

INTERNATIONAL STANDARD

Synthetic quartz crystal – Specifications and guidelines for use

Withdrawn



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2008 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

Synthetic quartz crystal – Specifications and guidelines for use

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE

X

ICS 31.140

ISBN 978-2-88910-286-0

CONTENTS

FOREWORD	5
1 Scope	7
2 Normative references	7
3 Terms and definitions	7
4 Specification for as-grown synthetic quartz crystal	11
4.1 Standard values	11
4.1.1 Orientation of the seed.....	11
4.1.2 Inclusion density	11
4.1.3 Infrared quality indications, α_{3500} , α_{3585} , α_{3410}	11
4.1.4 Frequency-versus-temperature characteristics (Figure 4 and 4.2.7).....	12
4.1.5 Etch channel density ρ	12
4.2 Requirements and measuring methods.....	13
4.2.1 Orientation.....	13
4.2.2 Handedness.....	13
4.2.3 Synthetic quartz crystal dimensions.....	13
4.2.4 Seed dimensions	13
4.2.5 Imperfections	13
4.2.6 Evaluation of infrared quality by alpha-measurement	15
4.2.7 Frequency versus temperature characteristics.....	17
4.2.8 Etch channel density.....	18
4.3 Marking.....	19
4.3.1 Shipping requirements	19
5 Specification for lumbered synthetic quartz crystal	20
5.1 Standard values.....	20
5.1.1 Tolerance of dimensions	20
5.1.2 Reference surface flatness.....	20
5.1.3 Angular tolerance of reference surface	20
5.1.4 Centrality of the seed.....	20
5.2 Requirements and measuring methods.....	20
5.2.1 As-grown quartz bars used for lumbered quartz bars	20
5.2.2 Dimensions of lumbered synthetic quartz crystal	20
5.2.3 Identification on reference surface	20
5.2.4 Measurement of reference surface flatness.....	20
5.2.5 Measurement of reference surface angle tolerance.....	20
5.2.6 Centrality of the seed.....	20
5.3 Delivery conditions.....	21
5.3.1 Marking	21
5.3.2 Packing	21
5.3.3 Making batch	21
6 Inspection rule for synthetic quartz crystal and lumbered synthetic quartz crystal.....	21
6.1 Inspection rule for as-grown synthetic quartz crystal	21
6.1.1 Inspection.....	21
6.1.2 Lot-by-lot test.....	21
6.2 Inspection rule for lumbered synthetic quartz crystal	22
6.2.1 Lot-by-lot test.....	23
7 Guidelines for the use of synthetic quartz crystal	23

7.1	General	23
7.1.1	Overview	23
7.1.2	Synthetic quartz crystal	23
7.2	Shape and size of synthetic quartz crystal	24
7.2.1	Crystal axis and face designation	24
7.2.2	Seed	24
7.2.3	Shapes and dimensions	24
7.2.4	Growth zones	24
7.3	Standard method for evaluating the quality of synthetic quartz crystal	25
7.4	Other methods for checking the quality of synthetic quartz crystal	25
7.4.1	Visual inspection	25
7.4.2	Infrared radiation absorption method	26
7.4.3	Miscellaneous	26
7.5	Alpha-grade	27
7.6	Optional grading (only as ordered), in inclusions, etch channels, Al content	27
7.6.1	Inclusions	27
7.6.2	Etch channels	27
7.6.3	Al content	27
7.6.4	Swept quartz	28
7.7	Ordering	28
Annex A (informative)	Frequently used sampling procedures	38
Annex B (informative)	Numerical example	40
Annex C (informative)	Example of reference sample selection	41
Annex D (informative)	Explanations of point callipers	42
Annex E (informative)	Infrared absorbance alpha value compensation	43
Annex F (informative)	The differences of the orthogonal axial system for quartz between IEC standard and IEEE standard	47
	Bibliography	49
	Figure 1 – Idealized sections of a synthetic quartz crystal grown on a Z-cut seed	29
	Figure 2 – Quartz crystal axis and face designation	30
	Figure 3 – Typical example of cutting wafers of AT-cut plate, minor rhombohedral-cut plate, X-cut plate, Y-cut plate and Z-cut plate	31
	Figure 4 – Frequency-temperature characteristics of the test specimen for slope	32
	Figure 5 – Quartz crystal axis and face designation	33
	Figure 6 – A synthetic quartz crystal grown on a Z-cut seed of small X-dimensions	34
	Figure 7 – An example of an early 1970s relation between the extinction coefficient of infra-red radiation and the Q-value of synthetic quartz	34
	Figure 8 – Lumbered synthetic quartz crystal outline and dimensions along X-, Y- and Z-axes	35
	Figure 9 – Angular deviation for reference surface	36
	Figure 10 – Centrality of the seed with respect to the dimension along the Z- or Z'-axis	37
	Figure D.1a – Point callipers	42
	Figure D.1b – Digital point callipers	42
	Figure E.1 – Schematic of measurement set-up	44

