

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Fibre optic active components and devices – Performance standards –  
Part 10: Radio-over-fibre (RoF) transceivers for mobile fronthaul**

**Composants et dispositifs actifs fibroniques – Normes de performances –  
Partie 10: Émetteurs récepteurs radio sur fibre (RoF) pour le fronthaul des  
réseaux mobiles**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2018 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms, containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Catalogue IEC - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

#### Recherche de publications IEC - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 21 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [sales@iec.ch](mailto:sales@iec.ch).

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Fibre optic active components and devices – Performance standards –  
Part 10: Radio-over-fibre (RoF) transceivers for mobile fronthaul**

**Composants et dispositifs actifs fibroniques – Normes de performances –  
Partie 10: Émetteurs récepteurs radio sur fibre (RoF) pour le fronthaul des  
réseaux mobiles**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 33.180.99

ISBN 978-2-8322-6174-3

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references .....	6
3 Terms, definitions, symbols and abbreviated terms.....	7
3.1 Terms and definitions.....	7
3.2 Symbols.....	7
3.3 Abbreviated terms.....	7
4 Product parameters .....	8
4.1 Absolute limiting ratings .....	8
4.2 Operating environment.....	8
4.3 Functional specification.....	8
5 Testing .....	8
5.1 General.....	8
5.2 Characterization testing .....	9
5.3 Performance testing.....	9
6 Environmental specifications .....	9
6.1 General safety .....	9
6.2 Laser safety .....	9
6.3 Electromagnetic compatibility (EMC) requirements.....	9
Annex A (normative) Specifications for RoF transceivers for mobile fronthaul .....	10
A.1 Absolute limiting ratings.....	10
A.2 Operating environment.....	10
A.3 Functional specification.....	10
A.4 Diagrams .....	11
A.5 Labelling .....	13
A.6 Testing .....	13
A.6.1 General .....	13
A.6.2 Characterization testing .....	14
A.6.3 Performance testing.....	14
Annex B (normative) Sample size and grouping requirements.....	17
Bibliography.....	18
Figure A.1 – Block diagram of RoF transceiver .....	12
Figure A.2 – Interface/reference points compliant with ITU-T G-Series Recommendations – Supplement 55 .....	13
Table 1 – Operating environment.....	8
Table A.1 – Absolute limiting ratings .....	10
Table A.2 – Functional specification.....	11
Table A.3 – Characterization tests .....	14
Table A.4 – Performance test plan .....	15
Table B.1 – Sample size, sequencing and grouping requirements.....	17

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES –  
PERFORMANCE STANDARDS –****Part 10: Radio-over-fibre (RoF) transceivers for mobile fronthaul****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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 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 IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62149-10 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

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

CDV	Report on voting
86C/1501/CDV	86C/1531/RVC

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 62149 series, published under the general title *Fibre optic active components and devices – Performance standards*, 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

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

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## iTeh STANDARD PREVIEW (standards.itih.ai)

[IEC 62149-10:2018](#)

<https://standards.itih.ai/catalog/standards/sist/3f3e4a88-a417-46a3-a2e5-06a735f3833c/iec-62149-10-2018>

## INTRODUCTION

This part of IEC 62149 covers the performance specification for radio-over-fibre (RoF) transceivers in fibre optic mobile fronthaul applications. The performance criteria are generally well specified for a number of internationally agreed application areas, such as ITU-T G-series Recommendations – Supplement 55. This document provides optical interface specifications toward the realization of transversely compatible mobile fronthaul systems based on RoF technology. RoF transceivers for mobile fronthaul systems are supplied by different manufacturers, but those manufacturers do not guarantee the operation of RoF transceivers in mobile fronthaul systems. Manufacturers using this document are responsible for meeting the required performance and/or reliability and quality assurance under a recognized scheme.

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[IEC 62149-10:2018](https://standards.iteh.ai/catalog/standards/sist/3f3e4a88-a417-46a3-a2e5-06a735f3833c/iec-62149-10-2018)

<https://standards.iteh.ai/catalog/standards/sist/3f3e4a88-a417-46a3-a2e5-06a735f3833c/iec-62149-10-2018>

# **FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – PERFORMANCE STANDARDS –**

## **Part 10: Radio-over-fibre (RoF) transceivers for mobile fronthaul**

### **1 Scope**

This part of IEC 62149 covers the performance specification for radio-over-fibre (RoF) transceivers used for mobile fronthaul systems. The performance standard contains a definition of the product performance requirements together with a series of tests and measurements with clearly defined conditions, severities, and pass/fail criteria. The tests are intended to be run on a one-off basis to prove any product's ability to satisfy the performance standard's requirements.

