

Waveguide type dielectric resonators —

Part 1-3: General information and test conditions — Measurement method of complex relative permittivity for dielectric resonator materials at microwave frequency

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 23 and a back cover.

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Partie 1-3: Informations générales et conditions d'essais - Méthode de mesure de la permittivité relative complexe des matériaux diélectriques pour les résonateurs diélectriques fonctionnant aux hyperfréquences
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Dielektrische Resonatoren vom Wellenleitertyp
Teil 1-3: Allgemeine Informationen und Prüfbedingungen - Meßverfahren für die relative Dielektrizitätskonstante von dielektrischen Resonatorwerkstoffen im Mikrowellen-Frequenzbereich
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European Committee for Electrotechnical Standardization
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Foreword

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Annexes designated "informative" are given for information only.
In this standard, annex A is informative.

Endorsement notice

The text of the International Standard IEC 61338-1-3:1999 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

Dielectric materials for microwave resonators and filters have high relative permittivity, a low loss factor and superior temperature stability of resonance frequencies. Knowledge of these parameters is of primary importance for the development of new materials on the supplier side and for the design of dielectric microwave components on the customer side.

The parameters of dielectric resonator materials needed for the design of microwave components are:

- the real component ϵ' of the complex relative permittivity;
- the loss factor $\tan \delta$;
- the temperature coefficient of resonance frequency (*TCF*);
- the temperature dependence of $\tan \delta$.

Several measurement methods are proposed to determine the complex permittivity at microwave frequencies:

- the dielectric rod resonator method using TE_{011} resonance mode;
- the cylindrical cavity method using $TE_{01\delta}$ resonance mode;
- the perturbation method using a cylindrical cavity;
- the S-parameter method using a coaxial line.

WAVEGUIDE TYPE DIELECTRIC RESONATORS –

Part 1-3: General information and test conditions – Measurement method of complex relative permittivity for dielectric resonator materials at microwave frequency

1 Scope and object

This part of IEC 61338 describes the dielectric rod resonator measurement method for a wide range of microwave dielectric properties in practical applications. This method has the following characteristics:

- a complete and exact mathematical solution of complex relative permittivity is given by easy computer software;
- the measurement error is less than 0,3 % for ε' and less than $0,05 \times 10^{-4}$ for $\tan \delta$;
- the TCF is directly measured without any compensation with a measurement error less than $1 \times 10^{-6}/K$.

The object of this standard is to describe the measurement methods of the complex relative permittivity of dielectric resonator materials at microwave frequencies by means of the dielectric rod resonator method short-circuited at both ends by parallel conducting plates. The measuring parameters are ε' , $\tan \delta$, TCF and the temperature dependence of $\tan \delta$ at the resonance frequency. The dielectric materials are assumed to be isotropic and homogeneous.

2 Measuring parameters

The terms of the measuring parameters are defined as follows:

$$\varepsilon_r = \varepsilon' - j\varepsilon'' = D/(\varepsilon_0 E) \quad (1)$$

$$\tan \delta = \varepsilon''/\varepsilon' \quad (2)$$

$$TCF = -\frac{1}{2} TC \varepsilon - \alpha \quad (3)$$

where

D is the electric flux density;

E is the electric field strength;

ε_0 is the electric constant;

ε' and ε'' are the real and imaginary components of the complex relative permittivity ε_r .

It should be noted that the TCF is defined by equation (3) as the material constant, $TC\varepsilon$ being the temperature coefficient of relative permittivity and α the coefficient of thermal expansion of the dielectric specimen. Each of the temperature coefficients is given as follows: