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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Fibre optic interconnecting devices and passive components – Basic test and measurement procedures –
Part 1: General and guidance

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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 1: General and guidance

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61300-1:2022. 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 61300-1 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2016. This edition constitutes a technical revision.

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

a) addition of the information of measurement uncertainties in 4.2.1;
b) change of the requirements for attenuation variation in 4.2.2;
c) addition of the multimode launch conditions of other fibres than A1-OM2, A1-OM3, A1-OM4, A1-OM5 and A3e in 10.4;
d) addition of the multimode launch conditions of the planar waveguide in 10.6;
e) splitting Annex A for EF and Annex B for EAF;
f) correction of errors in the definitions of encircled flux and encircled angular flux.

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

Draft	Report on voting
86B/4582/FDIS	86B/4602/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/standardsdev/publications.

A list of all parts in the IEC 61300 series, published under the general title, *Fibre optic interconnecting and passive components – Basic test and measurement 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,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The publications in IEC 61300 series [1][1] contain information on mechanical and environmental testing procedures and measurement procedures relating to fibre optic interconnecting devices and passive components. They are intended to be used to achieve uniformity and reproducibility in environmental testing procedures and measurement procedures.

The term "test procedure" refers to procedures commonly known as mechanical and environmental tests. The expressions "environmental conditioning" and "environmental testing" refer to the environments to which components or equipment may be exposed so that an assessment may be made of their performance under the conditions of use, transport and storage.

The term "measurement procedure" refers to those measurements which are necessary to assess the physical and optical characteristics of a component and may also be used before, during or after a test procedure to measure the effects of environmental conditioning or testing. The return loss and attenuation tests are examples of measurement procedures.

The requirements for the performance of components or equipment subjected to the test and measurement procedures described in this document are not included. The relevant specification for the device under test defines the allowed performance limits.

When drafting a specification or purchase contract, only those tests which are necessary for the relevant components or equipment taking into account the technical and economic aspects should be specified.

The mechanical and environmental test procedures are contained in IEC 61300-2 (all parts) and the measurement procedures in IEC 61300-3 (all parts). Each test or measurement procedure is published as a stand-alone publication so that it may be modified, expanded or cancelled without having an effect on any other test or measurement procedure. However, it should be noted that, where practical, reference is made to other standards as opposed to repeating all or part of already existing standards. As an example, the cold test for fibre optic apparatus refers to IEC 60068-2-1 [2], but it also provides other needed information such as purpose, recommended severities and a list of items to be specified.

Multiple methods may be contained in a test or measurement procedure. As an example, several methods of measuring attenuation are contained in the attenuation measurement procedure.

If more than one method is contained in a test or measurement procedure, the reference method may be identified.

The tests in this document permit the performance of components or equipment to be compared. To assess the overall quality of a production lot, the test procedures should be applied in accordance with a suitable sampling plan and may be supplemented by appropriate additional tests, if necessary.

To provide tests appropriate to the different intensities of an environmental condition, some of the test procedures have a number of degrees of severity. These different degrees of severity are obtained by varying the time, temperature or some other determining factor separately or in combination.

[1] Numbers in square bracket refer to the Bibliography.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 1: General and guidance

1 Scope

This part of IEC 61300 provides general information and guidance for the basic test and measurement procedures defined in IEC 61300-2 (all parts) and IEC 61300-3 (all parts) for interconnecting devices, passive components, mechanical splices, fusion splice protectors, fibre management systems and protective housings.

This document ~~should be~~ is used in combination with the relevant specification which defines the tests to be used, the required degree of severity for each of them, their sequence, if relevant, and the permissible performance limits. In the event of conflict between this document and the relevant specification, the latter takes precedence.

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 60050-731, *International Electrotechnical Vocabulary – Part 731: Optical fibre communication* (available at www.electropedia.org)

IEC 60617, *Graphical symbols for diagrams* (available at http://std.iec.ch/iec60617)

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

IEC 60793-2-30, *Optical fibres – Part 2-30: Product specifications – Sectional specification for category A3 multimode fibres*

~~IEC 60793-2-40, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*~~

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

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

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

IEC 61280-4-1, *Fibre-optic communication subsystem test procedures – Part 4-1: Installed ~~cable~~ cabling plant – Multimode attenuation measurement*

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

IEC 61300-3 (all parts), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3: Examinations and measurements*

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

IEC 61300-3-35, *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 61300-3-53, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-53: Examinations and measurements – Encircled angular flux (EAF) measurement method based on two-dimensional far field data from step index multimode waveguide (including fibre)*~~

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
test
technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure and normally consists of the following steps:

a) preparation (where required);
b) preconditioning (where required);
c) initial examination and measurement (where required);
d) conditioning;
e) recovery (where required);
f) final examination and measurement

3.1.2
device under test
DUT
interconnecting device, passive component, equipment or other item designated to be tested

3.1.3
preparation
preparing the DUT according to the manufacturer's instructions or as specified in the relevant specification

3.1.4
preconditioning
treatment of a DUT with the object of removing or partly counteracting the effects of its previous environmental history or acclimatisation of the test specimen to standard atmospheric conditions

3.1.5
conditioning
exposure of a DUT to environmental or mechanical conditions for a specified duration in order to determine the effects of such conditions on the DUT

3.1.6
recovery
treatment of a DUT after conditioning in order that the properties of the DUT may stabilise before measurement

3.1.7
examination
visual and/or mechanical inspection of a DUT made with or without the use of special equipment

Note 1 to entry: Examination is usually carried out before and after the test, and/or during the test.

3.1.8
measurement
process of obtaining one or more values that can reasonably be attributed to a quantity

[SOURCE: IEC 60050-112:2010, 112-04-01, modified – The adverb "experimentally" has been removed from the definition, as well as the notes.]

3.1.9
uncertainty of measurement
quantified doubt about the result of a measurement

Note 1 to entry: ISO/IEC Guide 98-3:2008 [3] defines uncertainty of measurement.

Note 2 to entry: IEC TR 61282-14 [4] provides the information of measurement uncertainties.

3.1.10
encircled flux
EF
fraction of cumulative near-field power to the total output power as a function of radial distance from the optical centre of the core, defined by Formula (1):

$$EF(r) = \frac{\int_0^r xI(x)dx}{\int_0^R xI(x)dx} \quad (1)$$

where

$I(x)$ is the near-field intensity profile as a function of radial position, ~~r~~ x;

R is the maximum range of integration

Note 1 to entry: The encircled flux shall be measured according to IEC 61280-1-4.

3.1.11
encircled angular flux
EAF
fraction of cumulative far-field power to the total output power as a function of incident angle θ from the optical central axis of the far-field pattern, defined by Formula (2):

~~$$EAF(\theta') = \frac{\int_0^{2\pi}\int_0^{\theta'} I(r,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}d\theta d\varphi}{\int_0^{2\pi}\int_0^{\theta_{max}} I(r,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}d\theta d\varphi}$$~~ (2)

~~where~~

~~$I(r,\varphi)$ is the 2-dimensional far-field intensity profile as a function of moving radius r and argument φ;~~

~~incident angle θ' = tan-1(r/d);~~

~~d is the distance between luminescent point and far field screen; and~~

~~θmax is the maximum range of integration.~~

~~Note 1 to entry: *EAF* shall be measured according to IEC 61300-3-53.~~

$$EAF(\theta') = \frac{\int_0^{2\pi}\int_0^{\theta'} I(\theta,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}d\theta d\varphi}{\int_0^{2\pi}\int_0^{\theta_{max}} I(\theta,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}d\theta d\varphi} \quad (2)$$

where

$I(\theta,\varphi)$ is the far-field intensity profile as a function of radial angle and circular angle;

r is the radial distance from the origin corresponding to an angle between one ray emitted from the multimode waveguide and the optical axis of the multimode waveguide, calculated by $d_f \tan\theta$;

φ is a circular angle in polar coordinates;

θ is an angle between one ray emitted from the multimode waveguide and the optical axis;

θ_{max} is the maximum ray angle, which is approximately 30° for category A3 multimode fibre for example;

d_f is the distance between the end of multimode optical waveguide and far field pattern (FFP) screen.

Note 1 to entry: The encircled angular flux is measured according to IEC 61300-3-53 [5].

3.1.12
differential mode attenuation
DMA
variation in attenuation among the propagating modes of a multimode optical fibre

[SOURCE: IEC TR 62614-2:2015 [6], 3.4]

3.1.13
standard uncertainty
uncertainty of a measurement result expressed as a standard deviation

Note 1 to entry: For further information, see the ISO/IEC Guide 98-3.

3.1.14
uncertainty type A
type of uncertainty obtained by a statistical analysis of a series of observations, such as when evaluating certain random effects of measurement

Note 1 to entry: See Annex A and ISO/IEC Guide 98-3.

3.1.15
uncertainty type B
type of uncertainty obtained by means other than a statistical analysis of observations, for example an estimation of probable sources of uncertainty, such as when evaluating systematic effects of measurement

Note 1 to entry: See Annex A and ISO/IEC Guide 98-3.

3.1.16
measurement repeatability
measurement precision under a set of repeatability conditions of measurement

3.1.17
measurement reproducibility
reproducibility measurement precision under reproducibility conditions of measurement

3.1.18
stability
ability of a measuring instrument to keep its performance characteristics within a specified range during a specified time interval, all other conditions being the same

3.1.19
repeatability condition
condition of measurement that includes the same measurement procedure, same operators, same measuring system, same operating conditions and same location, and replicate measurements on the same or similar objects over a short period of time

3.1.20
reproducibility condition
condition of measurement that includes different locations, operators, measuring systems, and replicate measurements on the same or similar objects

3.2 Abbreviated terms

~~For the purposes of this document, the following abbreviations apply:~~

DMA	differential mode attenuation
DUT	device under test
EAF	encircled angular flux
EF	encircled flux
FFP	far field pattern
FP-LD	Fabry-Perot laser diode
GI	graded index
LED	light emitting diode
NA	numerical aperture
SI	step index
VCSEL	vertical cavity surface emitting laser

4 Requirements for IEC 61300-2 (all parts) and IEC 61300-3 (all parts)

4.1 Requirements for IEC 61300-2 (all parts) (tests)

IEC 61300-2 (all parts) shall contain the following items:

– test apparatus;

– test procedures~~, stated in the test requirements~~;
– severities;
– details to be specified and reported.

