

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

REDLINE VERSION

Delsystem för fiberoptisk kommunikation – Grundläggande provningsmetoder – Del 4-2: Installationer med optokablar – Mätning av dämpning och reflexionsdämpning för installerade singelmodfibrer

*Fibre-optic communication subsystem test procedures –
Part 4-2: Installed cabling plant –
Single-mode attenuation and optical return loss measurement*

En så kallad ”Redline version” (RLV) innehåller både standarden som fastställts som SEK-publication och en ändringsmarkerad IEC-standard. Alla tillägg och borttagningar sedan den tidigare utgåvan av IEC-standarderna är markerade med färg. Med en RLV sparar du mycket tid när du ska identifiera och bedöma aktuella ändringar i standarden. SEK Svensk Elstandard kan bara ge ut RLV i de fall den finns tillgänglig från IEC.



IEC 61280-4-2

Edition 3.0 2024-05
REDLINE VERSION

INTERNATIONAL STANDARD



**Fibre- optic communication subsystem test procedures –
Part 4-2: Installed ~~cable~~ cabling plant – Single-mode attenuation and optical
return loss measurements**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.100.01

ISBN 978-2-8322-8892-4

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

| | |
|--|---------------|
| FOREWORD..... | 8 |
| INTRODUCTION..... | 10 |
| 1 Scope..... | 11 |
| 2 Normative references | 11 |
| 3 Terms, definitions, graphical symbols and abbreviated terms..... | 12 |
| 3.1 Terms and definitions..... | 12 |
| 3.2 Graphical symbols | 15 |
| 3.3 Abbreviated terms..... | 16 |
| 4 Measurement methods | 17 |
| 4.1 General..... | 17 |
| 4.1.1 Document structure | 17 |
| 4.1.2 Attenuation | 17 |
| 4.1.3 Optical return loss | 18 |
| 4.2 Cabling configurations and applicable test methods | 18 |
| 4.2.1 Cabling configurations and applicable test methods for attenuation measurements..... | 18 |
| 4.2.2 Cabling configurations and applicable test methods for optical return loss measurements..... | 23 |
| 5 Overview of uncertainties for attenuation measurements | 23 |
| 5.1 General..... | 23 |
| 5.2 Sources of significant uncertainties..... | 24 |
| 5.3 Consideration of the power meter | 24 |
| 5.4 Consideration of test cord and connector grade | 24 |
| 5.4.1 General | 24 |
| 5.4.2 Mode field diameter variation..... | 24 |
| 5.5 Reflections from other interfaces..... | 25 |
| 5.6 Optical source..... | 25 |
| 5.7 Output power reference | 25 |
| 4.3.6 Received power reference | 25 |
| 5.8 Bi-directional measurements..... | 25 |
| 5.9 Typical uncertainties for attenuation methods A, B, C, and D..... | 25 |
| 5.10 Typical uncertainty values for single-mode attenuation testing for method E | 27 |
| 6 Apparatus..... | 28 |
| 6.1 General..... | 28 |
| 6.2 Light source | 28 |
| 6.2.1 Stability | 28 |
| 6.2.2 Spectral characteristics | 28 |
| 6.3 Launch cord | 29 |
| 6.4 Receive or tail cords | 29 |
| 6.5 Substitution cord..... | 29 |
| 6.6 Power meter – LSPM methods only..... | 30 |
| 6.7 OTDR apparatus..... | 30 |
| 6.8 Return loss test set..... | 30 |
| 6.9 Connector end-face cleaning and inspection equipment..... | 31 |
| 6.10 Adapters | 32 |
| 7 Procedures..... | 32 |
| 7.1 General..... | 32 |

| | | |
|---------------------|--|----|
| 7.2 | Common procedures | 32 |
| 7.2.1 | Care of the test cords | 32 |
| 7.2.2 | Make reference measurements (LSPM and OCWR methods only) | 32 |
| 7.2.3 | Inspect and clean the ends of the fibres in the cabling | 32 |
| 7.2.4 | Make the measurements | 33 |
| 7.2.5 | Make the calculations | 33 |
| 7.3 | Calibration | 33 |
| 7.4 | Safety | 33 |
| 8 | Calculations | 33 |
| 9 | Documentation | 33 |
| 9.1 | Information for each test | 33 |
| 9.2 | Information to be made available | 34 |
| Annex A (normative) | One-cord reference method | 35 |
| A.1 | Applicability of test method | 35 |
| A.2 | Apparatus | 35 |
| A.3 | Procedure | 35 |
| A.4 | Calculation | 36 |
| A.5 | Components of reported attenuation | 37 |
| Annex B (normative) | Three-cord reference method | 38 |
| B.1 | Applicability of test method | 38 |
| B.2 | Apparatus | 38 |
| B.3 | Procedure | 38 |
| B.4 | Calculations | 40 |
| B.5 | Components of reported attenuation | 40 |
| Annex C (normative) | Two-cord reference method | 42 |
| C.1 | Applicability of test method | 42 |
| C.2 | Apparatus | 42 |
| C.3 | Procedure | 42 |
| C.4 | Calculations | 44 |
| C.5 | Components of reported attenuation | 44 |
| Annex D (normative) | Equipment cord method | 46 |
| D.1 | Applicability of the test method | 46 |
| D.2 | Apparatus | 46 |
| D.3 | Procedure | 46 |
| D.4 | Calculation | 47 |
| D.5 | Components of reported attenuation | 48 |
| Annex E (normative) | Optical time domain reflectometer | 49 |
| E.1 | Applicability of test method | 49 |
| E.2 | Apparatus | 49 |
| E.2.1 | General | 49 |
| E.2.2 | OTDR | 49 |
| E.2.3 | Test cords | 49 |
| E.3 | Procedure (test method) | 50 |
| E.4 | Calculation of attenuation | 51 |
| E.4.1 | General | 51 |
| E.4.2 | Connection location | 52 |
| E.4.3 | Definition of the power levels F_1 and F_2 | 54 |
| E.4.4 | Alternative calculation | 56 |

| | | |
|-----------------------|---|---------------|
| E.5 | Calculation of optical return loss | 58 |
| E.6 | Calculation of reflectance for discrete components | 60 |
| E.7 | OTDR uncertainties | 62 |
| Annex F (normative) | Continuous wave optical return loss measurement – Method A..... | 63 |
| F.1 | Applicability of test method | 63 |
| F.2 | Apparatus | 63 |
| F.2.1 | General | 63 |
| F.2.2 | Light source..... | 63 |
| F.2.3 | Branching device or coupler | 63 |
| F.2.4 | Power meters | 64 |
| F.2.5 | Connector interface | 64 |
| F.2.6 | Low reflection termination..... | 64 |
| F.3 | Procedure | 64 |
| F.3.1 | Test set characterization..... | 64 |
| F.3.2 | Measurement procedure | 66 |
| F.3.3 | Calculations..... | 66 |
| E.3.4 | Measurement uncertainty..... | 66 |
| Annex G (normative) | Continuous wave optical return loss measurement – Method B..... | 68 |
| G.1 | Applicability of test method | 68 |
| G.2 | Apparatus | 68 |
| G.2.1 | General requirements | 68 |
| G.2.2 | Known reflectance termination..... | 69 |
| G.3 | Procedure | 69 |
| G.3.1 | Set-up characterization..... | 69 |
| G.3.2 | Measurement procedure | 70 |
| G.3.3 | Calculation | 70 |
| F.3.4 | Measurement uncertainty..... | 70 |
| Annex G (informative) | Measurement uncertainty examples | |
| G.1 | Reduction of uncertainty by using reference grade terminations and related issues | |
| G.1.1 | Motivations for using reference grade terminations on test cords..... | |
| G.1.2 | Adjusting acceptance limits to allow for different expected losses when using reference grade and standard grade connectors..... | |
| G.2 | Estimation of the measurement uncertainties | |
| G.2.1 | Measurement uncertainty..... | |
| G.2.2 | Uncertainty due to the instrument | |
| G.2.3 | Uncertainty due to the source | |
| G.2.4 | Uncertainty due to the device under test..... | |
| G.2.5 | Example of uncertainty accumulation using a single power meter | |
| G.2.6 | Example of uncertainty accumulation using two power meters | |
| Annex H (normative) | On the use of reference-grade test cords | 78 |
| H.1 | General..... | 78 |
| H.2 | Practical configurations and assumptions..... | 78 |
| H.2.1 | Component specifications..... | 78 |
| H.2.2 | Conventions | 79 |
| H.2.3 | Reference planes | 79 |
| H.3 | Impact of using reference-grade test cords for recommended LSPM methods..... | 80 |
| H.4 | Examples for LSPM measurements..... | 80 |
| H.4.1 | Example 1 (configuration A, one-cord method, Annex A) | 80 |

| | | |
|---------|---|-----|
| H.4.2 | Example 2 (configuration B, three-cord method, Annex B) | 81 |
| H.4.3 | Example 3 (configuration C, two-cord method, Annex C) | 81 |
| H.4.4 | Example 4 – Long haul system (one-cord reference method) | 82 |
| H.5 | Impact of using reference-grade test cords for different configurations using the OTDR test method | 82 |
| H.5.1 | Cabling configurations A, B and C | 82 |
| H.5.2 | Cabling configuration D | 83 |
| Annex I | (informative) OTDR configuration information | 85 |
| I.1 | Introductory remarks | 85 |
| I.2 | Fundamental parameters that define the operational capability of an OTDR | 86 |
| I.2.1 | Dynamic range | 86 |
| I.2.2 | Dynamic margin | 86 |
| I.2.3 | Pulse width | 86 |
| I.2.4 | Averaging time | 86 |
| I.2.5 | Dead zone | 86 |
| I.3 | Other parameters | 87 |
| I.3.1 | Index of refraction | 87 |
| I.3.2 | Measurement range | 87 |
| I.3.3 | Distance sampling | 87 |
| I.4 | Other measurement configurations | 87 |
| I.4.1 | General | 87 |
| I.4.2 | Macrobend attenuation measurement | 87 |
| I.4.3 | Splice attenuation measurement | 90 |
| I.4.4 | Measurement with high reflection connectors or short length cabling | 90 |
| I.4.5 | Ghost | 94 |
| I.5 | More on the measurement method | 96 |
| I.6 | Bi-directional measurement | 98 |
| I.7 | OTDR bi-directional trace analysis | 98 |
| I.8 | Non-recommended practices | 99 |
| I.8.1 | Measurement without tail cord | 99 |
| I.8.2 | Two cursors measurement | 99 |
| Annex J | (informative) Test cord attenuation verification | 101 |
| J.1 | Introductory remarks | 101 |
| J.2 | Apparatus | 101 |
| J.3 | Procedure | 101 |
| J.3.1 | General | 101 |
| J.3.2 | Test cord verification for the one-cord and two-cord reference test methods when using non-pinned or unpinned and non-plug or socket style connectors | 102 |
| J.3.3 | Test cord verification for the one-cord and two-cord reference test methods using pinned-to-unpinned or plug-to-socket style connectors | 103 |
| J.3.4 | Test cord verification for the three-cord reference test method using non-pinned or unpinned and non-plug or socket style connectors | 105 |
| J.3.5 | Test cord verification for the three-cord reference test method using pinned-to-unpinned or plug-to-socket style connectors | 107 |
| Annex K | (informative) Spectral attenuation measurement | 109 |
| K.1 | Applicability of test method | 109 |
| K.2 | Apparatus | 109 |
| K.2.1 | Broadband light source | 109 |
| K.2.2 | Optical spectrum analyser | 109 |

| | | |
|---------------------|--|---------------|
| K.3 | Procedure | 110 |
| K.3.1 | Reference scan | 110 |
| K.3.2 | Measurement scan | 110 |
| K.4 | Calculations | 110 |
| Bibliography | | 111 |
| | | |
| Figure 1 | – Connector symbols | 15 |
| Figure 2 | – Symbol for cabling under test | 16 |
| Figure 3 | – Configuration A – Start and end of measured losses in reference test method | 17 |
| Figure 4 | – Configuration B – Start and end of measured losses in reference test method | 17 |
| Figure 5 | – Configuration C – Start and end of measured losses in reference test method | 17 |
| Figure 3 | – Configuration A – Start and end of measured attenuations in RTM | 20 |
| Figure 4 | – Configuration B – Start and end of measured attenuations in RTM | 21 |
| Figure 5 | – Configuration C – Start and end of measured attenuations in RTM | 21 |
| Figure 6 | – Configuration D – Start and end of measured attenuations in RTM | 22 |
| Figure 7 | – Typical OTDR schematic diagram | 30 |
| Figure 8 | – Illustration of return loss test set | 31 |
| Figure A.1 | – One-cord reference measurement | 36 |
| Figure A.2 | – One-cord test measurement | 36 |
| Figure B.1 | – Three-cord reference measurement | 39 |
| Figure B.2 | – Three-cord test measurement | 40 |
| Figure C.1 | – Two-cord reference measurement | 43 |
| Figure C.2 | – Two-cord test measurement | 43 |
| Figure C.3 | – Two-cord test measurement for plug-to-socket style connectors | 44 |
| Figure D.1 | – Reference measurement | 47 |
| Figure D.2 | – Test measurement | 47 |
| Figure E.1 | – Test measurement for OTDR method D | 51 |
| Figure E.2 | – Location of the cabling under test ports | 53 |
| Figure E.3 | – Graphic construction of F_1 and F_2 | 55 |
| Figure E.4 | – Graphic construction of F_1 , F_{11} , F_{21} and F_2 | 57 |
| Figure E.5 | – Graphic representation of OTDR ORL measurement | 60 |
| Figure E.6 | – Graphic representation of reflectance measurement | 61 |
| Figure F.1 | – Return loss test set illustration | 63 |
| Figure F.2 | – Measurement of the system internal attenuation P_{ref2} | 65 |
| Figure F.3 | – Measurement of the system internal attenuation P_{ref1} | 65 |
| Figure F.4 | – Measurement of the system reflected power P_{rs} | 65 |
| Figure F.5 | – Measurement of the input power P_{in} | 66 |
| Figure F.6 | – Measurement of the reflected power P_r | 66 |
| Figure G.1 | – Return loss test set illustration | 68 |
| Figure G.2 | – Measurement of P_{rs} with reflections suppressed | 69 |

