

Introduction to SDR Dongles

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Introduction

- Brief history of SDR systems.
- Typical SDR Hardware.
- Screenshots comparing Bandwidth and ADC performance.
- Screenshots of SDR software options.
- PC and Laptop Specifications.
- Cables
- Antenna options.
- List of websites.
- Brief summary and question time.
- Hands on demo if time allows.

Brief History of SDR – The early days

1984

Raytheon coins “Software Radio” in a company newsletter. They built a prototype using an array of processors to perform adaptive filtering in a digital baseband receiver.

1991 & 1992

DARPA SPEAKeasy military broad band radio for the US Airforce.

Joe Mitola publishes a paper in the IEEE National Conference.

Brief History of SDR – Creation of standards

1996 to 1998

SDR Forum and JTRS (Joint Tactical Radio System) start forming standards.

Nutaq team with MathWorks implement SDR in Texas DSP and Xilinx FPGA.
The SignalMaster board gave developers and Universities easy to use tools.

2001

GNU Radio project creates Open-source framework for SDR applications on a PC.

Brief History of SDR – 1st Commercial hardware

2004

First FCC approved commercial use in GSM and CDMA Base Stations.

Various chip makers start launching Single Chip SDR devices.

2005

OpenHPSDR (High Performance Software Defined Radio) project starts.

First modular SDR transceivers available for Amateurs are mounted in 18" racks and use a USB connection to a host Windows PC. Spin-off hardware includes the ANAN series, Flex Radio and Apache Labs.

SDR Hardware

Soft Rock series - 2005 Onwards

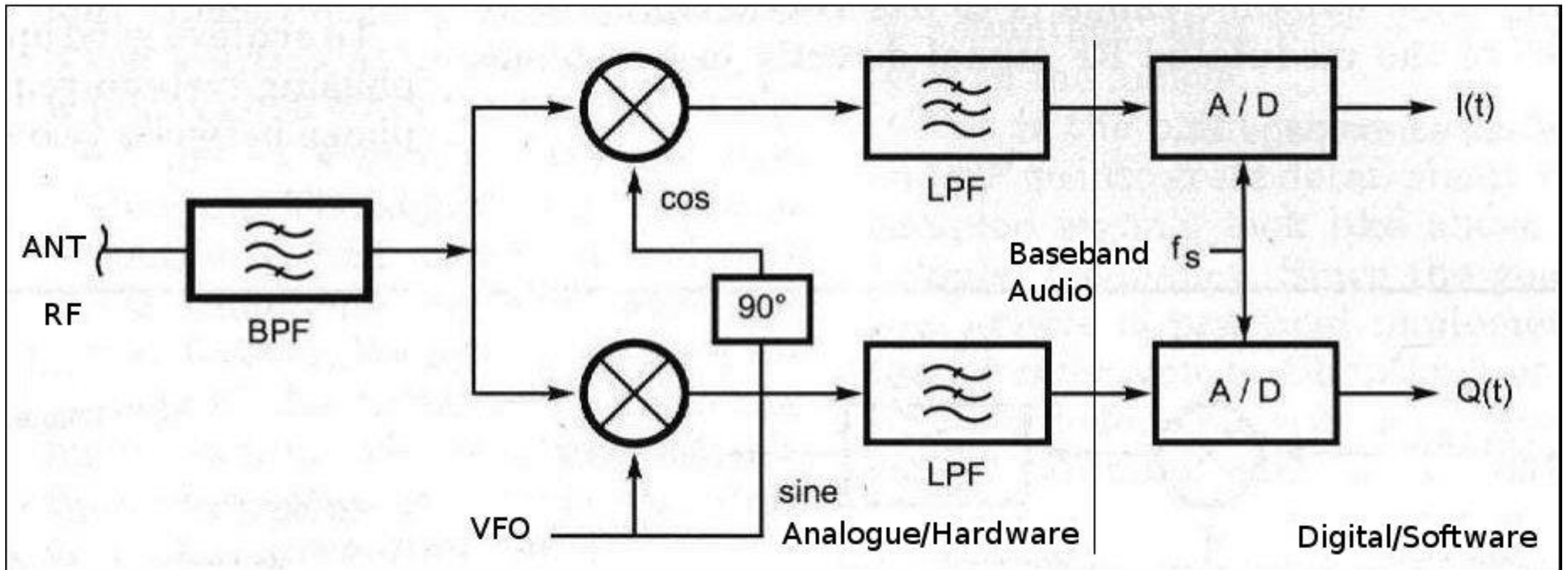
Soft Rock series of low cost SDR kits created by Tony Parks KB9YIG based on experience with a Flex Radio SDR 1000.

USB controls VFO for HF receivers.
Requires an external ADC to sample IQ stream.

Some versions built capable of QRP TX in fixed bands.
Require external 12V for TX.

\$20 to \$140





SDR Hardware

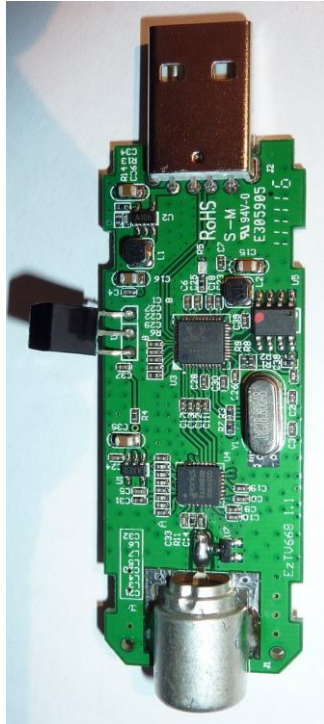
RTL-SDR - 2010 onwards

Eric Fry experimented with an RTL SDR Quad Realtek DVB tuner to make it work with Linux. Antti Palosaari and Osmocom were mainly responsible for the big explosion in popularity of the RTL-SDR family of low cost receivers.

Rafael 820T2 tuner chip has 24MHz to 1.7 GHz input range.
Can use direct sampling into the RTL2832U demodulator for low cost HF.
Will get better performance using an up converter for HF bands at extra cost.

2MHz displayed bandwidth and 8bit ADC.

RTL SDR



Generic plastic TV Dongles
VHF/UHF only.
From £2 to £20 on line.



Branded quality Dongles
VHF/UHF only.
From £20 to £60 on line.



Dongles with VHF/UHF and
Direct sampling HF inputs.
From £3 to £30 on line.

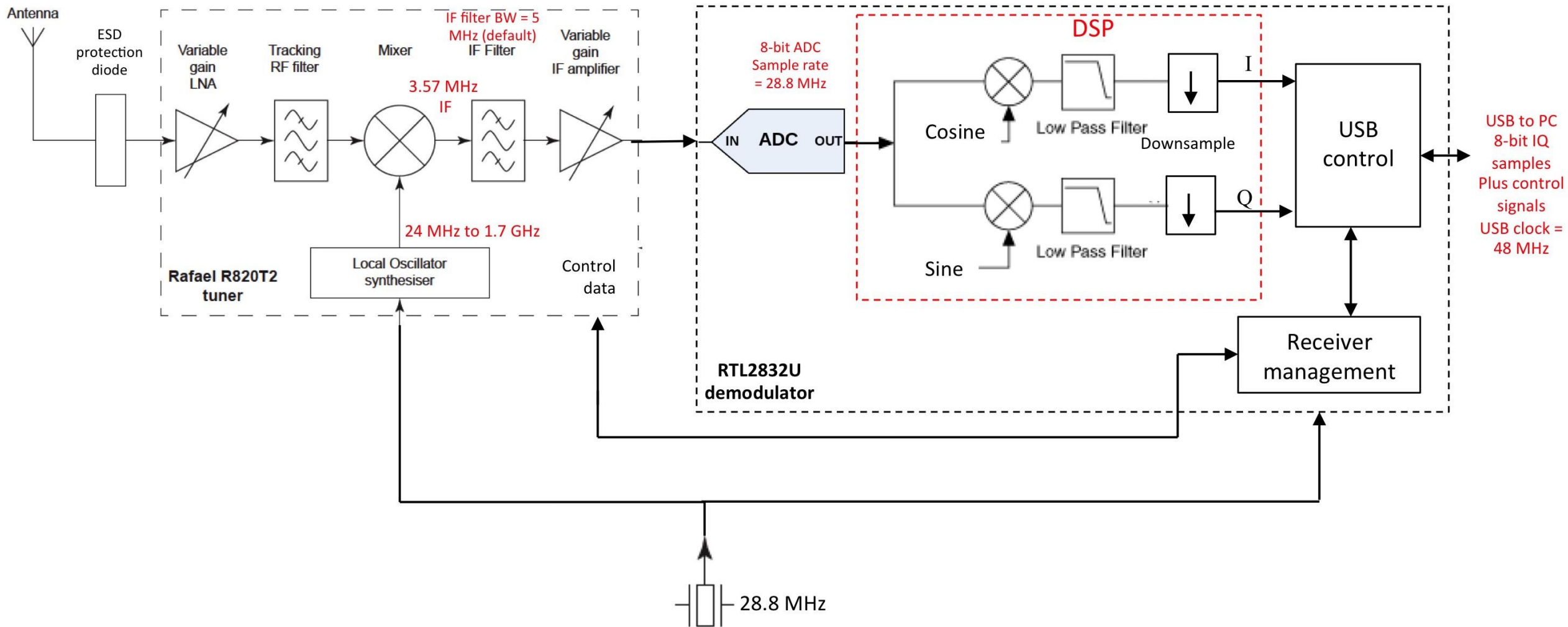
Complete all band SDR for around £100



NooElec NESDR SMARt HF
Bundle: 100kHz-1.7GHz
Software Defined Radio Set for
HF/UHF/VHF including RTL-
SDR, Assembled Ham It Up
Upconverter, Balun,
Adapters...



Simplified Block Diagram of NooElec RTL-SDR



SDR Hardware

Perseus Direct Sampling SDR

10kHz to 30 MHz

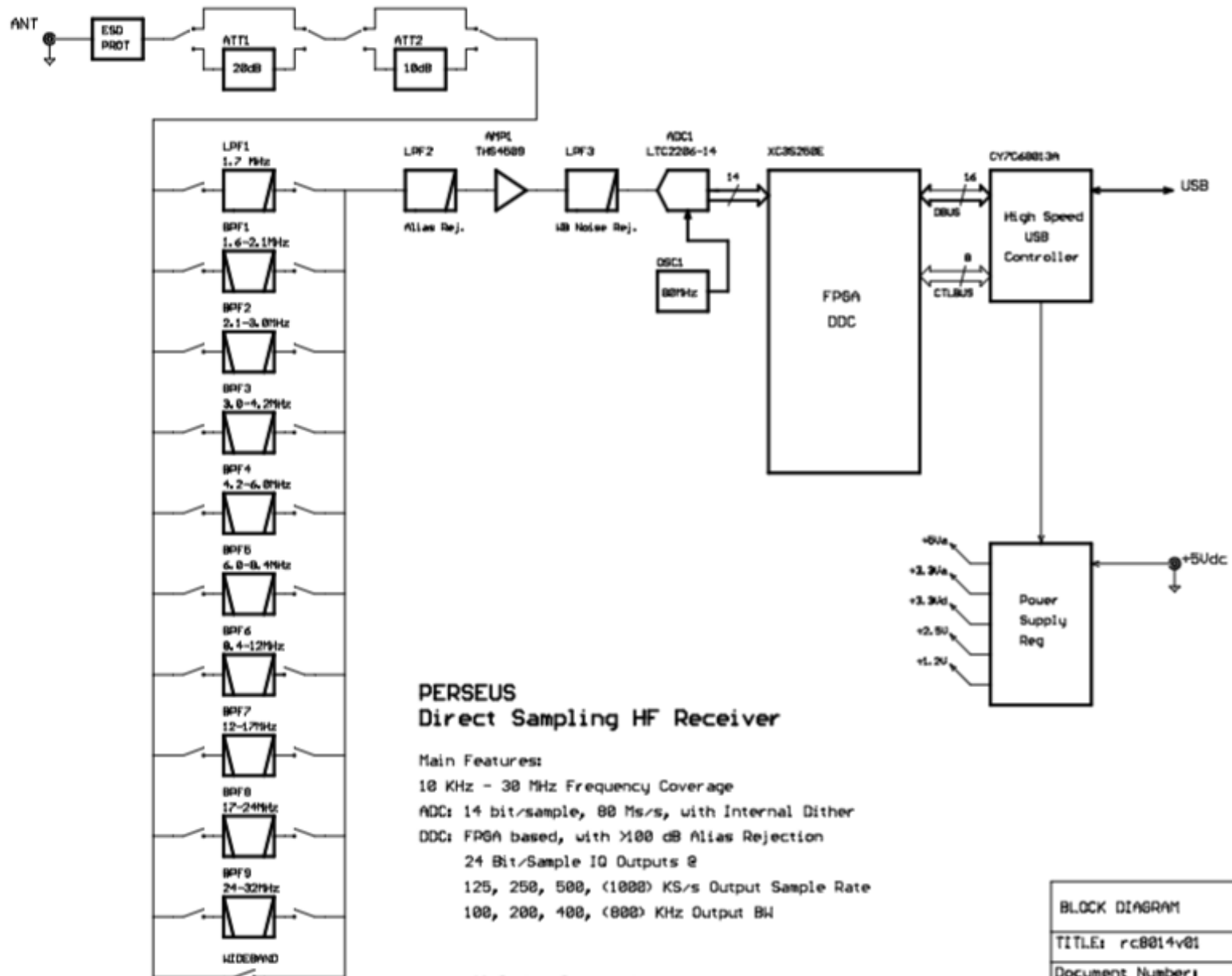
Up to 800kHz displayed bandwidth

80 Mega Samples per second ADC

14 bits ADC and 24 bit IQ stream

Around £700





PERSEUS Direct Sampling HF Receiver

Main Features:

10 KHz - 30 MHz Frequency Coverage

ADC: 14 bit/sample, 80 Ms/s, with Internal Dither

DDC: FPGA based, with >100 dB Alias Rejection

24 Bit/Sample IQ Outputs @

125, 250, 500, (1000) KS/s Output Sample Rate

100, 200, 400, (800) KHz Output BW

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(c) 2007, IUV3NSU - Microtelecom s.r.l. - Pavia di Udine - Italy

BLOCK DIAGRAM

TITLE: rc8014v01

Document Number:

REV:
8.1

Date: 04/06/2007 13.15.56

Sheet: 1/4

Hardware

FUNcube - 2013 onwards

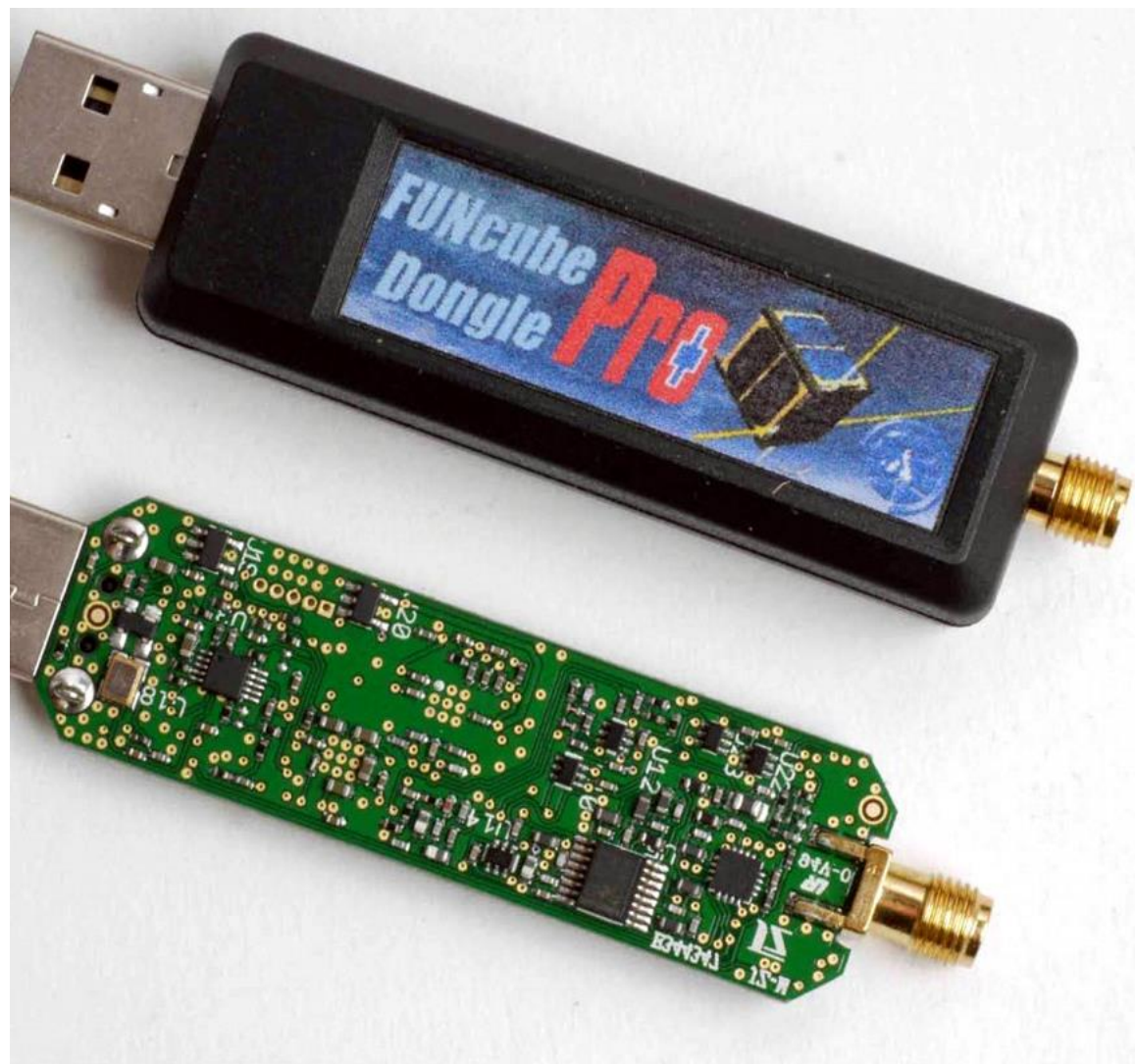
A group RF engineers working on the ISS formed AMSAT-NL and developed the first Dutch Nanosatellite. A group of UK amateur founded AMSAT-UK and created the FUNcube SDR receiver for Schools as part of their STEM education.

150kHz to 260MHz and 460MHz to 2GHz

192kHz IQ sample rate and displayed BW

24bit ADC truncated to 16bits over USB

£150



SDR Hardware

SDRplay - 2014 Onwards

1kHz to 2GHz

Up to 10MHz bandwidth

14 bit ADC

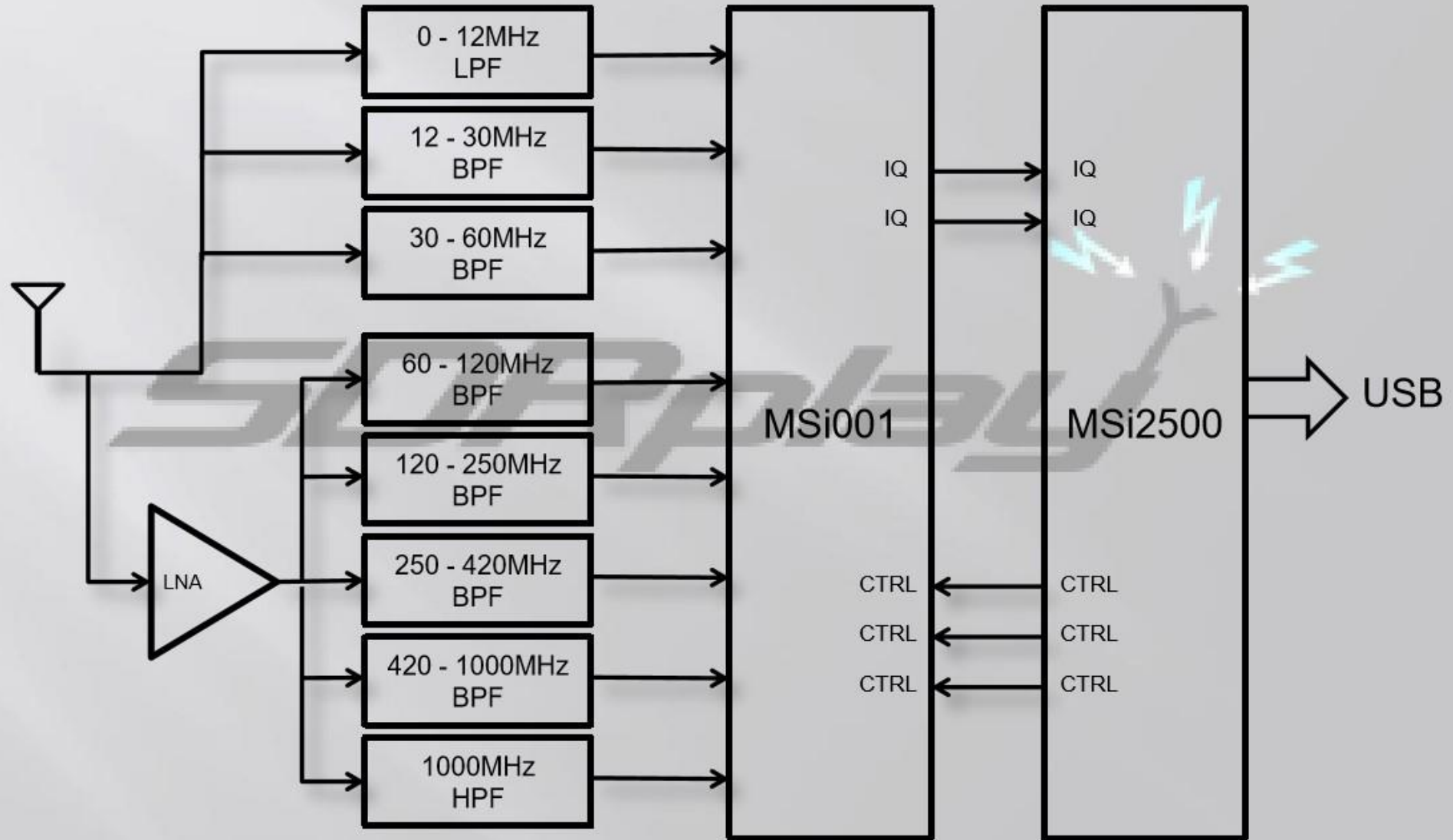
RSP1 SDR receiver

RSP2 and RSP2 Pro

RSPduo dual tuner (2MHz per tuner)

From £95 to £240





SDR Hardware

AirSpy - 2015 Onwards

Various bandwidths

12bit ADC

AirSpy Mini & R2 VHF/UHF

SpyVerter HF Up converter

HF+ Discovery and Dual Port
HF/VHF/UHF

From £120 to £230

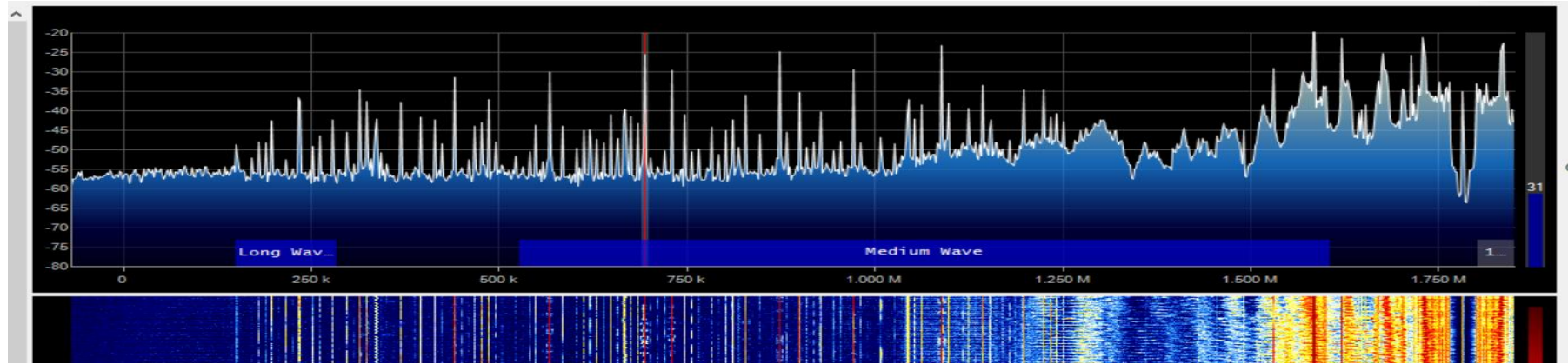


Bandwidth and ADC performance

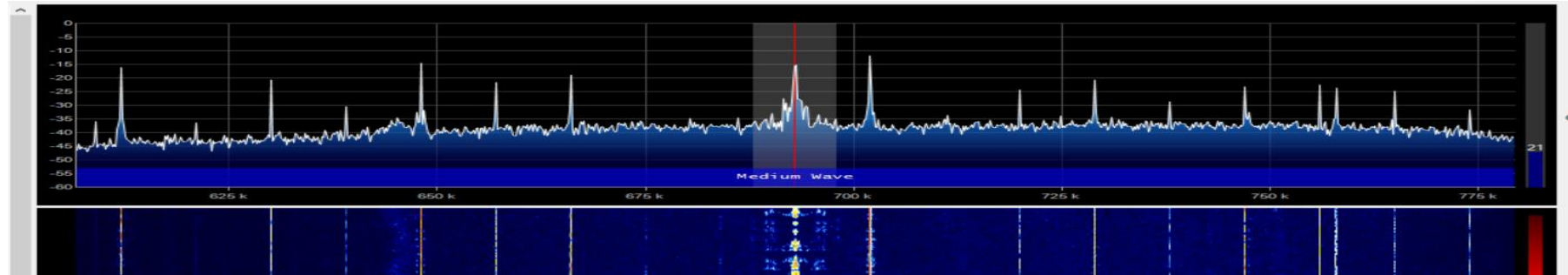
- MW Radio 5 Live 693kHz Bandwidth
- Shortwave Radio China International 7.3MHz Bandwidth
- FM Band Radio 1 98.8MHz Bandwidth and Resolution

MW Radio 5 Live 693kHz

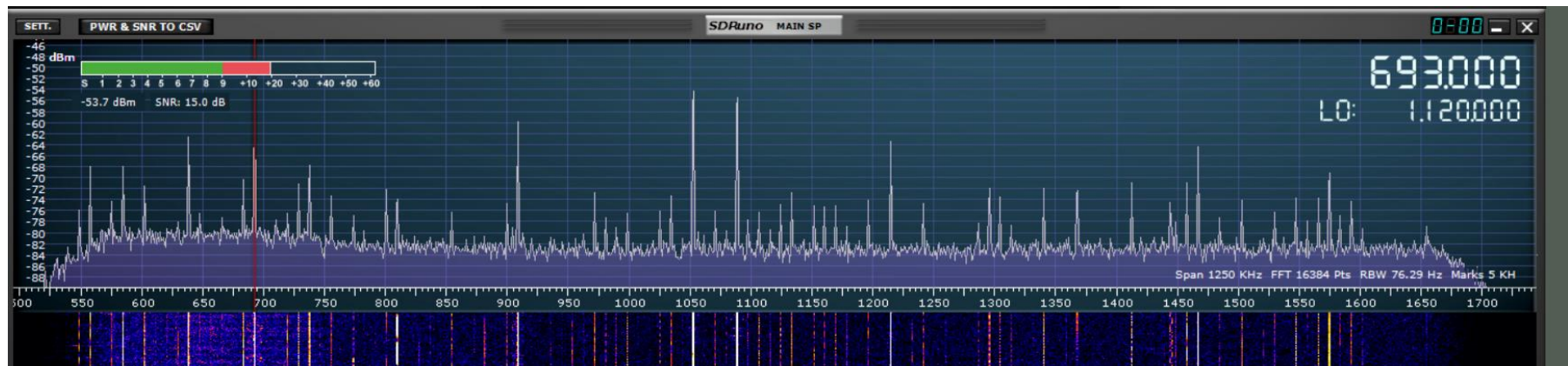
RTL SDR
BW 2MHz



FUNCube
BW 192kHz

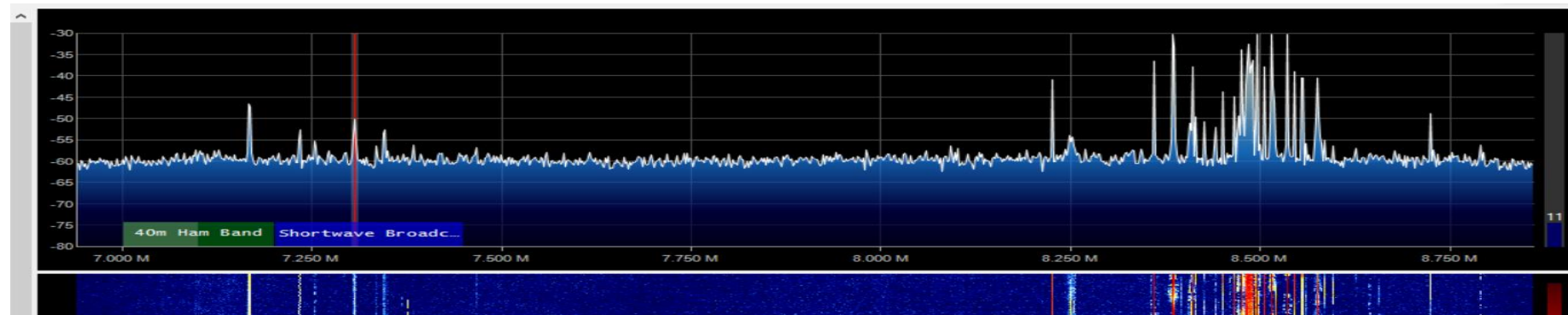


RSPduo
BW 1.25MHz

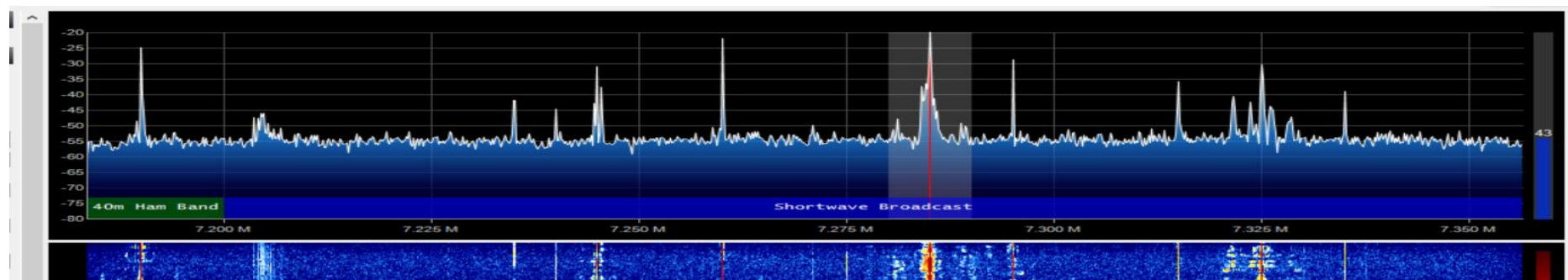


Shortwave Radio China International 7.3MHz

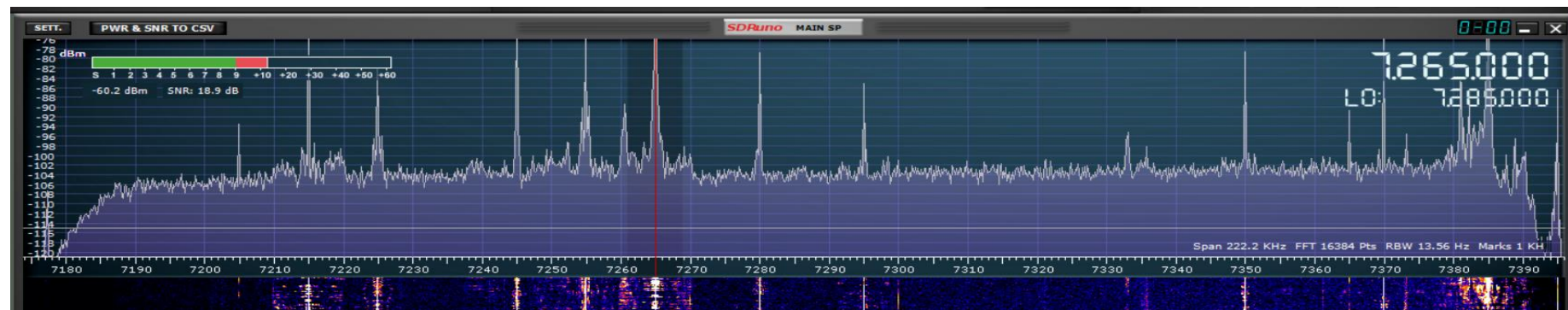
RTL SDR
BW 2MHz



FUNcube
BW 175kHz



RSPduo
BW 220kHz

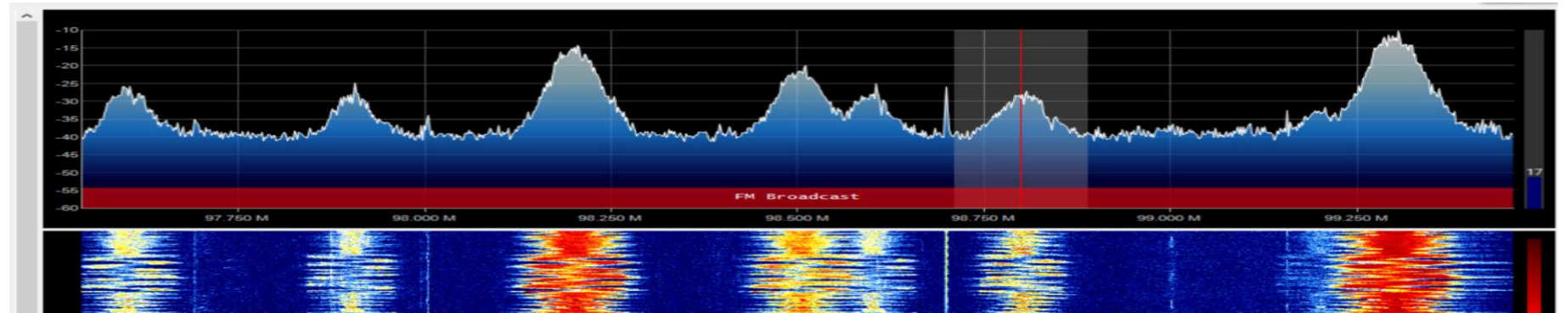


FM Band

Radio 1 98.8MHz

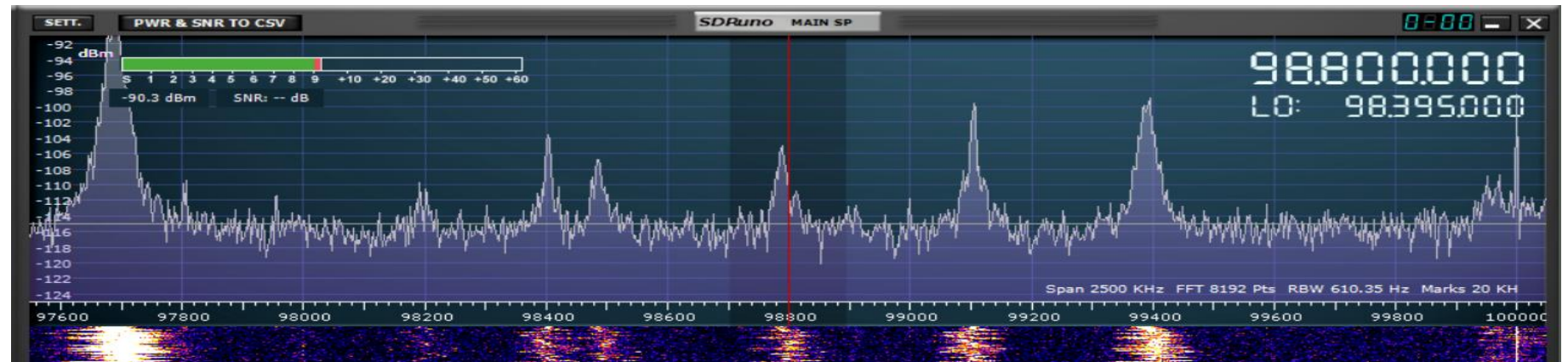
RTL SDL

ADC 8 Bit
Base -40dB
Peak -30dB
SNR 10dB
BW 2MHz



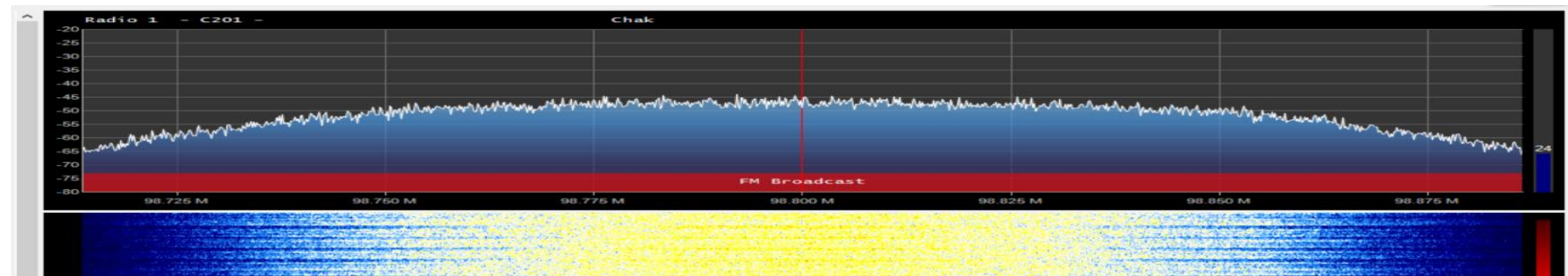
RSPduo

ADC 14 Bit
Base -118dB
Peak -106dB
SNR 12dB
BW 2.5MHz



FUNcube

ADC 16 Bit
Base -65dB
Peak -47dB
SNR 18dB
BW 175kHz



Software

- SDR Touch
- SDR#
- RSPuno
- HDSDR
- SDR Console

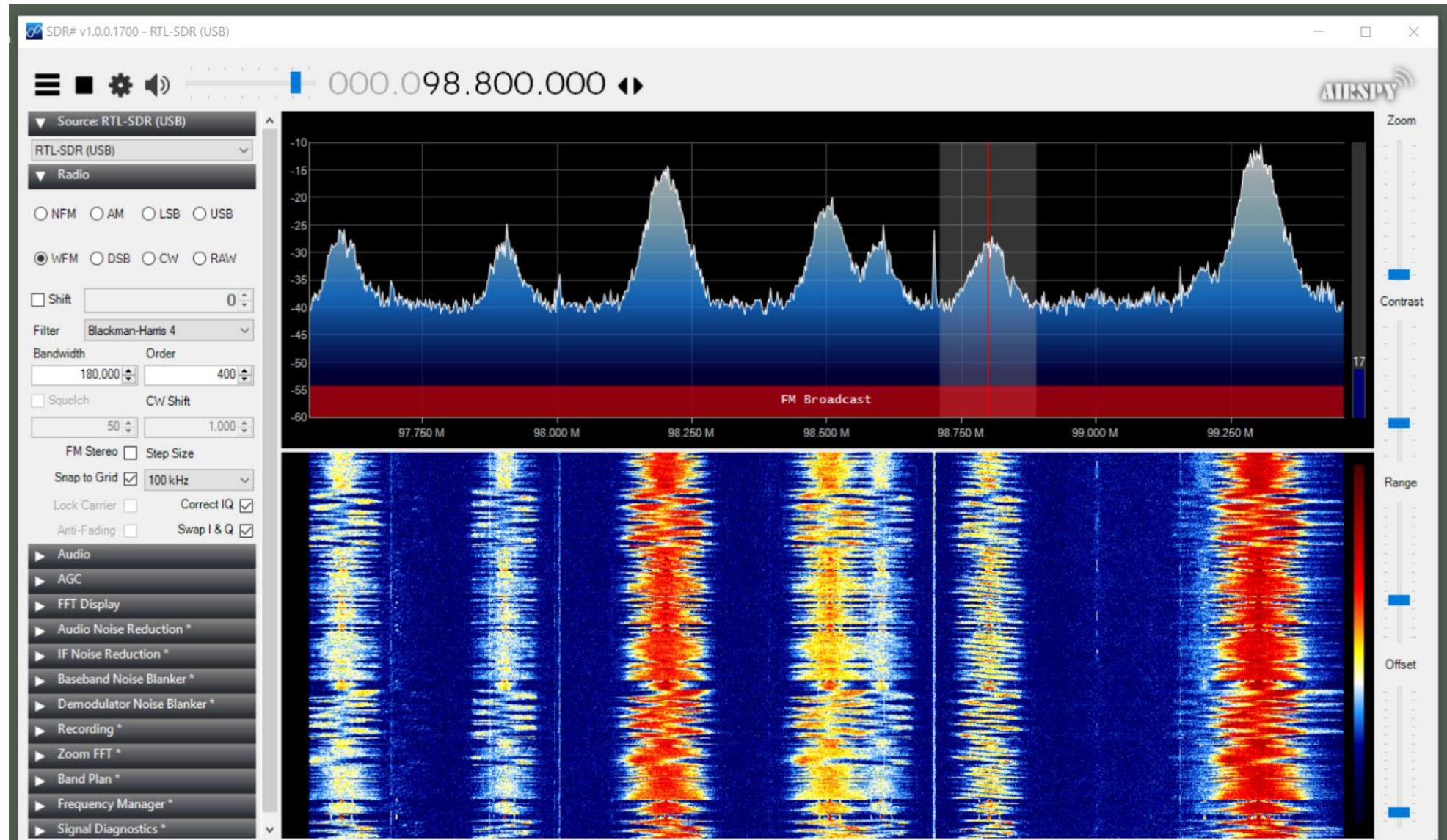
SDR Touch for PC and Android



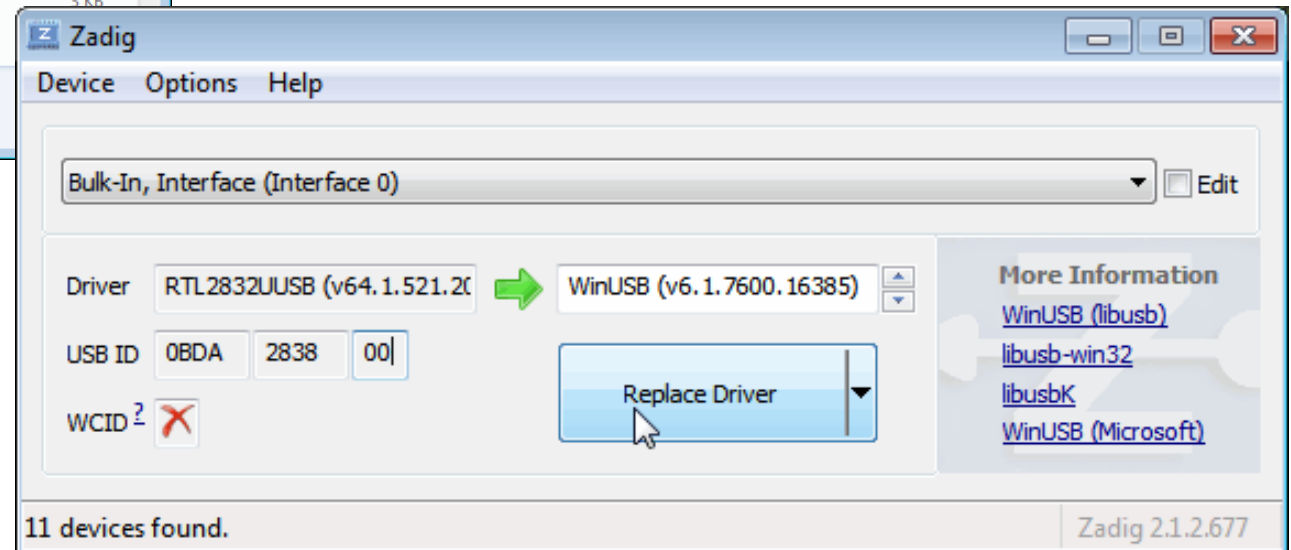
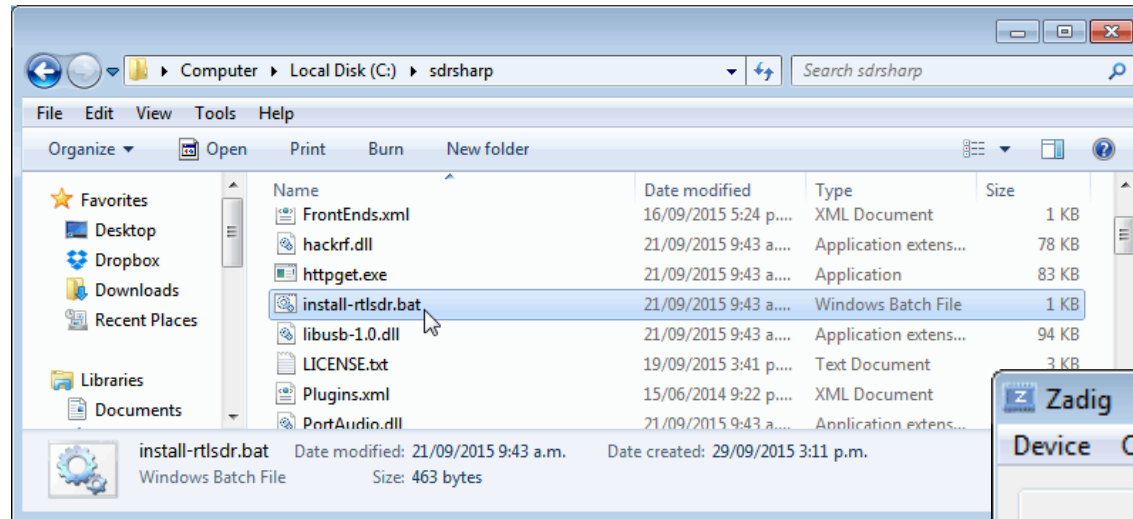
RTL SDR

