

INTERNATIONAL STANDARD



**Semiconductor devices –
Part 14-11: Semiconductor sensors – Test method of surface acoustic
wave-based integrated sensors for measuring ultraviolet, illumination and
temperature**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2021 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

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 It also gives information on projects, replaced and withdrawn publications.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 online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. 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 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.



IEC 60747-14-11

Edition 1.0 2021-03

INTERNATIONAL STANDARD



**Semiconductor devices –
Part 14-11: Semiconductor sensors – Test method of surface acoustic
wave-based integrated sensors for measuring ultraviolet, illumination and
temperature**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.080.01

ISBN 978-2-8322-9465-9

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

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
3.1 General terms.....	6
3.2 SAW-based integrated light sensors	7
3.3 Characteristics parameters	7
4 Device structure and characteristics	8
4.1 General.....	8
4.2 Device structure.....	8
4.2.1 SAW based resonator type light-sensor elements	8
4.2.2 SAW-based delay line type light sensor elements	9
4.3 Characteristics of integrated UV and visible-light sensors	9
4.4 Key points of integrated UV and visible-light sensors	10
4.4.1 UV sensitive layer.....	10
4.4.2 Visible-light sensitive layer	10
5 Test conditions	10
5.1 Test environmental conditions.....	10
5.2 Darkroom condition.....	11
5.3 Setup conditions	11
5.3.1 Starting conditions of test	11
5.3.2 Conditions of UV and visible light measurement equipment	11
6 Test methods.....	11
6.1 General.....	11
6.2 Test methods of DC-characteristics for the light sensor element	12
6.3 Test methods of RF characteristics for integrated light sensors.....	14
6.3.1 Direct mode	14
6.3.2 Differential amplifier mode	14
Annex A (informative) Ultraviolet and visible light characteristics of the sensitive layer	18
Annex B (informative) Hysteresis of frequency shift according to the on/off state light condition	20
Bibliography.....	21
Figure 1 – Configuration of an interdigital transducer (IDT).....	7
Figure 2 – Conceptual diagram for SAW based resonator type light sensor elements.....	9
Figure 3 – Conceptual diagram for SAW based delay line type light sensor elements	9
Figure 4 – Conceptual diagram for integrated multi UV and visible light sensors	10
Figure 5 – Measurement procedure for the semiconductor light sensor	12
Figure 6 – Test setup to measure the I-V characteristics of semiconductor light sensor	13
Figure 7 – Example of I-V characteristics of a UV sensor element as a function of UV intensity	13
Figure 8 – Test setup to measure the frequency shift of semiconductor light sensor	14
Figure 9 – Differential amplifier mode method	16
Figure 10 – Measurement results of UV and visible light sensors using differential amplifier mode	17

Figure A.1 – Operation principle of the ZnO sensitive layer for UV sensing 18
Figure A.2 – Operation principle in terms of band theory 19
Figure B.1 – Hysteresis of the frequency shift under optimal light conditions 20

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES –**Part 14-11: Semiconductor sensors – Test method of surface acoustic wave-based integrated sensors for measuring ultraviolet, illumination and temperature**

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) 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 60747-14-11 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

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

CDV	Report on voting
47E/674/CDV	47E/709/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60747 series, published under the general title *Semiconductor 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 "<http://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.

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.

SEMICONDUCTOR DEVICES –

Part 14-11: Semiconductor sensors – Test method of surface acoustic wave-based integrated sensors for measuring ultraviolet, illumination and temperature

1 Scope

This part of IEC 60747 defines the terms, definitions, configuration, and test methods can be used to evaluate and determine the performance characteristics of surface acoustic wave-based semiconductor sensors integrated with ultraviolet, illuminance, and temperature sensors. The measurement methods are for DC characteristics and RF characteristics, and the measurement method for RF characteristics includes a direct mode and differential amplifier mode based on feedback oscillation. This document excludes devices dealt with by TC 49: piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection.

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 63041-1, *Piezoelectric sensors – Part 1: Generic specifications*

IEC 63041-2, *Piezoelectric sensors – Part 2: Chemical and biochemical sensors*

3 Terms and definitions

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

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

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

Units, letter symbols and terminology shall, wherever possible, be taken from IEC 63041-1 and IEC 63041-2.

3.1 General terms

3.1.1

surface acoustic wave

SAW

acoustic wave, propagating along the surface of an elastic substrate, the amplitude of which decays exponentially with substrate depth

Note 1 to entry: This entry was numbered 561-06-01 in IEC 60050-561:1991, Amendment 1:1995.

[SOURCE: IEC 60050-561:2014, 561-01-86]