

Quartz crystal controlled oscillators of assessed quality —

Part 1: Generic specification

The European Standard EN 60679-1:2007 has the status of a
British Standard

ICS 31.140

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 60679-1:2007. It is identical with IEC 60679-1:2007. It supersedes BS EN 60679-1:1998 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/49, Piezoelectric devices for frequency control and selection.

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

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**Quartz crystal controlled oscillators of assessed quality -
Part 1: Generic specification
(IEC 60679-1:2007)**

Oscillateurs pilotés par quartz
sous assurance de la qualité -
Partie 1: Spécification générique
(CEI 60679-1:2007)

Quarzoszillatoren
mit bewerteter Qualität -
Teil 1: Fachgrundspezifikation
(IEC 60679-1:2007)

This European Standard was approved by CENELEC on 2007-05-01. 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.

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CENELEC

European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 49/769/FDIS, future edition 3 of IEC 60679-1, 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 60679-1 on 2007-05-01.

This European Standard supersedes EN 60679-1:1998 + A1:2002 + A2:2003.

It represents a step in a revision of all parts of the EN 60679 series to include the test requirements of the IECQ system. EN 60679-1:2007 is based on the relevant standards of that system.

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) | 2008-02-01 |
| – latest date by which the national standards conflicting
with the EN have to be withdrawn | (dow) | 2010-05-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60679-1:2007 was approved by CENELEC as a European Standard without any modification.

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QUARTZ CRYSTAL CONTROLLED OSCILLATORS OF ASSESSED QUALITY –

Part 1: Generic specification

1 Scope

This part of IEC 60679 specifies the methods of test and general requirements for quartz crystal controlled oscillators of assessed quality using either capability approval or qualification approval procedures.

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, *International Electrotechnical Vocabulary (IEV) – Part 561: Piezoelectric devices for frequency control and selection*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*
Amendment 1 (1992)

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

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

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

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

IEC 60068-2-10, *Environmental testing – Part 2-10: Tests – Test J and guidance: Mould growth*

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

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

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

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

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

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

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

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

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

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

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

IEC 60068-2-58, *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, *Environmental testing – Part 2: Test methods – 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 60469-1:1987, *Pulse techniques and apparatus – Part 1: Pulse terms and definitions*

IEC 60617-DB: 2001¹, *Graphical symbols for diagrams*

IEC 60679-5, *Quartz crystal controlled oscillators of assessed quality – Part 5: Sectional specification – Qualification approval*

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

IECQ 01, *IEC Quality Assessment System for Electronic Components (IECQ) – Basic Rules*

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

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

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

ITU-T G.810, *Definitions and terminology for synchronization networks*

ITU-T G.811: *Timing characteristics of primary reference clocks*

ITU-T G.812, *Timing requirements of slave clocks suitable for use as node clocks in synchronization networks*

ITU-T G.813, *Timing characteristics of SDH equipment slave clocks (SEC)*

ITU-T G.825, *The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)*

¹ “DB” refers to the IEC on-line database.

ANSI T1.101, *Synchronization Interface Standard*

ANSI T1.105.03, *Synchronous Optical Network (SONET) – Jitter and Wander at Network Equipment Interfaces*

ETSI EN 300 462 (all parts), *Transmission and Multiplexing (TM); Generic requirements for synchronization networks*

Telcordia GR-253, *Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria*

- **Order of precedence**

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

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

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

3 Terms, definitions and general information

3.1 General

Units, graphical symbols, letter symbols and terminology shall, wherever possible, be taken from the following standards:

IEC 60027
IEC 60050-561
IEC 60469-1
IEC 60617
ISO 1000

3.2 Definitions

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

3.2.1

simple packaged crystal oscillator SPXO

crystal controlled oscillator having no means of temperature control or compensation, exhibiting a frequency/temperature characteristic determined substantially by the piezoelectric resonator employed

[IEV 561-04-01]

3.2.2

overtone crystal controlled oscillator

oscillator designed to operate with the controlling piezoelectric resonator functioning in a specified mechanical overtone order of vibration

[IEV 561-04-02]

3.2.3

crystal cut

orientation of the crystal element with respect to the crystallographic axes of the crystal

NOTE This definition is included as it may be desirable to specify the cut (and hence the general form of the frequency/temperature performance) of a crystal unit used in an oscillator application. The choice of the crystal cut will imply certain attributes of the oscillator which may not otherwise appear in the detail specification.

3.2.4

voltage controlled crystal oscillator

VCXO

crystal controlled oscillator, the frequency of which can be deviated or modulated according to a specified relation, by application of a control voltage

[IEV 561-04-03]

3.2.5

temperature compensated crystal oscillator

TCXO

crystal controlled oscillator whose frequency deviation due to temperature is reduced by means of a compensation system, incorporated in the device

[IEV 561-04-04]

3.2.6

oven controlled crystal oscillator

OCXO

crystal controlled oscillator in which at least the piezoelectric resonator is temperature controlled

[IEV 561-04-05]

NOTE This mode of operation ensures that the oscillator frequency will remain sensibly constant over the operating temperature range of the OCXO, therefore independent of the frequency/temperature characteristic of the crystal unit.

3.2.7

nominal frequency

frequency used to identify the crystal controlled oscillator

[IEV 561-04-06]

3.2.8

frequency tolerance

maximum permissible deviation of the oscillator frequency from a specified nominal value when operating under specified conditions

[IEV 561-04-07]

NOTE Frequency tolerances are often assigned separately to specified ambient effects, namely electrical, mechanical and environmental. When this approach is used, it is necessary to define the values of other operating parameters as well as the range of the specified variable, that is to say:

- deviation from the frequency at the specified reference temperature due to operation over the specified temperature range, other conditions remaining constant;
- deviation from the frequency at the specified supply voltage due to supply voltage changes over the specified range, other conditions remaining constant;
- deviation from the initial frequency due to ageing, other conditions remaining constant;
- deviation from the frequency with specified load conditions due to changes in load impedance over the specified range, other conditions remaining constant.

