INTERNATIONAL STANDARD

ISO 6624-3

First edition
2001-08-15

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

Reference number
ISO 6624-3:2001(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 6624 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6624-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

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, ISO 6622, ISO 6623, ISO 6625, ISO 6626 and ISO 6627 (see Bibliography for details).

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 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 [4] and ISO 6621-4 [5] before completing a selection.

Internal combustion engines — Piston rings —

Part 3:
Keystone rings made of steel

1 Scope

This part of ISO 6624 specifies the essential dimensional features of keystone rings made of steel, types T, TB, TBA, TM, K, KB, KBA and KM, having diameters of from 70 mm up to and including 160 mm, used in reciprocating internal combustion piston engines.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 6624. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6624 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 6621-4:—[1)], *Internal combustion engines — Piston rings — Part 4: General specifications*

3 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 10 and 11 give the force factors for the different types of ring, while Table 12 and Table 13 give the dimensions and forces of keystone rings 6° and 15°, respectively.

1) To be published. (Revision of ISO 6621-4:1988)

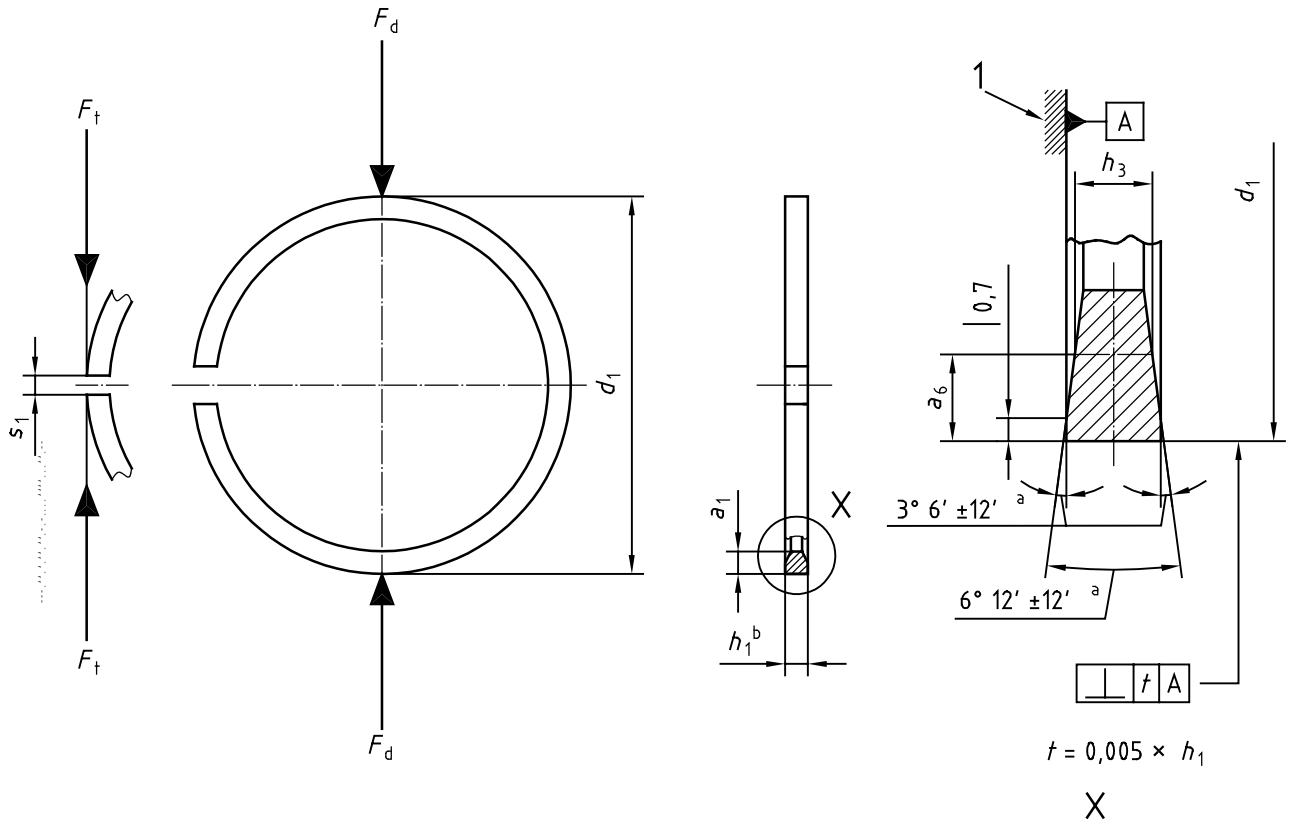
4 Ring types and designation examples

4.1 Type T — Straight faced keystone ring 6°

4.1.1 General features

See Table 12 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

4.1.2 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 (MC62), and having a fully faced chromium plated peripheral surface with a minimum thickness of 0,1 mm (CR2):

