



**SLOVENSKI STANDARD**  
**oSIST prEN IEC 60793-1-44:2022**  
**01-september-2022**

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**Optična vlakna - 1-44. del: Merilne metode in postopki preskušanja - Mejna valovna dolžina**

Optical fibres - Part 1-44: Measurement methods and test procedures - Cut-off wavelength

Lichtwellenleiter - Messmethoden und Prüfverfahren - Teil 1-44: Grenzwellenlänge

Fibres optiques - Partie 1-44: Méthodes de mesure et procédures d'essai - Longueur d'onde de coupure

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TITLE:

**Optical fibres - Part 1-44: Measurement methods and test procedures - Cut-off wavelength**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## OPTICAL FIBRES –

**Part 1-44: Measurement methods and test procedures –  
Cut-off wavelength**

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International Standard IEC 60793-1-44 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 2011. This edition constitutes a technical revision. The modifications are listed below.

- a) Used the diameter of the fibre loops to describe deployment
- b) Added annex D, Cut-off curve Artifacts
- c) Reorganized information and added more figures to clarify concepts.

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

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

140 A list of all parts of the IEC 60793-1-4x series, published under the general title *Optical fibres*  
141 – *Measurement methods and test procedures*, can be found on the IEC website

142 The committee has decided that the contents of this publication will remain unchanged until the  
143 stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to  
144 the specific publication. At this date, the publication will be

- 145 • reconfirmed,
- 146 • withdrawn,
- 147 • replaced by a revised edition, or
- 148 • amended.

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

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## OPTICAL FIBRES –

### Part 1-44: Measurement methods and test procedures – Cut-off wavelength

#### 166 1 Scope

157 This part of IEC 60793 establishes uniform requirements for measuring the cut-off wavelength  
158 of single-mode optical fibre, thereby assisting in the inspection of fibres and cables for  
159 commercial purposes.

160 This standard gives methods for measuring the cut-off wavelength for uncabled or cabled single  
161 mode telecom fibre. These procedures apply to all category B and C fibre types (see Normative  
162 references).

163 There are three methods of deployment for measuring the cut-off wavelength.

- 164 • Method A: Cable cut-off using uncabled fibre 22 m long sample,  $\lambda_{cc}$
- 165 • Method B: Cable cut-off using cabled fibre 22 m long sample,  $\lambda_{cc}$
- 166 • Method C: Fibre cut-off using uncabled fibre 2 m long sample,  $\lambda_c$

167 All methods require a reference measurement. There are two reference-scan techniques, either  
168 or both of which may be used with all methods:

- 169 • bend-reference technique.
- 170 • multimode-reference technique using category A1 multimode fibre.

#### 171 2 Normative references

172 The following referenced documents are indispensable for the application of this document. For  
173 dated references, only the edition cited applies. For undated references, the latest edition of  
174 the referenced document (including any amendments) applies.

175 IEC 60793-1-1, *Optical fibres – Part 1-1: Measurement methods and test procedures – General*  
176 *and guidance*

177 IEC 60793-1-40, *Optical fibres – Part 1-40: Measurement methods and test procedures –*  
178 *Attenuation*

#### 179 3 Background

180 Theoretical cut-off wavelength is the shortest wavelength at which only the fundamental mode  
181 can propagate in a single-mode fibre, as computed from the refractive index profile of the fibre.

182 In optical fibres, the change from multimode to single mode behaviour does not occur at an  
183 isolated wavelength, but rather smoothly over a range of wavelengths. For purposes of  
184 determining fibre performance in a telecommunications network, theoretical cut-off wavelength  
185 is less useful than the lower value actually measured when the fibre is deployed.

186 Measured cut-off wavelength is defined as the wavelength greater than which the ratio between  
187 the total power, including launched higher-order modes, and the fundamental mode power has  
188 decreased to less than 0,1 dB. According to this definition, the second-order (LP<sub>11</sub>) mode



189 undergoes 19,3 dB more attenuation than the fundamental ( $LP_{01}$ ) mode at the cut-off  
190 wavelength.

