INTERNATIONAL STANDARD

IEC 61290-10-1

First edition
2003-03

Optical amplifiers – Test methods –

Part 10-1: Multichannel parameters – Pulse method using an optical switch and optical spectrum analyzer

Amplificateurs optiques – Méthodes d'essai

Partie 10-1: Paramètres à canaux multiples – Méthode d'impulsion utilisant un commutateur optique et un analyseur de spectre optique

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International Electrotechnical Commission
Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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.
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The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of two patents.

One patent concerns a technique for determining the amplified spontaneous emission noise of an optical amplifier in the presence of an optical signal given in Clause 3 and Clause 5.

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The holder of this patent right has assured the IEC that he/she is willing to negotiate licenses under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with the IEC. Information may be obtained from:

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USA

Another patent concerns a measurement system and noise measurement apparatus for an optical amplifier given in clause 3 and clause 5.

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Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61290-10-1 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 IEC 61290-3.

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

FDIS	Report on voting
86C/498/FDIS	86C/533/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 2.

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

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- withdrawn;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

A bilingual edition of this standard may be issued at a later date.

INTRODUCTION

As far as can be determined, this is the first International Standard on this subject. The technology of optical fibre amplifiers is quite new and still emerging, hence amendments and new editions to this document can be expected.

Each abbreviation introduced in this International 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 abbreviations used in this International Standard is given in Annex A.

OPTICAL AMPLIFIERS – TEST METHODS –

Part 10-1: Multichannel parameters – Pulse method using an optical switch and optical spectrum analyzer

1 Scope and object

This part of IEC 61290 applies to optical fibre amplifiers (OFAs) using active fibres, containing rare-earth dopants, currently commercially available. It establishes uniform requirements for accurate and reliable measurements of the signal-spontaneous noise figure as defined in 3.1.18 of IEC 61291-1.

The test method independently detects amplified signal power and amplified spontaneous emission (ASE) power by launching optical pulses into the OFA under test and synchronously detecting "on" and "off" levels of the output pulses by using an optical sampling switch and an optical spectrum analyzer (OSA).

Such a measurement is possible because the gain response of the rare-earth doped OFA is relatively slow, particularly in Er-doped OFAs. However, since the OFA gain dynamics vary with amplifier types, operating conditions and control scheme, the amplifier type should be considered when applying the present test method.

The test method is described basically for multichannel applications, which includes single channel applications as a special case of multichannel (wavelength-division multiplexed) applications.

NOTE All numerical values followed by (‡) are intended to be currently 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 61291-1, *Optical fibre amplifiers – Part 1: Generic specification*

3 Apparatus

The basic measurement set-up is given in Figure 1.

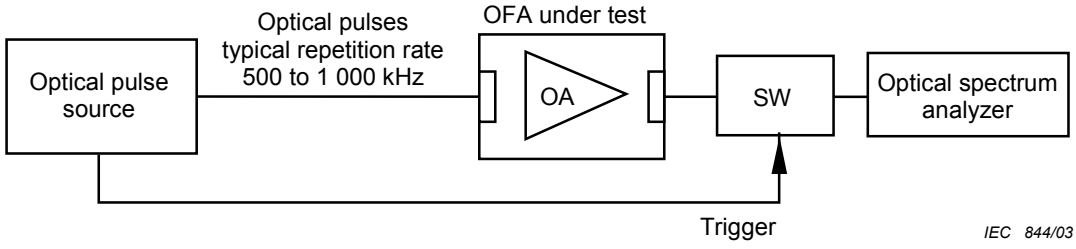

Figure 1 – Typical arrangement of the optical pulse test method

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

a) *Optical pulse source*: Two arrangements of the optical pulse source are possible as shown in Figure 2. Optical pulse source *a* (Figure 2a) consists of CW optical sources with an external optical switch and attenuator(s). Optical pulse source *b* (Figure 2b) consists of directly modulated optical sources and attenuator(s).

Optical pulse source *a*

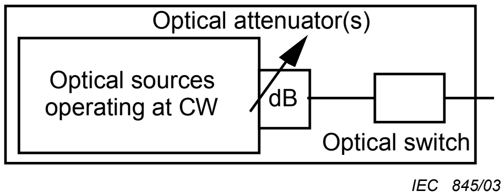

Figure 2a – Pulse source consisting of CW optical sources with an external optical switch and attentuator(s)

Optical pulse source *b*

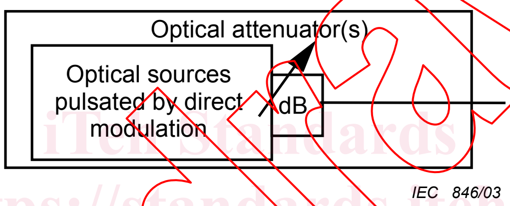

Figure 2b – Pulse source consisting of directly modulated optical sources and attenuator(s)

Figure 2 – Two arrangements of the optical pulse source

Unless otherwise specified, the full width at half maximum (FWHM) of the output spectrum of optical pulse source *a* or *b* shall be narrower than 0,1 nm(‡) so as not to cause any interference to adjacent channels. In the case of a single-channel source, it shall be narrower than 1 nm (‡). Distributed feedback (DFB) lasers, distributed Bragg reflection (DBR) lasers, and external cavity lasers (ECLs), for example, are applicable. The suppression ratio of the side modes of these DFB lasers shall be higher than 30 dB(‡). The output power fluctuation shall be less than 0,05 dB(‡), which may be more easily attainable with an optical isolator placed at the output port of each source.

Optical pulse source *a* simultaneously pulsates wavelength-division multiplexed light with an optical switch, where the switching time is common to all the channels; timing adjustment is not needed. Moreover, frequency chirping and spontaneous emission can be minimum; the extinction ratio of the “on” versus “off” stages can be uniquely determined at a high level if a high extinction-ratio switch is used. An acousto-optic modulator (AOM) is typically used as the switch.

For optical pulse source *b*, the leakage power at the off-state should be as small as possible to minimize the measurement error, although calibration is possible by subtracting the leaked power. This may demand a zero-bias operation of laser diode sources. Moreover, care must be taken in synchronizing optical pulses because the pulse timing may differ from one source to another.

b) *Variable optical attenuator:* The attenuation range and stability shall be over 40 dB(‡) and better than ± 0,1 dB(‡), respectively. The reflectance from this device shall be smaller than –40 dB(‡) at each port. The variable optical attenuator may be incorporated in the optical pulse source.

c) *Optical switch*: This device shall have a polarization sensitivity less than ±0,1 dB(‡), static isolation better than 65 dB(‡), transition time less than 50 ns(‡), and switching delay time less than 2 ms(‡). The reflectance from this device shall be smaller than –40 dB(‡) at each port. Figure 3 defines the optical switch static isolation. The optical switch is not required for optical pulse source *b*.

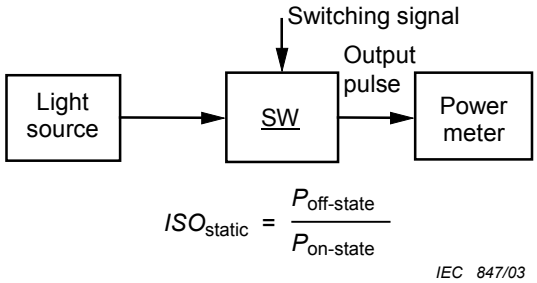

Figure 3 – Static isolation of an optical switch

d) *Pulse generator:* This device is used to drive optical pulse sources and the optical sampling switch. When using an internally modulated optical pulse source, an independent pulse generator is not required. Pulse train(s) shall be generated with a pulse interval rate of, typically, 1 µs to 2 µs (‡). The pulse widths shall be adjustable from 100 ns to 2 ms(‡) with a minimum of 5 ns step or finer. The delay shall be adjustable at least from 100 ns to 4 µs(‡) in steps of 5 ns or finer. The rise time and fall time, t_r and t_f, of the output optical pulse shall be less than 10 ns(‡). Definitions of t_r and t_f are given in Figure 4.

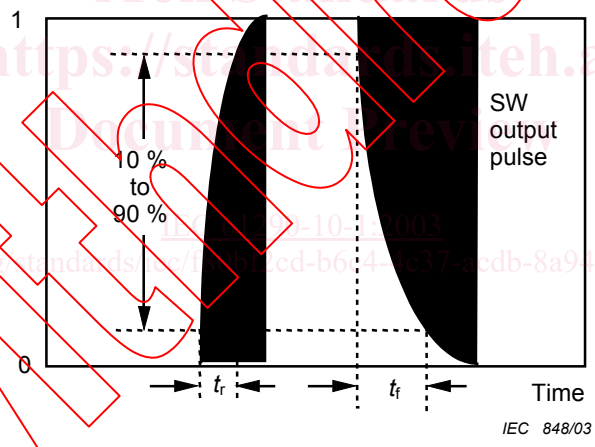

Figure 4 – Definitions of rise time and fall time, t_r and t_f of optical pulses

e) *Optical spectrum analyzer:* This device shall have polarization sensitivity less than 0,1 dB(‡), stability better than ±0,1 dB(‡), wavelength accuracy better than ±0,5 nm(‡), and wavelength reproducibility better than 0,01 nm(‡). The device shall have a measurement range at least from –75 dBm to +20 dBm(‡) with a resolution better than 0,1 nm (‡). The reflectance from this device shall be smaller than –40 dB(‡) at its input port.

f) *Optical power meter:* This device shall have a measurement accuracy better than ±0,2 dB(‡), irrespective of the state of the input light polarization, within the operational wavelength band of the OFA and within a power range from –40 dBm to +20 dBm(‡).

g) *Optical connectors*: The connection loss repeatability shall be better than ±0,1 dB(‡). The reflectance from this device shall be smaller than –40 dB(‡).

h) *Optical fibre jumpers*: The mode field diameter of the optical fibre jumpers shall be as close as possible, so as not to cause excessive loss and reflectance, to that of fibres used as input and output ports of the OFA. The reflectance from optical fibre jumpers shall be smaller than –40 dB(‡), and the device length shall be short (<2 m).