



DPC: 20/30425193 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

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Title: Draft BS EN IEC 61744 Calibration of fibre optic chromatic dispersion test sets.

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- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



86/569/CD

COMMITTEE DRAFT (CD)

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SUPERSEDES DOCUMENTS:

86/568/RR

IEC TC 86 : FIBRE OPTICS	
SECRETARIAT: United States of America	SECRETARY: Mr Steve Swanson
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

Calibration of fibre optic chromatic dispersion test sets

NOTE FROM TC/SC OFFICERS:

Revision approved in TC 86 Plenary in Shanghai on 2019-10-23. See 86/562/RM.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**CALIBRATION OF FIBRE OPTIC CHROMATIC DISPERSION
TEST SETS**

FOREWORD

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International Standard IEC 61744 has been prepared by IEC technical committee 86: Fibre optics.

This third edition cancels and replaces the second edition published in 2005. This edition constitutes a technical revision. The principal technical changes are the following ones:

- a) updated terms and definitions;
- b) the use of a reference fibre standard for calibration is now allowed and at the same level as the other calibration method;
- c) removed Annex E and other references in text to use of air wavelength since it is not used in the fibre domain;
- d) removed Annex D and other references in text to calibration compensation to align with other calibration documents.

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

FDIS	Report on voting
86/xxx/FDIS	86/xxx/RVD

108
109 Full information on the voting for the approval of this standard can be found in the report on
110 voting indicated in the above table.

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

112 The committee has decided that the contents of this publication will remain unchanged until the
113 maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data
114 related to the specific publication. At this date, the publication will be

- 115 • reconfirmed,
- 116 • withdrawn,
- 117 • replaced by a revised edition, or
- 118 • amended.

119

0 Introduction

0.1 Chromatic dispersion in optical fibres

Chromatic dispersion is the variation with optical light wavelength of the light propagation delay time in a length of fibre. This variation can cause bandwidth limitation in the fibre when used to transmit communication signals. For a more detailed explanation, refer to Annex C and IEC 60793-1-1.

0.2 Chromatic dispersion (CD) test sets

CD test sets are used to measure the chromatic dispersion properties of optical fibres and typically comprise an optical source of known wavelength(s), a fibre light input coupling and output coupling means, optical detection means, and electronic or optical means of determining the optical delay or dispersion at the source wavelength. There are several variants each requiring slightly different calibration techniques. Refer to Annex C for further details.

In general, all CD test sets produce an output of fibre delay or dispersion versus the light wavelength, typically in graphical form.

In essence, all CD test sets operate with wavelength as a programmed (independent) variable, usually the ordinate (x-axis) and dispersion or time delay as the abscissa (y-axis) as a measured (dependent) variable. By their nature, fibre chromatic dispersion measurements require multiple wavelengths to be programmed. Even in the case of a single dispersion point obtained using the differential phase shift method, two separate wavelength values are used. It is also typical to expect a wide range of dispersion values over a range of wavelengths to be measured.

0.3 Overview of calibration procedures described in this standard

The requirement to calibrate the CD test set, traceable to known standards, is essential for quality control in fibre optic production, fibre research and similar activities. This standard describes the detailed procedures used to establish calibration of a CD test set.

Calibration of a CD test set is established by applying known artefacts or standards (themselves calibrated to reference standards) to the CD test set, and measuring its response.

Primarily the artefacts or standards used are as follows:

- a) wavelength artefact(s) or traceable wavelength measuring instruments used to calibrate the light source wavelength(s) used by the CD test set. This is to establish the correct excitation wavelength for the system (the 'x-axis');
- b) delay or dispersion artefact(s) used to calibrate the delay or dispersion response of the CD test set (the 'y-axis').
- c) Traceable chromatic dispersion reference fibre used to calibrate the CD test set. This method allows a simultaneous calibration of the whole CD test set, including the measurement of the delay or dispersion response of the CD test set as a function of wavelength and also the internal data processing part. A proper selection of the type of reference fibre is important, especially for an accurate calibration of the zero dispersion wavelength.

Calibration can only be carried out using these artefacts, including the use of a known standard fibre (reference fibre) whose chromatic dispersion is known. The fibre forms a stable source of known dispersion and may be used as a simple dispersion artefact.

If it is found that the CD test set measurement results have changed significantly compared to the user requirements (i.e. the test set has drifted), then adjustment should be carried out.

164 In this document, the reference medium for wavelength and the velocity of light is assumed to
165 be in vacuum, and hence define the refractive index $n = 1,0000000$.

166

CALIBRATION OF FIBRE OPTIC CHROMATIC DISPERSION TEST SETS

1 Scope

This International Standard provides standard procedures for the calibration of optical fibre chromatic dispersion (CD) test sets.

This standard is applicable to all types of CD test sets, with the exception that measurements on multimode optical fibres are excluded.

The purpose of this standard is to define a standard procedure for calibrating optical fibre chromatic dispersion (CD) test sets. The detailed calibration steps used vary according to the measurement technique used in the CD test set.

Whilst it is acknowledged that chromatic dispersion also occurs in multimode fibre and this fibre may be measured on many CD test sets, this standard will restrict discussion to single mode fibre measurements only.

The purpose of the procedures outlined in this standard is to focus manufacturers and users of CD test sets toward the reduction of measurement uncertainty in chromatic dispersion determination in optical fibres under all applicable conditions. The procedures apply to calibration laboratories and to the manufacturers or users of CD test sets for the purpose of

a) calibrating CD test sets;

b) setting specifications of CD test sets;

Use of the procedures also allows correct evaluation of CD test set uncertainty, relative and traceable to appropriate (for example, national) standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-731, *International Electrotechnical Vocabulary (IEV) – Chapter 731: Optical fibre communication*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*

IEC 62129-1, *Calibration of optical spectrum analyzers*

ISO 9000 (all parts), *Quality management and quality assurance standards*

200 GUM: JCGM 100:2008, Evaluation of measurement data - *Guide to the expression of*
201 *uncertainty in measurement*

202 ISO/IEC 17025, *General requirements for the competence of testing and calibration*
203 *laboratories*

204 **3 Terms and definitions**

205 For the purposes of this document, the terms and definitions contained in IEC 60050(731) and
206 the following definitions apply.

207 ISO and IEC maintain terminological databases for use in standardization at the following
208 addresses:

- 209 • ISO Online browsing platform: available at <https://www.iso.org/obp>
- 210 • IEC Electropedia: available at <http://www.electropedia.org/>

211 **3.1**

212 **accredited calibration laboratory**

213 calibration laboratory authorized by the appropriate national standards laboratory to issue
214 calibration certificates with a minimum specified uncertainty, which demonstrate traceability to
215 national standards

216 **3.2**

217 **adjustment**

218 modifying the hardware or firmware of a CD test set with the intention of making the
219 measurement result of the CD test set equal to that of a national standard or a similar
220 calibrated CD test set. This has the effect of correcting all subsequent measurements on that
221 CD test set

222 **3.3**

223 **artefact**

224 device, instrument or equipment used in the process of calibrating a CD test set, for
225 wavelength, delay or chromatic dispersion

226 **3.4**

227 **calibration**

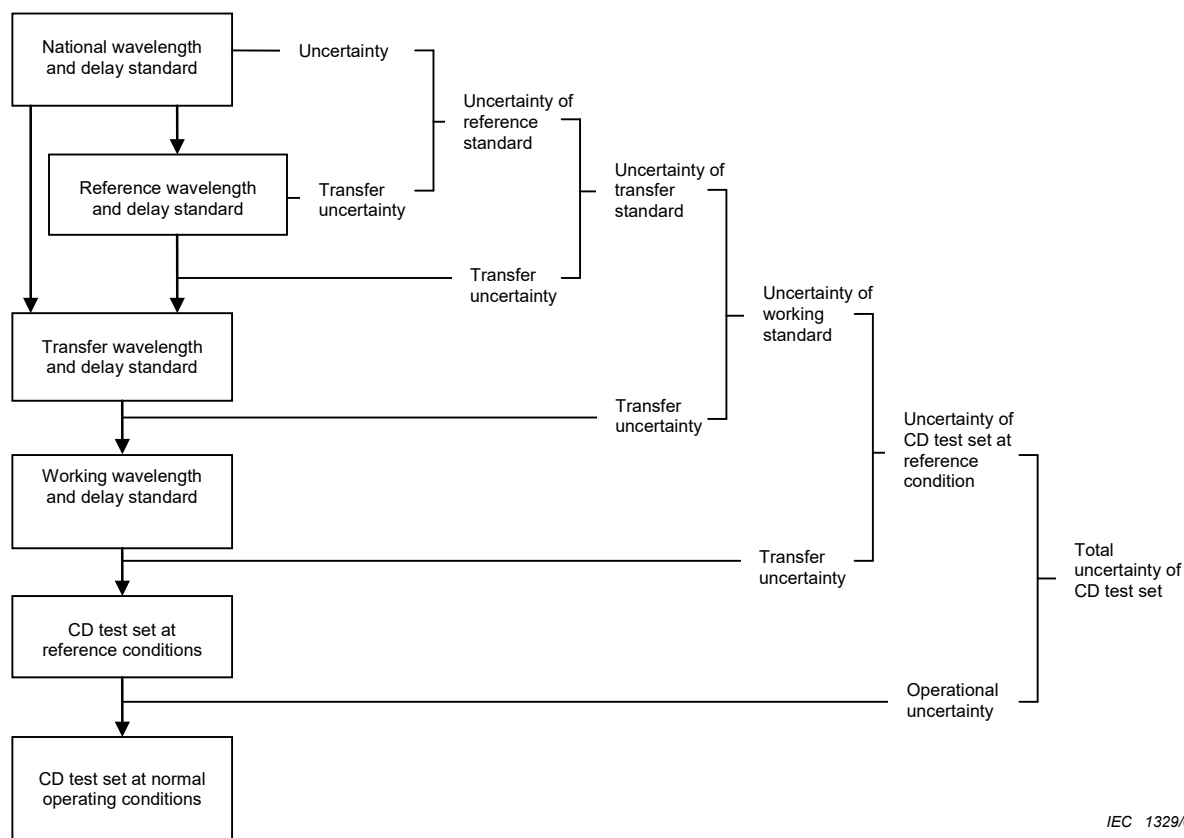
228 process by which the relationship between the values indicated by the infant CD test set and
229 known values of the calibration standard is established under specified conditions