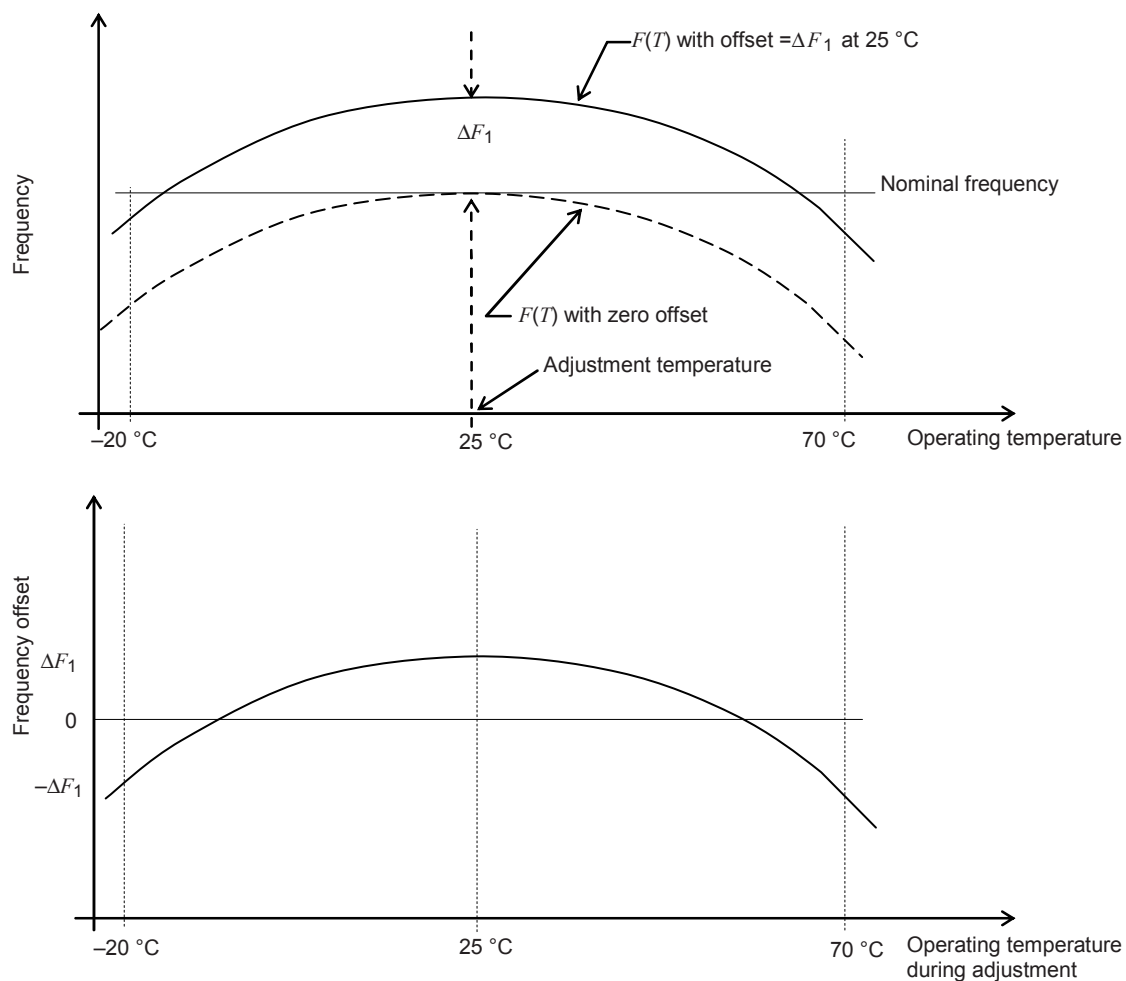
In some cases, an overall frequency tolerance may be specified, due to any/all combinations of operating parameters, during a specified lifetime.

3.2.9**frequency offset**

frequency difference, positive or negative, which should be added to the specified nominal frequency of the oscillator, when adjusting the oscillator frequency under a particular set of operating conditions in order to minimize its deviation from nominal frequency over the specified range of operating conditions

[IEV 561-04-08]

EXAMPLE In order to minimize the frequency deviation from nominal over the entire temperature range, a frequency offset may be specified for adjustment at the reference temperature (see Figure 1).



IEC 445/07

Figure 1 – Example of the use of frequency offset

3.2.10**adjustment frequency**

frequency to which an oscillator must be adjusted, under a particular combination of operating conditions, in order to meet the frequency tolerance specification over the specified range of operating conditions, i.e. adjustment frequency = nominal frequency + frequency offset

[IEV 561-04-09]

3.2.11**frequency adjustment range**

range over which the oscillator frequency may be varied by means of some variable element, for the purpose of:

- a) setting the frequency to a particular value, or
- b) to correct the oscillator frequency to a prescribed value after deviation due to ageing, or other changed conditions.

[IEV 561-04-10]

3.2.12

storage temperature range

minimum and maximum temperatures as measured on the enclosure at which the crystal controlled oscillator may be stored without deterioration or damage to its performance

3.2.13

operating temperature range

range of temperature over which the oscillator will function, maintaining frequency and other output signal characteristics within specified tolerances

[IEV 561-04-11]

3.2.14

operable temperature range

range of temperature over which the oscillator will continue to provide an output signal, though not necessarily within the specified tolerances of frequency, level, waveform, etc.

[IEV 561-04-12]

3.2.15

reference temperature

temperature at which certain oscillator performance parameters are measured, normally 25 °C ± 2 °C

3.2.16

reference point temperature

temperature measured at a specific reference point relative to the oscillator

3.2.17

thermal transient frequency stability

oscillator frequency time response when ambient temperature is changed from one specific temperature to another with a specific rate

3.2.18

stabilization time

time, measured from the initial application of power, required for a crystal controlled oscillator to stabilize its operation within specified limits

[IEV 561-04-13]

3.2.19

frequency/voltage coefficient

fractional change in output frequency resulting from an incremental change in supply voltage, other parameters remaining unchanged

[IEV 561-04-14]

NOTE In the case of OCXOs, a considerable time may elapse before the full effect of a supply voltage change is observed, as the temperature of the oven may drift gradually to a new value following the voltage perturbation.

