

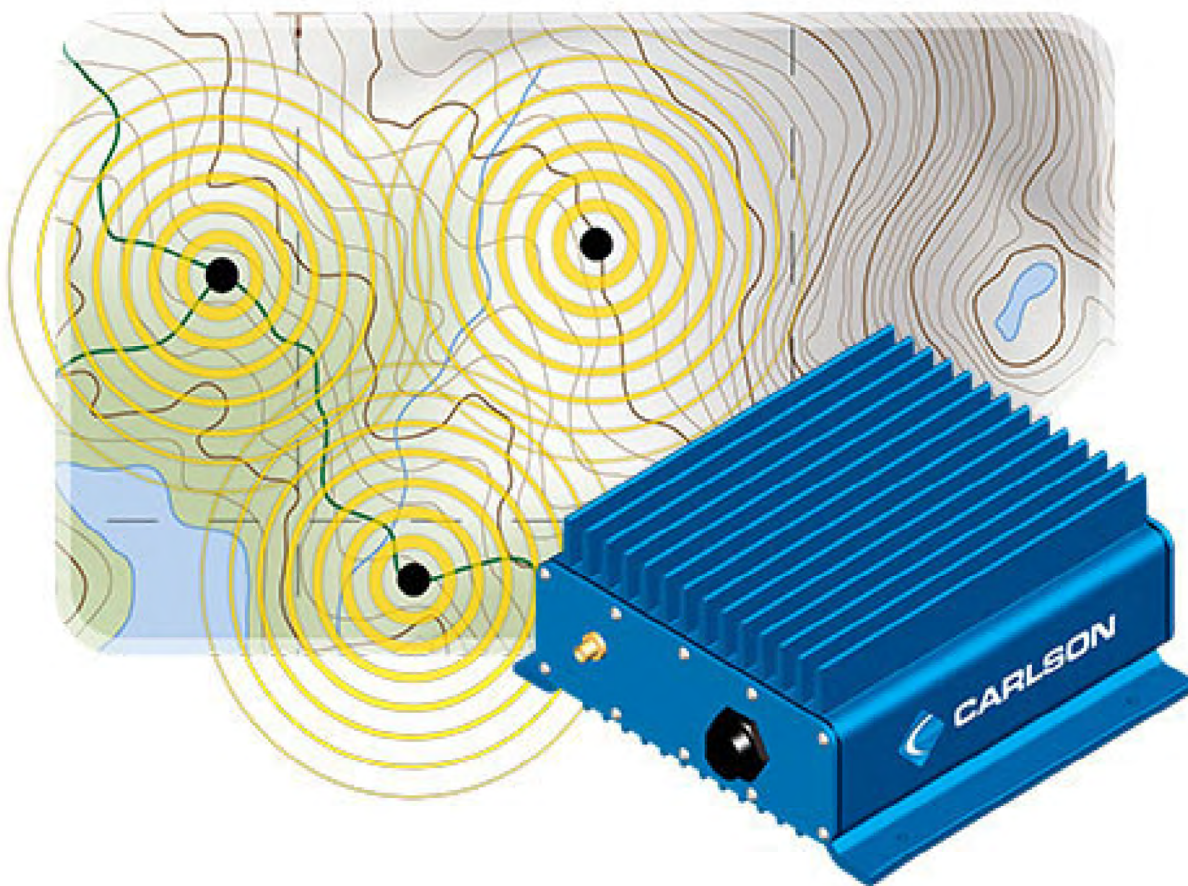
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# RuralConnect<sup>®</sup>

## TV White Space Radio

### Installation & User Guide



Carlson Wireless Technologies, Inc.  
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Revised December 2, 2013

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Carlson Headquarters: 2700 Foster Avenue, Arcata, CA 95521 USA

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Please contact the Carlson Sales Department for sales and/or application inquiries. Purchasers of Carlson products are required to make their own evaluations of product suitability for their specific application(s). Carlson's obligations regarding the use and/or application of our products and/or the use of this manual are limited to the terms set forth in the Standard Terms and Conditions of Sale for a delivered product.

### Technical Support

Training and support are only available for products purchased directly from Carlson; the purchaser is responsible for technical assistance for all other system components. Carlson Support is available from 7:30 AM to 4:30 PM Pacific Standard Time, excluding weekends and holidays.

Tel: +1 (707) 822-7000

Email: [support@carlsonwireless.com](mailto:support@carlsonwireless.com)

### Repair and Return

Carlson will replace or repair this product within one year from the date of shipment if it does not meet published specifications, or if it fails while in service due to a manufacturer's defect. You must obtain a return merchandise authorization (RMA) prior to returning equipment to Carlson. You can request an RMA on our web site at <http://www.carlsonwireless.com/support/rma-request.html>.

### Safety Warnings

In order to prevent personal injury, property damage, and/or equipment failure, it is essential that the installer employ appropriate safety measures when testing, installing, or maintaining RuralConnect® equipment. You are required to review all safety warnings in this manual prior to testing, installing, and/or maintaining the system.

### Qualified Personnel

Professionally trained service technicians are the only personnel qualified to perform the testing and/or configuration steps outlined in this manual. Technicians are responsible for adhering to all applicable safety regulations and industry-standard best practices. Carlson does not

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authorize non-qualified personnel to work on equipment without the direct supervision of a professionally trained service technician.

### Proper Handling and Grounding

The electronic components of the RuralConnect® equipment are sensitive to electrostatic discharge (ESD). In order to prevent potential warranty voiding damage, you must use an adequately grounded anti-static wrist strap when handling the equipment. It is also important to avoid the use of conductive tools. In order to prevent electric shock, always disconnect the remote power source and all cables from the system prior to disconnecting the grounding connection.

### Installation

You must never perform any installation work on a tower, mast, or rooftop during lightning storms or other inclement weather. Dangerous work of this nature could result in serious injury and/or death. It is important to adhere to all of the applicable local, state, and federal regulations pertaining to safety equipment and tower climbing practices.

### RF Hazards

Per FCC regulations, RuralConnect® systems must be installed in a manner that ensures a minimum of 40 centimeters (15.7 inches) separation between the antenna and any person. Failure to do so could result in a fine and/or personal injury.

### RF Exposure

The radio described in this manual transmits RF energy. The concentrated energy from the antenna may pose a health hazard. All antennas used with this radio must be installed to provide a minimum separation from all persons of 40 cm (15.7 inches). The above separation distance must be maintained at all times. More information can be obtained from the FCC at the following website:

[http://www.fcc.gov/Bureaus/Engineering\\_Technology/Documents/bulletins/oet65/oet65.pdf](http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf)

### Regulatory Compliance Information

Per Part 15 of the FCC regulations, the RuralConnect® operates within the specified limits of a Class A digital device. Those limits ensure reasonable protection from harmful interference when operating the equipment in a commercial setting. This system generates, utilizes, and may radiate radio frequency energy. Incorrect installation and/or equipment use inconsistent with the instructions in the manual may result in harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference in which case the user will be required to correct the interference at his or her expense.

RuralConnect® operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

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**Additional Information on TV Band Interference Protection**

This equipment has been tested and found to comply with the rules for TV band devices, pursuant to Part 15 of the FCC Rules. These rules are designed to provide reasonable protection against harmful interference. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna.
2. Increase the separation between the equipment and receiver.
3. Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
4. Consult the manufacturer, dealer or an experienced radio/ TV technician for help.

**FCC Registration Requirements**

Per FCC regulations; you must register your RuralConnect® system with a certified spectrum database (such as Spectrum Bridge) prior to performing any bench tests and/or completing the final installation. You will need a Special Temporary Authority (STA) if you are using uncertified experimental hardware or software.

**Compliance and US Regulatory Information**

FCC Identifier OPA-RC2  
FCC Part 15H 470-608 MHz (TV channels 14-36)  
FCC Part 15H 614-698 MHz (TV channels 38-51)

**Emission designators**

6 MHz channels      6M00F1D

**Declaration of Conformity**

Manufacturer's Name: Carlson Wireless Technologies Inc.  
Manufacturer's Address: 2700 Foster Ave, Arcata, CA 95521 USA

Declares that the product:

Product Name: RuralConnect®

Conforms to the following standard(s) or other normative document(s):

EMC:  
FCC Part 15.247 subpart H

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## 1. Introduction

### 1.1. Scope of Manual

The purpose of this manual is to provide professional planning and installation personnel with the appropriate information and procedures required to install and operate the RuralConnect® TV White Space Broadband Radio and accessory equipment. In order to avoid harm to persons or damage to the product, please ensure that you have read and understand the safety, unpacking, and installation sections before proceeding.

### 1.2. Overview

The RuralConnect® TV White Space Broadband Radio is designed to utilize “white space” spectrum in the 470-608 MHz (TV channels 14-36) and 614-698 MHz (TV channels 38-51) frequencies in order to provide reliable, high speed broadband for applications where traditional microwave solutions won’t provide adequate RF performance.



The system uses state of the art Single Carrier Frequency Domain Equalization (SC-FDE) to provide protection against signal fading caused by multipath interference (phase-shifting) while offering a robust clean transmit spectrum. Reflections from trees, buildings and hills are inevitable for long range wireless links. These reflections arrive at slightly different times, causing deep fading across the channels used by white space systems. Without equalization, this fading causes poor performance; even for links between devices that are theoretically in range. SC-FDE allows more flexible installations where obstructions and foliage are known factors. Combined with a proprietary adaptive equalization system, SC-FDE allows the system to correct for multipath fading. This ensures reliable connections even in mountainous, forested, and/or built-up areas where strong signal reflections are common.



Figure 2: RuralConnect® CPE Unit

In the U.S., the RuralConnect® is only available with a 6 MHz channel bandwidth. The system is fully compliant with FCC Part 15H regulations.

Our international models ensure worldwide compatibility, regardless of the TV broadcast technology in use. International users must ensure compliance with their regulatory authorities. For export only, international models are available in both 6 MHz and 8 MHz versions.

## 2. Pre-test and System Planning

### 2.1. Proper Handling

You must follow precautionary measures when handling RuralConnect® devices. Improper handling of your equipment may cause damage and void your warranty. The electronic

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components of the RuralConnect® equipment are sensitive to electrostatic discharge (ESD). Use adequate ESD protection, such as an anti-static wrist strap, whenever handling the equipment. It is also important to avoid the use of conductive tools.

### 2.2. Grounding

A ground is a low impedance electrical connection to the earth utilized for energy dissipation. Grounding the RuralConnect® is very important for safety reasons, as well as protecting the system from damage due to lightning and/or static charge build up. Since lightning strikes and surges are high-current and high-frequency events; short, straight ground wires (not coiled or looped) must be used. Choose the largest diameter ground wire your ground connectors will accept for good electrical conductivity. We recommended a #8 gauge copper wire or larger.

Utility company grounds, grounding rods, well casings, and cold water pipes constructed of continuous metal are strongly recommended. A note of caution: sometimes repaired and/or extended metal cold-water pipes include PVC sections hidden behind drywall. PVC will disrupt conductivity and render the pipe unacceptable as a ground. Conductivity is often poor in desert areas, so multiple ground rods may be required (preferably bonded together to make a suitable connection). The impedance of your grounding should never exceed 5 Ohms. Carlson recommends maintaining a ground with less than 3 Ohms. Undesirable grounds include, but are not limited to, sprinkler pipes, PVC pipes, conduit, and buried wire. Never use an unverified ground.

In order to prevent electric shock, always disconnect the remote power source and all cables from the system prior to removing the grounding connection.

### 2.3. Lightning Protection

Poorly grounded lightning protection is the same as having no protection at all!

Lightning is one of the most dangerous, yet most common, natural hazards for a RuralConnect® system. It is absolutely essential to install and maintain adequate lightning protection for your equipment. Verified ground connections are imperative for lightning protection to work correctly.

Primary lightning protection is located outside the enclosure. Install primary lightning protection with a good ground on all RF and/or data connections that have even a moderate outdoor line build-out. Best practices dictate all lines entering or exiting a building need protection. You must use protection on both ends of the cables between buildings! Contact your sales representative for detailed specifications and usage information for the primary lightning protection solutions available from Carlson.

In areas with frequent lightning activity, augmenting the client station install with a nearby lightning rod is strongly recommended. Lightning can be unpredictably strike, might miss the antenna mast altogether, and make contact with underlying wiring/cabling instead. Lightning discharges into the lowest impedance path to ground, i.e. earth. In many cases this will be the master ground in the primary AC panel, unless nearby grounding is installed.

### 2.4. Cable Recommendations

Use of proper high-quality cabling is important to ensure the best performance for your RuralConnect® system. Carlson extensively researched and tested cabling before selecting those offered for RuralConnect® customers. It is recommended that you use only Carlson approved cables. Discuss your cabling options with your Carlson Sales Representative.



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### 2.4.1. RF Cables

Carlson carries professional-grade RF coax cables that provide greater durability and less attenuation/loss than those readily available. We offer and recommend well-insulated 75-Ohm broadband coaxial cable with gas-injected foam polyethylene insulation. For short jumper connections, use 18 AWG RG-6/U cables with a solid .040" bare copper conductor. For longer runs, use 14 AWG RG-11 cables with a .064" bare copper conductor.

Only use cables with 100% solid copper center conductors. Lower-quality copper-clad conductors have decreased performance and can lead to failures.

75-Ohm cabling used for RuralConnect® installation cannot exceed 150-feet (45.72 meters). Terminate all coax cables with weather-sealed 75-Ohm F-type compression connectors with PVC jackets. Do not use crimp-type connectors.

Avoid cable bends as much as possible; do not put more than a 90-degree bend in any cable run.

### 2.4.2. Data Cables

Network performance is greatly affected by the quality of the data cabling used. Carlson carries and recommends shielded, grounded, outdoor Category-5 or higher twisted pair cable.

## 2.5. Recommended Tools

These are the tools needed to set up a RuralConnect® system. Make sure you have them handy to ensure a seamless installation.

- ESD gear
- Wrench set (Standard)
- Socket set (Standard)
- Screwdriver set (Phillips and Standard)
- Multimeter/multitester
- Wire cutters
- Wire strippers
- Vapor wrap
- Electrical tape

You will need an IBM PC-compatible computer (or equivalent virtual machine) equipped with the following:

- Microsoft Windows 7 or greater
- Microsoft .NET Framework 4.5
- At least 512 Megabytes (MB) of RAM
- Keyboard and mouse (or other compatible pointing device)
- Display adapter and monitor (1024x768 or higher resolution)
- 100/1000 Mbps Ethernet network adapter
- Pre-Installation

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### 2.6. Before Arrival

Users operate the RuralConnect® system from the Online Management Center, or OMC. After placing your order, and prior to receiving the equipment, you will need to have a registered OMC user account.

If you do not have an OMC account, visit <http://omc.neul.com> and click “register a new account”. You may wish to have multiple accounts for your employees. Send your new username(s) to Carlson Support, at [support@carlsonwireless.com](mailto:support@carlsonwireless.com).

Carlson will assign each account to a user group for your company, along with your desired set of permissions for each user/group.

*Please note: You will not be able to properly test or configure your RuralConnect radios until you have a registered OMC account.*

### 2.7. Unpacking

Before opening package(s), inspect them and report any damage to the shipping carrier. Per shipping insurance agreements, the shipping carrier is responsible for any damage to the equipment. Unpack and compare the contents against the packing slip and inspect everything for damage. Report any missing or damaged components to your Carlson Customer Service Representative.

### 2.8. Spectrum Database Registration

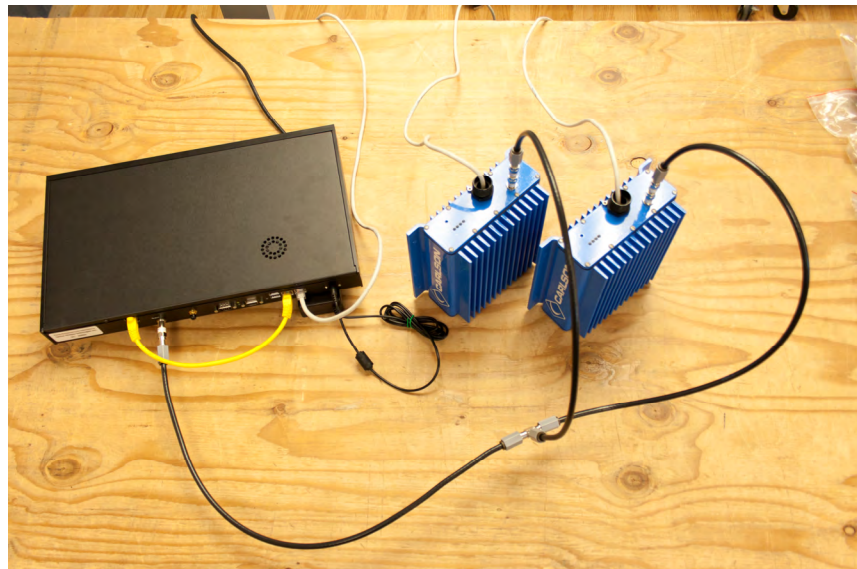
Unless registered with a Certified TVWS Database Administrator, it is necessary to apply for a Special Temporary Authority (STA) before conducting any over-the-air testing. If the fixed TVBD is moved to another location or if its stored coordinates become altered, the operator shall re-establish the device’s registration with the database based on the device’s new coordinates. Follow this link to apply for an STA:

<https://apps.fcc.gov/oetcf/els/forms/STANotificationPage.cfm>

*Note: Prior to powering your radios and conducting tests, you must have a list/map of allowable channels specific to the Basestation and CPE locations. Use the online Spectrum Bridge [Show My White Spaces](#) tool to get a list of channel available in your areas.*

### 2.9. Bench Testing

Prior to deploying your RuralConnect® units, it is important to become familiar with their operation and verify their functionality. The following section provides detailed instructions required for a complete bench test. Please contact Carlson Support if you require further information and/or assistance with that process.



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Warning: Never power up a unit without proper cabling and attenuation. You must have at least 60 dB of attenuation between RuralConnect® units. Failure to do so could result in system damage that may void the warranty.

### 2.9.1. Test Cable Set

The bench-testing cable set (“RC-TECH-KIT”) will allow you to bench test a Basestation with two CPEs. Connect the units with the supplied cables and connectors. This consists of a set of coax jumper cables (one for each unit), an F-type splitter and five 19 dB attenuators (one for the Basestation, two for each CPE).



Figure 3: Bench-Testing Cable Set

### 2.9.2. Setting up the Bench

Use the supplied yellow Ethernet patch cable to connect the radio’s Ethernet port to the Base controller board Ethernet port as shown in Figure 4.

For Internet access, connect the Basestation unit to a DHCP-enabled network via a standard Ethernet cable. Plug the Ethernet cable into the Ethernet port nearest to the power jack. Note the blue cable in Figure 5 as an example:



Figure 4: Basestation with Ethernet cable connected

Connect the Basestation unit’s power supply to its barrel-type power jack, as shown in photo.

Using a standard Ethernet cable (not supplied), connect each CPE unit to the “Out” connection of a POE injector as shown below:

Connect each unit to a power source.

Wait approximately 3-5 minutes for the system to initialize.



Figure 6: POE Injector Connections



Figure 5: Basestation Connections

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### 2.9.3. Getting Started on the OMC

You will use the Neul/Carlson Operation & Management Center to test and operate your RuralConnect® radios. Open a web browser and browse to <http://omc.neul.com>.

Enter your OMC user name and password. You should have an OMC account created by Carlson. The username will match your Carlson Customer ID. If you do not have a user account, you will need to create one and submit a request to have your radios assigned to your new account.

*Note: database requests take a minimum of 24 hours to process.*

On the Welcome page, click the “Stations” tab.

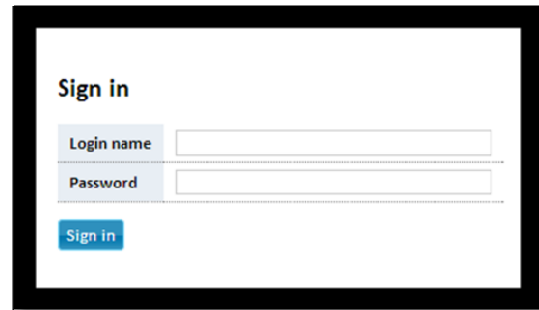


Figure 7: OMC Sign-In



Figure 8: OMC Shortcut Tabs

ID	Name	Guid	Description	Rtt	After-boot System	Type Id	Last Reported	Changeable	Controllable	Versions
CSB00069		c90d5766-bbb9-4240-a6ff-83088ccc8d05	Carlson Base 69 (Arcata Trial)	x	UMS 2013-03-R11		Last Seen 1m ago	✓	✓	Firmware: 16831 Variant: CW7185C rpgg: 14g Variant: NMAC041212_1454 Stack: 1.0.16830.0

Figure 9: Station Listing

Note: If you do not have any stations listed, contact Carlson Support.

Click on the named hyperlink for your Basestation (i.e., "CSB00123"), which will take you to the “Basestation Details” page.

**Basestation Details**

Name	CSB00069	Whitespace Provider	FixedChannelPropertyWhitespaceDatabase			
Description	Carlson Base 69 (Arcata Trial)	Frequency	Bandwidth	Max Tx Power	Start Time	Expiry Time
StationGuid	c90d5766-bbb9-4240-a6ff-83088ccc8d05	599 MHz	51xMHz	Infinity	2013-04-05 15:21:11Z	2013-04-06 15:22:10Z
AfterBootSystem	UMS 2013-03-R11	<a href="#">Force WSDb Query</a>				
Set for Reboot	<a href="#">Reboot</a>					

Buttons: Health, System Images, Fingerprints, Properties, Activity, Messages, Audit Log, Refresh, Open in New Window

Figure 10: Individual Basestation Detail

On the “Basestation Details” page, click the “Messages” tab.

ID	Generated	Received	Code	Message
602767	2013-04-04 23:17:44Z	2013-04-04 23:17:44Z	0	Completed Initialization.
602768	2013-04-04 23:17:41Z	2013-04-04 23:17:44Z	0	Radio Connected!

Figure 11: Messages Listing

The last few messages should include “Radio Connected!” and “Completed Initialization”.

Verify that the message dates and times are correct for system initialization.

If “Radio Connected!” and “Completed Initialization” messages are not displayed, then troubleshoot your Internet connection and/or wait another 3-5 minutes. If the system still fails to initialize, contact Carlson Support.

### 2.9.4. Verifying Geographical Coordinates

Click the “Properties” tab.

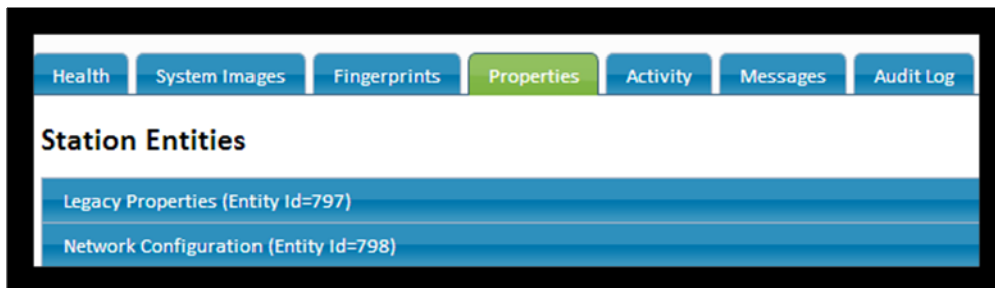


Figure 12: Properties Tab

Under “Station Entities”, select the “Legacy Properties” drop-down tab.

Scroll down to view latitude and longitude information.

Verify the latitude and longitude information is correct for the Basestation. Geographic coordinates shall be determined to an accuracy of ±50 meters by either an incorporated geo-location

Firmware	
deviceType	8
latitude	40.88377
longitude	-124.1053

capability or a professional installer.

Figure 13: Latitude/Longitude Settings

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If you find incorrect latitude and longitude information, contact Carlson Support or your spectrum database manager for correction.

Close the “Basestation Details” window.

### 2.9.5. Verifying Cell Control

At the top of the page, click the “Cell Control” tab.

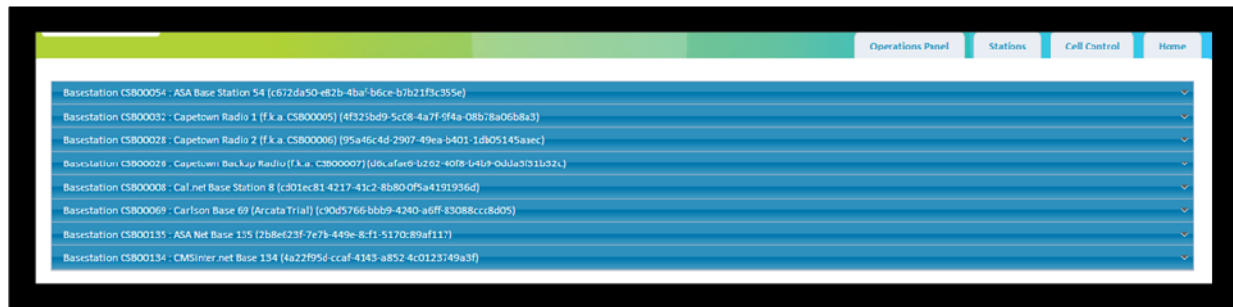


Figure 14: Cell Control Tab

Select the tab shown for your Basestation. Both the Basestation and its active CPEs will appear.

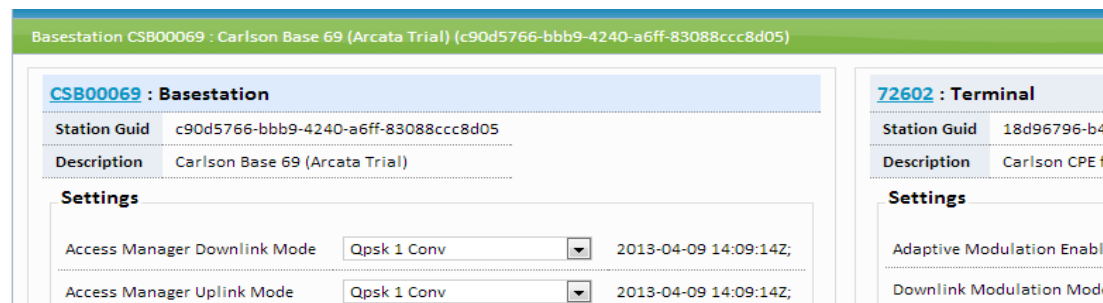


Figure 15: Cell Control - Basestation & CPEs

If the Basestation and CPEs do not appear, troubleshoot the Internet connection and/or wait another 3-5 minutes. If they fail to appear, contact Carlson Support for technical assistance.

Using a standard Ethernet cable (not supplied), connect a PC to the “IN” port of the POE injector connected to the first CPE.

Open a web browser and navigate to a webpage of your choice. A successful connection verifies the operational status of the link.

If you are unable to browse to a website, troubleshoot your Internet connection and/or wait another 3-5 minutes. If you need assistance, contact Carlson Support.

Repeat link verification steps for remaining CPE unit(s).

Once you have verified the operational status of every unit, congratulations! You have completed the first step in testing your new RuralConnect system.

Turn to Page 18 for more information about the Operation and Management Center (OMC).

## 2.10. RF Testing with RadioTest

Either on the bench or in the field, you can use the RadioTest software to test the RF performance of the radio. This software will provide you with accurate measurement of the signal-to-noise ratio (SNR), bit error rate (BER) and more.

### 2.10.1. Minimum System Requirements

Use of the RadioTest software requires two IBM-compatible PCs with the following:

- 1 GHz processor
- 512 MB of RAM
- Microsoft Windows 7 operating system
- Microsoft .NET Framework 4.5
- An Ethernet patch cable

### 2.10.2. Download the RadioTest Software

You may obtain the RadioTest software from our website by following the link below:

<http://www.carlsonwireless.com/applications/RadioTest/RadioTest.zip>

This section of the manual is under development. Visit the Carlson [Online Help Desk](#) if you have any questions.

## 3. Installation

### 3.1. Field Installation

#### 3.1.1. Professional Installers

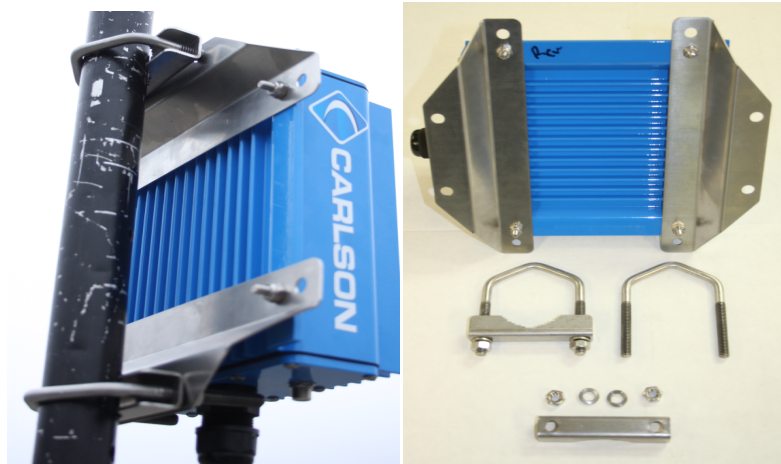
RuralConnect® radios can only be installed by professionally trained personnel.

#### 3.1.2. Antenna height and RF exposure warnings

RuralConnect® installations must adhere to all local, state, and federal regulations. Failure to follow those guidelines could result in costly fines, damage to the equipment, and/or inadequate RF protection for end users. Per FCC regulations; antennas used with fixed TV Band devices may not be more than 30 meters above ground level, or 250 meters above average terrain. All persons are required to maintain at least a 40 cm distance from the device; additional hardware may be required to ensure that separation. All regulatory compliance requirements related to the installation and operation of RuralConnect® devices are the sole responsibility of the operator.

#### 3.1.3. Installing RuralConnect® CPE units

Most CPE installs will use pole mounts for mounting RuralConnect® Tower Top units



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directly below the antenna (see Figure 16).

The pole mount clamp is reversible for a wide variety of mast sizes. Please note that the articulating bolts need to be tighter than you would expect in order to retain their position.

This section of the manual is under development. Visit the Carlson [Online Help Desk](#) if you have any questions.

Figure 16: CPE pole mount detail

### 3.1.4. Installing RuralConnect® Basestation units

Rack-mounted Basestations require 3U of 19" rack space.

This section of the manual is under development. Visit the Carlson [Online Help Desk](#) if you have any questions.

## 4. Configuration and Setup

This section of the manual is under development. Visit the Carlson [Online Help Desk](#) if you have any questions.

### 4.1. Basestation



Figure 17: Carlson Basestation

The Basestation is a 19" rack mountable device that will normally be installed in a weatherproof cabinet at or close to the mounting point for its external antenna. Suitable antennas are available from Carlson.

The Basestation connects to the internet via a standard Ethernet port, where it automatically obtains an IP address from a DHCP server. It encodes data from the Ethernet connection for transmission to one or more CPE units. It decodes transmissions from the CPEs and sends these to the internet.

Carlson designers have deliberately limited the number of physical controls on the Basestation. All of the control, configuration and management options of the Basestation are handled via the cloud-based OMC interface.



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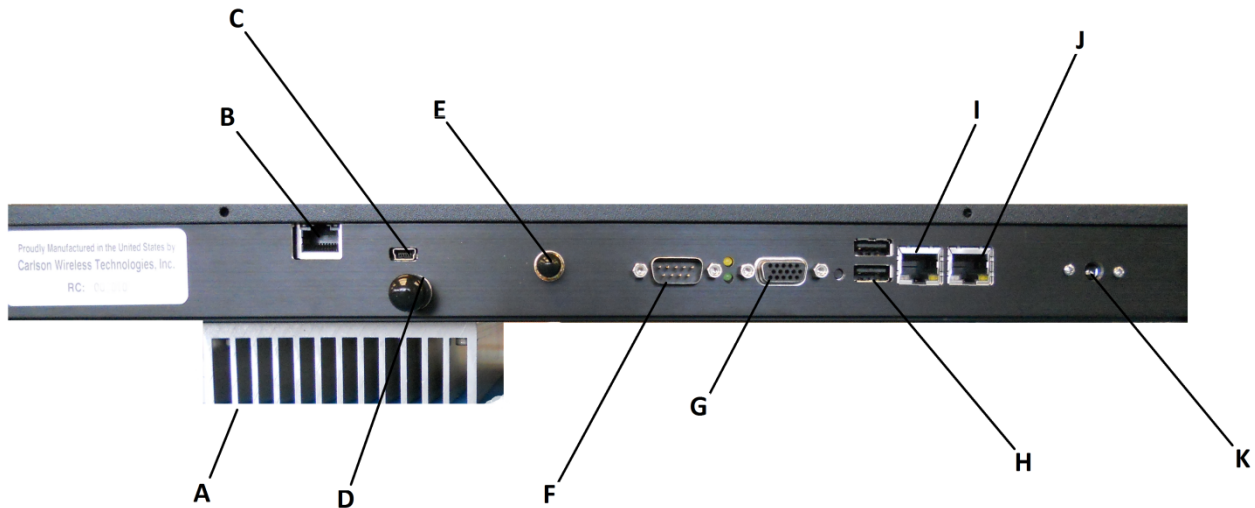


Figure 18: Carlson Basestation Rear Panel

The rear panel of the Basestation has the following ports:

- A. Heat Sink
- B. Radio Board Ethernet Port\*
- C. Mini USB Diagnostic Port (Unused)
- D. RF Port
- E. GPS Antenna Port
- F. Serial Port (Unused)
- G. VGA Port (Unused)
- H. USB Ports (Unused)
- I. Base Controller Board Ethernet Port\*
- J. Ethernet Port (Internet in/out)
- K. AC Power

\*Base Controller Board and Radio Card Connected via Ethernet Cable



Figure 19: Carlson Basestation Ethernet Cable Connections

## 4.2. CPE (Customer Premise Equipment)

The CPE, also call "Client Station", is installed at the subscriber's CPEs use external antennas that operate over the entire UHF ba Speak to your Carlson Sales Representative about the antenna s



Figure 20: RuralConnect® CPE

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CPEs connect to a Basestation via a UHF radio signal. Due to the unique propagation characteristics of signals in the UHF band, good connections are generally possible even if there is a non-line-of-sight path to the Basestation. Once a link to the Basestation is established, CPEs provide network access via a standard Ethernet connection.

The bottom plate of the CPE has an RF port, Ethernet port and four (4) RSSI LEDs.



Figure 21: RuralConnect® CPE Bottom

## 5. Operation and Management Center (OMC)

### 5.1. Registration

The Carlson/Neul Operation and Management Center (OMC) provides a cloud level view of all RuralConnect® devices registered under a given user name. You will use this online tool to manage your RuralConnect® network.

The RuralConnect® Basestation obtains and reports information to and from the OMC via the Internet. Regardless of the RF status, the OMC pushes settings to the Basestation, and polls its status. If the Basestation is offline during a configuration change, the OMC will apply those changes upon re-establishing a connection to the Basestation.

This user guide will provide you with all the information you need to operate your RuralConnect® system.

### 5.2. Signing into the OMC

Open your web browser and navigate to <http://omc.neul.com>.

At the sign-in screen, enter your login name and password.

Press Enter or click the “Sign in” button.

Your account(s) should be setup ahead of time. If you do not have an OMC account, click “Register a new account”. Enter a desired username and your email address. You must then send your username to Carlson Support, who will send a permissions request to allow access to your RuralConnect radios.

*Note: database requests take a minimum of 24 hours to process.*

If you do not remember your password, click “Retrieve forgotten login information”. You will receive an email with a verification link to gain access to your account.

Sign in

Login name	shamusjennings
Password	.....
<input type="button" value="Sign in"/>	

Figure 22: OMC Sign-In Screen

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### 5.3. Home Page

After logging in, you will see the Home page, displaying bulleted text hyperlinks to help you navigate to each section.

The OMC also has navigation tabs, available from any page. While browsing around the OMC, the “Home” tab will bring you back to this page.

### 5.4. Operations Panel

To access the Operations Panel, click on its link. This section of the OMC provides you with a high-level overview of your entire RuralConnect® network.

#### Welcome to the OMC

- [Operations Panel](#): Monitor and manage base stations and terminals.
- [Stations](#): Manage base stations and terminals.
- [Cell Control](#): Control base stations and terminals.

Figure 23: Home Page - Text Hyperlinks

#### 5.4.1. System Health

The first drop-down tab shown is “System Health”. This section displays the most recent messages and a status summary of your entire system.

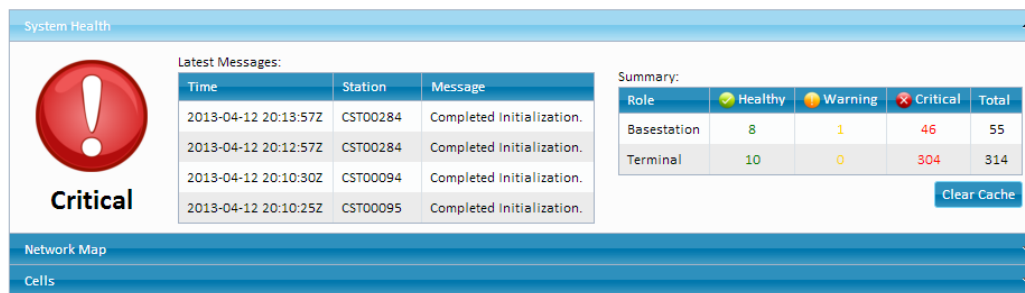


Figure 24: Messages

#### 5.4.2. Network Map

Click on the next drop-down tab, “Network Map”. This displays all your radios, based on the roles and coordinates of each.

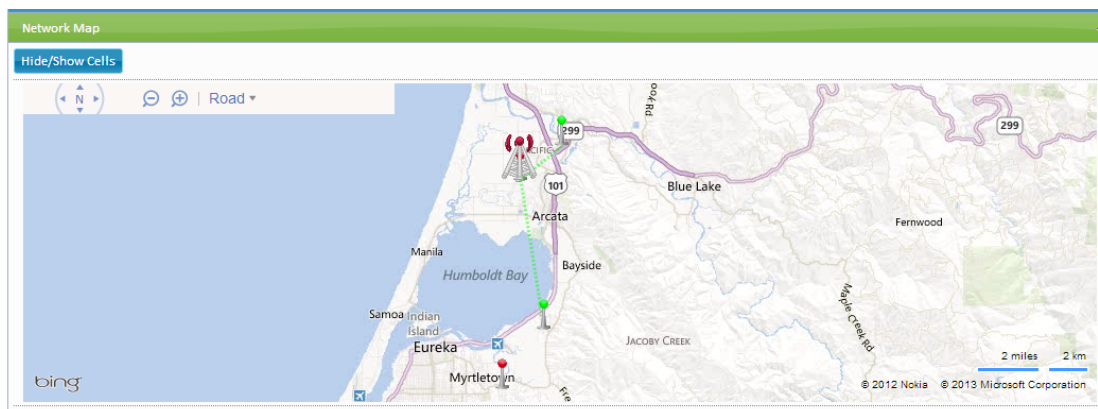


Figure 25: Network Map

The map displays Basestations with tower-like figures, and CPEs as smaller beacon-like figures.

### 5.4.3. Cells

Click on the “Cells” drop-down tab. This section displays each Basestation assigned to your account and the associated CPEs of each. You will see each station name, its Globally Unique Identifier (GUID), description and health.

To filter the list of Basestations, click on the filter icon next to any column heading. Enter any keywords you wish to search for and press Enter, or click the “Filter” button.

After a brief delay, you will see the results of your search.

Click on the arrow to the left of any Basestation. This will expand the “cell” list, showing associated CPEs.

Clicking the “Id” or “Name” hyperlink of any station will give you a popup “Station Properties” window. See Section 5.7 of this manual to learn more about Station Properties.

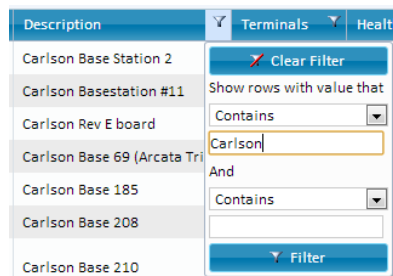


Figure 26: Filtering Choices

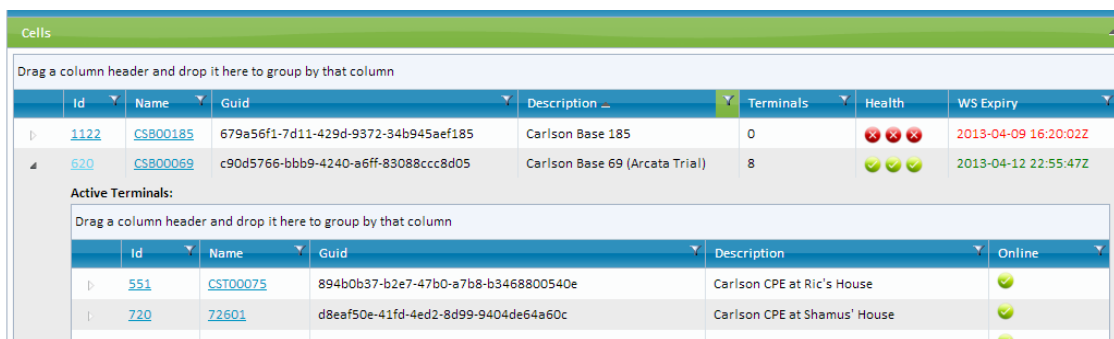


Figure 27: Expanded "Cell" List

## 5.5. Stations

Click on the “Stations” tab at the top of the OMC window.

This is a list of radios assigned to your account. The OMC will only display radios assigned to your account. If an expected radio does not appear in this list, you must make a request to Carlson Support for a database update.

Each radio will have a customized name and description. Unless requested otherwise, Carlson will use a default naming convention. Basestation names begin with “CSB”, followed by the serial number with one leading zero removed (i.e., “CSB00123”). CPE names begin with “CST”, using the same serial number syntax (i.e., “CST00123”).

The “Rbt” column shows if the

### Stations

ID	Name	Guid	Description	Rbt	After-boot S
620	CSB00069	c90d5766-bbb9-4240-a6ff-83088ccc8d05	Carlson Base 69 (Arcata Trial)	X	UMS 2013-C
1122	CSB00185	679a56f1-7d11-429d-9372-34b945aef185	Carlson Base 185	X	UMS 2013-C
551	CST00075	894b0b37-b2e7-47b0-a7b8-b3468800540e	Carlson CPE at Ric's House	X	

Figure 28: Stations Display

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Basestation is currently in a “soft-reboot” state, indicated by a checkmark. The radio is not accessible while in this state; access will resume upon successful completion of the boot sequence.

*Note: the Basestation boot process can take up to five (5) minutes or more.*

The “Last Reported” column displays the amount of time elapsed since your Basestation last reported state to the OMC. Active Basestations always report in less than one minute, indicated in green.

## 5.6. Cell Control

Click the “Cell Control” tab at the top of the OMC window.

The screenshot shows the OMC interface for Cell Control. It features two main panels. The left panel is titled 'CSB00069 : Basestation' and contains fields for 'Station Guid' (c90d5766-bbb9-4240-a6ff-83088ccc8d05) and 'Description' (Carlson Base 69 (Arcata Trial)). Below these are 'Settings' for 'Access Manager Downlink Mode' (Qpsk 1 Conv), 'Access Manager Uplink Mode' (Qpsk 1 Conv), and a 'Mute' checkbox. The right panel is titled '72602 : Terminal' and contains fields for 'Station Guid' (18d96796-b469-) and 'Description' (Carlson CPE for J). It also has 'Settings' for 'Adaptive Modulation Enabled', 'Downlink Modulation Mode', and 'Uplink Modulation Mode'. Both panels have a 'Save Changes' button at the bottom.

Figure 29: Cell Control Display

Cell Control is the area of the OMC where you can view and edit the settings affecting the performance of each radio.

As of April 13, 2013, this is the only area of the OMC where end users can make changes.

After making your desired changes, click the “Save Changes” button to apply them.

Use the “Mute” button to disable the radio on the Basestation. Place a check into the box to enable this feature. This will disable the Basestation radio. Your RuralConnect® network will not function with this feature enabled.

### 5.6.1. Modulation Modes

The performance of each RF link is determined by the signal quality and the modulation mode used. These drop-down menus allow you to select the modulation mode for both the uplink and downlink of each CPE. You can only change the setting for one station at a time. After making changes, press the “Save Changes” button. The changes will be applied and the Cell Control tab will reset.

Complex modulation types are at the top of the list, followed by simpler modulation types and various forms of forward error correction (FEC). Complex

This screenshot shows the 'Modulation Settings' for Basestation CSB00069. The 'Access Manager Downlink Mode' dropdown menu is open, displaying a list of modulation modes: Qpsk 1 Conv, -- Please Select --, Qam16 1 None, Qam16 1 Conv Punct, Qam16 1 Conv, Qpsk 1 Conv Punct, Qpsk 1 Conv, Bpsk 1 Conv Punct, and Bpsk 1 Conv. The 'Access Manager Uplink Mode' is set to Qpsk 1 Conv. The 'Mute' checkbox is unchecked. A 'Save Changes' button is visible at the bottom left of the settings area.

Figure 30: Modulation Settings

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modulations, such as quadrature amplitude modulation (QAM) provide a mechanism for higher bit rates, and thus more available throughput. These complex modulations, however, have a negative impact on the receive threshold of the radio, the signal level at which the link is unreliable.

Modulation modes are in order of net bit rate, with the highest bit rate at the top of the list. The effective throughput of an RF link is based on the net bit rate, less the PHY and link-layer overheads. Modulation modes in Cell Control include acronyms for modulation types and abbreviations for FEC types. “Conv\_Punct”, a 3/4 punctured convolutional coding rate, provides 25% FEC, reducing the available payload to 75% of the gross bit rate. “Conv” is a 1/2 convolutional coding rate. This 50% FEC produces a reliable communications channel, while reducing the available payload to 50% of the gross bit rate.

Basestations will commonly use “Qpsk\_1\_Conv” for the Uplink and Downlink modulation modes. This modulation mode provides a good link reliability and provides enough bandwidth for system controls

Set your CPE stations with the modulation mode that meets the needs of the installation and application. Stronger signal-to-noise ratios will allow the use of higher modulation modes, providing higher throughput. An SNR of 25 or greater will allow the use of QAM16 with FEC, while an SNR of 30 or greater is required before you can disable FEC (“QAM16\_None”).

For troubleshooting RF links with errors and/or poor signals, select a lower modulation mode.

An “Adaptive Modulation” button is available, which will enable dynamic control of the link modulation mode, to maintain link stability in varied conditions. Although this is useful feature, a fixed modulation type will provide better performance.

### 5.7. Station Properties

From many areas around the OMC, you can click on the “Id” or “Name” hyperlink of a station to open a “Station Properties” pop-up window. Clicking the ID will open a new webpage. Clicking the Name will open a pop-up window.

Basestations and CPEs have similar properties, along with sections unique to each role. The upper section includes the Stations Details. The lower section includes various tabs for each control and status area of the station.

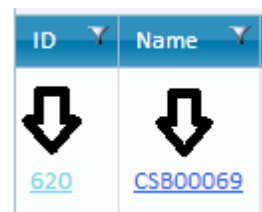


Figure 31: Station Links

#### 5.7.1. Basestation Details

##### Basestation 1661 Details

Name	CSB00524	Whitespace Provider	SpectrumBridgeTestWsdB
Description	FCC Testing Base 524	AfterBootSystem	UMS 2013W23
StationGuid	498edecd-fa34-4b01-8e71-72fed3015f94		
IP Address	65.125.25.69		

Reboot Restart Stack

Health Registration System Images Fingerprints Topology Properties Activity Messages Audit Log

Figure 32: Basestation Details

For smaller screens, you can maximize the window by clicking its header/title bar.

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Basestation Details include the name, description, GUID, IP Address, whitespace database provider. You will also see the “AfterBootSystem”, the boot image used to initialize the Basestation with the OMC upon establishing a connection.

You will also see two buttons. To perform a “soft reboot” of a Basestation, click the “Reboot” button. To restart the station software alone, without a reboot, click the “Restart Stack” button.

### Health

The first Station Properties tab, “Health”, is open by default, displaying the last reported date and time for each control interface. Basestations also report the current channel and channel allocations.

### Channel Allocations

The spectrum database provides a list of available channels, based on the registration details. The OMC displays the allocated channel is a list on this tab.

	Frequency	Bandwidth	Max Tx Power	Start Time	Expiry Time
Channel Allocations	587 MHz	SixMHz	Infinity	2013-11-21 15:04:51Z	2013-11-23 15:05:51Z
	593 MHz	SixMHz	Infinity	2013-11-21 15:04:51Z	2013-11-23 15:05:51Z
Current Channel	587 MHz				
Last WSDb Activity Timestamp	2013-11-21 15:05:50Z				
Last WSDb Activity Result	Success				
Last WSDb Registration	2013-11-18 19:21:34Z				

Figure 33: Channel Allocation

An active RuralConnect network requires an active channel allocation. You can find this information in other areas of the OMC, as well.

On the right of each channel listed, you will see the expiration, or “Expiry Time”. This is a color-coded indicator of the expiration of the channel allocation lease provided by the spectrum database. If the Basestation fails to acquire a new lease before the Expiry Time shown, it will cease transmission. The radio will not transmit until the OMC obtains a new channel allocation lease.

Underneath the channel allocations, you will also see the current channel and details of the last spectrum database activity results.

### Interfaces

Each radio has multiple network connections created for controls to and from the OMC. This value indicates the most recent date and time interface successfully established a connection to the station. If an Internet connection fails, these interfaces will fail to communicate. During such down time, the OMC cannot control the station, though local network functionality will continue until the channel

Interfaces		
	IBasestationChannelAllocationService	2013-11-21 15:54:22Z
	INetworkConfiguration	2013-11-21 15:54:18Z
	IRelayedFrameTap	2013-11-21 15:54:22Z
	ITraceReader	2013-11-21 15:53:40Z
	IM2MmessageToTerminal	2013-11-21 15:54:22Z
	IUmsCommands	2013-11-21 15:53:48Z

Figure 34: Interface Date/Time Stamps

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allocation lease expires.

Registration

The Registration Details include the station site coordinates, antenna height and your contact information. These fields are required for registration with the spectrum database.

Click the "Edit" button, fill out all the fields and then click the "Confirm" button.

Activity

Click on the "Activity" tab to view the RF network history of the RuralConnect Basestation.

This is a list of all currently and recently active CPE connections, listed by GUID. On the right, a bar graph indicates the timeline of each active CPE connection. Click and drag this timeline to scroll it left and right, viewing the history of these connections.

Registration Details	
Latitude (decimal degrees)	39.9907
Longitude (decimal degrees)	-76.7646
Antenna Height (metres AGL)	30
Contact Name	Jim Carlson
Contact Phone	707-822-7000 x106
Contact Email	<a href="mailto:jcarlson@carlsonwireless.com">jcarlson@carlsonwireless.com</a>
Street	2700 Foster Ave
City	Arcata
State/County	CA
Zip/Postal Code	95521
Country	US

Figure 35: Base Registration Details

<a href="#">72623 (897651d3-0bb0-40b4-8b95-d0f35beea767)</a>	
<a href="#">72615 (2b2f1c1c-cb31-47f9-aa2a-a3f7d600d5db)</a>	
<a href="#">CIT00110 (f16a5c1f-f9fe-49b3-a3ef-5cb14f9eed82)</a>	

Figure 36: Active Terminals

5.7.2. CPE Properties/Details

This screen displays the name, description, GUID and spectrum database provider.

Terminal 1873 Details

Name	75981	Whitespace Provider	SpectrumBridgeDemoWsdB
Description	Carlson Arcata CPE 75981 @ Shamus'		
StationGuid	536a58b6-a087-4c18-88e7-93c69456df32		

Figure 37: CPE Details

Click the "Reboot" button to reboot the CPE from this screen.

Health

The first Station Properties tab, "Health", is open by default, displaying the last reported date and time for each control interface. Stations also report the current channel and channel allocations.



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### Registration

The Registration Details include the station site coordinates, antenna height and your contact information. These fields are required for registration with the spectrum database.

Click the “Edit” button, fill out all the fields and then click the “Confirm” button.

### Channel Allocations

The spectrum database provides a list of available channels, based on the registration details. The OMC displays the allocated channel is a list on this tab.

Registration Details	
Latitude (decimal degrees)	39.9907
Longitude (decimal degrees)	-76.7646
Antenna Height (metres AGL)	30
Contact Name	Jim Carlson
Contact Phone	707-822-7000 x106
Contact Email	<a href="mailto:jcarlson@carlsonwireless.com">jcarlson@carlsonwireless.com</a>
Street	2700 Foster Ave
City	Arcata
State/County	CA
Zip/Postal Code	95521
Country	US

Figure 38: CPE Registration Details

Channel Allocations	Frequency	Bandwidth	Max Tx Power	Start Time	Expiry Time
	587 MHz	SixMHz	Infinity	2013-11-21 15:04:51Z	2013-11-23 15:05:51Z
	593 MHz	SixMHz	Infinity	2013-11-21 15:04:51Z	2013-11-23 15:05:51Z

Current Channel	587 MHz
Last WSDb Activity Timestamp	2013-11-21 15:05:50Z
Last WSDb Activity Result	Success
Last WSDb Registration	2013-11-18 19:21:34Z

Figure 39: CPE Channel Allocations

On the right of each channel listed, you will see the expiration, or “Expiry Time”. This is a color-coded indicator of the expiration of the channel allocation lease provided by the spectrum database. If the CPE fails to acquire a new lease before the Expiry Time shown, it will cease transmission. The radio will not transmit until the OMC obtains and allocates a list of available channels.

Underneath the channel allocations, you will also see the current channel and details of the last spectrum database activity results.

### Interfaces

Each radio has multiple network connections created for controls to and from the OMC. This value indicates the most recent date and time each interface successfully established a connection to the station. If an Internet connection fails, these interfaces will fail to communicate. During such down time, the OMC cannot control the station, though wireless network functionality will continue until the channel allocation lease expires.

Interfaces	Last Reported
IM2MmessageToTerminal	2013-11-21 16:20:00Z
IUmsCommands	2013-11-21 16:19:38Z
INetworkConfiguration	2013-11-21 16:20:00Z

Figure 40: Interfaces Last Reported

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Performance

This tab provides a line graph of the uplink and downlink SNR history for the CPE.

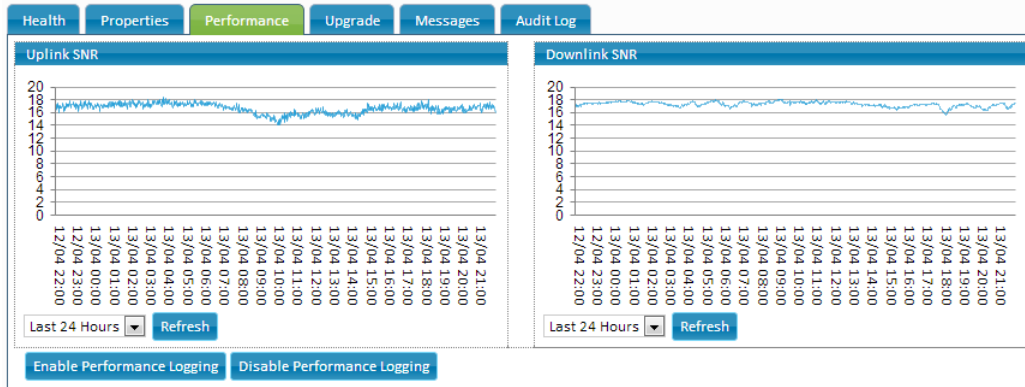


Figure 41: SNR History Graph

The drop-down menu allows a choice of timelines. Click “Enable/Disable Performance Logging” to start/stop the log,

## 6. Appendices

### 6.1. Specifications

#### SYSTEM SPECIFICATIONS

Frequency Bands	UHF 470-786 MHz (US and ETSI)
Channel Spacing	6 MHz (US), 8 MHz (ETSI)
Bandwidth	100 kHz (M2M) to 4.5 MHz (Rural BB)
Modulation	QPSK, 16QAM
Data Rates	4, 6, 8, 12, and 16 Mb/s
Data Rate Control	Dynamic or fixed
Receive Interface	Proprietary technology is used to reduce co-channel interference
RX Sensitivity	-89 dBm for 10 <sup>-6</sup> BER using QPSK 1/2 -86 dBm for 10 <sup>-6</sup> BER using 16QAM 1/2
RX Blocking Resistance	-50dBm TV transmission on chan N+2 -20 dBm cellular station transmissions
RX Max Signal	-16dBm with full linearity
Operating Mode	TDD (Time Division Duplexing)
User Ports	10/100 baseT Ethernet
Warranty	Limited Warranty, USA

#### NETWORK SPECIFICATIONS

Multipoint Client Capacity	4096 (M2M)
Typical Client Loading Management	20 clients with 3Mb/1Mb residential SLA
End-to-End Latency	Web-based browser using https interface 30-100 ms typ.

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**REGULATORY SPECIFICATIONS**

ACP and Spectrum Mask Meets FCC and Ofcom specifications  
-55 dBr +/- 3 MHz relative to 12.2 dBm  
(measured at 100 KHz increments)

**ENVIRONMENTAL SPECIFICATIONS**

Operating Humidity Operating Temperature -30° to 55° C  
Shock and Vibration Up to 95%, non-condensing  
MIL-STD-810

**SECURITY**

Security Mechanism WPA2/AES-128 bit shared secret key

**BASESTATION**

Antenna System SISO with MIMO Space Diversity option  
Antenna Connector "F" type female 75 Ohms

**MECHANICAL SPECIFICATIONS**

Unit Dimensions 19.6" x 6" x 1.75"  
Enclosure Material Painted steel  
Weight 5 lbs  
Mounting 19 inch EIA 2 unit rack

**POWER - INDOOR RACK MOUNT**

Voltage 100-240 VAC, 50-60 Hz or 12 VDC  
Current Tx: 30W, Rx: 15W, Idle: 13W  
Connector POE

**6.2. Warranty**

Carlson Wireless Technologies, Inc. or Carlson Wireless USA, collectively referred to as "Carlson"), will repair this product with new or rebuilt parts, free of charge, in the USA or Puerto Rico for one (1) year from the date of original purchase in the event of a defect in material or workmanship. You can obtain mail-in service in the USA during the warranty period from a Carlson Factory Service Center by visiting <http://www.carlsonwireless.com/support/rma-request.html> for an RMA (Return Materials Authorization) number. After receiving your RMA number, ship your product adequately packed, postage paid and insured to the address provided. This warranty extends to the original purchaser only. A purchase receipt or other proof of the date of original purchase will be required before the rendering of warranty services. This warranty only covers failures due to defects in materials or workmanship, which occur during normal use. It does not cover damages incurred in shipment or failures caused by products not supplied by Carlson. It also does not cover failures which result from accident, misuse, abuse, neglect, mishandling, misapplication, alteration, modification, lightning, power line surge, introduction of sand, dust, humidity and/or liquids, or service by anyone other than a Carlson Factory Service Center or authorized Carlson Service Center, or damage that is attributable to acts of God.

**Limits and Exclusions**

There are no express warranties except as listed above.

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CARLSON SHALL NOT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF THIS PRODUCT OR ARISING OUT OF ANY BREACH OF THIS WARRANTY. ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED TO THE APPLICABLE WARRANTY PERIOD SET FORTH ABOVE.

Some states do not allow the exclusion or limitation of incidental or consequential damages or a limitation on how long an implied warranty lasts, so the above exclusions or limitations may not apply to you. This warranty gives you specific legal rights. You may also have other rights, which vary from state to state. If a problem with this product develops during or after the warranty period, you may contact your dealer or service center.

### 6.3. Acronyms/Abbreviations

API	application programming interface
CPE	Customer Premises Equipment (Client Station)
dB	decibel
EMC	electromagnetic compatibility
ESD	electrostatic discharge
FTDI	Future Technology Devices International
GUI	graphical user interface
IP	Internet protocol
LAN	local area network
OMC	Operations and Management Center
OSHA	Occupational Safety and Health Administration
QAM	Quadrature amplitude modulation
RF	Radio frequency
RG-11	75 ohm cable standard (1.63 mm core with triple/quad shielding)
RG-6/U	75 ohm cable standard (1.0 mm core with double shielding)
RMA	return material authorization
Rx	receive
SC-FDE	Single Carrier Frequency Domain Equalization
STA	Special Temporary Authority
SU	subscriber unit
Tx	transmit
USB	Universal Serial Bus

### 6.4. Glossary

#### Access Point

An access point is a device that allows a wireless device (or multiple devices) to connect to a network (or the Internet).

#### Attenuation

Amplitude reduction of an electrical signal.

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**bps**

Bits per second, the rate of at which data is transmitted.

**Byte**

A digital “word” usually made up of eight bits.

**CPE**

Customer Premise Equipment, or “Client Station”; an endpoint, usually at a customer’s location, that connects to a network (or the Internet) via an access point

**Ethernet**

A set of computer networking technologies for local area networks (LANs).

**IP**

Internet protocol provides for transmitting blocks of data between hosts identified by fixed-length addresses.

**LAN**

Local area network, a privately owned network that offers high-speed communications channels connecting information processing equipment in a limited geographic area.

**Modulation**

Any of several techniques for combining user information with a transmitter carrier signal.

**Packet**

Data encapsulated with control information. The three principal elements of a packet include the header, text, and trailer bits (for error detection and correction). A header contains the data needed to route the packet through a network to its final destination.

**Quadrature amplitude modulation (QAM)**

A modulation method that conveys two bit streams by changing the amplitudes of two carrier waves.

**Router**

A network device used to forward data between multiple networks.

**Single Carrier Frequency Domain Equalization (SC-FDE)**

An alternative to solve the common multipath issues associated with commonly-used OFDM systems. This advanced carrier technique improves performance of a non-line-of-sight wireless system, allowing the RuralConnect® to deliver high-speed Internet access to areas where traditional wireless technologies will not operate.

**Single Carrier Frequency Division Multiple Access (SC-FDMA)**

A frequency-division multiple access scheme that deals with the assignment of multiple users to a shared communication resource.

**Special Temporary Authority (STA)**

A type of broadcast license which temporarily allows a broadcast station to operate outside of its normal technical or legal parameters.

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## 6.5. Useful URLs

Carlson provides the following URLs for reference purposes only. This is not a comprehensive source for this information. The purchaser must be familiar themselves with all relevant safety and/or regulatory information prior to the operation of a RuralConnect® system. Carlson does not authorize untrained and/or unqualified personnel to work on the system without the supervision of a qualified technician.

### FCC Experimental License Application License for TVWS Device Operation

<https://apps.fcc.gov/oetcf/els/forms/STANotificationPage.cfm>

### US Federal Regulations

Title 47: Telecommunications

[http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title47/47tab\\_02.tpl](http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title47/47tab_02.tpl)

Part 15: Radio Frequency Devices

<http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr;sid=f1da62e9cb3d6edca075f32556594ab7;rgn=div5;view=text;node=47%3A1.0.1.1.16;idno=47;cc=ecfr>

Subpart H: Television Band Devices

<http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=ec1bcacee1c437294c3e48e0acb755b&rgn=div6&view=text&node=47:1.0.1.1.16.8&idno=47>

### Spectrum Registration

FCC information regarding White Space Database Administration

<http://www.fcc.gov/encyclopedia/white-space-database-administration>

### ESD Protection

General information

[http://en.wikipedia.org/wiki/Electrostatic\\_discharge](http://en.wikipedia.org/wiki/Electrostatic_discharge)

ESD Association

<http://www.esda.org/>

IPC: Association Connecting Electronics Industries

<http://www.ipc.org/default.aspx>

### Cable information

General Coaxial Cable information

[http://en.wikipedia.org/wiki/Coaxial\\_cable](http://en.wikipedia.org/wiki/Coaxial_cable)

General F Connector information

[http://en.wikipedia.org/wiki/F\\_connector](http://en.wikipedia.org/wiki/F_connector)

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Weatherproofing RF connections

<http://www.dxengineering.com/pdf/WeatherProofingCoax-TechTip.pdf>

**RF Safety information**

FCC: Radio Frequency Safety

<http://transition.fcc.gov/oet/rfsafety/ef-faqs.html>

VHF/UHF Exposure information/warnings

<http://transition.fcc.gov/oet/rfsafety/ef-faqs.html#Q17>

**Tower Safety information**

Tower installation crews MUST be; adequately trained, licensed, and properly equipped with all of the safety equipment required by law. Failure to follow federal and/or local regulations may result in; warranty voiding equipment damage, personal injury, fines, and/or the loss of applicable licenses. Information provided here is strictly for reference purposes.

OSHA Guidelines: Part 1910 - Occupational Safety and Health Standards

[http://www.osha.gov/pls/oshaweb/owasrch.search\\_form?p\\_doc\\_type=STANDARDS&p\\_toc\\_level=1&p\\_keyvalue=1910](http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=1910)

General Tower Safety Guide

[http://homepower.com/view/?file=HP128\\_pg66\\_Woofenden](http://homepower.com/view/?file=HP128_pg66_Woofenden)

General TV White Space information

[http://en.wikipedia.org/wiki/White\\_spaces\\_\(radio\)](http://en.wikipedia.org/wiki/White_spaces_(radio))

General IEEE 802.22 information

[http://en.wikipedia.org/wiki/IEEE\\_802.22](http://en.wikipedia.org/wiki/IEEE_802.22)

**Manufacturer Information**

Carlson Wireless Technologies, Inc

<http://www.carlsonwireless.com/>

Neul Ltd

<http://www.neul.com/>

**6.6. Manual Revision Notes**

Revision History

Rev 1.5.	January 2013	Development draft
Rev 1.6.	April 2013	Preliminary release draft
Rev 1.74	June 2013	New OMC release, removed a few tabs
Rev 1.74c	November 2013	Overview, Current & Allocated Channels
Rev 1.74d	December 2013	Verified mandatory FCC language