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G.984.2

Amendment 2
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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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Gigabit-capable Passive Optical Networks (GPON): Physical Media Dependent (PMD) layer specification

Amendment 2

CAUTION !

PREPUBLISHED RECOMMENDATION

This prepublication is an unedited version of a recently approved Recommendation. It will be replaced by the published version after editing. Therefore, there will be differences between this prepublication and the published version.

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Draft G.984.2 Amendment 2

Gigabit-capable Passive Optical Networks (GPON): Physical Media Dependent (PMD) layer specification

1. Summary

This amendment provides an enhancement to G.984.2 to support optical layer supervision and a new OLT optical interface specification (C+) that can enable a loss budget extension of 4 dB. Also, a modification to the 2.488 Gb/s downstream extinction ratio is made, to bring it in line with G.957, and to add some text regarding network timing.

2. Abstract

As a necessary part of OLS, transceiver parameter monitoring is important. Detailed and clear descriptions about transceiver parameter monitoring should be added into G.984.2 to explain the purpose, requirements, and recommended measurement parameters.

Also, to address the possibility of a single-sided reach enhancement to G-PON systems, a new OLT optical interface specification is described.

3. Revisions to section 3 in G.984.2

Revise the title and contents of section 3 to read as shown:

3 Terms and Definitions

3.1 Definitions

For convenience, the main definitions related to the GPON PMD layer are reported in this clause.

3.1.1 Optical Access Network (OAN): The set of access links sharing the same network-side interfaces and supported by optical access transmission systems. The OAN may include a number of ODNs connected to the same OLT.

3.1.2 Optical distribution network (ODN): In the PON context, a tree of optical fibers in the access network, supplemented with power or wavelength splitters, filters, or other passive optical devices.

3.1.3 Optical line termination (OLT): A device that terminates the common (root) endpoint of an ODN, implements a PON protocol, such as that defined by G.984, and adapts PON PDUs for uplink communications over the provider service interface. The OLT provides management and maintenance functions for the subtended ODN and ONUs.

3.1.4 Optical network termination (ONT): A single subscriber device that terminates any one of the distributed (leaf) endpoints of an ODN, implements a PON protocol, and adapts PON PDUs to subscriber service interfaces. An ONT is a special case of an ONU.

3.1.5 Optical network unit (ONU): A generic term denoting a device that terminates any one of the distributed (leaf) endpoints of an ODN, implements a PON protocol, and adapts PON PDUs to subscriber service interfaces. In some contexts, an ONU implies a multiple subscriber device.

3.1.6 Time Division Multiple Access (TDMA): Transmission technique involving the multiplexing of many time slots onto the same time payload.

3.1.7 Wavelength Division Multiplexing (WDM): Bidirectional multiplexing using different optical wavelength for up and downstream signals.

3.1.8 Response Time (RT): The response time explains the real-time requirement for OLS reasons. It refers to the response time for measurement circuit, from the time the test is initiated to the time the valid measurement is available. It does not include the delays associated with the transmission of the result to higher layers.

3.1.9. **Optical Line Supervision (OLS)**: A set of capabilities relating to the measurement and reporting of the state of the optical link.

3.2 Terms defined in other Recommendations

This Recommendation makes frequent use of terms defined in ISO VIM (DGUIDE 99999), which are reproduced below for convenience.

3.2.1 Range of Indications (Range)

This term can be either called as "range of indications" or "indication intervals". It's the set of quantity values bounded by the extreme possible indications of a measuring system.

3.2.2 Resolution of a Measuring System (Resolution)

This is the smallest change in the value of the quantity being measured by a measuring system that causes a perceptible change in the corresponding indication.

3.2.3 Accuracy of a Measuring System (Accuracy)

This is the ability of a measuring system to provide an indication value that is close to the true value being measured. This is normally expressed as an error range around the true value.

3.2.4 Repeatability of a Measuring System (Repeatability)

This is the property of a measuring system to provide closely similar indications for replicated measurements of the same quantity under repeatable conditions. This is normally expressed as a range of indications that result from repeated measurements of identical conditions.

Modifications to section 8

Add the following note to the end of section 8.2.3.1 Downstream:

"Note: The OLT may source its timing from either a dedicated timing signal source, or from a synchronous data interface (line timing). A packet-based timing source may also be used."

[Ed. Note: This text is a paraphrase of text which was agreed at an Q2 interim meeting. Further modifications are likely necessary.]

Modify table 2c/G.984.2 so that the following row reads:

Extinction ratio [Note 5]	dB	more than 8.2	more than 8.2

Add the following note at the end of the table

Note 5: The extinction ratio of 8.2 dB was a relaxation of the former value of 10dB. The new value does imply an improvement of the ONU receiver of 0.5 dB optical modulation amplitude.

4. <u>Addition of new sections to G.984.2</u>

Add the following 2 appendix sections to the end of G.984.2

Appendix IV – Description of physical layer measurements to support Optical Layer Supervision

IV.1 Introduction

This appendix describes physical layer parameters measurements that are required to provide the G-PON system with a basic optical layer supervision capability. The quantities to be measured are enumerated, along with the desired range, accuracy, and resolution. These measurements can be obtained by different practical and cost-effective monitoring methods, and the method of measurement is left to implementation choice.

IV.2 Transceiver Parameters monitoring

In PON systems, physical monitoring for OLS may be used for:

i) Normal status monitoring: Get and buffer 'historic' data as a reference in a normally working system.

ii) Degradation detection: Find the potential faults before they become service effecting, and identify the source of the problem (e.g. ODN, OLT or ONT).

iii) Fault management: Detect, localize, and diagnose faults.

In order to achieve these objectives, the following performance items should be monitored in a PON system.

– Transceiver Temperature (OLT & ONT);

– Transceiver Voltage (OLT & ONT);

– Laser Bias Current (OLT & ONT);

– OLT Transmit power;

– OLT Receive power (per ONT);

– ONT Transmit power;

– ONT Receive power.

Section IV.3 specifies recommended measurement performance parameters for each of these transciever performance measurements.

Note: These are obtainable using currently available detecting and monitoring technology.

IV.3 Measurements Table for Transceiver Parameters

Table IV.1 gives information on the standard measurement performance that should be obtainable with measurement equipment embedded in the OLT or/and ONTs.

Note: The values specified in this table pertain to the measurement, and not the reporting of data. Therefore, the resolution mainly refers to the intrinsic quantization size of the measurement circuit, and not the message field format of the report. The typical response time refers to the timeliness of the measurement circuit in the optical module, and not to the actual reporting of data over the PON or to the EMS.

Table IV.1/G.984.2 – Optical Line Supervision related measurement specifications.

	Typical Range [Note 1]	**Resolution**	**Accuracy**	**Repeatability**	**Typical Response time**
Temperature – OLT & ONT	-45 to +90 C	0.25 C	± 3 C	± 1 C	1s
Voltage – OLT & ONT [Note 4]	0 to 6.55 V	0.5 % of nominal	± 3 % of nominal	± 1 % of nominal	1s
Bias Current - OLT & ONT [Note 4]	0 to 131 mA	1 % of nominal	± 10 % of nominal	± 5 % of nominal	1s
ONT Transmit power	-10 to +8 dBm	0.1 dB	± 3 dB	± 0.5 dB [Note 2]	300ns
ONT Receive power	-34 to -8 dBm	0.1 dB	± 3 dB	± 0.5 dB [Note 2]	300ns
OLT Transmit power	-10 to +9 dBm	0.1 dB	± 2 dB	± 0.5 dB [Note 2]	300ns
OLT Receive power [Note 3]	-34 to -8 dBm	0.1 dB	± 2 dB	± 0.5 dB [Note 2]	300ns

Note 1: The typical range attempts to capture the most common range of parameters of an operational optical module. If a module has a different operational range, then the measurement range should follow that range, augmented by the measurement inaccuracy on either end.

Note 2: ONT and OLT optical repeatability refers to multiple measurements taken when the true values of the ONT or OLT temperature and voltage are the same at the time of measurement. However, the normal range of those parameters should be exercised in between tests as a means to gauge their aging effects.

Note 3: The OLT's measurement should reflect the average power received during a burst. This requires the OLT to perform the measurement at the proper time with respect to the incoming burst, and that said burst is long enough to support the response time of the detector. The deviation due to non-50% duty cycle in the upstream data pattern is not to be charged against the measurement accuracy or repeatability specifications.

Note 4: Nominal refers to the design value of the quantity being measured (i.e., Voltage or bias current) for the particular device implementation.

IV.4 OLS Physical Layer Performance Measurements Requirements

All the above parameters should be monitored continuously in real-time, in order to reflect the actual quality of physical links and operational status of optical modules. Moreover, the monitoring process should not significantly degrade the normal service transmissions.

Appendix V – Industry best practice for Single-sided Extended 2.488 Gbit/s downstream, 1.244 Gbit/s upstream G-PON (class C+)

V.1 Introduction

The single-sided extended 2.488/1.244 Gb/s G-PON is achieved by using a more capable OLT interface. This interface would have all the characteristics of the existing S/R interface, with the exception of certain OLT optical parameters, as listed in table V.1. Note that the ONU specifications should be achievable with ONU optics that are substantially similar to those described in Appendix III, except for the difference in upstream wavelength (described in G.984.5) and operation with FEC (described in G.984.3).

Table V.1/G.984.2 – Optical power levels for the 2.4 Gbit/s downstream, 1.2 Gbit/s upstream single-sided reach extended system (Class C+)

Items	**Unit**	**Single fibre**
Reach Extended OLT:		**OLT**
Mean launched power MIN	dBm	+3
Mean launched power MAX	dBm	+7
Downstream optical penalty	dB	1
Bit error ratio (pre-FEC) [Note 1]		10^{-4}
Minimum sensitivity [Note 1]	dBm	–32
Minimum overload	dBm	–12
Upstream wavelength range (G.984.5)	nm	1290 ~ 1330
ONU:	-	**ONU**
Mean launched power MIN	dBm	+0.5
Mean launched power MAX	dBm	+5
Upstream optical penalty	dB	0.5
Upstream wavelength range (G.984.5)	nm	1290 ~ 1330
Bit error ratio (pre-FEC) [Note 2]	-	10^{-4}
Minimum sensitivity [Note 2]	dBm	–30
Minimum overload [Note 3]	dBm	–8

Note 1: The OLT sensitivity assumes the use of the optional RS(255,239) FEC capability of the G-PON TC layer, as well as intrinsic detector technology improvements, e.g., SOA preamplification.

Note 2: The ONU sensitivity assumes the use of the optional RS(255,239) FEC capability of the G-PON TC layer with the current class B+ ONU detector technology.

Note 3: The ONU overload is set at -8dBm to be common with the class B+ value, even though in this application -10dBm is sufficient.

The single-sided extended ODN link budget is given in Table V.2. This budget covers all optical components between the extended OLT and ONU, including non-integrated WDM filters for the multiplex of video overlays and other enhancement band services, and must include any Raman impairment from the overlay signal.

Table V.2/G.984.2 – Loss budgets for the single-sided extended G-PON system (class C+)

Items	**Unit**	**Single fibre**
Minimum optical loss at 1490 nm	dB	17
Minimum optical loss at 1310 nm	dB	17
Maximum optical loss at 1490 nm	dB	32
Maximum optical loss at 1310 nm	dB	32
Maximum fiber length	km	60