

WiNRADIO G33DDC and G39DDC

Application Note

Introduction

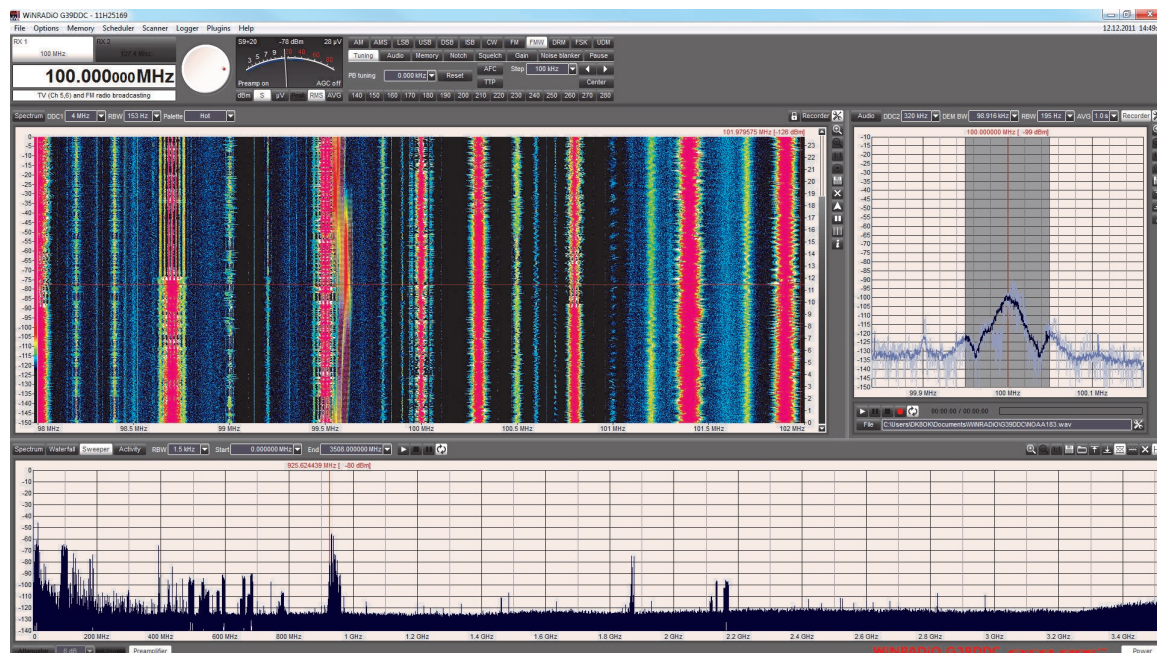
What WiNRADIO offers is simply sensational - “Excelsior” seamlessly covers the entire frequency range from 9 kHz to 3.500 MHz in steps as small as one Hertz!

Any range up to 4 MHz wide may be recorded and can be played back as were it a live session. Moreover a spectrum analyzer with a 16 MHz display bandwidth is available. The receiver has two mutually independent channels which allow simultaneous reception within this 16 MHz range. And it has an ultra fast scanner offering a scanning rate of up to 1 GHz per second. And even if “Excelsior” nearly offers the entire world of “ExcaliburPRO” in the range up to 50 MHz (except for instance the input filters) it also opens up access to the enormous frequency range above with a similar quality.

The number of functions is so huge, that I will have to confine myself to what is most useful to the reader, namely to demonstrate a few, excellent features in practice. This should be taken literally because first of all meticulously selected and commented

screen shots demonstrate the performance of the receiver in an instructive and comprehensible way. Unfortunately for the frequencies above 30 MHz only a broadband discone antenna installed in the attic is at my disposal. However, the results even with this set- up are impressive.

First a couple of technical details regarding the signal path of the receiver. Basically “Excelsior” is a software-defined receiver (SDR) which samples signals at 100 MHz and in 16-bit resolution. The signals are fed to the SDR after preceding single or double frequency up-conversion to the IF. All signals below 50 MHz are then passed through a low-pass filter with this frequency. The filter is followed by an attenuator adjustable in 6 dB steps from 0 to 18 dB. A fixed gain pre-amplifier increases the gain to approx. 22 dB before the signals finally reach the mixer. The first IF is 3910 MHz (BW=30 MHz) and IF2 70 MHz (BW=16 MHz).



WiNRADIO G33DDC and G39DDC

Application Note

Two independent receivers within a bandwidth of 16 MHz

All signals above 50 MHz are also up-mixed to 70 MHz. But before the mixer stage signals are passed through one of seven automatically selected filters followed by a two-stage amplifier with a fixed gain of 10 dB and with the possibility of adding another 10 dB of gain. The amplifier is followed by the mixer. The first IF is at 3.91 GHz - above the highest receiving frequency. The IF is amplified and transfers a 30 MHz wide band to the second IF at 70 MHz – at this stage the signal paths are re-joined and then digitized (100 MHz/16 bit). The resulting 16 MHz wide band is processed in parallel in two completely independent receivers.

The receivers have DDC bandwidths which are adjustable in 24 steps from 20 kHz to 4 MHz. These are also the bandwidths in the HF range which may be recorded and played back. By virtue of the broad range of available band widths it is possible to accurately adapt the recorded range to the task at hand (one station or one, two, three broadcast bands). In the external version of the receiver, which may be connected through a USB 2.0 plug. The serial interface limits the bandwidth of the secondary receiver to 2 MHz, while the primary receiver still offers 4

MHz. The internal version - G39DDCi – offers a full 4 MHz bandwidth for both receivers. This feature is so unusual that at least one outstanding characteristic must be explained: Within the 16 MHz bandwidth, both virtual receivers may be linked together in such a way that two independent stations may be simultaneously received – one channel goes to the left side of the headset and the other channel to the right side. The corresponding frequency ranges are displayed in the lower display. As an example the user is able to listen to two randomly selected frequencies within all broadcasting bands between 49 m and 13 m in parallel! The corresponding frequency ranges are displayed in the lower window, which is also 16 MHz wide.

Here is even more: Both virtual receivers may record simultaneously – i.e. with the internal version of the receiver it is possible to record a bandwidth of up to 8 MHz (4 MHz + 4 MHz) and with the external version even up to 6 MHz (4 MHz + 2 MHz). This feature is absolutely revolutionary.

