



BSI Standards Publication

Non-destructive testing — Ultrasonic testing — Characterization and sizing of discontinuities

National foreword

This British Standard is the UK implementation of EN ISO 16827:2025. It is identical to ISO 16827:2025. It supersedes BS EN ISO 16827:2014, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee WEE/46/3, Ultrasonic Testing.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Characterization and sizing of discontinuities (ISO
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Essais non destructifs - Contrôle par ultrasons -
Caractérisation et dimensionnement des discontinuités
(ISO 16827:2025)

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Beschreibung und Größenbestimmung von
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European foreword

This document (EN ISO 16827:2025) has been prepared by Technical Committee ISO/TC 135 "Non-destructive testing" in collaboration with Technical Committee CEN/TC 138 "Non-destructive testing" the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2025, and conflicting national standards shall be withdrawn at the latest by December 2025.

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Endorsement notice

The text of ISO 16827:2025 has been approved by CEN as EN ISO 16827:2025 without any modification.

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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).

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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 16827:2012), which has been technically revised.

The main changes are as follows:

- figures have been updated;
- references have been updated;
- information added in the scope that the technique can also be used with phased array.

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 on ultrasonic testing 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 — Through transmission technique*

ISO 16826, *Non-destructive testing — Ultrasonic testing — Testing 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*

Non-destructive testing — Ultrasonic testing — Characterization and sizing of discontinuities

1 Scope

This document specifies the general principles and techniques for the characterization and sizing of previously detected discontinuities in order to ensure their evaluation against applicable acceptance criteria.

This document is applicable, in general terms, to discontinuities in those materials and applications covered by ISO 16810.

Phased array techniques can also be applied but additional steps or verifications can be needed.

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

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

3 Terms and definitions

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

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 Principles of characterization of discontinuities

4.1 General

Characterization of a discontinuity involves the determination of those features which are necessary for its evaluation with respect to specified acceptance criteria.

Characterization of a discontinuity can include:

- a) determination of basic ultrasonic parameters (echo height, time of flight);
- b) determination of its basic shape and orientation;
- c) sizing, which may take the form of either:
 - 1) the determination of one or more dimensions (or area/volume), within the limitations of the methods; or

- 2) the determination of some specified parameter, e.g. echo height, where this is taken as representative of the physical size of the discontinuity;
- d) location, e.g. the proximity to the surface or to other discontinuities;
- e) determination of any other parameters or characteristics that may be necessary for complete evaluation;
- f) assessment of probable nature, e.g. crack or inclusion, where adequate knowledge of the test object and its manufacturing history makes this feasible.
- g) The requirements of ISO 16810 apply unless stated otherwise.

Where the test in accordance with the principles of ISO 16810 yields sufficient data on the discontinuity for its evaluation against the applicable acceptance criteria, no further characterization is necessary.

- h) The techniques used for characterization shall be specified in conjunction with the applicable acceptance criteria.

4.2 Requirements for surface condition

- a) The surface finish and profile shall be such that it permits sizing of discontinuities with the desired accuracy.

In general, the smoother and flatter the surface the more accurate the results will be.

For most practical purposes a surface finish of $R_a = 6,3 \mu\text{m}$ for machined surfaces and $12,5 \mu\text{m}$ for shot-blasted surfaces are recommended.

NOTE Determination of the surface roughness is out of the scope of this document.

- b) The gap between the probe and the surface shall not exceed 0,5 mm.
- c) The above surface requirements shall normally be limited to those areas from which sizing is to be carried out as, in general, they are unnecessary for discontinuity detection.
- d) The method of surface preparation shall not produce a surface that gives rise to a high level of noise.

5 Pulse-echo techniques

5.1 General

The principal ultrasonic characteristics/parameters of a discontinuity that are most commonly used for evaluation by the pulse-echo techniques are described in [5.2](#) to [5.7](#) inclusive.

The characteristics/parameters to be determined shall be defined in the applicable standard or any relevant contractual document, and shall meet the requirements on the characterization of discontinuities given in ISO 16810.

5.2 Location of discontinuity

The location of a discontinuity is defined as its position within a test object with respect to an agreed system of reference co-ordinates.

