AS/NZS ISO/IEC 14763.3:2012

Australian/New Zealand Standard™

# Telecommunications installations—Implementation and operation of customer premises cabling

## Part 3: Testing of optical fibre cabling (ISO/IEC 14763-3:2011, MOD)

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Australian Information Industry Association
BICSI Australia
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# Telecommunications installations—Implementation and operation of customer premises cabling

# Part 3: Testing of optical fibre cabling (ISO/IEC 14763-3:2011, MOD)

Originated as AS/NZS ISO/IEC 14763.3:2007.
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# PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee CT-001, Communication Cabling, to supersede AS/NZS ISO/IEC 14763.3:2007, *Telecomunication installations—Implementation and operation of customer premises*, Part 3: *Acceptance testing for optical fibre cabling*.

The objective of this Standard is to provide users with specifications of systems and methods for the inspection and testing of optical fibre cabling in accordance with AS/NZS 3080 or equivalent standards.

This Standard is an adoption with national modifications and has been reproduced from, ISO/IEC 14763-3:2011, *Information technology—Implementation and operation of customer premises cabling, Part 3: Testing of optical fibre cabling*, and has been varied to take account of Australia/New Zealand conditions. Variations to ISO/IEC 14763-3 are listed in Appendix ZZ.

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| *Reference to International Standard* | | *Australian/New Zealand Standard* | |
|---|---|---|---|
| ISO/IEC 11801 | Information technology—Generic cabling for customer premises | AS/NZS 3080 | Telecommunications installations—Generic cabling for customer premises (ISO/IEC 11801:2002, MOD) |
| IEC 60825 | Safety of laser products | AS/NZS IEC 60825 | Safety of laser products |
| 60825-3 | Part 3: Safety of optical fibre communication systems (OFCS) | 60825.3 | Part 3: Safety of optical fibre communication systems (OFCS) |

Only international references adopted as Australian or Australian/New Zealand Standards have been listed.

The terms ‘normative’ and ‘informative’ are used to define the application of the annex or appendix to which they apply. A normative annex or appendix is an integral part of a standard, whereas an informative annex or appendix is only for information and guidance.

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# INTRODUCTION

This document is one of three prepared in support of International Standard ISO/IEC 11801.

Figure 1 below shows the inter-relationship between ISO/IEC 11801, these associated Technical Reports/Standards and other related standards.

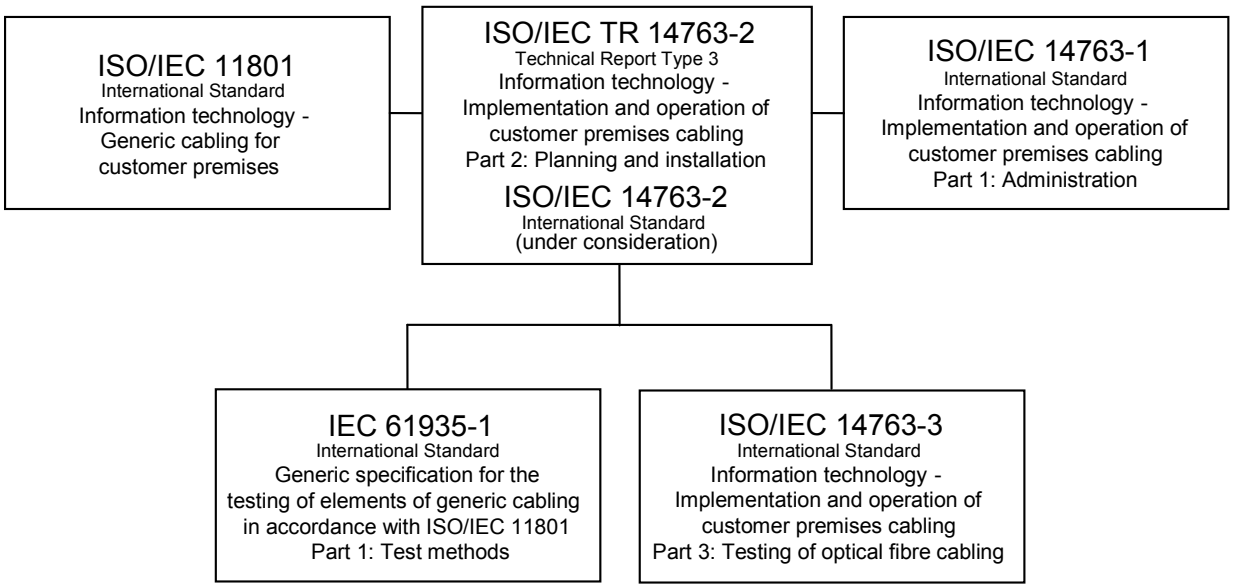


**Figure 1 – Document relationships**

Part 3 of ISO/IEC 14763 details inspection and test procedures for optical fibre cabling

- designed in accordance with ISO/IEC 11801 and equivalent standards and
- installed according to the requirements and recommendations of ISO/IEC 14763-2 (under consideration).

