PD IEC/TR 62343-6-3:2010

BSI Standards Publication

Dynamic modules

Part 6-3: Round robin measurement results for group delay ripple of tunable dispersion compensators

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

raising standards worldwide™

Full document details: PD IEC/TR 62343-6-3:2010

National foreword

This Published Document is the UK implementation of IEC/TR 62343-6-3:2010.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/3, Fibre optic systems and active devices.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© BSI 2010

ISBN 978 0 580 68755 6

ICS 33.180.99

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 July 2010.

Amendments issued since publication

Amd. No.	Date	Text affected

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62343-6-3:2010

IEC/TR 62343-6-3

Edition 1.0 2010-05

TECHNICAL REPORT

colour inside

Dynamic modules –
Part 6-3: Round robin measurement results for group delay ripple of tunable dispersion compensators

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE U

ICS 33.180

ISBN 978-2-88910-992-0

® Registered trademark of the International Electrotechnical Commission

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62343-6-3:2010

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Abbreviated terms 7
4 Types of tunable dispersion compensators (TDCs) 8
4.1 Virtual imaged phased array (VIPA) 8
4.2 Fibre Bragg grating (FBG) 8
4.3 Planar lightwave circuit (PLC) 8
4.4 Etalon 9
5 Measurement methods 9
5.1 Modulation phase shift (MPS) method 9
5.2 Modulation phase shift-Mueller matrix (MPS-Mueller) method 10
5.3 Polarization phase shift (PPS) method 10
5.4 Swept wavelength interferometry (SWI) method 10
6 DUTs and test parameters 10
7 Measurement results 11
7.1 VIPA 11
7.2 FBG 14
7.3 PLC 16
7.4 Etalon 19
8 Data analysis 21
8.1 Repeatability 21
8.2 Measurement method differences 22
9 Consideration of phase ripple 24
10 Conclusion 27

Figure 1 – Structure of the VIPA 8
Figure 2 – Chirped fibre grating 8
Figure 3 – PLC (MZ interference circuit) 9
Figure 4 – Etalon (Gires-Tournois interferometer) 9
Figure 5 – GD and IL of the VIPA 12
Figure 6 – GD deviation with each measurement method of the VIPA 12
Figure 7 – GD deviation at different RBWs of the VIPA 13
Figure 8 – Summary of GDR measurement results of the VIPA 13
Figure 9 – Summary of GDR repeatability of the VIPA 14
Figure 10 – GD and IL of FBG1 14
Figure 11 – GD deviation with each measurement method of FBG1 15
Figure 12 – GD deviation at different RBWs of FBG1 15
Figure 13 – Summary of GDR measurement results of the FBGs 16
Figure 14 – Summary of GDR repeatability of the FBGs 16
Figure 15 – GD and IL of the PLC 17
Figure 16 – GD deviation of the PLC with different measurement methods 17

AVA Documents
Document Sharing Hub
Full document details: PD IEC/TR 62343-6-3:2010

Figure 17 – GD deviation of the PLC at different RBWs 18
Figure 18 – Summary of GDR measurement results of the PLC 18
Figure 19 – Summary of GDR repeatability of the PLC 19
Figure 20 – GD and IL of the etalon 19
Figure 21 – GD deviation of the etalon with different measurement methods 20
Figure 22 – GD deviation of the etalon at different RBWs 20
Figure 23 – Summary of GDR measurement results of the etalon 21
Figure 24 – Summary of GDR repeatability of the etalon 21
Figure 25 – RBW, measurement methods and GDR repeatability 22
Figure 26 – Differences in GDR measurement results between measurement methods 23
Figure 27 – GDR differences produced when measuring a TDC with GDR of less than 6 ps at RBW of 8 pm 23
Figure 28 – Typical measurement result of GDR 24
Figure 29 – Phase ripple calculated from GDR 25
Figure 30 – Amplitude, period, and EOP of GDR 25
Figure 31 – Phase ripple of the VIPA and FBGs 26
Figure 32 – Phase ripple repeatability of the VIPA and FBGs 26
Figure 33 – Differences in phase ripple between measurement methods 27

Table 1 – DUTs and measurement methods used in round robin testing 10
Table 2 – RBW and modulation frequency 11

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62343-6-3:2010

INTERNATIONAL ELECTROTECHNICAL COMMISSION

DYNAMIC MODULES –

Part 6-3: Round robin measurement results for group delay ripple of tunable dispersion compensators

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 62343-6-3, which is a technical report, has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
86C/917/DTR	86C/952/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

AVA Documents
Document Sharing Hub

Full document details: PD IEC/TR 62343-6-3:2010

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

A list of all parts of 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 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.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62343-6-3:2010

INTRODUCTION

The most important means of enhancing the technology for communication systems are networking, faster speed, and longer distance. In long-distance, high-speed communication systems operating at 40 Gbps or more, dispersion is known to limit transmission distance. Various tunable dispersion compensators (TDCs) have been commercialized in order to minimize the degradation of signals caused by chromatic dispersion. However, the group delay (GD) in TDCs is known to have ripples dependent on the principles of TDC operation, and such GD affects signal degradation.