4.2 Requirements for IEC 61300-3 (all parts) (examinations and measurement procedures)

4.2.1 General requirements

IEC 61300-3 (all parts) shall contain the following items:

– measurement apparatus;
– measurement procedures;
– method of calculation (where required);
– consideration of measurement uncertainty;
– details to be specified and reported.

NOTE 1 The measurement uncertainty herein means the measurement uncertainty of the physical value of the performance parameters of DUT, not that for measurement apparatus (instruments).

NOTE 2 The measurement uncertainty is expressed as an absolute value not using "±".

The measurement accuracy, linearity, stability and repeatability of each measurement apparatus are possible to affect the measurement uncertainty. The relation of those factors on the measurement uncertainty should be described. When the reference value, such as the setting values, the initial values, the nominal values, can be defined, the sign "±" can be adopted for the deviation from the reference values (refer to 6.2 and 6.3).

4.2.2 Requirements for attenuation variation

~~For interconnection devices, the attenuation variation is defined as the peak-to-peak variation of attenuation during the test, unless otherwise specified.~~

For interconnecting devices and passive optical components, the attenuation variation is defined as a plus or minus (±) deviation from the original value at the start of the test, unless otherwise specified.

5 Standard atmospheric conditions

Standard atmospheric conditions shall be controlled within some range to ensure proper correlation of data obtained from measurements and tests conducted in various facilities. Test and measurement procedures shall be conducted under the following atmospheric conditions unless otherwise specified. In some cases, special ambient conditions may be needed and can be specified in the relevant specification.

The standard range of atmospheric conditions for carrying out measurements and tests is set out in Table 1.

Table 1 – Standard atmospheric conditions

Temperature	Relative humidity	Air pressure
18 °C to 28 °C	25 % to 75 %	86 kPa to 106 kPa
NOTE Some dimensional measurements require a tighter temperature range of 18 °C to 22 °C as defined in ISO 1 [7].		

Variations in ambient temperature and humidity shall be kept to a minimum during a series of measurements.

6 Significance of the numerical value of a quantity

6.1 General

The numerical values of quantities for the various parameters (temperature, humidity, stress, duration, optical power levels, etc.) given in the basic methods of environmental and optical testing constituting IEC 61300-2 (all parts) and the optical and physical measurements constituting IEC 61300-3 (all parts) are expressed in different ways according to the needs of each individual test.

The two cases that most frequently arise are as follows:

a) the quantity is expressed as a nominal value with a tolerance;
b) the quantity is expressed as a range of values.

For these two cases, the significance of the numerical value is discussed in 6.2 and 6.3.

6.2 Quantity expressed as nominal value with tolerance

Examples of two forms of presentation are:

a) 40 mm ± 2 mm
   2 s ± 0,5 s
   0,3 dB ± 0,1 dB

a) 93 % $^{+3}_{-2}$ %

The expression of a quantity as a numerical value indicates the intention that the test should be carried out at the stated value. The object of stating tolerances is to take account of the following factors in particular:

- the difficulties in regulating some devices and their drift (undesired slow variation) during the test;
- uncertainties of instrument;
- non-uniformity of environmental parameters, for which no specific tolerances are given, in the test space in which the DUTs are located.

These tolerances are not intended to allow latitude in the adjustment of the values of the parameter within the test space. Hence, when a quantity is expressed by a nominal value with a tolerance, the test apparatus shall be adjusted so as to obtain this nominal value making allowance for the uncertainties of instrument.

In principle, the test apparatus shall not be adjusted to maintain a limiting value of the tolerance zone, even if its uncertainty is so small as to ensure that this limiting value would not be exceeded.

EXAMPLE If the quantity is expressed numerically as 100 ± 5, the test apparatus is adjusted to maintain the target value of 100 making allowance for the uncertainties of instrument and in no case is adjusted to maintain a target value of 95 or 105.

In order to avoid any limiting value applicable to the DUT during the carrying out of the test, it may be necessary in some cases to set the test apparatus near to one tolerance limit.

In the particular case where the quantity is expressed by a nominal value with a unilateral tolerance (which is generally the case unless justified otherwise by special conditions, for

example, a non-linear response), the test apparatus shall be set as close as possible to the nominal value (which is also a tolerance limit) taking account of the uncertainty of measurement, which depends on the apparatus used for the test (including the instruments used to measure the values of the parameters).

EXAMPLE If the quantity is expressed numerically as 100 % $^{+0}_{-5}$ % and the test apparatus is capable of an overall uncertainty in the control of the parameter of ±1 %, then the test apparatus is adjusted to maintain a target value of 99 %. If, on the other hand, the overall uncertainty is ±2,5 %, then the adjustment is set to maintain a target value of 97,5 %.

6.3 Quantity expressed as a range of values

Examples of forms of presentation:

a) From 18 °C to 28 °C

   Relative humidity from 80 % to 100 %

   From 1 h to 2 h

b) Return loss ≥ 55 dB

   Attenuation ≤ 0,50 dB

The use of words in expressing a range leads to ambiguity; for example, the phrase "from 80 % to 100 %" is recognised as "excluding the values of 80 and 100" by some readers, as "80 and 100 are included" by others. The use of symbols, for example > 80 or ≥ 80, is generally less likely to be ambiguous and ~~is~~ shall therefore ~~to~~ be preferred.

The expression of a quantity as a range of values indicates that the value to which the test apparatus is adjusted has only a small influence on the result of the test.

Where the uncertainty of the control of the parameter (including uncertainties of instrument) permits, any desired value within the given range may be chosen. For example, if it is stated that the temperature shall be from 18 °C to 28 °C, any value within this range can be used (but it is not intended that the temperature should be programmed to vary over the range).

7 Graphical symbols and terminology

The terminology used in the interpretation and preparation of fibre optic test and measurement procedures shall be taken from IEC 60050-731.

Graphical symbols used for the preparation and interpretation of fibre optic test and measurement procedures shall be selected where possible from IEC 60617.

8 Safety

As far as laser radiation is concerned, the precautions for carrying out fibre optic measurements ~~are~~ as given in IEC 60825-1 shall be used. Fibre optic components and systems may emit hazardous radiation. This may occur

a) at sources,

b) in transmission systems during installation, during service or intentional interruption and failure or unintentional interruption, and

c) while measuring and testing.

For hazard evaluation, precautions and manufacturer's requirements, ~~the relevant standards are~~ IEC 60825-1 and IEC 60825-2 shall be used.

Other safety aspects are referred to in applicable test methods and other standards.

9 Calibration

9.1 General

The equipment used shall have a valid calibration certificate in accordance with the applicable quality system for the period over which the testing is done. Preferably international or national standards should be adopted (e.g. IEC 61315 [8]). The calibration should be traceable to a national standard if available.

In cases where no calibration standard exists, the manufacturer or laboratory carrying out the test shall state the uncertainty of the test equipment to their best knowledge.

9.2 Round robin calibration procedure

Where the uncertainty is unknown, it may be necessary to evaluate the uncertainty with use a round robin calibration procedure for calibrating measuring instruments (e.g. gauges).

10 Launch conditions

10.1 General

The loss characteristics of a component frequently depend, to a very significant extent, on how the light is launched into the input fibre. ~~It is recommended that~~ The launch conditions ~~are~~ should be used for all optical measurements. In order to obtain repeatable measurements, it is necessary to use standard launch conditions, which are clearly defined, and can be duplicated easily and precisely.

To achieve consistent results, first inspect and, if necessary, clean and inspect again all connector plugs and adaptors prior to measurement. Visual examination shall be undertaken in accordance with IEC 61300-3-1. Additionally, end-faces of optical connectors shall be inspected in accordance with IEC 61300-3-35.

The power in the fibre shall be set high enough, within the power level, not to generate non-linear scattering effects.

Precautions shall be taken to ensure that cladding modes do not affect the measurement. Cladding modes shall be eliminated either as a natural function of the fibre coating in the input and output fibres, or by adding cladding mode eliminators if specified in the relevant specification.

Precautions shall be taken to ensure that excessive bending of the fibres on either the input or output fibre, which could affect the measurement, does not occur. The fibres should remain fixed in position during the measurement.

The stability of the launch shall be suitable for the measurement to be undertaken. The stability shall be maintained over the measurement time and operational temperature range.

10.2 Multimode launch conditions for ~~A1b fibre~~ A1 fibres

Annex A provides a procedure for establishing the launch conditions for multimode fibre of category A1 defined in IEC 60793-2-10. The launch conditions are defined by tolerance bands on a target encircled flux (EF) metric.

NOTE 1 IEC 62614-1 [9] and ~~IEC TR 61282-11~~ IEC TR 62614-2 provide useful information on multimode launch condition.

These tolerance bands have been created for testing installed fibre optic links ~~as defined in~~ according to IEC 61280-4-1, to limit the variation in measured attenuation. The expected tolerances for links (with multiple connectors) are different to those for a single connection. When the measured EF of the source is within the specified tolerance bands, the expected uncertainty for the measured attenuation value of a single connection for A1-OM2, A1-OM3, A1-OM4 and A1-OM5 fibres, in dB, is according to Table 2.

NOTE 2 Multimode optical interfaces are provided in IEC 63267 (all parts)[2] [10].

Table 2 – Expected ~~uncertainty for measured attenuation of single connections for A1b fibre~~ variation of attenuation due to mode variation of single connections for A1-OM2, A1-OM3, A1-OM4 and A1-OM5 fibres

Fibre nominal core diameter µm	Wavelength nm	Expected ~~uncertainty~~ variation of attenuation due to mode variation dB
50	850	±0,08

Table 2 is valid for attenuation values ≤ 0,75 dB due to launch condition and modal variation.

