INTERNATIONAL STANDARD

ISO 18669-2

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Internal combustion engines — Piston pins —

Part 2: Inspection measuring principles

Moteurs à combustion interne — Axes de pistons —

Partie 2: Principes de mesure pour le contrôle

Reference number
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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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18669-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

ISO 18669 consists of the following parts, under the general title *Internal combustion engines — Piston pins*:

Part 1: General specifications

Part 2: Inspection measuring principles

Internal combustion engines — Piston pins —

Part 2: Inspection measuring principles

1 Scope

This part of ISO 18669 defines the measuring principles to be used for measuring piston pins; it applies to piston pins from 8 mm up to and including 100 mm outside diameter for reciprocating internal combustion engines and compressors.

In certain applications, except road vehicles, and provided that mutual agreement is made between the purchaser and the manufacturer, this part of ISO 18669 may be used with suitable modifications.

2 Normative references

The following referenced documents are indispensable for the application 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 1101, *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 2639, *Steels — Determination and verification of the depth of carburized and hardened cases*

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

ISO 4288, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture*

ISO 9934 (all parts), *Non-destructive testing — Magnetic particle testing*

ISO 6506 (all parts), *Metallic materials — Brinell hardness test*

ISO 6507 (all parts), *Metallic materials — Vickers hardness test*

ISO 6508 (all parts), *Metallic materials — Rockwell hardness test*

QS 9000, *Quality Systems Requirements*

ISO 14104:1995, *Gears — Surface temper etch inspection after grinding*

ISO 14253 (all parts), *Geometrical Product Specifications (GPS) — Inspection by measurement of work pieces and measuring equipment*

ISO 18669-1:2004, *Internal combustion engines — Piston pins — Part 1: Specifications*

EN 583 (all parts), *Non-destructive testing — Ultrasonic examination*

3 Measuring principles

3.1 General measuring conditions

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

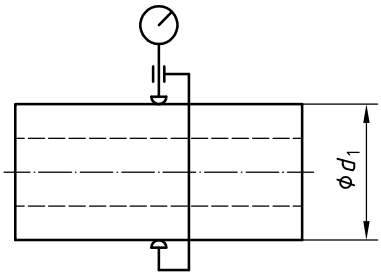
a) Measurements shall be made using instruments with a resolution not exceeding 10 % of the tolerance of the dimension being measured.

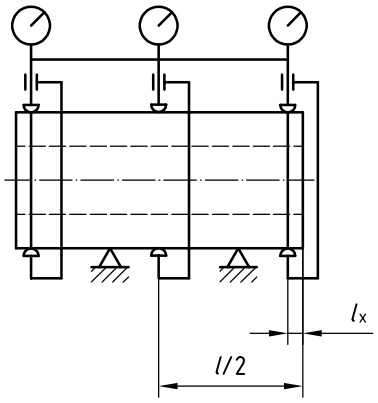
b) Concerning “Measuring uncertainty”, take notice of ISO 14253.

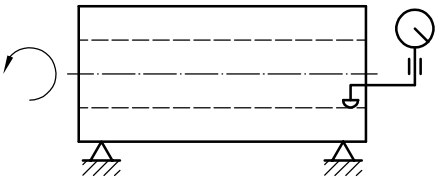
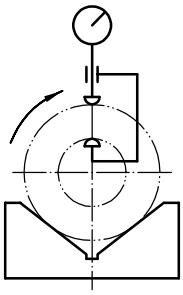
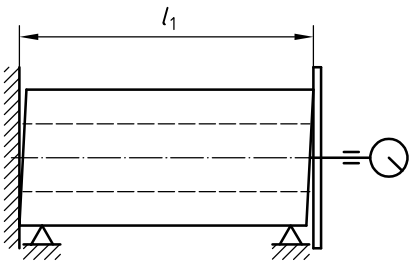
c) Concerning “Acceptance of gauge repeatability and reproducibility (% R & R)” take notice of QS 9000.

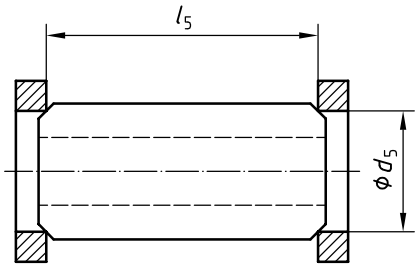
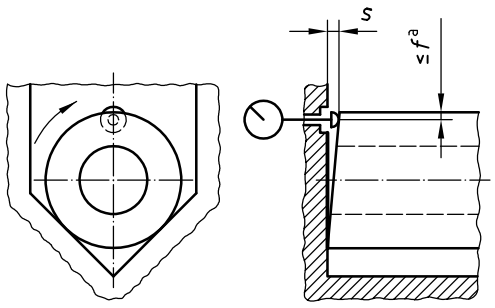
d) The reference temperature for outside-diameter measurements shall be 21 ± 1 °C.