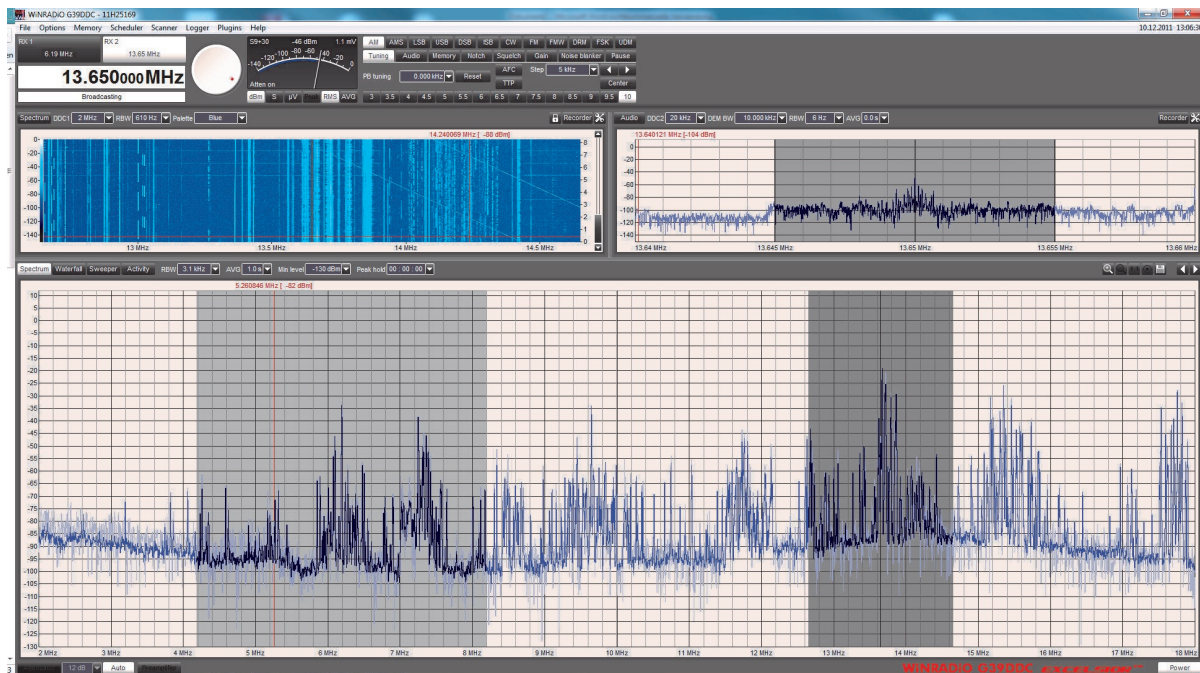


Fig. 2: The virtual front of G39DDC contains three large windows

WiNRADIO G33DDC and G39DDC

Application Note

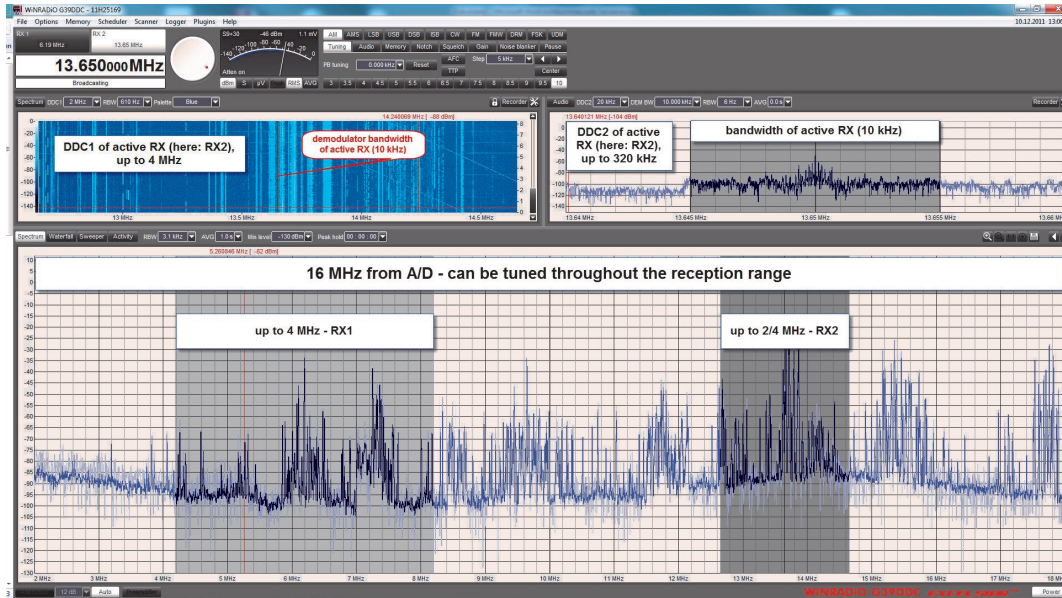


Fig.3: The lower window shows the total, active 16 MHz range of the analog-digital converter. Within this band two receivers are active: RX1 featuring a band width of 4 MHz and RX2 which in this case features 2 MHz. The up-

per left window contains the sonagram produced by RX2 and in the middle of the window the 10 kHz demodulator band width. The upper right window displays the output of DDC2 – in this case between 20 and 320 kHz.

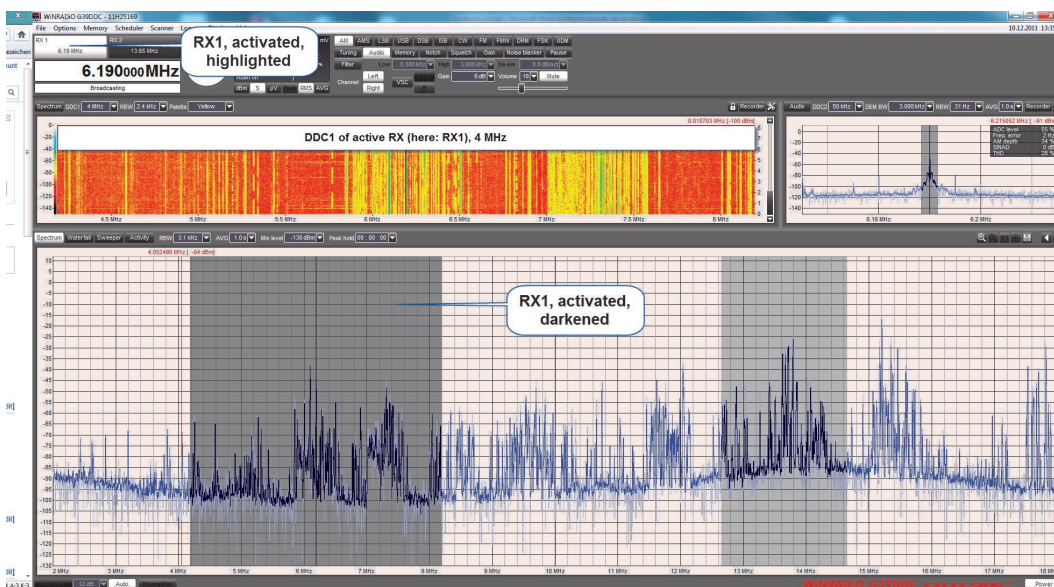


Fig. 4: If the operator switches from RX2 to RX1, the upper left window band width changes from 2 MHz to 4 MHz. Simultaneously in the lower window the frequency range of RX1 is darkened

to that in Fig. 2 where RX2 is darkened. Moreover I have increased the band width of DDC2 from 20 kHz to 50 kHz (upper right window) to display a larger part of the signal environment.

WiNRADiO G33DDC and G39DDC

Application Note

How is this concept then utilized? Two examples

- ◆ Within a 16 MHz wide band two frequencies may be monitored
- ◆ The total DDC1 band width of RX1 or RX2 may be recorded and indeed even RX1 *and* RX2

Why would one wish to monitor two frequencies in parallel? Well, in professional monitoring this task is as important as for us shortwave listeners. Let us assume that we wish to document all active channels of the Chinese service of PBS Xizang – not from hearsay, but so it to a certain degree will stand up in court.

The procedure is as follows

- ◆ RX1 is tuned to the broadcaster's frequency re-

ceived with the highest quality, e.g. 7240 kHz

- ◆ The RX1 audio is sent to the left side of the head-set
- ◆ RX2 is tuned to a parallel frequency, e.g. 6200 kHz
- ◆ The RX2 audio is sent to the right side of the head-set
- ◆ For each receiver, band width and volume is carefully adjusted so a certain “stereo effect” is obtained
- ◆ RX2 is then tuned to the next parallel frequency
- ◆ If volume and band width are properly adjusted, it is possible to detect a parallel transmission even if it is very weak or heavily disturbed.



Fig. 5a and 5b: RX1 is tuned to a “good” frequency, here 7240 kHz, and the audio signal is sent to the left audio channel. RX2 is then tuned to a parallel frequency, which is sent to the right audio channel.

Excelsior features up to 4 MHz wide recording of HF bands for both virtual receivers within a 16 MHz bandwidth. Thus a total recording band width of 8 MHz is available for the internal version of Excelsior and after all 6 MHz for the USB-version. Recording may either be manually started or stopped, or the user may utilize the receiver's “Scheduler”, which is simple to use.

Recordings are generally formatted as .WAV-files,

which are however called .DDC by the SDR radio to avoid confusion with audio data. The files may also be processed by third-party applications (RFSpace) if the .DDC filename extension is replaced with .WAV. This procedure is more difficult with the WINRADiO proprietary .RXW-format, which contains additional information like frequency and time – the solution is to play back the files with the WiNRADiO application.

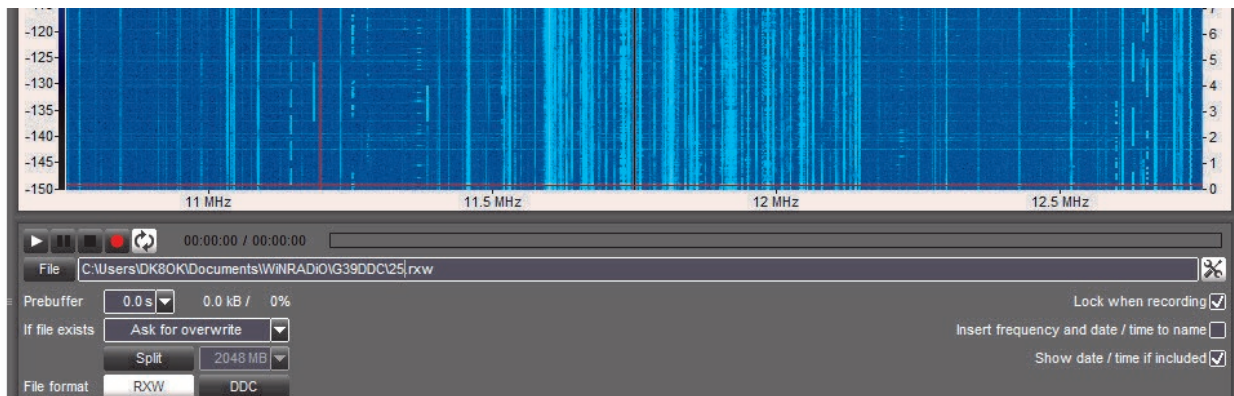
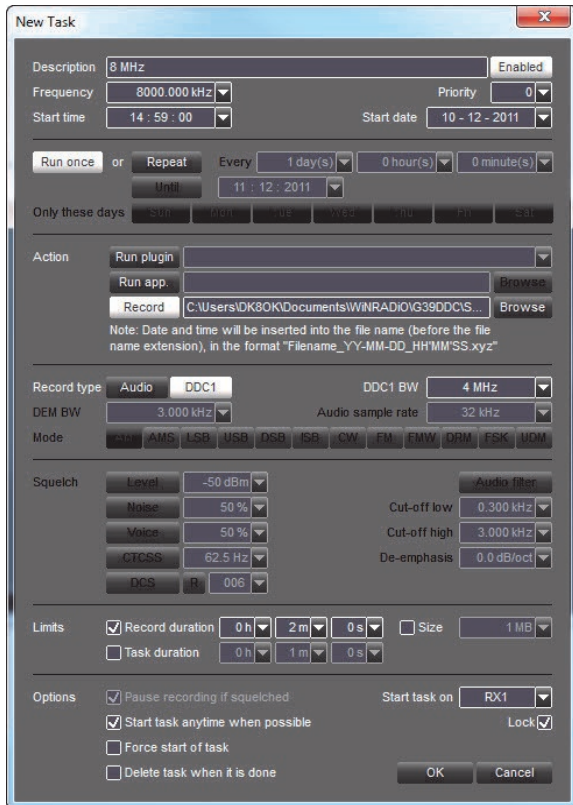


Fig. 6: Recording may be done in “RXW” or “DDC” format. If the “Insert frequency and date/time to name” box is clicked the selected filename is expanded to include center frequency and start time information.

