



SLOVENSKI STANDARD SIST EN ISO 21968:2019

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Nadomešča:
SIST EN ISO 21968:2005

Nemagnetne kovinske prevleke na kovinskih in nekovinskih osnovnih materialih - Merjenje debeline nanosa prevleke - Metoda vrtničnih tokov (ISO 21968:2019)

Non-magnetic metallic coatings on metallic and non-metallic basis materials -
Measurement of coating thickness - Phase-sensitive eddy-current method (ISO
21968:2019)

Nichtmagnetische metallische Überzüge auf metallischen und nichtmetallischen
Grundwerkstoffen - Messung der Schichtdicke - Phasensensitives Wirbelstromverfahren
(ISO 21968:2019)

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Revêtements métalliques non magnétiques sur des matériaux de base métalliques et
non métalliques - Mesurage de l'épaisseur de revêtement - Méthode par courants de
Foucault sensible aux variations de phase (ISO 21968:2019)

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Non-magnetic metallic coatings on metallic and non-metallic basis materials - Measurement of coating thickness - Phase-sensitive eddy-current method (ISO 21968:2019)

Revêtements métalliques non magnétiques sur des matériaux de base métalliques et non métalliques - Mesurage de l'épaisseur de revêtement - Méthode par courants de Foucault sensible aux variations de phase (ISO 21968:2019)

Nichtmagnetische metallische Überzüge auf metallischen und nichtmetallischen Grundwerkstoffen - Messung der Schichtdicke - Phasensensitives Wirbelstromverfahren (ISO 21968:2019)

This European Standard was approved by CEN on 15 September 2019.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents	Page
European foreword.....	3

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European foreword

This document (EN ISO 21968:2019) has been prepared by Technical Committee ISO/TC 107 "Metallic and other inorganic coatings" in collaboration with Technical Committee CEN/TC 262 "Metallic and other inorganic coatings, including for corrosion protection and corrosion testing of metals and alloys" the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by April 2020, and conflicting national standards shall be withdrawn at the latest by April 2020.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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Endorsement notice

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INTERNATIONAL
STANDARD

ISO
21968

Second edition
2019-09

**Non-magnetic metallic coatings
on metallic and non-metallic basis
materials — Measurement of coating
thickness — Phase-sensitive eddy-
current method**

*Revêtements métalliques non magnétiques sur des matériaux de
base métalliques et non métalliques — Mesurage de l'épaisseur
de revêtement — Méthode par courants de Foucault sensible aux
variations de phase*

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CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle of measurement	2
5 Factors affecting measurement uncertainty	5
5.1 Basic influence of the coating thickness.....	5
5.2 Electrical properties of the coating.....	5
5.3 Geometry — Base material thickness.....	5
5.4 Geometry — Edge effects.....	5
5.5 Geometry — Surface curvature.....	6
5.6 Surface roughness.....	6
5.7 Lift-off effect.....	6
5.8 Probe pressure.....	8
5.9 Probe tilt.....	8
5.10 Temperature effects.....	8
5.11 Intermediate coatings.....	8
5.12 External electromagnetic fields.....	8
6 Calibration and adjustment of the instrument	8
6.1 General.....	8
6.2 Thickness reference standards.....	9
6.3 Methods of adjustment.....	9
7 Measurement procedure and evaluation	10
7.1 General.....	10
7.2 Number of measurements and evaluation.....	10
8 Uncertainty of the results	11
8.1 General remarks.....	11
8.2 Uncertainty of the calibration of the instrument.....	11
8.3 Stochastic errors.....	12
8.4 Uncertainties caused by factors summarized in Clause 5	13
8.5 Combined uncertainty, expanded uncertainty and final result.....	13
9 Precision	14
9.1 General.....	14
9.2 Repeatability (r).....	14
9.3 Reproducibility limit (R).....	16
10 Test report	17
Annex A (informative) Eddy-current generation in a metallic conductor	18
Annex B (informative) Basics of the determination of the uncertainty of a measurement of the used measurement method corresponding to ISO/IEC Guide 98-3	24
Annex C (informative) Basic performance requirements for coating thickness gauges based on the phase-sensitive eddy-current method described in this document	26
Annex D (informative) Examples for the experimental estimation of factors affecting the measurement accuracy	28
Annex E (informative) Table of the student factor	33
Annex F (informative) Example of uncertainty estimation	34
Annex G (informative) Details on precision	37
Bibliography	39

ISO 21968:2019(E)

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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/107, *Metallic and other inorganic coatings*.

This second edition cancels and replaces the first edition (ISO 21968:2005), which has been technically revised. The main changes compared with the previous edition are as follows:

- this document has been adapted to the current requirements of ISO/IEC Guide 98-3 (also known as “GUM:1995”);
- hints, practical examples and simple estimations of the measurement uncertainty for most important factors have been added;
- repeatability and reproducibility values for typical applications of the method have been added;
- the annex has been expanded with further applications and experimental estimations of factors affecting the accuracy.

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.

Non-magnetic metallic coatings on metallic and non-metallic basis materials — Measurement of coating thickness — Phase-sensitive eddy-current method

1 Scope

This document specifies a method for using phase-sensitive eddy-current instruments for non-destructive measurements of the thickness of non-magnetic metallic coatings on metallic and non-metallic basis materials such as:

- a) zinc, cadmium, copper, tin or chromium on steel;
- b) copper or silver on composite materials.

The phase-sensitive method can be applied without thickness errors to smaller surface areas and to stronger surface curvatures than the amplitude-sensitive eddy-current method specified in ISO 2360, and is less affected by the magnetic properties of the basis material. However, the phase-sensitive method is more affected by the electrical properties of the coating materials.

