A Survey of HF SDR Receivers

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The SDR Marketplace 2019

- An explosion of hardware
- Much of it intended for wireless telecoms, so more microwave than HF oriented
- My focus: Receivers with HF coverage available at hobbyist prices
  - < $1000 (with a few exceptions)
  - Transceivers included if RX is capable and price is reasonable
  - Sound-card devices excluded
  - Only one RTL dongle shown; dozens of versions out there
  - Including some wide-range “DC to Daylight” devices
  - Tried to exclude vaporware

Important Characteristics

- Hardware-centric:
  - Frequency range
  - Dynamic range (bits)
  - Frequency/Clock source
  - Number of ADCs
  - PHY interface
- Software-centric:
  - IQ streaming bandwidth
  - Data format
  - Firmware hackability
  - Open API?
  - Compatible API?

And of course, Price!

HamSci Summary:
No One Device Meets All Our Criteria

- Ettus N200 is closest capability match, but too expensive
  - Wide software base, fast streaming, external clock, timestamping (through UHD driver)
- Red Pitaya 14-bit has everything right execpt the implementation
  - 16-bit version a contender, but a lot pricier
  - Open development environment means timestamping possible in FPGA (A Simple Matter of Firmware)
  - Clocking still a question (internal quality, external connector, frequency)
  - Have they solved digital noise problems?
- KiwiSDR is interesting
  - Very cost effective
  - 14 bit ADC – does overload if nearby BCB
  - Very clever frequency compensation via built-in GPS
  - Very open platform (Beagleboard, Linux) so could be repurposed from WebSDR paradigm
- iQuad HF2
  - Good performance and good price
  - Awkward form factor (plugs into BeMicro
  - We know the developer...

Ettus/National Instruments

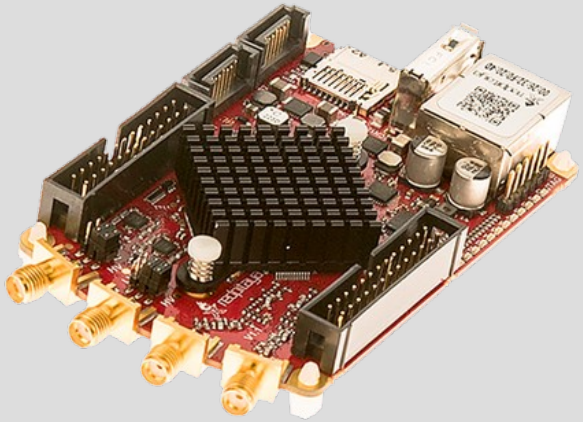
- The only moderate-cost Ettus radios that support HF operation are the N200 and N210 with BasicRX/TX or LFRX/TX daughterboards (cheaper B-series only go down to 70 MHz)
- 14 bit ADC
- 50 MHz IQ
- Internal clock unknown; accepts external 10 MHz
- GigE
- Only unit here that natively supports hardware timestamping

- Wide software support
- ~$2000

Red Pitaya (Original)

- DC to 62 MHz
- 14 bit dual ADC
- 40 MHz bandwidth claimed
- Don’t even ask about the internal clock! External clock at 125 MHz but is differential input on solder pads.
- GigE
- High input impedance an issue with common antennas
- May have digital noise issues

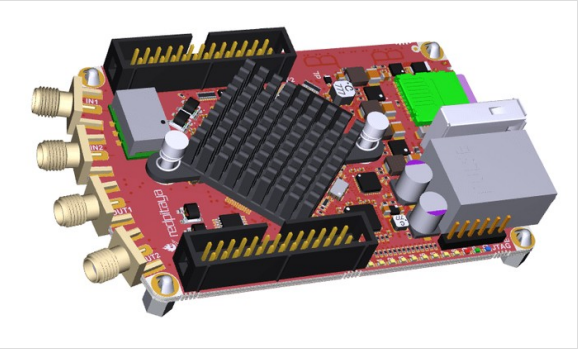
- Open Source platform runs Linux; firmware also open source
- Lots of apps
- $310 for basic kit



Red Pitaya “STEMlab 122.88-16”

- 300 kHz to ~60 MHz
- 16 bit dual ADC
- 122.88 MHz clock; no mention of external reference input
- “Improved distortions, dynamic range, sensitivity, noise & crosstalk”
- Other details still unknown

- Hardware compatible with HPSDR
- Taking pre-orders now
- 499 Euro (about $560) including 22% VAT



KiwiSDR

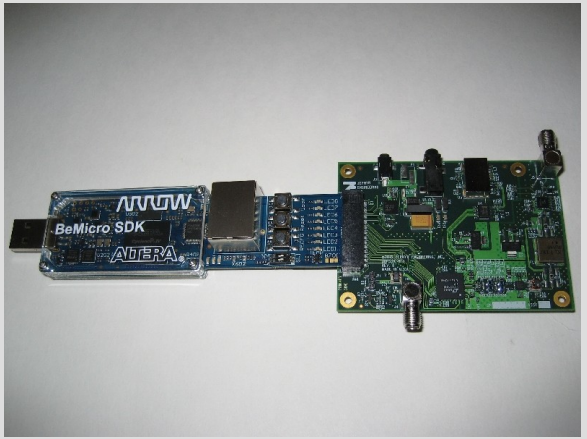
- 10 kHz – 30 MHz
- 14 bit ADC
- <20 kHz IQ
- Clock 66.666 MHz; clock input connector on board
- Board has GPS front end and uses GPS to compensate the clock
- Ethernet
- Built on BeagleBoard running Linux

- Web-based administration and web client front panel
- Open Source design
  - Custom firmware to make an IQ streamer?
- $299

iQuadLabs

- HF2 receiver:
  - Requires BeMicro
  - 16 bit, 100 kHz – 55 MHz
  -
- IQ2 – transceiver with same basic specs as Hermes; Ethernet

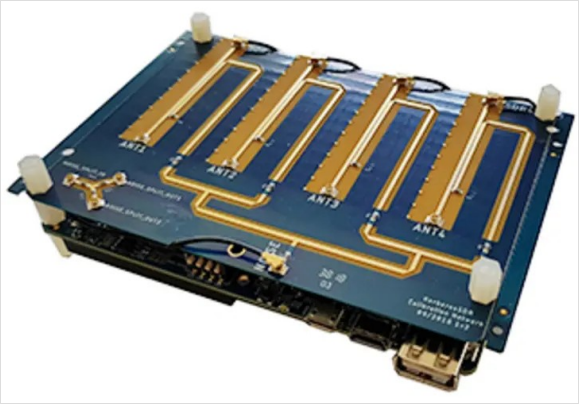
- HF2+BeMicro: $473



KerberosSDR

- 4 RTL-SDR Dongles in one box
  - Phase Coherent
  - Built-in noise source for phase calibration
  - Built-in USB hub
- Basic specs same as RTL-SDR.com dongle
- External clock capability unknown

- About $140
- Availability after IndieGoGo round unknown



The Field

Afedri SDR-Net HF

- 100 kHz – 35 MHz
- 12 bit ADC
- 1.85 MHz IQ
- Clock unknown
- USB and Ethernet

- Claims wide software compatibility
- Lots of versions; basic HF single channel is $209

Airspy HF+

- 9 kHz – 31 MHz;
  60 MHz – 260 MHz
- Tuner-based design; with BPF; claims 18 bit DDC, “22 bit resolution at 3 kHz channel” (?)
  - Sigma-Delta ADC
- 660 kHz/768ksps IQ (?)
- USB2

- OSS drivers; supports Gnuradio and other platforms
- $199

Colibri Nano

- 10 kHz – 55 MHz
- 14 bit ADC
- Up to 3 MHz IQ
- Clock 122.88 MHz, 0.5 ppm stability; external clock unknown
- USB2
- Also ColibriDDC which appears to be similar but with Ethernet interface, and much more expensive.

- ExtIO Dll support; other APIs unknown
- $289.95

Elad FDM-S2

- 9 kHz – 52 MHz
- 16 bit ADC
- Up to 6 MHz IQ
- Clock 122.88 MHz, other details unknown
- USB2

- Proprietary firmware and API; supports Gnuradio
- $475

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FunCube Dongle Pro+

- 150 kHz – 240 Mhz,420 MHz – 1.9 GHz
- 16 bit (“32 bits used internally”)
- 192 kHz IQ
- 1.5 PPM
- USB1.x
- Many front-end filters

- Wide software support
- GBP124.99

HackRF One

- 1 MHz – 6 GHz
- 8 bit ADC
- 20 MHz IQ
- Freq Accuracy unstated; accepts 10 MHz input
- USB2
- Has half-duplex TX capability; +5 to +15 dBm at HF

- Wide software support
- $299.95

HPSDR

Mercury, Hermes, Apache variants

- 10 kHz – 54 MHz
- 16 bit ADC
- 384 kHz IQ (Protocol 1)
  - Protocol 2 allows wider
- External 10 MHz reference
- Ethernet
  - Mercury can use USB2

- Mercury, Hermes out of stock
- Apache Labs sells higher-end variants
  - Seem to have dropped ANAN-10 and individual Orion MkII sales
- Various clones have been available (See IQ2 page)

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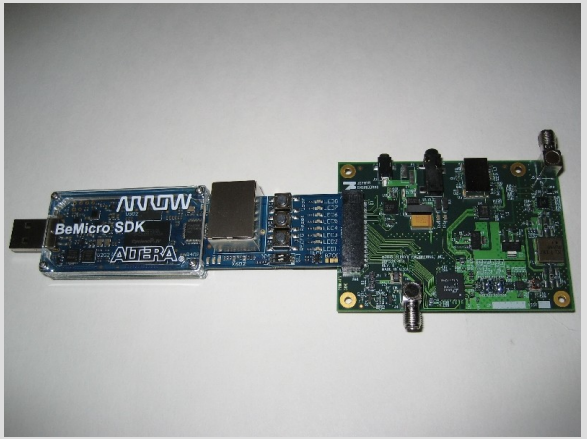