When calculating the total uncertainty of the multimode attenuation measurement, the uncertainty due to the modal variations shall be included.

10.3 Multimode launch conditions for A3e fibre

Annex B provides a procedure for establishing the launch conditions for category A3e multimode fibre defined in IEC 60793-2-30. The launch condition is defined by tolerance band on a target encircled angular flux (EAF) metric.

NOTE IEC 61300-3-53 provides useful information on multimode launch condition for step index (SI) fibre, defined in IEC 60793-2-30 and IEC 60793-2-40 [11].

These tolerance bands have been created for testing connecting devices, to limit the variation in measured attenuation. When the measured EAF of the source is within the specified tolerance band, the expected uncertainty for the measured attenuation value of a single connection, in dB, is according to Table 3.

Table 3 – Expected ~~uncertainty for measured~~ variation of attenuation due to mode variation of single connections for A3e fibre

Fibre nominal core diameter µm	NA	Wavelength nm	Expected ~~uncertainty~~ variation of attenuation due to mode variation dB
200	0,37	850	±0,2

Table 3 is valid for attenuation values ≤ 2,0 dB due to launch condition and modal variation.

When calculating the total uncertainty of the multimode attenuation measurement, the uncertainty due to the modal variations shall be included.

[2] Under preparation.

10.4 Multimode launch conditions for the other multimode fibres

For multimode fibres the other than A1 fibres and A3e fibres, the measurement launch condition shall be determined between suppliers and users. Unless otherwise specified, the recommended launch condition is EF for graded index fibres and EAF for SI fibres.

10.5 Single-mode launch conditions

For single-mode components, the wavelength of the source (including the total spectral width) shall be longer than the cut-off wavelength of the fibre. The deployment and length of the fibre on the input shall be such that any higher order modes that may initially be launched are sufficiently attenuated.

For polarization sensitive devices, the state of polarization of input power may be significant and, when required, shall be specified in the relevant specification.

10.6 Multimode planar waveguide launch conditions

For multimode planar waveguide components, the measurement launch condition shall be determined between suppliers and users. It is recommended to apply the launch conditions of EF for the graded index (GI) waveguides and EAF for the SI waveguides.

Typically, the launch angles and/or beam diameters of the horizontal axis (X-axis) and the vertical axis (Y-axis) are not the same, for example the beam shape is not circular symmetric. The launch conditions of EF and EAF are applied assuming the circular symmetric beam. It should be taken into consideration that the measurement launch conditions of EF or EAF is possible to be different from actual launch conditions in application.

The following items of the measurement launch condition for the application should be considered:

– direction of transmission of the light (i.e. GI to SI or SI to GI);
– the launch angle of the light source (i.e. vertical cavity surface emitting laser (VCSEL), Fabry-Perot laser diode (FP-LD), light emitting diode (LED) and so on);
– numerical aperture (NA) of the waveguides;
– the length of the waveguide and the fibres.

Annex A
(normative)

Multimode launch condition requirement for measuring attenuation of components terminated on IEC 60793-2-10 type ~~A1a and A1b~~ A1 fibres

A.1 General

Annex A describes the general multimode launch condition requirements used for measuring attenuation. The purpose of these requirements is to ensure consistency of field measurements with factory measurements and consistency of factory or field measurements when different types of test equipment are used.

Use of these launch conditions should ensure that, when a component is factory tested, it meets the requirements of field testing after installation of the product in the field.

For multimode step index (SI) fibre, defined by IEC 60793-2-30 and IEC 60793-2-40, encircled angular flux (EAF) measurement method, defined by IEC 61300-3-53, is used. See Annex B.

A.2 Technical background

Light sources, typically used in measuring attenuation, may have varying modal distributions when launched into multimode fibre. These differing modal distributions, combined with the differential mode attenuation (DMA) inherent in most multimode components, commonly cause measurement variations when measuring attenuation of multimode components. For example, attenuation measurement variations can occur when two similar light sources or different launch cords are used.

In the past, legacy (LED based) applications had a wide power budget which in most cases masked the variance in result between the factory and field measurement.

As technology has evolved, the system requirements for attenuation have become more stringent. Demanding application requirements are driving the need for accurate and reproducible multimode attenuation measurements over a variety of field-test instruments. Attenuation measurement experiments with different field-test instruments having the same standards-compliant set-up produce measurement variations that are induced by their differing launch conditions.

A.3 EF template

A.3.1 Applicable types of optical fibres

These guidelines are suitable for 50 µm and 62,5 µm core fibres, both with 125 µm cladding diameter.

A.3.2 Encircled flux

The EF is determined from the near field measurement of the light coming from the end of the reference grade launching cord.

A.3.3 EF template example

An example of an encircled flux template for 50 µm core fibre at 850 nm is shown in Figure A.1.

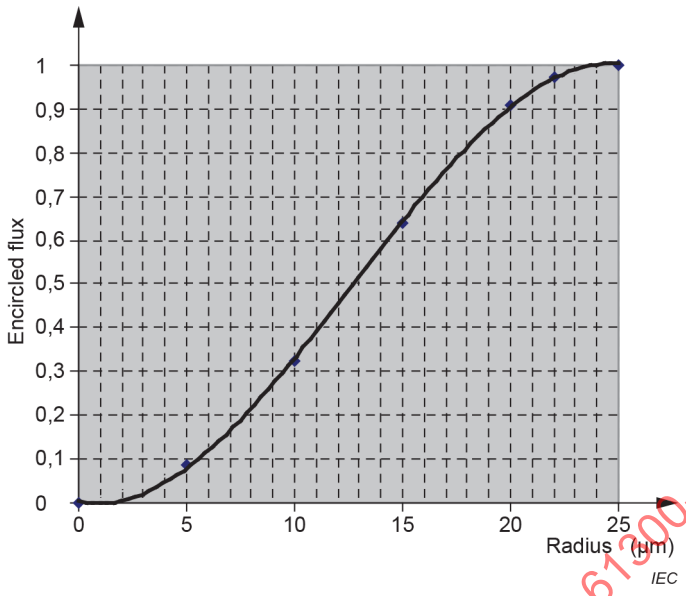


Figure A.1 – Encircled flux template example

A.4 Target launch and upper and lower tolerance bands for attenuation measurements of ~~A1a~~ A1-OM2 to A1-OM5 and ~~A1b~~ A1-OM1 optical fibre connections

A.4.1 General

The specified launch condition in this document is valid for attenuation measurement of multimode fibre optic connections. The launch condition for attenuation measurements for multimode connectors shall meet the EF requirements of Table A.1 to Table A.4 when measured at the output of the reference connector.

A.4.2 Limits on EF

The limits for the EF are derived from a target near field and a set of boundary conditions designed to constrain the variation in attenuation induced by variations in the source to within ±10 % or ±X dB, whichever is largest, of the value that would be obtained if the target launch were used. The variable X is a tolerance threshold that varies with fibre core size and wavelength according to the values in Table 2. The limits are derived from theoretical considerations.

Table A.1 – EF requirements for 50 µm core fibre at 850 nm

Radial offset µm	EF lower bound	EF target bound	EF upper bound
10	0,278 5	0,335	0,391 5
15	0,598 0	0,655	0,711 9
20	0,910 5	0,919 3	0,929 5
22	0,969 0	0,975 1	0,981 2

Table A.2 – EF requirements for 50 µm core fibre at 1 300 nm

Radial offset µm	EF lower bound	EF target bound	EF upper bound
10	0,279 2	0,336 6	0,394 0
15	0,599 6	0,656 7	0,713 8
20	0,907 2	0,918 6	0,930 0
22	0,966 3	0,972 8	0,979 3

Table A.3 – EF requirements for 62,5 µm fibre at 850 nm

Radial offset µm	EF lower bound	EF target bound	EF upper bound
10	0,168 3	0,210 9	0,253 5
15	0,369 5	0,439	0,508 5
20	0,633 7	0,692 3	0,750 9
26	0,924 5	0,935	0,945 5
28	0,971 0	0,978 3	0,985 6

Table A.4 – EF requirements for 62,5 µm fibre at 1 300 nm

Radial offset µm	EF lower bound	EF target bound	EF upper bound
10	0,168 0	0,211 9	0,255 8
15	0,369 9	0,440 9	0,511 9
20	0,636 9	0,694 5	0,752 1
26	0,925 4	0,935 7	0,946 0
28	0,970 8	0,978 2	0,985 6

Annex B
(normative)

Multimode launch condition requirement for measuring attenuation of components terminated on IEC 60793-2-30 type A3e fibres

B.1 EAF template

B.1.1 Applicable types of optical fibres

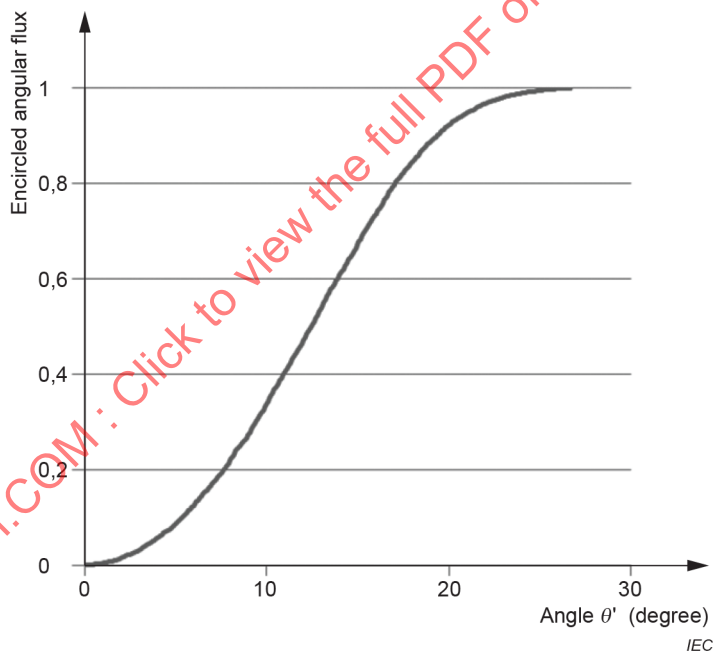
These guidelines are suitable for 200 µm core fibres with 230 µm cladding diameter.

