INTERNATIONAL STANDARD

ISO 6624-3

Second edition
2017-04

Internal combustion engines — Piston rings —

Part 3: Keystone rings made of steel

Moteurs à combustion interne — Segments de piston —

Partie 3: Segments 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. www.iso.org/directives

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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.

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

This second edition cancels and replaces the first edition (ISO 6624-3:2001), which has been technically revised. The main changes compared to the previous edition are as follows:

— PVD rings were included; and

— updates were made regarding technology improvements.

A list of all the parts in the ISO 6624 series can be found on the ISO website.

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].

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 refers to the specifications and requirements of ISO 6621-3[4] and ISO 6621-4 before completing a selection.

Internal combustion engines — Piston rings —

Part 3: Keystone rings made of steel

1 Scope

This document specifies the essential dimensional features of keystone rings made of steel, types T, TB, TBA, TM, K, KB, KBA and KM, having diameters from 70 mm up to and including 160 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 9 and Figures 9 to 15. Tables 11 and 12 give the force factors for the different types of rings, while Table 13 and Table 14 give the dimensions and forces of keystone rings 6° and 15°, respectively.

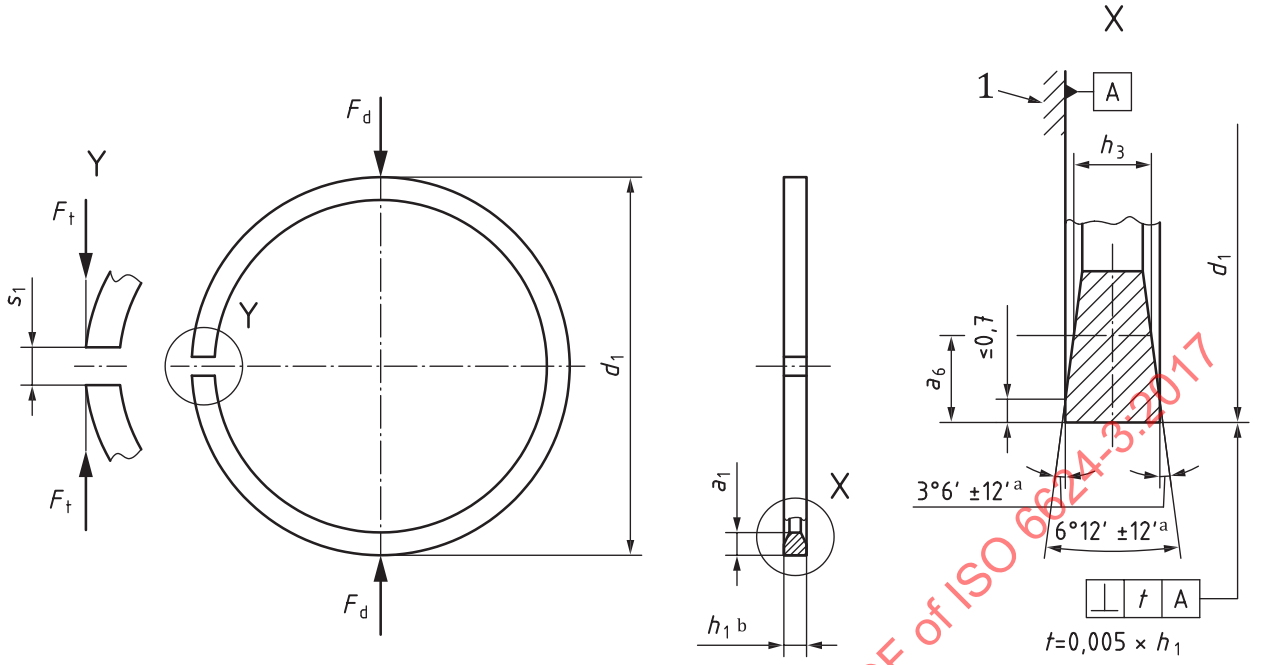
5 Ring types and designation examples

5.1 Type T — Straight faced keystone ring 6°

5.1.1 General features

See Table 13 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 1 — Type T

5.1.2 Designation

EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624-3, being a steel, 6° keystone ring with straight-faced peripheral surface (T), of nominal diameter d_1 = 90 mm (90) and nominal ring width h_1 = 2,5 mm (2,5), made of CrSi alloyed steel, subclass 62 (MC 62), and having a fully faced chromium plated peripheral surface with a minimum thickness of 0,1 mm (CR2). Parameters in parenthesis are used in the ISO ring designation:

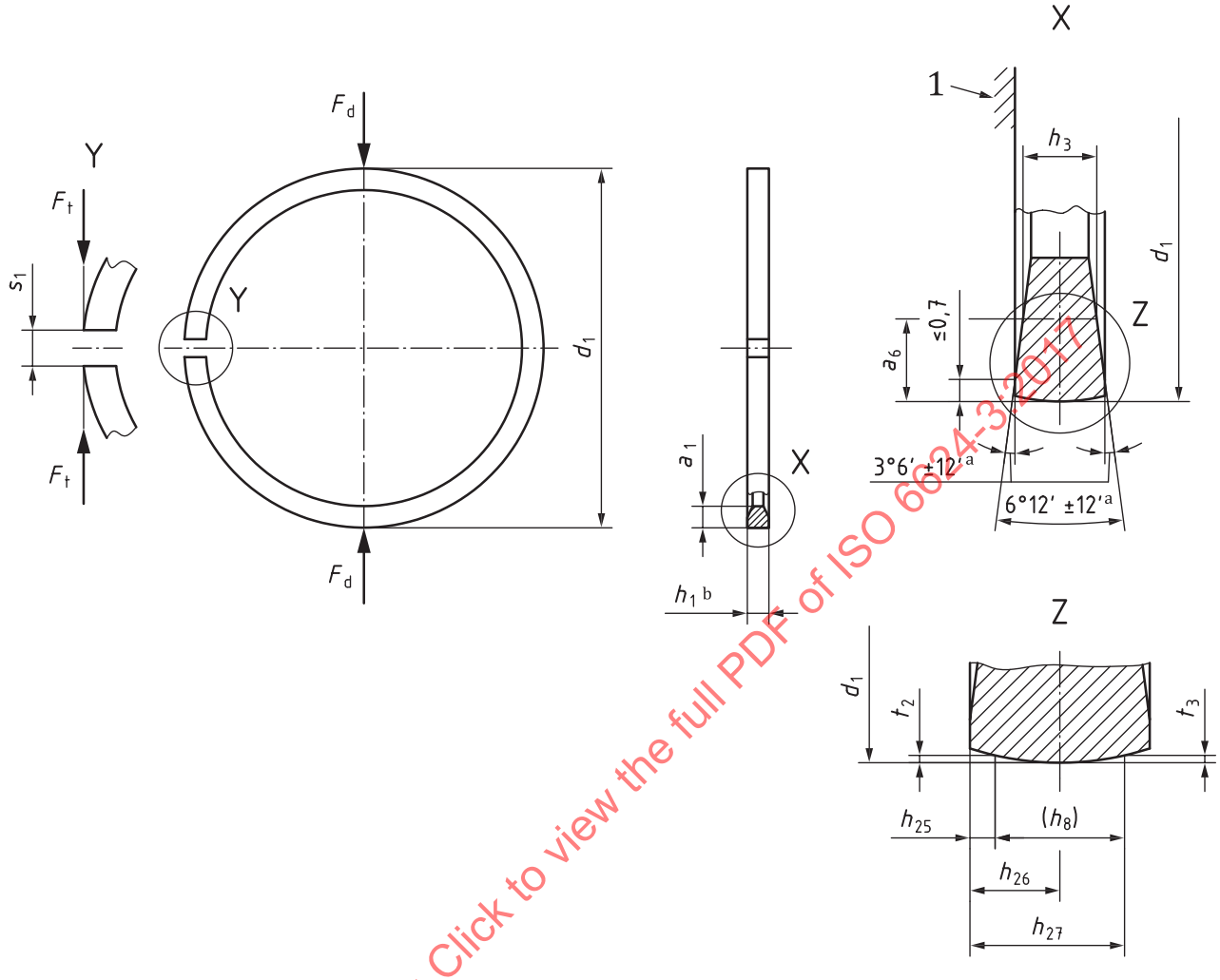
Piston ring ISO 6624-3 T - 90 x 2,5-MC 62/CR2

5.2 Type TB — Symmetrical barrel faced keystone ring 6°

5.2.1 General features

See Table 13 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 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

a Gauge width h_8, informative only, shall be used only if agreed between the manufacturer and customer.

5.2.2 Designation

EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624-3, being a steel, 6° keystone ring with 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 martensitic steel (11 % Cr min.), subclass 65 (MC 65), nitrided on the peripheral surface and side faces (NT) to a depth of 0,070 mm min. on the peripheral surface (070), and with an associated side face depth of a minimum of 0,020 mm. Parameters in parenthesis are used in the ISO ring designation:

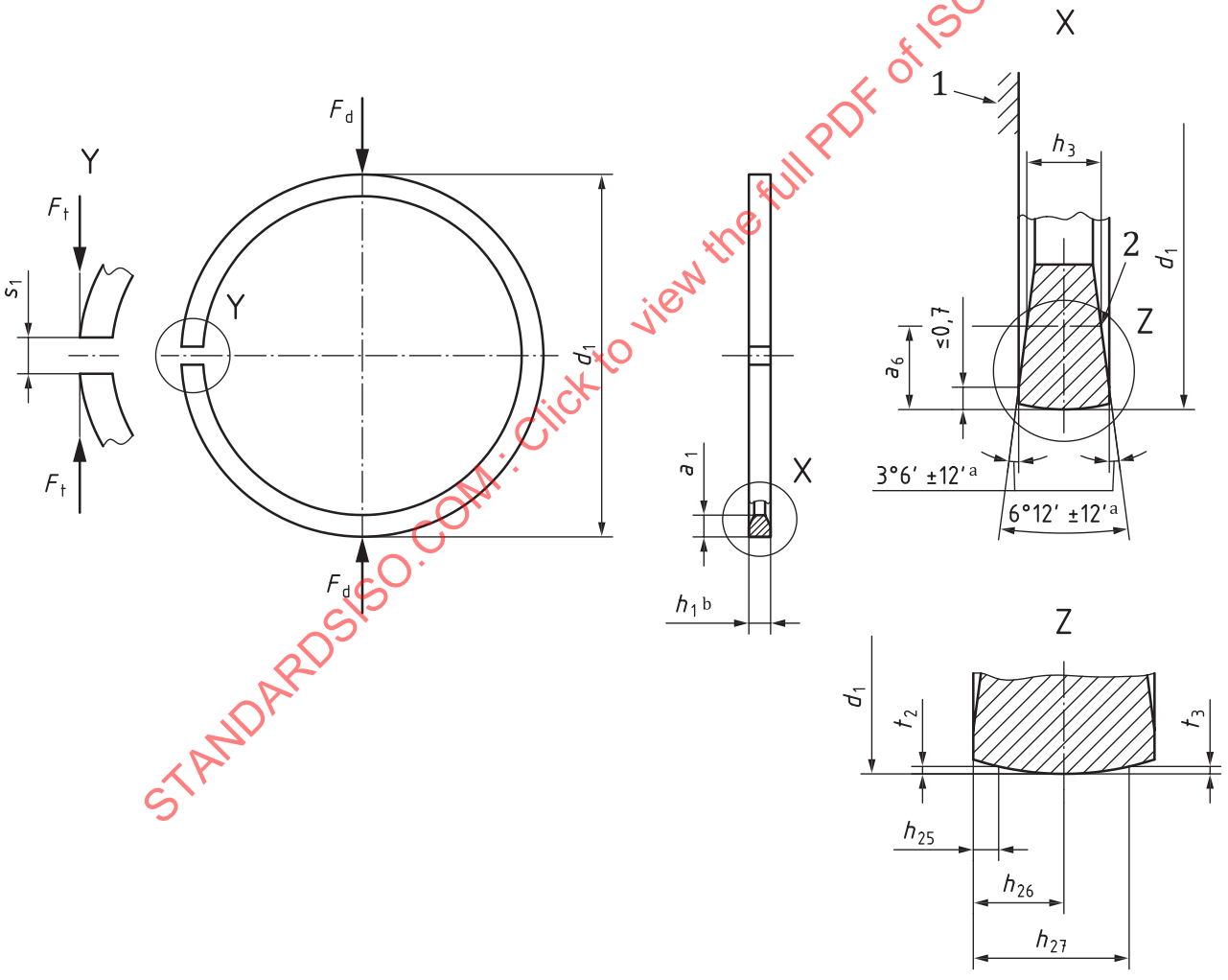
Piston ring ISO 6624-3 TB - 90 x 2,5-MC 65/NT070

5.3 Type TBA — Asymmetrical barrel faced keystone ring 6°

5.3.1 General features

See Table 13 for dimensions and forces.

