Measurement of quartz crystal unit parameters -- Part 6: Measurement of drive level dependence (DLD)

EESTI STANDARDIKESKUS EVS
ESTONIAN CENTRE FOR STANDARDISATION

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Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

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Mesure des paramètres des résonateurs à quartz - Partie 6: Mesure de la dépendance du niveau d'excitation (DNE)
(CEI 60444-6:2013)

Messung von Schwingquarz-Parametern - Teil 6: Messung der Belastungsabhängigkeit (DLD)
(IEC 60444-6:2013)

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Foreword

The text of document 49/1004/CDV, future edition 2 of IEC 60444-6, prepared by IEC/TC 49, "Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60444-6:2013.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-04-24
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This document supersedes EN 60444-6:1997.

EN 60444-6:2013 includes the following significant technical changes with respect to EN 60444-6:1997:

a) DLD measurement with oscillation circuit had the traditional method to detect the DLD abnormal modes at present time. Therefore, this method made the transition to the Annex B.

b) High reliability crystal unit is needed to use for various applications at the present day, in order to upgrade the inspection capabilities for DLD abnormal modes, the multi-level reference measurement method was introduced into this specification.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60444-6:2013 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)
Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60444-1	-	Measurement of quartz crystal unit parameters by zero phase technique in a pi-network - Part 1: Basic method for the measurement of resonance frequency and resonance resistance of quartz crystal units by zero phase technique in a pi-network	EN 60444-1	-
IEC 60444-5	-	Measurement of quartz crystal unit parameters - Part 5: Methods for the determination of equivalent electrical parameters using automatic network analyzer techniques and error correction	EN 60444-5	-
IEC 60444-8	-	Measurement of quartz crystal unit parameters - Part 8: Test fixture for surface mounted quartz crystal units	EN 60444-8	-

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INTRODUCTION

The drive level (expressed as power/voltage across or current through the crystal unit) forces the resonator to produce mechanical oscillations by way of piezoelectric effect. In this process, the acceleration work is converted to kinetic and elastic energy and the power loss to heat. The latter conversion is due to the inner and outer friction of the quartz resonator.

The frictional losses depend on the velocity of the vibrating masses and increase when the oscillation is no longer linear or when critical velocities, elongations or strains, excursions or accelerations are attained in the quartz resonator or at its surfaces and mounting points (see Annex A). This causes changes in resistance and frequency, as well as further changes due to the temperature dependence of these parameters.

At "high" drive levels (e.g. above 1 mW or 1 mA for AT-cut crystal units) changes are observed by all crystal units and these also can result in irreversible amplitude and frequency changes. Any further increase of the drive level may destroy the resonator.

Apart from this effect, changes in frequency and resistance are observed at "low" drive levels in some crystal units, e.g. below 1 mW or 50 μA for AT-cut crystal units). In this case, if the loop gain is not sufficient, the start-up of the oscillation is difficult. In crystal filters, the transducer attenuation and ripple will change.

Furthermore, the coupling between a specified mode of vibration and other modes (e.g. of the resonator itself, the mounting and the back-fill gas) also depends on the level of drive.

Due to the differing temperature response of these modes, these couplings give rise to changes of frequency and resistance of the specified mode within narrow temperature ranges. These changes increase with increasing drive level. However, this effect will not be considered further in this part of IEC 60444.

The first edition of IEC 60444-6 was published in 1995. However, it has not been revised until today. In the meantime the demand for tighter specification and measurement of DLD has increased.

In this new edition, the concept of DLD in IEC 60444-6:1995 is maintained. However, the more suitable definition for the user's severe requirements was introduced. Also, the specifications based on the matters arranged in the Stanford meeting in June, 2011 are taken into consideration.

MEASUREMENT OF QUARTZ CRYSTAL UNIT PARAMETERS –

Part 6: Measurement of drive level dependence (DLD)

1 Scope

This part of IEC 60444 applies to the measurements of drive level dependence (DLD) of quartz crystal units. Two test methods (A and C) and one referential method (B) are described. “Method A”, based on the π-network according to IEC 60444-1, can be used in the complete frequency range covered by this part of IEC 60444. “Reference Method B”, based on the π-network or reflection method according to IEC 60444-1, IEC 60444-5 or IEC 60444-8 can be used in the complete frequency range covered by this part of IEC 60444. “Method C”, an oscillator method, is suitable for measurements of fundamental mode crystal units in larger quantities with fixed conditions.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60444-1, *Measurement of quartz crystal unit parameters by zero phase technique in a π-network – Part 1: Basic method for the measurement of resonance frequency and resonance resistance of quartz crystal units by zero phase technique in a π-network*

IEC 60444-5, *Measurement of quartz crystal units parameters – Part 5: Methods for the determination of equivalent electrical parameters using automatic network analyzer techniques and error correction*

IEC 60444-8, *Measurement of quartz crystal unit parameters – Part 8: Test fixture for surface mounted quartz crystal units*

3 DLD effects

3.1 Reversible changes in frequency and resistance

Reversible changes are changes in frequency and resistance occurring under the same drive levels after repeated measurements made alternatively at low and high levels, or after continuous or quasi-continuous measurements from the lowest to the highest level and back, if these changes remain within the limits of the measurement accuracy.

3.2 Irreversible changes in frequency and resistance

Irreversible changes are significant changes in frequency and/or resistance occurring at low level after an intermediate measurement at high level e.g. when a previously high resistance at low level has changed in the repeated measurement to a low resistance. Especially, when the crystal unit has not been operated for several days, its resistance may have changed back to a high value when operated again at a lower level. Greater attention should be paid to the irreversible effect since it can significantly impair the performance of devices, which are operated only sporadically.