Users of this International Standard should be familiar with both ISO/IEC 11801 and ISO/IEC 14763-2.

The quality plan for each installation will define the acceptance tests and sampling levels selected for that installation. Requirements and recommendations for the development of a quality plan are described in ISO/IEC 14763-2 (under consideration).

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AUSTRALIA/NEW ZEALAND STANDARD

# Telecommunications installations—Implementation and operation of customer premises cabling

## Part 3:
## Testing of optical fibre cabling (ISO/IEC 14763-3:2011, MOD)

### 1 Scope

This part of ISO/IEC 14763 specifies systems and methods for the inspection and testing of optical fibre cabling designed in accordance with ISO/IEC 11801 or equivalent standards. The test methods refer to existing standards-based procedures where they exist.

### 2 Normative references

The following referenced documents are indispensable for the application 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.

ISO/IEC 11801, *Information technology – Generic cabling for customer premises*

ISO/IEC TR 14763-2, *Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation*[1]

IEC 60050-731, *International Electrotechnical Vocabulary – Chapter 731: Optical fibre communication*

~~IEC 60793-1-20, *Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*~~

IEC 60793-1-45, *Optical fibres – Part 1-45: Measurement methods and test procedures – Mode field diameter*

IEC 60793-2-10, *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*

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

IEC 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*

IEC 60874-14-1, *Connectors for optical fibres and cables – Part 14-1: Detail specification for fibre optic connector type SC/PC standard terminated to multimode fibre type A1a, A1b*

IEC 60874-14-2, *Connectors for optical fibres and cables – Part 14-2: Detail specification for fibre optic connector type SC/PC tuned terminated to single-mode fibre type B1*

IEC 60874-14-3, *Connectors for optical fibres and cables – Part 14-3: Detail specification for fibre optic adaptor (simplex) type SC for single-mode fibre*

IEC 60874-19, *Connectors for optical fibres and cables – Part 19: Sectional specification for fibre optic connector – Type SC-D(uplex)*

IEC 60874-19-1, *Connectors for optical fibres and cables – Part 19-1: Fibre optic patch cord connector type SC-PC (floating duplex) standard terminated on multimode fibre type A1a, A1b - Detail specification*

[1] ISO/IEC 14763-2 is planned to become an International Standard.

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IEC 60874-19-2, *Connectors for optical fibres and cables – Part 19-2: Fibre optic adaptor (duplex) type SC for single-mode fibre connectors – Detail specification*

IEC 61280-1-4, *Fibre optic communication subsystem test procedures – Part 1-4: General communication subsystems – Light source encircled flux measurement method*

IEC 61280-4-1, *Fibre optic communication subsystem test procedures – Part 4-1: Cable plant and links – Multimode fibre-optic cable plant attenuation measurement*

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 61300-3-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-4: Examinations and measurements – Attenuation*

IEC 61300-3-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*

~~IEC/PAS 61300-3-43, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-43: Examination and measurements – Mode Transfer Function Measurement for fibre optic sources*~~

IEC/PAS 62614, *Fibre optics – Launch condition requirements for measuring multimode attenuation*

## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of this document the following definitions apply in addition to those of ISO/IEC 11801 and IEC 60050-731.

**3.1.1**
**adapter**
device that enables interconnection between terminated optical fibre cables

**3.1.2**
**cabling interface adapter**
test cords and other components used to connect test equipment to the cabling under test

**3.1.3**
**connection**
mated device or combination of devices including terminations connecting two cables or cable elements

**3.1.4**
**cable sheath**
covering over the optical fibre or conductor assembly that may include one or more metallic members, strength members or jackets

~~**3.1.5**~~
~~**coupled power ratio (CPR)**~~
~~ratio of power coupled in a MMF to the power coupled in SMF which is related to the modal power distribution of the light in MMF~~

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**3.1.6**
**fail result**
measured value which fails to meet the specified requirement and where the absolute value of the difference between the measured value and the specified requirement is greater than the stated measurement uncertainty

**3.1.7**
**field calibration cord**
test cord used for referencing when using the ~~3 jumper~~ three test cord reference test method

**3.1.8**
**marginal result**
measured value which differs from the specified requirement by an amount not exceeding the stated measurement uncertainty

**3.1.9**
**multimode optical fibre (MMF)**
optical fibre which supports multiple paths of light transmission

**3.1.10**
**optical fibre**
any filament made of dielectric materials that guides light

**3.1.11**
**optical time domain reflectometer (OTDR)**
instrument used to characterise optical fibre cabling by measuring the backscatter and reflection of injected light pulses as a function of time

**3.1.12**
**pass result**
measured value which meets the specified requirement and where the absolute value of the difference between the measured value and the specified requirement is greater than the stated measurement uncertainty

**3.1.13**
**reference connector**
tighter tolerances or selected connector component which is used for measuring purposes

NOTE The characteristics or selection procedures are given in the relevant connecting hardware specification.

[IEC 60874-1, 1.3.14, modified]

~~**3.1.14**~~
~~**relative power distribution**~~
~~metric used to determine launch conditions in terms that are relative to a light source's overall launched power~~

**3.1.15**
**sheath**
see cable sheath

**3.1.16**
**single-mode optical fibre (SMF)**
optical fibre which supports only one mode of light transmission

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**3.1.17**
**test cord**
cable assembly used either to connect test equipment to the cabling under test or as part of a test reference measurement

**3.1.18**
**test operator**
skilled person testing in accordance with instructions provided by the test system designer

**3.1.19**
**test system**
test equipment and cabling interface adapters necessary to undertake a given test/measurement in accordance with the requirements of this standard

**3.1.20**
**attenuation**
reduction of optical power induced by transmission though a medium such as optical fibre; this is sometimes called insertion loss, $L$, and is given in dB as $L$ = 10 $\log_{10}(P_{in}/P_{out})$, where $P_{in}$ and $P_{out}$ are the power, typically measured in mW, into and out of the cabling

**3.1.21**
**encircled flux**
**EF**
fraction of cumulative near-field power to the total output power as a function of radial distance from the optical centre of the core

**3.1.22**
**OTDR dead zone**
distance in which an OTDR cannot detect an event following a reflective event

## 3.2 Abbreviations

For the purposes of this document the following abbreviations apply in addition to those of ISO/IEC 11801 and IEC 60050-731.

| | |
|---|---|
| APC | Angled physical contact |
| ~~CPR~~ | ~~Coupled power ratio~~ |
| EF | Encircled flux |
| IOR | Index of refraction |
| LMD | Launched modal distribution |
| LSA | Least squares average |
| LSPM | Light source and power meter |
| MMF | Multimode optical fibre |
| ~~MPD~~ | ~~Modal power distribution~~ |
| na | not applicable |
| OTDR | Optical time domain reflectometer |
| ~~RPD~~ | ~~Relative power distribution~~ |
| SMF | Single-mode optical fibre |

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### 3.3 Symbols

For the purposes of this document the following symbols apply.

Optical fibre connector (general)
Optical fibre connector on installed cabling
Optical fibre connector with reference termination
Joint

## 4 Conformance

To test installed cabling according to this International Standard:

- the general requirements of clauses 5 and 8 shall be met;
- the test equipment and test cords shall conform to the requirements of Clause 6;
- the test method, as appropriate, and treatment of results shall conform to Clauses 9 and 10;
- the test results shall be documented in accordance with 5.4;
- the requirements of IEC 60825-2 shall be met.

To inspect installed cabling according to this International Standard:

- the inspection equipment shall conform to the requirements of Clause 7;
- the inspection method, as appropriate, shall conform to Clause 11;
- the requirements of IEC 60825-2 shall be met.

Relevant national and local regulations covering safe working practices shall be observed.

## 5 General requirements

### 5.1 Test system

The test systems defined in this International Standard comprise local test equipment and remote test equipment (where required) together with cabling interface adapters which enable the connection of the test equipment to the cabling under test (see Figure 2).

The cabling interface adapters take the form of test cords together with any connecting hardware adapters that are required at the test interfaces.

The test system and, particularly the cabling interface adapters, affect the uncertainty of measurement for a given parameter.

Temporary index matching materials (gels and/or fluids) between the polished end faces of connectors shall not be used.

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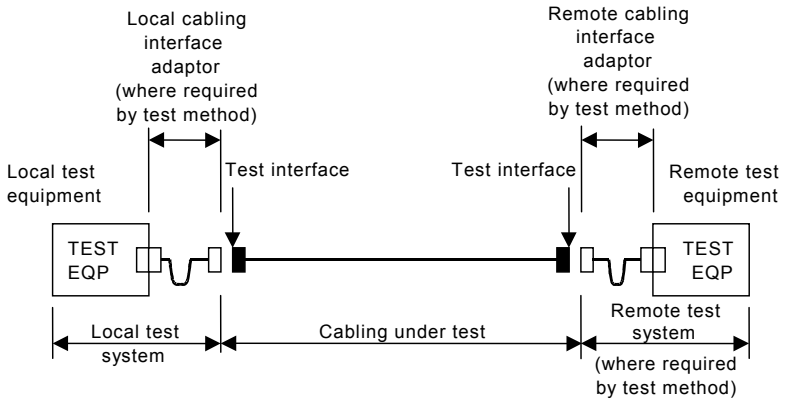


**Figure 2 – The test system and the cabling under test**

## 5.2 Normalisation and calibration

Normalisation processes are specified, where appropriate, to enable the test system to achieve the stated measurement uncertainty.

Test equipment should be calibrated using standardised procedures (e.g. IEC 61315 and IEC 61746), as appropriate.

The test operator shall have evidence, in the form of a valid calibration certificate, to support the use of the test equipment at the time the tests are undertaken.

## 5.3 Environmental conditions

### 5.3.1 Protection of transmission and terminal equipment

Transmission and terminal equipment shall be disconnected from the cabling under test before any testing or inspection according to this Standard is carried out.

### 5.3.2 Contamination

Dust, dirt and other contaminants at the interfaces to the cabling under test or at interfaces of the cabling interface adapter and at the interface to the test equipment may produce misleading results and in some cases damage the cabling under test.

Materials to clean the connections (such as 98 % reagent grade alcohol, appropriate cleaning solvents, lint-free wipes and clean compressed air) shall be available and used in accordance with suppliers' instructions.

Any connecting hardware adapters used together with all connector end-faces on the test cords comprising the cabling interface adapter and the cabling under test shall be cleaned according to the instructions provided by the manufacturer of the connectors. Cleaning shall be repeated every time a test cord is connected to the cabling or component under test.

Connections should be inspected with a microscope after cleaning, to verify that they are uncontaminated.

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### 5.3.3 Use of test equipment

External effects (for example, environmental, electromagnetic or physical) can affect the test equipment and thereby influence the measured results. Test equipment shall be operated as per manufacturer's specifications.

### 5.3.4 Relevance of measurement

Measurements shall either

a) be made under environmental conditions which are representative of the intended operational environment,

b) have correction factors applied to the measured results in accordance with manufacturers' specifications in order to reflect the intended operating environment, or

c) be documented as being performed under non-representative conditions.

### 5.3.5 Treatment of marginal test results

Marginal results may be treated in a number of ways including

a) verification of the normalisation of the test system,

b) acceptance of all marginal results,

c) repetition of the measurement using a test system with improved measurement uncertainty.

Further guidance for the treatment of marginal results is found in ISO/IEC 14763-2.

## 5.4 Documentation

The documentation for each parameter shall include

a) identification and details of the parameter,

b) whether channel or permanent link is being tested,

c) test equipment:

   1) type and manufacturer;

   2) serial number and calibration status;

   3) nominal wavelength,

d) ~~optical fibre details (fibre core size/MFD, fibre type e.g. OM1, OM2, OM3, OS1)~~,
   optical fibre cabling details (fibre core size/MFD; fibre type, e.g. A1a, A1b, A1a.2, B1.1, B1.3)

e) details of the cabling connector type(s),

f) the configuration of the cabling test equipment during the test,

g) the measured result,

h) the applicable requirements,

i) details of the reference numbers and direction of test,

j) the date of the test (the time may also be recorded),

k) the test operator,

l) the calculated measurement uncertainty of the test system.

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# 6 Test equipment

## 6.1 LSPM

### 6.1.1 General

Derived from IEC 61280-4-1, IEC 61280-4-2 and IEC 61300-3-4, the following has been adapted to the requirements of ISO/IEC 11801 for link and channel attenuation measurements with an LSPM.

### 6.1.2 Light sources

Light sources for testing multimode optical fibre (MMF) cabling and components shall conform to the spectral characteristics of Table 1.

**Table 1 – MMF light source characteristics**

| Centre wavelength nm |
|---|
| 850 ± 30 |
| 1 300 ± 30 |

Light sources for testing single-mode optical fibre (SMF) shall conform to the spectral characteristics of Table 2.

**Table 2 – SMF light source characteristics**

| Centre wavelength nm |
|---|
| 1 310 ± 30 |
| 1 550 ± 30 |

### 6.1.3 Power meters

The equipment shall be capable of measuring relative or absolute optical power (such as an optical power meter) and shall be designed in such a way as to make power measurements independent of modal distribution. The equipment shall enable optical power measurements to be recorded to at least one significant digit in the decimal place (for example, −14,3 dBm, 10,1 mW).

When the test set-up (LSPM) is used for a link or channel attenuation, the measurement uncertainty shall not be greater than ±0,02 dB.

When the test set-up (LSPM) is used for a field check of the reference connectors by measuring the attenuation, the measurement uncertainty should be <0,02 dB.

