# VHF - UHF - MICROWAVE SDR TRANSCEIVER ON THE AIR

John Petrich, W7FU

ARRL NW Division Convention

SEA-PAC 2017

June 3, 2017

# Presentation Goals

Discover what is “under the hood” of a VHF SDR (or any SDR)

Learn “how to” build a practical VHF SDR - with photos

Address the question: “Do SDR’s have a place in VHF communications?”

# VHF - UHF SDR Home Station

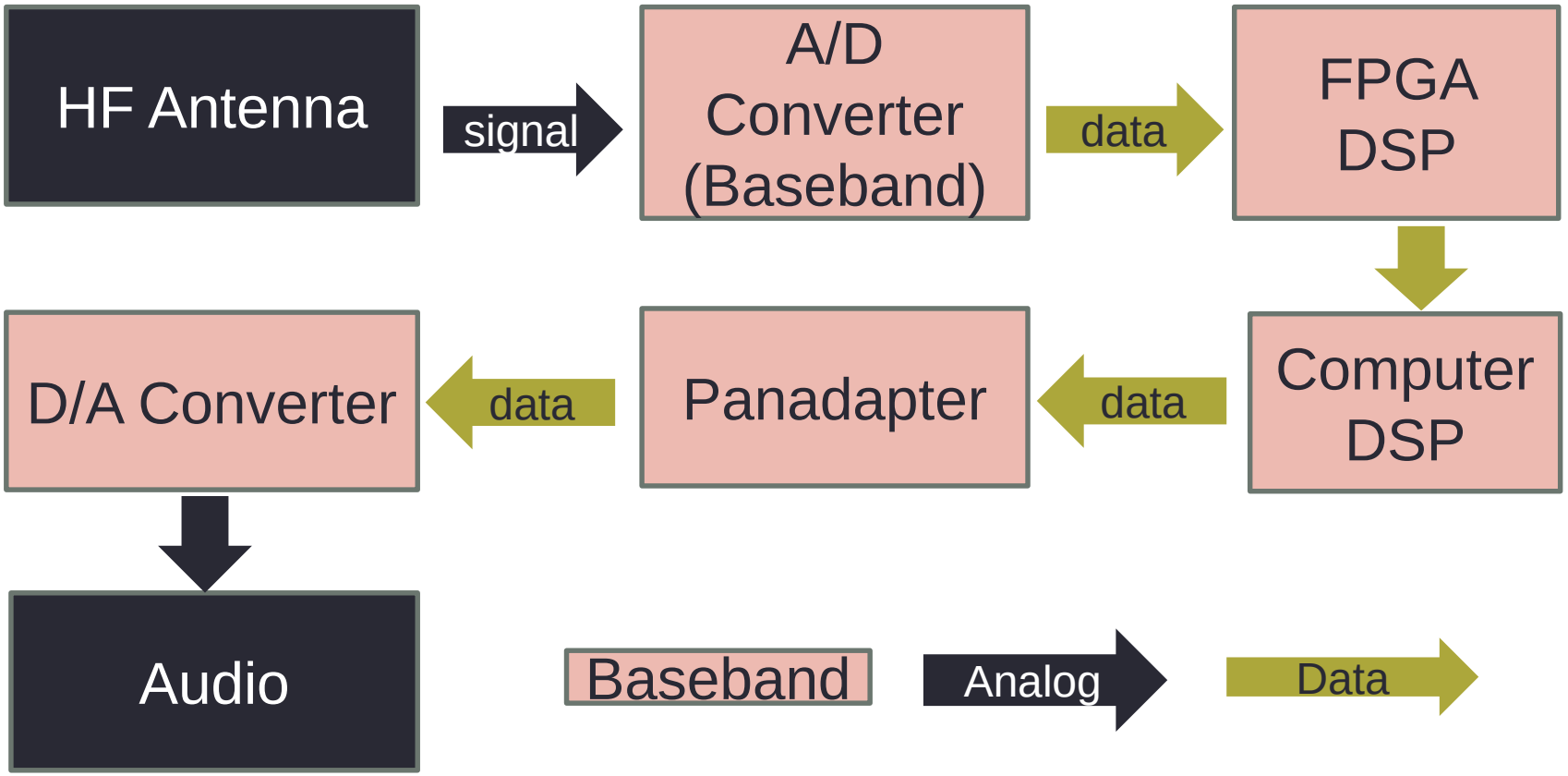
# Microwave SDR Rover Station

# Dirty Little Secret

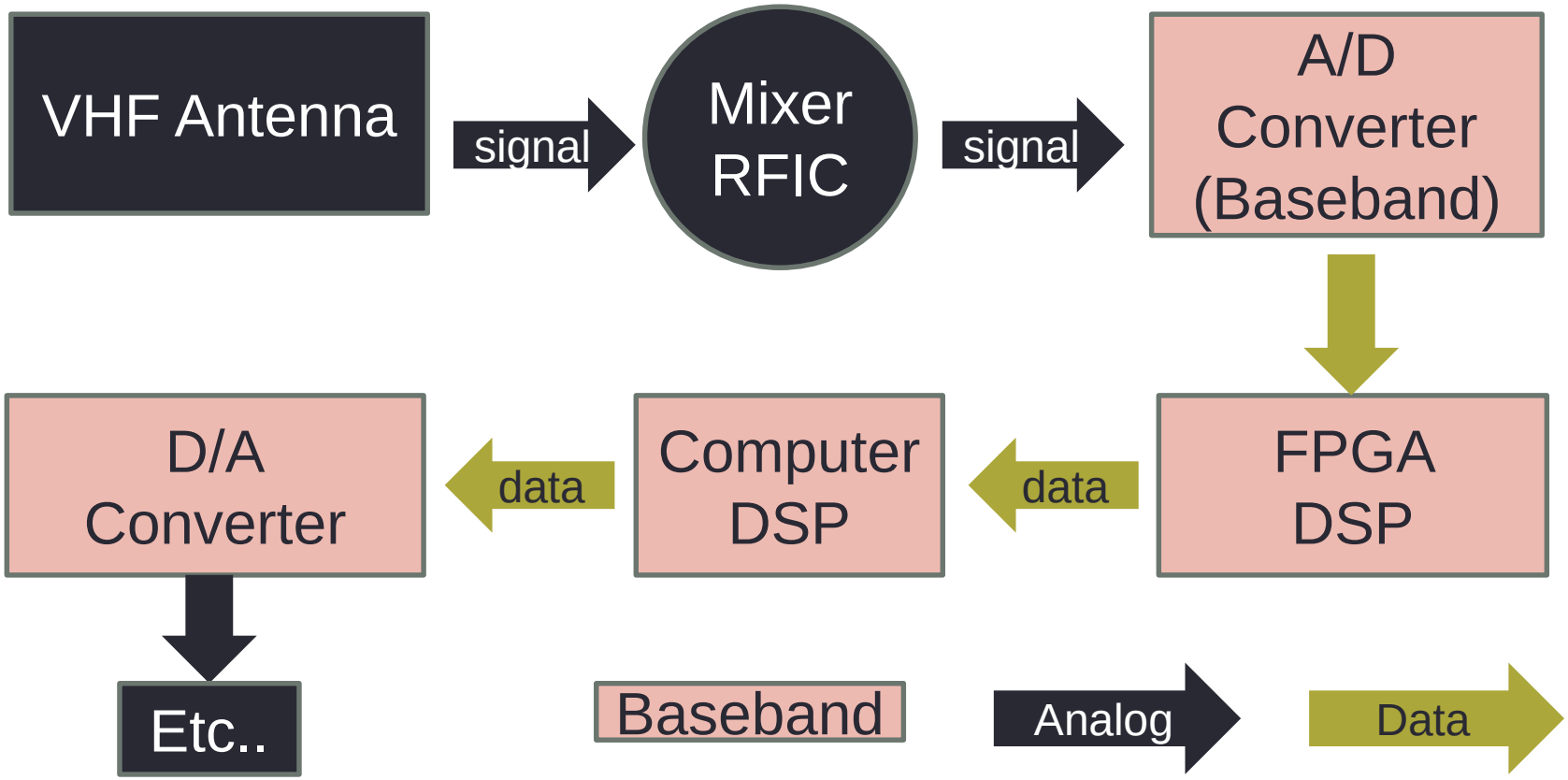
"These same principles apply to any SDR station HF to Microwave"

1. All SDRs need an RF interface to the amplifiers and antenna
2. All SDRs need peripheral devices to control the radio and station

# Direct Sampling HF SDR



# Direct Conversion VHF SDR



# What's under the hood?

VHF / Microwave any-mode SDR Transceiver

Direct conversion between RF and digital baseband

Single board solution with open source DSP software

# SDR Description

## Hardware

Ettus Research B210 SDR dual transceiver

- single board solution (6” x 4”) or (3.25” x 2”)
- State of the art RF & baseband performance
- TX RF output > +5 dBm, RX ~2+ dB NF

