

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Waveguide type dielectric resonators –  
Part 1-5: General information and test conditions – Measurement method of  
conductivity at interface between conductor layer and dielectric substrate at  
microwave frequency**

**Résonateurs diélectriques à modes guidés –  
Partie 1-5: Informations générales et conditions d'essais – Méthode de mesure  
de la conductivité au niveau de l'interface entre une couche conductrice et un  
substrat diélectrique fonctionnant aux hyperfréquences**



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INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 31.140

ISBN 978-2-8322-2721-3

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**WAVEGUIDE TYPE DIELECTRIC RESONATORS –****Part 1-5: General information and test conditions –  
Measurement method of conductivity at interface between  
conductor layer and dielectric substrate at microwave frequency**

## FOREWORD

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International Standard IEC 61338-1-5 has been prepared by IEC technical committee 49: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection.

This first edition cancels and replaces IEC PAS 61338-1-5 published in 2010.

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

- a) description of technical content related to patents (Japanese patent numbers JP3634966, JP3735501) in the Introduction;
- b) changes to normative references;
- c) addition to bibliography.

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

| CDV         | Report on voting |
|-------------|------------------|
| 49/1089/CDV | 49/1103/RVC      |

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 parts in the IEC 61338 series, published under the general title *Waveguide type dielectric resonators*, 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.

## INTRODUCTION

IEC 61338 consists of the following parts, under the general title *Waveguide type dielectric resonators*:

- Part 1: Generic specification
- Part 1-3: General information and test conditions – Measurement method of complex relative permittivity for dielectric resonator materials at microwave frequency
- Part 1-4: General information and test conditions – Measurement method of complex relative permittivity for dielectric resonator materials at millimeter-wave frequency
- Part 2: Guidelines for oscillator and filter applications
- Part 4: Sectional specification
- Part 4-1: Blank detail specification

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning:

- The use of a  $TE_{010}$  mode dielectric rod resonator for the interface resistance and the interface conductivity measurement, given in Clause 4;
- The use of a substrate/conductor/substrate layer structure, where a conductor is formed between two dielectric substrates, for the interface resistance and interface conductivity measurement, given in Clause 5.

IEC takes no position concerning the evidence, validity and scope of this patent right.

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## WAVEGUIDE TYPE DIELECTRIC RESONATORS –

### Part 1-5: General information and test conditions – Measurement method of conductivity at interface between conductor layer and dielectric substrate at microwave frequency

#### 1 Scope

Microwave circuits are popularly formed on multi-layered organic or non-organic substrates. In the microwave circuits, the attenuation of planar transmission lines such as striplines, microstrip lines, and coplanar lines are determined by their conductor loss, dielectric loss and radiation loss. Among them, the conductor loss is a major factor in the attenuation of the planar transmission lines. A new measurement method is standardized in this document to evaluate the conductivity of transmission line on or in the substrates such as the organic, ceramic and LTCC (low temperature co-fired ceramics) substrates. This standard describes a measurement method for resistance and effective conductivity at the interface between conductor layer and dielectric substrate, which are called interface resistance and interface conductivity.

This measurement method has the following characteristics:

- the interface resistance  $R_i$  is obtained by measuring the resonant frequency  $f_0$  and unloaded quality factor  $Q_u$  of a  $TE_{01\delta}$  mode dielectric rod resonator shown in Figure 2;
- the interface conductivity  $\sigma_i$  and the relative interface conductivity  $\sigma_{ri} = \sigma_i / \sigma_0$  are calculated from the measured  $R_i$  value, where  $\sigma_0 = 5,8 \times 10^7$  S/m is the conductivity of standard copper;
- the measurement uncertainty of  $\sigma_{ri}$  ( $\Delta\sigma_{ri}$ ) is less than 5 %.

#### 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 61338-1-3: *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 62562: *Cavity resonator method to measure the complex permittivity of low-loss dielectric plates*

#### 3 Measurement and related parameters

The IEC 61338-1-3 described the measurement method for the surface resistance  $R_s$  and effective conductivity  $\sigma$  on the surface of the conductor. The term  $\sigma$  is designated as  $\sigma_s$  in this standard, and is called surface conductivity (Figure 1). This standard describes a measurement method for resistance and effective conductivity at the interface between conductor layer and dielectric substrate designated as  $R_i$  and  $\sigma_i$  respectively, and are called interface resistance and interface conductivity.