Analysis to Achieve High Speed Optical Fiber using Dispersion Compensation for Smart Cities

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Abstract— This paper presents and focuses on Dispersion which is a very important factor in the transmission of data over a long distance. To overcome the loss caused by Dispersion, we can use many techniques. In this paper we propose to do the same by varying parameter in Electronic Equalization technique. It also helps to eliminate ISI at the receiver end by proper thresholding, the transmitted bit sequence can be obtained without any errors.

Key words: Dispersion, Electronic Equalizer, NRZ pulse, Q- factor, Min BER, Threshold

I. Introduction

Dispersion: Fiber limitations like dispersion severely affect the performance of the high speed optical fiber transmission systems. Dispersion is one of the important parameters and should be carefully monitored during the design process.

The process of balancing the positive and negative dispersion over the length of the fiber is called dispersion management. The total dispersion is near zero or within an acceptable limit, when the optical pulses reach the receiver. It is inversely proportional to the square of the data rate of the signal. Single mode fibers have minimum attenuation when they operate around 1550 nm. Hence, the accumulation of the dispersion components limits the distance of transmission to approximately 50 km on a 10Gbits/s system if dispersion compensation techniques are not used. One of the methods to expand the fiber's capacity is to enhance the number of DWDM channels transferred over a single fiber. The greater channel density has to compensate for the dispersion as well as the dispersion slope. Electronic Dispersion Compensation (EDC) has become one of the most important parts of an optical transponder design. In the current cost driven metro market, Electronic Dispersion Compensation can become a very valuable tool in enhancing the existing fiber links to higher bit rates. New applications using feed forward equalizer and decision feedback equalizer are being developed.

II. Equalization Hypothesis

A. Electronic Compensation

It is very attractive technique to compensate for dispersion at the electrical part of the receiver to the transmitter. It is a simple technique that doesn't need any changes in optical transmitting or receiving and also doesn't have considerable loss. Any network changes or adding new devices in the network can be done easily because of adaptive capability of electronic compensator. But there are some disadvantages of this system, for example circuits have limitation in speed compare to optical ones.

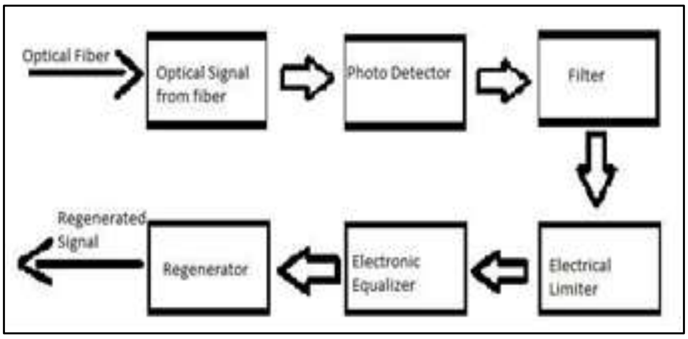

Fig. 1: Block diagram for the electronic equalizer

Optical fiber communication systems are affected by the effect of dispersion of the fibers used. Dispersion in the optical link makes it difficult to decode the received signal as the bit symbols get broadened and distorted. Dispersion compensation is generally done before the photo detection, in the optical domain. But, there are other techniques of electronic dispersion compensation that use electronics for that purpose.

The effect of dispersion cannot be directly removed in a direct detection receiver as it is a frequency- dependant phase change, and the phase information is most of the times lost in the detection process. As long as it is not too strong, the dispersion effect can be mitigated. Such methods typically rely on tapped delay equalizers where different portions of the electronic input signal are subject to different time delays and are recombined after amplification with suitable levels. The signal processing in the presence of nonlinear distortions such like those occurring due to self-phase modulation due to fiber nonlinearities can be improved by using purely linear equalization techniques. The full potential of optical dispersion compensation cannot be reached, though the signal quality can be significantly improved if the settings of such a system are carefully optimized. Based on the analog or digital signal processing techniques, the parameters may be adjusted automatically using the feedback techniques, thus, minimizing the bit error rate. The effect of intermodal dispersion can also be mitigated in multimode fibers that are used for short distance fiber optic links. The effect of chromatic dispersion can be directly removed if an electronic filter having an appropriate frequency response is applied to an intermediate frequency.

