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INTERNATIONAL STANDARD

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Semiconductor devices –
Part 18-2: Semiconductor bio sensors – Evaluation process of lens-free CMOS photonic array sensor package modules

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CONTENTS

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SEMICONDUCTOR DEVICES –

Part 18-2: Semiconductor bio sensors – Evaluation process of lens-free CMOS photonic array sensor package modules

FOREWORD

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

FDIS	Report on voting
47E/689/FDIS	47E/694/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.

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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 defines the evaluation process of lens-free CMOS photonic array sensor package modules
- IEC 60747-18-3 defines the fluid flow characteristics of lens-free CMOS photonic array sensor package modules 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 modules 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.:

KR1020150187389	[SOL]	The method of calibration of packaged photonic sensor pixel array by evaluating its characteristic	Subclause 5.2.1, 5.2.2
PCT/KR2016/006109	[SOL]	METHOD FOR CORRECTING OPTICAL SENSOR ARRAY MODULE THROUGH CHARACTERISTIC EVALUATION	Subclause 5.2.3, 5.2.4, 5.2.5
US15/577586	[SOL]		
JP2017562062	[SOL]		

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SEMICONDUCTOR DEVICES –

Part 18-2: Semiconductor bio sensors – Evaluation process of lens-free CMOS photonic array sensor package modules

1 Scope

This part of IEC 60747 specifies the evaluation process of lens-free CMOS photonic array sensor package modules. This document includes the measurement environment of each process, statistical analysis of test data, middle layer effect under various user light, evaluation of calibrated lens-free CMOS photonic array sensor package modules, and test report.

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 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 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 package modules
device composed of a lens-free CMOS photonic array sensor, middle layer, user light (first light source, second light source) and its own dark box

SEE: Figure 1.

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 sensors are typically different from those of general-purpose image sensors which are normally mounted with an external lens in module housings.

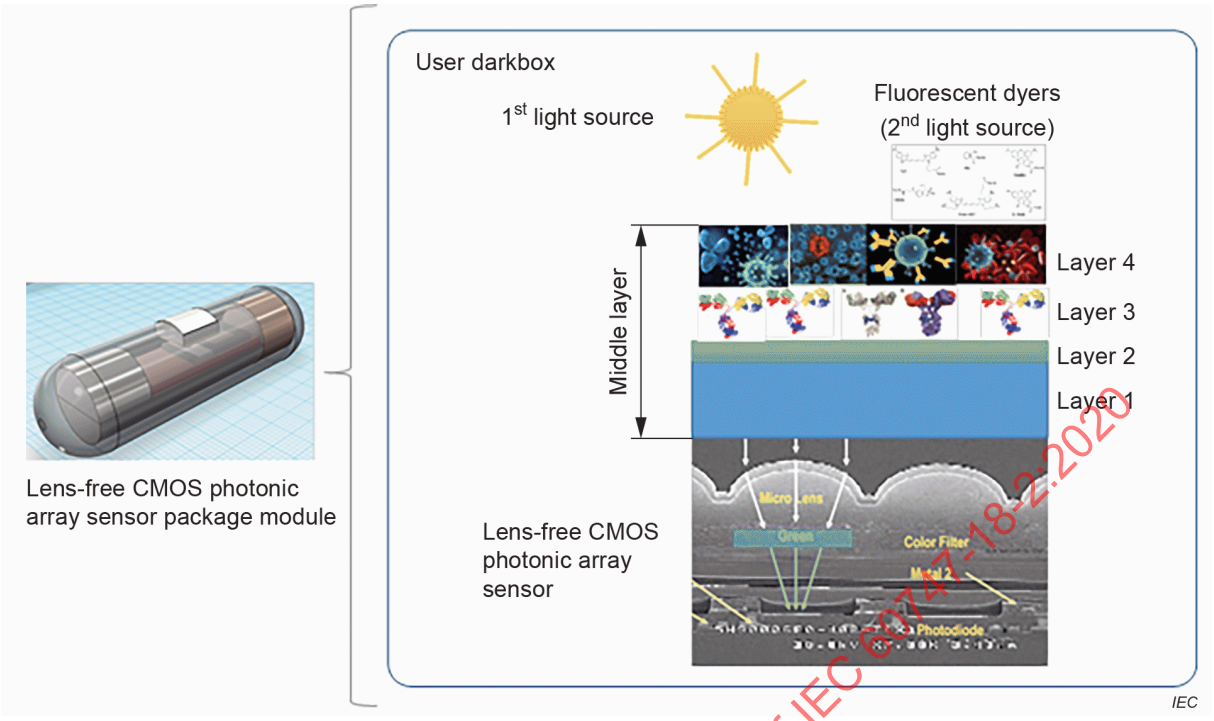

Figure 1 – Example of lens-free CMOS photonic array sensor package modules

3.2
photonic responsivity
ratio of the output electric signal of a sensor to the input light power

