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IEC PAS 61300-3-38

Pre-Standard

First edition
2007-04

Withdrawn

Fibre optic interconnecting devices and passive components – Basic test and measurement procedures –

Part 3-38: Group delay and chromatic dispersion

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 3-38: Group delay and chromatic dispersion

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The text of this PAS is based on the following document: | This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:

Draft PAS	Report on voting
86B/2337/PAS	86B/2380/RVD

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

Part 3-38: Group delay and chromatic dispersion

1 Scope

The purpose of this PAS is to define the measurement methods necessary to characterize the group delay properties of passive components. From these measurements further parameters like group delay ripple, linear phase deviation, chromatic dispersion, and dispersion slope can be derived. In addition, when these measurements are made with resolved polarization, the differential group delay (DGD) can also be determined as an alternative to separate measurement with the dedicated methods of IEC 61300-3-32.

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 60050-731:1991, *International Electrotechnical Vocabulary (IEV) – Chapter 731: Optical fibre communication*

IEC 60793-1-42:2001, *Optical fibres – Measurement methods and test procedures – Chromatic dispersion*

IEC/TR 61282-9:2006, *Fibre optic communication system design guides – Part 9: Guidance on polarization mode dispersion measurements and theory*

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IEC 61300-3-29:2005, *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*

IEC 61300-3-2:2006, *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*

3 Terms, definitions and abbreviations

For the purposes of this document, many of the terms, definitions and abbreviations are described in IEC 60050-731 and IEC 61300-3-29; some terms, definitions and abbreviations specific to this measurement method are given below.

BW bandwidth: spectral width of a signal or filter

CD chromatic dispersion (in ps/nm): change of group delay over wavelength: CD = d(GD)/dλ

δ step size of the VWS during a swept measurement

λ_c centre channel or nominal operating wavelength for a component

RF frequency of electrical driving signal of intensity modulator

GD group delay: time required for a signal to propagate through a device

SSE source spontaneous emission: broadband emissions from a laser cavity that bear no phase relation to the cavity field. These emissions can be seen as the baseline noise on an optical spectrum analyser

SW spectral width: spectral width of a given filter in relation to the pass band (i.e. –25dB SW). It differs from BW in that it is always defined by the outermost crossings in the event that there are more than two

GDR group delay ripple

LPV linear phase variation

MPS modulation phase shift

Φ phase delay

f_{RF} modulation frequency

SWI swept wavelength interferometry

VWS variable wavelength source

DWDM dense wavelength division multiplexing

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4 General description

This document covers transmission measurements of the group delay properties of passive components. In order to interpret the group delay properties, it is essential to have the amplitude spectral measurement also available. For this reason, loss measurements are also covered to the extent as it is required to make proper dispersion measurements.

The methods described in this procedure are intended to be applicable in any wavelength band (C, L, O, etc.) although examples may be shown only in the C band for illustrative purposes.

The document will be separated into different sections, one concentrating on the measurement methods and the other on analysis of the measurement data.

The measurement methods covered in this document are the modulation phase shift method and the swept-wavelength interferometry method. The modulation phase shift method is considered the reference method. The methods are selected particularly because of their ability to provide spectrally resolved results, which are often necessary for passive components and especially for wavelength-selective devices.

5 Apparatus

5.1 Modulation phase method

The measurement set-up for the characterization of the GD properties of optical components is shown in Figure 1. A detailed explanation of the various components of this system and their functions is given below.

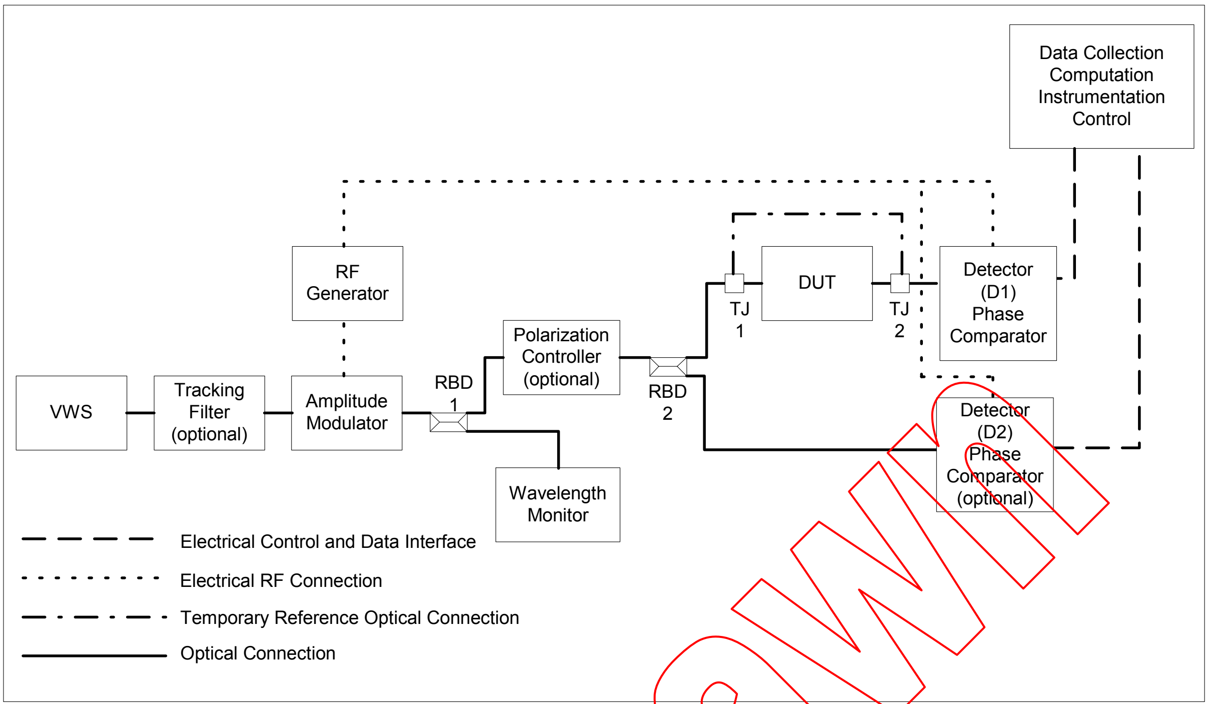

Figure 1 – MPS measurement method apparatus

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5.1.1 Variable wavelength source

