IEC TR 63099-1

Edition 1.0 2017-08

TECHNICAL REPORT

colour inside

Transmitting equipment for radiocommunication – Radio-over-fibre technologies for electromagnetic-field measurement – Part 1: Radio-over-fibre technologies for antenna measurement

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

Part 1: Radio-over-fibre technologies for antenna measurement

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IEC TR 63099-1, which is a Technical Report, has been prepared by IEC technical committee 103: Transmitting equipment for radiocommunication.

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

Enquiry draft	Report on voting
103/156/DTR	103/162/RVDTR

Full information on the voting for the approval of this Technical Report 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.

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

This document provides information on the current and latest applications for antenna measurement using radio-over-fibre technology. Antenna gain and antenna pattern measurement systems are covered, which are practically in use or will be used soon. It will be beneficial to system developers and system users in the fields of antenna measurement. As a Technical Report, this document contains no requirements and is informative only.

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

Part 1: Radio-over-fibre technologies for antenna measurement

1 Scope

The purpose of this document is to provide information about the current and latest applications for antenna measurement that use radio-over-fibre technologies. Antenna gain and the antenna radiation pattern measurement system are covered, which are practically in use and will be used soon. Basic concepts, system configurations and measurement examples of the systems are included. The theoretical background of antenna measurement is beyond the scope of this document.

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.

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

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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
Mach-Zehnder modulator
optical modulator used for controlling the amplitude of an optical wave

3.1.2
UTC-PD
uni-travelling-carrier photo-diode
high-speed photo-diode that can generate millimeter-wave and THz wave

3.1.3
log-periodic dipole array antenna
LPDA antenna
antenna having wideband characteristics due to logarithmic periodically aligned dipole elements

3.1.4
fibre Bragg grating
FBG
optical filter that is used as inline filter to block certain wavelengths, or as wavelength-specific reflectors

3.1.5
OEWG probe
open-ended waveguide probe
low gain antenna made with rectangular waveguide transmission line for measuring electromagnetic fields with near-field antenna measurement system

3.2 Abbreviated terms

LN-MZM	lithium niobate Mach-Zehnder modulator
UTC-PD	uni-travelling-carrier photo-diode
LPDA	log-periodic dipole array
FBG	fibre Bragg grating
OEWG	open-ended waveguide

4 Practical applications

4.1 List of applications

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The following list shows the application examples of antenna measurement using RoF technology:

a) antenna gain measurement system using a radio-over-fibre transceiver, described in 4.2;
b) millimetre-wave antenna pattern measurement system using a nested type LN-MZM and UTC-PD, described in 4.3;
c) very-near-field antenna pattern measurement system using an LN-MZM photonic sensor, described in 4.4.

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4.2 Antenna gain measurement system using a radio-over-fibre transceiver

4.2.1 Overview

There are a few types of antenna gain measurement methods, such as the substitution method, the two-antenna method, and the three-antenna method. These methods have in common the basic configuration of one vector network analyser and two antennas with coaxial cables. By measuring the S-parameters between the two antennas, the antenna gain is calculated.

The distance between antennas and the height of the antennas from the ground should be enough to measure the antenna gain accurately. The length of the coaxial cables may extend to tens of metres in some cases. Because coaxial cables are made from metal, they reflect and reradiate the electromagnetic waves from the antennas. Therefore, coaxial cables increase the uncertainty of the measurement system and may give inaccurate results. Antenna gain measurement system using a radio-over-fibre transceiver can solve these coaxial cable problems.

4.2.2 Features

The features of an antenna gain measurement system using a radio-over-fibre transceiver are the following:

- the optical fibre does not reflect electromagnetic waves radiated from the antennas;

- surface currents never flow on the optical fibre cable, even if the mismatch between the antenna and the cable is large;
- the system has cost advantages because the replacement cost of the optical fibre is lower than that of the coaxial cable of the same length.

4.2.3 System configuration

Figure 1 shows the system configuration of the antenna gain measurement system using radio-over-fibre transceivers. This system is composed of a transmitting antenna, a receiving antenna, two 6-dB attenuators, two pairs of radio-over-fibre transceivers, two single-mode optical fibres, and a vector network analyser.

Figure 2 shows the system configuration of the antenna gain measurement system using bi-directional type radio-over-fibre transceivers. This system is composed of a transmitting antenna, a receiving antenna, two pairs of bi-directional type radio-over-fibre transceivers, two single-mode optical fibres, and a vector network analyser.

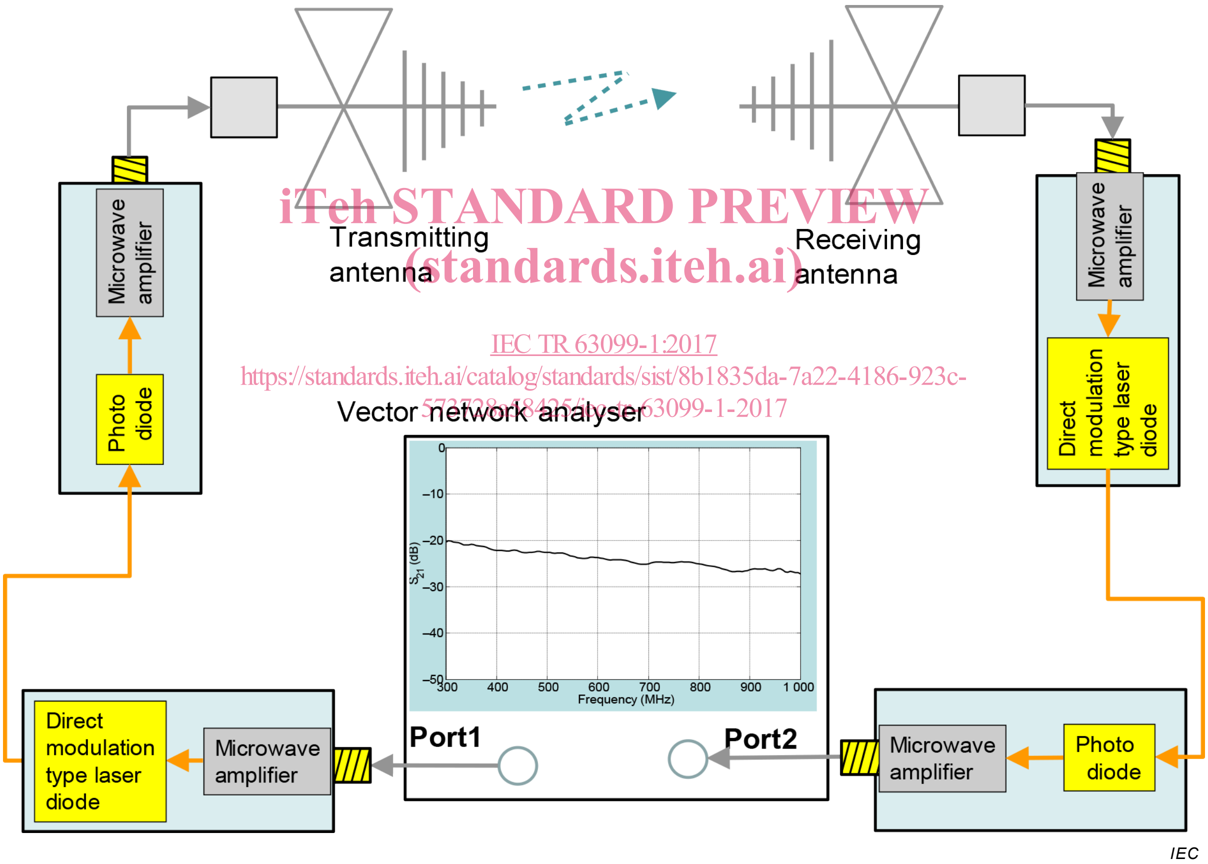

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Figure 1 – System configuration of antenna gain measurement system using a radio-over-fibre transceiver

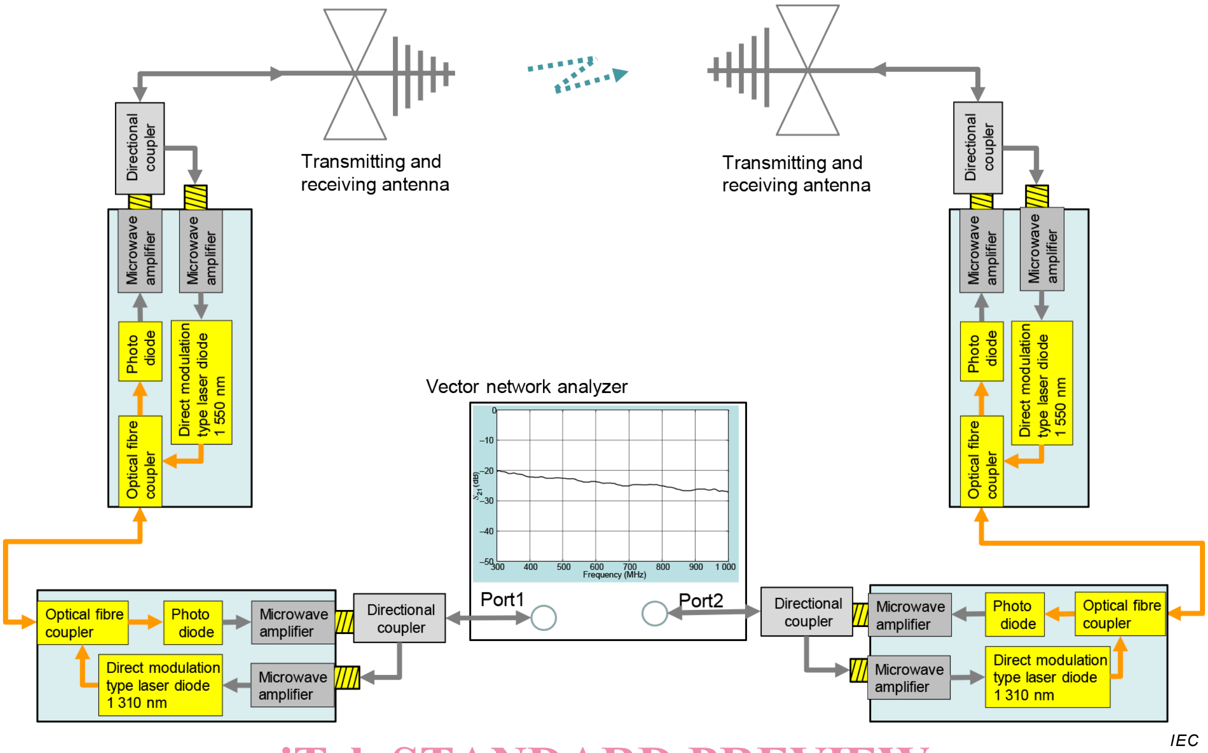

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Figure 2 – System configuration of antenna gain measurement system using bi-directional type radio-over-fibre transceiver specifications

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Table 1 shows the specifications of the radio-over-fibre transceiver used in the antenna gain measurement system. Figure 3 shows the appearance of a pair of radio-over-fibre transceivers.

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