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Design & Implementation for Combination of QPSK & BPSK Modulation Techniques

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***Abstract*—Modulation techniques have concerned increasing attention in optical wireless communications. Downlink transmission (base station to mobile terminal) using high data rate Mary Quadrature Amplitude Modulation (QAM), Quadrature Phase Shift Keying (QPSK) and Binary Phase Shift Keying (BPSK) modulation schemes are considered in a Wideband-Code Division Multiple Access (W-CDMA) system. QPSK or Quadrature Phase-Shift Keying is a higher order modulation scheme used in digital modulation. It is a widely used digital modulation technique in wireless communication, such as TDMA cellular telephone, OFDM, Bluetooth, Satellite communication etc. due to its advanced noise immunity, bandwidth efficiency and simpler circuitry. In this paper, we will be implementing a BPSK plus QPSK modulator for a communication link. In this, this system separately modulates the BPSK and QPSK signals with same input information and then combines in adder. Then it can demodulate with a common detector and we get the same output as input. We can analysis the performance of these modulation techniques when system is subjected to AWGN and fading are consider in the channel. Subsequently, a comparison study is carried out to obtain BER performance for each PSK-based transmission scheme. The design will be simulated by MATLAB tool. We will use MATLAB R2013a for simulation and evaluation of BER and SNR for system models. The output signal waveform will be measured and tested to find signal quality and the SNR or Signal to Noise Ratio. The comparison study showed that BER for BPSK + QPSK is higher than BPSK but lower than half of QPSK's BER .**

***Keywords*- Modulation techniques, Communication system performance, optical signal processing, capacity.**

I. INTRODUCTION

THE throughput of a dense wavelength-division-multiplexed (DWDM) transmission system can be increased by using a wider optical bandwidth, by increasing spectral efficiency, or by some combination of the two. Utilizing a wider bandwidth typically requires additional amplifiers and other optical components, so raising spectral efficiency is the more economical alternative.Modulation is the process of facilitating the transfer of information over a medium. Voice cannot be sent be very far by screaming. To extend the range of sound, we need to transmit it through a medium other than air, such as a phone line or radio. The process of converting information (voice in this case) so that it can be successfully sent through a medium (wire or radio waves) is called modulation.

Base band signals produced by various information sources are not always suitable for direct transmission over a given channel. This signals are usually further modified to facilitate transmission. This conversion process is known as modulation. In this process the baseband signal is used to modify some parameter of a high frequency carrier signal. A carrier is a sinusoid of high frequency, and one of its parameters - such as amplitude, frequency or phase – is varied in proportion to the base band signal. Accordingly, we have amplitude, frequency modulation or phase modulation [7].

When the number of signal and/or noise photons is small, the information-theoretic capacity of optical communication systems is also limited by the particle nature of photons. Coherent communication is equivalent to detecting the real and imaginary parts of the coherent states. Digital modulation offers many advantages over analog modulation and greatly improves the performance of the communication systems. Many types of digital modulation schemes are possible, and choice of which one to use depends on spectral efficiency, power efficiency, and bit rate performance. A trade-off between power and spectral efficiency always exists in the design of a modulation scheme. Furthermore, better bit rate performance can be achieved by assigning more bandwidth and a larger amount of signal power [4].

Currently, the trend is to utilize bandwidth efficient techniques that exploit orthogonal frequency division multiplexing (OFDM) [1] or coherent detection of complex multi level modulation formats (M-PSK, M-QAM). Although these techniques have significantly upgraded the performance of long-haul transmission systems, they are not appropriate for direct deployment at either the access or the metro part of the network due to their complexity, cost and energy footprint [3].

Targeting to the inherent capacity of the underlying channel, techniques which adapt and adjust (in real time) transmission parameters based on the link quality have been proposed. These are referred to as "Adaptive Modulation and Coding" (AMC) and they provide as their output the values of transmission parameters to be employed in a following transmission period, based on feedback information and in accordance with particular cost functions related to the targeted Quality of Service (QoS). At spectral efficiencies between 1 and 2 b/s/Hz, quaternary DPSK and PSK are perhaps most attractive techniques [15].

