An Introduction to Software Defined Radio

Steve Brightman
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- SDRplay
- What is an SDR?
- Why do I want one?
- Review of SDR solutions
- SDR software
- Documentation / Videos
- Panadapters
- Applications
- For further information

www.sdrplay.com
The story of SDRplay

- British Company 4 years old
- Joint venture supported by chip company Mirics
- 7 employees
- Subcontract manufacturing also in UK
- Registered office in Wakefield
What is an SDR?

A radio communication system where components that have been traditionally implemented in hardware...

(e.g. mixers, filters, amplifiers, modulators/demodulators, detectors, etc.)

...are implemented by software on a PC or embedded system.
Top Ten Reasons to buy a decent SDR

1. True general coverage
2. Work one frequency and still monitor the band (or another band!)
   - Panadapter (suddenly your eyes can do 1000X what previously only your ears could do, one signal at a time!)
3. Filters! (brick-wall envelopes... improving all the time with s/w upgrades)
4. Audio and IF Digital Signal Processing (DSP)
5. Harness the power of your existing Computer
6. Multiple VFOs
7. Record large bandwidths
8. Record/playback of audio
9. Allows you to explore new applications:
   - Digital modes, WX satellites, radio astronomy, aircraft monitoring, digital stations, TV, DAB, Iono sondes! etc etc
10. Can you ever have too many receivers?

www.sdrplay.com
Review of SDR receivers
– what to consider:

- **Frequency Range:** The range of frequencies the SDR can tune.

- **ADC Resolution:** Higher is better. More resolution means more dynamic range, less signal imaging, a lower noise floor, more sensitivity when strong signals are present and better ability to discern weak signals.

- **Instantaneous Bandwidth:** The size of the real time RF chunk available.

- **RX/TX:** Can the radio receive and/or transmit?

- **Preselectors:** Analogue filters on the front end to help reduce out of band interference and imaging.

- **Software:** Is your favourite package supported? Does manufacturer provide?

- **Price**
SDR receiver examples - 1

**R820T RTL2832U a.k.a RTL-SDR**

- **Cost:** $10 – 22 USD
- **Frequency Range:** approx. 24 MHz – 1768 MHz (below 24 MHz available on RTL-SDR.com V3 dongles)
- **ADC Resolution:** 8 Bits
- **Max Bandwidth:** 3.2 MHz / 2.4 or 2.8 MHz max stable.
- **TX/RX:** RX Only
- **Preselectors:** Uses tracking RF filters on the R820T2 chip.
- **Release Date:** August 2016

**Airspy R2**

- **Cost:** $189 USD
- **Frequency Range:** 24 MHz – 1.750 GHz
- **ADC Resolution:** 12 Bits (10.4 ENOB)
- **Max Bandwidth:** 10 MHz (9 MHz alias free)
- **TX/RX:** RX Only
- **Preselectors:** Uses tracking RF filters on the R820T2 chip.
- **Release Date:** Late 2014 (Airspy R1)
ColibiriNANO

Cost: €299.95 EUR -> ~$360 USD
Frequency Range: 100 kHz – 55 MHz, 100 kHz – 500 MHz (undersampling)
ADC Resolution: 14
Max Bandwidth: 3 MHz
TX/RX: RX Only
Preselectors: HF LPF
Release Date: 2017

Elad FDM-S1/S2

Cost: $379 USD / $580 USD
Frequency Range: 80 kHz – 30 MHz, 30MHz – 200 MHz (Under sampled) / 9 kHz – 52 MHz, 74 MHz – 108 MHz, 135 MHz – 160 MHz
ADC Resolution: 14 Bits / 16 Bits
Max Bandwidth: 6 MHz
TX/RX: RX Only
Preselectors: 30 MHz Low Pass Filter
### SDR Variety

**8-bit Dongles**
- $10 – 100
- Low performance
- Introductory

**General Purpose**
- $100 – 200
- Good performance
- Wide Coverage
- RSP, Airspy etc

**High End**
- $500 – 1000s
- High performance
- Specialized functionality
- RF Space, Flex, ELAD etc

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- **Large cost adder**
  - Modest performance gains

