IEC 62343-3-2

Edition 1.0 2016-05

INTERNATIONAL STANDARD

Dynamic modules –
Part 3-2: Performance specification templates – Optical channel monitor

IEC 62343-3-2:2016-05(en)

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

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
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 It also gives information on projects, replaced and withdrawn publications.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
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - 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: csc@iec.ch.

IEC 62343-3-2

Edition 1.0 2016-05

INTERNATIONAL STANDARD

Dynamic modules –
Part 3-2: Performance specification templates – Optical channel monitor

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.180.99, 33.180.01

ISBN 978-2-8322-3364-1

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

DYNAMIC MODULES –

Part 3-2: Performance specification templates – Optical channel monitor

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

International Standard IEC 62343-3-2 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

The text of this document is based on the following documents:

CDV	Report on voting
86C/1324/CDV	86C/1371/RVC

Full information on the voting for the approval of this document can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62343 series, published under the general title *Dynamic modules*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

An optical channel monitor (OCM) is a dynamic module that measures the optical characteristics, mainly power and frequency, of each channel present in a dense wavelength division multiplexing (DWDM) transmission line. The OCM is typically connected to an optical tap coupler which directs to the OCM anywhere between 1 % and 5 % of the optical signal in the fibre-optic transmission line. The data reported by the OCM are used in a reconfigurable optical add/drop multiplexer (ROADM) to dynamically equalize the power in the optical channels and to monitor the performance of the channels continuously over the lifetime of the system.

DYNAMIC MODULES –

Part 3-2: Performance specification templates – Optical channel monitor

1 Scope

This part of IEC 62343 provides a performance specification template for optical channel monitors. The objective of this performance specification template is to provide a framework for the performance specification of the optical channel monitor.

Additional specification parameters may be included for detailed product specifications or performance specifications. However, specification parameters specified in this document should not be removed from the detail product specifications or performance specifications.

This document outlines the parameters that are used to specify the performance of the optical channel monitor.

2 Normative references

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.

IEC 61280-2-9, *Fibre optic communication subsystem test procedures – Part 2-9: Digital systems – Optical signal-to-noise ratio measurement for dense wavelength-division multiplexed systems*

IEC 61300-3-21, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-21: Examinations and measurements – Switching time*

IEC 61300-3-29, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-29: Examinations and measurements – Spectral transfer characteristics of DWDM devices*

IEC 62074-1, *Fibre optic interconnecting devices and passive components – Fibre optic WDM devices – Part 1: Generic specification*

IEC 62343, *Dynamic modules – General and guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62343 and IEC 61280-2-9 apply.

4 Performance specification template

This specification template is a comprehensive compilation of all the performance parameters that may be relevant to optical channel monitors. Table 1 includes a column that indicates if a parameter is required or optional. The required parameters include the performance parameters that are deemed necessary to form a minimal specification. The optional parameters can be specified in addition to the required parameters depending on the specific requirements of the transmission system for which it is designed.

The product specification template is given in Table 1. The R/O column refers to whether that particular specification item could be considered required or optional. The notation of “na” signifies that no specification is provided in that cell. All Min. and Max. cells left blank shall be filled in with a specification.

Table 1 – Optical channel monitor specification template

No.	Parameter name	R/O	Min.	Max.	Unit	Test method	Notes
1	Input channel plan	R			THz		[a]
2	Channel frequency range	O			THz	IEC 62074-1	[b]
3	Input channels frequency spacing tolerance	R	n/a	± val.	THz	Under consideration	[c, f]
4	Input channels power dynamic range	R			dB	Under consideration	
5	Input channels non-uniformity	R	n/a		dB	Under consideration	
6	Input adjacent channels non-uniformity	O	n/a		dB	Under consideration	
7	Input channels non-uniformity for channel identification	O	n/a		dB	Under consideration	[c]
8	Input adjacent channels non-uniformity for channel identification	O	n/a		dB	Under consideration	[c]
9	Input total band power dynamic range for channel measurements	O			dBm	Under consideration	
10	Input total band power dynamic range for total band power measurements	O			dBm	Under consideration	
11	Input OSNR dynamic range	R			dBm	Under consideration	
12	Input channels bit rates	O			Gb/s		[d]
13	Reference measurement bandwidth	R	nominal value			IEC 61300-3-29, IEC 62074-1	[e]
14	Noise equivalent bandwidth	O	nominal value			Under consideration	[e]
15	Channel power absolute error	R	n/a	± val.	dB	Under consideration	
16	Channel power relative error	R	n/a		dB	Under consideration	
17	Channel power variability	R	n/a		dB	Under consideration	
18	Channel power resolution interval	O	n/a		dB	Under consideration	
19	Channel power polarization dependent error	O	n/a		dB	Under consideration	
20	Total band power absolute error	O	n/a	± val.	dB	Under consideration	
21	Total band power relative error	O	n/a		dB	Under consideration	
22	Total band power variability	O	n/a		dB	Under consideration	
23	Total band power resolution interval	O	n/a		dB	Under consideration	
24	Frequency absolute error	O	n/a	± val.	GHz	Under consideration	[f]
25	Frequency relative error	O	n/a		GHz	Under consideration	
26	Frequency variability	O	n/a		GHz	Under consideration	
27	Frequency resolution interval	O	n/a		GHz	Under consideration	
28	Frequency polarization dependent error	O	n/a		dB	Under consideration	
29	OSNR absolute error	O	n/a	± val.	dB	Under consideration	[f]
30	OSNR relative error	O	n/a		dB	Under consideration	

No.	Parameter name	R/O	Min.	Max.	Unit	Test method	Notes
31	OSNR variability	O	n/a		dB	Under consideration	
32	OSNR resolution interval	O	n/a		dB	Under consideration	
33	OSNR polarization dependent error	O	n/a		dB	Under consideration	
34	Back reflection	R	n/a		dB	Under consideration	
35	Operating temperature	R			ºC	-	
36	Storage temperature	R			ºC	-	
37	Operating relative humidity	R			%	-	
38	Storage relative humidity	R			%	-	
39	Response time	R	n/a		ms	IEC 61300-3-21	
40	Repeatability time interval	R	n/a		ms	Under consideration	

[a] Input channel plan is a parameter that is well suited in the context of DWDM transmission systems operating on fixed ITU grids, as defined in ITU-T G.694.1, of equal channel spacing. In such applications, the frequency band parameter is considered optional, as it can be derived using its definition and the input channel plan specification. However in the context of DWDM transmission systems operating on flexible ITU grids of varying channel spacing, the input channel plan is no longer a relevant parameter. The frequency band parameter takes precedence and becomes a required (R) parameter. In this case, the maximum number of channels shall be specified as well as the granularity of the flexible bandwidth structure. Note that the optical channel monitor does not distinguish between optical channels and optical sub-carriers within a channel. The optical channel monitor simply performs the power measurement over the specified measurement integration bandwidth.

It is universally understood that any optical power measurement shall be specified over an optical frequency (or wavelength) range. For example, optical spectrum analyser (OSA) instruments shall be set to a desired resolution bandwidth before a spectral measurement can be performed. Similarly, for optical channel monitors, the reference measurement bandwidth and the noise equivalent bandwidth are key parameters when defining the performance specification.

The reference measurement bandwidth is a parameter that is related to channel and total power measurements. The optical channel monitor reports the power integrated over the reference measurement bandwidth. The accuracy of that measurement can only be determined by comparing it to a measurement on a reference instrument, typically a calibrated OSA instrument, over the same reference measurement bandwidth.

[b] The input channels frequency spacing tolerance parameter is applicable to both fixed and flexible ITU grid specifications. In the case of flexible ITU grids, this specification may be broken out based on different channel spacing values, as lasers modulated at higher bit rates tend to be specified with tighter frequency tolerances. An alternative is to simply specify the frequency tolerances of the input signals based on their bit rate and modulation format.

[c] Channel identification is used in this document to cover a broad range of meanings depending on the application. In the context of a DWDM system transmitting at bit rates no higher than 10Gb/s, channel identification can mean that the optical channel monitor shall report the channels present. In the context of a DWDM system transmitting with channels with a mix of bit rates up to 100 Gb/s, channel identification can be enhanced to distinguish 40 Gb/s and 100 Gb/s channels from 10 Gb/s channels by their spectral shape. In the context of DWDM systems transmitting with channels with a mix of bit rates up to 1 Tb/s on flexible grids, the host can actually provide the channel plan to the optical channel monitor, in which case channel identification becomes not applicable. Input parameters related to channel identification are specified separately from other input parameters due to the fact that channel identification can pose unique challenges.

[d] The minimum and maximum channel bit rates can be specified generically. It can be helpful for clarity to specify the input channels modulation formats. This information can take the form of high resolution optical spectra to insure that the spectral shape is fully taken into account in the performance specification of the optical channel monitor.

[e] Values are nominal. Refer to IEC 61300-3-29, and IEC 62074-1 for additional details.

[f] Absolute error is by definition the deviation from a reference measurement. A given measurement can be greater or lesser than the reference measurement. Thus it is common to see the absolute error be specified as a plus or minus value. The specification can therefore be expressed with the "plus" and the "minus" errors listed respectively under the max and min columns. On the other hand, for all practical purposes, the absolute error of concern is the absolute value of the error measured. In other words, the magnitude of the error matters more than its sign. In Table 1, the parameters specified as a plus or minus error around a reference are denoted with "± val" in the max column. But a specification with "+ val" under the Max column and "- val" under the Min column is an acceptable alternative.

Annex A
(informative)

Background and additional information on this specification template

A.1 Background information on the structure of this specification template

A.1.1 Selecting “directionally correct” terminology

Terminology in marketing literature is often selected to appear favourable and this is true for the terminology for optical channel monitors.