Information technology continues to strongly benefit from laser technology which enabled the transition from comparably slow electronic telecommunication systems to all optical, spectrally broadband optical communication networks with high data transmission rates up to multiple Terabits per second. A key to high data transmission rates in optical fibers has been the development of efficient amplitude and/or phase modulators which are used to encode information in the carrier wave..In all proposed uses, reliable and versatile THz measurement systems require adequate optical components, i.e. modulators, for active adaptive control of the electromagnetic properties of the radiation [12].

The paper is organized as follows. In section II, we discuss related work with the modulation scheme. In Section III, It describes types of modulation techniques. In Section IV, it describes the system architecture and analyse the different parameters of system. The results are given in section V. Finally, conclusion is given in Section VI.

II. RELATED WORK

In literature, it proposes and experimentally demonstrates novel receiver architecture based on injection locking for demodulating a DPSK/ASK orthogonally modulated signal. The receiver exploits the limiting amplification of an injection locked laser to discriminate the two data streams, enhance performance of DPSK, and increase ASK extinction ratio up to 10 dB, making this modulation setup suitable for the cost-efficient capacity upgrade of metro networks [1].

Communication via diffusion of molecules is an effective method for transporting information in Nano-networks. In this paper, new modulation techniques called Concentration Shift Keying (CSK) and Molecule Shift Keying (MoSK) are proposed for coding and decoding information of the so-called messenger molecule concentration waves in Nano-networks. The first technique, CSK, modulates the information via the variation in the concentration of the messenger molecules whereas MoSK utilizes different types of messenger molecules to represent the information. Using simulation, the performance of these modulation techniques is evaluated in terms of susceptibility to noise and transmission power requirements [9].

PSK based digital modulation scheme (BPSK,QPSK or GMSK)gives the best BER performance in a multipath fading environment .GMSK's BER is slightly higher than that of BPSK and QPSK [15].

The goal for third generation (3G) of mobile communication system is to seamlessly integrate a wide variety of communication services. This can be achieve by combining Wideband Code Division Multiple Access (WCDMA) air interface with Radio over fiber [13].

Information-theoretic limits to spectral efficiency in dense wavelength-division-multiplexed (DWDM) transmission systems are reviewed, considering several modulation techniques(unconstrained, constant-intensity, binary), detection methods(coherent, direct), and propagation regimes (linear, nonlinear).Spontaneous emission from inline optical amplifiers is assumed to be the dominant noise source in all cases. Coherent detection permits use of two degrees of freedom per polarization, and its spectral efficiency limits are some b/s/Hz in typical terrestrial systems, even seeing nonlinear special effects. Using either constant-intensity modulation or straight detection, only one degree of freedom per polarization can be used, significantly reducing efficiency [3],[12].

III. VARIOUS DIGITAL MODULATION TECHNIQUES

After the conversion of an analog signal to digital by sampling different type of digital modulation schemes can be achieved by the variation of different parameter of the carrier signal for example the Amplitude variation gives BASK, Frequency variation gives BFSK and the phase variation gives BPSK. Also sometimes a combinational variation of this parameter is done to generate the hybrid modulation technique viz. a combinational variation of Amplitude and Phase Shift Keying (APSK). Many more digital modulation techniques are available and can also be designed depending upon the type of signal and the application. These digital modulation techniques can be classified basically either on the basis of their detection characteristics or in terms of their bandwidth compaction characteristics .

A. Binary Amplitude Shift Keying [BASK]

The BASK is obtained by the alteration of the amplitude of the carrier wave [1, 4]. It is a coherent modulation technique hence the concept of the co -relation between the signal, number of basis functions, the I and Q components and the symbol shaping are not applicable here. It has very poor bandwidth efficiency. The basic merit of this technique is its simple implementations but is highly prone to noise and the performance is well established only in the linear region which does not make it a viable digital modulation technique for wireless or mobile application in the present scenario. The combination with PSK [20] yields derivatives like QAM and M-ary ASK, which have important application with improved parameters [8].

B. Binary Frequency Shift Keying [BFSK]

When two different frequencies are used to represent two different symbols, then the modulation technique is termed as BFSK.BFSK can be a wideband or a narrow band digital modulation technique depending upon the separation between the two carrier frequencies, though cost effective and provides simple implementations but is not a bandwidth efficient technique and is normally ruled out because of the receiver design complexities[16].

C. Binary Phase Shift Keying [BPSK]

When the phase of the carrier wave is altered with reference of the modulating signal then the resultant modulation scheme is termed as Phase Shift Keying. BPSK is the simplest form of PSK. It uses two phase which are separated by 180. It is known as binary because the carrier phase represents only two phase states [13]. It is normally used for high speed data transfer application, provides a 3dB power advantage over the BASK modulation technique and is robust and simple in implementation. It is, however, only able to modulate at 1 bits/symbol and so is an inefficient user of the provided bandwidth and is normally termed as a non –linear modulation scheme. It provides small error rates than any other systems.

D. Quadrature Phase Shift Keying (QPSK)

Another extension of the PSK digital modulation technique is the division of the phase of the carrier signal designed by allotting four equally spaced values for the phase angle. With QPSK twice data can be sent in the same bandwidth compared to BPSK. QPSK provides twice the spectral efficiency with same energy efficiency. QPSK has four message points in the constellation diagram and so it becomes a highly bandwidth efficient digital modulation technique. But the exact phase retrieval becomes a very important factor for the receiver design considerations, failing which can give rise to erroneous detection of the signal. This factor increases the receiver design complexities. To compensate for these problems, normally the idea of pulse shaping the carrier modulated signal is employed with the Root Raised Cosine Pulse shaping for achieving better performances which in turn provides a demerits that the constant envelope property of the signal is lost [15].

E. Differential Phase Shift Keying [DPSK]

In BPSK and QPSK there is an ambiguity of phase if the constellation is rotated by some effect in the communication channel through which signal passes and also for the perfect detection of a phase modulated signal, the receiver needs a coherent reference signal. But if differential encoding and phase shift keying are incorporated together at the transmitter then the digital modulation technique evolved is termed as Differential Phase Shift Keying [1, 14]. For the transmission of a symbol 1, phase is unchanged whereas for transmission of symbol 0 , the phase of the signal is advanced by 180[10].

F. Minimum Shift Keying [MSK]

Minimum Shift Keying (MSK) is a modified form of continuous phase FSK. Here, in this case, the spacing between the two carrier frequencies is equal to half of the bit rate which is the minimum spacing that allows the two frequencies states to be orthogonal[5]. An MSK signal can be said to be derived from either an Offset Quadrature Phase Shift Keying (OQPSK) signal by replacing a square pulse by ½ co-sinusoidal pulse or alternatively from an FSK signal. The information capacity of an MSK signal is equal to that of QPSK signal but due to the ½ cosine pulse shaping the bandwidth requirement is lesser than that required by QPSK. It achieved smooth phase transitions thus providing a constant envelope. It has lower out of band power and can be said to be more spectrally efficient than the QPSK modulation technique [11].

G. Comparison of All Techniques

The BASK technique is simpler and economic in implementation and is less prone to errors but provides less bandwidth efficiency and operates efficiency in the linear region only, which does not make it an efficient technique for the wireless communication systems. On the other hand, he BFSK technique is still less prone to errors and the bandwidth requirement is the same as that of BASK but is not a bandwidth efficient technique. The BPSK modulation technique is still better than the above mentioned two modulation techniques. It is a coherent modulation technique and can be used for high speed data transfer application and has a basic advantage of double information capacity over BASK and BFSK. Simple implementation and robustness makes it a useful technique for satellite communication but on the other hand it has proved an inefficient use of the bandwidth and 2 is categorized under a class of non -linear modulation techniques. The error performance is better and is optimized to achieve minimum possible error rate. The detection of phase shift makes the receiver design complex, so the technique is not of interest for the wireless or mobile communication applications. The DPSK technique provides information capacity similar to BPSK and is considered to be more viable technique than BPSK and is a non-coherent orthogonal modulation. But the receiver complexities are more than BPSK because memory is required in the system to keep the track of relative phase difference [4].

In the detection of QPSK signal, the detection of exact phase shift becomes an important criterion which on the other hand increases receiver design complexities as well. The improvement further in this modulation technique can be achieved by pulse shaping the modulated carrier. The pulse shaping by ½ co-sinusoidal pulse shaping provides a better performance modulation technique, the Minimum Shift Keying (MSK), which can also be viewed as comprising of two CPFSK signals. This has a major advantage that the out of band power is significantly lower than QPSK [15].

IV. PROPOSED ARCHITECTURE AND PERFORMANCE PARAMETERS

In the first years of deep space program, phase shift keying (PSK) is developed for it offers low probability of error and, yet, high bandwidth efficiency. It is now widely used in both military and commercial communications systems. The general analytical expression for PSK can be given by eq. (1):

$$s(t) = \sqrt{\frac{2E}{T}} * \cos[2\pi f t + \emptyset(t)] \quad (1)$$

Where E is the transmitted signal energy per symbol, T is the symbol duration [13].

A. BPSK Modulation

The resulting modulation technique is called binary phase shift keying (BPSK) when M=2. This means a symbol information corresponds to a bit information as T=Tb and E=Eb. Hence, it is given by eq. 2:

$$s(t) = \sqrt{\frac{2E}{T}} * \cos[2\pi f t] \quad (2)$$

In BPSK modulation, modulating data signal shifts the phase of the waveform s(t) to one of two states, either zero or π radians (180°). Here, it is clear that there is only one basis function of unit energy, namely

$$\varnothing(t) = \sqrt{\frac{2}{T}} * \cos[2\pi f t] \quad (3)$$

In order to generate the BPSK signal, the binary data is converted to polar format with constant amplitude levels of $+\sqrt{Eb}$ and $-\sqrt{Eb}$. This binary wave and sinusoidal wave are applied to a product block as in Figure 1.

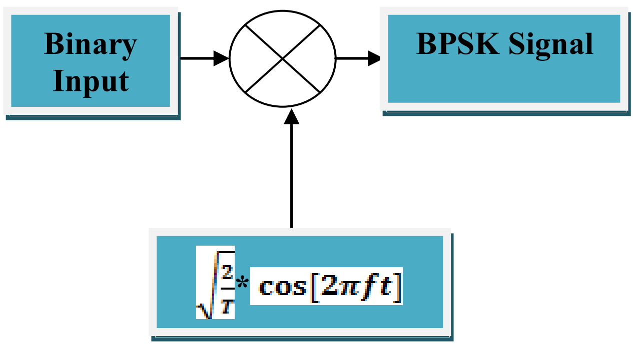

Figure 1: BPSK Modulator

B. QPSK Modulation

In order to generate the QPSK signal, the binary data are converted to polar format with constant amplitude levels of $+\sqrt{Eb}$ and $-\sqrt{Eb}$. Then, by means of a de-multiplexer, data are divided into two separate data sequences consisting of the odd- and even-numbered input bits. These data streams are used to modulate a pair of orthonormal basis functions.

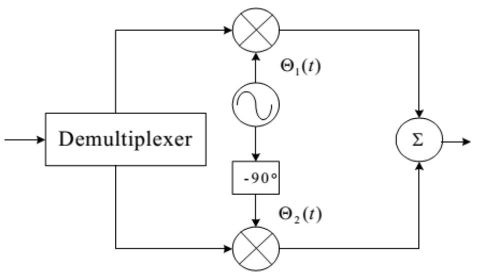

Figure 2: QPSK Modulator

Figure 2 shows the circuit block diagram of a QPSK modulator. Two bit data is sent to the bit splitter at the same time. These two groups of data will be split into parallel data. One of which will lead to I channel and gradually will transfer into I data and the other one will proceed to Q channel to become Q-data. The phase of I data is similar to the carrier of the reference oscillator, which will be modulated to become I-BPSK. Similarly the Q-data will become a Q-BPSK modulated signal.

