BS EN 61977:2015

BSI Standards Publication

Fibre optic interconnecting devices and passive components — Fibre optic filters — Generic specification

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 61977:2015. It is identical to IEC 61977:2015. It supersedes BS EN 61977:2010 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/2, Fibre optic interconnecting devices and passive components.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2015

ISBN 978 0 580 87210 5
ICS 33.180.20

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 December 2015.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61977

November 2015

ICS 33.180.20

Supersedes EN 61977:2010

English Version

Fibre optic interconnecting devices and passive components - Fibre optic filters - Generic specification (IEC 61977:2015)

Dispositifs d'interconnexion et composants passifs fibroniques - Filtres fibroniques - Spécification générique (IEC 61977:2015)

Lichtwellenleiter - Verbindungselemente und passive Bauteile - Lichtwellenleiterfilter - Fachgrundspezifikation (IEC 61977:2015)

This European Standard was approved by CENELEC on 2015-10-02. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

European foreword

The text of document 86B/3861/CDV, future edition 3 of IEC 61977, prepared by SC 86B "Fibre optic interconnecting devices and passive components" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61977:2015.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-07-02
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-10-02

This document supersedes EN 61977:2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61977:2015 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60068	NOTE	Harmonized in EN 60068 series.
IEC 61754	NOTE	Harmonized in EN 61754 series.
IEC 61978-1	NOTE	Harmonized as EN 61978-1.
IEC 62005	NOTE	Harmonized in EN 62005 series.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60027	series	Letter symbols to be used in electrical technology	-	-
IEC 60050-731	-	International Electrotechnical Vocabulary - Chapter 731: Optical fibre communication	-	-
IEC 60617	series	Graphical symbols for diagrams	-	-
IEC 60695-11-5	-	Fire hazard testing - Part 11-5: Test flames - Needle-flame test method - Apparatus, confirmatory test arrangement and guidance	EN 60695-11-5	-
IEC 60825	series	Safety of laser products	EN 60825	series
IEC 61300	series	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures	EN 61300	series
IEC/TR 61930	-	Fibre optic graphical symbology	-	-
ISO 129-1	-	Technical drawings - Indication 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	EN ISO 286-1	-
ISO 1101	-	Geometrical product specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out	EN ISO 1101	-
ISO 8601	-	Data elements and interchange formats - Information interchange - Representation of dates and times	-	-

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

This third edition cancels and replaces the second edition published in 2010. It constitutes a technical revision.

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

a) harmonization of a number of terms and definitions with other generic specifications;
b) deletion of the quality assessment level clause.

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

CDV	Report on voting
86B/3861/CDV	86B/3917/RVC

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

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

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

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

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

1 Scope

This International Standard 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).

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

This standard establishes uniform requirements for the following:

– optical, mechanical and environmental properties.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60050-731, *International Electrotechnical Vocabulary – Chapter 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*

ISO 129-1, *Technical drawings – Indication 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*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 60050-731 and the following apply.

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)

3.2 Component terms

3.2.1
BPF
band-pass filterfibre optic filter designed to allow signals between two specific wavelengths to pass

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

3.2.2
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.

3.2.3
FBG
fibre Bragg grating
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.

3.2.4
fibre optic filter
passive component used in fibre optic transmission 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: The wavelength band which transmits or attenuates the signal is called the passband. There may be more than one passband.

3.2.5
GFF
GEQ
gain flattening filter
gain equalizer
device 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.

3.2.6
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.

3.2.7
notch filter
fibre optic filter that passes all wavelengths except those in a stop band centred on a particular wavelength

3.2.8
reflecting type fibre optic filter
fibre optic filter in which the input and output ports are coincident

3.2.9
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.

3.2.10
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.

3.2.11
transmitting type fibre optic filter
fibre optic filter in which the input and output ports are separated

3.3 Performance terms

3.3.1
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.

