Design & Comparision of QPSK & QAM Modulator Using Matlab

Rakesh M.Moharle
Vidarbha Institute of Technology
Rashtrasant Tukdoji Maharaj Nagpur University
Nagpur, India
rakesh.moharle@gmail.com

Prof. Nilesh P. Bodne
Vidarbha Institute of Technology
Rashtrasant Tukdoji Maharaj Nagpur University
Nagpur, India
nileshbodne@gmail.com

Abstract—

Digital modulation is a process that impresses a digital symbol on to a signal suitable for transmission on a wired or wireless medium in order to receive that signal at receiving end correctly without any loss of information.
QAM are often referred to as "Quantized QAM" in Digital Formats and they are being increasingly in radio communications systems used for data communications. Radio communications systems ranging from cellular technology through wireless systems which includes WiMAX, Wi-Fi 802.11 use a different type of QAM, uses of QAM will increase within the field of radio communications The QAM modulator is so named because, in analog applications, the messages do in fact vary the amplitude of each of the DSBSC signals. Quadratic phase shift keying (QPSK) modulation technique is the most widely used modulation scheme in modern digital communication system such as CDMA technology and satellite communication etc.; it provides high performance on bandwidth efficiency and bit error rate. In QPSK the same modulator is used, but with binary messages in both the I and Q channels, each message has only two levels, ±V volt. For a non-band limited message this does not vary the amplitude of the output DSBSC. As the message changes polarity this is interpreted as a 1800 phase shift, given to the DSBSC. Thus the signal in each arm is said to be undergoing an 180^0 phase shift, or phase shift keying - or PSK. Because there are two PSK signals combined, in quadrature, the two-channel modulator gives rise to a quadrature phase shift keyed -QPSK - signal.In a sense, QPSK is an expanded version from binary PSK where in a symbol consists of two bits and two ortho normal basis functions are used. A group of two bits is often called a dibit‘. So, four dibits are possible. Each symbol carries same energy. QPSK modulation has various applications particularly in the design of wireless modem, cellular CDMA communication. QPSK, modulation is very robust, but requires some form of linear amplification. In a sense, QPSK is an expanded version from binary PSK where in a symbol consists of two bits and two orthonormal basis functions are used. A two bits group is often called a dibit‘. So, there are four dibits possible. Each symbol carries same energy.
Viewed as a phasor diagram (and for a non-bandlimited message to each channel), the signal is seen to occupy any one of four point locations on the complex plane. These are at the corner of a square (a square lattice), at angles π/4, 3π/4, 5π/4 and 7π/4 to the real axis. Using the latest available version of MATLAB and Simulink ®, this revision of a design of QAM & QPSK Modulation will take a user-chosen modulation type (QPSK & QAM), propagate it through noise, evaluate the BER & SNR with AWGN and finally tell the user which is best modulator.

Keywords**: *QPSK, QAM, BER, SNR, AWGN***

1.INTRODUCTION

M-ary term is derived from the binary word. It simply represents a digit that corresponds to the number of Conditions, levels, or combinations possible for a given number of binary variables. For example, a digital signal with four possible conditions (Voltage levels, frequencies, phases, and so on) is an M-ary system where M = 4. If there are eight possible conditions, M = 8 and so forth. The number of bits necessary to produce a given number of conditions is expressed mathematically as $N = \log_2 M$ -------- (1) Where N = number of bits necessary
M = number of conditions, levels, or combinations possible with N bits. Equation 1 can be simplified and rearranged to express the
Number of conditions possible with N bits as $2^N=M$ -----(2)
For example,if one bit, only $2^1 = 2$ conditions are possible.If two bits, $2^2 = 4$ conditions are possible,If three bits, $2^3 = 8$ conditions are possible, etc.
QAM (quadrature amplitude modulation) is a method of combining two amplitude-modulated (AM) signals into a single channel, thereby doubling the effective bandwidth.
QAM modulation technique is a combination of both Amplitude and phase modulation techniques.QAM is used with pulse amplitude modulation (PAM) in digital systems,

especially in wireless applications.QAM signal consists of two carriers, both the carriers having the same frequency but phase is differs by 90 degrees (one quarter of a cycle, hence the term quadrature arises). One signal is called the Q signal, and another one is the I signal. Mathematically, one signal can be represented by a sine wave, and the other signal represented by a cosine wave. Both the modulated carriers are combined at the source for transmission. A motivation for the use of quadrature amplitude modulation comes from the fact that a straight amplitude modulated signal, i.e. double sideband even with a suppressed carrier occupies twice the bandwidth of the modulating signal. QAM restores the balance by placing two independent double sideband suppressed carrier signals in the same spectrum as one ordinary double sideband suppressed carrier signal.Quadrature Amplitude Modulation or QAM is a form of modulation which is widely used for modulating data signals onto a carrier used for radio communications.

