SLOVENSKI STANDARD
oSIST prEN IEC 60679-2:2025
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Piezoelektrični, dielektrični in elektrostatični oscilatorji ocenjene kakovosti - 2. del: Smernice za uporabo oscilatorjev

Piezoelectric, dielectric and electrostatic oscillators of assessed quality - Part 2: Guidelines for the use of oscillators

Oscillateurs piézoélectriques, diélectriques et électrostatiques sous assurance de la qualité - Partie 2: Lignes directrices pour l’utilisation des oscillateurs

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IEC TC 49 : PIEZOELECTRIC, DIELECTRIC AND ELECTROSTATIC DEVICES AND ASSOCIATED MATERIALS FOR FREQUENCY CONTROL, SELECTION AND DETECTION	
SECRETARIAT: Japan	SECRETARY: Mr Masanobu Okazaki
OF INTEREST TO THE FOLLOWING COMMITTEES:	HORIZONTAL FUNCTION(S):
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TITLE:

Piezoelectric, dielectric and electrostatic oscillators of assessed quality - Part 2: Guidelines for the use of oscillators

PROPOSED STABILITY DATE: 2028

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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PIEZOELECTRIC, DIELECTRIC AND ELECTROSTATIC OSCILLATORS OF ASSESSED QUALITY

Part 2: Guidelines for the use of oscillators

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IEC 60679-2 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 cancels and replaces the first edition published in 1981. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Some new contents that reflect the latest manufacturing technologies;

b) Added contents about the operating principle of crystal oscillators;

c) Added contents about usage precautions for crystal oscillators.

The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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.

INTRODUCTION

Crystal controlled oscillators are commonly used to provide the stable frequencies required for telecommunications, navigations and data processing systems. Depending upon the frequency of operation, ambient conditions and specific oscillator design, crystal oscillators are capable of providing frequency stability varying from 1×10^{-4} to 1×10^{-10}.

This guideline describes the general properties, performance characteristics and usage precautions for crystal oscillators.

PIEZOELECTRIC, DIELECTRIC AND ELECTROSTATIC OSCILLATORS OF ASSESSED QUALITY

Part 2: Guidelines for the use of oscillators

1 Scope

This part of IEC 60679 describes the general properties, performance characteristics and usage precautions for quartz crystal oscillators. This content mainly describes crystal oscillators, but some descriptions also apply to oscillators other than crystal units (e.g. MEMS resonators).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 – Part 561 Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection. Available at www.electropedia.org

IEC60068 Environmental testing.

IEC 60679-1, Piezoelectric, dielectric, and electrostatic oscillators of assessed quality – Part 1: Generic specification

IEC 62884-1, Measurement technologies of piezoelectric, dielectric and electrostatic oscillators – Part 1: Basic methods for the measurement

IEC 62884-2, Measurement technologies of piezoelectric, dielectric and electrostatic oscillators – Part 2: Phase jitter measurement method

IEC 62884-3, Measurement technologies of piezoelectric, dielectric and electrostatic oscillators – Part 3: Frequency Aging test methods

IEC 62884-4, Measurement technologies of piezoelectric, dielectric and electrostatic oscillators – Part 4: Short-term frequency stability test methods

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60679-1 and the following apply.

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

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

4 Oscillating principle of crystal oscillators

The operating principle of crystal oscillators is easier to understand when compared with that of a pendulum. To maintain the swing of a pendulum, the position and time point of maximum amplitude of the pendulum should be detected, and the operation of pushing the pendulum back should be repeated so that the time point and position are maintained. The pendulum corresponds to a crystal unit which comprises an amplifier with a feedback circuit that provides the detection and push-back force (See Figure 1).

A typical feedback amplifier (Colpitts circuit) is shown in Figure 2, where the signals at both terminals of the crystal unit are divided at capacitors C_A, C_B , one connected to the input side and the other to the output side. It can be considered that the "detection" in the case of the pendulum is on the input side of the feedback amplifier and the "push-back force" is given on the output side. Here, R_A and R_B are bleeder resistance to provide a fixed bias to the base terminal of the oscillation transistor, R_E is negative feedback resistance connected to the emitter and R_C is load resistance connected to the collector.

Next, in the state of oscillation, as shown in Figure 3, the oscillator circuit side which is viewed from the crystal unit terminals can be represented by a series circuit of equivalent input capacitance C_i and equivalent input resistance R_i . In this case, the crystal unit side is equivalently an inductive effective inductance L_e and an effective resistance R_e and the crystal oscillation conditions are as follows:

Frequency condition ...... $\omega L_e - \frac{1}{\omega C_i} = 0$

Amplitude condition ...... $R_e \le |R_i|$, (R_i : negative resistance)

The frequency condition determines the oscillation frequency. For the amplitude condition, equivalent input resistance on the circuit side shall be negative value in the vicinity of the oscillation frequency and at the small signal on the start-up, then this is called negative resistance. This negative resistance can be obtained with active circuits such as transistors and operational amplifiers. The absolute value of the negative resistance $|R_i|$ shall be designed to be sufficiently larger than R_e in order to ensure oscillation at the start-up of the oscillator, meaning that $R_e = |R_i|$ in the steady-state following the end of the start-up and the oscillation becomes the steady-state amplitude.

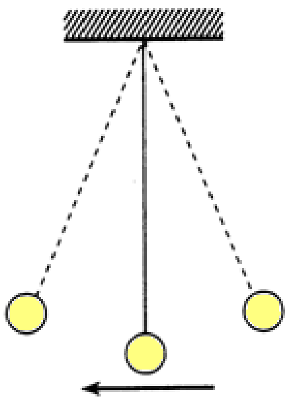

Figure 1 – Swinging pendulum motion

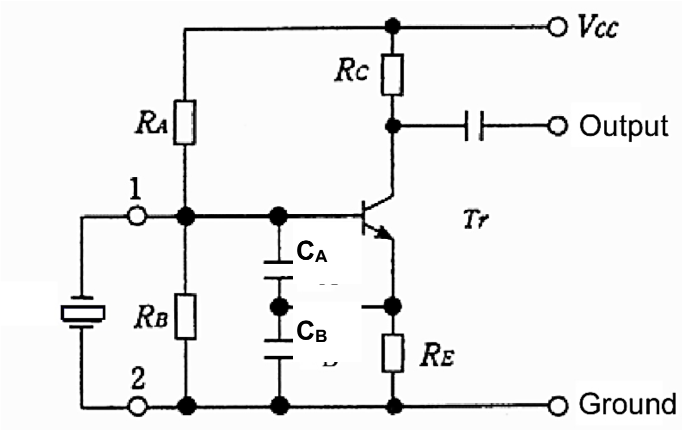

Figure 2 – Colpitts oscillator circuit

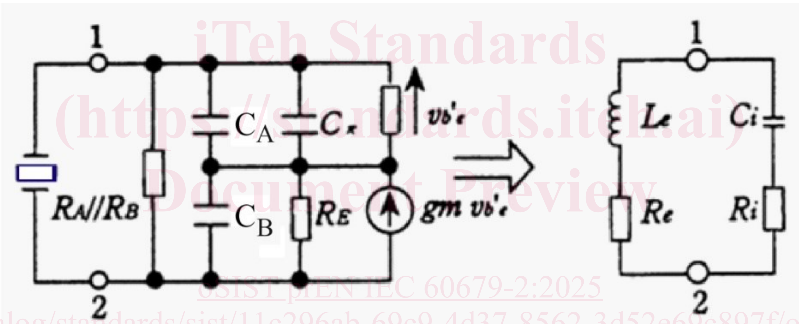

Figure 3 – Equivalent circuit of a Colpitts oscillation circuit

The circuit side capacitance C_i is called the load capacitance (C_L) with respect to the unit and is an important parameter that determines the frequency change amount from the series resonance frequency, variable sensitivity and frequency stability, etc. The relational equation is as follows:

Fractional load resonance frequency offset (D_L) $= \frac{1}{2r\left(1+\frac{C_L}{C_0}\right)}$

Pulling sensitivity (S) $= \frac{-1}{2rC_0\left(1+\frac{C_L}{C_0}\right)^2}$

Where

C_0 : Shunt capacitance of the crystal unit,

C_1 : Motional capacitance of the crystal unit,