

**Internal Combustion Engines—Piston Rings—Inspection Measuring Principles**

**1. Scope**—Differences, where they exist, are shown in Appendix A.

This SAE Standard 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 combustion engines.

These inspection measuring principles may also be used for piston rings for compressors working under analogous conditions.

**1.1 Rationale**—SAE J1589 is being discontinued because the content of this standard is also contained in ISO 6621-2. Therefore, to eliminate duplication and confusion in coordinating the standards between ISO and SAE, this document will be discontinued. The SAE Piston and Ring Standards Committee will now continue to support ISO in updating the standards as appropriate.

**2. References**

|             |                  |
|-------------|------------------|
| SAE         | ISO <sup>1</sup> |
| DESIGNATION | EQUIVALENT       |

**INTERNAL COMBUSTION ENGINES—PISTON RINGS**

|           |        |                         |
|-----------|--------|-------------------------|
| SAE J1588 | 6621-1 | Vocabulary              |
| SAE J1589 | 6621-2 | Measuring principles    |
| SAE J1590 | 6621-3 | Material specifications |
| SAE J1591 | 6621-4 | General specifications  |
| SAE J1996 | 6621-5 | Quality requirements    |

**INTERNAL COMBUSTION ENGINES—PISTON RINGS**

|           |           |                                          |
|-----------|-----------|------------------------------------------|
| SAE J1997 | 6621-1    | Rectangular rings                        |
| SAE J1998 | 6622-2 TR | Rectangular rings with narrow ring width |

|           |      |                                                               |
|-----------|------|---------------------------------------------------------------|
| SAE J1999 | 6623 | <b>INTERNAL COMBUSTION ENGINES—PISTON RINGS—SCRAPER RINGS</b> |
|-----------|------|---------------------------------------------------------------|

**INTERNAL COMBUSTION ENGINES—PISTON RINGS**

|           |           |                     |
|-----------|-----------|---------------------|
| SAE J2000 | 6624-1    | Keystone rings      |
| SAE J2001 | 6624-2 TR | Half keystone rings |

1. TR refers to Technical Report

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SAE J1589 Cancelled JUN2008

|           |         |                                                                               |
|-----------|---------|-------------------------------------------------------------------------------|
| SAE J2002 | 6625    | INTERNAL COMBUSTION ENGINES—PISTON RINGS—OIL CONTROL RINGS                    |
| SAE J2003 | 6625    | INTERNAL COMBUSTION ENGINES—PISTON RINGS—COIL SPRING LOADED OIL CONTROL RINGS |
| SAE J2004 | 6627 TR | INTERNAL COMBUSTION ENGINES—PISTON RINGS—EXPANDER/ SEGMENT OIL CONTROL RINGS  |
| SAE J2226 |         | INTERNAL COMBUSTION ENGINES—PISTON RINGS—STEEL RECTANGULAR RINGS              |
|           | ISO 286 | ISO SYSTEM OF LIMITS AND FITS                                                 |

**3. Measuring Principles**

**3.1 General Measuring Conditions**—The following general notes are applicable to all measuring principles unless otherwise specified:

- 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.
- 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.
- 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

TABLE 1—CHARACTERISTICS

| Subclause                                    | Characteristics of the Ring             | Ring Width      |
|----------------------------------------------|-----------------------------------------|-----------------|
| <b>Principal characteristics of the ring</b> |                                         |                 |
| 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                         | $F_d$           |
| <b>Characteristics of ring shape</b>         |                                         |                 |
| 3.2.7                                        | Ovality or circularity                  | $U$             |
| 3.2.8                                        | Point deflection                        | $W$             |
| 3.2.9                                        | Light tightness                         | —               |
| <b>Associated with peripheral surface</b>    |                                         |                 |
| 3.2.10                                       | Taper on periphery                      | —               |
| 3.2.11                                       | Barrel on periphery                     | $t_2, t_3, h_8$ |
| 3.2.12                                       | Land width                              | $h_4, h_5$      |
| 3.2.13                                       | Land offset                             | —               |
| 3.1.14                                       | Coating/inlay thickness                 | —               |
| <b>Associated with sides</b>                 |                                         |                 |
| 3.2.15                                       | Keystone angle                          | —               |
| 3.2.16                                       | Obliqueness                             | —               |
| 3.2.17                                       | Twist                                   | —               |
| 3.2.18                                       | Unevenness                              | $Te_r, Te_u$    |
| <b>Other</b>                                 |                                         |                 |
| 3.2.19                                       | Helix (axial displacement of butt ends) | —               |
| 3.2.20                                       | Free flatness                           | —               |
| 3.2.21                                       | Surface roughness                       | $R_a, R_z$      |

