# IEC 61753-111-08

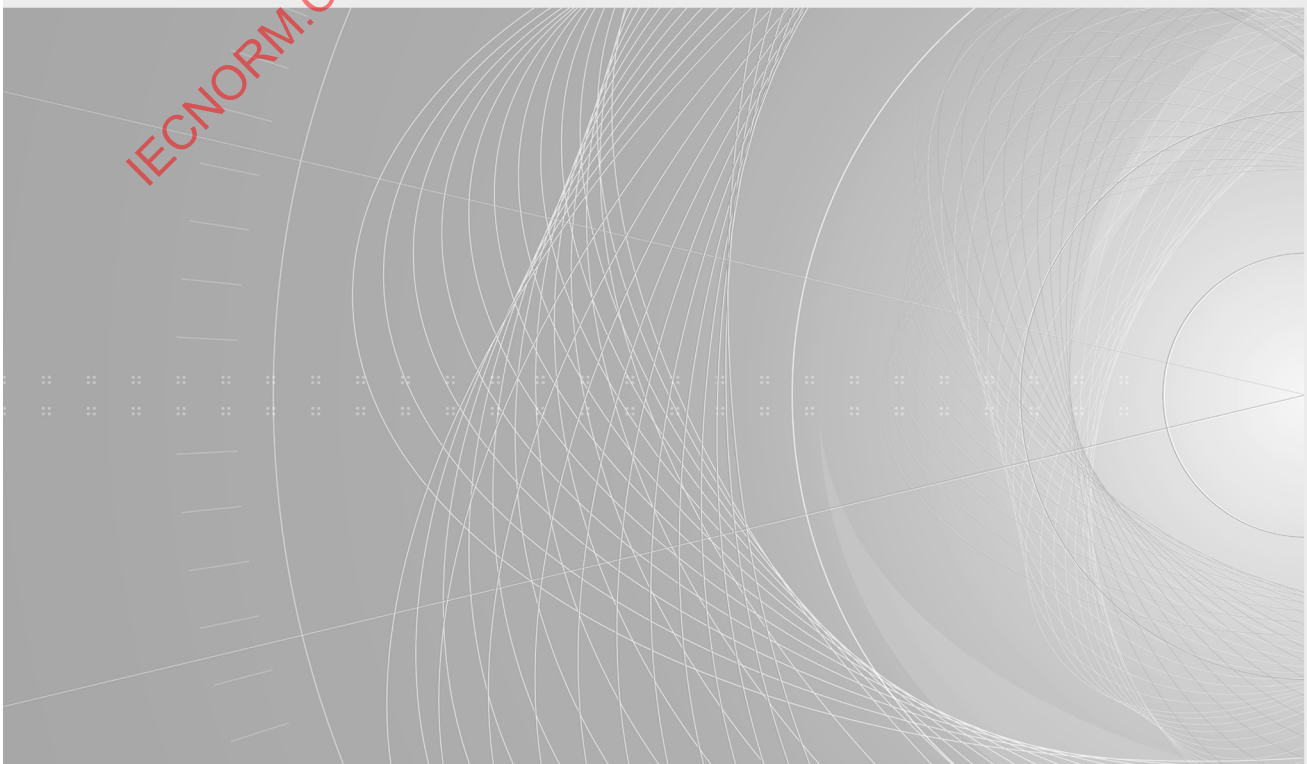
Edition 1.0 2021-04

# INTERNATIONAL STANDARD





## Fibre optic interconnecting devices and passive components – Performance standard –
## Part 111-08: Sealed closures for category G – Ground



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colour inside



## Fibre optic interconnecting devices and passive components – Performance standard – Part 111-08: Sealed closures for category G – Ground

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – PERFORMANCE STANDARD –

## Part 111-08: Sealed closures for category G – Ground

## FOREWORD

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IEC 61753-111-08 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is an International Standard.

This first edition cancels and replaces IEC 61753-111-8 published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 61753-111-8:

a) terms and definitions updated according to IEC 61753-1:2018 and IEC 61756-1:2019;
b) test severities updated according to IEC 61753-1:2018;
c) sealing tests are done with 20 kPa overpressure;
d) pass-fail criterion of pressure loss during test added to mechanical sealing tests;
e) vibration sealing test changed to 10 Hz, 3 mm amplitude and 1 000 000 cycles;

f) reduced loads added in cable retention test for small diameter cables and tubes;

g) reduced loads for cable axial compression test for small diameter cables;

h) the duration of the cycles in torsion and bending test is added;

i) free fall test removed (is covered by the optical shock test);

j) crush resistance test of 1 000 N for 10 min is added;

k) assembly and disassembly test: duration reduced to 5 cycles;

l) resistance to solvents and contaminating fluids: added immersion in diesel with duration of 1 h and 24 h drying time and added immersion in petroleum jelly for 5 days;

m) resistance to stress cracking solvents added for 5 days;

n) duration of the change of temperature reduced to 12 cycles;

o) water immersion test at 1 m for 7 days added.

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

| FDIS | Report on voting |
|---|---|
| 86B/4426/FDIS | 86B/4455/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 the 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/standardsdev/publications.

A list of all parts of IEC 61753 series, published under the general title *Fibre optic interconnecting devices and passive components – Performance standard*, 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,
- 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

Performance standards for sealed closures define the requirements for standard optical performance under a set of specified conditions. This subpart of the IEC 61753-111 series contains a series or a set of tests and measurements with clearly stated conditions, severities and pass/fail criteria. The set of tests is intended to be a basis to prove the product's ability to satisfy the requirements of a specific application, market sector or user group.

A product that has been shown to meet all the requirements of this performance standard may be declared as complying with this performance standard. Products having the same classification from one manufacturer that satisfy this performance standard will operate within the boundaries set by the performance standard. There is no guarantee that products from different manufacturers, having the same classification and which conform to the same performance standard, will provide an equivalent level of performance when they are used together.

Conformance with IEC environmental policy according to IEC Guide 109 and concerning the need to reduce the impacts on the natural environment of fibre optic closures during all phases of their life – from acquiring materials to manufacturing, distribution, use, and end-of-life treatment (i.e. re-use, recycling – recovery and disposal) – are not part of this document, but will be covered in the generic specification.

Conformance to a performance standard demonstrates that a product has passed a design verification test. It is not a guarantee of lifetime assured performance or reliability. Reliability testing is the subject of a separate test schedule, where the tests and severities selected are such that they are truly representative of the requirements of this reliability test programme. Consistency of manufacture should be maintained using a recognised quality assurance programme whilst the reliability of product should be evaluated using the procedures recommended in IEC 62005 (all parts).

# FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – PERFORMANCE STANDARD –

## Part 111-08: Sealed closures for category G – Ground

## 1 Scope

This part of IEC 61753 contains the minimum tests, test severities and measurement requirements which a sealed fibre optic closure need to meet in order to be categorised as meeting the IEC standard for category G – Ground, as defined in Table A.14 of IEC 61753-1:2018. Free breathing closures are not covered in this document.

## 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 60068-2-10, *Environmental testing – Part 2-10: Tests – Test J and guidance: Mould growth*

IEC 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 61300-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance*

IEC 61300-2-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal)*

IEC 61300-2-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-4: Tests – Fibre or cable retention*

IEC 61300-2-5, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-5: Tests – Torsion*

IEC 61300-2-9, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-9: Tests – Shock*

IEC 61300-2-10, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-10: Tests – Crush resistance*

IEC 61300-2-11, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-11: Tests – Axial compression*

IEC 61300-2-12, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-12: Tests – Impact*

IEC 61300-2-22, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*

IEC 61300-2-23, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-23: Tests – Sealing for non-pressurized closures of fibre optic devices*

IEC 61300-2-26, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-26: Tests – Salt mist*

IEC 61300-2-33, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-33: Tests – Assembly and disassembly of fibre optic mechanical splices, fibre management systems and closures*

IEC 61300-2-34, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-34: Tests – Resistance to solvents and contaminating fluids of interconnecting components and closures*

IEC 61300-2-37, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-37: Tests – Cable bending for fibre optic closures*

IEC 61300-2-38, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-38: Tests – Sealing for pressurised fibre optic closures*

IEC 61300-3-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-1: Examinations and measurements – Visual examination*

IEC 61300-3-3, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-3: Examinations and measurements – Active monitoring of changes in attenuation and return loss*

IEC 61300-3-28, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-28: Examinations and measurements – Transient loss*

IEC 61753-1:2018, *Fibre optic interconnecting devices and passive components – Performance standard – Part 1: General and guidance*

IEC 61756-1:2019, *Fibre optic interconnecting devices and passive components – Interface standard for fibre management systems – Part 1: General and guidance*

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

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions 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

**3.1**
**distribution joint**
protective housing that allows the splicing of the fibres from a feeder cable to the fibres of multiple smaller drop cable and that allows easy fibre access, maintenance, re-arrangement and addition of fibre circuits or passive optical components

Note 1 to entry: Storage of uncut fibres and fibre cable elements is allowed.

Note 2 to entry: A distribution joint is typically used in access and distribution networks.

**3.2**
**excursion loss**
change in optical attenuation during the slow variations of environmental parameters

Note 1 to entry: Excursion loss is the ± deviation from the original value of the transmitted power at the start of the test.

**3.3**
**fibre management system**
system to control, protect and store splices, connectors, passive optical components and fibres from incoming to outgoing cables

Note 1 to entry: A fibre management system is intended for installation within a protective housing.

Note 2 to entry: A fibre management system is often called an "organiser".

[SOURCE: IEC 61756-1:2019, 3.1.2]

**3.4**
**intervention**
gain access to modify, add, remove or repair fibre circuits, splices, connectors or other components between the incoming and outgoing cables of an existing closure

**3.5**
**installation**
activities and handling operations to establish and install a protective housing including the cables or by adding new circuits, splices, connectors and other components

**3.6**
**installation conditions**
circumstances that shall be fulfilled for an installation, which includes environmental conditions, size interface between the closure and the fibre management system, optical performance, additional/special conditions and safety requirements

**3.7**
**multiple element**
physical fibre separation level consisting of more than one single element

Note 1 to entry: This separation level has fibres from multiple cable elements on one splice tray and is also called mass storage. It is the lowest (worst) degree of physical circuit separation.

[SOURCE: IEC 61756-1:2019, 3.1.3]

**3.8**
**multiple ribbon**
multiple element consisting of multiple optical fibres (circuits) arranged in ribbons (fibres in parallel) which are also arranged (for example, in stacks)

[SOURCE: IEC 61756-1:2019, 3.1.5]

**3.9**
**residual loss**
change in optical power between initial and final measurements

**3.10**
**sealed closure**
watertight and dust-tight housing that can hold a varying overpressure or underpressure caused by temperature changes or atmospheric pressure changes

Note 1 to entry: There is no exchange of air with the outside environment when exposed to temperatures over the specified operating temperature range.

Note 2 to entry: Although sealed closures are often referred to as hermetic sealed closures, humidity can enter the inner closure by diffusion.

[SOURCE: IEC 61753-1:2018, 3.3.5, modified – Note 2 to entry has been rephrased, and Note 3 to entry and Note 4 to entry have been deleted.]

**3.11**
**single circuit**
physical fibre separation level where the optical circuit consists of one fibre (single fibre), or more than one fibre, providing all services for one subscriber

Note 1 to entry: This fibre separation level has the fibre(s) of only one customer on one splice tray. It is the highest (best) degree of physical circuit separation.

[SOURCE: IEC 61756-1:2019, 3.1.7]

**3.12**
**single element**
physical fibre separation level in the cable subassembly comprising one or more optical fibres inside a common covering for example in a tube or inside one groove of a grooved cable (slotted core cable)

Note 1 to entry: A single element provides services to more than one subscriber.

Note 2 to entry: This fibre separation level has all fibres from a cable element (e.g. loose tube) on one splice tray. It is an intermediate degree of physical circuit separation (between single circuit and multiple element).

[SOURCE: IEC 61756-1:2019, 3.1.9]

**3.13**
**single ribbon**
single element designed to carry all fibres of one ribbon

Note 1 to entry: Depending on the fibres deployment, a single ribbon can contain all the fibres of one circuit (single circuit) or the fibres of more than one circuit (single element).

[SOURCE: IEC 61756-1:2019, 3.1.11]

**3.14**
**splice tray**
structure that organises and controls storage of fibre splices in an orderly manner, together with the associated excess uncabled fibre length

Note 1 to entry: It can be a part of a fibre management system.

[SOURCE: IEC 61756-1:2019, 3.1.12]

**3.15**
**track/spur joint**
protective housing that allows the splicing of all the fibres of at least three cables

Note 1 to entry: The track/spur joint acts as a reinstatement of the cable length. It will not be re-entered except for repair or reinstatement of damaged cables.

Note 2 to entry: This closure configuration is typically used in trunk and junction networks to connect the cable sections from various cable reels or to split one cable into at least two smaller cables.

