

# INTERNATIONAL STANDARD

**IEC**  
**60444-8**

First edition  
2003-07

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## Measurement of quartz crystal unit parameters –

### Part 8: Test fixture for surface mounted quartz crystal units

*Mesure des paramètres des résonateurs à quartz –*

*Partie 8:  
Dispositif d'essai pour les résonateurs à quartz  
montés en surface*



Reference number  
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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MEASUREMENT OF QUARTZ CRYSTAL UNIT PARAMETERS –****Part 8: Test fixture for surface mounted quartz crystal units**

## FOREWORD

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International Standard IEC 60444-8 has been prepared by IEC technical committee 49: Piezoelectric and dielectric devices for frequency control and selection.

This International Standard cancels and replaces IEC/PAS 62277 published in 2001, of which it constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
49/599/FDIS	49/611/RVD

Full information on the voting for the approval of this standard 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.

This standard forms Part 8 of a series of publications dealing with measurements of quartz crystal unit parameters.

IEC 60444 consists of the following parts under the general title *Measurement of quartz crystal unit parameters*:

- 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
- Part 2: Phase offset method for measurement of motional capacitance of quartz crystal units
- Part 4: Method for the measurement of the load resonance frequency  $f_L$ , load resonance resistance,  $R_L$  and the calculation of other derived values of quartz crystal units, up to 30 MHz
- Part 5: Methods for the determination of equivalent electrical parameters using automatic network analyzer techniques and error correction
- Part 6: Measurement of drive level dependence (DLD)
- Part 7: Measurement of activity and frequency dips of quartz crystal units<sup>1</sup>

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

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<sup>1</sup> Under consideration.

## INTRODUCTION

This document is only for the test fixture applied to leadless surface mounted quartz crystal units. The document is the specification for the test fixture [1]<sup>2</sup> that allows the accurate measurement of resonance frequency, resonance resistance, and equivalent electrical circuit parameters of leadless surface mounted quartz crystal units. The measurement method using an automatic network analyzer is based on IEC 60444-5.

The measuring frequency range is from 1 MHz to 150 MHz when the load capacitance is not used, and is from 1 MHz to 30 MHz when the load capacitance is used. The use of the test fixture with the measurement method yields measurement accuracy of about  $10^{-6}$  over of the frequency range, and the accuracy of the resonance resistance is  $\pm 2 \Omega$  or  $\pm 10 \%$ .

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<sup>2</sup> Numbers in square brackets refer to the bibliography.

## MEASUREMENT OF QUARTZ CRYSTAL UNIT PARAMETERS –

### Part 8: Test fixture for surface mounted quartz crystal units

#### 1 Scope

This part of IEC 60444 explains the test fixture that allows the accurate measurement of resonance frequency, resonance resistance, and equivalent electrical circuit parameters of a leadless surface mounted quartz crystal units using zero phase technique as specified in IEC 60444-4 and IEC 60444-5.

An equivalent circuit constant and the application frequency range obtained by using the test fixture are then shown.

In addition, this is applied to the enclosure shown in IEC 61240 as a crystal unit without lead wires. An equivalent circuit of the test fixture and an electric values are based on IEC 60444-1 and IEC 60444-4. The range of load capacitance is 10 pF or more. Calibration of the measurement system and  $C_L$  adapter board is explained hereafter.

This document applies to the test fixture that allows the accurate measurement of resonance frequency, resonance resistance, parallel capacitance  $C_0$ , motional capacitance  $C_1$ , and motional inductance  $L_1$  of the crystal unit over the frequency range from 1 MHz to 150 MHz using an automatic network analyzer, based on IEC 60444-5.

#### 2 Normative references

The following referenced documents are indispensable for the application 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 60444-1:1986, *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*

IEC 60444-2:1980, *Measurement of quartz crystal unit parameters by zero phase technique in a pi-network. Part 2: Phase offset method for measurement of motional capacitance of quartz crystal units*

IEC 60444-5:1995, *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 61240:1994, *Piezoelectric devices – Preparation of outline drawings of surface-mounted devices (SMD) for frequency control and selection – General rules*

#### 3 General issue

The test fixture and the method for measuring the resonance frequency, resonance resistance, and equivalent electrical circuit parameters must be specified in the contract between the crystal unit supplier and the user. The crystal unit requires special consideration as it has no lead wires.

## 4 Leadless surface mounted quartz crystal units

### 4.1 Enclosure

No particular specification shall be made regarding the enclosure type. However, it is recommended that enclosures such as those shown in IEC 61240, be used.

### 4.2 Overtone and frequency range

No particular specification shall be made regarding the overtone, because the measurement is made using the zero phase technique. The frequency range is from 1 MHz to 150 MHz when the load capacitance is not used, and is from 1 MHz to 30 MHz when the load capacitance is used.

## 5 Specifications of measurement method, test fixture

### 5.1 Specifications of measurement method

The measurement method is according to IEC 60444-5. The method uses the admittance circle technique.