Piston ring ISO 6624-3 T - 90 × 2,5-MC62/CR2

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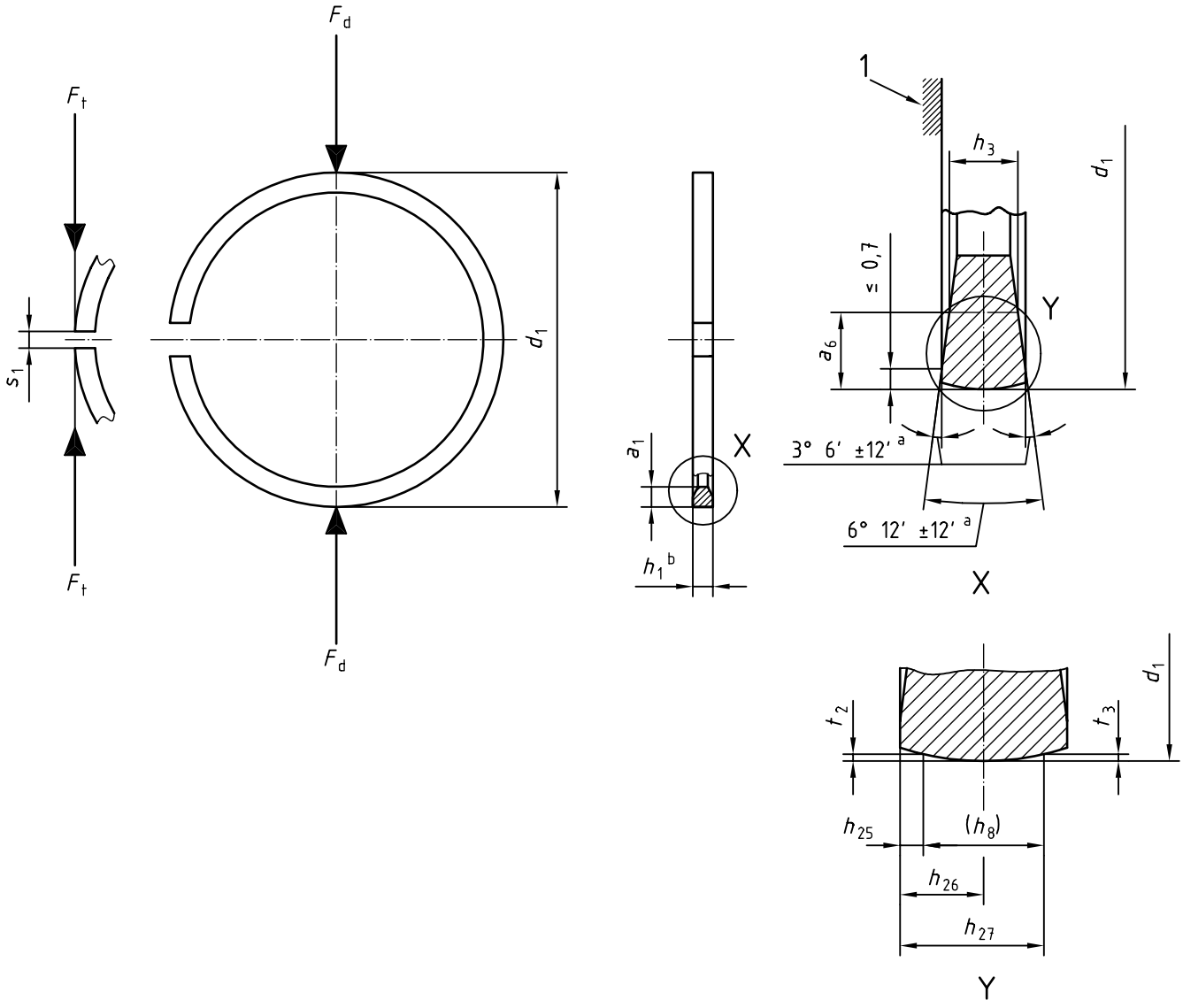
4.2 Type TB — Symmetrical barrel faced keystone ring 6°

4.2.1 General features

See Table 12 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}	Tolerance	h_{27}	t_2, t_3	h_8 [a]
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 manufacturer and client.

4.2.2 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 (MC65), 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:

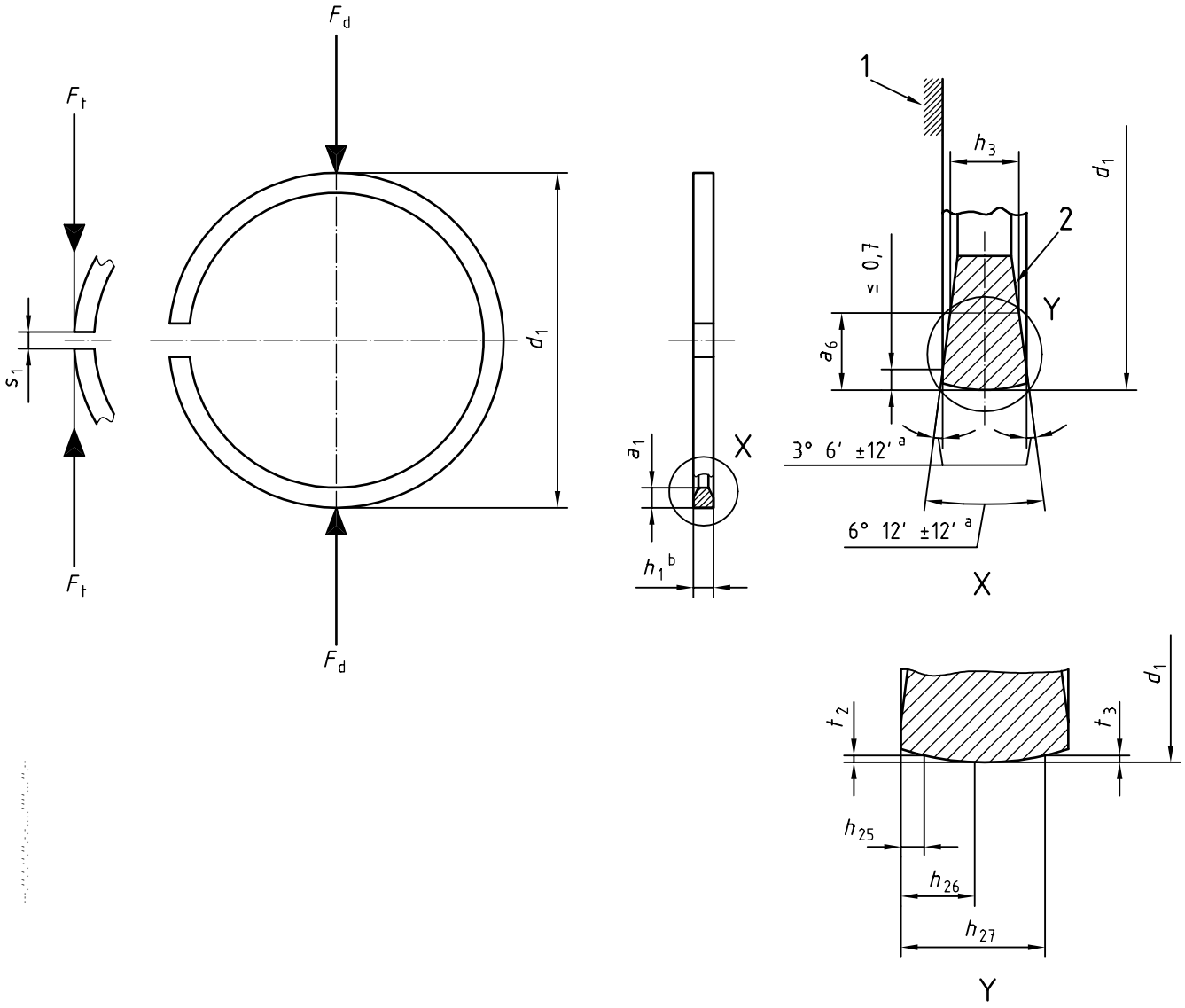
Piston ring ISO 6624-3 TB - 90 × 2,5-MC65/NT070

4.3 Type TBA — Asymmetrical barrel faced keystone ring 6°

4.3.1 General features

See Table 12 for dimensions and forces.

Dimensions in millimetres



Key

1 Reference plane
2 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}	Tolerance	h_{27}	t_2 [b]	t_3 [b]
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 manufacturer and client.

4.3.2 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 (MC66), 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:

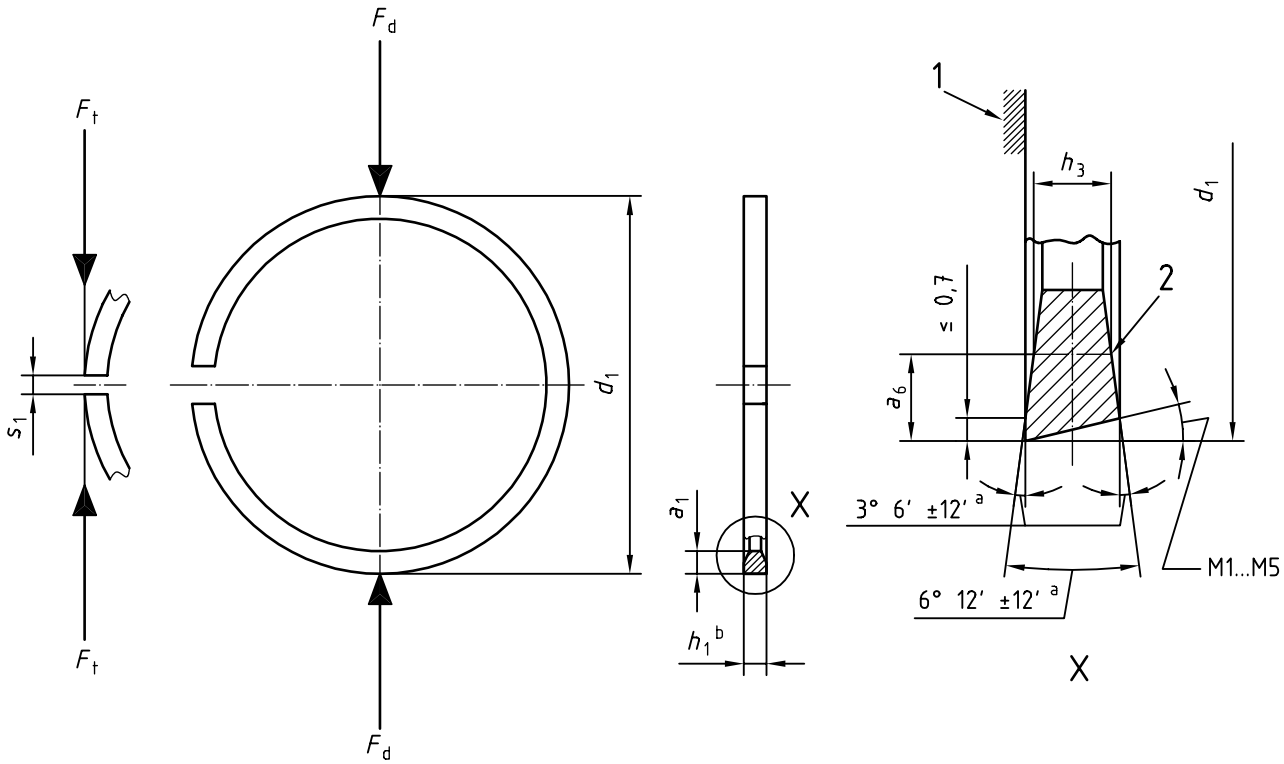
Piston ring ISO 6624-3 TBA - 90 × 2,5-MC66/NT070

4.4 Type TM — Taper faced keystone ring 6°

4.4.1 General features

See Table 12 for dimensions and forces.

Dimensions in millimetres



Key

1 Reference plane

2 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.

4.4.2 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 (MC65), and having a fully faced chromium plated peripheral surface with a minimum thickness of 0,1 mm (CR2):

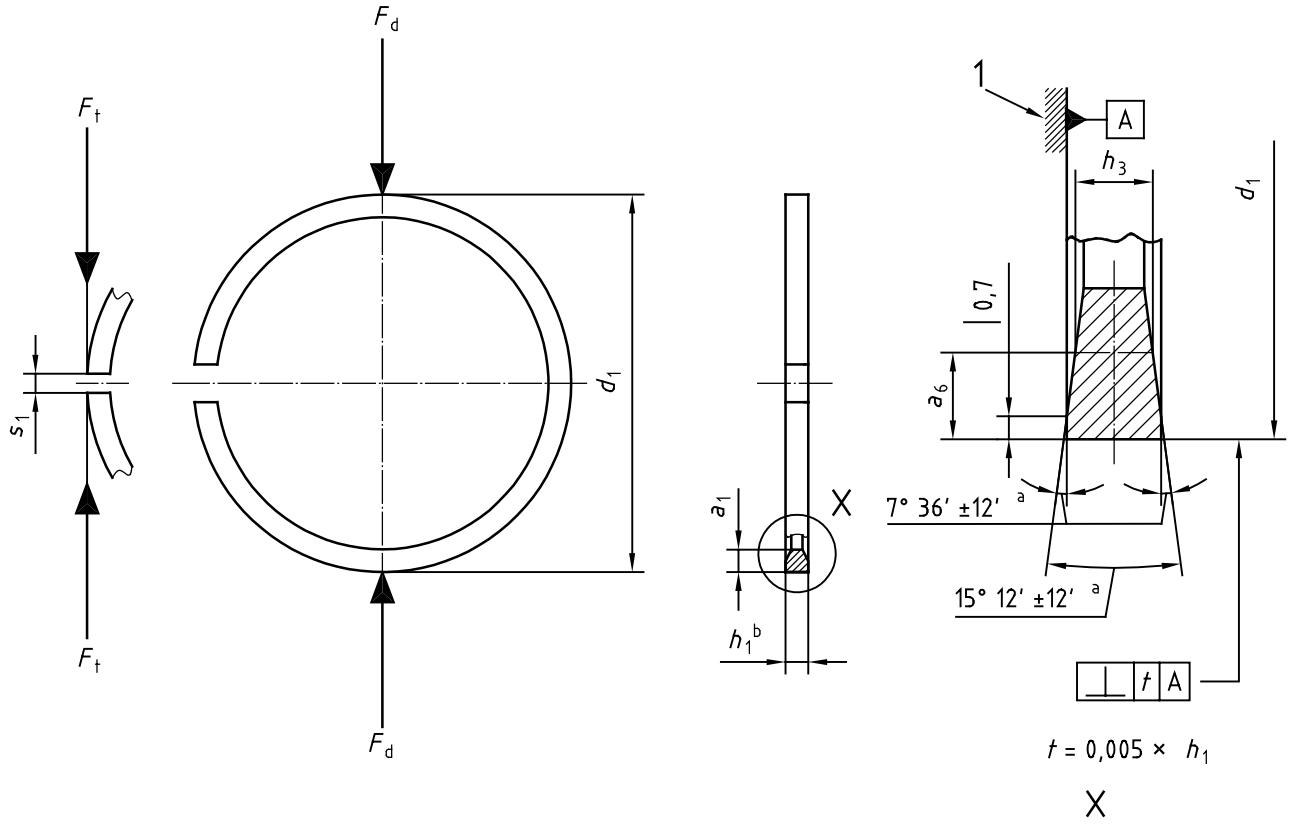
Piston ring ISO 6624-3 TM1 - 90 × 2,5-MC65/CR2

