IEC 63098-3

Edition 1.0 2022-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Transmitting and receiving equipment for radiocommunication – Radio-over fibre technologies and their performance standard –
Part 3: Radio-over-fibre-based remote radar for foreign object debris (FOD) detection systems**

**Matériaux émetteurs et récepteurs pour les radiocommunications –
Technologies radio sur fibre et leur norme de performance –
Partie 3: Radar distant fondé sur la radio sur fibre pour système de détection des objets intrus (FOD)**

IEC 63098-3:2022-12(en-fr)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
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 corrigendum or an amendment might have been published.

IEC publications search - 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 It also gives information on projects, replaced and withdrawn publications.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
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - 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.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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.

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

Service Clients - 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.

IEC Products & Services Portal - products.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 63098-3

Edition 1.0 2022-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Transmitting and receiving equipment for radiocommunication – Radio-over fibre technologies and their performance standard –
Part 3: Radio-over-fibre-based remote radar for foreign object debris (FOD) detection systems

Matériaux émetteurs et récepteurs pour les radiocommunications –
Technologies radio sur fibre et leur norme de performance –
Partie 3: Radar distant fondé sur la radio sur fibre pour système de détection des objets intrus (FOD)

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.060.20

ISBN 978-2-8322-6087-6

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

TRANSMITTING AND RECEIVING EQUIPMENT FOR RADIOCOMMUNICATION – RADIO-OVER-FIBRE TECHNOLOGIES AND THEIR PERFORMANCE STANDARD –

Part 3: Radio-over-fibre-based remote radar for foreign object debris (FOD) detection systems

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.

IEC 63098-3 has been prepared by IEC technical committee 103: Transmitting and receiving equipment for radiocommunication. It is an International Standard.

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

Draft	Report on voting
103/245/FDIS	103/250/RVD

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

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

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

A list of all parts in the IEC 63098 series, published under the general title *Transmitting and receiving equipment for radiocommunication – Radio-over-fibre technologies and their performance standard*, can be found on the IEC website.

Future documents in this series will carry the new general title as cited above. Titles of existing documents in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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.

INTRODUCTION

A remote radar system generally consists of a central station (CS) and remote radar heads (RRHs) connected by radio over fibre (RoF). Each RRH has a maximum detection range of several hundred metres because millimetre waves theoretically undergo a larger propagation loss compared with conventional aeronautical frequencies below 10 GHz. The RoF system is key to enhancing the radar coverage and connecting the CS with the RRHs located along a runway for its entire coverage.

To ensure the connection between the CS and RRHs, radio frequency (RF) and optical interfaces should be categorized according to their specifications, specifically, their link characteristics.

TRANSMITTING AND RECEIVING EQUIPMENT FOR RADIOCOMMUNICATION – RADIO-OVER-FIBRE TECHNOLOGIES AND THEIR PERFORMANCE STANDARD –

Part 3: Radio-over-fibre-based remote radar for foreign object debris (FOD) detection systems

1 Scope

This part of IEC 63098 provides the specifications of the RoF interface connecting the central station (CS) with the remote radar heads (RRHs) in a remote radar system, along with the necessary information to ensure compatibility between vendors and, hence, choose appropriate systems to cover any type of RoF systems for delivering the signal.

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 62149-10:2018, *Fibre optic active components and devices – Performance standards – Part 10: Radio-over-fibre (RoF) transceivers for mobile fronthaul*

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

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminology 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
system input level
electrical or optical input level to the system

3.1.2
system output level
electrical or optical output level from the system

3.1.3
frequency multiplication factor
order of harmonic RF output that is derived from the optical or electrical system

3.1.4
input frequency range
RF frequency range accepted by the system

3.1.5
output frequency range
RF frequency range emitted by the system

3.1.6
frequency flatness
deviation of the RF output within the output frequency range

3.2 Abbreviated terms

CS	central station
DUT	device under test
FM-CW	frequency-modulated continuous wave
IF	intermediate frequency
LO	local oscillation
RF	radio frequency
RoF Rx	RoF receiver
RoF Tx	RoF transmitter
RRH	remote radar head
SMF	single-mode fibre

4 RoF system in remote radar system

4.1 General

Radars detect objects that transmit radio waves and measure the reflected waves.

A multi-radar system would require a larger coverage than a single-radar system. To satisfy this requirement, a remote radar system whose radar heads are connected by RoF is necessary.

To transfer the transmitting and receiving signals, at least one pair of RoF links can be installed. In order to ensure the connectivity between the CS and RRHs, this document specifies the performance of the RoF system using this purpose.

4.2 Structures

A remote radar system exchanges the signals between the CS and RRHs. Figure 1 illustrates the typical structure of a remote radar system where the CS and an RRH are connected through RoF links. Some types of remote radar systems can be equipped with multiple RRHs to widen their coverage. The basic structure of a remote radar system consists of the following components:

– central station,
– remote radar head,
– transmission RoF Tx,
– transmission RoF Rx,
– reference RoF Tx,
– reference RoF Rx,
– reception RoF Tx,
– reception RoF Rx.

Three types of RoF links are included in the radar architecture and depend on it. The RoF transmission link feeds the signal for the transmission to the radar. The RoF reference link provides the signal for the frequency reference in the radar for down-converting the received signal. The RoF reception link sends the received and down-converted signal to the radar. Each type of RoF link treats the signal in the original RF, harmonic frequency or intermediate frequency (IF) depending on the radar system architecture.

At least one RoF link is installed to connect a remote radar head depending on the radar architecture. Each RoF link has different requirements for the purpose of transmitted signal. Several examples of remote radar systems are introduced in Annex A.

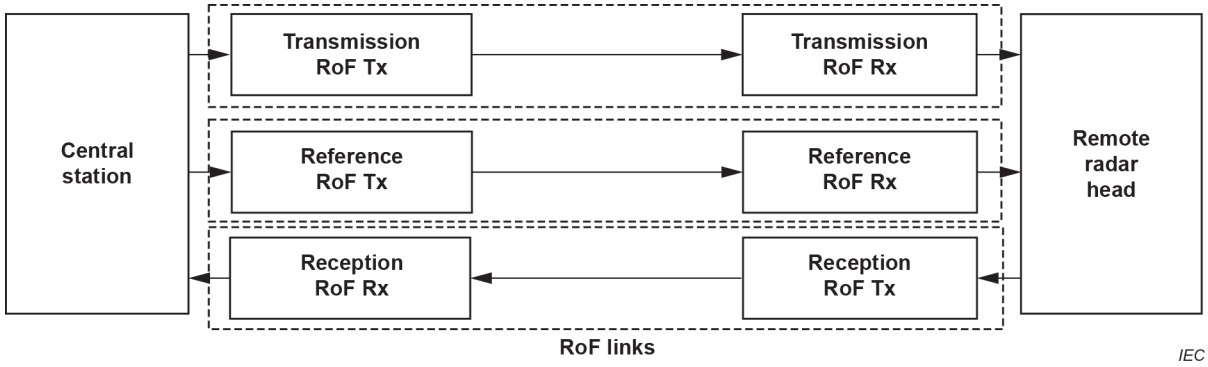

Figure 1 – Structure of a remote radar system

4.3 Operating frequency range

The frequency range of the RoF system is significantly changed between RF and IF. The adequate operating RF range is selected for each RoF link to cover the operation range of the remote radar system.

The RoF transmission and reference links have a higher frequency range than the RoF reception one. To ensure connectivity, the RoF links should be chosen to cover the frequency range of each RoF link for the target purpose.

Moreover, a frequency multiplier can be installed in the RoF transmission and local oscillation (LO) link to obtain a higher frequency. The frequency multiplication is also derived into the optical or electrical section or both; to clarify the whole performance of all the RoF links, this frequency multiplication factor should be considered for the design of the remote radar systems.