### 5.2 Specifications of test fixture

An equivalent circuit of the test fixture and an electric values are based on IEC 60444-1. The size and the structure are different in this document from those of IEC 60444-1. The size and the structure suit leadless crystal units.

The test fixture configuration is as specified in IEC 60444-1. Figure 1 and Figure 2 show the test fixture, but stray capacitances between measurement terminals such as  $C_{t1}$  and  $C_{t2}$  in Figure 2 of IEC 60444-1 are not specified. Figure 3 and Figure 4 show 3-D and design of the test fixture.

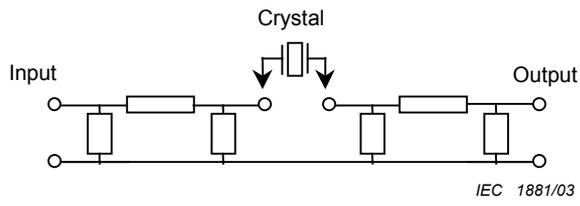
No specifications shall be made as to the structures of the test fixture to be used, except that they must secure the mechanical contact of the electrode performing the same function as the lead wire of an ordinary quartz crystal unit and the measurement terminals of the test fixture.

Figure 4 shows the structure of the test fixture that ensures the connection of its contact to the electrodes of the crystal unit, thereby providing high measurement accuracy and facilitating measurement.

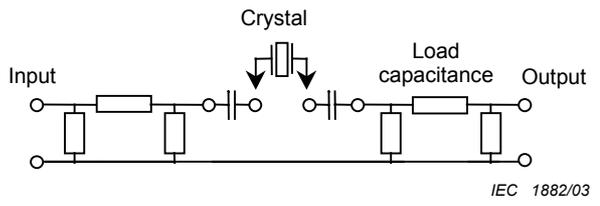
The measurement terminal of the test fixture should form a reliable contact with the electrode of the crystal unit in order to avoid measurement errors.

Due to this, 1,96 N (200 gf) is the minimum necessary pressure of the measurement terminal of the test fixture for an electrode of the crystal unit.

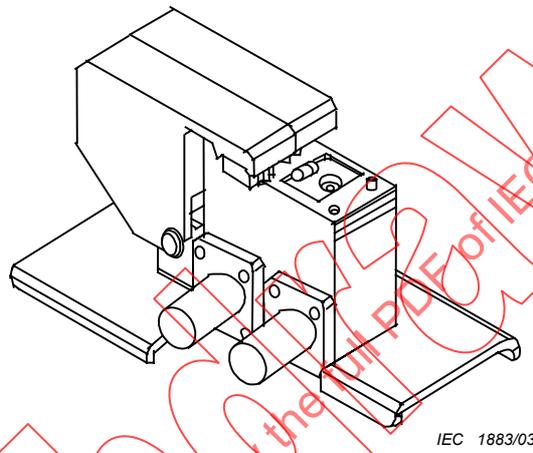
NOTE If the crystal is grounded in the application, the working frequency may depend on the orientation of the crystal in the circuit. It is therefore recommended to make use of the orientation mark on the crystal (for example pad 1) when correlating the working frequency in the oscillator with the load resonance measurement according to IEC 60444-1 and IEC 60444-5.