Note 1 to entry: It is in general a function of wavelength and of incident power.

Note 2 to entry: Photonic responsivity as a function of wavelength is referred to as spectral responsivity.

Note 3 to entry: Units for output electric signal are V, A, or DN.

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

[SOURCE: IEC 60747-18-1:2019, 3.3].

4 Measurement setup

4.1 General

The lens-free CMOS photonic array sensor package modules can include a middle layer, user light sources as shown in Figure 1 to be evaluated at each step for a more precise calibration.

4.2 Measurement system

All measurements shall be performed under the standard conditions, according to 4.2 of IEC 60747-18-1:2019, as shown in Figure 2 and Figure 3. All items mentioned in 4.2 of IEC 60747-18-1:2019 shall also be defined.

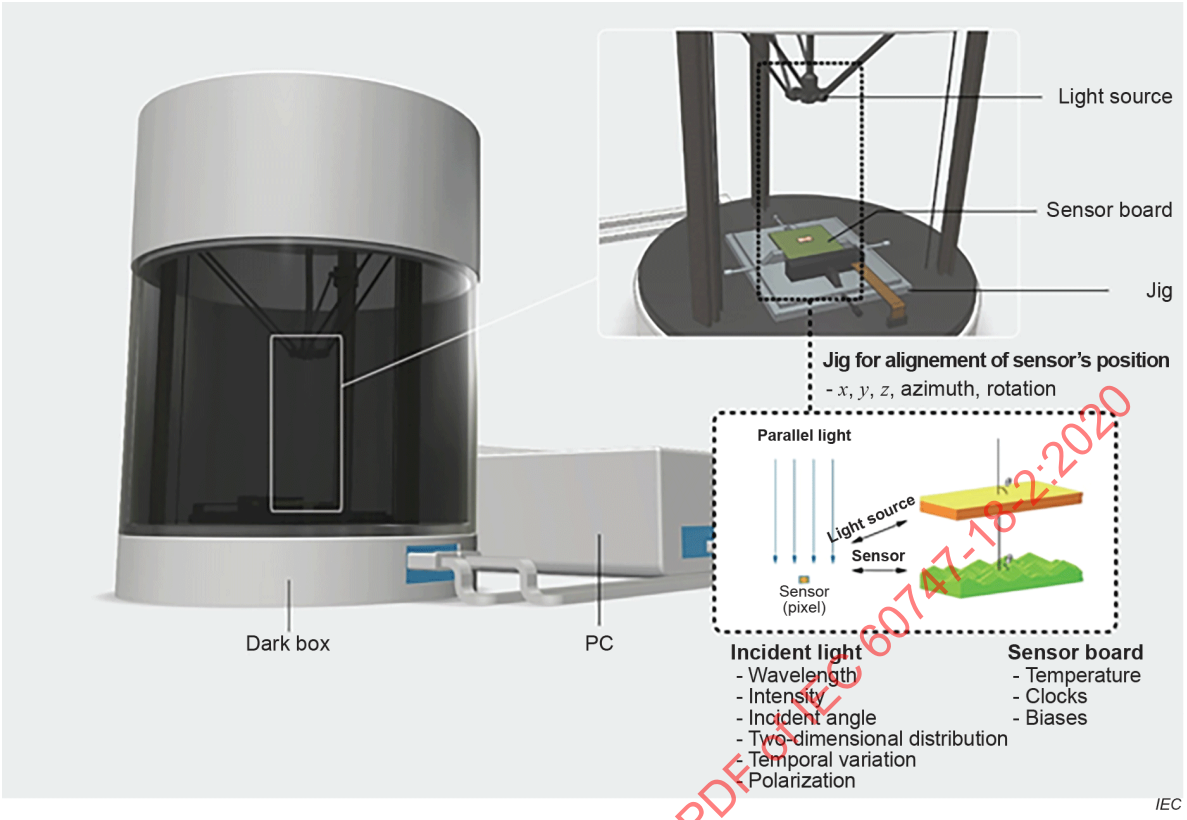

Figure 2 – Example of measurement system with incident parallel light

The photoelectric characteristics of a sensor board shall be measured using the system shown in Figure 3 by each step of the structure component of the package modules.

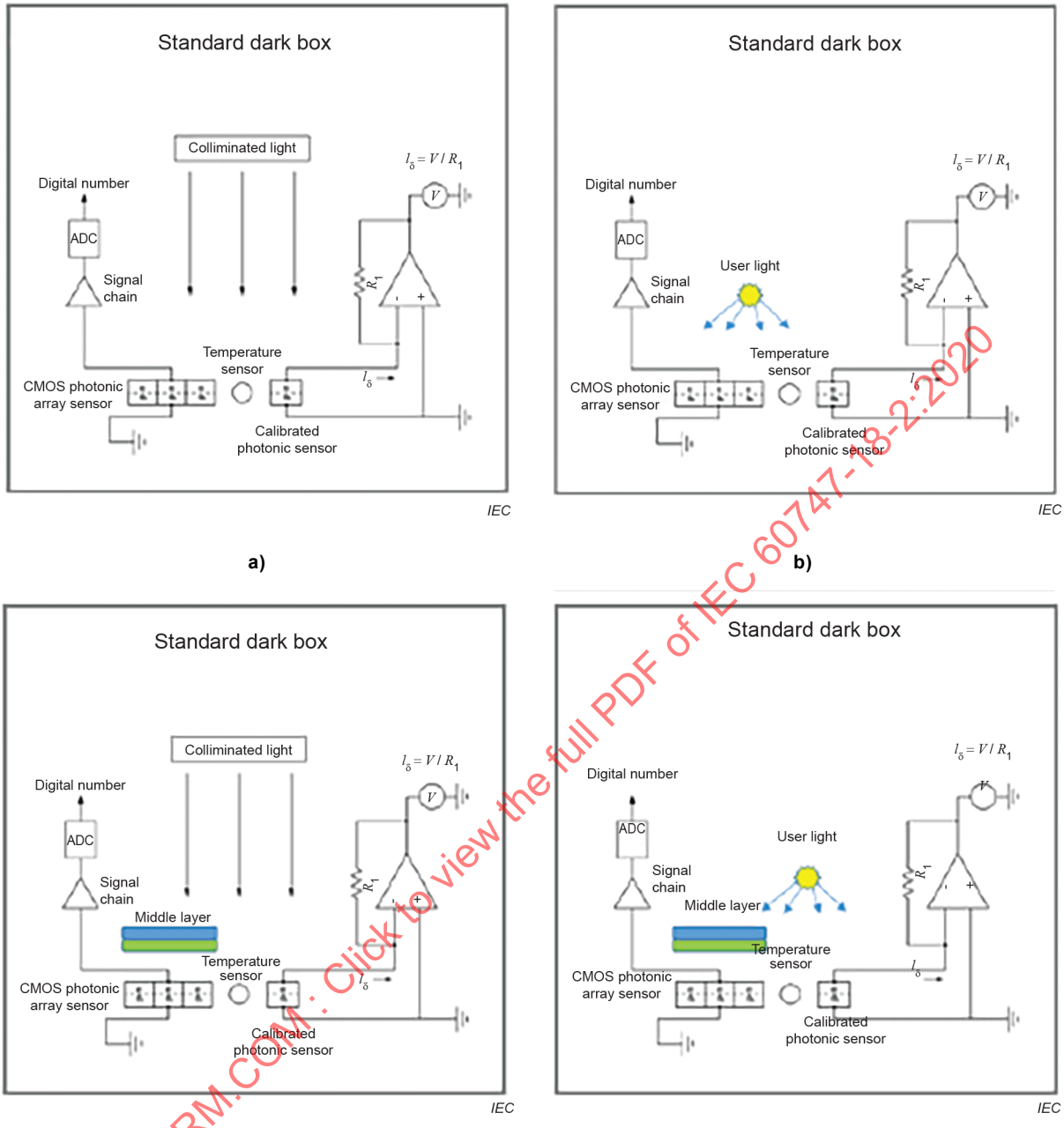

Figure 3 – Example of photoelectric measurement schematics

5 Measurement

5.1 General

All results shall include the accuracy information of the test performed and the information of the measurement system used for the product. The parameters defined in the product specifications shall be tested according to the procedure described in the test and calibration flow in Figure 4 and Figure 5.

The configurations in 4.2 shall be set up prior to the measurement of the lens-free CMOS photonic array sensor package modules. To ensure the best results, the key parameters (temperature change, wavelength, incident angle, etc.), which can affect the sensor characteristics and the measurement, shall be rechecked and managed properly. In other words, the factors which can affect the characteristic values of the sensors such as the ambient temperature, the condition of the incident light and the sensor board, etc. shall be checked and the corresponding configurations set up accordingly.

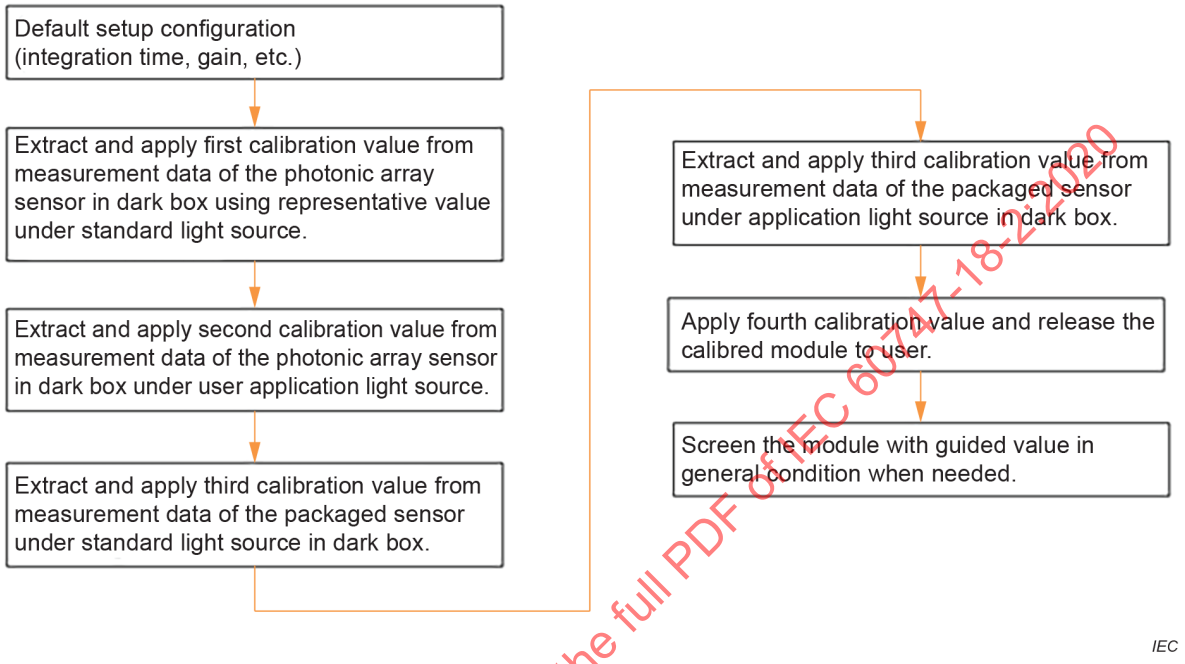

Figure 4 – Test and calibration flow diagram

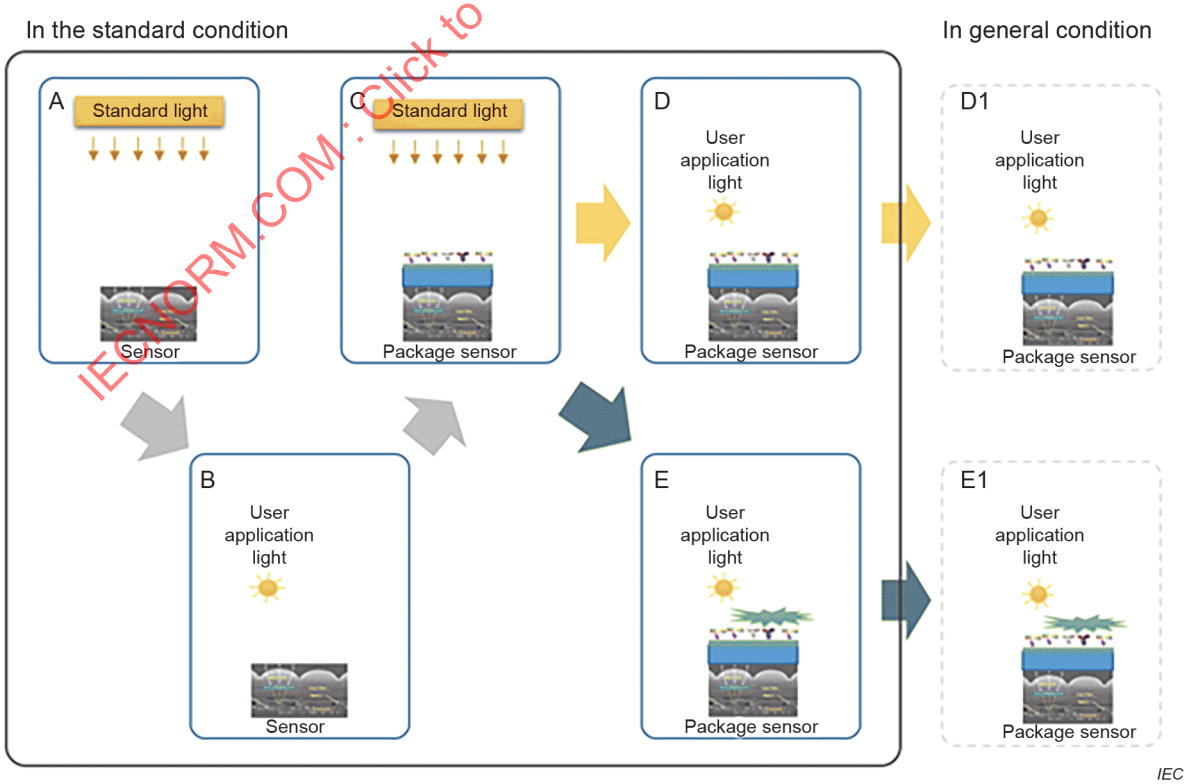

Figure 5 – Test and calibration flow schematics

5.2 Measurement in the standard condition

5.2.1 General

All tests shall be performed under well certified and defined conditions to avoid any external disturbances.

5.2.2 A: Sensor characteristics

5.2.2.1 General

The purpose of this step is to test the sensor characteristics (planarization and linearity) in the standard condition. For example, the measurement for the sensor characteristics is performed as shown in Figure 3a) and Figure 6.

5.2.2.2 Measurement

5.2.2.2.1 Planarization

The frame measurement shall be performed according to 5.2.1 of IEC 60747-18-1:2019.

5.2.2.2.2 Linearity

The frame measurement shall be performed according to 5.2.2 of IEC 60747-18-1:2019.

5.2.2.3 Data analysis

5.2.2.3.1 Planarization

The reference pixel shall be determined according to 6.2.1 of IEC 60747-18-1:2019. The lookup table of the representative value corresponding to each pixel shall be made according to 6.2.2 of IEC 60747-18-1:2019. The lookup table (Lookup table_A_RVP) shall be included in the test report.

5.2.2.3.2 Linearity

Light intensity effective area for linearity shall be determined according to 6.3 of IEC 60747-18-1:2019. The lookup table of light intensity effective area for linearity shall be written in test report. The lookup table (Lookup table_A_RVL) shall also be included in the test report.

5.2.2.4 Calibration

A calibration lookup table shall be created using the lookup table_A_RVP in 5.2.2.3.1 and the lookup table_A_RVL in 5.2.2.3.2 according to Table 1 of IEC 60747-18-1:2019. The caibration lookup table (Lookup table_A_CAL) shall also be included in the test report.

