

RF Space SDR-IQ
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The [RF Space SDR-IQ](#) has totally changed my perception of radio. Compared to ordinary receivers, even current DSP-based receivers still in production, the change of concept that the IQ represents is even more dramatic than the change from valve to solid-state receivers.

SDRs are nothing new of course. Winradio for one has had them for some time. What's new (though not exclusively the IQ) is the possibility to not only monitor, but to record a large RF spectrum; in this case up to 190 kHz. Only a few commercially available SDRs can do that, and probably none as elegantly as the IQ. And it is implemented with a hardware so small that 10 of them could easily fit inside the enclosure of a current desktop receiver or transceiver.

Of course, a year or two from now we might laugh at 190 kHz, having recordable spectrums available of 1 MHz or more... Indeed, we are in the midst of a receiver revolution and one can but wonder for how long traditional HF receivers or transceivers will be in use.

The Hardware

The RF Space SDR-IQ is basically a 9.5 x 9.5 cm PCB with a BNC antenna input, an RS-232 input for external receivers, and a USB 2.0 output for a moderately powered PC. It covers 500 Hz to 30 MHz in 1 Hz steps and is controlled with [Spectravue](#) software. The sample rate is 66.666 MHz with 23-bit accuracy. Depending on the PC, it can sample up to 190 kHz and you can record that span at a 67.8 GB per 24h hard drive consumption for later analysis. The IQ has all common modes including AM, SSB and CW and can receive DRM broadcasts with third-party software. The IQ does the sampling itself and is not dependent on a high-end soundcard on the PC.

I received my IQ in mid-March, and as usual, the first thing I did was to measure its sensitivity. Well... I wasn't exactly blown away by -101 dBm (2.0 μ V) sensitivity on AM, 30% modulation 6 kHz bandwidth. But sensitivity figures can be deceiving. Bandwidths can be chosen semi-continuously up to 20 kHz for AM; 12.9 kHz for SSB. SSB bandwidths can be configured not only by width but also by how close you want to put it to the center of the passband. Common SSB bandwidths usually have a low offset by 100-300 Hz but you can choose to set the offset to 0 Hz and thus avoid the tinny sound often associated with SSB filters when listening to AM transmissions.

The bandwidths are exceptionally sharp and appear to have excellent ultimate rejection. The selectivity is every bit as good, and possibly in some cases better, than my DSP-based Icom IC-746Pro and IC-7000 transceivers.

Spurious signals do occur and there are quite a few of them. But they are weak and except one strong spur on 13 MHz there are none that should influence on reception.

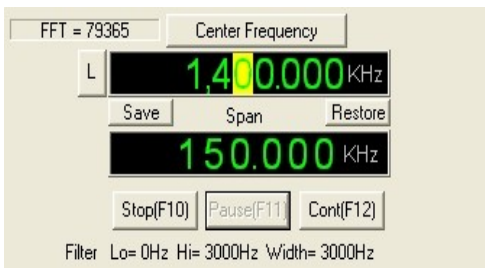
Audio quality is very good. But what really impressed me was the audio response when listening to SW signals in deep selective fades. Usually this means an awful lot of distortion. Only during the most extreme fades do I hear some distortion with the IQ. I suspect that they have an audio filter built-in since the treble response is somewhat muted even in relatively wide (6 kHz) bandwidth settings. The audio filter is likely to contribute to the distortion-free reception.

The software

The control software is [Spectravue](#). It installs, starts and stops very quickly, and I have yet to observe a crash. Another program can be used, [Winrad](#), but it is at this stage not designed to meet the needs of an HF or MF broadcast DX-er (no AM mode, for instance) so I will not spend more time on Winrad here.

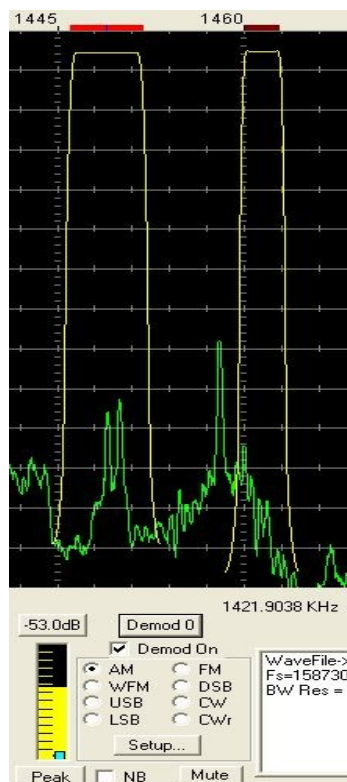
Spectravue's interface is somewhat unusual for the broadcast DX-er. For instance, one has to open a dialog box to adjust bandwidths, and to start an audio or RF recording, and it has no notch filter or passband tuning. And the tuning principle takes getting used to. That said, Spectravue is a very powerful and versatile program. Once on top of the learning curve, there is a useful option for just about everything.