BIT ERROR RATE: Better accuracy of the transmitted signal is measured by BER, BER=Number of Error rates/Total number of bits.

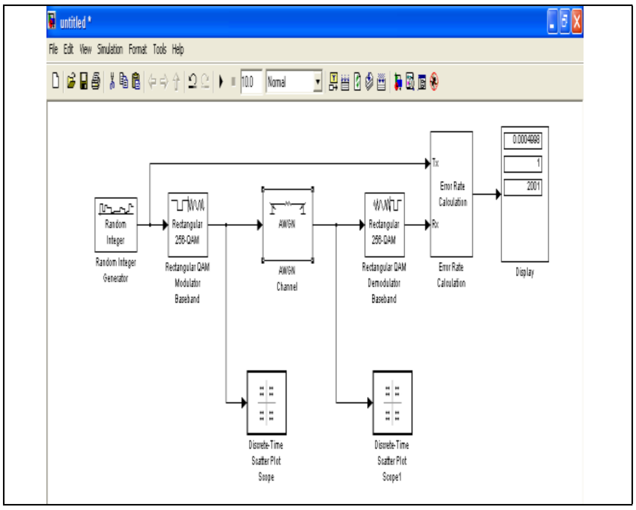

FIG.1.QPSK SIMULINK MODEL

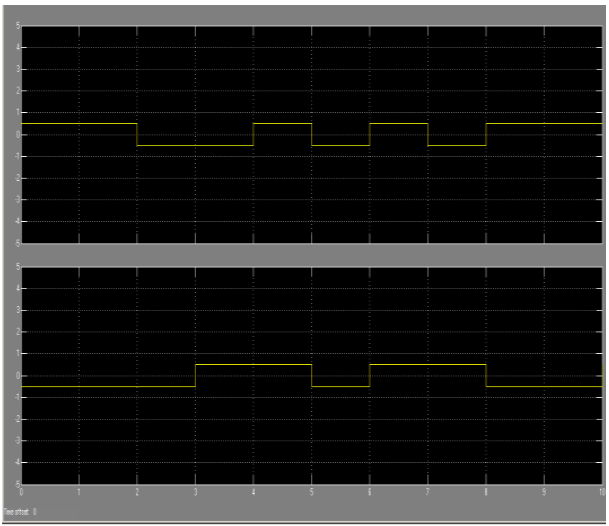

Fig.2.Scope Output

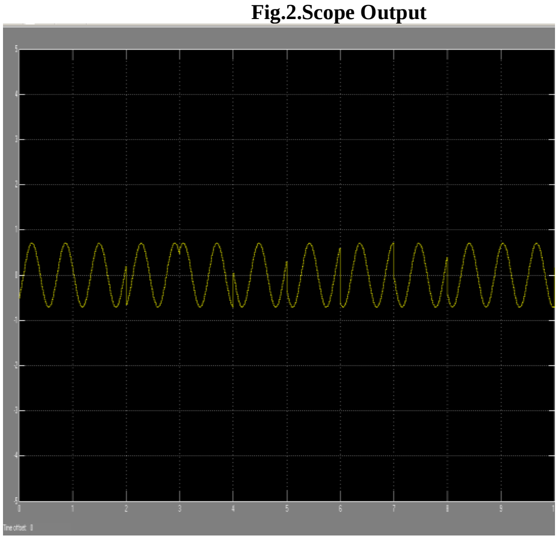

Fig.3.Scope 1 Output

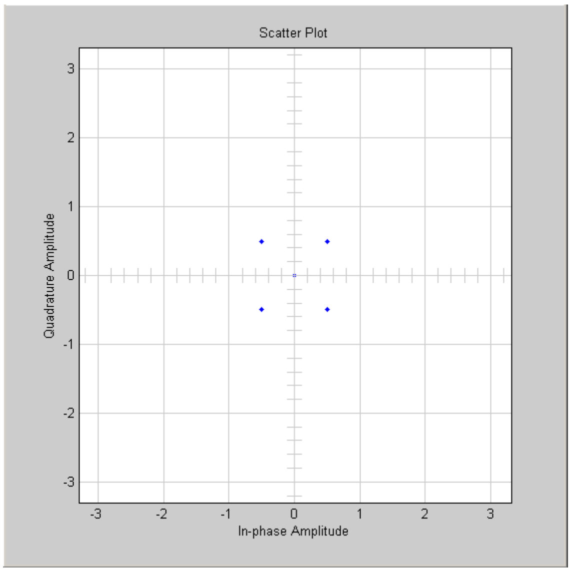

Fig.4.Scatter Plot Output

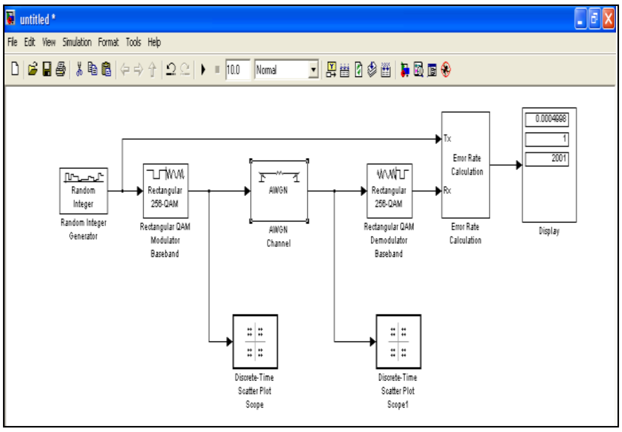

FIG. 5.QAM SIMULINK MODEL

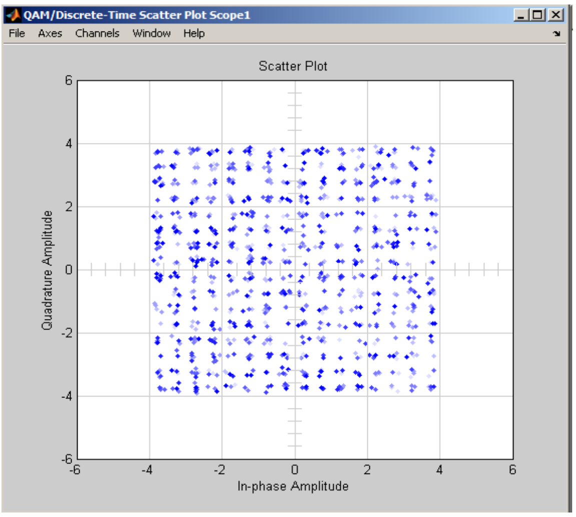

Fig.6. **Signal with 20dB SNR AWGN noise**

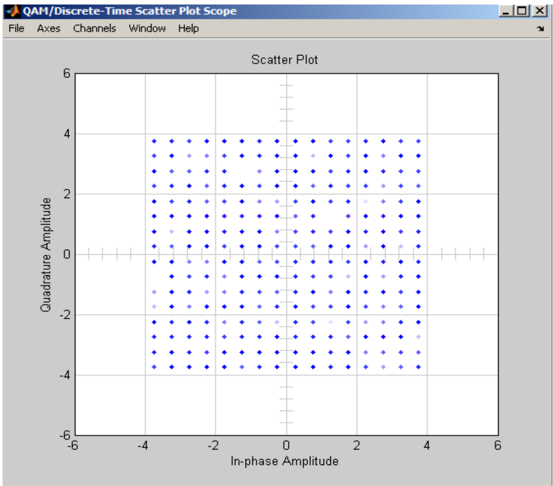

Fig.7. **Transmitted signal**

I.THEORY QPSK

The binary data stream is splitted into the two components in-phase and quadrature-phase components. These components are then separately modulated onto two orthogonal basis functions. In this implementation, two
Sinusoids are used. After that, the two signals are superimposed, and the resulting signal obtained is the QPSK signal. Note that the use of polar NRZ encoding. These encoders block can be placed before for binary data source, but have been placed after to illustrate the conceptual difference between digital and analog signals involved with digital modulation.

I.1 PN-Sequence generator (Random Generator)