SDR#

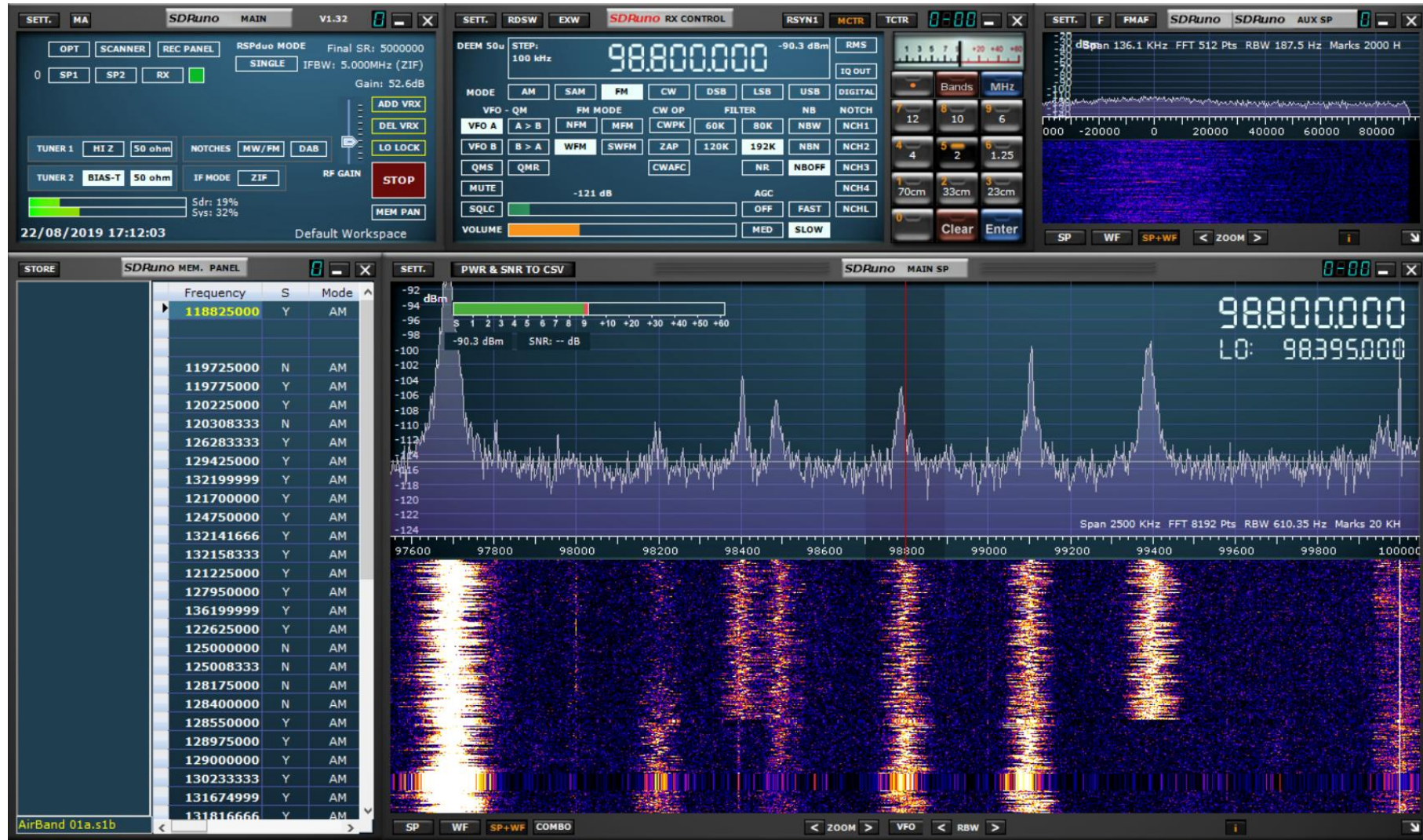
Radio 1 98.8MHz FM



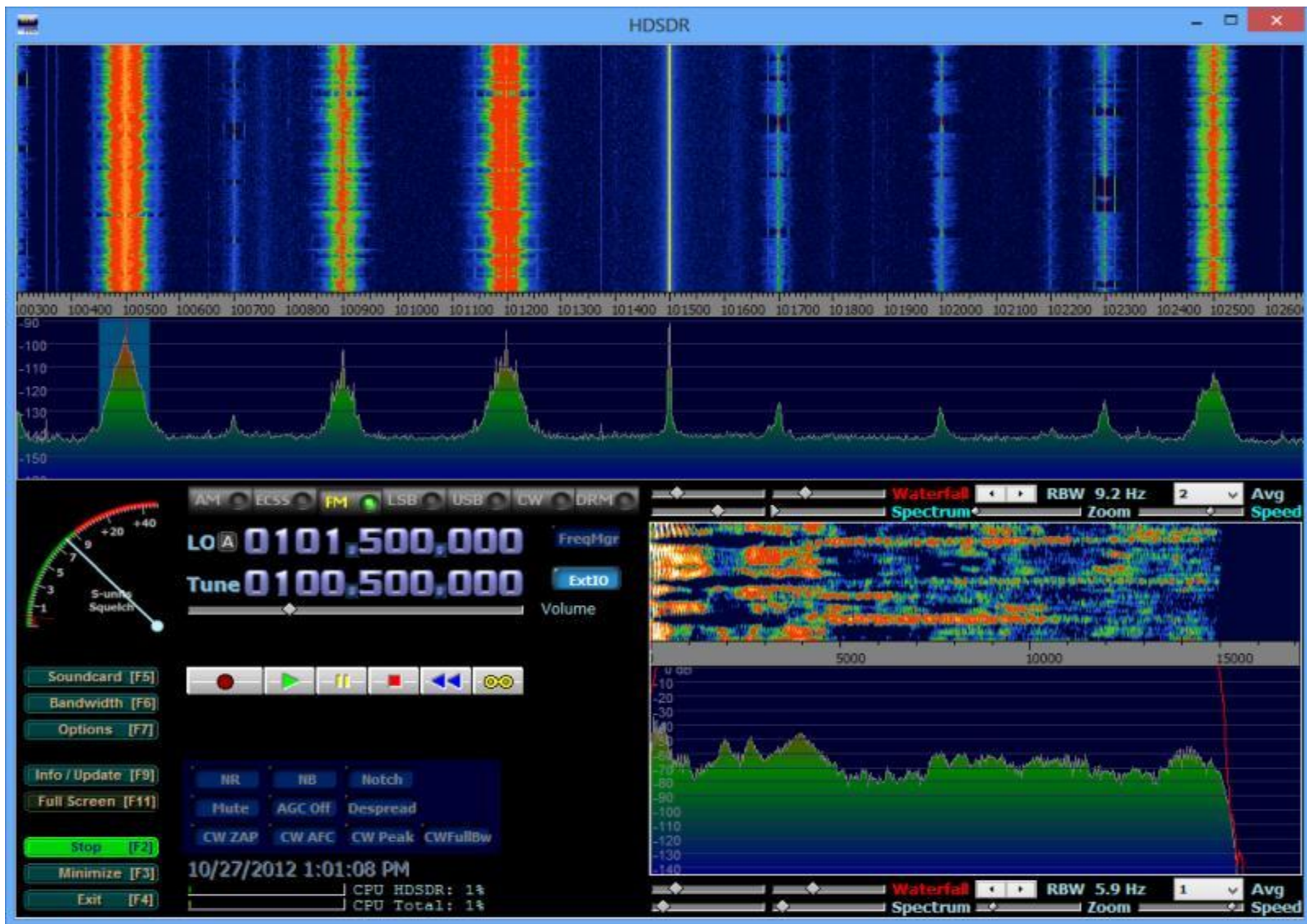
SDR# Software Install



RSPduo SDRuno Radio 1 98.8MHz FM



HSDR



SDR Console



PC and Laptop Specifications

SDR Touch

Android Phone or Tablet. Low power Laptop or PC.

SDR#

Laptop or PC with Intel Core i3 CPU and 4Meg of RAM.
12" (300mm) Screen.

SDRuno

Laptop or PC with Intel Core i5 CPU and 8Meg of RAM.
16" (400mm) Screen.

Cables



On The Go (OTG) cable



USB cable with EMI filters



SMA Male to BNC Female cable

Antenna options



Home made
telescopic dipole.

13.4m random wire.

Both antenna
mounted on a PAM-
KIT tripod mast.

Wire ends attached
to top of French
Doors and
workshop wall.

Mast 3.8m tall.



MegActiv MA305
Active Antenna
mounted on a
modified lightweight
camera tripod.

Tripod 1.3m tall.

Antenna options

Bonito Active Antenna

MegActiv MA305 Active Antenna

Frequency range: 9KHz – 300MHz

Enlarged and flexible 200mm radiating element.

USB-powered

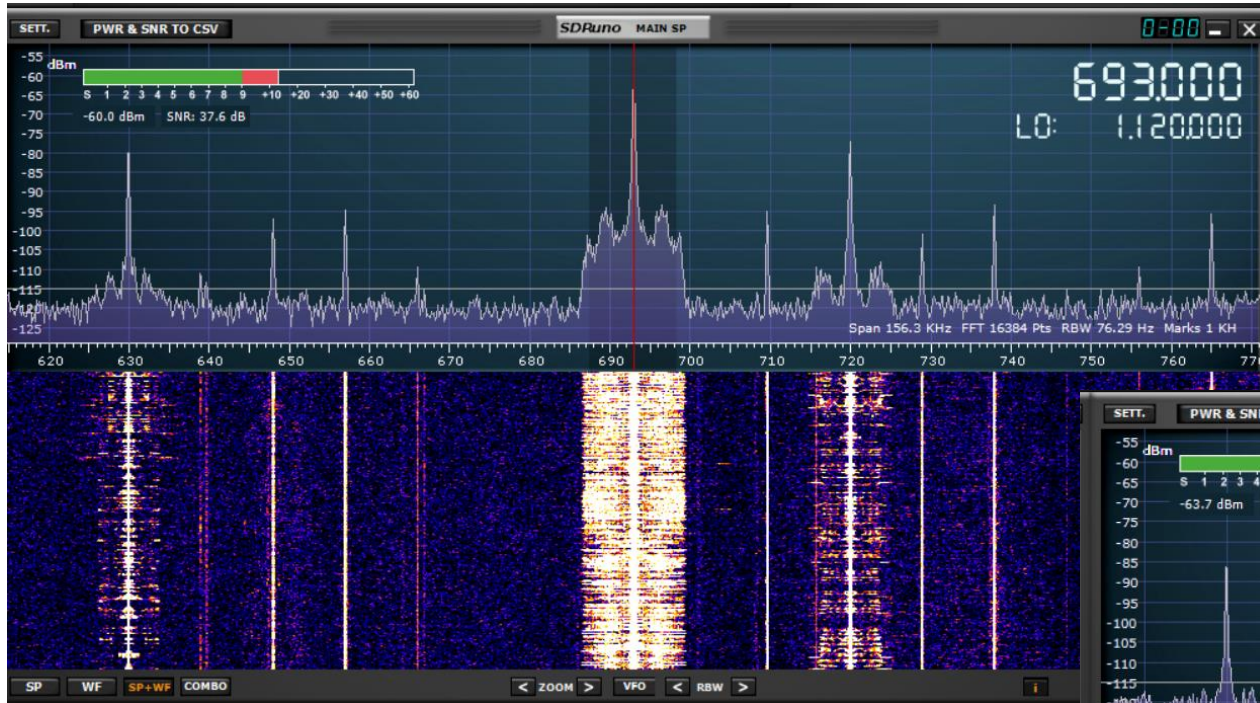
Large supply voltage range of 5-15V with a power requirement of only 10 mA.

Can be powered via USB or autonomously and noise-free via a separate USB Power Bank.

£170

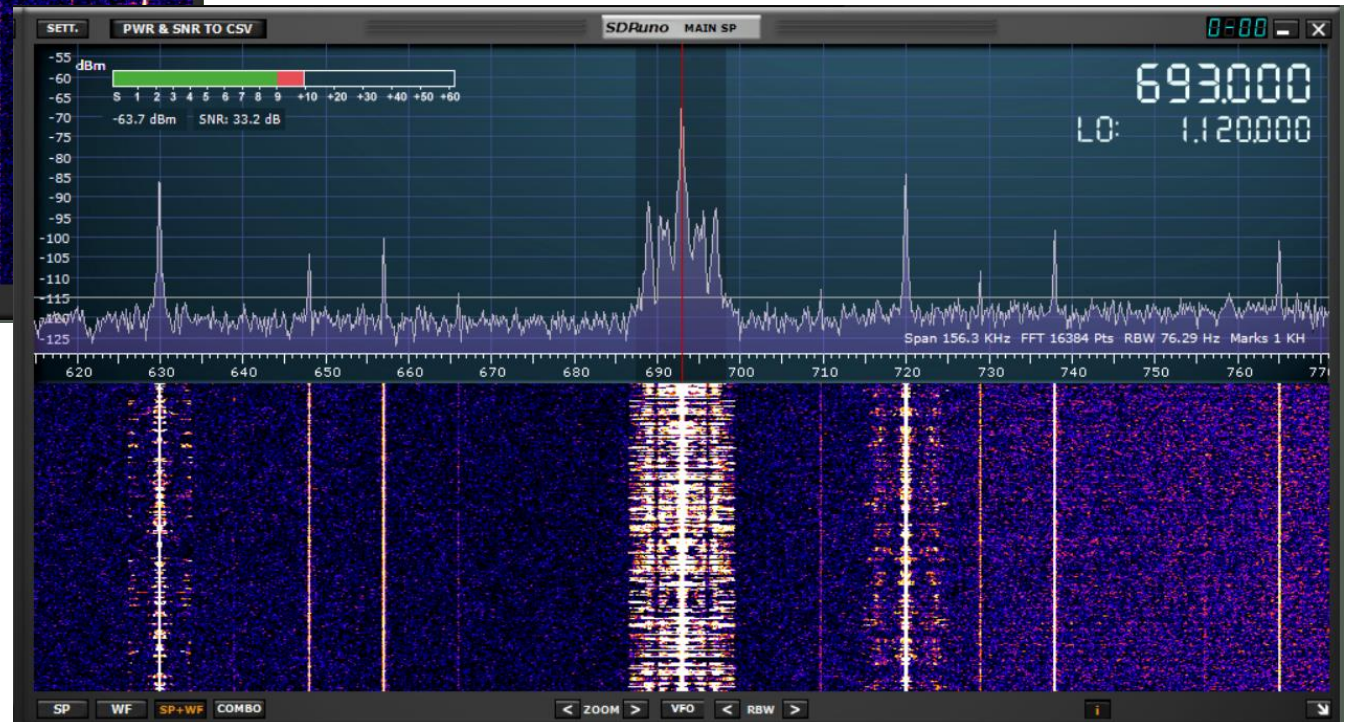


Radio 5 Live 693kHz MW

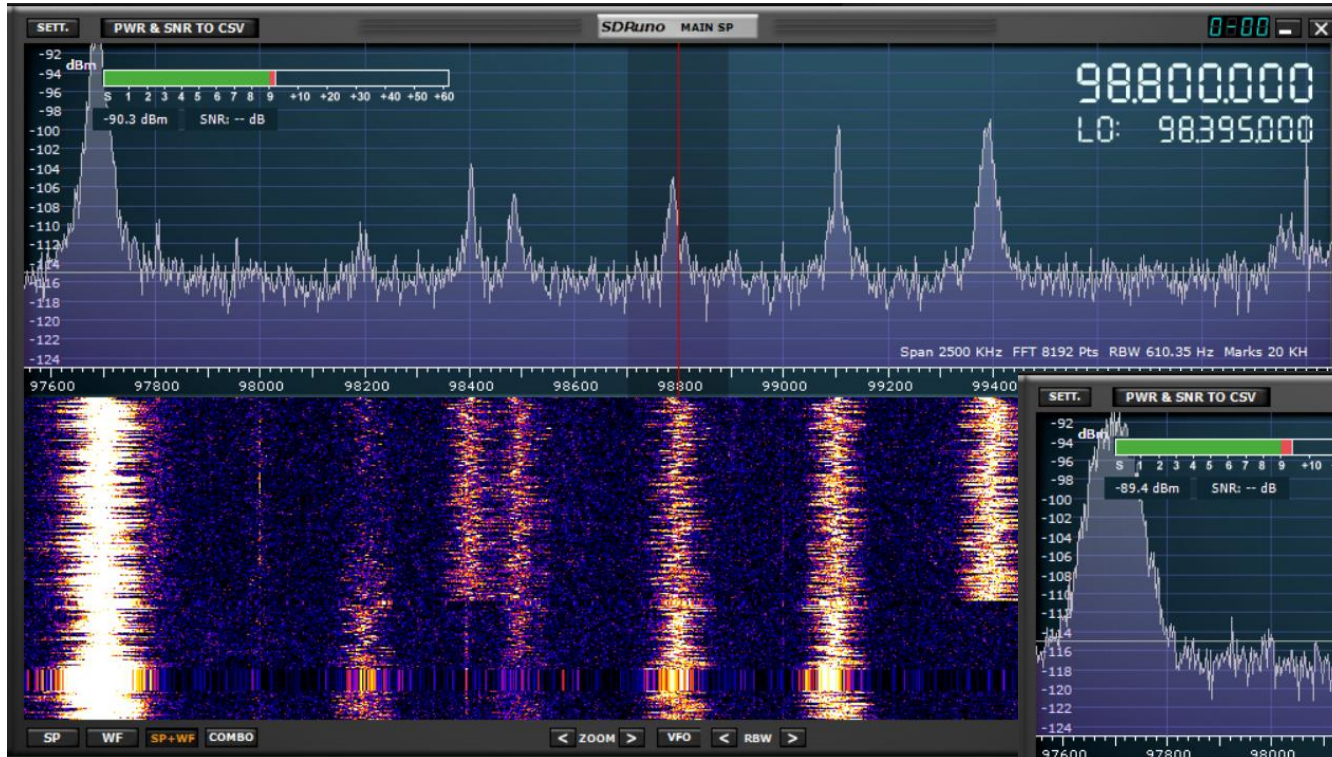


Random Wire
Base -120dB
Peaks -70dB
SNR 50dB

Bonito
Base -120dB
Peaks -70dB
SNR 50dB

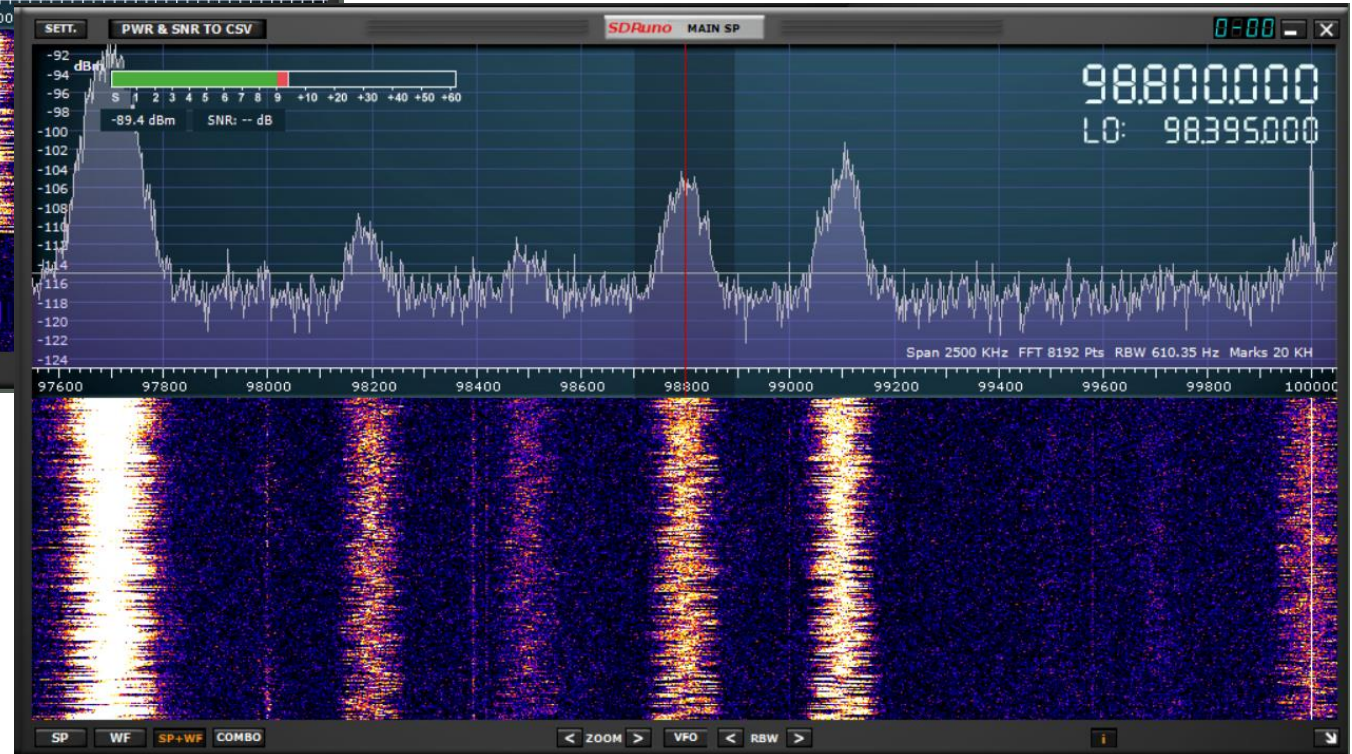


98.8MHz Radio 1 FM

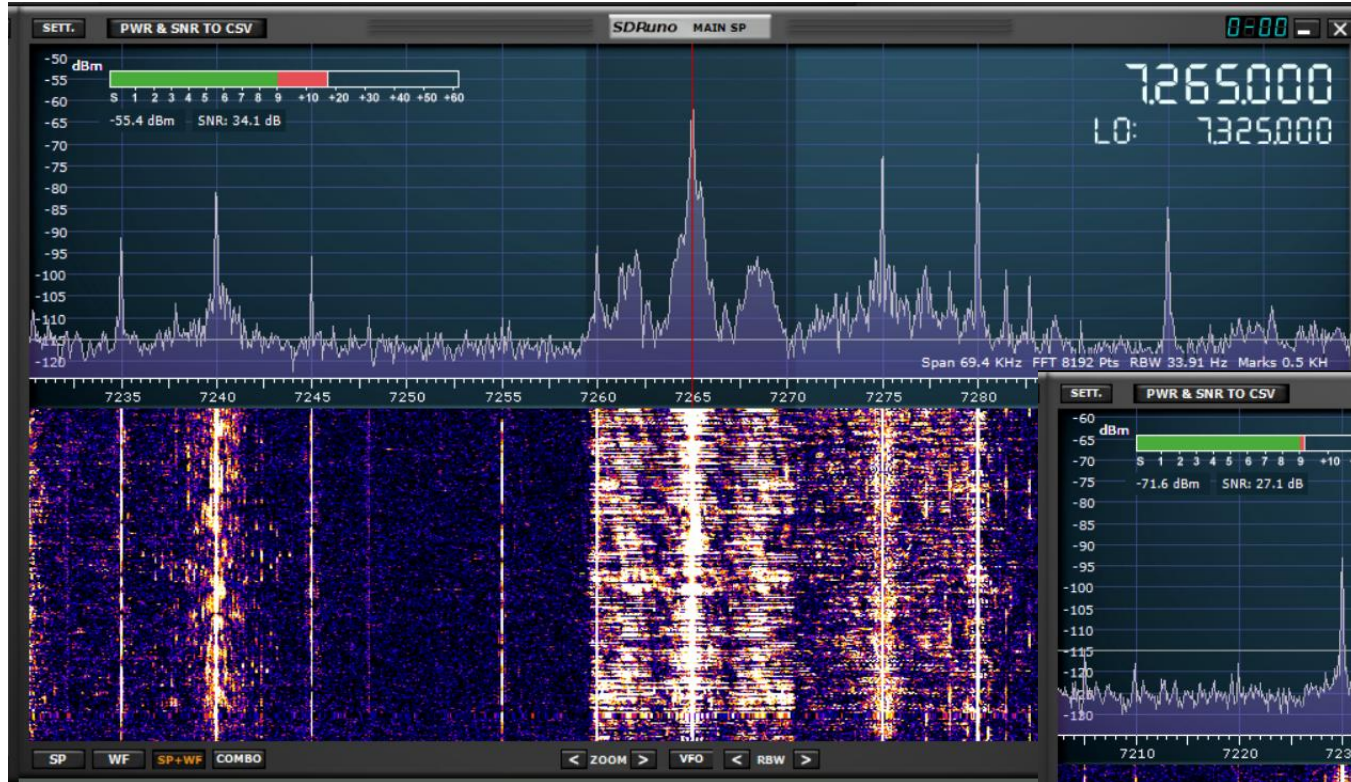


Dipole
Base -118dB
Peak -106dB
SNR 12dB

Bonito
Base -116dB
Peak -106dB
SNR 10dB

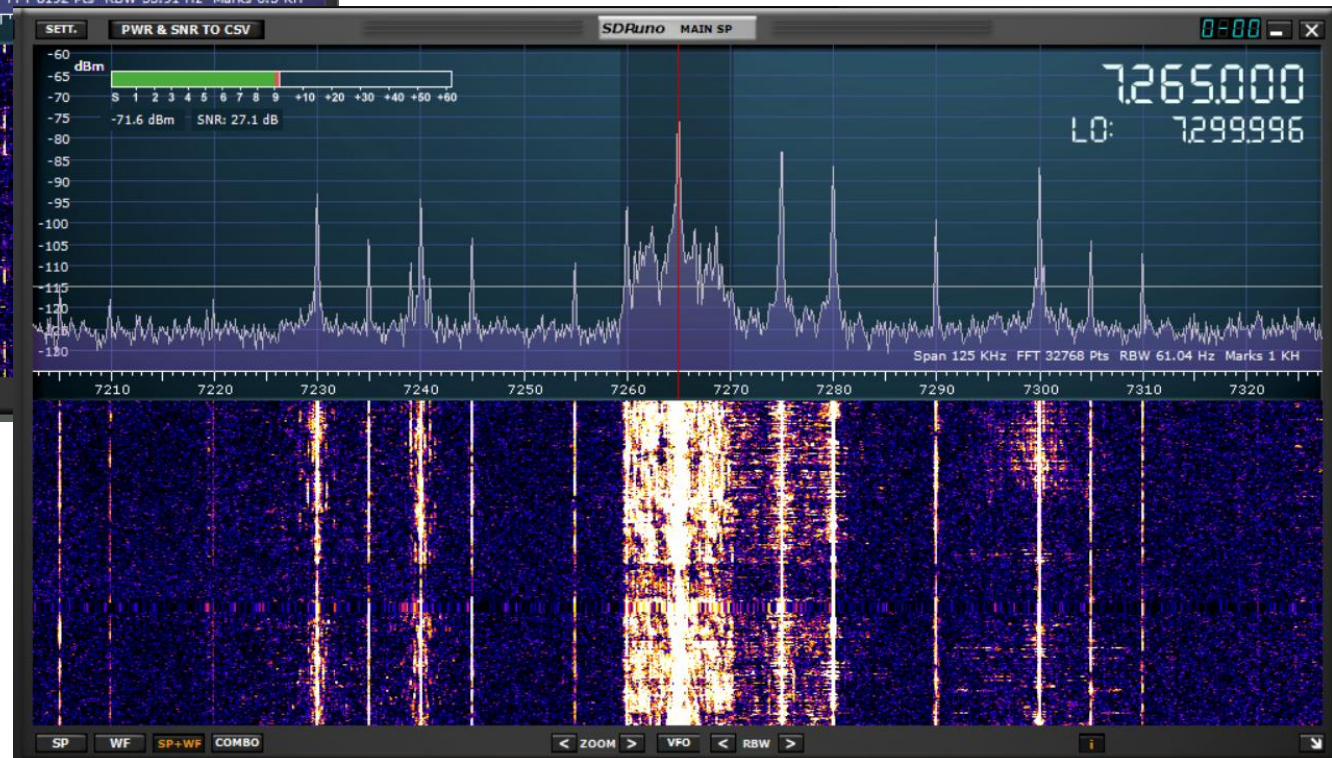


Radio China International 7.265MHz



Diversity
Base -125dB
Peaks -80dB
SNR 45dB

Bonito
Base -115dB
Peaks -65dB
SNR 50dB



Loop Antenna



Tecsun AN-200 Passive Loop
Tuneable over Medium Wave
Around £30



Wellbrook Active Loop
1m diameter 20kHz to 30MHz
From £250

Bonito Active Loop Antenna

MegaLoop ML200 Active Loop Antenna

Frequency range: 9 kHz - 200 MHz

Amplifying switchable: High / Low (+ 0dB / - 9dB)

Low Gain: 9KHz 170MHz (-3dB)

High Gain: 9KHz - 110MHz (-3dB)

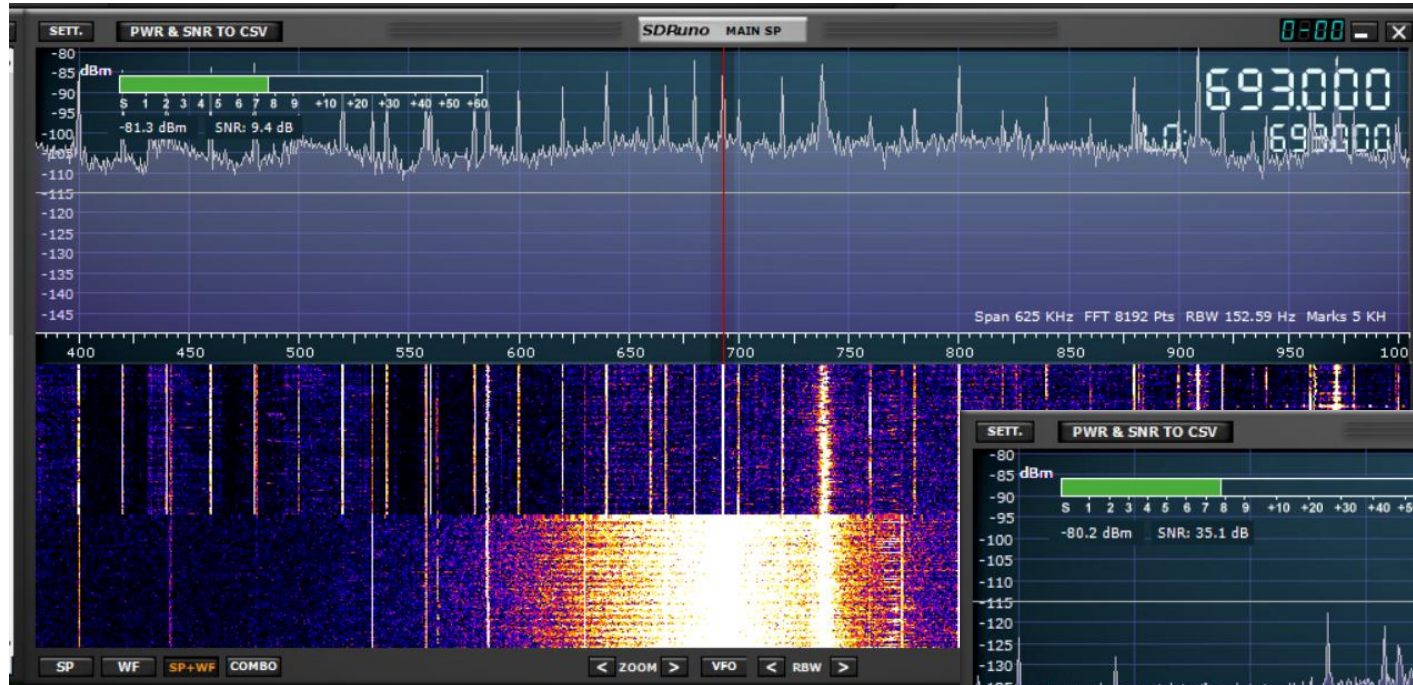
USB-powered

Power Supply: 5 V - 15V

£230



QRM Solar PV Inverter

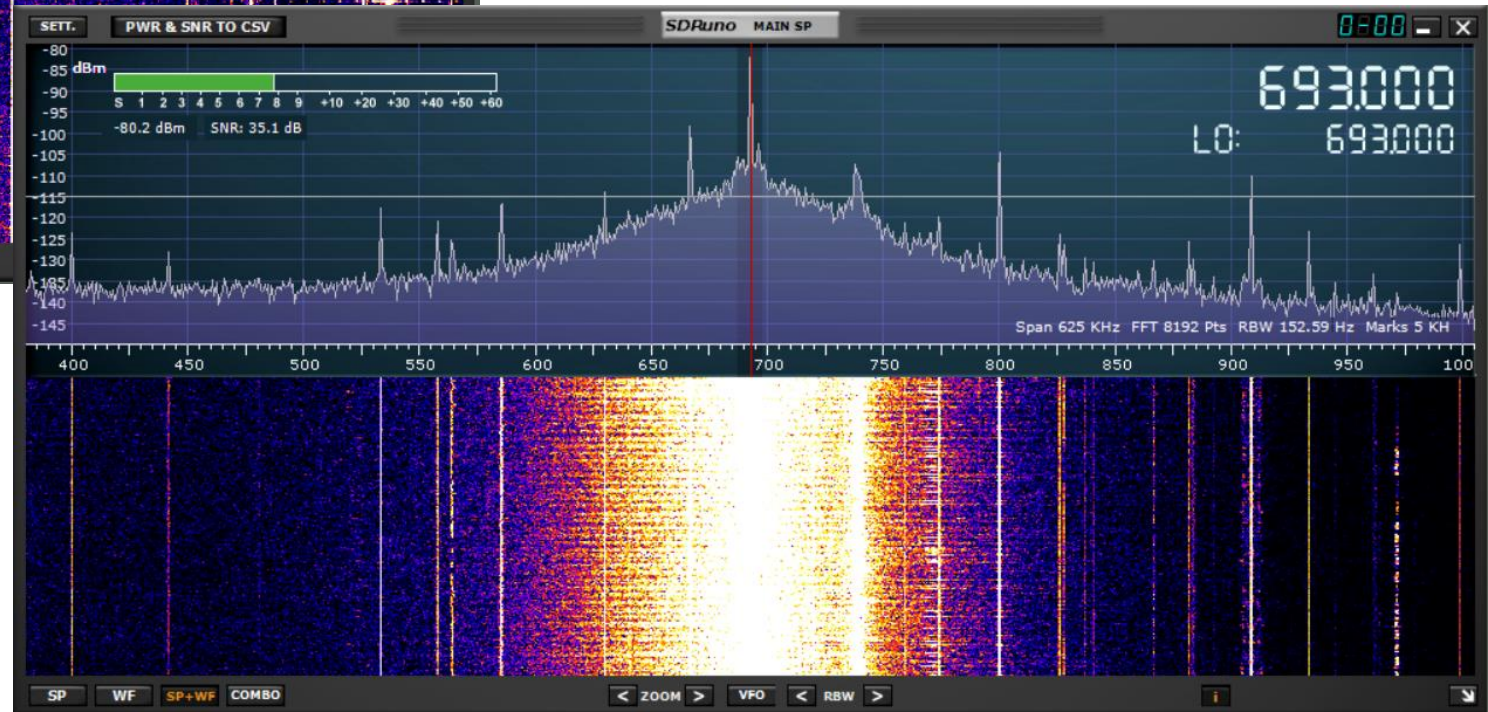


Tecsun AN200
Magnetic Loop

Base -115dB
Peak -80dB
SNR 35dB

Bonito MegActiv

Base -105dB
Peak -85dB
