IEC 60794-1-215

Edition 1.0 2020-06

INTERNATIONAL STANDARD

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colour inside

Optical fibre cables –
Part 1-215: Generic specification – Basic optical cable test procedures – Environmental test methods – Cable external freezing test, Method F15

Câbles à fibres optiques –
Partie 1-215: Spécification générique – Procédures fondamentales d'essais des câbles optiques – Méthodes d'essais d'environnement – Essai de résistance au gel en extérieur des câbles, méthode F15

IEC 60794-1-215:2020-06(en-fr)

IEC Central Office
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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Part 1-215: Generic specification – Basic optical cable test procedures – Environmental test methods – Cable external freezing test, Method F15

FOREWORD

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International Standard IEC 60794-1-215 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

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

FDIS	Report on voting
86A/2008/FDIS	86A/2026/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.

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- withdrawn,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.

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INTRODUCTION

This part of IEC 60794 defines a test method to determine the ability of a cable to withstand the effects of freezing water that can immediately surround the optical fibre cable sheath by observing any changes in the physical appearance of the sheath, or in the measured cable optical attenuation. The cable external freezing test in a rigid conduit (duct) is an item of F15 under consideration in IEC 60794-1-22:2017.

This document includes method F15 of IEC 60794-1-22:2017 as F15A: Cable external freezing test for a buried cable, as in wet earth or water. There is no technical change in F15A. F15B is a new introduced method. The numbering of these tests continues the F-series numbering sequence of IEC 60794-1-22:2017.

The number of IEC 60794-1-215 is in line with the new numbering system of test methods as planned in IEC 60794-1-2[1].

[1] Fifth edition under preparation. Stage at the time of publication: IEC/CC 60794-1-2:2020.

OPTICAL FIBRE CABLES –

Part 1-215: Generic specification – Basic optical cable test procedures – Environmental test methods – Cable external freezing test, Method F15

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 freezing water that can immediately surround the optical fibre cable sheath by observing any changes in the physical appearance of the sheath, or in the measured cable optical attenuation.

Method F15A is a test standard to simulate freezing of the medium surrounding a buried cable, as in wet earth or water. Method F15A is moved from method F15 in IEC 60794-1-22:2017 without any technical changes.

Method F15B is a test standard to simulate freezing of the medium surrounding an outside cable in a rigid conduit (duct) which is made of rigid material, for example steel. Method F15B includes the solution to prevent the cable from being crushed when experiencing freezing conditions in a rigid conduit (duct) which are pressure absorber pads and any other suggested means of cable protection.

A reference guide to test methods of all types as well as general requirements can be found in IEC 60794-1-2.

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

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 apply.

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 F15A – Cable external freezing test for a buried cable as in wet earth or water

4.1 Object

This test determines the ability of a buried cable, as in wet earth or water, to withstand the effects of freezing water that can immediately surround the optical fibre cable sheath by observing any changes in the physical appearance of the sheath, or in the measured cable optical attenuation.

The external freezing test simulates freezing of the medium surrounding a buried cable, as in wet earth or water. It is not intended to simulate freezing of a cable in a rigid conduit (duct) or pipe; refer to F15B for this testing. This external freezing test has little use for evaluating an outdoor cable, since such cables rarely fail the test. The aggregate of other requirements for outdoor cables results in a cable that is sufficiently robust to easily withstand this test. For freezing of microduct cables in microducts, consideration of ITU-T L.108:2018, Appendix II, is suggested [2][2]. It can be useful for evaluating cables not normally intended for outdoor installation. Users are encouraged to refer to national standards in effect in applicable regions.

4.2 Sample

A 50 m minimum length of cable shall be loosely coiled in the water to be frozen. Contact between the cable coil and the water tank wall shall be random. Additional length sufficient to make the required optical measurements and to connect the cable from the apparatus to the measuring equipment shall be provided.

4.3 Apparatus

The apparatus shall be a water tank suitable to contain the sample gauge length covered with water.

The water shall be common tap water. This procedure is written in view of the use of tap water. Other types of water, such as sea water or the like, shall be as specified by the detail specification. In these cases, the detail specification can prescribe temperatures other than those specified herein.