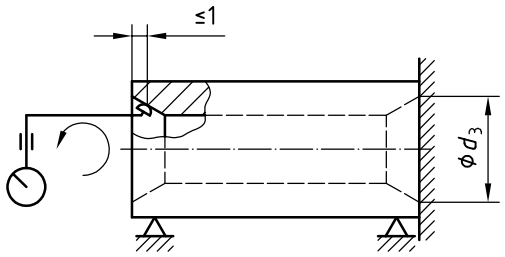
3.2 Characteristics and measuring principles

Characteristic	Measuring principle
3.2.1 Outside diameter d_1	
Diameter of the outer surface measured at any point excluding areas of edge drop-off, b (see Figure 10, ISO 18669:2004).	**Method A:** Reference method. Measure with a precision calliper having spherical measuring probes each of radius 1,5 mm min. exerting a measuring force of approximately 1 N (see Figure 1).  **Figure 1 — Outside-diameter measuring principle** **Other methods:** All methods which are able to guarantee the required measurement uncertainty. Method must be agreed to between manufacturer and client. **Measurement uncertainty:** ± 0,000 5 mm in accordance with ISO 14253

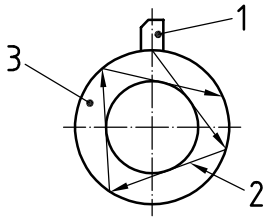
Characteristic	Measuring principle
3.2.2 Cylindricity of the outside diameter d_1	
Geometric form of the peripheral surface excluding areas of edge drop-off, b. Characteristics measured in the axial direction are taper, convexity, concavity and waviness. (Reference: ISO 1101)	**Method A:** Record and evaluate a macro-form diagram of opposite sides in the axial direction (profile lines) or by recording and evaluating of a multiple polar diagram (measuring in min. 3 planes, near both ends and centre of pin). **Method B:** Outside diameter, d_1 measured in a V-block by diametral gauging at centre of piston pin and at distance l_x from both ends and calculating the difference rate (see Figure 2). Measuring sensor: according to 3.2.1. $l_x = 0{,}15 \times d_1 \quad d_1 \geqslant 50$ mm $l_x = 0{,}10 \times d_1 \quad d_1 < 50$ mm  **Figure 2 — Cylindricity measuring principle**
3.2.3 Circularity of the outside diameter d_1	
All deviations of the peripheral surface from circularity such as waviness, ovality and spherical-triangular forms. (Reference: ISO 1101)	Recording and evaluation of a macro-form diagram in the circumferential direction and at several planes (polar diagram).
3.2.4 Edge drop-off b, c	
Geometric form of the peripheral surface at the outside edges.	Record and evaluate a macro-form diagram on both ends in the axial direction (profile lines), (see Figure 10, ISO 18669-1:2004).
3.2.5 Inside diameter d_2, d_4	
Diameter of the bore measured at any point.	Measured with inside measuring devices.

Characteristic	Measuring principle
3.2.6 Concentricity of inside diameter ID relative to outside diameter OD	
Difference between the maximum and minimum dimensions of the wall thickness (a) as measured in a plane perpendicular to the peripheral surface. (Reference: ISO 1101)	**Method A:** Measured with a thickness gauge (e.g. dial calliper or comparable gauges) (see Figure 3).  **Figure 3 — Inside-diameter concentricity** (Radial runout) **Method B:** Measured with a calliper or probe-indicator by 360° rotation in a V-block (see Figure 4).  **Figure 4 — Wall-thickness measuring principle**
3.2.7 Length l_1	
Maximum dimension measured between two planes perpendicular to the peripheral surface.	**Method A:** Measured between two planes parallel to each other and perpendicular to the outside surface (see Figure 5).  **Figure 5 — Length measuring principle** **Other methods:** All methods, which are able to guarantee the required measurement uncertainty and take account of runout.

