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Performance Analysis of Gain Characteristics of Semiconductor Optical Amplifier

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ABSTRACT: In this paper, investigations are made on performance analysis of the semiconductor optical amplifier (SOA). A single channel semiconductor optical amplifier (SOA) based communication system is designed in OPTSIM 4.0. This analysis is done at data rate 10Gb/s. The value of launched input power is varied for different confinement factor, active layer length and width of SOA. The received power is noted at the receiver end. The results are then plotted using Matlab 7.7 and analyzed.

KEYWORDS: EDFA, SOA,G,NRZ.

I. INTRODUCTION

SOA is a very interesting and cheap alternative as compared to Erbium Doped Fiber Amplifier **(**EDFA) and Raman amplifier and can also be used in metropolitan area networks [1]. SOA can be used as booster, in-line amplifier and preamplifier has capability to implementing all optical signal processing, optical gating and wavelength conversion. Farah Diana Mahad et al [2] has optimized the SOA parameters in order obtain improved amplification and switching functions. He has evaluated the gain in unsaturated region is around to be 45.7 dB and SOA starts to saturate at an output power of around 11 dBm. The gain saturation, g is reduced when P becomes comparable to saturation power P_s, the amplification factor G decreases with an increase in the signal power.

Gain is obtained as:

$$G=\frac{P_{out}}{P_{in}} \tag{1.1}$$

The output saturation power is defined as the output power for which the amplifier gain G is reduced by 3 dB from its unsaturated value Go.

Peak gain is related with carrier population N as following:

$$g(N)=(\Gamma\sigma_g/V)(N-N_0) \tag{1.2}$$

Where Γ is the confinement factor, σ_g is the differential gain, V is the active region volume and N_0 is the value of N required at transparency. The carrier population N changes with the injection current I and the signal power P.

Volume of cavity of SOA amplifier = length x width x Height (1.3)

Optical gain is related with power as following:

$$g=g_0/(1+P/P_s) \tag{1.4}$$

Where g_0 is the peak value of the gain, P is signal power and P_s is the saturation power.

II. SIMULATION SETUP

The simulation are genrated by setup as shown in figure 1. This system consists of the data source, NRZ electrical driver, CW laser source and external Sin^2 Mach-Zehnder modulator in transmitter section. The data source is generating signal of 10 Gb/s with pseudo random sequence.

The NRZ electrical driver converts the logical input signal into an electrical signal. The CW Laser signal is modulated by NRZ electrical driver at a data rate 10 Gb/s. The CW laser wavelength is set to be fixed at 1550 nm. These all simulation parameters are given in table 2.1.The power of CW laser is varied accordingly as shown in table 3.1.

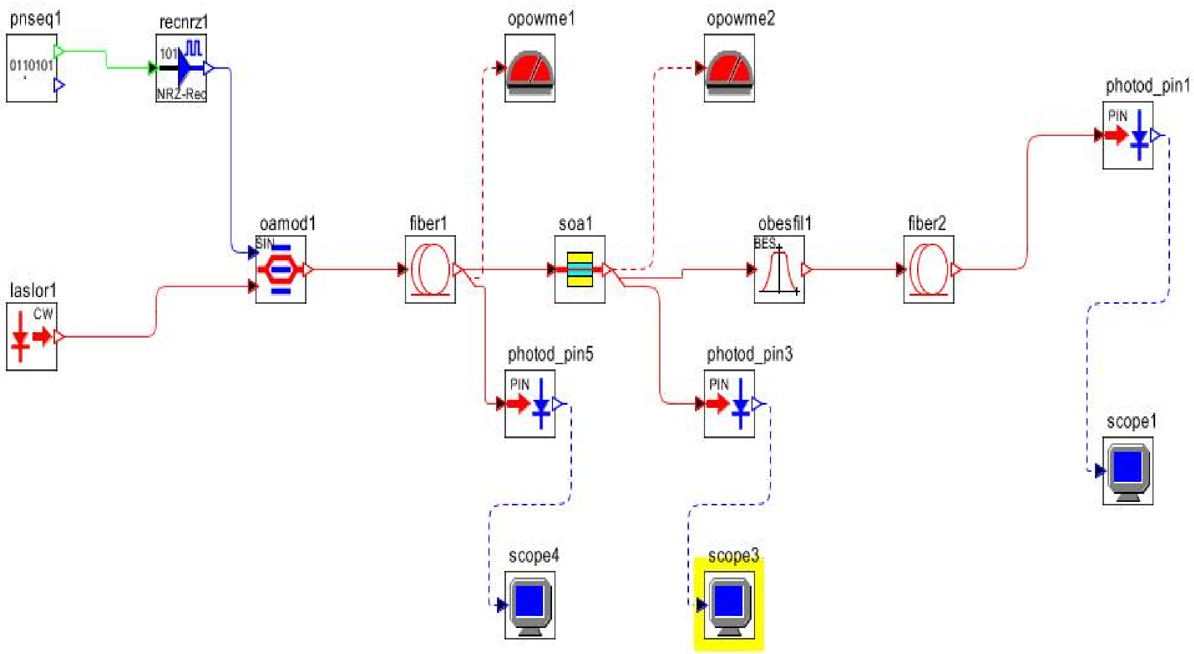

Fig-1:-Simulation schematic of SOA

Table 2.1: Simulation Parameters

Parameter	**Value**
Laser source wavelength	1550 nm
Data rate	10 Gb/s
Optical fiber length	10 Km

Table 2.2: Parameters of SSMF

Parameter	**Value**
Reference wavelength for dispersion	1550 nm
Dispersion at the reference frequency (D)	16 ps/nm/km
Dispersion at the reference frequency (β_2)	-20.407 ps^2/km
Zero Dispersion frequency	215.44 THz
Fiber loss	0.2 dB/km

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III. RESULTS AND DISCUSSIONS

The output power increases with input power in the same ratio until the SOA saturates and the carriers in the active region become depleted, leading to a decrease in the amplifier gain. The SOA effectively operates as a constant gain amplifier before reaching its saturation value and the output signal is not affected by the SOA nonlinear response. This gain in the unsaturated region is measured to be around 45.7dB from the software, and the SOA starts to saturate at an output power of around 11 dBm also estimated from the curve. In order to verify the simulated results, mathematical analysis is done using these values inserted into a gain saturated rate equation from the many literatures [3] using Matlab and Microsoft Excel packages. The results are shown in Fig. 2. It can be seen that the gain difference between the simulated and mathematical results in the unsaturated region is < l dB. At the higher SOA inputs, the software simulation package inherent algorithms and iterations could not seem to match the ultrafast saturation dynamics of the SOA.

Hence, there is a small offset mismatch. The simulation result has been verified using mathematical analysis. The mathematical analysis is in good agreement with the simulation result, with only a small offset due to inherent software limitations in matching the gain dynamics of the SOA. Table 3.1 shows the details of output power as a function of input power with the variation of SOA active layer length and optical confinement factor. Figure 3.5 shows the graph. It has been observed that output power increasing with the increase in input power for active layer length 1000 µm and for confinement factor 0.35.The curves coressponding to different confinement factor at same active layer length of 1000 µm are overlapped. According to the relationship (1.2) between gain and active layer volume, the gain increases with the decrease in active layer length. Gain is directly proportional to output power form equation (1.1). The output power received for active layer length 1500 µm is lesser than the power received for active layer length of 1000 µm and confinement factor 0.35-0.45.

Table 3.1: Output power as a function of input power by varying SOA active layer length and optical confinement factor

Length of SOA Amplifier	Confinement Factor	Input power (dBm)	Received Power(dBm)
1000µm	0.35	5	-100
		10	-93.977
		15	-82.276
		20	-66.614
		25	-46.955
		30	-34.525
		35	-29.137
		40	-25.088
		45	-21.453
	0.45	5	-100
		10	-98.052
		15	-85.756
		20	-68.154
		25	-46.660
		30	-34.525
		35	-29.137
		40	-25.088
		45	-18.150
1500µm	0.35	5	-100
		10	-100
		15	-100
		20	-100
		25	-78.918
		30	-40.626
		35	-31.407
		40	-25.756
		45	-21.287
	0.45	5	-100
		10	-100
		15	-100
		20	-100
		25	-84.028
		30	-40.394
		35	-31.538

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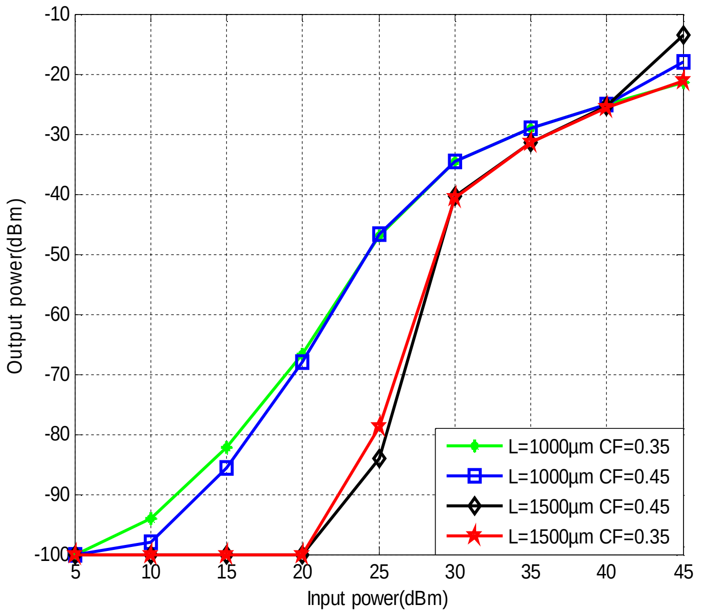

Fig.2- Output power versus Input power for the variation of length and CF of SOA amplifier

IV. CONCLUSION

The single channel SOA based communication system is successfully designed and implemented in Optsim 4.0. The results obtained are plotted using Matlab 7.7 and then analyzed. It has been also observed from the results that output power increasing with the increase in input power for active layer length 1000 µm and for confinement factor 0.35. The output power received for active layer length 1500 µm is lesser than the power received for active layer length of 1000 µm and confinement factor 0.35-0.45. Similarly, the maximum output power is achived for 1.0 µm active layer width and for confinement factor 0.45.

REFERENCES

[1] Govind P. Agarwal, “Fiber Optic Communication Systems”, John Wiley & sons, Inc. Publication, 2003.
[2] Farah Diana Mahad, “Modeling of Semiconductor Optical Amplifier gain characteristics for amplification and switching,” International Conference on Enabling Science and Nanotechnology IEEE, pp. 1-2, December 2010.
[3] Farah Diana Mahad, “Review of semiconductor optical amplifier (SOA) functionalities,” Journal of Optics Communication (Elsevier), vol. 55, pp. 85–96, 2011.