International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869, Volume-2, Issue-5, May 2014

Investigating 802.11A Wireless Standard for High Speed Network Using Different Modulation Techniques

Suman, Mr. Rambir Singh

***Abstract*— In an OFDM system, typical sub-carrier modulation schemes include Binary Phase Shift Keying(BPSK) Quadrate Phase Shift Keying (QPSK), and Quadrature Amplitude Modulation (QAM). High level of modulation is used in order to increase the data rate of the OFDM system. In this paper the analysis of high level of modulations techniques such as BPSK, QPSK, 8PSK, 16PSK, QAM using MATLAB SIMULINK on OFDM system is presented. Here AWGN channels have been used for analysis purpose and their effect on BER for high data rates and signal to noise ratio (SNR) to be improved in a noisy channel at the cost of maximum data transmission capacity have been presented.**

***Index Terms*— OFDM ,MC-FDMA ,AWGN,BER,PAR,SNR**

I. INTRODUCTION

Recently, intense interest is focused on modulation techniques which can provide broadband transmission over wireless channels for applications including wireless multimedia, wireless local loop, and future generation mobile communication systems such as CDMA,WCDMA,3G. While standard single carrier modulation techniques (PSK, QAM ...) take advantage of a flat (narrowband) channel, multicarrier modulation is a technique to deal with non-flat broadband channels. It splits up the channel into a large number of sub channels which all can be considered flat, so standard QAM or PSK can be used in each sub channel [1]. Multicarrier modulation (MCM) is a spectral efficient modulation scheme which transforms the single high speed serial signal to multiple parallel low-speed signals with different carriers, and then combines these signals to one serial signal for the further transmission. By transmitting simultaneously N data symbols through N carriers the symbol rate is reduced to the one of the original symbol rate, and therefore the symbol duration is increased by N times. This leads to a transmission system which is robust against channel dispersions/fading, impulse noise and multipath interference. At the receiver port, it firstly demodulates the received signal to multiple low speed signals with the help of the relevant carriers, and then transforms the multiple parallel low-speed signals to the high-speed original signal. The one way symbol duration of the MCM is longer than that of the single-carrier modulation, which can effectively counteract the inter-symbol interference (ISI) and signal-to-interference-plus-noise-ration(SINR) caused by multipath transmission. MCM technique carries out the integral of numbers of symbol duration, which can effectively counteract pulse interference by dispersing effect of interference. Thereby, multi-carrier modulation technology is one effective high-speed transmission technology in wireless environment. Multicarrier modulation techniques, including orthogonal frequency division multiplex (OFDM) and wavelet packet division are among the promising techniques. The Orthogonal Frequency Division Multiplexing (OFDM) is a MCM technique that is widely adopted and most commonly used today. In OFDM system, the modulation and demodulation can be implemented easily by means of IDFT and DFT operators. In such a system, however, the input data bits are actually truncated by a rectangular window and the envelope of the spectrum takes the forms of sinc (w) which create rather high side lobes. This leads to rather high interference when the channel impairments can„t be fully compensated. Time synchronization errors originating from misalignment of symbols at demodulator is a serious OFDM design consideration. This is because they cause Inter Symbol Interference (lSI) and Inter Carrier Interference (ICI) which severely degrade the OFDM performance [2].

II. OFDM SPECTRUM

Another way to view the Orthogonality property of OFDM signals is to look at its spectrum. In the frequency domain each OFDM subcarriers has a sinc, *sin(x)/x,* frequency response, as shown in Figure1.The *sinc* shape has a narrow main lobe, with many side-lobes that decay slowly with the magnitude of the frequency difference away from the centre. Each carrier has a peak at the centre frequency and nulls evenly spaced with a frequency gap equal to the carrier spacing. The orthogonal nature of the transmission is a result of the peak of each subcarriers corresponding to the nulls of all other subcarriers.

