The Perseus SDR

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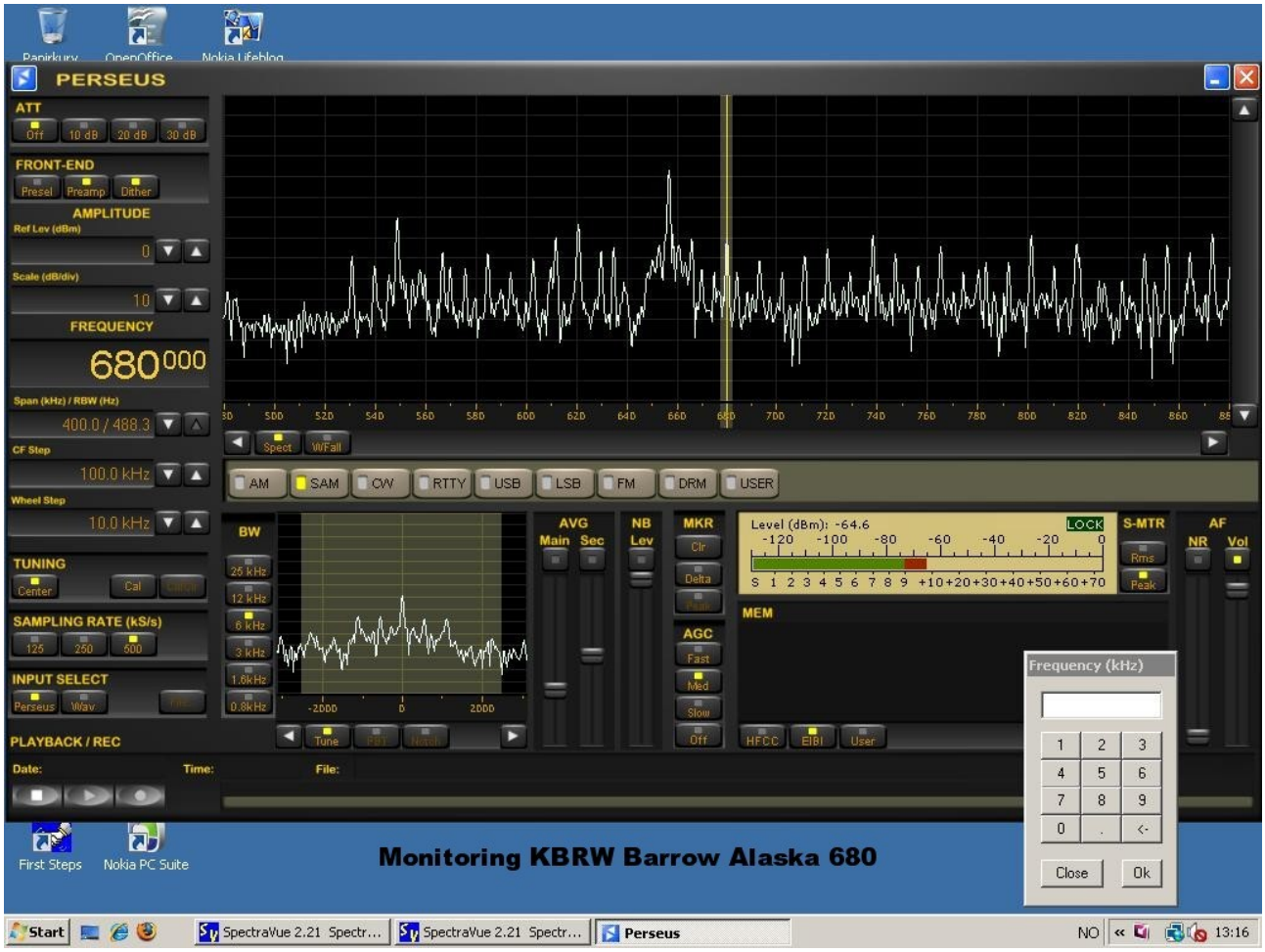
Seven months after I received my first Software Defined Radio, the SDR-IQ featuring a 190 kHz recordable frequency span, I upgraded to the 400 kHz (now 800 kHz) capacity Perseus in late November. The SDR evolution is going at a fast rate nowadays, and even if they can't match a conventional receiver in terms of sensitivity yet, SDRs offer unprecedented flexibility in selectivity options and the ability to record a large frequency spectrum for later analysis. The following are my initial impressions with the Perseus SDR. Since I already own two SDR-IQs, it comes natural to compare the two, both with regard to hardware and software.

The article is likely to be updated, should there be software upgrades that change the conclusions below.



Manufacturer, price
The Perseus was developed by Nico Palermo of Microtelecom s.r.l. in Italy. The price is EUR 666 (export).

Physically
The Perseus SDR is a small, relatively black, box. It measures 110 x 35 x 185 mm and is very lightweight. It connects to the PC via a USB 2.0 cable. It requires a separate 5 VDC power input; more about it later.

Published specifications
The frequency range is 10 kHz to 30 Mhz. The claimed sensitivity is 0.39 uV in SSB, 2.4 kHz for a 10 dB SNR on 14.15 Mhz. The Perseus sports 10 bandpass filters, starting on 1.7 Mhz. The Dynamic Range is 103 dB (SSB, 14.15 Mhz) and IP3 is +31 dBm. Image rejection is 90 dB. For more information, see the published specifications.

Software
While other software like Winrad can be used with the Perseus, their own software (unsurprisingly enough named "Perseus") is the one that comes with the radio. The initial version was 0.31. Version 1.0 was made available on February 29.

My radio setup
Since I already had a PC dedicated for SDR work and running two SDR-IQs without problems, I thought I might as well connect the Perseus to the same PC and see if things would work as smooth as I hoped. The PC is a Fujitsu-Siemens Scaleo with two HDDs of 820 GB combined, an AMD 6300+ dual core processor, 3 GB RAM and an Nvidia 7300GS graphics board, running Windows Vista. The Scaleo had no problems running all three SDRs. CPU usage was around 80-90% when they were all demodulating.

Sensitivity
The SDRs I have tried still have a road to go when it comes to sensitivity. The Perseus displayed a rather uniform -101 to -105 dBm sensitivity on AM, 30% modulation, 6 kHz nominal bandwidth (5 kHz real), 400 Hz tone across the MF and HF spectrum, depending on the settings of Preselector, Preamp and Dither functions. Best sensitivity is achieved with Preamp and Dither set to Off (indeed!) and Preselector set to either On or Off. Now, 1.3 µV is not bad, but when DX-ing weak signals on MW in daytime in a very quiet location it simply isn't enough so an external 10dB preamplifier is needed. The Perseus is marginally more sensitive than the SDR-IQ (-102 dBm or 1.8 µV). It is interesting to note that unlike other receivers, switching the Preamp on does not improve the Perseus' sensitivity; in fact switching the Preamp o*ff* improves sensitivity. I am not sure what purpose the Preamp has.

The Perseus Frequency Displays
The software shows two displays; one of the full (sizeable) frequency spectrum (with a spectrum or waterfall display) and one of the selected frequency with the bandwidth settings. I like this. In Spectravue it is difficult to see details of the selected frequency unless manually closing in on the frequency range. Below the selected frequency display there are up/down tuning buttons, changing the frequency according to the selected tuning steps ("Wheel Step" on the left panel).

Both displays lack vertical displays of signal levels, which is unfortunate. You can change amplitude settings, which is good, but that has limited value as long as you can't easily see the signal levels of other signals than the one you monitor. The signal level indicator however is well designed and shows S-meter and dBm levels on a horizontal bar. The dBm level is also digitally displayed.

The S-meter and dBm level does not change when engaging the 10-20-30 dB attenuator, that is, it is reduced by a mere 1.5 dB when the 30 dB attenuator is on. The good part is that you will always know the "true" signal level of a station, but at the risk of forgetting that the attenuator is on. The S-meter appears to be very well calibrated when compared to the input of a signal generator.