3.2.20

frequency/load coefficient

fractional change in output frequency resulting from an incremental change in electrical load impedance, other parameters remaining unchanged

[IEV 561-04-15]

3.2.21**long-term frequency stability (frequency ageing)**

relationship between oscillator frequency and time. This long-term frequency drift is caused by secular changes in the crystal unit and/or other elements of the oscillator circuit, and should be expressed as fractional change in mean frequency per specified time interval.

3.2.22**short-term frequency stability**

random fluctuations of the frequency of an oscillator over short periods of time

[IEV 561-04-16]

3.2.23**Allan variance of fractional frequency fluctuation**

unbiased estimate of the preferred definition in the time domain of the short-term stability characteristic of the oscillator output frequency:

$$\sigma_y^2(\tau) \equiv \frac{1}{M-1} \sum_{k=1}^{M-1} \frac{(Y_{k+1} - Y_k)^2}{2}$$

where

Y_k are the average fractional frequency fluctuations obtained sequentially, with no systematic dead time between measurements;

τ is the sample time over which measurements is averaged;

M is the number of measurements.

The confidence of the estimate improves as M increases.

3.2.24**r.m.s. fractional frequency fluctuation**

measure in the time domain of the short-term frequency stability of an oscillator, based on the statistical properties of a number of frequency measurements, each representing an average of the frequency over the specified sampling interval τ . The preferred measure of fractional frequency fluctuation is:

$$\frac{\Delta F}{F_0}(\tau)_{rms} = \left[\frac{1}{2(M-1)} \sum_{k=1}^{M-1} (Y_{k+1} - Y_k)^2 \right]^{1/2} = [\sigma_y^2(\tau)]^{1/2}$$

3.2.25**phase noise**

frequency-domain measure of the short-term frequency stability of an oscillator, normally expressed as the power spectral density of the phase fluctuations, $S_\phi(f)$, where the phase fluctuation function is $\phi(t) = 2\pi F t - 2\pi F_0 t$. The spectral density of phase fluctuation can be directly related to the spectral density of frequency fluctuation by

$$S_\phi(f) = \left(\frac{F_0}{f} \right)^2 S_y(f) \quad \text{rad}^2/\text{Hz}$$

where

F is the oscillator frequency;

F_0 is the average oscillator frequency;

f is the Fourier frequency.

3.2.26

spectral purity

measure of frequency stability in the frequency domain usually represented as the signal side noise power spectrum expressed in decibels relative to total signal power, per hertz bandwidth. It includes non-deterministic noise power, harmonic distortion components and spurious single frequency interferences

3.2.27

incidental frequency modulation

optional measure of frequency stability in the frequency domain, best described in terms of the spectrum of the resultant base-band signal obtained by applying the oscillator signal to an ideal discriminator circuit of specified characteristics. If the detection bandwidth is adequately specified, the incidental frequency modulation may be expressed as a fractional proportion of the output frequency (for example 2×10^{-8} r.m.s. in a 10 kHz band)

3.2.28

amplitude modulation distortion

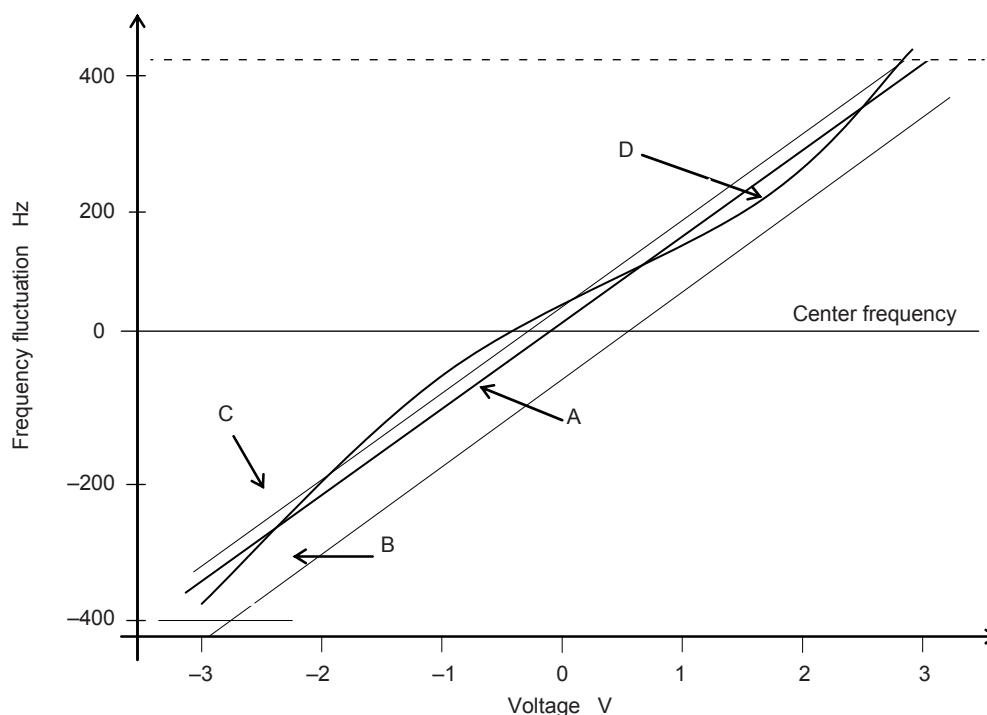
non-linear distortion in which the relative magnitudes of the spectral components of the modulating signal waveform are modified. It is also commonly known as frequency distortion, amplitude distortion and amplitude/frequency distortion

3.2.29

linearity of frequency modulation deviation

measure of the transfer characteristic of a modulation system as compared to an ideal (straight line) function, usually expressed as an allowable non-linearity in per cent of the specified full range deviation. Modulation linearity can also be expressed in terms of the permissible distortion of base-band signals produced by the modulation device (for example, intermodulation and harmonic distortion products not to exceed -40 dB relative to the total modulating signal power)

EXAMPLE: Figure 2 is a plot of the output frequency of a typical modulated oscillator specified to have a modulation characteristic of $133,3$ Hz/V over a range of ± 3 V, with an allowed non-linearity of $\pm 5\%$. Curve *D* is the actual characteristic compared with the ideal (curve *A*) and the limits (curves *B* and *C*).