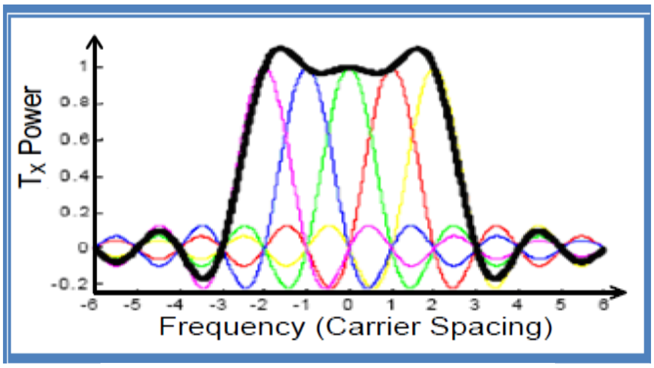


Figure1 OFDM spectrums [3]

Manuscript received May 20, 2014.
Suman, Department of Electronics and Communication Engineering, Mata Rajkaur Institute of Engineering and Technology, Rewari,
Mr. Rambir Singh, MD University (Rohtak), Haryana, India.

III. Issues in OFDM

OFDM though has to contend with other problems besides multipath distortion. Two of the most important are frequency offset and phase noise :

A. Frequency Offset and Phase noise

These are, at heart, both engineering problems. Both can happen when the receiver's voltage-controlled oscillator (VCO) is not oscillating at exactly the same carrier frequency as the transmitter's VCO. When the problem is permanent, its called frequency offset; when it varies over time, it's called phase noise jitter. In either case, it causes more errors because the no-longer orthogonal sub-carriers can interfere with each other. The solution that IEEE 802.11a uses is to include a training sequence at the beginning of every packet and using four pilot carriers of 802.11a's 52 subcarriers. These carriers let both sides determine the frequency offset and phase noise jitter between the transmitter and the receiver. Once known, adjusting the VCO's frequency and adaptively correcting for the current state of interference can deal with the interference.

B. Peak to average Ratio

Another problem with OFDM is that, like any multi-carrier system, it has vast variations between its peaks and valleys of signal power: the peak-to-average ratio (PAR). PAR's large dynamic range poses a real problem for power amplifier (PA) designs. One interesting class of approaches reduces PAR by constraining the modulation sequences for the sub-carriers.There are many ways to deal with PAR and because of this OFDM implementations tend to use incompatible methods. On packet-based networks, like 802.11a, the approach is simply to limit power output and retransmit packets if data goes missing with these problems taken care of, a variety of different encoding methods can be used to transmit data. In 802.11a, these include BPSK for 6 to 9 Mbps, Quadrature Phase Shift Keying (QPSK) for 12 to 18 Mbps and Quadrature Amplitude Modulation (QAM) for speeds from 24 to 54 Mbps[4].

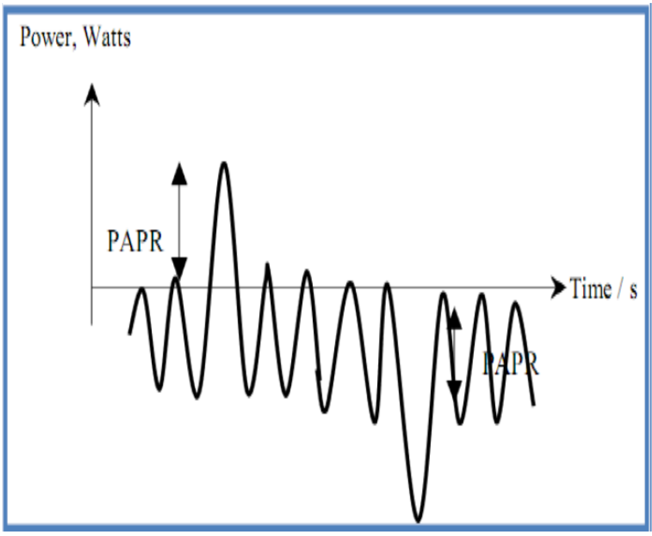


Figure 2 Peaks to Average Power Ratio [7]

