International Standard 6621/2

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Internal combustion engines — Piston rings — Part 2: Inspection measuring principles

Moteurs à combustion interne — Segments de piston — Partie 2: Principes de mesure pour inspection

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Descriptors : internal combustion engines, piston rings, inspection, dimensional measurement, specifications.

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

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It has been approved by the member bodies of the following countries :

Australia	Germany, F.R.	Poland
Austria	Hungary	Romania
Belgium	Iran	Spain
Brazil	Italy	Sweden
Bulgaria	Japan	Switzerland
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France	New Zealand	

No member body expressed disapproval of the document.

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Internal combustion engines — Piston rings — Part 2: Inspection measuring principles

0 Introduction

ISO 6621 is one of a series of International Standards being prepared that deal with piston rings for reciprocating internal combustion engines:

ISO 6621, *Internal combustion engines — Piston rings —*

Part 1: Vocabulary.

Part 2: Measuring principles.

Part 3: Material specifications.

Part 4: General specifications.

Part 5: Quality requirements.

ISO 6622, *Internal combustion engines — Piston rings —*

Part 1: Rectangular rings.

Part 2: Rectangular rings with narrow ring width.

ISO 6623, *Internal combustion engines — Piston rings — Scraper rings.*

ISO 6624, *Internal combustion engines — Piston rings —*

Part 1: Keystone rings.

Part 2: Half keystone rings.

ISO 6625, *Internal combustion engines — Piston rings — Oil control rings.*

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

1 Scope and field of application

This part of ISO 6621 defines the measuring principles to be used for measuring piston rings; it applies to piston rings up to and including 200 mm diameter for reciprocating internal combustion piston engines.

This part of ISO 6621 may be used for piston rings for compressors working under analogous conditions.

2 References

ISO 468, *Surface roughness — Parameters, their values and general rules for specifying requirements.*

ISO 1302, *Technical drawings — Methods of indicating surface texture on drawings.*

ISO 6624/1, *Internal combustion engines — Piston rings — Part 1: Keystone rings.* [1]

1) At present at the stage of draft.

3 Measuring principles

3.1 General measuring conditions

The following general notes are applicable to all measuring principles unless otherwise specified:

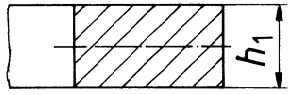
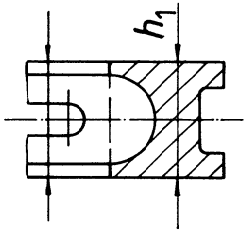
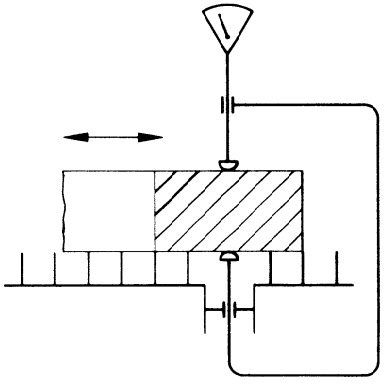
a) the ring shall rest on the datum surface in the free or open condition. No additional force shall be applied to load the ring on the datum surface;

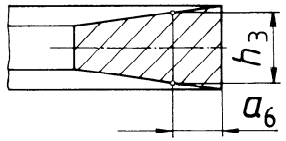
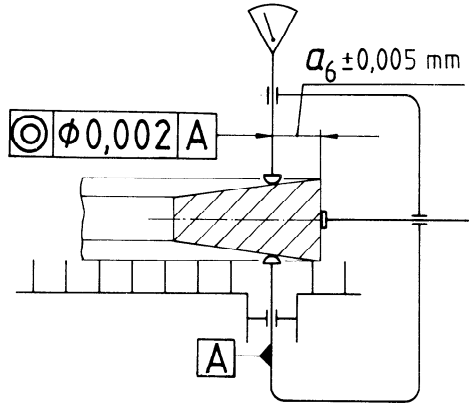
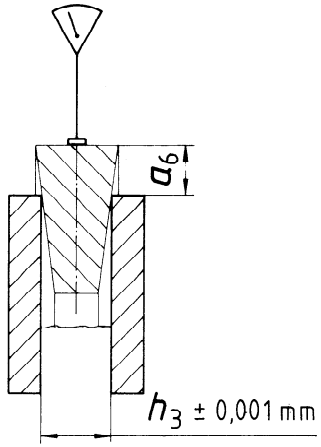
b) certain measurements are made with the ring in the closed condition in a gauge of nominal cylinder bore diameter. When orientated rings are measured in this way, they shall be so placed that the top is towards the datum surface;

