1. INTRODUCTION
1.1 Introduction to NI LabVIEW Communications System Design Software
Labview which is virtual instrumentation software by which we can monitor different sensors using only signal computer. To run Labview software, system must have high performance processor such as laptop, that supports an idea of Interfacing LabVIEW with Arduino which was cheaper. As this project is helpful in different applications like industries, agriculture, home and many more. Labview is abbreviation of Laboratory virtual instrument engineering workbench which is created by national instruments. It is a graphical programming language which uses icons instead of text create applications. Labview codes are also known as virtual instruments or VI’S for short. Labview is extensively used for data acquisition signal analysis and also for hardware control. Labview consist of: 1) Front panel window and 2) block diagram window. Front panel window’s function is to control and show indicators of the system. Block diagram window’s function is to make programs and coding of the system (Sandip Parmar, 2018).
1.2 Introduction to USRP 2900

The System Block that mention how USRP 2900 can be used or connected as User Define Radio is shown in Picture 2. Transmitting, Modulation, Amplification, Filtering, Demodulation Process are done in Labview by interfacing LabVIEW communication design suit to USRP 2900. NI USRP 2900 having USB 3.0 interface is used to receive FM radio. USRP which is also said to SDR have two channels. The first is the transceiver and second is the receiver. This powerful hardware has RF frequency from 70MHz to 7GHz. As we know, FM radio frequencies lie in USRP supporting band. 101MHz radio station is tuned on USRP by LabVIEW. Internal Block Diagram of USRP 2900 was shown in Picture 3. The Detail Specification of this User Define Radio Device was shown in Picture 4 with Table 1 and Table 2.

![LabVIEW Window](image1.png)

**Picture 1. LabView Window**

![How to Interface USRP to External Devices](image2.png)

**Picture 2. How to Interface USRP to External Devices**

![USRP 2900 Layout](image3.png)

**Picture 3. USRP 2900 Layout**
Table 1. Connector Descriptions

<table>
<thead>
<tr>
<th>Connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX2</td>
<td>Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.</td>
</tr>
<tr>
<td>TX1 RX1</td>
<td>Input and output terminal for the RF signal. TX1 RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.</td>
</tr>
</tbody>
</table>

Table 2. LED Indicators

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
<th>Color</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF 0</td>
<td>RX2: Indicates the receive status of the device.</td>
<td>Off</td>
<td>The device is not active.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green</td>
<td>The device is receiving data.</td>
</tr>
<tr>
<td></td>
<td>TX1: Indicates the transmit status of the device.</td>
<td>Off</td>
<td>The device is not active.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green</td>
<td>The device is receiving data.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Red</td>
<td>The device is transmitting data.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orange</td>
<td>The device is switching between transmitting and receiving data.</td>
</tr>
</tbody>
</table>

2. PROGRAMMING IN LABVIEW COMMUNICATION DESIGN SUIT

2.1 Understanding NI LabVIEW Communication Design Suit

For the projects using National Instruments Software Define Radio (SDR) hardware, LabVIEW provides a simple interface for configuring and operating various external I/O, including the NI SDR hardware used in lab. This is the main reason why we use LabVIEW as the programming language to build an SDR in this project. We can realize that the algorithms considered here could also be programmed in optimized C/C++, assembly, or VHDL and implemented on a DSP, microcontroller, or an FPGA. The choice of hardware and software in this lab is mostly a matter of convenience.

For Communication Laboratories, we need to be familiar with LabVIEW and the documentation/help available in firmware. The following tutorials and reference material will help guide us through the process of learning LabVIEW:

- LabVIEW Communications System Design Suite 1.0 Online Manual
- LabVIEW Communications Guided Help tutorials
- Context help

The context help window displays basic information about LabVIEW objects when you move the cursor over each object. To toggle the display of the context help window, select View » Context Help or press <Ctrl-H>, this window is as shown in Picture 4.
The LabVIEW online help is the best source of detailed information about specific features and functions in LabVIEW. Online help entries break down topics into a concepts section with detailed descriptions and a how-to section with step-by-step instructions for using LabVIEW functions as shown in Picture 5.

2.2 Lab Procedure for Fundamental Testing

The following procedures are done and we can study and analyze the interfacing of LabVIEW Communication Design Suit to USRD 2900 with functionable Programme.

- Connect the TX1 output to the RX2 SMA connector using a loopback cable and 30 dB attenuator provided.
- Connect the USRP software defined radio to the computer as described in the Getting Started Guide for NI USRP transceiver.
- Launch the NI USRP Configuration Utility6 to find the Device Name for your NI USRP device. ***Start/All Programs/National Instruments/NI USRP/ NI USRP Configuration Utility***
- From the lobby in LabVIEW Communications, open the following NI USRP example:
  - Give the example a project name and click Create.
- From the example, open another NI USRP example:
  - Give the example a project name and click Create.
- On the Tx Continuous Async example (referred to as the transmitter program), enter the device name you found using the USRP configuration utility and note the value of the tone frequency control. This program generates a single frequency tone at baseband and sends it to the USRP.
- Run the transmitter program.
• On the Rx Continuous Async example (referred to as the receiver program) example window, enter the same device name as the transmitter and change the Active Antenna to RX2.
• Run the receiver program and analyze the Baseband Power Spectrum Graph. You should see a spike near the center of the graph. This is the single tone that was generated by the transmitter.
• Without changing the value of the Carrier Frequency control on the receiver or transmitter program, “move” the location of the single tone on the Baseband Power Spectrum graph to 150 kHz.

2.3 LabVIEW Plalettes and Descriptions

The LabVIEW Pallettes from LabVIEW communication design suit to be used are mentioned in Picture 8. Some explanation can be easily known by “help” menu.

Picture 8(a) Receiving Process

Opens a receive (Rx) session to the device(s) you specify in the device names input and returns session handle out, which you use to identify this instrument session in all subsequent NI-USRP nodes.

Picture 8(b)

Transfers data between the diagram and panel, between the diagram and other VIs, or between copies of the same terminal on the diagram. The color and symbol of each input and output terminal indicate the data type of the corresponding control or indicator.

Duplicating a terminal creates a local variable on the diagram. Right-click the terminal and select Create Duplicate Terminal to duplicate the terminal on the diagram.

Picture 8(c)

Configures properties of the transmit (Tx) or receive (Rx) signal.

Starts the Rx acquisition.

Fetches complex, double-precision floating-point data from the specified channel.

Returns the polar components of a complex number. Given $z$ in rectangular form $z = a + bi$, this node converts the polar components of $z=r\cos(\theta)+ir\sin(\theta)$ according to the following equations:

\[ r = \| z \| = \sqrt{a^2 + b^2} \]
\[ \theta = \arg(z) = \arctan\left(\frac{b}{a}\right) \]
IMPLEMENTATION OF FM DEMODULATION

Signals received by the USRP-2900 are amplified, downconverted, filtered, digitized, and decimated before being passed to the host computer. Signals transmitted by the USRP-2900 are upsampled, reconstructed, filtered, upconverted, and amplified before being transmitted.

The following lists describe the individual blocks:
Receive Path:
- The low-noise amplifier and drive amplifier amplify the incoming signal.
- The phase-locked loop (PLL) controls the voltage-controlled oscillator (VCO) so that the device clocks and local oscillator (LO) can be frequency-locked to a reference signal.
- The mixer downconverts the signals to the baseband in-phase (I) and quadrature-phase (Q) components.
- The bandpass filter reduces noise and high frequency components in the signal.
- The analog-to-digital converter (ADC) digitizes the I and Q data.
- The digital downconverter (DDC) mixes, filters, and decimates the signal to a user-specified rate.
- The downconverted samples are passed to the host computer over a USB 3.0 or USB 2.0 connection.

