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Study of various parameters of MZM and OPM modulators by observing optical spectrum BER and Eye diagram

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Introduction : ROF technology has emerged as a cost effective approach in which the central site and multiple number of remote sites are connected by using optical fiber. It is a technology by which microwave signals are distributed by means of optical components and techniques
Radio-over-Fiber technology uses optical fiber links to distribute modulated RF signals from BS to Remote Antenna Unit (RAU). In narrowband communication systems, RF signal processing functions such as frequency up-conversion, carrier modulation, and multiplexing are performed at the BS and then fed into the antenna

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Key words: RoFSO, EAM, MZM, BER.

MZM : A Mach-Zehnder modulator is used for controlling the amplitude of an optical wave. The input waveguide is split up into two waveguide interferometer arms. If a voltage is applied across one of the arms, a phase shift is induced for the wave passing through that arm. When the two arms are recombined, the phase difference between the two waves is converted to an amplitude modulation.
This is a multiphysics model, showing how to combine the Electromagnetic Waves, Beam Envelopes interface with the Electrostatics interface to describe a realistic waveguide device.

OPM : Optical phase modulator (OPM) is an optical device in which a signal-controlled element 8exhibiting the electro-optic effect is used to modulate a beam of light. The modulation may be imposed on the phase, frequency, amplitude, or polarization of the beam. Modulation bandwidths extending into the gigahertz range are possible with the use of laser-controlled modulators.

The electro-optic effect is the change in the refractive index of a material resulting from the application of a DC or low-frequency electric field. This is caused by forces that distort the position, orientation, or shape of the molecules constituting the material. Generally, a nonlinear optical material (organic polymers have the fastest response rates, and thus are best for this application) with an incident static or low frequency optical field will see a modulation of its refractive index.

The simplest kind of EOM consists of a crystal, such as lithium niobate, whose refractive index is a function of the strength of the local electric field. That means that if lithium niobate is exposed to an electric field, light will travel more slowly through it. But the phase of the light leaving the crystal is directly proportional to the length of time it takes that light to pass through it. Therefore, the phase of the laser light exiting an EOM can be controlled by changing the electric field in the crystal.

The voltage required for inducing a phase change of is called the half-wave voltage (. For a Pockels cell, it is usually hundreds or even thousands of volts, so that a high-voltage amplifier is required. Suitable electronic circuits can switch such large voltages within a few nanoseconds, allowing the use of EOMs as fast optical switches.

Two different modulator has been studied under the effect of XPM. A simulation models has been developed and run on OPSIM. These two modulator has been studied by varies parameter like attenuation , beam distance , amplifier ,transmission powar, bit rate, etc and the initial values are

Channel Frequencies	193.025, 193.075 THz
Bit Rate	10 Gbps
Fiber Length	200 km
Ref frequency for loss	193.05 THz
Dispersion	-2 to 5 ps/nm-km
PIN efficiency	0.75
Fiber non linearity coefficient	1.8

The developed models have been simulated through OPTSIM. The analysis has been done by observing optical spectrum BER and Eye diagram for both modulation.

1.1 TRANSMITTED OPTICAL SPECTRUM

The following fig show the mzm transmitted signal optical spectrum where the graph is between frequency and data bits. The graph show that frequency increase with low rate is transmitted and the peak become high in mid of frequency rate.

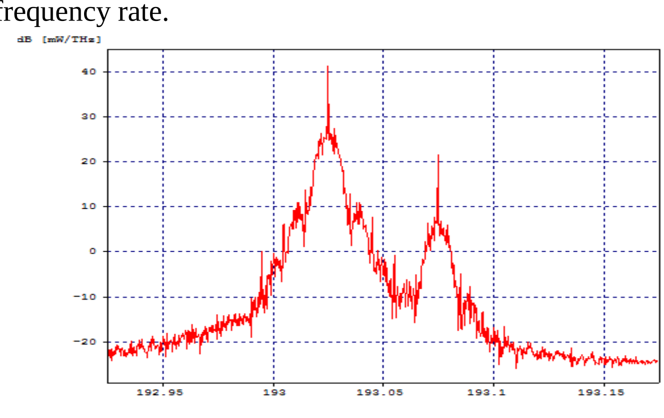

Fig 1.1(a) MZM transmitted signal optical spectrum

The following graph show the opm transmitted signal optical spectrum where the peak generated by the transmitted data is sharp and the signal we received is clear with no distortion or noise.

