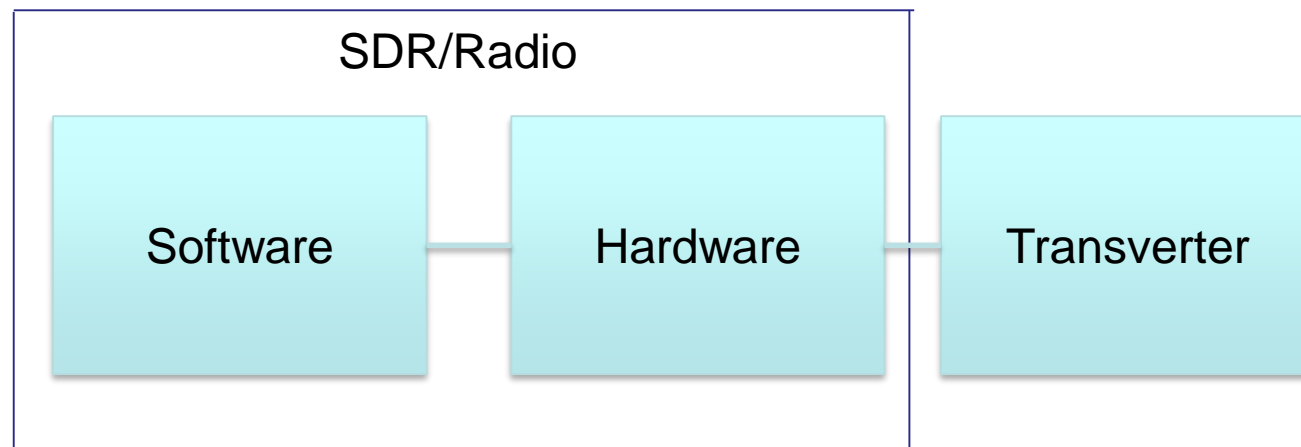


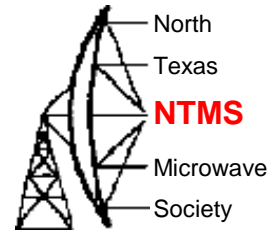
SDR and GNU Radio for Microwave

Cowtown
January 19, 2019

N5BRG



SDR on the Raspberry Pi



PiHPSDR

Program runs on Ubuntu and other Raspberry Pi operating systems. Connects to a Software Defined Radio - HPSDR – Hermes – Many Others

Credit John Melton G0ORX/N6LYT

<> Code

! Issues 0

🔗 Pull requests 0

📁 Projects 0

📊 Insights

Branch: master ▾

OpenHPSDR-Firmware / Protocol 2 /

👤 mh Adding v1.5

Types of SDR Hardware Available

📁 ANAN-10E & 100B

Added Protocol 2 code for ANAN-10E & 100B

📁 Angelia (ANAN-100D)

replaced release notes, modified Orion_MkII folder name

📁 Documentation

Add files via upload

📁 Hermes (ANAN-10 and 100)

replaced release notes, modified Orion_MkII folder name

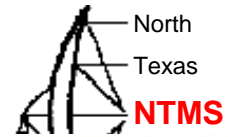
📁 Orion (ANAN-200D)

Adding v1.5

📁 Orion_MkII (ANAN-7000DLE-8000DLE)

Adding v1.5

Thetis v2.6.2 Most current Beta in Early 2019 Skin view



Thetis v2.6.0 (4/10/18) beta

Setup Memory Wave Equalizer XVTRs CWX Diversity Collapse Spot Linearity RA WB PI

VFO A
1.840 000
160M CW TX

VFO Sync Tune Step: - 25Hz +
VFO Lock: A B 7.000000 BandStack
Rx Ant Save Restore 1 5

VFO B
1.908 000
TX 160M SSB/SSTV/Wide B

RX1 Meter TX Meter
Signal ALC
-86.6 dBm

1.834 1.836 1.838 1.840 1.842 1.844 1.846

4 1.836 1.838 1.840 1.842 1.844 1.846

Seq=> 8 4056.4Hz -106.8dBm 1.844 056 MHz

Pan: Center Zoom: 0.5x 1x 2x 4x

SPLT A > B ANF
0 Beat A < B NB SNB
IF->V A <> B MUT BIN
MNF CTUN

RIT 0 XIT 0
0 0

VAC1 VAC2

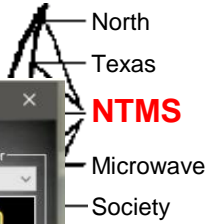
VAC1 RXGain: -20
VAC1 TXGain: 1
TXProfile: DIG

