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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 pour fibres optiques ne dépendant pas de la longueur d'onde – Partie 1: Spécification générique

IEC 60875-1:2010

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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 fifth edition cancels and replaces the fourth edition published in 2000. It constitutes a technical revision. The changes with respect to the previous edition are to delete the clause of Quality assessment procedures and reconsider the constitution of this standard.

This bilingual version (2010-10) replaces the English version.

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

FDIS	Report on voting
86B/2986/FDIS	86B/3022/RVD

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

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The list of all parts of 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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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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 referenced documents are indispensable for the application 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) – Chapter 731: Optical fibre communication*

IEC 60617-SN, *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 61930, *Fibre optic graphic symbology*

IEC Guide 102, *Electronic components – Specification structures for quality assessment (Qualification approval and capability approval)*

IECQ 01, *IEC Quality Assessment System for Electronic Components (IECQ Scheme) – Basic Rules*

IECQ 001002-3, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of Procedure – Part 3: Approval procedures*

ISO 129-1, *Technical drawings – Indication of dimensions and tolerances – Part 1: General principles*

ISO 286-1, *ISO system of limits and fits – Part 1: Bases 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 the following apply.

3.1 Basic term 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

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.

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.

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
logarithmic transfer matrix
in general, the logarithmic transfer matrix is as follows:

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

where

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

$$a_{ij} = -10 \log t_{ij}$$

where t_{ij} is the transfer matrix coefficient

3.1.6
conducting ports
two ports i and j between which t_{ij} is nominally greater than zero

3.1.7
isolated ports
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
passive component possessing three or more ports which operates over a specified range of wavelengths and shares the optical power coming into an input port among its output ports in a predetermined fashion, without any amplification, switching, or other active modulation

3.2.2
splitter
term frequently used as a synonym for a non-wavelength-selective branching device with 1 or 2 entries (input ports) and more then 4 exits (output ports) designed and intended to produce equal optical power at the output ports

3.2.3
coupler
term frequently used as a synonym for a non-wavelength-selective branching device with 1 or 2 entries (input ports) and 4 or less exits (output ports) or with M entries (input ports) and up to N exits (output ports) where the number of exits (output ports) is larger then one (N>1)

3.2.4
symmetric non-wavelength-selective branching device
device whose transfer matrix is diagonally symmetric, i.e. where for all i and j, t_{ij} and t_{ji} are nominally equal

3.2.5
asymmetric non-wavelength-selective branching device
device whose transfer matrix is diagonally asymmetric, i.e. where there exists at least one i and j for which t_{ij} and t_{ij} are nominally unequal

3.2.6
balanced coupler
term frequently used as a synonym for a symmetric non-wavelength-selective branching device which is designed and intended to produce that each output port power from the same input port is equal

3.2.7
unbalanced coupler
term frequently used as a synonym for a asymmetric non-wavelength-selective branching device which is designed and intended to produce that power at each output port is different

3.2.8
tap-coupler
term frequently used as a synonym for a unbalanced coupler, typically the coupling ratio is from 1 % to 20 %

3.2.9
polarization dependent loss
PDL
maximum variation of insertion loss due to a variation of the state of polarization (SOP) over all the SOPs

3.3 Performance parameter definitions

3.3.1
insertion loss
element, a_{ij} (where $i \neq j$), of the logarithmic transfer matrix; reduction in optical power between an input and output port of a passive component expressed in decibels and defined as

$$a = -10 \log (P_1/P_0)$$

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
element, a_{ij} (where i = j), of the logarithmic transfer matrix; fraction of input power that is returned from the input port of a passive component and defined as

$$RL = -10 \log (P_1/P_0)$$

where

P_0 is the optical power launched into the input port;

P_1 is the optical power received back from the same port

3.3.3
directivity
value of a_{ij} between two isolated ports

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

$$EL_i = -10 \log \sum_j t_{ij}$$

where the summation is performed only over those values j for which i and j are conducting ports. 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
logarithmic transfer matrix of a branching device may contain a specified set of coefficients which are nominally finite and equal. In this case, the range of these coefficients a_{ij}, expressed in decibels, is termed the uniformity of the branching device

3.3.6
coupling 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

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

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

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 For a non-wavelength-selective branching device with more than one operating wavelength, the corresponding wavelength ranges are not necessarily equal.

