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Edition 1.0 2018-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Optical amplifiers – Test methods – Part 4-4: Gain transient parameters – Single channel optical amplifiers with gain control

Amplificateurs optiques – Méthodes d'essai – Partie 4-4: Paramètres de gain transitoire – Amplificateurs optiques monocanaux avec commande de gain

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FOREWORD

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

FDIS	Report on voting
86C/1507/FDIS	86C/1525/RVD

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.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the 61290 series, published under the general title *Optical amplifiers – Test methods*, 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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This document is based on standard OITDA AM 01 published by the optoelectronic industry and technology development association (OITDA).

OPTICAL AMPLIFIERS – TEST METHODS –

Part 4-4: Gain transient parameters – Single channel optical amplifiers with gain control

1 Scope

This part of IEC 61290-4 applies to optical amplifiers (OAs) and optically amplified elementary sub-systems. More specifically, it applies to OAs using active fibres (optical fibre amplifiers, OFAs) containing rare-earth dopants, such as erbium doped fibre amplifiers (EDFAs), presently commercially available, as indicated in IEC 61291-1.

This document provides the general background for optical amplifier gain transients and their measurements and indicates those IEC standard test methods for accurate and reliable measurements of the following transient parameters:

a) optical input power increase/decrease transient gain overshoot and transient net gain overshoot;

b) optical input power increase/decrease transient gain undershoot and transient net gain undershoot;

c) optical input power increase/decrease gain offset;

d) optical input power increase/decrease transient gain response constant (settling time).

These parameters have been included to provide a complete description of the transient behaviour of gain controlled OA. The parameters defined here are applicable if the amplifier is an OFA or an alternative type of OA.

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 60050-731, *International Electrotechnical Vocabulary – Chapter 731: Optical fibre communication* (available at www.electropedia.org)

IEC 61291-1, *Optical amplifiers – Part 1: Generic specification*

IEC TR 61931, *Fibre optic – Terminology*

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-731, IEC 61291-1 and IEC TR 61931 apply.

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

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

3.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in IEC 61291-1 and the following apply.

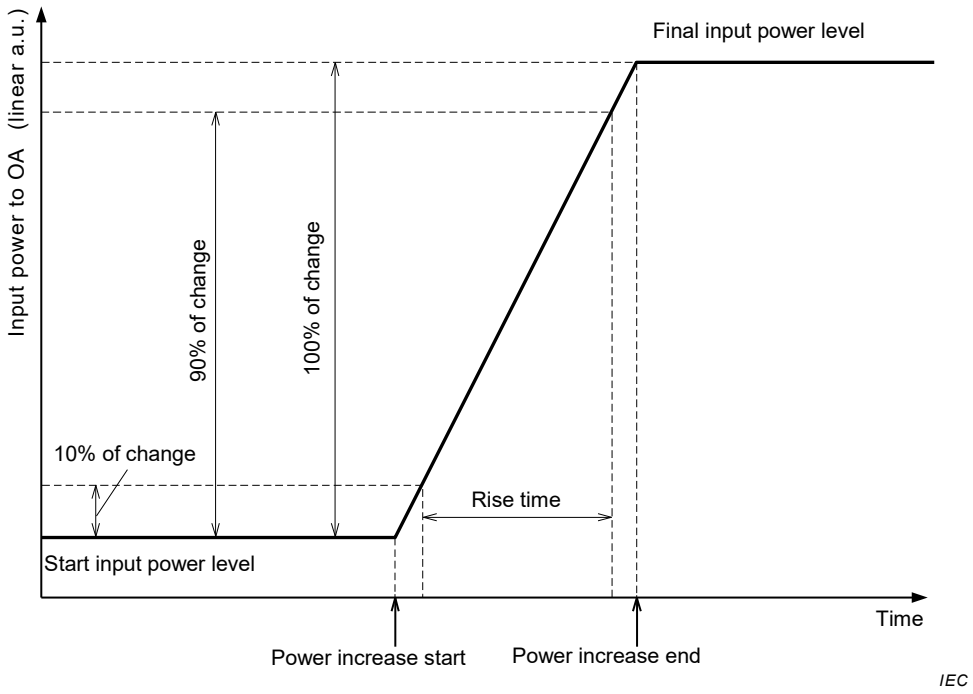
DFB	distributed feedback
DUT	device under test
NEM	network equipment manufacturer
OA	optical amplifier
O/E	optical-to-electronic
OFA	optical fibre amplifier
SOP	state of polarization
VOA	variable optical attenuator

NOTE DFB applies to lasers.

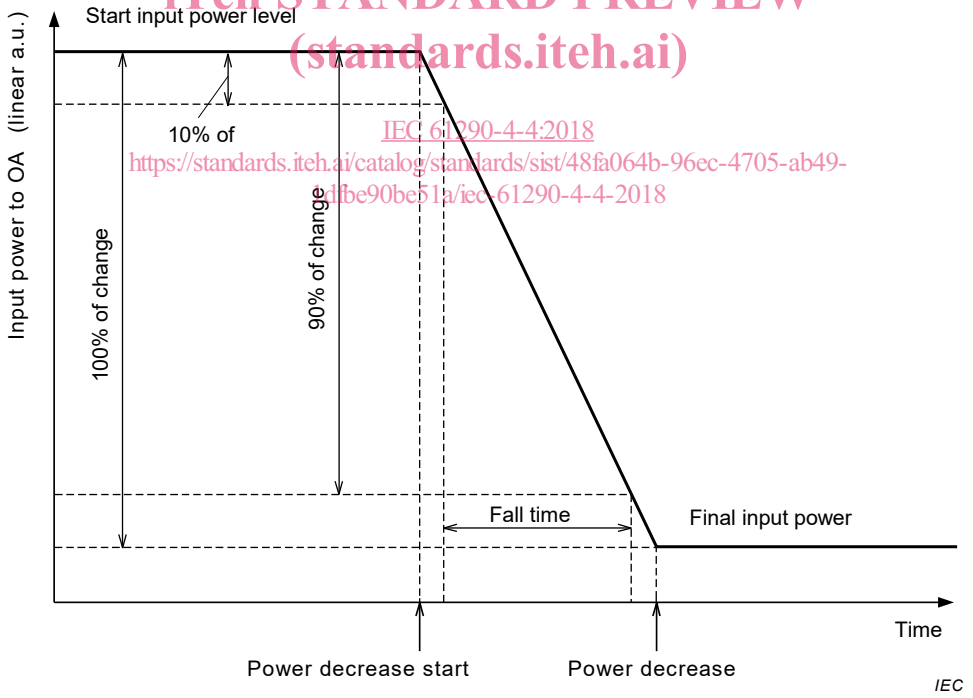
4 Apparatus

4.1 General

When the input power to an OA operating in saturation changes sharply, the gain of the amplifier will typically exhibit a transient response before settling to the required gain. This response is dictated both by the optical characteristics of the active fibre within the OA as well as the performance of the gain control mechanism. Definitions are provided that describe a dynamic event leading to transient response. Rise and fall time definitions are shown in Figure 1.



a) **Power increase event**



b) **Power decrease event**

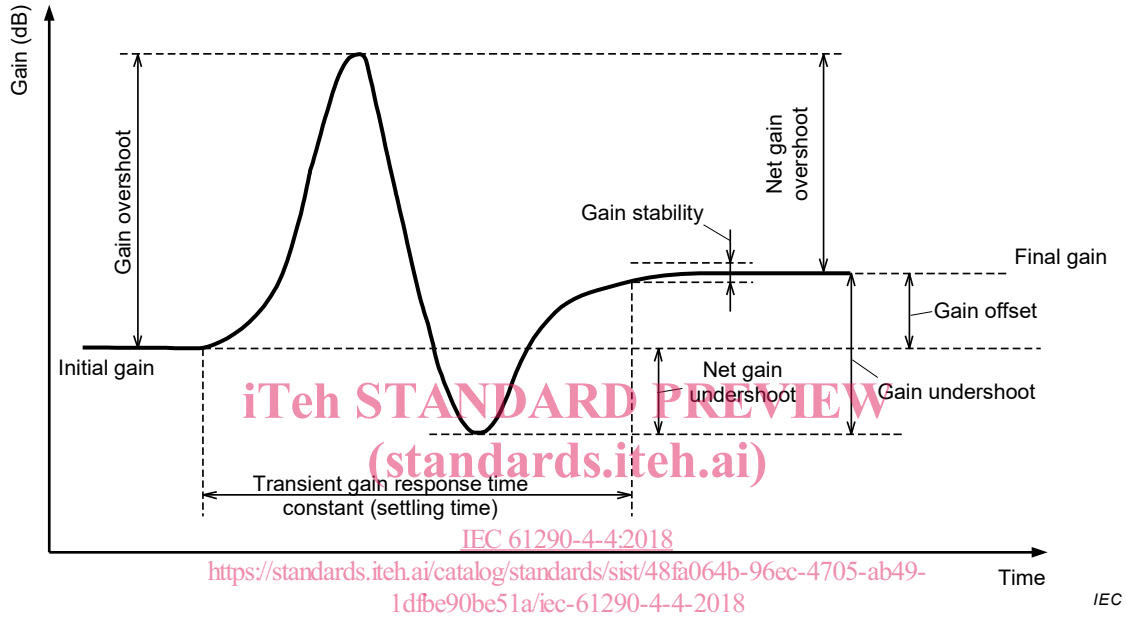
Figure 1 – Definition of rise and fall times

The terms generally used to characterize the transient gain behaviour of a gain controlled OA for the case of optical input power decrease are defined in Figure 2 a). The figure specifically represents the dependence of the gain of optical signal when optical input power is decreased. Likewise, the transient gain behaviour for the case when optical input power is increased is shown Figure 2 b).

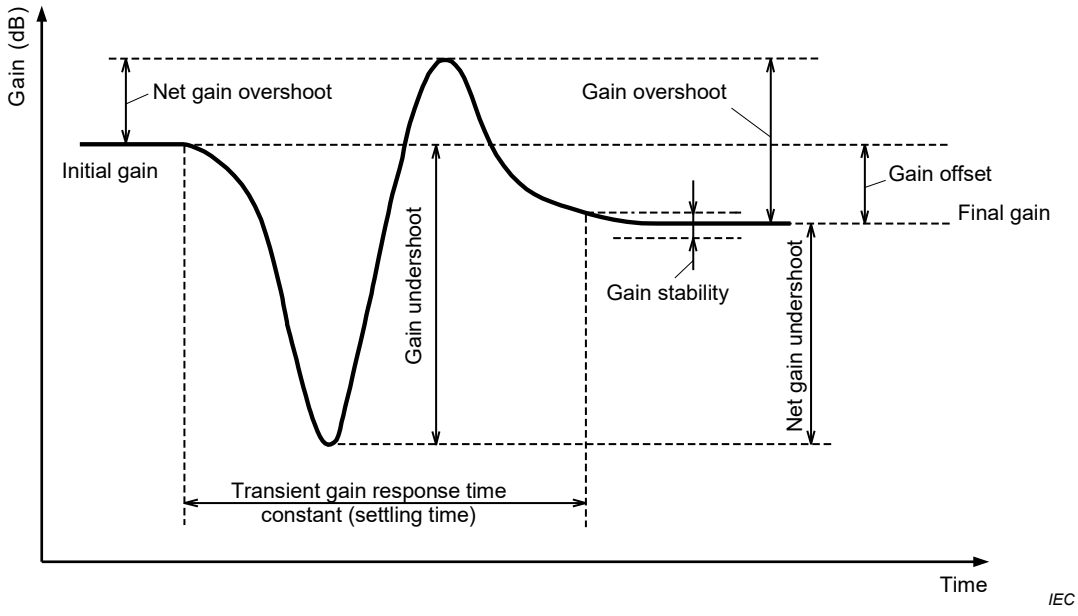
The main transient parameters are the following:

– transient gain response time constant (settling time);
– gain offset;
– transient net gain overshoot;
– transient gain net undershoot.