Sample Rate: 48000
Chnls / IQ: Stereo

SQL: -64
10/12/2018
LOC 11:20:15
CPU% 9

160 80 60
40 30 20
17 15 12
10 6 LFMF
VHF+ WWV SWL
LSB USB DSB
CWL CWU FM
AM SAM SPEC
DIGL DIGU DRM
3.0k 2.5k 2.0k
1.5k 1.0k 800
600 300 150
75 Var 1 Var 2
Width: Shift: Reset
Low High 3000

Example of two Receivers using Thetis



Thetis v2.3.11 (2/14/17)

Setup Memory Wave Equalizer XVTRs CWX Diversity Collapse Spot Linearity RA WB PI

VFO A

14.170 421

20M Extra SSB

TX

VFO Sync Tune Step: - 100Hz +

VFO Lock 7.000000

Save Restore

VFO B

7.010 000

40M Extra CW

TX

RX1 Meter TX Meter

Signal ALC

-99 dBm

160	80	60
40	30	20
17	15	12
10	6	LFMF
VHF+	WWV	GEN

LSB	USB	DSB
CwL	CWU	FM
AM	SAM	SPEC
DIGL	DIGU	DRM

5.0k	4.4k	3.8k
3.3k	2.9k	2.7k
2.4k	2.1k	1.8k
1.0k	Var 1	Var 2

Master AF: 30

RX1 AF: 46

RX2 AF: 0

AGC Gain: 85

Drive: 50

AGC ATT

Med QdB

SQL: -150

3/16/2017

LOC 14:47:31

CPU% 41

SPLT A > B

0 Beat A < B

IF->V A < B

XIT 0 RIT 0

VAC1 VAC2

NR ANF

NB SNB

MUT BIN

MNF

Panadaoter

AVG Peak

CTUN

Vol Pan Vol

MultiRX Swap

MIC 6 dB

COMP 1 dB

VOX 100

DEXP -40

Transmit Profile: Default

RX EQ TX EQ

TX FL

5.0k 4.4k 3.8k

3.3k 2.9k 2.7k

2.4k 2.1k 1.8k

1.0k Var 1 Var 2

Width: [Slider]

Shift: [Slider] Reset

Low 150 High 2850

Play (k)

VFOB Band 40m

AGC Gain: 90

NR ANF

NB SNB

MUT BIN

AGC Med

Panadaoter

LSB USB DSB

CwL CWU FM

AM SAM SPEC

DIGL DIGU DRM

5.0k 4.4k 3.8k

3.3k 2.9k 2.7k

2.4k 2.1k 1.8k

1.0k Var 1 Var 2

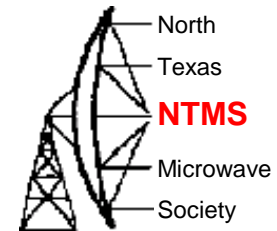
Low High

9:07 / 13:46

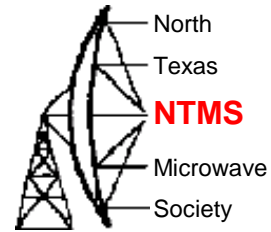
RX2 Meter Signal

-92 dBm

Another SDR Option Analog Devices Pluto



GNU Radio on a DVD



GNU Radio Live SDR Environment

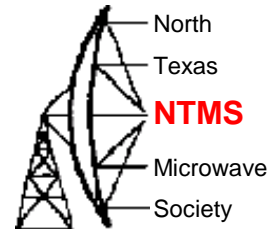
The GNU Radio Live SDR Environment, produced by [Corgan Labs](#), is a bootable Ubuntu Linux DVD or USB drive image, with GNU Radio and third party software pre-installed. It is designed for quick and easy testing and experimentation with GNU Radio without having to make any permanent modifications to a PC or laptop. It does not, however, provide for permanent installation.

It is supplied as an ISO image to be downloaded and burned onto a recordable DVD disc or copied to a USB flash drive using a utility such as the [Ubuntu Startup Disk Creator](#) (Ubuntu Linux OS) or [Unetbootin](#) (Windows, MacOS, Linux). Creating a USB drive from the image will provide much faster booting and operation, and allow making changes and storing files. Finally, the ISO image may be booted within a virtual environment such as VirtualBox, QEMU/kvm, VMware, or Parallels.

Link to download on next page

GNU Radio 3.7.11

(Note current release now 3.7.13.4)



Current Stable Release

This version of the ISO image is based on the latest stable release of GNU Radio, 3.7.11, and the stable releases of third party software at that time:

<http://s3-dist.gnuradio.org/ubuntu-16.04.2-desktop-amd64-gnuradio-3.7.11.torrent>

The use of Bittorrent reduces the load on the GNU Radio web server and lowers project bandwidth costs.

If a Bittorrent client is not available or its use is restricted, you may download the ISO image file by choosing from one of the following mirror sites:

<http://s3-dist.gnuradio.org/ubuntu-16.04.2-desktop-amd64-gnuradio-3.7.11.iso>

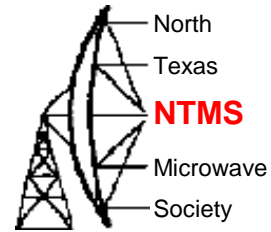
<http://eu1-dist.gnuradio.org/s3/ubuntu-16.04.2-desktop-amd64-gnuradio-3.7.11.iso>

<http://eu2-dist.gnuradio.org/ubuntu-16.04.2-desktop-amd64-gnuradio-3.7.11.iso>

MD5 sum:

```
001a31c924f91665eb34b4b3502564c2  ubuntu-16.04.2-desktop-amd64-gnuradio-3.7.11.iso
```

GNU Radio SDR Blocks Available



Pre-Installed SDR Hardware Drivers

Drivers for these GNU Radio-compatible SDR peripherals have been pre-installed:

- Ettus Research [UHD](#) [release_003_009_006](#)
- Great Scott Gadgets [HackRF products](#)
- Nuand [bladeRF products](#)
- osmoSDR [RTL-SDR](#) driver
- AirSpy <http://airspy.com/>

Each of these provides its own set of utilities and files. Please consult the manufacturers' documentation for more information.

Adalm-Pluto by Analog Devices @ Mouser for \$150

<https://www.gnuradio.org>

<https://www.gnuradio.org/grcon/grcon18/>



About ▾

Blog

News

Documentation

Events ▾

Getting Started

GRCon18

Presentations

GNU Radio Conference 2018

Many Youtube type Videos about GNU Radio

Activities GNU Radio Companion Mon 2:47 PM *pluto_usb_xcvr.grc - /home/bstricklin/Desktop - GNU Radio Companion

File Edit View Run Tools Help

Options
ID: usb_xcvr_bpf
Title: Upper Sideband - KK6RUM
Author: Jenner ...idge KK6RUM
Description: USB XCVR
Generate Options: WX GUI

WX GUI Text Box
ID: usrp_freq
Label: VFO
Default Value: 902.1M
Converter: Float
Grid Position: 1, 0, 1, 1

WX GUI Static Text
ID: rx_freq
Label: RX Frequency
Default Value: 902.1M
Converter: Float
Grid Position: 1, 1, 1, 1

WX GUI Chooser
ID: chooser
Label: TX-RX
Default Value: 2
Choices: 1, 2
Labels: Transmi..., Receiving
Type: Button
Grid Position: 1, 5, 1, 5

WX GUI Notebook
ID: notebook_0
Tab Orientation: Left
Labels: FFT, Wa..., Wide FFT
Grid Position: 2, 0, 5, 10

WX GUI Slider
ID: offset_coarse
Label: Coarse Tuning
Default Value: 0
Minimum: -25k
Maximum: 25k
Converter: Float
Grid Position: 0, 0, 1, 5

WX GUI Slider
ID: offset_fine
Label: Fine Tuning
Default Value: 0
Minimum: -2k
Maximum: 2k
Converter: Float
Grid Position: 0, 5, 1, 5

WX GUI Slider
ID: af_gain
Label: Volume
Default Value: 5
Minimum: 50m
Maximum: 10
Converter: Float
Grid Position: 1, 3, 1, 1

Variable
ID: freq_offset
Value: 150k

Variable
ID: samp_rate
Value: 1M

Note
Note: Transmit Section

Variable
ID: tx_processing_rate
Value: 100k

Constant Source
Constant: 0

Rational Resampler
Interpolation: 25
Decimation: 12
Taps: Fractional BW: 0

Signal Source
Sample Rate: 100k
Waveform: Sine
Frequency: 0
Amplitude: 100m
Offset: 0

Float To Complex

Multiply

WX GUI FFT Sink
Title: FFT Tx 1 Plot
Sample Rate: 20k
Baseband Freq: 0
Y per Div: 5 dB
Y Divs: 10
Ref Level (dB): 10
Ref Scale (p2p): 2
FFT Size: 1.024k
Refresh Rate: 15
Average Alpha: 0
Notebook: notebook_0, 0
Freq Set Varname: None

Band Pass Filter
Decimation: 1
Gain: 1
Sample Rate: 48k
Low Cutoff Freq: 300
High Cutoff Freq: 3.5k
Transition Width: 1k
Window: Hamming
Beta: 6.76

DC Blocker
Length: 32
Long Form: True

Audio Source
Sample Rate: 48kHz

Selector
Input Index: 0
Output Index: 1

Null Sink

Band Pass Filter
Interpolation: 1
Gain: 1
Sample Rate: 100k
Low Cutoff Freq: 300
High Cutoff Freq: 3k
Transition Width: 100
Window: Hamming
Beta: 6.76

