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Calibration of fibre-optic power meters

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CALIBRATION OF FIBRE-OPTIC POWER METERS

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

This third edition cancels and replaces the second edition published in 2005. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) update of terms and definitions;
b) update of 5.1, including Table 1 (new type of source);
c) update of Annex A;
d) addition of Annex B on dB conversion.

The text of this International Standard is based on the following documents:

CDV	Report on voting
86/533/CDV	86/540A/RVC

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

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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~~ is therefore ~~be~~ an integral part of the *calibration*.

This document 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~~ some uncertainties are type B estimations, experience-based,

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

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

~~Calibration according to~~ Clause 5 defines absolute power *calibration*, which is mandatory for *calibration* reports referring to this document.

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 5.4, 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 document. 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 document is applicable to instruments measuring *radiant power* emitted from sources that 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.~~ Both divergent and collimated radiations are covered. This document ~~describes~~ defines the *calibration* of power meters to be performed by *calibration* laboratories or by power meter manufacturers.

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~~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 TR 61931:1998, *Fibre optic – Terminology*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

~~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)*~~

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Edition 3.0 2019-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Calibration of fibre-optic power meters

Étalonnage de wattmètres pour dispositifs à fibres optiques



IEC 61315:2019-03(en-fr)

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ÉTALONNAGE DE WATTMÈTRES POUR DISPOSITIFS À FIBRES OPTIQUES

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La Norme internationale IEC 61315 a été établie par le comité d'études 86 de l'IEC: Fibres optiques.

Cette troisième édition annule et remplace la deuxième édition parue en 2005. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) mise à jour des termes et définitions;
b) mise à jour du 5.1, y compris le Tableau 1 (nouveau type de source);
c) mise à jour de l'Annexe A;
d) ajout d'une Annexe B sur la conversion en dB.

Le texte de cette Norme internationale est issu des documents suivants:

CDV	Rapport de vote
86/533/CDV	86/540A/RVC

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

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– *termes définis dans le document: caractères italiques.*

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INTRODUCTION

Les *wattmètres pour dispositifs à fibres optiques* sont conçus pour mesurer la puissance optique des sources à fibres optiques avec la plus grande exactitude possible. Cette capacité dépend surtout de la qualité du processus d'*étalonnage*. Par opposition à d'autres types d'appareillages de mesure, les *résultats de mesure* des *wattmètres pour dispositifs à fibres optiques* dépendent généralement de nombreuses conditions de mesure. Les conditions de mesure au cours du processus d'*étalonnage* sont appelées *conditions d'étalonnage.* Leur description précise fait donc partie intégrante de l'*étalonnage*.

Le présent document définit toutes les étapes du processus d'*étalonnage*: établissement des *conditions d'étalonnage*, réalisation de l'*étalonnage*, calcul de l'incertitude et rapport de l'incertitude, des *conditions d'étalonnage* et de la *traçabilité*.

L'*étalonnage* de puissance absolu décrit la façon de déterminer le rapport entre la valeur de la puissance d'entrée et le résultat du wattmètre. Ce rapport est appelé *facteur de correction*. L'incertitude de mesure du *facteur de correction* est composée suivant l'Annexe A à partir des contributions à l'incertitude de l'*appareil de référence*, de l'*appareil de mesure d'essai*, du montage et de la procédure.

Les calculs font l'objet d'interprétations détaillées d'incertitudes individuelles. Il est important de savoir que

a) certaines incertitudes sont des estimations de type B, fondées sur l'expérience,

b) une analyse détaillée de l'incertitude n’est généralement effectuée qu’une seule fois pour chaque type de wattmètre en essai et que tous les *étalonnages* suivants reposent souvent sur cette analyse ponctuelle, en utilisant les contributions de mesure de type A appropriées évaluées au moment de l'*étalonnage*, et

c) certaines incertitudes individuelles sont simplement considérées comme faisant partie d'une liste de contrôle, et auxquelles est associée une valeur réelle qui peut être négligée.

L’Article 5 définit l’*étalonnage* de puissance absolu qui est obligatoire pour les rapports d’*étalonnage* faisant référence au présent document.

L'Article 6 décrit l'évaluation de l'incertitude de mesure d'un wattmètre étalonné fonctionnant dans les *conditions de référence* ou dans les *conditions de fonctionnement*. Elle dépend de l'incertitude d'*étalonnage* du wattmètre calculée en 5.4, des conditions et de sa dépendance par rapport à ces conditions. Elle est généralement effectuée par des fabricants, afin d'établir des spécifications, et n'est pas obligatoire pour les rapports faisant référence au présent document. L'un de ces facteurs de dépendance, la *non-linéarité*, est déterminé dans un *étalonnage* séparé (Article 7).

ÉTALONNAGE DE WATTMÈTRES POUR DISPOSITIFS À FIBRES OPTIQUES

1 Domaine d'application

Le présent document s'applique aux appareils qui mesurent la *puissance rayonnante* émise par des sources typiques pour l'industrie des communications par fibres optiques. Ces sources comprennent les diodes laser, les diodes émettant de la lumière (LED) et les sources fibrées. Le rayonnement divergent ainsi que le rayonnement collimaté sont couverts par le présent document. Ce dernier définit l'*étalonnage* des wattmètres à effectuer par des laboratoires d'*étalonnage* ou par des fabricants de wattmètres.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences 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 60793-2, *Fibres optiques – Partie 2: Spécifications de produits – Généralités*

IEC TR 61931:1998, *Fibres optiques – Terminologie*

ISO/IEC 98-3 Guide:2008*, Incertitude de mesure – Partie 3: Guide pour l'expression de l'incertitude de mesure (GUM:1995)*