Cerberus

RFEngineers, Inc. Broadcast Monitor

1U Rack Mount with up to four Watch Dog Receivers

User Manual

Document Version 0.0.9
Covers Firmware versions 2.3.0 and above
Covers Dashboard for Windows versions 2.1.0 and above

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Introduction

Congratulations!

You've just purchased a unique and highly versatile set of FM, AM, and NOAA Weather receivers. Your Cerberus 1U rack, contains up to four Watch Dog Cerberus (WDC) receivers. Each WDC contains a number of features which aid in continually verifying the quality of your signal and alerting you or your infrastructure to any anomalies; Hence its name.

One major aspect that makes Cerberus unique and versatile is its integrated USB serial interface Hub and API. This allows complete control of each WDC receiver from a single USB connection. The Windows based dashboard provides easy programming and monitoring of each receiver. Also a simple Python script can make the WDC receivers do some cool things. Our customers have already come up with very clever uses of their own.

Another aspect that makes the WDC receivers unique and versatile is their modular hardware design. All of their internal boards were designed with future upgrades and expandability in mind. We already have a number of projects in the works that will allow customers to use their WDC receivers in novel and useful ways.

We truly hope that Cerberus will be a meaningful addition to your studio or other infrastructure.

System Overview

The Cerberus has been designed to perform multiple functions for the broadcast industry. Cerberus includes up to four independent receivers; Each is capable of receiving AM/FM/NOAA Weather bands. This allows Cerberus to fill multiple rolls in a single 1U slot, such as; EAS, live broadcast monitoring and weather monitoring. Each receiver utilizes a state of the art Digital Signal Processor (DSP) to provide the best quality reception, and a host of other features.

Each WDC receiver delivers both single-ended headphone audio through a front-panel 1/8" phone jack and balanced analog audio via a rear-panel mounted StudioHub+ RJ45 connector.

Four user-programmable open-collector alarm outputs are available from a rear-panel 6-pin MiniDIN connector.
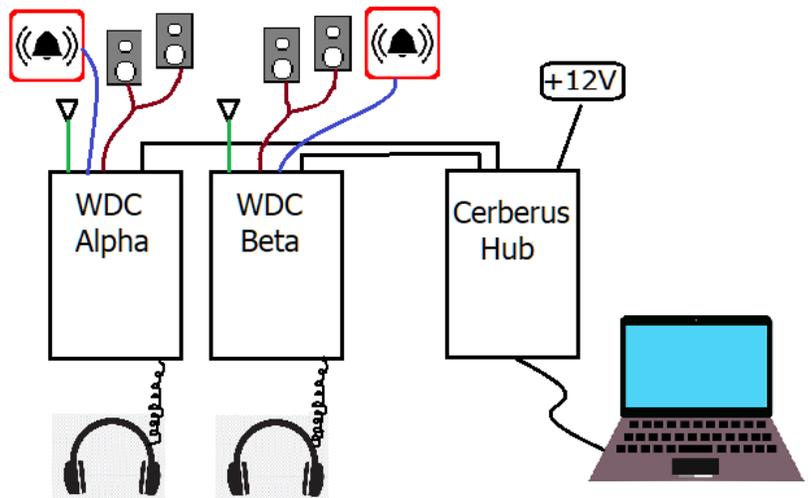
WDC Receiver Features

