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INTERNATIONAL STANDARD

colour inside

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

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FOREWORD

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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- withdrawn,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.

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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]

3.1.2
interdigital transducer
IDT
SAW transducer made of a comb-like conductive structure that is deposited on a piezoelectric substrate and consists of interleaved metal electrodes (fingers) whose function is to transform electrical energy into acoustic energy or vice versa by means of the piezoelectric effect

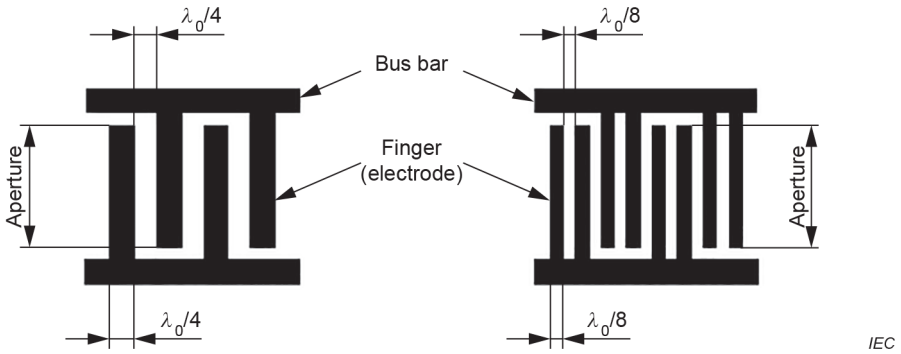


Figure 1 – Configuration of an interdigital transducer (IDT)

Note 1 to entry: This entry was numbered 561-06-09 in IEC 60050-561:1991, Amendment 1:1995.

[SOURCE: IEC 60050-561:2014, 561-01-41]

3.2 SAW-based integrated light sensors

3.2.1
ultraviolet sensor element
ultraviolet sensor component with a sensitive layer that detects the frequency, phase, delay, electrical charge, etc.

Note 1 to entry: Semiconductor materials, such as ZnO and ZnS, are used to detect ultraviolet.

3.2.2
visible-light sensor element
visible-light sensor component with a sensitive layer that detects the frequency, phase, delay, electrical charge, etc.

Note 1 to entry: Semiconductor materials, such as CdS and PbS, are used to detect visible light.

3.2.3
reference sensor element
device component used as a reference to minimize the effect of temperature variations in experimental environments

3.2.4
integrated multi-light sensor
sensor that can detect ultraviolet and visible light together with an array of two different light sensor components on one substrate

Note 1 to entry: Ultraviolet is electromagnetic radiation with wavelengths approximately in the 100 nm to 400 nm range, and visible light is defined as electromagnetic radiation with wavelengths of 400 nm to 700 nm. The integrated multi-light sensor measures both ultraviolet and visible light.

3.3 Characteristics parameters

3.3.1
centre frequency
arithmetic mean of two frequencies at which the attenuation relative to the minimum insertion attenuation reaches a specified value

Note 1 to entry: This entry was numbered 561-07-01 in IEC 60050-561:1991, Amendment 2:1997.

[SOURCE: IEC 60050-561:2014, 561-01-07]

3.3.2
phase shift
in angle modulation by a discretely timed signal, the difference between the phases of two signal elements of the modulated signal, assuming steady-state conditions

[SOURCE: IEC 60050-702:1992, 702-06-39]

3.3.3
frequency shift
intentional frequency change produced by modulation, or an unintentional change due to a natural phenomenon

[SOURCE: IEC 60050-702:1992, 702-01-12]

3.3.4
resonance frequency
frequency at which resonance exists

[SOURCE: IEC 60050-801:1994, 801-24-06]

3.3.5
insertion loss
resulting from the insertion of a network into a transmission system, the ratio of the power delivered to that part of the system following the network, before insertion of the network, to the power delivered to that same part after insertion of the network

Note 1 to entry: The insertion loss is generally expressed in decibels.

[SOURCE: IEC 60050-726:1982, 726-06-07, modified – The term and the definition have been modified so that only the concept of insertion loss is defined (the concept of insertion gain is no longer included in the entry).]