IV. Work Methdology

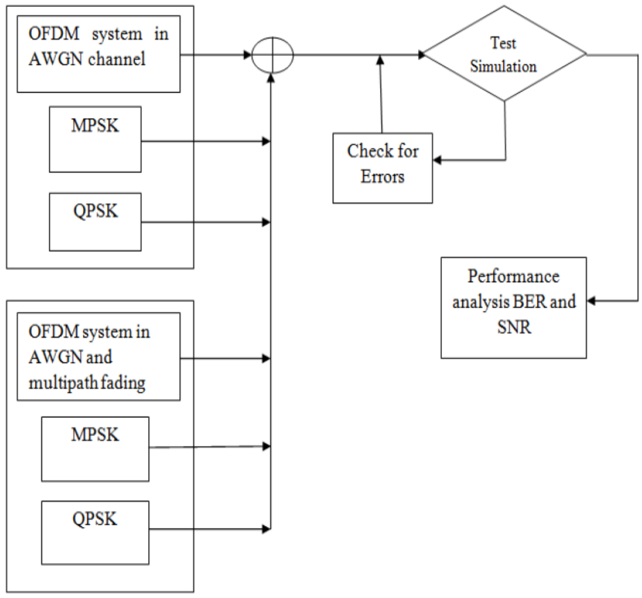


Figure 3Simulation Flow Chart for Work Methodology

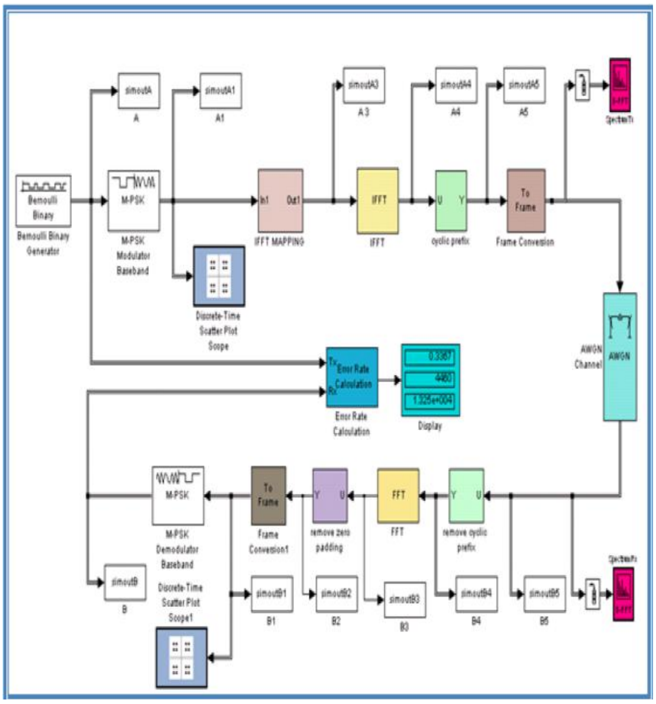
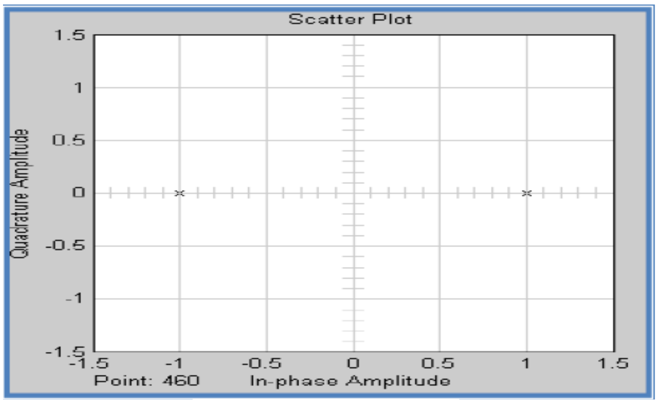


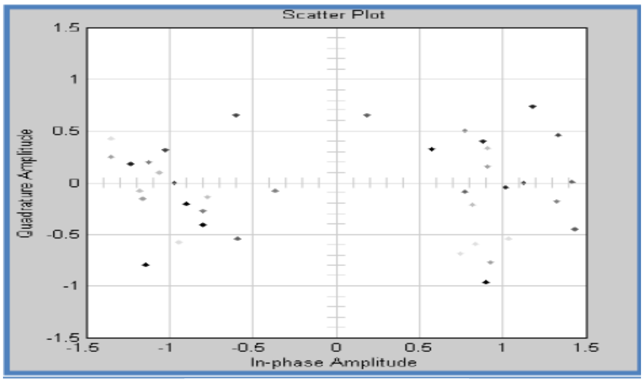
Figure 4 OFDM Tran receiver SIMULINK model

V. . SCATTER PLOT FOR BPSK

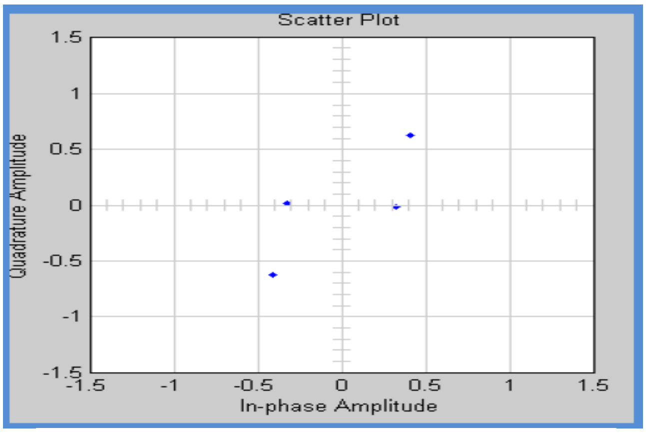
To draw the scatter plots for BPSK in OFDM system layout the used value of m=2, means two symbols are used , one for 0 degree and another for 180 degree and used different channel different channel are (1) Without channel (2) With AWGN channel (3) With AWGN and multipath channel.



Without channel



AWGN channel



AWGN and MULTIPATH channel

Figure 5 Scatter plots of BPSK

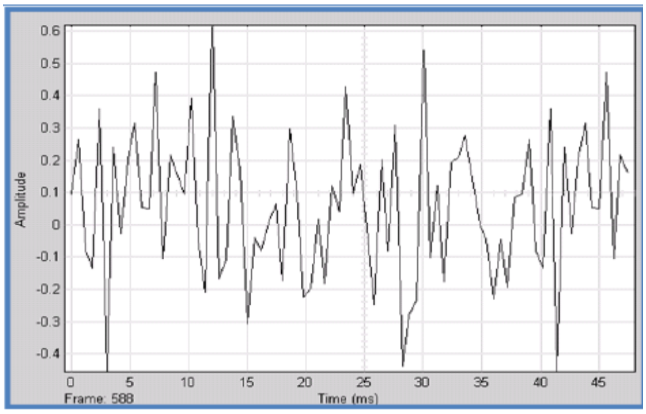
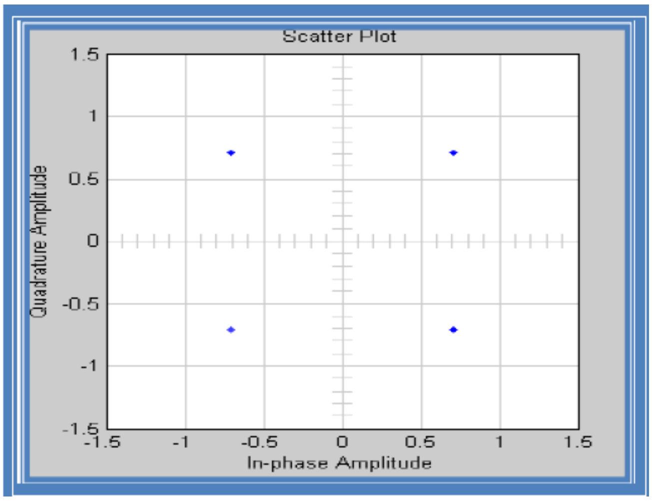
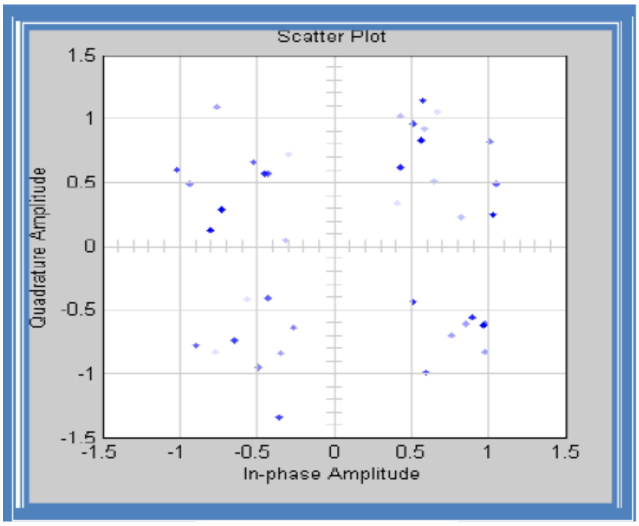