4.5 Type K — Straight faced keystone ring 15°

4.5.1 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 5 — Type K

4.5.2 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 (MC61), and having a fully faced chromium plated peripheral surface with a minimum thickness of 0,1 mm (CR2):

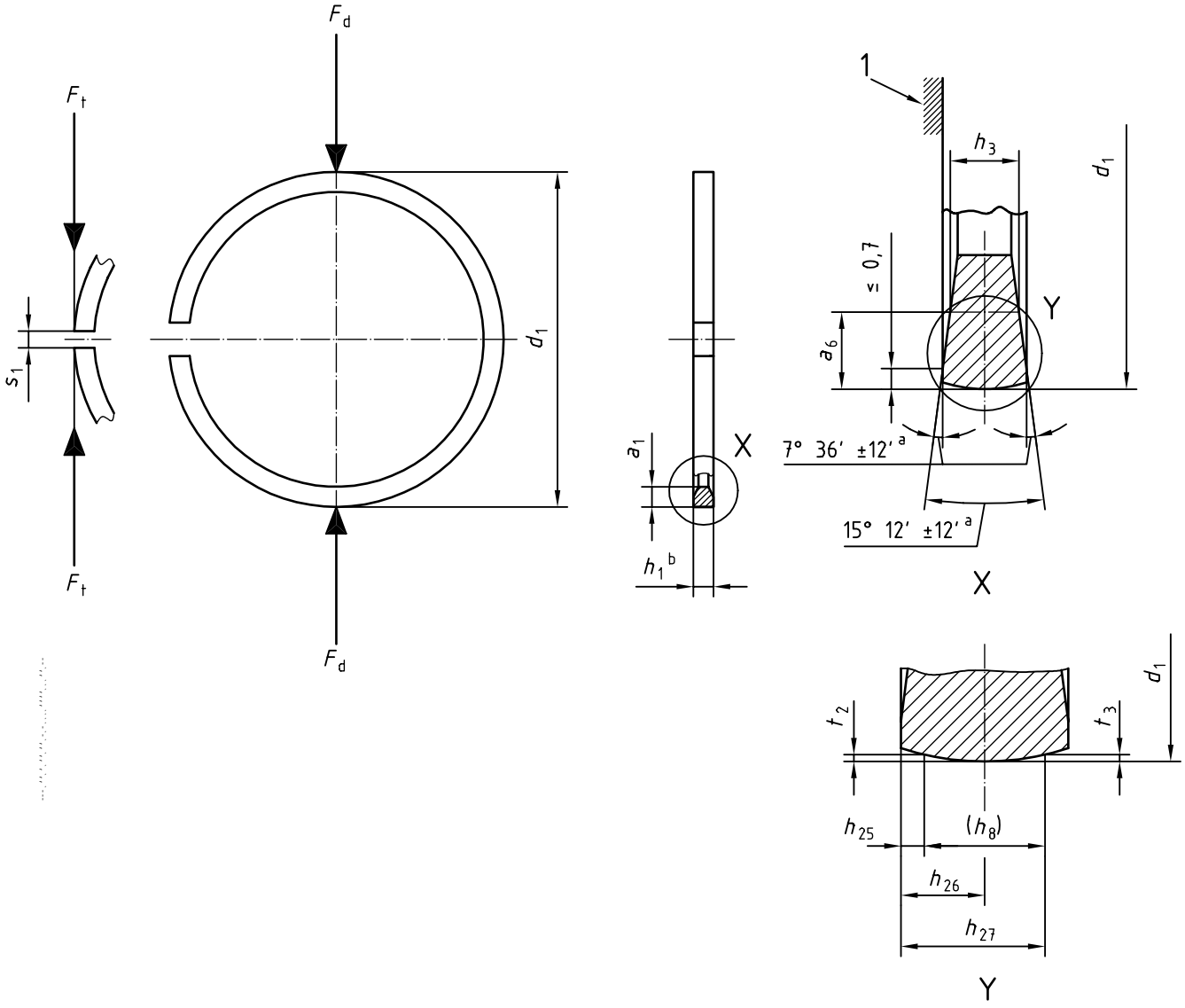
Piston ring ISO 6624-3 K - 90 × 2,5-MC61/CR2

4.6 Type KB — Symmetrical barrel faced keystone ring 15°

4.6.1 General features

See Table 1 for symmetrical barrel dimensions. 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 6 — Type KB

4.6.2 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 (MC66), 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:

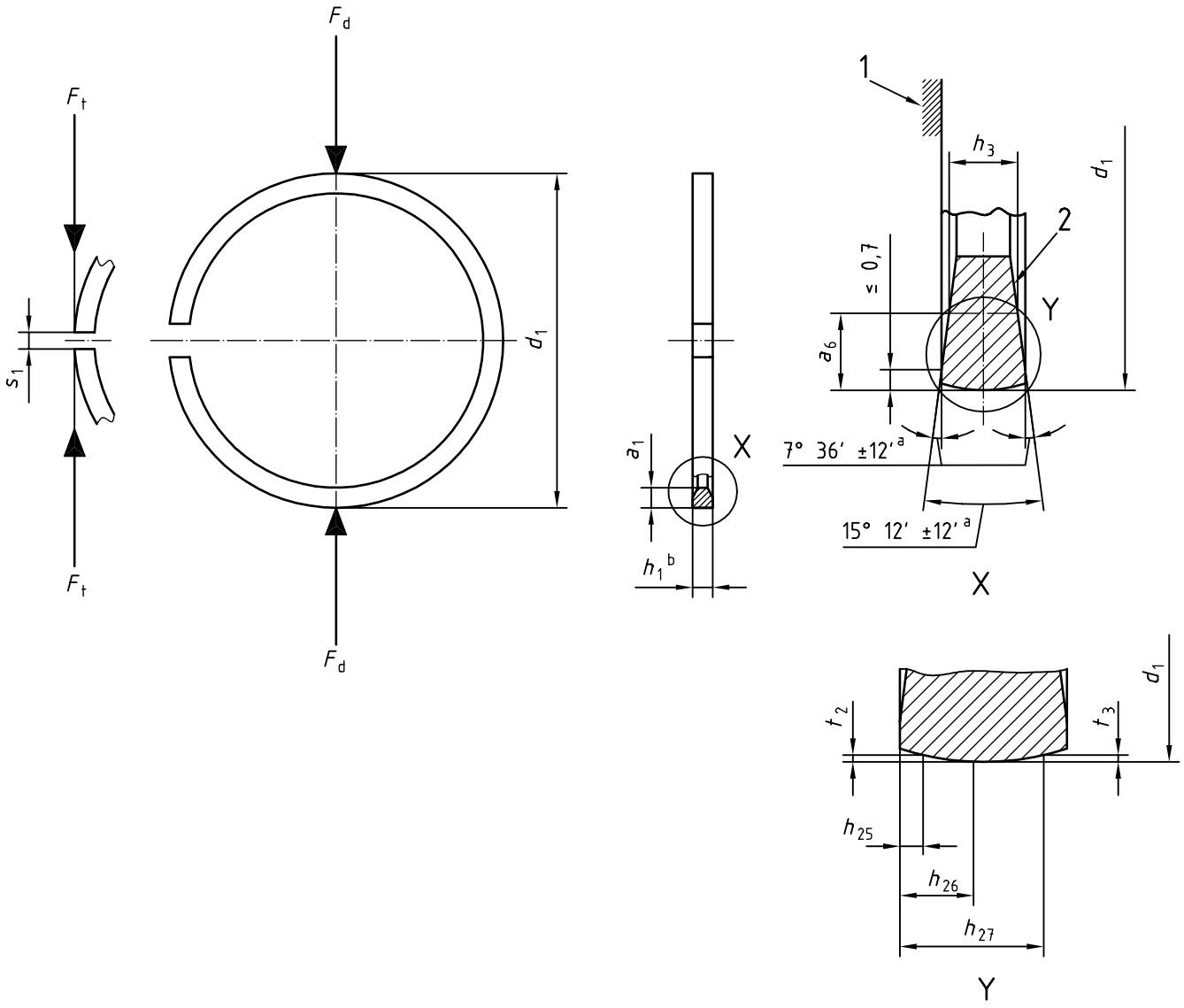
Piston ring ISO 6624-3 KB- 90 × 2,5-MC66/NT090

4.7 Type KBA — Asymmetrical barrel faced keystone ring 15°

4.7.1 General features

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

Dimensions in millimetres



Key

1	Reference plane	a	Due to manufacturing processing, side angle tolerances are not cumulative.
2	Mark	b	Nominal.

Figure 7 — Type KBA

4.7.2 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 (MC66), 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:

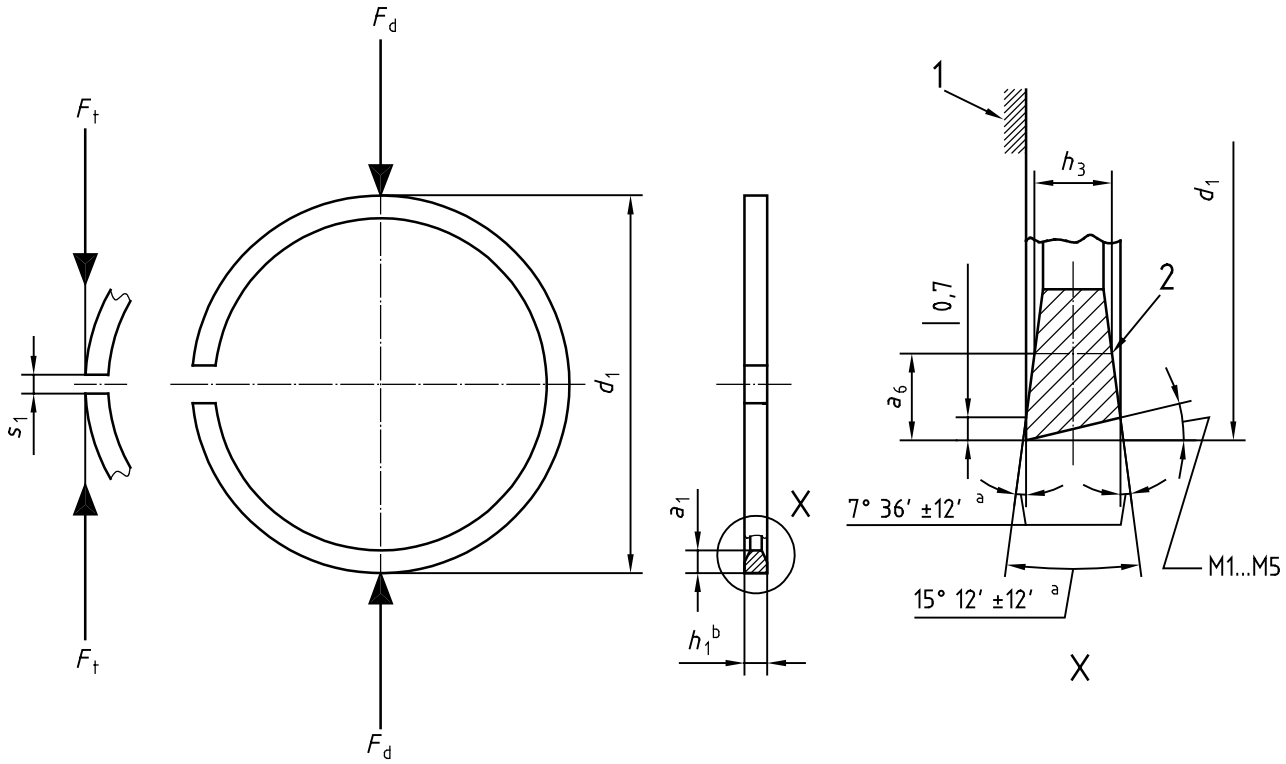
Piston ring ISO 6624-3 KBA - 90 × 2,5-MC66/NT070

4.8 Type KM — Taper faced keystone ring 15°

4.8.1 General features

See Table 3 for taper. See Table 13 for dimensions and forces.

Dimensions in millimetres



Key

1 Reference plane

2 Mark

a Due to manufacturing processing, side angle tolerances are not cumulative.

b Nominal.

Figure 8 — Type KM

4.8.2 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 (MC61), and having a fully faced chromium plated peripheral surface with a minimum thickness 0,1 mm (CR2):

Piston ring ISO 6624-3 KM1 - 90 × 2,5-MC61/CR2

5 Common features

5.1 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.

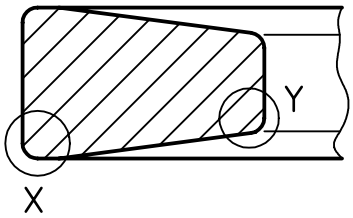


Figure 9 — Outside and inside rounded edges

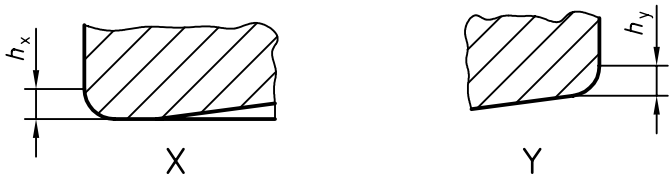


Figure 10 — Details of figure 9

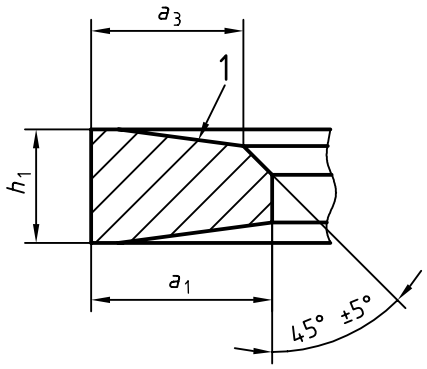
Table 4 — h_x and h_y dimensions

Dimensions in millimetres

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

5.2 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 13.



Key
1 Mark

Figure 11 — Internal bevel top side (IF)

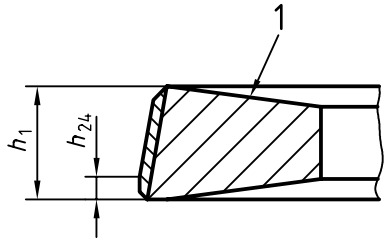
Table 5 — a_3 dimensions

Dimensions in millimetres

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

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

Taper M1 is excluded.



Key

1 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.		

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

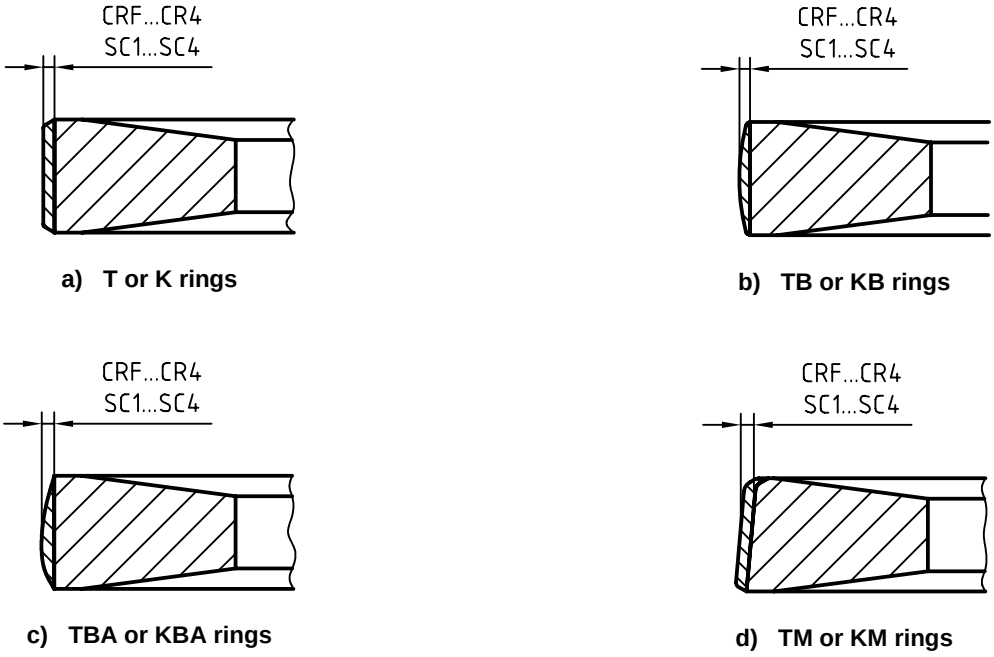
5.4.1 Chromium plated or spray coated rings

5.4.1.1 General

Semi-inlaid types are not recommended.

5.4.1.2 Fully faced

See Figure 13.



