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Fibre optic interconnecting devices and passive components – Fibre optic fixed filters – Generic specification

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – FIBRE OPTIC FIXED FILTERS – GENERIC SPECIFICATION

FOREWORD

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International Standard IEC 61977 has been prepared by subcommittee SC 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee TC 86: Fibre optics.

This fourth edition cancels and replaces the third edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) change of the title and the scope for the limitation to fibre optic fixed filters;
b) addition of new terms and definitions reflecting new title;
c) removal of terms and definitions duplicated in IEC TS 62627-09;
d) harmonization of the vertical axis of Figures 1 to 5;
e) restructuration of Clause 4 reflecting the latest technical and market situation.

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

FDIS	Report on voting
86B/4267/FDIS	86B/4286/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.

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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

There are two generic specifications for fibre optic filters: fibre optic fixed filters and fibre optic tuneable filters. This document focuses on fibre optic fixed filters. Fibre optic tuneable bandpass filter is standardized in IEC 63032.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – FIBRE OPTIC FIXED FILTERS – GENERIC SPECIFICATION

1 Scope

This document applies to the family of fibre optic filters. These components have all of the following general features:

– they are passive for the reason that they contain no optoelectronic or other transducing elements which can process the optical signal launched into the input port;

– they modify the spectral intensity distribution in order to select some wavelengths and inhibit others;

– they are fixed, i.e. the modification of the spectral intensity distribution is fixed and cannot be tuned;

– they have input and output ports or a common port (having both functions of input and output) for the transmission of optical power; the ports are optical fibre or optical fibre connectors;

– they differ according to their characteristics. They can be divided into the following categories:

  - short-wave pass (only wavelengths lower than or equal to a specified value are passed);
  - long-wave pass (only wavelengths greater than or equal to a specified value are passed);
  - band-pass (only an optical window is allowed);
  - notch (only an optical window is inhibited);
  - gain flattening (compensating the spectral profile of the device).

It is also possible to have a combination of the above categories.

This document provides the generic information including terminology of IEC 61753-04x series documents. Published IEC 61753-04x series documents are listed in the Bibliography.

This document establishes uniform requirements for optical, mechanical and environmental properties.

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 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050-731, *International Electrotechnical Vocabulary (IEV) – Part 731: Optical fibre communication* (available at http://www.electropedia.org)

IEC 60617 ~~(all parts)~~, *Graphical symbols for diagrams* (available at http://std.iec.ch/iec60617)

~~IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*~~

IEC 60825 (all parts), *Safety of laser products*

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

IEC TR 61930, *Fibre optic graphical symbology*

IEC TS 62627-09, *Fibre optic interconnecting devices and passive components – Vocabulary for passive optical devices*

ISO 129-1, *Technical~~ drawings~~ product documentation (TPD) –~~ Indication~~ Presentation of dimensions and tolerances – Part 1: General principles*

ISO 286-1, *Geometrical product specifications (GPS) – ISO code system for tolerances on linear sizes – Part 1: Basis of tolerances, deviations and fits*

ISO 1101, *Geometrical product specifications (GPS) – Geometrical tolerancing – Tolerances of form, orientation, location and run-out*

~~ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*~~

ISO 8601-1, *Date and time – Representations for information interchange – Part 1: Basic rules*

3 Terms and definitions

For the purpose of this document, terms and definitions given in IEC 60050-731, IEC TS 62627-09 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 Basic terms~~

~~3.1.1~~
~~port~~
~~optical fibre or optical fibre connector attached to a passive component for the entry and/or exit of the optical power (input and/or output port)~~

3.1 Component terms

3.1.1
bandpass filter
BPF
~~band-pass filter~~fibre optic filter designed to allow signals between two specific wavelengths to pass

Note 1 to entry: This note applies to the French language only.

3.1.2
etalon
device consisting of a transparent plane-parallel plate with two reflecting surfaces, or two parallel reflecting mirrors

Note 1 to entry: The varying transmission function of an etalon is caused by interference between the multiple reflections of light between the two reflecting surfaces.

Note 2 to entry: Annex A describes the outline of etalon technology.

3.1.3
fibre Bragg grating
FBG
fibre optic device which has a short periodic variation to the refractive index of the fibre core along the fibre

Note 1 to entry: An FBG can reflect particular wavelengths of light and transmit other wavelengths.

Note 2 to entry: Annex B describes the outline of FBG technology.

Note 3 to entry: This note applies to the French language only.

3.1.4
fibre optic filter
passive component used in fibre optic transmission system to modify the spectral intensity distribution of a signal in order to transmit or attenuate some wavelengths and block some others

Note 1 to entry: There are two types of fibre optic filters: fibre optic fixed filters and fibre optic tuneable filters.

Note 2 to entry: The wavelength band which transmits or attenuates the signal is called the passband. There may be more than one passband.

3.1.5
fibre optic fixed filter
fibre optic filter which spectral profile is fixed

3.1.6
fibre optic tuneable filter
fibre optic filter which spectral profile is changeable

Note 1 to entry: Fibre optic tuneable bandpass filter is standardized in IEC 63032.

3.1.7
gain flattening filter
gain equalizer
GFF
GEQ
~~device~~ fibre optic filter designed to have the inverse characteristic of the wavelength dependent ~~insertion~~ loss of an optical device

Note 1 to entry: A GFF (GEQ) is used for the purpose of minimizing the wavelength dependent loss of a fibre optic device.

Note 2 to entry: A GFF (GEQ) is typically used with (in) an optical amplifier.

Note 3 to entry: This note applies to the French language only.

Note 4 to entry: This note applies to the French language only.

3.1.8
long wavelength pass filter
LWPF
fibre optic filter that passes long wavelength signals but reduces the amplitude of short wavelength signals

Note 1 to entry: This note applies to the French language only.

3.1.9
notch filter
fibre optic filter that passes all wavelengths except those in a stop band centred on a particular wavelength

3.1.10
reflecting type fibre optic filter
~~fibre optic filter in which the input and output ports are coincident~~
wavelength selective reflecting device having two ports that reflects back the light to the launch port at different wavelength range (OTDR monitoring range)

3.1.11
short wavelength pass filter
SWPF
fibre optic filter that passes short wavelength signals but reduces the amplitude of long wavelength signals

Note 1 to entry: This note applies to the French language only.

3.1.12
thin-film filter
TFF
fibre optic filter which passes particular wavelength band(s) and reflects all other wavelengths by using the interference effect of thin-film

Note 1 to entry: One of the typical TFF is a dielectric multi-layer film filter. Annex C describes the outline of TFF technology.

Note 2 to entry: This note applies to the French language only.

3.1.13
transmitting type fibre optic filter
fibre optic filter in which the input and output ports are separated

3.2 Performance terms

3.2.1
operating wavelength
nominal wavelength λ_h, at which a fibre optic filter operates with the specified performances

Note 1 to entry: The term "operating wavelength" includes the nominally transmitting wavelength, and designated attenuation/isolation wavelength.

3.2.2
operating wavelength range
specified range of wavelengths including all operating wavelengths

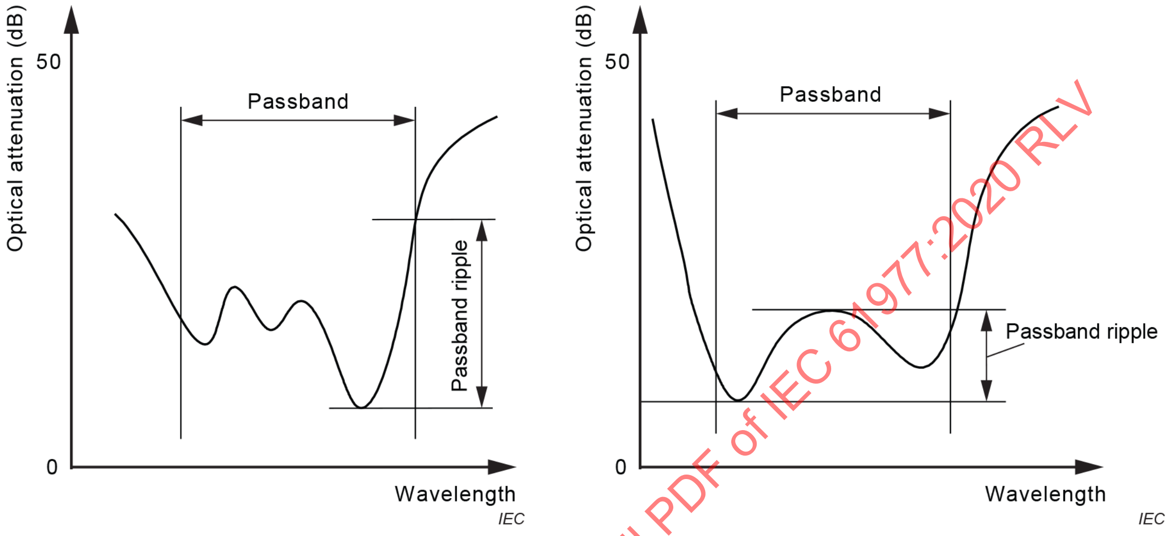
Note 1 to entry: It includes all passbands and isolation wavelength ranges.

3.2.3
passband
wavelength range within which a passive optical component is required to operate with optical attenuation less than or equal to a specified optical attenuation value

Note 1 to entry: There may be one or more passbands for a fibre optic filter.

3.2.4
passband ripple
maximum peak-to-peak variation of the insertion loss (absolute value) over the passband

Note 1 to entry: See Figure 1.



a) Passband ripple at band edges **b) Passband ripple in band**

Figure 1 – Illustration of passband ripple

Note 2 to entry: For a wide wavelength division multiplexing (WWDM) fibre optic filter which has only one passband, the term "spectral ripple" or "flatness" is used instead of "passband ripple".

3.2.5
insertion loss
attenuation
a
reduction of optical power in a passband, when transmitted ~~between the ports of a two-port~~ through a fibre optic filter

Note 1 to entry: The insertion loss is expressed in decibels and defined as:

$$a = -10\log_{10}\left(\frac{P_{out}}{P_{in}}\right)$$

where

P_{in} is the optical power launched into ~~one of the two ports~~ the fibre optic filter;

P_{out} is the optical power received ~~from the other port~~ out of the fibre optic filter.

Note 2 to entry: The insertion loss (attenuation) is a function of wavelength.

3.2.6
free spectral range
FSR
difference between two adjacent operating wavelengths, in the case of a periodic spectral response of a fibre optic filter~~, difference between two adjacent operating wavelengths~~

Note 1 to entry: This note applies to the French language only.

3.2.7
isolation wavelength
nominal wavelength λ_k (where $\lambda_h \neq \lambda_k$), that is nominally suppressed by a fibre optic filter

3.2.8
isolation wavelength range
stopband
specified range of wavelengths from λ_{kmin} to λ_{kmax} around the isolation wavelength λ_k, that are nominally suppressed by a fibre optic filter

Note 1 to entry: There may be one or more isolation wavelength ranges (stopbands) for a fibre optic filter.

Note 2 to entry: The term "stopband" is an antonym of the term passband.

Note 3 to entry: See Figure 2.

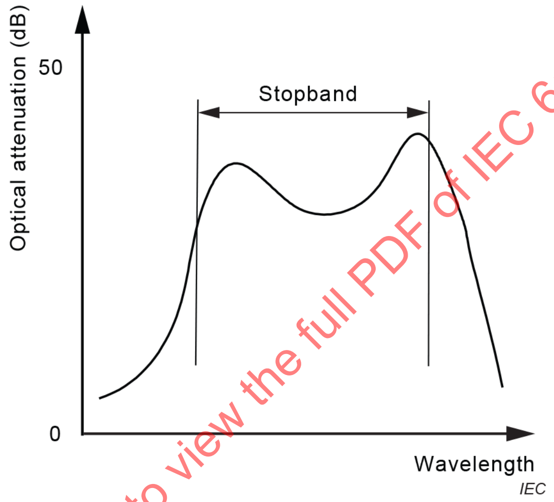


Figure 2 – Illustration of a stopband

3.2.9
maximum insertion loss within a passband
maximum attenuation within a passband
maximum value of the ~~insertion loss~~ optical attenuation within a passband

Note 1 to entry: Figure 3 shows passband and maximum insertion loss within a passband.

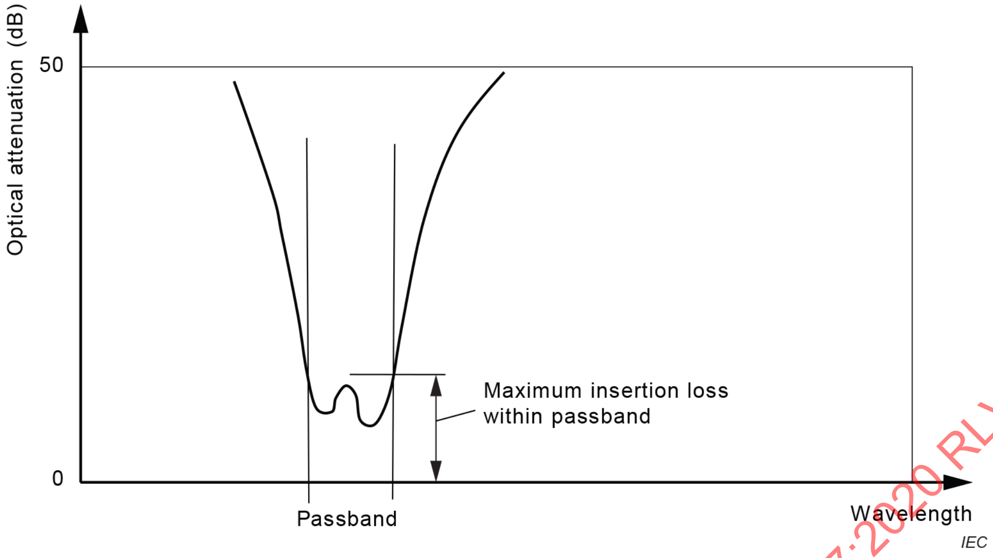


Figure 3 – Illustration of maximum insertion loss within a passband

3.2.10
maximum slope of passband ripple
maximum value in fibre optic filter of the derivative of the insertion loss (for transmitting type fibre optic filter) or return loss (for reflecting type fibre optic filter) as a function of wavelength over the passband

3.2.11
minimum insertion loss within a passband
minimum attenuation within a passband
minimum value of the ~~insertion loss~~ optical attenuation within a passband

Note 1 to entry: Figure 4 shows passband and minimum insertion loss within a passband.

