IEC 60875-1

Edition 6.0 2015-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

Dispositifs d'interconnexion et composants passifs à fibres optiques – Dispositifs de couplage à fibres optiques ne dépendant pas de la longueur d'onde – Partie 1: Spécification générique

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

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
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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International Standard IEC 60875-1 has been prepared by subcommittee SC86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

This sixth edition cancels and replaces the fifth edition published in 2010 and constitutes a technical revision.

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

a) removal of terms and definitions for splitter, coupler, symmetric non-wavelength-selective branching device, asymmetric non-wavelength-selective branching device;
b) addition of terms and definitions for bidirectional non-wavelength-selective branching device and non-bidirectional non-wavelength-selective branching device
c) removal of assessment level.

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

CDV	Report on voting
86B/3806/CDV	86B/3872/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.

A list of all parts in the IEC 60875 series, published under the general title *Fibre optic interconnecting devices 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 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,
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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 the entry and/or exit of optical power, and share optical power among these ports in a predetermined fashion;
– the ports are optical fibres, or optical fibre connectors.

This standard establishes uniform requirements for the 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 (all parts), *International Electrotechnical Vocabulary* (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*

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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, as well as the following, apply.

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

3.1.2
optical pigtail
short length of jumper or cable forming an optical port for an optic 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

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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 which is designed and intended to produce that each output port power from the same input port is equal

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

3.2.6
tap-coupler
unbalanced coupler, 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

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

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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

$$EL_{\mathrm{i}} = -10 \log_{10} \sum_{\mathrm{j}} t_{\mathrm{ij}}$$

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.

3.3.5
uniformity
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 the difference of maximum and minimum value of each 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.

3.3.6
coupling ratio
splitting ratio
for a given input port i, the ratio of light at a given output port k to the total light from all output ports and defined as

$$CR_{\mathrm{ik}} = t_{i\mathrm{k}} \Big/ \sum_{\mathrm{j}} t_{\mathrm{ij}}$$

where j represents the operational output ports.

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

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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

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

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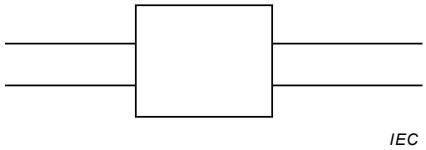

Figure 1 – Non-wavelength-selective branching device

4.1.3.3 Configuration B

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

EXAMPLE

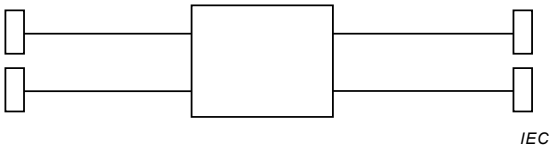

Figure 2 – Non-wavelength-selective branching device

4.1.3.4 Configuration C

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

EXAMPLE

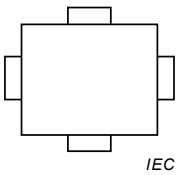

Figure 3 – Non-wavelength-selective branching device

4.1.3.5 Configuration D

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

EXAMPLE

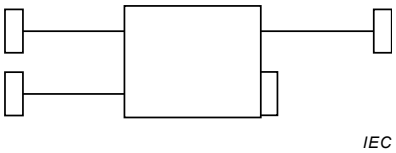

Figure 4 – Non-wavelength-selective branching device

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:

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– 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.

4.2 Documentation

4.2.1 Symbols

Graphical and letter symbols shall, whenever possible, be taken from IEC 60027, IEC 60617 and IEC 61930.

4.2.2 Specification system

4.2.2.1 General

This specification is part of a three-level IEC specification system. Subsidiary specifications shall consist of blank detail specifications and detail specifications. This system is shown in Table 1. There are no sectional specifications for non-wavelength-selective branching devices.

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Table 1 – Three-level IEC specification structure

Specification level	Examples of information to be included	Applicable to
Basic	Assessment system rules Inspection rules Optical measuring methods Environmental test methods Sampling plans Identification rule Marking standards Dimensional standards Terminology standards Symbol standards Preferred number series SI units	Two or more component families or sub-families
Generic	Specific terminology Specific symbols Specific units Preferred values Marking Quality assessment procedures 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

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:

– 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.

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4.2.2.3 Detail specifications

A specific non-wavelength-selective branching device 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 non-wavelength-selective branching device design 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 4.7.2);
– drawings, dimensions required (see 4.2.3);
– performance requirements (see 4.6).

4.2.3 Drawings

4.2.3.1 General

The drawings and dimensions given in detail specifications shall not restrict themselves to details of construction, nor shall they 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 and the conversion between systems of units shall use a factor of 25,4 mm to 1 inch.

4.2.4 Measurements

4.2.4.1 Measurement method

The measurement method for optical, mechanical, climatic, and environmental characteristics of branching devices 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 detail specification for any 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.

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4.2.4.3 Gauges

Gauges, if required, shall be specified in the relevant specification.

4.2.5 Test data sheets

Test data sheets 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 of test and date;
– specimen description including the type of fibre and the variant identification number (see 4.7.2);
– test equipment used and date of latest calibration;
– all applicable test details;
– all measurement values and observations;
– sufficiently detailed documentation to provide traceable information for failure analysis.

4.2.6 Instructions for use

Instructions for use, when required, shall be given by the manufacturer and shall include:

– assembly and connection instructions;
– cleaning method;
– safety aspects;
– additional information, as necessary.

4.3 Standardization system

4.3.1 Interface standards

The interface standards provide both manufacturer and user with all the information they require to make or use a product conforming to the physical features of that standard interface. Interface standards fully define and provide dimensions for the features essential for the mating and unmating of optical connectors and other components. They also serve to position the optical datum target, where defined, relative to other reference datum.

Interface standards ensure that connectors and adaptors 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 from products having different manufacturing specifications, although the level of performance cannot be expected to be any better than that of the lowest specified performance.

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