



UHF SDR TRANSCEIVER AND HAM RADIO SYSTEM

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Agenda

- Advanced IC and SDR technology: UHF SDR project description
- SDR project photos and performance data
- The journey to a UHF SDR system: perspective from traditional analog systems and opportunities with SDR designs

Advanced IC and SDR Technology

UHF / Microwave Multi-mode
Direct Conversion SDR Transceiver

Single board solution with open source
DSP software

SDR Project Description

Hardware

Ettus Research B200 SDR transceiver

- single board solution (6" x 4")
- 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, Ubuntu OS platform
- Graphical DSP authoring

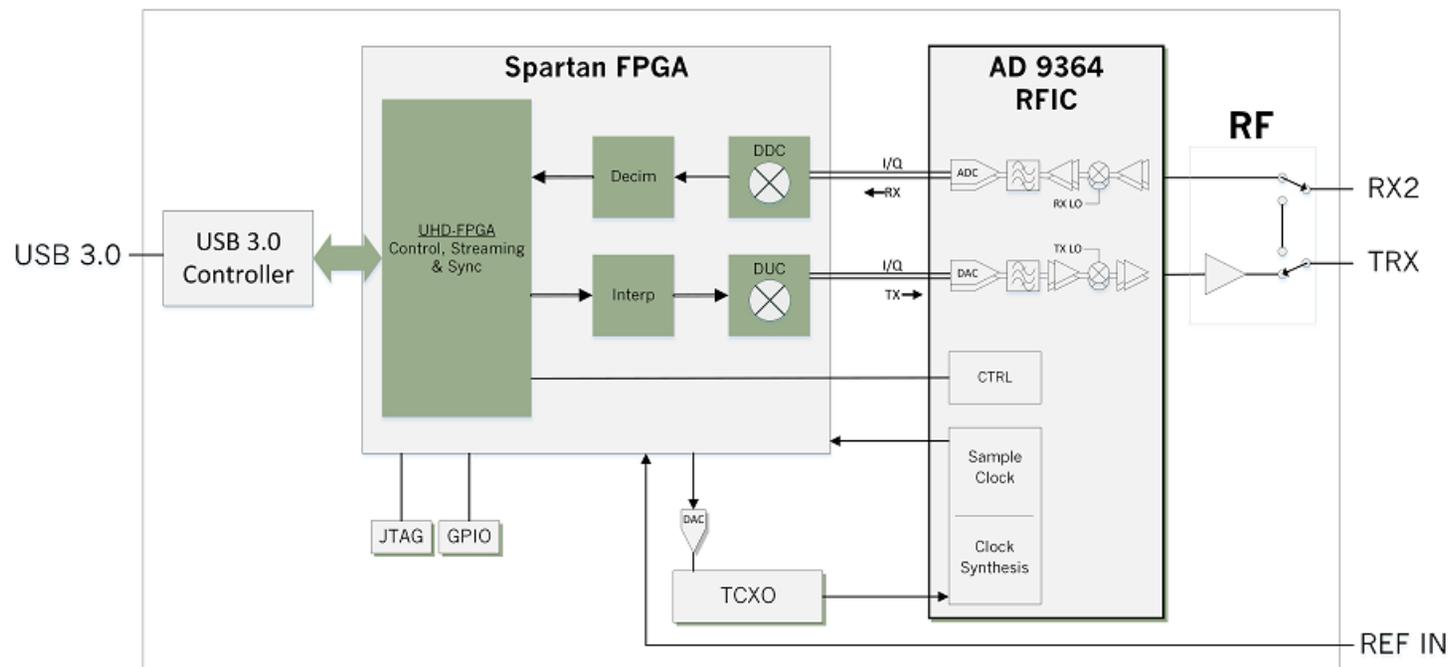
Advanced SDR Hardware

Ettus USRP B200 SDR Transceiver



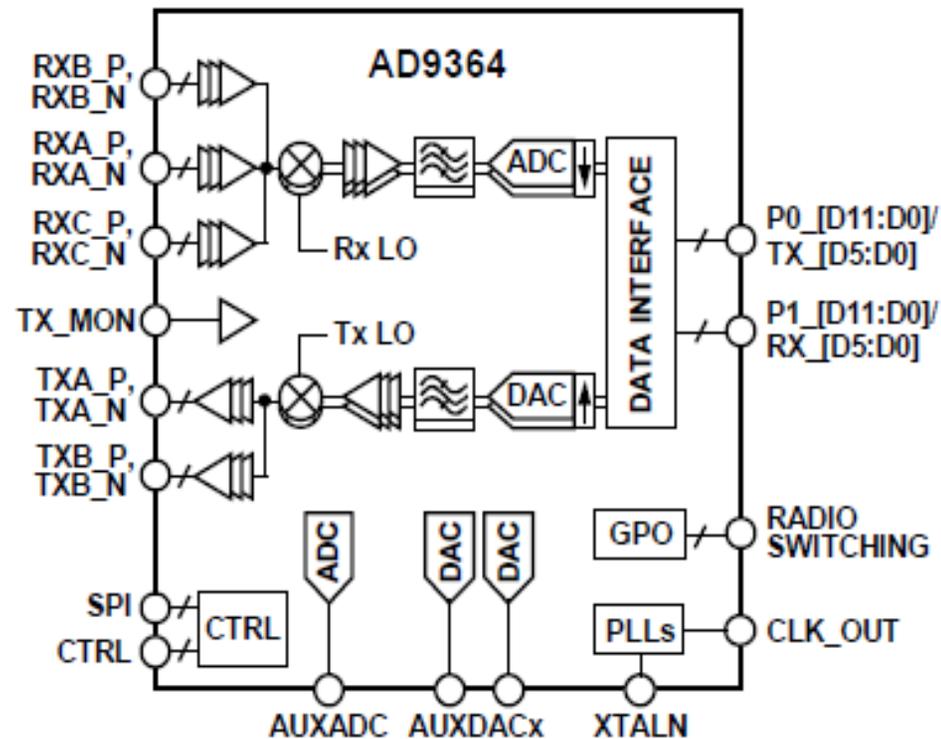
Advanced SDR Hardware

Ettus USRP B200 SDR Transceiver



Advanced SDR Hardware

Analog Devices 9364 RFIC



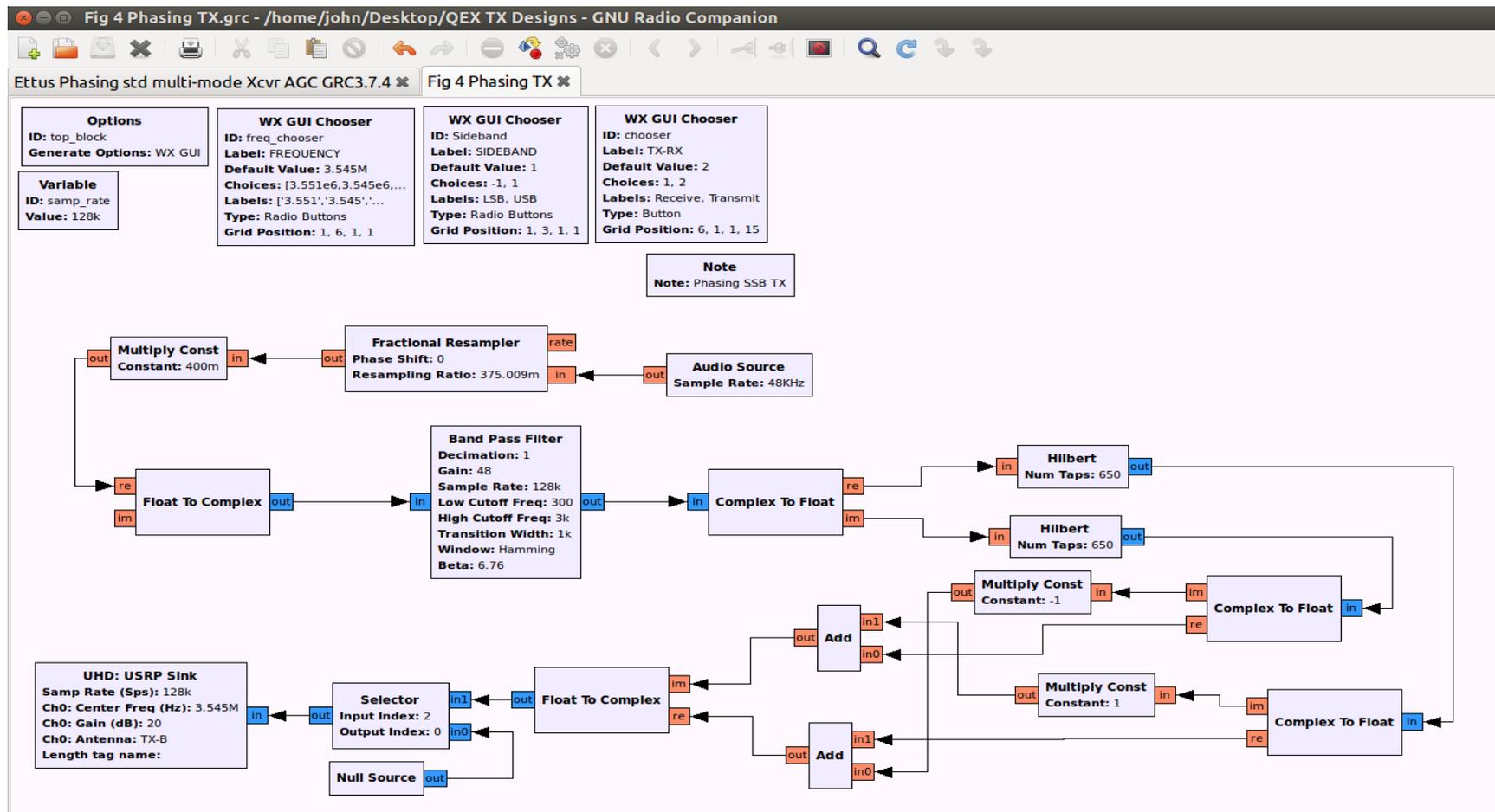
'Advanced' DSP Software

GNU Radio

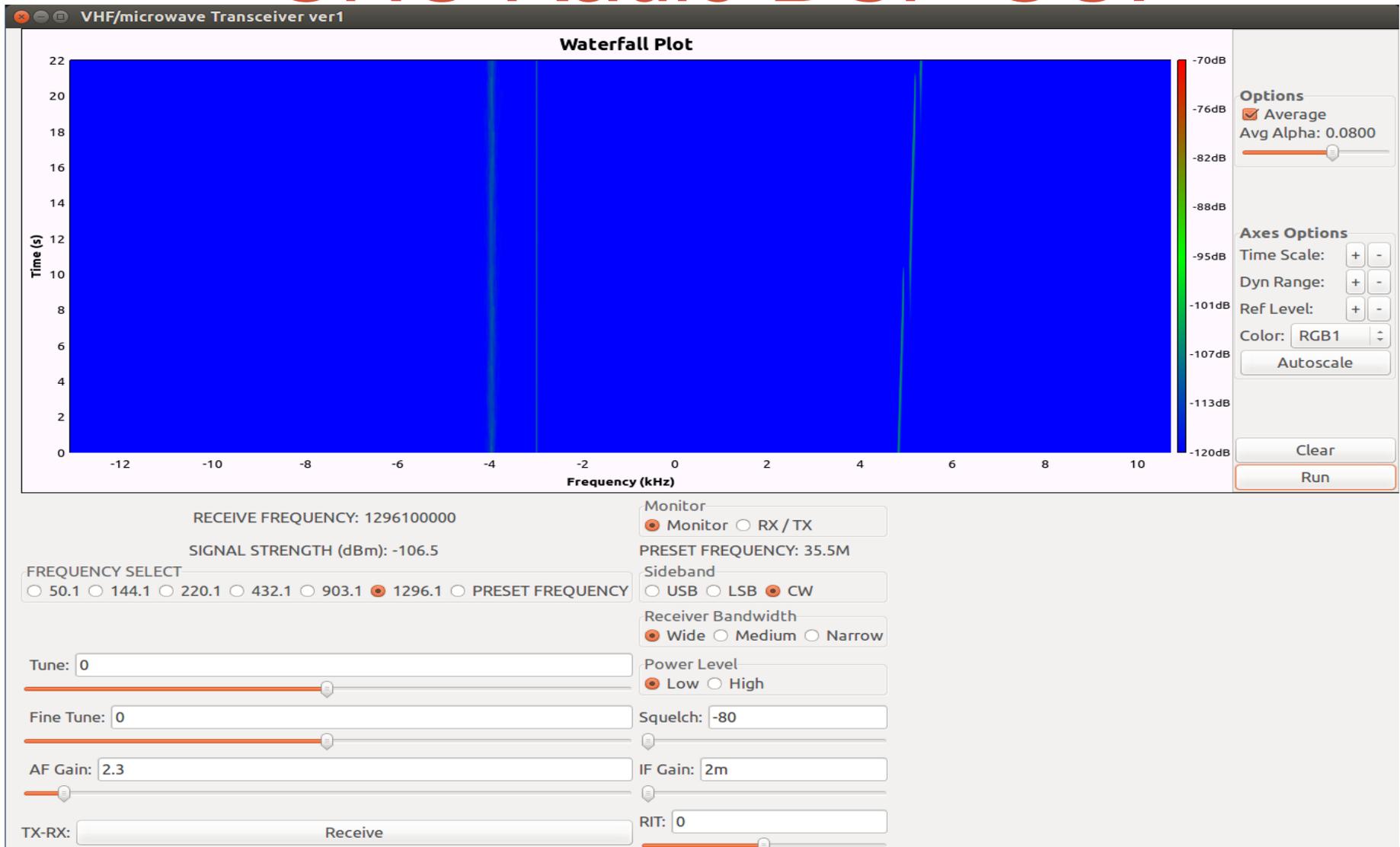
- Open source DSP library, (Linux, Ubuntu OS)
- Graphical DSP authoring simplified
- Optimized for 'real time' signal processing (VOLK, C++ API) as different from 'modeling'
- Supports transmit and receive DSP
- UHD (Universal Hardware Driver) interface, developed and maintained in conjunction with Ettus USRP

GNU Radio DSP Flow Graph

SSB Phasing Transmitter DSP



GNU Radio DSP GUI



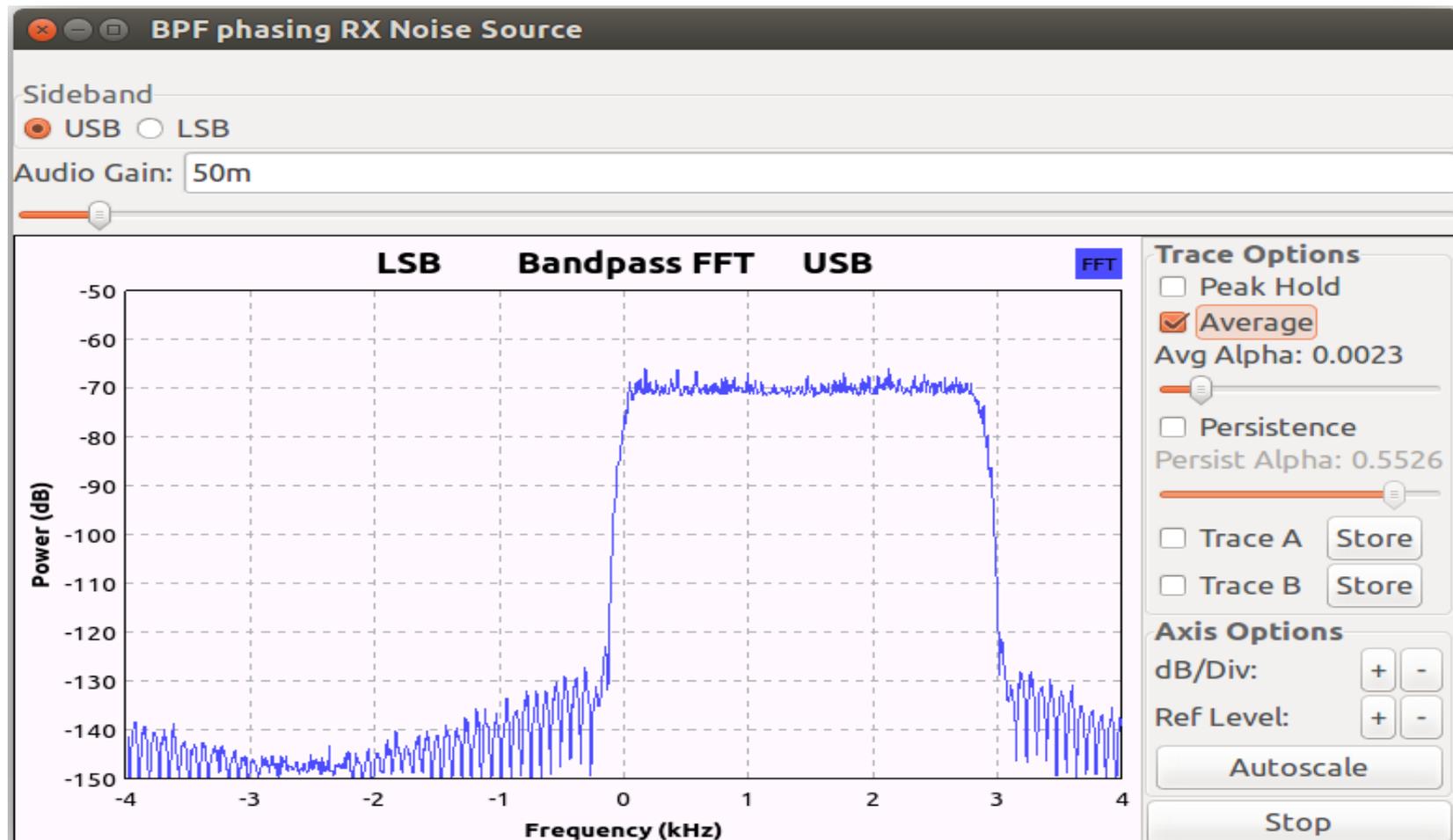
Performance Measures

Receiver Filter Bandwidth optimized for
UHF operation

Transmitter Spurious Output and Phase
Noise

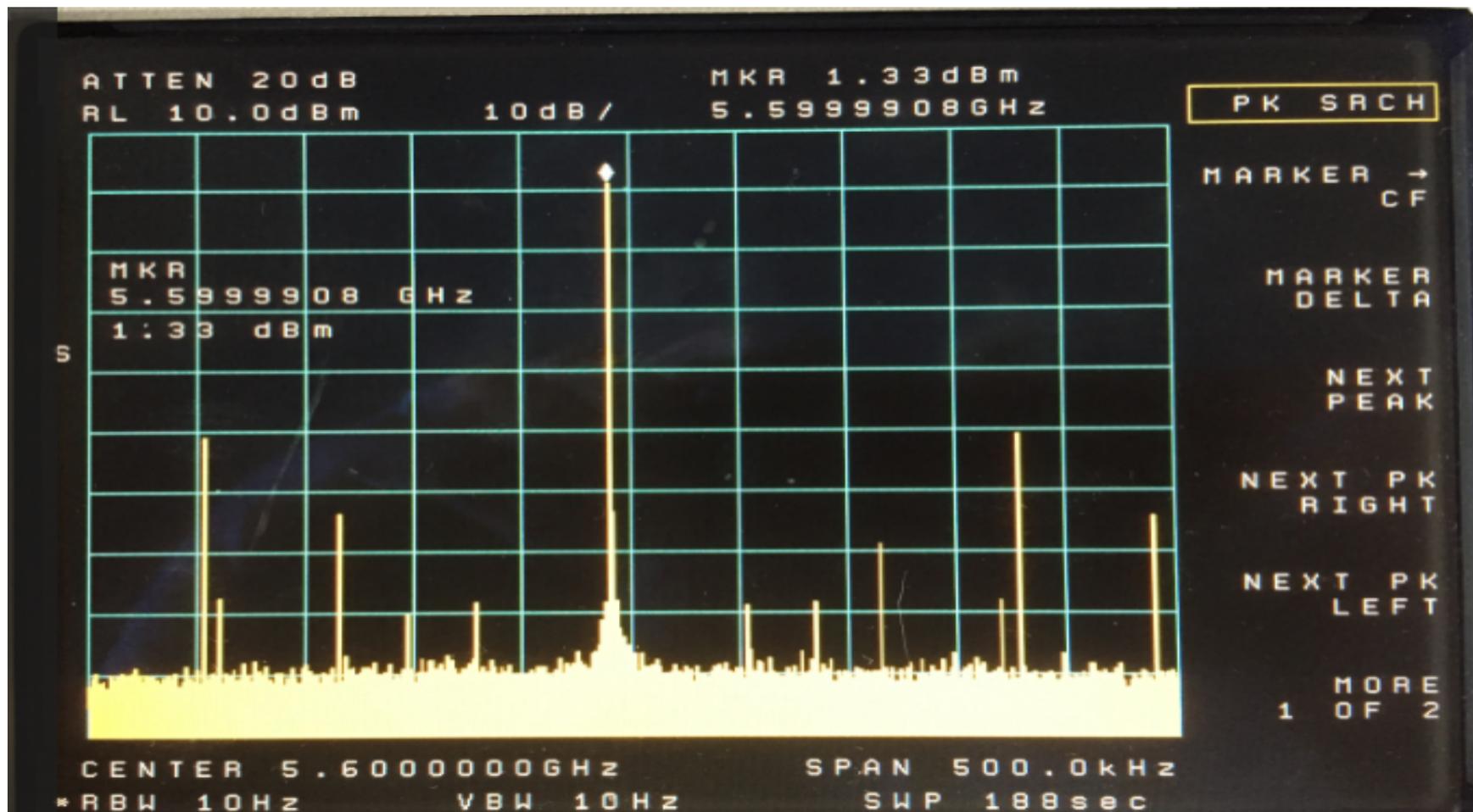
Receiver Bandwidth Spectrum

Receiver Bandwidth 3 kHz



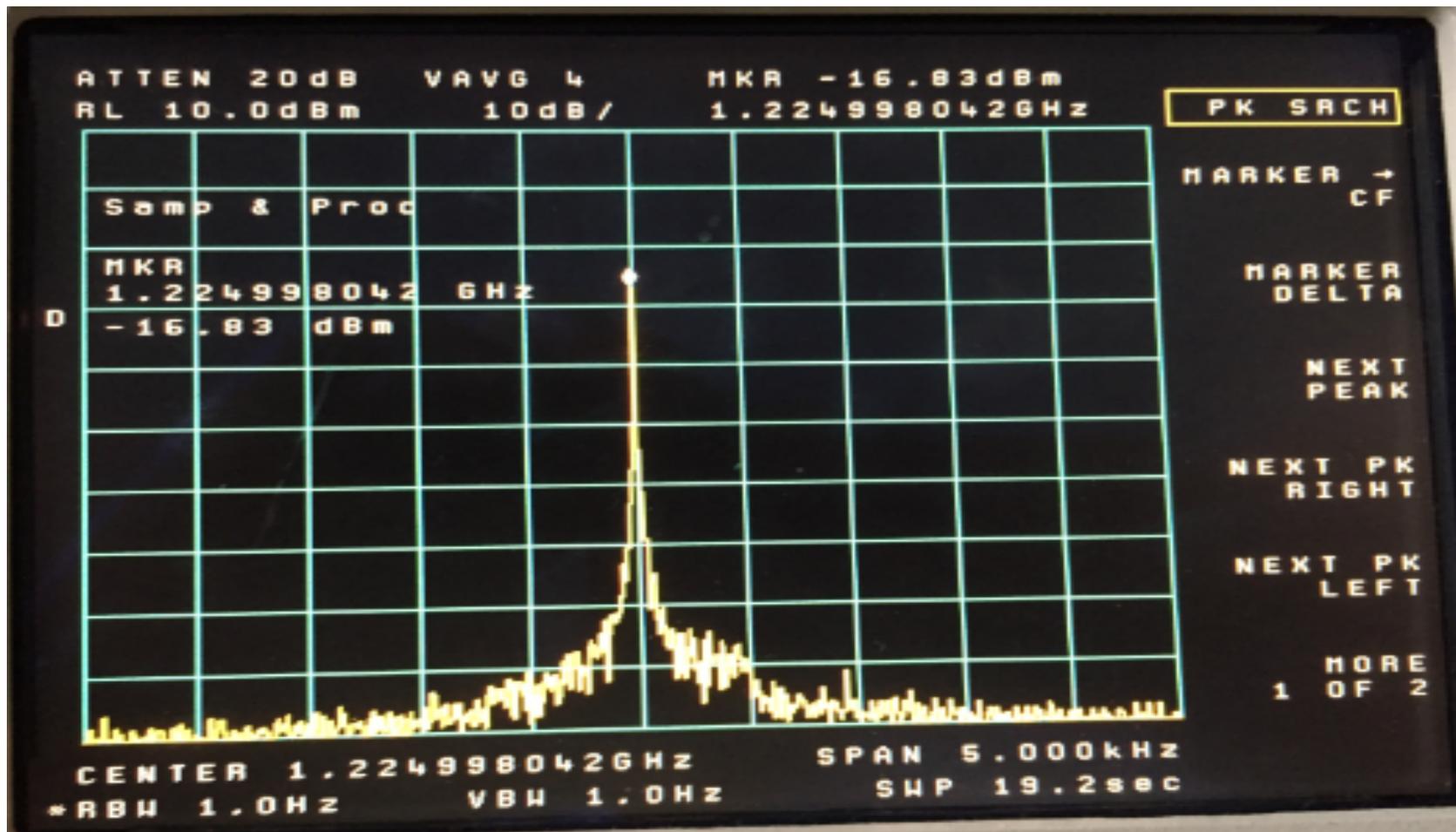
Microwave Spectral Purity

Transmit Spectrum at 5.6 GHz



Microwave Phase Noise

Transmit Phase Noise at 1.2 GHz



Transition from Analog to SDR

The analog system leverages highly developed,

- high performance HF transceivers
- sophisticated UHF filter, LNA, and power amplifier technology
- and proven overall system design

Question ?

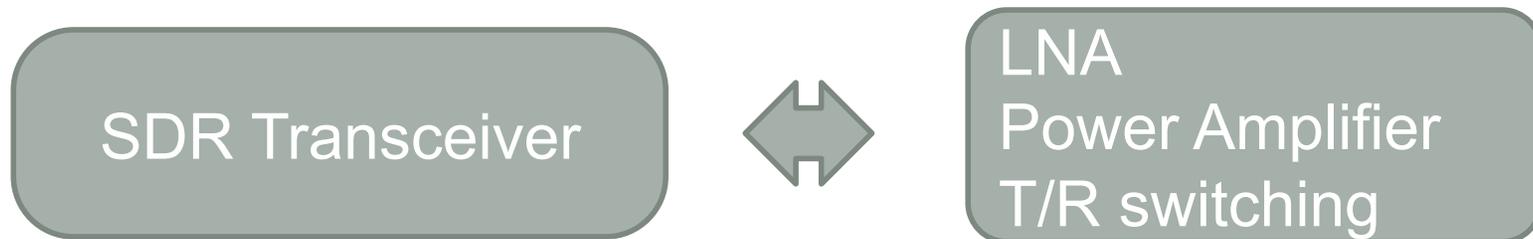
- Why not improve transceiver performance and operating flexibility with SDR?
- Why not build on the proven analog system approach with SDR?

Typical Analog Ham UHF System



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

Advanced SDR Ham UHF Radio System



- High performance direct conversion SDR transceiver
 - Custom per band antenna 'interface'

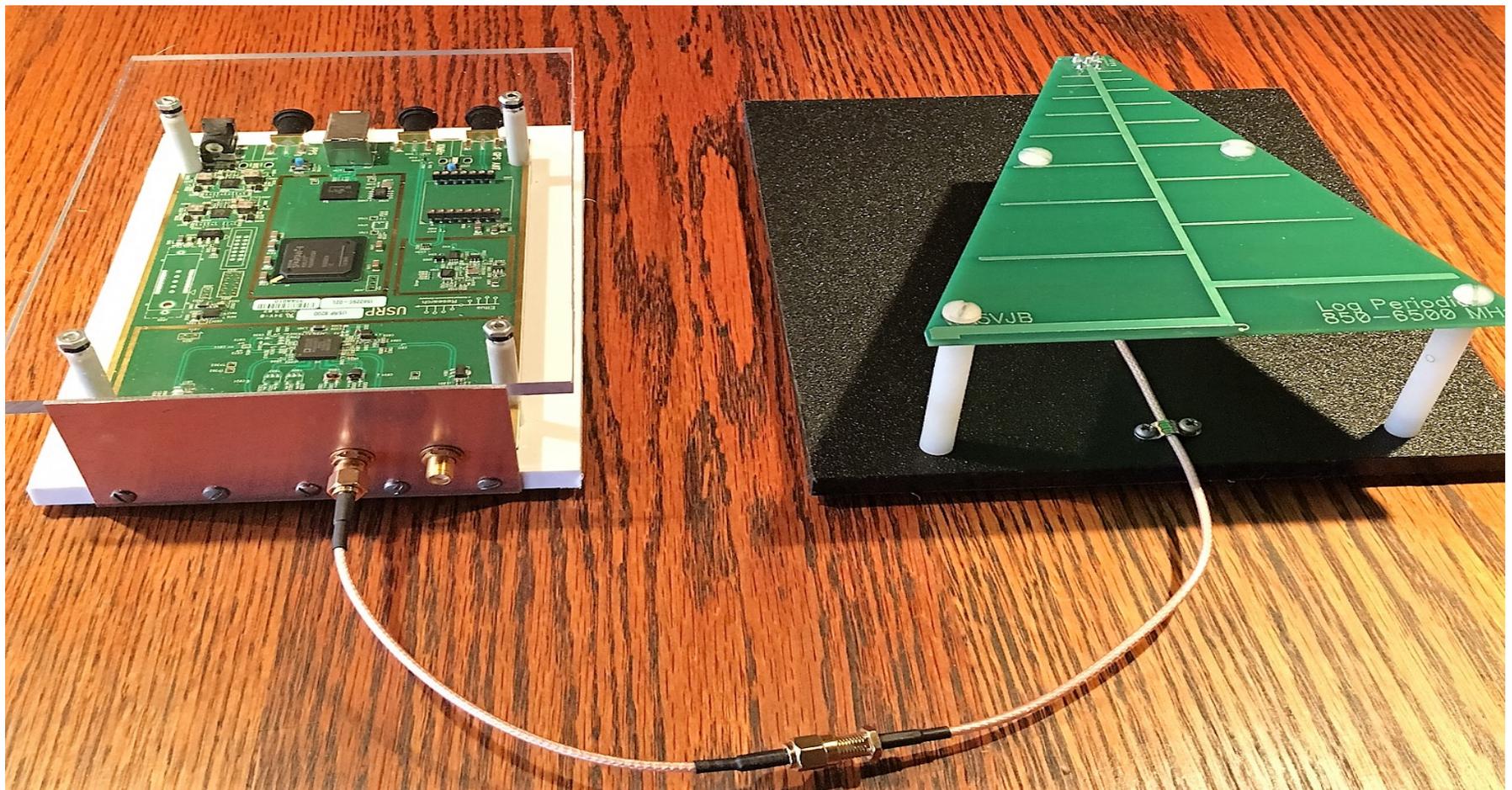
VHF/UHF SDR System

VHF/UHF SDR Transceiver and $\frac{1}{2}$ W Interface



UHF/Microwave SDR System

UHF/Microwave SDR Transceiver and Antenna



SDR: The New Normal?

- Near ideal signal processing ability: ‘digital determinism’, can approximate the Shannon limit
- Wide design flexibility – supports all existing available amateur bandwidths
- Integrates well with existing RF systems
- Size and weight attractive compared to analog counterparts

SDR Opportunities with Phase 4 satellite

- Higher order modulation that allows major increases in “data” rates, results in more and higher fidelity information throughput:
e.g. 256 QAM vs. PSK 31 = >10x “data” rate!
- Microwave uplink and downlink

In Conclusion

I want to thank

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For their generous assistance with this project

Thanks also to the MicroHAMS for the opportunity
to present this project at the 2016 MHDC

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

FAQ's: Software

Q: Does GNU Radio function with a Windows OS?

A: “Sorta”, hard work with significant limitations.

They are working on it. The GNU Radio developers are primarily oriented to Linux OS.

Q: How do I get started with GNU Radio?

A: That is what www.Gnuradio.org/ and www.w7fu.com are all about. GRC DSP information oriented to beginners.

FAQ's: General

Q: What about homebrew UHF SDRs?

A: Yes. You can make custom software and analog interface system. The FPGAs and RFICs require automated assembly.

Q: Where do I turn for more information on VHF/ Microwave opportunities in our area?

A: PNW VHF Society is very active locally, sponsors a wide range of operating activities, and a source of good technical information:

<http://www.pnwvhfs.org/>

Additional Questions ?

Hardware ?

Software ?

Other related topics ?