ACM IN OPTICAL FIBRE

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Abstract: **High-speed fibre optical communication links have become more popular for personal mobile applications. This is a consequence of the increasing demand from the personal information service boom. Compared to the radio frequency domain, optical fibre communication offers much higher speeds and bit rates per unit power consumption. Focus on the modulation aspects of the optical communication, this thesis try to improve the channel immunity by utilizing optimized modulation to the channel. Modulation schemes such as Quadrature Ampitude Modulation (QAM4), QAM16, QAM64, QAM256 have been validated. The combined power and bandwidth requirements suggest that the adaptive modulation schemes can provide reliability when deployed in a real time channel, resulting in improved system performance.**

Keywords: **Opticle Fibre, QAM.**

I. INTRODUCTION

There are two trends which are ever evident in today's optical networks: (i) the transmission data rate per channel has been fast increasing and rapidly approaching 100 Gb/s, and (ii) the dynamically reconfigurable network has gradually become a reality thanks to deployment of optical Add/Drop Multiplexers (OADM). These trends place significant challenges to the high-speed transmission link for the optical networks. In particular, as the transmission rate approaches 100 Gb/s, conventional meticulous per-span optical dispersion compensation becomes too costly and time-consuming if not possible, as the dispersion compensation requires precise fiber dispersion measurement and precise matching of the dispersion compensation cross broad wavelength range. Most importantly, a dynamically reconfigurable network mandates a fast link setup and leaves the manual optical dispersion compensation impractical. Coherent optical orthogonal frequency-division multiplexing (CO-OFDM) has been recently proposed in response to the above-mentioned challenges. OFDM is a multicarrier transmission technique where a data stream is carried with many lower-rate subcarrier ones. It has emerged as the leading physical-layer interface in wireless communications in the last decade. OFDM has been widely studied in mobile communications to combat hostile frequency-selective fading and has been incorporated into wireless network standards (802.11a/g WiFi, HiperLAN2, 802.16 WiMAX) and digital audio and video broadcasting (DAB and DVB-T) in Europe, Asia, Australia, and other parts of the world. CO-OFDM combines the advantages of 'coherent detection' and 'OFDM modulation' and posses many merits that are critical for future high-speed fiber transmission systems. First, the chromatic dispersion and polarization mode dispersion (PMD) of the transmission system can be effectively estimated and mitigated. Second, the spectra of OFDM subcarriers are partially overlapped, resulting in high optical spectral efficiency. Third, by using direct up/down conversion, the electrical bandwidth requirement can be greatly reduced for the CO-OFDM transceiver, which is extremely attractive for the high-speed circuit design, where electrical signal bandwidth dictates the cost. At last, the signal processing in the OFDM transceiver can take advantage of the efficient algorithm of Fast Fourier Transform (FFT)/Inverse Fast Fourier Transform (IFFT), which suggests that OFDM has superior scalability over the channel dispersion and data rate. CO-OFDM was first proposed to combat chromatic dispersion. It was soon extended to polarization-diversity detection, and has been shown to be resilient to fiber PMD. The first CO-OFDM transmission experiment has been reported for 1000 km SSMF transmission at 8 Gb/s, and more CO-OFDM transmission experiment has quickly been reported for 4160 km SSMF transmission at 20 Gb/s. The first COOFDM transmission with polarization-diversity has recently been demonstrated showing record PMD tolerance. In the same report, the first experiment of nonlinearity mitigation has also been reported for CO-OFDM systems. Although this paper places a focus on the coherent flavour of optical OFDM, we would like to stress that the direct detection flavour of optical OFDM has also been actively pursued by other groups, with applications including multimode fiber transmission, short-haul single-mode transmission, and long haul transmission.

The proposed flow chart of system is shown in figure shown in appendix.

II. RESULT

In case of adaptive code modulation as discussed, depending upon the SNR of received signal modulation type is selected. Quadrature amplitude modulation is selected for this purpose. Different types of QAM are used like 4-QAM, 16 QAM, 64 QAM and 256 QAM and selection amongst these is done on the basis of SNR. The simulation of proposed work is done by using ‘’OptiSystem’’ tool which dedicatedly designed for simulation and experiments on optical fiber.

OptiSystem is an optical communication system simulation package for the design, testing, and optimization of virtually any type of optical link in the physical layer of a broad spectrum of optical networks, from analog video broadcasting systems to intercontinental backbones. For adaptive code modulation, as discussed above OFDM in optical fiber is implemented. A generic CO-OFDM system includes five basic functional blocks: OFDM transmitter, RF to optical (RTO) up-converter, optical link, optical to RF (OTR) down converter, and OFDM receiver. The above schematic demonstrates a 10 Gbps coherent 512-subcarrier 4-QAM OFDM system; however the input data for the OFDM modulator can have different modulation formats such as BPSK, QPSK, QAM, etc. At the transmission block, both modulation and multiplexing are achieved digitally using an inverse fast Fourier transform (IFFT). The subcarrier frequencies are mathematically orthogonal over one OFDM symbol period. A CW laser and two Mach- Zehnder modulators are used to up-convert the RF data to the optical domain. The signal is then propagated through the optical link and becomes degraded due to fiber impairments. A coherent receiver with a local oscillator is used to down-convert the data to the RF domain, and finally data is demodulated and sent to the detector and decoder for BER measurements. In this different QAM modulation techniques are used along with mach zender modulator for optical modulation. Complete system model is shown in figure 5.2. Components and parameters used in this are discussed in next section. Optical fiber of 50 km length is used and system is tested for 10 Gbps bit rate. The complete system model is shown in appendix. Initially, number of bits is set to 2 in QAM sequence generator and system is analysed. After modulation the QAM electrical signal by CW laser to convert the electrical signal to optical signal, the optical spectrum analyzer is shown in figure 1. It shows at transmitter end before optical fiber the power is confined into a small wavelength region. Figure 2 shows power spectrum after transmitting through optical fibre. Notice the width of main lobe in the spectrum. After passing through optical fibre, main lobe width is increased.

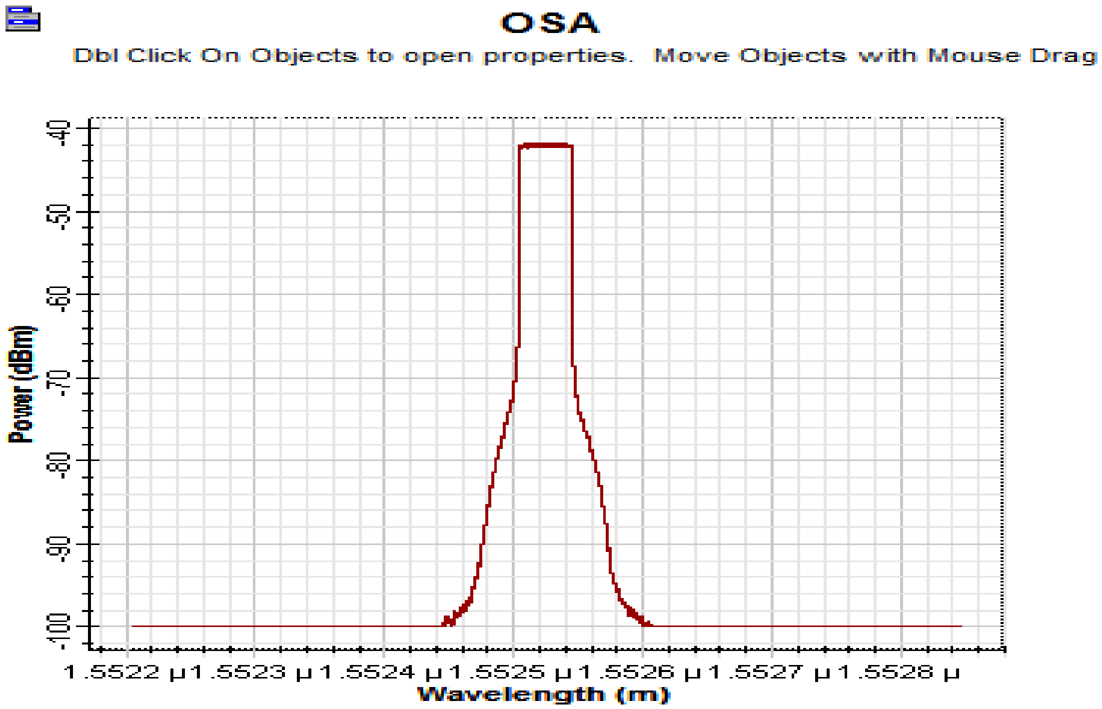


Figure 1: Power spectrum of optical modulated signal

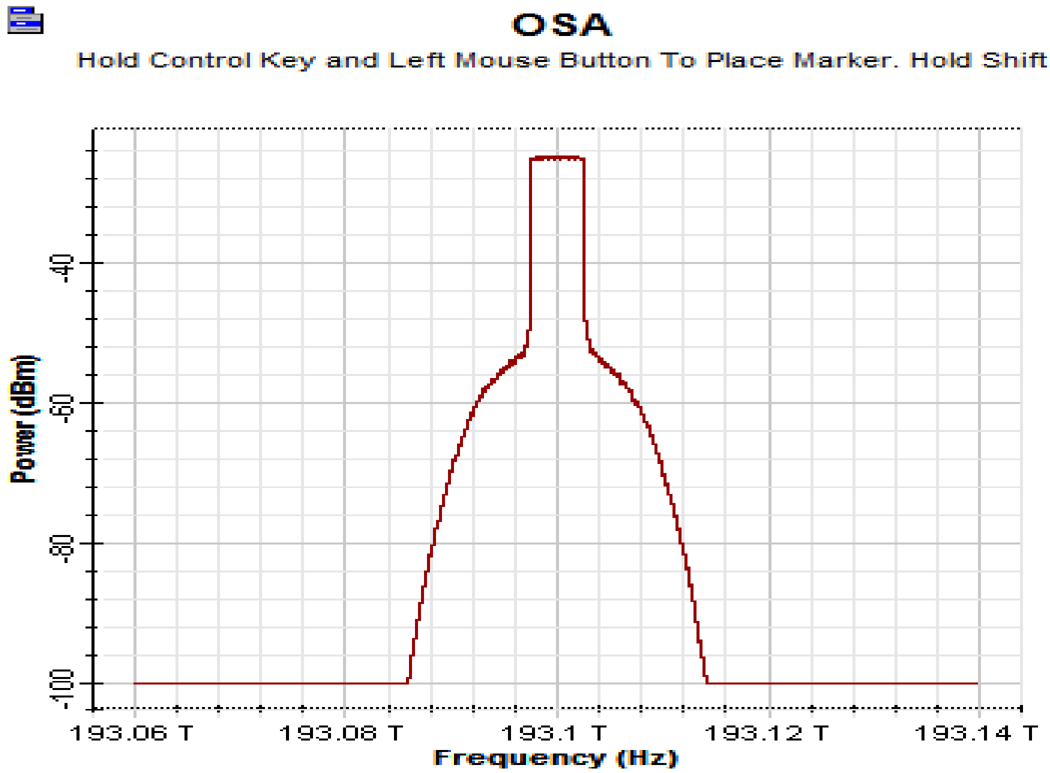


Figure 2: Power spectrum after transmitting through optical fibre

The bit error rate in case of 4 QAM is shown in figure 2. the minimum BER in this case is 0.483365. Log of bit error rate is minimised at 0.3157 and remains constant further.

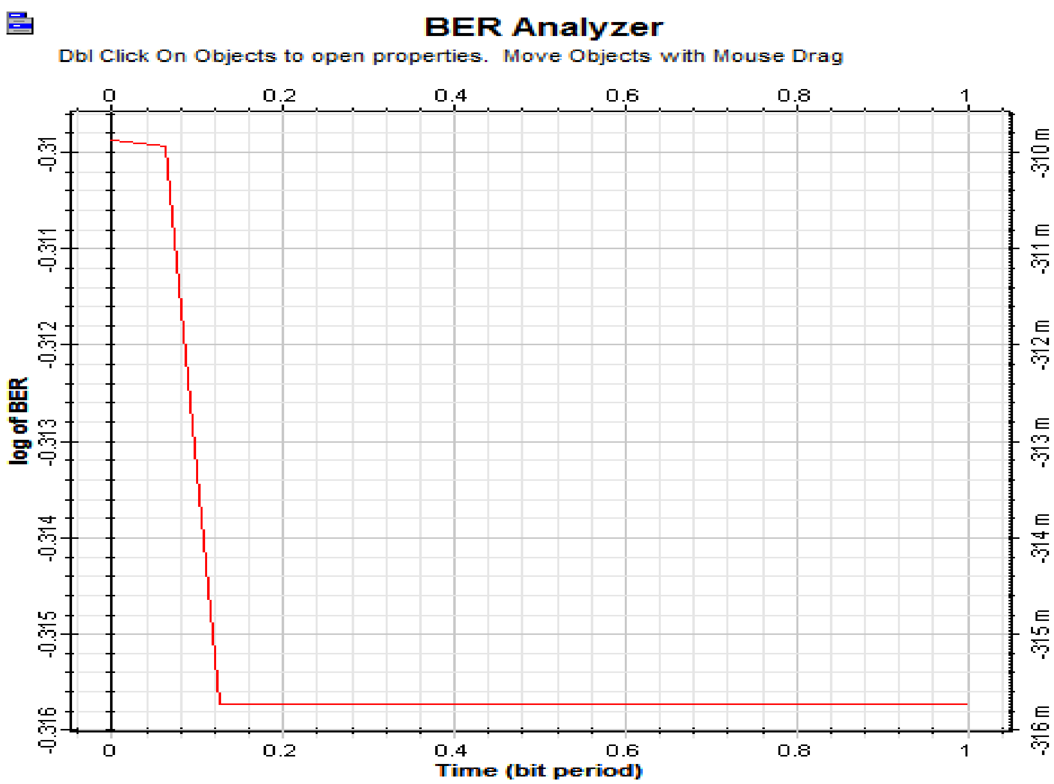


Figure 3: BER curve of the output

Bit error rate for 16,64 and 256 QAM is shown in figure. Now for adaptive code modulation initially modulation with 4 QAM is started and depending upon the BER, modulation switches to other technique. The condition has been defined after surveying the BER of all modulation technique above.

