BS EN 61300-1:2016

BSI Standards Publication

Fibre optic interconnecting devices and passive components — Basic test and measurement procedures

Part 1: General and guidance

bsi.

National foreword

This British Standard is the UK implementation of EN 61300-1:2016. It is identical to IEC 61300-1:2016. It supersedes BS EN 61300-1:2011 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/2, Fibre optic interconnecting devices and passive components.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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European foreword

The text of document 86B/3992/FDIS, future edition 4 of IEC 61300-1, prepared by SC 86B “Fibre optic interconnecting devices and passive components” of IEC/TC 86 “Fibre Optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61300-1:2016.

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• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-12-09

This document supersedes EN 61300-1:2011.

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Endorsement notice

The text of the International Standard IEC 61300-1:2016 was approved by CENELEC as a European Standard without any modification.

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

IEC 60068-2-1	NOTE	Harmonized as EN 60068-2-1.
IEC 61315	NOTE	Harmonized as EN 61315.
IEC 62614	NOTE	Harmonized as EN 62614.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

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

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

Publication	Year	Title	EN/HD	Year
IEC 60050-731	-	International Electrotechnical Vocabulary - Chapter 731: Optical fibre communication	-	-
IEC 60617-DB	-	Graphical symbols for diagrams	-	-
IEC 60793-2-10	-	Optical fibres - Part 2-10: Product specifications - Sectional specification for category A1 multimode fibres	EN 60793-2-10	-
IEC 60793-2-30	-	Optical fibres - Part 2-30: Product specifications - Sectional specification for category A3 multimode fibres	EN 60793-2-30	-
IEC 60793-2-40	-	Optical fibres - Part 2-40: Product specifications - Sectional specification for category A4 multimode fibres	EN 60793-2-40	-
IEC 60825-1	-	Safety of laser products - Part 1: Equipment classification and requirements	EN 60825-1	-
IEC 60825-2	-	Safety of laser products - Part 2: Safety of optical fibre communication systems (OFCS)	EN 60825-2	-
IEC 61280-1-4	-	Fibre optic communication subsystem test procedures - Part 1-4: General communication subsystems - Light source encircled flux measurement method	EN 61280-1-4	-
IEC 61280-4-1	-	Fibre optic communication subsystem test procedures - Part 4-1: Installed cable plant - Multimode attenuation measurement	EN 61280-4-1	-
IEC 61300-2	Series	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2: Tests	EN 61300-2	Series

Publication	Year	Title	EN/HD	Year
IEC 61300-3	Series	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3: Examinations and measurements	EN 61300-3	Series
IEC 61300-3-1	-	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-1: Examinations and measurements - Visual examination	EN 61300-3-1	-
IEC 61300-3-35	-	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-35: Examinations and measurements - Visual inspection of fibre optic connectors and fibre-stub transceivers	EN 61300-3-35	-
IEC 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)	EN 61300-3-53	-

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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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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 fourth edition cancels and replaces the third edition published in 2011. This edition constitutes a technical revision.

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

a) reconsideration of the terms and definitions;
b) addition of Clause 4.

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

FDIS	Report on voting
86B/3992/FDIS	86B/4008/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.

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 publication will remain unchanged until the stability date indicated on the IEC website 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 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 part of IEC 61300 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 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 may be identified.

The tests in this standard 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.

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 the IEC 61300-2 and IEC 61300-3 series for interconnecting devices and passive components.

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

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

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 (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*

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 abbreviations

3.1 Terms and definitions

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

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

3.1.5
conditioning
exposure of a DUT to environmental 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: 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 60050:2010, 112-04-01, modified – The adverb "experimentally" has been removed from the definition, as well as the notes.]

3.1.9
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 Equation (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;

R is the maximum range of integration

Note 1 to entry: EF shall be measured according to IEC 61280-1-4.

3.1.10
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 Equation (2),

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

where

I(r,φ) 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.

3.2 Abbreviations

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

DMA differential mode dispersion
DUT device under test
EAF encircled angular flux
EF encircled flux
LED light emitting diode
SI step index

4 Requirements for the IEC 61300-2 series and the IEC 61300-3 series

4.1 Requirements for the IEC 61300-2 series

The IEC 61300-2 series shall contain these items:

- test apparatus;
- test procedures, stated in the test requirements;
- severities;
- details to be specified.

4.2 Requirements for the IEC 61300-3 series

4.2.1 General requirements

The IEC 61300-3 series shall contain these items:

- measurement apparatus;
- measurement procedures;
- method of calculation (where required);
- measurement uncertainty;
- details to be specified.

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 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

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 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 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 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 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

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.

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). 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 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 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.

10.2 Multimode launch conditions for A1b fibre

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 IEC 62614 and IEC TR 61282-11 provide useful information on multi-mode launch condition.

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 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, in dB, is according to Table 2.

Table 2 – Expected uncertainty for measured attenuation of single connections for A1b fibre

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

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.

10.3 Multimode launch conditions for A3e fibre

Annex A 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 multi-mode launch condition.

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 attenuation of single connections for A3e fibre

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

Table 3 is valid for attenuation values ≤ 2,0 dB.

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

10.4 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.

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.

Annex A
(normative)

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

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.

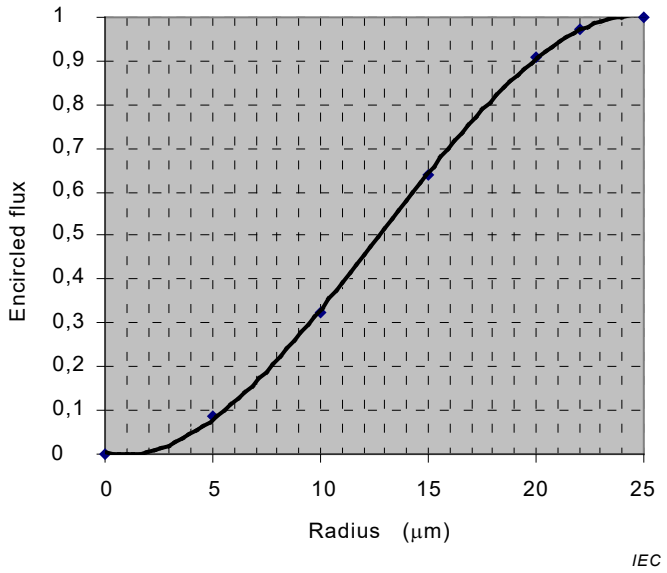


Figure A.1 – EF template example

A.4 Target launch and upper and lower tolerance bands for attenuation measurements of A1a and A1b 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 Tables A.1 to 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 upper bound
10	0,278 5	0,391 5
15	0,598 0	0,711 9
20	0,910 5	0,929 5
22	0,969 0	0,981 2

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

Radial offset (μm)	**EF lower bound**	**EF upper bound**
10	0,279 2	0,394 0
15	0,599 6	0,713 8
20	0,907 2	0,930 0
22	0,966 3	0,979 3

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

Radial offset (μm)	**EF lower bound**	**EF upper bound**
10	0,168 3	0,253 5
15	0,369 5	0,508 5
20	0,633 7	0,750 9
26	0,924 5	0,945 5
28	0,971 0	0,985 6

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

Radial offset (μm)	**EF lower bound**	**EF upper bound**
10	0,168 0	0,255 8
15	0,369 9	0,511 9
20	0,636 9	0,752 1
26	0,925 4	0,946 0
28	0,970 8	0,985 6

A.5 EAF template

A.5.1 Applicable types of optical fibres

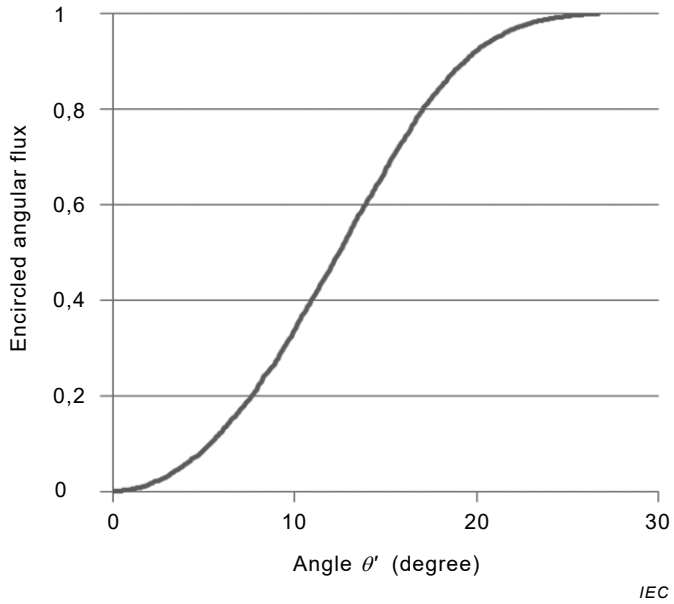
These guidelines are suitable for 200 μm core fibres with 230 μm cladding diameter.

A.5.2 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.

A.5.3 EAF template example

An example of an encircled angular flux template for 200 μm core fibre at 850 nm is shown in Figure A.2.



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

Figure A.2 – Encircled angular flux template example

A.6 Target launch and upper and lower tolerance bands for attenuation measurements of A3e optical fibre connections

A.6.1 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 Tables A.5 when measured at the output of the reference connector.

A.6.2 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 $\pm$ 10 % or $\pm X$ 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.5 – 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 Equation (2), which is the definition of EAF, is radian, the unit of the radiation angle is degree.

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IEC 61315, *Calibration of fibre optic power meters*

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

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