IMPLEMENTATION OF 280GBPS MDRZ-OTDM USING MZM CASCADED RECEIVER

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Abstract- **This paper implies advanced modulation formats and modulators that improve the quality of signal generated. In this project, Modified duo-binary return to zero MDRZ and Return to zero RZ modulation techniques are used. Performance of designed structure is analysed by Mach-Zehnder modulators with additional circuitry at transmitter and cascaded arrangement at the receiver. A bit rate of 280Gbps is successfully transmitted with Quality factor, bit error rate and Eye Height at an adequate range over a distance of 480km.**

Keywords – Optical time division multiplexing OTDM, Modified Duo binary Return to Zero MDRZ, Dispersion compensating fiber DCF, Quality Factor, Erbium Doped fiber amplifier EDFA, Mach-Zehnder Modulator MZM, Electrical time division multiplexing ETDM, Single mode fiber SMF, laser diode ld and Pseudo random Bit Sequence PRBS, Gigabits per second Gbps.

I. INTRODUCTION

Demand of higher bit rate is increasing rapidly as technology is growing at a very rapid rate; with technology applications which are using higher bit rate is also increasing. With this increase in demand of higher bit rate, need of large data handling system is felt. To fulfil this requirement we need to change the whole network with a high capacity network. For this purpose optical communication is better choice, because an optical network has capacity to carry out Terabits per second (TBPS). But counterpart ETDM can only transport a few Gbit/s presently. In optical domain Optical time division multiplexing (OTDM) transmission is most suitable technologies to accomplish this [1]-[2]. But the limitation is that, we do not have an advanced electronics technology to handle such a huge data rate. So we need to keep our eye on the advancement in electronics mechanism, but the deadline has already been touched. Therefore the only option is to focus on all optical communication system. In this direction optical time division multiplexing OTDM is superior choice [3]. Further to generate such a high bit rate we need electronic to optical conversion.

OTDM technology is same as ETDM where many low data rate electrical channels are combined to construct a very high bit stream, but in the optical domain signal is in the form of light. At the user end data is used in electronic form. Local area network are not in optical domain so electronic to optical conversion is required at transmitter for multiplexing and Optical to electrical at receiver for de-multiplexing. OTDM is being used since three decades, much advancement has been made. But still we need to refine transmitter, fiber and receiver technology. Refinements in laser diode, optical amplifier and other connecting devices in channels are required [4]. Next generation of communication will be all optical technology to satisfy large capacity requirement. Packet addressing and switching with wavelength division multiplexing or optical time division multiplexing or composition of both is used to construct ultra high speed optical networks. At a very high speed it is required that whole signal routing, switching, de-multiplexing and processing should be in the optical form only [5]-[6].

II. SYSTEM DESCRIPTION

In this work Some Advance modulation techniques have implemented in optiwave's OptiSystem software. Block diagram of 280Gbps MDRZ OTDM system has prepared according to system requirements as shown in fig.1 from the diagram given below OTDM system is implemented in software. Measurement tools RF Spectrum analyser, BER analyser, Eye diagram analyser are placed at receiver end to measure output characteristics that is BER, Q-factor and spectrum of signal.

Transmitter: In the block diagram the continuous wave laser source is used with 10Mhz line width, which is operating at 193.101THz (1552.52nm) [7]. Power splitter 1x8 divides incoming power at 35GBps to each tributary, which is further fed to MDRZ Modulator Sub system. This sub system contains PRBS generator with Bit sequence of 2^7 -1. Eight tributaries of such type are incorporated in this project. At the output of MDRZ modulator we obtain MDRZ signal and is fed as input to Optical time delay. Time delay is used to delay the signal for a pre-specified time to obtain an OTDM signal. Here we use eight delay line D0-D7. D0 is set to time delay zero. Time of second delay line is set in such a way that first channel complete it's transmission, 2nd starts immediately, 3rd and fourth so on up to eight works in same fashion [8]. Each of the eight tributaries modulates signal 35GBPS each.

Channel: In the channel various dispersion management techniques are adopted. In this system arrangement dispersion compensation fiber DCF is used with inverse dispersion properties. It has symmetric configuration. An erbium-doped fiber amplifier EDFA of gain 5dB is used. In this arrangements single mode fiber SMF0 is of 25km length with dispersion 17ps/nm/km and attenuation 0.2dB/km is used after that EDFA of gain 5dB subsequently DCF of 10km with -85ps/nm/km and attenuation 0.5dB/km, EDFA of gain 5dB at last SMF1 of length 25km followed by EDFA of gain 5dB. By selecting the above parameters of channel subsystem fiber attenuation and dispersion is almost compensated. Fiber discussed above is of 60km span. It is used in loop configuration. Desired length can be achieved by adjusting number of loops.

Receiver: At the receiver end de-multiplexer DEMUX is used to decompose signal into different low bit rate channels. For this purpose power splitter 1x8 is used. It divides signal into eight tributaries. For clock re-production, clock recovery and clock signal generator is used with feedback circuit. Clock and data are recovered from the received OTDM signal. De-multiplexed channels are now fed to optical receiver. It contains precise photo detector with feedback for better outcomes. Output of optical receiver is bit stream in electrical form. To check the performance of OTDM system different tools are used for measurement such as BER Analyser, Optical Spectrum Analyser etc.

280Gbps MDRZ-OTDM using MZM Cascaded Receiver at 480km distance is implemented and analysed. In this implementation of OTDM system using cascaded configuration of receiver is carried out. Eight tributaries are used, So eight MDRZ modulator, eight delay line, 1x8 power splitter, 8x1 power combiner at transmitter are used and accordingly at receiver side also. 280Gbps data is successfully transmitted at distance at different distances from 60km-480km with acceptable results.

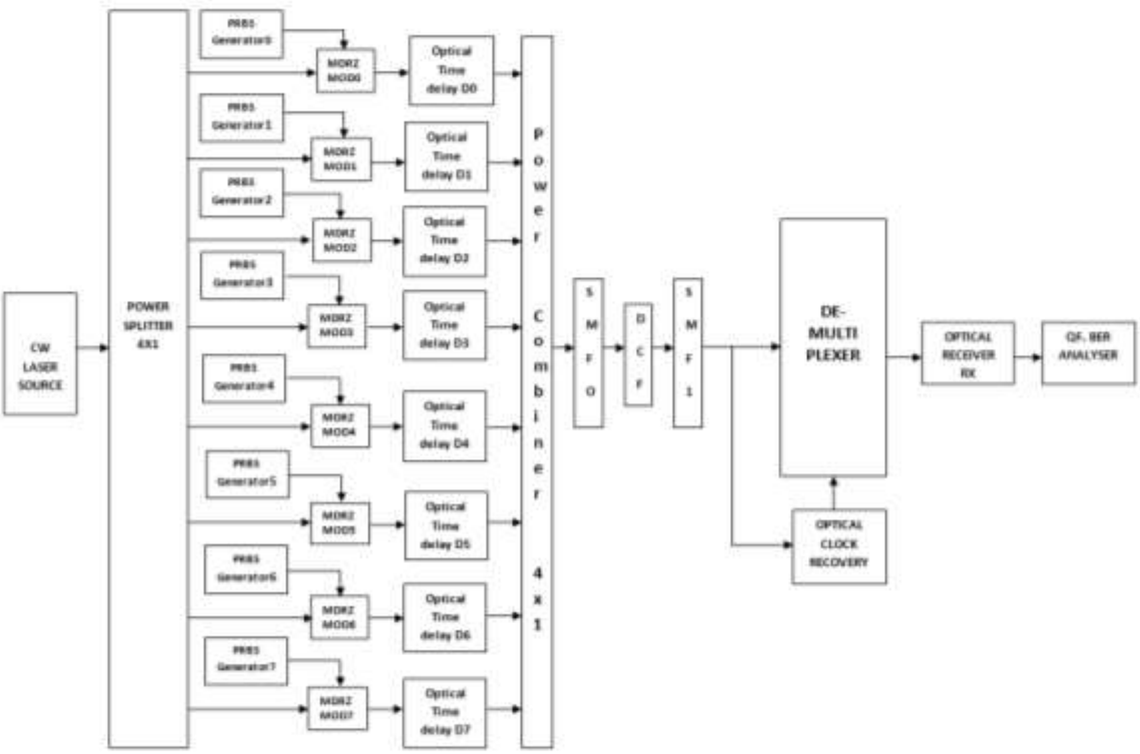

Figure 1 Block Diagram of 280Gbps OTDM system with MDRZ modulation format using 8x1 tributaries.

