
**Metallic materials — Leeb hardness
test —**

**Part 2:
Verification and calibration of the
testing devices**

iTeh STANDARD PREVIEW
*Matériaux métalliques — Essai de dureté Leeb —
Partie 2: Vérification et étalonnage des dispositifs d'essai*
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary Information](#)

The committee responsible for this document is ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

ISO 16859 consists of the following parts, under the general title *Metallic materials — Leeb hardness test*:

- *Part 1: Test method*
- *Part 2: Verification and calibration of the testing devices*
- *Part 3: Calibration of reference test blocks*

Metallic materials — Leeb hardness test —

Part 2:

Verification and calibration of the testing devices

1 Scope

This part of ISO 16859 specifies methods for direct and indirect verification of test instruments used for determining Leeb hardness in accordance with ISO 16859-1, and also describes when these two types of verification are to be performed.

The direct verification involves checking that individual instrument performance parameters fall within specified limits, whereas the indirect verification utilizes hardness measurements of reference test blocks, calibrated in accordance with ISO 16859-3, to check the overall performance of the instrument for testing in the direction of gravity. The indirect method can be used on its own for the periodic performance checking in service.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16859-1, *Metallic materials — Leeb hardness test — Part 1: Test method*

ISO 16859-3, *Metallic materials — Leeb hardness test — Part 3: Calibration of reference test blocks*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

3 General conditions

Before a Leeb hardness testing instrument is verified, the instrument shall be checked to ensure that it is properly set up and operating in accordance with the manufacturer's instructions.

Especially it should be checked that

- a) the impact body is correctly installed in the guide tube,
- b) the support ring is mounted tightly to the bottom of the impact device,
- c) cables are correctly connected, if applicable, and
- d) the settings of the indicating unit are correct.

4 Direct verification

4.1 General

4.1.1 Direct verification should be carried out at a temperature of (23 ± 5) °C. If the verification is made outside this temperature range, this shall be reported in the verification report.

4.1.2 The instruments used for verification shall be traceable to national measurement standards.

4.1.3 Direct verification is comprised of the following:

- a) verification of mass and geometry of impact body in accordance with 4.3;
- b) verification of geometry of indenter ball, and of hardness of ball except for type E, in accordance with 4.4;
- c) verification of geometry of support ring in accordance with 4.5;
- d) verification of impact velocity in accordance with 4.6.

4.2 Calibration parameters

Calibration parameters for reference in direct calibrations of Leeb impact devices are specified in Table 1.

Table 1 — Dimensions of Leeb impact devices for reference in direct calibrations

			Parameters of types of impact devices						
			D	S	E	DL	D+15	C	G
v_A	m/s	Impact velocity ^a	2,05 ± 0,1	2,05 ± 0,1	2,05 ± 0,1	1,82 ± 0,1	1,7 ± 0,1	1,4 ± 0,1	3,0 ± 0,1
	mm	Maximum distance of ball indenter from test piece surface at velocity measurement	2,00	2,00	2,00	2,00	2,00	2,00	3,00
M	g	Mass of impact body (incl. ball indenter)	5,45 ± 0,1	5,40 ± 0,1	5,45 ± 0,1	7,25 ± 0,1	7,75 ± 0,1	3,1 ± 0,05	20,0 ± 0,3
R	mm	Spherical radius of indenter ball	1,5 ± 0,005	1,5 ± 0,005	1,5 ± 0,005	1,39 ± 0,005	1,5 ± 0,005	1,5 ± 0,005	2,5 ± 0,005
		Material of indenter	tungsten-carbide cobalt: balance; other carbides: < 2wt.-%; cobalt: 5-7 wt.-%; mass density 14,8 g/cm ³ ± 0,2 g/cm ³	ceramics Si ₃ N ₄ > 90 wt.-%; mass density 3,1 g/cm ³ ± 0,2 g/cm ³	polycrystalline diamond Syndite; mass density 3,5 g/cm ³ ± 0,2 g/cm ³	tungsten-carbide cobalt: balance; other carbides: < 2wt.-%; cobalt: 5-7 wt.-%; mass density 14,8 g/cm ³ ± 0,2 g/cm ³	tungsten-carbide cobalt: balance; other carbides: < 2wt.-%; cobalt: 5-7 wt.-%; mass density 14,8 g/cm ³ ± 0,2 g/cm ³	tungsten-carbide cobalt: balance; other carbides: < 2wt.-%; cobalt: 5-7 wt.-%; mass density 14,8 g/cm ³ ± 0,2 g/cm ³	tungsten-carbide cobalt: balance; other carbides: < 2wt.-%; cobalt: 5-7 wt.-%; mass density 14,8 g/cm ³ ± 0,2 g/cm ³
HV	HV2	Vickers hardness of Indenter	1600 ± 100	1600 ± 100	≥ 4500 ^b	1600 ± 100	1600 ± 100	1600 ± 100	1600 ± 100
d_x	mm	Minimum protrusion of spherical surface of indenter with respect to indenter holder	0,3	0,3	0,3	2,0	0,3	0,3	0,6
	mm	Dimensions of round bar of DL holder				diameter: 2,5 ± 0,1; length 55,15 ± 0,1			

^a Impact vertically down, in direction of gravity.

^b The indicated hardness of the indenter of impact body E is informational, but not required to be verified.

4.3 Verification of mass and geometry of impact body

4.3.1 The mass of the impact body shall be verified according to the requirements defined in [Table 1](#).

4.3.2 The impact body shall consist of a ball indenter and a holder of the indenter. If the impact signal is read out via a coil using electromagnetic induction, the impact body shall contain a permanent magnet.

