SLOVENSKI STANDARD
oSIST prEN IEC 61280-1-4:2022

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Postopki preskušanja optičnega komunikacijskega podsistema - 1-4. del: Splošni komunikacijski podsistemi - Merilna metoda za pretok, ki ga obkroža svetlobni vir

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

Lichtwellenleiter-Kommunikationsuntersysteme - Grundlegende Prüfverfahren - Teil 1-4: Allgemeine Kommunikationsuntersysteme - Verfahren zur Messung des begrenzten Lichtstroms einer Strahlungsquelle

Procédures d'essai des sous-systèmes de télécommunications fibroniques - Partie 1-4: Sous-systèmes généraux de télécommunication - Méthode de mesure du flux inscrit de la source optique

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IEC SC 86C : FIBRE OPTIC SYSTEMS AND ACTIVE DEVICES			
SECRETARIAT: United States of America		SECRETARY: Mr Fred Heismann	
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TITLE:

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

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NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIBRE OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 1-4: General communication subsystems – Light source encircled flux

FOREWORD

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IEC 61280-1-4 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2009. This edition constitutes a technical revision.

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

a) improvement of calibration procedure and calibration traceability;
b) improvement of fibre shaker description and requirements;
c) addition of pulsed light sources;
d) removal of a poorly traceable calibration process using a micro positioner.

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

Draft	Report on voting
86C/XX/FDIS	86C/XX/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.

The language used for the development of this International Standard is English.

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

A list of all parts of the IEC 61280 series can be found, under the general title *Fibre optic communicationsubsystem test procedures*, on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

INTRODUCTION

This part of IEC 61280 specifies how to measure the encircled flux of a multimode light source. Encircled flux is a fraction of the cumulative output power to the total output power as a function of radial distance from the centre of the multimode optical fibre's core.

The basic approach is to collect two-dimensional (2D) nearfield data, using a calibrated camera, and to mathematically convert the 2D data into three normalized functions of radial distance from the fibre's optical centre. The three functions are *intensity*, *incremental flux,* and *encircled flux*. The intensity represents optical power per surface area (in watts per square meter). The incremental flux represents optical power per radius differential (in watts per meter), and the encircled flux represents a fraction of the cumulative output power to the total output power.

These three radial functions are intended to characterize fibre optic laser sources either for use in mathematical models predicting the minimum guaranteed length of a communications link, or to qualify a light source to measure insertion loss in multimode links.

FIBRE OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 1-4: General communication subsystems - Light source encircled flux measurement method

1 Scope

This part of IEC 61280 establishes the characterization process of the encircled flux measurement method of light sources intended to be used with multimode fibre.

This international standard sets forth a procedure for the collection of two-dimensional fibre optic nearfield greyscale data and subsequent reduction to one-dimensional data expressed as a set of three sampled parametric functions of radius from the fibre's optical centre.

Estimation of the fibre core diameter is not an objective of this standard.

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 61745:2017, *End-face image analysis procedure for the calibration of optical fibre geometry test sets*

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

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

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
calibration light source
light source used to find the optical centre of a multimode fibre

3.2
centroid image
image used to determine the optical centre of the multimode fibre core

3.3
corrected image
image which has had a dark image subtracted from it and whose elements have had uniformity correction applied

3.4
dark image
image taken with the measured light source either turned off or not installed in the input port. Stray light and electrical signals of the detection system will remain in the dark image

3.5
image
two-dimensional rectangular array of numbers whose elements are pixels and whose pixel values linearly correspond to the optical power falling on the pixels

3.6
light source
something that emits light that is coupled into a fibre, the output of which can be measured (can be a calibration light source, a transmission light source or a light source used for attenuation measurements)

3.7
measurement light source
light source intended to be used in the measurement of attenuation

3.8
nominal core radius
half the nominal core diameter of the multimode fibre to be measured

3.9
ring smoothing
technique to reduce the two dimensional near field image into a 1-D near field intensity profile while cancelling the effects of the periodic spacing of imager pixels of finite area

3.10
transmission light source
light source used to transmit digital data over multimode fibre optic links

3.11
uniformity correction
process to correct the sensitivity of a pixel so that it performs substantially like an average pixel

3.12
valid pixel
optical detection element in the detector matrix whose sensitivity, when corrected, is within 5 % of the mean sensitivity of the average conversion efficiency of the detector

4 Symbols

B baseline intensity. This value is determined from a region of the computed near field just outside the core boundary.

D distance from the centre of the centroid image to the nearest boundary of the image.

D_L,D_R,D_T, D_B set of distances from the centre of the centroid image to, respectively, the left, right, top and bottom boundaries of the image. The minimum of this set is used to compute D.

$EF(i)$ encircled flux vector.

$EF'(i)$ non-normalized encircled flux vector.

i index parameter used in the parametric result vectors and $EF(i)$.

I_{dark} matrix of pixel intensities of a dark image as measured by the detector and digitizer.

I_{raw} matrix of pixel intensities of the light source, before correction, as measured by the detector and image digitizer.

$I_{r,c}$ near-field intensity matrix. This is a matrix of pixel intensities, based on I_{raw}, as measured by thedetector and corrected using U and I_{dark}.

ring-smoothed intensity vector, each element being the arithmetic average of

$I(i)$	the set of radialcoordinates of all the pixels in a given ring.
N_R	number of rings used to compute the 1-D near field.
N_r	number of rows in an image. All columns in an image have the same number of rows.
N_c	number of columns in an image. All rows in an image have the same number of columns.
P_{Max}	most intense valid pixel in the centroid image.
P_{Min}	least intense valid pixel in the centroid image.
R	radial coordinate, in µm, of the centre of any pixel, referenced to the optical centre X_0, Y_0.
$R(i)$	ring-smoothed radial vector, each element being the arithmetic average of the radii of all thepixels in the i^{th} ring.
R_{max}	integration limit along the radius
S_c	column-weighted summation of all pixel intensities greater than T in the centroid image.
$S_I(i)$	intensity summation vector used in ring smoothing.
S_P	summation of all pixel intensities greater than T in the centroid image.
$S_N(i)$	pixel counting vector used in ring smoothing.
$S_R(i)$	radius summation vector used in ring smoothing.
S_r	row-weighted summation of all pixel intensities greater than T in the centroid image.
S_x	horizontal geometric calibration factor (along columns)
S_Y	vertical geometric calibration factor (along rows),
T	threshold used to determine which pixels in the centroid image will be used to determine the optical centre. All pixels greater than or equal to T are used to compute the centroid.
$U_{r,c}$	sensitivity correction matrix, applied to a dark-subtracted image to reduce non-uniformity of the detector's pixel-to-pixel conversion efficiency.
W	half-width, in µm, of the rings used to compute the 1-D near field.
X_0	*x*-axis (column) location of the centre of the centroid image.
Y_0	*y*-axis (row) location of the centre of the centroid image.

5 Assumptions

5.1 Assumptions applicable to the characterization of data sources

The 50 µm or 62,5 µm core near-parabolic graded-index multimode fibre used as the “test jumper assembly” is treated as if it possessed perfect circular symmetry about its optical centre, because asymmetries in the launched optical flux distributions will dominate any distortions introduced by the test jumper assembly, such as lateral and angular misalignments. It is further assumed that all cladding modes will be stripped by passage through the specified ten metres or more of fibre. The modes of a mode group need not carry equal flux. In fact, with such short fibres, one thousand metres or less, unequal distribution of flux in the modes of a group is the norm, not the exception.

5.2 Assumptions applicable to the characterization of measurement sources.

Measurement sources are assumed to be sufficiently broadband and incoherent, so that speckle is not a problem, and to have a sufficiently symmetrical nearfield distribution, so that the truncated centroid of that nearfield indicates the location of the optical centre of the fibre with sufficient accuracy for the purposes of this standard.

6 Apparatus

6.1 Common apparatus

6.1.1 General

Figure 1 below shows an apparatus block diagram.