SLOVENSKI STANDARD
oSIST prEN IEC 60404-3:2022

01-april-2022

Magnetni materiali - 3. del: Metode merjenja magnetnih lastnosti električnih jeklenih trakov in pločevine z uporabo enolistnega preskuševalnika

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

Ta slovenski standard je istoveten z: **prEN IEC 60404-3:2022**

ICS:

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

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IEC

68/699/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 60404-3 ED3**	
DATE OF CIRCULATION: **2022-01-28**	CLOSING DATE FOR VOTING: **2022-04-22**
SUPERSEDES DOCUMENTS: **68/687/CD, 68/696/CC**	

IEC TC 68 : MAGNETIC ALLOYS AND STEELS	
SECRETARIAT: Germany	SECRETARY: Mr Richard Daniel Knobloch
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT	☒ QUALITY ASSURANCE ☐ SAFETY
☒ SUBMITTED FOR CENELEC PARALLEL VOTING **Attention IEC-CENELEC parallel voting** The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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TITLE:

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

PROPOSED STABILITY DATE: 2027

NOTE FROM TC/SC OFFICERS:

This Committee Draft for Vote was prepared by the responsible Project Leader and Team on the basis of the last CD, 68/687CD, and the comments received from National Committees which are listed together with the observations in 68/696/CC.

National Committees are invited to send their comments and vote on this document.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MAGNETIC MATERIALS –

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

FOREWORD

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

This revised version of IEC 60404-3 was prepared on the basis of the consolidated edition 60404-3 Ed.2.2 which was modified introducing the following changes:

The text of the main part was revised, leaving the substantial technical contents unchanged;

Annex A forms an integral part of this standard. The method of determining the yokes’ lamination resistance was added to Annex A.

Annex B of Ed.2.2 referred to calibration of the SST using the Epstein method. It was cancelled.

Annex B (new), C and D were revised, they are for information only.

Annex C was modified taking account of the new situation regarding P and R grades.

Annex D was amended by addition of sub-clause D.4 on the numerical air flux compensation

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

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 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 °C ± 5 °C on test specimens which have first been demagnetized.

NOTE Throughout this part 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.

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 http://www.electropedia.org/
- ISO Online browsing platform: available at http: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).

Care shall be taken to ensure that the temperature changes of the specimen are 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 0,1 T. (see Annex A). It shall be manufactured in accordance with the requirements of Annex A.

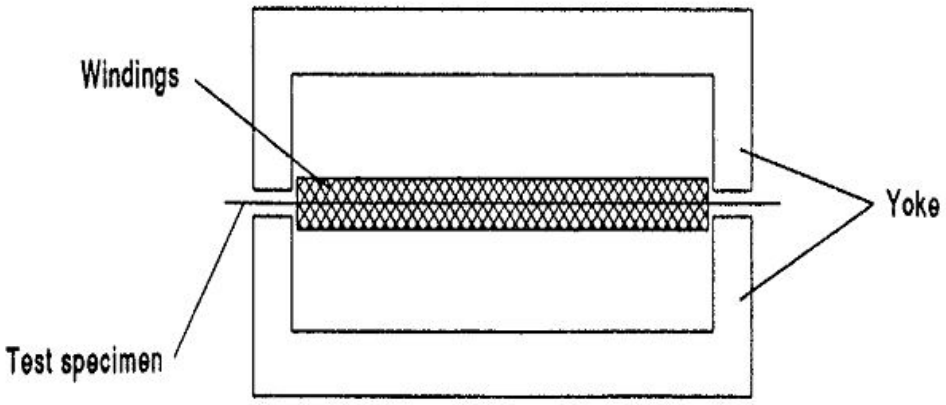
In order to reduce the effect of eddy currents and give a more homogeneous distribution of the flux over the inside of the yokes, the latter shall be made of a pair of wound cut C-cores or a glued stack of laminations in which case the corners shall have staggered butt joints (see Figure 1).

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

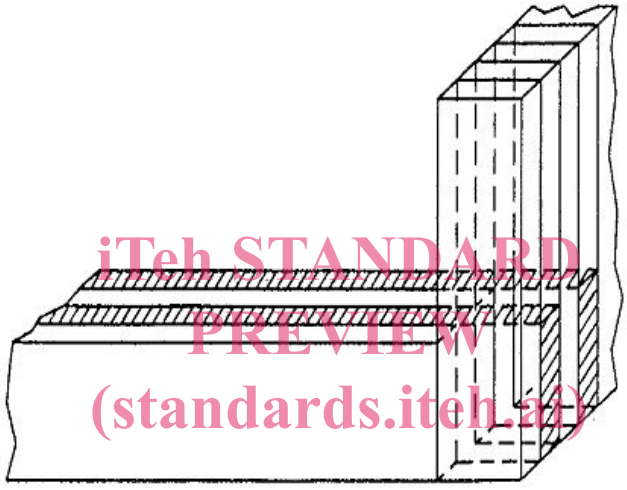
The two pole faces of each yoke shall be coplanar to within 0,5 mm and the gap between the opposite pole faces of the yokes shall not exceed 0,005 mm at any point. Also, the yokes shall be rigid in order to avoid creating mechanical stresses in the test specimen.

The height of each yoke shall be between 90 mm and 150 mm. Each yoke shall have a width of 500 $^{+5}_{-5}$ 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.



(a)



(b)

Figure 1 – Schematic diagrammes of the test apparatus; Cross section of the SST (a) and schematic view of the corner of a yoke with stacked lamination (b)

The upper yoke shall be movable upwards to permit insertion of the test specimen. After insertion of the test specimen the upper yoke shall be lowered to close the magnetic circuit and, simultaneously, the pole faces of the bottom and upper yokes shall be aligned accurately. To minimize the effects of pressure on the test specimen, the upper yoke shall be provided with a means of suspension. The suspension of the upper yoke shall allow part of its weight to be counterbalanced so as to give a force on the test specimen of between 100 N and 200 N.

