IEC 60794-1-22

Edition 2.0 2017-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Optical fibre cables –
Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods

Câbles à fibres optiques –
Partie 1-22: Spécification générique – Modes opératoires de base applicables aux essais des câbles optiques – Méthodes d'essais d'environnement

IEC 60794-1-22:2017-10(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 60794-1-22 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This bilingual version (2018-04) corresponds to the monolingual English version, published in 2017-10.

This second edition cancels and replaces the first edition published in 2012. It constitutes a technical revision.

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

a) new test method designation F16 – Compound flow (drip) [E14 in IEC 60794-1-21];
b) new test method F17 – Cable shrinkage test (fibre protrusion);

c) new test method F18 – Mid-span temperature cycling test.

NOTE Missing numbers in the test methods sequence are intentional. They can suggest a deleted test method or a test method that was never published.

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

FDIS	Report on voting
86A/1813/FDIS	86A/1827/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

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

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 "http://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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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

IEC 60794-1-2:2003 has been split into five new documents:

- IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures – General guidance*
- IEC 60794-1-21, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical tests methods*
- IEC 60794-1-22, *Optical fibre cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental tests methods*
- IEC 60794-1-23, *Optical fibre cables – Part 1-23: Generic specification – Basic optical cable test procedures – Cable elements tests methods*
- IEC 60794-1-24, *Optical fibre cables – Part 1-24: Generic specification – Basic optical cable test procedures – Electrical tests methods*

OPTICAL FIBRE CABLES –

Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods

1 Scope

This part of IEC 60794 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.

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 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60544-1, *Electrical insulating materials – Determination of the effects of ionizing radiation – Part 1: Radiation interaction and dosimetry*

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

IEC 60793-1-46, *Optical fibres – Part 1-46: Measurement methods and test procedures – Monitoring of changes in optical transmittance*

IEC 60793-1-54, *Optical fibres – Part 1-54: Measurement methods and test procedures – Gamma irradiation*

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

IEC 60811-503, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 503: Mechanical tests – Shrinkage test for sheaths*

ISO 4892-2, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 4892-3, *Plastics – Methods of exposure to laboratory light sources – Part 3: Fluorescent UV lamps*

3 Terms and definitions

No terms and definitions are listed in this document.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://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 case), the stability behaviour of the attenuation connected to a substantially microbend-free situation of the fibre within the cable structure.

NOTE 1 Method F12 is a specialized subset of this method, specifically addressing cables for use in patch cords.

NOTE 2 The ageing test, F9, uses method F1 as its pre- and post-test temperature cycle. Often these tests are done together.

NOTE 3 The cable shrinkage test, F17, uses method F1 as temperature cycling. These tests can be done together.

4.2 Sample

The sample shall be a factory length or a sample of sufficient length as indicated in the detail specification but, nevertheless, of length appropriate to achieve the desired accuracy of attenuation measurements. 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.

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.

When necessary, 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 60793-1-40 and 60793-1-46).

b) a climatic chamber of a suitable size to accommodate the sample and 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 60068-2-14:2009.

c) A temperature sensing device to measure the temperature of the sample, when applicable. Samples with a large thermal mass can require measurement to verify temperature stability rather than utilizing a specified exposure period, t_1 (see Table 1).

4.4 Procedure

4.4.1 Initial measurement

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

4.4.2 Pre-conditioning

Pre-conditioning conditions shall be agreed between customer and supplier.

4.4.3 Conditioning

Figure 1 and Figure 2 show graphically the initial cycle(s) and the final cycle. Together, they illustrate the temperature cycle sequence to be used. If only one high and low temperature is specified, use Figure 1; for cycles with multiple high and/or low temperature steps, use Figure 2.

NOTE The language of the conditioning procedure is written in reference to Figure 1, for clarity. If Figure 2, with multiple low and/or high temperatures, is used, the appropriate steps are repeated for each temperature. That is, steps (2) to (4) would be repeated for each additional low temperature and/or steps (5) to (7) would be repeated for each high temperature.

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 ºC per hour, unless otherwise specified.

   NOTE The initial cycles use the temperature extremes, T_{A2} and T_{B2}, regardless of whether the cycle Figure 1 or Figure 2 is being used.
3) After temperature stability in the chamber has been reached, the sample shall be exposed to the low temperature conditions for the appropriate period t_1 (see (4), below).
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.
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 ºC per hour, unless otherwise specified.
6) After temperature stability in the chamber has been reached, the sample shall be exposed to the high temperature conditions 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 (see Figure 1 or Figure 2). If this is the intermediate step in a series of cycles, no soak is required, but no measurements shall be taken.
8) Continue to the next cycle, using steps 2) through 7). The sample shall be subjected to at least two cycles unless otherwise required by the relevant detail specification. The initial cycle(s) shall comprise one low temperature and one high temperature, as per Figure 1. The final cycle shall comprise one low temperature and one high temperature, as per Figure 1, as required by the relevant detail specification. If multiple low or high temperature steps are required, the final cycle shall comprise two or more low temperatures and two or more high temperatures, as per Figure 2. On the last cycle, if multiple temperatures are specified, the sample shall be held at each intermediate temperature (T_{A1} or T_{B1}) for the appropriate time t_1. At the end of the cycling sequence, hold the sample at ambient temperature for the appropriate period t_1.
9) The 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.
10) Before removal from the chamber, the sample under test shall have reached temperature stability at ambient temperature.

Table 1 – Minimum soak time t_1

Minimum soak times for a given sample mass	
Sample mass kg	**Minimum soak time, t_1** h
Under 0,35	0,5
0,36 to 0,7	1
0,8 to 1,5	2
1,6 to 15	4
16 to 100	8
101 to 250	12
251 to 500	14
Over 501	16
NOTE It is the responsibility of the tester to assure that the soak time is long enough to bring the cable to equilibrium with the specified temperature.	

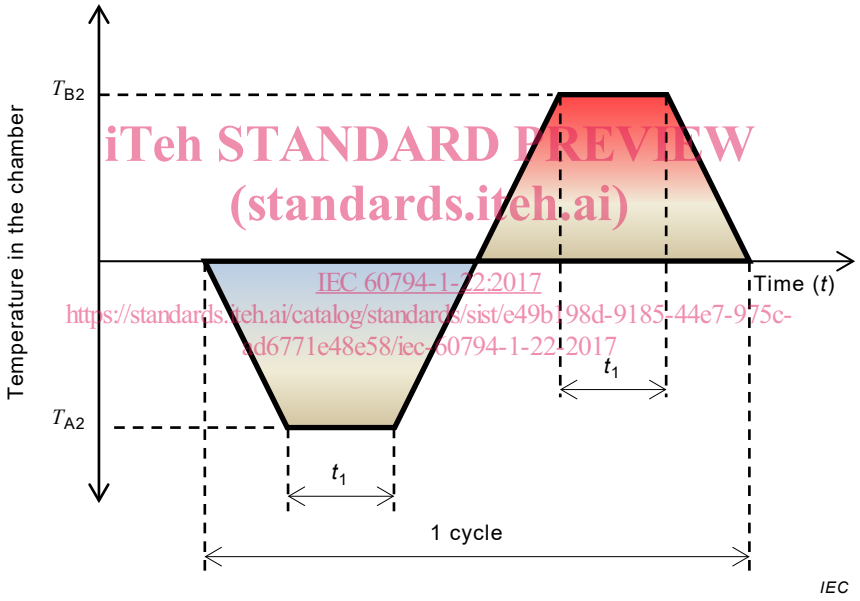

Figure 1 – Initial cycle(s) procedure

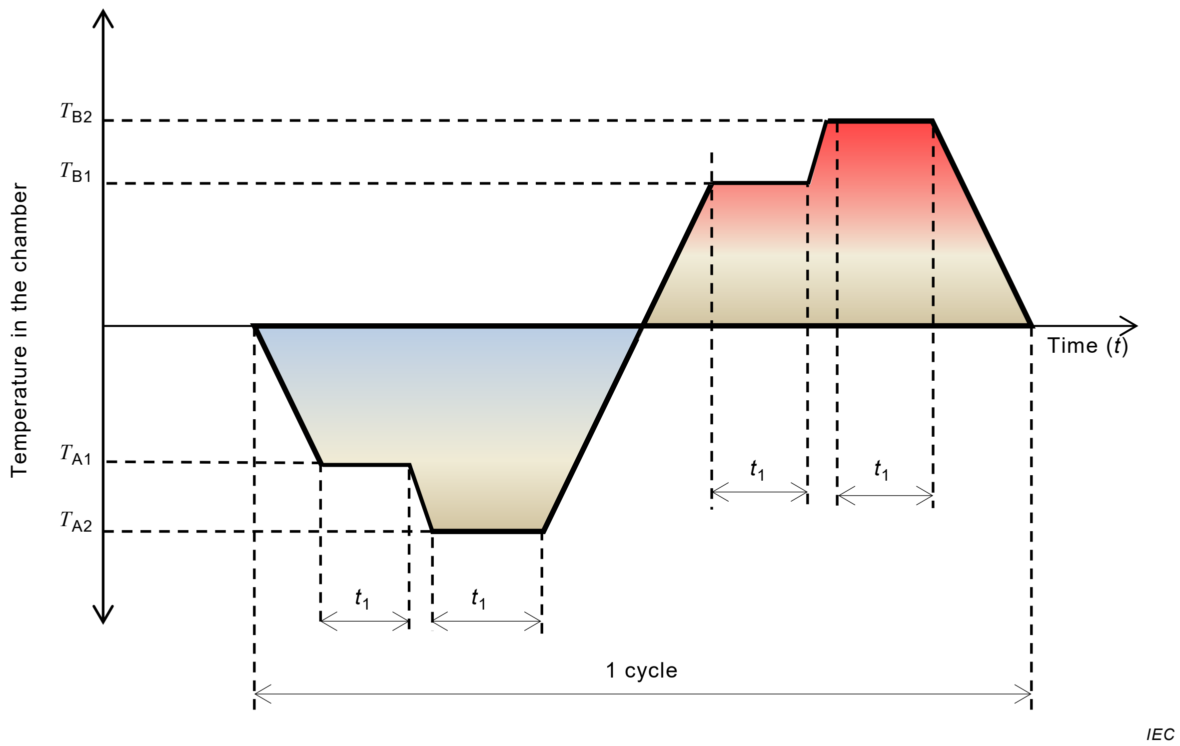

Figure 2 – Final cycle procedure

4.4.4 Recovery

If the ambient temperature is not the standard atmospheric condition to be used for testing after removal from the chamber, the sample shall be allowed to attain temperature stability at this latter condition.

The relevant detail specification can call for a specific recovery period for a given type of sample.

4.5 Requirements

The acceptance criteria for the test shall be as stated in the detail specification. Typical failure modes include loss of optical continuity, degradation of optical transmittance or physical damage to the cable. Unless otherwise specified, the change in attenuation shall be calculated with respect to the attenuation value attained at ambient conditions prior to the start of the temperature cycling test (4.4.1).

4.6 Details to be specified

The detail specification shall include the following:

a) cable sample length;

b) number of fibres tested if different from 4.2;

c) length of the fibre under test;

d) type of connection between concatenated fibres (optional);

e) temperature limits:

   i) T_{A2} and T_{B2} (Figure 1), or

   ii) T_{A1}, T_{A2}, T_{B1} and T_{B2} (Figure 2);

f) number of cycles;

g) humidity levels at each temperature extreme (if specified);