GPON Optical Repeater

GPON Optical Repeater for 1.25/2.5 Gbps Continuous Downstream and 1.25 Gbps Burst-Mode Upstream

Introduction

GPON Optical Repeater is an OEO based optical repeater for GPON. This repeater can extend the transmission distance by > 40 Km. The OEO transceiver modules are hot pluggable SFP type with an SC/UPC optical connector. To minimize the power consumption, the downstream TX is automatically shutdown when no optical signal from the OLT to the repeater is absent.

Description

GPON Optical Repeater is composed of ONU transceiver with a burst-mode TX with high extinction ratio and OLT transceiver with a burst-mode RX. The transceivers are hot pluggable SFP type. The repeater only requires a single 5V power supply or 110 V AC line source. The power supply source is automatically selected.

Features

- Extension of GPON transmission distance by > 40 km.
- Comparable optical amplification is > 28 dB.
- Easy to use. Only requirement is single 5V DC (600 mA) or 110 V AC power supply. DC or AC power supply is automatically selected.
- High extinction ratio in upstream optical signal (> 20 dB).
- Auto-TX shutdown in the downstream in absence of the downstream signal from the OLT
- Battery back-up feature

Operation

Figure 1 illustrates the operation of the GPON Optical Repeater. The down stream is 1.25 or 2.5 Gbps continuous optical signal with a wavelength of 1.49 um and the upstream is 1.25 Gbps burst-mode packet signal with a wavelength of 1.31 um. This repeater can be used for A-PON and B-PON.

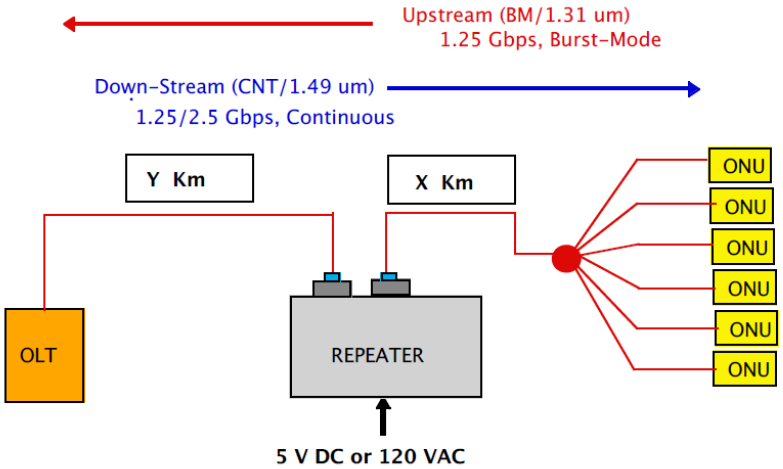

Figure 1: Extension of transmission distance in GPON Repeater

Electrical Specifications

Parameter	Symbol	Min.	Typ Max	Max	Unit
Power Supply Voltage (DC)	Vccdc	4.75	5	12	Vdc
Power Supply Current (DC)	Iccdc		0.65		Adc
Power Supply (AC)	Vccac	90	110	240	Vac
Operating temperature	Topr	-20		70	oC

