
Superprevodnost - 26. del: Meritve kritičnega toka - Enosmerni kritični tok pri superprevodnikih iz kompozita RE-Ba-Cu-O (IEC 61788-26:2020)

Superconductivity - Part 26: Critical current measurement - DC critical current of RE-Ba-Cu-O composite superconductors (IEC 61788-26:2020)

Supraleitfähigkeit - Teil 26: Messung des kritischen Stroms - Kritischer DC-Strom von RE-Ba-Cu-O-Komposit-supraleitern (IEC 61788-26:2020)

Supraconductivité - Partie 26: Mesurage du courant critique - Courant critique continu des composites supraconducteurs de RE-Ba-Cu-O (IEC 61788-26:2020)

[SIST EN IEC 61788-26:2020](https://standards.iteh.ai/catalog/standards/sist/a63ddb65-d9e5-4197-ada5-63bb70af58ed/sist-en-iec-61788-26-2020)

[https://standards.iteh.ai/catalog/standards/sist/a63ddb65-d9e5-4197-ada5-](https://standards.iteh.ai/catalog/standards/sist/a63ddb65-d9e5-4197-ada5-63bb70af58ed/sist-en-iec-61788-26-2020)

Ta slovenski standard je istoveten z: EN IEC 61788-26:2020

ICS:

17.220.20	Merjenje električnih in magnetnih veličin	Measurement of electrical and magnetic quantities
29.050	Superprevodnost in prevodni materiali	Superconductivity and conducting materials

SIST EN IEC 61788-26:2020**en**

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN IEC 61788-26:2020

<https://standards.iteh.ai/catalog/standards/sist/a63ddb65-d9e5-4197-ada5-63bb70af58ed/sist-en-iec-61788-26-2020>

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN IEC 61788-26

August 2020

ICS 17.220.20; 19.080; 29.050

English Version

**Superconductivity - Part 26: Critical current measurement - DC
critical current of RE-Ba-Cu-O composite superconductors
(IEC 61788-26:2020)**

Supraconductivité - Partie 26: Mesurage du courant critique
- Courant critique continu des composites
supraconducteurs de RE-Ba-Cu-O
(IEC 61788-26:2020)

Supraleitfähigkeit - Teil 26: Messung des kritischen Stroms
- Kritischer DC-Strom von RE-Ba-Cu-O Komposit
Supraleitern
(IEC 61788-26:2020)

This European Standard was approved by CENELEC on 2020-07-16. 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.

SIST EN IEC 61788-26:2020

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



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 61788-26:2020 (E)**European foreword**

The text of document 90/455/FDIS, future edition 1 of IEC 61788-26, prepared by IEC/TC 90 "Superconductivity" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61788-26:2020.

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) 2021-04-16
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2023-07-16

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

iTeh STANDARD PREVIEW
Endorsement notice
(standards.iteh.ai)

The text of the International Standard IEC 61788-26:2020 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 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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-815	-	International Electrotechnical Vocabulary - Part 815: Superconductivity	-	-

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN IEC 61788-26:2020
<https://standards.iteh.ai/catalog/standards/sist/a63ddb65-d9e5-4197-ada5-63bb70af58ed/sist-en-iec-61788-26-2020>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN IEC 61788-26:2020

<https://standards.iteh.ai/catalog/standards/sist/a63ddb65-d9e5-4197-ada5-63bb70af58ed/sist-en-iec-61788-26-2020>



IEC 61788-26

Edition 1.0 2020-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Superconductivity –

Part 26: Critical current measurement – DC critical current of RE-Ba-Cu-O composite superconductors

Supraconductivité –

Partie 26: Mesurage du courant critique – Courant critique continu des composites supraconducteurs de RE-Ba-Cu-O

