



# INTERNATIONAL STANDARD



---

**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

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

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	8
2 Normative references .....	8
3 Terms and definitions .....	8
4 Measurement setup .....	9
4.1 General.....	9
4.2 Measurement system.....	9
4.2.1 Overall system.....	9
4.2.2 Dark box.....	11
4.2.3 Light source.....	11
4.2.4 Sensor board.....	11
4.2.5 Configuration parameters .....	12
5 Measurement.....	12
5.1 General.....	12
5.2 Case 1: Fixed wavelength ( $\lambda$ ) of light .....	12
5.2.1 Planarization: At fixed $\lambda$ and incident light intensity.....	12
5.2.2 Linearity: Varying the incident light intensity with a fixed wavelength .....	14
5.3 Case 2: Various wavelength ( $\lambda$ ) of light .....	14
6 Data analysis.....	14
6.1 Data plot.....	14
6.1.1 General .....	14
6.1.2 Sensor screening.....	16
6.2 Planarization characteristics .....	16
6.2.1 Criterion of determining the reference pixel .....	16
6.2.2 Lookup table of representative value for planarization calibration of each pixel.....	17
6.3 Linearity.....	17
6.3.1 Criterion of linear region of each pixel .....	17
6.3.2 Criterion of light intensity effective area for linearity.....	18
6.3.3 Lookup table of the representative value for linearity calibration of each pixel .....	18
7 Calibration.....	19
7.1 Calibration lookup table .....	19
7.2 Reference for establishing the representative output value in the effective area.....	20
8 Test report.....	21
Annex A (informative) Test report .....	23
A.1 Test environment specification.....	23
A.2 Specification of CMOS photonic array sensor .....	24
A.3 Calibration lookup table .....	24
A.4 Representative value look up table for planarization calibration of the sensor .....	24
A.5 Representative value look up table for linearity calibration of the sensor.....	25
Bibliography.....	26
Figure 1 – Example of box plot.....	9

Figure 2 – Example of measurement system with integrating sphere.....	10
Figure 3 – Example of measurement system with incident parallel light.....	10
Figure 4 – Example of photoelectric measurement schematic .....	11
Figure 5 – Measurement flow .....	12
Figure 6 – $n$ trial data of frame capture .....	13
Figure 7 – Two frame subtracted data .....	13
Figure 8 – Dark frame subtracted data .....	14
Figure 9 – Example of output electric signal non-linearity of 2D pixel array .....	15
Figure 10 – Example of output electric signal non-linearity of one row of pixels .....	15
Figure 11 – Example of one pixel’s output electric signal according to input light power.....	16
Figure 12 – Example of determining the reference pixel.....	17
Figure 13 – Example of the representative value for planarization.....	17
Figure 14 – Example of light intensity effective area for linearity .....	18
Figure 15 – Example of the representative value for linearity .....	19
Figure 16 – Example of a simplified pixel structure and cross-sectional view with bio reaction .....	19
Figure 17 – Example of the representative value of the sensor .....	21
Table 1 – Calibration lookup table.....	20
Table 2 – Representative value table of the sensor.....	21

## 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<sup>1</sup> defines the evaluation process of lens-free CMOS photonic array sensor package module
- IEC 60747-18-3<sup>2</sup> 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.

<sup>1</sup> Under preparation. Stage at the time of publication: IEC/PRVC 60747-18-2:2019.

<sup>2</sup> Under preparation. Stage at the time of publication: IEC/PRVC 60747-18-3:2019.

ISO ([www.iso.org/patents](http://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.