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INTERNATIONAL STANDARD

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

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

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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

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INTRODUCTION

A variety of microwave/millimeter-wave-photonic 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 5376619B),

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.	(JP2009-22992[illegible]A) JP 4991[illegible]0

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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*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62007-1:2015 and IEC 62007-2:2009 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
half-wavelength voltage
V_π
voltage required for a Pockels effect material based Mach-Zehnder optical modulator to induce a phase shift of half a wavelength between the lightwaves of two arms of the Mach-Zehnder interferometer

SEE: Figure 1.

Note 1 to entry: It corresponds to an ON/OFF voltage of the Mach-Zehnder optical modulator.

Note 2 to entry: IEC PAS 62593 defines a measurement method for a half-wavelength voltage suitable for lower frequency applications, especially less than 5 GHz.