NOTE The square configuration of the yoke has been chosen in order to have only one test specimen for non-oriented material. By rotating the test specimen through 90° it is possible to determine the characteristics in the rolling direction and perpendicular to the rolling direction.

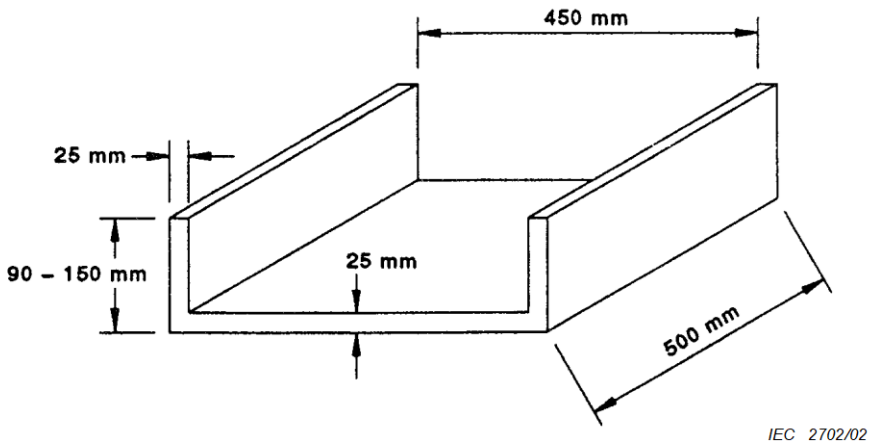


Figure 2 – Yoke dimensions

4.3.2 Windings

The coil system inside the yokes shall have two windings:

– a primary winding, on the outside (magnetizing winding);

– a secondary winding, on the inside (voltage winding);

The primary (outer) and secondary (inner) windings shall be at least 440 mm in length and shall be wound uniformly on a non-conducting, non-magnetic and rectangular former. The dimensions of the former shall be as follows:

– length: 445 mm ± 2 mm;

– internal width: 510 mm ± 1 mm;

– internal height: $5\ ^{0}_{-2}$ mm;

– height: ≤15 mm.

The primary winding can be made up of:

– either five or more coils having identical dimensions and the same number of turns connected in parallel and taking up the whole length (see Figure 3). For example, with five coils, each coil can be made up of 400 turns of copper wire 1 mm in diameter, wound in five layers;

– or a single continuous and uniform winding taking up the whole length. For example this winding can be made up of 400 turns of copper wire 1 mm in diameter, wound in one layer.

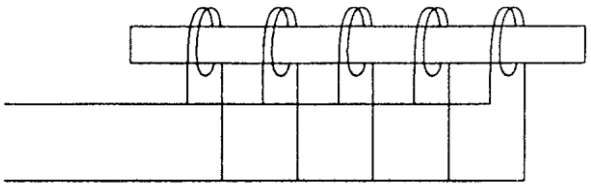
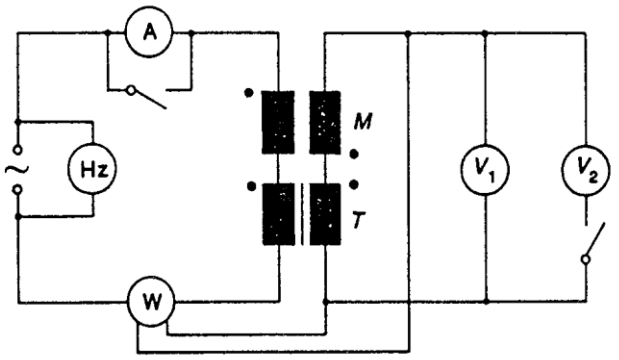


Figure 3 – Diagram of the connections of the five coils of the primary winding

The number of turns on the secondary winding will depend on the characteristics of the measuring instruments. In any case, the determination of the number of turns of the primary and secondary windings shall be made with greatest reliability because a mistake would mean a permanent error.

4.4 Air flux compensation

Compensation shall be made for the effect of air flux. This can be achieved, for example, by a mutual inductor M (see Figure 4). The primary winding of the mutual inductor is connected in series with the primary winding of the test apparatus, while the secondary winding of the mutual inductor is connected to the secondary winding of the test apparatus in series opposition.



Key

V1	measures the average rectified voltage
V2	measures the r.m.s. voltage
A	measures the r.m.s. value of the primary current
Hz	measures the frequency
W	measures the power
M	is the mutual inductor
T	is the test frame

Figure 4 – Circuit for the determination of the specific total loss

The adjustment of the value of the mutual inductance shall be made so that when passing an alternating current through the primary windings in the absence of the test specimen in the test apparatus, the voltage measured between the non-common terminals of the secondary windings shall be no more than 0,1 % of the voltage appearing across the secondary winding of the test apparatus alone. Thus the average value of the rectified voltage induced in the combined secondary windings is proportional to the peak value of the magnetic polarization in the test specimen.

NOTE 1 Alternatively, the air flux compensation can be executed by the numerical method (for details see Annex D, Clause D.4).

NOTE 2 In the rest of this document the term “compensated secondary voltage” is used to mean “voltage induced in the secondary winding compensated for the effect of air flux”.

4.5 Test specimen

The length of the test specimen shall be not less than 500 mm. Although the part of the test specimen situated outside the pole faces has no great influence on the measurement, this part shall not be longer than is necessary to facilitate insertion and removal of the test specimen.

The width of the test specimen shall be as large as possible and at its maximum equal to the width of the yokes.