LAB 1

INTRODUCTION:

In this lab we are going to make basic spectrum analyzer using GNURadio and observe the FM spectrum, waterfall plot of FM spectrum ,Wi-Fi spectrum showing a packet, waterfall plot of Wi-Fi spectrum and received spectrum of the transmitted signal.

PROCEDURE:

Spectrum analyzer

1.Open GNURadio.

2.Place the "USRP source" and "QT sink" on the canvas.

3.Connect the USRP output to the input of QT sink.

4.Set the sample rate to 20 million samples per second by double-clicking the "samp_rate" block and changing its value.

5.Place two "QT GUI Entry" blocks on the canvas and set the frequency to 2.4GHz and gain to 50.

6.Go to the USRP source and set the center frequency to "Frequency" and the gain to "Gain".

7.In the QT sink, set the center frequency to "Frequency".

8.Save the flow graph and run it by clicking the green arrow.

9.The QT sink will show the received signal in real-time, and the frequency and gain can be adjusted while running.

10.To stop the flow graph, click the red square.

11.To make changes, double-click a block and adjust its parameters, then save and re-run the flow graph.

12Set the averaging to 32 and the FFT size to 4096.

13.To get WiFi signal tune center frequency of 2.440 GHz and set the averages to 1. Turn on Max and min hold and observe the Wifi spectrum.

Transmitter

1.Open GNURadio and create a new canvas.

2.Find the "samp_rate" variable and change its value to 2 million samples per second.

3.Create a new variable called "Frequency" and set it to 2.412GHz.

4.Create another new variable called "TxGain" with the value of 100.

5.Place a "Wav File Source" block on the canvas, select the audio file , set "Repeat" to "Yes" and "Channels" to 2.

6.Place a "Float to Complex" block on the canvas and connect it to the output of the "Wav File Source".

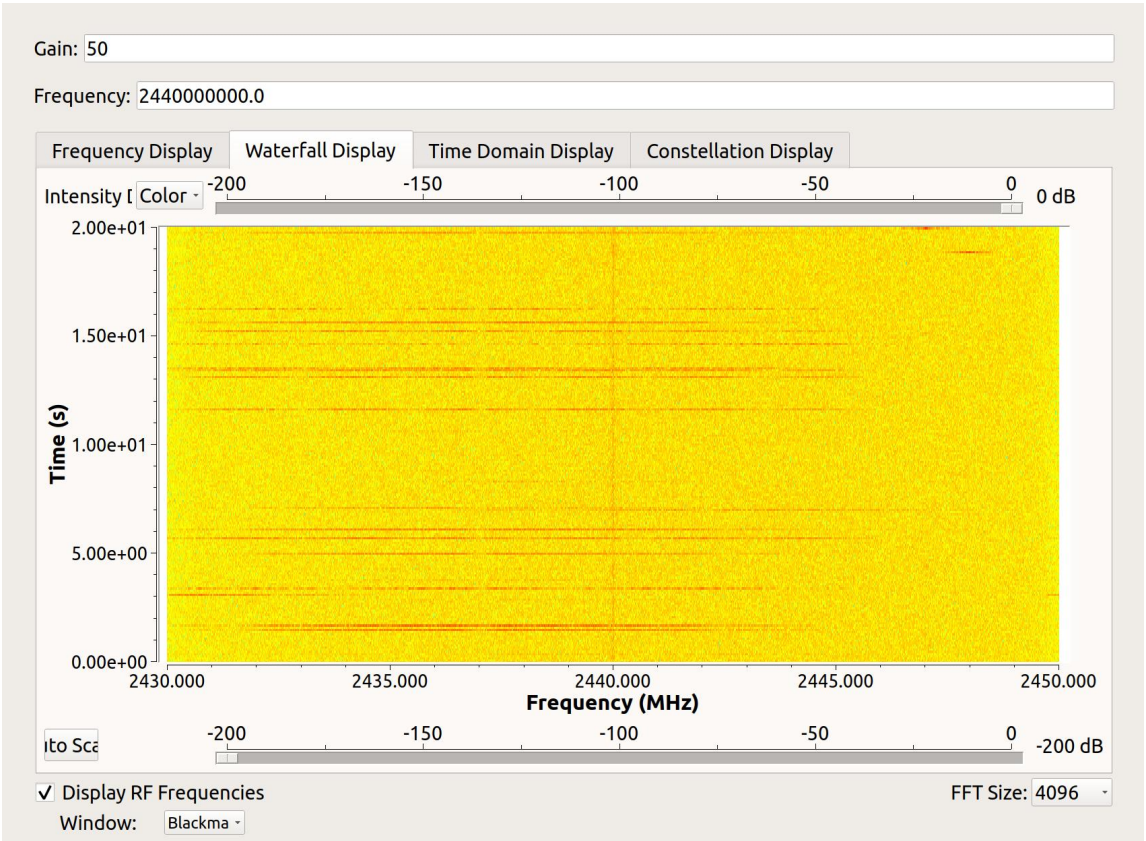
7.Place a "Rational Resampler" block on the canvas, set "Interpolation" to 10 and "Decimation" to 1, and connect it to the output of the "Float to Complex" block.

