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A Performance Evaluation of 8-Channel WDM System Using Optical Amplifiers

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***Abstract*—**In This paper, we have investigated the proposed 8-channel WDM system transmitted over 100 km distance is amplified with EDFA-SOA post-amplifier configuration for different EDFA length. For different EDFA-SOA combination gives different results for different EDFAs length (5m, 10m, and 15m). The proposed EDFA-SOA post-amplifier improves the input power to the receiver subsystem. Performance of hybrid amplifiers (EDFA-SOA) has been analyzed for different EDFAs lengths by Q-factor, min BER rate, threshold, and height. Also, detail analysis of the performance of both the amplifiers combination for different lengths for a WDM network shows that EDFA-SOA amplifier combination give favorable results when EDFA length is small (5m).

Keywords*—EDFA;SOA;EDFA-SOA;WDM;BER.*

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I. INTRODUCTION

High bandwidth requirement is the biggest challenge of modern day's communication systems.the optical communication systems offer the solution for this high bandwidth demand[1]. Optical amplifier works on optical signal (light signal) and it can be used for long distance communication by amplifying signal (non-distortion) successfully without any distortion. Optical fibers are indispensable elements of high capacity and multiply connected optical communication networks [2].Optical amplifier compensate for losses due to the fiber transmission medium, and the power division for multi-point connectivity. Optical amplifiers improve a system performance by increasing the level of power to be detected within the receiver's dynamic range. In contrast, amplifiers provide gain for a large number of channels in wavelength division multiplexed (WDM) systems [3]. Wavelength division multiplexing is the basic technology of optical networking. This is a technique for using a optical device to carry many separate and independent optical channels [4].

There are two types of WDM-

Coarse WDM

Dense WDM

In Coarse Wavelength Division Multiplexing (CWDM) systems, the wavelengths are equally spaced by a large spacing of 20 nm. CWDM system which is transmitted at Fast Ethernet rate of 100 Mb/s[4]Dense WDM however is another thing. Dense WDM refers to the close spacing of channels. To some, a series of WDM channels spaced at 3.6 nm apart qualifies for the description. Others use the term to distinguish systems where the wavelength spacing is 1 nm per channel or less. WDM is the basic technology for full optical networking [5].

The amplifier placement in a network would result in different performance as each configuration is used to achieve different objectives. Optical amplifiers can be configured as post-amplifiers, in-line amplifiers and pre-amplifiers [6].Power (booster) amplifier or post amplifier applications include placing the device immediately after an optical transmitter to boost the transmitted power. This serves to increase the transmission distance by 10-100km.In this configuration, the input power level will be relatively high [8]. The limitation here is likely to be total output power of the amplifier. For example if we want to amplify a mixed WDM network of 10 channels from -5 dBm by 8 dB the total output power of the amplifier will be 10 channels at 3dBm (that is, 2 mW). Total amplifier power needed in this case is 20 mW[7].The types of optical amplifiers are-

1. Fibre Raman amplifier.(FRA)
2. Erbium doped fibre optical amplifier. (EDFA)
3. Erbium doped waveguide amplifier. (EDWA)
4. Semiconductor optical amplifiers. (SOA)

Erbium-doped fiber amplifier (EDFA) is the most deployed fiber amplifier as its amplification window coincides with the third transmission window of silica-based optical fiber. An optical fiber is doped with the rare earth element erbium so that the glass fiber can absorb light at one frequency and emit light at another frequency. An external semiconductor laser couples light into the fiber at infrared wavelengths of either 980 or 1480 nanometers [10]. Doped Fiber Amplifier (EDFA) has been analyzed for different fiber lengths, core radius, and numerical aperture. Performance of Semiconductor Optical Amplifier (SOA) has been analyzed for different injection current for the same network.[8]A semiconductor optical amplifier is an optical amplifier based on a semiconductor gain medium. SOAs are often used in telecom systems in the form of fiber-pigtailed components, operating at signal wavelengths near 1.3 or 1.5 μm, and offering a gain of up to ≈ 30 dB. Semiconductor-optical-amplifier (SOA) technology provides this high-speed switching capability as well as gain, high extinction ratio, and high integration potential [9].SOAs can be classified as resonant devices or traveling-wave (TW) devices. Resonant SOAs are manufactured using an AR coating with a reflectivity around 10^{-2}. They typically feature a gain ripple of 10 to 20 dB and a bandwidth of 2 to 10 GHz. TW devices incorporates a coating with a reflectivity less than 10^{-4} [10].

Semiconductor-optical-amplifier (SOA) technology provides this high-speed switching capability as well as gain, high extinction ratio, and high integration potential [11]. The WDM system as shown in Fig. 2 transmits eight wavelengths ranging from 1471 nm to 1611 nm. The transmitter subsystem comprises of input signals and a multiplexer. Then, in the optical transmission link, several fiber spools are placed before the receiver subsystem which consists of a demultiplexer.[15]

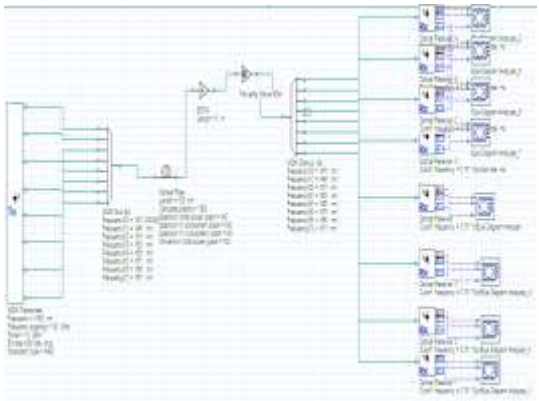

Figure 1. 8-channel WDM system using EDFA-SOA configuration at EDFA length 5m.

II. PERFORMANCE ANALYSIS OF EDFA AT LENGTH 5m.

Effect has been shown in figures on Q-factor, Min.Bit error Rate (BER), threshold, height and eye diagram using EDFA at length 5m

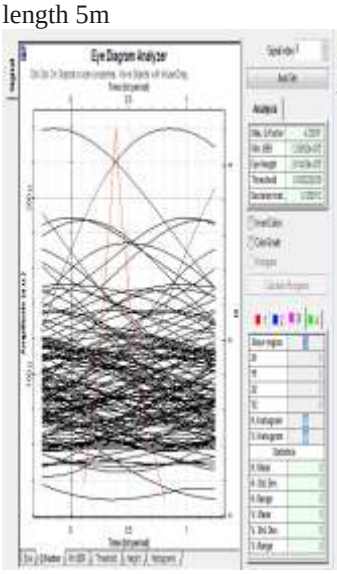

Figure.1(a)Q-Factor

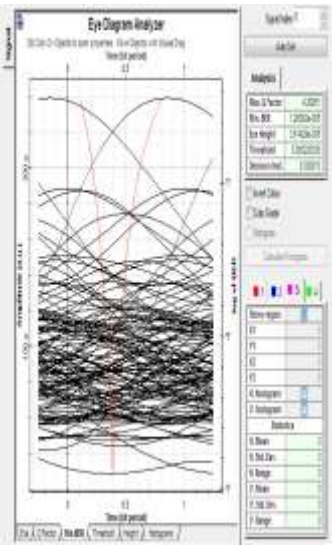

Figure 1.(b) Min BER

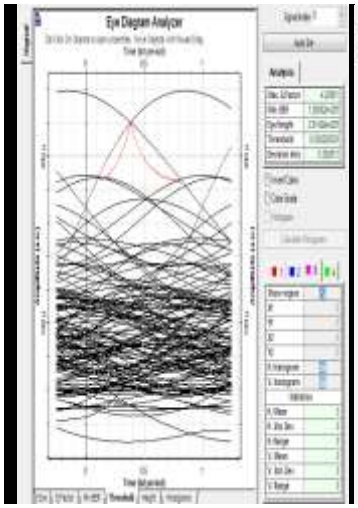

Figure 1.(c) Threshold

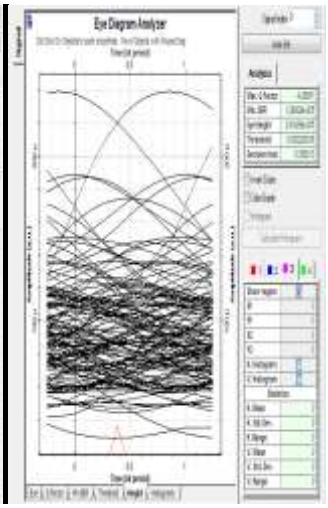

Figure 1.(d) Height

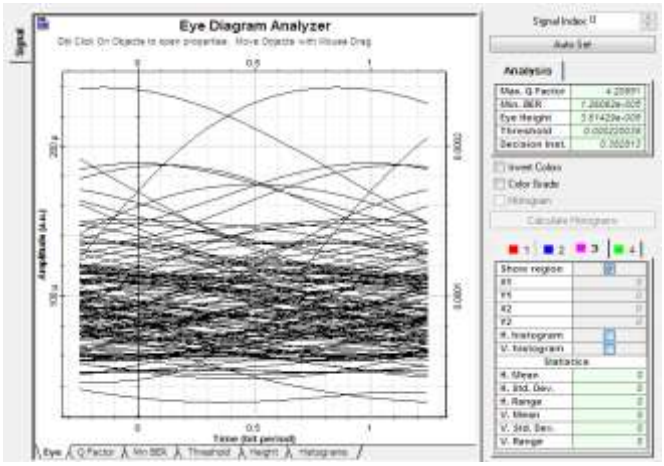

Figure 1.(e) Eye Diagram

III. PERFORMANCE ANALYSIS OF EDFA AT LENGTH 15m.

Effect has been shown in figures on Q-factor, Min.Bit error Rate (BER), threshold, height and eye diagram using EDFA at length 5m

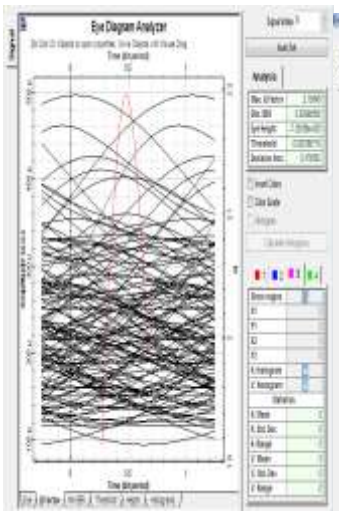

Figure 2.(a) Q-Factor

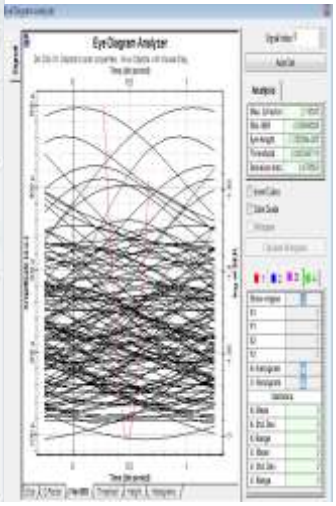

Figure 2(b)Min BER

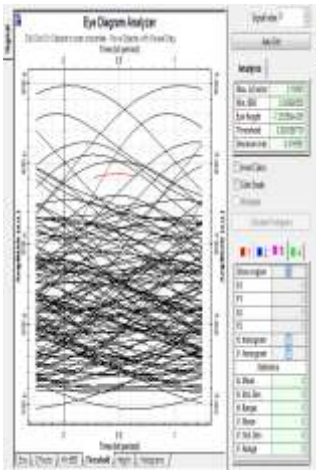

Figure 2.(c)Threshold

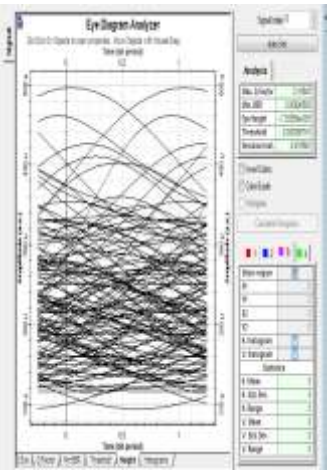

Figure 2.(d) Height

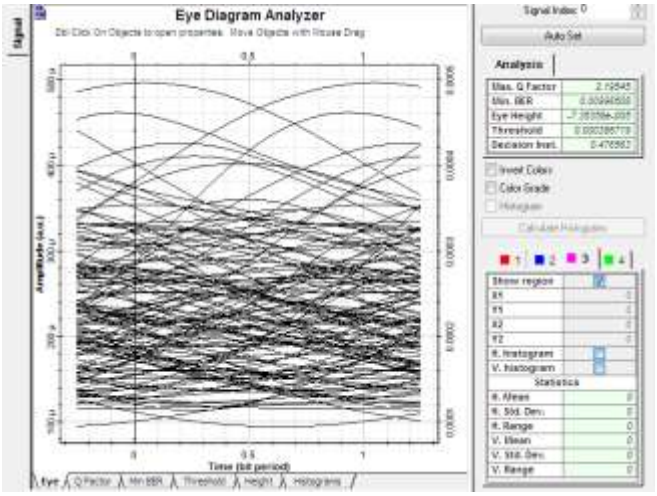

Figure 2.(e) Eye Diagram

IV. PERFORMANCE ANALYSIS WHEN SOA IS CONNECTED BEFORE EDFA AT LENGTH 10m.

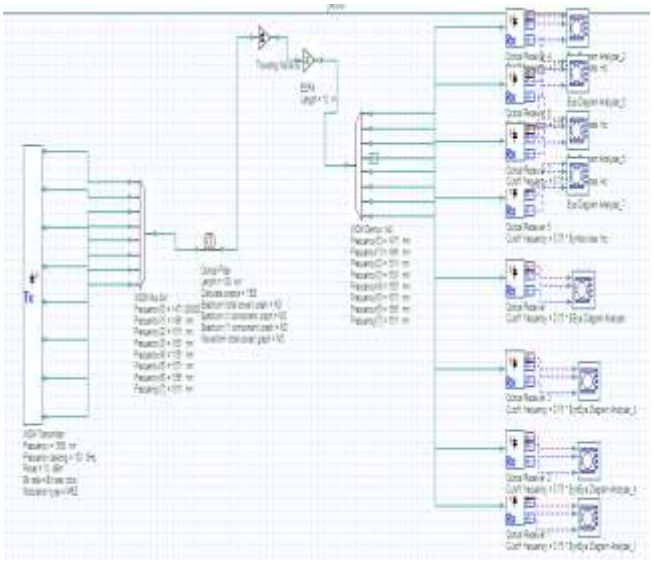

Figure 2. Shows that 8 –channel WDM network when SOA is is connected before EDFA at length 10m.

Effect has been shown in figures on the Q-factor, Min. (BER), threshold, height and eye diagram using EDFA at length 10m.

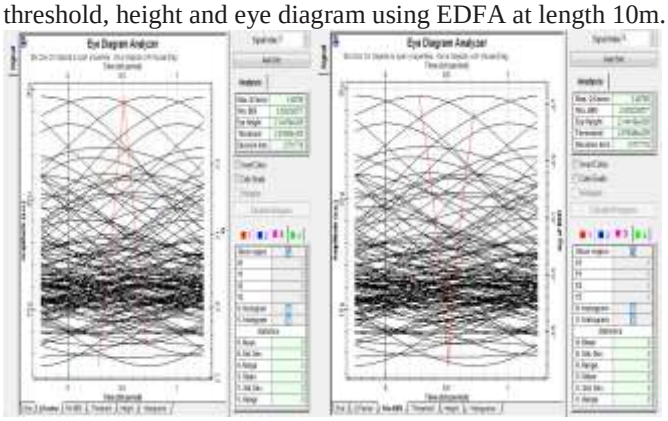

Figure 3.(a)Q-Factor Figure 3.(b) Min. BER

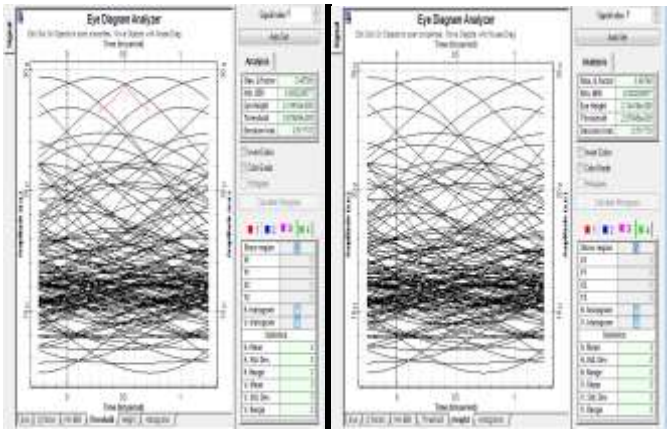

Figure 3.(c)Threshold Figure 3.(d)Height

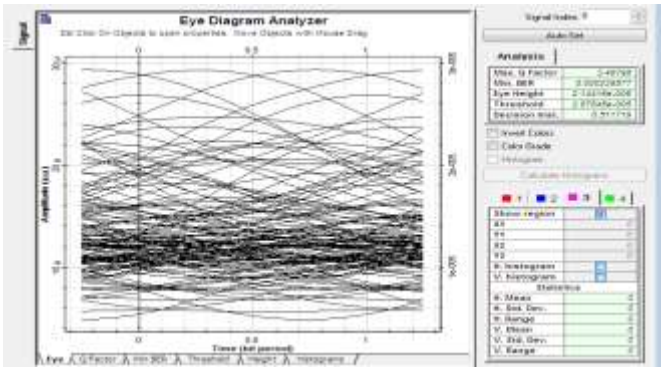

Figure 3.(e) Eye Diagram

RESULT AND ANALYSIS-

parameters	EDFA-SOA (Length of EDFA is 5m)	EDFA-SOA (Length of EDFA is 15m)	SOA-EDFA(Length of EDFA is 10m)
Q-Factor	4.20951	2.19545	3.48798
MIN BER	1.26062e-005	0.00996508	0.000239577
EYE HEIGHT	3.61429e-005	-7.35358e-005	2.14416e-006
THRESHOLD	0.000220038	0.000386719	2.87845e-005
DECISION INSTANTANEOUS VALUE	0.382813	0.476563	0.511719

CONCLUSION

The performance of hybrid amplifiers (EDFA-SOA)is compared at different EDFA length(5m,10,15m) at distance of 100km.We have analyzed the performance of EDFA-SOA combination for different EDFA lengths by improve Q-factor, min BER rate,threshold,height and eye diagram. The results shown that the combination of EDFA-SOA shows better results at EDFA length at 5m than EDFA-SOA at 15m and SOA-EDFA at 10m .semiconductor optical amplifier (SOA) for different EDFA lengths the injection current is 0.5mA. It is Concluded that an EDFA-SOA is best optimized at 1550nm for EDFA length=15m. An SOA is best optimized when injection current is 0.05mA. Also, with a Q -factor of 4.20951, an eye Height of 3.61429e-005 and minimum BER value of

1.26062e-005, we concluded that EDFA –SOA combination gives better result for a WDM network when EDFA length is 5m.*b*

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