SLOVENSKI STANDARD
SIST EN 61788-2:2001

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Superconductivity - Part 2: Critical current measurement - DC critical current of Nb3Sn composite superconductors

Superconductivity -- Part 2: Critical current measurement - DC critical current of Nb3Sn composite superconductors

Supraleitfähigkeit -- Teil 2: Messen des kritischen Stromes - Kritischer Strom (Gleichstrom) von Nb3Sn-Verbundsupraleitern

Supraconductivité -- Partie 2: Mesure du courant critique - Courant critique continu des supraconducteurs composites Nb3Sn

Ta slovenski standard je istoveten z: **EN 61788-2:1999**

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English version

Superconductivity
Part 2: Critical current measurement
DC critical current of Nb_3Sn composite superconductors
(IEC 61788-2:1999)

Supraconductivité
Partie 2: Mesure du courant critique
Courant critique continu des
supraconducteurs composites Nb_3Sn
(CEI 61788-2:1999)

Supraleitfähigkeit
Teil 2: Messen des kritischen Stromes
Kritischer Strom (Gleichstrom) von
Nb_3Sn-Verbundsupraleitern
(IEC 61788-2:1999)

This European Standard was approved by CENELEC on 1999-08-01. 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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

The text of document 90/55/FDIS, future edition 1 of IEC 61788-2, prepared by IEC TC 90, Superconductivity, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61788-2 on 1999-08-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-05-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2002-08-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annexes A, B and C are informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61788-2:1999 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE: When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-815	[1]	International Electrotechnical Vocabulary (IEV) Chapter 815: Superconductivity	-	-
IEC 61788-1	1998	Superconductivity Part 1: Critical current measurement DC critical current of Cu/Nb-Ti composite superconductors	EN 61788-1	1998

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Partie 2:
Mesure du courant critique – Courant critique continu des supraconducteurs composites Nb_3Sn

Superconductivity –

Part 2:
Critical current measurement – DC critical current of Nb_3Sn composite superconductors

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SUPERCONDUCTIVITY –

Part 2: Critical current measurement – DC critical current of Nb_3Sn composite superconductors

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
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5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61788-2 has been prepared by IEC technical committee 90: Superconductivity.

The text of this standard is based on the following documents:

FDIS	Report on voting
90/55/FDIS	90/57/RVD

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

Annexes A, B and C are for information only.

INTRODUCTION

The critical currents of composite superconductors are used to establish design limits for applications of superconducting wires. The operating conditions of superconductors in these applications determine much of their behaviour and tests made with the method given in the present standard may be used to provide part of the information needed to determine the suitability of a specific superconductor.

Results obtained from this method may also be used for detecting changes in the superconducting properties of a composite superconductor due to processing variables, handling, ageing or other applications or environmental conditions. This method is useful for quality control, acceptance or research testing if the precautions given in this standard are observed.

The critical current of composite superconductors depends on many variables. These variables need to be considered in both the testing and the application of these materials. Test conditions such as magnetic field, temperature and relative orientation of the specimen, current and magnetic field are determined by the particular application. The test configuration may be determined by the particular conductor through certain tolerances. The specific critical current criterion may be determined by the particular application. It may be appropriate to measure a number of test specimens if there are irregularities in testing.

The test method covered in this standard is based on that for the determination of the critical current of Cu/Nb-Ti composite superconductors (IEC 61788-1) and the VAMAS (Versailles Project on Advanced Materials and Standards) prestandardization work on the critical current of Nb_3Sn composite superconductors. The critical current of Nb_3Sn superconductors is known to be highly sensitive to mechanical strain compared to Cu/Nb-Ti superconductors. Hence, some modifications are made on the test procedures which may affect the strain state of a test specimen. See annex B for the background to these modifications.

SUPERCONDUCTIVITY –

Part 2: Critical current measurement – DC critical current of Nb_3Sn composite superconductors

1 Scope

This part of IEC 61788 covers a test method for the determination of the d.c. critical current of Nb_3Sn composite superconductors which are fabricated by either the bronze process or the internal tin diffusion process and have a copper/non-copper ratio larger than 0,2.

This method is intended for use with superconductors which have critical currents of less than 1 000 A and *n*-values larger than 12 under standard test conditions and at magnetic fields of less than or equal to 0,7 times the upper critical magnetic field. The test specimen is immersed in a liquid helium bath at a measured temperature during testing. The Nb_3Sn composite test conductor has a monolithic structure with a total round-cross-sectional area that is less than 2 mm^2. The specimen geometry used in this test method is an inductively coiled specimen. Deviations from this test method that are allowed for routine tests and other specific restrictions are given in this standard.

Nb_3Sn conductors with critical currents above 1 000 A or total cross-sectional areas greater than 2 mm^2 can be measured with the present method with an anticipated reduction in precision and a more significant self-field effect (see annex C). Other, more specialized, specimen test geometries may be more appropriate for larger conductor testing which have been omitted from this present standard for simplicity and to retain precision.

The test method given in this standard should in principle apply to Nb_3Sn composite wires fabricated by any other process, such as the modified jelly-roll process. This method is also expected to apply to other superconducting composite wires after some appropriate modifications.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050-815:—, *Superconductivity* [1)]

IEC 61788-1:1998, *Superconductivity – Part 1: Critical current measurement – DC critical current of Cu/Nb-Ti composite superconductors*

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1) To be published.

3 Terminology

For the purpose of this part of IEC 61788, the definitions given in IEC 60050-815 and the following apply:

The critical current (I_c) is defined as the current at which a specific electric field strength (electric field) criterion (E_c) or resistivity criterion (ρ_c) is reached in the specimen at a certain value of a static applied magnetic field at a specific temperature in a liquid helium bath at a constant pressure. For either E_c or ρ_c, there is a corresponding voltage criterion V_c for a specified sample length

4 Requirements

The critical current of a superconductor shall be measured by applying a direct current (I) to the superconductor specimen and then measuring the voltage (V) generated along a section of the specimen. The current shall be increased from zero and the voltage-current (V-I) characteristic generated and recorded.

The specimen shall be wound on a cylindrical reaction mandrel with a helical groove and after reaction, transferred to a measurement mandrel of the same diameter on which the helical angle is preserved.

The specimen shall be affixed to the measurement mandrel by tightening the specimen and/or bonding with a low temperature adhesive.

In this test method, the applied magnetic field shall be parallel to the measurement mandrel axis.

The target precision of this method is a coefficient of variation (standard deviation divided by the average of the critical current determinations), that is less than 3 % for the measurement at 12 T and near 4,2 K.

The use of a common current transfer correction is excluded from this test method. Furthermore, if a current transfer signature is pronounced in the measurement, then the measurement shall be considered invalid.

It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use. Specific precautionary statements are given below.

Hazards exist in this type of measurement. Very large direct currents with very low voltages do not necessarily provide a direct personal hazard, but accidental shorting of the leads with another conductor, such as tools or transfer lines, can release significant amounts of energy and cause arcs or burns. It is imperative to isolate and protect current leads from shorting. Also, the stored energy in the superconducting magnets commonly used for the background magnetic field can cause similar large current and/or voltage pulses, or deposit large amounts of thermal energy in the cryogenic systems causing rapid boil-off or even explosive conditions. The use of cryogenic liquids is essential to cool the superconductors to allow transition into the superconducting state. Direct contact of skin with cold liquid transfer lines, storage dewars or apparatus components can cause immediate freezing, as can direct contact with a spilled cryogen. It is imperative that safety precautions for handling cryogenic liquids be observed.