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INTERNATIONAL STANDARD

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Semiconductor devices –
Part 18-5: Semiconductor bio sensors – Evaluation method for light responsivity characteristics of lens-free CMOS photonic array sensor package modules by incident angle of light

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Part 18-5: Semiconductor bio sensors – Evaluation method for light responsivity characteristics of lens-free CMOS photonic array sensor package modules by incident angle of light

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

Draft	Report on voting
47E/779/CDV	47E/791/RVC

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 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 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- withdrawn,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.

INTRODUCTION

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

- IEC 60747-18-1 defines the test method and data analysis for calibration of lens-free CMOS photonic array sensors;
- IEC 60747-18-2 [1][1] defines the evaluation process of lens-free CMOS photonic array sensor package modules;
- IEC 60747-18-3 [2] defines the fluid flow characteristics of lens-free CMOS photonic array sensor package modules with fluidic system;
- IEC 60747-18-4 [3] defines the evaluation method of noise characteristics of lens-free CMOS photonic array sensors;
- IEC 60747-18-5 defines the evaluation method for light responsivity characteristics of lens-free CMOS photonic array sensor package modules by incident angle of light.

The IEC 60747-18 series [4] includes subjects such as noise analysis, long-term reliability tests, test methods for lens-free CMOS photonic array sensor package modules under patchable environments, test methods under implantable environments, etc.

[1] Numbers in square brackets refer to the Bibliography.

SEMICONDUCTOR DEVICES –

Part 18-5: Semiconductor bio sensors – Evaluation method for light responsivity characteristics of lens-free CMOS photonic array sensor package modules by incident angle of light

1 Scope

This part of IEC 60747 specifies the evaluation method for light responsivity characteristics of lens-free CMOS photonic array sensor package modules by incident angle of light. This document includes the test setup, test procedure, test item, and test report for lens-free CMOS photonic array sensor package modules.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes the 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 60747-18-1:2019, *Semiconductor devices – Part 18-1: Semiconductor bio sensors – Test method and data analysis for calibration of lens-free CMOS photonic array sensors*

3 Terms and definitions

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

3.1
angular response
light response characteristic of a photonic array sensor depending on the incident angle of light source

Note 1 to entry: The characteristic of angular response should be defined as the wavelength of light because the optical penetrating path into the lens-free CMOS photonic array sensor is different for each wavelength.

3.2
spectral responsivity
responsivity per unit wavelength interval at a given wavelength

[SOURCE: IEC 60050-731:1991 [5], 731-06-37]

4 Measurement setup

4.1 General

The input factors and environmental factors affecting sensor angular response are:

1) input component: light power (wavelength, intensity, incident angle) and its stability over time, electric inputs;
2) environmental factor: temperature. The evaluation environment provides a method that allows 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 quantum efficiency, sensitivity, cross talk, etc.

4.2 Measurement system

All measurements shall be performed under the standard conditions, according to 4.2 of IEC 60747-18-1:2019.

5 Measurement

5.1 General

Each pixel of the CMOS photonic array sensor experiences noise from multiple noise sources, and there are responsivity variations between pixels in the array sensor [6]. Therefore, multiple measurements with the same input and environment factors should be made and these should be statistically processed in order to cope with such noise and spatial variations in responsivity. The measurement workflow may be carried out in accordance with Figure 1.