Upstream Burst-Mode Specification

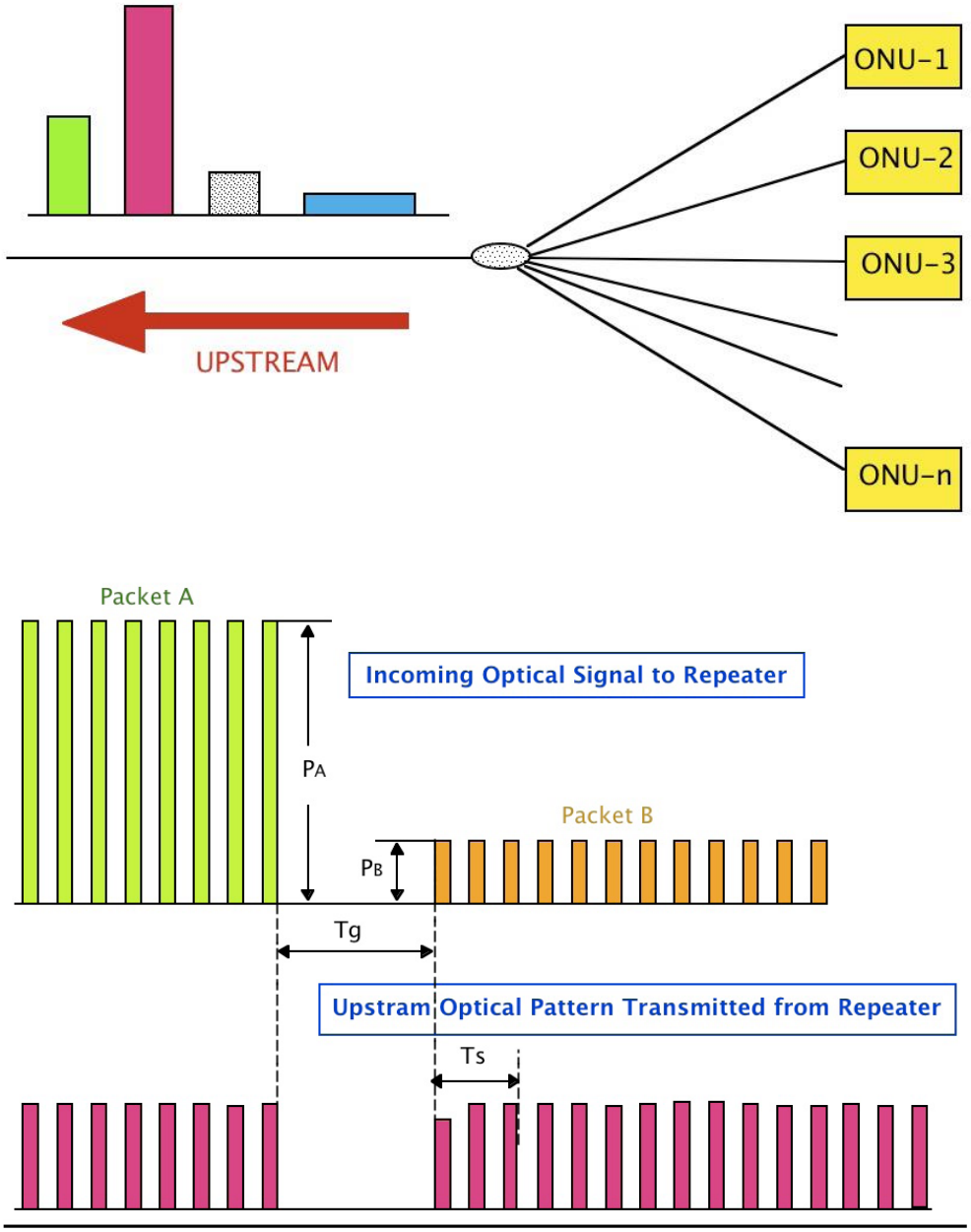

Figure 2: Timing relationship among the upstream burst-mode signals

Timing Parameters

Parameters	Symbol	Min	Typ	Max	Unit	Comment
Hi/Lo ratio	Hi/Lo		15		dB	Strongly depending on the quality of incoming optical signal of the ONUs
Packet-to-packet spacing	Tg	25			ns	Guard time needed is strongly dependent on Hi/Lo ratio
BM TX Stabilization Period	Ts			8	ns	Strongly dependent on Hi/Lo ratio and Tg.
Optical Delay via Repeater Downstream (3R) Upstream (2R)	 τDS τUP		 9 2		ns	

Optical I/O Characteristic

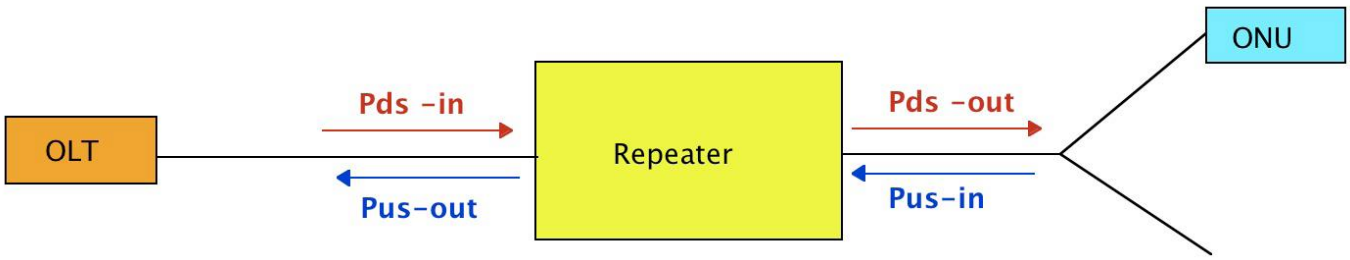

Figure 3: Definition of Optical I/O of Repeater

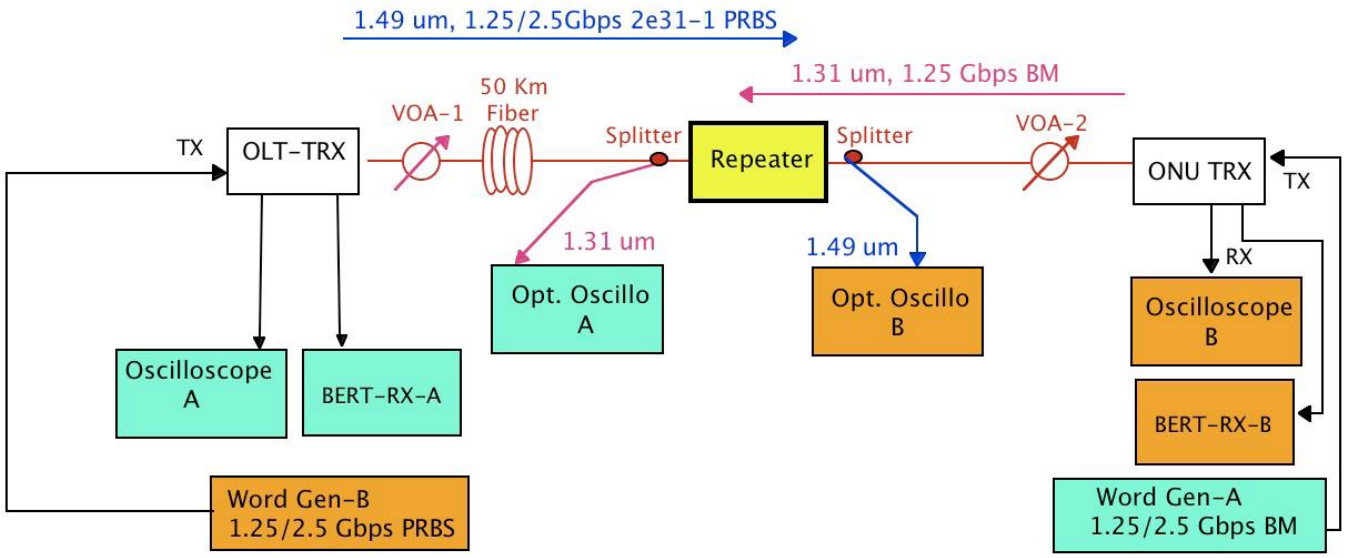

Figure 4: Characterization Setup

Figure 3 illustrates the definition of the optical I/O of a repeater. The characterization shown here are for G-PON, where the downstream data rate is 1.25 Gbps in continuous mode and the upstream data rate is 1.25 Gbps in burst-mode.

Figure 4 illustrates the characterization setup.

Parameters	Typical	Comments
RX Sensitivity/Overload in DS (Pds-in)	-20 /-2dBm	VOA-1 is fixed at – 20 dB. BER @ ONU = 10e-10. [Note 1]
RX Sensitivity/Overload in US (Pus-in)	-26/-7dBm	VOA-2 is fixed at – 20 dB. BER @ OLT = 10e-10. [Note 2,3]
TX Power in DS (Pds-out)	2.5 dBm	
TX Power in US (Pus-out)	1 dBm	
Extinction Ratio of TX in US	20 dB	The upstream optical signal supports BM RX of any OLT TRX.

[Note 1] VOA-A = 22 dB corresponds to the case where the number of splits is 64 and the distance between ONU and repeater is 10 Km. Optical power to the RX should not exceed 7dBm to avoid possible damage to the photo detector.

[Note 2] VOA-B = 20 dB corresponds to the optical loss @ 1.31 um through 60 Km long SM fiber. Optical power to the RX should not exceed 7dBm to avoid possible damage to the photo detector.

[Note 3] RX sensitivity and overload values are strongly dependent on the quality of optical signal transmitted from the ONU. In this test, the ONU transceiver is DNU-73B94B-PM3HX with high extinction ratio (> 20 dB).

