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Edition 2.0 2010-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic communication subsystem test procedures –
Part 2-1: Digital systems – Receiver sensitivity and overload measurement

Procédures d'essai des sous-systèmes de télécommunications à fibres optiques –
Partie 2-1: Systèmes numériques – Mesure de la sensibilité et de la surcharge d'un récepteur

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIBRE OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 2-1: Digital systems – Receiver sensitivity and overload measurement

FOREWORD

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International Standard IEC 61280-2-1 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition, published in 1998, and constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

– revised to include the requirements associated with data communication equipment, regenerators and amplifiers;
– the term "jumper lead" has been replaced by "test cord":
– a section for definitions has been added;
– a section on measurement uncertainties has been added.

This bilingual version (2015-12) corresponds to the monolingual English version, published in 2010-03.

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

CDV	Report on voting
86C/881/CDV	86C/945/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.

The French version of this standard has not been voted upon.

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

A list of all parts of the IEC 61280 series, published under the general title *Fibre optic communication subsystem test procedures,* 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- withdrawn,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.

FIBRE OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 2-1: Digital systems – Receiver sensitivity and overload measurement

1 Scope and object

This part of IEC 61280 describes the test procedures applicable to digital fibre optic communication and data systems.

The object of this test procedure is to measure the minimum and maximum optical powers required and allowed at the optical input port of a fibre optic system to ensure its operation within specified limits. Another objective is to verify that the guaranteed error performance is obtained at the minimum and the maximum optical input powers specified by the terminal equipment manufacturer.

Figure 1 shows the typical elements associated with optical fibre systems. Optical amplifiers or regenerators may be used in long haul telecom systems, but are not usually associated with data transport systems such as Ethernet, etc. In bi-directional systems the transmitter and corresponding receiver are usually co-located, as indicated by the dotted lines. This specification is concerned with the characteristics of the optical input interface of the receiver, amplifier or regenerator shown.

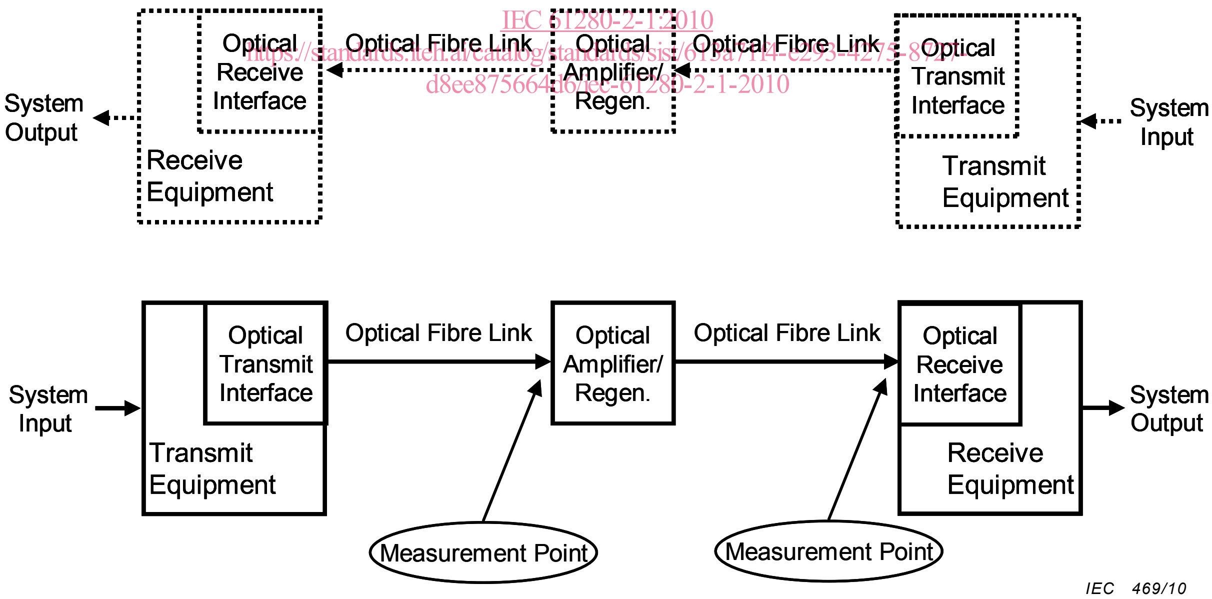

Figure 1 – Optical fibre system

It should be noted that the performance of fibre optic receivers may differ for different signal formats. It is therefore necessary to use the signal format that represents actual operating conditions.