Transmit Path:
- The host computer synthesizes baseband I/Q signals and transmits the signals to the device over a USB 3.0 or USB 2.0 connection.
- The digital upconverter (DUC) mixes, filters, and interpolates the signal to 61.44 MS/s.
- The digital-to-analog converter (DAC) converts the signal to analog.
- The bandpass filter reduces noise and high frequency components in the signal.
- The mixer upconverts the signals to a user-specified RF frequency.
- The PLL controls the VCO so that the device clocks and LO can be frequency-locked to a reference signal.
- The transmit amplifier amplifies the signal and transmits the signal through the antenna.

Our Communication Laboratory upon FM Demodulation using NI USRP interfacing with LabVIEW communication design suit was implemented for Cherry FM (89.5 MHz). We analyze how performance are different or accurate using three methods: math script, Digital Signal Processing, Modulated Toolkit. The LabVIEW Block Diagram was constructed as shown in Picture 9. The Hardware Interfacing of USRP with LabVIEW communication design suit and Receiver Antenna connection are done as Shown in Picture 10.
4. TEST RESULTS

We can make performance analysis of three Rx Acquisition Methods: Math Script, Digital Signal Processing, Modulated Toolkit in Software Define Radio, USRP 2900. The Cherry FM which is design to broadcast at the area of Southern Shan State and Kayah State was tested as input FM with carrier frequency of 89.5 MHz. By this Testing Result, we can proof DSP was unsuitable for FM Demodulation as acquisition techniques. Configure the panel with the settings as in Table 3. The results of implementing FM Demodulation by building block diagram in LabVIEW communication design suit, interfacing USRP 2900, utilization and Rx antenna connecting, Setting data in front panel are shown in Picture 11 to 14.

Table 3. Cherry FM Receiver Setting in SDR

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Name</td>
<td>NI 2900</td>
</tr>
<tr>
<td>IQ rate</td>
<td>200 k</td>
</tr>
<tr>
<td>Carrier Frequency</td>
<td>38.9 M</td>
</tr>
<tr>
<td>Gain(dB)</td>
<td>20</td>
</tr>
<tr>
<td>Active Antenna</td>
<td>Rx</td>
</tr>
<tr>
<td>Number of Symbol</td>
<td>10000</td>
</tr>
</tbody>
</table>

International Journal of Informatics, Technology & Computers
ISSN: 2317-3793, Volume 4, Issue 2, page 75 - 85

Picture 11. FM Demodulation of 89.5 MHz using Mathscript calculation method

Picture 12. FM Demodulation of 89.5 MHz using Modulation toolkit calculation method

Picture 13. FM Demodulation of 89.5 MHz using DSP calculation method
5. DISCUSSION AND CONCLUSION

By the understanding of LabVIEW programming using block diagram, we now improve to LabVIEW communication design suit which was suitable for Communication Laboratory. By studying this plates in LabVIEW communication design suit, we can defined our Demodulation Block that can operate in RF frequency from 70MHz to 7GHz. Although we specifically implemented and carried out FM Demodulation of Cherry FM (89.5 M), we can test any FM or our design FM between these possible frequency ranges of 70MHz to 7GHz. By this paper, the performance of Frequency Modulation and Demodulation are analyzed, and also, how can we easily defined in software for our Demodulation Design was practiced. This paper represent all possible Communication Lab using USRP 2900 and we will arrange other practices like OFDM, Transceiver for our Final Year undergraduate Electronic Engineering students.

6. ACKNOWLEDGEMENT

Special thanks are due to Director General, Dr. Thein Win, DHE,MOE for his budget permission to buy NI LabVIEW and USRP 2900 suit for our communication lab improvement. Authors would like to express thanks to Pro-Rector Dr. Zaw Win Aung, his effective guidance to improvement of every research activities in our department. The first author would like to mention his appreciation to
second and third author, Daw Lay Nandar Soe, Daw Nang Tee Shar. All the teaching staff from EcE Department of TU(Loikaw) are to be expressed as acknowledged persons.

7. REFERENCES
3. Abinav, A. k., Naveena, K., Pratibha, R., Gandhiraj, R., & Soman,” Detection and classification of signals to configure software defined radio”, Second national conference on recent trends in communication, computation and signal processing, March 2627