

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.984.2
Amendment 2
(03/2008)

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

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

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

Amendment 2

ITU-T Recommendation G.984.2 (2003) –
Amendment 2



ITU-T G-SERIES RECOMMENDATIONS
TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
General	G.900–G.909
Parameters for optical fibre cable systems	G.910–G.919
Digital sections at hierarchical bit rates based on a bit rate of 2048 kbit/s	G.920–G.929
Digital line transmission systems on cable at non-hierarchical bit rates	G.930–G.939
Digital line systems provided by FDM transmission bearers	G.940–G.949
Digital line systems	G.950–G.959
Digital section and digital transmission systems for customer access to ISDN	G.960–G.969
Optical fibre submarine cable systems	G.970–G.979
Optical line systems for local and access networks	G.980–G.989
Access networks	G.990–G.999
QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G.7000–G.7999
PACKET OVER TRANSPORT ASPECTS	G.8000–G.8999
ACCESS NETWORKS	G.9000–G.9999

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation G.984.2

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

Amendment 2

Summary

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

Source

Amendment 2 to ITU-T Recommendation G.984.2 (2003) was approved on 29 March 2008 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). 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.

INTELLECTUAL PROPERTY RIGHTS

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 not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

© ITU 2008

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

CONTENTS

	Page
3 Definitions	1
3.1 Terms defined elsewhere	1
3.2 Terms defined in this Recommendation	1
Appendix IV – Description of physical layer measurements to support optical layer supervision	3
IV.1 Introduction	3
IV.2 Transceiver parameters monitoring	3
IV.3 Measurement table for transceiver parameters	3
IV.4 OLS physical layer performance measurements requirements	4
Appendix V – Industry best practice for Single-sided Extended 2.488 Gbit/s downstream, 1.244 Gbit/s upstream G-PON (class C+)	5
V.1 Introduction	5
Bibliography	7

ITU-T Recommendation G.984.2

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

Amendment 2

Abstract

As a necessary part of OLS, transceiver parameter monitoring is important. A detailed description about transceiver parameter monitoring is added as Appendix IV 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, as Appendix V.

Revise the title and contents of clause 3 to read as shown below.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation makes frequent use of terms defined in [b-ISO Guide 2], which are reproduced below for convenience.

3.1.1 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.

3.1.2 range of indications (range): This term can be either called as "range of indications" or "indication intervals". It is the set of quantity values bounded by the extreme possible indications of a measuring system.

3.1.3 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.

3.1.4 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 Terms defined in this Recommendation

This Recommendation uses the following terms related to the G-PON PMD layer:

3.2.1 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.

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

3.2.3 optical line supervision (OLS): A set of capabilities relating to the measurement and reporting of the state of the optical link.

3.2.4 optical line termination (OLT): A device that terminates the common (root) endpoint of an ODN, implements a PON protocol, such as that defined by [b-ITU-T G.984.3], 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.

3.2.5 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.

3.2.6 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.

3.2.7 response time (RT): The response time explains the real-time requirement for OLS reasons. It refers to the response time for a 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.

3.2.8 time division multiple access (TDMA): Transmission technique involving the multiplexing of many time slots onto the same time payload.

3.2.9 wavelength division multiplexing (WDM): Bidirectional multiplexing using different optical wavelength for upstream and downstream signals.

Add the following note to the end of clause 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.

Modify row 13 of Table 2c as follows:

Extinction ratio (Note 5)	dB	more than 8.2	more than 8.2
---------------------------	----	---------------	---------------

Add the following note at the end of Table 2c:

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

Add the following new Appendices IV and V:

Appendix IV

Description of physical layer measurements to support optical layer supervision

(This appendix does not form an integral part of this Recommendation)

IV.1 Introduction

This appendix describes physical layer parameter 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:

- 1) Normal status monitoring: Get and buffer 'historic' data as a reference in a normally working system.
- 2) Degradation detection: Find the potential faults before they become service-affecting, and identify the source of the problem (e.g., ODN, OLT or ONT).
- 3) 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 and ONT);
- Transceiver voltage (OLT and ONT);
- Laser bias current (OLT and ONT);
- OLT transmit power;
- OLT receive power (per ONT);
- ONT transmit power;
- ONT receive power.

Clause IV.3 specifies recommended measurement performance parameters for each of these transceiver performance measurements.

NOTE – These are obtainable using currently available detecting and monitoring technology.

IV.3 Measurement 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 and/or 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 and ONT	–45 to +90 C	0.25 C	±3 C	±1 C	1 s
Voltage – OLT and ONT [Note 4]	0 to 6.55 V	0.5% of nominal	±3% of nominal	±1% of nominal	1 s
Bias current – OLT and ONT [Note 4]	0 to 131 mA	1% of nominal	±10% of nominal	±5% of nominal	1 s
ONT transmit power	–10 to +8 dBm	0.1 dB	±3 dB	±0.5 dB [Note 2]	300 ns
ONT receive power	–34 to –8 dBm	0.1 dB	±3 dB	±0.5 dB [Note 2]	300 ns
OLT transmit power	–10 to +9 dBm	0.1 dB	±2 dB	±0.5 dB [Note 2]	300 ns
OLT receive power [Note 3]	–34 to –8 dBm	0.1 dB	±2 dB	±0.5 dB [Note 2]	300 ns

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+)

(This appendix does not form an integral part of this Recommendation)

V.1 Introduction

The single-sided extended 2.488/1.244 Gbit/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 [b-ITU-T G.984.5]) and operation with FEC (described in [b-ITU-T G.984.3]).

Table V.1/G.984.2 – Optical power levels for the 2.488 Gbit/s downstream, 1.244 Gbit/s upstream single-sided reach extended system (Class C+)

Item	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 -8 dBm to be common with the class B+ value, even though in this application -10 dBm 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 fibre length	km	60

Bibliography

- [b-ITU-T G.984.3] ITU-T Recommendation G.984.3 (2004), *Gigabit-capable Passive Optical Networks (G-PON): Transmission convergence level specification*.
- [b-ITU-T G.984.5] ITU-T Recommendation G.984.5 (2007), *Gigabit-capable Passive Optical Networks (G-PON): Enhancement band*.
- [b-ISO/IEC Guide 2] ISO/IEC Guide 2 (2004), *Standardization and related activities – General vocabulary*. http://www.iso.org/iso/iso_catalogue_tc/catalogue_detail.htm?csnumber=39976.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems