IEC 61338-1

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Waveguide type dielectric resonators –
Part 1: Generic specification

Résonateurs diélectriques à modes guidés –
Partie 1: Spécification générique

IEC 61338-1:2004

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WAVEGUIDE TYPE DIELECTRIC RESONATORS –

Part 1: Generic specification

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). 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. 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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This International Standard IEC 61338-1 has been prepared by IEC technical committee 49: Piezoelectric and dielectric devices for frequency control and selection.

IEC 61338-1 cancels and replaces the first edition of IEC 61338-1-1 published in 1996 and the first edition of IEC 61338-1-2 published in 1998.

This bilingual version (2013-08) corresponds to the monolingual English version, published in 2004-11.

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

DIS	Report on Voting
49/690/FDIS	49/699/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.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 2: Guidelines for oscillator and filter applications

Part 4: Sectional specification

Part 4-1: Blank detail specification

The committee has decided that the contents of this publication 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 publication will be

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- withdrawn;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

WAVEGUIDE TYPE DIELECTRIC RESONATORS –

Part 1: Generic specification

1 General

1.1 Scope

This part of IEC 61338 applies to waveguide type dielectric resonators of assessed quality using either capability approval or qualification approval procedures. It also lists the test and measurement procedures which may be selected for use in detail specifications for such resonators.

1.2 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 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050(561):1991, *International Electrotechnical Vocabulary (IEV) – Chapter 561: Piezo-electric devices for frequency control and selection*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests – Tests B: Dry Heat*

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Tests Fc: Vibration (sinusoidal)*

IEC 60068-2-7:1983, *Environmental testing – Part 2: Tests – Tests Ga and guidance: Acceleration, steady state*

IEC 60068-2-13:1983, *Environmental testing – Part 2: Tests – Tests M: Low air pressure*

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests – Tests N: Change of temperature*

IEC 60068-2-20:1979, *Environmental testing – Part 2: Tests – Tests T: Soldering*

IEC 60068-2-21:1999, *Environmental testing – Part 2: Tests – Tests U: Robustness of terminations and integral mounting devices*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Tests Ea and guidance: Shock*

IEC 60068-2-29:1987, *Environmental testing – Part 2: Tests – Tests Eb and guidance: Bump*

IEC 60068-2-30:1980, *Environmental testing – Part 2: Tests – Tests Db and guidance: Damp heat, cyclic (12 +12 hour cycle)*

IEC 60068-2-58:2004, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-78, *Environmental testing – Part 2: Tests – Test Cab: Damp heat, steady state*

IEC 60617, *Graphical symbols for diagrams*

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*

IEC 61338-4, *Waveguide type dielectric resonators of assessed quality – Part 4: Sectional specification* [1]

ISO 1000:1992, *SI units and recommendation for the use of their multiples and of certain other units*

QC 001001:2000, *IEC Quality Assessment System for Electronic Components (IECQ) – Basic Rules*

QC 001002-1:1998, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of Procedure – Part 1: Administration*

QC 001002-2:1998, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of Procedure – Part 2: Documentation*

QC 001002-3:1998, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of Procedure – Part 3: Approval Procedures*

QC 001005:2000, *Register of Firms, Products and Services approved under the IECQ System, including ISO 9000*

1.3 Order of precedence

Where any discrepancies occur for any reason, documents shall rank in the following order of priority:

– detail specification;
– sectional specification;
– generic specification;
– any other international documents (for example, of the IEC) to which reference is made.

The same order of preference shall apply to equivalent national documents.

2 Terminology and general requirements

2.1 General

Units, graphical symbols, letter symbols and terminology shall whenever possible, be taken from the following documents:

ISO 1000 SI units and recommendations for the use of their multiples and of certain other units

[1] To be published.

IEC 60617 Graphical symbols for diagrams

IEC 60027 Letter symbols to be used in electrical technology

IEC 60050 International Electrotechnical Vocabulary

Any other units, symbols and terminology peculiar to one of the components covered by this generic specification, shall be taken from the relevant IEC or ISO documents listed under 1.2, Normative references.

