محاكاة لتقنية تعديل 16 –QAM في قناة AWGN

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الملخص :

تلعب QAM دورًا مهمًا في مجال الاتصالات اليوم ، لذلك من المهم من الناحية النظرية والعملية إجراء دراسة عملية لـ QAM-16 ، في هذه الورقة ، يتم محاكاة تأثير قناة الضوضاء البيضاء الغوسية المضافة (AWGN) على أداء 16- تعديل سعة التربيع لقيم مختلفة من Eb / No باستخدام برمجة MATLAB. تظهر نتائج المحاكاة أن معدل خطأ البتات المحاكي لتشكيل QAM-16 في توافق جيد مع القيمة (Eb / No = -12dB).

Simulation For 16 –QAM modulation technique in AWGN channel

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***Abstract** :QAM plays an important role in today's communications field, so it is of theoretical and practical important to conduct an in- study of 16-QAM,in this paper, the effect of Additive White Gaussian Noise (AWGN) Channel is simulated on the performance of 16- Quadrature Amplitude Modulation for different values of Eb/No using MATLAB programming. The simulation results show that the simulated bit error rate for 16 - QAM modulation in is good agreement at the value (Eb/No=-12dB).*

Keywords- **16-QAM, Simulation, MATLAB.**

I. Introduction

In Digital Communication, there is method, which is versatile and widely used in transferring digital data, and this method called amplitude modulation (AM).

The AM is one of widely used modulation techniques because of its efficiency in power and bandwidth [1]. AM is also a digital modulation technique that combines phase and amplitude control. It has a wide range of applications, in not only the field of mobile communications but also in cable TV transmission, digital video broadcasting, satellite communications and other fields [2].The most common forms are 16QAM, 64-QAM, 128-QAM and 256-QAM. In this paper will focus on the 16-QAM and the bit error rate (BER) on Additive White Gaussian Noise (AWGN) using MATLAB.

This paper is organized as follows: In Section II the limitations of previous work are clarified. In Section III, additive white Gaussian Noise (AWGN) is described. Baseband Rectangular QAM modulator and **(16-QAM)** are described in Sections IV,V. Simulation results and discussed are presented in section VI. Finally, a conclusion is presented in Section VII.

II. REVIEW OF SIMILAR WORK

Many of research have been implemented based on different technologies have been proposed in literatures. In this paper is discussed some of these works similar for our study.

A work done by Ghanim et.al, shows that QAM gives less bit error rate that makes CDMA more flexible and suitable for mobile communication for next generation technology [3].

P. K. Vitthaladevun et .al, in this paper, a 16-QAM transmitter for software defined radio is designed and simulated using MATLAB-Simulink environments diagrams of multiple QAM schemes has been studied, examined and compared to achieve multiple system requirements. The experimental and simulation results shows an important development and the SDR transmitter style guide for current and future wireless and mobile systems. This development could support the 3G and accelerate the transformation to 4G [4].

Perera et .al shows that in a models a 16-QAM coherent optical transmission system and evaluates its performance. Simulation results show an improvement of the performance of the system with the adaptation of guide phase concept and noise averaging concept [5].

Tahir A and Zhao F, they found that the performance of QPSK is improved than QAM when the system is subjected to AWGN Channel [6].

Recently simulation performed **by Bin Zhang et .al**, In this paper, the system has been constructed, and has used Simulink for modeling, simulation, and performance verification performance analysis of QAM .The simulation results show that the constructed QAM digital transmission system can achieve good transmission of analog signals [2].

This paper will focus on Simulation for 16 –QAM modulation technique in AWGN channel simulating to test its performance through simulations using MATLAB.

III. Additive White Gaussian Noise (AWGN) Channel

Additive white Gaussian noise (AWGN) is a basic noise model used in Information theory to imitate the effect of many random processes that occur in nature [7]. Let's break each of those words down for further clarity:

Additive as its name suggests, noise is added to a signal. In another meaning, the signal that is received equates to the signal transmitted plus some noise.

Gaussian because it has a normal distribution in the time domain with an average time domain value of zero.

White refers to the idea that it has uniform power across the frequency band for the information system. It is an analogy to the color white, which has uniform emissions at all frequencies in the visible spectrum.

The channel is linear and time-invariant (LTI).

When a signal passes through an AWGN channel, itadds white Gaussian noise to it. The amplitude frequency response of this channel is flat, and the phase response is linear at all frequencies it allows modulated signals to pass through with no amplitude loss or phase distortion. As a result, fading does not exist in this case, and the only distortion that exists is caused by the AWGN [8]. The received signal is simplified to where n (t) represents the noise, which has a Gaussian distribution with zero mean and variance as the noise power, and x(t) represents the transmitted signal as shown in below figure .The received signal simplified as follows:

$$y = x + n \qquad (1)$$

BER is the Number of errors/ Transmitted bits $= \frac{n_e}{N}$ (2)

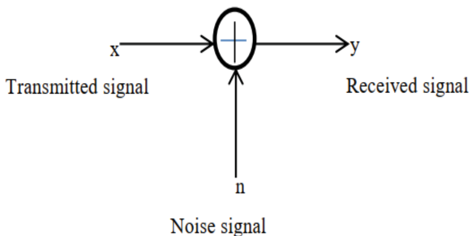


Figure 1. AWGN received signal diagram.

IV. Quadrature Amplitude Modulation

Quadrature amplitude modulation (QAM) is widely used in many digital radio communications and data communication applications. QAM is modulated using two carriers shifted in phase by 90 degrees, the resultant output consists of both amplitude and phase variations [8].

In QAM, there are two baseband real-valued signals m1 (t) and m2 (t) are transmitted simultaneously via the corresponding QAM signal as shown in figure (2).

The general expression of the quadrature amplitude modulation (QAM) signal is:

$$xQAM(t) = m_1(t)\sqrt{2}\cos(2\pi f_c t) + m_2(t)\sqrt{2}\sin(2\pi f_c t) \qquad (3)$$

Where: $m_1\ (t)$& $m_2\ (t)$ are transmitted simultaneously

f_c: represents the carrier frequency.

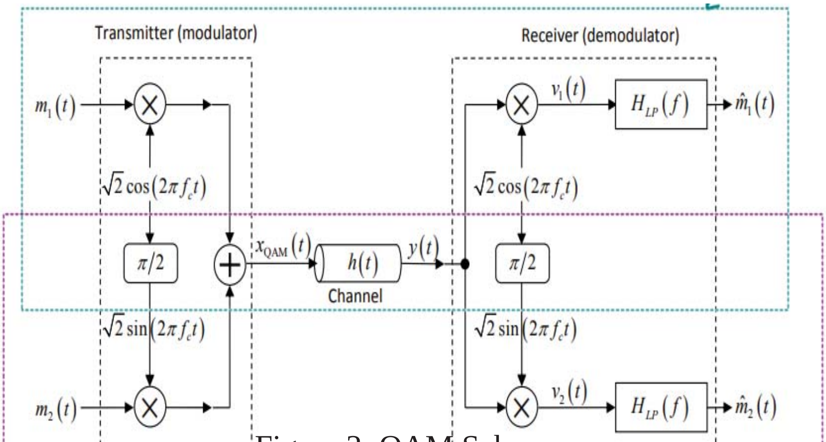


Figure 2: QAM Scheme

V. 16-Quadrature amplitude Modulation (16-QAM)

The 16-QAM modulator input data is divided into 4-bit groups and each of the group is mapped to any of the 16 constellation points each constellation points are divided into two components *(I and Q)* and these values are used to modulate two orthogonal carriers. The modulated orthogonal carriers are combined together and transmitted in the channel as shown in figure 3 [9].

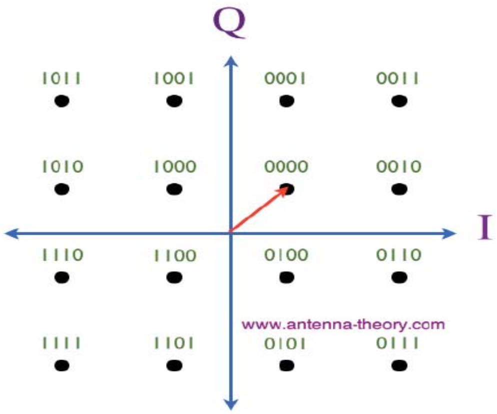


Fig .3 shows Constellation diagram of 16 –QAM.

In general, the constellation points for M-QAM modulation can be generated as [10]:

$$MQAM = a + jb \quad where\ a, b \in \{\pm 1, \pm 3, \dots, \pm([\sqrt{M}] - 1)\} \qquad (4)$$

The energy of a single constellation point is calculated as:

$E = VI,i^2 + VQ,i^2$ (5)

Where VI,i and VQ,i are I and Q components of the signaling point respectively. For a set of n constellation points, the total energy is calculated as:

$$E = \sum_{i=1}^{n} (V_{I,i} + V_{Q,I}{}^{2}) \qquad (6)$$

The 16 QAM signal (M= 16) correspond a 16 States and when transmitting two signals by modulating them with QAM, the transmitted signal will be of the form

Calculating the total energy in any one of the quadrant, say for example -the top-right quadrant.

$$E = (1^2 + 1^2) + (1^2 + 3^2) + (3^2 + 1^2) + (3^2 + 3^2) = 40 \qquad (7)$$

The average energy is

E_{avg}=E/4=40/4=10 (8)

The normalization factor will be:

$$Norm\ Factor = \frac{1}{\sqrt{E_{avg}}} = \frac{1}{\sqrt{10}} \quad (9)$$

VI. SIMULATION RESULT

In this section, Simulations of 16QAM were implemented using MATLAB. The simulation parameters are produced in Table [1].

Table I. Shows variables of the Designed BPSK Modulation.

Parameter	**Description**
N=1000	Number of input symbols
EbN0dB= -6,-8,-12	Define EbN0dB range for simulation
M=16	for 16-QAM modulation
k=log2(M)	Number of bits for symbol
s=refArray(data+1)	16-QAM Constellation mapping with Gray coding
NoiseVariance = 1/(10.^(x/10)), x=Eb N0 dB	Standard deviation for AWGN Noise

The output of the Matlab code shows how pass band16-QAM modulation and demodulation can be done, random binary data was generated and added to AWGN**.** The constellation diagram input binary data receiver signal is as shown in Figure 4 (a) , the constellation simulation results of the transmitted signal when are ***values of*** signal -to-noise ratio per bit (EB/ N0=-6dB , EB/ N0=-8dB and EB/ N0=-12dB) are shown in Figures 4b, 5b,6b.

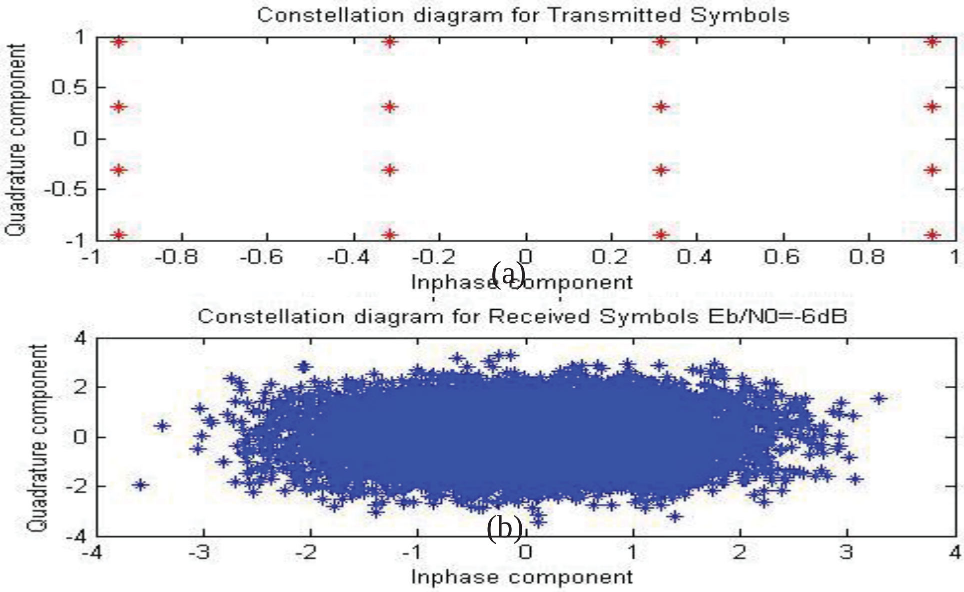
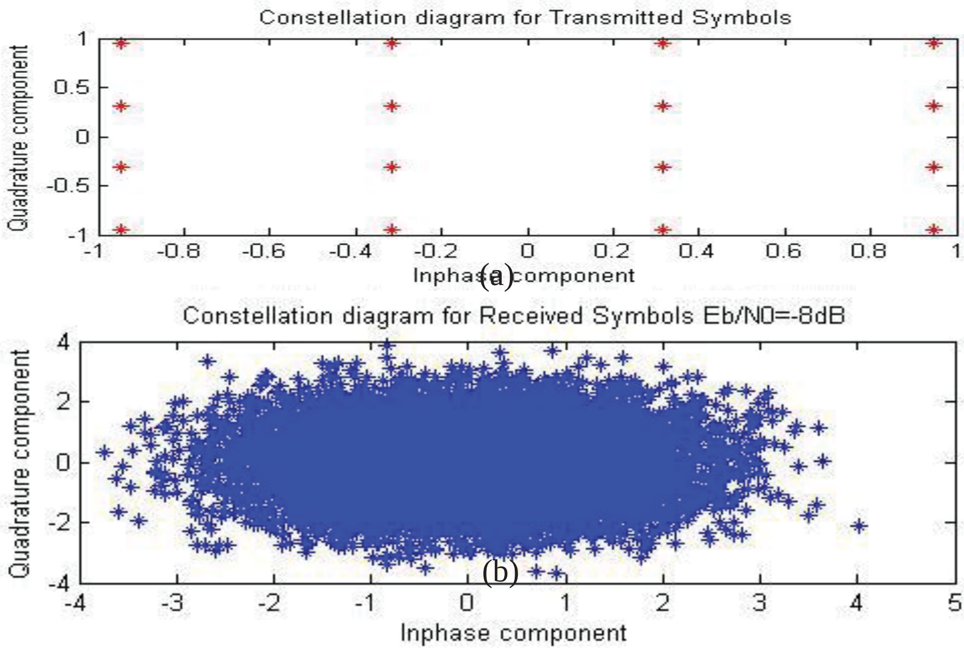


Fig. (4) (a) : 16 QAM modulation system constellation diagram for Transmitted Symbols ,(b) 16 QAM modulation system constellation diagram for Received Symbols EB/N0=6dB



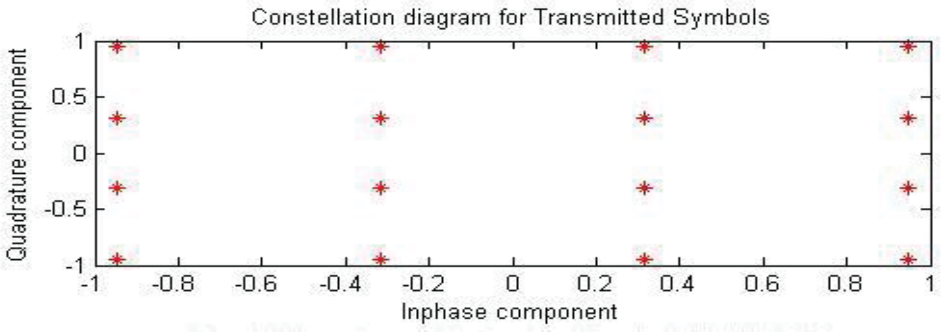
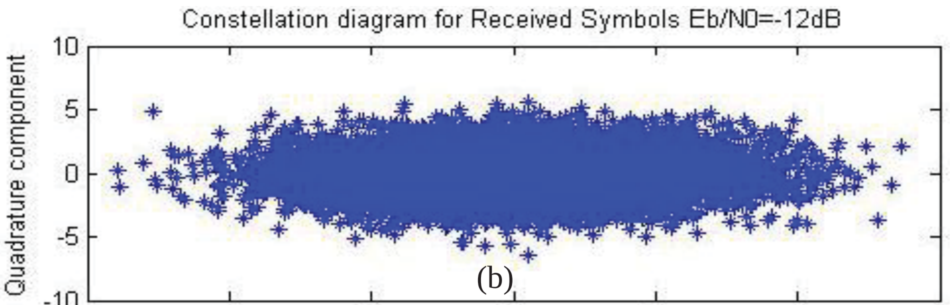


Fig. (5) (a) : 16 QAM modulation system constellation diagram for Transmitted Symbols ,(b) 16 QAM modulation system constellation diagram for Received Symbols EB/N0=8dB.

(a)



(b)

Fig. (6) (a) : 16 QAM modulation system constellation diagram for Transmitted Symbols ,(b) 16 QAM modulation system constellation diagram for Received Symbols EB/N0=8Db.

VII .Conclusions and Discussion

This paper has focus on Simulation for 16 –QAM modulation technique in AWGN channel simulating to test its performance through simulations using MATLAB.

In this paper is implemented 16-QAM system for different value of signal at (EB/ N0= -6dB, EB/ N0= -8 dB, EB/ N0= -12 dB), we found that the simulation of performance of 16-QAM at EB/ N0 = - 12dB better than simulation at EB/ N0= -6dB and EB/ N0= - 8dB as shown results.

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