

BS EN 61280-4-2:2014



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Fibre-optic communication subsystem test procedures

Part 4-2: Installed cable plant —
Single-mode attenuation and optical
return loss measurement

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English Version

**Fibre-optic communication subsystem test procedures - Part 4-2:
Installed cable plant - Single-mode attenuation and optical return
loss measurement
(IEC 61280-4-2:2014)**

Procédures d'essai des sous-systèmes de
télécommunication à fibres optiques - Partie 4-2:
Installations câblées - Mesure de l'affaiblissement de
réflexion optique et de l'affaiblissement des fibres
unimodales
(CEI 61280-4-2:2014)

Prüfverfahren für Lichtwellenleiter-
Kommunikationsuntersysteme - Teil 4-2: Installierte
Kabelanlagen - Einmoden-Dämpfungs- und optische
Rückflussdämpfungsmessung
(IEC 61280-4-2:2014)

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Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Foreword

The text of document 86C/1238/FDIS, future edition 2 of IEC 61280-4-2, prepared by SC 86C, "Fibre optic systems and active devices", of IEC TC 86, "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61280-4-2:2014.

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This document supersedes EN 61280-4-2:1999.

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60793-1-40	NOTE	Harmonized as EN 60793-1-40.
IEC 60793-2	NOTE	Harmonized as EN 60793-2.
IEC 61280-1-3	NOTE	Harmonized as EN 61280-1-3.
IEC 61753-1	NOTE	Harmonized as EN 61753-1.
IEC 61755-2-1	NOTE	Harmonized as EN 61755-2-1.
IEC 61755-2-2	NOTE	Harmonized as EN 61755-2-2.
IEC 61755-2-4	NOTE	Harmonized as EN 61755-2-4 ¹⁾ .
IEC 61755-2-5	NOTE	Harmonized as EN 61755-2-5 ¹⁾ .

¹⁾ To be published.

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-2-50	-	Optical fibres -- Part 2-50: Product specifications - Sectional specification for class B single-mode fibres	EN 60793-2-50	-
IEC 60825-2	-	Safety of laser products -- Part 2: Safety of optical fibre communication systems (OFCS)	EN 60825-2	-
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 61300-3-6	-	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures -- Part 3-6: Examinations and measurements - Return loss	EN 61300-3-6	-
IEC 61300-3-35	-	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures -- Part 3-35: Examinations and measurements - Visual inspection of fibre optic connectors and fibre-stub transceivers	EN 61300-3-35	-
IEC 61315	-	Calibration of fibre-optic power meters	EN 61315	-
IEC 61746-1	2009	Calibration of Optical Time-Domain Reflectometers (OTDR) -- Part 1: OTDR for single-mode fibres	EN 61746-1	2011
IEC/TR 62627-01	-	Fibre optic interconnecting devices and passive components - Part 01: Fibre optic connector cleaning methods	-	-

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INTRODUCTION

This second edition of IEC 61280-4-2 for testing single-mode cable plant follows on from the second edition of IEC 61280-4-1, dealing with multimode cable plants.

Cabling design standards such as ISO/IEC 11801 for commercial premises, ISO/IEC 24702 for industrial premises, ISO/IEC 24764 for data centres and ISO/IEC 15018 for residential cabling contain specifications for this type of cabling. These standards support cabling lengths of up to 2 km for commercial premises and data centres and up to 10 km for industrial premises. ISO/IEC 14763-3, which supports these design standards, makes reference to the test methods of this standard.

Various recommendations from ITU-T have requirements for longer distance applications including short haul (40 km), long haul (80 km) and ultra long haul (160 km). The testing of cable plant for these is covered in ITU-T Recommendation G.650.3, which makes reference to the test methods of this standard.

FIBRE-OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 4-2: Installed cable plant – Single-mode attenuation and optical return loss measurement

1 Scope

This part of IEC 61280 is applicable to the measurement of attenuation and optical return loss of installed optical fibre cable plant using single-mode fibre. This cable plant can include single-mode optical fibres, connectors, adapters, splices and other passive devices. The cabling may be installed in a variety of environments including residential, commercial, industrial and data centre premises, as well as outside plant environments.