The random bit generator generates a bit sequence (PN-sequence) that is used as input data for our QPSK modulator. A PN-sequence generator circuit is an array of D-flip flops. Various combination of X-OR gates can be used to get various bit sequences.

I.2 Integer to Bit Converter

Map a vector of Integers to a vector of bits. The first bit of the vector is the MSB.The output of bits per integer value defines how many bits are mapped from each integer.

I.3 DEMUX 1

It splits the bits into either
a) Vector signals into scalars or smaller vector.

b) Bus signals produced by the MUX block into their constitute scalar,vector or matrix signals.

I.4 NRZ coding

Adds or subtract the inputs either
a) String containing + or – for each input port,for spacer between ports.
b) Scalar>=1.A value >1 sums all Input; 1 sums elements of a single Input vector.

I.5 Constant Block

Output of constant specified by the constant value paramreter.If constant value is a vector & interpret vector parameters as 1-D is on, treat the constant value as a 1-D array otherwise o/p a matrix with the same dimensions as the constant. Source Block There are two source block 0*Pi & Pi/2 Output of sine wave O(t) =Amp.*(Frequecy*t+Phase)+Bias Sine type determine the computational technique used. The parameter in the two types are related through Samples per period=2*Pi/ (Freq.*Samples) No. of Offset Samples=Phase*Samples Per period/ (2*Pi).

