

Superconductivity —

Part 9: Measurements for bulk high temperature superconductors — Trapped flux density of large grain oxide superconductors

The European Standard EN 61788-9:2005 has the status of a British Standard

ICS 17.220; 29.050

National foreword

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The UK participation in its preparation was entrusted to Technical Committee L/-/90, Superconductivity, which has the responsibility to:

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 20, an inside back cover and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 24 January 2006

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Superconductivity
Part 9: Measurements for bulk high temperature superconductors -
Trapped flux density of large grain oxide superconductors
(IEC 61788-9:2005)

Supraconductivité

Partie 9: Mesures pour supraconducteurs
haute température massifs –
Densité de flux résiduel des oxydes
supraconducteurs à gros grains
(CEI 61788-9:2005)

Supraleitfähigkeit

Teil 9: Messungen an massiven
Hochtemperatursupraleitern -
Eingefrorene magnetische Flussdichte
bei grobkörnigen oxidischen Supraleitern
(IEC 61788-9:2005)

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CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 90/167/FDIS, future edition 1 of IEC 61788-9, prepared by IEC TC 90, Superconductivity, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61788-9 on 2005-06-01.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2006-03-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2008-06-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61788-9:2005 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

Large grain bulk high temperature superconductors (BHTSC) have significant potential for a variety of engineering applications, such as magnetic bearings, flywheel energy storage systems, load transports, levitation, and trapped flux density magnets. Large grain superconductors have already been brought to market worldwide.

For industrial applications of bulk superconductors, there are two important material properties. One is the magnetic levitation force, which determines the tolerable weight supported by a bulk superconductor. The other is the trapped flux density, which determines the maximum field that a bulk superconductor can generate. The users of bulk superconductors must know these values for the design of their devices. However, these values are strongly dependent on the testing method, and therefore it is critically important to set up an international standard for the determination of these values both for manufacturers and industrial users.

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

SUPERCONDUCTIVITY –

Part 9: Measurements for bulk high temperature superconductors – Trapped flux density of large grain oxide superconductors

1 Scope

This part of IEC 61788 specifies a test method for the determination of the trapped field (trapped flux density) of bulk high temperature superconductors.

This International Standard is applicable to large grain bulk oxide superconductors that have well defined shapes such as round discs, rectangular, and hexagonal pellets. The trapped flux density can be assessed at temperatures from 4,2 K to 90 K. For the purpose of standardization, the trapped flux density will be reported for liquid nitrogen temperature.

2 Normative references

The following referenced documents are indispensable for the application 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):2000, *International Electrotechnical Vocabulary – Part 815: Superconductivity*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050(815) and the following apply.

3.1

trapped flux density

strength of the magnetic flux density (T) trapped by a bulk high temperature superconductor (BHTSC) at a defined gap and at a defined temperature

3.2

maximum trapped flux density

peak value of the trapped flux density

NOTE For most measurements, only the z component of the flux density is measured, which is strongly affected by the sample geometry or the demagnetizing effect (see Clause A.2). Thus the total flux density, which is the integration of all the field components, may also be regarded as the materials property to stand for the trapped flux density (see Clause A.1).

4 Principle

Superconductors that exhibit flux pinning are capable of trapping magnetic fields, as shown in Figure 1. Here the internal magnetic flux density rotation ($\nabla \times \mathbf{B}$) in the BHTSC is proportional to the critical current density (J_c), as expressed by the following equation:

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J}_c$$

In one dimension, the equation is reduced to

$$dB_z/dx = \mu_0 J_c^y$$

in rectangular coordinates or to

$$dB_z/dr = \mu_0 J_c^\theta$$

in cylindrical coordinates.

The maximum value of the trapped flux density in the z component ($B_{z,\max}$) in an infinite cylinder ($2R$ in diameter) is given by the following equation:

$$B_{z,\max} = \mu_0 J_c^\theta R$$

In practical samples, this value is reduced by the demagnetizing effect or the geometrical effect as follows:

$$B_{z,\max} = D(R/t) \mu_0 J_c^\theta R$$

where $D(R/t)$ is a geometrical constant that depends on the shape (the ratio of radius/thickness) of the BHTSC.

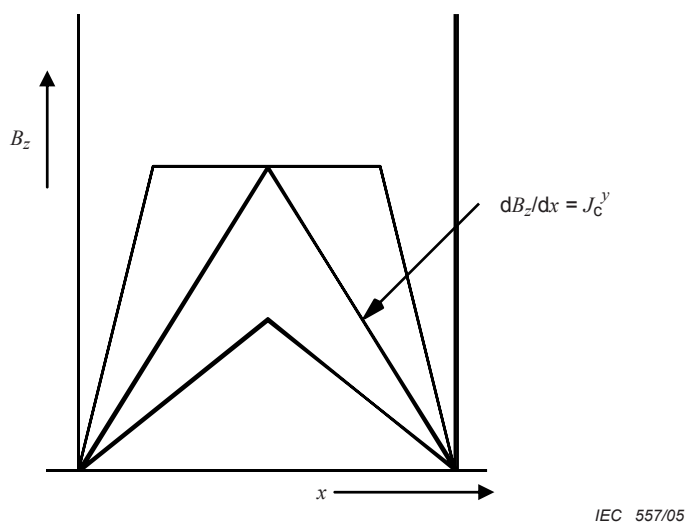


Figure 1 – Principle of trapped flux density in bulk superconductor