| | |
|---|-----|
| Figure G.3 – Measurement of P_{ref} with reference reflector..... | 69 |
| Figure G.4 – Measurement of the system reflected power P_{RS} | 70 |
| Figure G.5 – Measurement of the reflected power P_{r} | 70 |
| Figure H.1 – Cabling configurations A, B and C tested with the OTDR method..... | 82 |
| Figure H.2 – Cabling configuration D tested with the OTDR method..... | 84 |
| Figure I.1 – Splice and macrobend attenuation measurement..... | 89 |
| Figure I.2 – Attenuation measurement with high reflection connectors..... | 91 |
| Figure I.3 – Attenuation measurement of a short length cabling..... | 93 |
| Figure I.4 – OTDR trace with ghost..... | 95 |
| Figure I.5 – Cursor positioning..... | 97 |
| Figure I.6 – Bi-directional OTDR trace display..... | 99 |
| Figure I.7 – Bi-directional OTDR trace loss attenuation analysis..... | 99 |
| Figure J.1 – Obtaining reference power level P_0 | 103 |
| Figure J.2 – Obtaining power level P_1 | 103 |
| Figure J.3 – Obtaining reference power level P_0 | 104 |
| Figure J.4 – Obtaining power level P_1 | 104 |
| Figure J.5 – Obtaining reference power level P_0 | 105 |
| Figure J.6 – Obtaining power level P_1 | 105 |
| Figure J.7 – Obtaining reference power level P_0 | 106 |
| Figure J.8 – Obtaining power level P_1 | 107 |
| Figure J.9 – Obtaining power level P_6 | 107 |
| Figure J.10 – Obtaining reference power level P_0 | 108 |
| Figure J.11 – Obtaining power level P_1 | 108 |
| Figure K.1 – Result of spectral attenuation measurement..... | 110 |
| | |
| Table 1 – Cabling configurations..... | 18 |
| Table 2 – Test methods and configurations..... | 23 |
| Table 3 – Test limit adjustment and uncertainty related to test cord connector grade..... | 24 |
| Table 4 – Uncertainty for given fibre length and attenuation at 1 310 nm, 1 550 nm and 1 625 nm..... | 26 |
| Table 5 – Uncertainty for a given fibre length at 1 310 nm and 1 550 nm using an OTDR..... | 27 |
| Table 6 – Spectral requirements..... | 29 |
| Table E.1 – Typical launch and tail cord lengths..... | 50 |
| Table H.1 – Expected attenuation for examples..... | 79 |
| Table H.2 – Test limit adjustment when using reference-grade test cords..... | 80 |
| Table H.3 – Test limit adjustment when using reference-grade test cords – OTDR test method..... | 83 |
| Table I.1 – Example of effective group index of refraction values..... | 87 |

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIBRE-OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

**Part 4-2: Installed ~~cable~~ cabling plant –
Single-mode attenuation and optical return loss measurements**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61280-4-2:2014. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61280-4-2 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) addition of the equipment cord method;
- b) addition of test limit adjustment related to test cord grades;
- c) refinements on measurement uncertainties.

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

| Draft | Report on voting |
|---------------|------------------|
| 86C/1912/FDIS | 86C/1916/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 ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61280 series, published under the general title *Fibre optic communication subsystem test procedures*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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

~~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.~~

This document is part of a series of IEC standards for measurements of installed fibre optic cabling plants. This document is applicable for the measurement of installed single-mode fibres.

Cabling design standards such as ISO/IEC 11801-1 ~~for commercial premises, ISO/IEC 24702 for industrial premises, ISO/IEC 24764 for data centres and ISO/IEC 15018 for residential cabling contain specifications~~ provide general requirements 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~~ ISO/IEC 11801-1, normatively references IEC 61280-4-2.

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~~ cabling plant for these applications is covered in ITU-T Recommendation G.650.3, which refers to the test methods of this document.

FIBRE-OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

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

1 Scope

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

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

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

This document is not intended to apply to ~~cable~~ cabling plants that include active devices such as fibre amplifiers or dynamic channel equalizers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

~~IEC 60793-2-50, 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 (OFCSs)*

~~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 of fibre optic connectors and fibre-stub transceivers*

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 – Part 01: Fibre optic connector cleaning methods*

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

Delsystem för fiberoptisk kommunikation – Grundläggande provningsmetoder – Del 4-2: Installationer med optokablar – Mätning av dämpning och reflexionsdämpning för installerade singelmodfibrer

*Fibre-optic communication subsystem test procedures –
Part 4-2: Installed cabling plant –
Single-mode attenuation and optical return loss measurement*

Som svensk standard gäller europastandarden EN IEC 61280-4-2:2024. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61280-4-2:2024.

Nationellt förord

Europastandarden EN IEC 61280-4-2:2024

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61280-4-2, Third edition, 2024 - Fibre-optic communication subsystem test procedures – Part 4-2: Installed cabling plant – Single-mode attenuation and optical return loss measurement**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 61280-4-2, utg 2:2015 med eventuella tillägg, ändringar och rättelser gäller ej fr o m 2027-06-10.

