WiNRADiO G39DDCe Wide-Frequency-Coverage Receiver

By Bob Grove, W8JHD

With the global success of its predecessor, the G31DDCe 9 kHz-50 MHz receiver (*MT First Look Review* November 2010), this newly-released, 9 kHz-3500 MHz, double-receiver descendant was inevitable. Using the new WiNRADIO G39DDC software defined receiver (SDR), you can monitor two different stations within the same 16 MHz span of spectrum, independently or mixed, or listen to one while recording the other.

Still packaged in a compact brick size like its predecessor, but now with heat fins to dissipate the power required for signal processing, the new G39DDCe "*Excelsior*" is a remarkable receiving laboratory.

The G39 is also available as an internal PCI express plug-in card, the G39DDCi. The only difference between the two models is that the 2 MHz span of the secondary spectrum display of the external model, limited by the USB interface, is a wider 4 MHz on the card.

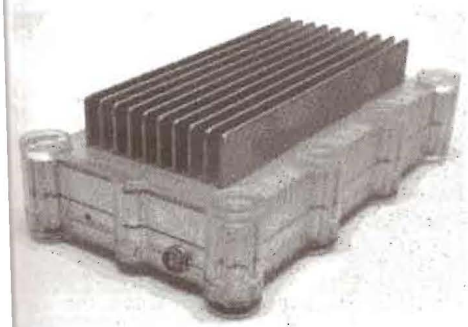
Computer requirements to host the operation of the G39 are a Windows XP, Vista, or 7 OS with 2 GB of RAM and a 2 GHz computer processing unit (CPU). Slower CPU speeds affect selectivity and bandwidth. The display is configured for standard SVGA, and 20 MB of hard-drive free space is required.

Receiver Overview

The G39 is a marriage of a multimode receiver and a spectrum analyzer. As a receiver it is capable of demodulating AM, AMS, CW, LSB, USB, ISB, DSB, FMN, FMW (stereo), FSK, and DRM (with an optional software license purchase).

Tuning and slewing speeds can be adjusted to select 1, 10, 100 Hz, 1, 3.125, 5, 6.25, 10, 12.5, 25, 50, or 100 kHz steps. You can even jump rapidly in 10 MHz increments by using the arrow keys on the spectrum display.

The signal strength meter may be selected to show S units, microvolts (uV), or dBm.



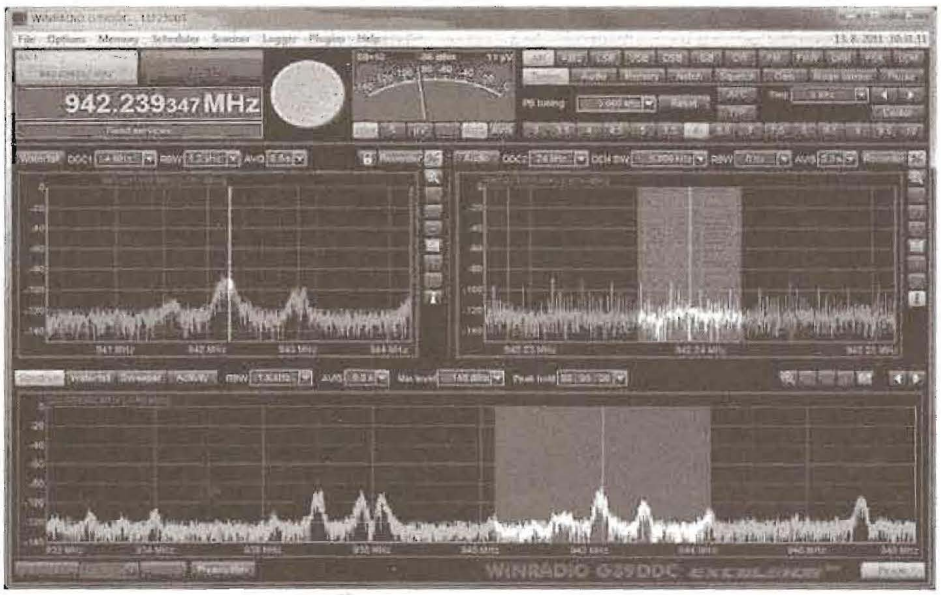


Figure 2 - Screen Shot 1

As you can see from the accompanying illustration (Figure 2), the receiver's virtual control panel is a busy place! Daunting at first, it gradually makes sense and, after a while, actually become intuitive. A full operating manual disc is included. Read it!

Handily, the entire display may be custom-sized vertically or horizontally to fit the requirements of the computer screen. The three spectrum displays are interlinked. The main display at the bottom is always a span of 16 MHz, chosen anywhere in the receivable spectrum, and it's in real time.

You say you'd like to see the entire receivable spectrum at once? Choose the sweeper mode and select the number of 16 MHz swaths you'd like stitched together, up to the full 3500 MHz, all on screen in one continuous, rapidly swept swath of 1 GHz per second!

The upper two, smaller displays are finely-tunable span segments of the main display. My preference is to set the left-hand segment digital downconverter (DDC1) to display a 1 or 2 MHz span, and the right-hand segment (DDC2) to about 20 kHz (it can be as wide as 320 kHz).

That arrangement allows me to click my cursor on a signal spike on the main display, quickly sharpen it with a click on the DDC1, then examine the modulation envelope of the carrier in detail on the right-hand display. The shaded area surrounding the cursor on the main display in Figure 2 is the span chosen for DDC1.

An audio button over DDC2 switches that display to a real-time audio spectrum analyzer. Spectrum markers may be placed on the display to indicate frequencies of interest, set reference points, and calculate differential frequencies.

Even better, the displays can be shown as a waterfall spectrum as shown in Figure 3.

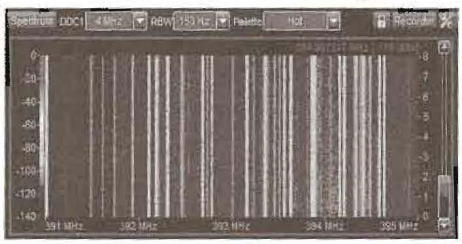


Figure 3 - Screen Shot 2

The waterfall display is speed-adjustable as it scrolls upward from the bottom, revealing signal presence on the spectrum over time. This allows the user to refer back to any active frequency, even after the signal is absent, in order to mark it for later reference or determine its frequency.

The spectrum display may be recorded at any time as a BMP image file for archival retrieval. A variety of colors for the display may be selected from a palette to suit the user's preference. On a personal note, I found that watching the soothing scroll of colors can be

G39DDCE SPECIFICATIONS

Receiver type
Dual DDC software-defined receiver with up-converter superheterodyne front end

Frequency range
9 kHz to 3500 MHz

Tuning resolution
1 Hz

Mode
AM, AMS, CW, LSB, USB, ISB, DSB, FMN, FMW (stereo), FSK,
UDM (user-definable mode), DRM (optional, license fee required)

Image Rejection
85 dB (< 50 MHz)
65 dB (50 - 500 MHz)
85 dB (> 500 MHz)

IP3 (Third order intermodulation)
+6 dBm typ. (< 50 MHz) @ 5 kHz spacing
+2 dBm typ. (> 50 MHz) @ 10 kHz spacing
(preamp off)

SFDR (Dynamic Range)
91 dB typ. (< 50 MHz)
88 dB typ. (> 50 MHz) (preamp off)
87 dB typ. (> 50 MHz) (preamp on)

Noise figure
14 dB typ. (< 50 MHz)
14 dB typ. (> 50 MHz) preamp off
5 dB typ. (> 50 MHz) preamp on

MDS
-130 dBm / 500 Hz typ. (< 50 MHz)
-130 dBm / 500 Hz typ. (> 50 MHz) preamp off
-139 dBm / 500 Hz typ. (> 50 MHz) preamp on

Internal spur reduction
Below -95 dBm, typ. less than -115 dBm of equiv. antenna input

RSSI accuracy (S meter)
2 dB

RSSI sensitivity
-140 dBm

Processing and recording bandwidth
20 kHz - 4 MHz (selectable in 24 steps)

Demodulator processing bandwidth
20 kHz - 320 kHz (selectable in 13 steps)