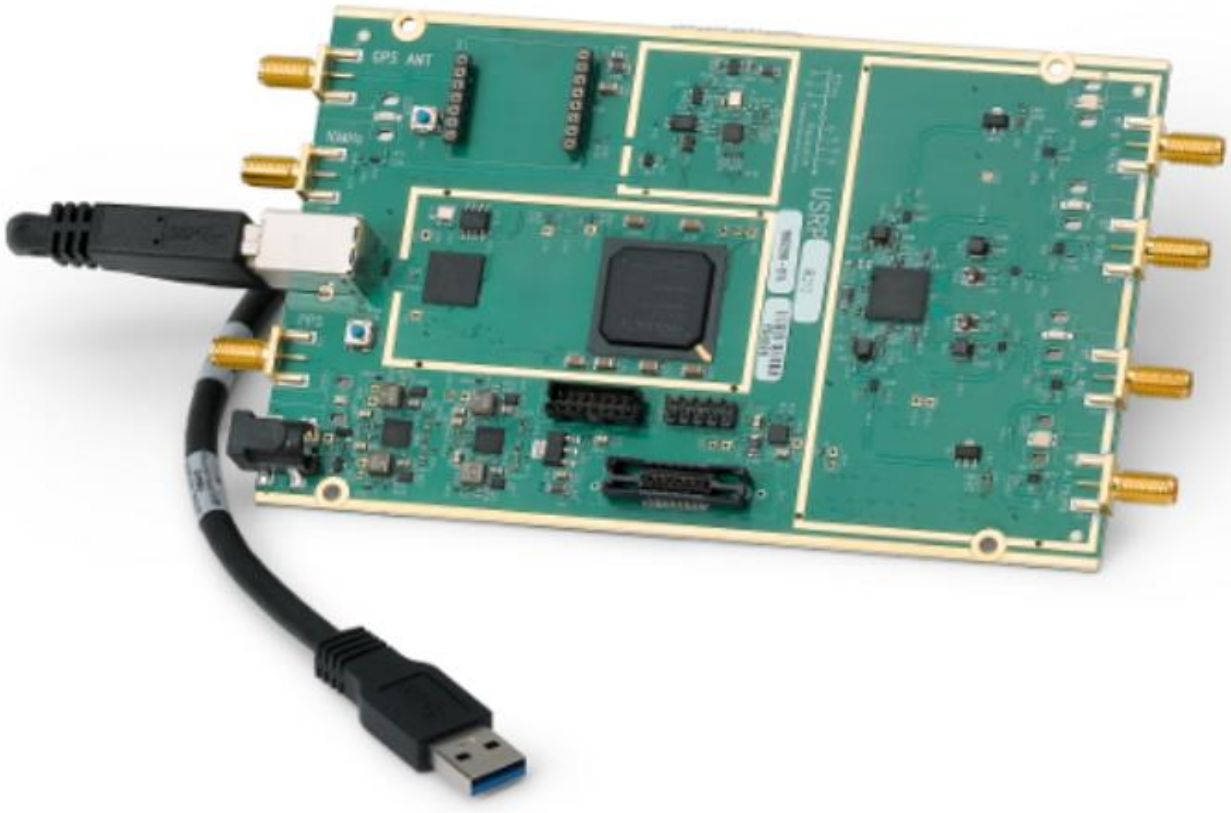
## Software DSP

GNU Radio open source software DSP library

- Linux, Windows OS platform
- Graphical DSP authoring

# Advanced SDR Hardware

## Ettus USRP B210 SDR Dual Transceiver



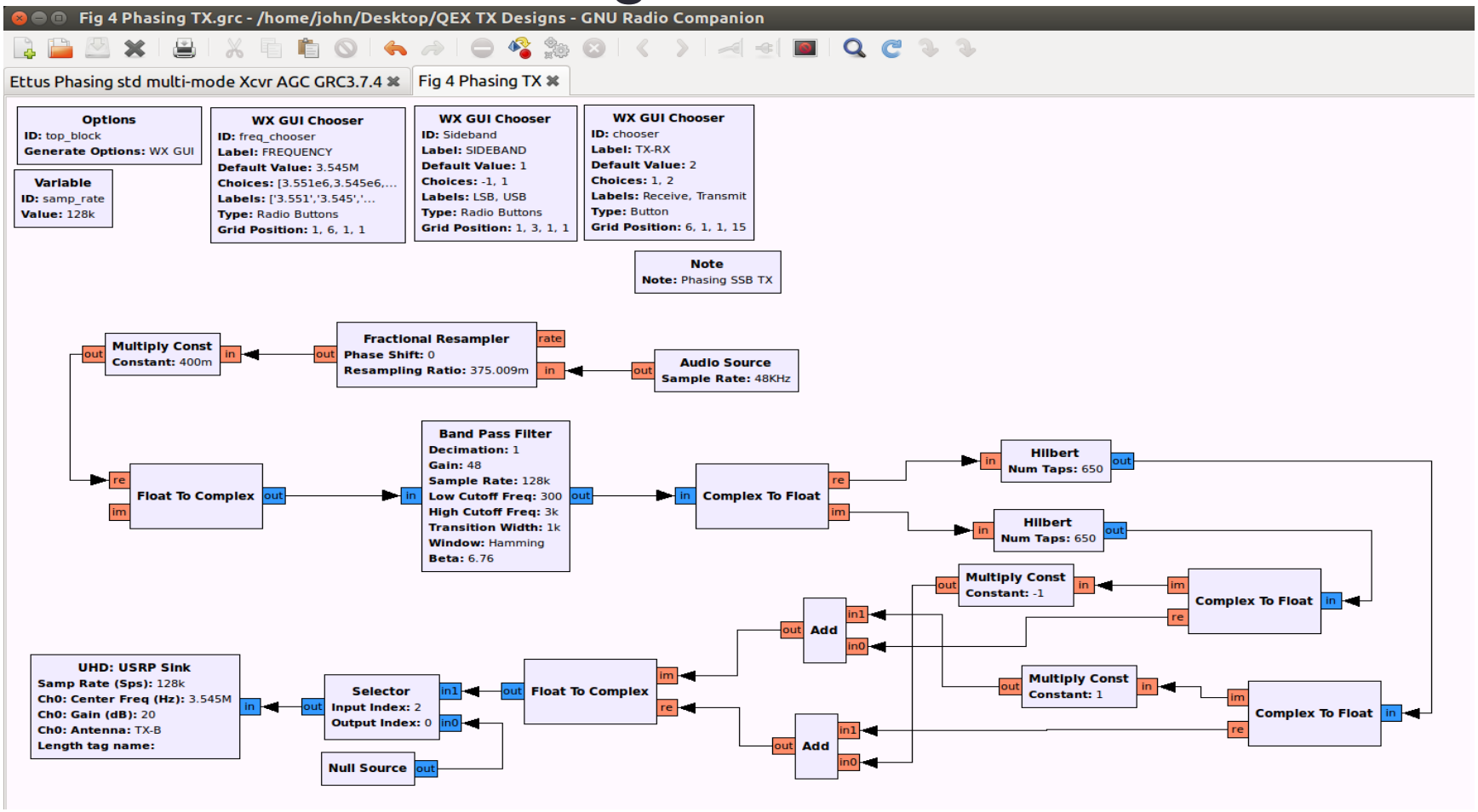
