Performance Analysis of 64 Channel DWDM System Using Single Mode Fiber at Different Power Levels and Frequency Spacing

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Abstract. Dense wavelength division multiplexing system is processing at a superifying due to very high transmission capacity in optical communication. In this research article, we analysis 64 channels DWDM system at 10 Gbps data rate is used to rectify the system quality at different power levels and different frequency spacing an 50 km Single Mode Fiber (SMF). For the better gain we used EDFA (Erbium Doped Amplifiers), system efficiency and system capacity enhancing using DCF in this work. Also simulation at different power levels and frequency spacing analyze BER, Q-factor and Eye height is the terms of results using Optisystem software.

Keyword: DWDM (Dense wavelength division multiplexing), BER (Bit Error Rate), Q-factor, Eye height, EDFA, SMF, Optisystem.

1. Introduction

Dense wavelength division multiplexing (DWDM) system is processing at a stupefying due to very high data transmission capacity in optical communication, DWDM system is increasing high speed data, telecom and internet services. This system have more capacity and more satisfying networking system. DWDM system uses various wavelength to transmit over a single fiber. First of all very important to set up the parameters of the system. Optical signals faces two challenges one is attenuation and second is dispersion in long distance transmission. Solve this two challenges we use Erbium Doped Amplifiers (EDFA) and Dispersion Compensation Fiber (DCF). For the EDFA is acceptably used because of its high gain, low insertion loss and signal capability with optical fiber. The EDFA operates on wave band of 1550 nm. Due to the material of fiber, fiber suffers from dispersion effect, this effect minimize by some specific method but we use DCF with SMF is one of the method overcome this problem also, DCF is not easily effected by large band width and temperature of system. There is basic three method for increase the transmission capacity of optical communication system. One is increasing the bandwidth, second is increasing the spectral efficiency of optical fiber and third method is increasing different power levels and different frequency spacing.
In this work we use third method. When increasing different power levels and different frequency spacing between the channels. We have simulate 64 channels 10Gbps DWDM system having central frequency 190 THz at different power levels and different frequency spacing. This simulation performance of parameter are evaluating by using optisystem software.

This paper has been arrange as follow. Frist part is DWDM transmission system modelling, second part is describe the simulation system setup, third is results and discussion with different power levels and different frequency spacing and last is conclusion part of this work.

2. DWDM Transmission System Model
In this work, 64 channel DWDM is modified. DCF is use to reduce the effect of dispersion and data losses in fiber link for different power levels and different frequency spacing. Block diagram of DWDM system model shown in figure-1.

![Figure 1. Block diagram of DWDM system model.](image)

Basically any communication system consist of three portion: transmitter, communication channel and receiver. A solid-state laser (SSL) source should provide stable light within a narrow and specific bandwidth which carries digital data modulated by an analog signal. Electrical bits to optical pulses converted by transmitter. In the case of dispersion effect system requires highly accurate and stable wavelengths and high performance requirement. A comparative analysis of different modulation schemes has been done in this report. Transmitter portion consist of three component WDM transmitter, multiplexer and WDM analyzer. WDM transmitter produce specific wavelength laser signals and then combine from transmission into communication channel.

Communication channel consist of single mode fiber (SMF), Dispersion compensation fiber and EDFA. Output of multiplexed signals fed to single mode fiber. EDFA used for the better gain for the long distance transmission. DCF is used to control the dispersion effect having attenuation 0.5 dB/km. The receiver portion is consist of optical demultiplexer, optical receiver and BER analyzer. Optical demultiplexer is used to distribute the optical demultiplexer to wavelength selectors. Optical signal receive in optical receiver and BER analyzer id used to visualize the simulation results in terms of eye diagram, bit error rate, q-factor, eye height etc.
3. Simulation Setup

In this model, 64 channels are transmitted at 10 Gbps speed at different power levels and different frequency spacing. The DWDM system is designed in optisystem software, in this model three portions: transmitter, communication channel and receiver portion. The DWDM transmitter having operating frequency 190 THz and wavelength range 1530 to 1580 nm. The communication channel consist of single mode fiber (SMF) having length 50km and with attenuation of 0.2 dB/km. EDFA having the ability to amplifying multiple signals on various wavelength with gain 10dB. DCF is used 15km to reduce the dispersion effect. Other parameters shown in table-1. The simulation result are acquired in terms of bit error rate (BER), Q-factor, eye height etc. Using optisystem software. The simulation model show in figure-2.

| Table-1. Simulation Parameters |
|--------------------------------|
| WDM transmitter frequency     | 190THz          |
| Frequency spacing             | 100,90,70 GHz   |
| Input power                   | -7,-3,3,7 dBm   |
| Bit rate                      | 10 Gb/sec       |
| Modulation type               | NRZ             |
| Fiber length                  | 50km            |
| Attenuation                   | 0.2 dB/km       |
| EDFA gain                     | 10 dB           |
| DCF length                    | 15 km           |
| Reference wavelength          | 1450 nm         |

4. Results And Discussion

In this section, analyze the performance of optical signal when it passes through the single mode fiber. This analysis two different method. One is the effect of different power levels and second is different frequency spacing, after that analyze BER. The result is shown in terms of BER, Q-factor, eye height etc.
4.1. BER Analysis at Different Power Levels
Presently, move towards the investigation of WDM framework at different power levels of single mode fiber. To expands system quality and fluctuate the power level from –7 dBm to 7 dBm perform examination.

4.1.1 At 7 dBm input power
At the point when the input power of optical source is set at 7 dBm, at that point the eye diagram with most extreme quality factor, BER, eye height and so on is shown in figure 3.

4.1.2 At 3 dBm input power
Now decrease the input power level of optical source set at 3 dBm at that point the eye diagram with eye height, Q-factor, BER etc. shown in figure. 4.

4.1.3 At -3 dBm input power
Again decrease the input power level of optical source up to -3 dBm we get the eye diagram with BER, eye height Q-factor etc. shown in figure. 5.

4.1.4 At -7 dBm input power
Now again decrease the input power level of optical source set up to -7 dBm. Obtain eye diagram and we get Q-factor, BER, eye height etc. as shown in figure. 6.

4.2. BER Analysis At Different Frequency Spacing
Right now, the DWDM system analyze at different frequency spacing 100GHz, 90GHz, and 70 GHz at -10 dBm fixed input power level.

4.2.1 At 100 GHz frequency spacing
Now, BER analyze at 100 GHz frequency spacing with -10 dBm input optical power level analyze BER, Q-factor eye height etc. as shown in figure.7.
4.2.2 At 90 GHz frequency spacing
Now decrease the frequency spacing at 90 GHz with -10 dBm input optical power level analyze BER, Q-factor eye height etc. as shown in figure.8.

4.2.3 At 70 GHz frequency spacing
Now again, decrease the frequency spacing at 70 GHz with -10 dBm input optical power level analyze BER, Q-factor eye height etc. as shown in figure.9.

According to different frequency spacing with respect to eye parameter shown in table-3.
Figure 6. Input power of optical source at -7 dBm

Figure 7. At 100 GHz frequency spacing with -10 dBm input optical power

Table 2. Different input power level of optical source with respect to eye parameters

| Eye parameter   | 7 dBm     | 3 dBm     | -3 dBm     | -7 dBm     |
|-----------------|-----------|-----------|------------|------------|
| Min. BER        | 9.74951e-026 | 1.93459e-027 | 3.37287e-026 | 1.79765e-021 |
| Max. Q-factor   | 10.4228    | 10.7893   | 10.5232    | 9.4429     |
| Eye height      | 0.00161199 | 0.00110281 | 0.000589908 | 0.000345176 |
| Threshold       | 0.00140486 | 0.000910111 | 0.000473128 | 0.000272833 |
Figure 8. At 90 GHz frequency spacing with -10 dBm input optical power

Figure 9. At 70 GHz frequency spacing with -10 dBm input optical power

Table 3. Different frequency spacing with respect to eye parameter

| Eye parameter | 100 GHz     | 90 GHz      | 70 GHz     |
|---------------|-------------|-------------|------------|
| Min. BER      | 1.23286e-035 | 6.8165e-018 | 4.10471e-006 |
| Max. Q-factor | 12.4041     | 8.53581     | 4.45934    |
| Eye height    | 0.000592815 | 0.000190832 | 6.88162e-005 |
| Threshold     | 0.000412713 | 0.000155685 | 0.000149619 |

5. Conclusion
This work of 64 channels performance analysis single channel is supplant in to 64 channel using single mode fiber and accomplished better result in case of system quality at different frequency spacing and different power levels. The superior result of DWDM system has been observed with Q-factor of 12.4041 in case of different frequency spacing at 100GHz frequency spacing at -10dBm input signal.
power and 10.7893 in case of different power levels at 3 dBm input signal power. This result are shown in eye diagram. It is show superior estimation at quality factor and minimum bit error rate.

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