A Literature Survey on Comparative Analysis of RZ and NRZ Line Encoding Over 40 Gbps Fiber Optic System

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Abstract— Modern world is the world of internet which requires more capacity and more bandwidth to modernize the world. Hence we move towards optical communication. When we talk about optical communication then chromatic dispersion is biggest obstacle for high speed optical channel. Chromatic dispersion can be reduced either by compensation technique [1, 2] or either by electronic dispersion compensation. In this paper, we make comparative analysis in RZ and NRZ line encoding over 40 Gbps system. Two different modulation formats including non-return-to-zero (NRZ), return-to-zero (RZ) is compared on the basis of Bit error rate and quality factor. The 40 Gbps signal is transmitted over 200 km in single mode fiber.

Key words: Dispersion compensation, Bit error rate (BER), Q-factor, RZ, NRZ, chromatic Dispersion

I. INTRODUCTION

Fiber optic communication completely changes the telecommunication industry and also plays a important role in data networking. The first optical fibers for communications purposes were developed in the 1970s having low losses. After that first optical telecommunication system which ran over 45 km and has a wavelength of 0.5 mm and a data rate of 45 Mbps. For efficient transmission using optical fiber, construction and design of optical fiber is important after that WDM systems came into light, with the invention of WDM system in optical communication allows a path towards the usable bandwidth of optical window to achieve high data rate. So it is compulsory to analysis the effect of chromatic dispersion and transmission characteristics on fiber optic cable. These characteristics are analyzed before the transmission of optical data over fiber optic cable. To serve the increasing demands of high speed internet, the length of fiber also increases. But when we increase the length of fiber then chromatic dispersion also increases. Another important part is the optical code pattern. The code pattern decides the spectrum efficiency, transmission quality and dispersive tolerance of the system. Thus, the chosen code pattern is the first and important factor in the high-speed optical transmission system [1, 2]. Many code- patterns have been proposed in terms of a 40 GB/s optical transmission system [3–7]. Below fig.1 shows various coding techniques.

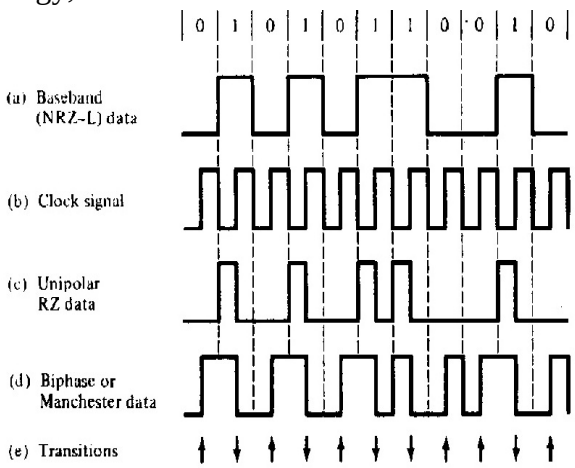

Fig. 2.1: Different coding techniques

In the next section we show the impact of photodiode on signal performance of WDM system with different encoding schemes. The performance is analyzed from the eye diagram for a system of wavelength 1550 nm. PIN photodiode is used to detect the optical signal and the modulation format used in this optical system is RZ. From the eye pattern Q factor is analyzed and on the basis of quality factor signal performance is decided also Q factor is kept much high as possible. In the next eye pattern, NRZ line encoding are used and APD and PIN diodes are used to detect the optical signals respectively. From the eye diagram it is clear that the Q factors in these designs are high when APD diode are used and low when PIN diode are used. APD photodiodes give better performance with NRZ line encoding rather than pin diode. Hence with NRZ encoding APD is preferred at 1310 nm. There are different approaches which are used to convert data into signal. From the eye patterns it is clear that APD have better performance in both RZ and NRZ with respect to PIN diode. Hence we preferred APD photodiode.

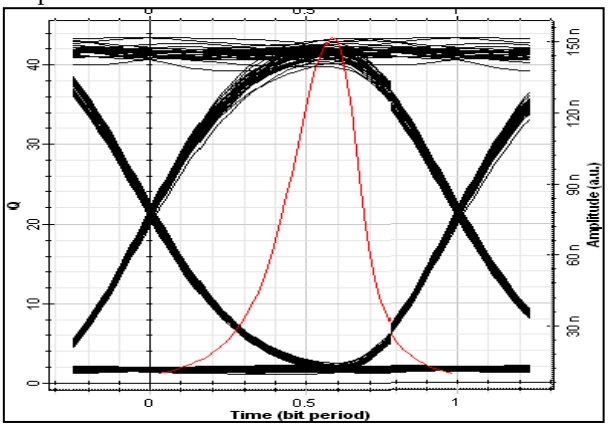

Fig. 2.2: Eye diagram NRZ modulated using APD photodiode system

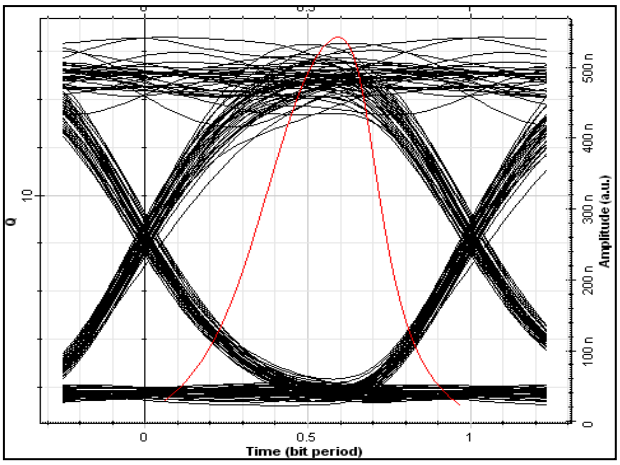

Fig. 2.3: Eye diagram NRZ modulated using PIN photodiode system

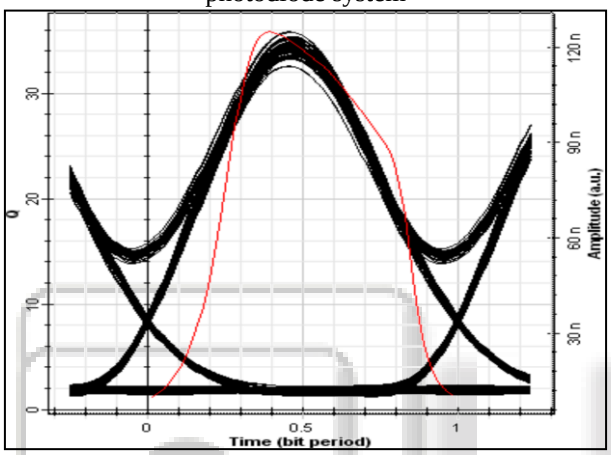

Fig. 2.4: Eye diagram RZ modulated using APD photodiode system

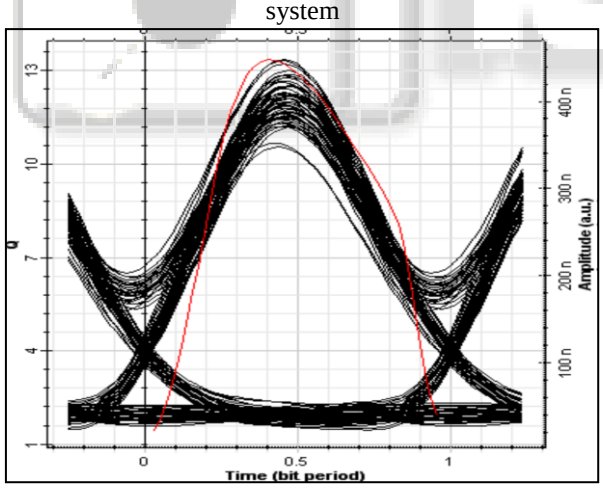

Fig. 2.5: Eye diagram RZ modulated using PIN photodiode system

II. LINE ENCODING CHARACTERISTICS

A. *No. Of Signal Level:*

This refers to the number of values used in a signal, known as signal levels to represent data. Figure 5.2 shows two signal levels, whereas Figure 4.3 shows three signal levels to represent binary data.

B. *Bit rate and baud rate:*

The bit rate represents the number of bits sent per second, whereas the baud rate defines the number of signal elements per second in the signal. Depends on the encoding techniques used baud rate may be more than or less than the data rate.

C. *DC component:*

After line coding, the signal may have zero frequency component in the spectrum of the signal wave, which is known as the direct current component. DC component in a signal wave is not desirable because the DC component does not pass through some component of a communication system such as transformer. This leads to distortion in the signal and may create error at the output. The DC component also results in the unwanted energy loss on the communication line.

D. *Signal Spectrum:*

Different encoding of data gives spectrum of the signal. It is essential to use suitable encoding technique to match with the medium so that the signal may suffers minimum attenuation and distortion as it is transmitted through a medium.

E. *Synchronization:*

The bit interval of receiver should be exactly same or within certain limit of that of the transmitter for correctly interpretation of received signal. It may lead wrong interpretation of the received signal, if any mismatch between the two. Generally, clock is generated and synchronized from the received signal with the help of a special hardware known as phase lock loop. However we can get it if the received signal is self synchronized having frequent transition in the signal.

F. *Cost of Implementation:*

It is desirable to keep the encoding technique simple enough such that it does not require high cost of implementation.

III. PRINCIPLE OF RZ AND NRZ CODE PATTERN

Now the question is how we choose the code pattern so there are some principles of choosing the code pattern. The first principle said that when we enhance the operating factor of spectrum then the compact modulation signal is also increased. The second principle said that non linearity tolerance is always kept high as possible and thirdly we always kept the structure of transmitter and receiver simple. Mach–Zehnder modulator (MZM) and the (CW) laser used in the modulation system.

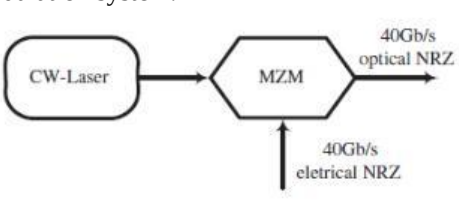

Fig. 3.1: Block diagram of NRZ

When ‘‘1’’ is transmitted in the NRZ, optical signal impulse occupies a whole bit-time; when there is no optical pulse, the signal is ‘‘0’’. NRZ can used upto the speed of 10 Gbps. There are many advantages of using NRZ encoding such as simplicity of application, having low cost and high spectrum efficiency, the application of NRZ includes synchronous digital hierarchy (SDH), wavelength-division-multiplexing systems and SONET networks. Hence below

10 Gbps we preferred the NRZ modulation scheme. The disadvantage of NRZ is that the transition does not return to zero between two codes hence it is not suitable for high-speed transmission for long-distance optical communication.

In RZ line encoding we can used two Mach–Zehnder modulator (MZM). RZ line codes are used in high-speed 40 Gbps optical transmission systems. In case of RZ code pulse sequence has an independent time envelope for logic 1. This happens because There are different transition occurs for both logic 1 and logic 0

Advantages of RZ includes that it is used up to 40Gbps system and also it has high efficiency over such high speed.

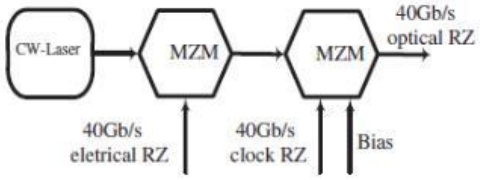

Fig. 3.1: Block diagram of RZ

Also RZ requires less optical power and insensitive to non-linearity effect and anti-polarization mode dispersion (PMD).

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