



VHF/UHF/MICROWAVE SDR TRANSCEIVER ON THE AIR

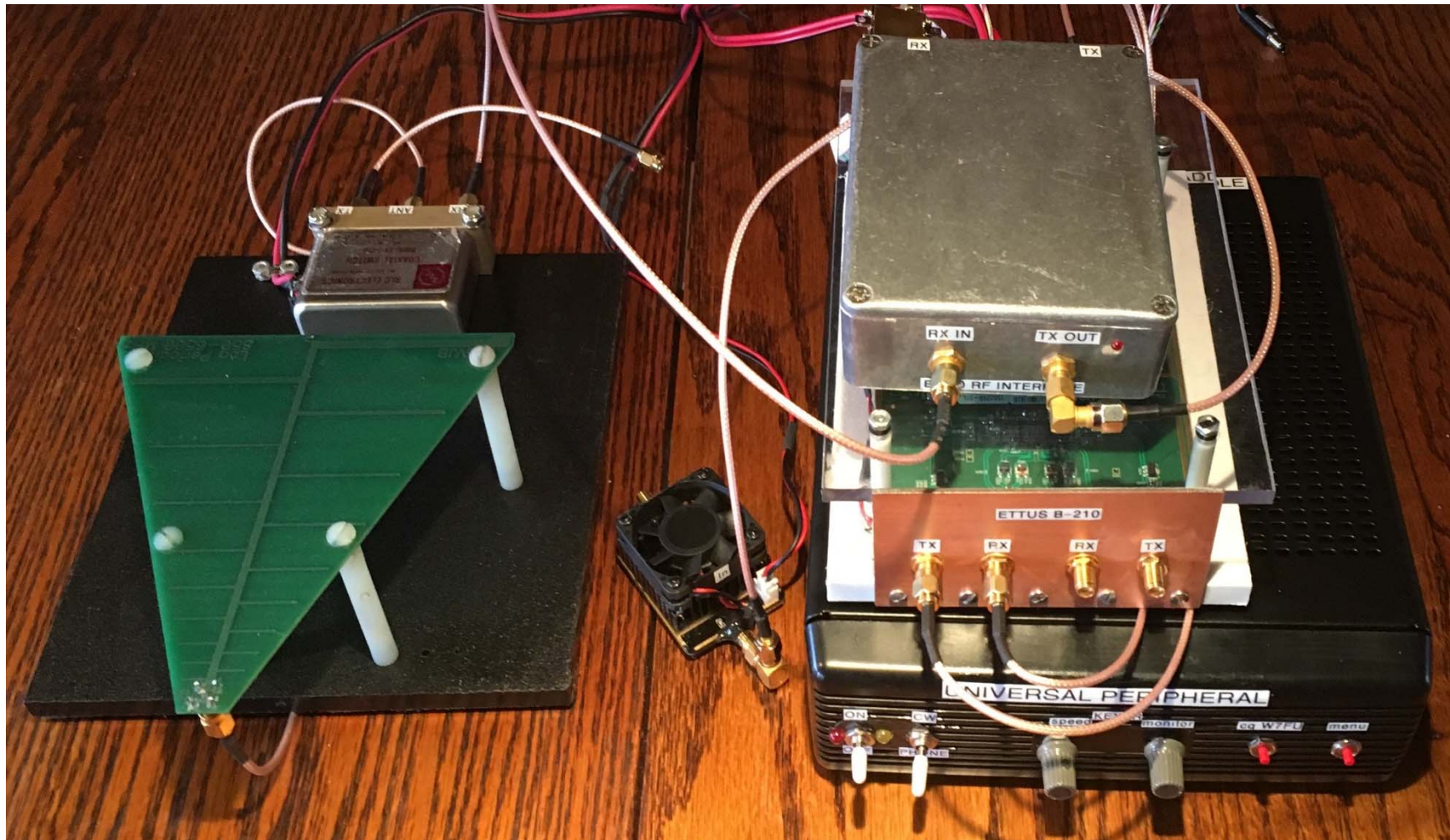
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PNWVHFS 2016 Conference

Bend, OR

October 8, 2016

Microwave SDR - rover station



Agenda

- Overview: the 'now' advanced communications technology available to us
- What is under the hood: VHF/microwave SDR (any SDR) – hardware and software
- Performance measures: spurs, phase noise
- How To: VHF/microwave SDR system with photos

Overview

- Advanced SDR technology has transformed radio communications systems design
- Modern DSP combined with state of the art analog signal processing permit exceptional frequency coverage, exceptional signal quality, and integrated packaging

Overview

- Same principle as your great modern HF transceiver - but more so.
- Not for every ham today, but on the ham radio horizon – e.g. AMSAT Phase 4 Satellite

What's under the hood?