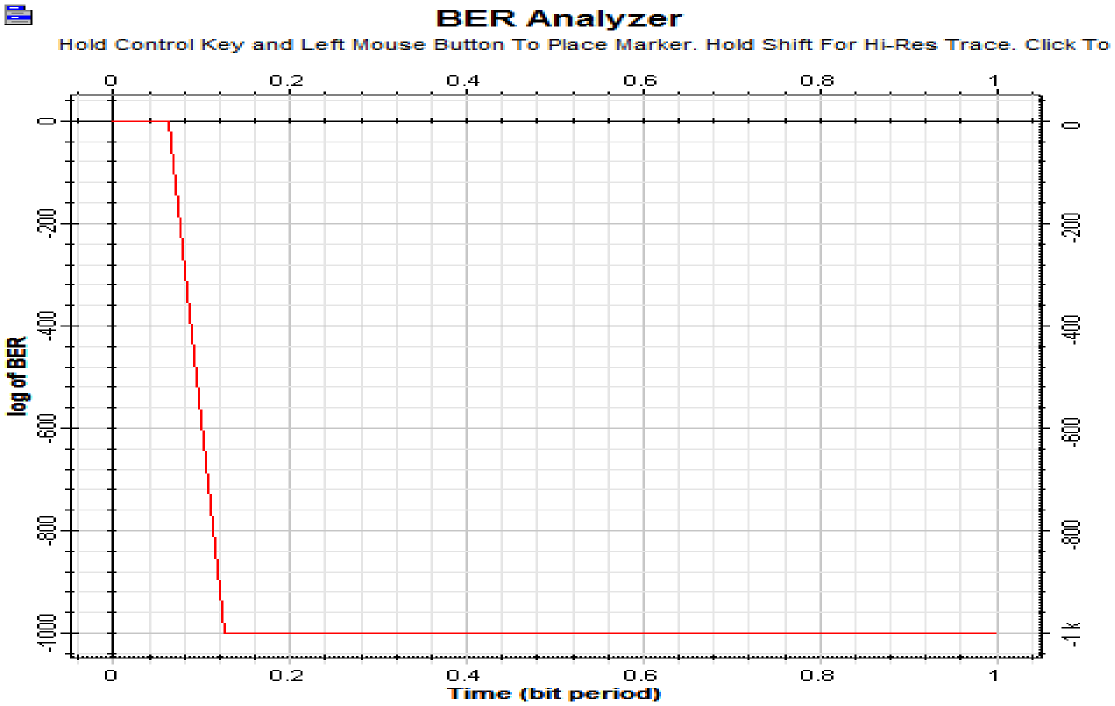


Figure4 (a): Bit error rate curve for 16 QAM

The condition developed is as:

If BER<0.483 Switch to QAM16 If BER>0.483 Switch to QAM256

After this switching the final BER and its constellation diagram is shown in figure 5(a) and (b).

