IEC 61280-2-13

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic communication subsystem test procedures –
Part 2-13: Digital systems – Measurement of error vector magnitude

Procédures d'essai des sous-systèmes de télécommunication fibroniques –
Partie 2-13: Systèmes numériques – Mesure de l'amplitude du vecteur d'erreur

IEC 61280-2-13:2024 (en-fr)

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FIBRE OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 2-13: Digital systems – Measurement of error vector magnitude

FOREWORD

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IEC 61280-2-13 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics. It is an International Standard.

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

Draft	Report on voting
86C/1900/CDV	86C/1924/RVC

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 of the IEC 61280 series, published under the general title *Fibre optic communication subsystem test procedures*, can be found on the IEC website.

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- withdrawn, or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.

INTRODUCTION

The error vector magnitude (EVM) is a single, real-valued parameter that characterizes the signal quality of n-state amplitude phase shift keyed (n-APSK) signals, which are also known as vector modulated signals. Similar to the Q-factor used for intensity-modulated directly-detected optical signals, it measures the average deviations of the transmitted signal states from their ideal values. These deviations can be caused by noise and by linear and nonlinear waveform distortions. The EVM is therefore a useful quantity to characterize the quality of transmitted source signals at the input of a transmission system or the quality of received signals at the output of a transmission system [1][1].

Despite the fact that the EVM is often reported by commercial optical modulation analysers, there are only a few standards that define a procedure for calculating the EVM of optical signals.

ITU-T Recommendation G.698.2 [2], for example, specifies a maximal EVM value for polarization-multiplexed 100 Gbit/s QPSK signals generated by an optical transmitter at the input of a DWDM transmission system. These recommendations provide detailed instructions for numerical signal processing steps that are to be performed on the received signal before the EVM is calculated. The steps include removal of undesired frequency and phase offsets, spectral filtering, DC offset removal, and even the addition of artificial noise to the signal.

Similarly, OIF Implementation Agreement OIF-400ZR-01.0 [3] describes a set of signal processing steps for determining the EVM in polarization-multiplexed 400 Gbit/s 16-QAM signals, which include the addition of artificial noise, but does not specify a maximal EVM value for the transmitted signals at the input of the transmission system.

The detailed signal processing steps defined in ITU-T G.698.2 and in OIF-400ZR-01.0 are specific to the particular modulation formats and to the applications considered in these documents. They are not applicable to arbitrary n-APSK signals or to other applications.

This document specifies a general procedure for calculating the EVM of optical n-APSK signals from a set of transmitted and properly received symbols. It does not specify any signal processing steps necessary to extract the symbols from the raw received signals or optional processing steps impacting the signal quality. This document rather defines the normalization of the reference states used in the EVM calculations as well as a procedure for proper scaling of the measured signal states. It is intended to serve as a reference for instrument vendors, transmission equipment manufacturers, and users of such instruments and transmission equipment.

The procedures described in this document apply to single-polarized optical signals as well as to conventional polarization-multiplexed signals with independently modulated polarization tributaries, which are often referred to as three-dimensionally (3-D) coded signals. In general, it is not advisable to apply these procedures without modifications to four-dimensionally (4-D) coded signals, in which optical amplitude, phase and polarization state are simultaneously modulated to encode the information data [4]. At the time of writing, procedures for calculating the EVM of 4-D coded signals were still under study.

1 Numbers in brackets refer to the Bibliography.

FIBRE OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 2-13: Digital systems – Measurement of error vector magnitude

1 Scope

This part of the IEC 61280-2 series defines a procedure for calculating the root-mean-square error vector magnitude of optical n-APSK signals from a set of measured symbols. It specifically defines the normalization of the reference states and a procedure for optimal scaling of the measured symbol states.

The procedure described in this document applies to single-polarized optical signals as well as to conventional polarization-multiplexed signals with independently modulated polarization tributaries. In general, it is not advisable to apply these procedures without modification to signals, in which optical amplitude, phase, and polarization state are simultaneously modulated to encode the information data.

This document does not specify any signal processing steps for extracting the symbols from the received optical signals, because these steps depend on the optical receiver and can vary with the type of the transmitted n-APSK signal. These and optional additional signal processing steps are defined in application-specific documents.

2 Normative references

There are no normative references in this document.

3 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
digital modulation
modulation of an optical sinusoidal carrier by a digital signal

Note 1 to entry: Digital modulation is generally an amplitude shift keying, a frequency shift keying, a phase shift keying or their combination.

[SOURCE: IEC 60050-713:1998, 713-07-12, modified – addition of "optical".]

3.2
binary (digital) signal
digital signal in which each signal element has one of two permitted discrete values

[SOURCE: IEC 60050-704:1993, 704-16-03]