SDRplay RSP1A Review by Mike Richards

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Review SDRplay This article is copyright of the Radio Society of Great Britain and reproduced with their kind permission – first published in January 2018 RadCom magazine Radio Spectrum Processor 18 (RSP-1A)

he original RSP-1 was launched back in 2014 and provided a very useful wide coverage SDR platform at an affordable price point, see the review in the March 2016 RadCom. Since then, a more sophisticated version of the processor has been released in the form of the RSP-2. This used the same chipset but provided more user control with 3 optimised antenna ports that could be software selected along with external clock synchronisation and other enhancements. These enhancements came at a price and the RSP-2 currently costs £164.

The new RSP-1A builds on the original RSP-1 design with the same Mirics chipset but the SDRplay team have both refined the design and lowered the price. The result is a straightforward SDR receiver with continuous tuning from 1kHz through to 2GHz that costs just under £100 including VAT and DHL delivery.

RSP-1A improvements

I've summarised the improvements over the RSP-1 in **Table 1** and will run through them in a bit more detail here. Whilst the stability of the original RSP-1 was very good, it didn't use a temperature controlled crystal oscillator (TCXO). That has been rectified in the RSP-1A, which now has a 0.5ppm TCXO, along with a software option to trim the oscillator to within 0.01ppm. One of the problems facing wideband SDRs with analogue front ends is mixing artefacts. When the analogue mixer is exposed to 10MHz of RF bandwidth you need a very good quality mixer and excellent local oscillator purity to avoid generating spurious signals. You must also protect against overload/non-linearity in both the mixer and any RF amplifiers in the signal path. The conventional solution is to include, software switchable, RF preselection filters to tame the incoming RF and so minimise the problems. Following extensive experience



with the RSP-1 and 2, the SDRplay team have increased the number of preselection filter bands from 8 to 11, see **Table 3**.

In addition to increasing the number of filters, the order has also been increased so the new filters are sharper. The filtering is further extended through the addition of a switchable AM/FM filter that attenuates the strong broadcast signals in the medium wave and VHF/FM broadcast bands. A second switchable filter has also been provided to deal with the commercial DAB signals in the 160MHz to 235MHz band. The filter profiles have been specially developed for the Mirics tuner architecture and are based on practical experience with the SDRplay receivers.

One of the shortfalls of the RSP-1 was very limited control of the low noise amplifier (LNA) in the front end. The only option was to switch it on or off and this was often too crude an adjustment. That is rectified with a new, 10-step variable gain control that makes it much easier to match the RF gain to the prevailing conditions.

Whilst the original RSP-1 had a tuning gap at 380MHz and a low frequency limit of 100kHz, the RSP-1A now features continuous coverage from 1kHz through to 2GHz.



The inclusion of a software controlled bias-T power feed is very welcome, especially for those with an interest in the higher frequency bands, where masthead preamps are often used. The bias-T also provides an opportunity for some DIY external antenna switching. Another small but useful improvement is the conductive screening finish that's applied to the inside of the case, see **Photo 2**. I'll cover the analogue to digital conversion (ADC) enhancement separately but the final point is the cost. The original RSP-1 retailed at £175 and the drop to just under £100 makes the RSP-1A a very attractive proposition.



PHOTO 2: Inside view of the RSP-2 showing the silvery conductive internal finish.



14-bit ADC

When I first saw the promotional material on the RSP-1A I was curious how they had managed to increase the ADC resolution from 12-bit to 14-bit without changing the chipset. A quick note to the SDR play support team revealed a very clear explanation and I'll try to cover it here. The ADC is crucial to any SDR as it's the device that converts the incoming analogue RF signal into a digital format that can be processed by the SDR software. The basic ADC conversion process is straightforward and requires a series of voltage measurements to be taken to capture the incoming signal. The frequency of the voltage readings is clearly important if we are to faithfully capture the analogue signal. Harry Nyquist was the man that developed

the theorem that you are probably familiar with where you need to sample (take voltage readings) at twice the rate of the highest frequency signal you want to capture. As an example, if you want to capture the RF spectrum from 0-10MHz you need to take measurements at greater than 20 million times per second. The output this type of ADC is a stream of numbers containing the voltage readings. The resolution of these voltage readings depends on the number of bits used for each reading. I've shown a table of the relationship between resolution and bits in Table 2. Like all devices, ADCs introduce noise into the system and the main culprit is quantisation noise. This is caused by the sampling process and is simply the difference between the original smooth

TABLE 1: RSP-1A Enhancements over the RSP-1.0.5ppm TCXOEnhanced RF preselection filtersSelectable AM/FM and DAB notch filtersVariable gain LNAImproved intermodulation performanceLower frequency coverage extended from 10kHz to 1kHzSoftware controlled bias-TADC resolution increased to 14 bits (below 6MHz)Conductive plating inside the enclosureLower retail price

signal and the digitally sampled signal. The digital signal will comprise a series of steps for each level change as shown in Figure 1. The ADC used in the RSP-1A is a more complex device that employs what's known as Sigma-Delta sampling, Figure. 2. In this technique, the core ADC samples with much fewer bits than the target output but it does so at a much higher sampling rate. This can be many times the basic Nyquist rate that I mentioned earlier. Although the sampling uses fewer bits, so has less resolution than we want, this is compensated for by the much higher sampling rate. To transform this high-speed data into the target bit rate (14 bits) the ADC includes a 'decimation' (or under-sampling) stage. One of the advantages of this technique is a reduction in quantisation noise. This occurs because the high sampling rate includes frequencies beyond those we need, and these are filtered out, along with the associated quantisation noise during the decimation and filtering. This extension from 12 bits to 14 bits has been achieved using a decimation option that was not previously revealed in the Mirics chipset. This additional resolution is only available below 6MHz and is automatically activated when you're tuning in that range.

