Effect of channel wavelength spacing for WDM system on the quality of the transmission

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Abstract

In this paper, we investigate the quality of the transmission of each channel for a Wavelength Division Multiplexed (WDM) system with a 640 GB/s data rate (16 x 40 GB/s) with RZ modulation for different channel spacing.

Keywords: *WDM; RZ; dispersion compensating Fiber; bit error rate.*

1. Introduction

Since the advent of optical communications, a great technological effort has been devoted to the exploitation of the huge bandwidth of optical fibers. Starting from a few Mb/s single channel systems, a fast and constant technological development has led to the actual 10 Gb/s per channel dense wavelength division multiplexing (DWDM) systems, with dozens of channels on a single fiber. Transmitters and receivers are now ready for 40 Gb/s, whereas hundreds of channels can be simultaneously amplified by optical amplifiers [1].

2. Description of a general optical link

Optical components employed in building a typical point-to-point optical WDM transmission system are depicted in Figure 1 Several optical signals sent by transmitters (lasers) are coupled together using a (wavelength) multiplexer into a fiber. Signals are amplified, when necessary, using amplifiers such as erbium-doped fiber amplifiers (EDFAs) to compensate for signal attenuation [2].

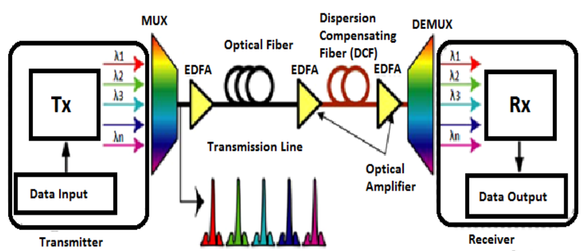

Fig.1 A typical point-to-point optical fiber communication link.

3. Presentation of the WDM system

The optical link to simulate is a network of 16 WDM channels with RZ modulation formats at 40 Gb/s [3].

To generate the optical signals we have used a CW laser source, Mach-Zehnder modulators, RZ pulse pattern generator and a sinusoidal electrical signal generator. The

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transmission rate is 40 Gb/s by channel giving a total bit rate of 640Gb/s.

In our simulations, we have used optical amplifiers after each fiber to compensate for the span loss. The dispersion parameter of SMF is 50 km long and 17 ps/nm-km. Therefore, total accumulated dispersion is 17x50 = 850 ps/nm. This dispersion can be compensated by using a 10 km long DCF with -85 ps/km-nm dispersion. We have two Erbium Doped Fiber Amplifier (EDFA).The first amplifier has a gain of 10 dB placed after the SMF fiber span and the second has a gain of 5 dB located after the DCF fiber span. Total transmission distance is 50x6 =300 km for each case.

At the receiver after demultiplexing we place a PIN photo-detector and fourth order low-pass Bessel electrical filter with 32 GHz (0.8 *Bit rate) cut-off frequency. The thermal noise of the photo-detector is not taken into account [4].

4. Results and discussion

4.1 Effect of wavelength spacing of the quality factor Q and BER

This section shows the effect of the wavelength on the BER and on the quality factor, we put together to compare curves of BER and quality factor function of the wavelength channel for different channel spacing (Figure 2 and 3).