**3.16**
**transient loss**
short term (ms) reversible change of optical transmission characteristics arising from optical discontinuity, physical defects and modifications of the attenuation (e.g. bending loss) normally caused by mechanical stress

**3.17**
**uncut fibre**
fibres from a continuous cable with the cable sheath removed over a defined length without cutting the fibres or tubes

Note 1 to entry: The uncut tubes or fibres are stored e.g. in a space saving loop. When required, the fibres are cut and spliced or connected.

[SOURCE: IEC 61756-1:2019, 3.1.14]

## 4 Abbreviated terms

| | |
|---|---|
| FMS | fibre management system |
| ME | multiple element |
| MR | multiple ribbons |
| NA | not applicable |
| SC | single circuit |
| SE | single element |
| SR | single ribbon |

## 5 General requirements

### 5.1 Storage, transportation and packaging

The classes of environmental conditions and their severities to which sealed closures may be exposed during transportation are defined in IEC 60721-3-2. Normal transportation time is considered to be 30 days or less.

The product, in its original packaging, shall be suitable for normal public or commercial transportation and storage in weather protected non-temperature controlled storage environments and, after installation, meet the requirements as specified in Table 1, Table 2 and Table 3.

### 5.2 Installation and intervention

The minimum and maximum temperatures at which a closure may be installed (installation conditions) or re-entered (intervention) are not necessarily equal to the maximum temperature excursion of the environment in which it will reside, once installed. Accessing fibres and the fibre management system inside the closure is typically done in a more controlled environment. Closures and the fibre management system shall be installable in the temperature range between −5 °C and +45 °C. Closure and cable handling alone shall be possible at temperatures between −15 °C and +45 °C.

Typically, the following operations are carried out during an intervention:

– handling of closure;
– opening closure;
– getting access to fibres and splices (e.g. hinging, pivoting, sliding, removal of splice trays, or other FMS components);
– breaking a splice, rerouting fibres and connecting to another fibre end;
– cutting one or more uncut fibres, rerouting and connecting to another fibre end;
– disconnecting a connector and mating with another connector (when applicable);
– adding FMS elements/components and connecting the fibres;
– closing and sealing the closure.

### 5.3 Marking and identification

Product marking and identification shall survive the storage and transportation.

Each test sample should contain the following information at a minimum:

– manufacturer's identification mark or logo;
– product designation, model or type;
– one of the following: lot number, batch number, date (at least month and year) of production or serial number;
– expiry date (at least year) if the product contains components with a limited shelf-life.

### 5.4 Materials

For all applied materials, a material safety data sheet shall be made available upon request.

All materials that are likely to come in contact with personnel shall meet appropriate health and safety regulations.

The materials of the sealed closure and fibre management system shall be compatible with the other materials or solvents that can come into contact with it during installation and operation, for example water, cable filling compounds and degreasing agents. Exposure to these solvents shall not adversely affect the product's performance.

The effect of ultraviolet (UV) light on all polymeric materials that are directly exposed to the environment shall not adversely affect the product's performance. UV test shall be according to ISO 4892-3, lamp type 1A (UVA-340), cycle 1, duration 2 160 h. The effect of UV light shall be determined by measuring a suitable property (e.g. tensile strength and elongation at yield) both before and after exposure of the material slabs. The average change in mechanical characteristics of the tested material slabs shall be less than 20 %.

Polymeric materials shall not support mould growth causing mechanical degradation of the materials. Mould growth shall be tested according to IEC 60068-2-10. The effect of mould growth shall be determined by measuring a suitable property (e.g. tensile strength and elongation at yield) both before and after exposure of the material slabs. The average change in mechanical characteristics of the tested material slabs shall be less than 20 %.

Metallic elements shall be corrosion resistant. Dissimilar metals should not be used in contact with each other unless they are suitably finished to prevent electrolytic corrosion.

Materials which are not specified or which are not specifically described are left to the discretion of the manufacturer.

### 5.5 Closure overpressure safety

Special attention should be taken when opening sealed closures that are carrying an overpressure. Overpressure can build up in sealed closures due to temperature differentials, atmospheric pressure changes over a period of time, flash testing of the seals after installation or incorrect installation techniques. Care should be taken when opening a sealed closure. Provisions shall be made that overpressure is exhausted when opening the closure prior to complete removal of the cover.

## 6 Test

### 6.1 General

The mechanical and environmental performance of a closure is vital to the optical cabling system. The purpose of testing is to demonstrate that the closure can survive under defined environmental conditions, without irreversible or reversible failures and perform according to the requirements.

The performance test procedure of a closure shall:

– evaluate the product for three basic acceptance criteria: sealing, mechanical integrity by visual inspection and optical transmission requirements,

– simulate the effects of exposure to the environment in which it will be installed, and

– simulate installation and intervention conditions.

Optical performance testing is accomplished by subjecting the test sample to a number of mechanical and environmental conditions and measuring any optical performance deviations at prescribed intervals during and after completion of each test.

### 6.2 Test sample preparation

Sealing performance test samples shall be provided with an air pressure test access valve. The length of the cables extending the closure shall be long enough to perform the tests. The free ends of the cables shall be sealed. Each applicable cable type with minimum and maximum cable dimensions shall be represented in the test program. When applicable, open closure ports shall be sealed with a cap or a plug.

Optical test samples shall be constructed in such a way that they will cover all allowed functions as specified by the manufacturer, being "track joint" configuration or "track joint and distribution joint" configuration. This shall be realised by building optical circuits for each fibre separation level (typical SC, SE, SR, ME or MR splicing and uncut fibre storage). The type of fibre for the optical test samples and the test sample preparation are single-mode fibres as described in Annex A.

### 6.3 Test and measurement methods

All tests and measurements have been selected from IEC 61300 (all parts).

All optical losses indicated are referenced to the initial attenuation at the start of the test.

No deviation from the specified test method is allowed.

Since only optical fusion splices are used, the optical effects of other passive optical components are not considered for the evaluation of the closure system.

Closures under test shall be mounted and connected in accordance with the manufacturer's guidelines.

Unless otherwise specified, tests shall be carried out under standard atmospheric conditions according to IEC 61300-1.

### 6.4 Pass/fail criteria

A product meets the requirements of this document provided no failures occur in any test. The pass/fail criteria for sealed closures are specified in Table 1.

In the event of a failure occurring on a sealing performance test sample, the test shall be re-run using a sample size double that of the original.

Due to the complexity of the optical test samples, consecutive testing on the same optical sample is allowed. In case of a failure during the consecutive testing, a new sample shall be prepared and the failed test shall be re-done.

