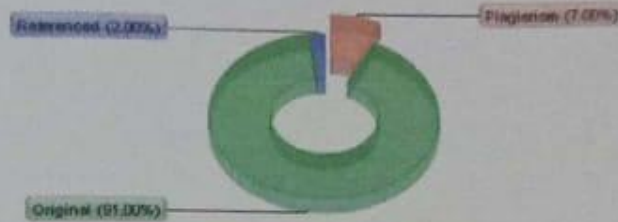


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PERANCANGAN JARINGAN FIBER TO THE HOME (FTTH) MENGGUNAKAN TEKNOLOGI 10-GIGABIT PASSIVE OPTICAL NETWORK (XG-PON) PADA PERUMAHAN ANTHURIUM REGENCY KEDUNGRANDUDESIGN OF FIBER TO THE HOME (FTTH) NETWORK USING

SURAT PERNYATAAN

Yang bertanda tangan di bawah ini :

Nama : Fajar Kusdwianto

Jabatan : Site Manager Fiber Academy Purwokerto

Menerangkan bahwa, data yang diberikan kepada a.n Kartika Nitiyogya mengenai jaringan *Fiber To The Home* yang berlokasi di Purwokerto dengan rincian sebagai berikut :

1. Menggunakan perangkat OLT jenis ZTE ZXA10_C300, ODC jenis 144 *splitter* merk Sunsea, jenis ODP Clossure Aerial merk Telkom Indo dan jenis ONT ZTE ZXHN_F609.
2. Pada jaringan fiber optik ini, perangkat OLT terletak di Witel Purwokerto di Jalan Merdeka No. 26, perangkat ODC terletak di Jalan Az - Zahra, perangkat ODP dan ONT terletak di Perumahan Anthurium Regency.

Dengan rincian sebagai berikut :

- a. OLT menuju ODC berjarak 5,35 km.
 - b. ODC menuju ODP berjarak 2,52 km.
 - c. ODP menuju ONT berjarak 0,04 km.
3. Dalam jaringan ini menggunakan 2 tipe *splitter* yaitu *splitter* 1:4 untuk ODC dan *splitter* 1:8 untuk ODP.
 4. Untuk kapasitas 1 haspel kabel *feeder* dan distribusi yaitu 4 km, tetapi pada kabel distribusi terdapat percabangan di jarak 2 km.



Atas penerimaan data yang diberikan kepada a.n Kartika Nitiyogya, dapat digunakan sebagaimana mestinya dan dapat dipertanggung jawabkan.

Purwokerto, 22 Maret 2019

Hormat Saya,

Telkom Akses
by Telkom Indonesia

Fajar Kusdwianto
NIK. 955137

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.987.2
Amendment 1
(08/2017)

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

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

10-Gigabit-capable passive optical networks (XG-
PON): Physical media dependent (PMD) layer
specification

Amendment 1

Recommendation ITU-T G.987.2 (2016) –
Amendment 1

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
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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
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MULTIMEDIA 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.

Recommendation ITU-T G.987.2

10-Gigabit-capable passive optical networks (XG-PON): Physical media dependent (PMD) layer specification

Amendment 1

Summary

Recommendation ITU-T G.987.2 describes the physical layer requirements and specifications for the XG-PON physical media dependent (PMD) layer. Wavelength enhancement bands are described in Recommendation ITU-T G.987.1. The transmission convergence (TC) layer is described in Recommendation ITU-T G.987.3. The ONU management and control interface (OMCI) specifications are described in Recommendation ITU-T G.988.

Recommendation ITU-T G.987.2 describes a flexible optical fibre access network capable of supporting the bandwidth requirements of business and residential services. The G.987 series of standards allows for multiple upstream and downstream line rates. This Recommendation currently defines one type of 10-Gigabit-capable passive optical network (XG-PON) system with asymmetric nominal line rate of 9.95328 Gbit/s in the downstream direction and 2.48832 Gbit/s in the upstream direction.

This Recommendation describes a system that represents an evolutionary development from the systems described in the ITU-T G.984 series. To the greatest extent possible, this Recommendation maintains the requirements of Recommendation ITU-T G.984.1 to ensure maximal continuity with existing systems and optical fibre infrastructure.

