SLOVENSKI STANDARD
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Generic specification: Waveguide type dielectric resonators

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Fachgrundspezifikation: Dielektrische Resonatoren vom Wellenreitertyp

Spécification générique: Résonateurs diélectriques à modes guidés

Ta slovenski standard je istoveten z: EN 170000:1999

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31.140	Piezoelektriį ne in dielektriį ne naprave	Piezoelectric and dielectric devices

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EUROPEAN STANDARD
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English version

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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

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 49, Piezoelectric devices for frequency control and selection.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 170000 on 1999-08-01.

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)	2000-05-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2002-05-01

Contents

1 General

1.1 Scope

This Generic Specification 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

This European Standard incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

CECC 00 109	1974	Rule of procedure 9: Certified Test Records
CECC 00 111-3	1994	Rule of procedure 11: Part 3: Regulations for CECC specifications for components for general and professional (civil and military) usage (excluding Detail Specifications)
CECC 00 114-2	1994	Rule of procedure 14: Quality assessment procedures Part 2: Qualification approval of electronic components
CECC 00 114-3	1993	Part 3: Capability approval of an electronic component manufacturing activity
EN 100114-1	1996	Part 1: CECC requirements for the approval of an organization
EN 60068-1	1994	Environmental testing Part 1: General and guidance (IEC 60068-1:1988 + corr. October 1988 + A1:1992)
EN 60068-2-1	1993	Part 2: Tests - Tests A: Cold (IEC 60068-2-1:1990)
EN 60068-2-2	1993	Tests B: Dry heat (IEC 60068-2-2:1974 + IEC 60068-2-2A:1976)
EN 60068-2-6	1995	Test Fc: Vibration (sinusoidal) (IEC 60068-2-6:1995 + corr. March 1995)
EN 60068-2-7	1993	Test Ga and guidance: Acceleration, steady state. (IEC 60068-2-7:1983 + A1:1986)

EN 60068-2-21	1997	Test U: Robustness of terminations and integral mounting devices (IEC 60068-2-21:1983 + corr. Nov. 1991 + A1:1985)
+ A2	1997	(IEC 60068-2-21:1983/A2:1991)
+ A3	1997	(IEC 60068-2-21:1983/A3:1992)
EN 60068-2-27	1993	Test Ea and guidance: Shock (IEC 60068-2-27:1987)
EN 60068-2-29	1993	Test Eb and guidance: Bump (IEC 60068-2-29:1987 + corr.)
EN 60617	series	Graphical symbols for diagrams (IEC 60617 series)
HD 323.2.3 S2	1987	Test Ca: Damp heat, steady state (IEC 60068-2-3:1969 + A1:1984)
HD 323.2.13 S1	1987	Test M: Low air pressure (IEC 60068-2-13:1983)
HD 323.2.14 S2	1987	Test N: Change of temperature (IEC 60068-2-14:1984 + A1:1986)
HD 323.2.20 S3	1988	Test T: Soldering (IEC 60068-2-20:1979 + A2:1987)
HD 323.2.30 S3	1988	Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle) (IEC 60068-2-30:1980 + A1:1985)
HD 323.2.58 S1	1991	Test Td: Solderability, resistance to dissolution of metallization and to soldering heat of Surface Mounting Devices (SMD) (IEC 60068-2-58:1989)
IEC 60027-1	1992	Letter symbols to be used in electrical terminology Part 1: General
IEC 60050	series	International Electrotechnical Vocabulary (IEV)
IEC 61338-1-3[1]		Waveguide type dielectric resonators Part 1-3: Measurement method of complex relative permittivity for dielectric resonator materials at microwave frequency
ISO 1000	1992	SI units and recommendation for the use of their multiples and of certain other units

[1] In preparation.

1.3 Units, symbols and terminology

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

EN 60617 Graphical symbols for diagrams (IEC 60617)

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.

1.3.1 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. ie. 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.

1.3.2 Absolute permittivity (ε)

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

$$D = \varepsilon E, \quad \varepsilon = \varepsilon_o \varepsilon_r$$

1.3.3 Electric constant (ε_o)

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

1.3.4 Relative permittivity (ε_r)

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

NOTE:: The complex relative permittivity ε is defined as:

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

where

ε' is usually called dielectric constant;
ε'' corresponds to the dielectric loss of the material.

1.3.5 **Loss angle (δ)**

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

1.3.6 **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.

1.3.7 **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.

1.3.8 **Temperature coefficient of permittivity (TCε)**

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

$$TC\varepsilon = \frac{\varepsilon_T - \varepsilon_{ref}}{\varepsilon_{ref}(T - T_{ref})} \times 10^6 \quad [1 \times 10^{-6}/K]$$

where

ε_T is the permittivity at temperature T;
ε_{ref} is the permittivity at reference T_{ref}.

1.3.9 **Coefficient of linear thermal expansion** (δ)

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

$$\delta = \frac{l_T - l_{ref}}{l_{ref}\,(T - T_{ref})} \quad x \quad 10^6 \qquad [1 \times 10^{-6}/K]$$

where

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

1.3.10 **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.

1.3.11 **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).

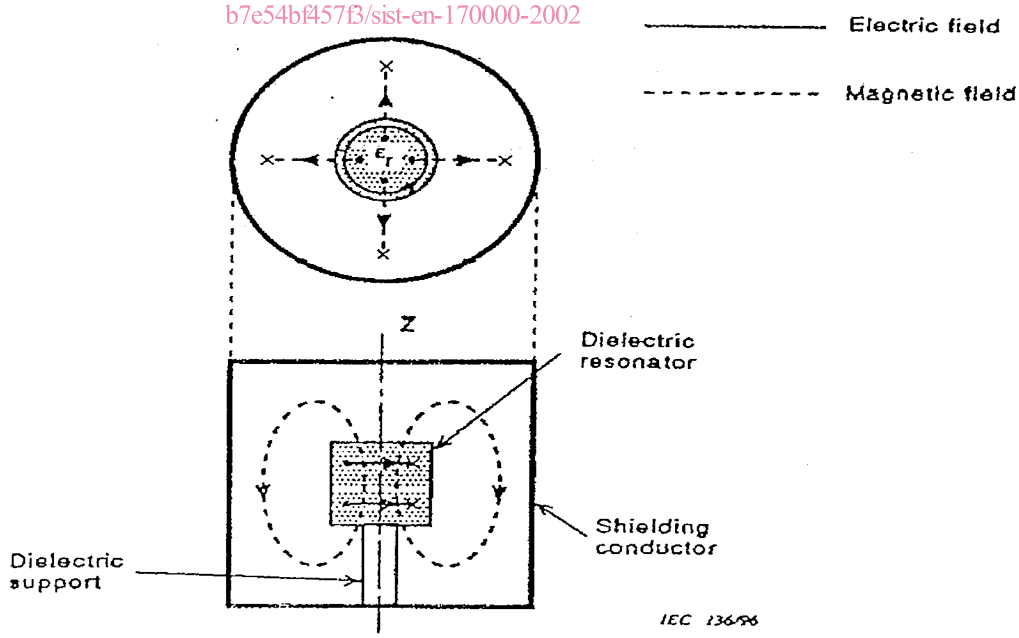

Figure 1 – $TE_{01\delta}$ mode dielectric resonator

1.3.12 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.

1.3.13 $TE_{01\delta}$ 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).

1.3.14 TM mode dielectric resonator

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

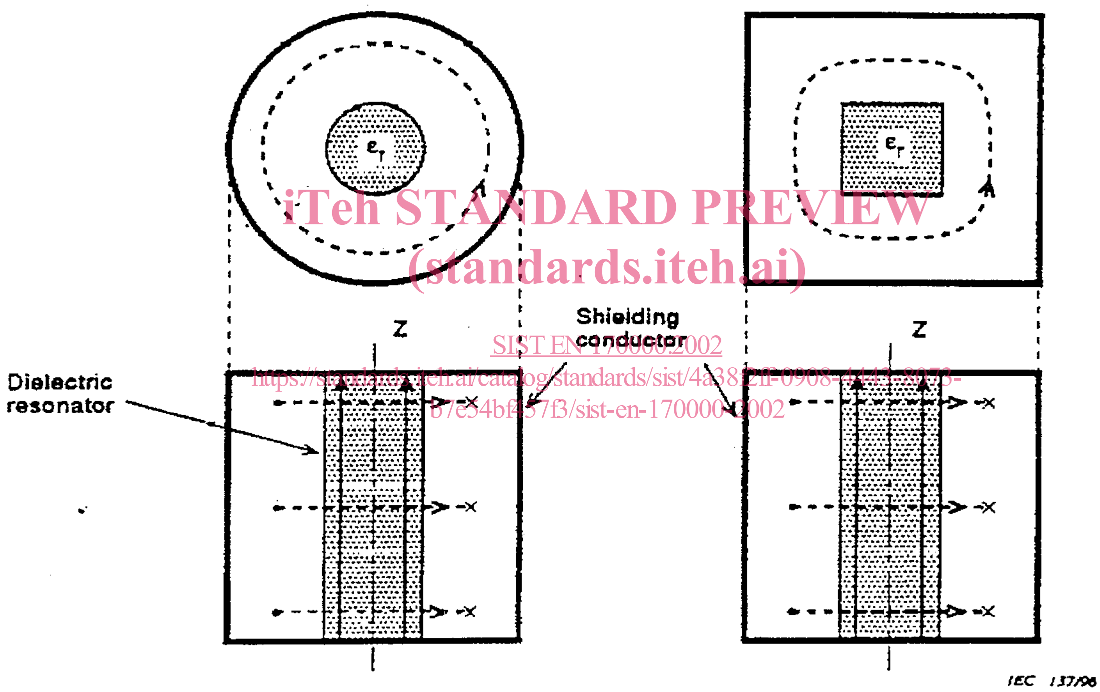

Figure 2a - TM $_{01\delta}$ mode **Figure 2b - TM $_{11\delta}$ mode**

Figure 2 - TM mode dielectric resonator

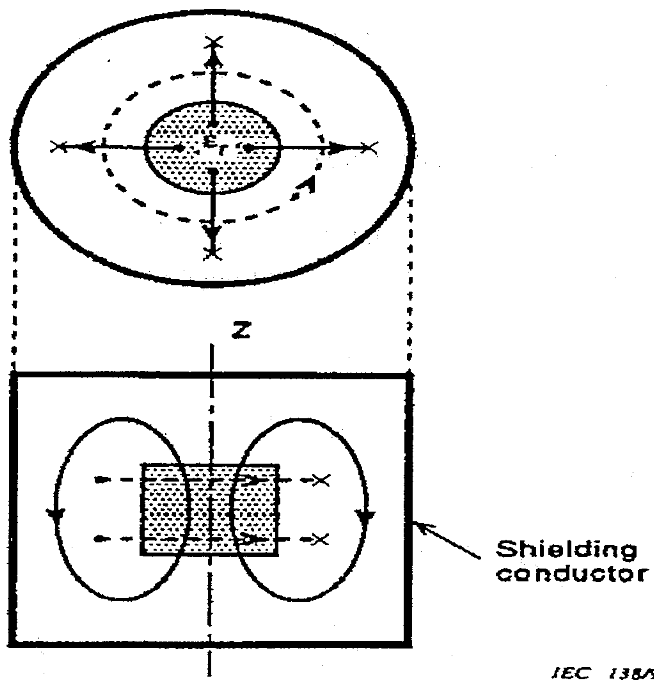

Figure 3 – TM $_{01\delta}$ mode dielectric resonator

1.3.15 **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).

1.3.16 **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).

1.3.17 **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 can not 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.