SLOVENSKI STANDARD

SIST EN 61315:2006

julij 2006

Umerjanje optovlakenskih števcev električne energije (IEC 61315:2005)

Calibration of fibre-optic power meters (IEC 61315:2005)

ICS 33.140; 33.180.01

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Calibration of fibre-optic power meters
(IEC 61315:2005)

Etalonnage de wattmètres pour dispositifs à fibres optiques
(CEI 61315:2005)

Kalibrierung von Lichtwellenleiter-Leistungsmessern
(IEC 61315:2005)

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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.

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

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Foreword

The text of document 86/239/FDIS, future edition 2 of IEC 61315, prepared by IEC TC 86, Fibre optics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61315 on 2005-11-01.

This European Standard supersedes EN 61315:1997.

Changes from EN 61315:1997 consist of adapting the uncertainty calculations to the approach taken by the GUM, and adapting the terminology and graphical symbology to international standards VIM, IEC 61931 and IEC 61930.

The importance of the nonlinearity calibration is emphasized by giving more detail and is now in a separate clause.

Requirements concerning organization and traceability have been taken out of this standard since they are general requirements concerning calibration laboratories and are given in EN ISO/IEC 17025.

The goal to standardize the type of power meter specifications has been removed since it does not belong in a standard on calibration. Specifications should, however, still be based on calibrations made following this standard and EN 60359.

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)	2006-08-01
–	latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2008-11-01

Endorsement notice

The text of the International Standard IEC 61315:2005 was approved by CENELEC as a European Standard without any modification.

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
61315

Deuxième édition
Second edition
2005-10

Etalonnage de wattmètres pour dispositifs à fibres optiques

Calibration of fibre-optic power meters

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CALIBRATION OF FIBRE-OPTIC POWER METERS

FOREWORD

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International Standard IEC 61315 has been prepared by IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 1995. It constitutes a technical revision.

Changes from the previous edition of this International Standard consist of adapting the uncertainty calculations to the approach taken by the GUM, and adapting the terminology and graphical symbology to international standards VIM, IEC 61931 and IEC 61930.

The importance of the nonlinearity calibration is emphasized by giving more detail and is now in a separate clause.

Requirements concerning organization and traceability have been taken out of this standard since they are general requirements concerning calibration laboratories and are given in IEC/ISO 17025.

The goal to standardize the type of power meter specifications has been removed since it does not belong in a standard on calibration. Specifications should, however, still be based on calibrations made following this standard and IEC 60359.

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

FDIS	Report on voting
86/239/FDIS	86/248/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.

INTRODUCTION

Fibre-optic power meters are designed to measure optical power from fibre-optic sources as accurately as possible. This capability depends largely on the quality of the calibration process. In contrast to other types of measuring equipment, the measurement results of fibre-optic power meters usually depend on many conditions of measurement. The conditions of measurement during the calibration process are called *calibration conditions*. Their precise description must therefore be an integral part of the calibration.

This International Standard defines all of the steps involved in the calibration process: establishing the *calibration conditions*, carrying out the calibration, calculating the uncertainty, and reporting the uncertainty, the *calibration conditions* and the *traceability*.

The absolute power calibration describes how to determine the ratio between the value of the input power and the power meter's result. This ratio is called *correction factor*. The measurement uncertainty of the correction factor is combined following Annex A from uncertainty contributions from the reference meter, the test meter, the setup and the procedure.

The calculations go through detailed characterizations of individual uncertainties. It is important to know that:

a) estimations of the individual uncertainties are acceptable;

b) a detailed uncertainty analysis is only necessary once for each power meter type under test, and all subsequent calibrations can be based on this one-time analysis, using the appropriate type A measurement contributions evaluated at the time of the calibration;

c) some of the individual uncertainties can simply be considered to be part of a checklist, with an actual value which can be neglected.

Calibration according to Clause 5 is mandatory for reports referring to this standard.

Clause 6 describes the evaluation of the measurement uncertainty of a calibrated power meter operated within *reference conditions* or within *operating conditions*. It depends on the calibration uncertainty of the power meter as calculated in 5.3, the conditions and its dependence on the conditions. It is usually performed by manufacturers in order to establish specifications and is not mandatory for reports referring to this standard. One of these dependences, the nonlinearity, is determined in a separate calibration (Clause 7).

NOTE Fibre-optic power meters measure and indicate the optical power in the air, at the end of an optical fibre. It is about 3,6 % lower than in the fibre due to Fresnel reflection at the glass-air boundary (with N = 1,47). This should be kept in mind when the power in the fibre has to be known.

CALIBRATION OF FIBRE-OPTIC POWER METERS

1 Scope

This international standard is applicable to instruments measuring radiant power emitted from sources which are typical for the fibre-optic communications industry. These sources include laser diodes, light emitting diodes (LEDs) and fibre-type sources. The radiation may be divergent or collimated. The standard describes the calibration of power meters to be performed by calibration laboratories or by power meter manufacturers.

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 60050-300, *International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*

IEC 60359, *Electrical and electronic measurement equipment – Expression of performance*

IEC 60793-2, *Optical fibres – Part 2: Product specifications – General*

IEC 61300-3-12, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-12: Examinations and measurements – Polarization dependence of attenuation of a single-mode fibre optic component: Matrix calculation method*

IEC 61930, *Fibre optic graphical symbology*

IEC 61931, *Fibre optic – Terminology*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, and OIML:1993, *International vocabulary of basic terms in metrology (VIM)*

BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, and OIML:1995, *Guide to the expression of uncertainty in measurement (GUM)*

3 Terms and definitions

For the purposes of this International Standard, the definitions contained in IEC 61931 and the following definitions apply.

