SLOVENSKI STANDARD
oSIST prEN IEC 60793-1-44:2022

01-september-2022

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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COMMITTEE DRAFT FOR VOTE (CDV)

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IEC SC 86A : FIBRES AND CABLES	
SECRETARIAT: France	SECRETARY: Mr Laurent Gasca
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	
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TITLE:

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

PROPOSED STABILITY DATE: 2027

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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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.

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

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

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- withdrawn,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

OPTICAL FIBRES –

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

1 Scope

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

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

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

- Method A: Cable cut-off using uncabled fibre 22 m long sample, λ_{cc}
- Method B: Cable cut-off using cabled fibre 22 m long sample, λ_{cc}
- Method C: Fibre cut-off using uncabled fibre 2 m long sample, λ_{c}

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

- bend-reference technique.
- multimode-reference technique using category A1 multimode fibre.

2 Normative references

The following referenced documents are indispensable for the application 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 60793-1-1, *Optical fibres – Part 1-1: Measurement methods and test procedures – General and guidance*

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

3 Background

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

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

Measured cut-off wavelength is defined as the wavelength greater than which the ratio between the total power, including launched higher-order modes, and the fundamental mode power has decreased to less than 0,1 dB. According to this definition, the second-order (LP_{11}) mode

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

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

- Cable cut-off wavelength (λ_{cc}) measured in an uncabled fibre deployment condition (method A), or in a cabled condition (method B).
- Fibre cut-off wavelength (λ_c) measured on a short length of uncabled, primary-coated fibre (method C).

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

4 Overview of methods

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

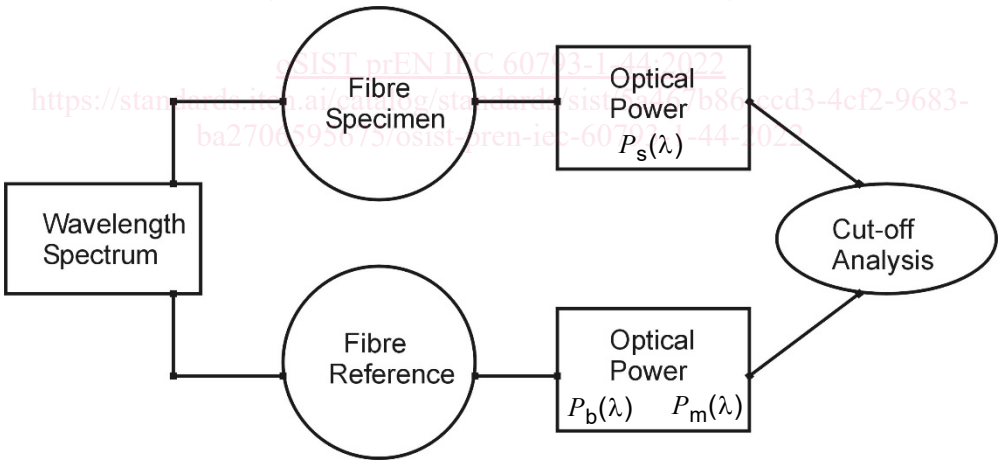

Figure 1 - Cut-off measurement system block diagram

The reference scan uses one of the following two techniques:

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

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

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

λ_{cc}. For normal installed cable spans, it is common for the measured λ_c value to exceed the long fibre's transmission wavelength.

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

5 Reference test method

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

6 Apparatus

6.1 Light source

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

6.2 Modulation

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

6.3 Launch optics

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

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

6.4 Support and positioning apparatus

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

6.5 Deployment mandrel

6.5.1 General

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

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

6.5.2 Cable cut-off wavelength deployment, Method A

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

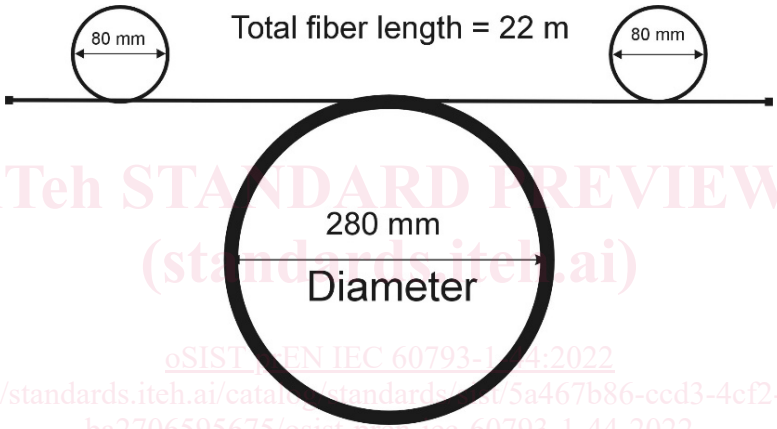

Figure 2 – Deployment configuration for cable cut-off wavelength λ_{cc}, method A

6.5.3 Cable cut-off wavelength deployment, Method B

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

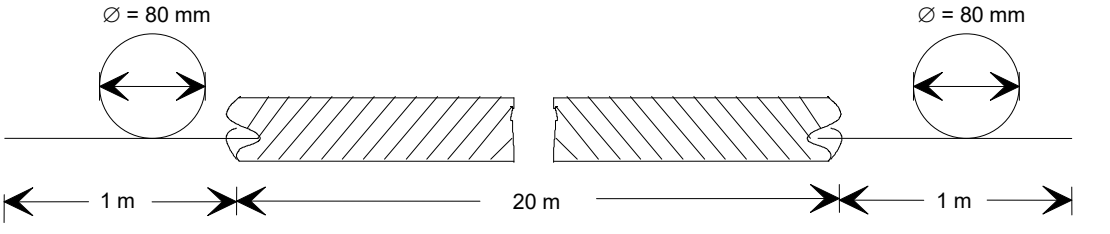

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Figure 3 – Deployment configuration for cable cut-off wavelength λ_{cc}, method B