

SDRplay RSPdx SDRuno 41-meter band. (Courtesy of the author)

TSM Reviews:

SDRplay RSP SDRs

By Larry Van Horn N5FPW

Hot on the heels of the release of the new Airspy HF+ Discovery (*TSM First Look* September 2019 / *Global Radio Guide* Winter 2019/2020 Full Review), SDRplay Limited, a UK-based company, has recently released a new RSP (aka Radio Signal Processor) Software Defined Radio (SDR)—the RSPdx.

This SDR is a wideband full featured 14-bit SDR which covers the entire RF spectrum from 1 kHz to 2 GHz. Combined with the power of readily available SDR receiver software you can monitor up to 10 MHz spectrum at a time. The RSPdx provides three software selectable antenna inputs, and an external clock input. All it needs is a computer and an antenna to provide excellent communications receiver functionality. A documented API allows developers to create new demodulators or applications around the platform.

According to a company documents on their website the RSPdx is designed to provide enhanced performance with additional and improved pre-selection filters, improved intermodulation performance, the addition of a user selectable DAB notch filter and more software selectable attenuation steps.

The RSPdx, when used in conjunction with SDRplay's own house brand software – SDRuno, introduces a special

HDR (High Dynamic Range) mode for reception within selected bands below 2 MHz. HDR mode delivers improved intermodulation performance and fewer spurious responses for those challenging bands.

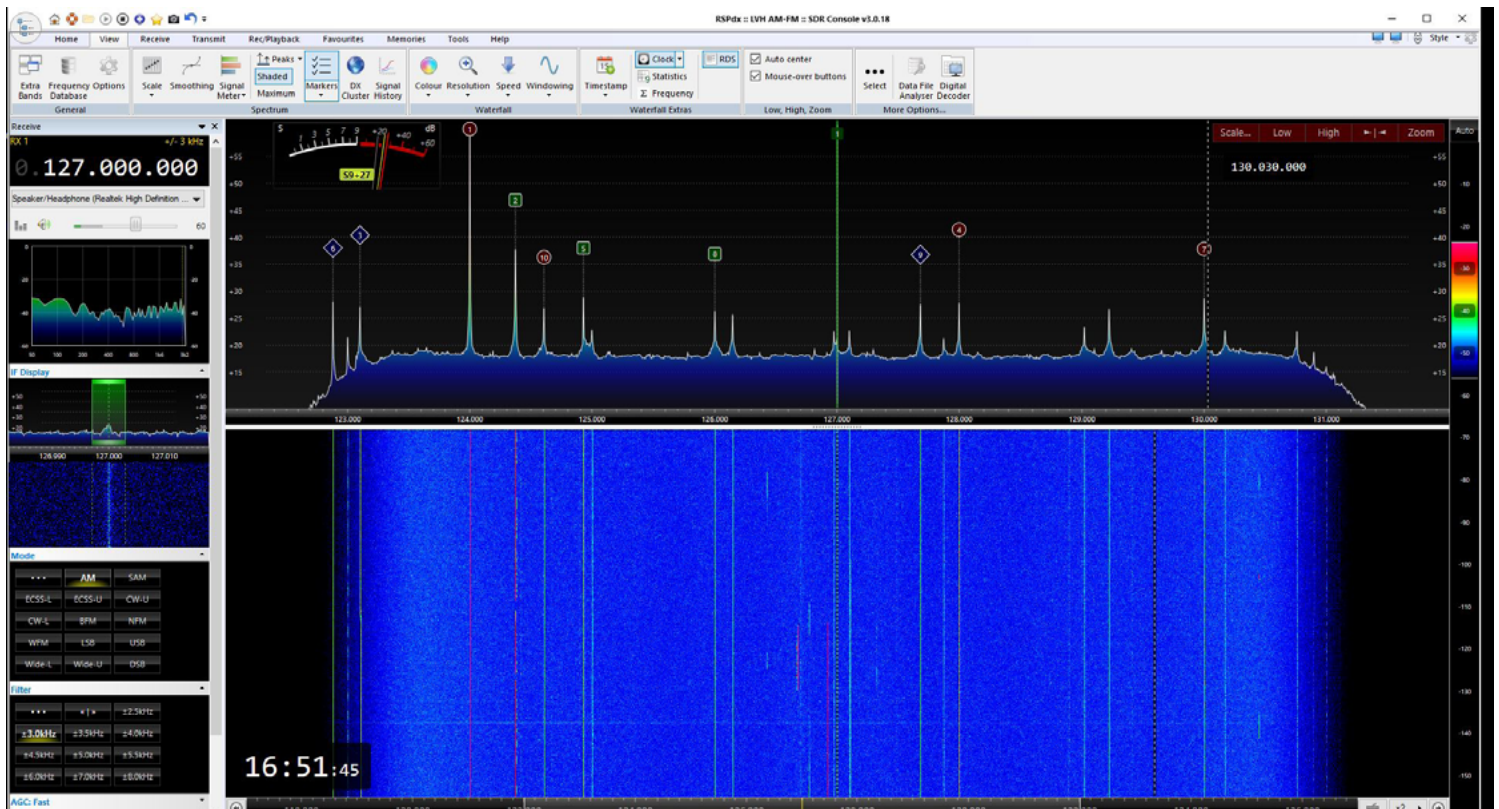
Jon Hudson, Co-Founder and Director of SDRplay, said, “The SDRplay RSPdx is a complete redesign and replacement for the popular RSP2 and RSP2pro multi-antenna receivers.