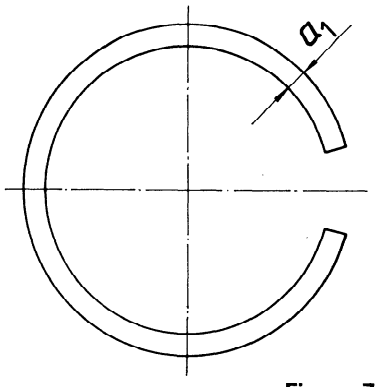
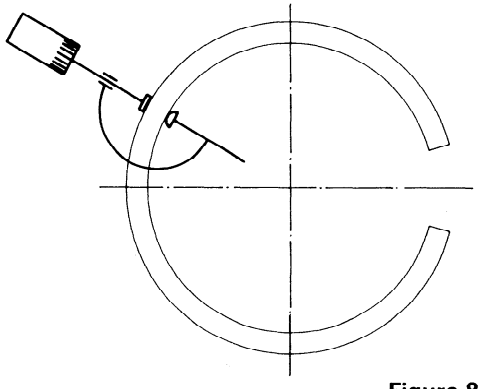
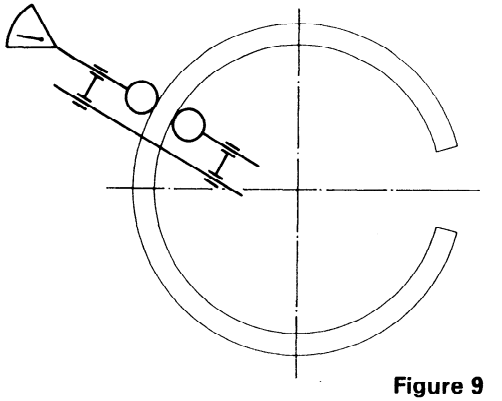
c) measurements shall be made using instruments with a resolution not to exceed 10 % of the tolerance of the dimension being measured.

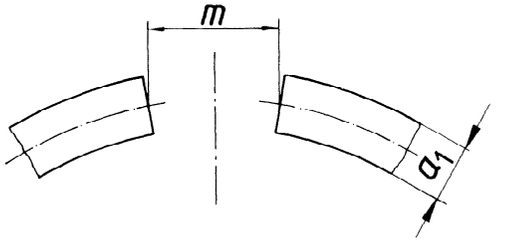
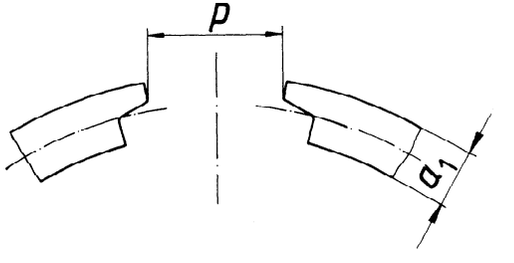
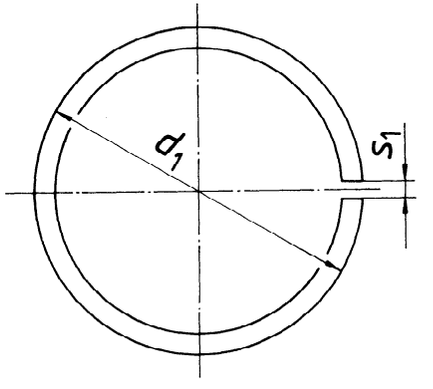
3.2 Characteristics and measuring principles

