SLOVENSKI STANDARD
oSIST prEN IEC 62522:2023

01-april-2023

Umerjanje nastavljivih laserskih virov

Calibration of tuneable laser sources

Kalibrierung von abstimmbaren Laserquellen

Étalonnage des sources laser accordables

Ta slovenski standard je istoveten z: **prEN IEC 62522:2023**

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33.180.01	Sistemi z optičnimi vlakni na splošno	Fibre optic systems in general

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SECRETARIAT: United States of America	SECRETARY: Mr Peter Pondillo
OF INTEREST TO THE FOLLOWING COMMITTEES: SC 86C	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	
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TITLE:

Calibration of tuneable laser sources

PROPOSED STABILITY DATE: 2029

NOTE FROM TC/SC OFFICERS:

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94 INTERNATIONAL ELECTROTECHNICAL COMMISSION

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97 # CALIBRATION OF TUNEABLE LASER SOURCES

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99 ## FOREWORD

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133 Standard.

134 This second edition cancels and replaces the first edition published in 2014. This edition
135 constitutes a technical revision.

136 This edition includes the following significant technical changes with respect to the previous
137 edition:

138 a) Addition of IEC 61315 in the Normative references (and reference to);

139 b) Addition of Tables 1 and 2 on uncertainties;

140 c) Clarify the settings of the reference power meter in 6.2.3 and 6.3.2.3.

141 The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

142
143 Full information on the voting for its approval can be found in the report on voting indicated in
144 the above table.

145 The language used for the development of this International Standard is English.

146 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
147 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available
148 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are
149 described in greater detail at www.iec.ch/standardsdev/publications.

150 The committee has decided that the contents of this document will remain unchanged until the
151 stability date indicated on the IEC website under webstore.iec.ch in the data related to the
152 specific document. At this date, the document will be

153 • reconfirmed,
154 • withdrawn,
155 • replaced by a revised edition, or
156 • amended.

157

INTRODUCTION

Wavelength-division multiplexing (WDM) transmission systems have been deployed in optical trunk lines. ITU-T Recommendations in the G.694 series describe the frequency and wavelength grids for WDM applications. For example, the frequency grid of G.694.1 supports a variety of channel spacing ranging from 12,5 GHz to 100 GHz and wider. WDM devices, such as arrayed waveguide grating (AWG), thin film filter or grating based multiplexers (MUX), and demultiplexers (DMUX) with narrow channel spacing are incorporated in the WDM transmission systems. When measuring the characteristics of such devices, wavelength tuneable laser sources are commonly used and are required to have well-calibrated performances; wavelength uncertainty, wavelength tuning repeatability, wavelength stability, and output optical power stability are important parameters.

The tuneable laser source (TLS) is generally equipped with the following features:

a) the output wavelength is continuously tuneable in a wavelength range starting at 1 260 nm or higher and ending at less than 1 675 nm (the output should excite only the fundamental LP01 fibre mode);

b) an output port for optical fibre connectors.

The envelope of the spectrum is a single longitudinal mode with a FWHM of at most 0,1 nm. Any adjacent modes are at least 20 dB lower than the main spectral mode (for example, a distributed feedback laser diode (DFB-LD), external cavity laser, etc.)

CALIBRATION OF TUNEABLE LASER SOURCES

1 Scope

This document provides a stable and reproducible procedure to calibrate the wavelength and power output of a tuneable laser against reference instrumentation such as optical power meters and optical wavelength meters (including optical frequency meters) that have been previously traceably calibrated.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

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

IEC 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*

IEC 61315, *Calibration of fibre-optic power meters*

IEC 62129-2, *Calibration of wavelength/optical frequency measurement instruments – Part 2: Michelson interferometer single wavelength meters*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO/IEC Guide 99:2007, *International vocabulary of metrology – Basic and general concepts and associated terms (VIM)*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
accredited calibration laboratory
calibration laboratory authorized by an appropriate national organization to issue calibration certificates that demonstrates traceability to national standards

3.1.2
adjustment
set of operations carried out on an instrument in order that it provides given indications corresponding to given values of the measurand

[SOURCE: IEC 60050-300:2001, 311-03-16, modified – minor editorial change, omission of the NOTE]

[See also ISO/IEC Guide 99:2007, 3.11, modified – 3 NOTES omitted].

3.1.3
calibration
set of operations that establish, under specified conditions, the relationship between the values of quantities indicated by a measuring instrument and the corresponding values realized by standards

Note 1 to entry: The results of a calibration permit either the assignment of measurand values to the indications or the determination of corrections with respect to the indications.

Note 2 to entry: A calibration may also determine other metrological properties such as the effects of influence quantities.

Note 3 to entry: The result of a calibration may be recorded in a document, called a calibration certificate or a calibration report.