Dimensions in millimetres



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	±0,20	1,50	0...0,007	0,009...0,030
2,50	0,45	0,70	±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	±0,30	2,40	0...0,009	0,012...0,040
4,00	0,65	0,95		2,80		0,013...0,045

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

[b] t_2 or t_3 or both may be varied as agreed between the manufacturer and customer.

5.3.2 Designation

EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624-3, being a steel, 6° keystone ring with 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 martensitic steel (17 % Cr min.), subclass 66 (MC 66), nitrided on the peripheral surface and side faces (NT) to a minimum depth of 0,070 mm on the peripheral surface (070), and with an associated side face depth of a minimum of 0,020 mm. Parameters in parenthesis are used in the ISO ring designation:

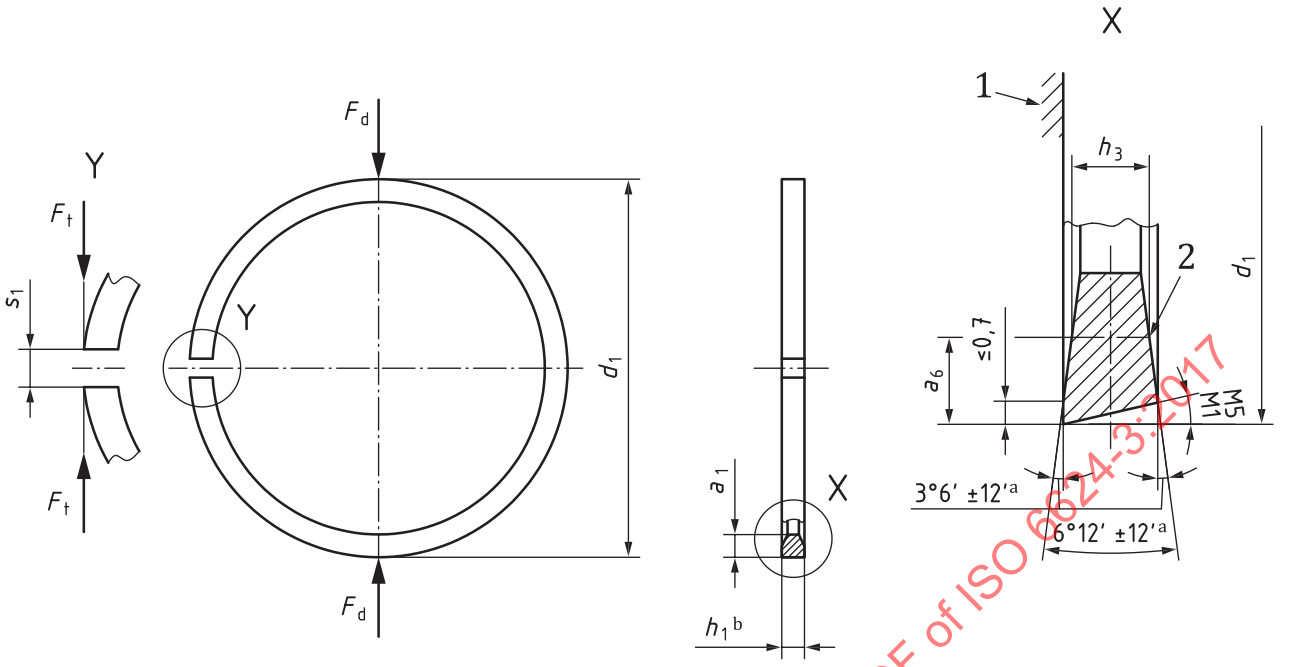
Piston ring ISO 6624-3 TBA - 90 x 2,5-MC 66/NT070

5.4 Type TM — Taper faced keystone ring 6°

5.4.1 General features

See Table 13 for dimensions and forces.

Dimensions in millimetres



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[a]	Internal twist feature designs Tolerance[a]
M1[b]	10	$^{+50}_{0}$	$^{+60}_{0}$
M2	30	$^{+60}_{0}$	$^{+70}_{0}$
M3	60		
M4	90		
M5	120		

a 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: $^{+70}_{0}$; M3 with internal features = 60 tolerance: $^{+80}_{0}$).

b 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 6624-3, being a steel, 6° keystone ring with 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 martensitic steel (11 % CR min.), subclass 65 (MC 65), and having a fully faced chromium plated peripheral surface with a minimum thickness of 0,1 mm (CR2). Parameters in parenthesis are used in the ISO ring designation:

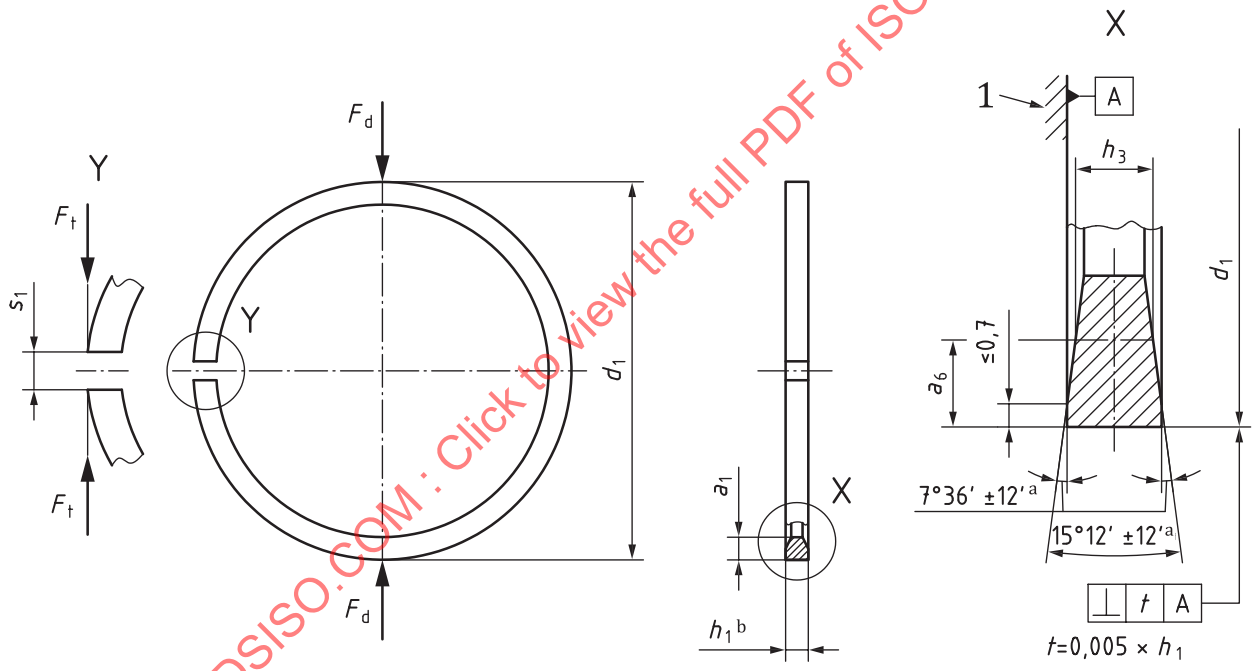
Piston ring ISO 6624-3 - TM1 x 2,5-MC 65/CR2

5.5 Type K — Straight faced keystone ring 15°

5.5.1 General features

See Table 14 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 5 — Type K

5.5.2 Designation

EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624-3, being a steel, 15° keystone ring with 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 CrMoV alloyed steel, subclass 61 (MC 61), and having a fully faced chromium plated peripheral surface with a minimum thickness of 0,1 mm (CR2). Parameters in parenthesis are used in the ISO ring designation:

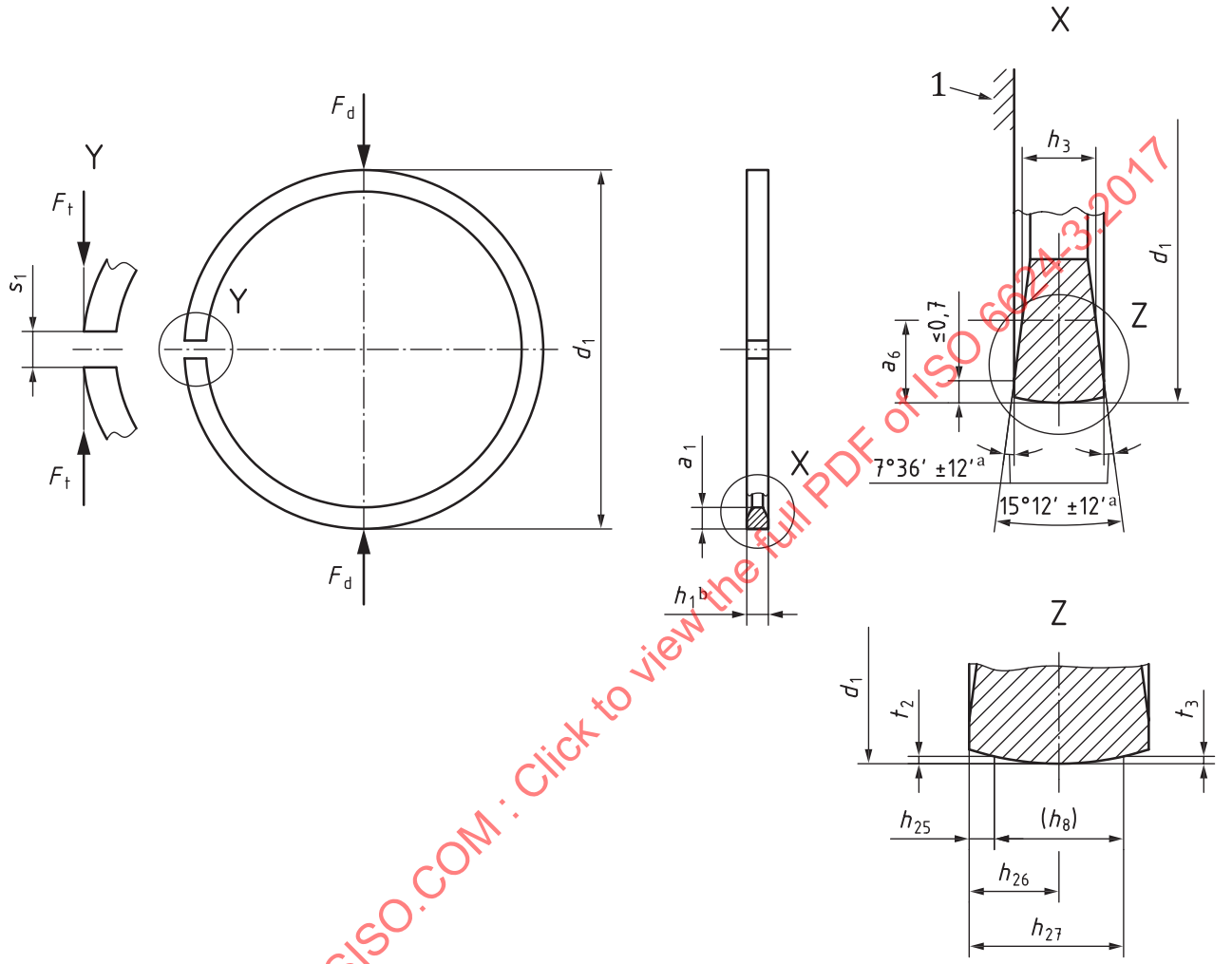
Piston ring ISO 6624-3 K - 90 x 2,5-MC 61/CR2

5.6 Type KB — Symmetrical barrel faced keystone ring 15°

5.6.1 General features

See Table 1 for symmetrical barrel dimensions. See Table 14 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 6624-3, being a steel, 15° keystone ring with 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 martensitic steel (17 % Cr min.), subclass 66 (MC 66), nitrided on the peripheral surface and side faces (NT), to a minimum depth of 0,090 mm on the peripheral surface (090), and with an associated side face depth of a minimum of 0,020 mm. Parameters in parenthesis are used in the ISO ring designation:

