

Quartz crystal controlled oscillators of assessed quality —

Part 1: Generic specification

The European Standard EN 60679-1:1998, with the incorporation of amendment A1:2002 and amendment A2:2003, has the status of a British Standard

ICS 31.140

National foreword

This British Standard is the English language version of EN 60679-1:1998, including amendment A1:2002 and amendment A2:2003. It is identical with IEC 60679-1:1997, including amendment 1:2002 and amendment 2:2003. It supersedes BS EN 169000:1993 which will be withdrawn in due course (see note on page 2).

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] <A1>. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by [A1] <A1>.

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

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

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Cross-references

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English version

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(includes amendment A1:2002+A2:2003)
(IEC 60679-1:1997 + A1:2002+A2:2003)

Oscillateurs pilotés par quartz sous assurance
de la qualité —

Partie 1: Spécification générique

(inclut les amendement A1:2002 et A2:2003)

(CEI 60679-1:1997 + A1:2002+A2:2003)

Quarzoszillatoren mit bewerteter Qualität —
Teil 1: Fachgrundspezifikation

(enthält Änderungen A1:2002 und A2:2003)

(IEC 60679-1:1997 + A1:2002+A2:2003)

This European Standard was approved by CENELEC on 1998-01-01. Amendment A1 was approved by CENELEC on 2002-03-01. Amendment A2 was approved by CENELEC on 2003-09-01. 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.

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European Committee for Electrotechnical Standardization

Comité Européen de Normalisation Electrotechnique

Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 49/385/FDIS, future edition 2 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 1998-01-01.

This European Standard supersedes EN 169000:1992 and its amendment A1:1998.

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) 1998-10-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) —

NOTE The latest date of withdrawal will be fixed when all parts of EN 60679, which are to replace EN 169000 and its related specifications, are approved.

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

In this standard, Annex A and Annex ZA are normative and Annex B is informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60679-1:1997 was approved by CENELEC as a European Standard without any modification.

In the official version, for Annex B, Bibliography, the following notes have to be added for the standards indicated:

- | | |
|---------------|---|
| IEC 60027-2 | NOTE Harmonized, together with supplements A:1975 and B:1980, as HD 245.2 S1:1983 (not modified). |
| IEC 61000-4-3 | NOTE Harmonized as EN 61000-4-3:1996 (not modified). |

Foreword to amendment A1

The text of document 49/523/FDIS, future amendment 1 to IEC 60679-1:1997, 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 amendment A1 to EN 60679-1:1998 on 2002-03-01.

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- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2002-12-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2005-03-01

Endorsement notice

The text of amendment 1:2002 to the International Standard IEC 60679-1:1997 was approved by CENELEC as an amendment to the European Standard without any modification.

Foreword to amendment A2

The text of document 49/591/FDIS, future amendment 2 to IEC 60679-1:1997, 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 amendment A2 to EN 60679-1:1998 on 2003-09-01

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2004-06-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2006-09-01

Annexes designated ‘normative’ are part of the body of the standard.

In this standard, Annex ZA is normative. Annex ZA has been added by CENELEC.

Endorsement notice

The text of amendment 2:2003 to the International Standard IEC 60679-1:1997 was approved by CENELEC as an amendment to the European Standard without any modification.

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1 General

1.1 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.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60679. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60679 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60027, *Letter symbols to be used in electrical technology*.

IEC 60050-561:1991, *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 60068-2-1:1990, *Environmental testing — Part 2: Tests — Tests A: Cold*.

Amendment 1 (1993)

Amendment 2 (1994)

IEC 60068-2-2:1974, *Environmental testing — Part 2: Tests — Tests B: Dry heat*.

Amendment 1 (1993)

Amendment 2 (1994)

IEC 60068-2-3:1985, *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 and guidance: Acceleration, steady state*.

Amendment 1 (1986)

IEC 60068-2-10:1988, *Environmental testing — Part 2: Tests — Test J and guidance: Mould growth*.

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*.

Amendment 1 (1986)

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

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

Amendment 2 (1987)

IEC 60068-2-21:1983, *Environmental testing — Part 2: Tests — Test U: Robustness of terminations and integral mounting devices*.

Amendment 2 (1991)

Amendment 3 (1992)

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)*.

Amendment 1 (1985)

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

Amendment 2 (1990)

IEC 60068-2-36:1973, *Environmental testing — Part 2: Tests — Test Fdb: Random vibration wide band — Reproducibility medium.*

Amendment 1 (1983)

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

Amendment 1 (1993)

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

IEC 60068-2-58:1989, *Environmental testing — Part 2: Tests — Test Td: Solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD).*

IEC 60469-1:1987, *Pulse techniques and apparatus — Part 1: Pulse terms and definitions.*

IEC 60617, *Graphical symbols for diagrams.*

IEC 60679-4, *Quartz crystal controlled oscillators of assessed quality — Part 4: Sectional specification — Capability approval.¹⁾*

IEC 60679-5, *Quartz crystal controlled oscillators of assessed quality — Part 5: Sectional specification — Qualification approval.²⁾*

 IEC 60748-2:1997, *Semiconductor devices — Integrated circuits — Part 2: Digital integrated circuits.* 

IEC 60801-2:1991, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 2: Electrostatic discharge requirements.*

IEC QC 001001:1986, *Basic rules of the IEC Quality Assessment System for Electronic Components (IECQ).*

Amendment 2 (1994)

Amendment 3 (1995)

IEC QC 001002:1986, *Rules of procedure of the IEC Quality Assessment System for Electronic Components (IECQ).*

Amendment 2 (1994)

IEC QC 001005:1996, *Register of firms, products and services approved under the IECQ System, including ISO 9000.*

 IEC/PAS 62179, *Electrostatic discharge (ESD) sensitivity testing human body model (HBM).*

IEC/PAS 62180, *Electrostatic discharge (ESD) sensitivity testing machine model (MM).* 

ISO 31-3:1992, *Quantities and units — Part 3: Mechanics.*

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

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

ITU-T O.172, *Jitter and wander measuring equipment for digital systems which are based on the synchronous digital hierarchy (SDH).*

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

ETSI EN 300462, *Transmission and Multiplexing™; Generic requirements for synchronization networks.*

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



¹⁾ In preparation.

²⁾ In preparation.

1.3 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.

2 Terminology and general requirements

2.1 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

2.2 Definitions

For the purpose of this part of IEC 60679, the following definitions are applicable:

2.2.1

simple packaged crystal oscillator (SPXO)

a 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]

2.2.2

overtone quartz crystal controlled oscillator

an oscillator designed to operate with the controlling piezoelectric resonator functioning in a specified mechanical overtone order of vibration [IEV 561-04-02]

2.2.3

crystal cut

the 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.

2.2.4

voltage controlled crystal oscillator (VCXO)

a 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]

2.2.5

temperature compensated crystal oscillator (TCXO)

a 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]

2.2.6

oven controlled crystal oscillator (OCXO)

a 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.

2.2.7

nominal frequency

the frequency used to identify the crystal controlled oscillator [IEV 561-04-06]

2.2.8

frequency tolerance

the 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:

- 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.

2.2.9

frequency offset

the 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).

2.2.10

adjustment frequency

the 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]

2.2.11

frequency adjustment range

the 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]

2.2.12

storage temperature range

the 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

2.2.13**operating temperature range**

the range of temperature over which the oscillator will function, maintaining frequency and other output signal characteristics within specified tolerances [IEV 561-04-11]

2.2.14**operable temperature range**

the 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]

2.2.15**reference temperature**

the temperature at which certain oscillator performance parameters are measured, normally $25\text{ °C} \pm 2\text{ °C}$

2.2.16**reference point temperature**

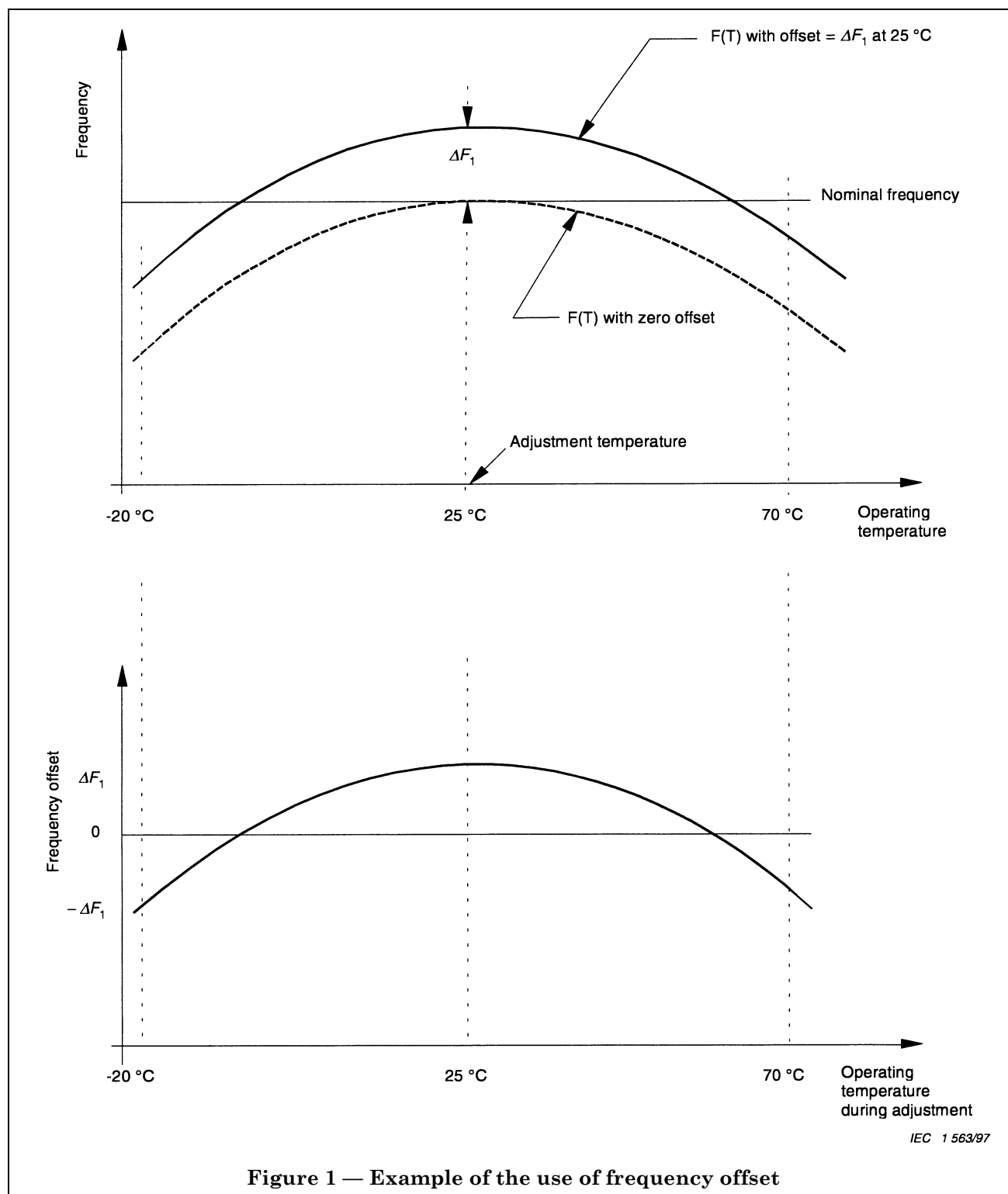
the temperature measured at a specific reference point relative to the oscillator

2.2.17**thermal transient frequency stability**

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

2.2.18**stabilization time**

the 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]



2.2.19***frequency/voltage coefficient***

the 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.

2.2.20***frequency/load coefficient***

the fractional change in output frequency resulting from an incremental change in electrical load impedance, other parameters remaining unchanged [IEV 561-04-15]

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

the 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

2.2.22***short-term frequency stability***

the random fluctuations of the frequency of an oscillator over short periods of time [IEV 561-04-16]

2.2.23***Allan variance of fractional frequency fluctuation***

an 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 measurement is averaged;

M is the number of measurements.

The confidence on the estimate improves as M increases

2.2.24***RMS fractional frequency fluctuation***

a 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:

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

2.2.25***phase noise***

the frequency-domain measure of the short-term frequency stability of an oscillator, 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:

$$S_{\varphi}(f) = \left(\frac{F_0}{f}\right)^2 S_y(f) \text{ radian}^2 \text{ per hertz}$$

where

F is the oscillator frequency;

F_0 is the average oscillator frequency;

f is the Fourier frequency.

2.2.26***spectral purity***

the 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

2.2.27***incidental frequency modulation***

the optional measure of frequency stability in the frequency domain. 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} r.m.s. in a 10 kHz band)

2.2.28***amplitude modulation distortion***

the 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

2.2.29***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 ± 5 %. Curve D is the actual characteristic compared with the ideal (curve A) and the limits (curves B and C).

2.2.30***harmonic distortion***

the 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

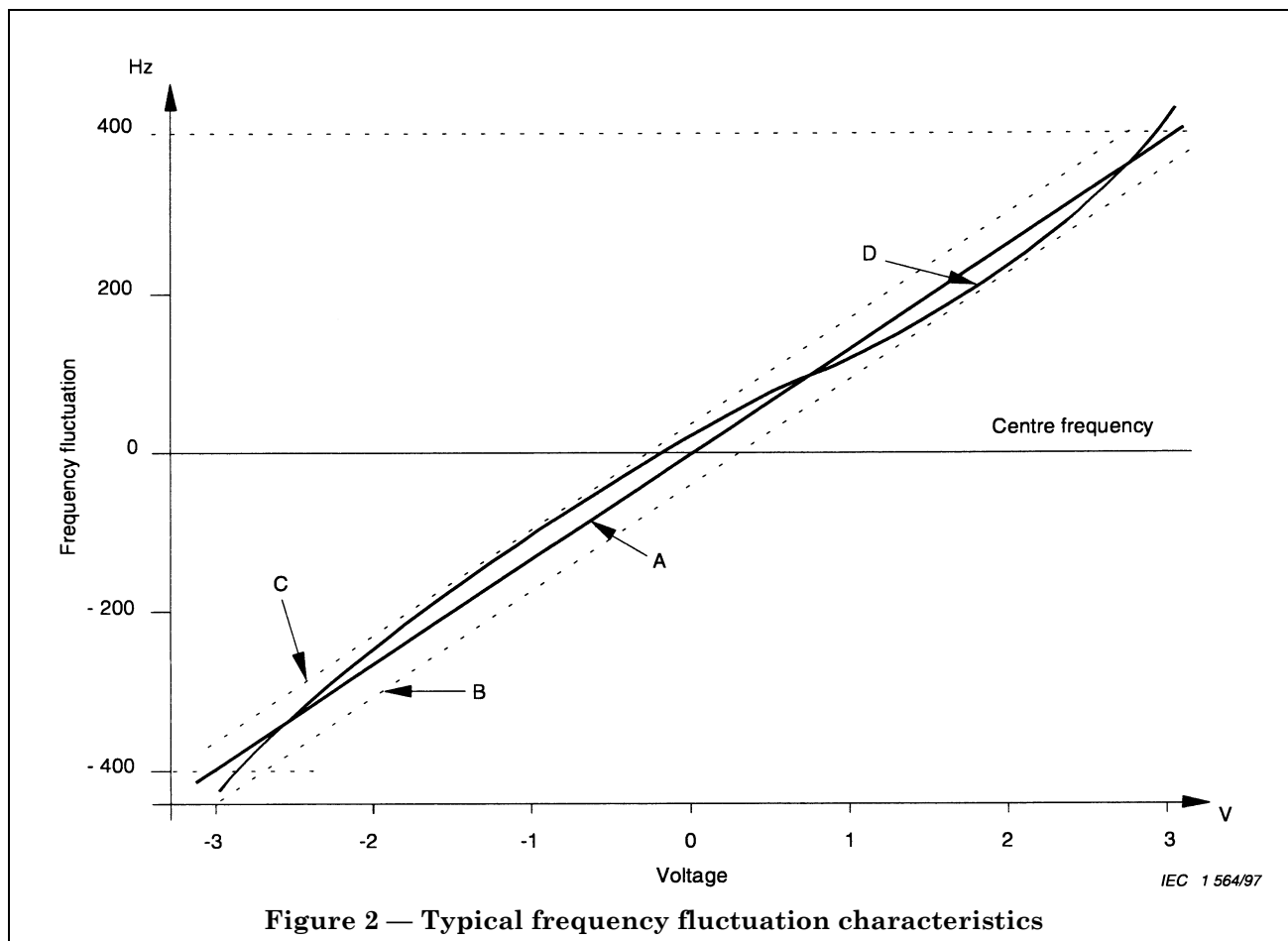


Figure 2 — Typical frequency fluctuation characteristics

2.2.31

spurious oscillations

the 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

2.2.32

pulse duration

the duration between pulse start time and pulse stop time (see Figure 3) [IEC 60469-1]

2.2.33

rise time

the 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.

2.2.34

decay (or fall) time

the 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)

2.2.35

tri-state output

an 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

2.2.36

symmetry (mark/space ratio or duty cycle)

the 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)

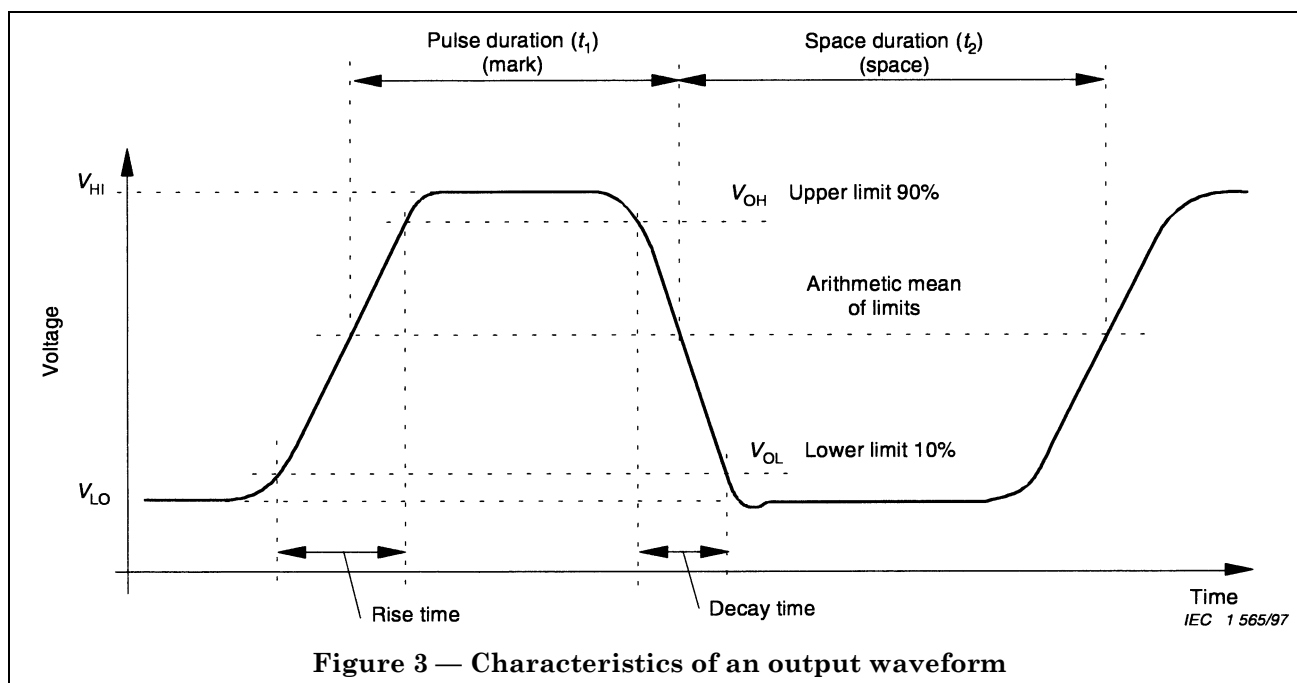
The ratio is expressed as:

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

2.2.37

retrace characteristics

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



2.2.38

start-up time

the 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 15).

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.

A₂

2.2.39

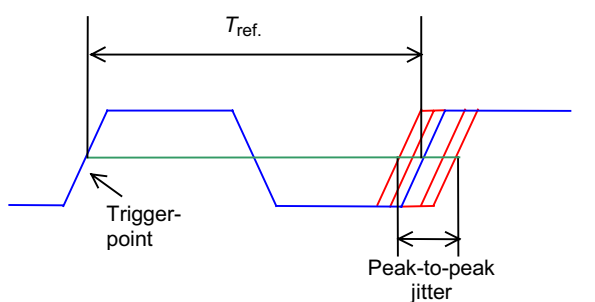
phase jitter

phase jitter is the short-term variation of the zero crossings of the oscillator output signal from their ideal position in time. Phase jitter is defined as phase variation $\Delta\varphi$ 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).

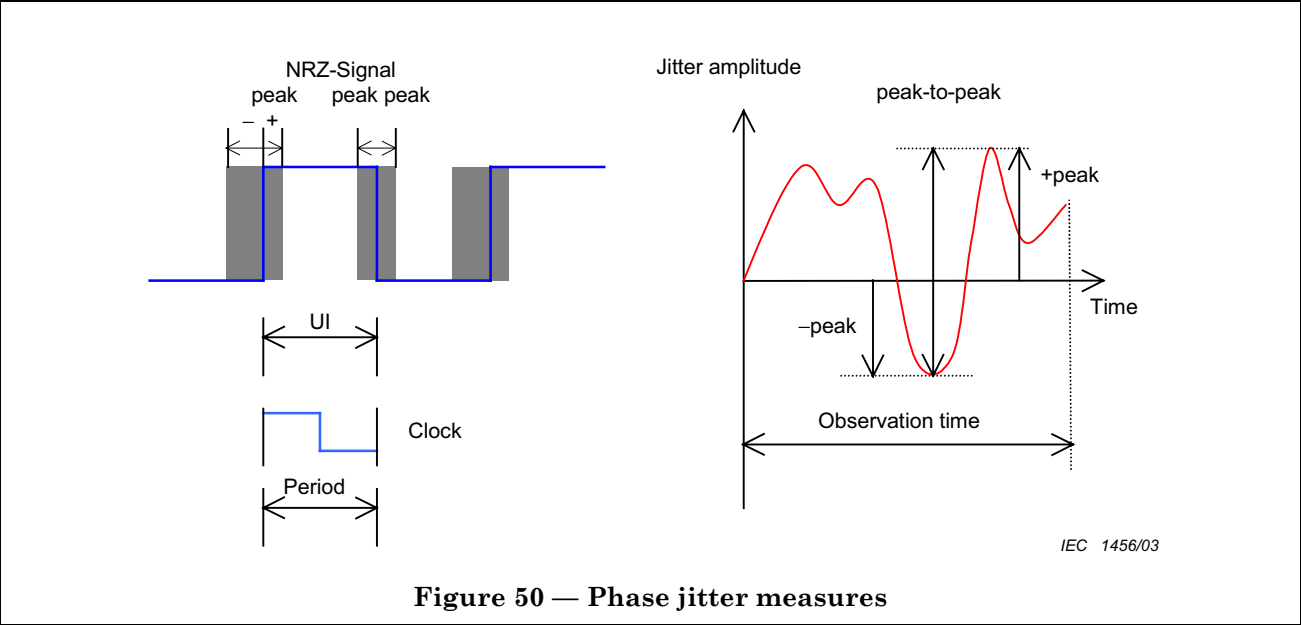
**Key**

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

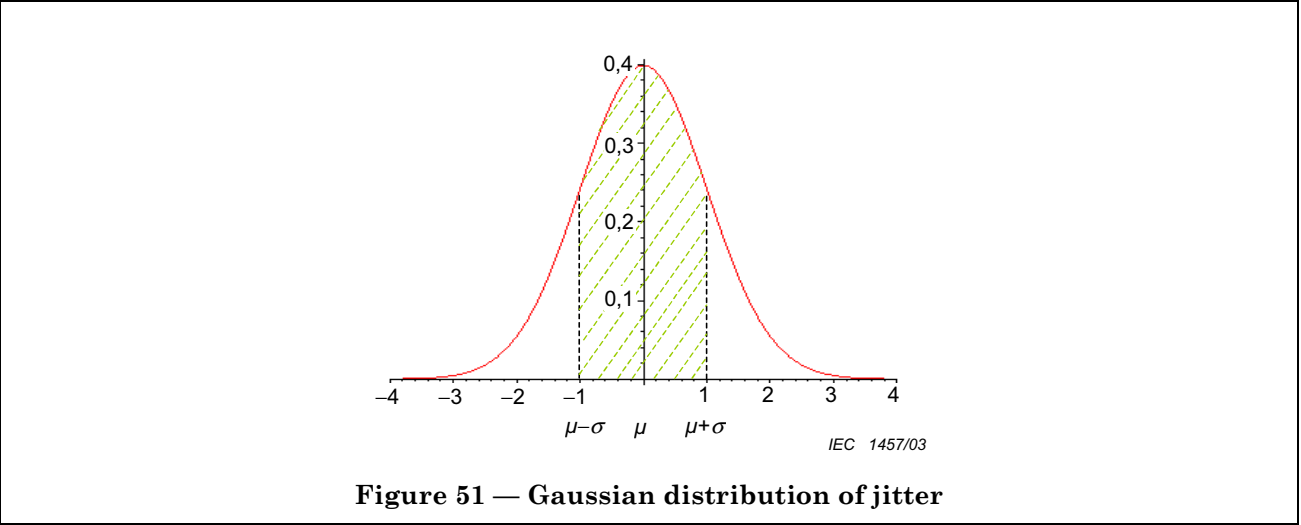
Figure 49 — Clock signal with phase jitter

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. **A₂**

A2



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).



A2

A2

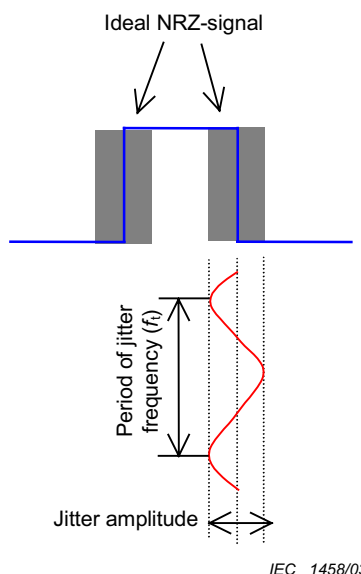
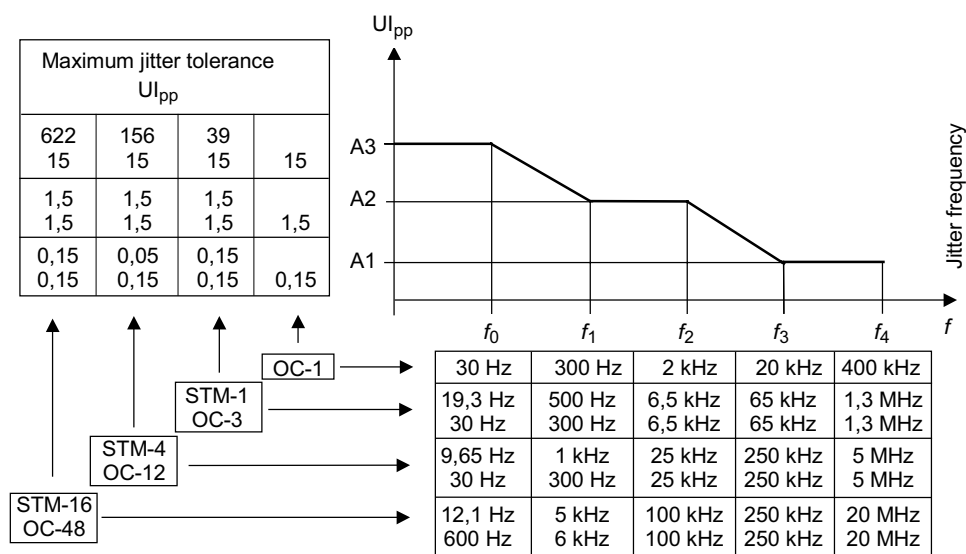


Figure 52 — Jitter amplitude and period of jitter frequency

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 is sensitive to incidents. The recommended observation time for peak-to-peak jitter is 1 min.

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).



IEC 1459/03

Figure 53 — Jitter tolerance according to ITU-T G.825, ANSI T1.105.03, Telcordia GR-253 and ETSI EN 300462

A2

A2 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 characterizes frequency offsets. MTIE(τ) is defined as the largest peak-to-peak TIE in any observation interval of length τ (in seconds).

TDEV characterizes the spectral content. TDEV(τ) is defined as the r.m.s. of filtered TIE, where the bandpass filter is centred 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.