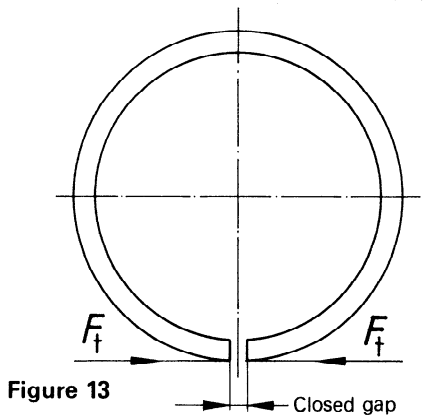
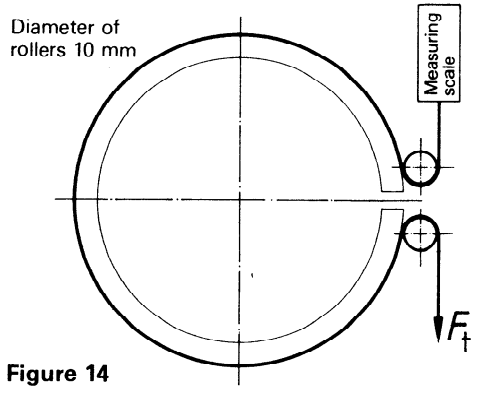
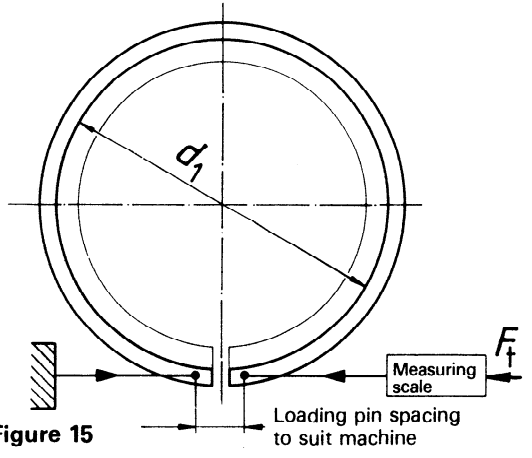
Sub-clause	Characteristics of the ring	Symbol
	Principal characteristics of the ring	
3.2.1	Ring width	
	a) parallel sided rings	h_1
	b) keystone rings	h_3, a_6
3.2.2	Radial wall thickness	a_1
3.2.3	Total free gap	m, p
3.2.4	Closed gap	s_1
3.2.5	Tangential force	F_t
3.2.6	Diametral force	F_d
	Characteristics of ring shape	
3.2.7	Ovality or circularity	U
3.2.8	Point deflection	W
3.2.9	Light tightness	—
	Associated with peripheral surface	
3.2.10	Taper on periphery	—
3.2.11	Barrel on periphery	t_2, t_3
3.2.12	Land width	h_4, h_5
3.2.13	Land offset	—
3.2.14	Coating/inlay thickness	—
	Associated with sides	
3.2.15	Keystone angle	—
3.2.16	Obliqueness	—
3.2.17	Twist	—
3.2.18	Unevenness	Te_r, Te_u
	Other	
3.2.19	Wind (axial displacement of butt ends)	—
3.2.20	Free flatness	—
3.2.21	Surface roughness	R_a, R_z

