VHF/UHF/MICROWAVE SDR TRANSCEIVER ON THE AIR

John Petrich, W7FU

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VHF/UHF SDR - home station
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 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

Wideband Transmit Spectrum @ 2.3 GHz

Ref -20.000 dBm
Div 10.0

RBW 100.000000 kHz
Atten 0

VBW 100.000000 kHz

Mkr 1: 2.300097 GHz, -29.579 dBm

Start 1.300097 GHz
Center 2.300097 GHz
Span 2.000000 GHz
Stop 3.300097 GHz
70000 pts in 30451 ms
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

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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?

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?