International Telecommunication Union

ITU-T

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G.983.1

Amendment 1

(05/2005)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Optical line systems for local and access networks

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Broadband optical access systems based on Passive Optical Networks (PON)

Amendment 1: PICS for OLT and ONU

ITU-T -T Recommendation G.983.1 (2005) – Amendment 1

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ITU-T Recommendation G.983.1

Broadband optical access systems based on Passive Optical Networks (PON)

Amendment 1

PICS for OLT and ONU

Summary

This amendment provides PICS for OLT and ONU as two appendices to ITU-T Rec. G.983.1. It consists of Appendix V for OLT and Appendix VI for ONU.

Source

Amendment 1 to ITU-T Recommendation G.983.1 (2005) was agreed on 27 May 2005 by ITU-T Study Group 15 (2005-2008).

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation G.983.1

Broadband optical access systems based on Passive Optical Networks (PON)

Amendment 1

PICS for OLT and ONU

Add new Appendices V and VI as follows:

Appendix V

PICS (Protocol Implementation Conformance Statement) for OLT

V.1 Scope

This appendix specifies PICS for OLT in ITU-T Rec. G.983.1. It does not require any modifications of ITU-T Rec. G.983.1.

V.2 Definitions

This appendix applies the following definitions in PICS[1] tables.

Req: **Requirement**. This column indicates whether the conformance requirement of a particular clause in the standard is mandatory, optional, or conditional.

Conf: **Conformance result**. Compliance or not will be indicated.

M: **Mandatory**. Conformance cannot be approved unless the parameter is implemented as specified.

O: **Optional**. The parameter may be implemented or not but, if implemented, it must be as stated in the standard.

C: **Conditional**. If an associated major option is implemented, this parameter must be implemented.

V.3 Abbreviations

PICS Protocol Implementation Conformance Statement

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[1] **Copyright release for PICS proforma**

Users of this Recommendation may freely reproduce the PICS proforma in this appendix so that it can be used for its intended purpose, and may further publish the completed PICS.

V.4 Overview of PICS for OLT

Contents in the PICS tables are summarized in Table V.1/G.983.1

Table V.1/G.983.1 – Protocol summary

Item	Parameter	Clause in Appendix V/G.983.1	Req	Conf
1	Optical and related items	V.5.1	M	
2	Structure of TC frame	V.5.2	M	
3	Divided_slots	V.5.3	O	
4	Churning	V.5.4	M	
5	Verification function	V.5.5	O	
6	VP/VC for higher layer	V.5.6	M	
7	Duplex PON system	V.5.7	O	
8	ATM specific TC functions	V.5.8	M	
9	OAM functions	V.5.9	Depending on the parameter	
10	Ranging method	V.5.10	M	

There are 5 options depending on the bit rate. Possible options are shown in Table V.2/G.983.1.

Table V.2/G.983.1 – Possible options according to the bit rate

		Downstream bit rate (Mbit/s)		
		155.52	622.08	1244.16
Upstream bit rate (Mbit/s)	155.52	Option-1	Option-2	Option-4
	622.08	N/A	Option-3	Option-5

V.5 PICS tables

V.5.1 Optical and related items

Parameters in this clause are for optical and related items.

To set up PON-link between the OLT and the ONU, parameters in this clause shall be complied with.

V.5.1.1 Optical interface parameters of downstream direction

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-1-1	Nominal bit rate. When the OLT and the end office are in their normal operating state	8.2.1 8.2.3	accuracy of 1×10^{-11}	M	
1-1-2	Nominal bit rate. When the end office is in its free-running mode	8.2.1 8.2.3	accuracy of 4.6×10^{-6}	M	
1-1-3	Nominal bit rate. When the OLT is in its free-running mode	8.2.1 8.2.3	accuracy of 3.2×10^{-5}	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-1-4	Operating wavelength at 155.52 Mbit/s, at 622.08 Mbit/s	8.2.1	Single fibre 1480-1580 nm Dual fibre 1260-1360 nm	C (If Option-1, Option-2, or Option-3 in Table V.2/G.983.1 is selected)	
1-1-5	Operating wavelength at 1244.16 Mbit/s	8.2.1	Single fibre 1480-1500 nm Dual fibre 1260-1360 nm	C (If Option-4, or Option-5 in Table V.2/G.983.1 is selected)	
1-1-6	Line code	8.2.1	Scrambled NRZ	M	
1-1-7	Mask of the transmitter eye diagram	8.2.1	Meets requirement of Figure 6/G.983.1	M	
1-1-8	Minimum ORL of ODN at O_{ld} and O_{lu}	8.2.1	more than 32 dB	M	
1-1-9	Mean launched power MIN at 155.52 Mbit/s	8.2.1	Single fibre/Class B –4 dBm Single fibre/Class C –2 dBm Dual fibre/Class B –4 dBm Dual fibre/Class C –2 dBm	C (If Option-1 in Table V.2/G.983.1 is selected)	
1-1-10	Mean launched power MIN at 622.08 Mbit/s	8.2.1	Single fibre/Class A –7 dBm Single fibre/Class B –2 dBm Single fibre/Class C –2 dBm Dual fibre/Class A –7 dBm Dual fibre/Class B –2 dBm Dual fibre/Class C –2 dBm	C (If Option-2, or Option-3 in Table V.2/G.983.1 is selected)	
1-1-11	Mean launched power MIN at 1244.16 Mbit/s	8.2.1	Single fibre/Class A –4 dBm Single fibre/Class B +1 dBm Single fibre/Class C +5 dBm Dual fibre/Class A –4 dBm Dual fibre/Class B +1 dBm Dual fibre/Class C +5 dBm	C (If Option-4, or Option-5 in Table V.2/G.983.1 is selected)	
1-1-12	Mean launched power MAX at 155.52 Mbit/s	8.2.1	Single fibre/Class B +2 dBm Single fibre/Class C +4 dBm Dual fibre/Class B +1 dBm Dual fibre/Class C +3 dBm	C (If Option-1 in Table V.2/G.983.1 is selected)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-1-13	Mean launched power MAX at 622.08 Mbit/s	8.2.1	Single fibre/Class A –1 dBm Single fibre/Class B +4 dBm Single fibre/Class C +4 dBm Dual fibre/Class A –2 dBm Dual fibre/Class B +3 dBm Dual fibre/Class C +3 dBm	C (If Option-2, or Option-3 in Table V.2/G.983.1 is selected)	
1-1-14	Mean launched power MAX at 1244.16 Mbit/s	8.2.1	Single fibre/Class A +1 dBm Single fibre/Class B +6 dBm Single fibre/Class C +9 dBm Dual fibre/Class A +1 dBm Dual fibre/Class B +6 dBm Dual fibre/Class C +9 dBm	C (If Option-4, or Option-5 in Table V.2/G.983.1 is selected)	
1-1-15	Extinction ratio	8.2.1	more than 10 dB	M	
1-1-16	Tolerance to the transmitter incident light power	8.2.1	more than –15 dB	M	
1-1-17	If MLM Laser – Maximum RMS width at 155.52 Mbit/s	8.2.1	Single fibre 1.8 nm Dual fibre 5.8 nm	C (If Option-1 in Table V.2/G.983.1 is selected)	
1-1-18	If MLM Laser – Maximum RMS width at 622.08 Mbit/s	8.2.1	Single fibre NA Dual fibre 1.4 nm	C (If Option-2, or Option-3 in Table V.2/G.983.1 is selected)	
1-1-19	If MLM Laser – Maximum RMS width at 1244.16 Mbit/s	8.2.1	Single fibre NA Dual fibre NA	C (If Option-4, or Option-5 in Table V.2/G.983.1 is selected)	
1-1-20	If SLM Laser – Maximum –20 dB width	8.2.1	1 nm	M	
1-1-21	If SLM Laser – Minimum side mode suppression ratio	8.2.1	30 dB	M	

V.5.1.2 Optical interface parameters of upstream direction

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-2-1	Maximum reflectance of equipment, measured at receiver wavelength	8.2.1	less than –20 dB	M	
1-2-2	Bit error ratio	8.2.1	less than 10^{-10}	M	
1-2-3	Minimum sensitivity at 155.52 Mbit/s	8.2.1	Single fibre/Class B –30 dBm Single fibre/Class C –33 dBm Dual fibre/Class B –30 dBm Dual fibre/Class C –33 dBm	C (If Option-1, Option-2, or Option-4 in Table V.2/G.983.1 is selected)	
1-2-4	Minimum sensitivity at 622.08 Mbit/s		Class A –27 dBm Class B –27 dBm Class C –32 dBm	C (If Option-3, or Option-5 in Table V.2/G.983.1 is selected)	
1-2-5	Minimum overload at 155.52 Mbit/s	8.2.1	Single fibre/Class B –8 dBm Single fibre/Class C –11 dBm Dual fibre/Class B –9 dBm Dual fibre/Class C –12 dBm	C (If Option-1, Option-2, or Option-4 in Table V.2/G.983.1 is selected)	
1-2-6	Minimum overload at 622.08 Mbit/s		Class A –6 dBm Class B –6 dBm Class C –11 dBm	C (If Option-3, or Option-5 in Table V.2/G.983.1 is selected)	
1-2-7	Consecutive identical digit immunity	8.2.1	more than 72 bit	M	
1-2-8	Tolerance to the reflected optical power	8.2.1	less than 10 dB	M	

V.5.1.3 Line code

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-3-1	High level of light emission for the downstream direction	8.2.4	Binary ONE	M	
1-3-2	Low level of light emission for the downstream direction	8.2.4	Binary ZERO	M	
1-3-3	High level of light emission for the downstream direction	8.2.4	Binary ONE	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-3-4	Low level of light emission for the downstream direction	8.2.4	Binary ZERO	M	

V.5.2 Structure of TC frame

The following conformance parameters are described in this clause:

1) TC frame structure;

2) PLOAM structure.

To set up PON-link between the OLT and the ONU, parameters in this clause shall be complied with.