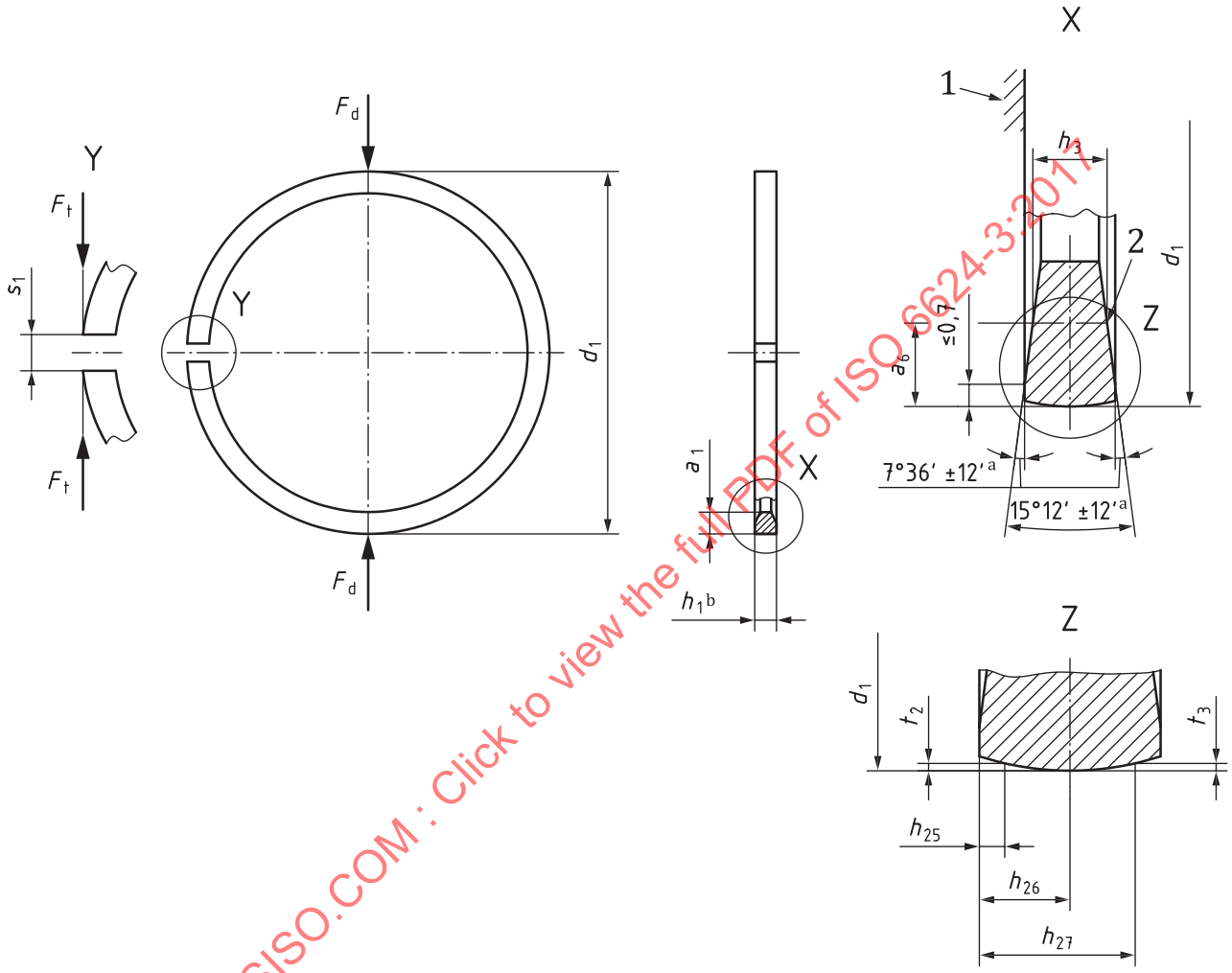
Piston ring ISO 6624-3 KB- 90 x 2,5-MC 66/NT090

5.7 Type KBA — Asymmetrical barrel faced keystone ring 15°

5.7.1 General features

See Table 2 for asymmetrical barrel dimensions. See Table 13 for dimensions and forces.

Dimensions in millimetres



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

5.7.2 Designation

EXAMPLE Designation of a piston ring complying with the requirements of ISO 6624-3, being a steel, 15° keystone ring with 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 martensitic steel (17 % Cr min.), subclass 66 (MC 66), nitrided on the peripheral surface and side faces (NT), to a depth of 0,070 mm min. on the peripheral surface (070), and with an associated side face depth of a minimum of 0,020 mm. Parameters in parenthesis are used in the ISO ring designation:

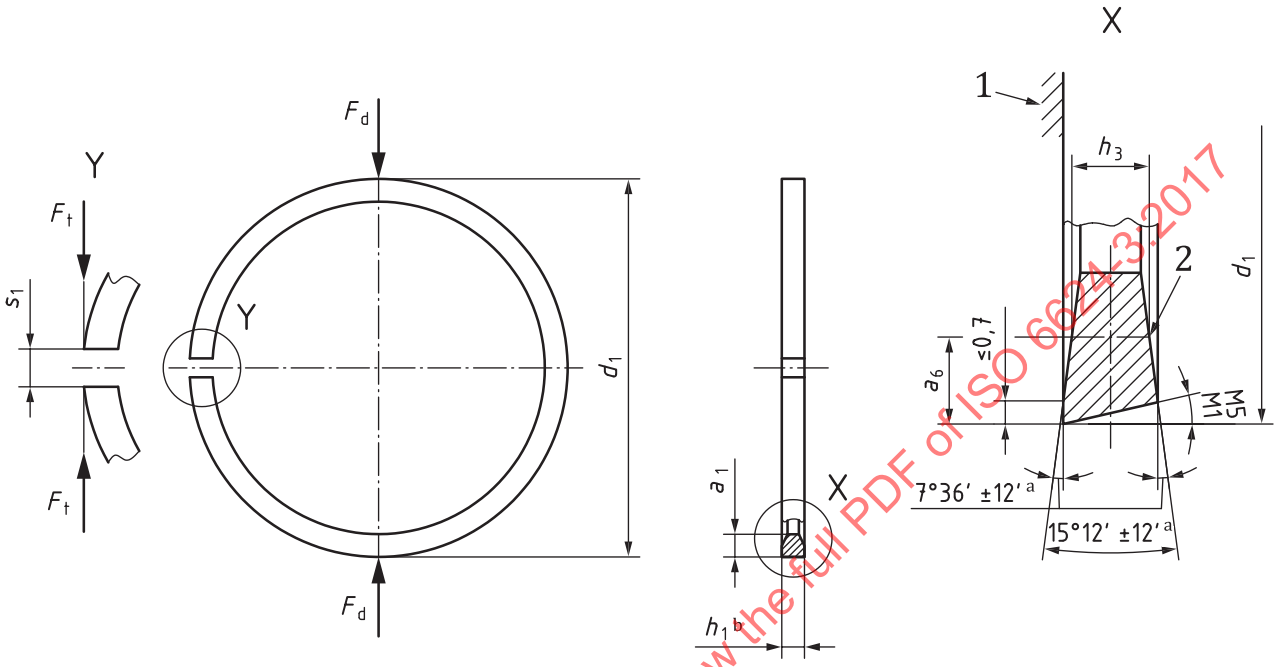
Piston ring ISO 6624-3 KBA - 90 x 2,5-MC 66/NT070

5.8 Type KM — Taper faced keystone ring 15°

5.8.1 General features

See Table 3 for taper. See Table 14 for dimensions and forces.

Dimensions in millimetres



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 6624-3, being a steel, 15° keystone ring with 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 CrMoV alloyed steel, subclass 61 (MC 61), and having a fully faced chromium plated peripheral surface with a minimum thickness 0,1 mm (CR2). Parameters in parenthesis are used in the ISO ring designation:

Piston ring ISO 6624-3 KM1 x 2,5-MC 61/CR2

6 Common features

6.1 Type T, TB, TBA, TM, K, KB, KBA, KM rings — Outside and inside rounded edges

Outside and inside rounded edges are shown in Figure 9 and Figure 10; their dimensions are given in Table 4.

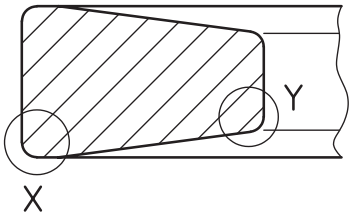


Figure 9 — Outside and inside rounded edges

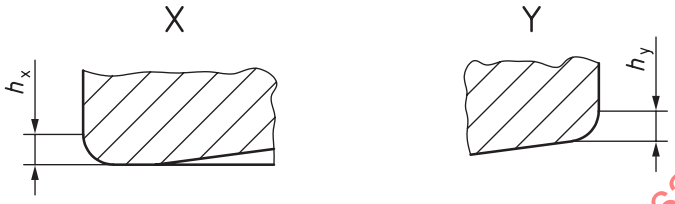


Figure 10 — Details of Figure 9

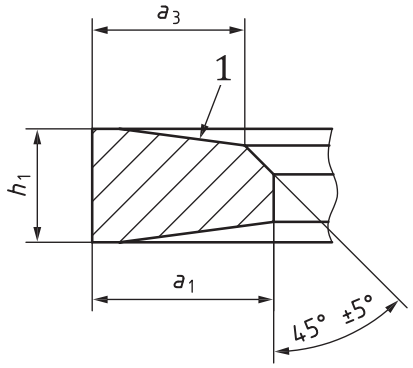
Table 4 — h_x and h_y dimensions

Dimensions in millimetres

h_1	h_x max.	h_y max.
$2 \leq h_1 < 2{,}5$	0,3	0,35
$h_1 \geq 2{,}5$	0,3	0,4

6.2 Type T, TB, TBA, TM, K, KB, KBA, KM rings (positive twist type) — Internal bevel 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 14.



Key

1 top side identification mark

Figure 11 — Internal bevel top side (IF)

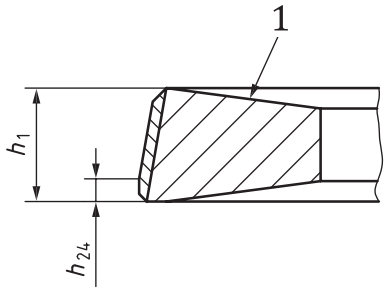
Table 5 — a_3 dimensions

Dimensions in millimetres

d_1	a_3	
		Tolerance
$70 \leq d_1 \leq 160$	$0{,}8 \times a_1$	$^{0}_{-0{,}3}$

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

Taper M1 is excluded.



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
Partly cylindrical peripheral surfaces shall be visible.		

6.4 Type T, TB, TBA, TM, K, KB, KBA, KM rings — Plating or coating configuration

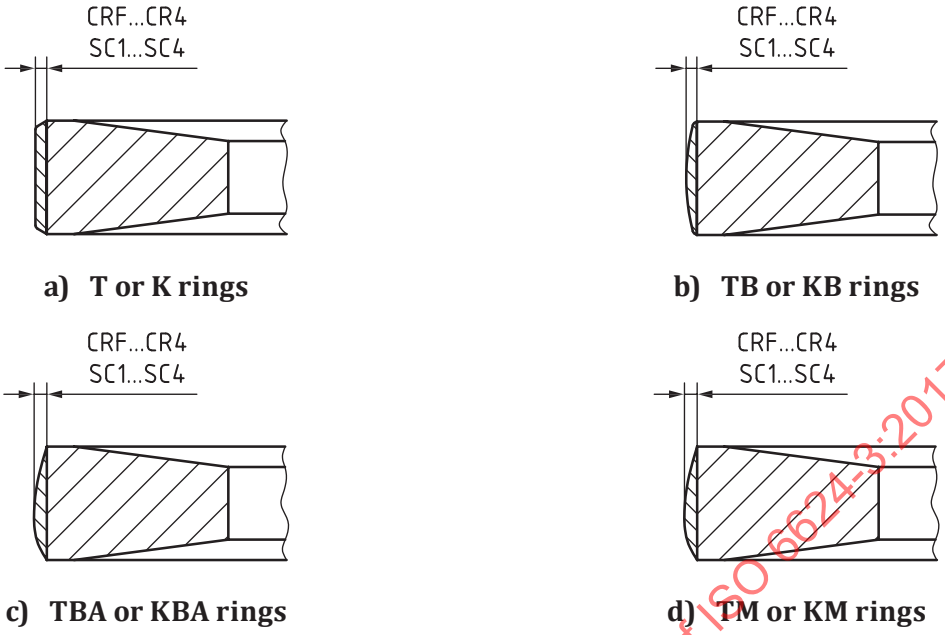
6.4.1 Chromium plated or spray coated rings

6.4.1.1 General

Semi-inlaid types are not recommended.

