



NSAI
Standards

Irish Standard
I.S. EN 61788-12:2013

Superconductivity -- Part 12: Matrix to
superconductor volume ratio
measurement - Copper to non-copper
volume ratio of Nb₃Sn composite
superconducting wires (IEC 61788
-12:2013 (EQV))

I.S. EN 61788-12:2013

Incorporating amendments/corrigenda issued since publication:

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SWiFT xxx: A rapidly developed recommendatory document based on the consensus of the participants of an NSAI workshop.

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EUROPEAN STANDARD
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EUROPÄISCHE NORM

EN 61788-12

October 2013

ICS 29.050

Supersedes EN 61788-12:2002

English version

**Superconductivity -
Part 12: Matrix to superconductor volume ratio measurement -
Copper to non-copper volume ratio of Nb₃Sn composite
superconducting wires
(IEC 61788-12:2013)**

Supraconductivité -
Partie 12 : Mesure du rapport volumique
matrice/supraconducteur -
Rapport volumique cuivre/non-cuivre des
fils en composite supraconducteur Nb₃Sn
(CEI 61788-12:2013)

Supraleitfähigkeit -
Teil 12: Messung des Verhältnisses von
Matrixvolumen zu Supraleitervolumen -
Verhältnis des Kupfervolumens
zum kupferfreien Volumen
von Nb₃Sn-Verbundsupraleiterdrähten
(IEC 61788-12:2013)

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 90/322/FDIS, future edition 2 of IEC 61788-12, prepared by IEC/TC 90 "Superconductivity" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61788-12:2013.

The following dates are fixed:

- latest date by which the document has to be (dop) 2014-04-17
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publication of an identical national
standard or by endorsement
- latest date by which the national (dow) 2016-07-17
standards conflicting with the
document have to be withdrawn

This document supersedes EN 61788-12:2002.

EN 61788-12:2013 includes the following significant technical changes with respect to EN 61788-12:2002:

The main revision is the addition of two new annexes, "Uncertainty considerations" (Annex H) and "Uncertainty evaluation in the test method of the copper to non-copper volume ratio of Nb₃Sn composite superconducting wires" (Annex I).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61788-12:2013 was approved by CENELEC as a European Standard without any modification.

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 | Series | International Electrotechnical Vocabulary (IEV) | - | - |
| IEC 61788-5 | - | Superconductivity - Part 5: Matrix to superconductor volume ratio measurement - Copper to superconductor volume ratio of Cu/Nb-Ti composite superconductors | EN 61788-5 | - |

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CONTENTS

| | |
|---|----|
| FOREWORD..... | 4 |
| INTRODUCTION..... | 6 |
| 1 Scope..... | 7 |
| 2 Normative references | 7 |
| 3 Terms and definitions | 7 |
| 4 Principle | 8 |
| 5 Apparatus..... | 8 |
| 6 Measurement procedure | 8 |
| 6.1 Preparation of specimen..... | 8 |
| 6.1.1 General | 8 |
| 6.1.2 Procedures | 8 |
| 6.2 Measurement | 9 |
| 6.2.1 Photo of cross-section | 9 |
| 6.2.2 Transfer..... | 9 |
| 6.2.3 Cutting..... | 9 |
| 6.2.4 Measurement of paper mass..... | 9 |
| 6.3 Test procedure for the second specimen | 9 |
| 6.4 Paper mass | 9 |
| 7 Calculation of results | 9 |
| 8 Uncertainty of the test method | 10 |
| 9 Test report..... | 10 |
| 9.1 Copper to non-copper volume ratio..... | 10 |
| 9.2 Identification of test specimen | 10 |
| Annex A (normative) Measurement – Image processing method | 11 |
| Annex B (normative) Measurement – Copper mass method | 12 |
| Annex C (normative) Measurement method using planimeter | 13 |
| Annex D (informative) Specimen polishing method | 14 |
| Annex E (informative) Difference of the copper to non-copper volume ratio before and after the Nb ₃ Sn generation heat treatment process | 15 |
| Annex F (informative) Paper mass bias at copy | 16 |
| Annex G (informative) Cross-sections of Cu/Nb ₃ Sn wires..... | 17 |
| Annex H (informative) Uncertainty considerations | 18 |
| Annex I (informative) Uncertainty evaluation in the test method of the copper to non-copper volume ratio of Nb ₃ Sn composite superconducting wires..... | 23 |
| Figure G.1 – Cross-sections of four Cu/Nb ₃ Sn wire types according to the layout of the stabilizer | 17 |

I.S. EN 61788-12:2013

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– 3 –

| | |
|---|----|
| Table H.1 – Output signals from two nominally identical extensometers | 19 |
| Table H.2 – Mean values of two output signals | 19 |
| Table H.3 – Experimental standard deviations of two output signals | 19 |
| Table H.4 – Standard uncertainties of two output signals | 20 |
| Table H.5 – Coefficient of variations of two output signals | 20 |

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SUPERCONDUCTIVITY –

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

FOREWORD

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International Standard IEC 61788-12 has been prepared by IEC technical committee 90: Superconductivity.

This second edition cancels and replaces the first edition published in 2002. It constitutes a technical revision. The main revision is the addition of two new annexes, "Uncertainty considerations" (Annex H) and "Uncertainty evaluation in the test method of the copper to non-copper volume ratio of Nb₃Sn composite superconducting wires" (Annex I).

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

| | |
|-------------|------------------|
| FDIS | Report on voting |
| 90/322/FDIS | 90/325/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 2.

A list of all parts of the IEC 61788 series, published under the general title *Superconductivity*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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.

IMPORTANT – The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

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 standard 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 precludes 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 copper mass method, where the copper of the specimen is dissolved in nitric acid solution to leave only the non-copper portion, and to measure the mass of the specimen and the non-copper portion of specimen.

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 part of IEC 61788 describes a 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 3,0 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, Cu-Sn alloy, 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 uncertainty increases, 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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <<http://www.electropedia.org>>)

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 document, the terms and definitions given in IEC 60050-815 as well as the following apply.

3.1

copper to non-copper volume ratio

ratio of the volume of the copper stabilizing material to the volume without copper consisting of Cu/Nb₃Sn wires

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