A2

2.3 Preferred values for ratings and characteristics

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

2.3.1 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.

2.3.2 Bump severity

(4 000 $\pm$ 10) bumps at 400 m/s² peak acceleration in each direction along three mutually perpendicular axes (see 4.6.6). Pulse duration: 6 ms.

2.3.3 Vibration severity

Sinusoidal 10 Hz to 55 Hz 0,75 mm displacement amplitude (peak value) 55 Hz to 500 Hz or 55 Hz to 2 000 Hz 100 m/s ² acceleration amplitude (peak value)	30 min in each of three mutually perpendicular axes at 1 octave/min (see 4.6.7)
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) Random	30 min in each of three mutually perpendicular axes at 1 octave/min (see 4.6.7)
(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 4.6.7)

2.3.4 Shock severity

1 000 m/s² peak acceleration for 6 ms duration; three shocks in each direction along three mutually perpendicular axes (see 4.6.8), half-sine pulse, unless otherwise stated in the detail specification.

2.3.5 Leak rate

10⁻¹ Pa cm³/s (10⁻⁶ bar cm³/s)

10⁻³ Pa cm³/s (10⁻⁸ bar cm³/s)

2.4 Marking

2.4.1 The quartz crystal controlled oscillator shall be clearly and durably marked (see 4.6.21) 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.

2.4.2 The primary packaging containing the quartz crystal controlled oscillator(s) shall be clearly marked with the information listed in 2.4.1 except item g) and electrostatic sensitive device (ESD) identification, where necessary.

3 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.

3.1 Primary stage of manufacture

The primary stage of manufacture for a quartz crystal controlled oscillator in accordance with 11.1.1 of IEC QC 001002 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.

3.2 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.

3.3 Subcontracting

These procedures shall be in accordance with **11.1.2** of IEC QC 001002.

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.

3.4 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 programme maintaining a record of results;
- sufficient goods inward inspection procedures to ensure continued satisfactory performance of the final product.

3.5 Manufacturer's approval

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

3.6 Approval procedures

3.6.1 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 IEC QC 001001 and IEC QC 001002.

3.6.2 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 and the component may be listed in IEC QC 001005.

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 **11.7.4.2** of IEC QC 001002.

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 **3.7** and in the sectional specification IEC 60679-4.

3.6.3 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 programme 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 **3.8** and the sectional specification IEC 60679-5.

3.7 Procedures for capability approval

3.7.1 General

The procedures for capability approval shall be in accordance with IEC QC 001002.

3.7.2 Eligibility for capability approval

The manufacturer shall comply with the requirements of 11.1 of IEC QC 001002 and the primary stage of manufacture as defined in 3.1 of this generic specification.

3.7.3 Application for capability approval

In order to obtain capability approval the manufacturer shall apply the rules of procedure given in 11.7 of IEC QC 001002.

3.7.4 Granting of capability approval

Capability approval shall be granted when the procedures in accordance with 11.7 of IEC QC 001002 have been successfully completed.

3.7.5 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.

3.8 Procedures for qualification approval

3.8.1 General

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

3.8.2 Eligibility for qualification approval

The manufacturer shall comply with the requirements of 11.1 of IEC QC 001002 and the primary stage of manufacture as defined in 3.1 of this generic specification.

3.8.3 Application for qualification approval

In order to obtain qualification approval the manufacturer shall apply the procedures given in 11.2 of IEC QC 001002.

3.8.4 Granting of qualification approval

Qualification approval shall be granted when the procedures in accordance with 11.3 of IEC QC 001002 have been successfully completed.

3.8.5 Quality conformance inspection

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

3.9 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.

3.10 Screening requirements

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

3.11 Rework and repair work

3.11.1 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.

3.11.2 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.

3.12 Certified test records

The requirements of clause 14 of IEC QC 001002 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.

3.13 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 4.5.4 and 4.5.17, with a sample tested as described in 4.6.3.1, prior to release.

3.14 Release for delivery

Quartz crystal controlled oscillators shall be released in accordance with 12.5 of IEC QC 001002.

3.15 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.

4 Test and measurement procedures

4.1 General

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

4.2 Test and measurement conditions

4.2.1 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	45 % to 75 %
Air pressure	86 kPa to 106 kPa (860 mbar to 1 060 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 1 060 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.