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**Non-destructive testing — Ultrasonic  
testing — Characterization and  
verification of ultrasonic thickness  
measuring equipment**

*Essais non destructifs — Contrôle par ultrasons — Caractérisation et  
vérification des appareils de mesure de l'épaisseur par ultrasons*

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ISO copyright office  
Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

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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 16831 was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 3, *Ultrasonic testing*.

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## Introduction

This International Standard is based on EN 15317:2007, *Non-destructive testing — Ultrasonic testing — Characterization and verification of ultrasonic thickness measuring equipment*.

The following International Standards are linked.

ISO 16810, *Non-destructive testing — Ultrasonic testing — General principles*

ISO 16811, *Non-destructive testing — Ultrasonic testing — Sensitivity and range setting*

ISO 16823, *Non-destructive testing — Ultrasonic testing — Transmission technique*

ISO 16826, *Non-destructive testing — Ultrasonic testing — Examination for discontinuities perpendicular to the surface*

ISO 16827, *Non-destructive testing — Ultrasonic testing — Characterization and sizing of discontinuities*

ISO 16828, *Non-destructive testing — Ultrasonic testing — Time-of-flight diffraction technique as a method for detection and sizing of discontinuities*

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# Non-destructive testing — Ultrasonic testing — Characterization and verification of ultrasonic thickness measuring equipment

## 1 Scope

This International Standard specifies methods and acceptance criteria for assessing the performance of instruments for measuring thickness using pulse-echo ultrasound.

This International Standard covers both direct (digital) reading and waveform display types using single or dual element probes.

This International Standard can be used for verifying equipment covered by EN 12668 when used for thickness measurement.

## 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 5577, *Non-destructive testing — Ultrasonic inspection — Vocabulary*

EN 1330-4, *Non destructive testing — Terminology — Part 4: Terms used in ultrasonic testing*

EN 10025-2, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

EN 12668-2, *Non-destructive testing — Characterization and verification of ultrasonic examination equipment — Part 2: Probes*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577 and EN 1330-4 apply.

## 4 General requirements for compliance

Ultrasonic thickness measuring equipment complies with this standard if it satisfies all the following conditions:

- a) ultrasonic instrument and probe comply with the technical requirements of this standard;
- b) either a declaration of conformity, issued by an organization certified in accordance with ISO 9001; or a certificate issued by an organization accredited according to ISO/IEC 17050-1 and ISO/IEC 17050-2, or a test report issued by an organization performing in-house calibration;
- c) ultrasonic instrument and probe are clearly marked to identify the manufacturer, type and series, and carry a unique serial number;
- d) user instruction manual for the particular type and series of the ultrasonic equipment is available;

- e) manufacturer's technical specification for the appropriate type and series of ultrasonic equipment which defines the performance criteria in accordance with this standard is available.

NOTE The manufacturer's technical specification does not in itself constitute the certificate of measured values required in b).

## 5 Manufacturer's technical specification for ultrasonic thickness measuring equipment

### 5.1 General

The manufacturer's technical specification for a particular model of ultrasonic thickness measuring equipment shall contain, as a minimum, the information listed in 5.2 to 5.5. Values obtained from the tests described in Clause 7 shall be quoted as nominal values with tolerances given as indicated.

### 5.2 General attributes

The following shall be detailed:

- a) size;
- b) ~~Mass~~ mass (at an operational stage);
- c) type(s) of power supply;
- d) type(s) of probe sockets;
- e) battery operational time (as new, at maximum power consumption with a specified duty cycle);
- f) temperature and voltage (mains and/or battery) ranges, in which operation complies with the technical specification – if a warm-up period is necessary, the duration of this shall be stated;
- g) form of indication given when a low battery voltage takes the ultrasonic instrument performance outside of specification;
- h) pulse repetition frequencies (PRFs) (switched positions and/or variable ranges);
- i) if available, monitor outputs to indicate when the measurement values fall outside a set tolerance;
- j) if equipment can measure through coatings;
- k) minimum measurable and maximum measurable thicknesses on a defined material;

NOTE A minimum measurable thickness of zero cannot be verified and therefore not specified.

- l) accuracy and resolution shall be stated in mm for steel (longitudinal waves).

### 5.3 Display

The following shall be detailed:

- a) type of display (alphanumeric or graphical and also whether LED, LCD or CRT);
- b) dimension of alphanumeric display;
- c) dimension of graphical display.



## 5.4 Transmitter

The following shall be detailed:

- a) shape of transmitter pulse;
- b) at each pulse energy setting with the output connected to a suitable specified probe or a defined artificial load:
  - 1) transmitter pulse voltage (peak-to-peak);
  - 2) pulse rise time;
  - 3) pulse duration (for square wave, the range over which the pulse duration can be set).

## 5.5 Receiver

The following shall be detailed:

- a) characteristics of gain control if user selected;
- b) frequency range of operation.

## 5.6 Other information

In addition to the information given in 5.2 to 5.5, details should be supplied on the principles of:

- a) data output and storage facilities (memory capacity);
- b) calibration setting storage; [ISO 16831:2012](https://standards.iteh.ai/catalog/standards/sist/1a617fa5-13d3-49ab-b2a9-3772a1e42dbe/iso-16831-2012)
- c) calibration mechanisms; <https://standards.iteh.ai/catalog/standards/sist/1a617fa5-13d3-49ab-b2a9-3772a1e42dbe/iso-16831-2012>
- d) display and recall facilities;
- e) display response time;
- f) number of pixels to display the waveform;
- g) printer output.

Where applicable, these details should also include sampling rates used, effect of pulse repetition frequency or display range on the sampling rate and response time.

