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)

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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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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):

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

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):

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

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

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.