Complementary Detection Technique to Performance Analysis of RZ&NRZ on MDW Code in FTTH Network

Muthana.Y.aldouri
Communications engineering

S.A.Aljunid
Communications engineering

R.Badlishah Ahmad
Communications engineering

Hilal A.Fadhil
Communications engineering

ABSTRACT

Modified double weight (MDW) code is presented here to support Fiber-To-The-Home (FTTH) access network in point-to-point (P2P) and point-to-multipoint (P2MP) application. The Bit Error Rate (BER) performance is evaluated based on Modified Double Weight "MDW" code. Optical Code Division Multiple Access (OCDMA) system is considered a promising technique for Fiber-To-The-Home (FTTH) access networks. The performance of RZ against NRZ is compared through simulation by using opt system software version 7. We used two networks designed as follows, one used RZ pulse generator and the second used NRZ pulse generator, and both systems are tested with and without Erbium Doped Fiber Amplifier (EDFA). It is found that NRZ pulse generator in this system is better than RZ pulse generator for all simulation results. The conversion used a Mach-Zehnder interferometer (MZI) wavelength converter. Also, we are proposing a detection scheme known as complementary subtraction detection technique implemented with fiber Bragg Grating (FBG) acts as encoder and decoder. The performances are characterized through BER and bit rate (BR), also, the received power at a variety of bit rate.

Keyword: SAC-OCDMA, detection scheme, complementary subtraction technique, NRZ&RZ pulse generator,

1. INTRODUCTION

A straightforward method was used in optical communication in order to convert from electrical to optical binary information. Electrical bit "1" was associated with a higher optical while bit "0" was associated to a lower optical intensity. Two formats are included in this modulation group: Non-return-to-zero (NRZ) and Return-to-zero (RZ) .NRZ is the oldest and simplest modulation format and is obtained by switching a laser source between ON or OFF. RZ describes a line code used in telecommunications signals in which the sign drops to zero between each pulse. This takes place even if a number of consecutive "0" or "1" occurs in the signal. The signal is self-clocking. This revenue that a separate clock does not need to be sent along side the signal, but suffers from using twice the bandwidth to accomplish the same data-rate as compared to non-return-to-zero format. Although return-to-zero (RZ) hold a provision for synchronization, it motionless has a DC component resulting in 'baseline wander" during long strings of (o) or (1) bits, just like the line code non-

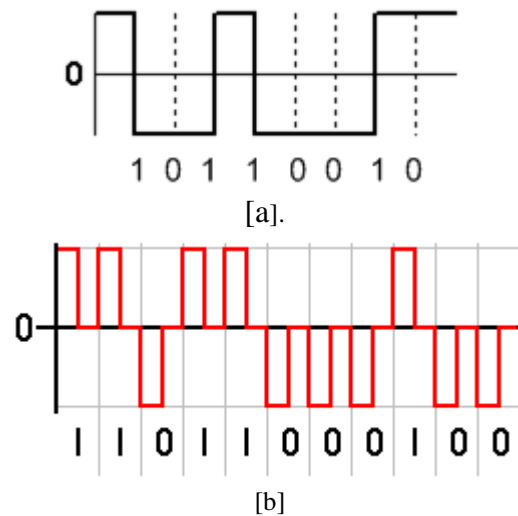return-to-zero. The RZ and NRZ data signals formats are showing in figure 1.a&b respectively [1].

Fig 1. [a] NRZ, [b] RZ) data signal format

In this paper, we make obvious all optical format conversion between RZ and NRZ using a Mach-zehnder type interferometer wavelength converter. For the conversion from RZ to NRZ, we use a duplicator to make numerous copies of the input RZ pulses within one bit period before the RZ signal is injected into the wavelength converter [6].