# ‘Advanced’ DSP Software

GNU Radio

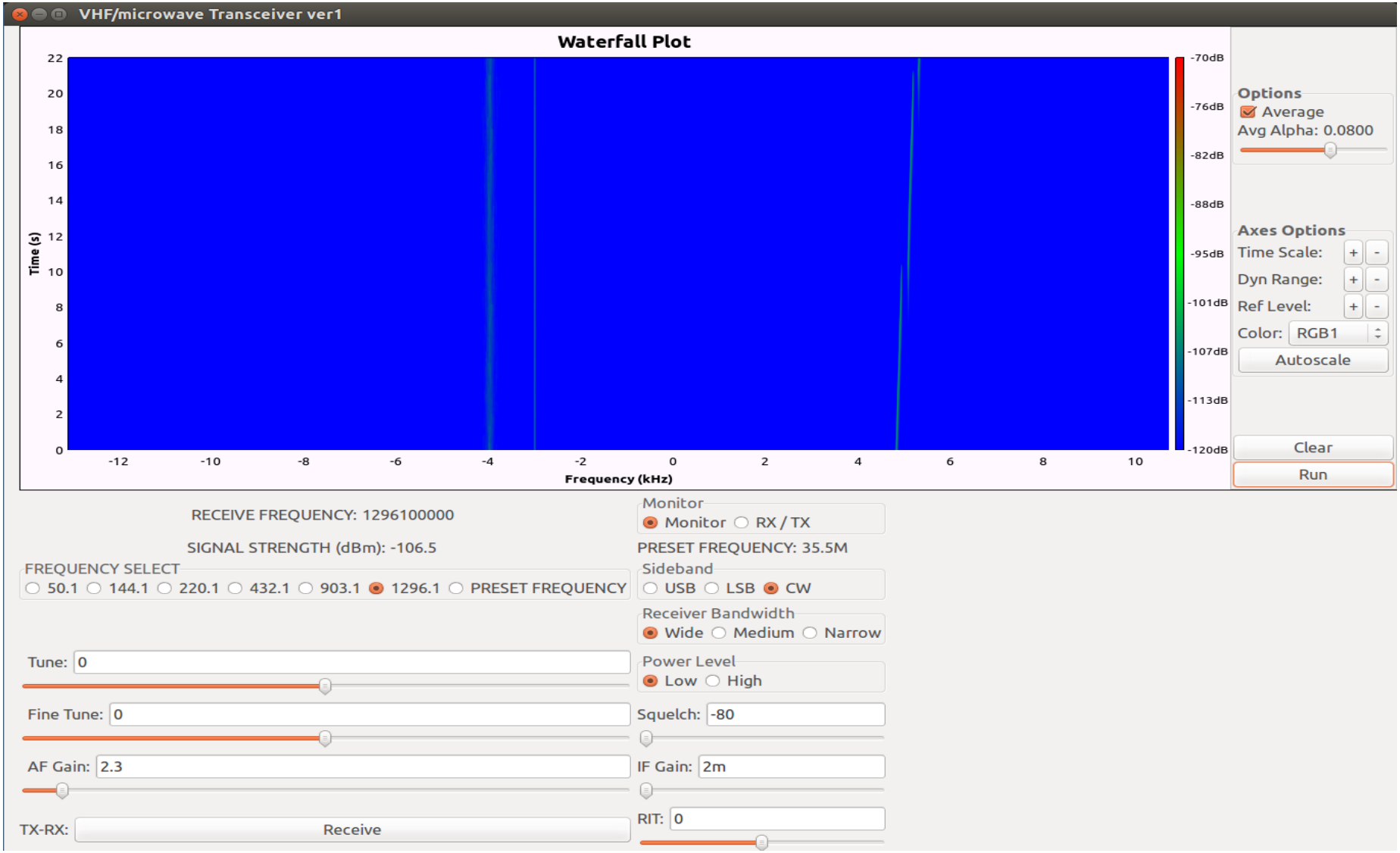
- Open source DSP library: (Linux, Windows, OSX, OS)
- Graphical DSP authoring simplified
- Optimized for ‘real time’ signal processing (VOLK, C++ API)
- Supports transmit and receive DSP