6.4.1.2 Fully faced

See Figure 13.



a) T or K rings

b) TB or KB rings

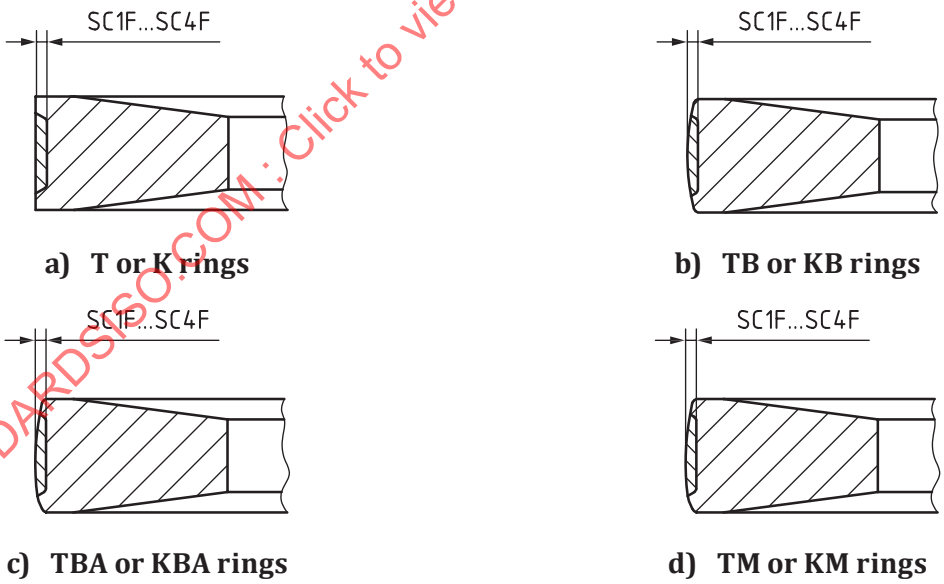
c) TBA or KBA rings

d) TM or KM rings

Figure 13 — Fully faced rings

6.4.1.2.1 Inlaid

Inlaid types are not recommended for chromium plated rings. See Figure 14.



a) T or K rings

b) TB or KB rings

c) TBA or KBA rings

d) TM or KM rings

Figure 14 — Inlaid rings

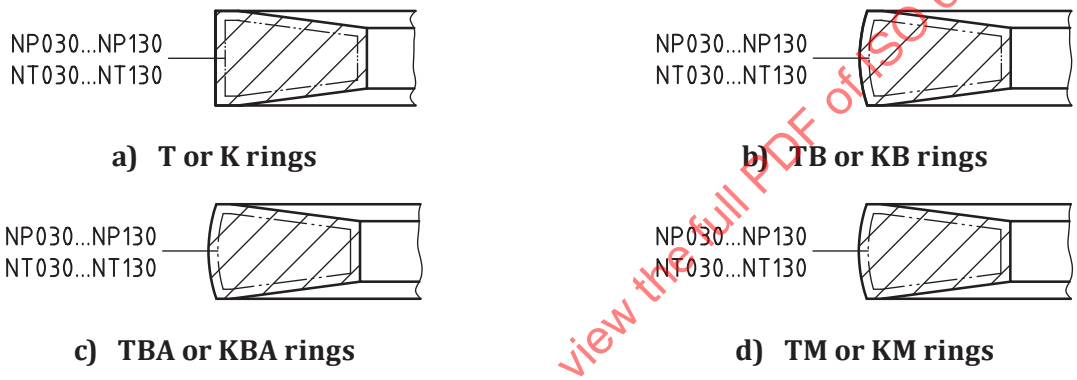
Table 7 — Plating/coating thickness

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

6.4.2 Nitrided surface

See Figure 15.



a) T or K rings

b) TB or KB rings

c) TBA or KBA rings

d) TM or KM rings

Figure 15 — Nitrided rings

Table 8 — Nitrided case depth of peripheral surface

Dimensions in millimetres

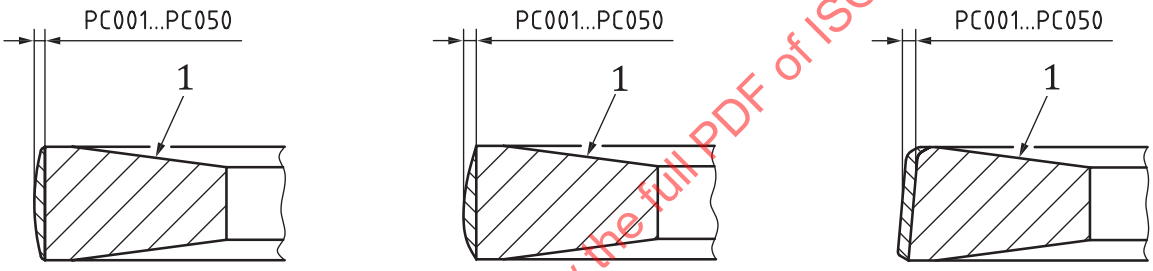
Code	Nitrided case depth min.
NP030	0,030
NP050	0,050
NP070	0,070
NP090	0,090
NP110	0,110
NP130	0,130
NOTE The nitrided case depth on side faces and the inside surface is not specified.	

Table 9 — Nitrided case depth of peripheral surface and side faces

Dimensions in millimetres

Code	Nitrided case depth	
	Peripheral surface min.	Side faces min.
NT030	0,030	0,010
NT050	0,050	0,015
NT070	0,070	0,020
NT090	0,090	0,020
NT110	0,110	0,030
NT130	0,130	0,030
NOTE The nitrided case depth on the inside surface is not specified.		

6.4.3 PVD rings



a) TB or KB rings b) TBA or KBA rings c) TM or KM rings

Key

1 top side identification mark

Figure 16 — PVD rings

Table 10 — PVD coating thickness

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

7 Force factors

The tangential and diametral forces given in Tables 13 and 14 shall be corrected when additional features are used.

The force correction factor for the ratio $m/(d_1 - a_1)$ given in ISO 6621-4 shall be used.

For common features, the multiplier correction factors given in Tables 11 and 12 shall be used.

Table 11 — Force correction factors for T, TB, TBA, TM, K, KB, KBA and KM rings with features IF and taper

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

Table 12 — Force correction factors for chromium plated, spray coated, PVD coated or nitrided T, TB, TBA, TM, K, KB, KBA and KM rings

d_1	Factor						
mm	CRF / PC001... PC030	CR1 / PC040... PC050	CR2/SC1	CR3/SC2	CR4/SC3	SC4	NP030...NP130 NT030...NT130
$70 \le d_1 < 100$	1	0,91	0,86	0,82	0,78	0,74	1,03
$100 \le d_1 < 125$	1	0,93	0,89	0,86	0,82	0,79	
$125 \le d_1 \le 160$	1	0,94	0,91	0,89	0,86	0,83	

Table 13 — Dimensions of T, TB, TBA, TM keystone rings 6°

Dimensions in millimetres

Nominal diameter	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			Measured value									
d_1	a_1		h_1		a_6	h_3		h_3			s_1		h_1			h_1		
		Tolerance	1	2		1	2	1	2	a_6		Tolerance	1	2	Tolerance	1	2	Tolerance
70	2,5										0,20	+0,20 0	10,4	13,2		22,3	28,4	
71													10,3	13,1		22,0	28,1	
72													10,1	12,9		21,8	27,7	
73													10,0	12,7		21,5	27,4	
74													11,4	14,6		24,6	31,3	
75	2,7												11,3	14,4		24,3	31,0	
76													11,1	14,1		23,8	30,3	
77													10,8	13,8		23,2	29,6	
78						1,832	2,332			1,61			10,7	13,6		23,0	29,3	
79						0	0			0			12,1	15,4		26,0	33,2	
80			2,0	2,5	1,5	−0,024	−0,024	1,8	2,32	−0,22			12,0	15,3		25,7	32,8	

Table 13 *(continued)*

Nominal diameter	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				Measured value								
d_1	a_1		h_1		a_6	h_3		h_3			s_1	h_1			h_1		
		Tolerance	1	2		1	2	1	2	a_6	Tolerance	1	2	Tolerance	1	2	Tolerance
81	2,9	±0,15										11,8	15,1		25,5	32,5	
82												11,7	15,0		25,2	32,2	
83		Within										11,6	14,8		24,9	31,8	
84		a ring:				For phos-phated PO sur-face: +0,010 −0,024	For phos-phat-ed PO sur-face: +0,010 −0,024			For phos-phated PO surface: +0,09 −0,22		11,4	14,5		24,4	31,2	
85												13,0	16,6		27,9	35,7	
86		0,15 max.									0,25	12,9	16,5		27,7	35,4	
87	3,1										+0,25 0	12,6	16,1		27,1	34,7	
88												12,5	16,0		26,9	34,4	
89												12,3	15,7		26,3	33,7	
90												15,5	18,9		33,4	40,7	
91												17,7	21,6		38,1	46,4	
92												17,3	21,1		37,2	45,4	
93	3,3											17,0	20,8		36,7	44,7	
94												16,7	20,3		35,8	43,6	
95												16,3	19,8		34,9	42,6	
96												18,5	22,6		39,9	48,6	
97												18,3	22,3		39,3	48,0	
98	3,5											18,0	22,0	±30 % if	38,7	47,3	±30 % if
99												17,8	21,7	F_t <10 N	38,2	46,6	F_d < 21,5 N
100												17,5	21,3		37,6	45,8	
101						2,278	2,778			2,08	0,30	17,2	21,0		37,1	45,2	
102						0	0			0		19,7	24,0		42,3	51,6	
103						−0,024	−0,024			−0,22		19,3	23,6		41,6	50,7	
104	3,7							2,27	2,77			19,1	23,3	±20 % if	41,1	50,1	±20 % if
105												18,8	22,9	$F_t \geq 10$ N	40,3	49,2	$F_d \geq 21,5$ N
106												18,5	22,6		39,8	48,6	
107			2,5	3,0	2,0	For phos-phated PO sur-face: +0,010 −0,024	For phos-phat-ed PO sur-face: +0,010 −0,024			For phos-phated PO surface: +0,09 −0,22		18,2	22,2		39,1	47,7	
108												20,7	25,3		44,5	54,4	
109												20,3	24,8		43,6	53,2	
110	3,9	±0,20										19,8	24,2		42,6	52,1	
111												19,4	23,7		41,6	50,9	
112		Within										18,9	23,1		40,6	49,7	
113		a ring:										21,5	26,3		46,3	56,6	
114												21,2	26,0		45,7	55,9	
115	4,1	0,20 max.									+0,25 0	20,9	25,6		44,9	54,9	
116												20,5	25,1		44,1	54,0	
117											0,35	20,2	24,7		43,4	53,0	
118												19,8	24,2		42,6	52,1	
119												22,6	27,7		48,6	59,5	
120												22,2	27,2		47,8	58,5	

Table 13 *(continued)*

Nominal diameter	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				Measured value								
d_1	a_1		h_1		a_6	h_3		h_3			s_1	h_1			h_1		
		Tolerance	1	2		1	2	1	2	a_6	Tolerance	1	2	Tolerance	1	2	Tolerance
121												21,9	26,8		47,0	57,6	
122	4,3											21,5	26,3		46,2	56,6	
123												21,1	25,9		45,5	55,7	
124												20,8	25,5		44,7	54,7	
125												29,0	34,3		62,3	73,8	
126												28,3	33,5		60,9	72,1	
127	4,5										0,35	27,7	32,7		59,5	70,4	
128												27,0	32,0		58,0	68,7	
129												26,3	31,2		56,6	67,1	
130												29,9	35,5		64,4	76,3	
131												29,5	35,0		63,4	75,2	
132	4,7					2,724	3,224			2,63		29,0	34,3		62,3	73,8	
133						0	0			0		28,5	33,8		61,3	72,7	
134						−0,024	−0,024			−0,22		28,0	33,2	±30 % if	60,2	71,3	±30 % if
135						For phosphated PO surface: +0,010 −0,024	For phosphated PO surface: +0,010 −0,024			For phosphated PO surface: +0,09 −0,22		27,4	32,5	F_t < 10 N	59,0	69,9	F_d < 21,5 N
136												31,2	37,0		67,2	79,6	
137												30,7	36,4		66,0	78,2	
138	4,9											30,2	35,7		64,8	76,9	
139		±0,20						2,71	3,21		0,40	29,6	35,1		63,7	75,5	
140			3,0	3,5	2,5						+0,25 0	29,1	34,5		62,5	74,1	
141												28,5	33,8	±20 % if	61,3	72,7	±20 % if
142		Within										32,4	38,5	F_t ≥ 10 N	69,7	82,7	F_d ≥ 21,5 N
143		a ring:										31,9	37,8		68,5	81,3	
144	5,1	0,20 max.										31,3	37,2		67,3	79,9	
145												30,8	36,5		66,2	78,5	
146												30,2	35,9		65,0	77,1	
147												29,6	35,1		63,6	75,5	
148												33,7	40,0		72,4	86,0	
149												32,9	39,1		70,8	84,0	
150	5,3											32,1	38,2		69,1	82,1	
151						2,724	3,224			2,63		31,3	37,1		67,2	79,9	
152						0	0			0		30,5	36,2		65,6	77,9	
153						−0,029	−0,029			−0,26		34,7	41,2		74,6	88,6	