### 6.5 Test report

Conformance to a performance standard shall be supported by a test report. The test report shall clearly demonstrate that the tests were carried out in accordance with the requirements of the performance standard and provide full details of the tests together with a pass/fail declaration. An analysis of the cause of the failure shall be undertaken and any corrective actions taken shall be described.

If design changes are made, a risk assessment should be carried out to determine whether full or partial requalification should be done.

## 7 Performance requirements

### 7.1 Sample size

A detailed description of the sample size can be found in Annex B.

### 7.2 Sealing, optical and visual examination pass/fail criteria

The sealing, optical and visual examination pass/fail criteria are described in Table 1.

**Table 1 – Sealing, optical and visual examination pass/fail criteria**

| No. | Test | Requirement | Details | |
|---|---|---|---|---|
| 1 | Sealing for pressurised closures of fibre optic devices – sealing performance after test | No emission of air bubbles indicating a leak | Method:<br>Test temperature:<br>Test pressure:<br>Immersion depth:<br>Duration:<br>Pressure detector:<br>Pre-conditioning procedure: | IEC 61300-2-38, method A<br>+23 °C ± 5 °C<br>Internal overpressure 20 kPa ± 2 kPa<br>Just below the surface of the water<br>15 min<br>Minimum resolution 0,1 kPa<br>Sample conditioned to room temperature for at least 4 h |
| 2 | Pressure loss during test | Difference in pressure before and after test shall be less than 2 kPa. Measurements taken at same atmospheric test conditions | Method:<br>Test temperature:<br>Test pressure:<br>Pressure detector:<br>Pre-conditioning procedure: | IEC 61300-2-38, method B<br>As specified by individual test<br>Internal overpressure 20 kPa ± 2 kPa sealed at test temperature<br>Minimum resolution 0,1 kPa<br>Sample conditioned to test temperature and test pressure for at least 4 h |
| 3 | Visual examination | No defects which would affect functionality of the closure | Method:<br>Examination: | IEC 61300-3-1<br>Product shall be checked with naked eye |
| 4 | Active monitoring of change in attenuation[a] and return loss | Excursion losses:<br>δ ≤ 0,2 dB at 1 310 nm and 1 550 nm per incoming fibre during test.<br>δ ≤ 0,5 dB at 1 625 nm per incoming fibre during test.<br>Residual losses:<br>δ ≤ 0,1 dB at 1 310 nm, 1 550 nm and 1 625 nm per incoming fibre after test. | Method:<br>Wavelengths[b]:<br>Source stability:<br>Detector linearity:<br>Measurements required:<br>Sampling rate: | IEC 61300-3-3, method 1<br>1 310 nm ± 25 nm<br>1 550 nm ± 25 nm<br>1 625 nm ± 25 nm<br>Within ±0,05 dB over the measuring period<br>Within ±0,05 dB over the dynamic range to be measured<br>Before, during and after the test<br>Every 10 min |
| 5 | Transient loss[a] | Transient losses:<br>δ ≤ 0,5 dB at 1 550 nm per active circuit during test.<br>δ ≤ 1 dB at 1 625 nm per active circuit during test.<br>Residual losses:<br>δ ≤ 0,1 dB at 1 550 nm and 1 625 nm per active circuit after test | Method:<br>Wavelengths[b]:<br>Source stability:<br>Detector linearity:<br>Measurements required:<br>Active circuit: | IEC 61300-3-28<br>1 550 nm ± 30 nm<br>1 625 nm ± 30 nm<br>Within ±0,05 dB over the measuring period<br>Within ±0,05 dB over the dynamic range to be measured<br>Before, during and after the test<br>10 incoming fibres in series |

[a] The change in attenuation values refer to the ± deviation from the original value of the transmitted power at the start of the test.

[b] Testing at 1 625 nm is optional for enterprise applications but required for carrier applications.

### 7.3 Sealing performance requirements

The sealing performance requirements are described in Table 2.

**Table 2 – Sealing performance requirements**

| No. | Test | Requirement | Details | |
|---|---|---|---|---|
| 6 | Vibration (sinusoidal) | Sealing performance (test 1)<br>Visual examination (test 3) | Method:<br>Frequency range:<br>Amplitude:<br>Cable clamping distance:<br>Number of cycles:<br>Test temperature:<br>Test pressure:<br>Pre-conditioning procedure: | IEC 61300-2-1<br>10 Hz<br>3 mm<br>500 mm from closure<br>1 000 000 (about 28 h)<br>+23 °C ± 5 °C<br>Internal overpressure 20 kPa ± 2 kPa<br>Sample conditioned at room temperature for at least 4 h |
| 7 | Cable retention | Sealing performance (test 1)<br>Pressure loss (test 2)<br>Visual examination (test 3) | Method:<br>Test temperatures:<br>Load (N):<br><br><br><br>Load application:<br>Duration:<br>Test pressure:<br>Pre-conditioning procedure: | IEC 61300-2-4<br>−15 °C ± 2 °C and +45 °C ± 2 °C<br>20 × $Ø_{Cable}$ (mm) for $Ø_{Cable}$ > 7 mm<br>10 × $Ø_{Cable}$ (mm) for $Ø_{Cable}$ ≤ 7 mm<br>10 N for tubes and cables without strength member attachment<br>The greater of 400 mm or 50 × cable diameter measured from closure<br>1 h per cable<br>Internal overpressure 20 kPa ± 2 kPa sealed at test temperature<br>Sample conditioned at the specified test temperature and test pressure for at least 4 h |
| 8 | Axial compression of cable | Visual examination (test 3)<br>No movement of cable by more than 5 mm | Method:<br>Test temperature:<br>Load:<br><br><br><br><br><br>Load application:<br>Duration:<br>Pre-conditioning procedure: | IEC 61300-2-11<br>+23 °C ± 5 °C<br>10 N for $Ø_{Cable}$ < 3 mm<br>20 N for 3 mm ≤ $Ø_{Cable}$ < 6 mm<br>50 N for 6 mm ≤ $Ø_{Cable}$ < 10 mm<br>100 N for 10 mm ≤ $Ø_{Cable}$ < 20 mm<br>200 N for $Ø_{Cable}$ ≥ 20 mm<br>10 N for tubes and cables without strength member attachment<br>At maximum twice the cable diameter measured from closure<br>30 min per cable<br>Sample conditioned at room temperature for at least 4 h |

| No. | Test | Requirement | Details | |
|---|---|---|---|---|
| 9 | Cable bending | Sealing performance (test 1)<br>Pressure loss (test 2)<br>Visual examination (test 3) | Method:<br>Test temperatures:<br>Bending angle:<br>Force application:<br>Number of cycles:<br>Duration:<br>Test pressure:<br>Pre-conditioning procedure: | IEC 61300-2-37<br>−15 °C ± 2 °C and +45 °C ± 2 °C<br>+30° and –30° (maximum force shall not exceed 500 N)<br>400 mm from end of seal [a]<br>5 cycles per cable<br>5 min at extreme positions<br>Internal overpressure 20 kPa ± 2 kPa sealed at test temperature<br>Sample conditioned at the specified test temperature and test pressure for at least 4 h |
| 10 | Torsion | Sealing performance (test 1)<br>Pressure loss (test 2)<br>Visual examination (test 3) | Method:<br>Test temperatures:<br>Torsion angle:<br>Force application:<br>Number of cycles:<br>Duration:<br>Test pressure:<br>Pre-conditioning procedure: | IEC 61300-2-5<br>−15 °C ± 2 °C and +45 °C ± 2 °C<br>+90° and –90° (maximum torque shall not exceed 50 Nm)<br>400 mm from end of seal [a]<br>5 cycles per cable<br>5 min at extreme positions<br>Internal overpressure 20 kPa ± 2 kPa sealed at test temperature<br>Sample conditioned at the specified test temperature and test pressure for at least 4 h |
| 11 | Impact | Sealing performance (test 1)<br>Pressure loss (test 2)<br>Visual examination (test 3) | Method:<br>Test temperatures:<br>Impact tool:<br>Drop height:<br>Impact locations:<br>Number of impacts:<br>Test pressure:<br>Pre-conditioning procedure: | IEC 61300-2-12, method B<br>−15 °C ± 2 °C and +45 °C ± 2 °C<br>Steel ball of 1 kg<br>1 m<br>Centre of closure at 0°, 90°, 180° and 270° around longitudinal axis of closure<br>1 per location<br>Internal overpressure 20 kPa ± 2 kPa sealed at test temperature<br>Sample conditioned at the specified test temperature and test pressure for at least 4 h |
| 12 | Crush resistance | Sealing performance (test 1)<br>Pressure loss (test 2)<br>Visual examination (test 3) | Method:<br>Test temperatures:<br>Load:<br>Application area:<br>Locations:<br>Duration:<br>Test pressure:<br>Pre-conditioning procedure: | IEC 61300-2-10<br>–15 °C ± 2 °C and +45 °C ± 2 °C<br>1 000 N<br>25 $cm^2$ (circular shape)<br>Centre of closure at 0° and 90° around longitudinal axis of closure<br>10 min per location<br>Internal overpressure 20 kPa ± 2 kPa sealed off at test temperature<br>Sample conditioned at the specified test temperature and test pressure for at least 4 h |

| No. | Test | Requirement | Details | |
|---|---|---|---|---|
| 13 | Assembly and disassembly of closures | Sealing performance (test 1) within 10 min after closing the closure.<br>Visual examination (test 3) | Method:<br>Test temperature:<br>Conditioning between each re-entry:<br>Number of re-entries: | IEC 61300-2-33<br>+23 °C ± 5 °C<br>Ageing of minimum 1 temperature cycle as specified in test 14<br>5 |
| 14 | Change of temperature | Sealing performance (test 1)<br>Visual examination (test 2) | Method:<br>Extreme temperatures:<br>Dwell time:<br>Rate of change<br>Number of cycles:<br>Test pressure: | IEC 61300-2-22<br>−40 °C ± 2 °C and +65 °C ± 2 °C<br>4 h<br>1 °C/min<br>12<br>Internal overpressure 20 kPa ± 2 kPa regulated |
| 15 | Water immersion | No ingress of water<br>Visual examination (test 3) | Method:<br>Test temperature:<br>Water column height:<br>Wetting agent:<br>Duration:<br>Test pressure: | IEC 61300-2-23<br>+23°C ± 5°C<br>1 m<br>None<br>7 days<br>No internal overpressure sealed at room temperature |
| 16 | Salt mist | Sealing performance (test 1)<br>Visual examination (test 3) | Method:<br>Test temperature:<br>Salt solution:<br>Duration:<br>Test pressure: | IEC 61300-2-26<br>+35 °C ± 2 °C<br>5 % NaCl (pH 6,5 to pH 7,2)<br>5 days<br>No internal overpressure sealed at room temperature |
| 17 | Resistance to solvents and contaminating fluids | Sealing performance (test 1)<br>Visual examination (test 3) | Method:<br>Test temperature:<br>Submersion in:<br><br><br><br>Immersion depth:<br><br>Drying time:<br><br><br>Test pressure: | IEC 61300-2-34<br>+23 °C ± 5 °C<br>HCl at pH2 for 5 days<br>NaOH at pH 12 for 5 days<br>Petroleum jelly for 5 days<br>Diesel for 1 h<br>Just underneath the surface, but fully immersed or covered by the fluid<br>HCl, NaOH and petroleum jelly: no drying time required<br>Diesel: 24 h at room temperature<br>Internal overpressure 20 kPa ± 2 kPa regulated |

| No. | Test | Requirement | Details | |
|---|---|---|---|---|
| 18 | Resistance to stress cracking solvents | Sealing performance (test 1)<br>Visual examination (test 3) | Method:<br>Test temperature:<br>Submersion in:<br>Immersion depth:<br>Drying time:<br>Duration:<br>Test pressure: | IEC 61300-2-34<br>+50 °C ± 3 °C<br>10 % nonylphenol, ethoxylate solution (Igepal®[1])<br>Just underneath the surface, but fully immersed or covered by the fluid<br>None, sample shall be checked immediately at the end of the test<br>5 days<br>Internal overpressure 20 kPa ± 2 kPa regulated |
| [a] For rigid cables with diameter Ø > 25 mm, the clamping distance shall be increased to 1 000 mm. | | | | |

## 7.4 Optical performance requirements

The optical performance requirements are described in Table 3.

**Table 3 – Optical performance requirements**

| No. | Test | Requirement | Details | |
|---|---|---|---|---|
| 19 | Cable retention | Transient loss (test 5)<br>Visual examination (test 3) | Method:<br>Test temperature:<br>Load (N):<br><br><br>Load application:<br><br>Duration:<br>Optical circuit: | IEC 61300-2-4<br>+23 °C ± 5 °C<br>20 × $Ø_{Cable}$ (mm) for $Ø_{Cable}$ > 7 mm<br>10 × $Ø_{Cable}$ (mm) for $Ø_{Cable}$ ≤ 7 mm<br>10 N for tubes and cables without strength member attachment<br>The greater of 400 mm or 50 × cable diameter measured from end of closure<br>1 h per cable<br>10 live fibres placed in series |
| 20 | Vibration (sinusoidal) | Transient loss (test 5)<br>Visual examination (test 3) | Method:<br>Test temperature:<br>Frequency sweep range:<br>Amplitude/ acceleration:<br>Cross-over frequency:<br>Number of sweeps<br>No. of axes:<br>Optical circuit: | IEC 61300-2-1<br>+23 °C ± 5 °C<br>5 Hz to 500 Hz to 5 Hz at 1 octave/min<br>3,5 mm or 10 m/s$^2$ (~ 1 $g_n$) maximum<br>9 Hz<br>10 sweeps (5 Hz to 500 Hz to 5 Hz)<br>3 mutually perpendicular<br>10 live fibres placed in series |



[1] Igepal is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this product.

| No. | Test | Requirement | Details | |
|---|---|---|---|---|
| 21 | Shock | Transient loss (test 5)<br>Visual examination (test 3) | Method:<br>Test temperature:<br>Wave form:<br>Duration pulse:<br>Acceleration:<br>Number shocks:<br>Number of axes:<br>Optical circuit: | IEC 61300-2-9<br>+23 °C ± 5 °C<br>half sine<br>11 ms<br>150 m/s$^2$ (~ 15 $g_n$)<br>3 up and 3 down per axis<br>3 mutually perpendicular<br>10 live fibres placed in series |
| 22 | Cable bending | Transient loss (test 5)<br>Visual examination (test 3) | Method:<br>Test temperatures:<br>Bending angle:<br>Force application:<br>Number of cycles:<br>Duration:<br>Optical circuit: | IEC 61300-2-37<br>+23 °C ± 5 °C<br>+30° and –30° (maximum force shall not exceed 500 N)<br>400 mm from end of seal[a]<br>5 cycles per cable<br>5 min at extreme positions<br>10 live fibres in series |
| 23 | Torsion | Transient loss (test 5)<br>Visual examination (test 3) | Method:<br>Test temperature:<br>Torsion angle:<br>Torque application:<br>Number of cycles:<br>Duration:<br>Optical circuit: | IEC 61300-2-5<br>+23 °C ± 5 °C<br>+90° and –90° (maximum torque shall not exceed 50 Nm)<br>400 mm from end of seal[a]<br>5 cycles per cable<br>5 min at extreme positions<br>10 live fibres in series |
| 24 | Assembly and disassembly of closures | For the distribution joint configuration only<br>Transient loss (test 5)<br>Visual examination (test 3)<br>Operations shall be carried out on fibres in splice trays, installed between other active splice trays (that contain the 10 live fibres)<br>Circuit separation (SC, SE, SR, ME or MR) if applicable | Method:<br>Test temperature:<br>Operations:<br>Optical circuit: | IEC 61300-2-33<br>+23 °C ± 5 °C<br>All manipulations that will normally occur during an intervention after initial installation (see Annex C). These are typically:<br>1 moving closure to working location. Unloop cables and expose closure to typical handling operations like torsion (−90°/+90°) and bending (−30°/+30°) of closure;<br>2 opening closure. Gaining access to previously installed fibres in the FMS;<br>3 adding /installing drop cables;<br>4 breaking splice (not a splice from the live circuit) and splicing to other fibre;<br>5 cutting one or more uncut fibres and splicing them to other fibres;<br>6 adding splicing trays;<br>7 closing the closure and looping cables. Exposing closure to typical handling operations like torsion (−90°/+90°) and bending (−30°/+30°) of closure.<br>Ten live fibres placed in series |

| No. | Test | Requirement | Details | |
|---|---|---|---|---|
| 25 | Change of temperature | Change in attenuation (Test 4)<br>Visual examination (Test 3) | Method:<br>Low temperature:<br>High temperature:<br>Duration at temperature extreme:<br>Rate of change of temperature:<br>Number of cycles:<br>Measurements required:<br>Recovery procedure: | IEC 61300-2-22<br>−40 °C ± 2 °C<br>+65 °C ± 2 °C<br>4 h<br>1 °C/min<br>12<br>Before, during (maximum interval 10 min) and after the test.<br>4 h at normal ambient conditions |
| [a] For rigid cables with diameter Ø > 25 mm, the clamping distance shall be increased to 1 000 mm. | | | | |

# Annex A
(normative)

# Sample definition

## A.1 Fibre type for test sample

The bending radius for installed and stored fibres in a FMS shall be as given by IEC 61756-1. The fibres for the optical test samples with an FMS designed for B-652.D fibres are covered in Table A.1. The fibres for the optical test samples with an FMS designed for B-657 fibres are covered in Table A.2 and Table A.3.

**Table A.1 – Fibre references for IEC 60793-2-50, sub-category B-652.D**

| Fibre type | IEC 60793-2-50, sub-category B-652.D<br>Dispersion unshifted single-mode fibre |
|---|---|
| Proof stress: | ≥ 0,69 GPa |
| Mode field diameter at 1 310 nm: | Nominal value between 9,0 µm and 9,2 µm<br>Tolerance ±0,4 µm |
| Cabled fibre cut off wavelength: | ≤ 1 260 nm |
| 1 625 nm loss performance: | ≤ 0,1 dB for 100 turns on 30 mm mandrel radius |
| Cladding diameter: | 125,0 µm ± 0,7 µm |
| Non coloured primary coating diameter: | 245 µm ± 10 µm |
| Coloured primary coating diameter: | 250 µm ± 15 µm |

**Table A.2 – Fibre references for IEC 60793-2-50, sub-category B-657.A1**

| Fibre type | IEC 60793-2-50, sub-category B-657.A1<br>Low bend loss single-mode fibre |
|---|---|
| Proof stress: | ≥ 0,69 GPa |
| Mode field diameter at 1 310 nm: | Nominal value between 8,6 µm and 9,2 µm<br>Tolerance ±0,4 µm |
| Cabled fibre cut off wavelength: | ≤ 1 260 nm |
| 1 625 nm bend loss performance: | ≤ 1,0 dB for 10 turns on 15 mm mandrel radius<br>≤ 1,5 dB for 1 turn on 10 mm mandrel radius |
| Cladding diameter: | 125,0 µm ± 0,7 µm |
| Non coloured primary coating diameter: | 245 µm ± 10 µm |
| Coloured primary coating diameter: | 250 µm ± 15 µm |

**Table A.3 – Fibre references for IEC 60793-2-50, sub-category B-657.A2**

| Fibre type | IEC 60793-2-50, sub-category B-657.A2<br>Low bend loss single-mode fibre |
|---|---|
| Proof stress: | ≥ 0,69 GPa |
| Mode field diameter at 1 310 nm: | Nominal value between 8,6 µm and 9,2 µm<br>Tolerance ±0,4 µm |
| Cabled fibre cut off wavelength: | ≤ 1 260 nm |
| 1 625 nm bend loss performance: | ≤ 0,1 dB for 10 turns on 15 mm mandrel radius<br>≤ 0,2 dB for 1 turn on 10 mm mandrel radius<br>≤ 1,0 dB for 1 turn on 7,5 mm mandrel radius |
| Cladding diameter: | 125,0 µm ± 0,7 µm |
| Non coloured primary coating diameter: | 245 µm ± 10 µm |
| Coloured primary coating diameter: | 250 µm ± 15 µm |

Sealed closures that were qualified with IEC 60793-2-50 sub-category B-652.D fibre are automatically qualified for use with all IEC 60793-2-50 sub-category B-657 fibres and all IEC 60793-2-10 sub-category A1 multimode fibres. Closures qualified with B-657.A1 fibre are automatically qualified for use with B-657.A2, B2 and B3 fibres.

## A.2 Closure optical test sample configuration

The optical test sample is built with two closures: one configured as track/spur joint and one configured as distribution joint (access point for connections to customers). The selected cables shall be suitable for the selected temperature range.

Step 1: Both extremities of a looped cable are terminated in the track/spur joint closure (see Figure A.1). The length of the looped cable is chosen to be longer than the "dead zone" of an optical time domain reflectometer (OTDR). Typically, a cable loop length of 25 m to 50 m is used, allowing location of the potential causes of optical losses and to distinguish wether a change in signal is induced by the fibre management system in a single location or distributed evenly over the whole circuit length.

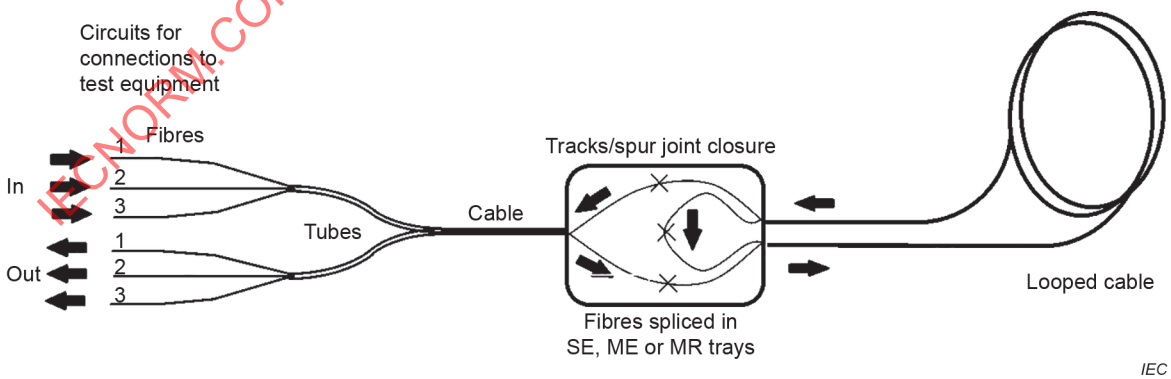


**Figure A.1 – Track/spur joint configuration sample**

In the track/spur joint closure, the fibres from one cable end are connected to the fibres of the other cable end in such a way that light will sequentially flow through an optical circuit of 10 random selected incoming fibres from the cable loop. An incoming fibre is a part of an optical circuit containing the fibre entering the closure, spliced to a fibre leaving the closure. Typically, an optical circuit contains 10 incoming fibres.

The first and the last incoming fibre of this circuit will be spliced to the fibres of a cable for making external connections to a light source and optical power meter.

When applicable, all relevant fibre separation levels (SE, ME and MR) shall be represented in the test sample, preferably in separate circuits. As example, additional circuits as indicated by 1, 2 and 3 are shown in Figure A.2.

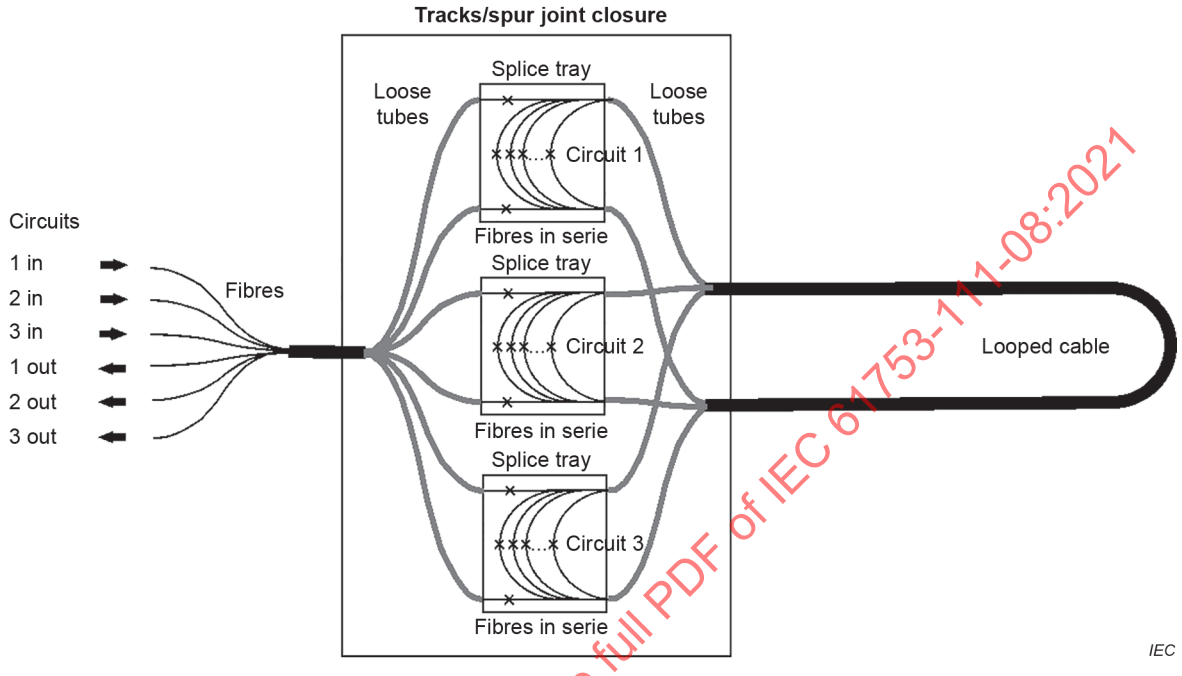


**Figure A.2 – Optical circuits in track/spur joint closure**

When the closure also allows a distribution joint configuration, an additional closure shall be added to the test sample construction as described in step 2.

Step 2: In the middle of the looped cable, the cable jacket is removed over a distance (window cut) according to the installation instructions. The bundles of uncut loose tubes are inserted and stored inside the distribution joint closure (see Figure A.3 and Figure A.4). If fibres can be stored in different separation levels (SC, SE, SR, ME and MR), each of these options shall be executed in separate circuits.

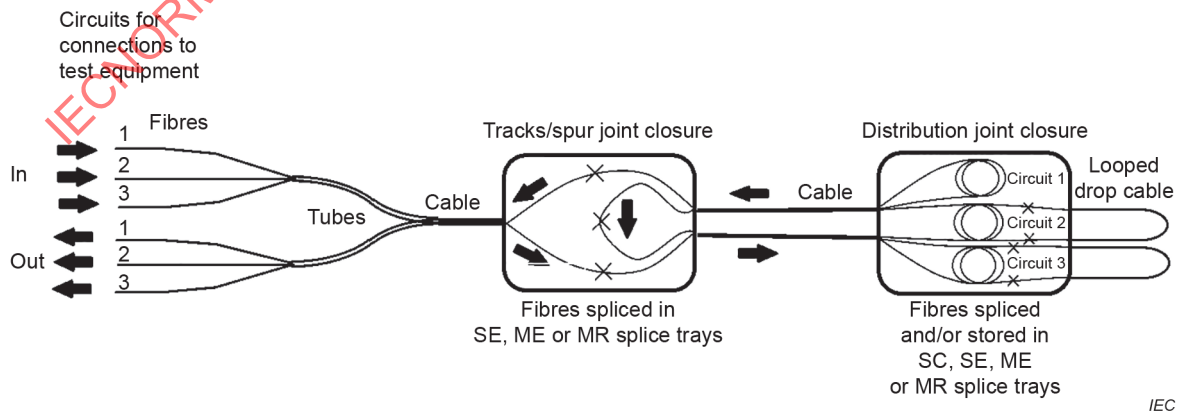


**Figure A.3 – Distribution joint configuration sample**

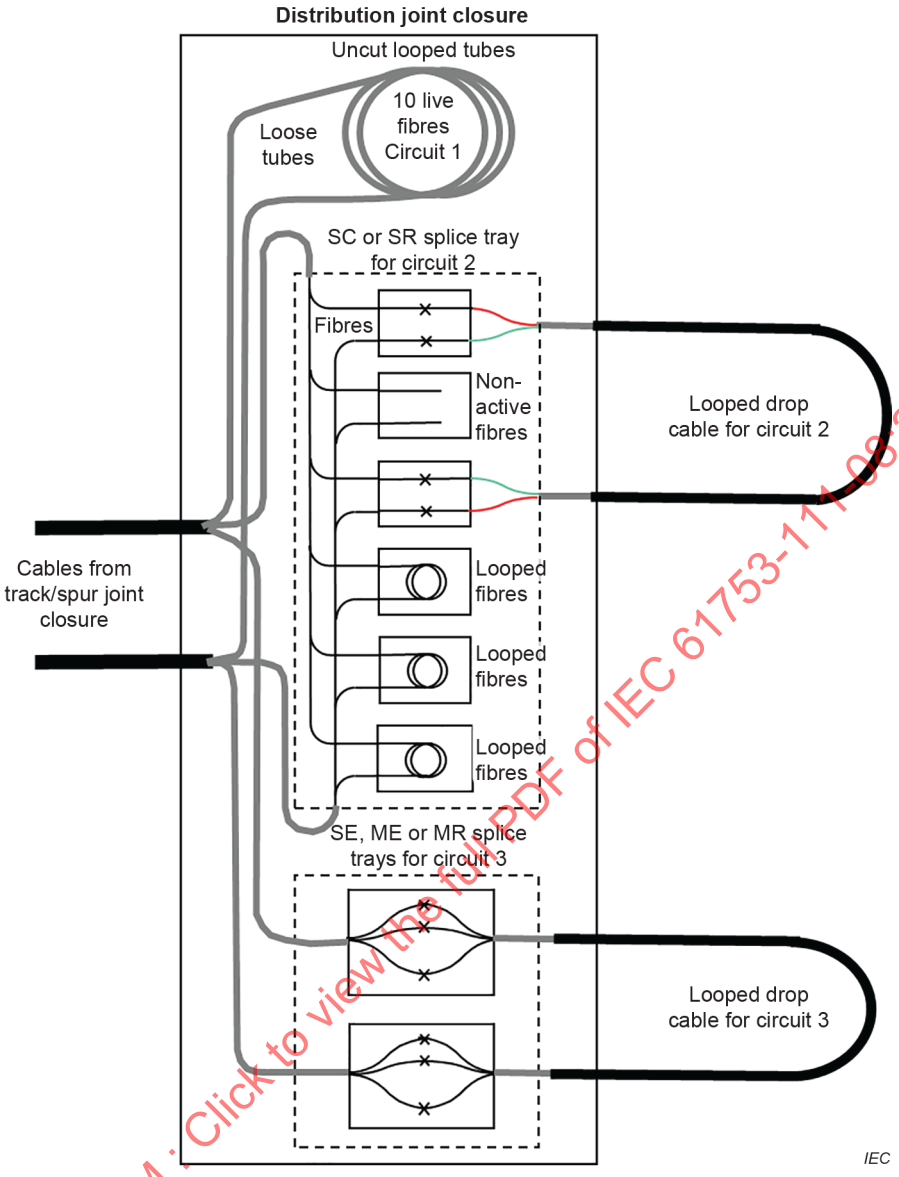


**Figure A.4 – Optical circuits in the distribution joint closure**

Typically, the following separate circuits will be made as shown in Figure A.4:

– Circuit 1: uncut looped fibres in uncut loose tube (stored in loose tube basket);

– Circuit 2: uncut looped fibres stored in SC or SR trays, two uncut looped fibres shall be broken in the middle and the fibre ends are spliced to the fibres of a looped drop cable with minimum 2 fibres; the remaining non-active fibres in circuit 2 are stored in SC/SR trays located between 2 active SC/SR trays. These non-active fibres will be accessed again during the intervention/reconfiguration test 24;

– Circuit 3: fibres stored in SE, ME or MR trays, spliced to fibres of a looped drop cable with minimum 12 fibres.

The non-active fibres from the remaining loose tubes in the looped cables are installed in the closure and the fibres are stored randomly in the fibre management system in between the live fibre circuits.