3.3.2
operating wavelength range
specified range of wavelengths including all operating wavelengths

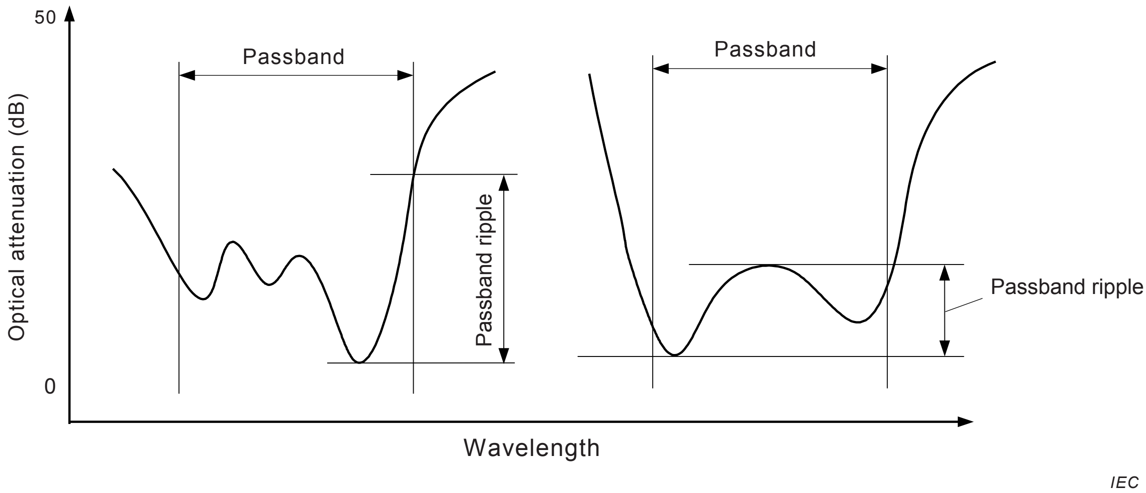
Note 1 to entry: It includes all passbands and isolation wavelength ranges.

3.3.3
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.

3.3.4
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 WWDM (wide wavelength division multiplexing) fibre optic filter which has only one passband, the term spectral ripple or flatness is used instead of passband ripple.

3.3.5
insertion loss
reduction of optical power in a passband, when transmitted between the ports of a two-port 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

P_{out} is the optical power received from the other port

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

3.3.6
free spectral range
in the case of a periodic spectral response of a fibre optic filter, difference between two adjacent operating wavelengths

3.3.7
isolation wavelength
nominal wavelength λ_k (where $\lambda_h \neq \lambda_k$), that is nominally suppressed by a fibre optic filter

3.3.8
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.

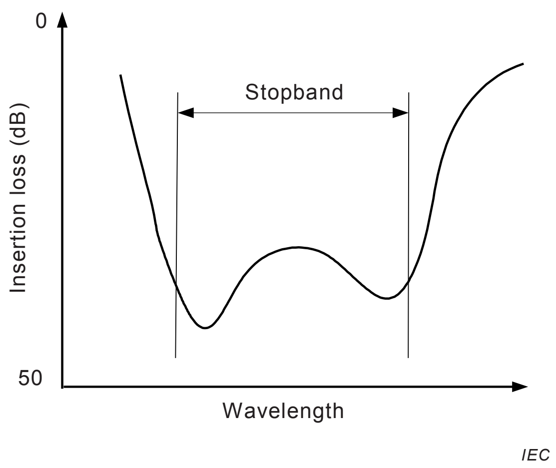


Figure 2 – Illustration of a stopband

3.3.9
maximum insertion loss within a passband
maximum value of the insertion loss within a passband

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

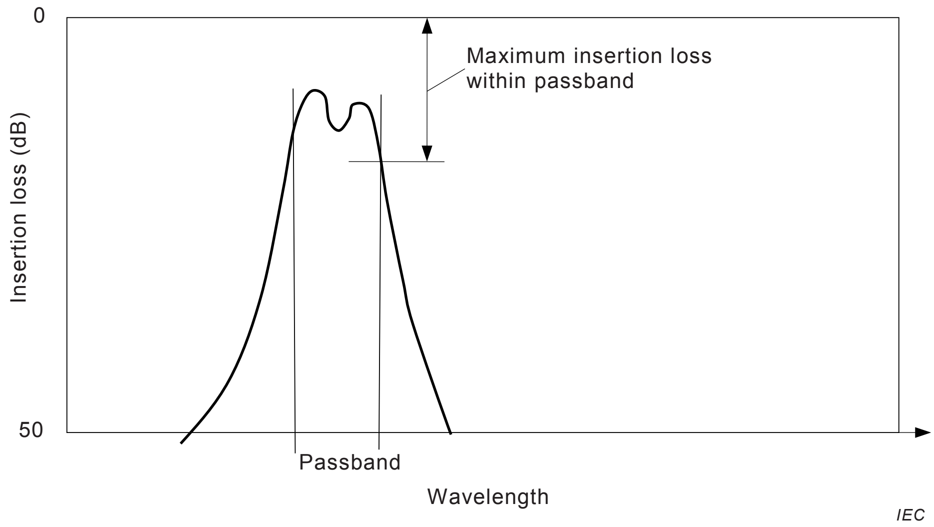


Figure 3 – Illustration of maximum insertion loss within a passband

3.3.10
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

3.3.11
minimum insertion loss within a passband
minimum value of the insertion loss within a passband

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

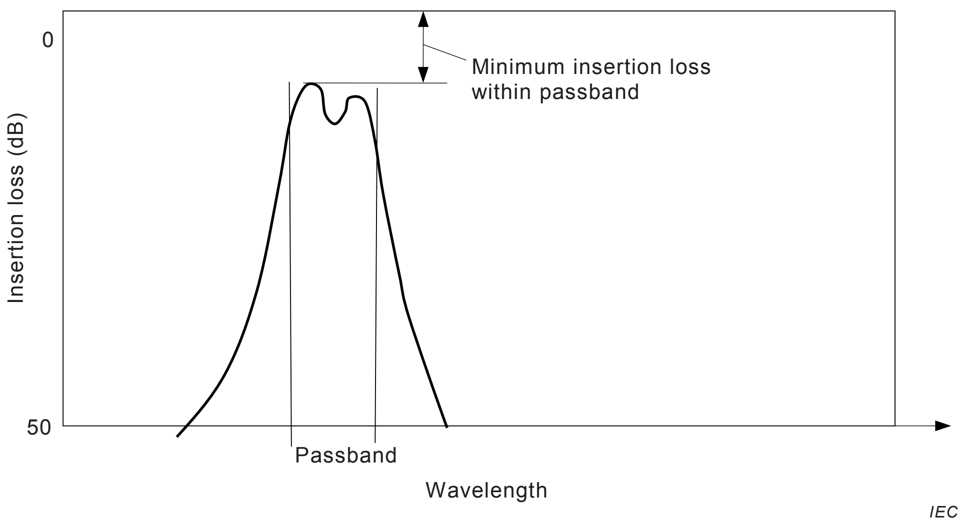


Figure 4 – Illustration of minimum insertion loss within a passband

3.3.12
return loss
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:

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

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.

3.3.13
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.

3.3.14
***X* dB bandwidth**
minimum band width which the variation of insertion loss 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.

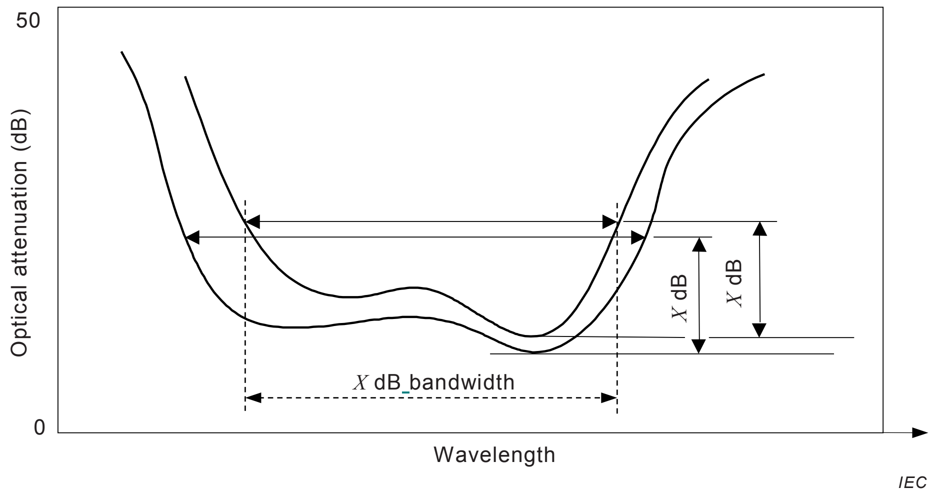


Figure 5 – Illustration of *X* dB bandwidth

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:

Table 1 – Example of a typical filter classification

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

4.1.2 Type

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

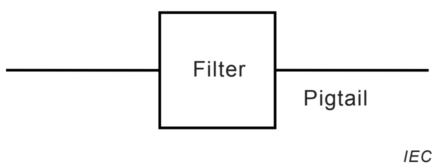
– long wavelength pass filter (LWPF);
– band-pass filter (BPF);
– short wavelength pass filter (SWPF);
– gain flattening filter (GFF)/ gain equalizer (GEQ);
– notch.

4.1.3 Style

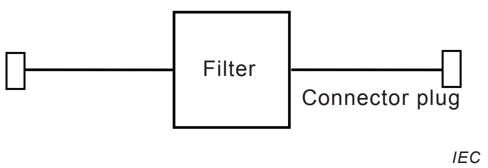
The optic filter style shall be defined on the basis of the following elements:

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

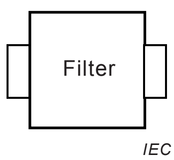
The seven different input and output configurations can be scheduled as shown in Figure 6:



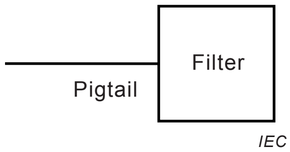
a) Configuration A – Device containing fibre optic pigtails without connector plug



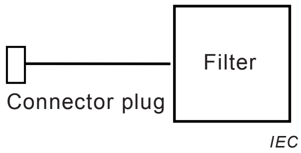
b) Configuration B – Device containing integral fibres, with a connector plug on each fibre



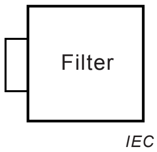
c) Configuration C – Device containing fibre optic connectors as a part of the device housing



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

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 the IEC 60027 series, the IEC 60617 series 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).

4.2.3 Drawings

4.2.3.1 General

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

4.2.3.2 Projection system

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

4.2.3.3 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.

4.2.4 Test and measurements

4.2.4.1 Test and measurement procedures

The test and measurement procedures for optical, mechanical, climatic and environmental characteristics of filters to be used shall be defined and selected preferentially from the IEC 61300 series. 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.

4.2.4.2 Reference components

Reference components 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.

4.2.5 Test report

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

Data sheets 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;

4.2.6 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.

4.3.2 Performance standards

Performance standards contain a series of tests and measurements (which may or may not be grouped into a specified schedule depending on the requirements of that standard) 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.