4 Requirements

4.1 Classification

4.1.1 General

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

– type;
– style;
– variant;
– performance standard grad;
– 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), cable type(s), 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.

EXAMPLE

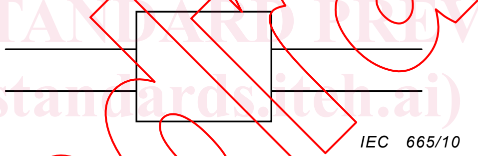

Figure 1 – Non-wavelength-selective branching device

4.1.3.3 Configuration B

Device containing integral fibre optic pigtails, with a connector on each pigtail.

EXAMPLE

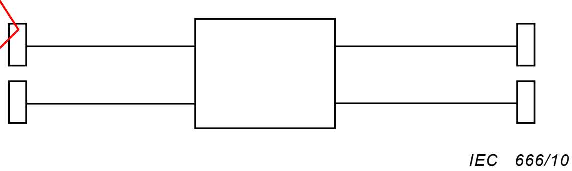

Figure 2 – Non-wavelength-selective branching device

4.1.3.4 Configuration C

Device containing fibre optic connectors as an integral part of the device housing.

EXAMPLE

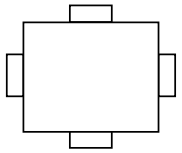

Figure 3 – Non-wavelength-selective branching device

4.1.3.5 Configuration D

Device containing some combination of the interfacing features of the preceding configurations.

EXAMPLE

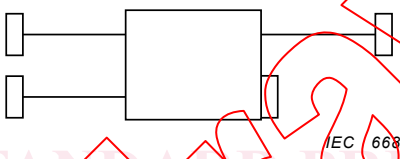

Figure 4 – Non-wavelength-selective branching device

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 Assessment level

Assessment level defines the inspection levels and the acceptable quality level (AQL) of groups A and B and the periodicity of inspection of groups C and D. Detail specifications shall specify one or more assessment levels, each of which shall be designated by a capital letter.

The following are the preferred levels:

Assessment level A

– group A inspection: inspection level II, AQL = 4 %;
– group B inspection: inspection level II, AQL = 4 %;
– group C inspection: 24 month periods;
– group D inspection: 48 month periods.

Assessment level B

– group A inspection: inspection level II, AQL = 1 %;
– group B inspection: inspection level II, AQL = 1 %;

– group C inspection: 18 month periods;
– group D inspection: 36 month periods.

Assessment level C

– group A inspection: inspection level II, AQL = 0,4 %;
– group B inspection: inspection level II, AQL = 0,4 %;
– group C inspection: 12 month periods;
– group D inspection: 24 month periods.

One additional assessment level may be added in the detail specification. When this is done, the capital letter X shall be used.

4.1.6 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.

Examples of optical connector extensions are given as follows:

- Using IEC 61754-4 and IEC 61754-15 to partially define a future specification of the IEC 60874 series for a duplex type SC/LSH hybrid connector adapter.
- Using IEC 61754-13 and IEC 60869-1 to partially define a future specification of the IEC 60874 series for an integrated type "FC" preset attenuated optical connector.
- Using IEC 61754-15 and IEC 61754-4 to partially define a future specification of the IEC 60874 series for a duplex LSH receptacle incorporating integral mechanical splices.

Other examples of requirements for normative extensions are as follows:

a) Some commercial or residential building applications may require direct reference to specific safety codes and regulations or incorporate other specific material flammability or toxicity requirements for specialized locations.
b) Specialized field tooling may require an extension to implement specific ocular safety, electrical shock, burn hazard avoidance requirements, or require isolation procedures to prevent potential ignition of combustible gases.