Amendment 1 continues the maintenance and evolution of physical media dependent (PMD) layer specifications for XG-PON as defined in this Recommendation. It includes technical updates and corrections for changing references to XG-PON1 to XG-PON, replacing the mask of the eye diagram for ONU transmitter, and correcting the X/S tolerance mask for ONU.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.987.2	2010-01-13	15	11.1002/1000/10411
2.0	ITU-T G.987.2	2010-10-07	15	11.1002/1000/10889
2.1	ITU-T G.987.2 (2010) Amd. 1	2012-02-13	15	11.1002/1000/11499
3.0	ITU-T G.987.2	2016-02-26	15	11.1002/1000/12832
3.1	ITU-T G.987.2 (2016) Amd. 1	2017-08-13	15	11.1002/1000/13290

Keywords

10-Gigabit-capable passive optical network, FTTx network, OLT, ONU, optic, optical network terminal (ONT), passive optical network (PON), physical layer interfaces, physical layer requirements, physical layer specification, PMD, XG-PON.

* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

FOREWORD

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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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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/>.

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Recommendation ITU-T G.987.2

10-Gigabit-capable passive optical networks (XG-PON): Physical media dependent (PMD) layer specification

Amendment 1

Editorial note: This is a complete-text publication. Modifications introduced by this amendment are shown in revision marks relative to Recommendation ITU-T G.987.2 (2016).

1 Scope

This Recommendation pertains to flexible access networks using optical fibre technology. The focus is primarily on a network supporting services with bandwidth requirements ranging from that of voice to data services running at up to 10 Gbit/s. Also included are broadcast services.

This Recommendation describes characteristics of the physical medium dependent (PMD) layer of an optical access network (OAN) with the capability of transporting various services between the user-network interface and the service node interface.

The OAN dealt with in this Recommendation enables the network operator to provide a flexible upgrade to meet future customer requirements, in particular, in the area of the optical distribution network (ODN). The ODN considered is based on a point-to-multipoint tree and branch option.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T G.652] Recommendation ITU-T G.652 (2009), *Characteristics of a single-mode optical fibre and cable.*
- [ITU-T G.657] Recommendation ITU-T G.657 (2012), *Characteristics of a bending loss insensitive single mode optical fibre and cable for the access network.*
- [ITU-T G.783] Recommendation ITU-T G.783 (2006, as amended), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks.*
- [ITU-T G.825] Recommendation ITU-T G.825 (2000, as amended), *The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH).*
- [ITU-T G.957] Recommendation ITU-T G.957 (2006), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy.*
- [ITU-T G.959.1] Recommendation ITU-T G.959.1 (2016), *Optical transport network physical layer interfaces.*
- [ITU-T G.982] Recommendation ITU-T G.982 (1996), *Optical access networks to support services up to the ISDN primary rate or equivalent bit rates.*

- [ITU-T G.984.1] Recommendation ITU-T G.984.1 (2008, as amended), *Gigabit-capable passive optical networks (GPON): General characteristics*.
- [ITU-T G.984.2] Recommendation ITU-T G.984.2 (2003, as amended), *Gigabit-capable Passive Optical Networks (G-PON): Physical Media Dependent (PMD) layer specification*.
- [ITU-T G.984.5] Recommendation ITU-T G.984.5 (2014), *Gigabit-capable Passive Optical Networks (G-PON): Enhancement band*.
- [ITU-T G.987] Recommendation ITU-T G.987 (2012), *10-Gigabit-capable passive optical network (XG-PON) systems: Definitions, abbreviations and acronyms*.
- [ITU-T G.987.1] Recommendation ITU-T G.987.1 (2010), *10 Gigabit-capable passive optical network (XG-PON): General requirements*.
- [ITU-T G.987.3] Recommendation ITU-T G.987.3 (2014), *10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification*.
- [ITU-T G.988] Recommendation ITU-T G.988 (2012), *ONU management and control interface (OMCI) specification*.
- [ITU-T G-Sup.39] ITU-T G-series Recommendations – Supplement 39 (2016), *Optical system design and engineering considerations*.
- [ITU-T L.313] Recommendation ITU-T L.313/L.66 (2007), *Optical fibre cable maintenance criteria for in-service fibre testing in access networks*.

3 Definitions

See clause 3 of [ITU-T G.987].

4 Abbreviations and acronyms

See clause 4 of [ITU-T G.987].

5 Conventions

See clause 5 of [ITU-T G.987].

6 Architecture of the optical access network

See [ITU-T G.984.1]. For convenience, Figure 1 of [ITU-T G.984.2] is reproduced below.

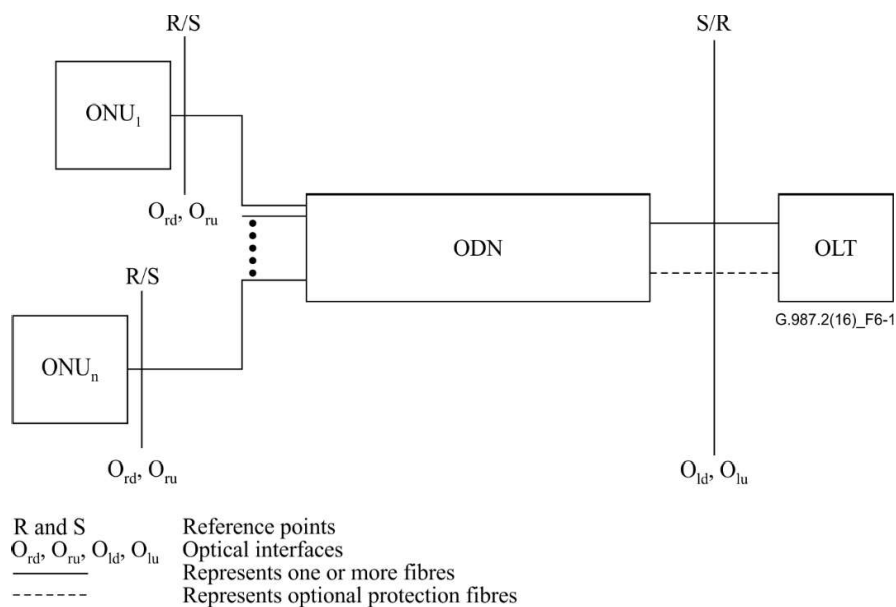


Figure 6-1 –Generic physical configuration of the optical distribution network (reproduced from Figure 1 of [ITU-T G.984.2])

The following reference points are defined in Figure 6-1:

- S: Point on the optical fibre just after the OLT[Downstream]/ONU[Upstream] optical connection point (i.e., optical connector or optical splice).
- R: Point on the optical fibre just before the ONU[Downstream]/OLT[Upstream] optical connection point (i.e., optical connector or optical splice).
- S/R, R/S: Combination of points S and R existing simultaneously in a single fibre, when operating in bidirectional mode.
- Oru, Ord: Optical interface at the reference point R/S between the ONU and the ODN for the upstream and downstream directions respectively.
- Olu, Old: Optical interfaces at the reference point S/R between the OLT and the ODN for the upstream and downstream directions respectively.

The two directions for optical transmission in the ODN are identified as follows:

- downstream direction for signals travelling from the OLT to the ONU(s), and
- upstream direction for signals travelling from the ONU(s) to the OLT.

Transmission in downstream and upstream directions takes place on the same fibre and components (duplex/duplex configuration).

6.1 Classes for optical path loss

Recommended classes for optical path loss are shown in Table 6-1.

Table 6-1 –Classes for optical path loss defined in this Recommendation

	Nominal1 class (N1 class)	Nominal2 class (N2 class)	Extended1 class (E1 class)	Extended2 class (E2 class)
Minimum loss	14 dB	16 dB	18 dB	20 dB
Maximum loss	29 dB	31 dB	33 dB	35 dB

For single-star architectures, the absence of optical branching devices may result in optical path losses of less than 5 dB. In such a case, the ODN must contain additional optical attenuators guaranteeing minimum channel insertion loss for the given class to prevent potential damage to receivers.

6.2 Categories for fibre differential distance

Categories for fibre differential distance

Recommended categories for fibre differential distance (DD) are shown in Table 6-2.

Table 6-2 –Categories for fibre differential distance defined in G.987.2

	DD20	DD40
Maximum differential distance	20 km	40 km

7 Services

See clause 7 of [ITU-T G.987.1].

8 User network interface and service node interface

See Appendix I of [ITU-T G.987.1].

9 Optical network requirements

9.1 Layered structure of optical network

See clause 5.2.5 of [ITU-T G.987.1].

9.2 Physical media dependent layer requirements for the XG-PON

All parameters are specified as follows, and are in accordance with Table 9-2 through Table 9-4.

There are two optical network unit (ONU) types, based on different ONU receiver sensitivity.

All parameter values specified are worst-case values, to be met over the range of standard operating conditions (i.e., temperature and humidity), and they include ageing effects. The parameters are specified relative to an optical section design objective of a bit error ratio (BER) not worse than the values specified in Table 9-3 and Table 9-4, for the extreme case of optical path attenuation and dispersion conditions.

In particular, the values given in Table 9-3 and Table 9-4 are valid for the cases of an enhancement band, as described in clause 10.

9.2.1 Line rate

The transmission line rate is a multiple of 8 kHz. The target standardized 10-gigabit-capable passive optical network (XG-PON) system supports the following variant: XG-PON₄ with a downstream line rate of 9.95328 Gbit/s and an upstream line rate of 2.48832 Gbit/s.

Parameters to be defined are categorized by downstream and upstream, and the nominal line rate as shown in Table 9-1.

Table 9-1 – Relation between parameter categories and tables

Variant	Transmission direction	Nominal line rate [Gbit/s]	Reference table
XG-PON ₄	Downstream	9.95328	Table 9-3
	Upstream	2.48832	Table 9-4

9.2.1.1 Downstream accuracy

When the optical trunk line (OLT) and the end office are in their normal operating state, the OLT is typically traceable to a Stratum-1 reference (accuracy of 1×10^{-11}). When the OLT is in its free running mode, the accuracy of the downstream signal is at least that of a Stratum-4 clock (3.2×10^{-5}). OLTs intended for timing-critical applications such as mobile backhaul may require stratum-3 quality in free-running mode

NOTE The OLT may derive 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.

9.2.1.2 Upstream accuracy

When in one of its operating states and granted an allocation, the ONU shall transmit its signal with frequency accuracy equal to that of the received downstream signal.

9.2.2 FEC code selection for XG-PON

See clause 10.3 of [ITU-T G.987.3].

9.2.3 Physical media and transmission method

9.2.3.1 Transmission medium

This Recommendation is based on the fibre described in [ITU-T G.652]. Other fibre types may be compatible with this Recommendation, e.g., [ITU-T G.657] used for example for in-building cabling, drop section.

9.2.3.2 Transmission direction

The signal is transmitted both upstream and downstream through the transmission medium.

9.2.3.3 Transmission methodology

Bidirectional transmission is accomplished by use of wavelength division multiplexing (WDM) technique on a single fibre.

9.2.4 Line code

The scrambling method is defined in [ITU-T G.987.3].

The convention used for optical logic levels is:

- high level of light emission for a binary ONE;
- low level of light emission for a binary ZERO.

9.2.4.1 Downstream

Downstream line coding for XG-PON1: NRZ.

9.2.4.2 Upstream

Upstream line coding for XG-PON1: NRZ.

9.2.5 Operating wavelength

9.2.5.1 Downstream wavelength allocation

The operating wavelength range for XG-PON1 for the downstream direction is defined in Table 9-3.

9.2.5.2 Upstream wavelength allocation

The operating wavelength range for XG-PON1 for the upstream direction is defined in Table 9-4.

9.2.6 XG-PON PMD parameters

9.2.6.1 XG-PON compatible ODN

XG-PON shall operate over an ODN whose parameters are described by Table 9-2.

Table 9-2 –Physical parameters of a simple ODN (ODS)

Item	Unit	Specification
Fibre type (Note)	–	[ITU-T G.652], or compatible
Attenuation range (as defined in clause 6.1)	dB	N1 class: 14 – 29 N2 class: 16 – 31 E1 class: 18 – 33 E2 class: 20 – 35
Maximum fibre distance between S/R and R/S points	km	DD20: 20 DD40: 40
Minimum fibre distance between S/R and R/S points	km	0
Bidirectional transmission	–	1-fibre WDM
Maintenance wavelength	nm	See [ITU-T L.313]
NOTE – See clause 9.2.3.1		

9.2.6.2 Optical interface parameters of 9.95328 Gbit/s downstream direction

Table 9-3 –Optical interface parameters of 9.95328 Gbit/s downstream direction

Item	Unit	Value					
OLT transmitter (optical interface O_{ld})							
Nominal line rate	Gbit/s	9.95328					
Operating wavelength (Note 1)	nm	1575 – 1580					
Line code	–	NRZ					
Mask of the transmitter eye diagram	–	see clause 9.2.7.6.1					
Maximum reflectance at S/R, measured at transmitter wavelength	dB	NA					
Minimum ORL of ODN at O _{lu} and O _{ld} (Notes 2 and 3)	dB	more than 32					
ODN Class		N1	N2		E1	E2	
			N2a	N2b		E2a	E2b
Mean launched power MIN	dBm	+2.0	+4.0	+10.5	+6	+8	+14.5
Mean launched power MAX	dBm	+6.0	+8.0	+12.5	+10	+12	+16.5
Launched optical power without input to the transmitter	dBm	NA					
Minimum extinction ratio	dB	8.2					
Transmitter tolerance to reflected optical power (Note 7)	dB	more than –15					
Dispersion Range	ps/nm	0-400 (DD20) 0-800 (DD40)					
Minimum side mode suppression ratio	dB	30					

Table 9-3 – Optical interface parameters of 9.95328 Gbit/s downstream direction

Item	Unit	Value					
Maximum differential optical path loss	dB	15					
Jitter generation	–	see clause 9.2.9.7.3					
ONU receiver (optical interface O_{rd})							
Maximum optical path penalty (Note 6)	dB	1.0					
Maximum reflectance at R/S, measured at receiver wavelength	dB	less than –20					
Bit error ratio reference level	–	10 ⁻³ (Note 4)					
ODN Class		N1	N2		E1	E2	
			N2a	N2b		E2a	E2b
Minimum sensitivity at BER reference level (Note 5)	dBm	–28.0	–28.0	–21.5	–28.0	–28.0	–21.5
Minimum overload at BER reference level	dBm	–8.0	–8.0	–3.5	–8.0	–8.0	–3.5
Consecutive identical digit immunity	bit	more than 72					
Jitter tolerance	–	see clause 9.2.9.7.2					
Receiver tolerance to reflected optical power (Note 8)	dB	less than 10					
<p>NOTE 1 – In the case of outdoor OLT deployment, it is allowed for the operating wavelength to span between 1575 – 1581 nm.</p> <p>NOTE 2 – There are optional cases where the "minimum ORL of ODN at O_{lu} and O_{ld}" can be as low as 20 dB. (see [b-ITU-T G.983.1] Appendix I)</p> <p>NOTE 3 – The value of ONU transceiver reflectance corresponding to the "minimum ORL of ODN at O_{lu} and O_{ld}" is 20 dB. (see [b-ITU-T G.983.1] Appendix II)</p> <p>NOTE 4 – See [ITU-T G.Sup39], clause 9.4.1 for additional details.</p> <p>NOTE 5 – This sensitivity shall be met in the presence of G-PON and video overlay on the same ODN. If either G-PON, or video overlay, or both of them are absent, the sensitivity may be different (precise value is FFS).</p> <p>NOTE 6 – The specified penalty must be met by optics complying with the specified launch power range. If a transmitter exhibits a higher penalty, it can still comply if it equally increases the minimum launch power while remaining under the maximum launch power. In no case should the OPP exceed 2 dB.</p> <p>NOTE 7 – Parameter known in [ITU-T G.984.2] as "Tolerance to the transmitter incident light power".</p> <p>NOTE 8 – Parameter known in [ITU-T G.984.2] as "Tolerance to the reflected optical power".</p>							

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Pembimbing 1 : Fauza Khair, S.T., M.Eng
Pembimbing 2 : Eka Wahyudi, S.T., M.Eng

No	Revisi/saran pada bagian	Halaman	Koreksi oleh Mahasiswa
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3	BAB 2:		
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 Pembimbing 1 : Fauza Khair, S.T., M.Eng
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No	Revisi/saran pada bagian	Halaman	Koreksi oleh Mahasiswa
1	ABSTRACT: <ul style="list-style-type: none"> o bus. Inggris dipertahankan o S.O.P.A. o Kata sambung yang sbg bus 		
2	BAB 1: <ul style="list-style-type: none"> o Daftar isi dengan huruf besar semua o Daftar lambang & simbol di hapus 		
3	BAB 2: <ul style="list-style-type: none"> o Tambahan 141 Snell's & sudut kritis, satuan & (ditanya teori $n_2 = f(n_1, n_2)$) o Satuan, dB, $v/2$ o safety margin 	914	
4	BAB 3: <ul style="list-style-type: none"> o Alur pemeliharaan o tipe bus keisi keisi o Tambahan proses perancangan by opti system. 		