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Fibre optic interconnecting devices and passive components – Fibre optic passive power control devices –
Part 1: Generic specification

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – FIBRE OPTIC PASSIVE POWER CONTROL DEVICES –

Part 1: Generic specification

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International Standard IEC 60869-1 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC TC 86: Fibre optics.

This fifth edition cancels and replaces the fourth edition published in 2012 and constitutes a technical revision.

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

a) the terms and definitions have been reviewed;
b) the requirement concerning the IEC Quality Assessment System has been reviewed;
c) the clause concerning quality assessment procedures has been deleted;
d) Annex G, relating to technical information on variable optical attenuators, has been added.

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

FDIS	Report on voting
86B/4139/FDIS	86B/4144/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- withdrawn,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.

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – FIBRE OPTIC PASSIVE POWER CONTROL DEVICES –

Part 1: Generic specification

1 Scope

This part of IEC 60869 applies to fibre optic passive power control devices. These have all of the following general features:

– they are passive in that they contain no optoelectronic or other transducing elements;

– they have two ports for the transmission of optical power and control of the transmitted power in a fixed or variable fashion;

– ~~the ports are unconnectorized optical fibre tails or optical fibre pigtails with connectors.~~

– the ports are non-connectorized optical fibre pigtails, connectorized optical fibres or receptacles.

This document establishes generic requirements for the following passive optical devices:

– optical attenuator;

– optical fuse;

– optical power limiter.

~~Test and measurement procedures for the above products are described in IEC 61300-1, the IEC 61300-2 series and the 61300-3 series [1,2,3] [1].~~

This document also provides generic information including terminology for the IEC 61753-05x series. Published IEC 61753-05x series documents are listed in Bibliography.

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 – Chapter 731: Optical fibre communication* (available at www.electropedia.org)

IEC 60617, *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*

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~~[1] References in square brackets refer to the Bibliography.~~

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

~~ISO 129, *Technical drawings – Indication of dimensions and tolerances*~~

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

ISO 286-1, *Geometrical product specifications (GPS) – ISO ~~coding~~ code system for tolerances ~~of~~ on linear sizes – Part 1: ~~Bases~~ 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, 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

~~NOTE Definitions are given in three sub-groups; basic terms, component terms and performance terms.~~

~~3.1 Basic terms~~

~~**3.1.1**~~
~~**insertion loss**~~
~~reduction in optical power between an input and output port of a passive device, intended to be transparent, expressed in decibel~~

~~Note 1 to entry: This is defined as follows:~~

~~$IL = -10 \log_{10} (P_1/P_0) = 10 \log_{10} (P_0/P_1)$~~

~~where P_0 is the optical power launched into the input port, and P_1 the optical power received from the output port.~~

~~**3.1.2**~~
~~**operating wavelength**~~
~~nominal wavelength λ at which a passive device is designed to operate with the specified performance~~

~~**3.1.3**~~
~~**operating wavelength range –passband**~~
~~specified range of wavelengths from $\lambda_{i\,min}$ to $\lambda_{i\,max}$ about a nominal operating wavelength λ_i, within which an optical passive device is designed to operate with the specified performance~~

~~**3.1.4**~~
~~**return loss**~~
~~fraction of optical input power that is returned from the port of a passive device~~

~~Note 1 to entry: This is defined as follows:~~

~~$RL = -10 \log_{10} (P_1/P_0) = 10 \log_{10} (P_0/P_1)$~~

~~where P_0 is the optical power launched into the port, and P_1 the optical power received back from the same port.~~

3.1 Component terms

3.1.1
fibre optic passive power control device
passive optical device (component) which controls a transmittance with a designed wavelength-independent transfer coefficient

Note 1 to entry: The transfer coefficient may be controlled for all intensity of input power or for input power over a threshold power.

3.1.2
optical attenuator
passive optical device (component), which produces a wavelength-independent controlled signal attenuation in an optical fibre transmission line

Note 1 to entry: An attenuator is intended to be wavelength independent.

3.1.3
fixed optical attenuator
optical attenuator in which attenuation is constant

3.1.4
variable optical attenuator
VOA
~~optically passive device, an attenuator that regulates the optical power in fibres, producing a controlled, optical output power, as a result of manual or electrical control input~~
optical attenuator in which attenuation is controllable

Note 1 to entry: Attenuation values of variable optical attenuators are generally controlled by manual or electric means.

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

3.1.5
optical fuse
fibre optic passive power control device, which produces ~~a~~ controlled, permanent, signal blocking ~~at~~ for higher optical power than a predetermined power threshold in an optical fibre transmission line

3.1.6
optical power limiter
fibre optic passive power control device that regulates the optical power in fibres, producing a controlled, constant optical output power ~~P_{limit}~~ of optical limit power, as a result of varying optical input power higher than ~~P_{limit}~~ the input optical limit power ~~, and has no influence at optical powers below P_{limit}~~

3.1.7
plug-receptacle style device
fibre optic device having a combination of two interfacing features, a plug at one end and a receptacle at the other

~~**3.2.5**~~
~~**plug-style device**~~
~~device having a combination of two interfacing features, a plug on one end and a socket on the other~~

~~**3.2.6**~~
~~**adaptor style device**~~
~~device having a combination of two sockets as interfacing features~~

3.2 Performance terms

3.2.1
optical fuse power threshold
P_{th}
optical input power, into an optical fuse, in which the optical output power is blocked

Note 1 to entry: The optical fuse power threshold P_{th} is expressed in watt or dBm.

3.2.2
optical fuse response time
~~total time when the optical fuse output power level is higher than the optical fuse power threshold by 1 dB, staring when the rising power passes the power fuse power threshold plus 1 dB and ending when the declining power passes the fuse power threshold plus 1 dB on its way down~~
time between the start of the input power and the end time when the output optical power has decreased to be less than the predetermined optical power

Note 1 to entry: The predetermined power shall be either of the power threshold, P_{th} minus insertion loss, IL, ($P_{th} - IL$) in dB, or the input power, P_{in} minus the required blocking attenuation at threshold, A_{block}.

Note 2 to entry: The optical fuse response time depends on the optical input power level and the input pulse time.

Note 3 to entry: An example of the input power, P_{in}, is recommended to be 3 dB over of the power threshold, P_{th}, and the rectangle shape pulse of 1 ms ($P_{in} = P_{th} + 3$ dB). An example of the required blocking attenuation at threshold, A_{block} of 30 dB is recommended.

3.2.3
optical fuse blocking attenuation at threshold
A_{block}
optical fuse blocking attenuation at threshold
drop ~~of~~ in optical power through the optical fuse when exposed to more than the optical fuse power threshold P_{th}, ~~and responds~~ with response by blocking the power, expressed in dB

3.2.4
optical power limiter response time
~~total time where the optical power limiter output power level is higher than limit power + 1 dB, staring when the rising power passes the limit power plus 1 dB and ending when the declining power passes the limit power plus 1 dB on its way down~~
length of time between the start of the input power and the end time in decreasing the output power to be less than or equal to the predetermined power

Note 1 to entry: The optical power limiter response time depends on the optical input power level and the input pulse time.

Note 2 to entry: An example of the input power, P_{in} is recommended to be 3 dB over of the optical limit power and the rectangular pulse of 1 ms ($P_{in} = P_{limit} + 3$ dB). An example of the pre-determined optical power of $P_{limit} + 1$ dB is recommended.

~~**3.3.5**~~
~~**optical limit power**~~
~~optical input power, into an optical power limiter, in which the optical output power is latched and cannot exceed this value. The optical limit power P_{limit} is expressed in Watt or dBm~~

3.2.5
input optical limit power
$P_{in\text{-}limit}$
optical input power, into an optical power limiter, at which the optical output power is latched and cannot exceed that value, $P_{in\text{-}limit}$, which is expressed in watt or dBm

3.2.6
output optical limit power
$P_{\text{out-limit}}$
optical output power from an optical power limiter, at which the optical output power is latched and cannot exceed that value, $P_{\text{out-limit}}$, which is expressed in watt or dBm

3.2.7
minimum insertion loss
~~term applicable only to variable optical attenuators, (VOAs); it is the lowest insertion loss to which the device may be adjusted~~
lowest insertion loss to which a VOA is adjusted

3.2.8
variable attenuation range
range of ~~insertion loss~~ attenuation to which the device may be adjusted

Note 1 to entry: This term is applicable only to VOAs.

