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**Kalibriranje optične časovne domene reflektometrov (OTDR) (IEC 61746:2005)**

Calibration of optical time-domain reflectometers (OTDR) (IEC 61746:2005)

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English version

**Calibration of optical time-domain reflectometers (OTDR)**  
(IEC 61746:2004)

Etalonnage des réflectomètres optiques  
dans le domaine de temps (OTDR)  
(CEI 61746:2004)

Kalibrierung optischer  
Rückstreumessgeräte (OTDR)  
(IEC 61746:2004)

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

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

## Foreword

The text of document 86/230/FDIS, future edition 2 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 2005-02-01.

This European Standard supersedes EN 61746:2001.

Specific changes to EN 61746:2001 include the development of Clause 9, "Reflectance calibration", and the introduction of Annexes E, F and G.

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) 2005-11-01
- latest date by which the national standards conflicting  
with the EN have to be withdrawn (dow) 2008-02-01

Annex ZA has been added by CENELEC.

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**Endorsement notice**

The text of the International Standard IEC 61746:2005 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 standards indicated:

IEC 60825-1	NOTE	Harmonized as EN 60825-1:1994 (not modified).
IEC 60825-2	NOTE	Harmonized as EN 60825-2:2004 (not modified).
IEC 61300-3-6	NOTE	Harmonized as EN 61300-3-6:2003 (not modified).

## Annex ZA (normative)

### Normative references to international publications with their corresponding European publications

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.

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-1	Series	Optical fibres Part 1: Measurement methods and test procedures	EN 60793-1	Series
IEC 60793-1-40 (mod)	- <sup>1)</sup>	Optical fibres Part 1-40: Measurement methods and test procedures – Attenuation	EN 60793-1-40	2003 <sup>2)</sup>
IEC 60794-1-2	- <sup>1)</sup>	Optical fibre cables Part 1-2: Generic specification – Basic optical cable test procedures	EN 60794-1-2	2003 <sup>2)</sup>
IEC 61300-3-2	- <sup>1)</sup>	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 <sup>2)</sup>
ITU-T Recommendation G.650.1	2004	Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable	-	-
ITU-T Recommendation G.650.2	2002	Definitions and test methods for statistical and non-linear attributes of single-mode fibre and cable	-	-

<sup>1)</sup> Undated reference.

<sup>2)</sup> Valid edition at date of issue.

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INTERNATIONALE  
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Deuxième édition  
Second edition  
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**Etalonnage des réflectomètres optiques  
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Международная Электротехническая Комиссия

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

# CALIBRATION OF OPTICAL TIME-DOMAIN REFLECTOMETERS (OTDR)

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

This second edition cancels and replaces the first edition published in 2001. It constitutes a technical revision. Specific technical changes include the development of Clause 9, "Reflectance calibration," and the introduction of Annexes E, F and G.

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

FDIS	Report on voting
86/230/FDIS	86/232/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.

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.

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## CALIBRATION OF OPTICAL TIME-DOMAIN REFLECTOMETERS (OTDR)

### 1 Scope

This International Standard provides procedures for calibrating single-mode optical time domain reflectometers (OTDR). 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 must 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).
- f) the ability to evaluate the reflectance of a reflective event.

### 2 Normative references

[SIST EN 61746:2005](https://standards.iteh.ai/catalog/standards/sist/49b366c2-b9be-467c-82ac-e7962d5aa8b6/sist-en-61746-2005)

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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 60793-1 (all parts), *Optical fibres – Part 1: Measurement methods and test procedures*

IEC 60793-1-40, *Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation*

IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*

IEC 61300-3-2, *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*

ITU-T Recommendation G.650.1:2004, *Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable*

ITU-T Recommendation G.650.2:2002, *Definitions and test methods for statistical and non-linear attributes of single-mode fibre and cable*

### 3 Terms, definitions and symbols

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

NOTE For more precise definitions, the references to IEC 60050-731 should be consulted.