- a) It shall be determined in relation to one or more datum points and with reference to the index point and beam angle of the probe, and measurement of the probe position and sound path length at which the maximum echo height is observed.
- b) Depending on the geometry of the test object and the type of discontinuity, it may be necessary to confirm the location of the discontinuity from another direction, or with another beam angle, to ensure that the echo is not caused e.g. by a wave mode conversion at a geometrical feature of the test object.

5.3 Orientation of discontinuity

The orientation of a discontinuity is defined as the direction or plane along which the discontinuity has its major axis (axes) with respect to a datum reference on the test object.

- The orientation can be determined by a geometrical reconstruction analogous to that described for location, with the difference that more beam angles and/or scanning directions are generally necessary than for a simple location.
- The orientation may also be determined from observation of the scanning direction at which the maximum echo height is obtained.
- In several applications, the precise determination of the discontinuity orientation in space is not required, only the determination of the projection of the discontinuity onto one or more specified planes and/or sections within the test object.

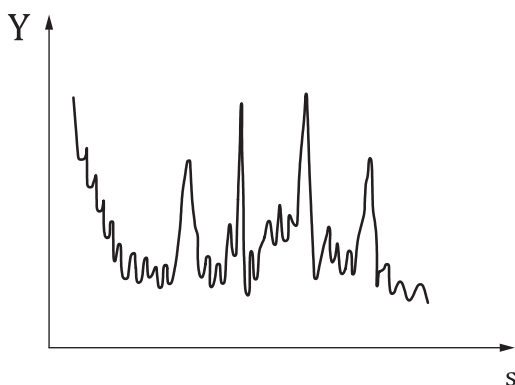
5.4 Assessment of multiple indications

The method for distinguishing between single and multiple discontinuities may be based on either qualitative assessment or quantitative criteria.

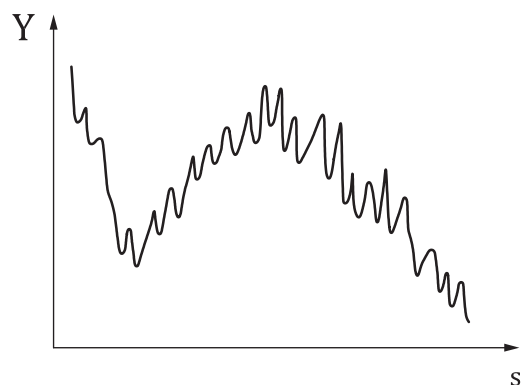
- The qualitative determination consists of ascertaining, through the observation of the variations of the ultrasonic indications, whether or not such indications correspond to one or more separate discontinuities. [Figure 1](#) shows typical examples of signals from grouped discontinuities in a forging or casting.
- Where acceptance criteria are expressed in terms of maximum allowable dimensions, preliminary quantitative determinations shall be made in order to determine whether separate discontinuities are to be evaluated individually or collectively according to pre-established rules governing the evaluation of the group.
- Such rules may be based on the concentration of individual discontinuities within the group, expressed in terms of the total of their lengths, areas or volumes in relation to the overall length, area or volume of the group.

Alternatively, the rules may specify the minimum distance between individual discontinuities, often as a ratio of the dimensions of the adjacent discontinuities.

- Where a more accurate characterization of a group of indications is required, an attempt shall be made to determine whether the echoes arise from a series of closely spaced but separate discontinuities, or from a single continuous discontinuity having a number of separate reflecting facets, using the techniques in accordance with [Annex A](#).



a) Resolvable grouped discontinuities



b) Unresolvable grouped discontinuities

Key

- s sound path
Y signal amplitude

Figure 1 — Examples of A-scan signals from grouped discontinuities

5.5 Shape of discontinuity

5.5.1 Simple classification

There is a limited number of basic reflector shapes that can be identified by ultrasonic testing.

In many cases, evaluation against the applicable acceptance criteria only requires a relatively simple classification in accordance with [B.1](#).

- a) According to this, the discontinuity shall be classified as either:
 - 1) point, i.e. having no significant extent in any direction;
 - 2) elongated, i.e. having a significant extent in one direction only;
 - 3) complex, i.e. having a significant extent in more than one direction.
- b) When required, the classification “complex” may be sub-divided into:
 - 1) planar, i.e. having a significant extent in 2 directions only, and
 - 2) volumetric, i.e., having a significant extent in 3 directions.
- c) Depending upon the requirements of the acceptance standard, either:
 - 1) separate acceptance criteria may apply to each of the above classifications; or
 - 2) the discontinuity, independently of its point, elongated or complex configuration, is projected onto one or more pre-established sections, and each projection is conservatively treated as a crack-like planar discontinuity.
- d) Simple classification will normally be limited to the use of those probes and techniques specified in the test procedure.
- e) Additional probes or techniques may only be used where agreed.

5.5.2 Detailed classification

- a) In order to correctly identify the discontinuity types specified in the acceptance criteria, or to make a correct fitness-for-purpose evaluation, it can be necessary to make a more detailed assessment of the shape of the discontinuity.

Guidance on the methods that may be used for a more detailed classification is contained in [B.2](#).

A classification can require the use of additional probes and scanning directions to those specified in the test procedure for the detection of discontinuities, and can also be aided by the use of the special techniques in [Annexes E, F and G](#).

- b) Classification of discontinuity shape will be limited to the determination of those discontinuity shapes which are necessary for the correct evaluation of a discontinuity against the acceptance criteria or other requirements.

The validity of such a classification should be proven for the specific application, e.g. materials and configuration of the test object, test procedure, type of instrument and probes used.

5.6 Maximum echo height of indication

The maximum echo height from a discontinuity is related to its size, shape and orientation. It is measured by comparison with a specified reference level according to the methods described in ISO 16811.

Depending on the application and acceptance criteria the maximum echo height can be:

- a) compared directly with a reference level that is specified in the acceptance standard;
- b) used to determine the equivalent size of a discontinuity by comparison with the echo from a reference reflector at the same sound path length in the material under test, or in a reference block having the same acoustic properties, as described in [5.7.2](#);
- c) used in probe movement sizing techniques based on a specified echo drop (e.g. 6 dB) below the maximum, as described in [5.7.3](#).

5.7 Size of discontinuity

5.7.1 General

The sizing of a discontinuity consists in determining one or more projected dimensions/areas of the discontinuity onto pre-established directions and/or sections.

If sizing is required, sizing techniques according to [Annex C](#) or [Annex D](#) shall be applied.

A short description of these techniques is found in [Annex F](#) and further details are given in ISO 16811.

5.7.2 Maximum echo height techniques

These techniques are based on a comparison of the maximum echo height from a discontinuity with the echo height from a reference reflector at the same sound path length.

They are only meaningful if:

- a) the shape and orientation of the discontinuity are favourable for reflection, hence the need to perform echo height determinations from several directions or angles, unless the shape and orientation are already known; and
- b) the dimensions of the discontinuity, perpendicular to the beam axis, are less than the beam width in either one or both directions;
- c) the basic shape and orientation of the reference reflector are similar to those of the discontinuity to be evaluated.
- d) The reference reflector may be either a disc-shaped reflector, e.g. flat-bottomed hole, or an elongated reflector, e.g. a side-drilled hole or notch.
- e) Discontinuities subject to sizing may be classified as follows:
 - 1) discontinuities whose reflective area has dimensions less than the beam width in all directions;
 - 2) discontinuities whose reflective area shows a narrow, elongated form, i.e. having a length greater than the beam width and a transverse dimension less than the beam width.
- f) For discontinuities corresponding to e) 1), the area of the discontinuity, projected onto a section normal to the ultrasonic beam axis, is assumed to be equivalent to the area of a disc-shaped reflector, perpendicular to the beam axis, producing a maximum echo of the same height at the same sound path length.
- g) For discontinuities corresponding to e) 2), the reference reflectors are generally of elongated form, transverse to the ultrasonic beam axis, and having a specified transverse profile.

Such reflectors may be notches with rectangular, U- or V-shaped profile, or side-drilled holes.

