

The SFP Transceiver for 10Gbps Asymmetric Next Generation-PON ONT

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Abstract

We present the first cost-effective 10Gbps SFP transceiver module as ONT solution for both NG-GPON and NG-EPON compliant in asymmetric architecture.

Introduction

Passive optical network (PON) is an emerging technology that can efficiently increase the transmission bandwidth capacity of access networks. Recently, the commercial E-PON system with 1.25Gbps/1.25Gbps down/upstream and G-PON system with 2.49Gbps/1.25Gbps down/upstream are being deployed to provide IP-TV and triple play service to the subscribers.

However, to satisfy the more requirements for bandwidth, there is necessary to expand the PON bandwidth. Recently, the two standard groups, ITU-T with FSAN and IEEE, have studied for NG-GPON and NG-EPON with 10Gbps symmetric PON and 10Gbps asymmetric PON [1] [2].

Considering the NG-PON, the asymmetric architecture is more useful than the symmetric architecture, because the access service has the asymmetric properties such as high definition broadcasting service, IPTV, and bandwidth guaranteed service.

Also, asymmetric PON have to be achieved the bandwidth upgrade with low cost. In PON architecture, the overall equipment cost of PON is weighted more toward to the ONT, because the OLT cost is shared between subscribers. For a typical 1×32 PON, the ONT represents 85% of the overall equipment cost and should be the main target for cost reduction as possible [3].

To reduce the cost, using the common platform for both NG-GPON and NG-EPON is one solution to reduce the manufacturing cost.

In this paper, we present the firstly cost-effective SFP transceiver module as ONT solution for the both NG-PON and NG-EPON with 10Gbps downstream and upstream with up to 2.5Gbps. This has some remarkable feature in respect to package, bit-rate, and electrical crosstalk.

SFP module for NG-E and NG-GPON

Figure 1 shows a) the developed SFP module and b) its block diagram for NG-ONT. It consists of TO-CAN packaged bi-directional optical subassembly (BOSA), printed circuit board with burst mode LD

driver and Limiting amplifier, and mechanical components such as LC receptacles.

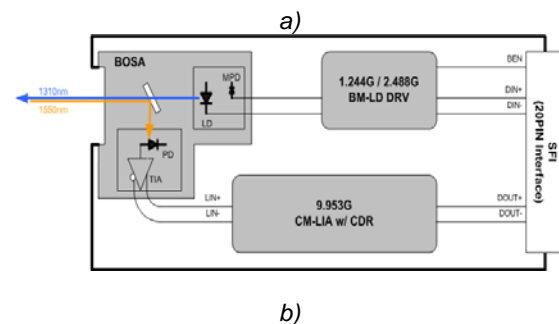


Figure 1: SFP module for NG-GPON and NG-EPON

The BOSA module consists of 4-pin leads TO-CAN to adopt an uncooled 1310nm DFB-LD for up to 2.5Gbps upstream, 5-pin leads TO-CAN to adopt PIN-PD and TIA for 10Gbps downstream and wavelength-division multiplexing (WDM) filter to split the 1310nm and 1550nm signal. To reduce the resonance due to inductance, the lead of the BOSA is cut as short as possible, and to avoid the crosstalk between LD and PIN-PD, PIN-PD is isolated from LD electrically.

For burst mode transmission, burst mode LD driver provides modulation current and bias current to LD inside BOSA. Also, it generates the regulated and stabilized optical output power by using the fast and accurate digital automatic power control. The upstream data transmits on/off according to the burst enable (BEN) signal from system. Between LD and burst mode LD driver, the compensation network is configured to reduce the impedance mismatch effect.

For continuous mode reception, the limiting amplifier is used with PIN-PD and transimpedance amplifier inside BOSA.

Also, it has the LC optical interface for PON side and SFI interface for system side.

Performance and result

Table 1 summarizes the considered specification of asymmetric NG-PON of FSAN and IEEE. In respect to line rate, NG-GPON group considers 9.95Gbps for downstream and 1.24Gbps or 2.49Gbps for upstream based on GEM frame, and NG-EPON considers 10.31Gbps for downstream and 1.25Gbps for upstream based on Ethernet frame. In case of turn-on to avoid interference on packet to packet, NG-GPON has more tightly specification than NG-EPON.

Standard Group	Upstream		Downstream
	bit-rate	Turn-on /turn-off	bit-rate
NG-GPON (FSAN)	1.24Gbps/ 2.49Gbps	13ns	9.95Gbps
NG-EPON (IEEE802.3av)	1.25Gbps	500ns	10.31Gbps

Table 1: Bit-rate and guard time for NG-GPON and NG-EPON

Figure 2 a) and b) shows the eye diagram at 1.25Gbps and 2.5Gbps. The +2.56dBm of optical output power is measured at 1311.5nm. The extinction ratio is 14.5dB at 1.25Gbps and 11.9dB at 2.5Gbps.

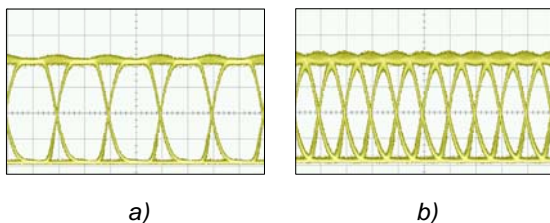


Figure 2: Eye diagram of a) 1.25Gbps and b) 2.5Gbps

To measure properties of the upstream data, 2 generators are used for data signal (DATA) and burst envelop signal (BEN). Figure 3 shows the burst mode properties of this module. The burst mode upstream data include guard bit (1's), preamble and data bits. The upstream data must absolutely turn off to avoid the interference to the other upstream signal from different ONTs. In this test setup, the circulating data pattern is used for measurement of turn-on/off time.

In this module, the turn-on and turn-off time are to be measured 2.54ns and 4.5ns. The optical output

power is measured -65.4dBm when BEN signal turn off.

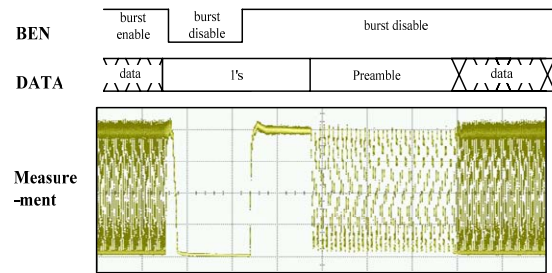


Figure 3: Burst mode upstream properties

Figure 4 shows bit error rate of continuous mode downstream data. For this measurement, EML with 8dB extinction ratio is used. For 10.31Gbps downstream, it has -18.2dBm sensitivity at 10E-12 BER with 0.2dB crosstalk between turn-on and turn-off of transmitter.

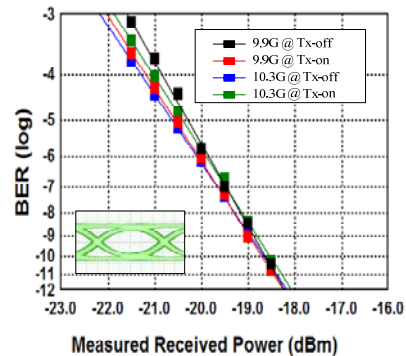


Figure 4: Receiver sensitivity of SFP module (inset: the eye diagram of 10G received data)

Conclusion

In this paper, we present the firstly cost-effective SFP transceiver module as ONT solution which can support NG-GPON with 9.9Gbps / 2.4Gbps down/upstream and NG-EPON with 10.3Gbps/1.25Gbps down/upstream simultaneously. Our bidirectional SFP module has +2.56dBm output power at 1311.5nm for 2.5Gbps transmission with up to 4.5ns turn-on/off time and -18.2dBm sensitivity for 10.3Gbps reception.

References

[1] IEEE Draft P802.3av/D1.2,(2008)
 [2] FSAN NG-PON white paper draft 0.21, (2008)
 [3] Wei-Ping Huang, et., al., J. Lightwave Technol., vol. 25, no. 1,pp.11-25, (2007)