WiNRADIO G33DDC and G39DDC

Application Note



A two minute recording of a 4 MHz wide frequency span requires 2344 MB of hard disk space. This is a good length to record plus minus one minute around full hour or half hour to hopefully catch any ID announcement from broadcasting stations, which then can be comfortably stored as audio using the built-in functions.

Other ways of recording are also available to accommodate monitoring tasks in the frequency bands above 30 MHz where it is common to pinpoint network control centers and determine activity patterns. For such tasks sonagrams with a maximum of 16 MHz of bandwidth offer an excellent overview which should be evident from the aeronautical band sonagrams in fig. 9 and 10. However, if a more accurate evaluation is desired a resort to numerical methods is inevitable. The channel raster and the signal strength threshold value are defined for the signal to be acquired (Fig. 11).

Fig. 7: Almost by just clicking it is possible to program very different recording options for Excelsior.

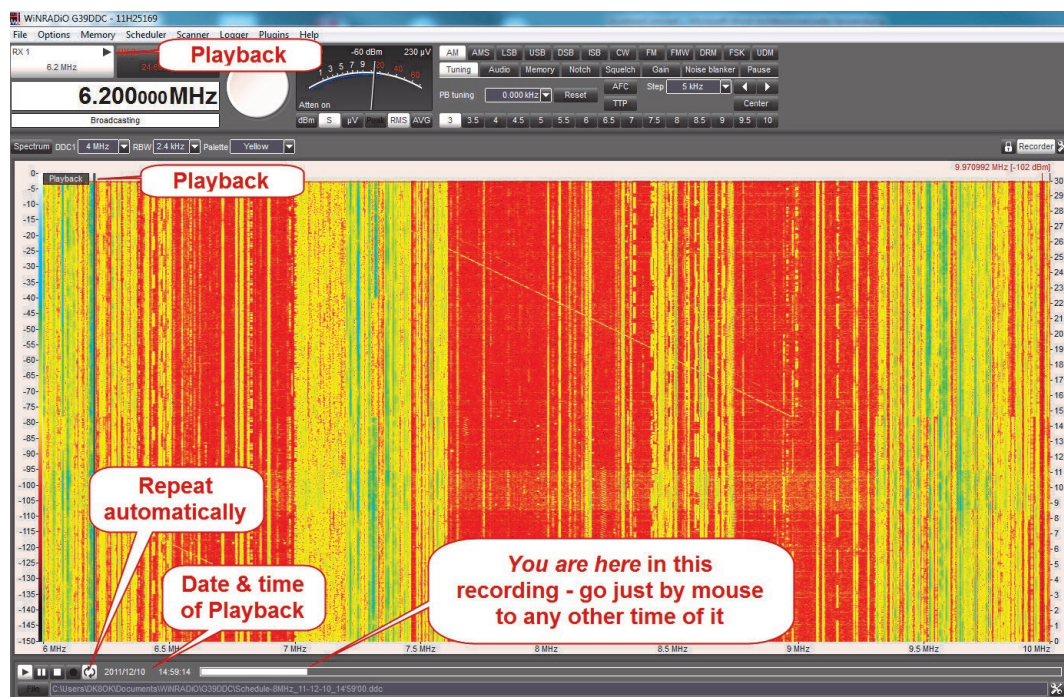


Fig. 8: This is the way Excelsior looks like when playing back. The icons are similar to the ones used in consumer electronics.

WiNRADIO G33DDC and G39DDC

Application Note

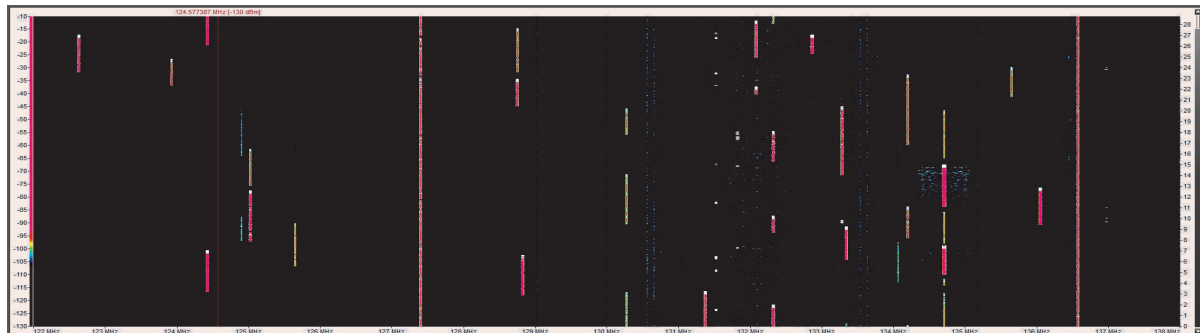


Fig. 9: An observation time of 30 seconds for 122 - 138 MHz is useful to detect short communications bursts.

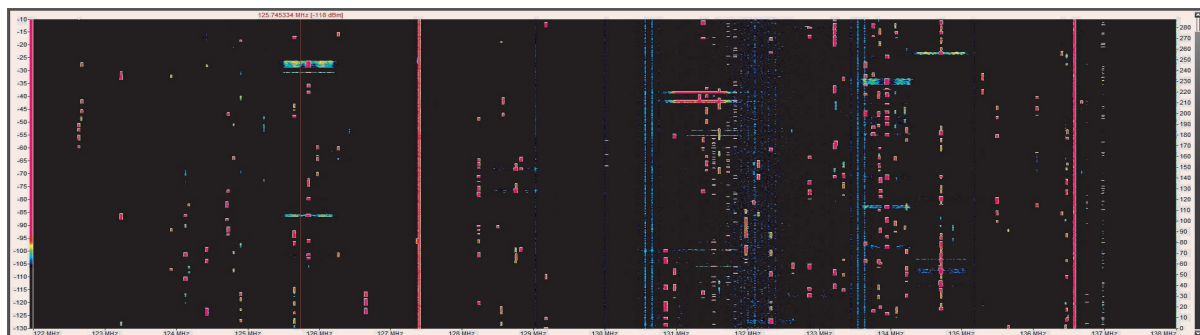


Fig. 10: The same span as in fig. 9, but this time the observation time has been increased tenfold to allow for a more precise activity profile.

Since this method relies on an extremely fast scanning process jumping from channel to channel, its frequency span is only limited by the frequency range of the receiver itself. When a scan is started it will sweep through up to 80.000 channels per second. In the example chosen here the aeronautical band from 118 to 136 MHz would be scanned ap-

proximately 55 times per second. In practice the receiver will register short voice transmissions equally well as it will register data bursts. A list is produced containing for each scanned channel a number indicating as a percentage how many scans detected an activity on the channel exceeding the selected threshold.

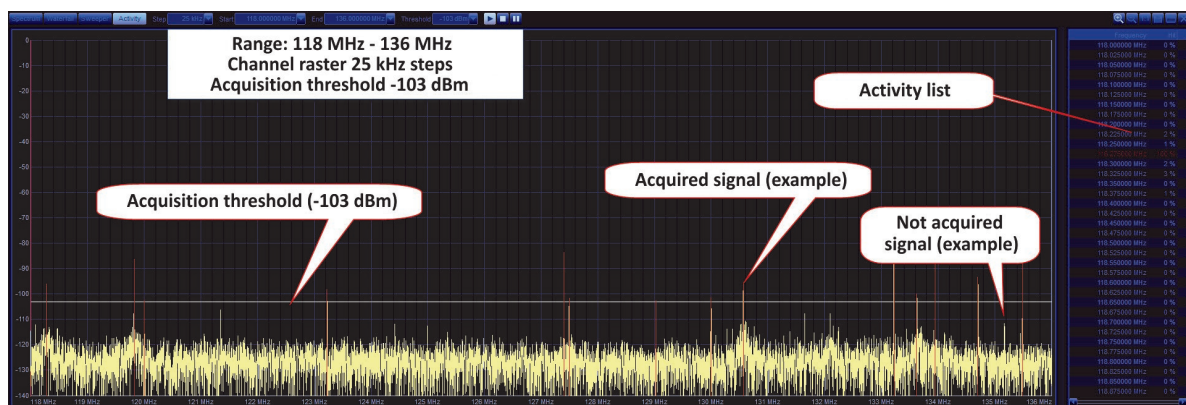


Fig. 11: Everything is lined up to produce an activity pattern for the aeronautical band from 118 to 136 MHz. After this the scan was started.

WiNRADIO G33DDC and G39DDC

Application Note

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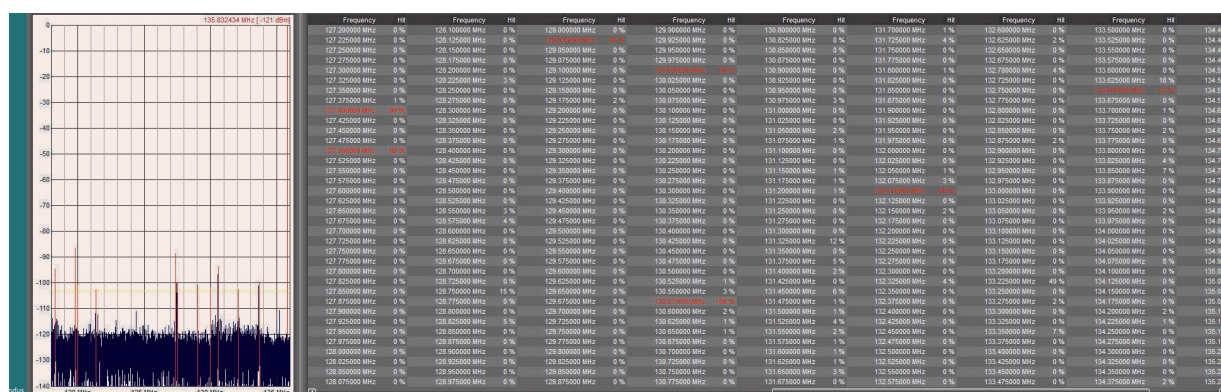


Fig. 12: For evaluation each channel is listed with a percentile hit rate

| Frequency | Hit |
|----------------|-------|
| 118.275000 MHz | 100 % |
| 119.625000 MHz | 100 % |
| 120.000000 MHz | 26 % |
| 121.350000 MHz | 44 % |
| 124.425000 MHz | 8 % |
| 125.025000 MHz | 15 % |
| 126.650000 MHz | 15 % |
| 127.400000 MHz | 99 % |
| 127.500000 MHz | 83 % |
| 128.750000 MHz | 15 % |
| 128.825000 MHz | 5 % |
| 129.025000 MHz | 83 % |
| 130.000000 MHz | 94 % |
| 130.575000 MHz | 100 % |
| 131.325000 MHz | 12 % |
| 131.375000 MHz | 5 % |
| 131.450000 MHz | 6 % |
| 132.100000 MHz | 68 % |
| 133.225000 MHz | 49 % |
| 133.350000 MHz | 7 % |
| 133.625000 MHz | 18 % |
| 133.650000 MHz | 82 % |
| 133.850000 MHz | 7 % |
| 134.075000 MHz | 8 % |
| 134.700000 MHz | 48 % |
| 135.500000 MHz | 46 % |

From fig. 12 it is obvious how voluminous and unmanageable the list becomes. Consequently after completion the list is filtered. I have done so (fig. 13) using a threshold value of 5% - this means that all channels which showed activity for a minimum of ten percent of the scans are displayed. Thus the list of 720 entries is reduced to 26 frequencies considered "active". Clicking on any entry will open the displayed menu and for instance allow directly tuning to the frequency of the selected entry as I have done with the weather forecast frequency 127.400 MHz. Or the frequency may be stored with a mouse click.

In addition to the "Activity" tick box, a "Sweep" tick box is available. Here a frequency range is also defined, which is then swept very fast with up to 1 GHz per second and the spectrum is displayed with an adjustable resolution between 1.5 and 48.8 kHz. Besides the current spectrum, maxima and minima may also be indicated. Selected parts of spectrum may then be zoomed in to (fig. 15 and 16).

Fig. 13: If all entries of fig. 12 with a hit rate of less than five percent are filtered out, the list becomes manageable. Right-hand clicking on an entry produces a context menu allowing to directly tune to the frequency.

WiNRADiO G33DDC and G39DDC

Application Note

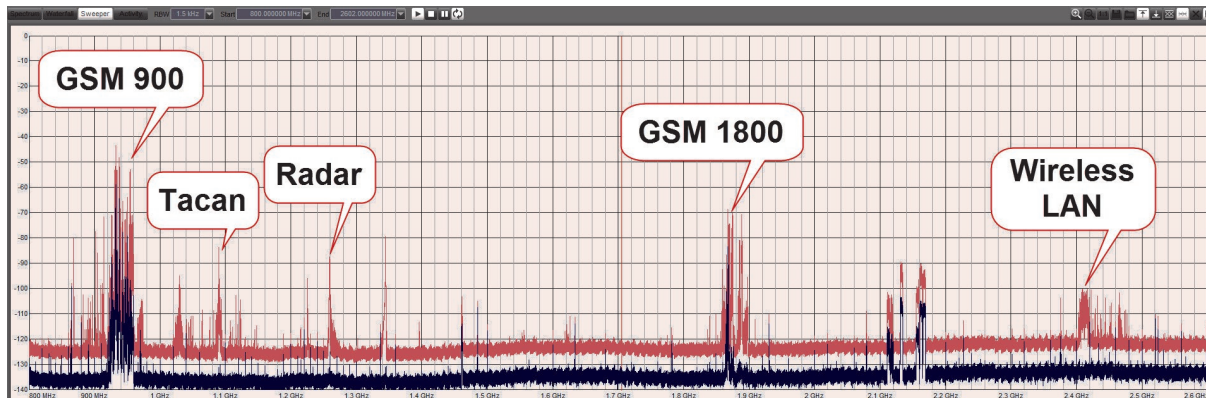


Fig. 14: A sweep of nearly 2 GHz (800 MHz – 2.6 GHz) shows the channel occupancy in this range.

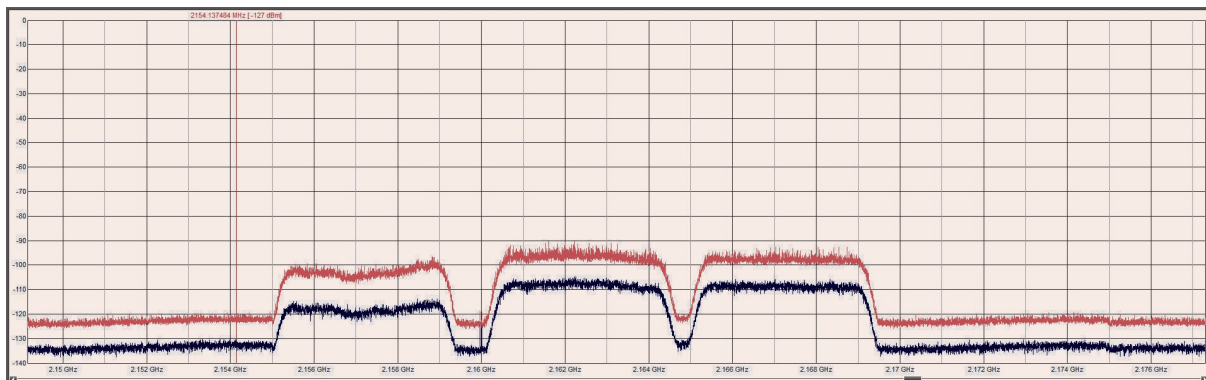


Fig. 15: Any part of the spectrum may be zoomed in to for a more accurate analysis.

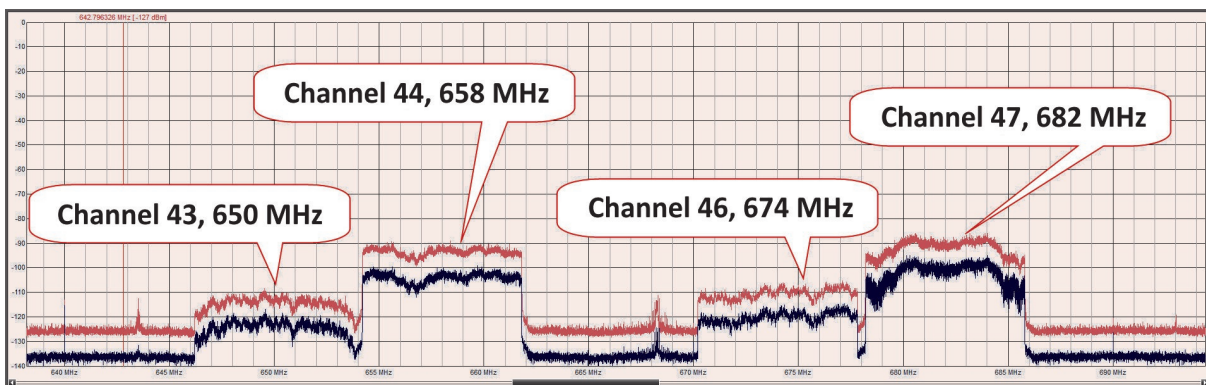


Fig. 16: Using “Sweep” all DVB-T channels in an area may be detected. The figure shows an enlarged view of parts of UHF bands IV and V.

WiNRADIO G33DDC and G39DDC

Application Note

From the tracking down of bugs to the reception of INMARSAT communication this receiver has it all. Its high sensitivity even ensures that satellites may be received with a small antenna – for instance the ORBCOMM communication satellites between 137.2 and 137.8 MHz. The decoding is

done with “W-CODE” from WAVECOM, which for the best results of the decoding of the SDPSK modulated signals accepts not just audio outputs but also I/Q outputs. To process these signals the VSC output of Excelsior must be changed from “Audio” to “IF”.

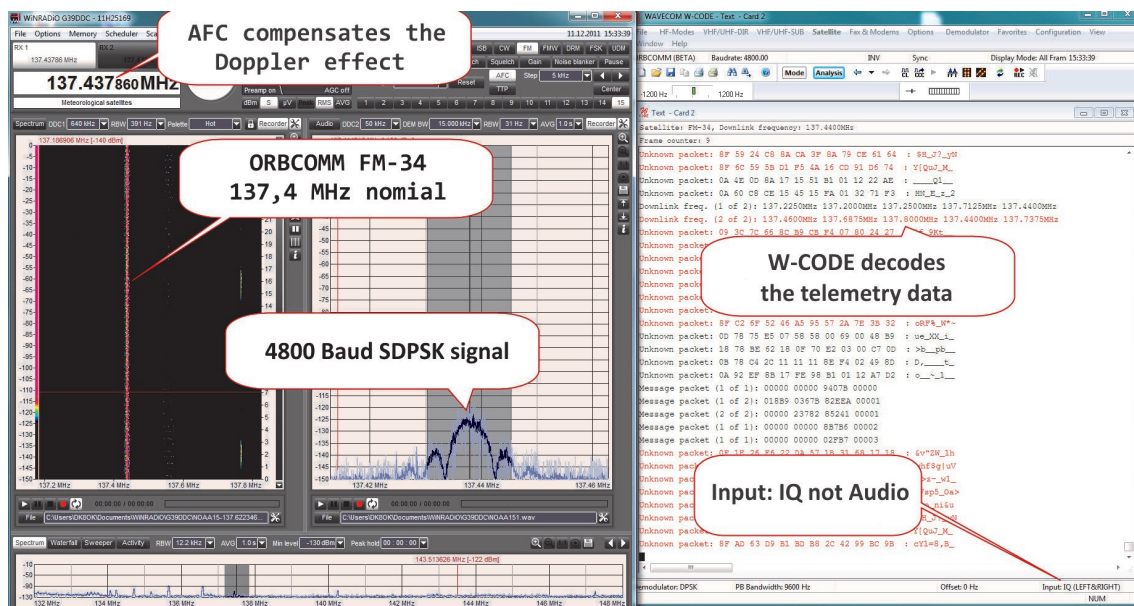
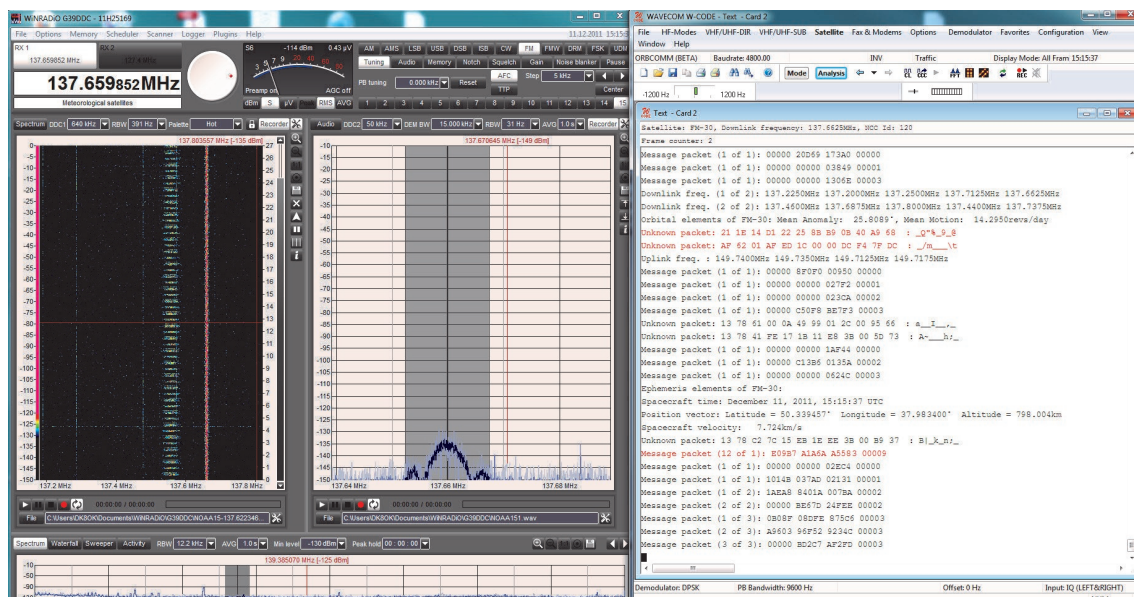


Fig. 17 and Fig. 18: Reception of one of the 36 orbiting ORBCOMM satellites on 137.4 MHz and decoding of the telemetry data with W-CODE from WAVECOM.



WiNRADiO G33DDC and G39DDC

Application Note

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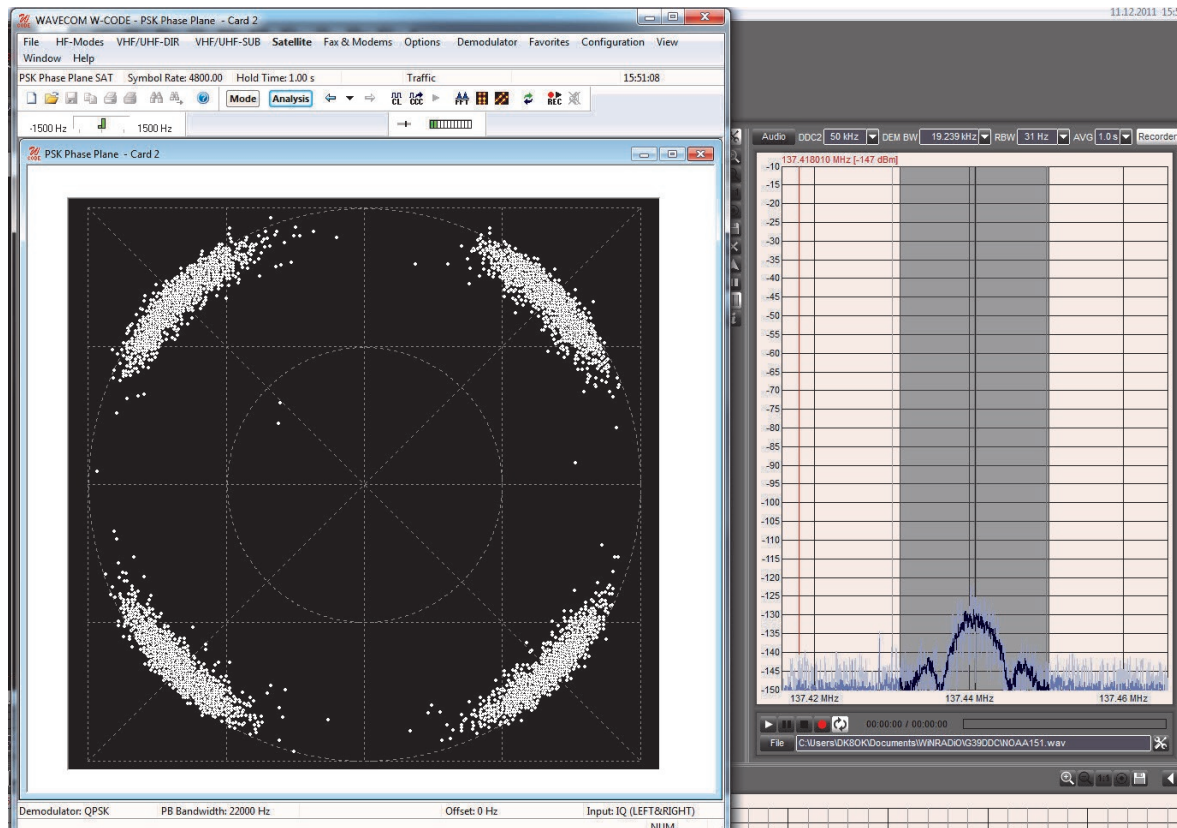