The IQ has two frequency displays – well three actually. The lower display, the Span display shows the width of the span that is displayed. It can be set from 1 Hz to 190 kHz.



The upper display is the main tuning display, which can be set to Center Frequency (the frequency you tune to is always at the center of the Span), or Demod Frequency (any frequency within the Span you have tuned to.) Normally when you tune around, you would choose the Center Frequency.

Tuning is in principle decadic. Move the mouse pointer over the digit you want to change, and the black background colour turns yellow. Left mouse-click tunes down, right mouse-click tunes up. Or you can choose to reverse the left-right buttons. Or use left or right arrow to choose digit, then up or down arrow to tune. This way of tuning works OK for 10 kHz steps, but not for 5 kHz or 9 kHz steps. A better way to tune is to click at the selected frequency on the 2D display (provided it is within the Span). If you do that, you will also have access to pre-selected tuning resolutions such as 9 and 5 kHz. If you want to go to 1386 kHz, and you have selected 9 kHz tuning resolution, you can click somewhere near 1386 and it will tune to exactly 1386. You can start, pause; or stop demodulation by using the F12, F11 or F10 function keys respectively. Tuning can be locked by clicking on the "L" to the left of the upper display. The bottom line shows the bandwidth, in this case 3.0 kHz USB. There is a "Save" button so you can leave your selected frequency to check out others, like to check for parallel transmissions. Click on "Restore" and you're back.

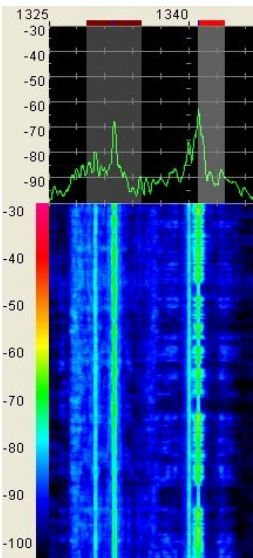


Readout is very accurate but once when I turned the radio on it was suddenly 60 Hz off. There is a very straightforward frequency calibration routine in Spectravue.

Two frequencies can be monitored when in Demodulation mode, though only one is active and tuneable. Their audio outputs can be directed to the left and right stereo channels, and recorded by Spectravue or third party software. Mode and bandwidth settings can be set individually. On the picture to the left the active channel is placed on 1449 kHz in AM Mode, 6 kHz bandwidth while the other is placed on 1460 kHz in USB Mode, 3 kHz bandwidth. The "Demod" button is used to select the active frequency. Light curves show bandwidth response. The signal level can be read on the vertical bar at the left bottom, either as the Peak signal or an average passband level (RMS). The signal level can be read as dBm or S-units.

Changing bandwidths, as well as changing AGC and Noise Blanker settings are done after pressing the Setup button. Maximum AGC decay time is 2000 ms, which I find quite adequate for most situations. I wouldn't mind if it was increased to 3000 or 4000 ms though. There is an easy to use Squelch function as well.

The bandwidth change function is unnecessarily convoluted. Luckily though, when you adjust the bandwidth in the dialog box you hear the effect of the bandwidth change immediately. The Setup function also allows you to choose a visual representation of the selected bandwidth.