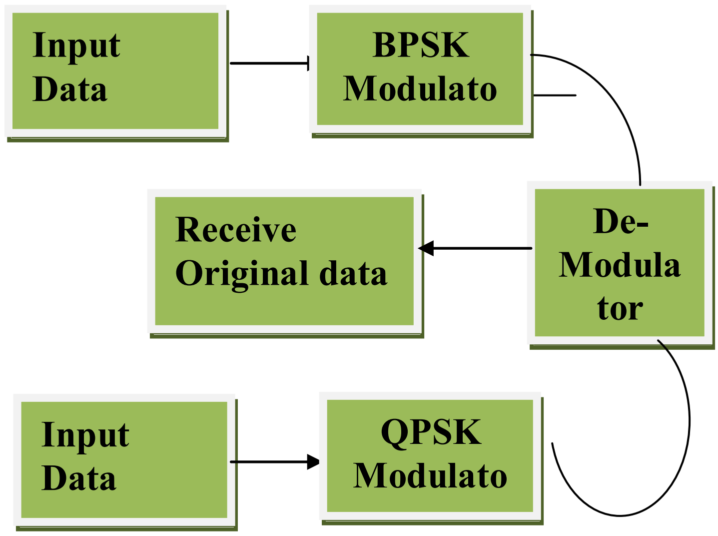

Figure 3: BPSK +QPSK Proposed Model

Most communications systems use a combination of multiplexing methods. Frequency Division Multiple-Access (FDMA) splits the available frequency band into smaller fixed frequency channels. Each transmitter or receiver uses a separate frequency. This technique has been used since around 1900 and is still in use today. Transmitters are narrowband or frequency-limited. A narrowband transmitter is used along with a receiver that has a narrow band filter so that it can demodulate the desired signal and reject unwanted signals, such as interfering signals from adjacent radios. Time-division multiplexing involves separating the transmitters in time so that they can share the same frequency. The simplest type is Time Division Duplex (TDD). This multiplexes the transmitter and receiver on the same frequency.

C. Proposed Algorithm

1. Interface GUI with MATLAB.
2. Enter the size of modulation to select modulation technique.
3. Calculate various parameters like signal attenuation, spectral density, SNR etc.
4. (For BPSK+QPSK Transmission)
    a) Enter information data for transmission.
    b) Find minimum carrier frequency and bit rate.
    c) Find the modulated signal using BPSK and QPSK technique separately.
    d) Combine these two modulated signals and passed on to receiver.
    e) For demodulation, multiply received signal with in-phase carrier signal.
    f) Integrate using trapezoidal rule.
    g) if (integrated data > 0) then
        Receive data=1.
    Else
        Receive data=0.
5. Find Bit error rate and then compare with BPSK and QPSK technique.

D. Performance Measures

A fair comparison between various types of modulation schemes must include the power and bandwidth constraints of a real system. Neither energy nor bandwidth consumption alone is a sufficient measure of a modulation scheme. When a large amount of power is available, it is easy to reduce the bandwidth of a modulation scheme; similarly high power is not needed to achieve a low BER if a wide bandwidth can be tapped [10].

1. Spectral Efficiency

There are several different spectral measurements used for modulation schemes. We define the spectral efficiency as eq. (1):

$$\eta = \frac{Bitspersec}{Bandwidthofchannel} \quad (1)$$

2. Energy Efficiency

The conventional measure E_b/N_o only takes into account the received power and provides no information on how much DC power consumption is required for the transmission of one information bit. Alternative energy efficiency is given by eq. (2):

$$SNR = \frac{Et}{No} \quad (2)$$

3. Bit Error Rate (BER)

BER is a performance measurement that specifies the number of bit corrupted or destroyed as they are transmitted from its source to its destination. Several factors that affect BER include bandwidth, SNR, transmission speed and transmission medium.

4. Signal to Noise Ratio (SNR)

SNR is defined as the ratio of a signal power to noise power and it is normally expressed in decibel (dB).

V. RESULTS

A. Input Parameters

Table 1 show the various input parameters used by this proposed system.

Table 1: Input Optical Parameters

Input Parameters	Value
Wavelength	100 µm
Energy	100 db
Noise	10 db
Frequency	1000000 Hz

B. Graphical User Interface

In computing graphical user interface is a type of user interface that allows users to interact with electronic devices using images rather than text commands. GUIs can be used in computers, hand-held devices such as MP3 players, portable media players or gaming devices, household appliances, office, and industry equipment.

Figure 4: Graphical User Interface

C. Proposed Output:

Input data before the transmission is shown and also data after BPSK modulation is shown in fig 5.