NOTE It is therefore recommended to use a power meter with a power resolution of at least 2 decimal places.

If the power meter consists of an optoelectronic detector with a demountable adapter then the adapter shall be fitted to the meter in accordance with the instructions provided by the supplier of the power meter.

### 6.1.4 Test system stability

The stability of the light source contributes directly to measurement variability. A light source shall be used in such a way that any variation in output power from the normalised values (see 5.2) shall be as specified in ISO/IEC 14763-2.

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A power meter with adequate equipment temperature stability and optical power linearity to meet the desired measurement uncertainty shall be used.

NOTE Non-linearity between the measured and incident optical power may cause measurement errors. Also, equipment with internal waveguides may exhibit measurement variability with varying modal conditions.

## 6.2 OTDR

### 6.2.1 General

OTDR equipment for testing multimode optical fibre (MMF) cabling and components shall conform to the central wavelengths of Table 1.

OTDR equipment for testing single-mode optical fibre (SMF) shall conform to the central wavelengths of Table 2.

See Annex C for further information on optical fibre time domain reflectometry.

### 6.2.2 OTDR characterization using a launch cord only

Characterization of cabling using an OTDR with a launch cord only

- produces a characterization of the form shown in Figure 3,

  NOTE There may not be a remote interface reflection if the far end of the optical fibre is broken or terminated with an angled interface.

  - SMF may not produce a remote interface reflection if the optical fibre is broken,
  - APC connectors may not produce a discernable reflective event,
- does not provide any continuity measurement for the cabling under test,
- provides information about the general quality of the local interface to the cabling under test, the quality of the installed cable and any embedded joints within the cabling under test,
- does not allow any quantitative measurement of the local interface to the cabling under test unless the scattering characteristics of the optical fibre within the launch cord are the same as those of the optical fibre under test,
- does not allow any quantitative measurement of embedded connecting hardware joints within the cabling under test unless the scattering characteristics of the optical fibres on either side of the embedded connecting hardware are identical or unless measurements are taken in each direction,
- cannot be used for measurement of the channel or link (see 8.1) attenuation/insertion loss as it does not provide optical attenuation measurement for the remote connector and therefore cannot provide an optical attenuation measurement for the channel or permanent link under test.

### 6.2.3 OTDR characterization using a launch cord and a tail cord

Characterization of cabling using an OTDR using a launch cord and a tail cord

- produces an unidirectional characterization of the form shown in Figure 4 (two traces need to be combined and evaluated),
- provides a continuity measurement for the cabling under test,
- provides information about the general quality of both the local and remote interface to the cabling under test, the quality of the installed cable and any embedded connecting hardware,
- provides quantitative measurement of the local and remote interfaces to the cabling under test using measurements taken in each direction,
- provides quantitative measurement of the channel or link (see 8.1) attenuation when the measurement is taken in one direction provided that

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- the channel or link only contains a single fixed cable and terminating connectors,
- the scattering characteristics of the optical fibre within the launch and tail cords are the same,

- provides quantitative attenuation measurement of the channel, or link embedded connecting hardware (see 8.1) when the measurement is taken from two directions provided that
  - attenuation measurements of permanent links, channel or embedded connecting hardware are derived by averaging the associated bi-directional test results,
  - the distance between embedded connecting hardware is not less than the dead zone of the ODTR.

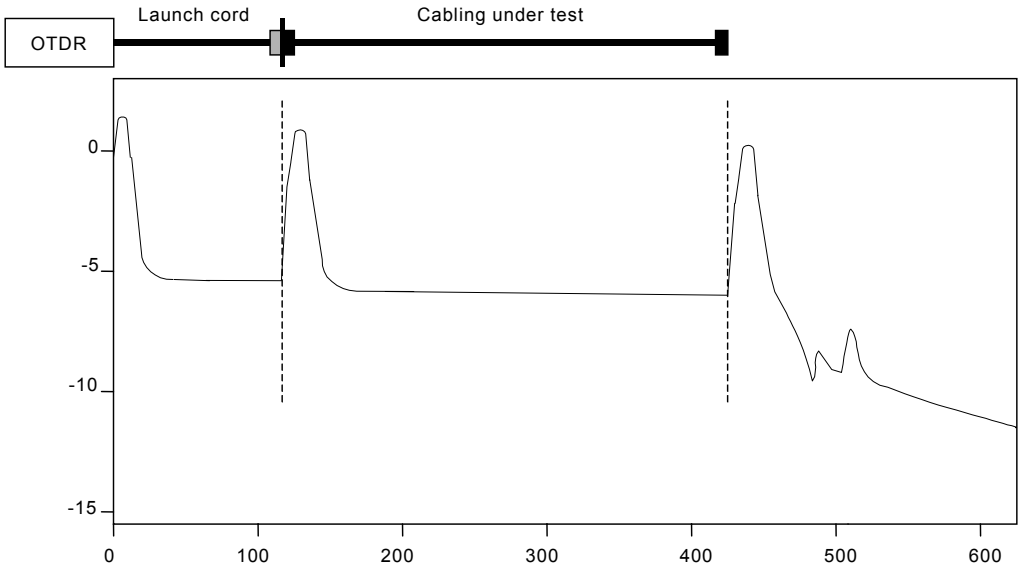


**Figure 3 – OTDR characterization using a launch cord only**

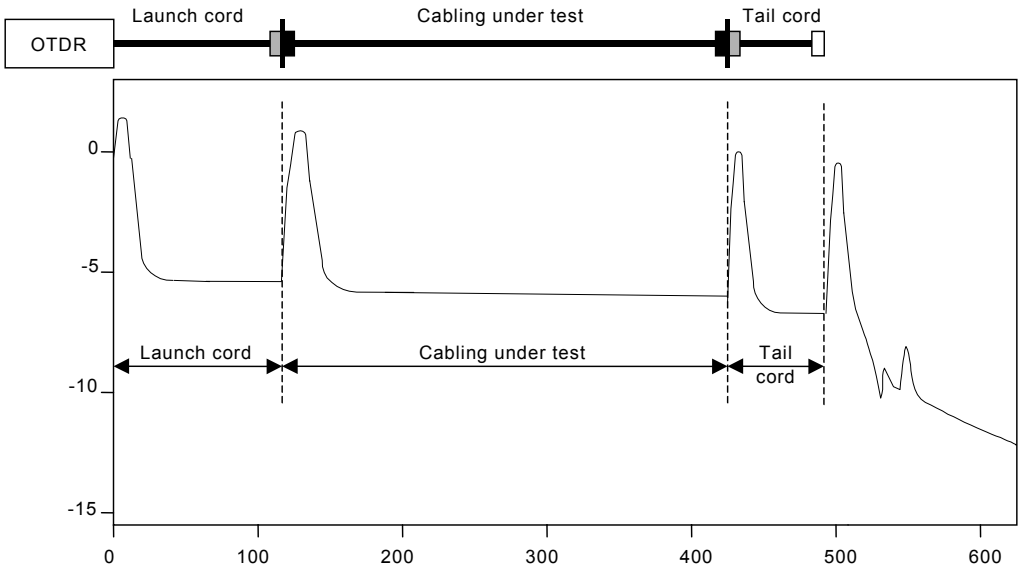


**Figure 4 – OTDR characterization using a launch cord and a tail cord**

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## 6.3 Cabling interface adapters

### 6.3.1 Connecting hardware at test interfaces

The connecting hardware to be connected to the cabling under test (i.e. launch cords and tail cords) together with the hardware that terminates the field calibration cords and any connecting hardware adapters used as part of the test methods specified by this international Standard shall

- have the same product specification as the hardware terminating the cabling under test,
- have a controlled end face for radius, dome offset and fibre position,
  - for the duplex SC connector for MMF as specified in IEC 60874-19-1,
  - for the simplex SC connector for SMF as specified in IEC 60874-14-2,
- be of the same product as defined by the supplier where IEC specifications do not guarantee interoperability (the only interfaces specified to be interoperable are IEC 60874-14 and IEC 60874-19),
- where used, connecting hardware adapters shall be reference adapters in accordance with the relevant IEC product specification,
  - for SC MMF (duplex) as specified in IEC 60874-19-2,
  - for SC SMF (simplex) as specified in IEC 60874-14-3.

The inspection and testing of test cords and connecting hardware adapters shall be done in accordance with Annex D prior to any normalisation process being undertaken.

### 6.3.2 Reference connector requirements

The requirements for multimode SC reference connectors are given in IEC 60874-14-1. The requirements for single-mode SC reference connectors are given in IEC 60874-14-2.

The requirements for reference connectors of other (non-SC) cylindrical and rectangular styles are given in Table 3.

**Table 3 – Non-SC reference connector requirements**

| | Cylindrical connector styles | | Rectangular connector styles | |
|---|---|---|---|---|
| | MMF | SMF | MMF | SMF |
| Eccentricity of core centre to ferrule outer diameter | <1 µm | <0,3 µm | na | na |
| True position of the fibre core | na | na | <1 µm | <0,3 µm |
| Exit angle | ≤0,2 ° | ≤0,2 ° | ≤0,2 ° | ≤0,2 ° |
| Accuracy of ferrule diameter | ±0,5 µm | ±0,5 µm | na | na |
| Attenuation between 2 reference connectors | ≤0,10 dB | ≤0,20 dB | ≤0,10 dB | ≤0,20 dB |

When the test set-up (LSPM) is also used for a link or channel attenuation the measurement uncertainty should be <0,2 dB.

When the test set-up (LSPM) is used for a field check of the reference connectors by measuring the attenuation, the measurement uncertainty should be <0,02 dB.

NOTE It is therefore recommended to use a power meter with a power resolution of at least 2 decimal places.

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### 6.3.3 MMF test cords

#### 6.3.3.1 General

Each test cord shall

- contain optical fibre of the same nominal characteristics (core/cladding diameters, numerical aperture) as the optical fibre under test,
- be labelled by having a unique identifier with each connector labelled as indicated in Figure 5.

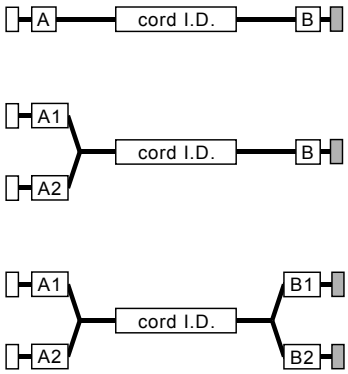


**Figure 5 – Test cord labeling and identification**

#### 6.3.3.2 LSPM launch cord

The launch cord shall be

- between 1 m and 5 m in length,
- terminated at one end with one or more connectors suitable for attachment to the light source,
- terminated at the other end with one or more reference connectors compatible with the interface to the installed cabling.

If the light source is not known to provide the specified launched modal distribution (see 6.4) then the launch cord shall contain a mandrel or other mode-conditioning devices to ensure that the specified launched modal distribution is maintained.

#### 6.3.3.3 LSPM tail cord

The tail cord shall be

- between 1 m and 5 m,
- terminated at one end with one or more connectors suitable for attachment to the power meter,
- terminated at the other end with one or more reference connectors compatible with the interface to the installed cabling.

#### 6.3.3.4 LSPM combination launch/tail cord

A duplex launch/tail cord shall be

- between 1 m and 5 m in length,
- terminated at one end with one or more connectors suitable for attachment to the LSPM equipment,

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- terminated at the other end with one or more reference connectors compatible with the interface to the installed cabling.

#### 6.3.3.5 LSPM field calibration cord

The field calibration cord shall

- not exceed 2 m in length,
- be terminated at both ends with reference connectors compatible with the interfaces to the installed cabling.

#### 6.3.3.6 OTDR launch cord

The OTDR shall provide the specified launch modal distribution (see 6.4).

The launch cord shall be

- longer than the attenuation dead zone of the OTDR (see Annex C for further details),
- long enough for a reliable straight-line fit to be made to the backscatter trace following the dead zone (C1 to C2 in Figure 11) so that reliable insertion loss measurements may be carried out. For example, in multimode fibre installations the length of the launch cord should be at least 75 m,
- terminated at one end with one or more connectors suitable for attachment to the OTDR,
- terminated at the other end with one or more reference connectors compatible with the interface to the installed cabling.

The length of optical fibres used to create test cords often requires that they be protected within a closure (see Figure 6) which may also include any launched modal distribution devices.

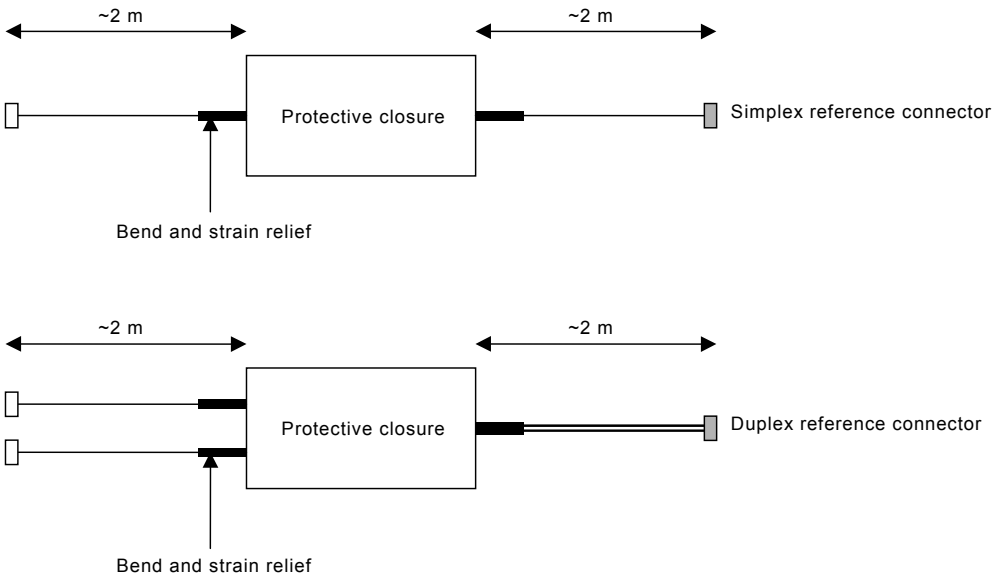


**Figure 6 – OTDR launch cord schematic**

Where the interface to the cabling or component under test is duplex, the launch cord shall contain two optical fibres enabling the testing of both optical fibres by switching the OTDR connections rather than re-connecting cords at the interface under test. The OTDR connections shall be uniquely identified with markers as shown in Figure 5.

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#### 6.3.3.7 OTDR tail cord

The tail cord shall be

- of a different length than the corresponding launch cord (but longer than the attenuation dead zone of the OTDR, see Annex C for further details),
- long enough for a reliable straight-line fit to be made to the backscatter trace following the dead zone (C3 to C4 in Figure 11), so that reliable insertion loss measurements may be made). For example, in multimode installations the length of the tail cord should be at least 75 m,
- terminated at one end with one or more reference connectors compatible with the interface to the installed cabling.

The termination of the other end(s) is optional.

The length of optical fibres used to create test cords often requires that they be protected within a closure (see Figure 6).

Where the interface to the cabling or component under test is duplex, the two optical fibres shall both be shorter than the corresponding launch cord (but longer than the attenuation dead zone of the OTDR) but shall be of different lengths in order to determine the maintenance of polarity in the cabling under test.

### 6.3.4 SMF test cords

#### 6.3.4.1 General

Each test cord shall

- contain optical fibre of the same nominal characteristics (mode field and cladding diameters) as the optical fibre under test,
- be labelled with a unique identifier with each connector labelled as indicated in Figure 5.

#### 6.3.4.2 LSPM launch cord

The launch cord shall be

- between 1 m and 5 m in length,
- terminated at one end with one or more connectors suitable for attachment to the light source,
- terminated at the other end with one or more single-mode reference connectors compatible with the interface to the installed cabling.

#### 6.3.4.3 LSPM tail cord

The tail cord shall be

- between 1 m and 5 m in length,
- terminated at one end with one or more connectors suitable for attachment to the light source,
- terminated at the other end with one or more single-mode reference connectors compatible with the interface to the installed cabling.

#### 6.3.4.4 LSPM combination launch/tail cord

A duplex launch/tail cord shall be

- between 1 m and 5 m in length,

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- terminated at one end with one or more connectors suitable for attachment to the LSPM equipment,
- terminated at the other end with one or more single-mode reference connectors compatible with the interface to the installed cabling.

#### 6.3.4.5 LSPM field calibration cord

The field calibration cord shall

- not exceed 2 m in length,
- each end shall be terminated with single-mode reference connectors compatible with the interfaces to the installed cabling.

#### 6.3.4.6 OTDR launch cord

The launch cord shall be

- longer than the attenuation dead zone of the OTDR,
- long enough for a reliable straight-line fit to be made to the backscatter trace following the dead zone (C1 to C2 in Figure 11), so that reliable insertion loss measurements may be carried out. For example, in single-mode installations the length of the launch cord should be at least 150 m,
- terminated at one end with one or more connectors suitable for attachment to the OTDR, see Annex C for further details,
- terminated at the other end with one or more single-mode reference connectors compatible with the interface to the installed cabling.

The length of optical fibres used to create test cords often requires that they be protected within a closure (see Figure 6).

Where the interface to the cabling or component under test is duplex, the launch cord shall contain two optical fibres enabling the testing of both optical fibres by switching the OTDR connections rather than re-connecting cords at the interface under test. The OTDR connections shall be uniquely identified as shown in Figure 5.

#### 6.3.4.7 OTDR tail cord

The tail cord shall be

- of a different length than the corresponding launch cord (but longer than the attenuation dead zone of the OTDR, see Annex C for further details),
- long enough for a reliable straight-line fit to be made to the backscatter trace following the dead zone (C3 to C4 in Figure 11), so that reliable insertion loss measurements may be carried out. For example, in single-mode installations the length of the tail cord should be at least 150 m,
- terminated at one end with one or more reference connectors compatible with the interface to the installed cabling.

The termination of the other end(s) is optional.

The length of optical fibres used to create test cords often requires that they be protected within a closure (see Figure 6).

Where the interface to the cabling or component under test is duplex, the two optical fibres shall both be shorter than the corresponding launch cord (but longer than the attenuation dead zone of the OTDR), but shall be of different lengths in order to determine the maintenance of polarity in the cabling under test.

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