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BER AND Q FACTOR ESTIMATION AT 10 GB/S IN HYBRID SYSTEM

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Abstract: *In this paper, we will focus on the modulation format used to create the optical pulses, which is non-return-to-zero (NRZ) wavelength-division-multiplexing (WDM) signals in optical communication system and to analyze the performance of Hybrid eight channel WDM systems by comparing BER, Jitter and Quality Factor at a data rate of 10 Gb/s with the help of optsim 3.6 software. NRZ is more adversely affected by nonlinearities, whereas RZ is more affected by dispersion. In 10 Gb/s systems operate better using NRZ modulation format because non linearity dominates. And analyze Non Return to Zero (NRZ) modulation format for wavelength division multiplexing (WDM) systems operating at a data rate of 10 Gb/s. For a better system Quality factor should be high, Jitter and BER (Bit Error Rate) Should be less. In this Quality Factor, Jitter performance and BER are evaluated at different distances which are 5Km, 10Km, 15Km, 20Km, 25Km, 30Km, 40Km, 50Km, 70Km, 100Km. NRZ is a modulation technique or we can use this in hybrid systems. Hybrid systems are the combination of Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).*

Keywords: *Non Return to Zero, Return to Zero, Duo binary, Bit Error Rate, Jitter, Quality Factor.*

1. INTRODUCTION

Compared with time division multiplexing based passive optical network (TDM-PON), wavelength division multiplexing based passive optical network (WDM-PON) is a better technology for the wider bandwidth and one to one connection provided [1]. An efficient evolution from TDM-PON to WDM-PON without changing the current PON is needed. Hybrid systems are the mixture of both TDM-PON and WDM –PON. The good performance and feasibility of the method after a 20-km transmission is experimentally demonstrated [4]-[6]. For a given data signaling rate, *i.e.*, bit rate, the NRZ code requires only half the bandwidth required by the Manchester code when a separate clock signal is available [2]. NRZ-Level itself is not a synchronous system but rather an encoding that can be used in either a synchronous or asynchronous transmission environment, that is, with or without an explicit clock signal involved. Because of this, it is not strictly necessary to discuss how the NRZ-Level encoding acts "during a clock cycle" since all transitions happen in the given amount of time representing the actual or implied integral clock cycle [9]. The real question is that of sampling--the high or low state will be received correctly provided the transmission line has stabilized for that bit when the physical line level is sampled at the receiving end [4]. Nonlinear crosstalk suppression methods using both dispersion management and timing controlled RZ signals [3]. The NRZ pulses have a narrow optical spectrum [5]. For increasing data rate per channel, the number of channels per fiber is also increased through wavelength division multiplexing (WDM) or dense WDM (DWDM) to further improve overall capacity [7]. WDM technology enables us to construct flexible optical networks [5]. Wavelength-division-multiplexing (WDM) technology is attractive for large capacity transmission systems [1]. Furthermore, WDM technology enables us to construct flexible optical networks. In multi gigabit WDM return to zero (RZ) signals has been studied [3]. 40-Gb/s systems favor the usage of NRZ because dispersion becomes the key limiting factor at 40 Gb/s [6]. For a long time, non-return-to-zero (NRZ) has been the dominant modulation format in intensity modulation direct detection (IMDD) fiber optical communication systems. The major reasons for using NRZ in the early days of fiber optical communication were a relatively low electrical bandwidth for the transmitters and receivers compared to return-to-zero (RZ) [8]. In general, NRZ modulated optical signal has the most compact spectrum compared to that with other modulation formats. However, this does not mean that NRZ optical signal has superior resistance to residual

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chromatic dispersion in an amplified fiber system. In addition, NRZ modulated optical signal has been found to be less resistive to fiber nonlinearities [10]-[11]. The WDM transmission performances of NRZ and RZ signal formats employing unequal channel spacing around the zero-dispersion wavelength are compared by numerical simulations. The power penalties versus the total fiber input power characteristics, and the power penalties versus the relative bit position differences between the even and odd channels at the fiber input end are numerically evaluated [5].