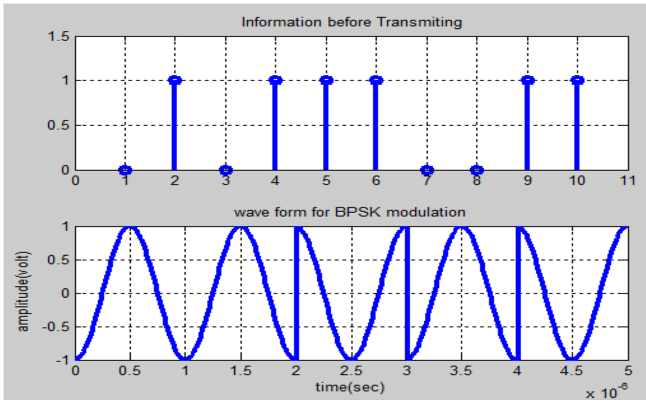

Figure 5: Input Data and BPSK Modulated Output

The inphase and quadrature phase QPSK is shown in fig 6. The proposed BPSK + QPSK modulated signal is also shown in the fig 6.

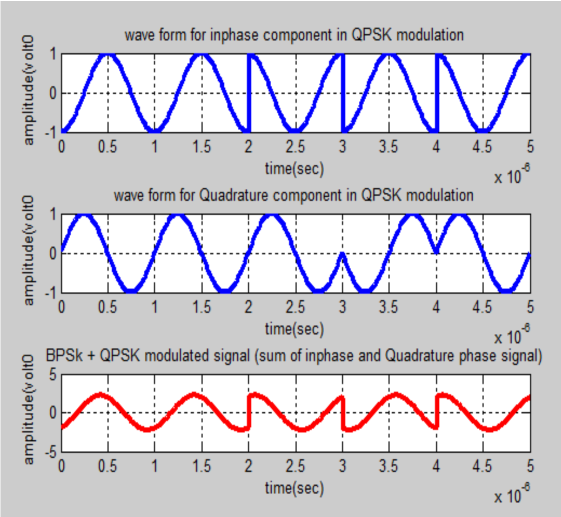

Figure 6: Proposed System Output (BPSK+QPSK)

The proposed system output for BPSK + QPSK is shown in fig 7. It gives the same data which was transmitted.

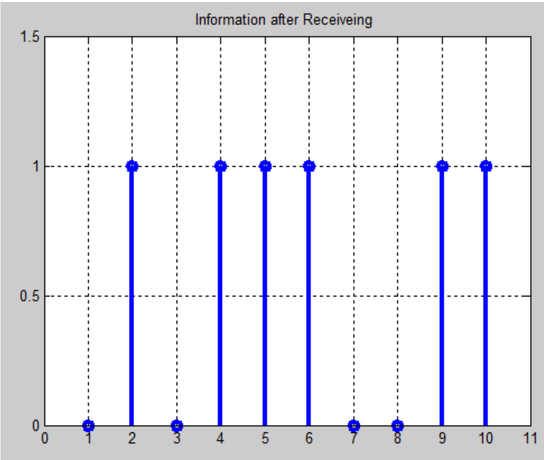

Figure 7: Output Data after Demodulation

The Scatter plot for the proposed system is shown in figure 8.

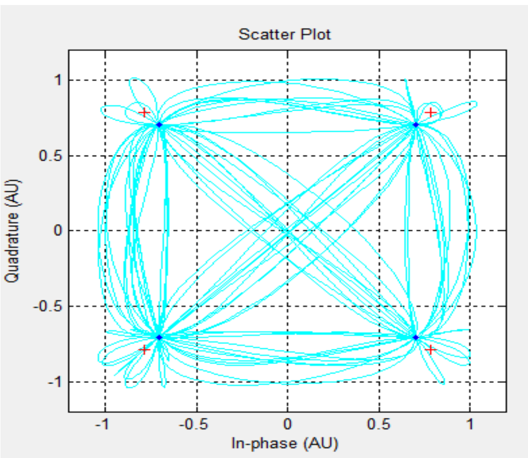

Figure 8: Signal Space Diagram of Proposed System

D. BER Comparisons

Measuring the bit error ratio helps people choose the appropriate forward error correction codes. Since most such codes correct only bit-flips, but not bit-insertions or bit-deletions, the Hamming distance metric is the appropriate way to measure the number of bit errors. Many FEC coders also continuously measure the current BER.

