DD IEC/TS 61994-3:2011

BSI Standards Publication

Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection – Glossary

Part 3: Piezoelectric and dielectric oscillators

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National foreword

This Draft for Development is the UK implementation of IEC/TS 61994-3:2011.

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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Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection – Glossary –
Part 3: Piezoelectric and dielectric oscillators

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PIEZOELECTRIC, DIELECTRIC AND ELECTROSTATIC DEVICES AND ASSOCIATED MATERIALS FOR FREQUENCY CONTROL, SELECTION AND DETECTION – GLOSSARY –

Part 3: Piezoelectric and dielectric oscillators

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 61994-3, which is a technical specification, has been prepared by IEC technical committee 49: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection.

This second edition of IEC 61994-3 cancels and replaces the first edition published in 2004. 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,
– new terminologies are added,
– drawings inserted for easier understanding.

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

Enquiry draft	Report on voting
49/928/DTS	49/949/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 ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61994 series, under the general title *Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection – Glossary*, can be found on the IEC website.

NOTE Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of next edition.

The committee has decided that the contents of this publication 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

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- withdrawn,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

PIEZOELECTRIC, DIELECTRIC AND ELECTROSTATIC DEVICES AND ASSOCIATED MATERIALS FOR FREQUENCY CONTROL, SELECTION AND DETECTION – GLOSSARY –

Part 3: Piezoelectric and dielectric oscillators

1 Scope

This part of IEC 61994 specifies the terms and definitions for piezoelectric dielectric oscillators representing the state-of-the-art, which are intended for use in the standards and documents of IEC TC 49.

2 Normative references

Void

3 Terms and definitions

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

3.1
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

[IEC 60679-1: 2007, 3.2.10]

3.2
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:

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

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.

NOTE The confidence of the estimate improves as M increases.

[IEC 60679-1: 2007, 3.2.23, modified]

3.3
amplitude modulation distortion
non-linear distortion in which the relative magnitudes of the spectral components of the modulating signal waveform are modified

NOTE This amplitude modulation distortion is also commonly known as frequency distortion, amplitude distortion and amplitude/frequency distortion.

[IEC 60679-1: 2007, 3.2.28, modified]

3.4
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.

[IEC 60679-1: 2007, 3.2.3]

3.5
decay time
fall time
time interval required for the trailing edge of a waveform to change between two defined levels

NOTE These two defined levels may be the logic levels V_{OH} and V_{OL} being at 90 % and 10 %, respectively, of the maximum amplitude (equaling V_{HI} - V_{LO}) of the waveform, or any other ratio as defined in the detail specification (see Figure 1),

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.

[IEC 60679-1: 2007, 3.2.34, modified]