ICS 33.180.01

Denna standard är fastställd av SEK Svensk Elstandard, som också kan lämna upplysningar om **sakinnehållet** i standarden.
Postadress: Box 1042, 172 21 Sundbyberg
Telefon: 08 - 444 14 00.
E-post: sek@elstandard.se. Internet: elstandard.se

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1042
172 21 Sundbyberg
Tel 08-444 14 00
elstandard.se

English Version

Fibre-optic communication subsystem test procedures - Part 4-2:
Installed cabling plant - Single-mode attenuation and optical
return loss measurements
(IEC 61280-4-2:2024)

Procédures d'essai des sous-systèmes de
télécommunication fibroniques - Partie 4-2: Installations
câblées - Mesures de l'affaiblissement de réflexion optique
et de l'affaiblissement des fibres unimodales
(IEC 61280-4-2:2024)

Prüfverfahren für Lichtwellenleiter-
Kommunikationsuntersysteme - Teil 4-2: Installierte
Kabelanlagen - Einmoden-Dämpfungs- und optische
Rückflussdämpfungsmessung
(IEC 61280-4-2:2024)

This European Standard was approved by CENELEC on 2024-06-10. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 86C/1912/FDIS, future edition 3 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 IEC 61280-4-2:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2025-03-10 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2027-06-10 document have to be withdrawn

This document supersedes EN 61280-4-2:2014 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61280-4-2:2024 was approved by CENELEC as a European Standard without any modification.

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

| | | |
|--------------------|------|--|
| IEC 60793-1-40 | NOTE | Approved as EN IEC 60793-1-40 |
| IEC 60793-2 | NOTE | Approved as EN IEC 60793-2 |
| IEC 60793-2-50 | NOTE | Approved as EN IEC 60793-2-50 |
| IEC 61280-1-3 | NOTE | Approved as EN IEC 61280-1-3 |
| IEC 61280-4-3:2022 | NOTE | Approved as EN IEC 61280-4-3:2022 (not modified) |
| IEC 61280-4-5 | NOTE | Approved as EN IEC 61280-4-5 |
| IEC 61300-3-4 | NOTE | Approved as EN IEC 61300-3-4 |
| IEC 61300-3-6 | NOTE | Approved as EN 61300-3-6 |
| IEC 61745 | NOTE | Approved as EN 61745 |
| IEC 61753-1 | NOTE | Approved as EN IEC 61753-1 |
| IEC 61754-19 | NOTE | Approved as EN 61754-19 |
| IEC 61755-1 | NOTE | Approved as EN IEC 61755-1 |
| IEC 61755-2-1 | NOTE | Approved as EN IEC 61755-2-1 |
| IEC 61755-2-2 | NOTE | Approved as EN IEC 61755-2-2 |
| IEC 61755-2-4 | NOTE | Approved as EN 61755-2-4 |
| IEC 61755-2-5 | NOTE | Approved as EN 61755-2-5 |

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where 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.cencenelec.eu.

| <u>Publication</u> | <u>Year</u> | <u>Title</u> | <u>EN/HD</u> | <u>Year</u> |
|--------------------|-------------|---|-------------------|-------------|
| IEC 60825-2 | - | Safety of laser products - Part 2: Safety of optical fibre communication systems (OFCSs) | - | - |
| 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 IEC 61300-3-35 | - |
| IEC 61315 | - | Calibration of fibre-optic power meters | EN IEC 61315 | - |
| IEC 61746-1 | 2009 | Calibration of optical time-domain reflectometers (OTDR) - Part 1: OTDR for single mode fibres | EN 61746-1 | 2011 |
| - | - | | + AC | 2014 |
| IEC/TR 62627-01 | - | Fibre optic interconnecting devices and passive components - Part 01: Fibre optic connector cleaning methods | - | - |

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Fibre- optic communication subsystem test procedures –
Part 4-2: Installed cabling plant – Single-mode attenuation and optical return
loss measurements**

**Procédures d'essai des sous-systèmes de télécommunication fibroniques –
Partie 4-2: Installations câblées – Mesures de l'affaiblissement de réflexion
optique et de l'affaiblissement des fibres unimodales**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.180.01

ISBN 978-2-8322-8789-7

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

| | |
|---|----|
| FOREWORD..... | 8 |
| INTRODUCTION..... | 10 |
| 1 Scope..... | 11 |
| 2 Normative references | 11 |
| 3 Terms, definitions, graphical symbols and abbreviated terms..... | 12 |
| 3.1 Terms and definitions..... | 12 |
| 3.2 Graphical symbols | 14 |
| 3.3 Abbreviated terms..... | 16 |
| 4 Measurement methods | 16 |
| 4.1 General..... | 16 |
| 4.1.1 Document structure | 16 |
| 4.1.2 Attenuation | 17 |
| 4.1.3 Optical return loss | 17 |
| 4.2 Cabling configurations and applicable test methods | 18 |
| 4.2.1 Cabling configurations and applicable test methods for attenuation measurements..... | 18 |
| 4.2.2 Cabling configurations and applicable test methods for optical return loss measurements..... | 22 |
| 5 Overview of uncertainties for attenuation measurements | 22 |
| 5.1 General..... | 22 |
| 5.2 Sources of significant uncertainties..... | 22 |
| 5.3 Consideration of the power meter | 22 |
| 5.4 Consideration of test cord and connector grade | 23 |
| 5.4.1 General | 23 |
| 5.4.2 Mode field diameter variation..... | 23 |
| 5.5 Reflections from other interfaces..... | 23 |
| 5.6 Optical source..... | 24 |
| 5.7 Output power reference | 24 |
| 5.8 Bi-directional measurements..... | 24 |
| 5.9 Typical uncertainties for attenuation methods A, B, C, and D..... | 24 |
| 5.10 Typical uncertainty values for single-mode attenuation testing for method E | 26 |
| 6 Apparatus..... | 26 |
| 6.1 General..... | 26 |
| 6.2 Light source | 26 |
| 6.2.1 Stability | 26 |
| 6.2.2 Spectral characteristics | 27 |
| 6.3 Launch cord..... | 28 |
| 6.4 Receive or tail cords | 28 |
| 6.5 Substitution cord..... | 28 |
| 6.6 Power meter – LSPM methods only..... | 28 |
| 6.7 OTDR apparatus..... | 29 |
| 6.8 Return loss test set..... | 29 |
| 6.9 Connector end-face cleaning and inspection equipment..... | 30 |
| 6.10 Adapters | 30 |
| 7 Procedures..... | 31 |
| 7.1 General..... | 31 |
| 7.2 Common procedures..... | 31 |

