

# Low Cost SDR for EMC

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Electro Magnetic Applications, Inc.



**IEEE**





# Useful Equipment





# Useful Equipment





# Useful Equipment





# Useful Equipment



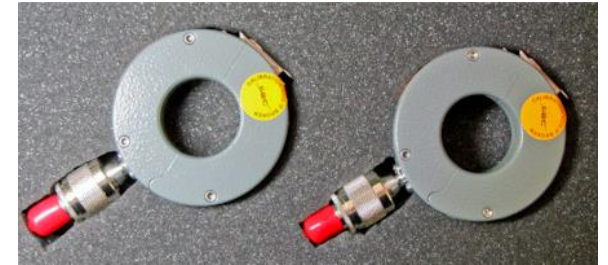


# Useful Equipment





# Useful Equipment





# Useful Equipment

Essential Tools for EMC Troubleshooting

Kenneth Wyatt







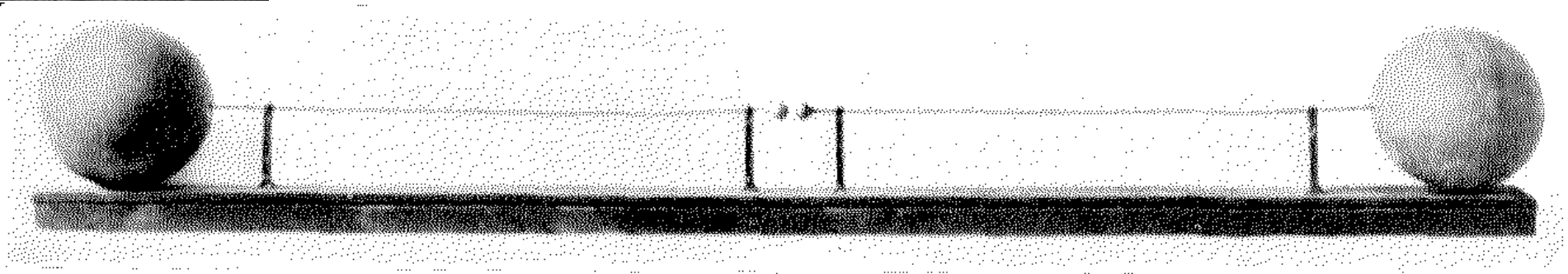
# Low Cost SDR





## 1886

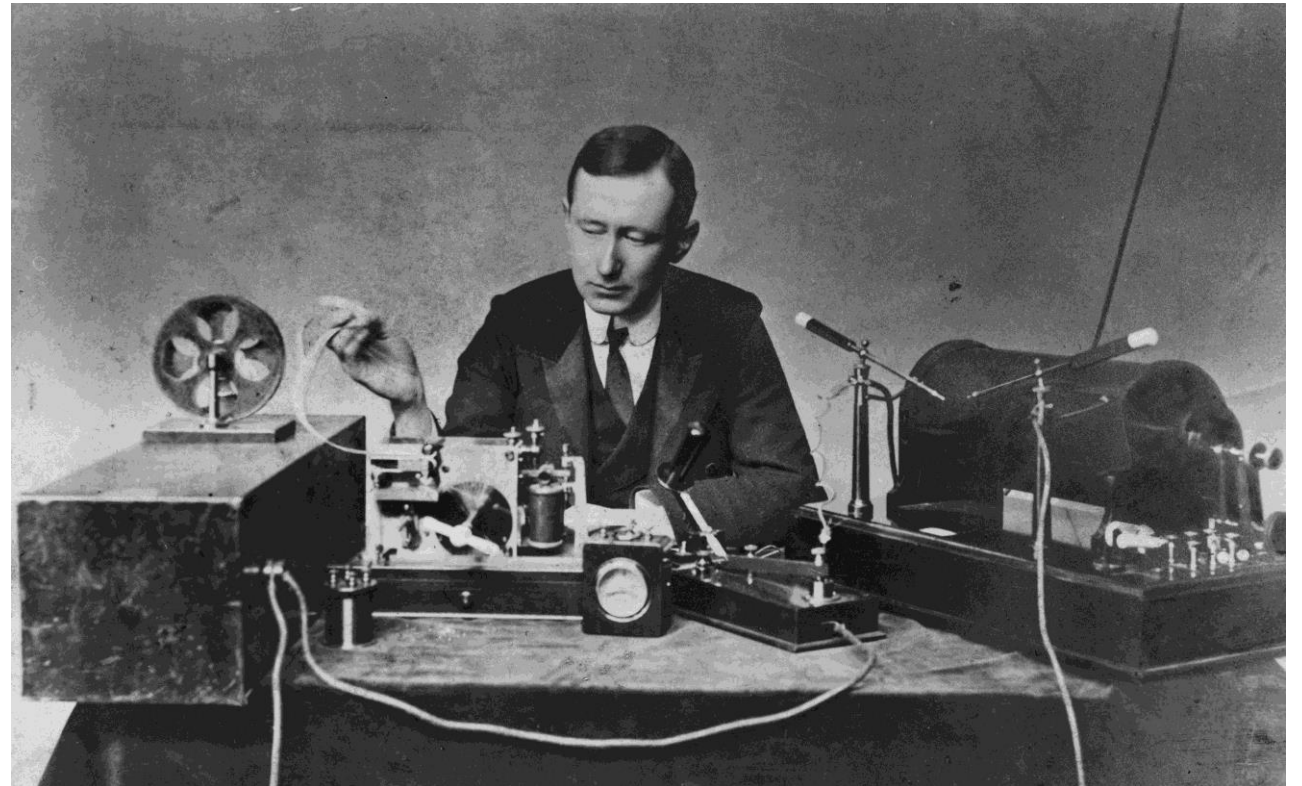
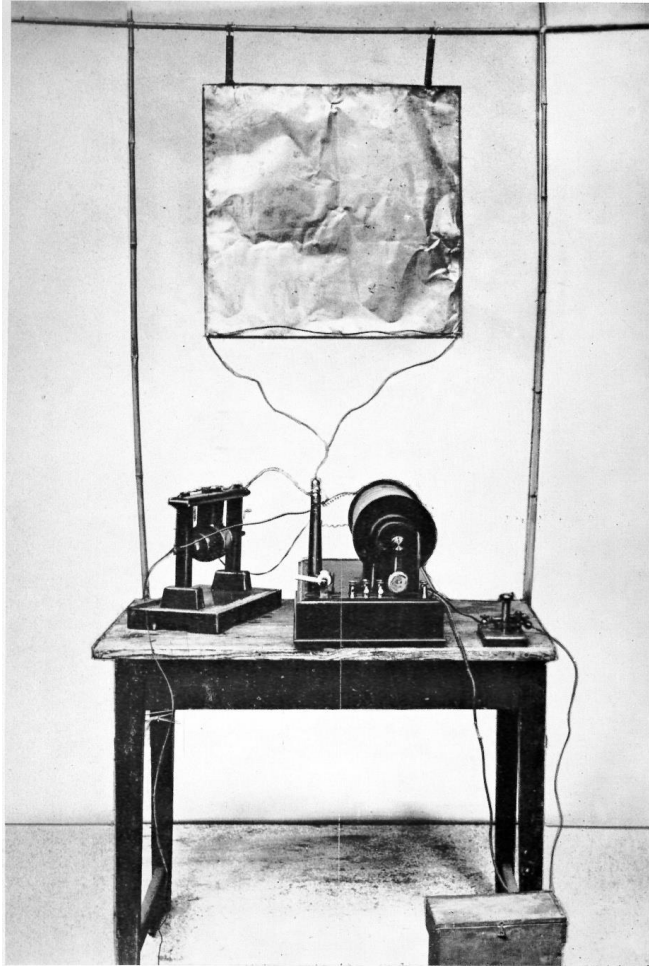
Heinrich Hertz proves the existence of electromagnetic waves





## 1896/1901

Marconi develops radio transmitters and demonstrates transatlantic communication



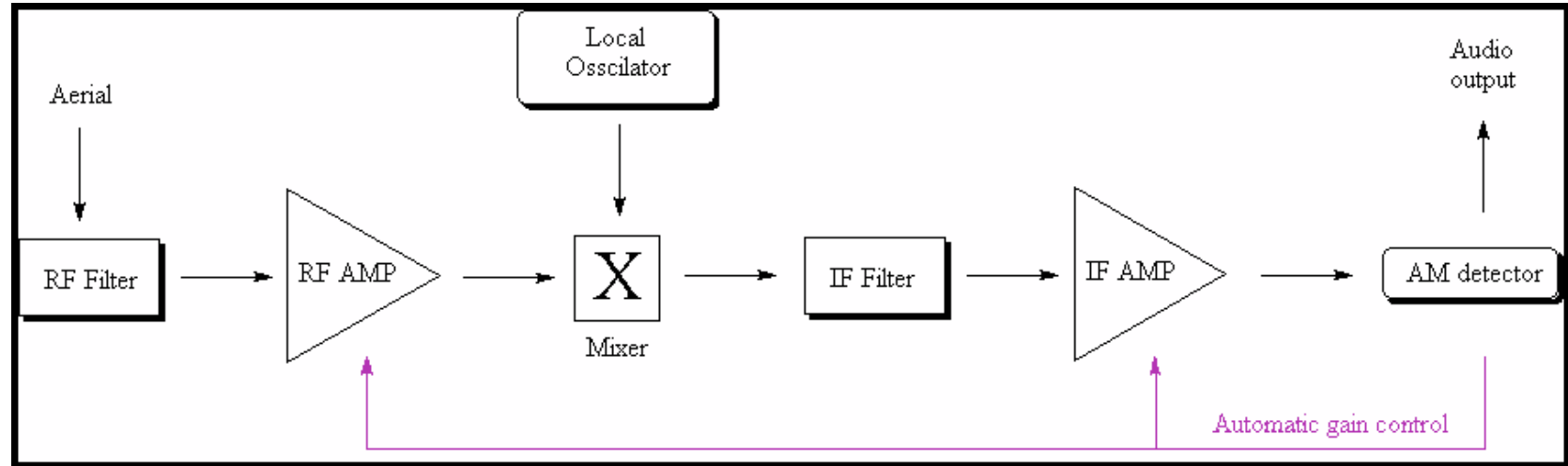


E. H. ARMSTRONG  
inventor of the "feed-back" circuit, in the uniform of a major in the Signal Corps during the war



## 1917

Lucien Lèvy, Edwin Armstrong, and Walter Schottky all file patents for the superheterodyne radio



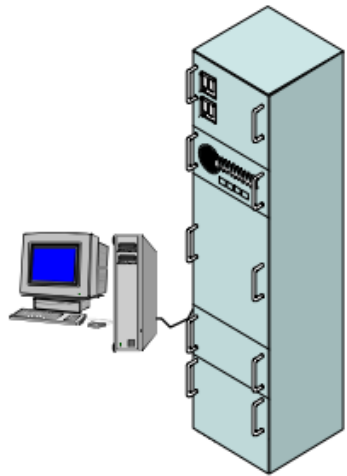


Skip ahead  
a bit...



## 1991

US Military commissions SpeakEasy program to develop SDR



Phase-1 Equipment Rack

## 1994

SpeakEasy I successfully demonstrated

## 1998

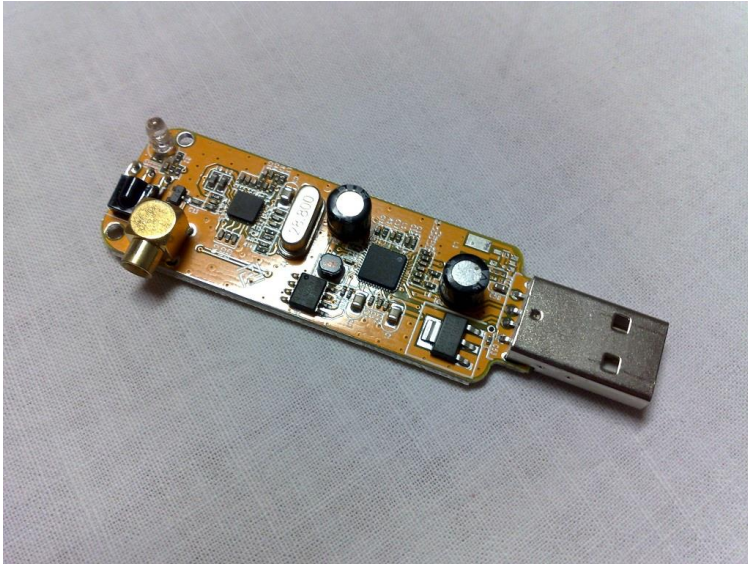
SpeakEasy II successfully demonstrated



Phase-2 TF-XXI Model



## 2012



Eric Fry and others discovered that the guts of a mass produced Digital HDTV USB receiver, using the RTL2832U chip (pictured) could be used as a wideband (3 MHz) SDR receiver



2021

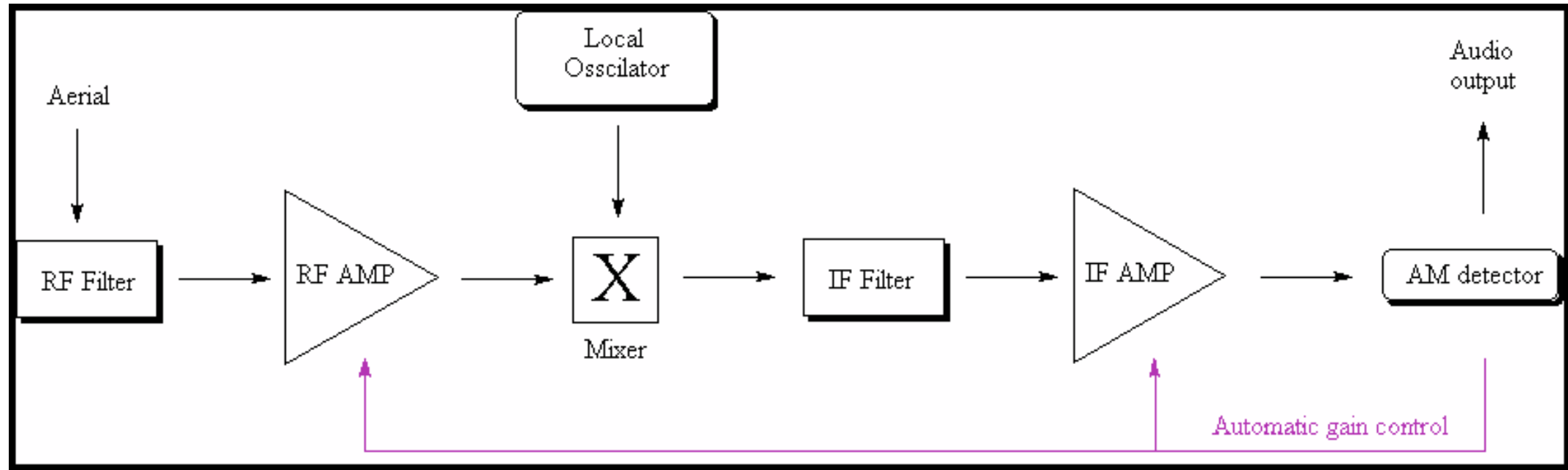


SDR dongles + antennas available for < \$30 on Amazon, SDR Freeware ubiquitous





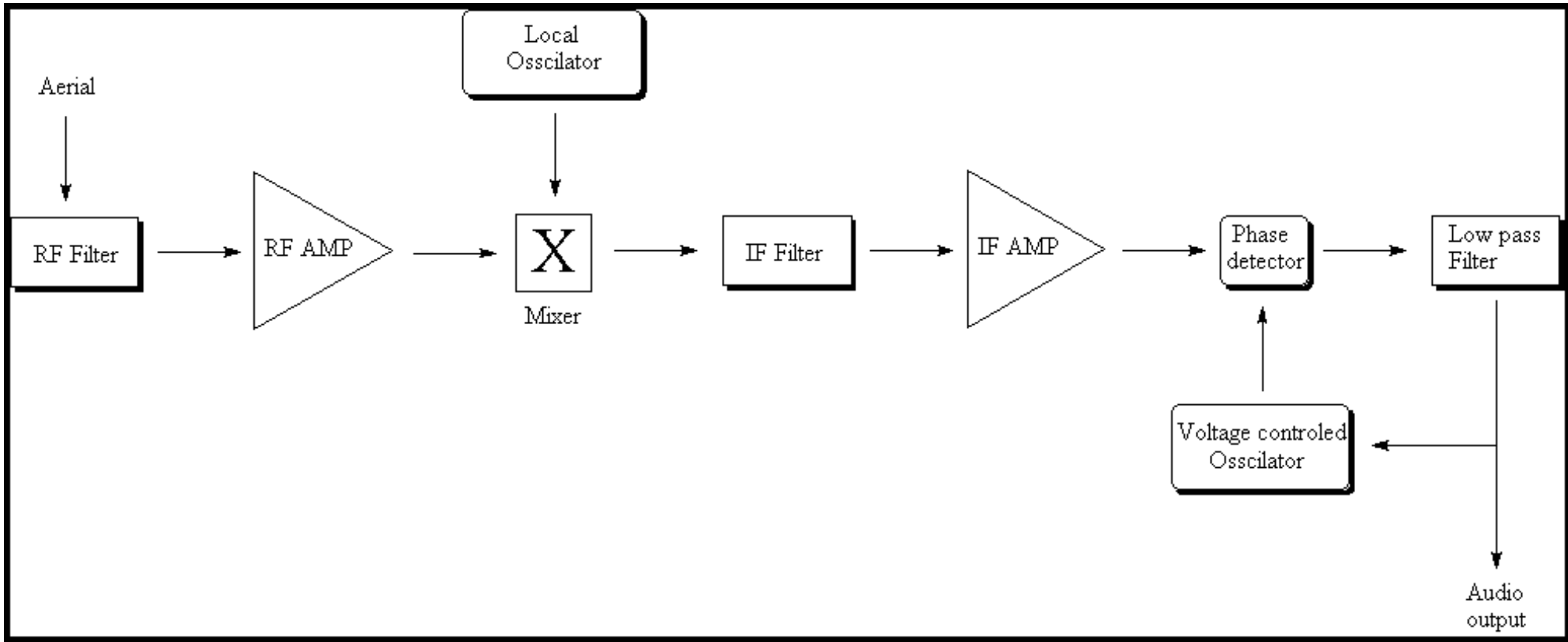
# Radio Architecture



Superheterodyne AM Receiver



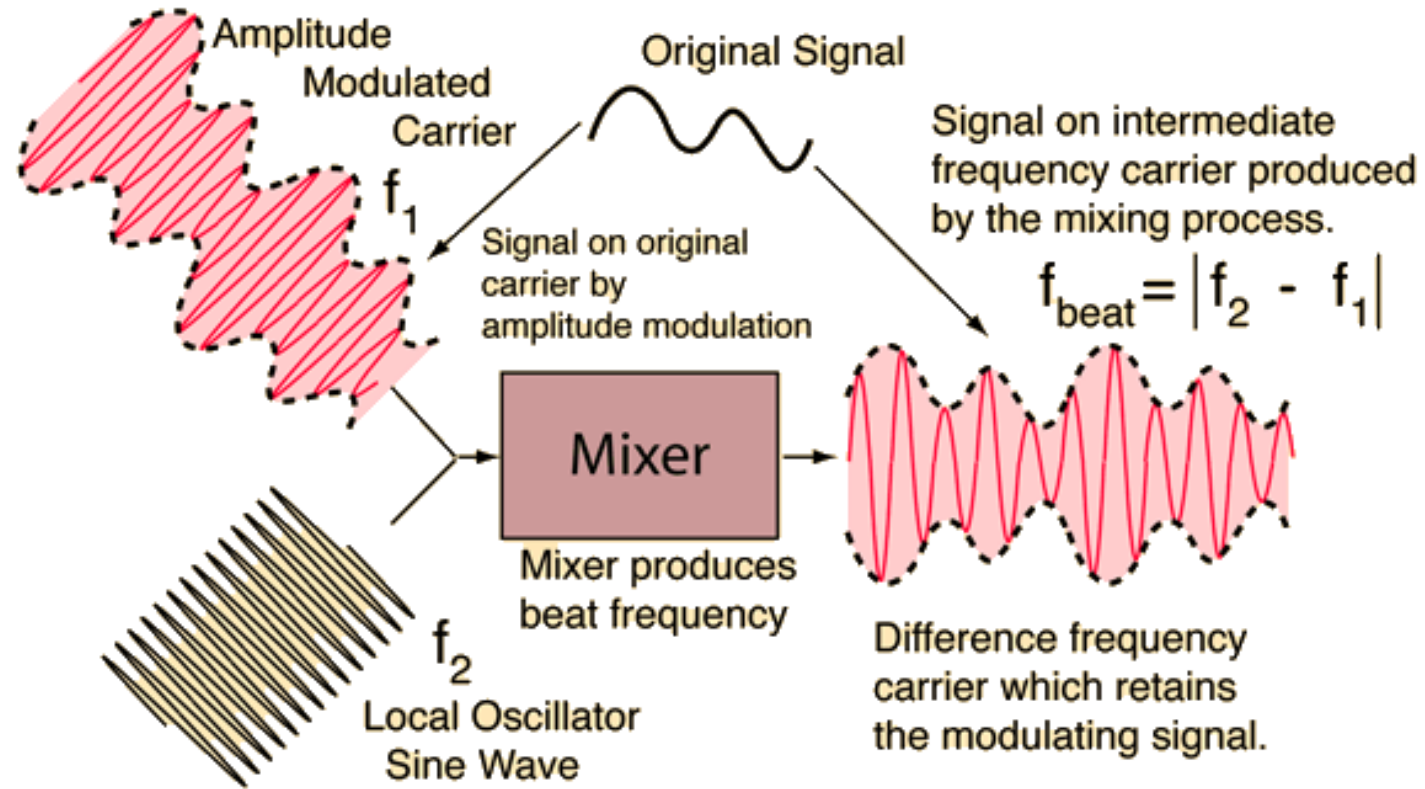
# Radio Architecture



Superheterodyne FM Receiver

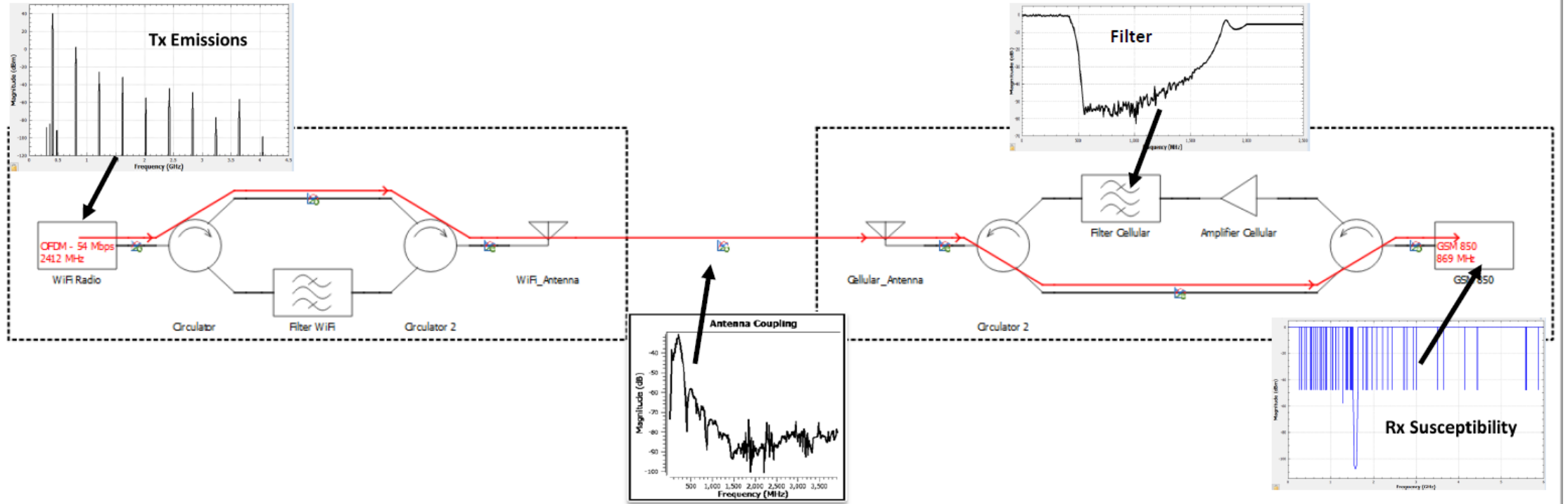


# Mixer Product



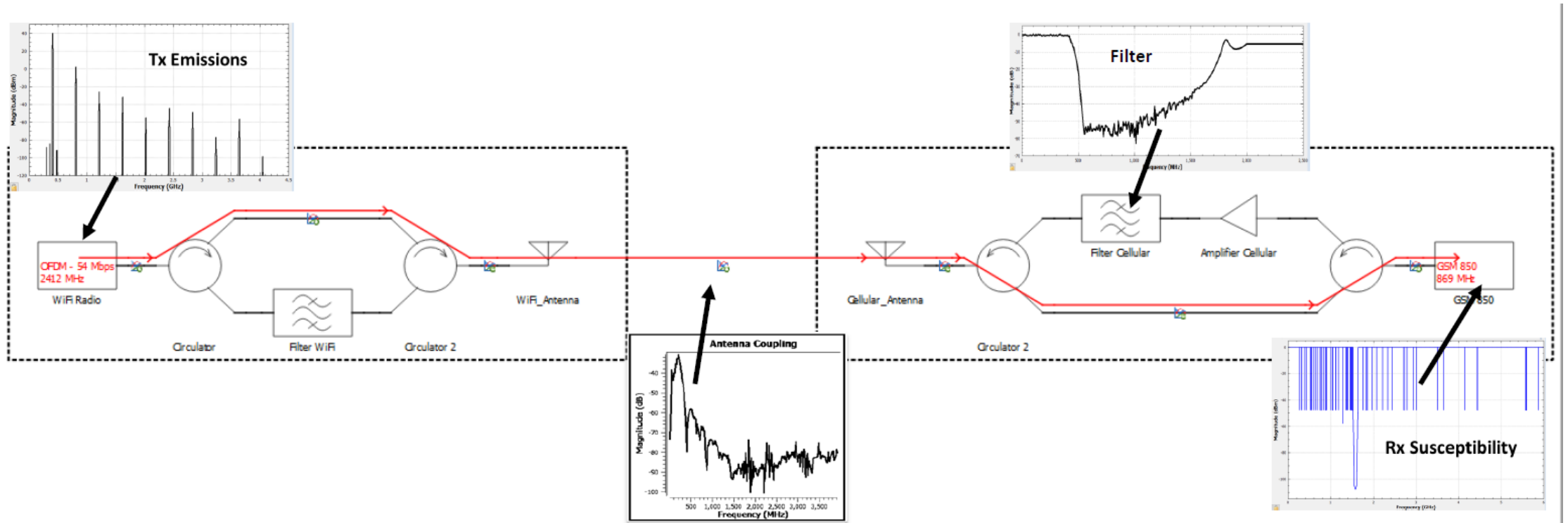


# Interference





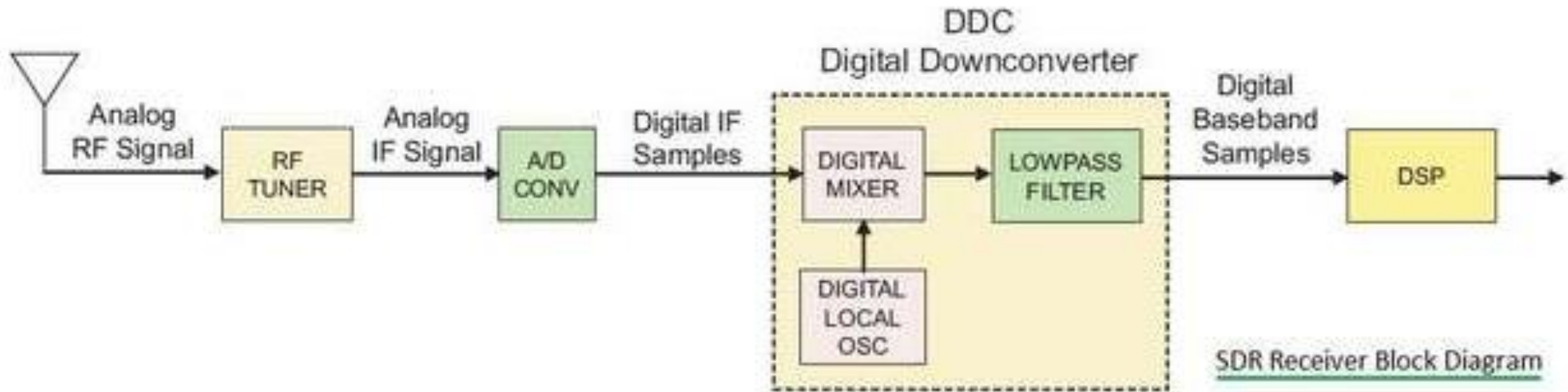
# Interference



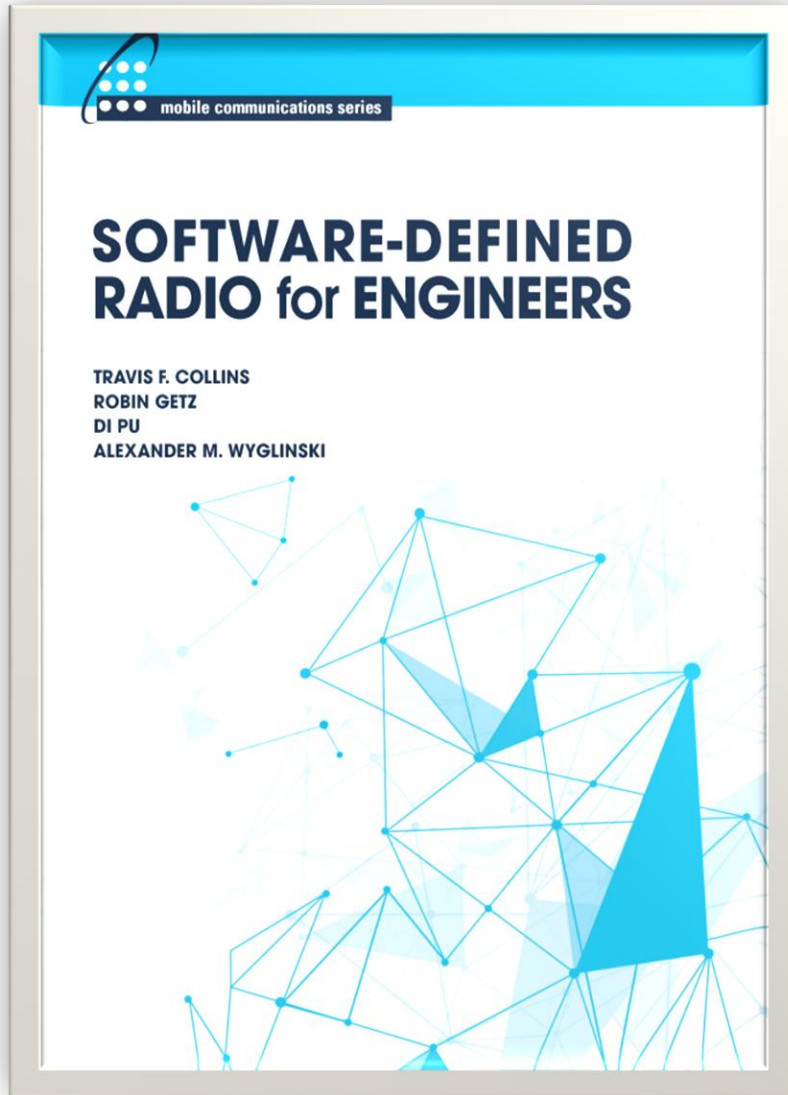
“Modeling Radio Frequency Interference (RFI) Between Co-Located RF Systems” 2021-01-0153, SAE WCX



# SDR Architecture



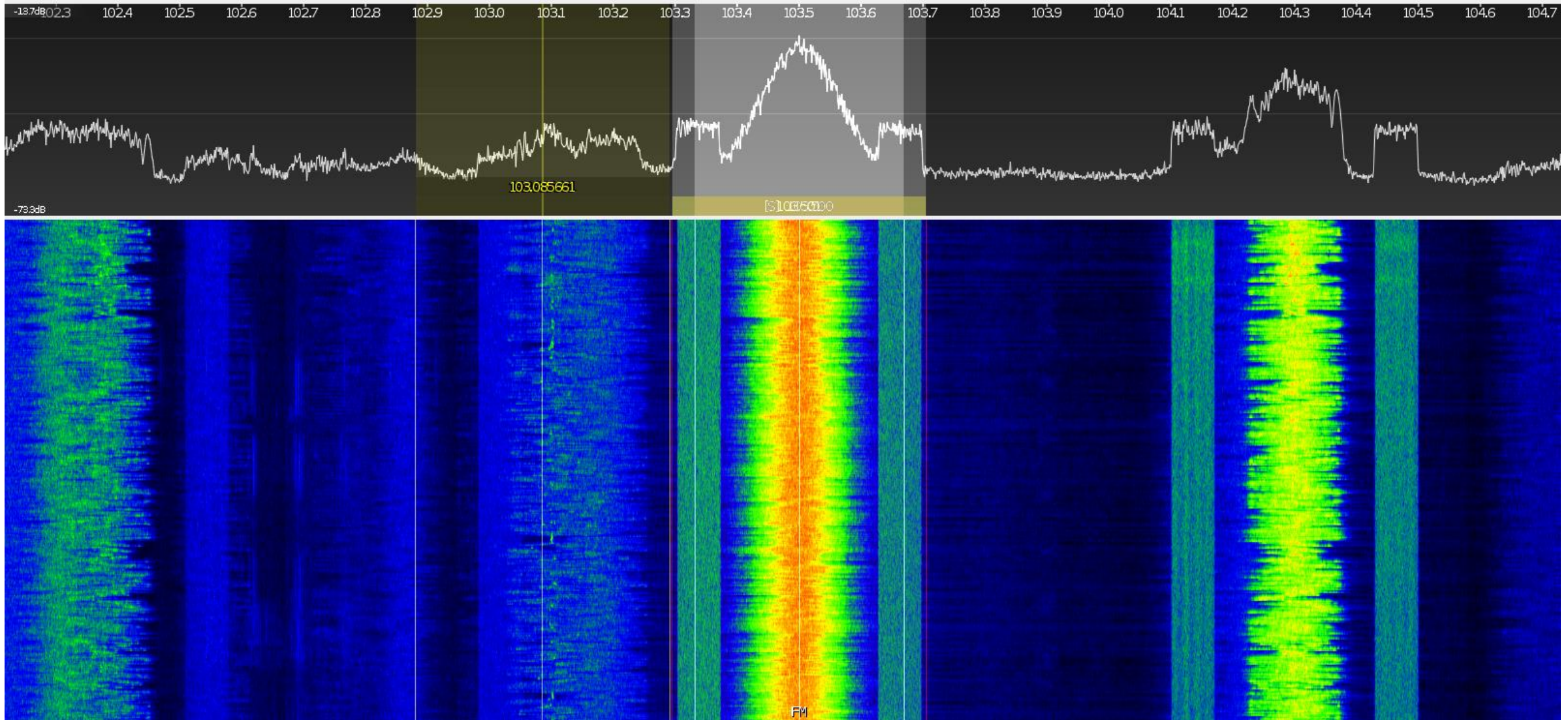
Source: RF Wireless World



<https://www.analog.com/media/en/training-seminars/design-handbooks/Software-Defined-Radio-for-Engineers-2018/SDR4Engineers.pdf>



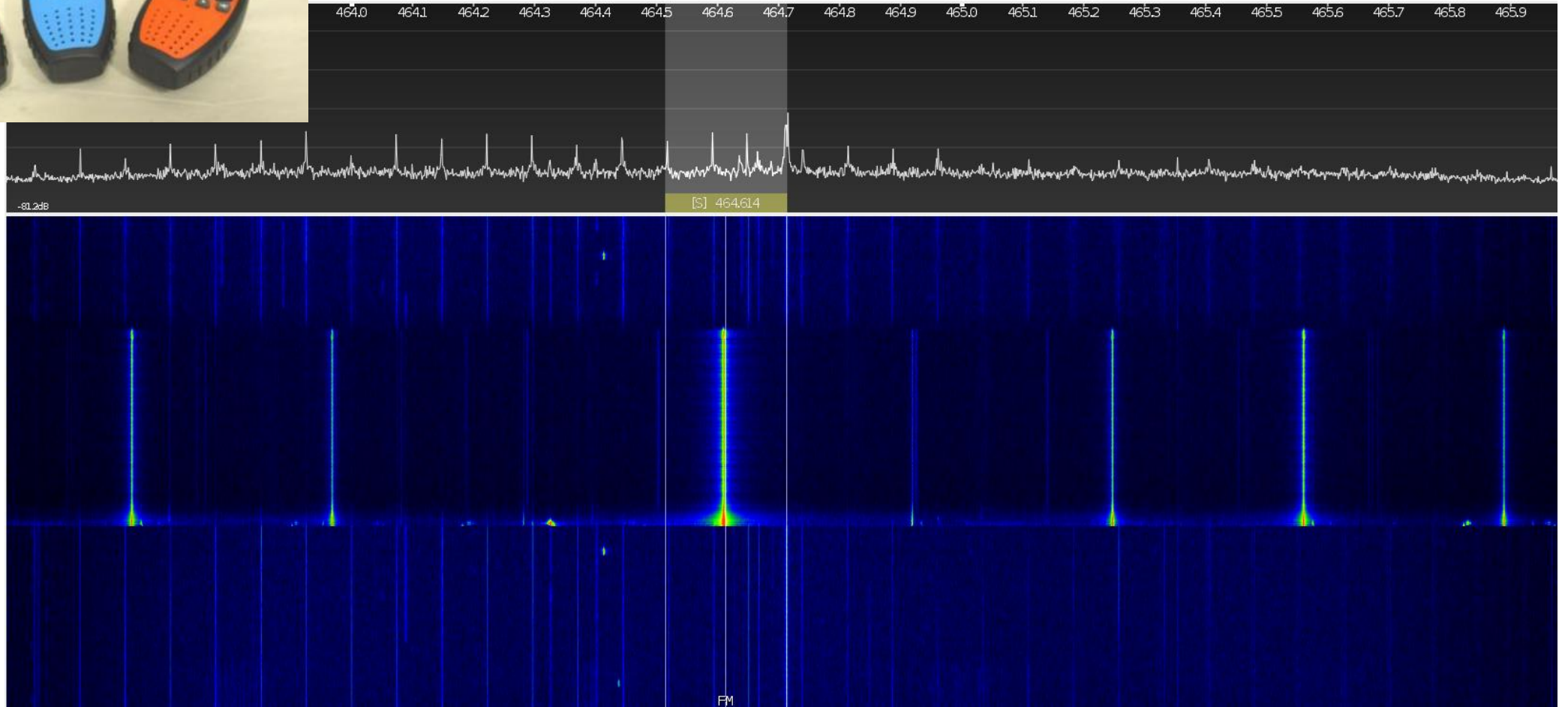
# SDR Applications – FM Radio





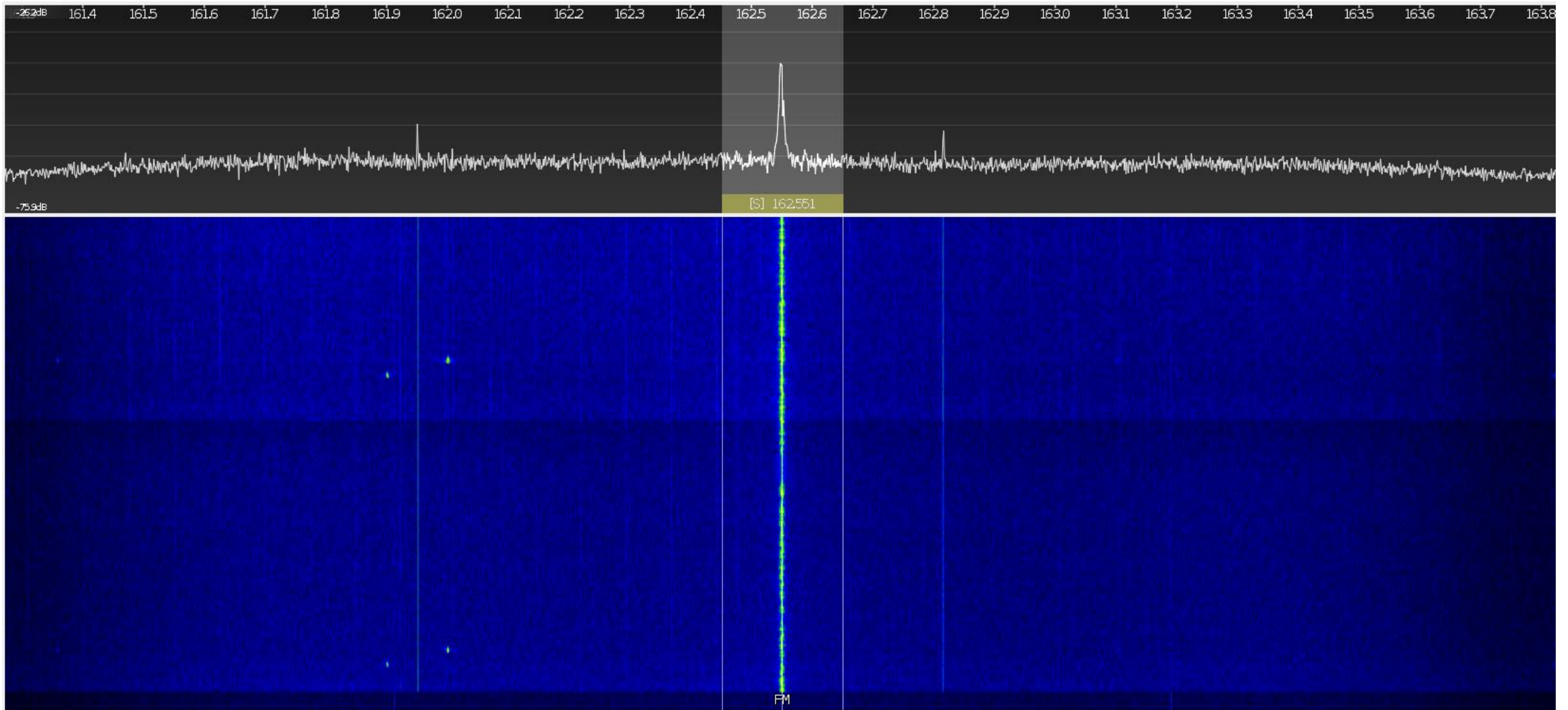


# SDR Applications – Family Radio System





# SDR Applications – Short Wave Radio (NOAA)





# SDR Applications – Listening

- Police/EMS Scanner
- Baby monitors
- Local Ham radio traffic in frequency range
- ISS Comms (145.825 MHz when ISS is locally overhead)
- Amateur radio astronomy
- Air traffic control (108 – 135 MHz, AM)
- Aircraft Tracking (1090 MHz)



# SDR Applications – Track Aircraft

Mode S data Tx on  
1.090 GHz from aircraft

The image shows two software windows. The left window is RTL1090, displaying a list of Mode S data packets received from an aircraft at 1090.000 MHz. The right window is the Virtual Radar Server interface, showing the server status as online and a table of tracked aircraft.

IP Address	User	Last Request	Bytes Sent	Last URL

Name	Connection Status	Total Messages	Bad Messages	Aircraft Tracked
Receiver	Connected	214	0	4

<https://www.youtube.com/watch?v=9QzklSyKqQM>



# SDR Applications – Track Aircraft

Can feed into web application to track live on map and pull aircraft database information

**G-EUPZ** 400935  
British Airways  
United Kingdom  
Airbus A319 131  
Altitude: 7025 ft 0 ft/m  
Vertical Speed: 0 ft/m  
Speed: 271.7 kts  
Heading: 112.5°  
Distance: 9.43 nmi  
Squawk: 4236  
Engines: Twin jet  
Species: Landplane  
Wake Turbulence: Medium  
Route: EGAC George Best Belfast City, United Kingdom  
EGLL London Heathrow, United Kingdom

Silhouette	Flag	Reg.	ICAO	Callsign	Route	Altitude	Speed
		CS-GLE	491D85	NJE244K		9575 ft	
		TC-JOF	4BA9E6				
		G-EUYX	406862			8425 ft	255.8 kts
		G-TCDH	406037			30000 ft	395.9 kts
		CN-RNQ	020026			7975 ft	255.5 kts
		BI-DCJ	4CA226	RYR724F	LIPE-EGCC	36000 ft	379.0 kts
		G-EUPZ	400935	SHT88C*	EGAC-EGLL	7025 ft	271.7 kts
		G-PRPD	40609A	BEEIVF*	EGFF-EGLC	9675 ft	

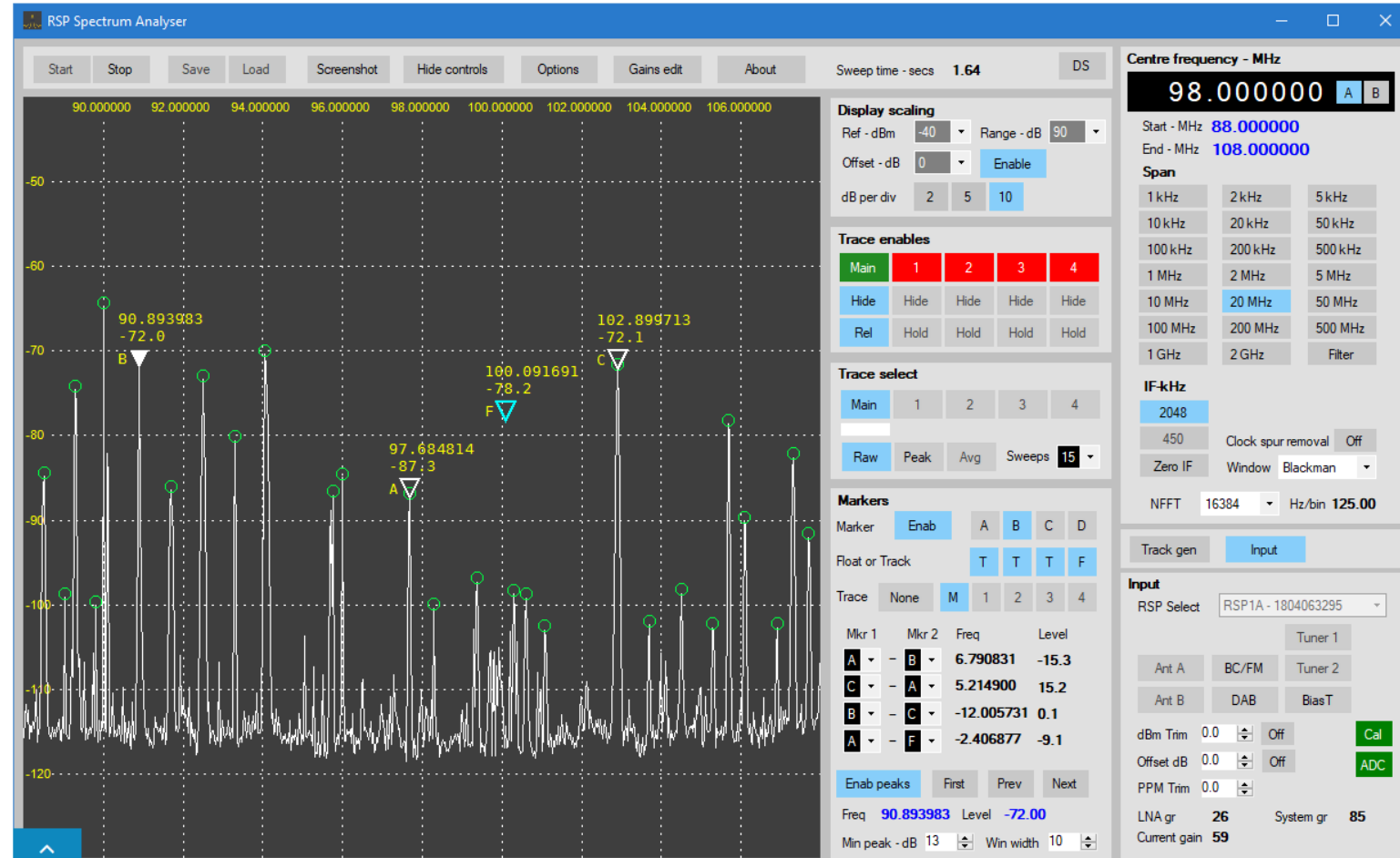
Powered by Virtual Radar Server

<https://www.youtube.com/watch?v=9QzklSyKqQM>



# SDR Applications – Spectrum Analyzer

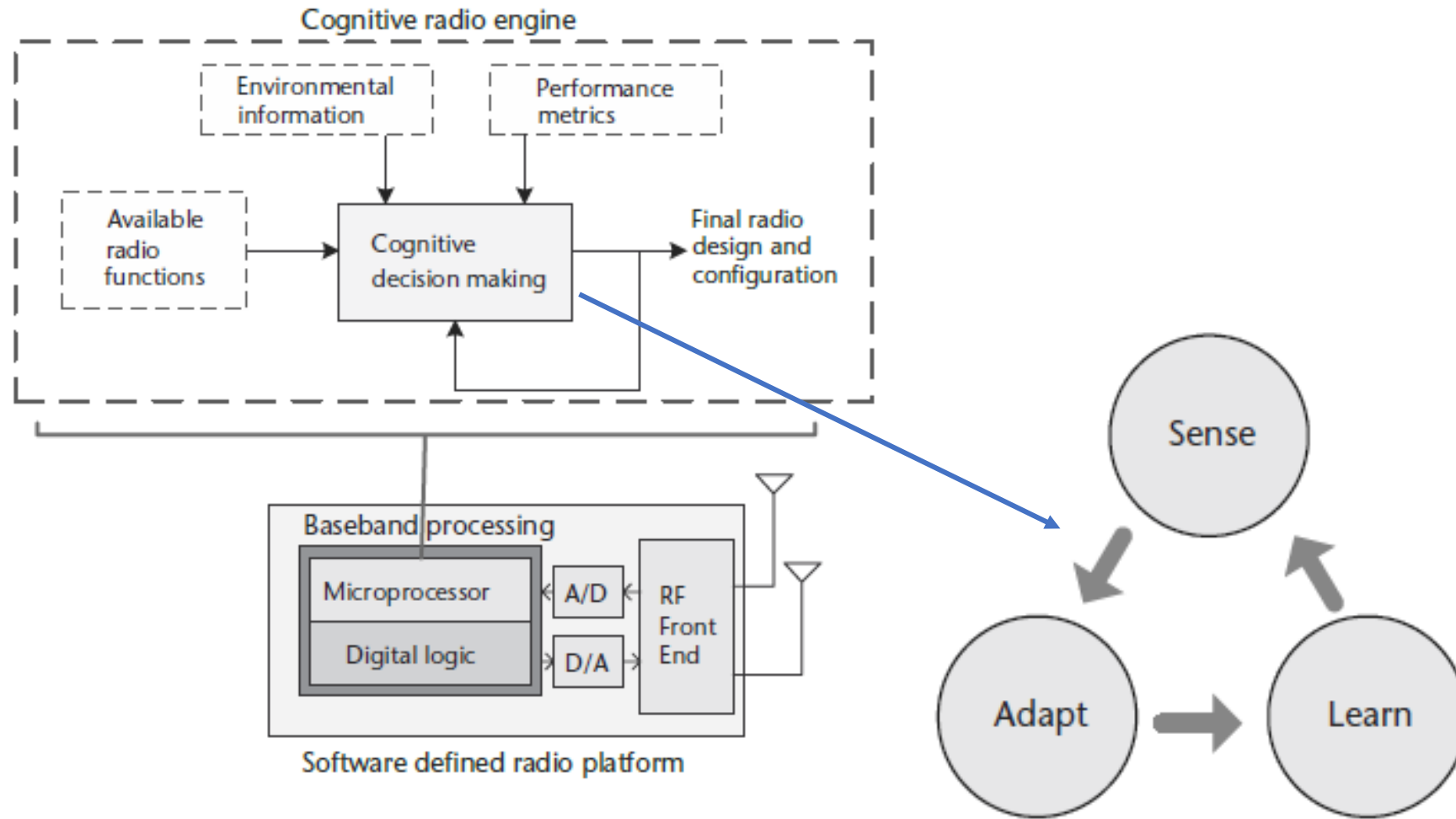
SDRPlay freeware has spectrum analyzer-specific functionality. Compatible with SDRPlay RSP units (\$100 – 300)



<https://www.sdrplay.com/spectrum-analyser/>

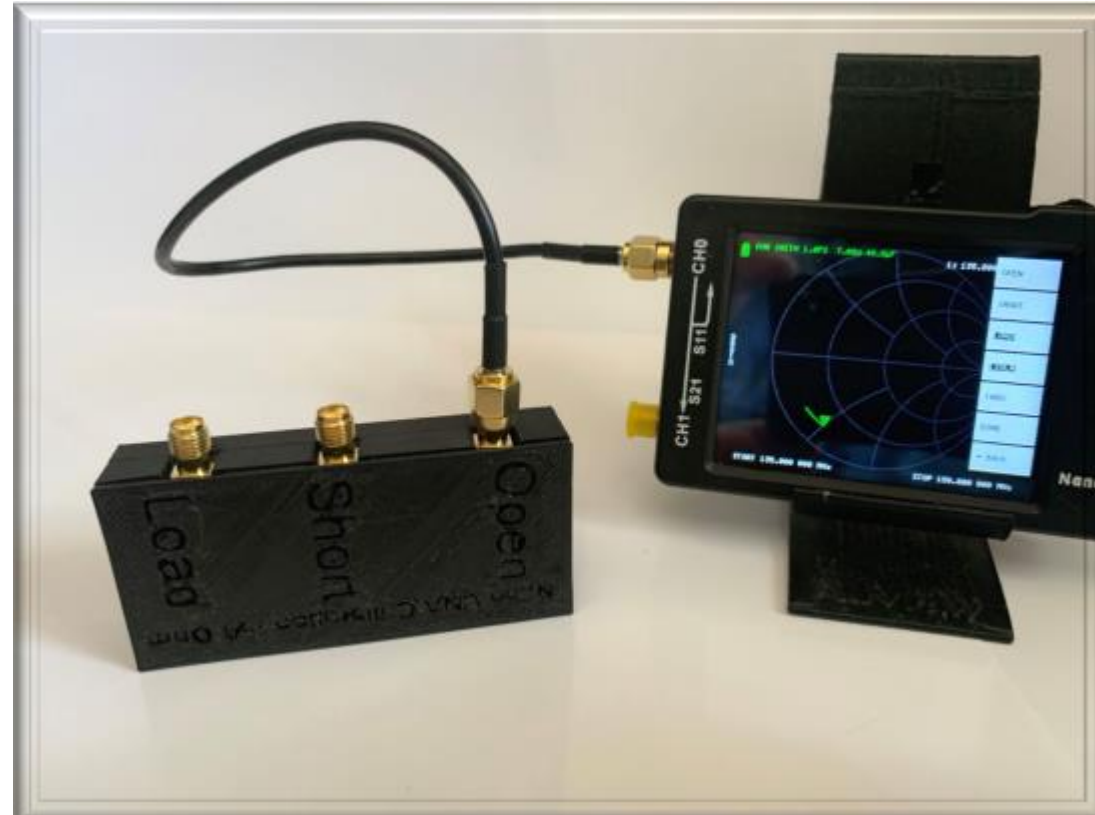


# SDR Applications – Cognitive Radio





Using different technology, NanoVNA's are now available for < \$100, and can be used either stand-alone or with computer software packages to analyze a wide range of systems







- 25 MHz – 1.7 GHz
  - Range can be extended down to 100 kHz with “Ham It Up” up-converter module

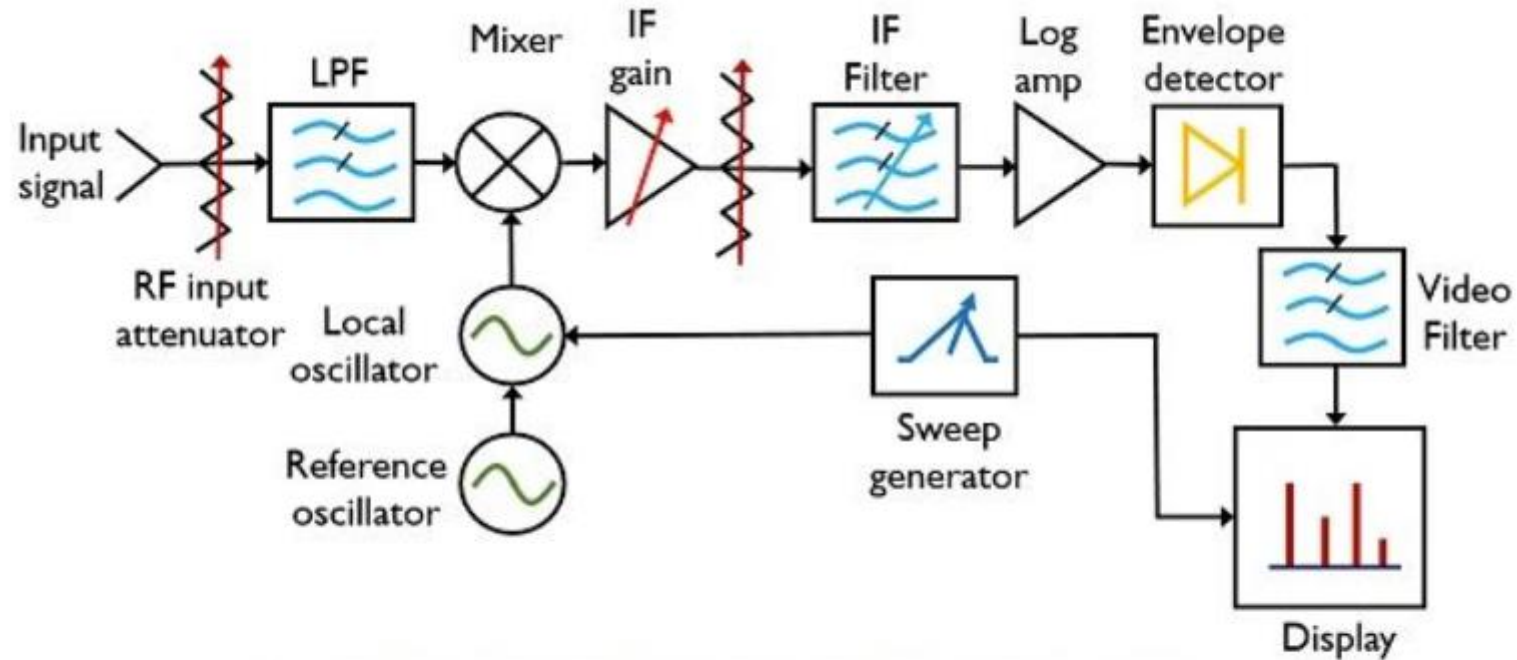
## Technical Details

[^ Collapse all](#)

### [^ Other Technical Details](#)

Brand	NooElec
Item model number	NESDR SMART Bundle
Item Weight	5.3 ounces
Product Dimensions	11.42 x 3.94 x 0.79 inches
Item Dimensions LxWxH	11.42 x 3.94 x 0.79 inches
Power Source	USB
Manufacturer	Nooelec Inc.
ASIN	B01GDN1T4S
Is Discontinued By Manufacturer	No
Date First Available	June 17, 2016

# Spectrum Analyzer

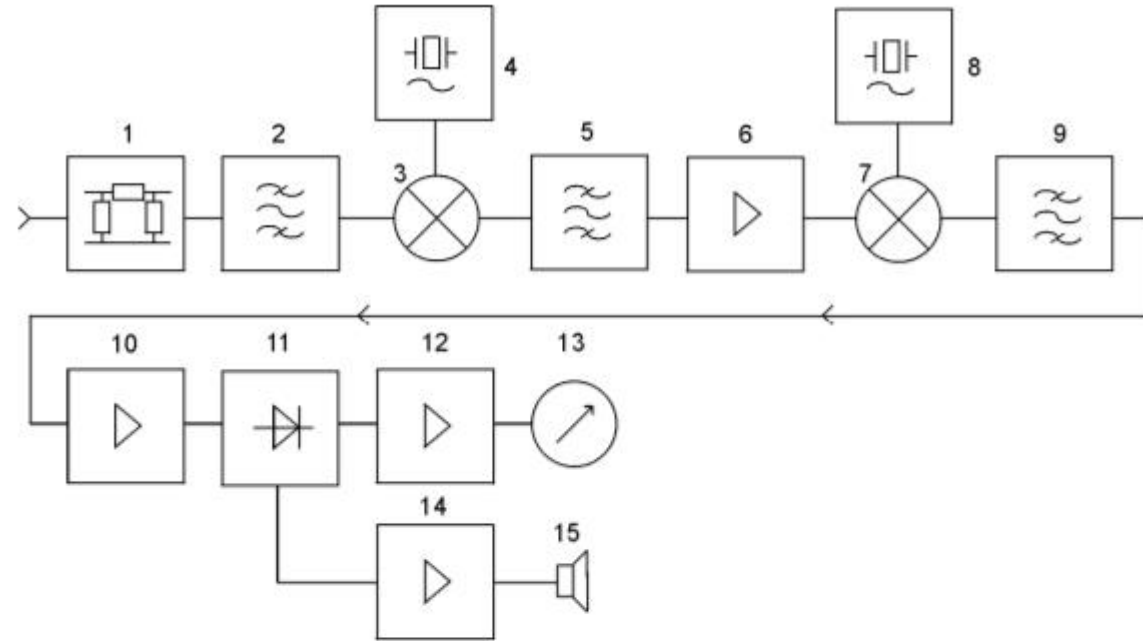


Block Diagram of Spectrum Analyzer

Electronics Desk

<https://electronicsdesk.com/spectrum-analyzer.html>

# EMI Receiver



<http://www.schwarzbeck.com/appnotes/EMIRcvrCISPR16.pdf>

Fig. 2: Block Diagram of an EMI-Receiver (simplified)

- 1: Input Step Attenuator
- 2: Preselector
- 3: 1st Mixer
- 4: 1st Local Oscillator
- 5: 1st IF-Filter
- 6: IF-Amplifier
- 7: 2nd Mixer
- 8: 2nd Local Oscillator
- 9: 2nd IF-Filter
- 10: IF-Amplifier
- 11: Demodulator / Detectors
- 12: Display Amplifier
- 13: Display
- 14: Audio-Amplifier
- 15: Loudspeaker / Headphone

# Questions?

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