Characteristic	Measuring principle
3.2.8 Gauge length l_5	
Dimension between the gauge points measured perpendicular to the peripheral surface.	The pin is put between two ring gauges perpendicular to the outside surface, with inside diameters d_5. The sharp edges of these gauges measure from contact point to contact point. This "assembly" of pin and two rings is put in a height gauge and measured. A known standard is used to set the gauge at "0" (see Figure 6)  **Figure 6 — Gauge-length measuring principle** NOTE Other lengths: all methods which are able to measure the characteristics according to specification.
3.2.9 Runout s of the end faces	
Axial distance between two circles located concentrically to the axis of the piston pin, between which all points of the end face of the piston pin must lie during rotation around the axis.	Supporting surface: V-block with longitudinal stop at least as large as the outside diameter d_1. Measurement by 360° rotation in the V-block. Measured value = axial eccentricity or runout (see Figure 7). f / r: see Figure 11, ISO 18669-1:2004.  **Figure 7 — Runout measuring principle**
3.2.10 Outside-edge profile	
Transition from the peripheral surface to the end face of piston pin.	Measuring of the transition using contour-measuring method, or other appropriate methods (see Figure 11, ISO 18669-1:2004).
3.2.11 Inside chamfer t	
Transition from the inside cylindrical surface to the end face.	Measurement using calliper, measuring lenses or contour-measuring equipment (see Figure 12, ISO 18669-1:2004).
3.2.12 Tapered bore diameter d_3	
Diameter of the taper at the end face.	Measured by using e.g. calliper or contour-measuring equipment (see Figure 13, ISO 18669-1:2004).

Characteristic	Measuring principle
3.2.13 Tapered bore angle α	
Angle of inclination measured from the peripheral surface.	Measured by using contour-measuring equipment (see Figure 13, ISO 18669-1:2004).
3.2.14 Runout tapered bore	
Concentricity of the tapered bore to the outside diameter.	Measured with an internal calliper by 360° rotation in a V-block. Measuring point shall be located 1 mm max. from the end face (see Figure 8).  **Figure 8 — Runout tapered bore measuring**
3.2.15 Roughness	
Ra: Value in accordance with ISO 4287.	Measurement with electrical stylus instruments, in accordance with ISO 4287.
Rz: Definition according to ISO 4287.	Limit wave length: 0,8 mm Measuring distance: 4,0 mm Stylus tip radius: 2 to 7 µm
Rt: Maximum peak-to-valley height in accordance with ISO 4287	Measurement of tool marks and scratches on the outer and inner cylindrical surface is accomplished by tracing with a micro-stylus system in a longitudinal or circumferential direction depending on the defect type. Measurement is carried out in the visually worst zone. Evaluation and comparability in accordance with ISO 4288.
3.2.16 Carburised and nitrided case depth	
Thickness of the surface layer with a hardness value which is greater than the limit hardness H_S, measured perpendicular to the piston pin peripheral surface or bore surface on the finish-machined piston pin.	Determination of the depth at which the limit hardness H_S exists, measured in HV 1 or HV 0,3 according to ISO 2639. Limit hardness H_S of carburised case hardened piston pins: 1. non-limited volume change H_S = 550 HV 0,3 with carburised case depth $\leqslant$ 0,2 mm H_S = 550 HV 1 with carburised case depth $>$ 0,2 mm 2. limited volume change H_S = 500 HV 0,3 with carburised case depth $\leqslant$ 0,2 mm H_S = 500 HV 1 with carburised case depth $>$ 0,2 mm Limit hardness Hs of nitrided piston pins: H_S = 550 HV 0,3 with nitrided case depth $\leqslant$ 0,2 mm H_S = 550 HV 1 with nitrided case depth $>$ 0,2 mm

Characteristic	Measuring principle
3.2.17 Core hardness	
Hardness in the core zone that is not affected by the case-hardened or nitrided layer.	**Method A:** reference method Testing with Vickers HV 30 in accordance with ISO 6507. **Method B:** Testing with Brinell HB 2,5/187,5 in accordance with ISO 6506. **Method C:** Testing with Rockwell C in accordance with ISO 6508. Measure in the centre of the core zone that is not affected by the case-hardened or nitrided layer. The core zone, when sampled, must not be cold-hardened or heated, and must be located at least 1/3 $\times$ l_1 from the end face. The average of 3 measurements is taken as the determining value. No individual value may deviate more than 10 % from the average value.
3.2.18 Peripheral surface hardness	
Hardness measured on the peripheral surface of the carburised or nitrided layer.	**Method A:** Reference method Case-hardened and nitrided piston pins: Testing with Vickers HV 10 in accordance with ISO 6507. **Method B:** Case-hardened piston pins: Testing with Rockwell C, A or N in accordance with ISO 6508. NOTE In order to attain a precise measurement result, testing should be done with the highest possible load, but with consideration to the danger of pressing through the case-hardened layer.
3.2.19 Volume change	
A change in volume detected as a permanent outside-diameter dimensional deviation at reference temperature after being heated to a test temperature for a specified period of time.	At reference temperature measure the outside diameter d_1 at a minimum of 2 locations. Permanently mark the locations for later measurement. The measuring gauges used shall comply with the requirements described in 3.2.1. Test conditions shall comply with the following: — Uniform heating at the test temperature. — 4 h holding time at the test temperature. — Limit temperature deviation to $\pm$ 5 °C. — Cooling to reference temperature with no quenching. — New measurement at the same measuring locations. The average of the outside-diameter differences found at all measuring locations is the determining value.