“The RSP2 and RSP2pro design was over three years old now so the RSPdx has taken advantage of a lot of the learning from our work on the newer RSP1A and RSPduo designs as well as ongoing feedback from customers,” Hudson said.

Here, while the focus will be on the RSPdx, I will incorporate some additional information on the company's other two SDRs currently being sold in the radio marketplace – RSP-1A/RSPduo.

What is Software Defined Radio (SDR) Technology?

In order to appreciate the marvel that is the software defined radio like any of the SDRplay RSP SDRs, a “brief primer” is in order.



SDRplay RSPdx SDR Console V3 Civilian Air Band. (Courtesy of the author)

The software-defined radio is a technology that offers a simple alternative to bulkier analog radios, adding more flexibility and performance in a much smaller case. You may not realize it but SDRs are everywhere, from your cell phone to your wireless headset and even your cable modem.

In a nutshell, an SDR is a radio where the components that have been traditionally implemented in hardware (e.g. mixers, filters, amplifiers, modulators/demodulators, detectors, etc.) are instead implemented by means of software on a personal computer or embedded system.

So, what happens in the black box versus what happens in the computer? The SDR black box is the RF front end of the receiver. The PC takes the output of the hardware front end and does all the processing necessary to create the spectrum display, the waterfall, receiver front end control, and can create one or more receivers that will each select a signal for demodulation. It is possible to select multiple signals for demodulation at the same time.

A basic SDR system may consist of a personal computer equipped with a sound card, or other analog-to-digital converter, preceded by the radio frequency (RF) front end like the RSP SDRs. Significant amounts of signal processing are handed over to the general-purpose processor, rather than being done in special-purpose hardware (electronic circuits).

The SDR software also performs all the demodulation, filtering (both radio frequency and audio frequency), and signal enhancement (equalization and binaural presentation).

SDR usages include every common amateur modulation: Morse code, single sideband modulation, frequency modulation, amplitude modulation, and a wide variety of digital modes such as RTTY, SSTV, packet radio, and many

other digital modes. SDRs are also being used to demodulate Digital Radio Mondiale (DRM) broadcast streams without the need to purchase a hardware-based receiver. Listeners using this method can use the DREAM open-source project that decodes the coded orthogonal frequency division multiplexing (COFDM) technique to listen to DRM transmissions (see link in Table Two).

The bottom line on decoding various digital modes and modulation schemes is this. The days of the hardware decoder are over. Now with an SDR, in order to receive a new modulation or digital mode, you only need to upgrade a software package or firmware in the radio instead of replacing the whole hardware-based unit as we have done in the past.

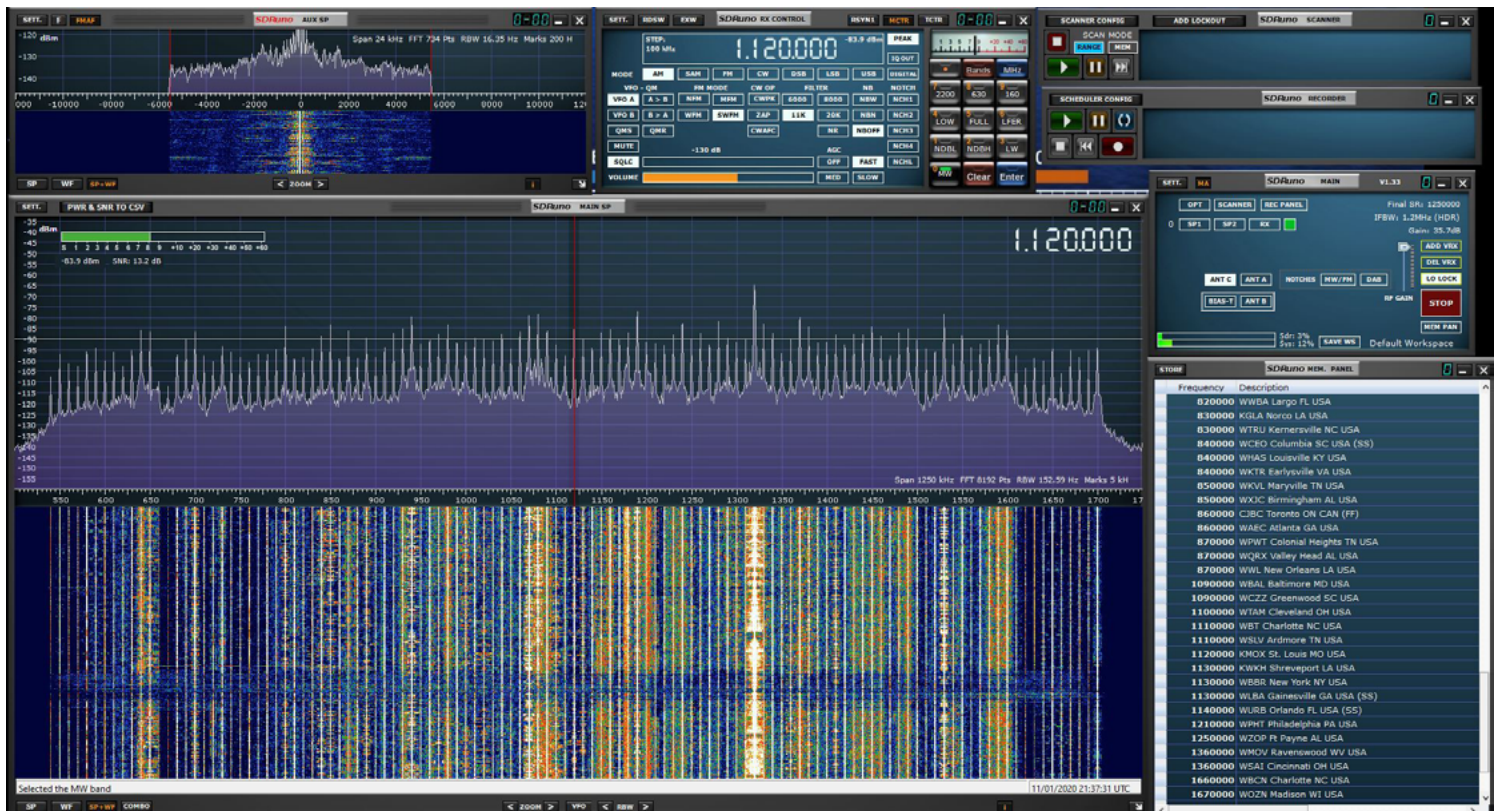
Should You Own One?

The short answer is yes. A wise man once told me that once I started using waterfall and spectrum technology I would never go back to the old ways of a tuning knob and frequency readout associated with hardware-based receivers. And you know something, he was right. There is no comparison.

So, what can you do with these radios and how are some of them being used? Here are just a few applications that SDRplay provided.

Hams and Radio Monitoring Hobbyist

Shortwave radio listening (SWL), broadcast DXing (AM/FM/TV), panadapter, aircraft (ADS-B and ATC), slow scan TV, multi-amateur band monitoring, WSPR and digi-



SDRplay RSPdx SDRuno Entire MW band from Brasstown. (Courtesy of the author)

tal modes, weather fax (HF and satellite), general satellite monitoring, geostationary environmental/weather satellites, conventional and trunked radio scanning, utility and emergency service monitoring, and fast and effective antenna comparison.

Industrial Uses: Spectrum analyzer, surveillance, wireless microphone monitoring, RF surveying, Internet of Things (IoT) projects receiver chain, signal logging, RFI/EMC detection, broadcast integrity monitoring, spectrum monitoring, and power measurements.

Educational/Scientific Uses: Teaching, receiver design, radio astronomy, passive radar, ionosonde. spectrum analyzer, receiver for Internet of Things (IoT) sensor projects, antenna research and a whole lot more.