# GNU Radio DSP Flow Graph

## SSB Phasing Transmitter DSP



# GNU Radio DSP GUI

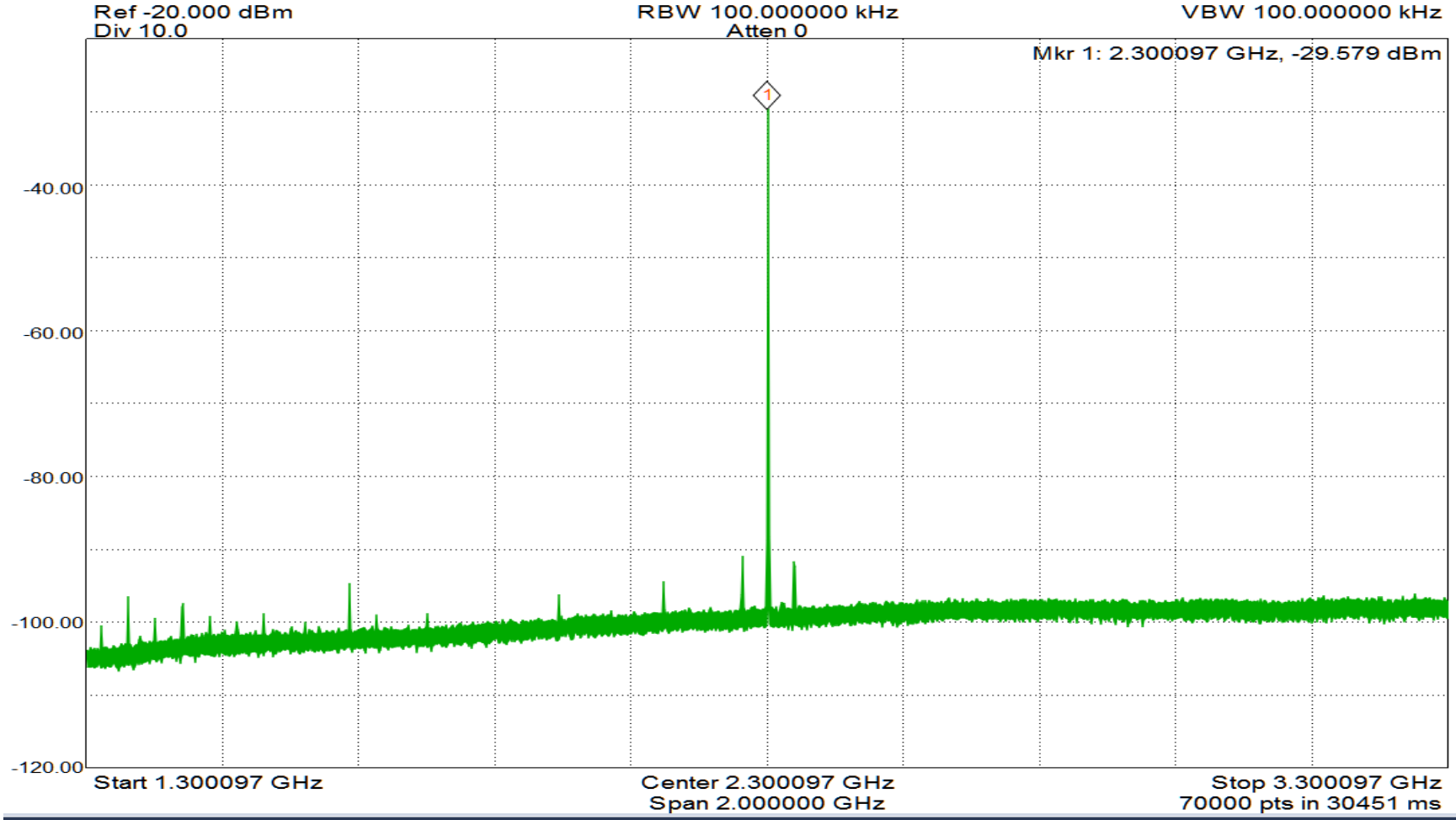


# Performance Measures

Transmitter Spurious Output and Harmonics

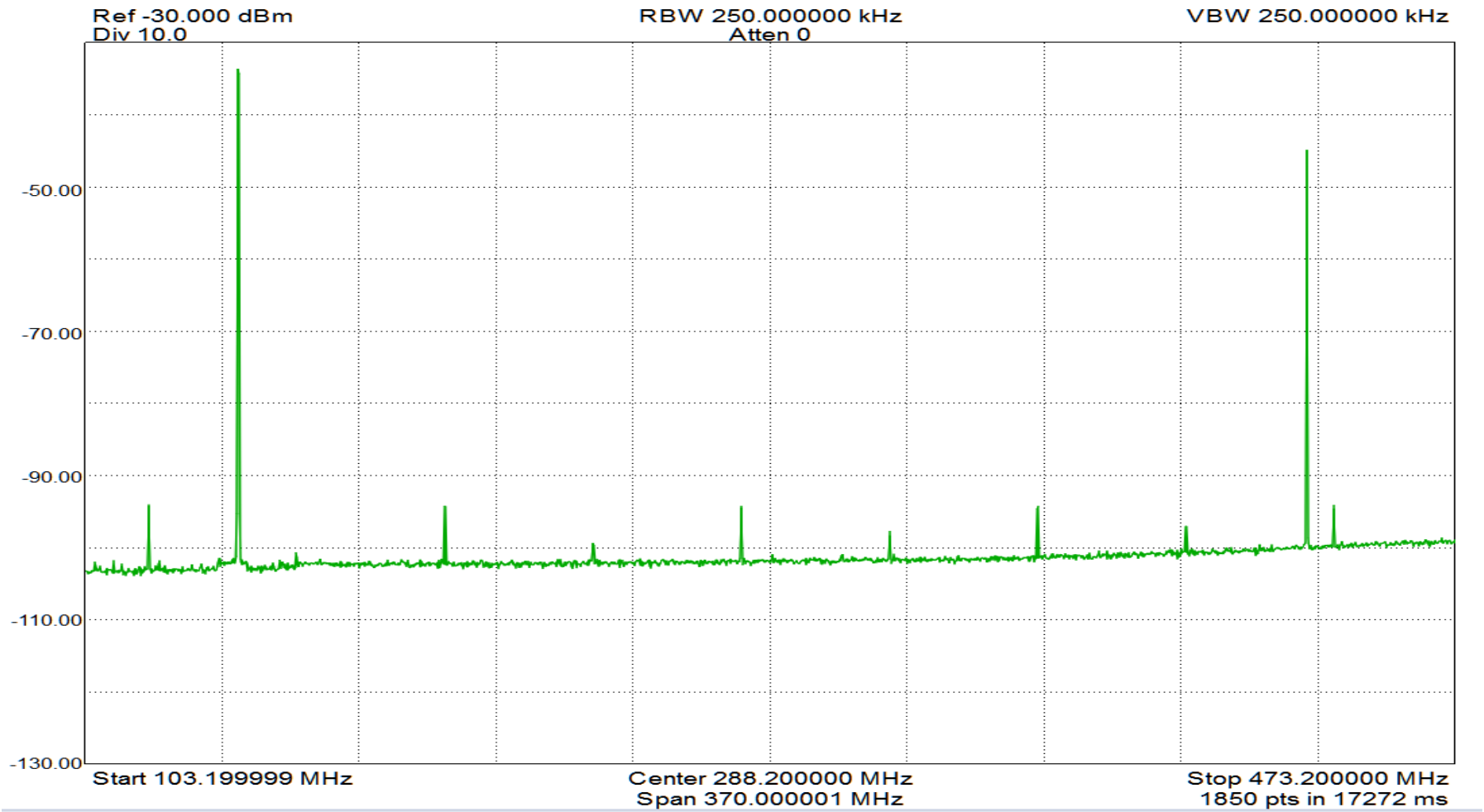
# Microwave Spectral Purity

## Wideband Transmit Spectrum @ 2.3 GHz



# VHF Harmonic Analysis

## Harmonic Analysis @ 144 MHz (typical)



# “How to”: VHF – UHF - Microwave SDR

- What parts are involved?
- How it is done?
- What does a VHF to microwave SDR actually look like?

# VHF/Microwave SDR Station

Conceptual model in four parts:

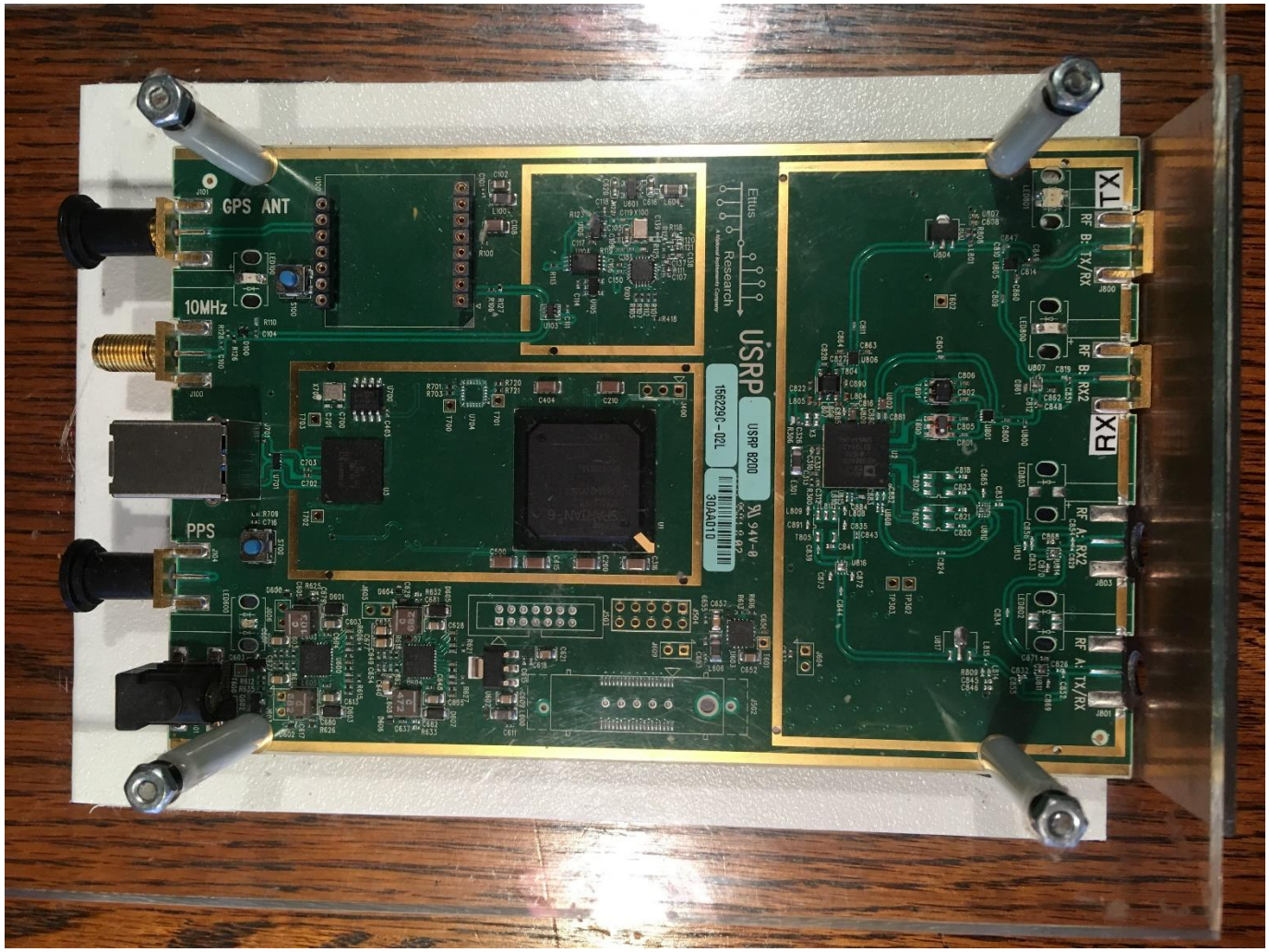
1) Broadband, direct conversion, Transceiver

