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160 Gbps MDRZ-OTDM using Single and Cascaded EAM and MZM Reception

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***Abstract*- In this paper uses Modified Duobinary Return-to-Zero (MDRZ) modulation format and produce Optical Time Division Multiplexing (OTDM) technology. System is evaluated on reception by using both EAM and MZM in single and cascaded configurations and conclusion have been drawn by demultiplexing from 160 Gb/s to 40 Gb/s over a 2400 km with acceptable bit error rate (BER) and Quality factor (Q) value.**

Keywords - MDRZ, OTDM, Q Factor, Electroabsorption Modulator (EAM) and Mach-Zehnder Modulator (MZM)

I INTRODUCTION

Optical Fiber system plays a vital role in optical communication system. The optical carrier signal has very great probable transmission bandwidth than metallic cable systems. Development of different multiplexing technology sanctioned very high capacity optical fiber communication networks that offer transmission over many thousands of kilometers without using any electronic repeater [1]. Optical technology plays a crucial role in the decrease of the necessity of the electronic processing by steering the traffic in the optical domain direct to the target in order to avoid the need for large electronic processors at intermediate network positions [2]. There is an increasing insists for extended transmission capacity. This demand can be fulfill by OTDM technology. In OTDM, a data stream of high bit rate is constructed directly by time division multiplexing various optical streams of lower bit rate [3]. At the receiver side, demultiplexing of the very high bit-rate optical signal to several lower bit-rate signals is performed before detection and conversion into the electrical field. The time-division multiplexing is a completely digital technique and hence it is compatible with the idea of an all-digital network which combines switching and transmission. Moreover, OTDM provides system flexibility and it is capable to allocation of bandwidth in to different baseband channels. In this only a single transmitter laser is required for all the channels. Very high-speed optical OTDM systems having single wavelength channel rates in excess of 100 Gb/s, offer simple organization and control, the capacity to provide truly flexible bandwidth on demand service, packet switching, and scalability in the number of users [4]. At present time, the major research work on ultrafast optical networks has been dedicated to device technology demonstrations such as all-optical logic at OTDM rates [5], high repetition rate short optical pulse sources [6], self-synchronization methods [7], wavelength conversion [8], and long-haul transmission using ultra-short pulses. A higher Time Division Multiplexing (TDM) bit rate makes transmission systems a more exposed to chromatic dispersion (CD) and polarization-mode dispersion (PMD), and creating the need for a higher optical signal-to-noise ratio (OSNR) in the wavelength channel. A higher OSNR is obtained by employing a higher signal power, and this will make the system more sensitive to fiber nonlinearity. A different and more challenging view as regards OTDM technology is that optical networks will evolve into "photonic networks," in which ultrafast optical signals of any bit rate and modulation format will be transmitted and processed from end to end without optical–electrical–optical conversion. With this as the target, OTDM technology presents us with the challenge of investigating and developing high-speed optical signal processing and exploring the ultimate capacity for fiber transmission in a single wavelength channel [9].

II SYSTEM DESCRIPTION

In the block diagram the continuous wave laser source is used with 10 db line width, which is operating at 193.1 THz (1552.5243nm). The transmitter consists of fork 1*4 use to split the 40Gbps channel into four channels. Four channels from the Continuous Wave (CW) laser are MDRZ modulated with a different pseudo-random bit sequence (PRBS) generator. Among the four splited channels each channel espouse from optical delay. Then it fed through the 4*1 power combiner. An OTDM signal is generated and passes through the 25 km single mode fiber with dispersion of 17 ps/nm/km. Then an erbium doped fiber amplifier (EDFA) is employed with gain of 5 dB. EDFA uses 10 dBm of power for its operation. The higher bit rate of OTDM signal makes it more exposed to the CD. So to compensate the dispersion, fiber length consists of Dispersion Compensating fiber (DCF) to make the total dispersion null.