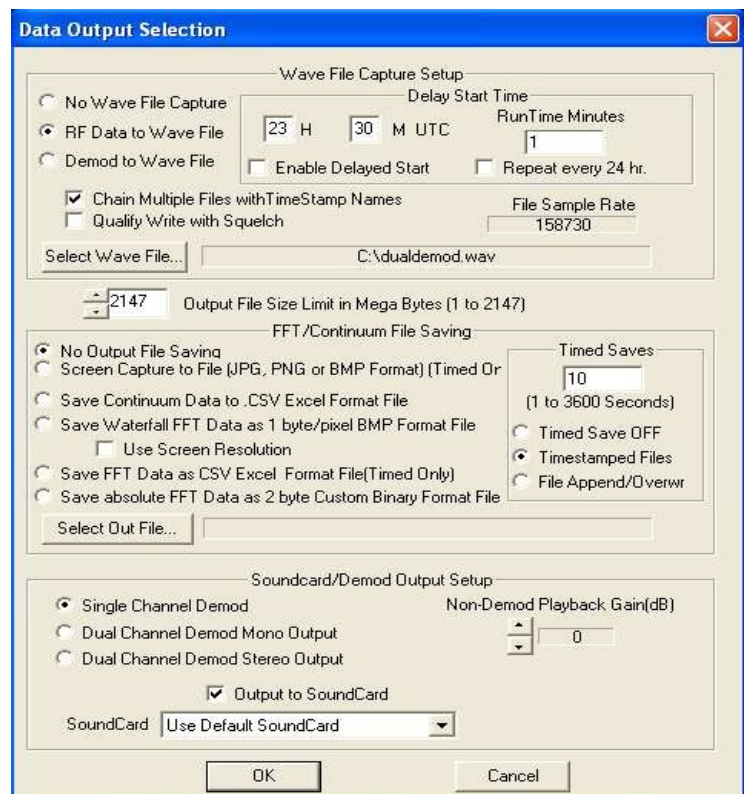
There are many displays to choose from. On the previous page is a standard 2D plot. One very useful display is a combination of a vertical waterfall and 2D, as seen to the left. The demodulators are placed on 1341 (USB) and 1332 kHz (AM) and we see their signals on the waterfall. But we also see weaker signals on the North American frequencies 1340 and 1330 kHz, indicating that there may be interesting stations to hear. Using the waterfall gives the possibility of seeing a carrier long before it transforms into an audible signal. This is very useful for DX-ers.

One of the main things that makes SDRs like the IQ so exciting is their ability to record a large part of the RF spectrum. The IQ can record up to 190 kHz and save it to a wav file. Now, if you have a hard drive with only a few GB free, you won't be able to benefit much. The maximum file size is 2147 MB and that is a mere 45 minutes! You have to select a dialog box in order to get to the recorder. That done, you can choose between no recording, a standard audio recording (Demod to Wave File) or RF Data to Wave File (selected option in the picture below). If you want a long recording, choose "Chain Multiple Files with TimeStamp Names" and you will be able to record until the HDD bulges. On playback there is a status bar at the bottom of the display where you will see the time and date as the playback progress. And here's the great part: During playback you can move back and forth seamlessly, and without even the slightest delay, and choose frequency, mode, bandwidth or whatever.

There is a timer control but unfortunately rather pedestrian with only one timer option and repeat only every 24 hours.

When using RF Spectrum Recording, the ordinary tuning function is disabled; instead you have to tune by pointing to and clicking the signal you want to hear on the display. No big deal but I wasn't aware of that to begin with.

The SDR-IQ can be set up in a wired or wireless (minimum 802.11g) network. And four IQs can run on one PC if it is powerful enough. A current dual-core PC with 2 GB RAM should do nicely. Just remember that four IQs in RF Recording mode will eat up a medium-sized hard drive faster than you can say "what happened?"



Since Spectravue has so many functions and choices, you will need to do a lot of adjustments if you go from one type of DX to another. Fortunately the author has anticipated that, and you can save customised setup files for whatever kinds of DX you do.

