Investigation of different configurations of amplifiers for inter satellite optical wireless transmission

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Abstract

In this article, different amplifiers such as erbium doped fiber amplifier, Raman amplifier and semiconductor optical amplifier, have been investigated in inter-satellite links on optical wireless communication system. It has been observed that EDFA performs better at long range than Raman and SOA amplification while later mentioned amplifiers perform well in the context of less distances. Q-Factor has been used for the assessment of the techniques to give the simulation results. The results show that EDFA which has simple design performs best at a higher transmission range for the data rate of 45 Gbps. EDFA systems has been simulated at different power levels and Q-factor has been observed at these power levels. The increasing aperture diameters of both transmitters and receivers have shown significant improvement in the performance system.

***Index terms*-** **Q-factor, BER, EDFA ,WDM, IsOWC**

Introduction

Inter-satellite Optical wireless communication (IsOWC) is a capable solution for very high data rate point to point communication. With the rising popularity of high definition television and video conferencing, the demand for both high paces wired and wireless access is continuously increasing in indoor and outdoor environments [1]. The microwave and RF frequencies are used to transfer the information but they suffer from serious drawbacks like radiations make a way into walls and less data rate transfer due to losses [2]. So the microwave and RF links are replaced by optical wireless technology. The IsOWC technology has a lot of reimbursements than the disadvantages. Its high data rate capability, license free operation, unregulated bandwidth, low power, high efficiency, lesser antenna sizes and low cost. All these features made the IsOWC technology came into survival [3].

The disadvantage includes the tracking problem and misalignment of transmitter and receiver apertures and the changes due to atmospheric conditions. The tracking problem causes various noise sources such as laser relative noise intensity, Johnson noise, dark current noise. Vibration noise is the most degrading factor in IsOWC communication system. These noises made the system more susceptible towards the pointing errors. The main focus is to reduce the power dissipation and to reduce the BER. This result in high transmitter power and lesser receiver noise to obtain desired signal [4]. IsOWC has provided a bottleneck solution for the connectivity and long range data transmission problems. The system consists of a laser beam modulated with data and is transmitted through free space with less attenuation than microwave and RF links as light travels faster in vaccum and can travel a long distance in thousands of kilometers with minimum bit error rate [5]. The system is admirable until the atmospheric disturbances are not present and effect of atmospheric turbulences is dissimilar for different modulation formats [6]. The data rate can be varied from 10Gbps to 40Gbps with a tolerable quality factor. The other parameters which affect the transmission properties include transmission aperture diameter, receiver aperture diameter and power of the operating laser source. The system needs more power when operated at large distances. The satellites should be in Line-of-Sight links to avoid the tracking problems so transmitter and receiver pointing angles must be precisely accustomed. Even a small deviation in beam angles can make the signal reception intricate or impossible.

Further, the best scheme is pragmatic under different power levels and analyzed at different transmitter and receiver aperture diameters. This chapter gave the comparative study of different amplifiers. The piece of writing presents the simulation set up of different amplifiers schemes in multiple channel ISL systems. The simulative set up description of IsOWC system is reported in this work and deals with the simulation results of EDFA at different powers, aperture diameters of transmitter and receiver.

system description

IsOWC system has been modeled and performance depiction by OptiSystem7. In our proposed system, the first section is the transmitter part which consists of PRBS generator. It generates the data which is to be transmitted i.e. data source. The second section represents the different amplifiers which get its output from the previous wavelengths. For the line coding we are using non return to zero modulation formats. External modulation is considered such as mech zender modulator, which has high extinction ratio. Eight transmitter are used which operates on wavelength of C band because of low attenuation characteristics in optical communication in this wavelength region. The free space between transmitter and receiver is considered as OWC channel which is the propagating medium for the transmitted optical signal. The optical receiver comprises of a photo detector followed by a low pass Bessel filter. In this section of system, the optical signal is converted back into electrical signal. PIN is used because of its high gain property and low cost. BER is seen for the final evaluation. The system works on data rate of 45 Gbps (each wavelength) at a link range of 100 km.