3.1
accredited calibration laboratory
a calibration laboratory authorized by the appropriate national organization to issue calibration certificates with a minimum specified uncertainty, which demonstrate traceability to *national standards*

3.2
adjustment
set of operations carried out on an instrument in order that it provides given indications corresponding to given values of the measurand

[IEV 311-03-16; see also VIM 4.30]

NOTE When the instrument is made to give a null indication corresponding to a null value of the measurand, the set of operations is called **zero adjustment**

3.3
calibration
set of operations that establish, under specified conditions, the relationship between the values of quantities indicated by a measuring instrument and the corresponding values realized by standards

[VIM, 6.11, modified]

NOTE 1 The result of a calibration permits either the assignment of values of measurands to the indications or the determination of corrections with respect to indications.

NOTE 2 A calibration may also determine other metrological properties such as the effect of influence quantities.

NOTE 3 The result of a calibration may be recorded in a document, sometimes called a **calibration certificate** or a **calibration report**.

3.4
calibration conditions
conditions of measurement in which the calibration is performed

3.5
centre wavelength
λ_{centre}
the power-weighted mean wavelength of a light source in vacuum.

For a continuous spectrum the centre wavelength is defined as:

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

and the total power is:

$$P_{\text{total}} = \int p(\lambda) \times d\lambda$$

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

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

$$\lambda_{\text{centre}} = \frac{\sum P_{\text{i}} \times \lambda_{\text{i}}}{\sum P_{\text{i}}}$$

where

P_{i} is the power of the i^{th} discrete line, for example in W, and

λ_{i} is the vacuum wavelength of the i^{th} discrete line.

NOTE The above integrals and summations theoretically extend over the entire spectrum of the light source, however it is usually sufficient to perform the integral or summation over the spectrum where the spectral density $p(\lambda)$ or power P_{i} is higher than 0,1 % of the maximum spectral density $p(\lambda)$ or power P_{i}.

3.6
correction factor
CF
numerical factor by which the uncorrected result of a measurement is multiplied to compensate for systematic error

[VIM, 3.16]

3.7
decibel
dB
submultiple of the bel (1 dB = 0,1 B), unit used to express values of power level on a logarithmic scale. The **power level** is always relative to a reference power P_0:

$$L_{P/P_0} = 10 \times \log_{10}\left(\frac{P}{P_0}\right) \text{ (dB)}$$

where P and P_0 are expressed in the same linear units.

The reference power must always be reported, for example, the power level of 200 µW relative to 1 mW can be noted $L_{\text{P/1 mW}}$ = –7 dB or L_{P}(re 1 mW) = –7 dB.

The linear ratio, R_{lin}, of two radiant powers, P_1 and P_2, can alternatively be expressed as a **power level difference** in decibels (dB):

$$\Delta L_{\text{P}} = 10 \log_{10}(R_{\text{lin}}) = 10 \log_{10}(P_1/P_2) = 10 \log_{10}(P_1) - 10 \log_{10}(P_2).$$

Similarly, relative uncertainties, U_{lin}, or relative deviations, can be alternatively expressed in decibels:

$$U_{\text{dB}} = \frac{10}{\ln 10} U_{\text{lin}} \cong 4{,}34 \times U_{\text{lin}} \text{ (dB)}$$

NOTE ISO 31-2 and IEC 60027-3 should be consulted for further details. The rules of IEC 60027-3 do not permit attachments to unit symbols. However, the unit symbol dBm is widely used to indicate power levels relative to 1 mW and often displayed by fibre-optic power meters.

3.8
detector
the element of the power meter that transduces the radiant optical power into a measurable, usually electrical, quantity. In this standard, the detector is assumed to be connected with the optical input port by an optical path

[see IEC 61931 and VIM, 4.15]

3.9
deviation
D
for the purpose of this standard, the relative difference between the power measured by the test meter P_{DUT} and the reference power P_{ref}

$$D = \frac{P_{\mathrm{DUT}} - P_{\mathrm{ref}}}{P_{\mathrm{ref}}}$$

3.10
excitation (fibre)
a description of the distribution of optical power between the modes in the fibre. In context with multimode fibres, the fibre excitation is described by:

a) the *spot diameter* on the surface of the fibre end, and

b) the *numerical aperture* of the radiation emitted from the fibre.

Full excitation means radiation characterized by a spot diameter which is approximately equal to the fibre's core diameter, and by a numerical aperture which is approximately equal to the fibre's numerical aperture.

Single mode fibres are generally assumed to be excited by only one mode (the fundamental mode)

3.11
instrument state
set of parameters that can be chosen on an instrument

NOTE Typical parameters of the instrument state are the optical power range, the wavelength setting, the display measurement unit and the output from which the measurement result is obtained (for example display, interface bus, analogue output).

3.12
irradiance
the quotient of the incremental radiant power ∂P incident on an element of the reference plane by the incremental area ∂A of that element:

$$E = \frac{\partial P}{\partial A} \ (\mathrm{W/m^2})$$

[IEC 61931, definition 2.1.15, modified]

3.13
measurement result
y
(displayed or electrical) output of a power meter (or standard), after completing all actions suggested by the operating instructions, for example warm-up, zeroing and wavelength-correction, expressed in watts (W). For the purpose of uncertainty analysis, measurement results in other units, for example volts, should be converted to watts. Measurement results in decibels (dB) should also be converted to watts, because the entire uncertainty accumulation is based on measurement results expressed in watts.

3.14
measuring range
set of values of measurands for which the error of a measuring instrument is intended to lie within specified limits

[VIM, 5.4]