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TECHNICAL SPECIFICATION

Piezoelectric and dielectric devices for frequency control and selection – Glossary – Part 1: Piezoelectric and dielectric resonators

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FOREWORD

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IEC 61994-1, which is a technical specification, has been prepared by IEC technical committee 49: Piezoelectric and dielectric devices for frequency control and selection.

This second edition of IEC 61994-1 cancels and replaces the first edition published in 2003. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

– definitions updated;
– terminology given in orderly sequence;

– drawings inserted for easier understanding.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
49/761/DTS	49/766/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the IS0/IEC Directives, Part 2.

IEC 61994 consists of the following parts under the general title: *Piezoelectric and dielectric devices for frequency control and selection – Glossary*:

— Part 1: Piezoelectric and dielectric resonators

— Part 2: Piezoelectric and dielectric filters

— Part 3: Piezoelectric oscillators

— Part 4-1: Piezoelectric materials – Synthetic quartz crystal

— Part 4-2: Piezoelectric and dielectric materials – Piezoelectric ceramics

— Part 4-3: Materials for dielectric devices[1]

— Part 4-4: Materials – Materials for Surface Acoustic Wave (SAW) devices

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

- transformed into an international standard;
- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

[1] To be published.

PIEZOELECTRIC AND DIELECTRIC DEVICES FOR FREQUENCY CONTROL AND SELECTION – GLOSSARY –

Part 1: Piezoelectric and dielectric resonators

1 Scope

This technical specification gives the terms and definitions for piezoelectric and dielectric resonators representing the present state-of-the-art, which are intended for use in the standards and documents of IEC technical committee 49.

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 60050(561):1991, *International Electrotechnical Vocabulary (IEV) – Chapter 561: Piezoelectric devices for frequency control and selection*
Amendment 1 (1995)

IEC 60122-1:2002, *Quarts crystal units of assessed quality – Part-1: Generic specification*

IEC 60642:1979, *Piezoelectric ceramic resonators and resonator units for frequency control and selection – Chapter I: Standard values and conditions – Chapter II: Measuring and test conditions*

IEC 61019-1:2004, *Surface acoustic wave (SAW) resonators – Part 1: Generic specification*

IEC 61338-1:2004, *Waveguide type dielectric resonators – Part 1: Generic specification*

3 Terms and definitions

3.1
adjustment tolerance
the maximum permissible deviation of the working frequency of a piezoelectric resonator from the nominal frequency at the reference temperature under specified conditions

[IEV 561-02-16 modified]

3.2
ageing tolerance
the maximum permissible deviation of the working frequency of a piezoelectric resonator from its initial frequency which is observed with the passage of time under specified conditions

[IEV 561-02-17 modified]

3.3
ageing – long-term parameter variation
relationship which exists between any parameter (for example resonance frequency) and time

[IEC 61019-1, 4.2.9]

3.4
apodisation (spurious suppression for SAW devices)
weighting method produced by the change in finger overlap over the length of the IDT to suppress the transverse spurious modes

[IEV 561-06-18 modified]

3.5
anti-resonance frequency
f_a
the higher of two frequencies of a piezoelectric resonator vibrating alone, under specified conditions, at which the electrical impedance of the resonator is resistive

[IEV 561-02-10]

3.6
bus bar
common electrode region of an IDT which connects individual fingers together and also connects the IDT to an external circuit (see Figure 5)

[IEV 561-06-15 modified]

3.7
capacitance ratio
$$r = \frac{C_0}{C_1}$$
where C_0 and C_1 represent the shunt capacitance and the motional capacitance respectively in the equivalent circuit (see Figure 2)

the capacitance ratio indicates one of the merits of the resonator

[IEC 61019-1, 4.2.10.9 modified]

3.8
centre frequency of a two-port SAW resonator
f_c

arithmetic mean of two frequencies at which the attenuation relative to the minimum insertion attenuation reaches a specified value

[IEC 61019-1, 4.2.11.9]

3.9
clamped capacitance (of a piezoelectric resonator)
the capacitance of a piezoelectric resonator measured at a frequency well above any pronounced resonance

NOTE In practice, the value of the capacitance is often indirectly determined, because a direct measurement is affected by the presence of factors such as lead inductance.

[IEV 561-02-35]

3.10
coaxial dielectric resonator
dielectric resonator characterized by a TEM mode field distribution with a coaxial waveguide structure of finite length

[IEC 61338-1, 2.2.19]

3.11
coplanar resonator
dielectric resonator characterised by a TEM mode field distribution. The structure is a coplanar-line waveguide of finite length

[IEC 61338-1, 2.2.4]

3.12
coupling coefficient of SAW materials
***k*s**
the SAW electromechanical coupling coefficient is defined as follows:

$$k_S^2 = 2\left|\frac{\Delta v}{v}\right|$$

where $\Delta v/v$ is the relative velocity change produced by short-circuiting the surface potential from the open-circuit condition

[IEC 60862-2, 3.1.8; IEC 61019-1, 4.1.12]

3.13
crystal element
piezoelectric substrate cut to a given geometric shape, size and orientation with respect to the crystallographic axes of the crystal

[IEC 60122-1, 2.2.1]

3.14
crystal resonator
the mounted crystal element that vibrates when an alternating electric field is applied between the electrodes