- **Small cost adder**
  - Big performance gain
SDRplay Receivers

- Continuous SDR receiver coverage from VLF to 2 GHz
- All the amateur radio bands from VLF to 23cm
- High performance ADC technology (not another compromise SDR!)
- Built-in high performance front-end filters
- Use as a stand-alone general coverage receiver, or as a high resolution panadapter
- Visualize all the signals in multiple bands simultaneously
- SDRuno Windows SDR software provided free-of-charge
- Also works with other platforms and popular SDR Software (e.g. HDSDR, SDR-Console & Cubic SDR)
- Ideal for portable operation (powered via USB)
- Run on a Raspberry Pi3 – download our SD Card image
- Can be used as a Spectrum Analyzer or an RF Power Meter
- Backed by the world’s biggest and best SDR support community!
The SDRplay RSP1A is a major upgrade to the popular RSP1—it is a powerful wideband full featured 14-bit SDR which covers the RF spectrum from 1kHz to 2GHz. All it needs is a PC and an antenna to provide excellent communications receiver functionality. Combined with the power of readily available SDR receiver software (including ‘SDRuno’ supplied by SDRplay) you can monitor up to 10MHz of spectrum at a time. Documented API allows developers to create new demodulators or applications around the platform.

- Calibrated S meter and power measurements with SDRuno
- Up to 10MHz visible bandwidth
- 11 high-selectivity, built in front-end preselection filters
- Software selectable AM/FM and DAB broadcast band notch filters
- Software selectable multi-level Low Noise Preamplifier
- Bias-T power supply for powering antenna-mounted LNA
- RF shielding layer inside case
- Single SMA antenna socket covering entire frequency range
The RSP2 and RSP2pro are powerful wideband full-featured SDR receivers which cover all frequencies from 1kHz up to 2GHz. The RSP2 and RSP2pro provide three software selectable antenna inputs, and clocking features ideally suited to industrial, scientific and educational applications. By using SDRplay’s own powerful SDRuno software, this versatile receiver can monitor up to 10MHz of spectrum and accurately record RF power and noise measurements over time. A documented API allows developers to create new demodulators or applications around the platform. The RSP2 is housed in an RF shielded robust plastic case and the RSP2pro is enclosed in a rugged black painted steel case.

- Supports up to 3 simultaneously connected antennas
- 2 x 50-Ohms and one High-Z port for lower frequencies
- 10 high-selectivity, built in front-end preselection filters
- Software selectable AM/FM broadcast band notch filter
- Additional ‘in’ and ‘out’ ports, enabling...
- External sync to reference clock + synchronising multiple RSPs
Software

- Multi-platform support for Windows, Mac, Linux, Android, Raspberry Pi 2/3
- SDRuno Windows SDR s/w (based on Studio1 which cost $179) provided free of charge
- ExtIO compatibility
- Supports CubicSDR for MAC, Linux and Raspberry Pi3 users
- Software upgradeable for future standards
- API provided to allow demodulator or application development
- Works well with 3rd Party *free* software including:

 **SDRConsole**  
 **HDSDR**  
 **Cubic SDR**
Users are asking, which receiver we would recommend. The answer depends on many factors amongst application, environment, antenna and price. Focusing on ready-to-use SDR hardware for listening with Windows we can recommend following tested receivers:

<table>
<thead>
<tr>
<th>Price</th>
<th>Model / Manufacturer</th>
<th>Frequency Range in MHz</th>
<th>Remarkable properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10 £EUR</td>
<td>RTL-SDR (DVB-T/DAB with RTL2832+R820T2) Search 'RTL2832' or 'R820T2' on eBay</td>
<td>24 - 1766 MHz</td>
<td>2 MHz Bandwidth, 8 bit For beginners - don’t expect wonders!</td>
</tr>
<tr>
<td>~ 20 £EUR</td>
<td>RTL-SDR V3 (DVB-T/DAB with RTL2832+R820T2) RTL-SDR.com</td>
<td>0.5 - 24, 1766 MHz</td>
<td>2 MHz Bandwidth, 8 bit For beginners - don’t expect wonders!</td>
</tr>
<tr>
<td>~ 110 £EUR</td>
<td>RSP1A (Radio Spectrum Processor) / SDRplay</td>
<td>0.001 - 2000 MHz</td>
<td>up to 8 MHz Bandwidth, up to 14 bit, Bias-T, 0.5PPM TCXO</td>
</tr>
<tr>
<td>~ 175 £EUR</td>
<td>RSP2 (Radio Spectrum Processor) / SDRplay</td>
<td>0.001 - 2000 MHz</td>
<td>Similar as RSP1A but with 3 antenna ports, External clock input/output</td>
</tr>
<tr>
<td>369 £EUR</td>
<td>FDM-S1 / ELAD</td>
<td>0.02 - 30 MHz</td>
<td>5 MHz Bandwidth, 14 bit Bandpass undersampling up to 200 MHz possible</td>
</tr>
<tr>
<td>525 £EUR</td>
<td>FDM-S2 / ELAD</td>
<td>0.009 - 52, 74 - 108, 135 - 160 MHz</td>
<td>5 MHz Bandwidth, 16 bit very good reception quality</td>
</tr>
</tbody>
</table>

