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INTERNATIONAL STANDARD

Dynamic modules –
Part 3-3: Performance specification templates – Wavelength selective switches

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FOREWORD

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International Standard IEC 62343-3-3 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

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

a) modification of the normative references;

b) modification of the terms and definitions.

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

FDIS	Report on voting
86C/1648/FDIS	86C/1655/RVD

Full information on the voting for the approval of this International Standard 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 62343 series, published under the general title *Dynamic modules,* 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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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INTRODUCTION

A wavelength selective switch (WSS) is a dynamic module (DM), which is mainly used in a reconfigurable optical add-drop multiplexer (ROADM) system to switch a particular wavelength signal to any output ports in DWDM networks. The WSS ~~module~~ has one input port and a plurality of output ports (i.e. 1 × N WSS) and can be used in reverse, with N input ports and one output port, depending on its application. It is controlled with software, which determines any wavelength signal among a DWDM signal from one input port to switch to a particular output port in case of 1 × N application.

DYNAMIC MODULES –

**Part 3-3: Performance specification templates –
Wavelength selective switches**

1 Scope

This part of IEC 62343 provides a performance specification template for wavelength selective switches. The object is to provide a framework for the preparation of detail specifications on the performance of wavelength selective switches.

Additional specification parameters ~~may be~~ are often included for detailed product specifications or performance specifications if necessary. However, specification parameters specified in this document ~~shall~~ are not ~~be~~ removed from the detail product specifications or performance specifications.

The technical information regarding wavelength selective switches and their applications in DWDM systems with single-mode fibres ~~will be~~ are described in IEC TR 62343-6-4~~, currently under consideration~~.

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 61290-7-1, *Optical amplifiers – Test methods – Part 7-1: Out-of-band insertion losses – Filtered optical power meter method*

IEC 61300-2-14, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-14: Tests – High optical power*

IEC 61300-3-2, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-2: Examination and measurements – Polarization dependent loss in a single-mode fibre optic device*

IEC 61300-3-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*

IEC 61300-3-14, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-14: Examinations and measurements – ~~Accuracy~~ Error and repeatability of the attenuation settings of a variable optical attenuator*

IEC 61300-3-21, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-21: Examinations and measurements – Switching time ~~and bounce time~~*

IEC 61300-3-29, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-29: Examinations and measurements – ~~Measurement techniques for characterizing the amplitude of the spectral transfer function of DWDM components~~ Spectral transfer characteristics of DWDM devices*

IEC 61300-3-32, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-32: Examinations and measurements – Polarization mode dispersion measurement for passive optical components*

IEC 61300-3-38, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-38: Examinations and measurements – Group delay, chromatic dispersion and phase ripple*

IEC 61753-021-2, *Fibre optic interconnecting devices and passive components performance standard – Part 021-2: Grade C/3 single-mode fibre optic connectors for category C – Controlled environment*

IEC 62074-1, *Fibre optic interconnecting devices and passive components – Fibre optic WDM devices – Part 1: Generic specification*

IEC 62343, *Dynamic modules – General and guidance*

IEC 62343-1, *Dynamic modules – Part 1: Performance standards – General conditions*

~~IEC 62343-4-1, *Dynamic modules – Part 4-1: Software and hardware interface standards – 1x9 wavelength selective switch*~~ [1]

IEC 62343-5-2, *Dynamic modules – Part 5-2: Test methods – 1 x N fixed-grid WSS – Dynamic crosstalk measurement*

ITU-T Recommendation G.694.1, *Spectral grids for WDM applications: DWDM frequency grid*

~~ITU-T G.Sup39, *Optical system design and engineering considerations*~~

3 Terms and definitions

For the purpose of this document, the ~~following~~ terms and definitions given in IEC 62343 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

~~**3.1**~~
~~**wavelength selective switch**~~
~~WSS~~
~~dynamic module, which is mainly used in a reconfigurable optical add drop multiplexer (ROADM) system to switch all wavelength signals to their respective required output port in DWDM networks~~

~~Note 1 to entry: It is electrically controlled with software, which directs each wavelength signal among an input DWDM signal from one input port to the required output port for each wavelength signal.~~

~~[1] Under consideration.~~

3.2
operating wavelength range
specified range of wavelengths from λ_{imin} to λ_{imax} about a nominal operating wavelength λ_I, within which a dynamic optical module is designed to operate with a specified performance and generally corresponds to spectral bands for single-mode systems defined in ITU-T G.Sup39

3.3
port
optical fibre or optical fibre connector attached to a WSS module for the entry and/or exit of the optical signal (input and/or output)

3.4
channel
signal at wavelength, λ, that corresponds to ITU grid (ITU-T Recommendation G.694.1) within the range of operating wavelength range

3.5
channel spacing
centre-to-centre difference in frequency (or wavelength) between adjacent channels in a device

3.6
channel frequency range
frequency range within which a device is expected to operate with a specified performance

Note 1 to entry: For a particular nominal channel central frequency, f_{nomi}, this frequency range is from $f_{imin} = (f_{nomi} - \Delta f_{max})$ to $f_{imax} = (f_{nomi} + \Delta f_{max})$, where Δf_{max} is the maximum channel central frequency deviation.

Note 2 to entry: Nominal channel centre frequency and maximum channel centre frequency deviation are defined in ITU-T Rec. G.692.

3.7
insertion loss
IL
value defined in the equation below at the particular wavelength between two conducting ports

Note 1 to entry: It is the reduction in optical power between an input and output port of a module expressed in decibels.

$$IL = -10 \log (P_{out}/P_{in})$$

where

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

P_{out} is the optical power received from the output port.

3.8
insertion loss uniformity
difference between the maximum and minimum insertion loss at the output for a specified set of input ports

3.9
insertion loss ripple
maximum peak-to-peak variation of the insertion loss within a channel frequency (or wavelength) range

3.10
***X*-dB passband width**
width of a channel centred about the channel central wavelength within which the optical attenuation is within X dB

Note 1 to entry: The terms "operating wavelength range" or "channel passband" are used and have the same meaning as passband for DWDM devices. The X-dB bandwidth is defined through the spectral dependence of a_{ij} (where $i \neq j$) as the minimum wavelength range centred about the operating wavelength λ_h within which the variation of a_{ij} is less than X dB. The minimum wavelength range is determined considering thermal wavelength shift, polarization dependence and long-term aging shift (refer to Figure 1 below).

Note 2 to entry: It is recommended that the passband width be specified as 0,5 dB, 1 dB and 3 dB (X = 0,5, 1 and 3).

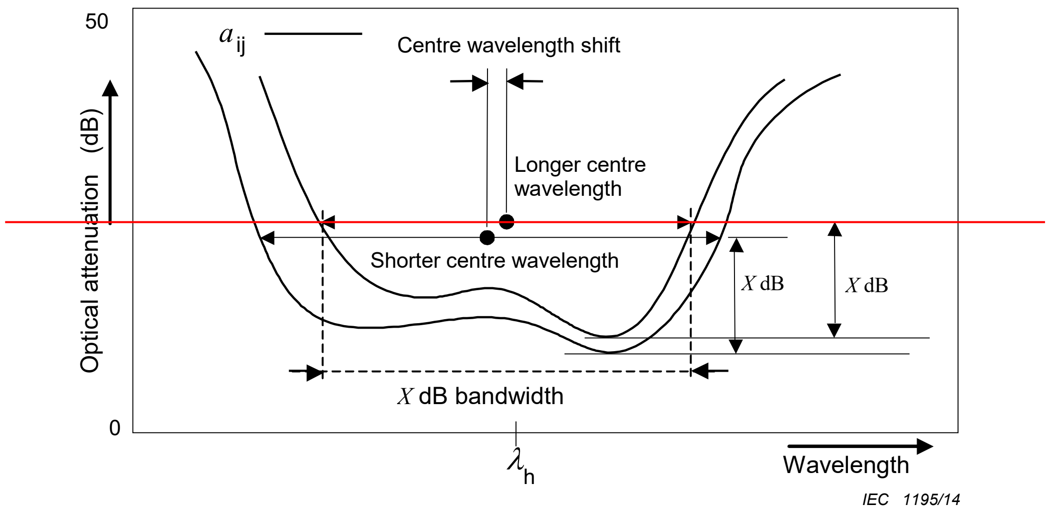

Figure 1 – Illustration of X-dB bandwidth

3.11
return loss
RL
fraction of input power that is returned from any port of a module expressed in decibels and defined in this equation at the particular wavelength between two conducting ports

$$RL = -10 \log (P_{refl}/P_{in})$$

where

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

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

3.12
adjacent channel crosstalk
adjacent channel isolation
crosstalk with the restriction that x, the isolation wavelength number, is restricted to the channels immediately adjacent to the (channel) wavelength number associated with output port

Note 1 to entry: Adjacent channel crosstalk is a negative value in dB (see Figure 2, below).

Note 2 to entry: The adjacent channel isolation is different from adjacent channel crosstalk. In Figure 2, an up-pointing arrow shows positive, a down-pointing arrow negative. Generally, there are two adjacent channel isolations for the shorter wavelength (higher frequency) side and a longer wavelength (lower frequency) side.

Note 3 to entry: The term crosstalk and isolation are often used with almost the same in meaning. Care should be taken not to confuse crosstalk and isolation. Crosstalk is defined so that for WDM devices, the value of the ratio between the optical power of the specified signal and the specified noise, is a negative value in dB. The crosstalk is defined for each output port. Crosstalk for WDM devices is defined for a DEMUX (1 × N WDM device). The crosstalk for port o to port j is the subtraction from the insertion loss of port i to o (conducting port pair) to the isolation of port j to o (isolated port pair). For WDM devices having three of more ports, the crosstalk should be specified as the maximum value of the crosstalk for each output port. On the other hand, isolation is the minimum value of a_{ij} (where $i \neq j$) within isolation wavelength range for isolated port pair. Isolation is positive value in dB.

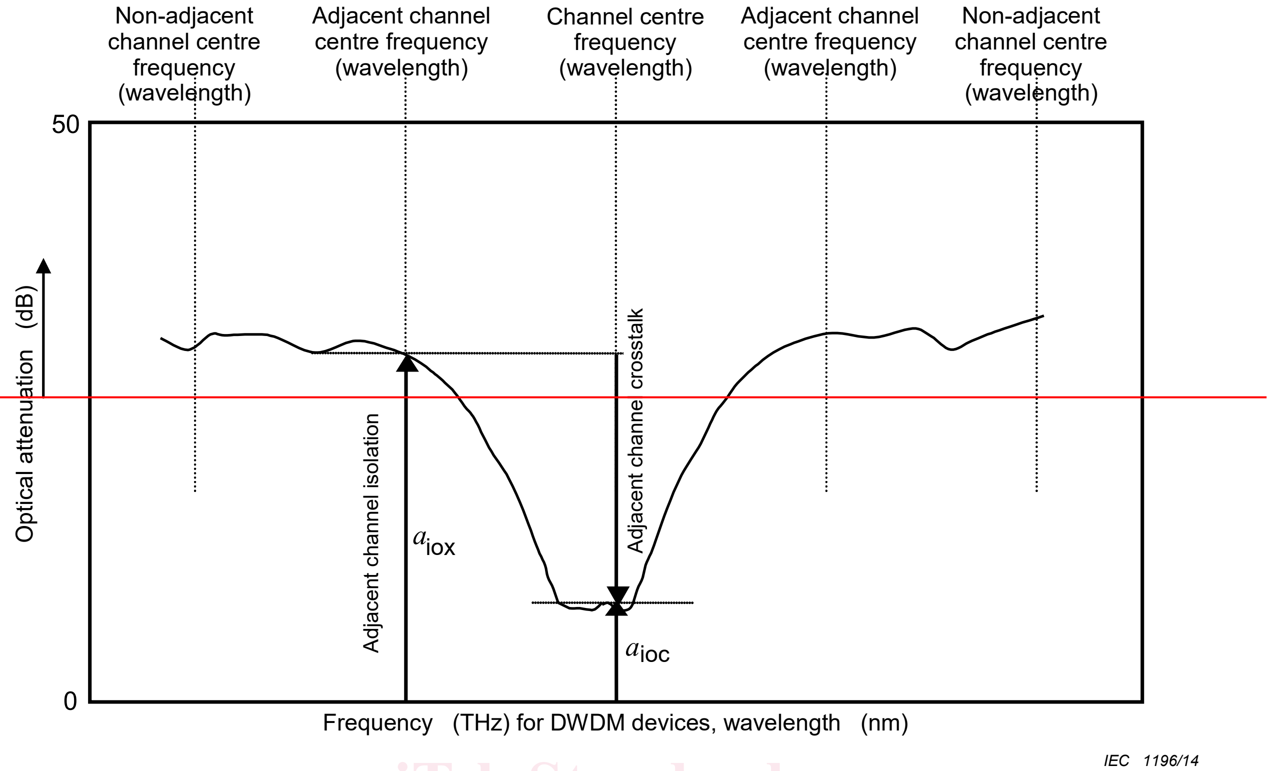

Figure 2 – Illustration of adjacent channel crosstalk

3.13
non-adjacent channel crosstalk
non-adjacent channel isolation
crosstalk with the restriction that the isolation wavelength (frequency) is restricted to each of the channels not immediately adjacent to the channel associated with output port

Note 1 to entry: The non-adjacent channel crosstalk is different from non-adjacent channel isolation. In Figure 3, up-pointing arrow shows positive, down-pointing arrow negative.

