IEC 62343-5-2

Edition 1.0 2018-01

INTERNATIONAL STANDARD

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colour inside

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

Modules dynamiques –
Partie 5-2: Méthodes d'essai – Commutateurs sélectifs en longueur d'onde à grille fixe 1 x N – Mesure de diaphonie dynamique

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DYNAMIC MODULES –

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FOREWORD

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International Standard IEC 62343-5-2 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

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

CDV	Report on voting
86C/1449/CDV	86C/1480/RVC

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- withdrawn,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

Dynamic crosstalk is attributed to both channel crosstalk (due to same wavelength and/or other wavelengths) and port isolation. It is predicted to change during port switching operations and is a significant performance issue studied and summarized in IEC TR 62343-6-9 for 1 x N ($N \geq 3$) wavelength selective switches (WSSs).

It was revealed that dynamic crosstalk exists in actual 1 x N ($N \geq 3$) WSSs in IEC TR 62343-6-9 and predicted that it would influence transmission properties to some extent when a specific channel passes through the WSS.

This document standardizes the measurement method of dynamic crosstalk of 1 x N ($N \geq 3$) WSSs.

This document is based on OITDA DM 01 from the Optoelectronic Industry and Technology Development Association (OITDA).

DYNAMIC MODULES –

Part 5-2: Test methods – 1 x N fixed-grid WSS – Dynamic crosstalk measurement

1 Scope

This part of IEC 62343 describes the measurement methods of dynamic crosstalk during port switching for 1 x N fixed-grid wavelength selective switches (WSSs).

The objective of this document is to establish a standard test method for different-channel dynamic crosstalk and same-channel dynamic crosstalk that occur when a particular optical channel signal is switched to the specific branching port against a common port in ITU-T 50 GHz and 100 GHz fixed grid 1 x N ($N \geq 3$) WSSs.

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 61300-3-29, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-29: Examinations and measurements – Spectral transfer characteristics of DWDM devices*

IEC TR 61931, *Fibre optic – Terminology*

IEC 62343, *Dynamic modules – General and guidance*

IEC TS 62538, *Categorization of optical devices*

ISO/IEC Guide 99, *International vocabulary of metrology – Basic and general concepts and associated terms (VIM)*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC TR 61931, IEC 62343, IEC TS 62538, ISO/IEC Guide 99, and the following 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 Basic terms

3.1.1
fixed grid
grid where the frequency of channel spacings of WSSs having a port configuration of 1 x N ($N \geq 2$) is predetermined for all channels and not variable

3.1.2
port pair
combination of one input port and one arbitrary output port among N ports, as for a WSS having a port configuration of 1 x N ($N \geq 2$)

Note 1 to entry: It is also valid when the WSS is used as an N x 1 port configuration. In this case, the port pair is defined as a combination of one arbitrary input port among N ports and one output port, as for the WSS having a port configuration of N x 1 ($N \geq 2$).

3.1.3
conducting port pair
two ports, i and j, between which transfer coefficient, t_{ij}, which is defined in IEC TS 62627-09, is nominally greater than zero

Note 1 to entry: The conducting port pair is defined at a specific switching state and a specified wavelength.

3.1.4
isolated port pair
two ports, i and j, between which transfer coefficient, t_{ij}, which is defined in IEC TS 62627-09, is nominally zero, and logarithmic transfer coefficient, a_{ij}, which is defined in IEC TS 62627-09, is nominally infinite

Note 1 to entry: The isolated port pair is defined at a specific switching state and a specified wavelength.

3.1.5
attenuating port pair

two ports, i and j, between which transfer coefficient, t_{ij}, which is defined in IEC TS 62627-09, is nominally greater than zero and smaller than the insertion loss

Note 1 to entry: The attenuating port pair is defined at a specific switching state and a specified wavelength.

3.1.6
conducting channel
channel intended to be conducted at the specific conducting port pair

3.1.7
isolated channel
channel intended to be isolated at the specific conducting port pair

3.1.8
common port
port for the "1" side, not for the "N" side, with a WSS having a port configuration of 1 x N ($N \geq 2$)

3.1.9
branching port
port for the "N" side, not for the "1" side, with a WSS having a port configuration of 1 x N ($N \geq 2$)

3.1.10
static state
state when the conducting port pair, isolated port pair and attenuating port pair are not under switching and/or attenuating operation, and the optical power is kept within 10 % in linear scale at any intended conduction port pair

3.1.11
dynamic state
state when at least one conducting port pair, isolated port pair or attenuating port pair is under switching and/or attenuating operation, and the optical power varies more than 10 % in linear scale at a specific intended conduction port pair in this state

3.2 Performance parameter terms

3.2.1
crosstalk
ratio of the transfer coefficient of the power to be isolated to the transfer coefficient for the power to be conducted for an output port

Note 1 to entry: Crosstalk is generally a negative value expressed in dB.

Note 2 to entry: For fibre optic filters and WDM devices, crosstalk is defined for one port pair at two or more different wavelengths (channels).

Note 3 to entry: For fibre optic switches, crosstalk is defined for two or more port pairs at one wavelength.

Note 4 to entry: Crosstalk for a passive optical device (component) is generally the maximum value of crosstalks for all port pairs defining crosstalks.

Note 5 to entry: For WSSs, crosstalk is defined for two or more port pairs at two or more different wavelengths (channels).

[SOURCE: IEC TS 62627-09:2016, 3.4.10, modified — Note 5 has been added.]

3.2.2
static crosstalk
crosstalk in a static state for a 1 x N ($N \geq 2$) WSS, specified by the unintended signal transmission ratio divided by the intended signal transmission ratio

Note 1 to entry: Static crosstalk is generally a negative value expressed in dB.

Note 2 to entry: Two types of static crosstalk are defined: different channel static crosstalk and same channel static crosstalk.

3.2.3
different channel static crosstalk
static crosstalk, specified by the ratio of the isolated channel power divided by the conducting channel power in the same conducting port pair, when the input channel power in the isolated channel and conducting channel is the same

Note 1 to entry: Different channel static crosstalk is generally a negative value expressed in dB.

3.2.4
same channel static crosstalk
static crosstalk, specified by the ratio of the channel power in the isolated port pair divided by the channel power in the conducting port pair, when the input channel power in the isolated port pair and the conducting port pair are the same

Note 1 to entry: Same channel static crosstalk is generally a negative value expressed in dB.

3.2.5
dynamic crosstalk
transient crosstalk
crosstalk attributed to both channel crosstalk (due to the same wavelength and/or other wavelengths) and port isolation, predicted to change during the switching operation in the WSS module

Note 1 to entry: Dynamic crosstalk is generally a negative value expressed in dB.

Note 2 to entry: Two types of dynamic crosstalk are defined: different channel dynamic crosstalk and same channel dynamic crosstalk.

Note 3 to entry: Dynamic crosstalk is applied to 1 x N ($N \geq 3$) WSSs.

[SOURCE: IEC 62343-3-3:2014, 3.15, modified — The term "dynamic crosstalk" has been added as a first preferred term, and the note to entry has been replaced by three new notes.]

3.2.6
different channel dynamic crosstalk
optical power ratio of the isolated channel power divided by the conducting channel power in the selected output port, when the input power of the conducting channel and the isolated channel are the same

Note 1 to entry: Different channel dynamic crosstalk is generally a negative value expressed in dB.

Note 2 to entry: Signal leakage of the blue isolated channel in port 2 is the noise component for the red conducting channel signal in port 2 for the demultiplexing WSSs shown in Figure 1 a).

Note 3 to entry: Different channel dynamic crosstalk is applied to 1 x N ($N \geq 3$) WSSs.

3.2.7
same channel dynamic crosstalk
optical power ratio of the isolated channel power in the isolated port pair divided by the conducting channel power in the conducting port pair, when the channel power in the input port of the conducting port pair and the channel power in the input port of the isolated port pair are the same

Note 1 to entry: Same channel dynamic crosstalk is applied to 1 x N ($N \geq 3$) WSSs.

Note 2 to entry: Same channel dynamic crosstalk is generally a negative value expressed in dB.

Note 3 to entry: Red coloured signals in ports 1 and N are the noise components for the red signal in port 2, when the conducting port pair for the blue signal is switched from port 1 to N in the multiplexing WSS shown in Figure 1 b). All red signals in the isolated port pairs will be noise components. However, same channel dynamic crosstalk is defined by the ratio of the optical loss between the conducting port pair and an isolated port pair.

Noise observed in port during switching operation

a) Demultiplexing WSS **b) Multiplexing WSS**

Figure 1 – Noise observed in port during conducting port switching in 1 x N WSS

3.3 Abbreviated terms

ASE amplified spontaneous emission
DLP digital light processor
ITU-T International Telecommunication Union, Telecommunication Standardization Sector
LC liquid crystal
LCOS liquid crystal on silicon
LED light emitting diode
MEMS micro-electro-mechanical system
OE optical-to-electrical
OPM optical power meter
RBD reference branching device
TJ temporary joint
TLS tuneable laser source
WSS wavelength selective switch

4 Apparatus

4.1 Test set-up

The test set-up consists of a light source, i.e. tuneable laser source (TLS) or broadband light source, detector, i.e. optical power meter (OPM) or OE converter, and other equipment. An example of the measurement set-up for measurement of the noise power to obtain the dynamic crosstalk is given in Figure 2. The light of wavelength λ is input into the common port of the WSS as a device under test (DUT) using TLS. Optical power, which is output from all branching ports 1 to N, is measured simultaneously and continuously with a multi-port OPM connected to each branching port. All apparatus are connected by the temporary joint (TJ). If necessary, the wavelength meter with a reference branching device (RBD) may be used. Power variation during switching of the the conducting port of the WSS is measured with the OPM and recorded.

Figure 1 shows noise power that influences the different channel dynamic crosstalk is generated in the case where the WSS is used as a demultiplexer, and noise power that influences the same channel crosstalk is generated in the case where the WSS is used as a multiplexer. However, optical noise power to measure both dynamic crosstalks is measured with the test set-up shown in Figure 2, because the WSS is bidirectional.

In this test set-up, not only optical noise power in dynamic state but also optical noise power in static state before and after switching the conducting port can be measured.

