Comparative Study of EDFA and SOA in WDM Optical Network Placed at Different Position

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Abstract- In this paper, comparative study of Erbium Doped Fiber Amplifier (EDFA) and Semiconductor Optical Amplifier (SOA) in optical communication link has been presented. Optisystem 12.0 software package has been used for this purpose. Quality factor, Minimum bit error rate (BER) and eye height in eye diagram have been calculated for both optical amplifiers to compare the performance in power amplifier, in-line amplifier, and pre amplifier configuration. It is found that EDFA gives favorable result than SOA for all three configurations.

Key Words: WDM, BER, EDFA, SO.

1. INTRODUCTION

With the development of high-capacity and high-speed telecommunication systems, the demand for optical amplification is rapidly increasing [1]. Optical signal suffers attenuation, when it propagated through the optical fibre. To compensate this attenuation, in conventional optical communication systems, repeaters are used after 20-30km. Repeaters convert optical signal into electrical signal, then amplify, and reshape it and then again convert in optical signal and transmit further. But this whole process introduces latency in the signal. Also, in case of DWDM system, first all DWDM channels should be demultiplexed before converting these into electrical signal, which makes all process very complex and expensive. To overcome this problem, optical amplifiers are used to amplify the signal without converting it in electrical signal. In this case signals are amplified in optical domain without converting in electrical domain [2-3]. Further, all wavelength channels propagating in the fibre got equal amplifications simultaneously, so demultiplexing before amplification is not required in this case. This makes optical amplifiers highly suitable for the high speed DWDM systems [4-5]. Due to vast applications of optical amplifiers in optical communications, in last 25 years, these amplifiers have been studied extensively [6-10]. In this paper, a comparative study of Erbium Doped Fiber Amplifier (EDFA) and Semiconductor Optical Amplifier (SOA) in optical communication link has been presented. Performances of both these amplifiers have been studied for a WDM network on the basis of their position i.e. Post amplifier, Inline Amplifier, and Pre amplifier.

2. COMPARING EDFA AND SOA PERFORMANCES

To compare the performance of these two amplifiers in WDM network on the basis of their positions, all the parameters are kept fixed for the network and the only change being made is in the type of amplifier used i.e. EDFA or SOA and the three positions mentioned above.

The parameters kept constant are:
- Transmitting frequency = 190 Thz
- Frequency spacing = 200 Ghz
- Power = -6.47dbm
- Single mode fiber length=20km
- Dispersion compensation fiber (DCF) length= 5km
- Demultiplexer bandwidth= 50 Ghz

3. RESULT AND DISCUSSION

A. COMPARISON AS POWER AMPLIFIER

Power or booster amplifier applications include placing the amplifier just after the optical transmitter or WDM multiplexer to boost the transmitted power. Keeping the above parameter fixed, simulation has been performed for power amplifier. Results of the simulation have been presented in Fig. 1 (a) and 1 (b), and also tabulated in table (1). It is observed that the Q-factor for the EDFA power amplifier is greater than that for the SOA power amplifier. Also the amount of distortion for the EDFA is small as the eye height for the EDFA is greater than that for SOA.

Fig 1(a): BER output for SOA Power Amplifier in WDM network
Table 1: Comparison of EDFA and SOA as Power Amplifiers

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>SOA Power Amplifier</th>
<th>EDFA Power Amplifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Q-Factor</td>
<td>0</td>
<td>4.76157</td>
</tr>
<tr>
<td>2</td>
<td>Min. BER</td>
<td>1</td>
<td>8.6477e-007</td>
</tr>
<tr>
<td>3</td>
<td>Eye Height</td>
<td>0</td>
<td>0.00065344</td>
</tr>
</tbody>
</table>

B. COMPARISON AS IN LINE AMPLIFIER

In a single mode fibre link, main limitation to repeater spacing is fibre attenuation, because the effect of dispersion may be very small. Since such a link does not necessarily require complete regeneration of the signal, only amplification is sufficient. Thus, an in line optical amplifier can be used to compensate the transmission loss and increase the distance between regenerative repeaters. In this case also, simulation has been performed. Results of the simulation have been presented in Fig. 2 (a) and 2 (b), and also tabulated in table (2). It is observed that the quality of signal received at the output of the EDFA is better than that for SOA as the Q-factor for EDFA is greater than SOA. The eye height implies that the amount of distortion for the EDFA is larger than the SOA, because eye is wide open for the EDFA as compared to SOA.

Table 2: Comparison of EDFA and SOA as In Line Amplifiers

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>SOA In-Line Amplifier</th>
<th>EDFA In Line Amplifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Q-Factor</td>
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<td>2</td>
<td>Min. BER</td>
<td>1</td>
<td>8.94215e-010</td>
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<tr>
<td>3</td>
<td>Eye Height</td>
<td>0</td>
<td>0.000911248</td>
</tr>
</tbody>
</table>

C. COMPARISON AS PRE AMPLIFIER

This amplifier is used as front-end preamplifier for an optical receiver. So, a weak optical signal is amplified before photo detection so that the SNR degradation in the receiver electronics can be minimized. Compared with other front end devices an optical pre-amplifier provides a larger gain factor as well as larger bandwidth. In this case also, simulation has been performed. Results of the simulation have been presented in Fig. 3 (a) and 3 (b), and also tabulated in table (3). It is observed from the below table that, the quality of signal achieved at the receiver is better in case of EDFA than that for SOA as the Q-factor for EDFA is greater than for SOA. The eye height also explains that the amount of distortion in the case of EDFA less, as eye is wider open for EDFA than SOA.
Fig 3(b): BER output for EDFA Pre Amplifier in WDM network

Table 3: Comparison of EDFA and SOA as Pre Amplifiers

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>SOA Pre Amplifier</th>
<th>EDFA Pre Amplifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Q-Factor</td>
<td>0</td>
<td>6.6368</td>
</tr>
<tr>
<td>2</td>
<td>Min. BER</td>
<td>1</td>
<td>1.55026e-011</td>
</tr>
<tr>
<td>3</td>
<td>Eye Height</td>
<td>0</td>
<td>0.0010237</td>
</tr>
</tbody>
</table>

4. CONCLUSION

Comparative study of EDFA and SOA in WDM optical network for power amplifier, in-line amplifier, and pre amplifier has been performed. Optisystem 12.0, a software package has been used for this purpose. It is found that EDFA gives better result than SOA for all three configurations.

ACKNOWLEDGMENT

Author is highly thankful to Optiwave Systems Inc. to provide the trial version of Optisystem 12.0 for the evaluation purpose. After evaluation it is found that, this is highly efficient for designing the high speed optical communication system.

REFERENCES