III. Simulation Parameters

Table 1 Simulation Set up Parameters for 280Gbps MDRZ OTDM system.

CW Laser frequency	193.101 THz
CW Laser Line width	10 MHz
CW Laser power	0dBm
Data rate	280Gb/s
DCF length	10 km
EDFA Gain	5 dB
Photo detector	PIN

IV. Simulation set up of 280Gbps MDRZ-OTDM

Simulation set up 280Gbps MZM cascaded system is shown in fig.2. Laser diode, power splitter with 8 outputs, delay D0-D7 and power combiner with eight inputs is shown. At receiving end two receivers are connected in series. Parameters required for simulation are shown in table 1, frequency 193.101THz, laser line width 10MHz and power 0dBm. Optical spectrum of 193.101(1.55252nm) is obtained from Optisystem 7.0 is shown in fig.3.

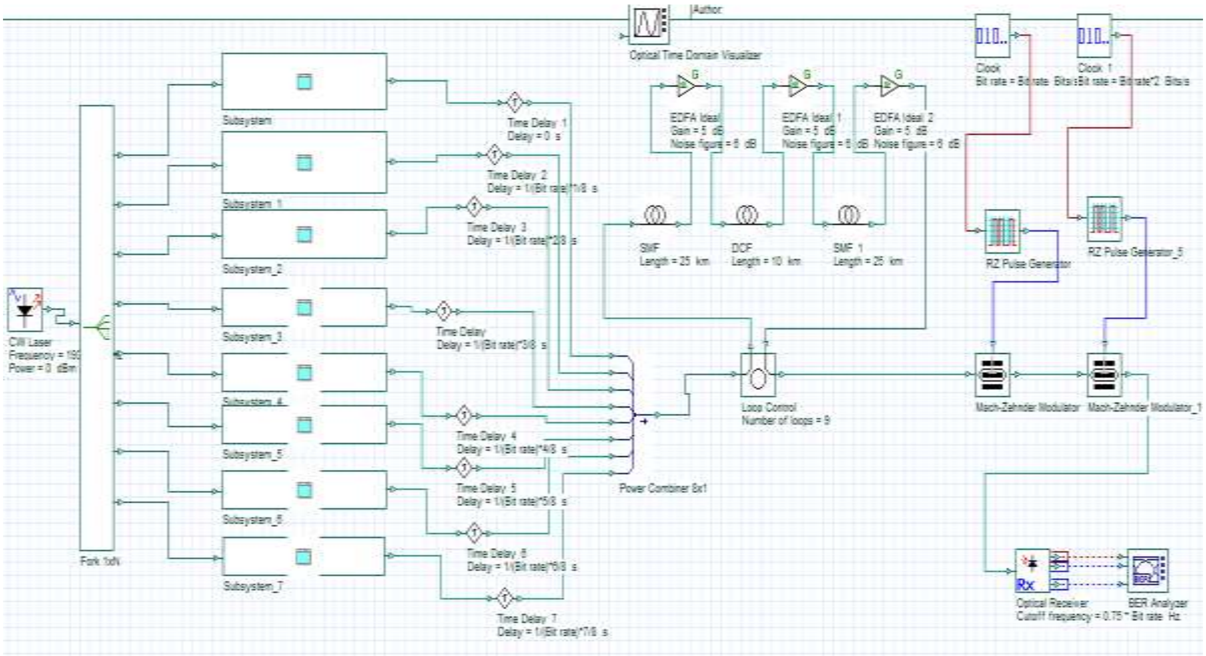

Fig.2 Simulation set up of 280Gbps MDRZ-OTDM using MZM Cascaded Receiver.