4.4 Operating environment

The standard environment of an RoF system for the remote radar system is described in Table 1.

Table 1 – Operating environment

Parameter	Symbol	Value		Unit
		Minimum	Maximum	
Operating temperature (case)	T_{op}	−20	+60	°C

The special conditions of the operating environment can be specified by the customer who operates the remote radar systems under severe weather.

5 Testing

5.1 General

This Clause 5 specifies the testing conditions to adopt for characterizing the RoF links. The other performance test plan shall be followed in accordance with IEC 62149-10:2018, Annex A.

5.2 Temperature

All the test measurements should be performed in a room at three different temperatures, that is, at 0 °C, 25 °C and 60 °C. If the operating temperature range of the measuring instruments is narrower than this range, their specifications should be followed. The measurement temperature should be controlled within ±5 °C to minimize the influence of the temperature drift of the measuring instruments. The DUT temperature can be changed using a controller to verify the temperature dependence of the measured parameters as necessary.

5.3 Warming-up of the measuring equipment

The warming-up time shall be typically 60 min or follow the specifications of the measuring equipment. Moreover, the warming-up time should be taken to be the longest among all of the measuring equipment.

6 Specifications for RoF links of remote radar systems

6.1 General

This Clause 6 specifies the physical requirements of the RoF links that enable the interchangeability of the elements.

6.2 Laser safety

Fibre optic transmitters and transceivers using the laser diode specified in this document shall be Class 1–3R lasers certified under any operating condition, including single-fault conditions, whether coupled into a fibre or with an open bore. They shall also be certified to conform to IEC 60825-1.

6.3 Physical interface of the RoF system

6.3.1 RF interfaces

The RF input and output ports of, respectively, the RoF transmitter and receiver shall be a standard type of RF connectors with an appropriate cut-off frequency including the whole operating RF range of the RoF link. The selected connector type and gender should be specified.

6.3.2 Optical interfaces

The optical output and input ports of, respectively, the RoF transmitter and receiver shall be a standard type of optical connectors to ensure SMF connectivity. The selected connector and physical contact types should be specified.

6.3.3 Power supply interface

The power supply interface for the internal circuits of the RoF links shall be attached to their enclosure. Optical ports for optical power transmission can also be attached if an optical power transmitter is installed.

6.4 Optical specifications

6.4.1 Wavelength

The wavelength of the RoF system shall be specified. The wavelength of the RoF transmitter should be within the acceptable range of the RoF receiver.

6.4.2 Operating optical output power

The operating optical output power shall be specified as the optical output level measured at the RoF transmitter port, and it should not exceed the absolute optical input limit of the RoF receiver.

6.4.3 Operating optical input power

The operating optical input power of the RoF receiver shall be specified as the optical input level without any distortion by saturation of the RF signal transmission. The loss of the optical distribution line should be compensated by inserting an optical amplifier to maintain the optical input dynamic range of the RoF receiver.

6.4.4 Absolute optical input limit

The absolute optical input limit shall be specified to prevent the system from breaking.

6.4.5 Optical return loss

The optical return loss of the optical input of the RoF receiver shall be specified to avoid the mismatch of the optical section.

6.5 RF specifications

6.5.1 Operating RF range

The frequency response shall be measured by providing the operating optical input power. The operating RF range is determined by the frequency response measured within the frequency flatness, and its boundary depends on the low/high cut-off frequency.

6.5.2 Dynamic range

The RF input/output dynamic range shall be measured by providing the RF input. According to the multiplication factor, the RF output level is proportional to the theoretical prediction. The upper boundary of the RF input/output level is measured at the point which is 1 dB lower than the proportional curves.

6.5.3 Absolute RF input power

The absolute RF input limit shall be specified to prevent the system from breaking.

6.5.4 RF return loss

The RF return loss of the RF input of the RoF system shall be specified to avoid the mismatch of the RF section in the operating RF range.

6.5.5 Multiplication factor

The multiplication factor of the RoF transmitter should be specified to consider the RF output range.