IEC 61300-3-50

Edition 1.0 2013-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic interconnecting devices and passive components – Basic test and measurement procedures –
Part 3-50: Examinations and measurements – Crosstalk for optical spatial switches

Dispositifs d'interconnexion et composants passifs à fibres optiques – Procédures fondamentales d'essais et de mesures –
Partie 3-50: Examens et mesures – Diaphonie relative aux commutateurs spatiaux optiques

IEC 61300-3-50:2013

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

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

FDIS	Report on voting
86B/3593/FDIS	86B/3622/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.

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

A list of all parts in the IEC 61300 series, published under the general title, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures* 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- withdrawn,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.

The contents of the corrigenda 1 (January 2015) and 2 (July 2015) have been included in this copy.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 3-50: Examinations and measurements – Crosstalk for optical spatial switches

1 Scope

This part of IEC 61300 describes the procedure to measure the crosstalk of optical signals between the ports of a multiport *M* x *N* (*M* input ports and *N* output ports) fibre optic spatial switch. The crosstalk is defined as the ratio of the optical power at an output port which comes from the unconnected input port, to the optical power at the output port which comes from the connected input port.

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 61300-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance*

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

3 General description

The general meaning of crosstalk is the ratio of an undesired signal power to a desired signal power. The crosstalk of *N* x 1 (*N* input ports and one output port) fibre optic spatial switches is shown in Figure 1. For an *N* x *M* (*N* input ports and *M* output ports) fibre optic switch, the crosstalk is the same as that for an *N* x 1 optical switch but expanded across *M* output ports. A fibre optic switch is basically bidirectional, i.e. a 1 x *N* (1 input port and *N* output ports) optical switches can operate as an *N* x 1 (*N* input ports and 1 output port) switch. The crosstalk for an *N* x 1 optical switch is measured as a 1 x *N* optical switch, as shown in Figure 2. When the input port for a 1 x *N* optical switch is connected to a light source, the crosstalk for a transmitting output port versus an isolated output port is the ratio of output power of these two output ports, expressed in decibels. Crosstalk is a negative value in dB.

Do not use “isolation” in place of “crosstalk” as the two have a different values and meanings. The meaning of isolation is the optical loss for a port pair intended to block transmission, i.e. for which loss is nominally infinite. Isolation is a positive value in dB. Crosstalk is a negative value in dB.

NOTE 1 For WDM devices, crosstalk is defined as the value of the ratio between the optical power of the specified signal and all noise, as defined in IEC 62074-1 [1][1]. The crosstalk for WDM devices is generally used as

[1] Numbers in square brackets refer to the Bibliography.

not simply “crosstalk”, but “some prefix” crosstalk, such as adjacent channel crosstalk, total crosstalk and so on. The measurement method of crosstalk for DWDM devices are described in IEC 61300-3-29 [2].

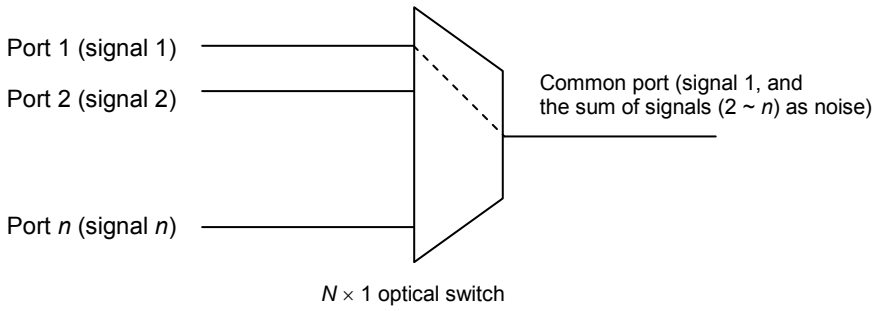

Figure 1 – Crosstalk for *N* x 1 optical switch

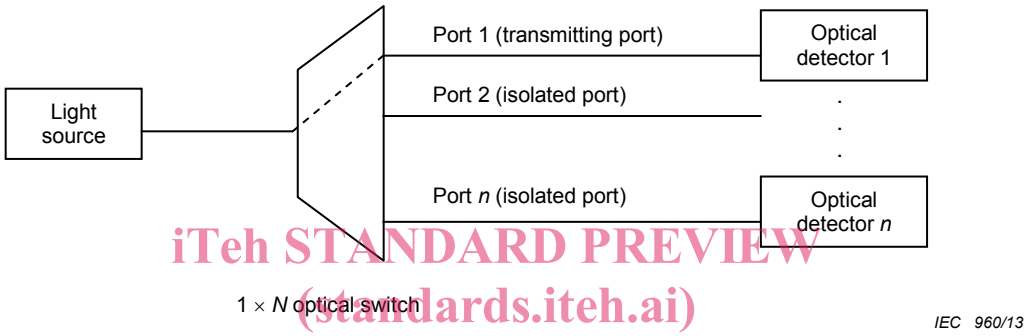

Figure 2 – Measurement set-up of crosstalk for 1 x *N* optical switch

For single mode fibre optic switches, the crosstalk may depend on the polarization state of the input light. A polarization state change system (PSCS; a polarization controller or a polarization scrambler) should be used with a light source. In this case, the crosstalk is generally defined as the maximum value of the measured crosstalk for all polarization states of the input light. For multi-mode fibre optic switches, the launch mode of input light shall be in accordance with IEC 61300-1.

