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STN	**Supravodivosť Časť 7: Merania elektronických charakteristík Povrchový odpor vysokoteplotných supravodičov pri mikrovlnových frekvenciách**	**STN EN IEC 61788-7 34 5685**

Superconductivity - Part 7: Electronic characteristic measurements - Surface resistance of high-temperature superconductors at microwave frequencies

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

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English Version

Superconductivity - Part 7: Electronic characteristic measurements - Surface resistance of high-temperature superconductors at microwave frequencies (IEC 61788-7:2020)

Supraconductivité - Partie 7: Mesurages des caractéristiques électronique - Résistance de surface des supraconducteurs haute température critique aux hyperfréquences (IEC 61788-7:2020)

Supraleitfähigkeit - Teil 7: Messungen der elektronischen Charakteristik - Oberflächenwiderstand von Hochtemperatur-Supraleitern bei Frequenzen im Mikrowellenbereich (IEC 61788-7:2020)

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European foreword

The text of document 90/447/FDIS, future edition 3 of IEC 61788-7, prepared by IEC/TC 90 "Superconductivity" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61788-7:2020.

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)	2021-01-24
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2023-04-24

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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 60050-815	-	International Electrotechnical Vocabulary - Part 815: Superconductivity	-	-

IEC 61788-7

Edition 3.0 2020-03

INTERNATIONAL STANDARD

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Superconductivity – Part 7: Electronic characteristic measurements – Surface resistance of high-temperature superconductors at microwave frequencies

Supraconductivité – Partie 7: Mesurages des caractéristiques électronique – Résistance de surface des supraconducteurs haute température critique aux hyperfréquences

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INTERNATIONAL STANDARD

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CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
2 Normative references 8
3 Terms and definitions 8
4 Requirements 8
5 Apparatus 9
5.1 Measurement system 9
5.2 Measurement apparatus for R_s 10
5.3 Dielectric rods 12
6 Measurement procedure 12
6.1 Specimen preparation 12
6.2 Set-up 13
6.3 Measurement of reference level 13
6.4 Measurement of the frequency response of resonators 14
6.5 Determination of surface resistance of the superconductor and ε' and tan δ of the standard sapphire rods 16
7 Uncertainty of the test method 17
7.1 Surface resistance 17
7.2 Temperature 18
7.3 Specimen and holder support structure 18
7.4 Specimen protection 19
7.5 Uncertainty of surface resistance measured by standard two-resonator method 19
8 Test report 19
8.1 Identification of test specimen 19
8.2 Report of R_s values 19
8.3 Report of test conditions 19
Annex A (informative) Additional information relating to Clauses 1 to 8 20
A.1 Scope 20
A.1.1 General 20
A.1.2 Cylindrical cavity method [10] [17] 20
A.1.3 Parallel-plates resonator method [18] [19] 20
A.1.4 Microstrip-line resonance method [20] [21] 20
A.1.5 Dielectric resonator method [22] [23] [24] [25] 20
A.1.6 Image-type dielectric resonator method [26] [27] 21
A.1.7 Two-resonator method [28] [29] 22
A.2 Requirements 22
A.3 Theory and calculation equations 22
A.4 Apparatus 25
A.5 Dimensions of the standard sapphire rods 26
A.6 Dimension of the closed type resonator 28
A.7 Sapphire rod reproducibility 30
A.8 Test results 30
A.9 Reproducibility of measurement method 31

A.10 tan δ deviation effect of sapphire rods on surface resistance 32
Annex B (informative) Evaluation of relative combined standard uncertainty for surface resistance measurement 34
B.1 Practical surface resistance measurement 34
B.2 Determination of surface resistance of the superconductor 35
B.3 Combined standard uncertainty 36
B.3.1 General 36
B.3.2 Calculation of c_2 to c_5 (12 GHz resonance at 20 K) 36
B.3.3 Determination of u_1 to u_5 37
B.3.4 Combined relative standard uncertainty 39
Bibliography 41

Figure 1 – Schematic diagram of measurement system for temperature dependence of R_s using a cryocooler 9
Figure 2 – Typical measurement apparatus for R_s 11
Figure 3 – Insertion attenuation, IA, resonant frequency, f_0, and half power bandwidth, Δf, measured at T kelvin 14
Figure 4 – Reflection scattering parameters (S_{11} and S_{22}) 16
Figure 5 – Term definitions in Table 4 18
Figure A.1 – Schematic configuration of several measurement methods for the surface resistance 21
Figure A.2 – Configuration of a cylindrical dielectric rod resonator short-circuited at both ends by two parallel superconductor films deposited on dielectric substrates 23
Figure A.3 – Computed results of the u-v and W-v relations for TE_{01p} mode 24
Figure A.4 – Configuration of standard dielectric rods for measurement of R_s and tan δ 25
Figure A.5 – Three types of dielectric resonators 26
Figure A.6 – Mode chart to design TE_{011} resonator short-circuited at both ends by parallel superconductor films [28] 27
Figure A.7 – Mode chart to design TE_{013} resonator short-circuited at both ends by parallel superconductor films [28] 28
Figure A.8 – Mode chart for TE_{011} closed-type resonator [28] 29
Figure A.9 – Mode chart for TE_{013} closed-type resonator [28] 30
Figure A.10 – Temperature-dependent R_s of YBCO film with a thickness of 500 nm and size of 25 mm square 31
Figure A.11 – Temperature dependent R_s of YBCO film when R_s was measured three times 32
Figure B.1 – Schematic diagram of TE_{011} and TE_{013} mode resonance 34
Figure B.2 – Typical frequency characteristics of TE_{011} mode resonance 35
Figure B.3 – Frequency characteristics of a resonator approximated by a Lorentz distribution 39

Table 1 – Typical dimensions of pairs of single-crystal sapphire rods for 12 GHz, 18 GHz and 22 GHz 12
Table 2 – Dimensions of superconductor film for 12 GHz, 18 GHz, and 22 GHz 13
Table 3 – Specifications for vector network analyzer 17

Table 4 – Specifications for sapphire rods 17

Table A.1 – Standard deviation of the surface resistance calculated from the results of Figure A.11 32

Table A.2 – Relationship between x, defined by Equation (A.12), and y, defined by Equation (A.13) 33

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SUPERCONDUCTIVITY –

Part 7: Electronic characteristic measurements – Surface resistance of high-temperature superconductors at microwave frequencies

FOREWORD

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International Standard IEC 61788-7 has been prepared by IEC technical committee 90: Superconductivity.

This third edition cancels and replaces the second edition, published in 2006. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) informative Annex B, relative combined standard uncertainty for surface resistance measurement has been added;
b) precision and accuracy statements have been converted to uncertainty;
c) reproducibility in surface resistant measurement has been added.

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

FDIS	Report on voting
90/447/FDIS	90/452/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document 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 document will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the document will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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INTRODUCTION

Since the discovery of some Perovskite-type Cu-containing oxides, extensive research and development (R & D) work on high-temperature superconductors (HTS) has been, and is being, done worldwide, and its application to high-field magnet machines, low-loss power transmission, electronics and many other technologies is in progress.

In various fields of electronics, especially in telecommunication fields, microwave passive devices such as filters using HTS are being developed and are undergoing on-site testing [1][1] [2].

Superconductor materials for microwave resonators [3], filters [4], antennas [5] and delay lines [6] have the advantage of very low loss characteristics. The parameters of superconductor materials needed for the design of microwave low loss components are the surface resistance, (R_s) and the temperature dependence of the R_s. Knowledge of this parameter is of primary importance for the development of new materials on the supplier side and for the design of superconductor microwave components on the customer side.

R_s of high quality HTS films is generally several orders of magnitude lower than that of normal metals [7] [8] [9] [10], which has increased the need for a reliable characterization technique to measure this property. Traditionally, the R_s of niobium or any other low-temperature superconducting material was measured by first fabricating an entire three-dimensional resonant cavity and then measuring its Q-value [11]. The R_s could be calculated by solving the electro-magnetic field (EM) distribution inside the cavity. Another technique involves placing a small sample inside a larger cavity. This technique has many forms but usually involves the uncertainty introduced by extracting the loss contribution due to the HTS films from the experimentally measured total loss of the cavity.

The best HTS samples are epitaxial films grown on flat crystalline substrates and no high-quality films have been grown on any curved surface so far. What is needed is a technique that: can use these small flat samples; requires no sample preparation; does not damage or change the film; is highly repeatable; has great sensitivity (down to 1/1 000 the R_s of copper); has great dynamic range (up to the R_s of copper); can reach high internal powers with only modest input powers; and has broad temperature coverage (4,2 K to 150 K).

The dielectric resonator method is selected among several methods to determine the surface resistance at microwave frequencies because it is considered to be the most popular and practical at present. Especially, the sapphire resonator is an excellent tool for measuring the R_s of HTS materials [12] [13] [14]

The test method given in this document can also be applied to other superconductor bulk plates including low T_c materials.

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

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

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1 Numbers in square brackets refer to the bibliography.

SUPERCONDUCTIVITY –

Part 7: Electronic characteristic measurements – Surface resistance of high-temperature superconductors at microwave frequencies

1 Scope

This part of IEC 61788 describes measurement of the surface resistance (R_s) of superconductors at microwave frequencies by the standard two-resonator method. The object of measurement is the temperature dependence of R_s at the resonant frequency.

The applicable measurement range of R_s for this method is as follows:

– Frequency: 8 GHz < f < 30 GHz

– Measurement resolution: 0,01 mΩ at 10 GHz

The R_s data at the measured frequency, and that scaled to 10 GHz, assuming the f^2 rule for comparison, is reported.

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 60050-815, *International Electrotechnical Vocabulary (IEV) – Part 815: Superconductivity*