Figure 6 OFDM frame with BPSK

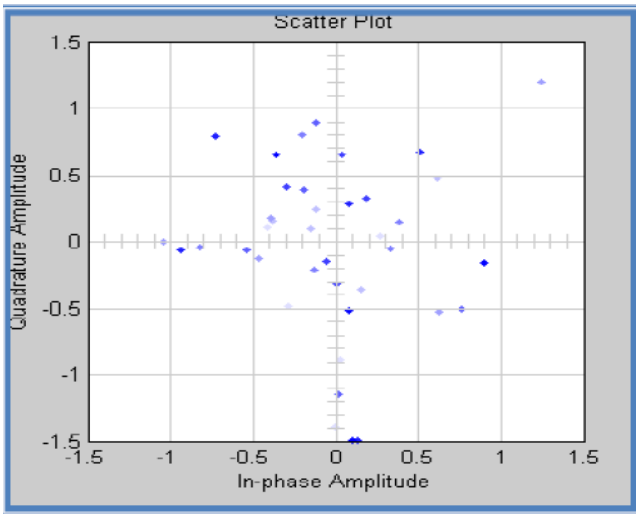
B. SCATTER PLOTS FOR QPSK To draw and used different channel different channel are (1) Without channel (2) With AWGN channel (3) With AWGN and multipath



Without channel



AWGN channel



AWGN and MULTIPATH channel

Figure 7 Scatter plots of QPSK

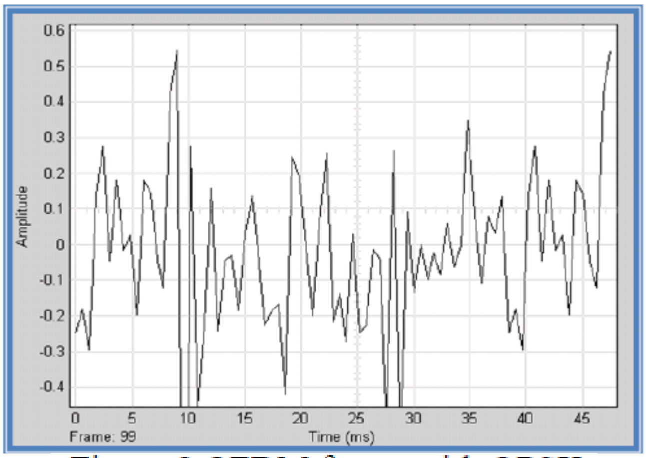


Figure 8 OFDM frame with QPSK

C. BER PERFORMANCE

The PSK-based digital modulation scheme (BPSK, QPSK etc.) that gives the best BER performance in a multipath fading environment using computer simulation .The comparison study showed that BER for BPSK, QPSK, MPSK and QAM are similar and they give the lowest BER under multipath fading. While these modulation schemes shows high robustness under multipath fading channel, a modulation scheme that can increase transmission rate. In the study of communication systems, the classical (ideal) additive white Gaussian noise (AWGN)channel, with statistically independent Gaussian noise samples corrupting data samples free of inter symbol interference (ISI), is the usual starting point for understanding basic performance relationships.In constructing a mathematical model for the signal at the input of the receiver, the channel is assumed to corrupt the signal by the addition of white Gaussian noise as shown in Figure 9 below, therefore the transmitted signal, white Gaussian noise and received signal are expressed by the following equation with *s (t)*, *n(t)* and *r(t)* representing those signals respectively:

r(t)=s(t)+n(t) (1)

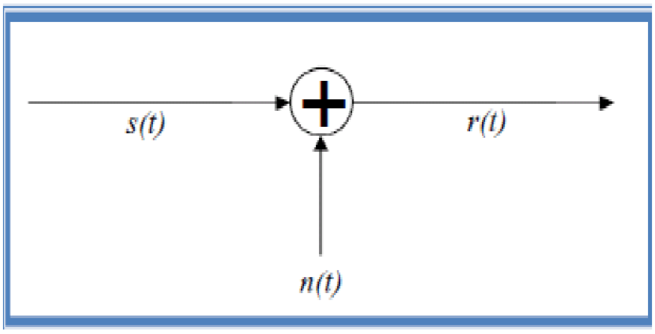


Figure 9 Received signal corrupted by AWGN

Where n (t) is a sample function of the AWGN process with probability density function (pdf) and power spectral density as follows:

Φmm=1/2 N_o [W/Hz] (2)

Where N_o is a constant and called the noise power density[5]

.

SNR performance of OFDM is similar to a standard single carrier digital transmission. This is to be expected, as the transmitted signal is similar to a standard Frequency Division Multiplexing (FDM) system. Figure 10 shows the results from the simulations. The results show that using QPSK the transmission can tolerate a SNR of >18-25 dB. However, using BPSK allows the BER to be improved in a noisy channel, at the expense of transmission data capacity. Using BPSK the OFDM transmission can tolerate a SNR of >18-23 dB. If the SNR is >25 dB 16PSK can be used, doubling the data capacity compared with QPSK. If SNR is >28 dB QAM can be used for data capacity. Fig.4.8 shows the comparisons of BER Vs SNR graph with different modulation schemes with AWGN channel and 64 carriers.

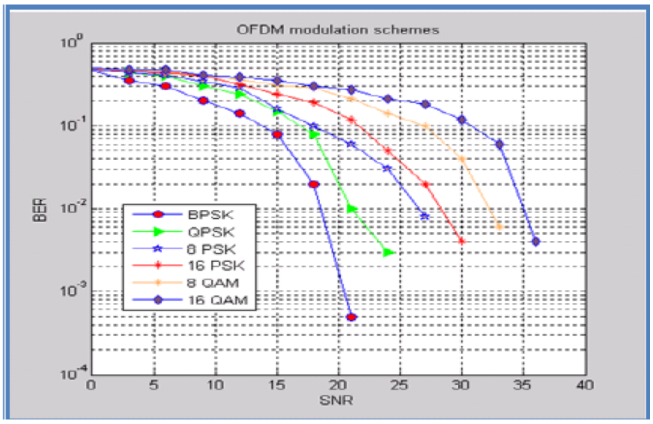


Figure 10 BER verse Eb/N SNR for OFDM using BSPK, QPSK, 8PSK, 16PSK and QAM

Eb/No (the energy per bit to noise power spectral density ratio) is an important parameter in digital communication or data transmission. It is a normalized signal-to-noise ratio (SNR) measure, also known as the "SNR per bit". It is especially useful when comparing the bit error rate (BER) performance of different digital modulation schemes without taking bandwidth into account. The graph compares the bit-error rates of BPSK, QPSK, 8-PSK, 16-PSK and QAM. It is seen that higher-order modulations exhibit higher error-rates; in exchange however they deliver a higher raw data-rate. Figure 4.9 shows the comparisons of BER Vs Eb/No graph with different modulation schemes with AWGN channel and 64 carriers.