V.5.2.1 Frame structure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-1-1	Frame structure for 155/155 Mbit/s PON	8.3.5.1	Defined in Figure 11/G.983.1	C (If Option-1 in Table V.2/G.983.1 is selected)	
2-1-2	Frame structure for 622/155 Mbit/s PON	8.3.5.1	Defined in Figure 12/G.983.1	C (If Option-2 in Table V.2/G.983.1 is selected)	
2-1-3	Frame structure for 622/622 Mbit/s PON	8.3.5.1	Defined in Figure 13/G.983.1	C (If Option-3 in Table V.2/G.983.1 is selected)	
2-1-4	Frame structure for 1244/155 Mbit/s PON	8.3.5.1	Defined in Figure 14/G.983.1	C (If Option-4 in Table V.2/G.983.1 is selected)	
2-1-5	Frame structure for 1244/622 Mbit/s PON	8.3.5.1	Defined in Figure 15/G.983.1	C (If Option-5 in Table V.2/G.983.1 is selected)	
2-1-6	Guard time length	8.3.5.1	4 bits or more are required.	M	
2-1-7	The total overhead length	8.3.5.1	24 bits	M	
2-1-8	The upstream PLOAM rate	8.3.5.1	One PLOAM cell every 100 ms or more are required.	M	
2-1-9	PLOAM header pattern	8.3.5.2	Meets requirement of Table 7	M	

V.5.2.2 Downstream PLOAM structure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-2-1	Payload content of PLOAM cell	8.3.5.3	Meets requirement of Table 8/G.983.1	M	
2-2-2	Contents of the IDENT byte	8.3.5.3.2	Meets requirement of Table 9/G.983.1	M	
2-2-3	Synchronization field (SYNC1-SYNC2)	8.3.5.3.4	Meets requirement of Figure 1/G.983.1	O	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-2-4	Data grant encoding	8.3.5.3.5	Any value except 1111 1101(b) 1111 1110(b) 1111 1111(b)	M	
2-2-5	PLOAM grant encoding	8.3.5.3.5	Any value except 1111 1101(b) 1111 1110(b) 1111 1111(b)	M	
2-2-6	Divided_slot grant encoding	8.3.5.3.5	Any value except 1111 1101(b) 1111 1110(b) 1111 1111(b)	O	
2-2-7	Ranging grant encoding	8.3.5.3.5	1111 1101(b)	M	
2-2-8	Unassigned grant encoding	8.3.5.3.5	1111 1110(b)	M	
2-2-9	Idle grant encoding	8.3.5.3.5	1111 1111(b)	M	
2-2-10	Number of ONUs supported.	8.3.5.3.5	OLT should support 32 ONUs (Mandatory), and may optionally support up to 64 ONUs	M	
2-2-11	Grants protection	8.3.5.3.6	A Cyclic Redundancy Check (CRC) protects a group of seven grants. The generating CRC polynomial for the grants is: $g(x) = x^8 + x^2 + x + 1$	M	
2-2-12	MESSAGE field protection	8.3.5.3.7	The message will be discarded at reception when the CRC is incorrect. The generating CRC polynomial for the grants is: $g(x) = x^8 + x^2 + x + 1$	M	
2-2-13	The range of MESSAGE_PON_ID	8.3.5.3.7	For a particular ONU, from 0x00 to 0x3F shall be mapped. For a broadcast, 0x40 is set to this field.	M	
2-2-14	Generating BIP-8	8.3.5.3.8	A one byte BIP-8 in each downstream PLOAM cell covers $28 \times 53 - 1$ bytes or 1483 bytes between two consecutive BIPs.	M	

V.5.2.3 Upstream PLOAM structure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-3-1	Payload content of PLOAM cell	8.3.5.4	Meets requirement of Table 12/G.983.1	M	
2-3-2	Contents of the IDENT byte	8.3.5.4.2	Meets requirement of Table 13/G.983.1	M	
2-3-3	MESSAGE field protection	8.3.5.4.3	The generating CRC polynomial for the grants is: $g(x) = x^8 + x^2 + x + 1$	M	
2-3-4	Monitoring the BER	8.3.5.4.4	A one byte BIP-8 in each PLOAM cell is calculated by the ONU on all the bytes from the cells (though not the overhead bytes) it sent between two consecutive BIPs except the overhead bytes and minislots.	M	
2-3-5	Receiver Control Field	8.3.5.4.6	The OLT programs this pattern using the Upstream_Rx_control message.	O	

V.5.2.4 Downstream messages flow

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-4-1	OLT messaging and granting should take into account that ONU has PLOAM message processing time of up to 6*Tframe.	8.3.8 8.4.3		M	

V.5.2.5 No message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-5-1	Sending trigger of No message	8.3.8.1	Empty message queue.	M	
2-5-2	Format of No message in the downstream PLOAM channel	8.3.8.2.1	35th Octet: 0x40 36th Octet: 0x00	M	
2-5-3	The receive-event of No message in the upstream PLOAM channel	8.3.8.1	Discard	M	

V.5.2.6 Vendor-specific message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-6-1	Sending trigger of Vendor-specific message	8.3.8.1	Vendor specific.	O	
2-6-2	Format of Vendor-specific message in the downstream PLOAM channel	8.3.8.2.1	35th Octet: xxxx xxxx(b) Directed message to one ONU or broadcast 36th Octet: 0111 1zzz(b) 37th-46th Octet: yyyy yyyy Vendor specific.	C (If Item 2-6-1 is complied with)	
2-6-3	The receive-event of Vendor-specific message in the upstream PLOAM channel	8.3.8.1	Vendor specific	O	

V.5.3 Divided_slots

Parameters in this clause relate to the message format of Divided_slot_configuration message.

Divided_slots are used for DBA function. Specifications about DBA function are described in ITU-T Rec. G.983.4. Without DBA function, the OLT and the ONU are able to set up PON-link. Parameters in this clause are optional. If the system requires divided_slots, parameters in this clause shall be complied with.

V.5.3.1 Divided_Slot_Grant_ configuration message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
3-1-1	Sending trigger of Divided_Slot_Grant_ configuration message	8.3.8.1	The OLT needs/no longer needs the service provided by the minislot.	O	
3-1-2	Number of sending times of Divided_Slot_Grant_ configuration message	8.3.8.1	3 times	C (If Item 3-1-1 is complied with)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
3-1-3	Format of Divided_Slot_Grant_ configuration message	8.3.8.2.1	35th Octet: PON_ID of the destination ONU 36th Octet: 0x0b 37th Octet: 0x01 = Activate grant for this ONU 0x00 = Deactivate grant for this ONU 38th Octet: The grant value. 39th Octet: The length of the minislot payload in number of bytes. The valid range: [1, (53 – OFFSET)] 40th Octet: The offset of the start of the minislot in number of bytes. The valid range: [0, 52] 41st Octet: The value is 0x00	C (If Item 3-1-1 is complied with)	

V.5.4 Churning

The following conformance parameters are described in this clause:

1) Coding method of churning;
2) Message flow for the churning function;
3) Format of the message relevant to the churning function;
4) Behaviour caused by the message reception relevant to churning function.

Due to the multicast nature of the PON, downstream cells are churned at the TC layer. Parameters in this clause shall be complied with.

V.5.4.1 Specification

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-1-1	Churn in OLT	8.3.5.6	Defined in Figure 19/G.983.1	M	
4-1-2	Churning enable/disable unit	8.3.5.6	The churning is performed for point to point downstream connections and churning can only be enabled or disabled per VP at its setup.	M	
4-1-3	Churn key update rate	8.3.5.6	At least 1 update per second per ONU	M	
4-1-4	Churning message flow	8.3.5.6.6	Defined in Figure 20/G.983.1	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-1-5	Churning start timing	8.3.5.6.6	Churning for a ranged or reranged ONU starts after reception of the first key from this ONU.	M	
4-1-6	Minimum interval between new_key_request	8.3.5.6.6	The OLT can send a new_key_request if no new_churning_key is received on a previous request within a time-out of 300 ms; or it can send the new_key_request after activating the new key and having received at least one acknowledge.	M	
4-1-7	Churned_VP restore	8.3.5.6.6	Churned VPs for previously active ONU(s) should be restored when coming back to the PON.	M	

V.5.4.2 New_churning_key_request message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-2-1	Sending trigger of New_churning_key_request message	8.3.5.6 8.3.8.1	At least 1 update per second per ONU	M	
4-2-2	Number of sending times of New_churning_key_ request message	8.3.8.1	1 time	M	
4-2-3	Format of New_churning_key_ request message	8.3.8.2.1	35^{th} Octet: PON_ID of the destination ONU 36^{th} Octet: 0x08	M	
4-2-4	The receive-event of New_churning_key message	8.3.8.1	The OLT initializes the churning engine with this new key if it receives three consecutive identical keys and switches to the new key 48*Tframe after the first churning_key_update message.	M	
4-2-5	The receive-event of Big_Key message	8.3.8.1	The OLT initializes the encryption logic with this new key if it receives three consecutive identical keys and switches to the new key 48*Tframe after the first churning_key_update message.	O	

V.5.4.3 Churning_key_update message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-3-1	Sending trigger of Churning_key_update message	8.3.8.1	When the OLT is ready to churn data for ONU with PON_ID.	M	
4-3-2	Number of sending times of Churning_key_update sent	8.3.8.1	3 times	M	
4-3-3	Format of Churning_key_update	8.3.8.2.1	35th Octet: PON_ID of the destination ONU 36th Octet: 0x09 37th Octet: Goes from 1 to 3	M	
4-3-4	The receive-event of Acknowledge message for Churning_key_update	8.3.8.1	The OLT recognizes the success of Churning_key_update reception.	M	
4-3-5	Priority of Churning_key_update	8.3.8.1	Priority is 1 for the churning_key_update message. The priority level is 0 for the others.	M	
4-3-6	Behaviour after acknowledge of churning_key_update lost	8.3.5.6.6	If the OLT receives no acknowledge after a time-out of 300 ms after sending the last churning_key_update message, the OLT detects the Loss of Acknowledge state (LOAi) for this ONU.	M	

V.5.4.4 Churned_VP message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-4-1	Sending trigger of Churned_VP message	8.3.8.1	When a new VP must be churned or not.	M	
4-4-2	Number of sending times of Churned_VP message	8.3.8.1	3 times	M	
4-4-3	Format of Churned_VP message	8.3.8.2.1	35th Octet: PON_ID of the destination ONU 36th Octet: 0x0F 37th Octet: 0x01: Churned 0x00: Not churned 38th Octet: VPI[11..4] 39th Octet: ijkl 0000: ijkl = VPI[3..0]	M	
4-4-4	The receive-event of Acknowledge message for Churned_VP	8.3.8.1	The OLT recognizes the success of Churned_VP reception.	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-4-5	Behaviour after acknowledge of Churned_VP lost	8.3.5.6.6	If the OLT receives no acknowledge after a time-out of 300 ms after sending the last Churned_VP message, the OLT detects the Loss of Acknowledge state (LOAi) for this ONU.	M	

V.5.5 Verification function

Following conformance parameters are described in this clause:

1) Method of password acquisition;

2) Format of the message relevant to the password acquisition.

Since all the serial numbers of the ONUs can be extracted from downstream PLOAM cells as they are conveyed during the ranging protocol, a malicious user can masquerade another ONU by eavesdropping the PLOAM cells and extract all the serial numbers. By this counteract, the OLT may request the password of the ONU. (i.e., Optional function).

V.5.5.1 Specification

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
5-1-1	The OLT has a table of the passwords of the connected ONUs	8.3.5.7	Initialized on operator command, only a comparison is required of the received password with the local table of valid passwords.	O	
5-1-2	Memorize the password received from the ONU at the first ranging success	8.3.5.7	The first time the ONU is ranged the received password is taken as the valid reference for the rest of the lifecycle of the ONU.	O	

V.5.5.2 Request_password message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
5-2-1	Sending trigger of Request_password message	8.3.8.1	After an ONU is ranged.	C (If Item 5-1-1 and/or Item 5-1-2 are complied with)	
5-2-2	Number of sending times of Request_password message	8.3.8.1	1 time	C (If Item 5-1-1 and/or Item 5-1-2 are complied with)	
5-2-3	Message format of Request_password message	8.3.8.2.1	35th Octet: PON_ID of the destination ONU 36th Octet: 0x0E	C (If Item 5-1-1 and/or Item 5-1-2 are complied with)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
5-2-4	The receive-event of Password message	8.3.8.1 8.3.5.7	If it receives three identical passwords, and password is registered, the OLT declares this password as valid. If password is not registered, inform the operator.	C (If Item 5-1-1 and/or Item 5-1-2 are complied with)	

V.5.6 VP/VC for higher layer

The following conformance parameters are described in this clause:

1) Message format of Configure_VP/VC message;

2) Message flow relevant to Configure_VP/VC message;

3) Behavior caused by the message reception of Configure_VP/VC.

Configure_VP/VC message is used to set up OMCC, therefore all parameters in this clause shall be complied with.

V.5.6.1 Configure_VP/VC message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
6-1-1	Sending trigger of Configure_VP/VC message	8.3.8.1	When the OLT wants to set up or tear down a connection with the ONU, for example, for configuration of the UPC function, filling filtering tables or configuration of the interfaces of the ONU.	M	
6-1-2	Number of sending times of Configure_VP/VC message	8.3.8.1	3 times	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
6-1-3	Format of Configure_VP/VC message	8.3.8.2.1	35th Octet: PON_ID of the destination ONU 36th Octet: 0x0C 37th Octet: 0x01: activates this VP/VC 0x00: deactivates this VP/VC 38th-41st: ATM header 1st-4th 42nd-45th: All the bits of MASK that are set to 1 define the corresponding bits in HEADER that must be used for termination or generation of cells at the ATM layer. MASK4: Only the 4 most significant bits are used	M	
6-1-4	The receive-event of Acknowledge message for Configure_VP/VC message	8.3.8.1	The OLT recognizes the success of Configure_VP/VC reception.	M	
6-1-5	Behavior after acknowledge of Configure_VP/VC lost	8.3.5.6.6	If the OLT receives no acknowledge after a time-out of 300 ms after sending the last Configure_VP/VC message, the OLT detects the Loss of Acknowledge state (LOAi) for this ONU.	M	

V.5.7 Duplex PON system

Parameters in this clause are for PST message.

Specification about Duplex PON is described in ITU-T Rec. G.983.5. Without duplex PON, the OLT and ONU are able to set up PON-link. Parameters in this clause are optional. If the system requires duplex PON, parameters in this clause shall be complied with.

V.5.7.1 PST message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
7-1-1	Sending trigger of PST message	8.3.8.1	Send it at a certain rate	O	
7-1-2	Number of sending times of PST message	8.3.8.1	1 time/second	C (If Item 7-1-1 is complied with)	
7-1-3	Format of PST message	8.3.8.2.1	35th Octet: 0x40 36th Octet: 0x80 37th Octet: Line number 0 or 1 38th Octet: K1 byte as specified in ITU-T Rec. G.783 39th Octet: K2 byte as specified in ITU-T Rec. G.783	C (If Item 7-1-1 is complied with)	

V.5.8 ATM-specific TC functions

The following conformance parameters are described in this clause:

1) Idle cells insertion and discarding;

2) Scrambling and de-scrambling method;

3) Upstream cell delineation method.

To set up PON-link between the OLT and the ONU, parameters in this clause shall be complied with.

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
8-1	Downstream scrambler operation	8.3.6.1.4	As defined in ITU-T Rec. I.432.	M	
8-2	Idle cells insertion in the downstream signal	8.3.6.1.5	When there are no valid cells, the OLT inserts the idle cells in the downstream signal.	M	
8-3	Upstream cell delineation per ONU	8.3.6.2.3	After ranging and one correct delimiter and HEC, the ONU is declared in sync. For eight consecutive incorrect delimiters or HECs, the ONU is declared out of sync (LCDi, Loss of Cell Delineation) and it will be deactivated and re-ranged.	M	
8-4	Upstream de-scrambler operation	8.3.6.2.4	Defined in Figures 22/G.983.1 and 23/G.983.1	M	
8-5	Idle cells discarding in the upstream signal	8.3.6.2.5	Discard	M	
8-6	PLOAM cells discarding in the upstream signal	8.3.6.2.6	Discard at the ATM layer.	M	

V.5.9 OAM functions

The following conformance parameters are described in this clause:

1) Condition of alarm detection and cancellation;
2) Format of PLOAM message relevant to the alarms;
3) Message sending trigger relevant to the alarms;
4) Behaviour caused by the message reception relevant to the alarms.

V.5.9.1 Transmitter failure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-1-1	TF detection	8.3.7.1	The OLT transmitter is declared to have failed when there is no nominal back facet photocurrent or when the drive currents go beyond the maximum specification.	O	

V.5.9.2 Startup failure of ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-2-1	SUFi detection	8.3.7.1	The ranging of ONUi has failed n times (n = 2; refer to 8.4.4.3.3/G.983.1) while the OLT has received optical bursts from this ONU.	M	
9-2-2	The action after SUFi detected	8.3.7.1	Send three times deactivate_PON_ID messages.	M	
9-2-3	SUFi cancellation	8.3.7.1	The ONU is reranged successfully.	M	

V.5.9.3 Physical equipment error of ONUi

Item	Parameter	Reference	Value/Comment	Req	Conf
9-3-1	PEEi detection	8.3.7.1	When the OLT receives a PEE from the ONU.	O	
9-3-2	PEEi cancellation	8.3.7.1	When the OLT does not receive a PEE message from the ONUi in three seconds.	C (If Item 9-3-1 is complied with)	
9-3-3	Sending trigger of Physical_equipment_error message (PEE)	8.3.8.1	When the OLT detects it cannot send both ATM cells and OMCC cells in the direction from ATM layer to TC layer.	O	

Item	Parameter	Reference	Value/Comment	Req	Conf
9-3-4	Number of sending times of PEE message	8.3.8.1	1 time/second	C (If Item 9-3-3 is complied with)	
9-3-5	Format of PEE message	8.3.8.2.1	Octet 35: 0x40 Octet 36: 0x0D	C (If Item 9-3-3 is complied with)	

V.5.9.4 Loss of cell delineation of ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-4-1	LCDi detection	8.3.7.1	When eight consecutive invalid delimiters or invalid HECs from ONUi are received.	M	
9-4-2	The action after LCDi detected	8.3.7.1	Send three times deactivate_PON_ID messages.	M	
9-4-3	LCDi cancellation	8.3.7.1	When cell delineation for ONUi is achieved in the operating state.	M	

V.5.9.5 PLOAM cell loss for ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-5-1	OAMLi detection	8.3.7.1	When three consecutive PLOAM cells of ONUi are missing	M	
9-5-2	The action after OAMLi detected	8.3.7.1	Send three times deactivate_PON_ID messages.	M	
9-5-3	OAMLi cancellation	8.3.7.1	When the OLT receives a PLOAM cell corresponding to its PLOAM grant in the Operating state.	M	

V.5.9.6 Cell phase error for ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-6-1	CPEi detection	8.3.7.1	When the OLT can receive the correct delimiter and the received cell phase is beyond the limits and the corrective actions of the OLT do not solve the problem.	M	
9-6-2	The action after CPEi detected	8.3.7.1	Send three times deactivate_PON_ID messages.	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-6-3	CPEi cancellation	8.3.7.1	When the OLT receives a cell in the correct position in the operating state.	M	

V.5.9.7 Loss of signal of ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-7-1	LOSi detection	8.3.7.1	No valid optical signal at the O/E receiver received for ONUi when expected during eight upstream sequential cells.	M	
9-7-2	The action after LOSi detected	8.3.7.1	Send three times deactivate_PON_ID messages.	M	
9-7-3	LOSi cancellation	8.3.7.1	When the OLT receives a valid optical signal corresponding to its grant in the Operating state.	M	

V.5.9.8 Loss of acknowledge with ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-8-1	LOAi detection	8.3.7.1	The OLT does not receive an acknowledgement from ONUi after a set of downstream messages that imply an upstream acknowledge.	M	
9-8-2	The action after LOAi detected	8.3.7.1	Send three times deactivate_PON_ID messages.	M	
9-8-3	LOAi cancellation	8.3.7.1	When the OLT receives an acknowledgement.	M	

V.5.9.9 Deactivate failure of ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-9-1	DFi detection	8.3.7.1	The ONU does not react correctly after three DACT messages.	O	
9-9-2	DFi cancellation	8.3.7.1	Cancelled by the operator.	C (If Item 9-9-1 is complied with)	

V.5.9.10 Block error detection of ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-10-1	ERRi detection	8.3.7.1	The upstream received BIP-8 is compared with the calculated BIP-8 on the received stream. When there is a difference between them, the OLT issues ERRi.	M	
9-10-2	ERRi cancellation	8.3.7.1	ERRi should be cleared when the next upstream PLOAM cell with a BIP-8 that matches the calculated BIP-8 is received at the OLT from ONUi.	M	

V.5.9.11 Signal degraded of ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-11-1	SDi detection	8.3.7.1	The number of differing bits is accumulated in Error_I during interval Tmeasure. The BER is defined as BER=Error_i/(BW*T measure) where BW is the allocated upstream bandwidth. When the upstream BER of ONUi becomes $\geq 10^{-5}$, this state is entered.	M	
9-11-2	SDi cancellation	8.3.7.1	When the upstream BER of ONUi becomes $<10^{-5}$, this state is cleared.	M	

V.5.9.12 Remote error indication of ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-12-1	REIi detection	8.3.7.1	When the OLT receives a non-zero REI message it issues REIi	M	
9-12-2	REIi cancellation	8.3.7.1	REIi should be cleared when an REI message reporting zero errors is received at OLT from ONUi	M	
9-12-3	The receive-event REI (Remote Error Indication) message	8.3.8.1	Read out the Error count 1-4. The OLT can show the average BER in function of time for an ONU.	M (If indication of average BER per ONU is optional)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-12-4	Sending trigger of BER_interval message	8.3.8.1	OpS defines this interval and can focus on one particular ONU.	M	
9-12-5	Number of sending times of BER_interval sent	8.3.8.1	3 times	M	
9-12-6	Format of BER_interval message	8.3.8.2.1	35th Octet: PON_ID of the destination ONU 36th Octet: 0x81 37th Octet-40th Octet: 32 bit interval	M	
9-12-7	The receive-event of Acknowledge message for BER_interval message	8.3.8.1	The OLT recognizes the success of BER_interval reception.	M	
9-12-8	Behavior after acknowledge of BER_interval lost	8.3.5.6.6	If the OLT receives no acknowledgement after a time-out of 300 ms after sending the last BER_interval message, the OLT detects the Loss of Acknowledge state (LOAi) for this ONU.	M	

V.5.9.13 Message_Error message from ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-13-1	MEMi detection	8.3.7.1	When the OLT receives an unknown message from ONUi or received message_error message.	M	
9-13-2	MEMi cancellation	8.3.7.1	When the operator is informed.	M	

V.5.9.14 Receive alarm inhibition of ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-14-1	R-INHi detection	8.3.7.1	When the OLT receives R-INH message from ONUi, R-INHi is detected.	M	
9-14-2	Action at OLT after R-INHi is detected	8.3.7.1	OLT should ignore alarms from ONUi. Inform OpS.	M	
9-14-3	R-INHi cancellation	8.3.7.1	When the OLT receives a PLOAM cell in the ranging process of ONUi.	M	

V.5.9.15 Link mismatch of ONUi

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-15-1	The receive-event of PST message	8.3.8.1	OLT checks link number with own link number and generates a Link Mismatch MISi if different.	C (If Item 7-1-1 is complied with)	
9-15-2	MIS detection	8.3.7.1	The OLT detects that the received PSTi and the transmitted PST are different.	C (If Item 7-1-1 is complied with)	
9-15-3	MIS cancellation	8.3.7.1	The OLT detects that received PSTi and the transmitted PST are the same.	C (If Item 7-1-1 is complied with)	

V.5.10 Ranging method

The following conformance parameters are described in this clause:

1) Phase relation specification between downstream and upstream;
2) Message flow relevant to the ranging;
3) Message format relevant to the ranging;
4) Behaviour caused by the message reception relevant to the ranging.

To set up PON-link between the OLT and the ONU, parameters in this clause shall be complied with.

V.5.10.1 The installation method of ONUs

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-1-1	PON link range	8.4.1	The operator may provision the PON with minimum (default: 0 km) and maximum (default: 20 km) OLT-ONU distance. The maximum range of the PON is at least 20 km	M	
10-1-2	The implementation of Ranging method-A	8.4.1.1	The serial number of the ONU is registered at the OLT by the OpS system.	M (See Note 1)	
10-1-3	The implementation of Ranging method-B	8.4.1.1	An automatic detection mechanism of the serial number (or soft coded unique number) of the ONU.	M (See Note 1)	
10-1-4	Ranging initiation method-1	8.4.1.1	The network operator enables the ranging process.	M (See Note 2)	
10-1-5	Ranging initiation method-2	8.4.1.1	The OLT periodically and automatically initiates the ranging process.	M (See Note 2)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-1-6	The frequency of polling	8.4.1.1	Less than 1 second	C (If Item 10-1-4 is complied with) (See Note 3)	
NOTE 1 – Ranging method-A and/or Ranging method-B shall be implemented. NOTE 2 – Ranging initiation method-1 and/or ranging initiation method-2 shall be implemented. NOTE 3 – Polling frequency value.					

V.5.10.2 Phase relation specification between downstream and upstream

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-2-1	Phase relation in the normal operation state at 155.52 Mbit/s	8.4.2.3	The following condition should be verified; the maximum value of Td ≥ 32 000 bits	C (If Option-1, Option-2, or Option-4 in Table V.2/G.983.1 is selected)	
10-2-2	Phase relation in the normal operation state at 622.08 Mbit/s	8.4.2.3	The following condition should be verified; the maximum value of Td ≥ 128 000 bits	C (If Option-3, or Option-5 in Table V.2/G.983.1 is selected)	
10-2-3	Granularity of the equalization_delay	8.4.2.4	The granularity of 1 bit.	M	
10-2-4	Ranging window and phase relation	8.4.2.5	Defined in Figure 27/G.983.1	M	
10-2-5	The value of pre-assigned equalization_delay	8.4.2.5	Minimum value is 0	M (See Note 1)	
10-2-6	The interval between opening windows	8.4.2.5	Defined in Figure 29/G.983.1	M (See Note 2)	
10-2-7	The time taken to complete the ranging procedure.	8.4.2.5	Defined in Figure 29/G.983.1	M (See Note 3)	
NOTE 1 – Delay time value. NOTE 2 – Interval value (number of frames). NOTE 3 – Time value (number of frames).					

V.5.10.3 Ranging procedure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-3-1	The receive-event of Serial_number_ONU	8.3.8.1	The OLT extracts the serial number and can assign a free PON_ID to this ONU.	M	
10-3-2	Binary Tree Search	8.4.4.1	Automatic detection mechanism of the serial number (or soft coded unique number) of the ONU.	C (If Item 10-1-2 is complied with)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-3-3	Procedure for the equalization_delay	8.4.4.3.3	A successful equalization_delay measurement is indicated if all of the following conditions are satisfied: 1) a valid PLOAM cell is detected in the ranging window; 2) the Serial_number_ ONU message in the PLOAM cell matches that of the addressed ONU; 3) the measured Td is less than or equal to a certain value (for example; 79 cells); 4) the acquisition phase of the ONU is located in less than or equal to ± 2 bits, compared with the phase of the reference cell.	M	
10-3-4	Maximum period of phase monitoring and updating equalization_delay	8.4.4.3.4	The phases of the cells arriving at the OLT are averaged over a certain period with an appropriate sampling of cells for each ONU, and the updated equalization_delay is sent via the Ranging_time message to that ONU which will adjust its equalization_delay.	M (See Note)	
NOTE – Value of monitoring period.					

V.5.10.4 Upstream_RX_control message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-4-1	Sending trigger of Upstream_RX_control message	8.3.8.1	Each time a ranging process is started.	O	
10-4-2	Number of sending times of Upstream_RX_control message	8.3.8.1	3 times	C (If Item 10-4-1 is complied with)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-4-3	Format of Upstream_RX_control message	8.3.8.2.1	35th Octet: 0x40 36th Octet: 0x01 37th Octet: Submessage count n n can be 0x00 or 0x01. It indicates which part of the RXCF field is indicated in the remaining octets of this message 38th Octet-46th Octet: n = 0x00: RXCF 1-9 n = 0x01: RXCF 10-16	C (If Item 10-4-1 is complied with)	

V.5.10.5 Upstream_overhead message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-5-1	Sending trigger of Upstream_overhead message	8.3.8.1	Each time a ranging process is started.	M	
10-5-2	Number of sending times of Upstream_overhead message	8.3.8.1	3 times	M	
10-5-3	Format of Upstream_overhead message	8.3.8.2.1	35th Octet: 0x40 36th Octet: 0x02 37th Octet: Number of guard bits of the upstream overhead. This range is [4..24] 38th-40th Octet: overhead byte 1-3	M	

V.5.10.6 Serial_number_mask message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-6-1	Sending trigger of Serial_number_mask message	8.3.8.1	To find the serial number of a unique ONU.	M	
10-6-2	Number of sending times of Serial_number_mask message	8.3.8.1	1 time	M	
10-6-3	Format of Serial_number_mask	8.3.8.2.1	35th Octet: 0x40 36th Octet: 0x04 37th Octet: Number of valid bits, count started from LSB of byte 45 counting up to the MSB of byte 38 38th Octet-45th Octet: Serial number byte 1-8	M	

V.5.10.7 Assign_PON_ID message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-7-1	Sending trigger of Assign_PON_ID message	8.3.8.1	When the OLT has found the serial number of a unique ONU.	M	
10-7-2	Number of sending times of Assign_PON_ID sent	8.3.8.1	3 times	M	
10-7-3	Format of Assign_PON_ID message	8.3.8.2.1	35th Octet: 0x40 36th Octet: 0x05 37th Octet: PON_ID The range is [0..63] 38th Octet-45th Octet: Serial number byte 1-8	M	

V.5.10.8 Grant_allocation message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-8-1	Sending trigger of Grant_allocation message	8.3.8.1	After a PON_ID is allocated to the ONU.	M	
10-8-2	Number of sending times of Grant_allocation message	8.3.8.1	3 times	M	
10-8-3	Format of Grant_allocation message	8.3.8.2.1	35th Octet: PON_ID of the destination ONU 36th Octet: 0x0A 37th Octet: data grant 38th Octet: 0x01 = Activate data grant for this ONU 0x00 = Deactivate data grant for this ONU 39th Octet: PLOAM grant 40th Octet: 0x01 = Activate PLOAM grant for this ONU 0x00 = Deactivate PLOAM grant for this ONU	M	

V.5.10.9 Ranging_time message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-9-1	Sending trigger of Ranging_time message	8.3.8.1	When the OLT decides that the delay must be updated.	M	
10-9-2	Number of sending times of Ranging_time message	8.3.8.1	3 times	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-9-3	Format of Ranging_time message	8.3.8.2.1	35th Octet: PON_ID of the destination ONU 36th Octet: 0x03 37th Octet-39th Octet: delay	M	

V.5.10.10 Deactivate_PON_ID message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-10-1	Sending trigger of Deactivate_PON_ID message	8.3.8.1	When the LOSi, LCDi, OAMLi, LOAi, SUFi or CPEi are detected.	M	
10-10-2	Number of sending times of Deactivate_PON_ID message	8.3.8.1	3 times	M	
10-10-3	Format of Deactivate_PON_ID message	8.3.8.2.1	35th Octet: PON_ID of the destination ONU 36th Octet: 0x06	M	

V.5.10.11 Disable_serial_number message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-11-1	Sending trigger of Disable_serial_number message	8.3.8.1	On command from the OpS.	M	
10-11-2	Number of sending times of Disable_serial_number message	8.3.8.1	3 or until no burst is detected.	M	
10-11-3	Format of Disable_serial_number message	8.3.8.2.1	35th Octet: 0x40 36th Octet: 0x07 37th Octet: 0xFF: The ONU with this serial number is denied upstream access. 0x0F: All ONUs which were denied upstream access, can participate in ranging process. The content of byte 38~45 are irrelevant. 0x00: The ONU with this serial number can participate in the ranging process. 38th Octet-45th Octet: Serial number byte 1-8	M	

V.5.10.12 POPUP message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-12-1	Sending trigger of POPUP message	8.3.8.1	To speed up the re-ranging of a subset or all of these connected ONUs.	O	
10-12-2	Number of sending times of POPUP message	8.3.8.1	3 times	C (If Item 10-12-1 is complied with)	
10-12-3	Format of POPUP message	8.3.8.2.1	Octet 35: 0x40 Octet 36: 0x10	C (If Item 10-12-1 is complied with)	

V.5.10.13 Ranging time requirements

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-13-1	Cold PON, cold ONU, each ONU, Method-A	8.4.5	2 s	C (If Item of 10-1-1 is complied with)	
10-13-2	Cold PON, cold ONU, each ONU, Method-B	8.4.5	10 s	C (If Item 10-1-2 is complied with)	
10-13-3	Warm PON, cold ONU, one ONU, Method-A	8.4.5	1s	C (If Item 10-1-1 is complied with)	
10-13-4	Warm PON, cold ONU, one ONU, Method-B	8.4.5	3 s	C (If Item 10-1-2 is complied with)	
10-13-5	Warm PON, cold ONU, 31 ONU, Method-A/B	8.4.5	93 s	M	
10-13-6	Warm PON, warm ONU, 16 ONU, Method-A	8.4.5	100 ms	O	

Appendix VI

PICS for ONU

VI.1 Scope

This appendix specifies PICS for ONU in ITU-T Rec. G.983.1. It does not require any modifications of ITU-T Rec. G.983.1.

VI.2 Definitions

This appendix applies the following definitions in PICS[1] tables.

Req: **Requirement**. This column indicates whether the conformance requirement of a particular clause in the standard is mandatory, optional, or conditional.

Conf: **Conformance result**. Compliance or not will be indicated.

M: **Mandatory**. Conformance cannot be approved unless the parameter is implemented as specified.

O: **Optional**. The parameter may be implemented or not but, if implemented, it must be as stated in the standard.

C: **Conditional**. If an associated major option is implemented, this parameter must be implemented.

VI.3 Abbreviations

PICS Protocol Implementation Conformance Statement

VI.4 Conventions

Description in this Recommendation is also applied to "ONT".

VI.5 Overview of PICS for ONU

Contents in the PICS tables are summarized in Table VI.1/G.983.1.

Table VI.1/G.983.1 – Protocol summary

Item	Parameter	Clause in G.983.1	Req	Conf
1	Optical and related items	VI.6.1	M	
2	Structure of TC frame	VI.6.2	M	
3	Divided_slots	VI.6.3	O	
4	Churning	VI.6.4	M	
5	Verification function	VI.6.5	O	
6	VP/VC for higher layer	VI.6.6	M	
7	Duplex PON system	VI.6.7	O	
8	ATM specific TC functions	VI.6.8	M	
9	OAM functions	VI.6.9	Depending on the parameter	
10	Ranging method	VI.6.10	M	

There are 5 options depending on the bit rate as shown in Table VI.2/G.983.1.

Table VI.2/G.983.1 – Possible options according to the bit rate

		Downstream bit rate (Mbit/s)		
		155.52	622.08	1244.16
Upstream bit rate (Mbit/s)	155.52	Option 1	Option 2	Option 4
	622.08	N/A	Option 3	Option 5

VI.6 PICS proforma tables

VI.6.1 Optical and related items

Parameters in this clause are for optical and related items.

To set up PON-link between the OLT and the ONU, parameters in this clause shall be complied with.

VI.6.1.1 Optical interface parameters of downstream direction

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-1-1	Maximum reflectance of equipment, measured at receiver wavelength	8.2.1	less than –20 dB	M	
1-1-2	Bit error ratio	8.2.1	less than 10^{-10}	M	
1-1-3	Minimum sensitivity at 155.52 Mbit/s	8.2.1	Single fibre/Class B −30 dBm Single fibre/Class C −33 dBm Dual fibre/Class B −30 dBm Dual fibre/Class C −33 dBm	C (If Option 1 in Table VI.2/G.983.1 is selected)	
1-1-4	Minimum sensitivity at 622.08 Mbit/s	8.2.1	Single fibre/Class A −28 dBm Single fibre/Class B −28 dBm Single fibre/Class C −33 dBm Dual fibre/Class A −28 dBm Dual fibre/Class B −28 dBm Dual fibre/Class C −33 dBm	C (If Option 2 or Option 3 in Table VI.2/G.983.1 is selected)	
1-1-5	Minimum sensitivity at 1244.16 Mbit/s	8.2.1	Single fibre/Class A −25 dBm Single fibre/Class B −25 dBm Single fibre/Class C −26 dBm Dual fibre/Class A −25 dBm Dual fibre/Class B −25 dBm Dual fibre/Class C −25 dBm	C (If Option 4 or Option 5 in Table VI.2/G.983.1 is selected)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-1-6	Minimum overload at 155.52 Mbit/s	8.2.1	Single fibre/Class B −8 dBm Single fibre/Class C −11 dBm Dual fibre/Class B −9 dBm Dual fibre/Class C −12 dBm	C (If Option 1 in Table VI.2/G.983.1 is selected)	
1-1-7	Minimum overload at 622.08 Mbit/s	8.2.1	Single fibre/Class A −6 dBm Single fibre/Class B −6 dBm Single fibre/Class C −11 dBm Dual fibre/Class A −7 dBm Dual fibre/Class B −7 dBm Dual fibre/Class C −12 dBm	C (If Option 2 or Option 3 in Table VI.2/G.983.1 is selected)	
1-1-8	Minimum overload at 1244.16 Mbit/s	8.2.1	Single fibre/Class A −4 dBm Single fibre/Class B −4 dBm Single fibre/Class C −4 dBm Dual fibre/Class A −4 dBm Dual fibre/Class B −4 dBm Dual fibre/Class C −4 dBm	C (If Option 4 or Option 5 in Table VI.2/G.983.1 is selected)	
1-1-9	Consecutive identical digit immunity	8.2.1	more than 72 bits	M	
1-1-10	Jitter tolerance	8.2.1	Meets requirement of Figure 9/G.983.1	M	
1-1-11	Tolerance to the reflected optical power	8.2.1	less than 10 dBm	M	

VI.6.1.2 Optical interface parameters of upstream direction

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-2-1	Operating wavelength at 155.52 Mbit/s	8.2.1	1260-1360 nm	C (If Option 1, Option 2, or Option 4 in Table VI.2/G.983.1 is selected)	
1-2-2	Operating wavelength at 622.08 Mbit/s	8.2.1	MLM type 1 or SLM: 1260-1360 MLM type 2: 1280-1350 MLM type 3: 1288-1338	C (If Option 3, or Option 5 in Table VI.2/G.983.1 is selected)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-2-3	Line code	8.2.1	Scrambled NRZ	M	
1-2-4	Mask of the transmitter eye diagram	8.2.1	Meets requirement of Figure 7/G.983.1	M	
1-2-5	Maximum reflectance of equipment, measured at transmitter wavelength	8.2.1	less than –6 dB	M	
1-2-6	Minimum ORL of ODN at O_{ru} and O_{rd}	8.2.1	more than 32 dB	M	
1-2-7	Mean launched power MIN at 155.52 Mbit/s	8.2.1	Single fibre/Class B –4 dBm Single fibre/Class C –2 dBm Dual fibre/Class B –4 dBm Dual fibre/Class C –2 dBm	C (If Option 1, Option 2, or Option 4 in Table VI.2/G.983.1 is selected)	
1-2-8	Mean launched power MIN at 622.08 Mbit/s	8.2.1	Class A –6 dBm Class B –1 dBm Class C –1 dBm	C (If Option 3, or Option 5 in Table VI.2/G.983.1 is selected)	
1-2-9	Mean launched power MAX at 155.52 Mbit/s	8.2.1	Single fibre/Class B +2 dBm Single fibre/Class C +4 dBm Dual fibre/Class B +1 dBm Dual fibre/Class C +3 dBm	C (If Option 1, Option 2, or Option 4 in Table VI.2/G.983.1 is selected)	
1-2-10	Mean launched power MAX at 622.08 Mbit/s	8.2.1	Class A –1 dBm Class B +4 dBm Class C +4 dBm	C (If Option 3, or Option 5 in Table VI.2/G.983.1 is selected)	
1-2-11	Launched optical power without input to the transmitter	8.2.1	less than Min sensitivity –10 dBm	M	
1-2-12	Extinction ratio	8.2.1	more than 10 dB	M	
1-2-13	Tolerance to the transmitter incident light power	8.2.1	more than –15 dB	M	
1-2-14	If MLM Laser – Maximum RMS width for 155.52 Mbit/s	8.2.1	5.8 nm	C (If Option 1, Option 2, or Option 4 in Table VI.2/G.983.1 is selected)	
1-2-15	If MLM Laser – Maximum RMS width for 622.08 Mbit/s	8.2.1	MLM type 1: 1.4 MLM type 2: 2.1 MLM type 3: 2.7	C (If Option 3 or Option 5 in Table VI.2/G.983.1 is selected)	
1-2-16	If SLM Laser – Maximum –20 dB width	8.2.1	1 nm	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-2-17	If SLM Laser – Minimum side mode suppression ratio	8.2.1	30 dBm	M	
1-2-18	Jitter transfer	8.2.1	Meets requirement of Figure 8/G.983.1	M	
1-2-19	Jitter generation from 0.5 kHz to 1.3 MHz	8.2.1	0.2 UI ptp	M	

VI.6.1.3 Line code

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
1-3-1	High level of light emission for the downstream direction	8.2.4	Binary ONE	M	
1-3-2	Low level of light emission for the downstream direction	8.2.4	Binary ZERO	M	
1-3-3	High level of light emission for the upstream direction	8.2.4	Binary ONE	M	
1-3-4	Low level of light emission for the upstream direction	8.2.4	Binary ZERO	M	

VI.6.2 Structure of TC frame

The following conformance parameters are described in this clause:

1) TC frame structure;

2) PLOAM structure.