2) Broadband RF Interface

3) Band specific Power Amplifiers, antennas

4) SDR Peripherals: transceiver system control

# SDR Transceiver



# SDR RF ‘Interface’

The RF Interface links the SDR with the rest of the RF system – antennas, amplifiers

- Receiver input protection relay with termination, RFI filter for FM Broadcast
- Low level transmit amplifier, T/R relay

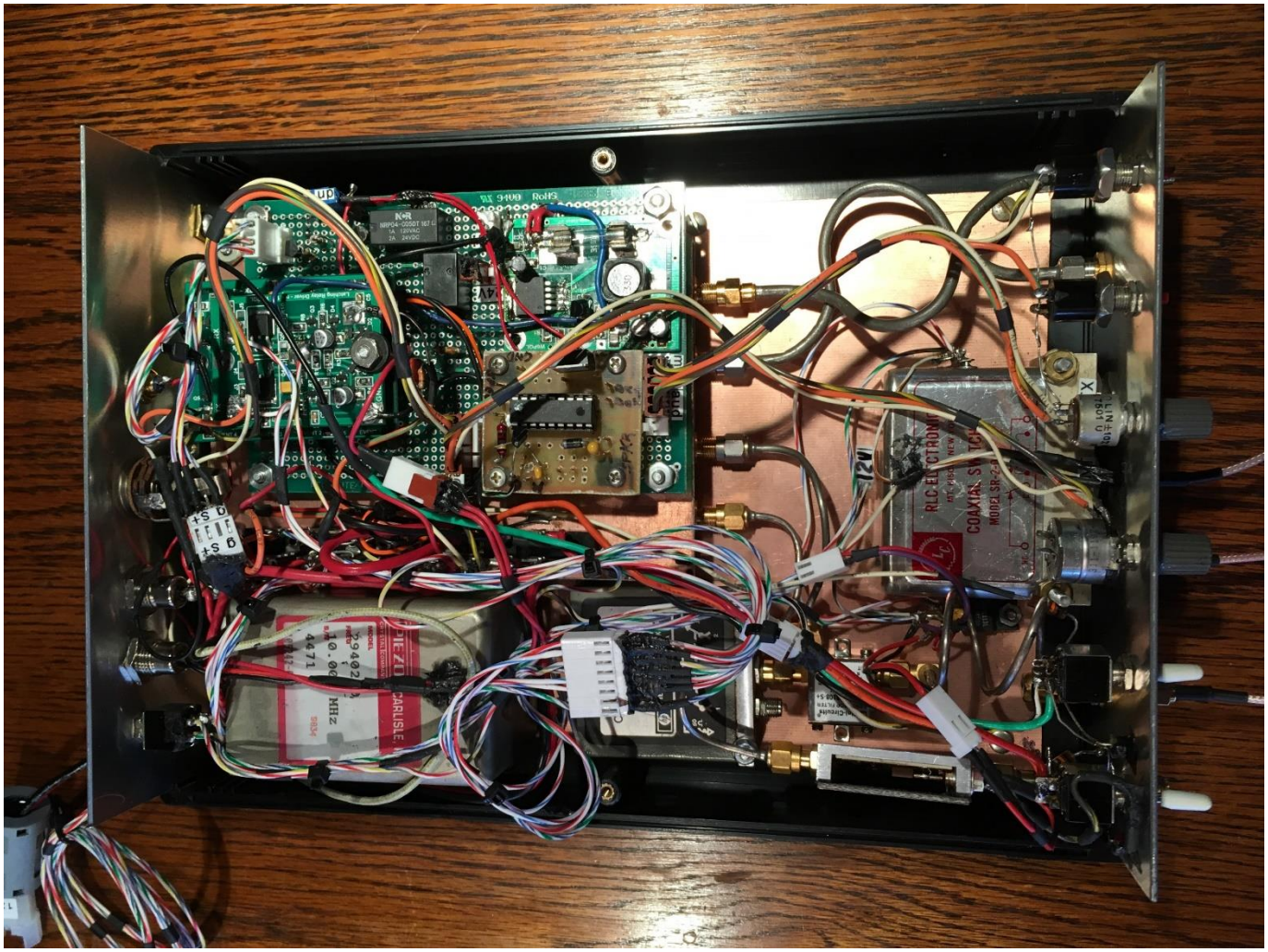
# SDR RF Interface

# SDR ‘Peripherals’

The SDR Peripherals link all the SDR transceiver and rig control functions:

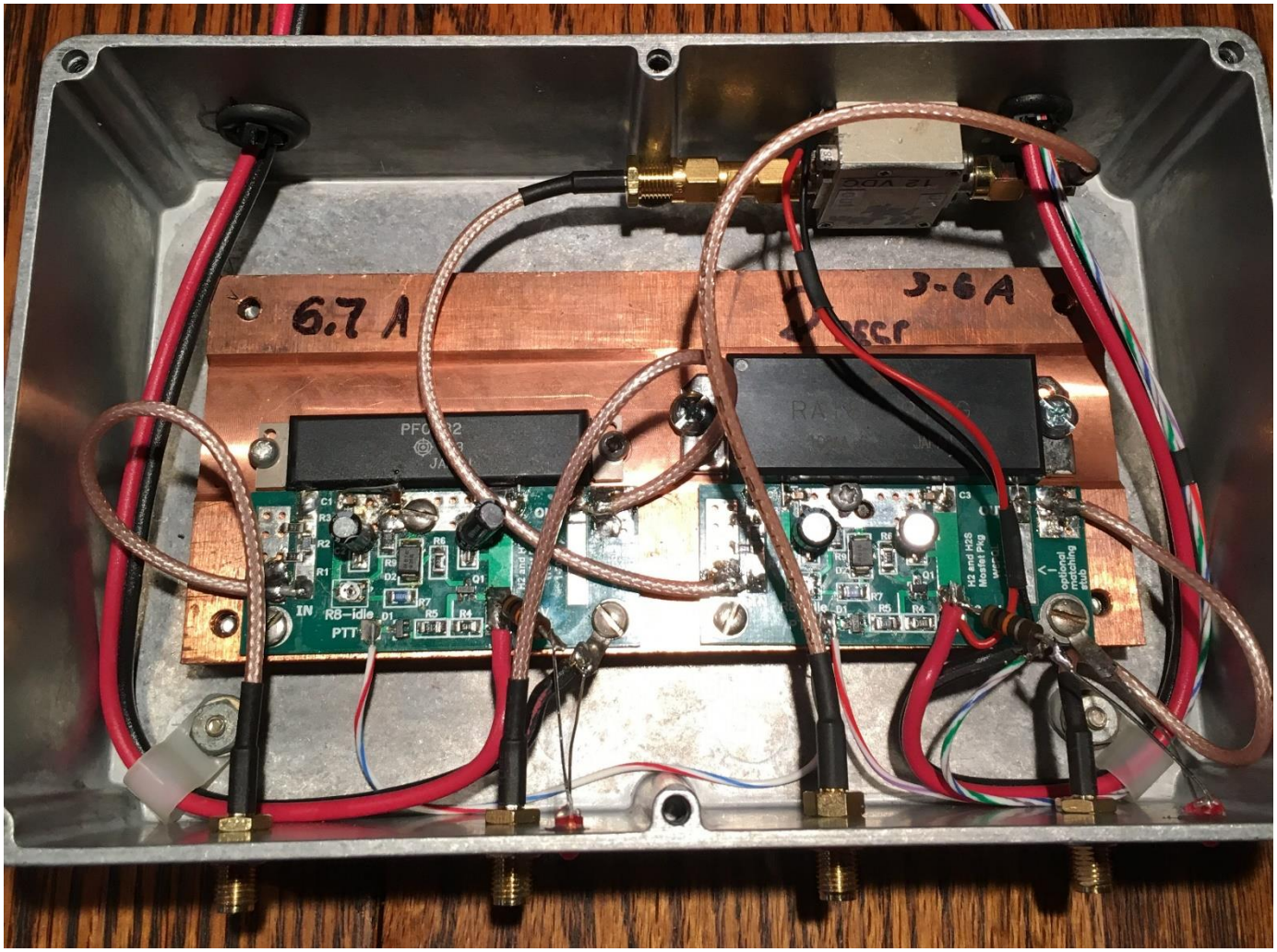
- OCXO
- Keying circuits
- Memory keyer
- PTT and amplifier control
- T/R relay– sequencer
- DC power distribution system