The funniest application I have seen to date was posted by a man named Clayton who used his SDR and the RTLAMR software decoder package to locate, wait for it, a water leak. No, I'm not kidding. There are literally hundreds of uses for a fully functional, multi-mode radio like this. SDRs can be incorporated easily into your radio listening environment and they work with a wide variety of added software decoding packages, analyzers and a whole lot more. Pick the package, add the antenna and the SDR does the rest.

The RSPdx – Three Antenna Ports – 14-bit SDR

SDRplay RSP SDRs is a line of popular SDR receivers developed and designed to achieve high performance at an affordable price.

SDRplay Limited is a UK based company and consists of a small group of engineers with strong connections to the

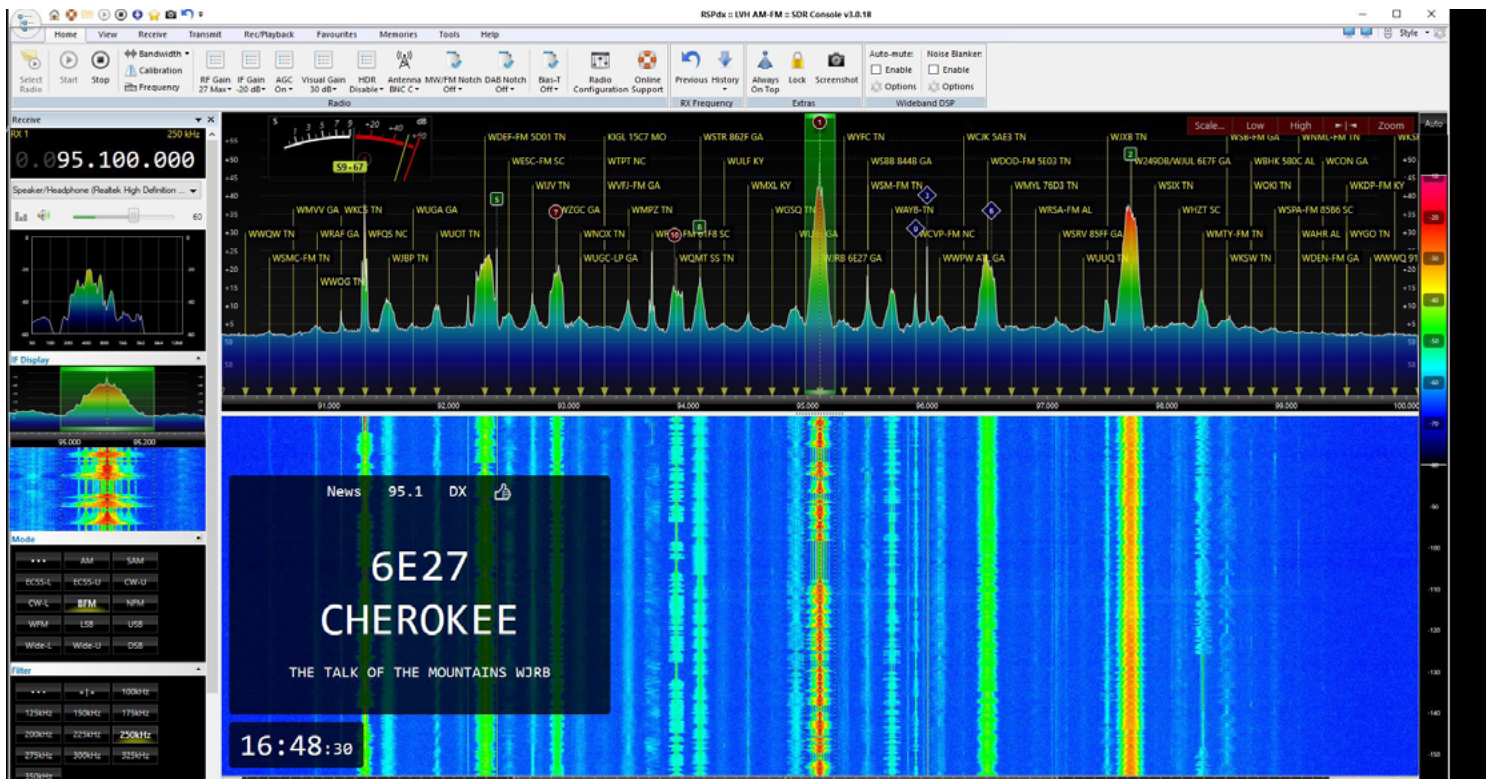
UK wireless semiconductor industry. SDRplay announced its first product, the RSP1 in August 2014.

