IEC 61290-4-2

Edition 1.0 2011-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Optical amplifiers – Test methods –
Part 4-2: Gain transient parameters – Broadband source method

Amplificateurs optiques – Méthodes d'essai –
Partie 4-2: Paramètres de gain transitoire – Méthode par source large bande

IEC 61290-4-2:2011

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 61290-4-2

Edition 1.0 2011-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Optical amplifiers – Test methods –
Part 4-2: Gain transient parameters – Broadband source method

Amplificateurs optiques – Méthodes d'essai –
Partie 4-2: Paramètres de gain transitoire – Méthode par source large bande

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX R

ICS 33.180.30

ISBN 978-2-88912-573-9

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL AMPLIFIERS – TEST METHODS –

Part 4-2: Gain transient parameters – Broadband source method

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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 IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61290-4-2 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This standard shall be used in conjunction with IEC 61291-1. It was established on the basis of the second (2006) edition of that standard.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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

CDV	Report on voting
86C/957/CDV	86C/991/RVC

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.

A list of all parts of the IEC 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 publication will remain unchanged until the stability 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 61290-4 is devoted to the subject of optical amplifiers. The technology of optical amplifiers is quite new and still emerging; hence amendments and new editions to this standard can be expected.

Each abbreviation introduced in this standard is explained in the text at least the first time it appears. However, for an easier understanding of the whole text, a list of all abbreviations used in this standard is given in 3.3.

OPTICAL AMPLIFIERS –
TEST METHODS –

Part 4-2: Gain transient parameters –
Broadband source method

1 Scope and object

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.

The object of this part of IEC 61290-4 is to establish uniform requirements for accurate and reliable measurements, by means of the broadband source method, of the transient response of OFAs to dynamic changes in their input power, as defined in IEC 61290-4-1:2011.

The broadband source method is different from the two-wavelength method described in IEC 61290-4-1:– in that the saturating signal is not located at a single wavelength, but is rather spread out across the entire specified DWDM transmission band of the OFA-under-test (e.g. the C-Band, 1 525 nm to 1 565 nm). Thus, this method may be relevant to the characterization of transient events where the DWDM signals that are added or dropped are more or less uniformly spread across the transmission band. The difference between the two measurement methods is discussed in more detail in Annex A.

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 61290-4-1:2011, *Optical amplifiers – Test methods – Part 4-1: Gain transient parameters – Two wavelength method*

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

3 Terms, definitions and abbreviations

3.1 General

When the input power to an OFA operating in saturation changes sharply, the gain of the amplifier will typically exhibit a transient response before settling back into the required gain. This response is dictated both by the optical characteristics of the active fibre within the OFA, as well as the performance of the automatic gain control (AGC) mechanism.

Since a change in input power typically occurs when part of the DWDM channels within the specified transmission band are dropped or added, definitions are provided that describe a dynamic event leading to a transient response. Rise and fall time definitions are shown in Figure 1.

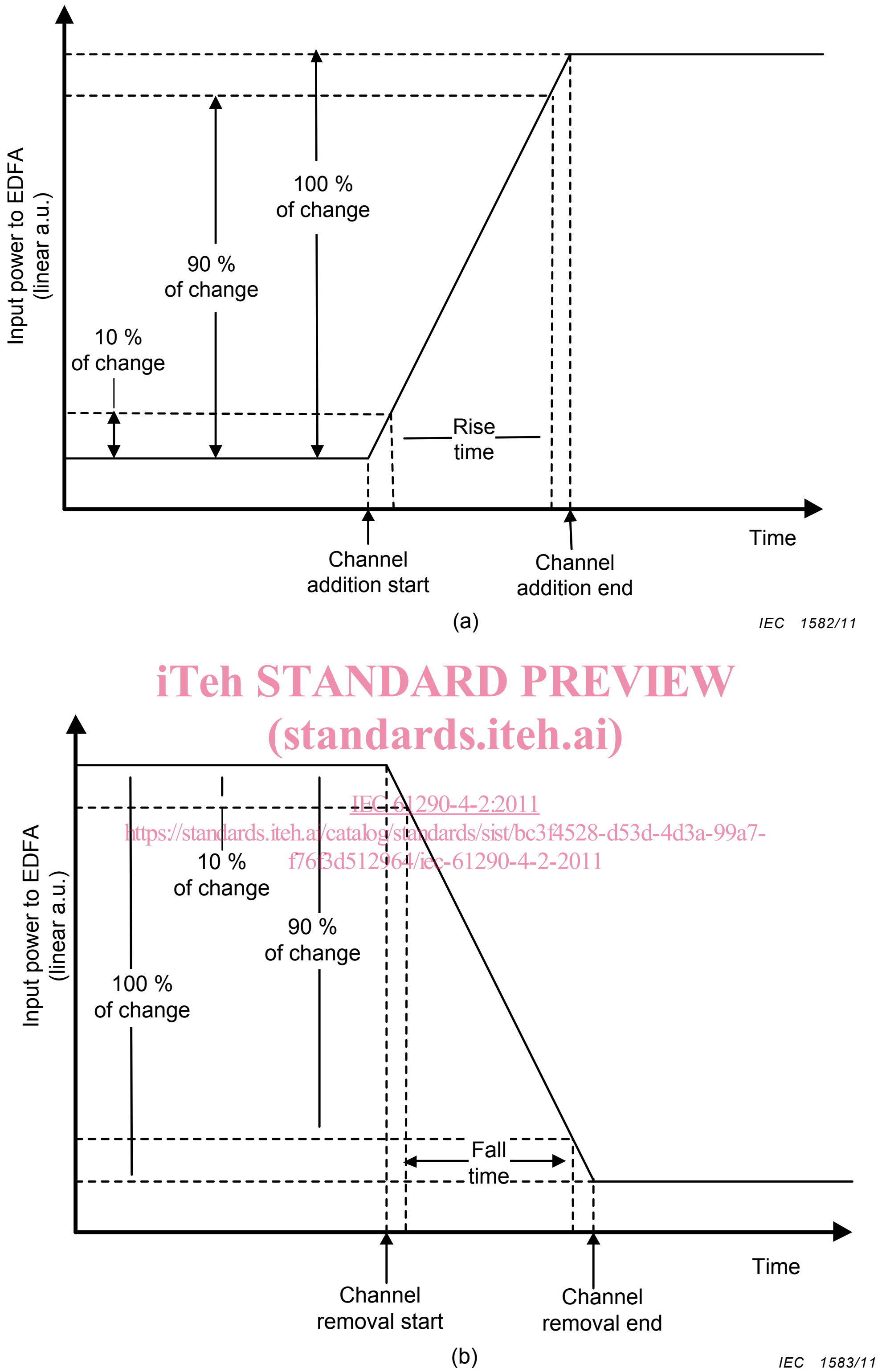

Figure 1 – Definitions of rise and fall times for (a) a channel addition event, and (b) a channel removal event

The parameters generally used to characterize the transient gain behaviour of a gain controlled OFA for the case of channel addition/removal are defined in Figure 2. Figure 2(a) specifically represents the time dependence of the gain of one of the surviving channels when channels are removed. Likewise the transient gain behaviour of a pre-existing channel for the case when channels are added is shown in Figure 2(b). The main transient parameters are: transient gain response time constant (setting time), gain offset, transient net gain overshoot, and transient net gain 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. Properly designed optical amplifiers have very small values for these transient parameters.

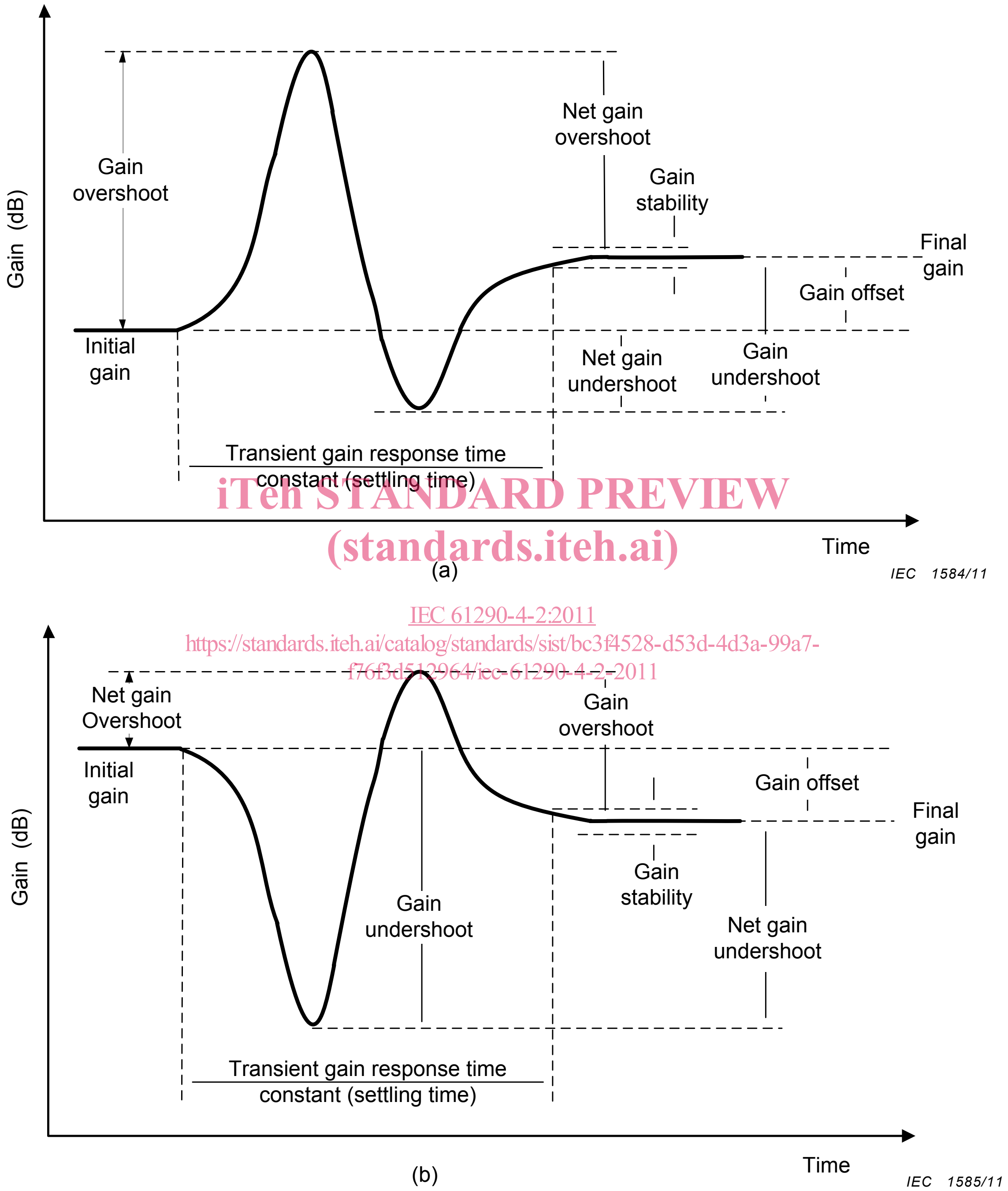

Figure 2 – OFA transient gain response for (a) a channel removal event, and (b) a channel addition event

3.2 Terms and definitions

For the purposes of this document, the following terms, definitions and abbreviations apply.

3.2.1
surviving (pre-existing) signal
optical signal that remains (exists) after (before) a drop (add) event

3.2.2
saturating signal
optical signal that is switched off (on), thus triggering the drop (add) event

3.2.3
drop (add) level (dB)
amount in dB by which the input power decreases (increases) due to dropping (adding) of channels

3.2.4
add rise time
time it takes for the input power to rise from 10 % to 90 % of the total difference between the initial and final input power levels during an add event (see Figure 1a)

3.2.5
drop fall time
time it takes for the input power to fall from 10 % to 90 % of the total difference between the initial and final input power levels during a drop event (see Figure 1b)

3.2.6
initial gain
gain of the surviving (pre-existing) channel before a drop (add) event

3.2.7
final gain
steady state gain of the surviving (pre-existing) channel a very long time (i.e. once the gain has stabilized) after a drop (add) event

3.2.8
gain offset
change in dB of the gain between initial and final state, defined as final gain – initial gain

NOTE Gain offset may be positive or negative for both channel addition and removal events.

3.2.9
gain stability
specified peak-to-peak gain fluctuations of the OFA under steady state conditions (i.e. not in response to a transient event)

3.2.10
transient gain response time constant (settling time)
amount of time required to bring the gain of the surviving (pre-existing) channel to the final gain

NOTE 1 This parameter is the measured time from the beginning of the drop (add) event that created the transient gain response, to the time at which the surviving (pre-existing) channel gain first enters within the gain stability band centred on the final gain.

NOTE 2 Hereon this will also be referred to as settling time.

3.2.11
transient gain overshoot
difference in dB between the maximum surviving (pre-existing) channel gain reached during the OFA transient response to a drop (add) event, and the lowest of either the initial gain and final gain

NOTE Hereon this will also be referred to as gain overshoot.

3.2.12
transient net gain overshoot
difference in dB between the maximum surviving (pre-existing) channel gain reached during the OFA transient response to a drop (add) event, and the highest of either the initial gain and final gain

NOTE 1 The transient net gain overshoot is just the transient gain overshoot minus the gain offset, and represents the actual transient response not related to the shift of the amplifier from the initial steady state condition to the final steady state condition.

NOTE 2 Hereon this will also be referred to as net gain overshoot.

3.2.13
transient gain undershoot
difference in dB between the minimum surviving (pre-existing) channel gain reached during the OFA transient response to a drop (add) event, and the highest of either the initial gain and final gain

NOTE Hereon this will also be referred to as gain undershoot.

