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**Internal combustion engines —  
Piston rings —**

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

*Moteurs à combustion interne — Segments de piston —*

*Partie 1: Segments trapézoïdaux en fonte*

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# Contents

	Page
Foreword.....	iv
Introduction.....	v
<b>1 Scope.....</b>	<b>1</b>
<b>2 Normative reference.....</b>	<b>1</b>
<b>3 Terms and definitions.....</b>	<b>1</b>
<b>4 Overview.....</b>	<b>1</b>
<b>5 Ring types and designation examples.....</b>	<b>1</b>
5.1 Type T — Straight faced keystone ring 6°.....	1
5.1.1 General features.....	1
5.1.2 Designation.....	2
5.2 Type TB — Symmetrical barrel faced keystone ring 6°.....	2
5.2.1 General features.....	2
5.2.2 Designation.....	4
5.3 Type TBA — Asymmetrical barrel faced keystone ring 6°.....	4
5.3.1 General features.....	4
5.3.2 Designation.....	5
5.4 Type TM — Taper faced keystone ring 6°.....	5
5.4.1 General features.....	5
5.4.2 Designation.....	6
5.5 Type K — Straight faced keystone ring 15°.....	7
5.5.1 General features.....	7
5.5.2 Designation.....	7
5.6 Type KB — Symmetrical barrel faced keystone ring 15°.....	7
5.6.1 General features.....	7
5.6.2 Designation.....	8
5.7 Type KBA — Asymmetrical barrel faced keystone ring 15°.....	8
5.7.1 General features.....	8
5.7.2 Designation.....	9
5.8 Type KM — Taper faced keystone ring 15°.....	9
5.8.1 General features.....	9
5.8.2 Designation.....	10
<b>6 Common features.....</b>	<b>11</b>
6.1 Type T, TB, TBA, TM, K, KB, KBA, KM rings — Inside chamfered edges (KI).....	11
6.2 Type T, TB, TBA, TM, K, KB, KBA, KM rings (positive twist type) internal bevel or internal step top side.....	11
6.3 Type TM or KM rings with partly cylindrical machined (LM) or lapped (LP) peripheral surface.....	12
6.4 Type T, TB, TBA, TM, K, KB, KBA, KM rings — Plating/coating configuration.....	13
6.4.1 Uncoated rings.....	13
6.4.2 Chromium plated, PVD coated or spray coated rings.....	14
<b>7 Force factors.....</b>	<b>16</b>
<b>8 Dimensions.....</b>	<b>16</b>
<b>Bibliography.....</b>	<b>24</b>

## 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 voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 34, *Propulsion, powertrain and powertrain fluids*.

This third edition cancels and replaces the second edition (ISO 6624-1:2001), which has been technically revised.

The main changes compared to the previous edition are as follows:

- PVD coating thickness has been included with a new [Table 8](#);
- updates have been made regarding technology improvements.

## Introduction

ISO 6624 belongs to the series of International Standards dealing with piston rings for reciprocating internal combustion engines. Others are ISO 6621, ISO 6622, ISO 6623, ISO 6625, ISO 6626 and ISO 6627 (see Bibliography for details).

The common features and dimensional tables presented in this document constitute a broad range of variables and, in selecting a particular ring type, the designer must 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 a selection.

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# Internal combustion engines — Piston rings —

## Part 1: Keystone rings made of cast iron

### 1 Scope

This document specifies the essential dimensional features of keystone rings made of cast iron, types T, TB, TBA, TM, K, KB, KBA and KM, having diameters from 70 mm up to and including 200 mm, used in reciprocating internal combustion piston engines.

### 2 Normative reference

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 6621-4, *Internal combustion engines — Piston rings — Part 4: General specifications*

### 3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

### 4 Overview

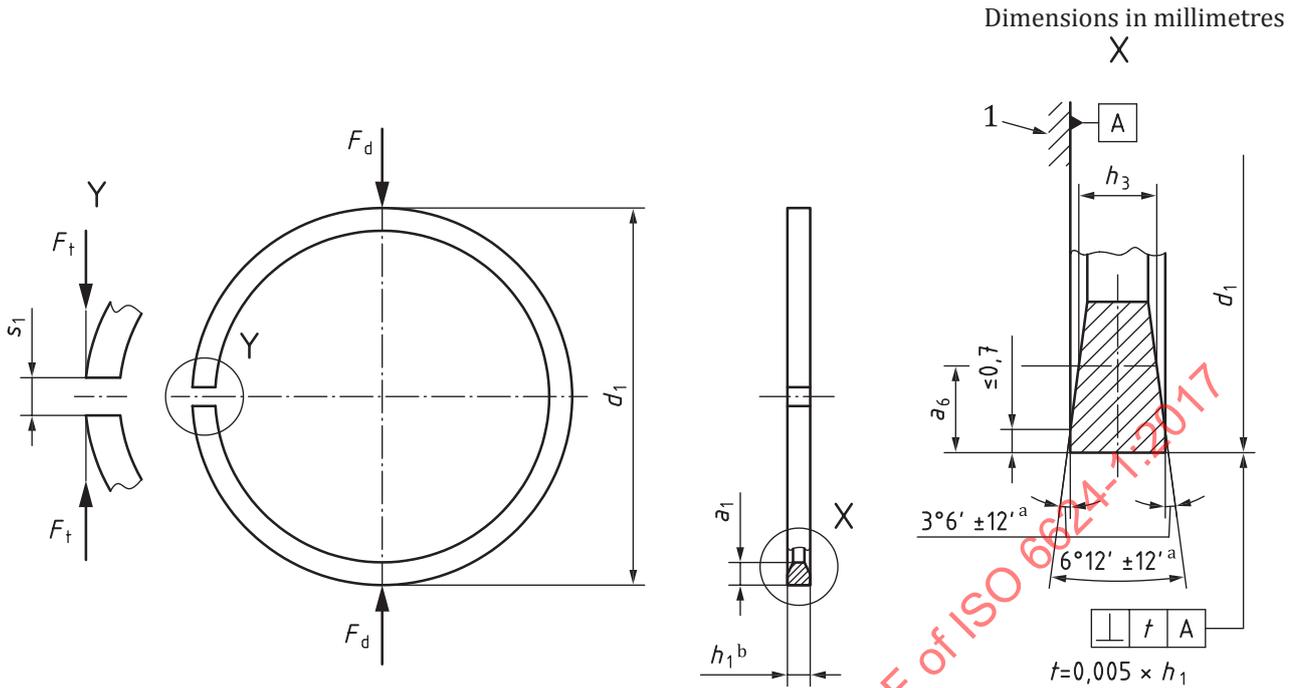
The keystone ring types are specified in [Tables 1 to 3](#) and [Figures 1 to 8](#). Their common features and the dimensions of those features are specified in [Tables 4 to 8](#) and [Figures 9 to 16](#). [Tables 9](#) and [10](#) give the force factors for the different types of ring, while [Table 11](#) and [Table 12](#) give the dimensions and forces of keystone rings 6° and 15°, respectively.

### 5 Ring types and designation examples

#### 5.1 Type T — Straight faced keystone ring 6°

##### 5.1.1 General features

See [Table 10](#) for dimensions and forces.



**Key**

- 1 reference plane
- a Due to manufacturing processing, side angle tolerances are not cumulative.
- b Nominal.