Tuning the Perseus
As mentioned in the previous paragraph, there are up and down tuning buttons below the secondary frequency display. Alas, these buttons are disabled during recording and playback of a recorded RF file. One can also use the mouse scroll wheel. Scroll back is up; forward is down. By double-clicking the frequency readout on the left panel a separate "keyboard" window is opened, in which you can enter the frequency you want to go to. Or you can point the mouse over the current frequency and tune the digit that the pointer hits up and down with the scroll wheel.

Being used to clicking in the Spectravue spectrum/waterfall display for tuning according to pre-selected tuning steps, I found that doing the same in Perseus is not quite as useful. Double-clicking in the Perseus spectrum/waterfall display does change the frequency, but with a fixed resolution of 1 kHz independent of Wheel Step. You can move the frequency spectrum by dragging the horisontal frequency line. It would have been a nice feature if the chosen frequency was fixed as long as it was inside the frequency spectrum.

Sadly, tuning is not possible using the mouse buttons, nor is it possible using the up/down keyboard arrows or the Page Up/Page Down keyboard. This is rather important if using a laptop, or if your mouse doesn't feature a scroll wheel. I hope further Perseus upgrades will find inspiration in Spectravue's tuning features.

Memory positions
The Perseus has the capacity to use frequency lists like those created by HFCC and EiBi. This may be of value for the Shortwave Listener who is more interested in listening to international broadcasters than doing MW or Utility DX-ing. Incorporating further lists is underway.

Modes and Bandwidths
The Perseus sports all common modes, including Synchronous AM (SAM) and DRM (requiering an external DRM capture program) and a user defineable mode. The bandwidth settings are initially fixed at 0.8/1.6/3.0/6.0/12.0/25.0 kHz. But the actual -6dB bandwidths are actually lower than that, since the -6dB values are determined by the "grey" field in the selected frequency display. So for instance the "6 kHz" setting is actually 5 kHz. Not a major point but confusing. Each mode is assigned to a bandwidth, but by dragging the upper and lower bandwidth limits in the secondary frequency display you can tailor-make the bandwidth to the interference you face or to the audio quality you want. You have full passband tuning capability by using the right mouse button to move the passband around the carrier. And you can change the bandwidths by using the mouse wheel forward (wider) or backward (narrower).

While AM is assigned to 6 kHz bandwidth, and SSB is assigned to 3 kHz, one can choose any of the preselected bandwidths independent of mode. Although the preselected values are well chosen, I miss the possibility to actually change the default values to better suit my needs. Instead of fixed values, I would prefer the six bandwidth choices to be mode dependent. That way, for each mode one would have six preselected bandwidth settings to choose from. AM bandwidths could be, say 3, 4.5, 6, 8, 10, 12 kHz while CW bandwidths might be 0.2, 0.3, 0.5, 0.8, 1.0, 1.5 or something similar. This is a matter of preference though, and for all I know I may be the only one in the world wanting that.

When bandwidths are set manually, Perseus will remember the values until you reset them by clicking the appropriate bandwidth button.
All in all, the bandwidth options and implementations are excellent, and (at least to my eyes) very novel.

AGC
There are four AGC settings – Fast, Medium, Slow and Off. I haven't found information on the values of these settings, but they seem to be well chosen. Still, I would prefer to be able to adjust the AGC release time myself. With AGC Off I haven't found a way to reduce RF Gain similar to a conventional receiver.

Audio quality
Perceived audio quality is difficult to measure by objective parameters. My main parameter is signal intelligibility of a weak signal in relation to noise – be it slop by nearby stations, atmospheric or weather-induced – anything that would reduce "my" station's intelligibility. I did some comparisons between my Icom IC-746Pros, my SDR-IQs and the Perseus. The Icom nearly always came out on top, and the IQ nearly always came out second. While the differences were small (and sometimes nonexistent), it could be that the Perseus has a potential of improvement with regards to audio quality. I and others have also noted instances of audio hesitation and pops. This too should be an addressable issue.

Others may want to emphasise the audio quality when listening to stronger AM stations on MW and SW. The common distortion effect from selective fading is actually very modest, both in AM and especially in SAM. Few conventional receivers can match the Perseus here.

Stability
According to the manufacturer, the Perseus main crystal oscillator is rated to have 10 ppm drift in the 0-25 Celsius temperature range. In normal room temperatures (around 20 C) the Perseus appears to be very stable. I measured the drift when the room temperature was -0.5 Celsius, and the drift was around 10 Hz on upper Mediumwave and around 80 Hz on the 31-meter Shortwave band. This is quite acceptable.

Recording and playing back an RF Spectrum
Many DX-ers find the possibility to record a large portion of the RF Spectrum to disk for later analysis the most interesting facet of SDRs like the SDR-14, SDR-IQ and Perseus. The Perseus in its current configuration can record an 800 kHz spectrum, or roughly two thirds of the MW spectrum, at a rate of approx. 20 GB per hour or 480 GB per day or 0.6 GB per kHz per day. The software automatically limits file size to 1.67 GB which gives 5 minutes per file in 800 kHz mode, 10 minutes per file in 400 kHz mode and 20 minutes per file in 200 kHz mode.

Spectravue/SDR-IQ in comparison uses around 68 GB per day when recording 190 kHz, corresponding to 0.358 GB pr kHz/day or only around 60% of the hard drive consumption per kHz that the Perseus requires. I wonder if it's not possible to make Perseus a little less demanding.

Making a recording is quite simple, just press the round "Record" button at the bottom left. You need to name the file in a dialogue box however, before recording starts. A more automatic approach would be to have the software automatically naming the file with time and date (as Spectravue does) and possibly even with the frequency range, something like ddmmyy-hhmmss_f1-f2. Press the "Stop" button to stop recording. The Perseus automatically goes into receiving mode again.

Multiple files will chain automatically and you can record for as long as you want, limited only by hard drive capacity.

Playing back the file is straightforward, and like Spectravue it is possible to click on whatever point in the playback bar you want to listen. Perseus also has a feature to select a portion of the playback

bar and play (and loop) only that portion, and that is very useful. Although a recording session is divided into many smaller files (depending on length of the recording session), Perseus will jump seamlessly from one file to the other on playback. Again: very useful. Maybe the playback bar should have some kind of length indication or with markings every 1/10 of the bar.

Unfortunately, during playback you can not use the up/down buttons on the secondary display to change the frequency. You are restrained to using the mouse scroll wheel or the direct input window (or double-click on the main display)

You cannot take a Perseus recording with you to another PC unless you take the receiver with you as well. The receiver must be connected in order to play back an RF file.

There is no timer built in for starting a recording. That would be a very valueable addition to the software, especially a multi-timer. That way I could monitor the full hour (when most stations ID) overnight or over several nights with little hard drive consumption.

A Side Note – Choosing The Correct External Hard Drive

You will probably need an external hard drive if your ambition is to record more than a few hours of DX, especially if you need to use a laptop. Beware that external 3.5" HDDs (those with most storage capacity and GB to Price ratio) depend on standalone power supplies. The ones supplied are cheap, switching devices and are likely to impose RFI. If so, you will want to replace them with stabilised powers. Which in some (most?) cases you can't because the power supplies are designed to deliver both 12VDC **and** 5VDC. Both my external 3.5" hard drives (a LaCie Porsche and a WD Elements) have 12VDC/5VDC supplies. There are exceptions though. The LaCie 500GB HDD (**not** the Porsche design) and the LaCie 500GB Neil Poulton design (possibly the same internal design) use a common 12VDC input. The same goes for the Seagate FreeAgent Desktop and Pro series hard drives, and the WD MyBook series. And there may be others. Thanks to Arnstein Bue, Tore B. Vik and my son Henning for supplying info on these devices. Of course, if you choose 2.5" USB-powered hard drives you will not face RFI problems, at least not from power supplies.