IEC 446/07

Figure 2 – Typical frequency fluctuation characteristics

3.2.30**harmonic distortion**

non-linear distortion characterized by the generation of undesired spectral components harmonically related to the desired signal frequency. Each harmonic component is usually expressed as a power ratio (in decibels) relative to the output power of the desired signal

3.2.31**spurious oscillations**

discrete frequency spectral components, non-harmonically related to the desired output frequency, appearing at the output terminal of an oscillator. These components may appear as symmetrical sidebands or as signal spectral components, depending upon the mode of generation. Spurious components in the output spectrum are usually expressed as a power ratio (in decibels) with respect to the output signal power

3.2.32**pulse duration**

duration between pulse start time and pulse stop time (see Figure 3)

[IEC 60469-1, definition 3.3.2]

3.2.33**rise time**

time interval required for the leading edge of a waveform to change between two defined levels. These levels may be two logic levels V_{OL} and V_{OH} or 10 % to 90 % of its maximum amplitude ($V_{HI} - V_{LO}$), or any other ratio defined in the detail specification (see Figure 3)

where

V_{OL} is the low level output voltage;

V_{OH} is the high level output voltage;

V_{HI} is the upper flat voltage of the pulse waveform;

V_{LO} is the low flat voltage of the pulse waveform.

3.2.34**decay (or fall) time**

time interval required for the trailing edge of a waveform to change between two defined levels. These levels may be two logic levels V_{OH} and V_{OL} or 90 % to 10 % of its maximum amplitude ($V_{HI} - V_{LO}$), or any other ratio as defined in the detail specification (see Figure 3)

3.2.35**tri-state output**

output stage which may be enabled or disabled by the application of an input control signal. In the disable mode, the output impedance of the gate is set to a high level permitting the application of test signals to following stages

3.2.36**symmetry (mark/space ratio or duty cycle)**

ratio between the time (t_1), in which the output voltage is above a specified level, and the time (t_2), in which the output voltage is below the specified level, in percent of the duration of the full signal period. The specified level may be the arithmetic mean between levels V_{OL} and V_{OH} , or 50 % of the peak-to-peak amplitude (see Figure 3).

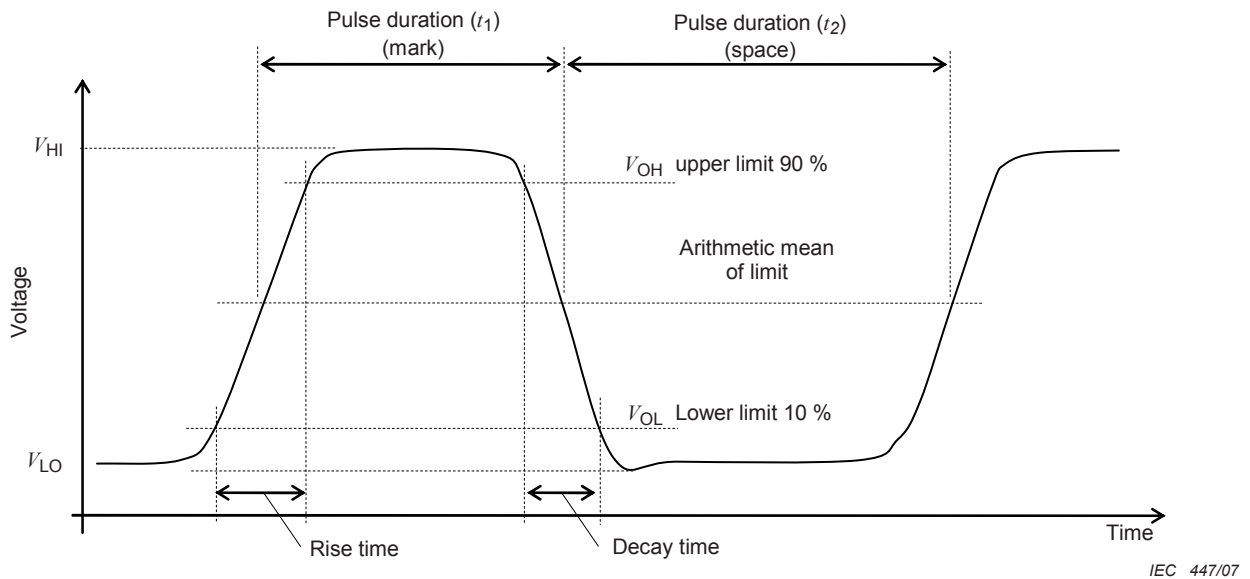


Figure 3 – Characteristics of an output waveform

The ratio is expressed as:

$$\frac{100 t_1}{t_1 + t_2} : \frac{100 t_2}{t_1 + t_2}$$

3.2.37

retrace characteristics

ability of an oscillator to return, after a specified time period, to a previously stabilized frequency, following a period in the energized condition

3.2.38

start-up time

time difference t_{SU} between the application of the supply voltage to the oscillator and the time when the r.f. output signal of desired frequency controlled by the quartz resonator fulfils specific conditions which are given below

a) Quasi-sinusoidal waveforms

The signal envelope is 90 % of the steady-state peak-to-peak amplitude (see Figure 20).

b) Pulse waveforms

The output pulse sequence is periodical near the steady-state frequency while its low level V_{LO} remains below V_{OL} and its high level V_{HI} exceeds V_{OH} permanently, where V_{OH} and V_{OL} are defined by the applicable logic family.

