

# INTERNATIONAL STANDARD



**Fibre optic sensors –  
Part 1-1: Strain measurement – Strain sensors based on fibre Bragg gratings**



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Part 1-1: Strain measurement – Strain sensors based on fibre Bragg gratings**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## FIBRE OPTIC SENSORS –

**Part 1-1: Strain measurement –  
Strain sensors based on fibre Bragg gratings**

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International Standard IEC 61757-1-1 has been prepared by subcommittee SC 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

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

CDV	Report on voting
86C/1322/CDV	86C/1353/RVC

Full information on the voting for the approval of 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.

A list of all parts in the IEC 61757 series, published under the general title *Fibre optic sensors*, can be found on the IEC website.

This International Standard is to be used in conjunction with IEC 61757-1:2012.

The committee has decided that the contents of this publication will remain unchanged until the stability 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- withdrawn,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.

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## INTRODUCTION

It has been decided to restructure the IEC 61757 series, with the following logic. From now on, the sub-parts will be renumbered as IEC 61757- $M$ - $T$ , where  $M$  denotes the measure and  $T$ , the technology.

The existing part IEC 61757-1:2012 will be renumbered as IEC 61757 when it will be revised as edition 2.0 and will serve as an umbrella document over the entire series.

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## FIBRE OPTIC SENSORS –

### Part 1-1: Strain measurement – Strain sensors based on fibre Bragg gratings

#### 1 Scope

This part of IEC 61757 defines detail specifications for fibre optic sensors using one or more fibre Bragg gratings (FBG) as the sensitive element for strain measurements. Generic specifications for fibre optic sensors are defined in IEC 61757-1:2012.

This standard specifies the most important features and characteristics of a fibre optic sensor for strain measurements based on use of an FBG as the sensitive element, and defines the procedures for their determination. Furthermore, it specifies basic performance parameters and characteristics of the corresponding measuring instrument to read out the optical signal from the FBG. This standard refers to the measurement of static and dynamic strain values in a range of frequencies.

A blank detail specification is provided in Annex B.

#### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 <http://www.electropedia.org>)

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

IEC 60793-2, *Optical fibres – Part 2: Product specifications – General*

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

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

IEC 61757-1:2012, *Fibre optic sensors – Part 1: Generic specification*

IEC 62129-1, *Calibration of wavelength/optical frequency measurement instruments – Part 1: Optical spectrum analyzers*

IEC 62129-2, *Calibration of wavelength/optical frequency measurement instruments – Part 2: Michelson interferometer single wavelength meters*

IEC TS 62129-3, *Calibration of wavelength/optical frequency measurement instruments – Part 3: Optical frequency meters using optical frequency combs*

IEC TR 61931, *Fibre optic – Terminology*

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

### 3 Terms and definitions

For the purposes of this document, the definitions given in IEC 61757-1:2012, the IEC 60050 series, IEC TR 61931, ISO/IEC Guide 99 (VIM), as well as the following apply.

NOTE Long period gratings, non-uniform gratings, angled gratings, and FBG in polarization maintaining fibre are not considered.

#### 3.1

##### **FBG**

##### **fibre Bragg grating**

phase diffraction grating integrated in optical single-mode silica-based fibres, according to category B of IEC 60793-2, to selectively reflect a very narrow range of wavelengths while transmitting others

Note 1 to entry: To achieve this characteristic, periodically spaced zones in the fibre core are altered to have different refractive indexes slightly higher than the core.

#### 3.2

##### **FBG strain sensor**

device that uses one or more fibre Bragg gratings (3.1) as a sensitive element for strain measurements

Note 1 to entry: Different configurations are possible (see 5.2).

#### 3.3

$\lambda_B$

##### **Bragg wavelength**

wavelength of the FBG (3.1), generally corresponding to the Bragg reflection peak or transmission minimum, without applied strain under reference ambient conditions

Note 1 to entry: If referred to as an FBG strain sensor (see 3.2), it refers to the configuration prior to its installation.

#### 3.4

$\lambda_0$

##### **reference wavelength**

wavelength response of an FBG after installation or at the beginning of measurement to the affecting loading and ambient conditions

#### 3.5

$R_{\text{FBG}}$

##### **FBG reflectivity**

ratio of the incident optical power  $P_0$  to the reflected optical power  $P_{\lambda_B}$  at Bragg wavelength  $\lambda_B$

Note 1 to entry: The power transmitted to the FBG strain sensor is less than the incident (input) optical power due to losses in the fibre at the connector and even in the grating. The definition of the FBG reflectivity should therefore use the incident optical power  $P_0$  (see formulas in 7.4.2.) that represents the measurable part at the connector of a fibre optic sensor.

Note 2 to entry:  $P_0$  depends on the measurement device and has no absolute characteristic value. From the user's point of view, the reflectivity is important if operational or installation conditions exist that influence the reflective characteristic.

#### 3.6

##### **transmission loss of an FBG sensor**

loss of power of the transmitted optical signal passing along the optical fibre, the fibre Bragg grating and the components to connect an FBG strain sensor outside the FBG spectrum