3.2.9
nominal attenuation
supplier specified attenuation value for fixed attenuators and user-set attenuation value for variable attenuators

~~**3.3.8**~~
~~**insertion loss setting resolution**~~
~~minimal adjustable step size or difference of the insertion loss of the device~~

~~Note 1 to entry: This term is applicable only to VOAs.~~

~~**3.3.9**~~
~~**accuracy of setting value of attenuation**~~
~~difference between the insertion loss of the device at a given setting and the manually or electrically nominal adjusted value of the insertion loss~~

~~Note 1 to entry: This term is applicable only to VOAs.~~

3.2.10
maximum attenuation
<for variable optical attenuator> attenuation of the maximum value which is set

3.2.11
minimum attenuation
<for variable optical attenuator> attenuation of the minimum value which is set

3.2.12
attenuation setting resolution
minimal adjustable step size or difference of the attenuation of a VOA

Note 1 to entry: This term is applicable only to VOAs.

3.2.13
error of setting value of attenuation
difference between the insertion loss of the device at a given setting and nominal attenuation

Note 1 to entry: This term is applicable only to VOAs.

3.2.14
repeatability of setting attenuation value
~~difference between the insertion loss of the device at a given setting and the value of the insertion loss in previous same settings~~

maximum deviation of the insertion loss of the device at a given setting in multiple times of repeated settings

Note 1 to entry: This term is applicable only to VOAs.

3.2.15
maximum allowed power input
maximum input power that the device can handle without causing ~~dysfunction~~ malfunction or permanent damage, expressed in watt or dBm

Note 1 to entry: This term is applicable to all fibre optic passive power control devices.

Note 2 to entry: This term is equal to optical fuse power threshold to optical fuse.

Note 3 to entry: The maximum input power defined in IEC TS 62627-09 has a different meaning of the maximum input optical power for which a passive optical device keeps the required optical performances.

4 Description of devices

4.1 Optical attenuator

The optical attenuator is a passive optical device used for optical power reduction into or out of an optical device. The optical attenuator is normally used for a broad range of wavelengths, attenuating the power ~~at~~ by a predetermined ~~level~~ attenuation rate.

There are two types of optical attenuator: a fixed optical attenuator and a variable optical attenuator.

The power reduction rate of a fixed optical attenuator is constant. The performance curve of a~~n~~ fixed optical attenuator is shown in Figure 1, where the attenuated power is always lower than the non-attenuated power and proportional to it.

Annex E describes the fixed optical attenuator application note as a users' guide.

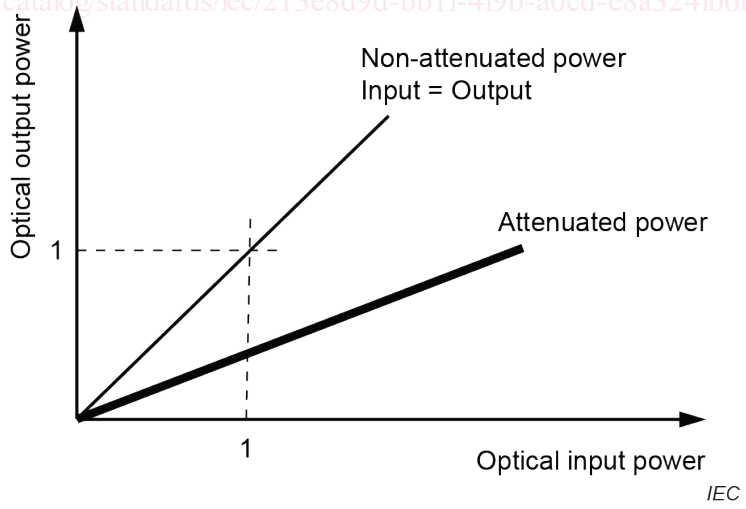


Figure 1 – Fixed optical attenuator operation curve

~~**4.2 Variable optical attenuator (VOA)**~~

The performance curve of a variable optical attenuator (VOA) is ~~similar to Figure 1 of an attenuator, where~~ shown in Figure 2. In a manner similar to that of the fixed optical attenuator, the attenuated power is always lower than the non-attenuated power and proportional to it. The VOA produces a controlled, optical output power, as a result of manual or electrical control input. ~~The VOA is a passive device used for optical power reduction into or out of an~~