A product that has been shown to meet all the requirements of a performance standard can be declared to be in compliance with the performance standard.

### **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 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-38, *Environmental testing – Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60749-25, *Semiconductor devices – Mechanical and climatic test methods – Part 25: Temperature cycling*

IEC 60749-26, *Semiconductor devices – Mechanical and climatic test methods – Part 26: Electrostatic discharge (ESD) sensitivity testing – Human body model (HBM)*

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

IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61300-2-47, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-47: Tests – Thermal shocks*

ITU-T G-Series Recommendations – Supplement 55, *Radio-over-fibre (RoF) technologies and their applications*



### 3 Terms, definitions, symbols and abbreviated terms

#### 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 <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

##### 3.1.1

##### **frequency response**

quantitative measure of the output spectrum of a system or device in response to a stimulus, and used to characterize the dynamics of the system

##### 3.1.2

##### **spurious-free dynamic range**

ratio of the fundamental signal to the strongest spurious signal at the output

##### 3.1.3

##### **RF link gain**

amount of RF gain that the RF signal experiences when going through the mobile fronthaul link

##### 3.1.4

##### **third-order intercept**

measure for weakly nonlinear systems and devices, for example receivers, linear amplifiers and mixers

##### 3.1.5

##### **gain change over temperature**

gain variations for a change in temperature

#### 3.2 Symbols

$T_{STG}$	storage temperature
$T_{OP}$	operating temperature
$V_{CC}$	power supply voltage
$I_{CC}$	power supply current
$P_o$	optical output power
$Z$	input/output impedance
$SFDR$	spurious-free dynamic range
$EIN$	input noise floor
$IIP3$	input third-order intercept
$RSNS$	optical receiver sensitivity
$RMAXP$	maximum optical power for receiver
$OMI$	optical modulation index/channel

#### 3.3 Abbreviated terms

BBU	Baseband unit
CNR	Carrier-to-noise ratio

CWDM	Course wavelength-division multiplexing
E/O	Electrical to optical
ESD	Electrostatic discharge
HBM	Human body model
IMD	Intermodulation distortion
LTE	Long-term evolution
OLT	Optical line termination
ODN	Optical distribution network
ONU	Optical network unit
QAM	Quadrature amplitude modulation
RRH	Remote radio head
SNI	Service node interface
UNI	User network interface
VSWR	Voltage standing wave ratio

## 4 Product parameters

### 4.1 Absolute limiting ratings

Absolute limiting (maximum and/or minimum) ratings imply that no catastrophic damage will occur if the product is subject to these ratings for short periods, provided each limiting parameter is in isolation and all other parameters have values within the normal performance parameters. It should not be assumed that limiting values of more than one parameter can be applied at any one time.

### 4.2 Operating environment

The operating environment of the RoF transceivers is specified in Table 1.

**Table 1 – Operating environment**

Parameter	Symbol	Value		Unit
		Minimum	Maximum	
Operating temperature (case)	$T_{OP}$	–20	+60	°C

### 4.3 Functional specification

Functional specifications are listed in Annex A.

## 5 Testing

### 5.1 General

Initial characterization and qualification shall be undertaken when a build standard has been completed and set. Qualification maintenance is carried out through periodic testing programmes. Test conditions for all tests unless otherwise stated are 25 °C ±2 °C.

## 5.2 Characterization testing

Characterization shall be carried out on at least 20 products taken from at least 3 different manufacturing lots. The characteristics and conditions of RoF transceivers are tested at the operating temperature and the operating current to satisfy the functional specifications defined in Annex A.

## 5.3 Performance testing

Performance testing is undertaken when characterization testing is complete. The performance test plan and recommended performance test failure criteria are specified in Annex A.

# 6 Environmental specifications

## 6.1 General safety

All products complying with this document shall conform to IEC 60950-1.

## 6.2 Laser safety

Fibre optic transmitters and transceivers using the laser diode specified in this document shall be class 1 to 3R lasers verified under any condition of operation. This includes single fault conditions, whether coupled into a fibre or out of an open bore. Fibre optic transmitters and transceivers using the laser diode specified in this document shall be certified to be in conformance with IEC 60825-1.

Laser safety standards and regulations require that the manufacturer of a laser product provide information about the product's laser safety features, labelling, use, maintenance and service. This documentation shall explicitly define requirements and usage restrictions on the host system, necessary to meet these safety certifications.

