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SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Transmission media and optical systems characteristics –
Characteristics of optical components and subsystems

Characteristics of PMD compensators and PMD compensating receivers

Recommendation ITU-T G.666

ITU-T G-SERIES RECOMMENDATIONS
TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G.600–G.699
General	G.600–G.609
Symmetric cable pairs	G.610–G.619
Land coaxial cable pairs	G.620–G.629
Submarine cables	G.630–G.639
Free space optical systems	G.640–G.649
Optical fibre cables	G.650–G.659
Characteristics of optical components and subsystems	G.660–G.679
Characteristics of optical systems	G.680–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G.7000–G.7999
PACKET OVER TRANSPORT ASPECTS	G.8000–G.8999
ACCESS NETWORKS	G.9000–G.9999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T G.666

Characteristics of PMD compensators and PMD compensating receivers

Summary

Recommendation ITU-T G.666 contains parameters and definitions for devices providing polarization mode dispersion (PMD) compensation needed for transmission and detection of optical signals in a system exhibiting high levels of PMD which would otherwise cause unacceptable levels of system outage. Single and multichannel line PMD compensators are described, as well as single and multichannel PMD compensating receivers. Information on test configurations and implementation options can be found in informative appendices.

Source

Recommendation ITU-T G.666 was approved on 29 March 2008 by ITU-T Study Group 15 (2005-2008) under Recommendation ITU-T A.8 procedure.

FOREWORD

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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CONTENTS

Page

1	Scope	1
2	References.....	1
3	Terms and definitions	2
3.1	Terms defined elsewhere	2
3.2	Terms defined in this Recommendation.....	2
4	Abbreviations and acronyms	3
5	Reference configurations	4
5.1	Line PMDCs.....	4
5.2	PMDC receivers	4
6	Parameters of PMDCs	5
Appendix I – Measurements of parameters of PMDCs		9
I.1	Measurement of parameters for PMDC receivers	9
I.2	Measurement of parameters for line PMDCs.....	11
I.3	First order dynamic PMD emulator implementation.....	11
I.4	First and second order PMD emulator implementation	12
Appendix II – Single-channel and multichannel PMDC receiver implementation		16
II.1	Single-channel PMDC receiver implementation.....	16
II.2	Multichannel PMDC receiver implementation	17
Bibliography.....		19

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Recommendation ITU-T G.666

Characteristics of PMD compensators and PMD compensating receivers

1 Scope

This Recommendation contains parameters and definitions for devices providing polarization mode dispersion (PMD) compensation needed for transmission and detection of optical signals in a system exhibiting high levels of PMD. The PMD compensating devices described include both single and multichannel applications. This Recommendation defines requirements and key parameters for first and higher order PMD compensators (PMDCs) and includes dynamic PMD characteristics. This Recommendation distinguishes line PMDCs from PMDC receivers which may comprise electrical as well as optical forms of PMD compensation.

Measurement methods for PMD-related impairments can be found in [ITU-T G.650.2]

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T G.650.2] Recommendation ITU-T G.650.2 (2005), *Definitions and test methods for statistical and non-linear related attributes of single-mode fibre and cable.*
- [ITU-T G.652] Recommendation ITU-T G.652 (2005), *Characteristics of a single-mode optical fibre and cable.*
- [ITU-T G.653] Recommendation ITU-T G.653 (2003), *Characteristics of a dispersion-shifted single-mode optical fibre and cable.*
- [ITU-T G.654] Recommendation ITU-T G.654 (2004), *Characteristics of a cut-off shifted single-mode optical fibre and cable.*
- [ITU-T G.655] Recommendation ITU-T G.655 (2003), *Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable.*
- [ITU-T G.656] Recommendation ITU-T G.656 (2004), *Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport.*
- [ITU-T G.661] Recommendation ITU-T G.661 (1998), *Definition and test methods for the relevant generic parameters of optical amplifier devices and subsystems.*
- [ITU-T G.662] Recommendation ITU-T G.662 (2005), *Generic characteristics of optical amplifier devices and subsystems.*
- [ITU-T G.665] Recommendation ITU-T G.665 (2005), *Generic characteristics of Raman amplifiers and Raman amplified subsystems.*
- [ITU-T G.671] Recommendation ITU-T G.671 (2005), *Transmission characteristics of optical components and subsystems.*
- [ITU-T G.694.1] Recommendation ITU-T G.694.1 (2002), *Spectral grids for WDM applications: DWDM frequency grid.*

3 Terms and definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 differential group delay (DGD): [ITU-T G.650.2], symbol $\Delta\tau$.

3.1.2 polarization dispersion vector (PDV): [ITU-T G.650.2], symbol $\vec{\Omega}$.

NOTE – In a former version of this Recommendation, PDV was called "First order DGD vector". The renaming is due to an alignment of terms with respect to [ITU-T G.650.2].

3.1.3 principle state of polarization vector: [ITU-T G.650.2], symbol $\vec{p}$.

3.1.4 ripple: [ITU-T G.671].

3.1.5 spectral excursion: [ITU-T G.698.1].

3.1.6 Stokes vector: [ITU-T G.650.2], Symbol $\vec{s}$.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 DGD rate of change: The DGD rate of change is defined as the absolute value of the derivative of the DGD with respect to time, i.e., $\left| \frac{\partial \Delta\tau}{\partial t} \right|$, and is measured in ps/ms.

3.2.2 OSNR penalty due to DGD: An optical signal that has been subject to a DGD requires a larger OSNR at the receiver to achieve $\text{BER} = 10^{-12}$ than an optical signal which has not been affected by DGD (i.e., $\Delta\tau = 0$), assuming the same receiver input power in both cases. This OSNR difference is called the OSNR penalty due to DGD. In this case no SOPMD is considered.

NOTE – For applications where FEC bytes are required to be transmitted, the BER of 10^{-12} is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder for these cases can therefore be significantly higher than 10^{-12} .

3.2.3 polarization rotation speed (PRS): The polarization rotation speed is the absolute value of the temporal change of the Stokes vector $\vec{s}$, i.e., $\text{PRS} = \left| \frac{\partial \vec{s}}{\partial t} \right|$, and is measured in rad/ms.

3.2.4 PMDC receiver sensitivity: The value of mean received power at point MPI-R to achieve the specified BER. This must be met across all states of input polarization with a worst-case transmitter, but does not have to be met with degradations of the optical path other than the PMD.

3.2.5 PSP rate of change: The PSP rate of change is defined as the derivative of the principle state of polarization vector $\vec{p}$ in Stokes space with respect to time, i.e., $\left| \frac{\partial \vec{p}}{\partial t} \right|$, and is measured in rad/ms.

3.2.6 second-order PMD (SOPMD): Second-order PMD is defined by $\text{SOPMD} = \vec{\Omega}_\omega = \Delta\tau_\omega \vec{p} + \Delta\tau \vec{p}_\omega$. This is the derivative of the PDV (first-order DGD vector) with respect to the optical frequency ω . The SOPMD consists of two terms, namely $\Delta\tau_\omega \vec{p}$ and $\Delta\tau \vec{p}_\omega$. The first term, $\Delta\tau_\omega \vec{p}$, represents the polarization-dependent chromatic dispersion term (PCD),

while $\Delta\tau \vec{p}_\omega$ is the so-called depolarization term (DEPOL) which describes the PSP unit vector rotation with respect to frequency (at the centre frequency of the signal). The corresponding magnitudes of these quantities are given as follows: Magnitude of the SOPMD = $|\vec{\Omega}_\omega|$, magnitude of the depolarization = $|\Delta\tau \vec{p}_\omega|$, magnitude of the PCD = $|\Delta\tau_\omega|$.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BER	Bit Error Ratio
DEMUX	Demultiplexer
DEPOL	Depolarization term
DGD	Differential Group Delay
LPMD	Line Polarization Mode Dispersion Compensator
M-LPMD	Multichannel Line Polarization Mode Dispersion Compensator
M-PMDC-Rx	Multichannel Polarization Mode Dispersion Compensating Receiver
MPI	Main Path Interface
MUX	Multiplexer
NRZ	Non-Return to Zero
OA	Optical Amplifier
O-E-O	Optical-Electrical-Optical (conversion)
OSNR	Optical Signal-to-Noise Ratio
PCD	Polarization-dependent Chromatic Dispersion
PDL	Polarization Dependent Loss
PDV	Polarization Dispersion Vector
PMD	Polarization Mode Dispersion
PMDC	Polarization Mode Dispersion Compensator
PMDC-Rx	Polarization Mode Dispersion Compensating Receiver
PRBS	Pseudo-Random Binary Sequence
PRS	Polarization Rotation Speed
PSP	Principle State of Polarization
RZ	Return to Zero
S-LPMD	Single-Channel Line Polarization Mode Dispersion Compensator
S-PMDC-Rx	Single-Channel Polarization Mode Dispersion Compensating Receiver
SOP	State of Polarization
SOPMD	Second Order Polarization Mode Dispersion
WDM	Wavelength Division Multiplexing