- 1U Rack mounting
- Supports up to four WDC receivers
- Each WDC is a completely independent radio receiver
- All WDCs are controlled through a common USB interface
- Each WDC is independently addressable through the common USB interface
- Single 2A 12VDC power supply
- FM / AM / NOAA Weather band receiver
- Class AB balanced speaker output (StudioHub+)
- Class AB single-ended headphone output
- Live RDS decoding
- Designed and tested for 24x7x365 operation
- Can be easily configured, controlled, and monitored from a PC or other computer
- Includes FREE *WDC Dashboard for Windows* software
  - Point and click configuration
  - Easily monitor the receiver's various indicators, meters, and live RDS display in real-time
- WDC serial interface / API
  - Able to be monitored and controlled remotely with the right configuration
  - Facilitates using the WDC receiver as part of a larger automation system
  - Build your own software around the WDC serial interface / API
- Fully configurable matrix of alarms and alarm output destinations
  - RSS below threshold alarm
  - SNR below threshold alarm
  - RDS loss alarm
  - Audio loss alarm
  - FM pilot loss alarm
  - NOAA 1,050 Hz alert tone detected
  - Front panel alarm output LEDs x 3
  - Rear panel General Purpose Output (GPO) alarm outputs x 4
    - Facilitates using the WDC receiver as part of a larger automation system
- Tamper-resistant controls
- Embedded 32-bit microprocessor, firmware on modern Real-Time Operating System (RTOS)
- Integrated Hardware Watchdog Timer (WDT) automatically hard reboots the WDC receiver
- Receiver settings are automatically restored from EEPROM after a power interruption
- Field-upgradable firmware
- Modular, upgradable hardware design
- Designed, assembled, and individually tested in the USA

WDC Receiver Specifications

StudioHub+	Output power	THD + N = 1%, f = 1kHz, Rl = 8 Ω	1.27 W
Headphone	Output power	RL = 32 Ω, THD+N = –60 dB	20 mW
	Output power	RL = 16 Ω, THD+N = –60 dB	60 mW
	Output Voltage	AC-coupled load = 16 Ω (single-ended), driver gain = 0 dB, parasitic capacitance = 30 pF	0.707VRMS
FM Receiver	Frequency		64 – 108MHz
	Minimum Step		10kHz
	Sensitivity	(S+N)/N = 26 dB	3 µV EMF
	RDS Sensitivity		9 µV EMF
	Selectivity	±200 kHz	38 to 50dB
	Selectivity	±400 kHz	60 to 70dB
AM Receiver	Frequency	Band 1	520 – 1710kHz
	Frequency	Band 2 (optional)	144 – 288kHz
	Frequency	Band 3 (optional)	2.3 – 30MHz
	minimum Step		1kHz
	Sensitivity	(S+N)/N=26 dB	25dBuV
WB Receiver	Frequency		162.4 – 162.55MHz
	Sensitivity	SINAD = 12 dB	0.65 µV EMF
	Selectivity	±25 kHz	40 to 55dB

Input, Output and Connections

Front Panel Overview

The Cerberus front panel features a headphone audio jack, power indicator LED, and 3 alarm indicator LEDs for each installed WDC receiver.

Headphone audio output
- Female 1/8" 3-conductor output jack
- Class AB single-ended audio output

Three Alarm indicator LEDs
- Each can be mapped to any number of alarm conditions
- Designated as alarm outputs A, B, and C

USB – B User interface
- Used to program individual WDC receivers
- The power LED will blink indicating which WDC receiver is being controlled
- All WDC receivers will power cycle when a computer is first connected
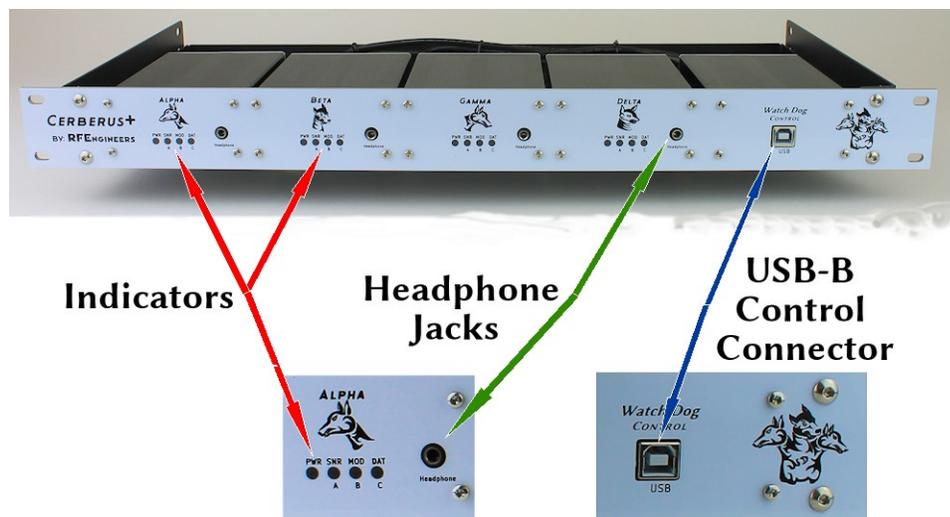
Figure 1: Front Panel Features

Rear Panel Overview

The rear panel of the WDC features antenna, mini-USB, StudioHub+ and MiniDIN connectors.