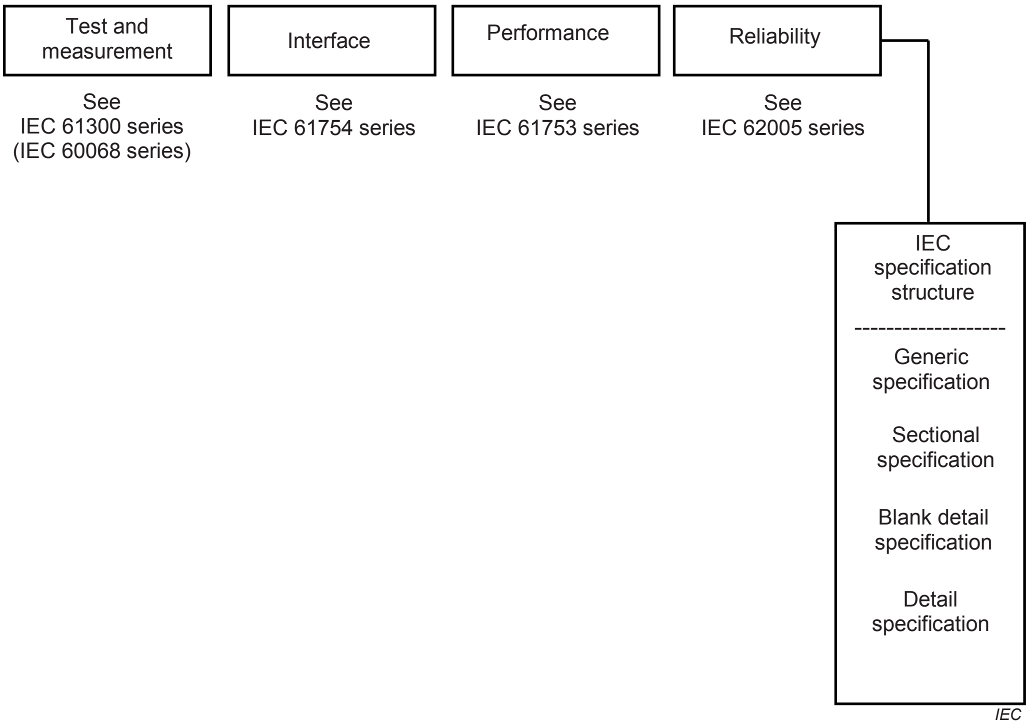


Figure 7 – Standards currently under preparation

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

The devices shall be manufactured with materials which meet the requirements of the relevant specification.

When non-flammable materials are required, the requirements shall be specified in the relevant specification, and IEC 60695-11-5 shall be referenced.

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 Performance requirements

Filters shall meet the performance requirements specified in the relevant specification.

4.6 Identification and marking

4.6.1 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)

4.6.3 Component marking

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

a) port identification;
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.

4.6.4 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 be marked with the reference number of the certified record of released lots, the manufacturer's factory identity code and the component identification.

4.7 Packaging

Packages shall include instructions for use when required by the specification (see 4.2.6).

4.8 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, see ISO 8601) together with any requirements or precautions concerning safety hazards or environmental conditions for storage.

4.9 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 the IEC 60825 series, the relevant document 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 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:

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

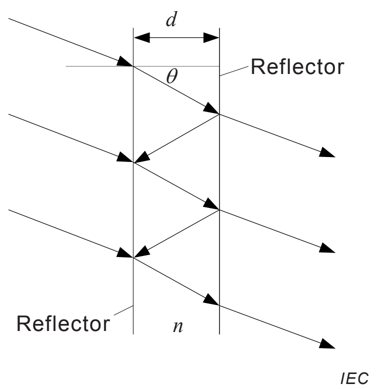


Figure A.1 – Schematic diagram of an etalon

A.2 Transmission characteristics of etalon filter

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

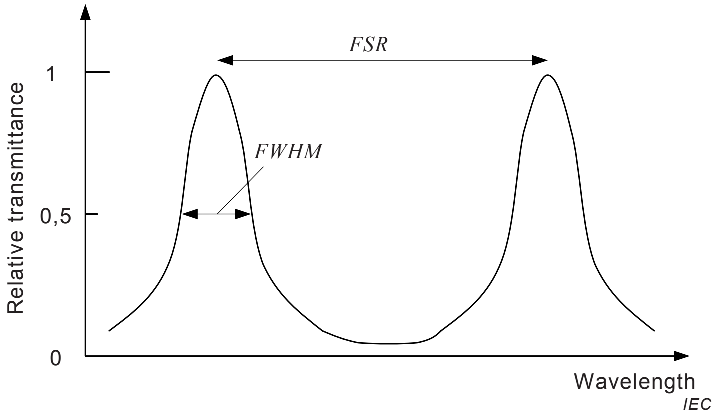


Figure A.2 – Transmission characteristic of an etalon

It is called the free spectral range (FSR), and is given by:

$$FWHM = \frac{FSR}{F}$$

where F is the finesse and is given by:

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

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.

