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**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*

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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](http://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](http://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,<sup>[2][3][4][5]</sup> ISO 6622,<sup>[6][7]</sup> ISO 6623,<sup>[8]</sup> ISO 6625,<sup>[9]</sup> ISO 6626,<sup>[10][11][12]</sup> and ISO 6627.<sup>[13]</sup>

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# 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<sup>[4]</sup> 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).

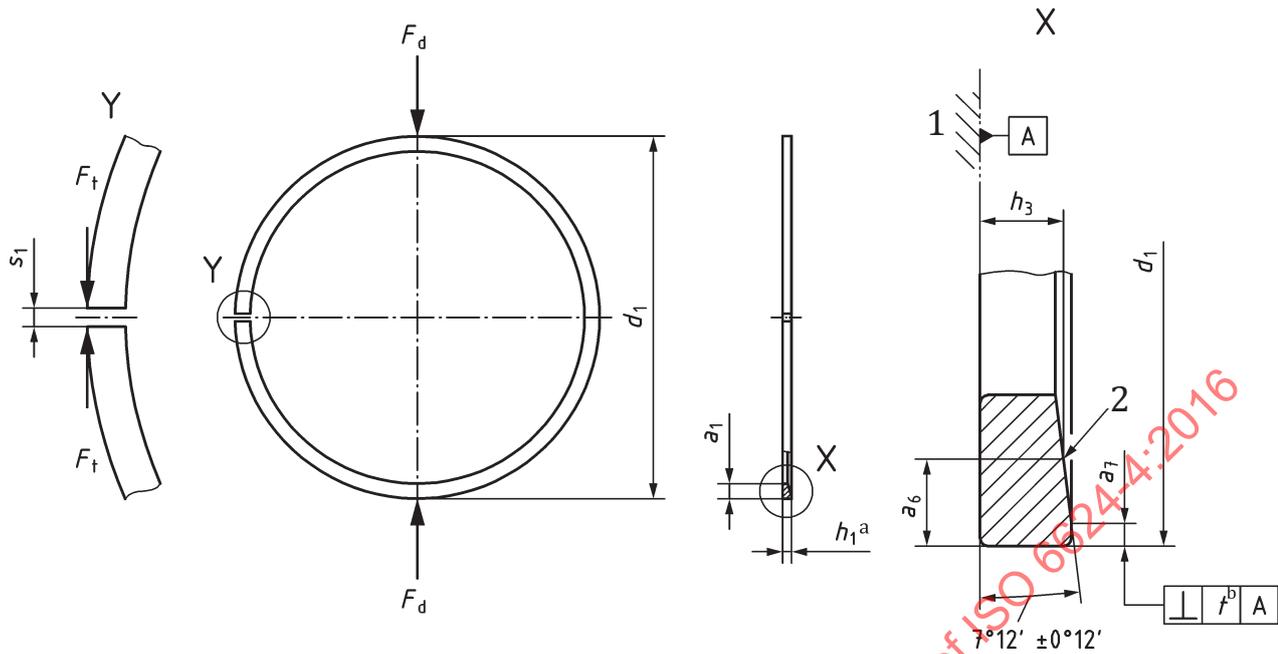
#### 4.1 Type HK — Straight faced half keystone ring 7°

##### 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**

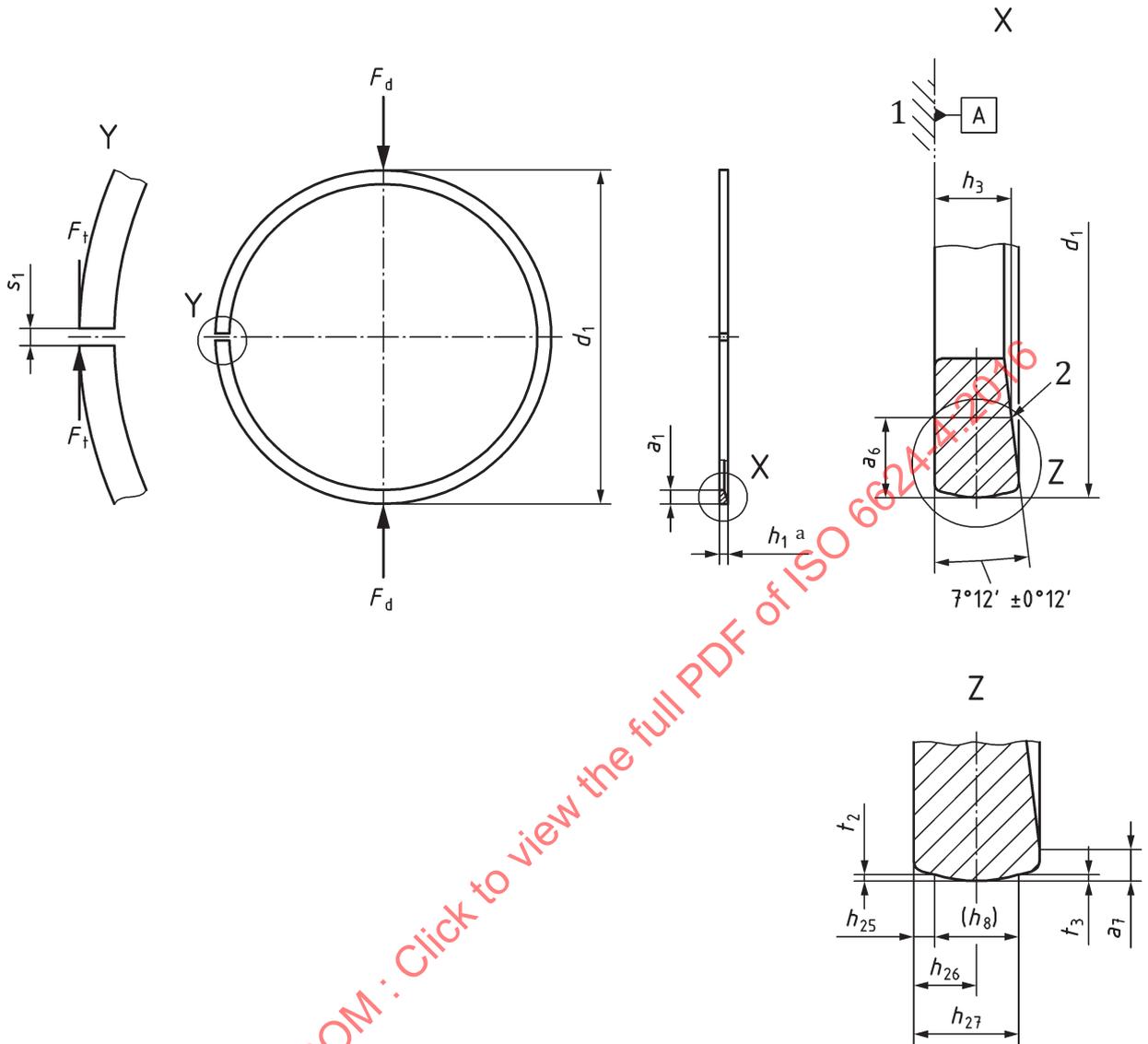
**4.2 Type HKB — Barrel faced half keystone ring 7°**

**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 ( $h_3$ )**

Dimensions in millimetres

$h_1$	$h_{25}$	$h_{26}$	$h_{26}$ tol.	$h_{27}$	$t_2, t_3$	$h_3^a$
1,2	0,30	0,60	±0,20	0,90	0,002...0,012	0,60
1,5	0,35	0,75	±0,25	1,15	0,003...0,015	0,80
1,75	0,35	0,85	±0,30	1,35		1,00
2,0	0,40	1,00	±0,30	1,60		1,20
2,5	0,45	1,25	±0,40	2,05		1,60
3,0	0,50	1,50	±0,50	2,50	0,005...0,020	2,00
3,5	0,55	1,75	±0,50	2,95		2,40

<sup>a</sup> Gauge width ( $h_3$ ) only informative; may be used only if agreed between manufacturer and customer.

**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:

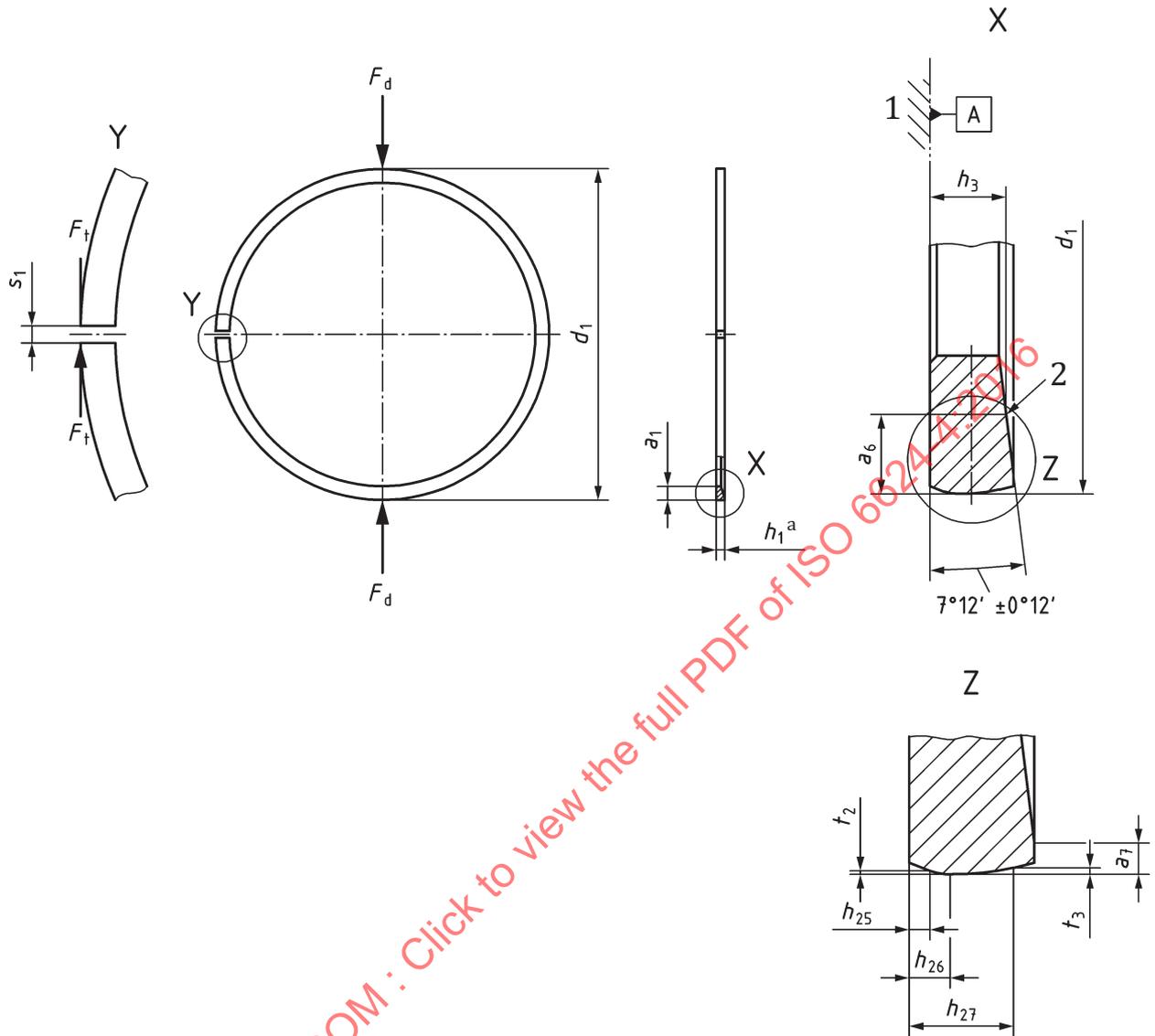
**Piston ring ISO 6624-4 HKB - 60 × 1,5 - MC65/NT050**

**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

<sup>a</sup>  $h_{25}$  may be lowered for rings with reduced edge dimensions.

<sup>b</sup>  $t_2$  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)



Key  
1 top side identification mark

Figure 4 — Nitrided rings

5.1.2 PVD rings

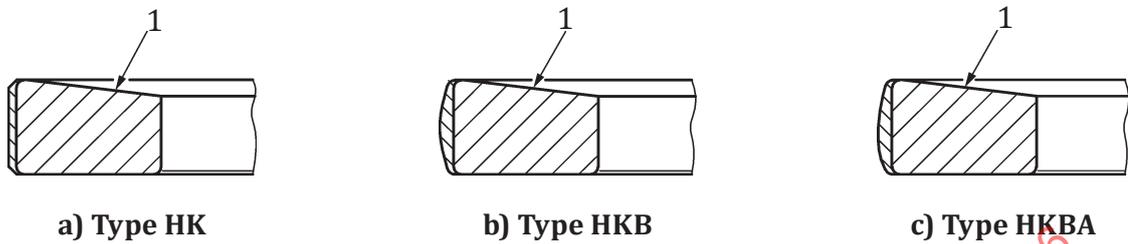


Key  
1 top side identification mark

Figure 5 — PVD rings

5.1.3 Chromium plated or spray coated rings

5.1.3.1 Fully faced

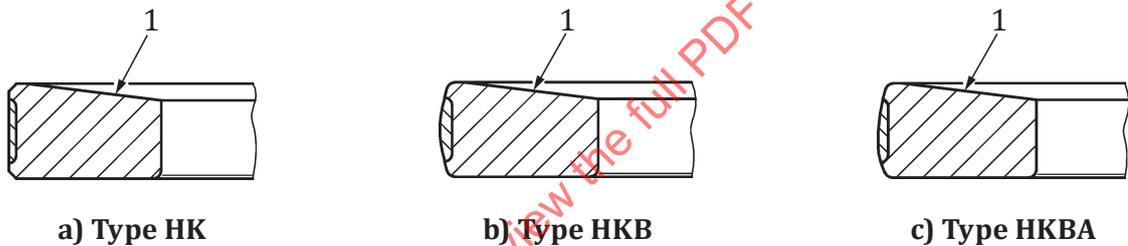


Key

1 top side identification mark

Figure 6 — Fully faced rings

5.1.3.2 Inlaid (not recommended for chromium plated rings)



Key

1 top side identification mark

Figure 7 — Inlaid rings

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

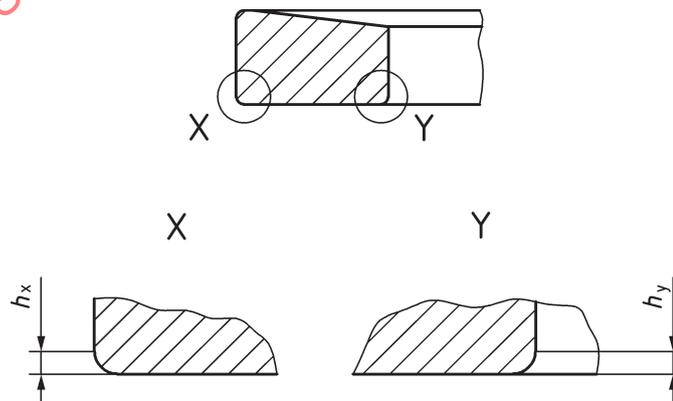


Figure 8 — Outside and inside rounded edges

**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**



**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 <sup>a</sup>	SC3 <sup>a</sup>	0,15
CR4 <sup>a</sup>	SC4 <sup>a</sup>	0,20

<sup>a</sup> Not recommended for rings  $h_1 \leq 1,5$ .

