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Implementation of Green radio communication networks applying radio-over-fibre (ROF) technology for wireless access

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ABSTRACT

This paper aims to simulate the transmission of wireless and baseband RF signals via fiber for a long distance in high quality, consuming a low-power budget using Optisystem Software. ROF has achieved an effective delivery of wireless and baseband signal, and has also reduces the power consumption. Whereas recent fast growing broadband access technology through wireless is WiMAX (Worldwide Interoperability for Microwave Access). In this Paper, the ROF implements into WiMAX. And we will be carried out digital modulation techniques 4 –QAM .It shows the advantage of transmitting signals via fibre rather than via free space in terms of optical spectrum and Constellation Diagram.

Key Words: OFDM, QAM, CONSTELLATION DIAGRAM

1. INTRODUCTION

There has been a huge increase in the demand for high speed communication with mobile connectivity. Earlier high speed communication was distributed through wired connections, particularly optical fiber, while mobile communication is supported via wireless Infrastructure. But the wireless network has severe performance deterioration due to interference, low data rate etc. The design of communication networks that provides high-speed and mobility is facilitated by radio over fiber networks.[1]

Orthogonal frequency division multiplexing (OFDM) has played an important role in wireless communication since many years. Recently optical OFDM has emerged as a new trend in optical communication networks to overcome the effects of dispersion in optical fiber [2]. Optical OFDM is mainly classified into direct detection system and coherent detection system. In direct detection system a single photodiode is used, while in coherent detection the principle of optical mixing is utilized with local oscillator and optical hybrid.

OFDM uses different subcarriers to send low rates in parallel data streams. The M-array Quadrature Amplitude Modulation (QAM) is used to modulate the subcarriers before it is being transferred on a high frequency microwave carrier. In OFDM multilevel Quadrature amplitude modulation (MQAM) provides the delivery of very high data rates. It reduces the amount of dispersion produced by multipath delay. Also OFDM symbols use a guard interval, which eliminates Inter-Symbol Interference (ISI) produced by a dispersive channel [3].

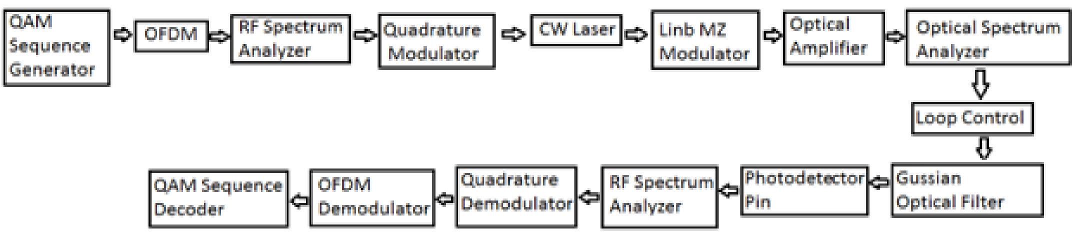

Figure 1: block diagram of OFDM-ROF using QAM

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2. OVERVIEW SYSTEM DESIGN-PRINCIPLE OF OPERATION

The main idea behind this project is to incorporate the OFDM modulation technique to the Radio over Fiber (ROF) system networks [4]. It has a good amount of carrier spacing due to which the sub channels can maintain the orthogonality, although each sub-channels does experience overlap within the system. Hence, there is no inter-sub-carrier interference with ideal OFDM systems.

In this project, the optical OFDM system model consists of four parts: OFDM transmitter, fiber optic link, photo-detector and OFDM receiver. To generate OFDM orthogonal signal at the base station (BS), it is to sweep the input signal and feeded into M-QAM sequence generator and OFDM modulator. In the optical link of LiNb modulator the electrical wave signal from OFDM transmitter are combined with the continuous wave light from CW laser. These two waves are then modulated by LiNb modulator to form the optical signal. After that the signal is sent through the optical fiber upon the direction of light propagation. [5] The use of a laser means that multi- gigahertz modulation is possible, and the stimulated light emission is assumed to be directional. Length of the fiber for transmission link is of 50 Km with modulation type 4 QAM/ 4 bit per symbol. By the implementation of the receiver, PIN photodiode is used to directly convert optical power into electrical power at the receiver end. The signal is then recombined again in the OFDM receiver to get the original data back.[6].

In the transmitter section a pseudo-random binary sequence (PRBS) block produces a random bit sequence as the input of the OFDM signal. Then it is connected to an M-array QAM sequence generator and then the signal is sent to the Quadrature modulator. After that the signal is mixed with the light wave generated by the Continuous Wave (CW) laser by an external modulator of LiNb MZ modulator [7]. The signal that is generated from the LiNb MZ modulator is connected to a fiber optic transmission link. Figure 2 shows the transmitter block of OFDM-RoF.