Demodulation bandwidth (selectivity)
1 Hz - 320 kHz (continuously variable in 1 Hz steps within current demodulator processing bandwidth)

Spectrum analyzer
16 MHz wide real-time spectrum, 1.5 kHz resolution bandwidth (RBW)

ADC
16 bit, 100 MSPS

Search speed
Up to 1 GHz/s

Scanning speed
Up to 80,000 ch/s (12.5 kHz channel separation)

Sensitivity
AM: 30% mod., 10 dB S+N/N
SSB, CW: 10 dB S+N/N
FM: 3 kHz dev., 12 dB SINAD
FMW: 50 kHz dev., 12 dB SINAD (Signal to noise and distortion)

Mode
< 50 MHz
> 50 MHz (preamp off)
> 50 MHz (preamp on)

AM
-105 dBm, (1.3 μV)
-105 dBm, (1.3 μV)
-113 dBm, (0.5 μV)

SSB
-118 dBm, (0.3 μV)
-118 dBm, (0.3 μV)
-125 dBm, (0.13 μV)

CW
-125 dBm, (0.13 μV)
-125 dBm, (0.13 μV)
-132 dBm, (0.06 μV)

FM
-114 dBm, (0.45 μV)
-115 dBm, (0.4 μV)
-122 dBm, (0.2 μV)

FMW
not specified
-108 dBm, (0.9 μV)
-115 dBm, (0.4 μV)

Intermediate frequencies
IF1: 3910 MHz (BW=30 MHz)
IF2: 70 MHz (BW=16 MHz)

Tuning accuracy
0.5 ppm @ 25 ° C

Tuning stability vs. temperature
0.5 ppm (0 to 50° C)

Antenna input
50 ohm (SMA connector)

Output
Digitized IF signal over USB interface

Interface
USB 2.0 High speed

Power supply
12 V DC @ 1.5 A max.

Operating temperature
0°C to 50°C

Dimensions
Length: 166 mm (6.5")
Width: 97 mm (3.8")
Height: 59 mm (2.3")

Weight
805 g (28.4 oz)

Specifications are subject to change without notice due to continuous product development and improvement.

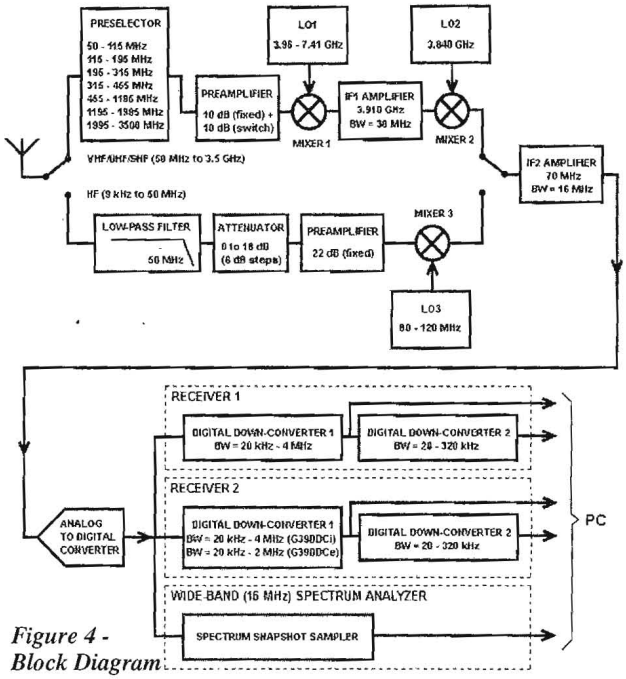


Figure 4 - Block Diagram

addictive!

As shown in Figure 4 (next column), the RF signals are initially preselected in bands, then up-converted by approximately 4 GHz or higher, then down-converted again for processing. Note that there are actually two receivers and a spectrum analyzer in the architecture. The final 70 MHz down conversion allows the signals to be processed digitally.

❖ Let's Listen

The starting frequency is typed on the computer's keyboard, followed by a k, m, or g to indicate kilohertz, megahertz, or gigahertz. The virtual tuning knob can tune across the spectrum in 1, 10, 100, or 1000 Hz steps, as can the computer keyboard arrows, by pressing the Shift, Alt, and Ctrl computer keyboard keys. The modulation mode is cursor-selected from the modulation mode toolbar (Figure 5).

Figure 5 - Modulation Bar

DRM (Digital Radio Mondiale), a digital mode occasionally used by some shortwave broadcasters, is a licensed internal application that requires the additional purchase of a software key to open it. UDM is a user defined mode which may be configured independently along with other custom characteristics.

Although the bandwidth may be adjusted continuously, it is often more convenient merely to pushbutton-select a common selectivity as allowed by another bar. Additional audio bandwidth tapering is accomplished by an audio bandpass filter, allowing upper and lower roll-off skirts to be selected (Figure 6).

Figure 6 - Audio Filter Bar

Much of the receiver's computer power goes into selectivity/bandwidth filtering. With older, less powerful computers, the response time may slow down or even freeze. An analytical box (Figure 7, next page) is provided to assist the user in choosing the most practical settings for his computer.

Even a software defined receiver (SDR) like the G39 can suffer the indignities of strong signal overload. This is especially likely when using long shortwave antennas which have large capture areas to maximize signal strengths.

If overload occurs, the S meter will display "ADC CLP" (analog-to-digital converter clipping). In such a circumstance, the user

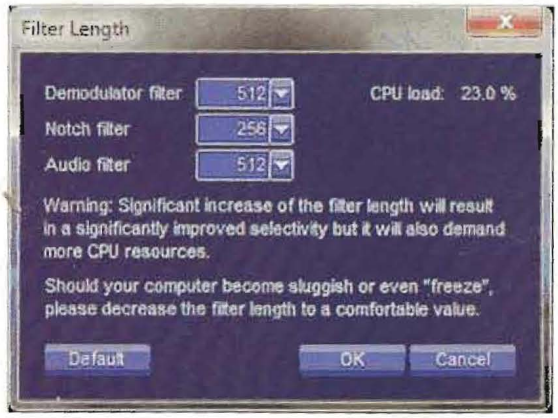


Figure 7 - Filter Length

may select either the attenuator button, or the Auto button which automatically chooses the optimum level. This feature is for under-50 MHz reception where such overload is most likely to occur.

An RF notch filter can be invoked to remove strong-signal interference; it not only removes the center frequencies, but its width is adjustable to remove the sidebands as needed.

A selectable preamplifier may be enabled for VHF and above, providing an additional 10 dB of gain. I found this to be especially useful on weak signal reception, both for raising the audible content of the modulation above the noise floor as well as for increasing the spectrum display spikes.

Digital Selectivity

Digitization of the signal allows considerable flexibility in reception. Referring once again to the spectrum display on the virtual panel (Figure 8, below), you will note a grey area encompassing the signal spike envelope. That's its adjustable bandwidth.

Simply dragging the cursor across the area allows customization of the detection window, narrowing it or moving its center (as in IF shift) to suppress adjacent channel interference. Of course you can also change the bandwidth by selecting from a large drop-down list.

Want to stay right on center frequency? The G39 has spectrum centering, AFC (automatic frequency control), and tune-to-peak control, all of which sharply define the signal's center. Automatic gain control (AGC) is present in six speeds and continuously-adjustable attack and decay times.

The effective noise blanker allows two different approaches, short-time DDC averaging and ADC input threshold, allowing the presence of random spikes in the digital stream to be replaced with zeroes.

Five Different Squelch Choices

A *level* squelch permits the user to choose at which point above the background noise a signal can be heard.

Noise squelch provides a custom point at which noise in the signal mutes the audio, particularly useful in weak FM.

Voice squelch detects the presence of voice-frequencies to open the audio.

CTCSS is the familiar tone squelch used by traditional public safety agencies.

DCS is the newer digital squelch system.

Memory

Memory channels can be scanned, selectively skipped (locked out), or manually stepped through. The memory mode is highly flexible, allowing most any storage and access capability one could want.

An infinite (limited by your computer's hard drive) number of frequencies can be stored for later recall, along with mode, call sign, description, bandwidth, squelch settings, audio filter choices, and a hotkey. The memory function is under the Store frequency pop-up and its template for filling in the information. The channels can be scanned in a conventional manner, pausing or stopping on a busy channel, then resuming when the signal disappears, or after a delay.

Many other memory functions are offered as well.

The Antenna Dilemma

The presence of only one antenna connection (an SMA in this case) would seem to pose a problem on an extremely-wide-frequency-coverage receiver. I know of no 9 kHz-3500 MHz antenna available, and antenna switches and RF combiners (multicouplers) that operate from "DC to daylight" are difficult to find. Even WiNRADiO has no antennas for that wide of frequency coverage.

On the other hand, suppose WiNRADiO had supplied more antenna connectors for different frequency ranges. What would those ranges be? I'd have a hard time deciding whether a cutoff for shortwave should include 30-50 MHz as many receivers now have. And what about all those VHF/UHF bands? Perhaps it was a good idea to allow the end user to decide how to feed signals to this receiver based upon his needs.

Mobile Operation

With the small size of the G39 and the ready availability of lightweight portable computers, the temptation to "go mobile" with the system is persuasive. But the mandate to operate the receiver from 12 VDC within one volt must be observed to avoid damaging the circuitry.

The cigarette lighter jack may be used for 12 volt power *only if the engine is not running,* but if it is, then regulation is necessary to avoid damage from those 16-volt surges from the alternator.

I would recommend using an inexpensive 12VDC/120VAC inverter plugged into the cigarette lighter jack, and the supplied WiNRADiO AC power supply plugged into that.

With the small package of electronics on my front seat and a mag-mount whip on the roof of my car, I decided to see if I could hear the 1 milliwatt VHF telemetry tracking transmitters on the legs of a pair of whooping cranes than had nested nearby.

I was able to get to within about 500 feet or so and, sure enough, the G39's spectrum display came alive with the pulse emissions, and the familiar "chirp chirp" was heard from the speaker!

The Bottom Line

This is the most amazing receiver I've ever encountered. It employs the latest proven SDR architecture, operates well beyond the spectral range that most of us would ever think of trying to hear, and demodulates all conventional modes.

Its three integral spectrum displays are extraordinarily useful, allowing spectral chunks from a few kilohertz up to 3.5 gigahertz to be examined in detail simultaneously.

Competitive receivers and spectrum analyzers with similar features sell typically in the ten thousand dollar range and more. The G39DDCe is available for under five thousand dollars.

This is a receiver we expect to see adopted eagerly by government, military, and professional users for SIGINT, signals surveillance, laboratory R&D, test bench applications, and other analytical applications.

I ordinarily find something to complain about in my reviews, but trying to find something I don't like about the G39DDCe has left me at a loss, and that's a gain for this winner.

The WiNRADiO G39DDCe is available to US and Canadian clients from Grove Enterprises. (See ad in this issue for contact details.)

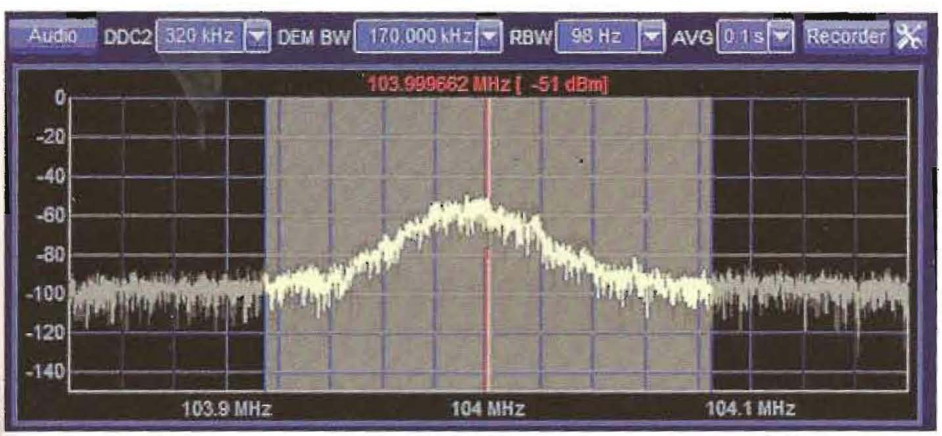


Figure 8 - Screen Shot 3