



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

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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

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TITLE:

Calibration of fibre optic chromatic dispersion test sets

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CONTENTS

1		
2		
3	FOREWORD	4
4	0 Introduction	6
5	0.1 Chromatic dispersion in optical fibres	6
6	0.2 Chromatic dispersion (CD) test sets	6
7	0.3 Overview of calibration procedures described in this standard	6
8	1 Scope	8
9	2 Normative references	8
10	3 Terms and definitions	8
11	4 Calibration	12
12	4.1 General	12
13	4.2 Preparation for calibration	12
14	4.2.1 General advice and organization	12
15	4.2.2 Environmental conditions requirements	12
16	4.2.3 Measurement equipment requirements	12
17	4.2.4 Traceability	13
18	4.3 Calibration procedure	13
19	5 Wavelength and delay calibration procedure	13
20	5.1 Wavelength calibration procedure	13
21	5.1.1 General	13
22	5.1.2 Discrete sources	14
23	5.1.3 Tuneable sources	14
24	5.1.4 Uncertainties and reporting	16
25	5.2 Delay [dispersion] calibration procedure	17
26	5.2.1 General	17
27	5.2.2 Equipment and preparation	17
28	5.2.3 Calibration procedure	19
29	5.2.4 Uncertainties and reporting	20
30	6 Calibration using a reference fibre	20
31	6.1 General	20
32	6.2 Equipment and preparation	20
33	6.3 Procedure	20
34	6.4 Uncertainties and reporting	21
35	7 Documentation	21
36	7.1 Calibration certificate contents	21
37	Annex A (normative) Mathematical basis for measurement uncertainty calculations	23
38	A.1 General	23
39	A.2 Deviations	23
40	A.3 Uncertainties type A	23
41	A.4 Uncertainties type B	24
42	A.5 Determining the combined standard uncertainty	25
43	A.6 Reporting	26
44	Annex B (normative) Calibration uncertainty	27
45	B.1 Introduction	27
46	B.2 Wavelength and delay calibration uncertainties	27

47	B.2.1	Wavelength uncertainties.....	27
48	B.2.2	Optical delay calibration uncertainty	27
49	B.2.3	Effect of dispersion modelling	27
50	B.3	Uncertainty of a calibration using a reference fibre.....	28
51	Annex C (informative)	Uncertainty at operating conditions	29
52	C.1	Introduction.....	29
53	C.2	Fibre related uncertainties	29
54	C.2.1	Axial fibre strain.....	29
55	C.2.2	Fibre temperature	29
56	C.2.3	Second order modes.....	29
57	C.2.4	OH ⁻ absorption	30
58	C.2.5	Total fibre loss.....	30
59	C.2.6	Optical reflections.....	30
60	Annex D (informative)	Chromatic dispersion.....	31
61	D.1	Chromatic dispersion in fibres	31
62	D.2	Description of chromatic dispersion test sets.....	31
63	D.3	Measurement techniques	32
64	D.3.1	Pulse delay method	32
65	D.3.2	Phase shift method.....	32
66	D.3.3	Differential phase shift method	33
67	D.4	Fibre chromatic dispersion specifications	33
68	Bibliography.....		34
69			
70	Figure 1 – Example of a traceability chain.....		9
71	Figure 2 – Typical optical delay line artefact for CD test set delay calibration.....		18
72	Figure 3 – Typical differential delay [dispersion] simulator for CD test set calibration.....		19
73	Figure 4 – Reference fibre comparison		21
74	Figure A.1 – Deviation and uncertainty type B and how to replace both by an		
75	appropriately larger uncertainty.....		24
76	Figure D.1 – Schematic diagram of a CD test set.....		32
77			
78			
79			

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

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FOREWORD

- 88 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising
89 all national electrotechnical committees (IEC National Committees). The object of IEC is to promote
90 international co-operation on all questions concerning standardization in the electrical and electronic fields. To
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121 patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

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

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

- 128 a) updated terms and definitions;
- 129 b) the use of a reference fibre standard for calibration is now allowed and at the same level
130 as the other calibration method;
- 131 c) Annex B was split into a new Annex B (on Calibration uncertainty, still normative) and a
132 new Annex C (Uncertainty at operating conditions, informative);
- 133 d) removed former clause C.3.4 on Interferometric method since this method is no longer
134 supported in IEC 60793-1-42;

- 135 e) removed Annex D and other references in text to calibration compensation to align with
 136 other calibration documents;
- 137 f) removed Annex E and other references in text to use of air wavelength since it is not used
 138 in the fibre domain.

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

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

140
 141 Full information on the voting for its approval can be found in the report on voting indicated in
 142 the above table.

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

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

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

- 151 • reconfirmed,
- 152 • withdrawn,
- 153 • replaced by a revised edition, or
- 154 • amended.

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156 0 Introduction

157 0.1 Chromatic dispersion in optical fibres

158 Chromatic dispersion is the variation with optical light wavelength of the light propagation
159 delay time in a length of fibre. This variation can cause bandwidth limitation in the fibre when
160 used to transmit communication signals. For a more detailed explanation, refer to Annex D
161 and IEC 60793-1-42.

162 0.2 Chromatic dispersion (CD) test sets

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

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

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

178 0.3 Overview of calibration procedures described in this standard

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

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

184 Primarily the artefacts or standards used are as follows:

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

196 Calibration can only be carried out using these artefacts; the use of a known standard fibre
197 (reference fibre described in c)) whose chromatic dispersion is known is recommended as the
198 fibre forms a stable source of known dispersion and may be used as a simple dispersion
199 artefact.

200 If it is found that the CD test set measurement results have changed significantly compared to
201 the user requirements (i.e. the test set has drifted by more than the repeatability), then
202 adjustment may be carried out depending on the need.

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

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CALIBRATION OF FIBRE OPTIC CHROMATIC DISPERSION TEST SETS

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1 Scope

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

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

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

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

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

224 a) calibrating CD test sets;

225 b) evaluating the level of performance of the instrument.

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

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2 Normative references

229 The following documents are referred to in the text in such a way that some or all of their
230 content constitutes requirements of this document. For dated references, only the edition cited
231 applies. For undated references, the latest edition of the referenced document (including any
232 amendments) applies.

233 IEC 60050-731, *International Electrotechnical Vocabulary (IEV) – Chapter 731: Optical fibre*
234 *communication*

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

3 Terms and definitions

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

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

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

243 **3.1**
 244 **accredited calibration laboratory**
 245 calibration laboratory authorized by the appropriate national standards laboratory to issue
 246 calibration certificates with a minimum specified uncertainty that demonstrate traceability to
 247 national standards

248 **3.2**
 249 **adjustment**
 250 set of operations carried out on an instrument in order that it provides given indications
 251 corresponding to given values of the measurand

252 **3.3**
 253 **artefact**
 254 device, instrument, or equipment used in the process of calibrating a CD test set for
 255 wavelength, delay, or chromatic dispersion

256 **3.4**
 257 **calibration**
 258 set of operations that establish, under specified conditions, the relationship between the
 259 values of quantities indicated by a measuring instrument and the corresponding values
 260 realized by measurement standards

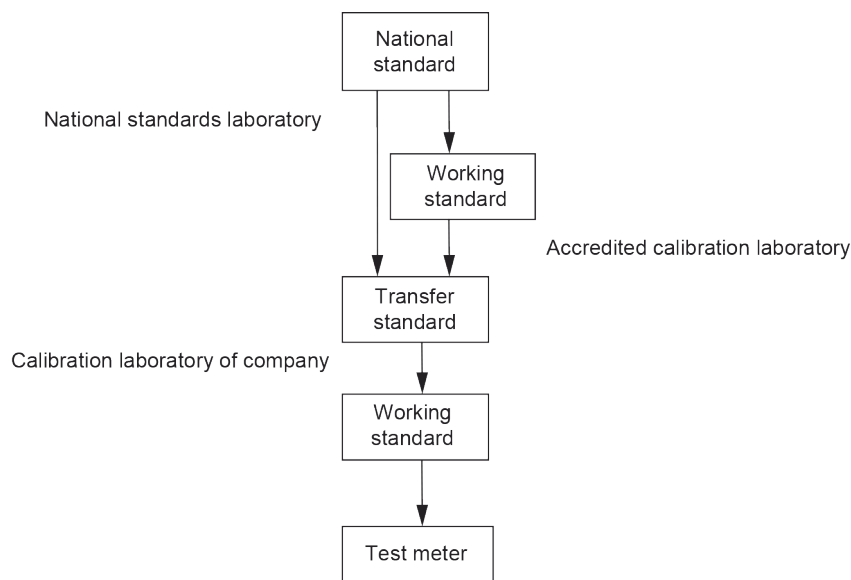
261 Note 1 to entry: The result of a calibration permits either the assignment of values of measurands to the
 262 indications or the determination of corrections with respect to indications.

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

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

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

268 **3.5**
 269 **traceability chain**
 270 unbroken chain of comparison using standards (see Figure 1)



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Figure 1 – Example of a traceability chain

273 **3.6**
 274 **centroidal wavelength**
 275 power-weighted mean wavelength of a light source in vacuum

276 Note 1 to entry: For a continuous source spectrum, the centroidal wavelength λ_C in vacuum is defined by the
 277 following integral, where the integration limits enclose the entire spectrum of the source. However, it is usually
 278 sufficient to perform the integral or summation over the spectrum where the spectral density $p(\lambda)$ or power P_i is
 279 higher than 0,1 % of the maximum spectral density $p(\lambda)$ or power P_i :

$$280 \quad \lambda_C = (1/P_{\text{total}}) \times \left[\int p(\lambda) \times \lambda \, d\lambda \right] \quad (1)$$

281 where

282 $P_{\text{total}} = \int p(\lambda) \, d\lambda$ is the total optical source power.

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

$$284 \quad \lambda_C = (1/P_{\text{total}}) \times \left[\sum_i p_i \lambda_i \right] \quad (2)$$

285 where

286 $p(\lambda)$ is the spectral power spectral density of the source in W/nm;

287 λ_C is the centroidal wavelength in vacuum in nanometers;

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

289 p_i is the power levels at λ_i in W;

290 $P_{\text{total}} = \sum_i p_i$ is the total power in W.

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291 **3.7**
 292 **chromatic dispersion (CD) test sets**
 293 instrument capable of measuring the chromatic dispersion of a single mode fibre at various
 294 wavelengths in the transmission windows of interest, typically the 1 310 nm and/or 1 550 nm
 295 wavebands

296 **3.8**
 297 **correction offset**
 298 **CO**

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

301 **3.9**
 302 **instrument state**
 303 complete description of the measurement conditions and state of the CD test set during the
 304 calibration process

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

307 **3.10**
 308 **measurement result**
 309 displayed or electrical output of any CD test set, in

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