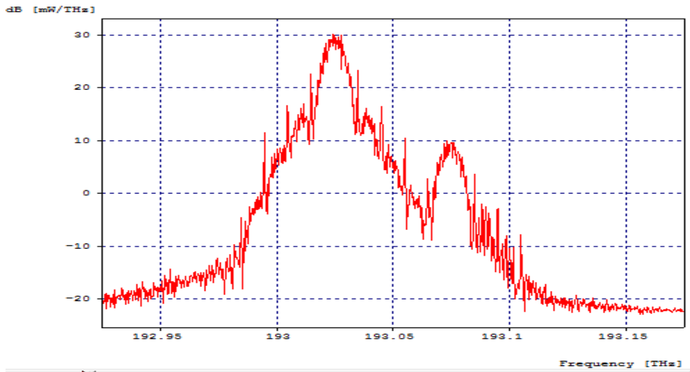

Fig 1.1(b)OPM transmitted signal optical spectrum

It is visible that peak generated through MZM are accurate and sharp.

RECEIVED OPTICAL

Optical spectrum is observed for different values of dispersion. This graph show the received signal spectrum from MZM. In this we observe that as the frequency increases the bit rate of the signal goes down and we recived the accurate and sharp peak of the signal

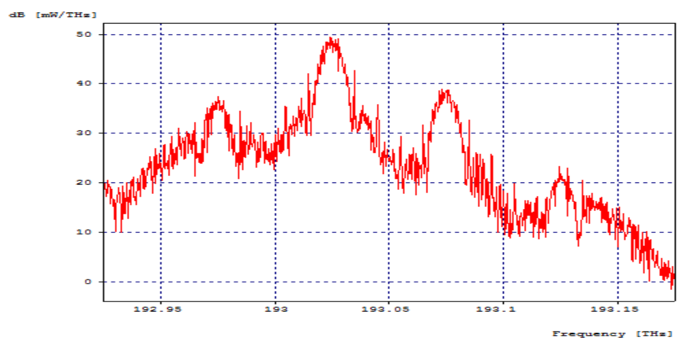

Fig 1.2(a)MZM received signal

In the following fig we can see that received waves from opm signal optical spectrum suddenly got decrease when the frequency become very high and the signal we received is sharp and accurate.

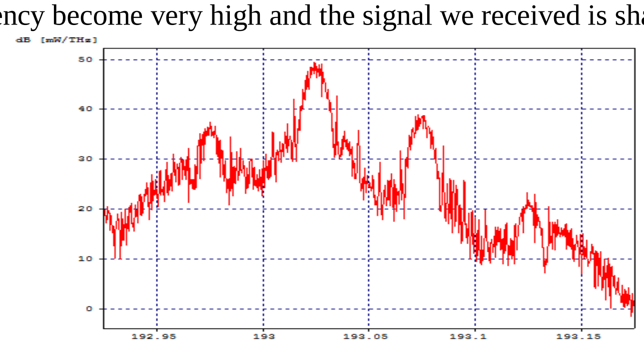

Fig 1.2(b OPM received signal

Received spectrum at disp 1ps/ns/km

In this when we increase the dispersion value i.e 1ps/ns/km the signal become more accurate and sharp and the level of wave i.e wave will show after 0mh/ths.in opm.