The following paragraphs contain additional terminology applicable to waveguide type dielectric resonators.

2.2 Definitions

The following paragraphs contain additional terminology applicable to waveguide type dielectric resonators.

2.2.1 Dielectric material

Material which predominantly exhibits dielectric properties.

NOTE The dielectric material defined herein is intended to be used for resonator applications at high frequency. i.e. UHF or SHF range. Therefore, the dielectric material is required to have high dielectric constant, a low loss factor and a low temperature coefficient of permittivity.

2.2.2 Electric constant (ε_0)

Constant equal to 8,8542 × 10^{-12} As V^{-1} m^{-1}, defined by the permittivity of vacuum.

2.2.3 Relative permittivity (ε_r)

Absolute permittivity of a material or medium divided by the electric constant ε_0.

NOTE The complex relative permittivity ε_r is defined as

$$\varepsilon_r = \varepsilon' - j\varepsilon'', \ \varepsilon' = \mathrm{Re}\,(\varepsilon), \ \varepsilon'' = -\,\mathrm{Im}\,(\varepsilon)$$

where

ε' is usually called dielectric constant;

ε'' corresponds to the dielectric loss of the material.

2.2.4 Absolute permittivity (ε)

Quantity which when multiplied by the electric field strength E is equal to the electric flux density D.

$$D = \varepsilon E, \ \varepsilon = \varepsilon_0 \, \varepsilon_r$$

2.2.5 Loss angle (δ)

Phase displacement between the component of the electric flux density and the electric field strength.

2.2.6 Loss factor

Tangent of the loss angle δ.

$$\tan \delta = \varepsilon''/\varepsilon'$$

NOTE The loss factor can be determined by the ratio of the magnitude of the negative part to the real part of the complex relative permittivity.

2.2.7 Quality factor of a material (Q_o)

Reciprocal of the tangent of the loss angle,

$$Q_o = \varepsilon'/\varepsilon'' = 1/\tan\delta$$

NOTE The quality factor of a material is also defined as 2π times the ratio of the stored electromagnetic energy to the energy dissipated in the material per cycle. It is frequency dependent.

2.2.8 Temperature coefficient of permittivity ($TC\varepsilon$)

Fractional change of permittivity due to a change in temperature divided by the change in temperature.

$$TC\varepsilon \quad \frac{\varepsilon_T - \varepsilon_{ref}}{\varepsilon_{ref}\ T - T_{ref}} \times 10^6 \qquad \left(1\times10^{-6}\ /K\right)$$

where

ε_T is the permittivity at temperature T;

ε_{ref} is the permittivity at reference T_{ref}.

2.2.9 Coefficient of linear thermal expansion (α)

Fractional change of dimension due to a change in temperature divided by the change in temperature.

$$\alpha \quad \frac{\ell_T - \ell_{ref}}{\ell_{ref}\ T - T_{ref}} \times 10^6 \qquad 1\times10^{-6}\ /K$$

where

ℓ_T is the dimension at temperature T;

ℓ_{ref} is the dimension at reference temperature T_{ref}.

2.2.10 Dielectric resonator

Resonator using dielectrics with a high dielectric constant and the structure of which is a dielectric waveguide of finite length.

NOTE The dielectric resonators in use are always shielded with conductors.

2.2.11 Dielectric support

Element supporting a dielectric resonator. The support is generally used for $TE_{01\delta}$ mode resonators and has a low dielectric constant (see Figure 1).

2.2.12 TE mode dielectric resonator

Dielectric resonator characterized by a transverse electric mode (TE mode) field distribution and usually having a high unloaded quality factor Q_u.

2.2.13 $TE_{01\delta}$ mode dielectric resonator

Dielectric resonator characterized by a dominant TE mode field distribution, whose field leaks in the direction of wave propagation (see Figure 1).