To set up PON-link between the OLT and the ONU, parameters in this clause shall be complied with.

VI.6.2.1 Frame structure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-1-1	Frame structure for 155/155 Mbit/s PON	8.3.5.1	Defined in Figure 11/G.983.1	C (If Option 1 in Table VI.2/G.983.1 is selected)	
2-1-2	Frame structure for 622/155 Mbit/s PON	8.3.5.1	Defined in Figure 12/G.983.1	C (If Option 2 in Table VI.2/G.983.1 is selected)	
2-1-3	Frame structure for 622/622 Mbit/s PON	8.3.5.1	Defined in Figure 13/G.983.1	C (If Option 3 in Table VI.2/G.983.1 is selected)	
2-1-4	Frame structure for 1244/155 Mbit/s PON	8.3.5.1	Defined in Figure 14/G.983.1	C (If Option 4 in Table VI.2/G.983.1 is selected)	
2-1-5	Frame structure for 1244/622 Mbit/s PON	8.3.5.1	Defined in Figure 15/G.983.1	C (If Option 5 in Table VI.2/G.983.1 is selected)	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-1-6	PLOAM header pattern	8.3.5.2	Meets requirement of Table 7/G.983.1	M	

VI.6.2.2 Downstream PLOAM structure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-2-1	Payload content of PLOAM cell	8.3.5.3	Meets requirement of Table 8/G.983.1	M	
2-2-2	Contents of the IDENT byte	8.3.5.3.2	Meets requirement of Table 9/G.983.1	M	
2-2-3	PLOAM should be processed as long as no OAML/FRML/LCD/LOS is detected.	8.3.5.3.1		M	
2-2-4	PLOAM cells arriving in unexpected slots should be discarded	8.3.5.3.1		M	
2-2-5	Frame synchronization	8.3.5.3.3	Meets requirement of Figure 16/G.983.1	M	
2-2-6	Synchronization field (SYNC1-SYNC2)	8.3.5.3.4	Meets requirement of Figure 17/G.983.1	O	
2-2-7	Reception of the Data grant	8.3.5.3.5	Send a data cell or an idle cell if no data cell is available.	M	
2-2-8	Reception of the PLOAM grant	8.3.5.3.5	Send a PLOAM cell in response to this grant.	M	
2-2-9	Reception of the Divided_slot grant	8.3.5.3.5	Send a minislot.	O	
2-2-10	Reception of the Unassigned grant	8.3.5.3.5	The ONU does not send any cells.	M	
2-2-11	Reception of the Idle grant	8.3.5.3.5	The ONU does not send any cells.	M	
2-2-12	Reception of Ranging grant	8.3.5.3.5	Send ranging cell in response to this grant	M	
2-2-13	Grants protection Grants processing as long as there is no LOS/LCD, and regardless of header correctness. When error is detected in a grant block, the entire block is ignored.	8.3.5.3.6	A Cyclic Redundancy Check (CRC) protects a group of seven grants. The generating CRC polynomial for the grants is: $g(x) = x^8 + x^2 + x + 1$	M	
2-2-14	MESSAGE field protection Message is processed regardless of header correctness	8.3.5.3.7	The message will be discarded at reception when the CRC is incorrect. The generating CRC polynomial for the grants is: $g(x) = x^8 + x^2 + x + 1$	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-2-15	The range of MESSAGE_PON_ID	8.3.5.3.7	For a particular ONU, from 0x00 to 0x3F shall be mapped. For a broadcast, 0x40 is set to this field.	M	
2-2-16	Monitoring the BER on the downstream link	8.3.5.3.8	A one byte BIP-8 in each PLOAM cell covers $28 \times 53 - 1$ bytes or 1483 bytes between two consecutive BIPs.	M	

VI.6.2.3 Upstream PLOAM structure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-3-1	Payload content of PLOAM cell	8.3.5.4	Meets requirement of Table 12/G.983.1	M	
2-3-2	Contents of the IDENT byte	8.3.5.4.2	Meets requirement of Table 13/G.983.1	M	
2-3-3	MESSAGE field protection	8.3.5.4.3	The generating CRC polynomial for the grants is: $g(x) = x^8 + x^2 + x + 1$	M	
2-3-4	Monitoring the BER on the upstream link	8.3.5.4.4	A one byte BIP-8 in each PLOAM cell is calculated by the ONU on all the bytes from the cells (though not the overhead bytes) it sent between two consecutive BIPs except the overhead bytes and minislots.	M	
2-3-5	The use of Laser Control Field	8.3.5.4.5	The ONU programs this field	O	

VI.6.2.4 Downstream messages flow

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-4-1	The processing time of all downstream messages	8.3.8	Within 6 Tframes	M	

VI.6.2.5 No message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-5-1	Sending trigger of the No message	8.3.8.1	Empty message queue.	M	
2-5-2	Format of No message in the upstream PLOAM channel	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x00	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-5-3	The receive-event of No message in the downstream PLOAM channel	8.3.8.1	Discard	M	

VI.6.2.6 Vendor-specific message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
2-6-1	Sending trigger of Vendor-specific message	8.3.8.1	Vendor specific.	O	
2-6-2	Format of Vendor-specific message in the upstream PLOAM channel	8.3.8.2.2	2nd Octet: xxxx xxxx(b) Directed message to one ONU or broadcast 3rd Octet: 0111 1zzz(b) 4th Octet-13th Octet: yyyy yyyy Vendor specific.	C (If Item 2-6-1 is complied with)	
2-6-3	The receive-event of Vendor-specific message in the downstream PLOAM channel	8.3.8.1	Vendor specific	O	

VI.6.3 Divided_slots

Parameters in this clause are for Divided_slot_configuration message.

Divided_slots are used for DBA function. Specifications about DBA function are described in ITU-T Rec. G.983.4. Without DBA function, the OLT and the ONU are able to set up PON-link. Parameters in this clause are optional. If the system requires divided_slots, parameters in this clause shall be complied with.

VI.6.3.1 The receive-event of Divided_Slot_Grant_ configuration message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
3-1-1	The receive-event of Divided_Slot_Grant_ configuration message	8.3.8.1	The ONU sends the minislot after receiving this allocated divided_slot. If deallocated, the ONU no longer reacts to this Divided_Slot_grant.	O	
3-1-2	Format of Divided_slots	8.3.5.5	(See Note)	C (If Item 3-1-1 is complied with)	
NOTE – Refer to ITU-T Rec. G.983.4.					

VI.6.4 Churning

The following conformance parameters are described in this clause:

1) De-coding method of churning;

2) Message flow for the churning function;

3) Format of the message relevant to the churning function;

4) Behaviour caused by the message reception relevant to churning function.

Due to the multicast nature of the PON, downstream cells are churned at the TC layer. Parameters in this clause shall be complied with.

VI.6.4.1 Specification

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-1-1	Dechurn in ONU	8.3.5.6.3 8.3.5.6.4	Defined in Figure 19/G.983.1	M	
4-1-2	Churning enable/disable unit	8.3.5.6	The churning is performed for point to point downstream connections and churning can only be enabled or disabled per VP at its setup.	M	
4-1-3	Generation of churn key	8.3.5.6.1	Churn key is calculated by Exclusive OR of a 3 byte randomly generated number and 3 byte data extracted from upstream user data to increase security robustness. These 3 byte codes are defined as X1 ~ X8, P1 ~ P15 and P16.	M	
4-1-4	Churning message flow	8.3.5.6.6	Defined in Figure 20/G.983.1	M	
4-1-5	Dechurning start timing	8.3.5.6.6	Dechurning starts after completion of churning message flow	M	

VI.6.4.2 The receive-event of New_churning_key_request message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-2-1	The receive-event of New_churning_key_request message	8.3.8.1	The ONU generates a new key and conveys the key to the OLT with a new_churning_key message.	M	
4-2-2	Sending trigger of New_churning_key message	8.3.8.1	After the OLT request, the ONU fetches a new key and sends it to the OLT.	M	
4-2-3	Number of New_churning_key message sent	8.3.8.1	3 times	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-2-4	Format of New_churning_key message	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x01 4th Octet: (MSB) X1, X2, ..., X8 (LSB) 5th Octet: (MSB) P1, P2, ..., P8 6th Octet: P9, P10, ..., P16 (LSB)	M	

VI.6.4.3 The receive-event of Churning_key_update message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-3-1	The receive-event of Churning_key_update message	8.3.8.1	The ONU switches to the new churning key 48*Tframe after the first update message. Send one acknowledge after each correctly received message.	M	
4-3-2	Number of Acknowledge message for Churning_key_update	8.3.8.1	1 time	M	
4-3-3	Response time of Acknowledge message for Churning_key_update	8.3.8.1	Less than 300 ms	M	
4-3-4	Priority of Acknowledge message for Churning_key_update	8.3.8.1	Priority is 1. The priority level is 0 for the others.	M	
4-3-5	Format of Acknowledge message for Churning_key_update	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x02 4th Octet: Message identification of downstream message 5th Octet-13th Octet: Byte 37-45 of downstream message	M	

VI.6.4.4 The receive-event of Churned_VP message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-4-1	The receive-event of Churned_VP message	8.3.8.1	Mark this VP as churning. Send one acknowledge after each correctly received message.	M	
4-4-2	Number of Acknowledge message for Churned_VP	8.3.8.1	1 time	M	
4-4-3	Response time of Acknowledge message for Churned_VP	8.3.8.1	Less than 300 ms	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-4-4	Format of Acknowledge message for Churned_VP	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x02 4th Octet: Message identification of downstream message 5th Octet-13th Octet: Byte 37-45 of downstream message	M	

VI.6.4.5 Sending trigger of Big_Key message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
4-5-1	Sending trigger of Big_Key message	8.3.8.1	After the OLT request, the ONU fetches a new key and sends it to the OLT	O	
4-5-2	Number of Big_Key message sent	8.3.8.1	3	C (If Item 4-5-1 is complied with)	
4-5-3	Format of Big_Key message	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x06 4th Octet: Key_Index 5th Octet: Frag_Index 6th Octet-13th Octet: KeyBYTE 0-7	C (If Item 4-5-1 is complied with)	

VI.6.5 Verification function

Parameters in this clause are for the format of the message relevant to the password acquisition.