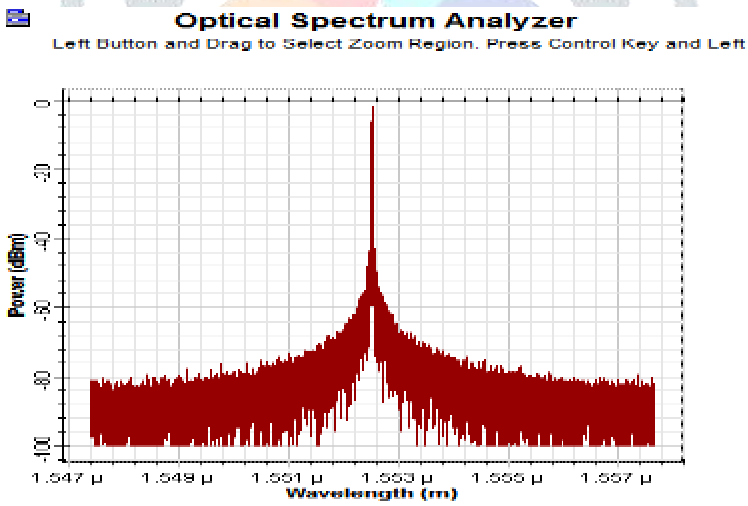

Fig.3. Optical spectrum of 193.101(1.55252nm) at 280Gbps OTDM syste

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V. RESULTS AND DISCUSSION

Data rate of 280Gbps is applied to MDRZ OTDM system corresponding BER, Q Factor, Eye diagram are obtained and recorded in table. Results obtained from the MDRZ OTDM system show that it gives good BER and Q-factor at 280Gbps at different distances of 240km to 480km, as shown in the table 2 and diagrams.

Table 2 Q Factor, BER and EYE Height Parameters for 280Gbps

Distance	Max. Q Factor	Min. BER	Eye Height
240km	8.02454	1.84673e-016	5.26464e-005
300km	8.80957	3.64576e-019	4.95127e-005
360km	7.59651	6.66628e-015	4.16384e-005
480km	6.80156	1.85613e-012	3.37237e-005
540km	5.89798	4.90775e-010	2.89839e-005

As shown in the table 2 to analyze and to check the performance MDRZ OTDM system we apply data rate 280Gbps. Q-Factor at distances of 240km, 300km, 360km and 480km shows values 8.02454, 8.80957, 7.59651 and 6.80156 respectively. As distance is further increased to 540km its value decreases to 5.89798, which is below acceptable range. The value of Q-Factor for proper communication should be greater than 6.

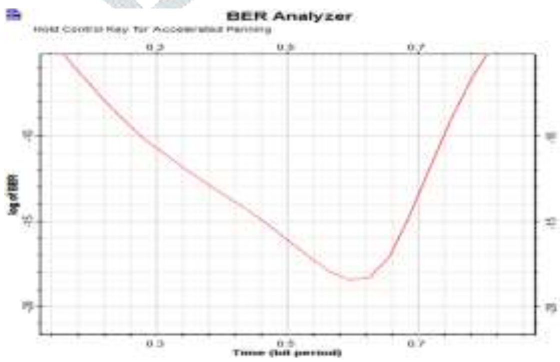
Bit Error Rate BER is also shown in table 2. Here the values of parameter BER at 280Gbps at different distances of 240km, 300km, 360km and 480km are 1.84673e-016, 3.64576e-019, 6.66628e-015 and 1.85613e-012 respectively. As distance is further increased to 540km its value decreases to 4.90775e-010 that is acceptable. As data rate and distance is further increased from 280Gbps and 540km the BER is going on decreasing, the value of BER for proper communication should be greater than 10^{-9}. Eye Height is also shown in the table 2 to check the performance of MDRZ OTDM system. Eye height varies from 5.26464e-005 to 3.37237e-005 at different distances from 240km to 480km respectively. It shows good results for proper data communication.

IV. Simulation Results and Discussion of modified duo-binary Return to Zero at 280Gbps

As shown in figures obtained for 280Gbps at a distance of 300km, in fig.4.a Q-Factor of signal vs. Bit time period is shown. At bit time period 0.58 to 0.61 it shows constant value 8.80957 for a small interval. Either side of 0.58 to 0.61 the value of Q-factor continually decreases. In fig.4.b log of BER of signal vs. Bit time period is shown. It shows the value 3.64576e-019 for time period of 0.58 to 0.61. It is very good result greater than 10^{-9}. In fig.4.c EYE diagram of signal is shown. It shows eye height 4.95127e-005. Signal quality at this rate is acceptable.

At bit rate 280Gbps and distance of 480km Q Factor of signal vs. Bit time period is shown in fig.5.a. Graph shows its value 6.80156. At bit time period 0.62 it shows peak value 6.80156. Either side of 0.62 the Value of Q-factor continually decreases. In fig.5.b log of BER of signal vs. Bit time period is shown. It shows the value 1.85613e-012 at 0.62 time period of bit. The result is greater than 10^{-9}. In fig.5.c Eye diagram of signal is shown. It shows Eye height 3.37237e-005.

a)



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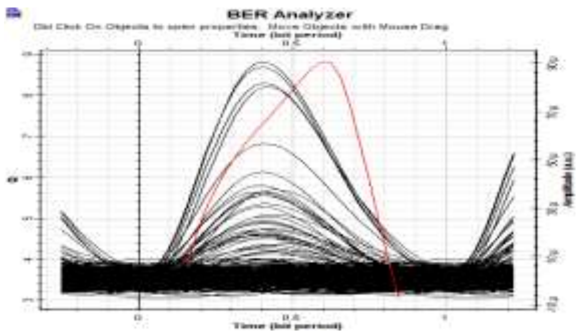

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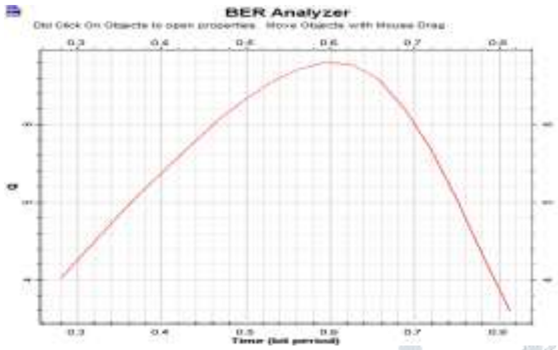
Fig.4 a) Quality Factor Vs Bit Time Period, b) Bit Error Rate Vs Bit Time Period c) Eye Diagram of Bit Error Rate Vs Bit Time Period, at 280Gbps at 240km.



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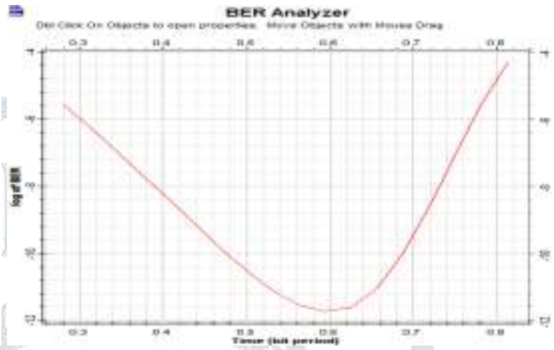

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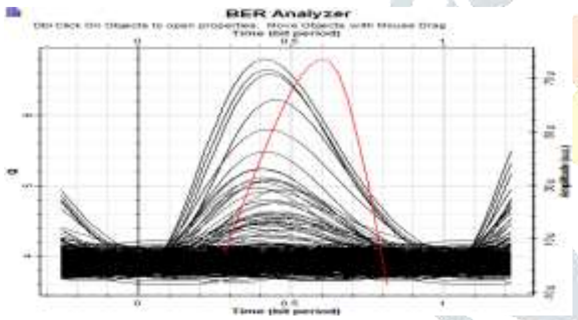

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Fig.5 a) Quality Factor Vs Bit Time Period, b) Bit Error Rate Vs Bit Time Period c) Eye Diagram of Bit Error Rate Vs Bit Time Period, at 280Gbps at 480km.

IV CONCLUSION

In this paper 280Gbps MDRZ-OTDM system using MZM Cascaded Receiver at different distances of 240km to 480km is implemented and analysed. This implementation of OTDM system incorporates cascaded configuration of reciever and eight tributries are used instead of four by other researchers. So eight MDRZ modulators, eight delay line, 1x8 power splitter, 8x1 power combiner at transmitter are used and accordingly at receiver side also. Each of the tributaries is fed with 35Gbps. So 35x8=280Gbps data is successfully transmitted at distance of 480km with acceptable results of Q-factor value 6.80156, BER 1.85613e-012 and Eye Height 3.37237e-005. As compared to other papers only 240Gbps data are transmitted at distance upto 180km [9].

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