I.6 Product Block

Multiply & divide the input:Choose element wise or matrix product & specify one of the following
a) * or / for each input port (eg.**/*)
b) Scalar specifies the no. of input ports to bre multiplied.

I.7 SUM

Adds or subtract the inputs as discussed in NRZ coding.

I.8 Real Image to Complex

Construct a complex output from real & / or Imaginary Input.

II.THEORY QAM

The blocks and lines in the Simulink model describe mathematical relationships among signals and states:

- The Random Integer Generator block, generates a signal consisting of a sequence of random integers between zero and 255
- The random integer value modulates in Rectangular QAM Modulator using rectangular quadrature amplitude modulation method.

The AWGN Channel block models a noisy channel by adding white Gaussian noise to the modulated signal.

The rectangular Demodulator QAM demodulates the input signals.

Error rate calculation block compares the received data with delayed of transmitted data.

II.1 Random Integer Generator

The random bit generator generates uniformly distributed integer in the range (0,M-1) when M is the M-ary number.

II.2 Rectangular QAM Modulated Baseband

It modulates the Input signal using the rectangular QAM method.

The M-ary number value must be an integer power of two. The input can be either bits or integer. The symbols input can be binary mapped or Gray mapped.

III.3 AWGN

This blocks adds the Additive white Gaussian noise to the input signal, but the input signal are real & complex hence this block supports the multichannel input & output signal with frame based processing.

When using either of the variance mode with complex input,th variance values are equally divided among the real & imaginary components of the input signal.

III.4 Rectangular QAM Demodulator

It demodulates the input signal using rectangular QAM method.For sample based input the input must be scalar.
For frame based input the input must be column vector.
The symbols can be either binary demapped or Gray Demapped.

III.5 Discrete Scatter plot

It displays a modulated signal constellation in its signal space by plotting the Inphase component versus the quadrature component with 20db SNR.

III.6 Error Rate Calculation

It compute error rate comparing the received data with delayed version of transmitted data. The output is a three element vector consists of the error rate, followed by the number of errors detected & the total number of symbols compared.
The delays are specified in number of samples, regardless of whether the input is scalar or a vector.
Display block shows the BER performance of the QAM system.

Advantage

QPSK

- Higher data rate than in PSK (2 bits per bit interval), while bandwidth occupancy remains the same
- 4-PSK can easily be extended to 8-PSK, i.e. n-PSK
- However, higher rate PSK schemes are limited by the ability of equipment to distinguish small differences in phase.

QAM

- QAM increase the efficiency of transmission for radio communications systems by utilizing both amplitude and phase variations.
- QAM is very high Noise immunity.
- QAM is having high bit rates.
- QAM has Low error probability.
- Due to Baud rate is half the bit rate hence more effective utilization of the available bandwidth of the transmission channel.

Application

QPSK

- WLAN IEEE802.11b (2 Mbps, 5.5 Mbps, 11 Mbps)
- 3G WDMA
- DVB-T (with OFDM)

QAM

- Telephone modem (16QAM)
- Downstream of Cable modem (64QAM, 256QAM)
- WLAN IEEE802.11a/g (16QAM for 24Mbps, 36Mbps; 64QAM for 38Mbps and 54 Mbps)
- LTE Cellular Systems

III.CONCLUSION

At this work a MATLAB simulation was carried out in order to analyze the QAM & QPSK Modulator.

Our results show that the throughput of the system is increased when transmitting more bits per symbol. This increase in SNR comes at the expense of BER. Which can be mitigated by increasing the energy per bit to noise power spectral density ratio of the system? It is clear that there has to be a compromise between higher SNR, BER. Based on our results, it is important to further investigate the implementation of 8-bit, 32-bit & 128-bit QAM & OQPSK in wireless broadband systems. This research will be continued to reinforce the results in this paper.

In our project I finally study both modulations QAM & QPSK with comparing the BER, SNR, and Symbol Initial speed.

QAM Simulink model as shown in Fig. discuss the all blocks used in the QAM simulink model as shown in Fig.1.In this paper we have to get the output in the Scatter plot which shows that QAM has a qudrature modulation technique. Also we have seen the different output first is Signal with 20db SNR with AWGN noise & second is Transmitted signal. We have achieved the BER is 0.0004998ms. QAM is best modulator hence it will be used in Higher modulation.

IV. Future Scope

Our results show that further investigation is needed to determine the practicality implementing high order QAM in wireless broadband systems. In the future we will add empirical models to the simulation. This will allow us to examine the performance of high order QAM in the presence of large-scale path loss. Additionally, we will to incorporate Orthogonal Frequency Division Multiplexing (OFDM), which is being highly adopted by modem broadband communications systems into the system.We can also design 8-bit, 32 bit & 128 bit QAM.

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