Since then the RSP line has continued to mature in development. At the present time there are three units in production.

The RSP-1A was a major upgrade from the popular RSP-1 and is considered an entry-level SDR receiver. It is a wideband full featured 14-bit SDR and I think it is a perfect all-round general coverage communications receiver and a lot more. This unit covers the complete radio spectrum from 1 kHz (VLF) to 2 GHz (Microwaves) with up to a 10 MHz visible bandwidth. This SDR is in a shielded plastic case, and only has two connectors (USB B like those used with printers and a female SMA antenna). Ham Radio Outlet is the exclusive US dealer for the RSP line and their current price for the RSP-1A is US\$119.

SDRplay's RSPduo is a dual-tuner wideband full featured 14-bit SDR which also covers the entire RF spectrum from 1 kHz to 2 GHz providing up to 10 MHz of spectrum visibility. Using SDRuno software for Windows, you can simultaneously monitor two separate 2 MHz bands of spectrum anywhere between 1 kHz and 2 GHz. The RSPduo provides three software selectable antenna inputs, and clocking features ideally suited to industrial, scientific and educational applications. All it needs is a PC and an antenna to achieve communications receiver functionality. Like the RSP-1A, a documented API allows developers to create new demodulators or applications around the platform. As we go to press the HRO price for the RSPduo was discounted to US\$240 from US\$280.

Some key features and benefits available with the RSP-



SDRplay RSPdx SDR Console V3 FM Band Brasstown. (Courtesy of the author)

duo include:

- Dual tuner provides independent coverage from 1 kHz to 2 GHz using two antenna ports simultaneously.
- 14-bit ADC silicon technology (not just another 8-bit dongle!).
- Up to 10 MHz visible bandwidth (single tuner mode) or two slices of 2 MHz spectrum (dual tuner mode).
- Three software-selectable antenna ports (Two 50 Ω and one 1,000 Ω high impedance balanced/unbalanced input).
- High impedance antenna port (1 kHz to 30 MHz) with selectable MW notch filter and choice of two pre-selection filters.
- Software selectable AM/FM and DAB broadcast band notch filters for the two SMA antenna (1 kHz to 2 GHz) antenna ports.
- External clock input and output enables easy synchronization to multiple RSPs or external reference clock.
- Powers over the USB cable with a simple type B socket.
- 11 high-selectivity, built in front-end preselection filters on both the two SMA antenna Ports.
- Software selectable multi-level Low Noise Preamplifier.
- Bias -T power supply for powering antenna-mounted LNA.
- Enclosed in a rugged black painted steel case.

The subject of this review is, of course, the new RSPdx released in November 2019. Like the RSPduo, the RSPdx comes in a rugged black painted steel case. It even has four feet to help stabilize it on the desk. Some of the key features and benefits available with the RSPdx (and very similar to

the RSPduo) include:

- Covers all frequencies from 1 kHz through VLF, LF, MW, HF, VHF, UHF and L-band to 2-GHz, with no gaps in frequency coverage.
- Receive, monitor and record up to 10 MHz of spectrum at a time.
- Performance below 2 MHz substantially enhanced – improved dynamic range and Selectivity.
- Software selectable choice of three antenna ports.
- Enhanced ability to cope with extremely strong signals.
- External clock input for synchronization purposes, or connection to GPS reference clock for extra frequency accuracy.
- Excellent dynamic range for challenging reception conditions.
- Free use of windows based SDRuno control software which provides an ever-increasing feature-set.
- Strong and growing software support network.
- Calibrated S meter/ RF power and SNR measurement with SDRuno (including data-logging to .CSV file capability).
- Documented API provided to allow demodulator or application development on multiple platforms.

Initial Testing

Our SDRplay RSPdx (serial number 1911007B42) that we tested was purchased from HRO Atlanta (www.hamradio.com). We received prompt and courteous service from the company, and I especially want to thank David Brown AI4XL and Mark Holmes KJ4VO of HRO Atlanta for all their help in getting an early production unit to us. The unit

was shipped from their Virginia store via UPS. It was well packaged and arrived in good shape.

Normally, this section of my review is the part where I would tell you what is in the box. Like most commercial SDRs today, that is quite simple, the RSPdx unit. The user will have to supply an USB A to B cable to connect the SDR to the computer being used to control the SDR. I highly recommend in today's noisy local environments (Wi-Fi interference, LCD/LED monitor screen noise, electrical appliance, etc.) that you do not scrimp on the cable. Get one that uses quality shielded cable and RF chokes. This is especially important if you plan to use it in a ham radio environment.

There is one caveat on the box the unit was packaged in that you may miss, but since most of us are hams, we need to know.

“IMPORTANT. Do not directly connect the RSPdx to the same antenna as your transmitter or to an antenna in the near field of a transmitting antenna as this is likely to result in permanent damage to your RSPdx and void your warranty. (Maximum rated input 0 dBm continuous or 10 dBm for short durations). Disconnecting the USB cable does NOT protect the radio from damage due to electrical over-stress so it is essential to disconnect your antenna when transmitting with high power from a nearby antenna. Alternatively, use an antenna switch with sufficient isolation.”

A complete set of specifications for this unit can be found in Table One.

Let me make this clear from the onset, there are no instructions or manuals included in the box. This isn't a plug and play radio. You will need to interface with the website for the control software you intend to use for additional operational information (see the links listed in Table Two). On the SDRplay website they have all sorts of information, links to videos, software, SDRuno software manual in English and French on the downloads page at <https://www.sdrplay.com/downloads/>. For initial installation, the SDRplay has a “Start Here page at <https://www.sdrplay.com/start-here/>. I highly recommend you start on that website page.

It's All About the Software

As I mentioned before the RSP SDRs are the black box RF front ends and the rest of the radio is the software package you have loaded on your PC.

The choice of your SDR software package is an important decision that the radio hobbyist needs to make. There are two main packages that support the RSP radios: SDRuno and SDR Console. Both packages are excellent and are “free.” The package that I use depends on what sort of listening I am doing. Another article could be written about the various SDR software packages and I hope to have that completed soon.

- The current version of SDRplay's house software is SDRuno v1.33. Some of the software's features include: High Dynamic Range mode (HDR) for RSPdx use below 2 MHz.

- Highly integrated native Windows support for the SDRplay family.
- Multiple ‘virtual receivers’ for simultaneous reception and demodulation of different types of signals within the same receiver bandwidth.
- An integrated frequency scanner (for frequency ranges and stored memory panel lists).
- A selectivity filter with an ultimate rejection greater than 140 dB.
- A unique distortion-free double stage Automatic Gain Control (AGC) with fully adjustable parameters.
- Automatic Frequency Control (AFC) for FM signals.
- Multiple notch filters with bandwidth adjustable to 1 Hz plus a notch lock feature.
- A unique synchronous AM mode with selectable/adjustable sidebands, dedicated Phase Locked Loop (PLL) input filter, and selectable PLL time constants.
- Stereo Noise Reduction (SNR) featuring a proprietary noise reduction algorithm for stereo broadcast.
- Wideband noise filter for addressing common sources of Radio Frequency Interference (RFI) (e.g. power supplies, internet over DSL etc.).
- Calibration for receiver frequency errors.
- Radio Data System (RDS) support optimized for low signal environment.
- Active Noise cancelling.
- Computer Aided Transceiver (CAT) and Omnirig control.
- Calibrated RF Power Meter with > 100 dB of usable range.
- Calibrated S-Meter supporting the current IARU S-Meter Standard.
- The ability to save power (dBm) and SNR (dB) measurements over time, to a CSV file for future analysis.
- IQ output accessible by 3rd party applications.

SDRplay released the following update on additional software packages for the RSPdx as I was finishing this article. Simon Brown has released his latest version of SDR Console V3 which supports the RSPdx (Version 3.0.18 dated January 1st) over on <https://www.sdr-radio.com/> (make sure you download the latest API 3.x from our downloads page first).

SDRplay has released an EXTIO plugin for the RSPdx which will enable the RSPdx to work with any EXTIO-based software (e.g. HSDR) although it doesn't support HDR mode. HDR mode will not be added and the source code for the plugin can be found on our GitHub repository (https://github.com/SDRplay/ExtIO_SDRplay). They will not be supporting the plugin source code or extending the plugins capabilities. They are all free to be modified.

It is important to note that the RSPdx ExtIO plugin does not, and will not, support HDR mode. If you need HDR mode, then SDRuno is the best option. HDR mode requires the end application to work in a certain way and this is not something that can be controlled via the ExtIO protocol.

Work has also begun on supporting RSPdx for SoapySDR based applications such as Cubic SDR (again this won't include HDR mode). A Gnu Radio source block for the RSPdx will follow.

SDRplay is working with Steve Andrew, author of the Software Analyzer software program (see <https://www.sdrplay.com/spectrum-analyser>) to help get compatibility for the RSPdx.

