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61290-10-3

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2002-12

Optical amplifiers – Test methods –

Part 10-3: Multichannel parameters – Probe methods

Amplificateurs optiques –
Méthodes d'essai –

Partie 10-3:
Paramètres à canaux multiples –
Méthodes de sonde

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL AMPLIFIERS – TEST METHODS –

Part 10-3: Multichannel parameters – Probe methods

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 co-operation 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 express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, 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.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61290-10-3 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This standard should be read in conjunction with IEC 61291-1 and 61290-3

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

FDIS	Report on voting
86C/459/FDIS	86C/483/RVD

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 3.

The committee has decided that the contents of this publication will remain unchanged until 2008-12. At this date, the publication will be

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- withdrawn;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

INTRODUCTION

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

OPTICAL AMPLIFIERS –
TEST METHODS –

Part 10-3: Multichannel parameters –
Probe methods

1 Scope and object

This part of IEC 61290 applies to commercially available optical fibre amplifiers (OFAs) using active fibres containing rare-earth dopants as described in the following.

The object of this international standard is to establish uniform requirements for accurate and reliable measurements of the multichannel gain and noise parameters as defined in IEC 61291-4.

The test methods described in this standard use small-signal probes to obtain the multichannel gain and noise parameters while one or more lasers set the saturation condition for the OFA. These methods are classified as *indirect* in that there is not a laser source at each wavelength of the multichannel plan. Multichannel parameters are estimated from the probe data. IEC draft standards 61290-10-1 and 61290-10-2 are test methods for measuring noise parameters using pulse techniques. These methods are *direct* in that the multichannel source is required to have a laser at each wavelength for which multichannel parameters are to be measured.

Probe techniques provide clear advantages for measuring multichannel gain characteristics in that a simple source configuration can provide parameters for a wide range of multichannel plans. Either a small-signal laser or a broadband noise source serves as the probe signal, and single or multiple lasers are used to set the OFA saturation condition. Pulse modulation of the saturating sources may optionally be used to measure ASE at or near the saturating laser wavelengths without the contaminating effect of source spontaneous emission. If pulse modulation is not used, the source spontaneous emission must be measured, and its effect removed from the measured result. For a multichannel source with high spontaneous emission or at high total input power, the source noise subtraction method can lead to large uncertainty.

The probe techniques described herein are indirect in that laser sources are not required at each channel frequency. A measurement error results from inhomogeneous effects that are DUT dependent. The main source of this error is spectral hole burning (see [1][1] [2] and [4]).

The applicability of pulse modulation of the saturating signal(s) and the selection of the modulation rate are dependent on the optical fibre amplifier's characteristics, specifically its time response. They may be unsuitable for amplifiers with active automatic level control (ALC) or automatic gain control (AGC) circuits. They may also be unsuitable for praseodymium-doped OFAs that have gain relaxation times that are much faster than erbium-doped designs. For erbium-doped fibre amplifiers (EDFAs), inaccuracy due to modulation is generally small. Refer to IEC document 61290-10-2 for a discussion of inaccuracy due to pulse repetition rate.

In order to predict multichannel parameters by probe methods it is necessary to properly set the output level of the saturating signal(s) to simulate the saturation effect of a specified multichannel plan. Clause 5 describes a methodology to accomplish this under the assumption of homogeneous behavior within a wavelength region. This methodology has the

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1 Numbers in brackets refer to the bibliography.

limitation that the wavelength dependence of any output coupling circuit from the active fibre to the output port is assumed to be zero within defined regions.

Parameters measured with the methods described herein include channel gain, channel signal-spontaneous noise figure, and amplified spontaneous emission (ASE).

Values marked with(*) indicate preliminary values. Final values are under study.

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 61290-3, *Optical fibre amplifiers – Basic specification – Part 3: Test methods for noise figure parameters*

IEC 61290-10-1, *Optical fibre amplifiers – Basic specification – Part 10-1: Test methods for multichannel parameters – Pulse method using optical switch and OSA (multichannel capable* [2]

IEC 61290-10-2, *Optical fibre amplifiers – Basic specification – Part 10-2: Test methods for multichannel parameters – Pulse method using a gated OSA* [3]

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

IEC 61291-4, *Optical amplifiers – Part 4: Multichannel applications – Performance specification template* [4]

3 Apparatus

The probe methods require two sources. The first establishes the inversion (saturation) level of the optical amplifier and consists of one or more lasers. The second source is the small-signal probe and may consist of a laser or broadband noise source. In either case, care must be taken that the probe does not effect amplifier inversion. The laser source module may be pulse modulated in order to extinguish the source for more-accurate noise measurement as described in IEC draft standards 61290-10-1 or 61290-10-2. For the probe methods described herein, modulation is optional.

Both laser and noise probe methods can provide similar measurement uncertainty. The noise probe method is generally faster so is preferred when measurement throughput is important.

3.1 Laser probe method

Figure 1(a) is a diagram of the laser probe configuration. The source module, as described in 3.3, may consist of a single or multiple lasers. Optional polarization controllers following the sources improve accuracy by averaging system and amplifier polarization dependencies. They also may be used to quantify the polarization dependent gain (PDG) and polarization hole burning (PHB) of the OFA. While a single polarization controller is shown external to the source module, for best accuracy with a multichannel source, each channel requires polarization averaging to eliminate uncertainty due to polarization hole burning. The optional optical switch at the output of the DUT is to implement the pulse technique with optical switching.

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[2] To be published.

[3] To be published.

[4] In preparation.

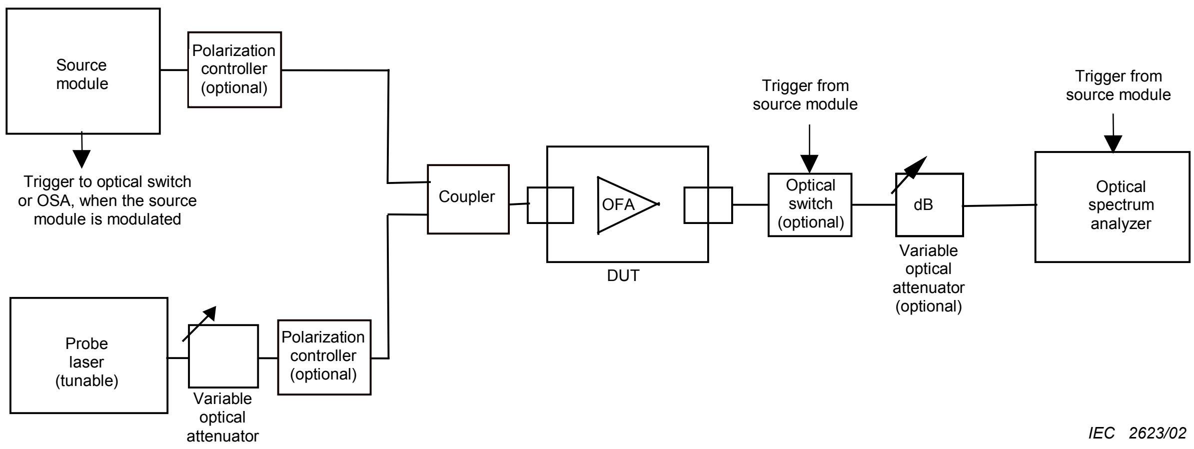

Figure 1(a) – Block diagram for probe method using a laser probe source

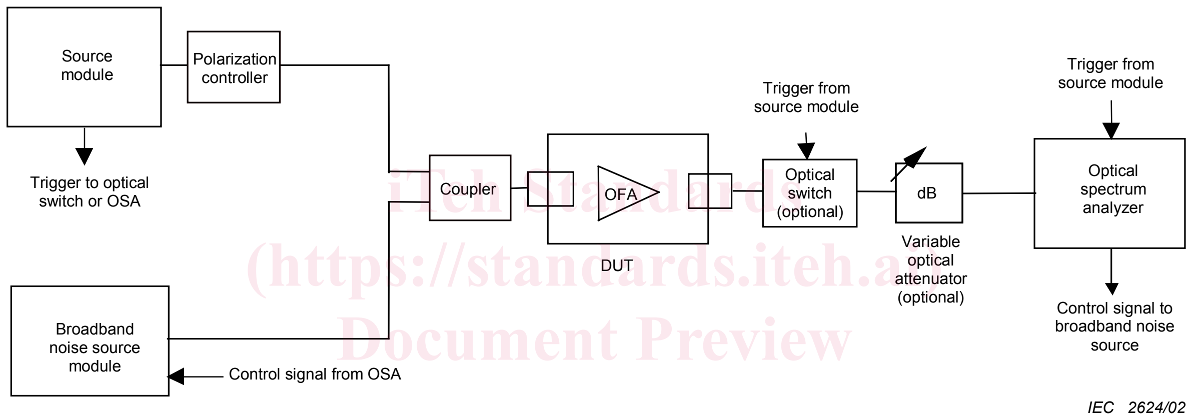

Figure 1(b) – Block diagram for probe method using a broadband noise probe source

Figure 1 – Block diagrams for probe methods

3.2 Broadband noise probe method

Figure 1(b) is a diagram of the noise probe configuration. In order for the broadband source to have sufficiently low total output power, it is necessary that it be modulated at a low repetition rate and a low duty cycle and that the OSA measurement be synchronized with the probe ON and OFF periods. This is accomplished with a control signal from the OSA.

