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INTERNATIONAL STANDARD

colour inside

Fibre optic interconnecting devices and passive components – Non-wavelength-selective fibre optic branching devices –
Part 1: Generic specification

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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – NON-WAVELENGTH-SELECTIVE FIBRE OPTIC BRANCHING DEVICES –

Part 1: Generic specification

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60875-1:2015. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60875-1 has been prepared by IEC technical committee 86B: Fibre optic interconnecting devices and passive components. It is an International Standard.

This seventh edition cancels and replaces the sixth 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) removal of variant and reference extensions in clause classification
b) removal of specification system in clause documentation
c) removal of interface standards, reliability standards and interlinking in clause standardization system

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

Draft	Report on voting
86B/4868/FDIS	86B/4903/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60875 series, published under the general title *Fibre optic interconnecting and passive components – Non-wavelength-selective fibre optic branching devices*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn, or
- revised.

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – NON-WAVELENGTH-SELECTIVE FIBRE OPTIC BRANCHING DEVICES –

Part 1: Generic specification

1 Scope

This part of IEC 60875 applies to non-wavelength-selective fibre optic branching devices, all exhibiting the following features:

– they are passive, in that they contain no optoelectronic or other transducing elements;
– they have three or more ports for either the entry or exit, or both, of optical power, and share optical power among these ports in a predetermined fashion;
– the ports are optical fibres, or optical fibre connectors.

This document establishes uniform requirements for the 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 (all parts), *International Electrotechnical Vocabulary* (available at http://www.electropedia.org/)~~

IEC 60050-731, *International Electrotechnical Vocabulary – Chapter 731: Optical fibre communication*

IEC 60617 (all parts), *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*

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

IEC TR 61930, *Fibre optic graphic symbology*

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

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

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

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-731 and IEC TS 62627-09 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1 Basic terms and definitions

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

3.1.1
optical pigtail
~~short length of jumper~~ fibre or cable terminated with or without a connector at the end forming an optical port for an optical component

~~**3.1.3**~~
~~**transfer matrix**~~
~~optical properties of a non-wavelength-selective optic branching device can be defined in terms of an $n \times n$ matrix of coefficients, n being the number of ports, with the coefficients representing the fractional optical power transferred between designated ports~~

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

$$T = \begin{bmatrix} t_{11} & t_{12} & \cdot & \cdot & \cdot & t_{1n} \\ t_{21} & & & & & \\ \cdot & & & & & \\ \cdot & & & t_{ij} & & \\ \cdot & & & & & \\ t_{n1} & & & & & t_{nn} \end{bmatrix}$$

~~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:~~

$$t_{ij} = P_{ij}/P_i$$

~~The transfer matrix is used to classify the different types of non-wavelength-selective branching devices which are specified in this generic specification.~~

~~Note 2 to entry: In a non-wavelength-selective branching device, the coefficients t_{ij} may be a function of the input wavelength, input polarization or modal power distribution. The values of these parameters are provided in the detail specification, when necessary.~~

~~Note 3 to entry: Single-mode, non-wavelength-selective branching devices may operate in a coherent fashion with respect to multiple inputs. Consequently, the transfer coefficients may be affected by the relative phase and intensity of simultaneous coherent optical power inputs at two or more ports.~~

~~**3.1.4**~~
~~**transfer coefficient**~~
~~element t_{ij} of the transfer matrix~~

~~**3.1.5**~~
~~**conducting port pair**~~
~~two ports i and j between which t_{ij} is nominally greater than zero~~

~~**3.1.6**~~
~~**isolated port pair**~~
~~two ports i and j between which t_{ij} is nominally zero, and a_{ij} is nominally infinite~~

3.2 Component definitions

3.2.1
non-wavelength-selective branching device
<optical> coupler
<optical> splitter
bidirectional passive 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

3.2.2
bidirectional non-wavelength-selective branching device
device whose transfer matrix element of t_{ij} is equal to t_{ji} for all i and j

3.2.3
non-bidirectional non-wavelength-selective branching device
device which at least one transfer matrix element of t_{ij} is not equal to t_{ji}

3.2.4
balanced coupler
non-wavelength-selective branching device designed ~~and intended to produce~~ to ensure that the power at each output port ~~power~~ from the same input port is equal

3.2.5
unbalanced coupler
non-wavelength-selective branching device designed ~~and intended to produce~~ to ensure that the power at ~~least one~~ each output port ~~power~~ from the same input port is not equal

3.2.6
tap-coupler
unbalanced coupler

Note 1 to entry: Typically the coupling ratio is from 1 % to 20 %.

3.3 Performance parameter definitions

~~**3.3.1**~~
~~**insertion loss**~~
~~reduction in optical power between an input and output port of a passive component expressed in decibels and defined as~~

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

~~where~~

~~P_0 is the optical power launched into the input port;~~

~~P_1 is the optical power received from the output port.~~

~~**3.3.2**~~
~~**return loss**~~
~~fraction of input power that is returned from a port of a passive component expressed in decibelsand defined as~~

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

~~where~~

~~P_0 is the optical power launched into a port;~~

~~P_r is the optical power received back from the same port.~~

~~**3.3.3**~~
~~**directivity**~~
~~optical attenuation expressed in decibels between ports which have conducting connections at any state within isolated port pairs~~

~~Note 1 to entry: It is a positive value expressed in dB. Generally, directivity for a passive device is defined as the minimum value of directivities of all ports.~~

~~Note 2 to entry: Directivity is the optical loss between ports which has no conducting connections within all operating wavelength ranges.~~

~~Note 3 to entry: Directivity is defined for port pairs which are expected to be isolated but not expressly intended to be isolated. That means it is expected to isolate leak light and/or stray light.~~

~~**3.3.4**~~
~~**excess loss**~~
~~total power lost in a non-wavelength-selective branching device when an optical signal is launched into port i, defined as~~

$$~~EL_i = -10 \log_{10} \sum_j t_{ij}~~$$

~~where the summation is performed only over those values j for which i and j are conducting ports~~

~~Note 1 to entry: For a non-wavelength-selective branching device with n input ports, there is an array of n values of excess loss, one for each input port i.~~

3.3.1
uniformity
U
difference between the maximum and minimum attenuation measured for all output ports for one input port

Note 1 to entry: For each input port, it is the maximum value over the operating wavelength range or ranges. The uniformity for a device with more than one input port is defined as the maximum value of uniformities of all input ports.

Note 2 to entry: Uniformity is expressed as difference of maximum and minimum value of each attenuation (insertion loss) from a common input port. It is expressed in decibels.

Note 3 to entry: Generally, uniformity for a passive device is defined as maximum value of uniformities of all ports.

3.3.2
coupling ratio
splitting ratio
CR
for a given input port i, the ratio of light at a given output port k to the total light from all output ports where j represents the operational output ports

Note 1 to entry: Coupling ratio is calculated by

$$CR_{ik} = t_{ik} \Big/ \sum_j t_{ij}$$

where t_{ij} is a transmission element from port i to port j.

~~**3.3.7**~~
~~**operating wavelength**~~
~~nominal wavelength λ, at which a passive component is designed to operate with the specified performance~~

~~**3.3.8**~~
~~**operating wavelength range**~~
~~specified range of wavelengths from $\lambda_{i\,min}$ **to** $\lambda_{i\,max}$ about a nominal operating wavelength λ_i, within which a passive component is designed to operate with the specified performance~~

~~Note 1 to entry: For a non-wavelength-selective branching device with more than one operating wavelength, the corresponding wavelength ranges are not necessarily equal.~~

~~**3.3.9**~~
~~**polarization dependent loss**~~
~~PDL~~
~~maximum variation of insertion loss due to a variation of the state of polarization (SOP) over all the SOPs~~

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

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

4 Requirement

4.1 Classification

4.1.1 General

Several technologies exist for the manufacturing of non-wavelength-selective branching devices. Typical technologies of non-wavelength selective branching devices are:

– Fused biconic taper;
– Planar lightwave circuit.

Some examples are given in Annex A.

Non-wavelength-selective branching devices shall be classified as follows:

– type;
– style~~;~~
~~– variant;~~
~~– performance standard grade;~~
~~– assessment level;~~
~~– normative reference extensions~~.

4.1.2 Types

The main characteristics of each type are as follows:

– transmissive ~~or~~;
– reflective~~;~~.
~~– bidirectional or unidirectional;~~
~~– tree or star;~~
~~– any combination of the above.~~

4.1.3 Style

~~4.1.3.1 General~~

~~Non-wavelength-selective branching devices may be classified into styles based on the fibre type(s), the connector type(s), the cable type(s), the housing shape, and the configuration. The configuration of branching device ports are classified as follows:~~

~~4.1.3.2 Configuration A~~

~~Device containing integral fibre optic pigtails, without connectors (see Figure 1).~~

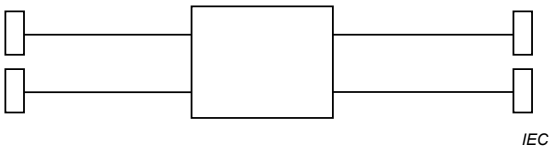
~~EXAMPLE~~

~~Figure 1 – Non-wavelength-selective branching device~~

~~4.1.3.3 Configuration B~~

~~Device containing integral fibre optic pigtails, with a connector on each pigtail (see Figure 2).~~

~~EXAMPLE~~



~~Figure 2 – Non-wavelength-selective branching device~~

~~4.1.3.4 Configuration C~~

~~Device containing fibre optic connectors as an integral part of the device housing (see Figure 3).~~

EXAMPLE

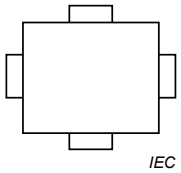


Figure 3 – Non-wavelength-selective branching device

4.1.3.5 Configuration D

Device containing some combination of the interfacing features of the preceding configurations (see Figure 4).

EXAMPLE

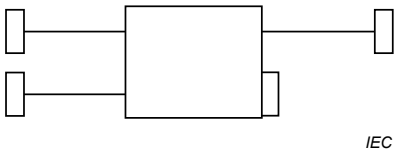


Figure 4 – Non-wavelength-selective branching device

4.1.4 Variant

The branching device variant identifies those common features which encompass structurally similar components.

Examples of features which define a variant include, but are not limited to the following:

– orientation of ports;
– means of mounting.

4.1.5 Normative reference extensions

Normative reference extensions are used to identify the integration of independent standards specifications or other reference documents into blank detail specifications.

Unless otherwise specified, 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 used for other than fibre optics.

Published reference documents produced by ITU, consistent with the scope of the relevant IEC specification series may be used as extension.

Some optical splice 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 necessary to assure 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 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.

In the event of conflicting requirements, precedence, in descending order, shall be generic over mandatory extension, over blank detail, over detail, over application specific extension.