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Role of EYCDFA for Optical Communication System

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Abstract:- In this paper, performance analysis of Erbium ytterbium co-doped fiber amplifier is presented. 60Gbps single channel link is used with EDFA-EYCDFA cascaded structure. Various parameters like bit error rate (BER), received optical power, Q factor, noise figure and dispersion are used to measure system performance. The signal to noise ratio has been improved by using this optical amplifier. The main objective to present this work is to use the erbium ytterbium co-doped fiber amplifier to achieve higher power, this amplifier is used because it absorb higher amount of energy.

Index Terms: *Erbium ytterbium co-doped fiber amplifier (EYCDFA), Erbium-doped fiber amplifier (EDFA), Optical Communication System and bit error rate (BER).*

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1. INTRODUCTION

Vashi et al. described that the gain flatness is required in various applications like WDM system and all optical networks. In this paper, a flat gain of 36db is achieved by taking the noise figure in the range of 4.0 - 4.2 db. The EDFA and EYCDFA were used in the cascading mode [1]. Semmalar et al. performed the ASE noise analysis using cascaded EDFA and EYCDFA. The performance was observed with the various parameters like gain, forward output signal power and ASE noise. It was analyzed that EDFA gives the maximum gain and EYCDFA gives the minimum noise [2]. Ji et al. improved the performance of hybrid amplifier configuration by taking the length of EYCDFA into concentration and amount of erbium ions in EYCDFA. The EDFA works as a pre–amplifier and the EYCDFA as a post-amplifier in the cascaded mode. Authors described that the hybrid fiber amplifier was designed and investigated to achieve the high power and extremely high gain accompanied with good noise figure. The cascaded structure of EDFA and EYCDFA was used. At the signal wavelength of 1550 nm, the signal gain of approximately 70 dB and the maximum output power of 36.9 dBm were achieved with the total pump power of 12.5 W [3]. Kaur et al. analyzed the performance of dense wavelength division multiplexing (DWDM) using different optical amplifiers like RAMAN, EDFA and EYCDFA. The gain increases due to varying length of different amplifier. The gain flatness was observed higher in RAMAN as comparison to EDFA and EYCDFA amplifier [4]. Verma et al. proposed that EDFA gain flatness is important in WDM systems. Gain flatness is improved using fiber length, numerical aperture, pump power and low pass filter. Flattened gain (33.57–33.97dB) is achieved in 1546-1558nm band. In this band low noise figure, low BER and high Q factor is achieved [5]. Lavrinovica et al. experimentally measure the effective area (A_{eff}) for ytterbium (Yb^{3+}) and erbium (Er3+) doped optical fibers using transverse shift measurement method. Higher peak power values (in the range -30dBm) are obtained for erbium fiber than ytterbium fiber (in the range -20dBm) achieved low peak power values [6]. Harun et al. observed gain improvement in the L-band by using double pass amplification (forward ASE and EDF) with the help of a circulator. A high gain enhancement (11 dB) is obtained for a 1570-nm signal with an input power of -20 dBm at 98 mW of pump power [7]. Sodhi et al. analyzed hybrid combination of Raman and EDFA amplifier for 160 x 10 Gbps DWDM systems. A flat gain (> 10 dB) is obtained at input power of 3 mW. At this input power maximum output power (> 8.9 dBm) is reported [8]. Bayaki et al. used all-optical relays equipped with EDFAs to avoid O-to-E and E-to-O conversions. Accurate signal and noise models are developed for fixed and variable gain all-optical and electrical relaying [9].