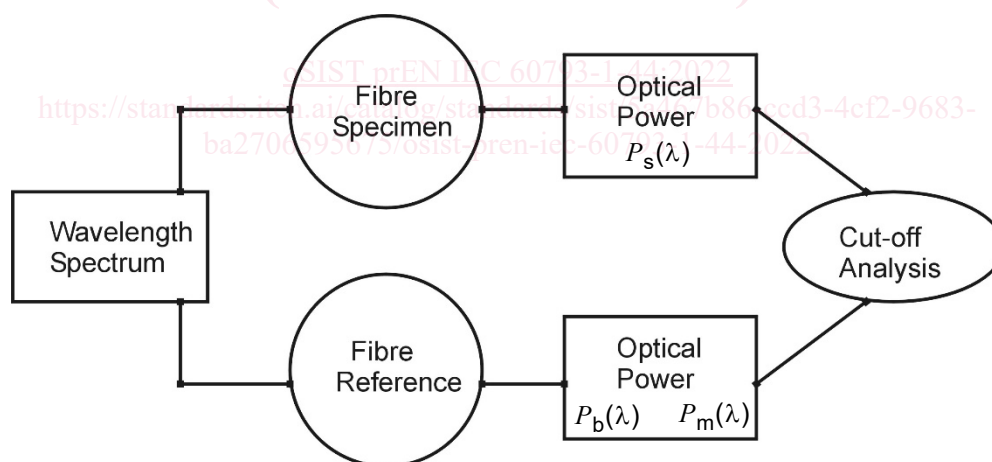
191 Because measured cut-off wavelength depends on the length and bends of the fibre, the  
192 resulting value of cut-off wavelength depends on whether the measured fibre is configured in a  
193 deployed, cabled condition or if it is short and uncabled. Consequently, there are two overall  
194 types of cut-off wavelength:

- 195 • Cable cut-off wavelength ( $\lambda_{cc}$ ) measured in an uncabled fibre deployment condition  
196 (method A), or in a cabled condition (method B).
- 197 • Fibre cut-off wavelength ( $\lambda_c$ ) measured on a short length of uncabled, primary-coated  
198 fibre (method C).

199 Cable cut-off wavelength is the preferred attribute to be specified and measured.

## 200 4 Overview of methods

201 All of the methods shall use the transmitted-power technique. A general system block diagram  
202 is depicted in figure 1. A fibre specimen is scanned by a wavelength spectrum. The output  
203 optical power is measured and stored. This stored data is then analysed against a reference  
204 power spectrum. The reference scan normalizes any wavelength-dependent fluctuations in the  
205 measurement equipment that is not associated with the loss of the  $LP_{11}$  mode. The resulting  
206 attenuation will thus properly characterize the cut-off wavelength.



207

208

209 **Figure 1 - Cut-off measurement system block diagram**

210

211 The reference scan uses one of the following two techniques:

- 212 • Bend reference where a small diameter bend is added to the fibre specimen.
- 213 • Multimode reference where the optical power through an A1 fibre is measured.

214 Either reference technique can determine the cut-off wavelength of a fibre specimen in a cabled  
215 or uncabled condition.

216 The fibre cut-off wavelength,  $\lambda_c$ , measured under the standard length and bend conditions  
217 described in this standard, will generally exhibit a value larger than the cable cut-off wavelength,

218  $\lambda_{cc}$ . For normal installed cable spans, it is common for the measured  $\lambda_c$  value to exceed the  
219 long fibre's transmission wavelength.

220 Cable cut-off wavelength is more useful in describing an installed network system performance  
221 and capability, while fibre cut-off would apply to short cables or pigtails. The two cut-off  
222 wavelengths can be mapped to each other for a specific fibre type and cut-off measurement  
223 method. The customer and the supplier shall agree to the confidence level of each mapping  
224 function established, see section 10 for details.

## 225 5 Reference test method

226 Method A, cable cut-off wavelength using uncabled fibre, is the reference test method (RTM).  
227 This method shall be used to settle any disputes.

## 228 6 Apparatus

### 229 6.1 Light source

230 Provide a filtered white light source, with line width not greater than 10 nm, stable in position  
231 and intensity. The light source should be capable of operating over the wavelength range 1000  
232 nm to 1600 nm for most category B fibres. An operating range of 800 nm to 1700 nm may be  
233 necessary for some B-655 fibres, B-656 fibres or category C fibres. A scanning monochromator  
234 with a halogen bulb is one example of this kind of source.

### 235 6.2 Modulation

236 Modulate the light source to prevent ambient light affecting the results, and to aid signal  
237 recovery. A mechanical chopper with a reference output is a suitable arrangement.

### 238 6.3 Launch optics

239 Provide launch optics, such as a lens system or a multimode fibre, to overfill the test fibre over  
240 the full range of measurement wavelengths. This launch is relatively insensitive to the input end  
241 face position of the single-mode fibre and is able to excite the fundamental and any higher-  
242 order modes in the specimen. If using a butt splice, provide means of avoiding interference  
243 effects.