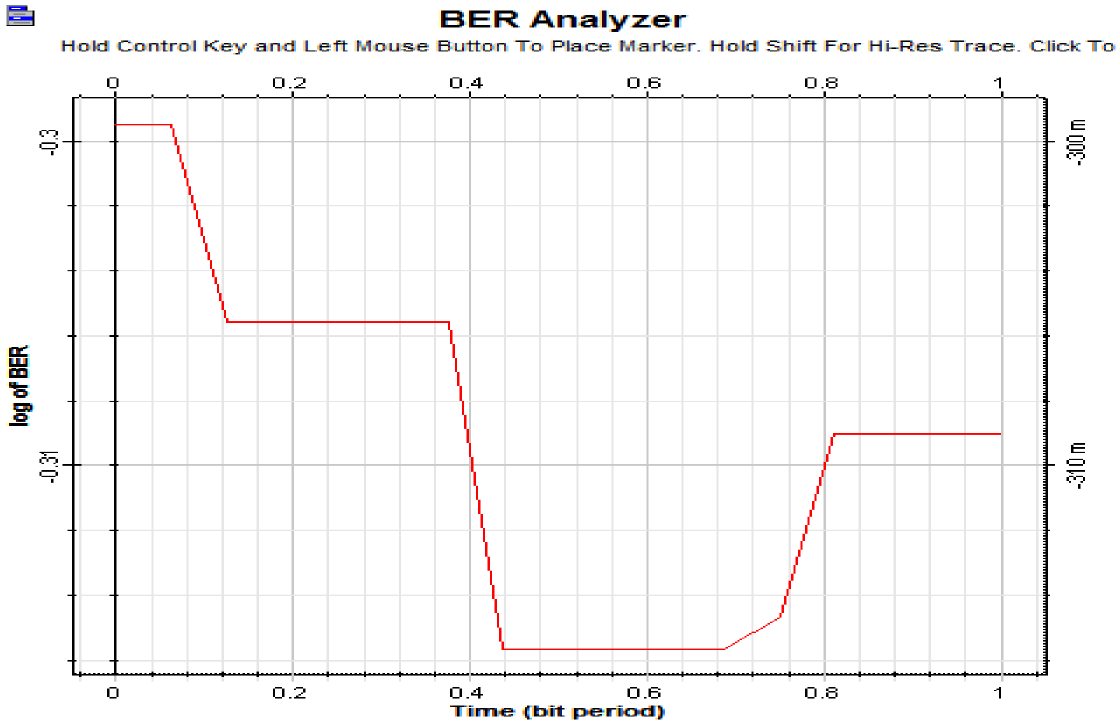


Figure 4(b): Bit error rate for 64 QAM

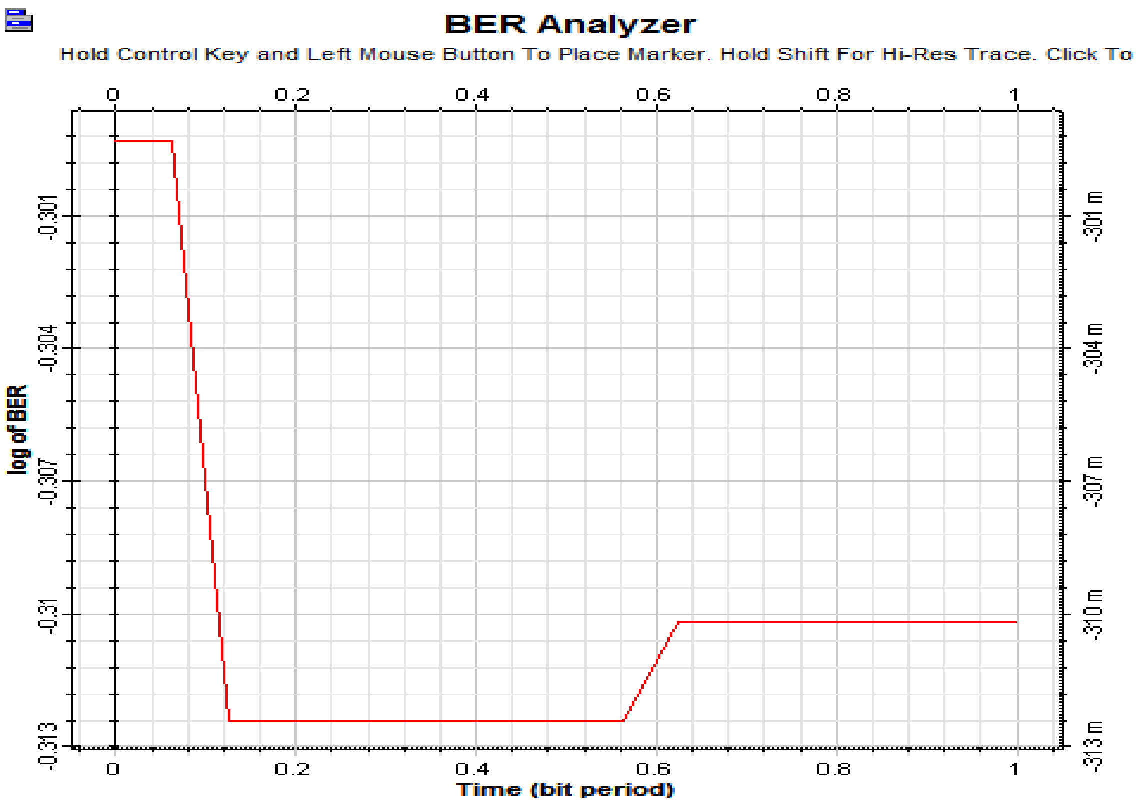


