CR-SEH & CR-SEH/X
Wireless Ethernet Bridge

User's Manual

CIRRONET™

Important Regulatory Information

Cirronet Product FCC ID: HSW-2411
IC 4492A-2411

Note: This unit has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their expense.

FCC s MPE Requirements

Information to user/installer regarding FCC s Maximum Permissible Exposure (MPE) limits.

Notice to users/installers using the 24 dBi parabolic dish antenna in conjunction with all Cirronet RF products.

*FCC rules limit the use of this antenna, when connected to Cirronet RF products for **point-to-point applications only**. It is the responsibility of the installer to ensure that the system is prohibited from being used in point-to-multipoint applications, omni-directional applications, and applications where there are multiple co-located intentional radiators transmitting the same information. Any other mode of operation using this antenna is forbidden.*

Notice to users/installers using the following fixed antennas, with Cirronet RF products:

Andrews 24dBi parabolic dish Andrews 18dBi parabolic dish Cushcraft 15dBi Yagi, Mobile Mark 14dBi Corner Reflector, Mobile Mark 9dBi Corner Reflector	The field strength radiated by any one of these antennas, when connected to Cirronet RF products, may exceed FCC mandated RF exposure limits. FCC rules require professional installation of these antennas in such a way that the general public will not be closer than 2 m from the radiating aperture of any of these antennas. End users of these systems must also be informed that RF exposure limits may be exceeded if personnel come closer than 2 m to the apertures of any of these antennas.

Notice to users/installers using the following mobile antennas, with Cirronet RF products:

Mobile Mark 12dBi omni-directional, Mobile Mark 9dBi omni-directional, MaxRad 5dBi whip, Cirronet Patch antenna, Ace 2dBi dipole, Mobile Mark 2dBi Stub	The field strength radiated by any one of these antennas, when connected to Cirronet RF products, may exceed FCC mandated RF exposure limits. FCC rules require professional installation of these antennas in such a way that the general public will not be closer than 20 cm from the radiating aperture of any of these antennas. End users of these systems must also be informed that RF exposure limits may be exceeded if personnel come closer than 20 cm to the apertures of any of these antennas.

Declaration of Conformity

CE **0889** ①

① Warning! The RLAN transceiver within this device uses a band of frequencies that are not completely harmonized within the European Community. Before using, please read the European Operation Section of the Products User's Guide for limitations.

0889 is the identification number of RADIO FREQUENCY INVESTIGATION LTD - Ewhurst Park, Ramsdell RG26 5RQ Basingstoke, United Kingdom – the Notified Body having performed part or all of the conformity assessment on the product.

The WIT2411 to which this declaration relates is in conformity with the essential requirements of the R&TTE directive 1999/5/EC and complies with the following standards and/or other normative documents:

For Interfaces

EN 55022
EN 55024

For RLAN Transceiver

EN 300 328
EN 301 489 -1, -17
EN 60950

Canadian Department of Communications Industry Canada (IC) Notice
Canadian Department of Communications Industry Canada (IC) Notice
This apparatus complies with Health Canada's Safety Code 6 / IC RSS 102.
"To prevent radio interference to the licensed service, this device is intended to be operated indoors and away from windows to provide maximum shielding. Equipment (or its transmit antenna) that is installed outdoors may be subject to licensing."

ICES-003
This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of Industry Canada.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de Classe B prescrites dans le règlement sur le brouillage radioélectrique édicté par Industrie Canada.

WARNING!!

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For our Customers who wish to use this product in hazardous locations.

This CR-SEH, CR-SEHX has been tested by Underwriters Laboratories Inc. for use in Class I, Division 2, Groups A, B, C, and D Hazardous Locations as specified in UL1604 and UL/C-UL/Zones(UL2279).

Such areas *may* **have Explosive Gases**.

To install the CR-SEH, CR-SEHX in this environment the following steps **must** be implemented.

1) The power supply used with the product **must** be a UL Class 2 rated device.
2) Contract a Qualified Licensed Electrician to install and run the power wiring from a screw type, hard wired 12 VDC 1A Class 2 Output power supply in a UL Listed Box and route a conduit to the CR-HN50 which **must** be installed in a UL Listed Plastic Box suitable for the environment. The conduit **must** be gas tight so no gases can flow through conduit.
3) Any Cirronet products with outdoor (designation "X") radio transceivers (tower mounted) marked for Hazardous Locations **must** have the interconnecting multi-conductor cable run in approved conduit for the location. The cable **must** be in the conduit until out of the Hazardous Location and the conduit **must** be gas tight so no gases can flow through conduit.
4) Do **NOT** remove the power connector to the device while circuit is live. Disconnect power only while circuit is dead, or the location is known to be non-hazardous. Failure to do so, may result in a "**Risk of Fire or Explosion**"

Only then is the unit suitable for a hazardous location.

For more information on Hazardous Locations contact UL and ask for UL1604 requirements. www.ul.com

RF Exposure

WARNING: End Users of these systems must be informed that RF exposure limits may be exceeded if personnel come closer than 45 cm to the antenna aperture when exceeding 9 dBi of gain in conjunction with the transceiver.

Repairs

Cirronet does not recommend field repairs of the radio equipment. Surface Mount Technology (SMT) has been used in the production of the transceiver module, which requires specialized training and equipment for proper servicing. The equipment should be returned to the factory for any repair.

Table of Contents

Introduction

The CR-SEH family of products from Cirronet™ Incorporated provides wireless Ethernet connectivity between networks located more than 5 miles apart. Built around the WIT2411 frequency hopping spread spectrum data modem, CR-SEH products provide a 10/100BaseT connection to Ethernet networks. CR-SEH products operate in a point-to-point mode or a point-to-multipoint mode using a star configuration. The center of the "star" is the Master device and the remote CR-SEHs are Slave devices. Peer-to-peer communication is accomplished by using the master CR-SEH device to relay datagrams from one slave CR-SEH device to another slave CR-SEH device.

Contained in a DIN Rail enclosure, CR-SEH is designed for factory and industrial applications. The CR-SEHX features a remote radio in a NEMA 4X/IP66 rated enclosure that can be mounted outdoors up to 300 feet from the network connection. Communication between CR-SEH products is performed using the WIT2411 over-the-air protocol. Thus the CR-SEH products are 802.3 compatible but not 802.11 compatible and provides over 1Mbs data throughput. Certified by the FCC and ETSI, and CE marked, CR-SEH products can be deployed license-free around the world.

The CR-SEHs enjoy the same benefits of frequency-hopping spread spectrum technology that the WIT2411s do. Namely, the immunity to multipath fading and resistance to jamming that is provided by changing frequency every few milliseconds. Operating in the 2.4GHz ISM band, CR-SEHs can be used license-free worldwide and are not subject to the congestion in the 900MHz band caused by cordless telephones.

The radios in CR-SEH products include a robust over-the-air protocol. This protocol insures error-free data through the use of a 24-bit CRC and ARQ to detect errors and to automatically request a retransmission. All of this is transparent to the network which just sees complete error-free data.

Getting Started

The CR-SEH family of wireless Ethernet modems is easy to install and operate. In most instances, the only installation steps will be setting IP addresses, configuring one CR-SEH as the master and connecting the antenna, power and Ethernet cable. While the operation of the CR-SEH and CR-SEHX is the same, the installation and connection is slightly different. Please refer to the appropriate section below for connection and installation of your product.