4 Device structure and characteristics

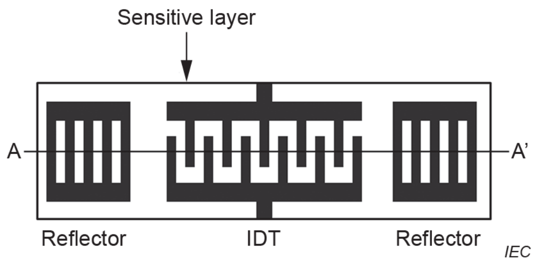
4.1 General

The SAW light sensor is used as a sensor in a smart device to measure the UV and visible light intensity, using semiconductor materials such as ZnO and CdS as the sensitive layer. The device's structure and the characteristics of SAW light detection sensors are shown in detail in 4.2 to 4.4.

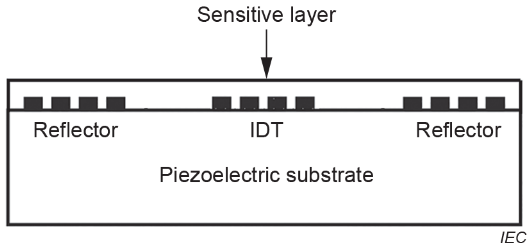
4.2 Device structure

4.2.1 SAW based resonator type light-sensor elements

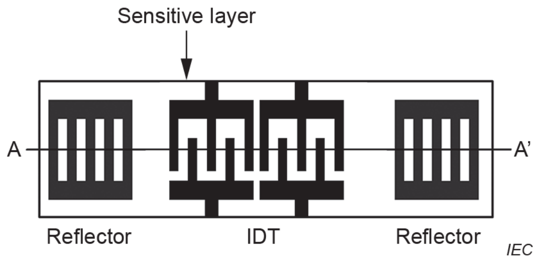
Figure 2 shows the practical conceptual diagram for a surface acoustic wave (SAW) based resonator type integrated light-sensor element. In the figure, mounting stages and enclosures are omitted.



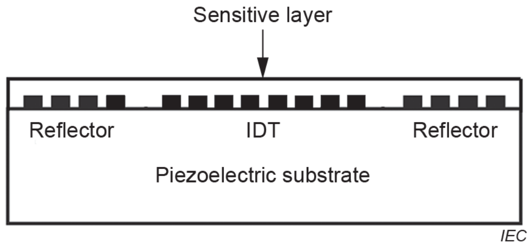
a) Top view of one-port resonator type



b) Side view (cross-section of the A-A' line) of one-port resonator type



c) Top view of two-port resonator type

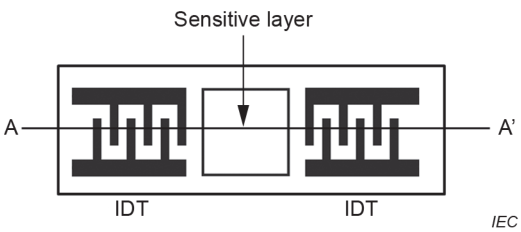


d) Side view (cross-section of the A-A' line) of two-port resonator type

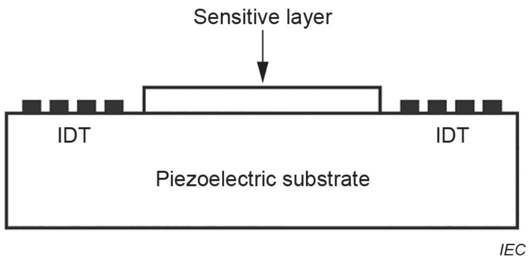
Figure 2 – Conceptual diagram for SAW-based resonator type light-sensor elements

4.2.2 SAW-based delay line type light sensor elements

Figure 3 shows the practical conceptual diagram for a surface acoustic wave (SAW) based delay line type integrated light sensor element. In the figure, mounting stages and enclosures are omitted.



a) Top view of two-port delay line type



b) Side view (cross-section of the A-A' line) of two-port delay line type

Figure 3 – Conceptual diagram for SAW-based delay line type light sensor elements

4.3 Characteristics of integrated UV and visible-light sensors

Figure 4 shows a conceptual diagram of the integrated multi-light sensor elements. The sensors are composed of three different layers, and each layer is a sensitive layer for a UV sensor, a visible-light sensor, and a reference sensor element, which serves to compensate changes in temperature of the SAW sensor.