

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



Optical fibres – **iTeh STANDARD PREVIEW**  
Part 1-42: Measurement methods and test procedures – Chromatic dispersion  
(standards.iteh.ai)

Fibres optiques –  
Partie 1-42: Méthodes de mesure et procédures d'essai – Dispersion  
chromatique

IEC 60793-1-42:2013  
<https://standards.iteh.ai/catalog/standards/sist/d2647059-a404-4d6c-9918-494adcd9f5a9/iec-60793-1-42-2013>





## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2013 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### Useful links:

IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,...).

It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).

### A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Liens utiles:

Recherche de publications CEI - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

La recherche avancée vous permet de trouver des publications CEI en utilisant différents critères (numéro de référence, texte, comité d'études,...).

Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

Just Published CEI - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications de la CEI. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).



IEC 60793-1-42

Edition 3.0 2013-01

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



Optical fibres – **iTeh STANDARD PREVIEW**  
Part 1-42: Measurement methods and test procedures – Chromatic dispersion  
(standards.iteh.ai)

Fibres optiques –  
Partie 1-42: Méthodes de mesure et procédures d'essai – Dispersion  
chromatique

IEC 60793-1-42:2013

494adcd9f5a9/iec-60793-1-42-2013

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE  
CODE PRIX

U

ICS 33.180.10

ISBN 978-2-83220-576-1

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references .....	7
3 Overview of methods .....	7
3.1 Method A, phase shift.....	7
3.2 Method B, spectral group delay in the time domain.....	7
3.3 Method C, differential phase shift .....	7
4 Reference test methods.....	8
4.1 Category A1 and sub-category A4f, A4g and A4h multimode fibres .....	8
4.2 Class B single-mode fibres .....	8
5 Apparatus.....	8
5.1 General.....	8
5.2 Launch optics .....	8
5.3 High-order mode filter (single-mode) .....	8
5.4 Input positioning apparatus .....	8
5.5 Output positioning apparatus.....	8
5.6 Computation equipment.....	9
6 Sampling and specimens.....	9
6.1 Specimen length.....	9
6.2 Specimen end face.....	9
6.3 Reference fibre.....	9
7 Procedure.....	9
8 Calculations .....	9
8.1 General.....	9
8.2 Category A1 and sub-category A4f, A4g, A4h multimode fibres and category B1.1, B1.3 and sub-category B6_a1 and B6_a2 single-mode fibres .....	10
8.3 Category B1.2 single-mode fibres.....	10
8.4 Category B2 single-mode fibres.....	10
8.5 Category B4 and B5 single-mode fibres.....	11
9 Results .....	11
9.1 Report the following information with each measurement: .....	11
9.2 The following information shall be available upon request: .....	11
10 Specification information .....	11
Annex A (normative) Requirements specific to method A, phase-shift .....	12
Annex B (normative) Requirements specific to method B, spectral group delay in the time domain .....	17
Annex C (normative) Requirements specific to method C, differential phase-shift .....	21
Annex D (normative) Chromatic dispersion fitting.....	26
Bibliography.....	28
Figure A.1 – Chromatic dispersion measurement set, multiple laser system (typical) .....	13
Figure A.2 – Typical delay and dispersion curves.....	13
Figure A.3 – Chromatic dispersion measurement set, LED system (typical) .....	15
Figure B.1 – Block diagram, fibre Raman laser system .....	18
Figure B.2 – Block diagram, multiple laser diode system.....	18

ITEH STANDARD PREVIEW

(standards.iteh.ai)

IEC 60793-1-42:2013

<https://standards.iteh.ai/catalog/standards/sist/d2647059-a464-4d8c-9518-494adcd9f5a9/iec-60793-1-42-2013>

Figure C.1 – Chromatic differential phase dispersion measurement set, multiple laser system .....	22
Figure C.2 – Chromatic differential phase dispersion measurement set, LED system .....	23
Figure C.3 – Chromatic dispersion measurement set, differential phase by dual wavelength method .....	23
Figure C.4 – Chromatic dispersion measurement set, differential phase by double demodulation .....	24
Table D.1 – Definition of fit types and fit coefficients; equations for group delay and dispersion coefficient .....	26
Table D.2 – Slope equations .....	26
Table D.3 – Zero-dispersion wavelength and slope equations .....	27

## **iTeh STANDARD PREVIEW** **(standards.iteh.ai)**

[IEC 60793-1-42:2013](https://standards.iteh.ai/catalog/standards/sist/d2647059-a464-4dbe-95f8-494adcd9f5a9/iec-60793-1-42-2013)

<https://standards.iteh.ai/catalog/standards/sist/d2647059-a464-4dbe-95f8-494adcd9f5a9/iec-60793-1-42-2013>

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## OPTICAL FIBRES –

**Part 1-42: Measurement methods and test procedures –  
Chromatic dispersion**

## 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.  
<https://standards.iteh.ai/catalog/standards/sist/d2647059-a464-4dbe-95f8->
- 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.

International Standard IEC 60793-1-42 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This third edition cancels and replaces the second edition, published in 2007. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the inclusion of category B6 single-mode fibres;
- b) the deletion of test method D (interferometry).

This standard should be read in conjunction with IEC 60793-1-1.

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

CDV	Report on voting
86A/1419/CDV	86A/1443/RVC

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 the parts in the IEC 60793 series, published under the general title *Optical fibres*, 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.

## iTeh STANDARD PREVIEW

**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.**

<https://standards.iteh.ai/catalog/standards/sist/d2647059-a464-4dbe-95f8-494adcd9f5a9/iec-60793-1-42-2013>

## OPTICAL FIBRES –

### Part 1-42: Measurement methods and test procedures – Chromatic dispersion

#### 1 Scope

This part of IEC 60793 establishes uniform requirements for measuring the chromatic dispersion of optical fibre, thereby assisting in the inspection of fibres and cables for commercial purposes.

Chromatic dispersion varies with wavelength. Some methods and implementations measure the group delay as a function of wavelength and the chromatic dispersion and dispersion slope are deduced from the derivatives (with respect to wavelength) of this data. This differentiation is most often done after the data are fitted to a mathematical model. Other implementations can allow direct measurement (of the chromatic dispersion) at each of the required wavelengths.

For some (sub-) categories of fibre, the chromatic dispersion attributes are specified with the parameters of a specific model. In these cases, the relevant recommendation or standard defines the model appropriate for the definition of the specified parameters. For other fibre (sub-) categories, the dispersion is specified to be within a given range for one or more specified wavelength intervals. In the latter case, either direct measurements may be made at the wavelength extremes or some fitting model may be used to either allow group delay measurement methods or implementations, or to allow storage of a reduced set of parameters that may be used to calculate the interpolated dispersion for particular wavelengths which may not have actual direct measurement values.

Annex D gives a general description of chromatic dispersion fitting and outlines a number of fitting equations suitable for use with any of the measurement methods or fibre categories.

This standard gives three methods for measuring chromatic dispersion:

- method A: phase shift;
- method B: spectral group delay in the time domain;
- method C: differential phase shift.

Methods A, B, and C apply to the measurement of chromatic dispersion of the following fibres from IEC 60793-2 over a specified wavelength range:

- category A1 graded-index multimode fibres;
- sub-category A4f, A4g and A4h multimode fibres;
- category B1, B2, B4, B5 and sub-categories B6\_a1 and B6\_a2 single-mode fibres.

The methods can be applied to laboratory, factory and field measurements of chromatic dispersion, and the wavelength range of the measurements can be tailored as required. Measurements are made at temperature as stated in Table 1 of IEC 60793-1-1:2008, Standard range of atmospheric conditions.

The methods are suitable for fibre or cable lengths greater than 1 km. They may also be applied to shorter lengths, but accuracy and repeatability may be compromised.

Information common to all methods is contained in Clauses 1 to 8, and information pertaining to each individual method appears in Annexes A, B and C, respectively.



## 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 60793-1-1:2008, *Optical fibres – Part 1-1: Measurement methods and test procedures – General and guidance*

IEC 60793-1-41, *Optical fibres – Part 1-41: Measurement methods and test procedures – Bandwidth*

IEC 60793-2, *Optical fibres – Part 2: Product specifications – General*

## 3 Overview of methods

### 3.1 Method A, phase shift

This method describes a procedure for determining the chromatic dispersion of the categories of class B single-mode fibres B1, B2, B4, B5 and sub-categories B6\_a1 and B6\_a2, category A1 graded-index multimode fibres and sub-category A4f, A4g and A4h fibres, over a specified wavelength range using the relative phase shifts among sinusoidally modulated optical sources of different wavelengths. The sources are typically laser diodes or filtered light emitting diodes or filtered amplified spontaneous emission (ASE) sources. Relative phase shifts are converted to relative time delays, and the resultant spectral group delay data are then fitted to an equation defined for each fibre (sub) category.

### 3.2 Method B, spectral group delay in the time domain

This method describes a procedure for determining the chromatic dispersion of the categories of class B single-mode fibres B1, B2, B4, B5 and sub-categories B6\_a1 and B6\_a2, category A1 graded-index multimode fibres and sub-category A4f, A4g and A4h fibres with the use of a Nd:YAG/fibre Raman laser source or multiple laser diodes operating at a number of wavelengths, both greater than and less than, the typical zero-dispersion wavelength.

In this method, the time difference of optical pulse delay through a known length of fibre at several wavelengths is measured. A reference set of measurements shall also be taken through a short reference fibre and data are subtracted from data taken from the fibre under test to obtain relative spectral group delay. The resultant spectral group delay data are then fitted to an equation defined for each fibre (sub) category.

### 3.3 Method C, differential phase shift

This method describes a procedure for determining the chromatic dispersion of the categories of class B single-mode fibres B1, B2, B4, B5 and sub-categories B6\_a1 and B6\_a2, category A1 graded-index multimode fibres and sub-category A4f, A4g and A4h fibres. The dispersion coefficient at a particular wavelength is determined from the differential group delay between two closely spaced wavelengths.

In this procedure, a modulated light source is coupled into the fibre under test, and the phase of the light exiting the fibre at a first wavelength is compared with the phase of the light exiting at a second wavelength. Average chromatic dispersion over the interval between the two wavelengths is determined from differential phase shift, wavelength interval, and fibre length.

The chromatic dispersion coefficient at a wavelength medial to the two test wavelengths is assumed to be equal to the average chromatic dispersion over the interval between the two

wavelengths. The resultant chromatic dispersion data are then fitted to an equation defined for each fibre (sub) category.

## 4 Reference test methods

### 4.1 Category A1 and sub-category A4f, A4g and A4h multimode fibres

For category A1 and sub-category A4f, A4g and A4h multimode fibres, method B, spectral group delay in the time domain, is the reference test method ("RTM"), which shall be the one used to resolve disputes .

### 4.2 Class B single-mode fibres

For the categories of class B single-mode fibres B1, B2, B4, B5 and sub-categories B6\_a1 and B6\_a2, method A, phase shift, is the RTM. In the absence of method A, method C, differential phase shift, may also be used to resolve disputes.

## 5 Apparatus

### 5.1 General

The following apparatus is common to all measurement methods. Annexes A, B and C include layout drawings and other equipment requirements that individually apply for each of the methods, A, B and C respectively.

### 5.2 Launch optics

The output from the signal sources shall be coupled to the fibre under test or the reference fibre such that the physical path length for each source is held constant during the measurement. (This requirement ensures that the relative phases of the sources do not change due to path-length changes.) Suitable devices may include multichannel single-mode optical switches or demountable optical connectors.

For measurement of category A1, and sub-category A4f, A4g, A4h multimode fibre, launch conditions shall comply with method A, Impulse response, of IEC 60793-1-41.

### 5.3 High-order mode filter (single-mode)

For measurement of single-mode fibre, use a method to remove high-order propagating modes in the wavelength range of interest. An example of such a high-order mode filter is a single loop of radius sufficiently small to shift cut-off wavelength below the minimum wavelength of interest.

### 5.4 Input positioning apparatus

Provide means to couple the input of the specimen to the light source. Examples include the use of x-y-z micropositioner stages, or mechanical coupling methods such as connectors, vacuum splices, three-rod splices, etc. The position of the fibre shall remain stable over the duration of the test.

### 5.5 Output positioning apparatus

Provide means of positioning the output end of the specimen such that the guided optical power is coupled to the system detector. Such coupling may include the use of lenses, or may be a mechanical connection to a detector pigtail.

## 5.6 Computation equipment

A digital computer may be used for purposes of equipment control, data acquisition, and numerical evaluation of the data.

## 6 Sampling and specimens

### 6.1 Specimen length

Methods A, B, and C require the specimen to be a fibre or cable of known length sufficiently long to produce adequate phase measurement accuracy. A typical minimum length is 1 km. Because sub-category A4f, A4g and A4h fibres have higher loss than category A1 fibres, for these A4 fibres a minimum length of 100 m is acceptable.

NOTE Reproducibility is affected when using shorter measuring length. Longer lengths generally yield better reproducibility.

