STUDY AND COMPARATIVE ANALYSIS OF BIT ERROR RATE FOR OFDM-IDMA SYSTEM

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Abstract
This paper contains study and comparative analysis of OFDM-IDMA system using BPSK technique in Simulink environment. Orthogonal frequency division multiplexing technique reduces long delay spread due to low data rate of subcarriers and due to which Inter Symbol Interference (ISI) is eliminated. Also the orthogonality of subcarriers reduces Inter Carrier Interference (ICI).Interleaver division multiple access (IDMA) layer are used to randomize the data so that the effect of channel noise does not corrupt the data serially. The main objective of this papers to analysis the performance of the OFDM-IDMA system on the basis of Bit Error Rate (BER). This simulation was done in MATLAB/Simulink and results are exported with the help of bertool.

Keyword: OFDM, IDMA, BPSK, BER, ICI.

I. Introduction

OFDM is widely used in wireless communication as it employs an overlapping multicarrier scheme to convert wideband spectrum into narrowband spectrum. The orthogonal property helps in reducing inter carrier interference and cyclic prefix eliminates the problem of inter symbol interference [1]. OFDM also provides high data rates without compromising with the length of data as the subcarriers individually have low data rates.
Implementation of IDMA with OFDM [2] technique is used to multi-access interference (MAI). OFDM layer is used to reduce Intercarrier interferences (ICI) and intersymbol interference (ISI) while IDMA layer is responsible for reducing multi access interference (MAI).The performance of the channel is improve by using OFDM-IDMA [3] system along with Binary phase shift keying technique.

II. The State of Art

This section contains various approaches to enhance the performance of channel access technique. Furthermore it is presented an overview OFDM-IDMA system through literature survey in the field of wireless technology. This idea can be deployed to exploit the bandwidth for the better performance of the spectral efficiency and analysis bit error rate accordance with the signal to noise ratio.

III. OFDM Technique

It is the combination of multiplexing and modulation schemes. It converts the wideband Spectrum into the narrowband spectrum. Cyclic prefix uses to reduce intersymbol Interference (ISI).Data from source is converted into parallel form to perform IFFT to generate orthogonal subcarriers which can allow overlapping in the spectrum followed by cyclic prefix to reduces interference to support high data rate[4] .
It is an advanced version of FDM (Frequency Division Multiplexing) and rectifies the shortcomings, such as use of guard bands. Data from the user is converted to parallel form to perform IFFT and then cyclic prefix is appended. The role of IFFT is to create orthogonal subcarriers which can be overlapped in spectra without inter carrier interference, resulting in efficient utilization of the spectrum. Next Cyclic prefix (CP) is added to reduce intersymbol interference (ISI).

IV. Interleaver

Interleavers are used to randomize the data so that the effect of channel noise does not corrupt the data serially [5]. On ordered serial transmission of data the noise can change the successive data bits and thus decoding is not accurate. During transmission of interleaved or randomized data, if the error is introduced in the consecutive bits, after de interleaving the corrupted bits are scattered along the data and thus decoding is relatively error-free. There are various types of interleavers. The most commonly used is block interleaver [6]. Block interleaver is used for the modeling and simulation in this paper .Block interleaver follows the sequence as given below.

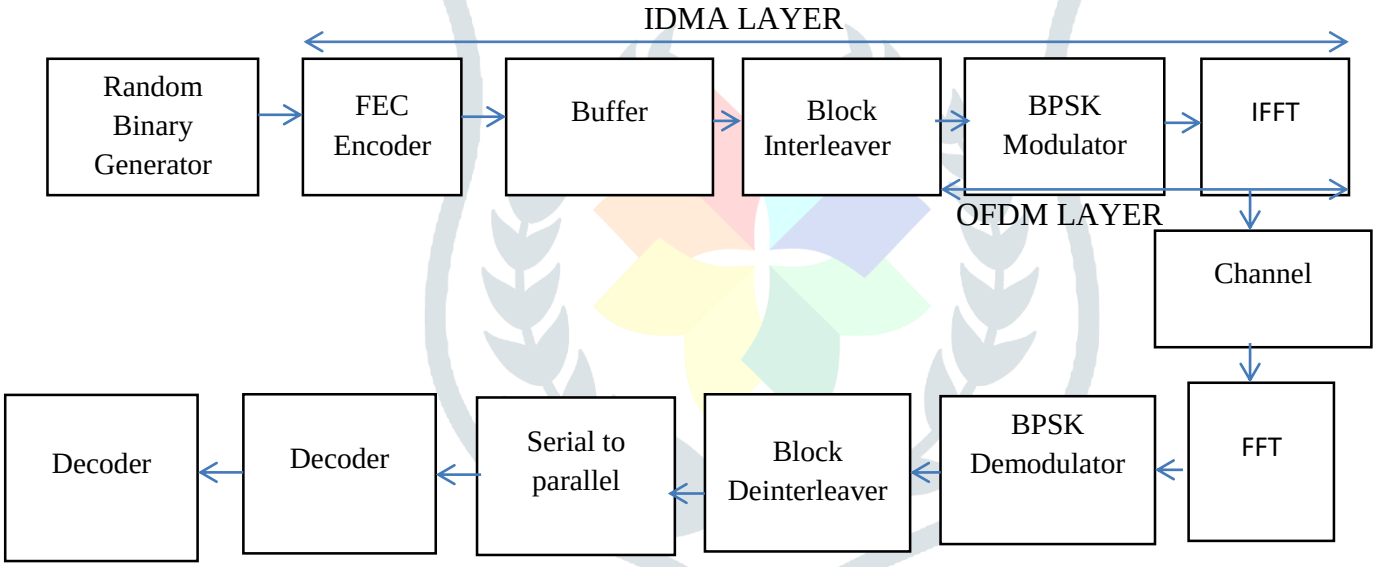
1	2	3		1	4	7
4	5	6	→	2	5	8
7	8	9		3	6	9

Input vector
[1 2 3 4 5 6 7 8 9]

Output vector
[1 4 7 2 5 8 3 6 9]

V. OFDM-IDMA System

Block diagram of OFDM-IDMA system is designed [7] in Simulink environment as shown in figure 5.1.The input is taken from random binary generator used to generate random binary sequence followed by encoding techniques. Block interleaver takes the input as column vector and produces the sequence in parallel. Further Binary phase shift keying modulation technique is used. Inverse Fast Fourier Transform (IFFT) is used and transmits through channel.



Block Diagram of OFDM-IDMA System

At the receiver side, reverse operation is performed to receive the encrypted message. Fast Fourier Transform is performed to plot FFT magnitude spectrum. Demodulation is carried out to retrieve the signal subsequently, de-interleaving is performed. Finally, decoding is executed to recover the users signal.

VI.Comparison of Modulation Techniques

There is a comparison shown between the PSK ,QAM and other modulation schemes [8]. In the above table BPSK , QPSK, OOK , 16 QAM , and 64 QAM are compared on the basis of bits per symbol , error margin and the complexity. Different modulation technique has some useful facts depending upon the channel demand it may be used. In terms of bits per symbol then 64 QAM has highest bits per symbol while BPSK has only one bit either 0 or 1.In terms of error margin BPSK is a better technique than other.

Table A Summary of Types of Modulation

MODULATION	BITS PER SYMBOL	ERROR MARGIN		COMPLEXITY
BPSK	1	1	1	Medium
QPSK	2	1 / √2	0.71	Medium
OOK	1	½	0.5	Low
16 QAM	4	√2 / 6	0.23	High
64QAM	6	√2 / 14	0.1	High

Third discussing parameter is complexity then OOK(ON OFF keying) is better because it has low complexity somehow BPSK is having moderate complexity. In this report PSK and QAM are used as modulation technique . BPSK has enough noise margin [9]while QAM is used to transmit large bits per symbol by increasing the order of the QAM.

VI. Simulations Results

In this section simulation results are presented which are simulated in MATLAB/Simulink environment. Analysis is completed on the basis of bit error rate along with the signal to noise ratio(SNR) in dB.

A. BER comparison for BPSK AND QAM

Bpsk is having moderate complexity. In this report PSK and QAM are used as modulation technique . BPSK has enough noise margin while QAM is used to transmit large bits per symbol by increasing the order of the QAM

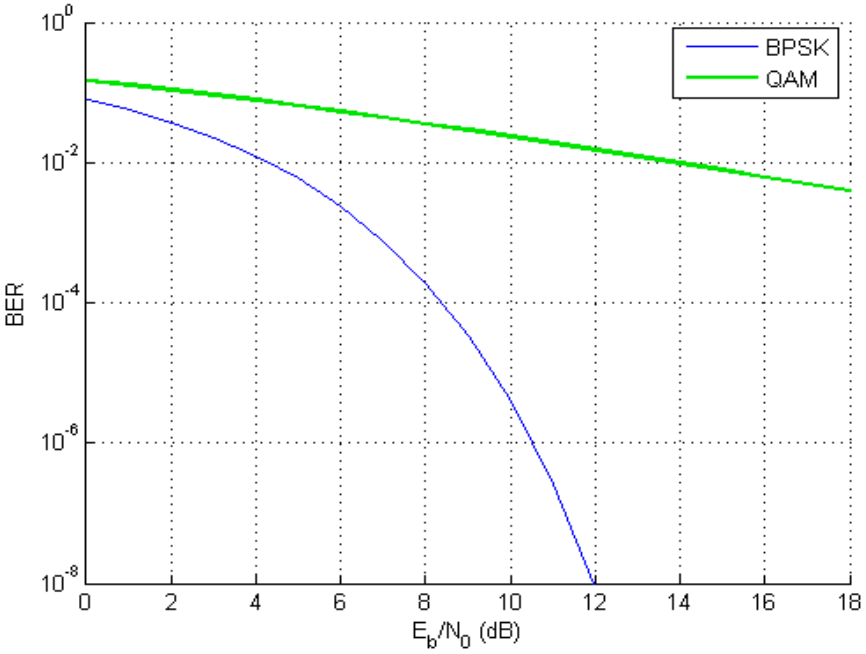


Figure 7.1 BER comparison of BPSK and QAM modulation technique

Figure 7.1 Shows BER comparisons for BPSK and QAM modulation technique in which BPSK is better than QAM in terms of Bit Error Rate. Quadrature amplitude modulation is replaced by Binary phase shift keying to implement OFDM technique for underwater acoustics communication.

B. BER comparison of different channel coding for BPSK

Bit Error Rate is a function of SNR as increment in SNR value, bit error rate will decrease. This is simulated for analysis different channel coding for BPSK. This is done with the help of Bertool of MATLAB/Simulink.

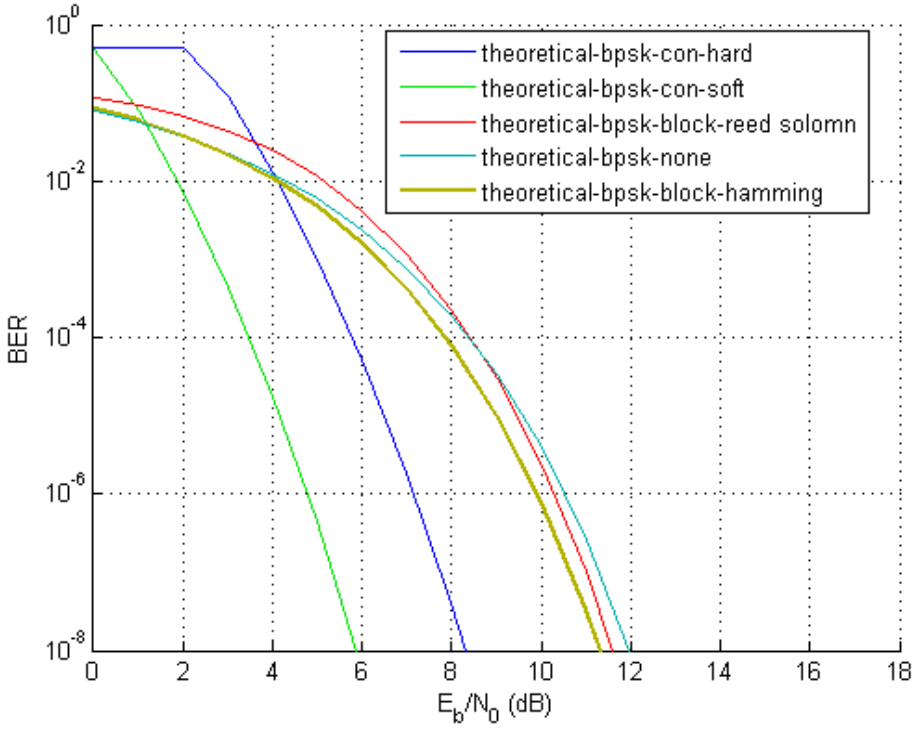


Figure 7.2 BER comparison for BPSK using different channel coding

Above graph shows BPSK modulation schemes with different channel coding. BPSK with convolution channel coding gives some better response than hamming and reed solomn etc. therefore BPSK with convolution is adopted for this simulation results.

