Comparison of BER for QAM and QPSK Based OFDM System in AWGN Channel

Prabhatkumar M. Rabari[1]Prof.R.N.Patel[2]Prof.C.D.Parekh[3]
[1]PG student, [1,2]Department of electronics and communication,
[1,2]Saffrony institute of Technology, North Gujarat, India
[3]Department of Telecommunication,Raksha Shakti University, Ahmedabad, India
[1]rabariprabhat55@gmail.com, [2]ratansing.patel@yahoo.com, [3]rishi1745@gmail.com

Abstract—*In this paper, we have implemented OFDM system for 16-QAM and QPSK scheme in frequency selective fading. Here we have calculated BER for both schemes over AWGN channel. Scatter plot of 16-QAM and QPSK are shown. Simulation results show that for different values of SNR, BER are calculated. Also compared BER for 16-QAM and QPSK over AWGN channel. Here results tells us that 16-QAM scheme gives better result than QPSK scheme over AWGN channel.*

Keywords:AWGN, BER,FFT, OFDM, QPSK,16-QAM, SNR

I. INTRODUCTION

High rate data transmission and reception can be successfully implemented if the high rate signal to be split into multiple parallel low rate signals and each of them is transmitted on a separate frequency (or sub-carrier). To facilitate separation of the signals at the receiver, the carrier frequencies were spaced sufficiently far apart so that the signal spectra do not overlap. Empty spectral regions between the signals assured that they can be separated with readily realizable filters. The resulting spectral efficiency is therefore quite low. Such a parallel Multi-carrier system can limit spectral efficiency, defined as the total bit rate divided by the total bandwidth. Orthogonal frequency division multiplexing (OFDM) is a special case of multi-carrier transmission that permits the sub-channels to overlap in frequency without mutual interference. In OFDM, the data is divided among large number of closely spaced carriers. The entire bandwidth is filled from a single source of data is carried on each carrier, and by this lowering of the bit rate per carrier (not the total bit rate), the influence of inter-symbol interference is significantly reduced. In addition to improve spectral efficiency, this technique exploits digital signal processing technology to obtain a cost-effective means of implementation. ([1],[2],[3])

II. OFDM SYSTEM

Basic OFDM system consists some blocks like modulation scheme, serial to parallel, parallel to serial, channel, IFFT,FFT, demodulation techniques etc. Here 16-QAM and QPSK modulation Techniques are used. AWGN channel is used as a frequency selective fading channel.
Message error probability for M-ary QAM is

$$Pe, QAM = 4Q\left(\sqrt{\frac{3*(log\,2M)*Eb}{(M-1)*N0}}\right).$$ [5]

And for QPSK is

$$Pe, QPSK = 2Q\left(\sqrt{\frac{2*\Pi*\Pi*(log\,2M)*Eb}{M*M*N0}}\right).$$ [5]

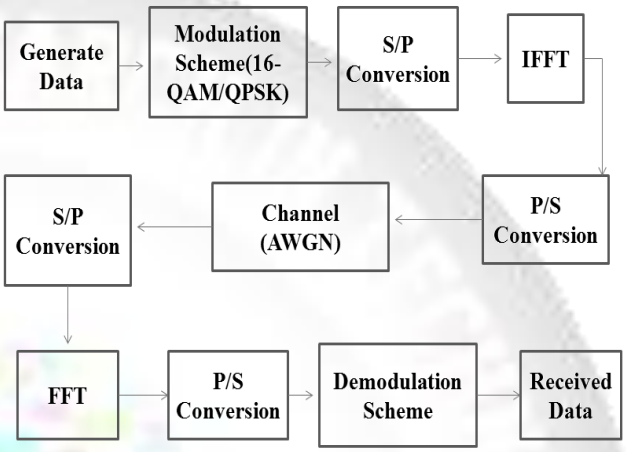

Fig. 1: Block diagram of basic OFDM system.