4.3.3 The spherical surface of the indenter shall protrude from the holder by a minimum of 0,3 mm for impact device types D, D+15, S, E, and C, and by a minimum of 0,6 mm for impact device type G. The indenter of impact device type, DL, is captured in a holder consisting of a round bar of diameter $(2,5 \pm 0,1)$ mm and length $(55,15 \pm 0,1)$ mm, and the indenter shall protrude from this holder by a minimum of 2 mm.

4.4 Verification of geometry and hardness of indenter ball

4.4.1 For the purpose of verifying the size and the hardness of the balls, a sample selected at random from a batch shall be tested. A certificate or proof of required hardness shall be made available. The balls verified for hardness shall be discarded.

4.4.2 The diameter of the ball indenter shall be determined by taking the mean value of not less than three single values of diameter measured at different positions on the ball. No single value shall differ from the nominal diameter by more than the tolerance given in [Table 1](#).

4.4.3 The indenter of the impact body shall be made from tungsten-carbide cobalt, ceramics, or synthetic diamond, as specified in [Table 1](#). The hardness shall conform with the specifications in [Table 1](#), in accordance with ISO 6507-1. The ball can be tested directly on this spherical surface or by sectioning the ball and testing on the ball interior. The PCD balls do not require verification of hardness.

4.4.4 The spherical indenter surface shall be polished and free from surface defects when inspected under 100x total magnification.

4.5 Verification of geometry of support ring

The thickness of the support ring determines the distance of the ball indenter from the test piece surface at the velocity measurement. Verification of the thickness of the support ring is done through direct measurement. The thickness of the support ring shall be determined by taking the mean value of not less than three single values of thickness measured at different positions on the support ring. No single value shall differ from the nominal thickness by more than 0,1 mm.

4.6 Verification of impact velocity

4.6.1 Verification of the impact velocity should be done by direct velocity measurement in the direction of gravity. The impact velocity shall be measured at a maximum height of the indenter spherical surface above the test piece surface that is specified in [Table 1](#).

4.6.2 If direct velocity measurement is not possible, an indirect verification of the velocity shall be conducted. For example, the impact body of the impact device can be replaced by a reference impact body that meets the parameter tolerances defined in ISO 16859-3:2015, Table A.1, and the impact device be connected to the reference indicating device. Following the impact in direction of gravity on a test piece, the displayed measurement signal can be compared to the reference signal value, as illustrated in [Annex B](#). The signal waveform response before impact is instrument-specific and independent of the tested material.

4.7 Indirect verification of instrument

Following a successful direct verification, an indirect verification shall be performed in accordance with [Clause 5](#).

5 Indirect verification

5.1 General

5.1.1 Indirect verification should be conducted at a temperature of (23 ± 5) °C using reference test blocks calibrated in accordance with ISO 16859-3. If indirect verification is done out of this temperature range, a note must be included in the verification report/calibration certificate.

5.1.2 Impact device, impact body, support ring, cables, and indicating device shall be inspected visually for exterior damage.

5.1.3 The resolution of the indicating unit shall be at least 1 HL.

5.1.4 The Leeb hardness testing instrument shall be tested for common hardness values using three reference test blocks from various hardness ranges according to [Table 2](#).

Table 2 — Leeb hardness ranges

Type of impact device	Leeb hardness range for calibration HL ^a
D, D+15	< 500 500 to 700 > 700
DL, S	< 700 700 to 850 > 850
C, E	< 600 600 to 750 > 750
G	< 450 450 to 600 > 600

^a HLD for impact devices D, HLD+15 for impact devices D+15, HLDL for impact devices DL, HLS for impact devices S, HLC for impact devices C, HLE for impact devices E, HLG for impact devices G.

5.2 Procedure

The reference test block shall be placed on a rigid support. Make 10 indentations on each reference test block uniformly distributed over the test surface in the direction of gravity. Testing shall be done in accordance with ISO 16859-1.

NOTE 1 For special applications, verification of the instrument can be limited to the hardness range corresponding to the hardness of the test pieces.

NOTE 2 Only the calibrated surface of the test blocks are to be used for testing.

NOTE 3 For testing in directions other than in direction of gravity, the measured hardness number will be different. For such cases, the applicable correction method can be provided by the manufacturer.

5.3 Variation coefficient (V)

$$V = \frac{s(H)}{\bar{H}} \cdot 100 \text{ in \%} \quad (1)$$

where $s(H)$ is the standard deviation from $n = 10$ Leeb hardness readings:

$$s(H) = \sqrt{\frac{\sum_{i=1}^n (H_i - \bar{H})^2}{n-1}} \quad (2)$$

The arithmetic mean value \bar{H} from $n = 10$ measured Leeb hardness readings is calculated as

$$\bar{H} = \frac{H_1 + H_2 + \dots + H_n}{n} \quad (n = 10) \quad (3)$$

where

H_1, H_2, \dots, H_n are measured Leeb hardness readings;

n is number of Leeb hardness readings.

The variation coefficient shall be considered as sufficient when meeting the requirements from [Table 3](#).

5.4 Error of test instrument (standards.iteh.ai)

The error of the test instrument

$$E = \bar{H} - H_{CRM} \quad (4)$$

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where

H_{CRM} is Leeb hardness of utilized reference test block.

The permissible error of the Leeb hardness test instrument is calculated from

$$E_{rel} = \frac{\bar{H} - H_{CRM}}{H_{CRM}} \cdot 100 \text{ in \%} \quad (5)$$

The permissible error of the Leeb hardness tester, expressed in percentage of the given Leeb hardness of the reference test block, shall not exceed the limits given in [Table 3](#).