TABLE 2—MEASURING PRINCIPLES

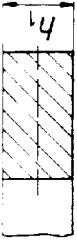
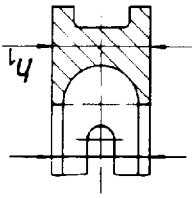
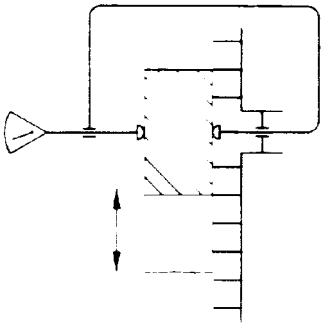
| Term                                        | Definition                                                                                                        | Measuring Principles                                                                                                                                                                                                                                                                     | Illustration of measuring principles                                                                                                                                                                                                                                                                      |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>3.2.1 Ring width</b><br>(in millimeters) |                                                                                                                   |                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                           |
| a) Parallel sided rings,<br>$h_1$           | The distance between the sides, at any particular point perpendicular to the datum surface (see Figures 1 and 2). | <p>Measure with spherical measuring probes each of radius <math>1,5 \pm 0,05</math> mm, exerting a measuring force of approximately 1 N (see Figure 3).</p> <p>In the case of slotted oil rings, the measurement shall be made between the slots and not across them (see Figure 2).</p> |  <p>FIGURE 1—</p>  <p>FIGURE 2—</p>  <p>FIGURE 3—</p> |

TABLE 2—MEASURING PRINCIPLES (CONTINUED)

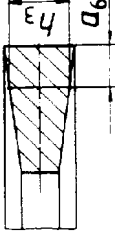
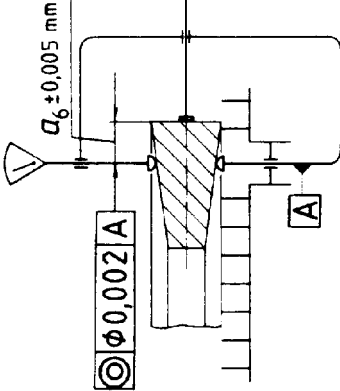
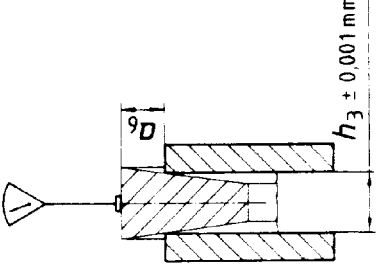
| Term                        | Definition                                                                                               | Measuring Principles                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Illustration of measuring principles                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| b) Keystone rings,<br>$h_3$ | The distance between the sides at a specified distance $a_6$ from the peripheral surface (see Figure 4). | <p>a) Method A</p> <p>This method determines <math>h_3</math> (see Figure 4) for a specified value of <math>a_6</math>.</p> <p>Measure with spherical measuring probes each of radius <math>1,5 \pm 0,05</math> mm exerting a measuring force of approximately 1 N (see Figure 5).</p> <p>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:</p> <p>for <math>6^\circ</math> keystone angle: 0,004 mm<br/>for <math>15^\circ</math> keystone angle: 0,026 mm.</p> <p>To obtain the correct measured width of the keystone ring the above values shall be deducted from the measured values.</p> <p>Values of <math>a_6</math> are given in ISO 6624/1.</p> <p>b) Method B</p> <p>This method determines <math>a_6</math> for a specified width <math>h_3</math> (see Figure 4).</p> <p>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 <math>h_3</math> (see Figure 6).</p> <p>Values of <math>h_3</math> are given in ISO 6624/1.</p> |  <p>FIGURE 4—<math>h_3</math> AND <math>a_6</math></p>  <p>FIGURE 5—SPHERICAL MEASURING PROBES</p>  <p>FIGURE 6—FLAT FACE MEASURING PROBE</p> |

TABLE 2—MEASURING PRINCIPLES (CONTINUED)