The water tank shall be positioned in an apparatus suitable for freezing the water and maintaining it at the specified temperature ±3 °C. An environmental chamber is a common example. Optionally, a temperature monitoring device may be used to monitor the cable temperature. In this case, the device shall be in close proximity to the sample under test.

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2 Numbers in square brackets refer to the Bibliography.

4.4 Procedure

1) Place the cable gauge length in the water tank, either as a coil or by coiling it into the tank. Cover the cable with water.
2) Perform initial attenuation measurements as indicated by the detail specification.
3) If the optional temperature monitoring device is used, the chamber temperature may be lowered so far as to −40 °C until the ice is completely frozen and the ice temperature is −10 °C or lower.
4) Raise the chamber temperature to −2 °C and hold this temperature for 1 h.

NOTE This is the temperature at which pure water experiences its greatest volume expansion as ice.

5) Measure the attenuation as indicated by the detail specification.
6) Elevate the chamber temperature to melt the ice. If the optional temperature monitoring device is used, the chamber temperature may be raised so high as to +65 °C, in order to accelerate the ice melting. Maintain the high temperature until the water reaches +15 °C. Then, return the chamber temperature to +23 °C and hold this temperature until the water reaches +23 °C ± 5 °C.
7) Measure the attenuation as indicated by the detail specification.
8) Remove the cable from the water tank and examine the exterior of the gauge length for any physical damage.

4.5 Requirements

After exposure, there shall be no visible cracks or other openings in the cable sheath. The maximum increase in attenuation during and after the test shall be as shown in the relevant detail specification, when frozen and no change after thawing.

4.6 Details to be specified

The detail specification shall include the following:

a) change of attenuation during and after the test;
b) any deviations from the criteria specified herein;
c) minimum bend diameter.

5 Method F15B – Cable external freezing test in a rigid conduit (duct)

5.1 Object

This test determines the ability of a cable to withstand the effects of freezing water in a rigid conduit (duct) that can immediately surround the optical fibre cable sheath by observing any changes in the physical appearance of the sheath, or in the measured cable optical attenuation.

NOTE This external freezing test of F15B simulates freezing of the medium surrounding an outside cable in a rigid conduit (duct). The similar test of F15A addresses the freezing of a medium surrounding a buried cable, as wet earth or water, thus not constrained by a rigid duct.

5.2 Sample

The sample length shall be of a length sufficient to carry out the specified test. Additional length sufficient to make the required optical measurements and to connect the cable from the apparatus to the measuring equipment shall be provided. The sample length shall be as specified by the detail specification. The sample shall be loosely installed in the conduit (duct).

NOTE The typical sample length is longer than L_1 when the sample gauge length of L_1 is 5 m.

5.3 Apparatus

The apparatus (see Figure 1) shall be the conduit (duct) suitable to contain the sample gauge length (L_1, per the detail specification, typically 5 m) covered with water. To keep the water in the conduit (duct) without water blocking or sealing, the entrances of the conduit (duct) are gradually curved with a sufficient large bending radius with no change of the physical and optical property of the sample. The water shall be common tap water.

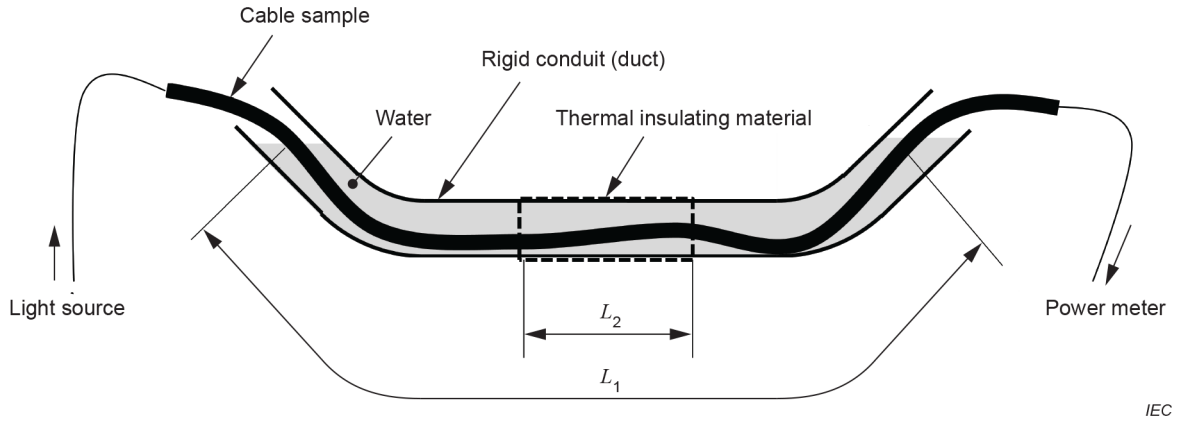

Figure 1 – Example of F15B apparatus of cable external freezing test in a rigid conduit