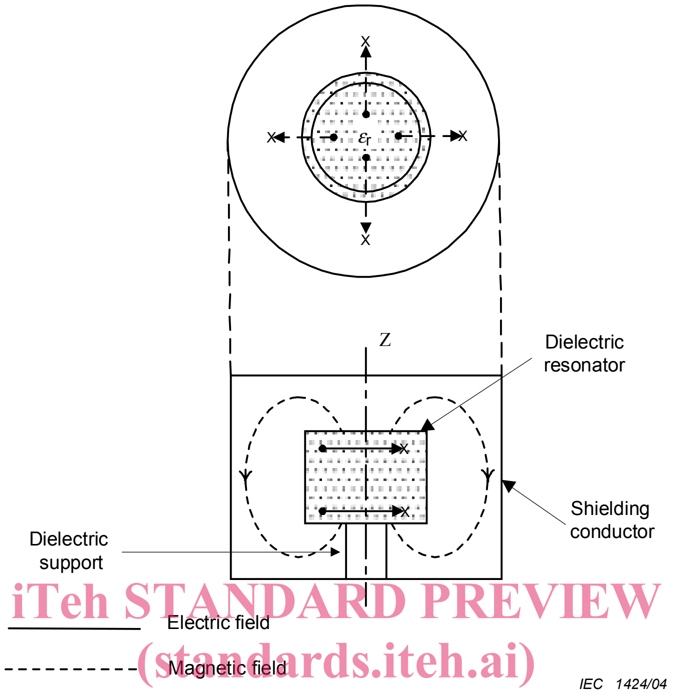


Figure 1 – $TE_{01\delta}$ mode dielectric resonator

2.2.14 TM mode dielectric resonator

Dielectric resonator characterized by a transverse magnetic mode (TM mode) field distribution (see Figure 2).

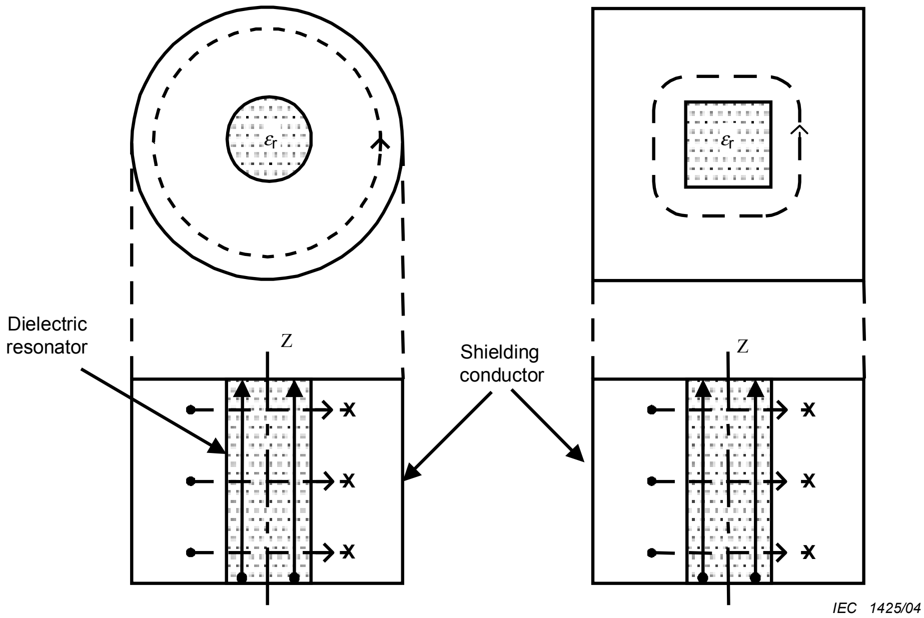


Figure 2 – TM mode dielectric resonator

2.2.15 $TM_{01\delta}$ mode dielectric resonator

Dielectric resonator characterized by a dominant TM mode field distribution, whose field leaks in the direction of wave propagation (see Figure 3).

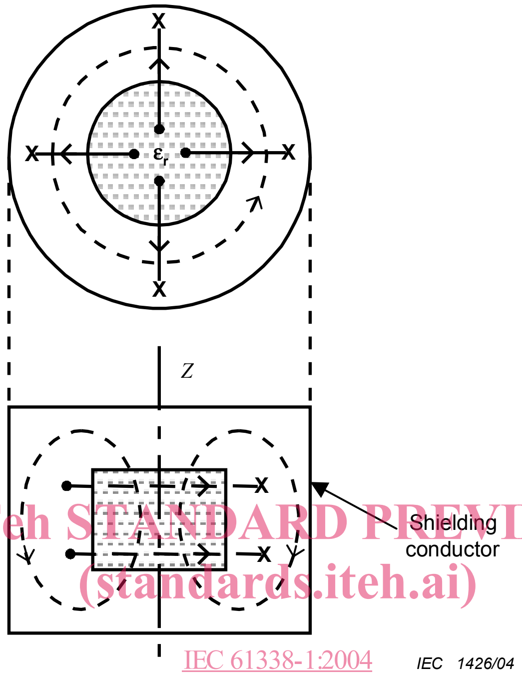


Figure 3 – $TM_{01\delta}$ mode dielectric resonator

2.2.16 Hybrid mode dielectric resonator

Dielectric resonator characterized by a hybrid mode field distribution. Hybrid mode is the mode which has axial components both of the electric and magnetic fields (see Figure 4).

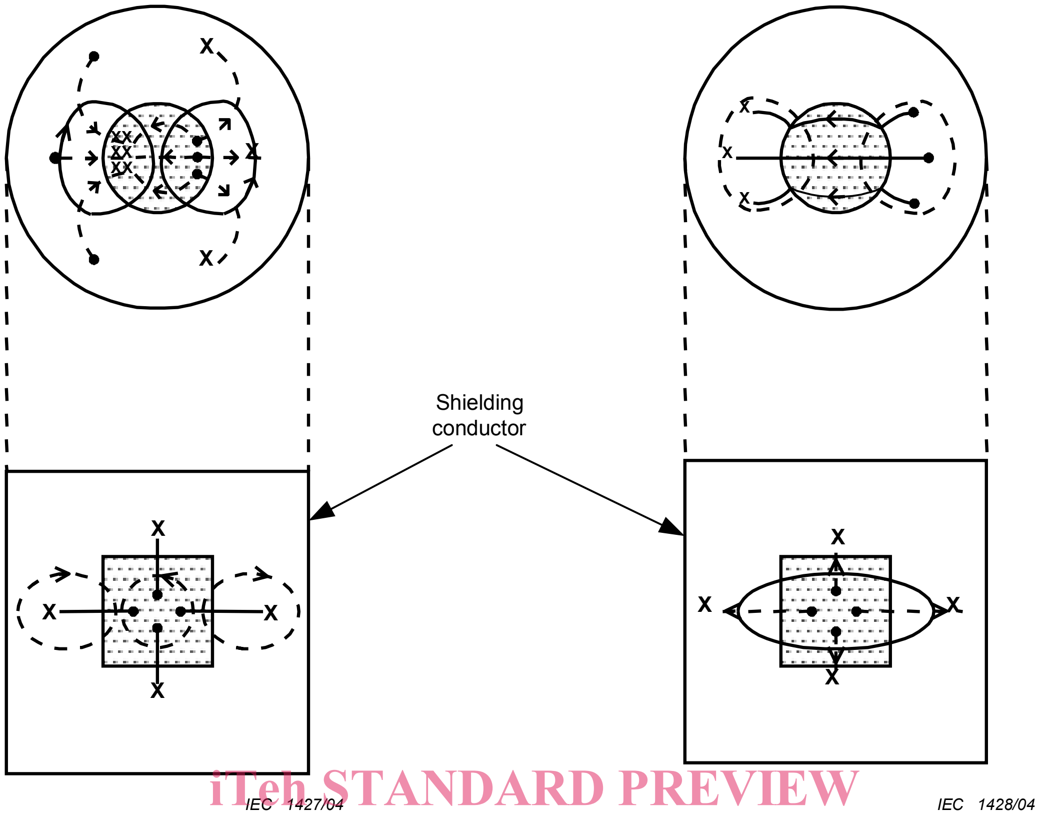


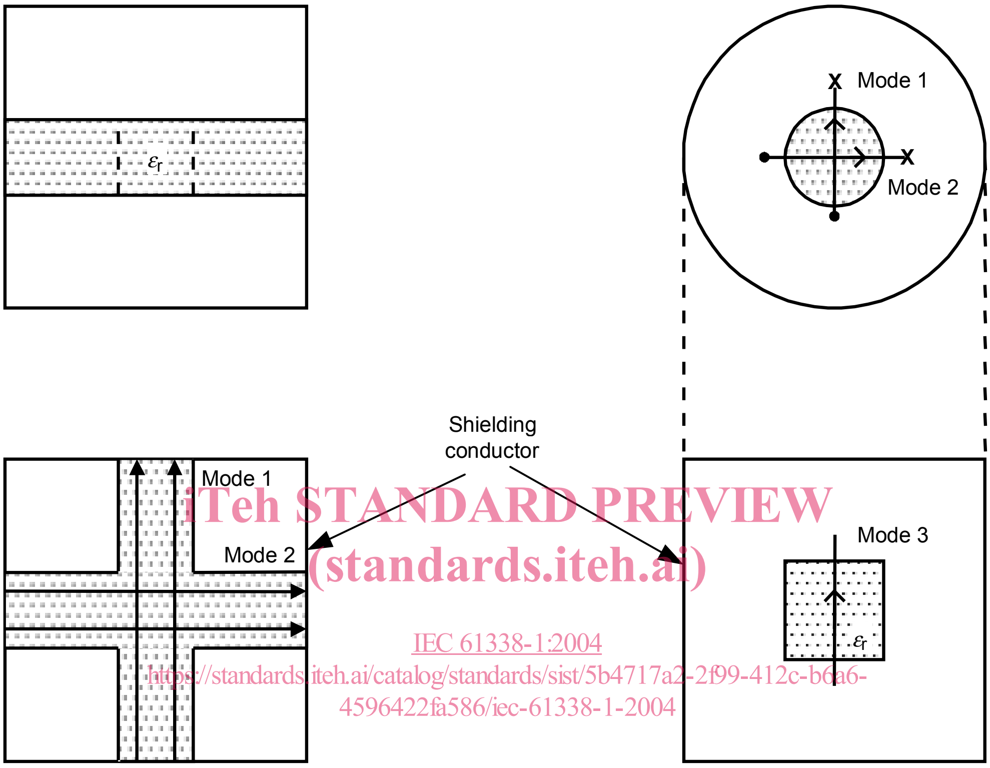
Figure 4a – $EH_{11\delta}$ mode

Figure 4b – $HE_{11\delta}$ mode

Figure 4 – Hybrid mode dielectric resonator

2.2.17 Multimode dielectric resonator

Dielectric resonator characterized by the existence of several orthogonal resonance modes, the resonance frequencies of which coincide in such a way that any of which cannot be obtained by the superposition of others (see Figure 5). Any electromagnetic field perturbation affects independence of certain of these modes and causes energy coupling between them. This allows realization of reduced volume filters.



IEC 1429/04

IEC 1430/04

Figure 5a – $TM_{11\delta}$ dual mode

Figure 5b – Triple mode of $EH_{11\delta}$ dual mode and $TM_{11\delta}$ mode

Figure 5 – Multimode dielectric resonators

2.2.18 TEM mode dielectric resonator

Dielectric resonator characterized by a transverse electromagnetic mode (TEM mode) field distribution causing significant size reduction effect (see Figure 6).

2.2.19 Coaxial dielectric resonator

Dielectric resonator characterized by a TEM mode field distribution with a coaxial waveguide structure of finite length (see Figure 6).

2.2.20 Quarter wavelength resonator

Resonator characterized by any guided mode field distribution with standing wave of a quarter wavelength (see Figure 6a in the case of TEM mode).