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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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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.

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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

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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.

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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*

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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.

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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

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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.

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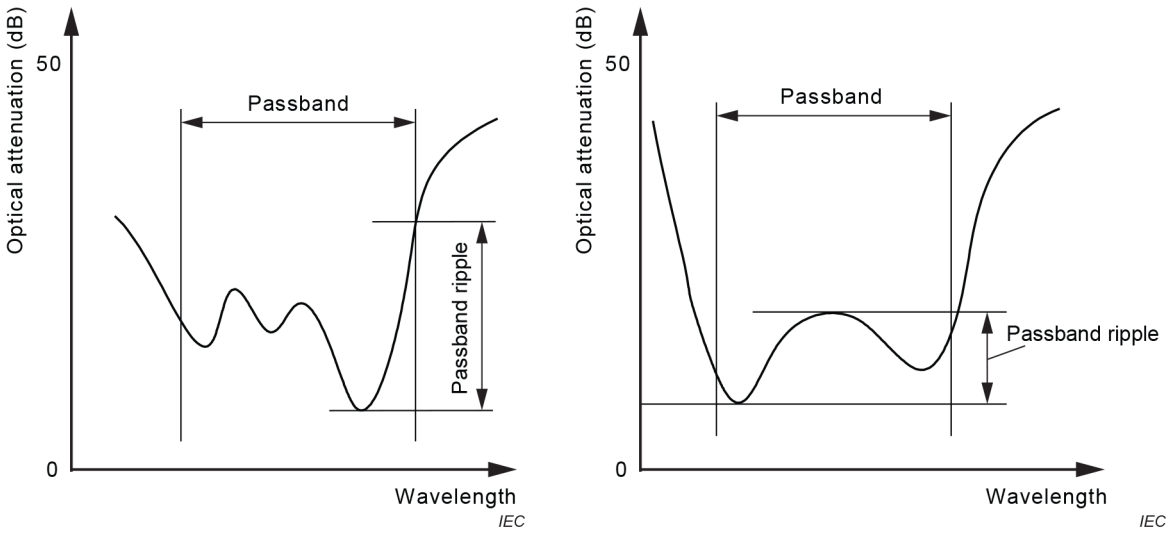

a) Passband ripple at band edges **b) Passband ripple in band**

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:

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

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

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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.

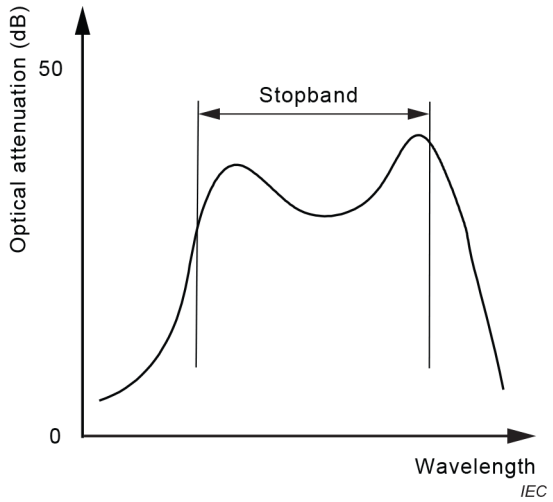

Figure 2 – Illustration of a stopband

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.

