



GROUP SPECIFICATION

Fifth Generation Fixed Network (F5G); Test Specification for 50G-PON Functionality and Performance

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Reference

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Fifth Generation Fixed Network (F5G).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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1 Scope

The present document specifies the testing methodology and criteria of the functionality and performance of 50G TDM PON as specified in Recommendation ITU-T G.9804.x series [3], [4] and [5]. Relevant standards of the Broadband Forum (BBF) are referenced or extended.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

- [1] [Recommendation ITU-T G.984.2 \(2019\)](#): "Gigabit-capable Passive Optical Networks (G-PON): Physical Media Dependent (PMD) layer specification".
- [2] [Recommendation ITU-T G.987.2 \(2023\) Amd.2](#): "10-Gigabit-capable passive optical networks (XG-PON): Physical media dependent (PMD) layer specification".
- [3] [Recommendation ITU-T G.9804.1 \(2019\) Amd.2](#): "Higher speed passive optical networks – Requirements".
- [4] [Recommendation ITU-T G.9804.2 \(2021\) Amd.2](#): "Higher speed passive optical networks – Common transmission convergence layer specification".
- [5] [Recommendation ITU-T G.9804.3 \(2021\) Amd.2](#): "50-Gigabit-capable passive optical networks (50G-PON): Physical media dependent (PMD) layer specification".
- [6] [Recommendation ITU-T G.9807.1 \(2023\) Amd.1](#): "10-Gigabit-capable symmetric passive optical network (XGS-PON)".
- [7] [Recommendation ITU-T G.652 \(08/2024\)](#): "Characteristics of a single-mode optical fibre and cable".
- [8] [Recommendation ITU-T G.657 \(08/2024\)](#): "Characteristics of a bending-loss insensitive single-mode optical fibre and cable".
- [9] [IEEE 802.3ah-2004™](#): "IEEE Standard for Information technology-- Local and metropolitan area networks-- Part 3: CSMA/CD Access Method and Physical Layer Specifications Amendment: Media Access Control Parameters, Physical Layers, and Management Parameters for Subscriber Access Networks".
- [10] [IEEE 802.3av-2009™](#): "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment 1: Physical Layer Specifications and Management Parameters for 10 Gb/s Passive Optical Networks".
- [11] [BBF TR-423 \(August 2025 - Issue 3\)](#): "PON PMD Layer Conformance Test Plan".
- [12] [BBF TP-255 \(Issue 2\)](#): "G-PON & XG-PON & XGS-PON Interoperability Test Plan".

2.2 Informative references

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Not applicable.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

Dynamic Bandwidth Assignment (DBA): process by which the Optical Line Terminal (OLT) distributes upstream Passive Optical Network (PON) capacity between the traffic-bearing entities within Optical Network Units (ONUs), based on the dynamic indication of their traffic activity and their configured traffic contracts

ODN Optical Path Loss class (ODN class): categorization of an Optical Distribution Network (ODN) based on the predefined values of minimum and maximum optical path loss over all possible paths between the S/R [or S/Rm] and any of the R/S reference points and over all possible operating wavelengths of a specific PON system

Optical Distribution Network (ODN): Optical Distribution Network including the fibres, splitters and connectors

Optical Modulation Amplitude (OMA): absolute difference between the optical power of a logic one level and the optical power of a logic zero level

Optical Path Penalty (OPP): apparent degradation of receiver sensitivity due to impairments from fibre transmission and apparent increase in ODN loss due to Raman depletion. The optical path penalty accounts for the effects of reflections, inter-symbol interference, mode partition noise, fibre dispersion, and fibre non-linearities

Transmission Container (T-CONT): traffic-bearing object within an Optical Network Unit (ONU) that represents a group of logical connections, is managed via the ONU Management and Control Channel (OMCC), and, through its TC layer Alloc-ID, is treated as a single entity for the purpose of upstream bandwidth assignment on the Passive Optical Network (PON)

Transmitter and Dispersion Eye Closure (TDEC): TDEC is an optical transmitter quality metric derived using histograms extracted from the eye diagram

NOTE: The optical transmitter is measured using a waveform monitoring device in a set-up that emulates the worst-case channel, including fibre, reference receiver and equalizer.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

50G-PON	50 Gbit/s Passive Optical Network
---------	-----------------------------------

CEx Coexistence Element Type

NOTE: x(x = 1, 2, etc.).