**Figure 1 — Type T**

**5.1.2 Designation**

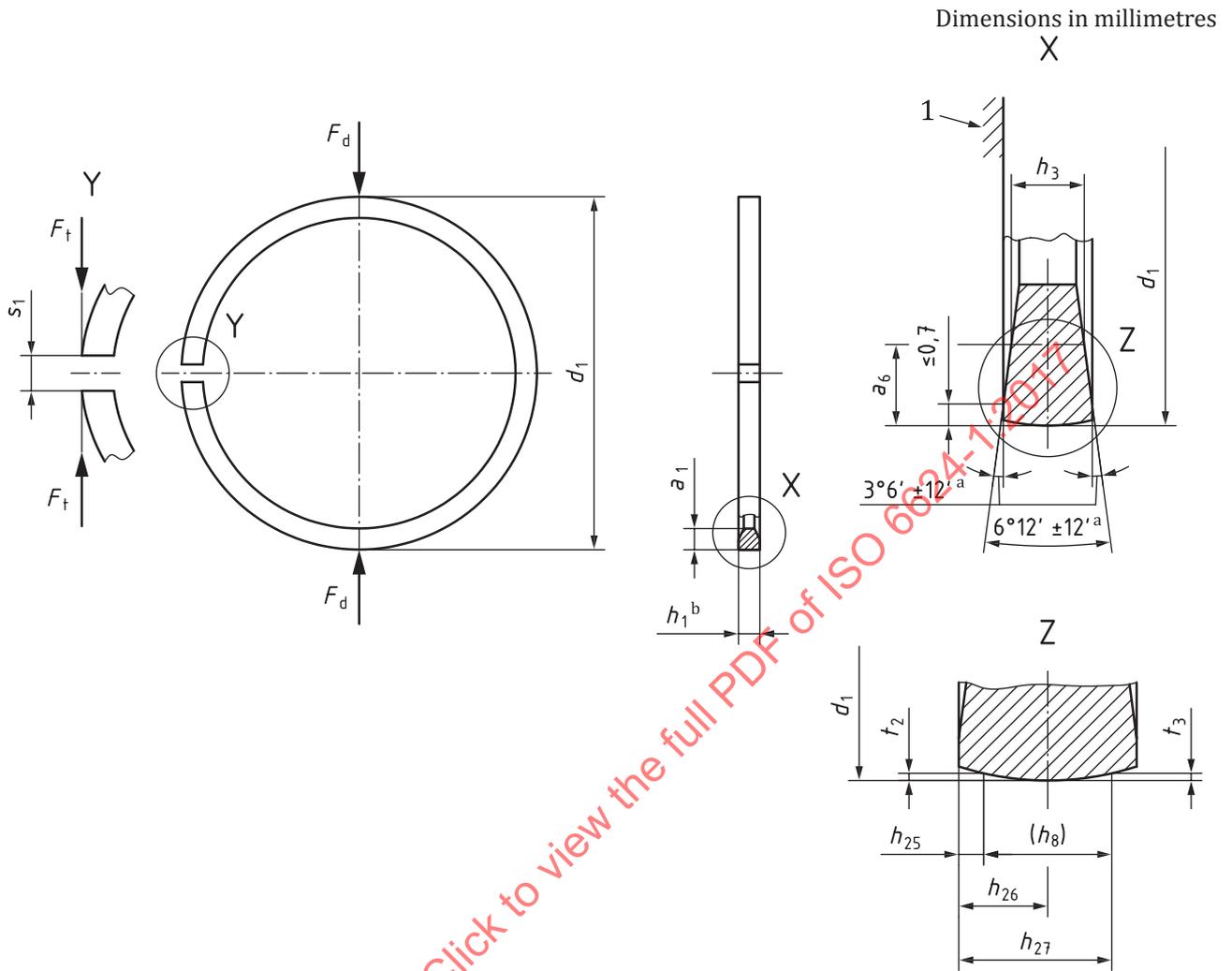
**EXAMPLE** Designation of a piston ring complying with the requirements of ISO 6624-1, being a cast iron, 6° keystone ring with a straight faced peripheral surface (T), of nominal diameter  $d_1 = 90$  mm (90) and nominal width  $h_1 = 2,5$  mm (2,5), made of grey cast iron, subclass 12 (MC12), and 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 6624-1 T-90 × 2,5-MC12/CR2**

**5.2 Type TB — Symmetrical barrel faced keystone ring 6°**

**5.2.1 General features**

See [Table 10](#) for dimensions and forces.



**Key**

- 1 reference plane
- a Due to manufacturing processing, side angle tolerances are not cumulative.
- b Nominal.

**Figure 2 — Type TB**

**Table 1 — Symmetrical barrel dimensions**

Dimensions in millimetres

$h_1$	$h_{25}$	$h_{26}$		$h_{27}$	$t_2, t_3$	$h_8^a$
		Tolerance				
2,0	0,40	1,00	±0,30	1,60	0,003...0,015	1,2
2,5	0,45	1,25	±0,40	2,05		1,6
3,0	0,50	1,50	±0,50	2,50	0,005...0,020	2,0
3,5	0,55	1,75		2,95		2,4
4,0	0,60	2,00	±0,60	3,40	0,005...0,023	2,8
4,5	0,65	2,25		3,85		3,2

<sup>a</sup> Gauge width  $h_8$ , informative only, shall be used only if agreed between manufacturer and customer.

5.2.2 Designation

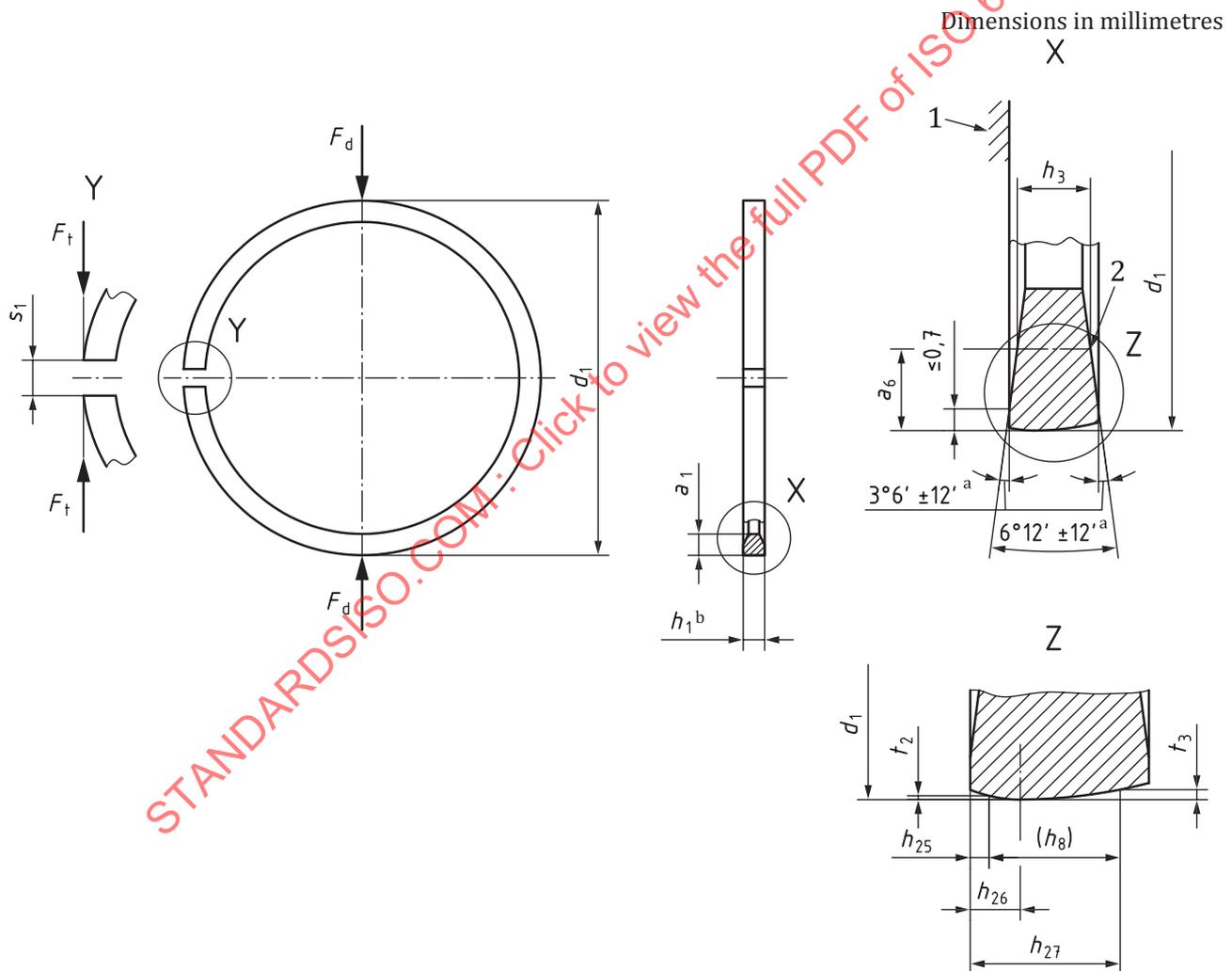
EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624-1, being a cast iron, 6° keystone ring with a symmetrical barrel faced peripheral surface (TB), of nominal diameter  $d_1 = 90$  mm (90) and nominal ring width  $h_1 = 2,5$  mm (2,5), made of heat-treated martensitic spheroidal graphite cast iron, subclass 53 (MC53), and having a semi-inlaid spray coating on the peripheral surface with a minimum thickness of 0,2 mm (SC4E). Parameters in parenthesis are used in the ISO ring designation:

Piston ring ISO 6624-1 TB-90 × 2,5-MC53/SC4E

5.3 Type TBA — Asymmetrical barrel faced keystone ring 6°

5.3.1 General features

See Table 10 for dimensions and forces.