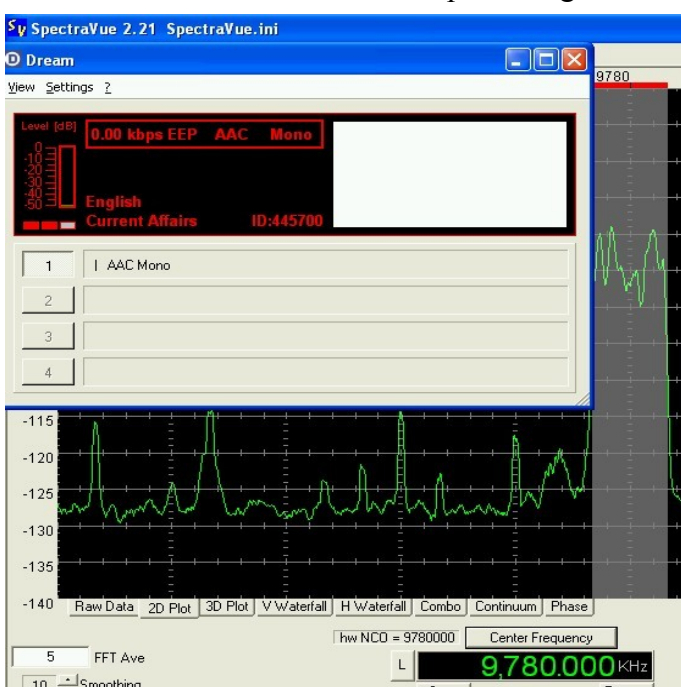
My own experiences

I've had the IQ a few weeks now, and I have tested it both as a DX receiver, a DRM receiver and a SWL receiver with various antennas. There is one problem with being able to record a wide spectrum: There is no roofing filter that attenuates signals from outside the passband. In fact, the only filtering the IQ has are highpass/lowpass filters on 5 and 15 MHz, and lowpass filters on 30 and 40 MHz. Actually, the IQ couldn't have come to a worse place for testing, as there is a 250 kW Loran C transmitter only 15 km away. For the first test I connected a short beverage (175 meters) pointing almost directly towards the Loran C. My other receivers do not have much trouble with it, except the Etón E1 below 1000 kHz if its preamp is on. On the IQ, Loran C noise was bleeding out all over the MW band. Luckily, I have a 100 kHz [notch filter](#) which I connected to the feedline. Loran C gone!

Next I connected a large-circumference (24 meters) amplified loop, the [Wellbrook ALA-100](#), to the IQ. No problems; I could tune quite a bit into the LW spectrum before I was troubled with the Loran C. But I use beverages, and preferably longer beverages than 175 meters for my DX, so external filtering is indeed necessary when using such long antennas so close to the Loran C transmitter.

I am used to receivers with sensitivity figures in the 0.5 – 0.8 μV range, hence the IQ with 7-10dB worse sensitivity should be considered rather deaf during periods with very low signal levels (such as after sunrise or before sunset on MW). In fact the IQ proved otherwise, and I simply don't know why. Maybe it has to do with the way it resolves audio. Or the AGC. Or that the noise floor is lower. But on several occasions it proved to deliver more audible signals than my IC-7000. Especially in AM mode. Less difference in SSB (ECSS) modes but still either equally good or better.

As mentioned earlier, the IQ seems to be immune to distortion caused by selective fading. Tuning around the Short-wave bands was pure delight because of this, even signals with deep selective



fades had little distortion. A brief A-B test with the Etón E1 in AM-Sync mode proved the IQ to be superior. The E1 had a little better treble response, but the signal fluctuated much more than the IQ. I am not implying that this is always the case, but at least during this test it was.

DRM reception is done via third-party software. I used [Dream](#) for my tests. The first test involved RTL Luxembourg 1440. It decoded ok at an SNR around 20 dB, but started to clip at 19 dB and basically disappeared at an SNR below 18.

When I tried a later date with shortwave signals, results were exceptionally disappointing. Very strong DRM signals would not decode with Dream; the picture to

the left speaks for itself. No audio, only occasionally a recognition that something was there. I tried to decode 4 or 5 signals, all of equal strength, but nothing. Which is to blame? SDR-IQ/Spectravue? Don't think so. Dream software? Don't think so. DRM? Think so.

Two IQs on one PC

After having used a lone SDR-IQ with the Toshiba laptop for a while, I decided to get another. And, because of the high storage capacity I would need for recording RF, I decided to buy a new PC too. An AMD 3800+ system with 1GB RAM and two hard drives, 320GB and 500GB, and a separate nVidia graphics board (all very standard stuff, no high-end) was purchased, and arrived the same day as the no 2 IQ, in late June 2007. Running two IQs on one PC does not seem to be much of a trouble, but it may be wise not to connect both IQs to the same USB controller – they may not work properly then.

Conclusion

The generation of SDRs that the IQ represents is not evolutionary, it's revolutionary with its ability to record a spectrum as wide as 190 kHz. It is an excellent DX receiver as well although there is room for improvement on the user interface, sensitivity and strong signal handling. But the pros massively outnumber the cons.