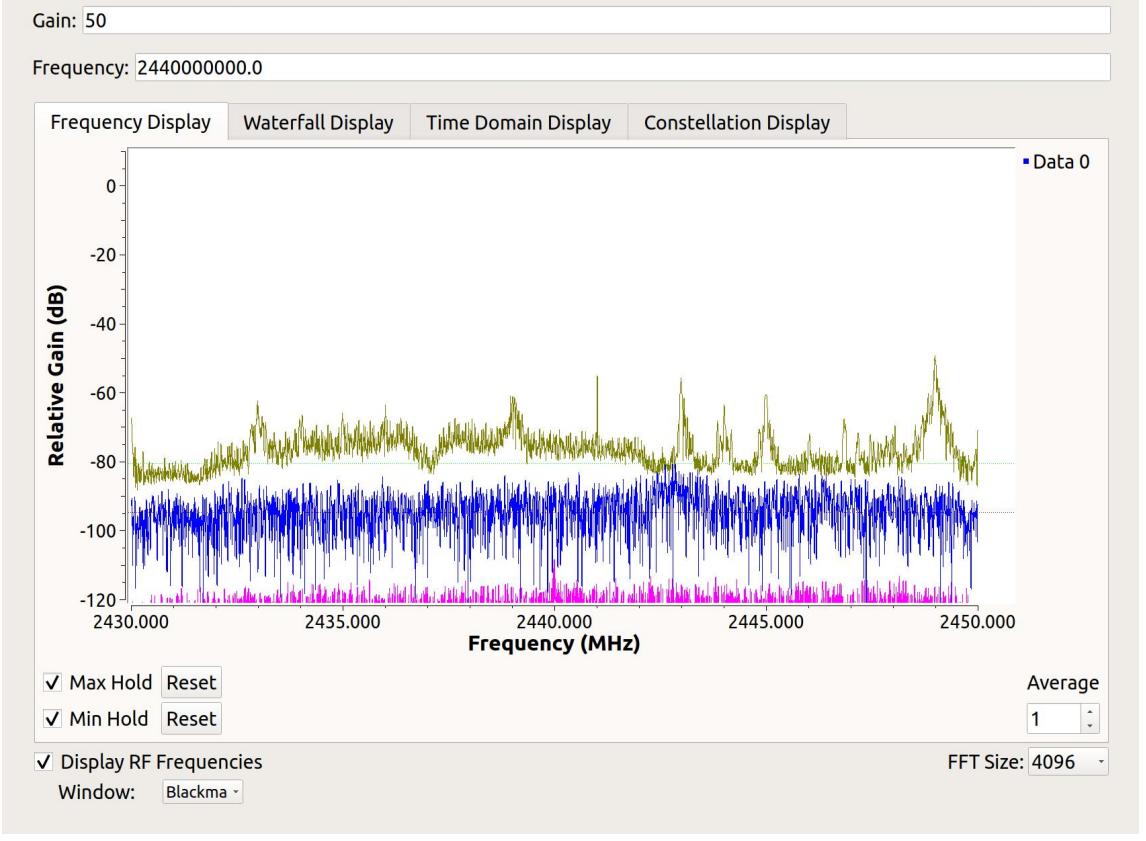
8.Place a "USRP Sink" block on the canvas, set "Sample Rate" to "samp_rate", "Center Frequency" to "Frequency", and "Gain" to "TxGain". Connect the output of the "Rational Resampler" block to the input of the "USRP Sink".

9.Add QT GUI Entry and enter the same values from Spectrum Analyzer.

10. Save and run the flow graph and observe the received spectrum.

RESULTS:

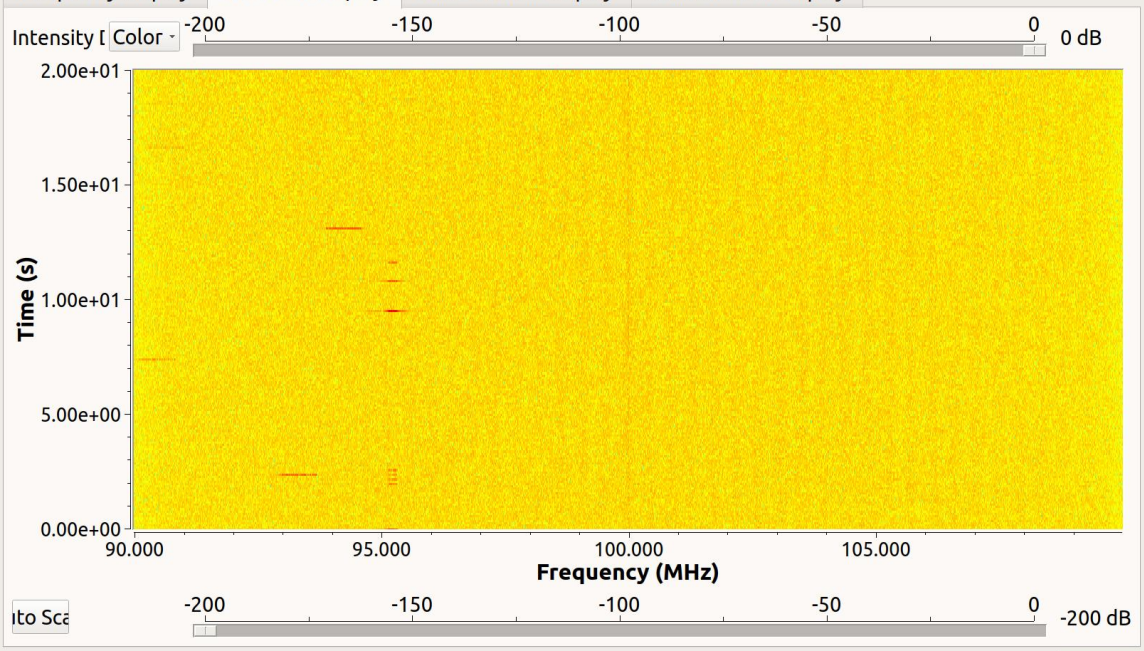

Gain: 50
Frequency: 2440000000.0
Frequency Display
Waterfall Display
Time Domain Display
Constellation Display
Intensity [
Color
-200
-150
-100
-50
0
0 dB
2.00e+01
1.50e+01
1.00e+01
5.00e+00
0.00e+00
Time (s)
2430.000
2435.000
2440.000
2445.000
2450.000
Frequency (MHz)
ito Sca
-200 dB
Display RF Frequencies
FFT Size: 4096
Window: Blackma


Gain: 50
Frequency: 2440000000.0
Frequency Display
Waterfall Display
Time Domain Display
Constellation Display
Data 0
0
-20
-40
-60
-80
-100
-120
Relative Gain (dB)
2430.000
2435.000
2440.000
2445.000
2450.000
Frequency (MHz)
Max Hold
Reset
Min Hold
Reset
Average
1
Display RF Frequencies
FFT Size: 4096
Window: Blackma

Gain: 50

Frequency: 100e6

Frequency Display | Waterfall Display | Time Domain Display | Constellation Display



