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G.983.1

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

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Broadband optical access systems based on passive optical networks (PON)

Amendment 1

ITU-T Recommendation G.983.1 – Amendment 1

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ITU-T Recommendation G.983.1

Broadband optical access systems based on passive optical networks (PON)

Amendment 1

Summary

This amendment describes modifications to ITU-T Rec. G.983.1. The modifications are to address 622.08 Mbit/s upstream bit rate operation, while retaining the existing definitions for optical distribution networks and minimizing changes to the G.983.x series of Recommendations.

Source

Amendment 1 to ITU-T Recommendation G.983.1 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 November 2001.

FOREWORD

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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.

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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

This amendment describes modifications to ITU-T Rec. G.983.1. The modifications are intended to extend the existing protocol to include 622.08 Mbit/s upstream rate while maintaining the maximal continuity with existing systems.

1) Summary

The second sentence of the Summary should be expanded to read as follows:

This Recommendation describes systems with nominal symmetrical line rates of 155.520 Mbit/s and 622.080 Mbit/s, and asymmetrical line rates of 155.520 Mbit/s upstream and 622.080 Mbit/s downstream.

2) Clause 8.2.1

The list of options in the clause is updated to include the following items:

– Option 1: Symmetric 155.52 Mbit/s.

– Option 2: Asymmetric 155.52 Mbit/s upstream/622.08 Mbit/s downstream.

– Option 3: Symmetric 622.08 Mbit/s.

3) Table 3 and Tables 4-a and 4-c

Table 3 and its associated text are modified to include the following items:

Table 3/G.983.1 – Relation between parameter categories and tables

Transmission direction	Nominal bit rate	Table
Downstream	155.52 Mbit/s	Table 4-b (downstream, 155 Mbit/s)
	622.08 Mbit/s	Table 4-c (downstream, 622 Mbit/s)
Upstream	155.52 Mbit/s	Table 4-d (upstream, 155 Mbit/s)
	622.08 Mbit/s	Table V.4-e (upstream, 622 Mbit/s)

All parameters are specified as follows, and shall be in accordance with Table 4-a (ODN), Table 4-b (downstream, 155 Mbit/s), Table 4-c (downstream, 622 Mbit/s), Table 4-d (upstream, 155 Mbit/s), and Table V.4-e (upstream, 622 Mbit/s). These tables are collectively called Table 4 in this Recommendation when there is no possible confusion.

Modify Table 4-a to read as follows:

Table 4-a/G.983.1 – Physical medium dependent layer parameters of ODN

Items	Unit	Specification
Fibre type	–	ITU-T Rec. G.652
Attenuation range (ITU-T Rec. G.982)	dB	Class A: 5-20 Class B: 10-25 Class C: 15-30
Differential optical path loss	dB	15
Maximum optical path penalty	dB	1
Max differential logical reach	km	20
Maximum fibre distance between S/R and R/S points	km	20
Minimum supported split ratio	–	Restricted by path loss and ONU addressing limits. PON with passive splitters (16- or 32-way split)
Bidirectional transmission	–	1-fibre WDM or 2 fibres
Maintenance wavelength	nm	to be defined

Modify Table 4-c to read as follows:

Table 4-c/G.983.1 – Optical interface parameters of 622 Mbit/s downstream direction

Items	Unit	Single fibre			Dual fibre		
OLT Transmitter (optical interface O_{ld})							
Nominal bit rate	Mbit/s	622.08			622.08		
Operating wavelength	nm	1480-1580			1260-1360		
Line code	–	Scrambled NRZ			Scrambled NRZ		
Mask of the transmitter eye diagram	–	Figure 6			Figure 6		
Maximum reflectance of equipment, measured at transmitter wavelength	dB	NA			NA		
Minimum ORL of ODN at O_{lu} and O_{ld} (Notes 1 and 2)	dB	more than 32			more than 32		
ODN Class		Class A	Class B	Class C	Class A	Class B	Class C
Mean launched power MIN	dBm	–7	–2	–2	–7	–2	–2
Mean launched power MAX	dBm	–1	+4	+4	–2	+3	+3
Launched optical power without input to the transmitter	dBm	NA			NA		
Extinction ratio	dB	more than 10			more than 10		
Tolerance to the transmitter incident light power	dB	more than –15			more than –15		
If MLM Laser – Maximum RMS width	nm	NA			1.4		
If SLM Laser – Maximum –20 dB width (Note 3)	nm	1			1		

Table 4-c/G.983.1 – Optical interface parameters of 622 Mbit/s downstream direction

Items	Unit	Single fibre			Dual fibre		
If SLM Laser – Minimum side mode suppression ratio	dB	30			30		
ONU Receiver (optical interface O_{rd})							
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20			less than –20		
Bit error ratio	–	less than 10^{-10}			less than 10^{-10}		
ODN Class		Class A	Class B	Class C	Class A	Class B	Class C
Minimum sensitivity	dBm	–28	–28	–33	–28	–28	–33
Minimum overload	dBm	–6	–6	–11	–7	–7	–12
Consecutive identical digit immunity	bit	more than 72			more than 72		
Jitter tolerance	–	Figure 9			Figure 9		
Tolerance to the reflected optical power	dB	less than 10			less than 10		

NOTE 1 – The value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" should be more than 20 dB in optional cases which are described in Appendix I.

NOTE 2 – The values on ONU transmitter reflectance for the case that the value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" is 20 dB are described in Appendix II.

NOTE 3 – Values of maximum −20 dB width, and minimum side mode suppression ratio are referred to in ITU-T Rec. G.957.

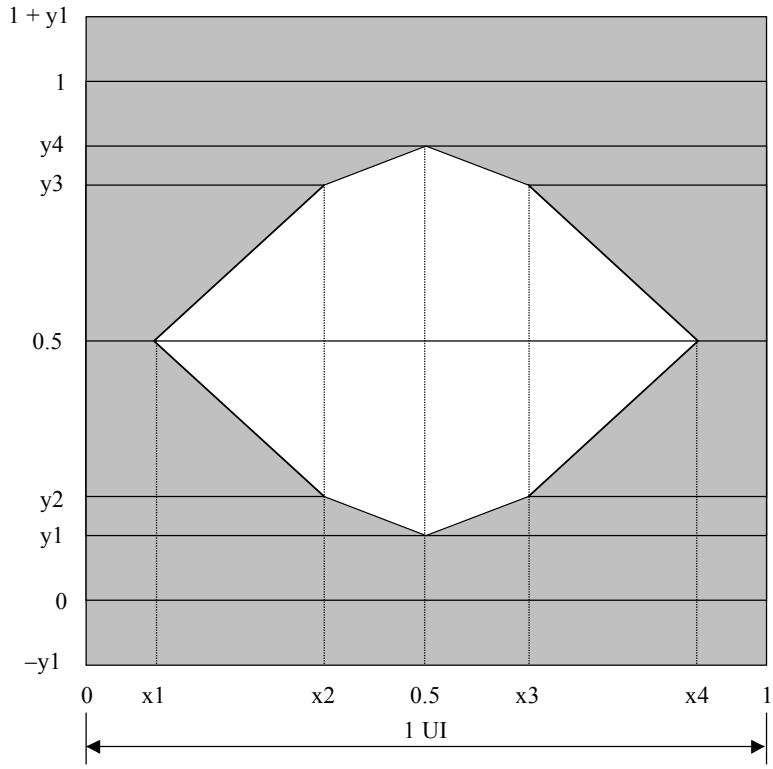
4) Clause 8.2.3.2

Modify the first sentence of the clause as follows:

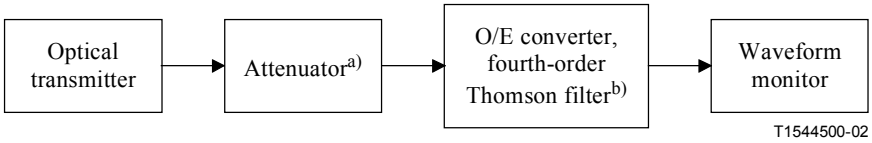
When in one of its operating states and given a grant, the ONU shall transmit a signal at 155.52 Mbit/s or 622.08 Mbit/s with an accuracy equal to that of the received downstream signal.

5) Clause 8.2.6.6.2

Replace Figure 7, Mask of the eye diagram for the upstream transmission signal, as follows:



	155.52 Mbit/s	622.08 Mbit/s
x1/x4	0.10/0.90	0.20/0.80
x2/x3	0.35/0.65	0.40/0.60
y1/y4	0.13/0.87	0.15/0.85
y2/y3	0.20/0.80	0.20/0.80



a) Attenuator is used if necessary.

b) Cut-off frequency (3 dB attenuation frequency) of the filter is 0.75 times output nominal bit rate.

Figure 7/G.983.1 – Mask of the eye diagram for the upstream transmission signal

6) Clause 8.2.7.1

Expand the first sentence of the clause to read as follows:

Three classes of attenuation ranges are being specified as defined in ITU-T Rec. G.982:

– 5-20 dB: Class A;
– 10-25 dB: Class B;
– 15-30 dB: Class C.

7) Clause 8.2.8.7.1

Expand the tabular data found in Figure 8, Jitter transfer for ONU, to read as follows:

	fc [kHz]	P [dB]
155.52/155.52	130	0.1
155.52/622.08	500	0.1
622.08/622.08	500	0.1

Expand the tabular data found in Figure 9, Jitter tolerance mask for ONU, to read as follows:

	ft [kHz]	f0 [kHz]	A1 [Ulp-p]	A2 [Ulp-p]
155.52/155.52	65	6.5	0.075	0.75
155.52/622.08	250	25	0.075	0.75
622.08/622.08	250	25	0.075	0.75

8) Clause 8.3.4

Revise the second sentence in the clause to read as follows:

The transfer capacities for the upstream interfaces have upper limits of:

147.2 Mbit/s $\left[155.52\times\frac{53}{56}\text{Mbit/s}\right]$ for the 155.52 Mbit/s interface, and 588.8 Mbit/s for the 622.08 Mbit/s interface.

9) Clause 8.3.5.1

Modify the first sentence of the third paragraph of the clause to read as follows:

In the upstream direction, the frame contains 53 time slots of 56 bytes for the 155 Mbit/s upstream case, and for the 622.08 Mbit/s case, it contains 212 time slots.

10) Clause 8.3.5.1.1

The title of this clause should read:

8.3.5.1.1 Frame structure for 155/155 Mbit/s PON

Modify the first sentence of the clause to read as follows:

The frame structure for a 155/155 Mbit/s symmetric PON is shown in Figure 11.

11) New clause 8.3.5.1.3, Frame Structure for 622/622 Mbit/s PON

Insert new clause 8.3.5.1.3 as follows:

8.3.5.1.3 Frame structure for 622/622 Mbit/s PON

In this case the downstream and upstream rates are both exactly four times higher than the 155 Mbit/s symmetrical case. This is shown in Figure 12a.

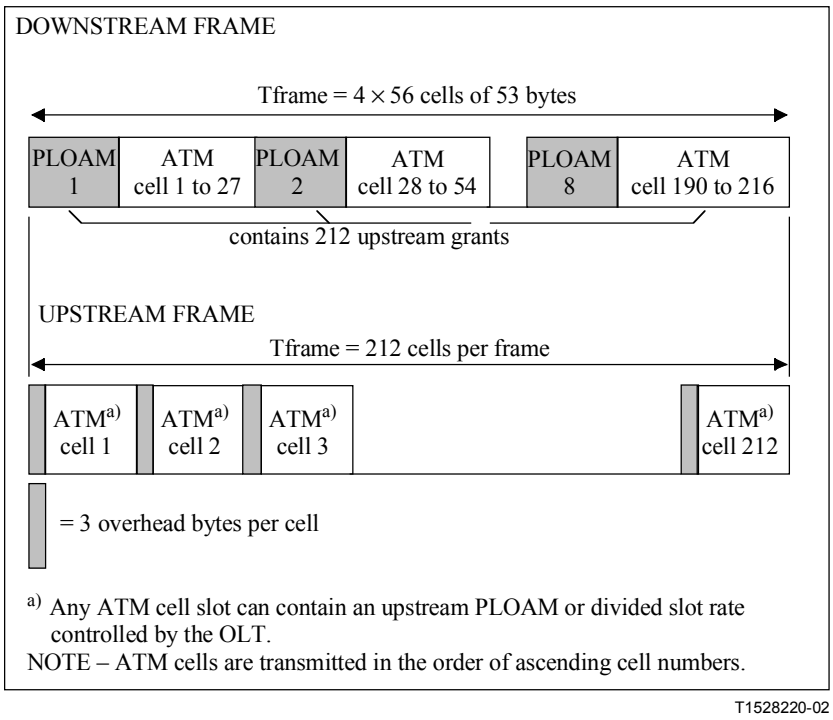


Figure 12a/G.983.1 – Frame format for 622.08/622.08 Mbit/s PON

12) Renumbered clause 8.3.5.1.3, Time relation downstream-upstream frame

Renumber the clause to read as follows:

8.3.5.1.4 Time relation downstream-upstream frame

Modify the first sentence of the first paragraph to read as follows:

In Figures 11, 12 and 12a, the start of the downstream frame and the start of the upstream frame are drawn aligned to each other to indicate the equal duration of the two frames.

Modify the first sentence of the second paragraph to read as follows:

For the cases described in Figures 11 and 12, 53 grants are mapped in the first two PLOAM cells of a frame and are numbered from 1 to 53; for the case described in Figure 12a, 212 grants are mapped into the eight PLOAM cells in the frame, and are numbered 1-212.

13) Clause 8.3.5.3.1

Modify the last sentence of the clause to read as follows:

Any cell, numbered "ATM cell 1" up to "ATM cell 54" in Figure 11, or numbered "ATM cell 1" up to "ATM cell 216" in Figure 12 or 12a, that has a header equal to the specified header of a PLOAM cell, is discarded at the ONU in the ATM specific TC layer.

14) Clause 8.3.5.3.5

Replace the third through sixth sentences of the first paragraph of the clause with:

For the 155 Mbit/s upstream cases, 53 per frame are needed. The 53 active grants are mapped in the first two PLOAM cells of the downstream frame. For the 622 Mbit/s upstream case, 212 per frame are needed. The 212 active grants are mapped into the first eight PLOAM cells of the downstream frame. The last grant of any even numbered PLOAM cells is filled with an idle grant.

15) Clause 8.3.6.1.6

Modify the sentence in the clause to read as follows:

Any cell numbered "ATM cell 1" up to "ATM cell 54" in Figure 11 or numbered "ATM cell 1" up to "ATM cell 216" in Figure 12 or 12a that has a header equal to the specified header of a PLOAM cell, is discarded at the ONU.

16) Clause 8.4.2.2

The response time specification bounds should be expanded to include:

3136 bits ≤ Tresponse(ONU) ≤ 4032 bits (at 155.52 Mbit/s)

6272 bits ≤ Tresponse(ONU) ≤ 8064 bits (at 622.08 Mbit/s)

The Note should be expanded to read as follows:

NOTE – The delay variation due to Tresponse(ONU) is considered as an ONU location ambiguity of about the equivalent of 600 m and 300 m for upstream rates of 155 and 622 Mbit/s, respectively.

17) Clause 8.4.2.3

The maximum value of Td specification bounds should be expanded to include:

the maximum value of Td ≥ 32 000 bits (at 155.52 Mbit/s)

the maximum value of Td ≥ 128 000 bits (at 622.08 Mbit/s)

18) Clause 8.4.2.4

Modify the sentence in the clause to read as follows:

The equalization_delay (Td) should be defined with a granularity of 1 bit for all rates.