Electrical and Optical Pattern

Test Condition:
Pus-in in Figure 4 is fixed at -20 dBm
Distance between OLT and repeater: 50.3 km.

Downstream Transmitter
(A) Optical Pattern at Optical Oscilloscope B in Fig. 4.

Downstream PRBS TX Optical pattern (Opt. Oscillo B in Figure 4), where 3R configuration is used in GPON Optical Repeater

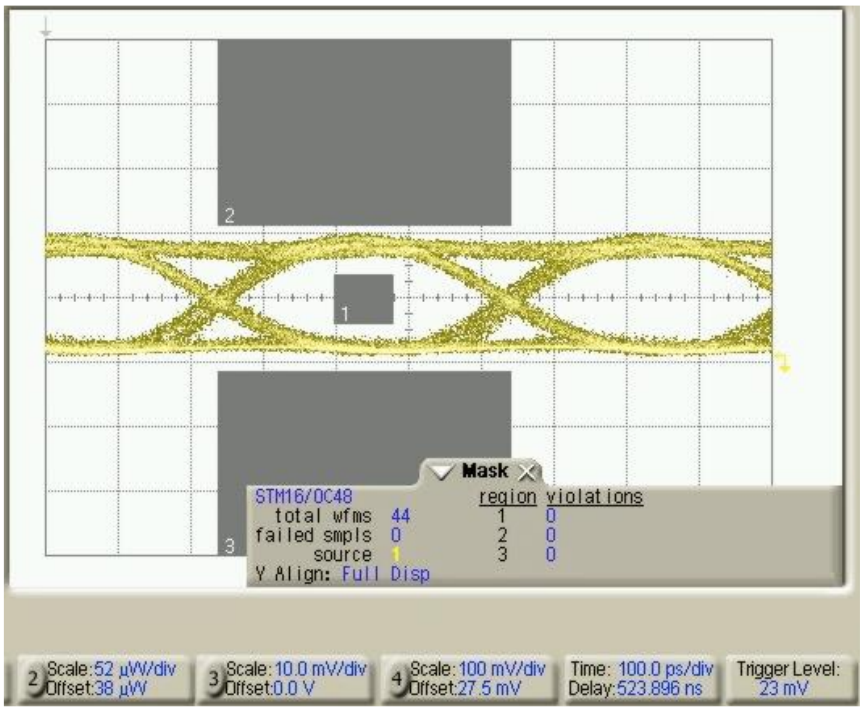

Figure 5(A): Optical pattern from the repeater in downstream (Opt. Oscillo B in Figure 4). The pattern is 2.5 Gbps 231-1 PRBS (1.49 um), where the distance between the OLT and repeater is 50 km.

(B) Auto-shutdown of downstream transmitter.

Since ac-couple is implemented at the LD driver data input in the downstream optical transmitter, the transmitter continues to transmit DC bias power even when no optical data signal incomes to the repeater (Pds-in in Fig.3). When no communication is established between the repeater and OLT or when the OLT stops transmitting optical signal to the repeater, the downstream transmitter in the repeater is automatically shutdown and the green LED indicator also turns off. Once incoming optical signal from the OLT to the repeater resumes, the downstream transmitter in the repeater turns on and the green LED indicator turns on. The transmitter turn-off time is ~ 15 us after incoming downstream optical signal stops. Transmitter turn-on time is ~ 1 ms after downstream incoming optical signal to the repeater is resumed.

Upstream Burst Transmitter:

Optical Pattern (Opt. Oscill A in Figure 4)

The upstream transmitter in the repeater is FBV (First Bit Valid) BM (Burst-Mode) type, where the first bit transmitted from the BM transmitter is valid.

