IEC 62614-1

Edition 1.0 2020-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Fibre optics – Multimode launch conditions –
Part 1: Launch condition requirements for measuring multimode attenuation

Fibronique – Conditions d’injection en multimodal –
Partie 1: Exigences des conditions d’injection pour la mesure de l’affaiblissement en multimodal

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FIBRE OPTICS – MULTIMODE LAUNCH CONDITIONS –

Part 1: Launch condition requirements for measuring multimode attenuation

FOREWORD

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International Standard IEC 62614-1 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This first edition cancels and replaces IEC 62614, published in 2010, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 62614:

a) increase of the value of the uncertainty attenuation variation coefficient Y for 50 µm core fibre at 1 300 nm, due to launch conditions, to twice the previous value;
b) changes to 3.4, 5.6, including Table 5, and some references to remain consistent with IEC 61280-4-1:2019;
c) changes to multimode fibre references to be consistent with IEC 60793-2-10:2019.

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

CDV	Report on voting
86C/1625/CDV	86C/1654A/RVC

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

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

A list of all parts in the IEC 62614 series, published under the general title *Fibre optics – Multimode launch conditions*, 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 "http://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- withdrawn,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.

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FIBRE OPTICS – MULTIMODE LAUNCH CONDITIONS –

Part 1: Launch condition requirements for measuring multimode attenuation

1 Scope

This part of IEC 62614 describes the launch condition requirements used for measuring multimode attenuation in passive components and in installed cable plants.

In this document, the fibre types that are addressed include category A1-OMx, where x = 2, 3, 4 and 5 (50 µm/125 µm), and A1-OM1 (62,5 µm/125 µm) multimode fibres, as specified in IEC 60793-2-10. The nominal test wavelengths detailed are 850 nm and 1 300 nm. This document can be suitable for multimode attenuation measurements for other multimode categories and/or other wavelengths, but the source condition for other categories and wavelengths are not defined here.

The purpose of these requirements is as follows:

- to ensure consistency of field measurements when different types of test equipment are used;
- to ensure consistency of factory measurements when different types of test equipment are used;
- to ensure consistency of field measurements when compared with factory measurements.

This document describes launch condition requirements for optical attenuation using sources with a controlled encircled flux (EF).

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

3 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
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

3.2
multimode attenuation
attenuation pertaining to multimode fibres and/or multimode fibre components, systems and subsystems

3.3
reference grade launch cord
launch cords constructed with a reference grade termination at the interface to the device under test

3.4
reference grade termination
connector and plug with tightened tolerances terminated onto an optical fibre with tightened tolerances such that the expected attenuation of a connection formed by mating two such assemblies is lower and more repeatable than a standard-grade termination

Note 1 to entry: An adapter, required to assure the reduced attenuation, may be considered part of the reference grade termination where required by the test configuration.

Note 2 to entry: IEC 61755-6-2 defines reference grade terminations for 50/125 µm fibre.

4 Background on multimode launch conditions

There have been a wide range of launch conditions used for testing multimode fibre components and systems. Light sources, typically used in measuring attenuation, can produce 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.

Legacy (LED based) applications had a wide power budget, which in most cases masked the variance in results 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 instruments having the same standards compliant set up, produce measurement variations that are induced by their differing launch conditions.

Experts have concluded that the launch condition should be expressed at the interface between the test instrument launch cord and the terminated fibre to be tested. That is, the launch condition should be based in part on the measured near field at the output of the launch cord. The key to making reproducible attenuation measurements across various sources is to narrowly constrain the range of power distribution at large radii so that all compliant sources produce closely agreeing attenuation measurement results. This is because the variation in the allowed power distribution at large radii across different sources translates directly into variability of attenuation measurements. Smaller power variations enable more reproducible attenuation measurements.

5 Test source launch

5.1 General

The source launch conditions are described at the output of the reference grade launch cord. It is expected that the source and launch cord, as supplied, have been verified by the test equipment manufacturer to produce the specified launch measured according to IEC 61280-1-4. For reference grade fibre, core diameter tolerances of ±0,7 µm have been evaluated with some success. Variance of other parameters, such as numerical aperture and core concentricity, need more study.

5.2 Encircled flux

The EF shall be determined from the near field measurement of the light coming from the end of the reference grade launch cord in accordance with IEC 61280-1-4.

The measured near field result is a function of the near field profile, $I(r)$, of radius r, away from the optical centre of the core, and the edge of the near field profile, R, which is used to generate the EF function as shown in Formula (1):

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

5.3 Encircled flux template illustration

An illustration of an EF template is shown in Figure 1. A target EF value for a set of particular radial control points is defined. Upper and lower limit of EF values for a set of particular radial control points may also be defined. A compliant launch is a launch that falls within the template at the particular radial control points.

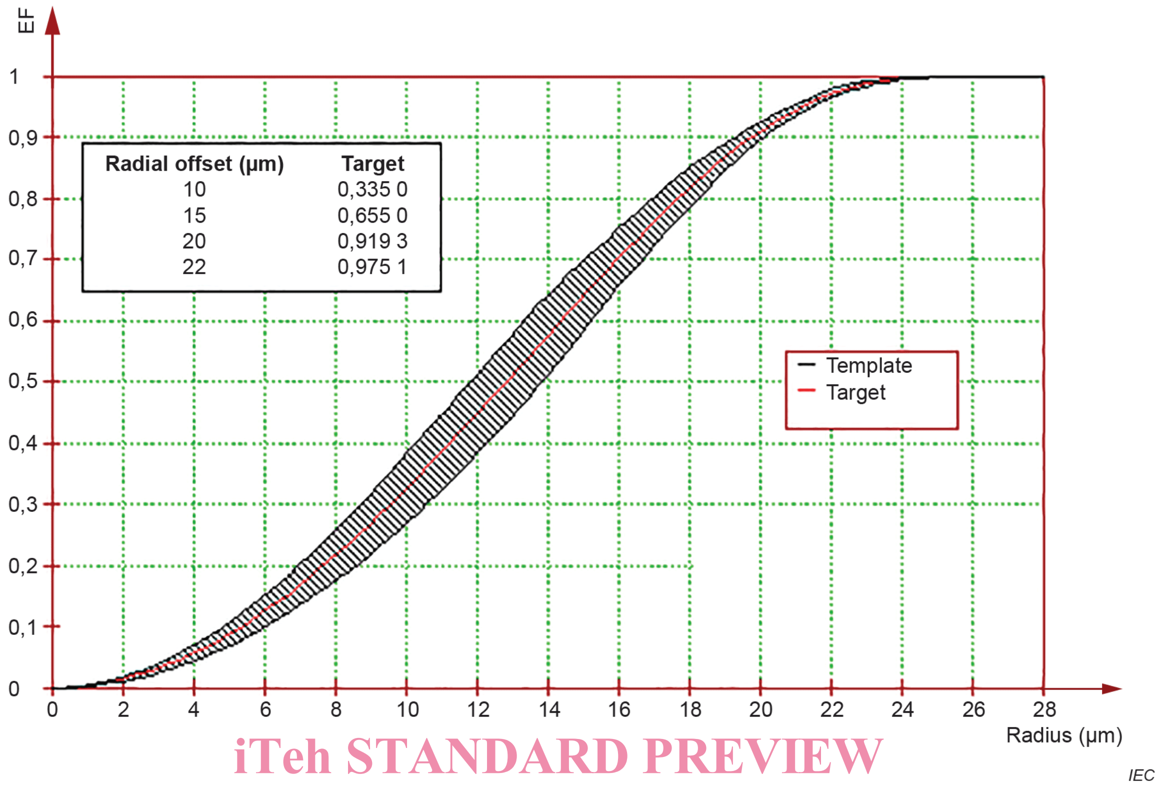

Figure 1 – EF template illustration for 50 µm core fibre cabling at 850 nm

5.4 Encircled flux target for attenuation measurement

For the purposes of this document, the EF requirement is defined as a target EF value for a set of particular radial control points for each of four combinations of fibre core diameter and wavelength, as tabulated in Table 1 through Table 4.

Table 1 – EF target for 50 µm core fibre at 850 nm

Radial offset µm	**Target**
10	0,335 0
15	0,655 0
20	0,919 3
22	0,975 1

Table 2 – EF target for 50 µm core fibre at 1 300 nm

Radial offset µm	**Target**
10	0,336 6
15	0,656 7
20	0,918 6
22	0,972 8

Table 3 – EF target for 62,5 µm fibre at 850 nm

Radial offset µm	Target
10	0,210 9
15	0,439 0
20	0,692 3
26	0,935 0
28	0,978 3

Table 4 – EF target for 62,5 µm fibre at 1 300 nm

Radial offset µm	Target
10	0,211 9
15	0,440 9
20	0,694 5
26	0,935 7
28	0,978 2

5.5 Harmonization of multimode launch conditions to eliminate wavelength bias

Efforts were taken to harmonize the expected component attenuation at 850 nm and 1 300 nm wavelengths for a given fibre core diameter. This was accomplished by adjustment of the 850 nm and 1 300 nm EF targets to produce comparable extrinsic component attenuation. An example of matching the attenuation characteristics at the two wavelengths is illustrated in Figure 2. This elimination of bias provides an opportunity to ensure dual wavelength compliance of a passive component or short cable plant link using a single source condition.

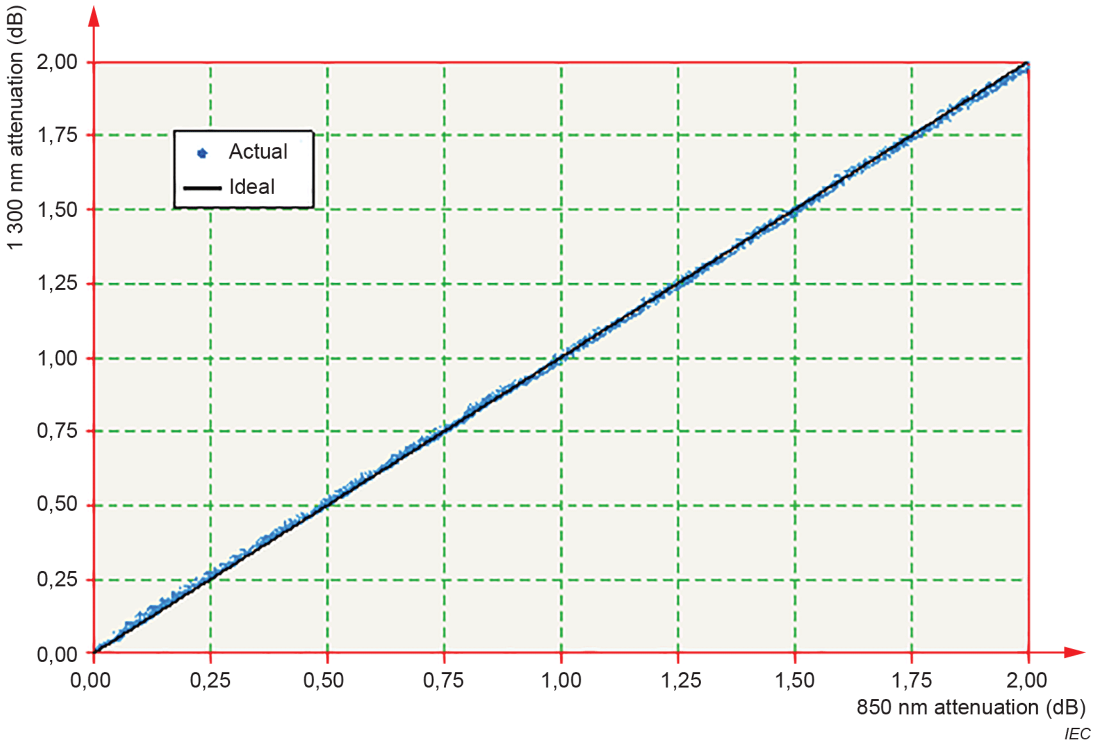

Figure 2 – Wavelength comparison

5.6 Uncertainties expectations

The limits for encircled flux templates are derived from a target near field and a set of boundary conditions designed to constrain the variation in attenuation measurement to ±Y times the dB attenuation or ±X dB, whichever is largest. The reliability of the possible variation of attenuation measurement X or Y is another parameter called β.

The variable X is a tolerance threshold. The variable Y is the coefficient of attenuation variation. These variables X, Y, and β vary with optical fibre core size and wavelength according to the values in Table 5. They need to be considered for measurement uncertainties calculation. Please refer to IEC TR 61282-14 for more details.

Table 5 – Attenuation, threshold tolerance and confidence level

Optical fibre nominal core diameter µm	**Wavelength** nm	**Threshold, X** dB	**Attenuation variation coefficient, Y**	**Reliability level, β**
50	850	0,08	0,10	0,368
50	1 300	0,12	0,20	0,333
62,5	850	0,10	0,10	0,170
62,5	1 300	0,15	0,10	0,030

Only coupling attenuations are taken into account for these attenuation values.

This table is referenced to nominal core diameter. Control of the core diameter of the optical fibre in the actual launch cord to tight tolerances (e.g., ± 0,7 µm) is important to ensure uncertainties expectations.

Re-evaluation of uncertainties has determined the attenuation variation coefficient Y to be 0,20 after adjustment of 1 300 nm EF targets to produce comparable extrinsic component attenuation for 50 µm fibres and 1 300 nm.

In IEC TR 61282-14, beta parameter, β, is considered as uncertainty of the uncertainties, $\frac{\Delta u_i}{u_i}$, to calculate the effective degree of freedom and then calculate expanded uncertainty of attenuation uncertainties.

5.7 Encircled flux limits

Upper and lower bounds (i.e. tolerance range) of the encircled flux are chosen to constrain the measured attenuation variation and are established around a target. These upper and lower bounds can be determined by modelling the mode coupling through various concatenated connections (the number of connections and their lateral offset magnitude chosen to be relevant to the topologies of installed cabling) while searching for all launch conditions that constrain the attenuation variation to within specific values.

The limits and thresholds differ for each of the four combinations of core size and wavelength specified in 5.4. The differences are a result of accommodating, to some degree, the variation of the sources sampled experimentally, the desire to allow the application of a common mode conditioner to both 850 nm and 1 300 nm nominal wavelength sources, and the recognition that the tightest constraints are needed for 850 nm applications operating on 50 µm core diameter fibre.

The limits are chosen to constrain attenuation variation, relative to being exactly on the target launch, to be no greater than the larger of the attenuation variation coefficient, or the threshold value. For example, at 850 nm and 50 µm, the threshold value of 0,08 dB means that the attenuation variation is expected to be within ±10 % for attenuation equal to or greater than 0,8 dB, and within 0,08 dB for attenuation less than 0,8 dB.