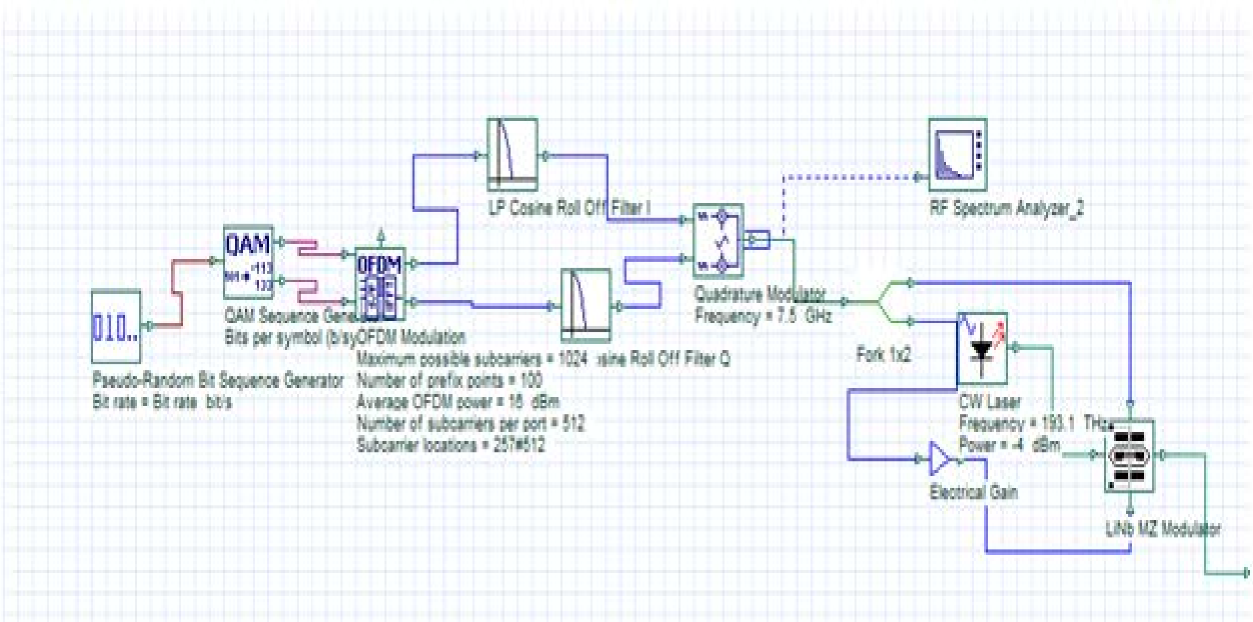

Figure 2: transmitter part

Table 1: OFDM modulator parameters

]o[-Number of sub carriers	512
Maximum possible carriers	1024
Average OFDM power	16dBM
Number of prefix points	16