Setting up a pair of CR-SEHs requires the following steps:

- Enter IP addresses into each CR-SEH

- Configure one CR-SEH as the Master

The default settings in the CR-SEHs are sufficient to allow connection to Ethernet networks and to have the slave CR-SEH connect with the master. Other steps you may want to take include:

- Enter a default route IP address if data is to be sent off the CR-SEH's subnetwork (See *Ethernet Commands*)

- Enable one or more of the security features of the CR-SEH (See *Security Commands*)

- Adjust the RF bandwidth allocation (See *Radio Commands*)

- Filter out broadcast and multicast packets (See *Bridge Commands*)

- Change the network number (*See Radio Commands)*

Instructions on setting up the CR-SEHs are detailed in the *Configuring the CR-SEH* section of this manual. Details on the various operating modes and configurations can be found the *CR-SEH Operation* section.

CR-SEH

Figure 1 identifies the various connectors and LEDs of the CR-SEH.

Figure 1. CR-SEH Front Panel Diagram

The RF connection on the CR-SEH is the antenna connector on the top of the CR-SEH. The antenna connector is a reverse TNC type connector. An antenna may be connected directly to this connector. Alternatively, an antenna may be located away from the CR-SEH using RF cable to connect the CR-SEH to the antenna. Cirronet does not recommend using RF cables longer than 5 feet. If more distance is required between the CR-SEH and the antenna Cirronet recommends using the CR-SEHX. If the CR-SEHX is not used, high-quality, low-loss RF feed line must be used.

Connectors

The 10/100BaseT Ethernet connector is the standard RJ-45 connector and is located on the bottom front of the CR-SEH. The CR-SEH is set up to use a straight through cable to connect to a PC. If a straight through cable is used to connect the CR-SEH to other devices through a hub, the CR-SEH must be connected to the uplink port on the hub. A cross over Ethernet cable is also provided to connect to downlink ports on a hub.

The SYNC IN and SYNC OUT signals are provided for special applications where multiple master CR-SEHs are co-located. The synchronizing signals are RS-485 levels and may be connected using an RJ-11 connector. If the sync signals are required, one of the master CR-SEHs must be designated as the sync master. See the section *CR-SEH/Radio* Commands for details. If there are no co-located master CR-SEHs, sync should be left disabled.

The Console port is an RS-232 serial port that may be used to configure the CR-SEH. Connection to this port is made with the 9-pin D to RJ-11 serial cable included with the CR-SEH. This is useful when the default IP address of the CR-SEH cannot be used with the existing network preventing configuration through the IPHunter utility. See the section *Configuring the CR-SEH* for details of using this port.

The power connector is a 2-pin terminal block connector. The provided AC adapter provides a 12 volt power level to the CR-SEH. The CR-SEH can accept DC voltages ranging between 12VDC and 30VDC if alternative power supplies are to be used.

Status Indicators

Figure 2 shows the status indicators on the CR-SHE. The PWR indicator on the front panel indicates that power is applied to the CR-SEH. The CR-SEH does not have a power switch. Power is applied and removed to the CR-SEH by connecting and disconnecting the power connector.

The Ethernet LEDs include LINK, TXD and RXD. The LINK LED lights when a valid Ethernet connection is made. The CR-SEH is set up to use a straight through cable to connect to a PC. If a straight through cable is used to connect the CR-SEH to other devices through a hub, the CR-SEH must be connected to the uplink port on the hub or the crossover Ethernet cable must be used. TXD and RXD are indicators of Ethernet data activity. They indicate the transmission and reception of data over the Ethernet connection. Note that these LEDs can be active even when the CR-SEH is not communicating with another CR-SEH. When on, the XCVR LED on the CR-SEBX indicates the remote radio of the CR-SEBX is operating properly.

On a slave CR-SEH, the RF Link LED indicates the CR-SEH has established a connection with the master CR-SEH. When a slave CR-SEH is powered on, it will take a few seconds for this LED to turn on. On a master CR-SEH the RF Link LED is on as long as any one Slave is linked.
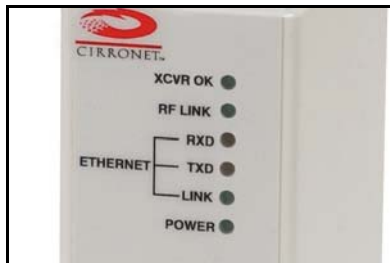

Figure 2. CR-SEH RF Indicators

CR-SEHX

Figure 3 shows the various connectors and LEDs of the CR-SEHX. Figure 4 illustrates the remote radio assembly. Connection between the CR-SEHX enclosure and the remote radio assembly is made through the 16-pin remote radio connector on the front of the CR-SEHX. Digital signals, rather than RF signals are sent over the connecting cable which may be up to 300 feet in length. These cables may be ordered from Cirronet in lengths of 100 feet to 300 feet in 100-foot increments.
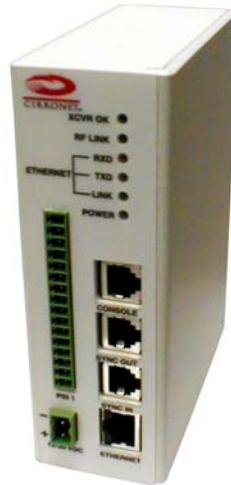
Figure 3. CR-SEHX Front Panel Diagram

The remote radio assembly has mounting holes to secure the antenna. The antenna is attached to the remote radio through the included 24-inch RF cable. If the antenna is not to be mounted on the remote radio assembly, connection between the remote radio and the antenna must be made with high-quality , low-loss RF cable. Cirronet recommends limiting the length of the RF cable to 5 feet to minimize RF signal loss.
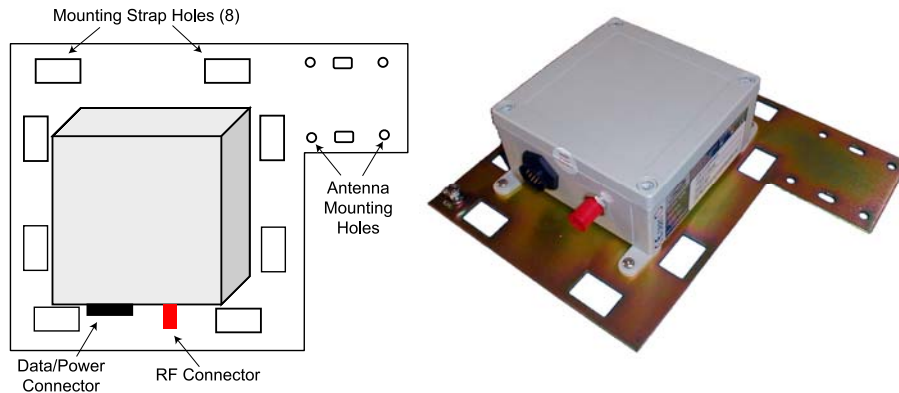
Figure 4. Remote Radio Assembly

Note that the remote radio assembly should be mounted on a tower or building top oriented as in Figure 4. It is important that the RF connector on the remote radio assembly point to the ground to avoid any issues with rain water.

Important Note:

If an alternate source of power is used with the CR-SEHX, it must be limited to +12VDC +/-10%. Failure to meet this specification can result in damage to the remote radio assembly.

Connectors

The 10/100BaseT Ethernet connector is the standard RJ-45 connector and is located on the bottom front of the CR-SEHX. The CR-SEHX is set up to use a straight through cable to connect to a PC. If a straight through cable is used to connect the CR-SEHX to other devices through a hub, the CR-SEH must be connected to the uplink port on the hub. (See SEH Section)

The SYNC IN and SYNC OUT signals are provided for special applications where multiple master CR-SEHs are co-located. The synchronizing signals are RS-485 levels and may be connected using an RJ-11 connector. If the sync signals are required, one of the master CR-SEHs must be designated as the sync master. See the section *CR-SEH/Radio* Commands for details. If there are no co-located master CR-SEHs, sync should be left disabled.

The Console port is an RS-232 serial port that may be used to configure the CR-SEHX. Connection to this port is made with the 9-pin D to RJ-11 serial cable included with the CR-SEHX. This is useful when the default IP address of the CR-SEHX cannot be used with the existing network preventing configuration through the IPHunter utility. See the section *Configuring the CR-SEH* for details of using this port.

The power connector is a 2-pin DIN type connector. The provided AC adapter provides a 12 volt power level to the CR-SEHX. The CR-SEHX must have a DC voltage of 12VDC +/-10% alternative power supplies are to be used.

Status Indicators

Figure 5 shows the status indicators on the CR-SEHX. The PWR indicator on the front panel indicates that power is applied to the CR-SEHX. The CR-SEHX does not have a power switch. Power is applied and removed to the CR-SEHX by connecting and disconnecting the power connector.

The Ethernet LEDs include RXD, TXD and LINK. The LINK LED lights when a valid Ethernet connection is made. The CR-SEH is set up to use a straight through cable to connect to a PC. If a straight through cable is used to connect the CR-SEH to other devices through a hub, the CR-SEH must be connected to the uplink port on the hub. TXD and RXD are indicators of Ethernet data activity. They indicate the transmission and reception of data over the Ethernet connection. Note that these LEDs can be active even when the CR-SEH is not communicating with another CR-SEH.

The RF indicators include LINK and XCVR OK. On a slave CR-SEH, the RF Link LED indicates the CR-SEH has established a connection with the master CR-SEH. When a slave CR-SEH is powered on, it will take a few seconds for this LED to turn on. On a master CR-SEH the RF Link LED is on as long as any one Slave is linked. The XCVR OK LED on the CR-SEHX when on indicates the remote radio of the CR-SEHX is operating properly.

Figure 5. RF Indicators

Configuring the CR-SEH
The network that the CR-SEH is connected to must be compatible with 10/100BaseT products. Before connecting a default configured CR-SEH to an active network that does not have a BOOTP or DHCP server, ask the network system administrator for an IP address for the CR-SEH that will not cause any problems on the network.

Setting IP Addresses
CR-SEHs are shipped from the factory with default settings that include a default IP address of 0.0.0.0 and a default configuration as a slave bridge. In order to set up a wireless link, alternate IP addresses need to be assigned and one of the CR-SEHs must be configured as a master device. If a BOOTP or DHCP server is not present a different IP address must be assigned to the CR-SEH. If a DHCP server is present on the network, the IP address can be set up through it.

The Master CR-SEH can obtain its IP address through a DHCP server residing on the Master CR-SEH's local network. The slave CR-SEHs receive their IP address through the Master CR-SEH from the DHCP server on the Master CR-SEH's local network. If the slave CR-SEH cannot establish a link with the master CR-SEH (due to different network numbers or some other configuration setting), the slave CR-SEH will need to have its IP address entered manually unless it will be configured through the console port. If it is desired to configure the slave CR-SEH through a browser session instead of the console port but use a DHCP server to provide the IP address after initial setup, a temporary IP address can be assigned manually but the IP address will need to be reset to 0.0.0.0 to have the slave CR-SEH obtain its IP address from the DHCP server.

IP Hunter Utility
The CR-SEH CD has a device detection and IP setting utility named IP Hunter. This utility will detect all Cirronet Ethernet devices on the local network, even those with no IP address. For those units without an IP address, IP Hunter can set the IP address and then open a browser session with that device to allow for further configuration. The IP Hunter will display devices that already have IP addresses and will open browser sessions with those units, but will not change the IP address already set.

