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# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

## Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-14: Examinations and measurements - Error and repeatability of the attenuation settings of a variable optical attenuator



## Dispositifs d'interconnexion et composants passifs fibroniques - Procédures fondamentales d'essais et de mesures - Partie 3-14: Examens et mesures - Erreur et répétabilité des positions d'affaiblissement d'un affaiblisseur optique variable

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-14: Examinations and measurements - Error and repeatability of the attenuation settings of a variable optical attenuator

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IEC 61300-3-14 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision

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

a) addition of IEC 61315, *Calibration of fibre-optic power meters* as normative reference;
b) addition of Clause 3 containing terms, definitions and abbreviated terms;
c) addition of notes for permission of repeatability definition with 2σ;

d) correction of error in Figure 1 a) and Figure 1 b);

e) addition of a clear statement on EF launch condition requirement for MM source;

f) change of “Detector” to “Power meter”;

g) combination of Clause 7 and Clause 8 into a new Clause 8 titled “Details to be specified and reported”;

h) addition of uncertainty considerations in Clause 7;

i) correction of error in Formula (B.3).

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

| Draft | Report on voting |
|---|---|
| 86B/5123/FDIS | 86B/5151/RVD |

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61300 series, published under the general title, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,

– withdrawn, or

– revised.

# 1 Scope

This part of IEC 61300 provides a method to measure the error and repeatability of the attenuation value settings of a variable optical attenuator (VOA). There are two control technologies for VOAs: manually controlled and electrically controlled. This document covers both VOA control technologies and also both single-mode fibres and multimode fibres VOAs. For electrically controlled VOAs, the hysteresis characteristics of attenuation are sometimes important. The hysteresis characteristics can be measured as stated in Annex B.

# 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 61300-1, *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 1: General and guidance*

IEC 61300-3-4, *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-4: Examinations and measurements - Attenuation*

IEC 61315*, Calibration of fibre-optic power meters*

# 3 Terms, definitions and abbreviated terms



## 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61300-1 apply.



ISO and IEC maintain terminology databases for use in standardization at the following addresses:

– IEC Electropedia: available at https://www.electropedia.org/
– ISO Online browsing platform: available at https://www.iso.org/obp

## 3.2 Abbreviated terms

DOP degree of polarization
DUT device under test
LS light source
PM power meter
PDL polarization dependent loss
RF reference fibre
RMS root mean square
TJ temporary joint
VOA variable optical attenuator

## 4 General description

A variable optical attenuator is adjusted sequentially through a series of nominal attenuation settings. It is recommended to adjust sequentially through 10 settings or more in the specific range or as defined in the product specification. For an electrically controlled VOA, the attenuation is set by applying electrical voltage or current to the device.

There are two categories of VOAs:

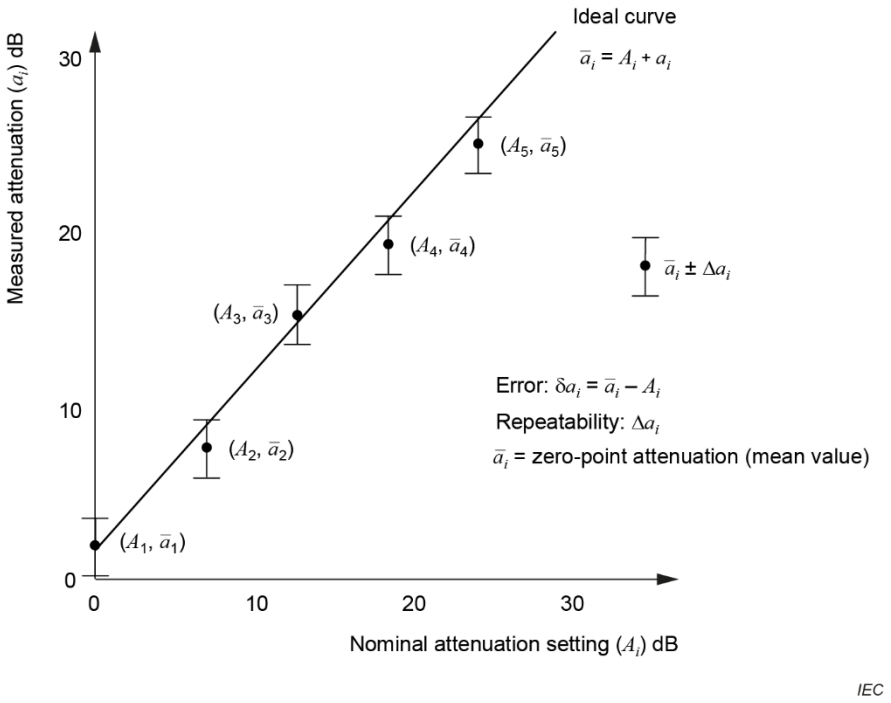
– those that can be adjusted to nominal attenuation settings;

– those that have no information on the nominal attenuation settings.