B.1.2 Encircled angular flux

The EAF is determined from the far field measurement of the light coming from the end of the reference grade launching cord.

B.1.3 EAF template example

An example of an encircled angular flux template for 200 µm core fibre at 850 nm is shown in Figure B.1.



NOTE Although the unit for Formula (2), which is the definition of EAF, is radian, the unit for the horizontal axis is degree.

Figure B.1 – Encircled angular flux template example

B.2 Target launch and upper and lower tolerance bands for attenuation measurements of A3e optical fibre connections

B.2.1 General

The specified launch condition in this document is valid for attenuation measurement of multimode fibre optic connections. The launch condition for attenuation measurements for multimode connectors shall meet the EAF requirements of Table B.1 when measured at the output of the reference connector.

B.2.2 Limits on EAF

The limits for the EAF is derived from a target far field and a set of boundary conditions designed to constrain the variation in attenuation induced by variations in the source to within ±10 % or ±X dB, whichever is largest, of the value that would be obtained if the target launch were used. The variable X is a tolerance threshold that varies with fibre core size and wavelength according to the values in Table 3. The limits are derived from theoretical considerations.

Table B.1 – EAF requirements for NA of 0,37 and 200 µm core fibre at 850 nm

Radiation angle degree[a]	EAF lower bound	EAF upper bound
5	0,075 3	0,119 7
10	0,293 4	0,445 4
15	0,606 9	0,832 9
20	0,870 8	0,987 1

[a] Although the unit for Formula (2), which is the definition of EAF, is radian, the unit of the radiation angle is degree.

Bibliography

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

[1] IEC 61300 (all parts), *Fibre optic interconnecting devices and passive components*

[2] IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

[3] ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

[4] IEC TR 61282-14, *Fibre optic communication system design guidelines – Part 14: Determination of the uncertainties of attenuation measurements in fibre plants*

[5] IEC 61300-3-53, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-53: Examinations and measurements – Encircled angular flux (EAF) measurement method based on two-dimensional far field data from multimode waveguide (including fibre)*

[6] IEC TR 62614-2:2015, *Fibre optics – Multimode launch conditions – Part 2: Determination of launch condition requirements for measuring multimode attenuation*

[7] ISO 1, *Geometrical product specifications (GPS) – Standard reference temperature for the specification of geometrical and dimensional properties*

[8] IEC 61315, *Calibration of fibre-optic power meters*

[9] IEC 62614-1, *Fibre optics – Multimode launch conditions – Part 1: Launch condition requirements for measuring multimode attenuation*

[10] IEC 63267 (all parts), *Fibre optic interconnecting devices and passive components – Connector optical interfaces for enhanced macro bend loss multimode fibres*[3]

[11] IEC 60793-2-40, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*

[12] IEC 60050-112, *International Electrotechnical Vocabulary (IEV) – Part 112: Quantities and units* (available at www.electropedia.org)

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[3] Under preparation.

IEC 61300-1

Edition 5.0 2022-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance

Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesures – Partie 1: Généralités et recommandations

IEC 61300-1:2022-04(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 1: General and guidance

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.
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IEC 61300-1 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2016. This edition constitutes a technical revision.

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

a) addition of the information of measurement uncertainties in 4.2.1;
b) change of the requirements for attenuation variation in 4.2.2;
c) addition of the multimode launch conditions of other fibres than A1-OM2, A1-OM3, A1-OM4, A1-OM5 and A3e in 10.4;
d) addition of the multimode launch conditions of the planar waveguide in 10.6;

e) splitting Annex A for EF and Annex B for EAF;

f) correction of errors in the definitions of encircled flux and encircled angular flux.

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

Draft	Report on voting
86B/4582/FDIS	86B/4602/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/standardsdev/publications.

A list of all parts in the IEC 61300 series, published under the general title, *Fibre optic interconnecting and passive components – Basic test and measurement 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,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The publications in IEC 61300 series [1][1] contain information on mechanical and environmental testing procedures and measurement procedures relating to fibre optic interconnecting devices and passive components. They are intended to be used to achieve uniformity and reproducibility in environmental testing procedures and measurement procedures.

The term "test procedure" refers to procedures commonly known as mechanical and environmental tests. The expressions "environmental conditioning" and "environmental testing" refer to the environments to which components or equipment may be exposed so that an assessment may be made of their performance under the conditions of use, transport and storage.

The term "measurement procedure" refers to those measurements which are necessary to assess the physical and optical characteristics of a component and may also be used before, during or after a test procedure to measure the effects of environmental conditioning or testing. The return loss and attenuation tests are examples of measurement procedures.

The requirements for the performance of components or equipment subjected to the test and measurement procedures described in this document are not included. The relevant specification for the device under test defines the allowed performance limits.

When drafting a specification or purchase contract, only those tests which are necessary for the relevant components or equipment taking into account the technical and economic aspects should be specified.

The mechanical and environmental test procedures are contained in IEC 61300-2 (all parts) and the measurement procedures in IEC 61300-3 (all parts). Each test or measurement procedure is published as a stand-alone publication so that it may be modified, expanded or cancelled without having an effect on any other test or measurement procedure. However, it should be noted that, where practical, reference is made to other standards as opposed to repeating all or part of already existing standards. As an example, the cold test for fibre optic apparatus refers to IEC 60068-2-1 [2], but it also provides other needed information such as purpose, recommended severities and a list of items to be specified.

Multiple methods may be contained in a test or measurement procedure. As an example, several methods of measuring attenuation are contained in the attenuation measurement procedure.

If more than one method is contained in a test or measurement procedure, the reference method may be identified.

The tests in this document permit the performance of components or equipment to be compared. To assess the overall quality of a production lot, the test procedures should be applied in accordance with a suitable sampling plan and may be supplemented by appropriate additional tests, if necessary.

To provide tests appropriate to the different intensities of an environmental condition, some of the test procedures have a number of degrees of severity. These different degrees of severity are obtained by varying the time, temperature or some other determining factor separately or in combination.

[1] Numbers in square bracket refer to the Bibliography.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 1: General and guidance

1 Scope

This part of IEC 61300 provides general information and guidance for the basic test and measurement procedures defined in IEC 61300-2 (all parts) and IEC 61300-3 (all parts) for interconnecting devices, passive components, mechanical splices, fusion splice protectors, fibre management systems and protective housings.

This document is used in combination with the relevant specification which defines the tests to be used, the required degree of severity for each of them, their sequence, if relevant, and the permissible performance limits. In the event of conflict between this document and the relevant specification, the latter takes precedence.

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 60050-731, *International Electrotechnical Vocabulary – Part 731: Optical fibre communication* (available at www.electropedia.org)

IEC 60617, *Graphical symbols for diagrams* (available at http://std.iec.ch/iec60617)

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

IEC 60793-2-30, *Optical fibres – Part 2-30: Product specifications – Sectional specification for category A3 multimode fibres*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

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

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

IEC 61280-4-1, *Fibre-optic communication subsystem test procedures – Part 4-1: Installed cabling plant – Multimode attenuation measurement*

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

IEC 61300-3 (all parts), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3: Examinations and measurements*

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

IEC 61300-3-35, *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*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
test
technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure and normally consists of the following steps:

a) preparation (where required);
b) preconditioning (where required);
c) initial examination and measurement (where required);
d) conditioning;
e) recovery (where required);
f) final examination and measurement

3.1.2
device under test
DUT
interconnecting device, passive component, equipment or other item designated to be tested

3.1.3
preparation
preparing the DUT according to the manufacturer's instructions or as specified in the relevant specification

3.1.4
preconditioning
treatment of a DUT with the object of removing or partly counteracting the effects of its previous environmental history or acclimatisation of the test specimen to standard atmospheric conditions

3.1.5
conditioning
exposure of a DUT to environmental or mechanical conditions for a specified duration in order to determine the effects of such conditions on the DUT

3.1.6
recovery
treatment of a DUT after conditioning in order that the properties of the DUT may stabilise before measurement

3.1.7
examination
visual and/or mechanical inspection of a DUT made with or without the use of special equipment

Note 1 to entry: Examination is usually carried out before and after the test, and/or during the test.

3.1.8
measurement
process of obtaining one or more values that can reasonably be attributed to a quantity

[SOURCE: IEC 60050-112:2010, 112-04-01, modified – The adverb "experimentally" has been removed from the definition, as well as the notes.]

3.1.9
uncertainty of measurement
quantified doubt about the result of a measurement

Note 1 to entry: ISO/IEC Guide 98-3:2008 [3] defines uncertainty of measurement.

Note 2 to entry: IEC TR 61282-14 [4] provides the information of measurement uncertainties.

3.1.10
encircled flux
EF
fraction of cumulative near-field power to the total output power as a function of radial distance from the optical centre of the core, defined by Formula (1):

$$EF(r) = \frac{\int_0^r xI(x)\,dx}{\int_0^R xI(x)\,dx} \tag{1}$$

where

$I(x)$ is the near-field intensity profile as a function of radial position x;

R is the maximum range of integration

Note 1 to entry: The encircled flux shall be measured according to IEC 61280-1-4.

3.1.11
encircled angular flux
EAF
fraction of cumulative far-field power to the total output power as a function of incident angle θ from the optical central axis of the far-field pattern, defined by Formula (2):

$$EAF(\theta') = \frac{\int_0^{2\pi}\int_0^{\theta'} I(\theta,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}\,d\theta d\varphi}{\int_0^{2\pi}\int_0^{\theta_{\max}} I(\theta,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}\,d\theta d\varphi} \tag{2}$$

where

$I(\theta,\varphi)$ is the far-field intensity profile as a function of radial angle and circular angle;

r is the radial distance from the origin corresponding to an angle between one ray emitted from the multimode waveguide and the optical axis of the multimode waveguide, calculated by $d_f \tan\theta$;

φ is a circular angle in polar coordinates;

θ is an angle between one ray emitted from the multimode waveguide and the optical axis;

θ_{max} is the maximum ray angle, which is approximately 30° for category A3 multimode fibre for example;

d_f is the distance between the end of multimode optical waveguide and far field pattern (FFP) screen.