Key

- 1 reference plane
- 2 top side identification mark
- a Due to manufacturing processing, side angle tolerances are not cumulative.
- b Nominal.

Figure 3 — Type TBA

Table 2 — Asymmetrical barrel dimensions

Dimensions in millimetres

$h_1$	$h_{25}^a$	$h_{26}$		$h_{27}$	$t_2^b$	$t_3^b$
		Tolerance				
2,00	0,40	0,60	$\pm 0,20$	1,50	0...0,007	0,009...0,030
2,50	0,45	0,70	$\pm 0,25$	1,80	0...0,008	0,011...0,035
3,00	0,55	0,80		2,10		0,012...0,038
3,50	0,60	0,90	$\pm 0,30$	2,40	0...0,009	0,012...0,040
4,00	0,65	0,95		2,80		0,013...0,045
4,50	0,70	1,05	$\pm 0,35$	3,20	0...0,010	0,015...0,050
<sup>a</sup> $h_{25}$ may be lowered for rings with reduced edge dimensions.						
<sup>b</sup> $t_2$ or $t_3$ or both may be varied as agreed between manufacturer and customer.						

### 5.3.2 Designation

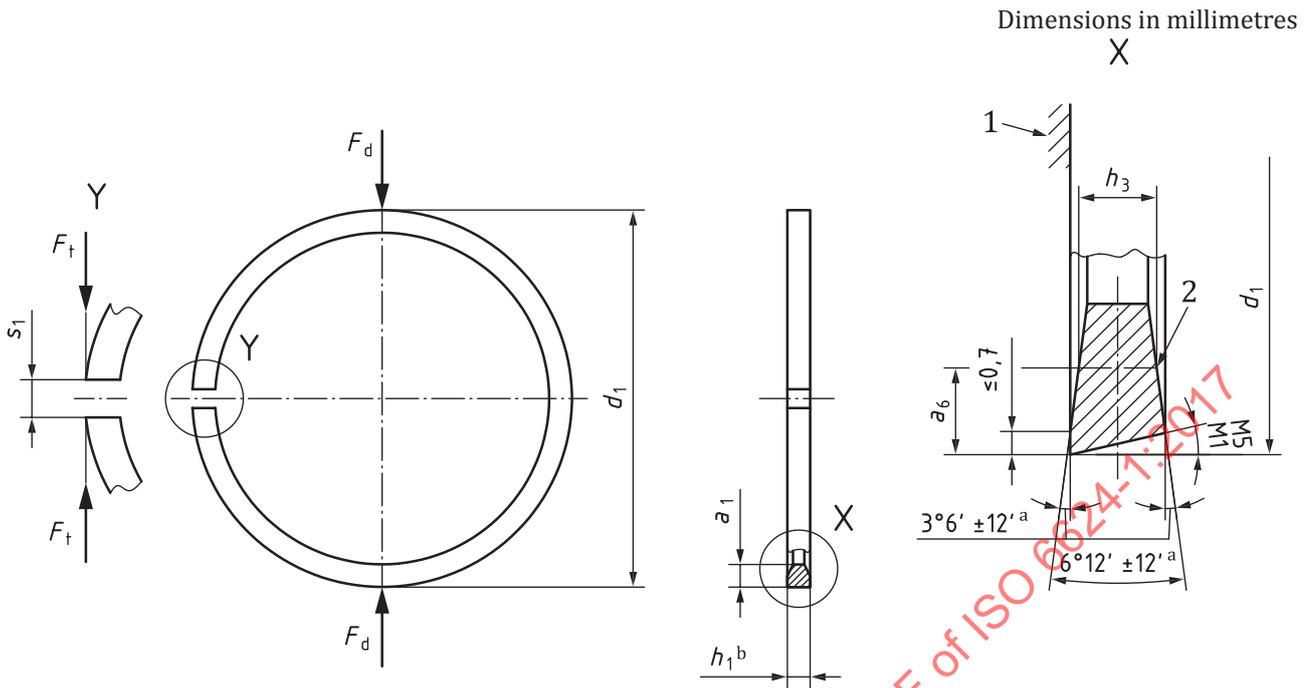
EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624-1, being a cast iron, 6° keystone ring with an asymmetrical barrel faced peripheral surface (TBA), of nominal diameter  $d_1 = 90$  mm (90) and nominal ring width  $h_1 = 2,5$  mm (2,5), made of heat-treated martensitic spheroidal graphite cast iron, subclass 53 (MC53), and having a semi-inlaid spray coating on the peripheral surface with a minimum thickness of 0,2 mm (SC4E). Parameters in parenthesis are used in the ISO ring designation:

**Piston ring ISO 6624-1 TBA-90 × 2,5-MC53/SC4E**

## 5.4 Type TM — Taper faced keystone ring 6°

### 5.4.1 General features

See [Table 10](#) for dimensions and forces.



**Key**

- 1 reference plane
- 2 top side identification mark
- a Due to manufacturing processing, side angle tolerances are not cumulative.
- b Nominal.

**Figure 4 — Type TM**

**Table 3 — Taper**

Dimensions in minutes

Code	Taper	Tolerance <sup>a</sup>	Internal twist feature designs Tolerance <sup>a</sup>
M1 <sup>b</sup>	10	+50 0	+60 0
M2	30		
M3	60	+60 0	+70 0
M4	90		
M5	120		

<sup>a</sup> For chromium plated rings with a tapered peripheral surface that is not ground, the tolerance shall be increased by 10 (e.g. M3 = 60 tolerance:  $\begin{matrix} +70 \\ 0 \end{matrix}$ ; M3 with internal features = 60 tolerance:  $\begin{matrix} +80 \\ 0 \end{matrix}$ ).

<sup>b</sup> M1 not for rings with partly cylindrical peripheral surface.

**5.4.2 Designation**

**EXAMPLE** Designation of a piston ring complying with the requirements of ISO 6624-1, being a cast iron, 6° keystone ring with a 10' taper faced peripheral surface (TM1), of nominal diameter  $d_1 = 90$  mm (90) and nominal ring width  $h_1 = 2,5$  mm (2,5), made of heat-treated grey cast iron, subclass 22 (MC22), and phosphate-coated all over (PO). Parameters in parenthesis are used in the ISO ring designation:

## Piston ring ISO 6624-1 TM1-90 × 2,5-MC22/PO

## 5.5 Type K — Straight faced keystone ring 15°

## 5.5.1 General features

See [Table 11](#) for dimensions and forces.

