IEC 62803-2

Edition 1.0 2024-08

INTERNATIONAL STANDARD

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**Transmitting and receiving equipment for radiocommunication – Frequency response of optical-to-electric conversion device in high-frequency radio-over-fibre systems –
Part 2: Measurement method of common-mode rejection ratio of optical coherent detection device for radio-over-fibre transmitter**

IEC 62803-2:2024-08(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.060.20 ISBN 978-2-8322-9567-0

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IEC 62803-2 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
103/269/FDIS	103/274/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 62803 series, published under the general title *Transmitting and receiving equipment for radiocommunication – Frequency response of optical-to-electric conversion device in high-frequency radio-over-fibre systems* 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- withdrawn, or
- revised.

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INTRODUCTION

A variety of photonic devices operated in microwave and millimetre-wave bands are useful for an optical fibre transport system as well as wireless communication and broadcasting systems. An optical-to-electric conversion device including an optical receiver plays as an interface, which converts an optical signal into an electrical signal directly.

Microwave and millimetre-wave radio-over-fibre (RoF) systems are comprised mainly of two parts: an RF to photonic converter (E/O) and a photonic to RF converter (O/E). Radio waves are converted into an optical signal at the E/O, and the signal is transferred through the optical fibre, and then the radio waves are regenerated at the O/E.

A variety of photonic devices which carry microwave and millimeter-wave signals at subcarrier frequencies are used for high-frequency RoF systems. In high-frequency RoF systems such as millimetre-wave band radio signal transfer systems, the specifications of conversion efficiency and its frequency response have been important technical parameters, and therefore, the IEC 62803 series has been developed. Nowadays, the coherent optical fibre network system is used widely, namely in core and metro networks with a capacity greater than 100 Gbit/s/ch. Finally, cost and performance have improved. In this coherent optical fibre network system, an optical coherent detection device, which is comprised of an optical 90° hybrid coupler and balanced photodetectors, provides an IQ separation in an optical domain for easy digital signal processing. This detection device can be useful not only for the coherent optical signal transport but also for a millimeter-wave RoF system with high signal quality. To achieve a high signal quality, which means a good suppression of noises, a common-mode rejection ratio is a key parameter of the optical coherent detection. This document has been developed to provide to the industry a measurement method of a coherent optical detection device for evaluating the specifications to be used in high-frequency RoF systems, as well as in an optical coherent transport system. This document defines the measurement method of a common-mode rejection ratio, which has a significant impact on the performance of RoF systems.

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Part 2: Measurement method of common-mode rejection ratio of optical coherent detection device for radio-over-fibre transmitter

1 Scope

This part of IEC 62803 provides the measurement method of the common-mode rejection ratio of optical coherent detection devices in high-speed RoF systems, as well as in high-speed optical signal transmission systems. In addition, the method is also effective for the estimation of the detailed frequency response of the common-mode rejection ratios and O/E conversion efficiency. The method applies for the following:

– frequency range: 1 GHz to 110 GHz;

– wavelength band: 0,8 µm to 2,0 µm.

The use of optical coherent detection devices for high-speed RoF system is shown in Annex A as an example.

2 Normative references

There are no normative references in this document.

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 https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
common-mode rejection ratio
ratio between the signal powers of differential signals and common-mode signals

3.1.2
two-tone lightwave
lightwave that contains two dominant spectral components whose power difference is relatively small and frequency separation is stable

3.1.3
carrier-suppressed
situation when an MZM is biased at its minimum transmission point, the non-modulated carrier lightwave transmitted through and the two arms of the MZM are cancelled with each other at the output coupler

3.2 Abbreviated terms

CMRR	common-mode rejection ratio
DUT	device under test
E/O	electrical-to-optical
IF	intermediate frequency
LD	laser diode
LO	local oscillator
MZM	Mach-Zehnder interferometer-type intensity modulator
SIG	signal

4 Optical coherent detection device

4.1 General

4.1.1 Configuration

A coherent detection device has a 90° optical hybrid coupler with two balanced photodiodes. Two optical input signals as an optical signal and an optical local oscillator are mixed with a phase difference of 90° in the coupler, and then, interference of two signals is input into a balanced photodiode to generate an in-phase and a quadrature phase component of the signal.

4.1.2 Component parts

The optical coherent detection device consists of basic parts as follows:

– 90° optical hybrid coupler;
– balanced photodiode;
– input fibre pigtails (where appropriate);
– input receptacles (where appropriate);
– output RF ports (where appropriate);
– photodiode bias electrode (where appropriate);
– transimpedance amplifier (where appropriate);
– impedance matching resistor (where appropriate).

4.1.3 Structure

The structure is as follows (see Figure 1):

– optical input: fibre pigtail or receptacle;
– output RF port: coaxial connector, microstrip line, coplanar waveguide, etc.;
– options: bias electrode, transimpedance amplifier, impedance-matching resistor.

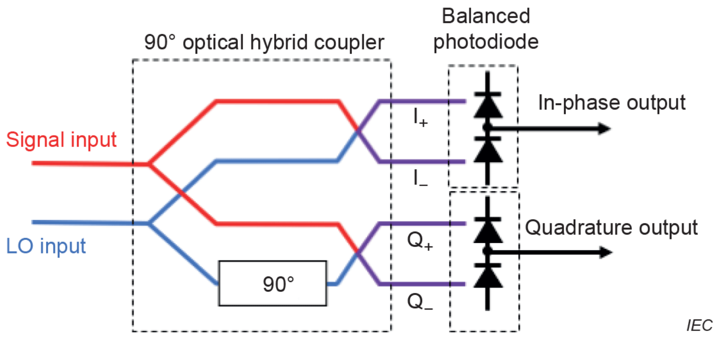

Figure 1 – Optical coherent detection device

4.2 Optical coherent detection device

4.2.1 General

This method is based on an optical phase delay to tune the phase difference of 90° in the 90° optical hybrid section and is based on a heterodyne detection in a balanced detection manner in the balanced photodiode section. The materials that should be used for the 90° optical hybrid and balanced photodiode are specified in 4.2.2 and 4.2.3.

4.2.2 Material of 90° optical hybrid

The main materials should be free-space optical circuits or photonic integrated circuits made with SiO_2, Si, SiN, GaAs, InP and InGaAs.

4.2.3 Material of balanced photodiode

The main materials of the photodiodes should be Si, GaAs, and InGaAs.

5 Sampling for quality control

5.1 Sampling

A statistically significant sampling plan shall be agreed upon between the user and supplier. Sampled devices shall be randomly selected and representatives of the production population shall satisfy the quality assurance criteria using the proposed test methods.

5.2 Sampling frequency

The appropriate statistical methods shall be applied to determine adequate sample size and acceptance criteria for the considered lot size. In the absence of more detailed statistical analysis, the following sampling plan can be employed:

Common-mode rejection ratio: two units at least per manufacturing lot.

6 Measurement method of common-mode rejection ratio

6.1 Circuit diagram

See Figure 2.