**Figure 1 – Equivalent circuit of the test fixture**

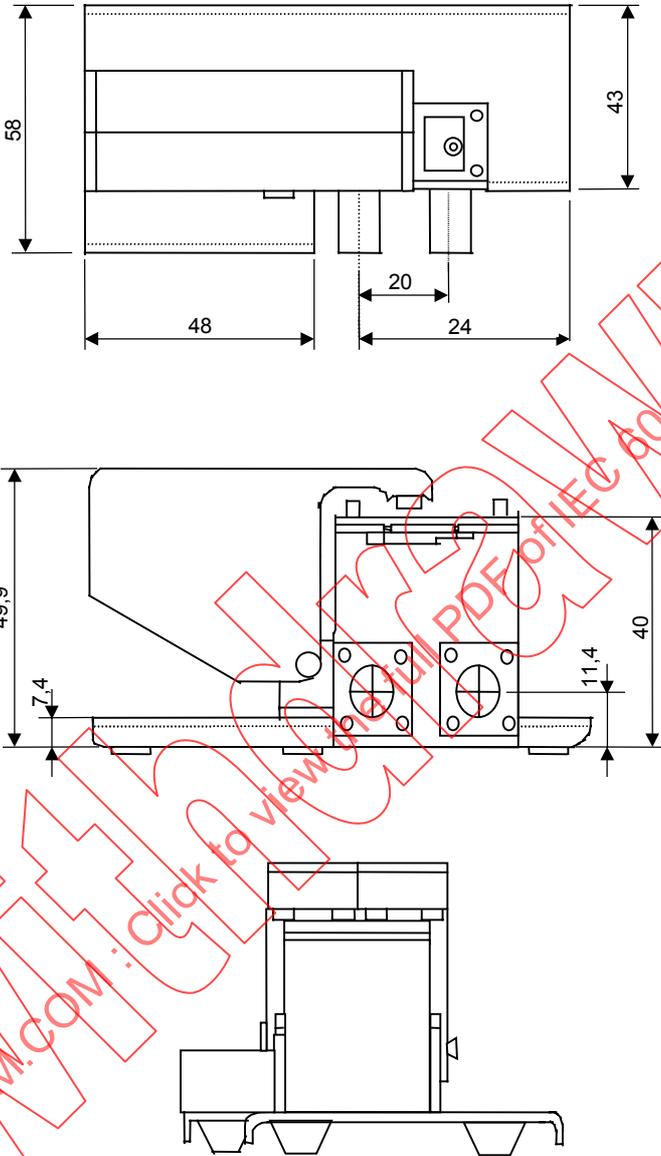


**Figure 2 – Equivalent circuit of the test fixture with load capacitance**



**Figure 3 – Three-dimensional projection for the test fixture**

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*Dimensions in millimetres*

**Figure 4 – Design of the test fixture**

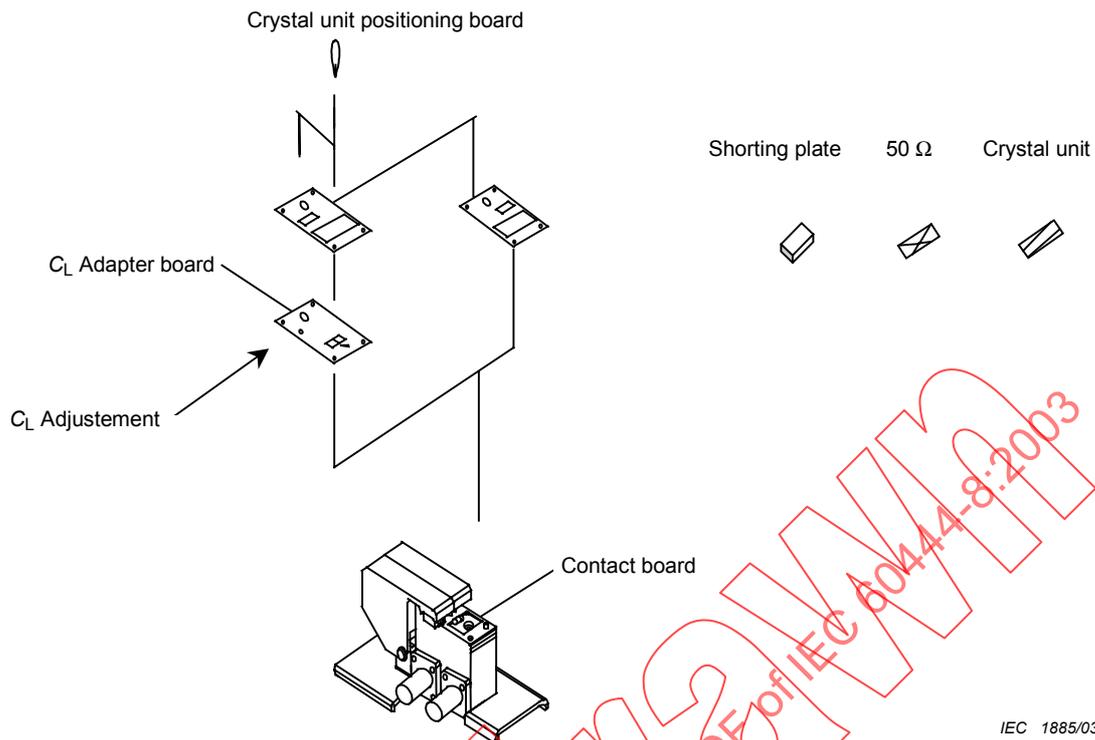


Figure 5 – Structure of the test fixture

## 6 Calibration of measurement system and $C_L$ adapter board

### 6.1 Calibration of measurement system

For the test fixture with the measurement system, the imaginary part of impedance can be omitted within the frequency range utilized by the user. Therefore, the user must utilize at least 3 reliable standard impedance elements for calibration. There are short element, open element and  $50 \Omega$  standard resistance. If there is significant stray capacitance between the measurement terminals of the measuring instrument, open calibration is necessary.

The specification of  $50 \Omega$  standard resistance is prescribed in the range from 1 MHz to 150 MHz, and the resistance value is  $50 \pm 5 \%$  and the phase is  $0,2^\circ$  maximum.

### 6.2 Calibration of $C_L$ adapter board

A capacitance meter is used for the calibration of  $C_L$  adapter board. The permissible value is  $\pm 0,002$  pF.

## Bibliography

- [1] M. Koyama, Y. Watanabe, Y. Oomura, *Results of the quartz crystal measurement data obtained at the leadless resonator measurement workshop held in Japan*, in Proceedings of the 47<sup>th</sup> Annual Symposium on Frequency Control, May 1993, pp. 614-619.
- [2] IEC 60444-4:1988, *Measurement of quartz crystal unit parameters by zero phase technique in a pi-network – Part 4: Method for the measurement of the load resonance frequency  $f_L$ , load resonance resistance  $R_L$  and the calculation of other derived values of quartz crystal units, up to 30 MHz*

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