



GROUP SPECIFICATION

Fifth Generation Fixed Network (F5G); Test Specification for PON Based Industrial Network

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Foreword

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Modal verbs terminology

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1 Scope

The present document specifies the test methods for functional requirements, performance requirements, basic management functions for PON based industrial networks, which are specified in ETSI GS F5G 022 [1].

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] [ETSI GS F5G 022](#): "Fifth Generation Fixed Network (F5G); Specification for PON based Industrial Network".
- [2] [IEEE 802.1Q™-2022](#): "IEEE Standard for Local and Metropolitan Area Networks -- Bridges and Bridged Networks".
- [3] [IEEE 802.1X™-2020](#): "IEEE Standard for Local and Metropolitan Area Networks -- Port-Based Network Access Control".
- [4] [IETF RFC 7348](#): "Virtual eXtensible Local Area Network (VXLAN): A Framework for Overlaying Virtualized Layer 2 Networks over Layer 3 Networks".
- [5] [BBF TR-423 Issue 3 \(August 2025\)](#): "PON PMD Layer Conformance Test Plan".
- [6] [ETSI GS F5G-TEST 030](#): "Fifth Generation Fixed Network (F5G); Test Specification for 50G-PON Functionality and Performance".
- [7] IEEE 802.3™: "IEEE Standard for Ethernet".

2.2 Informative references

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Not applicable.

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

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

10GE	10 Gbit/s Ethernet
50G-PON	50 Gbit/s Passive Optical Network
BPDU	Bridge Protocol Data Unit
CAN	Controller Area Network
DHCP	Dynamic Host Configuration Protocol
DSCP	Differentiated Services Code Point
DUT	Device Under Test
EAP	Extensible Authentication Protocol
EFM	Ethernet Fiber Multiplexer
EMS	Element Management System
EPON	Ethernet Passive Optical Network
FEC	Forward Error Correction
GARP	Generic Attribute Registration Protocol
GE	Gigabit Ethernet
GMRP	GARP Multicast Registration Protocol
GPON	Gigabit Passive Optical Network
GVRP	GARP VLAN Registration Protocol
HMI	Human Machine Interface
ID	Identifier
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPoE	IP over Ethernet
LACP	Link Aggregation Control Protocol
LAN	Local Area Network
MAC	Media Access Control
MQTT	Message Queuing Telemetry Transport
NAK	Negative Acknowledgement
NMS	Network Management System
O&M	Observations and Measurements
ODN	Optical Distribution Network
OLT	Optical Line Terminal
OMCI	Optical Network Unit Management and Control Interface
ONU	Optical Network Unit
OPC	Open Platform Communications
PC	Personal Computer
POTS	Plain Old Telephone Service
PPPoE	Point-to-Point Protocol over Ethernet
QoS	Quality of Service
SLA	Service-Level Agreement
SW	Switch
TCP	Transmission Control Protocol
TOS	Type Of Service
ToS	Type of Service
UA	Unified Architecture

UDP	User Datagram Protocol
UNI	User-Network Interface
USB	Universal Serial Bus
VLAN	Virtual Local Area Network
VNI	VxLAN Network Identifier
VTEP	VxLAN Tunnel End Point
VxLAN	Virtual eXtensible LAN
WLAN	Wireless Local Area Network
XG-PON	10-Gigabit-capable Passive Optical Network
XGS-PON	10-Gigabit-capable Symmetric Passive Optical Network

4 Reference Model for PON based Industrial Network

4.1 Test Reference Model for Industrial PON

The industrial PON system comprises of three key components:

- the Optical Line Terminal (OLT);
- the Optical Network Unit (ONU); and
- optical splitters.

Where the different components are located is deployment specific and does not affect the testing. It operates as a single-fiber bi-directional system, enabling efficient data transmission. The system is managed through an industrial PON management platform, which monitors the Operation and Maintenance (O&M) functions of the OLTs and ONUs. The tests specified in the present document focuses on evaluating the OLTs, ONUs, and their O&M capabilities for industrial application.

On the OLT, the industrial PON may integrate an edge computing unit, enhancing its functionality. On the ONU, a customized platform or open software platform is utilized to collect industrial data. The ONU is either directly connected to industrial terminals or functions as an industrial protocol transparent transmission gateway. In the latter case, it connects to industrial terminals via a dedicated industrial data collection gateway. The ONU may support a wide range of industrial interfaces, including Ethernet, WLAN, POTS, USB, RS232/485, and CAN, ensuring versatility in industrial applications.

During testing, the appropriate ONU type should be selected based on specific requirements. The user side of the ONU is then connected to an industrial data collection gateway, test instruments, PCs, or industrial terminal devices. Figure 1 illustrates the reference test model for the industrial PON, providing a visual guide to the system's configuration. The industrial PON technology system is compatible with both EPON/10G EPON and GPON/XG-PON, 50G-PON technology systems, making it a flexible and scalable solution for industrial networking needs.

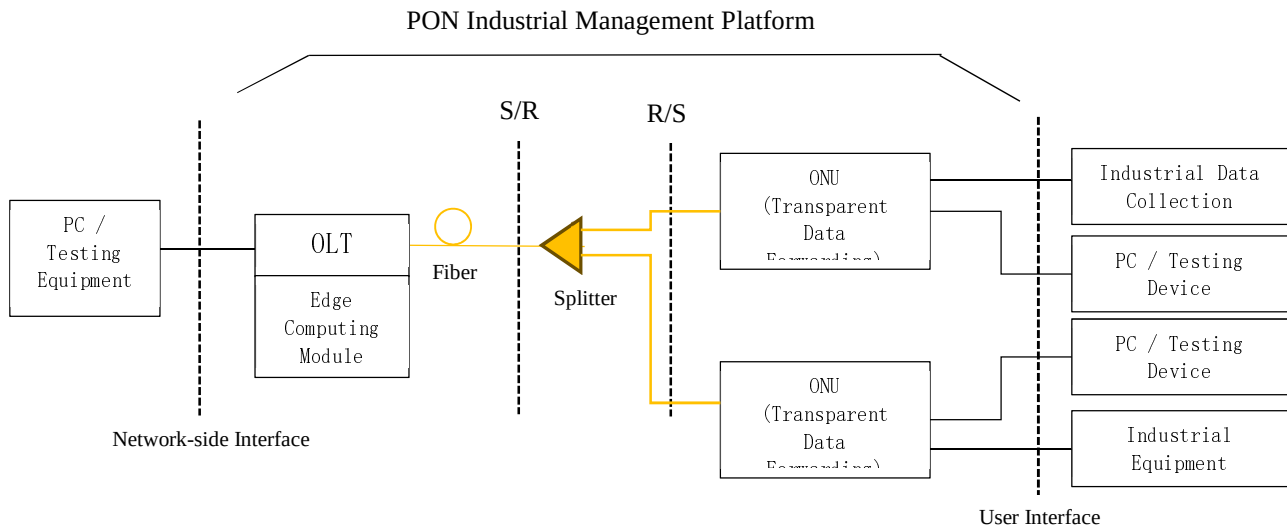


Figure 1: Reference model of the industrial PON set-up

4.2 Reference point for industrial PON testing

The reference model of industrial PON system is illustrated in Figure 1. The optical transmit signal is defined at the output end of the optical fiber, connected to the transmitter (reference point S). Unless otherwise specified, all transmitter tests outlined in the present document are conducted at point S. Similarly, the optical receiving signal is defined at the output end of the optical fiber, connected to the receiver (reference point R). Unless otherwise specified, all receiver tests described in the present document are performed at point R.

The test points of industrial PON equipment are as follows:

- Network-side interface:** refers to the reference point between the industrial PON OLT device and the industrial network connectivity to the enterprise network or a telecommunication network.
- Test point S:** indicates the fiber point close to the optical connector of the transmitter (OLT or ONU).
- Test point R:** indicates the fiber point that is close to the optical connector of the receiver (OLT or ONU).
- User-side interface:** refers to the reference point between an industrial PON device and a user terminal or other user-side devices.

5 Key function testing for industrial PON

5.1 PON interface test cases

5.1.1 OLT interface test cases

The PON interface test of 50G Industrial PON OLT shall use tests as defined in ETSI GS F5G-TEST 030 [6], clause 7.1, and the other speed rate of Industrial PON OLT shall use tests defined in BBF TR-423 [5], section 8.2.

5.1.2 ONU interface test cases

The PON interface test of 50G Industrial PON ONU shall use tests as defined ETSI GS F5G-TEST 030 [6], clause 7.2, and the other speed rate of Industrial PON ONU shall use tests as defined BBF TR-423 [5], section 7.2.

5.2 VLAN Function

5.2.1 Port-based VLAN function of the OLT (IEEE 802.1Q)

5.2.1.1 Test Purpose

To verify functions of the OLT on the IEEE 802.1Q [2] VLAN and port-based VLAN division, and to validate the OLT's support for VLAN port connection modes such as Access, Trunk, and Hybrid.

5.2.1.2 Test Configuration

The test configuration is shown in Figure 2.

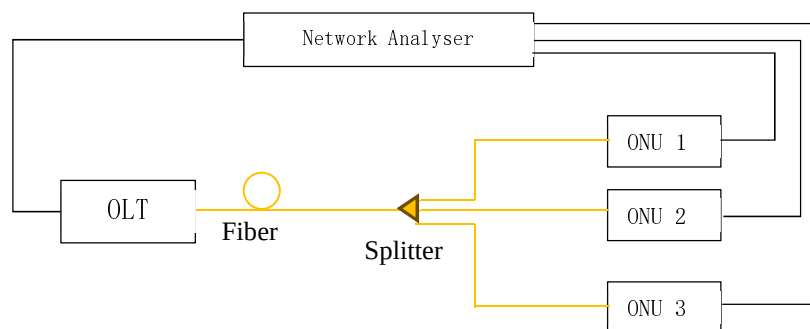


Figure 2: Test Configuration for Port-based VLAN Assignment on the OLT

5.2.1.3 Test Procedure

The test procedure shall be as follows:

- 1) Connect the ONU according to the configuration shown in Figure 2. Set the upstream port of the OLT to the VLAN Trunk mode and disable the VLAN tag function of the ONU.
- 2) On the OLT, set the following:
 - a) ONU 1 to Access mode and add it to VLAN 1.
 - b) ONU 2 to Trunk mode and add it to VLAN 2.
 - c) ONU 3 to Hybrid connection mode and add it to VLAN 3 and VLAN 4. VLAN 3 is the default VLAN of the port.
- 3) Use the network analyser to transmit three data streams with VLAN 1, VLAN 2 and VLAN 3 tags in the downstream direction. Observe the receiving status of the data streams.
- 4) Use the network analyser to transmit an untagged upstream data stream to the ONU 1.
- 5) Use the network analyser to transmit an upstream data stream with VLAN tag 2 to the ONU 2.
- 6) Use the network analyser to transmit two data streams to the ONU 3:
 - a) Data stream X does not carry the VLAN tag.
 - b) Data stream Y carries the VLAN tag 4.

Observe the receiving status of the two devices.

5.2.1.4 Expected Result

The expected result shall be as follows:

- In step 3, in the downstream direction shall be as follow:
 - a) The ONU 1 receives only the data stream of VLAN 1 without VLAN tags.
 - b) The ONU 2 receives only the data stream of VLAN 2 with VLAN tags.
 - c) The ONU 3 receives only the data stream of VLAN 3 without VLAN tags.
- In step 4, the data stream received by the upstream direction from the ONU 1 carries the VLAN 1 tag.
- In step 5, the data stream received by the upstream direction in the upstream direction from the ONU 2 carries the VLAN2 tag.
- In step 6, one data stream X received by the upstream direction from the ONU 3 carries a VLAN 3 tag, and the other data stream Y carries a VLAN 4 tag.

5.2.2 OLT VLAN function based on the Ethernet MAC frame encapsulation protocol

5.2.2.1 Test Purpose

To test the capability of the OLT to divide VLANs based on the Ethernet frame encapsulation protocol.

5.2.2.2 Test Configuration

The test configuration is shown in Figure 3.

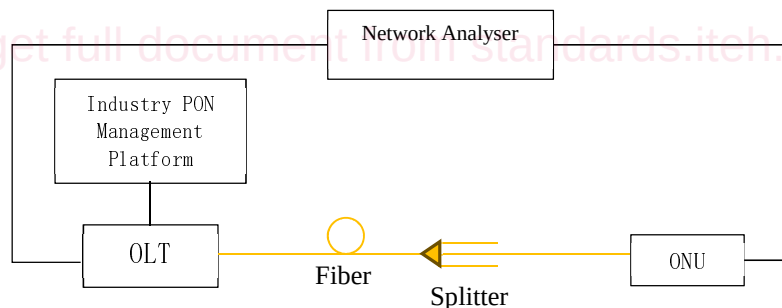


Figure 3: Test Configuration for VLAN Assignment Based on the Ethernet MAC Frame Encapsulation Protocol

5.2.2.3 Test Procedure

The test procedure shall be as follows:

- 1) Connect the circuit according to the test configuration shown in Figure 3.
- 2) Activate the function of VLAN division based on the Ethernet MAC frame encapsulation protocol on the OLT, and disable the ONU-related functions. Then, set the MAC frame protocol and VLAN/S-VLAN ID mapping parameters.
- 3) Use the network analyser to transmit two data streams that use different Ethernet frame encapsulation protocols to the Ethernet port of the ONU. The data streams are encapsulated in IPoE mode and encapsulated in PPPoE mode respectively.
- 4) Check the VLAN ID of the received flow on the upstream port of the OLT.

5.2.2.4 Expected Results

The two data streams received by the OLT shall carry different VLAN IDs.

5.2.3 VLAN ID switching function

5.2.3.1 Test Purpose

To test the function of modifying the VLAN ID tag of the user data streams on the OLT.

5.2.3.2 Test Configuration

The test configuration is shown in Figure 3.

5.2.3.3 Test Procedure

The test procedure shall be as follows:

- 1) Connect the circuit according to the test configuration shown in Figure 3.
- 2) Enable the VLAN ID switching function in the OLT. If the ONU supports the VLAN ID switching function - disable it on the ONU. Configure the OLT to forcibly change the VLAN ID of all traffic from the ONU user port to A.
- 3) Use the network analyser to transmit the upstream data with VLAN ID B to the user port of the ONU.
- 4) Check the VLAN ID of the received data stream on the upstream port of the OLT.
- 5) Use the network analyser to transmit the downstream data with VLAN ID A to the OLT.
- 6) Check the VLAN ID of the received data stream on the ONU.

5.2.3.4 Expected Result

The expected result shall be as follows:

- In step 4, the VLAN ID value of the data stream received by the OLT upstream port is changed to A.
- In step 6, the VLAN ID value of the data stream received by the ONU is modified to B.

5.3 OLT Upstream Port Link Aggregation Functionality

5.3.1 Test Purpose

To verify that the OLT upstream port supports the link aggregation function specified in IEEE 802.3 [7] when it has multiple Ethernet ports. To test the ability to load-balance upstream traffic from the ONU across the member links of the aggregation group. The resilience of the upstream link to the failure of one or more links.

5.3.2 Test Configuration

The test configuration is shown in Figure 4.