

<b>STN</b>	<b>Skúšobné postupy pre optické vláknové komunikačné podsystemy Časť 2-13: Digitálne systémy Meranie veľkosti chybového vektora</b>	<b>STN EN IEC 61280-2-13</b>  35 9270
------------	---	---

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

Táto norma obsahuje anglickú verziu európskej normy.  
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 10/24

Obsahuje: EN IEC 61280-2-13:2024, IEC 61280-2-13:2024

**139434**

---

Úrad pre normalizáciu, metrológiu a skúšobníctvo Slovenskej republiky, 2024  
Slovenská technická norma a technická normalizačná informácia je chránená zákonom č. 60/2018 Z. z. o technickej normalizácii  
v znení neskorších predpisov.

EUROPEAN STANDARD

**EN IEC 61280-2-13**

NORME EUROPÉENNE

EUROPÄISCHE NORM

September 2024

ICS 33.180.10

English Version

**Fibre optic communication subsystem test procedures - Part 2-13: Digital systems - Measurement of error vector magnitude (IEC 61280-2-13:2024)**

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)

Prüfverfahren für Lichtwellenleiter-Kommunikationssysteme - Teil 2-13: Digitale Systeme - Größenmessungen von Fehlervektoren (IEC 61280-2-13:2024)

This European Standard was approved by CENELEC on 2024-08-21. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

**EN IEC 61280-2-13:2024 (E)****European foreword**

The text of document 86C/1900/CDV, future edition 1 of IEC 61280-2-13, prepared by SC 86C "Fibre optic systems and active devices" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61280-2-13:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2025-05-21 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2027-08-21 document have to be withdrawn

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

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

**Endorsement notice**

The text of the International Standard IEC 61280-2-13:2024 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61280-2-8 NOTE Approved as EN IEC 61280-2-8



IEC 61280-2-13

Edition 1.0 2024-07

# 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**



**THIS PUBLICATION IS COPYRIGHT PROTECTED****Copyright © 2024 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

**About the IEC**

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

**About IEC publications**

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

**IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)**

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

**IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

**IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

**IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)**

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

**Electropedia - [www.electropedia.org](http://www.electropedia.org)**

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

**A propos de l'IEC**

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

**A propos des publications IEC**

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

**Recherche de publications IEC -****[webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)**

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

**IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

**Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [sales@iec.ch](mailto:sales@iec.ch).

**IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)**

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

**Electropedia - [www.electropedia.org](http://www.electropedia.org)**

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



IEC 61280-2-13

Edition 1.0 2024-07

# 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**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 33.180.10

ISBN 978-2-8322-9403-1

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references .....	6
3 Terms and definitions .....	6
4 Background and terminology .....	8
4.1 General.....	8
4.2 Vector modulated signals .....	9
4.3 Constellation diagram .....	10
4.4 Normalization of the reference constellation.....	11
4.5 Scaling of the measured vectors .....	12
4.6 Error vector magnitude of individual symbols .....	12
4.7 Root-mean-square EVM.....	13
4.8 Calculation of the scale factor.....	14
4.9 Iterative calculation of the scale factor .....	15
4.10 EVM for polarization multiplexed signals .....	16
5 EVM measurement procedure.....	16
5.1 Apparatus .....	16
5.2 Preparation of data samples .....	17
5.3 Calculation of the RMS EVM .....	17
5.3.1 General .....	17
5.3.2 Procedure with known reference states .....	18
5.3.3 Procedure with unknown reference states.....	18
5.4 Reporting.....	19
Annex A (informative) Relationship between RMS EVM and Q-factor.....	20
Bibliography.....	25
Figure 1 – Constellation diagrams of measured QPSK and 16-QAM symbols.....	11
Figure 2 – Error vector magnitude $D(k)$ of a single QPSK symbol.....	13
Figure A.1 – In-phase and quadrature histograms of a QPSK signal .....	22
Figure A.2 – In-phase and quadrature histograms of a 16-QAM signal .....	23
Table A.1 – Q-factor parameters for a QPSK signal .....	22
Table A.2 – Q-factor parameters for a 16-QAM signal .....	24

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIBRE OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –****Part 2-13: Digital systems – Measurement of error vector magnitude**

## 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://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](http://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]<sup>1</sup>.

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.

---

<sup>1</sup> 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.

**koniec náhľadu – text ďalej pokračuje v platenej verzii STN**