On the Air

All SDR hardware is dependent on software developers providing the computer interface and access the SDR features we have come to expect. The SDRplay range of receivers have their own software support through the SDRuno package. This provides all the controls you expect to see and has been optimised for the SDRplay hardware. The software is a free download and is available from the SDRplay website at www.sdrplay.com. I've shown a screenshot of the software in operation in Figure. 3. One often overlooked feature of SDRuno is the RF signal level measurement. The software uses internal gain profile tables to calculate and display the RF signal level in dBm. This feature works with all the RSPs including the RSP-1A. In my tests, the accuracy is around ± 1 dB, making it a very useful measuring receiver. In addition to their own SDRuno, several other popular packages provide software support for the RSP-1A, including SDR-Console and HD-SDR.

Many of the improvements in the RSP-1A focus on minimising the spurious responses due to out-of-band or very strong signals so the benefits will only be noticeable when

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FIGURE 3: SDRPlay's SDRuno running with the RSP-1A.

those signals are present. I found the 10step RF gain control to be extremely useful and a significant improvement over the on/ off LNA control of the previous version. When working on 40m in the evenings, my antenna system can drive the ADC into overload, but I was able to fine tune the RF gain for maximum sensitivity whilst avoiding that overload. The TCXO was another important improvement especially as there are so many narrow band data modes around that require accurate tuning and low drift. The review model required just +1.2ppm correction in the SDR software to get it spot-on and it remained there despite the wide temperature fluctuations in the shack. The 14 bits of ADC resolution below 6MHz is good to have but you won't really see the benefit unless you have very low levels of QRM.

Summary

It's good to see that SDRplay have been listening to their customers and implemented an excellent range of enhancements, whilst delivering a very low price. The RSP-1A is now a very attractive proposition for those wanting a wideband, budget, SDR. The RSP-1A is significantly better than any of the RTL-based alternatives. Some will be wondering whether they should upgrade from the RSP-1 and I would say it's certainly

| I | A | B | LE | 2: | Bits | vs | Reso | lution. | |
|---|---|---|----|----|------|----|------|---------|--|
| | | | | | | | | | |

TABLE 3: RSP-1A filter bands.

| Filter Bands | Туре |
|----------------|-----------|
| 2MHz | Low pass |
| 2-12MHz | Band pass |
| 12-30MHz | Band Pass |
| 30-60MHz | Band pass |
| 60-120MHz | Band pass |
| 120-250MHz | Band pass |
| 250-300MHz | Band pass |
| 300-380MHz | Band pass |
| 380-420MHz | Band pass |
| 420-1000MHz | Band pass |
| 1000MHz | High pass |
| 85-100MHz | Notch |
| 660kHz-1.55MHz | Notch |
| 165-230MHz | Notch |

worth it if you are experiencing strong signals. The combination of the new filter banks and the 10-step RF gain control make it easy to tame the incoming signal for best overall performance. Also, don't forget the bonus of RF level measurement. The SDRplay RSP-1A costs £99.60 inclusive of VAT and DHL carriage and is available from SDRplay (www.sdrplay.com). My thanks to them for the loan of the review model.

Feature

Some simple tips to get the best from RSGB publications

Clubs and other organisations are welcome to publicise their events through the pages of *RadCom*, GB2RS, the RSGB website and social media. But there are some simple tips to getting the best results.

Club Events Calendar and GB2RS

A single database is used to produce the entries in Club Calendar and Local News for GB2RS broadcasts and online news. All entries should be sent by email to radcom@rsgb.org.uk – please DON'T copy the information to any other editorial or HQ address, because this leads to duplication of effort and, occasionally, entries falling through the cracks.

At the start of your email, please put the FULL club name (NOT just initials) and your RSGB Region. Keep your Calendar entries simple and short. Remember to include contact details explicitly: don't just assume we know that you (or Fred) are the club contact. Always include the contact's name, callsign, email and phone number.

An ideal calendar entry is along these lines: Fraser Road Radio Club, Region 9 Contact Steve Thomas, M1ACB, 01234 832 700, email gm.dept@rsgb.org.uk March 2018

- 3 Club night in shack
- 12 Club net, 145.525MHz, 8pm
- 23 Talk on meerkats, Bob, G9ABC
- 30 Club net, GB9ABC, 8pm

Events Roundup

Keep your news item concise, no more than about 175 words about each event. If you are sending a photo, please make sure to attach it to your email as a separate jpg – *never* embedded in the email or a Word document. Try and avoid lines of people, including those holding certificates. Pictures of people taking part in radio activities are always more interesting to *everyone* reading *RadCom*. We cannot print every photo we receive within the 3 pages available to Around Your Region, so preference is given to high quality, interesting images of club activities. It is essential that you are either the originator, copyright owner, or have the written permission of the copyright owner for all images that are included in the submission. If your photos include identifiable children, you MUST make sure you have the parent or legal guardian's permission before submitting their likeness for publication. Further info is at www.tinyurl.com/RadComPix

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