INTERNATIONAL STANDARD

ISO 6627

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Internal combustion engines — Piston rings — Expander/segment oil-control rings

Moteurs à combustion interne — Segments de piston — Segments racleurs régulateurs d'huile/expandeurs

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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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6627 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

Introduction

ISO 6627 is one of a series of International Standards dealing with piston rings for reciprocating internal combustion engines. Others are ISO 6621, ISO 6622, ISO 6623; ISO 6624, ISO 6625 and ISO 6626 (see clause 2 and the bibliography).

The common features and dimensional tables included in ISO 6627 represent a broad range of variables. In selecting a ring type, the designer will above all need to consider the particular operating conditions. Moreover, it is essential that the designer refer to the specifications and requirements of ISO 6621-3 and ISO 6621-4 before completing the selection.

Internal combustion engines — Piston rings — Expander/segment oil-control rings

1 Scope

This International Standard specifies the essential dimensional features of expander/segment oil-control rings, without providing a complete product description (because expander-spacer design varies from piston-ring manufacturer to piston-ring manufacturer, the interaction between the manufacturer and the client will determine specific design details).

This International Standard applies to expander/segment oil-control rings of nominal diameters ranging from 40 mm to 125 mm for reciprocating internal combustion engines. It also applies to piston rings for compressors working under analogous conditions.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents 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 6621-2, *Internal combustion engines — Piston rings — Part 2: Inspection measuring principles.*

ISO 6621-3, *Internal combustion engines — Piston rings — Part 3: Material specifications*.

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

ISO 6626, *Internal combustion engines — Piston rings — Coil-spring-loaded oil control rings.*

3 Symbols and abbreviated terms

For the purposes of this International Standard, the symbols and abbreviated terms in Table 1 apply.

Table 1 — Symbols and abbreviations

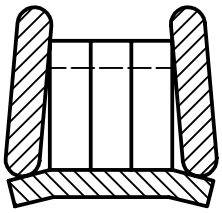
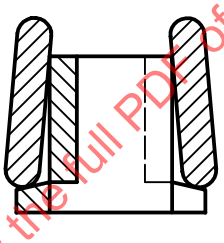
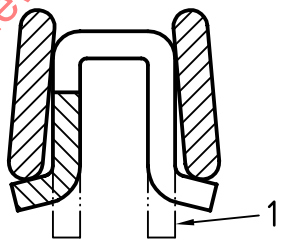
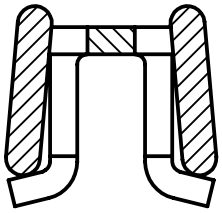
Symbol Abbreviation	Description
a_1	Segment radial wall thickness
a_8	Spacer radial thickness
a_9	Expander radial thickness
a_{11}	Assembly radial thickness
a_{14}	Seating tab height
d_1	Nominal ring assembly diameter (nominal diameter)
h_1	Nominal assembly width
h_9	Expander width
h_{10}	Segment width near inside diameter (ID), after coiling
h_{11}	Segment width near outside diameter (OD), after coiling and surface treatment or plating
h_{12}	Nominal segment width
h_{13}	Spacer width
p_o	Nominal contact pressure
p_{ou}	Unit contact pressure
s_1	Segment closed gap; stagger gap
F_t	Tangential force
F_{tc}	Specific tangential force
θ	Nominal seating tab angle
CR1...CR3	Chromium-plating thickness
ES1...ES4	Types of expander/segment oil-control rings
PNH	High nominal pressure
PNL	Low nominal pressure
PNM	Medium nominal pressure
PNR	Reduced nominal pressure
PNV	Very high nominal pressure
NS010-NS050	Nitrided surface (segment)
NX	Nitrided surface (expander-spacer)

4 Ring types and designations

4.1 Types of expander/segment oil-control rings

The more common designs (expander-spacers, segments and corresponding assemblies) in general use are shown in Figure 1.

NOTE The designations of design types ES3 and ES4 are different to the designations for those types given in ISO/TR 6627:1992.

