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Fibre optic interconnecting devices and passive components – Fibre optic spatial switches –
Part 1: Generic specification

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Part 1: Generic specification

FOREWORD

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International Standard IEC 60876-1 has been prepared by subcommittee SC86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

This fourth edition cancels and replaces the third edition published in 2001. It constitutes a technical revision. The changes with respect to the previous edition are to remove quality assessment procedures and to reconsider definitions.

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

CDV	Report on voting
86B/3276/CDV	86B/3339/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 the parts in the IEC 60876 series, published under the general title *Fibre optic interconnecting devices and passive components-Fibre optic spatial switches* can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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- withdrawn,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
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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – FIBRE OPTIC SPATIAL SWITCHES –

Part 1: Generic specification

1 Scope

This part of IEC 60876 applies to fibre optic switches possessing all of the following general features:

– they are passive in that they contain no optoelectronic or other transducing elements;
– they have one or more ports for the transmission of optical power and two or more states in which power may be routed or blocked between these ports;
– the ports are optical fibres or fibre optic connectors.

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 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 61300 (all parts), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures*

IEC/TR 61930, *Fibre optic graphical symbology*

IEC 62047-1, *Semiconductor devices – Micro-electromechanical devices – Part 1: Terms and definitions*

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

ISO 286-1, *Geometrical product specification (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 part of IEC 60876, the definitions given in IEC 60050-731 apply, together with the following definitions.

3.1 Basic terms and definitions

3.1.1
port
optical fibre or fibre optic connector attached to a passive component for the entry and/or exit of optical power

3.1.2
transfer matrix
optical properties of a fibre optic switch can be defined in a $n \times n$ matrix of coefficients (n is the number of ports)

Note 1 to entry: The T matrix represents the on-state paths (worst-case transmission) and the T° matrix represents the off-state paths (worst-case isolation).

3.1.3
transfer coefficient
element t_{ij} or $t°_{ij}$ of the transfer matrix

Note 1 to entry: Each transfer coefficient t_{ij} is the worst-case (minimum) fraction of power transferred from port i to port j for any state with path ij switched on. Each coefficient $t°_{ij}$ is the worst-case (maximum) fraction of power transferred from port i to port j for any state with path ij switched off.

3.1.4
logarithmic transfer matrix

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

where

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

t_{ij} is the transfer coefficient.

Note 1 to entry: Similarly, for the off state, $a°_{ij} = -10 \log t°_{ij}$

3.2 Component definitions

3.2.1
optical switch
passive component processing one or more ports which selectively transmits, redirects or blocks optical power in an optical fibre transmission line

3.2.2
switch state
particular optical configuration of a switch, whereby optical power is transmitted or blocked between specific ports in a predetermined manner

3.2.3
actuation mechanism
physical means (mechanical, electrical, acoustic, optical, etc.) by which a switch is designed to change between states

3.2.4
actuation energy
input energy required to place a switch in a specific state

3.2.5
latching switch
switch that maintains its last state and specified performance level when the actuation energy which initiated the change is removed

3.2.6
non-latching switch
switch that reverts to a home state or undefined state when the actuation energy which initiated a change is removed

3.2.7
blocking
inability to establish a connection from a free input port to a free output port due to the existence of some other established connection

Note 1 to entry: Blocking and various degrees of non-blocking operation functionalities are of various types. "Strict-sense non-blocking" refers to a switch matrix in which it is always possible to establish a connection between any free input port and any free output port irrespective of previously established connections.
"Wide-sense non-blocking" refers to a matrix in which it is always possible to establish a desired connection provided that some systematic procedure is followed in setting up connections. Some multistage switching architectures fall into this category.
"Rearrangeably non-blocking" refers to a switch matrix in which any free input port can be connected to any free output port provided that other established connections are unconnected and then reconnected as part of making the new connection.

3.2.8
magneto-optic effect switch
MO switch
optical switch which uses the magneto-optic effect (phenomenon of polarization state change in transmitted light and reflected light due to a magnetic field)

3.2.9
mechanical switch
optical switch, which realises the switching function by driving of the movable part

3.2.10
micro-electromechanical system switch
MEMS switch
optical switch using MEMS technology, as defined in IEC 62047-1

3.2.11
thermo-optic effect switch
TO switch
optical switch which uses the thermo-optic effect (phenomenon of refractive index change caused by temperature variation)

3.3 Performance parameter definitions

3.3.1
insertion loss
element a_{ij} (where i ≠ j) of the logarithmic transfer matrix

Note 1 to entry: It is the reduction in optical power between an input and output port of a passive component expressed in decibels and is defined as follows:

$$a_{ij} = -10 \log (P_j/P_i)$$

where

P_i is the optical power launched into the input port, and

P_j is the optical power received from the output port.

Note 2 to entry: The insertion loss values depend on the state of the switch.

3.3.2
return loss
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 the input port of a passive component and is defined as follows:

$$RL_i = -10 \log (P_{refl}/P_i)$$

where

P_i is the optical power launched into the input port, and

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

Note 2 to entry: The return loss values depend on the state of the switch.

3.3.3
operating wavelength
λ
nominal wavelength at which a passive component is designed to operate with the specified performance

3.3.4
latency time

3.3.4.1
latency time
t_l
<switching from isolated state to conducting state> elapsed time when the output power of a specified output port reaches 10 % of its steady-state value of the output power from the time the actuation energy is applied

SEE: Figure 1

3.3.4.2
latency time
t_l'
<switching from conducting state to isolated state> elapsed time when the output power of a specified output port reaches 90 % of its steady-state value of the output power from the time the actuation energy is removed

SEE: Figure 1

3.3.5
rise time
elapsed time when the output power of the specified output port rises from 10 % of the steady-state value to 90 % of the steady-state value

3.3.6
fall time
elapsed time when the output power of the specified output port falls from 90 % of the steady-state value to 10 % of the steady-state value

3.3.7
bounce time

3.3.7.1
bounce time

t_b

<switching from isolated state to conducting state> elapsed time when the output power of a specified output port maintains between 90 % and 110 % of its steady-state value of the output power from the first time the output power of a specified output port reaches to 90 % of its steady-state value of the output power

SEE: Figure 1

3.3.7.2
bounce time

t_b'

<switching from conducting state to isolated state> elapsed time when the output power of a specified output port maintains between 0 % and 10 % of its steady-state value of the output power from the first time the output power of a specified output port reaches to 10 % of its steady-state value of the output power

SEE: Figure 1

3.3.8
switching time

3.3.8.1
switching time

t_s

<switching from isolated state to conducting state> the switching time is defined as follows:

$$t_s = t_l + t_r + t_b$$

where

t_l is latency time;

t_r is rise time;

t_b is bounce time.

3.3.8.2
switching time

t_s'

<switching from conducting state to isolated state>the switching time is defined as follows:

$$t_s' = t_l' + t_f + t_b'$$

where

t_l' is latency time;

t_f is fall time;

t_b' is bounce time.