IEC TC86 (*Fibre optics*) describes several methods of measuring chromatic dispersion (CD). One example is IEC 61300-3-38, but it does not specify a measurement method for group delay ripple (GDR). The representative passive component for compensating for chromatic dispersion is dispersion compensation fibre (DCF), but given its principles, the GD has no ripples. Conversely, many TDCs use the interference effect, which explains why there are ripples.

Under these circumstances, round robin testing has been conducted by using various TDCs and diverse GD measurement methods. This technical report, based on the findings from round robin testing, examines the direction of standardization for GDR measurement methods.

This technical report is based on and translated from OITDA document- TP06/SP DM-2008 (Group Delay Ripple Measurement Method for Tunable Dispersion Compensators—Technical Paper).

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62343-6-3:2010

DYNAMIC MODULES –

Part 6-3: Round robin measurement results for group delay ripple of tunable dispersion compensators

1 Scope

This technical report describes the round robin measurement results for the group delay ripple (GDR) of tunable dispersion compensators (TDCs). It briefly explains the four typical TDCs measured and four typical methods of measuring group delay (GD), as well as the GDR round robin measurement results of TDCs, and an analysis of repeatability and differences among these measurement methods. This technical report also proposes suitable measurement parameters and a new parameter of phase ripple instead of GDR.

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/PAS 61300-3-38, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-38: Group delay and chromatic dispersion*

IEC 62343-1-2, *Dynamic modules – Part 1-2: Performance standards – Dynamic chromatic dispersion compensator with pigtails for use in controlled environments (Category C)*

3 Abbreviated terms

For the purposes of this document, the abbreviated terms apply.

CD	chromatic dispersion
DGD	differential group delay
DUT	device under test
EOP	eye opening penalty
FBG	fibre Bragg grating
FSR	free spectral range
GD	group delay
GDR	group delay ripple
MPS	modulation phase shift
MZ	Mach-Zender
PLC	planar lightwave circuit
PPS	polarization phase shift
RBW	resolution bandwidth
SWI	swept wavelength interferometry
TDC	tunable dispersion compensator
VIPA	virtually imaged phased array

Documents
Document Sharing Hub

Full document details: PD IEC/TR 62343-6-3:2010

4 Types of tunable dispersion compensators (TDCs)

Various TDCs have been announced and commercialized in the market. The following briefly describes typical TDCs.

4.1 Virtual imaged phased array (VIPA)

Figure 1 shows the structure of a virtually imaged phased array (VIPA). The input light from a single-mode fibre is line-focused onto a glass plate. The glass plate is coated on both sides and collimated light is emitted from the reverse side of the glass after multiple reflections on the glass plate. The light from the glass plate is focused onto a curved mirror. The reflected light travels back to the glass plate and is finally coupled to the fibre. The 3-dimensional mirror is moved to vary the optical distance for each wavelength, thereby changing the CD.

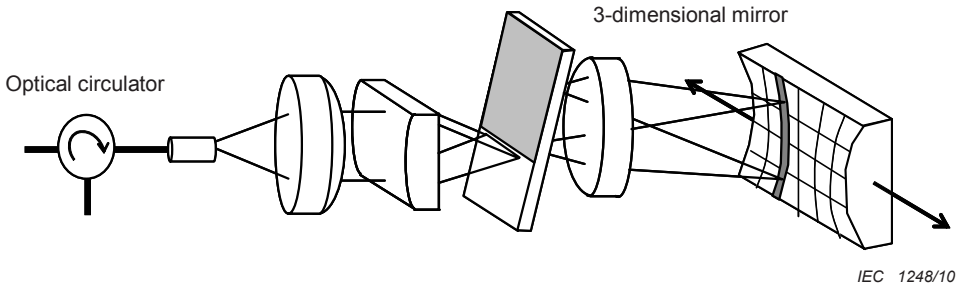

Figure 1 – Structure of the VIPA

4.2 Fibre Bragg grating (FBG)

An FBG periodically changes the refraction index of the optical fibre core, thereby forming a grating to generate Bragg diffraction, which functions as a reflection filter. Gradually changing the pitch of Bragg diffraction varies the reflection return time according to wavelength, thereby generating CD. The temperature of the fibre formed in the FBG can be varied or given tension to change the FBG pitch. This principle is used to change the CD.

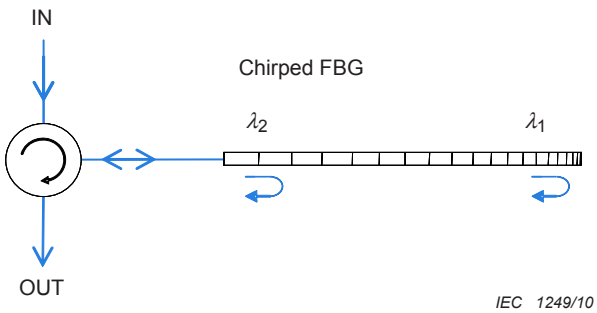

Figure 2 – Chirped fibre grating

4.3 Planar lightwave circuit (PLC)

A ring resonator can be formed on a quartz lightwave circuit. The resulting interference effect can then be used to produce periodic loss and GD characteristics over the wavelength. Moreover, the ring resonator can be replaced with MZ interference circuits in multiple stages to produce similar effects. The temperatures of some of these interference circuits can be varied to change the CD.

Documents
Document Sharing Hub
Full document details: PD IEC/TR 62343-6-3:2010