#### 3.1

##### attenuation

$A$

loss

optical power decrease in decibels (dB)

NOTE 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

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

[IEV 731-01-48, modified]

#### 3.2

##### attenuation coefficient

$\alpha$

attenuation of a fibre per unit length

[IEV 731-03-42, modified]

#### 3.3

##### 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  $\Delta F$

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.

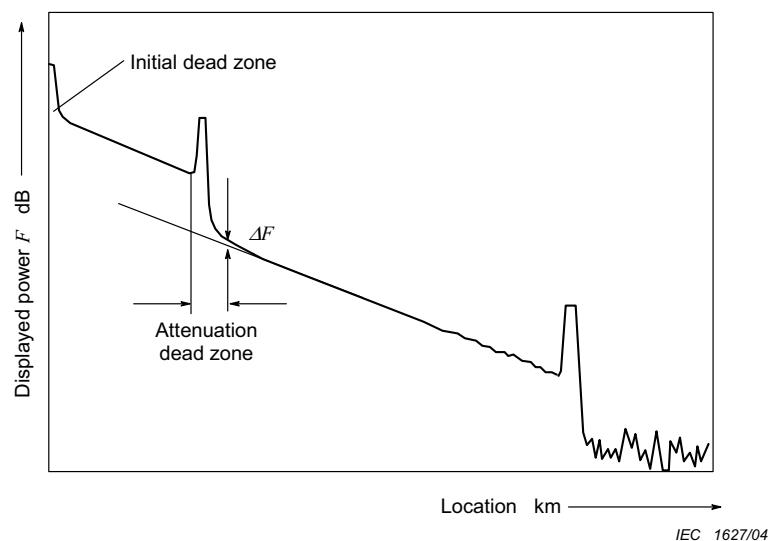


Figure 1 – Definition of attenuation dead zone

### 3.4

#### backscatter parameter

**$K$**

at a given point along the fibre, the backscattered propagating power per unit incident energy

NOTE 1  $K$  is given by the following formula:

$$K = S\alpha_s \frac{V}{2} \text{ s}^{-1} \quad (2)$$

where

$\alpha_s$  is the scattering coefficient, e.g.; in  $\text{m}^{-1}$

$S$  is the backscatter capture fraction. It depends on other standard fibre parameters such as the mode field diameter in single mode fibre;

$V$  is the group velocity, in metres per second;

=  $c / N$  where  $c$  is the speed of the light in vacuum,  $N$  the group index of the fibre.

NOTE 2 See also Annex G.

### 3.5

#### backscatter coefficient

**$C$**

for a given pulse, the ratio of backscattered power at the input side of the fibre to the pulse input power

NOTE 1 It represents the backscatter parameter for a given pulse width. The backscatter coefficient is defined from the backscatter parameter using the following formula:

$$C(\Delta T) = K\Delta T \quad (3)$$

where  $\Delta T$  is the pulse width, e.g. in seconds.

Usually the backscatter coefficient is expressed in dB for a given pulse width,  $\Delta T$ .

$$C_{\text{dB}}(\Delta T) = 10 \log_{10}(K\Delta T) \quad (4)$$

NOTE 2 The pulse width,  $\Delta T$  in the previous formula is used to normalise  $C(\Delta T)$ . Usual values for  $\Delta T$  are 1 ns and 1  $\mu\text{s}$ . See also Annex G.

### 3.6

#### 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

NOTE See ISO *Guide International vocabulary of basic and general terms in metrology*.

### 3.7

#### centre wavelength

**$\lambda_{\text{centre}}$**

power-weighted mean wavelength of a light source in vacuum, in nanometres (nm)

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

$$\lambda_{\text{centre}} = \frac{1}{P_{\text{total}}} \int p(\lambda) \lambda d\lambda \quad (5)$$

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

$$\lambda_{\text{centre}} = \frac{\sum_i P_i \lambda_i}{\sum_i P_i} \quad (6)$$