

<b>STN</b>	<b>Kalibrácia zariadení na meranie vlnovej dĺžky/optickej frekvencie</b> <b>Časť 3: Optické merače frekvencie s použitím frekvenčného hrebeňa</b>	<b>STN</b> <b>EN IEC 62129-3</b>  35 9208
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Calibration of wavelength/optical frequency measurement instruments - Part 3: Optical frequency meters internally referenced to a frequency comb

Táto norma obsahuje anglickú verziu európskej normy.  
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 11/19

Obsahuje: EN IEC 62129-3:2019, IEC 62129-3:2019

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**EN IEC 62129-3**

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English Version

Calibration of wavelength/optical frequency measurement  
instruments - Part 3: Optical frequency meters internally  
referenced to a frequency comb  
(IEC 62129-3:2019)

Étalonnage des appareils de mesure de longueur  
d'onde/appareil de mesure de la fréquence optique - Partie  
3: Fréquences optiques faisant référence en interne à  
un peigne de fréquence  
(IEC 62129-3:2019)

Kalibrierung von Messgeräten für die Wellenlänge/optische  
Frequenz - Teil 3: Optisches Frequenzmessgerät mit  
internem Bezug auf einen Frequenzkamm  
(IEC 62129-3:2019)

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**EN IEC 62129-3:2019 (E)****European foreword**

The text of document 86/551/FDIS, future edition 1 of IEC 62129-3, prepared by IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62129-3:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-03-24
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-06-24

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 62129-1	NOTE	Harmonized as EN 62129-1
IEC 62129-2:2011	NOTE	Harmonized as EN 62129-2:2011 (not modified)
ISO/IEC 17025	NOTE	Harmonized as EN ISO/IEC 17025
IEC 61315	NOTE	Harmonized as EN IEC 61315
IEC 60359	NOTE	Harmonized as EN 60359

## Annex ZA (normative)

### Normative references to international publications with their corresponding European publications

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NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: [www.cenelec.eu](http://www.cenelec.eu).

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-2-50	-	Optical fibres - Part 2-50: Product specifications - Sectional specification for class B single-mode fibres	EN IEC 60793-2-50	-
IEC 60825-1	-	Safety of laser products - Part 1: Equipment classification and requirements	EN 60825-1	-
IEC 60825-2	-	Safety of laser products - Part 2: Safety of optical fibre communication systems (OFCS)	EN 60825-2	-
IEC/TR 61931	-	Fibre optic - Terminology	-	-
ISO/IEC Guide 98-3	2008	Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)	-	-



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Edition 1.0 2019-05

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Calibration of wavelength / optical frequency measurement instruments –  
Part 3: Optical frequency meters internally referenced to a frequency comb**

**Étalonnage des appareils de mesure de longueur d'onde / appareil de mesure de  
la fréquence optique –  
Partie 3: Fréquencemètres optiques faisant référence en interne à un peigne de  
fréquence**



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Edition 1.0 2019-05

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Partie 3: Fréquence mètres optiques faisant référence en interne à un peigne de  
fréquence**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**CALIBRATION OF WAVELENGTH /  
OPTICAL FREQUENCY MEASUREMENT INSTRUMENTS –****Part 3: Optical frequency meters internally  
referenced to a frequency comb**

## FOREWORD

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International Standard IEC 62129-3 has been prepared by IEC technical committee 86: Fibre optics.

This first edition cancels and replaces IEC TS 62129-3, published in 2014.

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

- a) text has been added to 5.2.3 about calibration at a second optical frequency;
- b) Annex D is now normative;
- c) Subclause 4.2 has been improved;
- d) measurement method of frequency has been moved to Annex B;
- e) example of optical frequency comb has been moved to Annex C;
- f) frequency-dependence uncertainty has been moved to Annex D.

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

FDIS	Report on voting
86/551/FDIS	86/554/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 62129 series, published under the general title *Calibration of wavelength/optical frequency measurement instruments*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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## INTRODUCTION

It is essential for realizing fibre optic systems that optical channels are defined in the optical frequency domain, not the wavelength domain. One example: the anchor frequency of the ITU-T grid is 193,1 THz, and the channel spacings of the ITU-T grid are 12,5 GHz, 25 GHz, 50 GHz, and 100 GHz [1]<sup>1</sup>.

ITU-T has also discussed  $\lambda$ -interface systems such as "black link" [2]. "Black link" includes WDM MUX/DEMUX and a transmission fibre, and provides  $\lambda$ -interfaces. Especially in DWDM systems (channel spacing < 100 GHz), the uncertainty in specifying optical frequency needs to be minimized.

To implement future telecom systems, it is expected that optical frequency measurements will need to be extremely precise. For example, to achieve the channel spacing of 25 GHz, signal optical frequency uncertainty ( $U_{f_{\text{sig}}}$ ) and required measurement uncertainty ( $U_{f_{\text{meas}}}$ ) need to be 2 GHz to 200 MHz ( $U_{f_{\text{sig}}}/f = 10^{-5}$  to  $10^{-6}$ ) and 200 MHz to 2 MHz ( $U_{f_{\text{meas}}}/f = 10^{-6}$  to  $10^{-8}$ ), respectively. Unfortunately, conventional wavelength meters have measurement uncertainties of  $10^{-6}$  to  $10^{-7}$ . The solution is to use optical frequency measurements since measurement uncertainties can be as small as  $10^{-9}$ , which satisfies the above telecom requirement ( $U_{f_{\text{meas}}}/f = 10^{-6}$  to  $10^{-8}$ ). Therefore, an optical frequency measurement scheme is necessary for the calibration of future telecom systems.

The frequency meter to calibrate with the procedure described in this document is the measurement equipment internally utilizing the optical frequency comb. In Annex A, the mathematical basis for the uncertainty of measurement is described. The measurement procedure of the frequency with the frequency meter utilizing the optical frequency comb is shown in Annex B and the example of the optical frequency comb sources are shown in Annex C. Additionally, the uncertainty depending on the frequency is shown in Annex D.

This document defines all the steps involved in the calibration process of the frequency measuring with the optical frequency meter internally utilizing an optical frequency comb: establishing the calibration conditions, carrying out the calibration, calculating the uncertainty, and reporting the uncertainty, the calibration conditions and the traceability.

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<sup>1</sup> Numbers in square brackets refer to the Bibliography.

## CALIBRATION OF WAVELENGTH / OPTICAL FREQUENCY MEASUREMENT INSTRUMENTS –

### Part 3: Optical frequency meters internally referenced to a frequency comb

#### 1 Scope

This part of IEC 62129 describes the calibration of optical frequency meters using an optical frequency comb as an internal reference. It is applicable to instruments measuring the optical frequency emitted from sources that are typical for the fibre-optic communications industry. It is assumed that the optical radiation will be coupled to the optical frequency meter by a single-mode optical fibre. This document is part of the IEC 62129 series on the calibration of wavelength/optical frequency measurement instruments. Refer to IEC 62129-1 [3] for the calibration of optical spectrum analyzers, and refer to IEC 62129-2 [4] for calibration of Michelson interferometer single wavelength meters.

#### 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 TR 61931, *Fibre optic – Terminology*

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

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