

FINAL VERSION

VERSION FINALE

**Quartz crystal units of assessed quality –
Part 1: Generic specification**

**Résonateurs à quartz sous assurance de la qualité –
Partie 1: Spécification générique**

CONTENTS

FOREWORD.....	5
1 General.....	7
1.1 Scope.....	7
1.2 Normative references.....	7
1.3 Order of precedence.....	8
2 Terminology and general requirements.....	9
2.1 General.....	9
2.2 Terms, definitions and classification of phenomena.....	9
2.3 Preferred ratings and characteristics.....	22
2.3.1 Temperature ranges in degrees Celsius (°C) suitable for ambient operation.....	22
2.3.2 Elevated temperature ranges in degrees Celsius (°C) suitable for oven control.....	23
2.3.3 Frequency tolerance (1×10^{-6}).....	23
2.3.4 Circuit conditions.....	23
2.3.5 Levels of drive.....	23
2.3.6 Drive level dependency.....	24
2.3.7 Climatic category.....	24
2.3.8 Bump severity.....	24
2.3.9 Vibration severity.....	24
2.3.10 Shock severity.....	24
2.3.11 Leak rate.....	25
2.4 Marking.....	25
3 Quality assessment procedures.....	25
3.1 Primary stage of manufacture.....	25
3.2 Structurally similar components.....	25
3.3 Subcontracting.....	25
3.4 Manufacturer's approval.....	26
3.5 Approval procedures.....	26
3.5.1 General.....	26
3.5.2 Capability approval.....	26
3.5.3 Qualification approval.....	26
3.6 Procedures for capability approval.....	26
3.6.1 General.....	26
3.6.2 Eligibility for capability approval.....	27
3.6.3 Application for capability approval.....	27
3.6.4 Granting of capability approval.....	27
3.6.5 Capability manual.....	27
3.7 Procedures for qualification approval.....	27
3.7.1 General.....	27
3.7.2 Eligibility for qualification approval.....	27
3.7.3 Application for qualification approval.....	27
3.7.4 Granting of qualification approval.....	27
3.7.5 Quality conformance inspection.....	27
3.8 Test procedures.....	27

3.9	Screening requirements	27
3.10	Rework and repair work.....	28
3.10.1	Rework.....	28
3.10.2	Repair work.....	28
3.11	Certified records of released lots.....	28
3.12	Validity of release.....	28
3.13	Release for delivery	28
3.14	Unchecked parameters.....	28
4	Test and measurement procedures.....	28
4.1	General.....	28
4.2	Alternative test methods	28
4.3	Precision of measurement.....	29
4.4	Standard conditions for testing.....	29
4.5	Visual inspection	29
4.5.1	Visual test A.....	29
4.5.2	Visual test B.....	29
4.5.3	Visual test C.....	29
4.6	Dimensioning and gauging procedures	30
4.6.1	Dimensions, test A	30
4.6.2	Dimensions, test B	30
4.7	Electrical test procedures	30
4.7.1	Frequency and resonance resistance	30
4.7.2	Drive level dependency	30
4.7.3	Frequency and resonance resistance as a function of temperature	30
4.7.4	Unwanted responses	31
4.7.5	Shunt capacitance	31
4.7.6	Load resonance frequency and resistance.....	31
4.7.7	Frequency pulling range (f_{L1} , f_{L2}).....	31
4.7.8	Motional parameters	31
4.7.9	Insulation resistance.....	32
4.8	Mechanical and environmental test procedures	32
4.8.1	Robustness of terminations (destructive).....	32
4.8.2	Sealing tests (non-destructive)	32
4.8.3	Soldering (solderability and resistance to soldering heat) (destructive)	34
4.8.4	Rapid change of temperature, two-fluid bath method (non-destructive).....	34
4.8.5	Rapid change of temperature with prescribed time of transition (non-destructive)	34
4.8.6	Bump (destructive)	34
4.8.7	Vibration (destructive)	35
4.8.8	Shock (destructive).....	35
4.8.9	Free fall (destructive)	35
4.8.10	Acceleration, steady state (non-destructive)	35
4.8.11	Dry heat (non-destructive)	35
4.8.12	Damp heat, cyclic (destructive).....	35
4.8.13	Cold (non-destructive)	36
4.8.14	Climatic sequence (destructive).....	36
4.8.15	Damp heat, steady state (destructive).....	36
4.8.16	Immersion in cleaning solvents (non-destructive).....	36