### 6.2 Specimen end face

Prepare a flat end face, orthogonal to the fibre axis, at the input and output ends of each specimen.

### 6.3 Reference fibre

A single mode fibre with known dispersion characteristics shall be used to compensate for chromatic delays in the optical sources and other equipment components. The length of this fibre shall be less than or equal to 0,2 % of the specimen length.

In case of A4f, A4g and A4h fibres, the length of the reference fibre shall be less than or equal to 2 m. If this length is longer than 0,2 % of the length of the specimen under test, the chromatic dispersion of the reference fibres shall be taken into account by subtracting its chromatic dispersion value from the results measured on the specimen length.

The temperature of the specimen shall be stable during the measurement within 0,1 °C to 1 °C, depending upon the temporal behaviour due to this change.

## 7 Procedure

See Annexes A, B and C for the procedures for methods A, B and C, respectively.

Reference fibre measurements are required for all methods. Reference fibre data can be stored for use in making measurements on the specimens. The reference fibre measurement procedure should be repeated when equipment changes on the source or receive optics or electronics occur.

## 8 Calculations

### 8.1 General

The calculation of relative delay appropriate for each method is given in Annexes A, B and C, respectively.

The remainder of this clause describes the numerical fit that can be applied for all methods to the spectral group delay data normalized by length,  $\tau(\lambda)$ , see also the Annex D.

$\lambda$  is the wavelength (nm)

$\tau(\lambda)$	is the normalized spectral group delay data fit	(ps/km)
$D(\lambda)$	is the chromatic dispersion coefficient, with $D(\lambda) = d\tau(\lambda) / d\lambda$	(ps/(nm × km) )
$\lambda_0$	is the zero-dispersion wavelength	(nm)
$\tau(\lambda_0)$	is the relative delay minimum at the zero-dispersion wavelength	(ps/km)
$S(\lambda)$	is the dispersion slope, with $S(\lambda) = d D(\lambda) / d\lambda$ .	(ps/(nm <sup>2</sup> × km))
$S_0$	is the dispersion slope at the zero-dispersion wavelength	(ps/(nm <sup>2</sup> × km))

NOTE 1  $\tau(\lambda)$  and  $D(\lambda)$  may either be direct measurements or the result of fitting the direct measurements to a specified function.

NOTE 2 Where, for example, a data fitting function is specified, the parameters of the expression on the right side of the equation are determined so as to minimize the sum of squared errors with regard to the direct measurements. Once determined, this expression is used to determine the values of other various parameters.

NOTE 3 The fit parameters are given as the variables A, B, C, D, or E, see also Annex D.

## 8.2 Category A1 and sub-category A4f, A4g, A4h multimode fibres and category B1.1, B1.3 and sub-category B6\_a1 and B6\_a2 single-mode fibres

The following applies to category A1 and sub-category A4f, A4g and A4h multimode fibres, and to category B1.1, B1.3 and sub-category B6\_a1 and B6\_a2 single-mode fibres around 1 310 nm.

The delay or dispersion data fit shall be fitted with the 3-term Sellmeier fit type, see Annex D. Calculations for the chromatic dispersion coefficient  $D(\lambda)$ , the zero-dispersion wavelength  $\lambda_0$  and the dispersion slope at the zero-dispersion wavelength  $S_0$  are shown in Annex D.

In the 1 550 nm region only, the chromatic dispersion can be approximated as a linear function with wavelength (quadratic fit type to the delay data), see Annex D.

## 8.3 Category B1.2 single-mode fibres

The following applies to category B1.2 single-mode fibres.

Depending on accuracy requirements, for wavelength intervals of up to 35 nm, the quadratic fit type is allowed in the 1 550 nm region. This fitted equation should not be used to predict chromatic dispersion at wavelengths outside the range used for the fit. For longer wavelength intervals, either the 5-term Sellmeier fit type or the 4th order polynomial fit type is recommended. It is not meant to be used in the 1 310 nm region.

Calculations for the chromatic dispersion coefficient  $D(\lambda)$  and the dispersion slope  $S(\lambda)$  are shown in Annex D.

## 8.4 Category B2 single-mode fibres

The following applies to category B2 single-mode fibres.

Depending on accuracy requirements, for wavelength intervals of up to 35 nm, the quadratic fit type is allowed in the 1 550 nm region. The fitted equation should not be used to predict chromatic dispersion at wavelengths outside the range used for the fit.

For longer wavelength intervals, either the 5-term Sellmeier fit type or the 4th order polynomial fit type is recommended. It is not meant to be used in the 1 310 nm region.

The corresponding chromatic dispersion coefficient  $D(\lambda)$ , the zero-dispersion wavelength  $\lambda_0$  and the dispersion slope at the zero-dispersion wavelength  $S_0$  are shown in Annex D.

## 8.5 Category B4 and B5 single-mode fibres

The following applies to category B4 and B5 single-mode fibres.

For normal use over longer wavelength intervals ( $> 35$  nm), either the 5-term Sellmeier fit type or the 4th order polynomial fit type is recommended. The fitted equation should not be used to predict chromatic dispersion at wavelength outside the range used for the fit.

For B4 fibres only, the quadratic fit type may be used in case of a short wavelength interval ( $\leq 35$  nm). The fit type should not be used to predict chromatic dispersion at wavelengths outside the range used for the fit.

The corresponding chromatic dispersion coefficient  $D(\lambda)$  and the dispersion slope  $S(\lambda)$  are shown in Annex D.

## 9 Results

9.1 Report the following information with each measurement:

- date and title of measurement;
- equation(s) used to calculate the results;
- identification of specimen;
- length of specimen used for length normalization;
- measurement results as required by the detail specification.

NOTE Examples of the information that the detail specification may require:

- a) dispersion coefficient values measured at certain specified wavelengths;
- b) dispersion minimum and/or maximum over a specified range of wavelengths;
- c) the zero-dispersion wavelength and dispersion slope at this wavelength.

9.2 The following information shall be available upon request:

- method used: A, B or C;
- description of optical source(s) and measurement wavelengths used;
- modulation frequency (if applicable);
- description of signal detector, signal detection electronics and delay device;
- description of computational techniques used;
- date of latest calibration of measurement equipment.

## 10 Specification information

The detail specification shall specify the following information:

- (sub) category of fibre to be measured;
- failure or acceptance criteria;
- information to be reported;
- any deviations to the procedure that apply.

## Annex A (normative)

### Requirements specific to method A, phase-shift

#### A.1 Apparatus

##### A.1.1 Light source

The light source shall be stable in position, intensity, and wavelength over a time period sufficiently long to complete the measurement procedure. Multiple laser diodes (for an example, see Figure A.1), wavelength-tunable laser diodes, light-emitting diodes (for example, see Figure A.3), or broadband sources (for example, a Nd:YAG laser with a Raman fibre or an ASE source) may be used, depending on the wavelength range of the measurement.

The wavelength launched into the fibre under test may be selected using an optical switch, a monochromator, dispersive devices, optical filters, optical couplers, or by tuning the laser, depending on the type of light sources and measurement set-up. The wavelength selector may be used either at the input or at the output of the fibre under test.

For category B1 fibres measured with a three-wavelength system in which the source wavelengths bracket the zero-dispersion wavelength,  $\lambda_0$  (see Figure A.2), the tolerance or instability,  $\delta\lambda$ , in centre wavelength will lead to maximum errors of  $3\delta\lambda$  in measuring  $\lambda_0$ . Maximum errors in dispersion slope,  $S_0$ , are directly proportional to  $\delta\lambda/\Delta\lambda$  (where  $\Delta\lambda$  = source wavelength spacing) and will be approximately  $0,012 \text{ ps}/(\text{nm}^2 \times \text{km})$  for  $\delta\lambda/\Delta\lambda = 1 \text{ nm}/30 \text{ nm}$ .

Errors smaller than the above maximum errors can be achieved by selecting optical sources with an average wavelength close to the expected  $\lambda_0$  of the specimen and by using more than three wavelengths, or both.

When laser sources are used, typically, a temperature-controlled, single longitudinal-mode laser diode with output power stabilization (e.g. PIN photodiode feedback) is sufficient. An additional laser may be required for the reference link for field measurement sets (see A.1.4).

##### A.1.2 Spectral width

The spectral width of the source, as measured in the specimen, shall be less than or equal to 10 nm at 50 % power points (FWHM).