Figure E.2 – Graph relationship between averaged alpha and measured alpha at three wave numbers of α_{3500} , α_{3585} and α_{3410} 46

Figure F.1 – Left- and right-handed quartz crystals 48

Table 1 – Inclusion densities for the grades 11

Table 2 – Infrared quality indications for the grades 12

Table 3 – Etch channel densities for the grades 12

Table 4 – Test conditions and requirements for the lot-by-lot test for group A 22

Table 5 – Test conditions and requirements for the lot-by-lot test for group B 22

Table 6 – Test conditions and requirements for the lot-by-lot test 23

Table B.1 – Commodity bar sampling, method 1 40

Table B.2 – Commodity bar sampling 40

Table E.1 – Example of calibration data at α_{3585} 45

Table E.2 – Example of calibration data at α_{3500} 45

Table E.3 – Example of calibration data at α_{3410} 45

Withdrawing

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SYNTHETIC QUARTZ CRYSTAL –
SPECIFICATIONS AND GUIDELINES FOR USE**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60758 has been prepared by IEC technical committee 49: Piezoelectric and dielectric devices for frequency control and selection.

This fourth edition cancels and replaces the third edition, published in 2004. This edition constitutes a technical revision.

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

- preparation of AT-cut slice sample for etching is changed to make it easier;
- etch channel grade classification is changed considering request of the user;
- explanation of quartz axes difference between IEEE and IEC is added as Annex F.

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

FDIS	Report on voting
49/808/FDIS	49/814/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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

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

Withdrawn

SYNTHETIC QUARTZ CRYSTAL – SPECIFICATIONS AND GUIDELINES FOR USE

1 Scope

This International Standard applies to synthetic quartz single crystals intended for manufacturing piezoelectric elements for frequency control and selection.

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 60068-1:1988, *Environmental testing – Part 1: General and guidance*
Amendment 1: 1992

IEC 60122-1:2002, *Quartz crystal units of assessed quality – Part 1: Generic specification*

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 61994 (all parts), *Piezoelectric and dielectric devices for frequency control and selection – Glossary*

3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those given in IEC 61994, apply.

3.1

hydrothermal crystal growth

literally, crystal growth in the presence of water, elevated temperatures and pressures by a crystal growth process believed to proceed geologically within the earth's crust. The industrial synthetic quartz growth processes utilize alkaline water solutions confined within autoclaves at supercritical temperatures (330 °C to 400 °C) and pressures (700 to 2 000 atmospheres).

NOTE The autoclave is divided into two chambers: the dissolving chamber, containing raw quartz chips at the higher temperature; the growing chamber, containing cut seeds at the lower temperature (see 7.1.2)

3.2

synthetic quartz crystal

single crystal of α quartz grown by the hydrothermal method. The crystal is of either handedness and in the as-grown condition. Cultured quartz has the same meaning as synthetic quartz crystal

3.2.1

as-grown synthetic quartz crystal

single crystal quartz grown hydrothermally. As-grown refers to the state of processing and indicates a state prior to whatever treatment might occur after growth, excluding quality control operations