This standard may be applied to all single-mode fibre types including those designated by IEC 60793-2-50 as Class B fibres.

The principles of this standard may be applied to cable plants containing branching devices (splitters) and at specific wavelength ranges in situations where passive wavelength selective components are deployed, such as WDMs, CWDM and DWDM devices.

This standard is not intended to apply to cable plant that includes active devices such as fibre amplifiers or dynamic channel equalizers.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 60874-14-2, *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 61300-3-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*

IEC 61300-3-35, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-35: Examinations and measurements – Fibre optic cylindrical connector endface visual inspection*

IEC 61315, *Calibration of fibre-optic power meters*

IEC 61746-1:2009, *Calibration of optical time-domain reflectometers (OTDR) – Part 1: OTDR for single-mode fibres*

IEC TR 62627-01, *Fibre optic interconnecting devices and passive components – Fibre optic connector cleaning methods*

3 Terms, definitions, graphical symbols and abbreviations

For the purposes of this document, the following terms, definitions, graphical symbols and acronyms apply.

3.1 Terms and definitions

3.1.1

adapter

female part of a connector in which one or two plugs are inserted and aligned

[SOURCE: IEC TR 61931:1998, 2.6.4]

3.1.2

attenuation

measure of the reduction of optical power transmitted through the cabling under test

Note 1 to entry: Attenuation (L) is determined as the ratio of the input power (P_{in}) to output power (P_{out}) of the cabling under test, given as

$$L = 10 \times \log_{10} \times (P_{in}/P_{out})$$

Alternatively attenuation may be expressed as $L = -10 \times \log_{10} \times (P_{out}/P_{in})$. Both equations are mathematically equivalent, resulting in positive decibel values.

Note 2 to entry: Loss and attenuation are equivalent.

3.1.3

bidirectional measurement

two measurements of the same optical fibre made by launching light into opposite ends of that fibre

3.1.4

configuration

form or arrangement of parts or elements such as terminations, connections and splices

3.1.5

connector

component normally attached to an optical cable or piece of apparatus, for the purpose of providing frequent optical interconnection/disconnection of optical fibres or cables

[SOURCE: IEC TR 61931:1998, 2.6.1]

3.1.6

light source power meter

LSPM

test system consisting of a light source (LS), power meter (PM) and associated test cords used to measure the attenuation of installed cable plant

3.1.7

optical return loss

ORL

ratio of the input power (P_{in}) of the cabling under test to the backward power (P_r), reflected by the cabling under test, expressed in decibels:

$$ORL = 10 \times \log_{10}(P_{in}/P_r)$$

Note 1 to entry: Optical return loss is a positive number.

3.1.8

optical time domain reflectometer

OTDR

test system consisting of an optical time-domain reflectometer and associated test cords used to characterize and measure the attenuation and optical return loss of installed cable plant and specific elements within that cable plant

3.1.9

plug

free connector

male part of a connector

[SOURCE: IEC TR 61931:1998, 2.6.2]

3.1.10

reference grade termination

connector plug with tightened tolerances terminated onto a single-mode optical fibre with tightened tolerances such that the expected loss of a connection formed by mating two such assemblies is less than or equal to 0,2 dB

Note 1 to entry: An adapter, required to assure this performance, may be considered to be part of the reference grade termination where required by the test configuration.

Note 2 to entry: This definition is consistent with the reference grade 2 connections defined in IEC 61755-2-4 for non-angled (PC) and IEC 61755-2-5 for angled (APC) cylindrical ferrule connectors. These standards may be referenced for further information.

3.1.11

reference test method

RTM

test method used in the resolution of a dispute

3.1.12

reflectance

for a discrete component in the cabling, the ratio of the backward power (P_r) reflected by the component to the input power (P_{in}) into the component, expressed in decibels:

$$\text{Reflectance} = 10 \times \log_{10}(P_r / P_{in})$$

Note 1 to entry: Reflectance is a negative number.

Note 2 to entry: Alternatively, this is referred to (e.g. by IEC 61300-3-6) as the return loss of individual components and is expressed as $RL = -10 \times \log_{10}(P_r / P_{in})$, which is a positive number.

