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## Implementation of QPSK Communication System in LabVIEW

Suma Paulose<sup>1</sup>, Jinimole C.G<sup>2</sup>

PG Student [Communication Engineering], Dept. of ECE, Rajagiri School of Engineering and Technology,  
Kerala India<sup>1</sup>

PG Student [Communication Engineering], Dept. of ECE, Rajagiri School of Engineering and Technology,  
Kerala India<sup>2</sup>

**ABSTRACT:** Digital communication is widely used in all fields of communication. Different digital modulation schemes based on keying techniques are used for implementing digital communication systems. There are different types of keying like amplitude shift keying, frequency shift keying, phase shift keying etc. In this paper paper QPSK (Quadrature Phase Shift Keying), a type of phase shift keying is implemented. Phase shift keying uses four points on the constellation diagram to represent the four phases. QPSK can encode two bits per phase. Here we have used LABVIEW (Laboratory Virtual Instrumentation Engineering Workbench) as the simulation platform. This programming environment being graphical, gives good visualization of the results.

**KEYWORDS:** Digital Communication, Phase Shift Keying, QPSK, LABVIEW

### I. INTRODUCTION

Keying is a family of modulation forms used to transmit digital signals over an analog channel. Modulation is the technique of shaping a signal to convey information. For representing digital signals into analog waveform the techniques keying can be used. The modulating signals will have only limited number of states at all times to represent the corresponding digital states in keying.

Quadrature phase shift keying (QPSK) is a widely used digital modulation technique in wireless communication because of its ability to transmit twice the data rate for a given bandwidth [1]. For the efficient data transmission the wireless communication systems require high data rate. The purpose of the modulation techniques is to increase the data transmitting efficiency. QPSK is one of the forms of Phase Shift Keying modulation scheme. This technique is widely preferred because of its advantages increased data rate and ease of implementation. For a given binary data rate the transmission bandwidth is reduce by a factor of 2. The term quadrature means the signal shifts between the phases which are 90° apart.

Here QPSK communication system is being implemented using the software LabVIEW. AWGN noise is added to the QPSK output and the input signal is retrieved at the output after removing the noise.

### II. LITERATURE REVIEW

#### 1. Digital Modulation

In digital modulation the data symbol to be transmitted is impressed on to a signal suitable for transmission over a wired or wireless medium for receiving the data at the receiver without any loss. Digital modulation provides more information capacity, compatibility with digital data services, higher data security, better quality communications, and quicker system availability. Therefore the demand for digital modulation techniques has been increased to a great extent. There are many types of digital modulation techniques are available and even we can use a combination of these techniques as well. A sequence of digital symbols are used to vary the parameters such as frequency, amplitude and phase of a high frequency carrier. Thus the basic digital modulation schemes are:

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Examples of digital modulation include:

- ASK (Amplitude Shift Keying)
- FSK( Frequency Shift Keying)
- PSK (Phase Shift Keying)

The combination of ASK and PSK also used to form new techniques such as Quadrature Amplitude Modulation (QAM).

## 2. Quadrature Phase Shift Keying

Phase Shift Keying (PSK) is a large class of digital modulation techniques which are widely used in communication. In this the phase of the output signal is get shifted depending upon the input signal. PSK is considered to be very resistant to nonlinear effects since the envelope of the signal is constant [2]. Mainly two types: Binary PSK (BPSK) and Quadrature PSK (QPSK) depending upon the number of phase shifts used.

QPSK is a constant amplitude M-ary digital modulation scheme. Since QPSK provides high performance on bandwidth efficiency and bit error rate, it is considered as the most widely used modulation technique in digital communication system [3]. In this two successive bits from the data bits are combined to form a symbol and then each of such symbols are represented by a phase shift of the carrier signal. Thus in QPSK the number of bits is two and the number of signalling elements used is four. So this can carry twice as much data with the same given bandwidth as can be carried by a single bit system [1]. Thus provides enough SNR.

It uses four different phases separated by multiples of  $90^\circ$  of the carrier signal. Thus it can have four output phase for a single carrier frequency corresponding to 00, 01, 10, and 11 dibits. The carrier signal takes four phase reversals such as  $45^\circ$ ,  $135^\circ$ ,  $-45^\circ$  and  $-135^\circ$ . The constellation diagram of the same is given in fig. 1 [4].

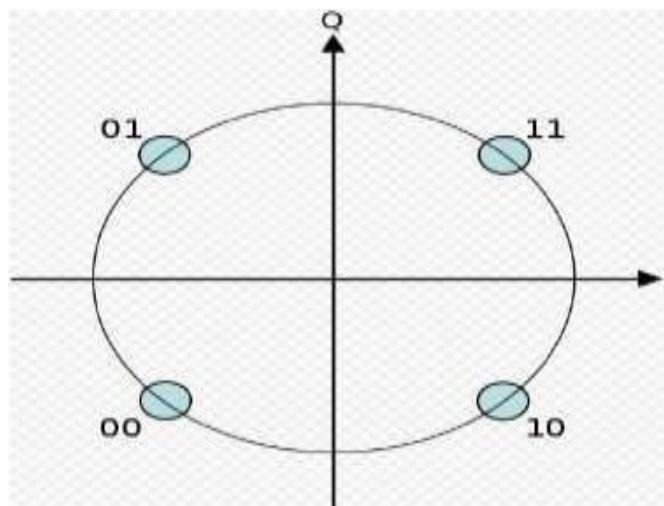


Fig. 1 QPSK Constellation Diagram

The basic mathematical expression of QPSK is given by eqn.1 [5].

$$S_{qpsk}(t) = \sqrt{\frac{2E_s}{T_s}} \cos\left(2\pi f_c t + (2n-1)\frac{\pi}{4}\right) \quad (1)$$

Where  $n=0, 1, 2, 3$ .

## 3. LabVIEW



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LabVIEW is the short for Laboratory Virtual Instrumentation Engineering Workbench and is a graphical programming language introduced by National Instruments. Since LabVIEW has many built-in features, it may be used as a tool for simulation and control. The main areas where this programming environment is used involves controller design applications, industrial automation etc. They can be implemented on many platforms including Microsoft Windows, UNIX and Linux[6].

The programs developed using LabVIEW are called virtual instruments (VIs). The front panel, block diagram and the connector panel are the three components for each VI in LabVIEW. To include a VI in the block diagrams of some other VI, the connector panel may be used. The inputs and outputs of the front panels are called controls and indicators respectively. Controls give information on the inputs used in the VI. Indicators display, the results of the inputs of the VI. The objects that we place on the front panel will be obtained as terminals on the back panel. There are options such as structures and functions on the back panel and the main objective of this environment is to do the operations on the specified input from controls and give the output to indicators. The Functions palette consists of structures and functions and can be placed on the back panel.

It is very easy to learn and implement LabVIEW because it only involves the drag and drop of the required blocks which are very familiar. Another advantage of using LabVIEW is that we can continuously vary the input parameters and can view the corresponding results just by making a change in the appropriate block in the front panel. The block diagram we are implementing is almost the same circuit diagram and hence it is easy to work in this graphical programming language. Also it is very easy to implement a concept to a working model.

## III.MODEL BLOCK DIAGRAM

### 1. QPSK Modulator

The block diagram of the QPSK modulator is shown in Fig.2 [7].

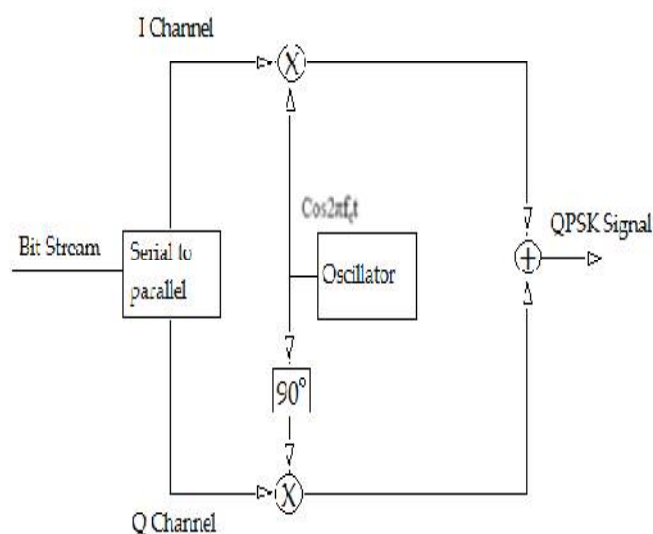


Fig.2 QPSK Modulator

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The QPSK Modulator uses a bit-splitter, two multipliers with local oscillator, a 2-bit serial to parallel converter, and a summer circuit. It can be say that it uses two binary phase shift keying (BPSK) modulators, but the data transmission in QPSK is twice when compared to BPSK. The first bit represents the In-phase (I) components and the second bit represents the Quadrature-phase (Q) components. The  $PSK_Q$  signal will be phase shifted by  $90^\circ$  from  $PSK_I$  signal. Both these I and Q components are added to produce the required QPSK signal.

The QPSK modulated signal is given in Fig. 3[8].

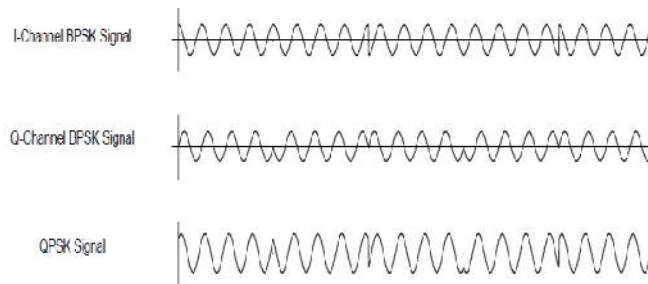


Fig.3 QPSK Modulated signal

## 2. QPSK Demodulator

The QPSK demodulator block diagram is given in Fig.4[9].

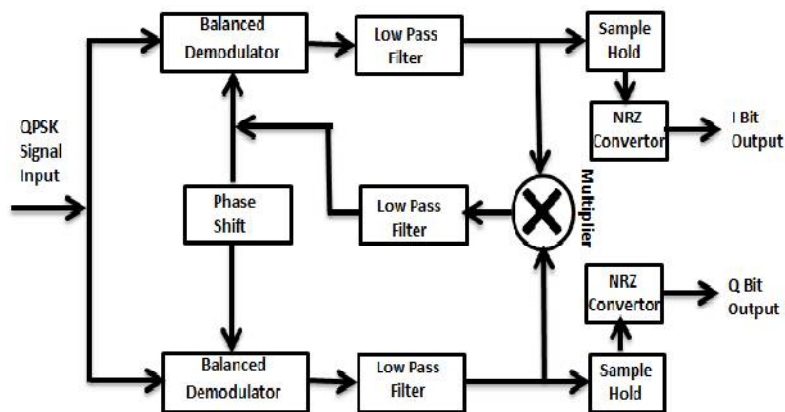


Fig.4.QPSK Demodulator

It uses two product demodulator circuits with local oscillator, two band pass filters, two integrator circuits, and a 2-bit parallel to serial converter. The two product demodulators simultaneously demodulated the two BPSK signals. These signals are processes and passed to the parallel-to-serial converter.

## IV. LabVIEW IMPLEMENTATION

### 1. QPSK Block Diagram VI

The QPSK modulator VI in LABVIEW is given in Fig. 5. Here four bit combinations 00,01,10,11 are generated by using two greater/equal circuits, AND and NOT circuits. Using two select switches, each of these combinations is

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assigned a phase of -45, +45,-135 and +135. These phases are fed to the phase input of a signal generation by duration VI and its frequency is selected as 2 KHz. The output of the signal generator is the QPSK wave form.

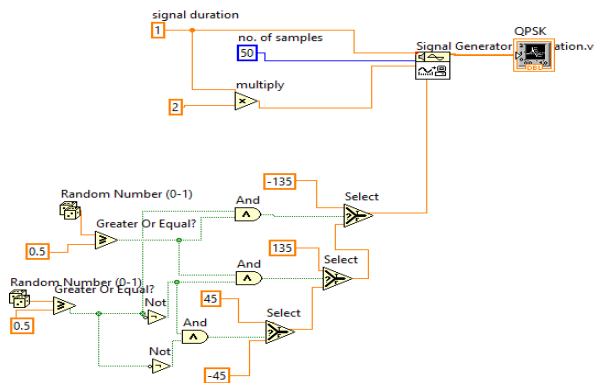


Fig.5 QPSK Modulator

## 2. QPSK with AWGN noise VI

The AWGN noise is added to the output of the QPSK signal before transmission. This is done in LABVIEW by using a Gaussian white noise VI. The AWGN noise is generated using this VI and then added to the output QPSK signal. The resulting noise added QPSK signal is transmitted.

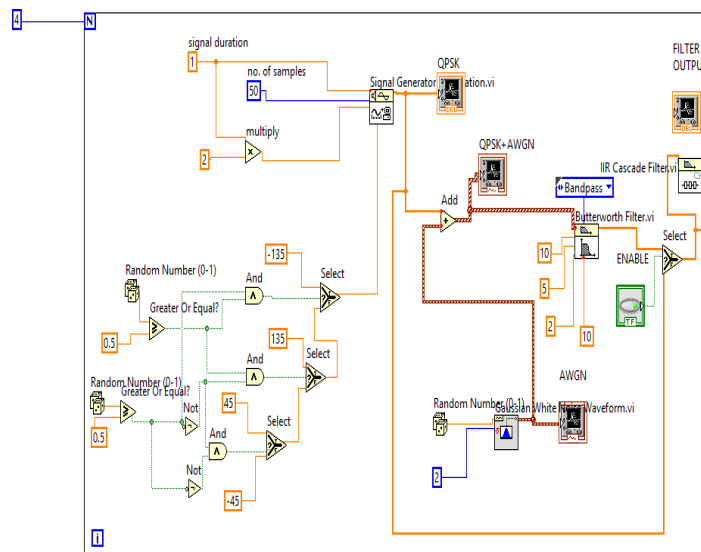


Fig.6. QPSK Modulator with AWGN added and Demodulator VI

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The figure given is the QPSK modulated signal retrieval block diagram from the noise added QPSK output. The added AWGN noise is removed and the QPSK modulated output is retrieved. The noise removed QPSK signal can be then demodulated to get the original digital data being sent.

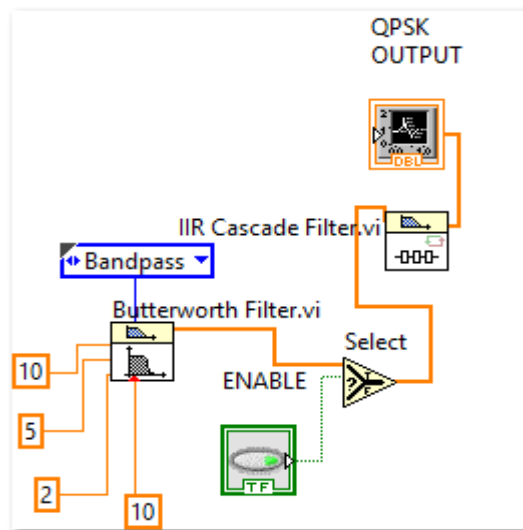


Fig.7.QPSK Retrieval Block Diagram VI

## V. RESULTS AND DISCUSSION

The various results obtained are given below. The QPSK modulated signal obtained at the front panel is given in Fig. 8. Four phases of QPSK are obtained by using two random bit generators. Four different phases are generated for representing the input data bits to be transmitted. One phase represents a dibit.

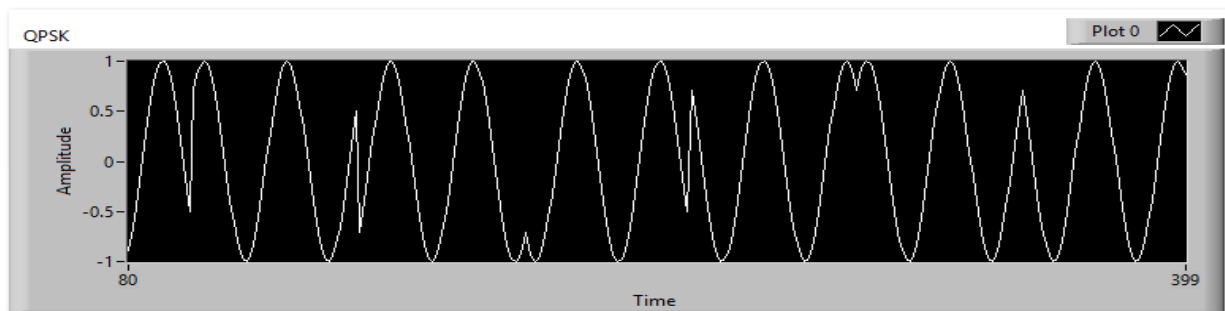


Fig.8 QPSK Modulated output

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This QPSK modulated signal is added with AWGN noise to simulate the effect of channel with AWGN noise..The generated AWGN noise is then added to the output of the QPSK modulator. Thus the noise affected signal is transmitted.The AWGN noise generated is shown in Fig.9.

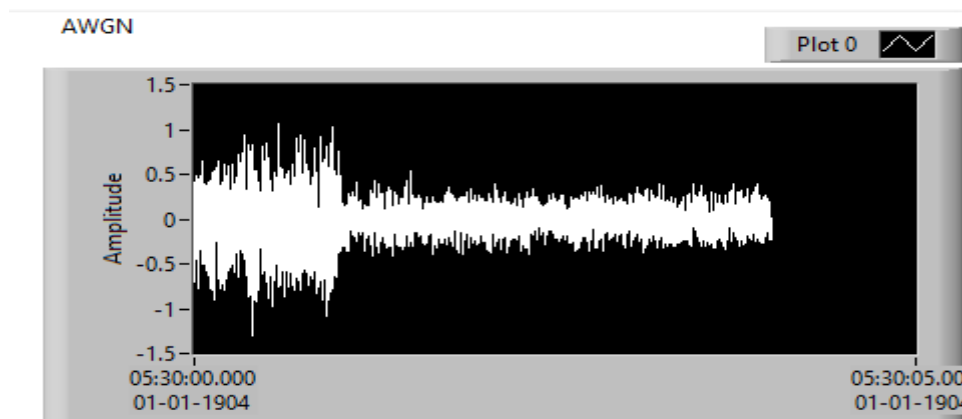


Fig.9 AWGN noise

The resulting QPSK modulated output signal after the addition of the AWGN noise is shown in Fig.10. Before demodulating the received QPSK modulated signal added with AWGN noise the original QPSK signal need to be extracted. For that the noise retrieval block shown in Fig.7 is used. So the following signal is passed to the noise removal block.