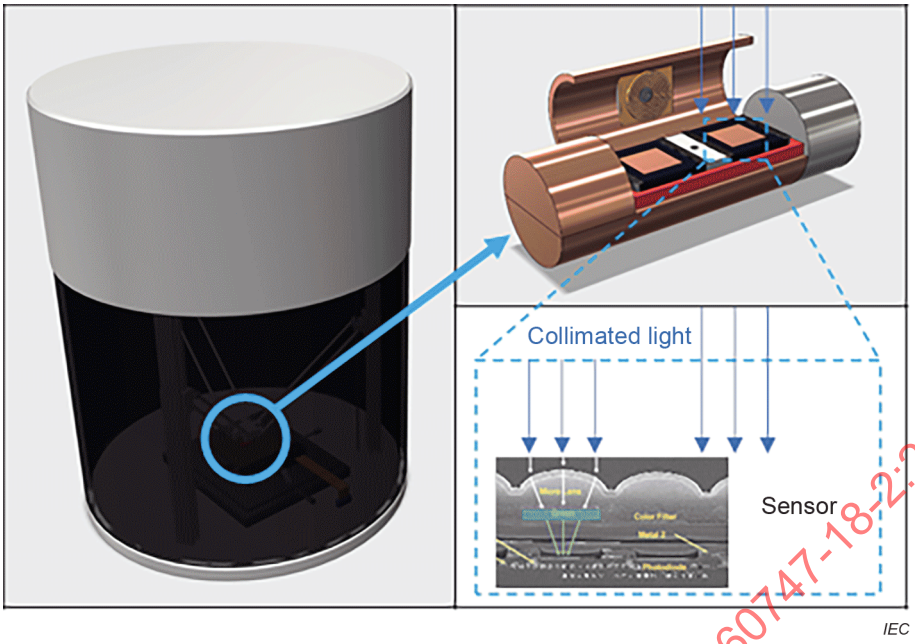

Figure 6 – Example of measurement for sensor characteristics

5.2.3 B: Spatial uniformity of user light

5.2.3.1 General

The purpose of this step is to test the spatial uniformity of the photonic responsivity of the pixel by the incident user light at each pixel. Based on the characteristics of the user light, the mounting position, the angle of the user light and the spatial non-uniformity of the surface shall be measured. The calibration table of the imbalance of the light source shall be created, comparing the sensor data. The measurement is performed as shown in Figure 3b) and Figure 7.

5.2.3.2 Measurement

5.2.3.2.1 Planarization

The frame measurement shall be performed according to 5.2.1 of IEC 60747-18-1:2019.

5.2.3.2.2 Linearity

The frame measurement shall be performed according to 5.2.2 of IEC 60747-18-1:2019.

5.2.3.3 Data analysis

5.2.3.3.1 Planarization

The reference pixel shall be determined according to 6.2.1 of IEC 60747-18-1:2019. The lookup table of the representative value corresponding to each pixel shall be created according to 6.2.2 of IEC 60747-18-1:2019. The lookup table (Lookup table_B_RVP) shall be included in the test report.

5.2.3.3.2 Linearity

The light intensity's effective area for linearity shall be determined according to 6.3 of IEC 60747-18-1:2019. The light intensity's effective area for linearity shall be written in the test report. The lookup table (Lookup table_B_RVL) shall also be included in the test report.

5.2.3.4 Calibration

A calibration lookup table shall be created using the lookup table_B_RVP in 5.2.3.3.1 and the lookup table_B_RVL in 5.2.3.3.2 according to Table 1 of IEC 60747-18-1:2019. The calibration lookup table (Lookup table_B_CAL) shall also be included in the test report.