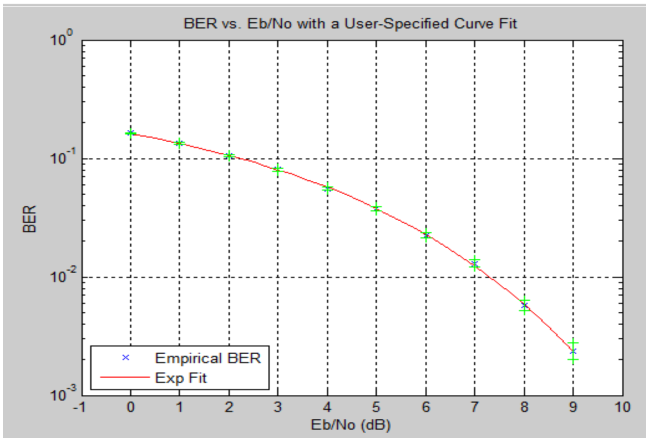

Figure 9:BER curve for Proposed system

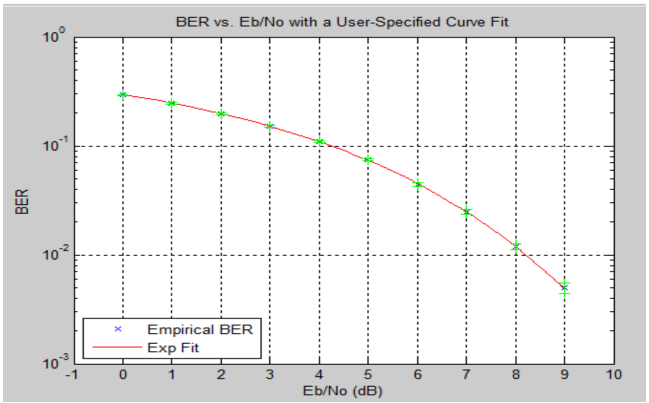

Figure 10: BER Performance of QPSK System

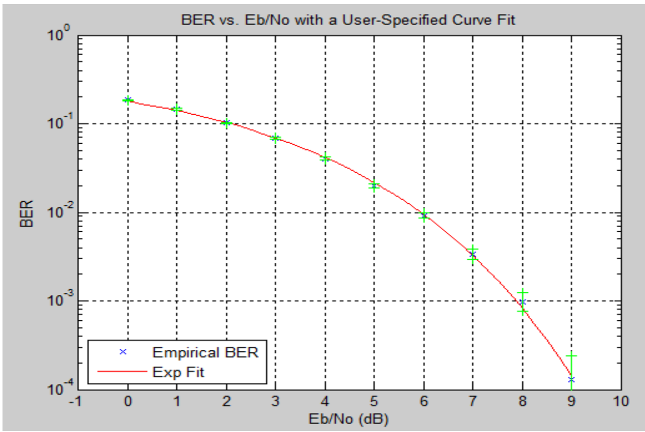

Figure 11: BER Performance of BPSK System

Table 2 shows the BER comparison of proposed technique with BPSK and QPSK technique.

Table 2: BER Performance by Various Techniques

Input Frequency=100000 Hz

Eb/No (db)	Proposed System	BPSK	QPSK
0	0.162	0.18	0.29
1	0.133	0.14	0.24
2	0.105	0.10	0.19
3	0.0803	0.06	0.15
4	0.055	0.04	0.11
5	0.037	0.02	0.07
6	0.022	0.009	0.044
7	0.012	0.003	0.024
8	0.005	0.0009	0.011
9	0.002	0.0001	0.004

VI. CONCLUSION

In telecommunication field the major challenges is to convey the information as efficiently as possible through limited bandwidth, though the some information bits are lost in most of the cases and signal which is sent originally will face fading. To reduce the bit error rate the loss of information and signal fading should be minimized. In this, a simple circuit which is combination of QPSK + BPSK is constructed and this circuit is of low cost. The cost can be reduced as well as the performance of the total circuit can be improved by the use of MATLAB. The proposed system consists of a combination of QPSK+BPSK modulated signal and then demodulated by a common detector. The output obtained is same transmitted at the input. The numerical investigation of the proposed transceiver exploited the adequate performance of the proposed signal for longer distances and higher bit rates. The various parameters like SNR, bit rate, attenuation factors also numerically investigated. The constellation plots of proposed technique are also investigated. The performance is studied in terms of BER. The BER of proposed technique is compared with QPSK and BPSK BER. The proposed BER shows the lower error date as compared to others BER. We have used 1MHz frequency for the carrier signal. If higher frequency could be used and if we can use frequency spectrum the system can be developed for wireless transmission.

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