Implementation of a NOR Gate using photonic transistor logic

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Abstract: In this paper we have implemented and analyze the performance of a optical NOR gate using a photonic transistor logic with a response speed of 80 Gb/s. The photonic transistor logic is based on a heterojunction configuration, similar to a semiconductor optical amplifier operation. The designed circuit is also suitable for construction of N-nary digital logic gates.

Index Terms: Semiconductor optical amplifier, Photonic transistor, N-valued digital logic, Logic gate.

I. Introduction

The future of the telecommunication network can be realized by the development of all-optical technologies .For the realization of such functionalities all optical logic gates are the key elements. In particular, semiconductor optical amplifiers (SOAs) are very attractive nonlinear elements for this purpose. Moreover, due to the limited SOA gain recovery velocity these structures are unable to process ultrafast signals that introduce insufferable pattern effects.

In order to design a device that is capable of implementing on/off switching functions for optical signals in a similar manner to the switching operation of a traditional electronic transistor N-nary photonic logic gates were constructed. With the help of such a device we can construct the photonic gates thus called – photonic transistor (PT) [8]. For the practical realization of such a switching device, device similar to semiconductor optical amplifier i.e. optical semiconductor devices can be used. The photonic transistor is controlled by an optical signal, and its operation as an optical signal intensity switch is based on the cross-gain modulation (CGM) properties of the SOA structure [8].

II. Operation Principle

The operational principle is shown in Fig. 1. „A" and „B" are the signals that have been processed, whose frequency are 1550 nm and 1560 nm respectively. Having a control signal working on a frequency of 1550 nm generated by a bit sequence generator which is then amplitude modulated to provide us with the signal. The input power required by the photonic transistor in order to produce the logic function is around 5 mW for both A and B inputs. A traveling wave SOA is inserted into the input signal lines to amplify the signal"s intensity having the following configurations, as in Fig. 2.

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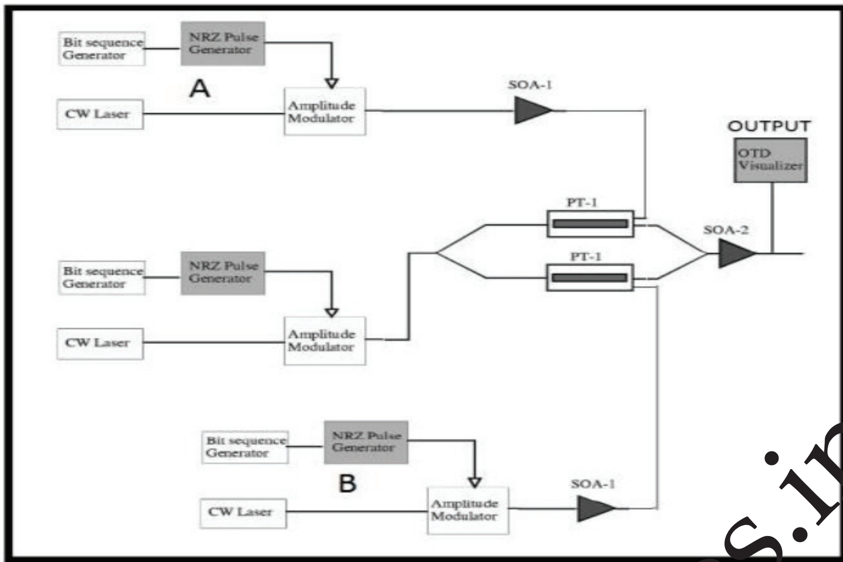

Fig. 1 – The Nor Gate Simulation Circuit

PROPERTIES	VALUES
INJECTION CURRENT	150 mA
ACTIVE LENGTH	30 MICRONS
WIDTH	1.5 MICRONS
HEIGHT	1.5 MICRONS

Fig. 2 – Properties of Traveling Wave SOA

For the switching device Wideband Traveling Wave SOA can be used as an optical signal intensity switch which works on the principle of cross-gain modulation (CGM) properties of SOA structure. Some important parameters of Wideband Traveling Wave SOA are listed in the Fig. 3.

PROPERTIES	VALUES
INJECTION CURRENT	100 mA
ACTIVE LENGTH	20 MICRONS
WIDTH	.55 MICRONS
HEIGHT	.078 MICRONS

Fig. 3 – Properties of Wideband Traveling Wave SOA

III. Conclusion

The gate design shown in the Fig. 1 was simulated using OPTISYSTEM software. The truth table of NOR gate is shown in Table 1 which explains the desired outputs for the proper working of a NOR logic gate. The input and the output signals were measured using Optical Time Domain (OTDM) analyzer as shown in the Fig. 4, 5 and Fig. 6. The input sequence generated for the input „A‟ is „01010101010‟ while the input sequence generated for the input signal „B‟ is „01001001110‟. Fig. 6 shows the output response for the NOR gate which can be read as „10100010001‟, which proves our relation between the input signal and the output signal.

Table 1: Truth Table for NOR Gate

SIGNAL INPUT A	SIGNAL INPUT B	NOR OUTPUT
0	0	1
0	1	0
1	0	0
1	1	0

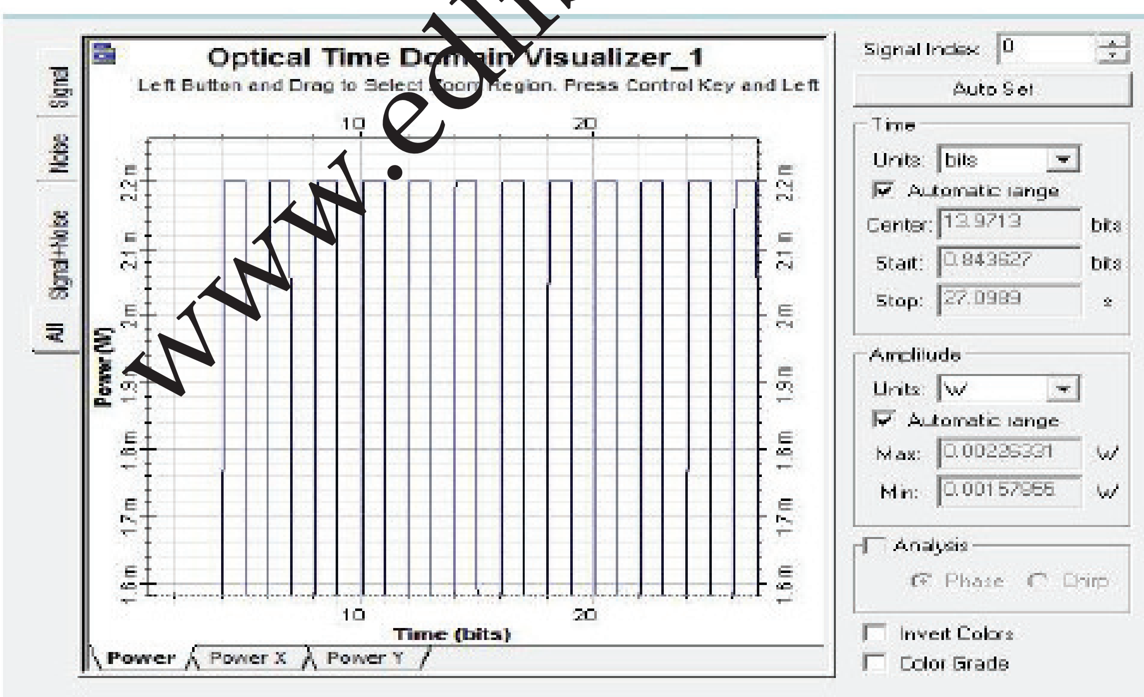

Fig. 4 – INPUT SIGNAL 'A'

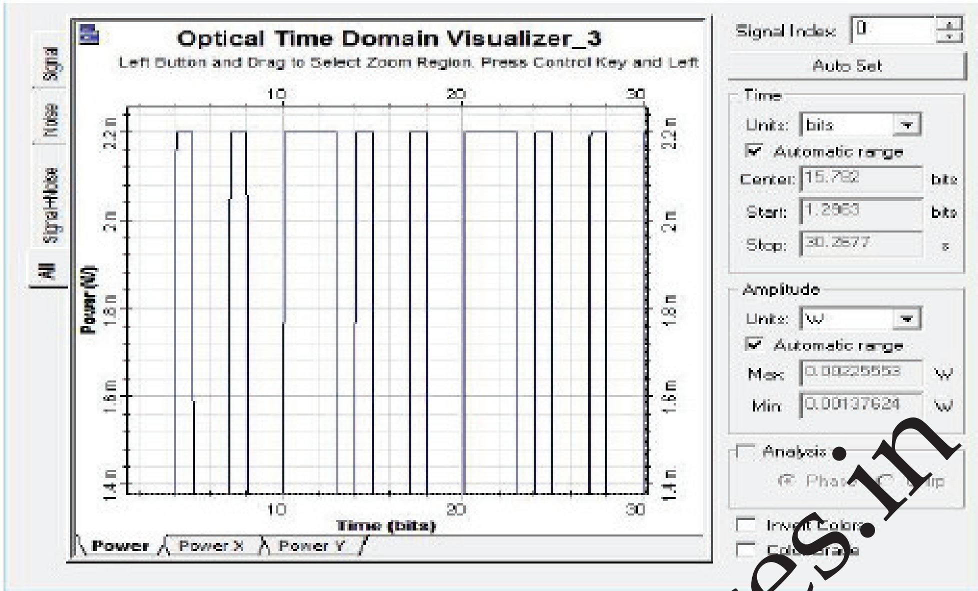

Fig. 5 – INPUT SIGNAL 'B'

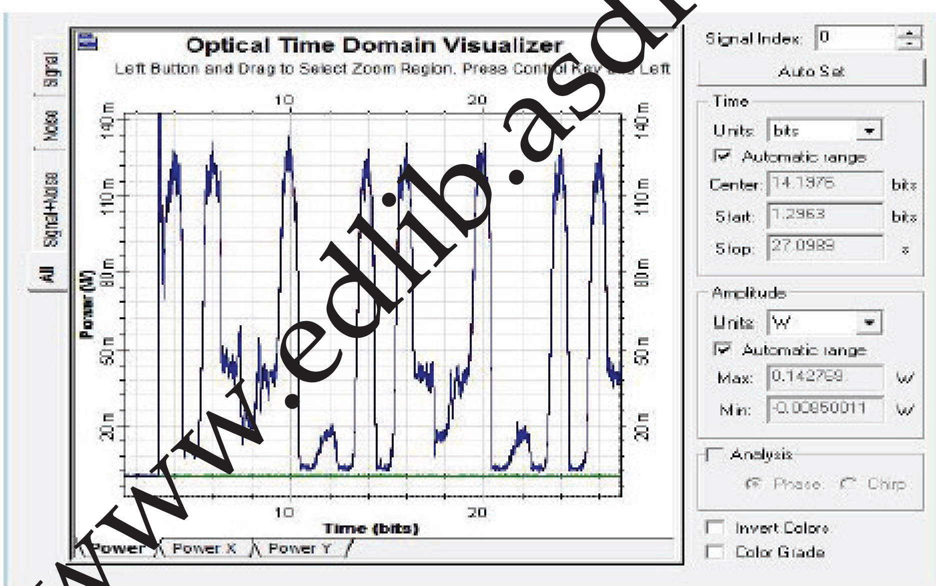

Fig. 6 – OUTPUT RESPONSE (NOR GATE)

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