# SDR Peripherals

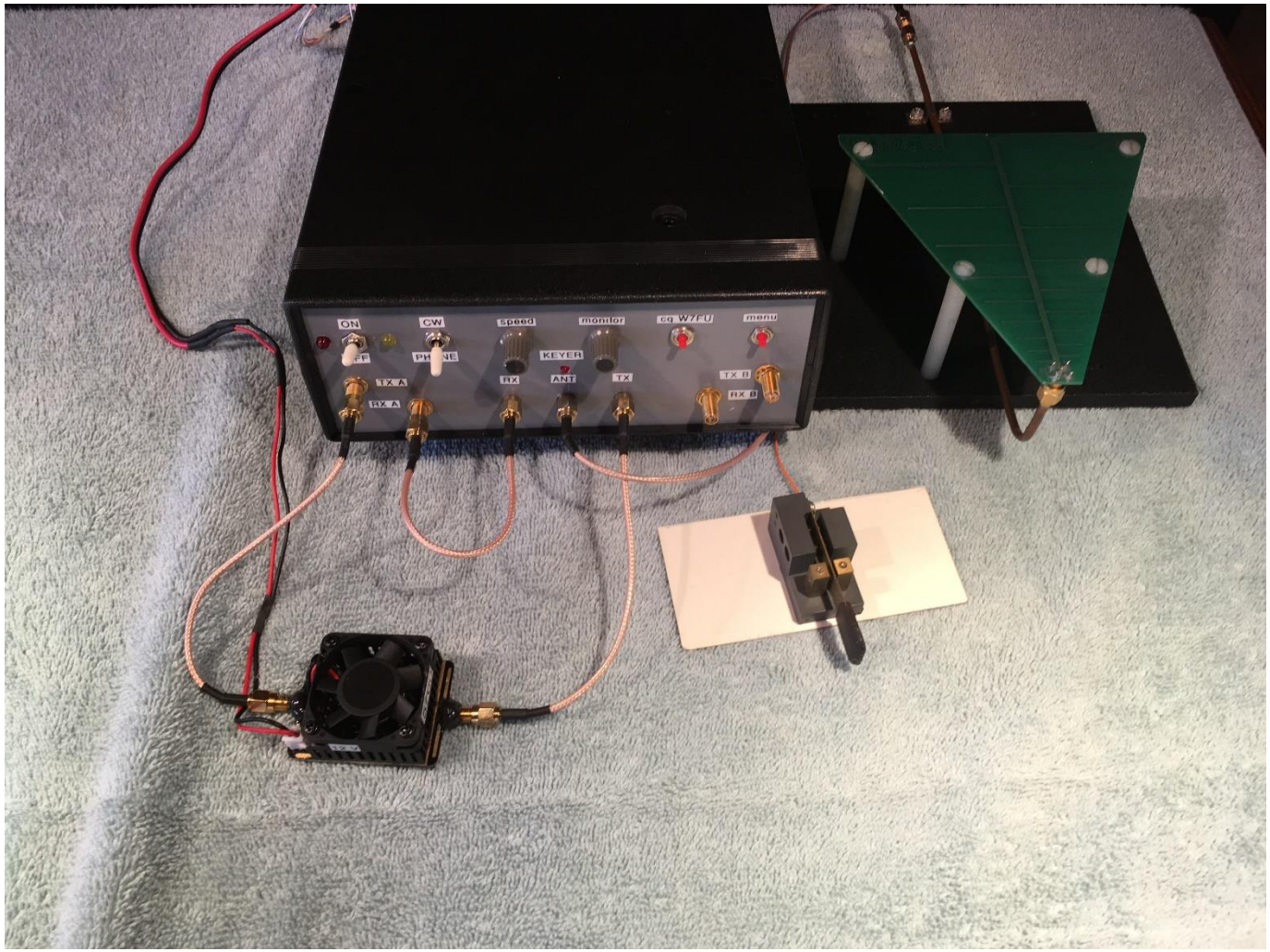


# Band Specific Power Amplifiers

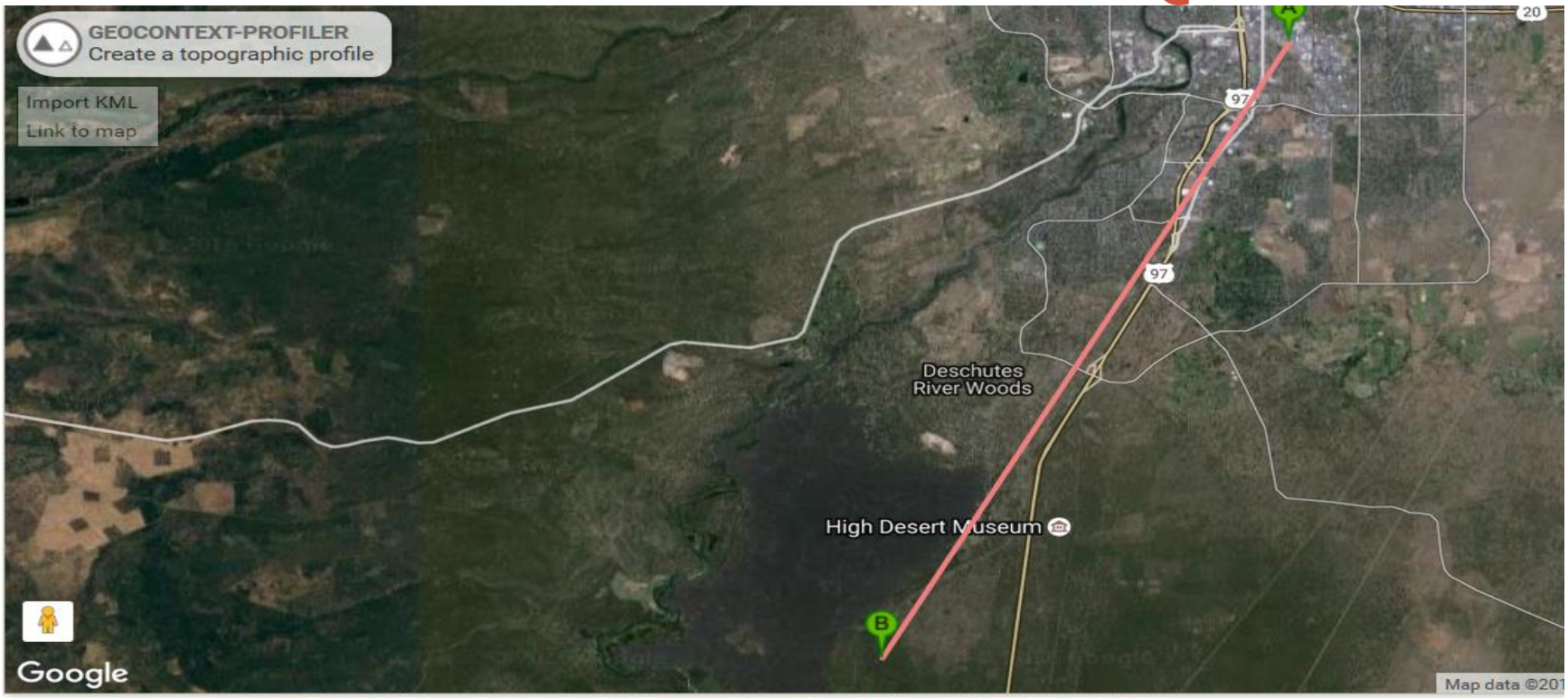
# Band Specific Power Amplifiers



# All put together: Microwave SDR Rover Station



# Bend, OR - Rover QSO




Zoom: 12 Counter markers: 2 Status: OK Azimuth: 208° Mouse px: 711px, 161px Lat./Lon.: 44°01'00.4"N 121°18'00.0"W
Center point: 43.99698941430785, -121.3163610137695 Center point location: ...


**Help**

How to make a topographic profile?

1. Reset
2. Find your area of interest on the map
3. Select the cursor min. 2 points (max. 300)
4. Ready – site profile will be generated in seconds
   a. Embed the chart on your site
   b. Copy and save the link to the chart
   c. Add the route to the map

Program Geocontext Profiler allows you to make for

# SDR: The New Normal?

- Near ideal signal processing ability: ‘digital determinism’ – high performance
- Supports all available amateur radio modulations and all VHF/UHF/lower Microwave frequencies --- wide design flexibility
- Integrates well with existing RF systems – simplifies system design
- Size and weight attractive compared to analog counterparts

# Typical Analog Ham VHF System


- High performance HF transceiver
- Outboard Linear Up-converter(s) per band
- Custom per band RF ‘interface’

# Advanced SDR Ham VHF Radio System


- High performance direct conversion SDR broadband transceiver

- Custom per band RF ‘interface’

# In Conclusion

I want to thank Barry Hansen, K7BWH,
Phil Horkin, AG7GY, Mariana Varotto, WA7EE
For their generous assistance with this project

Thanks also to the ARRL for the opportunity to present this project

# Down the Slippery Slope…

More information about DSP and SDR

www.w7fu.com

# Additional Questions ?

Hardware ?

Software ?

Other related topics ?