VHF / Microwave multi-mode
SDR Transceiver

Direct conversion to RF from digital
baseband

Single board solution with open source
DSP software

SDR Description

Hardware

Ettus Research B210 SDR 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

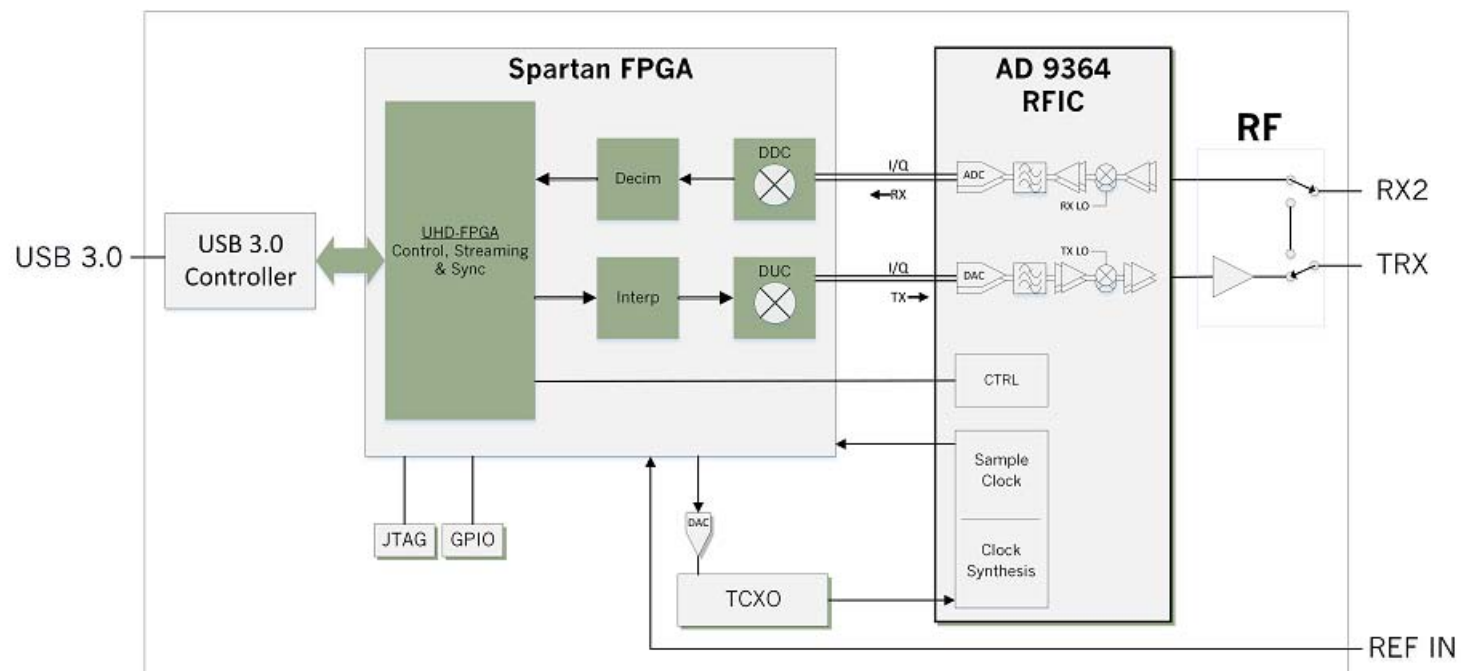
Advanced SDR Hardware

Ettus USRP B210 SDR Transceiver



Advanced SDR Hardware

Ettus USRP B200 SDR Transceiver

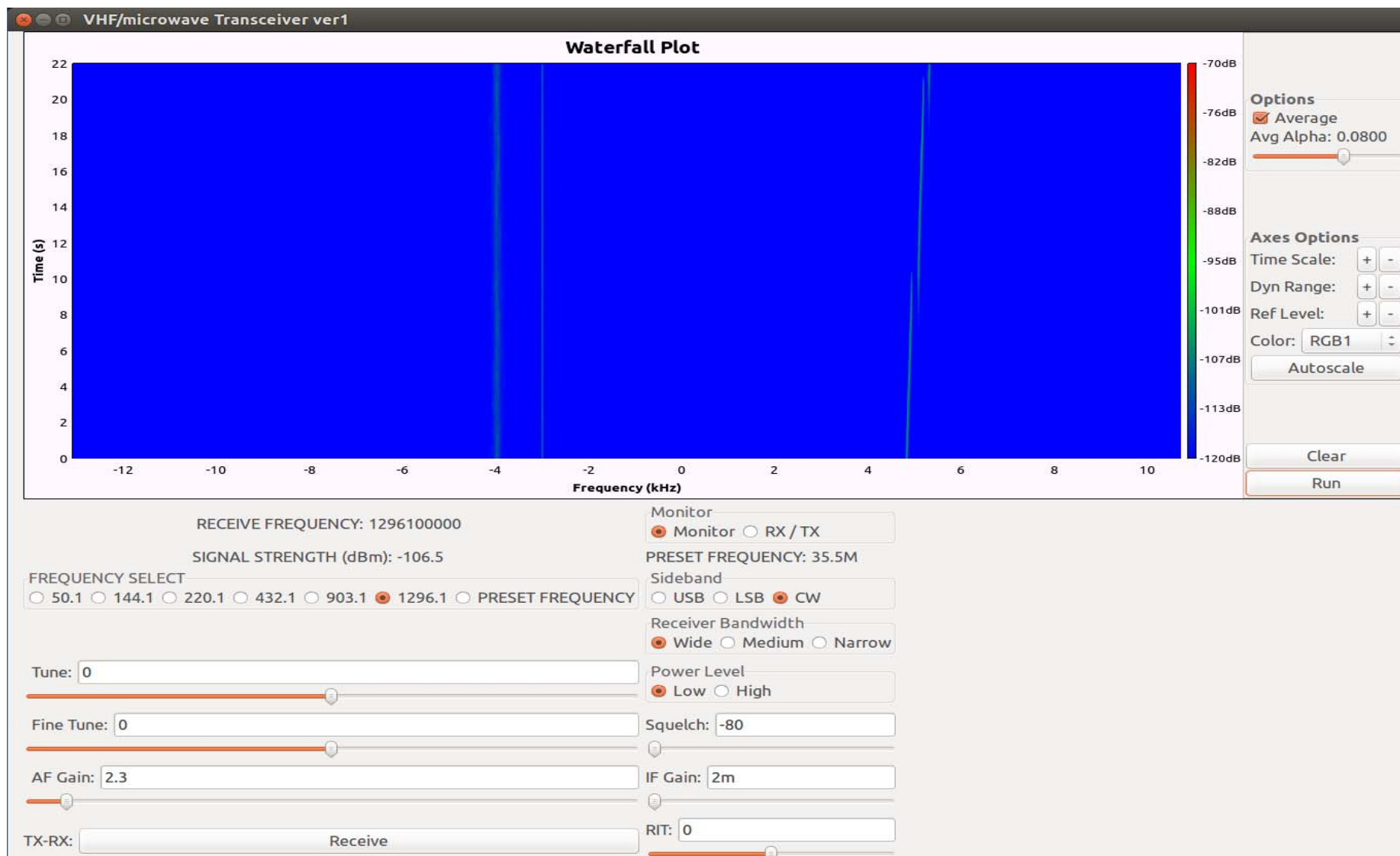


'Advanced' DSP Software

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 GUI



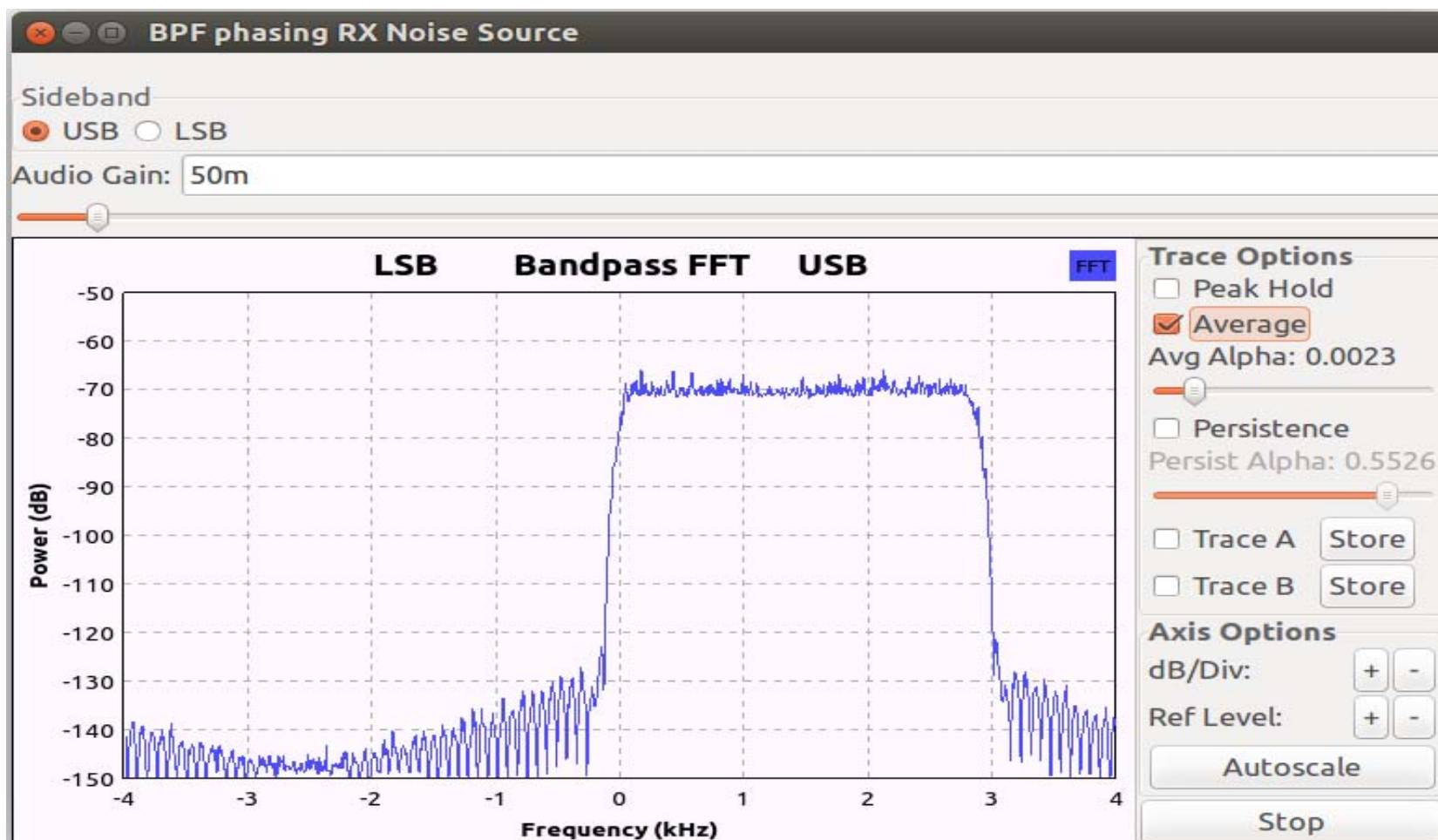
Performance Measures

Receiver Filter Bandwidth optimized for
UHF operation

Transmitter Spurious Output and Phase
Noise

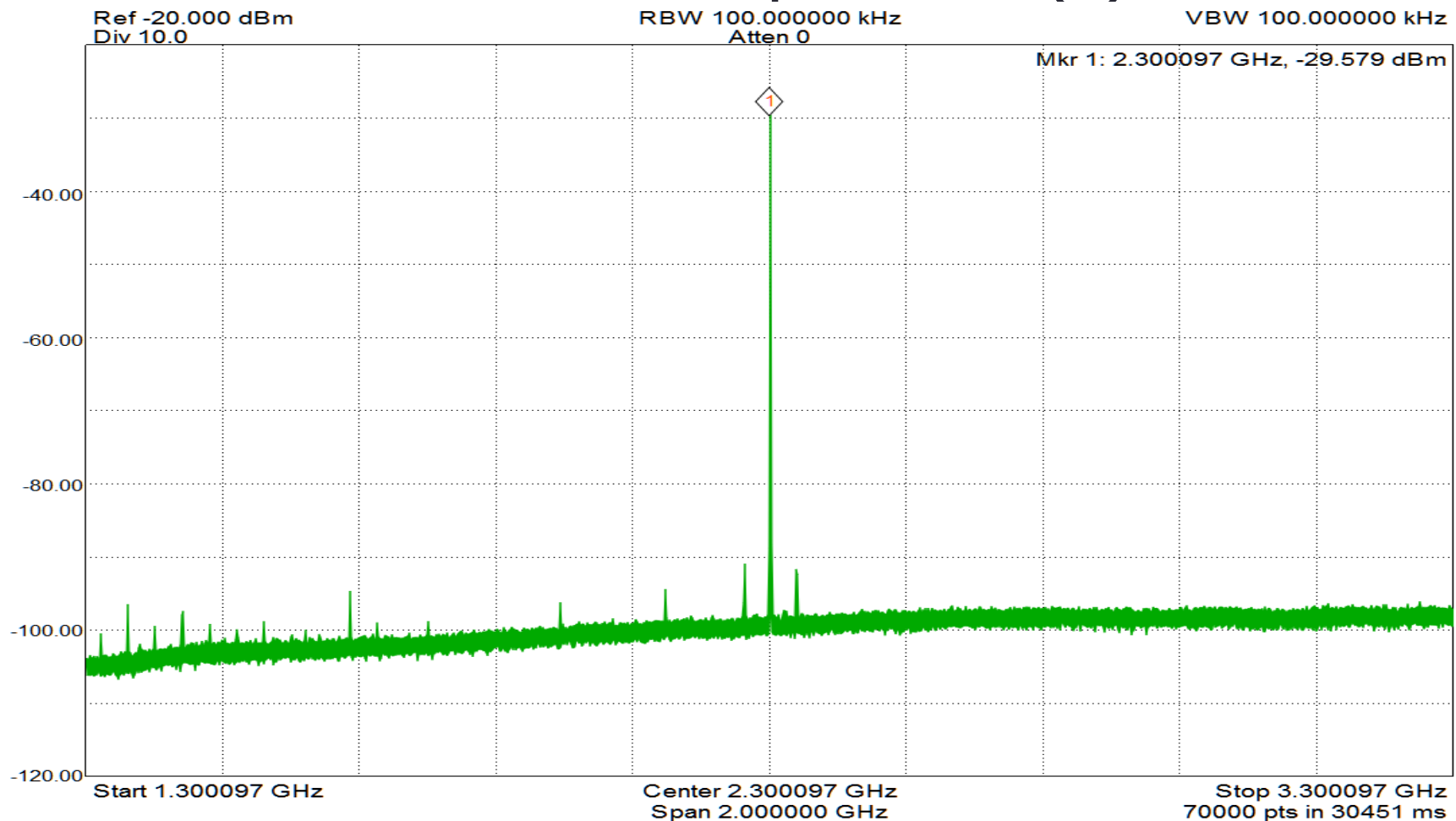
Receiver Bandwidth Spectrum

Receiver Bandwidth 3 kHz



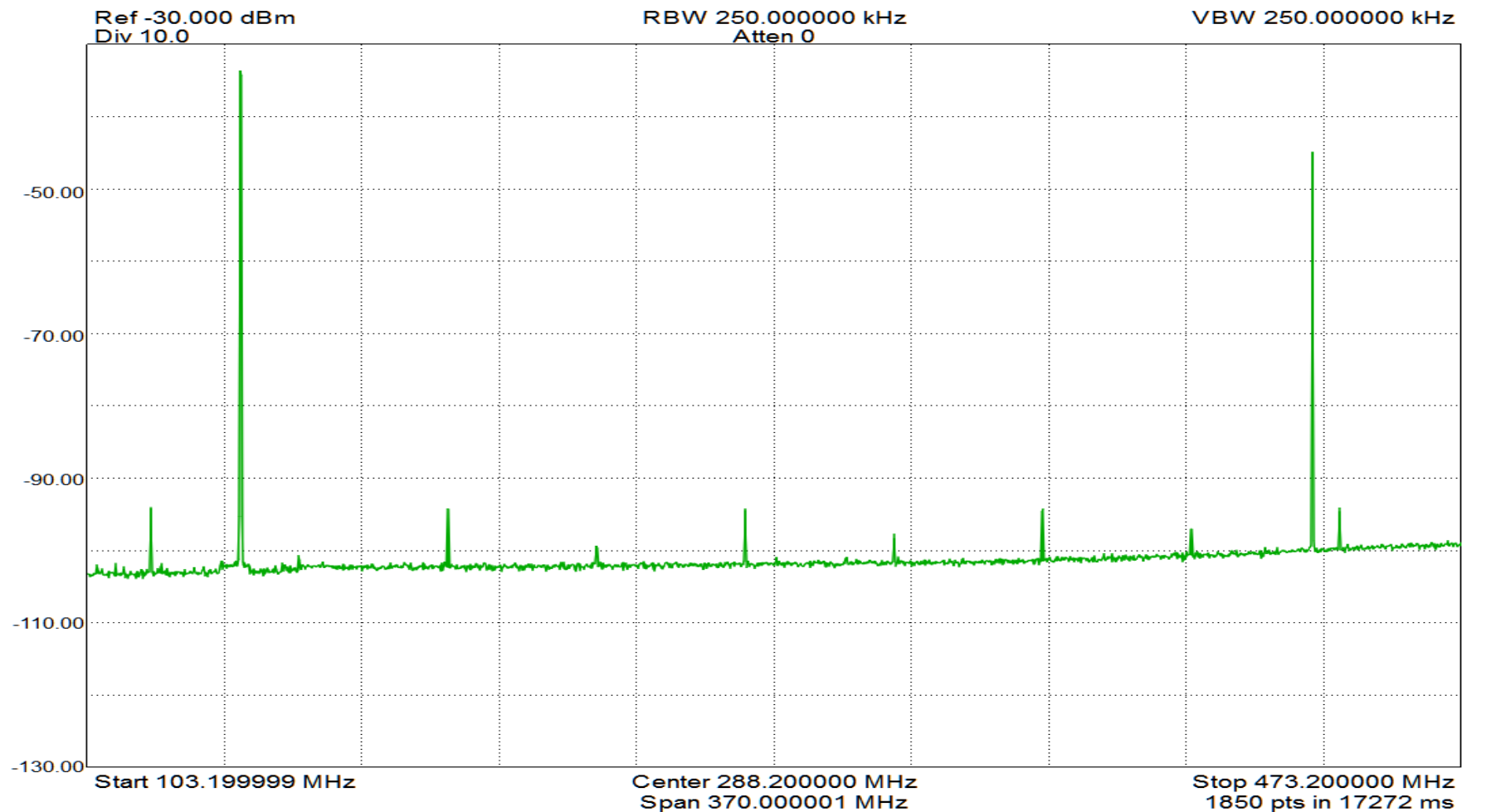
Microwave Spectral Purity

Wideband Transmit Spectrum @ 2.3 GHz



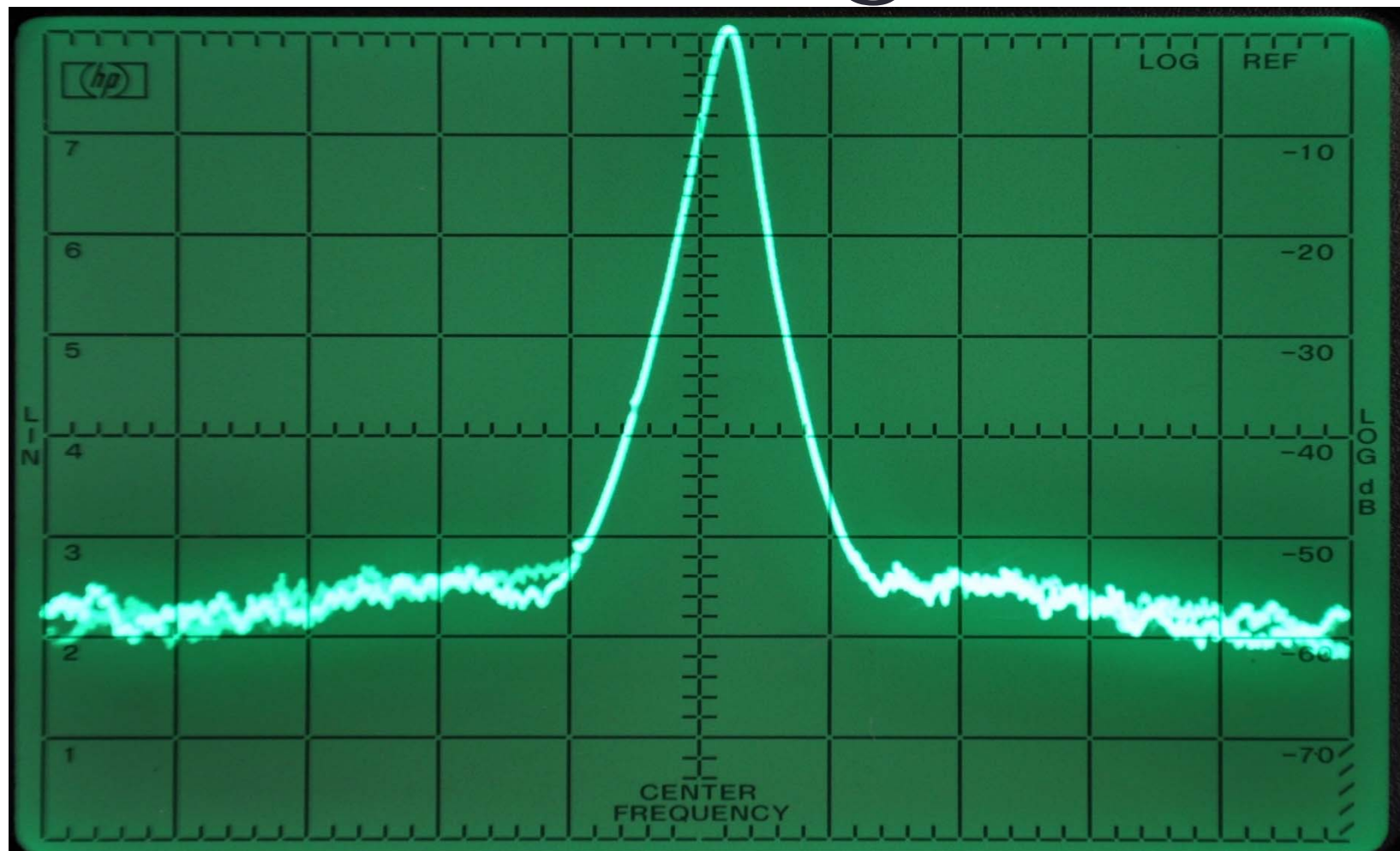
VHF Harmonic Analysis

Harmonic Analysis @ 144 MHz (typical)



