
**Non-destructive testing — Ultrasonic
testing — Vocabulary**

Essais non destructif — Contrôle par ultrasons — Vocabulaire

STANDARDSISO.COM : Click to view the full PDF of ISO 5577:2017



STANDARDSISO.COM : Click to view the full PDF of ISO 5577:2017



COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

| | Page |
|---|-----------|
| Foreword | iv |
| 1 Scope | 1 |
| 2 Normative references | 1 |
| 3 Terms related to frequencies, waves and pulses | 1 |
| 3.1 Frequencies..... | 1 |
| 3.2 Waves and pulses..... | 2 |
| 3.3 Types of waves..... | 4 |
| 4 Terms related to sound | 5 |
| 4.1 Sound generation and reception..... | 5 |
| 4.2 Sound propagation..... | 6 |
| 4.3 Loss of sound pressure..... | 9 |
| 4.4 Sound waves at interfaces..... | 9 |
| 5 Terms related to test equipment | 12 |
| 5.1 Instrument..... | 12 |
| 5.2 Probes..... | 15 |
| 5.3 Combined equipment..... | 20 |
| 5.4 Calibration, reference and test blocks..... | 21 |
| 6 Terms related to ultrasonic testing | 22 |
| 6.1 Testing techniques..... | 22 |
| 6.2 Test object..... | 26 |
| 6.3 Coupling..... | 28 |
| 6.4 Reflectors..... | 28 |
| 6.5 Signals and indications..... | 29 |
| 6.6 Presentations..... | 31 |
| 6.7 Location..... | 35 |
| 6.8 Evaluation of indications..... | 36 |
| Bibliography | 38 |

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 on 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 the following URL: www.iso.org/iso/foreword.html.

ISO 5577 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 138, *Non-destructive testing*, in collaboration with ISO Technical Committee TC 135, *Non-destructive testing*, Subcommittee SC 3, *Ultrasonic 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 5577:2000), which has been technically revised with changes to terms and definitions and structure.

Non-destructive testing — Ultrasonic testing — Vocabulary

1 Scope

This document defines the terms used in ultrasonic non-destructive testing and forms a common basis for standards and general use. This document does not cover terms used in ultrasonic testing with phased arrays.

NOTE Terms for phased array ultrasonic testing are defined in EN 16018.

2 Normative references

There are no normative references in this document.

3 Terms related to frequencies, waves and pulses

For the purposes of this document, the terms and definitions given in this clause and those given in Clauses 4, 5 and 6 for sound, test equipment and ultrasonic testing apply.

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

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

3.1 Frequencies

3.1.1

frequency

number of cycles per second

Note 1 to entry: Expressed in Hertz (Hz).

3.1.2

nominal frequency

probe frequency

frequency (3.1.1) of the *probe* (5.2.1) as stated by the manufacturer

3.1.3

test frequency

effective ultrasonic frequency of a system used to test a material or object

3.1.4

frequency spectrum

distribution of *amplitude* (3.2.2) in relation to *frequency* (3.1.1)

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

3.1.5

centre frequency

arithmetic mean of the cut-off frequencies

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

3.1.6

peak frequency

frequency (3.1.1) at which the maximum amplitude is observed

Note 1 to entry: See Figure 1.

3.1.7

cut-off frequency

frequency (3.1.1) at which the amplitude (3.2.2) of transmitted signal has dropped by a specified amount from the amplitude at peak frequency (3.1.6), for example, by 3 dB

Note 1 to entry: See Figure 1.

3.1.8

bandwidth

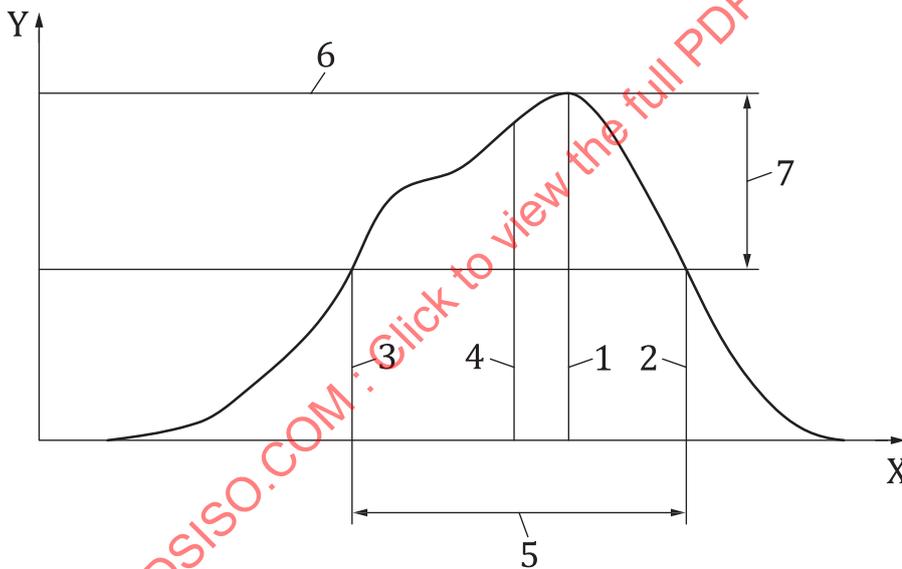
width of the frequency spectrum (3.1.4) between the upper and lower cut-off frequency

Note 1 to entry: See Figure 1.

3.1.9

relative bandwidth

ratio of the bandwidth (3.1.8) to the centre frequency (3.1.5), in per cent



Key

- | | | | |
|---|-------------------------|---|---------------------------------------|
| X | frequency | 4 | centre frequency |
| Y | amplitude | 5 | bandwidth at specified amplitude drop |
| 1 | peak frequency | 6 | peak amplitude |
| 2 | upper cut-off frequency | 7 | specified amplitude drop |
| 3 | lower cut-off frequency | | |

Figure 1 — Terms related to frequency and bandwidth

3.2 Waves and pulses

3.2.1

ultrasonic wave

any acoustic wave having a frequency (3.1.1) higher than the audible range of the human ear, generally taken as higher than 20 kHz

3.2.2**amplitude**

absolute or relative measure of a sound wave's magnitude

3.2.3**phase**

momentary condition of a vibration expressed as an arc measurement or an angle

3.2.4**wavelength**

distance between consecutive corresponding points of the same *phase* (3.2.3)

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

3.2.5**wavefront**

continuous surface joining all the most forward points of a wave that have the same *phase* (3.2.3)

3.2.6**time-of-flight****TOF**

time it takes an ultrasonic pulse to travel from the transmitter probe through the test object to the receiver probe

3.2.7**pulse**

electrical or ultrasonic signal of short duration

3.2.8**pulse amplitude**

maximum amplitude of a *pulse* (3.2.7) (peak-to-peak)

Note 1 to entry: For rectified pulses (A-scan), baseline-to-peak.

3.2.9**pulse rise time**

time taken for a *pulse amplitude* (3.2.8) to change between two defined levels

3.2.10**pulse duration**

time interval between the leading and trailing edges of a *pulse* (3.2.7) measured at a defined level below the peak amplitude

3.2.11**pulse shape**

diagrammatic representation of the *amplitude* (3.2.2) of a *pulse* (3.2.7) as a function of time

3.2.12**pulse envelope**

contour of a *pulse shape* (3.2.11) including all the peaks in terms of *amplitude* (3.2.2) and time

3.2.13**pulse energy**

total energy within a *pulse* (3.2.7)

3.2.14**pulse reverberation**

undesirable vibration at the beginning and end of a *pulse* (3.2.7) above a defined level

3.2.15**broad-band pulse**

pulse (3.2.7) in which the *relative bandwidth* (3.1.9) is $\geq 65\%$

3.2.16

medium-band pulse

pulse (3.2.7) in which the *relative bandwidth* (3.1.9) is >35 % and <65 %

3.2.17

narrow-band pulse

pulse (3.2.7) in which the *relative bandwidth* (3.1.9) is ≤35 %

3.2.18

pulse repetition frequency

PRF

number of *pulses* (3.2.7) generated per second, expressed in Hertz (Hz)

3.3 Types of waves

3.3.1

longitudinal wave

compressional wave

wave in which the direction of displacement of particles is in the same direction as the propagation of the wave

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

3.3.2

transverse wave

shear wave

wave in which the direction of displacement of particles is perpendicular to the direction of the propagation of the wave

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

3.3.3

surface wave

Rayleigh wave

wave which propagates on the surface of a material with an effective penetration depth of less than one *wavelength* (3.2.4)

3.3.4

creeping wave

wave generated at the first *critical angle* (4.4.11) of incidence and propagated along the surface as a *longitudinal wave* (3.3.1)

Note 1 to entry: It is not influenced by the test object's surface conditions, nor does the beam follow undulations on the surface.

3.3.5

plate wave

Lamb wave

wave which propagates within the whole thickness of a plate and which can only be generated at particular values of angle of incidence, *frequency* (3.1.1) and plate thickness

3.3.6

plane wave

wave with a planar wave front

3.3.7

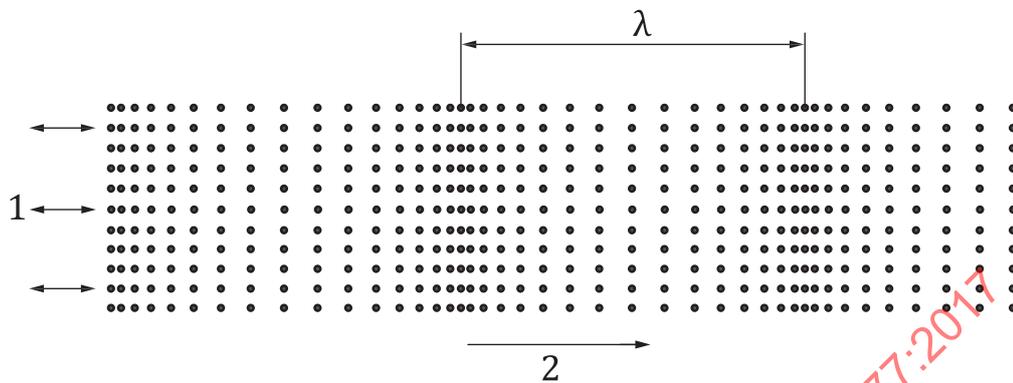
cylindrical wave

wave with a cylindrical wave front

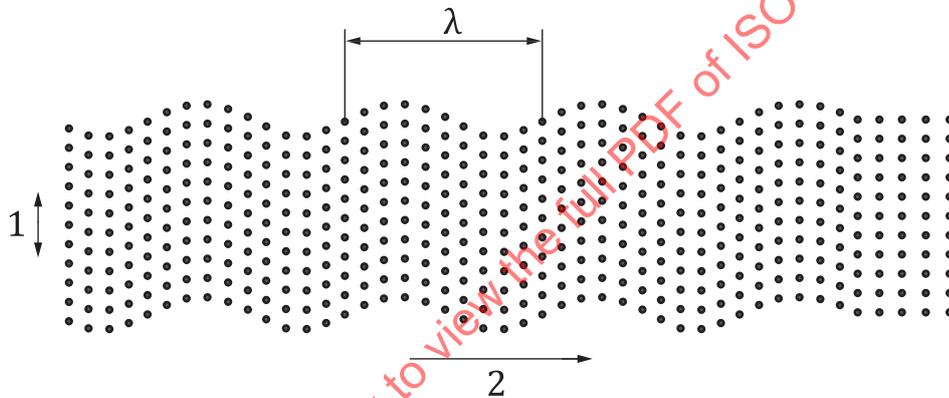
3.3.8

spherical wave

wave with a spherical wave front



a) Longitudinal wave; compressional wave



b) Transverse wave; shear wave

Key

- 1 direction of oscillation
- 2 direction of propagation
- λ wavelength

Figure 2 — Types of waves

4 Terms related to sound**4.1 Sound generation and reception****4.1.1****transducer**active element of a *probe* (5.2.1) which converts electrical energy into sound energy and vice versa**4.1.2****piezo-electric transducer***transducer* (4.1.1) made from piezo-electric material**4.1.3****composite transducer**

plate consisting of piezo-electric ceramic rods embedded in a polymer matrix

4.1.4
electro-magnetic acoustic transducer
EMAT

transducer (4.1.1) which uses magnetostriction or Lorentz force to generate ultrasound in paramagnetic materials

4.1.5
focusing transducer

piezo-electric transducer (4.1.2) having at least one curved surface, used for focusing the sound beam (4.2.2)

4.2 Sound propagation

4.2.1
sound field

three-dimensional pressure distribution produced by transmitted sound energy

4.2.2
sound beam

ultrasonic beam

part of the *sound field* (4.2.1) within which the major part of the ultrasonic energy is transmitted

4.2.3
beam axis

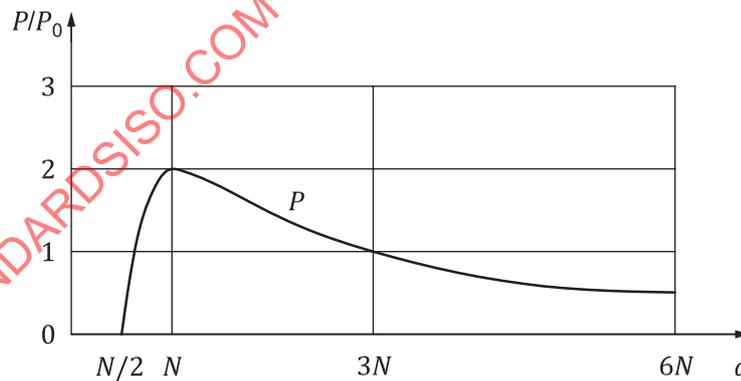
line through the points of maximum sound pressure at different distances

Note 1 to entry: See [Figures 3 b\)](#), [8](#), [9](#), [10](#) and [11](#).

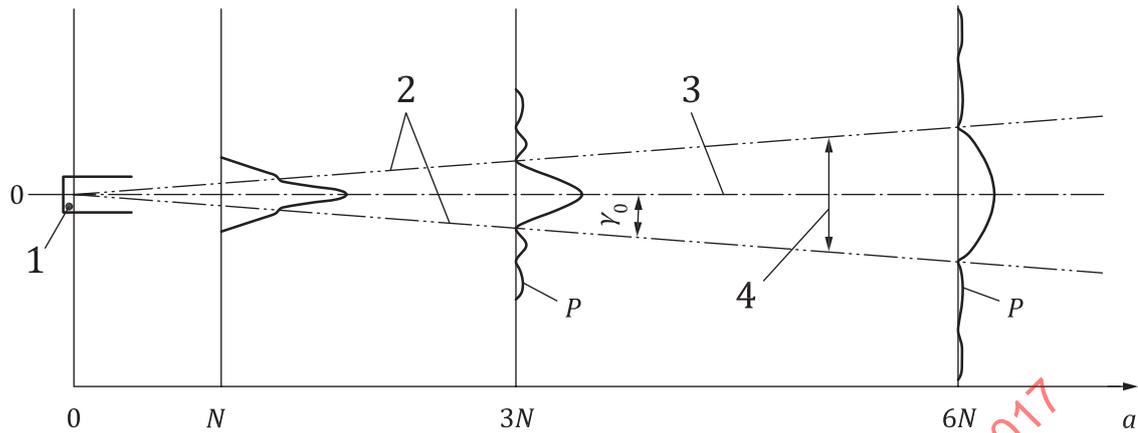
4.2.4
beam profile

curve which shows the signal amplitude along the *beam axis* (4.2.3) or perpendicular to the beam axis at a defined distance from the *probe* (5.2.1)

Note 1 to entry: See [Figure 3](#).



a) Profile along the beam axis



b) Profiles perpendicular to the beam axis

Key

| | | | |
|---|--------------------------------|------------|------------------------------------|
| 1 | transducer | γ_0 | angle of divergence (drop to zero) |
| 2 | beam boundary | a | distance |
| 3 | beam axis | N | near-field length |
| 4 | beam width at a given distance | P | sound pressure |

Figure 3 — Beam profiles**4.2.5****beam boundary**

boundary of the ultrasonic beam where the sound pressure has fallen to a given fraction of the value on the *beam axis* (4.2.3), measured at the same distance from the *probe* (5.2.1)

Note 1 to entry: See [Figures 3 b\)](#), [8](#), [9](#) and [11](#).

4.2.6**beam width**

dimension of the beam perpendicular to the *beam axis* (4.2.3) measured between the beam boundaries at a defined distance from the *probe* (5.2.1)

Note 1 to entry: See [Figure 3 b\)](#).

4.2.7**angle of divergence**

angle within the *far-field* (4.2.11) between the *beam axis* (4.2.3) and the *beam boundary* (4.2.5)

Note 1 to entry: See [Figures 3 b\)](#), [8](#) and [11](#).

4.2.8**near-field**

Fresnel zone

zone of the *sound beam* (4.2.2) where sound pressure does not change monotonically with distance because of interference

Note 1 to entry: See [Figure 8](#).

4.2.9**near-field point**

position on the *beam axis* (4.2.3) where the sound pressure reaches a final maximum

4.2.10

near-field length

distance between the *transducer* (4.1.1) and the *near-field point* (4.2.9)

Note 1 to entry: See [Figure 3](#).

4.2.11

far-field

zone of the *sound beam* (4.2.2) that extends beyond the *near-field point* (4.2.9)

Note 1 to entry: See [Figures 8](#) and [11](#).

4.2.12

focal point

focus

point where the sound pressure on the *beam axis* (4.2.3) is at its maximum

4.2.13

focal distance

focal length

distance from the *probe* (5.2.1) to the *focal point* (4.2.12)

Note 1 to entry: See [Figures 8](#) and [11](#).

4.2.14

focal zone

focal range

zone in *sound beam* (4.2.2) of a *probe* (5.2.1) in which the sound pressure remains above a defined level related to its maximum

4.2.15

length of the focal zone

distance along the *beam axis* (4.2.3) from the start to the end of the *focal zone* (4.2.14)

4.2.16

width of the focal zone

dimension of the *focal zone* (4.2.14) at *focal distance* (4.2.13) perpendicular to the *beam axis* (4.2.3)

4.2.17

acoustical properties

characteristic parameters of a material which control the propagation of sound in the material

4.2.18

acoustically anisotropic material

material which has differing sound velocities in differing directions of propagation

4.2.19

sound velocity

velocity of propagation

phase velocity (4.2.20) or *group velocity* (4.2.21) of a sound wave in a material in the direction of propagation

Note 1 to entry: In a non-dispersive material, there is no difference between phase and group velocity.

Note 2 to entry: In an anisotropic material, the velocities may depend on the direction of propagation.

4.2.20

phase velocity

velocity of propagation (4.2.19) of a wave front

4.2.21**group velocity**

velocity of propagation ([4.2.19](#)) of the acoustic energy

4.3 Loss of sound pressure**4.3.1****attenuation**

sound attenuation

decrease of sound pressure when a wave travels through a material, arising from *absorption* ([4.3.4](#)) and *scattering* ([4.3.3](#))

4.3.2**attenuation coefficient**

coefficient used to express *attenuation* ([4.3.1](#)) per unit of distance travelled, dependent on material properties, *wavelength* ([3.2.4](#)) and wave type

Note 1 to entry: The attenuation coefficient is usually expressed in dB/m.

4.3.3**scattering**

random reflections caused by grain structure and/or by small *reflectors* ([6.4.1](#)) in the beam path

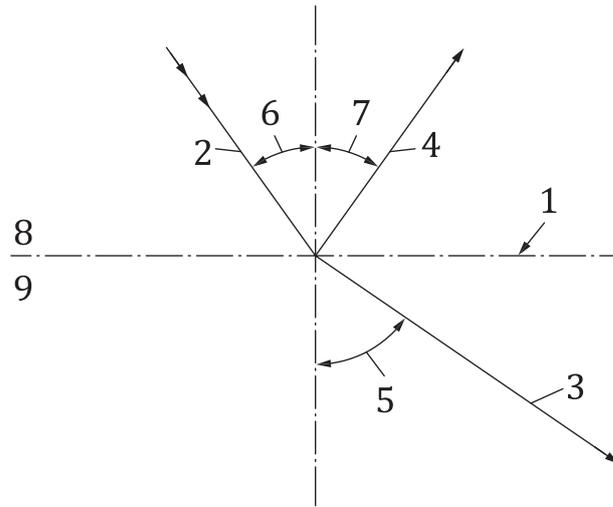
4.3.4**absorption**

part of the *attenuation* ([4.3.1](#)) resulting from transformation of ultrasonic energy into other types of energy, for example, thermal energy

4.4 Sound waves at interfaces**4.4.1****interface**

boundary between two materials, in acoustic contact, having different acoustic properties

Note 1 to entry: See [Figure 4](#).



Key

- | | | | |
|---|-----------------------------|---|---------------------|
| 1 | interface | 6 | angle of incidence |
| 2 | direction of incident wave | 7 | angle of reflection |
| 3 | direction of refracted wave | 8 | medium 1 |
| 4 | direction of reflected wave | 9 | medium 2 |
| 5 | angle of refraction | | |

Figure 4 — Refraction and reflection of waves

4.4.2

angle of incidence

angle between the direction of the incident wave and the normal to the *interface* (4.4.1)

Note 1 to entry: See [Figure 4](#).

4.4.3

reflection

change of the direction of sound propagation within the same material when impinging on an *interface* (4.4.1)

Note 1 to entry: See [Figure 4](#).

4.4.4

refraction

change of the direction of sound propagation when passing obliquely through the *interface* (4.4.1) between two materials of differing sound velocities

Note 1 to entry: See [Figure 4](#).

4.4.5

angle of reflection

angle between the direction of the reflected wave and the normal to the *interface* (4.4.1)

Note 1 to entry: See [Figure 4](#).

4.4.6

angle of refraction

angle between the direction of the refracted wave and the normal to the *interface* (4.4.1)

Note 1 to entry: See [Figure 4](#).

4.4.7**acoustical impedance**

ratio of sound pressure to particle displacement velocity

Note 1 to entry: In a material with perfect elastic properties for a plane longitudinal wave, it is equal to the product of *sound velocity* (4.2.19) and density.

4.4.8**reflection coefficient**

ratio of reflected sound pressure to incident sound pressure at a reflecting surface

Note 1 to entry: The corresponding transmission coefficient is defined in 4.4.9.

4.4.9**transmission coefficient**

ratio of sound pressure transmitted through an *interface* (4.4.1) to the incident sound pressure

Note 1 to entry: The corresponding reflection coefficient is defined in 4.4.8.

4.4.10**refractive index**

ratio of the sound velocities of two materials in contact

4.4.11**critical angle**

angle of incidence (4.4.2) at which the *angle of refraction* (4.4.6) is 90° for a defined wave type

Note 1 to entry: For *longitudinal* (3.3.1) and *transverse waves* (3.3.2), there are two different critical angles.

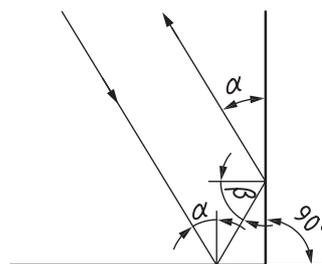
4.4.12**total reflection**

reflection (4.4.3) which occurs when the *angle of incidence* (4.4.2) is greater than the *critical angles* (4.4.11) or if the *reflection coefficient* (4.4.8) is unity

4.4.13**corner reflection**

reflection (4.4.3) of *ultrasonic waves* (3.2.1) in a corner formed by two or three coincident, mutually perpendicular surfaces

Note 1 to entry: See Figure 5.

**Key**

α and β angles of incidence

Figure 5 — Corner reflection

4.4.14**wave mode conversion**

change of wave mode to another by *refraction* (4.4.4) or *reflection* (4.4.3)

4.4.15
edge effect

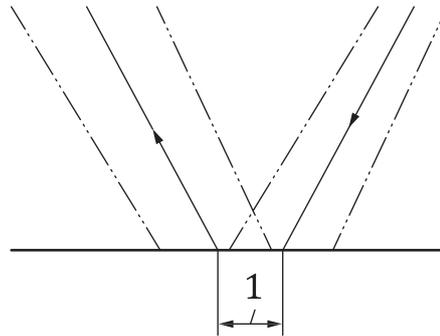
phenomenon resulting from the diffraction of an *ultrasonic wave* (3.2.1) by the edges of a *reflector* (6.4.1)

4.4.16
beam displacement

displacement of the beam due to *reflection* (4.4.3) from a surface of a solid

Note 1 to entry: It mainly depends on *frequency* (3.1.1) and angle.

Note 2 to entry: See [Figure 6](#).