Fig. 19: Left a clean screenshot from W-CODE of the ORBCOMM four-phase modulation; right G39DDC's spectrum presentation of the signal.

For German radio aficionado magazine "Funk-Telegramm", Nils Schiffhauer has done a test review of "Excelsior" - the latest software defined radio (SDR) from Australian WiNRADiO - which also demonstrates the versatility of Wavecom's W-CODE decoder.

As earlier stated all this are only small parts of the total spectrum of functions. However, to deal here with for instance the reception of transmissions from meteorological balloons and above all the abundance of private and government communication systems would exceed the limits laid down. The detailed technical specifications may be found in the datasheets from the manufacturer or the distributors. The software used in this review is still in a very early version, which was completely stable. Regarding price and performance Excelsior targets very demanding listeners or professionals. Both audiences should have their focus above 30 MHz. Even if the receiver is also a DX

machine to be taken seriously below 30 MHz, the user is even better served by Excalibur and its PRO version. On the other hand the advantage of Excelsior is its extremely fast scanning rate, its high sensitivity and its good large-signal characteristics – all above 30 MHz. It is remarkable how SDR technology not just improves the user friendliness and the overview, but also gets the best out also of FM – as with UHF broadcasting DX – in confused situations by visual controls and flexible band width adjustment. The examples shown in this review may be varied by the user for his or her particular field of interest or task. The possibilities offered by Excelsior are only limited by the imagination of the user.

Text, pictures and screenshots
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WiNRADIO G33DDC and G39DDC

Application Note

WR-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-defineable Mode), DRM (optional)

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

IP3 +6 dBm typ. (< 50 MHz) @ 5 kHz spacing

IP3 +2 dBm typ. (> 50 MHz) @ 10 kHz spacing (preamp off)

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

Noise: 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 spuri: Below -95 dBm, typ. less than -115 dBm of equiv. antenna input

RSSI accuracy: 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

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)

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

Tuning accuracy: 0.5 ppm @ 25 °C

Tuning stability: 0.5 ppm (0 to 50 °C)

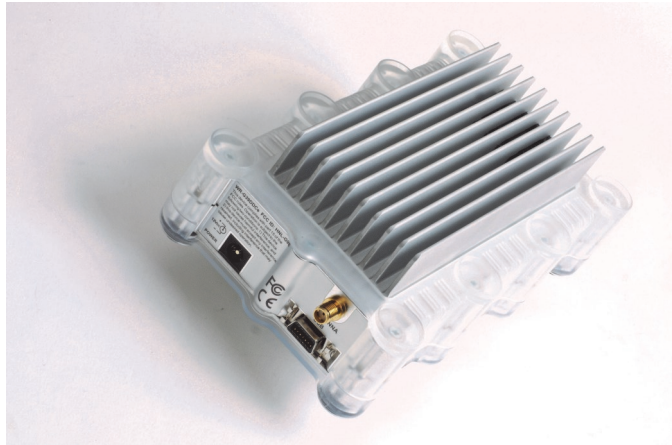


Fig. 20 and Fig. 21: The receiver. There is only one antenna plug (SMA) and the cooling ribs are cooled by a relatively quiet ventilator so they do not even become lukewarm. Excelsior is available from SSB-Electronic at 4,599 Euro (www.ssb.de).



| | |
|------------------|---|
| 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 temp.: | 0°C o 50°C |
| Dimensions: | Length 166 mm (6.5") Width 97 mm (3.8") Height 59 mm (2.3") |
| Weight: | 805 g (28.4 oz) |

<http://www.winradio.com/home/g39ddce-s.htm>

WiNRADiO G33DDC and G39DDC

Application Note



Since more than thirty years Wavecom Elektronik AG has developed, manufactured and distributed high quality devices and software for the decoding and retrieval of information from wireless data communication in all frequency bands. The nature

of the data communication may be arbitrary, but commonly contains text, images and voice. The company is internationally established within this industry and maintains a longstanding, world-wide network of distributors and business partners.

Product Information

| | |
|-------------------|---|
| Products | http://www.wavecom.ch/product-summary.php |
| Datasheets | http://www.wavecom.ch/brochures.php |
| Specifications | http://www.wavecom.ch/product-specifications.php |
| Documentation | http://www.wavecom.ch/manuals.php |
| Online help | http://www.wavecom.ch/content/ext/DecoderOnlineHelp/default.htm |
| Software warranty | One year free releases and bug fixes, update by DVD |
| Hardware warranty | Two years hardware warranty |
| Prices | http://www.wavecom.ch/contact-us.php |

System Requirements

| | <i>Minimum</i> | <i>Recommended</i> |
|--------|----------------------------|-----------------------------|
| CPU | Core i5 or Core i7 2.8 GHz | Core i7-6700 3.4 GHz |
| Memory | 4 - 8 GB RAM | 16 - 32 GB RAM |
| OS | Windows 7 | Windows 10 32-bit or 64-bit |

Distributors and Regional Contacts

You will find a list of distributors and regional contacts at <http://www.wavecom.ch/distributors.php>



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