Comparative Analysis of Different Digital Modulation Techniques Using RoF in Optical Communication System

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***Abstract*—** As the demand for high broadband capacity and wide coverage network is rising exponentially, Radio over fiber is becoming an important technology for the wireless transmission. Simulation has been done by using opti system software version 7.0. In this paper we have compared different digital modulation techniques such as DPSK, CPFSK, OQPSK and FSK used in RoF system in terms of Q factor, bit error rate and eye opening with respect to wavelength, bit rate and fiber length.

***Keywords*—** DPSK (Differential Phase Shift Keying), CPFSK (Continuous Phase Frequency Shift Keying), OQPSK (Offset Quardrature Phase Shift Keying), FSK(Frequency Shift Keying), ROF(Radio Over Fiber).

I. INTRODUCTION

Subscriber's demands for high speed network at lower cost, this demand can be achieved by send ing the large data at higher speed. For this there is need of large bandwidth. We can send more data at larger transmission distance by using optical communication system. The information is send in the form of light through optical fiber as shown in Fig. 1

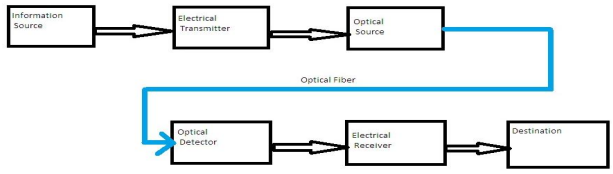

Fig.1: Block diagram of Optical Communication System

A Basic ROF system is consists of CS (central site) and BS (base station). Duplex operation (downlink-uplink) is main requirement of ROF System. At CS optical signal is transmitted by laser diode which is passing through the optical fiber reached at BS. By using photodiode this signal is received and converted into electrical signal. After amplification this signal is radiated by using antenna. This process is known as downlink transmission.

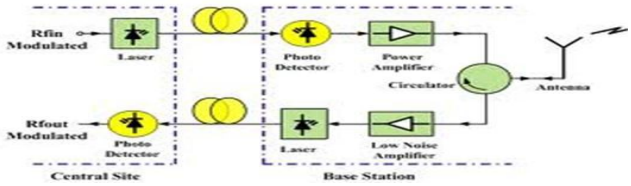

Fig. 2: Basic Diagram of ROF System

EXPERIMENTAL SETUP USING OPTISYSTEM

The experimental set up of RoF system using DPSK,CPFSK,OQPSK and FSK modulation techniques is shown in Figures 3(a),3(b),3(c),3(d). We have used two PRBS (pseudo random bit sequence) generators for modulating two different data signals. These data are used to modulate two different electrical carriers having frequencies 260GHz and 265GHz. These signals after passing through optical band pass filter (OBPF) are combined using electrical power combiner and this combined signal is used to modulate an optical carrier of frequency 193.1THZ using mach-zehnder modulator (MZM). This modulated signal has passed through 21km long of SMF (single mode fiber) and then amplified by using optical amplifier. After amplification an optical power splitter is used to split this optical signal into two signals. These optical signals are then passed through optical band pass filter (frequencies 193.119 THz, 193.120 THz respectively and bandwidth= 1.5 * Bit rate). At the receiving end an optical amplifier is passed through optical band pass filter (OBPF) to filter the upper sideband of optical signal which is then applied to the PIN photo-detector. This photo detector demodulate filtered optical signal and convert this optical signal directly into a baseband signal. Low pass filters (Cutoff frequency = .75 * Bit rate Hz) are used to filter higher frequency components. We have calculated the BER and Q factor at different transmission lengths. Output is observed using BER Analyzer and Eye Diagram Analyzer.

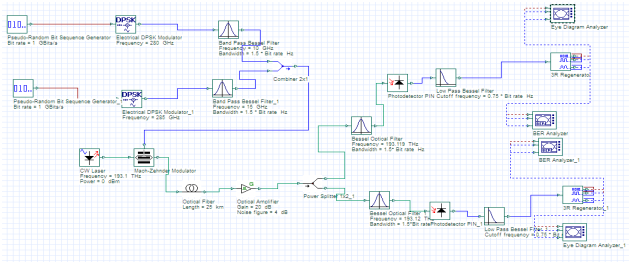

Fig. 3(a): RoF system using DPSK techniques

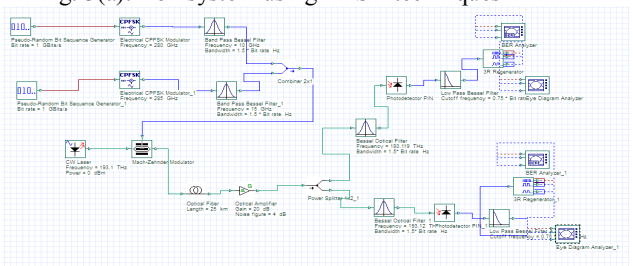

Fig. 3(b): RoF system using CPFSK technique

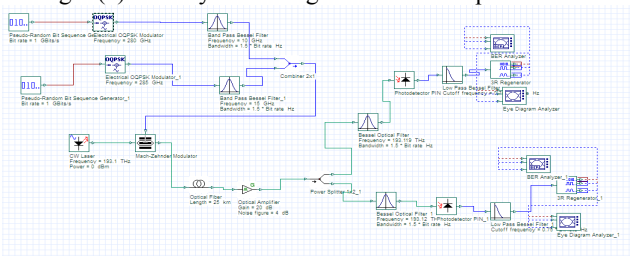

Fig. 3(c): RoF system using OQPSK technique

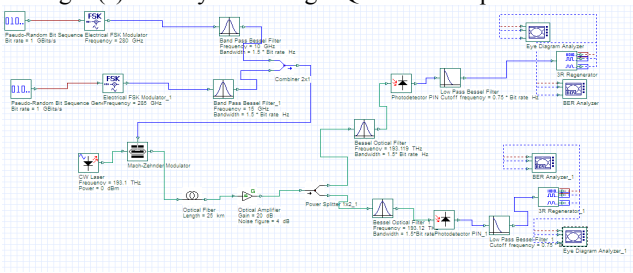

Fig. 3(d): RoF system using FSK technique

RESULT

Fig. 4(a),4(b),4(c),4(d). shows the Quality factor and Bit Error Rate analysis of the system using eye diagram under Differential Phase Shift Keying (DPSK), Continuous Phase Frequency Shift Keying respectively (CPSK). Offset Quadrature Phase Shift Keying (OQPSK) and Frequency Shift Keying(FSK).Comparison of DPSK,CPSK,OQPSK and FSK shows that DPSK modulation technique is best for Radio Over Fiber system because of highest quality factor and minimum bit error rate as shown in Tables.

Table 1: Results of different digital modulation techniques at fiber length of 21km

Parameters	DPSK	CPFSK	OQPSK	FSK
Maximum Q- factor	31..21	13.25	22.09	13.58
Minimum BER	$2.59\ e^{-214}$	$2.1\ e^{-040}$	$1.88\ e^{-108}$	$2.45\ e^{-042}$

Table 2: Results of different digital modulation techniques at fiber length of 23km

Parameters	DPSK	CPFSK	OQPSK	FSK
Maximum Q- factor	27.76	13.97	20.77	13.78
Minimum BER	$4.7\ e^{-0170}$	$1.1\ e^{-044}$	$3.40\ e^{-096}$	$1.48\ e^{-043}$

Table 3: Results of different digital modulation techniques at fiber length of 25km

Parameters	DPSK	CPFSK	OQPSK	FSK
Maximum Q- factor	23.62	12.44	19.98	11.82
Minimum BER	$8.3\ e^{-0124}$	$7.6\ e^{-036}$	$3.25\ e^{-089}$	$1.40\ e^{-032}$

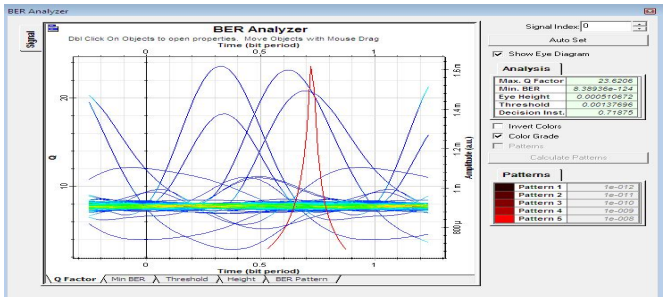

Fig. 4(a): RoF system using DPSK technique at 25km

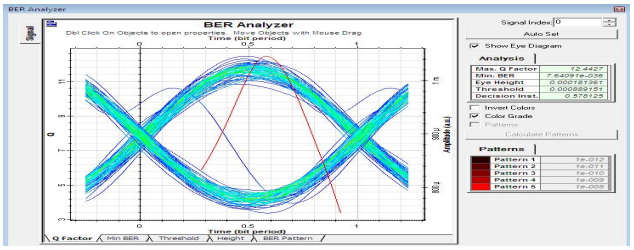

Fig. 4(b): RoF system using CPFSK technique at 25km

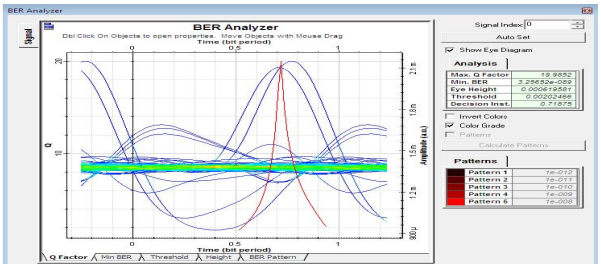

Fig. 4(c): RoF system using OQPSK technique at 25km

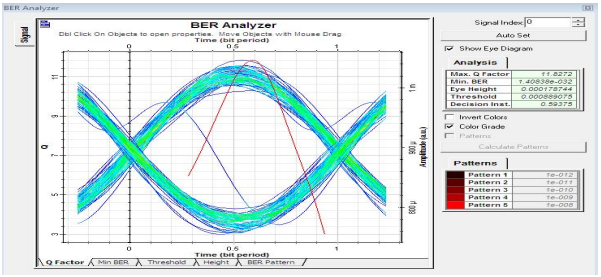

Fig. 4(d): RoF system using FSK technique at 25km

CONCLUSION

Q-factor and BER parameters have been compared for different modulation techniques such as DPSK, CPFSK, OQPSK, FSK. We have calculated the Q factor and BER at 21km,23km,25km length of optical fiber. As we increase the transmission distance Q factor decreases and BER increases. As shown in Tables the Q factor for DPSK technique at 25km is 23.62 and BER is 8.3 $e^{-0_{12}4}$ at 25km. So that after comparison we can see that DPSK modulation technique is best due to its high Q factor and minimum BER. In future we can increase number of users, bit rate and other parameter to improve the system and its performance.

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