Variable
ID: high
Value: 3k

Variable
ID: low
Value: 300

Multiply

Band Pass Filter
Interpolation: 1
Gain: 1
Sample Rate: 100k
Low Cutoff Freq: 300
High Cutoff Freq: 3k
Transition Width: 100
Window: Hamming
Beta: 6.76

Signal Source
Sample Rate: 100k
Waveform: Cosine
Frequency: 0
Amplitude: 1
Offset: 0

Multiply Const
Constant: 1k

Multiply Const
Constant: 30m

PlutoSDR Sink
IIO context URI: ip:...7.168
LO Frequency: 902.1M
Sample rate: 550k
RF bandwidth: 1.1M
Buffer size: 32.768k
Cyclic: False
Attenuation (dB): -10
Filter: Filter auto: True

(This is ethernet data flowing to AD Pluto)

>>> Done

Id	Value
Imports	
Variables	
af_gain	<Open Properties>

Example of GNU Radio Flow Chart for Receive

GNU Radio Companion

*pluto_usb_xcvr.grc - /home/bstricklin/Desktop - GNU Radio Companion

File Edit View Run Tools Help

Variable ID: low_0 Value: 200

Variable ID: high_0 Value: 2.8k

Variable ID: rx_target_rate Value: 50k

Variable ID: xlate_filter_taps Value: 33.8332m...m, 33.8332m

PlutoSDR Source
Device URI: ip:192.168.7.168
LO Frequency: 901.949M
Sample rate: 1M
RF bandwidth: 2M
Buffer size: 32.768k
Quadrature: True
RF DC: True
BB DC: True
Gain Mode: Manual
Manual Gain (dB): 64
Filter:
Filter auto: True

Note: Receive Section

WX GUI FFT Sink
Title: FFT Rx 1 Plot
Sample Rate: 1M
Baseband Freq: 901.95M
Y per Div: 5 dB
Y Divs: 10
Ref Level (dB): 10
Ref Scale (p2p): 2
FFT Size: 1.024k
Refresh Rate: 15
Average Alpha: 0
Notebook: notebook_0_3
Freq Set Varname: None

Signal Source
Sample Rate: 50k
Waveform: Cosine
Frequency: 1.5k
Amplitude: 1
Offset: 0

Complex To Float

Signal Source
Sample Rate: 50k
Waveform: Sine
Frequency: 1.5k
Amplitude: 1
Offset: 0

Multiply

Multiply

Add

Frequency Xlating FIR Filter
Decimation: 20
Taps: firdec_low_pass(1.sa...
Center Frequency: 150k
Sample Rate: 1M

Rational Resampler
Interpolation: 2
Decimation: 5
Taps: Fractional BW: 0

Rational Resampler
Interpolation: 32
Decimation: 50
Taps: Fractional BW: 0

WX GUI FFT Sink
Title: FFT Rx 2 Plot
Sample Rate: 20k
Baseband Freq: 902.1M
Y per Div: 5 dB
Y Divs: 16
Ref Level (dB): -40
Ref Scale (p2p): 2
FFT Size: 1.024k
Refresh Rate: 15
Average Alpha: 0
Notebook: notebook_0_0
Freq Set Varname: None

WX GUI Waterfall Sink
Title: Waterfall Plot
Sample Rate: 20k
Baseband Freq: 0
Dynamic Range: 80
Reference Level: -40
Ref Scale (p2p): 2
FFT Size: 1.024k
FFT Rate: 15
Grid Position: 0, 0, 5, 10
Notebook: notebook_0_1
Freq Set Varname: None

Multiply Const
Constant: 5

Selector
Input Index: 0
Output Index: 1

Null Sink

Audio Sink
Sample Rate: 32KHz

Note: TX / RX Chain Settings

WX GUI Slider ID: tx_bb_gain Label: Bb Gain Default Value: -15 Minimum: -35 Maximum: -4 Converter: Float Grid Position: 1, 20, 1, 5

WX GUI Slider ID: tx_rf_gain Label: RF Gain Default Value: 14 Minimum: 0 Maximum: 25 Converter: Float Grid Position: 2, 20, 1, 5

WX GUI Slider ID: carrier_level Label: Carrier level Default Value: 100m Minimum: 0 Maximum: 10 Converter: Float Grid Position: 3, 20, 1, 5

WX GUI Slider ID: trans Label: Transition Width Default Value: 500 Minimum: 100 Maximum: 2k Converter: Float Grid Position: 3, 0, 1, 10

WX GUI Slider ID: center Label: Center Default Value: 1.5k Minimum: -5k Maximum: 5k Converter: Float Grid Position: 2, 0, 1, 10

WX GUI Slider ID: width Label: Filter Width Default Value: 2.6k Minimum: 100 Maximum: 5k Converter: Float Grid Position: 1, 0, 1, 10

WX GUI Static Text ID: variable_static_text_0 Label: Receiver Default Value: Settings Converter: String Grid Position: 0, 0, 1, 10

Id Value

Imports

Variables

af_gain <Open Properties>

>>> Done

(This is ethernet data flowing from AD Pluto)

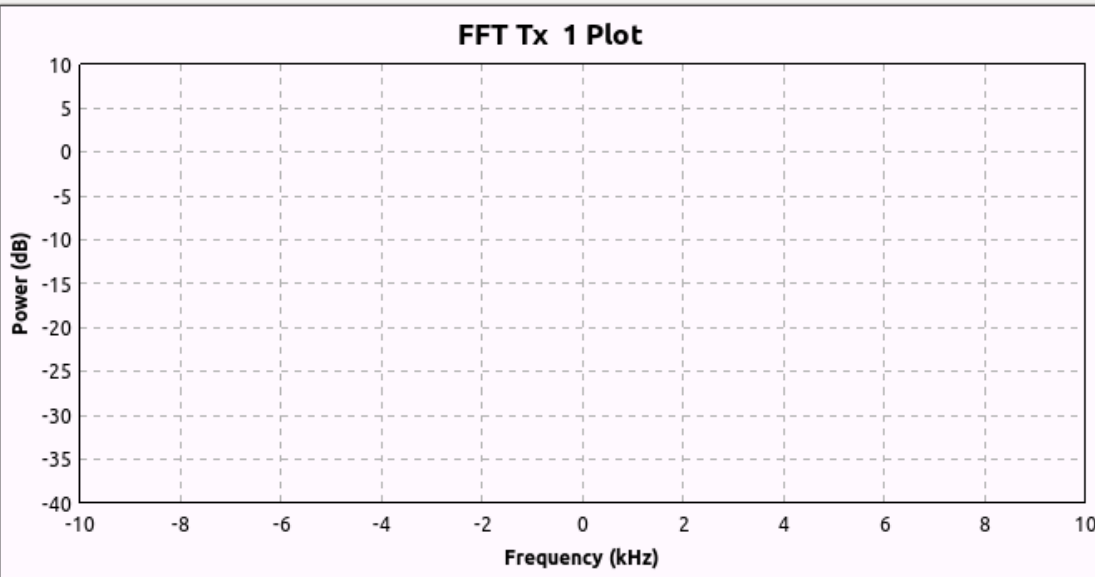
WWW.NTMS.ORG

13

Coarse Tuning: 0.0 Fine Tuning: 0.0

VFO: 902.1M RX Frequency: 902,100,000 Volume: 5.0 TX-RX: Receiving

- FFT
- Waterfall
- Gain Settings
- Wide FFT



Trace Options

Peak Hold

Average

Avg Alpha: 0.1333

Persistence

Persist Alpha: 0.1486

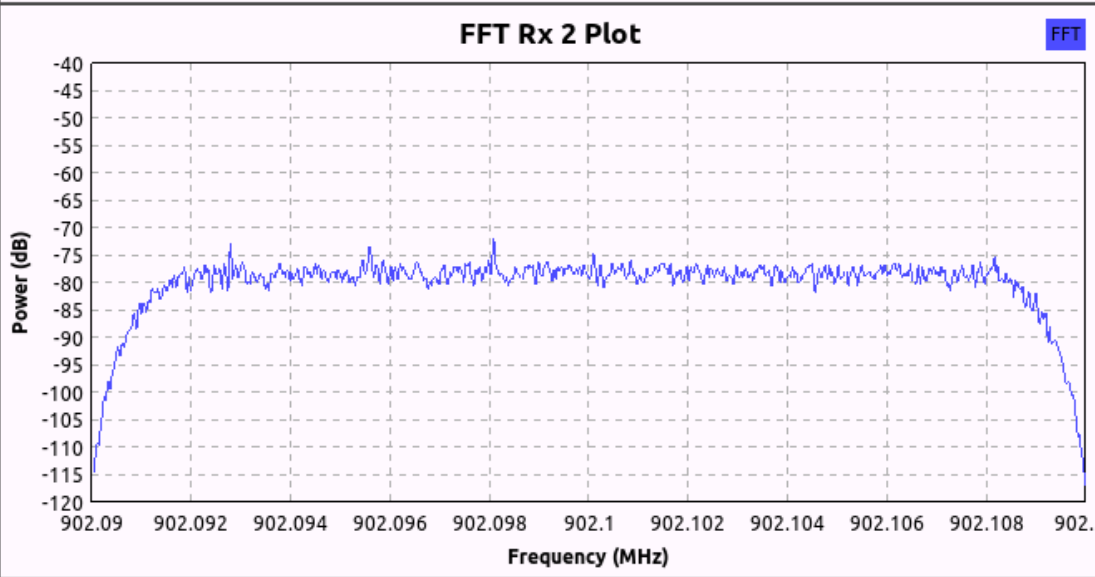
Trace A

Trace B

Axis Options

dB/Div: + -

Ref Level: + -



Trace Options

Peak Hold

Average

Avg Alpha: 0.1333

Persistence

Persist Alpha: 0.1486

Trace A

Trace B

Axis Options

dB/Div: + -

Ref Level: + -

W5HN

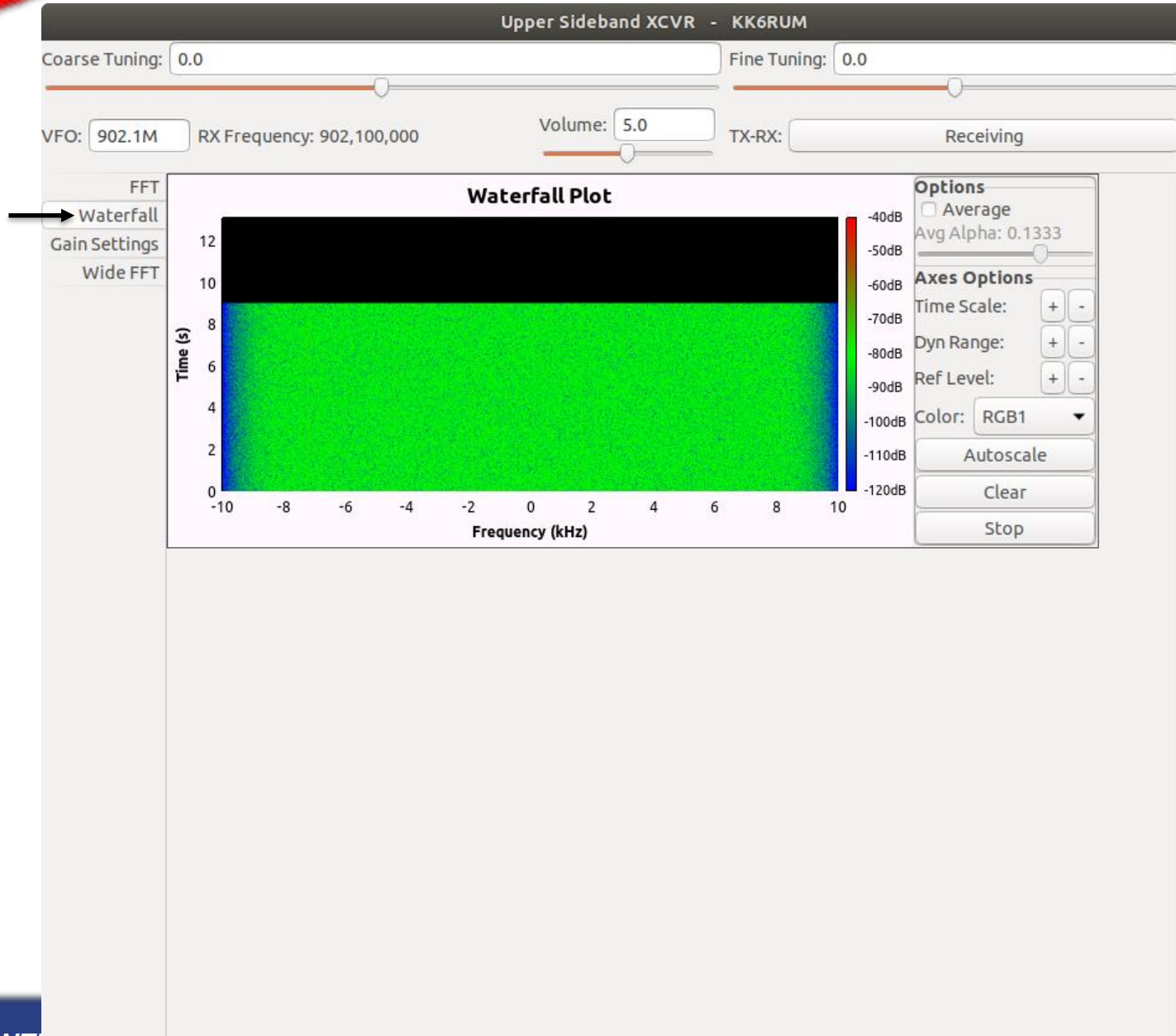
- North
- Texas
- NTMS**
- Microwave
- Society

AGC:

Medium

Example of the waterfall module output

- North
- Texas
- NTMS**
- Microwave
- Society



Coarse Tuning: 0.0 Fine Tuning: 0.0

VFO: 902.1M RX Frequency: 902,100,000 Volume: 5.0 TX-RX: Receiving

- FFT
- Waterfall
- Gain Settings
- Wide FFT

Receiver: Settings

Filter Width: 2.6k

Center: 1.5k

Transition Width: 500.0

LNA Gain: 0.0

RXVGA1: 30.0

RXVGA2: 5.0

Transmitter: Settings

Bb Gain: -15.0

RF Gain: 14.0

Carrier level: 100.0m

Signal level: 1.0k

Mic gain: 30.0m

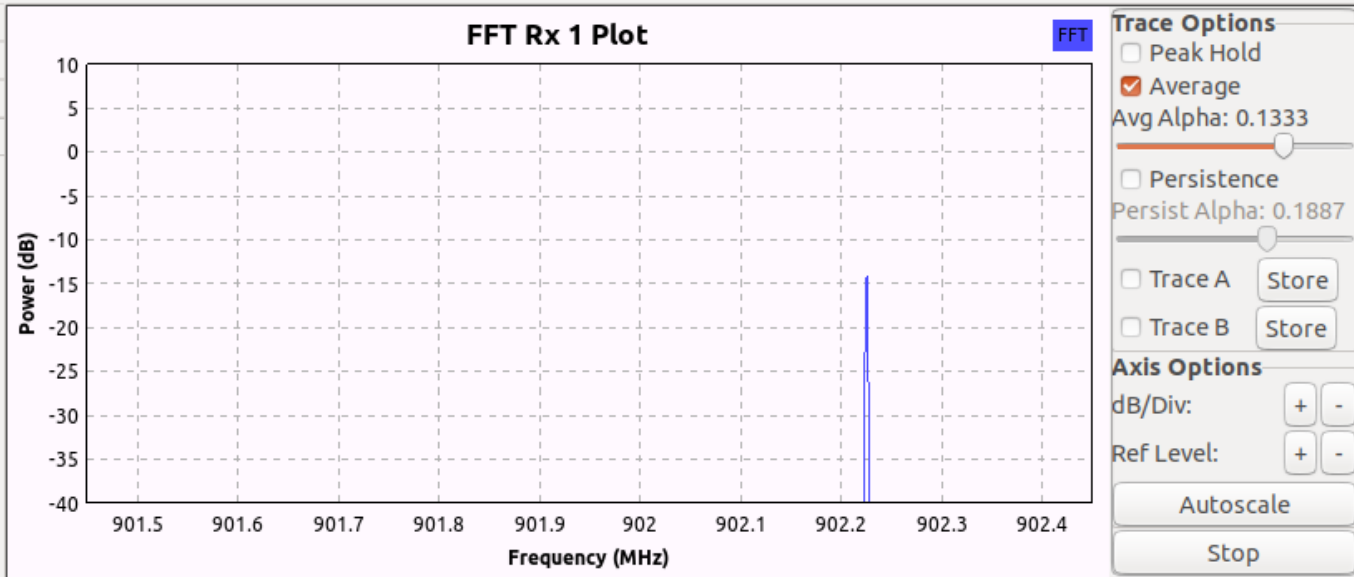
Mod. index: 300.0m

- North
- Texas
- NTMS**
- Microwave
- Society

Coarse Tuning: 0.0 Fine Tuning: 0.0

VFO: 902.1M RX Frequency: 902,100,000 Volume: 5.0 TX-RX: Receiving

- FFT
- Waterfall
- Gain Settings
- Wide FFT



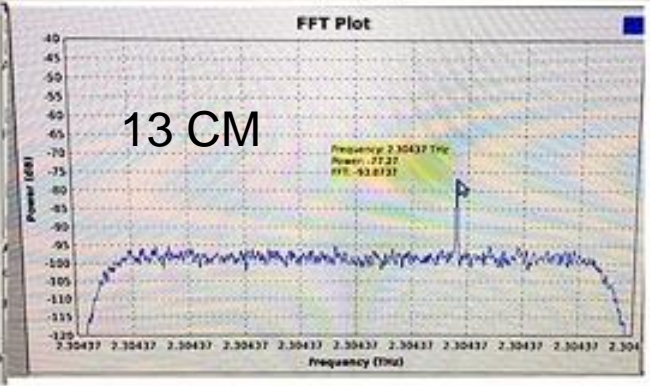
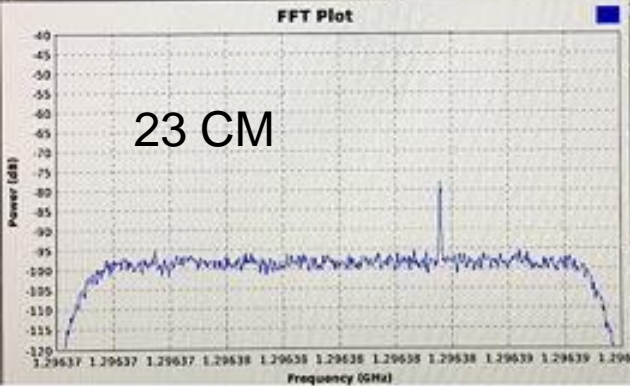
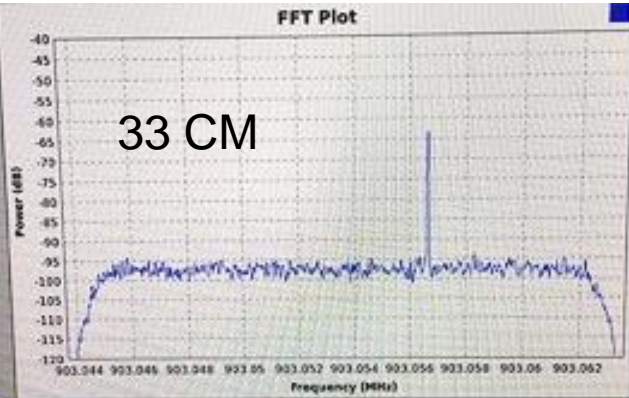
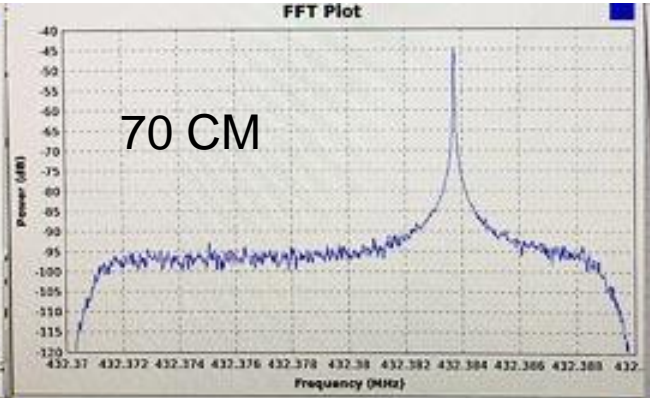
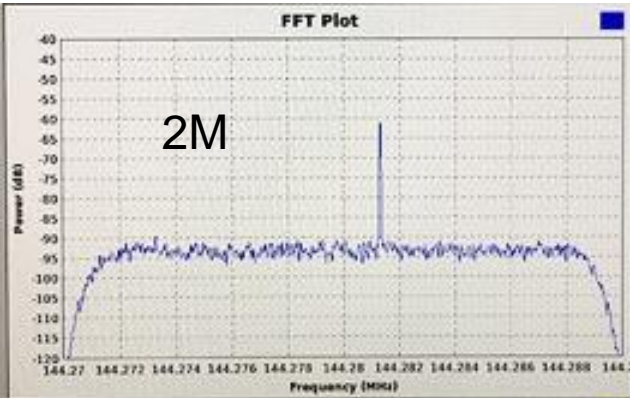
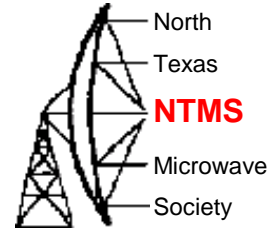
W5HN

orth
xas
TMS
crowave
ociety

AGC:

Medium ▾

W5HN Beacons on August 5, 2018



Noise Floor ~ -95 dB



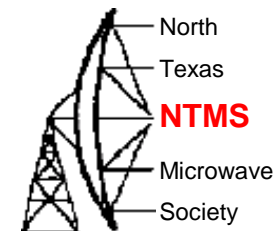
SMA Connector

USB Connector

Dongle Example

Note: SMA connector with a Bias Tee option for preamp power.

General Comments



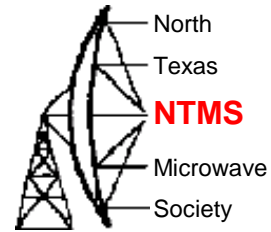
For best performance of GNU Radio you need a good computer. I have installed GNU Radio on Raspberry Pi 3 and it functions but it does not work well. I have a Intel 7 Motherboard with 16 GB of memory.

GNU Radio install and runs best on linux. It is difficult to get the package installed. Again a good computer speeds up this process.

A saved flow chart in GNU Radio produces a Python program that you can execute and run directly.

If you find this topic interesting join us at the NTMS meetings and At Microwave Update 2019.

Links for more info:



- <http://sdr.osmocom.org>
- <http://www.hermeslite.com>
- <http://www.rtl-sdr.com/big-list-rtl-sdr-supported-software/>
- <https://www.gnuradio.org>