Note 1 to entry: The encircled angular flux is measured according to IEC 61300-3-53 [5].

3.1.12
differential mode attenuation
DMA
variation in attenuation among the propagating modes of a multimode optical fibre

[SOURCE: IEC TR 62614-2:2015 [6], 3.4]

3.1.13
standard uncertainty
uncertainty of a measurement result expressed as a standard deviation

Note 1 to entry: For further information, see the ISO/IEC Guide 98-3.

3.1.14
uncertainty type A
type of uncertainty obtained by a statistical analysis of a series of observations, such as when evaluating certain random effects of measurement

Note 1 to entry: See Annex A and ISO/IEC Guide 98-3.

3.1.15
uncertainty type B
type of uncertainty obtained by means other than a statistical analysis of observations, for example an estimation of probable sources of uncertainty, such as when evaluating systematic effects of measurement

Note 1 to entry: See Annex A and ISO/IEC Guide 98-3.

3.1.16
measurement repeatability
measurement precision under a set of repeatability conditions of measurement

3.1.17
measurement reproducibility
reproducibility measurement precision under reproducibility conditions of measurement

3.1.18
stability
ability of a measuring instrument to keep its performance characteristics within a specified range during a specified time interval, all other conditions being the same

3.1.19
repeatability condition
condition of measurement that includes the same measurement procedure, same operators, same measuring system, same operating conditions and same location, and replicate measurements on the same or similar objects over a short period of time

3.1.20
reproducibility condition
condition of measurement that includes different locations, operators, measuring systems, and replicate measurements on the same or similar objects

3.2 Abbreviated terms

DMA differential mode attenuation
DUT device under test
EAF encircled angular flux
EF encircled flux
FFP far field pattern
FP-LD Fabry-Perot laser diode
GI graded index
LED light emitting diode
NA numerical aperture
SI step index
VCSEL vertical cavity surface emitting laser

4 Requirements for IEC 61300-2 (all parts) and IEC 61300-3 (all parts)

4.1 Requirements for IEC 61300-2 (all parts) (tests)

IEC 61300-2 (all parts) shall contain the following items:

– test apparatus;
– test procedures;
– severities;
– details to be specified and reported.

4.2 Requirements for IEC 61300-3 (all parts) (examinations and measurement procedures)

4.2.1 General requirements

IEC 61300-3 (all parts) shall contain the following items:

– measurement apparatus;
– measurement procedures;
– method of calculation (where required);
– consideration of measurement uncertainty;
– details to be specified and reported.

NOTE 1 The measurement uncertainty herein means the measurement uncertainty of the physical value of the performance parameters of DUT, not that for measurement apparatus (instruments).

NOTE 2 The measurement uncertainty is expressed as an absolute value not using "±".

The measurement accuracy, linearity, stability and repeatability of each measurement apparatus are possible to affect the measurement uncertainty. The relation of those factors on the measurement uncertainty should be described. When the reference value, such as the setting values, the initial values, the nominal values, can be defined, the sign "±" can be adopted for the deviation from the reference values (refer to 6.2 and 6.3).

4.2.2 Requirements for attenuation variation

For interconnecting devices and passive optical components, the attenuation variation is defined as a plus or minus (±) deviation from the original value at the start of the test, unless otherwise specified.

5 Standard atmospheric conditions

Standard atmospheric conditions shall be controlled within some range to ensure proper correlation of data obtained from measurements and tests conducted in various facilities. Test and measurement procedures shall be conducted under the following atmospheric conditions unless otherwise specified. In some cases, special ambient conditions may be needed and can be specified in the relevant specification.

The standard range of atmospheric conditions for carrying out measurements and tests is set out in Table 1.

Table 1 – Standard atmospheric conditions

Temperature	Relative humidity	Air pressure
18 °C to 28 °C	25 % to 75 %	86 kPa to 106 kPa
NOTE Some dimensional measurements require a tighter temperature range of 18 °C to 22 °C as defined in ISO 1 [7].		

Variations in ambient temperature and humidity shall be kept to a minimum during a series of measurements.

6 Significance of the numerical value of a quantity

6.1 General

The numerical values of quantities for the various parameters (temperature, humidity, stress, duration, optical power levels, etc.) given in the basic methods of environmental and optical testing constituting IEC 61300-2 (all parts) and the optical and physical measurements constituting IEC 61300-3 (all parts) are expressed in different ways according to the needs of each individual test.

The two cases that most frequently arise are as follows:

a) the quantity is expressed as a nominal value with a tolerance;

b) the quantity is expressed as a range of values.

For these two cases, the significance of the numerical value is discussed in 6.2 and 6.3.

6.2 Quantity expressed as nominal value with tolerance

Examples of two forms of presentation are:

a) 40 mm ± 2 mm

2 s ± 0,5 s

0,3 dB ± 0,1 dB

b) 93 % $^{+3}_{-2}$ %

The expression of a quantity as a numerical value indicates the intention that the test should be carried out at the stated value. The object of stating tolerances is to take account of the following factors in particular:

- the difficulties in regulating some devices and their drift (undesired slow variation) during the test;
- uncertainties of instrument;

- non-uniformity of environmental parameters, for which no specific tolerances are given, in the test space in which the DUTs are located.

These tolerances are not intended to allow latitude in the adjustment of the values of the parameter within the test space. Hence, when a quantity is expressed by a nominal value with a tolerance, the test apparatus shall be adjusted so as to obtain this nominal value making allowance for the uncertainties of instrument.

In principle, the test apparatus shall not be adjusted to maintain a limiting value of the tolerance zone, even if its uncertainty is so small as to ensure that this limiting value would not be exceeded.

EXAMPLE If the quantity is expressed numerically as 100 ± 5, the test apparatus is adjusted to maintain the target value of 100 making allowance for the uncertainties of instrument and in no case is adjusted to maintain a target value of 95 or 105.

In order to avoid any limiting value applicable to the DUT during the carrying out of the test, it may be necessary in some cases to set the test apparatus near to one tolerance limit.

In the particular case where the quantity is expressed by a nominal value with a unilateral tolerance (which is generally the case unless justified otherwise by special conditions, for example, a non-linear response), the test apparatus shall be set as close as possible to the nominal value (which is also a tolerance limit) taking account of the uncertainty of measurement, which depends on the apparatus used for the test (including the instruments used to measure the values of the parameters).

EXAMPLE If the quantity is expressed numerically as 100 % $^{+0}_{-5}$ % and the test apparatus is capable of an overall uncertainty in the control of the parameter of ±1 %, then the test apparatus is adjusted to maintain a target value of 99 %. If, on the other hand, the overall uncertainty is ±2,5 %, then the adjustment is set to maintain a target value of 97,5 %.

6.3 Quantity expressed as a range of values

Examples of forms of presentation:

a) From 18 °C to 28 °C

   Relative humidity from 80 % to 100 %

   From 1 h to 2 h

b) Return loss ≥ 55 dB

   Attenuation ≤ 0,50 dB

The use of words in expressing a range leads to ambiguity; for example, the phrase "from 80 % to 100 %" is recognised as "excluding the values of 80 and 100" by some readers, as "80 and 100 are included" by others. The use of symbols, for example > 80 or ≥ 80, is generally less likely to be ambiguous and shall therefore be preferred.

The expression of a quantity as a range of values indicates that the value to which the test apparatus is adjusted has only a small influence on the result of the test.

Where the uncertainty of the control of the parameter (including uncertainties of instrument) permits, any desired value within the given range may be chosen. For example, if it is stated that the temperature shall be from 18 °C to 28 °C, any value within this range can be used (but it is not intended that the temperature should be programmed to vary over the range).

7 Graphical symbols and terminology

The terminology used in the interpretation and preparation of fibre optic test and measurement procedures shall be taken from IEC 60050-731.

Graphical symbols used for the preparation and interpretation of fibre optic test and measurement procedures shall be selected where possible from IEC 60617.

8 Safety

As far as laser radiation is concerned, the precautions for carrying out fibre optic measurements as given in IEC 60825-1 shall be used. Fibre optic components and systems may emit hazardous radiation. This may occur

a) at sources,

b) in transmission systems during installation, during service or intentional interruption and failure or unintentional interruption, and

c) while measuring and testing.

For hazard evaluation, precautions and manufacturer's requirements, IEC 60825-1 and IEC 60825-2 shall be used.

Other safety aspects are referred to in applicable test methods and other standards.

9 Calibration

9.1 General

The equipment used shall have a valid calibration certificate in accordance with the applicable quality system for the period over which the testing is done. Preferably international or national standards should be adopted (e.g. IEC 61315 [8]). The calibration should be traceable to a national standard if available.

In cases where no calibration standard exists, the manufacturer or laboratory carrying out the test shall state the uncertainty of the test equipment to their best knowledge.

9.2 Round robin calibration procedure

Where the uncertainty is unknown, it may be necessary to evaluate the uncertainty with use a round robin calibration procedure for calibrating measuring instruments (e.g. gauges).

10 Launch conditions

10.1 General

The loss characteristics of a component frequently depend, to a very significant extent, on how the light is launched into the input fibre. The launch conditions should be used for all optical measurements. In order to obtain repeatable measurements, it is necessary to use standard launch conditions, which are clearly defined, and can be duplicated easily and precisely.

To achieve consistent results, first inspect and, if necessary, clean and inspect again all connector plugs and adaptors prior to measurement. Visual examination shall be undertaken in accordance with IEC 61300-3-1. Additionally, end-faces of optical connectors shall be inspected in accordance with IEC 61300-3-35.

