Zenko
technologies, inc.

Zenko Technologies
PON Module

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1. Introduction

Zenko Technologies, Inc. introduces a series of transceiver modules for Passive Optical Network (PON) applications, covering 155 Mbps ~ 622 Mbps BPON and 1.25 and 2.5 Gbps G-PON, 1.25 and 2.5 Gbps GE-PON and GE-PONII. The transceivers are designed for the point-to-multipoint Wavelength Division Multiplex (WDM) single fiber configurations (PON). In general, 1.31 μm and 1.55 or 1.49 μm wavelengths are used for the up-stream and down-stream, respectively. In particular, in the upstream, the uniquely designed burst-mode (BM) transmitter in the Optical Network Unit (ONU) and the resetless BM receiver in Optical Line Termination (OLT) make the system design easier and less costly. Our instantaneous BM OLT clock and data recovery (BMCDR) ICs do not require preamble in the CDR process, which potentially makes the PON operation more efficient.

The modules are made of compact 2 x 5 or 2 x 6 Small Form Factor (SFF) packages as standard products and SFP type OLT modules in the near future. There are two types of SFF packages. One type is the SC-connectorized (receptacle type) and the other is the pigtailed package, where a 50 cm long single-mode fiber (SM) with an SC/PC connector is standard. The users have the choice of a wide range of package selections according to their applications.

The resetless OLT BM receiver with a high tolerance to dc optical components in the incoming optical signal and the preambleless instantaneous CDRs for OLT will make the PON systems more efficient.

The simple PON configuration due to the resetless BM RX in OLT can be readily applicable to the low speed Ethernet-based PON (LEPON™) application, which may significantly reduce the cost of the present P2P Ethernet-based access, known as the media converters.

Figure 1 illustrates the PON configuration.

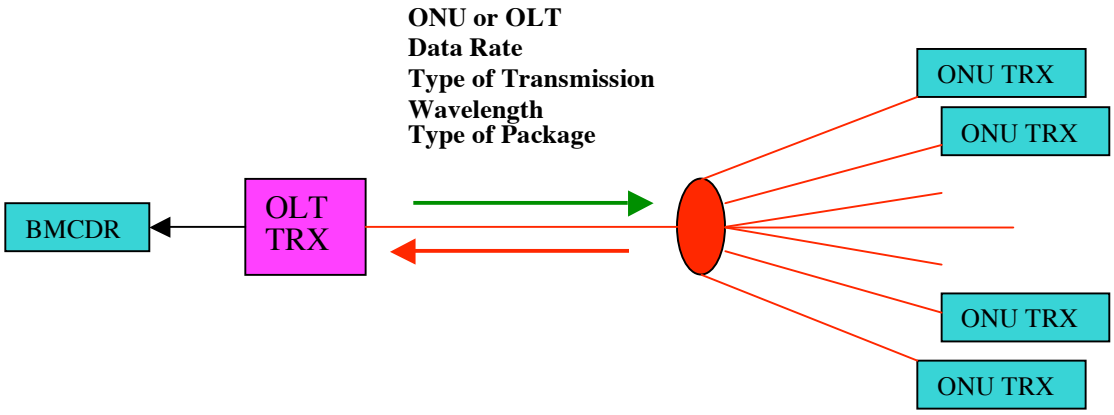
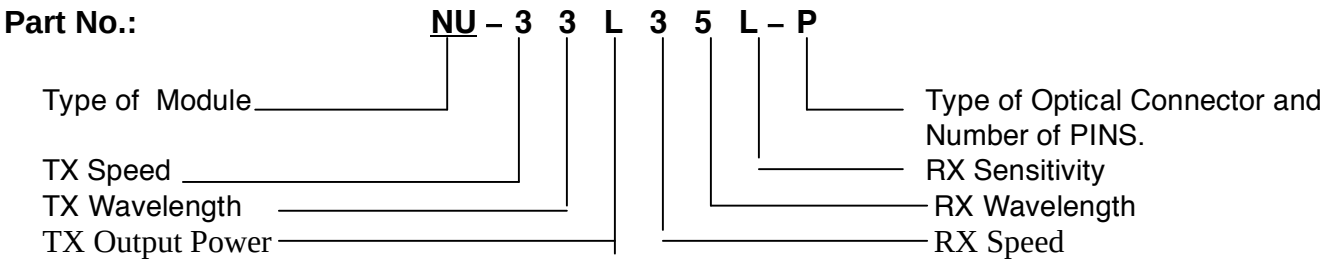


Figure 1: Basic configuration of PON

2. Selection of Transceivers for PONs

The appropriate transceiver module can be selected from the following **PON Module List**. The users can choose OLT and ONU transceivers for data rates from 100 Mbps to 2.5 Gbps.

PON Module Selection



For example, NU-33L35L-P is an ONU transceiver module for the standard LEPON™ application, packaged in a 2 x 5 SFF package with a pigtail with a SC connector.

The standard packages are K, KB and KC with RX output of 2R. The modules with other types of packages and optical connector are custom-made.

RoHS compliance is indicated by an X at the end of package code. For example, LT-94B73B-PCHX stands for a high sensitivity G-PON OLT module for Class B+ with RoHS compliance.

Detail of selection is found the specific module sections.

3. Unique Features of Zenko's Transceivers in PON Applications

a. Optical Data Packets

The basic configuration of the PON is a single point (Optical Line Termination/OLT) and is connected with multiple points (Optical Network Units/ONUs) through a passive optical splitter (or optical splitters) as shown in Figure 2, where the simplest configuration is shown and the number of splits varies according to the applications. In LEPON™ applications, n = 4 ~ 16. In Broadband-PON (GE-PON/BPON/G-PON), n is in general 16 or 32. Some times, n exceeds 64. The number of splits is strongly dependent on the TX output power and the transmission distance, if optical dispersion-data rate relation is ignored is ignored.

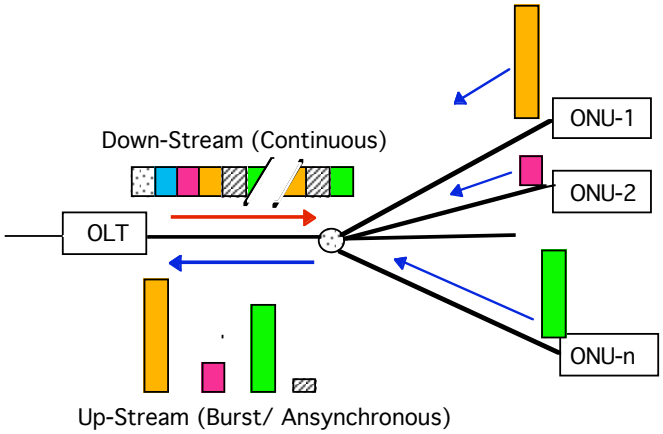


Figure 2: Typical PON Configuration and Optical Packets

The difference among the optical amplitudes of the packets in the up-stream is often more than 100 times (> 20 dB). Conventional electronics can be used for those for the down-stream such as the transmitter in the OLT, the receiver and CDR in the ONU. However, the electronics for the up-stream must cope with the asynchronous burst-mode optical transmission. The transmitter in the ONU, the receiver and CDR in the OLT must be able to handle the asynchronous burst-packet optical transmission.

b. Transmitter and Receiver for Down-Stream (Synchronous and Continuous)

The ICs for the laser driver in OLT, receiver and CDR in ONU for continuous optical data stream are commercially available. Standard ICs and opto-electronic devices used for Synchronous Optical Networks (SONETs) are adequate. Figure 4 illustrates the configuration of transmitter and receiver for the down-stream.

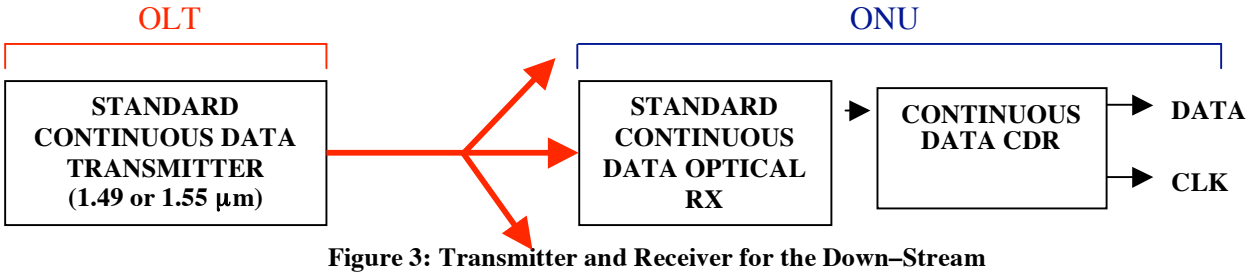


Figure 3: Transmitter and Receiver for the Down–Stream

c. Transmitter and Receiver for Up-Stream (Asynchronous and Burst-Mode)

In the upstream, packets of data are transmitted from multiple ONUs. Both transmitter in the ONU and receiver system in the OLT must handle the burst-mode optical data.

i. Burst-Mode Transmitter in ONU

The burst-mode (**BM**) optical transmitter in ONU must transmit packets of optical data in the burst-mode. In order to maximize the transmission efficiency, the Laser Diode (LD) transmission must be designed to start transmitting optical data as soon as possible after a data signal is applied to the transmitter.

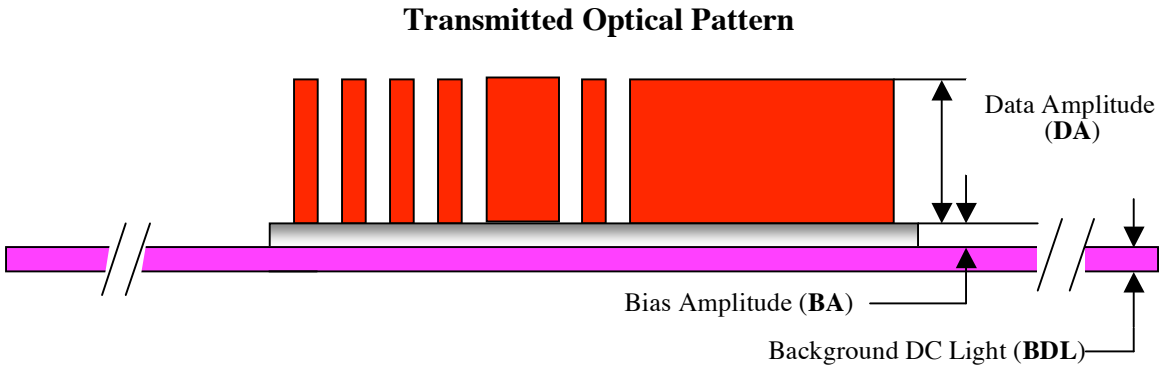


Figure 4: Optical Pattern Transmitted from BM Transmitter in ONU

1. Background DC Light

Figure 5 illustrates the typical optical transmission pattern from a BM transmitter in the ONU. Three types of optical signals are involved. One is the optical data that is controlled by the input data signal to transmitter (Data Amplitude:DA) (see Figure 5). The second is the bias optical signal that is constant within a packet and must be quickly removed as soon as the packet transmission is completed (Biased Amplitude:BA in Figure 5). The third is uncontrollable DC optical background that is constantly emitted from lasers (Back Ground DC Light:BDL in Figure 5). DA and BDL can be harmful to the BM Receiver (RX) in OLT. Therefore, strict specifications are applied to them. For example, the ratio of the data amplitude (DA)

to the bias optical amplitude (BA), so called extinction ratio **Er** should be as high as possible. In general, it is over 10 dB in the Ethernet based PON and the downstream of BPON/GPON (strictly speaking, (DA + B)/B). This ratio, extinction ratio, varies, depending on the applications). However, in the upstream of BPON and GPON, Er should be significantly higher than those of Ethernet based PONs and those of BPON and G-PON in the downstream In particular, the presence of BDL causes a serious problem in performance of the BM receiver in the OLT, because the BDLs from multiple ONUs are accumulated at OLT. Violation of this specification also causes system incompatibility depending on the system manufacturers in addition to the performance difference of BM CDR in the OLT. When the data rate is relatively low, for example, 155 Mbps, no dc bias is needed to an LD diode and it is no problem to assume that B ~ 0 and BDL ~ 0. However, when the data rate is 622 Mbps or higher, it is essential to provide dc bias to the LD diode prior to sending a data signal to the LD diode. In this case, it is important to control the timing to apply bias current and to reduce BDL.

2. Optical Output Control

It is straightforward to control optical output from an LD when it is used for continuous transmission. Any commercially available laser driver IC has an Automatic Power Control (APC) circuit. In continuous transmission, the photocurrent from a monitor photo-diode is averaged and the voltage generated from the averaged current level is used to control the laser drive current. However, in burst-mode transmission, the level of averaged current level varies with the frequency of packet transmission. Therefore, no simple current integrator can be used. Now, several companies have introduced BM LD driver ICs. However, the circuit configuration must be rearranged for the applications with tight restrictions.

ii. Burst-Mode Optical Receiver System in OLT

BM receiver for an OLT module is composed of a Burst-Mode Photodiode (BM-PD), BM-preamplifier, BM-postamplifier and BM-CDR.

1. Received Optical Pattern at OLT

Unlike the ONU receiver, the OLT receiver sees discrete packets of optical data, where the optical power varies from one packet to another. The variation often exceeds 100 times in the optical power within a short period of time. Figure 6 illustrates the optical pattern at the OLT. There are major parameters to take into account in designing an OLT receiver, that is, the optical powers of two neighboring packets, Ph and PL, (here, it is assumed that Ph >> PL), the packet-to-packet spacing, Td, the dc biased optical power B's (Bh and BL) and the accumulated dc optical power, BDLa.

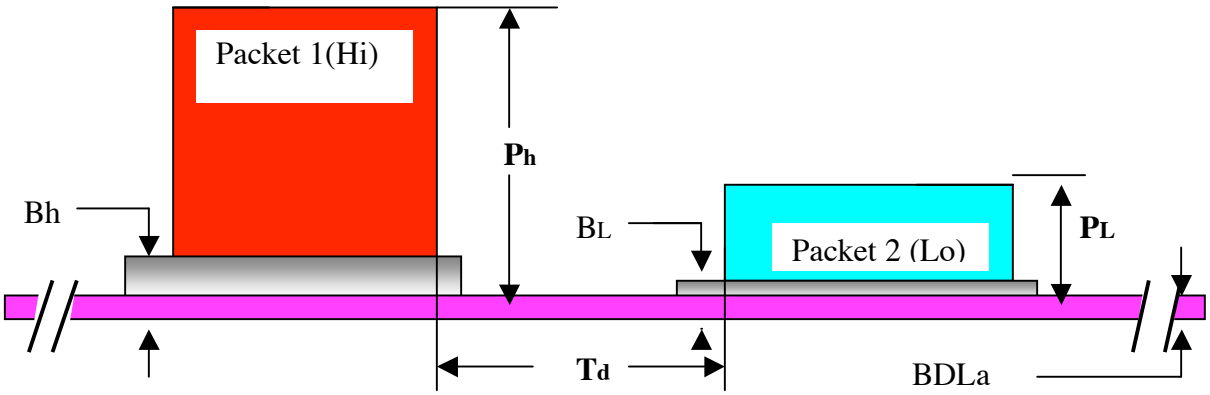


Figure 5: Optical Pattern at OLT BM Receiver

2: OLT Burst-Mode Receiver (BM RX).

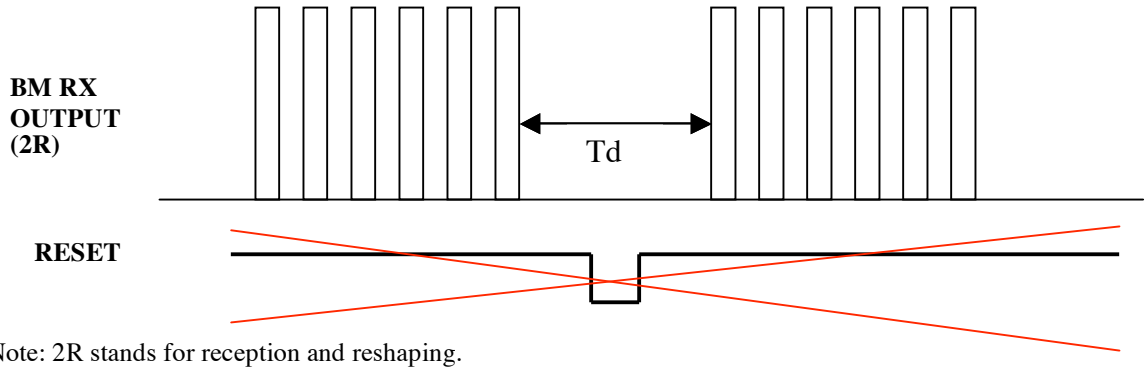
a. Tolerance to DC Optical Component

Although the BM transmitters in the ONU are designed to minimize the dc components, a certain degree of dc optical component is contained and the dc optical components from all ONUs are added at OLT. Therefore, BM receivers in the OLT must have some tolerance to the added dc optical components contained in the incoming optical signal. The dc

components from multiple ONUs cause serious problems to the OLT BM receiver, such as the pulse width distortion and receiver sensitivity penalty. Frequently, the output of the RX is simply high (‘1’) regardless of the data signals.

b. Resetless Burst and Packet Receiver

A BM RX generally needs a reset pulse between two packets (Td) to discharge the automatic threshold control (ATC) circuit as shown in Figure 7. Another reset signal is also needed to reset shift registers in the BM CDR (see Section C). The two-reset signals are different in phase. The phase relationship between the two-reset signals is extremely crucial. If one reset pulse is eliminated, the system operation becomes much simpler. Our effort has been focused on developing the BM receivers that do not require the reset signal (**RESETLESS** BM RX). It is also important to minimize the packet-to-packet spacing, Td in actual applications. In our OLT BM RXs, Td is designed to be less than 25 ns for BPON and G-PON and less than 100ns for GE-PON.



Note: 2R stands for reception and reshaping.

Figure 6. OLT BM Receiver 2R Output and Reset Signal Applied to the RX

3: Burst-Mode CDR (BM CDR)

a. BM CDR

In general, standard CDRs need significant length of preamble bits before clock and data recovery perform properly. Therefore, the conventional CDR circuit based on slow Phase-Locked Loop (PLL) is not adequate for CDR in PON OLT. Much effort has been made to reduce the preamble period for CDR in the OLT of the PON.

Zenko Technologies can provide variety of BM CDRs for data rates from 155 Mbps to 1.25 Gbps.

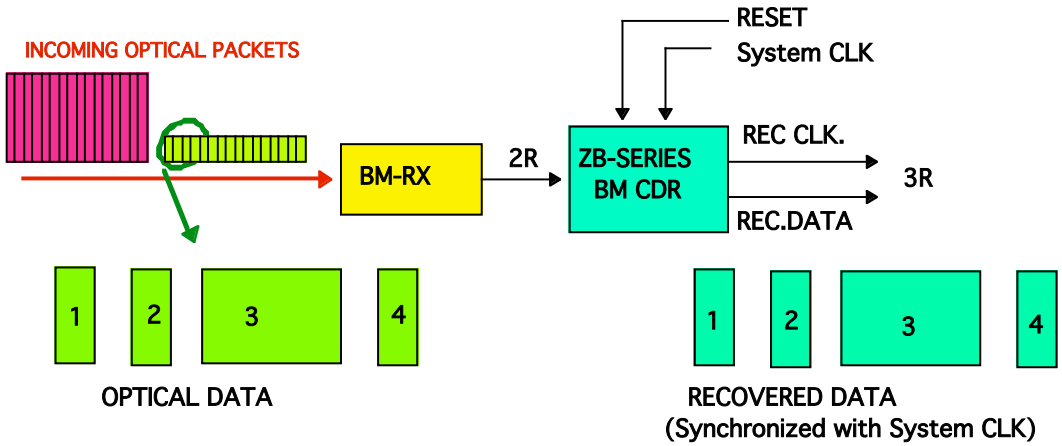


Figure 7: BM CDR Operation

4. Video-Overlay in PON Systems

Video transmission through the fiber infrastructure in the PON is very attractive in adding value to the PON. Zenko Technologies, Inc. has developed a low cost solution for video-overlay in the PON. Please go to the paper on 3W-TRX and VPON. Please see the "3W-TRX™ (patented by Zenko Technologies, US patent, 7062171).and VPON" document for details.