IEC 62047-44

Edition 1.0 2024-02

INTERNATIONAL STANDARD

Semiconductor devices – Micro-electromechanical devices –
Part 44: Test methods for dynamic performances of MEMS resonant electric-field-sensitive devices

iTeh Standards
(https://standards.iteh.ai)
Document Preview

IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/61afe7d6-a7f3-4c01-b8a6-42c9443c9257/iec-62047-44-2024

IEC 62047-44:2024-02(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2024 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 Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

iTeh Standards
(standards.iteh.ai)
Document Preview
IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/61afe7d6-a7f3-4c01-b8a6-42c9443c9257/iec-62047-44-2024

IEC 62047-44

Edition 1.0 2024-02

INTERNATIONAL STANDARD

Semiconductor devices – Micro-electromechanical devices – Part 44: Test methods for dynamic performances of MEMS resonant electric-field-sensitive devices

iTeh Standards
(https://standards.iteh.ai)
Document Preview
IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/61afe7d6-a7f3-4c01-b8a6-42c9443c9257/iec-62047-44-2024

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 31.080.99

ISBN 978-2-8322-8274-8

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 4
1 Scope 6
2 Normative references 6
3 Terms and definitions 6
4 Essential ratings and characteristics 7
4.1 Composition of MEMS resonant electric-field-sensitive devices 7
4.2 Identification and types 7
4.3 Description of application and specification 7
4.4 Recommended operating conditions 7
4.5 Additional information 8
5 Dynamic characteristics 8
5.1 Resonant frequency 8
5.2 Quality factor Q 8
5.3 Response time 8
6 Measuring methods 8
6.1 General 8
6.2 Resonant frequency 9
6.2.1 Purpose 9
6.2.2 Optical test method 9
6.2.3 Electrical test method 11
6.2.4 Data processing method 12
6.2.5 Specified conditions 12
6.3 Quality factor (Q) 12
6.3.1 Purpose 12
6.3.2 Circuit diagram 12
6.3.3 Principle of measurement 12
6.3.4 Precaution to be observed 13
6.3.5 Measurement procedure 13
6.3.6 Data processing method 13
6.3.7 Specified conditions 13
6.4 Response time 13
6.4.1 Purpose 13
6.4.2 Circuit diagram 13
6.4.3 Principle of measurement 13
6.4.4 Precaution to be observed 13
6.4.5 Measurement procedure 13
6.4.6 Data processing method 14
6.4.7 Specified conditions 14
Annex A (informative) Work principle and general description of MEMS resonant electric-field-sensitive devices 15
Annex B (informative) Sensitive structure and test of typical MEMS resonant electric-field-sensitive devices 17
B.1 Electrostatically driven MEMS resonant electric-field-sensitive devices 17
B.2 Thermally driven MEMS resonant electric-field-sensitive devices 18
B.3 Piezoelectrically driven MEMS resonant electric-field-sensitive devices 19

iTeh Standards
(https://standards.iteh.ai)
Document Preview
IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/61afe7d6-a7f3-4c01-b8a6-42c9443c9257/iec-62047-44-2024

Figure 1 – Terminals of MEMS resonant electric-field-sensitive devices 7
Figure 2 – Diagram of the MEMS resonant electric-field-sensitive device on the parallel plate system 9
Figure 3 – Test system diagram of optical test method 10
Figure 4 – Test system diagram of electrical test method 11
Figure A.1 – Example for working principle of MEMS resonant electric-field-sensitive device 16
Figure B.1 – Example for electrostatically driven MEMS resonant electric-field-sensitive device 17
Figure B.2 – Circuit diagram of electrical test system of electrostatic comb type electric-field-sensitive device 18
Figure B.3 – Example for thermally driven MEMS resonant electric-field-sensitive devices 18
Figure B.4 – Example for piezoelectrically driven MEMS resonant electric-field-sensitive devices 19

iTeh Standards
(https://standards.iteh.ai)
Document Preview
IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/61afe7d6-a7f3-4c01-b8a6-42c9443c9257/iec-62047-44-2024

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 44: Test methods for dynamic performances of MEMS resonant electric-field-sensitive devices

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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

iTeh Standards
(https://standards.iteh.ai)
Document Preview
IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/...6-42c9443c9257/iec-62047-44-2024

IEC 62047-44 has been prepared by subcommittee 47F: Micro-electromechanical systems, of IEC technical committee 47: Semiconductor devices. It is an International Standard.

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

Draft	Report on voting
47F/456/FDIS	47F/463/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.

A list of all parts in the IEC 62047 series, published under the general title *Semiconductor devices – Micro-electromechanical devices*, can be found on the IEC website.

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, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

iTeh Standards
(https://standards.iteh.ai)
Document Preview

IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/61afe7d6-a7f3-4c01-b8a6-42c9443c9257/iec-62047-44-2024

SEMICONDUCTOR DEVICES –
MICRO-ELECTROMECHANICAL DEVICES –

Part 44: Test methods for dynamic performances of MEMS resonant electric-field-sensitive devices

1 Scope

This part of IEC 62047 describes terminology, definitions and test methods that are used to evaluate and determine the dynamic performance of MEMS (Micro-Electromechanical Systems) resonant electric-field-sensitive devices. It also specifies sample requirements and test equipment for dynamic performances of MEMS resonant electric-field-sensitive devices. The statements made in this document are also applicable to MEMS resonant electric-field-sensitive devices with various driving mechanisms such as electrostatic, electrothermal, electromagnetic, piezoelectric, etc.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

iTeh Standards
(https://standards.iteh.ai)
Document Preview

For the purposes of this document, the following terms and definitions apply.