ES1	
ES2	
ES3	
ES4	

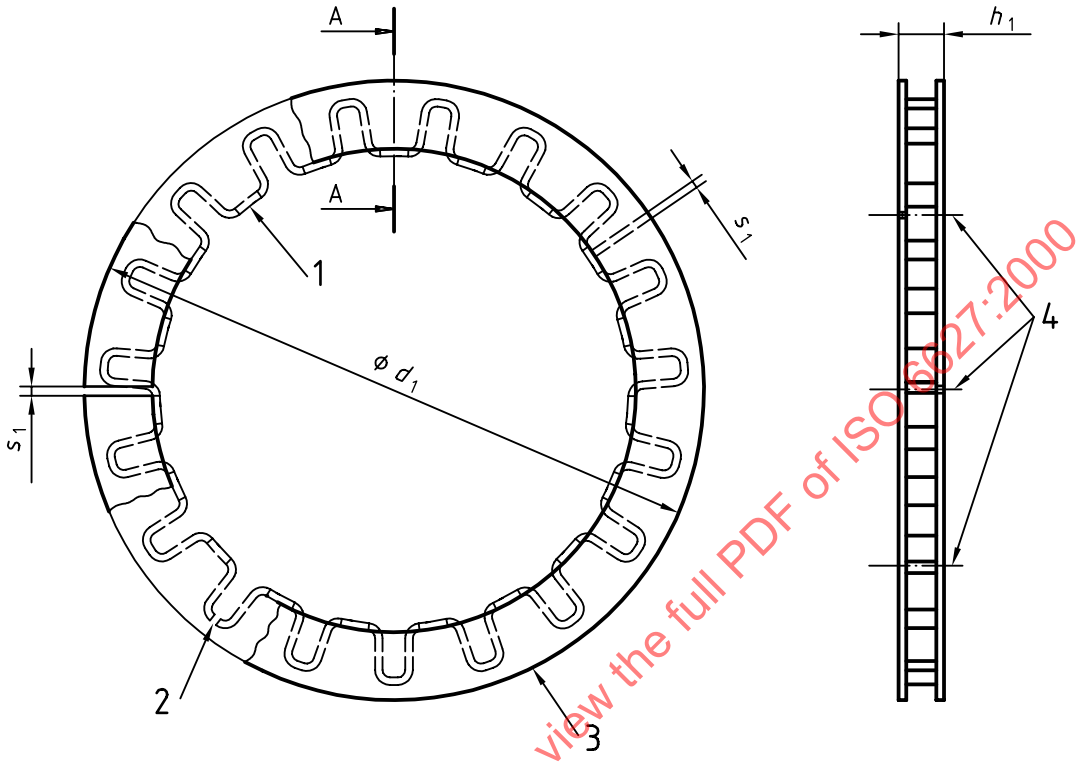
Key

1 Centring pad (optional)

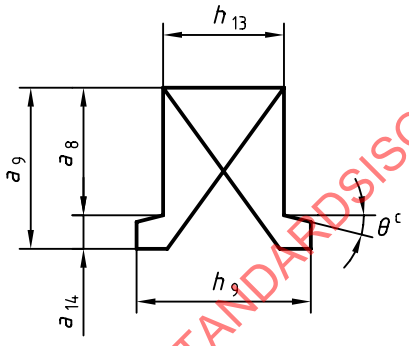
Figure 1 — Expander/segment oil-control ring designs

4.2 General features

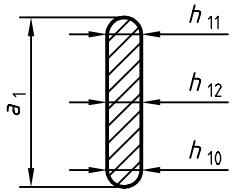
The expander/segment assembly shall be in accordance with Figure 2.



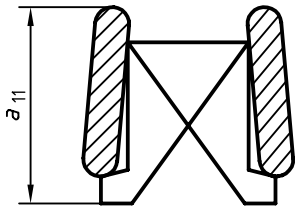
a) Assembly



b) Expander-spacer



c) Segment



d) Section A-A

Key

1 Seating tab
2 Expander-spacer ends
3 Peripheral surface
4 Stagger segments gaps and expander ends (all three components)[a, b]

a Stagger angle should be larger than 30°.
b For assembly arrangement regarding tangential force, see ISO 6621-2.
c Seating tab angle dimensions are defined in Table 2.

Figure 2 — Expander/segment assembly

4.3 Designation examples

The following are examples of piston ring designations in accordance with this International Standard.

EXAMPLE 1 Expander/segment oil-control ring type ES1 (ES1) of nominal diameter d_1 = 90 mm (90) and nominal assembly width h_1 = 3 mm (3), with segments made of unalloyed steel subclass 68 (MC68), a chromium-plated peripheral surface of minimum thickness 0,05 mm (CR1), and with an expander made of 16 % Cr (min.) austenitic steel, of material subclass 67 (MC67) and tangential force, F_t, according to the medium nominal contact pressure class (PNM):

Piston ring ISO 6627 ES1-90 × 3-MC68/CR1-MC67/PNM

EXAMPLE 2 Expander/segment oil-control ring type ES2 (ES2) of nominal diameter d_1 = 90 mm (90) and nominal assembly width h_1 = 2,5 mm (2,5), with segments made of 11 % Cr (min.) martensitic steel, subclass 65 (MC65), nitrided on the peripheral and inside surfaces (NS020) to a minimum depth of 0,020 mm on the peripheral surface, and with an expander made of 16 % Cr (min.) austenitic steel, of material subclass 67 (MC67), nitrided on the surface (NX), and tangential force, F_t, according to the reduced nominal contact pressure class (PNR):

Piston ring ISO 6627 ES2-90 × 2,5-MC65/NS020-MC67/NXPNR

5 Common features

5.1 Expander-spacer

5.1.1 Design considerations

In order to optimize the fit of the oil ring assembly into the engine cylinder bore, the following should be considered in the design of the expander/segment oil-control rings:

— total circumferential deflection of the expander;

— piston groove depth;

— features on the lands adjacent to the oil ring groove;

— groove-corner radius.

5.1.2 Without surface treatment

The expander-spacer lacking surface treatment is typically used together with chromium-plated segments (see 5.2.1).

5.1.3 Nitrided surface (NX)

The expander-spacer with a nitrided surface is typically used together with nitrided segments (see 5.2.2).

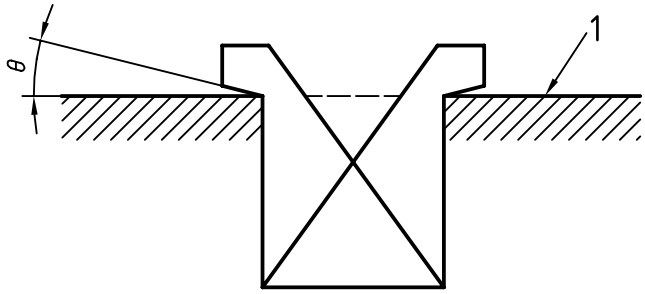
In respect of the nitriding case depth of nitrided expander-spacers, the minimum case depth shall be 0,003 mm, while the appropriate tolerance is $^{+0,012}_{0}$ mm.

NOTE 1 The specification for NX applies at all areas of contact between the expander-spacer and the segments.

NOTE 2 For the definition of nitriding case depth, see ISO 6621-2.

5.1.4 Seating tab angle

The expander-spacer is usually designed with the seating tabs at a slight angle. This results in side sealing between the segment and the side of the piston groove (see Figure 3).



Key

1 Reference plane

Figure 3 — Expander-spacer seating tab angle

The nominal seating angle shown in Figure 3 is defined as the minimum angle. The value of the nominal seating angle will depend on the expander-spacer design. The lowest nominal seating angle is 0° for expander-spacer type ES2. All other expander-spacer types shall have a nominal seating angle $\geqslant$ 5° (see Table 2).

Table 2 — Seating tab angle

Values in degrees

Type	Seating tab angle	
	θ	Tolerance
ES1, ES3, ES4	$\geqslant$ 5	$^{+10}_{0}$
ES2	$\geqslant$ 0	$^{+8}_{0}$

5.1.5 Expander-spacer dimensions

No values are given for features a_8, a_9 , a_{14}, h_9 and h_{13} (see Figure 2), as these dimensions depend on the expander-spacer design and shall be defined by the manufacturer.

5.2 Segment features

5.2.1 Chromium-plated peripheral surface

The common features of a chromium-plated segment are shown in Figure 4, with chromium-plating thicknesses given in Table 3.

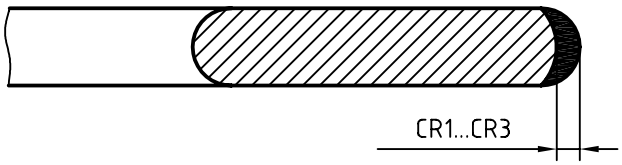


Figure 4 — Chromium-plated segment

Table 3 — Chromium-plating thicknesses

Code	Thickness min. mm
CR1	0,05
CR2	0,10
CR3	0,15

5.2.2 Nitrided surface codes NS010 to NS050

The common features of a nitrided segment are shown in Figure 5. The nitriding case depth (NS010 to NS050) is specified according to its reference to the peripheral surface, inside surface or the sides of the segment (see Table 4).

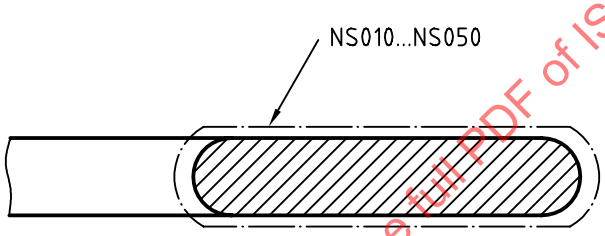


Figure 5 — Nitrided segment

Table 4 — Nitrided case depth

Dimensions in millimetres

Code	Nitrided case depth[a]		
	Peripheral surface min.	Inside surface min.	Side faces
NS010	0,010	0,005	nitrided surface permissible
NS020	0,020	0,005	
NS030	0,030	0,010	
NS050	0,050	0,020	

[a] For tolerances, see ISO 6621-4.

5.2.3 Segment dimensions

The nominal segment width (h_{12}) is defined as the width at the mid-point of the segment radial-wall thickness. The segment width defined near the internal diameter of the segment (h_{10}) and the outside diameter (h_{11}) is shown in Figure 6, while typical values are given in Table 5.

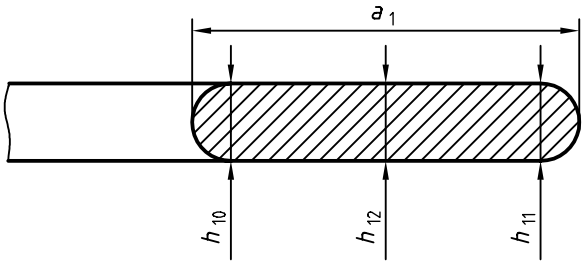


Figure 6 — Segment width

Table 5 — Segment width

Dimensions in millimetres

Segment width	Plated segment width max.		Nitrided segment width max.	
h_{12}	h_{10}	h_{11}	h_{10}	h_{11}
0,4	0,44	0,46	0,47	0,45
0,45	0,49	0,51	0,52	0,5
0,5	0,54	0,56	0,57	0,55
0,6	0,64	0,66	0,67	0,65

The radial wall thickness of the segment will vary in accordance with the expander-spacer design. Common ratios d_1/a_1 are between 40 and 20, approximately.

The common tolerance for the radial wall thickness (a_1) of the nitrided segments, and the chromium-plated segments CR1 and CR2, is ± 0,08 mm; it is ± 0,12 mm for CR3.

5.3 Expander/segment assembly

The nominal expander/segment assembly width (h_1) is shown in Table 6 with the specific tangential force (F_{tc}).

The radial thickness of the selected assembly (a_{11}) depends on its design (expander and segments) and shall be defined by the manufacturer.

