



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:

The National Standards Authority of Ireland (NSAI) produces the following categories of formal documents:

I.S. xxx: Irish Standard – national specification based on the consensus of an expert panel and subject to public consultation.

S.R. xxx: Standard Recommendation - recommendation based on the consensus of an expert panel and subject to public consultation.

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

<i>This document replaces:</i> EN 61788-12:2002	<i>This document is based on:</i> EN 61788-12:2013 EN 61788-12:2002	<i>Published:</i> 4 October, 2013 29 October, 2002
This document was published under the authority of the NSAI and comes into effect on: 8 October, 2013		ICS number: 29.050
NSAI 1 Swift Square, Northwood, Santry Dublin 9	T +353 1 807 3800 F +353 1 807 3838 E standards@nsai.ie W NSAI.ie	Sales: T +353 1 857 6730 F +353 1 857 6729 W standards.ie
Údarás um Chaighdeáin Náisiúnta na hÉireann		

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)

This European Standard was approved by CENELEC on 2013-07-17. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

CENELEC

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-07-17

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	-

This page is intentionally left BLANK.

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

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

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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 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 IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. 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.

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

This is a free preview. Purchase the entire publication at the link below:

[Product Page](#)

-
- [Looking for additional Standards? Visit Intertek Inform Infostore](#)
 - [Learn about LexConnect, All Jurisdictions, Standards referenced in Australian legislation](#)
-