First, in today's terms, the SDR control software that goes on your PC does not need the latest or greatest computer to operate the SDR. To get full functionality, the house brand software SDRuno only operates on a Windows platform. Using the house brand software allows you to use all the features built in to all the RSP SDRs. The learning curve for the SDR Uno software is steep and there are simpler packages out there that will run these units but usually at the expense of some capability or feature set. Software page link <https://www.sdrplay.com/downloads/>.

On Air Testing

To me the proof of a radio's true weight and metal is when you put it on the air and test it in real life monitoring situations.

I own an RSP-1A and have been very happy with its receiving capability above 500 kHz. On longwave frequencies not so much. The RSPdx SDR, however, below 2 MHz has been fun to play and DX with. I have added all sorts of longwave, AM BCB (including some trans-Atlantic MW stations) to my logbook.

In the longwave spectrum, for instance, during a half hour listening session, I added several new Non-Directional Beacons (NDB), including two new states and two Canadian beacons. I have also logged several longwave broadcasters from both Europe and Africa.

On the AM broadcast band, I have hit the new station mother lode using the RSPdx. I started DXing the medium wave band here in Brasstown, NC, back in the fall of 1993. The early days of DXing here were fantastic. Unfortunately, the last decade it has been nearly a bust due to electrical and Wi-Fi interference in the low bands.

Starting with my purchase of the Airspy HF+Discovery, the W6LVP magnetic loop antenna, and now the RSPdx, AM BCB is actually fun again. So far this season I have added over 115 new AM radio stations to the logbook. That's not a bad feat when you consider I started the AM DX season with 837 stations logged from here in Brasstown.

This is a direct result of the improvements in noise reduction that both the Airspy HF+ Discovery and SDRplay RSPdx SDR have brought to the table. The new below 2 MHz improvements, including the new HDR mode on the RSPdx have added to my AM BCB totals.

HF Bands

The big problem with many low-budget SDR receivers

and dongles is strong signal overload due to many, sometimes very strong summed signals on the shortwave. Unfortunately, most the low-priced SDRs have never been preselected, mostly for cost reasons and will suffer strong signal overload especially in high RF areas (urban/metro areas). Without exception, these devices usually have major problems with the antennas that radio hobbyist use. They overload very quickly, which made serious reception on long, medium and shortwaves rather difficult.

This is not the case with my two RSPs in our rural location of western North Carolina. I have a nice collection of plug-in SDR dongles in my go-bag that I no longer use of a regular basis. I just keep them around for special applications. I now have an excellent capability to monitor the HF radio spectrum from my shack and even on the go with the two RSPs.

On the HF bands the RSPdx like its RSP-1A sibling has also been a great performer. This receiver has filled the spectrum display with all sorts of voice and digital signals, some of which I have never heard before. Add to all this the capability to easily add various software decoder packages for digital signal decoding and I now have created a new dimension to my monitoring the HF bands.

VHF and Up

Since the goal with the release of the RSPdx was to improve reception of 2 MHz below and that was the focus of this review, I have not concentrated as much on the frequencies 30 MHz and above. Since the specs look identical between the two RSPs I assume that the performance is probably equivalent to the RSP-1A. Now I have the benefit of having two wideband SDR receivers that cover 1 kHz to 2 GHz.

I have had a chance to scroll through the VHF/UHF ham bands and some of the public safety bands below 470 MHz. Reception using even a preamp has been excellent with zero strong signal overload. The caveat here is that I have only tested the RSPdx in a rural area. I hope to conduct some further testing in several urban/metro areas to check on the unit's strong signal handling capability, but at this point I have no reason to believe that there will be any problems based on the comments of other reviewers and field reports.

One area I do want to explore with both the RSP-1A/RSPdx in the near term is using them to monitor various satellites including Inmarsat. I think that could prove very interesting and hopefully I can bring some of those results to *TSM* readers in future articles.

Some Final Thoughts

If you are looking to purchase one of the SDRplay RSP SDRs, I have some thoughts that might help make your selection easier. If you want to get your feet wet in the SDR world and you don't have a lot of cash to play with then I recommend the RSP-1A.



Three antenna connectors on SDRplay RSPdx. (Courtesy: SDRplay)

If you need a true diversity receiver and want multiple antenna ports including a high impedance port for a long-wire then the RSPduo is your answer.

If you have a couple of hundred dollars and are looking for an excellent value for the money, then get the RSPdx. With 1 kHz to 2 GHz frequency coverage, three selectable antenna connectors, newer technology and special features for reception below 2 MHz you will be getting a lot of bang for the buck.

