SLOVENSKI STANDARD
SIST EN 61315:1999

01-maj-1999

Calibration of fibre optic power meters (IEC 61315:1995)

Calibration of fibre optic power meters (IEC 61315:1995)

Kalibrierung von Lichtwellenleiter-Leistungsmessern

Etalonnage des radiomètres pour sources fibrées

Ta slovenski standard je istoveten z: EN 61315:1997

ICS:

33.140	Posebna merilna oprema za uporabo v telekomunikacijah	Special measuring equipment for use in telecommunications
33.180.10	(Optiļ na) vlakna in kabli	Fibres and cables

SIST EN 61315:1999 en

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61315

May 1997

ICS 33.140; 33.180.01

Descriptors: Calibration of fibre optic power meters

English version

Calibration of fibre optic power meters (IEC 1315:1995)

Etalonnage des radiomètres pour sources fibrées (CEI 1315:1995)

Kalibrierung faseroptischer Leistungsmesser (IEC 1315:1995)

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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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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 61315:1997 E

Foreword

The text of the International Standard IEC 1315:1995, prepared by IEC TC 86, Fibre optics, was submitted to the formal vote and was approved by CENELEC as EN 61315 on 1997-03-11 without any modification.

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)	1998-03-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	1998-03-01

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

Endorsement notice

The text of the International Standard IEC 1315:1995 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 359	1987	Expression of the performance of electrical and electronic measuring equipment	-	-
IEC 793-1	1992	Optical fibres Part 1: Generic specification	-	-
IEC 793-2	1992	Part 2: Product specifications	-	-
IEC 1040	1990	Power and energy measuring detectors, instruments and equipment for laser radiation	EN 61040	1992

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
1315

Première édition
First edition
1995-04

Etalonnage des radiomètres pour sources fibrées –

Calibration of fibre optic power meters –

Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève, Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE XB

Pour prix, voir catalogue en vigueur
For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CALIBRATION OF FIBRE OPTIC POWER METERS –

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 cooperation 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, prepared by technical committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

3) They have the form of recommendations for international use published in the form of standards, 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.

International Standard IEC 1315 has been prepared by technical committee 86: Fibre optics.

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

DIS	Report on voting
86(CO)12	86(CO)14

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

Annex A forms an integral part of this standard.

Annex B is for information only.

CALIBRATION OF FIBRE OPTIC POWER METERS –

Section 1: General

1.1 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 parameters. A precise description of these parameters must therefore be an integral part of the calibration, because the specified uncertainty can only be valid for these "reference" conditions.

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

Another important goal is to create a standardized type of power meter specification, which will make it easier to compare power meters from different vendors.

The document is divided into four sections and two annexes.

Section 1: General

This contains the introduction, the scope, and the normative references.

Section 2: Basis for calibrations

This contains the definitions, the mathematical basis and general advice.

Section 3: Calibration at reference conditions

This describes how to determine the difference between the power meter measurement result and the "true" input power, and it outlines the calculation of the power meter uncertainty at reference conditions. The uncertainty analysis starts with the "uncertainty at reference conditions" of the national working standard. The "uncertainty at reference conditions" of the next lower level instrument is accumulated, by the root-sum-square method, from:

1) the "uncertainty at reference conditions" of the parent meter (that is of the standard used in the specific step of the calibration; at the beginning of the chain, the national working standard is the parent meter);

2) the transfer uncertainty of the parent meter, accumulated from individual systematic-type uncertainties of the transfer process which can be attributed to the parent meter (for example the ageing of the parent meter from the time of its original calibration to its usage in the present calibration, or the uncertainty caused by a change of beam geometry);

3) the transfer uncertainty of the test meter (that is of the next level power meter), again accumulated from individual systematic type uncertainties of the transfer process which can be attributed to the test meter (for example as caused by the uncertainty of the calibration wavelength);

4) the random uncertainty, calculated from the measured experimental standard deviation of the calibration process and the number of averages used in the calculation of the measurement results.

This is a repetitive process. It ends with the "uncertainty at reference conditions" of the test meter.

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

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

b) estimations of the individual uncertainties are acceptable;

c) a detailed uncertainty analysis is only necessary once for each power meter type under test, and that all subsequent calibrations can be based on this one-time analysis.

Calibration according to section 3 is mandatory for power meters compatible with this standard.

Section 4: Calibration for operating conditions

This describes the evaluation of the power meter dependences on the operating conditions. One of these dependences, the nonlinearity, is often determined in a separate calibration. The "operational dependences" are necessary for the evaluation of the uncertainty at reference conditions in section 3, and for the evaluation of the power meter total uncertainty in section 4.

The "total uncertainty" is calculated by adding, with the root-sum-square method, to the "uncertainty at reference conditions" all operational uncertainties, that is the worst case dependences of the measurement result on the operating conditions.

Determining the total uncertainty is not mandatory for power meters compatible with this document.

Annex A

This annex contains all of the forms, that is calibration certificates, traceability information, and calculation worksheets. These forms should be considered as suggestions only.

1.2 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 serves the purposes of calibrating single power meters and of setting specifications of power meters, to be performed by calibration laboratories or by the manufacturer of the power meter.

1.3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 359: 1987, *Expression of the performance of electrical and electronic measuring equipment*

IEC 793-1: 1992, *Optical fibres – Part 1: General specification*

IEC 793-2: 1992, *Optical fibres – Part 2: Product specifications*

IEC 1040: 1990, *Power and energy measuring detectors, instruments and equipment for laser radiation*

Section 2: Basis of calibrations

2.1 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1.1 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.

2.1.2 accredited working standard: An optical power meter at the accredited calibration laboratory which is accredited by a national standards laboratory and is used for the calibration of power meters from customers outside the accredited calibration laboratory. It is assumed that the accredited working standard was calibrated from the national standard through an unbroken chain of comparisons.

2.1.3 adjustment: Modifying the hardware or the firmware of the test meter with the intention to make the measurement result of the test meter equal to the measurement result of the parent meter.

2.1.4 calibration: The set of operations which establish, under specified conditions, the relationship between the values indicated by the measuring instrument and the corresponding known values of a measurand [annex B, reference [1], 6.13].

NOTE – The intention is to bring operating characteristics into substantial agreement with the scale of the national standards laboratory. In this standard, the term "calibration" is used for both "calibration at reference conditions" and "calibration for operating conditions".

2.1.5 calibration at reference conditions: The calibration at reference conditions includes:

a) the transfer (between the parent meter and the test meter); and

b) the evaluation of the test meter uncertainty at reference conditions.

2.1.6 calibration for operating conditions: The calibration for operating conditions of a power meter includes the evaluation of the power meter operational uncertainty and the calculation of the power meter total uncertainty.

2.1.7 calibration chain: An unbroken chain of transfers from the national working standard to the test meter.

2.1.8 centre wavelength: For a given spectrum of an optical source, the centre wavelength λ_c is defined by the following integral, where the integration limits enclose the entire spectrum of the source:

$$\lambda_c = \frac{1}{P_o} \int p(\lambda)\, \lambda \, d\lambda \approx \frac{\Sigma P_i \lambda_i}{\Sigma P_i}$$

where

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

P_o is the total power, in watt

λ_i are the discrete wavelength points, in the case that the spectrum is digitized

P_i are the power levels at λ_i, in watt

2.1.9 (estimated) confidence level: Probability that the true value of a measurand lies within a given interval (the uncertainty range).

NOTE – For the sake of brevity, this standard mainly uses "confidence level" instead of "estimated confidence level". In this standard, the confidence level is standardized to 95 %. An alternative confidence level of 99,7 % may be used, if specifically stated.

See "uncertainty range" for further clarification.

2.1.10 correction factor: The numerical value by which the uncorrected measurement result is multiplied to compensate for an assumed individual error [modified from IEC 793-1, 3.15].

NOTE – Depending on their origin, this standard distinguishes between several types of correction factors. These are accumulated to a correction factor for the test meter, $CF_{test\ meter}$, which can either be recorded or adjusted to 1. For later use, the measurement result of the test meter should be multiplied by $CF_{test\ meter}$. Note that a correction factor expressed in decibels (dB) must be added to a measurement result expressed in dBm.

2.1.11 decibels (dB, dBm): The linear ratio, R_{lin}, of two radiant power levels, P_1 and P_2, can alternatively be expressed in dB (decibels) form. Similarly, relative uncertainties, U_{lin}, or relative deviations, can be alternatively expressed in dB form.

Power ratio: $R_{dB} = 10 \log (R_{lin}) = 10 \log (P_1/P_2)$

Uncertainty: $U_{dB} = 10 \log (1 + U_{lin})$