
Waveguide type dielectric resonators - Part 1-3: General information and test conditions (IEC 61338-1-3:1999)

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

Dielektrische Resonatoren vom Wellenleitertyp -- Teil 1-3: Allgemeine Informationen und Prüfbedingungen - Meßverfahren für die relative Dielektrizitätskonstante von dielektrischen Resonatorwerkstoffen im Mikrowellen-Frequenzbereich

Résonateurs diélectriques à modes guidés -- 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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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
(IEC 61338-1-3:1999)

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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 49/444/FDIS, future edition 1 of IEC 61338-1-3, prepared by IEC TC 49, Piezoelectric and dielectric devices for frequency control and selection, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61338-1-3 on 2000-01-01.

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) 2000-10-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2003-01-01

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

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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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1999-11

Résonateurs diélectriques à modes guidés –

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
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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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CONTENTS

	Page
FOREWORD	7
INTRODUCTION	11
Clause	
1 Scope and object	13
2 Measuring parameters	13
3 Theory and calculation equations	15
3.1 Relative permittivity and loss factor	15
3.2 Determination of the relative conductivity of conducting plates	21
3.3 Temperature coefficient of resonance frequency	23
3.4 Temperature dependence of $\tan \delta$	27
4 Preparation of dielectric specimen	27
4.1 Preparation of standard dielectric rods	27
4.2 Preparation of test specimen	29
5 Measurement equipment and apparatus	29
5.1 Measurement equipment	29
5.2 Measurement apparatus for complex permittivity	31
5.3 Measurement apparatus for temperature coefficient	35
6 Measurement procedure	35
6.1 Measurement procedure for complex permittivity	35
6.2 Measurement procedure for temperature coefficient	41
7 Accuracy and error estimation	41
7.1 Measurement error due to the size of conducting plates	41
7.2 Measurement error of relative conductivity	43
7.3 Errors due to the airgap between dielectric rod and conducting plates or to field disturbance	45
7.4 Result of round robin test (RRT)	45
Annex A – Bibliography	47
Figures	
Figure 1 – Configuration of a cylindrical dielectric rod resonator short-circuited at both ends by two parallel conducting plates	15
Figure 2 – Chart for relative permittivity calculation using $TE_{01\ell}$ mode	17
Figure 3 – Confirmation of standard dielectric rod resonators for measurement of conductivity of conducting plates	21
Figure 4 – Temperature dependence of f_0 (figure 4a) and $\tan \delta$ (figure 4b) for five kinds of dielectrics ($\epsilon' = 21, 25, 30, 38$ and 90)	25
Figure 5 – Mode chart of a dielectric rod resonator short-circuited at both ends by parallel conducting plates	31
Figure 6 – Schematic diagram of measurement equipment	33
Figure 7 – Measurement apparatus for complex permittivity	33

Figure 8 – Measurement apparatus for temperature coefficient	35
Figure 9 – Frequency response for TE ₀₁₁ mode resonator having $\epsilon' = 37,5$, $d = 8,00$ mm and $h = 3,3$ mm	39
Figure 10 – Insertion attenuation IA_0 , resonance frequency f_0 and half-power bandwidth Δf	39
Figure 11 – Measurement error on ϵ' and $\tan \delta$ by the size ratio d'/d	43
Tables	
Table 1 – Examples of dimensions for standard dielectric rods.....	27
Table 2 – Example of TE ₀₁₁ mode resonance frequency for various ϵ' and dimensions of a dielectric specimen	29
Table 3 – Recommended dimensions and materials for conducting plate	35

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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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International Standard IEC 61338-1-3 has been prepared by IEC technical committee 49: Piezoelectric and dielectric devices for frequency control and selection.

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

FDIS	Report on voting
49/444/FDIS	49/449/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 3.

Annex A is for information only.

This standard forms part 1-3 of IEC 61338.

IEC 61338, Waveguide type dielectric resonators, consists of the following parts:

- Part 1-1: General information and test conditions – General information (IEC 61338-1-1)
- Part 1-2: General information and test conditions – Test conditions (IEC 61338-1-2)
- Part 1-3: General information and test conditions – Measurement method of complex relative permittivity for dielectric resonator materials at microwave frequency (IEC 61338-1-3)
- Part 2: Guide to the use of waveguide type dielectric resonators (IEC 61338-2) (under consideration)
- Part 3: Standard outlines (IEC 61338-3) (under consideration)

The committee has decided that this publication remains valid until 2003. At this date, in accordance with the committee's decision, the publication will be

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

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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.

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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: