## Microwave Transceivers Made Simple: Harnessing SDR Innovation

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## **Presentation Outline**

- SDR Experience: PNW Microwave Group
- SDR Basic Station
- SDR Station Enhancements
- Real-Time Demos
- SDR as Test Instruments for the Home Lab
- Q & A

## SDR Technology and the PNW Microwave Group's Approach

**Software Defined Radio**: flexibility in radio communication by shifting signal processing tasks from hardware to software.

#### Hardware:

Analog Devices ADALM Pluto (\$230)

Ettus USRP B200mini (\$1,500)



- Based on AD936x chip
- FPGA for DSP
- 12-bit ADCs & DACs
- **RX/TX:** 70 MHz to 6 GHz
- Support External Freq. Ref.

## SDR Technology and the PNW Microwave Group's Approach (cont'd)

#### Software-Controlled

#### Features:

- Frequency selection
- modulation/demodulation
- rig control
- visual representation of signals.

#### **Modulation**:

- Analog: SSB, CW, FM.
- Digital: Fldigi (e.g., PSK, RTTY), WSJT-X (e.g., FT8, Q65).

#### Software:

- GNU Radio: An open-source software suite for signal processing – Graphical interface.
- Langstone Project: A flexible all-mode transceiver platform.

**SDR Console**: a full-featured software transceiver.







## **Enhancing SDR Stations**

#### **Key Hardware Enhancements**

- **Amplifiers and Preamplifiers**: To improve signal strength and clarity, particularly in microwave applications.
- External Frequency References: Necessary for maintaining accuracy in field operations and digital communications. Using Leo Bodnar GPS-referenced clocks

#### Harmonic Filtering and Signal Isolation

- **Mitigating Harmonic Signals**: Necessity of **low-pass filters** in the transmit chain to suppress harmonics in broadband amplifiers.
- Reciprocal Mixing Issues: Solutions such as high-pass/band-pass receiver filters to handle interference from nearby FM and TV stations at VHF/UHF frequencies.

#### Example Enhanced Stations – Demo: Mariana and John's 1296 MHz Stations

## **Expanding SDR Functionality: Microwave and Beyond**

## Signal Up-conversion to Microwave Frequencies

• Use of External Mixers: Upconverting native SDR frequencies to higher microwave ranges, e.g., **10 GHz**.

## **IF Flexibility and Choice**

• Choosing IF Frequencies: The flexibility to use non-standard intermediate frequencies (IF) to optimize mixer and LO performance.



## Expanding SDR Functionality: Microwave and Beyond (cont'd)

## **Dual-Mixer Architecture for Advanced Signal Processing**

Separating TX and RX paths to improve switching and eliminate IF relay switching.



#### **Example Enhanced Stations – Demo: Mariana and Pablo's 10 GHz Stations**

## **SDR as Versatile Test Instruments for Home Labs**

## SDR as a Spectrum Analyzer

- Spectrum Analysis Capabilities:
  - Wide frequency segment scans for identifying unknown signals.
  - Narrow frequency scans for fine equipment tuning and modulation analysis.
- Advantages: Software-driven calibration, trace persistence, and peak hold functionalities.



## SDR as Versatile Test Instruments for Home Labs (cont'd)

### **SDR** as a Signal Generator

- Test Signal Generation: Using SDR to generate a constant carrier signal for equipment testing.
- Applications: Tuning of receivers, RF filters, and amplifiers.

Options ID: Microwave_output_test Title: Source frk Analyzer Author: John Petrich 10-28-16 Generate Options: WX GUI Variable ID: samp_rate Value: 384k	WX GUI SIIder ID: freq Label: Frequency Default Value: 0 Minimum: -100k Maximum: 100k Converter: Float WX GUI SIIder ID: gain Label: Gain Default Value: 800m Minimum: 0 Maximum: 1 Converter: Float	WX GUI Chooser ID: freq_test Label: Frequency test Default Value: 1.2961G Choices: 3.408G,G, 3.4561 Labels: 3408 MH 3456.1 G Type: Radio Buttons WX GUI Chooser ID: tx_rx Label: TX - RX Default Value: 1 Choices: 1, 0 Labels: RX, TX Type: Radio Buttons	WX GUI Slider         ID: drive         Label: drive         Default Value: 0         Minimum: 0         Maximum: 200m         Converter: Float	Source for scalar Network Analyzer TX - RX  RX O TX Gain: 800m  Frequency test O 3408 MHz O 1.2961 GHz O 2.304 GHz O 5760.1GHz O 3456.1 GHz  Frequency: 0
Constant Source Constant: 0	Sel Input I Outpur	lector Index: 0 t Index: 1	UHD: USRP Sink Mb0: Clock Source: External Samp Rate (Sps): 384k Ch0: Center Freq (Hz):61G Ch0: Gain Value: 800m Ch0: Gain Type: Normalized Ch0: Antenna: TX/RX TSB tag name:	drive: 0

#### **Extending SDR's Frequency Range**

 Using External Mixers: Extending SDR's native range to 10 GHz and beyond for spectrum analysis and equipment tuning.

## **Field Operation Considerations**

## Adapting SDR for Outdoor Use

- Weather Protection: Enclosures and protection for field computers and SDR equipment (e.g., dealing with rain and daylight brightness).
- Field Challenges: Managing computer interface difficulties in bright sunlight and moist conditions.

## **Regulatory Considerations**

 Broadband Harmonics: Regulatory compliance through the use of filters, e.g., in mixer-based microwave stations.



# **Conclusions: SDR as a Versatile UHF & Microwave Station**

### **SDR** as an Alternative Radio Architecture

- Flexibility and Versatility: SDR's adaptability for VHF/UHF and microwave frequencies.
- Future Applications: Potential for further development in high-performance amateur and professional radio setups.

# Q & A