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Airspy SDR

Much higher performance than your average dongle…

INTRODUCTION. The Airspy is a natural progression in the development of software defined radios (SDR) that offer an extensive tuning range simultaneously with useful wide-band instantaneous frequency coverage. It was designed by the writers of the popular *SDR-Sharp* (*SDR#*) software to work with that and to address the lack of performance of the existing mainstream cheap dongles.

Like the majority of the existing dongles, the Airspy starts off with an R820 tuner chip that offers full spectrum coverage with no gaps from 24 to 1800MHz. The baseband output from the tuner is then sampled at 10MHz using a 12-bit analogue to digital converter (ADC). An external reference can be used for high tuning accuracy and frequency stability. The output of the ADC is sent as an I/Q data stream on a USB-2 interface to the host PC running one of the several SDR software packages that will support it. The extra four bits of resolution over that of the eight bits used in the original 'RTL' dongles means that when using the AIRSPY at its full frequency span, another 24dB of dynamic range is possible. (Dynamic range in ADCs can be estimated by using the simple approximation of 6dB per bit. This comes from 6dB corresponding to a voltage ratio of two, which is the enhancement obtained for each extra binary digit (bit). Further dynamic range extension is possible by decimating, or dividing down, the sampling rate and using lower bandwidths).

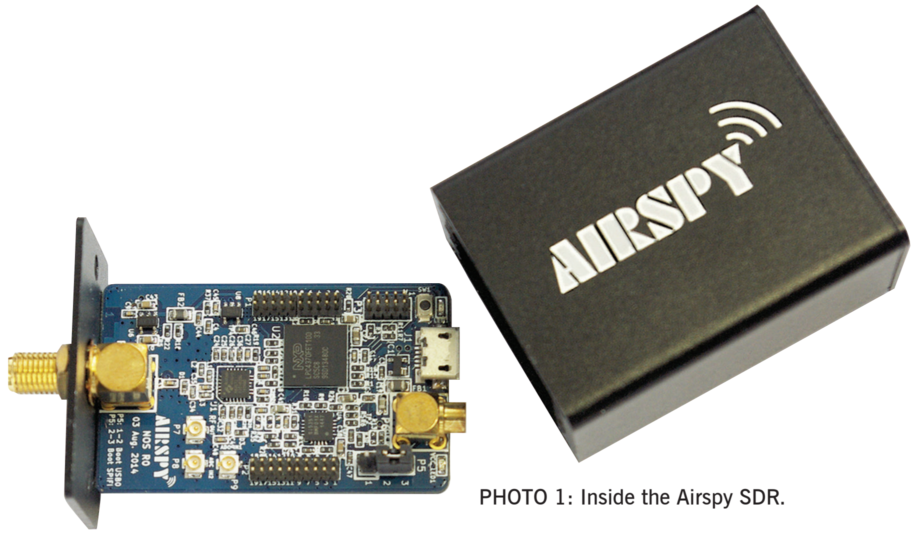

PHOTO 1: Inside the Airspy SDR.

IN PRACTICE. The hardware consists of a solid metal casing, not much larger than a matchbox, with an SMA connector for RF input on one end, see **Photo 1**. At the other end is a micro-USB for the PC (a suitable lead is supplied) and a small MCX connector for an external reference. My Airspy came with nothing in the way of instructions or software other than the notes available on the website [1]. There, it states that the Airspy requires no drivers when used with Windows 7 or later operating systems, and that Windows will find and load the drivers itself. Somewhat disbelievingly I just plugged it into a USB port on my 3GHz Win 7 desktop machine, sat back and watched developments. Sure enough the installer went away and searched for a suitable driver, eventually finding it on the web with little intervention from me other than a click to give permission to download and install. And that was it, all done! Firing up the *SDR#* software I found that Airspy had now appeared in the Source menu, so I selected that and it started working straightway. In operation *SDR#* ran as it did with any other radio attached, but now it would show 10MHz of spectrum visible at any time allowing point and click demodulation of anything visible.

It was quite noticeable that apart from 10MHz whiskers from the reference, there are far fewer spurii to be seen than when using my RTL dongle. Single carrier spurii at exact multiples of 10MHz (the reference clock) are obvious, but their accurate placing makes them unambiguous during normal operation. **Figure 1** illustrates a plot of a good clean CW signal and shows the typical dynamic range possible in full band mode. It is quite likely that even more range could be achieved, but I couldn't get the *SDR#* software to show any more dB on the vertical scale! The signal at the left of the display is the 10MHz harmonic whisker at 440.000MHz.

An internal bias tee allows external powering of an LNA or active antenna. This is enabled in the *SDR#* receiver Tools menu by clicking the 'Bias Tee' box.