This step can be achieved modulating the output of the laser using a MZM. For case of OOK the modulator is predisposed at 50% transmission and is driven to maximum to minimum transmission as illustrated in Fig [2]. And Fig [3] illustrates the construction of RZ –OOK. The two diagrams are used for simulation set up. These two data formats have found widespread use although the RZ data format requires twice the NRZ transmission bandwidth, it is quiet useful in application [1].
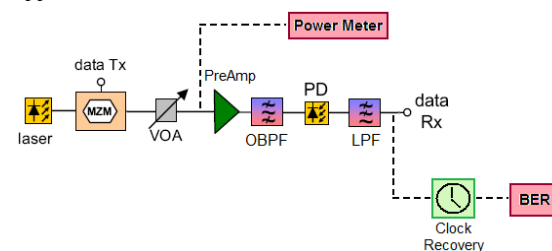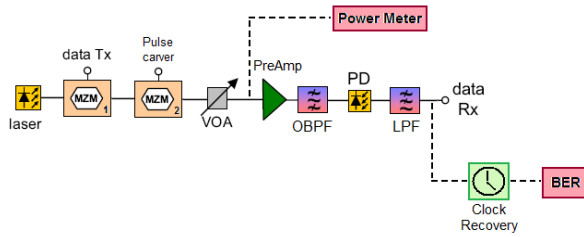

Fig [2] **structure for NRZ - OOK**

Fig [3] **structure for RZ – OOK**

2. MDW CODE

MDW is the customized version of DW code. The MDW code weight can be any even number that is grater than two. In this paper, the MDW with the weight of four is used as an example. As a family of DW code, MDW can also be represented by using the KxN matrix. The essential MDW code denoted by (9, 4, and 1) is shown below

$$H1= \begin{vmatrix} 0\ 0\ 0 & 0\ 1\ 1 & 0\ 1\ 1 \\ 0\ 1\ 1 & 0\ 0\ 0 & 1\ 1\ 0 \\ 1\ 1\ 0 & 1\ 1\ 0 & 0\ 0\ 0 \end{vmatrix}$$

Perceive that a similar structure of the basic DW code is still maintained with a minor modification, whereby, the double weight pairs are maintained in a way to consent to only two overlapping chips in every column. Thus, the 1, 2, 1 chips combination is maintained for every three columns as in the basic DW code.

This is important to maintain $\lambda=1$. The same mapping technique as for DW code is used to augment the number of user. The example shows that we can increase the number of users from four to six while the weight is still fixed at four. An MDW code with weight of four denoted by (N, 4, 1) for any given code length N, which can be related to the number of user K through

N= 3K + 8/3

The total spectral width $\Delta v=\Delta FN$
Where ΔF is the chip width .equation is always applicable for DW&MDW code systems because for K number of users multiplexed into a common fiber, the complete code length N is spectrally sheltered.

3. COMPLEMENTARY SUBTRACTION TECHNIQUE IN MDW CODE

In complementary subtraction detection technique under MDW code designed is shown in Fig. 4 for a weight code equal to four and users code sequences: user 1 code sequence=0 0 0 0 $\lambda5$ $\lambda6$ 0 $\lambda8$ $\lambda9$; user 2 code sequence = 0 $\lambda2$ $\lambda3$ 0 0 0 $\lambda7$ $\lambda8$, user 3 code sequence= $\lambda1$ $\lambda2$ 0 $\lambda4$ $\lambda5$ 0 0 0 0.