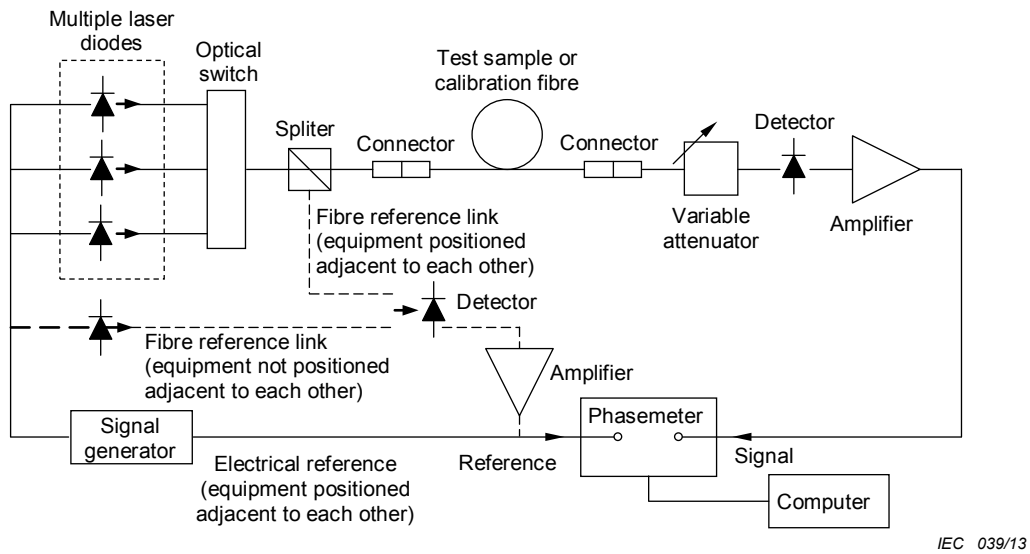


Figure A.1 – Chromatic dispersion measurement set, multiple laser system (typical)

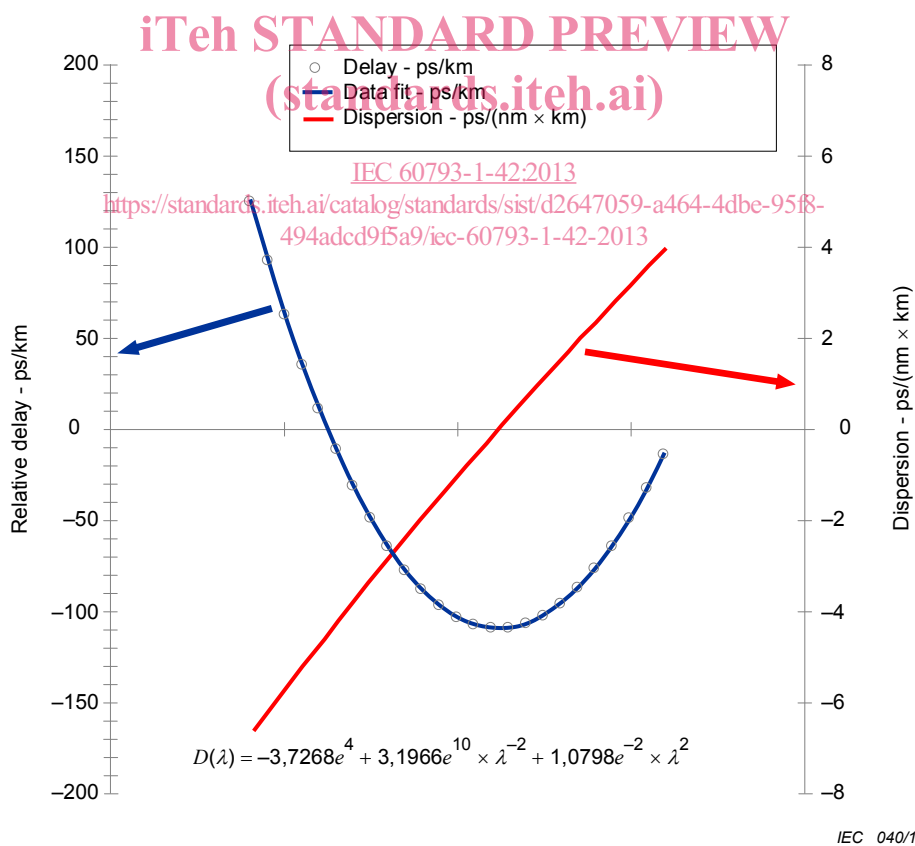


Figure A.2 – Typical delay and dispersion curves

**A.1.3 Modulator**

The modulator shall amplitude modulate the light sources to produce a waveform with a single, dominant Fourier component. For example, a sinusoidal, trapezoidal or square wave modulation shall be acceptable. The frequency stability shall be a minimum of one part in 10<sup>6</sup>.