IEC 60794-1-201

Edition 1.0 2024-05

INTERNATIONAL STANDARD

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Optical fibre cables – Part 1-201: Generic specification – Basic optical cable test procedures – Environmental test methods – Temperature cycling, method F1

Câbles à fibres optiques – Partie 1-201: Spécification générique – Procédures fondamentales d'essai des câbles optiques – Méthodes d'essai d'environnement – Cycles de température, méthode F1

IEC 60794-1-201:2024-05(en-fr)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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FOREWORD

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IEC 60794-1-201 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This document partially replaces IEC 60794-1-22:2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 60794-1-22:2017:

a) all references to the temperature sensing device have been removed and replaced with a note "for further study";

b) the conditioning procedure has been separated into Procedure 1 and Procedure 2 to avoid confusion;

c) the ambient temperature test condition has been defined as per IEC 60794-1-2;

d) the minimum soak time has been decreased for sample mass >16 kg in Table 1.

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

Draft	Report on voting
86A/2438/FDIS	86A/2463/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/publications.

A list of all parts in the IEC 60794 series, published under the general title *Optical fibre cables*, can be found on the IEC website.

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, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This document cancels and replaces method F1 of IEC 60794-1-22:2017, which will be withdrawn. It includes an editorial revision, based on the new structure and numbering system for optical fibre cable test methods. Additionally, technical changes were implemented. The environmental tests contained in IEC 60794-1-22:2017 will be individually numbered in the IEC 60794-1-2xx series. Each test method is now considered to be an individual document rather than part of a multi-test method compendium. Full cross-reference details are given in IEC 60794-1-2.

The numbering of this test method continues the F-series numbering sequence of IEC 60794-1-22:2017.

OPTICAL FIBRE CABLES –

Part 1-201: Generic specification – Basic optical cable test procedures – Environmental test methods – Temperature cycling, method F1

1 Scope

This part of IEC 60794-1 defines test procedures to be used in establishing uniform requirements for the environmental performance of:

- optical fibre cables for use with telecommunication equipment and devices employing similar techniques; and
- cables having a combination of both optical fibres and electrical conductors.

Throughout this document, the wording "optical cable" can also include optical fibre units, microduct fibre units, etc.

This document defines a test standard to determine the ability of a cable to withstand the effects of temperature cycling by observing changes in attenuation.

See IEC 60794-1-2 for a reference guide to test methods of all types and for general requirements and definitions.

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 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures – General guidance*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

4 Method F1 – Temperature cycling

4.1 Object

This measuring method applies to optical fibre cables, which are tested by temperature cycling in order to determine the stability behaviour of the attenuation of cables submitted to temperature changes. This method can also be used for evaluation of buffer tubes or other elements independent of a cable construction, as defined by a detail specification.

Changes in the attenuation of optical fibre cables, which can occur with changing temperature, are generally the result of buckling or tensioning of the fibres resulting from differences between their thermal expansion coefficient and the coefficients of the cable strength and sheath members. Test conditions for temperature-dependent measurements shall simulate the worst conditions.

This test can be used either for monitoring cable behaviour in the temperature range, which can occur during storage, transportation and usage, or to check, in a selected temperature range (usually wider than that required for the above-mentioned cases), the stability behaviour of the attenuation connected to a substantially microbend-free situation of the fibre within the cable structure.

NOTE 1 Method F12 in IEC 60794-1-212 is similar to this method, but with cable elements fixed at both sample ends. Method F12 assesses the attenuation behaviour of a cable without end movement intended for termination with, for example, interconnecting devices or passive components.

NOTE 2 The ageing test, method F9 in IEC 60794-1-209, uses method F1 as its pre- and post-test temperature cycle. Often these tests are performed together.

NOTE 3 The cable shrinkage (fibre protrusion) test, method F17, is similar to this method, but it determines the permanent fibre protrusion compared to the cable elements and the cable sheath due to thermal exposure of a cable.

4.2 Sample

The sample shall be of length appropriate to achieve the desired accuracy of attenuation measurements (generally ≥500 m). This may be a factory length, or a sample of sufficient length as indicated in the detail specification. The sample is additionally defined as the cable sample as deployed for testing.

In order to gain reproducible values, the cable sample shall be brought into the climatic chamber in a manner such that the deployment does not affect the measurement. Such methods could be a loose coil or on a reel with large diameter coils, cushioned reels with a soft layer or a zero-tension facility device.

The ability of the fibre(s) to accommodate differential expansion and contraction (e.g. by slipping within the cable) could be influenced by the bending radius of the cable. Sample conditioning should, therefore, be realized as close as possible to normal usage conditions. The bend diameter of the cable sample shall not violate the minimum bend diameter of the cable, tube or other unit as specified by the detail specification (generally around 20X cable OD).

Potential problems are due to an actual difference between the expansion coefficients of the test sample and of the holder (e.g. reel, basket, plate) which can induce, during thermal cycles, a significant effect on the test result if "no effect" conditions are not completely fulfilled. The intent is to simulate the installed condition, in which the cable is generally straight for the majority of its length.

Parameters of influence are mainly the details of conditioning, the type and materials of the holder, and the diameter of the sample coil or reel.