Noise reduction tools

Apart from the excellent selectivity options, Perseus has a Noise Reduction algoritm which I find quite useful in improving the signal to noise ratio while in ECSS mode. It appears to function very similar to the DSP Noise Reduction I find in my Icom IC-746Pros and the IC-7000. The NR doesn't do much in AM mode though. There is also a Noise Blanker, but I have not yet been exposed to any type of noise that the NB would reduce. And last but not least there is a manual Notch Filter which can be adjusted in width and moved around within the passband. It kills heterodynes quite effectively with its depth of >90 dB and 60 dB/octave slope according to the manufacturer. I quite like this one because its adjustable width makes it effective not only on heterodynes but on carriers as well.

-16 dBm tones at Perseus antenna input, frequencies in MHz, intercepts in dBm

Tones Freq.	**Intercept**	
	Presel. On	Presel. Off
6 + 9 = 15	IIP2 = +75	IIP2 = +82
2x6 + 9 = 21	IIP3 = +24	IIP3 = +32
2x9 - 6.05 = 11.95	IIP3 = +32	IIP3 = +34
9 - 6.05 = 2.95	IIP2 = +78	IIP2 = +76
2x6.05 - 9 = 3.1	IIP3 = +29	IIP3 = +36
0.6 + 0.7 = 1.3	IIP2 = +80	IIP2 = +77
2x .6 - 0.7 = 0.5	IIP3 = +21	IIP3 = +22
2x1.1 - 1.6 = 0.6	IIP3 = +30	IIP3 = +30
1.6 - 1.1 = 0.5	IIP2 = +75	IIP2 = +75
0.8 – 0.6 = 0.2	IIP2 = +76	IIP2 = +76
2x .6 - 1 = 0.2	IIP3 = +23	IIP3 = +23

Strong signal handling

On paper the specifications look promising. A number of bandpass filters should surely help. But the frequency range from 0 to 1700 kHz is wide open. A quick and dirty overload test in my environment is to connect a beverage to the radio without any Loran C notch filtering in front (the Loran C is 14 km away and very strong). The Perseus didn't pass that test, neither did the

SDR-IQ. Dallas Lankford recently did intercept tests on his Perseus. The test and the conclusions are cited below to the left and below.

In the SW bands the Perseus intercepts are generally higher, sometimes substantially higher when the preselector is turned off than when the preselector is turned on. The preselector should only be used when a strong SW signal outside the passband of the preslector filter causes A/D converter overload. The preselector should also be turned on when a strong SW signal causes A/D overload when tuning in the MW or LW band.

Software stability
Current software version is 1.0. Some quirks experienced in version 0.31 are gone. It will still pause several seconds if I remove a USB unit from the system though.Otherwise the software seems to run without any problems, at least on my Vista system. Except the pops/hesitations mentioned above.

Switching power supply causes RFI
I don't like switching power supplies. The Perseus requires a 5VDC +/- 5% supply and a small switching device was supplied with my Perseus. I was pleasantly surprised that it did not cause any interference on my Perseus. It is not noise-free however, because I noticed considerable interference on my SDR-IQs when the PC was connected to the same AC distribution outlet as the Perseus. I moved the Perseus power to another AC outlet and the noise disappeared. However, I am going to find myself a 5VDC linear, regulated power to avoid potential RFI problems.

Conclusion
All in all, the Perseus is an excellent receiver. My main objections are that it is not as easy to tune as I had anticipated, it is somewhat insensitive, and hard drive consumption appears to be somewhat high compared to the SDR-IQ. It's quite irritating too that I can't use the Perseus software on another PC without bringing the receiver along as well. I hope future software updates will address these issues. With a recording capacity of 800 kHz the Perseus is indeed a truly powerful DX tool. But with the rate of development of SDRs we see nowadays, today's winner is bound to be next week's number two.