SLOVENSKI STANDARD
SIST EN 13860-2:2004

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Neporuġitveno preskuġanje ï Preiskave z vrtinļnimi tokovi ï Karakteristike naprav in overjanje - 2. del: Karakteristike senzorjev in njihovo overjanje

Non-destructive testing - Eddy current examination - Equipment characteristics and verification - Part 2: Probe characteristics and verification

Zerstörungsfreie Prüfung - Wirbelstromprüfung - Kenngrößen von Prüfeinrichtung und deren Verifizierung - Teil 2: Kenngrößen von Sensoren und deren Verifizierung

Essais non destructifs - Examen par courants de Foucault - Caractéristiques et vérification de l'appareillage - Partie 2: Caractéristiques du traducteur et vérifications

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This European Standard was approved by CEN on 2 January 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (EN 13860-2:2003) has been prepared by 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of an identical text or by endorsement, at the latest by August 2003, and conflicting national standards shall be withdrawn at the latest by August 2003.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

EN 13860 comprises a series of European Standards for "*Eddy current examination - equipment*" which is made up of the following:

EN 13860-1 *Non-destructive testing - Eddy current examination - Equipment characteristics and verification - Part 1: Instrument characteristics and verification.*

EN 13860-2 *Non-destructive testing - Eddy current examination - Equipment characteristics and verification - Part 2: Probe characteristics and verification.*

prEN 13860-3 *Non-destructive testing - Eddy current examination - Equipment characteristics and verification - Part 3: System characteristics and verification.*

Annex A is informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard identifies the functional characteristics of a probe and its interconnecting elements and provides methods for their measurement and verification.

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

By careful choice of the characteristics, a consistent and effective eddy current examination system can be designed for a specific application.

Where accessories are used, these should be characterised using the principles of this standard.

This standard does not give the extent of verification nor acceptance criteria for the characteristics. These are given in the application documents.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 1330-5:1998 *Non-destructive testing - Terminology - Part 5: Terms used in Eddy current testing.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1330-5:1998 apply.

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:

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

— function e.g. separate or combined transmit receive probe;

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

— measurement mode e.g. absolute, differential;

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

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

4.1.3 Interconnecting elements

They may include:

— cables and/or extensions;

— connectors;

— slip rings;

— rotating heads;

— transformers;

— active devices, e.g. multiplexer, amplifier, ...

4.1.4 Physical characteristics

The following are to be stated among others:

— external size and shape;

— weight;

— information about mechanical mounting;

— model number and serial number;

— material of manufacture of probe housing;

— composition and thickness of facing material;

— presence and purpose of core or shield;

— type of interconnecting elements (see 4.1.3);

— orientation mark (direction for maximum sensitivity, see 6.2.3.3);

— position mark (electrical centre, see 6.2.3.4).

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 external electrical connections to the probe shall be clearly identified or declared in writing.

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

— recommended range of excitation current and voltage for safe operation;

— recommended range of excitation frequencies;

— impedance of the excitation element in air;

— resonant frequency of excitation element in air;

— impedance of the receiving element(s) in air.

The electrical characteristics of an extension cable shall also be clearly identified.

4.3 Functional characteristics

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

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

The functional characteristics of a probe are:

— directionality;

— response to elementary discontinuities (hole, slot);

— length and width of coverage;

— area of coverage;

— minimum dimensions of discontinuities for constant response;

— penetration characteristics;

— geometric effects;

— normalised impedance locus (when frequency is varied) of the exciting element with minimum probe clearance from a homogeneous block of a specified material.

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

When relevant, the influence of interconnecting elements on the functional characteristics of the probe shall be measured.

5 Verification

5.1 General

For a consistent and effective eddy current examination it is necessary to verify that the performance of the component parts of the eddy current test system is maintained within acceptable limits.

The physical condition of the reference blocks shall be verified to be within acceptable limits before being used to verify the system, or probes.

The measuring equipment used for verification shall be in a known state of calibration.

For a better understanding, the verification procedure is identically described in all three parts of EN 13860.

5.2 Levels of verification

There are three levels of verification. Each level defines the time intervals between verification and the complexity of the verification.

It is understood that initial type testing has already been done by the manufacturer or under his control.

LEVEL 1 - Global functional check

A verification performed at regular intervals of time on the eddy current test system using reference blocks to verify that the performance is within specified limits.

The verification is usually performed at the examination location.

The time interval and the reference blocks are defined in the verification procedure.

LEVEL 2 - Detailed functional check

A verification on an extended time scale, performed to ensure the stability of selected characteristics of the eddy current instrument, probe, accessories, and reference blocks.

LEVEL 3 - Characterisation

A verification performed on the eddy current instrument, probe accessories, and reference blocks to ensure conformity with the characteristics supplied by the manufacturer.