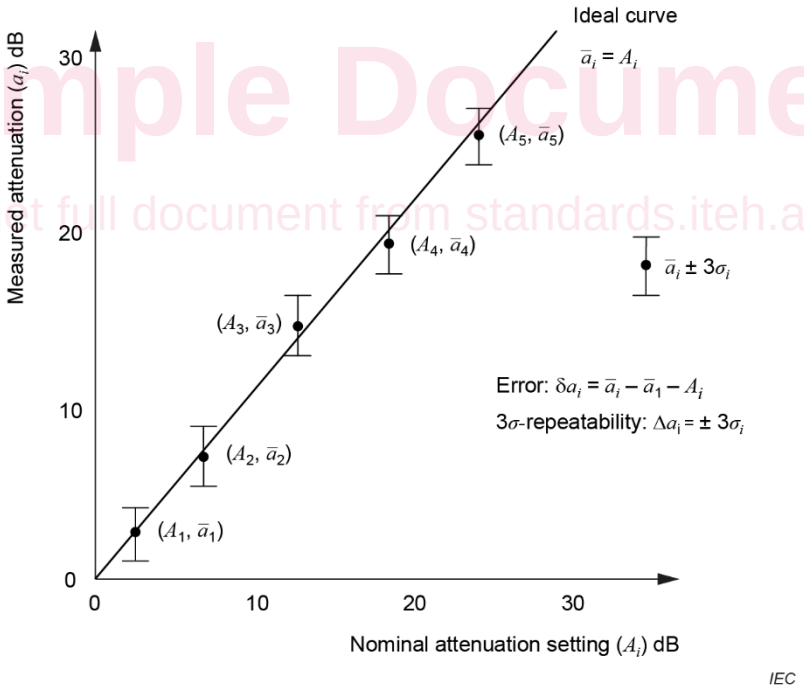
Some manually controlled VOAs have a scaled dial to indicate the nominal attenuation settings. Some electrically controlled VOAs have a table (or formula) indicating the applied voltage (or current) corresponding to the nominal attenuation settings. This measurement method of attenuation error and repeatability can only be applied to VOAs which can be adjusted to nominal attenuation settings.

In this type of measurement, the attenuation value is measured at each setting $i$ ($i$ = 1, 2 …$n$). This sequence of measurements is repeated a number of times $m$ as specified in 7.4. The error of the attenuator at each setting is then given by the difference between the average of the measured values and the nominal value. The repeatability at each setting is given by a value of plus and minus two or three times the standard deviation of the measurements.

Typically, the nominal attenuation settings are reported as absolute or relative calibrated attenuation settings. Figure 1 a) characterizes an attenuator which is calibrated to read the absolute measured attenuation. Figure 1 b) characterizes an attenuator for which the manufacturer provides the calibrated results relative to a zero-point setting. When the attenuator is adjusted to read zero, the actual or measured attenuation will be some value greater than zero.




**a) Absolute calibrated attenuation**




**b) Relative calibrated to zero-point setting**

**Figure 1 – Absolute versus relative calibrated attenuation settings**

# 5 Apparatus

## 5.1 Light source (LS) and launch conditions

The output power stability shall be within ± 0,05 dB over one hour. The dynamic range of the source and detector combination shall be at least 10 dB greater than the absolute value of the maximum attenuation value to be measured. However, the output power into the fibre shall not exceed the maximum operating input power rating of the VOA to be tested.

The wavelength and spectral width of the light source shall correspond to the operating wavelength range and calibration settings of the VOA to be measured. The spectral width is required to be narrower than the operational wavelength range.

For the measurement of single-mode VOAs, the polarization dependent loss (PDL) can influence the error and repeatability of attenuation values. Unless otherwise specified, random polarization states shall be used or the PDL shall also be characterized.

Other requirements of the light source and launch conditions shall be in accordance with IEC 61300-3-4. Multimode fibre light sources shall satisfy the launch condition defined in IEC 61300-1. Moreover, cladding modes shall be stripped, in accordance with IEC 61300-1, so that they do not affect the measurement.

## 5.2 Power meter (PM)

A high dynamic range optical power meter should be used. Its wavelength range shall be wider than the operating wavelength range of the VOA to be measured. In order to make measurements with low uncertainty, the linearity of the optical power meter is most important for the error and repeatability of VOA measurements. The minimum resolution of the detector shall be ≤ 0,005 dB. The nonlinearity of power meter shall be within ± 0,015 over the measurement dynamic range. The nonlinearity calibration or verification, or both of the power meter shall be in accordance with IEC 61315.



Other requirements relating to the power meter shall be in accordance with IEC 61300-3-4.

## 5.3 Reference fibre (RF)

In order to measure the output power of the light source, a reference fibre is used. The reference fibre shall be of the same type and category as the pigtail fibre of the VOA to be measured.

## 5.4 Temporary joint (TJ)

This is a method, device or mechanical fixture for temporarily aligning two fibre ends into a stable, reproducible, low-loss joint. It can for example, be a precision V-groove, vacuum chuck, a micromanipulator, or a fusion or mechanical splice. The temporary joint shall be stable to within ± 10 % of the measurement uncertainty required in dB over the time taken to measure $P_0$ and $P_i$, where $P_0$ is the reference power level before VOA insertion as shown in Figure 2 a) and $P_i$ is the power level after VOA insertion with a given attenuation setting ($i$) as shown in Figure 2 b).

A suitable refractive index matching material can be used to improve the stability of the TJ.

Patchcords with direct connection to the light source can be used and the use of TJs is not mandatory.