A. 16-QAM Modulation Scheme

QAM stands for quadrature amplitude modulation. Here scatter plot of 16-QAM is shown. In- Phase values are shown on x-axis, while quadrature values are shown on y-axis. [2]

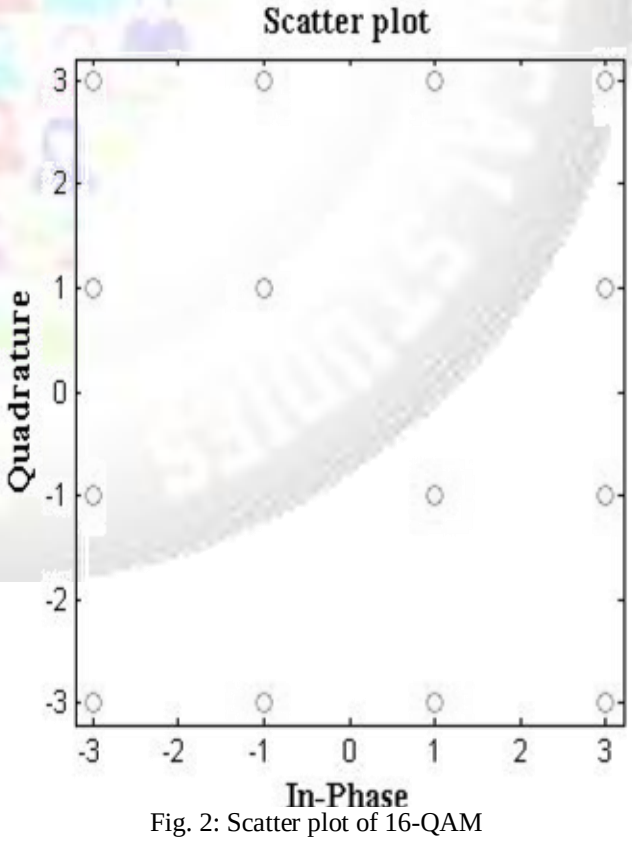

Fig. 2: Scatter plot of 16-QAM

B. QPSK Modulation Scheme

QPSK stands for quadrature phase shift keying modulation. Here scatter plot of QPSK is shown. In-Phase values are shown on x-axis, while quadrature value is shown on y-axis. [2]

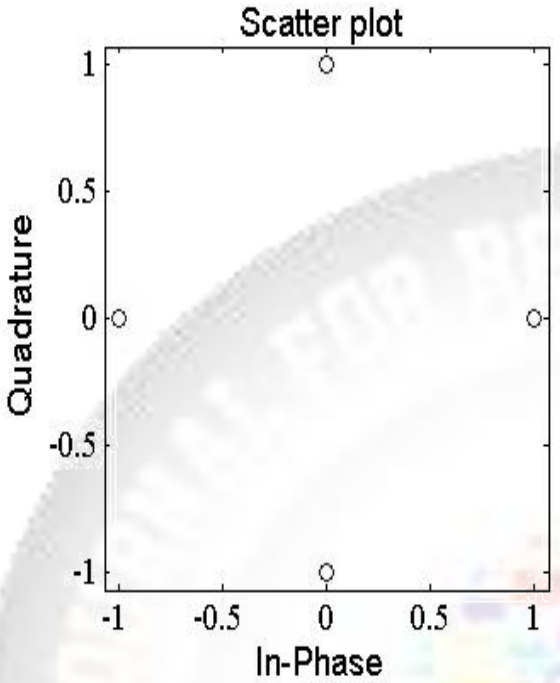

Fig. 3: Scatter plot of QPSK

C. AWGN Channel

Additive white Gaussian noise (AWGN) is used to model channel in which the only impairment to transmitted signal is a linear addition of white noise. The spectral density of white noise is constant. The amplitude of the white noise follows Gaussian distribution. If u (t) is the transmitted signal and y(t) is the received signal, then y(t) can be expressed as: $y(t) = u(t) + n(t)$ Where n(t) is the linear noise added by the channel.[4]

