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Performance Comparison of RSOA and MZM and Analysis of RSOA as a Remodulator in Data Transmission System

Jessin Salim [1], Vidya Raj [2]

PG Student [OEC], Dept. of ECE, TKM Institute of Technology, , Kollam, Kerala, India[1]

Assistant Professor, Dept. of ECE, TKM Institute of Technology, Kollam, Kerala, India[2]

ABSTRACT: Signal remodulation in the Passive Optical Network (PON) is the remodulation of downstream signal at the Optical Network Unit (ONU) to produce the upstream signal. That is it includes the extraction of downstream carrier from the downstream data and the data erased carrier is again modulated with respect to the upstream data to produce the upstream signal. That is, signal remodulation is effective because through which wavelength reuse can be achieved. In this paper, it proposes Reflective Semiconductor optical amplifier (RSOA) as a modulator for the efficient remodulation requirement in access networks. RSOA can be used simultaneously as an amplifier and modulator in remodulation systems instead of using common modulators like MZM and EAM. RSOA can be used for efficient remodulation in access networks.

KEYWORDS: Electro Absorption Modulator (EAM), Mach-Zehnder Modulator (MZM), Optical Network Unit (ONU), Passive Optical Network (PON), Reflective Semiconductor Optical Amplifier (RSOA)

I. INTRODUCTION

Passive optical network which is based on Fiber-to-the-Home (FTTH) technology is just one of the network access technologies that are used by the service providers. For Broadband for all concept, PON uses the optical fiber to serve high speed network [4]. So PON is a fiber access technology which provides immunity to electromagnetic interference, crosstalk and data security.

Optical network unit which is one of the key element of optical access networks is located at the Customer Premises and it has a direct impact on cost per customer and on the overall cost of the access networks. In order to minimize the cost of the network while maximizing output from it, cost effective solutions must be developed to be able to offer broadband connections to end users at a reasonable cost by designing simple ONUs [7]. ONU increases the cost of access networks because it requires wavelength specific light source for each ONU which is not cost effective. The solution to this problem is Centralized Light Source CLS [1] at Central Office (CO) which eliminates the requirement of wavelength specific light source for each ONU.

The wavelength division multiplexing passive optical network (WDM-PON) with CLS has been considered an ultimate solution for the fiber-to-the-home (FTTH) structure implementation [6]. Here comes the need for signal remodulation in which the downstream signal will be remodulated at the ONU to produce the upstream signal through which wavelength reuse can be achieved. ONU consist modulators to modulate the downstream carrier with the upstream data for wavelength reuse. Thus upstream signals are generated without using tunable lasers at the ONU as carrier generators.

For remodulation two optical modulators can be used, one remodulates a downstream signal to erase the optical bit pattern and the other modulates the lightwave to generate an upstream signal. The need for two modulators will probably make the system complicated and relatively expensive. For the purpose of carrier reusing, a gain-saturated SOA added prior to the upstream modulator is usually employed to bleach the data and to minimize the extinction ratio (ER) of data carried on the downstream carrier [2]. It also requires one data eraser and modulator for remodulation and it increases system complexity. Here in this paper, RSOA is analysed as a modulator in comparison with MZM and also it is analysed as a remodulator for remodulation for reducing system complexity and cost.

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II. Related work

There are many proposed WDM-PON architecture which are cost effective. A cost-effective WDM passive optical network architecture based on uncooled and unisolated FabryPerot semiconductor laser diode (FP SLD) has been proposed [8]. This is a novel WDM source with an ASE injected FP SLD and error free transmission of 155 Mb/s data through 120 km of fiber is possible. Low cost semiconductor optical amplifiers can be used in a transparent WDM metro ring architecture where all wavelengths are sourced by the server side and remotely modulated at customer end stations. This SOA also serve as transmission amplifiers [9]. Data-amplitude clipper can be done using a self-feedback power saturated semiconductor optical amplifier (SOA) has been proposed [2]. It helps to erase the downstream data for wavelength reuse or carrier reuse. The self-feedback architecture efficiently clips the downstream data amplitude to significantly reduce the extinction ratio of data on carrier. Interferometric crosstalk in an access network can be mitigated using RSOAs and centralized light generation [5].

III. System Modelling

The block diagram of an optical communication system using RSOA and MZM as modulators is shown in figure 1. It consists of a transmitter section, modulator section and a receiver section. Transmitter section includes Continuous Wave (CW) laser source which emits CW laser light. Optical fiber transmits the light to the modulation section and the data signal is transmitted through the fiber to the receiver part. Modulation block consists PRBS generator, NRZ pulse generator and RSOA or MZM as modulator. At this section Pseudo Random Bit Sequence Generator (PRBS) generates a data signal and which is encoded by NRZ pulse generator. The MZM/ RSOA at this section vary the intensity of the optical input signal according to the output of the NRZ pulse generator. Receiver section consists PIN photo detector, low pass Gaussian filter, 3R regenerator, and BER analyser. Receiver section receives the modulated signal and electrical output is generated and analysed.

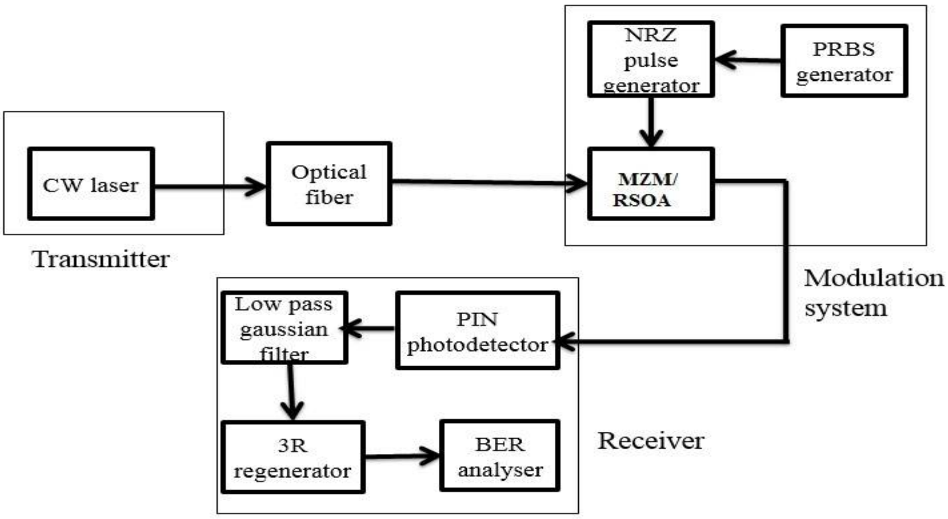

Figure: 1 Block diagram for a system employing signal modulation using RSOA/MZM

An optical data signal can be remodulated using RSOA. The block diagram of remodulation system using RSOA is shown in figure 2. It consists of transmitter block, block for remodulation and receiver block. Transmitter block consists PRBS generator, RZ pulse generator, a CW laser and MZM.

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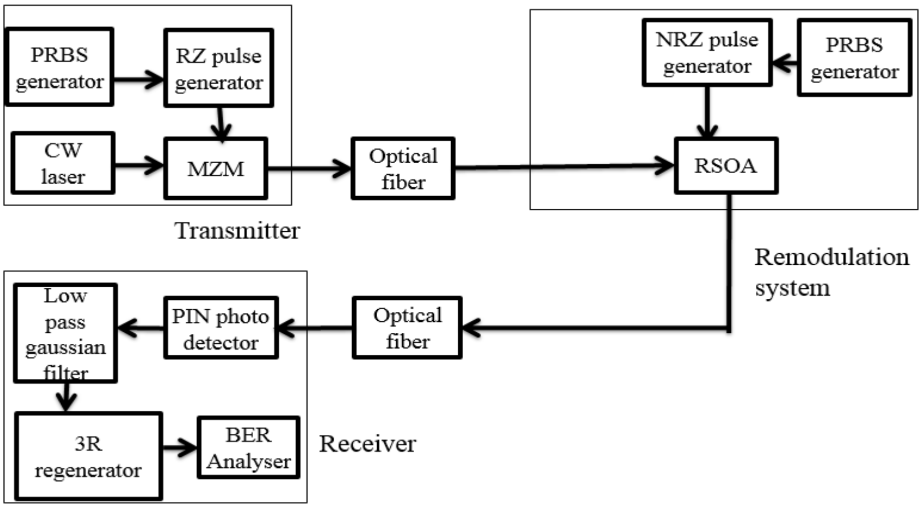

Figure: 2 Block diagram for a system employing signal remodulation using RSOA

It transmits a modulated light signal through the optical fiber. Remodulation block consists another PRBS generator, NRZ pulse generator and RSOA as modulator. This block remodulates the incoming signal with respect to another data and new data signal is generated. Receiver section consists PIN photo detector, low pass Gaussian filter, 3R regenerator, and analyser. Receiver section receives the remodulated signal and electrical output is generated and analysed.

IV. SIMULATION LAYOUT

The simulation set up for a simple communication system using RSOA and MZM as modulators is shown in figure 3 and figure 4 respectively. The CW laser light of wavelength 1550 nm and power 0.1 mW is emitted by CW laser source.

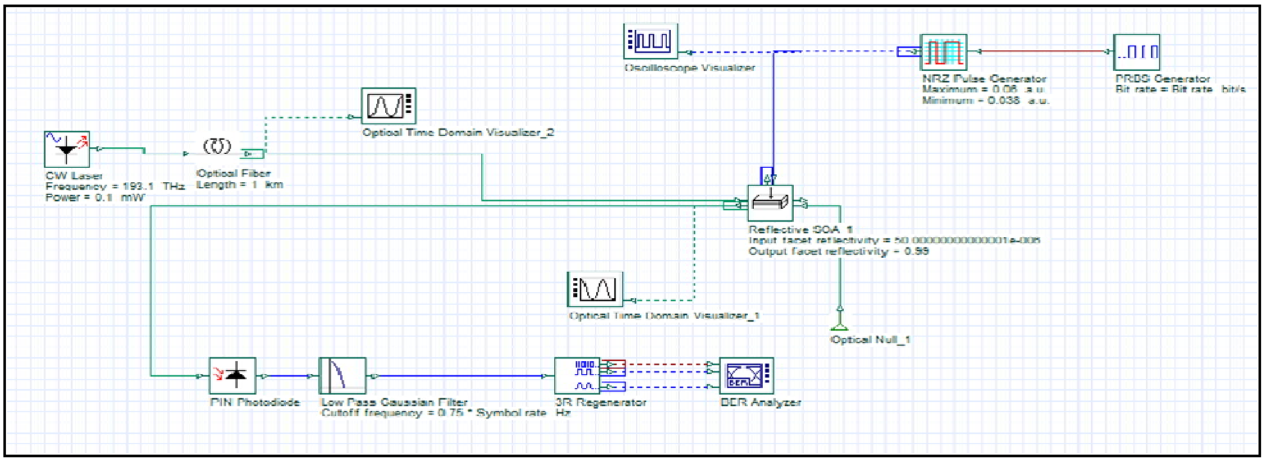

Figure: 3 Simulation layout for a system employing signal modulation using RSOA

The CW light is transmitted through an optical fiber channel having length 1 km and attenuation of 0.2dB/km. PRBS generator generates a sequence of bits which is the data signal. The generated signal is then encoded using NRZ pulse generator. MZM/RSOA is used to vary the intensity of the light from the CW laser according to the output of the NRZ pulse generator. That is RSOA/MZM is used as modulators and which modulates the CW laser light to an optical data

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signal. The modulated data signal is received at the receiver section by a PIN photo detector. The output of the PIN detector is fed to the low pass Gaussian filter. The filtered output is fed to a 3R regenerator and the output is analysed using a BER analyser. The outputs of RSOA/MZM modulator is analysed and compared by using optical time domain visualizer.

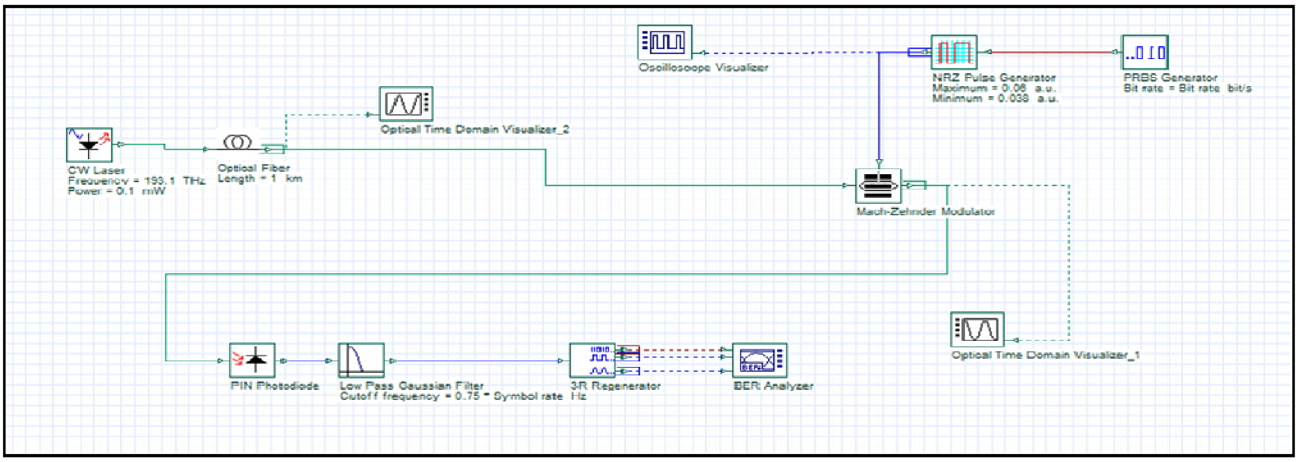

Figure: 4 Simulation layout for a system employing signal modulation using MZM

The simulation set up for remodulation using RSOA is shown in figure 5. PRBS generator generates a sequence of bits which is the data signal. The generated signal is then encoded using RZ pulse generator.

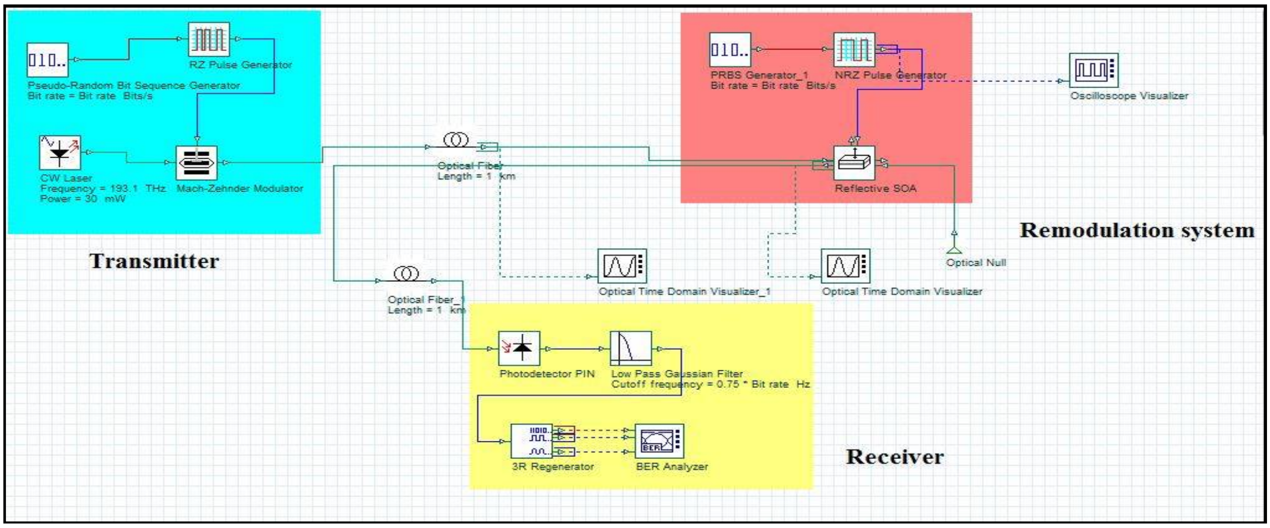

Figure: 5 Simulation layout for a system employing signal remodulation using RSOA

The CW laser light of wavelength 1550 nm is emitted by CW laser source. MZM is used to vary the intensity of the light from the CW laser according to the output of the RZ pulse generator. The output of the MZM will be transmitted through the optical fiber channel. The transmission channel used is the optical fiber channel of length 1 km with attenuation of 0.2dB/km. At the remodulation section PRBS generator generates a data signal and which is encoded by NRZ pulse generator. The RSOA at this section vary the intensity of the optical input data signal from the fiber channel according to the output of the NRZ pulse generator. The new data signal after data suppression [3] and

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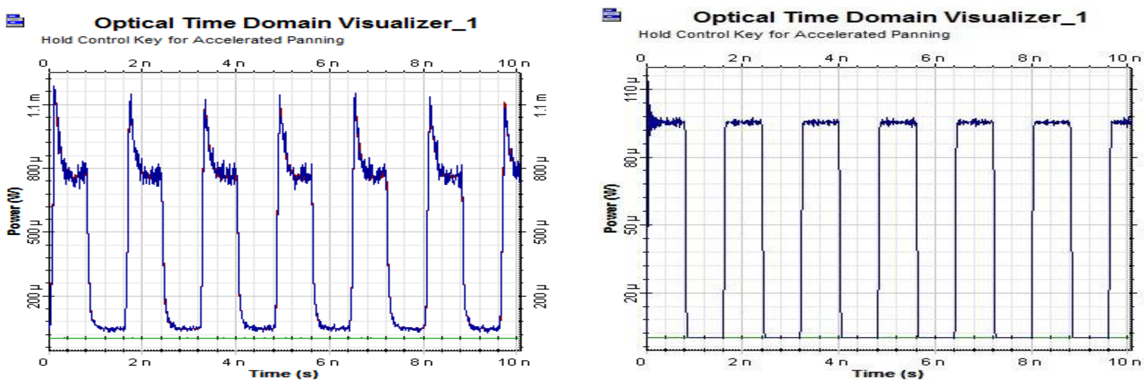
remodulation is transmitted through the fiber channel with attenuation of 0.2dB/km. The remodulated data signal is received at the receiver section by a PIN photo detector. The output of the PIN detector is fed to the low pass Gaussian filter. The filtered output is fed to a 3R regenerator and the output is analysed using a BER analyser that can be used to generate the eye diagram.

V. RESULTS AND DISCUSSION

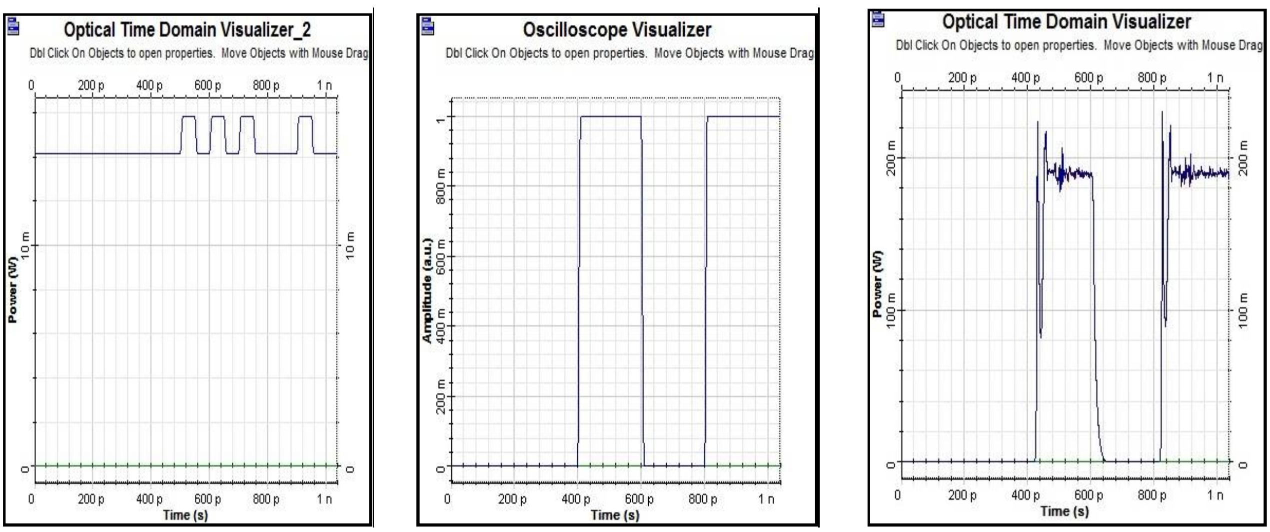
RSOA can be used as a modulator and it is simulated and analysed a modulation system using RSOA as modulator. The performance of RSOA and MZM as a modulator is compared. The analysis is shown as optical time domain spectrum output in figure 6.



(a) (b)

Figure: 6 Optical time domain spectrum outputs of modulation using (a) MZM (b) RSOA

RSOA gives an amplified remodulated output. That is the data in the input carrier data is erased, remodulated and amplified by the RSOA. RSOA can act as a perfect remodulator and it avoids the use of an optical amplifier as an amplifier or data eraser because RSOA can act both as an amplifier and modulator.



(a) (b) (c)

Fig.7 Optical time domain spectrum outputs for the input and output of remodulation system using RSOA modulator (a) Carrier signal (b) Modulating data signal (c) Remodulated output

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The power of modulated signal using RSOA is higher than that of the signal using MZM. Here the the optical input power of both RSOA and MZM is 0.1 mW. RSOA gives an output power of 1 mW from figure 6 (a). After transmission through the fiber the power of the input signal get attenuated and MZM generates a modulated output signal with power 0.095 mW which is less than input power from figure 6 (b). RSOA modulates the CW signal with respect to a modulating data and simultaneously it amplifies the signal to a high power modulated output. Thus RSOA can act both as an amplifier and a modulator simultaneously. So RSOA is used as an efficient modulator in remodulation systems. Figure 7 shows the analysis by showing the carrier data, modulating data and the remodulated output of a remodulation system employing RSOA as a remodulator.

VI. CONCLUSION

In this paper, the performance of RSOA in a data transmission system is compared with MZM. RSOA can be used as a perfect modulator because it can modulate and amplify the signal simultaneously. Also RSOA can be used as an efficient remodulator because it can extract the carrier from the data signal and modulates the carrier with another data. Thus, the cost and complexity of the data transmission system can be reduced.

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BIOGRAPHY

Jessin Salim received her B.Tech degree in Electronics and Communication Engineering from University of Calicut in 2014. She is currently pursuing second year M.Tech in Optoelectronics and Communication systems at TKM Institute of Technology.

Vidya Raj received her B.Tech degree in Electronics and Communication Engineering from Kannur University in 2007 followed by M.Tech in Nanotechnology from Anna University in 2012. She is currently working as Assistant Professor in the Department of Electronics and Communication Engineering at TKM Institute of Technology.