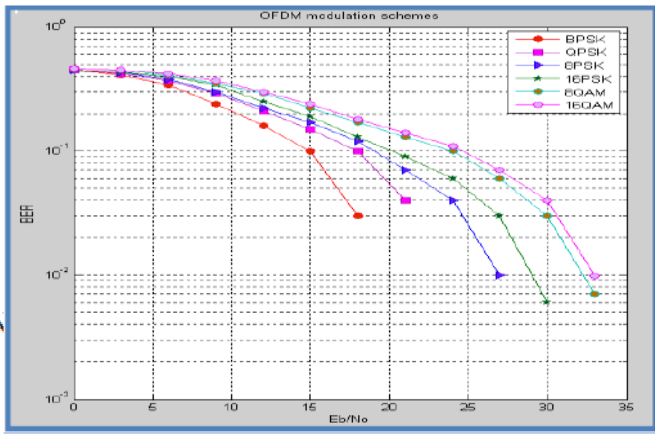


Figure 11 BER verse Eb/No for OFDM using BSPK, QPSK, 8PSK, 16PSK and QAM

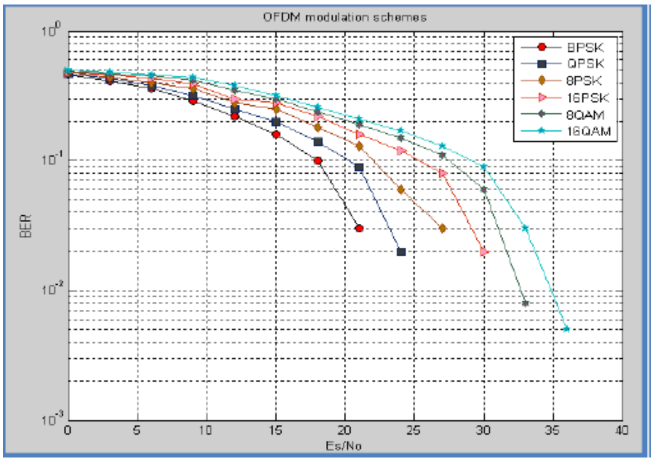


Figure 12 BER verse Es/No for OFDM using BSPK, QPSK, 8PSK, 16PSK and QAM

VI. Conclusion

From the simulation results, it is observed that the BPSK allows the BER and signal to noise ratio (SNR) to be improved in a noisy channel at the cost of maximum data transmission capacity. As we investigate different modulation techniques allows higher transmission capacity, but at the cost of slight increase in the probability of error. From the results, the use of 802.11a wireless standard with QPSK is beneficial for short distance transmission link, whereas for long distance transmission link OFDM with BPSK will be preferable. In simulation bit error rate and frame error rate in OFDM system are within the allowable range, which shows that computer simulation has achieved the expected results. The simulation results show that OFDM has a strong anti multipath interference capability in a high-speed data transfer conditions and has high spectral efficiency.

References

[1] Mesleh, R., Elgala H. and Haas H., "On the Performance of Different OFDM Based Optical Wireless Communication Systems", Journal of Optical Communications and Networking, Vol. 3, ISSN 4321-7441, Issue: 8, pp. 620 – 628, 1 Aug 2011.

[2] Char-Dir Chung, "Spectral precoding for constant-envelope OFDM", IEEE Transactions on Communications, Vol. 58, ISSN 0090-6778, Issue: 2, pp. 555 – 567, 11 Mar 2010.

[3] Tachikawa S. and Ueki, T., "Characteristics of OFDM/CDMA System Using Frequency and Time Domain Spreading", IEEE Ninth International Symposium on Spread Spectrum Techniques and Applications, ISSN 7803-9780, pp. 148 – 152, 2006.

[4] Ghassemi A. and Gulliver T., "PAPR reduction of OFDM using PTS and error-correcting code sub blocking - Transactions Papers", IEEE Transactions on Wireless Communications, Vol. 9, ISSN 1536-1276 Issue: 3, pp. 980 – 989, 2 Feb 2010.

[5] Islam M., Hannan M.A., Samad S.A. and Hussain A., "Bit-Error-Rate (BER) for modulation technique using Software defined Radio", International Conference on Electrical Engineering and Informatics, Vol. 02, ISSN 4244-4913, pp. 445 – 447, 6 Jun 2009.

[6] Al-Mahmoud M. and Zoltowski M.D., "Performance evaluation of Code-Spread OFDM with error control coding", IEEE Military Communications Conference, Vol. 6, ISSN 4244-2677, pp. 1 – 6, 8 Aug 2008 .

[7] Yung, C., K. Shang, C. Kuan, and C. Mao, "Turbo coded OFDM for reducing PAPR and error rates", IEEE Transactions on Wireless for Communications, Vol. 7, ISSN 1536-1276, Issue:1, pp. 84-89, 15 Dec 2008.

[8] Poegel, F., Zeisberg S. and Finger, A., "Comparison of different coding schemes for high bit rate OFDM in a 60 GHz environment", IEEE 4th International Symposium on Spread Spectrum Techniques and Applications Proceedings, Vol. 1, ISSN 7803-3569, pp. 122 – 125, 1996.

[9] Oetting J., "A Comparison of Modulation Techniques for Digital Radio", IEEE Transactions on Communications, Vol. 27, ISSN 0090-6778, Issue: 12, pp. 1752 – 1762, 12 Dec 1979.

[10] Dr. Upena Dalal, "wireless communication"", OXFORD University press, 2009

[11]J.G. Proakis, Digital Communications,4th edition McGraw-Hill 2001.