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Non-destructive testing — Ultrasonic testing — Sensitivity and range setting

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Contents

Foreword.....viii

Introduction.....ix

1 — Scope1

2 — Normative references1

3 — Terms and definitions1

4 — Quantities and symbols2

5 — Qualification of personnel3

6 — Test equipment4

6.1 — Instrument4

6.2 — Probes4

6.2.1 — General4

6.2.2 — Probe selection4

6.2.3 — Frequency and dimensions of transducer4

6.2.4 — Dead zone5

6.2.5 — Damping5

6.2.6 — Focusing probes5

6.3 — Coupling media5

6.4 — Standard blocks6

6.5 — Reference blocks6

6.6 — Specific test blocks6

7 — Categories of test objects7

8 — Test objects, reference blocks and reference reflectors7

9 — Probes13

9.1 — General13

9.2 — Longitudinally curved probes14

9.2.1 — Convex scanning surface14

9.2.2 — Concave scanning surface14

9.3 — Transversely curved probes14

9.3.1 — Convex scanning surface14

9.3.2 — Concave scanning surface15

10 — Determination of probe index point and beam angle15

10.1 — General15

10.2 — Flat angle-beam probes16

10.2.1 — Calibration block technique16

10.2.2 — Reference block technique16

10.3 — Angle-beam probes curved longitudinally16

10.3.1 — Mechanical determination16

10.3.2 — Reference block technique18

10.4 — Angle-beam probes curved transversely18

10.4.1 — Mechanical determination18

10.4.2 — Reference block technique20

10.5 — Probes curved in two directions21

10.6 — Probes for use on materials other than non-alloy steel22

11 Time base setting 22

11.1 General 22

11.2 Reference blocks and reference reflectors 23

11.3 Straight-beam probes 24

11.3.1 Single-reflector technique 24

11.3.2 Multiple-reflector technique 24

11.4 Angle-beam probes 24

11.4.1 Radius technique 24

11.4.2 Straight-beam probe technique 24

11.4.3 Reference block technique 24

11.4.4 Contoured probes 25

11.5 Alternative range settings for angle-beam probes 25

11.5.1 Flat surfaces 25

11.5.2 Curved surfaces 25

12 Sensitivity setting and echo height evaluation 27

12.1 General 27

12.2 Angle of incidence 27

12.3 Distance-amplitude curve (DAC) technique 28

12.3.1 Reference blocks 28

12.3.2 Preparation of a distance-amplitude curve 28

12.3.3 Evaluation of signals using a distance-amplitude curve 30

12.3.4 Evaluation of signals using a reference height 31

12.4 Distance-gain-size (DGS) technique 31

12.4.1 General 31

12.4.2 Reference blocks 34

12.4.3 Use of DGS diagrams 35

12.4.4 Restrictions on use of the DGS technique due to geometry 38

12.5 Transfer correction 39

12.5.1 General 39

12.5.2 Fixed-path length technique 39

12.5.3 Comparative technique 39

12.5.4 Compensation for local variations in transfer correction 41

Annex A (informative) Determination of sound-path distance and angle of incidence in category 2 test objects 42

A.1 Angle of incidence 42

A.2 Sound path when scanning from the outer (convex) surface 43

A.2.1 Full skip 43

A.2.2 Between half and full skip 44

A.2.3 Up to half skip 45

A.3 Sound path when scanning from the inner (concave) surface 46

A.3.1 Full skip 46

A.3.2 Between half and full skip 47

A.3.3 Up to half skip 48

Annex B (informative) General DGS diagram 50

B.1 General 50

B.2 Distance 50

B.3	Gain	51
B.4	Size	51
Annex C (informative)	Determination of contact transfer correction factors	52
C.1	General	52
C.2	Measurement	53
C.3	Evaluation	53
Bibliography		56
Foreword		viii
Introduction		ix
6.1	Instrument	4
6.2	Probes	4
6.2.1	General	4
6.2.2	Probe selection	4
6.2.3	Frequency and dimensions of transducer	4
6.2.4	Dead zone	5
6.2.5	Damping	5
6.2.6	Focusing probes	5
6.3	Coupling media	5
6.4	Standard blocks	6
6.5	Reference blocks	6
6.6	Specific test blocks	6
9.1	General	13
9.2	Longitudinally curved probes	14
9.2.1	Convex scanning surface	14
9.2.2	Concave scanning surface	14
9.3	Transversely curved probes	14
9.3.1	Convex scanning surface	14
9.3.2	Concave scanning surface	15
10.1	General	15
10.2	Flat angle-beam probes	16
10.2.1	Calibration block technique	16
10.2.2	Reference block technique	16
10.3	Angle-beam probes curved longitudinally	16
10.3.1	Mechanical determination	16
10.3.2	Reference block technique	18
10.4	Angle-beam probes curved transversely	18
10.4.1	Mechanical determination	18
10.4.2	Reference block technique	20
10.5	Probes curved in two directions	21
10.6	Probes for use on materials other than non-alloy steel	22
11.1	General	22
11.2	Reference blocks and reference reflectors	23
11.3	Straight-beam probes	24
11.3.1	Single-reflector technique	24
11.3.2	Multiple-reflector technique	24

11.4 Angle-beam probes.....24

11.4.1 Radius technique.....24

11.4.2 Straight-beam probe technique.....24

11.4.3 Reference block technique.....24

11.4.4 Contoured probes.....25

11.5 Alternative range settings for angle-beam probes.....25

11.5.1 Flat surfaces.....25

11.5.2 Curved surfaces.....25

12.1 General.....27

12.2 Angle of incidence.....27

12.3 Distance-amplitude curve (DAC) technique.....28

12.3.1 Reference blocks.....28

12.3.2 Preparation of a distance-amplitude curve.....28

12.3.3 Evaluation of signals using a distance-amplitude curve.....30

12.3.4 Evaluation of signals using a reference height.....31

12.4 Distance-gain-size (DGS) technique.....31

12.4.1 General.....31

12.4.2 Reference blocks.....34

12.4.3 Use of DGS diagrams.....35

12.4.4 Restrictions on use of the DGS technique due to geometry.....38

12.5 Transfer correction.....39

12.5.1 General.....39

12.5.2 Fixed path length technique.....39

12.5.3 Comparative technique.....39

12.5.4 Compensation for local variations in transfer correction.....41

Annex A (informative) Determination of sound path distance and angle of incidence in category 2 test objects.....42

A.1 Angle of incidence.....42

A.2 Sound path when scanning from the outer (convex) surface.....43

A.2.1 Full skip.....43

A.2.2 Between half and full skip.....44

A.2.3 Up to half skip.....45

A.3 Sound path when scanning from the inner (concave) surface.....46

A.3.1 Full skip.....46

A.3.2 Between half and full skip.....47

A.3.3 Up to half skip.....48

Annex B (informative) General DGS diagram.....50

B.1 General.....50

B.2 Distance.....50

B.3 Gain.....51

B.4 Size.....51

Annex C (informative) Determination of contact transfer correction factors.....52

C.1 General.....52

C.2 Measurement.....53

<u>C.3 Evaluation.....</u>	<u>53</u>
<u>Bibliography.....</u>	<u>56</u>

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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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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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).

This second edition cancels and replaces the first edition (ISO 16811:2012), which has been technically revised.

The main changes are as follows:

- normative references have been updated;
- Annex A and Annex B from the prior edition have been moved to the main text;
- document has been editorially revised.

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.

Introduction

The following ~~documents~~[standards on ultrasonic testing](#) are linked:

- ISO 16810, Non-destructive testing — Ultrasonic testing — General principles¹;
- ISO 16811, Non-destructive testing — Ultrasonic testing — Sensitivity and range setting²;
- ISO 16823, Non-destructive testing — Ultrasonic testing — Through transmission technique³;
- ISO 16826, Non-destructive testing — Ultrasonic testing — Testing for discontinuities perpendicular to the surface⁴;
- ISO 16827, Non-destructive testing — Ultrasonic testing — Characterization and sizing of discontinuities⁵;
- ISO 16828, Non-destructive testing — Ultrasonic testing — Time-of-flight diffraction technique as a method for detection and sizing of discontinuities⁶;

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¹It is intended to modify the title of the standard to become *Non-destructive testing — Ultrasonic testing — Time-of-flight diffraction technique for detection and sizing of discontinuities* during the next revision of the standard.

Non-destructive testing — Ultrasonic testing — Sensitivity and range setting

1 Scope

This document specifies the general rules for setting the time-base range and sensitivity (i.e. gain adjustment) of a manually operated ultrasonic instrument with A-scan display in order that reproducible determinations can be made of the location and echo height of a reflector.

~~This document~~ is applicable to contact techniques employing a single probe with either a single transducer or dual transducers, ~~but excludes, This document does not apply to~~ the immersion technique and techniques employing more than one probe.

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 2400, *Non-destructive testing — Ultrasonic testing — Specification for calibration block No. 1*²

ISO 5577, *Non-destructive testing — Ultrasonic testing — Vocabulary*

ISO 7963, *Non-destructive testing — Ultrasonic testing — Specification for calibration block No. 2*²¹

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

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

ISO 22232-2, *Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 2: Probes*

ISO 22232-3, *Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 3: Combined equipment*

3 Terms and definitions

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

² ~~With~~In the next revision of the standard, the term "calibration block" is intended to be replaced by the term "standard block".

- ISO and IEC maintain terminology databases for use in standardization at the following addresses:
- ISO Online browsing platform: available at <https://www.iso.org/obp>
 - IEC Electropedia: available at <https://www.electropedia.org/>

4 Quantities and symbols

A full list of the quantities and symbols used throughout this document is given in Table 1.

Table 1 — Quantities and symbols

Symbol	Quantity	Unit
A	Normalized distance in DGS diagram	
A'	Probe coordinate	mm
a	Projected sound path length	mm
a'	Reduced projected sound path length	mm
α	Beam angle in steel	°
α_r	Beam angle in a non-alloy steel reference block or wedge	°
α_d	Incident angle (beam angle in delay block)	°
α_t	Beam angle in test object	°
β	Angle of incidence	°
c_r	Sound velocity in reference block	m/s
c_t	Velocity of transverse waves in test object	m/s
c_d	Velocity of longitudinal waves in delay block or wedge	m/s
D_{obj}	Outer diameter of test object or curvature of scanning surface	mm
d	Wall thickness	mm
D_{eff}	Effective transducer size	mm
D_{SSH}	Diameter of spherical-shaped reflector	mm
D_{DSR}	Diameter of disc-shaped reflector	mm
D_{ps}	Diameter of probe shoe	mm
D_{SDH}	Diameter of side-drilled hole	mm
e_1 to e_7	Reference block dimensions	mm
g	Depth of contour on probe contact surface	mm
G	Normalized diameter of disc-shaped reflector in DGS-Diagram	
λ	Wavelength	mm
ΔH_0	Difference between the echo height from a reference reflector and the echo height from a discontinuity	dB
l_{ps}	Length of probe shoe	mm
l_d	Length of delay path	mm
Δl_{ps}	Length of contoured probe face	mm

Symbol	Quantity	Unit
N_{eff}	Effective near field length	mm
P_r	Reference point at s_{max}	
P_i	Reference point at s_i	
q	Coordinate of reflector	mm
s	Sound path length (single trip)	mm
s_d	Equivalent sound path distance in the delay block	
s_i	Sound path length of reference reflector	mm
s_{max}	Maximum sound path length	mm
s_u	Sound path length associated with evaluated signal	mm
s_v	Acoustic equivalent to delay path in test object	mm
t	Depth coordinate of reflector	mm
V	Gain in DGS diagram	dB
V_i	Basic gain	dB
V_r	Recording gain	dB
V_t	Gain for determining ΔV_t	dB
V_u	Indication gain	dB
ΔV	Gain difference	dB
ΔV_{\sim}	Correction for ΔV_t	dB
ΔV_k	Gain correction for cylindrical reflector surface	dB
ΔV_s	Gain difference associated with sound path length	dB
ΔV_t	Transfer correction (average)	dB
$V_{t,r}$	Gain for back wall echo on reference block	dB
$V_{t,t}$	Gain for back wall echo on test object	dB
ΔV_u	Difference between indication gain and recording gain	dB
w_{ps}	Width of probe shoe	mm
Δw_{ps}	Width of contouring of the probe face	mm
x	Distance between probe index point and front edge of probe, for an uncontoured probe	mm
Δx	Probe index shift	mm

5 Qualification of personnel

- The testing shall be performed by personnel qualified in accordance with ISO 9712.
- The requirements for qualification of test personnel shall be specified in the product standards and/or other applicable documents.

6 Test equipment

6.1 Instrument

The ultrasonic instrument shall fulfil the requirements of ISO 22232-1.

6.2 Probes

6.2.1 General

The probe(s) shall initially fulfil the requirements of ISO 22232-2.

6.2.2 Probe selection

The choice of the probe depends on the purpose of the testing and the requirements of the referencing standard or specification. It depends on:

- the material thickness, shape and surface condition of the test object;
- the type and metallurgical condition of the material to be tested;
- the type, position and orientation of discontinuities to be detected and assessed.

The probe parameters listed in 6.2.2, 6.2.3 and 6.2.4 shall be considered in relation to the characteristics of the test object stated above.

6.2.3 Frequency and dimensions of transducer

The frequency and dimensions of a transducer determine the shape of the sound beam (near field and beam divergence).

- a) The selection shall assure that the characteristics of the beam are the optimum for the testing by a compromise between the following:
 - 1) the near-field length which shall remain, whenever possible, smaller than the thickness of the test object.
- NOTE It is possible to detect discontinuities in the near field, but their characterization is less accurate and less reproducible than in the far field.
- 2) the beam width, which shall be sufficiently small within the test volume furthest from the probe to maintain an adequate detection level;
 - 3) the beam divergence, which shall be sufficiently large to detect planar discontinuities that are unfavourably orientated.
 - b) Apart from the above considerations, the selection of frequency shall take into account the influence of the sound attenuation in the material and the reflectivity of discontinuities.

The higher the frequency, the greater the test resolution, but the sound waves are more attenuated (or the spurious signals due to the structure are greater) than with lower frequencies.

The choice of frequency thus represents a compromise between these two factors.

Most ultrasonic tests are performed at frequencies between 1 MHz and 10 MHz.