D. FFT

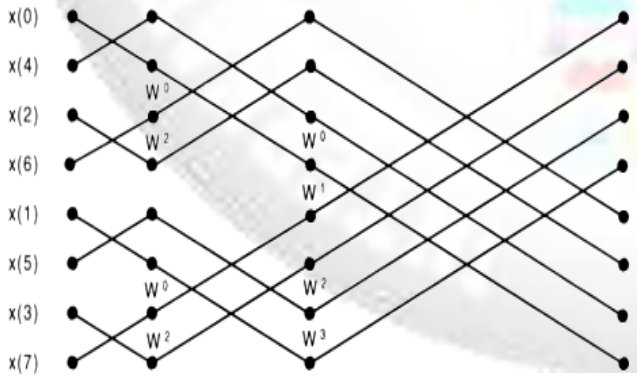

Fig. 4: FFT implementation(Decimation in time)

FFT stands for Fast Fourier Transform. We used 64 point FFT. FFT have less complexity compared to DFT. DFT and IDFT required N^2 computation, while FFT required only $N \log N$computation.[4]

III. SIMULATION RESULTS

Here we used 64,000 random bit. Then applied them to 16-QAM block and QPSK block randomly. Then passed them, from IFFT-FFT block. Here we used AWGN channel for different SNR value from 0 to 60. BER values are compared for 16-QAM and QPSK scheme over AWGN channel. Results are shown in simulation results.

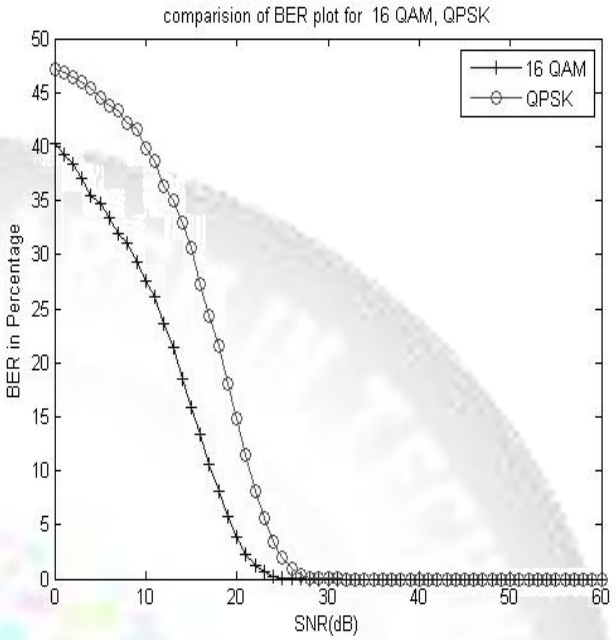

Fig. 5: Comparison of BER for 16-QAM and QPSK based OFDM system

IV. CONCLUSION

In this paper, we concluded that for SNR value of 26db BER plot reach to zero for 16-QAM over AWGN channel, while for QPSK scheme value of SNR is around 30db. So 16-QAM is better than QPSK for AWGN channel because it requires less SNR for zero BER.

REFERENCES

[1] Jiaqi Zhang, Yukui Pei, NingGe, "Comparison of Achievable Rates of OFDM and Single Carrier Communication Systems", TSINGHUA SCIENCE AND TECHNOLOGY ISSN 1007 0214 08/12 pp73-77 Volume 17, Number 1, February 2012.

[2] Pooppy George, Rashmi V Nathan, SiyanaShukkor, Neethu Lakshmi A, "BER Comparison of DCT and FFT Based OFDM Systems in AWGN and RAYLEIGH Fading Channels With Different Modulation Schemes", International Conference on Microelectronics, Communication and Renewable Energy (ICMiCR-2013), 978-1-4673-5149-2/13/$31.00 ©2013 IEEE

[3] "Orthogonal Frequency Division Multiplexing", U.S. Patent No. 3, 488,4555, filed November 14, 1966, issued Jan. 6, 1970.

[4] Ahmad R. S. Bahai and Burton R. Saltzberg, Multi-Carrier Digital Communications Theory and Applications of OFDM, Kluwer Academic Publishers

[5] J.G. Proakis, Digital Communications, McGraw-Hill, 1987.