## 6.3 Electromagnetic compatibility (EMC) requirements

Products defined in this specification shall comply with suitable requirements for electromagnetic compatibility (in terms of both emission and immunity), depending on the particular usage/environment in which they are intended to be installed or integrated. Guidance on the drafting of such EMC requirements is provided in IEC Guide 107.

## Annex A (normative)

### Specifications for RoF transceivers for mobile fronthaul

#### A.1 Absolute limiting ratings

Absolute limiting (maximum and/or minimum) ratings, as shown in Table A.1, imply that no catastrophic damage will occur if the product is subject to these ratings, provided each limiting parameter is in isolation and all other parameters have values within the normal performance parameters. It should not be assumed that the limiting value of more than one parameter can be applied at any one time.

**Table A.1 – Absolute limiting ratings**

Parameter	Symbol	Value		Unit
		Minimum	Maximum	
Storage temperature (case)	$T_{STG}$	–40	+85	°C
Operating temperature (case)	$T_{OP}$	–20	+60	°C
Maximum RF input into Tx (total)			+5	dBm
Maximum optical input into Rx (total)			2	mW

ITeH STANDARD PREVIEW  
(standards.iteh.ai)

#### A.2 Operating environment

The requirements of 4.2 shall be met. [IEC 62149-10:2018  
https://standards.iteh.ai/catalog/standards/sist/3f3e4a88-a417-46a3-a2e5-06a735f3833c/iec-62149-10-2018](https://standards.iteh.ai/catalog/standards/sist/3f3e4a88-a417-46a3-a2e5-06a735f3833c/iec-62149-10-2018)

#### A.3 Functional specification

The specifications in Table A.2 describe the functional requirements to meet ITU-T G-series Recommendations – Supplement 55.

**Table A.2 – Functional specification**

Parameter	Symbol	Value			Unit	Note
		Minimum	Typical	Maximum		
Optical output power	$P_o$			10	dBm	
Transmitter operating wavelength range		1 270		1 610	nm	a
Receiver operating wavelength range		1 270		1 610	nm	b
Flatness of frequency response				±1	dB	c
Input/output impedance	$Z$	48	50	52	Ω	
Input/output VSWR				1,5:1		
Spurious-free dynamic range @ 1 GHz	$SFDR$	116			(dB/Hz) <sup>2/3</sup>	d
Spurious-free dynamic range @ 3 GHz	$SFDR$	112			(dB/Hz) <sup>2/3</sup>	d
Optical modulation index/channel	$OMI$	0,01	0,1	0,3		
RF link gain		0			dB	d
Input noise floor @ 1 GHz	$EIN$			–141	dBm/Hz	d
Input noise floor @ 3 GHz	$EIN$			–137	dBm/Hz	d
Input third-order intercept @ 1 GHz	$IIP3$	33			dBm	d,e
Input third-order intercept @ 3 GHz	$IIP3$	31			dBm	d,e
Gain change over temperature				±1	dB	f
Isolation		45	50	55	dB	g
Optical receiver sensitivity	$RSENS$	–8		–6	dBm	h
Maximum optical input power for receiver	$RMAXP$			0	dBm	
<p>a CWDM wavelength plan.</p> <p>b CWDM wavelength plan.</p> <p>c Using a commercialized directly modulated laser diode, the available frequency range is located between 5 MHz and 3 000 MHz. If other light sources with higher bandwidth are employed, the flatness of frequency response should be redefined.</p> <p>d Measured and specified with optical loss budget of 0 dB, and 1 m of SMF 28 optical fibre.</p> <p>e IMD measurements of two-tone at 0 dBm/tone per carrier at specified frequencies.</p> <p>f –20 °C to 60 °C.</p> <p>g Typical value across the whole band, but measured at 1 GHz.</p> <p>h Typical optical receiver sensitivity to obtain 22 dB of CNR (for detecting 20 MHz LTE signal with 64-QAM modulation).</p>						

## A.4 Diagrams

The diagrams in Figure A.1 and Figure A.2 are representative examples for the block diagram of the RoF transceiver and the interface/reference points compliant with ITU-T G-Series Recommendations – Supplement 55, respectively.

Figure A.1 also shows the internal functional block diagram of the RoF transmitter. The RoF transmitter consists of 7 functional blocks and processes 4 main signals. The data signal is transferred to the electrical interface, converted into an optical signal by the laser diode and laser diode driver, and then transmitted through the optical interface. The power supply provides power to the entire RoF transmitter to perform the defined function. The control signal transfers a command for controlling the laser diode driver and the laser diode from the