

# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P01\_R01: Processing Architecture for SDR



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# Processing Architecture for SDR

- **General Purpose Processor**
- **Digital Signal Processor**
- **Field Programmable Gate Arrays**
- **Graphics Processing Unit**
- **Advanced RISC Machine**



In this topic we have learnt about the

- ✓ Processing Architecture for SDR
- ✓ Next we are going to learn SDR Software



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P02\_R01: SDR Software



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RAH S O F T

# SDR Software

- **The development environment is a pre-built packages.**
- **Signal Processing Blocks.**
- **Open Source.**
- **Hardware Support.**
- **Available Platform**



# CONT....

S.N.		Platform	Type
1.	SDR#	Windows	Free
2.	HDSDR	Windows	Free
3.	SDR-RADIO.COM V2/V3	Windows	Free
4.	Linrad	Windows/Linux/macOS	Free
5.	GQRX	OSX/Linux	Free
6.	CubicSDR	Linux/Windows/macOS	Free
7.	SDRUno	Windows	Free
8.	SigDigger	Linux	Free
9.	ShinySDR	GNU Radio	Free
10.	WebRadio	Linux	Free
11.	OpenWebRX	Python Based	Free
12.	Sodira	Windows	Trial/Paid
13.	SDR Touch	Android	Trial/Paid
14.	RTLSDR Scanner	Windows	Free
15.	Pothos SDR	Windows	Free
16.	Advance Design System (ADS)	Windows	Trial/Paid
17.	NI Labview	Linux/Windows	Trial/Paid
18.	SDR angel	Linux/Windows	Free
19.	IIO Oscilloscope	Linux/Windows/macOS	Free
20.	GNU Radio	Linux/Windows/macOS	Free
21.	MATLAB	Linux/Windows/macOS	Trial/Paid
22.	Scilab	Linux/Windows/macOS	Free
23.	SystemVue	Windows	Trial/Paid
24.	Python	Linux/Windows/macOS	Free

**In this topic we have learnt about the**

- ✓ **SDR Software**
- ✓ **Next we are going to learn IIO Oscilloscope**



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P03\_R01: IIO Oscilloscope



# IIO Oscilloscope

- The ADI IIO Oscilloscope is a cross platform GUI application, which demonstrates the interface of different transceiver boards.
- It supports data transmission and capture and data can be plotted in time domain, frequency domain, constellation and cross-correlation.
- This application shows several settings of SDRs to modify and view using GUI.
- Transmit only designed signals.



### AD9361 / AD9364 Global Settings

Active ENSM:	fdd	Calibration Mode:	auto	TRX Rate Governor:	nominal	Filter FIR configuration:	(None)
ENSM Modes:	fdd	Calibration Modes:	auto	TRX Rate Governor Available:	nominal		
RX Path Rates: BBPLL: 983.040 ADC: 245.760 R2: 122.880 R1: 61.440 RF: 30.720 RXSAMP: 30.720							
TX Path Rates: BBPLL: 983.040 DAC: 122.880 T2: 122.880 T1: 61.440 TF: 30.720 TXSAMP: 30.720							
XO Correction	40000037						
<input type="checkbox"/> Auto Filter							

### AD9361 / AD9364 Receive Chain

RF Bandwidth(MHz):	18.000	Sampling Rate (MSPS):	30.719999	RX LO Frequency(MHz):	2400.000000	RF Port Select:	A_BALANCED	Fastlock Profile:	0	<b>Tracking</b>
			30.719999			<input type="checkbox"/> External RX LO		<input type="button" value="Store"/> <input type="button" value="Recall"/>		<input checked="" type="checkbox"/> Quadrature
<b>RX 1</b>										
Hardware Gain(dB):	71.00									
RSSI(dB):	107.25 dB									
Gain Control:	slow_attack									
Gain Control Modes:	slow_attack									

### AD9361 / AD9364 Transmit Chain

RF Bandwidth(MHz):	18.000	Sampling Rate (MSPS):	30.719999	TX LO Frequency(MHz):	2450.000000	RF Port Select:	A	Fastlock Profile:	0
			30.719999			<input type="checkbox"/> External TX LO		<input type="button" value="Store"/> <input type="button" value="Recall"/>	
<b>TX 1</b>									
Attenuation(dB):	10.00								

# CONT....

**TX 1**  
Attenuation(dB): 10.00  
RSSI(dB): 0.00 dB

 **FPGA Settings**

**Transmit / DDS**

**DMA Buffer**

Sampling Rate (MSPS) 30719999

**DDS**

cf-ad9361-dds-core-lpc

**TX 1**

DDS Mode: DAC Buffer Output

**DAC Buffer Settings**

**File Selection**

(None)  Load

Scale(dBFS): 0.0 dB

**DAC Channels**

- voltage0
- voltage1



# CONT....

ADI IIO Oscilloscope - Capture1



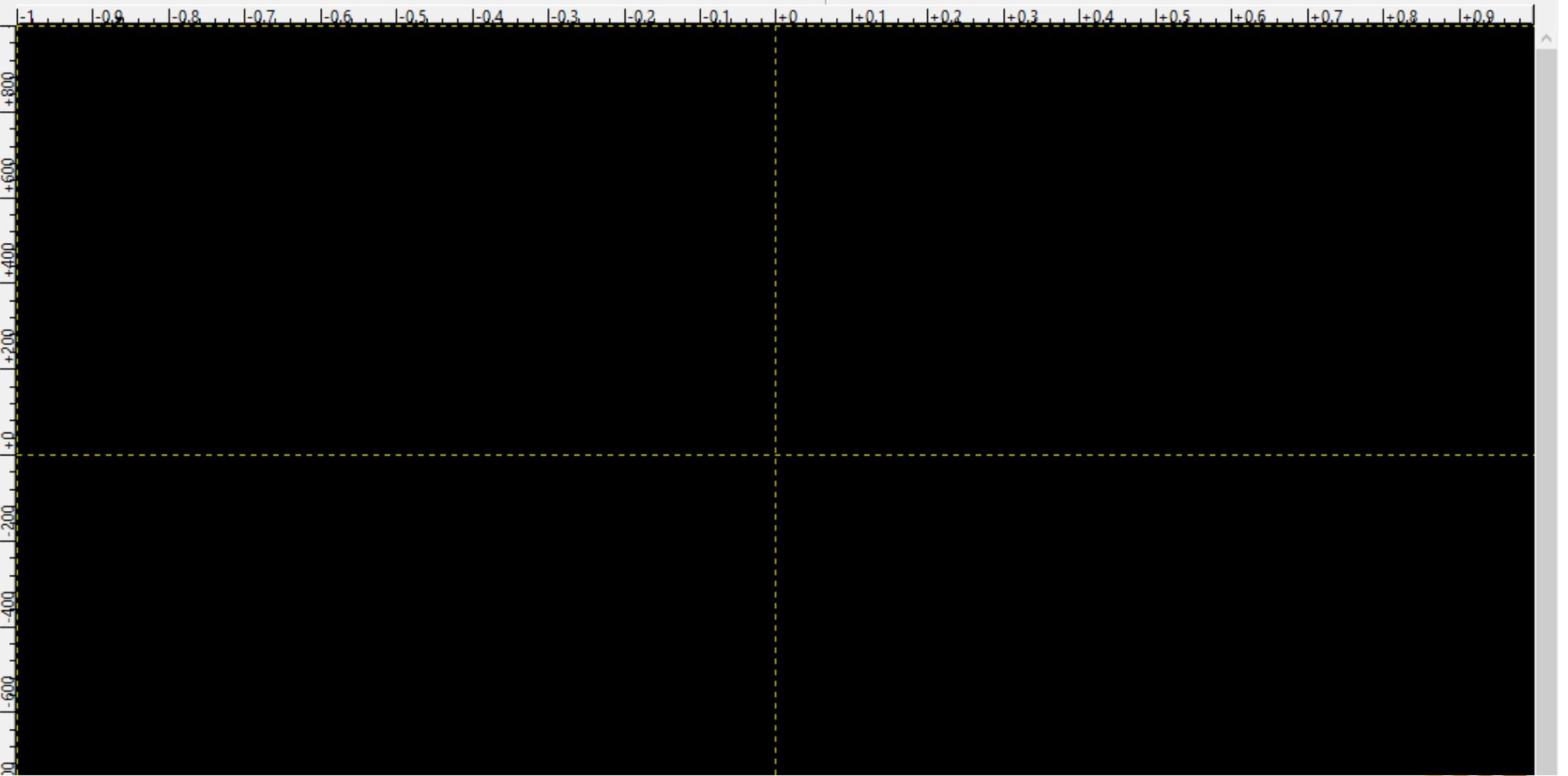
File Edit View

Plot Channels

Enable All

Plot navigation and settings: play, zoom in, zoom out, zoom reset, pan, auto scale, show grid, Y Max: 1000, Y Min: -1000

Samples



Plot Type

Plot configuration: Time Domain, 400 Samples, Graph Type: Lines

Info

Markers Devices

Info panel with scrollable area for Markers and Devices



In this topic we have learnt about the

- ✓ IIO Oscilloscope
- ✓ Next we are going to learn GNU RADIO



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P04\_R01: GNU RADIO



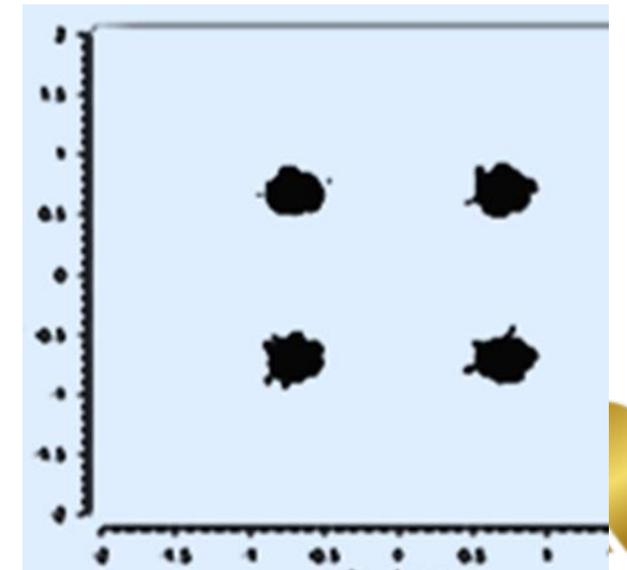
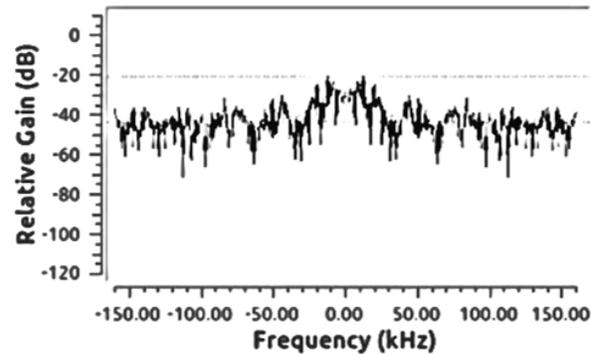
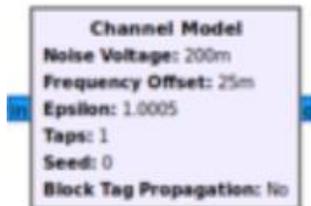
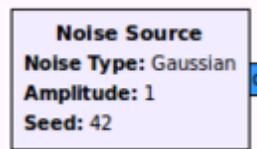
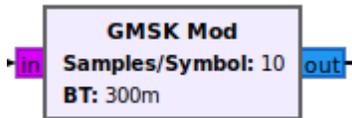
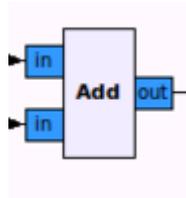
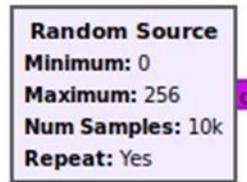
# GNU RADIO

