IEC 60747-18-1

Edition 1.0 2019-05

INTERNATIONAL STANDARD

colour inside

Semiconductor devices – Part 18-1: Semiconductor bio sensors – Test method and data analysis for calibration of lens-free CMOS photonic array sensors

IEC 60747-18-1:2019-05(en)

IEC Central Office
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 It also gives information on projects, replaced and withdrawn publications.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.

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 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC 60747-18-1

Edition 1.0 2019-05

INTERNATIONAL STANDARD

colour inside

Semiconductor devices – Part 18-1: Semiconductor bio sensors – Test method and data analysis for calibration of lens-free CMOS photonic array sensors

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 31.080.99

ISBN 978-2-8322-6909-1

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

SEMICONDUCTOR DEVICES –

Part 18-1: Semiconductor bio sensors – Test method and data analysis for calibration of lens-free CMOS photonic array sensors

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 60747-18-1 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:

FDIS	Report on voting
47E/643A/FDIS	47E/657/RVD

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 of 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.

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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.

INTRODUCTION

The IEC 60747-18 series on semiconductor bio sensors is expected to be composed of the following parts:

- IEC 60747-18-1 defines the test method and data analysis for calibration of lens-free CMOS photonic array sensor
- IEC 60747-18-2[1] defines the evaluation process of lens-free CMOS photonic array sensor package module
- IEC 60747-18-3[2] defines the fluid flow characteristics of lens-free CMOS photonic array sensor package module with fluidic system

The IEC 60747-18 series includes subjects such as noise analysis, long-term reliability tests, test methods for lens-free CMOS photonic array sensor package module under patchable environments, test methods under implantable environments, etc.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents given in several subclauses as indicated in the table below. These patents are held by their respective inventors under license to SOL Inc.:

KR1020150081134	[SOL]	The method of calibration of photon sensor pixel array by evaluating its characteristic	Subclauses 5.1, 5.2.1, 5.2.2, 5.3, 7.1
PCT/KR2016/006109	[SOL]	METHOD FOR CORRECTING OPTICAL SENSOR ARRAY MODULE THROUGH CHARACTERISTIC EVALUATION	Subclauses 5.1, 5.2.1, 5.2.2, 5.3, 7.1 Clause 6
US15/577586			
JP2017562062			

IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he/she is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

SOL Inc.
H Business Park
C1010, 26, Beobwon-ro 9-gil, SongPa-Gu
Seoul 05838
Republic of Korea

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

---

[1] Under preparation. Stage at the time of publication: IEC/PRVC 60747-18-2:2019.

[2] Under preparation. Stage at the time of publication: IEC/PRVC 60747-18-3:2019.

ISO (www.iso.org/patents) and IEC (http://patents.iec.ch) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

SEMICONDUCTOR DEVICES –

Part 18-1: Semiconductor bio sensors – Test method and data analysis for calibration of lens-free CMOS photonic array sensors

1 Scope

This part of IEC 60747 specifies the test methods and data analysis for the calibration of lens-free CMOS photonic array sensors. This document includes the test conditions of each process, configuration of lens-free CMOS photonic array sensors, statistical analysis of test data, calibration for planarization and linearity, and test reports.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes 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

3.1
lens-free CMOS photonic array sensor
semiconductor-based optical detector or sensor whose sensing elements are arrayed in a two-dimensional way and integrated with processing circuits on a chip

Note 1 to entry: Lens-free CMOS photonic array sensors are extensively utilized in bio diagnostic devices, healthcare devices, lens-free microscopes, and patchable/implantable medical devices.

Note 2 to entry: The sensing environments of such a lens-free CMOS photonic array sensor are typically different from those of general-purpose image sensors which are normally mounted with an external lens in module housings.

3.2
quantum efficiency
QE
ratio of the number of elementary events (such as release of an electron) contributing to the detector output, to the number of incident photons

Note 1 to entry: QE is the ability of a semiconductor to produce electron from incident photons.

Note 2 to entry: QE in general depends on the wavelength of the incident photon and can be obtained from spectral responsivity and conversion gain of the sensor.

[SOURCE: IEC 60050-845:1987, 845-05-67, modified – The abbreviated term and the notes to entry have been added.]

3.3
linearity
ability of a pixel of an array sensor to provide an output having a linear relationship with an input light power

3.4
box plot
graphically depicting group of numerical data through their quartiles Q1, Q2, and Q3

SEE: Figure 1.

Note 1 to entry: In this document, the noise RMS (root mean square) and average signal are added. The average signal is different from the median value, which is real measured data, whereas the average is calculated. Noise RMS is the root mean square value of the difference between the incident signal and average signal.

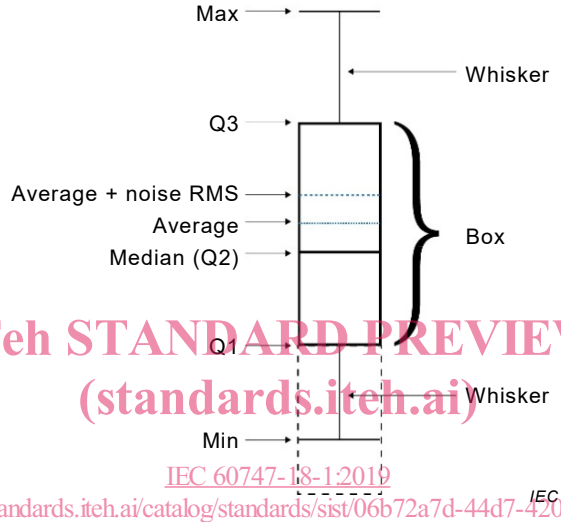

Figure 1 – Example of box plot

4 Measurement setup

4.1 General

Input factors and environmental factors affecting sensor performance are: (1) input component: light power (wavelength, intensity, incident angle, polarization) and its two-dimensional distribution as well as stability over time; electric inputs (drive pulses, bias voltages, etc.); and (2) environmental factor: temperature. The evaluation environment provides a method that allows us to control these factors and to obtain numerical results with the necessary accuracy. The performance of the lens-free CMOS photonic array sensor depends on the resolution, pixel size, pixel type, fill factor, quantum efficiency, conversion gain, sensitivity, saturation level, dynamic range, image lag, black level, dark signal, temporal noise, fixed-pattern noise, cross talk, etc. Clause A.1 and Clause A.2 show the required parameters.

4.2 Measurement system

4.2.1 Overall system

All tests shall be performed under well certified and defined conditions to avoid any external disturbances. Basic measurement setup schematics are depicted in Figure 2 or Figure 3.

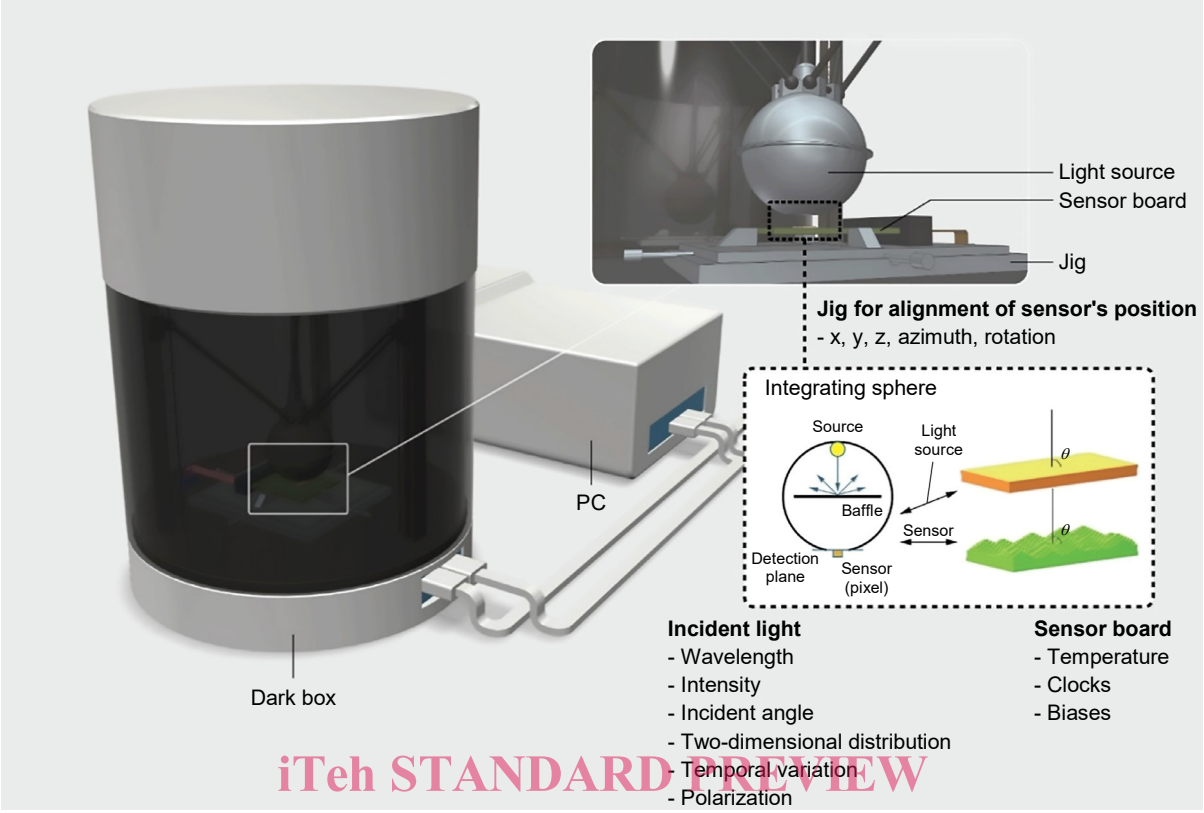

Figure 2 – Example of measurement system with integrating sphere

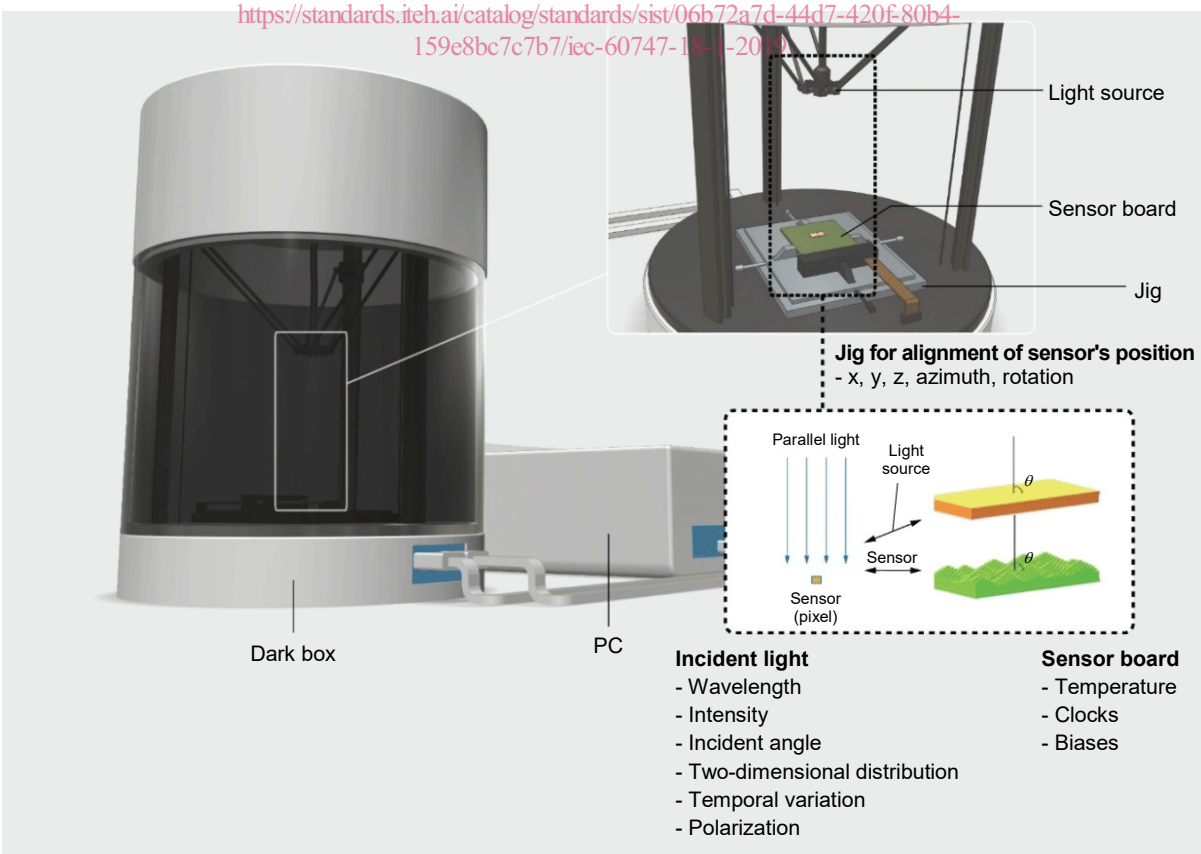

Figure 3 – Example of measurement system with incident parallel light