Analysis of DWDM System with Hybrid Amplifiers at Different Transmission Distance

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Abstract— In this paper, the 16 channel DWDM systems at 10 Gb/s have been investigated for the hybrid amplifiers. The performance has been analyzed on the basis of transmission distance. The comparison of BER, Q-factor and eye opening for hybrid amplifiers EDFA+RAMAN and RAMAN+EDFA at different transmission distance is done. It is observed that DWDM system using EDFA+RAMAN provides better results than the DWDM system using RAMAN+EDFA amplifier. The analysis is done using OptiSystem 7.0 simulator.

Keywords—*DWDM, BER, EDFA, RAMAN, QFactor, OptiSystem7.0*

I. INTRODUCTION

DWDM is dense wavelength multiplexer. DWDM technology uses multiple wavelengths to transmit information over a single fiber. Dense WDM is WDM utilizing closely spaced channels. Today the demand of network capacity increases. So to increase the information carrying capacity of the network the DWDM system is the most useful technique. In DWDM system with the increase in distance there occurs degradation of signal, so to decrease this degradation of signal hybrid amplifiers are used to boost up the signal. Basically an optical amplifier is a device which amplifies the optical signal directly without ever changing it to electricity. DWDM system uses a multiplexer at the transmitter end, which multiplexes more than one optical signal onto a single fibre and demultiplexer at the receiver to split them apart. “Fig.1” is showing a basic DWDM Technology.

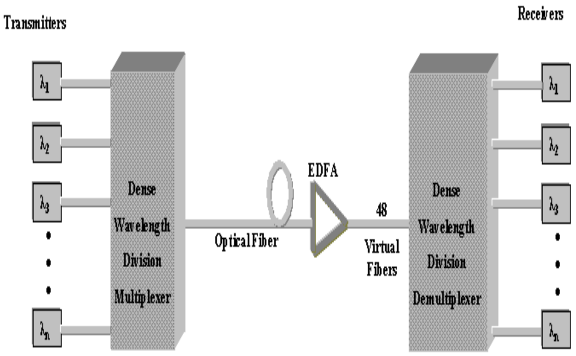


Fig.1: WDM System

In traditional systems optoelectronic repeaters are used in which optical signal is first converted into an electric current regenerated using a transmitter. The use of regenerators makes system complex and expensive. Currently the optical amplifiers are used which directly amplify the transmitter optical signal without conversion to electric forms as in-line amplifiers. An optical amplifier amplifies the signals simultaneously and decreases the attenuation. There are many possible types of optical amplifiers. The most important type of amplifier is the erbium doped fiber amplifier because it is low in cost (relatively), highly efficient and low in noise. But due to deeper saturation BER impairments are less. Raman amplifiers are very effective but they had a major problem in that low cost lasers of appropriate wavelength were not available. The Fiber Raman amplifiers (FRA) in long-distance transmission line eliminate noise effects. In Raman amplifiers there is no deeper saturation problem so higher BER. When RAMAN amplifier in cascaded with EDFA and vice versa then it is called hybrid amplifiers. In DWDM system we can increase the channel capacity by decreasing the channel spacing.

R.S. Kaler[1]observed the performance of 16 channel WDM systems based on optical amplifiers at different transmission distance he take bit rate 10Gbits/sec.

In this paper we have extended the work and we have analyzed the performance of 16 channel DWDM system using hybrid amplifiers in terms of BER, Q-factor and eye opening at different transmission distance

II. SYSTEM DESIGN

In this model, sixteen channels are transmitted at 10 Gb/s speed with 50 GHz channel spacing. Each input signal is modulated in NRZ format and pre-amplified by a booster. A WDM transmitter (T) with sixteen transmitters is used. In WDM transmitter section each transmitter consists of the data source, electrical driver, laser source and external Mach–Zehnder modulator. Basically the data source is generating signal of 10Gb/s with pseudo random sequence. Here the electrical driver is used to converts the logical input signal into an electrical signal. And The CW laser sources generate the 16 laser beams at 191.9–193.4 THz with 50GHz channel spacing. The signals from data source and laser are fed to the external Mach–Zehnder modulator and then the modulator output signal is fed to the multiplexer and then the signal is passed through the hybrid amplifiers and then demultiplexer convert single input to 16 outputs and then at eye analyzer the eye pattern is analyzed.