4.9	Endurance test procedure	36
4.9.1	Standard ageing test for production verification	36
4.9.2	Accelerated aging	37
4.9.3	Reference aging test	38
4.9.4	Extended ageing	39
Annex A (normative) Procedure for the determination of the fitting parameters for the frequency aging		41
Bibliography		43
Figure 1 – Symbol and equivalent electrical circuit of a piezoelectric resonator		11
Figure 2 – Impedance $ Z $, resistance R_e , reactance X_e , series arm reactance X_1 of a piezoelectric resonator as a function of frequency		14
Figure 3 – Impedance and admittance diagram of a piezoelectric resonator		15
Figure 4 – Resonance, anti-resonance and load resonance frequencies		16
Figure 5 – Equivalent circuit of a piezoelectric resonator with a series (load) capacitance C_L		22
Figure 6 – Terminal bend test tool		33
Table 1 – List of symbols used for the equivalent electric circuit of a piezoelectric resonator		19
Table 2 – Solutions for the various characteristic frequencies		21
Table 3 – Minimum values for the ratio Q^2/r to be expected for various types of piezoelectric resonators		21
Table 4 – Approximate relations between the characteristic frequencies and the series resonance frequency f_s of a piezoelectric resonator		21
Table 5 – Time acceleration factors for $E_a = 0,38$ eV		38
Table A.1 – Procedure for the determination of the frequency aging parameters		42

INTERNATIONAL ELECTROTECHNICAL COMMISSION

QUARTZ CRYSTAL UNITS OF ASSESSED QUALITY –

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

DISCLAIMER

This Consolidated version is not an official IEC Standard and has been prepared for user convenience. Only the current versions of the standard and its amendment(s) are to be considered the official documents.

This Consolidated version of IEC 60122-1 bears the edition number 3.1. It consists of the third edition (2002-08) [documents 49/551/FDIS and 49/558/RVD] and its amendment 1 (2017-12) [documents 49/1254/FDIS and 49/1259/RVD]. The technical content is identical to the base edition and its amendment.

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

International Standard IEC 60122-1 has been prepared by IEC technical committee 49: Piezoelectric and dielectric devices for frequency control and selection.

This third edition of IEC 60122-1 constitutes a technical revision.

International Standard IEC 60122-1 is the first part of a new edition of the IEC standard series for quartz crystal units of assessed quality.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

IEC 60122 consists of the following parts under the general title: Quartz crystal units of assessed quality:

- Part 1: Generic specification (IEC 60122-1);
- Part 2: Guide to the use of quartz crystal units for frequency control and selection (IEC 60122-2 at present);
- Part 3: Standard outlines and lead connections (IEC 60122-3);
- Part 4: Sectional specification – Capability Approval (IEC 61178-2 at present);
- Part 4-1: Blank detail specification – Capability Approval (IEC 61178-2-1 at present);
- Part 5: Sectional specification – Qualification Approval (IEC 61178-3 at present);
- Part 5-1: Blank detail specification – Qualification Approval (IEC 61178-3-1 at present).

The QC number which appears on the front cover of this publication is the specification number in the IEC Quality Assessment System for Electronic Components (IECQ).

The committee has decided that the contents of the base publication and its amendment 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.

QUARTZ CRYSTAL UNITS OF ASSESSED QUALITY –

Part 1: Generic specification

1 General

1.1 Scope

This part of IEC 60122 specifies the methods of test and general requirements for quartz crystal units of assessed quality using either capability approval or qualification approval procedures.

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: Piezoelectric 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 60068-2-3:1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*

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: 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, *Basic environmental testing procedures– 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 (Procedure 1)*