SLOVENSKI STANDARD

SIST EN 61746:2004

september 2004

Kalibriranje optične časovne domene reflektometrov (OTDRji) (IEC 61746:2001)*

Calibration of optical time-domain reflectometers (OTDRs) (IEC 61746:2001)

ICS 17.180.30; 33.180.99

Referenčna številka
SIST EN 61746:2004(en)

EUROPEAN STANDARD **EN 61746**

NORME EUROPÉENNE

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ICS 17.180.30;33.180.99

English version

Calibration of optical time-domain reflectometers (OTDRs)
(IEC 61746:2001)

Etalonnage des réflectomètres optiques dans le domaine de temps (OTDR)
(CEI 61746:2001)

Kalibrierung optischer Rückstreumessgeräte (OTDR)
(IEC 61746:2001)

This European Standard was approved by CENELEC on 2001-10-01. 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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 61746:2001 E

Foreword

The text of document 86/175/FDIS, future edition 1 of IEC 61746, prepared by IEC TC 86, Fibre optics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61746 on 2001-10-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2002-07-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2004-10-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annexes A, B, C and ZA are normative and annex D is informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61746:2001 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

Publication	Year	Title	EN/HD	Year
IEC 60050-731	1991	International Electrotechnical Vocabulary (IEV) Chapter 731: Optical fibre communication	-	-
IEC 60617-10	1996	Graphical symbols for diagrams Part 10: Telecommunications: Transmission	EN 60617-10	1996
IEC 60793-1	Series	Optical fibres Part 1: Generic specification	-	-
IEC 60794-1	Series	Optical fibre cables Part 1: Generic specification	EN 60794-1	Series
IEC 60825-1 A1 A2	1993 1997 2001	Safety of laser products Part 1: Equipment classification, requirements and user's guide	EN 60825-1 + corr. February + A11 - A2	1994 1995 1996 - 2001
IEC 61300-3-2	1999	Fibre optic interconnecting devices and passive components - Basic tests and measurement procedures Part 3-2: Examinations and measurements - Polarization dependence of attenuation in a single-mode fibre optic device	EN 61300-3-2	1999
ISO	1993	International vocabulary of basic and general terms in metrology	-	-
ISO	1995	Guide to the expression of uncertainty in measurement	-	-
ITU-T Recommendation G.650	1997	Definition and test methods for the relevant parameters of single-mode fibres	-	-

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Etalonnage des réflectomètres optiques dans le domaine de temps (OTDR)

Calibration of optical time-domain reflectometers (OTDRs)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CALIBRATION OF OPTICAL TIME-DOMAIN REFLECTOMETERS (OTDRs)

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61746 has been prepared by IEC technical committee 86: Fibre optics.

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

FDIS	Report on voting
86/175/FDIS	86/177/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.

Annexes A, B and C form an integral part of this standard.

Annex D is for information only.

The committee has decided that the contents of this publication will remain unchanged until 2002. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

CALIBRATION OF OPTICAL TIME-DOMAIN REFLECTOMETERS (OTDRs)

1 General

1.1 Scope

This International Standard provides procedures for calibrating single-mode optical time domain reflectometers (OTDRs). It only covers OTDR measurement errors and uncertainties.

This standard does not cover correction of the OTDR response.

In order for an OTDR to qualify as a candidate for complete calibration using this standard, it is to be equipped with the following minimum feature set:

a) a programmable index of refraction, or equivalent parameter;

b) the ability to present a display of a trace representation, with a logarithmic power scale and a linear distance scale;

c) two markers/cursors, which display the loss and distance between any two points on a trace display;

d) the ability to measure absolute distance (location) from the OTDR's zero-distance reference;

e) the ability to measure the displayed power level relative to a reference level (for example, the clipping level).

1.2 Normative references

Les documents de référence suivants sont indispensables pour l'application du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60050-731:1991, *International Electrotechnical Vocabulary (IEV) – Chapter 731: Optical fibre communication*

IEC 60617-10:1996, *Graphical symbols for diagrams – Part 10: Telecommunications – Transmission*

IEC 60793-1 (all parts), *Optical fibres – Part 1: Generic specification*

IEC 60794-1 (all parts), *Optical fibre cables – Part 1: Generic specification*

IEC 60825-1:1993, *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*
Amendment 1 (1997)[1)]
Amendment 2 (2001)

IEC 61300-3-2:1999, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-2: Examinations and measurements – Polarization dependence of attenuation in a single-mode fibre optic device*

ISO:1993, *International vocabulary of basic and general terms in metrology*

ISO:1995, *Guide to the expression of uncertainty in measurement*

ITU-T Recommendation G.650:1997, *Definition and test methods for the relevant parameters of single-mode fibres*

[1)] There is a consolidated edition 1.1 (1998) that includes IEC 60825-1 (1993) and its amendment 1 (1997).

2 Definitions

For the purpose of this International Standard the definitions given below apply. For more precise definitions, the references of IEC 60050-731 should be referred to.

2.1
attenuation, symbol *A*
optical power decrease in decibels (dB). If P_{in} (watts) is the power entering one end of a segment of fibre and P_{out} (watts) is the power leaving the other end, then the attenuation of the segment is

$$A = 10 \log_{10}\left(\frac{P_{in}}{P_{out}}\right) \quad \text{dB} \qquad (1)$$

An alternative for "attenuation" is "loss"
[IEV 731-01-48, modified]

2.2
attenuation coefficient, symbol α
attenuation of a fibre per unit length
[IEV 731-03-42, modified]

2.3
attenuation dead zone
for a reflective or attenuating event, the region after the event where the displayed trace deviates from the undisturbed backscatter trace by more than a given vertical distance ΔF

NOTE The attenuation dead zone will depend on the following event parameters: reflectance, loss, displayed power level and location. It may also depend on any fibre optic component in front of the event.

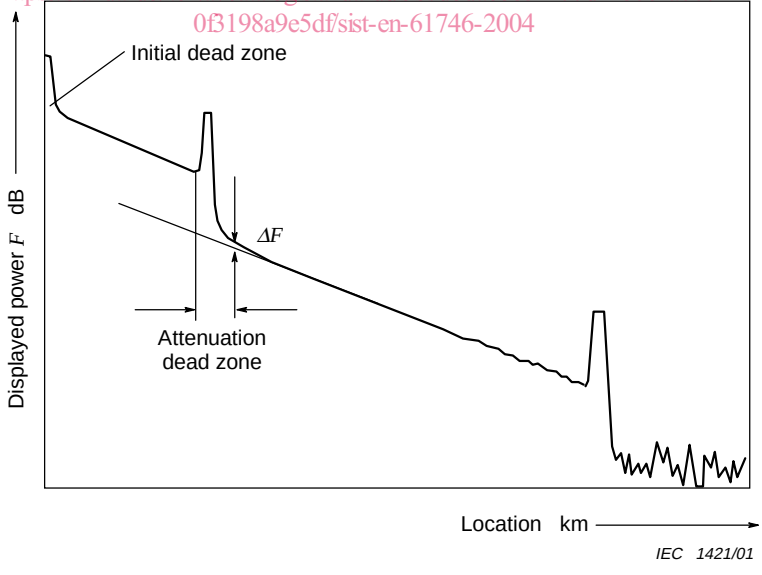

Figure 1 – Definition of attenuation dead zone

2.4
calibration
set of operations which establish, under specified conditions, the relationship between the values indicated by the measuring instrument and the corresponding known values of that quantity (see ISO *International vocabulary of basic and general terms in metrology*)

2.5
centre wavelength, symbol λ_{centre}
power-weighted mean wavelength of a light source in vacuum, in nanometres (nm)

For a continuous spectrum, the centre wavelength is defined as:

$$\lambda_{centre} = \frac{1}{P_{total}} \int p(\lambda) \lambda d\lambda \quad (2)$$

For a spectrum consisting of discrete lines, the centre wavelength is defined as:

$$\lambda_{centre} = \frac{\sum_i P_i \lambda_i}{\sum_i P_i} \quad (3)$$

where

$p(\lambda)$ is the spectral power density of the source, for example in W/nm;

λ_i is the i^{th} discrete wavelength;

P_i is the power at λ_i, for example in watts;

$P_{total} = \Sigma P_i$ is the total power, for example in watts.

