

MP1800A

Signal Quality Analyzer

PON Module Testing

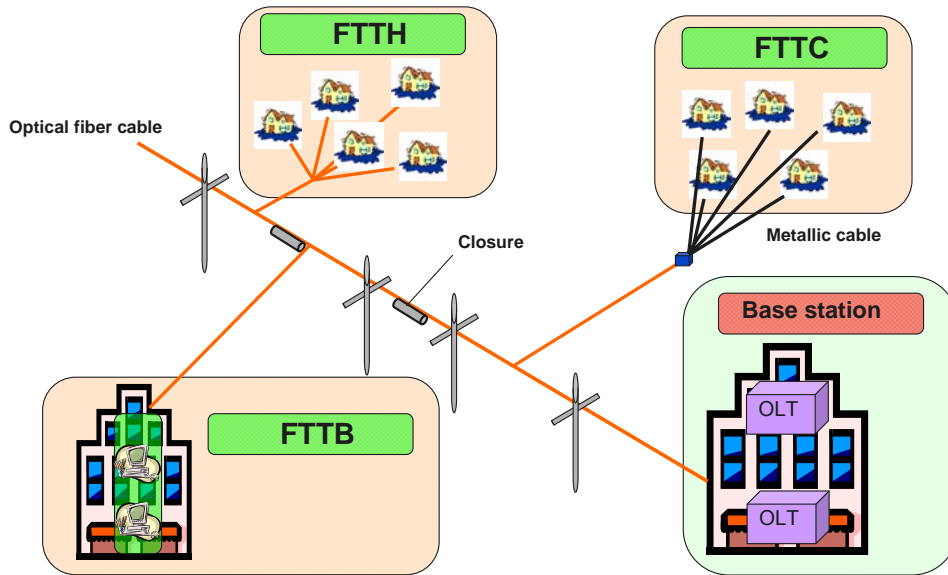
MP1800A Signal Quality Analyzer Application Note PON Module Testing

Anritsu Corporation
Measurement Group
IP Network Division

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Access Network



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What is FTTx?

FTTH (Fiber To The Home):

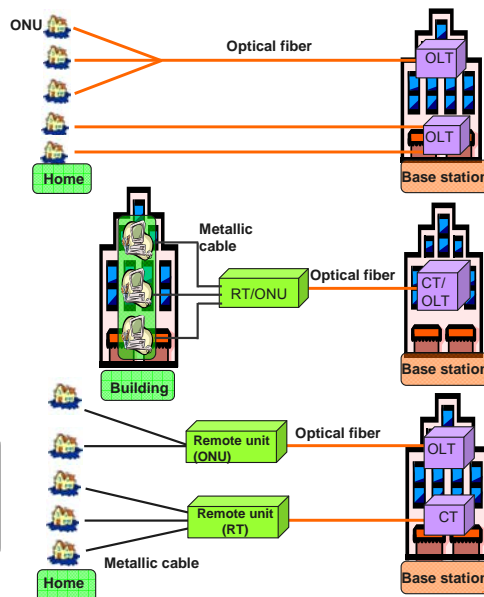
- Optical fiber installed individually to each household
- ONU (Optical Network Unit) installed in each user's home for individual use

FTTB (Fiber To The Building):

- Optical fiber installed up to user's building
- Metallic cable used for installation to each user in building
- RT (Remote Terminal) or ONU installed in building and shared by multiple users

FTTC (Fiber To The Curb):

- Optical fiber installed up to user's neighborhood
- RT or ONU installed in user's neighborhood and shared by multiple users
- Metallic cable used to connect remote unit and user



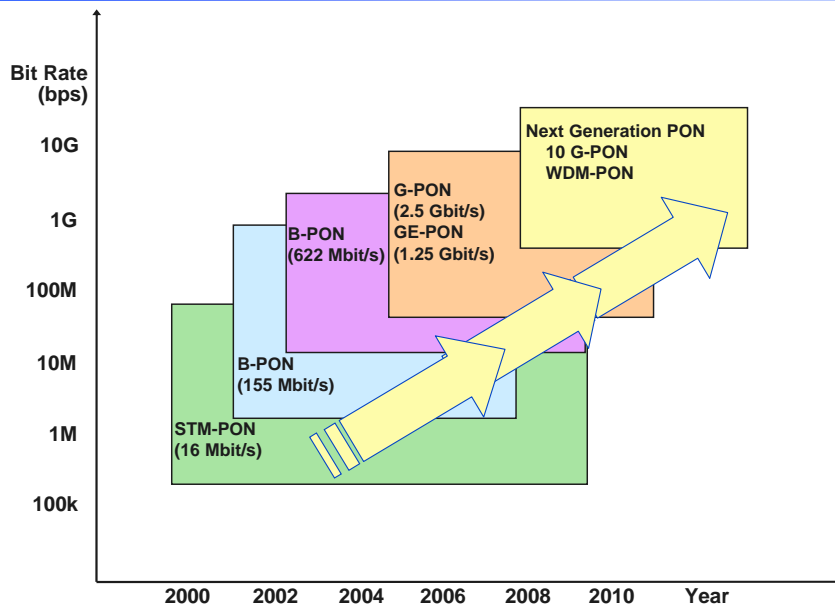
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Trend in Access Networks



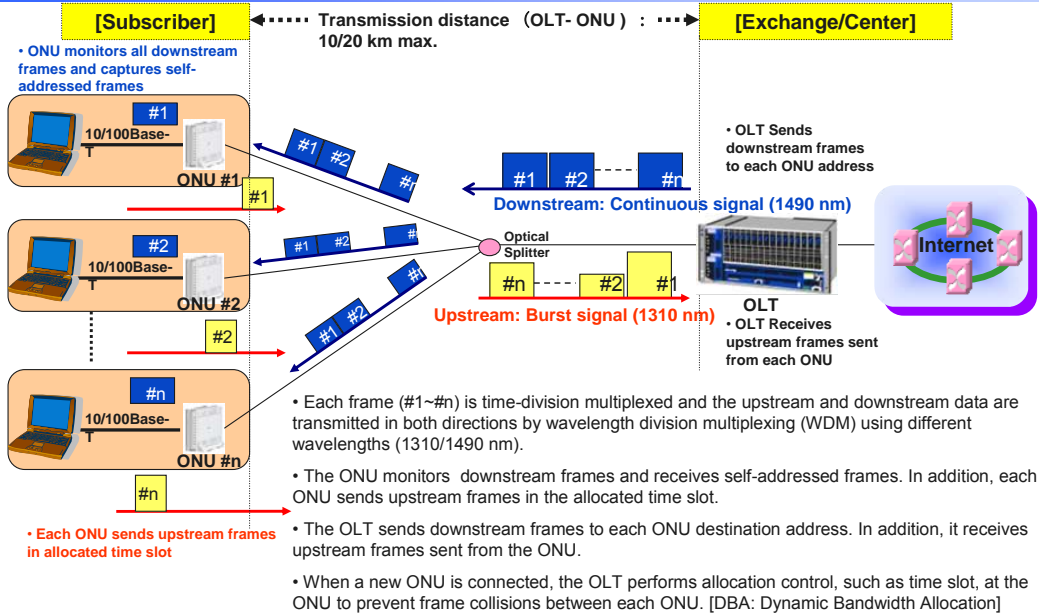
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PON Transmission Method



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PON Features

PON (Passive Optical Networks) Characteristics

	GE-PON(E-PON) Ethernet-based PON	G-PON Gigabit-capable PON	B-PON Broadband ATM-based PON
Standard	IEEE802.3ah	ITU-T G.984 / FSAN	ITU-T G.983.3 / FSAN
Up/Downstream Multiplexing	WDM (Wavelength Division Multiplexing)	WDM (Wavelength Division Multiplexing)	WDM (Wavelength Division Multiplexing)
Wavelength Range	Up: 1.27~1.36 um Down: 1.48~1.50 um	Up: 1.27~1.36 um Down: 1.48~1.50 um	Up: 1.26~1.36 um Down: 1.48~1.50 um Video: 1.55~1.56 um
Bit rate	Up: 1.25 Gbps Down: 1.25 Gbps	Up: 156 Mbps, 622 Mbps, 1.24 Gbps, 2.48 Gbps Down: 1.24 Gbps, 2.48 Gbps	Up: 155 Mbps, 622 Mbps Down: 155 Mbps, 622 Mbps
DBA (Dynamic Bandwidth Allocation)	Possible	Possible	Possible
Max. Transmission Reach (OLT-ONU)	10 km (1000BASE-PX10) 20 km (1000BASE-PX20)	20 km	20 km
Channel Insertion Loss	5~20 dB (1000BASE-PX10) 10~25 dB (1000BASE-PX20)	5~20 dB (Class A) 10~25 dB (Class B) 15~30 dB (Class C)	10~25 dB (Class B) 15~30 dB (Class C)
Split Ratio	16 min	64 max	32 max
Transmission Frame	MAC frame	Generic frame (GEM,GTC)	ATM cell
Service	Ethernet	Full service (Ethernet,TDM,POTS)	Full service (Ethernet,TDM,POTS)

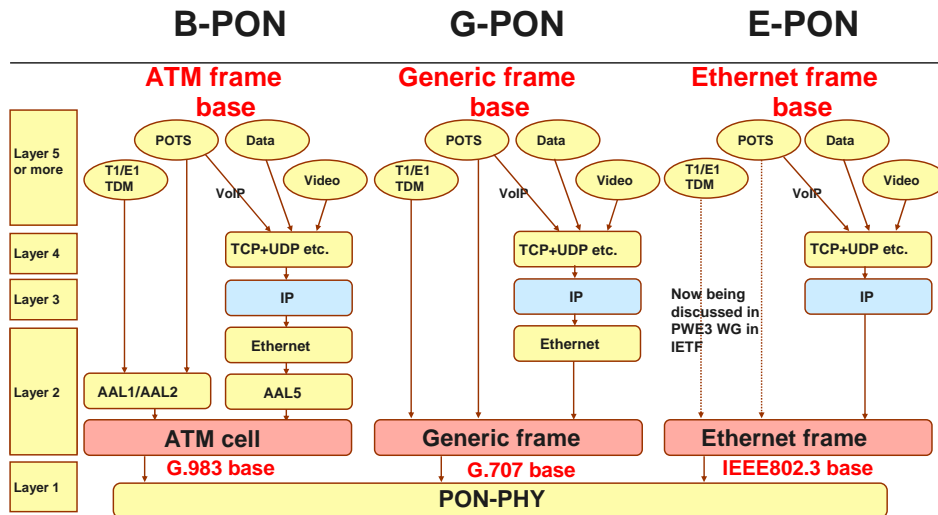
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Layered Structure of PON



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Optical Transceiver Module Characteristics

Optical Transmit Characteristics		OLT	ONU	OLT	ONU
Description	Unit	1000BASE-PX10-D	1000BASE-PX10-U	1000BASE-PX20-D	1000BASE-PX20-U
Signaling speed (range)	GBd	1.25 ±100 ppm		1.25 ±100 ppm	
Wavelength (range)	nm	1490 (1480 to 1500)	1310 (1260 to 1360)	1490 (1480 to 1500)	1310 (1260 to 1360)
RMS Spectral width (max)	nm	0.88	3.5 (at 1310 nm)	0.44	3.00 (at 1310 nm)
Average launch power (max/min)	dBm	+2/-3	+4/-1	+7/+2	+4/-1
Average launch power of OFF transmitter (max)	dBm	-39	-45	-39	-45
Extinction ratio (min)	dB	6		6	
RIN _{OMA} (max)	dB/Hz	-118	-113	-118	-113
Launch OMA (min)	dBm (mW)	-2.2 (0.6)	-0.22 (0.95)	2.8 (1.9)	-0.22 (0.95)
Transmitter eye mask definition (X1, X2, Y1, Y2, Y3)	UI	(0.22, 0.375, 0.20, 0.20, 0.30)		(0.22, 0.375, 0.20, 0.20, 0.30)	
Ton/Toff (max)	ns	N/A		N/A	
Optical return loss tolerance (max)	dB	15		15	
Optical return loss of ODN (min)	dB	20		20	
Transmitter reflectance (max)	dB	-10	-6	-10	-10
Transmitter and dispersion penalty (max)	dB	1.3	2.8	2.3	1.8
Decision timing offset for transmitter and dispersion penalty (min)	UI	±0.1		±0.1	
Optical Receive Characteristics		OLT	ONU	OLT	ONU
Description	Unit	1000BASE-PX10-D	1000BASE-PX10-U	1000BASE-PX20-D	1000BASE-PX20-U
Signaling speed (range)	GBd	1.25 ±100 ppm		1.25 ±100 ppm	
Wavelength (range)	nm	1310 (1260 to 1360)	1490 (1480 to 1500)	1310 (1260 to 1360)	1490 (1480 to 1500)
Bit error ratio (max)		10 ⁻¹²		10 ⁻¹²	
Average receive power (max)	dBm	-1	-3	-6	-3
Damage threshold (max)	dBm	+4	+2	+4	+7
Receiver sensitivity (max)	dBm	-24	-24	-27	-24
Receiver sensitivity OMA (max)	dBm (uW)	-23.2 (5.0)	-23.2 (5.0)	-26.2 (2.4)	-23.2 (5.0)
Signal detect threshold (min)	dBm	-45	-44	-45	-44
Receiver reflectance (max)	dBm	-12		-12	
Stressed receive sensitivity (max)	dBm	-22.3	-21.4	-24.4	-22.1
Stressed receive sensitivity OMA (max)	dBm (uW)	-21.5 (7.0)	-20.7 (8.6)	-23.6 (4.3)	-21.3 (7.4)
Vertical eye-closure penalty (min)	dB	1.2	2.2	2.2	1.5
Receiver settling (max)	ns	400	N/A	400	N/A
Stressed eye jitter (min)	Ulp-p	0.25	0.25	0.28	0.25
Jitter corner frequency	kHz	637		637	
Sinusoidal jitter limits for stressed receiver conformance test (min/max)	UI	0.05/0.15		0.05/0.15	

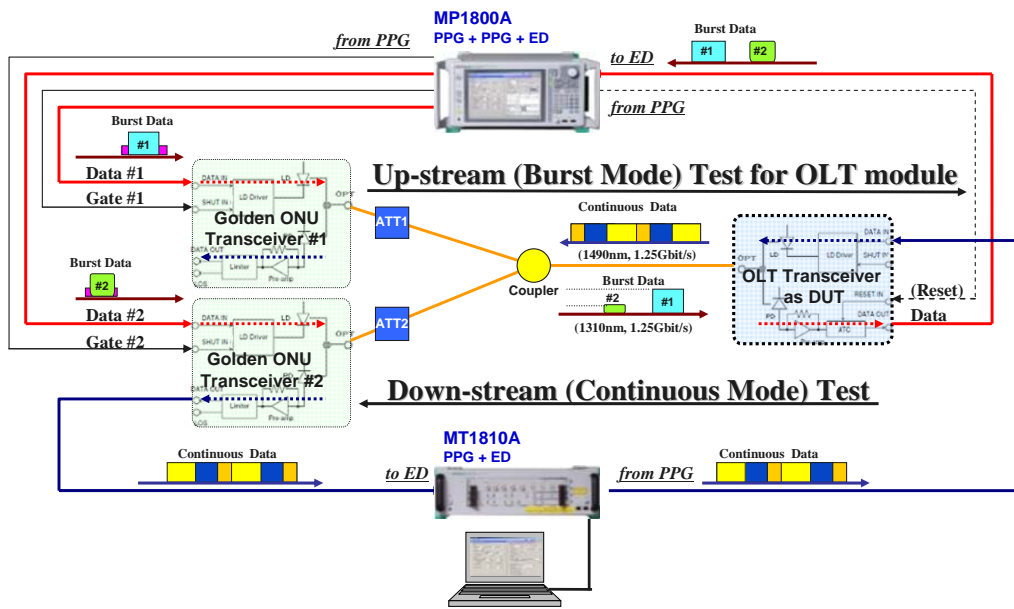
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OLT/ONU Transceiver module Test



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MP1800 Series Configuration

MP1800A for Upstream (ONU to OLT)				
Slot No	Model Number	Model Name	Option	Remarks
	MP1800A	Signal Quality Analyzer	015	Burst Mode Measurement
Slot1&2	MU181000A	Synthesizer		
Slot3	MU181800A	Clock Distributor		
Slot4	MU181020A	Pulse Pattern Generator	002, 030, 011 or 012	Data #1, Pre-bias #1
Slot5	MU181020A	Pulse Pattern Generator	002, 030, 011 or 012	Data #2, Pre-bias #2, Reset #2
Slot6	MU181040A	Error Detector	002, 030, 020	BER Measurement for Data #2

MT1810A for Downstream (OLT to ONU)				
Slot No	Model Number	Model Name	Option	Remarks
	MT1810A	4 Slot chassis	014	Continuous Mode Measurement
Slot1	MU181020A	Pulse Pattern Generator	001, 030, 011 or 012	
Slot2	MU181040A	Error Detector	001, 030, 020	
Slot3	Nil			
Slot4	Nil			

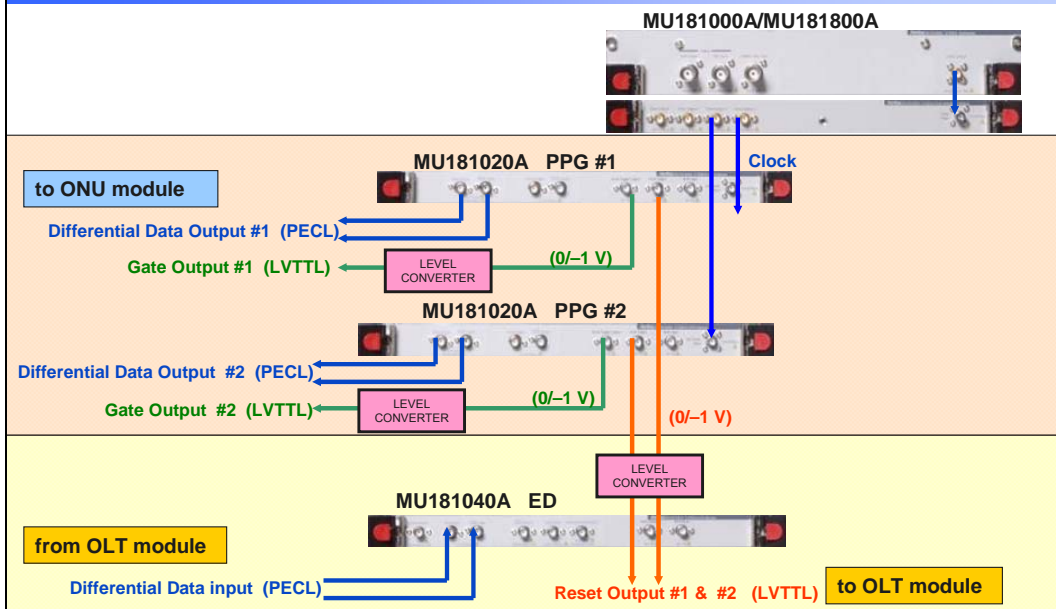
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Connection for Upstream (ONU to OLT) Testing



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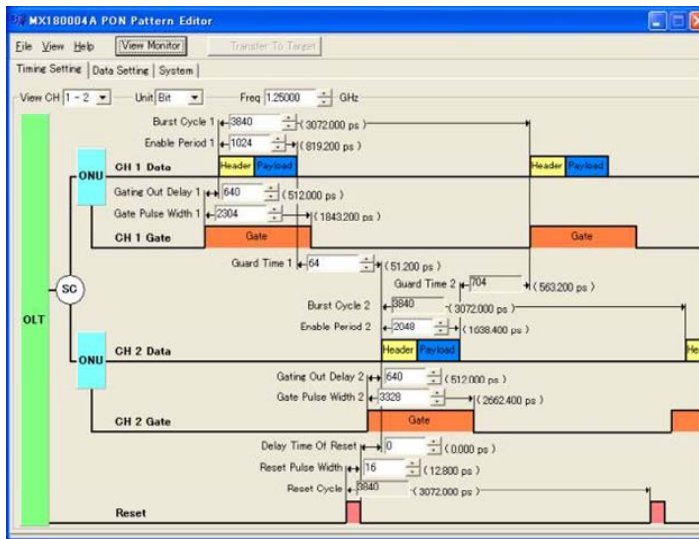
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MX180004A PON Pattern Editor–Timing Setting

Timing Setting



- Burst Cycle
- Enable Period for Valid Data
- Gate Out Delay and Gate Pulse Width
- Reset Delay and Reset Pulse Width

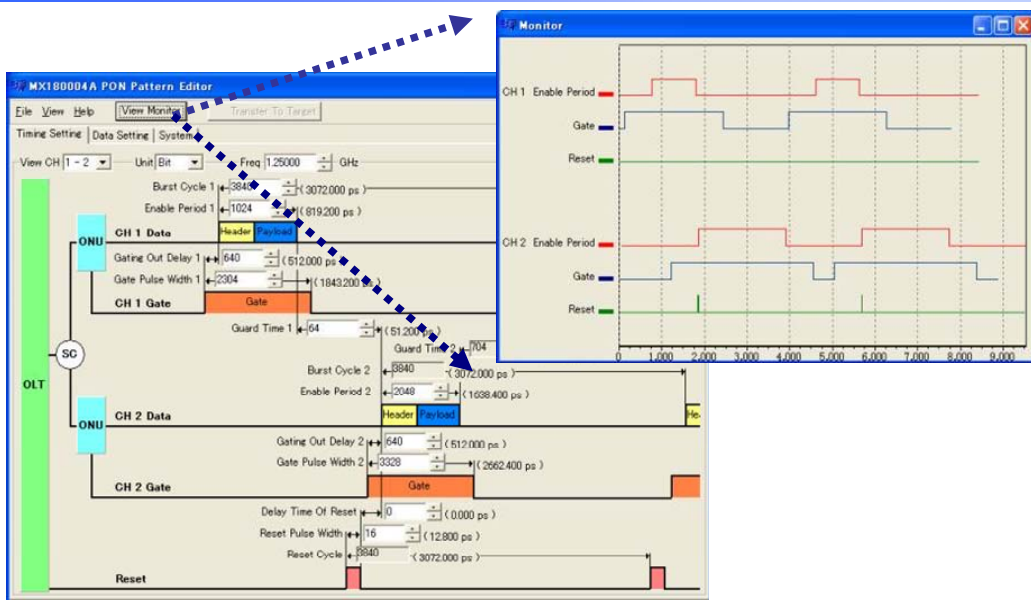
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MX180004A PON Pattern Editor–View Monitor



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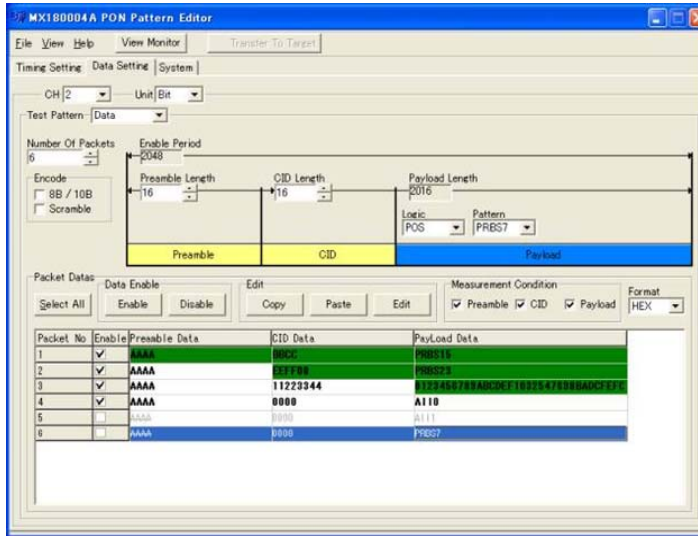
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MX180004A PON Pattern Editor–Data Setting

Data Setting



Pattern Setting for PPG and ED

- Number of Packets, Enable Packets
- Preamble/CID/Payload Length
- Pattern for Preamble/CID/Payload

ED Measurement Condition

- Selecting measurement area for Preamble/CID/Payload

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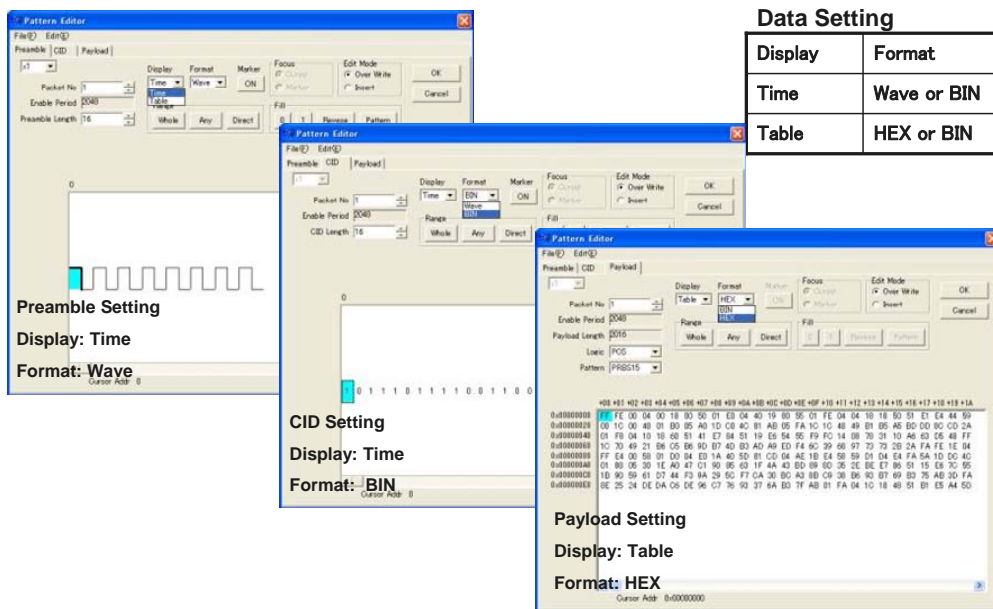
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MX180004A PON Pattern Editor–Pattern Editor

Data Setting

Display	Format
Time	Wave or BIN
Table	HEX or BIN



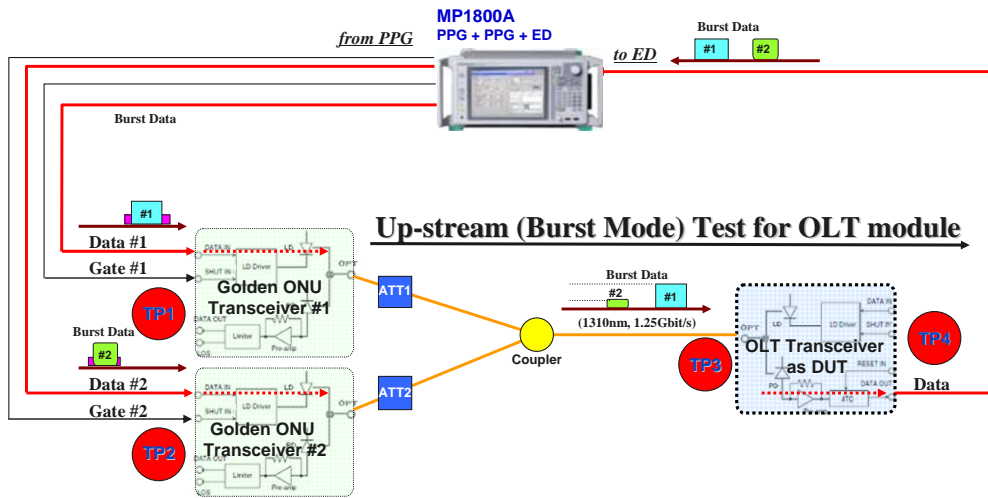
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Measurement setup for OLT module Evaluation



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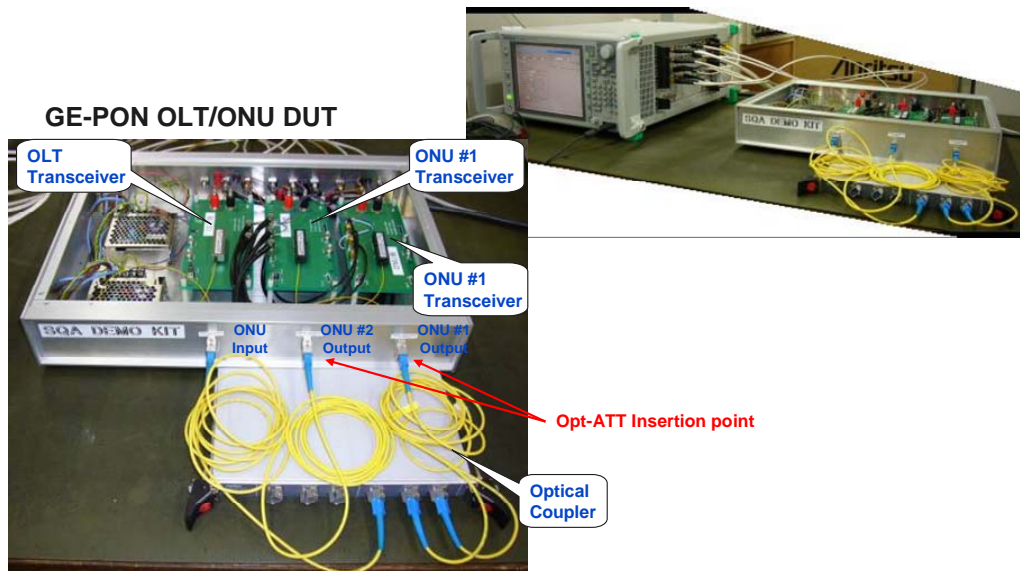
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Measurement Setup for OLT Module Evaluation

MP1800A and GE-PON OLT/ONU DUT



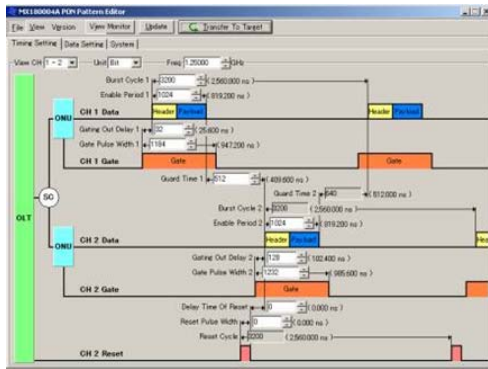
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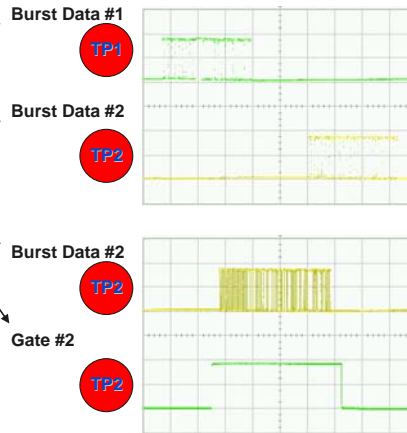
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OLT Module Evaluation (Signal Waveform)

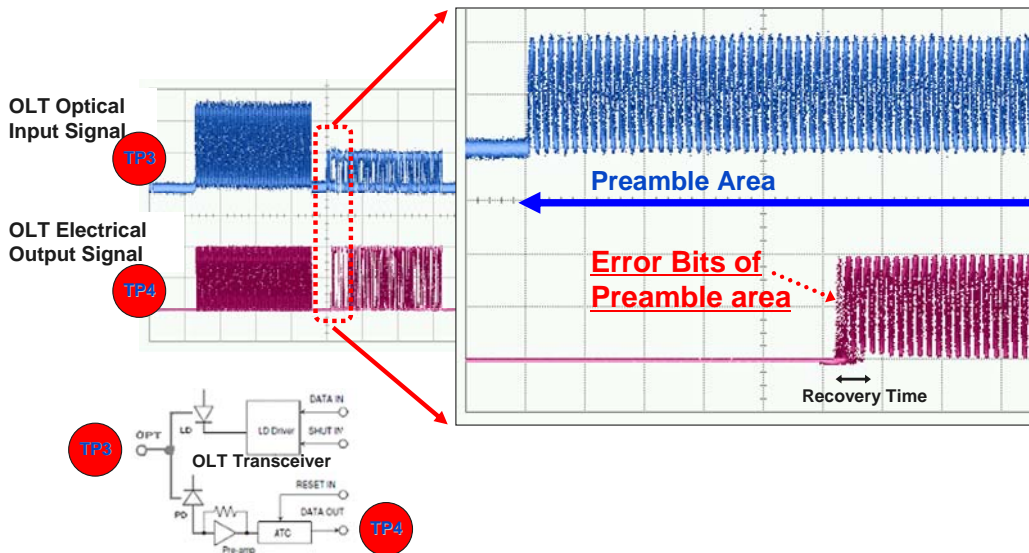


PPG's electrical output timing

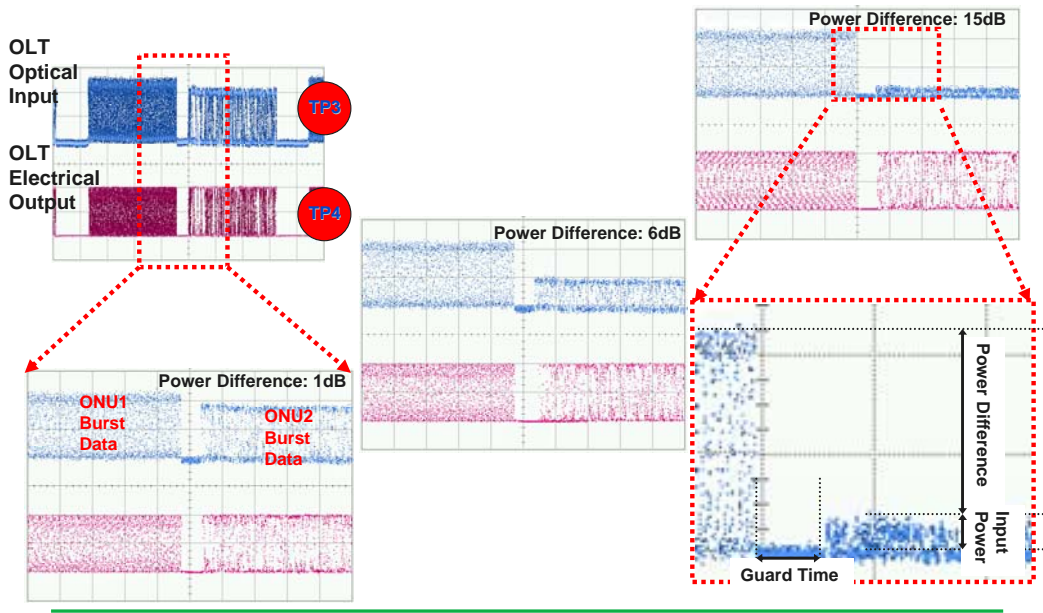


OLT Module Evaluation (Signal Waveform)

OLT Transceiver Waveform for Optical Input and Electrical Output



OLT Module Evaluation (Signal Waveform)



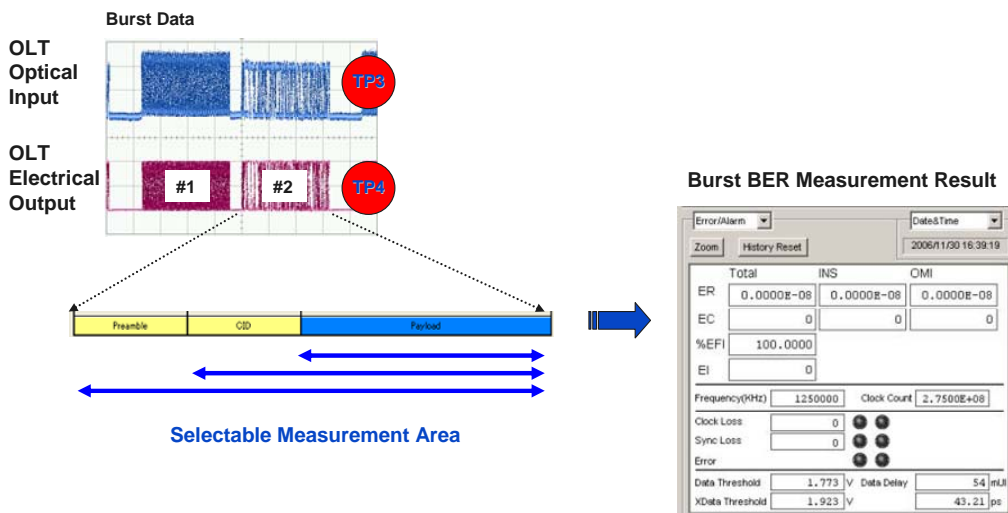
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OLT Module Evaluation (Signal Waveform)



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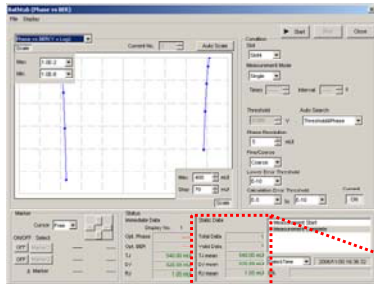
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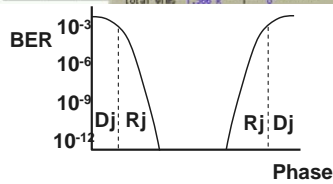
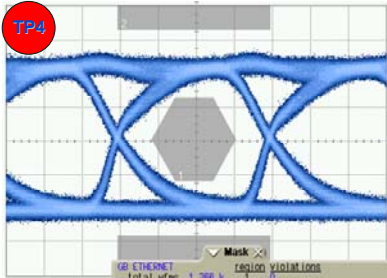
OLT Module Evaluation(OLT Module Performance)

Measurement Condition
 Bit rate : 1.25Gbit/s
 Pattern : PRBS 31 (Continuous)
 Input Optical Power at TP3 : -10dBm

Bathtub (Phase vs. BER) Measurement



OLT Electrical Output Waveform Mask Test



Static Data	
Total Data	1
Valid Data	1
TJ mean	540.00 mUI
DJ mean	525.59 mUI
RJ mean	1.05 mUI

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OLT Module Evaluation(OLT Module Performance)

Receive sensitivity measurement

1000BASE-PX10 (OLT Transceiver)

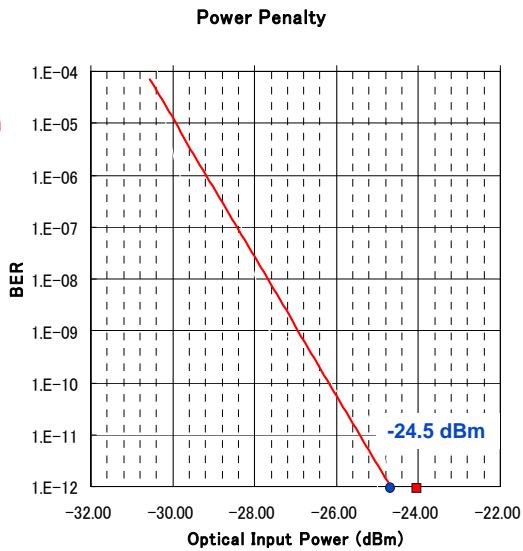
Receiver sensitivity spec (max) : - 24dBm

Measurement Condition

Bit rate : 1.25Gbit/s

Pattern : PRBS31 (Continuous)

Measurement result : - 24.5dBm



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Summary

Best BERTS for Evaluating PON Optical Modules



- **Supports Multi-channel measurement**
 - **Multiple Data/Enable/Reset Signal Output**
- **PON Pattern Editor for Easy Timing and Pattern Setting**
- **Burst BER Measurement**

Appendix

GE-PON Test Items

1. Wavelength measurements
2. Spectral width measurements
3. Optical power measurements
4. Extinction ratio measurements
5. OMA Measurements (#)
6. OMA Relationship to extinction ratio and power measurements (#)
7. Relative intensity noise optical modulation amplitude ($RIN_{15}OMA$)
8. Transmitter optical waveform (Transmit eye)
9. Transmitter and dispersion penalty (TDP)
10. Receive sensitivity measurement
11. Stressed receive conformance test
12. Jitter measurements (#)
13. Laser On/Off timing measurement
14. Receiver settling timing measurement (#)

List of Test Patterns and Tests

Test patterns	Tests
Any valid 8B/10B encoded signal	1/2, Central Wavelength/Spectrum Width 3. Optical Power 8. Eye Mask
Idle Patternless Frame	4. Extinction Ratio 5/6, OMA 7. $RIN_{15}OMA$
Random pattern test frame	9. TDP 10. Receiver Sensitivity 11. Stressed Receiver Sensitivity Receiver 3d B Upper Cutoff Frequency
Jitter pattern test frame	12. All Jitter Tests

(#) Informative Tests

Reference: IEEE802.3ah

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Laser On/Off Timing Measurement

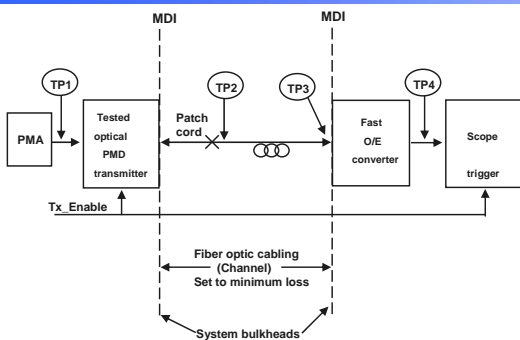


Fig. ONU PMD Laser On/Off Time Measurement Setup

Denote T_{on} as the time starting from the falling edge of the Tx_Enable line to the ONU PMD and ending at the time that the optical signal at TP2 of the ONU PMD is within 15% of its steady state parameters (average launched power, wavelength, RMS spectral width, transmitter and dispersion penalty, optical return loss tolerance, jitter, $RIN_{15}OMA$, extinction ratio and eye mask opening). Denote T_{off} as the time starting from the rising edge of the Tx_Enable line to the ONU PMD and ending at the time that the optical signal at TP2 of the ONU PMD reaches the specified average launch power of transmitter off.

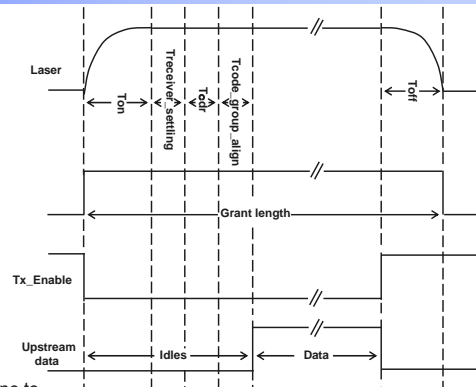


Fig. P2MP Timing Parameter Definition

- Ton value: <512 ns
- Receiver: <400 ns
- Tcdr: <400 ns
- Tcode group align: <4 octets
- Toff: <512 ns

Reference: IEEE802.3ah

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Receiver Settling Time Measurement

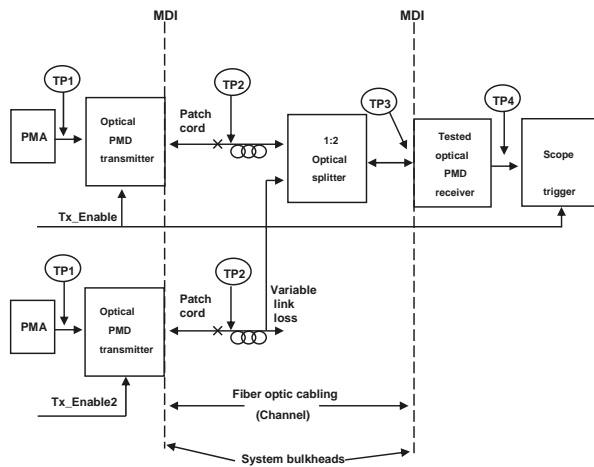


Fig. Receiver Settling Time Measurement Setup

Reference: IEEE802.3ah

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Transmitter Optical Waveform (Transmit Eye)

The required transmitter pulse shape characteristics are specified in the form of a mask of the transmitter eye diagram.

The eye shall comply to the mask of the eye using a fourth-order Bessel-Thomson receiver response with $f_r = 0.9375$ GHz, and where the relative response vs. relative frequency is defined in ITU-T G.957, Table B.2 (STM-16 values), along with the allowed tolerances for its physical implementation.

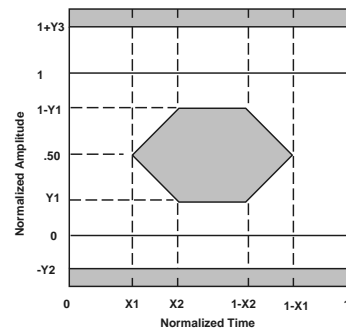


Fig. Transmitter Eye Mask Definition
 $X1 = 0.22$, $X2 = 0.375$, $Y1 = 0.20$ UI

Reference: IEEE802.3ah

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Thank you very much

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