EXTERNAL FREQUENCY LOCKING. The internal frequency reference used for the tuner is a temperature compensated crystal (TCXO), good for a couple of parts per million accuracy with a drift typically of a few tenths of a PPM over daily use. For higher precision work, the ability to feed in an external clock makes the Airspy stand out from the other USB

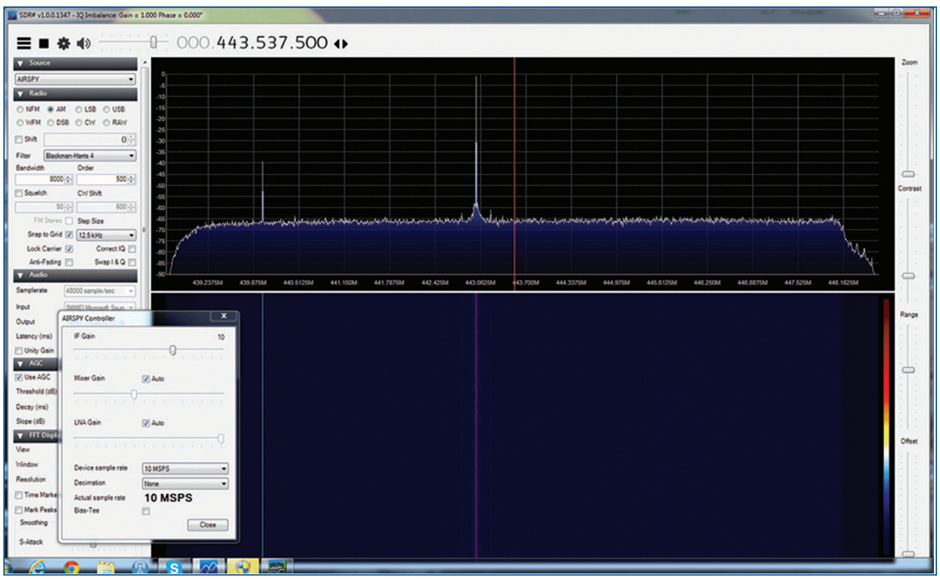

FIGURE 1: *SDR#* software used with the Airspy, showing the dynamic range and available span when using it as a spectrum analyser in its widest mode.

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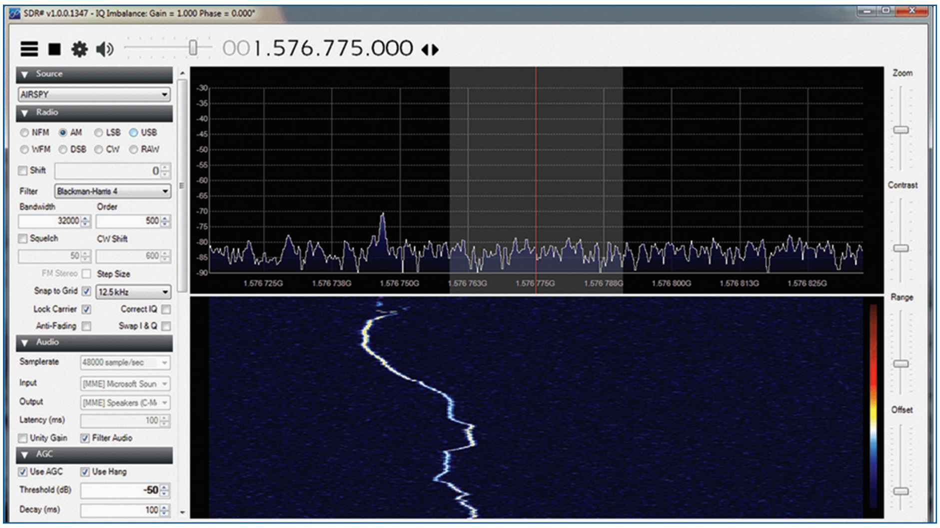

FIGURE 3: An interfering signal generated from an unstable active antenna amplifier that resulted in the blocking of several local GPS receivers. Found using the Airspy with another GPS antenna powered using the internal bias tee facility.

dongle type SDRs. The unit can take in a high stability externally generated signal, usually 10MHz, from a reference such as a rubidium standard, GPS locked source or even a good quality ovened oscillator. Apparently any reference frequency up to 80MHz is allowed although this would have to be defined in the software. There is a small MCX connector for reference input mounted adjacent to the USB socket; suitable connectors are widely available from the catalogue suppliers. I had an adapter lead to hand, so applied a 10MHz signal at 3V TTL level – and nothing happened at all! I tried a sine wave from another reference source, and still nothing. Hmm. A brief Skype chat message to the supplier **[2]** revealed all. You have to switch off (unplug the USB) then reconnect with the reference input attached so the internal hardware can 'pick up' or recognise this new input. And it worked. Looking in a narrow bandwidth, a stable test signal never shifted in a sub-Hz resolution waterfall display. But…

I tuned the receiver to 144.379000MHz USB, applied a test signal at 144.380000MHz and sent the resulting audio to *Spectran* audio analyser software expecting a 1000.00Hz tone. But it was about 30Hz low. I tried another frequency pairing at 400MHz: the tone was a few tens of Hz high. Then another pairing at 70MHz, similar error. In every case the tone output was a few tens of Hz away from where is should be – very stable, but with an unpredictable offset. It certainly wasn't a tuning or reference error. The SDR's local oscillator and the test input were being generated from the same master reference, so errors should cancel and the tone ought to be *exactly* 1000Hz – something was a bit out. I suspected it was all due to the tuning accuracy in the Fractional-N synthesiser used to generate the LO, which in turn was probably 'just software'. So another message to [2] who in turn contacted [1] and confirmed it. The reply from the design team stated: "*…yes, it's the tuning resolution. But [the error] is predictable and the same setting guarantees phase coherency. I'm planning to add new PLL code to skew the reference clock in the Silabs synthesiser. This can compensate for the tuner error to a fraction of a Hz. Apparently new software will correct this before too long. But in the meantime, the errors are constant and predictable – and more to the point, it is still stable in spite of the few tens of Hz random offset.*"

BASEBAND COVERAGE. As supplied the Airspy only goes down to 24MHz (although somewhat lower in practice). However, inside, there is a small connector on the board that gives direct access to a second ADC input. The connection is completely unprotected and has no filtering, but can (with care and an external anti-alias filter) be used with baseband from DC to several tens of MHz. An external sampling rate input, at a frequency significantly higher than 10MHz (80MHz is stated as being the maximum allowed) makes this baseband input particularly valuable. I never tested this, partly because little documentation existed, but mainly as I didn't have a suitable connector! A *YouTube* video **[3]** describes how one user has tried this and shows how it can be done.

CONCLUSIONS. The Airspy is a robust, well made little unit that offers a wider frequency span and tuning, better dynamic range and fewer spurii than the low cost dongles. It is unique in its ability to take in an external reference signal and, when the absolute calibration issues are finally sorted (and it *is* 'only software') will offer a very powerful accurate frequency detection and calibration tool too.

Displaying 10MHz of spectrum with its fast interface does need a decent computer though. A little low-end 1.7GHz HP-Mini notebook couldn't cope and audio stuttering was present. (To be fair, an RTL dongle also failed at any sampling rate above 1.5MHz on this machine). Also there is no support for older operating systems like Windows XP. But on a normal modern type of PC of the last couple of years, the Airspy works perfectly. Many SDR packages other than *SDR#* now support it, including *SDR-Console* version 2.3 onwards. See [1] for more details.

FINDING A GPS JAMMER. The delivery of this unit couldn't have happened at a better time chez 'JNT. For several days in succession, at certain times of the day, both my two older style GPS receivers would fail together – one is in a 'retro' nixie clock and the other in a 10MHz VE2ZAZ frequency standard. They are on separate antennas with slightly different views of the sky, so both failing together looked VERY suspicious and suggested interference. Nothing was visible on a normal spectrum analyser, so I connected a small active GPS antenna to the Airspy, using its internal bias tee to supply 5V power up the coax. And there it was, an unstable signal varying by a few tens of kHz at 1576MHz, see **Figure 2**. A bit above the GPS frequency band, but more than close enough to cause trouble with early 'second generation' receivers. Moving the antenna around a bit the signal peaked close to another small GPS antenna I had sitting on the window sill, supplying the timing source in a test beacon. It was my own active GPS antenna that was oscillating, at a frequency determined by the high Q ceramic patch antenna. I then recalled that this came from a batch that many years ago the manufacturer had recalled for this very reason, but this one had slipped though the net. It was a magnetically mounted one, and on a metal backing is stable. But on a wooden surface it periodically goes unstable and radiates a few microwatts – sufficient to block other GPS receivers in the locality – and it took the Airspy SDR to find it!

The Airspy is available in the UK from SecQuest [2] and thanks go to them for supply of the review equipment. Apparently, a 'getting started' document is being prepared at the time of writing this review.

WEBSEARCH

[1] www.airspy.com
[2] SecQuest, UK Airspy agents – www.airspy.co.uk
[3] Video showing how the Airspy can be used with a baseband input – www.youtube.com/watch?v=St_6C9yTKGY