3.1.13

return loss test set

RLTS

test system consisting of a light source (LS) and internal power meter (PM), directional coupler and additional external power meter and associated test cords used to measure the optical return loss of an installed cabling plant

3.1.14

socket-style connector

fixed connector, socket

connector for which the adapter, including any alignment device, is integrated with and permanently attached to the connector plug on one side of the connection

Note 1 to entry: Examples include the SG (IEC 61754-19) and many harsh environment connectors.

3.1.15**test cord**

terminated optical fibre cord used to connect the optical source or detector to the cabling or to provide suitable interfaces to the cabling under test

Note 1 to entry: There are five types of test cords:

- launch cord: used to connect the light source to the cabling;
- receive cord: used to connect the cabling to the power meter (LSPM only);
- tail cord: attached to the far end of the cabling when an OTDR is used at the near end. This provides a means of evaluating attenuation and optical return loss of the whole of the cabling including the far end connection;
- adapter cord: used to transition between sockets or other incompatible connectors in a required test configuration;
- substitution cord: a test cord used within a reference measurement which is replaced during the measurement of the loss of the cabling under test.

3.2 Graphical symbols

The following graphical symbols, as shown in Figure 1, for different connection options have been adapted from IEC 61930.

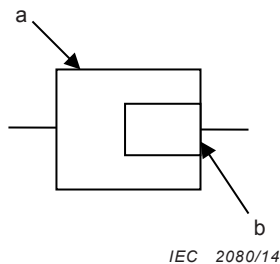


Figure 1a – Socket and plug assembly

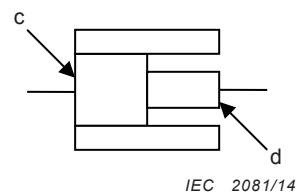


Figure 1b – Connector set (plug, adapter, plug)

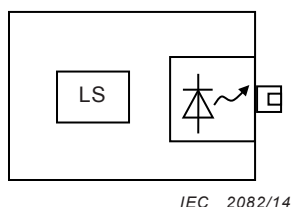


Figure 1c – Light source

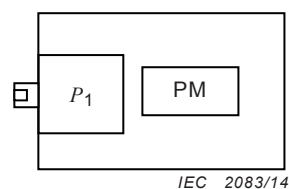


Figure 1d – Power meter

Key

a	socket
b	plug
c	plug-adapter assembly
d	plug inserted into plug-adapter assembly
LS	light source
PM	power meter

NOTE 1 In Figure 1b and elsewhere in this standard, the plugs are shown with different sizes to indicate directionality where the cabling has adapters pre-attached and the test cord does not, or vice versa. In Figure 1b, the plug on the left has the adapter pre-attached.

NOTE 2 Reference grade terminations are shown shaded with grey.

Figure 1 – Connector symbols

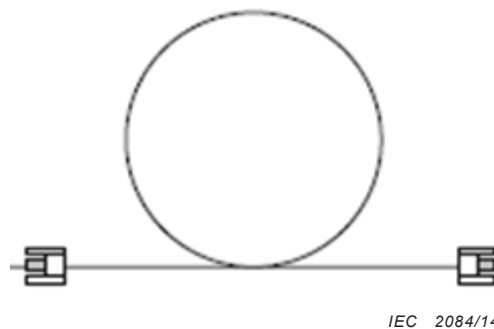


Figure 2 – Symbol for cabling under test

In the figures that illustrate the measurement configurations in Annexes A through D, the cabling under test is illustrated by a loop, as shown in Figure 2. Although illustrated as just a loop of fibre, it may contain additional splices and connectors in addition to the terminal connectors. Note that for purposes of measuring the attenuation of this cabling, the losses associated with the terminal connectors are considered separately from the cabling itself.

NOTE 1 In Figure 2, the cabling is shown with adapters pre-attached and the plugs going into them are associated with reference grade test cord plugs.

3.3 Abbreviations

This standard uses the following abbreviations:

APC	angled physical contact (description of connector style)
BBS	broadband source
CW	continuous wave
CWDM	coarse wavelength division multiplexing
DWDM	dense wavelength division multiplexing
FTTH	fibre to the home
LS	light source
LSA	least squares approximation
LSPM	light source power meter
OCWR	optical continuous wave reflectometer
ORL	optical return loss
OSA	optical spectrum analyser
OTDR	optical time domain reflectometer
PC	physical contact (description of connector style that is not angled)
PM	power meter
PON	passive optical network
ROADM	reconfigurable optical add drop multiplexer
RLTS	return loss test set
RTM	reference test method
WDM	wavelength division multiplexing

4 Measurement methods

4.1 General

Four attenuation measurement methods are designated. The four measurement methods use test cords to interface with the cable plant and are designated as follows:

- one-cord reference method;
- three-cord reference method;
- two-cord reference method;
- optical time domain reflectometer (OTDR) method.

The first three methods use an optical light source and power meter (LSPM) to measure input and output power levels of the cabling under test to determine the attenuation. The main functional difference between these methods is the way the input power level, known as the reference power level, is measured and hence the inclusion or exclusion of the losses associated with the connections to the cabling under test, and the associated uncertainties of these connections. The process of measuring the input power level is commonly referred to as "taking the reference power level."

The use of the term "reference" in the description of the test methods refers to the process of measuring the input power, not the status of the test.

The one-cord reference method produces results that include the attenuation associated with connections at both ends of the cabling under test. The three-cord reference method produces results that attempt to exclude the attenuation of the connections of both ends of the cabling under test. The two-cord reference method normally produces results that include the attenuation associated with one of the connections of the cabling under test.

NOTE The maximum allowed cabling attenuation specified (e.g. optical power budget or channel insertion loss) for a transmission system normally excludes the connections made to the transmission equipment. It is therefore appropriate to use the three-cord reference method where the cabling under test is intended to be connected directly to transmission equipment.

The OTDR method emits short light impulses into the cabling and measures the backscattered power as a function of propagation time delay or length along the fibre. This also allows the determination of individual cabling component attenuation values. It does not require a separate reference measurement to be completed. Requirements for the launch cord and tail cord are defined in Annex D.

This standard also defines two types of test methods that can be used for measuring the optical return loss of installed cabling:

- OTDR based method;
- continuous wave method using a return loss test set.

The OTDR method allows the optical return loss of the entire cabling to be measured as well as providing measurements of the reflectance of discrete components or the optical return loss of specific sections of the cabling. The measurement may be carried out in one step from each end of the cabling under test. This method is described in detail in Clause D.5.

The continuous wave method as described in Annex E directly measures the forward power into the cabling under test as an initial measurement step and then compares this with the reflected power measured back through a directional coupler. Additional reference or calibration measurements are required to quantify the attenuation through the directional coupler and to cancel out any internal reflections in the measurement apparatus.

An alternative continuous wave test method is described in Annex F. The forward power level is calculated from indirect measurements and the reflected power measured in a similar way.

to the method described in Annex E. Another additional reference measurement of a known reflectance termination is needed to implement this method.

Uncertainties in the specific methods are documented in respective annexes. An overview of these uncertainties is given in 4.2.

General requirements for apparatus, procedures and calculations common to all methods are given in the main text of this standard. Requirements that are specific to each particular method are documented in Annexes A through F. The main text also includes related procedures such as connector end face cleaning and inspection.

4.2 Cabling configurations and applicable test methods

4.2.1 Cabling configurations and applicable test methods for attenuation measurements

This standard assumes that the installed cabling takes one of three forms shown in Table 1. If the cabling is terminated with an adapter, the test cord shall be terminated with a plug and vice versa.

Table 1 – Cabling configurations

Configuration	Description
A	Adapters attached to plugs or sockets attached to both ends of the cabling
B	Plugs on both ends
C	Mixed, where one end of the cabling is terminated with an adapter and the other end is terminated with a plug

The variations in test method used to measure the cabling are dependent on the cabling configuration. For example, a common cabling configuration is that of having adapters or sockets on both ends of the cabling (e.g. within patch panels) awaiting connection to electronic equipment with an equipment cord. This corresponds to configuration A. In this case, the one cord reference method is used to include the losses associated with both end connectors of the cabling as illustrated in Figure 3.

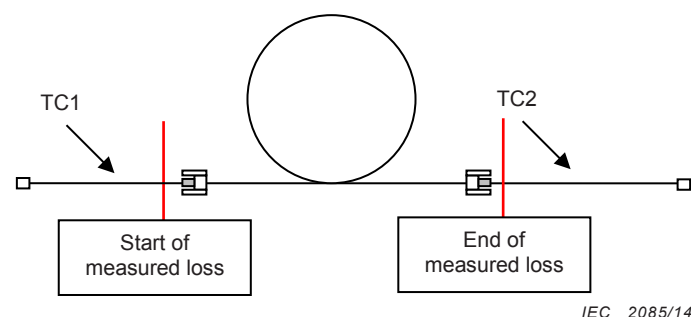


Figure 3 – Configuration A – Start and end of measured losses in reference test method

NOTE 1 Figure 3 is an example of cabling in configuration A with test cords TC1 and TC 2 attached, illustrating the start and end point of the measured losses when the reference test method is used (the one-cord reference method as detailed in Annex A).

Another example is a cabling configuration for which equipment cords are installed on both ends of the cabling and are awaiting connection to electronic equipment. This corresponds to configuration B. In this case, a three-cord reference method is used to exclude the loss of the end plug connections.

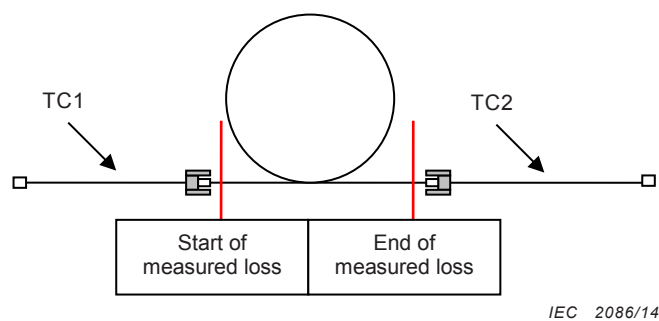


Figure 4 – Configuration B – Start and end of measured losses in reference test method

NOTE 2 Figure 4 is an example of cabling in configuration B with test cords attached, illustrating the start and end point of the measured losses when the reference test method is used (the three-cord reference method as detailed in Annex B).

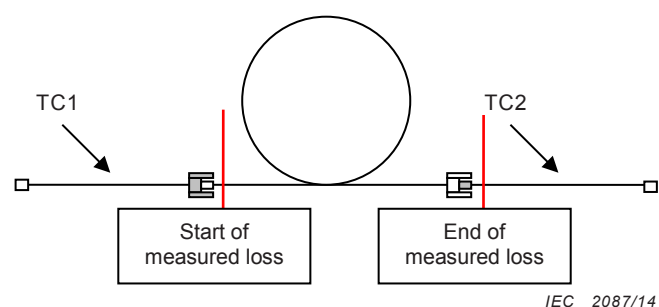


Figure 5 – Configuration C – Start and end of measured losses in reference test method

NOTE 3 Figure 5 shows an example of cabling in configuration C with test cords attached, illustrating the start and end point of the measured losses when the reference test method is used (the two-cord reference method as detailed in Annex C).

The configuration A, B or C defines the test methods that should be applied as described in Table 2. The reference test method offers the best measurement accuracy. Alternative test methods may be called up in specific circumstances or by other standards but are subject to reduced measurement accuracy compared with the reference test method. Reference grade terminations on the test cords as described in 5.2.3, 5.3 and 5.4 shall be used for the resolution of disputes, unless otherwise agreed.

Table 2 – Test methods and configurations

Configuration	RTM	Alternative method
A	Annex A	Annex B*, Annex D
B	Annex B	Annex D
C	Annex C	Annex B, Annex D
* For situations where pinned/unpinned or plug/socket style connectors are used such as MTRJ, SG or another harsh environment connector where the power meter does not accept the unpinned or plug connector of the launch cord, the method illustrated in Figure C.3 may be used. * Where information is required about the discrete components installed within the cabling under test, Annex D is the only one of these test methods that provides this.		
NOTE These configurations, RTMs and annexes are ordered according to the frequency in which different configurations are typically encountered.		

4.2.2 Cabling configurations and applicable test methods for optical return loss measurements

Any of the cabling configurations described in 4.2.1 can be measured using any of the three defined ORL test methods in Annexes D, E and F.

The OTDR ORL test method as described in Clause D.5 requires no separate reference measurements to be taken and is least likely to be affected by measurement errors. When the cabling is tested using a suitable launch cord and tail cord, then it is easy to define the start and end points of the ORL measurement as shown in Figure D.5.

The continuous wave ORL test method described in Annex E is likely to provide the most accurate ORL results, provided that reference measurements are carried out correctly and that unwanted reflections are suppressed. In particular, care needs to be taken if a short (<10 km) length of cable is tested with a PC (non-angled) connector at the far end. If this connector is left open, the unwanted reflection from this glass/air interface will dominate the total ORL. Hence the use of a tail cord with PC connection at one end and APC connection at the other in Figure E.1 to suppress the glass/air reflection whilst providing a contribution from a representative reflectance from a connector pair at the far end of the system.

The alternative configuration of CW ORL measurement described in Annex F has no direct measurement of the forward power going into the system under test, and reference measurements are required on known reflectance terminations.

4.3 Overview of uncertainties

4.3.1 General

The uncertainties are affected by the type of fibre, the terminations of the cabling and the measurement method used. See Annex G for some more detailed considerations.

4.3.2 Test cords

A main source of uncertainty involves the connection of the terminated cabling to the test equipment. The attenuation and reflectance associated with the test cord connections may be different from the attenuation and reflectance present when the cabling is connected to other cords or transmission equipment. The use of reference grade terminations on the test cords reduces this uncertainty and improves reproducibility of the measurement, but the allocation of acceptable attenuation is changed as listed in Table G.1.

4.3.3 Reflections from other interfaces

When conducting optical return loss measurements, reflections from other interfaces can be a significant cause of measurement uncertainty, particularly for the continuous wave method. It is important to configure the cabling under test such that unwanted reflections are suppressed. For example, when testing a short length of cable, a test cord should be coupled to the far end of the cabling under test with an angled connector at the remote end of the test cord. It is also usual for the connector interface to the return loss test set to be an angled connector.

For the OTDR based return loss method, the use of suitably long launch and tail leads can be used to eliminate the effect of unwanted reflections.

4.3.4 Optical source

The following sources of uncertainties are relevant to the attenuation measurements:

- wavelength of the source – causes fibre attenuation variations between source wavelength and cabling system transmitter wavelength;

- spectral width – wider spectral widths cause fibre attenuation variations between the source wavelength and the cabling system transmitter wavelength; narrower spectral widths can introduce coherent interference effects.

4.3.5 Output power reference

For methods using LSPM, one of the main sources of uncertainty is the variable coupling efficiency of the light source to the launch cord due to mechanical tolerances. To minimize this uncertainty, a reference power reading should be made whenever the connection is disturbed by stress on the connector or disconnection.

For LSPM methods, a reference measurement shall be made to determine the output power of the launch cord which will be coupled to the cable or cable plant under test. This measurement should be made each time the launch cord is attached to the source, as the coupling may be slightly different each time it is carried out.

4.3.6 Received power reference

If the power meter has a detector large enough to capture all incident light, then the coupling of the receive cord to the power meter is minimal and shall be discounted. In other circumstances (which may include the use of pigtailed detectors), the uncertainty introduced shall be included in the overall measurement uncertainty.

4.3.7 Mode field diameter variation

If the test interfaces have fibres with significant differences in mode field diameters, then additional attenuation may be introduced that will affect the measurement accuracy. The single-mode optical interface standards give details of the attenuation introduced by mode field diameter mismatches, e.g. IEC 61755-2-1 for non-angled interfaces and IEC 61755-2-2 for 8-degree angled interfaces.

4.3.8 Bi-directional measurements

For the LSPM methods of measuring attenuation, the test results from each end should be very similar. Comparing the results from each end to make sure that they are within a certain tolerance (for example 0,5 dB) of each other is a good way to make sure that the measurement results are valid and that no additional uncertainty is present due to measurement errors.

5 Apparatus

5.1 General

Apparatus requirements that are specific to particular methods are found in Annexes A to D. Some of the requirements common to the apparatus of LSPM methods are included in this clause.

5.2 Light source

5.2.1 Stability

The performance of the light source is defined at the output of the launch cord. This is achieved by transmitting the output of a suitable radiation source, usually a laser, into the launch cord. The source shall be stable in position, wavelength and power over the duration of the entire measurement procedure.

It is recommended that the stability of the source be verified by repeating the reference measurement at the end of the measurement procedure. It should remain within a certain tolerance (typically no more than 0,5 dB) of the initial reference value.

The stability of the light source will directly affect the measurement uncertainty. For measuring low loss systems, a lower value may be required to achieve the required measurement certainty.

5.2.2 Spectral characteristics

The wavelengths used for the attenuation measurement should be representative of the wavelengths at which systems will operate over the fibre. For premises cabling and many other applications, this measurement is carried out at nominal wavelengths of 1 310 nm and 1 550 nm.

If other wavelengths are to be used for transmission, additional test wavelengths may also be required. For example, if DWDM applications using the L-band (1 565 nm to 1 625 nm) are to be used, then testing at 1 625 nm as well is recommended; if a passive optical network for FTTH is being tested, then 1 490 nm testing may be required.

If the cabling under test may be used for CWDM systems that cover an extended wavelength range, then either the cabling could be tested at each wavelength individually, or alternatively, a spectral attenuation measurement may be taken to cover the entire wavelength range of interest using a suitable broadband light source and an optical spectrum analyser in place of the light source and power meter. See Annex J for further information.

It is recommended that OTDR testing be carried out on single-mode cabling using at least two wavelengths. This allows attenuation that is due to bending of the fibre to be identified by comparing the traces at the two wavelengths. See H.4.2 for further information on bending loss measurement. Often the wavelengths used are nominally 1 310 nm and 1 550 nm for shorter routes (<40 km) or 1 550 nm and 1 625 nm for longer routes. The wavelength of 1 650 nm, which is sometimes used for maintenance channels, is also very effective for detecting the presence of bends.

If the cabling under test includes wavelength selective elements such as WDM, DWDM or CWDM devices, optical filters, etc., then the spectral width of the light source shall be compatible with the filtering to be used; this may require a very narrow spectral width. Alternatively, the spectral response of the system may be evaluated using a broadband light source and optical spectrum analyser using the procedure described in Annex J.

5.2.3 Launch cord

The optical fibre within the launch cord at the connection to the cabling under test shall be of the same type as the optical fibre within the cabling under test. Except for the OTDR method, the launch cord shall be no shorter than 2 m, not so long that the attenuation of the fibre has a significant effect on the measurement. See Annex D for the length of the OTDR launch cord.

The connector or adapter terminating the launch cord shall be compatible with the cabling and the termination should be of reference grade to minimize the uncertainty of measurement results.

5.3 Receive or tail cord

The optical fibre within the receive or tail cord shall be of the same type as the optical fibre within the cabling under test.

The receive cord shall be no shorter than 2 m and not so long that the attenuation of the fibre has a significant effect on the measurement.

The connector or adapter terminating the receive or tail cord shall be compatible with the cabling and the termination should be of reference grade to minimize the uncertainty of measurement results.

The termination of a receive cord at the connection to the power meter shall be compatible with that of the power meter.

Where unidirectional testing is carried out, the remote end of the tail cord used for OTDR testing has no requirement for a reference grade termination. Where bi-directional testing is carried out, the tail cord becomes the launch cord (see Annex I) and shall comply with 5.2.3.

5.4 Substitution cord

The optical fibre within the substitution cord shall be of the same type as the optical fibre within the cabling under test.

The substitution cord shall be no shorter than 2 m and not so long that the attenuation of the fibre has a significant effect on the measurement.

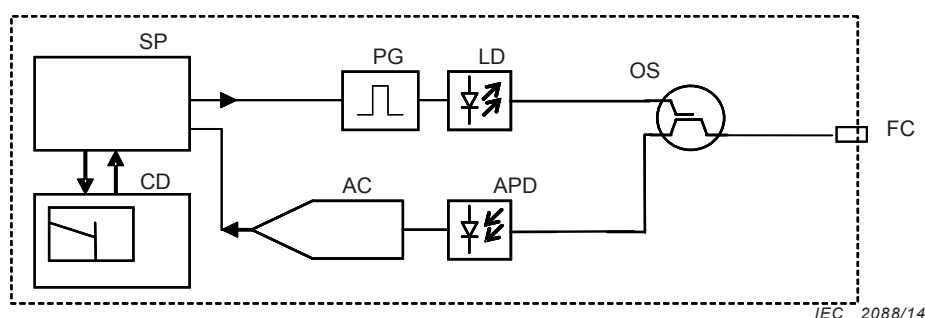
The connectors or adapters terminating the substitution cord shall be compatible with the cabling and the terminations should be of reference grade to minimize the uncertainty of measurement results.

5.5 Power meter – LSPM methods only

The power meter shall be capable of measuring the range of power at wavelengths normally associated with the cabling, including considerations on the power launched into the cabling. The power meter shall meet the calibration requirements of IEC 61315. The meter shall have a detecting surface of sufficient size to capture all the power coming from the fibre that is put into it. If a pigtail is used, the pigtail fibre shall be sufficiently large to capture all the power coming from the test cord.

5.6 OTDR apparatus

Figure 6 is a schematic of the typical OTDR apparatus shown with a simple attachment point. The OTDR shall meet the calibration requirements of IEC 61746-1. Annex D has some more detailed requirements for the length of the launch cord and other aspects related to the OTDR measurement.



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Key

PG	pulse generator
LD	laser diode
OS	optical splitter
FC	front panel connector
APD	avalanche photo diode
AC	amplifier and converter
SP	signal processor
CD	control and display

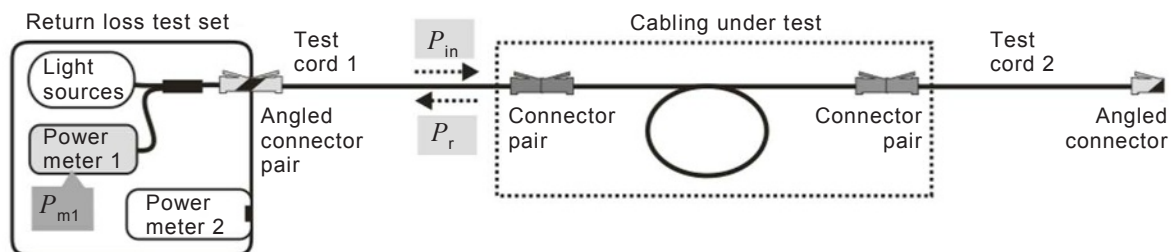
Figure 6 – Typical OTDR schematic

5.7 Return loss test set

A return loss test set typically comprises one or more stabilized laser sources. The output from the source passes through a directional coupler to the output port of the RLTS that should be fitted with a low reflectance connection. This should have reflectance that is 10 dB better than the ORL of the cabling under test; an angled connector interface can usually achieve this. The other leg of the directional coupler directs reflected light back to the internal power meter (P_{m1} on the diagram). A second power meter (P_{m2} on the diagram) with an external connector interface is often also fitted to measure the power level that is input to the cabling under test.

Alternative configurations are possible, including the use of a second return loss test set to measure the power input to the cabling under test, provided that the attenuation through the connector interface and the directional coupler can be calibrated out.

In a typical measurement configuration as shown, test cords are required to interface to the cabling under test and to suppress unwanted reflections through the use of angle polished connectors.



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Figure 7 – Return loss test set illustration

5.8 Connector end-face cleaning and inspection equipment

Cleaning equipment (including apparatus, materials, and substances) and the methods to be used shall be in accordance with IEC TR 62627-01. Connector suppliers' instructions shall be consulted where doubt exists as to the suitability of particular equipment and cleaning methods.

A microscope compatible with IEC 61300-3-35, low resolution method, is required to verify that the fibre and connector end faces of the test cords are clean and free of damage. Microscopes with adaptors that are compatible with the connectors used are required.

The use of a video microscope is recommended to avoid any risk associated with direct viewing of energized fibre end faces.

5.9 Adapters

Where appropriate, adapters shall be compatible with the connector style being used and shall allow the required performance of reference grade terminations to be achieved.

6 Procedures

6.1 General

Procedure requirements specific to particular methods are found in Annexes A through F.