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REALIZATION OF HIGH DATA RATE COMBINATIONAL CIRCUIT USING ALL-OPTICAL LOGIC GATES

Kundan Raj

M.Tech, Department of Electronics and Communication,ABSS Institute of Technology ,Meerut(Delhi NCR)

raj38443@gmail.com

Abstract: In this report, we focus to implement an all optical half adder and full adder which can perform additions of optical pulses at 10 Gb/s by simultaneously generating sum and carry output .In order to demonstrate these optical logic circuit, first we implement alloptical basic logic gate and then after we did implementation of all optical logic XOR and AND gate. Further we proceed to implement full adder with the help of half adder. The implementation employs two optical signals as inputs and SOA-MZI configuration switches and provides XOR and AND logical Boolean operations based on nonlinear characteristics of semiconductor optical amplifier.

Keywords: ***Semiconductor Optical Amplifier (SOA-MZI), Classification of Technologies to Implement All-Optical Logic Gates, All Optical Basic Logic Gate, All Optical Universal Logic Gate, Combinational Optical Circuits*.**

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I INTRODUCTION

As the speed of telecommunications systems rises and reaches the limit of electronic devices, requirements for all- optical signal processing are expected to increase quickly to prevent cumbersome electro-optic conversion in future high speed networks. There has been a revolutionary change in data processing in the seventies of the last century.

So to make the optical devices first we have to make optical gates, so we need a nonlinear medium where the probe signal modulates with the fluctuation of input power of signal and give desired output. Non linearity can be produced with much type such as nonlinear loop mirror, highly nonlinear fiber, filters, waveguide, interferometer etc. Semiconductor optical amplifier are the most prospective amplifiers for attaining different logical results, as they demonstrate that they are both highly profitable and intensively develop the refractive index. The concept of conversion optical data into electrical for processing and then again convert into optical domain.it is very complex process to execute for limit bit rate, need repeater and regenerator to obtained desired signal, So due to this O/E/O conversion, devices is expencive.so to abolish this problem SOA is good choice, due to its high non linearity property.

A Semiconductor Optical Amplifier (SOA) is a modified version of the semi-conductor laser, the only difference is at facet and the length. Aside from having no reflective facets, SOA is very comparable to a laser. A stronger signal emitted via stimulated emission when a weak signal is guided through the SOA's working area.

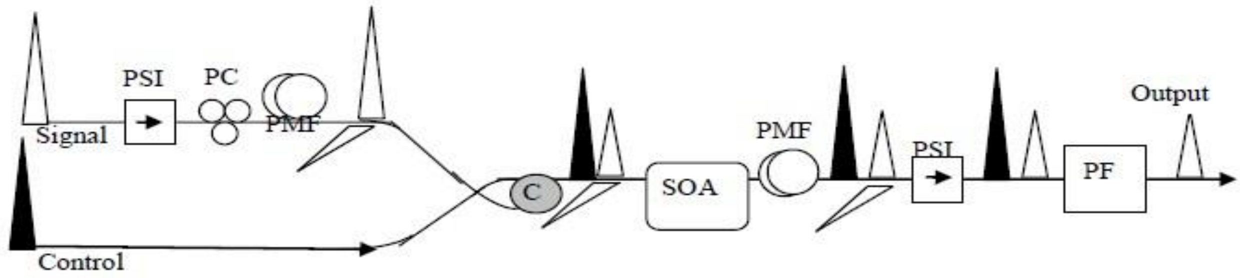
II SEMICONDUCTOR OPTICAL AMPLIFIER (SOA-MZI)

2.1 Classification of Technologies to Implement All-Optical Logic Gates

All-optical gates may be constructed using the nonlinearity effect which is introduced without SOA or with SOA. The classification for different approaches to make all optical gate. Numerous ways of all-optical gates without SOA using length of the fiber, waveguide, circulator, filters, acoustic-optic waves and changing the refractive index of the optical waveguide as well as gates constructed with SOA.

2.2 Ultra Nonlinear Configuration

Ultra-fast nonlinear interferometer (UNI) is basically a polarization interferometer. Figure shows a schematic of a UNI system which consists a 3 dB coupler and a SOA in interferometry arm, a signal is applied at the upper arm and a control signal on the lower arm at the coupler. The signal at upper arm is split into two orthogonal polarization through polarization controller and polarization maintaining fiber. These orthogonal polarization waves moves through polarization maintaining fiber such a way that there is no coupling of power between them.



