
**Non-destructive testing —
Characterization and verification of
ultrasonic test equipment —**

**Part 2:
Probes**

*Essais non destructifs — Caractérisation et vérification de
l'appareillage de contrôle par ultrasons —*

Partie 2: Traducteurs

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Published in Switzerland

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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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 3, *Ultrasonic testing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 138, *Non-destructive testing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 22232 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Non-destructive testing — Characterization and verification of ultrasonic test equipment —

Part 2: Probes

1 Scope

This document specifies the characteristics of probes used for non-destructive ultrasonic testing in the following categories with centre frequencies in the range of 0,5 MHz to 15 MHz, focusing or without focusing means:

- a) single- or dual-transducer contact probes generating longitudinal and/or transverse waves;
- b) single-transducer immersion probes.

Where material-dependent ultrasonic values are specified in this document they are based on steels having a sound velocity of $(5\,920 \pm 50)$ m/s for longitudinal waves, and $(3\,255 \pm 30)$ m/s for transverse waves.

This document excludes periodic tests for probes. Routine tests for the verification of probes using on-site procedures are given in ISO 22232-3.

If parameters in addition to those specified in ISO 22232-3 are to be verified during the probe's life time, as agreed upon by the contracting parties, the procedures of verification for these additional parameters can be selected from those given in this document.

This document also excludes ultrasonic phased array probes, therefore see ISO 18563-2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 testing — Vocabulary*

ISO 7963, *Non-destructive testing — Ultrasonic testing — Specification for calibration block No. 2*

ISO 22232-1, *Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 1: Instruments*

ISO/IEC 17050-1, *Conformity assessment — Supplier's declaration of conformity — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

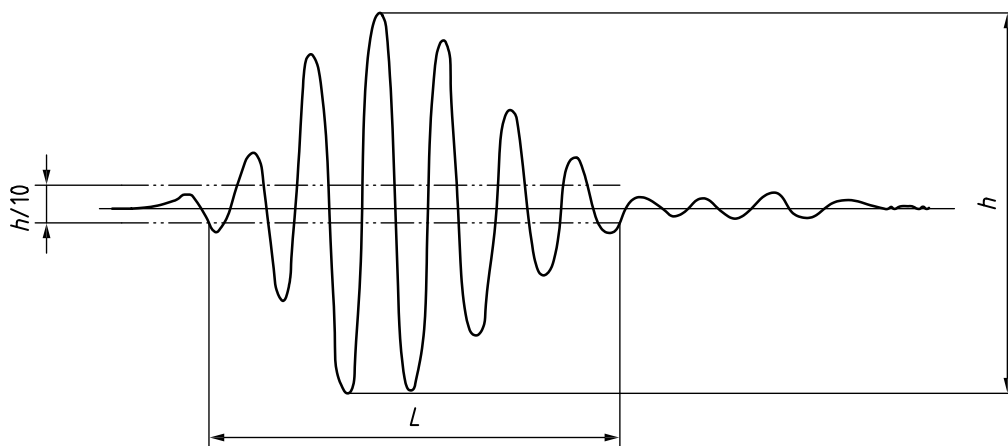
3.1
horizontal plane

<angle-beam probes> plane perpendicular to the *vertical plane* (3.7) of the sound beam including the beam axis in the material

3.2
peak-to-peak amplitude

difference between the highest positive and the lowest negative amplitude in a pulse

Note 1 to entry: See [Figure 1](#).



Key

h peak-to-peak amplitude
 L pulse duration

Figure 1 — Typical ultrasonic pulse

3.3
probe data sheet

document giving manufacturer's technical specifications of the same type of probes, i.e. probes manufactured in series

Note 1 to entry: The data sheet does not necessarily need to be a test certificate of performance.

Note 2 to entry: For individually designed or manufactured probes, some parameters may not be accurately known before manufacturing.

3.4
probe test report

document showing compliance with this document giving the measured values of the required parameters of one specific probe, including test equipment and conditions

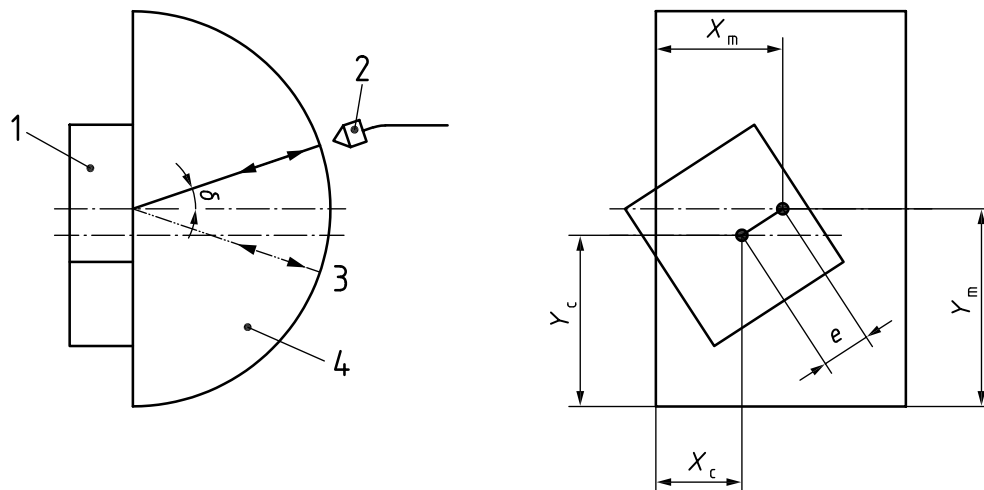
3.5
reference side

right side of an angle-beam probe looking in the direction of the beam, unless otherwise specified by the manufacturer

3.6
squint angle for straight-beam probes

deviation between the beam axis and the line perpendicular to the coupling surface at the point of incidence

Note 1 to entry: See [Figure 2](#).

**Key**

- 1 ultrasonic straight-beam probe
 2 EMA receiver
 3 echo point
 4 hemicylindrical test block

- e offset
 δ squint angle for straight-beam probes
 X_c, Y_c coordinates of the centre of the probe
 X_m, Y_m coordinate of EMA receiver
 X_c, Y_c coordinate of the centre of the block

Figure 2 — Squint angle and offset for a straight-beam probe

3.7**vertical plane**

<angle-beam probes> plane through the beam axis of a sound beam in the probe wedge and the beam axis in the test object

3.8**wear allowance**

maximum wear of the probe contact surface which does not affect the performance of the probe

Note 1 to entry: Wear allowance is typically expressed in millimetres.

4 Symbols

Symbol	Unit	Meaning
L	us	Pulse duration
h	V	Peak-to-peak amplitude
f_o	Hz	Centre frequency
f_u	Hz	Upper cut-off frequency
f_l	Hz	Lower cut-off frequency
Δf	Hz	Bandwidth
Δf_{rel}	%	Relative bandwidth
S	dB	Pulse-echo sensitivity
N_0	mm	Near field length
F_D	mm	Focal distance
F_L	mm	Length of focal zone at -6 dB using a reflector or -3 dB using a hydrophone
Z_P	mm	Focal point
W_x	mm	Focal width on X-axis

Symbol	Unit	Meaning
W_y	mm	Focal width on Y-axis
Ω_x	°	Angle of beam divergence in X direction
Ω_y	°	Angle of beam divergence in Y direction
X	mm	Probe index point
α	°	Beam angle
δ	°	Squint angle for straight-beam probes

5 General requirements of conformity

An ultrasonic probe complies with this document if it fulfils all of the following requirements:

- the probe shall comply with [Clause 8](#);
- a declaration of conformity according to ISO/IEC 17050-1 shall be available;
- the ultrasonic probe shall be clearly marked to identify the manufacturer, and carry a unique serial number or show a permanent reference number from which information can be traced to the data sheet and probe test report;
- a probe data sheet corresponding to the ultrasonic probe shall be available, which defines the performance criteria for the items given in [Clause 6](#);
- a probe test report shall be delivered together with the probe, which includes at least the test results given in [Clause 6](#).

[Table 1](#) summarises the tests to be performed on ultrasonic probes.

Table 1 — List of tests for ultrasonic probes

Title of test	Manufacturer's tests
	Subclause
Physical aspects	8.1
Pulse shape, amplitude and duration	8.2
Frequency spectrum and bandwidth	8.3
Pulse-echo sensitivity	8.4
Distance-amplitude curve	8.5
Beam parameters for immersion probes	8.6
Axial profile – Focal distance and length of the focal zone	8.6.2.2
Transverse profile – Focal width	8.6.2.3
Transverse profile – Beam divergence	8.6.2.4
Beam profile by scanning means – Focal distance and focal length	8.6.3.2
Beam profile by scanning means – Focal width and beam divergence	8.6.3.3

Table 1 (continued)

Title of test	Manufacturer's tests
	Subclause
Beam parameters for straight-beam single-transducer contact probes	8.7
Beam divergence and side lobes	8.7.2
Squint angle and offset for straight-beam probes	8.7.3
Focal distance (near field length)	8.7.4
Focal width	8.7.5
Length of the focal zone	8.7.6
Beam parameters for angle-beam single-transducer contact probes	8.8
Index point	8.8.2
Beam angle and beam divergence	8.8.3
Squint angle and offset	8.8.4
Focal distance (near field length)	8.8.5
Focal width	8.8.6
Length of the focal zone	8.8.7
Beam parameters for straight-beam dual-transducer contact probes	8.9
Delay line delay path	8.9.2
Focal distance	8.9.3
Axial sensitivity range (focal width)	8.9.4
Lateral sensitivity range (focal width)	8.9.5
Beam parameters for angle-beam dual-transducer contact probes	8.10
Index point	8.10.2
Beam angle and profiles	8.10.3
Wedge delay path	8.10.4
Distance to sensitivity maximum (focal distance)	8.10.5
Axial sensitivity range (length of the focal zone)	8.10.6
Lateral sensitivity range (focal width)	8.10.7
Crosstalk	8.11

6 Technical information for probes

6.1 General

The test conditions and the equipment used for the evaluation of the probe parameters shall be listed (see [Table 2](#)).

For individually designed or manufactured probes some parameters may not be accurately known prior to manufacturing. In that case the measured values shall be used as reference values.

6.2 Probe data sheet

The probe data sheet gives the list of information to be reported for all probes within the scope of this document (see [Table 2](#)).

6.3 Probe test report

The probe test report gives the measured values of the required parameters of one specific probe and other information from the probe data sheet (see [Table 2](#)).

The probe test report shall include the unique serial number or the permanent reference number to provide a uniquely assignment between the specific probe and the probe test report.

Table 2 — List of information to be given in a probe data sheet and a probe test report

Information to be given	Probe data sheet	Probe test report	Comment
Manufacturer's name	I	I	—
Probe type	I	I	—
Probe serial number	—	I	—
Probe housing dimensions	I	I	—
Probe weight	I	I	—
Type of connectors	I	I	—
Connectors interchangeability	I	I	Only for dual-transducer probes
Crosstalk	I	M	Only for dual-transducer probes
Transducer material	I	I	—
Shape and size of transducer	I	I	—
Roof angle of transducers	I	I	Only for dual-transducer probes
Wedge material	I	I	Only for angle-beam probes
Wedge delay path	I	I	Only for angle-beam probes,
Delay line material	I	I	Only for straight-beam probes
Delay line delay	I	I	Only for straight-beam probes,
Protection layer material	I	I	—
Wear allowance	I	I	—
Pulse shape	I	M	—
Frequency spectrum	I	M	—
Centre frequency	I	M	—
Bandwidth	I	M	—
Pulse duration	I	M	—
Pulse-echo sensitivity	I	M	—
Beam angle	I	M	Only for angle-beam probes
Angles of divergence	I	I	Not for focusing immersion probes
Squint angle	I	I	—
Squint offset	I	I	—
Probe index point	I	I	Only for angle-beam probes Alternatively the distance between the probe index point and the front of the probe can be given
Type of focus	I	I	—
Focal distance or near field length	I	I	—
Width of the focal zone	I	I	Only for focusing probes
Length of the focal zone	I	I	Only for focusing probes
Operating temperature range	I	I	—
Storage temperature range	I	I	—
DAC	I	—	—
Distance-amplitude curve available	I	—	—
Key			
I information			
M measurement			

Table 2 (continued)

Information to be given	Probe data sheet	Probe test report	Comment
Used equipment	I	I	—
Test conditions	I	I	—
Physical aspects	—	I	—
Key I information M measurement			

7 Test equipment

7.1 Electronic equipment

The ultrasonic instrument (or laboratory pulser/receiver) used for the tests specified in [Clause 8](#) shall be of the type designated on the probe data sheet and shall comply with ISO 22232-1 as applicable.

Where more than one type of ultrasonic instrument is designated the tests shall be repeated with each of the additional designated types.

Testing shall be carried out with the probe cables and electrical matching devices specified on the probe data sheet for use with the particular type of ultrasonic instrument.

NOTE Probe leads more than about 2 m long can have a significant effect on probe performance.

In addition to the ultrasonic instrument or laboratory pulser/receiver the items of equipment essential to assess probes in accordance with this document are as follows:

- a) an oscilloscope with a minimum bandwidth of 100 MHz;
- b) a frequency spectrum analyser with a minimum bandwidth of 100 MHz, or an oscilloscope/digitiser or computer capable of performing discrete Fourier transforms (DFT).

The following additional equipment is optional:

- c) for contact probes only:
 - 1) an electromagnetic-acoustic probe (EMA) and receiver;
 - 2) a plotter to plot directivity diagrams;
- d) for immersion probes only:

a hydrophone receiver with an active diameter less than two times the central ultrasonic wavelength of the probe (centre frequency) under test but not less than 0,5 mm. The bandwidth of the hydrophone and the amplifier shall cover the bandwidth of the probe under test.

7.2 Test blocks and other equipment

For contact probes to be used on carbon steel, the test block quality shall be as defined in ISO 7963. For contact probes to be used on other materials such as stainless steel, aluminum, titanium or plastics, the test block material shall be documented in the probe data sheet or probe test report including the measured sound velocity. The sound attenuation of other materials, especially plastics, shall be considered.

The following test blocks and additional equipment shall be used to carry out the specified range of tests, for contact probes:

- a) Hemicylindrical blocks with different radii (R) in the range from 12 mm to 200 mm. Steps of $R\sqrt{2}$ are recommended. The length of each block shall be equal to or larger than its radius, up to a maximum length of 100 mm. An example is shown in [Figure 3](#).
- b) Blocks with parallel faces and different thicknesses in the range from 12 mm to 200 mm. The length and width of each block shall be equal to or larger than its thickness, up to a maximum thickness of 100 mm.
- c) Blocks with side-drilled holes parallel to the test surface, of preferably 3 mm or 1,5 mm diameter as shown in [Figure 4](#) or [Figure 5](#), respectively. For probes with centre frequencies up to 2 MHz side-drilled holes of 5 mm diameter are recommended. The blocks shall meet the following requirements:
 - 1) the length, height and width shall be such that the sides of the blocks do not interfere with the ultrasonic beam;
 - 2) the depth positions of the holes shall be such that at least three holes fall outside the near field;
 - 3) the position of the holes shall be such that the signals do not interfere, e. g. the amplitude shows a drop of at least 26 dB between two adjacent holes.

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