VHF - UHF - MICROWAVE SDR TRANSCEIVER ON THE AIR

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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

HF Antenna → A/D Converter (Baseband) → FPGA DSP

D/A Converter → Panadapter → Computer DSP

Audio → Baseband

Analog → Data
Direct Conversion VHF SDR

VHF Antenna → Mixer RFIC → A/D Converter (Baseband)

signal

D/A Converter → Computer DSP → FPGA DSP

data

Etc.. → Baseband → Analog

data

Data
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

[Image of GNU Radio DSP Flow Graph showing the phasing transmitter DSP process with various nodes and connections, including Multiply Const, Complex To Float, and Hilbert filters.]
GNU Radio DSP GUI

Waterfall Plot

Options
- Average
- Avg Alpha: 0.0800

Axes Options
- Time Scale:
- Dyn Range:
- Ref Level:
- Color: RGB1

Clear
Run

RECEIVE FREQUENCY: 1296100000
SIGNAL STRENGTH (dBm): -106.5

FREQUENCY SELECT
- 50.1
- 144.1
- 220.1
- 432.1
- 903.1
- 1296.1
- PRESET FREQUENCY

Monitor
- Monitor
- RX / TX

PRESET FREQUENCY: 35.5M

Sideband
- USB
- LSB
- CW

Receiver Bandwidth
- Wide
- Medium
- Narrow

Power Level
- Low
- High

Tune: 0
Fine Tune: 0

AF Gain: 2.3
IF Gain: 2m

TX-RX: Receive
RIT: 0
Performance Measures

Transmitter Spurious Output and Harmonics
Microwave Spectral Purity

Wideband Transmit Spectrum @ 2.3 GHz
VHF Harmonic Analysis

Harmonic Analysis @ 144 MHz (typical)

- Ref: -30.000 dBm
- RBW: 250.000000 kHz
- VBW: 250.000000 kHz
- Attenuation: 0 dB

- Start: 103.199999 MHz
- Center: 288.200000 MHz
- Span: 370.000001 MHz
- Stop: 473.200000 MHz

1850 pts in 17272 ms
“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
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

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Down the Slippery Slope…

More information about DSP and SDR

www.w7fu.com
Additional Questions?

Hardware?

Software?

Other related topics?