The power in the fibre shall be set high enough, within the power level, not to generate non-linear scattering effects.

Precautions shall be taken to ensure that cladding modes do not affect the measurement. Cladding modes shall be eliminated either as a natural function of the fibre coating in the input

and output fibres, or by adding cladding mode eliminators if specified in the relevant specification.

Precautions shall be taken to ensure that excessive bending of the fibres on either the input or output fibre, which could affect the measurement, does not occur. The fibres should remain fixed in position during the measurement.

The stability of the launch shall be suitable for the measurement to be undertaken. The stability shall be maintained over the measurement time and operational temperature range.

10.2 Multimode launch conditions for A1 fibres

Annex A provides a procedure for establishing the launch conditions for multimode fibre of category A1 defined in IEC 60793-2-10. The launch conditions are defined by tolerance bands on a target encircled flux (EF) metric.

NOTE 1 IEC 62614-1 [9] and IEC TR 62614-2 provide useful information on multimode launch condition.

These tolerance bands have been created for testing installed fibre optic links according to IEC 61280-4-1, to limit the variation in measured attenuation. The expected tolerances for links (with multiple connectors) are different to those for a single connection. When the measured EF of the source is within the specified tolerance bands, the expected uncertainty for the measured attenuation value of a single connection for A1-OM2, A1-OM3, A1-OM4 and A1-OM5 fibres, in dB, is according to Table 2.

NOTE 2 Multimode optical interfaces are provided in IEC 63267 (all parts)[2] [10].

Table 2 – Expected variation of attenuation due to mode variation of single connections for A1-OM2, A1-OM3, A1-OM4 and A1-OM5 fibres

Fibre nominal core diameter µm	Wavelength nm	Expected variation of attenuation due to mode variation dB
50	850	±0,08

Table 2 is valid for attenuation values ≤ 0,75 dB due to launch condition and modal variation.

When calculating the total uncertainty of the multimode attenuation measurement, the uncertainty due to the modal variations shall be included.

10.3 Multimode launch conditions for A3e fibre

Annex B provides a procedure for establishing the launch conditions for category A3e multimode fibre defined in IEC 60793-2-30. The launch condition is defined by tolerance band on a target encircled angular flux (EAF) metric.

NOTE IEC 61300-3-53 provides useful information on multimode launch condition for step index (SI) fibre, defined in IEC 60793-2-30 and IEC 60793-2-40 [11].

These tolerance bands have been created for testing connecting devices, to limit the variation in measured attenuation. When the measured EAF of the source is within the specified tolerance band, the expected uncertainty for the measured attenuation value of a single connection, in dB, is according to Table 3.

2 Under preparation.

Table 3 – Expected variation of attenuation due to mode variation of single connections for A3e fibre

Fibre nominal core diameter µm	NA	Wavelength nm	Expected variation of attenuation due to mode variation dB
200	0,37	850	±0,2

Table 3 is valid for attenuation values ≤ 2,0 dB due to launch condition and modal variation.

When calculating the total uncertainty of the multimode attenuation measurement, the uncertainty due to the modal variations shall be included.

10.4 Multimode launch conditions for the other multimode fibres

For multimode fibres the other than A1 fibres and A3e fibres, the measurement launch condition shall be determined between suppliers and users. Unless otherwise specified, the recommended launch condition is EF for graded index fibres and EAF for SI fibres.

10.5 Single-mode launch conditions

For single-mode components, the wavelength of the source (including the total spectral width) shall be longer than the cut-off wavelength of the fibre. The deployment and length of the fibre on the input shall be such that any higher order modes that may initially be launched are sufficiently attenuated.

For polarization sensitive devices, the state of polarization of input power may be significant and, when required, shall be specified in the relevant specification.

10.6 Multimode planar waveguide launch conditions

For multimode planar waveguide components, the measurement launch condition shall be determined between suppliers and users. It is recommended to apply the launch conditions of EF for the graded index (GI) waveguides and EAF for the SI waveguides.

Typically, the launch angles and/or beam diameters of the horizontal axis (X-axis) and the vertical axis (Y-axis) are not the same, for example the beam shape is not circular symmetric. The launch conditions of EF and EAF are applied assuming the circular symmetric beam. It should be taken into consideration that the measurement launch conditions of EF or EAF is possible to be different from actual launch conditions in application.

The following items of the measurement launch condition for the application should be considered:

– direction of transmission of the light (i.e. GI to SI or SI to GI);
– the launch angle of the light source (i.e. vertical cavity surface emitting laser (VCSEL), Fabry-Perot laser diode (FP-LD), light emitting diode (LED) and so on);
– numerical aperture (NA) of the waveguides;
– the length of the waveguide and the fibres.

Annex A
(normative)

Multimode launch condition requirement for measuring attenuation of components terminated on IEC 60793-2-10 type A1 fibres

A.1 General

Annex A describes the general multimode launch condition requirements used for measuring attenuation. The purpose of these requirements is to ensure consistency of field measurements with factory measurements and consistency of factory or field measurements when different types of test equipment are used.

Use of these launch conditions should ensure that, when a component is factory tested, it meets the requirements of field testing after installation of the product in the field.

For multimode step index (SI) fibre, defined by IEC 60793-2-30 and IEC 60793-2-40, encircled angular flux (EAF) measurement method, defined by IEC 61300-3-58, is used. See Annex B.

A.2 Technical background

Light sources, typically used in measuring attenuation, may have varying modal distributions when launched into multimode fibre. These differing modal distributions, combined with the differential mode attenuation (DMA) inherent in most multimode components, commonly cause measurement variations when measuring attenuation of multimode components. For example, attenuation measurement variations can occur when two similar light sources or different launch cords are used.

In the past, legacy (LED based) applications had a wide power budget which in most cases masked the variance in result between the factory and field measurement.

As technology has evolved, the system requirements for attenuation have become more stringent. Demanding application requirements are driving the need for accurate and reproducible multimode attenuation measurements over a variety of field-test instruments. Attenuation measurement experiments with different field-test instruments having the same standards-compliant set-up produce measurement variations that are induced by their differing launch conditions.

A.3 EF template

A.3.1 Applicable types of optical fibres

These guidelines are suitable for 50 µm and 62,5 µm core fibres, both with 125 µm cladding diameter.

A.3.2 Encircled flux

The EF is determined from the near field measurement of the light coming from the end of the reference grade launching cord.

A.3.3 EF template example

An example of an encircled flux template for 50 µm core fibre at 850 nm is shown in Figure A.1.

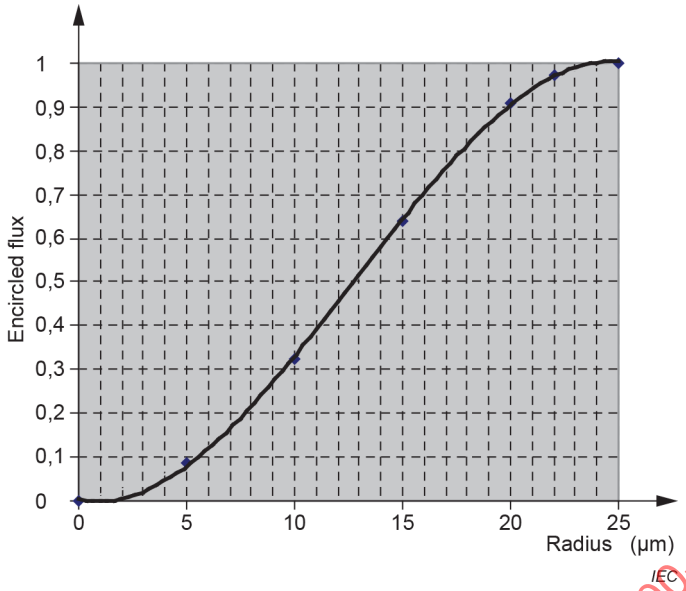


Figure A.1 – Encircled flux template example

A.4 Target launch and upper and lower tolerance bands for attenuation measurements of A1-OM2 to A1-OM5 and A1-OM1 optical fibre connections

A.4.1 General

The specified launch condition in this document is valid for attenuation measurement of multimode fibre optic connections. The launch condition for attenuation measurements for multimode connectors shall meet the EF requirements of Table A.1 to Table A.4 when measured at the output of the reference connector.

A.4.2 Limits on EF

The limits for the EF are derived from a target near field and a set of boundary conditions designed to constrain the variation in attenuation induced by variations in the source to within ±10 % or ±X dB, whichever is largest, of the value that would be obtained if the target launch were used. The variable X is a tolerance threshold that varies with fibre core size and wavelength according to the values in Table 2. The limits are derived from theoretical considerations.

Table A.1 – EF requirements for 50 µm core fibre at 850 nm

Radial offset µm	EF lower bound	EF target bound	EF upper bound
10	0,278 5	0,335	0,391 5
15	0,598 0	0,655	0,711 9
20	0,910 5	0,919 3	0,929 5
22	0,969 0	0,975 1	0,981 2

Table A.2 – EF requirements for 50 µm core fibre at 1 300 nm

Radial offset µm	EF lower bound	EF target bound	EF upper bound
10	0,279 2	0,336 6	0,394 0
15	0,599 6	0,656 7	0,713 8
20	0,907 2	0,918 6	0,930 0
22	0,966 3	0,972 8	0,979 3

Table A.3 – EF requirements for 62,5 µm fibre at 850 nm

Radial offset µm	EF lower bound	EF target bound	EF upper bound
10	0,168 3	0,210 9	0,253 5
15	0,369 5	0,439	0,508 5
20	0,633 7	0,692 3	0,750 9
26	0,924 5	0,935	0,945 5
28	0,971 0	0,978 3	0,985 6

Table A.4 – EF requirements for 62,5 µm fibre at 1 300 nm

Radial offset µm	EF lower bound	EF target bound	EF upper bound
10	0,168 0	0,211 9	0,255 8
15	0,369 9	0,440 9	0,511 9
20	0,636 9	0,694 5	0,752 1
26	0,925 4	0,935 7	0,946 0
28	0,970 8	0,978 2	0,985 6

Annex B
(normative)

Multimode launch condition requirement for measuring attenuation of components terminated on IEC 60793-2-30 type A3e fibres

B.1 EAF template

B.1.1 Applicable types of optical fibres

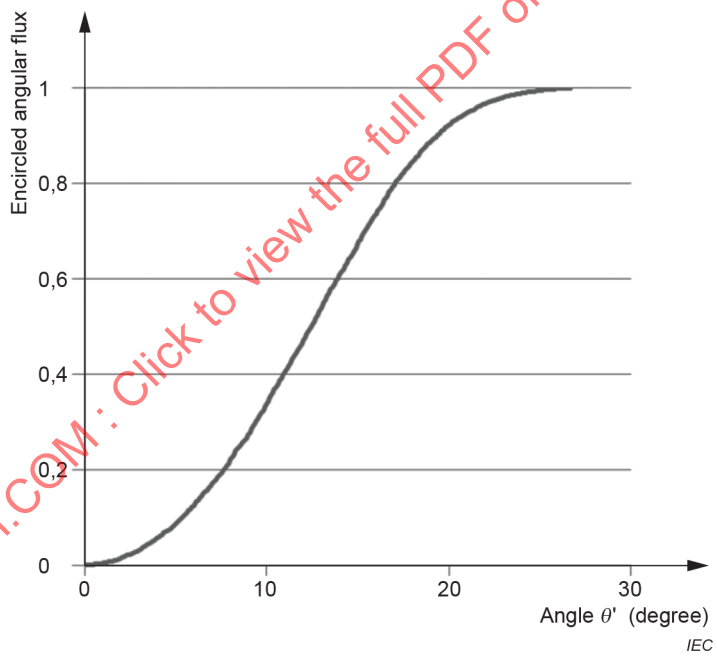
These guidelines are suitable for 200 µm core fibres with 230 µm cladding diameter.

B.1.2 Encircled angular flux

The EAF is determined from the far field measurement of the light coming from the end of the reference grade launching cord.

B.1.3 EAF template example

An example of an encircled angular flux template for 200 µm core fibre at 850 nm is shown in Figure B.1.



NOTE Although the unit for Formula (2), which is the definition of EAF, is radian, the unit for the horizontal axis is degree.

Figure B.1 – Encircled angular flux template example

B.2 Target launch and upper and lower tolerance bands for attenuation measurements of A3e optical fibre connections

B.2.1 General

The specified launch condition in this document is valid for attenuation measurement of multimode fibre optic connections. The launch condition for attenuation measurements for multimode connectors shall meet the EAF requirements of Table B.1 when measured at the output of the reference connector.

B.2.2 Limits on EAF

The limits for the EAF is derived from a target far field and a set of boundary conditions designed to constrain the variation in attenuation induced by variations in the source to within ±10 % or ±X dB, whichever is largest, of the value that would be obtained if the target launch were used. The variable X is a tolerance threshold that varies with fibre core size and wavelength according to the values in Table 3. The limits are derived from theoretical considerations.

Table B.1 – EAF requirements for NA of 0,37 and 200 µm core fibre at 850 nm

Radiation angle degree[a]	EAF lower bound	EAF upper bound
5	0,075 3	0,119 7
10	0,293 4	0,445 4
15	0,606 9	0,832 9
20	0,870 8	0,987 1

[a] Although the unit for Formula (2), which is the definition of EAF, is radian, the unit of the radiation angle is degree.

Bibliography

[1] IEC 61300 (all parts), *Fibre optic interconnecting devices and passive components*

[2] IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

[3] ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

[4] IEC TR 61282-14, *Fibre optic communication system design guidelines – Part 14: Determination of the uncertainties of attenuation measurements in fibre plants*

[5] IEC 61300-3-53, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-53: Examinations and measurements – Encircled angular flux (EAF) measurement method based on two-dimensional far field data from multimode waveguide (including fibre)*

[6] IEC TR 62614-2:2015, *Fibre optics – Multimode launch conditions – Part 2: Determination of launch condition requirements for measuring multimode attenuation*

[7] ISO 1, *Geometrical product specifications (GPS) – Standard reference temperature for the specification of geometrical and dimensional properties*

[8] IEC 61315, *Calibration of fibre-optic power meters*

[9] IEC 62614-1, *Fibre optics – Multimode launch conditions – Part 1: Launch condition requirements for measuring multimode attenuation*

[10] IEC 63267 (all parts), *Fibre optic interconnecting devices and passive components – Connector optical interfaces for enhanced macro bend loss multimode fibres*[3]

[11] IEC 60793-2-40, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*

[12] IEC 60050-112, *International Electrotechnical Vocabulary (IEV) – Part 112: Quantities and units* (available at www.electropedia.org)

3 Under preparation.

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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DISPOSITIFS D'INTERCONNEXION ET COMPOSANTS PASSIFS FIBRONIQUES – PROCÉDURES FONDAMENTALES D'ESSAIS ET DE MESURES –

Partie 1: Généralités et recommandations

AVANT-PROPOS

1) La Commission Électrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. À cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
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8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets..

La Norme internationale IEC 61300-1 a été établie par le sous-comité 86B: Dispositifs d'interconnexion et composants passifs à fibres optiques, du comité d'études 86 de l'IEC: Fibres optiques. Il s'agit d'une Norme internationale.

Cette cinquième édition annule et remplace la quatrième édition parue en 2016. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) ajout d'informations sur les incertitudes de mesure en 4.2.1;
b) modification des exigences pour la variation d'affaiblissement en 4.2.2;

c) ajout des conditions d'injection en multimodal des fibres autres que A1-OM2, A1-OM3, A1-OM4, A1-OM5 et A3e en 10.4;

d) ajout des conditions d'injection en multimodal du guide d'onde plan en 10.6;

e) séparation de l'Annexe A pour l'EF et de l'Annexe B pour l'EAF;

f) correction d'erreurs dans les définitions du flux inscrit et du flux angulaire inscrit.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
86B/4582/FDIS	86B/4602/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Le présent document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Une liste de toutes les parties de la série IEC 61300, publiées sous le titre général, *Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesure*s, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu du présent document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

INTRODUCTION

Les publications de la série IEC 61300 [1] [1] contiennent les informations concernant les procédures d'essai et de mesure mécaniques et d'environnement applicables aux dispositifs d'interconnexion et aux composants passifs fibroniques. Elles sont destinées à assurer l'uniformité et la reproductibilité des procédures d'essai et de mesure d'environnement.

Le terme "procédure d'essai" désigne les procédures généralement connues sous le vocable "essais mécaniques et d'environnement". Les expressions "conditionnement environnemental" et "essai d'environnement" font référence aux environnements auxquels peuvent être exposés les composants ou les équipements, de façon à pouvoir évaluer leurs performances dans leurs conditions d'utilisation, de transport et de stockage.

Le terme "procédure de mesure" fait référence aux mesurages qui sont nécessaires pour évaluer les caractéristiques physiques et optiques d'un composant et qui peuvent également être utilisés avant, pendant ou après une procédure d'essai pour mesurer les effets du conditionnement ou des essais d'environnement. Les essais d'affaiblissement de réflexion et d'affaiblissement sont des exemples de procédures de mesure.

Les exigences concernant les performances des composants ou des équipements soumis aux procédures d'essai et de mesure décrites dans le présent document ne sont pas incluses. La spécification applicable au dispositif en essai définit les limites de performances admises.

Lors de la rédaction d'une spécification ou d'un contrat d'achat, il convient de stipuler uniquement les essais nécessaires pour les composants ou l'équipement concerné(s) en tenant compte des aspects techniques et économiques.

L'IEC 61300-2 (toutes les parties) contient les procédures d'essai mécaniques et d'environnement et l'IEC 61300-3 (toutes les parties) contient les procédures de mesure. Chaque procédure d'essai ou de mesure fait l'objet d'une publication autonome qui peut par conséquent être modifiée, complétée ou annulée sans avoir aucune incidence sur les autres procédures d'essai ou de mesure. Toutefois, il convient de noter que lorsque cela est possible, les autres normes existantes sont citées en référence au lieu de répéter tout ou partie de leur contenu. Par exemple, l'essai de froid pour les équipements fibroniques fait référence à l'IEC 60068-2-1 [2], mais il fournit également d'autres informations nécessaires comme l'objectif poursuivi, les sévérités recommandées et une liste des points à spécifier.

Une procédure d'essai ou de mesure peut contenir plusieurs méthodes. À titre d'exemple, plusieurs méthodes de mesure de l'affaiblissement sont données dans la procédure de mesure de l'affaiblissement.

Si une procédure d'essai ou de mesure contient plusieurs méthodes, la méthode de référence peut être identifiée.

Les essais du présent document permettent de comparer les performances des composants ou des équipements. Pour évaluer la qualité globale d'un lot de produits, il convient d'appliquer les procédures d'essai conformément à un plan d'échantillonnage adapté; si nécessaire, elles peuvent être complétées par des essais supplémentaires appropriés.

Certaines procédures d'essai comportent plusieurs degrés de sévérité, ce qui permet de proposer des essais appropriés aux différentes intensités d'une condition environnementale. Ces différents degrés de sévérité s'obtiennent en faisant varier la durée, la température ou un autre facteur déterminant, individuellement ou de manière combinée.

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1 Les chiffres entre crochets renvoient à la Bibliographie.

DISPOSITIFS D'INTERCONNEXION ET COMPOSANTS PASSIFS FIBRONIQUES – PROCÉDURES FONDAMENTALES D'ESSAIS ET DE MESURES –

Partie 1: Généralités et recommandations

1 Domaine d'application

La présente partie de l'IEC 61300 donne des informations d'ordre général et des recommandations concernant les procédures fondamentales d'essai et de mesure définies dans l'IEC 61300-2 (toutes les parties) et l'IEC 61300-3 (toutes les parties) et applicables aux dispositifs d'interconnexion, aux composants passifs, aux épissures mécaniques, aux protecteurs d'épissures par fusion, aux systèmes de gestion des fibres et aux boîtiers de protection.

