Microwave Transceivers Made Simple: Harnessing SDR Innovation

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MUD 2024, October 4, 2024

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:

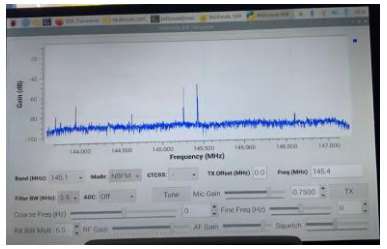
- Frequency selection
- modulation/demodulation
- rig control
- visual representation of signals.

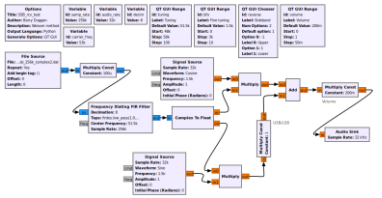
Modulation:

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

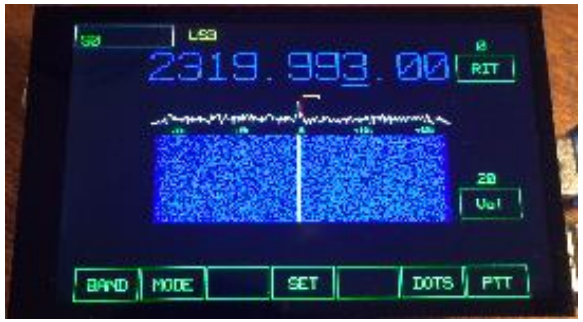
Software:

- **GNU Radio**: An open-source software suite for signal processing – Graphical interface.

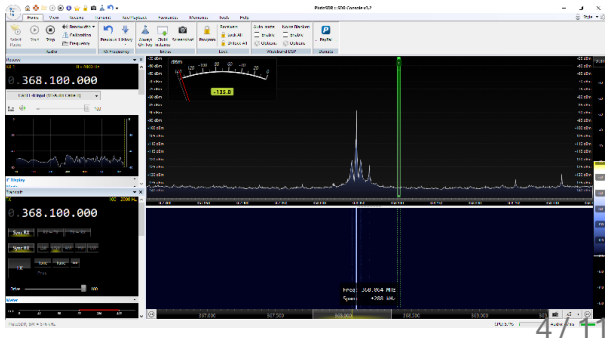




- **Langstone Project**: A flexible all-mode transceiver platform.



- **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

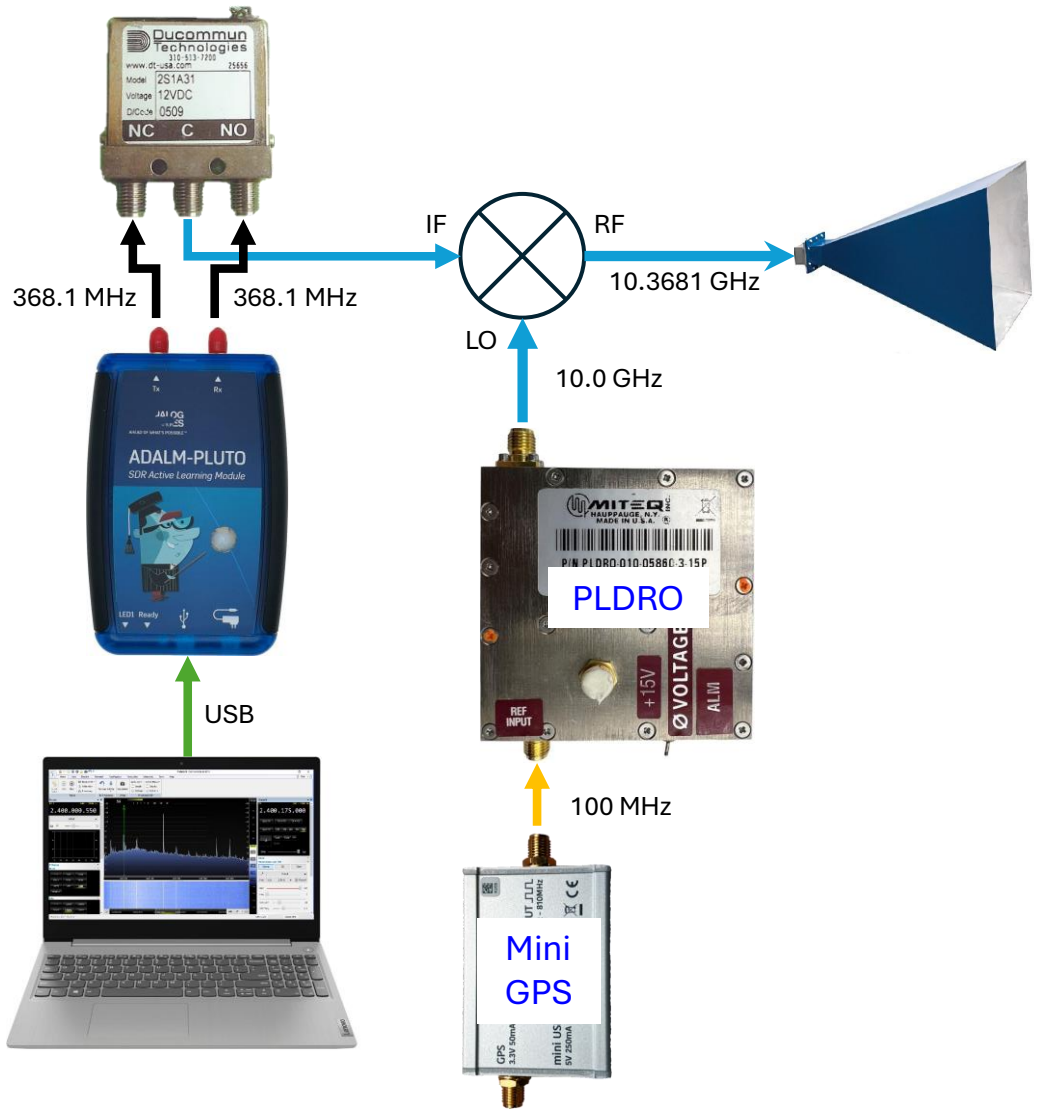
Expanding SDR Functionality: Microwave and Beyond

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.

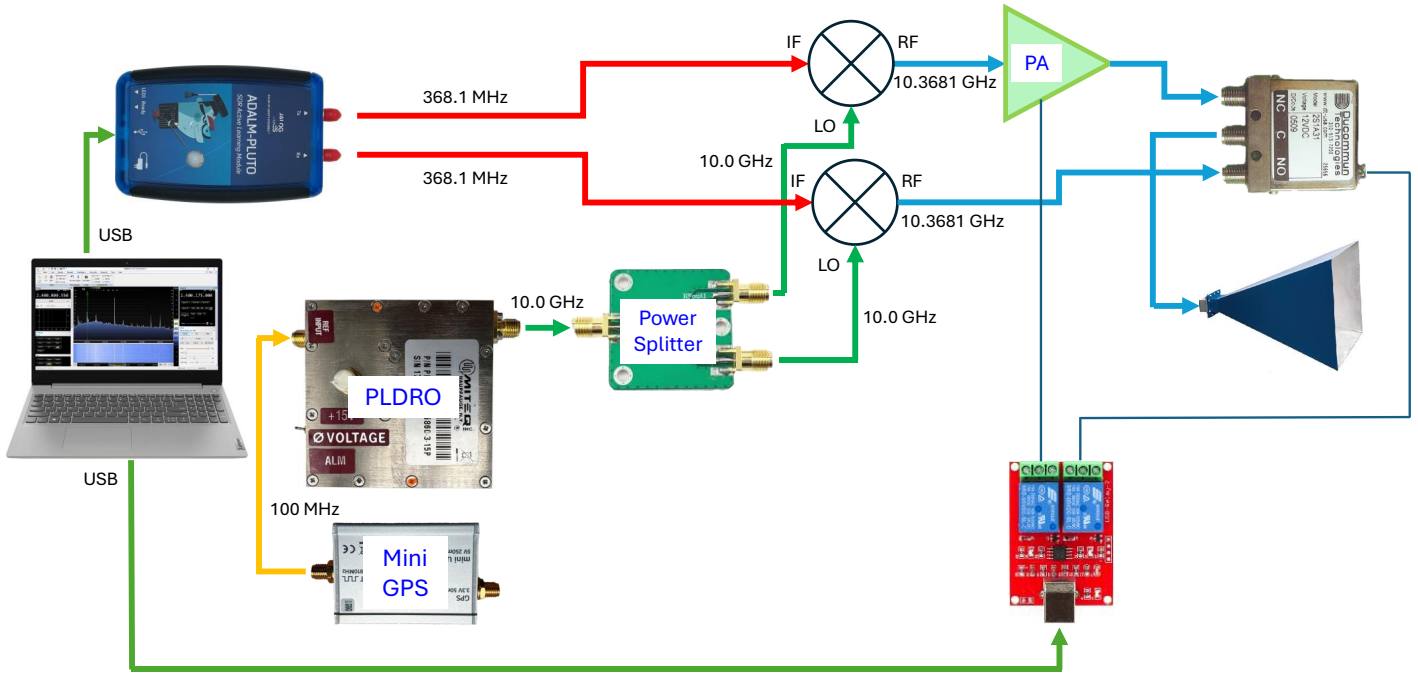


Single-Mixer Architecture

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.

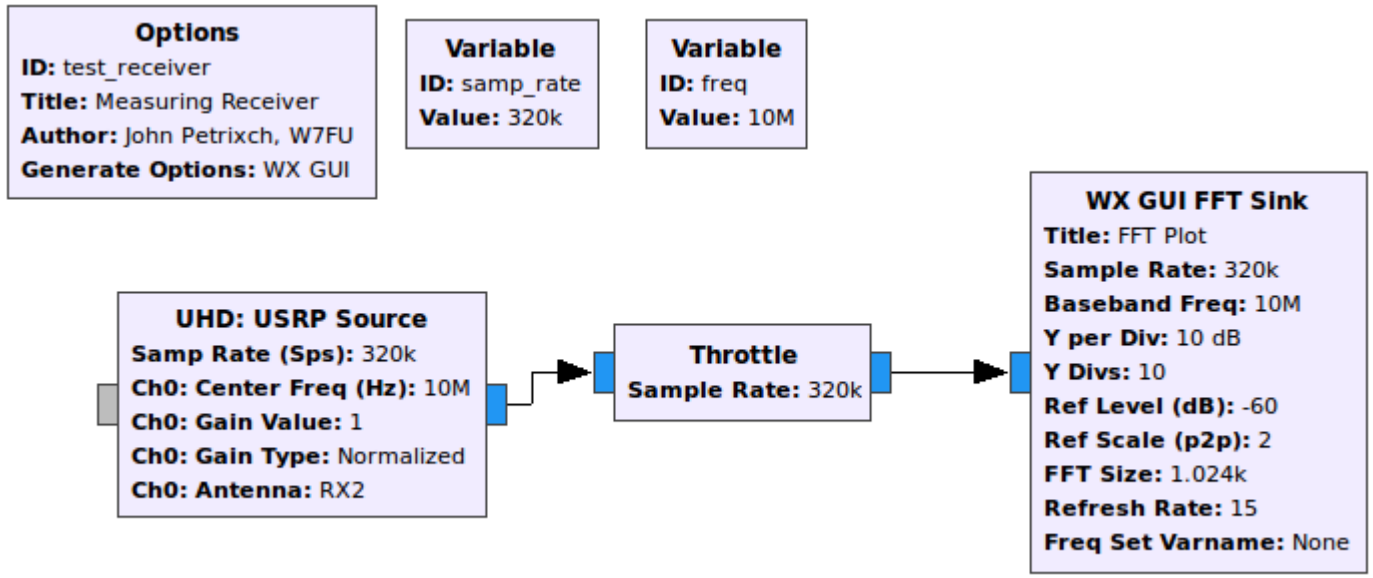


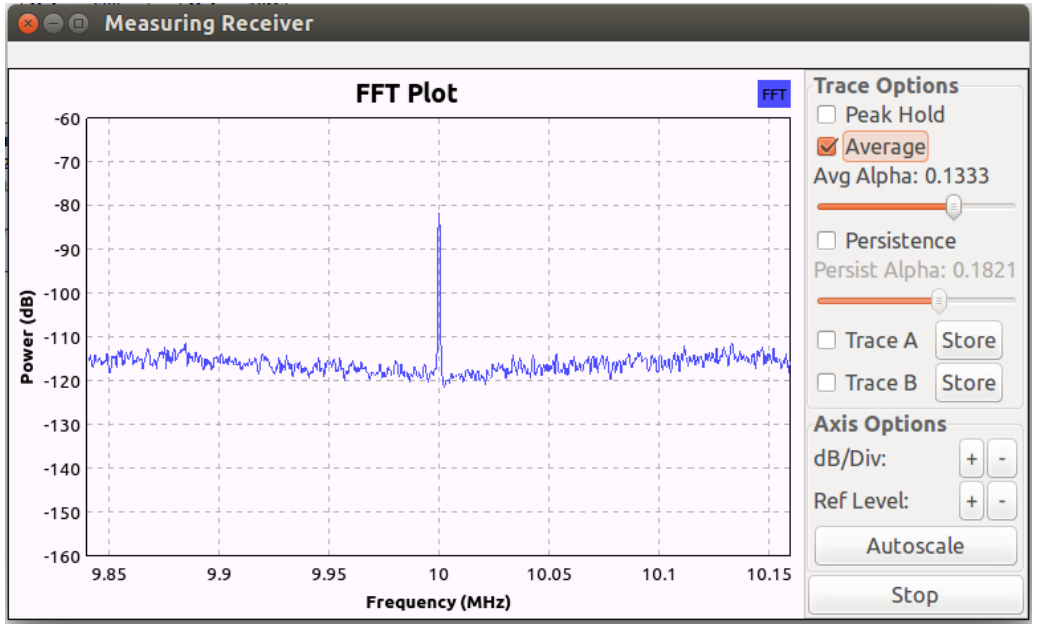
Example Enhanced Stations – Demo: Mariana and Pablo's 10 GHz Stations

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.

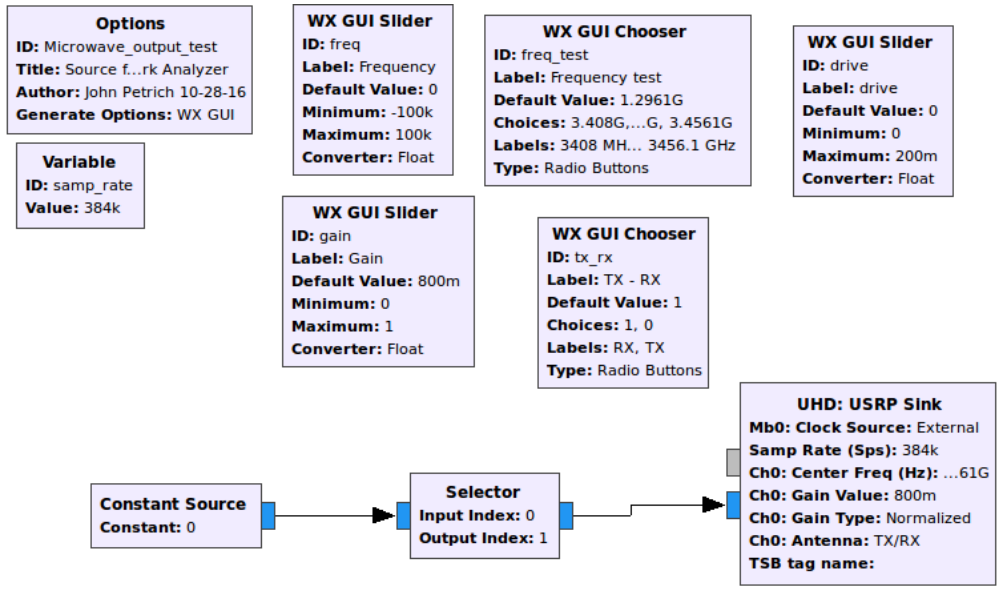


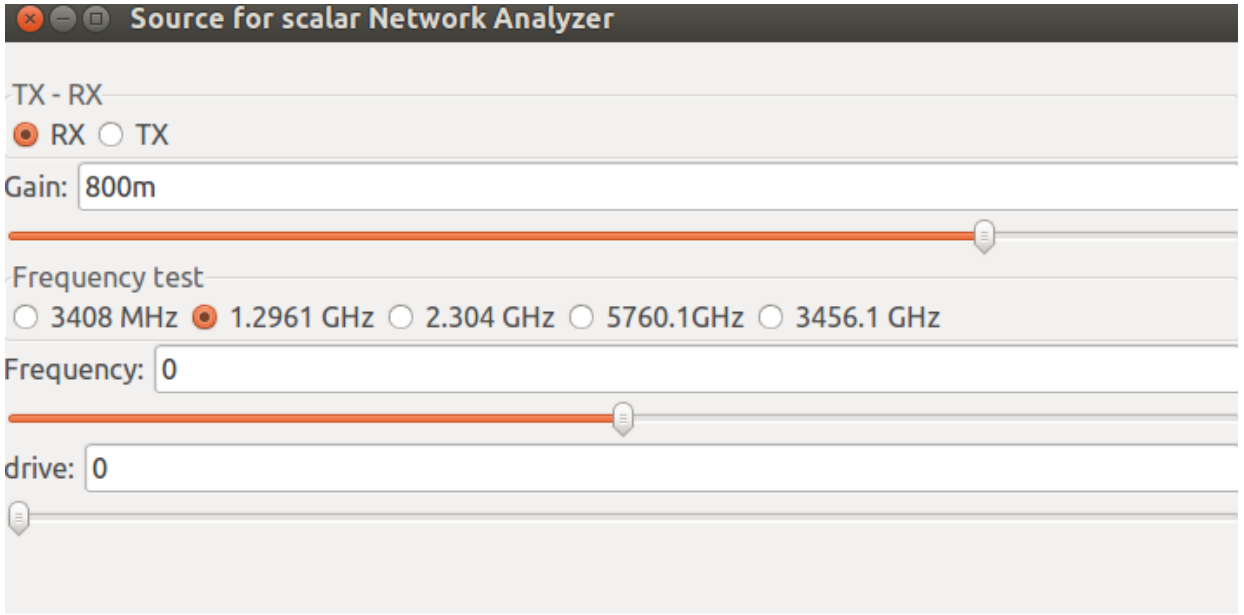


SDR as Versatile Test Instruments for Home Labs (cont'd)

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.





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