III REALIZATION OF BASIC LOGIC GATE

3.1 AND Logic Gate

Boolean AND operation becomes good choice in optical signal processing. This logic Functionality of this , it gives a logic "1" only when the two input signals under comparison are a logic "1". In other case, the output is a logic "0". Never theless, taking advantage of the SOA-MZI's versatility and its earlier mentioned benefits is preferred the MZI-based implementation with SOAs. Simulation layout is shown in fig3.1 for the optical AND gate.

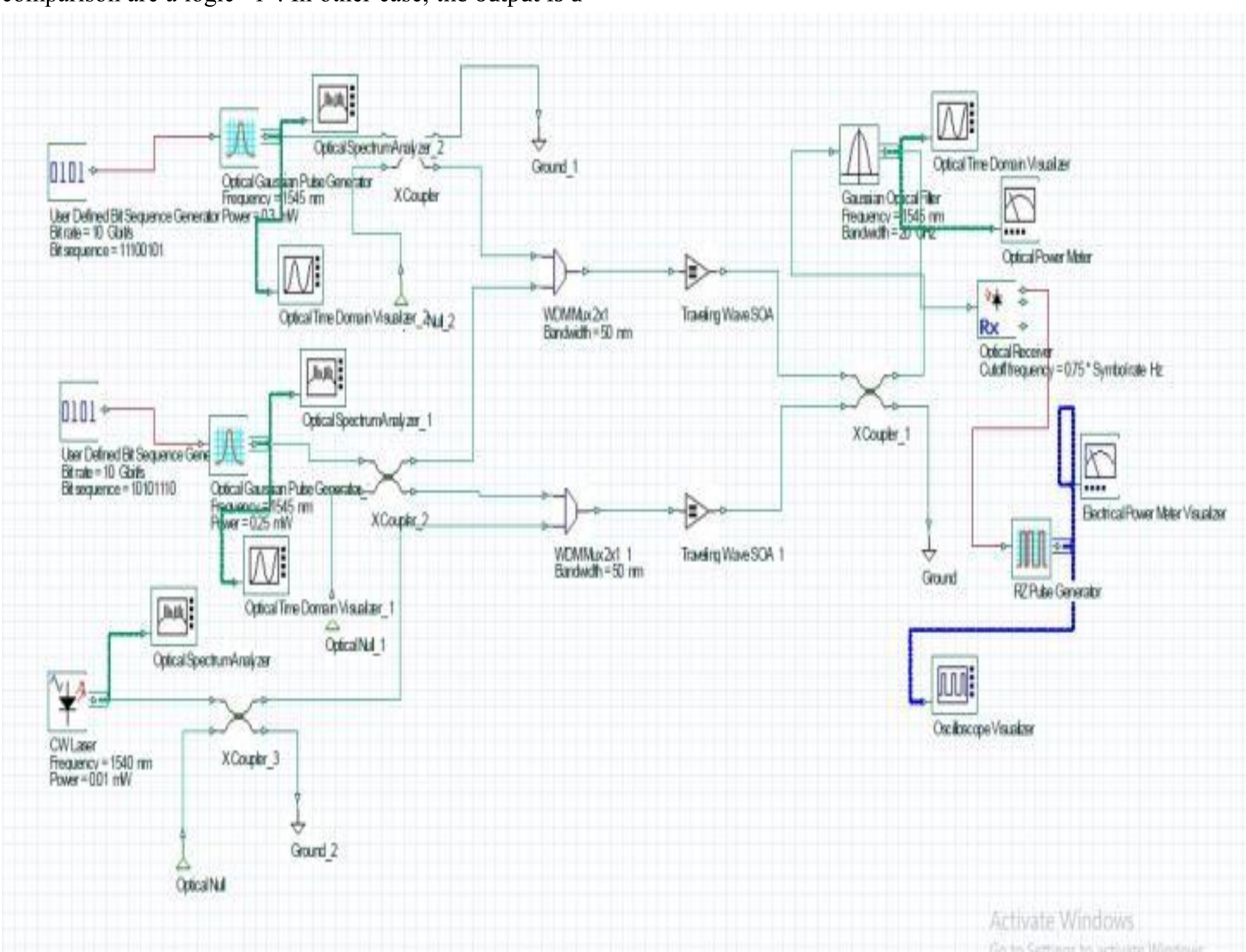


Figure 3.1: Simulation Layout for Optical AND Gate.

3.2. ALL OPTICAL OR GATE

Another logical function that can be implemented optically with the architecture based on the SOA-MZI is the OR. Fig.3.2 illustrates the implementation simulation for the optical OR gate. This Boolean function essentially provides a "1" logic when the two inputs are A= 1, B=0 and A= 0, B= 1 and A= 1, B= 1. On the other hand, if the inputs are (A= 0, B= 0), the OR output signal is a logic "0". The logic "1" is the presence of an optical pulses for the optical gates, while the logic "0" indicates the absence of optical power.

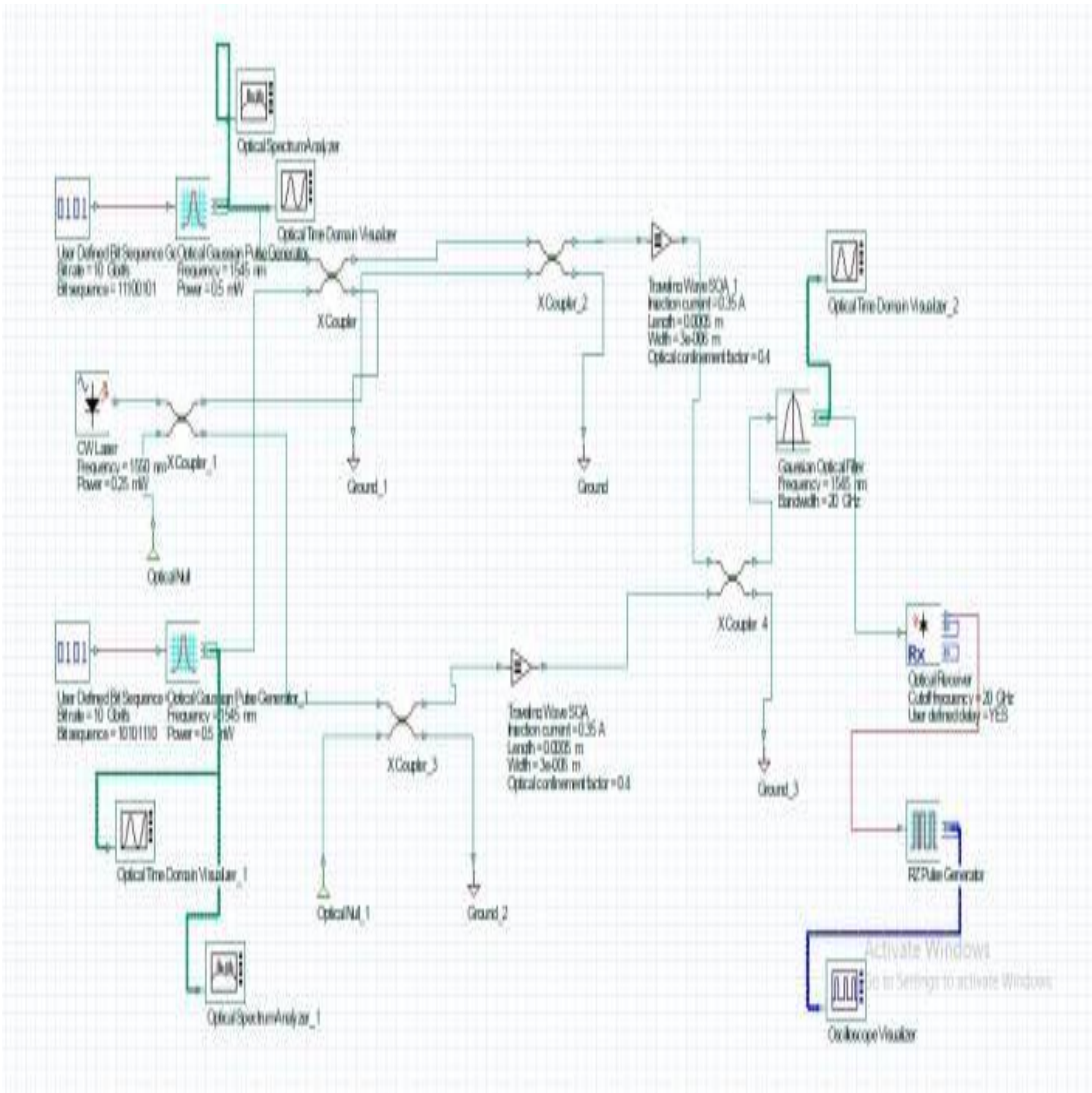


Figure 3.2: Implementation Layout for Optical OR Gate

IV REALIZATION OF OPTICAL UNIVERSAL LOGIC GATE

A universal gate is a gate that can execute any Boolean function without any other type of gate. The NAND and NOR gates are universal gates. This is advantageous in practical terms because NAND and NOR gates are cost effective, easier to fabricate and are the basic gates used in all IC digital logic families. Basically we are using AND and NOT all optical gate to implement all optical NAND gate. For NOR gate we are using all optical OR and NOT gate which we have discussed earlier The simulation layout for NAND gate is given in fig 4.

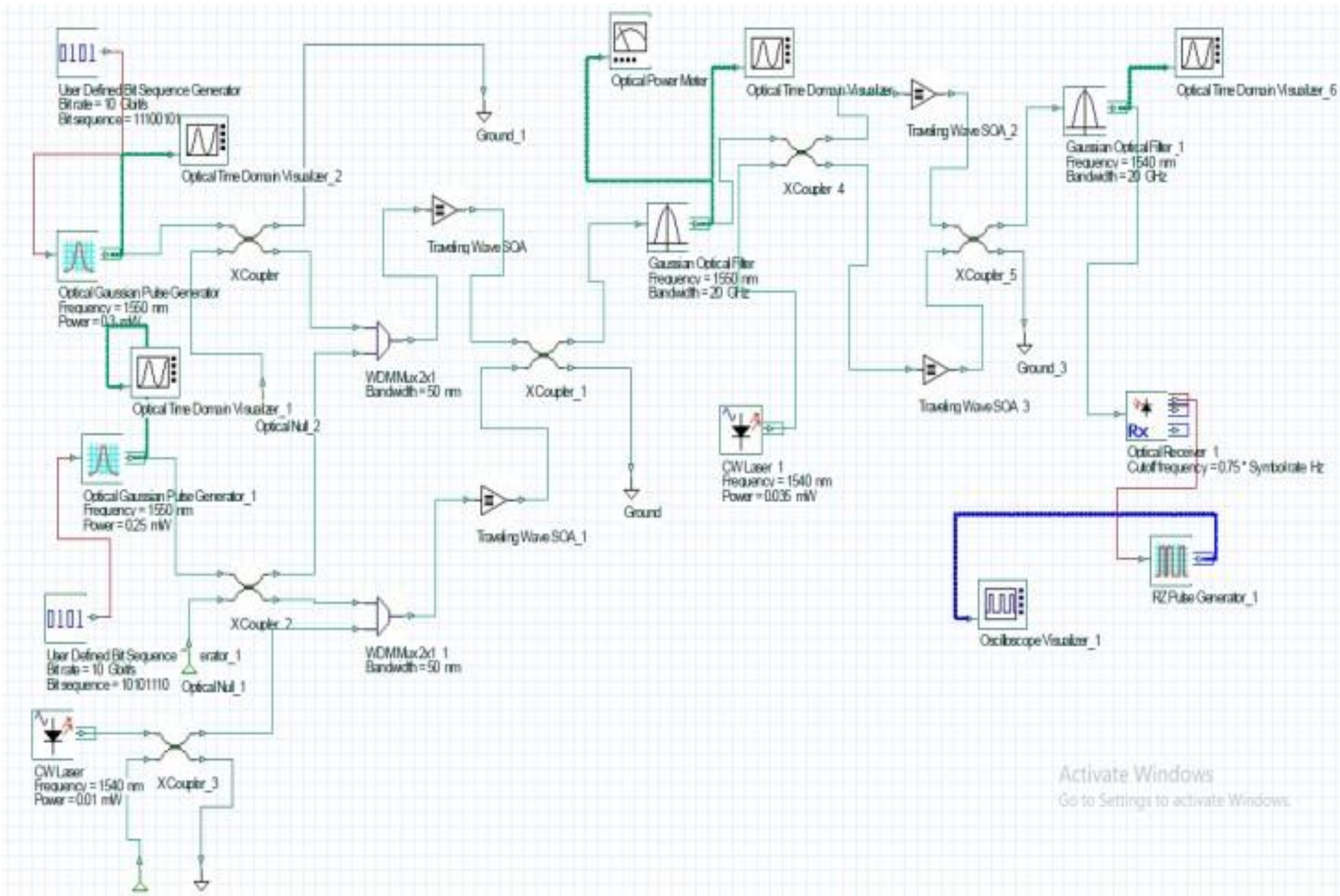


Figure 4: Implementation Layout for Optical NAND Gate

V COMBINATIONAL OPTICAL CIRCUITS

In digital circuit theory, combinational logic is a type of digital logic which is implemented by Boolean circuits, where the output is a pure function of the present input only. Combinational logic also referred as time independent logic. This is in sense of sequential logic, in which the output depends not only on the present input but also on the previous input. In other phrases, there is memory in sequential logic while combinational logic does not.

In computer circuits, combinational logic is used to execute Boolean algebra on input data signals. Circuits used in computers, such as encoder, decoder, multiplexer, De multiplexer, full adders, full subtractor, half adder and half subtractors are also made by using combinational logic does not. In order to be used as building blocks for optical signal processing systems, digital logic gates must be introduced on an optical domain. For example, logic devices are required to perform networking functions such as header recognition, addressing and data encoding in Optical Cross Connects (OXC) and Optical Add-Drop Multiplexers (OADM). Particularly, Half-adder and Full adder acquired from all-optical logic gates are of excellent significance as they can be used as building blocks for the construction of all- optical arithmetic logic unit (ALU).

VI FIGURES AND TABLES

6.1 FULL- ADDER USING TWO HALF-ADDERS

Figure 6.1.Schematic Diagram of Full-Adder Using Two Half-Adders with OR Gate

Table 6.1: Performance Parameters of Proposed Full Adder Implementation

Data Rate(Gbps)	Min-BER (Sum)	Q-Factor (Sum)	Min-BER (Carry)	Q-Factor (Carry)
2.5	1	0	2.72	7.2733
5	1.02	0.9587	3.2	3.40737
7.5	$5e^{-39}$	1.3042	2.1026	4.17644
10	2.34	5.0347	1.13	6.5153
12.5	7.42	4.9331	3.45	2.0018

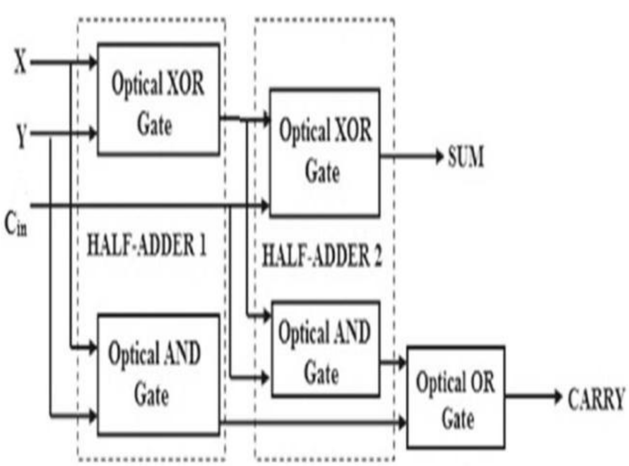
VII CONCLUSION

Due to less electro-magnetic interference, information transparency and high data rates, all-optical signal processing have shown potential impacts on future communication networks. Logical gates are one of the most significant components for the processing of the all-optical signals and, are used to create combination circuits such as encoding, comparator, adder, subtractor and others. A digital adder is a combinational circuit which gives the sum of the input bits. Half-adder implementation is one of the steps towards photonics computing

and optical domain binary addition. Different study groups have demonstrated logic gates and combinational circuits using semiconductor optical amplifiers (SOAs), which have a dominant position for future communication systems in all- optical signal processing. The commonly used SOA-based sig- nal processing needs two or more identical equipment, precise control, and interferometric structure stability.

VII FUTURE SCOPE OF WORK

In the present report, our initial goal has just been reached and a lot of further work remains for our future research. Using these optical XOR and AND Gates, we can introduce some additional optical combinational logic circuit such as half ad- der, half subtractor, full subtractor, full adder. An integrated optical system that can execute any logic, arithmetic or algebraic procedure as directed by the control signal can be created. Now with the help of these optical logic gates, optical register, counter, demultiplexer etc. may be developed. Again, there is a vast scope remaining to prepare adequate nonlinear components with organic materials which can serve the above logic purposes due to their high material nonlinearity. So I think that my future work has ample scope.



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