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NORME INTERNATIONALE

Fibre optic sensors – Generic specification

Capteurs à fibres optiques – Spécification générique

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FIBRE OPTIC SENSORS – GENERIC SPECIFICATION

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.
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International Standard IEC 61757 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This first edition of IEC 61757 cancels and replaces IEC 61757-1, published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 61757-1:2012:

a) change of the document number due to a new structure of the fibre optic standard series;
b) update of the normative references and bibliography;
c) revision of Annex A.

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

CDV	Report on voting
86C/1461/CDV	86C/1488/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.

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.

INTRODUCTION

A fibre optic sensor contains an optical or optically powered sensing element in which the information is created by reaction of light to a measurand. The sensing element can be the fibre itself or an optically powered element inserted along the optical path. In a fibre optic sensor, one or more light parameters are directly or indirectly modified by the measurand somewhere in the optical path, contrary to an optical data link where the information is merely transmitted from the transmitter to the receiver.

Generic tests or measurement methods for fibre optic sensors are defined in this document. Where possible, these definitions are by reference to an IEC standard – otherwise the test or measurement method is outlined in the relevant standard of the fibre optic sensor standard series.

Annex A gives examples of fibre optic sensors to better illustrate the classification scheme. The examples given are illustrative only and are not limitative, nor do they constitute a recommendation or endorsement of a particular transduction principle.

FIBRE OPTIC SENSORS – GENERIC SPECIFICATION

1 Scope

This document is a generic specification covering optical fibres, components and sub-assemblies as they pertain specifically to fibre optic sensing applications. It has been designed to be used as a common working and discussion tool by the vendors of components and subassemblies intended to be integrated in fibre optic sensors, as well as by designers, manufacturers and users of fibre optic sensors independent of any application or installation.

The objective of this document is to define, classify and provide the framework for specifying fibre optic sensors, and their specific components and subassemblies. The requirements of this document apply to all related fibre optic sensor standards which belong to IEC 61757 (all parts). Standards of IEC 61757 (all parts) contain requirements specific to sensors for particular quantities subject to measurement, and for a particular style or variant of such a fibre optic sensor.

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 60050 (all parts), *International Electrotechnical Vocabulary* (available at www.electropedia.org)

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-5, *Environmental testing – Part 2-5: Tests – Test Sa: Simulated solar radiation at ground level and guidance for solar radiation testing*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-10, *Environmental testing – Part 2-10: Tests – Test J and guidance: Mould growth*

IEC 60068-2-11, *Basic environmental testing procedures – Part 2-11: Tests – Test Ka: Salt mist*

IEC 60068-2-13, *Basic environmental testing procedures – Part 2-13: Tests – Test M: Low air pressure*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-42, *Environmental testing – Part 2-42: Tests – Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-43, *Environmental testing – Part 2-43: Tests – Test Kd: Hydrogen sulphide test for contacts and connections*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60079-28, *Explosive atmospheres – Part 28: Protection of equipment and transmission systems using optical radiation*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60793-1-20, *Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*

IEC 60793-1-21, *Optical fibres – Part 1-21: Measurement methods and test procedures – Coating geometry*

IEC 60793-1-31, *Optical fibres – Part 1-31: Measurement methods and test procedures – Tensile strength*

IEC 60793-1-32, *Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability*

IEC 60793-1-47, *Optical fibres – Part 1-47: Measurement methods and test procedures – Macrobending loss*

IEC 60793-1-54, *Optical fibres – Part 1-54: Measurement methods and test procedures – Gamma irradiation*

IEC 60794-1-21, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical tests methods*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 60874-1, *Fibre optic interconnecting devices and passive components – Connectors for optical fibres and cables – Part 1: Generic specification*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61300 (all parts), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures*

IEC 61300-2-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal)*

IEC 61300-2-9, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-9: Tests – Shock*

IEC 61300-2-18, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-18: Tests – Dry heat – High temperature endurance*

IEC 61300-2-22, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*

IEC 61300-2-34, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-34: Tests – Resistance to solvents and contaminating fluids of interconnecting components and closures*

IEC 61300-2-46, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-46: Tests – Damp heat, cyclic*

IEC 61300-3-35, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-35: Examinations and measurements – Visual inspection of fibre optic connectors and fibre-stub transceivers*

IEC 61753 (all parts), *Fibre optic interconnecting devices and passive components performance standard*

IEC TR 61931, *Fibre optic – Terminology*

IEC TR 62222, *Fire performance of communication cables installed in buildings*

IEC TR 62283, *Optical fibres – Guidance for nuclear radiation tests*

IEC TR 62627-01, *Fibre optic interconnecting devices and passive components – Part 01: Fibre optic connector cleaning methods*

ISO/IEC Guide 99, *International vocabulary of metrology – Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in IEC TR 61931, ISO/IEC Guide 99 (VIM), and the following 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
accuracy
<of a fibre optic sensor> quality which characterizes the ability of a measuring instrument to provide an indicated value close to a true value of the measurand

Note 1 to entry: This term is used in the "true value" approach. This is a value that would be obtained by a perfect measurement.

Note 2 to entry: Accuracy is all the better when the indicated value is closer to the corresponding true value.

3.2
analogue signal interface
signal interface which provides analogue output signals in a form directly usable for control or measurement purposes, and which is generally electrical

Note 1 to entry: Output schemes should preferably comply with existing interface standards such as those existing for electrical analogue signals. Output schemes can be, for example, 4 mA to 20 mA, 0 mA to 20 mA, 0 V to 5 V, etc. A fibre optic sensor with a photodetector or other square-law detector, or with integrated signal processing electronics is a representative application example.

3.3
characteristic curve
calibration curve
expression of the relation between indication and corresponding measured quantity value

Note 1 to entry: A characteristic curve/calibration curve expresses a one-to-one relation that does not supply a complete measurement result as it bears no information about the measurement uncertainty.

[SOURCE: ISO/IEC Guide 99:2007, 4.31, modified – The term "characteristic curve" has been added as a first preferred term, as well as in the note.]

3.4
communication interface
digital interface of a fibre optic sensor which provides digital output signals in a form directly usable for control or measurement purposes, or which enables digital communication with other digital devices (e.g. personal computer)

Note 1 to entry: It is usually designed to a specific standard (e.g. USB, RS-232) and used for transmitting control and measurement data.

3.5
distributed fibre optic sensor
fibre optic sensor which provides a spatially resolved measurement of a measurand over an extended region by means of a continuous sensing element

3.6
drift
change in the metrological characteristics of a measuring instrument (and/or fibre optic sensor), generally slow, continuous, not necessarily in the same direction and not related to a change in the measurand

3.7
durability
ability of a fibre optic sensor to perform a required function under defined conditions of use and maintenance, until a limiting state is reached

Note 1 to entry: A limiting state of an item may be characterized by the end of the useful life, unsuitability for any economic or technological reasons or other relevant factors.

3.8
extrinsic fibre optic sensor
fibre optic sensor in which the characteristics of the light are affected externally to the optical fibre(s) by the measurand

3.9
fibre optic sensor
part of a measuring instrument, or measuring chain, which is directly affected by the measurand and which generates a change in the optical characteristics of an optical fibre related to the value of the measurand

Note 1 to entry: The optical fibre itself acts as the sensing element or it includes an optical or optically powered sensing element and may include one or more of the following (see Figure 1, Figure 2, and Figure 3):

– optical fibre lead;

– signal conditioning.

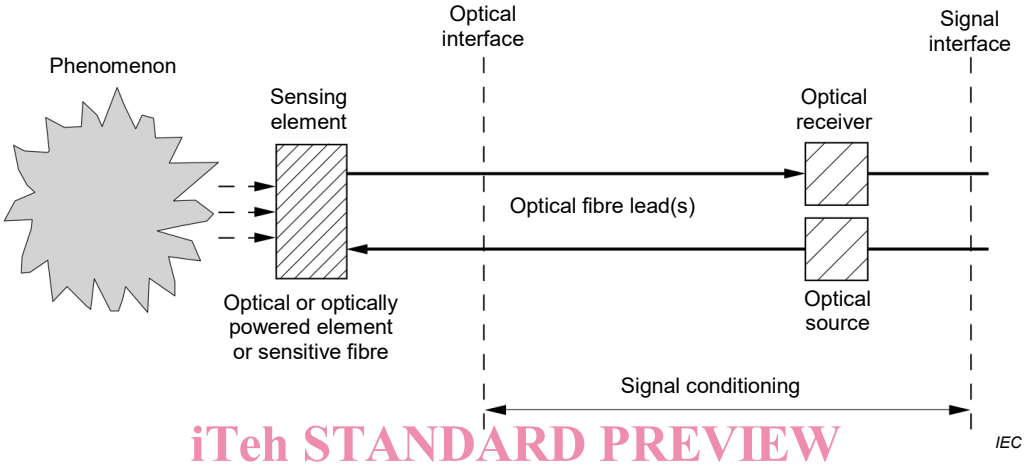


Figure 1 – Fibre optic sensor configuration with a passive sensing element and separate fibre leads for optical input and output

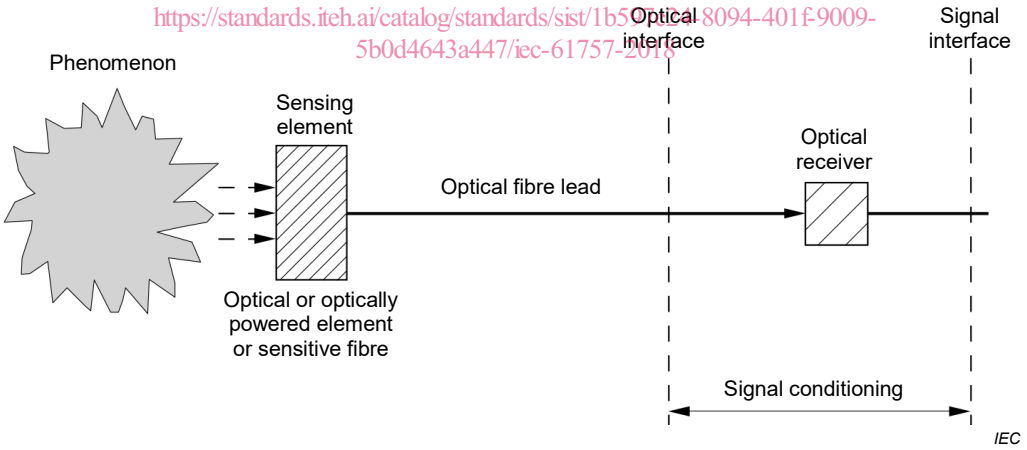
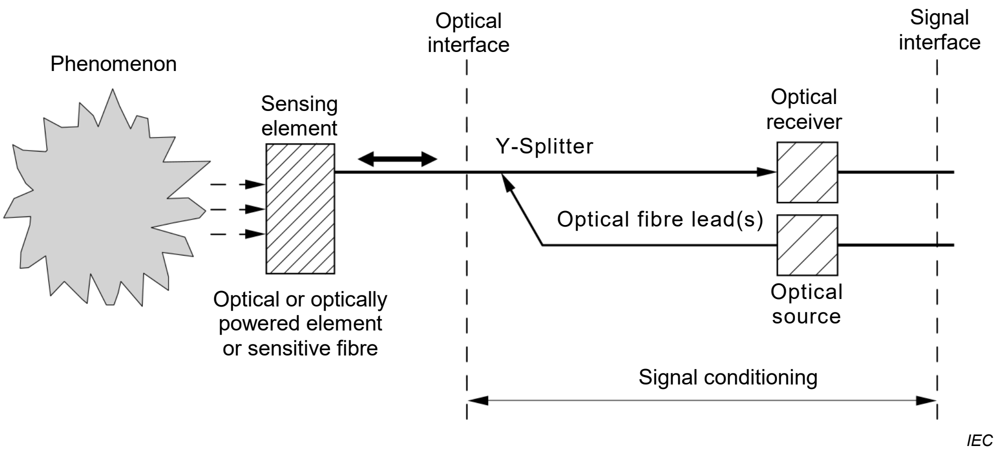


Figure 2 – Fibre optic sensor configuration with an active sensing element and one optical fibre lead for optical output



NOTE The signal separation is realized by a Y-splitter.

Figure 3 – Fibre optic sensor configuration with a passive sensing element and one fibre lead for optical input and output

3.10
gauge length
measurement basis
length marked on the parallel portion of a measured object from which the elongation is measured

Note 1 to entry: Used in mechanical testing of materials, it is the length marked on the parallel portion of a tensile test piece from which the elongation is measured.

Note 2 to entry: For example, if the sensor is only anchored at two fixed points L cm apart, then the gauge length is L. On the other hand, if a sensor of length l is continuously-fixed in or to a measured object of length L, then the actual gauge length depends on the method of attachment to the measured object and is a function of the mechanical properties of both the sensor and its surrounding; it is generally longer than l but shorter than L.

Note 3 to entry: If a user wants to achieve a pre-determined gauge length, he shall be very careful in selecting the procedure by which the sensor is anchored/attached/embedded. In case of continuously-fixed sensors, the fixing length shall exceed the defined gauge length by a few tens of fibre diameter to avoid shear-lag problems at the edges. In the specific case of fracture or cracks within the gauge length of the sample, the final gauge length shall be calculated then from the gauge length at fracture by subtracting from the latter the elastic portion of the elongation.

3.11
influence quantity
quantity that, in a direct measurement, does not affect the quantity that is actually measured, but affects the relation between the indication and the measurement result

[SOURCE: ISO/IEC Guide 99:2007, 2.52]

3.12
integrating fibre optic sensor
fibre optic sensor which provides a measurement result of a measurand over an extended region by means of a continuous sensing element of a defined length

Note 1 to entry: The measurand is not spatially resolved but is integrated or summed over the length of the sensing element.

3.13
intrinsic fibre optic sensor
fibre optic sensor whose sensing element consists of one or more optical fibre(s) in which one or more characteristics like intensity, phase, polarization, spectrum, wavelength or transit time of light depend on the measurand