In addition, the principles of any algorithm used to process data for display should be described.

## 6 Calibration blocks

### 6.1 General

In order to verify the ultrasonic thickness measuring equipment, it is necessary to take measurements on defined calibration blocks. These blocks are specified in 6.2 and 6.3.

### 6.2 Material

Blocks shall be manufactured from steel grade S355J0 specified in EN 10025-2.

Blocks shall be rough-machined before heat treatment which shall consist of:

- austenitizing at 920 °C for 30 min;
- rapid cooling (quenching) in water;
- tempering by heating to 650 °C for 3 h; and then
- cooling in air.

The velocity for longitudinal waves in the calibration block material shall be  $(5\,920 \pm 30) \text{ ms}^{-1}$ .

The surfaces used for measurement shall be machined to an  $Ra$  value not greater than  $0,8 \mu\text{m}$ .

Prior to final machining, the block shall be proved free from internal discontinuities.

It is permissible to chromium plate or electroless nickel plate the surfaces of the block to a maximum of 0,5 % of the block thickness.

NOTE If chromium plating is used, care should be taken to use a thickness of plating that will avoid separation.

### 6.3 Shape and size

#### 6.3.1 Accuracy blocks

These calibration blocks shall be cylinders with diameter,  $D$ , and length,  $L$ , and as shown in Table 1.

**Table 1 – Size of calibration blocks**

Block	Diameter $D$	Length $L$
A	$\geq 0,5L$	Minimum specified thickness
B	$\geq 0,5L$	$L_A + 0,25 (L_E - L_A)$
C	$\geq 0,5L$	$L_A + 0,50 (L_E - L_A)$
D	$\geq 0,5L$	$L_A + 0,75 (L_E - L_A)$
E	$\geq 0,5L$	Maximum specified thickness

where

$L_A$  is the height of block A; and

$L_E$  is the height of block E.

NOTE If  $L_A < 0,1 L_E$  the subtraction of  $L_A$  may be omitted.

$D$  shall not be  $<3$  times the probe face diagonal dimension.

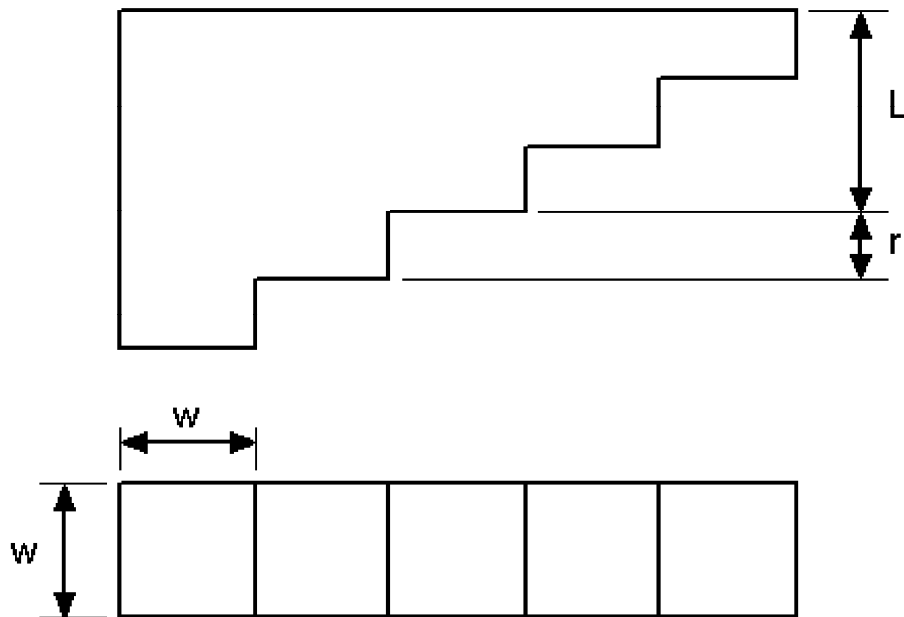
The values 0,25, 0,5 and 0,75 may be varied by up to 10 % of the value in question.

The overall height of the block shall be  $\leq 3 (10^{-4} L)$  across the measurement faces.

The fixed dimension for  $L$  shall be measured at the centre of the block to an accuracy of  $10^{-4} L$ .

The blocks shall be permanently, circumferentially marked with the actual length  $L$ , e.g.  $L = 50,333 \text{ mm}$ , and a unique identity (serial number).

### 6.3.2 Resolution block (see Figure 1)



#### Key

- $w$  step width  
 $r$  step height  
 $L$  length of block C (see Table 1)

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Figure 1 – Resolution block

Where  $w$  shall be  $\geq 3$  times the diagonal dimension of the probe face and  $r$  shall be less than or equal to the specified resolution.

The block shall provide a minimum of five steps.

## 7 Performance requirements for ultrasonic thickness measuring equipment

To comply with this standard, ultrasonic thickness measuring equipment shall be verified using the tests described below and shown in Table 2.

**Group 1:** Tests to be performed by the manufacturer (or the manufacturer's agent) on a representative sample of the ultrasonic thickness measuring equipment produced. These tests allow the manufacturer to verify and support the technical specification for the equipment.

**Group 2:** Tests to be performed on all ultrasonic thickness measuring equipment:

- 1) by the manufacturer, or the manufacturer's agent prior to the supply of the equipment (pre-commissioning test);
- 2) by the manufacturer, the owner, or a laboratory at annual intervals to verify the performance of the equipment during its lifetime;
- 3) following any equipment repairs.

**Group 3:** Tests to be completed by the operator on site prior to and at the completion of any series of measurements.