Key

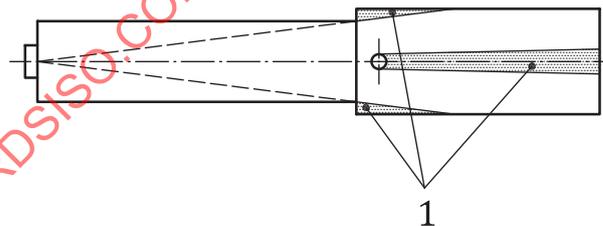
1 beam displacement due to reflection

Figure 6 — Beam displacement

4.4.17
acoustic shadow

region in an object which cannot be reached by *ultrasonic waves* (3.2.1) travelling in a given direction because of the geometry of the object or a discontinuity in it

Note 1 to entry: See [Figure 7](#).



Key

1 acoustic shadow

Figure 7 — Acoustic shadow

5 Terms related to test equipment

5.1 Instrument

5.1.1
ultrasonic instrument

instrument used together with the *probe* or *probes* (5.2.1), which transmits, receives, processes and displays ultrasonic signals for non-destructive testing purposes

5.1.2**transmitter**

electrical device which generates the *transmitter pulses* (5.1.3)

5.1.3**transmitter pulse**

electrical pulse generated by the *ultrasonic instrument* (5.1.1) for exciting the *transducer* (4.1.1)

5.1.4**receiver**

electrical device which amplifies or converts signals coming from the ultrasonic probe into usable signals

5.1.5**amplifier**

electronic device which converts a small signal to a larger signal

Note 1 to entry: This can be a linear amplifier using a linear law or a logarithmic amplifier using a logarithmic law.

5.1.6**attenuator**

electronic device which reduces the *amplitude* (3.2.2) or power of a signal without distortion

5.1.7**gain**

level of amplification of signals

Note 1 to entry: Usually expressed in decibels (dB).

5.1.8**gain control**

instrument control with which a signal may be adjusted to a given height

5.1.9**dynamic range**

ratio of the *amplitudes* (3.2.2) of the largest and smallest signal which an *ultrasonic instrument* (5.1.1) can display without distortion

Note 1 to entry: Dynamic range is usually expressed in decibels (dB).

5.1.10**linearity of amplitude**

vertical linearity

proportionality of the amplitude of signals on the vertical scale of the ultrasonic instrument's display

5.1.11**suppression**

reduction of noise indications by eliminating all *indications* (6.5.14) below a predetermined amplitude level (threshold value)

5.1.12**time-corrected gain****TCG**

distance–amplitude compensation

function of a device which changes the amplification of *echoes* (6.5.1) from *reflectors* (6.4.1) of equal size, but different distances and results in equal height of the echoes on the display

Note 1 to entry: This term shall not be confused with *distance–amplitude curve* (DAC) (6.8.15).

Note 2 to entry: This definition of *time-corrected gain* differs from the definition of the same term given by 6.8.16.

5.1.13

analogue-to-digital converter

device which converts analogue signals into discrete numbers representing the pattern of the signal

5.1.14

digitization error

inaccuracy introduced as a result of analogue-to-digital conversion

5.1.15

time base

abscissa of an A-scan calibrated in time or distance

Note 1 to entry: See [Figure 20](#).

5.1.16

time base control

instrument control which is used to adjust the *time base* ([5.1.15](#)) to a required range

5.1.17

time base range

maximum ultrasonic path length that is displayed on a particular *time base* ([5.1.15](#))

5.1.18

delayed time base sweep

time base sweep triggered with a given delay, fixed or adjustable, in relation to the *transmitter pulse* ([5.1.3](#)) or a *reference echo* ([5.4.4](#))

5.1.19

linearity of time base

horizontal linearity

proportionality of the positions of signals on the *time base* ([5.1.15](#)) of the ultrasonic instrument's display

5.1.20

monitor

component of an *ultrasonic instrument* ([5.1.1](#)) which provides a *gate* ([5.1.21](#)) within which the presence of *echoes* ([6.5.1](#)) above or below a defined level can be indicated

5.1.21

gate

time gate

window

electronic means of selecting a segment of the *time base* ([5.1.15](#)) for monitoring or further processing of signals

5.1.22

gate threshold

monitor level

defined amplitude level (threshold) above or below which echoes (see [6.5.1](#)) signals in a *gate* ([5.1.21](#)) are selected for further processing

5.1.23

proportional gate

gate ([5.1.21](#)) which provides a proportional output of any signal that is received during the period of the gate

Note 1 to entry: The output can be voltage or current.

5.2 Probes

5.2.1

probe

electro-acoustical device, usually incorporating one or more *transducers* (4.1.1), and possibly a *delay line* (5.2.7) intended for transmission and/or reception of *ultrasonic waves* (3.2.1)

5.2.2

single-transducer probe

probe (5.2.1) with a single *transducer* (4.1.1) for the transmission and reception of *ultrasonic waves* (3.2.1)

5.2.3

multi-transducer probe

probe (5.2.1) with several separated *transducers* (4.1.1), which through switching permits the creation of certain *sound beam* (4.2.2) configurations

5.2.4

transducer backing

material coupled to the rear surface of a *transducer* (4.1.1) to damp the transducer oscillation

Note 1 to entry: See [Figures 8, 9](#) and [11](#).

5.2.5

probe shoe

shaped piece of material which is interposed between the *probe* (5.2.1) and the test object for the purpose of improving the coupling and/or protecting the probe

5.2.6

protection layer

layer of protective material forming an integral part of the *probe* (5.2.1) and separating the *transducer* (4.1.1) from direct contact with the test object

Note 1 to entry: See [Figure 8](#).

5.2.7

delay line

delay block

component introduced to create the *delay path* (5.2.8)

5.2.8

delay path

path on the *beam axis* (4.2.3) between *transducer* (4.1.1) and point of entry into the test object

5.2.9

nominal transducer size

physical size of the *transducer* (4.1.1)

5.2.10

effective transducer size

reduced area of the physical size of the *transducer* (4.1.1)

Note 1 to entry: The effective transducer size is determined from the measured *focal distance* (4.2.13), *frequency* (3.1.1), *sound velocity* (4.2.19) and, for *angle-beam probes* (5.2.13), the measured *beam angle* (5.2.15).

5.2.11

wedge

wedge-shaped component usually made of plastic material which causes an *ultrasonic wave* (3.2.1) to be refracted into the test object at a defined angle

Note 1 to entry: See [Figure 9](#).

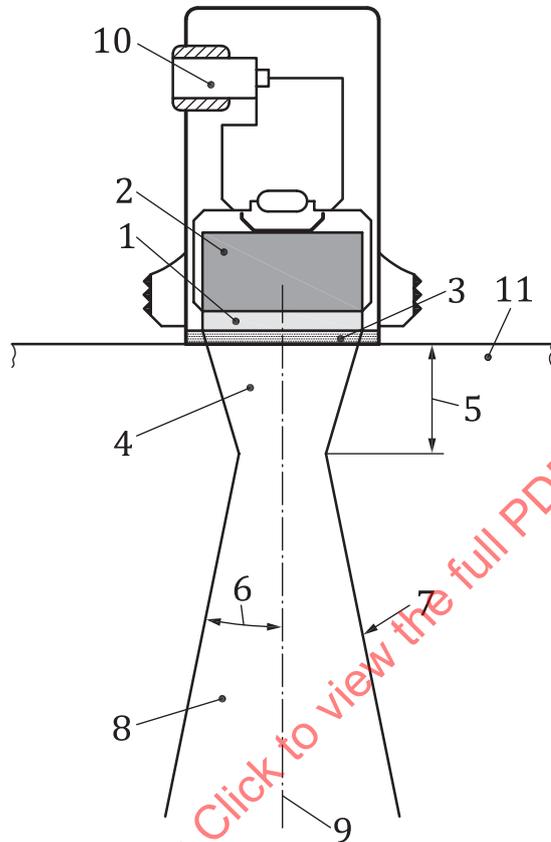
5.2.12

straight-beam probe

normal-beam probe

probe (5.2.1) whose beam axis (4.2.3) is perpendicular to the contact surface

Note 1 to entry: See Figure 8.



Key

- | | | | |
|---|---------------------|----|---------------|
| 1 | transducer | 7 | beam boundary |
| 2 | transducer backing | 8 | far-field |
| 3 | protection layer | 9 | beam axis |
| 4 | near-field | 10 | connector |
| 5 | focal distance | 11 | test object |
| 6 | angle of divergence | | |

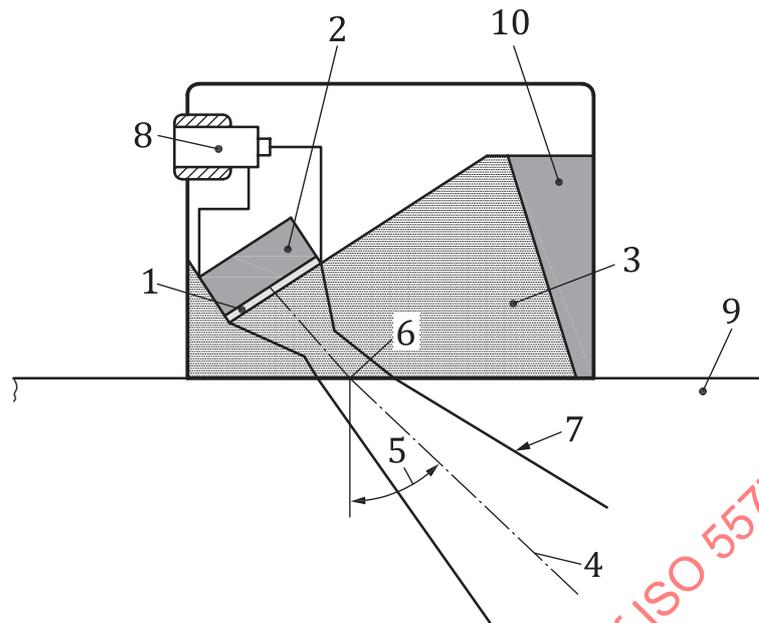
Figure 8 — Straight-beam probe

5.2.13

angle-beam probe

probe (5.2.1) generating a beam at an angle other than normal to the test surface (6.2.1)

Note 1 to entry: See Figure 9.

**Key**

| | | | |
|---|--------------------|----|-------------------|
| 1 | transducer | 6 | probe index point |
| 2 | transducer backing | 7 | beam boundary |
| 3 | wedge | 8 | connector |
| 4 | beam axis | 9 | test object |
| 5 | beam angle | 10 | damping material |

Figure 9 – Angle-beam probe**5.2.14****variable-angle-beam probe**

probe (5.2.1) generating a beam at angles that can be changed

5.2.15**beam angle**

angle between the *beam axis* (4.2.3) and the normal to the *interface* (4.4.1) for a particular *probe* (5.2.1)

Note 1 to entry: See [Figure 9](#).

5.2.16**probe index point**

intersection point of the sound beam axis with the probe contact surface

Note 1 to entry: See [Figures 9](#) and [15](#).

Note 2 to entry: The projection of the probe index point may be marked on the housing of an *angle-beam probe* (5.2.13).

5.2.17**nominal probe angle**

quoted value of the refraction angle of a *probe* (5.2.1) for a given material and temperature

5.2.18**probe axis**

geometrical reference axis through the *probe* (5.2.1), serving as the origin for angular coordinates used in describing the directional characteristics of a probe

Note 1 to entry: See [Figure 10](#).

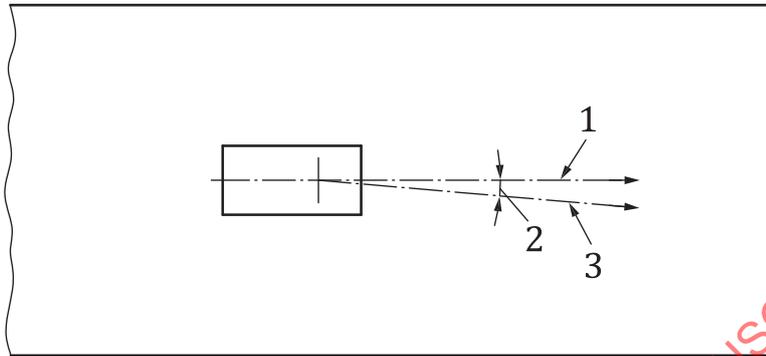
Note 2 to entry: For *straight-beam probes* (5.2.12), the probe axis is perpendicular to the *test surface* (6.2.1). For *angle-beam probes* (5.2.13), the probe axis is projected onto the test surface.

5.2.19

squint angle

angle between the *probe axis* (5.2.18) and the projection of the *beam axis* (4.2.3) on the *test surface* (6.2.1)

Note 1 to entry: See [Figure 10](#).



Key

- 1 probe axis
- 2 squint angle
- 3 beam axis

Figure 10 — Squint angle

5.2.20

longitudinal wave probe

compression wave probe
probe (5.2.1) generating and/or receiving *longitudinal waves* (3.3.1)

5.2.21

transverse wave probe

shear wave probe
probe (5.2.1) generating and/or receiving *transverse waves* (3.3.2) usually via *wave mode conversion* (4.4.14) by *refraction* (4.4.4)

5.2.22

surface wave probe

probe (5.2.1) generating and/or receiving *surface waves* (3.3.3)

5.2.23

contoured probe

probe (5.2.1) having a contact surface which is shaped to fit the curved surface of an object

5.2.24

focusing probe

probe (5.2.1) which concentrates the *sound beam* (4.2.2) by special devices, by curved transducer, lens or electronic mean, to generate a focused beam

5.2.25

cross talk

signal interference across an intended acoustic or electric barrier

Note 1 to entry: An example of electrical cross talk is that between adjacent transmit and receive channels of an *ultrasonic instrument* (5.1.1).

Note 2 to entry: An example of acoustical cross talk is that between *probes* (5.2.1) or between *transducers* (4.1.1) [*dual-transducer probe* (5.2.26)].

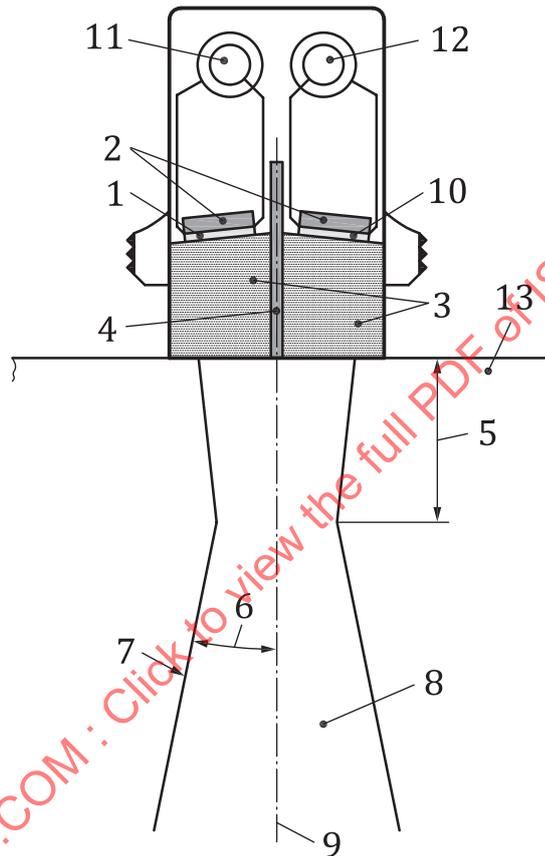
5.2.26

dual-transducer probe

dual-element probe

probe (5.2.1) in which the transmit and receive *transducers* (4.1.1) are separate and are electrically and acoustically isolated from each other

Note 1 to entry: See [Figure 11](#).



Key

- | | |
|---------------------------|---------------------------|
| 1 transmitting transducer | 8 far-field |
| 2 transducer backing | 9 beam axis |
| 3 delay block | 10 receiving transducer |
| 4 acoustic barrier | 11 transmitting connector |
| 5 focal distance | 12 receiving connector |
| 6 angle of divergence | 13 test object |
| 7 beam boundary | |

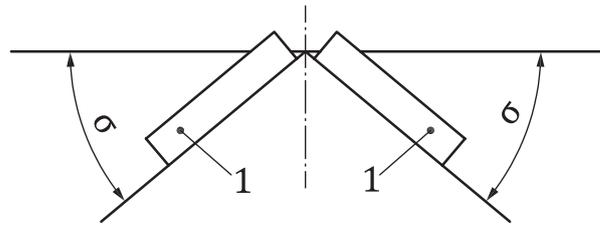
Figure 11 — Dual-transducer probe

5.2.27

roof angle

for *dual-transducer probes* (5.2.26), this angle indicates a difference in orientation of the transducer planes

Note 1 to entry: See [Figure 12](#).



Key

- 1 transducer
- σ roof angle

Figure 12 — Dual-transducer probe with roof angles

5.2.28

convergence zone

zone at the intersection of the transmitting and receiving beams of a *dual-transducer probe* (5.2.26)

5.2.29

immersion probe

probe (5.2.1) generating and/or receiving *longitudinal waves* (3.3.1) to be used in a liquid

5.2.30

wheel probe

probe (5.2.1) generating and/or receiving *ultrasonic waves* (3.2.1) incorporating one or more *transducers* (4.1.1) mounted inside a liquid-filled flexible tyre

5.3 Combined equipment

5.3.1

test equipment

equipment consisting of an *ultrasonic instrument* (5.1.1), *probes* (5.2.1), cables and all devices connected to the instrument during testing

5.3.2

ultrasonic test system

UT system

electro-mechanical system which allows ultrasonic testing of an object

5.3.3

dead zone

zone directly under the coupling surface in which discontinuities are undetectable

Note 1 to entry: The depth of the zone is dependent on various factors, e.g. *probe* (5.2.1), instrument setting, test object material.

5.3.4

detection sensitivity

characteristic of an *ultrasonic test system* (5.3.2) defined by the smallest detectable *reflector* (6.4.1)

5.3.5

lateral resolution

capability of an *ultrasonic test system* (5.3.2) to resolve two separate targets at the same distance

5.3.6

axial resolution

capability of an *ultrasonic test system* (5.3.2) to resolve two separate targets at different distances

5.4 Calibration, reference and test blocks

5.4.1

calibration block

piece of material of specified composition, surface finish, heat treatment and geometric form, by means of which ultrasonic *test equipment* (5.3.1) can be assessed and calibrated

Note 1 to entry: For example, see ISO 2400, ISO 7963 and ISO 16946.

5.4.2

reference block

block of material representative of the material to be tested with similar acoustic properties containing well-defined *reflectors* (6.4.1), used to adjust the sensitivity and/or *time base* (5.1.15) of the *ultrasonic instrument* (5.1.1) in order to compare detected discontinuity indications with those arising from the known reflectors (6.4.1)

5.4.3

test block

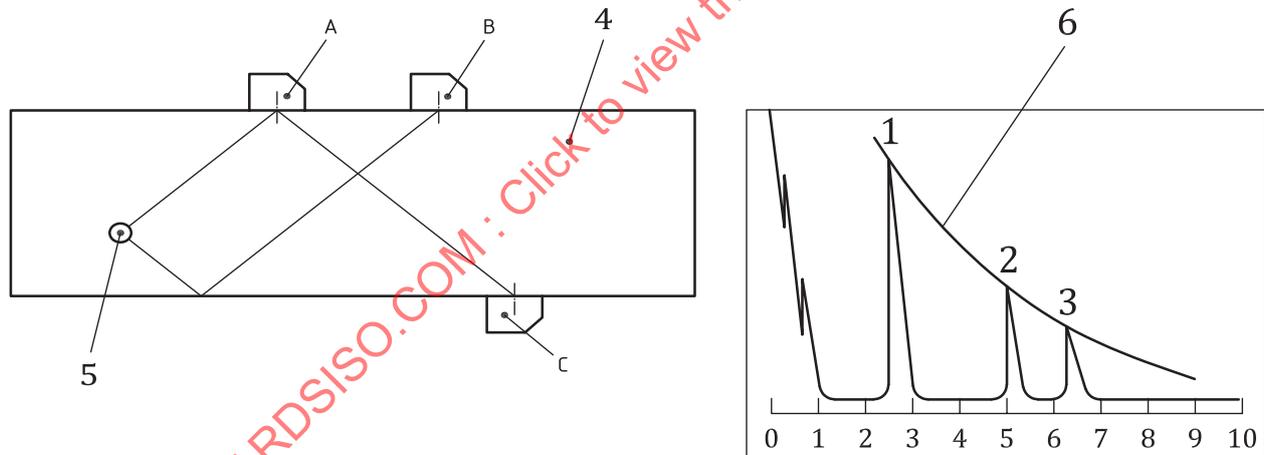
defined piece of material which allows tests for the accuracy and/or performance of an *ultrasonic test system* (5.3.2)

5.4.4

reference echo

echo (6.5.1) from a prescribed *reference reflector* (6.4.2)

Note 1 to entry: Example shown in [Figure 13](#).



a) Generation of reference echoes

b) Display of the reference echoes and the DAC

Key

- | | | | |
|---|---|---|--------------------------------|
| 1 | reference echo from position A (direct) | 4 | reference block |
| 2 | reference echo from position B (indirect) | 5 | reference reflector |
| 3 | reference echo from position C (indirect) | 6 | distance–amplitude curve (DAC) |

Figure 13 — Generation of a DAC

5.4.5

transfer correction

correction of the gain setting of the *ultrasonic instrument* (5.1.1) when transferring the *probe* (5.2.1) from a *calibration* (5.4.1) or *reference block* (5.4.2) to the test object

Note 1 to entry: Transfer correction includes losses due to coupling, surface reflection and *attenuation* (4.3.1).

6 Terms related to ultrasonic testing

6.1 Testing techniques

6.1.1

pulse-echo technique

technique in which an ultrasonic pulse is transmitted and any *echo* (6.5.1) received by the same *probe* (5.2.1) before the next (successive) *pulse* (3.2.7) is transmitted

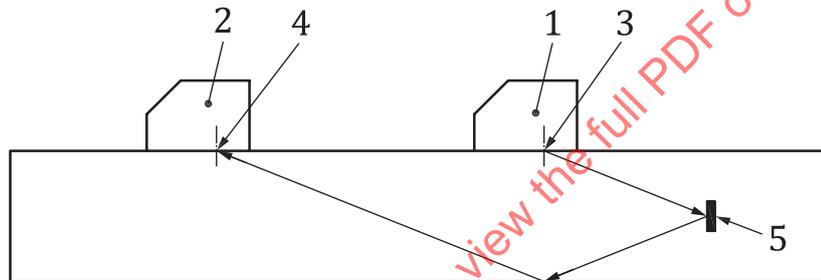
6.1.2

tandem technique

scanning technique involving the use of two or more *angle-beam probes* (5.2.13), usually having the same angle, facing in the same direction and having their ultrasonic beam axes in the same plane perpendicular to the *test surface* (6.2.1), where one *probe* (5.2.1) is used for transmission and the other for reception

Note 1 to entry: The purpose of the technique is mainly to detect discontinuities perpendicular to the *test surface* (6.2.1).

Note 2 to entry: See [Figure 14](#).



Key

- | | | | |
|---|--------------------|---|-----------------|
| 1 | transmitter probe | 4 | receiving point |
| 2 | receiver probe | 5 | reflector |
| 3 | point of incidence | | |

NOTE The function of the transmitter probe and receiver probe can be reversed.

Figure 14 — Tandem technique

6.1.3

through-transmission technique

technique in which the quality of a material is assessed by transmitting *ultrasonic waves* (3.2.1) through the entire material, using a transmitter probe on one side of the object and a receiver probe on the opposite side

6.1.4

contact technique

technique to test an object by means of an ultrasonic probe (or probes) in direct contact with it usually using a thin layer of *couplant* (6.3.3) between the *probe* (5.2.1) and the object

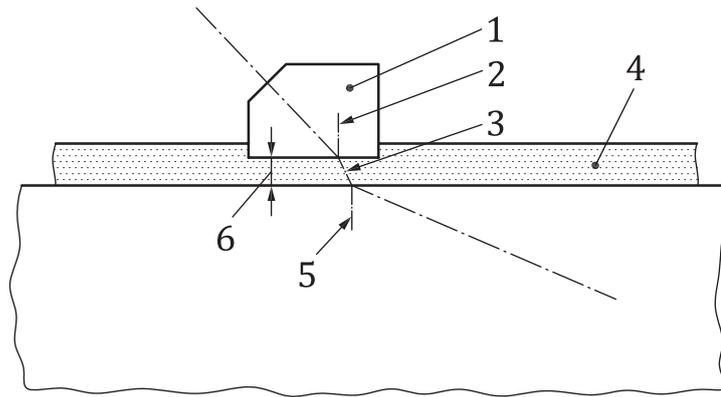
Note 1 to entry: For techniques without direct contact, see *gap technique* (6.1.5) or *immersion technique* (6.1.6).

6.1.5

gap technique

technique in which the *probe* (5.2.1) is not in direct contact with the surface of the test object, but is coupled to it through a layer of liquid, not more than a few *wavelengths* (3.2.4) thick

Note 1 to entry: See [Figure 15](#).

**Key**

| | | | |
|---|-------------------|---|--------------------|
| 1 | angle-beam probe | 4 | couplant |
| 2 | probe index point | 5 | point of incidence |
| 3 | couplant path | 6 | gap |

Figure 15 — Gap technique**6.1.6****immersion technique**

technique in which the test object and the *probe* (5.2.1) are immersed in a liquid used as *coupling medium* (6.3.3)

Note 1 to entry: Immersion can be total or partial. Applications using a water jet are also included.

Note 2 to entry: Depending on the probe setup and object geometry, beam refraction will occur.

6.1.7**multiple-echo technique**

technique in which repeated echoes from either the back surface or a discontinuity are used for the evaluation of echo amplitude and/or sound path

Note 1 to entry: In order to evaluate the quality of a material or bonding, the *amplitudes* (3.2.2) of successive echoes are used.

Note 2 to entry: In order to increase the accuracy of a wall thickness (sound path) measurement, a *multiple echo* (6.5.8) of highest possible number is used.

6.1.8**loss of back-wall echo**

significant reduction of the *amplitude* (3.2.2) of the *echo* (6.5.1) from the back surface

6.1.9**time-of-flight diffraction technique****TOFD technique**

technique using the *time-of-flight* (3.2.6) of diffracted signals from discontinuities in the test object

Note 1 to entry: Usually a pair of *angle-beam probes* (5.2.13) using *longitudinal waves* (3.3.1), one transmitting one receiving, is arranged symmetrically to the area of interest.

Note 2 to entry: For example, see ISO 16828.

6.1.10**synthetic aperture focusing technique****SAFT**

technique to improve the resolution of ultrasonic images by synthetically extending the aperture of a non-focusing probe achieved by digital processing several successive measurements

6.1.11 scanning

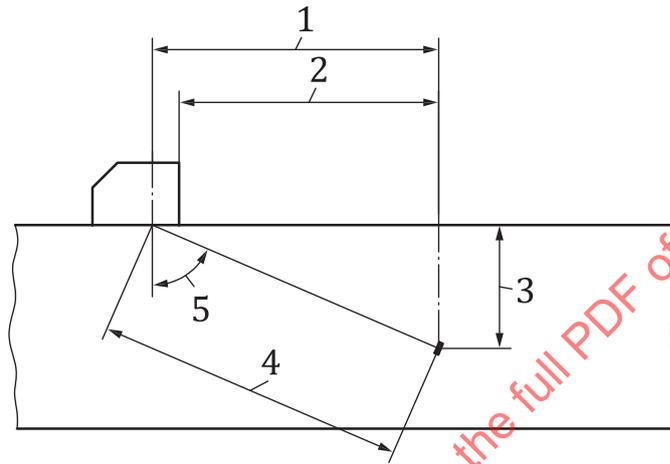
displacement of the *probe(s)* (5.2.1) relative to the test object

Note 1 to entry: Scanning can be done manually by the operator or automated using mechanized device(s).

6.1.12 direct scanning technique

scanning (6.1.11) in which a *sound beam* (4.2.2) is directed into a region of a test object without intermediate reflection

Note 1 to entry: See [Figure 16](#).



Key

- 1 projected sound path length
- 2 reduced projected sound path length
- 3 reflector depth
- 4 sound path length
- 5 angle of refraction

Figure 16 — Direct scanning

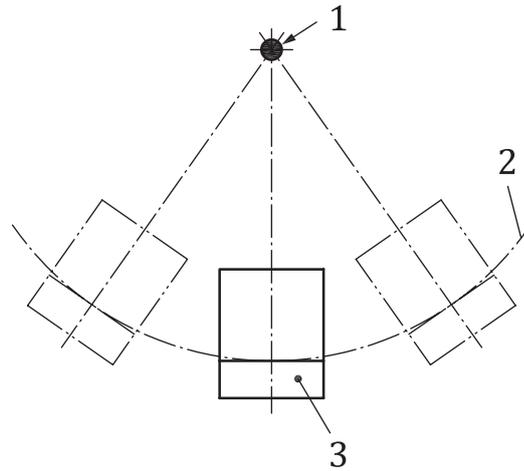
6.1.13 indirect scanning technique

scanning (6.1.11) in which a *sound beam* (4.2.2) is directed into a region of a test object by using *reflection(s)* (4.4.3) at surface(s) of the test object

6.1.14 orbital scanning

scanning (6.1.11) in which an *angle-beam probe* (5.2.13) is used to obtain information about the form of a discontinuity previously located, the scanning being made radially around the discontinuity

Note 1 to entry: See [Figure 17](#).

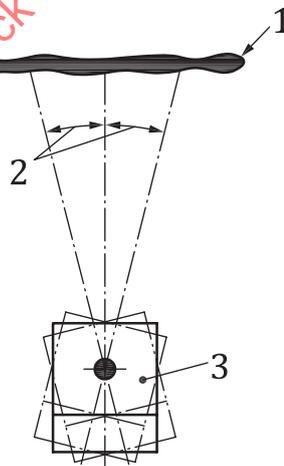
**Key**

- 1 centre of circular motion
- 2 orbit
- 3 angle-beam probe

Figure 17 — Orbital scanning**6.1.15****swivel scanning**

scanning (6.1.11) using an *angle-beam probe* (5.2.13) involving rotation of the *probe* (5.2.1) around an axis through the index point perpendicular to the scanning surface

Note 1 to entry: See [Figure 18](#).

**Key**

- 1 reflector
- 2 swivel angle
- 3 angle-beam probe

Figure 18 — Swivel scanning**6.1.16****spiral scanning**

scanning (6.1.11) of a disc-shaped object by means of radial displacement and simultaneous rotation (spiral trace)

6.1.17

helical scanning

scanning (6.1.11) of a cylindrical object by means of longitudinal displacement and simultaneous rotation (helical trace)

6.1.18

automated ultrasonic testing

AUT

technique by which an object is tested by ultrasound using *probes* (5.2.1) operating under mechanical control and where ultrasonic data is collected automatically

Note 1 to entry: The data may also be analyzed automatically against predetermined criteria without human intervention.

6.1.19

acoustical imaging

generation of an image of an object by using ultrasound

6.1.20

acoustical holography

generation of 3D images of a test object by reconstructing information from the *sound field* (4.2.1) reflected from within the test object located in the sound field

6.1.21

acoustical tomography

generation of a 3D image of a test object from 2D acoustic images representing sections through it

6.1.22

measurement modes

techniques by which the ultrasonic echo pulses are used for determination of time differences

6.1.23

flank-to-flank measurement mode

measurement of the time difference between similar edges (flanks) of two *echoes* (6.5.1), usually defined as rising (leading) or falling (trailing) edge, at a specified *amplitude* (3.2.2)

6.1.24

peak-to-peak measurement mode

measurement of the time difference between the maximum amplitudes of two *echoes* (6.5.1)

6.1.25

zero crossing measurement mode

measurement of the time difference between corresponding *zero crossings* (6.1.26) of two *echoes* (6.5.1)

6.1.26

zero crossing

time when the instantaneous amplitude of an unrectified signal reverses polarity

6.2 Test object

6.2.1

test surface

scanning surface

part of the surface of a test object over which a *probe* or *probes* (5.2.1) is/are moved

6.2.2

test area

defined area on the test object over which the tests are to be conducted

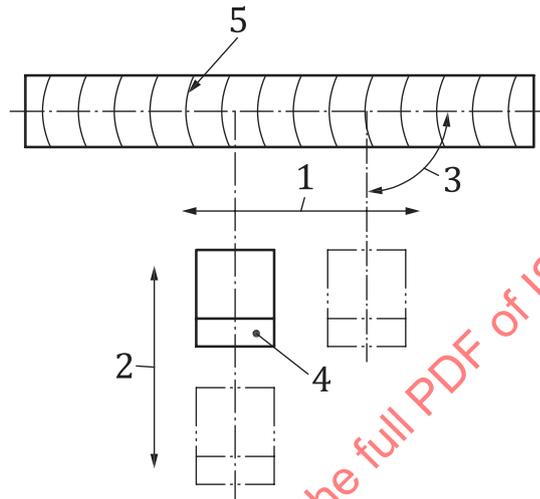
6.2.3**test volume**

volume of the test object which is covered by a test

6.2.4**probe orientation**

angle maintained during *scanning* (6.1.11) between a reference line and the projection of the *beam axis* (4.2.3) onto the *test surface* (6.2.1)

Note 1 to entry: See [Figure 19](#).

**Key**

- 1 scanning direction parallel to the weld
- 2 scanning direction perpendicular to the weld
- 3 probe orientation
- 4 angle-beam probe
- 5 weld

Figure 19 — Weld testing

6.2.5**scanning direction**

direction of movement of a *probe* (5.2.1) over the *test surface* (6.2.1)

Note 1 to entry: See [Figure 19](#).

6.2.6**point of incidence**

point on the test object where the *sound beam* (4.2.2) enters the object

Note 1 to entry: See [Figures 14](#) and [15](#).

6.2.7**receiving point**

point on the test object where the reflected or transmitted *sound beam* (4.2.2) can be received

Note 1 to entry: See [Figure 14](#).

6.3 Coupling

6.3.1

acoustical impedance matching

adaptation of *acoustical impedances* (4.4.7) of two coupled pieces of material, so as to provide optimum transfer of ultrasound between them

6.3.2

coupling techniques

techniques by which ultrasound is transmitted (coupled) from the *probe* (5.2.1) into the test object and vice versa

6.3.3

couplant

coupling medium

medium interposed between the *probe* (5.2.1) and the test object to enable the passage of ultrasound between them, such as water, glycerine or oil

Note 1 to entry: See [Figure 15](#).

6.3.4

couplant path

distance in the *coupling medium* (6.3.3) between the *probe index point* (5.2.16) and the *point of incidence* (6.2.6)

Note 1 to entry: See [Figure 15](#).

6.3.5

coupling losses

reduction of sound transmission across the *interface* (4.4.1) between a *probe* (5.2.1) and a test object

6.4 Reflectors

6.4.1

reflector

interface (4.4.1) at which an ultrasonic beam encounters a change in acoustic impedance and at which at least part of the ultrasound is reflected

Note 1 to entry: See [Figures 14](#) and [18](#).

6.4.2

reference reflector

reflector (6.4.1) (natural or artificial) with known form, size and distance from the *test surface* (6.2.1) in the *calibration block* (5.4.1) or *reference block* (5.4.2), which is used for calibration or assessment of *detection sensitivity* (5.3.4)

EXAMPLE *Side-drilled holes* (6.4.4), *flat-bottomed holes* (6.4.3), *hemispherical-bottomed holes* (6.4.5), *notches* (6.4.6).

Note 1 to entry: See [Figure 13](#).

6.4.3

flat-bottomed hole

FBH

disc-shaped reflector

borehole where the flat bottom acts as a disc-shaped reflector perpendicular to the *beam axis* (4.2.3)

6.4.4**side-drilled hole****SDH**

cylindrical reflector

borehole perpendicular to the *beam axis* (4.2.3) where the cylindrical surface acts as a *reflector* (6.4.1)

6.4.5**hemispherical-bottomed hole**

spherical-shaped reflector

borehole near parallel to the *beam axis* (4.2.3) where the hemispherical bottom acts as a *reflector* (6.4.1)

6.4.6**notch**

plane surface-breaking reflector usually perpendicular to the surface where the sides and/or the bottom can act as *reflectors* (6.4.1)

6.5 Signals and indications**6.5.1****echo**

signal on the display of the *ultrasonic instrument* (5.1.1) received from the test object

Note 1 to entry: See [Figure 20](#).

Note 2 to entry: Depending on the test setup, additional echoes may be received.

6.5.2**back-wall echo**

echo (6.5.1) from the surface of the test object opposite to the *probe* (5.2.1) which is perpendicular to the ultrasonic beam axis

Note 1 to entry: See [Figure 20](#).

6.5.3**surface echo**

echo (6.5.1) from the *test surface* (6.2.1), usually present in *immersion technique* (6.1.6) or with *contact technique* (6.1.4) using a *delay block* (5.2.7)

Note 1 to entry: See also *interface echo* (6.5.9).

6.5.4**side wall echo**

echo (6.5.1) from a surface of the test object other than the back and *test surface* (6.2.1)

6.5.5**echo width**

duration of an *echo* (6.5.1) measured at a specified level

6.5.6**echo height**

height of an echo indication on the display

6.5.7**spurious echo**

echo (6.5.1) which is not associated with a discontinuity and is of no interest

6.5.8**multiple echo**

echo (6.5.1) from repeated reflection of an ultrasonic pulse between two or more *interfaces* (4.4.1) or discontinuities

6.5.9

interface echo

echo (6.5.1) from the *interface* (4.4.1) between dissimilar materials

Note 1 to entry: Usually used for bond testing.

6.5.10

ghost echo

phantom echo

echo (6.5.1) originating from a transmitted pulse generated in a previous cycle

6.5.11

echo pattern

typical pattern of one or more *echoes* (6.5.1) displayed on the instrument

Note 1 to entry: For example, see ISO 23279.

6.5.12

dynamic echo pattern

envelope pattern generated by individual *echoes* (6.5.1) displayed on the instrument when moving the *probe* (5.2.1)

Note 1 to entry: For example, see ISO 23279.

6.5.13

static echo pattern

pattern of individual *echoes* (6.5.1) displayed on the instrument when the *probe* (5.2.1) is not moved

Note 1 to entry: For example, see ISO 23279.

6.5.14

indication

any signal shown on the display of an *ultrasonic instrument* (5.1.1), which can be separated from *noise* (6.5.15), surface and *back-wall echoes* (6.5.2)

6.5.15

noise

undesired signals (electrical or acoustical) that tend to interfere with the reception, interpretation or processing of the desired signal

6.5.16

noise level

amplitudes (3.2.2) of background *noise* (6.5.15) in an ultrasonic system

6.5.17

signal-to-noise ratio

ratio of the amplitude of an ultrasonic signal to the *amplitude* (3.2.2) of the *noise* (6.5.15) at approximately the same location

6.5.18

transmitter pulse indication

indication (6.5.14) of the *transmitter pulse* (5.1.3) on the display of the *ultrasonic instrument* (5.1.1)

Note 1 to entry: See [Figure 20](#).

6.5.19

transmission point

zero point

point on the *time base* (5.1.15) which corresponds to the instant at which ultrasound enters the test object

Note 1 to entry: The transmission point does not necessarily coincide with the *transmitter pulse indication* (6.5.18), e.g. in case of immersion testing or when using a *delay line* (5.2.7).

6.5.20**expanded time base**

scale expansion

zooming into a selected section of the set range which enables *echoes* (6.5.1) within the thickness or length of the test object to be displayed in greater detail on the display

6.5.21**display response**

time it takes the display device to change from one display state to another

Note 1 to entry: The display response is limiting the scanning speed.

6.5.22**radio frequency signal**

RF signal

unrectified signal

Note 1 to entry: In ultrasonic testing, the term radio frequency is misleading, because no radio frequencies are used.

6.6 Presentations

For an overview of the different presentations, see [Table 1](#).

Table 1 — Overview of the different presentations

| Type of presentation | Spatial coordinates | | Signal amplitude | Time | Other features | Type of data acquisition |
|---------------------------------------|--------------------------|--------------------------|------------------|------|----------------|--------------------------|
| | Direction 1 (d_1) | Direction 2 (d_2) | A | t | F | |
| A-scan (6.6.1) | | | • | • | | $A = f(t)$ |
| B-scan (d_1) (6.6.2) | • | | • | • | | $A = f(d_1, t)$ |
| B-scan (d_2) ^a (6.6.2) | | • | • | • | | $A = f(d_2, t)$ |
| C-scan (6.6.3) | • | • | • | | | $A = f(d_1, d_2)$ |
| F-scan (6.6.4) | • | • | | | • | $F = f(d_1, d_2)$ |
| T-scan (6.6.6) | • | • | | • | | $t = f(d_1, d_2)$ |
| V-scan (6.6.7) | • | • | • | • | | $A = f(d_1, d_2, t)$ |

^a B-scan (d_2) which is perpendicular to B-scan (d_1) is also called D-scan.

6.6.1**A-scan presentation**

display of the ultrasonic signals in which the X-axis represents time and the Y-axis represents *amplitude* (3.2.2)

Note 1 to entry: See [Figure 20](#).