General recommendations include the following:

a) The winding diameter shall be large enough to keep the ability of the fibre to accommodate differential expansion and contraction. A winding diameter substantially greater than the value selected for cable delivery can be necessary.

b) Any risk of cable expansion (or contraction) limitation created by conditioning shall be suppressed. In particular, special care should be taken to avoid residual tension on the cable during the test. For example, a tight winding on a drum is not recommended as it can limit cable contraction at low temperature. On the other hand, a tight multilayer winding can limit expansion at high temperature.

c) The use of loose winding is recommended with large diameter coils and cushioned reels with a soft layer or zero tension facility device.

d) The number of fibres tested shall conform to IEC 60794-1-1.

e) The fixed cable ends as well as connection to the equipment shall be outside of the temperature chamber to avoid negative influences.

In order to limit the length of the cable under test, it is permissible to concatenate several fibres of the cable and to measure the concatenated fibres. The number of connections shall be limited, and they should be located outside the climatic chamber.

4.3 Apparatus

The apparatus shall consist of the following.

a) An appropriate attenuation measuring apparatus for the determination of attenuation change (see the test methods of IEC 60793-1-46).

b) a climatic chamber of a suitable size to accommodate the sample whose temperature shall be controllable to remain within ±3 °C of the specified testing temperature. One example of a suitable chamber is given in Clause 8 of IEC 60068-2-14:2023.

4.4 Procedure

4.4.1 Preconditioning

The sample shall be preconditioned at standard ambient temperature conditions as defined in IEC 60794-1-2.

4.4.2 Initial measurement

The sample shall be visually inspected and a basic value for attenuation at the initial temperature shall be determined.

4.4.3 Conditioning

Procedure 1

If only one high and low temperature is specified in the detail specification, then Procedure 1 is applicable. Figure 1 shall be used for the initial cycle(s) and the final cycle during the test. Throughout this procedure, the ambient temperature condition is the standard test condition as defined in IEC 60794-1-2.

1) The sample at ambient temperature shall be introduced into the climatic chamber which is also at that temperature.

2) The temperature in the chamber shall then be lowered to the appropriate low temperature T_{A2} at a rate of cooling not to exceed 60 °C per hour, unless otherwise specified.

3) After the temperature within the chamber has stabilized, the sample shall soak at temperature T_{A2} for the appropriate period t_1 (see step 4)).

4) A minimum soak time is given in Table 1; however, the soak time, t_1, shall be sufficient to bring the complete cable to equilibrium with the specified temperature.

NOTE 1 Cable temperature sensing device to measure the temperature of the cable sample is for further study.

5) The temperature in the chamber shall then be raised to the appropriate high temperature T_{B2} at a rate of heating not to exceed 60 °C per hour, unless otherwise specified.

6) After the temperature within the chamber has stabilized, the sample shall soak at temperature T_{B2} for the appropriate period t_1.

7) The temperature in the chamber shall then be lowered to the value of the ambient temperature at the appropriate rate of cooling. This procedure constitutes one cycle. If this is the intermediate step in a series of cycles, no soak is required, and no measurements shall be taken.

8) Continue to the next cycles, using steps 2) through 7). The sample shall be subjected to at least two cycles unless otherwise required by the relevant detail specification. At the end of the cycling sequence, hold the sample at ambient temperature for the appropriate period t_1.

9) The change in attenuation shall be measured at ambient temperature at the start of the first cycle, at the end of the soak time t_1 at each of the specified temperature steps (T_{A2}, T_{B2}) in the final cycle, and at ambient temperature at the end of the final cycle. If measurement at intermediate cycles is required by the detail specification, the measurements shall be performed in the same manner.

10) Before removal from the chamber, the sample under test shall have reached temperature stability at ambient temperature.

Procedure 2

If multiple (two or more) low or high temperatures are specified in the detail specification, then Procedure 2 is applicable. Figure 1 shall be used for the initial cycle(s) except for the final cycle and Figure 2 shall be used for the final cycle during the test. Throughout this procedure, the ambient temperature condition is the standard test condition as defined in IEC 60794-1-2.

1) The sample at ambient temperature shall be introduced into the climatic chamber which is also at that temperature.

2) Using steps 2) through 7) of Procedure 1 for the initial cycle(s) (except for the final cycle).

NOTE 2 T_{A2} here is the extreme low temperature among multiple low temperatures and T_{B2} here is the extreme high temperature among multiple high temperatures.

3) During the last cycle, the sample shall be held at each intermediate temperature (T_{A1} or T_{B1}) and each extreme temperature (T_{A2} or T_{B2}) for the appropriate time t_1, as per Figure 2. At the end of the cycling sequence, hold the sample at ambient temperature for the appropriate period t_1.

4) The sample shall be subjected to at least totally two cycles (one initial cycle and one final cycle) unless otherwise required by the relevant detail specification. The change in attenuation shall be measured at ambient temperature at the start of the first cycle, at the end of the soak time t_1 at each of the specified temperature steps (T_{A1}, T_{A2}, T_{B1}, T_{B2}) in the final cycle, and at ambient temperature at the end of the final cycle. If measurement at intermediate cycles is required by the detail specification, the measurements shall be performed in the same manner.

5) Before removal from the chamber, the sample under test shall have reached temperature stability at ambient temperature.