2 Terms and definitions

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

2.1
bit error ratio (*BER*)
the number of errored bits divided by the total number of bits, over some stipulated period of time

[IEC 61931, definition 2.9.33]

2.2
bit sequence
a defined sequence of ones (1) and zeros (0) in a digital signal

2.3
bit pattern
a predetermined sequence of 1's and 0's in a digital signal which is repeated at regular intervals

2.4
errored block ratio (*EBR*)
the number of errored blocks, containing a defined number of digits, divided by the total number of blocks received in a specified period of time. An errored block may contain more than one errored bit

2.5
overload level
the maximum input power above which a specified quality of performance is no longer achieved

2.6
pseudo random binary sequence (PRBS)
a repeated bit sequence which simulates a random pattern of 1's and 0's. It is generated by the addition of the r^{th} preceding digit of a sequence of n bits and eliminating the sequence of n 0's (or n 1's). The pattern repeats after 2^n-1 bits

2.7
receiver sensitivity
the minimum power required to achieve a specified quality of performance

[IEC 61931, definition 2.7.58, modified]

2.8
system input and output signals
for the purpose of this specification, the system input and output are defined as signals which interface with external equipment. These signals have specified formats specific to the application and may be electrical or optical. The signals are accessed via physical interfaces that are specific to the equipment

3 Apparatus

3.1 General

The test setup is shown in Figure 2. It is important that test cords 3 and 4 are of a similar type and make and are of equal length.

3.2 BER test set

The BER test set is made up of the elements described here.

3.2.1 Data generator

The data generator of the BER test set shall be capable of providing a data input to the system which may be a pseudo-random sequence or otherwise specified bit pattern with the signal format (pulse shape, amplitude, etc.) that is consistent with the requirements at the system input interface of the EUT.

As a minimum requirement the data generator shall be capable of providing the following output date formats; other data formats may be used in compliance with the system requirements.

- a 2^{23}-1 pseudo-random data stream;
- an all 1 data stream;
- a 1 + 15 zeros data stream.

The format (pulse shape, amplitude, etc.) of the test signal shall be compliant with that required at the transmit input interface. The receiver portion of the test equipment shall be able to interface with the system output for the measurement of digital errors.

3.2.2 Error counter

The error counter of the BER test set shall be able to interface with the output of the EUT. It shall be capable counting single errors or errored blocks at the data rate of system output interface of the EUT. If the error counter has the facility for computing the BER or EBR value it must be capable of calculating a value as low as 10^{-12}.

3.3 Optical power meter

The optical power meter used shall have a resolution of at least 0,1 dB, shall be data format and bit rate independent and shall have been calibrated for the wavelength and power range of operation for the equipment to be tested. All measurements shall be recorded on the dB scale.

3.4 Variable optical attenuator

The optical attenuator shall be capable of attenuation in steps less than or equal to 0,25 dB and should be able to provide a total attenuation that is at least 5 dB greater than the specified input range of the receiver under test. Care should be taken to avoid back reflection into the transmitter.

3.5 Optical splitter

The optical splitter (coupler) shall have one input port and two output ports equipped with appropriate connectors. The splitting ratio for the output ports should be 50 % ± 0,1 dB (unless otherwise specified).

3.6 Test cords

Single-mode or multimode fibre reference test cords and fitted with the appropriate connectors as required by the application shall be used, unless otherwise agreed. The optical loss of the test cords including connectors shall not exceed 1,0 dB.

3.7 Optical transmit interface

The optical transmit interface shall have electrical and optical characteristics similar to those of transmitters that are used in the specified fibre optic terminal devices, except that the output power shall exceed the maximum specified input power of the receiver by at least 2 dB.

4 Equipment under test (EUT)

The EUT shall be a fibre optic receiver, optical amplifier or optical regenerator, including all associated signal conditioning, processing and multiplexing equipment used in the system under normal operating conditions. The system input and output terminations shall be those normally seen by the user of the system.