3.2.14
transient net gain undershoot
difference in dB between the minimum surviving (pre-existing) channel gain reached during the OFA transient response to a drop (add) event, and the lowest of either the initial gain and final gain

NOTE 1 The transient net gain undershoot is just the transient gain undershoot minus the gain offset, and represents the actual transient response not related to the shift of the amplifier from the initial steady state condition to the final steady state condition.

NOTE 2 Hereon this will also be referred to as net gain undershoot.

3.3 Abbreviated terms

AGC	automatic gain control
DFB	distributed feedback
DWDM	dense wavelength division multiplexing
EDFA	erbium-doped fibre amplifier
NEM	network equipment manufacturer
OA	optical amplifier
OFA	optical fibre amplifier
SHB	spectral hole burning
VOA	variable optical attenuator
WDM	wavelength division multiplexing

4 Apparatus

Figure 3 shows a generic setup to characterize the transient response properties of OFAs using the broadband source method.

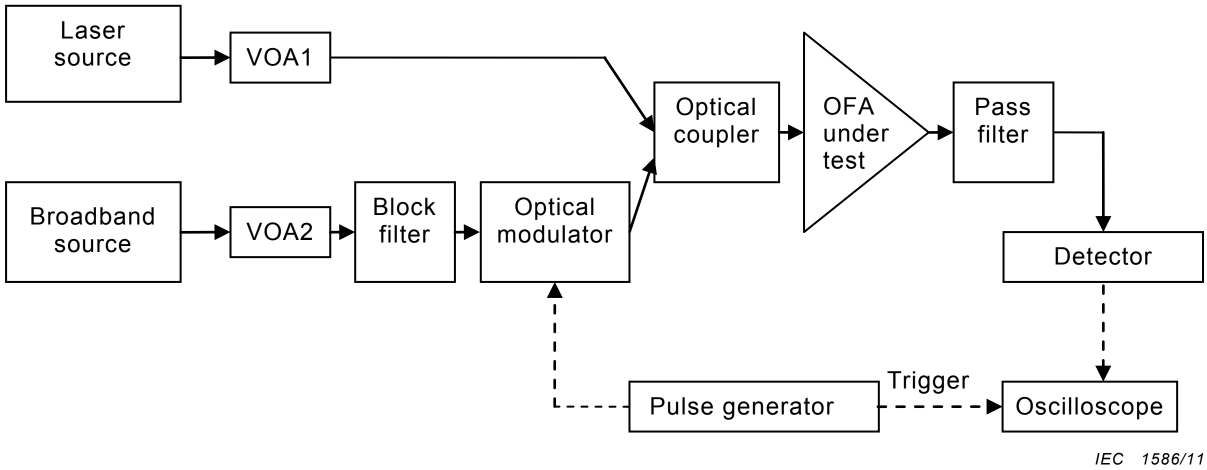

Figure 3 – Transient measurement test set-up for broadband source method

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

a) A laser source for supplying the surviving signal, with the following characteristics

1) Ability to support the range of surviving signal wavelengths for which the OFA under test is to be tested. This could be provided for example by a tunable laser, or a bank of distributed feedback (DFB) lasers

2) An achievable average output power such that at the input to the OFA under test the power will be above the maximum specified input power of the OFA

b) A broadband source for supplying the saturating signal, with the following characteristics

1) At least 95 % of the output power should be contained within the specified transmission band of the OFA under test

2) A variation of not more than 1dB peak-to-peak of the power level across the specified transmission band of the OFA under test

3) An achievable output power such that at the input to the OFA under test the power will be above the maximum specified input power of the OFA

c) VOA1 – A variable optical attenuator (VOA) with a dynamic range sufficient to support the required range of surviving signal levels at which the OFA under test is to be tested

NOTE 1 If the output power of the laser source can be varied over the required dynamic range, then VOA1 may not be needed.

d) VOA2 – A VOA with a dynamic range sufficient to support the required range of saturating signal powers (dictated by the sum of the surviving signal levels and drop level) at which the OFA under test is to be tested.

NOTE 2 If the output power of the broadband source can be varied over the required dynamic range, then VOA2 may not be needed.

e) Block filter – A filter designed to block the broadband signal in the vicinity of the surviving signal wavelength, with the following characteristics

1) Ability to support the range of surviving signal wavelengths for which the OFA under test is to be tested. This could be provided for example by a tunable filter, or a series of discrete filters.

2) Uniform insertion loss to within 0,5 dB over the entire specified transmission band of the OFA under test except in a range of ±125 GHz of the surviving signal wavelength.

3) Attenuation of at least 15 dB over the uniform Insertion Loss in a range of ±75 GHz of the surviving signal wavelength

f) Optical modulator to switch the saturating signal “on” and “off”, with the following characteristics