

Design of a Wireless Transceiver using Software Defined Radio with PSK Modulation Formats

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Submitted by
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CERTIFICATE

This is to certify that the work which is being presented in the dissertation entitled "**Design of wireless transceiver using software defined radio with PSK modulation formats**" is the authentic work of **Mayank Aggarwal** under my guidance and supervision in the partial fulfilment of requirement towards the degree of Master of Technology in Microwave and Optical Communication Engineering jointly run by Department of Applied Physics and Department of Electronics and Communication in Delhi Technological University during the 2016-18.

As per the candidate declaration this work has not been submitted elsewhere for the award of any other degree.

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Declaration

I hereby declare that all the information in this document has been obtained and presented in accordance with academic rules and ethical conduct. This report is my own, unaided work. I have fully cited and referenced all material and results that are not original to this work. It is being submitted for the degree of Master of Technology in Engineering at the Delhi Technological University. It has not been submitted before for any degree or examination in any other university.

Abstract

In today's world, technology grows rapidly and computers and other digital devices become powerful and effective, allowing researchers to explore modern technology that has been found in the hands of a few people over the years. This is the current state of the wireless system of communication technology. The previous operating method was difficult for the time and time when it was necessary to provide regular circuit boards to test for the purpose of the model.

Currently, computers are detected by researchers. They are used for the purpose of processing the signal previously performed with dedicated devices. The computers we use in our everyday life are used to make important statistics on these dedicated devices. The Software defined radio (SDR) is similar to this type of work.

The latest version of the signal service on the device dedicated to the PC-controlled system has created a lot of opportunities for a relatively limited amount. Now, we can easily scan and improve everything of a particular system of communication with the help of software described by the radio.

By working with this article, we can easily read the information of the SDR. After that I found this goal and motivation in my mind, I tried to use wireless networking using SDR technology, including Universal Peripheral Software Radio (400 MHz - 4.4 GHz) and the LAB View system. In this work, communication design Transferring the system and wireless receiver using voice change variation by pressing the Shift key (PSK). The design was based on specific requirements, such as planets graph, diagram, eye transgression, error transgene, size adjusted by error, size error, error analysis stage.

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Last but not least, I would like to thank my parents, for instilling a good spirit, and as a result I am able to do my work after graduation from this esteemed institution. I would like to thank my friends for believing in my abilities and always giving me their invaluable support and constant encouragement.

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Chapter 1

Introduction

1.1. Basic Introduction

The 5G communication system is a smart wireless system, where radio frequency groups are completely different from the effective use of radio broadcasts. In order to achieve the ability to convert the system, custom devices are handled by devices controlled by software known as the SDR. Radio that can be defined by waveforms to create a channel in the system. SDR is the building of a mental-health system as it equalizes equilibrium in highly reliable communication. The definition of radio technology has been explained in detail regarding factory births and researchers who begin to compare with traditional records.[1] The result is a radio broadcast tariff program, such as the generation of voice variation signal / deletion of voice and encryption stations decoders in the field signal processing and tracking connections, and all used in software rather than a real-time circuit because the system determines the radio can be easily reconfigured since you have the flexibility to adapt To improve and improve technology.[2]

There are currently many researchers receiving NI-USRP structures by comparing and measuring different modulation. Especially by using the rating, benefits and potential of this program that specifies the broadcast will be clearly set. It will look at the unique viewpoint of researchers that under different types of conditions, how the NI-USRP system works and avoids many problems.[3]

The good development of the wireless real-time process takes time, a long way to deal with many problems. Reliable communication system is the most important feature of all problems in order to ensure the operation of the wireless system. It's best to imitate apps in the nature of the software. But there are many programs for apps that may follow wireless communication

system.[4] So in the NI-USRP system used for the main test of the platform by simulating the various conversions of programs to find qualities in this new program, watching the radio.

The wireless simulation system has changed dramatically in recent years, and the USRP system benefit can provide information about wireless communication system[5]. As you can build NI-USRP for better search in the field of radio search, search is utilized at a maximum level of territory, so it's use NI-USRP as the end of sending and receiving data. With module modules, and engine operations for RF modules are NI-Lab VIEW because FPGA, serial communication port, group conversion and removal, which greatly reduces the timing process for evolutionary teaching is used by a specific design, for example to achieve[6].

The purpose of this message is to utilize all the uses and ratings under the NI-USRP system designs shortcut of this program, when determining the radio and then the conclusions can be good and bad NI-USRP shows comparisons with standard paper data that can help other researchers[7].

Phase Shift key (PSK) is widely used for current wireless technology. For example, there is a current and important application to modify the PSK Quadrature (QPSK) at levels such as LTE and LTE-in advance and IEEE 802.11b- 1999 and IEEE 802.11g-2003 and IEEE 802.15.4 [8]. Besides, over the past few years, the composition of various PSK structures has deteriorated under satellite communication and network space deeper due to simplicity and accreditation of Spectral boundaries [9].

In this project, all design information can be viewed and tested directly and people easily understand the communication concepts. And there will be a PSK operating system rating and can provide a deeper understanding of how the wireless connection system works under different circumstances. From that point on, projects will be introduced by both the NI-USRP environment and will lead to the USRP in the positive and negative of the program characters[9].

2.1 EXPLANATION

SDRs have been focusing on the early 1990s. The main purpose of SDR is to create a device capable of working on many radio stations to work with different parameters. Additionally, it cannot sync any list with any converting system using a powerful system and configured devices. There is another opportunity to define the SDR is to integrate hardware and software technology to make systematic and flexible as wireless communication devices [10]. SDR provides successful and inexpensive solution to create many cell phone situations and multi-functional and multi-functional tasks can be developed with software development analysis. Using SDR devices, the same part of "hardware" can be changed to perform different tasks at different times. The SDR makes a significant number of diagnostic signal on a regular PC. In the SDR, the signal is hosted on a digital domain instead of an analog domain as a common radio. An analog signal can switch to the digital domain with the help of Analog to Digital Converter. Fig.1.4 shows the concept of the dedicated Defined Radio. This figure shows that the ADC process occurs after the Front End (FE) region. The A / D converter will convert the signal to the digital form and transfer it to the baseline process for many processes; availability, enter code, source code and more.

Some radio software is a tool that helps wireless telecommunications and multilingualism. The SDR was introduced by Joseph Mitola of MITER in 1991 [10]. His first SDR paper was published in 1992 at the IEEE Telecommunications Systems Conference. Despite this suggestion for the first time in 1991, and the radio broadcast from the back of the protective industry since the end of the twentieth century both in the US and Europe.

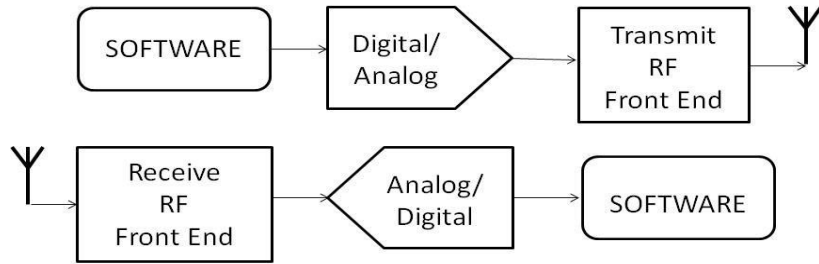


Figure 2.1: SDR sender and receiver module diagram[5]

2.2 THE NEED FOR A SOFTWARE RADIO PROGRAM

The “standard” receiver design is shown below. This figure illustrates the importance of software planning and implementation. All of the functions shown in the red block can be implemented by software running digital processing or an integrated software program running a microprocessor, rather than all functions performed only by consistent and complex hardware. Even digital HMIs are accessible by software when digital-to-digital conversion (or other means) is performed. This is the basis of radio broadcasting - most of the work is done in software. Therefore, the term "software radio" was created by a Doctor Joe in 1992 [11].

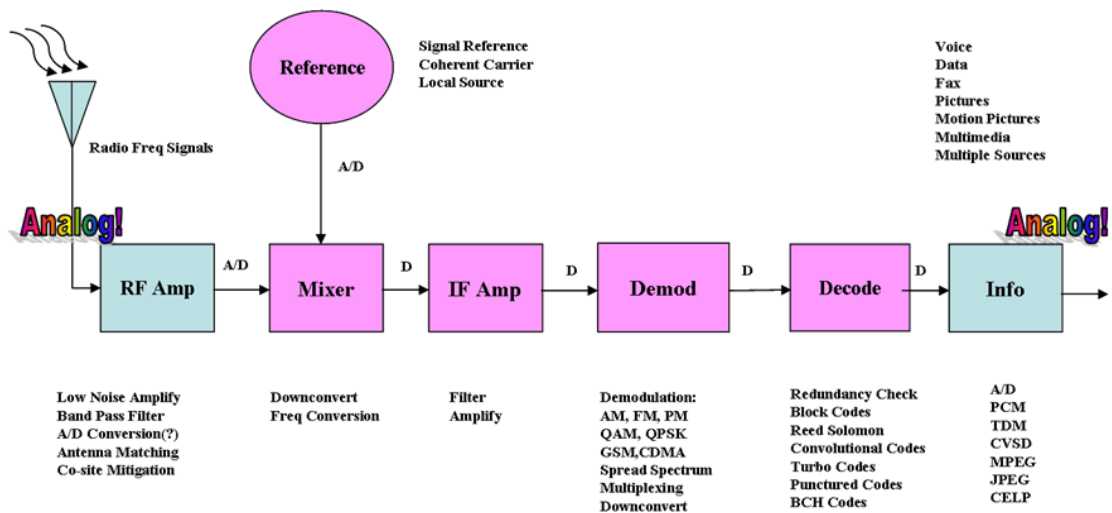


Figure 2.2: Design of standard Radio Receiver [11]

2.3 THE BASIC PRINCIPLE OF SOFTWARE DEFINED RADIO

The basic SDR principle is to reduce the hardware required to process the signal and its conversion to the software, which must be done by a global purpose of the purpose. The signal should be automatically activated and operated as much as possible inside the PC (performing functions such as solving, filtering, and even friction module FFT) until the signal is set to send. Data on status of digital samples and converted from analog blocks to analog signals. In the final section, the changed signal is provided to the transfer antenna.

The SDR concept is unique from the traditional radio that has been used so far. Traditional radio depends on all dedicated hardware features, and each hardware has a fixed function. In the case of the SDR, one processor will perform all functions processing the signal, and the software will be responsible for organizing tasks to be calculated [12]. The lack of dedicated hardware has more important benefits than traditional records because all restrictions used for the radio program can be modified by the software used. This makes the development of new programs easier, cheap and fast. We can explore all kinds of changes and configurations for using prototypes for radio broadcasts[13].

2.4 CHALLENGES OF SDR IMPLEMENTATION

During our application, it is aimed at using a PSK-based communication system, and the PSK is an extensive application. Many challenges prevent SDR usage from a limited amount of application.

- Power consumption of a SDR application: It has noted that the running run requires a powerful computer. Using the power of the SDR device is different from the required power by the radio hardware.
- Larger Size of Hardware Needed: The hardware required for signal usage is much larger than the radio hardware provided[14].

For the above reasons, systems with SDR portable devices have not developed a lot of applications that can be used by multiple radios, and the use of SDR is limited to research or applications at basic stations, rather than mobile browsers, and energy requirements are not essential[15].

3.1 Universal Software Radio Peripheral (USRP) Hardware

The USRP for research purposes is provided by the National Instruments. The NI USRP 2922 hardware is used to create communications systems for PSK programs [16].

The front panel of NI USRP 2922 is shown in the following figure



Figure 3.1: Front Panel of NI-USRP

NI USRP includes the RF at the end of the transceiver's proxy, and the entire processing of the signal is performed via Lab VIEW on a personal computer provided in the box. The Gigabit Ethernet cable is used to connect to the USRP and PC, and the USRP can be controlled by the PC [17]. NI USRP connects to a PC carrying and operating as a software described by the software. The SMA input signal connector is connected to the components of the baseband I / Q using the DCR that contains a 2-channel channel, 100 MS / s, 14-bit-ADC. The stored I / Q data follows a compatible method using the digital down conversion process that integrates, filters, and generates a 100 MS / s signal in user-defined measurement.

Samples converted, if represented as 32-bit (16 bits per I and Q), are sent to the host at a maximum of 20 MS / s above normal Gigabit Ethernet connections.

Transferring, base samples of baseband I / Q integrated with host and represented as 32 bits (16 bits per I and Q) and allocated to USRP-2920 to 20 MS / s over Gigabit Ethernet. The USRP hardware uses the digital up conversion (DUC) process to convert the input signal to 400 MS/s and converts the signal to the analog signal using the 16-bit digital-to-analog transformer. The following analog signal is composed of the frequency of the specified rows. 8-bit portable mode where the number of 16 layers is used to represent the values of I and Q a The sampled sample or sample to be lifted easily can reach a maximum of 40 MS/s through a Gigabit Ethernet connection between PC and host[18].

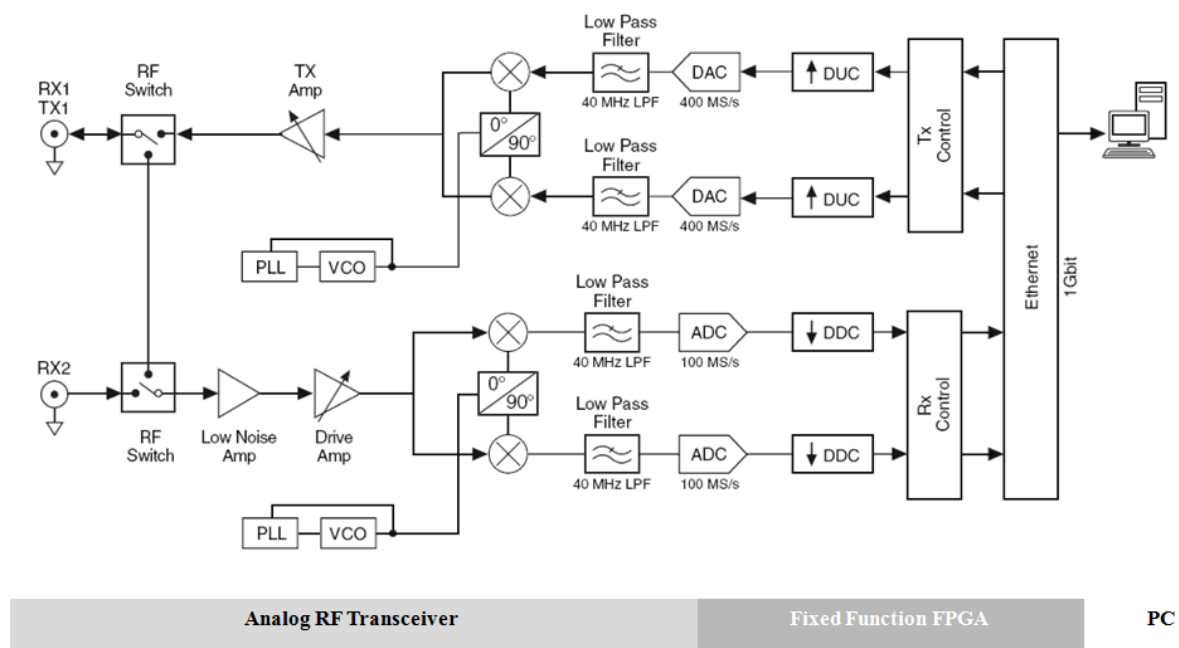


Figure 3.2: USRP Block Diagram

3.2 CONNECTORS OF NI USRP-2922:

The front end connectors of the USRP-2922 kit are discussed in the following table.

Table 3.1: Connectors of NI USRP-2922

S. No.	CONNECTOR	USE
1.	RX1 TX1	RF signal-input and output terminal. RX1 TX1 is an SMA (f) connector with an impedance of 50 Ω and is a Single ended input or output-channel.
2.	RX2	RF signal-input terminal. RX2 is an SMA (f) connector-with an impedance of 50 Ω and is a single-ended input channel.
3.	REF IN	Input terminal for an external-reference signal for the Local oscillator (LO). REF IN is an SMA (f) connector with an impedance of 50 Ω and is a single-ended Reference input. It takes a 10 MHz signal having a minimum input-power of 0 dBm (.632 V) and a maximum input power of 15 dBm (3.56 V) for a square-wave or sine-wave.
4.	PPS IN	Pulse per-second (PPS) timing reference-input terminal. PPS IN is an SMA (f) connector with-an impedance-of 50 Ω and is a single-ended input. It takes 0 V to 3.3 V-TTL and 0 V to 5 V TTL signals.
5.	MIMO EXPANSION	The multiple input multiple output(MIMO) EXPANSION-interface port connects two USRP-devices using a compatible MIMO cable.
6.	GB ETHERNET	The gigabit Ethernet-port accepts an RJ-45 connector (Category 5, Category 5e, or Category 6).
7.	POWER	The power-input takes a 6 Volt, 3 Ampere external DC power-connector.

3.3 NI USRP-2922 MODULE LEDs:

The module LEDs are listed in the following table

Table 3.2 : NI USRP-2922 Module LEDs

LED	INDICATION
A	Indicates the transmit status of the NI USRP-2922 module: OFF—The module is not transmitting data. GREEN—The module is transmitting data.
B	Indicates the status of the physical MIMO cable link: OFF—The modules are not connected using the MIMO cable. GREEN—The modules are connected using the MIMO cable.
C	Indicates the receive status of the NI USRP-2922 module: OFF—The module is not receiving data. GREEN—The module is receiving data.
D	Indicates the firmware status of the NI USRP-2922 module: OFF—The firmware is not loaded. GREEN—The firmware is loaded.
E	Indicates the reference lock status of the local oscillator (LO) on the NI USRP-2922 module: OFF—There is no reference signal, or the LO is not locked to a reference signal. BLINKING—The LO is not locked to a reference signal. GREEN—The LO is locked to a reference signal.
F	Indicates the power status of the NI USRP-2922 module: OFF—The module is powered off. GREEN—The module is powered on.

3.4 THE EIGHT MOST USED NI-USRP FUNCTIONS:

The following sections described the eight standard USRP features used by the lab. Their performance is divided into category. These sections include: Configure, Read / Write, and Close. These categories have been featured in many data recovery systems and are important examples of planning edits when creating new Lab VIEW Virtual Instruments (VIs).

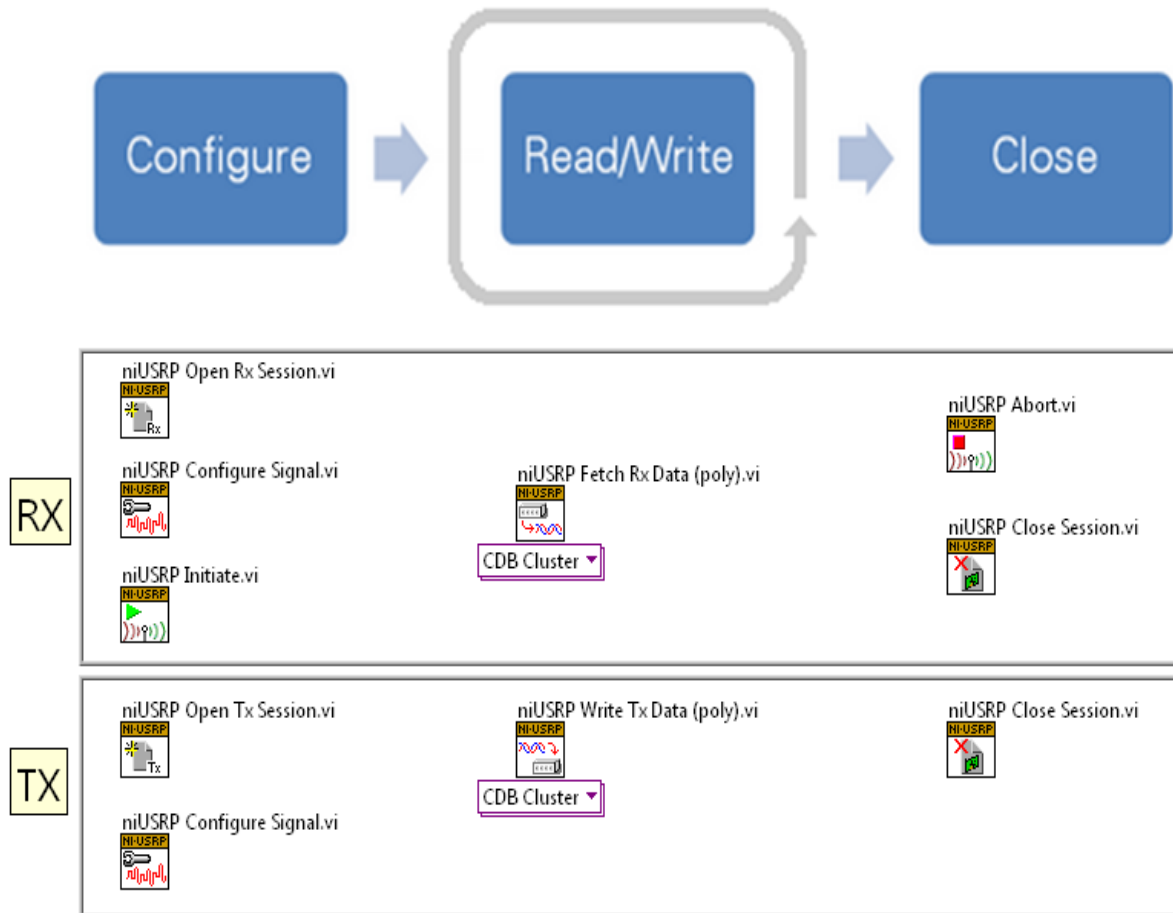


Figure 3.3 Different USRP functions

3.4.1 NI- USRP Open Receive Session

NI-USRP Rx Session VI The first VI that conducts a software session with the USRP has obtained RF features. Meetings are very important in posting information about configuration and obtaining IQ information from the USRP. Rx sessions can only be used for Rx services[19].

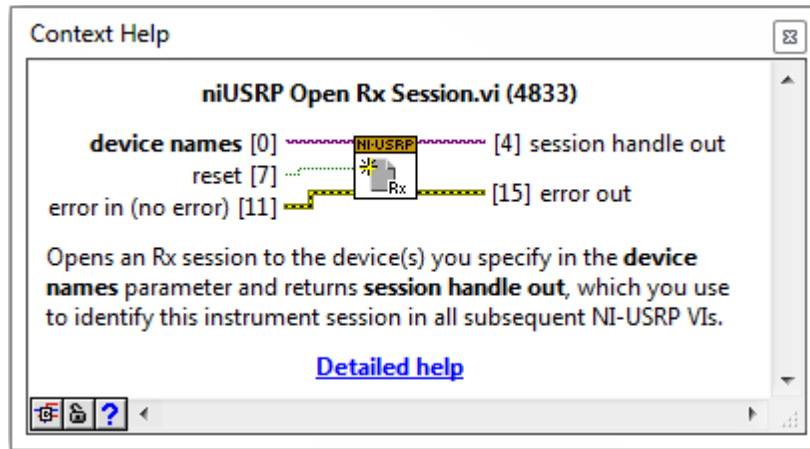


Figure 3.4 NI-USRP Open Receive Session Block

3.4.2 NI-USRP Initiate

The niUSRP Initiate VI launches a welcoming session and tells the USRP that complete suspension is complete, and the USRP must begin to include the IQ data (samples).

The VI can only be used during the period of Rx[19].

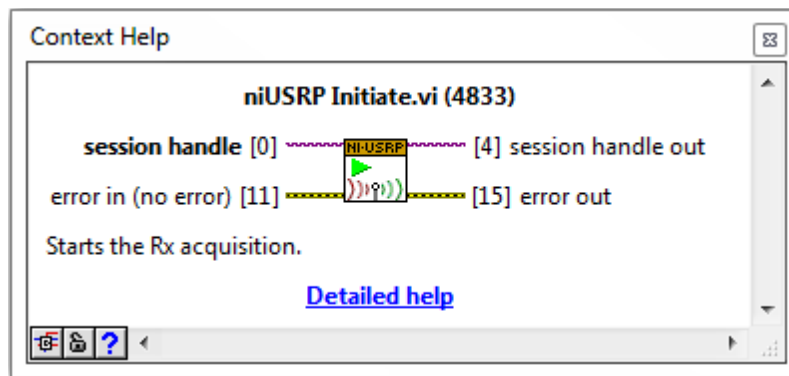


Figure 3.5 NI-USRP Initiate Block

3.4.3 NI-USRP Open Transmit Session

The niUSRP Open Tx Session VI is the first VI to create a connection to USRP

Used to transmit RF signals. Sending configuration data and sending IQ requires a session Data to USRP.

Tx sessions can only be used with the Tx feature[19].

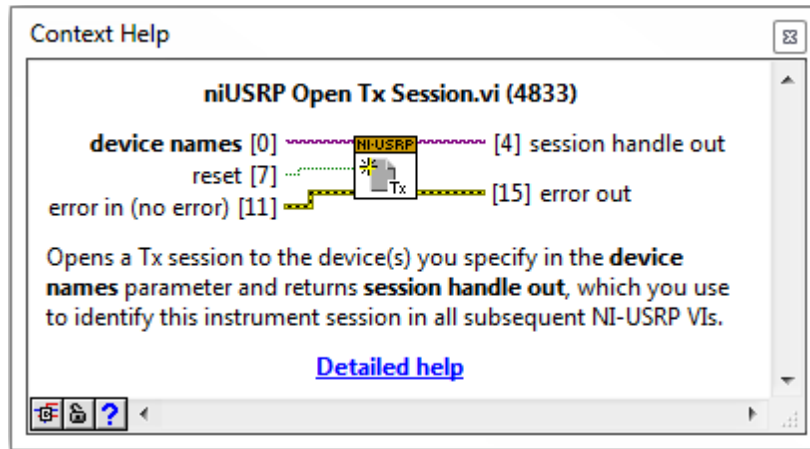


Figure 3.6 NI USRP Open Transmit Block

3.4.4 Read/Write Functions :NI-USRP Fetch Rx Data (Polymorphic)

NI-USRP Fetch Rx Data VI lets you get the IQ data from the USRP in a Rx session built using the USRP Open Rx Session VI. This data may be edited to a timeline or integrated with a digit to be updated. VI is a polymorphic, which means that many versions of the VIs should be selected, depending on the type of data you want to use.

The VI can only be used during the period of Rx[19].

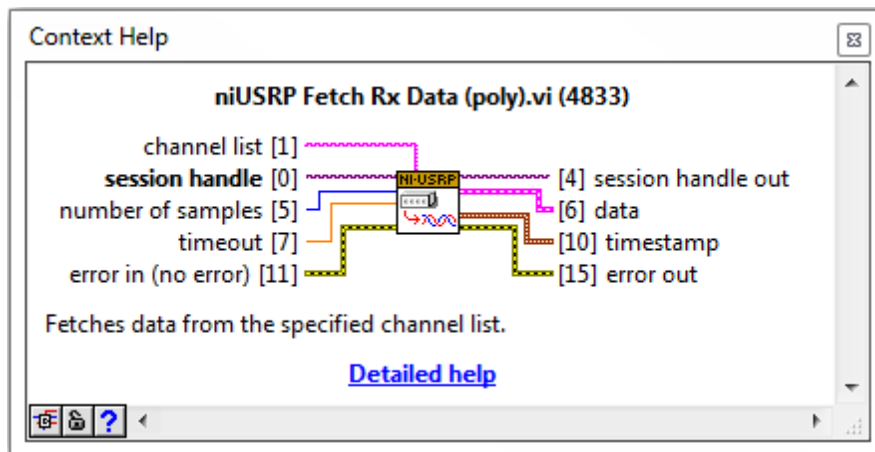


Figure 3.7 NI-USRP Fetch Receive Block

3.4.5 NI-USRP Write Transmit Data (Polymorphic):

NI-USRP Write Tx Data VI lets you send IQ data to the USRP to send data to the network frequency described by the USRP Configuration Signal VI.

VI is a polymorphic, which means that many versions of the VIs should be selected, depending on the type of data you want to use.

This VI can be used only during Tx session[19].

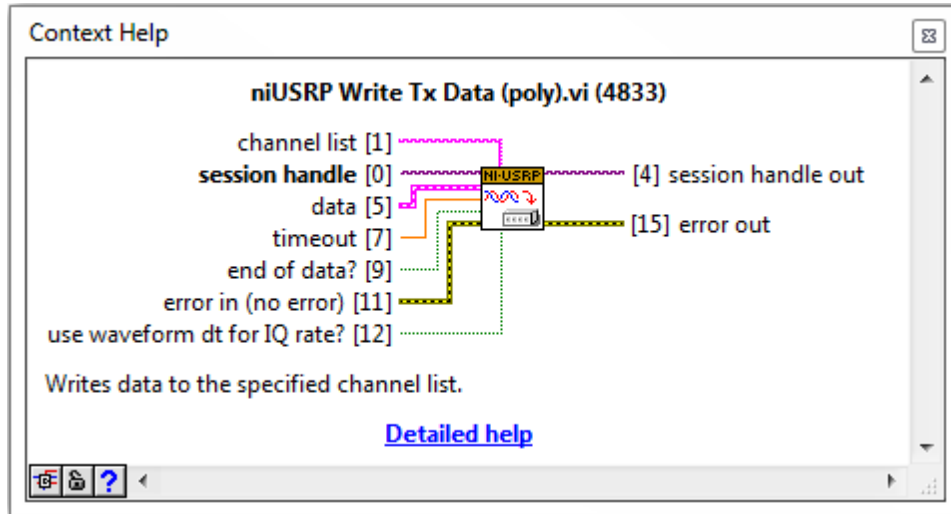


Figure 3.8 NI-USRP Write Transmit Data Block

3.4.6 Close Functions: NI-USRP Abort:

NI-USRP Abort VI told USRP to stop continuous purchases. This VI allows you to change the configuration settings without shutting down the session and creating a new session

Discussion. The VI can only be used during the period of Receive.

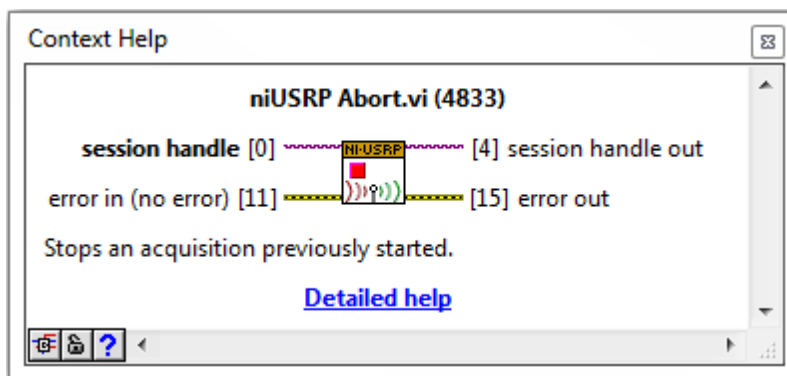


Figure 3.9 NI-USRP Abort Block

3.4.7 NI-USRP Close Session

The closing time for USRP VI closes the current time of Rx or Tx and releases the memory we use. You cannot transfer or retrieve data after calling this VI. USRP then open a new session.

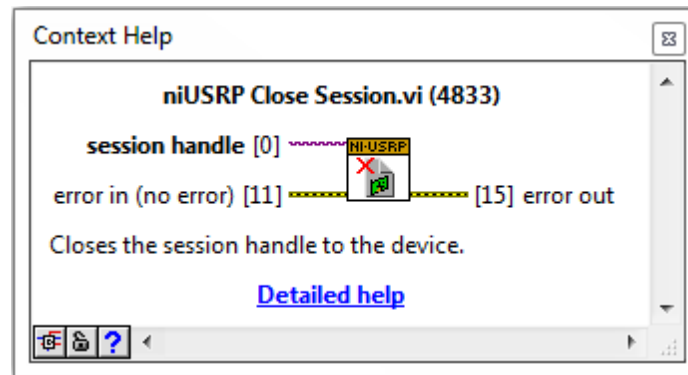


Figure 3.10 NI-USRP Close Session

3.5 Computer Software Role in SDR:

These hardware components include filters, amplifiers, modulators and pants. Because these features are described in the software, you can synchronize with software-defined systems when you need them, without major hardware changes. Because modern computers can have fast-paced and high-speed applications, we can use Lab VIEW to quickly use these features on a computer to use these features in the radios proposed by our software.

3.5.1 Driver Software

Driver software provides app software the ability to communicate with the device. It's easy to connect to devices by writing down hardware commands and registration levels. Generally, driving software discloses an application editing user interface (API) by editing the environment to create an application software.

For USRP NI-USRP is a hardware driver. NI provides development as described below the driver can call the NI-USRP environment, but other text-based environments can also access the hardware driver[19].

3.5.2 Application Software

Application software makes it easier to connect between machine and user to find, analyze and provide rating data. It may have been a previously built-in app that has been created with the appropriate skills or planning system for designing programs with custom features.

Custom applications are often used for multiple device functions, to make signal conversion, and to show user interaction. The NI-USRP pilot now supports Lab VIEW NI software for enhancing the image for quick-promoting procedural applications.

To implement the system on the SDR, we require an interface between the hardware and the PC. The system model was created in LabVIEW and the USRP driver software was installed for the interfacing with the hardware[20].

After all the steps, open LabVIEW software. Now after clicking “Launch LabVIEW”, two windows will open. One being the block diagram and other front panel as shown in the following figure.

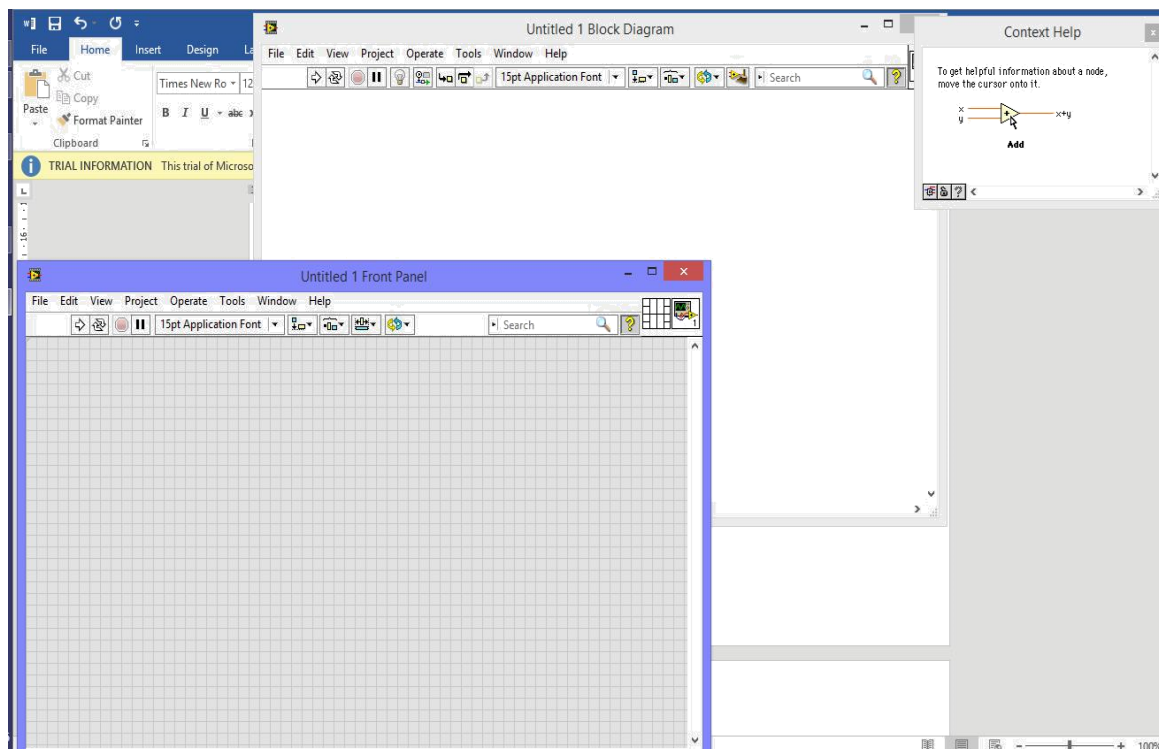


Figure3.11 LabVIEW Block diagram screen

4.1 RESEARCH OBJECTIVE

Many current SDR programs are specializing in the use of PSK transceivers for FPGAs. Designing and utilizing the PSK transmitter based on the concept of the SDR is a specific purpose of this work, while examining the performance of the drawing presented. This work is unique in previous studies focusing on the direct use of the FPGA-based transceiver using the RF portable transceiver and effectively placing certain transceiver parameters, such as constellation, eye diagram, modem error. Rate, size vector errors, etc. System disability such as restraint, frequency disconnection, section disruption, division / quadrature division (I / Q), moderation of modem, IQ inequality, amplitude height error, and peak suggestion error. Depending on the number of boundaries, various operating system indicators are calculated. Therefore, this study has made an important contribution to the development of the SDR system by representing the real model[21].

4.2 PRINCIPLE OF PSK MODULATION

In the last few years, due to the rapid technological advances of recent digital media, demand for high data transmission has increased dramatically. In fact, Digital Modulation is a complicated, very safe and effective way to transfer long distances. Besides, audio access and digital adjustment are more effective than their analog partner [21]. In digital modes, the features are transmitted via the baseband pulses that make high-frequency carrier. There are three primary recommendations for selecting the most acceptable modem for specific application :

Power efficiency: Reliable delivering of information with nominal power needs.

Bandwidth efficiency: The flexibility of the system to accommodate information within a prescribed bandwidth.

System complexity: the amount of circuits associated and the technical problems of the system, related with the cost[22].

Phase Shift Keying (PSK) is one of the foremost economical digital modulation techniques and is widely employed in current communication systems like satellite links and broadband microwave radio relay systems. In this scheme, the digital data is encoded within the phase property of a carrier signal [22]. PSK uses a finite range of phases, each allotted a specific pattern of binary digits. In other words, every pattern of bits forms the symbol that is specified by the particular phase. In order to reconstruct the original data, the demodulator determines the phase of the received signal and maps it back to the symbol it represents. The constellation points in this scheme are regularly positioned with uniform angular spacing. It provides maximum phase-separation between adjacent points and thus the best resistance to corruption. Since the data to be conveyed is normally in binary form, the PSK scheme is usually composed of the number of constellation points being a power of 2.

4.2.1 Binary Phase-Shift Keying

BPSK (also called PRK, phase inversion keying, or 2 PSK) is the easiest way to move the shift phase (PSK). Because it uses two sections divided into 180° , it can be called 2-PSK. This is not particularly important when constellation points are present and this time is displayed on the actual axis at 0° and 180° . Therefore, it controls high levels of noise or interference before the decision maker reaches the wrong decision. This makes it all the most powerful PSK. However, only the ability to edit bits / signals as shown in this calculation is not suitable for creating high data applications.

If a mysterious change is introduced by a communication channel, the publisher of the abuser cannot know which point of the star. As a result, the data is often displayed separately before the modem. BPSK functions equally with the 2 - QAM suspension[23].

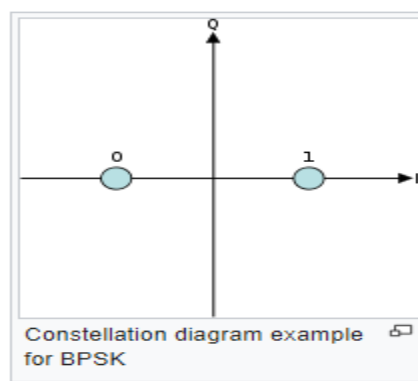


Figure 4.1 Constellation Diagram of BPSK

The general form for BPSK follows the equation:

$$S_n(t) = \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f t + \pi(1-n)), \quad n = 0, 1 \quad (4.1)$$

This yields two phases, 0 and π . In the specific form, binary data is often conveyed with the following signals:

$$s_0(t) = \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f t + \pi) = -\sqrt{\frac{2E_b}{T_b}} \cos(2\pi f t) \quad \text{for binary "0"} \quad (4.2)$$

$$s_1(t) = \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f t) \quad \text{for binary "1"} \quad (4.3)$$

Where f is the frequency of the base band.

Thus, the signal space is a single basis function

$$\phi(t) = \sqrt{\frac{2}{T_b}} \cos(2\pi f t) \quad (4.4)$$

Here 1 is represented and 0 is represented. Of course, this assignment is something wrong.

This operation of this infrastructure is shown at the end of the next section of the timeline. The maximum signal is the BPSK cosine wave shaped with BPSK. A small stream that causes this release will be displayed above the signal (part of this figure is only suitable for QPSK). After refining, the band / band signal is repeatedly sent to the top band $\cos(2\pi f t)$

4.2.2. Quadrature Phase-Shift Keying

It is sometimes referred to as the PSK phase, 4-PSK or 4-QAM. (Although QPSK and 4 QAM's general formats are different, the WAV radio wave is produced in the same way.) The QPSK star uses a single graph tropical point. Sometimes we lose good time of BPSK - four companies, QPSK has a demo of two bits encoded to reduce the level of BER.[23].

The analysis can be used to maintain same mark bandwidth , or to keep BPSK, and bandwidth indication to refer to QPSK data, compared to BPSK if needed. The purpose of the proposed procedure is to limit the establishment of the organization as the Federal Commission (CEO) of the wireless adapter, provided the value of α -QPSK to the communication station (CEO) revealed: QPSK delegation data binding to BPSK Comparison is provided - as transaction fee is a QPSK and the recipient is more difficult than the BPP. However, with modern technology, cost costs are limited. BPSKs are often troubled as the equipment are different types of computer usage, end-end part, and non-equivalent QPSK.

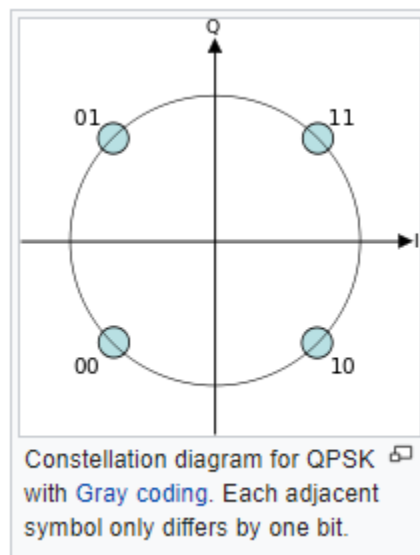


Figure 4.2 Constellation Diagram for QPSK signal

The implementation of the QPSK is commonplace with the BPSK and shows the launch of a higher PSK. Writing features in a constellation diagram based on the four and cosine waves used to transmit them:

$$S_n(t) = \sqrt{\frac{2E_s}{T_s}} \cos(2\pi f_c t + (2n-1)\frac{\pi}{4}), \quad n = 1, 2, 3, 4. \quad (4.5)$$

This yields the four phase's $\pi/4$, $3\pi/4$, $5\pi/4$ and $7\pi/4$ as needed.

This results in a two-dimensional signal space with unit basis functions

$$\phi_1(t) = \sqrt{\frac{2}{T_b}} \cos(2\pi f_c t) \quad (4.6)$$

$$\phi_2(t) = \sqrt{\frac{2}{T_b}} \sin(2\pi f_c t) \quad (4.7)$$

The first basic function is used as part of the signal section and secondly as part of the signal quadrature.

Hence, the signal gathering consists of the signal-space 4 point

$$(+/-\sqrt{E_b/2}) +/- \sqrt{E_b/2}$$

A 1/2 characteristic indicates that the total power is evenly distributed between the two users.

A comparison with these basics and BPSK clearly shows how QPSK can be viewed as two independent BPSK features. Note that the BPSK signal space point does not require separation of the bit (bit) power from the two carriers in the procedure shown in the BPSK character map.

CPSK programs can be used in a variety of ways. The main components of the transmitter and receiver structure are drawn as shown below.

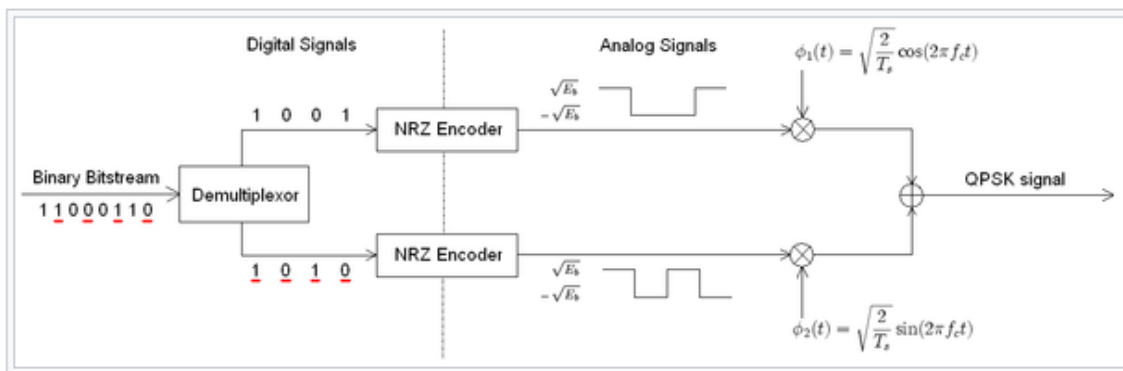


Figure 4.3 QPSK Transmitter block diagram

The QPSK concept is calculated by binary data broadcasting and the Cross Orthogonal section. They are divided into two separate doors. In this case, it is used twice to use. Thereafter, two features are promoted and reflect the QPSK signal. Note that the unwanted polio code is high.

These commands can be set before binary data source, but the difference between digital and analogue functions affected by a digital switch may delay the account.

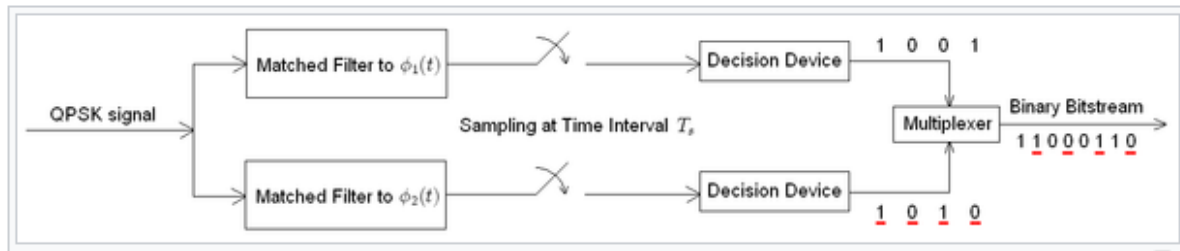


Figure 4.4 QPSK receiver Block diagram

4.2.3 Higher –order PSK

Any number of PS extension stages can be used, but the highest RSS are deployed in 8 PS. There are more than 8 stages, the error rate is high and better, although more complicated, modules such as width size modules can be used. Although it can be used at any stage, the fact is that the number of points should usually be associated with binary data, and the number of symptoms is usually a power of two in order to follow one bit of each signal allowed[24].

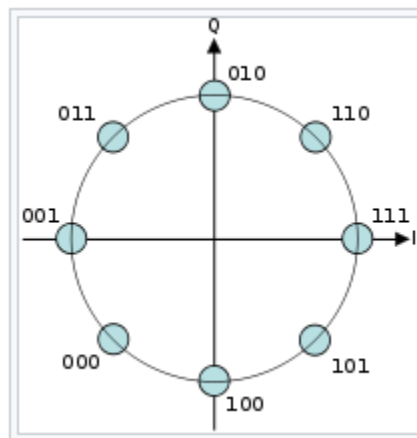


Figure 4.5 Constellation diagram for 8-PSK

4.2.4 Offset QPSK (OQPSK):

Offset QPSK uses four different transmission phase levels. It is sometimes referred to as a staggered QPSK. During the QPSK design, four types (two bits) can take signal signal at least 180° at a time. If the signal below the investigation (usually in the transmitter), the connection to

its initial change, the size of the same body of the communication machine differs. For some time, unusual or even time will reduce the amount spent, or at the same time, half a time of mind, part of the section and square of the area. Showing right, it seems that this phase change will not pass over 90 times at a time. It highlights invalid variations with invalid QPSK and is sometimes popular in operating[25].

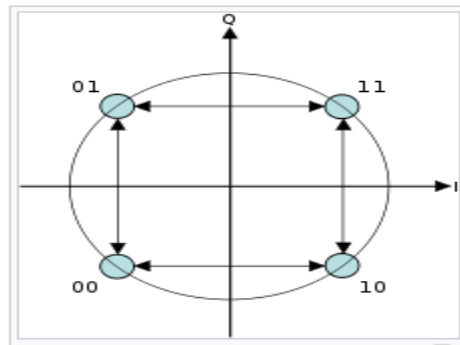


Figure 4.6 Constellation Diagram of OQPSK

4.2.5 $\pi/4$ -QPSK

This unique QPSK uses one another around 45 degrees around two stars. Usually, you use one of the stars or other features used to select one of the symbols or a unique symbol and choose a view from another star. This will reduce partial flow from 180 degrees, but since it is only 135 degrees, the dimensions of $\pi / 4$ QPSK are different between OQPSK and QPSK.

The only layout of the modem structure is that there is no way to use the original signal if a specific signal is presented in a complex area. In other words, the signal is less than the actual signal. This signal reduces flow in the Exchange variable, which is a signalling of engineering communication.

On the other hand, $\pi/4$ QPSK is engaged in simplifying and using such TDMA telephone program rules.

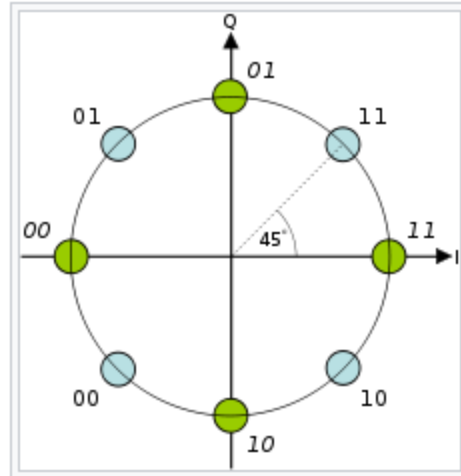


Figure 4.7 Constellation Diagram of $\pi/4$ QPSK

4.3 PARAMETERS UNDER CONSIDERATION

4.3.1 Constellation Diagram

An easy way to express the PSK Scheme is on the Constellation Diagram. This reflective, realistic and realistic axis displays the point in where the phase and quadrature axis are called respectively for the separation of 90° . Along with the phase axis, the dimension pocket wave of each point (or a pocket wave) is used to modulate the algorithm axis as well as dimensions and pocket alloy (or pocket) wave modulation. By convention, the phase modulation signals modulates the quadrature modulation.

In the PSK, the selected points are generally placed on the angular break around the rings. It maximizes phase separation between affiliate points and therefore provides excellent resistance to breaking. They are available in circles so that everything can be consistent with the same power. That is a problem that is needed in the same complexity numbers, the same will be the puppy speaker and the wave pocket will be the same.

4.3.2 Modulation Error Ratio (MER)

The MER is the standard used to measure the performance of a digital radio or receiver in the communication system using digital modification (e.g., PSK). The signal used for the ideal transmitter or signal found to have all the points of the constellation of a good condition, but there are various errors in the use (sound, minimum image loss, phase sound, company

cancellation, interruption, etc.) or actual deviation of signal signals from position good. Constellation point.

$$\text{MER (dB)} = 10 \log_{10} \left(\frac{P_{\text{signal}}}{P_{\text{error}}} \right) \quad (4.8)$$

where P_{error} is the RMS power of the error vector, and P_{signal} is the RMS power of ideal transmitted signal.

MER is defined as a percentage in a compatible (but reciprocal) way:

$$\text{MER (\%)} = \sqrt{\frac{P_{\text{signal}}}{P_{\text{error}}}} * 100\% \quad (4.9)$$

MER is near EVM but MER is based on the standard signature. The MER signal is also related to noise ratio, the Emperor contains all the errors, including dimensions of the dimension, error and barrier, while the sound is randomly dangerous[25].

4.3.3 Error Vector magnitude

Vector error I-Q flows between the vector error and the receiver received. In other words, the difference between the real logo and the best work. General dimension of commonly known dimension signal vector error is EVM. According to the format company, the root means a square (RMS) ratio. [1] The size of the magnetic vector reference meaning (RMS) is equal to the severity of the vector intensity of the vacant space.

$$\text{EVM (dB)} = 10 \log_{10} \left(\frac{P_{\text{error}}}{P_{\text{reference}}} \right) \quad (4.10)$$

where P_{error} is the RMS amplitude of the error vector. For a career module, the convergence, the $P_{\text{reference}}$ signal pulled out is the dimension of the outer most (highest power) approach. Recently, for multi carrier modulating, $P_{\text{references}}$ are described as average power. As shown in Figure 1 below, the measured symbol location by the demodulator is given by \underline{w} [25]. However, the ideal symbol location (using the symbol map) is given by \underline{v} . Therefore, the resulting error vector is the

difference between the actual measured and ideal symbol vectors, ie, $\underline{e} = \underline{w} - \underline{v}$. The error vector \underline{e} for a received symbol is graphically represented as follows:

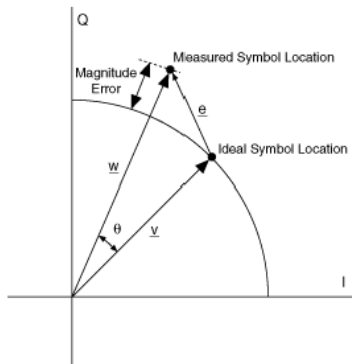


Figure 4.8 : Graphical Representation of Error Vector

In Figure 4.8,

\underline{v} is the ideal symbol vector,

\underline{w} is the measured symbol vector,

$\underline{w} - \underline{v}$ is the magnitude error,

θ is the phase error

$$\text{EVM} = \frac{\sqrt{\frac{1}{N} \sum_{j=1}^N [(I_j - \tilde{I}_j)^2 + (Q_j - \tilde{Q}_j)^2]}}{[V_{max}]} \quad (4.11)$$

where

I_j is the I component of the j-th symbol received

Q_j is the Q component of the j-th symbol received

\tilde{I}_j is the ideal I component of the j-th symbol received and

\tilde{Q}_j is the ideal Q component of the j-th symbol received.

4.3.4 EYE DIAGRAM

In the field of telecommunications, an eye diagram is an oscilloscope screen that collects digital signals from the receiver and applies them to vertical inputs, and uses the data rate to operate the horizontal sweep. The reason for this is that the pattern in some types of coding resembles a series of eyes between a pair of clues. This is a tool to evaluate the combined effect of channel noise and the interaction of symbols in the performance of the baseband pulse transmission system. This is a synchronous overlay for all possible applications of signals of interest observed during a given period of time for a signal.

Through the analysis, many metrics of system performance can be derived. When the signal is too long or too short, synchronization with the system clock is bad, too high, too low, noisy or too changed, or too much overflow or overflow of the eye diagram[26].

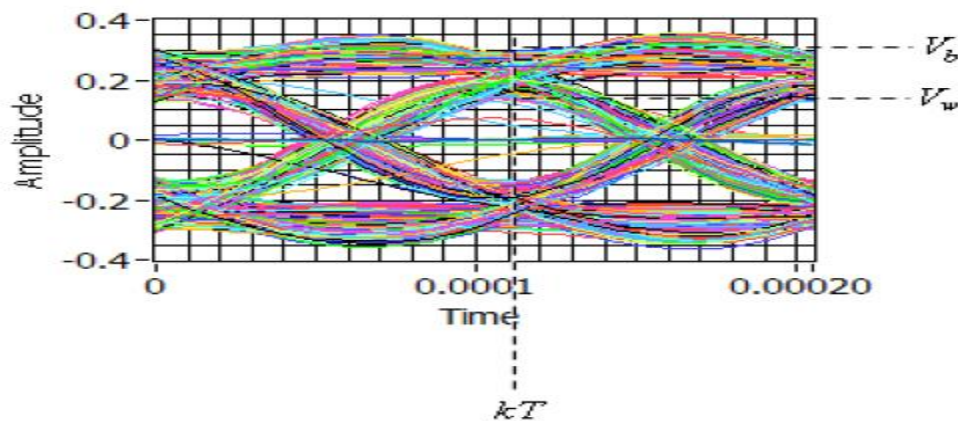


Figure 4.9 Eye Diagram

The sampling time kT and the best-case and worst-case voltages, V_b and V_w respectively, are shown. Note that V_b and V_w must both be measured at the same time value, kT .

The peak distortion is given as :

$$\text{Peak Distortion} = (V_b - V_w) / (V_b + V_w) \quad (4.12)$$

and eye opening is given as :

$$\text{Eye Opening} = 2V_w / (V_b + V_w)$$

4.4 INTERFACING OF THE HOST PC WITH THE KIT

Before installing USRP operating software, we need to install metabots and labs. Laboratory VIEW 2014 the latest LabVIEW version on the market was released in August 2014 for users. After installing the Lab View application, follow the steps below. USA USRP software suite DVD must be installed and installed on the computer.

There are some optional products that can be added as a Lab VIEW module tool, see the View Digital Filter Design Tool Kit and Lab View Math Script. The power cable is connected to the USRP[27].



Figure 4.10: Power connections to the USRP kit

Now, attach the cable or antenna to the terminals of the NI USRP-2922 front panel according to the requirement. Connect the device directly to your computer with the included Ethernet cable as shown in the following figure



Figure 4.11: Ethernet cable and antenna connections to the USRP kit

After verifying that all communications are correct, it takes time to start communicating with the USRP when editing the network. IP addresses: for computers and each device connected to the

USRP must be unique. To verify network connections, we must unlock NI-USRP support. The following window is shown:

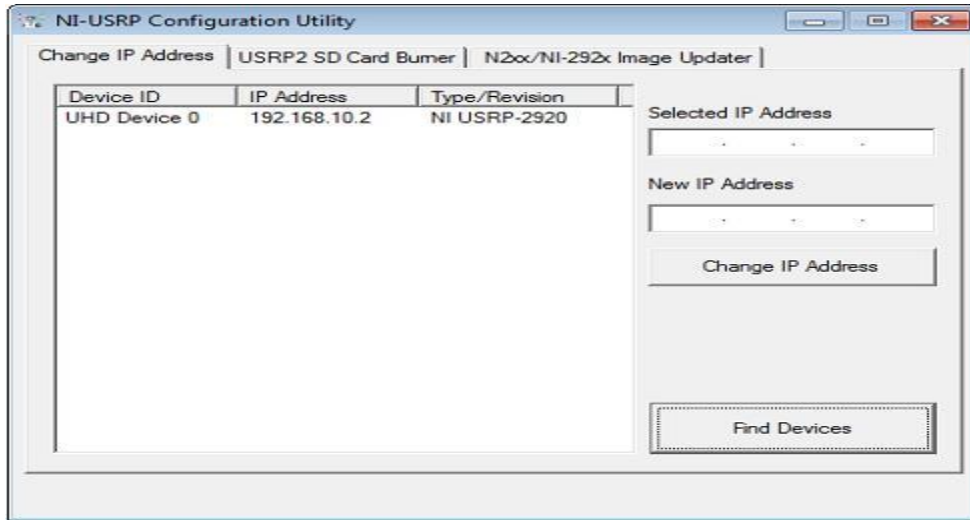


Figure 4.12: Verifying the device in NI-USRP-Configuration Utility

In this window, go to the IP subscribe IP address. Your device must appear in the selected IP address on the left side of the tab. If the device name is not registered, check all connectors and power again, then click the Get Device button to search for USRP devices. We can also change the device IP address by selecting a device from the list. The IP address of the device we selected is displayed in the box for the selected IP name[28]. We can enter the new IP address as the device in the new IP text box, as shown below:

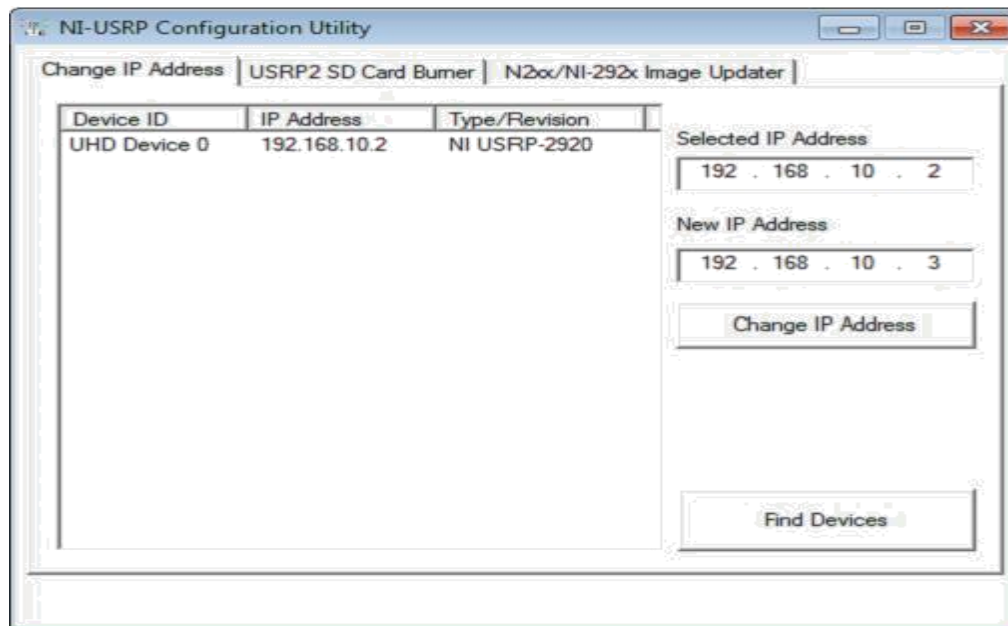


Figure 4.13: Changing the device IP of the device

4.5 SYSTEM ARCHITECTURE

The basics of the target network are shown in Figure 1. Here is a managed computer connected to the USRP. The USRP is connected to many directional antennas. The beam shaping process uses a control antenna. The direct antenna has an azimuth and elevation height of 11° . Regarding the discovery, many direct antennas are the primary transmitter antennas that are connected to another USRP device. The USRP device is connected to the computer. If the task is to handle the antenna path to find the rear of the antenna, the signal has been interrupted, otherwise it will not be installed. The signal processing feature causes USRP devices and results to appear in the host application.

Figure 2 shows the system transfer we initiated using USRP and directional antennas. Detailed description of block groups is as follows: by placing the correct IP address system, the device name that starts the USRP device. The power plant gives us the flexibility to allow USRP active channels. System privileges, such as IQ classification, frequency network, profit and service group. In transition to MT producing PSK system parameter (M), where the symbol. Activities, such as for input, evaluation of a combination of symptoms, and the capture signal[29]. Symptom continues BB-PSK generation.vi power signal is transmitted to the modem, e.g. add, second character logarithmic function, create a list, which makes the mark, a sequence of images in addition to each sample. The signal exceeds the MT format constellation. In the case of functions such as division of I and Q symbols, constellation mapping and the like. Then, if there are errors in the use, they are not together. Finally, data is transmitted over the USRP with a direct antenna[30]. Figure 3 shows the launch of our proposed system with USRP and directional antennas. Initially, following the same procedure as the effective channel USRP allow the sender to install, set limits, such as IQ samples, the carrier frequency, and an amplification of the active antenna, so that the limit PSK system. Here, in a given cycle below the left side of the symbol, the type and configuration of the end modulus terms of feelings such as the length of the interval and the filter type closing factor 3 of Figure. This loop prevents invalid filtering from formatting each pulse mode. In addition, it produces an appropriate filter that corresponds to the pulse filter. The signal is forwarded to the next cycle. First of all, the signals are given to each other's loops (see order), where the resampling function takes place. Here the function of interpolation and extraction occurs[31].

5.1 Simulation Setup and Results

In this chapter, results are made to match and use the Shift System (PSK) Transceiver on two computers with two separate USRPs. Each USRP runs as a sender and receiver in different ways.



Figure 5.1 Setup for PSK transceiver using Software Defined Radio

In the first step, the PSK program is built with the help of various blocks. Few of these blocks are available for use. However, depending on the needs of the system, follow some related obstacles and create some of these obstacles by creating unique virtual instruments in LabVIEW. The transmitter and receiver are configured throughout the program. The block of the transmitter block is displayed in the following calculations:

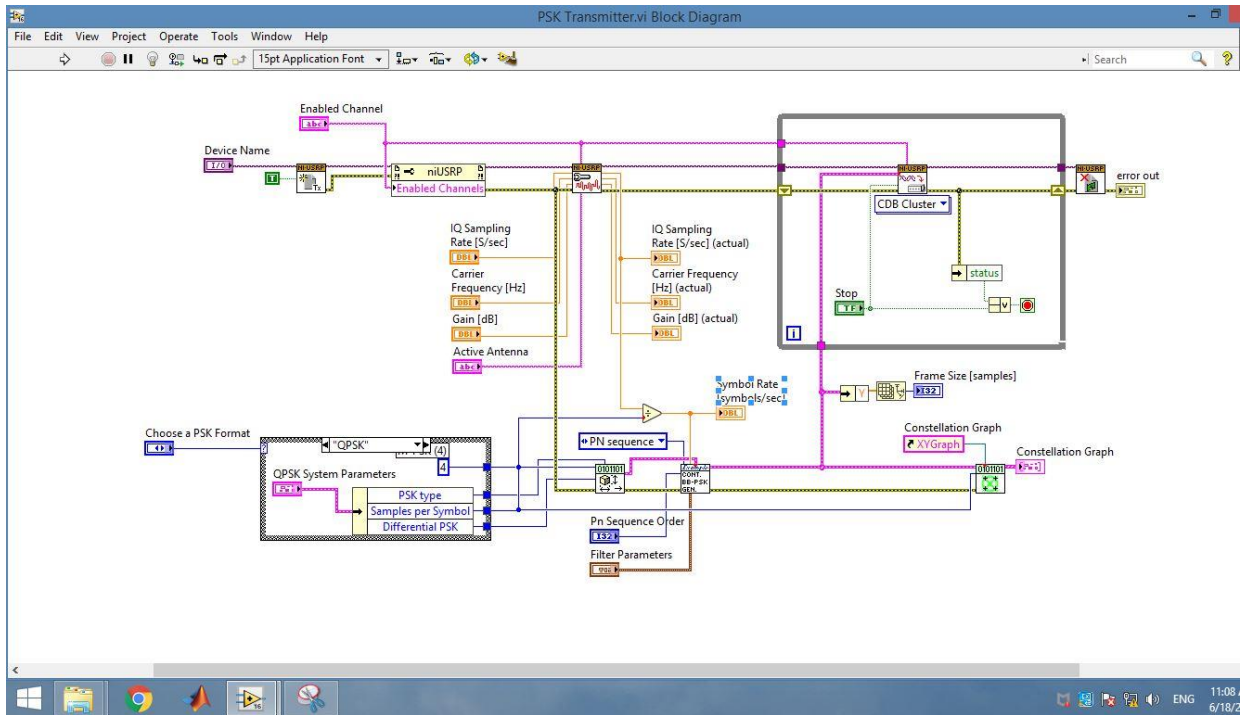


Figure 5.2: PSK Transmitter Block Diagram

The front panel of the transmitter is shown in the following calculation. The QPSK constellation drawing is shown in the calculation.

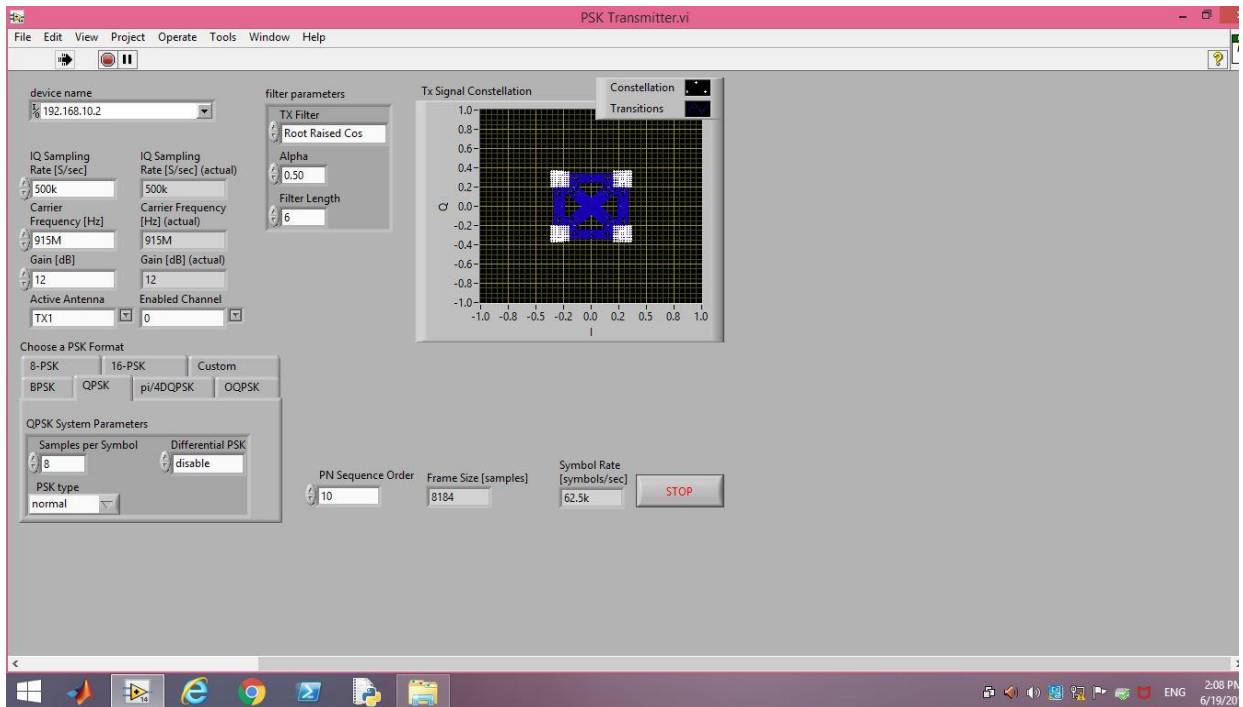


Figure 5.3 : Front Panel Of PSK transmitter

Similarly the constellation diagram of other PSK modulation formats are shown as follows :

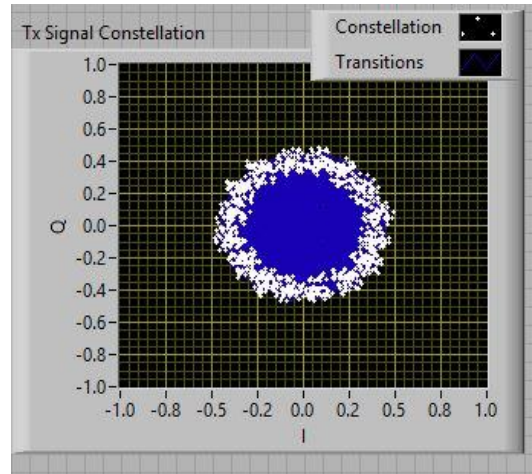
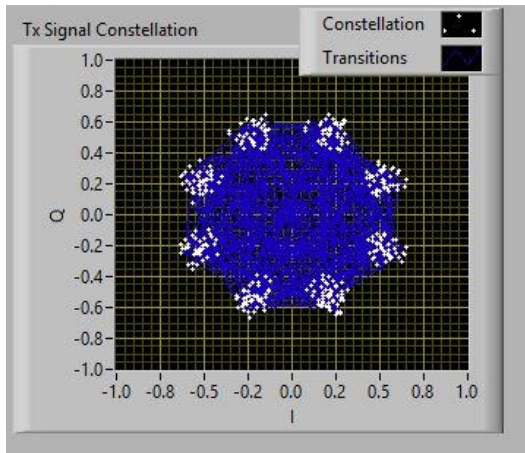


Figure 5.4 Transmitter Constellation of 8-PSK Figure 5.5 Transmitter Constellation of 16-PSK

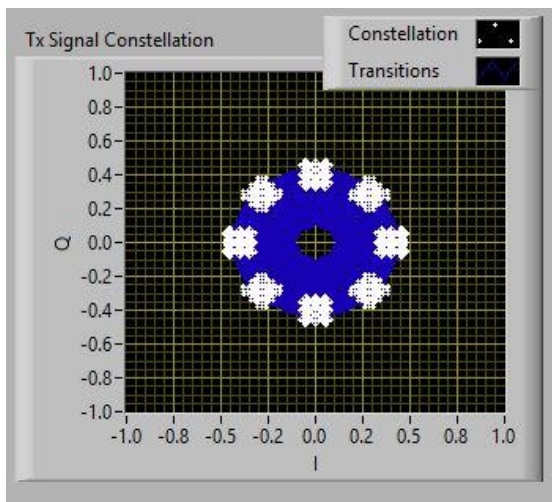


Figure 5.6 : Tx Constellation of $\pi/4$ QPSK

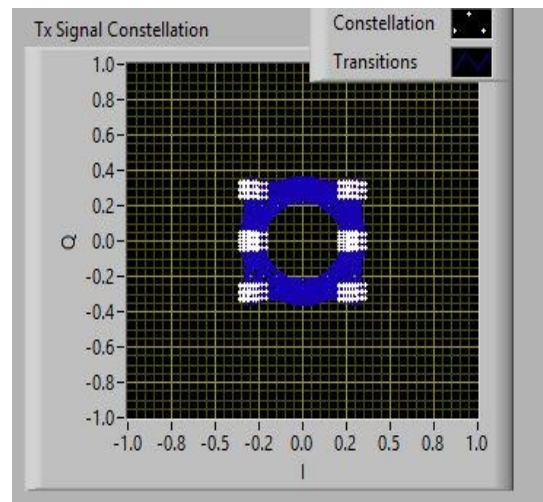


Figure 5.7 : Tx Constellation of OQPSK

Similarly the block diagram for the receiver is shown below :