As an example, datasheets can typically specify “channel power accuracy of ± 1,0 dB”. It would be technically correct but ambiguous to say that “the channel power accuracy increased from ± 1,0 dB to ± 0,5 dB”, because the value itself decreased. It would be clearer to say that “the channel power error *decreased* from ± 1,0 dB to ± 0,5 dB”. This last statement could be described as being “directionally correct”. In the commercial marketplace, on the other hand, promoting “channel power accuracy” rather than “channel power error” is preferred.

This International Standard utilizes terminology that offers the most clarity as opposed to the terminology that is more prevalent in the marketplace. For example, in Table 1:

- "error" was selected instead of "accuracy";
- "non-uniformity" was selected instead of "uniformity";
- "variability" was selected instead of "repeatability";
- "resolution-interval" was selected instead of "resolution".

A.1.2 Logical sequence of parameters in Table 1

The parameters listed in Table 1 follow a logical sequence beginning with the input parameters, followed by the performance parameters, and ending with operating parameters.

Input parameters specify the entire range of optical input conditions for which the performance parameters apply. In general, the greater the range of input parameters, the greater the specified error of an optical channel monitor. In this part of IEC 62343, the terminology for input parameters is made explicit by inclusion of the word input between parameter 1 to 12. For example, one input parameter is the input channels non-uniformity. As the input channels non-uniformity increases, the more challenging it becomes for the channel monitor to measure a channel with relatively low optical power when surrounded by channels with relatively high optical power. This is because the accuracy of the measurement of the relatively low optical power channel will be impacted by optical crosstalk from the neighbouring channels with relatively high optical power.

Performance parameters such as channel power absolute error are grouped in the middle of Table 1 from parameter 15 to 34.

Operating parameters can be found towards the end of Table 1 from parameter 35 and include the word operating in the term. An example operating parameter is operating temperature. These parameters represent the range of operating conditions over which the performance parameters shall meet their specifications. In general, the broader the range of the operating specifications, the more challenging it is for the optical channel monitor to maintain a specified performance specification.

The explicit identification of input conditions and operating parameters is helpful to formulate the definitions for the performance parameters: they can be globally referenced in the definitions with the simple phrase “specified over all input and operating ranges”.

A.1.3 Performance parameters hierarchical structure

The terminology for the performance parameters follows a hierarchical structure. The hierarchical construct can be used to create all the possible permutations for all the possible performance parameters that can be specified. All such permutations are shown in Table 1. But typically, not all performance parameters are specified in practice. To reflect this, many such parameters are listed as optional in Table 1.

The hierarchical structure consists of a root parameter and parameter attribute. Root parameters are:

- channel power;
- total band power;
- OSNR;
- frequency.

Each of these root parameters can be combined with any of the following performance attributes:

- absolute error;
- relative error;
- variability;
- resolution interval.

This hierarchical structure also facilitates the streamlining of all the definitions associated with each performance attribute. In this document, most of the definitions of the performance parameters are formed according to the following templates:

- [root parameter] absolute error: the maximum difference between the measured [root parameter] and the calibrated reference [root parameter], (within specific conditions relevant to this root parameter), during one measurement within the response time, specified over all input and operating ranges;
- [root parameter] relative error: the maximum variation of the [root parameter] absolute error, during one measurement within the response time, specified over all input and operating ranges;
- [root parameter] variability: the maximum variation of the [root parameter] absolute error over the repeatability time interval at a given input and operating condition, specified over all input and operating ranges;
- [root parameter] resolution interval: the smallest increment of the reported [root parameter] measurement value.

A.2 Additional information about reference measurement bandwidth

The reference measurement bandwidth is a value selected according to the bit rate and modulation format of the optical signals being measured.

- Typically, smaller reference measurement bandwidths are designed for optical signals modulated at symbol rates of 10 Gb/s and below.
- For optical signals modulated at symbol rates of 40 Gb/s and above, the reference measurement bandwidth is increased to insure that the entire spectrum of the signal is accounted for in the optical power measurement.
- For optical signals modulated at symbol rates of 400 Gb/s and above, the channel plans can be defined on a flexible grid. In this case, the host system can provide the reference measurement bandwidth to the optical channel monitor for each individual channel in the scan.

The noise equivalent bandwidth is a parameter that shall be defined to accurately characterize the performance parameters related to OSNR. Since OSNR is an optional performance parameter, so is the noise equivalent bandwidth.

- To compute the OSNR, it is useful to first compute the signal power, which is the channel power less the optical noise, both measured in the specified reference measurement bandwidth.
- Using the signal power (P_i) and the optical noise (N_i) of the ith channel, as well as the reference measurement bandwidth (B_r) and the noise equivalent bandwidth (B_m), the OSNR can then be calculated as defined in IEC 61280-2-9:

$$\mathrm{OSNR} = 10\log_{10}\frac{P_i}{N_\mathrm{i}} + 10\log_{10}\frac{B_\mathrm{m}}{B_\mathrm{r}} \quad \mathrm{dB} \tag{A.1}$$

Bibliography

ITU-T G.694.1, *Spectral grids for WDM applications: DWDM frequency grid*

____

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch