INTERNATIONAL STANDARD

ISO 20339

First edition
2017-03

Non-destructive testing — Equipment for eddy current examination — Array probe characteristics and verification

Essais non destructifs — Appareillage pour examen par courants de Foucault — Caractéristiques des capteurs multiéléments et vérifications

Reference number
ISO 20339:2017(E)

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

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

This document was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 4, *Eddy current testing*.

Non-destructive testing — Equipment for eddy current examination — Array probe characteristics and verification

1 Scope

This document identifies the functional characteristics of eddy current array probes and their interconnecting elements and provides methods for their measurement and verification.

The evaluation of these characteristics permits a well-defined description and comparability of eddy current array probes.

Where relevant, this document gives recommendations for acceptance criteria for the characteristics.

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 12718, *Non-destructive testing — Eddy current testing — Vocabulary*

ISO 15548-1, *Non-destructive testing — Equipment for eddy current examination — Part 1: Instrument characteristics and verification*

ISO 15548-2:2013, *Non-destructive testing — Equipment for eddy current examination — Part 2: Probe characteristics and verification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12718 and the following apply.

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

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
element
single physical component such as a coil, a GMR or a Hall probe which has a basic function of excitation or reception

3.2
pattern
single physical and electronic arrangement of simultaneously active elements

3.3
sequencing
chronology of the activation of patterns

3.4
threshold
lowest acceptable sensitivity value defined in an application document

4 Probe and interconnecting elements characteristics

4.1 General characteristics

4.1.1 Application

Probes and interconnecting elements are selected to satisfy the requirements of the intended application.

The design is influenced by the instrument with which they are used.

4.1.2 Probe types

The probe is described by the following:

— type of material to be examined, i.e. ferromagnetic, non-ferromagnetic with high or low conductivity;

— the geometry of the examined zone;

— whether it is conformable or not;

— family, e.g. coaxial probe, surface probe;

— the receiver type;

— the number of elements (transmitters and/or receivers);

— shape and assembly of elements and spacing;

— purpose of the examination, e.g. detection of discontinuities, sorting or thickness measurement, etc.;

— specific features, e.g. focused, shielded, etc.;

— the function of the elements (transmission or reception) as well as the type of measurement (absolute or differential) may coexist in the same array probe depending on the patterns, the sequencing and the instrument software.

4.1.3 Interconnecting elements

They may include the following:

— active devices, e.g. multiplexer (built-in or external), amplifier;

— cables and/or extensions;

— connectors;

— slip rings;

— rotating heads;

— polarizers.

4.1.4 Physical characteristics

The following are to be stated among others:

— external size and shape;

— weight;

— information for mechanical mounting;

— model number and serial number;

— material of probe housing;

— composition and thickness of facing material;

— presence and purpose of core or shield;

— type of interconnecting elements (see 4.1.3);

— at least one position mark (electrical centre; see 8.5).

4.1.5 Safety

The probe and its interconnecting elements shall meet the applicable safety regulations regarding electrical hazard, surface temperature, or explosion.

Normal use of the probe should not create a hazard.

4.1.6 Environmental conditions

The temperature and humidity for normal use, storage and transport should be specified for the probe and its interconnecting elements.

The tolerance of the probe and its interconnecting elements to the effects of interference noise and electromagnetic radiation shall conform to electromagnetic compatibility (EMC) regulations.

Materials used in the manufacture of the probe should be resistant to contaminants.

4.2 Electrical characteristics

The electrical characteristics of a probe connected to a specified length and type of cable are the following:

— recommended range of excitation voltage for safe operation;

— recommended range of excitation frequencies.

The electrical characteristics of any extension cable are the following:

— resistance and capacitive reactance per length unit.

4.3 Functional characteristics

The functional characteristics of an array probe shall be determined for a defined system.

The measurement of the functional characteristics of a probe requires the use of reference blocks. The material used for the reference block is determined by the application.

The functional characteristics of a probe are the following:

— angular sensitivity;

— response to elementary discontinuities or variations (hole, slot, deposit, etc.);

— length and width of coverage for a given pattern;

— area of coverage for a given pattern;

— minimum dimensions of discontinuities for constant response;

— penetration characteristics;

— geometric effects;

— cross-talk;

— number of dead elements.

These characteristics cannot be used alone to establish the performance (e.g. resolution, largest undetectable discontinuity, etc.) of the probe in a given test system for a given application.

When relevant, the functional characteristics shall be measured on the probe with the interconnecting elements required by the application.

5 Verification

5.1 Level of verifications

Two levels of verification may be required:

a) basic level: addresses detection performance;

b) advanced level: addresses characterization performance:

— verification of a motion system where there is a need for mechanization of some measurements (movement of the probe);

— digitization and scanning speed: number of measurement points per millimetre.

The qualification of a process which may imply an agreement between manufacturer and customer is not considered in this document.

5.2 Characteristics to be verified

The characteristics to be verified are listed in Table 1.

Table 1 — Array probe characteristics

Characteristic	Basic level	Advanced level
Outer dimensions	I	M
Conformability of the probe	I	M
Area of coverage	I	M
Number of elements	I	M
Arrangement	M	M
Excitation frequencies	M	M
Nature of elements	I	I
Element dimensions	I	I
Distances between elements	I	I
Assembly	I	I
External or built-in multiplexer	I	I
Length and type of supplied cable	I	I
I: measured by the manufacturer or design data, reported on the technical specification. M: measured by the manufacturer and/or the user. The manufacturer should add what type and orientation of discontinuity the probe is designed for. Where more information on the elements is needed by the user (e.g. for simulation), then it may be part of a specific agreement.		

6 Measurement of electrical and functional characteristics of an array probe

6.1 Electrical characteristics

6.1.1 General

The electrical characteristics alone do not define the probe characteristics in its application.

The methods and measuring instruments given below are for guidance; other equivalent methods and instrumentation can be used. When characteristics are measured using modelling, this shall be clearly stated.

6.1.2 Measurement conditions

Array probes (surface probes and coaxial probes) are in most cases specific to one application.

They are delivered with a cable, the design of which depends on the number of elements and which cannot be removed for measurements. The characteristics of the cable are generally proprietary information.

The manufacturer provides a cable, the length of which is compatible in terms of resonance and attenuation with the future use of the probe as described by the customer.

The following measurements are only applicable to elements consisting of coils.

In the case where receiving elements are not coils, specific measurements shall be defined.

The measurements are made at the probe connector which is at one end of the connecting cable, without the use of interconnecting elements of the inspection system. The probe is placed in air and away from any conductive or magnetic material. These measurements are only possible if no electronic components (such as amplifiers, multiplexers, etc.) are active in the probe.

The measurements are made for each element of the probe accessible at the probe connector. The other elements are left open circuit.

When the probe is designed for use under particular conditions, e.g. temperature or pressure, then any additional measurements that are required shall be specified in the application document.

6.1.3 Impedance of coil elements

The impedance of all coil elements shall be measured using an impedance meter or impedance analyser as long as the measurement is not prevented by built-in amplifiers. The measured impedance can be given as the values of an equivalent circuit (resistance, inductance and capacitance) or as curve vs. frequency (Bode plot or Nyquist plot).

6.1.4 Impedance of a pattern

This measurement is not normally performed by the user as it is not possible once the probe is assembled. It is the manufacturer's responsibility.

— **Impedance mode**

  Measure the complex impedance at the central frequency

— **Separate transmit receive**

  Feed a voltage with the central frequency at the input of the transmitting element and measure the voltage at the output

Repeat the measurements on each pattern.

Verify the homogeneity of the results.

In case of significant deviation (greater than 5 %), apply the adequate corrections (connections, etc.).

6.1.5 Channel assignment — Sequencing

Verification of channel assignment is essential. The following operating procedure is for guidance.

Measurements are carried out at the central frequency.

Produce a C-scan type cartography of a defect at angle with the direction of scanning: a slot at 45° (Block A1) for a surface probe, a helix on a tube wall (Block B2) for coaxial probes.

The value of the angle shall be chosen in accordance with the scanning step and the dimensions of a pattern.

Verify the channel assignment and the uniformity of the signals obtained on those channels.

In the case of complex configurations, the verification procedure is left to the manufacturer's initiative.

The case of static probes in which scanning is performed electronically is not covered by this measurement; a case-by-case procedure shall be produced.

6.1.6 Cross-talk

Cross-talk always exists in array probes. It is actually attenuated by multiplexing non-neighbouring elements in order to achieve an acceptable signal to noise ratio.

The level of acceptable cross-talk is very much dependent on the application; therefore, acceptance criteria cannot be given in this document.

6.2 Functional characteristics

6.2.1 General

This document characterizes commonly used array probe types. Probes which are designed for special (unusual) applications shall be characterized in accordance with an application document which follows the methodology of this document. The characteristics described in this document can give useful information about such probes.

The functional characteristics are defined for two classes of array probes: surface probes and coaxial probes.

6.2.2 Measurement conditions

6.2.2.1 General

A multi-channel eddy current instrument suitable for array probes and characterized in accordance with ISO 15548-1 can be used, provided that it has the required accuracy.

Alternatively, sufficient instrumentation comprising a voltage/current generator, synchronous detection amplifier and a voltmeter, oscilloscope or digitizer can be used.

When the probe does not feature a connecting cable, then the characteristics of the cable used for the measurements shall be documented.

The probe characteristics are measured within the frequency range specified by the probe manufacturer using reference blocks containing known features such as slots and holes.