C. Comparison of theoretical BPSK with interleaved BPSK

In this simulated results which are performed to analysis theoretical value with interleaved sequence. This is plotted in such a way to obtained desired response. It is simulated to obtained similar graph of theoretical curve for BPSK somehow it is obtained. Ideal BPSK is compared with OFDM implemented block containing interleaver as well

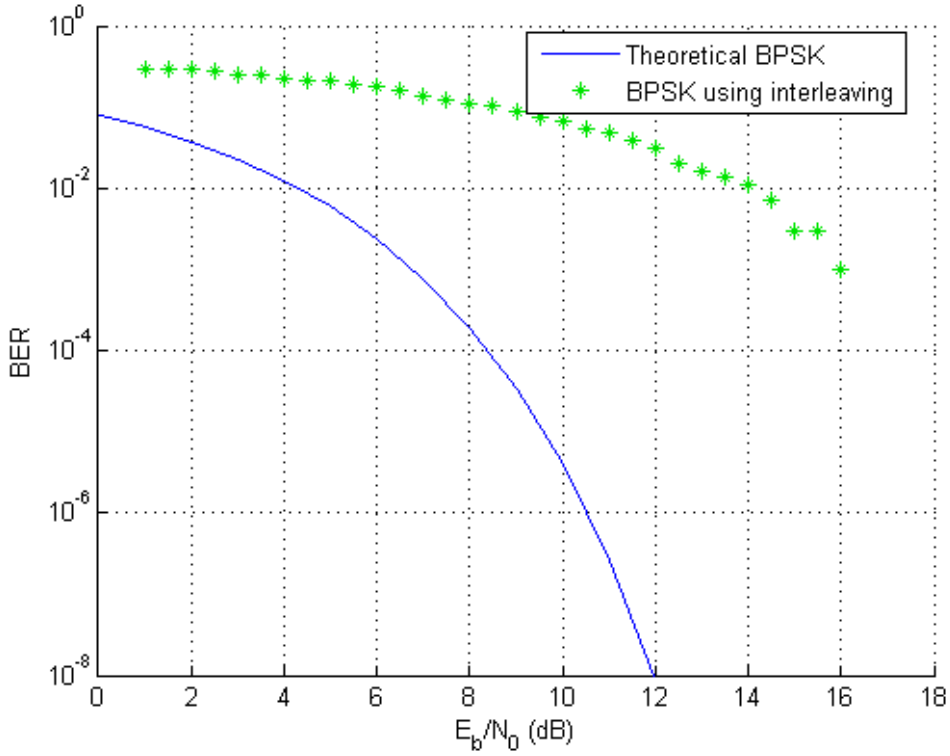


Figure 7.3 BER comparisons for Theoretical BPSK and interleaved Sequence

Figure 7.3 illustrates the comparisons for theoretical BPSK and after implementing interleaver. This is done at different SNR value. Simulated results is following theoretical curve which is desired response.

D. BER plot at different SNR values

Bit error rate is function of signal to noise ratio (SNR) [10], Bit error rate is decrease while increment is done SNR. This is simulated at different SNR values to obtained minimum bit error rate.

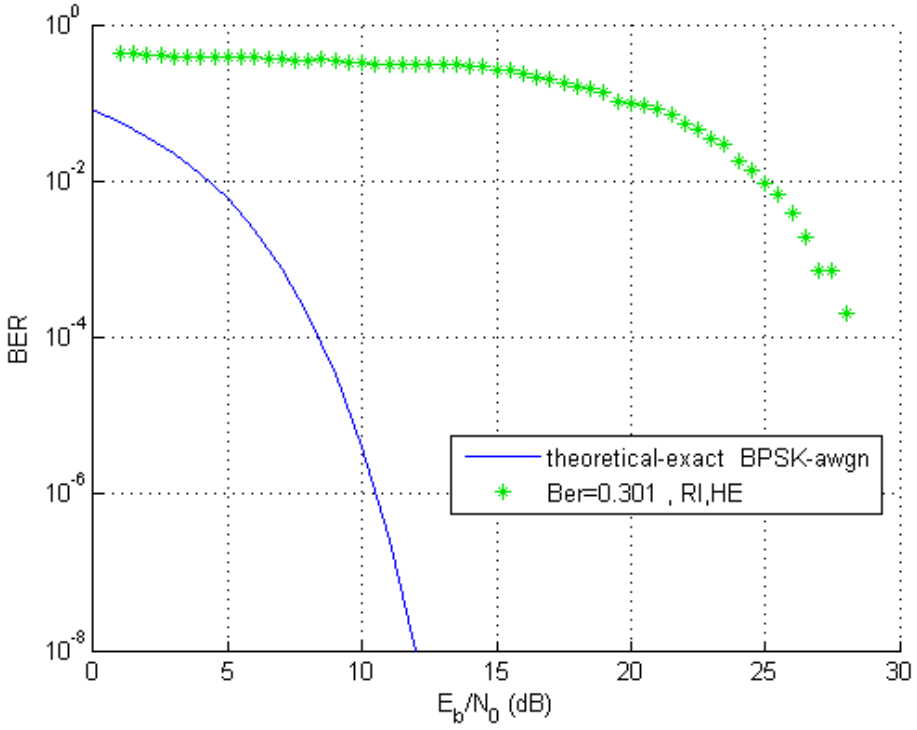


Figure 7.4 BER plot at different Signal to noise ratio

Previous results are obtained for fixed SNR value for the sake of simplicity and analysis purpose while figure 7.4 is obtained for different SNR value to follow the theoretical graph. In this simulation BPSK and random interleaver are used along with hamming encoder in AWGN channel environment. It is sometimes known as bi-phase modulation.

7.5 Constellation diagram for 8PSK

Constellation diagram for 8PSK is plotted in MATLAB/Simulink. Quadrature amplitude is represented on y-axis while In-phase is represented on x-axis. Number of points on the constellation diagram represents order of modulation technique

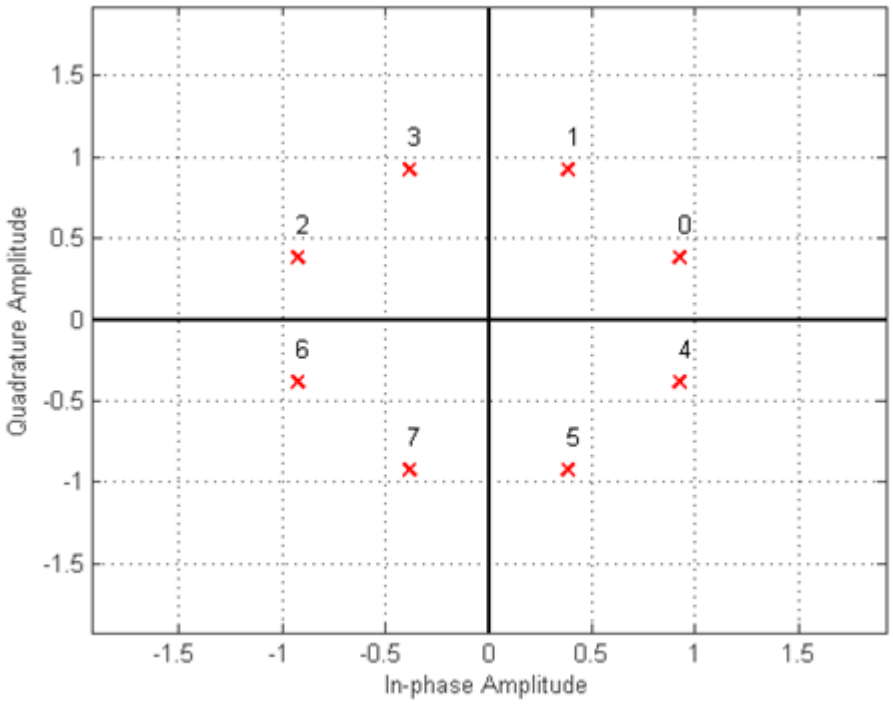


Figure 7.5 Constellation diagram for 8PSK

PSK has minimum bit error rate as compare to other technique . In multiple phase-shift keying (MPSK), it has large number of phases, typically 2^m four (0^0, $+90^0$, -90^0, and 180^0) or eight having angle in degrees (0, +45, -45, +90, -90, +135, -135, and 180). If m is equal to four then it has four phases, the MPSK mode is called quaternary phase-shift keying or quadrature phase-shift keying (QPSK), and each phase shift represents elements of different

VIII. Conclusions

Simulation of OFDM-IDMA system using BPSK technique is done in Simulink environment and analysis of bit error rate using bertool. Such informative analysis concludes that Binary phase shift keying is a better modulation technique than quadrature amplitude modulation on the basis of bit error rate. OFDM-IDMA system implementation is also done with the help of block interleaver which is one simplest and most popular interleaver. Bit error rate analysis accordance with the variation in signal to noise ratio(SNR) is also done using BPSK technique . The main objective switching towards BPSK it has low bit error rate than any other modulation technique and easier to implement. Future scope for OFDM_IDMA system it can be widely used for underwater acoustic communication.

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