[IEC 60122-1, 2.2.3 modified]

3.15
crystal unit
a crystal resonator mounted in an enclosure

[IEC 60122-1, 2.2.7]

3.16
d.c. breakdown voltage
the lowest d.c. voltage which causes the destruction of the resonator

[IEC 61019-1, 4.2.8]

3.17
dielectric material
material which predominantly exhibits dielectric properties

[IEC 61338-1, 2.2.1]

3.18
dielectric resonator
resonator using dielectrics with a high dielectric constant (ε_r) and the structure of which is a dielectric waveguide of finite length as shown in Figure 1

[IEC 61338-1, 2.2.10]

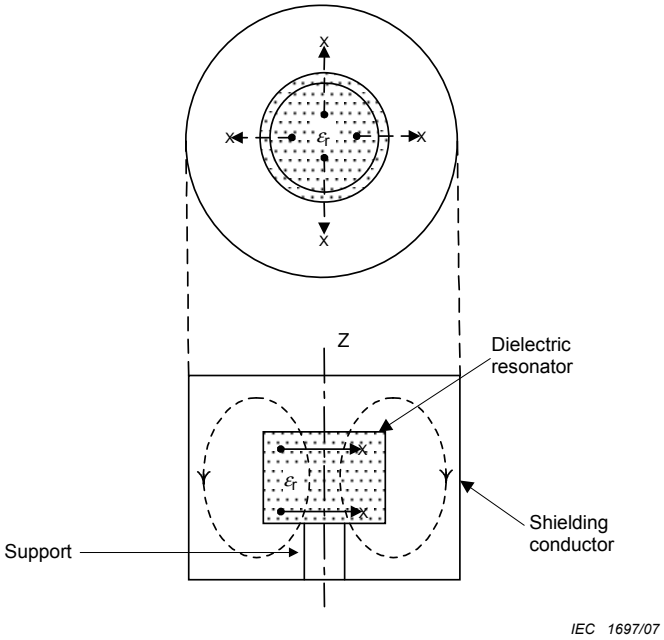


Figure 1 – Configuration of a dielectric resonator ($TE_{01\delta}$ mode type)

3.19
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).

[IEC 61338-1, 2.2.11]

3.20
drive level dependency
DLD
the permissible deviation of resonance frequency due to variation of the level of drive. The effect of changes in drive level conditions upon the resonance resistance of the crystal unit

[IEC 60122-1, 2.2.37 modified]

3.21
electrode (of piezoelectric resonator)
an electrically conductive plate in proximity to or film in contact with a face of a crystal or ceramic element by means of which a polarizing or driving field is applied to the element

[IEC 60122-1, 2.2.2 modified]

3.22
electromechanical coupling factor (of piezoelectric resonator)
a certain combination of elastic, dielectric and piezoelectric constants which appears naturally in the expression of impedance of a resonator. A different factor arises in each particular family of mode of vibration. The factor is closely related to the relative frequency spacing and is a convenient measure of piezoelectric transduction.

Alternatively, the coupling factor may be interpreted as the square root of the ratio of the electrical or mechanical work which can be accomplished to the total energy stored from a mechanical or electrical power source for a particular set of boundary conditions

[IEC 60642, 3.2.14 modified]

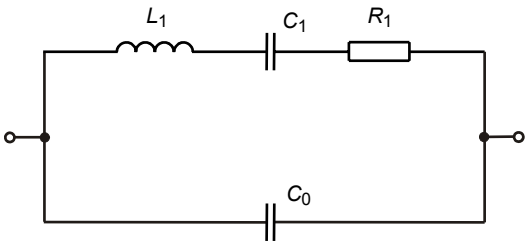
3.23
enclosure
an enclosure of specific outline dimensions and material with a defined method of sealing protecting the resonator and providing means of electrical connections to the circuit

[IEV 561-01-12 modified, IEC 60122-1, 2.2.5 modified, IEC 60642, 3.1.5 modified]

3.24
equivalent circuit (of piezoelectric resonators)
the electrical circuit which has the same characteristics as a piezoelectric resonator in the immediate neighbourhood of resonance

NOTE For example, one port piezoelectric resonator consists of series element L_1, C_1, R_1 in parallel with C_0, as shown in Figure 2 where L_1, C_1, R_1 represent the motional inductance, capacitance and resistance respectively and C_0 the shunt capacitance. The circuit of Figure 2 has the same impedance as a piezoelectric resonator in the neighbourhood of resonance.

[IEV 561-02-07 modified]



IEC 1698/07

Key

L_1 motional inductance
C_1 motional capacitance
R_1 motional resistance
C_0 shunt capacitance (static capacitance)
$Z = R_e + jX_e$ impedance of the circuit

Figure 2 – Equivalent circuit of a piezoelectric vibrator (one-port resonator)

3.25
external quality factor
Q_e
quality factor due to the energy loss in the external circuit, excluding the energy dissipated in the resonator

[IEC 61338-1, 2.2.27]

3.26
figure of merit

$$M = Q / r$$

where

Q is the quality factor,

r is the capacitance ratio.

the value indicates the activity of the resonator

[IEC 60122-1, IEC 61019-1, 4.2.10.10 modified]