Since, in practice the crosstalk levels of fibre optic switches can be very small, (of the order of under –70 dB), the measurement can be degraded by several factors. Therefore, this procedure is designed to either circumvent these factors, or to point them out so that adequate care can be taken and the right choice of test apparatus made. Factors which can degrade a measurement of crosstalk include:

– the coupling of ambient light into measurement channels;
– the reflection of light from the ends of fibre pigtails;
– the light carried in cladding modes;
– the uncertainty of the power meter at low light levels;
– the fibre pigtail lengths since light can scatter (Rayleigh scattering) along the pigtails.

4 Apparatus

4.1 Light source S

The light source is pigtailed or connected to a launch optical fibre compatible with the input port of the device under test (DUT). It is also designed and conditioned to achieve the required launch conditions as stated in IEC 61300-1. For measurements of DUTs which are not inherently broadband in optical performance, the spectral output of the light source shall be characterized not only in the vicinity of the operating wavelength range by means of full

width at half maximum (FWHM) but also in the region of the spectral tail. This requirement can be specified as "power less than X dB below peak at wavelengths Y nm from peak output" and can be achieved by use of in-line bandpass filters. The output power of the light source shall also be sufficiently high to permit a large measurement dynamic range with the optical detector used. The output power stability shall be less than or equal to 0,05 dB per hour. The dynamic range of the source/detector combination shall be at least 10 dB greater than the absolute value of the minimum crosstalk to be measured.

For the measurement of single mode fibre optic switches, the polarization dependency of crosstalk shall be considered. A polarization controller is used to measure the polarization dependency of crosstalk. The detail requirement of a PSCS is described in IEC 61300-3-2. The launch condition, power stability and dynamic range shall satisfy the requirement as mentioned above for the output power of a PSCS when a PSCS is used.

4.2 Temporary joint TJ

This is a method, device or mechanical fixture for temporarily aligning two fibre ends into a reproducible, low loss joint and polarization independent splicing. Typically, a fusion splice is used since mechanical splices may exhibit some polarization sensitivity if the endfaces are not perpendicular to the fibre axis. The stability of the temporary joint shall be compatible with the required measurement precision.

4.3 Terminations T

These terminations are components or techniques to suppress reflected light from the DUT output ports. Three types of terminations are suggested:

– angled fibre ends;
– the application of an index matching material to the fibre end;
– attenuation of the fibre, for example with a mandrel wrap.

The fibre termination shall have a return loss of at least 10 dB greater than the absolute value of the minimum crosstalk to be measured.

4.4 Detector D

A high dynamic range optical power meter should be used for the detector. Its wavelength range shall be wider than the operating wavelength range of the DUT. The linearity of sensitivity of the detector shall be small enough to minimize the measurement uncertainty. The detector shall have a sufficiently large detection area and be placed sufficiently close to the output to capture all of the light emitting from the output fibre of the DUT to be measured.

5 Measurement procedure

5.1 General

This clause describes the measurement procedure of crosstalk for *M* x *N* (*M* input ports and *N* output ports) fibre optic switches.

5.2 Test set-up

Figure 3 shows the test set-up for crosstalk measurement. The light source is connected to the selected input port (*I*1) of the DUT by means of a TJ where appropriate or by means of a connector in the case of a DUT fitted with a connector. The detector is connected to a transmitting output port of the DUT (port *O*1) which is to be measured for crosstalk against another chosen output port nominally isolated from the previous one (port *O*2). All other ports of the DUT are terminated (T).