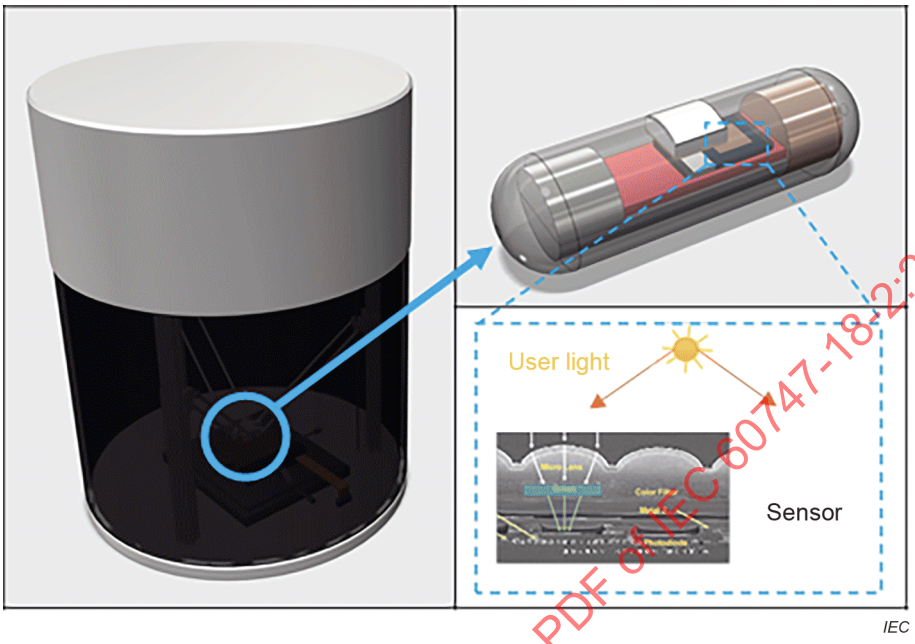

Figure 7 – Example of measurement for spatial uniformity of user light

5.2.4 C: Middle layer effect under collimated light

5.2.4.1 General

The purpose of this step is to test the effect of the middle layer on the sensor characteristics under collimated light. A calibration table measuring the degree of deformation during the exposure time (the time the light arrives to the sensor) shall be created by using the middle-layer number, characteristics, thickness, density and composition, etc. For example, the measurement is performed as shown in Figure 3c) and Figure 8.

5.2.4.2 Measurement

5.2.4.2.1 Planarization

The frame measurement shall be performed according to 5.2.1 of IEC 60747-18-1:2019.

5.2.4.2.2 Linearity

The frame measurement shall be performed according to 5.2.2 of IEC 60747-18-1:2019.

5.2.4.3 Data analysis

5.2.4.3.1 Planarization

The reference pixel shall be determined according to 6.2.1 of IEC 60747-18-1:2019. The lookup table of the representative value corresponding to each pixel shall be created according to 6.2.2 of IEC 60747-18-1:2019. The lookup table (Lookup table_C_RVP) shall be included in the test report.

5.2.4.3.2 Linearity

The light intensity's effective area for linearity shall be determined according to 6.3 of IEC 60747-18-1:2019. The light intensity's effective area for linearity shall be included in the test report. The lookup table (Lookup table_C_RVL) shall also be included in the test report.

5.2.4.4 Calibration

A calibration lookup table shall be created using the lookup table_C_RVP in 5.2.4.3.1 and the lookup table_C_RVL in 5.2.4.3.2 according to Table 1 IEC 60747-18-1:2019. The calibration lookup table (Lookup table_C_CAL) shall also be included in the test report.

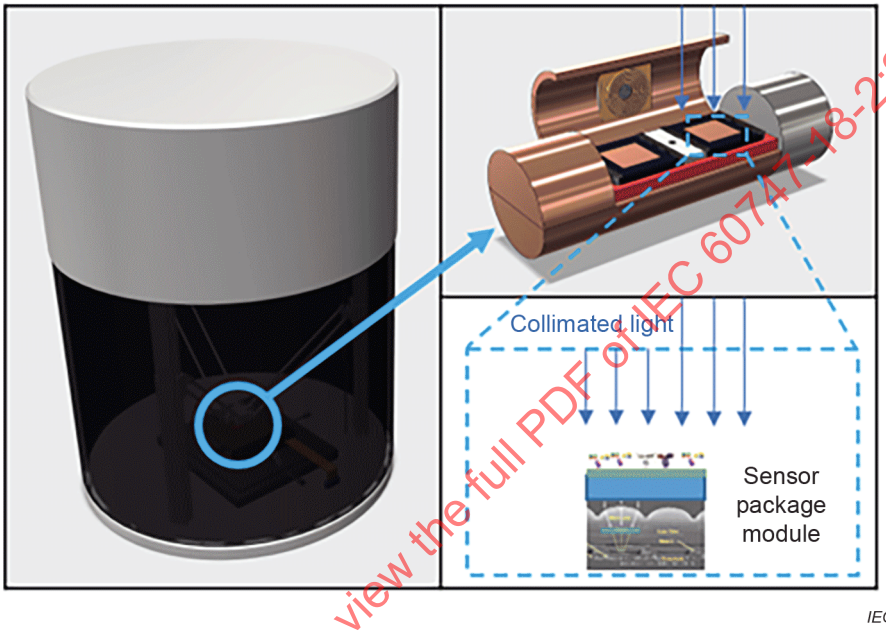

Figure 8 – Example of measurement for middle layer effect under collimated light

5.2.5 D: Middle layer effect under user light

5.2.5.1 General

The purpose of this step is to test the effect of the middle layer on the sensor characteristics under user light. A calibration table shall be created by measuring the binding imbalance caused by the user light source and middle layer. For example, measurement is performed as shown in Figure 3d) and Figure 9.

5.2.5.2 Measurement

5.2.5.2.1 Planarization

The frame measurement shall be performed according to 5.2.1 of IEC 60747-18-1:2019.

5.2.5.2.2 Linearity

The frame measurement shall be performed according to 5.2.2 of IEC 60747-18-1:2019.

5.2.5.3 Data analysis

5.2.5.3.1 Planarization

The reference pixel shall be determined according to 6.2.1 of IEC 60747-18-1:2019. The lookup table of the representative value corresponding to each pixel shall be created according to 6.2.2 of IEC 60747-18-1:2019. The lookup table (Lookup table_D_RVP) shall be included in the test report.

5.2.5.3.2 Linearity

The light intensity's effective area for linearity shall be determined according to 6.3 of IEC 60747-18-1:2019. The light intensity's effective area for linearity shall be included in the test report. The lookup table (Lookup table_D_RVL) shall also be included in the test report.

5.2.5.4 Calibration

A calibration lookup table shall be created using the ookup table_D_RVP in 5.2.5.3.1 and the lookup table_D_RVL in 5.2.5.3.2 according to Table 1 of IEC 60747-18-1:2019. The calibration lookup table (Lookup table_D_CAL) shall also be included in the test report.

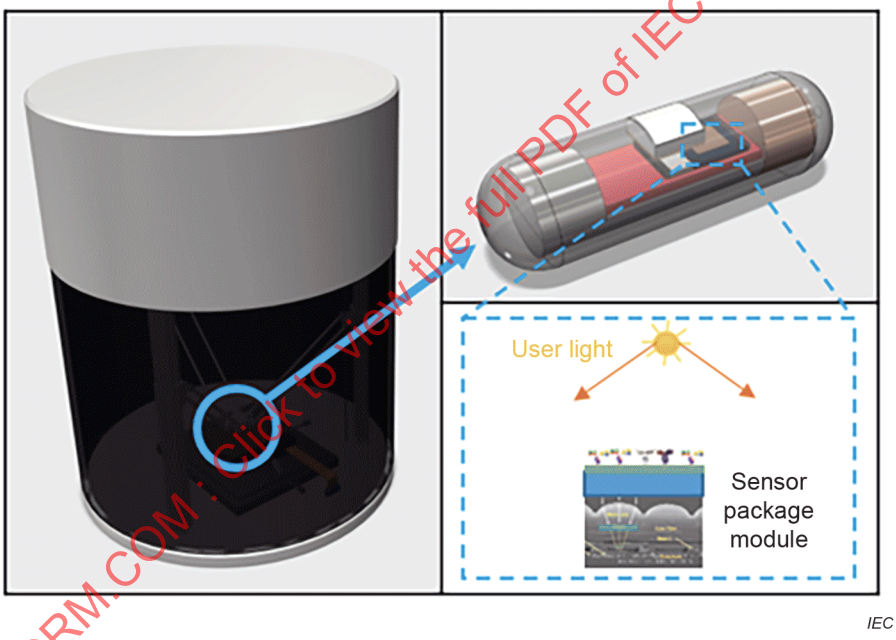

Figure 9 – Example of measurement for middle layer effect under user light

5.2.6 E: Middle layer effect under first and second user light

5.2.6.1 General

The purpose of this step is to test the effect of the middle layer on the sensor characteristics under the first and second user light. In case the second light source emits light relying on user light, as there are two different light sources with different wavelength and incident angle, the calibration table shall be created by evaluating the characteristics of the second light source. For example, measurement is performed as shown in Figure 10.

5.2.6.2 Measurement

5.2.6.2.1 Planarization

The frame measurement shall be performed according to 5.2.1 of IEC 60747-18-1:2019.