

Surface acoustic wave (SAW) resonators —

Part 1: Generic specification

The European Standard EN 61019-1:2005 has the status of a
British Standard

ICS 31.140

National foreword

This British Standard is the official English language version of EN 61019-1:2005. It is identical with IEC 61019-1:2004.

The UK participation in its preparation was entrusted to Technical Committee EPL/49, Piezo-electric devices for frequency control and selection, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 39 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 10 March 2005

© BSI 10 March 2005

ISBN 0 580 45575 0

EUROPEAN STANDARD

EN 61019-1

NORME EUROPÉENNE

EUROPÄISCHE NORM

January 2005

ICS 31.140

English version

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

Résonateurs à ondes acoustiques
de surface (OAS)
Partie 1: Spécification générique
(CEI 61019-1:2004)

Oberflächenwellenresonatoren
(OFW-Resonatoren)
Teil 1: Fachgrundspezifikation
(IEC 61019-1:2004)

This European Standard was approved by CENELEC on 2004-12-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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

© 2005 CENELEC - All rights of exploitation in any form and by any means reserved worldwide for CENELEC members.

Foreword

The text of document 49/689/FDIS, future edition 1 of IEC 61019-1, 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 61019-1 on 2004-12-01.

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) | 2005-09-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2007-12-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61019-1:2004 was approved by CENELEC as a European Standard without any modification.

CONTENTS

1	Scope.....	5
2	Normative references	5
3	Order of precedence.....	7
4	Terms and definitions	7
4.1	General terms	7
4.2	Operational properties	10
5	Preferred values for ratings and characteristics	18
5.1	Standard nominal frequency values in megahertz (MHz)	18
5.2	Standard operating temperature ranges in degrees Celsius (°C)	18
5.3	Standard values of load capacitance in picofarads (pF)	18
5.4	Standard levels of drive in milliwatts (mW)	18
5.5	Standard values of minimum insertion attenuation in decibels (dB).....	18
5.6	Standard climatic category	19
5.7	Bump severity	19
5.8	Vibration severity	19
5.9	Shock severity.....	19
5.10	Fine leak rate	20
6	Marking	20
6.1	Resonator marking	20
6.2	Package marking.....	20
7	Quality assessment procedures.....	20
7.1	Primary stage of manufacture.....	20
7.2	Structurally similar components.....	20
7.3	Subcontracting	21
7.4	Incorporated components	21
7.5	Manufacturer's approval	21
7.6	Approval procedures	21
7.7	Procedures for capability approval	22
7.8	Procedures for qualification approval.....	22
7.9	Test procedures	23
7.10	Screening requirements	23
7.11	Rework and repair work.....	23
7.12	Certified records of released lots	23
7.13	Validity of release.....	23
7.14	Release for delivery	23
7.15	Unchecked parameters.....	23
8	Test and measurement procedures.....	23
8.1	General	23
8.2	Test and measurement conditions	24
8.3	Visual inspection	25

8.4	Dimensions and gauging procedures	25
8.5	Measurement method of one-port resonator	25
8.6	Measurement method of two-port resonator.....	27
8.7	Mechanical and environmental test procedures	31
8.8	Endurance test procedure	36
Annex ZA (normative) Normative references to international publications with their corresponding European publications		37
Figure 1 – Basic configurations of SAW resonators.....		8
Figure 2 – One-port resonator equivalent circuit		11
Figure 3 – Vector admittance diagram of a one-port SAW resonator		13
Figure 4 – Typical frequency characteristics of a one-port SAW resonator inserted into a transmission line in series (see 4.2.10.2.1 and 4.2.10.3.1)		13
Figure 5 – Resonance and anti-resonance frequencies		14
Figure 6 – Two-port resonator equivalent circuits.....		16
Figure 7 – Typical frequency characteristics of a two-port resonator		17
Figure 8 – Reflection measurement		26
Figure 9 – Transmission measurement		28

SURFACE ACOUSTIC WAVE (SAW) RESONATORS –

Part 1: Generic specification

1 Scope

This part of IEC 61019 specifies the methods of test and general requirements for SAW resonators using either capability approval or qualification approval procedures of the IECQ system.

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 (IEC) – 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 – Test Fc: Vibration (sinusoidal)*

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

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

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

IEC 60068-2-17:1994, *Environmental testing – Part 2: Tests – Test Q: Sealing*

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

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

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

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

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

IEC 60068-2-32:1975, *Environmental testing – Part 2: Tests – Test Ed: Free fall*

IEC 60068-2-45:1980, *Environmental testing – Part 2: Tests – Test XA and guidance: Immersion in cleaning solvents*

IEC 60068-2-52:1996, *Environmental testing – Part 2: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60068-2-58:1999, *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 60068-2-64:1993, *Environmental testing – Part 2: Tests – Test Fh: Vibration, broad-band random (digital control) and guidance*

IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60617 – DB:2001¹ *Graphical symbols for diagrams*

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

IEC 60444 (all parts), *Measurement of quartz crystal unit parameters*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test*. Basic EMC Publication

IEC 61019-2:1995, *Surface acoustic wave (SAW) resonators – Part 2: Guide to the use*

IEC 61019-3:1991, *Surface acoustic wave (SAW) resonators – Part 3: Standard outlines and lead connections*

QC 001001:2002, *IEC Quality Assessment System for Electronic Components (IECQ) – Basic Rules*

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 001005:2003, *IEC Quality Assessment System for Electronic Components (IECQ) – Register of Firms, Products and Services approved under the IECQ System, including ISO 9000*

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

¹ DB refers to the IEC on-line database.

3 Order of precedence

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

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

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

4 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

Units, graphical symbols, letter symbols and terminology shall, wherever possible, be taken from the following standards: IEC 60027, IEC 60050-561, IEC 60122-1, IEC 60617, IEC 60642, ISO 1000.

4.1 General terms

4.1.1

surface acoustic wave (SAW)

acoustic wave, propagating along the surface of an elastic substrate, whose amplitude decays exponentially with substrate depth

4.1.2

surface acoustic wave resonator (SAW resonator or SAWR)

resonator using multiple reflections of surface acoustic waves

4.1.3

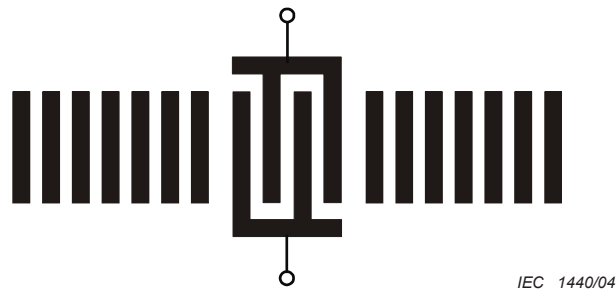
one-port resonator

SAW resonator having a pair of terminals (see 4.2.10 and Figure 1)

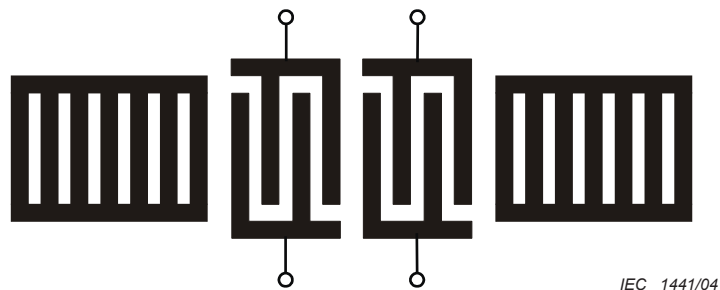
4.1.4

two-port resonator

SAW resonator having input and output ports (see 4.2.11 and Figure 1)



a) One-port resonator with opened arrays



b) Two-port resonator with shorted arrays

Figure 1 – Basic configurations of SAW resonators

4.1.5

SAW resonator oscillator

oscillator that uses a SAW resonator as the main frequency controlling element

4.1.6

interdigital transducer (IDT)

SAW transducer made of a comb-like conductive structure deposited on a piezoelectric substrate transforming electrical energy into acoustic energy or vice versa

4.1.7

finger

element of the IDT comb electrode

4.1.8

dummy finger

passive finger which may be included in order to suppress wave-front distortion

4.1.9

bus bar

common electrode which connects individual fingers together and also connects the resonator to an external circuit

4.1.10

shorting bar

common electrode which interconnects individual metal strips (see Figure 1)

4.1.11

apodization (spurious suppression for SAW resonator)

weighting produced by the change in finger overlap over the length of the IDT to suppress the transverse spurious modes

4.1.12

SAW coupling coefficient

$$k_S^2$$

SAW electromechanical coupling coefficient is defined as follows:

$$k_S^2 = 2 \left| \Delta v / v \right|$$

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

4.1.13

grating reflector

SAW reflecting array that normally makes use of the periodic discontinuity provided by metal strips, grooves or ridges

4.1.14

metal strip array

periodic discontinuity realised by electrically short- or open-circuit metal strips providing electrical and mass-loaded perturbations

4.1.15

grooved array

periodic discontinuity realized by topographic perturbation on a surface having shallow grooves

4.1.16

ridge array

periodic discontinuity realized by the mass-loaded perturbation of the surface having thin layer strips

4.1.17

shorted array

metal strip array interconnected with a shorting bar (see Figure 1b))

4.1.18

opened array

metal strip array without a metal strip array interconnection (see Figure 1a))

4.1.19

mass loading

perturbation in the SAW propagation caused by the mass of an overlay on the substrate surface

4.1.20

IDT aperture

maximum IDT finger overlap length which approximately corresponds to the SAW beamwidth, where the aperture may be expressed in length units or normalized term of wavelength

4.2 Operational properties

4.2.1

nominal frequency

frequency given by the manufacturer or the specification to identify the resonator

4.2.2

working frequency

f_w

operational frequency of the resonator together with its associated circuits

4.2.3

frequency tolerance

4.2.3.1

overall tolerance

maximum permissible deviation of the working frequency from the nominal frequency due to a specific cause or a combination of causes

4.2.3.2

adjustment tolerance

permissible deviation of the working frequency from the nominal frequency at the reference temperature under specified conditions

4.2.3.3

ageing tolerance

permissible deviation due to time under specified conditions

4.2.3.4

tolerance over the temperature range

permissible deviation over the temperature range with respect to the frequency at the specified reference temperature

4.2.3.5

tolerance due to level of drive variation

permissible deviation due to the level of drive variation

4.2.4

operating temperature range

range of temperatures as measured on the enclosure over which the resonator must function within the specified tolerances

4.2.4.1

operable temperature range

range of temperatures as measured on the enclosure over which the resonator must function though not necessarily within the specified tolerances

4.2.4.2

storage temperature range

range of temperatures over which the resonator can be stored without causing permanent change in the performance beyond the specified tolerances

4.2.4.3

reference temperature

temperature at which certain resonator measurements are made. For controlled temperature resonators, the reference temperature is the mid-point of the controlled temperature range. For non-controlled temperature resonators, the reference temperature is normally $25\text{ °C} \pm 2\text{ °C}$

4.2.5

spurious resonance

state of resonance of a resonator other than that frequency associated with the working frequency

4.2.6

transverse spurious resonance

spurious resonance caused by excitation of higher order transverse modes which appear at slightly higher frequencies. It is desirable to apodize the interdigital transducer to match the desired transverse mode profile

4.2.7

level of drive

measure of the operating conditions imposed upon the resonator expressed in terms of power dissipated

NOTE In special cases the level of drive may be specified in terms of resonator current or voltage.

4.2.8

d.c. breakdown voltage

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

4.2.9

ageing (long-term parameter variation)

relationship which exists between any parameter (for example, resonance frequency) and time

NOTE Such a parameter variation is due to long-term changes in the resonator and is usually expressed in fractional parts per period of time.

4.2.10

one-port SAW resonator

4.2.10.1

one-port resonator equivalent circuit

electrical circuit which has the same impedance as the resonator in the immediate neighbourhood of resonance. It is usually represented by a parallel capacitance shunted by a motional (series) arm. The motional (series) arm, in its turn, is represented by an inductance, capacitance and resistance in series. The parameters of the motional (series) arm of inductance, capacitance and resistance are usually given by L_1 , C_1 and R_1 respectively. The shunt capacitance is given by C_0 (see Figure 2)

NOTE The characteristic frequencies which occur in the resonance neighbourhood can be completely defined by considering the resistance and the reactance of the resonator as a function of frequency and from the impedance and admittance diagrams described in Figure 3, and IEC 60122-1, to which reference should be made.

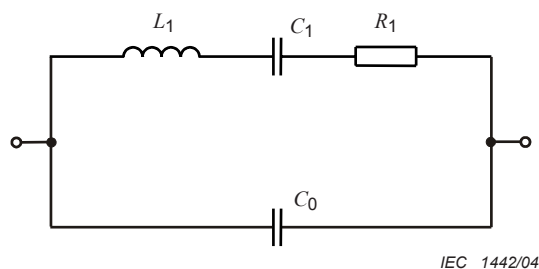


Figure 2 – One-port resonator equivalent circuit