III. SIMULATION SETUP

We have taken a binary source and encoded it using a NRZ pulse as shown in Fig 1.The optical source used is a CW Laser. Light is used as the carrier and modulated using the Mach Zehnder modulator. The signal is pre amplified using EDFA optical amplifier as the signal has a wavelength of 1550 nm. No inline amplification is used. At the receiver end, the output optical signal is filtered using the band pass Gaussian filter. The photo detector converts the received optical signal to electrical and then an electrical filter is used to further smooth the received output. Electrical limiter is used to limit the signal to a certain level. Then the signal is sent to the electronic equalizer where the equalization takes place. BER of the received signal is obtained using the BER analyser.

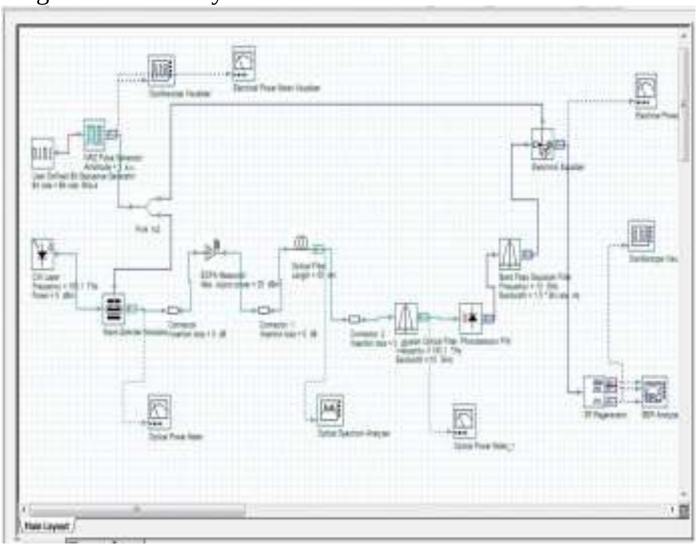

Fig. 1: Optisystem Schematic Diagram

IV. RESULTS AND ANALYSIS

For a transmission distance of 50-km on a single mode fiber, the simulation results with varying the power of CW laser on electronic equalizer are shown which clearly shows the advantage of using an electronic equalizer. Electronic equalizer achieves a performance gain above 2.5dBm for the bit error rate (BER) between10e-3 and 10e-5 when power of CW laser is 0dBm.

Fig. 2 shows the variation of eye diagram and received power for different transmission lengths and it has been observed that the fiber length with least distance gives maximum power in the receiver.

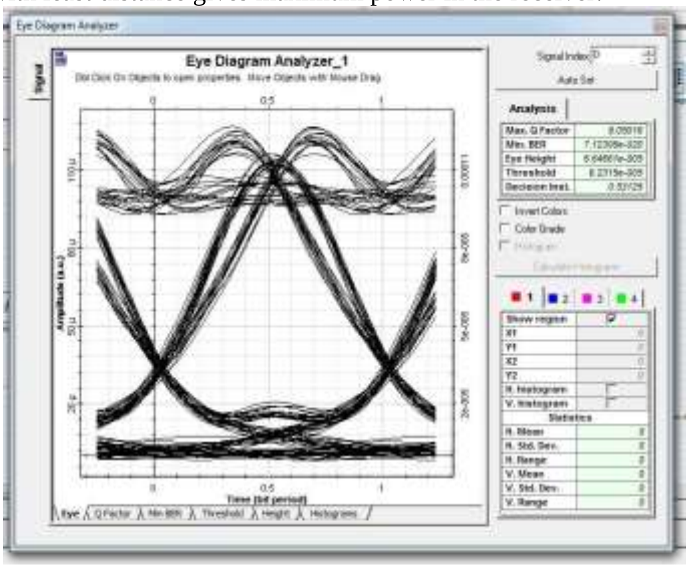

Fig. 2: Eye Diagram analyzer

Fig. 3 gives the variation of the Q factor, Min BER and Threshold for the power of CW laser is -10dBm, Fig. 4 gives the variation for power of CW laser is - 5dBm and Fig. 5 gives the variation for Power of CW laser is 0dBm of transmission. It has been observed that the model has been optimized for 10Gbpstransmission rat