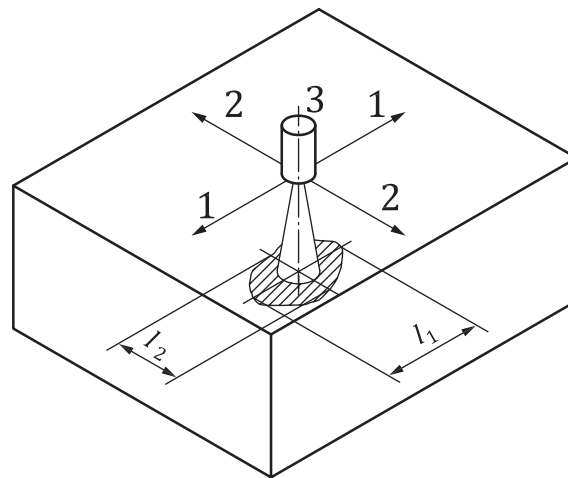
5.7.3 Probe movement sizing techniques

- a) When using a straight-beam probe the dimensions generally determined are l_1 and l_2 , in directions parallel to the scanning surface, by probe movement in two mutually perpendicular directions (see [Figure 2](#)).
- b) When using an angle-beam probe, the dimensions generally determined are:
 - 1) dimension, l , parallel to the lateral scanning direction, determined by lateral movement of the probe (see [Figure 3](#));
 - 2) dimension, h , perpendicular to the scanning surface, determined by transverse movement of the probe (see [Figure 3](#)).
- c) The techniques are classified into three categories, as follows:
 - 1) fixed amplitude level techniques where the ends of a discontinuity are taken to correspond to the plotted positions at which the echo height falls below a specified evaluation level;
 - 2) techniques where the edges of the discontinuity are taken to correspond to the plotted positions at which the maximum echo height at any position along the discontinuity has fallen by a specified number of decibels.

The edges of the discontinuity may be plotted along the beam axis or along a predetermined beam edge;

 - 3) techniques which aim to position the individual echoes from the tips of the discontinuity, or from reflecting facets immediately adjacent to the edges.

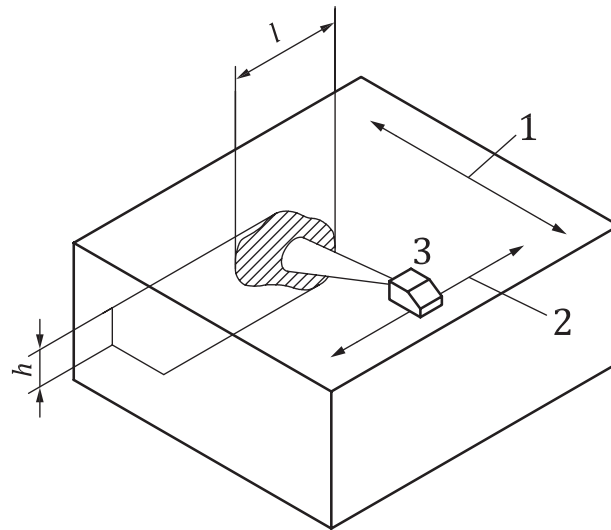
The principal probe movement sizing techniques are described in [Annex D](#).



Key

- 1 probe movement in direction x
- 2 probe movement in direction y
- 3 straight-beam probe
- l_1 extent in direction x
- l_2 extent in direction y

Figure 2 — Parameters l_1 and l_2 for the conventional sizing of a discontinuity by a straight-beam probe

**Key**

- 1 transverse movement
- 2 lateral movement
- 3 angle-beam probe
- l extent parallel to the lateral scanning direction
- h extent perpendicular to the scanning surface

Figure 3 — Projected parameters l and h for the conventional sizing of a discontinuity by an angle-beam probe

5.7.4 Selection of sizing techniques

The selection of sizing technique(s) depends upon the specific application and product type, and on the size and nature of the discontinuity.

The following general rules apply:

- a) maximum echo height techniques (see 5.7.2) may be applied only if the dimension to be measured is less than the 6 dB beam width;
- b) fixed amplitude level techniques [see 5.7.3, c)1)] may be applied to discontinuities of any dimension, but since the measured size is an arbitrary value dependent on the particular amplitude level selected, these techniques should only be used when specifically called for in the acceptance standard;
- c) techniques based on probe movement at a specified dB drop below the maximum echo height from the particular discontinuity [see 5.7.3, c)2)] may be applied only where the measured dimension is greater than the beam width at the same dB drop.
- d) If condition c) is not fulfilled the dimension of the discontinuity shall be assumed to be equal to the applicable beam width;
- e) techniques based on positioning the individual edges of a discontinuity [see 5.7.3, c)3)] can only be applied when the ultrasonic indication from the discontinuity shows two or more resolvable echo maxima;
- f) if the dimension to be determined is measured by more than one technique of 5.7.3, that value determined by the technique whose reliability and accuracy can be demonstrated to be the highest shall be assumed to be correct.
- g) Alternatively, the highest measured value shall be assumed.

5.7.5 Sizing techniques with focusing probes

If focusing probes are used for sizing, the techniques described in [5.7.2](#) and [5.7.3](#) can also be used, provided that the discontinuity falls within the focal zone of the beam.

In general, the rules given under [5.7.4](#) also apply to focusing probes.

Where a higher accuracy of sizing is requested, an alternative technique can be used that is based on the construction of a series of C-scan presentations of the discontinuity.

These shall be plotted through an iterative process of 6 dB steps, starting from an initial plot corresponding to the 6 dB step from the maximum echo of discontinuity, down to the step where the evolution of the plot corresponding to a 6 dB drop step is equal to, or less than, the 6 dB half-width of the ultrasonic beam.

In principle, this iterative technique can be used with both focused and unfocused ultrasonic beams, but where high accuracy is required, it is particularly suitable for use with focused beams.

[Annex E](#) illustrates this technique in detail.

5.7.6 Use of mathematical algorithms for sizing

The main purpose of the sizing techniques illustrated in [5.7.2](#) and [5.7.3](#) is to compare the determined discontinuity size with acceptance levels expressed in terms of maximum allowable dimensions (or areas/volumes).

Where a higher accuracy is required in order to better estimate the actual size of a discontinuity, but only data from the techniques described in [5.7.2](#) and [5.7.3](#) are available, mathematical algorithms may be of help.

[Annex F](#) illustrates in detail algorithms that can be used for the estimation of the actual size of discontinuities that are either larger or smaller than the diameter of the ultrasonic beam.

5.7.7 Special sizing techniques

Special sizing techniques are additional to those described in [5.7.2](#) to [5.7.6](#) and may be used in particular applications where higher levels of reliability and accuracy are called for.

- a) When required, the reliability and accuracy of a special technique, applied to meet specified acceptance criteria, shall be demonstrated on the same configuration and type of material using the same test procedure and type of instrument and probes.
- b) The following list of special techniques is not comprehensive due to the large number available and their continuous development. Those described are the most commonly applied and their use is sufficiently well established.

1) Tip diffraction techniques

These techniques can be used for the confirmation of the planar nature of a discontinuity (if this is the case) and for sizing the transverse dimension ("h" of [Figure 3](#)) of a planar discontinuity. They are based on the detection and location of pulses diffracted by discontinuity edges. See [Annex G.1](#).

2) Mode conversion techniques

Where applicable these techniques can be used for the detection and characterization of planar discontinuities.

They make use of mode conversion to generate an additional ultrasonic beam at a different reflected angle and velocity when the plane of the discontinuity is oriented at the appropriate angle to the incident beam.

In certain cases, these techniques can also be used for sizing, but require the use of special reference blocks representative of the test object and containing planar reflectors of different sizes.

3) Other special techniques

Other examples of ultrasonic techniques for the sizing of volumetric and planar discontinuities are:

- acoustical holography;
- acoustical tomography;
- array techniques using beams of variable angle;
- synthetic aperture focusing techniques (SAFT, see [G.2](#)); and
- construction of B-scan presentation or S-scan presentation, if applicable.

6 Through-transmission technique

6.1 General

The general principles and requirements of the through-transmission technique are given in ISO 16823.

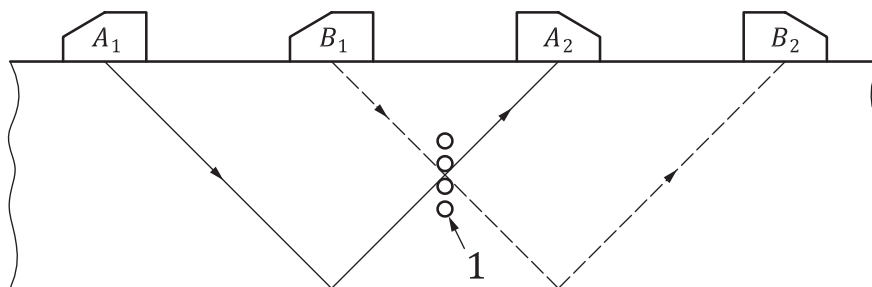
[6.2](#) to [6.5](#) describe some of the ultrasonic parameters and characteristics of the received signals that may be used, either alone or in combination, to evaluate a discontinuity by this technique.