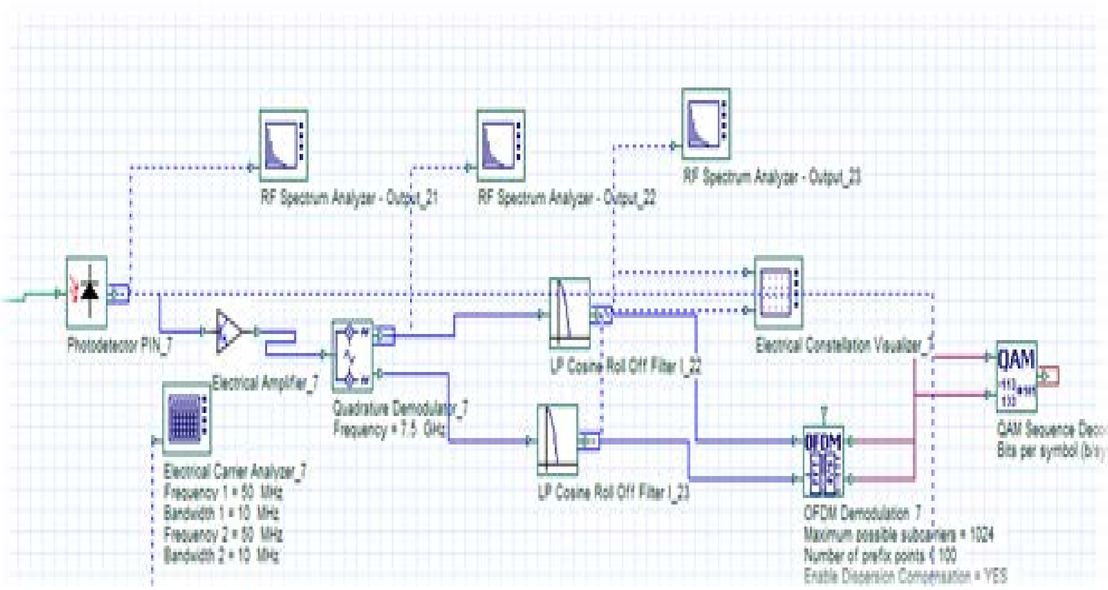

Figure 4: The OFDM- RoF Receiver Model Section

3. Results and Discussion

We present the simulation results from the system design simulated on optic system 14.0. Here the simulation only considers some important combinations of parameters that are dominant in optical data transmission for project simulation purpose. We have shown the constellation diagrams at various different length of the transmission. The system is analyzed and simulated in optisystem14.0 software. We have seen that while we are increasing the propagation distance we are getting more distorted signal at the receiver side. The performance of system is Checked at 10 Gbps from the constellation diagram of 4 QAM decoder output, frequency domain OFDM signal, the signal after LiNb MZ modulator and the optical signal frequency domain in fiber link media for different distance (eg. 1000km,1250km,1500km). Distortion in received signal increase as propagation distance increase.

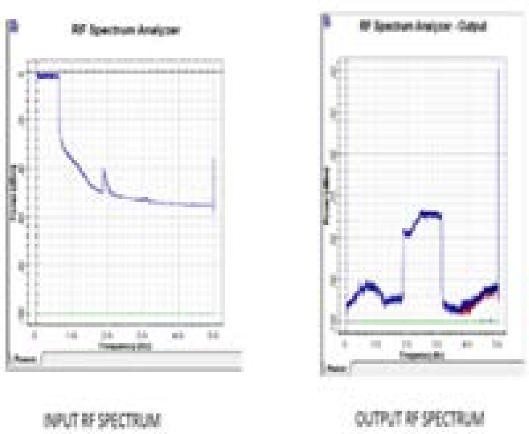

Figure 5: input vs output

The diagram shown in figure.6 shows the output of the analyzer after LP Cosine roll filter at both input and output side of the system.

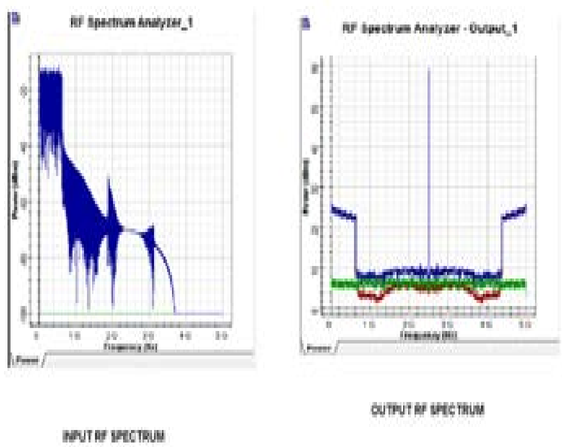

Figure 6: input vs output

From the output of Optical spectrum analyzer 1 that was Fed to the Quadrature modulator at the carrier of 7.5 GHz to give the output shown in figure 7.

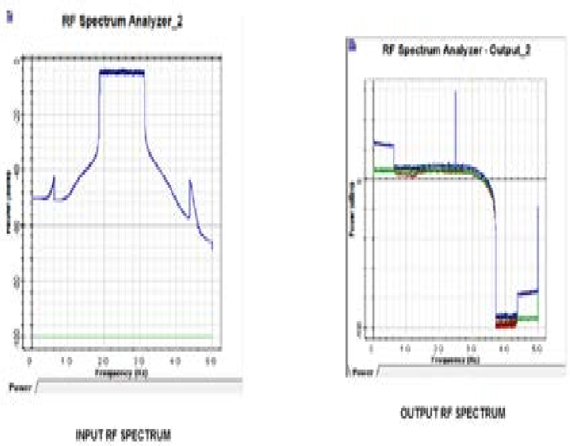

Figure 7: input vs output

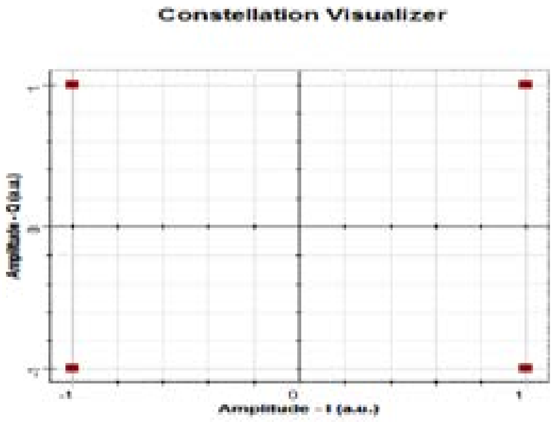

Figure 8: 4-QAM encoder constellation diagram

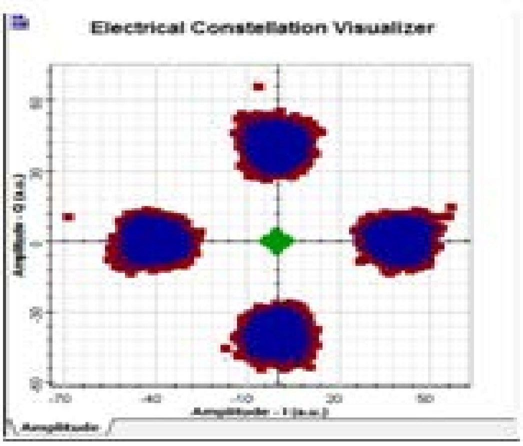

Figure 9: constellation diagram at 1000km.

