Realization of All Optical Full Adder by Utilizing DM Soliton Pulses

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ABSTRACT
Requirement of high bit rate circuits is increasing day by day, for achieving this we can use all optical processing digital circuits. These circuits are cost efficient and having high speed processing. The basic component for all-optical processing is optical transistor, which can be designed using all-optical logic gates. Many higher level circuits such as adders, Flip-flops, counters can be designed by utilizing these logic gates. In this paper, the Full Adder is proposed which utilizes dispersion managed soliton pulses as input by cross gain modulation of Semiconductor amplifier is simulated at 100 Gb/s. The circuit employs two all-optical XOR and AND gates and one OR gate

General Terms
SOA (Semiconductor Optical Amplifier), DM (Dispersion Managed) Solitons, XGM (Cross Gain Modulation), EDFA (Erbium Doped Fiber Amplifier), GVD (Group Velocity Dispersion)

Keywords
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1. INTRODUCTION
Internet as an industry is largely based around fiber due to its high switching speed so, all optical processing (AOP) is the field of teeming in research and it will be very useful in near future all-optical networks because of ultra high speed of optical circuits and speed constraints in electronic circuits. Optical networks designed for the business access environment will need to incorporate lower-cost systems to be cost effective and enable the wavelength services. Nonlinear effects are intensity dependent, so in optical fibers, these effects can be used for high-speed processing of optical signals. Also, High-speed switching is possible because of the non-resonant nature of fiber nonlinearity.

All-optical logic gates are used to replace the transistor in electrical circuits [1]. Now, some higher level digital circuits such as half-adder, full adder, flip-flop, shift registers, etc can be realized by utilizing these optical gates. This shall aid the important part in the development of all-optical processing in all-optical computers.

In all-optical computing, the three basic functions are switching, arithmetic operations and storage. Full adder is proposed for arithmetic operations which can simultaneously produce sum and carry [10].

The most widely used all-optical schemes for implementation of adder are All optical integrated full adder-subtractor and demultiplexer using SOA-based Mach–Zehnder interferometer [2], photonic crystals [3], dark/ bright solitons [4],quantum dot SOA based MZI[5]

In this paper a simple novel all-optical full adder is simulated at 100Gb/s by employing the XGM(Cross Gain Modulation) in semiconductor optical amplifier This circuit uses dispersion managed soliton pulses as input signal and it can be used opamp circuits, adaptive filter implementation, processors, arithmetic circuits etc.

NRZ, RZ, CS-RZ and soliton pulses are used as the input signal in most of the researches till date [7]. Optical soliton pulses assure of transmitting data at high speed in optical fibers over long distances but these pulses face difficulties such as timing jitter, Raman self frequency shift, third-order, and the linear fiber loss creep that crucially limits the available capacity and transmission distance in soliton based system and collectively distort the propagation of pulse. Fortunately, a significant breakthrough has finally come to overcome these limitations as dispersion management Dispersion managed (DM) soliton enhance energy as compared to classical soliton in fiber and allows suppression of jitter by reducing the average GVD without sacrificing of the signal-to-noise ratio [6].

In the proposed design of Full adder, sum and carry is generated using DM soliton as input pulses and exploiting nonlinear properties of SOA and XGM(Cross Gain Modulation). Cross-Phase Modulation (XPM) allows better control of switching using suitable control pulses. In comparison to other approaches that have been used for designing the same, the proposed structure in this paper is a much simpler design and moreover makes use of DM soliton pulses as data signals.

2. SIMULATION SETUP
The simulation setup for FULL ADDER is shown in fig.1 was performed using OptSim 5.2 by RSoft a simulation tool for designing advanced optical systems The data streams Data1 at wavelength 11557.75nm, data2 at wavelength 1557.75nm and data3 at wavelength 1557.75nm are generated by the mode locked lasers (MLLaser_1, MLLaser_2 & MLLaser_5). The output of the mode locked lasers i.e. soliton pulses are passed through a dispersion management block where they acquire the characteristics of dispersion managed soliton pulses. The dispersion managed soliton are modulated by an electrical PRBS (pseudo random binary sequence) generator. The custom files are used to provide data through PRBS generators. The two data streams data 1 and

data2 are combined to generate single stream using an optical multiplexer OptMux1 and then through probe given to The setup consists of two XOR gates and two AND gates and one OR gate. Sum is generated using two XOR gates [8] and Carry is generated by applying OR logic to two AND gates [9]. For this purpose, Cross Gain Modulation which produces non-linear effect in SOA cavity is used. Three high power control pulse (pump) and three low power probes are used. These control pulses are shot together with probes into SOA to realize different logic (XOR, AND, OR). For sum output, XOR logic is used and for carry AND and OR logic are used.

For SUM, The probe signal is generated by mode locked laser ML Laser_5 (at wavelength 1550 nm) and a custom file of alternating '1' and '0' is given from Clock2 which is given to XOR logic compound component sumhadder, and then data_3 is amplified using EdfaBB1 and the combined data from OptMux2 is amplified by edfa and then through Optcoup1, is given to SOAT1.OptFilt1 is tuned at 1554nm wavelength and 0.1 nm bandwidth to obtain the required spectrum which is inside compound component sumfulladd. carryhadder(contains logic AND).

The resultant SUM output was observed using signal analyzer sumfadder.

For CARRY, the data is combined by OptMux3 through and2 and carryhadder compound component, both of the components have Optical filters of wavelength 1490nm used for AND operation. An EDFA amplifier (Erbium Doped Fiber Amplifier) EdfaBB9 is used for amplifying of weak signal. The probe signal of wavelength 1550nm is generated using another mode locked laser MLLaser_6 and a custom file of alternating '1' and '0' is given from Clock_sequence1.The combined data and probe data is introduced to optical coupler OptCoup2 and then the combined data through OptMux4 is introduced to SOA2(semiconductor optical amplifier). Cross gain modulation (XGM) takes place inside SOA2 and gain of amplifier is modulated. An optical filter OptFilt2 with centre wavelength 1548.50nm (the mean of wavelengths of data1, data2 & data3) and bandwidth 0.1nm was used to select the required spectrum of data streams. The resultant CARRY output was observed using signal analyzer carryfadder.

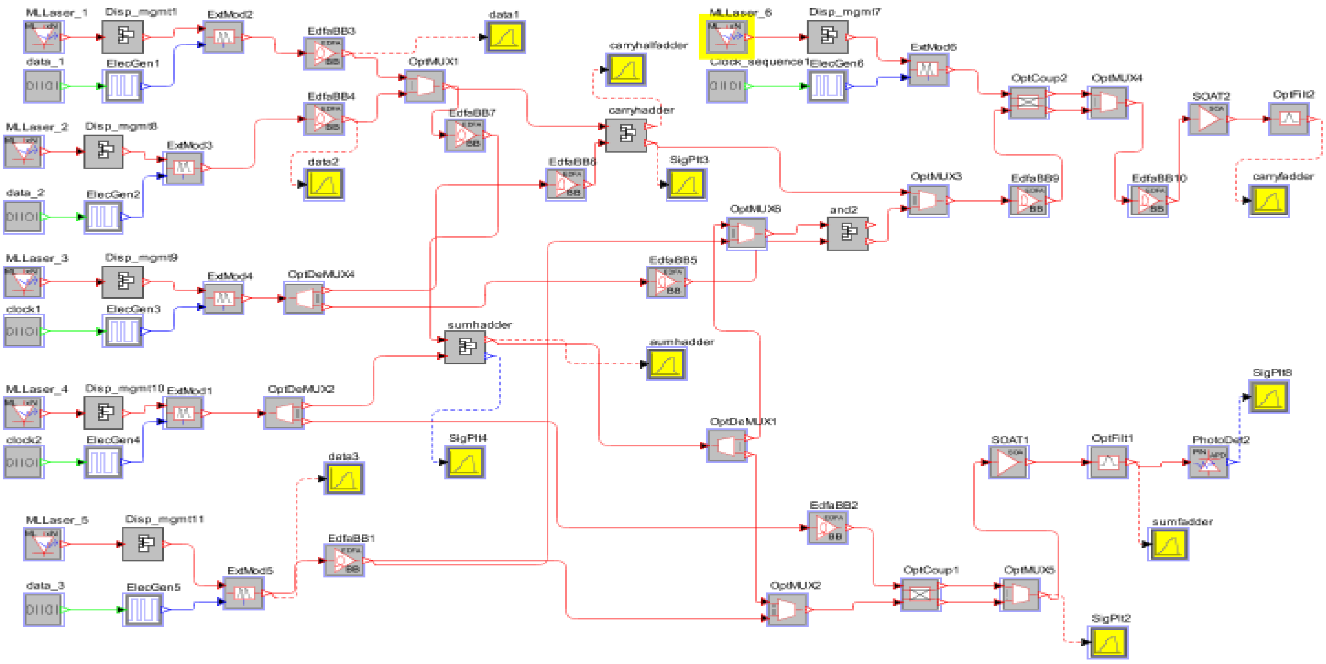

Fig. 1.Simulation setup for All-Optical Full Adder

3. RESULTS AND DISCUSSIONS

The input data streams of data1, data2 and data3 are shown in Fig.2, Fig.3 and Fig.4 respectively. As we know that in FULL ADDER, The sum output is high when either one input is high or all the inputs are high and carry output is high only if any of two inputs are high or all inputs are high. In the proposed all-optical full adder, same output was confirmed as the output waveform of resultant signal i.e. sum as shown in fig.5 and carry as shown in fig.6

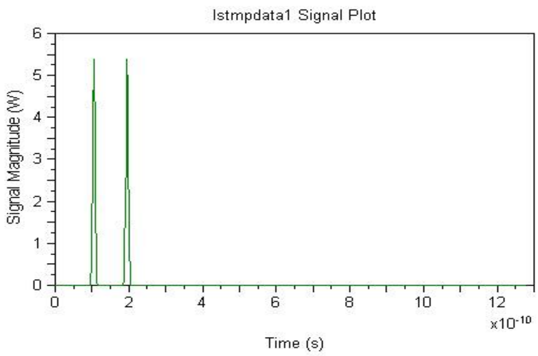

Fig 2.Input data 1(0010001000000)

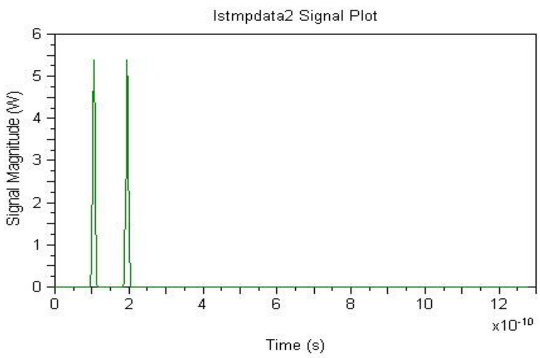

Fig. 3.Input data 2(0010001000000)

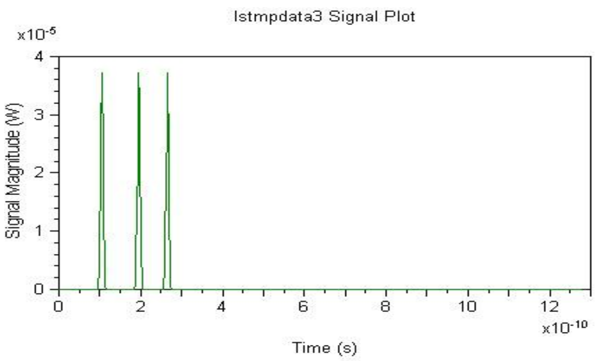

Fig. 4.Input data 3(0010001000100)

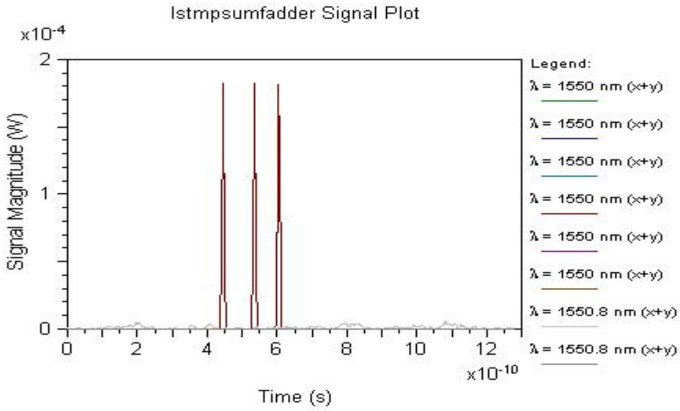

Fig. 5.Ouput signal SUM Full Adder

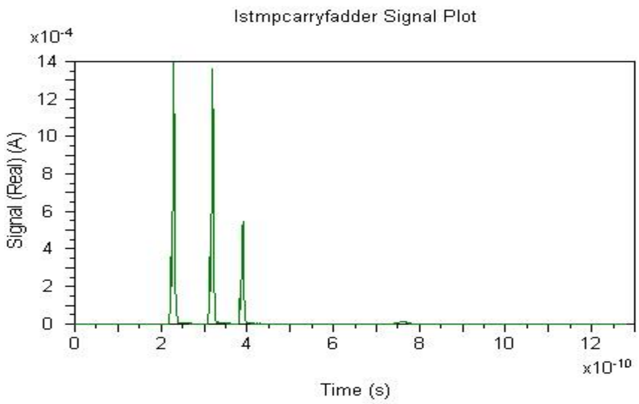

Fig. 6.Ouput signal CARRY Full Adder

Table 1- List of parameters for realizing Full Adder

Parameter	Value
Bit rate	100 Gb/s
Wavelength of Data 1,Data2,Data3	1557.75nm
Wavelength of Probe 1	1555.7nm
Wavelength of Probe 2	1548nm
Wavelength of Probe 2	1550nm
Modulation	Ideal
Drive type	On-off ramp
Signal type	Voltage
Modulation type	NRZ
Gain of EDFA	82 db
Psat of EDFA	18 dbm
BW of EDFA	0.3 nm

Pump current of SOA2	0.30 A
Pump current of SOA1	0.35 A
Spectral Shape of SOA	Parabolic
Line Enhancement factor of SOAs	5
Confinement factor of SOAs	0.6
Internal loss of SOAs	$900m^{-1}$
Gain slope of SOAs	2.78 E-20 m^{-2}
Length of SOAs	0.05 µm
Width of SOAs	3 µm
Thickness of SOAs	0.08 µm
Central Wavelength of Optfift1	1554 nm
Central Wavelength of Optfilt2	1548.5 nm
Filter Type	Fabry Parot
Bandwidth of filters	0.1 nm

4. CONCLUSION

The all-optical Full Adder was successfully demonstrated by employing DM soliton pulses and XGM behave of semiconductor optical amplifier. Performance of all-optical full adder is verified through simulation. The proposed full adder design has a simpler structure which can be used for photonic integration. The simulated system has the prospective to operate at 100 Gb/s and can be used for high speed optical networks, opamp circuits, adaptive filter implementation and in all-optical computing as well in future.

5. REFERENCES

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