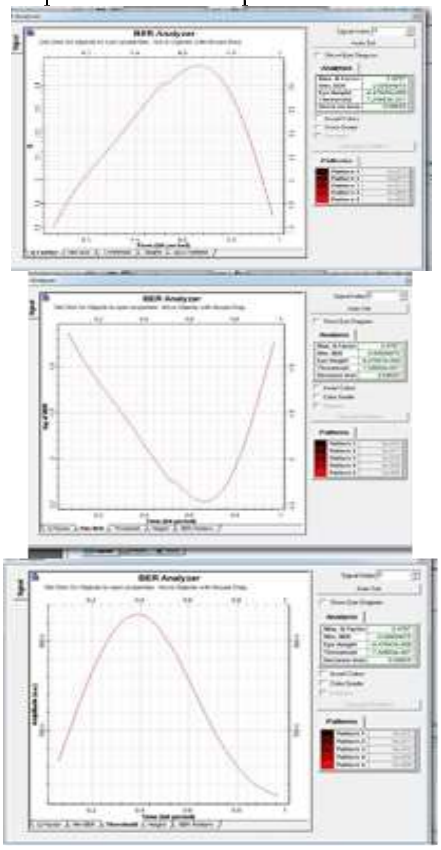

Fig. 3: Variation for -10dBm CW laser

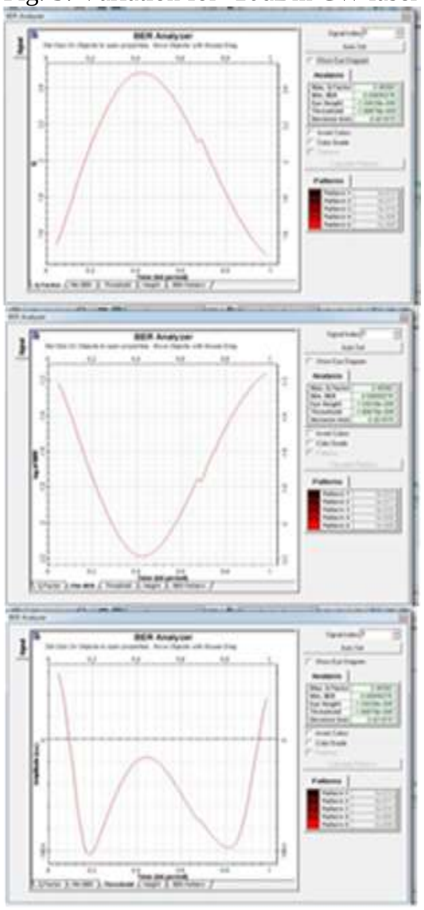

Fig. 4: Variation for -5dBm CW laser

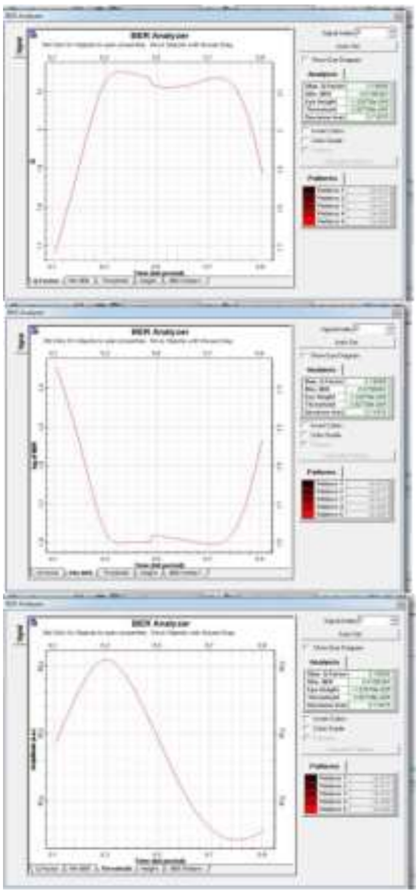

Fig. 5: Variation for 0dBm CW laser

V. CONCLUSION

A variety of linear and nonlinear transmission impairments are suffered by optical networks as they are analogue in nature. These impairments directly affect the Bit Error Rate (BER) performance of the system and the impact importantly increases in systems that support higher data rates and a larger number of channels.

From the results obtained it is clear that when the Electronic Equalization technique is used, data can be transmitted over an optical fiber up to a distance of 50 km with 10 Gbps data rate without any inline amplifier or repeater. Also performance of the line is improved as compared to that of unequalised line.

This method offers improved value of performance parameters such as Q- factor, min BER and Threshold value. During the analysis of simulation result it is also observed that BER pattern is much better than other available methods for dispersion compensation. BER analyzer shows better value of Q-factor and Threshold for power of CW laser is 0dBm which alternatively results in reduced jitter and improved synchronization in Optical Fiber Communication Networks.

Thus, we can conclude that we should use the power of CW laser to 0 dBm in electronic equalizers as the performance of the line is not compromised and also the cost of operation reduces by about 75-80%.

VI. FUTURE SCOPE

From this we can say that many different techniques for dispersion compensation in optical system used. By carefully manipulating various parameters, the distorted signal can be equalized for even higher data rates fiber links.

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