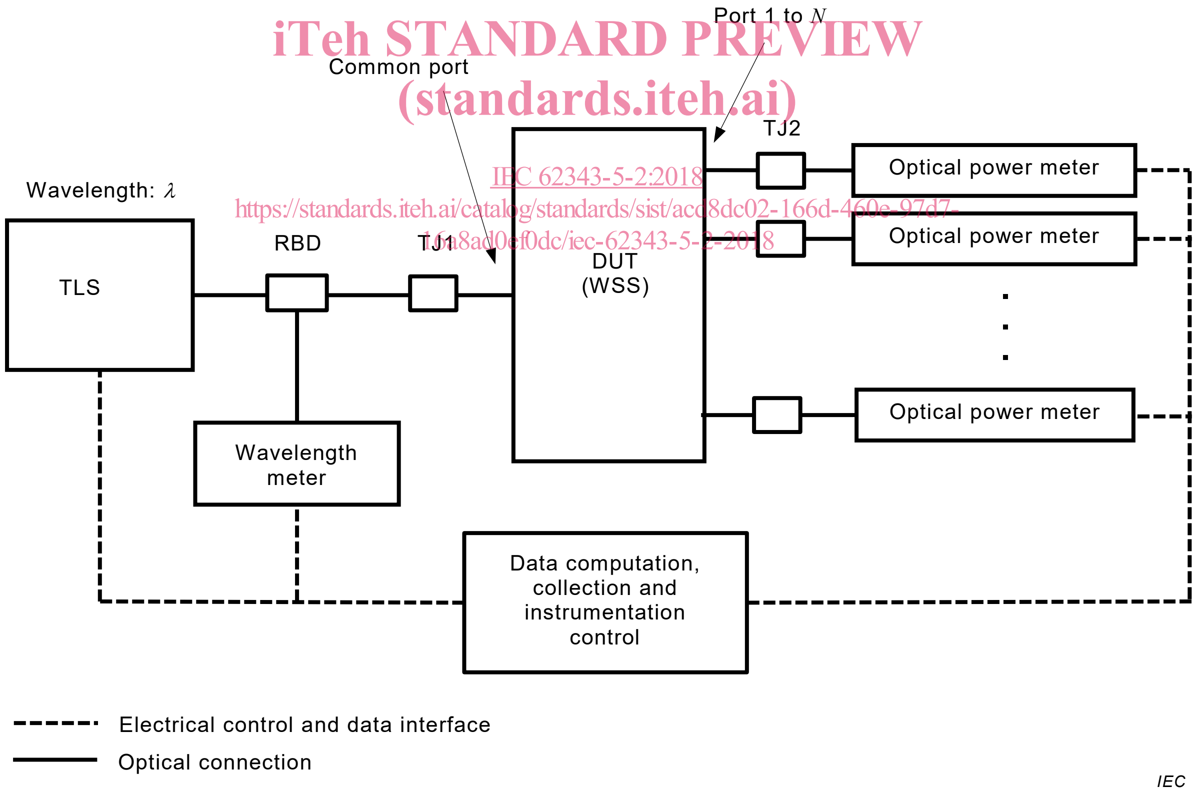

Figure 2 – Test set-up to measure dynamic crosstalk

4.2 Light source

4.2.1 Tuneable laser source (TLS)

The wavelength range of the TLS should be wider than the signal wavelength range of the DUT. Optical output of the TLS should be more than 10 dB higher than the sum of the minimum sensitivity of the optical detector, insertion loss of the test set-up [reference branching device (RBD) and temporary joints (TJs)], insertion loss of the DUT and the absolute value of measured dynamic crosstalk.

The side mode suppression ratio and signal to total source spontaneous emission ratio of the TLS should be more than 10 dB higher than the absolute value of measured dynamic crosstalk. For example, when the expected minimum value of dynamic crosstalk on the DUT is –40 dB, the signal to total source spontaneous emission of the TLS should be more than 50 dB. When the signal to total source spontaneous emission ratio of the TLS is insufficient, an appropriate tracking filter should be placed behind the TLS.

In the case of an ITU-T 50 GHz and 100 GHz fixed grid, the wavelength accuracy of the TLS should be within ±10 pm and ±20 pm, respectively. When the wavelength accuracy is insufficient, the output wavelength should be monitored by a wavelength meter and calibrated when necessary.

The spectral width of the TLS should be narrow enough for the pass band of the WSS. Less than 10 % of pass band is desirable.

In order to remove the influence of polarization dependent loss of the WSS, a polarization scrambler shall be placed after the TLS. The polarization scrambler shall have a speed fast enough (more than 10 times is desirable) than the averaging time of the detector.

4.2.2 Broadband light source and tuneable filter

A substitute system for the TLS is a test set-up that combines a broadband light source and tuneable filter.

The broadband light source should be an LED or light source that is depolarized and has a wide ASE spectrum. The spectrum of the light source should be wider than the signal wavelength range of the DUT.

A tuneable filter is used to set the wavelength to be measured. The wavelength range of the tuneable filter should be wider than the operating wavelength range of the DUT.

The accuracy of the centre wavelength of the tuneable filter should be within ±10 pm. The tuneable filter has a pass band that is narrow enough compared to that of the WSS (less than 10 % of the pass band is desirable) and wavelength isolation of more than 50 dB between the pass band and the stop band.

The optical output power generated by combining the broadband light source and tuneable filter should be more than 10 dB higher than the sum of the minimum sensitivity of the optical detector, insertion loss of the test set-up (RBD and TJs), insertion loss of the DUT and absolute value of the measured dynamic crosstalk.

4.3 Device under test

The driving engine of the WSS is one of the following:

- one dimensional arrayed MEMS mirror that uses MEMS technology;
- two dimensional arrayed MEMS mirrors that use a digital light processor (DLP);
- one dimensional arrayed LC element that uses LC technology;
- two dimensional arrayed LCOS element;
- hybrid technology combining MEMS and LC.

There are two types of WSS: one that provides an electronic switching signal and the other which does not. In the former case, the switching signal can be used as a synchronizing (trigger) signal for the instrumentation. In the latter case, the optical output signal of the output port can be used as an external trigger.