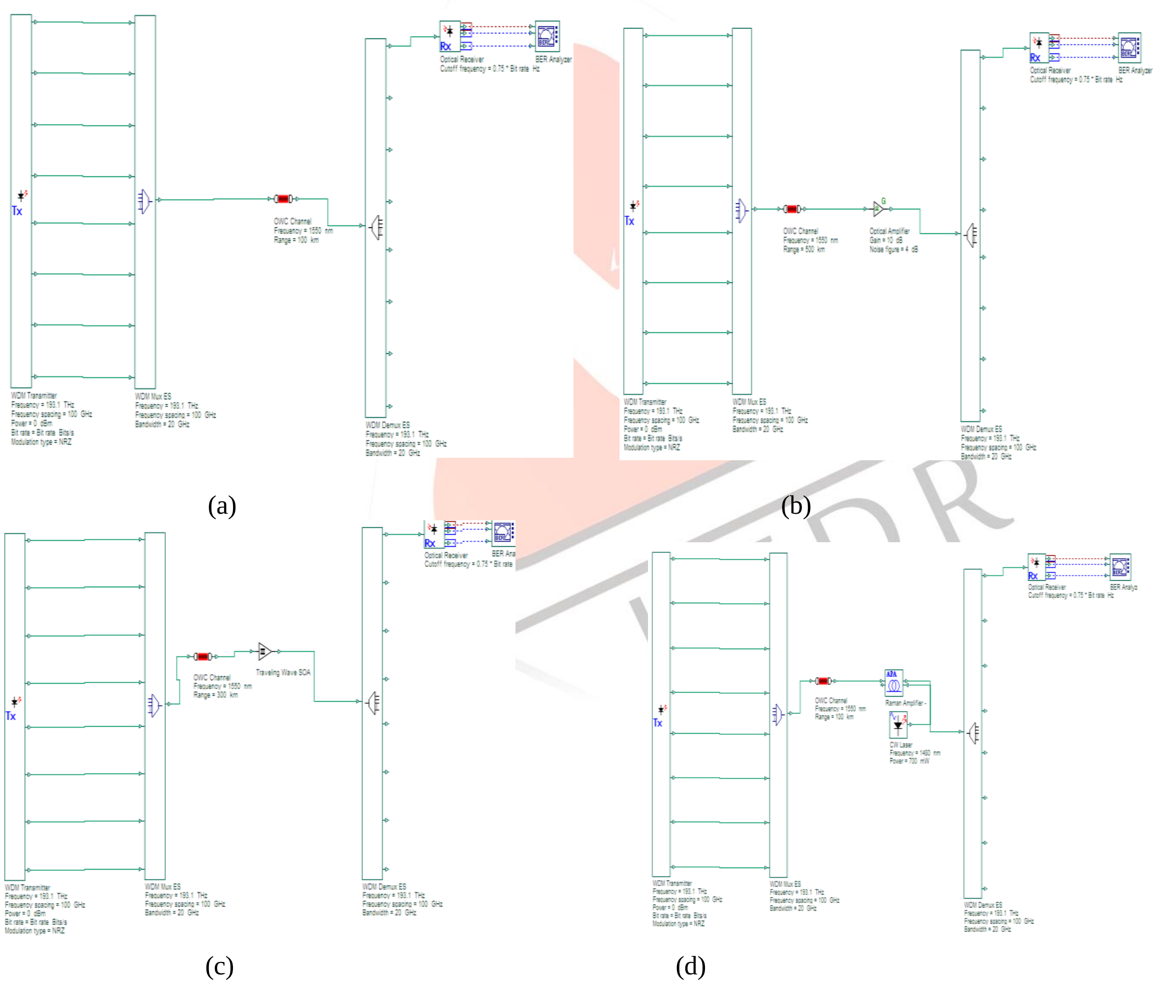

Fig 1.1: Subsystem of (a) W/o amplifier (b) EDFA (c) SOA (d) Raman amplifier WDM ISOWC System

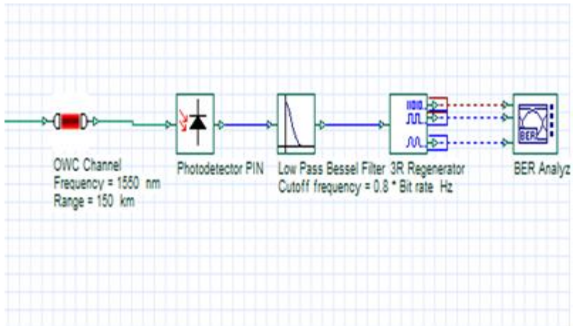

Fig 1.2: Simulation Set up of each receiver system

The analysis of different schemes shows that the EDFA performs better with other parameters remaining equal. It has been shown that there is a significant decrease in Q-Factor when increasing transmission distance. RAMAN is proven better than the SOA with much high Q-factor at a transmission distance of 100 km which shows its high transmission capability with acceptable Q- Factor and BER.