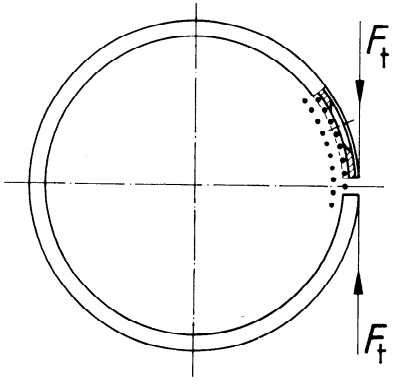
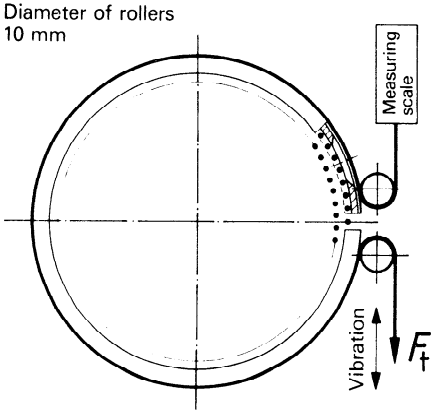
Term	Definition	Measuring principles	Illustration of measuring principles
3.2.1 Ring width (in millimetres) a) Parallel sided rings, h_1	The distance between the sides, at any particular point perpendicular to the datum surface (see figures 1 and 2).	Measure with spherical measuring probes each of radius 1,5 ± 0,05 mm, exerting a measuring force of approximately 1 N (see figure 3). In the case of slotted oil rings, the measurement shall be made between the slots and not across them (see figure 2).	 Figure 1  Figure 2  Figure 3

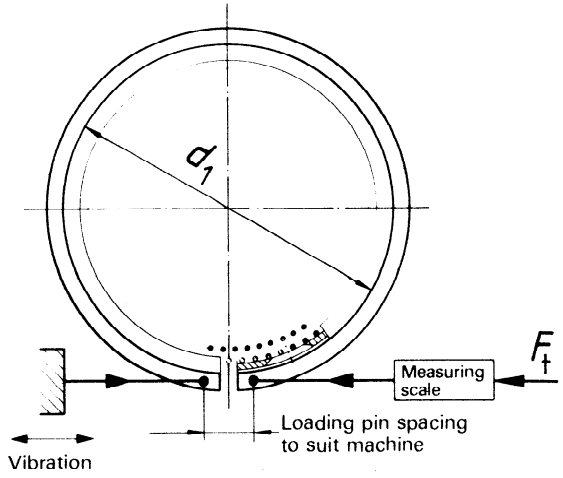
Term	Definition	Measuring principles	Illustration of measuring principles
b) Keystone rings, h_3	The distance between the sides at a specified distance a_6 from the peripheral surface (see figure 4).	a) Method A This method determines h_3 (see figure 4) for a specified value of a_6. Measure with spherical measuring probes each of radius 1,5 ± 0,05 mm exerting a measuring force of approximately 1 N (see figure 5). If the measuring equipment is set up with parallel gauges instead of keystone gauges the use of spherical measuring probes will give rise to an error as follows : for 6° keystone angle : 0,004 mm for 15° keystone angle : 0,026 mm. To obtain the correct measured width of the keystone ring the above values shall be deducted from the measured values. Values of a_6 are given in ISO 6624/1. b) Method B This method determines a_6 for a specified width h_3 (see figure 4). Measure with a flat face probe exerting a measuring force of approximately 1 N. The ring shall be placed between two sharp edged circular discs which are spaced apart at the specified gauge width h_3 (see figure 6). Values of h_3 are given in ISO 6624/1.	 Figure 4  Figure 5  Figure 6

Term	Definition	Measuring principles	Illustration of measuring principles
3.2.2 Radial wall thickness, a_1 (in millimetres)	The radial distance between the periphery and the bore of the ring (see figure 7).	a) Measure radially between a flat measuring surface on the periphery and a spherical measuring surface of radius approximately 4 mm on the bore, and using a measuring force of 3 to 10 N (see figure 8). b) Measure radially between cylindrical inserts or rollers of radius approximately 4 mm and with a measuring force of 3 to 10 N. The length of the rollers shall be greater than the ring width (see figure 9).	 **Figure 7**  **Figure 8**  **Figure 9**