This procedure is written in view of the use of tap water. Other types of water, such as sea water or the like, shall be as specified by the detail specification. In these cases, the detail specification may need to prescribe temperatures other than those specified herein.

The conduit (duct) shall be positioned in a climatic chamber suitable for freezing the water.

The 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 shall be used. Optionally, a temperature monitoring device may be used to monitor the cable temperature or nearby position temperature of the cable. In this case, the device shall be in close proximity to the sample under test.

NOTE 1 For example, thermocouple can be used as the device to monitor the temperature near the sample. Conventionally, the thermocouples are attached on the outer surface of the conduit (duct).

A heat insulating material is arranged at the central section (L_2, per the detail specification, typically 1 m to 2 m) of the conduit to delay freezing the water in this section.

NOTE 2 In the field, the temperature of the conduit depends on the buried depth. The freezing delay between the central section and the others can well simulate freezing the water in the conduit in the underground.

An attenuation measuring apparatus for the determination of attenuation changes shall comply with IEC 60793-1-46.

5.4 Procedure

1) Place the cable gauge length in the conduit (duct). Fill the conduit (duct) and cover the cable with water.

   As required by the detail specification, freezing pressure absorber elements, such as a cable outer element, shall be placed in the conduit (duct) with the cable sample.

   NOTE 1 For example, a cable outer element is a specially designed PE pipe (see [3] and Annex A). The preponderance of experience with freezing of cables in ducts indicates that some sort of pressure absorber element is important for acceptable performance of installed duct cable subject to freezing.

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

3) Perform initial attenuation measurements as indicated by the detail specification.
4) If specified, after that, measure the attenuation with a period of specified time of t_s (typically 1 h) during the test.

NOTE 2 The optional measurement of the attenuation during the test can terminate the test as soon as the attenuation change exceeds the specified criteria.

5) The temperature in the chamber shall then be lowered to the specified low temperature T_A (typically −20°C).
6) 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 (typically 40 h). At the end of the exposure to low temperature conditions, the attenuation shall be measured.
7) The temperature in the chamber shall then be raised to the specified high temperature T_B (typically 60°C), in order to accelerate the ice melting. Maintain the high temperature for the appropriate period t_2 (typically 3 h). Then, return the chamber temperature to the ambient temperature.
8) The steps 3) through 7) constitute one cycle.
9) The sample shall be subjected to 3 cycles unless otherwise required in the relevant detail specification.
10) At the end of the last cycle, the sample shall be held at ambient temperature for the appropriate period t_3 (typically 6 h).
11) The sample under test and the chamber shall have reached temperature stability at ambient temperature.
12) Remove the cable from the conduit (duct) and examine the exterior of the gauge length (L_1) for any physical damage.

5.5 Requirements

After exposure, there shall be no visible cracks or other openings in the cable sheath. The maximum increase in attenuation during and after the test shall be as shown in the relevant detail specification, when frozen and no change after thawing.

5.6 Details to be specified

The detail specification shall include the following:

a) change of attenuation during and after the test;
b) any deviations from the criteria specified herein;
c) length and outer diameter of cable sample;
d) conduit (duct) length;
e) inner and outer diameters, thickness and material of conduit (duct);
f) length, material and thickness of thermal insulating material;
g) number of fibres to be tested;
h) number of cycles, if other than three;
i) change of attenuation at a specified wavelength as a function of temperature cycling; that is, at the required values of T_A and ambient after;
j) number of cables in the conduit (duct);
k) as required, number of freezing pressure absorber elements, such as outer cable elements;
l) if required, specification of the freezing pressure absorber elements such as typical outer diameter and detailed configuration of outer cable element.