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ULTRASHORT PULSE GENERATION IN SEMICONDUCTOR OPTICAL AMPLIFIER BASED OSCILLATOR

[1]K IRENE MONICA, [2]Dr.A.SIVANANTHA RAJA

[1]Student, [2]Professor

Alagappa Chettiar Government College Of Engineering And Technology ,

[1]Karaikudi, Tamil Nadu, India

Abstract: Fiber optic communication system is an efficient technology to meet the need of various highspeed communications. Optical amplifiers plays a prominent role. Semiconductor Optical Amplifier (SOA) is used for many applications. Here SOA is used for ultrashort pulse generation. The analysis of the proposed method is conducted using OptiSystem software. In this paper, discussions on mode-locking technique in SOA, harmonics generation in time domain visualizer are provided. Here SOA act as a laser source and produce the signal at better power with nanosecond pulse width. The output power reaches to when the injection current of the SOA is 250mA.

***Index Terms* - Semiconductor Optical Amplifier, Mode-Locking, Harmonics.**

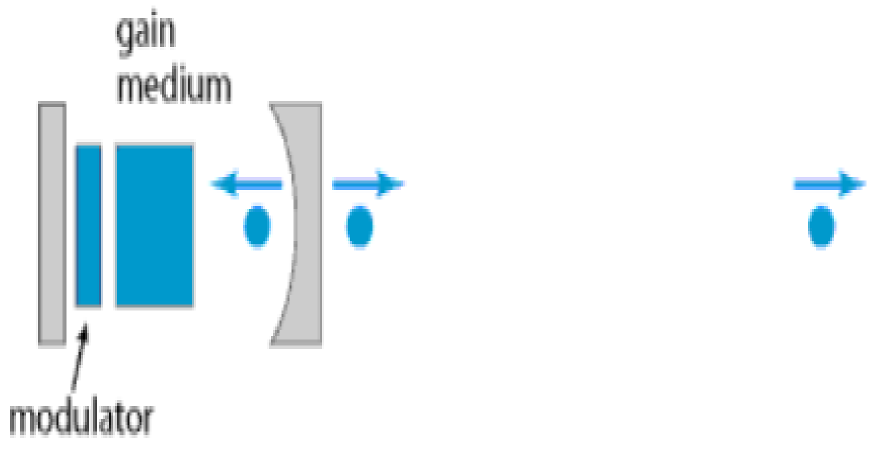
1.INTRODUCTION

In future high-speed telecommunication system, all optical signal processing techniques promise to play a prominent role to avoid electro-optic conversions that may create data-flow bottlenecks[1]. Semiconductor optical amplifiers (SOAs) have been widely used to perform a variety of all-optical functions such as wavelength conversion, signal regeneration, pulse reshaping, and power limiting. SOA based all-optical signal processing techniques have advantages in terms of low-power consumption, a small footprint, and monolithic integration[2-5]. However such techniques also have one serious limitation. While the nonlinear response of an optical fiber is almost instantaneous, the nonlinear response time of a SOA is tied to its carrier lifetime that governs how quickly the SOA gain recovers and typically exceeds 0.1 ns[6].

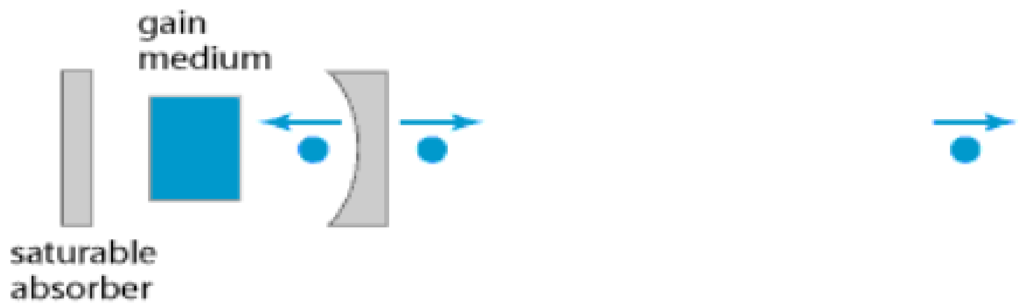
Lasers are generally capable of operating in variety of modes both axial and transverse normally, when a laser is operating in several such modes at once, the individual modes oscillating independently of each other and tend to have totally phase relations relative to each other[8]. Mode-locking is a process in which large number of modes are placed in lock step with each other[10]. The results of mode-locking leads to the very short pulses of extremely high peak power.

Methods for producing mode locking in a laser may be classified as either "active" or "passive". Active methods typically involve using an external signal to induce a modulation of the intracavity light. Passive methods do not use an external signal, but rely on placing some element into the laser cavity which causes self-modulation of the light.

Active mode locking involves the periodic modulation of the resonator losses or of the round-trip phase change, achieved e.g. with an acousto-optic or electro-optic modulator, a Mach–Zehnder integrated-optic modulator, or a semiconductor electro-absorption modulator. If the modulation is synchronized with the resonator round trips, this can lead to the generation of ultrashort pulses, usually with picosecond pulse durations.



(a)



(b)

fig 1. (a)Active mode locking (b) passive mode locking

2.SIMULATION SETUP:

Numerical simulations are conducted using OptiSystem software to investigate the demonstrated laser. The simulation setup consists of optimized semiconductor optical amplifier as a gain medium, 250 m of a polarization maintaining dispersion-shifted fiber, intensity modulator (IM), and optical filter. The IM is driven using sinusoidal electrical signal at different repetition rates. The noise seed of -30 dBm is given as an input to the SOA. Then SOA amplified output signal passed to the optical fiber with attenuation 2 dB/km, then the output signal given to coupler. 20% of the signal driven to optical spectrum analyzer (OSA) and time domain visualizer. The remaining 80% of the signal is again passed through IM and optical filter. Optical filter allows the desired wavelength and avoids the undesired signal. The output of the filter is connected another terminal of the seed. This forms the ring like structure. This continuous process takes place until mode-locking occurred in the ring. Numerical simulations take place to achieve mode-locked laser.

Generating higher-order mode locking for the laser is possible by increasing the sinusoidal wave generator repetition rate used to drive the modulator. The simulated active mode locking fiber has a very high efficiency. The output of the active mode-locked laser pulse train is shown in fig 3b. this demonstrated mode-locked laser design can be used in optical communication, metrology application and in industrial application.

Table 1. optimized parameters of SOA

Parameter	Value
SOA injection current	0.25 A
Optical confinement factor	0.34
Active length	0.0005 m
Width	2 μm
Height	0.2 μm
Input facet reflectivity	5 *e-005
Output facet reflectivity	5*e-005
Group velocity	75000000 m/s
Active refractive index	3.22

Table 2. parameters specification

Parameter	Value
IM extinction ratio	34 dB
Optical fiber with nonlinear refractive index	3.2×10^{-20} m²/W
Optical fiber with effective area	43 μm²
Optical fiber length	0.2 km
Optical fiber with dispersion	3 ps/(km nm)

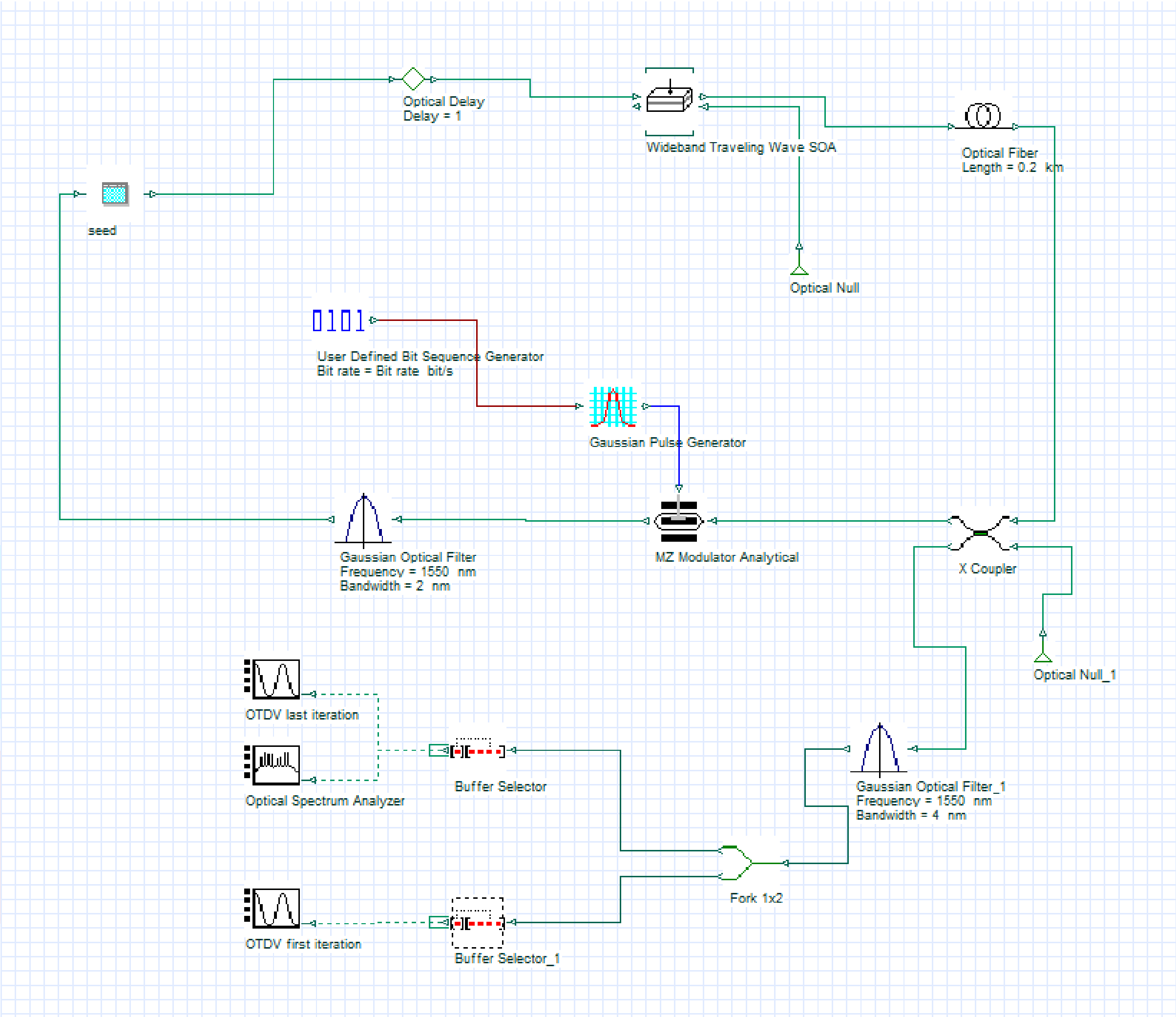


Figure 2. simulation setup of active mode-locked laser using SOA

3.RESULTS AND DISCUSSION:

In this work, optimized SOA parameters such as injection current, refractive index and optical confinement factor as in table 1 are carried out to start with. Then this SOA is given to fiber, coupler, one of the output terminals of the coupler is connect to the modulator and passes through seed and output terminal of seed is connect to input terminal of SOA. The another output terminal of the coupler connects to the OSA and OTDV (optical time domain visualizer). This forms a ring laser structure. This loop has several iterations at 10GHz repetition rate. At first iterations the pulse generates at unequal power and non-uniform but the unequal signal again goes into the loop and amplified for 50 iterations. At 50th iteration we are getting equal pulse generation at 0.25ns pulse width. This mode-locked laser generates ultrashort pulse as in figure 3b

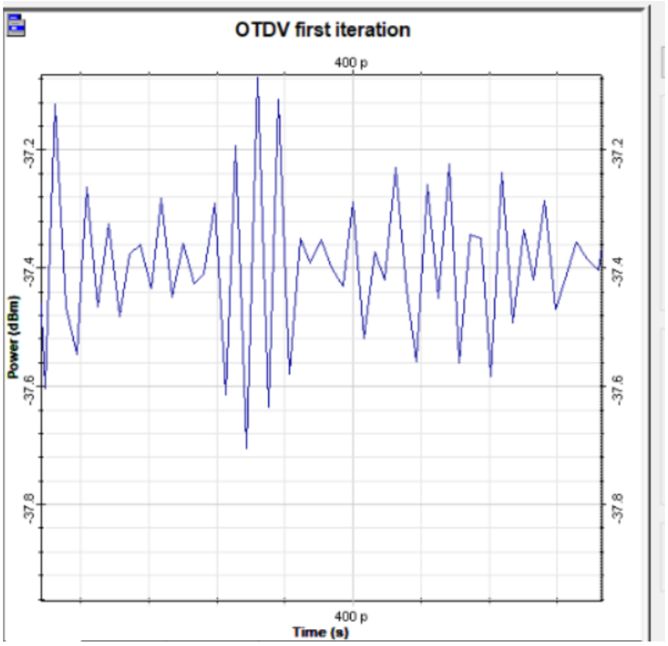


Fig 3a. harmonics generation in first iteration

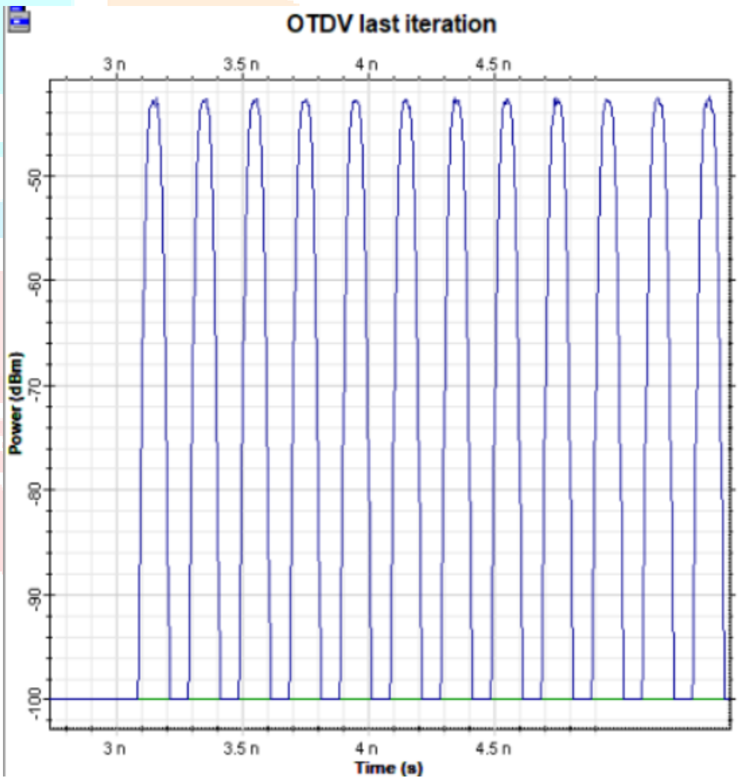


Fig 3b. pulse generation in last iteration

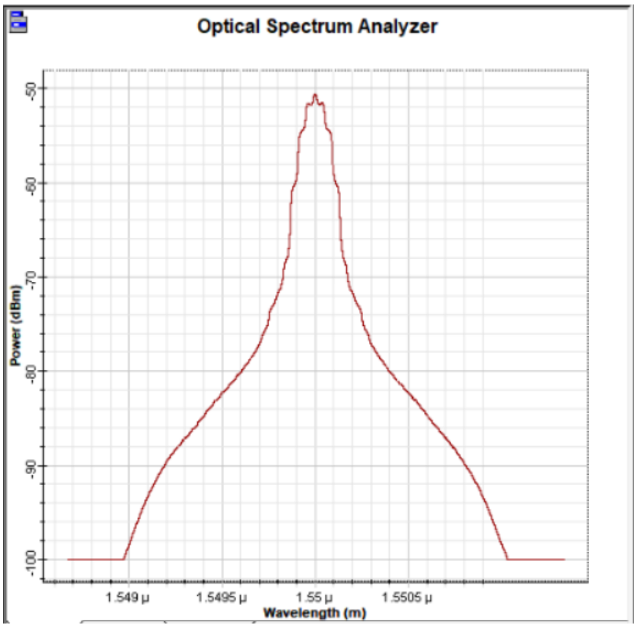


Fig 4. Power versus wavelength of the SOA

4.CONCLUSION:

From the simulated results, it is noted that the proposed system mode-locked laser using SOA is used to generate ultrashort pulse and it works like an oscillator which operates at wavelength 1550nm with the power of 10 nanoWatts and generates pulse harmonics with pulse width of 0.25ns. This power can be improved by adjusting the frequency of the IM and tuning the filter. This active mode-locked laser using SOA is used in ultrafast optics and optical communication.

5.ACKNOWLEDGEMENT:

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