In this document, the term “coating” is used for materials such as, for example, paints and varnishes, electroplated coatings, enamel coatings, plastic coatings, claddings and powder coatings.

This method is particularly applicable to measurements of the thickness of metallic coatings. These coatings can be non-magnetic metallic coatings on non-conductive, conductive or magnetic base materials, but also magnetic coatings on non-conductive or conductive base materials.

The measurement of metallic coatings on metallic basis material works only when the product of conductivity and permeability (σ, μ) of one of the materials is at least a factor of two times the product of conductivity and permeability for the other material. Non-ferromagnetic materials have a relative permeability of one.

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 2064, *Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness*

ISO 4618, *Paints and varnishes — Terms and definitions*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2064, ISO 4618 and the following apply.

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

— ISO Online browsing platform: available at <https://www.iso.org/obp>

ISO 21968:2019(E)

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

3.1 adjustment of a measuring system

set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured

Note 1 to entry: Types of adjustment of a measuring system can include zero adjustment of a measuring system, offset adjustment, and span adjustment (sometimes called gain adjustment).

Note 2 to entry: Adjustment of a measuring system should not be confused with *calibration* (3.2), which is a prerequisite for adjustment.

Note 3 to entry: After an adjustment of a measuring system, the measuring system shall usually be recalibrated.

Note 4 to entry: Colloquially the term “calibration” is frequently, but falsely, used instead of the term “adjustment”. In the same way, the terms “verification” and “checking” are often used instead of the correct term “calibration”.

[SOURCE: ISO/IEC Guide 99:2007, 3.11 (also known as “VIM”), modified — Note 4 to entry has been added.]

3.2 calibration

operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

Note 1 to entry: A calibration may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

Note 2 to entry: Calibration should not be confused with *adjustment of a measuring system* (3.1), often mistakenly called “self-calibration”, nor with *verification of calibration*.

Note 3 to entry: Often, the first step alone in the above definition is perceived as being calibration.

[SOURCE: ISO/IEC Guide 99:2007, 2.39 (also known as “VIM”)]

4 Principle of measurement

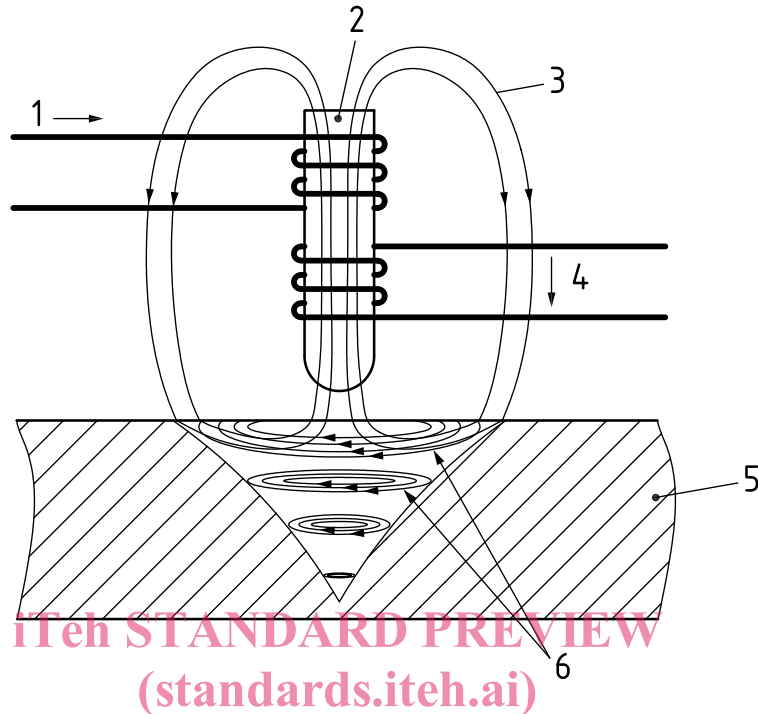
Phase-sensitive eddy-current instruments work on the principle that a high-frequency electromagnetic field generated by the probe system of the instrument will produce eddy currents in the coating on which the probe is placed and in the base material beneath the coating in case this base material is conductive (see [Figure 1](#)). These induced currents cause a change of the electromagnetic field surrounding the probe coil system and therefore result in a change of the amplitude and the phase angle of the probe coil impedance. The induced eddy-current density is a function of the coating thickness, the conductivity of the coating material, the used frequency of the probe system and the base metal conductivity. If the thickness of a coating of constant conductivity is increased for a given frequency, the impedance vector describes a so-called local function of the thickness in the impedance plane (see [Figure 2](#)). Each point of this local curve connects a phase angle of the impedance vector with the respective coating thickness. Consequently, this impedance angle (phase shift) can be used as a measure of the thickness of the coating on the conductor by means of a calibration with reference standards (see also [Annex A](#)).

In order to measure a change of the coil impedance phase angle, the test coil is usually part of a coil system and is coupled with the exciting coil on one ferrite core such as in a transformer (see [Figure 1](#)). The changes of phase angle and amplitude due to the impact of the induced eddy currents can be measured, for example, using a lock in amplifier. These values are usually pre-processed by digital means and the resulting thickness is then calculated and displayed.

The probe and measuring system/display may be integrated into a single instrument.

NOTE 1 [Annex C](#) describes the basic performance requirements of the equipment.

NOTE 2 Factors affecting measurement accuracy are discussed in [Clause 5](#).



Key

- | | | | |
|---|-------------------------------------------|---|-------------------------------------|
| 1 | exciting current | 4 | measured signal $U = f(t(\varphi))$ |
| 2 | ferrite core of probe | 5 | base material (conductive) |
| 3 | high-frequency alternating magnetic field | 6 | induced eddy currents |

Figure 1 — Phase-sensitive eddy-current method