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2. SIMULATION SETUP

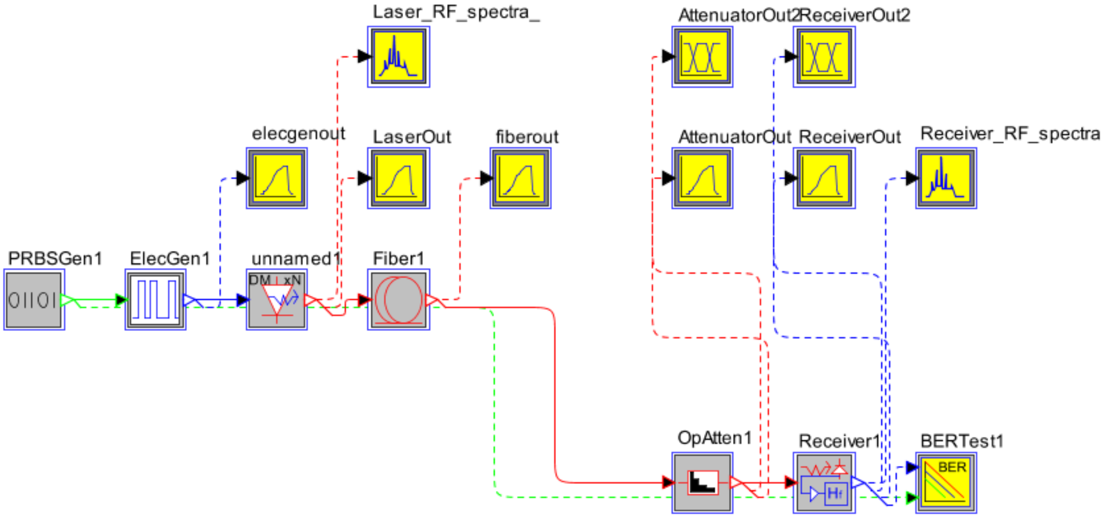

Figure 3: Simulation Setup of 60 Gbps Single Channel Optical Link

The simulation of 60 Gbps direct modulated single channel optical link is taken (Figure 3). In the 60 Gbps link topology the numbers of components are divided into four categories: transmitter, channel, receiver and control. The transmitter includes the pseudorandom bit sequence generator (PRBS), electrical signal generator and direct modulated laser. PRBS generates a binary sequence of specific length at a data rate of 60 Gbps. The generated binary sequence is converted into electrical form through electrical signal generator. This electrical signal is converted into optical form by passing through a direct modulated laser. The channel includes the models such as a fiber which carries the optical signal generated in the transmitter. The receiver includes the models such as the compound receiver and bit error rate tester. In the receiver section optical signal is converted back into electrical form. This electrical signal is passed through a BER tester to calculate the average bit error rate. In the end the plot icons are included in the control category.

The cascaded structure of EDFA and EYCDFA is used in the above discussed 60 Gbps single channel link (Figure 4). The EDFA cascaded with EYCDFA is added after the fiber or at the output of the fiber. The signal is coming out of the fiber end act as an input to the cascaded structure. By applying this structure at the fiber end we can achieve the maximum gain and minimum noise. The amplified spontaneous emission noise is obtained zero in the EYCDFA.

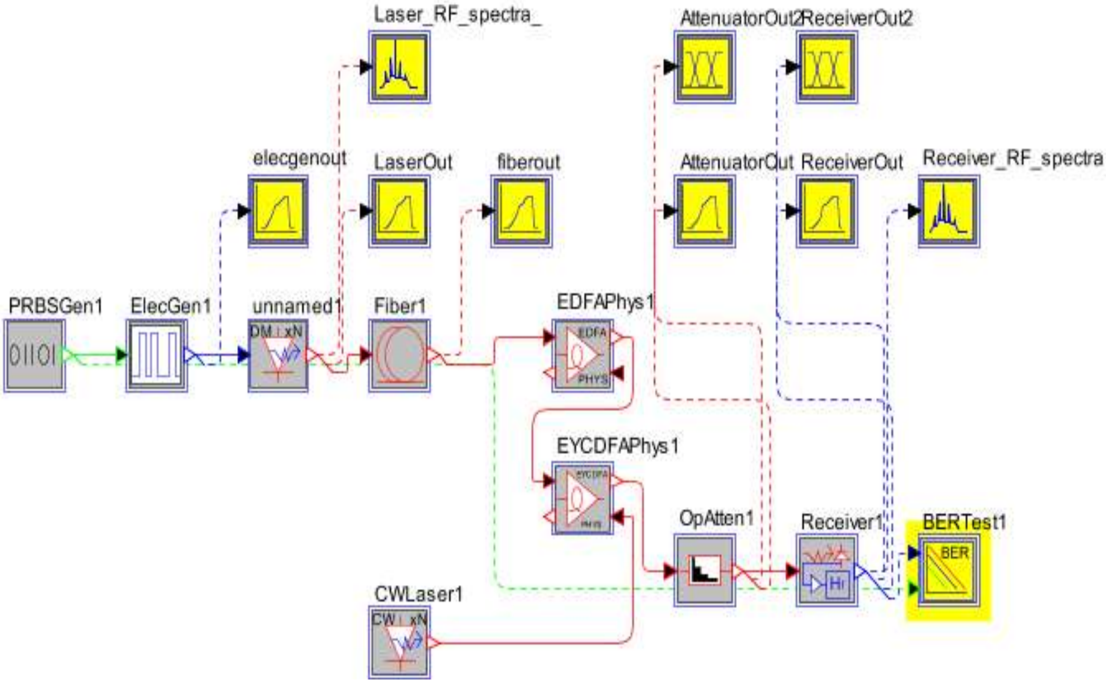

Figure 4: Simulation Setup using Cascaded EDFA-EYCDFA

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In the above figure 4 the EDFA output is given to the EYCDFA input and next the EYCDFA output is directly feed to the optical attenuator block. The receiver model incorporates the photodetector, trans-impedance amplifier, post amplifier, filter and noise of the optical power. The receiver model convert the optical input power to an electrical current and then models the amplification and shaping of that to produce the output electrical voltage signal. The electrical output signal of the receiver model is passed onto the BER tester. This block uses the signal waveform and time dependent noise which accompanies it to determine the average bit error rate. The BER block determine the ideal sampling time and decision threshold based on the input signal waveform.

3. RESULTS & DISCUSSIONS

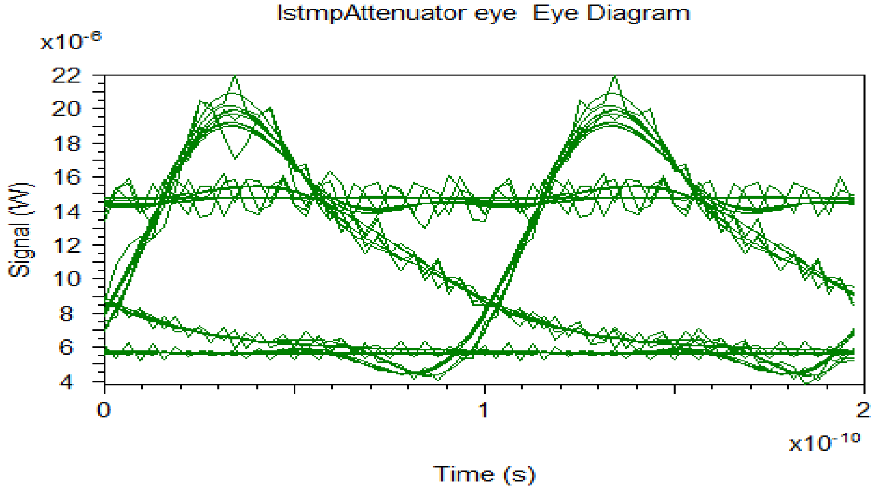

Figure 5: Eye diagram

The eye diagram (Figure 5) plot is between the signal and the time. The eye diagram of the electrical signal coming out of receiver is viewed from the eye diagram analyser. From this eye diagram different parameters like Q factor, BER and noise factor etc. can be analyzed.

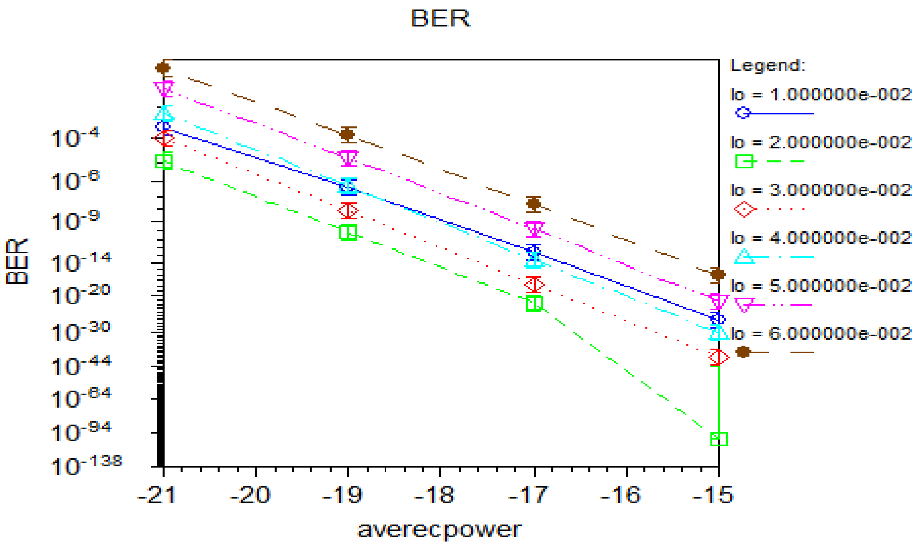

Figure 6: BER vs. Received Optical Power

Figure 6 provides the BER output from BER block in terms of average received power. In this variable is set to ‘average power’, the variable name used in the output power parameter of the power normalizer block. The start and end point of the scan is -15 and -21 and the step by -2 for each scan. Scan may be performed with either positive or negative step values. For the outer iteration variable is set to be ‘I_0’, the variable used in the bias current parameter of the laser. The start and end point is 10e-3 and 60e-3 with the step of 10e-3. Different bias current values are obtained from different curves. The minimum BER is obtained at bias current of 20e-3 and maximum at 60e-3.

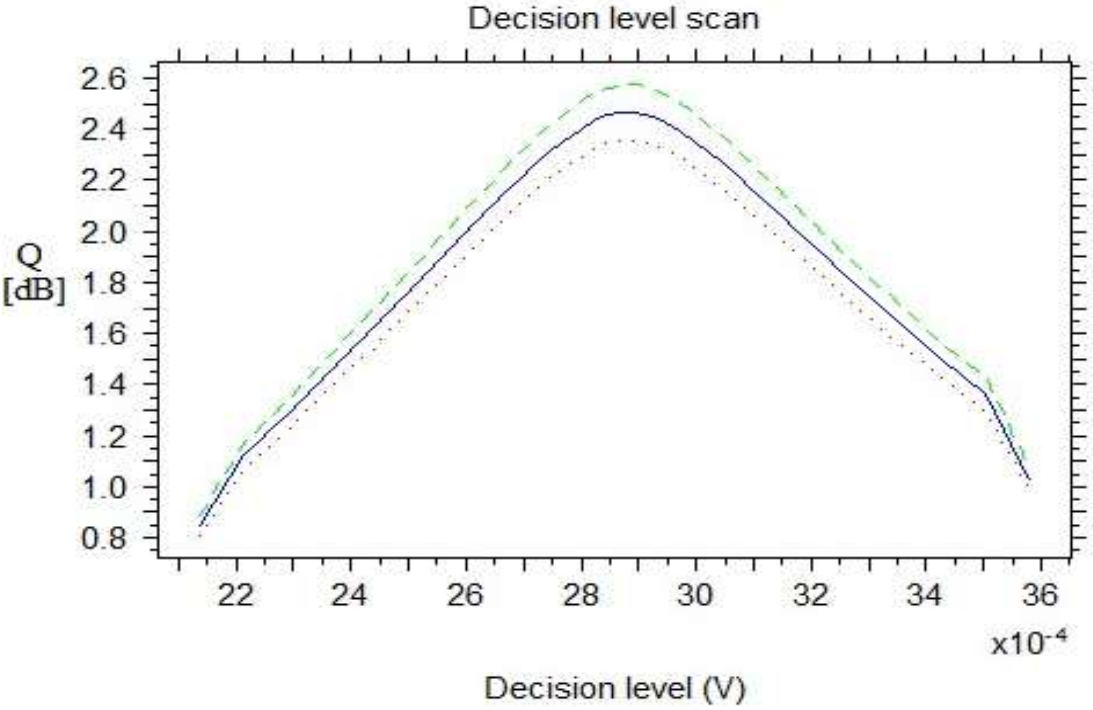

Figure 7: Decision Level Scan Q

Figure 7 provide the output from BER tester block in terms of decision level (V) and Q (dB). In this decision level scan Q plot, the higher value of Q is attained at the value 10e-3 (green curve) whereas minimum Q value is attained at 30e-3 (pink curve).

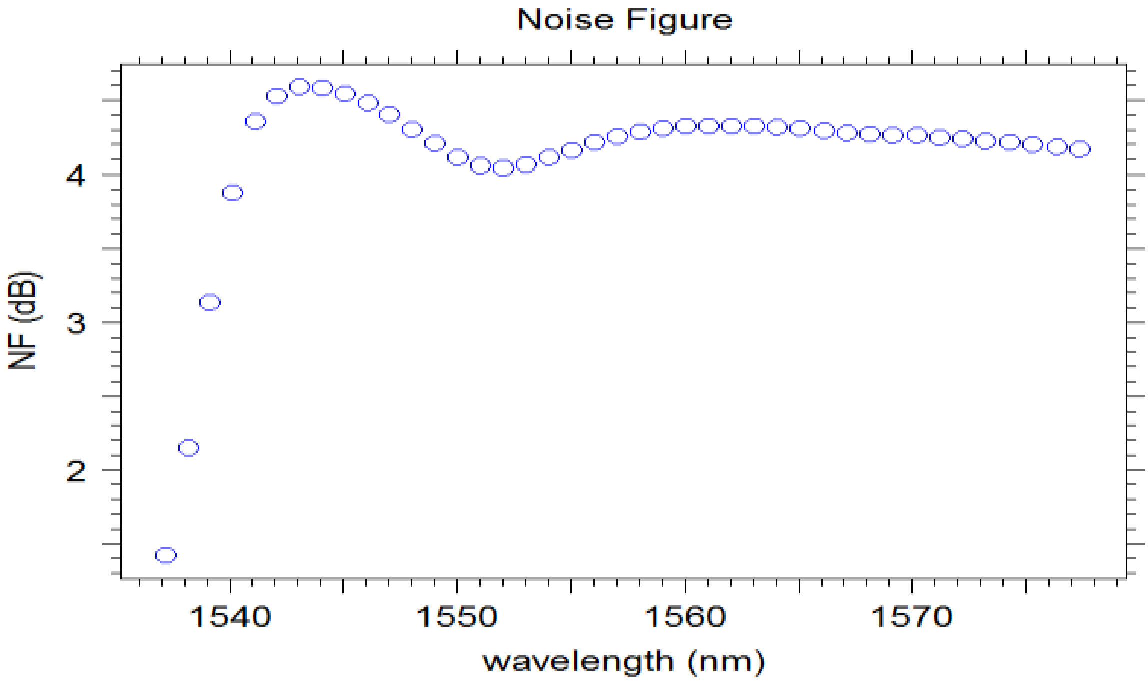

Figure 8: Noise Figure vs. Wavelength

Figure 8 provide the noise figure value with varying wavelengths. Wavelength is varied between 1535 to 1585 nm. Maximum noise figure is obtained at 1542 nm. Figure 9 provides the dispersion values at varying distance for different wavelengths. Distance is varied from 0 to 600 Km. It is analyzed that dispersion increases with distance.

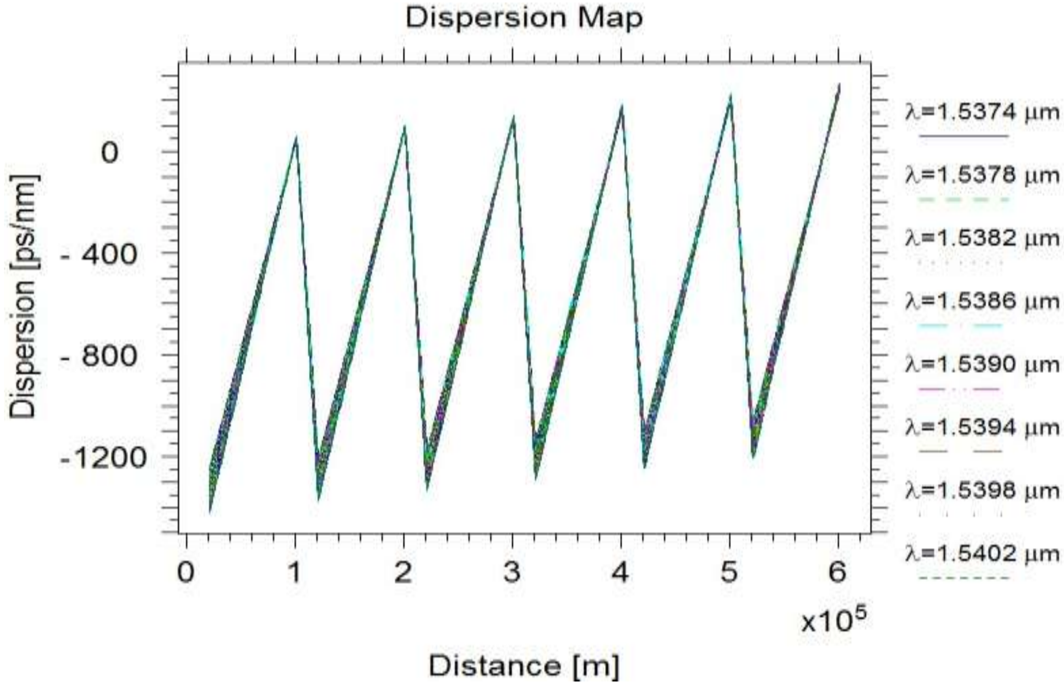

Figure 9: Dispersion with Varying Distance

4. CONCLUSIONS

The result from this work shows that flat BER value is achieved for the range of values of outer iteration variable by using EYCDFA cascaded with EDFA. The noise figure has also been drop down and due to this the signal to noise ratio is also improved. Amplified spontaneous emission is achieved zero in the EYCDFA. Also dispersion value increases with distance. So the cascaded model of EDFA and EYCDFA is helpful for the communication purpose with high transmission capacity and for long haul applications.

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