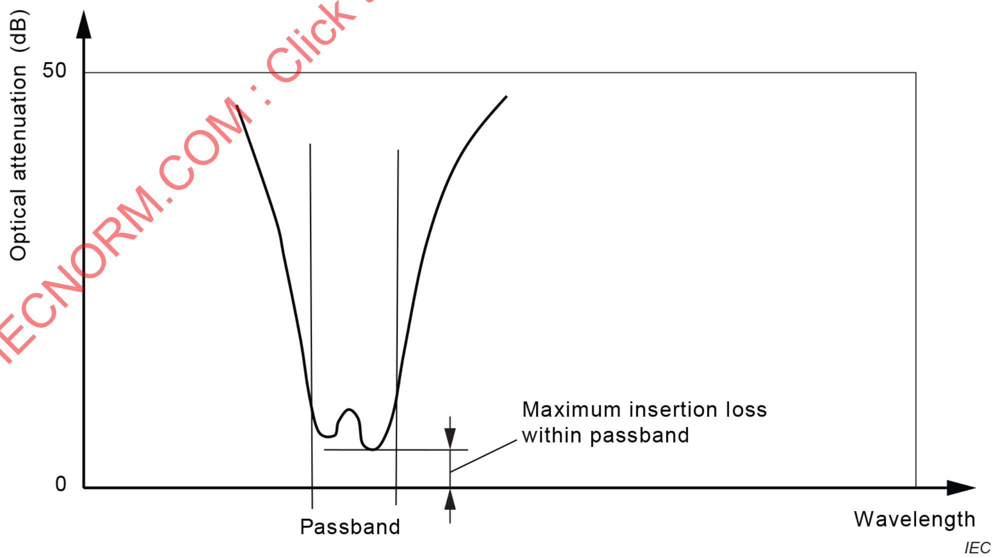


Figure 4 – Illustration of minimum insertion loss within a passband

3.2.12
return loss
a_{RL}
fraction of input power that is returned from a port of a fibre optic filter

Note 1 to entry: The return loss is expressed in decibels and defined as:

$$a_{RL} = -10\log_{10}\left(\frac{P_{refl}}{P_{in}}\right)$$

where

P_{in} is the optical power launched into the port;

P_{refl} is the optical power received back from the same port.

Note 2 to entry: The return loss is a function of wavelength.

3.2.13
wavelength dependent loss
variation of insertion loss of a fibre optic filter within passband(s)

Note 1 to entry: When there are two or more passbands, the wavelength dependent loss is generally defined as the maximum value of passband ripples.

Note 2 to entry: The term "wavelength dependent loss" is generally used for LWPFs, SWPFs or relatively wide passband filters. For BPF especially narrow passband filters, for example WDM application, passband ripple is generally used.

3.2.14
***X* dB bandwidth**
minimum band width which the variation of insertion loss (attenuation) is X dB within a passband

Note 1 to entry: X dB bandwidth shall be determined by considering the temperature dependency of wavelength, polarization dependency, long term stability of wavelength, etc.

Note 2 to entry: X is typically used as 0,5, 1, 3 or 20.

Note 3 to entry: See Figure 5.

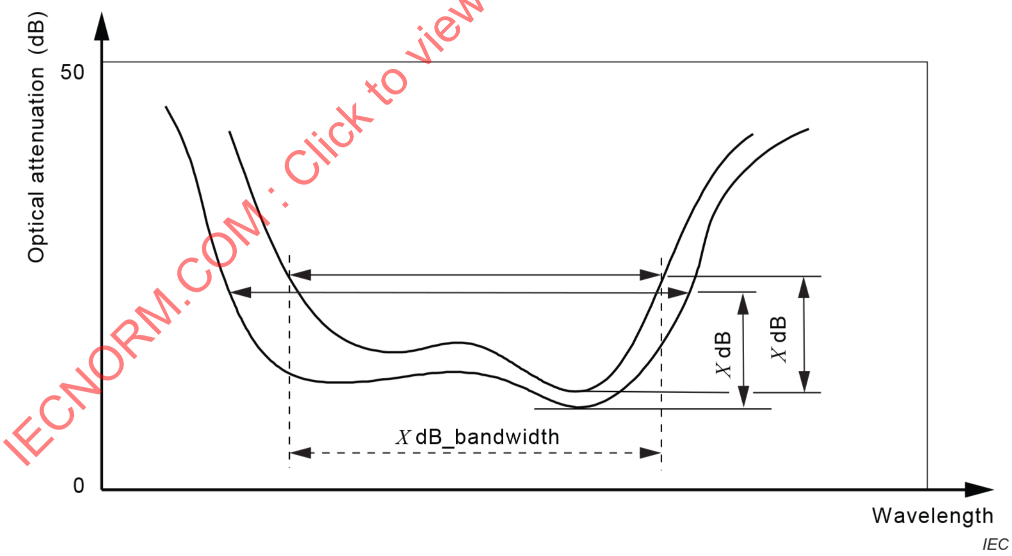


Figure 5 – Illustration of *X* dB bandwidth

4 Requirements

4.1 Classification

4.1.1 General

~~Filters are classified either totally or in part in the following categories:~~

- ~~type;~~
- ~~style;~~
- ~~variant;~~
- ~~environmental category;~~
- ~~assessment level;~~
- ~~normative reference extensions.~~

~~An example of a typical filter classification is given in Table 1:~~

Fibre optic fixed filters are classified either totally or in part in the following categories:

- technology and function type;
- interface style.

An example of a typical fibre optic fixed filter classification is given in Table 1.

Table 1 – Example of a typical fibre optic fixed filter classification

~~Type~~	~~Fixed~~
~~Style~~	~~– Configuration C~~ ~~– Fibre type: IEC type A1a~~ ~~– SC connector~~
~~Variant~~	~~Means of mounting~~
~~Assessment level~~	~~A~~

Items	Classifications
Technology and function type	Technology: TFF Function: LWPF
Interface style	Configuration B Fibre type: IEC 60793-2 type B1 IEC 61754-4 (SC connector)

4.1.2 Technology and function Type

~~The optic filter type shall be defined by its intended function and optical performance. There are several types of filters, for instance:~~

- ~~long wavelength pass filter (LWPF);~~
- ~~band-pass filter (BPF);~~
- ~~short wavelength pass filter (SWPF);~~
- ~~gain flattening filter (GFF)/ gain equalizer (GEQ);~~
- ~~notch.~~

4.1.2.1 Technologies

The fibre optic fixed filter shall be defined by its technology type. There are several technology types of filters, for instance:

- thin-film filter (TFF);
- fibre Bragg grating (FBG);
- etalon filter.

4.1.2.2 Functions

The fibre optic fixed filter type shall be defined by its intended function and optical performance. There are several types of filters, for instance:

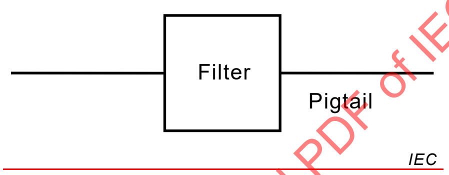
– long wavelength pass filter (LWPF);
– band-pass filter (BPF);
– short wavelength pass filter (SWPF);
– gain flattening filter (GFF)/ gain equalizer (GEQ);
– notch.

4.1.3 Interface style

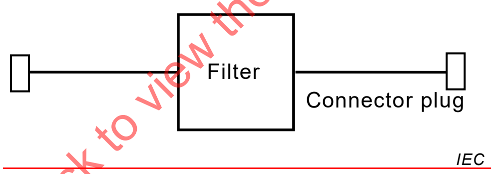
~~The optic filter style shall be defined on the basis of the following elements:~~

~~– the input and output port configuration;~~
~~– the connector set type(s), if any.~~

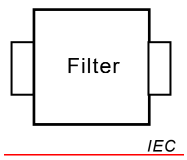
~~The seven different input and output configurations can be scheduled as shown in Figure 6:~~



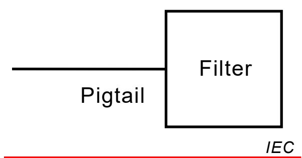
~~a) Configuration A – Device containing fibre optic pigtails without connector plug~~



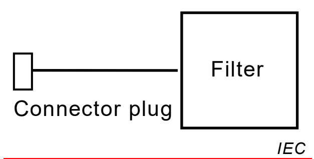
~~b) Configuration B – Device containing integral fibres, with a connector plug on each fibre~~



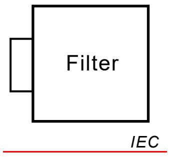
~~c) Configuration C – Device containing fibre optic connectors as a part of the device housing~~



~~d) Configuration D – Device containing one fibre optic pigtail without connector plug~~



~~e) Configuration E – Device containing one fibre optic pigtail with a connector plug~~



~~**f) Configuration F – Device containing one fibre optic connector as a part of the device housing**~~

~~NOTE Configuration G is a device containing some combination of the interfacing features of the preceding configurations.~~

~~**Figure 6 – Optic filter style configurations**~~

The fibre optic fixed filter style shall be defined on the basis of the following elements:

– the input and output port configuration;

– the connector set type(s), if any.

NOTE Examples of interface style are provided in Annex D.

~~4.1.4 Variant~~

~~The optic filter variant defines the feature that identifies the variety of structurally similar components. Examples of feature variables which create variants are:~~

– ~~cable type;~~

– ~~fibre type;~~

– ~~housing;~~

– ~~orientation of ports;~~

– ~~means of mounting.~~

~~4.1.5 Normative reference extensions~~

~~Normative reference extensions are used to identify independent standards specifications or other reference documents integrated into relevant specifications.~~

~~Unless a specified exception is noted, additional requirements imposed by an extension are mandatory. Usage is primarily intended to merge associated components to form hybrid devices, or integrated functional application requirements that are dependent on technical expertise other than fibre optics.~~

~~Some optical fibre filter configurations require special qualification provisions which shall not be imposed universally. This accommodates individual component design configurations, specialized field tooling, or specific application processes. In this case requirements are necessary to guarantee repeatable performance or adequate safety, and provide additional guidance for complete product specification. These extensions are mandatory whenever used to prepare, assemble or install an optical fibre splice either for field application usage or preparation of qualification test specimens. The relevant specification shall clarify all stipulations. However, design and style dependent extensions shall not be imposed universally.~~

~~Some commercial or residential building applications may require direct reference to specific safety codes and regulations or incorporate other specific material flammability or toxicity requirements for specialized locations.~~

~~Specialized field tooling may require an extension to implement specific ocular safety, electrical shock or burn hazard avoidance requirements, or require isolation procedures to prevent potential ignition of combustible gases.~~

4.2 Documentation

4.2.1 Symbols

Graphical and letter symbols shall, whenever possible, be taken from IEC 60027 (all parts), IEC 60617 and IEC TR 61930.

~~4.2.2 Specification system~~

~~4.2.2.1 General~~

~~This specification is part of the IEC specification system. Subsidiary specifications shall consist of relevant specifications. This system is shown in Table 2. There are no sectional specifications for filters.~~

~~Table 2 – The IEC specification structure~~

~~Specification level~~	~~Examples of information to be included~~	~~Applicable to~~
~~Basic~~	~~Assessment system rules~~ ~~Inspection rules~~ ~~Optical measurement methods~~ ~~Sampling plans~~ ~~Identification rule~~ ~~Marking standards~~ ~~Dimensional standards~~ ~~Terminology~~ ~~Symbol~~ ~~Preferred number series~~ ~~SI units~~	~~Two or more component families or sub-families~~
~~Generic~~	~~Specific terminology~~ ~~Specific symbols~~ ~~Specific units~~ ~~Preferred values~~ ~~Marking~~ ~~Selection of tests~~ ~~Qualification approval and/or capability approval procedures~~	~~Component family~~
~~Blank detail~~	~~Quality conformance test schedule~~ ~~Inspection requirements~~ ~~Information common to a number of types~~	~~Groups of types having a common test schedule~~
~~Detail~~	~~Individual values~~ ~~Specific information~~ ~~Completed quality conformance test schedules~~	~~Individual type~~

~~4.2.2.2 Blank detail specifications~~

~~The blank detail specification lists all of the parameters and features applicable to a fibre optic filter, including the type, operating characteristics, housing configurations, test methods, and performance requirements. The blank detail specification is applicable to any fibre optic filter design and quality assessment requirement. The blank detail specification contains the preferred format for stating the required information in the detail specification.~~

~~Blank detail specifications are not, by themselves, a specification level. They are associated with the generic specification.~~

~~Each blank detail specification shall be limited to one environmental category.~~

~~Each blank detail specification shall contain~~

- ~~the minimum mandatory test schedules and performance requirements,~~
- ~~one or more assessment levels,~~
- ~~the preferred format for stating the required information in the detail specification,~~
- ~~in case of hybrid components, including connectors, addition of appropriate entry fields to show the reference normative document, document title and issue date.~~

~~4.2.2.3 Detail specifications~~

~~A specific fibre optic filter is described by a corresponding detail specification, which is prepared by filling in the blanks of the blank detail specification. Within the constraints imposed by this generic specification, the blank detail specification may be filled in by any national committee of the IEC, thereby defining a particular fibre optic filter as an IEC standard.~~

~~Detail specifications shall specify the following, as applicable:~~

- ~~type (see 4.1.2);~~
- ~~style (see 4.1.3);~~
- ~~variant(s) (see 4.1.4);~~
- ~~part identification number for each variant (see 4.6.2);~~
- ~~drawings, dimensions required (see 4.2.3);~~
- ~~quality assessment test schedules (see 4.2.5);~~
- ~~performance requirements (see 4.5).~~

4.2.2 Drawings

4.2.2.1 General

The drawings and dimensions given in the relevant specifications shall not restrict detail construction nor be used as manufacturing drawings.

