

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

REDLINE VERSION

Delsystem för fiberoptisk kommunikation – Grundläggande provningsmetoder – Del 1-4: Provningsmetoder för allmänna delsystem – Mätning av cirkulärt flöde

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

En så kallad ”Redline version” (RLV) innehåller både den fastställda IEC-standarden och en ändringsmarkerad standard. Alla tillägg och borttagningar sedan den tidigare utgåvan är markerade med färg. Med en RLV sparar du mycket tid när du ska identifiera och bedöma aktuella ändringar i standarden. SEK Svensk Elstandard kan bara ge ut RLV i de fall den finns tillgänglig från IEC.



IEC 61280-1-4

Edition 3.0 2023-01
REDLINE VERSION

INTERNATIONAL STANDARD



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.180.01

ISBN 978-2-8322-6399-0

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	2
0.1 General.....
0.2 Changes from previous edition.....
0.3 Assumptions applicable to the characterization of data sources.....
0.4 Assumptions applicable to the characterization of measurement sources.....
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols	9
5 Assumptions.....	10
5.1 Assumptions applicable to the characterization of data sources	10
5.2 Assumptions applicable to the characterization of measurement sources.....	10
6 Apparatus.....	10
6.1 Common apparatus.....	10
6.1.1 General	10
6.1.2 Computer.....	11
6.1.3 Image digitizer	11
6.1.4 Detector	11
6.1.5 Magnifying optics.....	12
6.1.6 Attenuation Attenuator	12
6.1.7 Micro positioner (optional)	13
6.1.8 Input port.....	13
6.1.9 Calibration light source	13
6.2 Transmission source apparatus	13
6.2.1 General	13
6.2.2 Test jumper assembly.....	14
6.2.3 Fibre shaker	14
6.3 Measurement source apparatus	15
7 Sampling and specimens	15
8 Geometric calibration.....	16
9 Measurement procedure	16
9.1 Safety	16
9.2 Image acquisition.....	16
9.2.1 Raw image acquisition	16
9.2.2 Dark image acquisition	17
9.2.3 Corrected image	17
9.3 Optical centre determination	17
9.3.1 General	17
9.3.2 Centroid image	17
9.3.3 Centroid computation.....	18
9.4 Test source image acquisition.....	18
10 Computation of encircled flux	19
10.1 Computation of radial data functions	19
10.2 Integration limit and baseline determination	21
10.2.1 Integration limit.....	21

10.2.2	Baseline determination	21
10.2.3	Baseline subtraction	21
10.3	Computation of encircled flux	21
11	Results	22
11.1	Information available with each measurement	22
11.2	Information available upon request	22
12	Specification information	22
Annex A (informative)	Measurement sensitivity considerations	24
A.1	Baseline averaging considerations	24
A.2	Pixel sensitivity variation calibration	26
A.3	Correlated double sampling	26
A.4	Imperfections of practical detectors and optics	27
Annex B (informative) Theory of geometric calibration using the micropositioner		
Annex C (normative) Procedure for geometric calibration using the micropositioner		
	Bibliography	37
	Figure 1 – Apparatus block diagram	11
	Figure 2 – Typical set-up for transmission source measurement	14
	Figure 3 – Fibre shaker example	15
	Figure 4 – Pixel and ring illustration	19
	Figure A.1 – Core images from instrument A and instrument B	24
	Figure A.2 – Compressed core images from instrument A and instrument B	25
	Figure A.3 – Intensity versus radius for instruments A and B	25

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIBRE OPTIC COMMUNICATION SUBSYSTEM
TEST PROCEDURES –****Part 1-4: General communication subsystems –
Light source encircled flux measurement method**

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61280-1-4:2009. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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 International Standard is based on the following documents:

Draft	Report on voting
86C/1806/CDV	86C/1828/RVC

Full information on the voting for its approval 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 document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

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

INTRODUCTION

0.1 — General

This part of IEC 61280 ~~is used~~ specifies how to measure the encircled flux of a multimode light source. Encircled flux is ~~a measure, as a function of radius, of the~~ fraction of the cumulative output power to the total output power ~~radiating from~~ 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. ~~Intensity has dimension optical power per area; incremental flux has dimension power per differential of radius; and encircled flux has dimension total optical power, all three being functions of radius.~~ 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.

0.2 — Changes from previous edition

~~This edition of the standard differs from its predecessor in both scope and content. Many of the content changes improve the measurement precision. Several changes have been made to the computation procedure:~~

- ~~• the integration methodology of the radial functions was simple summation, and is now specified to use trapezoidal integration or other higher-order techniques (see 9.3);~~
- ~~• a baseline subtraction step is specified to improve immunity to DC drifts (see 9.2.2 and 9.2.3);~~
- ~~• the ring width parameter is explicitly specified (see 9.2.1);~~
- ~~• the integration limit is specified (see 9.3).~~

~~The geometric calibration of the apparatus microscope now specifies either (depending on the application) the methodology of IEC 61745 or the original technique using the micropositioning stage (see Clause 7). Pixel sensitivity uniformity correction is now optional.~~

0.3 — 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, as asymmetries in the launched optical flux distributions will dominate any lopsidedness of the test jumper assembly. 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.)~~

0.4 — Assumptions applicable to the characterization of measurement sources

~~Measurement sources are assumed to be sufficiently broadband and incoherent that speckle is not a problem, and to have a sufficiently symmetrical nearfield distribution 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.~~

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 is intended to characterize the encircled flux of two types of light sources: transmission light sources, which are usually coherent and substantially under excite the mode volume of a multimode fibre, and measurement light sources, which are incoherent and excite most of the mode volume of a multimode fibre.~~

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 document sets forth a **standard** 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. ~~This revision of IEC 61280-1-4 continues to fulfil its original purpose, characterization of transmission light sources, which enables the accurate mathematical prediction of minimum guaranteed link length in 1 gigabit per second or greater fibre optic data communication systems. New to this revision is support for improved measurement precision of insertion loss in multimode fibre optic links through the characterization of measurement light sources.~~

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

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 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*

~~IEC 61745:1988, *End-face image analysis procedure for the calibration of optical fibre geometry test sets*~~

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

Delsystem för fiberoptisk kommunikation – Grundläggande provningsmetoder – Del 1-4: Provningsmetoder för allmänna delsystem – Mätning av cirkulärt flöde

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

Som svensk standard gäller europastandarden EN IEC 61280-1-4:2023. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61280-1-4:2023.