a) T or K rings

b) TB or KB rings

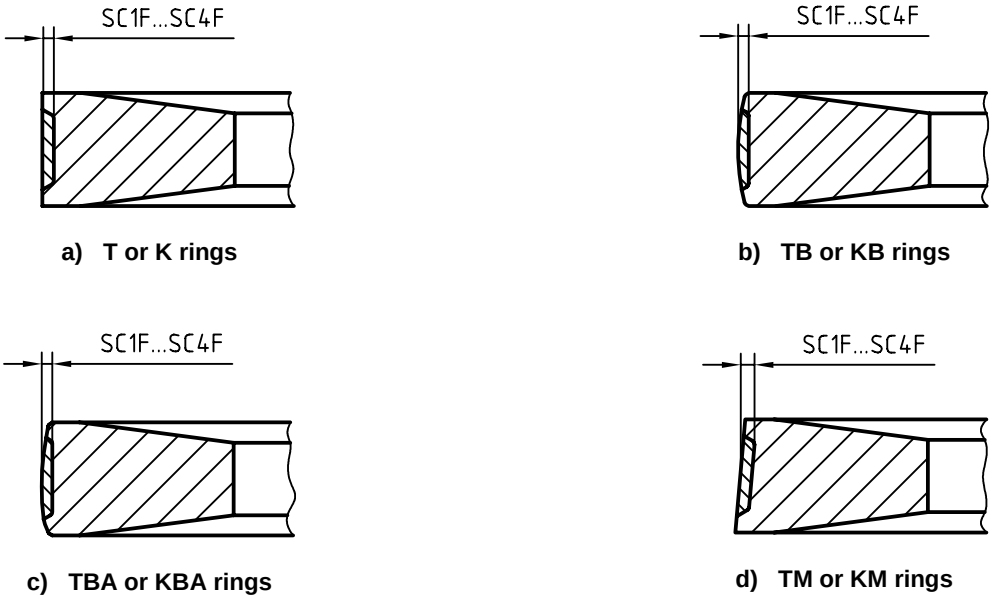
c) TBA or KBA rings

d) TM or KM rings

Figure 13 — Fully faced rings

5.4.1.3 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

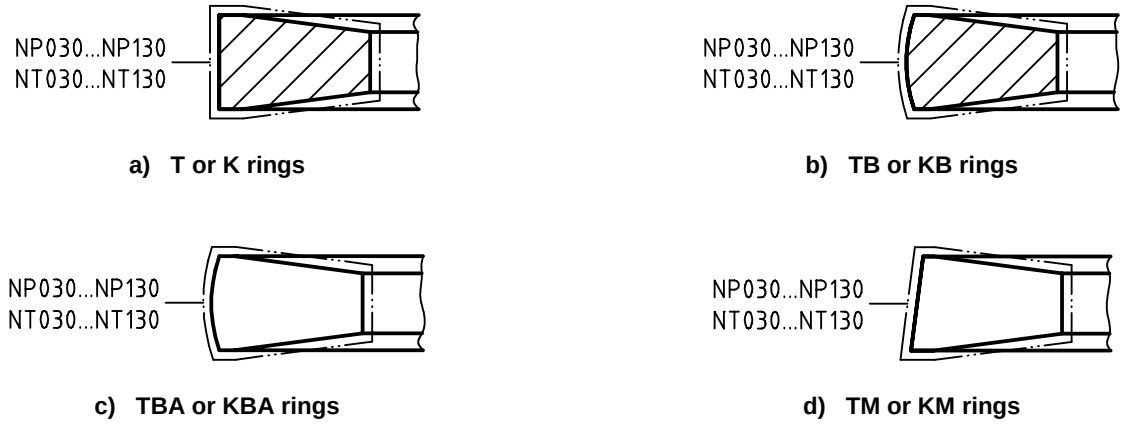
Table 7 — Plating / Coating thickness

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

5.4.2 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 Force Factors

The tangential and diametral forces given in Tables 12 and 13 shall be corrected when additional features are used.

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

For common features, the multiplier correction factors given in Tables 10 and 11 shall be used.

Table 10 — Force correction factors for chromium plated or spray coated 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 11 — Force correction factors for chromium plated, spray coated or nitrided T, TB, TBA, TM, K, KB, KBA and KM rings

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

Table 12 — 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													10,4	13,2		22,3	28,4	
71													10,3	13,1		22,0	28,1	
72	2,5										0,20	$^{+0,20}_{0}$	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													11,3	14,4		24,3	31,0	
76	2,7												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	
81	2,9	± 0,15											11,8	15,1		25,5	32,5	
82										For phos-phated PO surface: + 0,09 – 0,22			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 surface: + 0,010 – 0,024	For phos-phated PO surface: + 0,010 – 0,024						11,4	14,5		24,4	31,2	
85											0,25		13,0	16,6		27,9	35,7	
86		$0,15_{\text{max.}}$											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

Table 12 (*continued*)

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
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	$F_t \geqslant 10$ N	40,3	49,2	$F_d \geqslant 21,5$ N
106						For phos-	For phos-			For phos-			18,5	22,6		39,8	48,6	
107			2,5	3,0	2,0	phated PO	phated PO			phated PO			18,2	22,2		39,1	47,7	
108						surface:	surface:			surface:			20,7	25,3		44,5	54,4	
109						+ 0,010	+ 0,010			+ 0,09			20,3	24,8		43,6	53,2	
110	3,9	± 0,20				– 0,024	– 0,024			– 0,22			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	
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	

Table 12 (*continued*)

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
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												27,4	32,5	F_t < 10 N	59,0	69,9	F_d < 21,5 N
136						For phosphated PO	For phosphated PO			For phosphated PO		31,2	37,0		67,2	79,6	
137												30,7	36,4		66,0	78,2	
138	4,9					surface:	surface:			surface:		30,2	35,7		64,8	76,9	
139		± 0,20				+ 0,010	+ 0,010	2,71	3,21	+ 0,09	0,40	29,6	35,1		63,7	75,5	
140			3,0	3,5	2,5	– 0,024	– 0,024			– 0,22	$^{+0,25}_{0}$	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	$F_t \geqslant$ 10 N	69,7	82,7	$F_d \geqslant$ 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	
154												34,0	40,5		73,2	87,0	
155	5,5					For phosphated PO	For phosphated PO			For phosphated PO	0,50	33,4	39,7		71,8	85,3	
156											$^{+0,30}_{0}$	32,9	39,1		70,7	84,0	
157												32,2	38,3		69,3	82,3	
158						surface:	surface:			surface:		31,6	37,5		67,9	80,7	
159						+ 0,010	+ 0,010			+ 0,09		35,8	42,6		77,0	91,6	
160	5,7					– 0,029	– 0,029			– 0,27		35,0	41,6		75,2	89,4	

For intermediate sizes (e.g. repair sizes), the radial wall thickness of the next smaller nominal diameter should be applied.

NOTE 1 The values for F_t and F_d given in Table 12 apply to steel with a typical modulus of elasticity (E_n) of 210 GN/m². Multiplying factors are given in ISO 6621-4. Mean forces are calculated for nominal radial wall thickness (a_1) and mean trapezoidal ring width (h_3).

NOTE 2 For the sole purpose of this part of ISO 6624, the assumed average ratio F_d/F_t is 2,15.

NOTE 3 For measurement of keystone ring width see ISO 6621-2.

NOTE 4 Columns 1 and 2 of nominal value of ring width, h_1, are the basis for the two columns for h_3, method A and B, for F_t and F_d.