4.2.2.2 Projection system

Either first angle or third angle projection shall be used for the drawings in documents covered by this document. All drawings within a document shall use the same projection system and the drawings shall state which system is used.

4.2.2.3 Dimensional system

All dimensions shall be given in accordance with ISO 129-1, ISO 286-1 and ISO 1101. The metric system shall be used in all specifications. Dimensions shall not contain more than five significant digits. When units are converted, a note shall be added in each relevant specification.

4.2.3 Tests and measurements

4.2.3.1 Tests and measurements procedures

The tests and measurements procedures for optical, mechanical, climatic and environmental characteristics of fibre optic fixed filters to be used shall be defined and selected preferentially from IEC 61300 (all parts). The size measurement method to be used shall be specified in the relevant specification for dimensions which are specified within a total tolerance zone of 0,01 mm or less.

4.2.3.2 Reference components

Reference components (such as golden samples) for measurement purposes, if required, shall be specified in the relevant specification.

~~4.2.4.3 Gauges~~

~~Gauges, if required, shall be specified in the relevant specification.~~

4.2.4 Test report

The test reports shall be prepared for each test conducted as required by a relevant specification. The ~~data sheets~~ reports shall be included in the qualification test report and in the periodic inspection report.

~~Data sheets~~ Test reports shall contain the following information as a minimum:

– title and date of test;

~~– specimen description including the variant identification number (see 4.6.2);~~

– test equipment used;

– all applicable test details;

– all measurement values and observations.

4.2.5 Instructions for use

Instructions for use, when required, shall be given by the manufacturer.

4.3 Standardisation system

4.3.1 Interface standards

~~Interface standards provide both manufacturers and users with all the information they require to make or use products conforming to the physical features of that standard interface. Interface standards fully define the features essential for the mating and unmating of optical fibre connectors and other components. They also serve to position the optical datum target, where defined, relative to other reference data.~~

~~Interface standards ensure that connectors and adapters that comply with the standard will fit together. The standards may also contain tolerance grades for ferrules and alignment devices. Tolerance grades are used to provide different levels of alignment precision.~~

~~The interface dimensions may also be used to design other components that will mate with the connectors. For example, an active device mount can be designed using the adapter interface dimensions. The use of these dimensions combined with those of a standard plug, provides the designer with assurance that the standard plugs will fit into the optical device mount. They also provide the location of the plug's optical datum target.~~

~~Standard interface dimensions do not, by themselves, guarantee optical performance. They guarantee connector mating at a specified fit. Optical performance is currently guaranteed via the manufacturing specification. Products from the same or different manufacturing specifications using the same standard interface will always fit together. Guaranteed performance can be given by any single manufacturer only for products delivered to the same manufacturing specification. However, it can be reasonably expected that some level of performance will be obtained by mating products from different manufacturing specifications,~~

~~although the level of performance cannot be expected to be any better than that of lower specified performance.~~

Refer proper references when (in case) the connector is used, such as IEC 61754 (all parts).

4.3.2 Performance standards

Performance standards – IEC 61753 (all parts) – contain a series of tests and measurements (which may or may not be grouped into a specified schedule depending on the requirements of that standards) with clearly defined conditions, severities and pass/fail criteria. The tests are intended to be run on a "one-off" basis to prove the ability of any product to satisfy the "performance standards" requirement. Each performance standard has a different set of tests, and/or severities (and/or groupings) representing the requirements of a market sector, user group or system location.

A product that has been shown to meet all the requirements of a performance standard can be declared as complying with a performance standard but should then be controlled by a quality assurance/quality conformance programme.

~~It may be possible to define a key point of the test and measurements standards, when these are applied (particularly with regard to insertion loss and return loss) in conjunction with the interface standards of inter-product compatibility. Certainly conformance on each individual product to this standard will be ensured.~~

4.3.3 Reliability standards

Reliability standards are intended to ensure that a component can meet performance specifications under stated conditions for a stated time period.

~~For each type of component, the following shall be identified (and shall appear in the standard):~~

- ~~failure modes (observable general, mechanical or optical effects of failure);~~
- ~~failure mechanisms (general causes of failure, which may be common to several components), and~~
- ~~failure effects (detailed causes of failure, specific to component).~~

~~These are all related to environmental and material aspects.~~

~~There is an initial "infant mortality phase" just after component manufacturing, during which many components would fail if they were deployed in the field. To avoid early field failure, all components may be subjected to a screening process in the factory, involving environmental stresses that may be mechanical, thermal and humidity related. This is to induce known failure mechanisms in a controlled environmental situation to occur earlier than would normally be seen in the unscreened population. For those components that survive (and are then sold), there is a reduced failure rate since these mechanisms have been eliminated.~~

~~Screening is an optional part of the manufacturing process, rather than a test method. It will not affect the "useful life" of a component defined as the period during which it performs according to specifications. Eventually other failure mechanisms appear, and the failure rate increases beyond some defined threshold. At this point the useful life ends and the "wear-out region" begins, and the component must be replaced.~~

~~At the beginning of useful life, performance testing on a sampled population of components may be applied by the supplier, by the manufacturer, or by a third party. This is to ensure that the component meets performance specifications over the range of intended environments at this initial time. Reliability testing, on the other hand, is applied to ensure that the component meets performance specifications for at least a specified minimum useful lifetime or specified maximum failure rate. These tests are usually carried out by utilising the performance testing, but increasing its duration and severity, in order to accelerate the failure mechanisms.~~

~~A reliability theory relates component reliability testing to component parameters and to lifetime or failure rate under testing. The theory then extrapolates these to lifetime or failure rate under less stressful service conditions. The reliability specifications include values of the component parameters needed to ensure the specified minimum lifetime or maximum failure rate in service.~~

~~4.3.4 Interlinking~~

~~Standards currently under preparation are given in Figure 7. A large number of the test and measurements standards already exist, and quality assurance qualification approval standards have existed for many years.~~

~~With regard to interface, performance and reliability standards, once all these three standards are in place, the matrix given in Table 3 demonstrates some of the other options available for product standardisation.~~

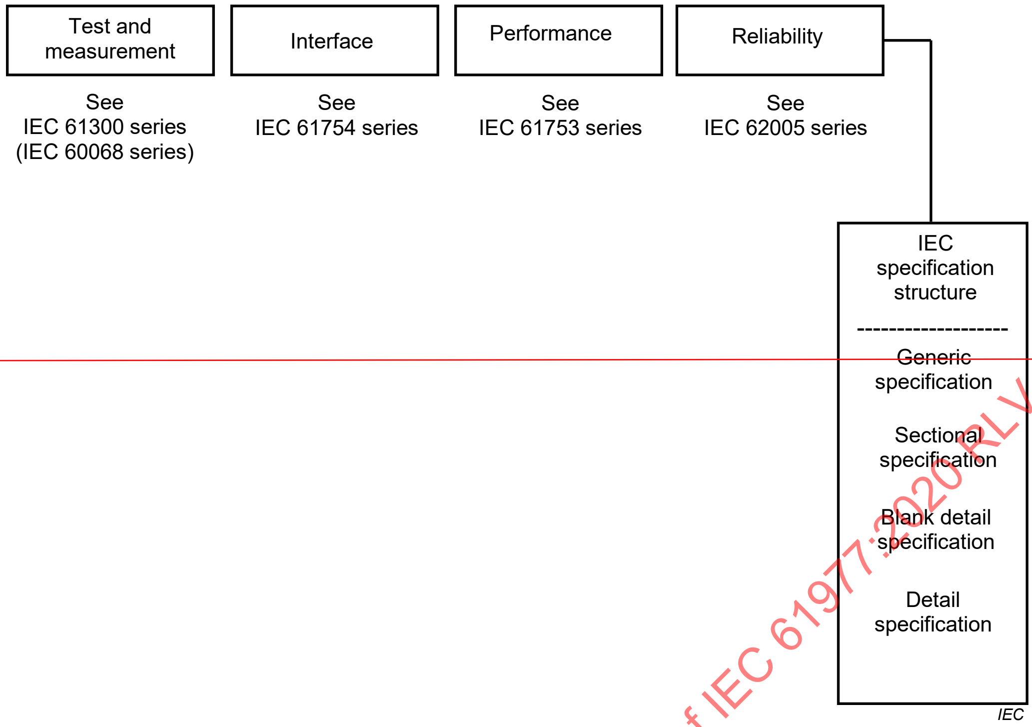
~~Product A is fully IEC standardised, having a standard interface and meeting defined performance and reliability standards.~~

~~Product B is a product with a proprietary interface but which meets a defined IEC performance standard and a reliability standard.~~

~~Product C is a product which complies with an IEC standard interface but does not meet the requirements of either an IEC performance standard or a reliability standard.~~

~~Product D is a product which complies with both an IEC standard interface and performance standard but does not meet any reliability requirements.~~

~~Obviously the matrix is more complex than shown since there will be a number of interface, performance and reliability standards which will be able to be cross-related. In addition, the products may all be subjected to a recognized quality assurance programme including qualification approval, capability approval and technology approval (as Table 4 attempts to demonstrate), or even under a national or company quality assurance system.~~



~~**Figure 7 – Standards currently under preparation**~~

~~**Table 3 – Standards interlink matrix**~~

	~~**Interface standard**~~	~~**Performance standard**~~	~~**Reliability standard**~~
~~Product A~~	~~YES~~	~~YES~~	~~YES~~
~~Product B~~	~~NO~~	~~YES~~	~~YES~~
~~Product C~~	~~YES~~	~~NO~~	~~NO~~
~~Product D~~	~~YES~~	~~YES~~	~~NO~~

~~**Table 4 – Quality assurance options**~~

	~~**Company A**~~			~~**Company B**~~			~~**Company C**~~		
	~~**QA[a]**~~	~~**CA[b]**~~	~~**TA[c]**~~	~~**QA[a]**~~	~~**CA[b]**~~	~~**TA[c]**~~	~~**QA[a]**~~	~~**CA[b]**~~	~~**TA[c]**~~
~~Product A~~	~~x~~			~~x~~					~~x~~
~~Product B~~	~~x~~				~~x~~				~~x~~
~~Product C~~	~~x~~				~~x~~				~~x~~
~~Product D~~	~~x~~					~~x~~			~~x~~

~~[a] Qualification approval~~

~~[b] Capability approval~~

~~[c] Technology approval~~

4.4 Design and construction

4.4.1 Materials

4.4.1.1 General

~~The devices~~ All housing materials used in the construction shall be manufactured with materials which meet the requirements of the relevant specification.

4.4.1.2 Non-flammable materials

When non-flammable materials are required, the requirements shall be specified ~~in the relevant specification~~, and reference should be made to IEC 60695-11-5. If an alternate standard is used for non-flammable materials, it shall be ~~referenced~~ declared.

4.4.2 Workmanship

Components and associated hardware shall be manufactured to a uniform quality and shall be free of sharp edges, burrs or other defects that would affect life, serviceability or appearance. Particular attention shall be given to neatness and thoroughness of marking, plating, soldering, bonding, etc.

4.5 Quality

Fibre optic fixed filters shall be controlled by the quality assessment procedures and declared.

4.6 Performance requirements

Fibre optic fixed filters shall meet the performance requirements specified in the relevant specification.

4.7 Identification and marking

4.7.1 General

Components, associated hardware and shipping packages shall be permanently and legibly identified and marked when required by the relevant specification.

~~4.6.2 Variant identification number~~

~~Each variant in a relevant specification shall be assigned a variant identification number; this number shall be set out as follows:~~

~~Example QC210101/US0001 001 A~~

~~Relevant specification number — QC210101/US0001~~

~~Variant number — 001~~

~~Assessment level — A~~

4.7.2 Component marking

Component marking, if required, ~~shall~~ should be specified in the relevant specification. The preferred order of marking is:

a) port identification (if required);

b) manufacturer's part number (including serial number, if applicable);

c) manufacturer's identification mark or logo.

~~d) manufacturing date;~~

~~e) variant identification number;~~

~~f) any additional marking required by the relevant specification.~~

If space does not allow for all the required marking on the component, each unit shall be individually packaged with a data sheet containing all of the required information which is not marked.

4.7.3 Package marking

Several devices may be packaged together for shipment.

Package marking, if required, shall be specified in the relevant specification. The preferred order of marking is:

a) manufacturer's identification mark or logo;

b) manufacturer's part number.

~~c) manufacturing date code (year/week, see ISO 8601);~~

~~d) variant identification number(s) (see 4.6.2);~~

~~e) the assessment level;~~

~~f) the type designations (see 4.1.2);~~

~~g) environmental category;~~

~~h) any additional marking required by the relevant specification.~~

When applicable, individual unit packages (within the sealed package) ~~shall~~ should be marked with the reference number of the certified record of released lots, the manufacturer's factory identity code and the component identification.

4.8 Packaging

Packaging shall be securely without any damage to passive optical components during transportation and storage.

Packages shall include instructions for use when required by the specification (see 4.2.~~6~~5).

4.9 Storage conditions

Where short-term degradable materials, such as adhesives, are supplied with the package, the manufacturer shall mark these with the expiry date ~~(year and week numbers,~~ according to ISO 8601-1~~)~~ together with any requirements or precautions concerning safety hazards or environmental conditions for storage.

4.10 Safety

Optical filters, when used on an optical fibre transmission system and/or equipment, may emit potentially hazardous radiation from an uncapped or unterminated output port or fibre end.

The optical filter manufacturers shall provide sufficient information to alert system designers and users about the potential hazard and shall indicate the required precautions and working practices.

In addition, each relevant specification shall include the following:

WARNING ~~NOTE~~

– Care should be taken when handling small diameter fibre to prevent puncturing the skin, especially in the eye area. Direct viewing of the end of an optical fibre or an optical fibre connector, when it is propagating energy, is not recommended unless prior assurance has been obtained as to the safety energy output level.

Reference shall be made to IEC 60825 (all parts), the relevant reference on safety.

Annex A
(informative)

Example of etalon filter technology

A.1 Operating principle of etalon filter

An etalon can be considered as an optical resonator. It consists of a transparent plane-parallel plate with two reflecting surfaces, or two parallel highly reflecting mirrors. The varying transmission function of an etalon is caused by interference between the multiple reflections of light between the two reflecting surfaces (see Figure A.1).

The reflected beam depends on the wavelength (λ) of the light, the angle of incidence (θ), the thickness of the etalon (d) and the refractive index of the material between the reflecting surfaces (n).

If both surfaces have a reflection coefficient R, the transmission function [$T(\lambda)$] of the etalon is given by:

$$T(\lambda) = \frac{(1-R)^2}{(1-R)^2 + 4R\sin^2(\frac{\delta}{2})}$$

where δ is the phase delay between two partial waves:

$$\delta = \frac{4\pi dn\cos(\theta)}{\lambda}$$

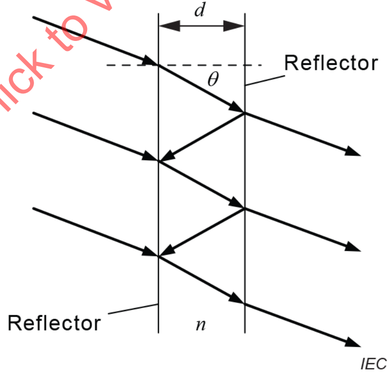


Figure A.1 – Schematic diagram of an etalon

A.2 Transmission characteristics of etalon filter

The wavelength separation between adjacent transmission peaks is shown in Figure A.2.

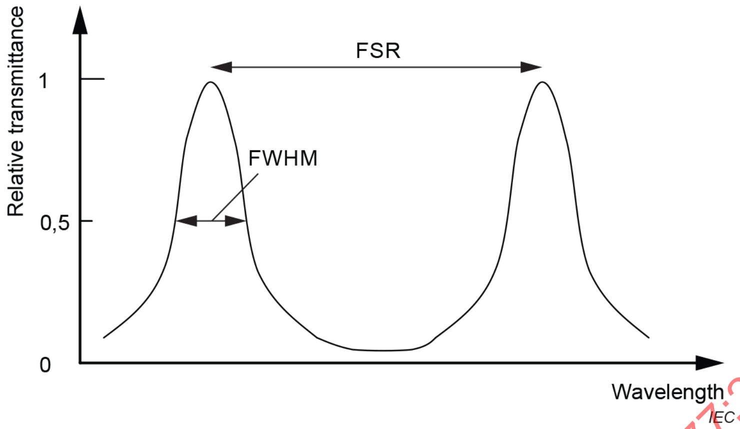


Figure A.2 – Transmission characteristic of an etalon

It is called the free spectral range (FSR), and full width half maximum (FWHM) is given by:

$$\delta\lambda_{\mathrm{FWHM}} = \frac{\delta\lambda_{\mathrm{FSR}}}{F}$$

where F is the finesse and is given by:

$$F = \frac{\delta\lambda_{\mathrm{FSR}}}{\delta\lambda_{\mathrm{FWHM}}} \approx \frac{\pi\sqrt{R}}{1-R}$$

Etalons with high finesse show sharper transmission peaks with lower minimum transmission coefficients. The peaks can be shifted by rotating the etalon with respect to the beam, due to the angle dependence of the transmission.

Annex B
(informative)

Example of fibre Bragg grating (FBG) filter technology

B.1 Operating principle of FBG

An FBG has a periodic variation to the refractive index of the fibre core, as shown in Figure B.1, and the periodic variation to the refractive index generates a wavelength specific mirror. Therefore, an FBG can be used as an optical filter or as a wavelength-specific reflector.

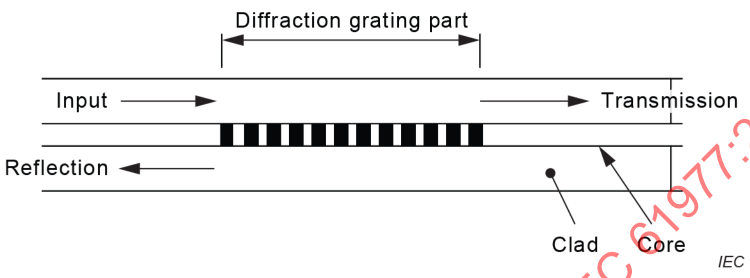


Figure B.1 – Technology of a fibre Bragg grating

The fundamental principle of an FBG, is Bragg reflection. The refractive index is assumed to have a periodic variation over a defined length. The reflected wavelength (λ_B), called the Bragg wavelength, is defined by the following relationship:

$$\lambda_B = 2n\Lambda$$

where

n is the average refractive index of the grating;

Λ is the period of the variation of the refractive index.

The bandwidth ($\Delta\lambda$), is given by:

$$\Delta\lambda = \left[\frac{2\delta n_0 \eta}{\pi}\right]\lambda_B$$

where

δn_0 is the variation in the refractive index;

η is the fraction of power in the core.

The peak reflection [$P_B(\lambda_B)$] is approximately given by:

$$P_B(\lambda_B) \approx \tanh^2\left[\frac{N\eta\delta n_0}{n}\right]$$

where

N is the number of periodic variations.

B.2 Example of usage of an FBG

An FBG can reflect particular wavelengths of light and transmit other wavelengths. It is used with an optical circulator in order to pick up reflected particular wavelengths as an optical add/drop module, as shown in Figure B.2.

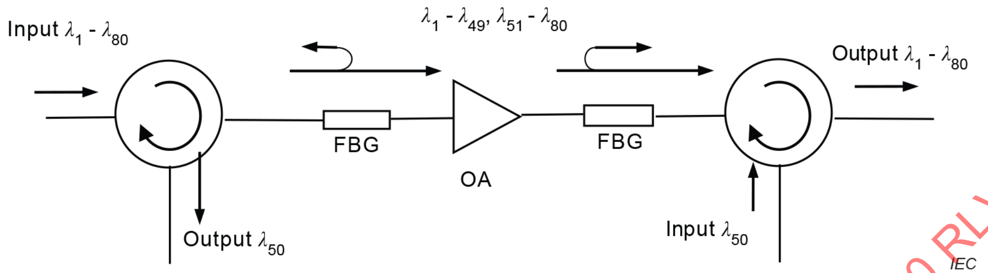


Figure B.2 – Application of an optical add/drop module

The second application shown in Figure B.3 is an optical time domain reflectometer (OTDR) sensor.

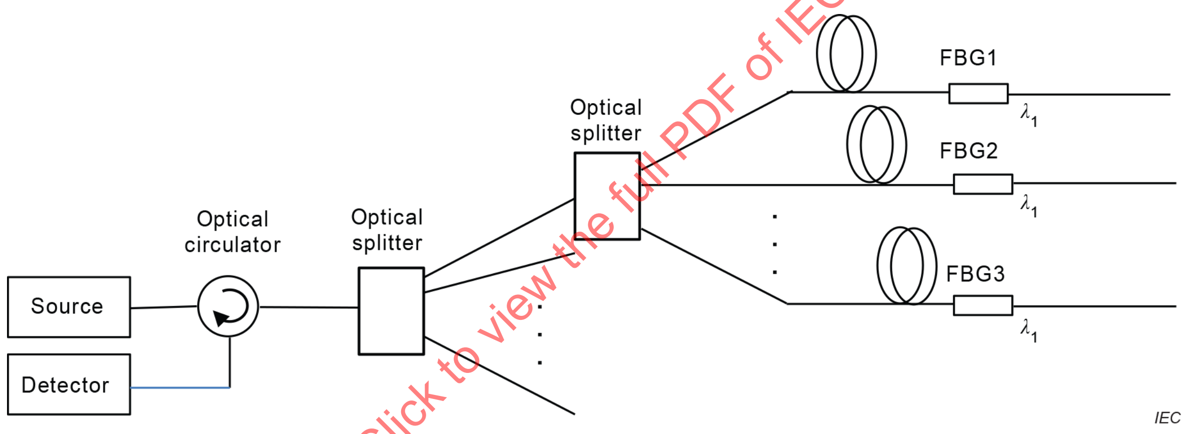


Figure B.3 – Application of an OTDR sensor

The third application is the wavelength stabilizer for a 980 nm pump LD, as shown in Figure B.4.

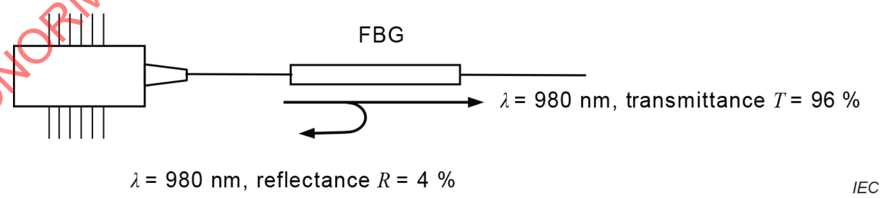


Figure B.4 – Application of the wavelength stabilizer for a 980 nm pump LD

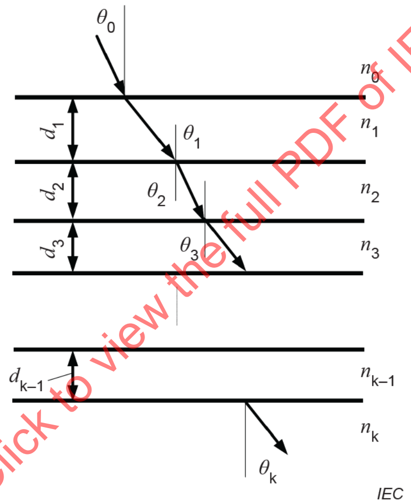
Annex C
(informative)

Example of thin film filter technology

C.1 Example of thin film filter technology

The fundamental structure of a thin-film filter is based on the Fabry-Perot etalon, which acts as a band-pass filter. A signal at the passband wavelength passes through the filter, and other wavelengths are reflected with a high reflectivity. The centre wavelength of the passband is determined by the cavity length of the filter.

Multilayer thin-film filters are known as wavelength selective optical filters. A structure of ~~multiplayer~~ multilayer thin-film filters is that alternating layers of an optical coating are built up on a glass substrate. By controlling the thickness and number of the layers, the wavelength of the passband of the filter can be tuned and made as wide or narrow as desired (see Figure C.1). The wavelength of the passband of the filter can be tuned also by the incident angle.



Key

d_k thickness

n_k refractive index

θ_k incident angle for the layer of k

Figure C.1 – Structure of a multilayer thin-film

C.2 Example of application of thin film filters

Figure C.2 and Figure C.3 show the applications of a GFF for an optical fibre amplifier and a BPF for an optical fibre amplifier, respectively.

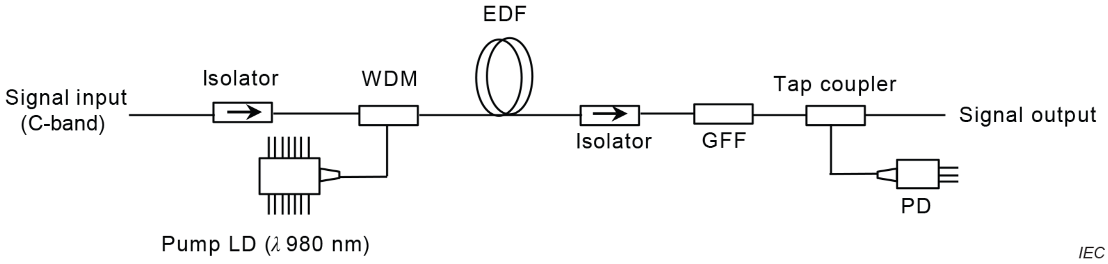


Figure C.2 – Application for a GFF for an optical fibre amplifier

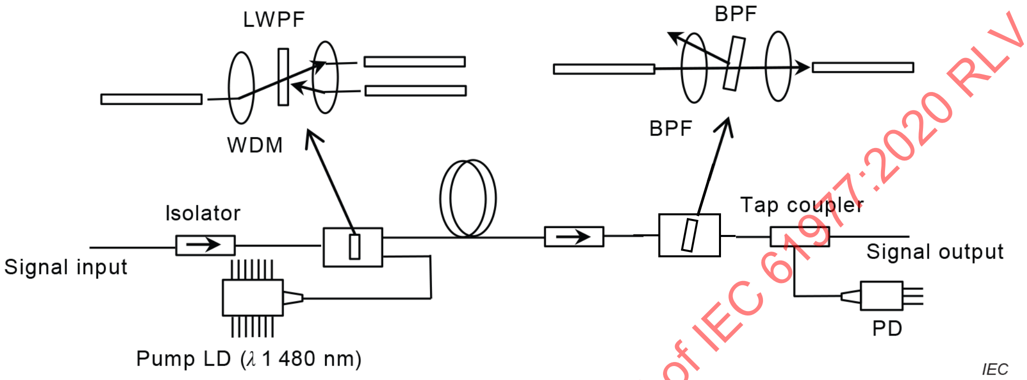
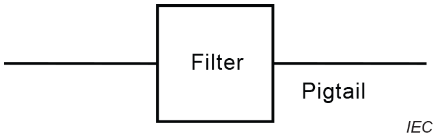


Figure C.3 – Application for a BPF for an optical fibre amplifier

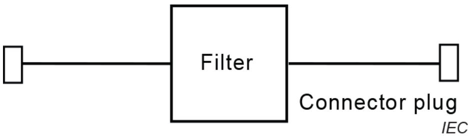
Annex D
(informative)

Examples of interface style

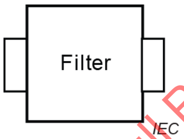
The six examples of interface style of configuration A to configuration F for fibre optic fixed filters are shown in Figure D.1 a) to Figure D.1 f).



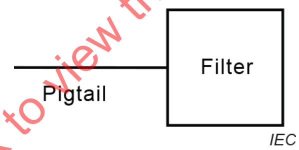
a) Configuration A – Device containing fibre optic pigtails without connector plug



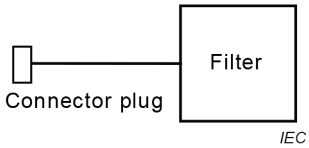
b) Configuration B – Device containing integral fibres, with a connector plug on each fibre



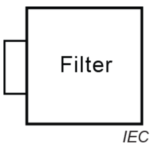
c) Configuration C – Device containing fibre optic connectors as a part of the device housing



d) Configuration D – Device containing one fibre optic pigtail without connector plug



e) Configuration E – Device containing one fibre optic pigtail with a connector plug



f) Configuration F – Device containing one fibre optic connector as a part of the device housing

Figure D.1 – Examples of interface style for fibre optic fixed filters

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IEC 61977

Edition 4.0 2020-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic interconnecting devices and passive components – Fibre optic fixed filters – Generic specification

Dispositifs d'interconnexion et composants passifs fibroniques – Filtres fibroniques fixes – Spécification générique

IEC 61977:2020-04(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – FIBRE OPTIC FIXED FILTERS – GENERIC SPECIFICATION

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International Standard IEC 61977 has been prepared by subcommittee SC 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee TC 86: Fibre optics.

This fourth edition cancels and replaces the third edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) change of the title and the scope for the limitation to fibre optic fixed filters;
b) addition of new terms and definitions reflecting new title;
c) removal of terms and definitions duplicated in IEC TS 62627-09;
d) harmonization of the vertical axis of Figures 1 to 5;
e) restructuration of Clause 4 reflecting the latest technical and market situation.

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

FDIS	Report on voting
86B/4267/FDIS	86B/4286/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.

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

There are two generic specifications for fibre optic filters: fibre optic fixed filters and fibre optic tuneable filters. This document focuses on fibre optic fixed filters. Fibre optic tuneable bandpass filter is standardized in IEC 63032.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – FIBRE OPTIC FIXED FILTERS – GENERIC SPECIFICATION

1 Scope

This document applies to the family of fibre optic filters. These components have all of the following general features:

– they are passive for the reason that they contain no optoelectronic or other transducing elements which can process the optical signal launched into the input port;
– they modify the spectral intensity distribution in order to select some wavelengths and inhibit others;
– they are fixed, i.e. the modification of the spectral intensity distribution is fixed and cannot be tuned;
– they have input and output ports or a common port (having both functions of input and output) for the transmission of optical power; the ports are optical fibre or optical fibre connectors;
– they differ according to their characteristics. They can be divided into the following categories:
  - short-wave pass (only wavelengths lower than or equal to a specified value are passed);
  - long-wave pass (only wavelengths greater than or equal to a specified value are passed);
  - band-pass (only an optical window is allowed);
  - notch (only an optical window is inhibited);
  - gain flattening (compensating the spectral profile of the device).

It is also possible to have a combination of the above categories.

This document provides the generic information including terminology of IEC 61753-04x series documents. Published IEC 61753-04x series documents are listed in the Bibliography.

This document establishes uniform requirements for optical, mechanical and environmental properties.

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 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050-731, *International Electrotechnical Vocabulary (IEV) – Part 731: Optical fibre communication* (available at http://www.electropedia.org)

IEC 60617, *Graphical symbols for diagrams* (available at http://std.iec.ch/iec60617)

IEC 60825 (all parts), *Safety of laser products*

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

IEC TR 61930, *Fibre optic graphical symbology*

IEC TS 62627-09, *Fibre optic interconnecting devices and passive components – Vocabulary for passive optical devices*

ISO 129-1, *Technical product documentation (TPD) – Presentation of dimensions and tolerances – Part 1: General principles*

ISO 286-1, *Geometrical product specifications (GPS) – ISO code system for tolerances on linear sizes – Part 1: Basis of tolerances, deviations and fits*

ISO 1101, *Geometrical product specifications (GPS) – Geometrical tolerancing – Tolerances of form, orientation, location and run-out*

ISO 8601-1, *Date and time – Representations for information interchange – Part 1: Basic rules*

3 Terms and definitions

For the purpose of this document, terms and definitions given in IEC 60050-731, IEC TS 62627-09 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 Component terms

3.1.1
bandpass filter
BPF
fibre optic filter designed to allow signals between two specific wavelengths to pass

Note 1 to entry: This note applies to the French language only.

3.1.2
etalon
device consisting of a transparent plane-parallel plate with two reflecting surfaces, or two parallel reflecting mirrors

Note 1 to entry: The varying transmission function of an etalon is caused by interference between the multiple reflections of light between the two reflecting surfaces.

Note 2 to entry: Annex A describes the outline of etalon technology.

3.1.3
fibre Bragg grating
FBG
fibre optic device which has a short periodic variation to the refractive index of the fibre core along the fibre

Note 1 to entry: An FBG can reflect particular wavelengths of light and transmit other wavelengths.

Note 2 to entry: Annex B describes the outline of FBG technology.

Note 3 to entry: This note applies to the French language only.

3.1.4
fibre optic filter
passive component used in fibre optic transmission system to modify the spectral intensity distribution of a signal in order to transmit or attenuate some wavelengths and block some others

Note 1 to entry: There are two types of fibre optic filters: fibre optic fixed filters and fibre optic tuneable filters.

Note 2 to entry: The wavelength band which transmits or attenuates the signal is called the passband. There may be more than one passband.

3.1.5
fibre optic fixed filter
fibre optic filter which spectral profile is fixed

3.1.6
fibre optic tuneable filter
fibre optic filter which spectral profile is changeable

Note 1 to entry: Fibre optic tuneable bandpass filter is standardized in IEC 63032.

3.1.7
gain flattening filter
gain equalizer
GFF
GEQ
fibre optic filter designed to have the inverse characteristic of the wavelength dependent loss of an optical device

Note 1 to entry: A GFF (GEQ) is used for the purpose of minimizing the wavelength dependent loss of a fibre optic device.

Note 2 to entry: A GFF (GEQ) is typically used with (in) an optical amplifier.

Note 3 to entry: This note applies to the French language only.

Note 4 to entry: This note applies to the French language only.

3.1.8
long wavelength pass filter
LWPF
fibre optic filter that passes long wavelength signals but reduces the amplitude of short wavelength signals

Note 1 to entry: This note applies to the French language only.

3.1.9
notch filter
fibre optic filter that passes all wavelengths except those in a stop band centred on a particular wavelength

3.1.10
reflecting type fibre optic filter
wavelength selective reflecting device having two ports that reflects back the light to the launch port at different wavelength range (OTDR monitoring range)

3.1.11
short wavelength pass filter
SWPF
fibre optic filter that passes short wavelength signals but reduces the amplitude of long wavelength signals

Note 1 to entry: This note applies to the French language only.

3.1.12
thin-film filter
TFF
fibre optic filter which passes particular wavelength band(s) and reflects all other wavelengths by using the interference effect of thin-film

Note 1 to entry: One of the typical TFF is a dielectric multi-layer film filter. Annex C describes the outline of TFF technology.

Note 2 to entry: This note applies to the French language only.

3.1.13
transmitting type fibre optic filter
fibre optic filter in which the input and output ports are separated

3.2 Performance terms

3.2.1
operating wavelength
nominal wavelength λ_h, at which a fibre optic filter operates with the specified performances

Note 1 to entry: The term "operating wavelength" includes the nominally transmitting wavelength, and designated attenuation/isolation wavelength.

3.2.2
operating wavelength range
specified range of wavelengths including all operating wavelengths

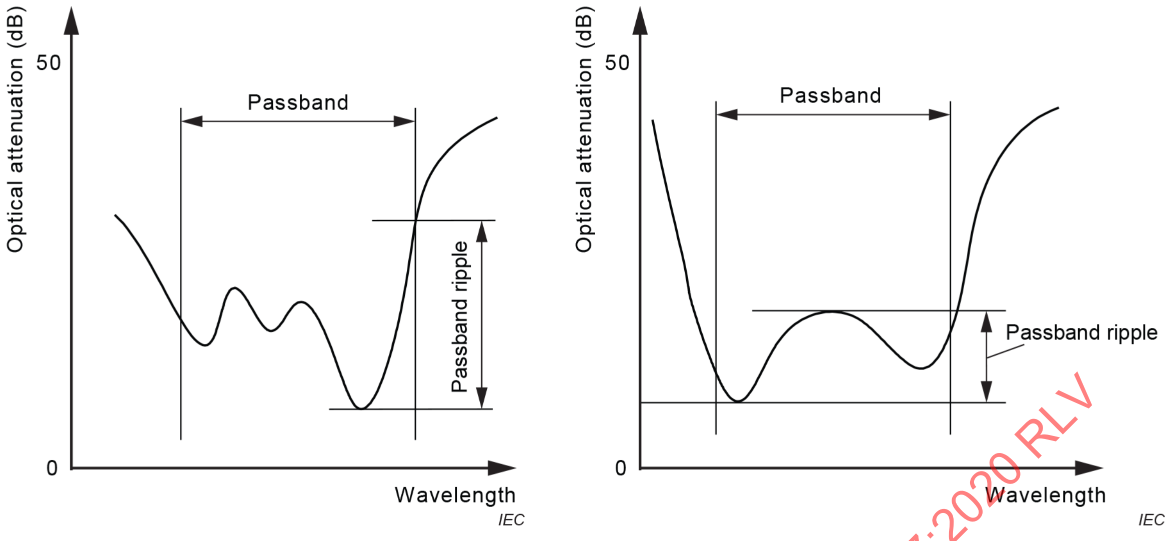
Note 1 to entry: It includes all passbands and isolation wavelength ranges.

3.2.3
passband
wavelength range within which a passive optical component is required to operate with optical attenuation less than or equal to a specified optical attenuation value

Note 1 to entry: There may be one or more passbands for a fibre optic filter.

3.2.4
passband ripple
maximum peak-to-peak variation of the insertion loss (absolute value) over the passband

Note 1 to entry: See Figure 1.



a) Passband ripple at band edges **b) Passband ripple in band**

Figure 1 – Illustration of passband ripple

Note 2 to entry: For a wide wavelength division multiplexing (WWDM) fibre optic filter which has only one passband, the term "spectral ripple" or "flatness" is used instead of "passband ripple".

3.2.5
insertion loss
attenuation
a
reduction of optical power in a passband, when transmitted through a fibre optic filter

Note 1 to entry: The insertion loss is expressed in decibels and defined as:

$$a = -10\log_{10}\left(\frac{P_{out}}{P_{in}}\right)$$

where

P_{in} is the optical power launched into the fibre optic filter;

P_{out} is the optical power received out of the fibre optic filter.

Note 2 to entry: The insertion loss (attenuation) is a function of wavelength.

3.2.6
free spectral range
FSR
difference between two adjacent operating wavelengths, in the case of a periodic spectral response of a fibre optic filter

Note 1 to entry: This note applies to the French language only.

3.2.7
isolation wavelength
nominal wavelength λ_k (where $\lambda_h \neq \lambda_k$), that is nominally suppressed by a fibre optic filter

3.2.8
isolation wavelength range
stopband
specified range of wavelengths from λ_{kmin} to λ_{kmax} around the isolation wavelength λ_k, that are nominally suppressed by a fibre optic filter

Note 1 to entry: There may be one or more isolation wavelength ranges (stopbands) for a fibre optic filter.

Note 2 to entry: The term "stopband" is an antonym of the term passband.

Note 3 to entry: See Figure 2.

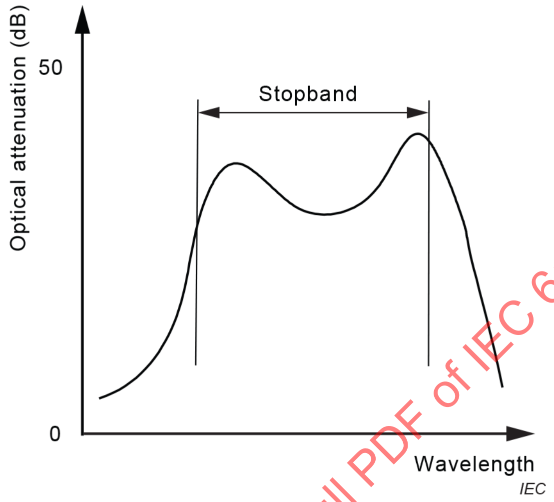


Figure 2 – Illustration of a stopband

3.2.9
maximum insertion loss within a passband
maximum attenuation within a passband
maximum value of the optical attenuation within a passband

Note 1 to entry: Figure 3 shows passband and maximum insertion loss within a passband.

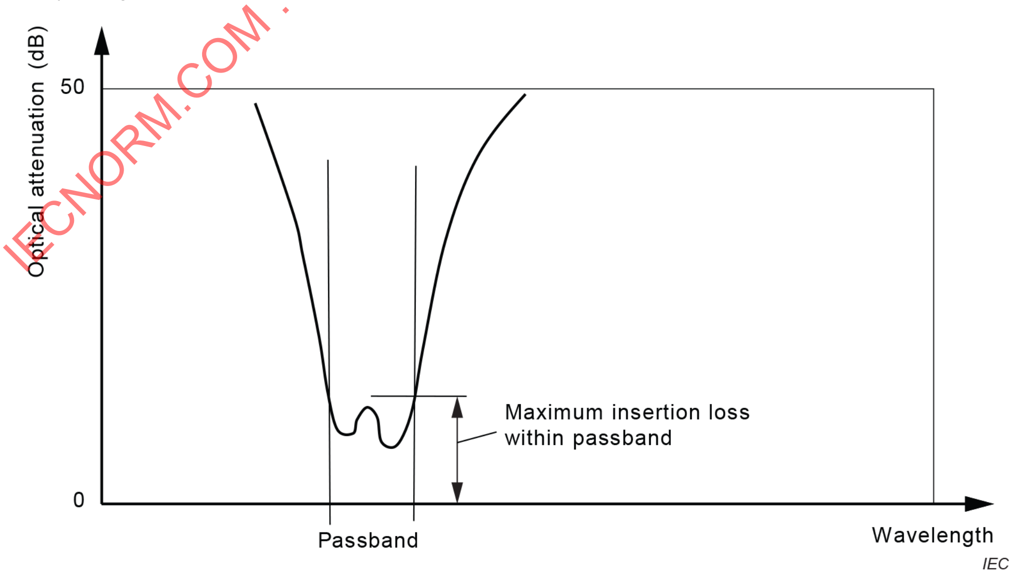


Figure 3 – Illustration of maximum insertion loss within a passband

3.2.10
maximum slope of passband ripple
maximum value in fibre optic filter of the derivative of the insertion loss (for transmitting type fibre optic filter) or return loss (for reflecting type fibre optic filter) as a function of wavelength over the passband

3.2.11
minimum insertion loss within a passband
minimum attenuation within a passband
minimum value of the optical attenuation within a passband

Note 1 to entry: Figure 4 shows passband and minimum insertion loss within a passband.

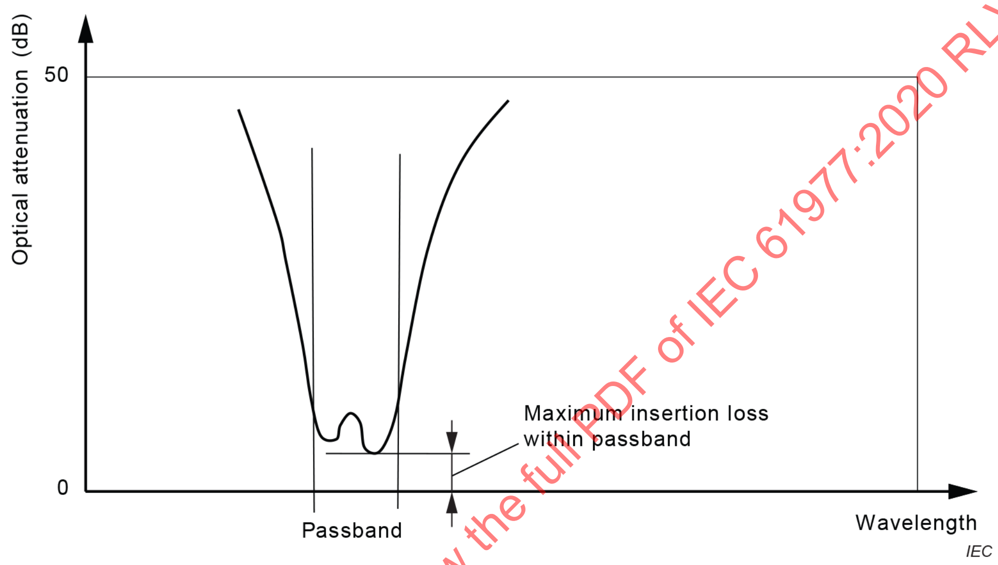


Figure 4 – Illustration of minimum insertion loss within a passband

3.2.12
return loss
a_{RL}
fraction of input power that is returned from a port of a fibre optic filter

Note 1 to entry: The return loss is expressed in decibels and defined as:

$$a_{RL} = -10\log_{10}\left(\frac{P_{refl}}{P_{in}}\right)$$

where

P_{in} is the optical power launched into the port;

P_{refl} is the optical power received back from the same port.

Note 2 to entry: The return loss is a function of wavelength.

3.2.13
wavelength dependent loss
variation of insertion loss of a fibre optic filter within passband(s)

Note 1 to entry: When there are two or more passbands, the wavelength dependent loss is generally defined as the maximum value of passband ripples.

Note 2 to entry: The term "wavelength dependent loss" is generally used for LWPFs, SWPFs or relatively wide passband filters. For BPF especially narrow passband filters, for example WDM application, passband ripple is generally used.

3.2.14
***X* dB bandwidth**
minimum band width which the variation of insertion loss (attenuation) is *X* dB within a passband

Note 1 to entry: *X* dB bandwidth shall be determined by considering the temperature dependency of wavelength, polarization dependency, long term stability of wavelength, etc.

Note 2 to entry: *X* is typically used as 0,5, 1, 3 or 20.

Note 3 to entry: See Figure 5.

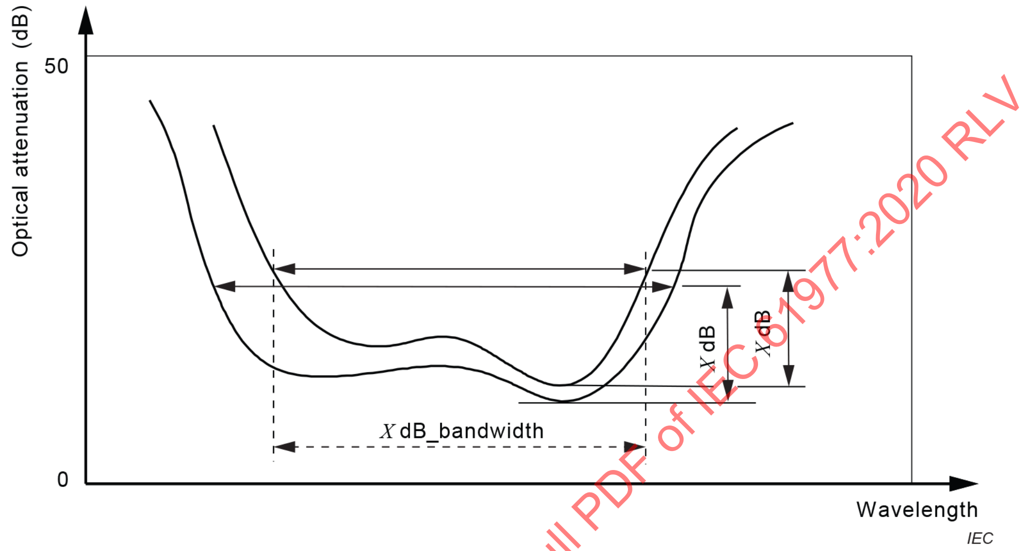


Figure 5 – Illustration of *X* dB bandwidth

4 Requirements

4.1 Classification

4.1.1 General

Fibre optic fixed filters are classified either totally or in part in the following categories:

– technology and function type;
– interface style.

An example of a typical fibre optic fixed filter classification is given in Table 1.

Table 1 – Example of a typical fibre optic fixed filter classification

Items	Classifications
Technology and function type	Technology: TFF Function: LWPF
Interface style	Configuration B Fibre type: IEC 60793-2 type B1 IEC 61754-4 (SC connector)

4.1.2 Technology and function type

4.1.2.1 Technologies

The fibre optic fixed filter shall be defined by its technology type. There are several technology types of filters, for instance:

– thin-film filter (TFF);
– fibre Bragg grating (FBG);
– etalon filter.

4.1.2.2 Functions

The fibre optic fixed filter type shall be defined by its intended function and optical performance. There are several types of filters, for instance:

– long wavelength pass filter (LWPF);
– band-pass filter (BPF);
– short wavelength pass filter (SWPF);
– gain flattening filter (GFF)/ gain equalizer (GEQ);
– notch.

4.1.3 Interface style

The fibre optic fixed filter style shall be defined on the basis of the following elements:

– the input and output port configuration;
– the connector set type(s), if any.

NOTE Examples of interface style are provided in Annex D.

4.2 Documentation

4.2.1 Symbols

Graphical and letter symbols shall, whenever possible, be taken from IEC 60027 (all parts), IEC 60617 and IEC TR 61930.

4.2.2 Drawings

4.2.2.1 General

The drawings and dimensions given in the relevant specifications shall not restrict detail construction nor be used as manufacturing drawings.

4.2.2.2 Projection system

Either first angle or third angle projection shall be used for the drawings in documents covered by this document. All drawings within a document shall use the same projection system and the drawings shall state which system is used.

4.2.2.3 Dimensional system

All dimensions shall be given in accordance with ISO 129-1, ISO 286-1 and ISO 1101. The metric system shall be used in all specifications. Dimensions shall not contain more than five significant digits. When units are converted, a note shall be added in each relevant specification.

4.2.3 Tests and measurements

4.2.3.1 Tests and measurements procedures

The tests and measurements procedures for optical, mechanical, climatic and environmental characteristics of fibre optic fixed filters to be used shall be defined and selected preferentially from IEC 61300 (all parts). The size measurement method to be used shall be specified in the relevant specification for dimensions which are specified within a total tolerance zone of 0,01 mm or less.

4.2.3.2 Reference components

Reference components (such as golden samples) for measurement purposes, if required, shall be specified in the relevant specification.

4.2.4 Test report

The test reports shall be prepared for each test conducted as required by a relevant specification. The reports shall be included in the qualification test report and in the periodic inspection report.

Test reports shall contain the following information as a minimum:

– title and date of test;
– test equipment used;
– all applicable test details;
– all measurement values and observations.

4.2.5 Instructions for use

Instructions for use, when required, shall be given by the manufacturer.

4.3 Standardisation system

4.3.1 Interface standards

Refer proper references when (in case) the connector is used, such as IEC 61754 (all parts).

4.3.2 Performance standards

Performance standards – IEC 61753 (all parts) – contain a series of tests and measurements (which may or may not be grouped into a specified schedule depending on the requirements of that standards) with clearly defined conditions, severities and pass/fail criteria. The tests are intended to be run on a "one-off" basis to prove the ability of any product to satisfy the "performance standards" requirement. Each performance standard has a different set of tests, and/or severities (and/or groupings) representing the requirements of a market sector, user group or system location.

A product that has been shown to meet all the requirements of a performance standard can be declared as complying with a performance standard but should then be controlled by a quality assurance/quality conformance programme.

4.3.3 Reliability standards

Reliability standards are intended to ensure that a component can meet performance specifications under stated conditions for a stated time period.

4.4 Design and construction

4.4.1 Materials

4.4.1.1 General

All housing materials used in the construction shall be manufactured with materials which meet the requirements of the relevant specification.

4.4.1.2 Non-flammable materials

When non-flammable materials are required, the requirements shall be specified, and reference should be made to IEC 60695-11-5. If an alternate standard is used for non-flammable materials, it shall be declared.

4.4.2 Workmanship

Components and associated hardware shall be manufactured to a uniform quality and shall be free of sharp edges, burrs or other defects that would affect life, serviceability or appearance. Particular attention shall be given to neatness and thoroughness of marking, plating, soldering, bonding, etc.

4.5 Quality

Fibre optic fixed filters shall be controlled by the quality assessment procedures and declared.

4.6 Performance requirements

Fibre optic fixed filters shall meet the performance requirements specified in the relevant specification.

4.7 Identification and marking

4.7.1 General

Components, associated hardware and shipping packages shall be permanently and legibly identified and marked when required by the relevant specification.

4.7.2 Component marking

Component marking, if required, should be specified in the relevant specification. The preferred order of marking is:

a) port identification (if required);

b) manufacturer's part number (including serial number, if applicable);

c) manufacturer's identification mark or logo.

If space does not allow for all the required marking on the component, each unit shall be individually packaged with a data sheet containing all of the required information which is not marked.

4.7.3 Package marking

Several devices may be packaged together for shipment.

Package marking, if required, shall be specified in the relevant specification. The preferred order of marking is:

a) manufacturer's identification mark or logo;

b) manufacturer's part number.

