

This is a preview - click here to buy the full publication



IEC 62802

Edition 1.0 2017-07

INTERNATIONAL STANDARD



Measurement methods of a half-wavelength voltage and a chirp parameter for Mach-Zehnder optical modulators in high-frequency radio on fibre (RoF) systems

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.060.20; 33.180.99

ISBN 978-2-8322-4609-2

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

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	8
2 Normative references	8
3 Terms, definitions and abbreviated terms	8
3.1 Terms and definitions.....	8
3.2 Abbreviated terms.....	10
4 Electro-optic material-based Mach-Zehnder optical modulators	10
4.1 Mach-Zehnder optical modulators	10
4.1.1 Component parts	10
4.1.2 Structure	10
4.2 Requirements for MZMs	11
4.2.1 General	11
4.2.2 Substrate material	11
4.2.3 Optical waveguide design	11
5 Sampling for quality control	11
5.1 Sampling.....	11
5.2 Sampling frequency	11
6 Measurement method of a half wavelength voltage.....	11
6.1 Circuit diagram	11
6.2 Measurement conditions	12
6.2.1 Temperature and environment.....	12
6.2.2 Warming-up of measurement equipment.....	12
6.3 Principle of measurement method	13
6.3.1 General	13
6.3.2 Mathematical expressions of basic measurement principle	13
6.3.3 Principle of half-wavelength voltage and chirp parameter with fixed DC-bias condition (method A).....	14
6.3.4 Principle of half-wavelength voltage and chirp parameter using DC-bias sweep (method B).....	14
6.3.5 Principle of half-wavelength voltage and chirp parameter using minimum transmission bias and maximum transmission bias (method C).....	15
6.4 Measurement procedure	15
6.4.1 Method A.....	15
6.4.2 Method B.....	16
6.4.3 Method C.....	16
Annex A (informative) Measurement methods for parallel integrated Mach-Zehnder modulators	18
A.1 General.....	18
A.2 Examples.....	18
A.2.1 Quad parallel Mach-Zehnder modulators	18
A.2.2 Dual parallel Mach-Zehnder modulators with four RF electrodes.....	20
Bibliography.....	22
Figure 1 – Transfer curve of a Mach-Zehnder optical modulator.....	9
Figure 2 – Optical phase retardations	10

Figure 3 – Circuit diagram.....	12
Figure A.1 – Optical sideband generation from a sub-MZM element in a parallel MZM.....	19
Figure A.2 – Halfwave voltages of sub-MZMs of a quad parallel MZM.....	19
Figure A.3 – Chirp parameters of sub-MZMs of a quad parallel MZM	20
Figure A.4 – Structure of dual parallel Mach-Zehnder modulators with four RF electrodes	20

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MEASUREMENT METHODS OF A HALF-WAVELENGTH VOLTAGE
AND A CHIRP PARAMETER FOR MACH-ZEHNDER OPTICAL MODULATORS
IN HIGH-FREQUENCY RADIO ON FIBRE (ROF) 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.

International Standard IEC 62802 has been prepared by IEC technical committee 103: Transmitting equipment for radiocommunication.

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

CDV	Report on voting
103/131/CDV	103/161/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.

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.

A bilingual version of this publication may be issued at a later date.

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.

INTRODUCTION

A variety of microwave/millimeter-wave-phonic devices are useful for wireless communication and broadcasting systems. An optical modulator is an interface which converts an electronic signal to an optical signal. In the field of optical fibre communication systems, the IEC 62007 series was published in 1999.

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

A variety of photonic devices that carry microwave and millimeter-wave signals as subcarrier frequencies are used for high-frequency RoF systems. In particular, the Mach-Zehnder optical modulator (MZM) plays an important role to convert electronic (high-frequency above millimeter-wave) signal to optical signal. In high-frequency RoF systems, specifications of drive voltages, chirp characteristics, inter-modulation distortion of the modulators have been the important technical parameters. This document is prepared to provide the measurement method of MZMs to the industry for evaluating electro-optic material of the modulators to be used in high-frequency RoF systems. This document defines the measurement methods of a half-wavelength voltage and a chirp parameter, which have a significant impact on the performance of RoF systems. Additionally, these methods are also used for the estimation of the intermodulation distortions and transmission performances.

The half-wavelength voltage and the chirp parameter can be measured at the same time using the methods defined in this document. The nonlinear distortion characteristics are also important for the performance of the systems. The intermodulation distortion of the MZM is calculated from the driving voltage and the half-wavelength voltage. The detailed explanations and calculation method of intermodulation distortions from the normalized optical modulation index (NOMI) are described in IEC PAS 62593:2008[1]¹, Annex B.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning:

- a) a method for characterization of optical modulator, and method for controlling high frequency oscillator using the same (JP 3538619B),
- b) a method and apparatus for measurement of characteristic of optical modulator (JP 3866082B),
- c) a method for evaluating characteristic of optical modulator having Mach-Zehnder interferometer (WO 2011-027409),
- d) a method of measuring half-wave voltage of optical modulator (JP 2009-229926A).

Details pertaining to the patent holders and the locations where the patents are referred to in the document are given in Table 1.

¹ Numbers in square brackets refer to the Bibliography.

Table 1 – Patents present in this document

Related clause	Patent holder	Patent number
Clause 6 Annex A (informative)	National Institute of Information and Communications Technology	JP 3538619
6.4.3	National Institute of Information and Communications Technology Sumitomo Osaka Cement Co., Ltd.	JP 3866082
A.2.1	National Institute of Information and Communications Technology Sumitomo Osaka Cement Co., Ltd.	(WO 2011-027409) EP 2477021A US 8867042 CN 102575971 JP 5622154
A.2.2	Sumitomo Osaka Cement Co., Ltd.	(JP2009-229926A) JP 4991610

IEC takes no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured the IEC that he/she is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holders of these patent rights are registered with IEC. Information may be obtained from:

National Institute of Information and Communications Technology
4-2-1 Nukui-Kitamachi, Koganei, Tokyo 184-8795, Japan

Sumitomo Osaka Cement Co., Ltd.
6-28 Rokubancho, Chiyoda-Ku, Tokyo 102-8465, Japan.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

ISO (www.iso.org/patents) and IEC (<http://patents.iec.ch>) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the databases for the most up-to-date information concerning patents.

MEASUREMENT METHODS OF A HALF-WAVELENGTH VOLTAGE AND A CHIRP PARAMETER FOR MACH-ZEHNDER OPTICAL MODULATORS IN HIGH-FREQUENCY RADIO ON FIBRE (ROF) SYSTEMS

1 Scope

This document specifies measurement methods of a half-wavelength voltage and a chirp parameter applicable to MZMs in microwave and millimeter-wave RoF systems. In addition, these methods are also effective for the estimation of the intermodulation distortions and transmission performances. The methods apply for the following:

- frequency range: 5 GHz to 110 GHz;
- wavelength band: 0,8 μm to 2,0 μm ;
- electro-optic material based MZMs and their modules.

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 62007-1, *Semiconductor optoelectronic devices for fibre optic system applications – Part 1: Specification template for essential ratings and characteristics*

IEC 62007-2, *Semiconductor optoelectronic devices for fibre optic system applications – Part 2: Measurement methods*