Display RF Frequencies

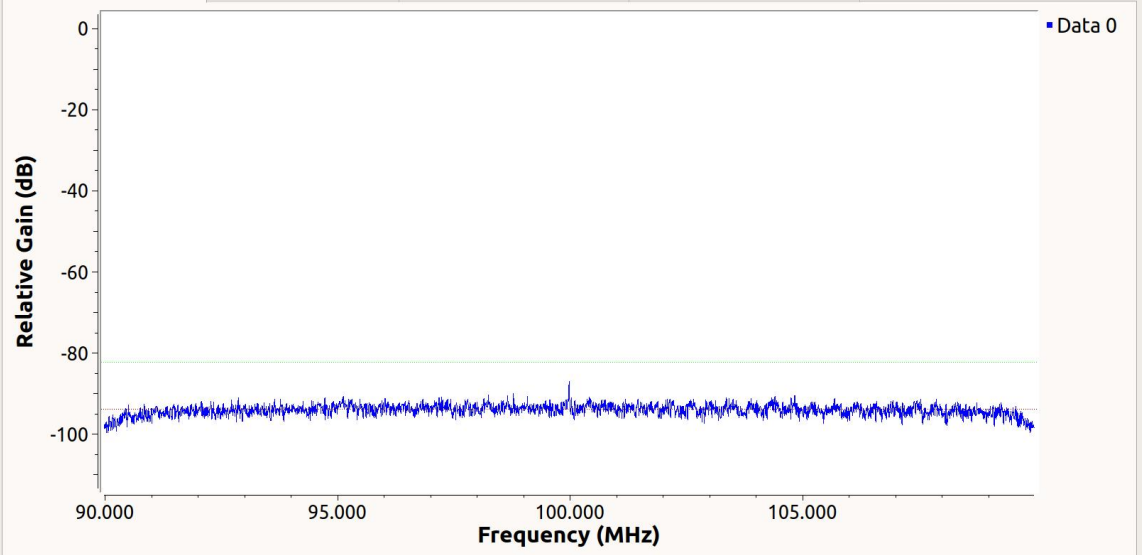
FFT Size: 4096

Window: Blackma

Gain: 50

Frequency: 100e6

Frequency Display | Waterfall Display | Time Domain Display | Constellation Display



Max Hold Reset

Min Hold Reset

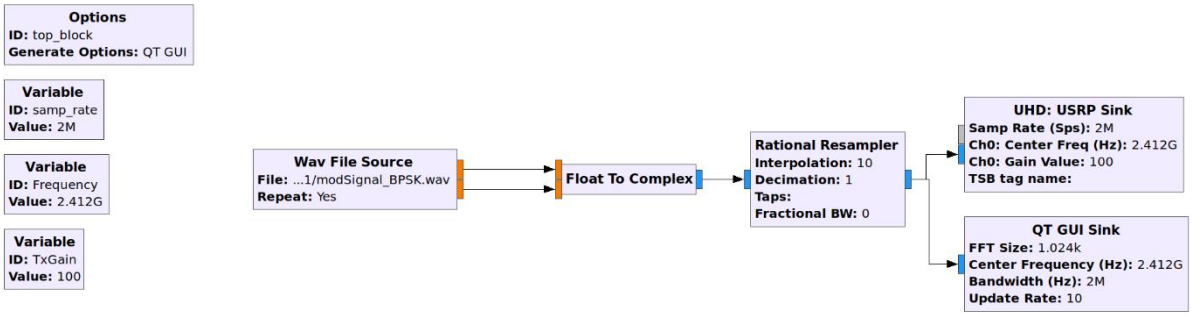
Average

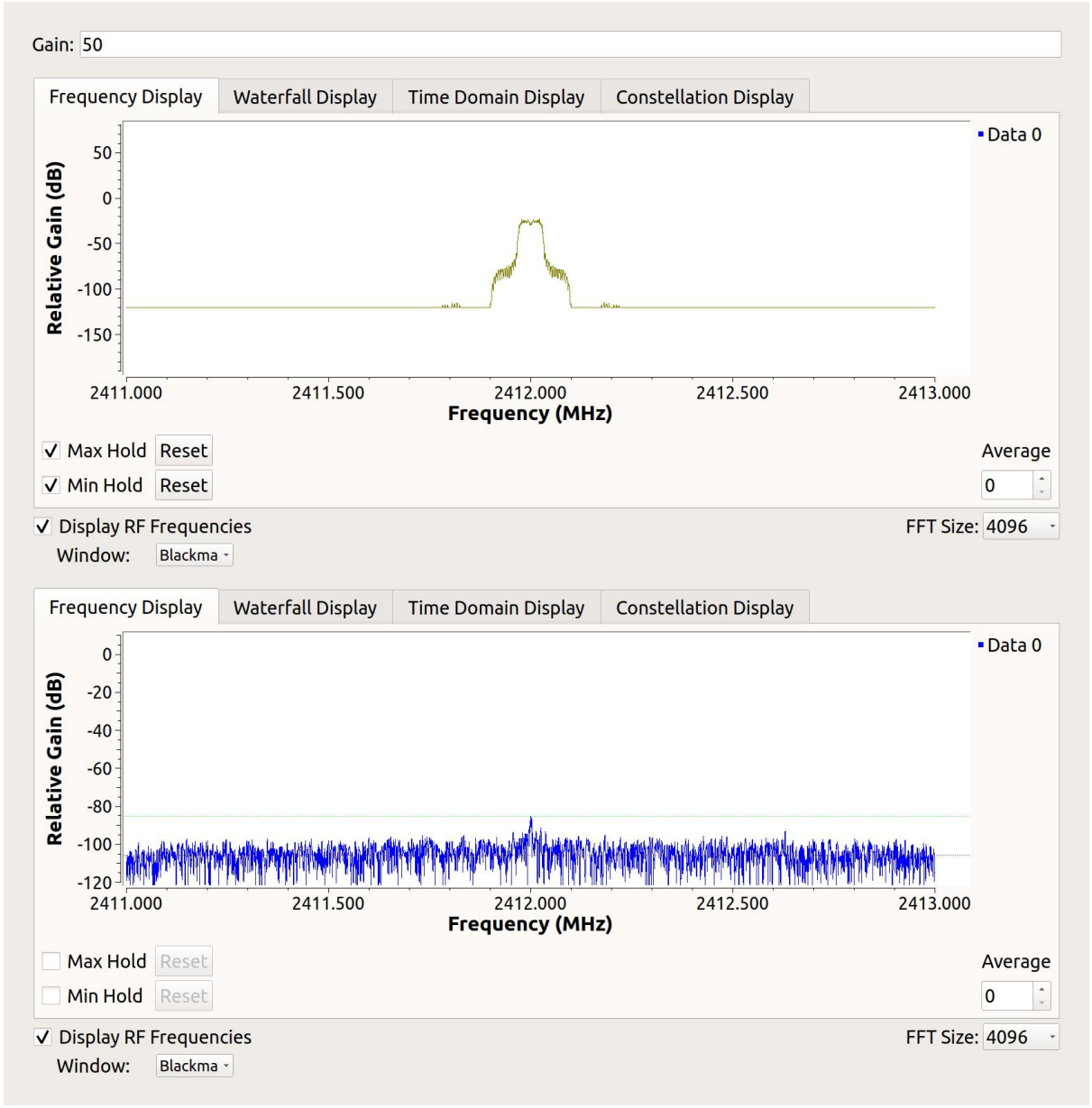
32

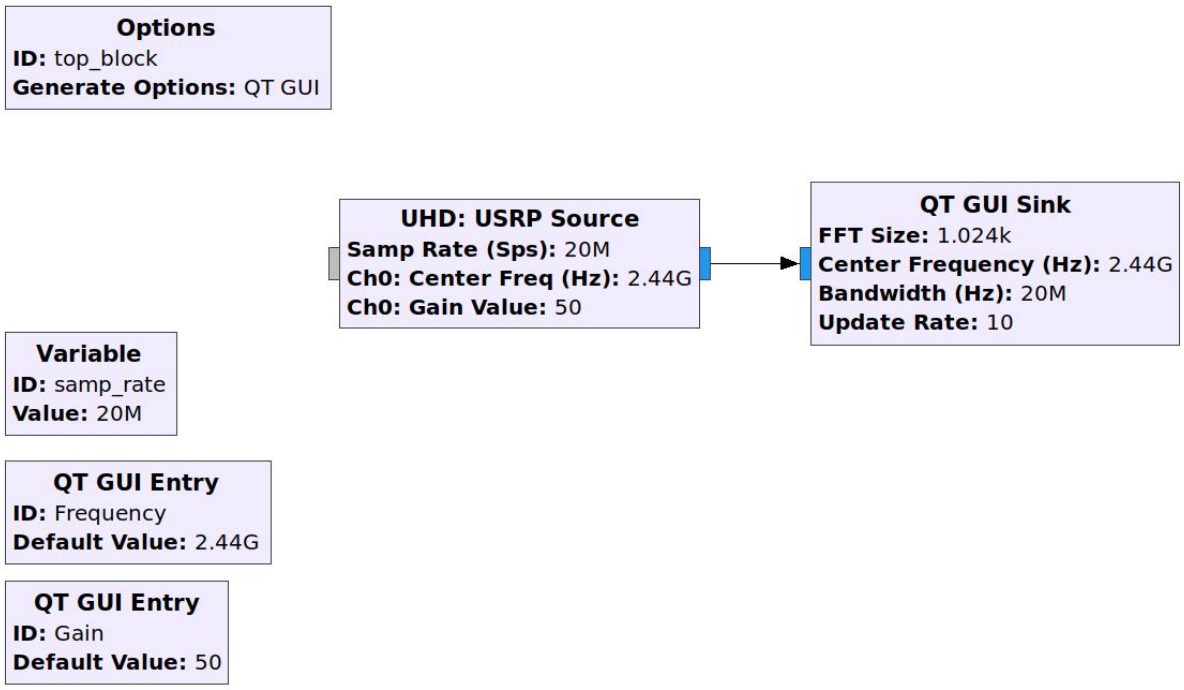
Display RF Frequencies

FFT Size: 4096

Window: Blackma


Options
ID: top_block
Generate Options: QT GUI
Variable
ID: samp_rate
Value: 2M
Variable
ID: Frequency
Value: 2.412G
Variable
ID: TxGain
Value: 100
Wav File Source
File: ...1/modSignal_BPSK.wav
Repeat: Yes
Float To Complex
Rational Resampler
Interpolation: 10
Decimation: 1
Taps:
Fractional BW: 0
UHD: USRP Sink
Samp Rate (Sps): 2M
Ch0: Center Freq (Hz): 2.412G
Ch0: Gain Value: 100
TSB tag name:
QT GUI Sink
FFT Size: 1.024k
Center Frequency (Hz): 2.412G
Bandwidth (Hz): 2M
Update Rate: 10


Gain: 50
Frequency Display
Waterfall Display
Time Domain Display
Constellation Display
Data 0
Relative Gain (dB)
50
0
-50
-100
-150
2411.000
2411.500
2412.000
2412.500
2413.000
Frequency (MHz)
Max Hold
Reset
Min Hold
Reset
Average
0
Display RF Frequencies
FFT Size: 4096
Window: Blackma
Frequency Display
Waterfall Display
Time Domain Display
Constellation Display
Data 0
Relative Gain (dB)
0
-20
-40
-60
-80
-100
-120
2411.000
2411.500
2412.000
2412.500
2413.000
Frequency (MHz)
Max Hold
Reset
Min Hold
Reset
Average
0
Display RF Frequencies
FFT Size: 4096
Window: Blackma



The output waveforms are generated as expected.

DISSCUSSIONS:

Spectrum Analyzer

1.What is the function of each of the blocks?

Variable block is used to set sample frequency.

QT GUI Entry Block: Used to set frequency and gain.

UHD USRP Source Block:Used to stream samples from a USRP device.

QT GUI Sink: It provides the graphical representation.

Wav File Source: It reads audio files.

Float to Complex: Convert a stream of float to 1 or 2 streams of complex.

Rational Resampler: It changes the sample rate of an input signal by performing interpolation and decimation.

2. How does the "samp_rate" variable affect the spectrum?

It is the number of samples taken per second and affects the spectral properties of a signal.

3. How does FFT length affect the spectrum?

It determines the frequency resolution of the spectrum. A longer FFT length provides better resolution but requires more computational resources.

4. Why use multiple averages for the FM signal but not for Wifi?

There are some additional measurement functions created like frequency response, impulse response, phase spectrum in FM signal not in WIFI.

5. Explain the shape of a FM radio signal.

It is a sine wave that varies in frequency over time, with the rate of change in frequency representing the modulating signal.

6. Explain the shape of a Wifi signal and why it is not a continuous signal.

A Wifi signal is composed of short pulses of data that are transmitted in rapid succession. It is not a continuous signal because it needs to be able to transmit multiple streams of data at once and avoid interference with other devices on the same frequency.

Transmitter

1. How is the complex signal stored in the wav file?

The complex signal is stored in a wav file as digital data, representing the amplitude and phase of the signal at each sample point.

2. The USRP sink is able to transmit symbols at samp_rate. What is the symbol rate (symbols per second) of the USRP sink output? What is the symbol rate of the output of wav file source?

The symbol rate is a measure of how many pieces of information are transmitted in a second. The higher the symbol rate, the more information can be transmitted in the same amount of time.

CONCLUSIONS:

The spectrum is generated for FM and Wi-Fi and waterfall plot and spectrum is observed and at the transmitter part received spectrum of the transmitted signal is observed.

MATLAB CODE: There is no matlab code for this lab

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