The above integrals and summations extend over the entire spectrum of the light source.

2.6
confidence level

estimated probability that the true value of a measured quantity lies within a given expanded uncertainty

NOTE In this standard, the confidence level is standardized to 95 %. See "expanded uncertainty" for further clarification.

2.7
distance
spacing (actual or simulated) between two features in a fibre, for example in metres

2.8
distance sampling error
maximum distance error attributable to the distance between successive sample points, specified in metres

NOTE The distance sampling error is repetitive in nature; therefore, one way of quantifying this error is by its amplitude.

2.9
distance scale deviation, symbol ΔS_L
average error of the distance scale, that is difference between the average displayed distance $< D_{otdr} >$ and the correspondent reference distance D_{ref} divided by the reference distance, for example in m/m:

$$\Delta S_L = \frac{< D_{otdr} > - D_{ref}}{D_{ref}} = \frac{< D_{otdr} >}{D_{ref}} - 1 \quad (4)$$

where $< D_{otdr} >$ is the displayed distance between two features on a fibre (actual or simulated) averaged over at least one sample spacing

NOTE It is assumed that a relatively long distance, for example 2 000 m, is used in this formula.

2.10
distance scale factor, symbol S_L
average displayed distance divided by the correspondent reference distance:

$$S_L = \frac{< D_{otdr} >}{D_{ref}} \quad (5)$$

where $< D_{otdr} >$ is the displayed distance between two features on a fibre (actual or simulated) averaged over at least one sample spacing

NOTE It is assumed that relatively long distances are used in this formula.

2.11
distance scale uncertainty, symbol $\sigma_{\Delta SL}$
uncertainty of the distance scale deviation, for example in m/m

$$\sigma_{\Delta SL} = \sigma\left(\frac{< D_{otdr} >}{D_{ref}} - 1\right) = \sigma\left(\frac{< D_{otdr} >}{D_{ref}}\right) \quad (6)$$

NOTE 1 It is assumed that the distance is relatively long, because short distances may lead to larger uncertainties.

NOTE 2 In the above formula, $\sigma()$ is understood as the standard uncertainty of ().

2.12
dynamic range (one-way)
amount of fibre attenuation that causes the backscatter signal to equal the noise level. It can be represented by the difference between the extrapolated point of the backscattered trace (taken at the intercept with the power axis) and the noise level expressed in decibels, using a standard category B fibre (see IEC 60793-1)

2.13
expanded uncertainty
range of uncertainties within which the true value of the measured quantity lies, at the given confidence level. For further information, see annex D and the ISO *Guide for the expression of uncertainty in measurement*

NOTE When the distribution of uncertainties is assumed to be gaussian, and the (estimated) confidence level is 95 %, then for a large number of measurements, the standard uncertainty is defined by ±2 times the standard deviation.

2.14
group index, symbol N
factor by which the speed of light in vacuum has to be divided to yield the propagation velocity of light pulses in the fibre

2.15
location, symbol L
spacing (actual or simulated) between the front panel of the OTDR and a feature in a fibre, for example in metres

2.16
location error, symbol ΔL
displayed location of a feature L_{otdr} minus the reference location L_{ref}, for example in metres. It is a function of the location

2.17
location offset, symbol ΔL_0
(constant) additive term of the location error model used in this standard, for example, in metres. This is approximately equivalent to the location of the OTDR front panel connector on the instrument's distance scale (for a perfect OTDR, the location offset is zero)