The spectral amplitude signal at the receiver side splits into two branches. The upper branch has the signal for use X, including the overlapped chips between X and Y and the lower branch have the overlapped chips only. These overlapped chips can be represented mathematically by AND operation between X and Y.
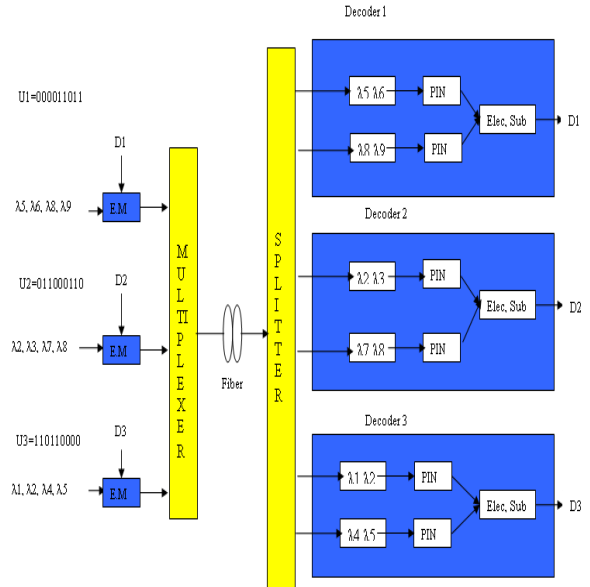

Fig [4] OCDMA system using AND-subtraction detection technique Under EDW code

Optical code-division multiple access (CDMA) systems are in receipt of more and more attractive in the field of all optical communications as multiple users can access the network asynchronously and simultaneously with high level of security. Optical spectrum code-division multiple -access (OSCDMA) is a multiplexing technique tailored from the successful implementation in wireless network [2].

4. SIMULATION SETUP

The simulation has been carried out by using opt system software version 7.In order to study the performance between RZ and NRZ using MDW code in fiber to the home(FTTH) access network for three users. In point-to-multipoint (P2MP), the network has been divided into two sets which are: with (EDFA) amplifier and without (EDFA) amplifier. A simple schematic block diagram for P2MP is illustrated in Figure 5. The system is represented by three sections: transmitter section, fiber optic length and receiver section. In the transmitter part for P2MP each of optical line terminal (OLT) consist of five components: pseudo random bit sequence (PRBS) generators, non-return-to-zero (NRZ) pulse generators, single light source diode (LED), filters and external modulators. In this occupation we used two models one used RZ pulse generator, with and with out erbium doped fiber amplifier (EDFA), and the second model by using NRZ pulse generator also with and without erbium doped fiber amplifier (EDFA).The fiber Bragg grating (FBG) is used as a filter in encoder and decoder. The function of the encoder is to encode the source according to the specific code it uses. The

modulators are Mach-Zehnder modulators, which is an intensity modulator based on an interferometer principle. The signals that coming from the transmitter will be combined by multiplexer and drive into a single fiber. The fiber length section includes the fiber cables used for the transmission. At 1550 nm wavelength. In this system, the splitter in ratio1:16 are used representing the branches to the drop part on an optical network unit (ONU). At the receiver part it shows the equipment at the customer premises. The incoming signal is split into two parts, one to the decoder that has an identical filter with the encoder and the other to the decoder that has the complementary filter .An electrical subtracted is used to subtract the overlapping data from the wanted one. The performance of the system referring to the bit error rate (BER) at BER analyzer. With the same setup, we place the EDFA with 20 dB gain, immediately after the transmitter to launch power signals into the fiber to see the difference of performance on FTTH system by using OSCDMA multiplexing scheme [5].
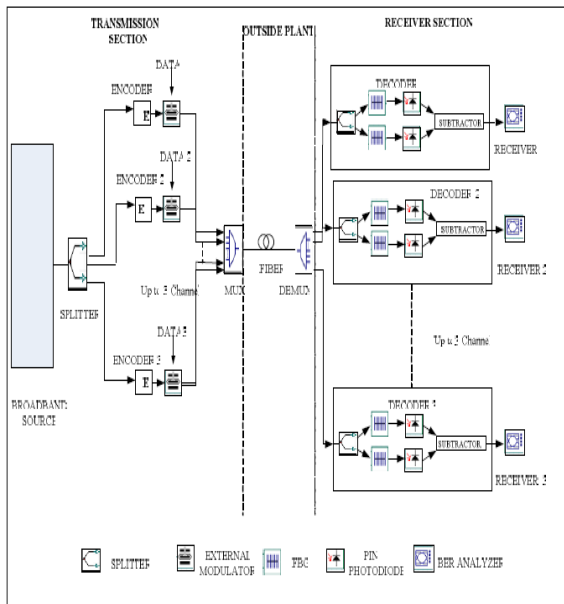

Fig [5]. Point-to-Multipoint Network Simulation Setup for complementary Subtraction Detection Technique.