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 17.220.20; 19.080; 29.050

ISBN 978-2-8322-8436-0

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
4 Principle	8
5 Apparatus.....	8
5.1 General.....	8
5.2 Critical current measuring system	8
6 Specimen preparation and setup	8
6.1 Length	8
6.2 Mounting of the specimen	9
7 Critical current measurement.....	9
8 Calculation of results	9
8.1 Critical current criteria.....	9
8.2 n -value (optional).....	11
9 Uncertainty of measurement.....	11
10 Test report.....	11
10.1 Identification of test specimen.....	11
10.2 Reporting of I_c values	11
10.3 Reporting of I_c test conditions.....	11
Annex A (informative) Additional information relating to measurement, apparatus, and calculation	12
A.1 General information	12
A.2 Measurement condition	12
A.3 Apparatus	13
A.3.1 Measurement holder material	13
A.3.2 Measurement holder construction	13
A.4 Specimen preparation	14
A.5 Measurement procedure	14
A.5.1 Voltage leads.....	14
A.5.2 Cooling process.....	14
A.5.3 Temperature of liquid nitrogen bath	14
A.5.4 System noise and other contributions to the measured voltage	15
A.6 Calculation of n -value	16
Annex B (informative) Evaluation of combined standard uncertainty for REBCO I_c measurement [8]	17
B.1 Practical critical current measurement	17
B.2 Model equation	18
B.3 I_c measurement results	19
B.4 Combined standard uncertainty [11].....	21
B.5 Type B uncertainty evaluation	22
B.5.1 General	22
B.5.2 Uncertainty of L_1 measurement.....	22
B.5.3 Uncertainty of voltage measurement.....	22

B.5.4	Uncertainty of current measurement	23
B.5.5	Uncertainty of temperature measurement	23
B.5.6	Uncertainty coming from intrinsic non-uniformity of I_c	24
B.5.7	Comparison between types A and B combined standard uncertainties	25
B.6	Influence of current ramp rate on the total uncertainty	26
Bibliography	27

Figure 1 – Schematic view of measurement setup	9
Figure 2 – Intrinsic U - I characteristic	10
Figure 3 – U - I curve with a current transfer component	10
Figure A.1 – Illustration of a measurement configuration for a short specimen of a few hundred amperes class REBCO conductor	13
Figure A.2 – Temperature dependence of I_c for commercial REBCO superconductors (data from [9])	14
Figure A.3 – Pressure dependence of boiling temperature of liquid nitrogen	15
Figure B.1 – Typical circuit to measure I_c	17
Figure B.2 – Typical voltage–current (U - I) characteristic of a superconductor	18
Figure B.3 – Ramp time dependence of total RSU of I_c for conductors B, C, and D	26

iTeh STANDARD PREVIEW

Table A.1 – Thermal contraction data of superconductor and sample-holder materials [1]	13
Table B.1 – Conductors distributed in the international RRT	19
Table B.2 – I_c data for conductor A	19
Table B.3 – I_c data for conductor B	20
Table B.4 – I_c data for conductor C	20
Table B.5 – I_c data for conductor D	20
Table B.6 – Statistics for each conductor	21
Table B.7 – ANOVA results for each conductor	21
Table B.8 – Atmospheric pressure from 1 January 2014 to 31 December 2014	24
Table B.9 – Intrinsic I_c non-uniformity evaluated by RTR-SHPM	24
Table B.10 – Budget table of SUs of I_c measurements for conductor C	25
Table B.11 – Comparison of the relative standard uncertainties for conductors B, C, and D	25

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SUPERCONDUCTIVITY –

**Part 26: Critical current measurement –
DC critical current of RE-Ba-Cu-O composite superconductors**

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 61788-26 has been prepared by IEC technical committee 90: Superconductivity.

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

FDIS	Report on voting
90/455/FDIS	90/458/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 in 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.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST EN IEC 61788-26:2020](https://standards.iteh.ai/catalog/standards/sist/a63ddb65-d9e5-4197-ada5-63bb70af58ed/sist-en-iec-61788-26-2020)

<https://standards.iteh.ai/catalog/standards/sist/a63ddb65-d9e5-4197-ada5-63bb70af58ed/sist-en-iec-61788-26-2020>

INTRODUCTION

In 1986, superconductivity in some perovskite type materials containing copper oxides at temperatures far above the critical temperatures of metallic superconductors was discovered. In 1987, it was discovered that Y-Ba-Cu-O (YBCO) has a critical temperature (T_c) of 93 K. After a quarter century, the RE-Ba-Cu-O (REBCO, RE = rare earth) superconductors became commercially available.

In 2013, VAMAS-TWA 16 started working on the critical current measurement methods in REBCO superconductors. In 2014, an international round robin test (RRT) on the critical current measurement method for REBCO superconductors was conducted that was led by VAMAS-TWA 16. 10 institutions/universities/industries from five countries participated. The pre-standardization work of VAMAS was taken as a base for this document, on the DC critical current test method of REBCO composite superconductors.

The test method covered in this document is intended to give an appropriate and accepted technical base to engineers working in the field of superconductivity technology.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN IEC 61788-26:2020

<https://standards.iteh.ai/catalog/standards/sist/a63ddb65-d9e5-4197-ada5-63bb70af58ed/sist-en-iec-61788-26-2020>