

INTERNATIONAL STANDARD

**Fibre optic communication subsystem test procedures –
Part 1-3: General communication subsystems – Central wavelength and spectral
width measurement**

IEC 61280-1-3:2010

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE



ICS 33.180.01

ISBN 978-2-88910-472-7

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**FIBRE OPTIC COMMUNICATION
SUBSYSTEM TEST PROCEDURES –**

**Part 1-3: General communication subsystems –
Central wavelength and spectral width measurement**

FOREWORD

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International Standard IEC 61280-1-3 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86.

This second edition cancels and replaces the first edition published in 1998. This edition constitutes a technical revision with changes reflecting new laser technology and includes a second method modified for state of the art instrumentation.

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

CDV	Report on voting
86C/ 887/CDV	86C/ 937/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 61280 series can be found, under the general title *Fibre optic communication subsystem test procedures*, on the IEC website.

The committee has decided that the contents of this amendment and the base 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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

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FIBRE OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 1-3: General communication subsystems – Central wavelength and spectral width measurement

1 Scope

This part of IEC 61280 provides definitions and measure procedures for several wavelength and spectral width properties of an optical spectrum associated with a fibre optic communication subsystem, an optical transmitter, or other light sources used in the operation or test of communication subsystems.

The measurement is done for the purpose of system construction and/or maintenance. In the case of communication subsystem signals, the optical transmitter is typically under modulation.

NOTE Different properties may be appropriate to different spectral types, such as continuous spectra characteristic of light-emitting diodes (LEDs), and multilongitudinal-mode (MLM), multitransverse-mode (MTM) and single-longitudinal mode (SLM) spectra, characteristic of laser diodes (LDs).

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 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 62129, *Calibration of optical spectrum analyzers*

3 Terms and definitions

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

3.1 Wavelength

NOTE The following wavelength terms provide quantitative definitions for the describing the central wavelength of a spectrum. In this standard, “central wavelength” is a general category label for these terms.

3.1.1 centre wavelength

λ_0

also called “half-power mid-point”, the mean of the closest spaced half-power wavelengths in an optical spectrum, one above and one below the peak wavelength

3.1.2 half-power wavelength

λ_{3dB}

a wavelength corresponding to a half peak power value of the optical spectrum

3.1.3**peak wavelength** λ_p

the wavelength corresponding to the maximum power value of the optical spectrum

3.1.4**centroidal wavelength** λ_c

the mean or average wavelength of an optical spectrum

3.2 Spectral width**3.2.1****root-mean-square (rms) width** $\Delta\lambda_{\text{rms}}$

the square root of the second moment of the power distribution about the centroidal wavelength

3.2.2***n*-dB-down width** $\Delta\lambda_{n\text{-dB}}$

the positive difference of the closest spaced wavelengths, one above and one below the peak wavelength λ_p , at which the spectral power density is *n* dB down from its peak value

3.2.3**full-width at half-maximum** $\Delta\lambda_{\text{fwhm}}$

a special case of *n*-dB-down width with *n* = 3

3.3 Additional spectral characteristics**3.3.1****side-mode suppression ratio***SMSR*

the ratio of the largest peak of the optical spectrum to the second largest peak, for a nominally SLM spectrum (see 8.8)

4 Apparatus**4.1 Calibrated optical spectrum analyzer**

This special-purpose test equipment uses a dispersive spectrophotometric method to resolve and record the optical spectral distribution. The required wavelength resolution and range depends on the type and variety of signals to be measured. Generally, LED sources have wide spectra with little structure so a range of at least 200 nm and resolution of 1 nm or narrower are recommended. Laser sources have much narrower spectra and may be used in wavelength-domain multiplexing (WDM) applications, where more accurate determination of the wavelength is required. A wavelength resolution of 0,1 nm or narrower is recommended and the actual requirement is determined by the application. In any case, the sensitivity and wavelength range of the spectrum analyzer shall be sufficient to measure all of the spectrum within at least –20 dB from the peak power. For measurement of *SMSR*, a larger dynamic range is typically required.

OSA equipment shall be calibrated in accordance with IEC 62129. The equipment used shall have a valid calibration certificate in accordance with the applicable quality system for the period over which the testing is done.

4.2 Power supplies

As required for the device under test.

4.3 Input signal source or modulator

The input signal source is a signal generator or modulator with the appropriate digital or analogue signal of the system.

4.4 Test cord

Unless otherwise specified, the physical and optical properties of the test cords shall match to the cable plant with which the equipment is intended to operate. The cords shall be 2 m to 5 m long, and shall contain fibres with coatings which remove cladding light. Appropriate connectors shall be used. Single-mode cords shall be deployed with two 90 mm diameter loops or otherwise assure rejection of cladding modes. If the equipment is intended for multimode operation and the intended cable plant is unknown, the fibre size shall be 50/125 μm .

5 Test sample

The test sample shall be a specified fibre optic subsystem, transmitter, or light source. The system inputs and outputs shall be those normally seen by the user. The spectral width parameters are typically used for characterizing MLM and LED transmitters. The width of MTM and SLM lasers without modulation are normally too narrow to measure with the dispersive spectral instruments used with this method. Modulated SLM transmitters have broadened linewidths for high data rates (above about 2,5 Gb/s) and due to chirp that may be measurable by this method.

WARNING – Exercise care to avoid possible eye damage from looking into the end of an energized fibre from any light source. Most importantly, avoid looking into any energized fibre using any type of magnification device.

The requirements in IEC 60825-1 shall be followed.

6 Procedure (Method A)

6.1 General

Method A is designed for the use of typical commercial optical spectrum analyzer instruments that allow quick measurement of spectra with 1 000 wavelength samples or more, and allows for the analysis of such spectra based on all of the samples rather than selecting for example only the samples at the peaks of mode wavelengths. The previous method using a smaller number of discrete wavelength points is included in Clause 7 as Method B, for compatibility with the first edition of this standard. Method A has the advantage of easier simpler automated analysis and better representation of complex but narrow spectra, such as multitransverse-mode vertical cavity surface emitting lasers (VCSELs). Due to its convenience and prevalence in the industry, Method A is considered the reference test method.

6.2 Setup

6.2.1 Use appropriate handling procedures to prevent damage from electrostatic discharge (ESD), which can cause opto-electronic devices to fail.

6.2.2 With the exception of ambient temperature, standard ambient conditions shall be used, unless otherwise specified. The ambient or reference point temperature shall be $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, unless otherwise specified.

6.2.3 Unless otherwise specified, apply a modulated input signal to the optical source. Allow sufficient time (per manufacturer's recommendation or as specified in the detail specification) for the optical source/transmitter to reach a steady-state temperature.

6.2.4 Turn the optical spectrum analyzer on, and allow the recommended warm-up and settling time to achieve rated measurement performance level.

6.2.5 Connect the optical output of the optical source under test to the optical input connector of the optical spectrum analyzer. If the transmitter under test does not include isolation from back-reflections, as often the case at 850 nm, these reflections can cause the spectrum to be unstable and should be reduced with high return-loss connections and possibly external isolation or attenuation at the transmitter output.

6.3 Adjustment of spectrum analyzer controls

6.3.1 Using the resolution control, select an appropriate resolution (see 4.1). Typically less than 1/10 of the spectral width to be measured, or the finest available resolution bandwidth (0,1 nm or narrower) should be used. Set the number of data points in the acquired signal to be sure to adequately sample the detail of the optical spectrum. Typically, this is set to at least 4 times the sample resolution times the total measured width. For example, a 10 nm measurement span, using 0,1 nm resolution, requires a minimum of 400 points in the measurement ($4 \times (\text{total span})/\text{resolution}$).

6.3.2 Using the span control, select an appropriate span of wavelength range on the display section of the spectrum analyzer. Initially select a sufficiently wide span to determine the appropriate position of the peak wavelength; then reduce and adjust the span again to fit all of the source spectrum or at least all that is within at least 20 dB of the peak power. For SLM lasers, the span may need to be changed, typically from 2 nm to 20 nm full scale, to determine the spectral width and SMSR.

6.3.3 Using the gain or reference level control, select a gain or reference level so that the amplitude of the peak output extends over the entire screen vertical scale.

6.3.4 If available, use the spectrum analyzer log-scale for amplitude measurement, to achieve the maximum dynamic range.

6.3.5 For OSAs that are not capable of performing the subsequent calculations in Clause 8 internally, download the measured optical spectra data to a computer for further analysis in a format that contains both the wavelength and amplitude of all points in the measurement.

7 Procedure (Method B)

7.1 Setup

7.1.1 Use appropriate handling procedures to prevent damage from electrostatic discharge (ESD), which can cause opto-electronic devices to fail.

7.1.2 With the exception of ambient temperature, standard ambient conditions shall be used, unless otherwise specified. The ambient or reference point temperature shall be $23\text{ °C} \pm 2\text{ °C}$, unless otherwise specified.

7.1.3 Unless otherwise specified, apply a modulated input signal to the optical source. Allow sufficient time (per manufacturer's recommendation or as specified in the detail specification) for the optical source/transmitter to reach a steady-state temperature.

7.1.4 Turn the optical spectrum analyzer on, and allow the recommended warm-up and settling time to achieve rated measurement performance level.