Above list is a small selection sorted by price. There are many other recommendable receivers, but we only considered receivers we have (tested).
SDRuno provides a rugged and flexible, high performance SDR receiver capability, featuring:

- Multiple ‘Virtual Receivers’ which allow for simultaneous reception and demodulation of different types of signals within the same receiver bandwidth
- A selectivity filter with an ultimate rejection greater than 140 dB
- A unique distortion-free double stage AGC with fully adjustable parameters
- Multiple notch filters with BW adjustable down to 1 Hz, Notch Lock feature
- A unique synchronous AM mode with selectable/adjustable sidebands, dedicated PLL input filter, and selectable PLL time constants
- Record and playback an entire amateur band!
- 29 pre-set amateur and broadcast bands
Multiple VFOs & different decode modes simultaneously!
Ham Band Framing + RF power level + SNR measurement & logging

www.sdrplay.com
SDRuno Roadmap:

1.23 Intermediate update:
• Recording of selected signal only (either I/Q or audio) to WAV file format
• Selected signal piped to VAC in I/Q format

1.3 Major update:
• Separation of VFO and LO frequency control
• Frequency scanning

1.31 Intermediate update
• Remote client for network based streaming I/Q server applications

1.4 Major update
• Addition of new API for third party plugins

Download link: http://www.sdrplay.com/downloads
Raspberry Pi3 setup supported

Pi Image file available for download!

www.sdrplay.com
Software and documentation

SDRPLAY - Downloads

SOFTWARE
- Windows
- Linux x64
- Mac
- Raspberry Pi
- Android
- ARM64

DOCUMENTATION
- Software
- App Notes
- Community Guides
- How To Guides
- Video guides & Media
- Links
- Datasheets

SDRUNO – V1.22 (13TH JAN 2018)
(RSP1/RSP1A/RSP2) Includes hardware driver

HDSDR – V2.76 (15TH NOV 2017)
(RSP1/RSP1A/RSP2) Includes hardware driver/APTXTO plugin

SDRUNO USER MANUAL
(version 1.22 / 13th January 2018)

SDRUNO RELEASE NOTES
(version 1.22 / 13th January 2018)

SDRuno User Manual v1.22
How-to videos:
SDRplay YouTube Channel

SDRplay.com
www.youtube.com/c/SDRplayRSP
What is a Panadapter?

“Panadapter” is short for Panoramic Adapter. The simple answer is that it allows us to see a panoramic display of the band our radio is tuned to. We can see every signal”*

Early implementations used a PC soundcard to achieve this function but were therefore limited to 200 kHz of bandwidth because they rely on the sound card.

The advent of affordable SDR hardware such as the RSP1A has allowed implementations with much greater bandwidth, and hence much more usefulness.

Combined with readily available, and capable, SDR software Panadapters are now an affordable and easy to implement reality!

* Definition courtesy KA9MOT http://mypanadapter.com/

“Go-to” choice for Kenwood, Yaesu, Icom, Elecraft etc!
The perfect Panadapter companion for your rig

• Any of the SDR Software programs that support RSP can be used to provide a basic spectrum display.

• SDRuno, HDSDR and SDR Console have built-in capabilities for CAT and other add-on software, to allow for communication between the SDR software and the transceiver.

• Ham Radio Deluxe and OmniRig are commonly used for synchronization/control between the TRx and SDR Rx.
Use a T/R switch if not using protected transceiver IF or RF out!
Doubles as a new piece of RF lab kit: An RF Power meter – get one for work!

