IEC 60747-14-1

Edition 2.0 2010-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices –
Part 14-1: Semiconductor sensors – Generic specification for sensors

Dispositifs à semiconducteurs –
Partie 14-1: Capteurs à semiconducteurs – Spécification générique pour les capteurs

IEC 60747-14-1:2010

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX S

ICS 31.080.01

ISBN 978-2-88910-276-1

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES –

Part 14-1: Semiconductor sensors – Generic specification for sensors

FOREWORD

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International Standard IEC 60747-14-1 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

This second edition cancels and replaces the first edition, published in 2000, and constitutes a technical revision.

The major changes with regard to the previous edition are as follows:

a) Title change from "Semiconductor sensors - General and classification" to "Semiconductor sensors - Generic specification for sensors";
b) Clause 3 has been divided into three Clauses 3, 4 and 5;
c) Added new terms from IEC 60747-14-5;
d) Added a new Clause relating to Quality assessment procedures;
e) Added a Bibliography;
f) Added a new Annex for the sampling procedure.

The text of this standard is based on the following documents:

FDIS	Report on voting
47E/387/FDIS	47E/391/RVD

Full information on the voting for the approval on this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The list of all parts of the IEC 60747 series, under the general title *Semiconductor devices – Discrete devices,* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

SEMICONDUCTOR DEVICES –

Part 14-1: Semiconductor sensors – Generic specification for sensors

1 Scope

This part of IEC 60147-14 describes general items concerning the specifications for sensors, which are the basis for specifications given in other parts of this series for various types of sensors. Sensors described in this standard are basically made of semiconductor materials, however, the statements made in this standard are also applicable to sensors using materials other than semiconductor, for example dielectric and ferroelectric materials.

2 Normative references

The following referenced documents are indispensable for the application 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 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60068-2 (all parts), *Environmental testing – Part 2: Tests*

IEC 60410, *Sampling plans and procedures for inspection by attributes*

IEC 60617-DB, *Graphical symbols for diagrams*

IEC 60747-1:2006, *Semiconductor devices – Part 1: General*

IEC 60749 (all parts), *Semiconductor device – Test method of mechanical and environment test*

IEC 62047-1, *Semiconductor devices – Micro-electromechanical devices – Part 1: Terms and definitions*

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units*

ISO 2859-1, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

IEC 61193-2, *Quality assessment systems – Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

IEC QC 001002-3:2005, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of Procedure – Part 3: Approval procedures*

3 Terminology, units, letter symbols, terms and definitions

3.1 Terminology, units and letter symbols

For the purposes of this document, the terms and definitions given in IEC 62047-1 and the following apply.

Units, graphical and letter symbols shall, wherever possible, be taken from the following standards:

IEC 60027;

IEC 60617;

ISO 1000.

Any other units, symbols or terminology peculiar to one of the devices covered by this generic specification shall be taken from the relevant IEC or ISO standards (see Clause 2) or derived in accordance with the principles of the standards listed above.

Table 1 lists the measurands which are defined as the input quantities, properties, or conditions that are to be detected or measured by sensors. For example if the measurand is heat, it is measured by a thermal sensor; if it is pressure, it is measured by a pressure sensor. The measurands, arranged in alphabetical order are: acoustic, biological, chemical, electrical, magnetic, mechanical, optical, radiational, and thermal properties. Each entry in Table 1 not only represents the measurand itself, but also its temporal or spatial distribution.

Table 1 – Measurands

1 Acoustic
1.1 Wave amplitude, phase, polarization, spectrum
1.2 Wave velocity
1.3 Other (specify)
2 Biological
2.1 Biomass (identities, concentrations, states)
2.2 Other (specify)
3 Chemical
3.1 Components (identities, concentrations, states)
3.2 Other (specify)
4 Electrical
4.1 Charge, current
4.2 Potential, potential difference
4.3 Electric field (amplitude, phase, polarization, spectrum)
4.4 Conductivity

4.5 Permittivity
4.6 Other (specify)
5 Magnetic
5.1 Magnetic field (amplitude, phase, polarization, spectrum)
5.2 Magnetic flux
5.3 Other (specify)
6 Mechanical
6.1 Position (linear, angular)
6.2 Velocity
6.3 Acceleration
6.4 Force
6.5 Stress, pressure
6.6 Strain
6.7 Mass, density
6.8 Moment, torque
6.9 Speed or flow, rate of mass transport
6.10 Shape, roughness, orientation
6.11 Stiffness, compliance
6.12 Viscosity
6.13 Crystallinity, structural integrity
6.14 Level (of liquid)
6.15 Other (specify)
7 Optical
7.1 Wave amplitude, phase, polarization, spectrum
7.2 Wave velocity
7.3 Other (specify)
8 Radiation
8.1 Type

8.2 Energy
8.3 Intensity
8.4 Other (specify)
9 Thermal
9.1 Temperature
9.2 Flux
9.3 Specific heat
9.4 Thermal conductivity
9.5 Other (specify)
10 Humidity
10.1 Humidity, moisture
11 Other (specify)

3.2 Terms and definitions

3.2.1
ambient conditions allowed
specified tolerance which the sensor can perform, including temperature, acceleration, vibration, shock, ambient pressure (e.g. high altitudes), moisture, corrosive materials, and electromagnetic field

IEC 60721-2-1 and IEC60 721-3-0 shall be referred to for basic conditions.

3.2.2
bias
voltage or current that apply to signal electrode, etc., to decide action datum of sensor

3.2.3
full scale output
upper limit of sensor output over the measuring range

3.2.4
full scale span
FSS
algebraic difference between the end points of the output. The upper limit of sensor output over the measuring range is called the full scale output (FSO), see Figure 1. This signal is the sum of the offset signal plus the full scale span

3.2.5
hysteresis
maximum difference in output, at any measurand value, within the measuring range when the value is approached first with an increasing and then decreasing measurand (Figure 2). Hysteresis is expressed in percent of FSO during one calibration cycle

3.2.6
input full scale
upper limit of sensor input over the measuring range

3.2.7
linearity
closeness between the calibration curve and a specified straight line. There are two basic methods for calculating linearity: end point straight line fit or a least squares best line fit. While a least squares fit gives the “best case” linearity error (lower numerical value), the calculations required are burdensome. Conversely, an end point fit will give the “worst case” error (often more desirable in error budget calculations) and the calculation are more straightforward for the user. The result is called the end-point or terminal linearity

3.2.8
long term stability
ability that can keep feature of sensor during certain period

3.2.9
measuring range
set of values for a measurand for which the error of a measuring instrument is intended to lie within specified limits (Figure 1)

NOTE 1 The upper and lower limits of the specified measuring range are sometimes called “maximum capacity” and “minimum capacity”, respectively.

NOTE 2 In some other fields of knowledge, “range” is used to mean the difference between the greatest and the smallest values.

3.2.10
measurable temperature range
temperature range that sensor can measure

3.2.11
offset
output of a sensor, under room-temperature condition unless otherwise specified, with zero measurand applied (Figure 1)

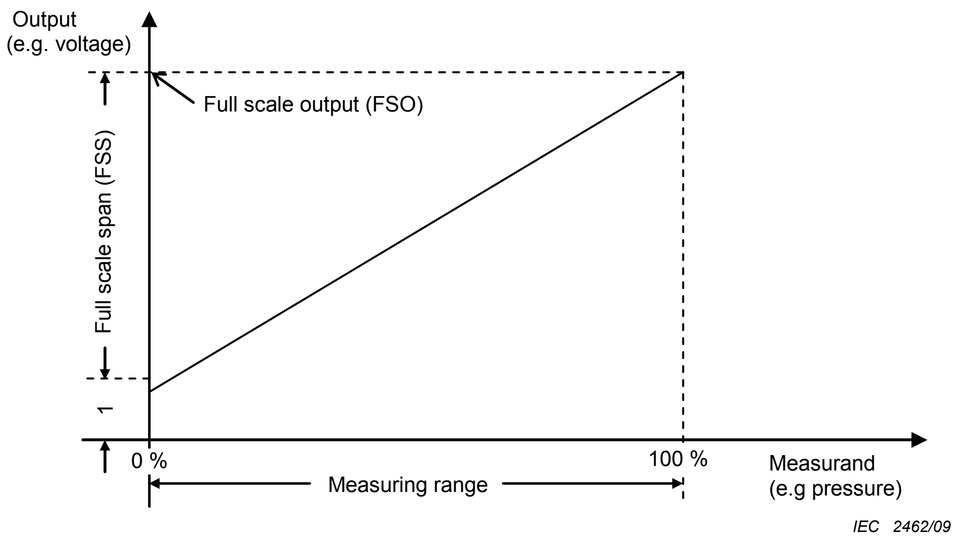

Figure 1 – Output-measurand relationship of a linear-output sensor with an offset

3.2.12
operating life
minimum duration over which the sensor will operate, either continuously or over a number of on-off cycles whose duration is specified, without changing performance characteristics beyond specified tolerances

