(continued)*

Closed gap		Tangential force F_t N							Diametral force F_d N							Nominal diameter d_1
s_1	Tolerance	For h_1 shown in column						Tolerance	For h_1 shown in column						Tolerance	
		1	2	3	4	5	6		1	2	3	4	5	6		
0,4	$^{+0,25}_{0}$	—	—	—	24,2	24,8	25,3	±30 % if F_t < 10 N ±20 % if F_t ≥ 10 N	—	—	—	52,0	53,3	54,3	±30 % if F_d < 21,5 N ±20 % if F_d ≥ 21,5 N	146
					23,7	24,3	24,8					51,0	52,2	53,3		147
					26,9	27,6	28,1					57,8	59,3	60,5		148
					26,3	27,0	27,5					56,5	58,1	59,1		149
0,5	$^{+0,3}_{0}$				—	26,3	26,8					—	56,6	57,7		150
						25,7	26,2						55,2	56,3		151
						25,0	25,5						53,8	54,8		152
						28,4	29,0						61,1	62,3		153
						27,9	28,5						60,0	61,2		154
						27,4	28,0						59,0	60,1		155
						26,9	27,5						57,9	59,0		156
						26,4	26,9						56,8	57,9		157
						25,9	26,4						55,7	56,8		158
						29,4	30,0						63,1	64,5		159
						28,7	29,3						61,7	63,0		160

NOTE 1 For intermediate sizes (for example repair sizes), the radial wall thickness of the next smaller nominal diameter should be applied.

NOTE 2 The values for F_t and F_d, given in Table 7, apply to steel with a typical modulus of elasticity (E_n) of 210 GN/m^2. Mean forces are calculated for nominal radial wall thickness (a_1) and mean ring width (h_1).

NOTE 3 For the sole purpose of this part of ISO 6624, the assumed average ratio F_d/F_t is 2,15. However, for rings up to 50 mm the ratio F_d/F_t shall be determined between manufacturer and customer.

a h_3 values are calculated based on Annex A.

b These tolerances are based on single keystone machined rings.

Annex A
(normative)

Calculation of measurement width h_3 of half keystone rings

The measurement width, h_3, as defined in DIN is calculated according to Formula (A.1):

$$h_3 = (h_1 + 0{,}05) - a_6 \tan 7{,}2° \qquad (A.1)$$

As the dimensioning of keystone rings in the ISO standard differs significantly from the dimensioning according to the old DIN standard and the tolerance values in the ISO standard have been increased, a correction value (h_{3k}) for the accurately calculated measurement width h_3 has been introduced to ensure continued compatibility of the rings according to the ISO standards. Therefore the measurement width h_3 as defined in ISO is calculated according to Formula (A.2):

$$h_3 = (h_1 + 0{,}05) - a_6 \tan 7{,}2° - h_{3k} \qquad (A.2)$$

The correction value, h_{3k}, is dependent on the nominal diameter, d_1 (see Table A.1).

Table A.1 — Correction value

Nominal diameter d_1 [mm]	Correction value h_{3k}
$d_1 < 60$	0,005 5
$60 \le d_1 < 90$	0,007 5
$90 \le d_1 < 160$	0,008 5

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1) To be published. (Revision of ISO 6626: 1989).

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