Figure 4(c): Bit error rate of 256 QAM

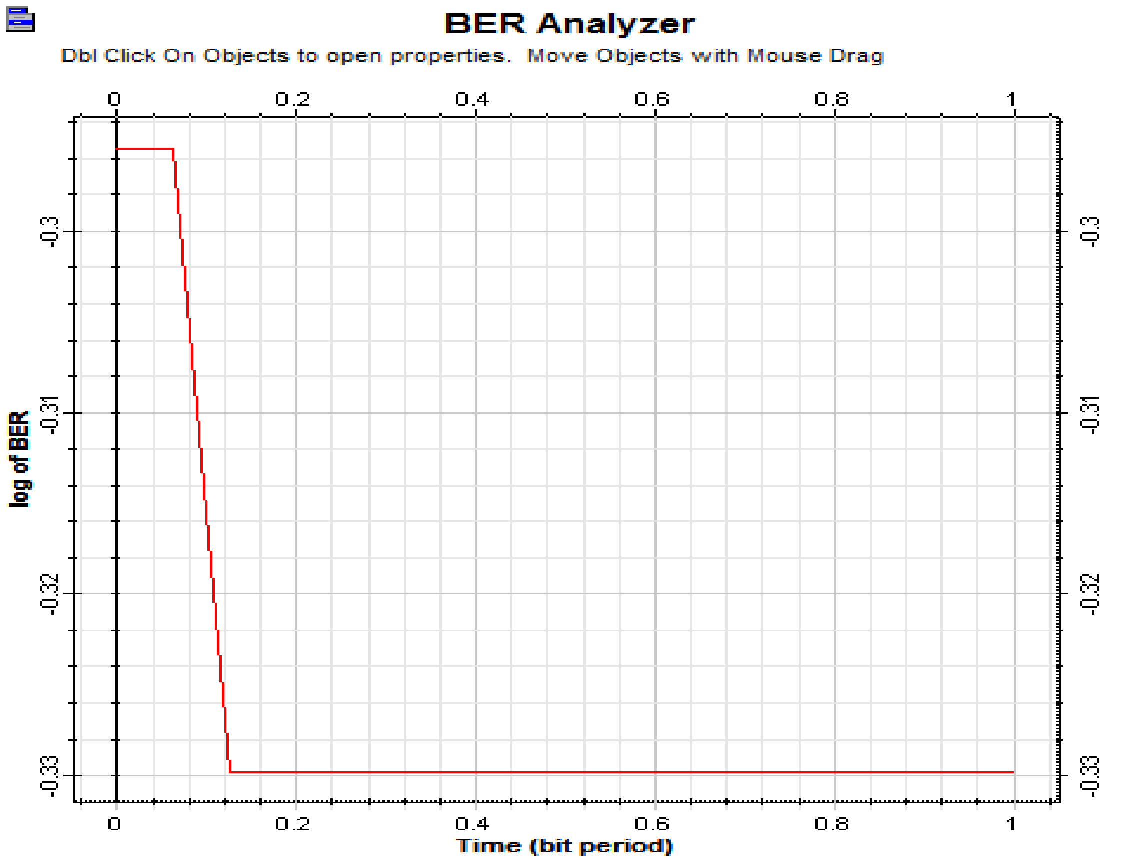


Figure5. (a): BER after adaptive switching

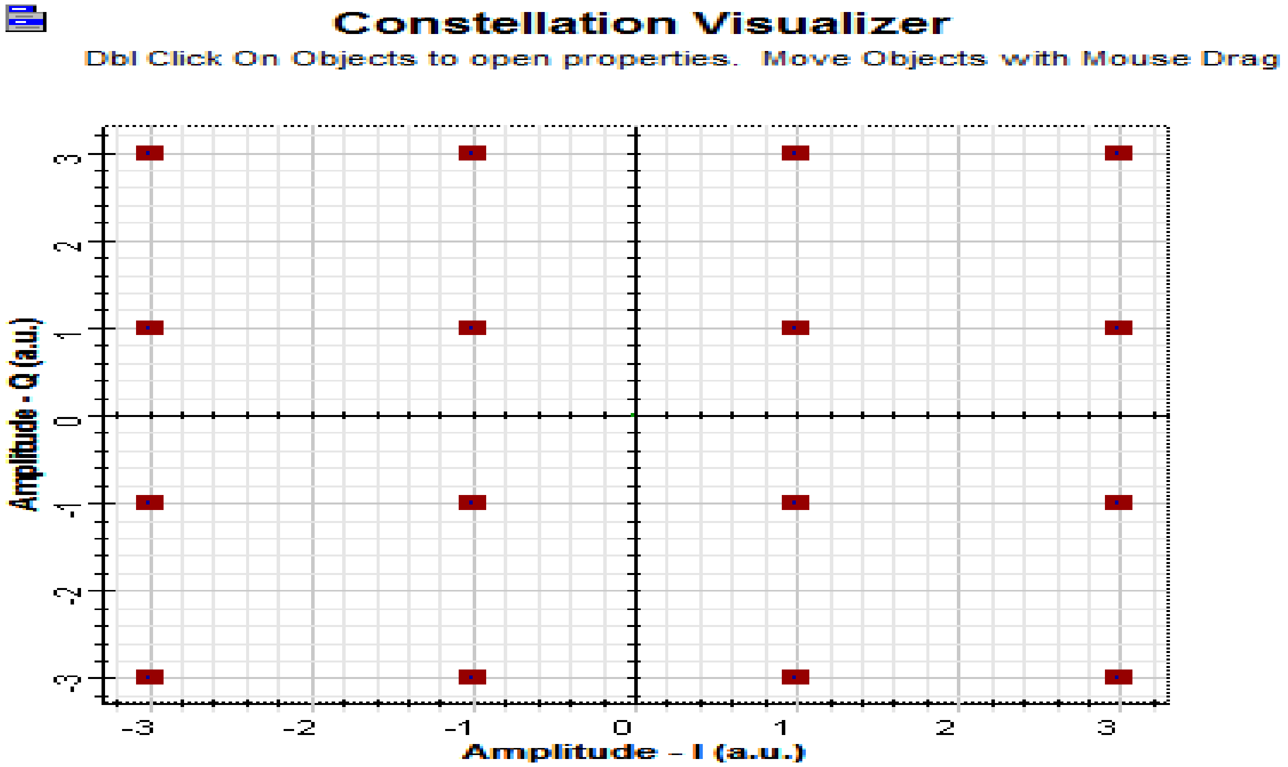
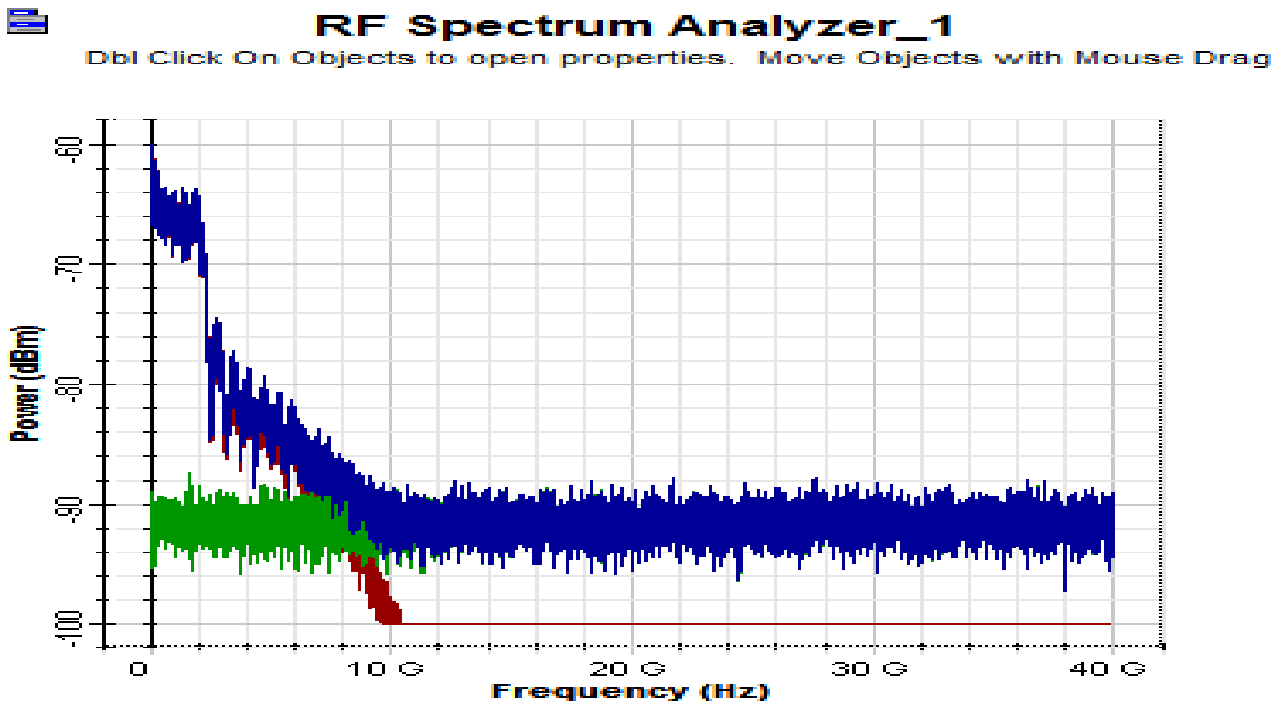


Figure 5(b) Constellation diagram of ACM

Constellation diagram shows that it resembles with 8 QAM after switching. The proposed algorithm is implemented into VB script in optisim which is placed in appendix below. The RF spectrum of signal and noise is shown in figure 6.



III. CONCLUSION

The objective of this paper was to design the OFDM i.e. orthogonal frequency demodulation in optical fiber. In OFDM we have selected coherent OFDM for optical fibre. Various modulation techniques like QAM4, QAM16, QAM64, and QAM256 are implemented in optical fiber. The simulation is done in Optisim tool which provides user a freedom to customize the components also. We have further modified our design for adaptive code modulation. Depending upon the BER at the output, modulation technique switches to minimize the BER.

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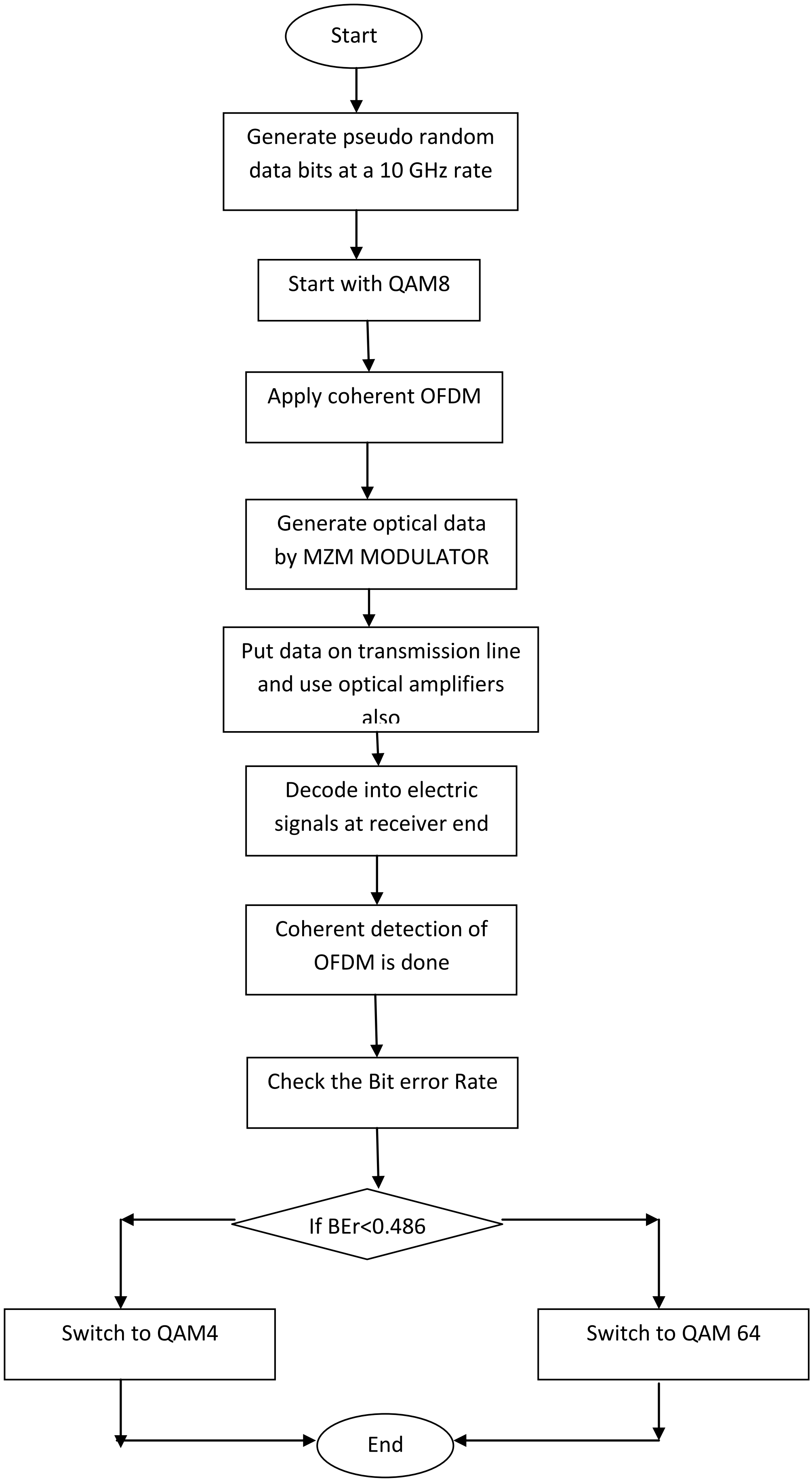
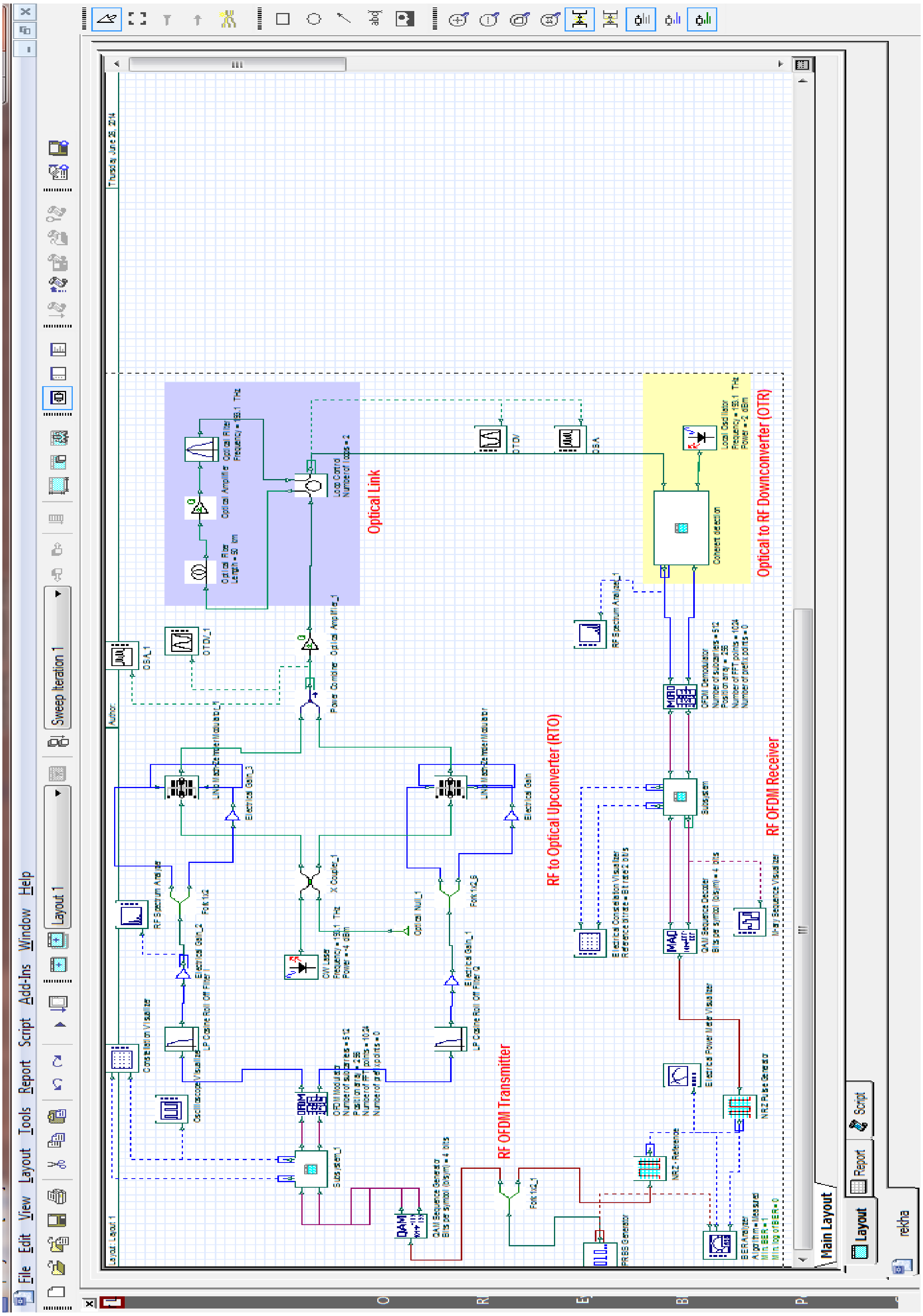
Flow Chart:




Optical Link
RF to Optical Upconverter (RTO)
Optical to RF Downconverter (OTR)
RF OFDM Receiver
RF OFDM Transmitter
Main Layout