IEC 62801

Edition 1.0 2020-09

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

colour inside

## Measurement method of half-wavelength voltage for Mach-Zehnder optical modulator in wireless communication and broadcasting systems

## Méthode de mesure de la tension à une demi-longueur d'onde relative aux modulateurs optiques Mach-Zehnder dans les systèmes de communication et transmission radiofréquence



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

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch


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# INTRODUCTION

A variety of microwave-photonic devices may be used in 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 first editions of the IEC 62007 series "Semiconductor optoelectronic devices for fibre optic system applications" were published in 1997. In the field of wireless systems, specifications of intermodulation and composite distortion of modulators have been the important issue and have been typically negotiated between users and suppliers. During the International Meeting on Microwave Photonics, a proposal was announced to address standardizations for key devices for radio-over-fibre (RoF) systems.

An RoF system is comprised mainly of two parts; one is the RF to photonic converter (E/O), and the other is the photonic to RF converter (O/E). Radio waves are converted into an optical signal at E/O, and the signal is transferred through the optical fibre, and then the radio waves are regenerated at O/E. The nonlinear distortion characteristics of both E/O and O/E are important for the performance of the system. Semiconductor photodiodes are commonly used for O/E. Several types of optical modulator are used for E/O, such as Mach-Zehnder modulators (MZM), electro-absorption modulators and directly modulated laser diodes (LDs).

This document has been prepared to provide industry standard measurement methods for evaluating electro-optic material based Mach-Zehnder optical modulators to be used in wireless communication and broadcasting systems. 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 details of calculations of the second-order intermodulation distortion (IM2) and the third-order intermodulation distortion (IM3) are described in Annex B. General characteristics of Mach-Zehnder optical modulators in wireless communication and broadcasting systems are described in Annex C. Notes on measurement of the half-wavelength voltage are described in Annex D.

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# MEASUREMENT METHOD OF HALF-WAVELENGTH VOLTAGE FOR MACH-ZEHNDER OPTICAL MODULATOR IN WIRELESS COMMUNICATION AND BROADCASTING SYSTEMS

## 1 Scope

This document specifies a measurement method of half-wavelength voltage applicable to Mach-Zehnder optical modulators in wireless communication and broadcasting systems. In addition, this method is also effective for the estimation of the intermodulation distortion of Mach-Zehnder optical modulators. The method applies for the following:

– frequency range: 10 MHz to 30 GHz;

– wavelength band: 0,8 μm to 2,0 μm;

– electro-optic material based Mach-Zehnder optical modulators 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: Essential ratings and characteristics*

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

## 3 Terms, definitions, symbols and abbreviated terms

### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62007-1 and IEC 62007-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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**3.1.1**
**half-wavelength voltage**

$V_\pi$

voltage required for a Pockels effect material based Mach-Zehnder optical modulator to induce a phase shift of one-half a wavelength between the lightwaves of two arms of the Mach-Zehnder interferometer

Note 1 to entry: It corresponds to an ON/OFF voltage of the Mach-Zehnder optical modulator as shown in Figure 1