When applicable, individual unit packages (within the sealed package) should be marked with the reference number of the certified record of released lots, the manufacturer's factory identity code and the component identification.

4.8 Packaging

Packaging shall be securely without any damage to passive optical components during transportation and storage.

Packages shall include instructions for use when required by the specification (see 4.2.5).

4.9 Storage conditions

Where short-term degradable materials, such as adhesives, are supplied with the package, the manufacturer shall mark these with the expiry date according to ISO 8601-1 together with any requirements or precautions concerning safety hazards or environmental conditions for storage.

4.10 Safety

Optical filters, when used on an optical fibre transmission system and/or equipment, may emit potentially hazardous radiation from an uncapped or unterminated output port or fibre end.

The optical filter manufacturers shall provide sufficient information to alert system designers and users about the potential hazard and shall indicate the required precautions and working practices.

In addition, each relevant specification shall include the following:

WARNING – Care should be taken when handling small diameter fibre to prevent puncturing the skin, especially in the eye area. Direct viewing of the end of an optical fibre or an optical fibre connector, when it is propagating energy, is not recommended unless prior assurance has been obtained as to the safety energy output level.

Reference shall be made to IEC 60825 (all parts), the relevant reference on safety.

Annex A
(informative)

Example of etalon filter technology

A.1 Operating principle of etalon filter

An etalon can be considered as an optical resonator. It consists of a transparent plane-parallel plate with two reflecting surfaces, or two parallel highly reflecting mirrors. The varying transmission function of an etalon is caused by interference between the multiple reflections of light between the two reflecting surfaces (see Figure A.1).

The reflected beam depends on the wavelength (λ) of the light, the angle of incidence (θ), the thickness of the etalon (d) and the refractive index of the material between the reflecting surfaces (n).

If both surfaces have a reflection coefficient R, the transmission function [$T(\lambda)$] of the etalon is given by:

$$T(\lambda)=\frac{(1-R)^2}{(1-R)^2+4R\sin^2(\frac{\delta}{2})}$$

where δ is the phase delay between two partial waves:

$$\delta=\frac{4\pi dn\cos(\theta)}{\lambda}$$

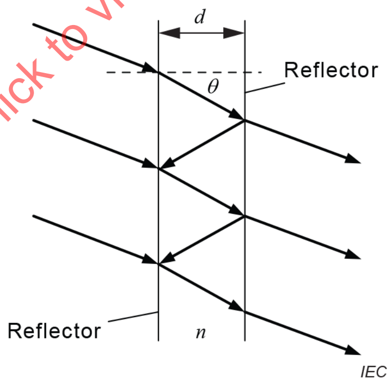


Figure A.1 – Schematic diagram of an etalon

A.2 Transmission characteristics of etalon filter

The wavelength separation between adjacent transmission peaks is shown in Figure A.2.

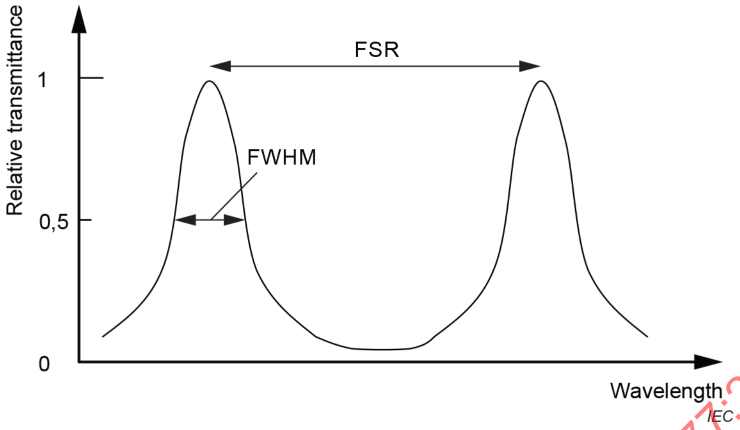


Figure A.2 – Transmission characteristic of an etalon

It is called the free spectral range (FSR), and full width half maximum (FWHM) is given by:

$$\delta\lambda_{\mathrm{FWHM}} = \frac{\delta\lambda_{\mathrm{FSR}}}{F}$$

where F is the finesse and is given by:

$$F = \frac{\delta\lambda_{\mathrm{FSR}}}{\delta\lambda_{\mathrm{FWHM}}} \approx \frac{\pi\sqrt{R}}{1-R}$$

Etalons with high finesse show sharper transmission peaks with lower minimum transmission coefficients. The peaks can be shifted by rotating the etalon with respect to the beam, due to the angle dependence of the transmission.

Annex B
(informative)

Example of fibre Bragg grating (FBG) filter technology

B.1 Operating principle of FBG

An FBG has a periodic variation to the refractive index of the fibre core, as shown in Figure B.1, and the periodic variation to the refractive index generates a wavelength specific mirror. Therefore, an FBG can be used as an optical filter or as a wavelength-specific reflector.

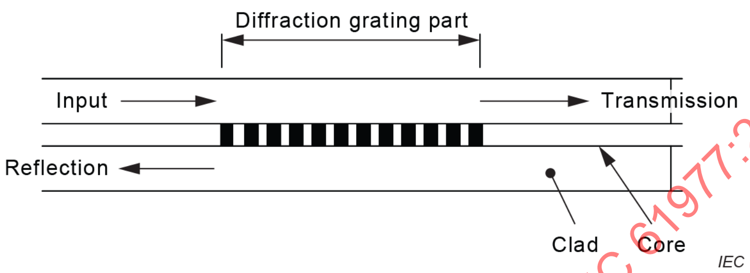


Figure B.1 – Technology of a fibre Bragg grating

The fundamental principle of an FBG, is Bragg reflection. The refractive index is assumed to have a periodic variation over a defined length. The reflected wavelength (λ_B), called the Bragg wavelength, is defined by the following relationship:

$$\lambda_B = 2n\Lambda$$

where

n is the average refractive index of the grating;

Λ is the period of the variation of the refractive index.

The bandwidth ($\Delta\lambda$), is given by:

$$\Delta\lambda = \left[\frac{2\delta n_0 \eta}{\pi}\right]\lambda_B$$

where

δn_0 is the variation in the refractive index;

η is the fraction of power in the core.

The peak reflection [$P_B(\lambda_B)$] is approximately given by:

$$P_B(\lambda_B) \approx \tanh^2\left[\frac{N\eta\delta n_0}{n}\right]$$

where

N is the number of periodic variations.

B.2 Example of usage of an FBG

An FBG can reflect particular wavelengths of light and transmit other wavelengths. It is used with an optical circulator in order to pick up reflected particular wavelengths as an optical add/drop module, as shown in Figure B.2.

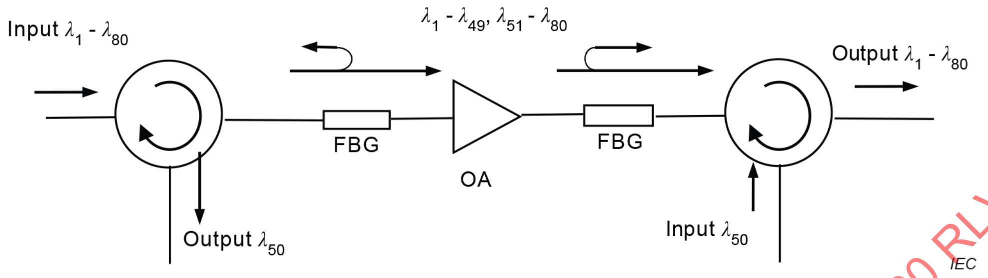


Figure B.2 – Application of an optical add/drop module

The second application shown in Figure B.3 is an optical time domain reflectometer (OTDR) sensor.

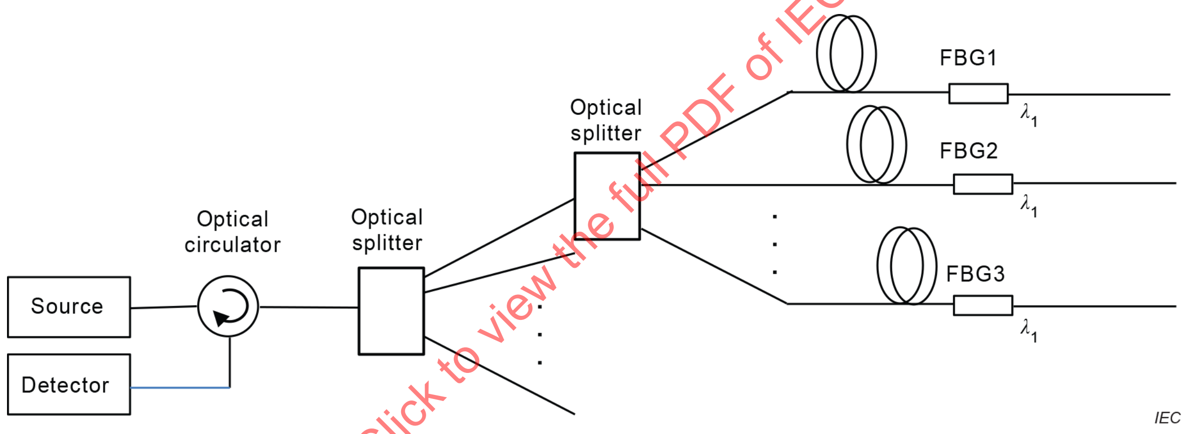


Figure B.3 – Application of an OTDR sensor

The third application is the wavelength stabilizer for a 980 nm pump LD, as shown in Figure B.4.

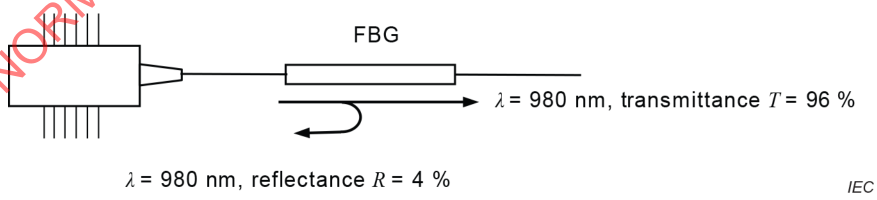


Figure B.4 – Application of the wavelength stabilizer for a 980 nm pump LD

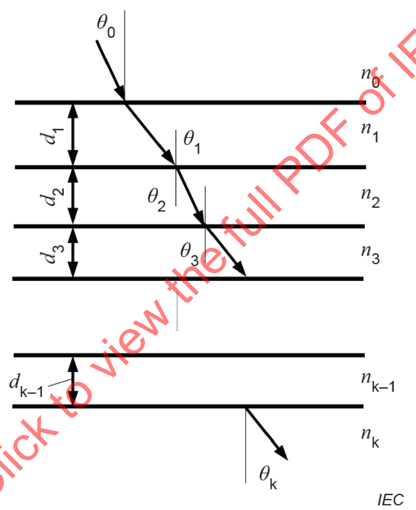
Annex C
(informative)

Example of thin film filter technology

C.1 Example of thin film filter technology

The fundamental structure of a thin-film filter is based on the Fabry-Perot etalon, which acts as a band-pass filter. A signal at the passband wavelength passes through the filter, and other wavelengths are reflected with a high reflectivity. The centre wavelength of the passband is determined by the cavity length of the filter.

Multilayer thin-film filters are known as wavelength selective optical filters. A structure of multilayer thin-film filters is that alternating layers of an optical coating are built up on a glass substrate. By controlling the thickness and number of the layers, the wavelength of the passband of the filter can be tuned and made as wide or narrow as desired (see Figure C.1). The wavelength of the passband of the filter can be tuned also by the incident angle.



Key

d_k thickness

n_k refractive index

θ_k incident angle for the layer of k

Figure C.1 – Structure of a multilayer thin-film

C.2 Example of application of thin film filters

Figure C.2 and Figure C.3 show the applications of a GFF for an optical fibre amplifier and a BPF for an optical fibre amplifier, respectively.

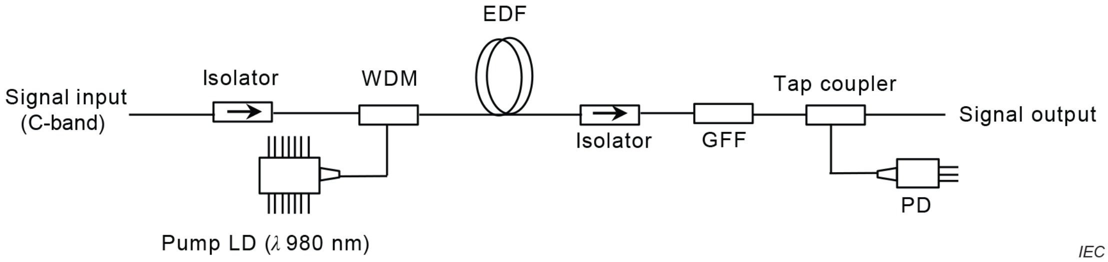


Figure C.2 – Application for a GFF for an optical fibre amplifier

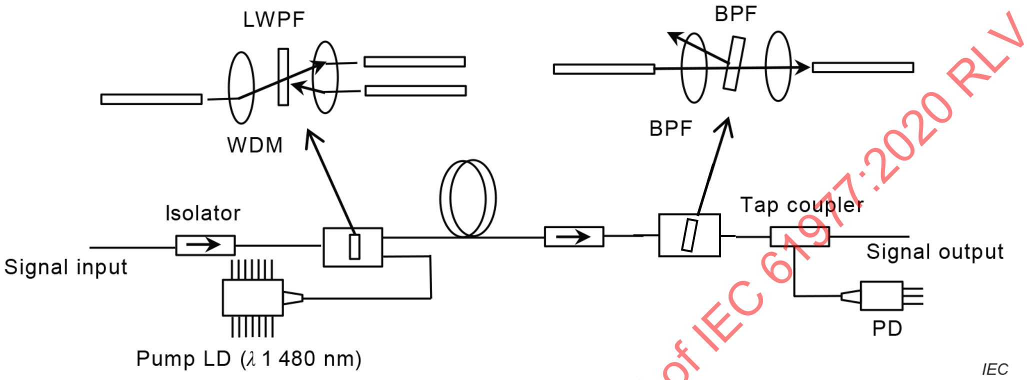
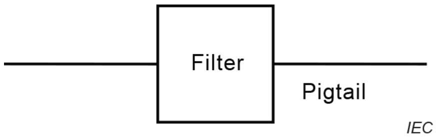


Figure C.3 – Application for a BPF for an optical fibre amplifier

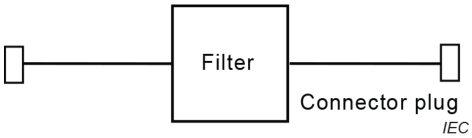
Annex D
(informative)

Examples of interface style

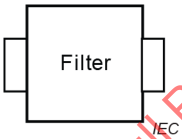
The six examples of interface style of configuration A to configuration F for fibre optic fixed filters are shown in Figure D.1 a) to Figure D.1 f).



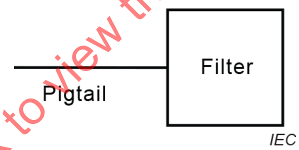
a) Configuration A – Device containing fibre optic pigtails without connector plug



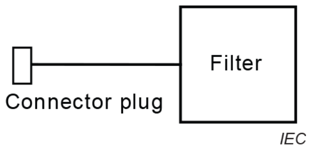
b) Configuration B – Device containing integral fibres, with a connector plug on each fibre



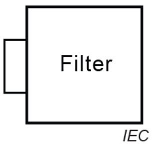
c) Configuration C – Device containing fibre optic connectors as a part of the device housing



d) Configuration D – Device containing one fibre optic pigtail without connector plug



e) Configuration E – Device containing one fibre optic pigtail with a connector plug



f) Configuration F – Device containing one fibre optic connector as a part of the device housing

Figure D.1 – Examples of interface style for fibre optic fixed filters

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IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

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

IEC 61753-041-2, *Fibre optic interconnecting devices and passive components – Performance standard – Part 041-2: Non-connectorized single-mode OTDR reflecting device for category C – Controlled environment*

IEC 61753-042-2, *Fibre optic interconnecting devices and passive components – Performance standard – Part 042-2: Plug-pigtail-style and plug-receptacle-style of OTDR reflecting devices for category C – Controlled environments*

IEC 61754 (all parts), *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces*

IEC 61754-4, *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces – Part 4: Type SC connector family*

IEC 61978-1, *Fibre optic interconnecting devices and passive components – Fibre optic passive chromatic dispersion compensators – Part 1: Generic specification*

IEC 62005 (all parts), *Reliability of fibre optic interconnecting devices and passive components*

IEC 63032, *Fibre optic interconnecting devices and passive components – Fibre optic tuneable bandpass filters – Generic specification*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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DISPOSITIFS D'INTERCONNEXION ET COMPOSANTS PASSIFS FIBRONIQUES – FILTRES FIBRONIQUES FIXES – SPÉCIFICATION GÉNÉRIQUE

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La Norme Internationale IEC 61977 a été établie par le sous-comité SC 86B: Dispositifs d'interconnexion et composants passifs à fibres optiques, du comité d'études 86 de l'IEC: Fibres optiques.

Cette quatrième édition annule et remplace la troisième édition parue en 2015 dont elle constitue une révision technique.

La présente édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) modification du titre et du domaine d'application pour limiter le présent document aux filtres fibroniques fixes;
b) introduction de nouveaux termes et définitions pour refléter le nouveau titre;
c) suppression des termes et définitions présents dans l'IEC TS 62627-09;

d) harmonisation de l'axe vertical des Figures 1 à 5;

e) restructuration de l'Article 4 pour refléter les dernières situations techniques et du marché.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
86B/4267/FDIS	86B/4286/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

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- amendé.

INTRODUCTION

Il existe deux spécifications génériques pour les filtres fibroniques: une pour les filtres fibroniques fixes et une pour les filtres fibroniques accordables. Le présent document porte sur les filtres fibroniques fixes. Les filtres fibroniques passe-bande accordables font l'objet de la norme IEC 63032.

DISPOSITIFS D'INTERCONNEXION ET COMPOSANTS PASSIFS FIBRONIQUES – FILTRES FIBRONIQUES FIXES – SPÉCIFICATION GÉNÉRIQUE

1 Domaine d'application

Le présent document s'applique à la famille des filtres fibroniques. Ces composants possèdent l'ensemble des caractéristiques générales suivantes:

– ils sont passifs du fait qu'ils ne contiennent aucun élément optoélectronique ou autres éléments transducteurs susceptibles de traiter le signal optique injecté dans le port d'entrée;
– ils modifient la distribution d'intensité spectrale afin de sélectionner certaines longueurs d'onde et en interdire d'autres;
– ils sont fixes, c'est-à-dire que la modification de la distribution de l'intensité spectrale est constante et ne peut donc être accordée;
– ils comportent des ports d'entrée et de sortie ou un port commun (comportant à la fois les fonctions d'entrée et de sortie) pour la transmission de la puissance optique; les ports sont une fibre optique ou des connecteurs à fibres optiques;
– ils diffèrent en fonction de leurs caractéristiques. Ils peuvent être répartis dans les catégories suivantes:
  • passe-bas (seules les longueurs d'onde inférieures ou égales à une valeur spécifiée sont transmises);
  • passe-haut (seules les longueurs d'onde supérieures ou égales à une valeur spécifiée sont transmises);
  • passe-bande (seule une fenêtre optique est autorisée);
  • coupe-bande (seule une fenêtre optique est interdite);
  • aplanissement de gain (compensation du profil spectral du dispositif).

Une combinaison des catégories ci-dessus est également possible.

Le présent document fournit des informations génériques et notamment la terminologie des documents de la série IEC 61753-04x. Les documents publiés de la série IEC 61753-04x sont indiqués dans la Bibliographie.

Le présent document établit des exigences uniformes pour les propriétés optiques, mécaniques et environnementales.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60027 (toutes les parties), *Symboles littéraux à utiliser en électrotechnique*

IEC 60050-731, *Vocabulaire électrotechnique international (IEV) – Partie 731: Télécommunications par fibres optiques* (disponible sur le site http://www.electropedia.org)

IEC 60617, *Symboles graphiques pour schémas* (disponible sur le site http://std.iec.ch/iec60617)

IEC 60825 (toutes les parties), *Sécurité des appareils à laser*

IEC 61300 (toutes les parties), *Dispositifs d'interconnexion et composants passifs fibroniques – Méthodes fondamentales d'essais et de mesures*

IEC TR 61930, *Symbologie des graphiques de fibres optiques*

IEC TS 62627-09, *Fibre optic interconnecting devices and passive components – Vocabulary for passive optical devices* (disponible en anglais seulement)

ISO 129-1, *Documentation technique de produits – Représentation des dimensions et tolérances – Partie 1: Principes généraux*

ISO 286-1, *Spécification géométrique des produits (GPS) – Système de codification ISO pour les tolérances sur les tailles linéaires – Partie 1: Bases des tolérances, écarts et ajustements*

ISO 1101, *Spécification géométrique des produits (GPS) – Tolérancement géométrique – Tolérancement de forme, orientation, position et battement*

ISO 8601-1, *Date et heure – Représentations pour l'échange d'information – Partie 1: Règles de base*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 60050-731 et de l'IEC/TS 62627-09, ainsi que les suivants, s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1 Termes concernant les composants

3.1.1
filtre passe-bande
BPF
filtre fibronique conçu pour permettre aux signaux de passer entre deux longueurs d'onde spécifiques

Note 1 à l'article: Le terme abérégé "BPF" est dérivé du terme anglais développé correspondant "band-pass filter".

3.1.2
étalon
dispositif constitué d'une plaque transparente plane parallèle à deux surfaces réfléchissantes, ou à deux miroirs parallèles hautement réfléchissants

Note 1 à l'article: La variation de la fonction de transmission d'un étalon est provoquée par l'interférence entre les réflexions multiples du rayonnement lumineux entre les deux surfaces réfléchissantes.

Note 2 à l'article: L'Annexe A décrit les principaux éléments de la technologie de l'étalon.

3.1.3
réseau de Bragg à fibres
FBG
dispositif fibronique ayant une variation périodique courte par rapport à l'indice de réfraction du cœur de la fibre, le long de la fibre

Note 1 à l'article: Un FBG peut réfléchir des longueurs d'onde particulières du rayonnement lumineux et transmettre d'autres longueurs d'onde.

Note 2 à l'article: L'Annexe B décrit les principaux éléments de la technologie du FBG.

Note 3 à l'article: Le terme abrégé "FBG" est dérivé du terme anglais développé correspondant "fibre Bragg grating".

3.1.4
filtre fibronique
composant passif utilisé dans un système de transmission fibronique, en vue de modifier la distribution de l'intensité spectrale d'un signal, afin de permettre la transmission ou l'affaiblissement de certaines longueurs d'onde et en bloquer d'autres

Note 1 à l'article: Il existe deux types de filtres fibroniques: les filtres fibroniques fixes et les filtres fibroniques accordables.

Note 2 à l'article: La longueur d'onde permettant la transmission ou l'affaiblissement du signal est désignée sous le nom de bande passante. Il peut exister plus d'une bande passante.

3.1.5
filtre fibronique fixe
filtre fibronique dont le profil spectral est fixe

3.1.6
filtre fibronique accordable
filtre fibronique dont le profil spectral est variable

Note 1 à l'article: Les filtres fibroniques passe-bande accordables font l'objet de l'IEC 63032.

3.1.7
filtre à aplanissement de gain
égaliseur de gain
GFF
GEQ
filtre fibronique conçu pour comporter la caractéristique inverse de la perte d'insertion dépendant de la longueur d'onde d'un dispositif optique

Note 1 à l'article: Un GFF (GEQ) est utilisé dans le but de réduire le plus possible la perte dépendant de la longueur d'onde d'un dispositif fibronique.

Note 2 à l'article: Un GFF (GEQ) est typiquement utilisé avec (dans) un amplificateur optique.

Note 3 à l'article: Le terme abrégé "GFF" est dérivé du terme anglais développé correspondant "gain flattening filter".

Note 4 à l'article: Le terme abrégé "GEQ" est dérivé du terme anglais développé correspondant "gain equalizer".

3.1.8
filtre passe-haut
LWPF
filtre fibronique qui transmet des signaux de grandes longueurs d'onde, mais réduit l'amplitude des signaux de courtes longueurs d'onde

Note 1 à l'article: Le terme abrégé "LWPF" est dérivé du terme anglais développé correspondant "long wavelength pass filter".

3.1.9
filtre coupe-bande
filtre fibronique qui transmet toutes longueurs d'onde, à l'exception de celles situées dans une bande d'arrêt centrée sur une longueur d'onde centrale

3.1.10
filtre fibronique de type réfléchissant
dispositif réfléchissant sélectif en longueur d'onde équipé de deux ports, qui rétroréfléchit le rayonnement lumineux dans le port d'injection sur une plage de longueurs d'onde différente (plage de contrôle OTDR)

3.1.11
filtre passe-bas
SWPF
filtre fibronique qui transmet des signaux de longueurs d'onde courtes, mais réduit l'amplitude des signaux de grandes longueurs d'onde

Note 1 à l'article: Le terme abrégé "SWPF" est dérivé du terme anglais développé correspondant "short wavelength pass filter".

3.1.12
filtre en couche mince
TFF
filtre fibronique qui transmet une ou plusieurs bandes de longueur d'onde particulières et réfléchit toutes les autres longueurs d'onde en utilisant l'effet d'interférence de la couche mince

Note 1 à l'article: Un filtre à film multicouche diélectrique est un TTF typique. L'annexe C décrit les principaux éléments de la technologie du TFF.

Note 2 à l'article: Le terme abrégé "TFF" est dérivé du terme anglais développé correspondant "thin film filter".

3.1.13
filtre fibronique de type transmission
filtre fibronique dans lequel les ports d'entrée et de sortie sont séparés

3.2 Termes concernant les performances

3.2.1
longueur d'onde de fonctionnement
longueur d'onde nominale λ_h, à laquelle fonctionne un filtre fibronique avec les performances spécifiées

Note 1 à l'article: Le terme "longueur d'onde de fonctionnement" inclut la longueur d'onde à transmission nominale, et la longueur d'onde d'affaiblissement/d'isolation désignée.

3.2.2
plage de longueurs d'onde de fonctionnement
plage spécifiée de longueurs d'onde, comprenant toutes les longueurs d'onde de fonctionnement

Note 1 à l'article: Elle comprend toutes les plages de longueurs d'onde des bandes passantes et d'isolation.

3.2.3
bande passante
plage de longueurs d'onde dans laquelle il est exigé qu'un composant optique passif fonctionne avec un affaiblissement optique inférieur ou égal à une valeur d'affaiblissement optique spécifiée

Note 1 à l'article: Il peut exister une ou plusieurs bandes passantes pour un filtre fibronique.

3.2.4
ondulation de la bande passante
variation maximale de crête à crête de la perte d'insertion (valeur absolue) sur la bande passante

Note 1 à l'article: Voir la Figure 1.