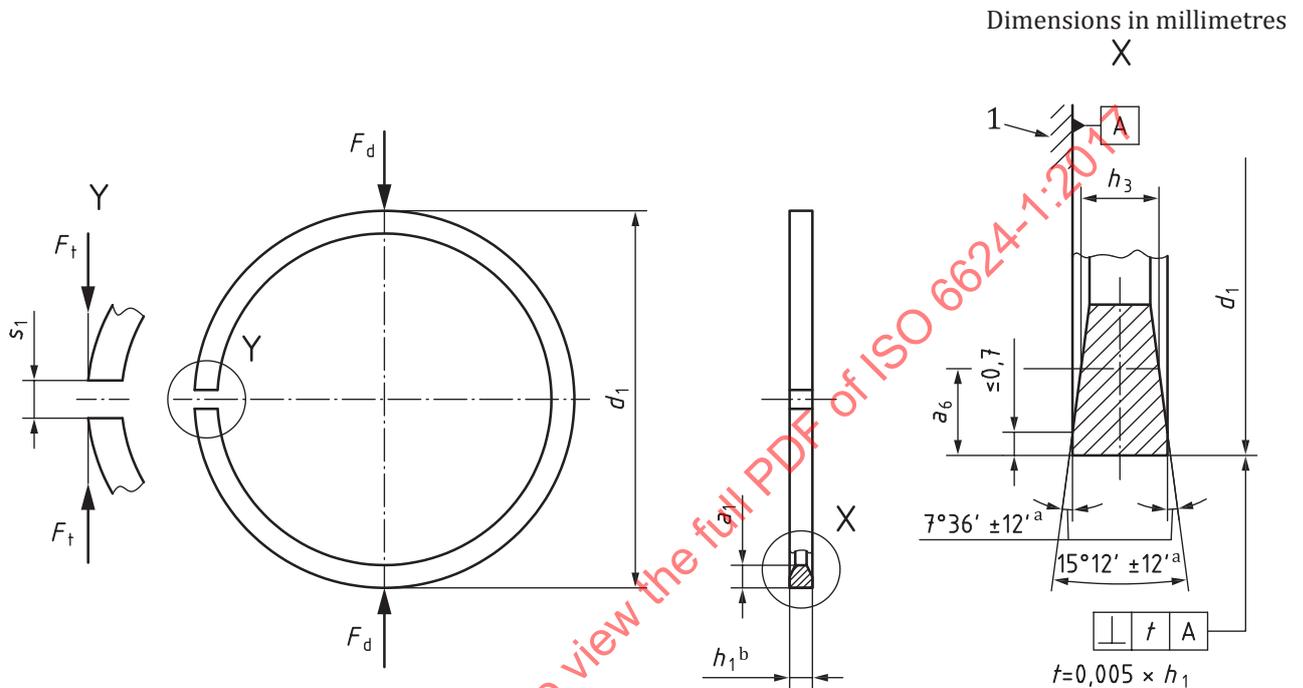


Figure 5 — Type K

## 5.5.2 Designation

EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624-1, being a cast iron, 15° keystone ring with a straight faced peripheral surface (K), of nominal diameter  $d_1 = 90$  mm (90) and nominal ring width  $h_1 = 2,5$  mm (2,5), made of carbidic cast iron, subclass 32 (MC32), and ferroxide coated all over (FE). Parameters in parenthesis are used in the ISO ring designation:

Piston ring ISO 6624-1 K-90 × 2,5-MC32/FE

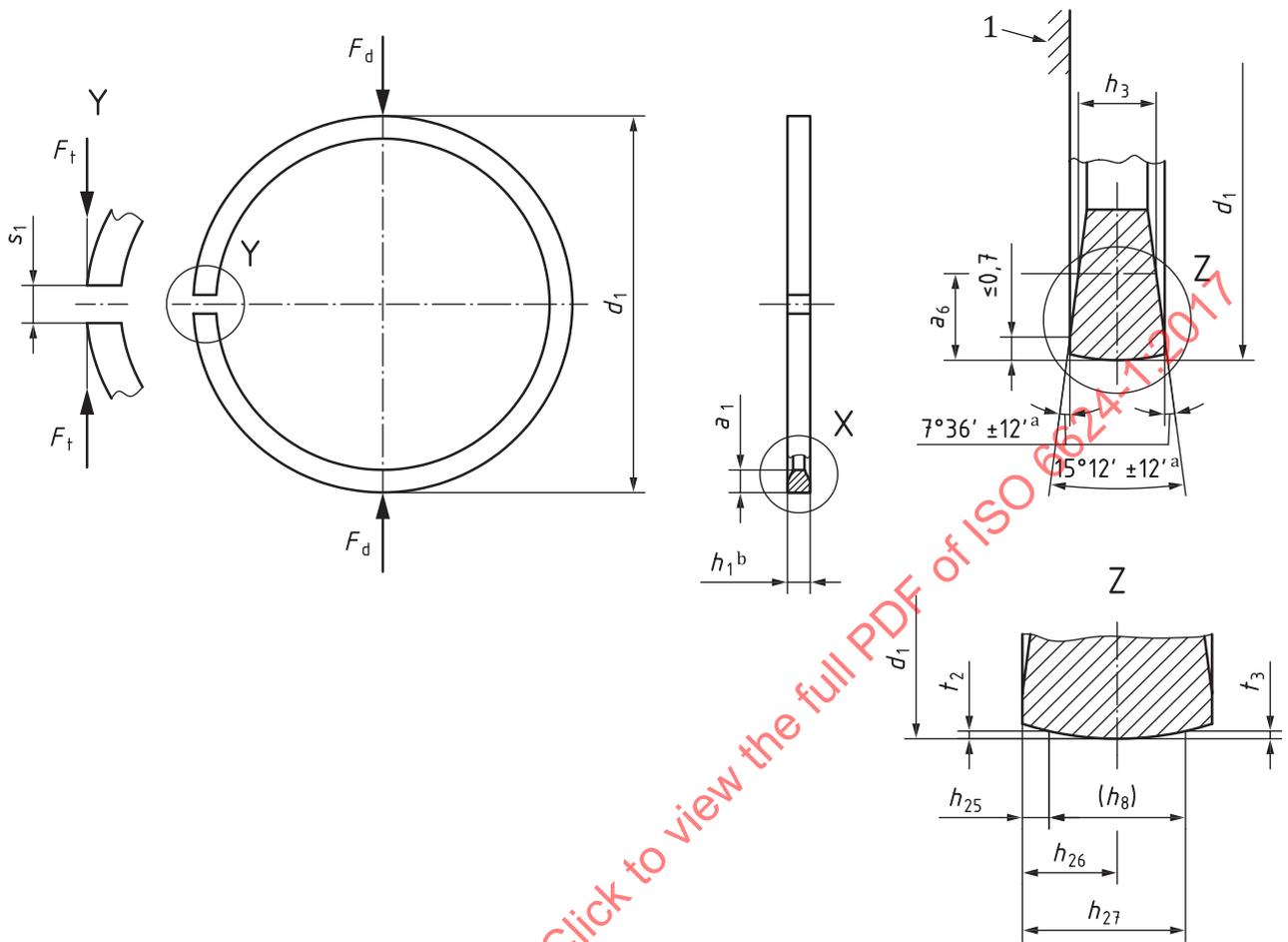
## 5.6 Type KB — Symmetrical barrel faced keystone ring 15°

## 5.6.1 General features

See [Table 1](#) for symmetrical barrel dimensions.

See [Table 11](#) for dimensions and forces.

Dimensions in millimetres



**Key**

- 1 reference plane
- a Due to manufacturing processing, side angle tolerances are not cumulative.
- b Nominal.

**Figure 6 — Type KB**

**5.6.2 Designation**

**EXAMPLE** Designation of a piston ring complying with the requirements of ISO 6624-1, being a cast iron, 15° keystone ring with a barrel faced peripheral surface (KB), of nominal diameter  $d_1 = 90$  mm (90) and nominal ring width  $h_1 = 2,5$  mm (2,5), made of malleable cast iron, subclass 41 (MC41), and having an inlaid spray coating on the peripheral surface with a minimum thickness of 0,2 mm (SC4F). Parameters in parenthesis are used in the ISO ring designation:

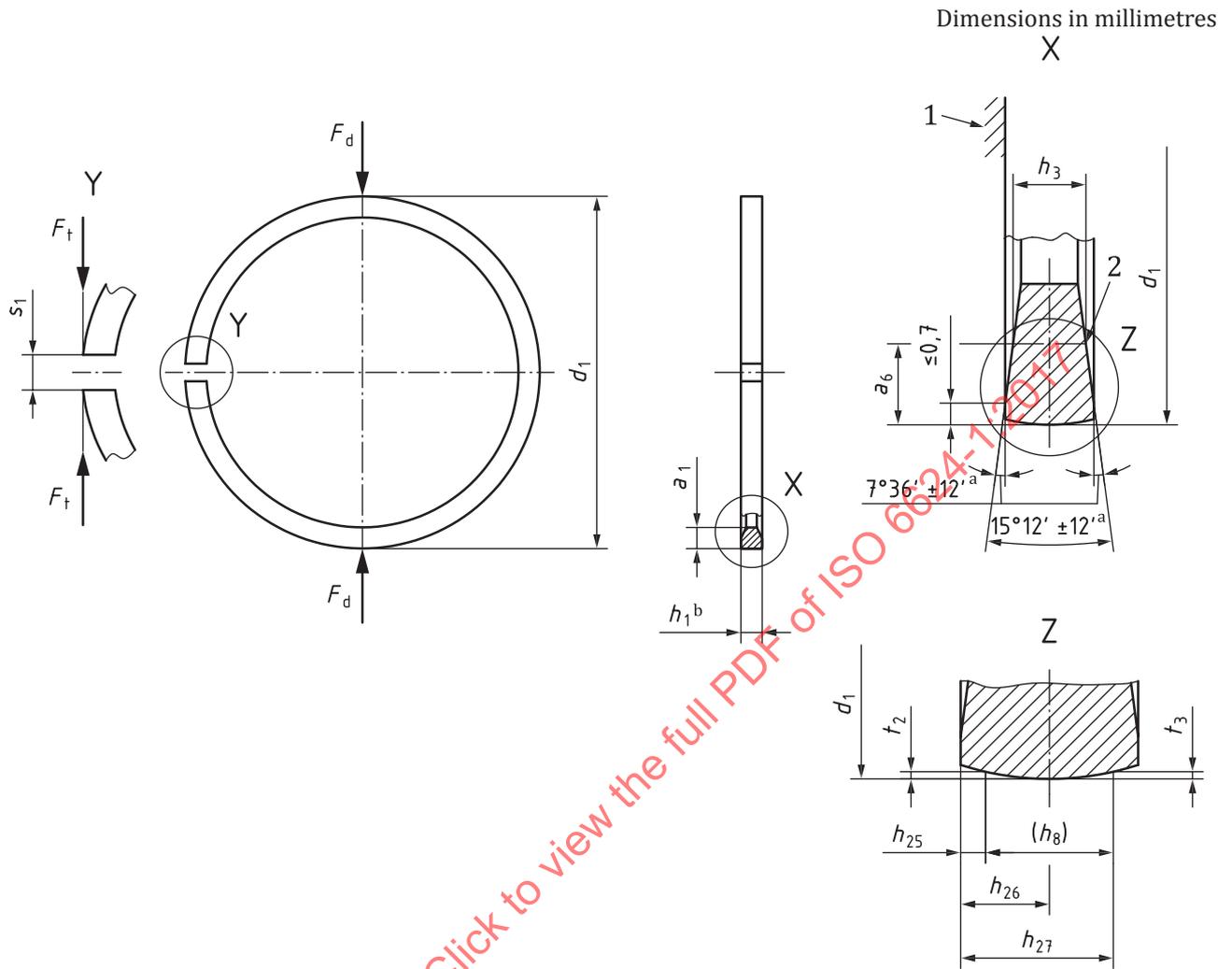
**Piston ring ISO 6624-1 KB-90 × 2,5-MC41/SC4F**

**5.7 Type KBA — Asymmetrical barrel faced keystone ring 15°**

**5.7.1 General features**

See [Table 2](#) for asymmetrical barrel dimensions.

See [Table 11](#) for dimensions and forces.



**Key**

- 1 reference plane
- 2 top side identification mark
- a Due to manufacturing processing, side angle tolerances are not cumulative.
- b Nominal.

**Figure 7 — Type KBA — Correction of details “X” and “Y”: show asymmetry more detailed**

**5.7.2 Designation**

**EXAMPLE** Designation of a piston ring complying with the requirements of ISO 6624-1, being a cast iron 15° keystone ring with an asymmetrical barrel faced peripheral surface (KBA) of nominal diameter  $d_1 = 90$  mm (90) and nominal ring width  $h_1 = 2,5$  mm (2,5), made of malleable cast iron, subclass 41 (MC41), and having an inlaid spray coating on the peripheral surface with a minimum thickness of 0,2 mm (SC4F). Parameters in parenthesis are used in the ISO ring designation:

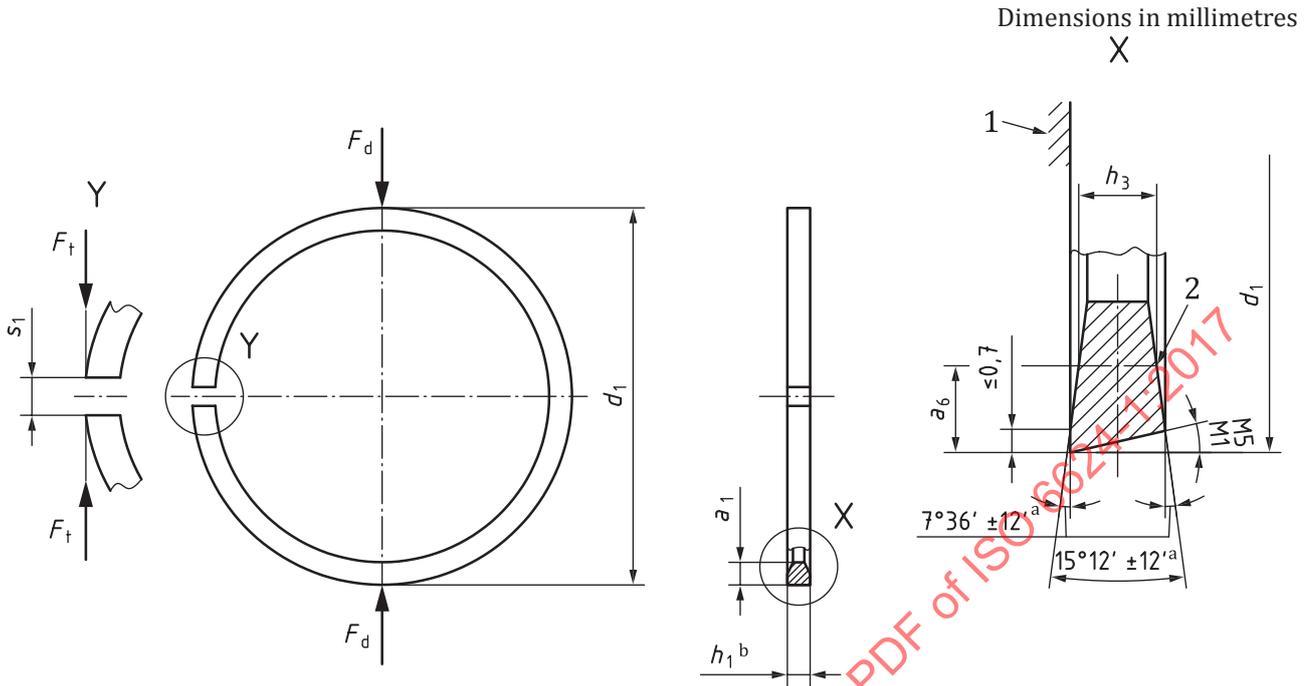
**Piston ring ISO 6624-1 KBA-90 × 2,5-MC41/SC4F**

**5.8 Type KM — Taper faced keystone ring 15°**

**5.8.1 General features**

See [Table 3](#) for taper.

See [Table 11](#) for dimensions and forces.



**Key**

- 1 reference plane
- 2 top side identification mark
- a Due to manufacturing processing, side angle tolerances are not cumulative.
- b Nominal.