244 When using a multimode fibre, overfilling the reference fibre can produce an undesired ripple  
245 effect in the power-transmission spectrum. Restrict the launch sufficiently to eliminate the ripple  
246 effect. One example of restricted launch is in method A, attenuation by cut-back of IEC 60793-  
247 1-40. Another example of restricted launch is a mandrel-wrap mode filter with sufficient  
248 (approximately 4 dB) insertion loss.

### 249 6.4 Support and positioning apparatus

250 Provide a means to stably support the input and output ends of the specimen for the duration  
251 of the test; vacuum chucks, magnetic chucks, or connectors may be used for this purpose.  
252 Support the fibre ends such that they can be repeatedly positioned in the launch and detection  
253 optics. When measuring  $\lambda_{cc}$  in method B, provide a means to suitably support the cable ends.  
254 The mechanism used to hold the fibre ends allows for fibre positioning with respect to the launch  
255 and detection optics. Holding and moving of the fibre should not cause micro-bends that affect  
256 the measurement accuracy.

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## 259 6.5 Deployment mandrel

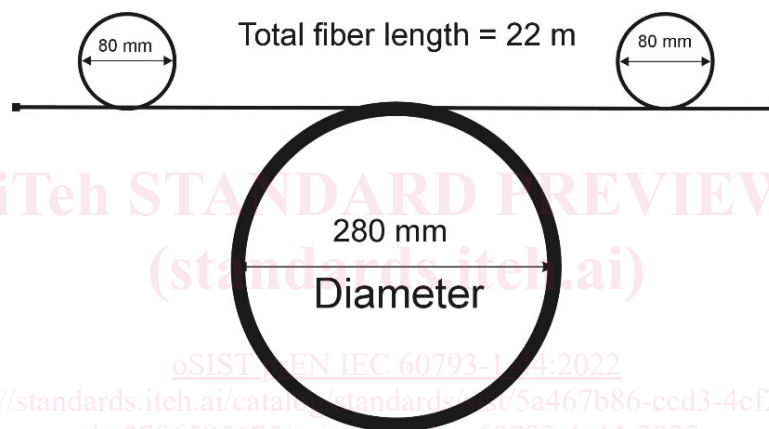
### 260 6.5.1 General

261 The fibre specimen's two ends, input and output, are mechanically held in place during the  
262 measurement. The deployment and length of the specimen, together with the support  
263 apparatus, are key elements of the measurement method, and they distinguish the types of cut-  
264 off wavelength.

265 Additional, alternative deployments may be used if the results obtained have been  
266 demonstrated to be empirically equivalent to the results obtained using the standard  
267 deployment, to within 10 nm, or they are greater than those achieved with the standard  
268 configurations.

### 269 6.5.2 Cable cut-off wavelength deployment, Method A

270 Provide a means to make an 80 mm diameter loop at each end of the specimen and a loop of  
271 diameter  $\geq 280$  mm in the central portion. See Figure 2.



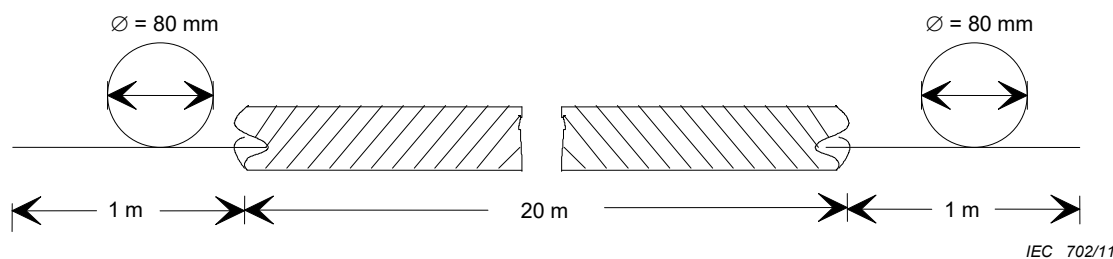
272

273 **Figure 2 – Deployment configuration for cable cut-off wavelength  $\lambda_{cc}$ , method A**

274

### 275 6.5.3 Cable cut-off wavelength deployment, Method B

276 Provide a means to make an 80 mm diameter loop at each end of the specimen.  
277 See Figure 3. The cabled fibre between the two 80 mm loops has a bending diameter  
278 than 280 mm.



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280 **Figure 3 – Deployment configuration for cable cut-off wavelength  $\lambda_{cc}$ , method B**

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