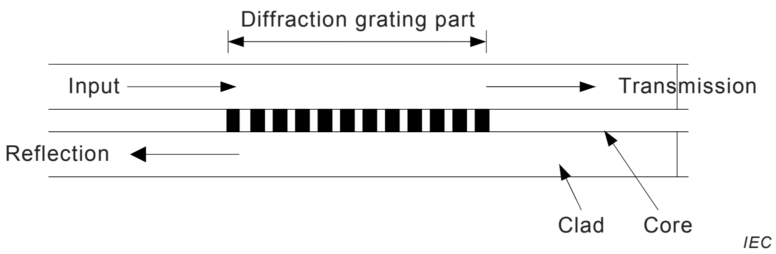


Figure B.1 – Technology of a fibre Bragg grating

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 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

A fibre Bragg grating (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.

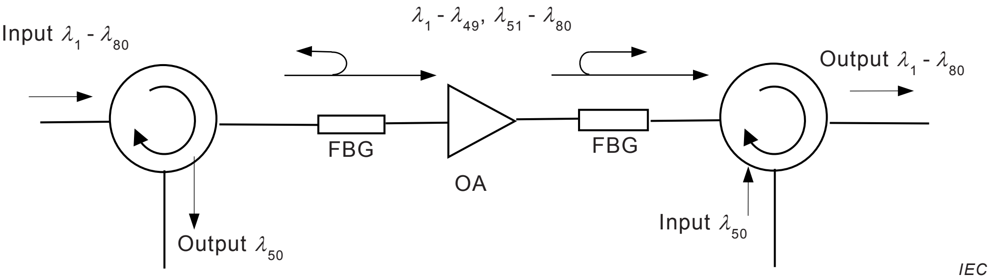


Figure B.2 – Application of an optical add/drop module

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

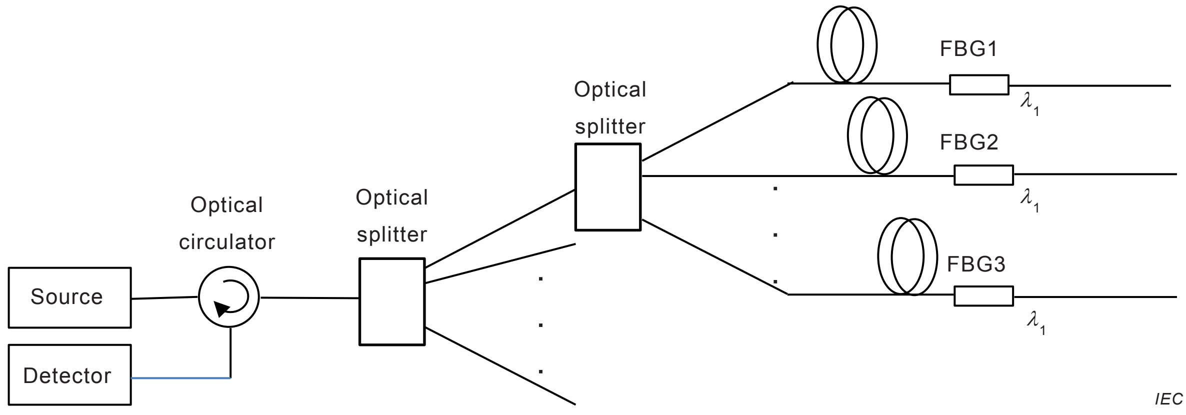


Figure B.3 – Application of an OTDR sensor

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

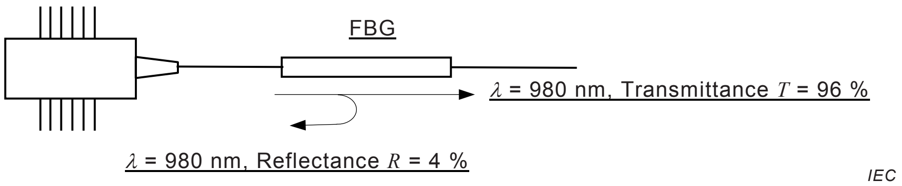


Figure B.4 – Application of the wavelength stabilizer for a 980 nm pump LD

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 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).

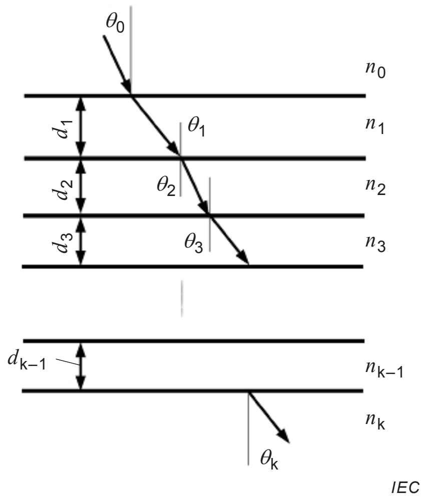


Figure C.1 – Structure of a multilayer thin-film

Key

d_k thickness

n_k refractive index

θ_K incident angle

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.

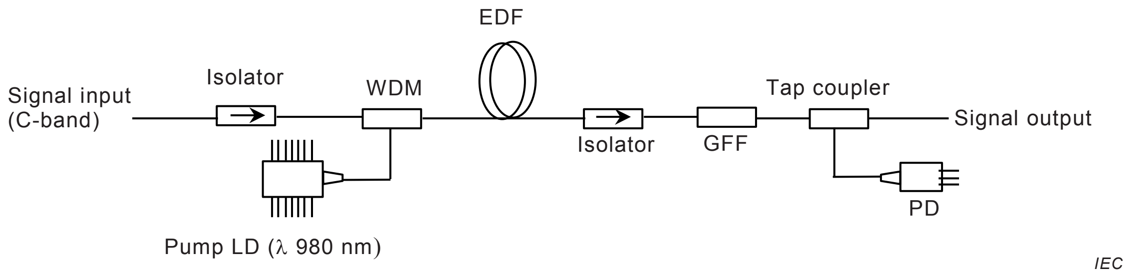


Figure C.2 – Application for a GFF for an optical fibre amplifier

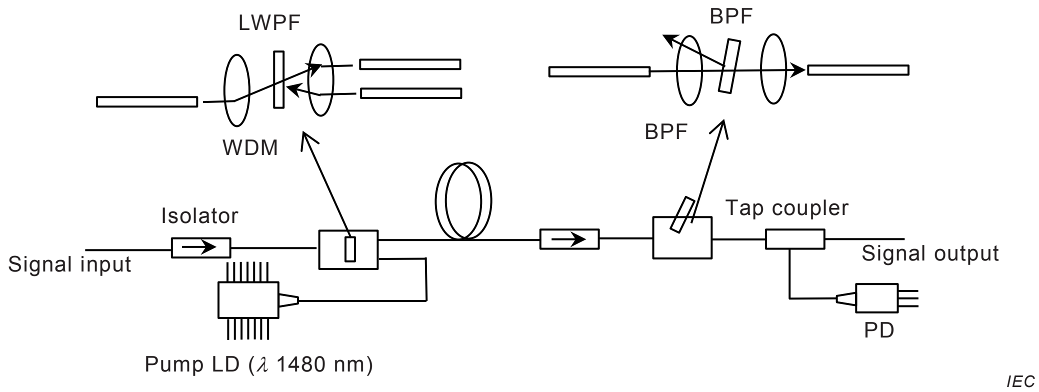


Figure C.3 – Application for a BPF for an optical fibre amplifier

Bibliography

IEC 60068 (all parts), *Environmental testing*

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

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*

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.

...making excellence a habit.™