SLOVENSKI STANDARD

SIST EN 61300-3-32:2007

01-september-2007

Optiļ ni spojni elementi in pasivne komponente ï Osnovni preskuġalni in merilni postopki ï 3-32. del: Preiskave in meritve ï Meritve disperzije glede na vrsto polarizacije pri pasivnih optiļ nih komponentah (IEC 61300-3-32:2006)

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 (IEC 61300-3-32:2006)

Lichtwellenleiter - Verbindungselemente und passive Bauteile - Grundlegende Prüf- und Messverfahren - Teil 3-32: Untersuchungen und Messungen - Messung der Polarisationsmodendispersion für passive optische Bauteile (IEC 61300-3-32:2006)

Dispositifs d'interconnexion et composants passifs a fibres optiques - Méthodes fondamentales d'essais et de mesures -- Partie 3-32: Examens et mesures - Mesure de la dispersion de mode de polarisation pour composants optiques passifs (IEC 61300-3-32:2006)

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English version

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
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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 61300-3-32:2006 E

Foreword

The text of document 86B/2325/FDIS, future edition 1 of IEC 61300-3-32, prepared by SC 86B, Fibre optic interconnecting devices and passive components, of IEC TC 86, Fibre optics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61300-3-32 on 2006-09-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2007-06-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2009-09-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61300-3-32:2006 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60793-1-48	-[1)]	Optical fibres Part 1-48: Measurement methods and test procedures - Polarization mode dispersion	EN 60793-1-48	2003[2)]
IEC/TR 61282-3	-[1)]	Fibre optic communication system design guides Part 3: Calculation of polarization mode dispersion	-	-
IEC/TR 61282-9	-[1)]	Fibre optic communication system design guides Part 9: Guidance on polarization mode dispersion measurements and theory	-	-
IEC 61300-3-2	-[1)]	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures Part 3-2: Examinations and measurements - Polarization dependence of attenuation in a single-mode fibre optic device	EN 61300-3-2	1999[2)]

1) Undated reference.

2) Valid edition at date of issue.

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Dispositifs d'interconnexion et composants passifs à fibres optiques – Méthodes fondamentales d'essais et de mesures –

Partie 3-32: Examens et mesures – Mesure de la dispersion de mode de polarisation pour composants optiques passifs

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

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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

FOREWORD

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International Standard IEC 61300-3-32 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

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

FDIS	Report on voting
86B/2325/FDIS	86B/2378/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.

IEC 61300 consists of the following parts, under the general title *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures:*

Part 1: General and guidance

Part 2: Tests

Part 3: Examinations and measurements

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

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

1 Scope

This part of IEC 61300 presents a number of alternative methods for measuring the polarization mode dispersion (PMD) of a passive fibre optic device under test (DUT). These methods typically measure PMD using either a frequency domain or time domain approach. In the frequency domain, the polarization properties of the DUT are analysed. In the time domain approach, the pulse delay or broadening is observed.

This procedure will cover measurements of both broadband, and narrowband dense wavelength division multiplexing (DWDM) passive fibre optic devices. Differences between measurement practices for these varied classes of passive fibre optic devices will be noted in the text.

This procedure can be applied to laboratory, factory and field measurements of PMD in passive fibre optic devices. Limitation of the application of some methods will be noted in the text when necessary.

This procedure can be applied to a transmissive or reflective DUT. In the latter case, the DUT connection is via a coupler or circulator, which should have a known very low PMD value.

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 60793-1-48, *Optical fibres – Part 1-48: Measurement methods and test procedures – Polarisation mode dispersion*

IEC 61282-3, *Fibre optic communication system design guides – Part 3: Calculation of polarization mode dispersion*

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

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

3 Abbreviations

ASE:	amplified spontaneous emission
DGD:	differential group delay
DOP:	degree of polarization
DUT:	device under test
DWDM:	dense wavelength division multiplexing
FA:	fixed analyser
FAFT:	fixed analyser Fourier transform
FAEC:	fixed analyser extrema counting
FWHM:	full width at half the maximum
INTY:	interferometry
ISI:	inter-symbol interference
JME:	Jones matrix eigenanalysis
MMA:	Mueller matrix analysis
MPS:	modulation phase shift
PDL:	polarization dependent loss
PMD:	polarization mode dispersion
PDV:	polarization dispersion vector
PPS:	polarization phase shift
PS:	Poincaré sphere
PSA:	Poincaré sphere analysis
PSP:	principal states of polarization
RBW:	resolution bandwidth
RMS:	root mean square
SOP:	state of polarization
SPE:	Stokes parameter evaluation
WDM:	wavelength division multiplexing

4 General description

PMD refers to the spreading of an optical pulse due to polarization-related anomalies. In optical communication systems, the spreading of a pulse leads to bit errors at the receiver due to inter-symbol interference (ISI) and consequently provides bandwidth limitation.

Each optical pulse is made up of a combination of two orthogonal SOPs called the principal SOPs (PSPs), due to birefringence possibly present in the DUT (see Figure 1). These different polarization components travel at different group velocities and will arrive at the output of the DUT at different times. PMD is related to the difference between the two PSP delays, the DGD $\Delta\tau$.

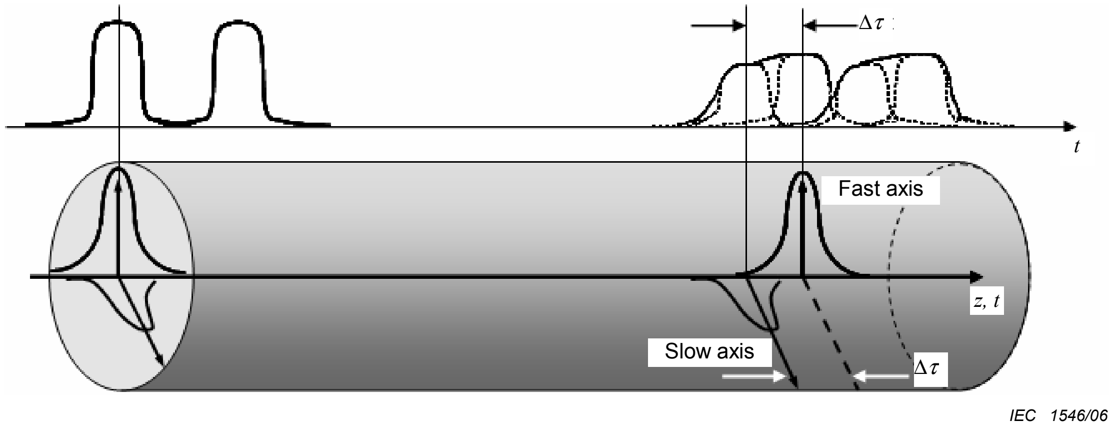

Figure 1– Effect of PMD phenomenon on transmission of an information bit pulse in a device

4.1 Mode coupling

PMD in passive fibre optic devices is usually deterministic by nature meaning that the phenomenon is predictable and can be reproduced and controlled. However, it is important to understand how the polarization modes can couple together in the device, and in fact they can couple differently. In optical passive fibre optic devices, the mode coupling is typically referred to as negligible or no or negligible (including the cases of polarization maintaining fibres and short lengths of ordinary fibre) as opposed to random or strong mode coupling such as frequently seen in the case of long lengths of fibre. In no or negligible mode coupling, the axis of birefringence in the device is fixed and constant in only one section of birefringence and consequently the DGD is constant as a function of wavelength. In that case the PMD is equal to the DGD.

There can however be types of passive fibre optic devices exhibiting many sections of fixed birefringence with their axes not necessarily aligned with each other making the DGD randomly varying as a function of wavelength. In that case, the mode coupling is random. Even if the DGD varies, as a function of wavelength and the mode coupling is random, this variation will be constant from one measurement to another and it can still be predicted and the phenomenon is still deterministic. In that case, the PMD is the average value of the DGD spectral distribution (the root mean squared – RMS – value may also be used and is accepted).

There can also be intermediate cases where the passive fibre optic device has few birefringence sections and the DGD can vary less randomly such as a monotonous or sine wave variation as a function of wavelength. The PMD is still the average or RMS value of the DGD distribution and the phenomenon is still deterministic but the mode coupling is neither negligible nor random.

The mode coupling describes how the SOPs are maintained as energy traverses the device. Rather, each device is shown to have a polarization transfer function whereby the SOP at the input is mapped to a different SOP at the output as a function of wavelength. This transfer function is commonly represented using the Jones matrix and will be explained later in the document.

4.2 Narrowband devices

There are other cases of classification that are related to the PMD phenomenon and need to be taken into account. This includes narrowband devices. A narrowband device can have a small DGD distribution while experiencing a wide Fourier time spectrum with a more complex spectrum in the time domain. Care will also have to be taken when making analysis of DGD in the time domain versus the spectral domain.

4.3 Polarization sensitivity

Another complicating factor is related to the presence of PDL in the DUT. Figure 1 illustrates such a case where at the output of the DUT the bits are not only broadened (in absence of PDL) but also distorted (in presence of PDL). In the case of PDL, the two PSPs are not necessarily orthogonal anymore (not anymore 180° apart on the Poincaré sphere). In this case, this test procedure will be restricted to devices with PDL equal to or less than 1 dB to allow the application of all suggested methods. This condition is typically met inside the passband of typical passive fibre optic devices used in DWDM systems.

PDL or polarization sensitivity may severely impact the correct determination of DUT DGD. PDL may be measured by using IEC 61300-3-2.

However, some possible exclusions or assumptions can be made to reduce the complexity of the situation. For example, a device with high PDL (>10 dB) will generally be used for single-polarization operation. It is therefore possible to argue that for such a device, PDL is the relevant parameter, not PMD.

Therefore with the above justification the scope of this document is restricted to exclude devices that have high (>10 dB) PDL. Such devices include polarizer, polarization sensitive splitters or modulators etc.

For devices with low PDL (<1 dB), which are the typical cases of DWDM devices, PDL generally presents little problem to the measurements of DGD, but will marginally increase uncertainty. As PDL rises, this uncertainty rises.

For devices with higher PDL (e.g. >10 dB) this error is likely to be unacceptably high.

4.4 Multiple path interference

Passive fibre optic devices may contain bulk optical elements, fibre-waveguide splices, and fibre-lens interfaces etc. that can give rise to reflections due to optical index mismatch between elements. The effect of these may be to induce multi-path dispersions that are either PMD-related (i.e. the path difference is polarization sensitive) or not (polarization insensitive path differences) [1][1].

Reflections and multiple delay paths that are not polarization sensitive can be separately removed from DGD. Any kind of polarization-sensitive differential delay, however, will be recorded as DGD.

4.5 Fibre pigtails

Finally, the fibre pigtails will add PMD of their own, which will vary as the leads are bent, coiled or twisted.

1 Figures in square brackets refer to the bibliography.