- GNU Radio is an open source Software toolkit for SDR that offers signal processing blocks for the implementation of SDRs.
- Provides hardware support along with simulation like environment.
- Broadly used in research, industry, academia, and hobbyist environments to support both wireless communications research and real-world radio systems.



# CONT....

- The individual processing stages can be thought of blocks which can be configured.



### Waveform Generation

- Constant Source
- Noise Source
- Signal Source  
(Square, Sine etc.)

### Modulators

- AM Demod
- Continuous Phase Modulation
- PSK Mod / Demod
- GFSK Mod / Demod
- GMSK Mod / Demod
- QAM Mod / Demod
- WBFM Receive
- NBFM Receive

### Math Operators

- Abs
- Add
- Complex Conjugate
- Divide
- Integrate
- Log10
- Multiply
- RMS
- Subtract



## Filters

- Band Pass / Reject Filter
- Low / High Pass Filter
- IIR Filter
- Generic Filter bank
- Hilbert
- Decimating FIR Filter
- Root Raised Cosine Filter
- FFT Filter

## Channel Models

- Fading Model
- Dynamic Channel Model
- Frequency Selective Fading Model

## Instrumentation

- Constellation Sink
- Frequency Sink
- Histogram Sink
- Number Sink
- Time Raster Sink
- Time Sink
- Waterfall Sink



## Fourier Analysis

- FFT
- Log Power FFT
- Goertzel (Resamplers)
- Fractional Resampler
- Polyphase Arbitrary Resampler
- Rational Resampler (Synchronizers)
- Clock Recovery MM
- Correlate and Sync
- Costas Loop
- FLL Band-Edge
- PLL Freq Det
- PN Correlator
- Polyphase Clock Sync



In this topic we have learnt about the

- ✓ **GNU RADIO**
- ✓ **Next we are going to learn NI LabVIEW**



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P05\_R01: NI LabVIEW



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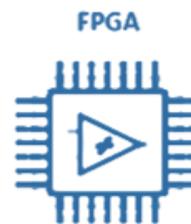
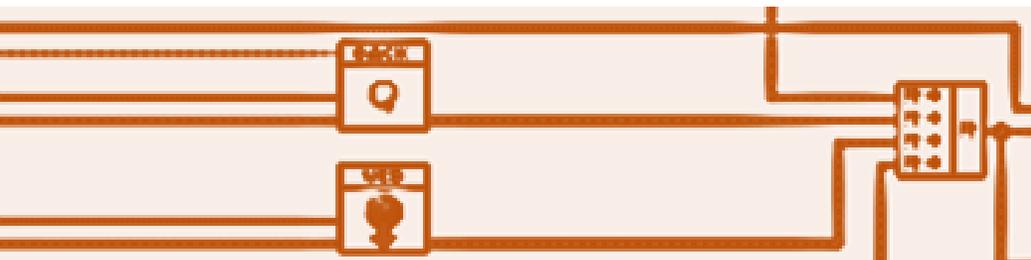
# NI LabVIEW

- A graphical programming interface where the created user interfaces is integrated into the development cycle.
- This graphical approach allows non-programmers to build programs by drag & drop of the virtual representations of lab equipment with which they are already familiar.
- LabVIEW programs-subroutines are termed virtual instruments (VIs). Each VI has three components: a block diagram, a front panel, and a connector pane.