2. WAVELENGTH DIVISION MULTIPLEXING (WDM)

Broad-band low-noise optical sources are of a vital importance for future large-capacity flexible optical network utilization of both optical time-division multiplexing (OTDM) and wavelength-division multiplexing (WDM). The wavelength-division-multiplexed passive optical network (WDM-PON) offers large bandwidth to subscribers for efficient broadband access [6]. For achieving wavelength division multiplexing (WDM) systems at different modulation formats it operates at bit rates of 10 Gb/s per channel. For increasing data rate per channel, the number of channels per fiber is also increased through wavelength division multiplexing (WDM) or dense WDM (DWDM) to further improve overall capacity. In addition to increases in data rate per channel, the number of channels per fiber is also increased through wavelength division multiplexing (WDM) or dense WDM (DWDM) to further improve overall capacity. WDM technology enables us to construct flexible optical networks. By encoding multiple bits per symbol, non-binary modulation techniques can accomplish significant spectral efficiency. Spectral narrowing alone can also reduce the effect of chromatic dispersion. Encoding multiple bits per symbol also gives rise to longer symbol duration that can in turn increase robustness to fiber propagation impairments. In recent years, as optical communication is advancing to mixed data rates, NRZ, RZ and Duo binary modulation formats must be investigated for the future mixed transmission in dense wavelength division multiplexing (DWDM) systems, where NRZ modulation format may not be the best choice for high capacity optical systems. However, due to its simplicity, and its historic dominance, NRZ can be used as a good foundation for the purpose of mixed data rate and format transmission [11]. Wave-length division multiplexing (WDM) provides transparent circuits between end terminals without regeneration but only with amplification in the middle. With the progress and the development being made in wavelength division multiplexing (WDM), optical networks seem to be one of the best solutions to increase the bandwidth and face the increasing demand for high traffic. WDM is a fiber-optic transmission technique that consists on multiplexing many different wavelength signals onto a single fiber to obtain a set of parallel optical channels. Each channel uses a specific wavelength or color.

3. METHODOLOGY OF HYBRID SYSTEMS

Our paper is based on the evaluation such system Parameters as the bit error rate (BER), Q-factor and Jitter using powerful techniques which are incorporated in OptSim 3.6 simulation software. Hybrid systems are the combination of Time division multiplexing (TDM) and Frequency division multiplexing (FDM). In 10-Gb/s systems, we find that NRZ is more adversely affected by nonlinearities whereas RZ is more affected by dispersion. Typically, 10 and 20 Gb/s systems are limited mostly by nonlinearities, whereas 40 Gb/s systems are limited mostly by dispersion. As shown in the graph Q- factor is going to be decreases when distance increases. The optical communication systems are used as high speed long haul communication system. Due to high data rates, limitation due to dispersion and nonlinearities in the optical communication system has been of great concern as these parameters (Q- factor, Jitter and BER) limits the overall efficiency of the system. Most commercial systems use the NRZ modulation format. The non-return-to-zero (NRZ) has been the most dominant modulation format in intensity modulated-direct detection fiber-optical communication systems for the last decade. The reasons for using the NRZ in the early days of fiber-optical communication as it is not sensitive to laser phase noise, requires a relatively low electrical bandwidth for transmitter and receivers compare with the RZ and the simplest configuration of transmitter and receiver. The NRZ pulses has a narrow optical spectrum .The reduced spectrum width improves the dispersion tolerance. Schematic model of optical system for the investigation of Q-factor, Jitter and BER for modulation format NRZ is presented in fig.1 for 8 numbers of channels. Number of channels can be change which depends upon various constrains like bandwidth etc.

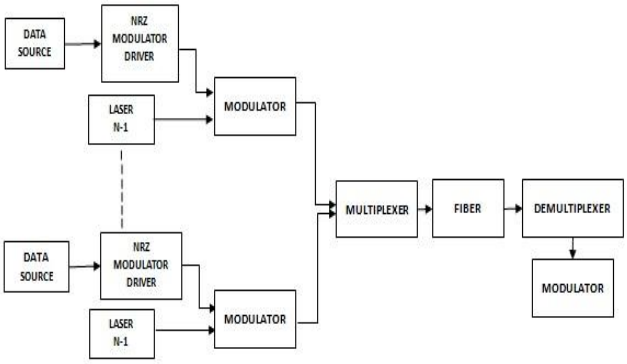

Figure1 Schematic model for NRZ

4. RESULTS AND DISCUSSION

The aim of this section is to verify systems simulation with the integrated OptSim package and to numerically evaluate and compare the performance of NRZ

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modulation format in WDM systems with typical system parameters. We have compared the Quality factor, Jitter and BER for hybrid systems and Non return to zero (NRZ) modulation format is used to create the optical pulses wavelength-division-multiplexing (WDM) signals at a data rate of 10 Gb/s in 8 channel system. The overall Quality factor is better in case of NRZ modulation format and it will be decreases as the distance increases or complicacy increases with increasing distance as shown in figure2. If number of channels are increases it also effect the performance of system in terms of Q-factor, Jitter and BER and which affects system tolerance, linearity, non linearity crosstalk etc and in this case NRZ becomes the best choice for users. But in case of hybrid systems dispersion tolerance improves due to less spectrum width. In this system Jitter initially constant for some distance and then gradually starts increasing after this increment it starts decreasing and then again constant for some distances. But Q- factor having a gradual increment or decrement with distance increment.

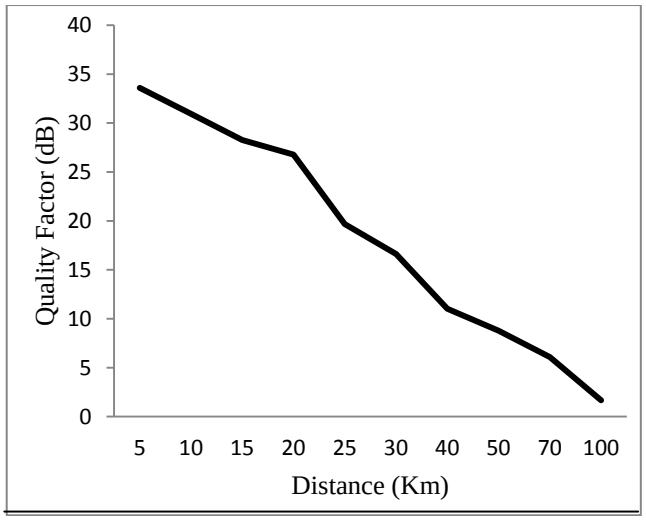

Figure 2 Quality Factor of Hybrid System

Jitter or per delay will be less by using NRZ modulation format as shown in figure3. This analysis and investigation has shown that conventional NRZ turns out to be superior when single-mode fibers are used as transmission media. On the other hand, because of the narrower optical spectrum of the NRZ format, NRZ enables higher spectral efficiency in WDM systems. NRZ may be a better choice for a system with a large number of channels. Bit error rate is the rate of error per bit it must be less.

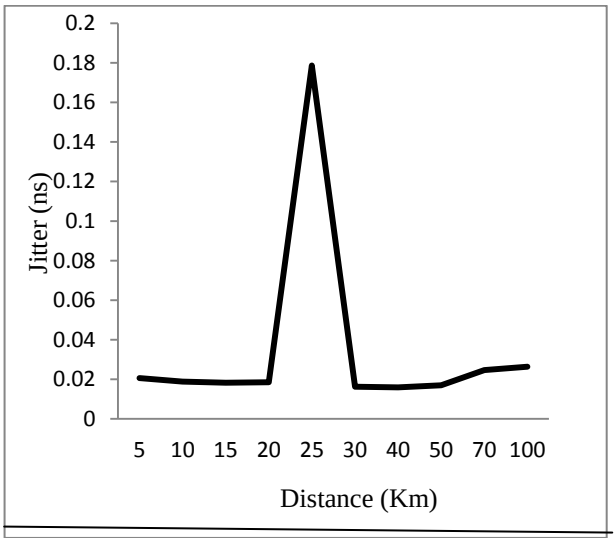

Figure 3 Jitter of Hybrid System

Numerical results are shown by the table1 which is having distance in Kilometer (Km), Q-factor in dB, Jitter in nanosecond (ns) and Bit error rate (BER).According to the table1 Q-factor decreases with increases distance. Jitter starts increasing and after some time it starts decreasing. And also the BER of these systems decreases as the distances increases.

Table 1: Numerical results for hybrid systems

Distance (Km)	Quality Factor (dB)	Jitter (ns)	BER
5	33.590	0.020610	1e- 040
10	30.946	0.018810	1e- 040
15	28.260	0.018230	1e- 040
20	26.770	0.018441	1e- 040
25	19.667	0.017871	1e- 040
30	16.620	0.016235	1e- 040
40	11.027	0.015886	6.3279e-028
50	08.780	0.016950	1.645e- 018
70	06.085	0.024615	1.8604e-009
100	01.660	0.026300	0.00037180

5. CONCLUSION

In this paper, we have discussed that the NRZ or hybrid system is better on the behalf of Q- factor, jitter performance and bit error rate (BER). As shown in table or graphs that Jitter will starts increasing as the distance increases but on further increment of distance it will be constant. Also bit error rate (BER) will be less and Q-factor is large. It shows that NRZ is a better modulation

technique in optical communication system. NRZ is also better for large number of channels used in the system.

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