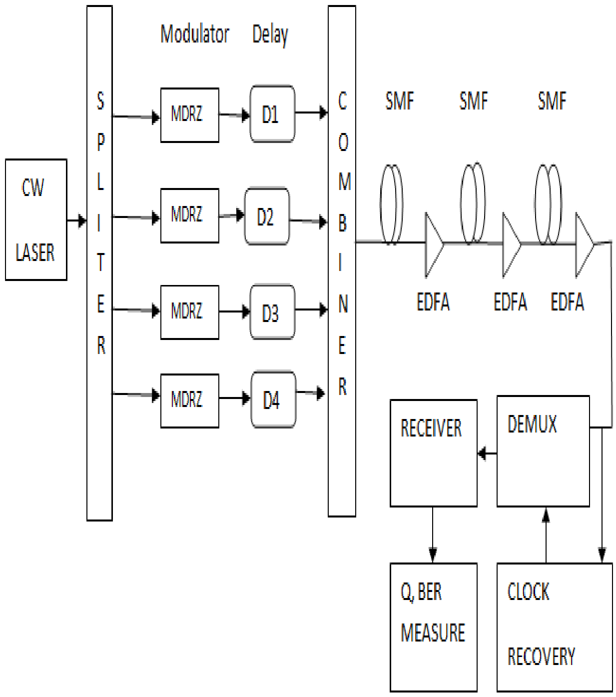


Fig 1. Block Diagram of 160Gbps OTDM system with MDRZ modulation format

The length of DCF is 10km with dispersion -85 ps/nm/km. At the receiver side EAM or MZM are used with PRBS and RZ pulse generator.PIN photo detector is use with responsivity of 1 A/W and dark current 1 nA. Low Pass filter is employed with cut off frequency of 0.75*Bit rate. The BER analyzer is use to measure Q value and the BER.

III RESULTS AND DISCUSSION

In OTDM system, Q value is one of an important parameter that is used to measure the performance of the system. The graphs are plotted between the Q value and the transmission distance by varying different parameters.

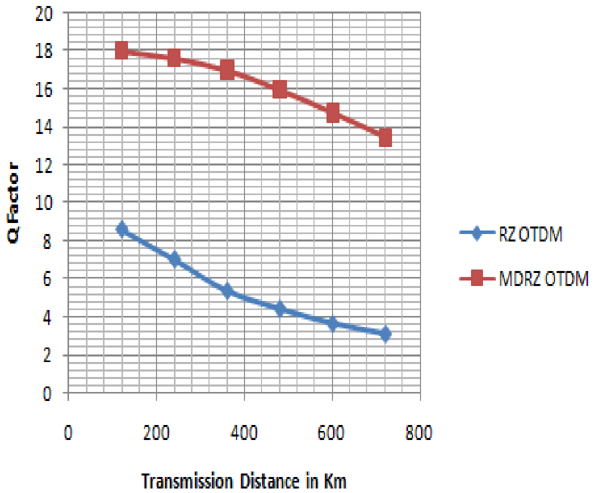
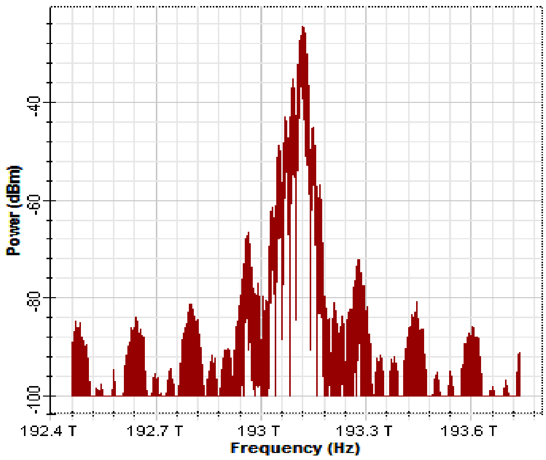
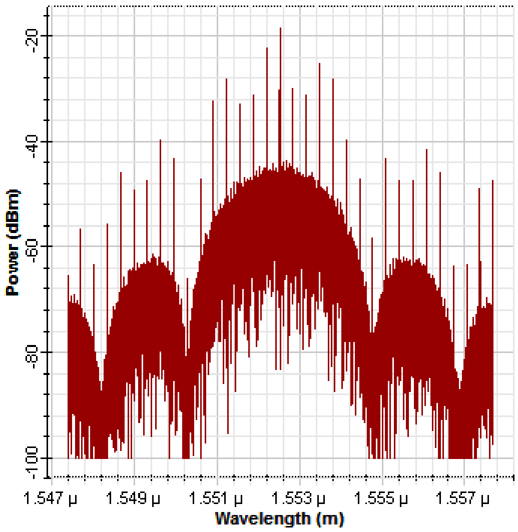


Fig 2. Comparison of performance between RZ OTDM and MDRZ OTDM.

By varying the distance travel by optical signal the Q factor value also changes. Between the RZ OTDM and MDRZ OTDM the MDRZ OTDM gives the most effective result in Fig 2. The RZ OTDM signal travel approximately 350 Km and MDRZ OTDM can travel upto 2100 Km with acceptable Q factor value with single MZM modulator at receiver side.



(a)



(b)

Fig 3. Power spectrum at 193.1 THz for the a) MDRZ OTDM system b) RZ OTDM system with 10MHz line width

It has narrow spectral width as compare to the fig 3(b) in fig (3a). More is the spectral width the more dispersion raise. So MDRZ OTDM system gives better performance than that of RZ OTDM system.

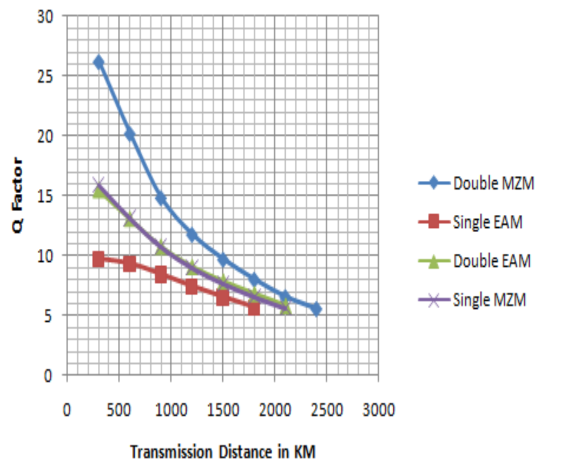


Fig 4. Q factor performance after demultiplexing 160 to 40 Gbps with single and cascaded modulators

When 0 dbm input power is applied then there are different Q factors values observed at different transmission distance for single and cascaded modulators in fig 4. It is clear that double MZM modulator gives best performance among them. And travel maximum achievable distance with acceptable Q value. Among them single EAM give the worst performance it travel only upto 1800 Km with acceptable limit. Single MZM and Double EAM gives approximately same performance.

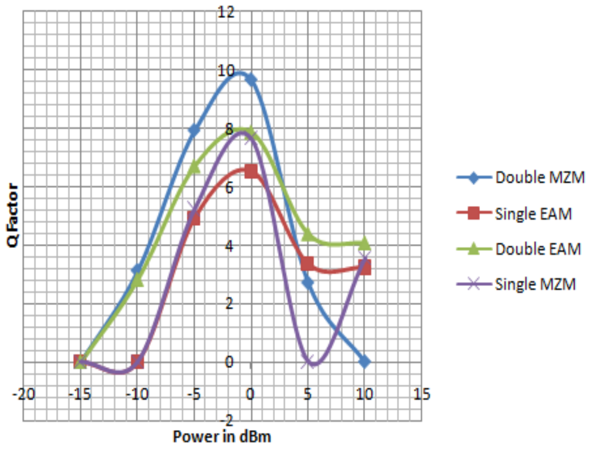
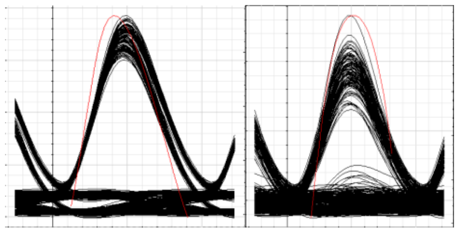
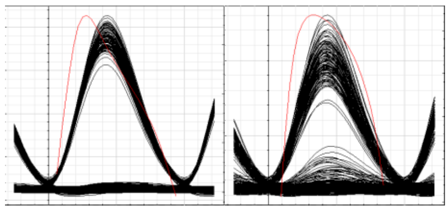


Fig 5 Q factor performance at the same transmission distance by varying the input power for single and cascaded modulators.

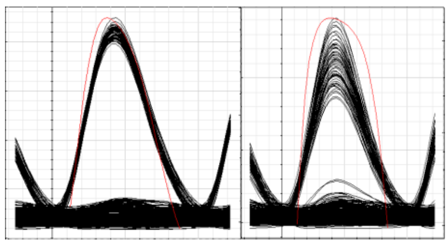
Among all the input powers the 0 dBm gives the best Q factor value as shown in fig 5. And among the modulators, double MZM gives the best result at 0 dBm input power. As we goes on increasing the power then the Q factor value is decreasing, but in case of single MZM at 5 dBm the value of Q factor is 0 and at 10 dBm the Q factor value is 3.55877.



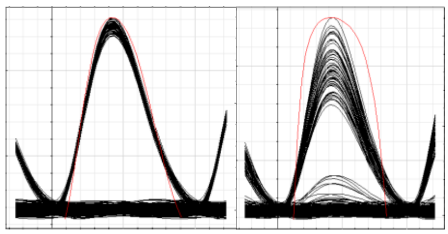
(a)



(b)



(C)



(d)

Fig 5. Evaluation of following system Eye diagrams at min and max transmission distance. a) Single EAM b) Single MZM c) Double EAM d) Double MZM

For the single and cascaded modulators Eye diagram are shown in fig. In fig 5(a) maximum achievable transmission distance of 1800 km on which eye height has acceptable value, i.e noise has not severe effect on the optical signal transmission. The eye diagram for single MZM and the double EAM are the approximately similar pattern at the maximum achievable distance of 2100 km. Best eye pattern among is of double MZM with maximum achievable distance of 2400 km.

IV CONCLUSION

In this paper first compared the Q factor value between RZ OTDM and MDRZ OTDM. And we found that in MDRZ OTDM technology the trnasmission distance without repeater is more than the RZ OTDM technology. RZ OTDM has transmission distance is only upto 300 km with acceptable BER and Q factor value.

And also compare performance of the MDRZ OTDM system by using single and cascaded modulators at receiver end. Among the the single EAM, double EAM, single MZM and double MZM modulator the double MZM gives the best result of transmission distance 2400 km without regenrator with accepatable Q factor value 5.51595 and BER $4.42527*10^{-9}$ at 0 dBm input power.

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