**Table 5 — PVD coating thickness**

Dimensions in millimetres

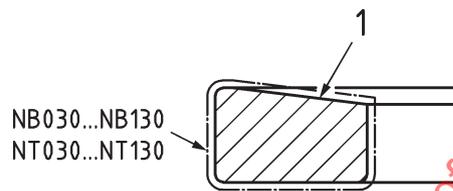
Code	Peripheral surface min.
PC001	0,001
PC003	0,003
PC005	0,005

<sup>a</sup> not typical for Diamond Like Carbon coatings (DLC)

Table 5 (continued)

Code	Peripheral surface min.
PC010 <sup>a</sup>	0,010
PC020 <sup>a</sup>	0,020
PC030 <sup>a</sup>	0,030
PC040 <sup>a</sup>	0,040
PC050 <sup>a</sup>	0,050
<sup>a</sup> 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 $d_1$	Radial wall thickness $a_1$		Nominal value of ring width $h_1$						$a_6$ Ref.	$a_7$	Method A Measured value, $h_3^{ab}$ For $h_1$ shown in column							Method B $h_3$ (ref.) Column						Measured value <sup>b</sup> $a_6$	Tolerance																		
	Tolerance		Column								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																				
50	1,7																																										
51	1,9								0,5 max.	1,118	1,418							1,11	1,41																								
52																																											
53																																											
54																																											
55	2,1	±0,15 Within a ring: 0,15 max.	1,2	1,5					1,0																																		
56																																											
57																																											
58																																											
59	2,3																																										
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71	2,5																																										
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73																																											
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Table 9 — (continued)

Closed gap		Tangential force							Diametral force						Nominal diameter		
$s_1$	Tolerance	$F_t$ N						Tol.	$F_d$ N						$d_1$		
		For $h_1$ shown in column							For $h_1$ shown in column								
		1	2	3	4	5	6		1	2	3	4	5	6			
0,15		4,2	5,3						9,0	11,4						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	+0,2 0	5,1	6,5	—	—			±30 % if $F_t < 10$ N	11,0	14,0					±30 % if $F_d < 21,$ 5 N	60	
		5,0	6,4					10,8	13,8							61	
		5,7	7,3					12,3	15,7							62	
		5,6	7,2					±20 % if $F_t \geq 10$ N	12,0	15,5					±20 % if $F_d \geq 21,5$ N	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)

Closed gap		Tangential force						Diametral force						Nominal diameter $d_1$		
$s_1$	Tolerance	$F_t$ N						$F_d$ N								
		For $h_1$ shown in column						For $h_1$ shown in column								
		1	2	3	4	5	6	1	2	3	4	5	6	Tolerance		
0,2	$\begin{matrix} +0,2 \\ 0 \end{matrix}$	6,6	8,5	10,1	11,7			14,2	18,3	21,7	25,1				74	
0,25		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	
		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			
0,3	$\begin{matrix} +0,25 \\ 0 \end{matrix}$	9,0	10,6	12,3	15,7			19,2	22,8	26,4	33,8			$\pm 30\%$ if $F_d < 21,5$ N	90	
		10,1	12,1	14,0	17,9			21,8	26,0	30,1	38,5				91	
		10,0	11,9	13,8	17,6			21,4	25,6	29,7	37,8				92	
		9,8	11,6	13,5	17,2			21,0	24,9	29,0	37,0			$\pm 20\%$ if $F_d \geq 21,5$ N	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	
		—	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)

Closed gap		Tangential force							Diametral force						Nominal diameter $d_1$		
$s_1$	Tolerance	$F_t$ N						Tolerance	$F_d$ N							Tolerance	
		For $h_1$ shown in column							For $h_1$ shown in column								
		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	—	—	41,0	42,2	43,0	43,6	±30 % 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		±20 % if $F_d \geq 21,5$ N	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	±20 % if $F_t \geq 10$ N	—	—	—	—	51,7	52,9	53,8	±20 % if $F_d \geq 21,5$ N	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											