230 Note 1 to entry: The intention of calibration is to bring all CD test sets into substantial agreement with a suitable
231 national standards laboratory. This may be performed by first comparing the relevant parameter of a measurement
232 artefact with that produced by the CD test set, followed by transfer of that result, either by adjustment of the CD test
233 set or by documentation of a calibration factor(s) in a calibration certificate. The pertaining environmental conditions
234 and instrument state are usually recorded. Calibration includes estimation of all uncertainties.

235 **3.5**

236 **traceability chain**

237 unbroken chain of standards and calibrations (see Figure 1)



IEC 1329/05

Figure 1 – Typical calibration chain for CD test sets

3.6

centroidal wavelength

power-weighted mean wavelength of a light source in vacuum, in units of nanometers (nm)

Note 1 to entry: For a continuous source spectrum, the centroidal wavelength λ_c in vacuum is defined by the following integral, where the integration limits enclose the entire spectrum of the source:

$$\lambda_c = (1/P_{\text{total}}) \times \left[\int p(\lambda) \times \lambda \, d\lambda \right] \quad (1)$$

where

$P_{\text{total}} = \int p(\lambda) \, d\lambda$ is the total optical source power.

For a spectrum consisting of i discrete lines, the centre wavelength in vacuum λ_c is defined as:

$$\lambda_c = (1/P_{\text{total}}) \times \left[\sum_i p_i \lambda_i \right] \quad (2)$$

where

$p(\lambda)$ is the spectral power density of the source in W/nm;

λ_c is the central wavelength in vacuum in nanometers;

λ_i is the i^{th} discrete line in nm;

p_i is the power levels at λ_i in W;

$P_{\text{total}} = \sum_i p_i$ is the total power in W.

3.7**chromatic dispersion (CD) test sets**

instrument capable of measuring the chromatic dispersion of a single mode fibre at various wavelengths in the transmission windows of interest, typically the 1 310 nm and/or 1 550 nm wavebands

3.8**correction offset*****CO***

number that is added to or subtracted from the measurement result of a CD test set to correct for a known physical effect or systematic uncertainty

3.9**instrument state**

complete description of the measurement conditions and state of the CD test set during the calibration process

Note 1 to entry: Typical parameters of the instrument state are the wavelength range in use, the data fit model (as applicable), warm-up time and other instrument settings.

3.10**measurement result**

displayed or electrical output of any CD test set, in

- dispersion D in units of $\text{ps} \times \text{nm}^{-1} \times \text{km}^{-1}$,
- lambda zero λ_0 in units of nm, or
- zero dispersion slope S_0 in units of $\text{ps} \times \text{nm}^{-2} \times \text{km}^{-1}$,

after completing all actions suggested by the operating instructions, for example warm-up.

3.11**national standard**

standard whose measurement is traceable to fundamental properties, such as the speed of light, which is recognized by an official national decision and used as the basis for fixing the value, in a country, of all other standards of the quantity concerned

3.12**national standards laboratory**

body or laboratory that maintains and operates the national standard

3.13**operating range**

all conditions of, for example, the dispersion, temperature and other influencing quantities, over which the CD test set is designed to perform within the stated expanded uncertainty

3.14**reference standard**

artefact calibrated against a national standard and used to calibrate CD test sets.

Note 1 to entry: The artefact may be a delay [dispersion] or wavelength standard artefact.

Note 2 to entry: Proper use of the calibration standard ensures traceability.

Note 3 to entry: The term includes the national standard, reference standard, the transfer standard and the working standard in descending order of metrological uncertainty