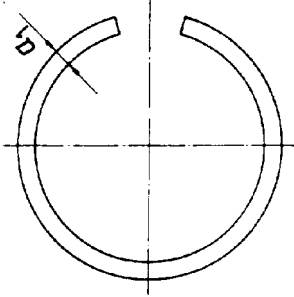
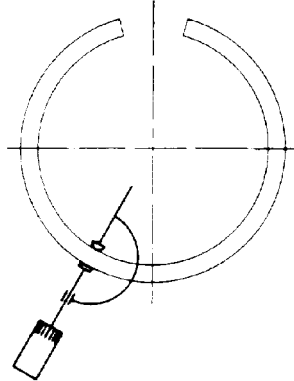
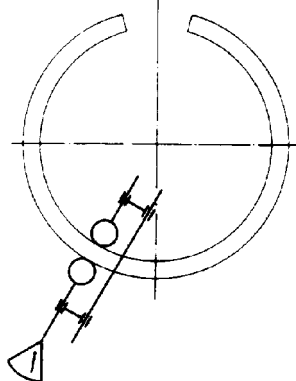
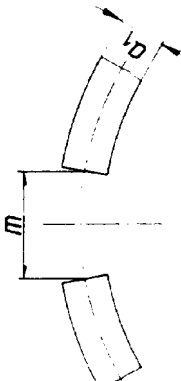
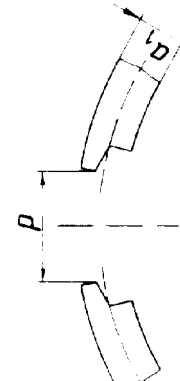
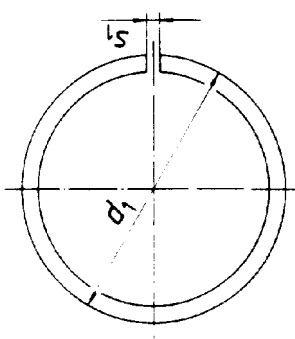
| Term                                                                     | Definition                                                                                   | Measuring Principles                                                                                                                                                                                                                                                                                                                                                                                                                                      | Illustration of measuring principles                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>3.2.2 Radial wall thickness, <math>a_1</math></b><br>(in millimeters) | The radial distance between the periphery and the inside surface of the ring (see Figure 7). | <p>a) Measure radially between a flat measuring surface on the periphery and a spherical measuring surface of radius approximately 4 mm on the inside surface, and using a measuring force of 3 to 10 N (see Figure 8).</p> <p>b) Measure radially between cylindrical inserts or rollers of radius approximately 4 mm and with a measuring force of 3 to 10 N.</p> <p>The length of the rollers shall be greater than the ring width (see Figure 9).</p> |  <p>FIGURE 7—a<sub>1</sub></p>  <p>FIGURE 8—METHOD a</p>  <p>FIGURE 9—METHOD b</p> |

TABLE 2—MEASURING PRINCIPLES (CONTINUED)

| Term                                                      | Definition                                                                                                                                                                                                                                                                                                          | Measuring Principles                                                                                                                                                                                                                                                                                                                                                                                                                                     | Illustration of measuring principles                                                                                                                                                                                                                                          |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>3.2.3 Total free gap</b><br>$m, p$<br>(in millimeters) | <p>The chordal distance between the butt ends of the ring in a free, unstressed state, measured at the centerline of the radial wall thickness (see Figure 10).</p> <p>For rings with an internal notch for a peg, the total free gap is defined by the chordal distance marked as <math>p</math> in Figure 11.</p> | <p>Measure with a steel rule to the nearest 0,25 mm.</p>                                                                                                                                                                                                                                                                                                                                                                                                 |  <p>FIGURE 10—<math>m</math> AND <math>a_1</math></p>  <p>FIGURE 11—<math>p</math> AND <math>a_1</math></p> |
| <b>3.2.4 Closed gap,</b><br>$s_1$<br>(in millimeters)     | <p>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).</p> <p>The closed gap <math>s_1</math> is related to the nominal diameter <math>d_1</math>.</p>                                | <p>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).</p> <p>The diameter of the bore gauge shall comply with the following deviations from the nominal ring diameter:</p> <p>Tolerance: <math>\begin{matrix} +0,001 \\ 0 \end{matrix} d_1</math></p> <p>Correction shall be made for any deviation of the bore gauge from the nominal ring diameter</p> |  <p>FIGURE 12—<math>s_1</math> AND <math>d</math></p>                                                                                                                                       |