SNR 20dB



Websites

- SDR History: <https://www.nutaq.com/blog/short-history-software-defined-radio-sdr-technology>
- Open SDR: <https://en.wikipedia.org/wiki/OpenHPSDR>
- Softrock SDR: <http://www.wb5rvz.com/sdr/>
- Rtlsdr History: <https://rtlsdr.org/#history> and discovery of rtl-sdr
- AMSAT-UK: <http://amsat-uk.org>
- Funcube SDR: http://www.funcubedongle.com/?page_id=1201
- SDRPlay: <https://www.sdrplay.com/>
- Airspy: <https://airspy.com/>
- Perseus: <http://microtelecom.it/perseus/>
- RTLSDR Install: <https://www.rtl-sdr.com/rtl-sdr-quick-start-guide>
- HDSDR: <http://www.hdsdr.de/screenshots.html>
- SDR Console: <https://www.sdr-radio.com/>

Brief summary and question time

- RTL SDR dongles are a cheap entry point in to SDR receivers.
- RSP Play offer a good range of affordable high performance dongles.
- AIRSPY range confusing but may offer slightly better HF performance.
- Direct Sampling dongles have superior performance but expensive.
- Wide range of SDR software available but confusing if you swap.
- Need to consider PC hardware carefully.
- A good active antennas are portable and make DXing fun.
- Thank you for listening.
- Any Question?