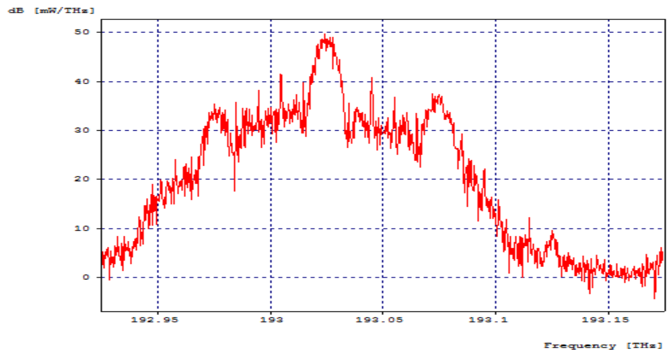

Fig 1.3(a) OPM received optical spectrum

In mzm received optical spectrum at 1ps/ns/km the sharp wave we observed and the wave level will be before 0mh/ths. As we increase the level of frequency the wave will comes to 0db and become constant.The frequency increase the level of waves goes down. As shown in fig below.

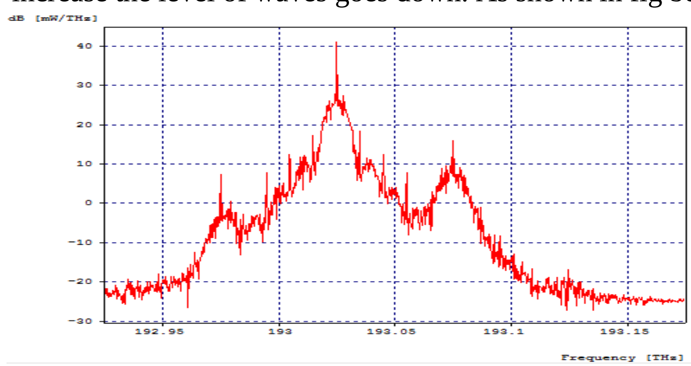

Fig 1.3(b) MZM received optical spectrum

Received optical spectrum disp at 3 ps/ns/km

At 3ps/ns/km the waves will display at 0db in both mzm and opm and as the frequency level increase the wave become constant at 0 db in both mzm and opm.

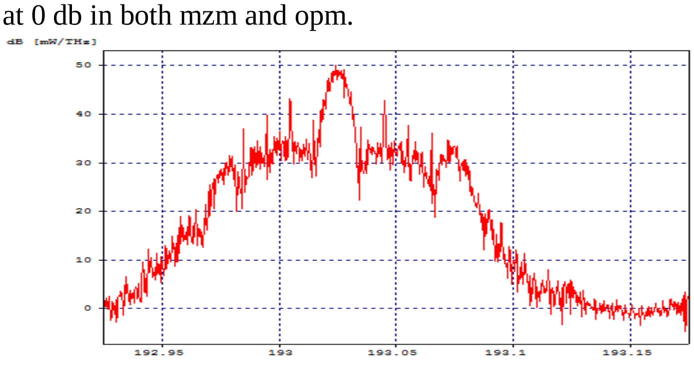

Fig 1.4(a) OPM received optical spectrum

In the fig 2.5 we observe that the level of signal wave that we received goes down from 0db this e start from the negative value nd we received the wave from negative values and at 0db the waves are very high and sharp and when we increase the frequency the waves become constant and it gets decreases from its level of starting.

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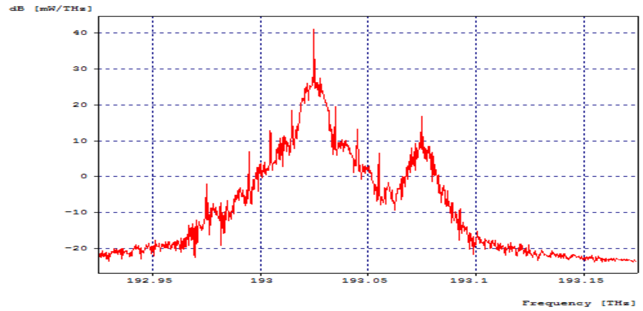


Fig 4.4 (b)MZM received optical spectrum

1.2 Bit Error Rate Comparision

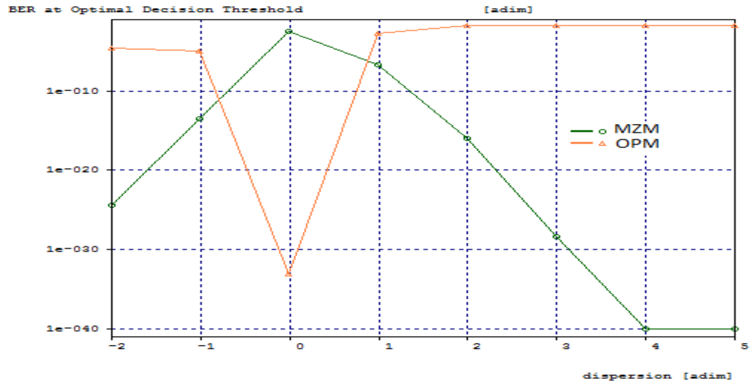


Fig 4.5 bit error rate

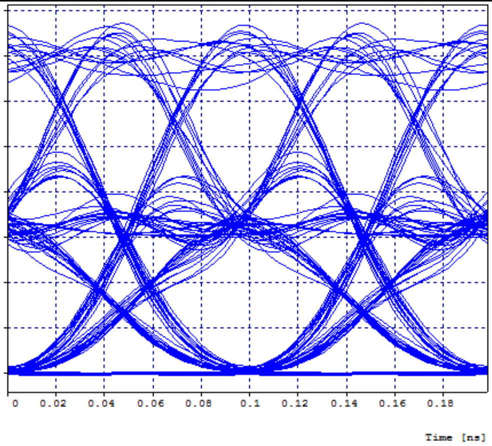
When we compare the bit error rate of both modulator i.e MZM and OPM we observe that the performance level of OPM is better then MZM. At 0db both MZM and OPM the BER level is same both become constant and from this OPM level goes increases and MZM goes decrease. And at a point both come constant

1.2 EYE DIAGRAMS

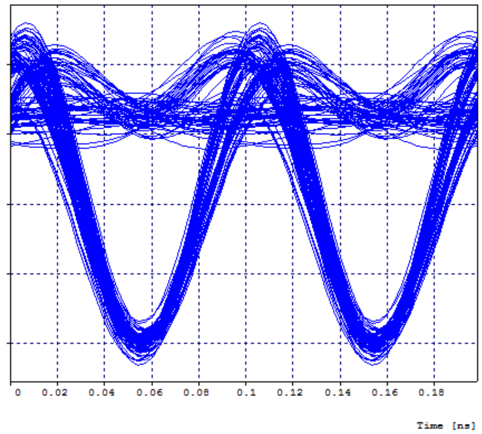
Eye diagrams taken for MZM & OPM based signals at different values of distance, bit rate and aperture area are presented in figure 4.6 . An eye diagram carries an important information about the signal. Its an indicator of the quality of received signal.

The opening of eye diagram is clearly visible which shows the quality of signal. In the first table MZM & OPM eye diagrams are compared at the dispersion of 0,1,2 & 3 ps/ns/km respectively. From eye diagrams it is reported that signal modulated through MZM provides improved performance compared to OPM. Further signal quality is acceptible at 1 &3 ns/ps/km for MZM and quality gets deteriorated for greater distances. Eye diagrams

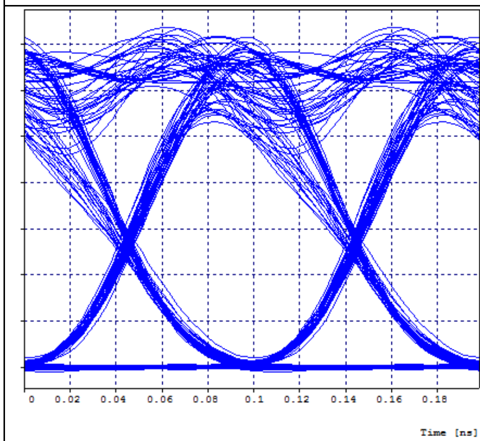
offer output in agreement with the previous results. It is observed that MZM based signal transmission is superior to OPM based signal



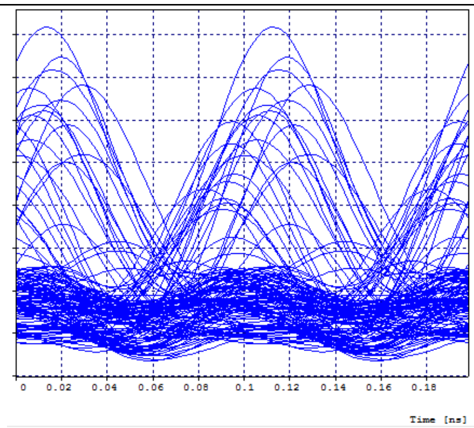
MZM at disp 0 j j ju



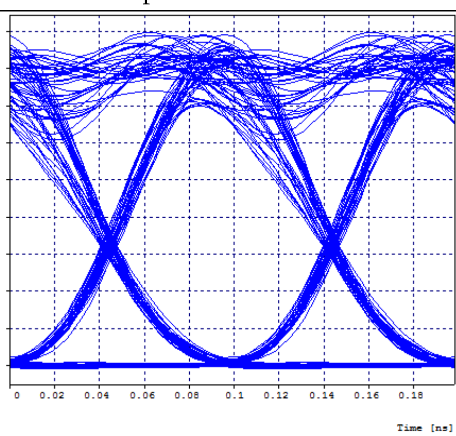
OPM at disp 0



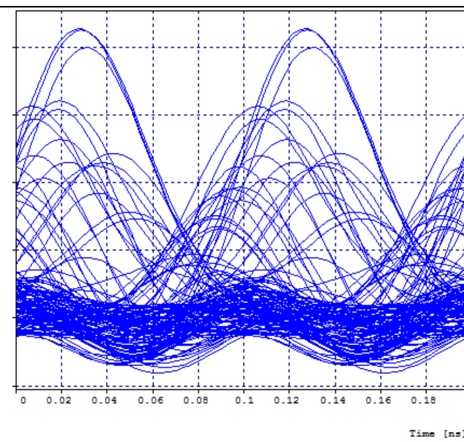
MZM at disp 3



OPM at disp 3



MZM at disp 4



OPM at disp 4

Fig 4.6 eye diagram

In the this table MZM & OPM eye diagrams are compared at the bit rate of 10 Gbps respectively The signal modulated through MZM provides improved performance compared to OPM. Further signal quality is acceptible at 10 Gbps for MZM and quality gets deteriorated for greater bitrates. Eye diagrams offer output in agreement with the previous results. It is observed that MZM based signal transmission is superior to OPM based signal.

Channel Frequencies	193.025, 193.075 THz
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CONCLUSION :

RoFSO based links are capable of meeting the continuous increasing demand of data transmission at ultra fast rates. An analysis of MZM & OPM modulators of RoFSO links for campus area networks has been presented. It is concluded that MZM performs better than OPM. MZM can support quality transmission at 500 meter larger distance with 1.2 Gbps enhanced data rates compared to OPM. Further it yields output with 5 dB higher power. Besides it, eye diagrams observed are in accordance with the theoretical and simulative results, showing the enhanced performance of MZM based transmission. . MZM can support quality transmission at 500 meter larger distance with 1.2 Gbps enhanced data rates compared to OPM.

FSO is growing with very high pace because of its low cost than fiber cables and in rapid installations time. FSO allows flexibility and fast data transmission upto several Gbps. The global market for free space optics based application was anticipated to be 2-4 billion connections by 2005. It is anticipated that by 2020 there will be 50 billion connections [11]. The primary driving application are metropolitan optic network, access and enterprize connectivity.

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