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

IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/61afe7d6-a7f3-4c01-b8a6-42c9443c9257/iec-62047-44-2024

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

3.1
MEMS electric-field-sensitive device
electric-field-sensitive device fabricated by MEMS technology, which can sense the electric field strength and convert it into electrical signal for output

Note 1 to entry: For a detailed description of the MEMS electric-field-sensitive device, see Annex A.

3.2
MEMS resonant electric-field-sensitive device
electric-field-sensitive device fabricated by MEMS technology, which senses the electric field strength by driving its sensitive structure to vibrate in the resonant state

Note 1 to entry: For a detailed description of the MEMS resonant electric-field-sensitive device, see Annex A.

3.3
standard electric field equipment
standard electric field equipment that is composed of parallel metal plate calibration system, shielding cover, high voltage source, etc., and can produce uniform electric field environment

Note 1 to entry: The high voltage source with continuous adjustable voltage is connected with the parallel metal plate calibration system. When the high voltage is loaded on the parallel metal plate calibration system, the uniform electric field can be maintained between the parallel metal plate calibration system.

Note 2 to entry: The electric-field-sensitive devices are placed in the standard electric field for dynamic performance test.

4 Essential ratings and characteristics

4.1 Composition of MEMS resonant electric-field-sensitive devices

MEMS resonant electric-field-sensitive device is generally composed of driving electrode, detecting electrode, shielding electrode, supporting substrate and so on. Some types of field sensitive devices do not have shielding electrodes, such as piezoelectric MEMS resonant electric-field-sensitive devices. More information on the work principle and the sensitive structure of typical MEMS resonant electric‑field‑sensitive devices are given in Annex A and Annex B respectively.

4.2 Identification and types

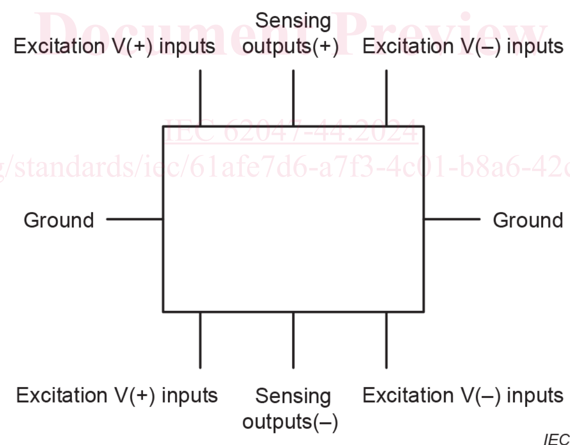
General description of the function of MEMS resonant electric-field-sensitive devices and their applications shall be stated. The statement shall include the details of manufacturing technologies about the MEMS resonant electric-field-sensitive devices with different operation, configuration, and actuation mechanism. More information on typical MEMS resonant electric‑field‑sensitive devices with different drive structures is given in Annex B.

4.3 Description of application and specification

Information on application of the MEMS resonant electric-field-sensitive devices shall be given. Block diagrams of MEMS resonant electric-field-sensitive devices and the applied systems should be also given. All terminals should be identified in the block diagram and their functions shall also be stated.

iTeh Standards (https://standards.iteh.ai) Document Preview

Figure 1 is an example of MEMS resonant electric-field-sensitive device.



IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/61afe7d6-a7f3-4c01-b8a6-42c9443c9257/iec-62047-44-2024

Figure 1 – Terminals of MEMS resonant electric-field-sensitive devices

4.4 Recommended operating conditions

The following items should be described in the specification, unless otherwise stated in the relevant procurement specifications. These conditions are recommended in order to keep the characteristics of the MEMS resonant electric-field-sensitive devices stable state during operation:

- power supply voltage;
- input voltage;
- operating temperature.

4.5 Additional information

Some additional information shall be given such as equivalent input and output circuits (e.g., Input/output impedance, DC block capacitors, etc.), internal protection circuits against high static voltages or electric fields, handling precautions, and application data/information, etc.

5 Dynamic characteristics

5.1 Resonant frequency

The resonant frequency is the corresponding excitation frequency when the working condition is resonance state. When in resonance, the amplitude gain of the vibration system reaches the maximum value.

5.2 Quality factor Q

Q value is the main parameter to measure the device in the sensitive period of electric field. It reflects the magnitude of damping ratio and the degree of energy consumption. The higher Q value is, the smaller the loss is, the higher the efficiency is, the more stable the resonant frequency is, and the better the repeatability is.

5.3 Response time

The response time is the time required for the output of the electric-field-sensitive devices to reach 90 % of the final value when a step electric field value is applied.

iTeh Standards
(https://standards.iteh.ai)
Document Preview

6 Measuring methods

6.1 General

This Clause 6 specifies measuring methods for dynamic performances of MEMS resonant electric-field-sensitive devices at a certain electric field strength.

IEC 62047-44:2024
https://standards.iteh.ai/catalog/standards/iec/61afe7d6-a7f3-4c01-b8a6-42c9443c9257/iec-62047-44-2024

The sensitive device is fixed on the fixture and remains stationary during the characteristic test. The induction direction of the electric-field-sensitive devices should be consistent with the applied electric field direction, and the sensing plane of the sensitive device should be flush with the grounded plate in the parallel plate system of standard electric field equipment. The diagram is shown in Figure 2.