Nationellt förord

Europastandarden EN IEC 61280-1-4:2023

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61280-1-4, Third edition, 2023 - Fibre optic communication subsystem test procedures - Part 1-4: General communication subsystems - Light source encircled flux measurement method**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 61280-1-4, utg 2:2010 med eventuella tillägg, ändringar och rättelser, gäller ej fr o m 2026-02-23.

ICS 33.180.01

Denna standard är fastställd av SEK Svensk Elstandard, som också kan lämna upplysningar om **sakinnehållet** i standarden.
Postadress: Box 1284, 164 29 KISTA
Telefon: 08 - 444 14 00.
E-post: sek@elstandard.se. Internet: www.elstandard.se

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

English Version

Fibre optic communication subsystem test procedures - Part 1-4:
General communication subsystems - Light source encircled flux
measurement method
(IEC 61280-1-4:2023)

Procédures d'essai des sous-systèmes de
télécommunication fibroniques - Partie 1-4: Sous-systèmes
généraux de télécommunication - Méthode de mesure du
flux inscrit de la source optique
(IEC 61280-1-4:2023)

Lichtwellenleiter-Kommunikationsunterssysteme -
Grundlegende Prüfverfahren - Teil 1-4: Allgemeine
Kommunikationsunterssysteme - Verfahren zur Messung des
begrenzten Lichtstroms einer Strahlungsquelle
(IEC 61280-1-4:2023)

This European Standard was approved by CENELEC on 2023-02-23. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 86C/1806/CDV, future edition 3 of IEC 61280-1-4, prepared by SC 86C "Fibre optic systems and active devices" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61280-1-4:2023.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-08-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2026-02-23

This document supersedes EN 61280-1-4:2010 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61280-1-4:2023 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 standard indicated:

IEC 60793-1-20 NOTE Approved as EN 60793-1-20

IEC 60793-1-41 NOTE Approved as EN 60793-1-41

IEC 61745:2017 NOTE Approved as EN 61745:2017 (not modified)

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where 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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-2-10	-	Optical fibres - Part 2-10: Product specifications - Sectional specification for category A1 multimode fibres	EN IEC 60793-2-10 -	
IEC 60825-1	-	Safety of laser products - Part 1: Equipment classification and requirements	EN 60825-1	-

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.180.01

ISBN 978-2-8322-6361-7

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols	8
5 Assumptions.....	10
5.1 Assumptions applicable to the characterization of data sources	10
5.2 Assumptions applicable to the characterization of measurement sources	10
6 Apparatus.....	10
6.1 Common apparatus.....	10
6.1.1 General	10
6.1.2 Computer.....	10
6.1.3 Image digitizer.....	11
6.1.4 Detector	11
6.1.5 Magnifying optics.....	11
6.1.6 Attenuator.....	12
6.1.7 Micro positioner (optional)	12
6.1.8 Input port.....	12
6.1.9 Calibration light source	12
6.2 Transmission source apparatus	13
6.2.1 General	13
6.2.2 Test jumper assembly.....	13
6.2.3 Fibre shaker	13
6.3 Measurement source apparatus	15
7 Sampling and specimens.....	15
8 Geometric calibration.....	15
9 Measurement procedure	15
9.1 Safety	15
9.2 Image acquisition.....	15
9.2.1 Raw image acquisition	15
9.2.2 Dark image acquisition	16
9.2.3 Corrected image	16
9.3 Optical centre determination	16
9.3.1 General	16
9.3.2 Centroid image	17
9.3.3 Centroid computation.....	17
9.4 Test source image acquisition.....	18
10 Computation of encircled flux	18
10.1 Computation of radial data functions	18
10.2 Integration limit and baseline determination	20
10.2.1 Integration limit.....	20
10.2.2 Baseline determination	20
10.2.3 Baseline subtraction	20
10.3 Computation of encircled flux.....	21
11 Results	21

11.1	Information available with each measurement	21
11.2	Information available upon request	21
12	Specification information	22
Annex A (informative)	Measurement sensitivity considerations	23
A.1	Baseline averaging considerations	23
A.2	Pixel sensitivity variation calibration.....	25
A.3	Correlated double sampling	25
A.4	Imperfections of practical detectors and optics.....	26
Bibliography	28
Figure 1	– Apparatus block diagram.....	10
Figure 2	– Typical set-up for transmission source measurement	13
Figure 3	– Fibre shaker example.....	14
Figure 4	– Pixel and ring illustration	18
Figure A.1	– Core images from instrument A and instrument B	23
Figure A.2	– Compressed core images from instrument A and instrument B.....	24
Figure A.3	– Intensity versus radius for instruments A and B.....	24

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIBRE OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

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

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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 International Standard is based on the following documents:

Draft	Report on voting
86C/1806/CDV	86C/1828/RVC

Full information on the voting for its approval 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 document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

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

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 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*