[SOURCE: ISO/IEC Guide 99:2007, 2.39, modified – shortened; the two NOTES replaced by 3 new NOTES].

3.1.4
calibration conditions
conditions of measurement in which the calibration is performed

3.1.5
calibration at reference conditions
calibration which includes the evaluation of the uncertainty at reference conditions of the light source under calibration

3.1.6
calibration at operating conditions
calibration which includes the evaluation of the uncertainty at operating conditions of the light source under calibration

3.1.7
level of confidence
estimated probability that the true value of a measured parameter lies in the given range

3.1.8
coverage factor
k
used to calculate the expanded uncertainty U from the standard uncertainty, u

3.1.9
optical power deviation
D_P
difference between the set power of the light source under calibration, P_{TLS}, and the corresponding reference power P_{meas}, measured by the reference power meter

$$D_P = \frac{P_{TLS} - P_{meas}}{P_{meas}}$$

Note 1 to entry: Power P is expressed in linear units, e.g. W

3.1.10
operating conditions
appropriate set of specified ranges of values with influence quantities usually wider than the reference conditions for which the uncertainties of a measuring instrument are specified

Note 1 to entry: Operating conditions and the uncertainty at operating conditions are usually specified by the manufacturer for the convenience of the user.

3.1.11
reference conditions
conditions used for testing the performance of a measuring instrument or for the intercomparison of the measurement results

Note 1 to entry: Reference conditions generally include reference values or reference ranges for the quantities influencing and affecting the measuring instrument.

3.1.12
side-mode suppression ratio
SMSR
peak power ratio between the main mode spectrum and the largest side mode spectrum in a single-mode laser diode such as a DFB-LD

Note 1 to entry: Side-mode suppression ratio is usually expressed in dB.

3.1.13
wavelength
wavelength (in a vacuum) of a light source

3.1.14
wavelength deviation
D_λ
difference between the target wavelength, set on the light source under calibration, λ_{TLS}, and the measured wavelength, λ_{meas}, in nm or μm

$$D_\lambda = \lambda_{TLS} - \lambda_{meas}$$

3.2 Abbreviations

APC	angled physical contact
DFB-LD	distributed feedback laser diode
FWHM	full-width/half-maximum
OSA	optical spectrum analyser
SMSR	side-mode suppression ration
TLS	tuneable laser source
WDM	wavelength-division multiplexing

4 Preparation for calibration

4.1 Organization

The calibration laboratory should satisfy requirements of ISO/IEC 17025.

There shall be a documented measurement procedure for each type of calibration performed, giving step-by-step operating instructions and equipment to be used.

4.2 Traceability

The requirements of ISO/IEC 17025 should be met.

All standards used in the calibration process shall be calibrated according to a documented program with traceability to national standards laboratories or to accredited calibration laboratories.

It is advisable to maintain more than one standard on each hierarchical level, so that the performance of the standard can be verified by comparisons on the same level. Make sure that any other calibration equipment which have a significant influence on the calibration results are calibrated.

4.3 Preparation

The environmental conditions shall be commensurate with the level of uncertainty that is required for calibration:

a) calibrations shall be carried out in a clean environment;

b) temperature monitoring and control is required;

c) all laser sources shall be safely operated (refer to IEC 60825-1 and IEC 60825-2);

d) the output of the tuneable laser source should be examined with an optical spectrum analyser (OSA) to check for single mode operation.

The recommended temperature is 23 °C (for example, 23 °C ± 2 °C). Give the calibration equipment a minimum of 2 h prior to testing to reach equilibrium within its environment. Allow the tuneable laser source a warm-up period in accordance to the manufacturer's instructions.

4.4 Reference calibration conditions

The reference calibration conditions usually include the following parameters and, if necessary, their tolerance bands: date, temperature, relative humidity, atmospheric pressure, displayed optical power, displayed wavelength, fibre, connector-adapter combination, (spectral) bandwidth and resolution bandwidth (spectral resolution) set. Unless otherwise specified, use a single-mode optical fibre category B1.1 or B1.3 pigtail as prescribed by IEC 60793-2-50, having a length of at least 2 m. It is desirable to perform all the calibration in a situation where back-reflections are negligible. Thus, angled connectors and isolators should be used wherever the situation permits.

Operate the tuneable laser source in accordance with the manufacturer's specifications and operating procedures. Where practical, select a range of calibration conditions and parameters that emulate the actual field operating conditions of the tuneable laser source under calibration. Choose these parameters so as to optimize the tuneable laser source's accuracy, as specified by the manufacturer's operating procedures.

Document the conditions as specified in Clause 7.

NOTE The calibration results only apply to the set of calibration conditions used in the calibration process.

5 Wavelength calibration

5.1 Overview

The factors making up the uncertainty in the wavelength of the light source under calibration consist of