The new RSPdx features including the special filters, broadcasting notch filters, better IMD performance, more attenuator settings and a high dynamic range mode, in addition to the improved performance in the 2200-, 630-, and 160-meter ham bands makes reception below 2 MHz really shine.

As I was writing this review my thoughts kept coming back to a common theme about purchasing and using SDR receivers that I think is worth sharing. If you are on the fence, here are a few words of wisdom from a guy who has been in the radio hobby for 55 plus years.

With today's SDRs I find I'm much less concerned about product obsolescence when hardware is designed to work in such an open-development environment. I like the thought of having a greater potential for forward-compatibility using the SDR and less reliance on replacing expensive hardware when it becomes obsolete.

It is worth repeating what that old radio friend of mine told me several years ago. Once you start using waterfall and spectrum technology you will never go back to the old ways of a tuning knob and a conventional frequency readout associated with hardware-based receivers.

Table One: SDRplay RSPdx Manufacturer Specifications

- Frequency Range: Continuous coverage 1 kHz – 2 GHz
- IF Modes: Zero IF, All IF bandwidths, Low IF, IF bandwidths ≤ 1.536 MHz
- IF Bandwidths (3 dB): 200 kHz, 300 kHz, 600 kHz, 1.536 MHz, 5.0 MHz, 6.0 MHz, 7.0 MHz, 8.0 MHz
- ADC Characteristics: Sample frequency 2 – 10.66 MSPS

14-bit native ADC (2 – 6.048 MSPS) 12-bit (6.048- 8.064 MSPS) 10-bit (8.064- 9.216 MSPS) 8-bit (> 9.216 MSPS)
Reference: High temp stability 0.5PPM TCXO, In-field trimmable to 0.01ppm.

- External Reference Clock: When an external 24 MHz clock is applied, auto-detect will switch to the external reference. Ideally the external clock source should be connected to the RSPdx before power up.
- Connectivity: USB 2.0 (high speed) type B socket
- Reference Clock Input: MCX female connector
- Antenna A Port Characteristics: 1 kHz – 2 GHz operation. 50 Ω input impedance, SMA female connector
- Antenna B Port Characteristics: 1 kHz – 2 GHz operation, 50 Ω input impedance, SMA female connector, selectable 4.7 V dc out (Bias T)
- Antenna C Port Characteristics: 1 kHz – 200 MHz operation, 50 Ω input impedance, BNC female connector
- Bias T (Antenna B Port only): Software selectable 4.7 V dc @ 100 mA
- Maximum recommended input power: 0 dBm continuous and 10 dBm for short periods
- Typical Noise Figures: 20 dB @ 2 MHz, 17 dB @ 12 MHz, 15 dB @ 25 MHz, 15 dB @ 40 MHz, 2.6 dB @ 100 MHz, 2.1 dB @ 200 MHz, 6.0 dB @ 340 MHz, 3.1 dB @ 660 MHz, 4.4 dB @ 1500 MHz, 5.0 dB @ 1800 MHz
- Notch Filters
- FM Notch Filter: >30 dB 77 – 115 MHz, >50 dB 85 – 107 MHz, and >4 dB 144 – 148 MHz
- MW Notch Filter: >15 dB 400 – 1650 kHz, >30 dB 500 – 1530 kHz, and >40 dB 540 – 1490 kHz
- DAB Notch Filter: >20 dB 155 – 235 MHz and >30 dB 160 – 230 MHz Note: The notch filters above are software selectable and remove specific broadcast bands.
- 12 high-selectivity built-in front end filters
- Low Pass: 500 kHz and 2 MHz
- Band Pass: 2-12 MHz, 12-30 MHz, 30-60 MHz, 60-120 MHz, 120-250 MHz, 250-300 MHz, 300-380 MHz, 380-420 MHz, and 420-1000 MHz
- High Pass: 1000 MHz
- Weight 11.11 ounces (315 grams)
- Size: 4.4 inches long (113 mm) x 3.7 inches wide (94mm) x 1.37 inches height (35mm)
- Low current consumption: 190 mA @ > 60 MHz and 120 mA @ < 60 MHz (both specs not including Bias T operations)
- Price: US\$200/£159 GBP (excluding taxes and S&H)

All specifications are based on typical operating of conditions of 0 to 35°C and altitudes of less than 6,600 feet (2000 meters). For further information on extended performances ranges contact SDRplay support via their website at <http://www.SDRplay.com>.