The RF spectrum analyzer in between the Quadrature modulator and in phase component of the OFDM spectrum output is shown in the constellation diagram.

After propagating signal through 1000 km over fiber, the recovered signal constellation diagram at the RF OFDM receiver is shown in figure 8.

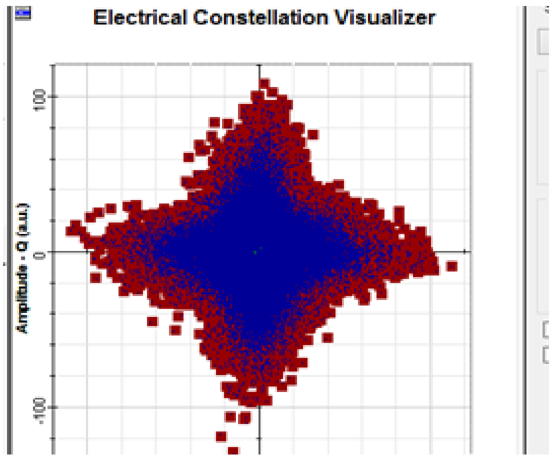

Figure 10: constellation diagram at 1250km

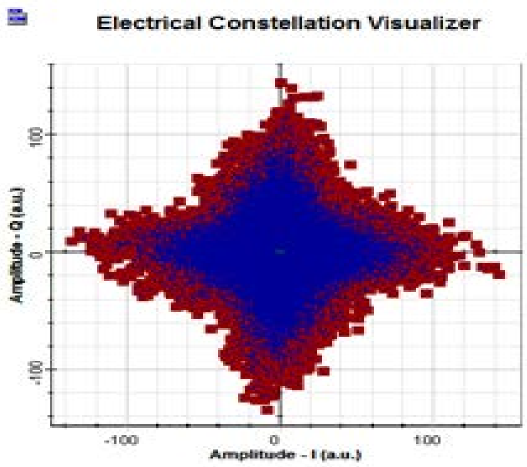

Figure 11: constellation diagram at 1500km

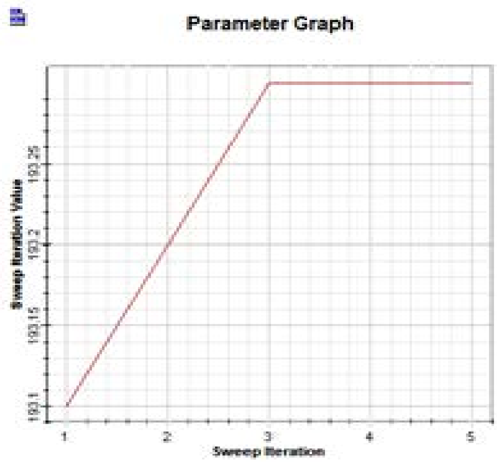

Figure: 12 plot of CW laser output with 5 iteration

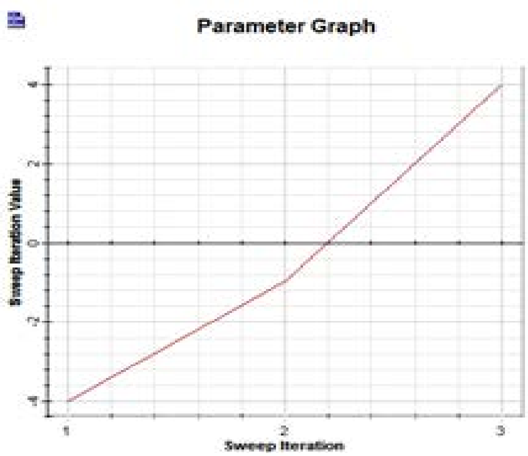

Figure 13: plot of CW laser output with 5 iteration

4. CONCLUSION

The paper presents OFDM – RoF system modulator demodulator system which transmits QAM-OFDM signal over optical fiber using optical simulation software, Optisystem 14.0. The system identification technique has been working with optical and electrical signal processing for performance improvement. Optical fibers with 50km length at various loop controls are used successfully to generate a 7.5GHz RF carrier from

RoF system network. This model will be useful to help improved the performance quality of the current RF signals wave which will become more useful in today's wireless communication network.

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