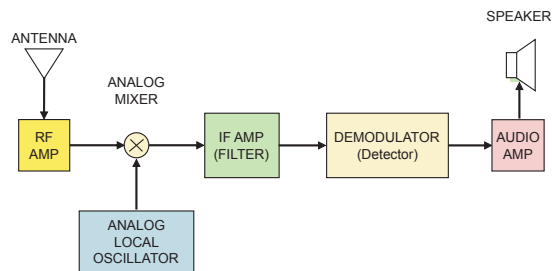


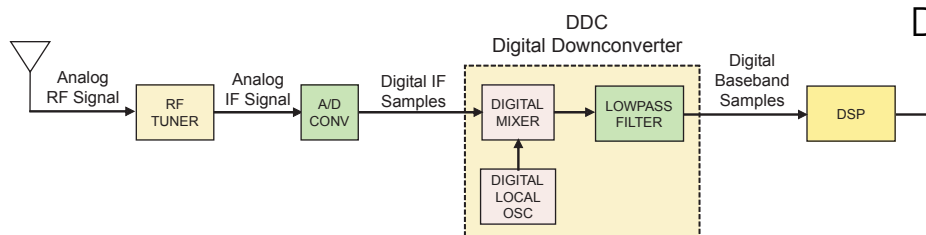
Experiments with Software Defined Radio and the RTL-SDR dongle

Eric Hansen, KB1VUN
Twin State Radio Club, September 2016

What is software defined radio?



Analog radio



Digital radio (SDR)

Ref: Pentek, Software Defined Radio Handbook, 12/e
<http://www.pentek.com/pildocs/8363/techother/DGTLRCVRHBK43.PDF>

How SDR is my radio?

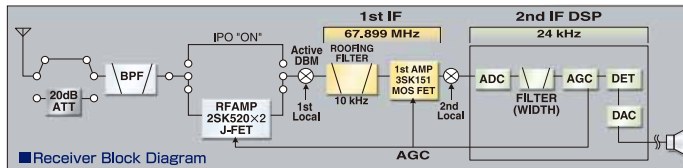
Neither of these is “SDR”, but they use digital signal processing

- Digital modes (PSK31, AFSK-RTTY, JT65) use audio sent by SSB. To receive, digitize the **audio** after SSB detection, then use software to decode (FLdigi, WSJT-X).



<http://www.tigertronics.com>

- Lots of radios have a DSP chip in the second IF, e.g., Yaesu FT-450D:

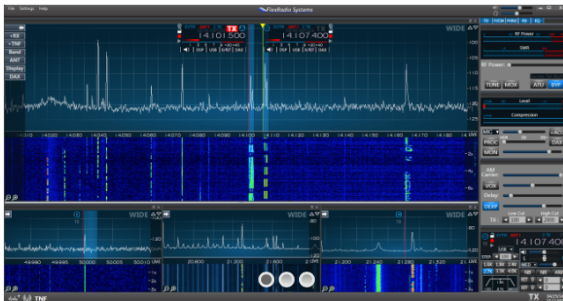


Ref: FT-450D product brochure

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Direct sampling SDR digitizes the RF

FlexRadio 6000 series
The radio is in the box, the user interface is in your PC



ICOM 7300
SDR with a “traditional” user interface



Direct RF sampling is limited by A/D conversion speed – gets harder above 50 MHz.

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Easy to get started listening with SDR



"RTL-SDR dongle" — this one about \$20 online

Get an adapter for an external antenna:

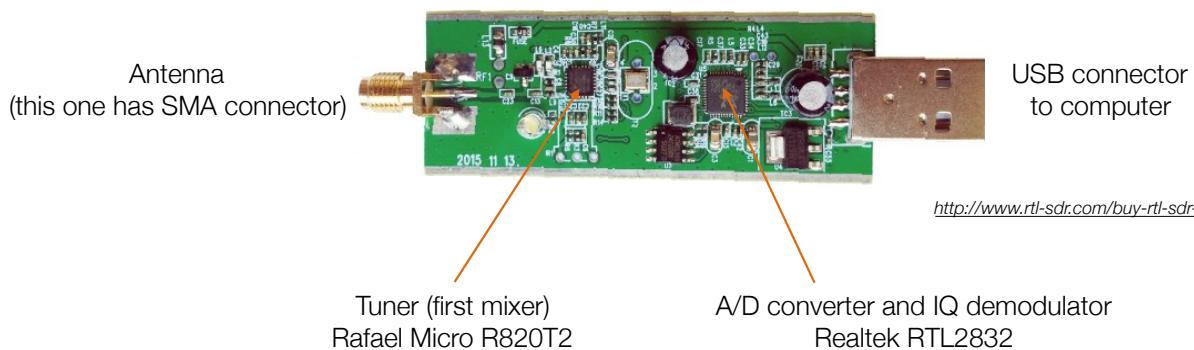


This MCX to UHF adapter — \$6.50 online

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The RTL-SDR dongle is...

Not direct sampling — digitizes first IF



Originally designed for European DVB-T television reception, it was discovered in 2010 that the dongle could be used for much, much more.

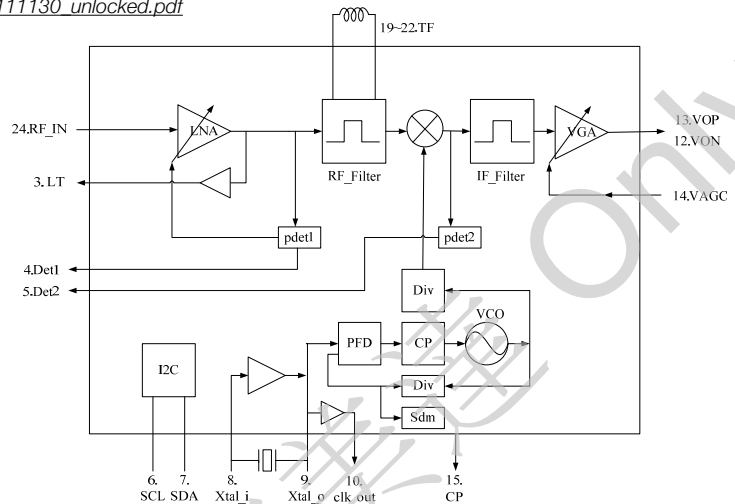
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R820T2 tuner

Datasheet

http://superkuh.com/gnuradio/R820T_datasheet-Non_R-20111130_unlocked.pdf

Operating range (nominal): 24-1766 MHz



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RTL2832 demodulator

The purpose of this chip is to receive the IF from the tuner and...

- Digitize the IF
- Mix the digitized IF down to obtain I and Q components
 - DVB-T signals are digital, bits are coded using amplitude and phase modulation,
<https://en.wikipedia.org/wiki/DVB-T>
 - I and Q preserve amplitude and phase for digital modulation, good for analog modes as well
- Output the I and Q signals, with selectable sampling rates, to USB port.

Realtek describes capabilities but does not make data sheet publicly available

<http://www.realtek.com.tw/products/productsView.aspx?Langid=1&PFid=35&Level=4&Conn=3&ProdID=257>

There has been a lot of reverse engineering: see <http://www.rtlsdr.com>

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For sub-VHF frequencies...

Upconverters

- Build your own
 - R. Nickels, W9RAN, "Cheap and Easy SDR" — QST, Jan 2013, pp 33ff
- Buy one online, e.g., NooElec "Ham It Up"

Or hack the dongle

- <http://www.rtl-sdr.com/rtl-sdr-direct-sampling-mode/>

Now, what about the software?

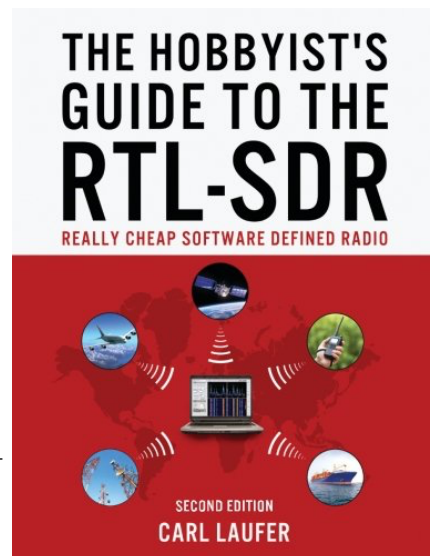
Turnkey solution for Windows: **SDR#** — <http://airspy.com>

- SDR# is a free download, runs on Vista, 7, 8, 8.1, 10
- Easy automated installer here: <http://rtlsdr.org/softwarewindows>

While you're at it, get this book (\$20 online)

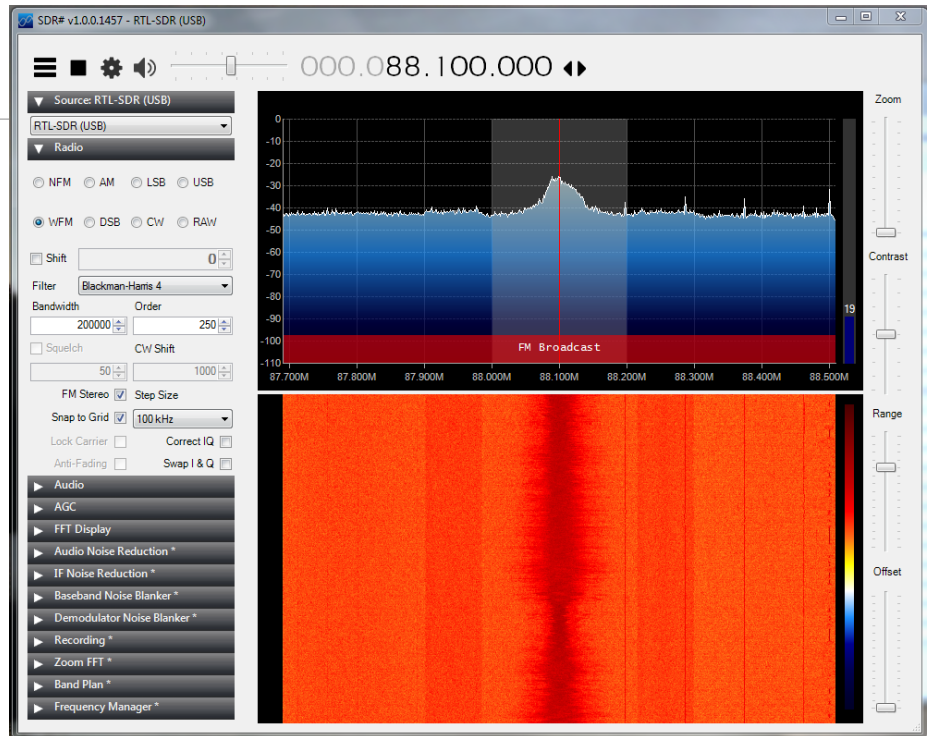
Turnkey solution for MacOS and Linux: **GQRX** — gqrx.dk

- On the Mac, you also need XQuartz: <https://www.xquartz.org>
- GQRX runs from a terminal "shell" (command line)
- Installation is simplified by using Macports: <https://www.macports.org>



SDR#

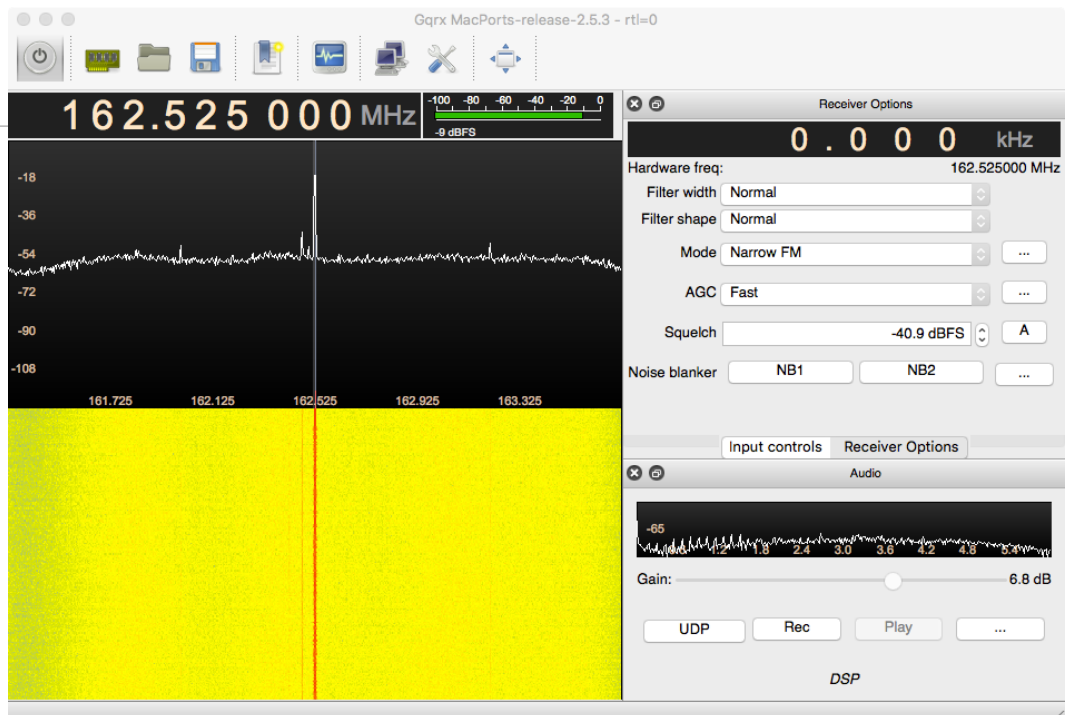
Listening to VPR Classical



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GQRX

Listening to NOAA



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GNU Radio — open source toolkit for SDR experimentation

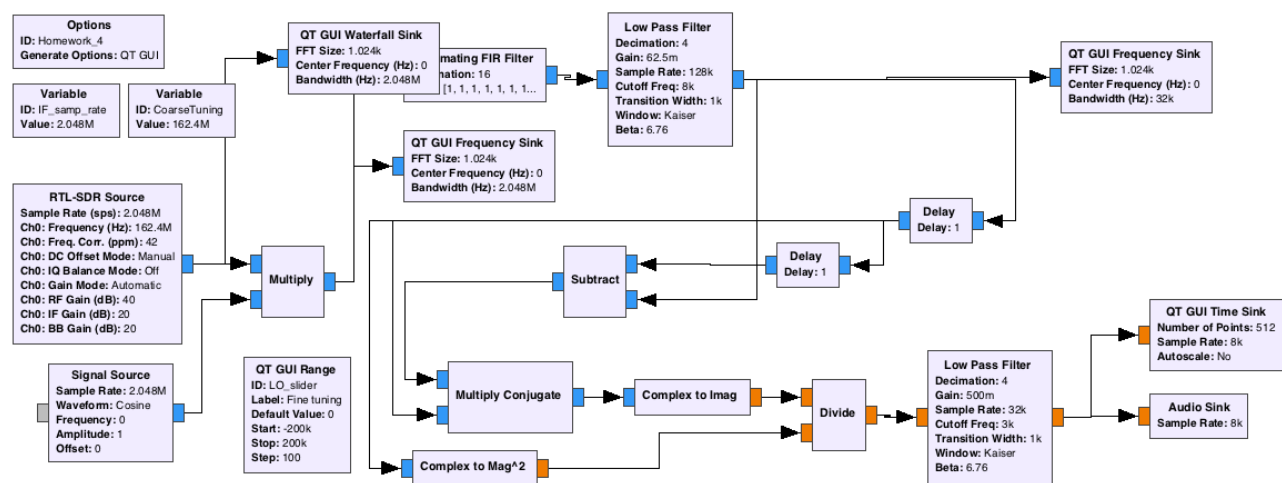
Start here: <http://gnuradio.org/redmine/projects/gnuradio/wiki>

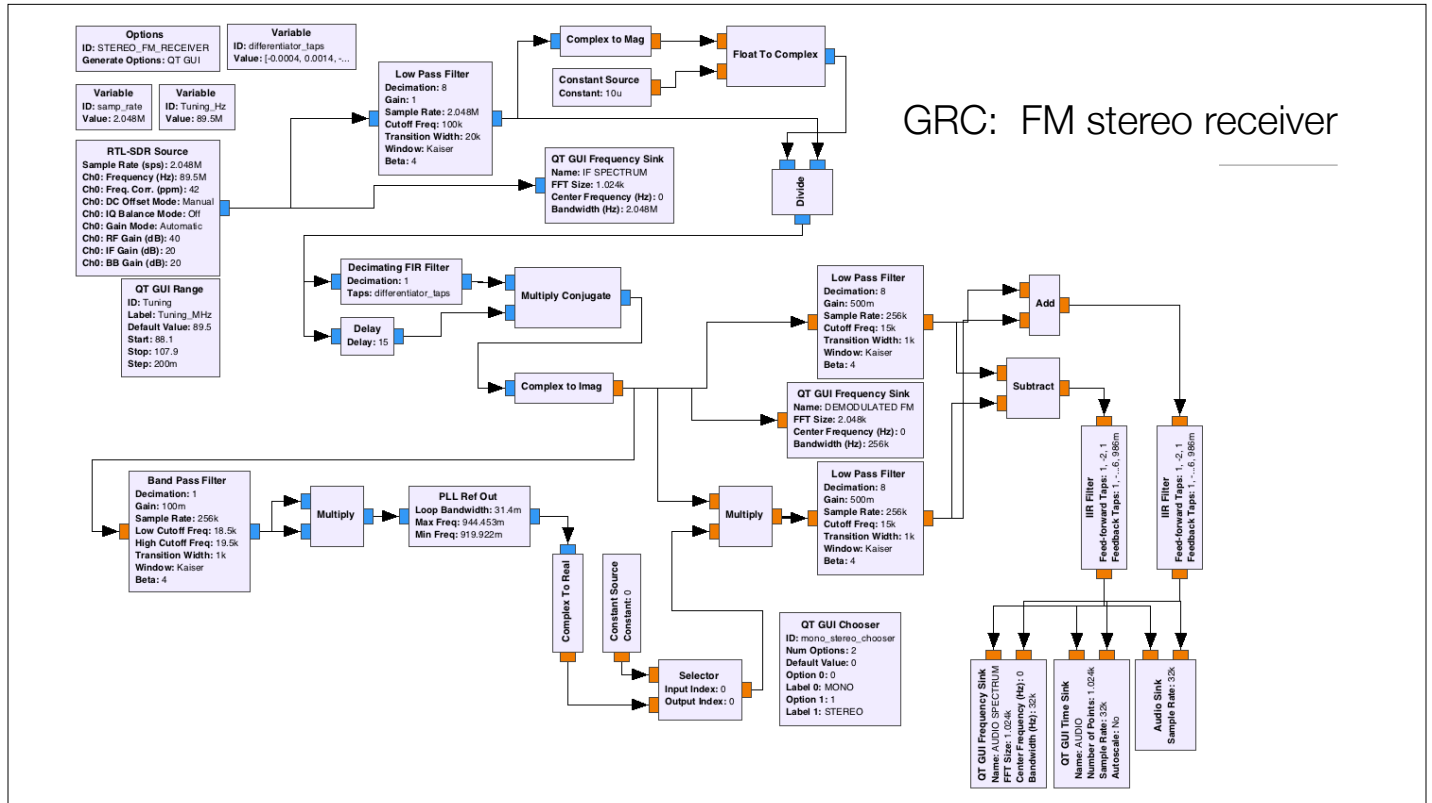
- Tutorials
- How to install the software

GNU Radio is:

- A graphical user interface (GNU Radio Companion) — build systems by connecting blocks together
- Block diagram compiles to a Python script
- Python script links basic functions, which are written in C++

GNU Radio Companion example: simple NBFM receiver

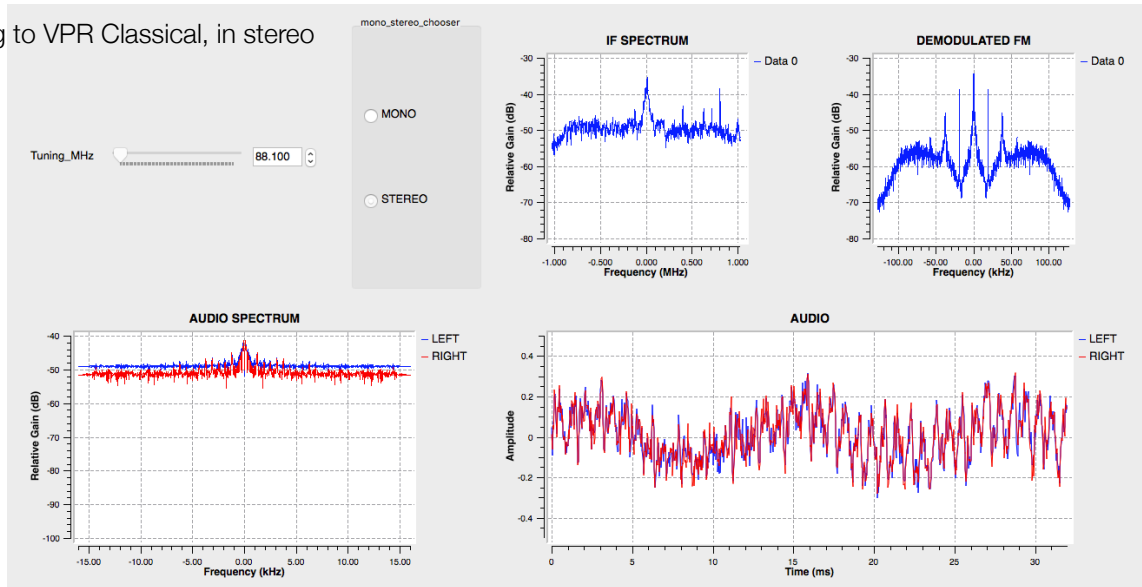




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FM stereo example

Listening to VPR Classical, in stereo



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