3.2.13
operating temperature range
temperature range that sensor can operate in without giving damage in sensor normally

3.2.14
output quantity
output is usually the electrical quantity produced by a sensor and is a function of the measurable. The output format includes analogue output (e.g. a continuous function of the measurand such as voltage amplitude, voltage ratio, and changes in capacitance). Frequency output (i.e. the number of cycles or pulses per second as a function of the measurand) and frequency-modulated output (i.e. frequency deviation from a centre frequency) are also forms of analogue output. Another output format is the digital output which represents the measurand in the form of discrete quantities coded in some system of notation (e.g. binary code)

3.2.15
overload characteristics
overload (or overrange) is the maximum magnitude of measurand that can be applied to a sensor without causing a change in performance beyond specified tolerance. A key parameter of the overload characteristics is the recovery time, which is the amount of time allowed to elapse after removal of an overload condition before the sensor again performs within the specified tolerance

3.2.16
precision
ability that can measure real value repeatedly

3.2.17
repeatability
ability of a sensor to reproduce output readings at room temperature, unless otherwise specified, when the same measurand is applied to it consecutively, under the same conditions and in the same direction (Figure 2). It is expressed as the maximum difference between output readings as determined by two calibration cycles (Figure 2). It is usually stated as "within x % FSO"

3.2.18
resolution
minimal change of the value necessary to produce a detectable change at the output. When the measurand increment is from zero, it is called the threshold

3.2.19
selectivity
ability of sensor to measure one (e.g. one chemical component) in the presence of others

3.2.20
sensitivity
ratio of the change in sensor output to the change in the value of the measurable. It is the slope of the calibration curve (Figure1). For a sensor in which the output y is related to the measurand x by the equation $y = f(x)$, the sensitivity $S(x_a)$, at point x_a is

$$S(x_a) = \left.\frac{dy}{dx}\right|_{x=x_a}$$

It is desirable to have a high and, if possible, constant sensitivity. For a sensor having $y = kx+b$, where k and b are constants, the sensitivity S is k for the entire measuring range. For a sensor having $y = kx^2+b$, the sensitivity S is $2kx$ and changes from one point to another over the measuring range

3.2.21
sensor
device which is affected by the measurand (stimulus) and provides an output quantity (response)

3.2.22
supply voltage range
supply voltage range not to affect the change for sensibility and feature of sensor

3.2.23
span
modulus of the difference between the two limits of the range

3.2.24
stability
ability of a sensor to maintain its performance characteristics for a certain period of time. Unless otherwise stated, stability is the ability of a sensor to reproduce output readings, obtained during the original calibration, and constant room conditions, for a specified period of time. It is typically expressed as a percentage of FSO

3.2.25
temperature coefficient
ratio of resistance change to temperature change

3.2.26
time of response
time interval, with the apparatus in a warmed-up condition, between the time when an instantaneous variation in volume ratio is produced at the apparatus inlet and the time when the response reaches a stated percentage (x) of the final indication.

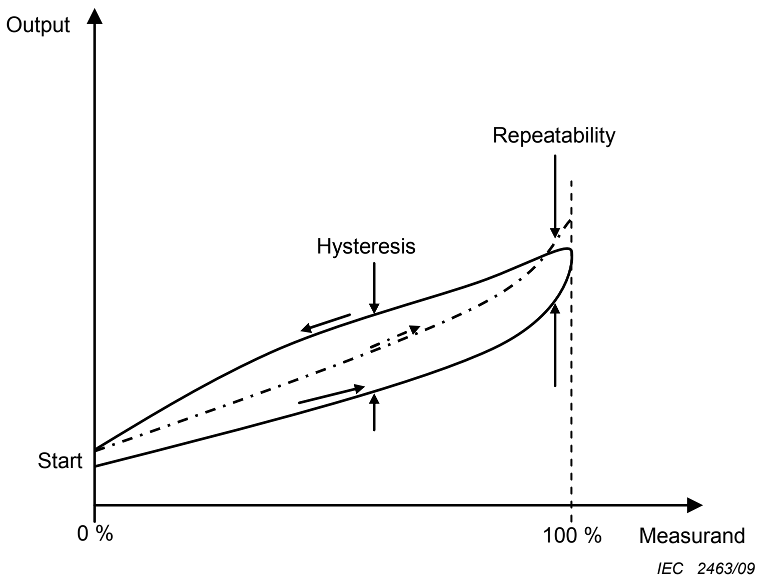

Figure 2 – Hysteresis and repeatability