SLOVENSKI STANDARD
SIST EN IEC 60404-7:2020

01-julij-2020

Magnetni materiali - 7. del: Metode za merjenje koercitivnosti (do 160 kA/m) magnetnih materialov v odprtem magnetnem krogu (IEC 60404-7:2019)

Magnetic materials - Part 7: Method of measurement of the coercivity (up to 160 kA/m) of magnetic materials in an open magnetic circuit (IEC 60404-7:2019)

Magnetische Materialien - Teil 7: Verfahren zur Messung der Koerzitivfeldstärke (bis160 kA/m) von magnetischen Werkstoffen in einem offenen Magnetkreis (IEC 60404-7:2019)

Matériaux magnétiques - Partie 7: Méthode de mesure de la coercitivité (jusqu'à 160 kA/m) des matériaux magnétiques en circuit magnétique ouvert (IEC 60404-7:2019)

Ta slovenski standard je istoveten z: EN IEC 60404-7:2020

ICS:

17.220.20	Merjenje električnih in magnetnih veličin	Measurement of electrical and magnetic quantities
29.030	Magnetni materiali	Magnetic materials

SIST EN IEC 60404-7:2020 en

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN IEC 60404-7

April 2020

ICS 29.030; 17.220.20

Supersedes EN 10330:2015 and all of its amendments and corrigenda (if any)

English Version

Magnetic materials - Part 7: Method of measurement of the coercivity (up to 160 kA/m) of magnetic materials in an open magnetic circuit (IEC 60404-7:2019)

Matériaux magnétiques - Partie 7: Méthode de mesure de la coercitivité (jusqu'à 160 kA/m) des matériaux magnétiques en circuit magnétique ouvert (IEC 60404-7:2019)

Magnetische Materialien - Teil 7: Verfahren zur Messung der Koerzitivfeldstärke (bis160 kA/m) von magnetischen Werkstoffen in einem offenen Magnetkreis (IEC 60404-7:2019)

This European Standard was approved by CENELEC on 2019-02-20. CENELEC 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 CEN-CENELEC Management Centre or to any CENELEC 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 CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN IEC 60404-7:2020 E

European foreword

The text of document 68/596/CDV, future edition 2 of IEC 60404-7, prepared by IEC/TC 68 "Magnetic alloys and steels" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60404-7:2020.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2020-10-24
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2023-04-24

This document supersedes EN 10330:2015 and all of its amendments and corrigenda (if any).

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

Endorsement notice

The text of the International Standard IEC 60404-7:2019 was approved by CENELEC as a European Standard without any modification.

IEC 60404-7

Edition 2.0 2019-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Magnetic materials –
Part 7: Method of measurement of the coercivity (up to 160 kA/m) of magnetic materials in an open magnetic circuit

Matériaux magnétiques –
Partie 7: Méthode de mesure de la coercitivité (jusqu'à 160 kA/m) des matériaux magnétiques en circuit magnétique ouvert

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.030; 17.220.20 ISBN 978-2-8322-6385-3

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

MAGNETIC MATERIALS –

Part 7: Method of measurement of the coercivity (up to 160 kA/m) of magnetic materials in an open magnetic circuit

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

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

International Standard IEC 60404-9 has been prepared by IEC technical committee 68: Magnetic alloys and steels.

This second edition cancels and replaces the first published in 1982. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Clause 1: The scope includes a more detailed description of the magnetic materials which applies to this standard;

b) Clause 4: Figure 2 – circuit diagram for methods A and B was simplified and the fluxgate probes inside the solenoid have been added;

c) Clause 7: Compensation for the earth's magnetic field and for static and dynamic magnetic noise fields has been added;

d) Clause 8: Magnetic shielding of the measuring region has been added;

e) 9.2.2: The measuring methods for local and integral measurement of the flux in the test specimen have been separated and the limitations in size and shape of the test specimen have been considered.

f) 9:3: The method C with a VSM (Vibrating Sample Magnetometer) has been moved from 9.3 to the Annex B.

g) The term "complex shaped test specimen" has been replaced in several clauses by "test specimen different from ellipsoids".

h) The character of Annex A has been changed from “informative” to “normative”.

The text of this International Standard is based on the following documents:

CDV	Report on voting
68/596/CDV	68/608A/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60404 series, published under the general title *Magnetic materials*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

MAGNETIC MATERIALS –

Part 7: Method of measurement of the coercivity (up to 160 kA/m) of magnetic materials in an open magnetic circuit

1 Scope

This part of IEC 60404 specifies a method of measurement of the coercivity of magnetic materials in an open magnetic circuit.

This document is applicable to all magnetic materials with coercivities from 0,2 A/m to 160 kA/m.

NOTE Examples of magnetic materials covered by this document are amorphous alloys, nanocrystalline alloys, all softmagnetic crystalline materials (e.g. Fe, FeSi-, CoFe- and FeNi-alloys), soft ferrites, hard metals, semi-hard magnetic alloys (e.g. FeCoTiAl-, FeCoV-, FeCrCo- and AlNiCo-alloys) [1] [1].

Special precautions are to be taken in measuring coercivities below 40 A/m, in materials with high conductivity and in test specimens which have a shape different from ellipsoids (see Annex A).

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.

There are no normative references in this document.

3 Terms and definitions

For the purpose of this document, the following terms and definitions 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
coercivity H_{cJ}
value of the coercive field strength in a material when the magnetic flux density, magnetic polarization or magnetization is brought from saturation by a monotonically changing magnetic field to zero

Note 1 to entry: The parameter that is varied should be stated, and the appropriate symbol used as follows: H_{cB} for the coercivity relating to the magnetic flux density, H_{cJ} for the coercivity relating to the magnetic polarization, H_{cM} for the coercivity relating to the magnetization. The first two symbols supersede H_{cB} and H_{cJ} respectively.

[1] Numbers in square brackets refer to the Bibliography.

3.2
demagnetize
to reduce the magnetic flux density of a magnetized material along the demagnetization curve

Note 1 to entry: The coercivities H_{cB} and H_{cJ} are respectively discriminated depending on the hysteresis loop being defined in the $B = f(H)$ or $J = f(H)$ system (see Figure 1). It can be shown that, for materials of high-differential permeability in the region B = 0, the difference between the coercivity H_{cJ} and the coercivity H_{cB} is negligible since:

$$H_{cB} = H_{cJ}\left(1 - \mu_0 \frac{\Delta H}{\Delta B}\right) \tag{1}$$

where

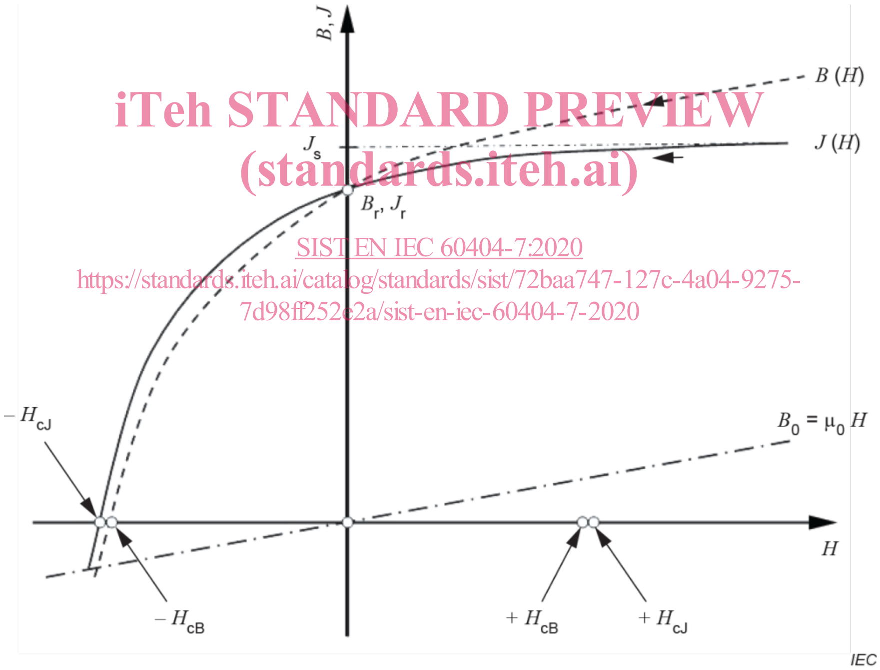
H_{cB} coercivity relating to the magnetic flux density, in amperes per metre;

H_{cJ} coercivity relating to the magnetic polarization, in amperes per metre;

ΔB incremental change in magnetic flux density (at B = 0), in teslas;

ΔH corresponding change in magnetic field strength, in amperes per metre;

μ_0 magnetic constant ($4\pi \times 10^{-7}$ in henrys per metre).



Key

B magnetic flux density, in teslas

J magnetic polarization, in teslas

H magnetic field strength, in amperes per metre

B_r remanent flux density in, teslas

B_0 flux density in air in, teslas

J_r remanent magnetic polarization, in teslas

J_s saturation magnetic polarization, in teslas

Figure 1 – Demagnetizing $B(H)$ and $J(H)$ curves from saturation

4 Principle of the method

If a magnetic test specimen is placed in a uniform and unidirectional magnetic field then it will distort this magnetic field unless a condition that no flux (additional to that previously carried by the air space it now occupies) enters or emerges from the test specimen. This condition represents a state of complete demagnetization which occurs when a demagnetizing coercive magnetic field strength is applied to the test specimen such that the magnetic polarization is zero [2].

The test specimen is magnetized to saturation (J_s) and then the magnetic field is reduced smoothly without interruption to zero (J_r). Afterwards the polarity of the magnetic field is reversed and a demagnetizing field is increased until the magnetic polarization of the test specimen is zero. The applied magnetic field strength required to achieve this condition is measured and defined as the coercivity H_{cJ} of the test specimen (see Figure 1).

A magnetic flux sensing probe enables the detection of the condition of no distortion of a uniform magnetic field by the test specimen and provides the means for determining the coercivity.

For this measurement, the test specimen and the magnetic flux sensing probes are placed in an open magnetic circuit in the uniform and unidirectional magnetic field of a solenoid. The flux sensing probe should be placed as follows:

a) inside the solenoid, close to the end of the test specimen (Method A – Hall probe, see Figure 3), or

b) inside the solenoid, at a distance from the test specimen, depending on the size and permeability of the test specimen (Method A – differential fluxgate probe, see Figure 4), or

c) outside the solenoid (Method B – differential fluxgate probe, see Figure 5).

The solenoid and measuring equipment shall be connected as shown in Figure 2.

NOTE There is an alternative way to use an axially vibrating search coil as magnetic sensing probe like Method A [3].

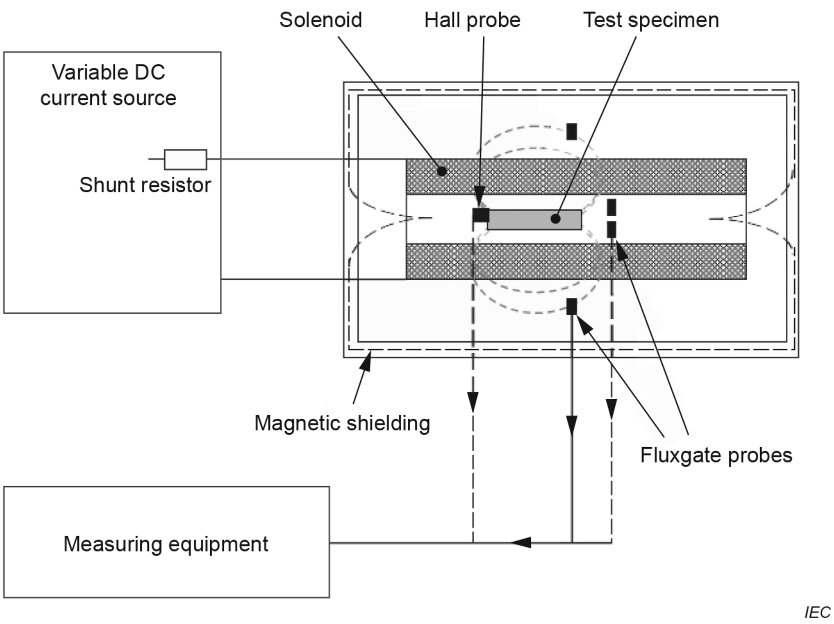


Figure 2 – Circuit diagram for Methods A and B

Alternatively, the test specimen is placed at the centre of the gap of an electromagnet as in Method C, see Annex B.