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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 à fibres optiques – Procédures fondamentales d'essais et de mesures –
Partie 1: Généralités et lignes directrices

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

This third edition cancels and replaces the second edition published in 2003. This edition constitutes a technical revision. The changes with respect to the previous edition are to reconsider the terms and definitions and multimode launch conditions.

The text of this standard is based on the following documents:

FDIS	Report on voting
86B/3112/FDIS	86B/3164/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The 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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The publications in the IEC 61300 series contain information on 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 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 standard 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 environmental test procedures are contained in the IEC 61300-2 series and the measurement procedures in the IEC 61300-3 series. 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, 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 is identified.

The tests in this standard permit the performance of sample 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.

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

Part 1: General and guidance

1 Scope

This part of IEC 61300 contains a series of environmental test and measurement procedures and, in some cases, preferred severities designed to assess the ability of fibre optic interconnecting devices and passive components to perform under expected service conditions. Although the severities are primarily intended for land-based communications, the procedures may be used for other applications. The object of this standard is to provide uniform and reproducible environmental test procedures and measurement procedures, for those preparing specifications for fibre optic interconnecting devices and passive components.

These test and measurement procedures are designed to provide information on the following properties of components and equipment, such as connectors, splices, switches, attenuators, etc.:

a) ability to operate within specified limits of temperature, pressure, humidity, mechanical stress or other environmental conditions and certain combinations of these conditions;

b) ability to withstand storage and transport;

c) ability to meet the specified levels of optical performance.

This standard should be used in combination with the relevant specification which will define 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 basic standard and the relevant specification, the latter will take precedence.

2 Normative references

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

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

IEC 60617, *Graphical symbols for diagrams*

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 (OFCS)*

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 plant – Multimode attenuation measurement*

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

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

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

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

3.1
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) pre-conditioning (where required);
b) initial examination and measurement (where required);
c) conditioning;
d) recovery (where required);
e) final examination and measurement.

3.2
device under test
(DUT)
single component, equipment or other item designated to be tested in accordance with the procedures of this standard

3.3
pre-conditioning
treatment of a DUT with the object of removing or partly counteracting the effects of its previous history

NOTE When called for, it is the first step in the test procedure.

3.4
conditioning
exposure of a DUT to environmental conditions in order to determine the effects of such conditions on the DUT

NOTE Where measurements are required during conditioning, this will be stated in the relevant specification.

3.5
recovery
treatment of a DUT after conditioning in order that the properties of the DUT may stabilise before measurement

3.6
sample
group of DUTs, selected at random or by some other specified procedure from a larger population and which, for the purpose of testing, is intended to be representative of the larger population

4 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 (860 mbar to 1 060 mbar)

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

5 Significance of the numerical value of a quantity

5.1 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 the IEC 61300-2 series and the optical and physical measurements constituting the IEC 61300-3 series are expressed in different ways according to the needs of each individual test.

The two cases that most frequently arise are:

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 5.2 and 5.3.

5.2 Quantity expressed as nominal value with tolerance

Examples of two forms of presentation:

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

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 shall be adjusted to maintain the target value of 100 making allowance for instrument errors and shall in no case be 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 should be adjusted to maintain a target value of 99 %. If, on the other hand, the overall uncertainty is $^{+2,5}_{-2,5}$ %, then the adjustment should be set to maintain a target value of 97,5 %.

5.3 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

NOTE The use of words in expressing a range may lead to ambiguity; for example the phrase "from 80 % to 100 %" may, for some readers, exclude the values of 80 and 100 while, for others, they may be included. The use of symbols, for example >80 or ≥80, is generally less likely to be ambiguous and is 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 instrument errors) 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).

6 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.

7 Safety

The precautions for carrying out fibre optic measurements, as far as laser radiation is concerned, are given in IEC 60825-1. 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;

c) while measuring and testing.

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

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

8 Calibration

8.1 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). 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.

8.2 Round robin calibration procedure

Where the uncertainty is unknown, it may be necessary to use a round robin calibration procedure for calibrating measuring instruments (e.g. gauges). Annex A gives one procedure for conducting a round robin. Although this test method refers to fibre optic connector sets, the principle of the round robin calibration procedure may be adapted for other measurements by users and/or manufacturers where intermateability of component parts coming from different sources cannot be achieved otherwise.

9 Launch conditions

9.1 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 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, clean and inspect all connectors and adaptors prior to measurement. Visual examination shall be undertaken in accordance with IEC 61300-3-1.

9.2 Multimode launch conditions

Annex B provides a procedure for establishing the launch conditions for multimode fibre. The launch conditions are defined by tolerance bands on a target encircled flux (EF) metric.

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

Table 2 – Expected uncertainty for measured attenuation of single connectors

Fibre nominal core diameter µm	Wavelength nm	Expected uncertainty dB
50	850	0,08
	1 300	0,12
62,5	850	0,10
	1 300	0,15

Table 2 is valid for attenuation values ≤ 0,75 dB.

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

9.3 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 some devices, the state of polarisation of input power may be significant and, when required, shall be specified in the relevant specification.

The power in the fibre shall not be at a high enough level to generate non-linear scattering effects.

Precautions shall be taken to ensure that cladding modes do not affect the measurement. Cladding modes shall be stripped either as a natural function of the fibre coating in the input and output fibres, or by adding cladding mode strippers 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. Where possible 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.