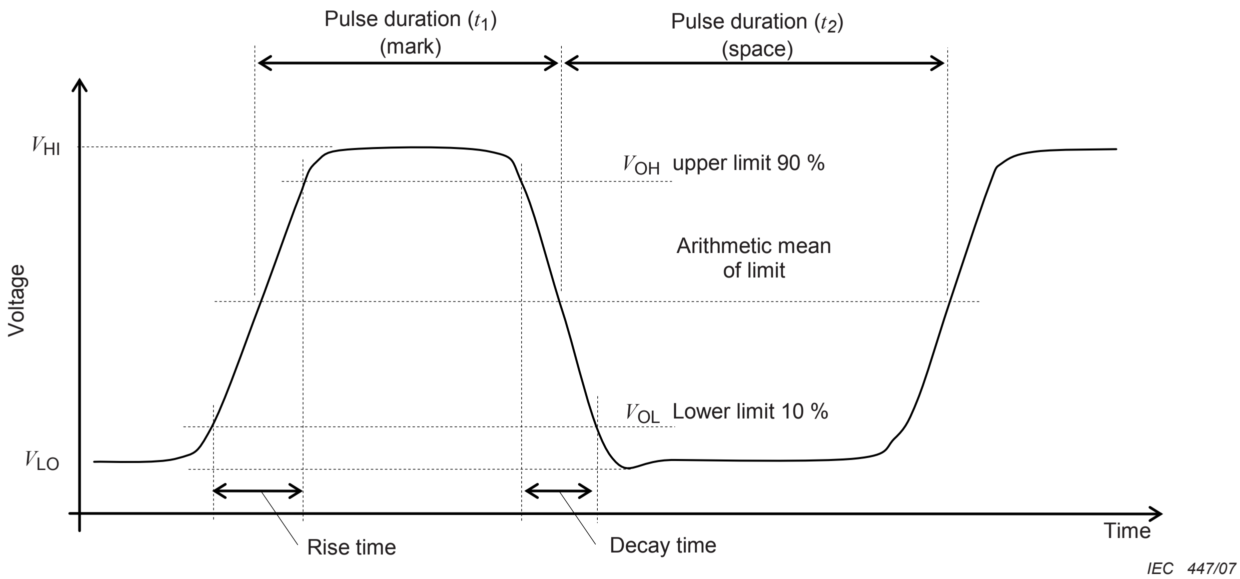


Figure 1 – Characteristics of an output waveform

3.6
electrostatic discharge
ESD
transfer of electric charge between bodies having different electrostatic potentials in proximity or through direct contact

[IEC 60050-161:1990, 161-01-22]

3.7
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

[IEC 60679-1: 2007, 3.2.11]

3.8
frequency/load coefficient
fractional change in output frequency resulting from an incremental change in electrical load impedance, other parameters remaining unchanged

[IEC 60679-1: 2007, 3.2.20]

3.9
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 minimise its deviation from nominal frequency over the specified range of operating conditions

[IEC 60679-1: 2007, 3.2.9]

NOTE In order to minimize the frequency deviation form nominal over the entire temperature range, a frequency offset may be specified for adjustment at the reference temperature (see Figure 2).

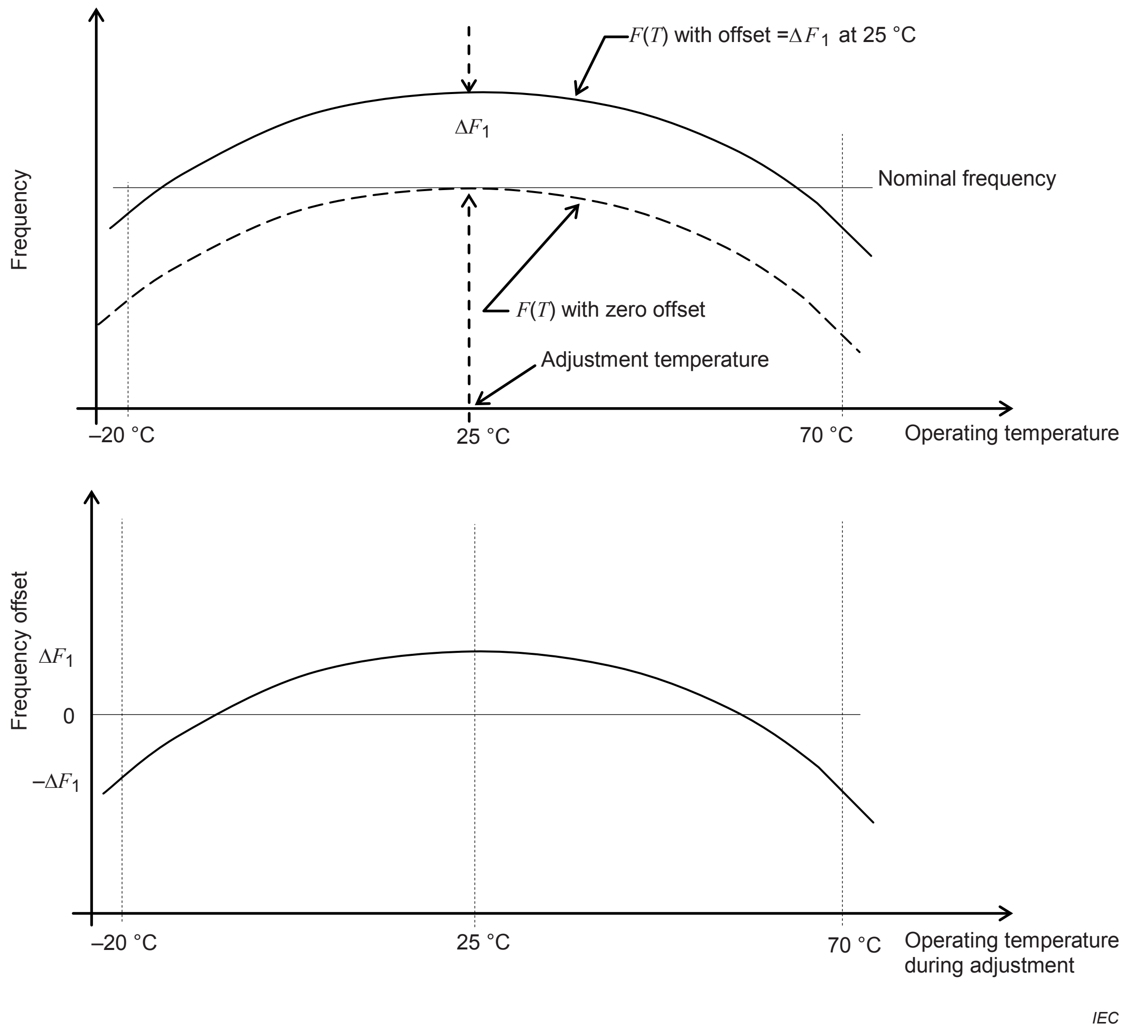


Figure 2 – Example of the use of frequency offset

3.10
frequency tolerance
maximum permissible deviation of the oscillator frequency from a specified nominal value when operating under specified conditions

[IEC 60679-1: 2007, 3.2.8]

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.

3.11
frequency/voltage coefficient
fractional change in output frequency resulting from an incremental change in supply voltage, other parameters remaining unchanged

[IEC 60679-1: 2007, 3.2.19]

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

3.12
harmonic distortion
non-linear distortion characterised by the generation of undesired spectral components harmonically related to the desired signal frequency

NOTE Each harmonic component is usually expressed as a power (in decibels) relative to the output power of the desired signal.

[IEC 60679-1: 2007, 3.2.30, modified]

3.13
incidental frequency modulation
optional measure of the 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

NOTE 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} rms in a 10 kHz band).

[IEC 60679-1: 2007, 3.2.27, modified]

3.14
latch-up
persistent state in which a low impedance path results from an input, output or supply overvoltage

3.15
linearity of frequency modulation deviation
measure of the transfer characteristic of a modulation system as compared to its an ideal (straight line) function, usually expressed as an allowable non-linearity in per cent of the specified full range deviation

NOTE 1 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).

NOTE 2 Figure 3 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 ± 5 %. Curve *D* is the actual characteristic compared with the ideal (curve *A*) and the limits (curve *B* and *C*).

[IEC 60679-1: 2007, 3.2.29, modified]

