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RESEARCH ARTICLE

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Performance Evaluation of Hybrid WDM/TDM PON Using Different Receiver Filters

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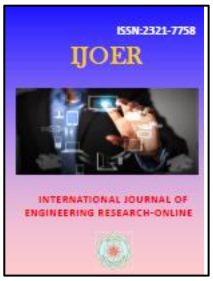


ABSTRACT

This paper presents the performance analysis of Hybrid Wavelength Division Multiplexing (WDM)/Time Division Multiplexing (TDM) Passive Optical Network (PON) by utilizing distinctive filters at the subscriber end. Five filters are used namely Low pass Chebyshev filter, low pass Butterworth filter, low pass RC filter, low pass Gaussian filter and low-pass Bessel filter. Bessel filter is the best filter among every one of the filters in our engineering on the premise of got bit error rate (BER) and receiver sensitivity values.

Keywords- Passive optical networks (PON's), Wavelength division multiplexing (WDM), Time division multiplexing (TDM), Bit error rate(BER).

1. Introduction

The developing use of data transfer capacity driven applications prompts shape new designs which can give high transmission capacity and cover extensive territory at less cost[1]. To satisfy these requirements passive optical networks (PONs) are deployed [2]. In different parts of the world, Fiber-To-The-x (FTTx) systems have been deployed. The models of FTTx, to be specific FTTH (home), FTTC (control) and FTTB (building) offer direct fiber association with or near the home. Most FTTX structures depend on PON because of its less cost and low energy utilization per bit [3]. PONs is cost effective systems as they need not any outer power [4]. So WDM/TDM PON design was made to join the elements of both WDM and TDM innovation. In such a design, different channels are utilized to convey information from optical line terminal (OLT) in a central office (CO) to a zone close to client premises [5]. A WDM multiplex number of signals into the single signal and de-multiplex single signal into different signals by which Bandwidth can be utilized effectively. In TDM PONs, a solitary wavelength is shared between all users. Bandwidth productivity can be enhanced utilizing TDM [6]. To satisfy high transfer speed request Hybrid WDM/TDM PON is the best arrangement. In this paper, the performance of different receiver filters is compared. These filters are Bessel filter, Chebyshev filter, Gaussian filter, RC filter and Butterworth filter.

The Butterworth filter guarantees flat response ('maximally flat') in the pass band and a sufficient roll off. This kind of filter is a decent 'all-rounder', easy to comprehend and is useful in applications, for example, sound preparing.

The Chebyshev channels are analog or digital filters gives a much more extreme roll off, but has ripples in the pass band, so it has no utilization in sound frameworks. It is nonetheless, far unrivaled in applications where there is single frequency present in the allow band, however, a few different. There are two sorts of Chebyshev low pass filters and both depend on Chebyshev polynomials. Sort 1

Chebyshev LPF has all-pole transfer function and sort 2 Chebyshev LPF has both poles and zeroes [7].
Bessel channel is a sort of analog linear filter which gives a consistent proliferation delay over the input frequency range. In this way applying a square wave to the input of a Bessel filter will yield a "square" wave on the yield with no overshoot (i.e. every one of the frequencies will be postponed by the same amount). Bessel channels are frequently utilized as a part of sound crossover systems. The Bessel filter has better-forming component, flatter phase delay, and flatter group delay than a Gaussian filter of the same order, however, the Gaussian has lower time delays [8].

The impulse response of the Gaussian filter is the Gaussian function. Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. Numerically, a Gaussian channel adjusts the input signal by convolution with a Gaussian function; this change is otherwise called the Weierstrass transform [9].

RC channel circuit comprises a resistor(R) in series arrangement with a load and a capacitor(C) in parallel. Capacitor restricts low-frequency signals to pass through the load. At high-frequency signals, capacitor works as a short out. Multiplication of R and C gives the time constant of filter [10].
This paper is organized as follows: section II describes the simulation setup. Results and discussions are explained in section III, section IV summarizes the Conclusion and References are given in section V.

2. Simulation Setup

The performance analysis of WDM-PON is realized using different receiver filters using Optisystem version 11.0. The block diagram of the network is shown in figure1.In this setup, four different wavelengths are multiplexed at a data rate of 1Gb/s and pseudo-random bit sequence (PRBS) of 128 bits assuming that each wavelength channel would support 8 end users at 1.25Gb/s through TDM. Data at the OLT is modulated using Mach Zehnder modulator and Non-return-to-zero (NRZ) modulation format is used. NRZ data modulation format is the most suitable format for passive optical network (PON) [11]. At central office(CO) four channels of frequencies 186THz to 189THz with a channel spacing of 1THz are multiplexed into fiber span of 83 km using 4×1 WDM multiplexer. The fiber span of 83 km consists of 70km of single mode fiber (SMF) and 13km of dispersion compensation fiber and an Erbium Doped Fiber Amplifier (EDFA). Dual pumping technique is used with pump wavelengths of both 1480nm and 10mW power. This EDFA compensates for our losses in the fiber by providing a gain of ~24dB. This amplified signal is de-multiplexed at the Remote Node (RN) into four transmitted wavelengths and each wavelength is time division multiplexed using a 1X8 splitter. This TDM signal passes through a 5km SMF before reaching the optical network unit (ONU).

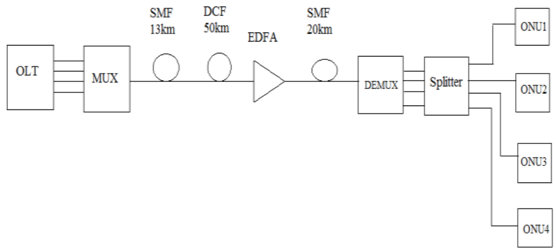


Figure1: Block diagram of simulation setup.

Splitter should be connected to a single wavelength channel. Rest of the lines out from the splitter can be left unattached.

At the receiver side, Four ONUs are used. Each ONU section consists of a PIN photodetector, a low pass filter, filter regenerator and Bit error rate (BER) analyzer as shown in figure 2.PIN photodiode converts the optical signal to electrical signal [12] and low pass filter reduces the noise of signal by filtering it. The performance of five different low pass filters is analyzed for single transmitted frequency of 186 THz by incorporating these filters in ONU section.

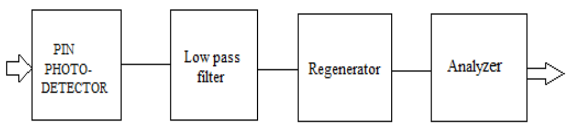
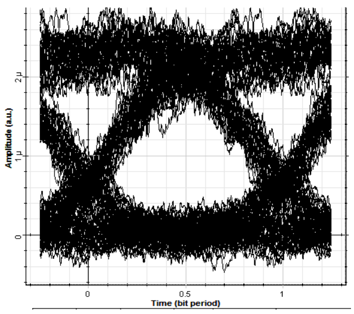


Figure 2: Block diagram of ONU.

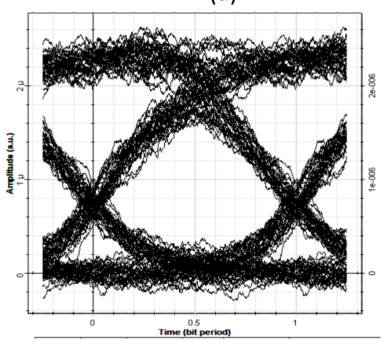
3. Result and discussion

In hybrid WDM/TDM PON, performance is evaluated using different receiver filters namely Chebyshev filter, Butterworth filter, RC filter, Gaussian filter and Bessel filter on the basis of calculated BER values. BER values are plotted against received signal power. From the Figure 3 given below, it is clearly visible that better bit error rate values are achieved for Low pass Bessel and Gaussian filter for the received power in the range of -30 to -35 dBm. Also, it is noted that at lower received power the difference in bit error rates in Low pass Gaussian and Bessel filter is small and it increases gradually at higher received power.

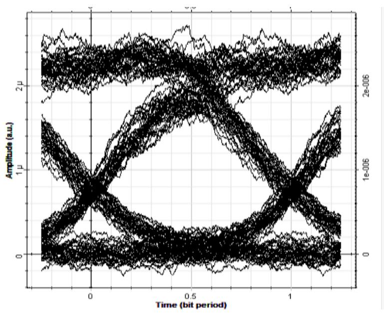
To further validate the performance of our filters eye diagrams are obtained for each filter at received power of -31dBm. The most important aspect of the eye diagram is the size of the eye opening. It is clear from the visual inspection of the eye diagram that eye openings are best observed in Low pass Bessel filter case.



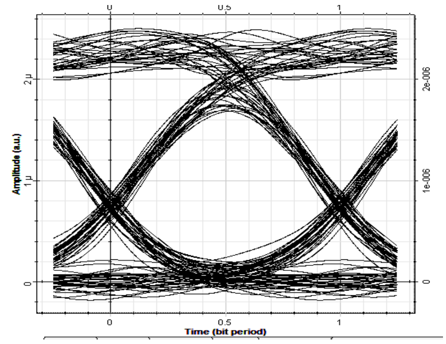
(a)



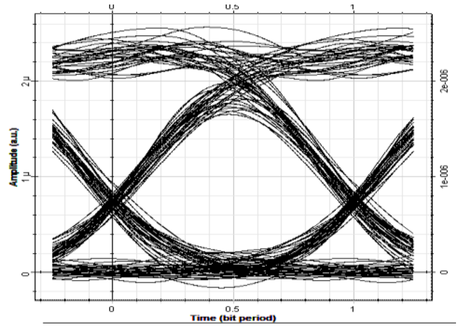
(b)



(c)



(d)



(e)

(TAKE EYE DIAGRAMS AT -31dBm)

Figure 3: Eye diagram of received signal with (a) Chebyshev filter, (b) Butterworth filter, (c) RC filter, (d) Gaussian filter, (e) Bessel filter.

4. Conclusion

The numerical investigation of the performance characteristics of Low Pass Chebyshev filter Low Pass Butterworth filter Low Pass RC filter Low Pass Gaussian filter and Low Pass Bessel filter is done. Bessel filter is found to be the best filter among all the filters in our architecture. BER value of Low pass Bessel filter is found to least in the received signal power range ie.-30dBm to -31dBm in our architecture. The results are further verified by the eye diagram analyzers.

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