IEC 60404-3

Edition 3.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Magnetic materials –
Part 3: Methods of measurement of the magnetic properties of electrical steel strip and sheet by means of a single sheet tester

Matériaux magnétiques –
Partie 3: Méthodes de mesure des caractéristiques magnétiques des bandes et tôles magnétiques en acier à l'aide de l'essai sur tôle unique



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MAGNETIC MATERIALS –

Part 3: Methods of measurement of the magnetic properties of electrical steel strip and sheet by means of a single sheet tester

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IEC 60404-3 has been prepared by IEC technical committee 68: Magnetic alloys and steels. It is an International Standard.

This third edition cancels and replaces the second edition published in 1992, Amendment 1:2002 and Amendment 2:2009. This edition constitutes a technical revision.

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

a) Annex A was revised. The method of determining the yokes’ lamination resistance was added to Annex A;
b) Annex B of the consolidated version of 2010 referred to calibration of the SST using the Epstein method. It was cancelled;
c) Annex B (new), Annex C and Annex D were revised, they are for information only;
d) Annex C was modified taking account of the new situation regarding P and R grades;
e) Annex D was amended by addition of Clause D.4 on the numerical air flux compensation.

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

Draft	Report on voting
68/699/CDV	68/710/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

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MAGNETIC MATERIALS –

Part 3: Methods of measurement of the magnetic properties of electrical steel strip and sheet by means of a single sheet tester

1 Scope

This part of IEC 60404 is applicable to grain-oriented and non-oriented electrical steel strip and sheet for measurement of AC magnetic properties at power frequencies.

The object of this document is to define the general principles and the technical details of the measurement of the magnetic properties of electrical steel strip and sheet by means of a single sheet tester (SST).

The single sheet tester is applicable to test specimens obtained from electrical steel strips and sheets of any grade. The AC magnetic characteristics are determined for sinusoidal induced voltages, for specified peak values of the magnetic polarization, for specific peak values of the magnetic field strength and for a specified frequency.

The measurements are made at an ambient temperature of (23±5)°C on test specimens which have first been demagnetized.

NOTE Throughout this document, the quantity "magnetic polarization" is used as defined in IEC 60050-221. In some standards of the IEC 60404 series, the quantity "magnetic flux density" was used.

In order to support the long-term reliability of the performance of this set up and to understand better the relationship between the Epstein method and the SST method, the informative Annexes B and C, respectively, have been included.

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.

IEC 60050-121, *International Electrotechnical Vocabulary – Part 121: Electromagnetism*

IEC 60050-221, *International Electrotechnical Vocabulary – Part 221: Magnetic materials and components*

IEC 60404-13, *Magnetic materials – Part 13: Methods of measurement of resistivity, density and stacking factor of electrical steel strip and sheet*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-121 and IEC 60050-221 apply.

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

- IEC Electropedia: available at https://www.electropedia.org/

- ISO Online browsing platform: available at https://www.iso.org/obp

4 General principles of AC measurements

4.1 General

Clause 4 specifies the general conditions for the determination of AC magnetic properties of electrical steel strip and sheet at power frequencies by means of a single sheet tester.

4.2 Principle of the single sheet tester method

The test specimen comprises a sample of electrical steel sheet and is placed in the center of two concentric windings:

– an exterior primary winding (magnetizing winding);

– an interior secondary winding (voltage winding).

The flux closure is made by a magnetic circuit consisting of two identical yokes, the cross-section of which is very large compared with that of the test specimen (see Figure 1).

The temperature changes of the specimen shall be kept below a level likely to produce stress in the test specimen due to thermal expansion or contraction.

4.3 Test apparatus

4.3.1 Yokes

Each yoke is in the form of a U made up of insulated sheets of grain-oriented electrical steel. It shall have a low reluctance and a low specific total loss in the low magnetic polarization region below 0,2 T (see Annex A). It shall be manufactured in accordance with the requirements of Annex A.

In order to reduce the effect of eddy currents and give a more homogeneous distribution of the flux over the inside of the yokes, the yokes shall be made of a pair of wound cut C-cores or a glued stack of laminations in which case the corners shall have staggered butt joints (see Figure 1).

The yoke shall have pole faces having a width of 25 mm ± 1 mm.

The two pole faces of each yoke shall be coplanar to within 0,5 mm and the gap between the opposite pole faces of the yokes shall not exceed 0,005 mm at any point. Also, the yokes shall be rigid in order to avoid creating mechanical stresses such as twisting, tensioning and compression in the test specimen.

The height of each yoke shall be between 90 mm and 150 mm. Each yoke shall have a width of 500^{+5}_{-0} mm and an inside length of 450 mm ± 1 mm (see Figure 2).

There shall be a non-conducting, non-magnetic support on which the test specimen is placed, between the vertical limbs of the bottom yokes. This support shall be centered and located in the same plane as the bottom yoke pole faces so that the test specimen is in direct contact with the pole faces without any gap. Care shall be taken that in no case the upper surface of the support is positioned higher than the plane of the pole faces of the bottom yoke.