IEC 60794-1-217

Edition 1.0 2024-04

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

colour inside

## Optical fibre cables – Part 1-217: Generic specification – Basic optical cable test procedures – Environmental test methods – Cable shrinkage (fibre protrusion), Method F17

## Câbles à fibres optiques – Partie 1-217: Spécification générique – Procédures fondamentales d'essais des câbles optiques – Méthodes d'essais d'environnement – Rétraction de câble (excroissance de la fibre), méthode F17



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IEC 60794-1-217 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) added clarification in the objective that the purpose of this test procedure is to measure the permanent fibre protrusion of cables without rigid strength members;
b) replaced the reference to method F1 for the apparatus with a detailed description for the temperature chamber and temperature sensing device as done in IEC 60794-1-211;

c) added a measuring device in the subclause for apparatus;

d) added conditioning before cutting the cable sample as done in IEC 60794-1-211

e) added all required steps in the subclause for temperature cycling as well as the table for the minimum soak time and the figure for the cycle procedure, and removed the reference to IEC 60794-1-22, method F1;

f) improved the figures and added a figure for preparation of the cable sample;

g) added the informative Annex A for the test procedure recommended for cables with rigid strength members.

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

| Draft | Report on voting |
|---|---|
| 86A/2358/CDV | 86A/2405/RVC |

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.

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# INTRODUCTION

This document defines the test method F17 to measure the change of fibre protrusion at both cable ends caused by cable shrinkage due to thermal exposure.

The numbering of this test method continues the F-series numbering sequence of IEC 60794-1-22:2017. This document cancels and replaces method F17 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.

All cables have a memory effect in the form of coils, and are elastic depending on the applied force, making repeatable and reproducible measurements from one end to the other end on a longer cable sample (for example 10 m or longer) very difficult or impossible. Therefore, measurement of the fibre or cable element protrusion at both ends is a suitable and simple alternative.

The advantage of this method is that the change in protrusion length can be directly compared with the capability to accommodate this change of protrusion length in the application situation (for example in a fibre distribution box). The limitation of this method is that the absolute changes of the cable elements and sheath lengths cannot be determined.

The test method in this document determines the permanent fibre protrusion of cables without rigid strength members compared to the cable elements and cable sheath due to temperature changes. The reference for the fibre protrusion is in this case the end of the cable sheath.

The determination of the permanent fibre protrusion according to this test method is not applicable if the strongest rigid strength member, often the central strength member, is to serve as a reference. This is the case when the fixing of the rigid strength member is used in a protective housing and the fixing of the rigid strength member is stronger than the fixing of the cable sheath. For such an installation situation, the recommended test procedure is given in Annex A.

IEC TR 62959 describes the test method F17 that can be optionally used as an indicator for cables terminated with hardened connectors, terminated into passive components, fixed into a module, a divider or a protective housing with the fibres terminated with splices.

IEC TR 62959 provides information on cable shrinkage characterisation of optical fibre cables that consist of standard glass optical fibres for telecommunication applications. The characterisation is directed to the effects of cable shrinkage or cable element shrinkage on the termination of cables. Recommended test methods for the evaluation of cable shrinkage as an indicator and classification by several grades are given.

A test procedure other than method F17 to measure shrinkage effects exists. Method F11 according to IEC 60794-1-211 defines shrinkage testing on a cable sample with a nominal length of 1 m or less by calculation of the change in sheath length measured before and after thermal exposure.

# OPTICAL FIBRE CABLES –

# Part 1-217: Generic specification – Basic optical cable test procedures – Environmental test methods – Cable shrinkage (fibre protrusion), method F17

## 1 Scope

This part of the IEC 60794 series defines the test procedure to measure the permanent fibre protrusion compared to the cable elements and cable sheath due to thermal exposure of a cable.

## 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

For the purposes of this document, the terms and definitions given in IEC 60794-1-1 and the following apply.

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

**3.1**
**shrinkage**
irreversible contraction after extrusion of plastic materials caused by heating or over time at ambient temperature

## 4 Method F17 – Cable shrinkage (fibre protrusion)

### 4.1 Objective

The purpose of this test procedure is to measure the permanent fibre protrusion of cables without rigid strength members compared to the cable elements and cable sheath due to temperature changes. The reference for the fibre protrusion is in this case the end of the cable sheath.

The determination of the permanent fibre protrusion according to this test method is not applicable if the strongest rigid strength member, often the central strength member, is to serve as a reference. This is the case when the fixing of the rigid strength member is used in a protective housing and the fixing of the rigid strength member is stronger than the fixing of the cable sheath. For such an installation situation, the recommended test procedure is given in Annex A.

Low shrinkage of cable elements and cable sheath is important for termination of connectors and passive optical components as well as in installations of protective housings with reinforced cables. The permanent (or irreversible) fibre protrusion at the cable ends can occur when the cable is used in areas with elevated temperature or direct exposure to the sun. Cable designs with low friction between the stabilisation elements (for example rigid strength member) and high material shrinkage (created by the extrusion process) can cause excessive and permanent fibre protrusion at the cable end and can lead to an attenuation increase, cable attachment degradation, sealing weakening, and in severe cases fibre breakage.

### 4.2 Sample

The cable sample shall have a minimum length of 10 m.

NOTE IEC TR 62959 recommends a length of 20 m for evaluation of the fibre protrusion because the observed change of fibre protrusion of cable samples with a length of 20 m were often larger than with a sample length of 10 m.

### 4.3 Apparatus

A temperature chamber of appropriate size and a temperature sensing device. The temperature chamber shall be able to accommodate the cable sample and maintain the specified temperature within ±3 °C.

A length measuring device of sufficient length for measuring the protrusion length of the fibres and secondary fibre protection or fibre tube with a minimum resolution of 1 mm (see Figure 2 and Figure 3).

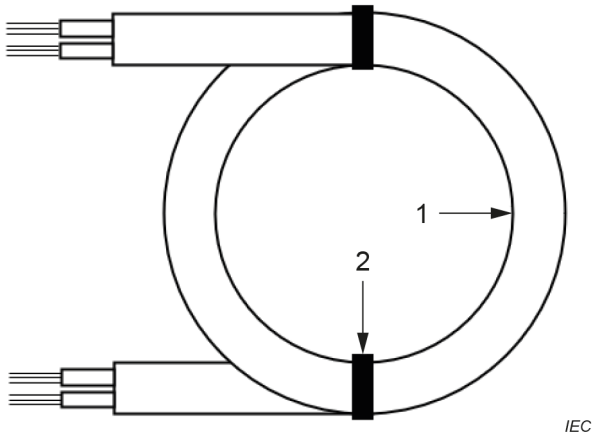
NOTE For the test procedure recommended for cables with rigid strength member(s), see Figure A.1 and Figure A.2.

### 4.4 Procedure

#### 4.4.1 Preparation of the cable sample

The cable on the supply reel, or alternatively the cable coil, shall be conditioned for 24 h at ambient temperature before cutting the cable sample, unless otherwise specified.

The cable sample shall be coiled in loose windings with a minimum diameter of 0,6 m, unless otherwise specified. The cable coils shall be loosely fixed at least at two places distributed around the circumference in a way that the cable elements are not held inside the cable and are free to move (expand and contract), as shown in Figure 1.




**Key**

1 coiled cable sample

2 loose fixing of cable sample coils

**Figure 1 – Preparation of cable sample with prepared ends**

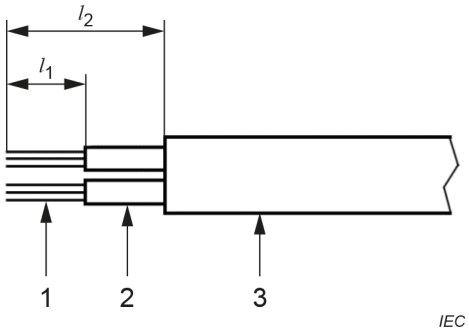
### 4.4.2 Preparation of the cable ends

The outer cable sheath shall be removed over a length of $l_2$ from the cable sample end, as shown in Figure 2. Also the strength members, inner sheath and other cable elements should be stripped closely to the end of the outer cable sheath. The secondary fibre protection or fibre tubes shall be removed over a length of $l_1$ from the end of the fibres as shown in Figure 2. This preparation shall be done at both cable sample ends.

For cable types where the fibres are loosely embedded in the cable, the pulling out and pushing in of the fibres should be avoided during preparation and measurement.



Dimensions in millimetres




| $l_1$ | $l_2$ |
|---|---|
| 100 | 200 |

**Key**

1 fibre or bundle of fibres

2 secondary fibre protection or fibre tube

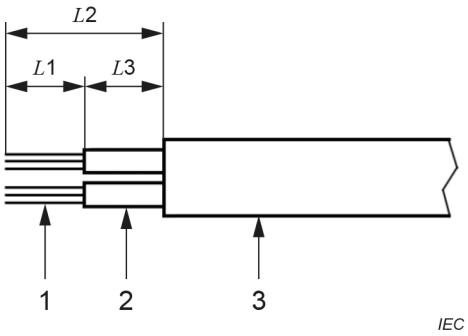
3 cable sheath

**Figure 2 – Preparation of cable sample ends**

At ambient temperature, the complete cable sample, including both cable ends, shall be put in the temperature chamber.

### 4.4.3 Initial measurements

The initial fibre protrusion shall be measured from the edge of the secondary fibre protection or fibre tube ($L1$) and from the edge of the cable sheath ($L2$) of all cable elements at both ends, as shown in Figure 3.




**Key**

1 fibre or bundle of fibres

2 secondary fibre protection or fibre tube

3 cable sheath

NOTE The protrusion of the secondary fibre protection or fibre tube is represented as length $L3$, that can be calculated as $L2$ minus $L1$.



**Figure 3 – Fibre protrusion measurement**

If multiple fibres are within a fibre tube, then one fibre shall be selected for the measurements (for example red coloured fibre).



### 4.4.4 Temperature cycling

The temperature in the temperature chamber shall be at ambient temperature. Throughout this procedure, the ambient temperature condition is the standard test condition as defined in IEC 60794-1-2. The temperature cycles shall be carried out as shown in Figure 4 and as follows:

– the temperature of the chamber shall be decreased to the low temperature $T_{A2}$ at a rate of cooling not to exceed 60 °C/h;

– as soon as the temperature in the chamber has reached stable condition, the cable sample shall be exposed to the low temperature for the appropriate period $t_1$ (see next bullet point);

– a minimum soak time is given in Table 1; however, the soak time, $t_1$, shall be sufficient to bring the cable sample to equilibrium with the specified temperature;

– the temperature in the chamber is then increased to the high temperature $T_{B2}$ at a rate of heating not to exceed 60 °C/h;

– as soon as the temperature in the chamber has reached stable condition, the cable sample shall be exposed to the high temperature for the appropriate period $t_1$;

– the temperature in the chamber shall be decreased to ambient temperature at a rate of cooling not to exceed 60 °C/h.

This procedure constitutes one cycle. If this is the intermediate step in a series of cycles, no soak is required, and no measurement shall be taken.

A minimum of four cycles shall be carried out, unless otherwise specified in the relevant specification.

At the end of the cycling sequence, hold the cable sample at ambient temperature for the appropriate period $t_1$.

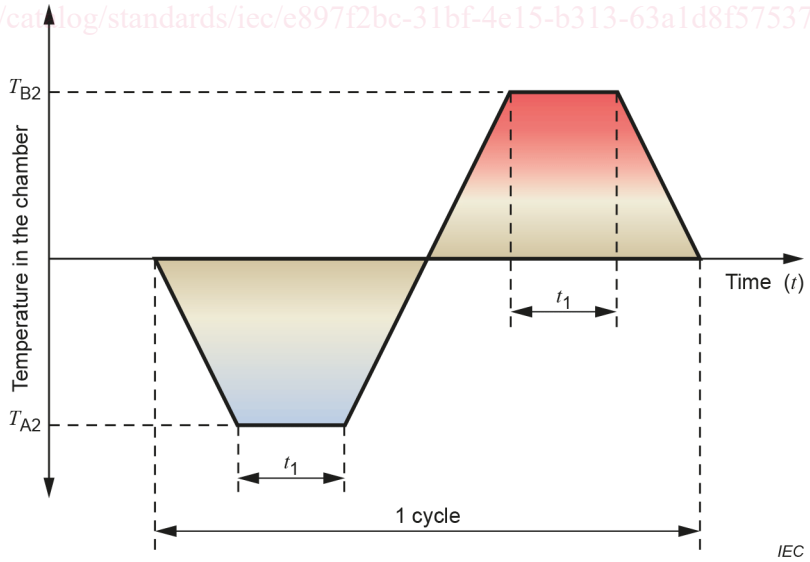
NOTE 1 The minimum number of four cycles is specifiedsince the shrinkage effects increases significantly with the first four cycles, as shown in the shrinkage study (see IEC TR 62959).

NOTE 2 Temperature cycling for cable shrinkage testing can be done together with IEC 60794-1-201, method F1, or with IEC 60794-1-212, method F12, if the specified test parameters are the same.

**Table 1 – Minimum soak time $t_1$**

| **Minimum soak times for a given sample mass (weight of cable sample)** | |
|---|---|
| **Sample mass**<br>kg | **Minimum soak time, $t_1$**<br>h |
| Under 0,35 | 0,5 |
| 0,36 to 0,7 | 1 |
| 0,8 to 1,5 | 2 |
| 1,6 to 100 | 4 |
| 101 to 250 | 6 |
| 251 to 500 | 8 |
| Over 501 | 12 |
| If more than one sample is put into the chamber, the largest sample mass of all single samples should be compared with the values in the table for the determination of the minimum soak time<br><br>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. | |






**Key**

$t_1$ soak time

$T_{A2}$ low temperature

$T_{B2}$ high temperature

$t$ unit of time

**Figure 4 – Cycle procedure**