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Edition 3.0 2021-01

TECHNICAL SPECIFICATION

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

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

Part 3: Piezoelectric, dielectric and electrostatic 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 TS 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 third edition of IEC 61994-3 cancels and replaces the second edition published in 2011. This edition constitutes a technical revision.

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

– some definitions have been updated;
– the terminology given in IEC 60679-1:2017 has been taken into account;
– new terminologies are added.

The text of this Technical Specification is based on the following documents:

Enquiry draft	Report on voting
49/1348/DTS	49/1355/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 document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61994 series, published 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.

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 the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- 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- withdrawn,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, dielectric and electrostatic oscillators

1 Scope

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

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
adjustment frequency
frequency to which an oscillator must be adjusted, under a particular combination of operating conditions, in order to meet the requirement for the frequency tolerance specification over the specified range of operating conditions

Note 1 to entry: Adjustment frequency corresponds to nominal frequency plus frequency offset.

[SOURCE: IEC 60679-1:2017, 3.2.22]

3.2
ADEV of fractional frequency fluctuation
Allan deviation of fractional frequency fluctuation
measure in the time domain of the short-term frequency stability of 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

Note 1 to entry: The preferred measure of fractional frequency fluctuation is:

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

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 are averaged;

M is the number of measurements.

Note 2 to entry: The confidence of the estimate improves as M increases.

[SOURCE: IEC 60679-1:2017, 3.2.38, modified – ADEV of fractional frequency fluctuation has been replaced as the first preferred term. The meaning of the symbols used in the mathematical formula has been added, as well as Note 2 to entry.]

3.3
AVAR of fractional frequency fluctuation
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

Note 1 to entry: The preferred measure of fractional frequency fluctuation is:

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

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 are averaged;

M is the number of measurements.

Note 2 to entry: The confidence of the estimate improves as M increases.

[SOURCE: IEC 60679-1:2017, 3.2.37, modified – The term "Allan variance AVAR of fractional frequency fluctuation" has been deleted. And AVAR of fractional frequency fluctuation has been replaced as the preferred term.]

3.4
amplitude modulation distortion
non-linear distortion in which the relative magnitudes of the spectral components of the modulating signal waveform are modified

Note 1 to entry: The test procedure is provided in 4.5.22.3 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.42, modified – Three entry terms except amplitude modulation distortion have been deleted.]

3.5
crystal cut
orientation of the crystal element with respect to the crystallographic axes of the crystal

Note 1 to entry: It can 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.

[SOURCE: IEC 60679-1:2017, 3.2.3]

3.6
fall time
decay time
time interval required for the trailing edge of a waveform to change between two defined levels

Note 1 to entry: These levels may be two logic levels V_{OH} and V_{OL} or 90 % to 10 % of its maximum amplitude ($V_{\mathrm{HI}} - V_{\mathrm{LO}}$), or any other ratio as defined in the detail specification as shown in Figure 1.

Note 2 to entry: The test procedure is provided in 4.5.16.2 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.48, modified – The term "fall time" has been replaced as the first preferred term.]