19) Clause 8.4.2.5

Add the following sentence at the head of this clause:

NOTE – The following presents examples that use 155.52 Mbit/s for the upstream rate. The values given for Tresponse and Td depend on the upstream rate. Therefore, these values do not apply to the 622 Mbit/s case. See the specifications above for those values.

20) New Appendix V

Add the following appendix:

Appendix V

Optical Parameters for 622.08 Mbit/s upstream

Introduction

Table V.4-e is an extension of Table 4 in the body of this Recommendation. This table describes the operation of the upstream link at 622.08 Mbit/s. All specifications are the same for both single- and dual-fibre cases.

Table V.4-e/G.983.1[1] – Optical interface parameters of 622 Mbit/s upstream direction

Items	Unit	Specifications		
ONU Transmitter (optical interface O_{ru})				
Nominal bit rate	Mbit/s	622.08		
Operating wavelength (Note 3)	nm	MLM type 1 or SLM: 1260-1360 MLM type 2: 1280-1350 MLM type 3: 1288-1338		
Line code	–	Scrambled NRZ		
Mask of the transmitter eye diagram	–	Figure 7		
Maximum reflectance of equipment, measured at transmitter wavelength	dB	less than −6		
Maximum ORL of ODN at O_{ld} and O_{lu} (Notes 1 and 2)	dB	more than 32		
ODN Class		Class A	Class B	Class C (Note 5)
Mean launched power MIN	dBm	−6	−1	−1
Mean launched power MAX	dBm	−1	+4	+4
Launched optical power without input to the transmitter	dBm	less than Min sensitivity −10		
Extinction ratio	dB	more than 10		
Tolerance to the transmitter incident light power	dB	more than −15		
If MLM Laser – Maximum RMS width (Note 3)	nm	MLM type 1: 1.4 MLM type 2: 2.1 MLM type 3: 2.7		
If SLM Laser – Maximum −20 dB width (Note 4)	nm	1		
If SLM Laser – Minimum side mode suppression ratio	dB	30		
Jitter transfer	–	Figure 8		

[1] This table is numbered (4-e) to point out that it is an extension of Table 4.

Table V.4-e/G.983.1[1] – Optical interface parameters of 622 Mbit/s upstream direction

Items	Unit	Specifications		
Jitter generation from 0.5 kHz to 1.3 MHz	UI p-p	0.2		
OLT Receiver (optical interface O_{lu})				
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20		
Bit error ratio	–	less than 10^{-10}		
ODN Class		Class A	Class B	Class C (Note 5)
Minimum Sensitivity	dBm	–27	–27	–32
Minimum Overload	dBm	–6	–6	–11
Consecutive identical digit immunity	bit	more than 72		
Jitter tolerance	–	NA		
Tolerance to the reflected optical power	dB	less than 10		

NOTE 1 – The value of "ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld} MIN" should be more than 20 dB in optional cases that are described in Appendix I.

NOTE 2 – The values of ONU transmitter reflectance for the case that the value of "ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld} MIN" is 20 dB are described in Appendix II.

NOTE 3 – Transmitter types meeting narrower spectral width specifications are allowed wider central wavelength ranges. The specified laser types produce less than 1 dB of optical path penalty over the ODN. Lasers with different optical parameters may be substituted provided that:

1) the total wavelength range does not exceed 1260 nm to 1360 nm; and
2) any increase in optical path penalty over 1 dB is compensated by an increase of the minimum transmitted launch power or a decrease of the minimum receiver sensitivity.

For interoperability, the specified laser types with less than 1 dB optical path penalty are recommended.

NOTE 4 – Values of –20 dB max width and minimum side mode suppression ratio are referred to in ITU-T Rec. G.957.

NOTE 5 – The values proposed for the upstream Class C are best estimates. They are therefore subject to change in the future.

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