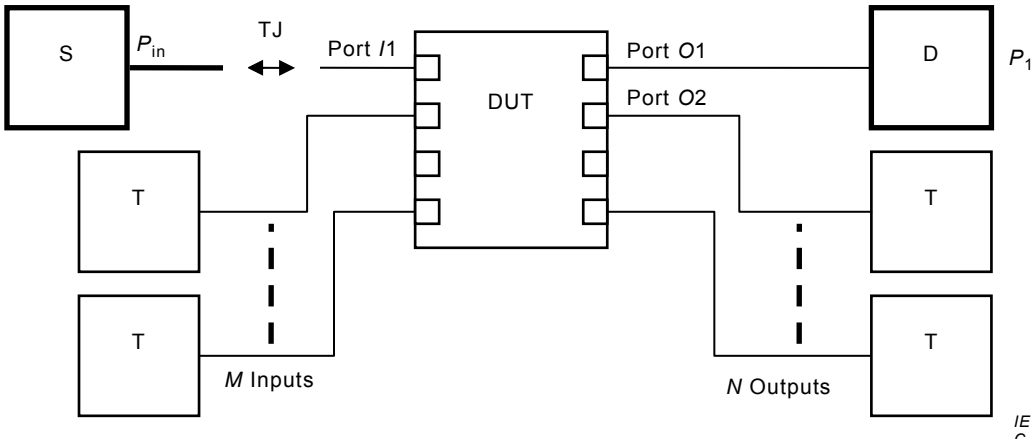

Figure 3 – Measurement setup of P_1

5.3 Measurement of P_1

Turn on the light source S and allow sufficient time for it to stabilize. Switch the fibre optic spatial switch DUT to connect between the selected input port and the transmitting output port (port *O*1). Measure and record P_1 (dBm).

When a PSCS is used with a light source for measuring single mode fibre optic spatial switches, change the polarization states of the input light in accordance with IEC 61300-3-2. Both the "all polarization state" method and Mueller matrix method may be used. P_1 in Figure 3 changes depending on the state of polarization, from P_{1min} to P_{1max}. Use P_{1max} as P_1.

5.4 Measurement of P_2

Move the detector D to port *O*2 which is the nominally isolated port for the selected input port as shown in Figure 4. Terminate port *O*1, ensuring that this port is still linked to the input port of the DUT. For the fibre optic switch DUT, this means ensure it is connected to port *O*1. Measure and record the output power from port O2 as P_2 (dBm).

When a PSCS is used with a light source for measuring single mode fibre optic spatial switches, change the polarization states of the input light in accordance with IEC 61300-3-2. Both the "all polarization state" method and Mueller matrix method may be used. P_2 in Figure 4 changes depending on the state of polarization, from P_{2min} to P_{2max}. Use P_{2min} as P_2.

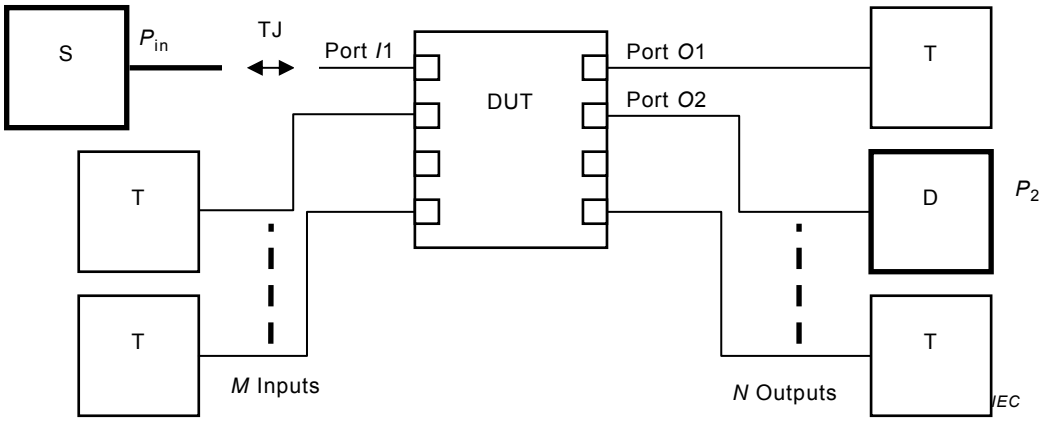

Figure 4 – Measurement setup of P_2

5.5 Measurement of P_i (i=3 to *N*)

Repeat the procedure of 5.4 for the output port *O*1, to measure P_i (dBm) and record, i = 3 to *N*.

5.6 Measurement for other input ports

Change the connection of light source S to another input port *I*j (j = 2 to *M*). Repeat the procedure of 5.2 to 5.5.

6 Calculation

6.1 Calculation of crosstalk for specified port pairs

The crosstalk (XT_{12}) for the pairs for port *O*1 to port *I*1 and port *O*2 to port *I*1 is given by Equation (1):

$$XT_{12} = P_2 - P_1 \text{ (dB)} \quad (1)$$

This crosstalk is the crosstalk of signal light 1 with signal light 2 as noise for signal light 1 for output port *O*1, when this DUT is used for *M* x *N* (*M* input ports and *N* output ports), connected port *I*1 to port *O*1 and input signal light 1 from port *O*1, signal light 2 from port *O*2.

For single mode fibre optic spatial switches, the polarization dependency of crosstalk shall be considered. In this case, the crosstalk (*XT*) is calculated by using Equation (2):

$$XT_{12} = IL_{max,11} - IL_{min,12} \quad (2)$$

where

$IL_{min,12}$ is the minimum insertion loss for input port 1 to output port 2;

$IL_{max,11}$ is the maximum insertion loss for input port 1 to output port 1

when input port 1 is connected to output port 1.

The minimum and maximum insertion loss is calculated from the average insertion loss (IL_{ave}) and *PDL* as Equations (3) and (4):