~~optical device. The optical attenuator is normally used for a broad range of wavelengths, attenuating the power at a pre-adjusted level.~~

Annex F describes the variable optical attenuator application note as a users' guide.

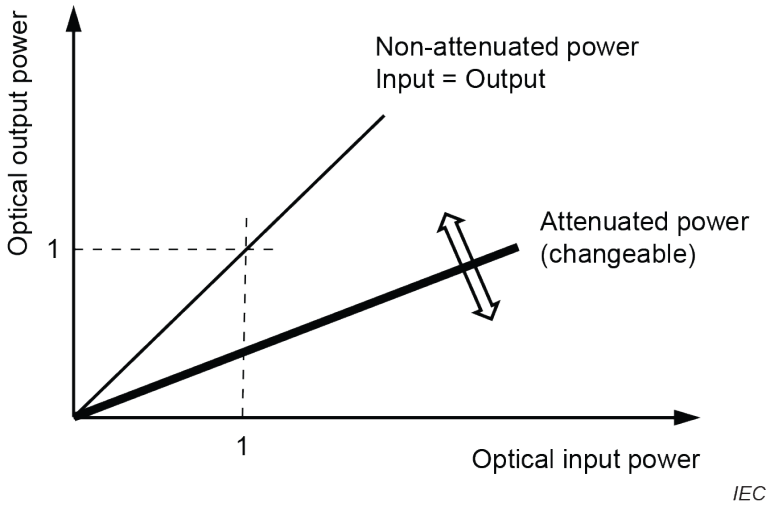
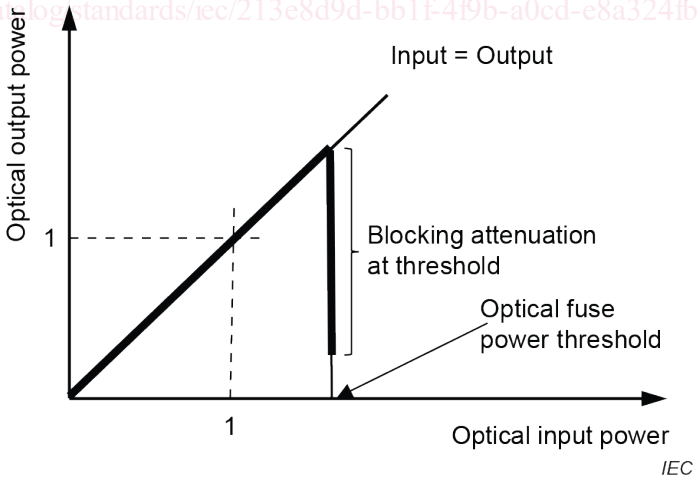


Figure 2 – VOA operation curve

4.2 Optical fuse

The optical fuse (see Figure 3) is a passive device, designed to protect equipment and fibre cables from damage due to optical overpower, spikes and surges. When the input power is lower than a predetermined threshold power, the optical fuse remains transparent, ideally. However, the optical fuse becomes permanently opaque when the optical power exceeds the specified predetermined threshold level. The optical fuse is wavelength independent in the region of its transparency. The optical fuse is bidirectional.



NOTE Figure 3 schematically explains how the optical fuse operates, with the representation of the ideal optical fuse, which has no insertion loss (*IL*).

Figure 3 – Optical fuse operation curve

The optical fuse protects against power spikes and surges. The optical fuse is placed either at the input port of an optical device, such as in the case of a detector, or at the output port of a high power device, such as in the case of a laser or optical amplifier. An activated (burnt) fuse permanently blocks the forward optical power without ~~enlarging~~ increasing the reflected power, thus preventing damage. The optical fuse can be used as an eye safety device.