The VWS is a light source that can select a specific output wavelength and can be tuned across a specified wavelength range. The power stability at any of the operating wavelengths shall be better than the required accuracy of the amplitude measurements for insertion loss. The relative accuracy and repeatability of wavelength, as determined by the VWS and wavelength monitor together, shall be accurate to 3 pm for each point in the measuring range and the absolute wavelength accuracy should satisfy the wavelength specifications of the device under test. This accuracy may be obtained by having the wavelength monitor feedback to the VWS. The line width of the source shall be less than 100 MHz. The tuning range of the VWS shall cover the entire spectral region of the DWDM device and the source shall also be free of mode-hopping over that tuning range. The output power of the VWS shall be sufficient to provide the apparatus with an order of magnitude more dynamic range than the device exhibits (i.e. the measurement apparatus shall be able to measure a 50 dB notch filter if the device is a 40 dB notch).

5.1.2 Tracking filter

The tracking filter may be used for any notch filter measurements if the dynamic range of the VWS and the detector does not allow for measuring a depth of at least 40 dB due to the shape of the device under test (DUT) and the broadband SSE of the VWS. The filter must track the VWS so as to provide the maximum SSE suppression and the maximum transmitted power as the VWS is scanned across the measurement region. The spectral shape of the filter shall provide enough out-of-band attenuation to allow for 40 dB to 50 dB dynamic range at the transmission detector.

5.1.3 Reference branching device (RBD1, 2)

The configuration of the RBD is 1×2 or 2×2. If its configuration is 2×2, one port of the RBD shall be terminated to have a back-reflection <-50dB. The splitting ratio of the RBD shall be stable with wavelength. It shall also be insensitive to polarization. The polarization sensitivity of transmission attenuation shall be less than one-tenth of the device wavelength dependency of attenuation, if this is to be measured. The directivity shall be at least 10 dB higher than the maximum return loss, if this is to be measured. The split ratio shall be sufficient to provide the dynamic range for the measurement of the transfer function and the power necessary for the wavelength monitor to operate correctly.

5.1.4 Wavelength monitor

In this test procedure, the wavelength accuracy of the source needs to be closely monitored. If the tuning accuracy of the VWS is not sufficient for the measurement, the wavelength monitor shall be required. For this measurement method, it is necessary to measure the spectral peak of any input signal within the device BW to an accuracy of 2 ppm. Acceptable wavelength monitors include an optical wavelength monitor or a gas absorption cell (such as an acetylene cell). If a gas absorption cell is used, the wavelength accuracy of the VWS must be sufficient to resolve the absorption lines. The VWS must be sufficiently linear between the absorption lines.

Included under this specification, is the wavelength repeatability of the VWS + monitor. It should be understood by the operator that if the test apparatus has 0,1 dB of ripple with a 30 pm period, then a random 3 pm wavelength variation from reference scan to device scan can result in as much as 0,03 dB of attenuation noise.

5.1.5 Device under test (DUT)

For the purposes of this document, the test ports shall be a single “input-output” path. The method described herein can be extrapolated upon to obtain a single measurement system capable of handling even an m × n device. The device shall be terminated in either pigtails or with connectors. It is noted that these measurements are very sensitive to reflections, and that precautions shall be taken to ensure that reflection cavities are not introduced in the test set-up. On the other hand, one of the benefits of measuring GD is to reveal such cavities in the device.

In many cases, the characteristics of DWDM components are temperature-dependent. This measurement procedure assumes that any such device is held at a constant temperature throughout the procedure. The absolute accuracy of the measurement may be limited by the accuracy of any heating or cooling device used to maintain a constant temperature. For example, if a device is known to have a temperature dependence of 0,01 nm/°C and the temperature during the procedure is held to a set temperature ±1 °C, then any spectral results obtained are known to have an uncertainty of 0,02 nm due to temperature.

5.1.6 Detector D1, D2 (optional)

The detectors consist of an optical detector, the associated electronics, and a means of connecting to an optical fibre. The use of detector D2 is considered optional, but provides correction for any instability in the GD of the instrument setup between the modulator and the DUT between Step 3 and Step 4 of 6.1.3. The optical connection may be a receptacle for an optical connector, a fibre pigtail, or a bare fibre adapter. The back-reflection from detectors D1 and D2 shall be minimized with any precautions available. The preferred option would be to use an APC connector. It should be noted that the use of an APC connector would contribute approximately 0,03 dB of PDL to the measurement if terminated in air.

The dynamic range and sensitivity of the detectors shall be sufficient for the required measurement range, given the power level provided by the modulated source. The linearity of the detectors shall be sufficient to provide accurate representation of the modulated signal. The detector shall transfer the optical modulation phase to the r.f. output phase with good stability and little dependence on the optical signal level.

Where during the sequence of measurements a detector shall be disconnected and reconnected the coupling efficiency for the two measurements shall be maintained to at least the accuracy of the mated connector.

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