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Optical fibres

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

National foreword

This British Standard is the UK implementation of EN 60793-1-42:2013. It is identical to IEC 60793-1-42:2013. It supersedes BS EN 60793-1-42:2007 which is withdrawn.

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

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**Optical fibres -
Part 1-42: Measurement methods and test procedures -
Chromatic dispersion
(IEC 60793-1-42:2013)**

Fibres optiques -
Partie 1-42: Méthodes de mesure
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Dispersion chromatique
(CEI 60793-1-42:2013)

Lichtwellenleiter -
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Chromatische Dispersion
(IEC 60793-1-42:2013)

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Foreword

The text of document 86A/1419/CDV, future edition 3 of IEC 60793-1-42, prepared by SC 86A "Fibres and cables" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60793-1-42:2013.

The following dates are fixed:

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-02-28

This document supersedes EN 60793-1-42:2007.

EN 60793-1-42:2013 includes the following significant technical changes with respect to EN 60793 1-42:2007:

- 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 EN 60793-1-1.

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Endorsement notice

The text of the International Standard IEC 60793-1-42:2013 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 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.

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-1-1	2008	Optical fibres - Part 1-1: Measurement methods and test procedures - General and guidance	EN 60793-1-1	2008
IEC 60793-1-41	-	Optical fibres - Part 1-41: Measurement methods and test procedures - Bandwidth	EN 60793-1-41	-
IEC 60793-2	-	Optical fibres - Part 2: Product specifications - General	EN 60793-2	-

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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.