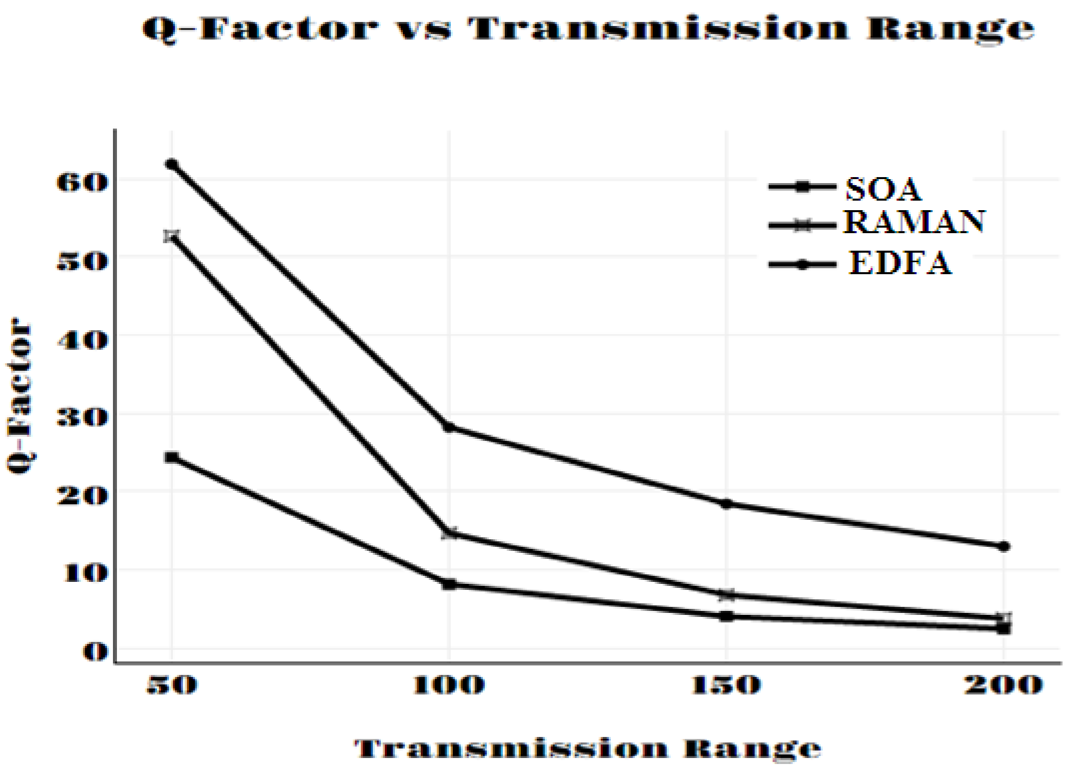

Fig 1.3: Q-Factor vs Transmission Distance for three modulation schemes

The BER for EDFA, RAMAN and SOA is -26, -23 and -8 respectively which affirms the better capability of EDFA amplification at a transmission distance of 100 km. The eye diagrams for these three amplifiers have been shown in figure 4.7.

The eye height for the comparison of three modulation schemes is shown in table 4.1. Furthermore EDFA system technique is realized with different power levels varying from- 20dB,-15dB,-10dB,-5dB, 0dB, 5dB, 10dB, 15dB, 20dB and 25dB. The results are shown in figure 4.8 which is Q vs transmission power.

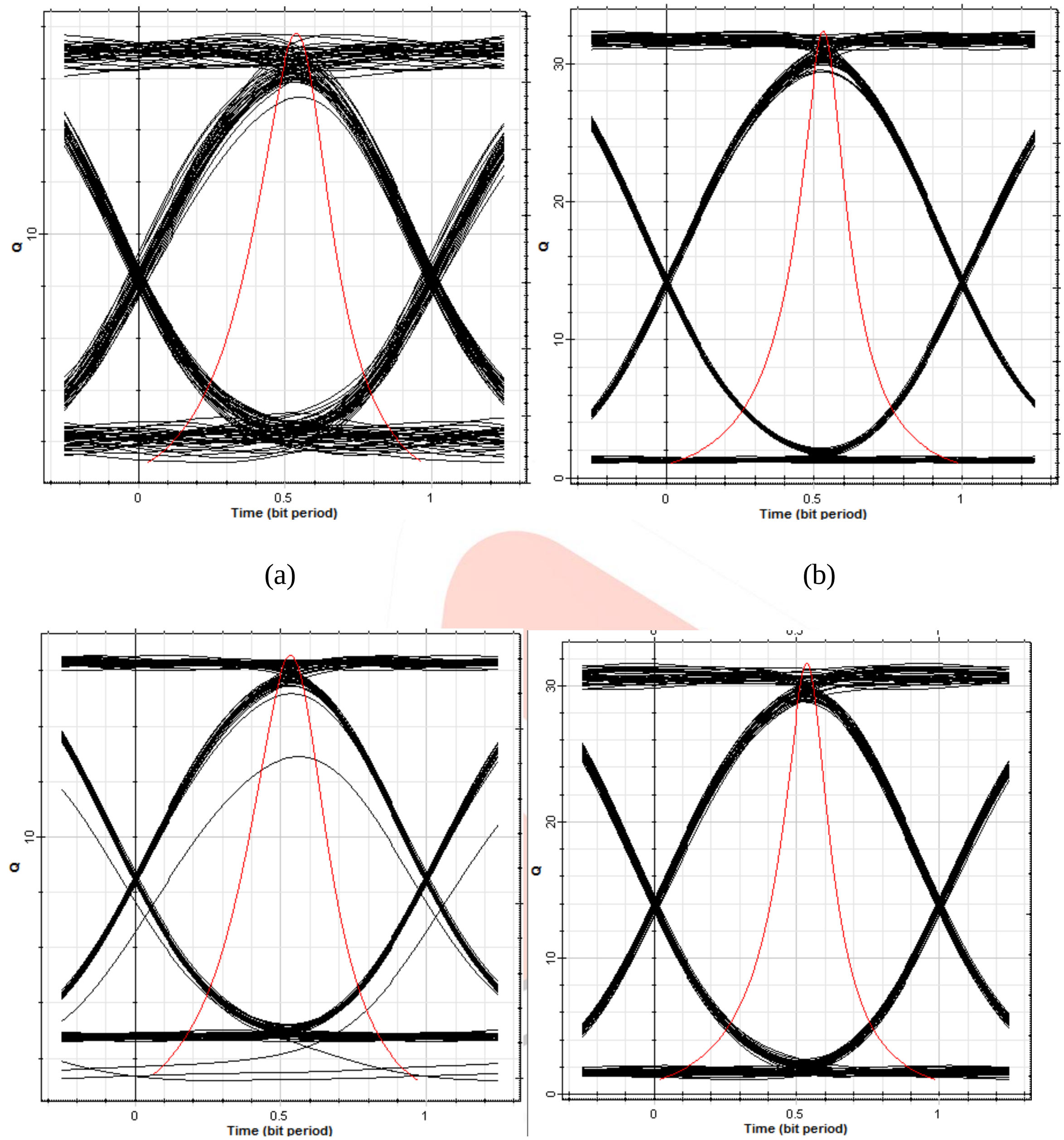

Fig 1.4 Eye depictions for (a) W/O Amplifier (b) EDFA (c) SOA (d) RAMAN

The results show that reduction in power increases the bit error rate. The system gives better results at transmission power of 0dB and till 25dB the quality factor increases and below 0dB less Q factor is obtained.

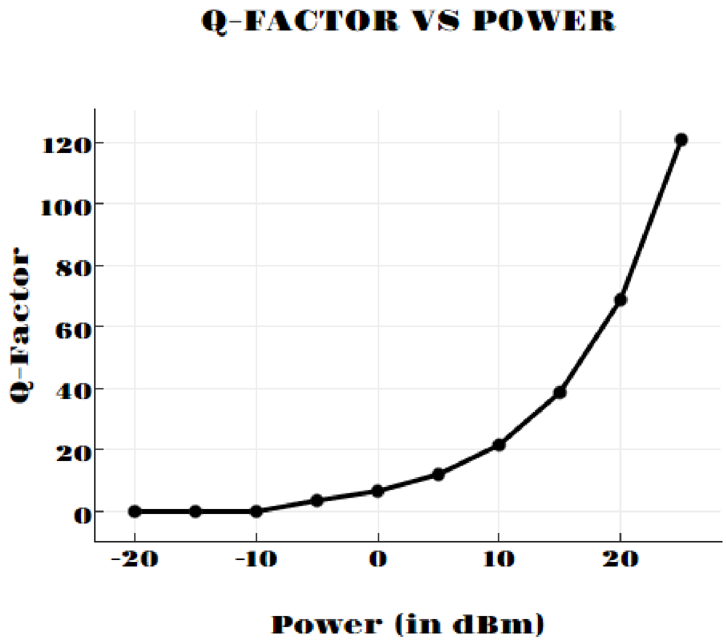

Fig 1.5: Q-factor of EDFA WDM at different power levels

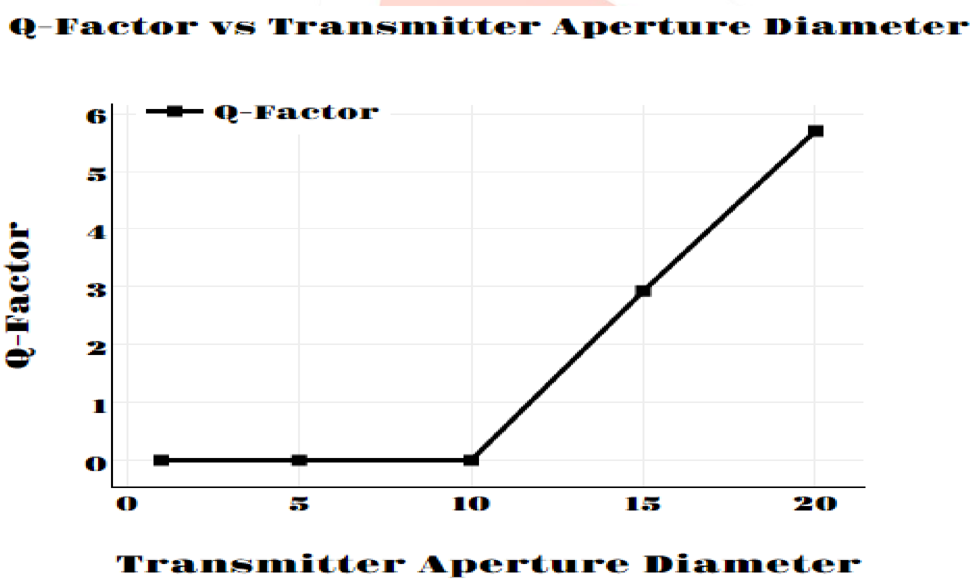

Fig 1.6: Q-Factor vs aperture diameter of transmitter

Now, the aperture diameters of both the transmitter and receiver are varied. The values of transmitter aperture diameter are 1cm, 5cm, 10cm, 15cm, 20cm and receiver aperture diameters are 3cm 7cm, 12cm, 17cm, 22cm with respect to transmitter. The effect of varying the aperture diameters can be easily seen from figure 1.6 and figure 1.7.

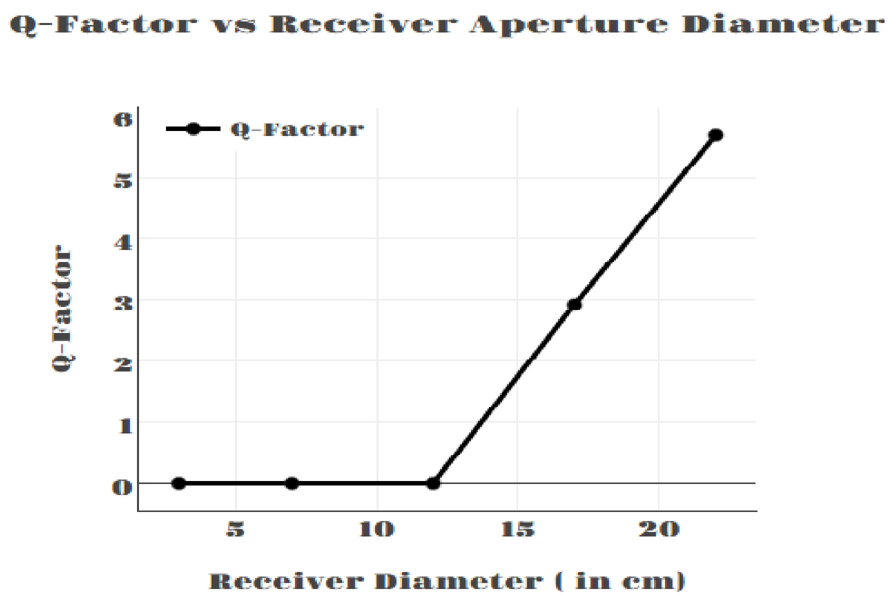

Fig 1.7: Q-Factor vs Receiver Aperture Diameter

The increase in aperture diameter sizes of both transmitter and receiver gives high Q-factor and less BER. There is a significant increase in Q-factor when increasing aperture sizes of both transmitter and receiver.

Conclusion

Research objective focused on different amplifiers such as erbium doped fiber amplifier, Raman amplifier and semiconductor optical amplifier, have been investigated in inter-satellite links on optical wireless communication system. It has been observed that EDFA performs better at long range than Raman and SOA amplification while later mentioned amplifiers perform well in the context of less distances. Q-Factor has been used for the assessment of the techniques to give the simulation results. The results show that EDFA which has simple design performs best at a higher transmission range for thse data rate of 45 Gbps. EDFA systems has been simulated at different power levels and Q-factor has been observed at these power levels. The increasing aperture diameters of both transmitters and receivers have shown significant improvement in the performance system.

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