NSAI Standards

Irish Standard
I.S. EN 61788-16:2013

Superconductivity -- Part 16: Electronic characteristic measurements - Power-dependent surface resistance of superconductors at microwave frequencies (IEC 61788-16:2013 (EQV))

I.S. EN 61788-16:2013

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EN 61788-16

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English version

Superconductivity - Part 16: Electronic characteristic measurements - Power-dependent surface resistance of superconductors at microwave frequencies (IEC 61788-16:2013)

Supraconductivité -
Partie 16: Mesures de caractéristiques électroniques -
Résistance de surface des supraconducteurs aux hyperfréquences en fonction de la puissance
(CEI 61788-16:2013)

Supraleitfähigkeit -
Teil 16: Messung der elektronischen Eigenschaften -
Leistungsabhängiger Oberflächenwiderstand bei Mikrowellenfrequenzen
(IEC 61788-16:2013)

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

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Foreword

The text of document 90/309/FDIS, future edition 1 of IEC 61788-16, prepared by IEC TC 90, "Superconductivity" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61788-16:2013.

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)	2013-11-20
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-02-20

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Endorsement notice

The text of the International Standard IEC 61788-16:2013 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.

Publication	Year	Title	EN/HD	Year
IEC 60050	Series	International electrotechnical vocabulary	-	-
IEC 61788-15	-	Superconductivity - Part 15: Electronic characteristic measurements - Intrinsic surface impedance of superconductor films at microwave frequencies	EN 61788-15	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SUPERCONDUCTIVITY –

Part 16: Electronic characteristic measurements – Power-dependent surface resistance of superconductors at microwave frequencies

FOREWORD

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International Standard IEC 61788-16 has been prepared by IEC technical committee 90: Superconductivity.

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

FDIS	Report on voting
90/309/FDIS	90/318/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 the 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.

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

Since the discovery of high-T_c superconductors (HTS), extensive researches have been performed worldwide for electronic applications and large-scale applications.

In the fields of electronics, especially in telecommunications, microwave passive devices such as filters using HTS are being developed and testing is underway on sites [1,2,3,4][1].

Superconductor materials for microwave resonators, filters, antennas and delay lines have the advantage of ultra-low loss characteristics. Knowledge of this parameter is vital for the development of new materials on the supplier side and the design of superconductor microwave components on the customer side. The parameters of superconductor materials needed to design microwave components are the surface resistance R_s and the temperature dependence of the R_s. Recent advances in HTS thin films with R_s, several orders of magnitude lower than normal metals has increased the need for a reliable characterization technique to measure this property [5,6]. Among several methods to measure the R_s of superconductor materials at microwave frequencies, the dielectric resonator method [7,8,9] has been useful due to that the method enables to measure the R_s nondestructively and accurately. In particular, the sapphire resonator is an excellent tool for measuring the R_s of HTS materials [10]. In 2002, the International Electrotechnical Commission (IEC) published the dielectric resonator method as a measurement standard [11].

The test method given in this standard enables measurement of the power-dependent surface resistance of superconductors at microwave frequencies. For high power microwave device applications such as those of transmitting devices, not only the temperature dependence of R_s but also the power dependence of R_s is needed to design the microwave components. Based on the measured power dependence, the RF current density dependence of the surface resistance can be evaluated. The simulation software to design the device gives the RF current distribution in the device. The results of the power dependence measurement can be directly compared with the simulation and allow the power handling capability of the device to be evaluated.

The test method given in this standard can be also applied to other superconductor bulk plates including low-T_c material.

This standard is intended to give an appropriate and agreeable technical base for the time being to those engineers working in the fields of electronics and superconductivity technology.

The test method covered in this standard is based on the VAMAS (Versailles Project on Advanced Materials and Standards) pre-standardization work on the thin film properties of superconductors.

1 Numbers in square brackets refer to the Bibliography.

SUPERCONDUCTIVITY –

Part 16: Electronic characteristic measurements – Power-dependent surface resistance of superconductors at microwave frequencies

1 Scope

This part of IEC 61788 involves describing the standard measurement method of power-dependent surface resistance of superconductors at microwave frequencies by the sapphire resonator method. The measuring item is the power dependence of R_s at the resonant frequency.

The following is the applicable measuring range of surface resistances for this method:

Frequency: f ~ 10 GHz

Input microwave power: P_{in} < 37 dBm (5 W)

The aim is to report the surface resistance data at the measured frequency and that scaled to 10 GHz using the $R_s \propto f^2$ relation for comparison.

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.com>)

IEC 61788-15, *Superconductivity – Part 15: Electronic characteristic measurements – Intrinsic surface impedance of superconductor films at microwave frequencies*

3 Terms and definitions

For the purposes of this document, the definitions given in IEC 60050-815, one of which is repeated here for convenience, apply.

3.1
surface impedance
impedance of a material for a high frequency electromagnetic wave which is constrained to the surface of the material in the case of metals and superconductors

Note 1 to entry: The surface impedance governs the thermal losses of superconducting RF cavities.

Note 2 to entry: In general, surface impedance Z_s for conductors including superconductors is defined as the ratio of the electric field E_t to the magnetic field H_t, tangential to a conductor surface:

$Z_s = E_t / H_t = R_s + jX_s$,

where R_s is the surface resistance and X_s is the surface reactance.