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PRE-STANDARD

Fibre optics - Launch condition requirements for measuring multimode attenuation

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FOREWORD

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IEC-PAS 62614 has been processed by IEC technical committee 86: Fibre optics.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
86/320/PAS	86/324/RVD

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

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FIBRE OPTICS – LAUNCH CONDITION REQUIREMENTS FOR MEASURING MULTIMODE ATTENUATION

1 Scope

This Publicly Available Specification (PAS) describes the launch condition requirements used for measuring multimode attenuation in passive components and installed cable plant.

In this PAS, the fibre types that are addressed include category A1a (50/125 µm) and A1b (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 PAS may 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 PAS describes launch condition requirements for optical attenuation using sources with a controlled encircled flux (EF).

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

IEC 61280-1-4: Ed. 2[1], *Fibre optic communication subsystem test procedures – Part 1-4: General communication subsystems - Light source encircled flux measurement method*

IEC 61931, *Fibre optic terminology*

3 Terms and definitions

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

In this clause only specific terms for the purpose of this document are provided. For common fibre optic terms, reference is made to IEC 61931.

3.1
multimode attenuation
attenuation pertaining to multimode fibres and/or multimode fibre components, systems and subsystems

1 To be published.

3.2
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

3.3
coupled power ratio
CPR
difference, expressed in dB, between the power exiting a multimode fibre and the power exiting a single-mode fibre concatenated to the same multimode fibre with the same launching conditions

3.4
mode power distribution
MPD
relative mode power in each of the mode groups of a multimode fibre, often shown graphically

3.5
reference grade termination
connector plug with tightened tolerances terminated onto an optical fibre with tightened tolerances such that the expected loss of a connection formed by mating two such assemblies is less than or equal to 0,1 dB (an adapter, required to ensure this performance, may be considered to be part of the reference grade termination where required by the test configuration).

NOTE 1 As an example, the core diameter tolerance may need to be ± 0,7 µm(ffs). Other fibre tolerances are ffs.

NOTE 2 This definition remains as a point under study. When a more complete definition is available in another document, this definition will be replaced by a reference.

3.6
reference grade launch cord
launch cords constructed with a reference grade termination at the interface to the device under test

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, may 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 setup, 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 loss measurements across various sources is to narrowly

constrain the range of power distribution at large radii so that all compliant sources produce closely agreeing loss measurement results. This is because the variation in the allowed power distribution at large radii across different sources translates directly into variability of loss measurements. Smaller power variations enable more reproducible loss 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 per IEC 61280-1-4. For reference grade fibre, core diameter tolerances of ± 0,7µm have been evaluated with some success. Variance of other parameters, such as numerical aperture and core concentricity, need more study

5.2 Encircled flux (EF)

The EF is 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 Ed.2.0.

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

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

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.

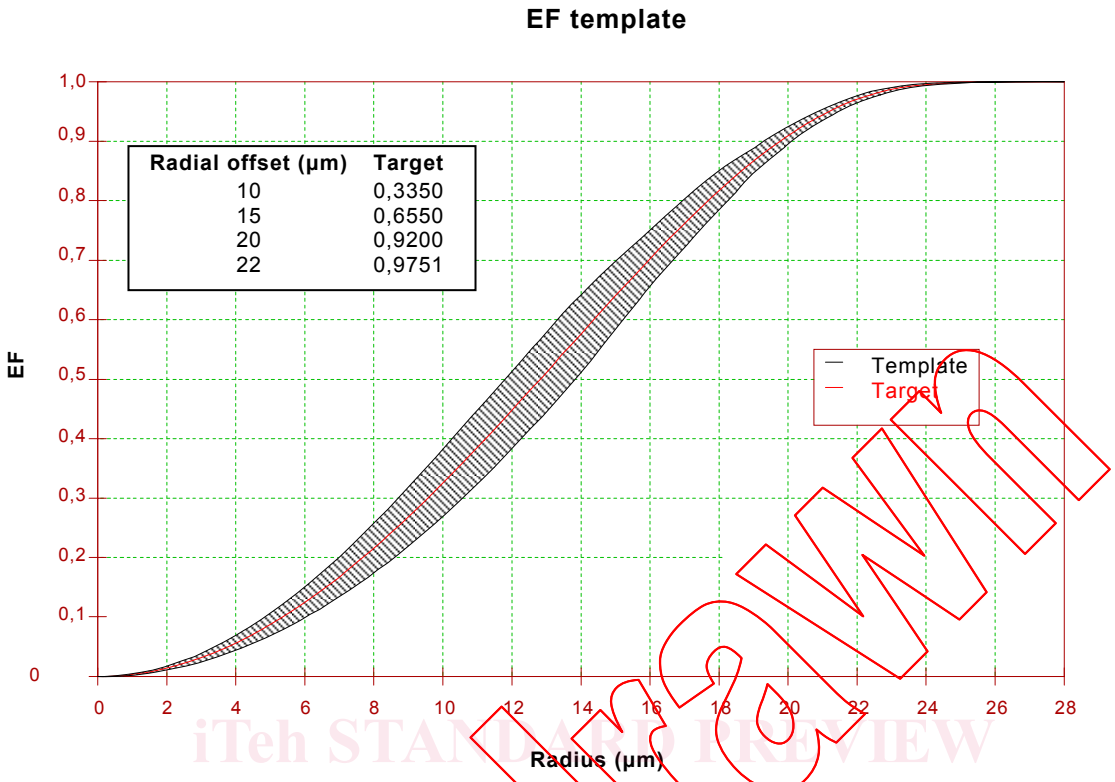

Figure 1 – EF template illustration

5.4 Encircled flux target for attenuation measurement

For the purpose of this PAS, 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 Limitations on multimode launch conditions

The objective of this launch is to limit the variance to ± a specified percentage (e.g.10 %) of target or ± X dB, whichever is larger. X is called the tolerance threshold and varies depending on core diameter and wavelength. The values in Table 5 have been set for installed cable plant. Other thresholds may be determined for factory measurements.

Table 5 – Tolerance threshold

Core diameter (µm)	Wavelength (nm)	Threshold (dB)
50	850	0,08
50	1 300	0,12
62,5	850	0,10
62,5	1 300	0,15

5.6 Encircled flux limits

Upper and lower bounds (i.e. tolerance range) of the encircled flux are chosen to constrain the measured loss variation and are established about 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 loss variation to be within specific values.

The limits and thresholds differ for each of the four combinations of core size and wavelength specified in 5.5. 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