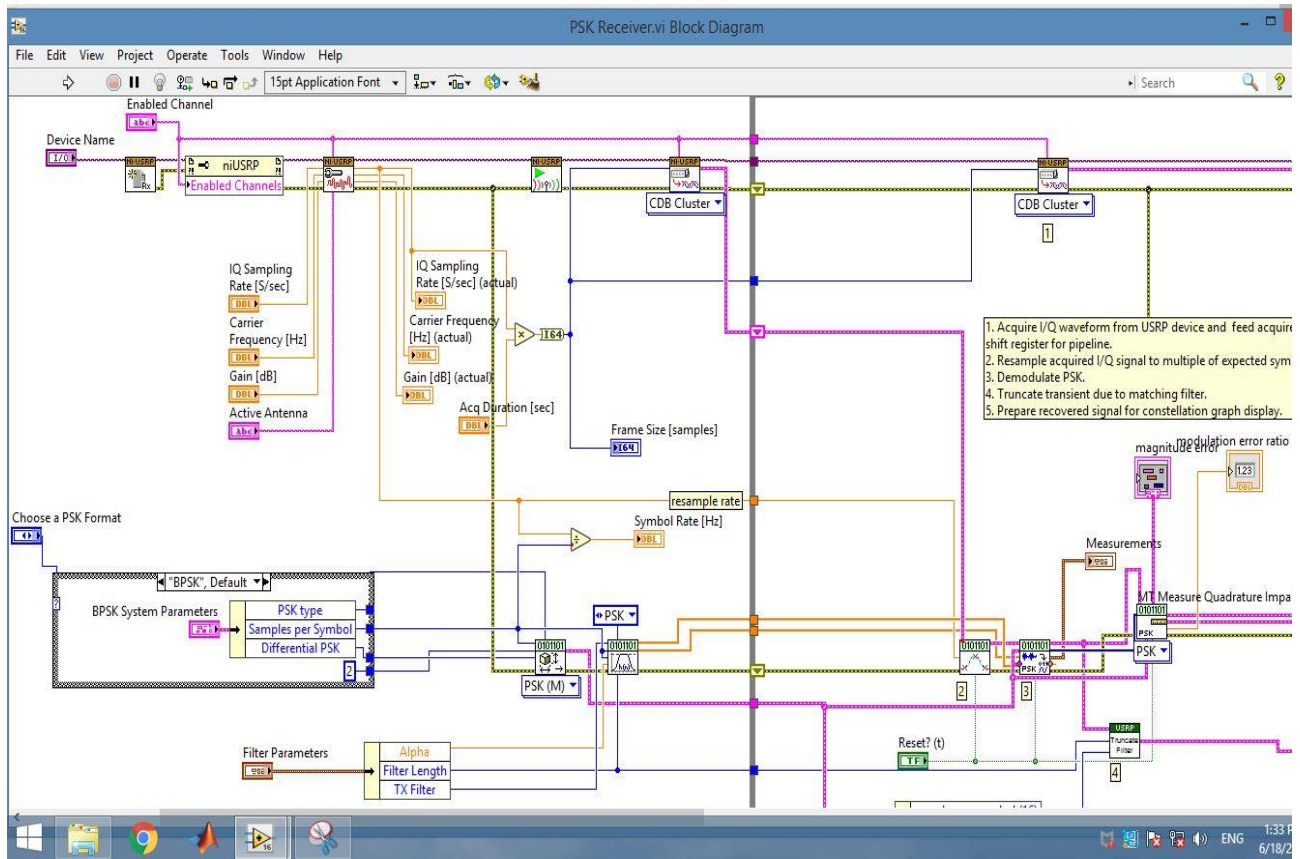


Figure 5.8 PSK Receiver block Diagram

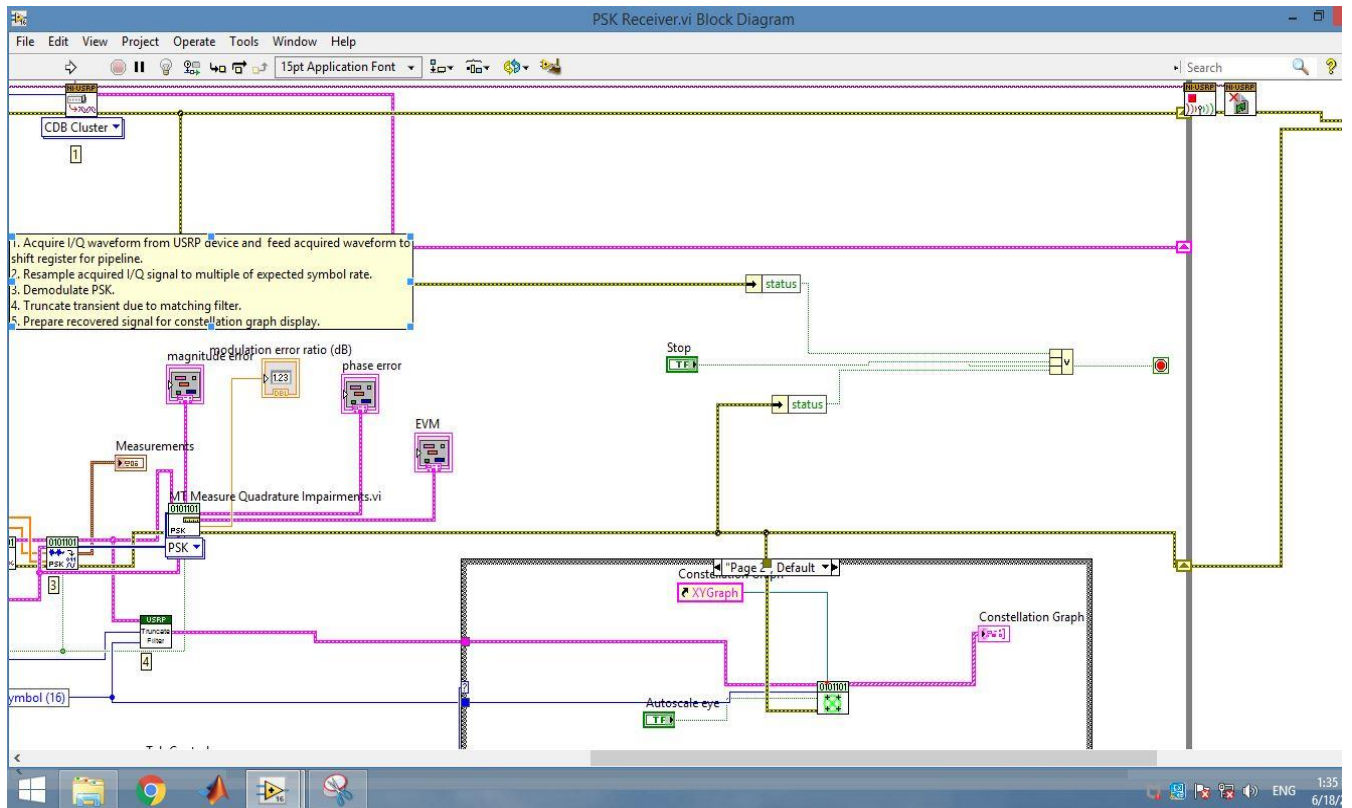


Figure 5.9 PSK receiver Block Diagram (contd.)

Thereafter, a large front receiver panel is available. This shows the parameter rate as modem error rating, vector error size, error, category error, and so forth. This number shows the face and face of the artist before the previous planet.

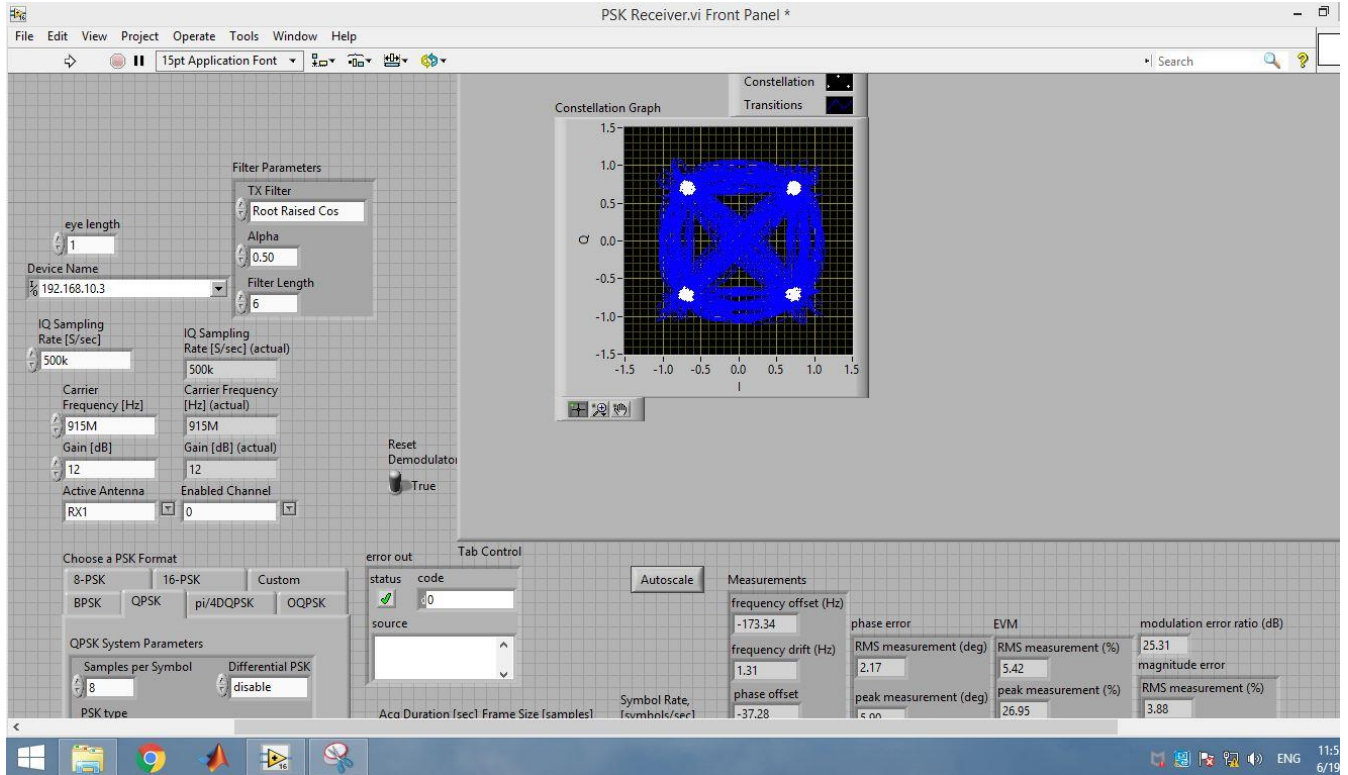


Figure 5.10 : Front Panel of PSK receiver showing Constellation Diagram of QPSK signal

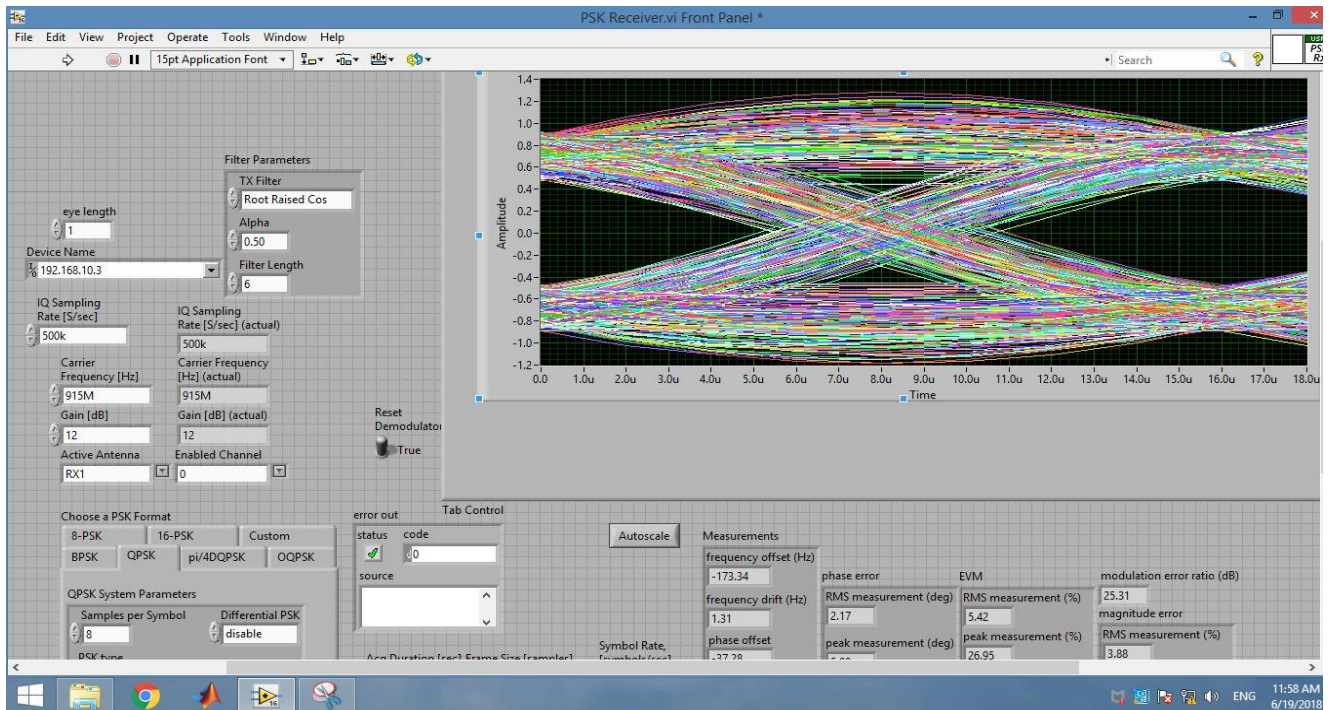


Figure 5.11: Front panel of PSK receiver showing Eye Diagram of QPSK signal

Constellation stars and painting of 8 PSK eyes, 16 PSK, 32 PSK, OQPSK, $\pi/4$ DQPSKs at the end of the show are shown in the following calculations:

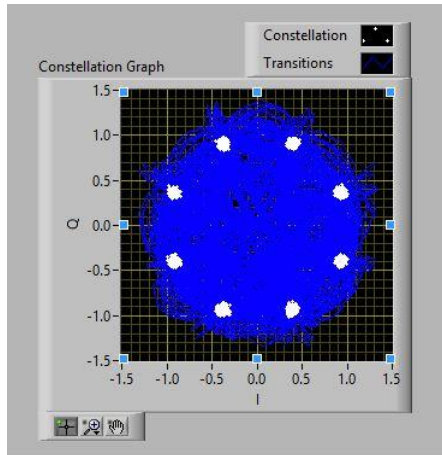


Figure 5.12: 8- PSK Rx constellation diagram

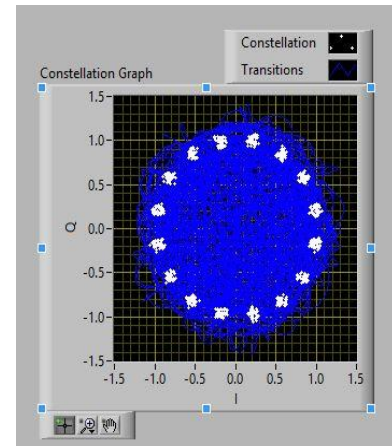


Figure 5.13 :16- PSK Rx constellation diagram

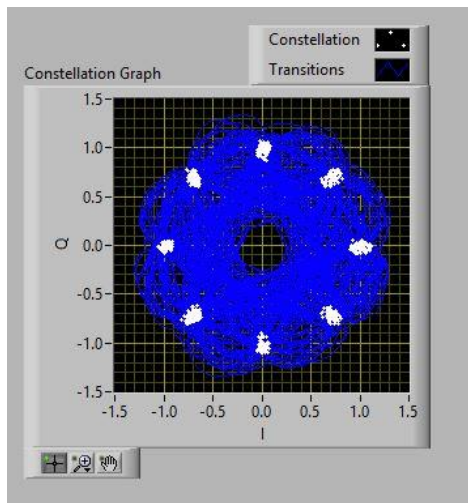


Figure 5.14 $\pi/4$ DQPSK Rx constellation diagram

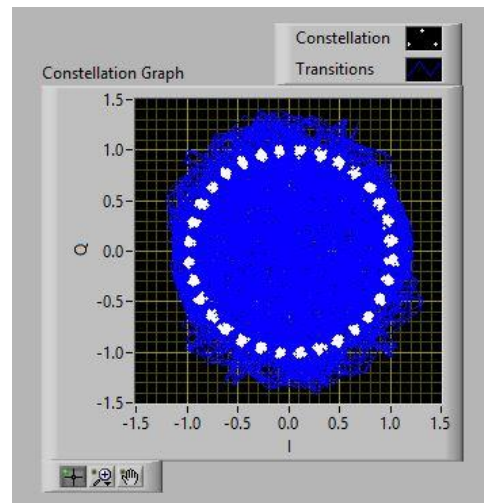


Figure 5.15 : 32 PSk Rx constellation diagram

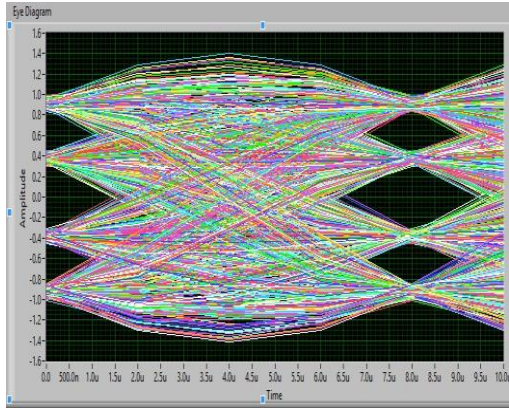


Fig. 5.16: 8 PSK Eye Diagram

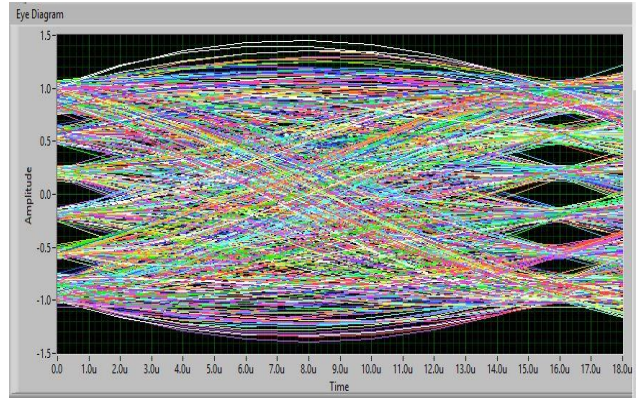


Fig.5.17: 16 PSK Eye Diagram

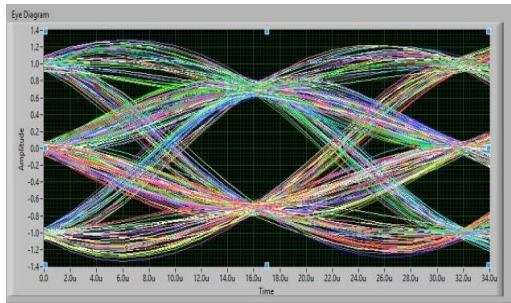


Fig. 5.18: $\pi/4$ QPSK Eye Diagram

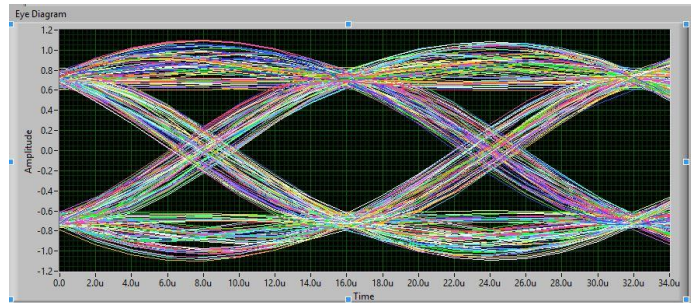


Fig. 5.19 : OQPSK Eye Diagram

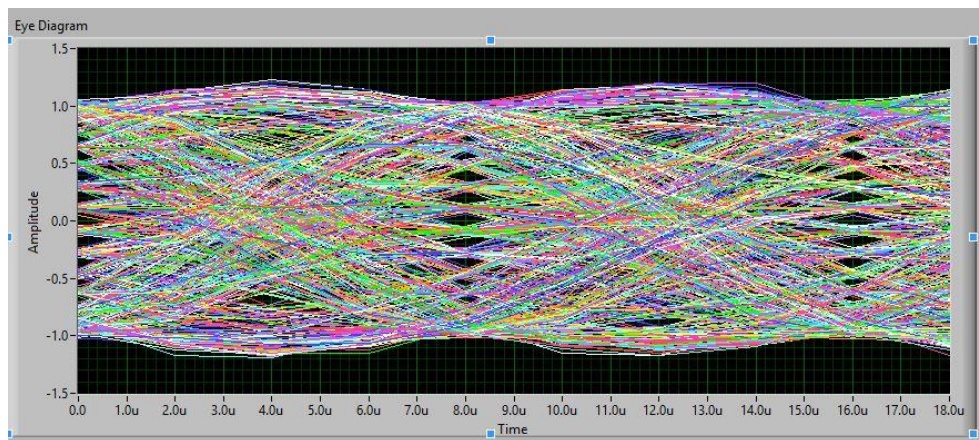


Fig. 5.20 : 32 PSK Eye Diagram

5.2 Calculations

The Eye Diagram calculations for various orders of PSK Modulation are shown in the Table 5.3

Modulation technique	Vb (volts)	Vw (volts)	Eye opening(%)	Intersymbol Interference(ISI)
32-PSK	0.93	0.6	78%	Very high
16-PSK	1.14	0.76	80.0%	High
8-PSK	1.03	0.8	87%	Medium
4-PSK	0.73	0.6	90%	Low

Table 5.3 : Eye Diagram Calculations for different orders of PSK Modulation Technique

It is concluded from table 5.3 that lower PSK order has more eye opening and as the order of the PSK system increases, there is more closing of the eye. As the eye becomes more diminished, higher is the Intersymbol Interference. This concludes that the higher the no. of bits per symbol can be transmitted i.e. higher is the spectral efficiency but at the same time due to closeness of the constellation points, the link is more susceptible to noise i.e. higher is the inter symbol interference (ISI).

For a better system, MER value should be high, EVM value, Magnitude Error should be low. Table 5.4 and Table 5.5 shows that as the order of PSK system increases, MER value decreases, EVM value increases and Magnitude Error increases. The calculations have been performed for two different distances i.e. 0.3 m and 1 m. This again shows that lower order systems are good systems and higher order systems have average performance.

Modulation technique	Modulation error ratio(MER)dB	Error vector magnitude(EVM)%	Magnitude error (%)
32-PSK	24.57	6.84	5.47
16-PSK	25.85	6.23	4.62
8-PSK	27.62	5.42	3.87
4-PSK	28.33	5.11	2.45

Figure 5.4 : Table of relative constellation error parameters for 0.3 m

Modulation technique	Modulation error ratio (MER) dB	Error vector magnitude(EVM)%	Magnitude error (%)
32-PSK	19.78	7.86	6.24
16-PSK	21.45	6.45	5.15
8-PSK	23.43	5.73	4.31
4-PSK	25.31	5.42	3.88

Figure 5.5 : Table of relative constellation error parameters for 1m

Conclusion & Future Scope

The aim of the project was to produce the difficult design of the wireless transceiver using Software Defined Radio in a modulation format and to limit network connections such as constellation drawings, eye diagram, modulation error measurement, Error Phase, Magnitude error, Error Vector Dimensions in different fields. Our complete system (including hardware and simulation simulation) works according to the first specifications and requirements of our project. Scheme Comparison is performed on LabVIEW software while the matching hardware works through the Universal Software Peripheral Radio (USRP) providing an expanded function in advance. The USRP used for our project works in a range of 400MHz-4.4GHz. Statistics and ratings are taken by 915MHz frequency with 12dB antenna profits.

From this project, we concluded that as the number of Bits i.e M value is increased the corresponding value of MER decreased and EVM increases. Also, as the bits per symbol increases the eye opening gets diminished. This concludes that the higher the no. of bits per symbol can be transmitted i.e. higher is the spectral efficiency but at the same time due to closeness of the constellation points , the link is more susceptible to noise higher is the inter symbol interference (ISI) .

6.2 Future Work

As the 5G communication increased significantly, there is a need for designing and testing frequency radio transceivers using high quality software radios to make overall communication more efficient and effective. In the first instance, a building that is designed to be powerful and costly, especially through communication and audio communication services, voice messages, video clips, etc. in a successful way, and we still have to consider several aspects of the development of the face. . SDR enabled devices have a good prospect for commercial applications, such as multimedia satellites, 5G shortcuts launches, and MIMO major communication systems. The SDR transceiver width can increase the connection between the

distance and distance range. Using software described by software, many accurate and practical systems can be done in the future.

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