SLOVENSKI STANDARD
SIST EN IEC 61788-22-2:2022

01-februar-2022

Merjenje upornosti v normalnem stanju in merjenje kritičnega toka - Spoj "High-Tc Josephson" (IEC 61788-22-2:2021)

Normal state resistance and critical current measurement - High-Tc Josephson junction (IEC 61788-22-2:2021)

Supraleitfähigkeit - Teil 22-2: Messung des Normalleitungswiderstands und des kritischen Stroms - HTS Josephson Kontakt (IEC 61788-22-2:2021)

Mesure de la résistance à l'état normal et du courant critique - Jonction Josephson à Tc élevée (IEC 61788-22-2:2021)

Ta slovenski standard je istoveten z: **EN IEC 61788-22-2:2021**

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 61788-22-2:2022 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 61788-22-2

November 2021

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English Version

Superconductivity - Part 22-2: Normal state resistance and critical current measurement - High-T_c Josephson junction (IEC 61788-22-2:2021)

Supraconductivité - Partie 22-2: Mesure de la résistance à l'état normal et du courant critique - Jonction Josephson à T_c élevée
(IEC 61788-22-2:2021)

Supraleitfähigkeit - Teil 22-2: Messung des Normalleitungswiderstands und des kritischen Stroms - HTS Josephson Kontakt
(IEC 61788-22-2:2021)

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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

European foreword

The text of document 90/484/FDIS, future edition 1 of IEC 61788-22-2, prepared by IEC/TC 90 “Superconductivity” was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61788-22-2:2021.

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) 2022–08–25
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024–11–25

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.

Any feedback and questions on this document should be directed to the users’ national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61788-22-2:2021 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.

Publication	Year	Title	EN/HD	Year
IEC 61788-22-1	-	Superconductivity - Part 22–1: Superconducting electronic devices - Generic specification for sensors and detectors	EN 61788-22-1	-
IEC 60050-815	2015	International Electrotechnical Vocabulary - Part 815: Superconductivity	-	-
IEC 60617	-	Graphical symbols for diagrams	-	-

IEC 61788-22-2

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Superconductivity –
Part 22-2: Normal state resistance and critical current measurement – High-T_c Josephson junction

Supraconductivité –
Partie 22-2: Mesurage de la résistance à l'état normal et du courant critique – Jonction Josephson à T_c élevée

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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.
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IEC 61788-22-2 has been prepared by IEC technical committee 90: Superconductivity. It is an International Standard.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
90/484/FDIS	90/486/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document 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 document using a colour printer.

INTRODUCTION

IEC 61788-22 (all parts) is a series of International Standards on superconductor electronic devices. Superconductivity offers various possibilities of realizing sensors and detectors for a variety of measurands. Several types of superconductor sensors and detectors have been developed, using such features as superconducting energy gaps, sharp normal-superconducting transition, nonlinear current-voltage characteristics, superconducting coherent states and quantization of magnetic flux. Superconductors are influenced by interaction with electromagnetic fields, photons, ions, etc. The superconductor sensors and detectors have extremely high performance in resolution, time response and sensitivity, which cannot be realized by any other sensors and detectors.

IEC 61788-22-1 lists various types of superconductor sensors and detectors. A key element of some sensors and detectors is Josephson junction. The superconductor material types used for Josephson junctions are divided into two categories: low-T_c superconductor (LTS) and high-T_c superconductor (HTS). This document (IEC 61788-22-2) defines a measurement method of normal state resistance (R_n) and intrinsic critical current (I_{ci}) of HTS Josephson junctions, which are used for magnetic measurement with superconductor quantum interference device (SQUID), detection of millimetre to terahertz band radiation and other applications.

The measurement method covered in this document is intended to give an appropriate and agreeable technical base for those engineers working in the field of superconductor technology. Although the mechanism of high-T_c superconductivity is under investigation, the occurrence of the Josephson effect in such weak link structures as bicrystal, step-edge and ramp edge is reliable, and characteristic parameters for conventional LTS Josephson junctions are valid also for HTS Josephson junctions. The important parameters of HTS Josephson junctions for designing superconductor devices are normal state resistance (R_n) and critical current (I_c), which are combined as I_cR_n product that is obtained experimentally. At this moment, most HTS Josephson junctions exhibit a non-hysteretic characteristic voltage-current (U–I) curve, which is typical for superconductor/normal-conductor/superconductor (SNS) junctions. On U–I curves, two types of distortions are often observed: noise-rounding and self-heating effects. Especially, maximum current values without voltage drop on the U–I curves are often considerably reduced because of the noise-rounding effect, and therefore it is difficult to estimate an intrinsic critical current value. This document provides a method to obtain intrinsic values by selecting a data set range to eliminate the distortions and by fitting a model function even when two effects are present.

The critical current obtained by this standard method is therefore called intrinsic critical current with the variable symbol of I_{ci}, eliminating the noise-rounding effect on U–I curves. On the other hand, the normal state resistance is insensitive to the noise rounding and it is possible to avoid the self-heating effect, so that the variable symbol R_n is used. The $I_{ci}R_n$ product is more essential for designing superconductor devices than the I_cR_n product. I_{ci} values estimated by this document are usually higher than experimental I_c values.

Practical application of this document to HTS Josephson junctions is shown in Annex A. The estimation method in this document is applied to SNS-type LTS Josephson junctions to check universality in Annex B.

SUPERCONDUCTIVITY –

Part 22-2: Normal state resistance and critical current measurement – High-T_c Josephson junction

1 Scope

This part of IEC 61788 is applicable to high-T_c Josephson junctions. It specifies terms, definitions, symbols and the measurement and estimation method for normal state resistance (R_n) and intrinsic critical current (I_{ci}), based on a combination of selecting a data set from measured U–I curves with a geometric mean criterion and fitting a hyperbolic function to that data set.

2 Normative references

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.

IEC 61788-22-1, *Superconductivity – Part 22-1: Superconducting electronic devices – Generic specification for sensors and detectors*

IEC 60617, *Graphical symbols for diagrams*: available at http://std.iec.ch/iec60617

IEC 60050-815:2015, *International Electrotechnical Vocabulary – Part 815: Superconductivity*: (available at http://www.electropedia.org/

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
***U*–*I* characteristic curve**
V–I characteristic curve
I–V characteristic curve
data set of voltage drop between two superconductors of a Josephson junction and current applied to the junction