DAW	Dedicated Activation Wavelength
DBA	Dynamic Bandwidth Assignment
DFB	Distributed Feedback
DUT	Device Under Test
EMS	Element Management System
EPON	Ethernet Passive Optical Network
FEC	Forward Error Correction
FP	Fabry-Perot
GE	Gigabit Ethernet
GPON	Gigabit Passive Optical Network
ID	IDentifier
IP	Internet Protocol
MAC	Media Access Control
MPM	Multi-PON Module
ODN	Optical Distribution Network
OLT	Optical Line Terminal
OMA	Optical Modulation Amplitude
OMCC	OMCI Communications Channel
ONU	Optical Network Unit
OPP	Optical Path Penalty
PON	Passive Optical Network
QoS	Quality of Service
SMSR	Side-Mode Suppression Ratio
SPM	Single-PON Module
TC	Transmission Convergence
T-CONT	Transmission Container
TDEC	Transmission and Dispersion Eye Closure
TDM	Time-Division Multiplexing
VLAN	Virtual Local Area Network
WDM	Wavelength Division Multiplexer
X/S	Crosstalk to Signal Ratio
XG	10-Gigabit
XG-PON	10-Gigabit-capable Passive Optical Network
XGS-PON	10-Gigabit-capable Symmetric Passive Optical Network

4 Test equipment and fibre requirement

4.1 Test equipment

The functions and requirements of the instruments used in testing are shown in Table 1.

Table 1: Test Equipment Functions and Requirements

Equipment	Function	Requirements
Optical Power Meter	Measures the optical power of optical transmitters or optical networks.	• Insertion loss: < 2,0 dB • Measurement accuracy: $\leq 0,1$ dB
Network Analyzer	Transmits and receives Ethernet data packets, and performs statistical analysis of results.	• Each port shall be capable of transmitting more than 16 k independent streams and receiving/analysing 64 k independent streams • Able to arbitrarily configure the template for each stream (including bandwidth, frame size, and frame content)
Optical Attenuator	Provides adjustable attenuation of optical signals. Used for testing receiver sensitivity, receiver overload optical power, FEC functionality, etc.	• Insertion loss: < 2,0 dB • Adjustment accuracy: $\leq 0,1$ dB • Wavelength range shall cover: – 1 260 nm ~ 1 310 nm – 1 340 nm ~ 1 344 nm – 1 560 nm ~ 1 581 nm
Oscilloscope	Tests the waveform characteristics of optical transmitter signals. Used for testing transmitter eye diagrams and extinction ratio.	• Wavelength range shall cover: 1 260 nm~1 310 nm, 1 340 nm~1 344 nm, 1 560 nm~1 581 nm • For test cases such as transmitter eye diagram and TDEC, shall be equipped with corresponding optical-to-electrical converter, fourth-order Bessel-Thomson filter, reference equalizer, and result analysis modules
Optical Spectrum Analyzer / Optical Wavelength Meter	Tests the optical spectrum of optical transmitters. Used for testing transmit wavelength and side mode suppression ratio.	• Wavelength accuracy: $\pm 0,05$ nm • Wavelength range shall cover: – 1 260 nm ~ 1 310 nm – 1 340 nm ~ 1 344 nm – 1 560 nm~1 581 nm • Supports testing and data acquisition for both FP lasers and DFB lasers

Other equipment requirements for BBF tests refer to BBF TR-423 [11].

4.2 Fibre requirement

Test procedures in the present document shall use the fibre described in Recommendation ITU-T G.652 [7]. Other fibre types may be compatible with these test procedures, e.g. Recommendation ITU-T G.657 [8].

5 PON interface test cases

5.1 OLT interface test cases

5.1.1 SPM: Optical parameter test cases

5.1.1.1 OLT transmit power of 49,7664 Gbit/s downstream direction test

This test case shall be performed as described in BBF TR-423 [11], section 8.2.1.

5.1.1.2 OLT SMSR test

This test case shall be performed as described in BBF TR-423 [11], section 8.2.7.

5.1.1.3 OLT transmitter wavelength of 49,7664 Gbit/s downstream direction test

This test case shall be performed as described in BBF TR-423 [11], section 8.2.6.

5.1.1.4 OLT transmit optical waveform (eye diagram)

This test case shall be performed as described in BBF TR-423 [11], section 8.2.4.

5.1.1.5 OLT extinction ratio test

This test case shall be performed as described in BBF TR-423 [11], section 8.2.6.

5.1.1.6 OLT receive sensitivity test

5.1.1.6.1 Test purpose

Verify that the OLT SPM PON interface receive sensitivity complies with the requirements of Recommendation ITU-T G.9804.3 [5].

5.1.1.6.2 Test configuration

For the receive sensitivity test of 24,8832 Gbit/s upstream direction, the configuration requirements for parameters such as the bit error rate reference threshold and transmitter extinction ratio shall comply with the requirements of Recommendation ITU-T G.9804.3 [5], Table 9-7.

For the receive sensitivity test of 49,7664 Gbit/s upstream direction, the configuration requirements for parameters such as the bit error rate reference threshold and transmitter extinction ratio shall comply with the requirements of Recommendation ITU-T G.9804.3 [5], Table 9-8.

Figure 1 shows the configuration of the test.

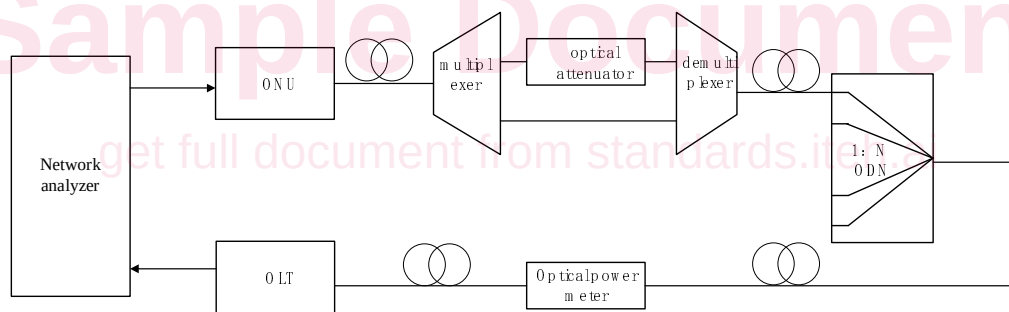


Figure 1: OLT transmitter receive sensitivity test environment

5.1.1.6.3 Test procedure

The test procedure shall be as follows:

- 1) Connect the optical paths between the equipment under test and the test instrument according to Figure 1, with upstream FEC enabled (the multiplexer/demultiplexer in Figure 1 is used to separate upstream and downstream wavelengths).
- 2) Send the test traffic from the network analyser to the ONU port.
- 3) Adjust the optical attenuator to gradually increase the attenuation until packet loss is detected by the network analyser, then slightly reduce the attenuation until packet loss disappears.
- 4) Measure the OLT PON interface received optical power.
- 5) Calculate the OMA sensitivity according to Appendix 1 of Recommendation ITU-T G.9804.3 [5], by combining the average transmitted optical power tested in section 5.1.1.1 and the extinction ratio tested in section 5.1.1.5.