Precaution

The output signal may show spurious oscillations prior to the appearance of the steady-state signal.

3.2.39

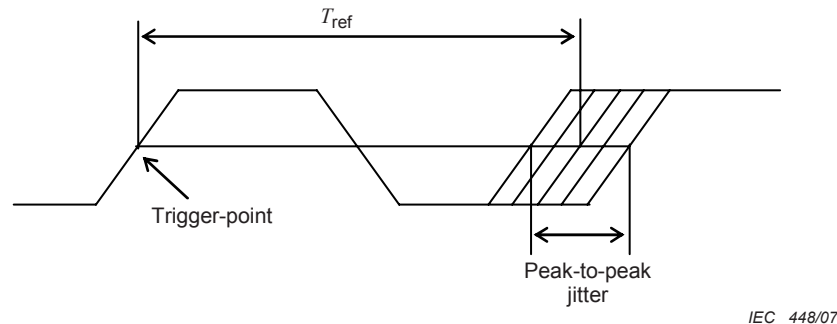
phase jitter

short-term variation of the zero crossings of the oscillator output signal from their ideal position in time. The phase variation $\Delta\phi$ with frequency components greater than or equal to 10 Hz. Variations slower than 10 Hz are called “wander”. Excessive jitter can increase the bit error rate (BER) of a communication signal by incorrectly transmitting a data-stream and can cause synchronization problems

The corresponding variation of the period length

$$\Delta T = \Delta \varphi / (2\pi f_c)$$

is called “period jitter” (f_c is the clock frequency).



Key

T_{ref} is the period of an ideal reference signal.

Figure 4 – Clock signal with phase jitter

The jitter amplitude is usually referred to the Unit Interval (UI) of one data bit-width (e.g. UI = 6,43 ns for 155,52 Mbit/s for STM-1/OC-3) or defined as absolute time variation (in nanoseconds, picoseconds or femtoseconds). It is quantified either as the peak-to-peak value, or as the r.m.s. value thereof.

“Higher confidence levels are required for some applications, so the peak-to-peak jitter can be specified as a larger range of σ in these cases.”

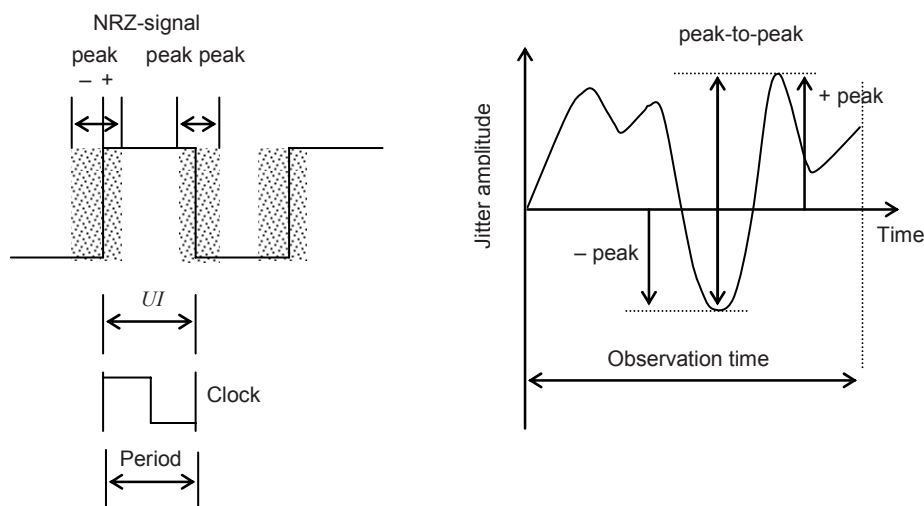


Figure 5 – Phase jitter measures

For random type jitter the r.m.s. value is defined as the standard deviation σ (sigma) of the underlying Gaussian distribution. The peak-to-peak jitter is then the range covered by 7σ (i.e. $\pm 3,5\sigma$), according to a confidence level of 99,95348 % (i.e. 465×10^{-6} tail).

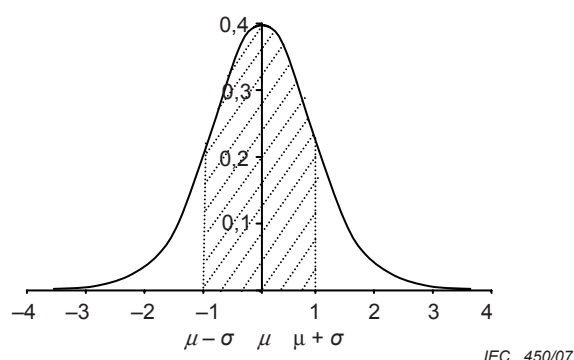


Figure 6 – Gaussian distribution of jitter

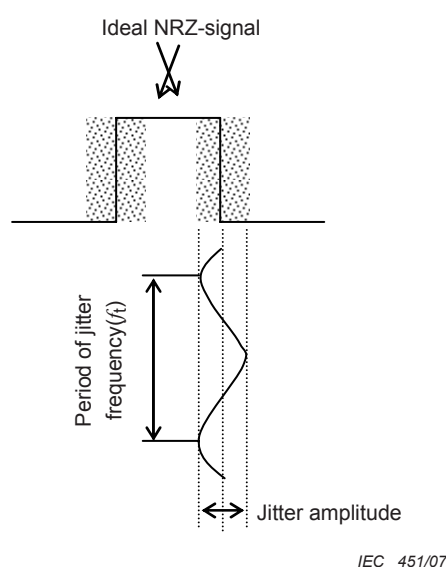


Figure 7 – Jitter amplitude and period of jitter frequency

In the case of subharmonics involved in the signal generation, phase jitter may contain non-random spectral components due to periodical change of the duty cycle. This causes a non-Gaussian distribution, i.e. the 7σ -rule for peak-to-peak values no longer applies. In such cases, only peak-to-peak values are meaningful. However, the determination of peak-to-peak values depends upon observation time. The recommended observation time for peak-to-peak jitter is 1 min. Longer times required when higher confidence is needed (i.e. when a larger range of σ is used to define peak-to-peak random jitter).