Le présent document est utilisé avec la spécification applicable qui définit les essais à réaliser, le degré de sévérité exigé pour chacun d'eux, l'ordre dans lequel ils sont effectués, le cas échéant, et les limites des performances admissibles. Si le présent document et la spécification applicable sont en contradiction, c'est cette dernière qui prévaut.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60050-731, *Vocabulaire électrotechnique international – Chapitre 731: Télécommunications par fibres optiques*

IEC 60617, *Symboles graphiques pour schémas* (disponible sur http://std.iec.ch/iec60617)

IEC 60793-2-10, *Fibres optiques – Partie 2-10: Spécifications de produits – Spécification intermédiaire pour les fibres multimodales de catégorie A1*

IEC 60793-2-30, *Fibres optiques – Partie 2-30: Spécifications de produits - Spécification intermédiaire pour les fibres multimodales de catégorie A3*

IEC 60825-1, *Sécurité des appareils à laser – Partie 1: Classification des matériels et exigences*

IEC 60825-2, *Sécurité des appareils à laser – Partie 2: Sécurité des systèmes de télécommunication par fibres optiques (STFO)*

IEC 61280-1-4, *Procédures d'essai des sous-systèmes de télécommunication à fibres optiques – Partie 1-4: Sous-systèmes généraux de télécommunication – Méthode de mesure du flux inscrit de la source lumineuse*

IEC 61280-4-1, *Procédures d'essai des sous-systèmes de télécommunication fibroniques – Partie 4-1: Installation câblée – Mesure de l'affaiblissement en multimodal*

IEC 61300-2 (toutes les parties), *Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesures – Essais*

IEC 61300-3 (toutes les parties), *Dispositifs d'interconnexion et composants passifs fibroniques – Examens et mesures*

IEC 61300-3-1, *Dispositifs d'interconnexion et composants passifs à fibres optiques – Méthodes fondamentales d'essais et de mesures – Partie 3-1: Examens et mesures – Examen visuel*

IEC 61300-3-35, *Dispositifs d'interconnexion et composants passifs à fibres optiques – Procédures fondamentales d'essais et de mesures – Partie 3-35: Examens et mesures – Examen visuel des connecteurs à fibres optiques et des émetteurs-récepteurs à embase fibrée*

3 Termes, définitions et termes abrégés

3.1 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1.1
essai
opération technique qui consiste à déterminer une ou plusieurs caractéristiques d'un produit, d'un processus ou d'un service donné selon un mode opératoire spécifié et qui est normalement composé des étapes suivantes:

a) préparation (si exigé);
b) préconditionnement (si exigé);
c) examen initial et mesurage initial (si exigé);
d) conditionnement;
e) récupération (si exigé);
f) examen final et mesurage final.

3.1.2
dispositif en essai
DUT
dispositif d'interconnexion, composant passif, équipement ou autre élément destiné à être soumis à un essai

Note à l'article: L'abréviation "DUT" est dérivée du terme anglais développé correspondant "*Device Under Test*".

3.1.3
préparation
opération qui consiste à préparer le DUT conformément aux instructions du fabricant ou selon les indications de la spécification applicable

3.1.4
préconditionnement
traitement d'un DUT dans le but de neutraliser ou de contrer partiellement les effets des conditions d'environnement auxquelles il a été soumis précédemment ou l'acclimatation de l'objet testé à des conditions atmosphériques standard

3.1.5
conditionnement
exposition d'un DUT à des conditions mécaniques ou d'environnement pendant une durée spécifiée afin de déterminer les effets de ces conditions sur ce DUT

3.1.6
récupération
traitement d'un DUT après conditionnement, afin de permettre la stabilisation de ses propriétés avant mesurage

3.1.7
examen
contrôle visuel et/ou mécanique d'un DUT réalisé avec ou sans équipement spécial

Note 1 à l'article: L'examen est généralement effectué avant et après l'essai et/ou au cours de l'essai.

3.1.8
mesurage
processus consistant à obtenir une ou plusieurs valeurs que l'on peut raisonnablement attribuer à une grandeur

[SOURCE: IEC 60050-112:2010, 112-04-01, modifié – L'adverbe "expérimentalement" a été supprimé de la définition, ainsi que les notes.]

3.1.9
incertitude de mesure
doute quantifié sur le résultat d'un mesurage

Note 1 à l'article: Le Guide ISO/IEC 98-3:2008 [3] définit l'incertitude de mesure.

Note 2 à l'article: L'IEC TR 61282-14 [4] fournit des informations sur les incertitudes de mesure.

3.1.10
flux inscrit
EF
fraction de la puissance cumulée en champ proche sur la puissance totale de sortie en fonction de la distance radiale par rapport au centre optique du cœur, définie par la formule (1):

$$EF(r) = \frac{\int_0^r xI(x)\,dx}{\int_0^R xI(x)\,dx} \tag{1}$$

où

$I(x)$ est le profil d'intensité en champ proche en fonction de la position radiale, x;

R est le rayon maximal d'intégration

Note 1 à l'article: Le flux inscrit doit être mesuré conformément à l'IEC 61280-1-4.

Note 2 à l'article: L'abréviation "EF" est dérivée du terme anglais développé correspondant "*Encircled Flux*".

3.1.11
flux angulaire inscrit
EAF
fraction de la puissance cumulée en champ lointain sur la puissance totale de sortie en fonction de l'angle incident θ par rapport à l'axe du centre optique du champ lointain, définie par la formule (2):

$$EAF(\theta') = \frac{\int_0^{2\pi}\int_0^{\theta'} I(\theta,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}d\theta d\varphi}{\int_0^{2\pi}\int_0^{\theta_{max}} I(\theta,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}d\theta d\varphi} \quad (2)$$

où

$I(\theta,\varphi)$ est le profil d'intensité en champ lointain en fonction de l'angle radial et de l'angle circulaire;

r est la distance radiale à partir de l'origine correspondant à un angle entre un rayon émis par le guide d'ondes multimodal et l'axe optique du guide d'ondes multimodal, calculée par $d_f \tan\theta$;

φ est un angle circulaire en coordonnées polaires;

θ est un angle compris entre un rayon émis par le guide d'ondes multimodal et l'axe optique;

θ_{max} est l'angle maximal de rayon qui est d'environ 30° pour une fibre multimodale de catégorie A3 par exemple;

d_f est la distance entre l'extrémité du guide d'onde optique multimodal et l'écran du diagramme de champ lointain (FFP - far field pattern).

Note 1 à l'article: Le flux angulaire inscrit est mesuré conformément à l'IEC 61300-3- 53 [5].

Note 2 à l'article: L'abréviation "EAF" est dérivée du terme anglais développé correspondant "*Encircled Angular Flux*".

3.1.12
affaiblissement en mode différentiel
DMA
variation de l'affaiblissement entre les modes de propagation d'une fibre optique multimodale

Note 1 à l'article: L'abréviation "DMA" est dérivée du terme anglais développé correspondant "*Differential Mode Attenuation*".

[SOURCE: IEC TR 62614-2: 2015 [6], 3.4]

3.1.13
incertitude-type
incertitude du résultat d'un mesurage exprimée sous la forme d'un écart-type

Note 1 à l'article: Pour de plus amples informations, voir le Guide ISO/IEC 98-3.

3.1.14
incertitude de type A
type d'incertitude obtenu par une analyse statistique d'une série d'observations, comme lors de l'évaluation de certains effets aléatoires de mesure

Note 1 à l'article: Voir l'Annexe A et le Guide ISO/IEC 98-3.

3.1.15
incertitude de type B
type d'incertitude obtenu par des moyens autres qu'une analyse statistique de séries d'observations, par exemple, une estimation des sources probables d'incertitude, comme lors de l'évaluation des effets systématiques de mesure

Note 1 à l'article: Voir l'Annexe A et le Guide ISO/IEC 98-3.

3.1.16
répétabilité de mesure
fidélité de mesure selon un ensemble de conditions de répétabilité

3.1.17
reproductibilité de mesure
fidélité de mesure selon un ensemble de conditions de reproductibilité

3.1.18
stabilité
aptitude d'un appareil de mesure à conserver ses caractéristiques de fonctionnement sans modification à l'intérieur d'une plage spécifiée pendant une durée spécifiée, toutes les autres conditions demeurant les mêmes

3.1.19
condition de répétabilité
condition de mesurage qui comprend la même procédure de mesure, les mêmes opérateurs, le même système de mesure, les mêmes conditions de fonctionnement et le même lieu, ainsi que les mesurages répétés sur le même objet ou des objets similaires pendant une courte période

3.1.20
condition de reproductibilité
condition de mesurage qui comprend des lieux, des opérateurs et des systèmes de mesure différents, ainsi que des mesurages répétés sur le même objet ou des objets similaires

3.2 Termes abrégés

DMA differential mode attenuation (affaiblissement en mode différentiel)
DUT device under test (dispositif en essai)
EAF encircled angular flux (flux angulaire inscrit)
EF encircled flux (flux inscrit)
FFP far field pattern (diagramme de champ lointain)
FP-LD Fabry-Perot laser diode (diode laser de Fabry-Perot)
GI graded index (gradient d'indice)
LED light emitting diode (diode électroluminescente)
NA numerical aperture (ouverture numérique)
SI step index (saut d'indice)
VCSEL vertical cavity surface emitting laser (laser à cavité verticale et à émission par la surface)

4 Exigences pour l'IEC 61300-2 (toutes les parties) et l'IEC 61300-3 (toutes les parties)

4.1 Exigences pour l'IEC 61300-2 (toutes les parties) (essais)

L'IEC 61300-2 (toutes les parties) doit traiter les points suivants:

– l'appareillage d'essai;
– les procédures d'essai;
– les sévérités;
– les éléments à spécifier et à consigner.