WiNRADiO G303i

Shortwave Receiver

by Ian Sachs

I must admit that I have been always wary about mixing radios with PCs. Somehow it did not sound right: How can you possibly combine an electromagnetic-storm-in-a-box such as a personal computer undoubtedly is, with a sensitive radio receiver, and yet still hope for a harmonious coexistence? Considering the odds, I would have thought that lasting peace in the Middle East would be a far more achievable proposition.

But ever since I got my first WiNRADiO DC-to-daylight scanner, the WR-1550e, my attitude to PC-based radios has somewhat changed; I now merrily click away for stations and don't miss the real tuning knob anymore (although I do admit to having had some initial withdrawal symptoms). I can scan for frequencies while typing away on my PC, and don't even have to raise my fingers from the keyboard to tune my scanner.

So, I eventually came to the conclusion that PC-based receivers do have some merit after all. But the WR-1550e is a VHF/UHF scanner and one of the often found shortcomings of wide-band scanners is their poor shortwave performance.

Granted, the design considerations of a DC-to-daylight receiver are rather different from that of a dedicated 30 MHz receiver. Besides, I admit I thought it would be pointless to build a PC-based

shortwave receiver anyway – PCs radiate much more in the HF region than in VHF/UHF, right?

The recent announcement of the new PC-based G303 shortwave receiver by WiNRADiO caught me by surprise. Not only is this the first shortwave radio which is supposed to work inside a PC, and hence totally defying my theories, but this is also the first software-defined radio one can buy. Given my previous good experience with this company, I placed an online order.

The receiver arrived a couple of days later. I can't remember having ever purchased a product that exceeded my expectations so much.

The G303 comes in a small cardboard carton which conceals a decorative glossy box. The receiver card is packed inside, in an antistatic bag. There is also what WiNRADiO aptly refers to as an immediate gratification start-up antenna (about 9 feet of thin coax with 9 feet of insulated wire at the end), an SMA-to-BNC adapter, a short audio cable, a CD ROM, and a user's manual.

The receiver itself resides on a glossy black PCI-bus card which is rather pleasing to the eye. The receiver enclosure is made of extruded aluminium with a lid made of brushed steel. The antenna connector is gold plated. This is a beautifully manufactured card, and should be indeed so, in order to properly illustrate what I always believed, that good shortwave receivers are not merely technology, but works of art. So far so good...

The card needs to be installed inside the PC. As much as I hate opening my PC (who likes to wrestle with the poorly fitting sheet metal casing which is so typical of most desktops), the procedure did not take long. The antenna connector (SMA) is small enough to easily protrude through the slot opening at the rear of the PC.

The SMA connector is rather unusual for a shortwave receiver, so I was relieved to find that an SMA-to-BNC adapter was included in the package.

After connecting my long wire antenna (I did not bother with the start-up antenna included with the kit), I needed to connect the supplied audio lead between the receiver output and the Line Input of my sound card.

The receiver output deserves some mentioning: This is not actually audio output. The G303 does not include any demodulator and audio amplifier. And that's one of the most interesting things about it, and I need to digress a bit to explain the software-defined radio concept which this what this receiver is about.

A software-defined radio is such where the back-end (i.e. last intermediate frequency stage and demodulator) are not made up from conventional components but rather "executed" in digital signal processing software. The last intermediate frequency is digitized and processed using digital processing techniques. The output of the G303 receiver is 12 kHz intermediate frequency, with a 15 kHz bandwidth. This signal is then digitized by the PC sound card and processed by the PC, which acts as a Digital Signal Processor.

With modern PCs now being more powerful than the most powerful DSPs were only a few years ago, you can now have your PC simultaneously demodulating radio signals while you are (for example) surfing the Web or reading email.

The advantage of a software-defined radio is in its performance consistency (all receivers perform exactly the same because the software is the same) and flexibility (simply download and install new demodulator software and you can have an entirely different receiver). The performance should also be better, because it is cheaper to make more complex and powerful demodulators for many different types of modulation in software rather than hardware.

So, with a software-defined radio, the hardware represents only one half of the receiver. The other half is your PC.

Now back to the installation process: After I installed the hardware (there are no jumpers to set up, this is Plug and Play), I then proceeded to install the software. This was smooth, using the CD ROM supplied.

Clicking on the desktop icon starts the program and reveals an attractive control panel which tempts one to start using it without reading the user's manual.

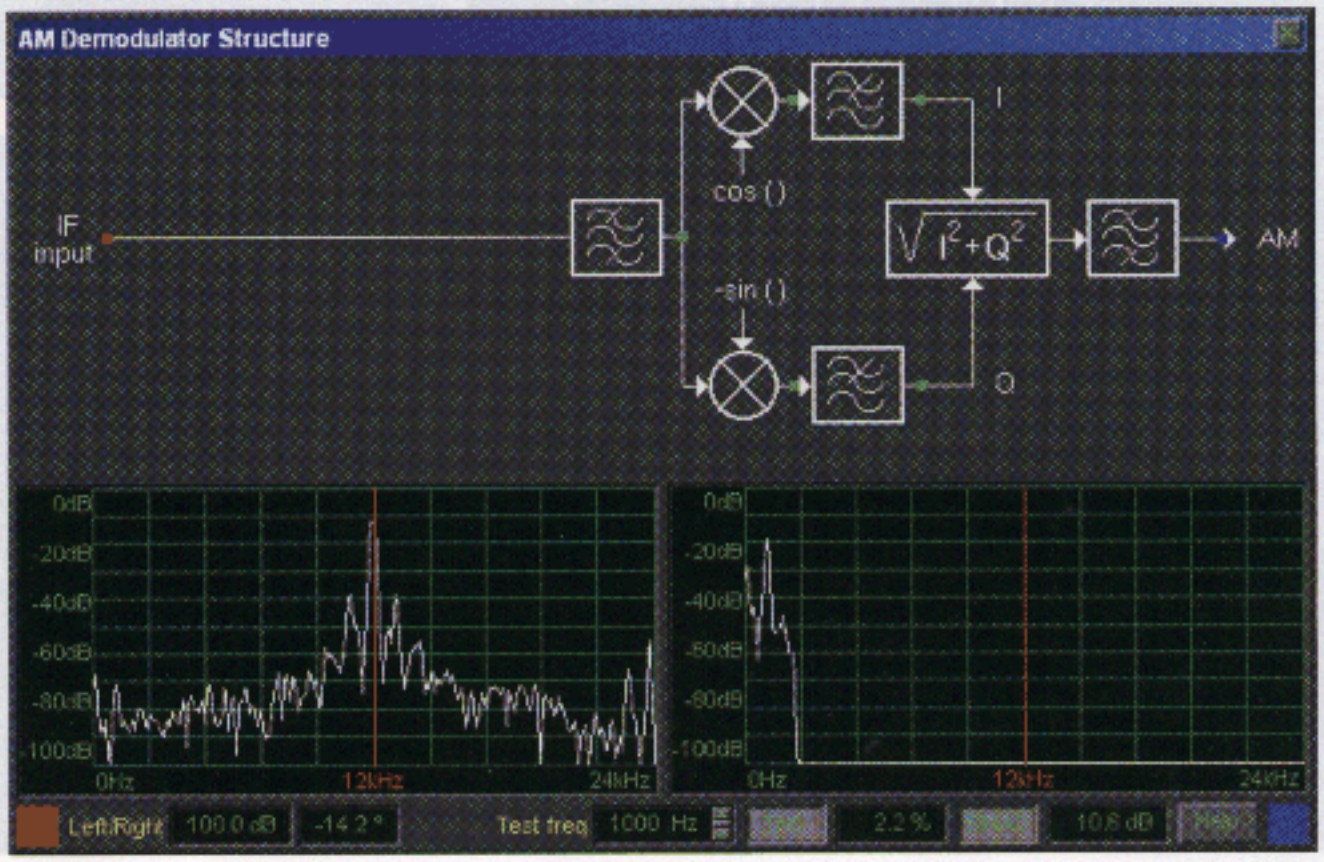
So I did of course – but there was no sound. OK, I grabbed the manual – I forgot to set up the sound card: Since the receiver is connected to the Line Input, the software must be told that this particular input is used. This is done by selecting the Line input from a drop-down list of the inputs available on the sound card. Finally, the input needs to be enabled in the sound card control panel. Finally, the receiver sprang to life.

Seeing the real time spectrum display (plus minus 10 kHz from the tuned frequency) is quite an experience. Precise tuning becomes a breeze. Seeing the neighbouring signal peaks makes it also possible to minimize interference.

I counted no less than six different ways of tuning this receiver: You can simply type the frequency in, use the tuning knob, step in fixed increments, increment individual digits of the display, or use one of the two "tuning bars" which allow you to change the tuning steps quickly, in convenient values.

The tuning knob is operated with the mouse. Left clicking turns it left, right clicking turns it right, in steps of 500 Hz. If you press the Alt key together with the mouse button, the step becomes 50 Hz. Shift and Ctrl buttons change this to 5 and 50 kHz, respectively. The minimum tuning step is 1 Hz, using the tuning bars. And if you do miss a "real" tuning wheel, the mouse wheel is a pretty close approximation.

What is most astonishing about this receiver is how well the software demodulator works. For example, you can listen to an AM station equally well by selecting USB or LSB, without the usual pitch changes which are common with conventional receivers. This is because there is no conventional BFO, but a DSP-based BFO which is accurate to a fraction of a Hertz.



This is very useful in crowded shortwave broadcast bands if one sideband is damaged by neighbouring interference. Simply turn the damaged sideband off using USB or LSB instead and the signal clarity improves dramatically.

One of the many unusual things this receiver has is the Audio AGC. This is in addition to the conventional hardware-based AGC. (By the way, this receiver allows you to disable conventional AGC and use manual gain adjustment instead – perfect for DX work.)

It took me a while to fully appreciate the Audio AGC concept, and understand the reason why this was implemented: Since the hardware front end uses 15 kHz bandwidth, then any strong signal located within the passband would cause quieting of a weak useful signal in the centre of the passband. Hence, the hardware AGC starts acting quite late, only just before the entire dynamic range of the receiver would be exhausted. Such delayed AGC action would normally cause variation in the audio output level. This is compensated by using the additional Audio AGC loop which is implemented entirely in software, and which brings the audio level up if it is too low.

Frequency	AM	SSB	CW	FM
10 MHz	0.8uV	0.15uV	0.12uV	0.3uV
1MHz	1.1uV	0.22uV	0.19uV	0.6uV
100kHz	1.2uV	0.28uV	0.22uV	0.7uV

I have found that this works very well with AM stations, but I would recommend turning this feature off for SSB and CW work as it tends to increase the background noise for weak signals.

At the time of writing this review, there were two types of demodulators available for the WR-G303 receiver: the Standard Demodulator, which comes with the receiver, and the Advanced Demodulator, which is an optional extra. The Standard Demodulator resembles that of a conventional receiver (with a few modes added, plus the real-time spectrum analyser, which is a part of the demodulator).

The Professional Demodulator is a real treat. As this was available at a discount price when bundled with the receiver, I purchased it at the same time.

This was the right decision - the benefits of the Professional Demodulator are enormous: There are two additional modes (ISB and DSB), but the main difference is in all the available software parameters settings. You have the real feeling of being let "under the bonnet" of the receiver. There are a lot of things to adjust, especially the various internal filter parameters, separately for each demodulation mode.

Each mode has also an interactive block diagram associated with it. You can click on the points of the diagram and see the spectrum shape, and measure the relative amplitude and phase of the processed signal.

There are also meters for SINAD (signal over noise and distortion) and THD (total harmonic distortion).

So if you have a signal generator you can very conveniently measure the true sensitivity of the receiver. Only high-end measurement receivers costing tens of thousands of dollars would have this kind of facilities – and here they are available for just a few hundred dollars!

I did use the in-built SINAD meter for my sensitivity test, and it came within a dB from my HP8290 test set. This is the only receiver that I am aware of which includes a tool to measure its own sensitivity! But the real icing on the cake of the Professional Demodulator is the continuously variable IF bandwidth. The bandwidth is adjustable from 1 Hz (yes, that's one Hertz!) to 15 kHz, in 1 Hz increments. The experience of being able to finely tune selectivity to suit a particular signal you are listening to is truly incredible, especially if you have been used to having just a few fixed bandwidths on your old radio.

My most favourite control on this radio is also one of the smallest – it is a little slider between the Up/Down buttons of the IF bandwidth control. Sliding it up and down using the mouse steps the IF bandwidth by 100 Hz, and causes the width of a highlighted area of the spectrum scope to vary accordingly, so you can see immediately the effect of the bandwidth change on your signal spectrum coverage (as well as hear the change in audio of course). This effect is truly awesome and impossible to fully appreciate unless experienced.

And there are other interesting new things to find: For example, the DSB and ISB modes. The DSB (Dual Side Band, suppressed carrier) is also great to use when you are listening to an AM signal where the carrier is damaged – I noticed that it improved listening to some fading signals. The ISB (Independent Side Bands) does not have much use apart from listening to genuine ISB signals (where are they?), but it is great fun to observe the interesting physiological effect listening to a sound which has a phase shift between left and right.

In the ISB mode, one of the sidebands is output to the left speaker, and the other to the right. The demodulator seems to introduce a 180 degree phase shift between the two, which results in a sense of "disorientation" (much to the amusement to my family, which then resulted in a partial forgiveness for having, yet again, invested in my "expensive" hobby).

So how does the radio actually perform? In short, the performance is superb. The sensitivity and selectivity surpassed my expectation, and there was no sight of intermod even in the presence of strong stations at night time.

What is absolutely incredible, I have not been able to find a single spurious signal, generated either by the radio or the PC, except a tiny birdie on 20,001.5 kHz which was at about –125 dBm level (just in case you are wondering, I have observed that this receiver has a minimum discernible signal level of –135 dBm, which appears rather impressive I'd say).

Considering the extremely noisy environment inside a PC, this is what surprised me most. Obviously, the internal parts of the receiver must be very well shielded.

Here are sensitivity figures I measured using the Standard Demodulator:

For AM I used 30% modulation and 10 dB SINAD; for FM I used 12dB SINAD. Test equipment used was a Racal Dana 9087 signal generator and HP8290 test set – impressively the SINAD measurements were only less than 1 dB away from the receiver's own SINAD meter.

This is truly incredible sensitivity, but what surprised me most was that it was as good all the way down to 9 kHz. This receiver seems to be especially suited for very low frequency radio experimentation.

I also found that by using the Professional Demodulator and twiddling a bit with the settings, I was able to improve all the above sensitivity figures by approximate 2dB. On CW, the effect was most impressive: by setting the filter lengths to max (to provide maximum selectivity) and narrowing the IF bandwidth to 50Hz, I was getting loud and clear CW reception at the antenna input level of 30nV.

Yes, that's thirty nanovolts of CW sensitivity, with the receiver located inside a PC!

The most intriguing part of the receiver must be the software defined radio concept itself. This got me seriously thinking: In my younger days, I used to build my own radios, starting with a crystal set, and then eventually working my way up to triple-conversion superheterodynes.

Apart from all the fun I had, I made them because I could not afford expensive professional products. This is something today's hobbyists hardly do anymore, as the financial incentive is no longer there, and PCs have long replaced radios as the most desirable items of technical interest.

Moreover, with the modern tiny components of today, it is no fun soldering 0402-sized surface-mount resistors and 84-lead fine pitch (or worse, BGA) ICs to a PCB – you can't make multilayer PCBs at home, anyway.

A few decades ago, one could be a hobbyist and still operate at the leading edge of technology. This is not possible any more; to remain at the technology edge one would need an investment far beyond that typically available to a hobbyist.

But software-defined radios may yet change all that: The G303 demodulators are PC-based programs. To make a better demodulator you don't need to solder a single diode. Could it be possible that, one day, a regular column in this magazine will be dedicated to discussions on the merits of some types of software demodulators as compared against others? And sharing source codes of some exciting new software demodulation algorithms?

The WiNRADiO G303 receiver, in addition to being an excellent receiver on its own right, has a certain exciting feeling about it. Perhaps this is because of the promise of a change of an entire paradigm which makes a difference between just another run-of-the-mill product and a truly innovative cult product, sparking an entirely new following. The G303 certainly got me turned on, and tuned in!

The WiNRADiO G303 receiver, serial number 101098, described in this article was purchased directly online from WiNRADiO Communications Web site at www.winradio.com.