For the characterization of jitter, it is important to define the considered Fourier frequency range, i.e. the frequency components of the jitter itself. This is defined by the application (see standards ITU-T G.825, ANSI T1.105.03, Telcordia GR-253 and ETSI EN 300462).

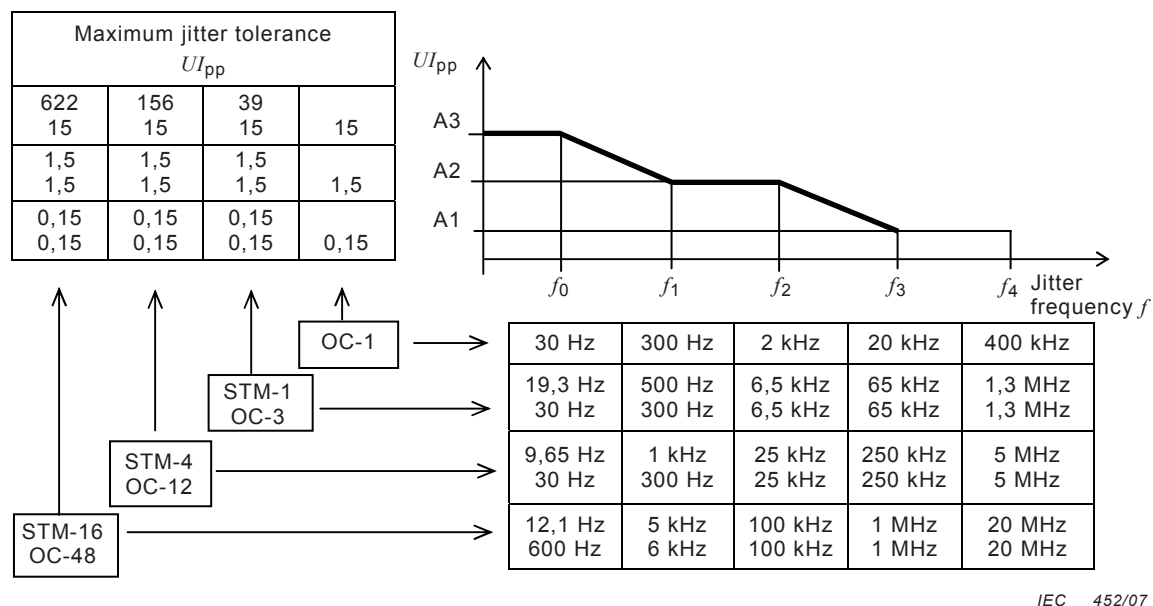


Figure 8 – Jitter tolerance according to ITU-T G.825, ANSI T1.105.03, Telcordia GR-253 and ETSI EN 300462

In connection with jitter and wander, the following three parameters are also used for clock characterization:

- TIE Time Interval Error (in nanoseconds or picoseconds);
- MTIE Maximum Time Interval Error (peak-to-peak TIE);
- TDEV Time deviation (r.m.s. value).

TIE is defined as the time deviation between the signal being measured and the reference clock, typically measured in nanoseconds.

MTIE is a measure that characterises frequency offsets. $MTIE(\tau)$ is defined as the largest peak-to-peak TIE in any observation interval of length τ (in seconds).

TDEV characterises the spectral content. $TDEV(\tau)$ is defined as the r.m.s. of filtered TIE, where the bandpass filter is centered on a frequency of $0,42/\tau$. It is calculated from the TIE samples for each point τ_i by the standard deviation $\sigma(\tau_i)$ (see note).

NOTE For more details, refer to standards ITU-T G.810 to G.813, or ANSI T1.101 and T1.105.03, Telcordia GR-253 and ETSI EN 300462.

3.3 Preferred values for ratings and characteristics

Values should be preferably chosen from the following paragraphs, unless otherwise stated in the detail specification.

3.3.1 Climatic category (40/085/56)

For requirements where the operating temperature range of the quartz crystal controlled oscillator is greater than $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$, a climatic category consistent with the operating temperature range shall be specified.

3.3.2 Bump severity

(4 000 $\pm$ 10) bumps at 400 m/s² peak acceleration in each direction along three mutually perpendicular axes (see 5.6.6). Pulse duration: 6 ms.

3.3.3 Vibration severity

Sinusoidal

10 Hz to 55 Hz
0,75 mm displacement amplitude
(peak value)
55 Hz to 500 kHz
or
55 Hz to 2 000 Hz
100 m/s² acceleration amplitude
(peak value)

30 min in each of three mutually
perpendicular axes at 1 octave/min
(see 5.6.7)

10 Hz to 55 Hz 1,5 mm displacement amplitude (peak value) 55 Hz to 2 000 Hz 200 m/s ² acceleration amplitude (peak value)	30 min in each of three mutually perpendicular axes at 1 octave/min (see 5.6.7)
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Random

(19,2 m/s ²) ² /Hz between 20 Hz and 2 000 Hz 196 m/s ² acceleration or (48 m/s ²) ² /Hz between 20 Hz and 2 000 Hz 314 m/s ² acceleration	30 min in each of three mutually perpendicular axes at 1 octave/min (see 5.6.7)
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3.3.4 Shock severity

1 000 m/s² peak acceleration for 6 ms duration; three shocks in each direction along three mutually perpendicular axes (see 5.6.8), half-sine pulse, unless otherwise stated in the detail specification.

3.3.5 Leak rate

10⁻¹ Pa cm³/s (10⁻⁶ bar cm³/s)

10⁻³ Pa cm³/s (10⁻⁸ bar cm³/s)

3.4 Marking

3.4.1 The quartz crystal controlled oscillator shall be clearly and durably marked (see 5.6.21) with items a) to g) below, and with as many of the remaining items as considered necessary:

- a) type designation as defined in the detail specification;
- b) nominal frequency in kilohertz or megahertz;
- c) year and week of manufacture;
- d) mark of conformity (unless a certificate of conformity is used);
- e) factory identification code;
- f) manufacturer's name or trade mark;
- g) terminal identification;
- h) designation of electrical connections;
- j) power supply voltage and polarity (if applicable);
- k) serial number (if applicable).

Where the available surface area of miniature quartz crystal controlled oscillators imposes practical limits in the amount of marking, instructions on the marking to be applied shall be given in the detail specification.

3.4.2 The primary packaging containing the quartz crystal controlled oscillator(s) shall be clearly marked with the information listed in 3.4.1 except item g) and electrostatic sensitive device (ESD) identification, where necessary.

4 Quality assessment procedures

Two methods are available for the approval of quartz crystal controlled oscillators of assessed quality. They are qualification approval and capability approval.

4.1 Primary stage of manufacture

The primary stage of manufacture for a quartz crystal controlled oscillator in accordance with 3.1.1.2 of IEC QC 001002-3 shall be as follows:

- a) for oscillators incorporating a sealed crystal unit:
 - the assembly of the quartz crystal controlled oscillator;
- b) for oscillators incorporating an unencapsulated crystal unit:
 - the final surface finishing of the crystal element in addition to the assembly of the oscillator.

NOTE The final surface finishing of the crystal element could be any of the following operations: lapping; polishing; etching; cleaning, in the case of polished plates.

4.2 Structurally similar components

The grouping of structurally similar crystal controlled oscillators for the purpose of qualification approval, capability approval and quality conformance inspection shall be prescribed in the relevant sectional specification.

4.3 Subcontracting

These procedures shall be in accordance with Annex B to Clause 2 of IEC QC 001002-3.

There shall be no subcontracting after the assembly of the crystal to the electronic circuit, except in the case of sealed crystal units, where the sealing of the final enclosure of the oscillator may be permitted.

4.4 Incorporated components

Where the final component contains components of a kind covered by a generic specification in the IEC series, these shall be produced using the normal IEC release procedures.

Where the contained components are not produced to an IEC detail specification, the approved manufacturer's chief inspector shall verify their quality by the use of

- a procurement specification covering all aspects necessary to ensure their satisfactory performance as part of the final product;
- an adequate approval test program maintaining a record of results;
- sufficient goods inward inspection procedures to ensure continued satisfactory performance of the final product.

4.5 Manufacturer's approval

To obtain manufacturer's approval the manufacturer shall meet the requirements of 10.2 of IEC QC 001002.

4.6 Approval procedures

4.6.1 General

To qualify a quartz crystal controlled oscillator, either capability approval or qualification approval procedures may be used. These procedures conform to those stated in IECQ 01 and IEC QC 001002-3.

4.6.2 Capability approval

Capability approval is appropriate when structurally similar quartz crystal controlled oscillators based on common design rules, are fabricated by a group of common processes.

Under capability approval, detail specifications fall into the following three categories:

a) capability qualifying components (CQCs)

A detail specification shall be prepared for each CQC as agreed with the NSI. It shall identify the purpose of the CQC and include all relevant stress levels and test limits;

b) standard catalogue items

When a component covered by the capability approval procedure is intended to be offered as a standard catalogue item, a detail specification complying with the blank detail specification shall be written. Such specifications shall be registered by the IECQ;

c) custom built quartz controlled oscillators

The contents of the detail specification shall be by agreement between the manufacturer and the customer in accordance with 6.6.1 of IEC QC 001002-3.

Further information on detail specifications is contained in the sectional specification IEC 60679-4.

The product and capability qualifying components (CQCs) are tested in combination and approval given to a manufacturing facility on the basis of validated design rules, processes and quality control procedures. Further information is given in 4.7 and in the sectional specification IEC 60679-4.

4.6.3 Qualification approval

Qualification approval is appropriate for components manufactured to a standard design and established production process and conforming to a published detail specification.

The program of tests defined in the detail specification for the appropriate assessment and severity level applies directly to the quartz crystal controlled oscillator to be qualified, as prescribed in 4.8 and the sectional specification IEC 60679-5.

4.7 Procedures for capability approval

4.7.1 General

The procedures for capability approval shall be in accordance with 4.2 of IEC QC 001002-3.

4.7.2 Eligibility for capability approval

The manufacturer shall comply with the requirements of 4.2.1 of IEC QC 001002-3 and the primary stage of manufacture as defined in 4.1 of this generic specification.

4.7.3 Application for capability approval

In order to obtain capability approval the manufacturer shall apply the rules of procedure given in 4.2.4 of IEC QC 001002-3.

4.7.4 Granting of capability approval

Capability approval shall be granted when the procedures in accordance with 4.2.7 of IEC QC 001002-3 have been successfully completed.

4.7.5 Capability manual

The contents of the capability manual shall be in accordance with the requirements of the sectional specification.

The NSI shall treat the capability manual as a confidential document. The manufacturer may, if he so wishes, disclose part or all of it to a third party.

4.8 Procedures for qualification approval

4.8.1 General

The procedures for qualification approval shall be in accordance with IEC QC 001002-3.

4.8.2 Eligibility for qualification approval

The manufacturer shall comply with the requirements of 3.1.1 of IEC QC 001002-3 and the primary stage of manufacture as defined in 4.1 of this generic specification.

4.8.3 Application for qualification approval

In order to obtain qualification approval the manufacturer shall apply the procedures given in 3.1.3 of IEC QC 001002-3.