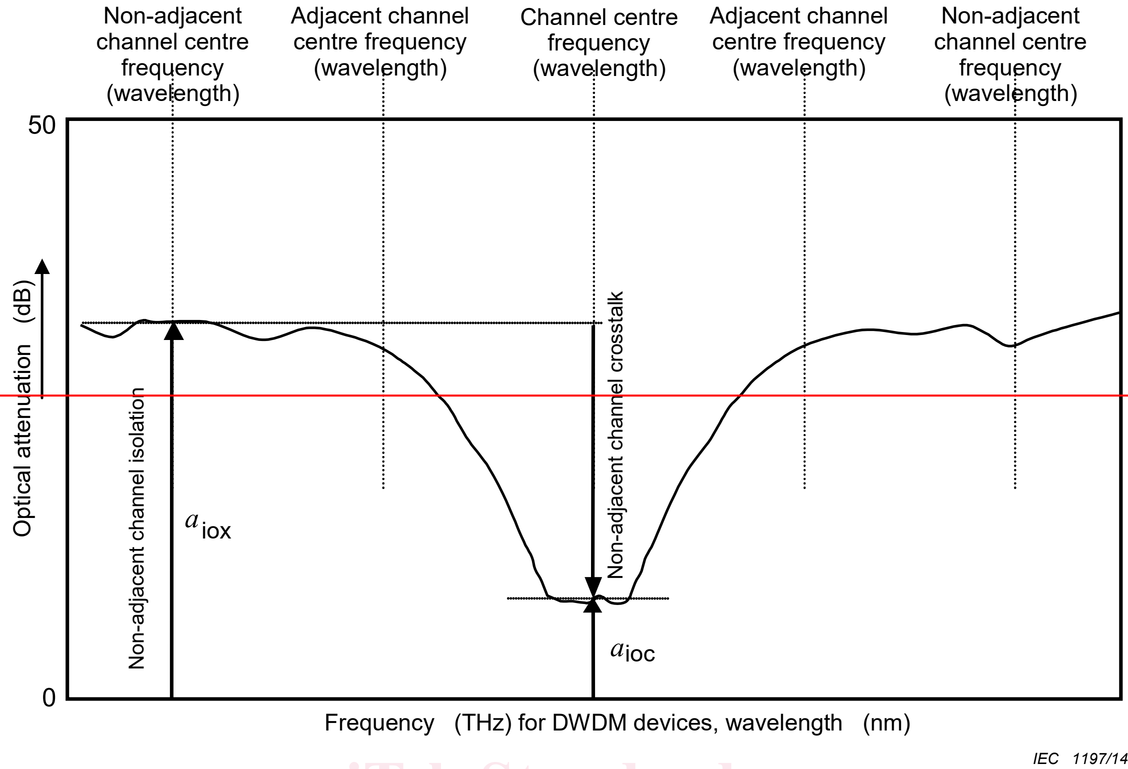

Figure 3 – Illustration of non-adjacent channel crosstalk

3.14
total channel crosstalk
total channel isolation
cumulative isolation due to the contributions at all the isolation wavelengths (frequencies) and transfer matrix coefficient for ports i and j, t_{ij} for any two ports i and j (where $i \neq j$). It is the ratio defined as

$$XT_{\text{tot}} = -10 \times \text{Log}\left[\frac{t_{ij}(\lambda_h)}{\sum_{k(k \neq h)}^{N} t_{ij}(\lambda_k)}\right]$$

where

N is the number of channels of the device;

λ_h is the nominal operating wavelength (frequency) for the two of ports, i and j;

λ_k are the nominal isolation wavelengths (frequencies) for the same pair of ports.

Note 1 to entry: Total channel crosstalk is also expressed by total channel isolation as in the following equation:

$$XT_{\text{tot}} = a_{ij}(\lambda_h) - I_{\text{tot}}$$

Note 2 to entry: Total channel crosstalk is a negative value in dB. For a WDM device, total channel crosstalk shall be specified as the maximum value of total channel crosstalk of all channels.

3.15
transient crosstalk
transient isolation/transient directivity
crosstalk that is attributed to both channel crosstalk (due to same wavelength and/or other wavelengths) and port isolation, predicted to change during switching operation in WSS module

Note 1 to entry: Hitless operation means that there is no influence on other performance during switching operation.

3.16
channel blocking attenuation
attenuation value when a particular channel is set in the blocking state (possible maximum attenuation)

3.17
attenuation without power
attenuation value when electric power for driving the attenuation is not supplied

3.18
variable attenuation range
attenuation value that can be changed with channel-by-channel independently controlled by driving circuit with software

3.19
variable attenuation resolution
resolution of the setting of attenuation value

3.20
attenuation accuracy
precision of attenuation value when once set by driving circuit with software and includes the point of view of both repeatability and stability in the timeframe

Note 1 to entry: This is important when used in open loop operation.

3.21
response time for attenuation
elapsed time to change the attenuation value of any channel from an initial value to the desired value, measured from the time the actuation energy is applied

3.22
out-of-band attenuation
minimum attenuation (in dB) of channels that fall outside of the operating wavelength range

3.23
switching time
when switching from isolated state to conducting state, switching time (t_s) 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.

Note 1 to entry: When switching from conducting state to isolated state, switching time (t_s') 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.