3.3 Detailed description of apparatus

3.3.1 Source module

When the source module is modulated, two arrangements are possible as shown in Figures 2(a) and 2(b). Source module (a) consists of CW optical sources with an external optical switch and attenuator(s). Source module (b) consists of directly modulated optical sources and attenuator(s). While only one attenuator is shown, for the multichannel source it will usually be necessary to independently set channel power so that an attenuator is necessary for each channel. While modulated sources are shown, this procedure may be implemented with unmodulated sources as well.

Unless otherwise specified, the full width at half maximum (FWHM) of the output spectrum of source modules (a) and (b) shall be narrower than 0,1 nm(*) so as not to cause any interference to adjacent channels. The suppression ratio of the side modes of the DFB laser, the DBR laser or the ECL shall be higher than 35 dB(*). The output power fluctuation shall be less than 0,05 dB(*), which is more easily attainable with an optical isolator placed at the output port of each source. The wavelength accuracy shall be better than ±0,1 nm(*) with stability better than ±0,01 nm(*). If the source is pulse modulated, the spontaneous emission level must be more than 35 dB/nm(*) below the total input power. If the source is not pulse modulated, the spontaneous emission level must be more than 43 dB/nm(*) below the total input power for 0-dBm total input power and more than 48 dB/nm(*) below total input power for 5-dBm total input power(*).

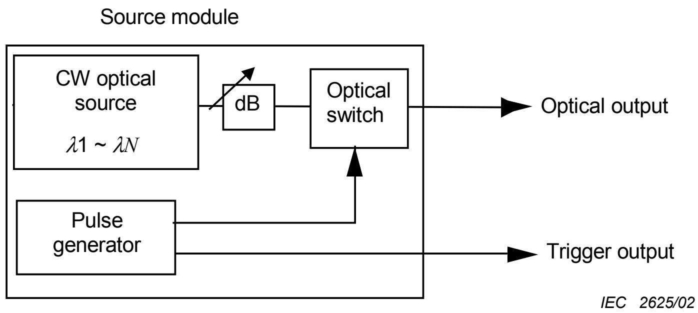

Figure 2(a) – Externally modulated optical source

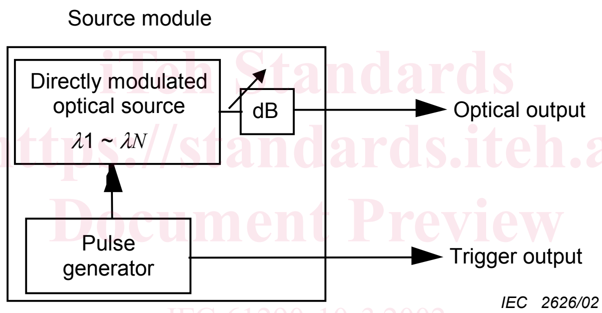

Figure 2(b) – Directly modulated optical source

Figure 2 – Modulated optical sources

For either arrangement of the source module, the extinction ratio shall be greater than 65 dB(*). For the directly modulated wavelength division multiplexing (WDM) source, care should be taken to assure timing synchronization of the individual lasers. The optical switch in the arrangement of Figure 2(a) is typically an acousto-optic device in order to obtain the necessary extinction ratio.

The pulse generator in combination with the modulator driver must provide optical pulses with 50 % duty cycle and a repetition frequency suitable for the OFA being tested. Typically, the repitition frequency will be in the range from 25 kHz to 1 000 kHz. The 10 % to 90 % rise and fall times shall be less than 10 % of the pulse width(*). The trigger output shall be coincident with the optical pulse turn-on edge with a precision of ±10 %(*) of the pulse period.

If an optical attenuator is not built into the source module, it must have an attenuation range of greater than 40 dB(*) and stability better than ±0,1 dB. The attenuation range is specified to be able to adjust the input power over a nominal range. The reflectance from this device shall be smaller than –40 dB(*) at each port.

3.3.2 Variable optical attenuator

The variable optical attenuator in front of the OSA shall have an attenuation range and stability of better than 20 dB(*) and ±0,1 dB respectively. The maximum attenuation value of