Using the SDRplay RSP2 for versatile RF Power measurement

Within 1dB accuracy!

www.SDRplay.com
Add-on Software
- Satellite working

WD9EWK VHF crossed dipole & Tablet + RSP for telemetry
NOAA Weather satellite (137 MHz) - Wxtoimg (RSP1)

Credit: Jeff Broughton, WB8RJY

User pictures from the facebook group: www.facebook.com/groups/sdrplay/

Wxtoimg: http://www.wxtoimg.com

Credit: Sefi Merkel
Hi Resolution satellite images
(1.7GHz)
RSP2
..including latest GOES-16

Processing a few images from GOES-16 testing received via RSP2 earlier in week. Looks great here. Himawari and GOES-16 Full Disks. @SDRPlay
How to get some very impressive GOES High Resolution Satellite images using the RSP2 and SDRuno

*Geostationary weather satellite image reception is more challenging than APT weather satellite image reception, but can be achieved well using an SDRplay RSP2* as described in this new post on our forum. The author writes: *Before getting started in putting together a receiving system for LBT and HBT images, it is a good idea to [...]*
Facebook Group

8000 users helping each other!
ADS-B decoding example using Dump1090 and VRS

Credit: Max Santos, AC5PY
FLdigi
NBEMS (Narrow Band Emergency Messaging System)

Credit: Jeff Kopcak, k8jtk

Fldigi: [http://www.w1hkj.com](http://www.w1hkj.com)

...and WEFAX Decoding

Credit: Erik Mikkel Wied
Direct support from SDRplay
Tune in to Jupiter!

RECEIVING JUPITER NOISE BURSTS WITH AN SDRPLAY RSP1

Over on YouTube user MaskibonSAE has uploaded a video showing him receiving some noise bursts from Jupiter with his SDRplay RSP1. The planet Jupiter is known to emit bursts of noise via natural ‘radio lasers’ powered partly by the planet’s interaction with the electrically conductive gases emitted by Io, one of the planet’s moons. When Jupiter is high in the sky and the Earth passes through one of these radio lasers the noise bursts can be received on Earth quite easily with an appropriate antenna.

In his video MaskibonSAE shows the 10 MHz of waterfall and audio from some Jupiter noise bursts received with his SDRplay RSP1 at 22119 kHz. According to the YouTube description, it appears that he is using the UTR-2 radio telescope which is a large Ukrainian radio telescope installation that consists of an array of 2040 dipoles. A professional radio telescope installation is not required to receive the Jupiter bursts (a backyard dipole tuned to ~20 MHz will work), but the professional radio telescope does get some really nice strong bursts as seen in the video.
Bill Otten | I'm a 41 year ham op. Until the SDRPlay came along I wasn't spending much time with radio. SDRPlay changed that and rekindled my interest in radio. I love it. I've done a lot of VLF listening this past winter, got into the WX satellites and built a QFH antenna that I use on a daily basis. Listen all over the short wave bands now, even check into my weekly ham net with the regular radio and then listen to the rest using my SDRPlay receiver. It's a remarkable receiver. I tend to use SDR Uno as my primary software too. de KC9CS
Hardware + Software + Community =

So many reasons to get one!

- Visualise multiple bands at the same time
- Designed & manufactured in the UK
- Perfect gift to impress the next generation
- Using the RSP2 for versatile RF Power Measurements
- Explore new digital modes: JT65, DSD+, etc.
- Explore new bands
- Satellites imaging

Recommended by authors of both HDSDR and SDR-Console
Backed by the world’s biggest & best SDR support community!

www.SDRplay.com
For more information

- **Company website:** [www.sdrplay.com](http://www.sdrplay.com)
  - We have distributors located [worldwide](http://www.sdrplay.com)
  - US Distributor: [Ham Radio Outlet](http://www.sdrplay.com)

- **Community Forums:** [www.sdrplay.com/community/](http://www.sdrplay.com/community/)

- **Email:**
  - North America: [support-usa@sdrplay.com](mailto:support-usa@sdrplay.com)
  - Rest of World: [support@sdrplay.com](mailto:support@sdrplay.com)

- **Facebook:** [SDRplay](https://www.facebook.com/SDRplay) and [SDRuno](https://www.facebook.com/SDRuno) specifically
  - Independent groups run by enthusiastic users!

- **Google / YouTube**
  - Many videos covering how to use the various software packages, implementing panadapters and much more. Use the Google search function!
  - SDRplay channel: [www.youtube.com/c/SDRplayRSP](http://www.youtube.com/c/SDRplayRSP)