5 Test procedure

The test procedure consists of the following steps.

5.1 Operating conditions and test environment

Unless otherwise specified, normal operating conditions apply. The ambient or reference point temperature and humidity shall be specified.

Switch on the EUT and all test equipment (apply any special operating conditions to the EUT if required) and allow 30 min. (unless otherwise specified) for the equipment to reach a steady-state temperature and performance condition.

5.2 Connector end-face cleaning

Whenever optical connections are changed, the end faces of the connectors shall be cleaned. Cleaning equipment (including apparatus, materials, and substances) and the methods to be used shall be suitable for the connectors to be cleaned. Connector suppliers' instructions shall be consulted where doubt exists as to the suitability of particular equipment and cleaning methods.

5.3 Measurement of input sensitivity

Connect the equipment as shown in Figure 2, if terminal equipment is tested, or Figure 3, if an amplifier or regenerator is tested, and set the data generator and error counter to operate with a pseudo random sequence with word length of 2^{23}-1 (unless otherwise specified).

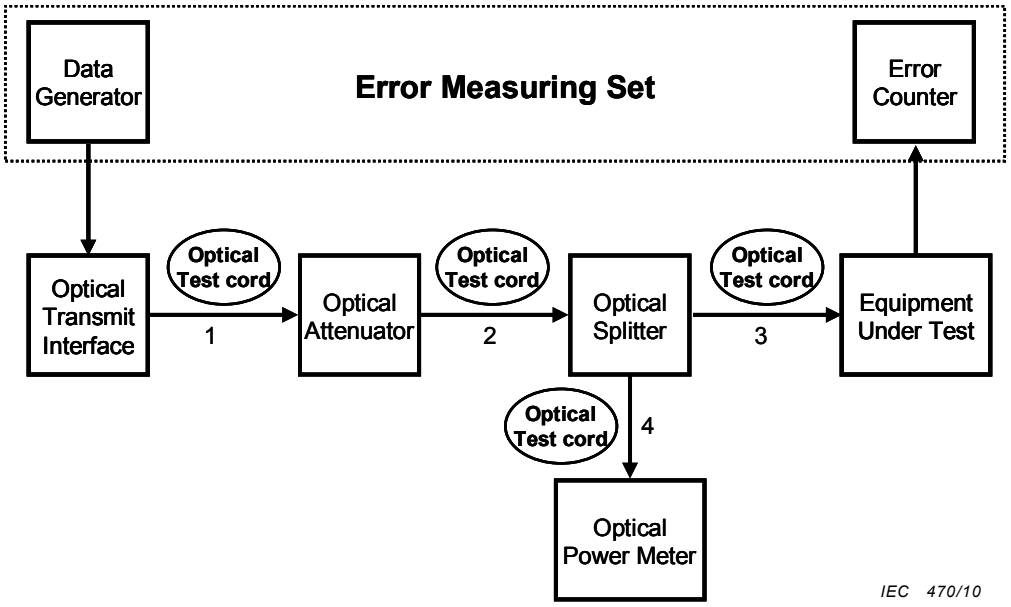

Figure 2 – Setup for the measurement of input sensitivity of a receive terminal

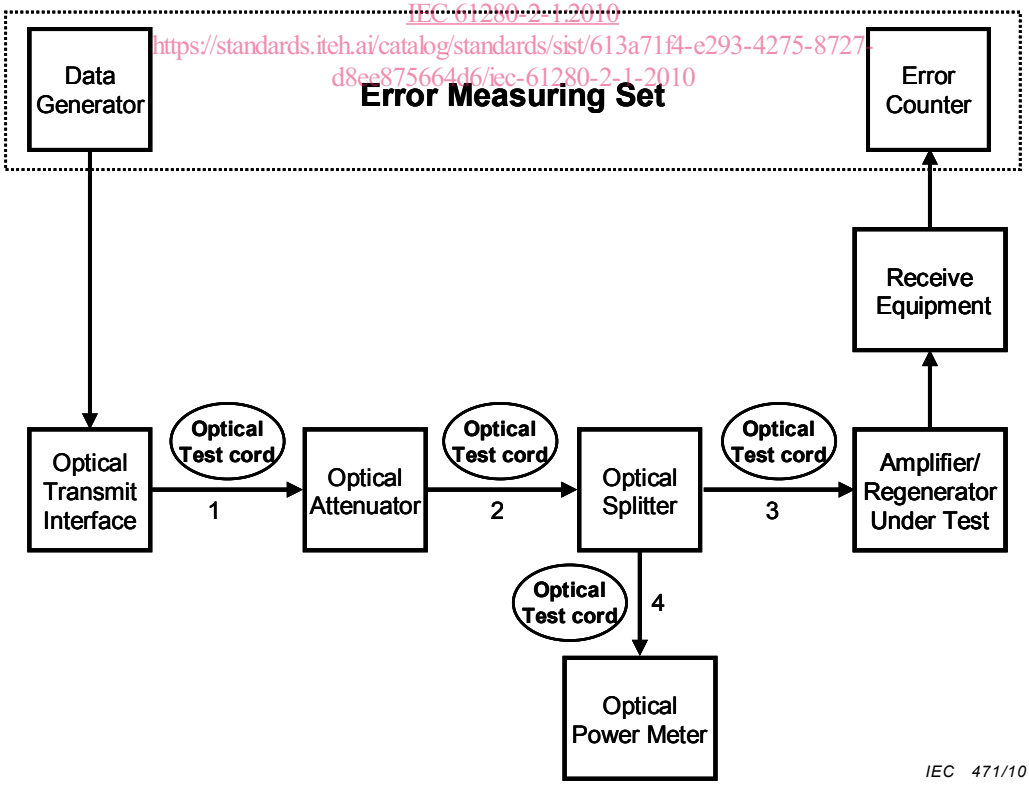

Figure 3 – Setup for the measurement of input sensitivity of an amplifier or regenerator

5.3.1 Optical input power calibration

This procedure shall be carried out as follows:

a) Disconnect the optical power meter from the output of optical test cord 4 and disconnect the output of optical test cord 3 from the EUT.

b) Connect the optical power meter to the output of optical test cord 3.

c) Set the attenuator to 0 dB and measure the optical power.

d) Connect the optical power meter to the output of test cord 4 and re-connect the output of optical test cord 3 to the EUT.

e) Measure the optical power.

f) Record any difference between the two measurements.

5.3.2 *BER* or *EBR* determination

The procedure consists of the following steps:

a) Adjust the optical attenuator to provide an optical power level which is 3 dB higher than the minimum specified input power.

b) Adjust the optical attenuator to increase the attenuation until the first errors are observed. If the error counter has the facility to compute the *BER* or *EBR* directly, record the result and power level.

c) If such a facility is not provided, count the number of errors occurring in a defined monitoring time that exceeds or is equal to the minimum monitoring time given in Table 1. Calculate the error ratio using the following formula:

$$BER = \frac{N}{DT} \quad \text{or} \quad EBR = \frac{BN}{DT}$$

where

N is the number of errors observed in monitoring time;

D is the data rate;

T is the monitoring time;

B is the number of data in a block.

Table 1 – Minimum monitoring time

Data rate	Minimum monitoring time, s
1 Mb/s < data rate < 30 Mb/s	(1/data rate) × 10^8
Data rate > 30 Mb/s	(1/data rate) × 10^{10}

NOTE When the *EBR* is measured, the minimum monitoring time should be multiplied by the number of data bits in the block.

d) Record the calculated error ratio together with the optical power.

e) Increase the attenuation in steps of 1 dB and record the power level and the measured or calculated error ratio for each step until the maximum error ratio specified for the equipment is reached. As the specified maximum error ratio is approached, it may be necessary increase the attenuation in smaller increments.

f) The input power level observed represents the receiver sensitivity or minimum required input power level for the equipment to meet the error performance specified for that equipment. Any difference between the actual and observed optical power determined by the calibration procedure shall be taken into account.

g) It should be noted that some equipment has internal error monitoring and may output a special signal at the system output to indicate loss of input when a specified error ratio is reached. In such case, the input sensitivity shall be taken as the input level measured at the onset of the special signal.