**Figure 8 — Type KM**

**5.8.2 Designation**

**EXAMPLE** Designation of a piston ring complying with the requirements of ISO 6624-1, being a cast iron, 15° keystone ring with a 10' taper faced peripheral surface (KM1), of nominal diameter  $d_1 = 90$  mm (90) and nominal ring width  $h_1 = 2,5$  mm (2,5), made of grey cast iron, subclass 12 (MC12). Parameters in parenthesis are used in the ISO ring designation:

**Piston ring ISO 6624-1 KM1-90 × 2,5-MC12**

6 Common features

6.1 Type T, TB, TBA, TM, K, KB, KBA, KM rings — Inside chamfered edges (KI)

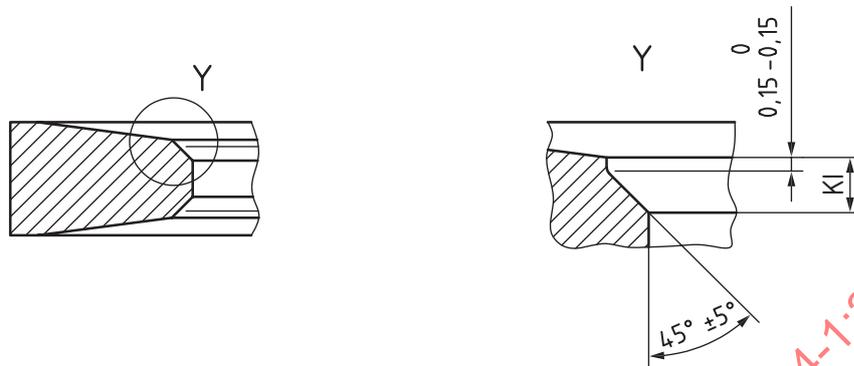


Figure 9 — Inside chamfered edges (KI)

Table 4 — KI dimensions

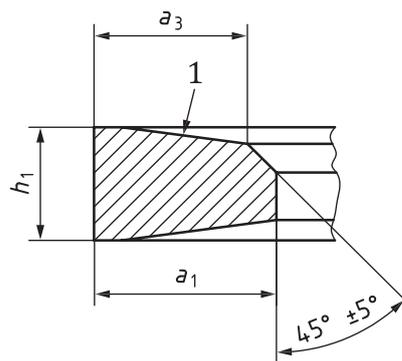
Dimensions in millimetres

$d_1$	KI
$70 \leq d_1 < 125$	$0,3 \pm 0,15$
$125 \leq d_1 < 175$	$0,4 \pm 0,15$
$175 \leq d_1 \leq 200$	$0,6 \pm 0,20$

6.2 Type T, TB, TBA, TM, K, KB, KBA, KM rings (positive twist type) internal bevel or internal step top side

An internal bevel is not recommended for the 15° keystone rings with ring width  $h_1$  given in the “nominal value of ring width” column 1 of [Table 11](#).

Dimensions in millimetres



Key

- 1 top side identification mark

Figure 10 — Internal bevel top side (IF)

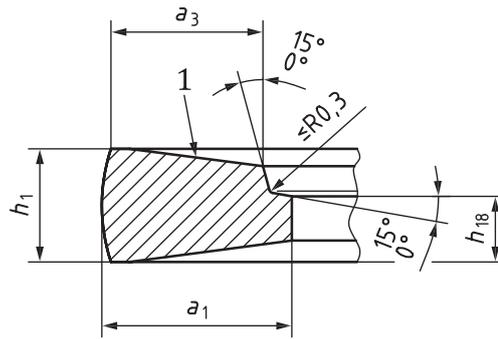


Figure 11 — Internal step top side (IW)

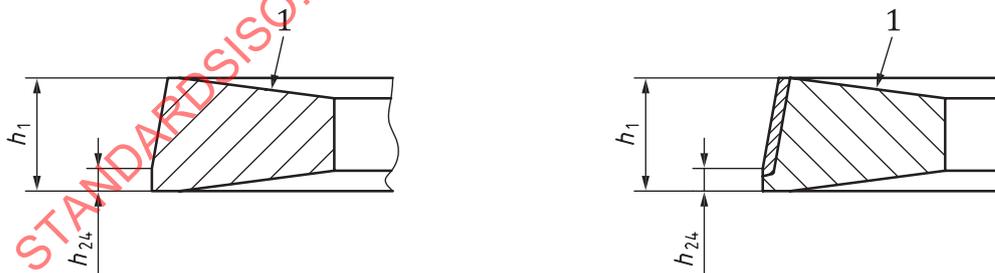
Table 5 —  $a_3$  and  $h_{18}$  dimensions

Dimensions in millimetres

$d_1$	$a_3$		$h_{18}$	
		Tolerance		Tolerance
$70 \leq d_1 < 100$	$0,8 \times a_1$	$\begin{matrix} 0 \\ -0,3 \end{matrix}$	$0,6 \times h_1$	$\begin{matrix} 0 \\ -0,25 \end{matrix}$
$100 \leq d_1 < 160$	$0,8 \times a_1$	$\begin{matrix} 0 \\ -0,3 \end{matrix}$	$0,6 \times h_1$	$\begin{matrix} 0 \\ -0,35 \end{matrix}$
$160 \leq d_1 \leq 200$	$0,8 \times a_1$	$\begin{matrix} 0 \\ -0,4 \end{matrix}$	$0,6 \times h_1$	$\begin{matrix} 0 \\ -0,45 \end{matrix}$

6.3 Type TM or KM rings with partly cylindrical machined (LM) or lapped (LP) peripheral surface

Taper M1 is excluded. Partly cylindrical peripheral surfaces shall be visible. See Table 6 for max. cylindrical peripheral surface dimension  $h_{24}$ .



Key

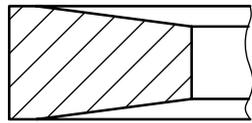
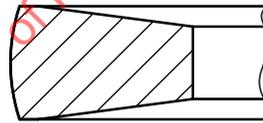
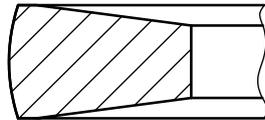
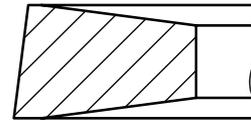
- 1 top side identification mark

Figure 12 — Partly cylindrical peripheral surface

**Table 6 —  $h_{24}$  dimensions**

Dimensions in millimetres

$h_1$	$h_{24}$ max.	$h_{24}$ max. each side of gap up to 30°
2,0	0,7	1,4
2,5	0,8	1,6
3,0	1,0	2,0
3,5	1,2	2,3
4,0	1,3	2,6
4,5	1,5	3,0

**6.4 Type T, TB, TBA, TM, K, KB, KBA, KM rings — Plating/coating configuration****6.4.1 Uncoated rings****a) T or K rings****b) TB or KB rings****c) TBA or KBA rings****d) TM or KM rings****Figure 13 — Uncoated rings**

6.4.2 Chromium plated, PVD coated or spray coated rings

6.4.2.1 Fully faced

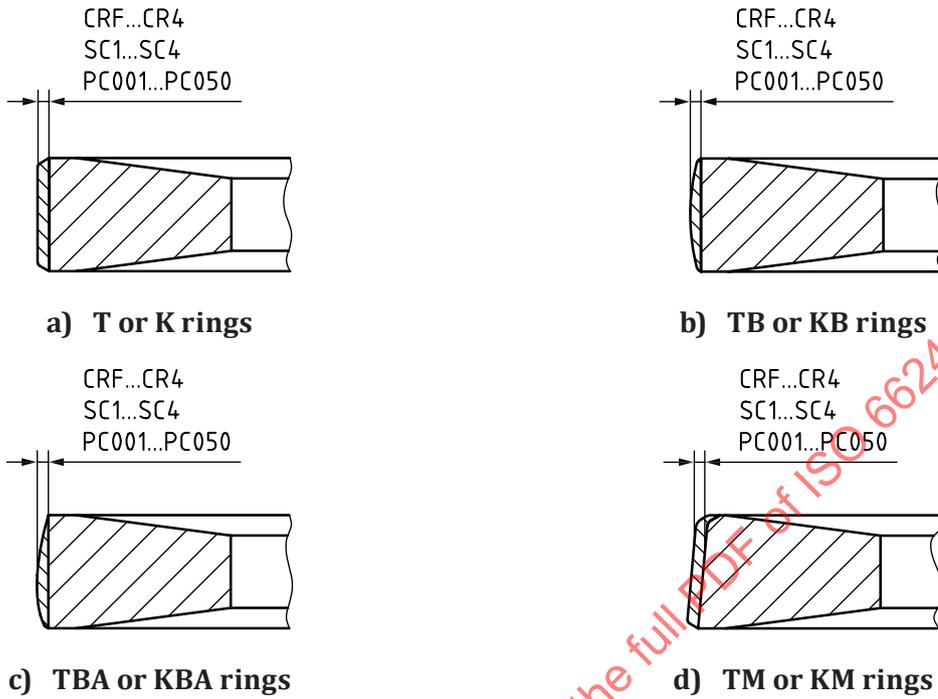


Figure 14 — Fully faced rings

6.4.2.2 Semi-inlaid

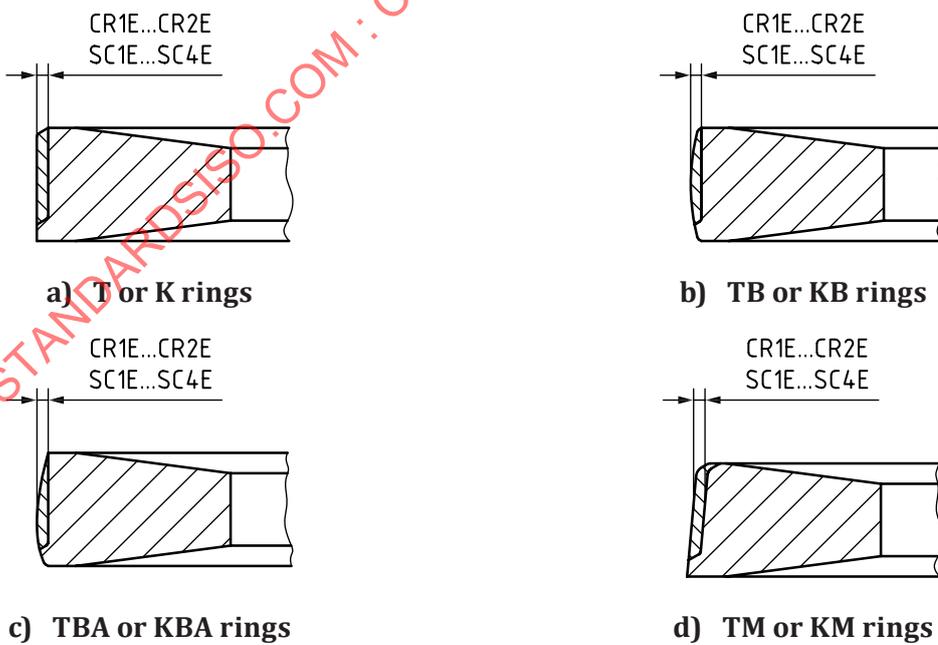


Figure 15 — Semi-inlaid rings

6.4.2.3 Inlaid

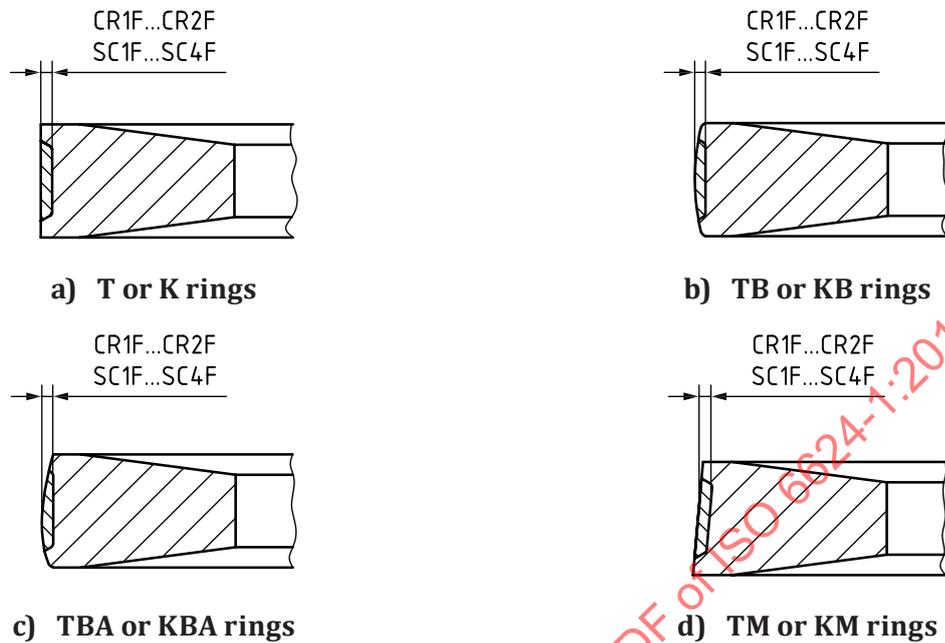


Figure 16 — Inlaid rings

Table 7 — Plating/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	SC3	0,15
CR4	SC4	0,20

Table 8 — PVD coating thickness

Dimensions in millimetres

PVD coating Code	Thickness min.
PC001	0,001
PC003	0,003
PC005	0,005
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).

**7 Force factors**

The tangential and diametral forces given in [Tables 11](#) and [12](#) shall be corrected when additional features or materials other than grey cast iron with a modulus of elasticity,  $E_n$ , of 100 GN/m<sup>2</sup>, or both, are used. Modulus of elasticity per ISO 6621-3 is determined by considering piston ring dimensions and measured tangential force.

For common features, the multiplier correction factors given in [Tables 9](#) and [10](#), and the force correction factors given in ISO 6621-4 shall be used.

**Table 9 — Force correction factors for T, TB, TBA, TM, K, KB, KBA, KM rings with features KI, IF, IW and taper**

Factor				
KI	M2 or M3	M4 or M5	IF	IW
0,96	0,98	0,96	0,88	0,78

**Table 10 — Force correction factors for chromium plated, PVD coated or spray coated T, TB, TBA, TM, K, KB, KBA, KM rings (fully faced, semi-inlaid and inlaid types)**

$d_1$ mm	Factor					
	CRF/ PC001 ... PC030	CR1/ PC040 ... PC050	CR2/SC1	CR3/SC2	CR4/SC3	SC4
$70 \leq d_1 < 100$	1	0,92	0,88	0,85	0,81	0,77
$100 \leq d_1 < 125$	1	0,94	0,91	0,88	0,86	0,83
$125 \leq d_1 < 150$	1	0,95	0,92	0,90	0,88	0,85
$150 \leq d_1 \leq 200$	1	0,96	0,93	0,91	0,89	0,87

**8 Dimensions**

The dimensions and the tangential and diametral forces of keystone rings 6° and 15° are given in [Tables 11](#) and [12](#).

**Table 11 — Dimensions of T, TB, TBA, TM, keystone rings 6°**

Dimensions in millimetres

Nom- inal diame- ter <sup>a</sup>	Radial wall thickness		Nom- inal value of ring width		Keystone ring width				Closed gap	Tangential force $F_t$ [N]			Diametral force $F_d$ [N]			
					Method A		Method B			$s_1$	$h_1$		Tolerance	$h_1$		Tolerance
					Measured value		Meas- ured value				1	2		1	2	
$d_1$	$a_1$	Toler- ance	1	2	$a_6$	1	2	1	2	$a_6$	1	2	Tolerance	1	2	Tolerance
70	2,90										9,9	12,6		21,3	27,1	
71	2,95										10,1	12,9		21,7	27,7	
72	3,00										10,3	13,2		22,1	28,4	
73	3,05										10,5	13,4		22,6	28,8	
74	3,10										10,7	13,7		23,0	29,5	
75	3,15										10,9	13,9		23,4	29,9	

Table 11 (continued)