4.8.4 Granting of qualification approval

Qualification approval shall be granted when the procedures in accordance with 3.1.5 of IEC QC 001002-3 have been successfully completed.

4.8.5 Quality conformance inspection

The blank detail specification associated with the sectional specification shall prescribe the test schedule for quality conformance inspection.

4.9 Test procedures

The test procedures to be used shall be selected from this generic specification. If any required test is not included, then it shall be defined in the detail specification.

4.10 Screening requirements

Where screening is required by the customer for quartz crystal controlled oscillators, this shall be specified in the detail specification.

4.11 Rework and repair work

4.11.1 Rework

Rework is the rectification of processing errors and shall not be carried out if prohibited by the sectional specification. The sectional specification shall state if there is a restriction on the number of occasions that rework may take place on a specific component.

All rework shall be carried out prior to the formation of the inspection lot offered for inspection to the requirements of the detail specification.

Such rework procedures shall be fully described in the relevant documentation produced by the manufacturer and shall be carried out under the direct control of the chief inspector.

Subcontracting of rework is not permitted.

4.11.2 Repair work

Repair work is the correction of defects in a component after release to the customer.

Components that have been repaired can no longer be considered as representative of the manufacturer's production and may not be released under the IECQ system.

4.12 Certified test records

The requirements of Annex B of IEC QC 001002-2 shall apply. When certified test records (CTR) are prescribed in the sectional specification for qualification approval and are requested by the customer, the results of the specified tests shall be summarized.

4.13 Validity of release

Quartz crystal controlled oscillators held for a period exceeding two years following acceptance inspection shall be reinspected for the electrical tests detailed in 5.5.4 and 5.5.17, prior to release.

4.14 Release for delivery

Quartz crystal controlled oscillators shall be released in accordance with 4.3 of IEC QC 001002-3.

4.15 Unchecked parameters

Only those parameters of a component which have been specified in a detail specification and which were subject to testing, can be assumed to be within the specified limits. It should not be assumed that any parameter not specified will remain unchanged from one component to another. Should it be necessary for further parameters to be controlled, then a new, more extensive, detail specification should be used. The additional test method(s) shall be fully described and appropriate limits, AQLs and inspection levels specified.

5 Test and measurement procedures

5.1 General

The test and measurement procedures shall be carried out in accordance with the relevant detail specification.

5.2 Test and measurement conditions

5.2.1 Standard conditions for testing

Unless otherwise specified, all tests shall be carried out under the standard atmospheric conditions for testing as specified in 5.3 of IEC 60068-1.

Temperature	15 °C to 35 °C
Relative humidity	25 % to 75 %
Air pressure	86 kPa to 106 kPa (860 mbar to 1060 mbar)

In case of dispute, the referee conditions are the following:

Temperature	25 °C ± 2 °C
Relative humidity	48 % to 52 %
Air pressure	86 kPa to 106 kPa (860 mbar to 1060 mbar)

Before measurements are made, the quartz crystal controlled oscillators shall be stored at the measuring temperature for a time sufficient to allow the quartz crystal controlled oscillator to reach thermal equilibrium. Controlled recovery conditions and standard conditions for assisted drying are given in 5.4 and 5.5 of IEC 60068-1.

The ambient temperature during the measurements shall be recorded and stated in the test report.

5.2.2 Equilibrium conditions

All electrical tests shall be conducted under equilibrium conditions, unless otherwise specified.

When test conditions cause a significant change with time of the characteristic being measured, means of compensation for such effects shall be specified, for example the period of time that the oscillator shall be maintained at specified test conditions before making a measurement.

5.2.3 Air flow conditions for temperature tests

When devices are to be measured at temperatures other than 25 °C ± 2 °C, they shall be subjected to adequate forced air circulation to ensure close temperature control.

If heat loss due to forced air circulation affects the performance of the oscillator, still air conditions shall be simulated by enclosing the oscillator in a draught shield consisting of a thermally conducting box, having internal dimensions so that a $20\text{ mm} \pm 5\text{ mm}$ clearance is maintained from all surfaces. The temperature at which measurements should be taken under these conditions is the reference point temperature on the surface of the draught shield.

If a draught shield is necessary, it shall be used for both high and low temperature tests.

5.2.4 Power supplies

DC power sources used in the testing of crystal controlled oscillators shall not have a ripple content large enough to effect the desired accuracy of measurement; a.c. power sources shall be transient free. When the ripple and/or the transient content of the power sources are critical to the measurement being performed, their effects shall be fully defined in the detail specification.

5.2.5 Precision of measurement

The limits given in the detail specification are true values. Measurement inaccuracies shall be taken into account when evaluating the results. Precautions should be taken to reduce measurement errors to a minimum.

5.2.6 Precautions

5.2.6.1 Measurements

The measurement circuits shown for specified electrical tests are the preferred circuits. Due allowance shall be made for any loading effects in cases where the measuring apparatus modifies the characteristics being examined.

5.2.6.2 Electrostatic sensitive devices

Where the component is identified as electrostatic sensitive, precautions shall be taken to prevent damage from electrostatic charge both before, during, and after test (see IEC 61000-4-2).

5.2.7 Alternative test methods

Measurements shall preferably be carried out using the methods specified. Any other method giving equivalent results may be used, except in case of dispute.

NOTE "Equivalent" means that the value of the characteristic established by such other methods falls within the specified limits when measured by the specified method.

5.3 Visual inspection

Unless otherwise specified, external visual examination shall be performed under normal factory lighting and visual conditions.

5.3.1 Visual test A

The quartz crystal controlled oscillator shall be visually examined to ensure that the condition, workmanship and finish are satisfactory. The marking shall be legible.

5.3.2 Visual test B

The quartz crystal controlled oscillator shall be visually examined under $\times 10$ magnification. There shall be no cracks in the glass or damage to the terminations. Minute flaking around the further edge of a meniscus shall not be considered a crack.