The transient gain overshoot and undershoot are particularly critical to carriers and network equipment manufacturers (NEMs), given that the speed and amplitude of gain fluctuations compound through the network as the optical signal passes through an increasing number of cascaded amplifiers. Optical amplifiers typically have very small values for these transient parameters.



a) Power decrease event



b) Power increase event

Figure 2 – OA transient gain response for power decrease event, and power increase event

4.2 Test set-up

Figure 3 shows a generic setup to characterize the transient response properties of gain controlled single-channel OAs.

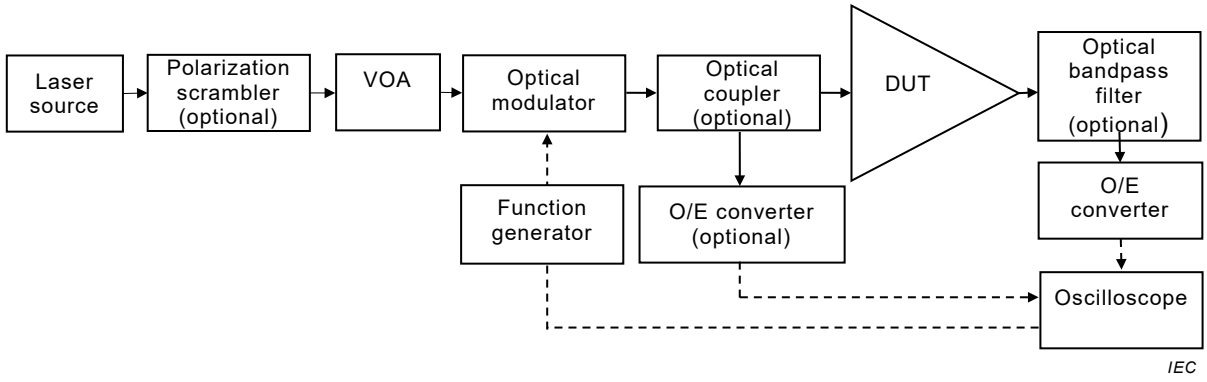


Figure 3 – Gain transient measurement test set-up

4.3 Characteristics of test equipment

The test equipment listed below is needed, with the required characteristics.

a) A laser source for supplying the input signal, with the following characteristics.
   - Ability to support the range of input signal wavelengths for which the DUT is to be tested. This could be provided, for example, by a tuneable laser, or a bank of distributed feedback (DFB) lasers.
   - An achievable average output power such that, at the input to the DUT, the power will be above the maximum specified input power of the OA.

b) Polarization scrambler to randomize the incoming polarization state of the laser source, or to control it to a defined state of polarization (SOP). The polarization scrambler is optional.

c) Variable optical attenuator (VOA) with a dynamic range sufficient to support the required range of input signal levels at which the DUT is to be tested.

d) Optical modulator to switch the saturating signal on and off with the following characteristics:
   - extinction ratio 5 dB higher than the maximum drop level for which the DUT is to be tested;
   - switching time fast enough to support the fastest drop time for which the DUT is to be tested.

e) Optical coupler – Low loss and wavelength dependence of separate ratio to support the range of signal wavelengths for which the DUT is to be tested. The optical coupler is optional.

f) Optical bandpass filter – A filter designed to pass only the input signal wavelength with the following characteristics. The optical bandpass filter is optional.
   - Ability to support the range of input signal wavelengths for which the DUT is to be tested. This could be provided, for example, by a tuneable filter, or a series of discrete filters.
   - 1-dB passband of within ± 20 GHz centred around the input signal wavelength.
   - At least 20 dB attenuation level below the minimum insertion loss across the entire specified transmission band of the DUT, except within a range of ± 100 GHz centred around the input signal wavelength.

g) O/E converter – to detect the filtered output of the DUT, with the following characteristics. O/E converter after optical coupler for measurement of optical input power is optional.