Since all the serial numbers of the ONUs can be extracted from downstream PLOAM cells as they are conveyed during the ranging protocol, a malicious user can masquerade another ONU by eavesdropping the PLOAM cells and extract all the serial numbers. By this counteract, the OLT may request the password of the ONU (i.e., Optional function).

VI.6.5.1 The receive-event of Request_password message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
5-1-1	The receive-event of Request_password message	8.3.8.1	Send the password message three times.	O	
5-1-2	Sending trigger of Password message	8.3.8.1	When the OLT requests the password by the request_ password message.	O	
5-1-3	Number of Password message sent	8.3.8.1	3	O	
5-1-4	Format of Password message	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x04 4th Octet-13th Octet: Password 1-password 10	O	

VI.6.6 VP/VC for higher layer

The following conformance parameters are described in this clause:

1) Message format of Configure_VP/VC message;

2) Message flow relevant to Configure_VP/VC message;

3) Behavior caused by the message reception of Configure_VP/VC.

Configure_VP/VC message is used to set up OMCC, therefore, all parameters in this clause shall be complied with.

VI.6.6.1 The receive-event of Configure_VP/VC message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
6-1-1	The receive-event of Configure_VP/VC message	8.3.8.1	The ONU activates/deactivates these VP/VCs for the communication channel. Send one acknowledge after each correctly received message.	M	
6-1-2	Number of Acknowledge message for Configure_VP/VC	8.3.8.1	1 time	M	
6-1-3	Response time of Acknowledge message for Configure_VP/VC	8.3.8.1	Less than 300 ms	M	
6-1-4	Format of Acknowledge message for Configure_VP/VC	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x02 4th Octet: Message identification of downstream message 5th Octet-13th Octet: Byte 37-45 of downstream message	M	

VI.6.7 Duplex PON system

Parameters in this clause are for message format of PST message.

Specification about Duplex PON is described in ITU-T Rec. G.983.5. Without duplex PON, the OLT and ONU are able to set up PON-link. Parameters in this clause are optional. In cases where the system requires duplex PON, parameters in this clause shall be complied with.

VI.6.7.1 PST message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
7-1-1	Sending trigger of PST message	8.3.8.1	1 time/second	O	
7-1-2	Format of PST message	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x82 4th Octet: Line number 0 or 1 5th Octet: K1 byte as specified in ITU-T Rec. G.783 6th Octet: K2 byte as specified in ITU-T Rec. G.783	C (In Item 7-1-1)	

VI.6.8 ATM-specific TC functions

The following conformance parameters are described in this clause:

1) Idle cells insertion and discarding;
2) Scrambling and de-scrambling method;
3) Downstream cell delineation.

To setup PON-link between the OLT and the ONU, parameters in this clause shall be complied with.

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
8-1	Downstream cell delineation	8.3.6.1.3	As defined in ITU-T Rec. I.432	M	
8-2	Downstream de-scrambler operation	8.3.6.1.4	As defined in ITU-T Rec. I.432.	M	
8-3	Idle cells discarding in the downstream signal.	8.3.6.1.5	Discard	M	
8-4	PLOAM cells discarding in the downstream signal.	8.3.6.1.6	Defined in 8.3.5.3.1/G.983.1	M	
8-5	Scrambler operation	8.3.6.2.4	Defined in Figures 22 and 23/G.983.1	M	
8-6	Idle cells insertion	8.3.6.2.5	The ONU sends an idle cell, as defined in ITU-T Rec. I.432, when it receives a data grant and has no cells available.	M	

VI.6.9 OAM functions

The following conformance parameters are described in this clause:

1) Condition of alarm detection and cancellation;
2) Format of PLOAM message relevant to the alarms;
3) Message sending trigger relevant to the alarms;
4) Behaviour caused by the message reception relevant to the alarms.

VI.6.9.1 Transmitter failure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-1-1	TF detection	8.3.7.2	The ONU transmitter is declared to have failed when there is no nominal back facet photocurrent, or when the drive currents go beyond the maximum specification.	O	

VI.6.9.2 Loss Of Signal

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-2-1	LOS detection	8.3.7.2	No valid optical signal.	M	
9-2-2	The action after LOS detected	8.3.7.2	Switch off laser	M	
9-2-3	LOS cancellation	8.3.7.2	Valid optical signal.	M	

VI.6.9.3 Physical_Equipment_error

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-3-1	PEE detection	8.3.7.2	When the ONU receives a Physical_equipment_ error message (PEE).	O	
9-3-2	PEE cancellation	8.3.7.2	When the ONU does not receive a PEE message in three seconds.	C (If Item 9-3-1 is complied with)	
9-3-3	Sending trigger of Physical_equipment_error message	8.3.8.1	When the ONU detects it cannot send both ATM cells and OMCC Cells in the direction from ATM layer to TC layer.	O	
9-3-4	Number of sending times of Physical_equipment_error message	8.3.8.1	1 time/second	C (If Item 9-3-3 is complied with)	
9-3-5	Format of Physical_equipment_error message	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x05	C (If Item 9-3-3 is complied with)	

VI.6.9.4 Startup failure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-4-1	SUF detection	8.3.7.2	The ranging of this ONU has failed (see ranging protocol for exact condition).	M	
9-4-2	SUF cancellation	8.3.7.2	When ranging is successful.	M	

VI.6.9.5 PLOAM cell loss

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-5-1	OAML detection	8.3.7.2	When three consecutive PLOAM headers are wrong.	M	
9-5-2	The action after OAML detected	8.3.7.2	Switch off laser	M	
9-5-3	OAML cancellation	8.3.7.2	OAM sync when three consecutive correct PLOAM headers.	M	

VI.6.9.6 Loss of cell delineation

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-6-1	LCD detection	8.3.7.2	When seven consecutive ATM cells have an invalid HEC.	M	
9-6-2	The action after LCD detected	8.3.7.2	Switch off laser	M	
9-6-3	LCD cancellation	8.3.7.2	When N consecutive ATM cells have correct HEC (N = 9 or 17).	M	

VI.6.9.7 FRML loss of downstream frame

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-7-1	FRML detection	8.3.7.2	When the frame bit is "0" for three consecutive frames.	M	
9-7-2	The action after FRML detected	8.3.7.2	Switch off laser	M	
9-7-3	FRML cancellation	8.3.7.2	When frame bit is "1" for three consecutive frames.	M	

VI.6.9.8 Block error detection

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-8-1	ERR detection	8.3.7.2	The downstream received BIP-8 is compared with the calculated BIP-8 on the received stream. The number of differing bits is accumulated in ERR.	M	
9-8-2	ERR status update	8.3.7.2	ERR is renewed at every reception of a downstream PLOAM cell.	M	
9-8-3	Sending trigger of REI (Remote Error Indication) message	8.3.7.2 8.3.8.1	When the BER_interval has expired.	M	
9-8-4	Number of sending times of REI (Remote Error Indication) message	8.3.8.1	1 time/BER_interval	M	
9-8-5	Format of REI (Remote Error Indication) message	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x80 4th Octet-7th Octet: 32 bit error counter 4: MSB side Octet 7: LSB side Octet 8: Sequence number. The 4 LSB bits SSSS are incremented every time this message is sent.	M	
9-8-6	The receive-event of BER_interval message	8.3.5.3.8 8.3.7.2 8.3.8.1	The ONU starts a BER_interval timer and accumulates the downstream bit errors. Send one acknowledge after each correctly received message. The sequence number in the REI messages is reset.	M	
9-8-7	BER_interval timer range	8.3.8.2.1	32 bit	M	

VI.6.9.9 Signal degraded

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-9-1	SD detection	8.3.7.2	Set active when the downstream BER $\geq 10^{-5}$	M	
9-9-2	SD cancellation	8.3.7.2	Set inactive when the downstream BER is $<10^{-5}$	M	

VI.6.9.10 Message error message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-10-1	MEM detection	8.3.7.2	When the ONU receives an unknown message.	M	
9-10-2	The action after MEM detected	8.3.7.2	Sending upstream Message_error message	M	
9-10-3	Number of sending times of Message_error message	8.3.8.1	3 times	M	
9-10-4	Format of Message_error message	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x83 4th Octet: Indicates unrecognized downstream message_id	M	

VI.6.9.11 Deactivate PON_ID

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-11-1	DACT detection	8.3.7.2	Reception of the Deactivate_PON_ID message addressed to this ONU, requesting the ONU to deactivate itself.	M	
9-11-2	The action after DACT detected	8.3.7.2	Switch off the laser and go to state O2.	M	
9-11-3	DACT cancellation	8.3.7.2	Reception of Upstream_overhead message.	M	

VI.6.9.12 Disabled ONU

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-12-1	DIS detection	8.3.7.2	When the ONU receives a Disable_serial_number message with its own serial number and the enable flag = 0xFF. It stays in this state even after power off.	M	
9-12-2	The action after DIS detected	8.3.7.2	Switch off laser. Go to Emergency Stop State O9.	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-12-3	DIS cancellation	8.3.7.2	When the ONU receives a Disable_serial_number message with Enable flag = 0x0F or when it receives a Disable_serial_number message with its own serial number and the enable flag = 0x00.	M	

VI.6.9.13 Link mismatching

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-13-1	MIS detection	8.3.7.2	The ONU detects that the received PST and transmitted PST are different.	C (If Item 7-1-1 is complied with)	
9-13-2	MIS cancellation	8.3.7.2	The ONU detects that the received PST and transmitted PST are the same.	C (If Item 7-1-1 is complied with)	
9-13-3	The receive-event of PST message	8.3.8.1	ONU checks link number with own link number and generates a Link Mismatch MIS if different.	C (If Item 7-1-1 is complied with)	

VI.6.9.14 R-INH message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
9-14-1	Sending trigger of R-INH message	8.3.8.1	The ONU generates this message when the power-off (such as the power switch off or the power cord extraction without battery backup) is activated in a normal operation.	M	
9-14-2	Number of sending times of R-INH message	8.3.8.1	At least 3 times	M	
9-14-3	Priority of R-INH message	8.3.8.1	Priority is 2	M	
9-14-4	Format of R-INH message	8.3.8.2.2	2nd Octet: PON_ID 3rd Octet: 0x81	M	

VI.6.10 Ranging method

The following conformance parameters are described in this clause:

1) Phase relation specification between downstream and upstream;
2) Message flow relevant to the ranging;
3) Message format relevant to the ranging;

4) Behaviour caused by the message reception relevant to the ranging.