Term	Definition	Measuring principles	Illustration of measuring principles
3.2.3 Total free gap m, p (in millimetres)	The chordal distance between the butt ends of the ring in a free unstressed state, measured at the centre line of the radial wall thickness (see figure 10). For rings with an internal notch for a peg, the total free gap is defined by the chordal distance marked as p in figure 11.	Measure with a steel rule to the nearest 0,25 mm	 **Figure 10**  **Figure 11**
3.2.4 Closed gap, s_1 (in millimetres)	The gap at the butt ends of the ring, measured at the narrowest point of the gap, which the ring would have when fitted in a gauge of nominal cylinder bore size (see figure 12). The closed gap s_1 is related to the nominal diameter d_1.	Measure in a bore gauge of nominal diameter using a wedge gauge or feeler gauges and using a measuring force of approximately 1 N (see figure 12). The diameter of the bore gauge shall comply with the following deviations from the nominal ring diameter : Tolerance : $^{+\,0,001}_{0}\ d_1$ Correction shall be made for any deviation of the bore gauge from the nominal ring diameter.	 **Figure 12**

Term	Definition	Measuring principles	Illustration of measuring principles
3.2.5 Tangential force, F_t (in newtons) a) For single-piece rings	The force necessary to maintain the ring at the closed gap condition by means of a tangential pull on the ends of a circumferential metal tape or hoop (see figure 13).	a) Tape method (see figure 14) The encircling steel tape of thickness 0,08 to 0,10 mm is carried round 10 mm diameter rollers set 20 mm apart (see figure 14). In tightening the tape, the ring is closed to the point where the butt ends touch and then opened to the closed gap dimension previously measured. The ring force is then read off from the precision measuring scale. The gap of the ring shall be symmetrically disposed between the rollers. b) Hoop method (see figure 15) The ring is placed in a correctly sized hoop with its gap aligned to the gap of the hoop. The hoop is then closed in a precision loading machine until the loading pins are at a predetermined distance apart at which point the hoop is precisely at the cylinder bore diameter appropriate to the ring (see figure 15). The force is then read off from the display.	 **Figure 13**  **Figure 14**  **Figure 15**

Term	Definition	Measuring principles	Illustration of measuring principles
b) For multi-piece rings	The force which is necessary to maintain the ring at the closed gap condition by means of a tangential pull on the ends of a circumferential metal tape or hoop whilst vibrating the butt ends of the ring [see figure 13a)].	For the measurement of coil spring loaded rings or similar rings where the spring is supported in the bore of the ring, the gap of the spring shall be positioned at 180° to the gap of the cast iron part. For the measurement of multi-piece steel rail oil control rings, the ring assembly shall be mounted in a carrier simulating the ring groove. The gap of the spring element is placed at 180° to the gap of the rails, both of which shall be in line. For the measurement of a ring provided with a wavy spring, or other spring which is groove root supported, the ring assembly shall be mounted in a carrier simulating the groove, the root diameter of which is equal to the mean diameter of the piston ring groove in which the ring will be used. Tolerance on carrier root diameter ± 0,02 mm. The gap of the wavy spring shall be at 180° to the gap of the cast iron part. a) Tape method Identical procedures are used as for single piece rings but an appropriate vibration shall be applied to the tape loading mechanism to relieve forces of friction [see figure 14a)]. A suitable level is 40 to 50 Hz at an amplitude of 0,15 mm.	 **Figure 13a)**  **Figure 14a)**

Term	Definition	Measuring principles	Illustration of measuring principles
		b) Hoop method Identical procedures are used as for single-piece rings but an appropriate vibration shall be applied to the hoop loading mechanism to relieve all forces of friction (see figure 15a). NOTES 1 Before tangential force measurements are made, rings must be degreased and lightly coated with thin machine oil. 2 It is recommended that closed gap measurements be made immediately prior to measuring tangential force. 3 In order to improve consistency of measurement and particularly with coil spring loaded rings which have been oxided or phosphated it is permissible to rotate the spring forwards and backwards to smooth the surface before carrying out measurements. 4 The reproducibility of tangential force measurements has not been high in the past but current machines using tape and hoop methods give an overall reproducibility of the order of 6,5 %. It is recommended that customer and supplier agree on a suitable factor to take account of different machines, different locations and different operators.	 Figure 15a)