# CONT....

- Also useful in Industrial application & data acquisition.
- Can program FPGA.



**In this topic we have learnt about the**

- ✓ **NI LabVIEW**
- ✓ **Next we are going to learn Python**



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P06\_R01: Python



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# Python

- Python is an open source Software toolkit for SDR that offers signal processing blocks for the implementation of SDRs.
- Lot of pre-built signal Processing Libraries are available.



In this topic we have learnt about the

- ✓ Python
- ✓ Next we are going to learn **MATLAB**



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P07\_R01: MATLAB



# MATLAB

- MATLAB or matrix laboratory is a programming language & numerical computing environment developed by MathWorks.
- Operations like matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.
- Also consist of Simulink where option of block wise programming is available.
- Useful in engineering, science, and economics.



In this topic we have learnt about the

- ✓ **MATLAB**
- ✓ Next we are going to learn **Scilab**



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P08\_R01: Scilab



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# Scilab

- Scilab is a free and open-source, cross-platform numerical computational package and a high-level, numerically oriented programming language.
- It can be used for signal processing, statistical analysis, image enhancement, fluid dynamics simulations, numerical optimization, and modeling, simulation of explicit and implicit dynamical systems and symbolic manipulations.
- Xcos is a graphical editor to design hybrid dynamical systems models. Models can be designed, loaded, saved, compiled and simulated.
- Xcos is freely available and distributed with Scilab.



# CONT....

Scilab 6.1.0 Console

File Edit Control Applications ?

File Browser C:\Users\SDR\_1\Documents\Scilab\

Scilab

Scilab 6.1.0 Console

```
Startup execution:  
loading initial environment  
  
-->
```

Variable Browser

Name	Value	Type	Visibility	Memory
<input checked="" type="checkbox"/> ans	1x1	Boolean	local	212

Command History

```
.....// -- 28/09/2020 10:52:42 -- //
```

News feed

Web tools in Scilab 6.1

## Web tools in Scilab 6.1

Leverage the new functions for server communication, based on the well known web protocol HTTPS:  
[GET](#) to simply get data from remote location [POST](#) to exchange data with the server through the request

# CONT....

Palette browser - Xcos

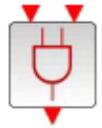
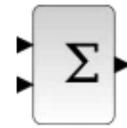
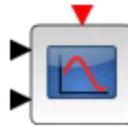
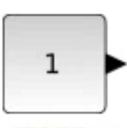
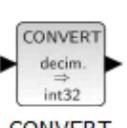
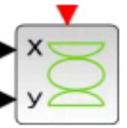
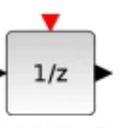
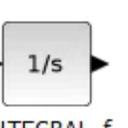
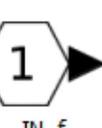
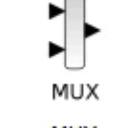
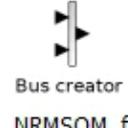
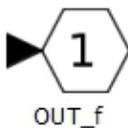
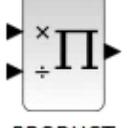
Palettes View



Palette browser - Xcos

Palettes

- Recently Used Blocks
- Continuous time systems
- Discontinuities
- Discrete time systems
- Lookup Tables
- Event handling
- Mathematical Operations
- Matrix
- Electrical
- Integer
- Port & Subsystem
- Zero crossing detection
- Signal Routing
- Signal Processing
- Implicit
- Annotations
- Sinks
- Sources
- Thermo-Hydraulics
- Demonstrations Blocks
- User-Defined Functions

 ANDBLK	 BIGSOM_f	 CMSCOPE	 SCALE_CMSCOPE	 CONST_m	 CONVERT	 CSCOPYX	 DEMUX DEMUX	 DOLLAR_f	 INTEGRAL_f	 IN_f
 LOGICAL_OP	 MUX MUX	 Bus creator NRMSOM_f	 OUT_f	 PRODUCT	 RELATIONALOP	 SATURATION	 Dynamic SWITCH2_m	...	TEXT_f	

In this topic we have learnt about the

- ✓ Scilab
- ✓ Next we are going to learn SDR Angel



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P09\_R01: SDR Angel



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# SDR Angel

- SDR angel is an signal analyzer frontend to various hardware.
- Blade RF
- Hack RF
- LimeSDR
- PlutoSDR
- SoapySDRa
- USRP
- XTRX



# CONT....

The screenshot displays the SDRangel software interface. The top-left pane shows the 'Fileinput' section with a 'R0' channel selected, a 48k sample rate, and a digital display showing '0,000,000 kHz'. Below this is a playback control area with a play button, a volume slider, and a '1' dropdown menu. The 'Spectrum Display' section below features a 'R0' channel selector, a 'Han' filter, a '1k' bandwidth, and various visualization icons. The 'Presets' table at the bottom left is currently empty.

Freq (MHz)	M	Description
------------	---	-------------

The main central area is a large spectrum plot with a vertical axis from -100 to 0.0 and a horizontal axis from 434.980 to 435.020 MHz. The plot is currently empty. On the right side, there is a 'Channels' panel with a 'R0' channel listed.

At the bottom of the interface, there are 'Presets' and 'Commands' sections with various icons for file operations and system control.

In this topic we have learnt about the

- ✓ SDR Angel
- ✓ Next we are going to learn SDR Sharp



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P10\_R01: SDR Sharp



# SDR Sharp

➤ The best free SDR software for Airspy and RTL-SDR dongles!

The screenshot displays the SDR Sharp software interface. At the top, the title bar reads "AIRSPY SDR# v1.0.0.1757 - AIRSPY". The main window features a central spectrum plot with a frequency range from 99,000 M to 107,000 M and a dBFS scale from -130 to -20. A prominent red vertical line is positioned at approximately 102,600 M, with the label "FM Broadcast" below it. The plot shows a wide, flat red band across the entire frequency range, indicating a strong signal or noise floor.

On the left side, there are several control panels. The top panel includes mode selection (WFM, DSB, CW, RAW) and a "Shift" knob. Below this is the "Filter" section, set to "Blackman-Harris 4", with "Bandwidth" (2,00,000) and "Order" (250) controls. Further down are "Squelch" (50) and "CW Shift" (1,000) settings, along with "FM Stereo" and "Step Size" (100 kHz) options. A "Snap to Grid" checkbox is checked. The bottom-left panel lists various processing options such as "Audio", "AGC", "Display", "Audio Noise Reduction", "IF Noise Reduction", "Baseband Noise Blanker", "IF Noise Blanker", "Demodulator Noise Blanker", "Recording", "Zoom FFT", "Band Plan", "Frequency Manager", and "Signal Diagnostics".

The right side of the interface contains a vertical control panel with "Zoom", "Contrast", "Range", and "Offset" sliders. The "AIRSPY" logo is visible in the top right corner.

In this topic we have learnt about the

✓ SDR Sharp

✓ Next we are going to learn SystemVue



# Fundamentals of SDR:RAHSDR480

## Module-4:Software for SDR

RAHSDR480\_L04\_P11\_R01: SystemVue



RAHSOFTWARE

# SystemVue

- Connect system-level design to RF circuit simulation. Verify physical layer system designs. Interoperate with test equipment while wireless standards evolve.
- Validate baseband and RF integration early
- Streamline verification with pre-built test benches
- Easily connect to test equipment
- Perform 5G architecture development and validation
- Create and verify algorithms with baseband libraries
- Simulate real-world scenarios.
- Standards libraries.



In this topic we have learnt about the

✓ **SystemVue**

✓ **Next we are going to learn Module-5:SDR SELECTION CRITERIA**