To set up a PON-link between the OLT and the ONU, parameters in this clause shall be complied with.

VI.6.10.1 Phase relation specification between downstream and upstream

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-1-1	ONU response time specification for 155.52 Mbit/s	8.4.2.2	The following condition should be verified; 3136 bits ≤ Tresponse(ONU) ≤ 4032 bits	C (If Option-1, Option-2, or Option-4 in Table VI.2/G.983.1 is selected)	
10-1-2	ONU response time specification for 622.08 Mbit/s	8.4.2.2	The following condition should be verified; 6272 bits ≤ Tresponse(ONU) ≤ 8064 bits	C (If Option-3, or Option-5 in Table VI.2/G.983.1 is selected)	
10-1-3	Phase relation in the normal operation state for 155.52 Mbit/s	8.4.2.3	The following condition should be verified; the maximum value of Td ≥ 32 000 bits	C (If Option-1, Option-2, or Option-4 in Table VI.2/G.983.1 is selected)	
10-1-4	Phase relation in the normal operation state for 622.08 Mbit/s	8.4.2.3	The following condition should be verified; the maximum value of Td ≥ 128 000 bits	C (If Option-3, or Option-5 in Table VI.2/G.983.1 is selected)	
10-1-5	Granularity of the equalization_delay	8.4.2.4	The granularity of 1 bit	M	
10-1-6	Pre-assigned equalization_delay (Te)	8.4.2.5.2	When the ONU receives the ranging grant it will respond with a ranging cell after a pre-assigned equalization_delay (Te) plus Tresponse(ONU).	M	

VI.6.10.2 The receive-event of Upstream_RX_control message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-2-1	The receive-event of Upstream_RX_control message	8.3.5.4.6 8.3.8.1	The ONU sets the upstream RXCF field of the upstream PLOAM cell.	M	

VI.6.10.3 The receive-event of Upstream_overhead message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-3-1	The receive-event of Upstream_overhead message in the Ranging standby state 1.	8.3.8.1 8.4.4.2.2	The ONU sets the upstream overhead and the pre-assigned equalization delay. After successful reception of the Upstream_overhead message, transition of the ONU state to Ranging standby state 2 occurs.	M	
10-3-2	The receive-event of Upstream_overhead in any state except Ranging standby state 1.	8.4.4.2.2	Discard	M	

VI.6.10.4 The receive-event of Serial_number_mask message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-4-1	The receive-event of Serial_number_mask message in Ranging standby state 2 and Ranging standby state 3. (Serial number and mask match the ONU's serial number)	8.3.8.1 8.4.4.2.2	The ONU is enabled to react on ranging grants. The ONU state undergoes a transition to Ranging standby state 3.	M	
10-4-2	The receive-event of Serial_number_mask message in Ranging standby state 2 and Ranging standby state 3. (Serial number and mask mismatch the ONU's serial number)	8.3.8.1 8.4.4.2.2	A transition to Ranging standby state 2 occurs	M	
10-4-3	The receive-event of Serial_number_mask in Operating standby state 1 and Operating standby state 2. (Serial number and mask match the ONU's serial number)	8.3.8.1 8.4.4.2.2	The ONU is enabled to react on ranging grants. The ONU state undergoes a transition to Operating standby state 2.	M	
10-4-4	The receive-event of Serial_number_mask in Operating standby state 1 and Operating standby state 2. (Serial number and mask mismatch the ONU's serial number)	8.4.4.2.2	A transition to Operating standby state 1 occurs.	M	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-4-5	The receive-event of Serial_number_mask in any state except the states below. Ranging standby state 2, Ranging standby state 3, Operating standby state 1 and Operating standby state 2.	8.4.4.2.2	Discard	M	

VI.6.10.5 The receive-event of Assign_PON_ID message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-5-1	The receive-event of Assign_PON_ID message in Operating standby state 1 and Operating standby state 2.	8.3.8.1 8.4.4.2.2	The ONU with this serial number uses this PON_ID and will be addressed by this PON_ID.	M	
10-5-2	The receive-event of Assign_PON_ID message in any state except Operating standby state 1 and Operating standby state 2.	8.4.4.2.2	Discard	M	

VI.6.10.6 The receive-event of Grant_allocation message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-6-1	The receive-event of Grant_allocation message (with the activation-flag enabled for the PLOAM grant and the data grant)	8.3.8.1 8.4.4.2.2	When the PON_ID in the Grant_allocation message matches its own PON_ID, a data grant and a PLOAM grant for its ONU is assigned, and then the ONU state is set to Operating standby state 3.	M	
10-6-2	The receive-event of Grant_allocation message (with the activation-flag disabled for the data grant)	8.3.8.1	When the PON_ID in the Grant_allocation message matches its own PON_ID, the data grant for its ONU is deactivated.	M	

VI.6.10.7 The receive-event of Ranging_time message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-7-1	The receive-event of Ranging_time message in Operating standby state 3	8.3.8.1 8.4.4.2.2	The equalization_delay is set, and the ONU state is set to the Operating state.	M	
10-7-2	The receive-event of Ranging_time in the Operating state.	8.3.8.1 8.4.4.2.2	The equalization_delay is updated.	M	
10-7-3	The receive-event of Ranging_time in any state except Operating standby state 3 and Operating state.	8.4.4.2.2	Discard	M	

VI.6.10.8 The receive-event of Deactivate_PON_ID message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-8-1	The receive-event of Deactivate_PON_ID message	8.3.8.1 8.4.4.2.2	The ONU with this PON_ID (or all ONUs, in case PON_ID = 0x40) switches off the laser and the PON_ID is discarded. It should be activated when the MPU becomes out of order.	M	

VI.6.10.9 The receive-event of Disable_serial_number message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-9-1	The receive-event of Disable_serial_number message (with the enable flag = 0xFF)	8.3.8.1 8.4.4.2.2	Moves the ONU to the emergency stop state. The ONU cannot respond to grants.	M	

VI.6.10.10 The receive-event of POPUP message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-10-1	The receive-event of POPUP message (only in POPUP state)	8.3.8.1 8.4.4.2.2	The ONU restores the parameters it was using in operating state before it detected an LOS, LCD, OAML or FRML, except the equalization delay which is set to the pre-assigned equalization delay.	C (If Item 10-12-1 in OLT-PICS (Appendix V/G.983.1) is complied with)	

VI.6.10.11 Grant reception in the ranging procedure

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-11-1	Data grant	8.4.4.2.2.2	The data grant is processed only in the Operating state.	M	
10-11-2	PLOAM grant	8.4.4.2.2.2	A PLOAM cell is transmitted to the OLT in response to a PLOAM grant in the Operating standby state 3 and the Operating state.	M	
10-11-3	Ranging grant	8.4.4.2.2.2	The Ranging grant is valid only in Ranging standby state 3 and Operating standby state 2	M	

VI.6.10.12 Serial_number_ONU message

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-12-1	Sending trigger of Serial_number_ONU message.	8.3.8.1 8.4.4.2.2.2	In response to a PLOAM grant in the Operating standby state 3. In response to a ranging grant in Ranging standby state 3 and Operating standby state 2.	M	
10-12-2	Format of Serial_number_ONU message	8.3.8.2.2	2nd Octet: At Operating standby state 2: 0x40 At Operating standby state 3: PON_ID 3rd Octet: 0x03 4th Octet: 0x00 5th Octet-8th Octet: Vendor_ID byte 1-4 9th Octet-12th Octet: Vendor specific Serial number byte 1-4	M	

VI.6.10.13 Other events

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-13-1	The need of Optical power set-up	8.4.4.2.2.3	Yes or No (if yes – optionally the number of upstream transmissions required by the ONU to complete the power setup).	O	

Item	Parameter	Reference in G.983.1	Value/Comment	Req	Conf
10-13-2	Optical power set-up complete	8.4.4.2.2.3	In Ranging standby state 2: This event causes a state transition to Operating standby state 1 after timer TO1 is set to start. In Ranging standby state 3: This event causes a state transition to Operating standby state 1 after timer TO1 is set to start.	C (If Item 10-13-1 is not complied with)	
10-13-3	Timer TO1 expire	8.4.4.2.2.3	This event is generated when the delay measurement procedure is not completed within a certain time period. This event generates a state transition to Ranging standby state 2. The value of TO1 is 10 seconds.	M	
10-13-4	LOS, LCD, OAML, or FRML detection in Operating state (O8).	8.4.4.2.2.3	This event causes the ONU state to move to the POPUP state (O10) after the timer TO2 is set to start.	M	
10-13-5	LOS, LCD, OAML, or FRML detection in any state except Operating state (O8).	8.4.4.2.2.3	This event causes the ONU state to move to the Initial state (O1).	M	
10-13-6	Clear of LOS, LCD, OAML, and FRML	8.4.4.2.2.3	This event causes the ONU state to move from the Initial state to Ranging standby state 1.	M	
10-13-7	Timer TO2 expire	8.4.4.2.2.3	This event is generated when the POPUP message is not received in the POPUP state within a certain time period. This event generates a state transition to Initial state (O1). The value of TO2 is 100 milliseconds.	M	

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