Table 13 — Dimensions of K, KB, KBA, KM keystone rings 15°

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	± 0,15 Within a ring: 0,15 max.	2,5	3,0	1,5	2,097 0 – 0,029 For phosphated PO surface: + 0,010 – 0,029	2,597 0 – 0,029 For phosphated PO surface: + 0,010 – 0,029	2,10	2,60	1,49 0 – 0,11 For phosphated PO surface: + 0,04 – 0,11	0,20	+0,20 0	11,9	14,7	± 30 % if F_t < 10 N	25,6	31,7	± 30 % if F_d < 21,5 N
71													11,8	14,6		25,3	31,3	
72													11,6	14,4		25,0	30,9	
73													11,5	14,2		24,7	30,6	
74	2,7												13,0	16,2		27,9	34,7	
75											0,25	+0,25 0	12,9	16,0	± 20 % if $F_t \geqslant$ 10 N	27,6	34,4	± 20 % if $F_d \geqslant$ 21,5 N
76													12,6	15,6		27,0	33,6	
77													12,3	15,3		26,4	32,9	
78													12,2	15,1		26,1	32,5	
79	2,9												13,6	17,0		29,3	36,6	
80													13,5	16,8		29,0	36,2	
81													13,4	16,7		28,7	35,8	
82													13,2	16,5		28,4	35,5	
83													13,1	16,3		28,2	35,1	
84													12,8	16,0		27,6	34,4	
85	3,1												14,5	18,2		31,3	39,1	
86													14,4	18,0		31,0	38,7	
87													14,1	17,7		30,4	38,0	
88													14,0	17,5		30,1	37,6	
89													13,7	17,2		29,5	36,9	
90	3,3										0,30		13,6	17,0		29,2	36,6	
91													15,4	19,3		33,0	41,4	
92													15,0	18,8		32,3	40,5	
93													14,8	18,5		31,8	39,9	
94													14,4	18,1		31,0	39,0	
95	3,5												14,1	17,7		30,3	38,0	
96													15,9	20,0		34,2	43,1	
97													15,7	19,8		33,7	42,5	
98													15,5	19,5		33,2	41,9	
99													15,2	19,2		32,8	41,3	

Table 13 (*continued*)

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
100													18,8	22,7		40,5	48,8	
101													18,6	22,4		40,0	48,2	
102													21,1	25,5		45,3	54,7	
103						2,463	2,963			2,05			20,7	25,0		44,5	53,8	
104	3,7					0	0			0			20,5	24,7		44,0	53,2	
105						– 0,034	– 0,034	2,45	2,95	– 0,13			20,1	24,3		43,2	52,2	
106													19,9	24,0		42,7	51,6	
107						For phosphated surface:	For phosphated surface:			For phosphated surface:			19,5	23,5		41,9	50,6	
108													22,0	26,7		47,4	57,4	
109													21,5	26,1		46,3	56,1	
110	3,9	± 0,20	3,0	3,5	2,0	+ 0,010	+ 0,010			+ 0,04			21,1	25,5		45,3	54,9	
111		Within				– 0,034	– 0,034			– 0,13			20,6	24,9		44,3	53,6	
112		a ring:											20,1	24,3		43,2	52,3	
113		$0{,}20_{\text{max.}}$											22,7	27,6		48,8	59,3	
114													22,4	27,2		48,2	58,5	
115	4,1										$^{+0,25}_{0}$		22,1	26,8		47,4	57,5	
116													21,7	26,3		46,6	56,5	
117													21,3	25,8		45,8	55,6	
118												0,35	20,9	25,4		44,9	54,6	
119													23,7	28,8		50,9	61,9	
120													23,3	28,3		50,0	60,9	
121													22,9	27,9		49,2	59,9	
122	4,3												22,5	27,4		48,4	58,9	
123													22,1	27,0		47,6	57,9	
124													21,8	26,5		46,8	57,0	
125													30,0	35,3		64,4	76,0	
126													29,3	34,5		63,0	74,3	
127	4,5											0,35	28,6	33,7		61,5	72,5	
128													27,9	32,9		60,0	70,8	
129													27,2	32,1		58,6	69,1	

Table 13 (*continued*)

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
130													30,8	36,4		66,2	78,2	
131													30,3	35,8		65,2	77,0	
132	4,7					2,830	3,330			2,61			29,8	35,2		64,0	75,6	
133						0	0			0			29,3	34,6		63,0	74,5	
134						– 0,034	– 0,034			– 0,13			28,8	34,0	± 30 % if	61,8	73,0	± 30 % if
135													28,2	33,3	$F_t < 10$ N	60,6	71,6	$F_d < 21,5$ N
136						For phos-	For phos-			For phos-			31,9	37,7		68,5	81,2	
137						phated PO	phated PO			phated PO			31,3	37,1		67,4	79,7	
138	4,9					surface:	surface:			surface:			30,8	36,4		66,2	78,3	
139		± 0,20				+ 0,010	+ 0,010	2,80	3,30	+ 0,04	0,40	$^{+0,25}_{0}$	30,2	35,8		65,0	76,9	
140			3,5	4,0	2,5	– 0,034	– 0,034			– 0,13			29,7	35,1	± 20 % if	63,8	75,5	± 20 % if
141													29,1	34,5	$F_t \geqslant 10$ N	62,6	74,1	$F_d \geqslant 21,5$ N
142		Within											32,8	39,0		70,6	83,8	
143		a ring:											32,3	38,3		69,4	82,4	
144	5,1	0,20 max.											31,7	37,7		68,3	81,0	
145													31,2	37,0		67,1	79,6	
146													30,6	36,4		65,9	78,2	
147													30,0	35,6		64,5	76,5	
148													33,9	40,3		72,9	86,6	
149													33,1	39,4		71,2	84,7	
150	5,3												32,4	38,5		69,6	82,7	
151													31,5	37,4		67,7	80,5	
152													30,7	36,5		66,1	78,6	
153													34,7	41,3		74,6	88,8	
154													34,0	40,5		73,2	87,2	
155	5,5											$^{+0,30}_{0}$	33,4	39,8		71,8	85,5	
156											0,50		32,9	39,1		70,6	84,1	
157													32,2	38,4		69,2	82,5	
158													31,6	37,6		67,9	80,8	
159													35,5	42,4		76,4	91,2	
160	5,7												34,7	41,4		74,6	89,1	

For intermediate sizes (e.g. repair sizes), the radial wall thickness of the next smaller nominal diameter should be applied.

NOTE 1 The values for F_t and F_d given in Table 13 apply to steel with a typical modulus of elasticity (E_n) of 210 GN/m^2. Multiplying factors are given in ISO 6621-4. Mean forces are calculated for nominal radial wall thickness (a_1) and mean trapezoidal ring width (h_3).

NOTE 2 For the sole purpose of this part of ISO 6624, the assumed average ratio F_d/F_t is 2,15.

NOTE 3 For measurement of keystone ring width see ISO 6621-2 item 3.2.1.

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7) To be published.

ICS 43.060.10

Price based on 23 pages