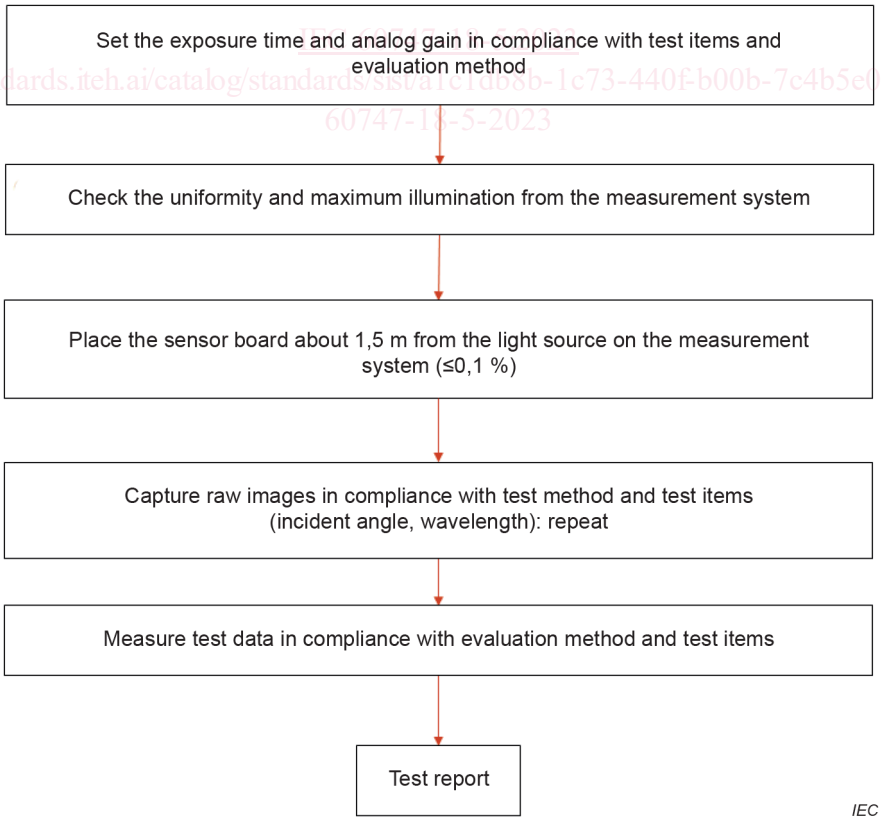

Figure 1 – Measurement workflow

5.2 Case 1: Spectral responsivity with various incident light angles

5.2.1 General

The response of photonic array sensor is a function of input light wavelength. This spectral responsivity varies with the incident light angle [7].

5.2.2 Step 1: Measure dark offset

Unwanted stray light and a dark signal of the detector could be source of measurement error. It should be eliminated by measuring before inputting the light source into the test ray path. To create dark conditions, use a mechanical shutter between the light source and DUT (device under test). After establishing dark conditions, measure the data of the reference detector and DUT.

5.2.3 Step 2: Status check of monochromatic light source within test spectral range

Light source characteristics should be measured before testing the DUT, and the intensity of the light with varying wavelengths should be measured by another reference detector. The reference detector should be calibrated by the target unit (for example: W/m^2).

5.2.4 Step 3: Measure responsivity to varying wavelengths of input light on optical axis

Store the data from the DUT after lighting up the DUT by taking away the shutter. Repeat the storing of DUT data by changing the wavelength of the light source every 5 nm. In this step, the angle should be perpendicular to the DUT (photonic array sensor).

5.2.5 Step 4: Measure responsivity to varying wavelengths of input light off optical axis

The storage of spectral responsivity data, like that measured in 5.2.4, should be repeated after changing the angle of the light source as in Figure 2.

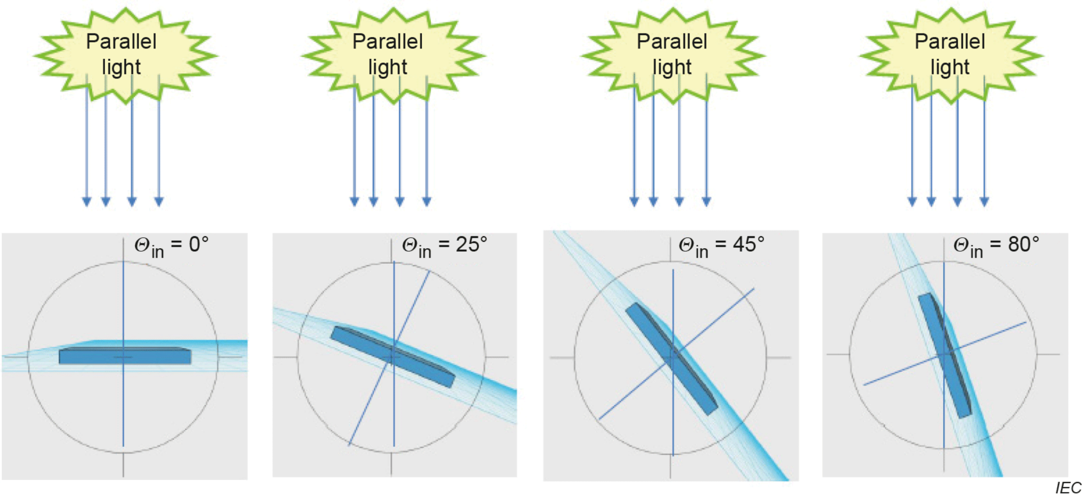

Figure 2 – Example of angular response measurement