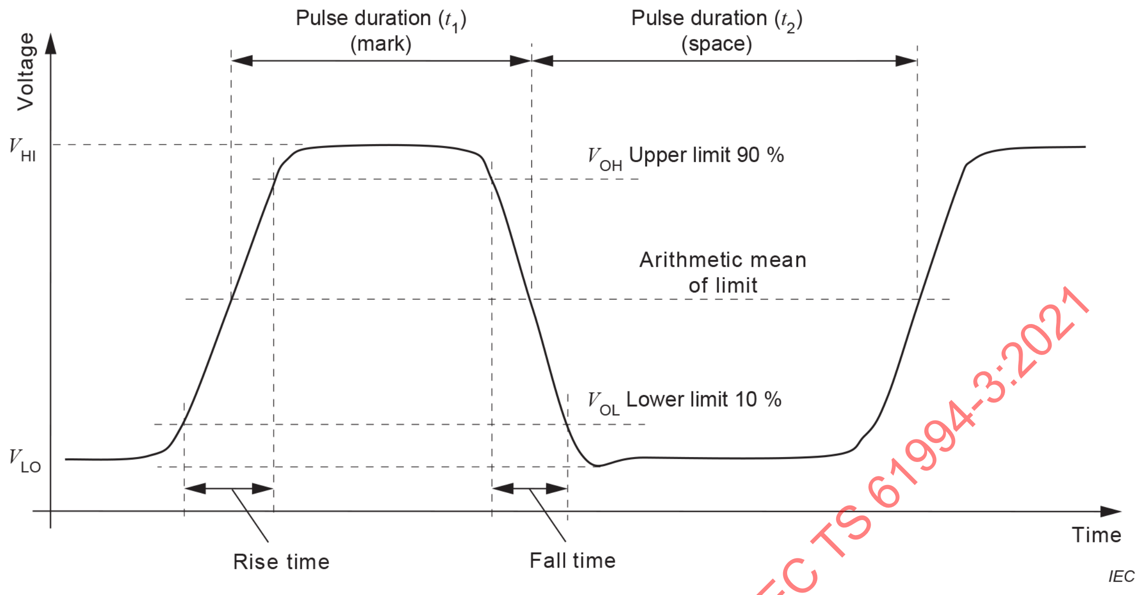


Figure 1 – Characteristics of an output waveform

3.7
DIXO
digital interfaced crystal oscillator
crystal oscillator, the frequency and the functions of which can be controlled, by application of an external digital signal

Note 1 to entry: The prefix "DI" is applied to TCXO and OCXO as DI-TCXO and DI-OCXO, respectively.

[SOURCE: IEC 60679-1:2017, 3.2.17, modified – DIXO has been replaced as the most first preferred term and the note has been reworded.]

3.8
MEMS oscillator
microelectromechanical system oscillator
oscillator that uses a MEMS device as the main frequency controlling element

[SOURCE: IEC 60679-1:2017, 3.2.15, modified – The term “electrostatic micro electro mechanical system oscillator” has been deleted and MEMS oscillator has been replaced as the first preferred term.]

3.9
frequency adjustment range
range over which oscillator frequency may be varied by means of some variable element

Note 1 to entry: The purpose is as follows:

a) setting the frequency to a particular value, or;

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

Note 2 to entry: The test procedure is provided in 4.5.11 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.23, modified – The end of definition has been replaced by Note 1 to entry.]

3.10
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 the nominal frequency over the specified range of operating conditions

Note 1 to entry: In order to minimize the frequency deviation from nominal frequency over the entire temperature range, a frequency offset may be specified for adjustment at the reference temperature as shown in Figure 2.

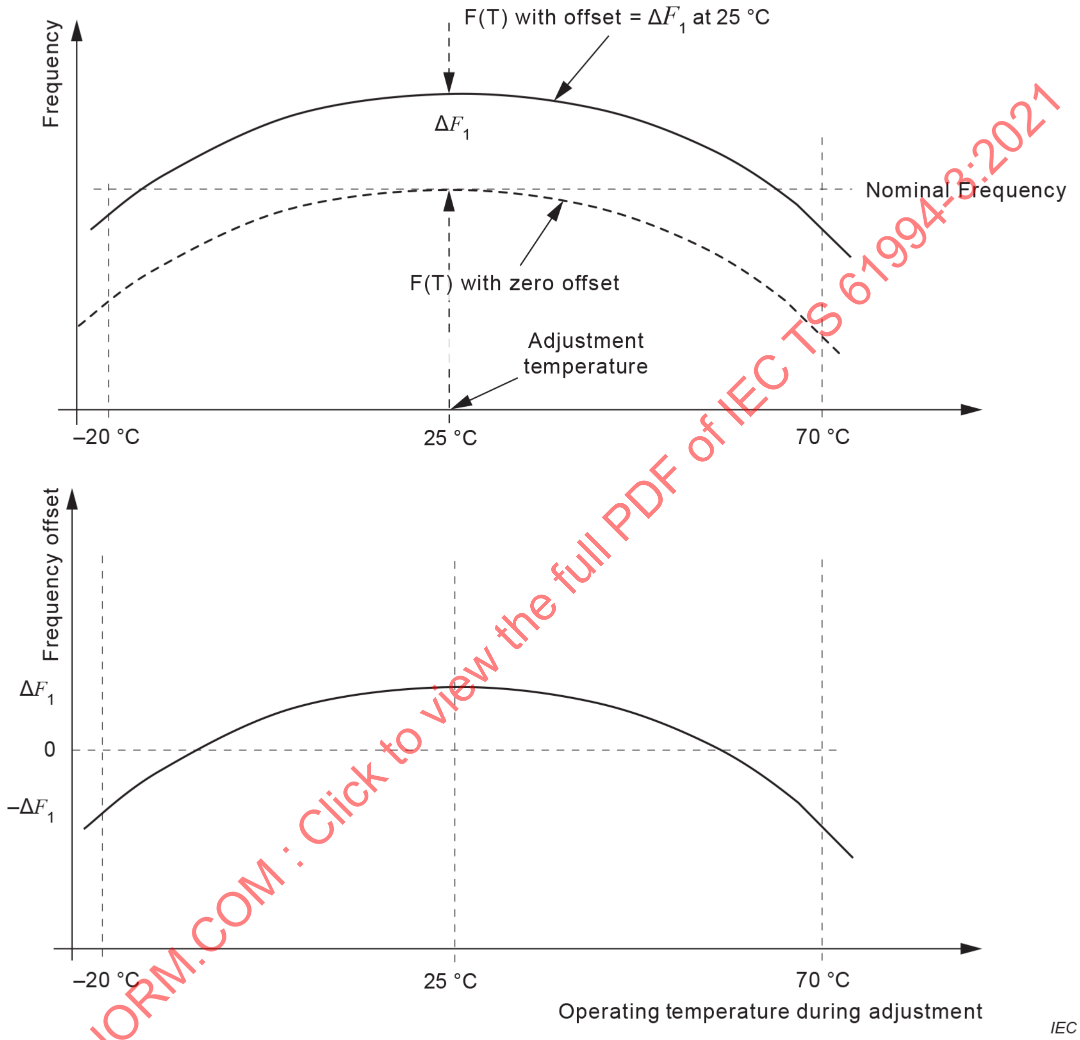


Figure 2 – Example of the use of frequency offset

[SOURCE: IEC 60679-1:2017, 3.2.21]

3.11
frequency tolerance
maximum permissible deviation from the specified nominal frequency from the specified value due to a specific cause, or a combination of causes

Note 1 to entry: 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 or all combinations of operating parameters, during a specified lifetime.

[SOURCE: IEC 60679-1:2017, 3.2.20, modified – "characteristic" of the definition has been replaced by "nominal".]

3.12
frequency/load coefficient
fractional change in output frequency resulting from an incremental change in electrical load impedance, other parameters remaining unchanged

Note 1 to entry: The test procedure is provided in 4.5.6 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.34]

3.13
frequency/temperature characteristics
deviation from the frequency at the specified reference temperature due to operation over the specified temperature range, other conditions remaining constant

Note 1 to entry: The test procedure is provided in 4.5.5 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.31]

3.14
frequency/temperature stability
maximum permissible deviation of the oscillator frequency, with no reference implied, due to operation over the specified temperature range at nominal supply and load conditions, other conditions constant

Note 1 to entry: The test procedure is provided in 4.5.5 of IEC 62884-1:2017 .

[SOURCE: IEC 60679-1:2017, 3.2.32, modified – The mathematical formula has been deleted.]

3.15
frequency/voltage coefficient
fractional change in output frequency resulting from an incremental change in supply voltage, other parameters remaining unchanged

Note 1 to entry: 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.

Note 2 to entry: The test procedure is provided in 4.5.7 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.33]

3.16
harmonic distortion
non-linear distortion characterized by the generation of undesired spectral components harmonically related to the desired signal frequency

Note 1 to entry: Each harmonic component is usually expressed as a power ratio (in decibels) relative to the output power of the desired signal.

Note 2 to entry: The test procedure is provided in 4.5.15 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.44]

3.17
incidental frequency modulation
optional measure of frequency stability in the frequency domain

Note 1 to entry: Incidental frequency modulation is 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} RMS in a 10 kHz band).

Note 2 to entry: The test procedure is provided in 4.5.30 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.41]

3.18
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

Note 1 to entry: 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 shall not exceed –40 dB relative to the total modulating signal power) . The test procedure is provided in 4.5.23.1 of IEC 62884-1:2017.

Note 2 to entry: 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 (curves B and C).

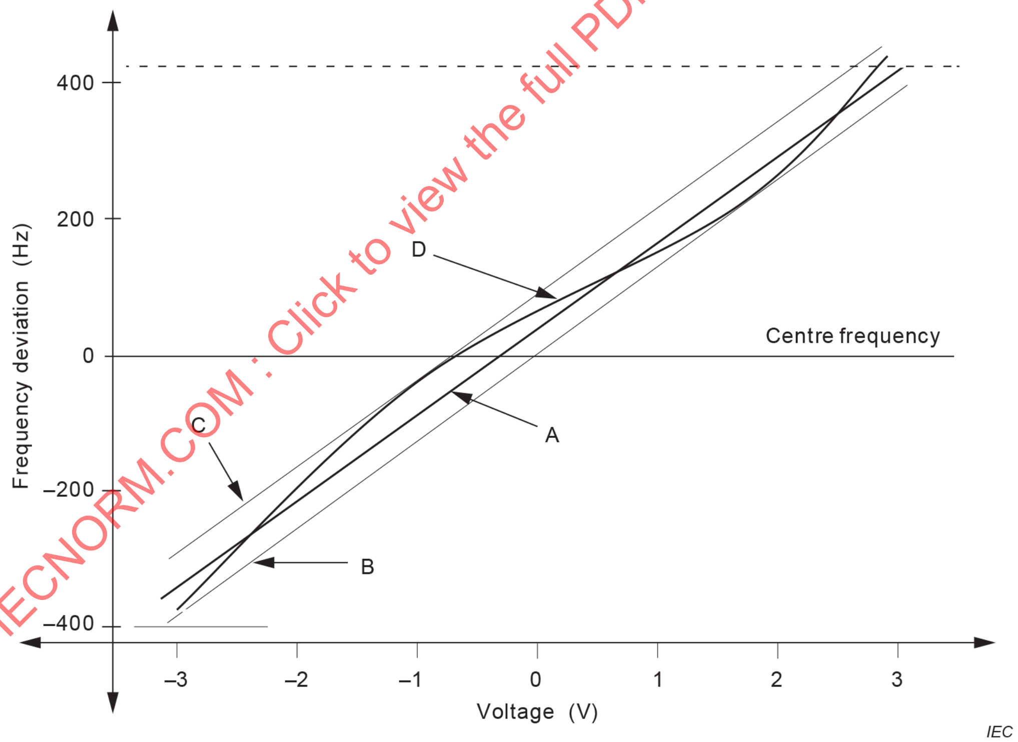


Figure 3 – Linearity of frequency modulation deviation

[SOURCE: IEC 60679-1:2017, 3.2.43]

3.19
long-term frequency stability
frequency ageing
relationship between oscillator frequency and time

Note 1 to entry: This long-term frequency drift that 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.

[SOURCE: IEC 60679-1:2017, 3.2.35]

3.20
nominal frequency
frequency given by the manufacturer or the specification to identify the oscillator

[SOURCE: IEC 60679-1:2017, 3.2.19]

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

Note 1 to entry: 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.

[SOURCE: IEC 60679-1:2017, 3.2.6, modified – OCXO has been replaced as the first preferred term.]

3.22
one-port SAW resonator
SAW resonator having a pair of terminals

Note 1 to entry: Basic configuration of the one-port SAW resonator is shown in Figure 4.

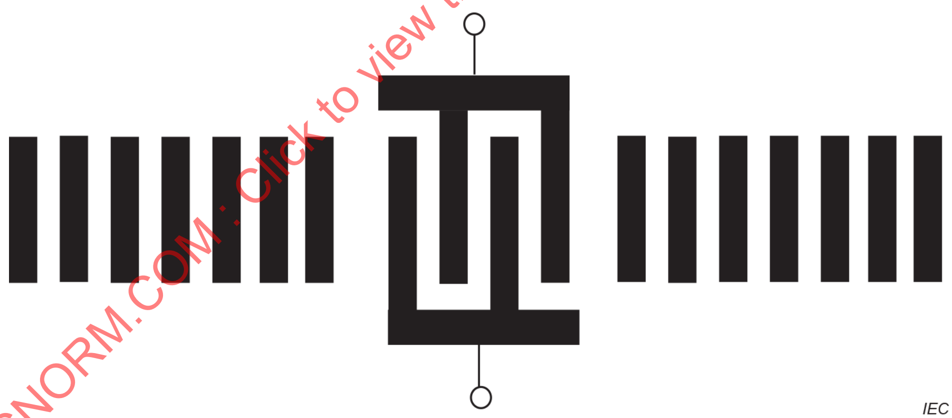


Figure 4 – Basic configuration of one-port SAW resonator with open-circuited metal strip arrays

[SOURCE: IEC 60679-1:2017, 3.2.9 modified – Note 1 to entry has been added.]

3.23
operable temperature range
range of temperatures over which the oscillator will continue to provide an output signal, though not necessarily within the specified tolerances of frequency, level, waveform, etc.

[SOURCE: IEC 60679-1:2017, 3.2.26]

3.24
operating temperature range, <of an oscillator>
range of temperatures over which the oscillator will function, maintaining frequency and other output signal characteristics within specified tolerances

[SOURCE: IEC 60679-1:2017, 3.2.25]

3.25
overtone crystal controlled oscillator
oscillator designed to operate with the controlling piezoelectric resonator functioning in a specified mechanical overtone order of vibration

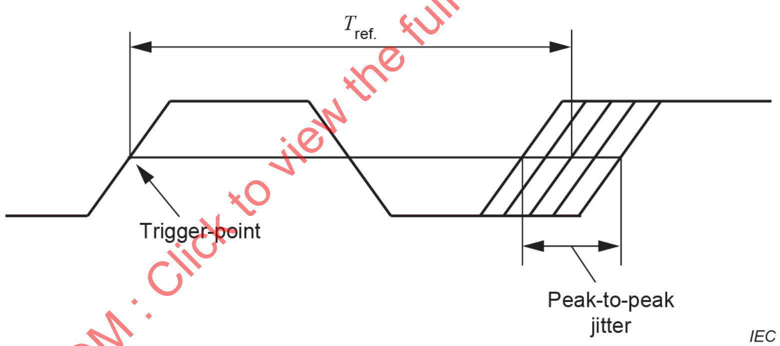
[SOURCE: IEC 60679-1:2017, 3.2.2]

3.26
phase jitter
short-term variation of the zero crossings of the oscillator output signal from their ideal position in time

Note 1 to entry: Clock signal with period jitter is shown in Figure 5.

Note 2 to entry: The phase variation Δφ with frequency components greater than or equal to 10 Hz is called jitter. 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.

Note 3 to entry: The corresponding variation of the period length, $\Delta T = \Delta\varphi/(2\pi f_c)$ is called “period jitter” (fc is the clock frequency).



Key

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

Figure 5 – Clock signal with period jitter

[SOURCE: IEC 60679-1:2017, 3.2.53, modified – Note 1 to entry has been added and the remaining notes renumbered accordingly.]

3.27
phase noise
frequency-domain measure of the short-term frequency stability of an oscillator

Note 1 to entry: This phase noise is normally expressed as the power spectral density of the phase fluctuations, $S_\varphi(f)$, where the phase fluctuation function $\phi(t)$ is expressed as

$$\frac{1}{2\pi}\frac{d\phi(t)}{dt} = F(t) - F_0$$

The spectral density of phase fluctuation can be directly related to the spectral density of frequency fluctuation, $S_y(f)$, by

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

Where

$F(t)$ is the instantaneous oscillator frequency

F_0 is the average oscillator frequency

f is the Fourier frequency

Note 2 to entry: The test procedure is provided in 4.5.25 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.39]

3.28
pulse duration
duration between pulse start time and pulse stop time

Note 1 to entry: Pulse duration is shown in Figure 1.

Note 2 to entry: The test procedure is provided in 4.5.16.3 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.46, modified – Note 1 to entry has been added and the existing note has been renumbered accordingly.]

3.29
reference point temperature
temperature measured at a specific reference point relative to an oscillator

[SOURCE: IEC 60679-1:2017, 3.2.28]

3.30
reference temperature
temperature at which certain oscillator performance parameters are measured

Note 1 to entry: The reference temperature is normally 25 °C ± 2 °C.

[SOURCE: IEC 60679-1:2017, 3.2.27]

3.31
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

Note 1 to entry: The test procedure is provided in 4.5.12 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.51]

3.32
rise time
time interval required for the leading edge of a waveform to change between two defined levels

Note 1 to entry: 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 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.

Note 2 to entry: The test procedure is provided in 4.5.16.2 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.47]

3.33
SAW
surface acoustic wave
acoustic wave, propagating along the surface of an elastic substrate, the amplitude of which decays exponentially with substrate depth

[SOURCE: IEC 60679-1:2017, 3.2.7, modified – SAW has been replaced as the first preferred term.]

3.34
SAW oscillator
oscillator that uses a SAW resonator as the main frequency controlling element

[SOURCE: IEC 60679-1:2017, 3.2.11]

3.35
SAW resonator
surface acoustic wave resonator
SAWR
resonator using multiple reflections of surface acoustic waves

[SOURCE: IEC 60679-1:2017, 3.2.8, modified – SAW resonator has been replaced as the first preferred term.]

3.36
short-term frequency stability
random fluctuations of the frequency of an oscillator over short periods of time

[SOURCE: IEC 60679-1:2017, 3.2.36]

3.37
SPSO
simple packaged SAW oscillator
SAW oscillator having no means of temperature control or compensation, exhibiting a frequency/temperature characteristic determined substantially by the SAW resonator employed

[SOURCE: IEC 60679-1:2017, 3.2.12, modified – SPSO has been replaced as the first preferred term.]

3.38
spectral purity
measure of frequency stability in the frequency domain

Note 1 to entry: This spectral purity is usually represented as the signal side noise power spectrum expressed in decibels relative to total signal power, per hertz bandwidth. This spectral purity includes non-deterministic noise power, harmonic distortion components and spurious single frequency interferences.

Note 2 to entry: The test procedure is provided in 4.5.29 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.40]

3.39
SSXO
spread spectrum crystal oscillator
crystal oscillator that reduces the peak of frequency spectrum by modulating the oscillation frequency

[SOURCE: IEC 60679-1:2017, 3.2.18, modified – SSXO has been replaced as the first preferred term.]

3.40
spurious oscillations
discrete frequency spectral components, non-harmonically related to the desired output frequency, appearing at the output terminal of an oscillator

Note 1 to entry: These components can 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.

[SOURCE: IEC 60679-1:2017, 3.2.45]

3.41
SPXO
simple packaged crystal oscillator
crystal controlled oscillator having no means of temperature control or compensation, exhibiting a frequency/temperature characteristic determined substantially by the quartz crystal resonator employed

[SOURCE: IEC 60679-1:2017, 3.2.1, modified – SPXO has been replaced as the first preferred term.]

3.42
stabilization time
duration, measured from the initial application of power, required for an oscillator to stabilize its operation within specified limits

Note 1 to entry: The test procedure is provided in 4.5.10 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.30]

3.43
start-up time
duration between the application of the supply voltage to oscillator and the time when the output signal of desired frequency controlled by the quartz resonator fulfils specified conditions

Note 1 to entry: The specified conditions are as follows:

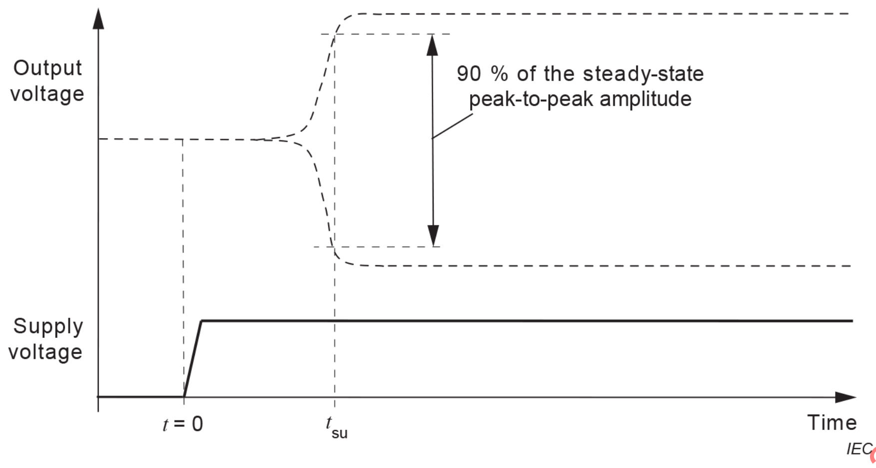
a) for quasi-sinusoidal waveforms, the signal envelope is 90 % of the steady-state peak-to-peak amplitude as shown in Figure 6;

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

Note 2 to entry: The output signal can show spurious oscillations prior to the appearance of the steady-state signal.

Note 3 to entry: The test procedure is provided in 4.5.9 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.52, modified – In the definition, "r.f. output signal" has been replaced by "output signal" and the items a) and b) have been moved to a new Note 1 to entry. The remaining entries have been renumbered accordingly.]



Key

t_{su} represents start-up time.

Figure 6 – Definition of start-up time

3.44
storage temperature range
minimum and maximum temperatures as measured on the enclosure at which an oscillator may be stored without deterioration or damage to its performance

[SOURCE: IEC 60679-1:2017, 3.2.24]

3.45
symmetry
duty cycle
mark/space ratio
ratio between the time, when the output voltage is above the specified level, and the time, when the output voltage is below the specified level

Note 1 to entry: The symmetry is expressed in percent of the duration of the full signal period

Note 2 to entry: The specified level may be the arithmetic mean between levels V_{OL} and V_{OH}, or 50 % of the peak-to-peak amplitude as shown in Figure 1.

Note 3 to entry: The ratio is expressed as:

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

where

t_1 is the time, when the output voltage is above the specified level

t_2 is the time, when the output voltage is below the specified level

Note 4 to entry: The test procedure is provided in 4.5.16.4 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.50, modified – In the definition, (t_1) and (t_2)have been deleted, and their meaning has been added to the explanation of the mathematical formula.]

3.46
TCXO
temperature compensated crystal oscillator
crystal controlled oscillator whose frequency deviation due to temperature is reduced by means of a compensation system, incorporated in the device

[SOURCE: IEC 60679-1:2017, 3.2.5, modified – TCXO has been replaced as the first preferred term.]

3.47
TCSO
temperature compensated SAW oscillator
SAW oscillator whose frequency deviation due to temperature is reduced by means of a compensation system incorporated in the device

[SOURCE: IEC 60679-1:2017, 3.2.14, modified – TCSO has been replaced as the first preferred term.]

3.48
thermal transient frequency stability
oscillator frequency time response when ambient temperature is changed from one specified temperature to another with a specific rate

[SOURCE: IEC 60679-1:2017, 3.2.29]

3.49
three-state output
output stage which can be enabled or disabled by the application of an input control signal

Note 1 to entry: 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.

Note 2 to entry: The test procedure is provided in 4.5.21 of IEC 62884-1:2017.

[SOURCE: IEC 60679-1:2017, 3.2.49, modified – 3-state output of term name has been replaced by three-state output.]

3.50
two-port SAW resonator
SAW resonator having input and output ports

Note 1 to entry: Basic configuration of the Two-port SAW resonator is shown in Figure 7.

[SOURCE: IEC 60679-1:2017, 3.2.10, modified – Note 1 to entry has been added.]