
Superconductivity - Part 12: Matrix to superconductor volume ratio measurement -
Copper to non-copper volume ratio of Nb₃Sn composite superconducting wires

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English version

Superconductivity
Part 12: Matrix to superconductor volume ratio measurement -
Copper to non-copper volume ratio of
Nb₃Sn composite superconducting wires
(IEC 61788-12:2002)

Supraconductivité
Partie 12: Mesure du rapport volumique
matrice/supraconducteur -
Rapport volumique cuivre/non-cuivre
des fils en composite
supraconducteur Nb₃Sn
(CEI 61788-12:2002)

Supraleitfähigkeit
Teil 12: Messung des Verhältnisses von
Matrixvolumen zu Supraleitervolumen -
Verhältnis des Kupfervolumens
zum kupferfreien Volumen von
Nb₃Sn-Verbundsupraleiterdrähten
(IEC 61788-12:2002)

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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.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

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

Foreword

The text of document 90/123/FDIS, future edition 1 of IEC 61788-12, prepared by IEC TC 90, Superconductivity, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61788-12 on 2002-10-01.

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) 2003-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2005-10-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A, B, C and ZA are normative and annexes D, E, F and G are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61788-12:2002 was approved by CENELEC as a European Standard without any modification.

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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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-815	- 1)	International Electrotechnical Vocabulary (IEV) Chapter 815: Superconductivity	-	-
IEC 61788-5	- 1)	Superconductivity Part 5: Matrix to superconductor volume ratio measurement - Copper to superconductor volume ratio of Cu/Nb-Ti composite superconductors	EN 61788-5	2001 2)

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1) Undated reference.

2) Valid edition at date of issue.

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61788-12

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Supraconductivité –

Partie 12:

**Mesure du rapport volumique
matrice/supraconducteur –**

**Rapport volumique cuivre/non-cuivre des
fils en composite supraconducteur Nb₃Sn**

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Part 12:

**Matrix to superconductor volume
ratio measurement –**

**Copper to non-copper volume ratio of Nb₃Sn
composite superconducting wires**

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International Electrotechnical Commission
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SUPERCONDUCTIVITY –

**Part 12: Matrix to superconductor volume ratio measurement –
Copper to non-copper volume ratio of Nb₃Sn composite
superconducting wires**

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 specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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- 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 61788-12 has been prepared by IEC technical committee 90: Superconductivity.

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

FDIS	Report on voting
90/123/FDIS	90/128/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.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annexes A, B and C form an integral part of this standard.

Annexes D, E, F and G are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

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

INTRODUCTION

The copper to non-copper volume ratio of superconducting wires serves as an important numeric value used when determining the critical current density and its stability, which are two of the important characteristics of superconducting wires. This test method is concerned with the standardization of the test method for the copper to non-copper volume ratio of copper stabilized Nb₃Sn multi-filamentary composite superconducting wires (hereinafter referred to as Cu/Nb₃Sn wires).

Cu/Nb₃Sn wires can be classified into four types according to the layout of the stabilizer as shown in Annex G: the external stabilizer type, the internal stabilizer type, the distributed stabilizer type and the contiguous stabilizer with distributed barrier type. The test method specified by this standard may be applicable to a type whose cross-section is of the external stabilizer or the internal stabilizer type regardless of the production process employed.

With regard to the internal stabilizer type, the internal structure of some Cu/Nb₃Sn wires prevents copper from being dissolved and removed. This defies the application of the copper mass method, unlike with copper matrix Nb-Ti superconducting wires. New methods are therefore needed, as detailed in the following:

- the paper mass method, where a photo of the cross-section of the wire being measured is traced onto tracing paper, or a copy is made of the photo using a copying machine; the paper is then cut out into different portions to measure the mass of each piece of paper;
- the image processing method, where the image of the photo of the cross-section is digitized and the areas are analyzed with software;
- the planimeter method, where the cross-sectional areas are measured with a planimeter.

This standard is concerned with the paper mass method which is adopted more generally. As supplementary methods, the image processing method and the copper mass method adopted for Cu/Nb₃Sn wires are specified in Annex A and Annex B, respectively. The method using a planimeter is specified in Annex C. In Annex D an example of a polishing method is also specified.

SUPERCONDUCTIVITY –

Part 12: Matrix to superconductor volume ratio measurement – Copper to non-copper volume ratio of Nb₃Sn composite superconducting wires

1 Scope

This standard describes the test method for determining the copper to non-copper volume ratio of Cu/Nb₃Sn wires.

The test method given hereunder is applicable to Nb₃Sn composite superconducting wires with a cross-sectional area of 0,1 mm² to 3 mm² and a copper to non-copper volume ratio of 0,1 or more. It does not make any reference to the filament diameter; however, it is not applicable to those superconducting wires with their filament, Sn, CuSn, barrier material and other non-copper portions dispersed in the copper matrix or those with the stabilizer dispersed. Furthermore, the copper to non-copper volume ratio can be determined on specimens before or after the Nb₃Sn formation heat treatment process.

The Cu/Nb₃Sn wire has a monolithic structure with a round or rectangular cross-section.

Though degraded in accuracy, this method may be applicable to the measurement of the copper to non-copper volume ratio of the Cu/Nb₃Sn wires whose cross-section and copper to non-copper volume ratio fall outside the specified ranges.

This test method may be applied to other composite superconducting wires after some appropriate modifications.

2 Normative references

The following referenced documents are indispensable for the application 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 60050-815, *International Electrotechnical Vocabulary (IEV) – Part 815: Superconductivity*

IEC 61788-5, *Superconductivity – Part 5: Matrix to superconductor volume ratio measurement – Copper to superconductor volume ratio of Cu/Nb-Ti composite superconductors*

3 Terms and definitions

For the purposes of this standard, the definitions given in IEC 60050-815 apply.

The copper to non-copper volume ratio of Cu/Nb₃Sn wires is defined as the ratio of area of the stabilizer copper to that of non-copper.