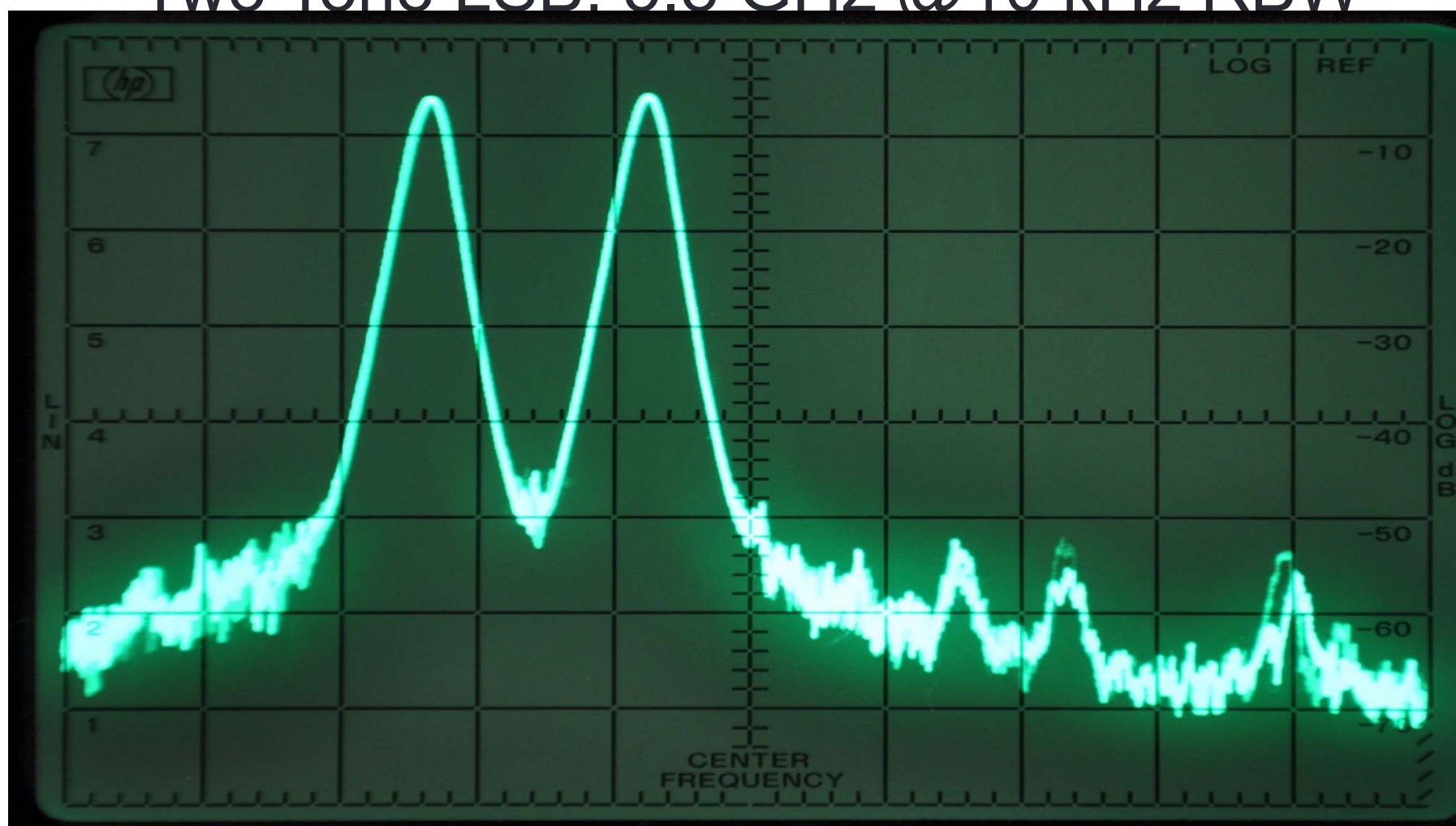
Microwave Phase Noise

Phase Noise: 5.8 GHz @10 kHz RBW



Microwave Transmit Linearity

Two Tone LSB: 5.8 GHz @10 kHz RBW



SDR: The New Normal?

- Near ideal signal processing ability: ‘digital determinism’
- Wide design flexibility – supports all existing available amateur radio bandwidths
- Integrates well with existing RF systems – simplifies system design
- Size and weight attractive compared to analog counterparts

How to: VHF/UHF/Microwave SDR

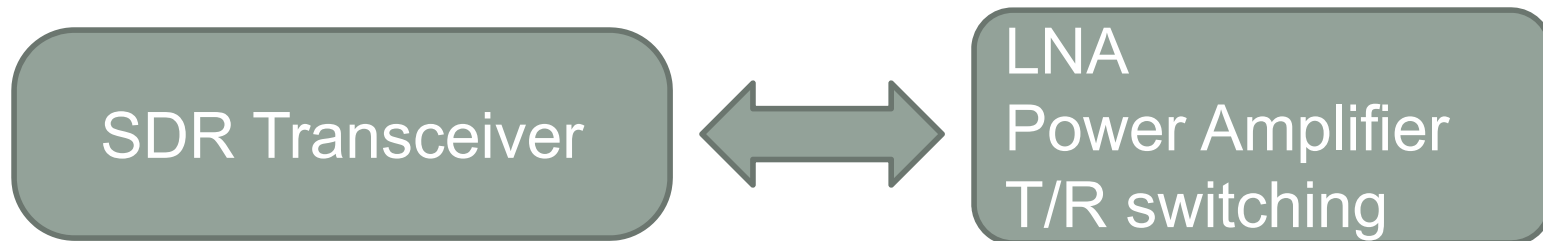
- How it is done?
- What is involved?
- What does a VHF/microwave SDR actually look like?

Typical Analog Ham VHF System



- High performance HF transceiver
- Outboard Linear Up-converter(s) per band
- Custom per band antenna 'interface'

Advanced SDR Ham VHF Radio System



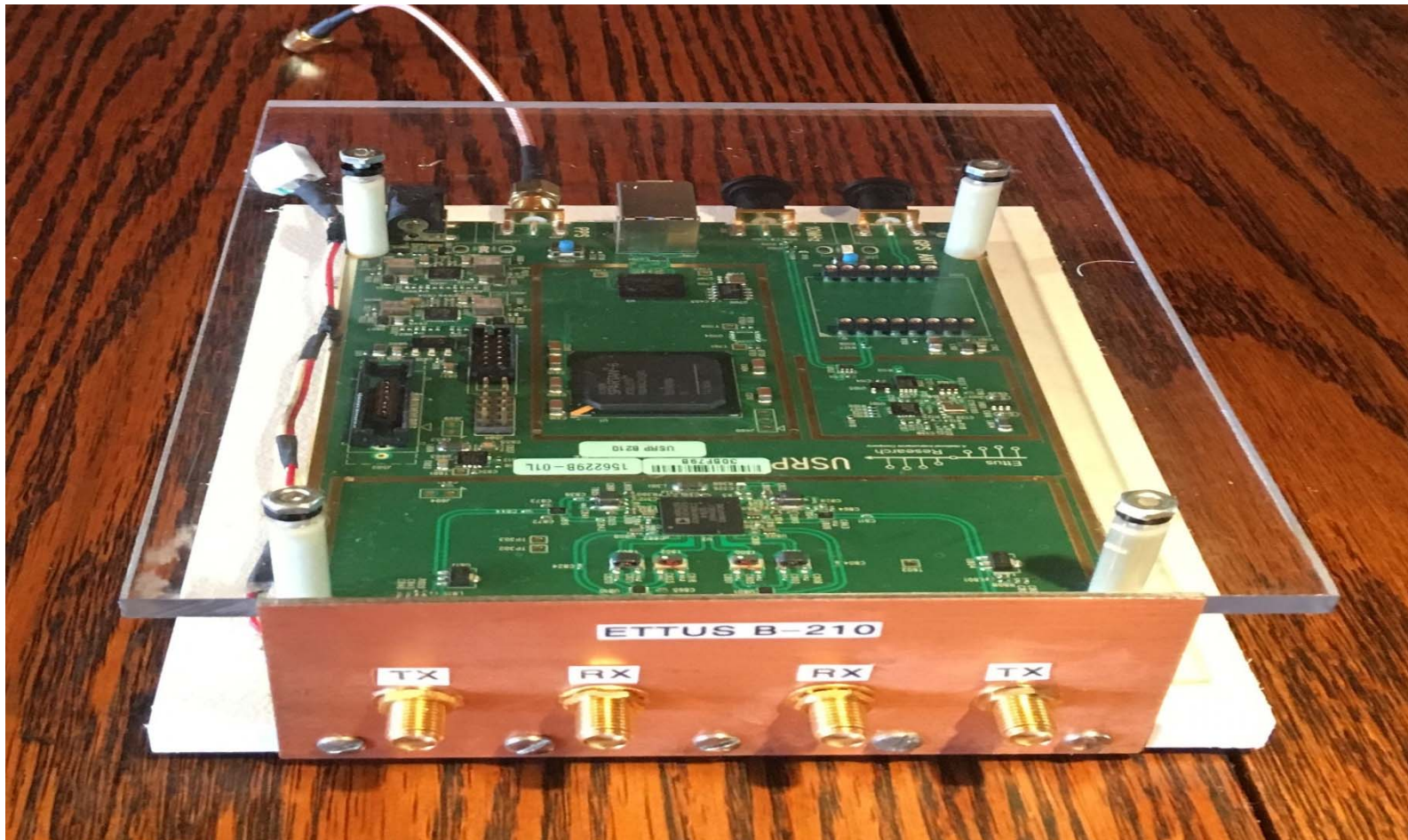
- High performance direct conversion SDR broadband transceiver (and peripheral)
 - Custom per band antenna 'interface'

VHF/Microwave SDR Station

Experimenter's station implemented using modular construction:

- 1) Broadband SDR module
- 2) Broadband RF Interface module
- 3) SDR Peripheral station control module
- 4) Band specific power amplifiers, antennas

SDR module



SDR RF Interface

The Interface links the SDR with the rest of the RF system

- Receiver input protection relay with termination
- Transmitter low level intermediate amplifier

SDR RF Interface



SDR Peripheral

The Peripheral links the SDR and rig control functions:

- OCXO
- Keying circuits
- Memory keyer
- PTT and amplifier control
- T/R relay
- Power distribution system – keyed & un-keyed

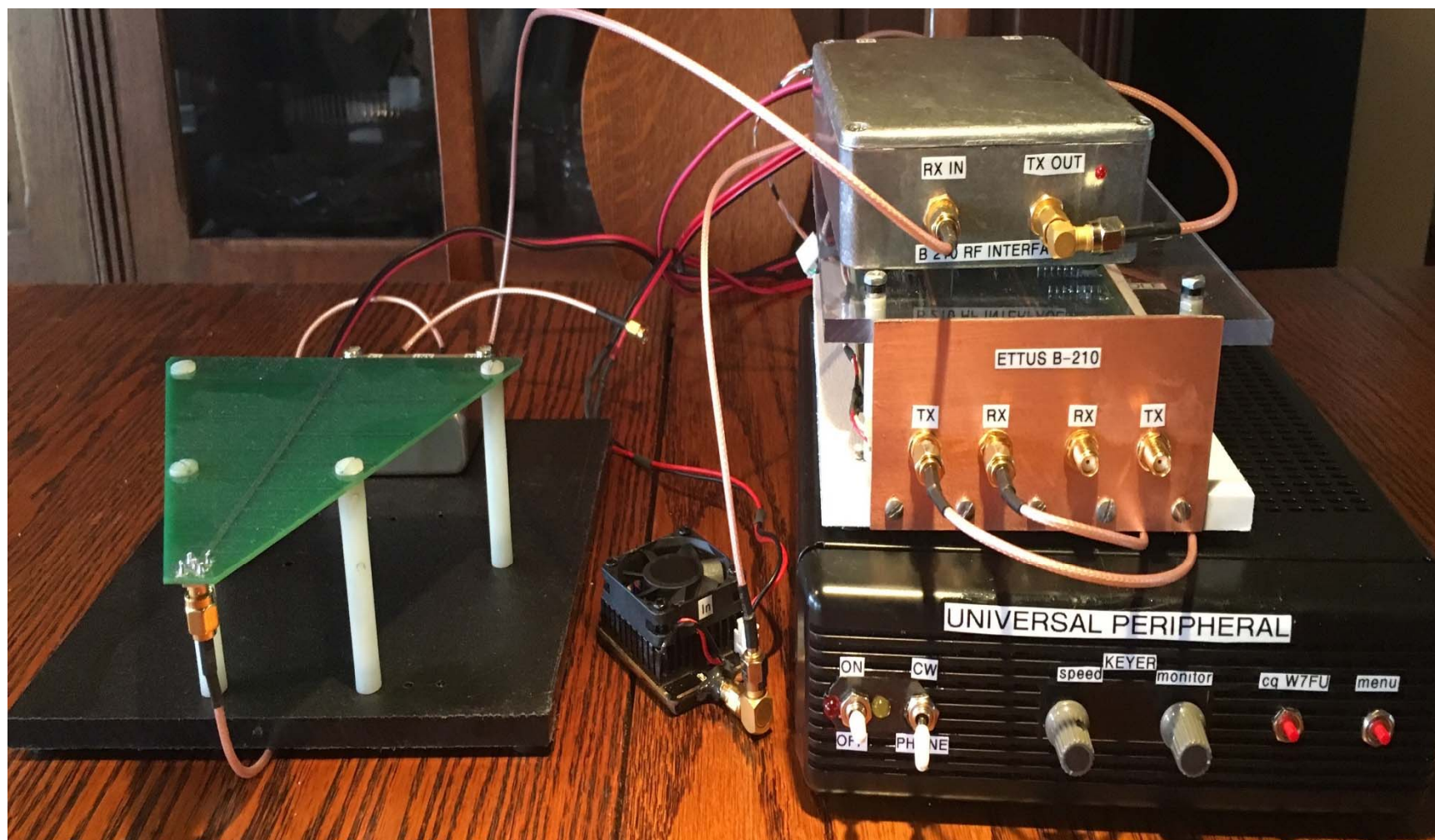
SDR Peripheral



Power Amplifier Modules



Complete SDR Rover Station



What Next?

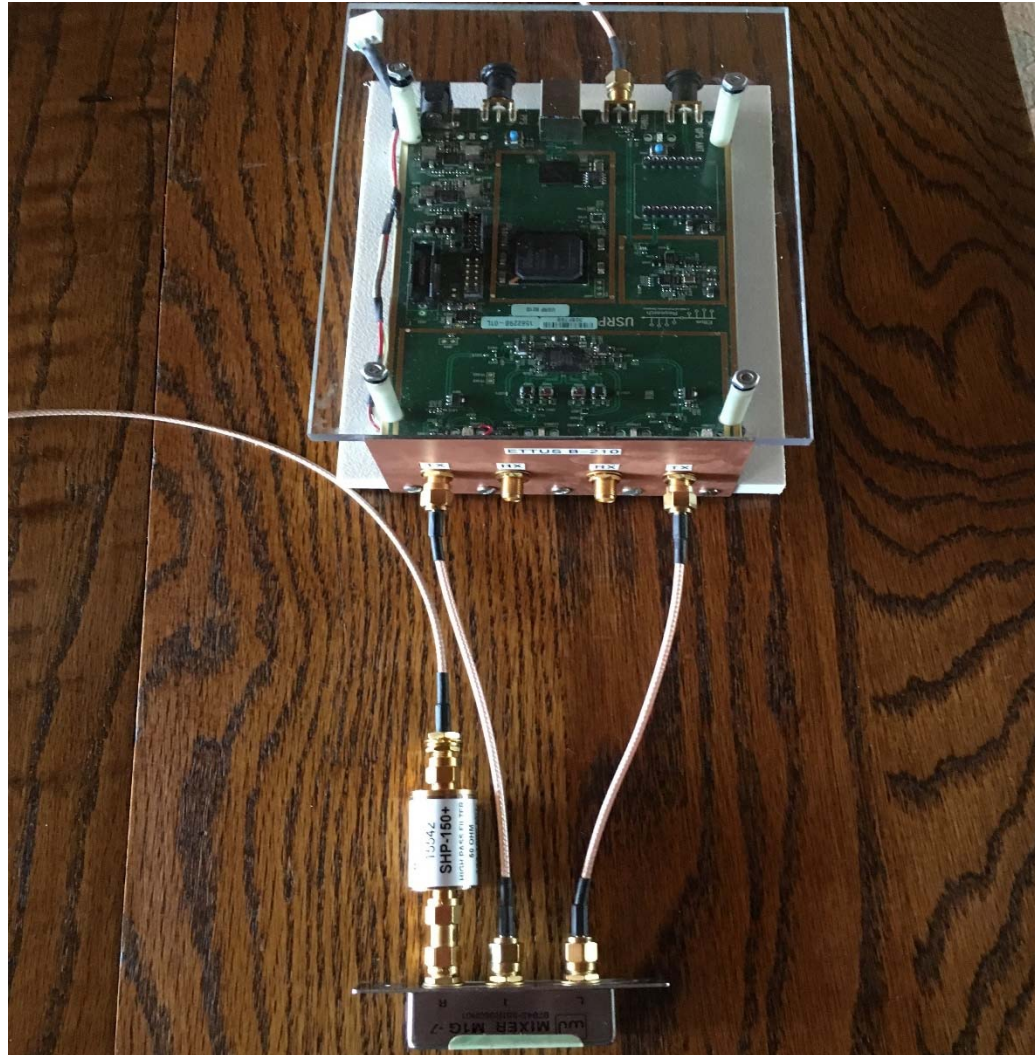
10 GHz, of course!

10 GHz Transceiver simplified:

- B-210 dual transceiver SDR
- 10 GHz Double Balanced Mixer
- High-pass filter
- Preamp, Amp, TX/RX relay and antenna

(and, I don't need fancy test equipment!)

10 GHz SDR Transceiver



In Conclusion

I want to thank

Michael Garrett, AC9LM, Barry Hansen, K7BWH,
Phil Horkin, AG7GY, Mariana Varotto, WA7EE
For their generous assistance with this project

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

Down the Slippery Slope...

More information about DSP and SDR

www.w7fu.com

Additional learning opportunity with the SDR-SIG
Meets on the odd month, third Tuesday 6:00-7:30

Facebook: PNW SDR SIG
(SDR-SIG information)

FAQ's: Hardware

Q: Are there UHF/ Microwave SDR transceiver hardware alternatives?

A: Yes: <http://greatscottgadgets.com/hackrf/>,
<http://www.Ettus.com> and <http://www.Nuand.com>

Q: Isn't the Ham Shield Arduino (VHF/UHF transceiver) a SDR?

A: Yes, by all means. Wonderful design, with a different purpose, not compatible with GNU Radio

Additional Questions ?

Hardware ?

Software ?

Other related topics ?