

Magnetic materials —

Part 5: Permanent magnet (magnetically hard) materials — Methods of measurement of magnetic properties

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National foreword

This British Standard is the UK implementation of EN 60404-5:2007. It is identical to IEC 60404-5:1993, incorporating amendment 1:2007. It supersedes BS EN 10332:2003 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

The UK participation in its preparation was entrusted to Technical Committee ISE/NFE/5, Magnetic alloys and steels.

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

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31 January 2010	Correction to core text; implementation of IEC amendment 1:2007

English version

**Magnetic materials -
Part 5: Permanent magnet (magnetically hard) materials -
Methods of measurement of magnetic properties
(IEC 60404-5:1993 + A1:2007)**

Matériaux magnétiques -
Partie 5: Aimants permanents
(magnétiques durs) -
Méthodes de mesure
des propriétés magnétiques
(CEI 60404-5:1993 + A1:2007)

Magnetische Werkstoffe -
Teil 5: Dauermagnetwerkstoffe
(hartmagnetische Werkstoffe) -
Verfahren zur Messung
der magnetischen Eigenschaften
(IEC 60404-5:1993 + A1:2007)

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European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the International Standard IEC 60404-5:1993 + A1:2007, prepared by IEC TC 68, Magnetic alloys and steels, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 60404-5 on 2007-10-01 without any modification.

This European Standard supersedes EN 10332:2003 (published by CEN).

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented
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| – latest date by which the national standards conflicting
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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60404-5:1993 + A1:2007 was approved by CENELEC as a European Standard without any modification.

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MAGNETIC MATERIALS –

Part 5: Permanent magnet (magnetically hard) materials – Methods of measurement of magnetic properties

1 General

1.1 Scope

The purpose of this part of IEC 404 is to define the method of measurement of the magnetic flux density, magnetic polarization and the magnetic field strength and also the determination of the demagnetization curve and recoil line of permanent magnet materials, such as those specified in IEC 404-8-1, the properties of which are presumed homogeneous throughout their volume.

The performance of a magnetic system is not only dependent on the properties of the permanent magnet material but also on the dimensions of the system, the air-gap and other elements of the magnetic circuit. The methods described in this standard refer to the measurement of the magnetic properties in a closed magnetic circuit simulating a ring.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 404. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 404 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

Ⓐ IEC 50(121), *International Electrotechnical Vocabulary (IEV) – Chapter 121: Electromagnetism*

IEC 50(151), *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*

IEC 50(221), *International Electrotechnical Vocabulary (IEV) – Chapter 221: Magnetic materials and components*

IEC 404-8-1 Ⓐ, *Magnetic materials – Part 8: Specifications for individual materials – Section One: Standard specifications for magnetically hard materials*

2 Definitions

The definitions relating to the various terms used in this part of IEC 404 are defined in IEC 50(121), IEC 50(151) and IEC 50(221).

For permanent magnet materials this standard deals with both the coercivity H_{cB} (the coercivity related to the magnetic flux density) and the intrinsic coercivity H_{cJ} (the coercivity related to the magnetic polarization).

The measurements specified in this standard are for both the magnetic flux density, B , and the magnetic polarization, J , as a function of the magnetic field strength, H . These quantities are related by the following equation:

$$B = \mu_0 H + J \quad (1)$$

where

- B is the magnetic flux density, in teslas;
- μ_0 is the magnetic constant = $4 \pi 10^{-7}$, in henry per metre;
- H is the magnetic field strength, in amperes per metre;
- J is the magnetic polarization, in teslas.

Using this relationship H_{cJ} values can be obtained from the $B(H)$ hysteresis loop and H_{cB} values can be obtained from the $J(H)$ hysteresis loop. The point at which the modulus of the product BH has a maximum value is called the working point for $(BH)_{max}$ (see figure 2).

3 Electromagnet and conditions for magnetization

The measurements are carried out in a closed magnetic circuit consisting of an electromagnet made of soft magnetic material and the test specimen. The construction of the yokes shall be symmetrical; at least one of the poles shall be movable to minimize the air-gap between the test specimen and the pole pieces (see figure 1). The end faces of both pole pieces shall be ground as nearly as possible parallel to each other and as nearly as possible perpendicular to the pole axis to minimize the air-gap (see figure A.1).

NOTE - For certain measurements, the yoke and the poles can be laminated to decrease eddy currents. The coercivity of the material should normally be not more than 100 A/m.

To obtain a sufficiently uniform magnetizing field in the space occupied by the test specimen, the following conditions shall be fulfilled simultaneously:

3.1 Geometrical conditions (figure 1)

$$d_1 \geq d_2 + 1,2 l' \quad (2)$$

$$d_1 \geq 2,0 l' \quad (3)$$

where

- d_1 is the diameter of a circular pole piece or the dimension of the smallest side of a rectangular pole piece, in millimetres;
- l' is the distance between the pole pieces, in millimetres;
- d_2 is the maximum diameter of the cylindrical volume with a homogeneous field, in millimetres.