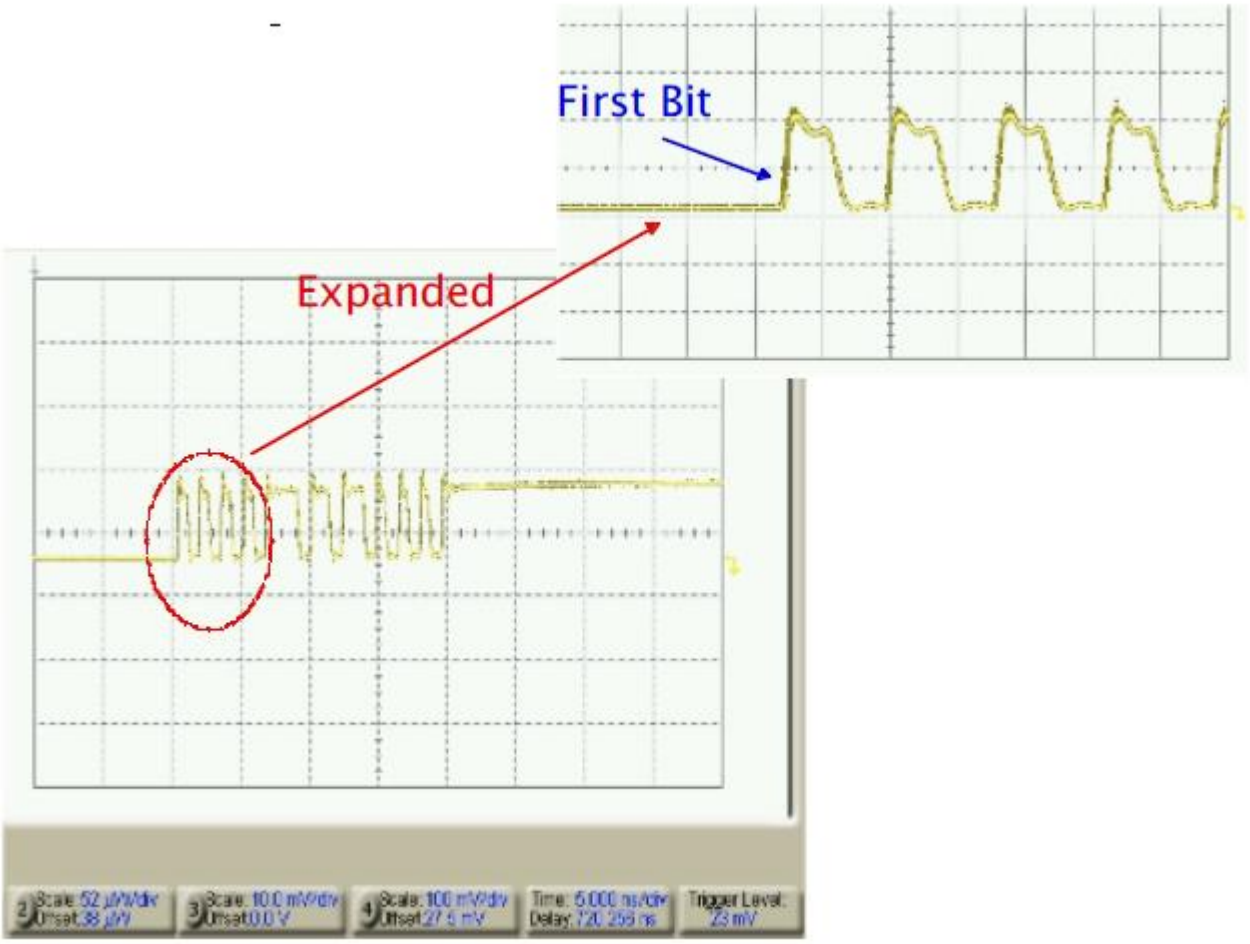

Figure 6(B): Optical pattern from the repeater in upstream (Opt. Oscillo A in Figure 5). The pattern is 1.25 Gbps burst-packet (1.31 um, 1.5 dBm), where the incoming optical power to the repeater from ONU (Pus-in inFigure4) is set to be -26 dBm (Corresponding optical amplification is 27.5 dB).

Operation Indicators:

Operation of the repeater is indicated by LEDs in the front panel.

- Red LED turns on when supply power is applied to the repeater.
- Yellow LED (US) turns on when the upstream optical power (from ONUs) to repeater is higher than – 26 dBm in average.
- Green LED (DS) turns on when the downstream, optical power (from OLT) to repeater is higher than -20 dBm.

Power Supply:

There are two power supply inputs. One takes DC power of voltage 5VDC ~ 12VDC and other takes AC power of 90VAC ~ 250VAC. When two power inputs are connected, the AC line is automatically selected and DC line is internally disconnected. This feature can be used as battery back-up feature.

Equipment Setup

Figure 7 illustrates a typical equipment setup. Either DC or AC supply can be used. DC or AC supply is automatically selected. If both AC and DC supplies are connected, AC power supply is automatically chosen.

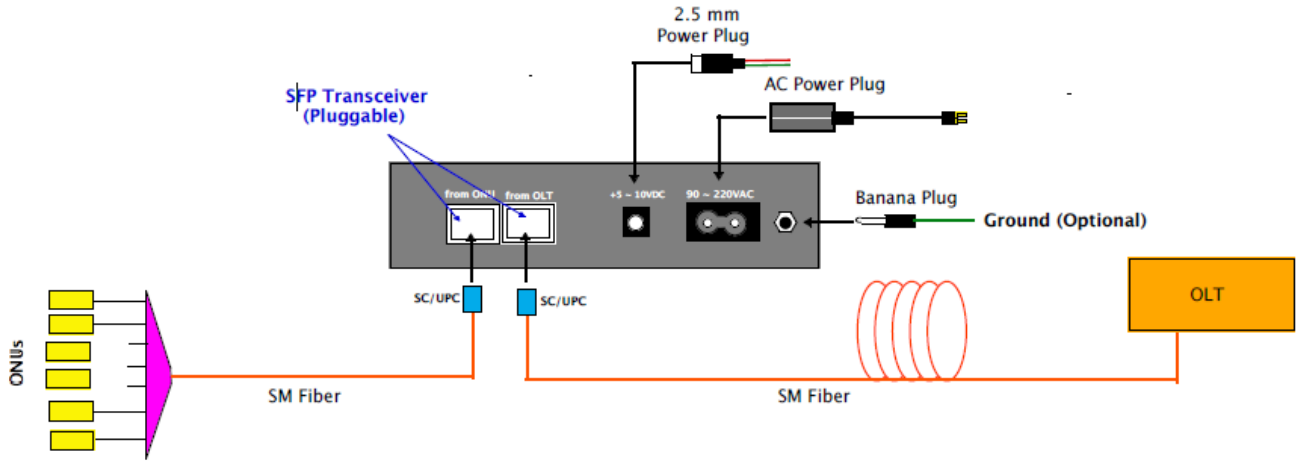

Figure 7: Typical equipment setup

Dimensions in inch (cm)

Dimensions: 6.3” (16 cm) W x 3.5” (8.9 cm) D x 1.4” (3.6cm) H
Weight: 0.55 Kg

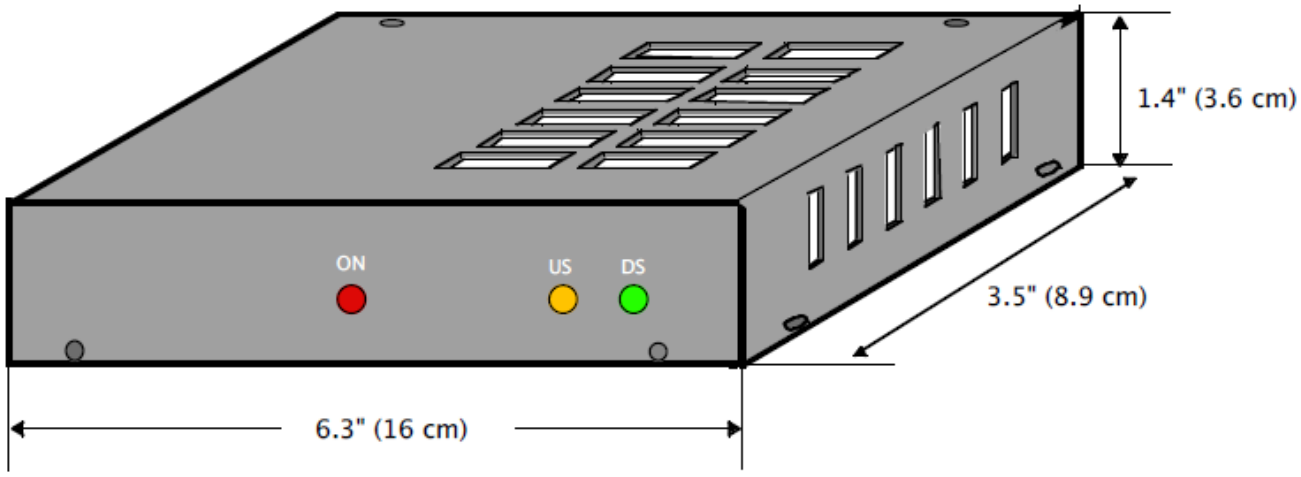

Figure 8: Dimensions of GPON Optical Repeater