6.2 Location of discontinuity

When using straight-beam probes as shown in [Figure 2](#), the location of a discontinuity is defined as the position on the surface of the test object, with respect to a two-dimensional co-ordinate system, at which the maximum reduction in received signal amplitude is observed.

If it is practicable to direct ultrasonic beams in two different directions through the area to be tested, e. g. by the use of pairs of angle-beam probes, the location of the discontinuity may be determined in 3 directions as illustrated in [Figure 4](#).

The discontinuity lies at the intersection of the two beam paths A_1A_2 and B_1B_2 , at which the maximum reduction in received signal amplitude is observed (see [Figure 4](#)).



Key

- A_1, A_2 pair of angle beam probes
 B_1, B_2 pair of angle beam probes
 1 artificial discontinuity represented by side drilled holes

Figure 4 — Location of discontinuities by the through-transmission technique using angle-beam probes

6.3 Evaluation of multiple discontinuities

- a) Whether a discontinuity is continuous or intermittent shall first be determined qualitatively by observing variations in signal amplitude as the probe is scanned over the discontinuity.

- b) If the signal amplitude remains relatively constant the discontinuity shall be classified as continuous and evaluated as such against the acceptance criteria.
- c) Conversely, if the signal amplitude shows marked maxima and minima the discontinuity may be classified as intermittent.

In this case, it is necessary to determine quantitatively whether the concentration of discrete discontinuities within the affected area is sufficiently high to apply the size/area limitations imposed by the acceptance criteria.

- d) The concentration of discontinuities within the affected area may be expressed, e. g. in terms of the ratio between:
 - 1) the dimensions (or area) of individual discontinuities and the distance between them;
 - 2) the total length of discontinuities and a specified overall length; and
 - 3) the total area of individual discontinuities and a specified overall area.

6.4 Reduction of signal amplitude

- a) The reduction of signal amplitude shall be taken into account whenever the signal amplitude falls below the specified evaluation level.
- b) If the signal is lost completely, the limits of the zone on the scanning surface over which this occurs shall be determined.
- c) If there is only partial loss of the signal, the position on the scanning surface corresponding to the maximum amplitude reduction shall be determined, together with the dB value of the reduction compared to the signal obtained in a zone free from discontinuities.
- d) If the area on the scanning surface, affected by the signal reduction, is less than the cross-sectional area of the ultrasonic beam, the size of the discontinuity normal to the beam shall be estimated by matching the reduction in amplitude with that due to a known reference reflector, e.g. a flat-bottomed hole, in a representative sample of discontinuity-free material (see 6.5 a)).
- e) Where a relatively constant partial reduction in signal amplitude is observed over a zone significantly greater than the area of the sound beam, it is probable that the discontinuity can take the form of, e.g. a band of numerous small inclusions, an area of abnormal grain structure, a layer of ultrasonically semi-transparent material, or a large discontinuity under high compressive stress.

6.5 Size of discontinuity

The sizing of a discontinuity consists in determining one or more dimensions (or the area) of the projection of the discontinuity onto the scanning surface. In particular, the dimensions (or areas) so determined are compared with the applicable acceptance standards, whenever these standards are expressed in terms of maximum allowable dimensions (or areas), in order to assess the acceptability or unacceptability of the discontinuity.

Sizing techniques can be classified essentially in the following two categories.

- a) Techniques based on the comparison of the maximum amplitude reduction of the signal with respect to the maximum amplitude reduction of an equivalent reflector.

Adoption of these techniques for sizing is limited to the case where the dimension (or area) of the zone on the scanning surface corresponding to the signal amplitude reduction below the evaluation level is less than the probe dimension (or area) projected onto the scanning surface.

In this case, the maximum amplitude reduction of the signal with respect to the signal amplitude in a zone free of discontinuities shall be determined, together with the reflector, generally a flat-bottomed hole perpendicular to the beam axis located at a given depth (e.g. half thickness), producing the same maximum reduction in the received signal amplitude.