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Amendment 1

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

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

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

Amendment 1: PICS for OLT and ONU

ITU-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.

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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 PICS¹ 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

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 minislots.	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	