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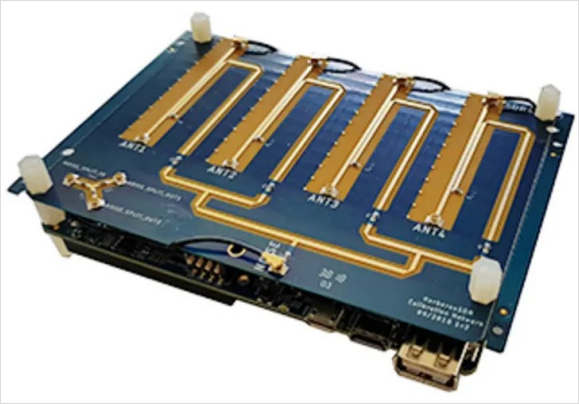

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LimeSDR

- 100 kHz – 3.8 GHz
- 12 bit ADC
- 61.44 MHz IQ
- Low-jitter, 1.5 PPM Rakon TCXO; external clock connector
- USB3
- MIMO – 6 RX, 4 TX
- TX power up to +10 dBm

- Wide software support
- $299
- Also a lower cost LimeSDR mini

Perseus

- 10 kHz – 30 MHz
- 14 bit ADC
- Up to 1600 kHz IQ
- Clock unknown
- USB2
- Current availability unknown

- Closed, Windows-only, environment.
- Last known price 799 Euros.

QuickSilver QS1R

- No longer available
- No information on replacements

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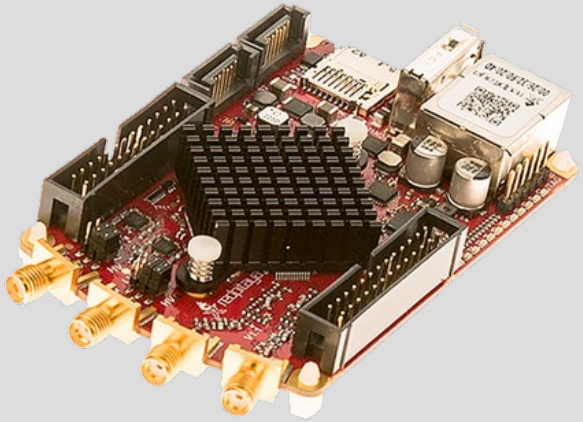

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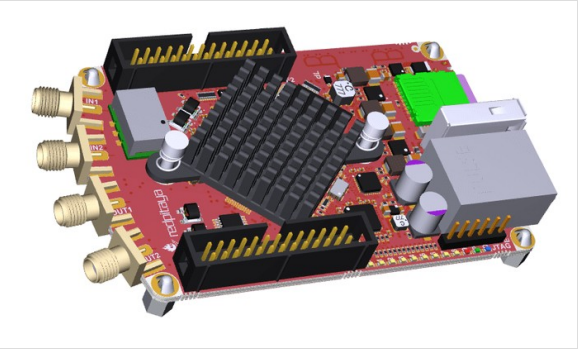

RF-Space SDR

- SDR14, SDR-IQ, NetSDR, CloudSDR, Cloud-IQ
- Currently seem to be unavailable
- Cloud-IQ said to be coming Q4 2018; no recent updates

RTL-SDR.com v3

- 500 kHz – 24 MHz direct sample; to 1766 MHz with tuner
- Single 8 bit ADC
- 2.4 MHz IQ
- 1 PPM TCXO; external clock possible (28.8 MHz)
- USB2
- Note: There are many “dongles” of various qualities. I won’t try to list them all. The RTL-SDR.com unit is one of the best.

- Wide software support
- ~$20

Satrian MK1.5 Andrus

- 5 kHz – 30 MHz
- 12 bit dual ADC (LM97593)
- Up to 400 kHz IQ
- Clock appears to be 25 MHz crystal, specs unknown; no external input
- Ethernet and USB2

- Open source hardware/firmware; wide software support
- Price and availability unknown

SDRplay RSP1A

- 1 kHz – 2 GHz
- 14 bit ADC
- 6 MHz IQ @14 bit
  - Up to 10 MHz @ 8 bit
- 0.5 PPM TCXO
- Numous front-end filters
- USB2

- SoapySDR and Gnuradio support claimed, but issues until recently
- $109

SDRPlay RSP2/RSP2Pro/RSPduo

- Adds multiple antenna ports and external clocking ability (24 MHz)
- Otherwise, appears to be the same as RSP1A.
- RSP2Pro adds metal case
- RSPduo appears to be dual-tuner version of RSP2.

- RSP2: $169.95
- RSP2pro: $199.95
- RSPduo: $279.95

WinRadio WR-G31DDC Excalibur

- 9 kHz – 50 MHz
- 16 bit ADC
- 2 MHz IQ
- Clock unknown
- USB2

- Appears to be closed software ecosystem
- $949.95