Nominal diameter <sup>a</sup>	Radial wall thickness		Nominal value of ring width		Keystone ring width						Closed gap		Tangential force $F_t$ [N]			Diametral force $F_d$ [N]		
					Method A			Method B										
					Measured value													
$d_1$	$a_1$	$h_1$		$a_6$	$h_3$		$h_3$		$a_6$	$s_1$	$h_1$		$h_1$		$h_1$		Tolerance	
		Tolerance	1	2		1	2	1	2		Tolerance	1	2	Tolerance	1	2	Tolerance	
76	3,15					1,832	2,332			1,61		10,6	13,6		22,8	29,2		
77	3,20	±0,15				0	0			0		10,8	13,9		23,2	29,9		
78	3,25	Within a ring: 0,15 max.	2,0	2,5	1,5	-0,024	-0,024			-0,22		11,0	14,1	±30 % if $F_t < 10$ N ±20 % if $F_t \geq 10$ N	23,7	30,3	±30 % if $F_d < 21,5$ N ±20 % if $F_d \geq 21,5$ N	
79	3,30										1,82	2,32				11,3		14,4
80	3,35					For phosphated PO surface:	For phosphated PO surface:			For phosphated PO surface:		11,5	14,7		24,7	31,6		
81	3,40										+0,25	11,7	15,0		25,2	32,3		
82	3,40					+0,010	+0,010			+0,09	0,25	0	11,4	14,6		24,5	31,4	
83	3,45					-0,024	-0,024			-0,22			11,6	14,9		24,9	32,0	
84	3,50												11,8	15,2		25,4	32,7	
85	3,55												12,0	15,4		25,8	33,1	
86	3,60												12,2	15,7		26,2	33,8	
87	3,65												12,5	16,0		26,9	34,4	
88	3,65												12,2	15,6		26,2	33,5	
89	3,70												12,4	15,9		26,7	34,2	
90	3,75									0,30			16,1	19,6		34,6	42,1	
91	3,80					2,278	2,778			2,08			16,3	20,0		35,0	43,0	
92	3,85					0	0			0			16,6	20,3		35,7	43,6	
93	3,90	±0,2				-0,024	-0,024			-0,22			16,9	20,6		36,3	44,3	
94	3,90	Within a ring: 0,2 max.	2,5	3,0	2,0	For phosphated PO surface:	For phosphated PO surface:			For phosphated PO surface:			16,5	20,2		35,5	43,4	
95	3,95											2,27	2,77			16,8	20,5	
96	4,00												17,1	20,9		36,8	44,9	
97	4,05					+0,010	+0,010			+0,09			17,3	21,2		37,2	45,6	
98	4,10					-0,024	-0,024			-0,22			17,6	21,5		37,8	46,2	
99	4,15												17,9	21,9		38,5	47,1	
100	4,15												17,5	21,4		37,6	46,0	
101	4,20												17,7	21,7		38,1	46,7	
102	4,25												18,0	22,0		38,7	47,3	
103	4,30												18,2	22,3		39,1	47,9	
104	4,30												17,9	21,9		38,5	47,1	
105	4,35												18,1	22,2		38,9	47,7	
106	4,40												18,3	22,5		39,3	48,4	
107	4,40												18,0	22,0		38,7	47,3	

Table 11 (continued)

Nominal diameter <sup>a</sup>	Radial wall thickness		Nominal value of ring width		Keystone ring width						Closed gap		Tangential force $F_t$ [N]			Diametral force $F_d$ [N]							
					Method A			Method B															
					Measured value																		
$d_1$	$a_1$	$h_1$		$a_6$	$h_3$		$h_3$		$a_6$	$s_1$	$h_1$		$h_1$		$h_1$								
	Tolerance	1	2		1	2	1	2		Tolerance	1	2	Tolerance	1	2	Tolerance							
108	4,45	±0,2 Within a ring: 0,2 max.	2,5	3,0	2,0	2,278	2,778	2,27	2,77	2,08	0,35	18,2	22,3		39,1	47,9							
109	4,50					0	0			0		18,4	22,6		39,6	47,1							
110	4,55					-0,024	-0,024			-0,22		18,6	22,8		40,0	49,0							
111	4,55					For phosphated PO surface:	For phosphated PO surface:			For phosphated PO surface:		18,2	22,4		39,1	48,2							
112	4,60											18,5	22,7		39,8	48,8							
113	4,65											18,7	22,9		40,2	49,2							
114	4,70											18,9	23,2		40,6	49,9							
115	4,70					+0,010	+0,010			+0,09		18,6	22,8		40,0	49,0							
116	4,75					-0,024	-0,024			-0,22		18,8	23,1		40,4	49,7							
117	4,80											19,0	23,4		40,9	50,3							
118	4,80											18,7	22,9		40,2	49,2							
119	4,85											18,9	23,2		40,6	49,9							
120	4,90					3,0	3,5			2,5		2,724	3,224		2,71	3,21	2,63	0,40	19,1	23,5		41,1	50,5
121	4,95											0	0				0		19,3	23,8		41,5	51,2
122	4,95	-0,024	-0,024	-0,22	19,0			23,3	40,9		50,1												
123	5,00	For phosphated PO surface:	For phosphated PO surface:	For phosphated PO surface:	19,2			23,6	41,3		50,7												
124	5,05				19,4			23,9	41,7		51,4												
125	5,05				23,4			27,8	50,3		59,8												
126	5,10				23,7			28,1	51,0		60,4												
127	5,15				24,0			28,5	51,6		61,3												
128	5,20				24,2			28,8	52,0		61,9												
129	5,20				23,8			28,3	51,2		60,8												
130	5,25				24,0			28,5	51,6		61,3												
131	5,30				24,3			28,8	52,2		61,9												
132	5,30				23,9			29,1	51,4		62,6												
133	5,35	+0,010	+0,010	+0,09	24,1			28,7	51,8		61,7												
134	5,40	-0,024	-0,024	-0,22	24,4	29,0	52,5	62,4															
135	5,40				24,0	28,5	51,6	6,3															
136	5,45				24,3	28,8	52,2	61,9															
137	5,50				24,5	29,1	52,7	62,6															
138	5,50				24,1	28,7	51,8	61,7															
139	5,55				24,4	29,0	52,5	62,4															
140	5,60				24,6	29,3	52,9	63,0															
141	5,65				24,9	29,6	53,5	63,6															
142	5,65				24,5	29,1	52,7	62,6															
143	5,70				24,7	29,4	53,1	63,2															
144	5,75				25,0	29,7	53,8	63,9															
145	5,75				24,6	29,3	52,9	63,0															

Table 11 (continued)

Nominal diameter <sup>a</sup>	Radial wall thickness		Nominal value of ring width		Keystone ring width						Closed gap		Tangential force $F_t$ [N]			Diametral force $F_d$ [N]				
					Method A			Method B												
					Measured value															
$d_1$	$a_1$	$h_1$		$a_6$	$h_3$		$h_3$		$a_6$	$s_1$	$h_1$		$h_1$							
		Tolerance	1	2		1	2	1	2		Tolerance	1	2	Tolerance	1	2	Tolerance			
146	5,80	±0,2 Within a ring: 0,2 max.										24,9	29,6		53,5	63,6				
147	5,85											25,1	29,9		54,0	64,3				
148	5,85											24,7	29,4		53,1	63,2				
149	5,90											25,0	29,7		53,8	63,9				
150	5,95											25,0	29,8		53,8	64,1				
152	6,00											24,9	30,1		53,5	63,9				
154	6,05											2,7240	3,224		2,630	24,8		29,5	53,3	63,4
155	6,10											-0,029	-0,029		-0,27	25,0		29,8	53,8	64,1
156	6,15											For phosphated PO surface:	For phosphated PO surface:		For phosphated PO surface:	25,2		30,1	54,2	64,7
158	6,20											+0,010	+0,010		+0,09	25,1		29,9	54,0	64,3
160	6,25											-0,029	-0,029		-0,027	25,0		29,8	53,8	64,1
162	6,35											0,50	+0,30		0	25,4		30,3	54,6	65,1
164	6,40											+0,010	+0,010		+0,09	25,3		30,2	54,4	64,9
165	6,40											-0,029	-0,029		-0,027	25,0		29,8	53,8	64,1
166	6,45				25,2	30,0	54,2	64,5												
168	6,50				25,1	29,9	54,0	64,3												
170	6,60				30,4	35,4	65,4	76,1												
172	6,65				30,3	35,2	65,1	75,7												
174	6,70				30,2	35,1	64,9	75,5												
175	6,75				0,60	30,3	35,2	65,1	75,7											
176	6,80					30,5	35,5	65,6	76,3											
178	6,85					30,4	35,4	65,4	76,1											
180	6,90					30,3	35,2	65,1	75,7											
182	6,95					30,1	35,1	64,7	75,5											
184	7,05					30,6	35,7	65,8	76,8											
185	7,05				3,172	3,672	3,20	30,3	35,2	65,1	75,7									
186	7,10				0	0	0	30,5	35,5	65,6	76,3									
188	7,15	3,5	4,0	3,0	-0,029	-0,029	3,15	3,65	-0,27	0,60	+0,30	0	30,4	35,4	65,4	76,1				
190	7,20				For phosphated PO surface:	For phosphated PO surface:	For phosphated PO surface:	30,3	35,2	65,1	75,7									
192	7,25				For phosphated PO surface:	For phosphated PO surface:	For phosphated PO surface:	30,1	35,1	64,7	75,5									
194	7,35				For phosphated PO surface:	For phosphated PO surface:	For phosphated PO surface:	30,6	35,7	65,8	76,8									
195	7,35				+0,010	+0,010	+0,09	30,2	35,2	64,9	75,7									
196	7,40				-0,029	-0,029	-0,27	30,5	35,5	65,6	76,3									