*Grenze International Journal of Engineering and Technology, June Issue*

# Performance Enhancement of Hybrid Passive Optical Networks with SNR Value

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***Abstract*— Hybrid Passive optical networks provide better communication link with high data rate and low power consumption. Hybrid system is more secured system for large bandwidth application. Here, in this paper, Wavelength Division Multiplexing and Time Division Multiplexing (WDM-TDM) both are used to establish a better communication system. Pump laser used here to transfer the energy from an external source to a gain medium of a laser. The performance can be observed by the observation of Q-Factor, BER value and SNR value. For simulation and optimization purpose OptiSystem software is used here.**

***Index Terms*— Hybrid Passive Optical Networks, Wavelength Division Multiplexing, Time Division Multiplexing, Pump Laser, Bit Error Rate, EYE Diagram.**

## I. INTRODUCTION

Fiber to the Home (FTTH) technique is very much useful to the user to get appropriate data with low power consumption and for long reach communication [1]. Passive Optical Networks (PON) consists of some passive components. Due to this low power consumption is achieved here. In WDM system total wavelength is divided into multiple wavelengths so that, multiple wavelengths can be dedicated for each user or shared among a group of users [2]. WDM system provides better security and scalability because each user only receives its own wavelength. One particular wavelength is dedicated to a particular user. WDM-PON increases the bandwidth by allowing different data streams. It can help to maximizes the usefulness of fiber [16]. It is useful for next-generation technologies that enhances the capacity, scalability, and flexibility of the system [3]. TDM-PON provides a specified wavelength to each subscriber. It is growing the demand for high-speed internet and three play services. Very much used in the telecommunication networks also. Optical Line Terminal (OLT), Optical Network Unit (ONU) / Optical Network Terminal (ONT), WDM and TDM Multiplexer and Demultiplexer, Wavelength-Tunable Transceivers these are the basic components of HPON system [9]. Pump laser offers the population inversion where more atoms or molecules in an excited state than in the ground state. Due to this the probability of stimulated emission of light supports to transfer data [4].

A Hybrid Passive Optical Networks (HPON) is highly cost-effective. It gives passive optical path between the service provider (SP) or optical line terminal (OLT) and the user device or optical network unit (ONU) [6]. Here point to multipoint network architecture, improves the data transmission between office or home or in any large area connection. It can operate both for residential and business environments [8].

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*Grenze ID: 01.GIJET.10.2.514_3*

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The performance of HPON, evaluated by the eye patterns, Q-Factor, BER measurement. Q-factor is a parameter to cheque the quality of the signal [5]. The Q-factor is defined as-

$$Q=\frac{m1-m0}{\sigma1+\sigma0} \qquad (1)$$

Where m1, m0 are the average value of the receiving signal at sampling instants when a logical 1 or 0 is transmitted and $\sigma1, \sigma0$, are the standard deviations.
The bit error rate defines as the percentage of error bits divided by the total number of transferred bits during a fixed time interval [12]. It is commonly expressed as tens to a negative power. BER can be expressed by -

$$BER=\frac{1}{2}\text{erfc}\ \frac{Q}{\sqrt{2}} \qquad (2)$$

In eye diagram, the best time for sampling of a received waveform is when the height of eye opening as large as possible [15]. But for amplitude distortion in the signal the eye height can be reduced. For a good result we can take vertical distance between the maximum signal level and the top of the eye opening [7]. Eye diagram describes the quality of the received signal at the ONU with respect to the transmitted signal at OLT. With zero noise or error-free transmission, the height of the eye opening will be large vertical opening [13]. If some noise introduced, it will give some interference between symbols which will generate some errors at the output signal [11]. Therefore, the higher vertical opening means the greater immunity to noise signal.
Here the performance of 8channels HPON system has been evaluated [10]. Some parameters can be varied for checking the changes of the signal. Here the data rate, fiber length and pump laser power are varied for evaluating the better result [14]. Due to low power consumption and large area coverage, it is applicable for next generation optical fiber communication.

## II. Design And Simulation

Here, 8 channels HPON system with pump laser has been designed. WDM MUX provides data from 193.1 THz with 100 GHz spacing.1:8 power splitter connected at the receiver section. Erbium doped Fiber of 5 m is used here. Pump laser with 100 mw applied to enhance the performance. The simulation is done by optisystem software. The used parameters are shown in "Fig.1".

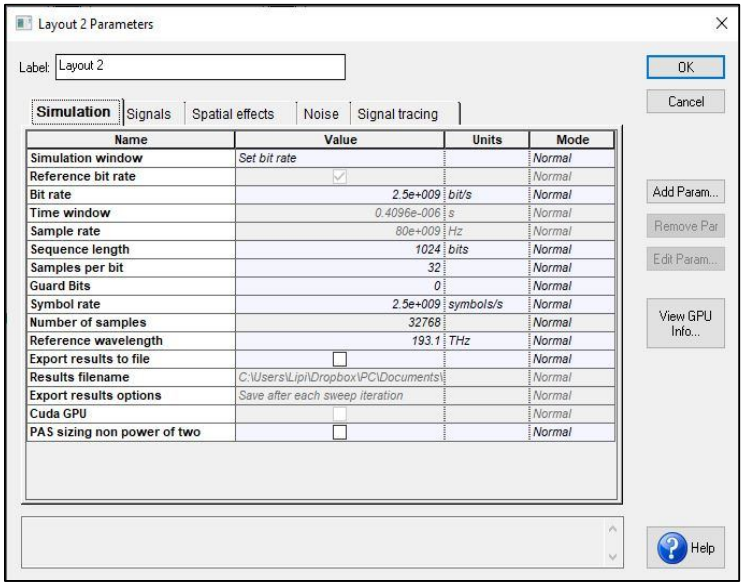


Figure 1. The parameters used in the simulation process.

"Fig. 2" shows an 8 channels HPON system using pump laser frequency 980 nm and power 100 dB. For simulation and evaluation purpose, the data rate, fiber length and Pump Laser input power are varied.
"Fig. 3" shows the internal structure of subsystem, which is ONU. Here, in ONU section PIN photodiode and Low Pass Bessel Filter is used for each and every user, for getting the appropriate signal.

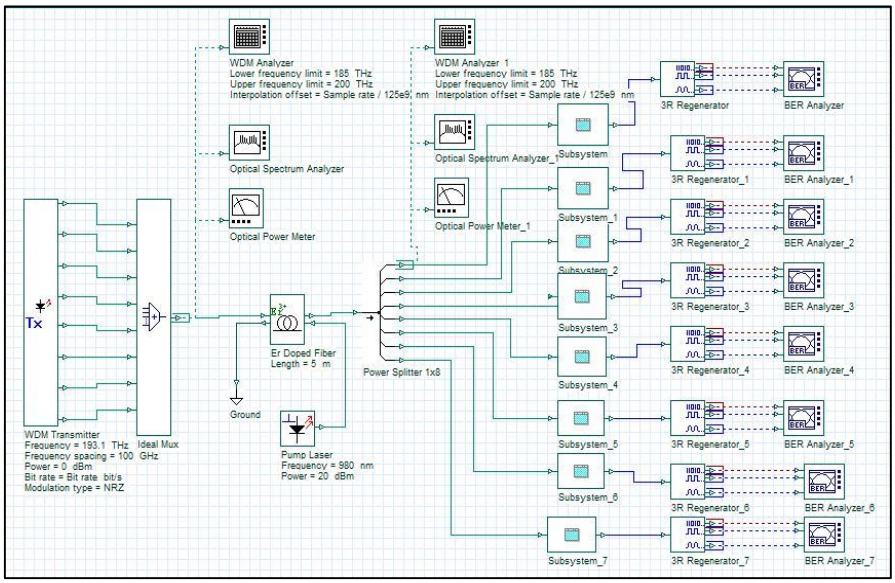


Figure 2. Hybrid Passive Optical Networks with pump laser.

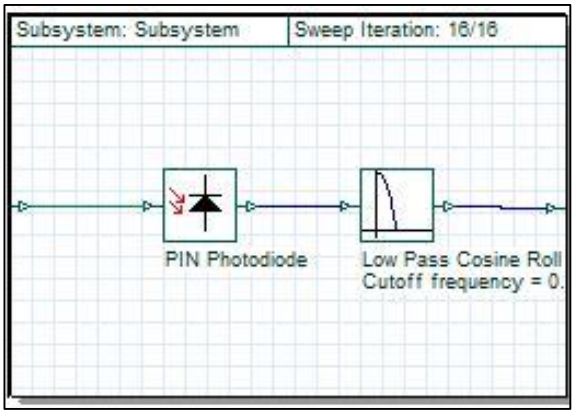


Figure 3. ONU internal structure.

## III. Result And Discussion

"Fig. 4" shows the 8 channel data frequencies coming from WDM system starting from 193.1 THz with 100 GHz spacing. "Fig. 5" shows that the received data by ONU-1. For 8 ONUs each and every user will get the different data at ONU section. 1:8 Power Splitter transmitted all the signals individually.

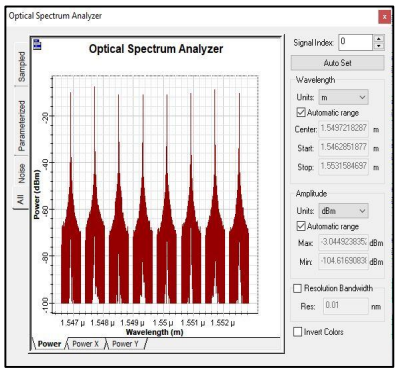


Figure 4. Transmitted frequencies from 8 channel WDM system.

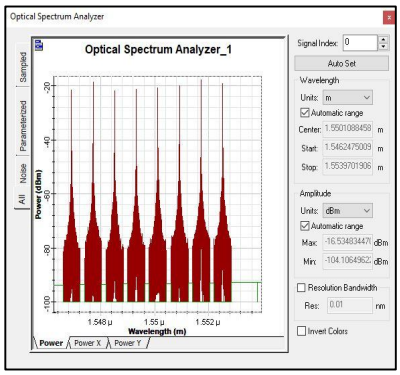


Figure 5. Received data for each user at ONU-1.

"Fig. 6" Shows that the EYE diagram for ONU-1 with Q-Factor 17.1258. It can be varied with the variation of data rate and fiber length. "Fig. 7" shows the variation of Bit Error Rate (BER) with the pump laser power. BER decreases with the increasing of input power.

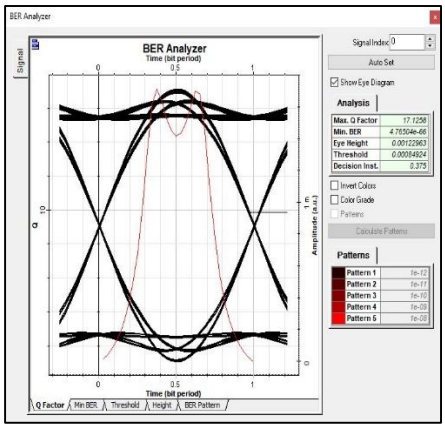


Figure 6. Q Factor and EYE diagram of ONU-1.

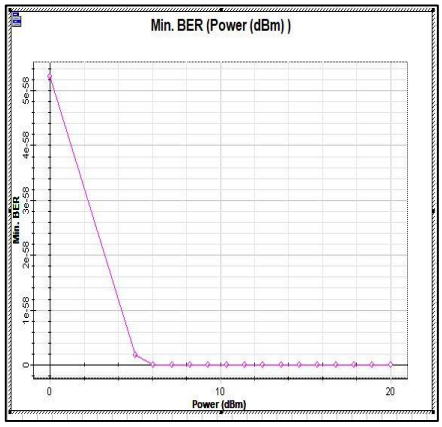


Figure 7. BER variation with the input power

"Fig. 8" shows that the OSNR value, which can be controlled by the data rate and fiber length.

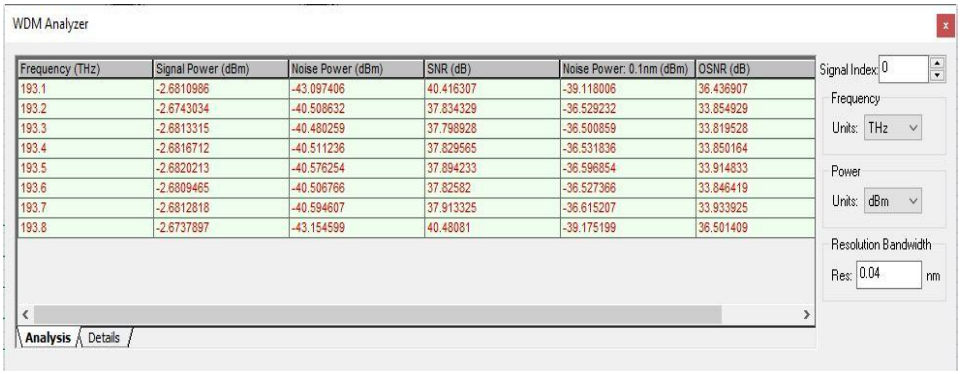


Figure 8. OSNR value at ONU section

## IV. CONCLUSION

In this paper a Hybrid Passive Optical networks has been designed with pump laser for getting better result. It has been seen that the Q factor value is increases and BER value is decreases with the pump laser power. Here the OSNR value is in stable state with low power consumption. With low power consumption, high data rate, large bandwidth, it is applicable for next generation communication system. In future the number of users can be increased and large data rate also can be achieved.

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