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TECHNICAL SPECIFICATION

Fibre optic interconnecting devices and passive components – Vocabulary for passive optical devices

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

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FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62627-09, which is a Technical Specification, has been prepared by subcommittee SC 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
86B/3993/DTS	86B/4016/RVC

Full information on the voting for the approval of this technical specification 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.

A list of all parts in the IEC 62627 series, published under the general title *Fibre optic interconnecting devices and passive components*, can be found on the IEC website.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

SC 86B, Fibre optic interconnecting devices and passive components, specifies several passive optical devices. Each passive optical device has generic specification and performance specifications. Generic specifications define terms, definitions and requirements (classifications, documentations, standardization systems and so on). Some basic terms and definitions are defined and used in two or more generic specifications. In order to harmonize terms and definitions in generic specifications, this technical specification defines terms and definitions commonly used in multiple generic specifications.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

Vocabulary for passive optical devices

1 Scope

This part of IEC 62627, which is a Technical Specification, applies to passive optical devices (components). It provides the definitions which are commonly used in the generic specifications, performance standards and tests and measurement standards for passive optical devices (components) prepared by SC 86B. It has the following three types of terms and definitions:

- basic terms and definitions;
- component terms and definitions;
- performance parameter terms and definitions.

The generic specifications for passive optical devices (components) are listed in Annex A.

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.

This document contains no normative references.

3 Terms, definitions and abbreviated terms

3.1 General

For the purposes of this document, the following terms and definitions 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

3.2 Basic terms and definitions

3.2.1
port
optical fibre or fibre optic connector attached to a passive component for the entry and/or exit of optical power

[SOURCE: IEC 60876-1:2014, 3.1.1]

3.2.2
input port
port where the optical power enters the device

3.2.3
output port
port where the optical power exits the device

3.2.4
transfer matrix
$n \times n$ matrix of coefficients where n is the number of ports, and the coefficients represent the fractional optical power transferred between designated ports

Note 1 to entry: In general, the transfer matrix T is:

$$T = \begin{bmatrix} t_{11} & t_{12} & \cdots & t_{1n} \\ & t_{22} & & \\ & & t_{ij} & \\ t_{n1} & t_{n2} & & t_{nn} \end{bmatrix} \quad (1)$$

where t_{ij} is the ratio of the optical power P_{ij} transferred out of port j with respect to input power P_i into port i, that is:

$$t_{ij} = \frac{P_{ij}}{P_i} \quad (2)$$

[SOURCE: IEC 60875-1:2015, 3.1.3, modified – The definition has been rephrased, the last sentence in note 1 has been deleted, as well as notes 2 and 3.]

3.2.5
transfer coefficient
element t_{ij} of the transfer matrix

[SOURCE: IEC 60875-1: 2015, 3.1.4]

3.2.6
logarithmic transfer matrix
$n \times n$ matrix of logarithmic transfer coefficients of a_{ij} where n is the number of ports

Note 1 to entry: In general, the logarithmic transfer matrix A is:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ & a_{22} & & \\ & & a_{ij} & \\ a_{n1} & a_{n2} & & a_{nn} \end{bmatrix} \quad (3)$$

where a_{ij} is the optical power reduction, in decibels, out of port j with unit power into port i, that is:

$$a_{ij} = -10 \log_{10} t_{ij} \quad (4)$$

where t_{ij} is the transfer coefficient.

3.2.7
logarithmic transfer coefficient
element a_{ij} of the logarithic transfer matrix

3.2.8
conducting port pair
two ports i and j between which t_{ij} is nominally greater than zero

Note 1 to entry: For optical switches of conducting ports, conducting port pair is defined at a specified switching state. For wavelength-selective branching devices and fibre optic filters, conducting port pair is defined at a specific wavelength. For wavelength switches, conducting port pair is defined at a specific switching state and a specified wavelength.

3.2.9
isolated port pair
two ports i and j between which t_{ij} is nominally zero, and a_{ij} is nominally infinite

Note 1 to entry: For optical switches of isolated ports, isolated port pair is defined at a specified switching state. For wavelength-selective branching devices and fibre optic filters, isolated port pair is defined at a specific wavelength. For wavelength switches, isolated port pair is defined at a specific switching state and a specified wavelength.

3.2.10
port configuration
relation of connection which satisfies the following requirements, between the M port group possessing M ports and the N port group possessing N ports for passive device possessing n ports ($n = M + N$):

a) any port of the M port group is not the relation of conducting, attenuating, splitting, and coupling with the others of M port group;
b) any port of the N port group is not the relation of conducting, attenuating, splitting, and coupling with the others of N port group;
c) any port of the M port group can be connected to conducting, attenuating, splitting, and coupling with any port of N port group;
d) any port of the N port group can be connected to conducting, attenuating, splitting, and coupling with any port of M port group.

Note 1 to entry: In the case of a branching device composed of an input port group possessing M ports and the output port group possessing N ports, $M \times N$ is often expressed even if M is more than N.

Note 2 to entry: In the case of wavelength selective branching device, the connection as conducting, attenuating, splitting and coupling is for any passband.

Note 3 to entry: In the case of optical switch, the connection as conducting, attenuating, splitting and coupling is for any state.

Note 4 to entry: The port configuration is expressed as $M \times N$. Unless otherwise noted, N is equal to or larger than M.

3.3 Component terms and definitions

3.3.1
passive optical device
optical device (component), other than an optical dynamic device or an optical active device, which does not require external power for its operation, unless to control the stability of its own characteristics

Note 1 to entry: Passive optical devices (components) may comprise optical detectors for monitoring purposes only.

[SOURCE: IEC TS 62538:2008, 2.1.3, modified – The term has been changed from "optical passive device" to "passive optical device", and the bracket "(component)" has been added to the definition and the note.]

3.3.2
fibre optic power control device
passive optical device (component) which controls a transmittance with a designed wavelength independent transfer coefficient

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

3.3.3
optical attenuator
passive optical device (component), which produces a wavelength independent controlled signal attenuation in an optical fibre transmission line

[SOURCE: IEC 60869-1:2012, 3.2.1, modified – The definition has been rephrased.]

3.3.4
fibre optic isolator
non-reciprocal passive optical device (component) intended to suppress backward transmittance along an optical fibre transmission line while the forward direction is the direction for which optical power transmission is intended

Note 1 to entry: Fibre optic isolators are commonly used to avoid reflections back into laser diodes and optical amplifiers, which can make the laser and amplifiers oscillate unstably, and cause noise in the fibre optic transmission system.

[SOURCE: IEC 61202-1:2009, 3.2.1, modified – The definition has been rephrased.]

3.3.5
fibre optic circulator
passive optical device (component) possessing three or more ports which input and output are cyclic

Note 1 to entry: In the case of 3 ports circulator with port 1, port 2 and port 3, supposing optical power is transmitted from port 1 to port 2, optical power from port 2 is transmitted to port 3.

[SOURCE: IEC 62077:2015, 3.2.1, modified – The term "optical device" and the brackets have been added.]

3.3.6
optical switch
passive optical device (component) processing two or more ports which selectively transmits, redirects or blocks optical power in an optical fibre transmission line

[SOURCE: IEC 60876-1:2014, 3.2.1, modified – The term "optical device" and the brackets have been added.]

3.3.7
wavelength switch
optical switch which is designed to operate in two of more defined wavelength bands of operation and which can selectively route or block light in one or more of the bands of operation as a function of the wavelength band

[SOURCE IEC 62099:2001, 1.3.2, modified – The adjective "optical" has been added to the term "switch" in the definition.]

3.3.8
non-wavelength-selective branching device
optical coupler
optical splitter
bidirectional passive optical device (component) possessing three or more ports which operates non-selectively over a specified range of wavelengths, divides or combines optical power coming into one or more input port(s) among its one or more output port(s) in a predetermined fashion, without any amplification, switching, or other active modulation

[SOURCE: IEC 60875-1:2015, 3.2.1, modified – The term "passive component" has become "passive optical device (component)" in the definition.]

3.3.9
etalon
passive optical device consisting of a cavity formed by a pair of parallel reflective mirrors

3.3.10
fibre Bragg grating
FBG
fibre type passive optical device (component) which has modulated refractive index profile in the core of the optical fibre

[SOURCE: IEC 61978-1:2014, 3.2.4, modified – The words "passive", "(component)" and "of the optical fibre" have been added.]

3.3.11
fibre optic filter
passive optical device (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 where the signal is transmitted is called the passband. There may be more than one passband.

[SOURCE: IEC 61977:2015, 3.2.4, modified – The term "optical device" and the brackets have been added.]

3.3.12
wavelength-selective branching device
wavelength multiplexer
wavelength demultiplexer
passive optical device (component) with three or more ports that shares optical power among its ports in a predetermined fashion, without any amplification or other active modulation but only depending on the wavelength, in the sense that at least two different wavelength ranges are nominally transferred between two different pairs of ports

[SOURCE: IEC 62074-1: 2014, 3.2.1, modified – The preferred terms "wavelength multiplexer" and "wavelength demultiplexer" have been added, as well as the words "optical device" and the brackets.]

3.3.13
coarse wavelength division multiplexing device
CWDM device
WDM device which is intended to operate for channel spacing less than 50 nm and greater than 1 000 GHz

[SOURCE: IEC 62074-1:2014, 3.2.4]

3.3.14
dense wavelength division multiplexing device
DWDM device
WDM device which is intended to operate for a channel spacing equal or less than 1 000 GHz (approximately 8 nm at 1 550 nm and 5,7 nm at 1 310 nm)

[SOURCE: IEC 62074-1:2014, 3.2.3]

3.3.15
wide wavelength division multiplexing device
WWDM device
WDM device which is intended to operate for channel spacing equal to or greater than 50 nm

[SOURCE: IEC 62074-1:2014, 3.2.5, modified – The abbreviated term "WDM" in the first preferred term has been spelled-out.]

3.3.16
cyclic arrayed waveguide grating
cyclic AWG
multi wavelength-selective branching device which can perform the function of a wavelength multiplexer and/or demultiplexer with DWDM channel spacing

3.3.17
passive chromatic dispersion compensator
PCDC
two-port in-line passive optical device (component) used to perform chromatic dispersion compensation

Note 1 to entry: PCDCs are commonly used to compensate the chromatic dispersion of an optical path by adding the opposite sign chromatic dispersion.

Note 2 to entry: The typical optical paths comprise single-mode fibre, dispersion shifted fibre and/or non-zero dispersion shifted fibre. PCDCs have either negative or positive chromatic dispersion values depending on the chromatic dispersion sign of the optical path.

[SOURCE: IEC 61978-1:2014, 3.2.1, modified – The term "passive device" has been replaced by "passive optical device (component)" in the definition.]

3.4 Performance parameter terms and definitions

3.4.1
operating temperature
temperature at which a passive optical device (component) is designed to operate with specified performance

Note 1 to entry: The case temperature may be used for a passive optical device which emits heat. For a passive optical device (component) which does not emit heat, the ambient temperature is used.

3.4.2
operating temperature range
specified range of temperatures including all operating temperatures

3.4.3
operating wavelength
λ
nominal wavelength at which a passive optical device (component) is designed to operate with the specified performance

Note 1 to entry: The term "operating wavelength" includes the wavelength to be nominally transmitted (propagated), attenuated and isolated.

3.4.4
operating wavelength range
specified range of wavelengths including all operating wavelengths

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

[SOURCE: IEC 61977:2015, 3.3.2]

3.4.5
channel
nominal wavelength or frequency of passband

Note 1 to entry: There are one or more channels for passive optical devices.

Note 2 to entry: For a passive optical components used in DWDM systems, a channel is expressed and characterised in frequency (Hz).

3.4.6
passband
one wavelength range within which a passive optical device (component) is required to operate with optical attenuation less than or equal to a specified optical attenuation value

Note 1 to entry: Passband is defined for conducting port pair.

Note 2 to entry: There may be two or more passbands in the operating wavelength range.

3.4.7
passband ripple
maximum peak-to-peak variation of insertion loss (attenuation) in the passband

3.4.8
insertion loss
insertion attenuation
maximum value of logarithmic transmission coefficient, a_{ij} (where i ≠ j) within the passband of a passive optical devide (component) in case of a conducting port pair

Note 1 to entry: It is the optical attenuation from a given port to a port which is another port of conducting port pair of the given port of a passive device. Insertion loss is a positive value in decibels. It is calculated as:

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

where

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

P_{out} is the optical power received from the other port of the conducting port pair.

Note 2 to entry: The term "attenuation" is sometimes used for the same meaning. However, attenuation for optical attenuators means optical attenuation for the port pair to be attenuated.

3.4.9
return loss
RL
element a_{ij} (where i = j) of the logarithmic transfer matrix

Note 1 to entry: It is the fraction of input power that is returned from a port of a passive device (component) and is defined as follows:

$$RL_{\mathrm{i}} = -10\log_{10}\left(\frac{P_{\mathrm{refl}}}{P_{\mathrm{i}}}\right)$$

where

P_{i} is the optical power launched into a port;

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

3.4.10
crosstalk
ratio of the transfer coefficient of the power to be isolated, to the transfer coefficient for the power to be conducted for an output port

Note 1 to entry: Crosstalk is a generally negative value expressed in the unit of dB.

Note 2 to entry: For fibre optic filters and wavelength-selective branching devices, crosstalk is defined for one port pair at different two or more wavelengths (channels).

Note 3 to entry: For fibre optic switches, crosstalk is defined for two or more port pairs at one wavelength.

Note 4 to entry: Crosstalk for a passive optical device (component) is generally the maximum value of crosstalks for all port pairs defining crosstalks.

3.4.11
isolation
value of a_{ij} (where i ≠ j) for isolated port pair

Note 1 to entry: Isolation is a positive value expressed in dB.

Note 2 to entry: For passive optical devices, isolation is generally the minimum isolation of all isolations for all isolated port pairs.

Note 3 to entry: In case of an optical isolator and an optical circulator, isolation is an attenuation value of reverse direction for a conducting port pair.

Note 4 to entry: In case of wavelength-selective branching device, isolation is attenuation in isolated wavelength range for a conducting port pair in passband.

Note 5 to entry: For add-drop wavelength-selective branching device, the relations between add-port group and drop-port group are isolated for all channels. The isolation in this case is called "add-drop isolation".

3.4.12
group delay
time delay between two (2) closely spaced wavelengths or frequencies inside the passband by which a pulse is widened by a passive optical device (component)

Note 1 to entry: The group delay is generally different for passbands.

Note 2 to entry: The group delay is mathematically defined as the first-order derivative of the wavenumber or effective index of refraction (β = kn) as a function of frequency.

3.4.13
chromatic dispersion
CD
derivative of group delay with respect to wavelength or frequency

Note 1 to entry: A typical unit is ps/nm or ps/GHz. The chromatic dispersion generally varies with the operating wavelength.

Note 2 to entry: The units of ps/GHz are not commonly used; however, it is suitable for the evaluation of transmission system influence.

Note 3 to entry: The chromatic dispersion is mathematically defined as the second-order derivative of the wavenumber or effective index of refraction (β) as a function of frequency.

[SOURCE: IEC 61978-1:2014, 3.3.3, modified – The abbreviated term "CD" has been added as a preferred term, and note 3 has been added.]

3.4.14
directivity
value of a_{ij} for two ports which is not conducting nor isolated at any state

Note 1 to entry: Directivity is a positive value expressed in the unit of dB.

Note 2 to entry: Directivity is applied for passive optical devices having three or more ports.

Note 3 to entry: Directivity for a passive optical device is generally the minimum value of directivities for all port pairs defining directivities.

Note 4 to entry: In case of optical circulator, directivity is applied for the port pair which is not conducting nor isolated.

Note 5 to entry: Directivity is not applied for add-drop port pair in case of wavelength-selective branching device.

Note 6 to entry: Directivity is not applied for a bypass path of 2 x 2 bypass optical switch.

Note 7 to entry: Isolation is applied for designed isolated port pair. Directivity is applied for no-designed but expected isolated port pair. No-designed isolated means expecting isolation of leackage of light and/or stray light.

3.4.15
polarization dependent loss
PDL
maximum variation of insertion loss caused by a variation in the state of polarization (SOP) over all the SOPs

Note 1 to entry: The terms "attenuation" is sometimes used for the same meaning. However, attenuation for optical attenuators means optical attenuation for the port pair to be attenuated.

Note 2 to entry: PDL is defined for conducting port pair.

[SOURCE: IEC 61978-1:2014, 3.3.15, modified – The notes have been added.]

3.4.16
wavelength dependent loss
WDL
maximum variation of the insertion loss over the passband

Note 1 to entry: The terms "attenuation" is sometimes used for the same meaning. However, attenuation for optical attenuators means optical attenuation for the port pair to be attenuated

[SOURCE: IEC 61978-1:2014, 3.3.16, modified – The words "the passband" have been replaced by "operating wavelength range", and the note has been added.]

3.4.17
polarization mode dispersion
PMD
average delay of the travelling time between the two principal states of polarization (PSP), when an optical signal passes through an passive optical device (component)

Note 1 to entry: Distortion in the time domain of the output signal induced by variation, inside of the passband, of the two principal states of polarization (PSP) with frequency. The PSP are the two states of polarization (SOP) that have the minimum and maximum delays between the input and output of a passive optical device (component). The arrival time difference between the two PSPs at the output of a passive optical device (component) is called the differential group delay (DGD). The statistical average (linear or RMS) of the variation of the DGD as a function of wavelength or frequency gives the value of the polarization mode delay (PMD). Most of passive optical devices (components) do not exhibit a strong variation of the DGD, if any. If there is not enough variation of the DGD as a function of wavelength or frequency, the PMD value can be approximately equal to the DGD.

[SOURCE: IEC 61978-1:2014, 3.3.17, modified – The term "passive optical component" has been replaced by "passive optical device (component)" in the definition, and the note has been added.]

3.4.18
reflectance
element of t_{ii}

Note 1 to entry: Reflectance is expressed in %.

Note 2 to entry: In a passive optical device (component), reflectance corresponds to the reflection of a single optical interface while return loss corresponds to the sum of all possible optical interfaces inside the passive optical device (component), if any. In that case, the definition of reflectance is the same as for return loss with units of dB, except for the opposite sign.

3.4.19
transmittance
element of t_{ij}

Note 1 to entry: Transmittance is generally expressed in %.

Note 2 to entry: For a passive optical device (component) having one port, transmittance is the same as reflectance.

3.4.20
differential mode delay
DMD
difference in optical pulse delay time between the fastest and slowest modes excited for all radial offset positions between and including the outer and inner limits of the radial offset position

Note 1 to entry: DMD can also be related to the strength of intermodal dispersion. DMD is then useful for characterizing the modal structure of a passive optical device (component) when used with short-pulse, narrow spectral-width laser sources.

3.4.21
maximum input power
maximum allowable input power below which a passive optical device (component) keeps designed performances

3.5 Abbreviated terms

AWG	arrayed waveguide grating
CD	chromatic dispersion
CWDM	coarce wavelength division multiplexer
DMD	differential mode delay
DWDM	dense wavelength division multiplexer
FBG	fibre Bragg grating
IL	insertion loss
PCDC	passive chromatic dispersion compensator
PDL	polarization dependent loss
PMD	polarization mode dispersion
RL	return loss
WDL	wavelength dependent loss
WWDM	wide wavelength division multiplexer