6 Dimensions

Table 6 — Dimensions of expander/segment oil-control rings

Dimensions in millimetres

Nominal diameter d_1	Segment width h_{12} (Column)				Segment closed gap s_1		Specific tangential force F_{tc}[N] (ρ_{ou} = 1 N/mm²) (Column)					Nominal assembly width h_1 (using available h_{12}) (Column)				
	1	2	3	4		Tolerance	1	2	3	4	Tolerance	1-3	1-3	1-4	1-4	4
40							16,0	18,0	20,0							
41							16,4	18,4	20,5							
42							16,8	18,9	21,0							
43							17,2	19,3	21,5							
44							17,6	19,8	22,0							
45							18,0	20,2	22,5							
46							18,4	20,7	23,0							
47							18,8	21,1	23,5							
48							19,2	21,6	24,0							
49					0,15	+0,50 0	19,6	22,0	24,5	—					—	—
50							20,0	22,5	25,0							
51							20,4	22,9	25,5							
52							20,8	23,4	26,0							
53							21,2	23,8	26,5							
54							21,6	24,3	27,0							
55							22,0	24,7	27,5							
56							22,4	25,2	28,0							
57							22,8	25,6	28,5							
58							23,2	26,1	29,0							
59							23,6	26,5	29,5							
60							24,0	27,0	30,0	36,0						
61							24,4	27,4	30,5	36,6						
62							24,8	27,9	31,0	37,2						
63							25,2	28,3	31,5	37,8	± 30 % if F_{tc} < 30 N					
64							25,6	28,8	32,0	38,4						
65							26,0	29,2	32,5	39,0	± 20 % if F_{tc} ⩽ 30 N					
66							26,4	29,7	33,0	39,6						
67					0,20		26,8	30,1	33,5	40,2						
68							27,2	30,6	34,0	40,8						
69							27,6	31,0	34,5	41,4						
70							28,0	31,5	35,0	42,0						
71							28,4	31,9	35,5	42,6						
72							28,8	32,4	36,0	43,2						
73							29,2	32,8	36,5	43,8						
74							29,6	33,3	37,0	44,4						
75						+0,75 0	30,0	33,7	37,5	45,0					4,0	4,75
76							30,4	34,2	38,0	45,6						
77							30,8	34,6	38,5	46,2						
78							31,2	35,1	39,0	46,8						
79							31,6	35,5	39,5	47,4						
80							32,0	36,0	40,0	48,0						
81							32,4	36,4	40,5	48,6						
82					0,25		32,8	36,9	41,0	49,2						
83							33,2	37,3	41,5	49,8						
84							33,6	37,8	42,0	50,4						
85							34,0	38,2	42,5	51,0						
86							34,4	38,7	43,0	51,6						
87							34,8	39,1	43,5	52,2						
88							35,2	39,6	44,0	52,8						
89							35,6	40,0	44,5	53,4						
	0,40	0,45	0,50	0,60								2,5	3,0	3,5		

Table 6 (*continued*)

Nominal diameter d_1	Segment width h_{12} (Column)				Segment closed gap s_1		Specific tangential force F_{tc}[N] (ρ_{ou} = 1 N/mm^2) (Column)					Nominal assembly width h_1 (using available h_{12}) (Column)				
	1	2	3	4		Tolerance	1	2	3	4	Tolerance	1-3	1-3	1-4	1-4	4
90							36,0	40,5	45,0	54,0						
91							36,4	40,9	45,5	54,6						
92							36,8	41,4	46,0	55,2						
93							37,2	41,8	46,5	55,8						
94							37,8	42,3	47,0	56,4						
95							38,0	42,7	47,5	57,0						
96							38,4	43,2	48,0	57,6						
97							38,8	43,6	48,5	58,2						
98							39,2	44,1	49,0	58,8						
99					0,30		39,6	44,5	49,5	59,4		2,5				
100							40,0	45,0	50,0	60,0						
101							40,4	45,4	50,5	60,6						
102							40,8	45,9	51,0	61,2						
103							41,2	46,3	51,5	61,8						
104							41,6	46,8	52,0	62,4						
105							42,0	47,2	52,5	63,0						
106							42,4	47,7	53,0	63,6	± 30 % if F_{tc} < 30 N					
107	0,40	0,45	0,50	0,60		+0,75 0	42,8	48,1	53,5	64,2	± 20 % if F_{tc} ⩽ 30 N		3,0	3,5	4,0	4,75
108							43,2	48,6	54,0	64,8						
109							43,8	49,0	54,5	65,4						
110							44,0	49,5	55,0	66,0						
111							44,4	49,9	55,5	66,6						
112							44,8	50,4	56,0	67,2						
113							45,2	50,8	56,5	67,8						
114							45,8	51,3	57,0	68,4						
115							46,0	51,7	57,5	69,0						
116							46,4	52,2	58,0	69,6						
117							46,8	52,6	58,5	70,2						
118					0,35		47,2	53,1	59,0	70,8		—				
119							47,8	53,5	59,5	71,4						
120							48,0	54,0	60,0	72,0						
121							48,4	54,4	60,5	72,6						
122							48,8	54,9	61,0	73,2						
123							49,2	55,3	61,5	73,8						
124							49,6	55,8	62,0	74,4						
125							50,0	56,2	62,5	75,0						

NOTE The specified F_{tc} values apply to oil ring assemblies which are evaluated with segments with mean radial wall thickness. Appropriate F_{tc} values for assemblies which are evaluated with segments of any radial wall thickness (within the specification) must be determined by manufacturer and client. In this case, careful consideration is to be given to the manufacturer's process capability in respect of expander load, expander deflection, and segment radial wall thickness. In lieu of relevant information on the manufacturer's capability, a tolerance of ± 40 % for F_{tc} < 30 N or a tolerance of ± 30 % for F_{tc} ⩾ 30 N is applicable.