SLOVENSKI STANDARD
oSIST prEN IEC 61744:2022

01-junij-2022

Umerjanje pribora za preskušanje kromatične disperzije

Calibration of fibre optic chromatic dispersion test sets

Kalibrierung von Prüfaufbauten zur Bestimmung der chromatischen Dispersion

Etalonnage des ensembles d'essai de la dispersion chromatique fibronique

Ta slovenski standard je istoveten z: **prEN IEC 61744:2022**

ICS:		
33.140	Posebna merilna oprema za uporabo v telekomunikacijah	Special measuring equipment for use in telecommunications
33.180.01	Sistemi z optičnimi vlakni na splošno	Fibre optic systems in general

oSIST prEN IEC 61744:2022 **en**

86/598/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:	
IEC 61744 ED3	
DATE OF CIRCULATION:	CLOSING DATE FOR VOTING:
2022-04-29	**2022-07-22**
SUPERSEDES DOCUMENTS:	
86/586/CD, 86/592/CC	

IEC TC 86 : FIBRE OPTICS

SECRETARIAT:	SECRETARY:
United States of America	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 CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

☒ SUBMITTED FOR CENELEC PARALLEL VOTING	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING
Attention IEC-CENELEC parallel voting The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	

This document is still under study and subject to change. It should not be used for reference purposes.

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

PROPOSED STABILITY DATE: 2029

NOTE FROM TC/SC OFFICERS:

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

CALIBRATION OF FIBRE OPTIC CHROMATIC DISPERSION TEST SETS

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.

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

This third edition cancels and replaces the second edition published in 2005. This edition constitutes a technical revision.

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

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) Annex B was split into a new Annex B (on Calibration uncertainty, still normative) and a new Annex C (Uncertainty at operating conditions, informative);

d) removed former clause C.3.4 on Interferometric method since this method is no longer supported in IEC 60793-1-42;

e) removed Annex D and other references in text to calibration compensation to align with other calibration documents;

f) removed Annex E and other references in text to use of air wavelength since it is not used in the fibre domain.

The text of this International Standard is based on the following documents:

Draft	Report on voting
86/XX/FDIS	86/XX/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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 D and IEC 60793-1-42.

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 D 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 abscissa (x-axis) and dispersion or time delay as the ordinate (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 dipersion wavelength.

Calibration can only be carried out using these artefacts; the use of a known standard fibre (reference fibre described in c)) whose chromatic dispersion is known is recommended as 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 by more than the repeatability), then adjustment may be carried out depending on the need.

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

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 applications 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) evaluating the level of performance of the instrument.

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 62129-1, *Calibration of optical spectrum analyzers*

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60050-731 and the following apply.

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

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

3.1
accredited calibration laboratory
calibration laboratory authorized by the appropriate national standards laboratory to issue calibration certificates with a minimum specified uncertainty that demonstrate traceability to national standards

3.2
adjustment
set of operations carried out on an instrument in order that it provides given indications corresponding to given values of the measurand

3.3
artefact
device, instrument, or equipment used in the process of calibrating a CD test set for wavelength, delay, or chromatic dispersion

3.4
calibration
set of operations that establish, under specified conditions, the relationship between the values of quantities indicated by a measuring instrument and the corresponding values realized by measurement standards

Note 1 to entry: The result of a calibration permits either the assignment of values of measurands to the indications or the determination of corrections with respect to indications.

Note 2 to entry: A calibration may also determine other metrological properties such as the effect of influence quantities.

Note 3 to entry: The result of a calibration may be recorded in a document, sometimes called a calibration certificate or a calibration report.

Note 4 to entry: See also ISO/IEC Guide 99:2007, 2.39.

3.5
traceability chain
unbroken chain of comparison using standards (see Figure 1)

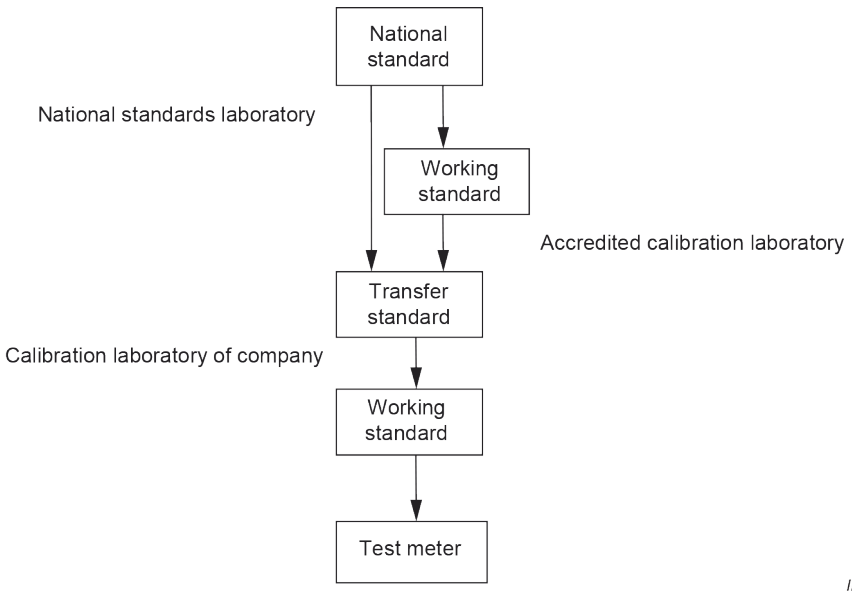

Figure 1 – Example of a traceability chain

3.6
centroidal wavelength
power-weighted mean wavelength of a light source in vacuum

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. However, it is usually sufficient to perform the integral or summation over the spectrum where the spectral density $p(\lambda)$ or power P_i is higher than 0,1 % of the maximum spectral density $p(\lambda)$ or power P_i.:

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

where

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

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

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

where

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

λ_c is the centroidal 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;

$P_{total} = \sum_i p_i$ 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 deviation

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 ps × nm^{-1} × km^{-1},
- lambda zero λ_0 in units of nm,
- zero dispersion slope S_0 in units of ps × nm^{-2} × km^{-1},