

**Fibre optic communication subsystem test procedures -  
Part 2-12: Digital systems - Measuring eye diagrams and  
Q-factor using a software triggering technique for  
transmission signal quality assessment**

## EESTI STANDARDI EESSÕNA

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English Version

Fibre optic communication subsystem test procedures - Part 2-12: Digital systems - Measuring eye diagrams and Q-factor using a software triggering technique for transmission signal quality assessment  
(IEC 61280-2-12:2014)

Procédures d'essai des sous-systèmes de télécommunication à fibres optiques - Partie 2-12: Systèmes numériques - Mesure des diagrammes de l'oeil et du facteur de qualité à l'aide d'une technique par déclenchement logiciel pour l'évaluation de la qualité de la transmission de signaux  
(CEI 61280-2-12:2014)

Prüfverfahren für Lichtwellenleiter-Kommunikationssysteme - Teil 2-12: Digitale Systeme - Messungen von Augendiagrammen und des Q-Faktors mit einem Software-Triggerverfahren für die Qualitätsbewertung von Übertragungssignalen  
(IEC 61280-2-12:2014)

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## Foreword

The text of document 86C/1150/CDV, future edition 1 of IEC 61280-2-12, 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 61280-2-12:2014.

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**Annex ZA**  
(normative)

**Normative references to international publications  
with their corresponding European publications**

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: [www.cenelec.eu](http://www.cenelec.eu)

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61280-2-2	-	Fibre optic communication subsystem test procedures - Part 2-2: Digital systems - Optical eye pattern, waveform and extinction ratio measurement	EN 61280-2-2	-
ITU-T Recommendation G.959.1	2012	Optical transport network physical layer interfaces	-	-

## CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references .....	6
3 Abbreviated terms .....	6
4 Software synchronization method and <i>Q</i> -factor .....	6
4.1 Example of asynchronous waveform and eye diagram reconstructed by software triggering technique .....	6
4.2 <i>Q</i> -factor formula.....	7
5 Apparatus.....	9
5.1 General.....	9
5.2 Optical bandpass filter .....	10
5.3 High frequency receiver .....	10
5.4 Clock oscillator .....	11
5.5 Electric pulse generator .....	11
5.6 Sampling module .....	11
5.7 Electric signal processing circuit .....	12
5.8 Optical clock pulse generator.....	12
5.9 Optical sampling module.....	12
5.10 Optical signal processing circuit.....	12
5.11 Synchronization bandwidth .....	12
5.12 Monitoring system parameters .....	13
6 Procedure.....	13
6.1 General.....	13
6.2 Measuring eye diagrams and <i>Q</i> calculations .....	13
Annex A (informative) Example of the signal processing required to reconstruct the synchronous eye diagram .....	15
Annex B (informative) Adequate sampling time width (gate width).....	17
Bibliography.....	18
Figure 1 – Asynchronous waveform and synchronous eye diagram of 40 Gbps RZ-signal reconstructed by software triggering technique .....	7
Figure 2 – RZ synchronous eye diagram reconstructed by software triggering technique, time window, and histogram.....	8
Figure 3 – Example of relationship between <i>Q</i> -factor and window width.....	8
Figure 4 – Test system 1 for measuring eye diagrams and <i>Q</i> -factor using the software triggering technique .....	9
Figure 5 – Test system 2 for measuring eye diagrams and <i>Q</i> -factor using the software triggering technique .....	10
Figure A.1 – Block diagram of the software triggering module .....	15
Figure A.2 – Example of interpolating a discrete spectrum and determining beat frequency.....	16
Figure B.1 – The typical calculated relationship between the adequate sampling time width (gate width) and the bit rate of the optical signal.....	17
Table 1 – Monitoring system parameters.....	13

## INTRODUCTION

Signal quality monitoring is important for operation and maintenance of optical transport networks (OTN). From the network operator's point of view, monitoring techniques are required to establish connections, protection, restoration, and/or service level agreements. In order to establish these functions, the monitoring techniques used should satisfy some general requirements:

- in-service (non-intrusive) measurement
- signal deterioration detection (both SNR degradation and waveform distortion)
- fault isolation (localize impaired sections or nodes)
- transparency and scalability (irrespective of the signal bit rate and signal formats)
- simplicity (small size and low cost).

There are several approaches, both analogue and digital techniques, which make it possible to detect various impairments:

- bit error rate (BER) estimation [1,2]<sup>1</sup>
- error block detection
- optical power measurement
- optical SNR evaluation with spectrum measurement [3,4]
- pilot tone detection [5,6]
- Q-factor monitoring [7]
- pseudo BER estimation using two decision circuits [8,9]
- histogram evaluation with synchronous eye diagram measurement [10].

A fundamental performance monitoring parameter of any digital transmission system is its end-to-end BER. However, the BER can be correctly evaluated only with out of service BER measurements, using a known test bit pattern in place of the real signal. On the other hand, in-service measurement can only provide rough estimates through the measurement of digital parameters (e.g., BER estimation, error block detection, and error count in forward error correction) or analogue parameters (e.g., optical SNR and Q-factor).

An in-service optical Q-factor monitoring can be used for accurate quality assessment of transmitted signals on wavelength division multiplexed (WDM) networks. Chromatic dispersion (CD) compensation is required for Q monitoring at measurement point in CD uncompensated optical link. However, conventional Q monitoring method is not suitable for signal evaluation of transmission signals, because it requires timing extraction by complex equipment that is specific to each BER and each format.

The software triggering technique [11-14] reconstructs synchronous eye-diagram waveforms without an external clock signal synchronized to optical transmission signal from digital data obtained through asynchronous sampling. It does not rely on an optical signal's transmission rate and data formats (RZ or NRZ). Measuring method of eye diagrams and Q-factor using the software triggering technique is a cost-effective alternative to BER estimations. With eye diagrams and Q-factor using software triggering test method, signal quality degradations due to optical signal-to-noise ratio (OSNR) degradation, to jitter fluctuations and to waveform distortion can be monitored.

This is one of the promising performance-monitoring approaches for intensity modulated direct detection (IM-DD) optical transmission systems.

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<sup>1</sup> Numbers in square brackets refer to the Bibliography.