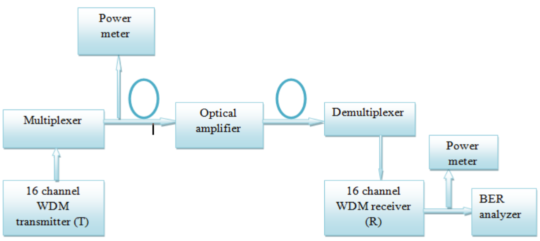


Fig.2: Block diagram of simulation setup

The simulations setup of EDFA, RAMAN using 16 channel WDM system at different trans-mission distance are shown in "Fig.2" The optical signal is transmitted and measured over different distance for 80, 100, 120, 140,160, 180, 200 and 220 km, at 2 ps/nm/km dispersion .Optical power meters are used for measuring the signal power at different levels. At the receiver side the modulated signal is converted into original signal with the help of PIN photodiode and electrical filters. 16 channel DWDM receiver (R) is used to detect all sixteen signals and converts these into electrical form. Different types of optical amplifiers are also applied at the receiver side here optical amplifiers used are hybrid which is combination of two optical amplifiers. The setup is repeated for measuring the signal strength by using hybrid amplifiers i.e. EDFA+RAMAN, RAMAN+EDFA. Performance analyses in terms of eye height, Q-factor and BER show that EDFA+ RAMAN amplifier has better results than the RAMAN+EDFA amplifier. Different components have different operational parameters. Its various parameters are reference frequency is 193.414 THz, attenuation is 0.2 dB/km and fiber polarization mode dispersion is 0.2 ps/km. EDFA is used for amplification and its parameters are, gain shape is flat and noise figure is 6 dB. The various parameters for RAMAN are Raman fiber length is 22 km, operating temperature is 300 K, pump wavelength is 980 nm and pump power is 250 mW. "Fig.3" and "Fig.4" shows the simulation setup of DWDM system using EDFA + RAMAN amplifier and RAMAN +EDFA respectively.

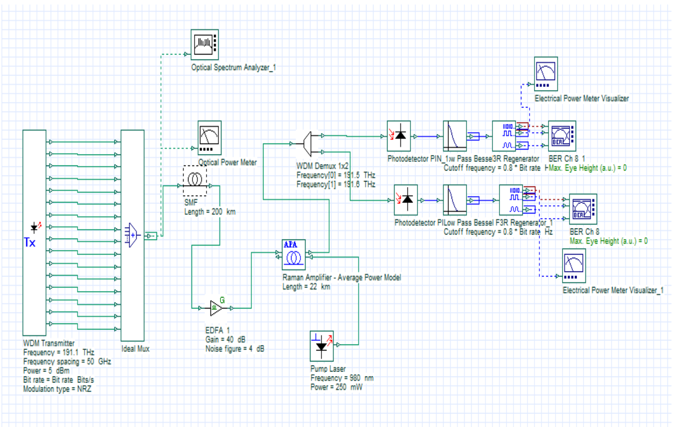


Fig.3: Simulation setup using EDFA+RAMAN amplifier

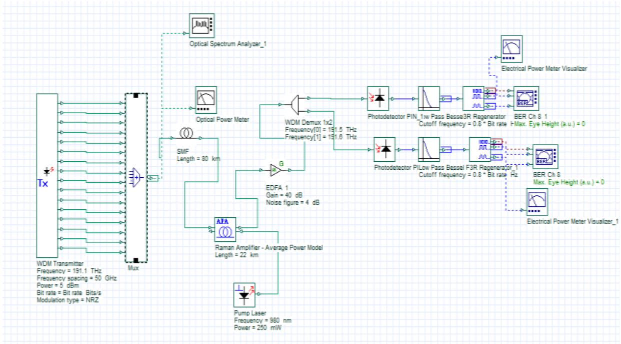


Fig.4:Simulation setup using RAMAN+EDFA amplifier

In Table 1, the parameters used for simulation are tabulated all these values are taken when we are doing simulation of DWDM system in Optisystem 7.0 simulator

Table1.Simulation Parameters.

WDM transmitter Frequency	191.9 THz
Frequency spacing	50 GHz
Input Power	5 dBm
Bit rate	20 Gbits/sec
Modulation Type	NRZ
Fiber length	80-220 km
Attenuation coefficient	0.2 db/km
EDFA Gain	40 db
Reference wavelength	1550 nm
Dispersion	2 ps/nm/km
noise figure	4 db
Raman fiber length	22 km
operating temperature	300 k
pump power	250 mW

III. Results and Discussion

Performance of DWDM system with hybrid amplifiers EDFA+RAMAN and RAMAN+EDFA are compared at different transmission distance and the graphs for Q-factor and BER v/s distance at dispersion 2 ps/nm/km are shown below. The graph show that as we increase the transmission distance from 80-220km the Q-factor decreases. The variation in the Q-factor is 21.4643 to 4.23112 for hybrid amplifier EDFA+RAMAN and 20.208 to 2.2112 for RAMAN+EDFA hybrid amplifier.

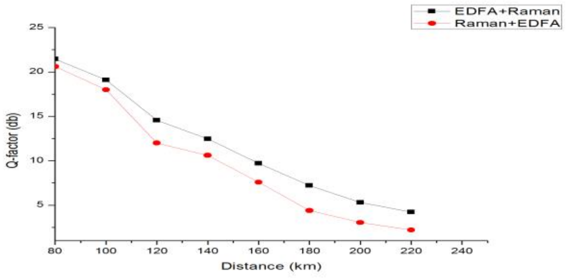


Fig.5:Q-factor v/s distance graph with EDFA+RAMAN and RAMAN+EDFA amplifies.

The BER increases from 138927E-47 to 4.69119E-05 with EDFA+RAMAN hybrid amplifier and 9.52367E-45 to 1.0446E-02 with RAMAN+EDFA hybrid amplifier as the distance increases from 80 to 220 km as shown in "Fig.6" .

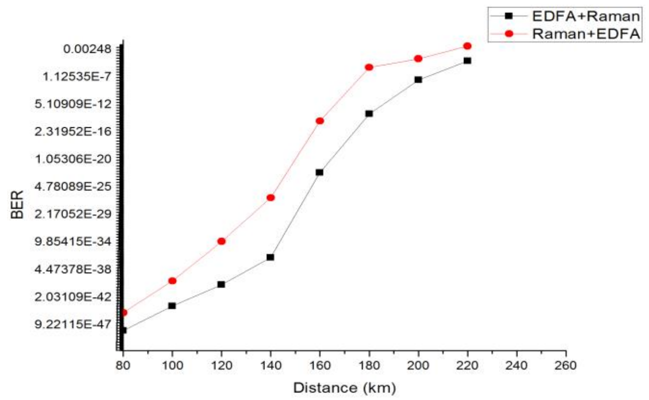
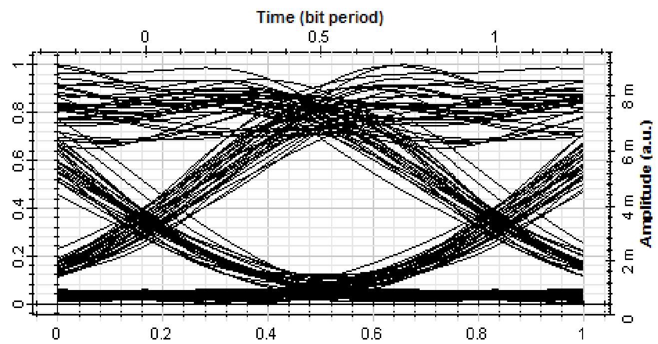
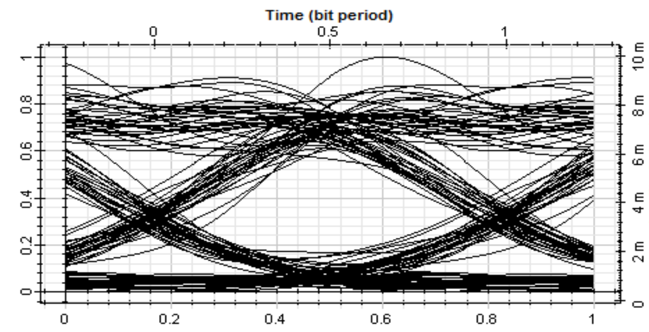


Fig.6: BER v/s distance graph with EDFA+RAMAN and RAMAN+EDFA amplifies.

The eye diagrams of the simulated systems are shown in "Fig.7" and shows that the EDFA+RAMAN performs better than RAMAN+EDFA hybrid amplifier at distance 160 km.



(a)



(b)

Fig.7: Eye diagram of hybrid amplifiers (a) EDFA+RAMAN and (b) RAMAN+EDFA

IV. CONCLUSION

We have analyzed the 16 channel DWDM system at 10 Gbps with hybrid amplifiers at different transmission distances. We observed that with increase in transmission distance the Q-factor decreases and BER increases. The system is analyzed with EDFA+RAMAN and RAMAN +EDFA hybrid amplifiers and the results are compared in terms of Q-factor and BER. It is observed that the system with EDFA+RAMAN hybrid amplifier performs better than the RAMAN+EDFA hybrid amplifier.

ACKNOWLEDGMENT

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V. REFERENCES

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