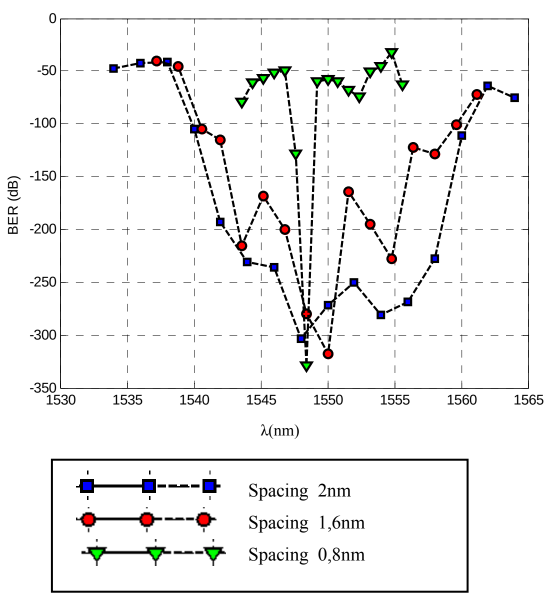

Fig. 2 BER as a function of wavelength and for different channel spacing

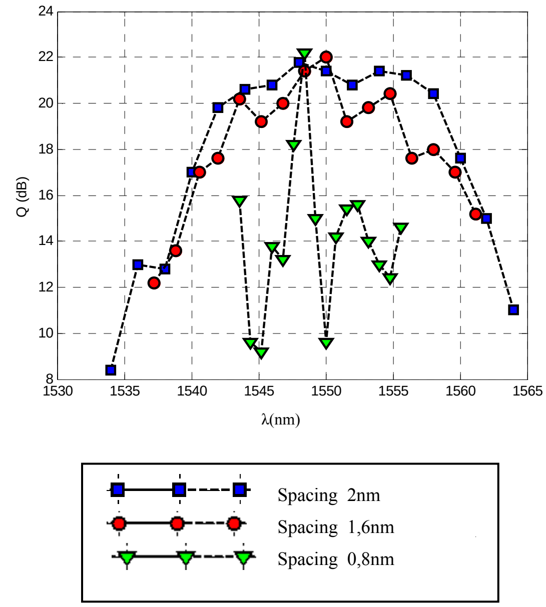

Fig. 3 Q as a function of wavelength and for different channel spacing

We notice from the previous figures more we increase the channel spacing more the link quality get better and the BER decreases.

4.2 Effect of the channel spacing on the quality of the optical link

To validate the previous study we have implemented another interesting demonstration that shows the variation of the BER and the quality factor as a function of channel spacing. We chose as reference the ninth channel with a wavelength of 1550 nm (figures 4 and 5), we also kept all the properties of the link.

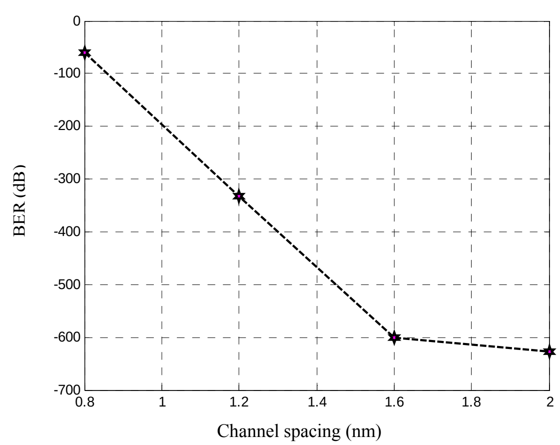

Fig 4. BER as a function of the channel spacing

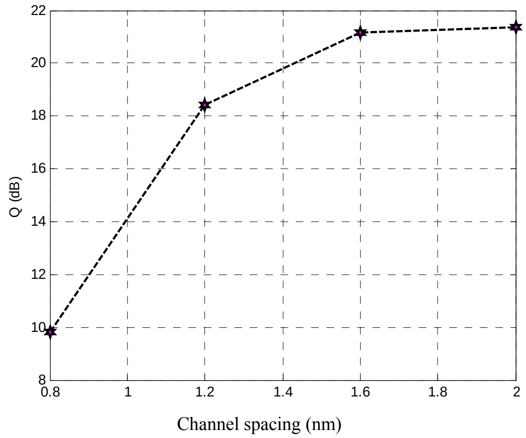

Fig. 5 Quality factor Q function of the channel spacing

We remark a decreasing on the curve of the BER, which confirms that a good quality transmission with WDM systems goes with larger channel spacing, to be careful to not excessively increase to avoid nonlinear effects. There is a logical increase of the quality factor as we can see on figure 5.

5. Conclusion

The aim of this article is to optimize the components characteristics with iterative simulations to estimate the link performance. The quality factor Q and the bit error rate BER are the criteria for judging the performance.

Optical components employed in building a typical point-to-point optical WDM transmission system are a continuous wave laser coupled with a multiplexer into a fiber. Signals are amplified, when necessary, using amplifiers such as erbium-doped fiber amplifiers (EDFAs) to compensate for signal attenuation and for dispersion we employed a dispersion compensating fiber (DCF). At the receiver we have a photodiode coupled with a Bessel filter.

The different results show first, a better link quality for wavelengths closer to the central wavelength. Then, we found that more we increase the channel spacing the quality factor increases with.

References

[1] E. Forestieri, Optical communication theory and coding, Italy, ENRICO FORESTIERI Scuola Superiore Sant'Anna, 2005.

[2] M. Ilyas, and H.T. Mouftah, The Handbook of Optical communication network, CRC press LLC, 2003.

[3] N. Boudrioua, J.P. Turkiewicz and T. Guillossou, " 40Gbps WDM Transmission Performance Comparison Between Legacy and Ultra Low Loss G.652 Fibers", Journal of Lightwave Technology, 2011, Vol. 29, Issue 23, pp 3587-3598.

[4] L. Zhu, Y. Zhang, Y. Dong, M. Chen, L. Xia and S. Xie, "Impact of optical (de)multiplexers on 40 Gbit/s WDM transmission system", Optics Communications, Elseiver, 2003, Vol. 217, pp. 221-225.

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