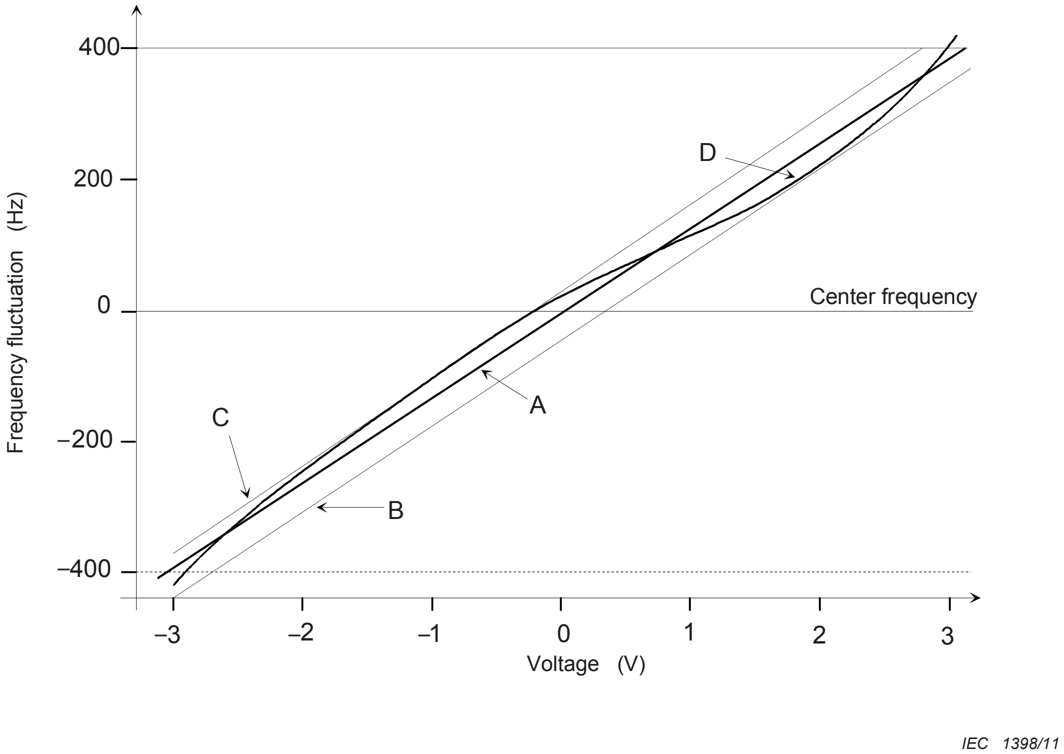


Figure 3 – Typical frequency fluctuation characteristics

3.16
long-term frequency stability
frequency ageing
relationship between oscillator frequency and time

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

[IEC 60679-1: 2007, 3.2.21, modified]

3.17
maximum time interval error
MTIE
largest peak to peak time interval error (TIE) in any observation interval of length τ (in seconds)

3.18
nominal frequency
frequency used to identify the crystal controlled oscillator

[IEC 60679-1: 2007, 3.2.7]

3.19
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.

[IEC 60679-1: 2007, 3.2.14]

3.20
operating temperature range
range of temperature over which the oscillator will function, maintaining frequency and other output signal characteristics within specified tolerances

[IEC 60679-1: 2007, 3.2.13]

3.21
oven controlled crystal oscillator
OCXO
crystal controlled oscillator in which at least the piezoelectric resonator is temperature controlled

[IEC 60679-1: 2007, 3.2.6]

3.22
overtone crystal controlled oscillator
oscillator designed to operate with the controlling piezoelectric resonator in a specified mechanical overtone order of vibration

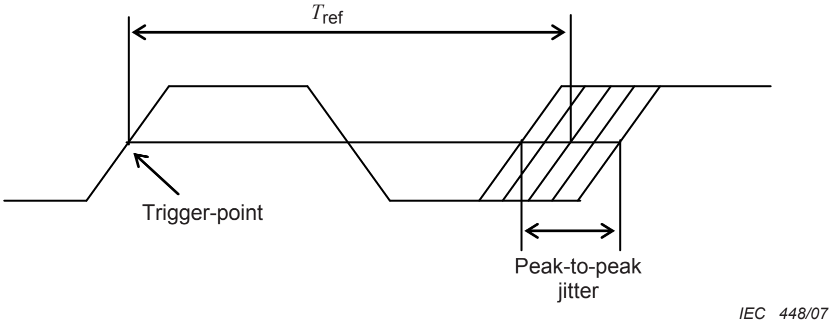
[IEC 60679-1: 2007, 3.2.2]

3.23
phase jitter
short-term variations of the zero crossings of the oscillator output signal from their ideal position in time

NOTE 1 See Figure 4.

NOTE 2 The phase variation $\Delta\varphi$ with frequency components greater than or equal to 10 Hz. Variations slower than 10 Hz are called "wander".

[IEC 60679-1: 2007, 3.2.39, modified]



Key

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

Figure 4 – Clock signal with phase jitter

3.24
phase noise
frequency-domain measure of the short-term frequency stability of an oscillator

NOTE This phase noise normally expressed as the power spectral density of the phase fluctuations, $S_\varphi(f)$, where the phase fluctuation function is $\varphi(t) = 2\pi Ft - 2\pi F_0 t$. The spectral density of phase fluctuation can be directly related to the spectral density of frequency fluctuation by the following formula:

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

where

F is the oscillator frequency;

F_0 is the average oscillator frequency;

f is the Fourier frequency.

[IEC 60679-1: 2007, 3.2.25, modified]

3.25
pulse duration
duration between pulse start time and pulse stop time(see Figure 1)

[IEC 60679-1: 2007, 3.2.32]

3.26
reference point temperature
temperature measured at a specific reference point relative to the oscillator

[IEC 60679-1: 2007, 3.2.16]

3.27
reference temperature
temperature at which certain oscillator performance parameters are measured; normally 25 °C ± 2 °C

[IEC 60679-1: 2007, 3.2.15]

3.28
retrace characteristics
ability of an oscillator to return, after a specified time period, to a previously stabilized frequency, following a period in the energised condition

[IEC 60679-1: 2007, 3.2.37]

3.29
rise time
time interval required for the leading edge of a waveform to change between two defined levels

NOTE These two defined levels may be the logic levels V_{OL} and V_{OH} being at 10 % and 90 %, respectively, of the maximum amplitude (equaling V_{HI} - V_{LO}) of the waveform, or any other ratio as defined in the detail specification (see Figure 1).

[IEC 60679-1: 2007, 3.2.33, modified]

3.30
rms 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 time interval τ

NOTE The preferred measure of rms fractional frequency fluctuation is:

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

[IEC 60679-1: 2007, 3.2.24, modified]

3.31
short-term frequency stability
random fluctuations of the frequency of an oscillator over short periods of time

[IEC 60679-1: 2007, 3.2.22]

3.32
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

[IEC 60679-1: 2007, 3.2.1]

3.33
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

NOTE This spectral purity includes non-deterministic noise power, harmonic distortion components and spurious frequency interferences.

[IEC 60679-1: 2007, 3.2.26, modified]

3.34
spurious oscillations
discrete frequency spectral components, non-harmonically related to the desired output frequency, appearing at the output terminal of an oscillator

NOTE 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.

[IEC 60679-1: 2007, 3.2.31, modified]

3.35
stabilization time
time, measured from the initial application of power, required for a crystal controlled oscillator to stabilize its operation within specified limits

[IEC 60679-1: 2007, 3.2.18]

3.36
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 specified conditions which are given below

a) Quasi-sinusoidal waveforms

   The signal envelope is 90 % of the steady-state peak-to-peak amplitude

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

[IEC 60679-1: 2007, 3.2.38]

3.37
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

[IEC 60679-1: 2007, 3.2.12]

3.38
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

NOTE 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 1).

The ratio is expressed as:

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

[IEC 60679-1: 2007, 3.2.36, modified]

3.39
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

[IEC 60679-1: 2007, 3.2.5]

3.40
thermal transient frequency stability
oscillator frequency time response when ambient temperature is changed from one specified temperature to another with a specific rate

[IEC 60679-1: 2007, 3.2.17]

3.41
time deviation
TDEV
rms of filtered time interval error (TIE), where the band-pass filter is centred on a frequency of $0{,}42/\tau$

3.42
time interval error
TIE
time deviation between the signal being measured and the reference clock, typically measured in nanoseconds

3.43
tri-state output
output stage which may be enabled or disabled by the application of an input control signal

NOTE 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.

[IEC 60679-1: 2007, 3.2.35, modified]

3.44
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

[IEC 60679-1: 2007, 3.2.4]

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

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