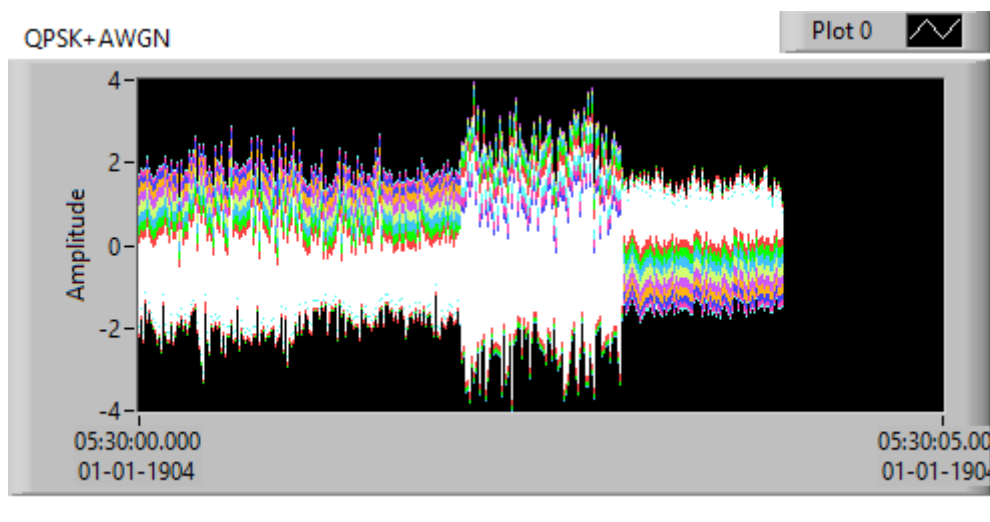


Fig. 10 QPSK output with AWGN noise added

Thus after passing the noise added QPSK modulated signal through the retrieval circuit the original QPSK signal is retrieved. The QPSK signal is retrieved from the noise added signal is given in Fig.11. Thus the AWGN noise is removed from the QPSK modulated output.This signal is then passed through the QPSK demodulator to get the original data bits sent.



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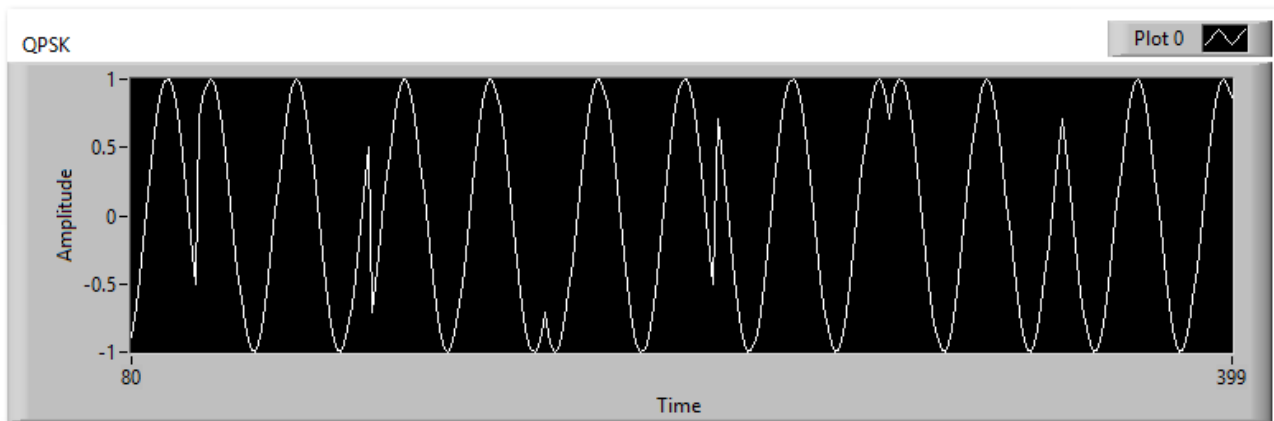


Fig. 11 QPSK Modulated signal Retrieved from the AWGN noise

## VI. CONCLUSION AND FUTURE WORK

Here QPSK is implemented using LabVIEW. Through some experimental results we have demonstrated the ability of LabVIEW programming language. This graphical environment is easy to learn and simple to transform a concept to a working program. Moreover it is possible to continuously vary the input parameters and observe the corresponding results. All the concepts being implemented are simulated using basic blocks like signal generator, multiplier, adder, select switch, for loop etc. This makes the system more users friendly.

LabVIEW also offers options for working with text-based math programming using m-file scripts. One way to do so is to combine text-based m-file script programming with traditional LabVIEW graphical programming using a script node interface. By adding a script node to a LabVIEW graphical program, Scriptnodes are resizable text entry regions that we can add to our graphical programs. Using that, the BER of the system may be found. Further the channel estimation may also be done.

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