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Design and Study with Optical XOR/XNOR Network

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***Abstract*— In this paper design and performance investigation for optical XOR/XNOR have been executed with non return to zero pulse pattern at 20Gbps data rate. For that semiconductor optical amplifiers nonlinear attribute the cross gain modulation have been exploited. Numerical simulations of the design have depicted good extinction factor (12dB) performance. Accordingly, exploration for the logic XOR/XNOR has confirmed the needed output optical pulse pattern for applied data inputs. These optical gates could be exercised for the parity checking (even/odd) with optical processing networks. The proposed design may be an assist toward the execution of the complex optical computing networks.**

***Keywords*— parity-check (PC), semiconductor optical amplifiers (SOA), non return to zero (NRZ), cross gain modulation (XGM), bit-error rate(BER).**

I. INTRODUCTION

The speed of telecommunication systems have enhanced and achieved the upper bound of the electronic devices. So the focus is towards development of the all optical networks. In the previous decades, long-span and high-speed optical communication schemes and numerous multiplexing technology with their respective pros and cons were explored [1]. However, the need for all-optical logic functions for instance regenerating, switching, decision-making, and basic or complex computing, parity checkers is growing swiftly. At the moment the parity-check (PC)-code-supported reception method has been extensively studied and it is anticipated to be extremely competent for the high-density optical recording. These devices have revealed their capacity to carry out direct bit-manipulation in the optical domain. This could be utilized for the packet header alteration and data integrity authentication and address recognition. However accompanied by the gradual growth of the modern optical devices such as semiconductor optical amplifiers (SOA) most useful and have been exploited to realize numerous logic operations, combinational logic designs [2-7].Moreover in order to comprehend high-performance communication networks, signal transmission and decision making tasks a reality it should be appropriately addressed.

For the decision related task the exploration of bit-error rate(BER) of product accumulate codes, realistic error free transmission for the detection of optical turbo-product codes [8-11] were illustrated effectively previously. As it is well known that in the digital communication, parity checking is one of the extensively exercised binary manipulations. It is appended to a binary word prior to data transmission. In order that receiver is having with well capable to authenticate reliability of the received digital data. Accordingly, all-optical parity checker was formulated for the data integrity verification [12-13]. Accordingly, numerous excellent investigations have been explored by the earnest scientist in the past with numerous pros and cons of the designs. Thus there is wide scope to uncover the area which of the prime interests towards growth of the modern the digital optical signal processing.

Thus, in this the paper presents the performance study for the all optical XOR/XNOR logic gate realization by exploiting the nonlinearity of the semiconductor optical amplifier. The paper is bifurcated in the four sections; begin with the Introduction part followed by the schematic presentation, the results and discussion part, subsequently the conclusion part.

II. THE DESIGN PRESENTATION

The proposed schematic for optical XNOR/XOR link is illustrated in the Figure1. Here the two data inputs are generated with pseudo random binary signal generators PRBS1 and PRBS2.The PRBS's generate the pulses of data rate 20Gbps with pre, post bit defined as 5 ,7, which passes through the signal generator with raised cosine drive type and changes the pulses to non return to zero type. The generates pulses are passes through the Mach Zehnder optical modulator with V_{bias} as 0.95 volts, which is accompanied by the continuous wave laser pulses with appropriately selected power of the lasers. The suitable selection of the laser power is required for the cross gain modulation. Here two branches are with SOA which generates the required even and odd parity operation. Here the branch two generates the XOR operation which is same as ODD parity operations and other branch is same XNOR operation is same as EVEN parity operations.

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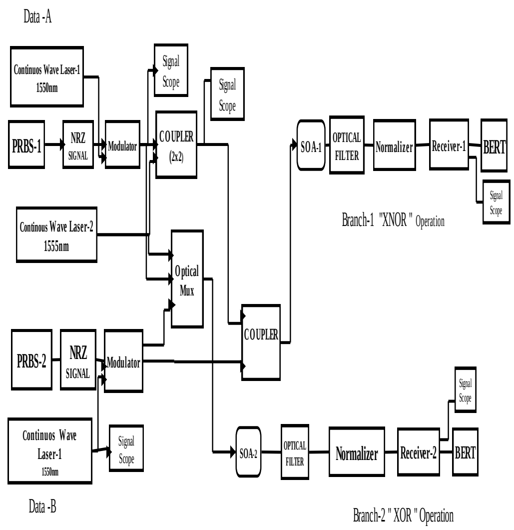

Fig.1. the design for optical XNOR/XOR network

The modulated non return to zero (NRZ) pulses are coupled, multiplexed were allowed to pass through the two branches which are with semiconductor optical amplifiers where the necessary nonlinearity cross gain modulation (XGM) operation. The cross gain modulation is responsible for the required function. Here, light wavelengths surpass through SOA in the gain saturation so that the accessible gain is distributed among two wavelength pulses. This distribution of the gain depends upon their relative photon densities. So then the gain of data pulse augments and simultaneously the clock pulse declines subsequently after passing through the SOA. After then signal processing through the power normalizer it is allowed to propagate through the detector and to the measurement tools as BERT .It generates the necessary pattern illustration.

III. Result And Discussion

In the present era of communication digital signal processing plays a significant one of the significant role. For that key issue faced in any communication system is the problem of errors. In these systems all forms of error checking engage inserting a bit to the propagating digital pattern. Thus it enhances the possible number of patterns for instance by insertion of one bit to a pattern doubles the number of likelihood. So by placing rules valid patterns could be achieved with least errors. Thus for error checking parity is the straightforward technique as it inserts one bit to the pattern and then it needs modulo-2 sum of all the bits of the pattern. Thus the parity bit is identified as solution, as the response is 0(LOW) for even parity and 1(HIGH) for the odd parity operation.

Accordingly, the injected pulse stream as data A and data B are shown in the Figures 2 & Figure3. Here data inputs are taken as Data A [0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0] and the data B [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]. Accordingly the output patterns from the branch one and branch two accompanying semiconductor optical amplifiers are illustrated in the Figure 4 and Figure5. Consequential output for the injected inputs after digital operations are as 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 1 1 1 1 1 1 1 for the odd parity .Likewise the XOR output and for the even parity is 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 is same as XNOR output. The Figure 6 illustrates the waveform pattern for the two multiplexed data inputs at wavelength 1550nm and 1555nm.

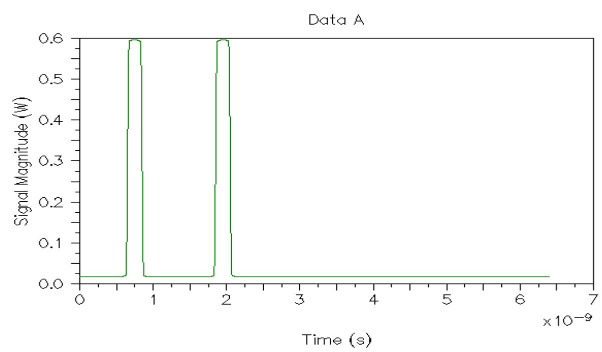

Fig 2. Data A[0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0]

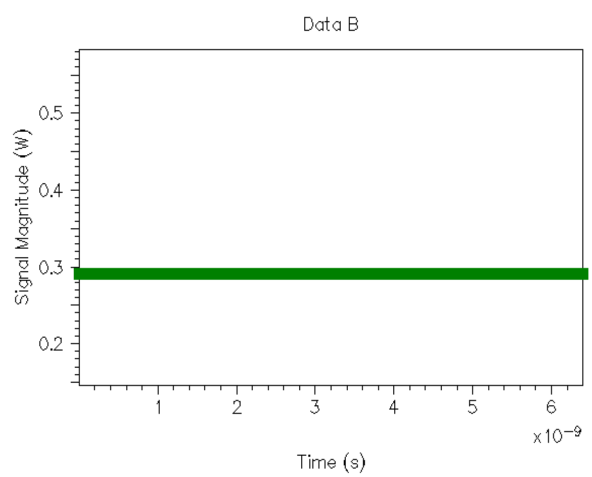

Fig 3. Data B [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

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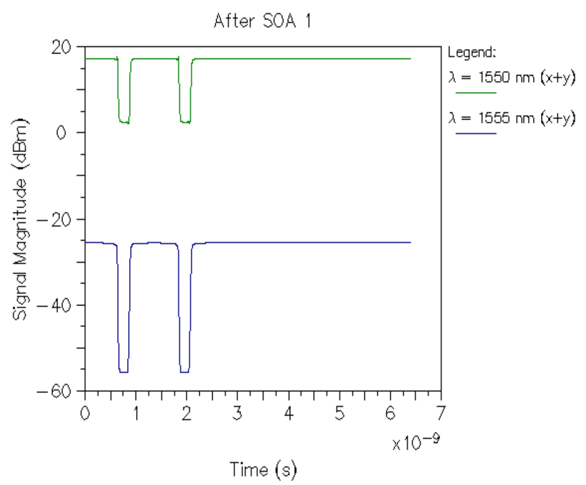

Fig 4. Output after SOA-1

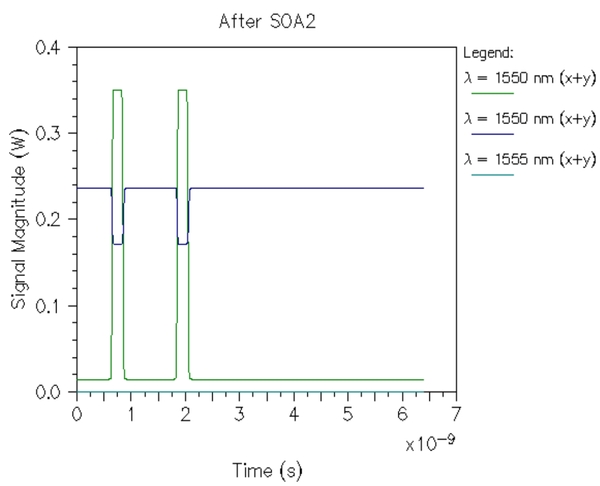

Fig 5. Output after SOA-2

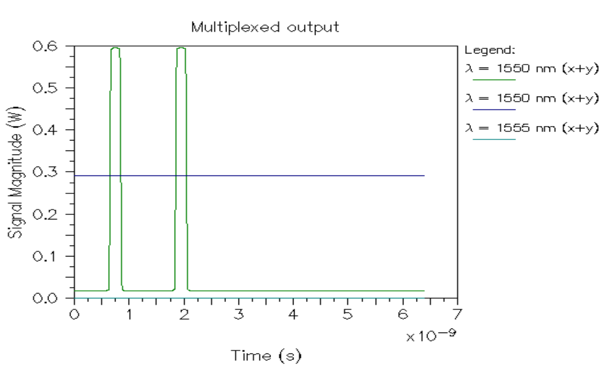

Fig 6. The multiplexed data input

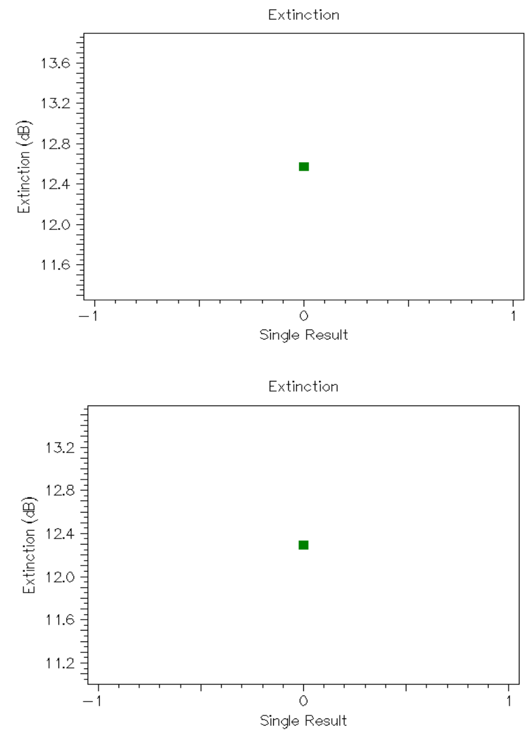

Fig 7. Output Extinction for (a) XNOR (b) XOR

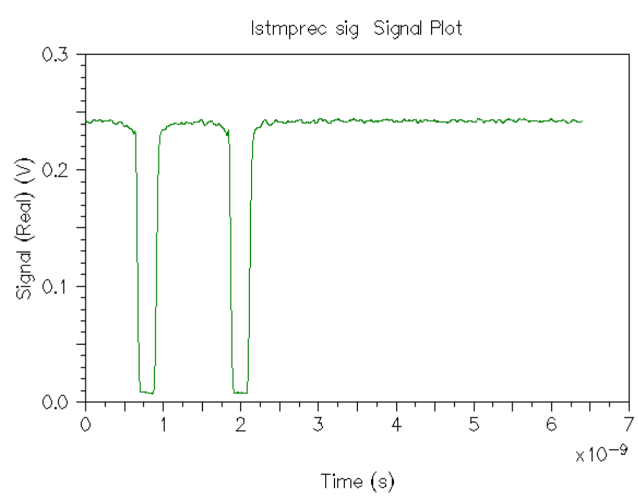

Fig 8. Output for XNOR logic

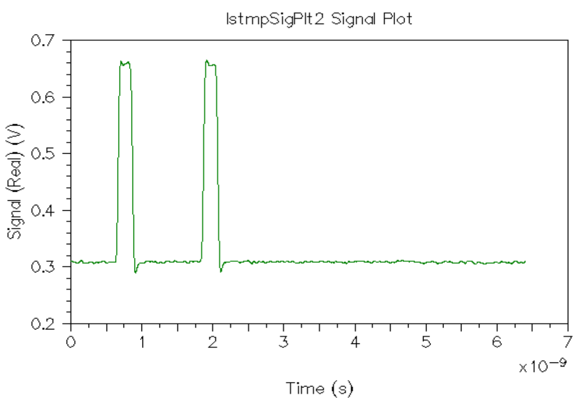

Fig 9. Output for XOR logic

Figure 7 illustrates the numerical simulations with optical network for the resultant extinction ratio factor for the XNOR/XOR. It depict good extinction ratio performance leading to satisfactory performance accordingly it must be at least 10dB.Here in this case extinction ratio factor of more than 12dB have been monitored.Resultant for the numerical simulations with optical parity checker for the applied inputs are demonstrated in the Figure 8 and Figure9 .It verifies for the resultant output optical pattern for the XNOR network results in three high pulses for three identical input patterns, which corresponds to even parity. Fig.9 displays outcome for the optical XOR logic gate and corresponds to ODD parity. It corresponds to two different input patterns it depicts two HIGH pulse pattern in the output pattern. Likewise even parity gate and the XNOR gate act alike. However for the more than two specific inputs, the XOR gate will give out HIGH (1) only once there is right one 1(HIGH) input. Whereas Odd Parity gate provides HIGH (1) for an odd number of HIGH (1) input. For the simulation of the design optical amplifiers nonlinearity cross gain modulation is exercised in order to accomplish the aforesaid operation. Under the cross gain modulation of light pulses passing through semiconductor optical amplifier leads to the gain saturation. So, that the accessible gain is distributed amid wavelengths. This distribution of the gain depends upon their relative photon densities. Subsequent to the semiconductor optical amplifier, the photon density of probe (data) pulse over the pump (clock) signal followed by the gain of data pulse augments and in unison the clock pulse deteriorates.

IV. CONCLUSION

All optical XNOR/XOR network has been designed and performance for the non return to zero pulse pattern at data rate of 20Gbps have been successfully realized. It depicted excellent performance metric, in terms of the extinction factor (>12dB). For the applied data inputs output patterns have been confirmed. It is also deduced that the schematic may be further expanded for the higher number of inputs, thus helpful to work out upcoming composite optical computing networks.

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