| | | |
|---------|--|----|
| 7.2.1 | Care of the test cords | 31 |
| 7.2.2 | Make reference measurements (LSPM and OCWR methods only) | 31 |
| 7.2.3 | Inspect and clean the ends of the fibres in the cabling | 31 |
| 7.2.4 | Make the measurements | 32 |
| 7.2.5 | Make the calculations | 32 |
| 7.3 | Calibration | 32 |
| 7.4 | Safety | 32 |
| 8 | Calculations | 32 |
| 9 | Documentation | 32 |
| 9.1 | Information for each test | 32 |
| 9.2 | Information to be made available | 33 |
| Annex A | (normative) One-cord reference method | 34 |
| A.1 | Applicability of test method | 34 |
| A.2 | Apparatus | 34 |
| A.3 | Procedure | 34 |
| A.4 | Calculation | 35 |
| A.5 | Components of reported attenuation | 36 |
| Annex B | (normative) Three-cord reference method | 37 |
| B.1 | Applicability of test method | 37 |
| B.2 | Apparatus | 37 |
| B.3 | Procedure | 37 |
| B.4 | Calculations | 38 |
| B.5 | Components of reported attenuation | 38 |
| Annex C | (normative) Two-cord reference method | 39 |
| C.1 | Applicability of test method | 39 |
| C.2 | Apparatus | 39 |
| C.3 | Procedure | 39 |
| C.4 | Calculations | 41 |
| C.5 | Components of reported attenuation | 41 |
| Annex D | (normative) Equipment cord method | 42 |
| D.1 | Applicability of the test method | 42 |
| D.2 | Apparatus | 42 |
| D.3 | Procedure | 42 |
| D.4 | Calculation | 43 |
| D.5 | Components of reported attenuation | 44 |
| Annex E | (normative) Optical time domain reflectometer | 45 |
| E.1 | Applicability of test method | 45 |
| E.2 | Apparatus | 45 |
| E.2.1 | General | 45 |
| E.2.2 | OTDR | 45 |
| E.2.3 | Test cords | 45 |
| E.3 | Procedure (test method) | 46 |
| E.4 | Calculation of attenuation | 47 |
| E.4.1 | General | 47 |
| E.4.2 | Connection location | 47 |
| E.4.3 | Definition of the power levels F_1 and F_2 | 48 |
| E.4.4 | Alternative calculation | 49 |
| E.5 | Calculation of optical return loss | 51 |

| | | |
|-----------------------|--|----|
| E.6 | Calculation of reflectance for discrete components | 53 |
| E.7 | OTDR uncertainties | 55 |
| Annex F (normative) | Continuous wave optical return loss measurement – Method A..... | 56 |
| F.1 | Applicability of test method | 56 |
| F.2 | Apparatus | 56 |
| F.2.1 | General | 56 |
| F.2.2 | Light source..... | 56 |
| F.2.3 | Branching device or coupler | 56 |
| F.2.4 | Power meters | 57 |
| F.2.5 | Connector interface | 57 |
| F.2.6 | Low reflection termination..... | 57 |
| F.3 | Procedure | 57 |
| F.3.1 | Test set characterization..... | 57 |
| F.3.2 | Measurement procedure | 59 |
| F.3.3 | Calculations..... | 59 |
| Annex G (normative) | Continuous wave optical return loss measurement – Method B..... | 61 |
| G.1 | Applicability of test method | 61 |
| G.2 | Apparatus | 61 |
| G.2.1 | General requirements | 61 |
| G.2.2 | Known reflectance termination..... | 61 |
| G.3 | Procedure | 62 |
| G.3.1 | Set-up characterization..... | 62 |
| G.3.2 | Measurement procedure | 62 |
| G.3.3 | Calculation | 63 |
| Annex H (normative) | On the use of reference-grade test cords | 64 |
| H.1 | General..... | 64 |
| H.2 | Practical configurations and assumptions..... | 64 |
| H.2.1 | Component specifications | 64 |
| H.2.2 | Conventions | 65 |
| H.2.3 | Reference planes | 65 |
| H.3 | Impact of using reference-grade test cords for recommended LSPM methods..... | 66 |
| H.4 | Examples for LSPM measurements..... | 66 |
| H.4.1 | Example 1 (configuration A, one-cord method, Annex A) | 66 |
| H.4.2 | Example 2 (configuration B, three-cord method, Annex B) | 67 |
| H.4.3 | Example 3 (configuration C, two-cord method, Annex C) | 67 |
| H.4.4 | Example 4 – Long haul system (one-cord reference method)..... | 68 |
| H.5 | Impact of using reference-grade test cords for different configurations using the OTDR test method | 68 |
| H.5.1 | Cabling configurations A, B and C | 68 |
| H.5.2 | Cabling configuration D | 69 |
| Annex I (informative) | OTDR configuration information..... | 71 |
| I.1 | Introductory remarks | 71 |
| I.2 | Fundamental parameters that define the operational capability of an OTDR..... | 72 |
| I.2.1 | Dynamic range | 72 |
| I.2.2 | Dynamic margin..... | 72 |
| I.2.3 | Pulse width..... | 72 |
| I.2.4 | Averaging time | 72 |
| I.2.5 | Dead zone | 72 |
| I.3 | Other parameters..... | 73 |

| | | |
|---|--|----|
| 1.3.1 | Index of refraction..... | 73 |
| 1.3.2 | Measurement range..... | 73 |
| 1.3.3 | Distance sampling..... | 73 |
| 1.4 | Other measurement configurations..... | 73 |
| 1.4.1 | General..... | 73 |
| 1.4.2 | Macrobend attenuation measurement..... | 73 |
| 1.4.3 | Splice attenuation measurement..... | 74 |
| 1.4.4 | Measurement with high reflection connectors or short length cabling..... | 74 |
| 1.4.5 | Ghost..... | 76 |
| 1.5 | More on the measurement method..... | 77 |
| 1.6 | Bi-directional measurement..... | 78 |
| 1.7 | OTDR bi-directional trace analysis..... | 79 |
| 1.8 | Non-recommended practices..... | 80 |
| 1.8.1 | Measurement without tail cord..... | 80 |
| 1.8.2 | Two cursors measurement..... | 80 |
| Annex J (informative) | Test cord attenuation verification..... | 81 |
| J.1 | Introductory remarks..... | 81 |
| J.2 | Apparatus..... | 81 |
| J.3 | Procedure..... | 81 |
| J.3.1 | General..... | 81 |
| J.3.2 | Test cord verification for the one-cord and two-cord reference test methods when using non-pinned or unpinned and non-plug or socket style connectors..... | 82 |
| J.3.3 | Test cord verification for the one-cord and two-cord reference test methods using pinned-to-unpinned or plug-to-socket style connectors..... | 83 |
| J.3.4 | Test cord verification for the three-cord reference test method using non-pinned or unpinned and non-plug or socket style connectors..... | 85 |
| J.3.5 | Test cord verification for the three-cord reference test method using pinned-to-unpinned or plug-to-socket style connectors..... | 87 |
| Annex K (informative) | Spectral attenuation measurement..... | 89 |
| K.1 | Applicability of test method..... | 89 |
| K.2 | Apparatus..... | 89 |
| K.2.1 | Broadband light source..... | 89 |
| K.2.2 | Optical spectrum analyser..... | 89 |
| K.3 | Procedure..... | 90 |
| K.3.1 | Reference scan..... | 90 |
| K.3.2 | Measurement scan..... | 90 |
| K.4 | Calculations..... | 90 |
| Bibliography..... | | 91 |
| Figure 1 – Connector symbols..... | | 15 |
| Figure 2 – Symbol for cabling under test..... | | 16 |
| Figure 3 – Configuration A – Start and end of measured attenuations in RTM..... | | 19 |
| Figure 4 – Configuration B – Start and end of measured attenuations in RTM..... | | 20 |
| Figure 5 – Configuration C – Start and end of measured attenuations in RTM..... | | 20 |
| Figure 6 – Configuration D – Start and end of measured attenuations in RTM..... | | 21 |
| Figure 7 – Typical OTDR schematic diagram..... | | 29 |
| Figure 8 – Illustration of return loss test set..... | | 30 |

| | |
|--|----|
| Figure A.1 – One-cord reference measurement..... | 35 |
| Figure A.2 – One-cord test measurement..... | 35 |
| Figure B.1 – Three-cord reference measurement | 37 |
| Figure B.2 – Three-cord test measurement | 38 |
| Figure C.1 – Two-cord reference measurement..... | 40 |
| Figure C.2 – Two-cord test measurement..... | 40 |
| Figure C.3 – Two-cord test measurement for plug-to-socket style connectors | 40 |
| Figure D.1 – Reference measurement..... | 43 |
| Figure D.2 – Test measurement..... | 43 |
| Figure E.1 – Test measurement for OTDR method | 47 |
| Figure E.2 – Location of the cabling under test ports | 48 |
| Figure E.3 – Graphic construction of F_1 and F_2 | 49 |
| Figure E.4 – Graphic construction of F_1 , F_{11} , F_{21} and F_2 | 51 |
| Figure E.5 – Graphic representation of OTDR ORL measurement..... | 53 |
| Figure E.6 – Graphic representation of reflectance measurement | 54 |
| Figure F.1 – Return loss test set illustration | 56 |
| Figure F.2 – Measurement of the system internal attenuation P_{ref2} | 58 |
| Figure F.3 – Measurement of the system internal attenuation P_{ref1} | 58 |
| Figure F.4 – Measurement of the system reflected power P_{rs} | 58 |
| Figure F.5 – Measurement of the input power P_{in} | 59 |
| Figure F.6 – Measurement of the reflected power P_r | 59 |
| Figure G.1 – Return loss test set illustration | 61 |
| Figure G.2 – Measurement of P_{rs} with reflections suppressed | 62 |
| Figure G.3 – Measurement of P_{ref} with reference reflector..... | 62 |
| Figure G.4 – Measurement of the system reflected power P_{rs} | 63 |
| Figure G.5 – Measurement of the reflected power P_r | 63 |
| Figure H.1 – Cabling configurations A, B and C tested with the OTDR method..... | 68 |
| Figure H.2 – Cabling configuration D tested with the OTDR method..... | 70 |
| Figure I.1 – Splice and macrobend attenuation measurement | 74 |
| Figure I.2 – Attenuation measurement with high reflection connectors | 75 |
| Figure I.3 – Attenuation measurement of a short length cabling | 76 |
| Figure I.4 – OTDR trace with ghost..... | 77 |
| Figure I.5 – Cursor positioning | 78 |
| Figure I.6 – Bi-directional OTDR trace display | 79 |
| Figure I.7 – Bi-directional OTDR trace attenuation analysis | 80 |
| Figure J.1 – Obtaining reference power level P_0 | 83 |
| Figure J.2 – Obtaining power level P_1 | 83 |
| Figure J.3 – Obtaining reference power level P_0 | 84 |
| Figure J.4 – Obtaining power level P_1 | 84 |
| Figure J.5 – Obtaining reference power level P_0 | 85 |

| | |
|--|----|
| Figure J.6 – Obtaining power level P_1 | 85 |
| Figure J.7 – Obtaining reference power level P_0 | 86 |
| Figure J.8 – Obtaining power level P_1 | 87 |
| Figure J.9 – Obtaining power level P_6 | 87 |
| Figure J.10 – Obtaining reference power level P_0 | 88 |
| Figure J.11 – Obtaining power level P_1 | 88 |
| Figure K.1 – Result of spectral attenuation measurement | 90 |
| Table 1 – Cabling configurations | 18 |
| Table 2 – Test methods and configurations | 21 |
| Table 3 – Test limit adjustment and uncertainty related to test cord connector grade | 23 |
| Table 4 – Uncertainty for given fibre length and attenuation at 1 310 nm, 1 550 nm and 1 625 nm | 25 |
| Table 5 – Uncertainty for a given fibre length at 1 310 nm and 1 550 nm using an OTDR | 26 |
| Table 6 – Spectral requirements | 27 |
| Table E.1 – Typical launch and tail cord lengths | 46 |
| Table H.1 – Expected attenuation for examples | 65 |
| Table H.2 – Test limit adjustment when using reference-grade test cords | 66 |
| Table H.3 – Test limit adjustment when using reference-grade test cords – OTDR test method | 69 |
| Table I.1 – Example of effective group index of refraction values | 73 |

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIBRE-OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 4-2: Installed cabling plant – Single-mode attenuation and optical return loss measurements

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61280-4-2 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) addition of the equipment cord method;
- b) addition of test limit adjustment related to test cord grades;
- c) refinements on measurement uncertainties.

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

| Draft | Report on voting |
|---------------|------------------|
| 86C/1912/FDIS | 86C/1916/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 ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61280 series, published under the general title *Fibre optic communication subsystem test procedures*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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

This document is part of a series of IEC standards for measurements of installed fibre optic cabling plants. This document is applicable for the measurement of installed single-mode fibres.

Cabling design standards such as ISO/IEC 11801-1 provide general requirements 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 ISO/IEC 11801-1, normatively references IEC 61280-4-2.

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 cabling plant for these applications is covered in ITU-T Recommendation G.650.3, which refers to the test methods of this document.

FIBRE-OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 4-2: Installed cabling plant – Single-mode attenuation and optical return loss measurements

1 Scope

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

This document is applicable to all single-mode fibre types including those designated by IEC 60793-2-50 as Class B fibres.

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

This document is not intended to apply to cabling plants that include active devices such as fibre amplifiers or dynamic channel equalizers.

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

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*

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 – Part 01: Fibre optic connector cleaning methods*