IEC

IEC TR 63099-3

Edition 1.0 2022-03

TECHNICAL REPORT

colour inside

Transmitting and receiving equipment for radiocommunication – Radio-over-fibre technologies for electromagnetic-field measurement – Part 3: Antenna near-field pattern measurement using optical techniques in terahertz-wave bands

iTeh STANDARD PREVIEW
(standards.iteh.ai)

IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-eea13744183c/iec-tr-63099-3-2022

IEC TR 63099-3:2022-03(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2022 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.

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 It also gives information on projects, replaced and withdrawn publications.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.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-eea13744183c/iec-tr-63099-3-2022

IEC TR 63099-3

Edition 1.0 2022-03

TECHNICAL REPORT

colour inside

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Transmitting and receiving equipment for radiocommunication – Radio-over-fibre technologies for electromagnetic-field measurement –
Part 3: Antenna near-field pattern measurement using optical techniques in terahertz-wave bands

IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-eea13744183c/iec-tr-63099-3-2022

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33,060,20

ISBN 978-2-8322-1090-4

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-eea13744183c/iec-tr-63099-3-2022

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-eea13744183c/iec-tr-63099-3-2022

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

TRANSMITTING AND RECEIVING EQUIPMENT FOR RADIOCOMMUNICATION – RADIO-OVER-FIBRE TECHNOLOGIES FOR ELECTROMAGNETIC-FIELD MEASUREMENT –

Part 3: Antenna near-field pattern measurement using optical techniques in terahertz-wave bands

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 TR 63099-3 has been prepared by of IEC technical committee 103: Transmitting and receiving equipment for radiocommunication. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
103/207/DTR	103/224/RVDTR

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 Technical Report is English.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-ae18744183c/iec-tr-63099-3-2022

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 63099 series, published under the general title *Transmitting and receiving equipment for radiocommunication – Radio-over-fibre technologies for electromagnetic-field measurement*, 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.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-eea13744183c/iec-tr-63099-3-2022

INTRODUCTION

This document provides technical information on the antenna near-field pattern measurement in terahertz-wave bands above 100 GHz, using optical techniques such as electro-optic (EO) frequency down-conversion. Two techniques are covered: a synchronous system based on a self-heterodyne technique, and an asynchronous system based on a phase noise-cancellation technique. The synchronous system is the vector network analyser (VNA) type system, which provides the RF signal to the antenna under test (AUT) and measures the amplitude and phase distributions of its radiation. In this system, the radio frequency (RF) and local oscillator (LO) signals are optically generated based on the self-heterodyne technique to realize the wide frequency tunability and precise phase measurements simultaneously. On the other hand, the asynchronous system applies to the AUT which integrates the transmitters where the measurement system cannot provide the RF signal to the AUT for the measurements. In this system, an optical frequency comb is used for the LO signal, and the electronics cancel residual frequency and phase noise between the RF and LO signals. Both systems employ the EO sensors for the field mapping which reduces the disturbance to the field compared with the waveguide-type probes employed in the conventional VNA-based measurement system.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-eea13744183c/iec-tr-63099-3-2022

TRANSMITTING AND RECEIVING EQUIPMENT FOR RADIOCOMMUNICATION – RADIO-OVER-FIBRE TECHNOLOGIES FOR ELECTROMAGNETIC-FIELD MEASUREMENT –

Part 3: Antenna near-field pattern measurement using optical techniques in terahertz-wave bands

1 Scope

This part of IEC 63099 provides technical information about the methods for an antenna near-field measurement in the terahertz-wave band. The methods are applied to the frequency bands above 100 GHz, which has potential for use in terahertz wireless communication. The methods consist in measuring the amplitude and phase distributions of the electromagnetic field at the near-field range of on-chip antenna devices which integrate RF and IF components. This document also gives examples of the far-field pattern calculated from the measured near-field pattern.

2 Normative references

iTeh STANDARD PREVIEW
(standards.iteh.ai)

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.

IEEE Std 145TM-2013, *IEEE Standard for Definitions of Terms for Antennas*

IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-eea13744183c/iec-tr-63099-3-2022

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEEE Std 145-2013 and the following 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
EO probe
probe in which an electro-optic (EO) crystal is attached to the optical fibre so that the electric field in the free-space can be measured by moving this probe

3.1.2
self-heterodyne technique
technique which enables the measurement of the phase information coherently using frequency fluctuating free-running lasers

3.1.3
uni-travelling-carrier photodiode
high-speed photodiode which can operate at terahertz-wave bands

3.2 Abbreviated terms

EO electro-optic
EM electromagnetic
GRIN graded index
HR high-reflection
IF intermediate frequency
LD laser diode
LO local oscillator
O/E optical to electrical
OFC optical frequency comb
PMF polarization maintaining fibre
RF radio frequency
SNR signal-to-ratio
TIA transimpedance amplifier
UTC-PD uni-travelling-carrier photodiode
VNA vector network analyser

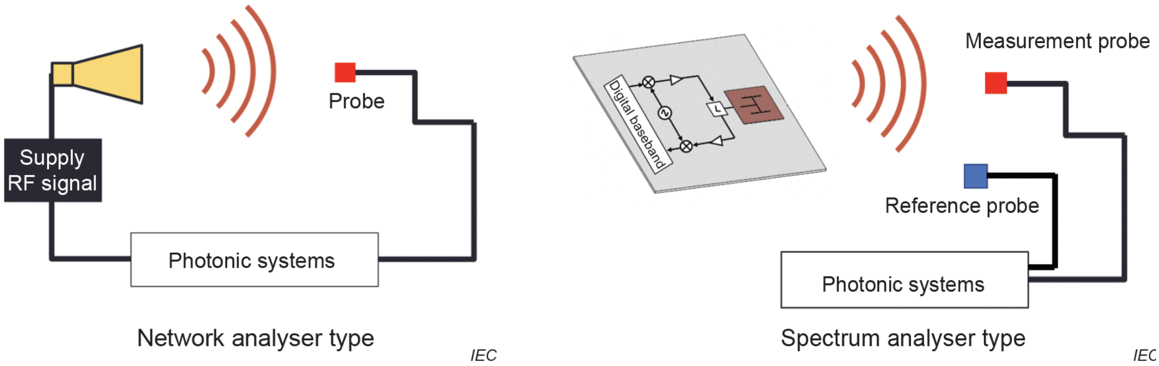
4 Practical examples of antenna near-field measurement using optical techniques in terahertz-wave bands

iTeh STANDARD PREVIEW
(standards.iteh.ai)

4.1 Overview

This document introduces practical examples of antenna near-field measurement using optical techniques in terahertz-wave bands. Two systems are discussed: a synchronous system based on a self-heterodyne technique, and an asynchronous system based on a phase noise-cancelling technique (Figure 1 a) and Figure 1 b)). In both systems, electro-optic (EO) probes are used for the measurement. The terahertz signal will be down-converted to the low-frequency signal in both systems by a non-polarimetric EO frequency down-conversion technique.

IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41a6-a442-eac137d1182e/iec-tr-63099-3-2022



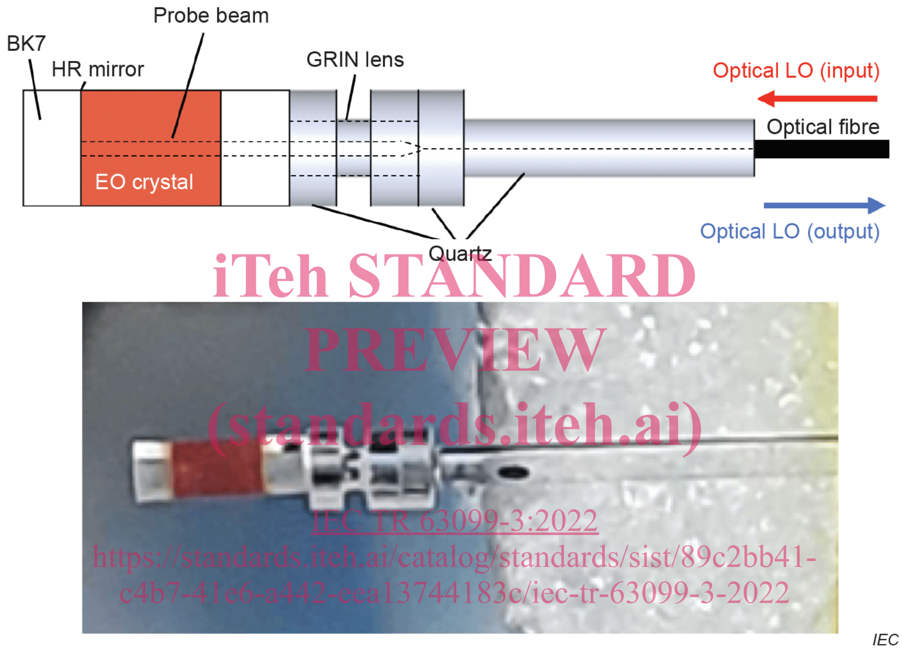
a) Synchronous system **b) Asynchronous system**

Figure 1 – Proposed measurement system

The remainder of this document is organized as follows. Subclause 4.2 describes the principle of the non-polarimetric EO frequency down-conversion technique. In 4.3, the configuration of the synchronous measurement system based on a self-heterodyne technique is described, and examples of the near-field measurement are shown. In 4.4, the configuration of the asynchronous measurement system based on the phase noise-cancelling technique is described, and examples of the near-field measurement taken by this system are given. A comparison between the results obtained by the synchronous and asynchronous systems is drawn in 4.5.

4.2 Non-polarimetric EO frequency down-conversion technique

Figure 2 shows a typical configuration of the EO probe used in both systems. The sensor head consists of an EO crystal, high-reflection (HR) mirror, spacer, and graded-index (GRIN) lens. The sensor head is attached to the polarization-maintaining optical fibre (PMF) to make up the EO probe. The GRIN lens collimate the 1,55 µm probe beam (LO signal) emitted from the PMF. The polarization direction of the probe beam is aligned with the slow-axis of the PMF fibre and the principal dielectric axes of the EO crystal. The diameter of the collimated probe beam in the EO crystal is typically 0,1 mm to 0,2 mm, which limits the ultimate spatial resolution. The THz field (RF signal) to be measured interacts with the optical LO (probe beam) in the EO crystal. The probe beam is reflected by the HR mirror and is focused on the PMF by the GRIN lens.



iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 63099-3:2022
https://standards.iteh.ai/catalog/standards/sist/89c2bb41-c4b7-41e6-a442-eca13744183c/iec-tr-63099-3-2022

Figure 2 – Schematic diagram and photograph of EO probe

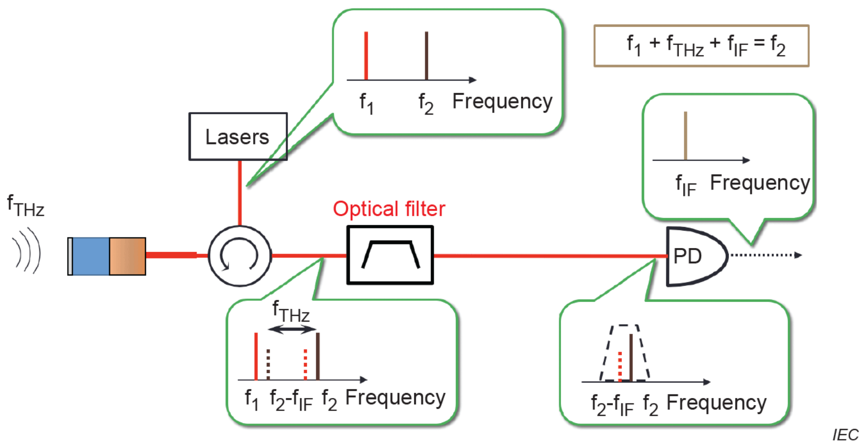


Figure 3 – Principle of the non-polarimetric EO frequency down-conversion technique

Figure 3 illustrates the principle of the non-polarimetric EO frequency down-conversion using frequency spectra. The detection principle is based on the coherent detection of the sideband generated by the electromagnetic (EM) field to be detected. In other words, the EM field is up-converted to the optical frequency region through the phase modulation of the LO beam in the