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Realization of All Optical Half Adder by Utilizing DM Soliton Pulses

Ank Raj, M.E student
Department of Electronics & Communication Engineering
PEC University of Technology, Sector-12 Chandigarh, India

Kadam Bhambri, Research Scholar
Department of Electronics & Communication Engineering
PEC University of Technology, Sector-12 Chandigarh, India

Neena Gupta, Professor
Department of Electronics & Communication Engineering
PEC University of Technology, Sector-12 Chandigarh, India

ABSTRACT
All optical processing deals with realizing digital circuits using optical elements only. To achieve higher bit rates and reduced cost efficiency all- optical processing became the need of the hour. All- optical logic gates are the key components in the all-optical processing systems. In this paper an all-optical Half Adder using dispersion managed solitons as input pulses and employing cross gain modulation of Semiconductor amplifier is simulated at 100 Gb/s. The circuit employs two all-optical XOR and AND gate.

General Terms
Dispersion managed solitons, Semiconductor optical amplifier, XOR gate, AND gate

Keywords
SOA(Semiconductor Optical Amplifier), DM(Dispersion Managed) Solitons, XGM(Cross Gain Modulation), EDFA(Erbium Doped Fiber Amplifier).

1. INTRODUCTION
All optical processing (AOP) is the swarming field of research in the present day all-optical networks as light based circuits are capable of performing signal processing operations at ultra high as compared to their electronic counterparts.

All-optical logic gates are key components in all-optical signal processing [1]. These gates can further be used in suitable combinations to realize higher level digital components like half-adder, full adder, flip-flop, shift registers, etc. This in turn shall aid the development of all-optical computers and processing.

In all-optical computing switching, arithmetic operations and storage are the basic functions. For arithmetic operations, half adder is proposed which can simultaneously produced sum and carry.

The most widely used all-optical schemes for implementation of half adder are implemented using SOA as the active element[2], photonic crystals [3], dark/ bright solitons[4], single PPLN based [5].

In this paper a simple novel all-optical half adder using dispersion managed solitons as input pulses and employing cross gain modulation of Semiconductor amplifier is simulated at 100 Gb/s that can be used opamp circuits, adaptive filter implementation, processors etc.

Till date in most of the research work NRZ , RZ , CS-RZ and soliton pulses are used as the input signal[7]. Optical solitons pulses offer great promise as means for transmitting high data rate information in optical fibers over transoceanic distances. When soliton pulses become short, effects such as Raman self frequency shift, third-order, and the linear fiber loss creep in and collectively distort the propagation of pulse. Generally, these limitations can be reduced with usage of optical solitons incorporating dispersion management. Dispersion managed (DM) solitons have their energy enhancement factor as compared to traditional solitons due to which they can provide higher signal to noise ratios at the receiver[6].

In the proposed design of half adder, sum and carry is generated using DM solitons as input pulses and exploiting nonlinear properties of SOA. 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 for HALF 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 1557.75nm and data2 at wavelength 1557.75nm are generated by the mode locked lasers (MLLaser1&MLLaser2). 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 data is provided through the custom files by the user in PRBS generators. The two data streams data 1 and data2 are combined to generate single stream using an optical multiplexer OptMux1.

The setup consists of XOR gate and AND gate. Sum is generated using XOR gate [8] and Carry is generated using AND gate [9]. For this purpose, Cross Gain Modulation which produces non-linear effect in SOA cavity is used. Two high power control pulse (pump) and two low power probes are used. These control pulses are shot together with probe1 into SOA1 to realize AND logic and with probe2 into SOA2 to realize XOR logic. For the outputs of the half adder there is sum and carry, so the sum output, XOR logic is used and for carry AND logic is used and half adder is realized and simulated.

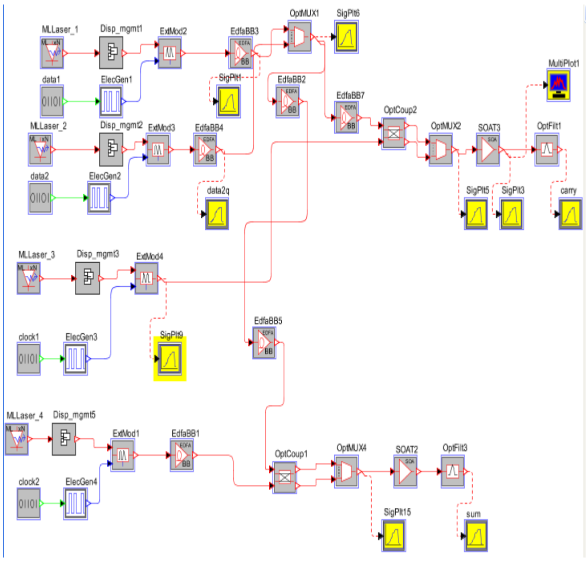

Fig 1: Simulation setup of all-optical Half Adder

For CARRY, the combined data is amplified using an EDFA amplifier (Erbium Doped Fiber Amplifier) EdfaBB2. The probe signal of wavelength 1555.7nm is generated using another mode locked laser MLLaser3 and a custom file of alternating '1' and '0' is given from Clock1, and then it is amplified using EdfaBB1.The combined data and probe data is introduced to optical coupler OptCoup2 and then the combined data through OptMux2 is introduced to SOA3(semiconductor optical amplifier). Cross gain modulation (XGM) takes place inside SOA3 and gain of amplifier is modulated. An optical band pass filter OptFilt1 with centre wavelength 1490nm (the mean of wavelengths of data1 and data2) and bandwidth 0.1nm was used to select the required spectrum of data streams. The resultant CARRY output was observed using signal analyzer carry.

For SUM, The probe signal is generated by mode locked laser ML Laser4 (at wavelength 1548 nm) and a custom file of alternating '1' and '0' is given from Clock2, and then it is amplified using EdfaBB1 and the combined data from OptMux1 is amplified by EdfaBB7 and then through Optcoup3, is given to SOAT2.OptFilt3 is tuned at 1555nm wavelength and 0.1 nm bandwidth to obtain the required spectrum. The resultant SUM output was observed using signal analyzer Sum.

3. RESULTS AND DISCUSSIONS

The input data streams of data1 and data2 are shown in Fig.2 and Fig.3 respectively. As we know that in HALF ADDER, The sum output is high when only one input is high and other input is low and carry output is high only if both inputs are high. In the proposed all-optical half 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.4. Thus the truth table of Half Adder is satisfied as shown in Table1

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Table 1. Truth Table for HALF ADDER

Data1	Data2	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Table 2-List of parameters for realizing HALF ADDER

Parameter	Value
Bit rate	100 Gb/s
Wavelength of Data 1	1557.75nm
Wavelength of Data 2	1557.75nm
Wavelength of Probe 1	1555.7nm
Wavelength of Probe 2	1548nm
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 SOA3	0.45 A
Pump current of SOA2	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	1490 nm
Central Wavelength of Optfilt3	1555 nm
Filter Type	Fabry Parot
Bandwidth of filters	0.1 nm

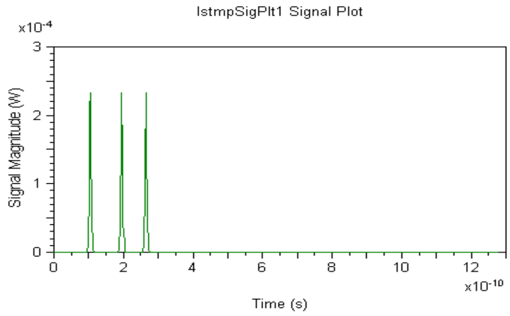

Fig 2: Input signal Data 1(00100000100100)

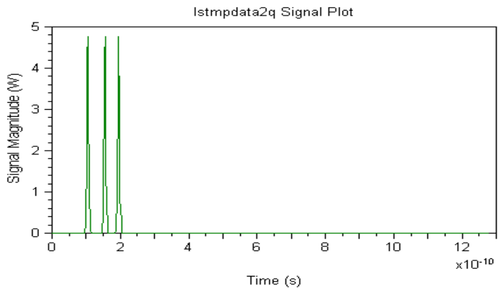

Fig 3: Input signal Data 2(00100100100000)

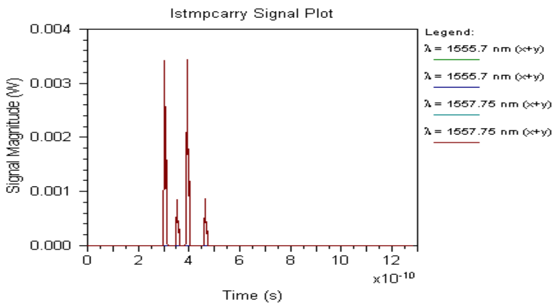

Fig 4: Output signal Carry

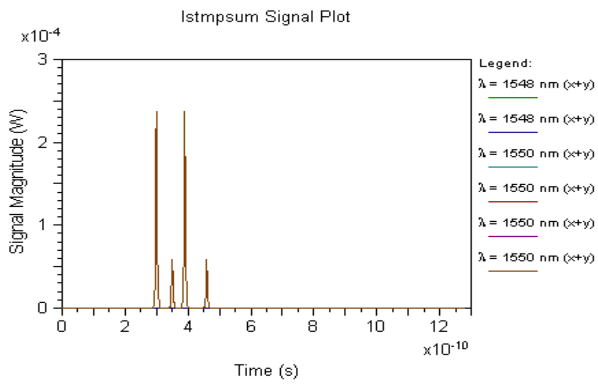

Fig 5: Output Signal SUM

4. CONCLUSION

The all-optical Half Adder was successfully demonstrated by employing DM soliton pulses and XGM behavior of SOA. Output signal versus Input signal was investigated and verified through simulation. The simulated system has the potential to operate at 100Gb/s and can be used for high speed optical networks and in all-optical computing as well. The proposed Half Adder is simpler in structure and can be used in complex processing devices like full adder, subtractor, serial and parallel adders, and other arithmetic devices and also in photonic integration which can be useful in all optical processing in future.

5. REFERENCES

[1] Novel all-optical AND gate based on cascaded single-port-coupled SOAs, Xinliang Zhang, Ying Wang, Junqiang Sun, Deming Liu and Dexiu Huang

[2] V.K. Srivastva, V.Priye ‘All-Optical Half adder using equations governing XGM and FWM effect in semiconductor optical amplifier’ International journal of Applied Engineering Research, Vol.1, No.3,2010

[3] Q Liu,Z Ouyang and group ‘All Optical Half adder based on cross structures in two dimensional photonic crystals’ Optics Express, Vol.16, Issue23, 2008.

[4] Sappasit Thongmeea,* and Preecha P.YupapinbAll Optical Half Adder/Subtractor using Dark-bright Soliton Conversion Control, 2ndInternational Science, Social-Science, Engineering and Energy Conference 2010: Engineering Science and Management

[5] Single-PPLN-based simultaneous half-adder, half-subtracter, and OR logic gate: proposal and simulation , Jian Wang, Junqiang Sun, Qizhen Sun Optics Express - OPT EXPRESS , vol. 15, no. 4, pp. 1690-1699, 2007

[6] N. J. Smith, W. Forysiak, and N. J. Doran, “Reduced Gordon-Haus jitter due to enhanced power solitons in strongly dispersion-managed systems,” *Electron. Lett.*, vol. 32, pp. 2085–2086, Jan. 1996

[7] John M. Jacob, Ekaterina A. Golovchenko, Alexei N. Pilipetskii, Gary M. Carter, Senior Member, IEEE, and Curtis R. Menyuk, Senior Member, IEEE, ‘10-Gb/s Transmission of NRZ over 10 000 km and solitons over 13,500km error free in the same dispersion managed system’ , IEEE PHOTONICS TECHNOLOGY LETTERS, VOL. 9, NO. 10, October 1997

[8] Kadam B., Gupta N. ‘All Optical XOR Gate Using Single SOA AT 100 GB/S’,International Journal of Computational Intelligence Techniques ISSN: 0976-0466 & E-ISSN: 0976-0474, Volume 3, Issue 2, 2012, pp.-86-89.

[9] Kadam Bhambri and Neena Gupta.’ Implementation of All-Optical AND & OR Gates using SOA’ Journal of Information Systems and Communication ISSN: 0976-8742 & E-ISSN: 0976-8750, Volume 3, Issue 2, 2012, pp.-371-374.