Antenna input:
- 50-Ohm BNC connector
- Common input for AM, FM and WB

USB Power & Data I/O:
- USB-A on the Hub to USB-Mini-B on each WDC

Alarm output:
- 6 Pin MiniDIN
- Alarm outputs D, E, F & G

Balanced audio output:
- StudioHub+ RJ45 Analog audio
- optional AES3 available

Main Power input:
- 5.5mm center positive
- 12VDC at 2 Amps
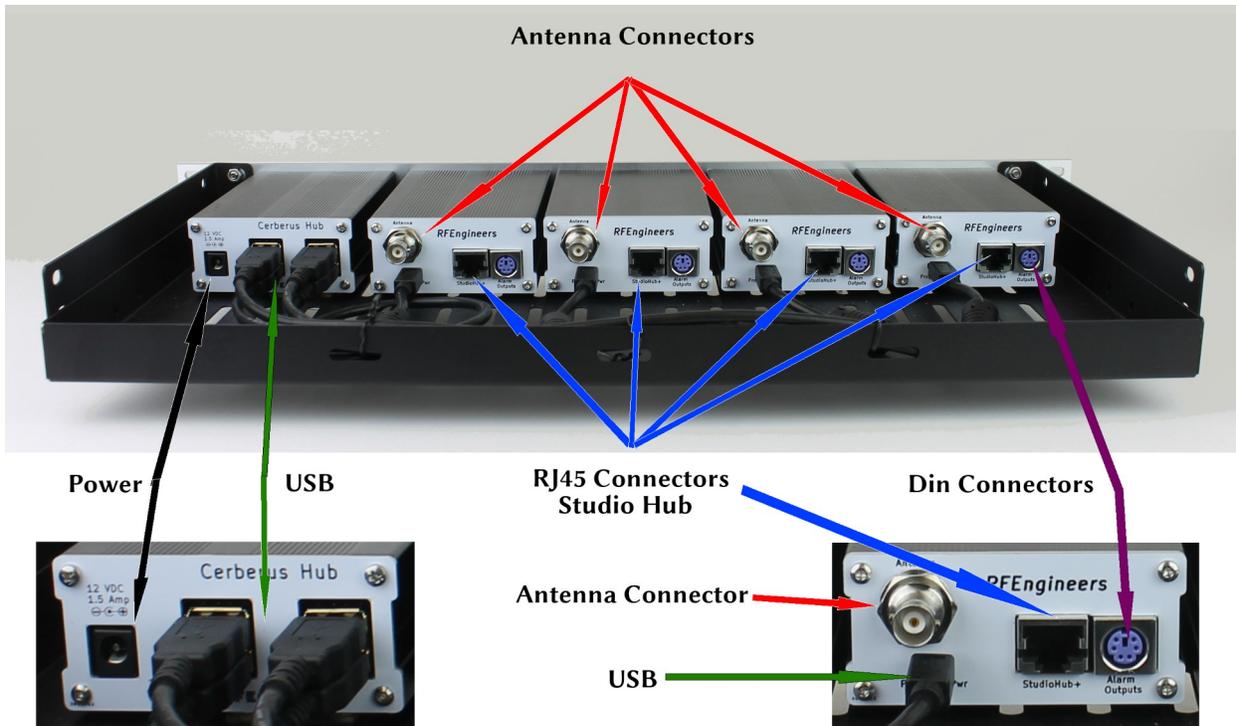
*Figure 2: Rear Panel Features*

Rear Panel Details

Mini DIN Connector Details

Each output is opto-isolated Darlington open-collector.

Limit collector Voltage to 30VDC max.

See LTV-845S datasheet for more details.

Pin 6 = Ground for outputs D, E & F   Pin 5 = Alarm output D
Pin 4 = Alarm output E   Pin 3 = Alarm output F
Pin 2 = Alarm output G   Pin 1 = Ground for output G
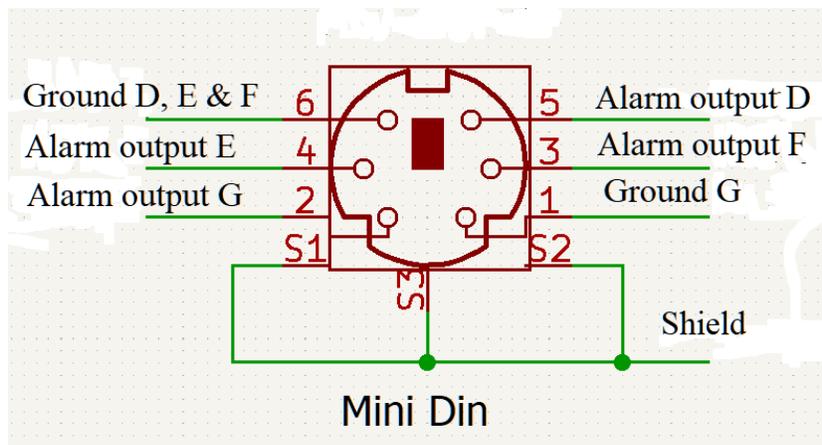
Figure 3: 6 Pin Mini DIN connector

Typical Alarm Application
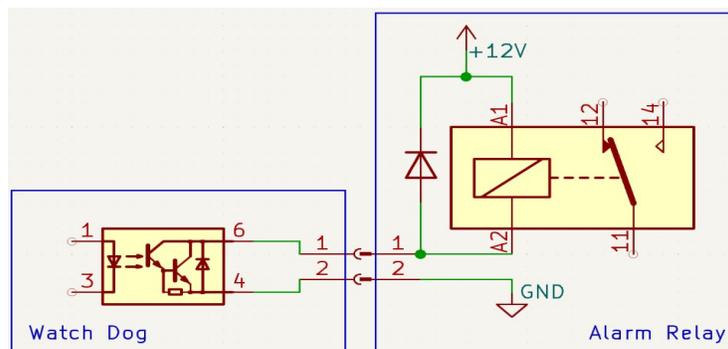
Figure 4: Alarm Relay Driver Example

StudioHub+ Connector Details
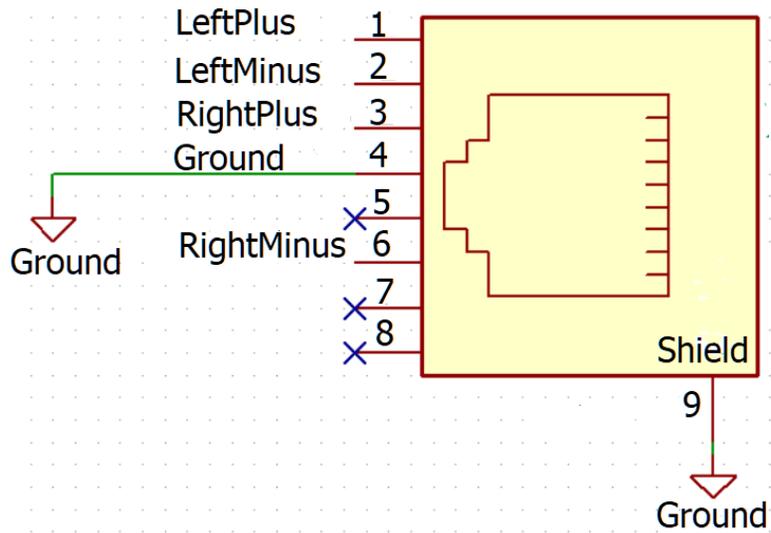
Figure 5: StudioHub+ connector Pinout (could use a better picture)

The WDC receiver's rear panel RJ45 connector is *balanced* (differential) audio. It should **NOT** be connected to an *unbalanced* load without proper matching devices. There are many sources of such matching devices and StudioHub+ adapters available from your favorite supplier.

IMPORTANT NOTE
We *strongly* advise using Shielded Twisted Pair (STP, not UTP) cable when interconnecting balanced devices in or near a dense RF environment.

Configuration and Monitoring with the Watch Dog Dashboard Software for Windows

Installing the Dashboard Software

1. Download the latest version of the *Watch Dog Dashboard* from

   http://www.RFEngineers.com/WDC

2. Double-click the downloaded installation file to install the software

3. Start the *Watch Dog Dashboard* by finding it in your Start Menu under *RFE Watch Dog Dashboard*

The easiest way to configure the WDC receiver is with the *Watch Dog Dashboard for Windows*.
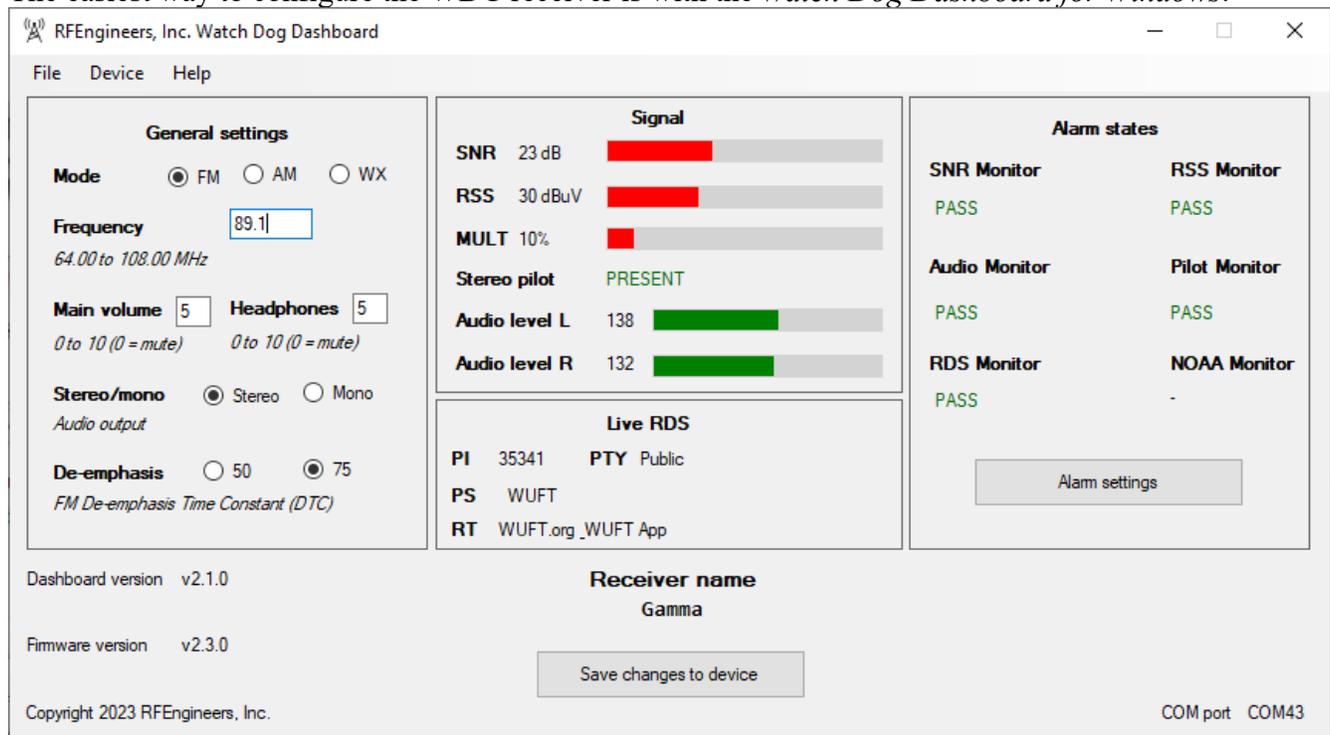
Figure 6: Watch Dog Dashboard connected to Gamma Receiver

Connecting the Dashboard to Cerberus

1. Connect the supplied USB-B cable between the Cerberus front-panel "Watch Dog Control" port and your computer.
   a) **NOTE: connecting to this port will cause the WDC receivers to power-cycle.** This is necessary to establish a USB connection to the receiver's micro-controller.
2. Start the *Watch Dog Dashboard* software
3. The program should automatically find all of the WDC receivers in your Cerberus.
4. Click on the *WDC* you wish to control.
   a) Each WDC has a unique name, Alpha, Beta, Gamma or Delta, identifying its position in the Cerberus. See *Device → Change Receiver Name* to select a different name for a receiver.
   b) To verify you are accessing the correct WDC the power LED currently under control will blink.
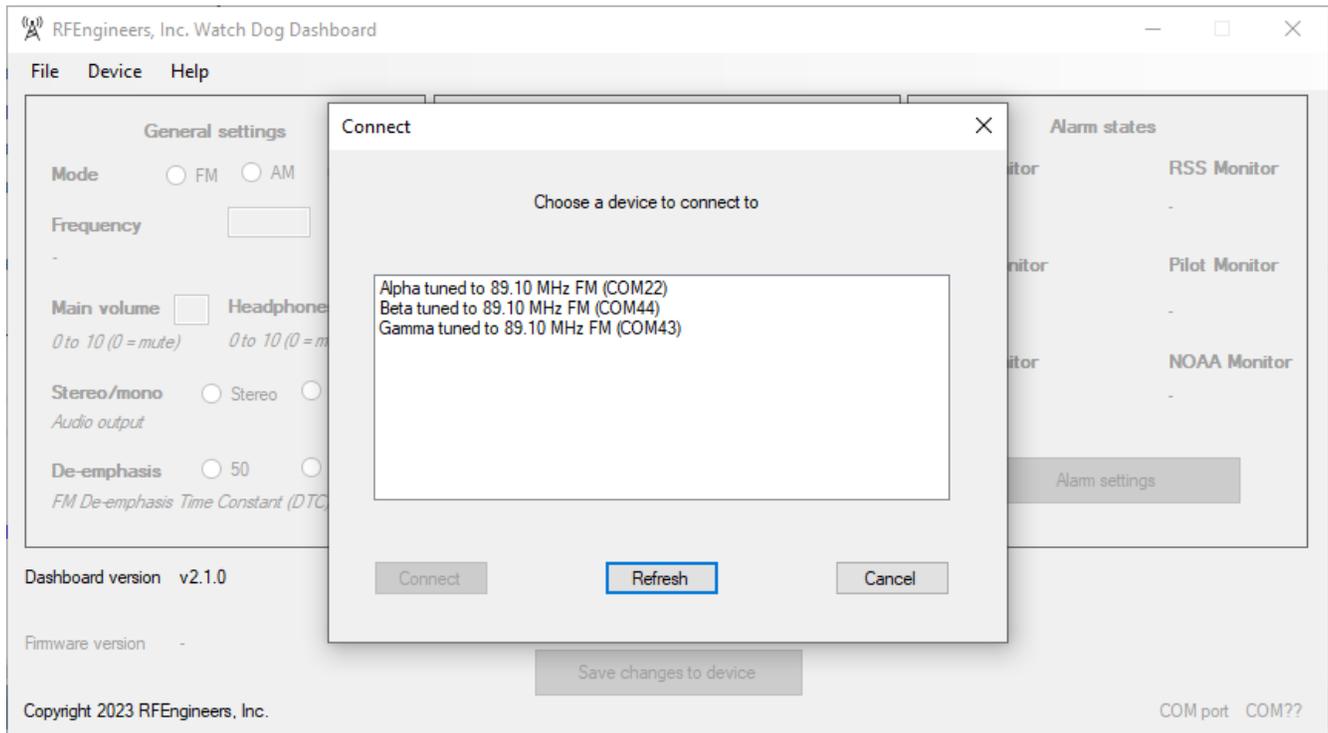
Figure 7: Connect to Device dialog.

Dashboard General Settings

The following receiver configuration parameters are accessible via the **General settings** pane of the Dashboard software:

- Receiver mode (FM, AM, or NOAA Weather)
- Frequency (FM or AM modes) or NOAA Weather channel number
- Main audio output level (0-10)
- Headphone audio output level (0-10)
- Stereo/mono audio output (FM mode only)
- FM De-emphasis Time Constant (DTC) (FM mode only)
- AM Bandwidth

Figure 8: Watch Dog Dashboard General Settings (on left)

Dashboard Alarm Settings

Alarm settings are accessed by clicking the "Alarm settings" button under the **Alarm states** pane of the Dashboard software. The WDC receiver has 6 built-in "monitors" for triggering alarms, based on configurable thresholds and configurable alarm output destinations.

Figure 9: Alarm Configuration dialog

Alarms and Monitors

Audio Monitor: Monitors the audio levels of the received (demodulated) signal
- The default assignment for LED B on the front panel.
- *Silence timeout* parameter specifies how many seconds of audio loss before entering alarm state.
- *Audio floor* parameter specifies the minimum audio level for considering audio to be present. The number used here is from the same scale as the audio level meters shown on the main Dashboard screen.

RSS Monitor: Monitors the Received Signal Strength (RSS) of the received signal.
- *Minimum RSS* parameter specifies the minimum RSS level before entering alarm state.
- *Low RSS timeout* parameter specifies how long the RSS level must be low before entering alarm state.

SNR Monitor: Monitors the Signal to Noise Ratio (SNR) of the received signal
- The default assignment for LED A on the front panel.
- *Minimum SNR* parameter specifies the minimum SNR level before entering alarm state.
- *Low SNR timeout* parameter specifies how long the SNR level must be low before entering alarm state.

Pilot Monitor: Monitors the presence of the pilot indicator (FM mode only)
- *Pilot loss timeout* parameter specifies how long the pilot indicator must be missing before entering alarm state.

RDS Monitor: Monitors the ongoing flow of RDS data (FM mode only)
- The default assignment for LED C on the front panel.
- *Data timeout* parameter specifies how long the RDS data must be "stalled" or missing before entering alarm state.

NOAA 1,050 Hz Monitor: Monitors the received audio for presence of the NOAA 1,050 Hz alert tone
- *Minimum duration* parameter specifies how long the alert tone must be present before entering alarm state

Alarm Output Assignment

The "output" of any "monitor" (the state of any alarm) can be sent to one or more alarm outputs. For example, the alarm state of the RSS, SNR, and RDS Monitors could be tied to alarm output B (the middle alarm LED on the WDC receiver's front panel) and the alarm state of the RDS Monitor tied to alarm output D (the first of 4 GPO alarm outputs). Any alarm output with more than one monitor tied to it will result in an OR condition: the alarm output will go high if ANY of the monitors go into alarm. A reset to factory defaults will return the front panel LED assignments to their default settings, see above.

Alarm Output Latching

An optional alarm latching period can be assigned, from 1-3,600 seconds (1 second to 1 hour). The latching period holds any alarm condition for an additional period of time after the condition clears.

No Windows? No Problem!

Don't have a computer running Microsoft Windows? No problem! See the *Receiver configuration and monitoring using the USB serial interface / API* section of this manual. Receiver configuration and monitoring using the USB serial interface / API

All features, and more, are available via the WDC receiver's extensive USB serial interface / Application Programming Interface (API). The USB serial interface / API provides a command-line interface for both power users and users without Windows computers. It is also a powerful interface for automating the use of the WDC receiver in a number of ways. More on that below.

Serial Connection Settings

Serial connections to the WDC receiver are made at 115,200 baud, 8 data bits, no parity, 1 stop bit (115200 8N1).

Serial Connection Programs

Popular programs for making a serial connection (terminal connection) to the WDC receiver include *Putty* (Mac OS X and Microsoft Windows) and *Minicom* (Linux). Plenty more information is available on these programs by doing a quick search of the Web.

```
HELP

MODE            Get current receiver mode
MODE FM         Set receiver mode to FM
MODE AM         Set receiver mode to AM
MODE WX         Set receiver mode to WX
FREQ            Get current frequency
FREQ <X>        Set frequency
                  - For FM mode, X must be between 64.0 and 108.0 MHz (6400 to
10800)
                  - For AM mode, X must be between 520 and 1710 kHz (520 to 171
0)
                  - For WX mode, X must be an NOAA Weather Radio channel number
 (1 to 7)
RSS             Display current Radio Signal Strength (RSS)
SNR             Display current Signal-to-Noise Ratio (SNR)
MULT            Display current Multipath value (FM mode only)
PILOT           Display current Pilot indicator value (FM mode only)
VOL             Get current volume level
VOL <X>         Set volume level to X (0-10, 0=MUTE)
VERSION         Get firmware version
FACTORYRESET    Reset all settings to factory defaults

SNRMONOUT       SNR Monitor: Get current alarm output settings
SNRMONOUT <X>   SNR Monitor: Set alarm output settings
                  - X is a 7-bit mask where the leftmost bit represents
                    alarm output A and the rightmost bit represents
                    alarm output G
                    i.e. SNRMONOUT 0001110 enables alarm outputs D, E, and F

AUDMONOUT       Audio Monitor: Get current alarm output settings
AUDMONOUT <X>   Audio Monitor: Set alarm output settings
                  - X is a 7-bit mask where the leftmost bit represents
```

Figure 10: Putty Serial Terminal Program controlling a WDC receiver.

Using the USB Serial Interface / API

Once connected to the WDC receiver via USB serial connection, simply type *HELP* to get a full and detailed listing of the various commands made available via the serial interface / API.

Example USB Serial Interface / API Commands

1. Send "MODE" to query the receiver's current mode
2. Send "MODE FM" to switch the receiver to FM mode
3. Send "FREQ 89100" to tune the receiver to 89.1 MHz
4. Send "RSS" to get the current Received Signal Strength (RSS) reading
5. Send "AUDMONOUT 0010000" to tie the Audio Monitor alarm output to alarm output C

Example USB Serial Interface / API Use Cases

There are a number of use cases for the WDC receiver's USB serial interface / API. These include:

- Don't have Microsoft Windows / Don't want Microsoft Windows?
  - The serial interface is a great alternative to using the *WDC Dashboard for Windows*
  - You can connect to the WDC receiver using any computer with a USB port and a serial terminal program

- Control by another machine / computer
  - The WDC receiver can be easily controlled by a computer program running on a computer with a USB connection to the receiver
  - Using a simple Python program, you could, for example, have a computer change the WDC receiver's frequency every 10 seconds, starting at 88.0 MHz and going up to 108.0 MHz in increments of 0.1 MHz before repeating; recording the time, frequency, and a sample of the RSS and SNR meters from the WDC at each frequency. This data could then be easily plotted on a graph, either later or in real-time.
  - You could also connect the WDC receiver to an existing Internet-reachable PC via USB at a tower site and then remotely control the WDC from its serial interface. You could also collect remote instrument readings this way (RSS, SNR, multipath, etc)
  - The alarm states of the WDC receiver can even be continually polled remotely with the right configuration
  - Another use could be reading the live RDS information over the serial interface and displaying it on a monitor or saving it to a log file

Some of those ideas sound really cool! But also overwhelmingly technical!
Do one or more of the above ideas sound interesting to you, but you aren't sure how to get started? Do you have your own unique use in mind for the WDC receiver but aren't quite sure how to get started with it? No problem! Send us an email at support@RFEngineers.com or visit our web contact page at http://www.RFEngineers.com/contact.html and we'll likely be able to get you pointed in the right direction.

Notes:

1: In order to establish a USB connection all WDC receivers will go through a short power cycle when the Cerberus front-panel USB interface is plugged into a powered computer. This will be indicated by the LEDs blinking on the Cerberus front panel.

2: Cerberus can NOT be powered from the front-panel USB connector. It must be powered from a 2A 12VDC power supply.