Characteristic	Measuring principle
3.2.20 Material defects	
Defects occurring on the peripheral surface, bore surface and core zone such as grinding cracks, hardening cracks, stress cracks, inclusions, slag lines and seams.	**Method A:** Magnetic particle inspection Magnetic particle inspection according to ISO 9934. Magnetisation in axial and circumferential direction using a minimum tangential field strength of 2500 A/m on the surface to be inspected. Evaluation shall be based on fluorescence. **Application:** Detection of defects on the surface and beneath the surface up to a depth of 0,2 mm. **Method B:** Ultrasonic inspection according to EN 583 Method using transverse waves. Inspect piston pin using the Pulse-echo technique with a direct contact angle-beam probe (see Figure 9) or by using the immersion technique.  **Key** 1 ultrasonic probe 2 sound propagation 3 piston pin **Figure 9 — Ultrasonic inspection principle** Coupling or immersion in a suitable couplant. Any means of rotating the part and/or transducer that insures full volume inspection. The incident angle shall insure full mode conversion to a transverse wave (must be equal to or greater than the first critical angle). **Frequency:** 4 to 12 MHz **Transducer-diameter for pin diameter:** — $\leqslant$ 50 mm: 8 — 10 mm — $>$ 50 mm: 8 — 15 mm **Reference:** Piston pins with defined artificial or natural defects shall be used as reference for the calibration. Proposed artificial notches on external and internal surfaces as follows: — width: 0,15 mm — depth: 0,20 mm — length: 20,00 mm **Calibration:** According to Figure 9, the probe is coupled to the reference pin and the echo of the internal and external reference reflectors are maximised. The highest amplitude shall be set to full (100 %) screen height.

Characteristic	Measuring principle
	Noise suppression may be used, but only to such a level that the noise is about to disappear. The rejection level (gate level) shall be set to 40 % screen height. **Application:** Detection of defects within the whole volume and on external and internal surfaces of the pin. Preferably, defects parallel to the pin axis (longitudinal flaws). **Detection limit:** Detection, which shows signals above 40 % screen height. **Method C:** Eddy current inspection Traverse length of peripheral surface as piston pin is scanned using a differential probe. Frequency range: from 200 Hz to 3 MHz. Piston pins must be demagnetised before Eddy current inspection. **Reference:** Piston pins with defined artificial or natural defects shall be used as reference for the calibration. Proposed artificial notches on external surface as follows: — width: 0,1 mm — depth: 0,1 mm — length: 5 mm **Calibration:** The probe is to be set to the reference pin at a distance of approximately 0,2 mm. Reflection of the reference is to be adjusted to maximum amplitude. The highest amplitude shall be set to 100 % monitor height. The rejection level shall be set to 40 % monitor height. **Application:** Detection of material defects on the scanned surface and beneath surface up to a depth of 0,05 mm. **Detection limit:** Detection, which shows signals above 40 % monitor height.
3.2.21 Residual magnetism	
Remaining magnetism after demagnetisation.	Measuring instrument: Residual-field-intensity instrument. Measure at the following locations: — End faces — Outside chamfers — 3 points (minimum) on peripheral surface.

Characteristic	Measuring principle
3.2.22 Visual defects	
All visible defects detected without magnification, by inspectors having normal eyesight (corrected if necessary) or detected automatically with opto-electronic systems.	**Method A: Visual inspection** Inspect under bright, none-dazzling light. Defect limits: In accordance with ISO 18669-1:2004, 9.3, Table 19. **Method B:** Automatic opto-electronic systems Systems, which are able to detect defects according to 6.3, Table 19 of ISO 18669-1:2004, or which are expedient to support visual inspection. Adjusting/defect limits: Adjust by using parts with natural or man-made defects in accordance with the definition in ISO 18669-1:2004, 10.3, Table 19.
3.2.23 Grinder burn	
Localised over- heating on ground surfaces, resulting in surface tempering and/or reheating with measurable changes in surface hardness.	**Method A:** Surface temper etches inspection in accordance with ISO 14104. Defect limits: According to ISO 14401-4:1995, Table 4. **Method B:** Barkhausen noise residual-stress measurement. Adjusting/defect limits: Adjust by using parts classified according to ISO 14104:1995, Table 4, defect limits likewise.
3.2.24 Streaks on bore surface	
Forming streaks on bore surface of cold-formed end-web pins.	**Method A:** Measure with macro- or micro-stylus system by scanning in longitudinal direction. **Method B:** Prepare a metallographic specimen from a cross-section through the streak and evaluate the depth microscopically.

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