Review: Simulation of Ultrahigh-Speed Optical Logic Gates Using SOA-MZI Structure

Neelam Gupta, Kiran rathi, Durgesh Kumar

Abstract— This whole work includes simulation of XOR, AND and NOR gate using of nonlinear element in Semiconductor Optical Amplifier Mach Zehnder Interferometer structure. Four-wave mixing (FWM) and Cross-gain modulation (XGM) and Crossphase modulation (XPM) and a detuning optical bandpass filter are also used to achieve the ultrafast speed of logic gates which can operate at 10Gbit/sec. Due to nonlinearity in semiconductor optical amplifier, it changes the refractive index and provides a high gain with ultrahigh speed. Thus realization of these logic gates at 10Gbit/sec will increase the super high-speed operation for optical signal processing operationsin the future.

Index Terms— semiconductor optical amplifier– Mach–Zehnder interferometer (SOA-MZI), Four-wave mixing (FWM) and Cross-gain modulation (XGM) and Cross-phase modulation (XPM).

1 INTRODUCTION

Semiconductor optical amplifier is a nonlinear element for the design of different logic gates. Logic gates are used for multiplexing (add and drop), signal processing, address recognition and packet synchronization etc[1].SOA makes a high-level change in refractive index so that high gain can be achieved. SOA is an optoelectronic device which amplifies light signals. Due to this property of SOA, this can be used in various application of logic gates to achieve high output saturation power, high output gain, low polarization dependence, and minimal facet refracitivities. The Best feature of this device is signal regeneration. The Mach Zehnder interferometer (MZI) mostly used in the implementation of all high speed logic gates[1][8]. The XOR, NOR and AND operation are performed up to Gbit/sec using Semiconductor Optical amplifier Mach Zehnder interferometer configuration. In order to realize the logical gates, many structures of optical logic gates used are like the ultrafast non-linear properties of detuning optical bandpass filter and SOA to achieve the ultrafast speed of logic gates[1][2].

2 THEORY

Nonlinearities of Logic Gates Based on SOAs: Nonlinearity effect of SOA device makes effective for application optical field that have been characterized by–FWM, XPM and XGM etc[3].

2.1 XGM(Cross Gain Modulation)

It has been realized that if there change input power of SOA, then gain changed If input power increased, the carrier density SOA gets depleted and hence, results reduction of amplification gain[2][7]. The dynamic processes are very fast It of the order of picoseconds that make semiconductor optical amplifier density that this variation can be use bit by bit gain fluctuation of the i/p signal power[5].

2.2 XPM (Cross Phase Modulation) The Operation principle of the Cross Phase Modulation the later effect. Refractive index changes by variation the carrier. Due to this, the continuous wave phase modulated[3]. By MZI configuration phase modulation changes intensitymodulation.

3 METHODS:-

A. Figure shows the wavelength conversion semiconductor amplifier which includes pump source, CW probe, SOA filter and modulated probe.SOA nonlinear element which exhibits strong changes refractive index and gives high gain.

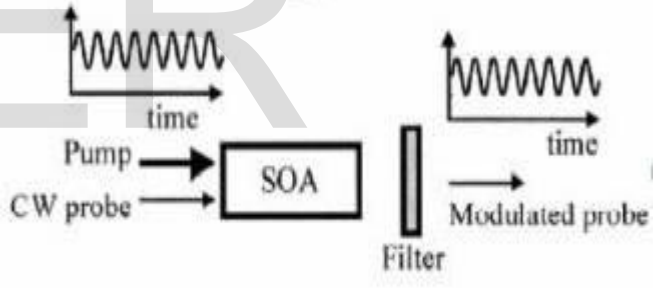
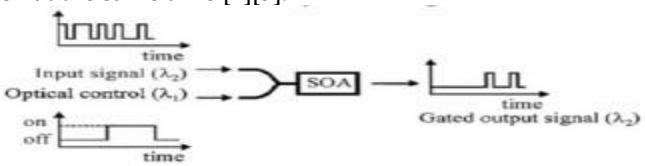


Figure 1: Wavelength conversion in SOA

B. In cross gain modulation, there are two input signals, one is a probe light and another is a pump light. Probe light is weak and pump light is strong which have a less harmonic signal modulation modulates at ω (angular frequency), both are given at the same time [1][5].



. Figure 2: Optically controlled SOA gate

C. Pump modulation on the probe is enforced to amplifier using XGM. Due to this, amplifier acts as Wavelength Converter means a signal having one wavelength is fed to another signal having other wavelengths [3].