The organisation requiring the verification shall specify the characteristics to be verified.

The main features of verification are shown in Table 1.

Table 1 — Verification levels

LEVEL	OBJECT	TYPICAL TIME PERIOD	INSTRUMENTS	RESPONSIBLE ENTITY
1 Global function check	Stability of system performance.	Frequently. e.g hourly, daily	Reference blocks.	USER
2 Detailed functional check and calibration	Stability of selected characteristics of the instrument, probes and accessories.	Less frequently but at least annually and after repair.	Calibrated measuring instruments, reference blocks.	USER
3 Characterisation	All characteristics of the instrument, probes and accessories.	Once (on release) and when required.	Calibrated laboratory measuring instruments and reference blocks.	MANUFACTURER, USER

5.3 Verification procedure

The characteristics to be verified are dependent on the application. The essential characteristics and the level of verification shall be specified in a verification procedure.

The examination procedure for the application shall refer to the verification procedure. This can restrict the number of characteristics of a general purpose instrument to be verified for a defined application.

Sufficient data on the characteristics featured in an instrument, probe, and reference block, shall be provided in order that verification may be performed within the scope of this standard.

5.4 Corrective actions

LEVEL 1 - When the performance is not within the specified limits, then a decision shall be made concerning the product examined since the previous successful verification. Corrective actions shall be made to bring the performance within acceptable limits.

LEVEL 2 - When the deviation of the characteristic is greater than the acceptable limits specified by the manufacturer or in the application document, then a decision shall be made concerning the instrument, the probe or the accessory being verified.

LEVEL 3 - When the characteristic is out of the acceptable range specified by the manufacturer or by the application document, then a decision shall be made concerning the instrument, the probe or the accessory being verified.

6 Measurement of electrical and functional characteristics of a 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.

6.1.2 Measurement conditions

The measurements are made at the probe connector without the use of interconnecting elements of the inspection system. The probe is placed in air and away from any conductive or magnetic material.

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 Resonant frequency of the excitation element

6.1.3.1 Excitation element with a single coil

Using an impedance meter, measure the resonant frequency F_{res} of the exciting element.

6.1.3.2 Excitation elements with multiple coils

An excitation element containing multiple coils will give multiple resonance frequencies. The lowest frequency shall be reported/measured.

6.1.4 Impedance of the excitation element

Measure the resistance R_0 using a multimeter, the inductance L_0 using an impedance meter. The inductance is measured at the lowest frequency of the recommended operating range for the probe.

The capacitance C_0 is calculated:

$$C_0 = 1/4\pi^2 F_{res}^2 L_0$$

The model of the excitation element impedance is given in Figure 1.

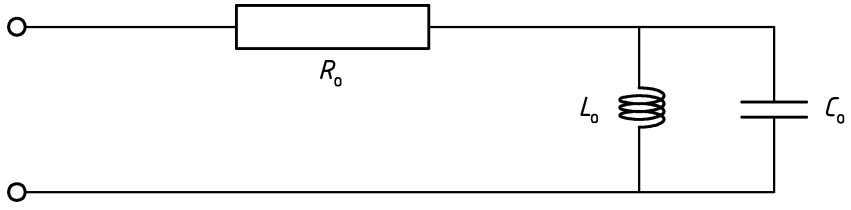

Figure 1 — Excitation element impedance

6.1.5 Impedance of the receiving element(s)

Measure the resistance using a multimeter, the inductance, and the capacitance using an impedance meter. The measured values of impedance can be given as a curve against frequency.

6.2 Functional characteristics

6.2.1 General

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

The functional characteristics are defined for two classes of probes: surface probes and co-axial probes.

6.2.2 Measurement conditions

6.2.2.1 General

A general purpose eddy current instrument characterised in accordance with Part 1 of EN 13860 can be used, provided that it has the required accuracy.

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

The reference blocks shall be made from the material, metallurgical properties and surface finish specified in the application document. Its geometry shall comply with the requirements included in the following subclauses. Blocks made with ferromagnetic material shall be demagnetized before use. The reference block can be replaced by any other device the equivalence of which shall be demonstrated for the measured characteristic, (alternative blocks, electric circuit, coil, ball, etc.).

The functional characteristics can be affected by the presence of any perturbing electromagnetic field or ferromagnetic material in the zone of influence of the probe. Care shall be taken to avoid these effects when making the measurements described below.

The measurement conditions for each characteristic shall be recorded e.g. excitation frequency and voltage/current, details of the reference block, etc.

The measured values are the amplitude of the signal and, when applicable, the phase of the signal.

6.2.2.2 Measurement of the amplitude of the signal

a) absolute measurements

The amplitude of the signal is the length of the vector joining the balance point to the point corresponding to the maximum excursion of the signal from the balance point, unless otherwise specified in an application document, see Figure 2a.