5. PRESENTATION ANALYSIS

The presentation of RZ, and NRZ in P2P, and P2MP was achieved from the results full from opt system 7. The simulations were carried out for MDW with two SCM channels. Simple model shown in figure 5, consist of three users. Each user has a spectral width of 0.8nm. The tests were carried out with the ITU-G652 standard single-mode optical fiber. The effect of varying Bit rates related to the BER at 30Km transmission fiber length for NRZ, RZ, and both illustrated in Figure.6.
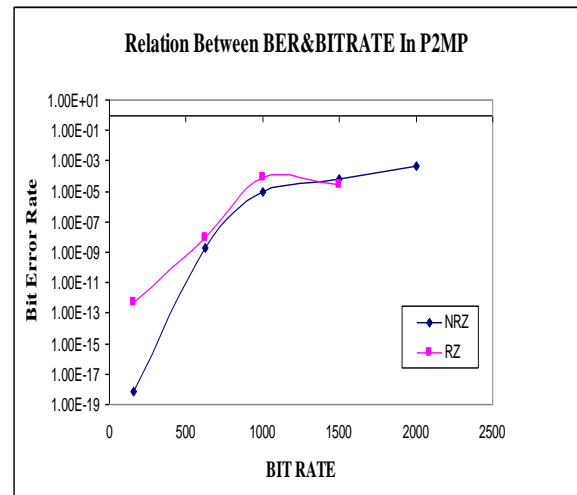

Fig. [6]. RZ and NRZ, performance in P2MP.

The motivation for this is as follows, the improvements in receiver sensitivity or the duty cycle is reduced. An optical RZ pulse width with 50% duty cycle will have twice the peak power of an NRZ pulse. Also, an RZ has a wider optical bandwidth than on NRZ pulse; it is more affected by dispersion, as can be seen from the eye diagrams in figures 8&9. Finally, RZ pulses have superior peak power and as such are more susceptible to FWM, SPM, and XPM.
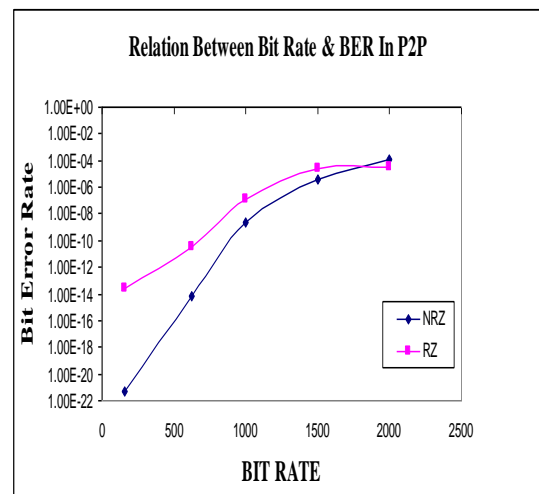

Fig. [7]. RZ and NRZ, performance in P2P.

From Figures 6&7 it seems that the system which is used NRZ is better than RZ in our model this is because the signal bandwidth of NRZ is a bout 50% smaller than the RZ format. This is illustrated better in the maximum bit rate value 2Gbps, 2.5Gbps when we used RZ and NRZ respectively.
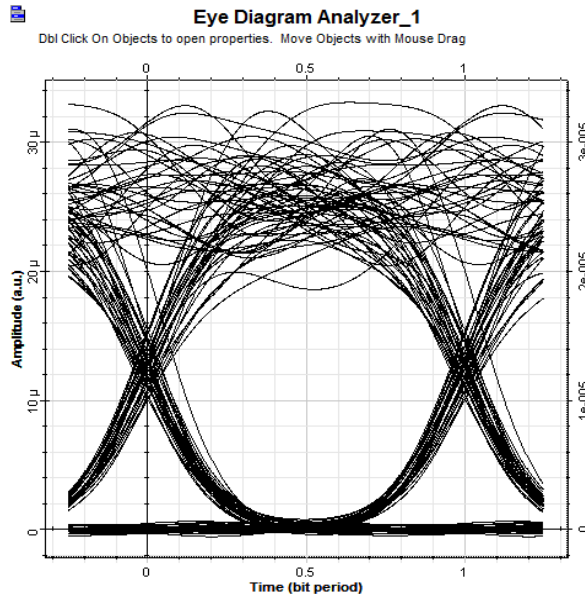
.

Fig. [8] Eye diagram user 1 with complementary subtraction detection technique NRZ
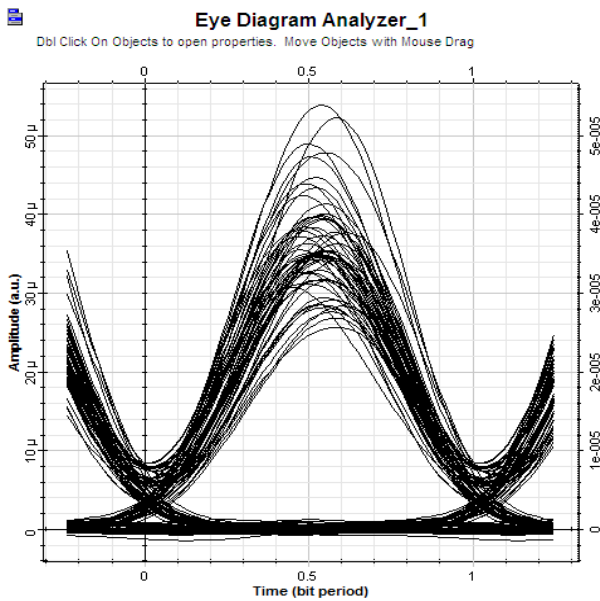
BER= 1×10^{-22}

Fig. [9].Eye diagram user 1with complementary subtraction detection technique RZ

BER= 1×10^{-14}

In addition we can demonstrate the difference in shape of RZ & NRZ from figures 10 &11 which is clearly appear that the frequency bandwidth in NRZ with 26dBm power, equal to the 50% of that bandwidth in RZ with 23dBm power.
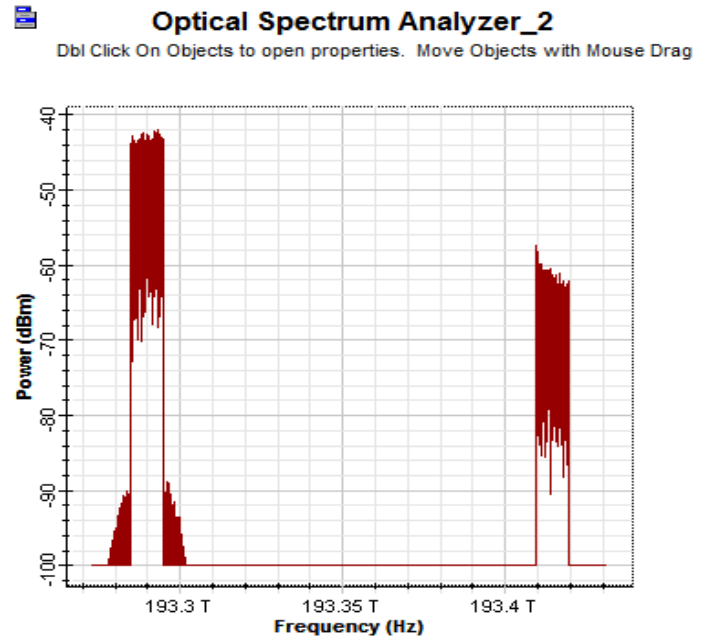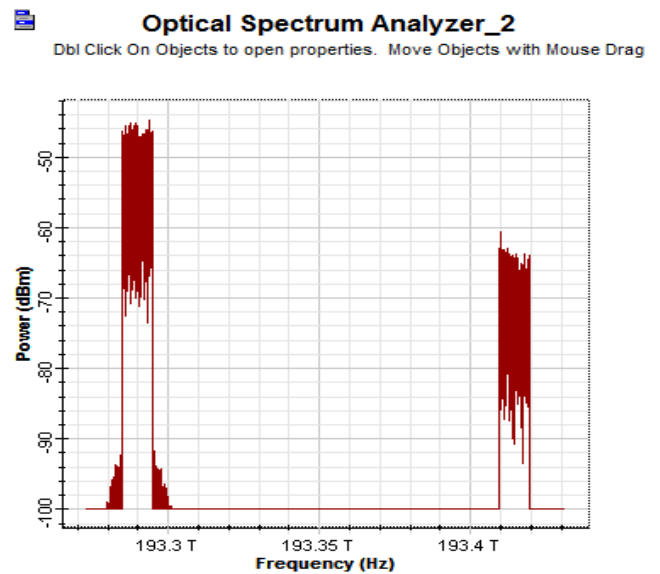

Fig. [10]. NRZ RF spectrum signal

Fig. [11]. RZ RF spectrum signal

6. CONCLUSION

In this paper, we have discussed that the RZ is more affected by dispersion and dispersion slop. For MDW OCDMA system P2MP will execute better than P2P in most causes using RZ&NRZ signal formats. It has been shown that NRZ may be a better choice for a system with a large number of channels. From the results optioned at 30 Km distance fiber, the BER at NRZ is improved than RZ.

Finally, implementing the RZ modulation scheme requires a higher bandwidth driver on the transmitter end. This scheme can also be implemented using two optical modulators. This solution may be expensive, however, since a higher bandwidth driver may be more cost effective than two optical modulators.

7. REFERENCES

[1] Aljunid, S. A., M. Ismail, A. R. Ramli, B. M. Ali, and M. K. Abdullah. 2004. A New Family of Optical Code Sequences for Spectral Amplitude-Coding Optical CDMA Systems. *IEEE Photonic Technology Letters*. 16(10):

[2] D. Norte and A. E. Willner, "Experimental demonstrations of all-optical conversion between RZ and NRZ data formats incorporating no inverting wavelength shifting leading to format transparency," *IEEE explorer 2002*.

[3] F.N. HASOON' S.A. ALJUNID "SPECTRAL AMPLITUDE CODING OCDMA SYSTEMS USING ENHANCED DOUBLE WEIGHT CODE" Journal of Engineering Science and Technology.Vol. 1, No. 2 (2006) 192- 202

[4] Javier Cano Adalid "Modulation Format Conversion in Future Optical Networks**"** Research Center COM Technical University of Denmark March, 2009

[5] X. Zhang, Y. Ji, and X. Chen, *Code Routing Technique in Optical Network*. Beijing, China: Beijing Univ. Posts & Telecommunications, pp. 416–419.

[6] Yang, C. C., J. F. Huang, and S. P. Tseng. 2004. Optical CDMA Network Codecs Structured with MSequenceCodes over Waveguide-Grating Routers. *IEEE Photonics Technology Letters*. 16(2): 641-643.

[7] Z. Zan, S. A. Aljunid, M. H. Yaacob, M. K. Abdullah &S. Shaari, Design Configuration of Encoder And Decoder Modules for Modified Double Weight (MDW)Code Spectral Amplitudes Coding (SAC) Optical Code Division Multiple Access (OCDMA) Based On Fiber Bragg Grating, *Second International Conference on Advanced Optoelectronics and Laser*s, 2, September