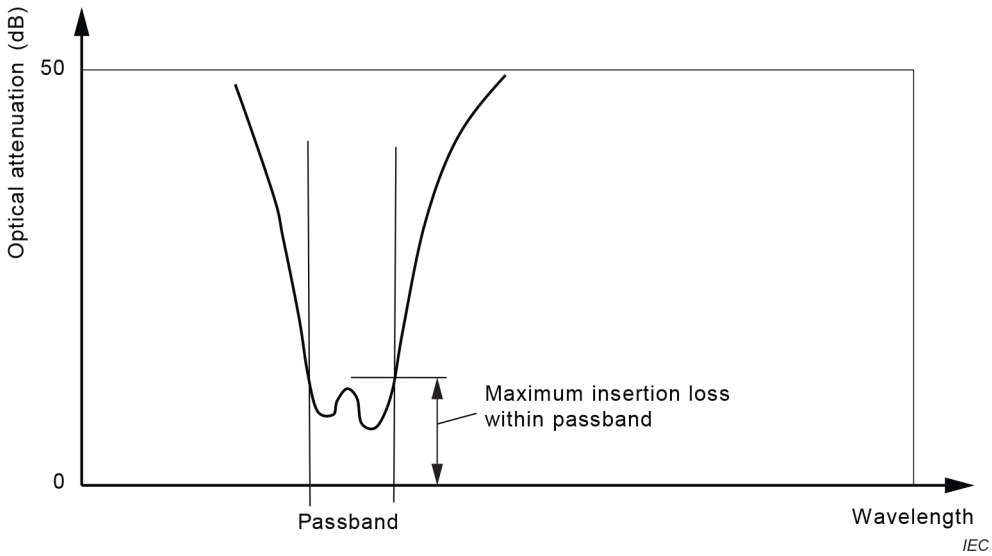

Figure 3 – Illustration of maximum insertion loss within a passband

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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.

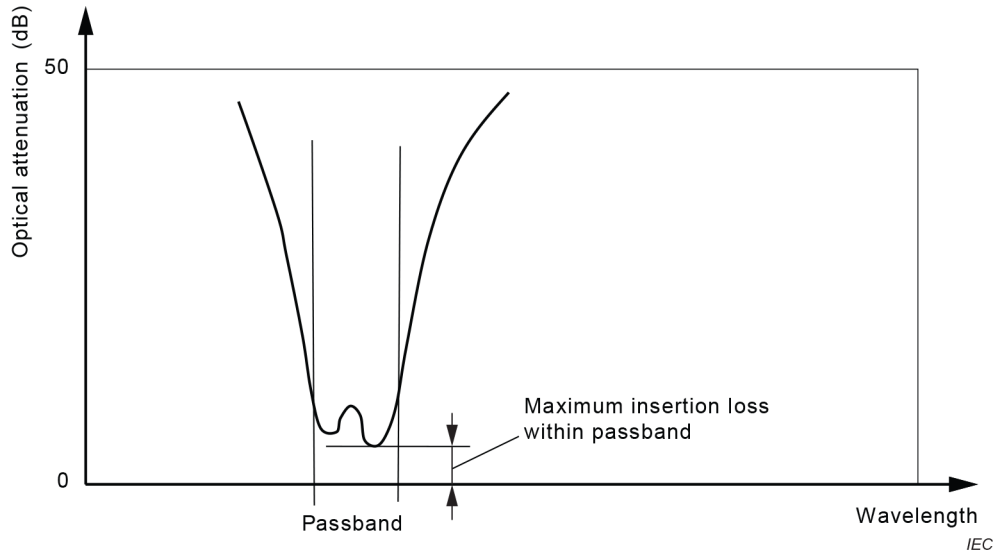

Figure 4 – Illustration of minimum insertion loss within a passband

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.

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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.

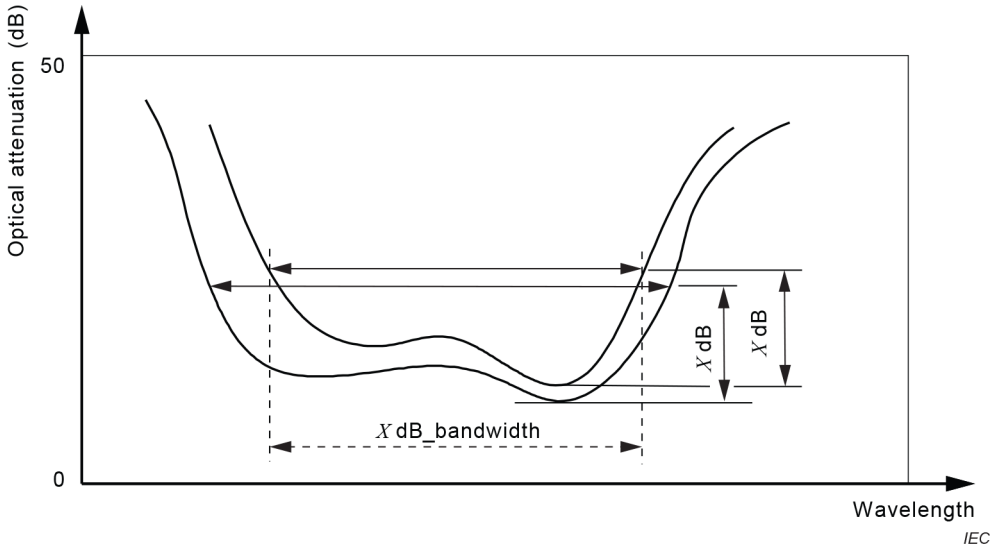

Figure 5 – Illustration of *X* dB bandwidth

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)

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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.

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