Open IP Hunter by double-clicking on the file iphunter.exe on the CR-SEH CD. The following screen will appear.
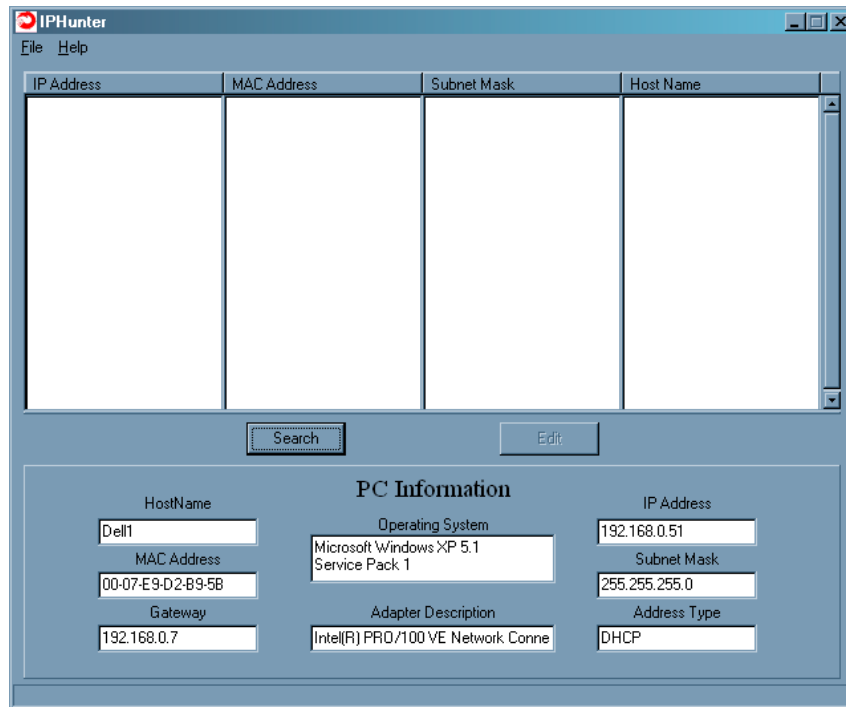
Click on the Search button to begin the search for Cirronet devices. Only Cirronet Ethernet devices will be displayed as shown below.
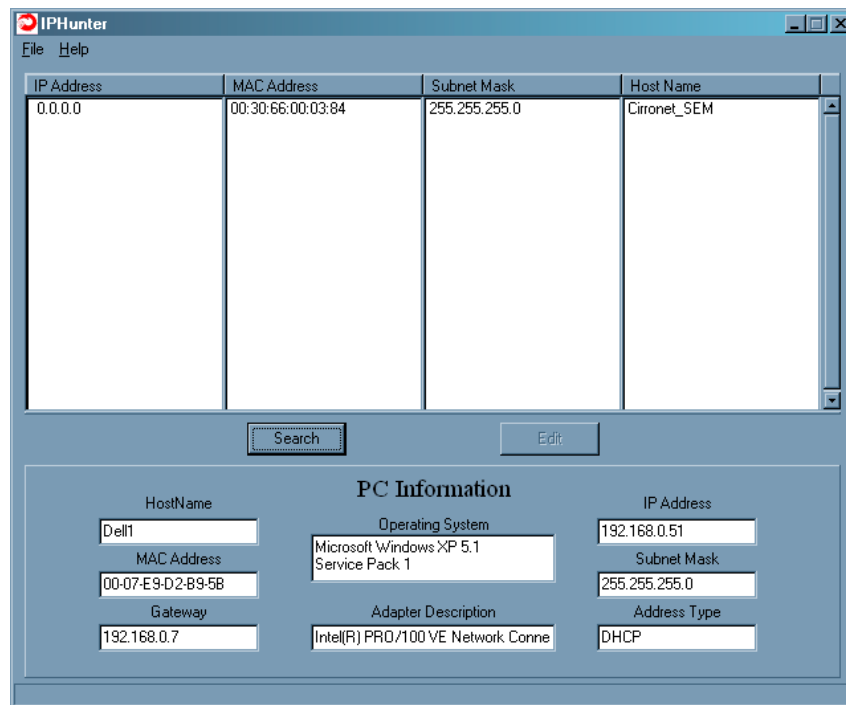
Ethernet devices from other manufacturers will not be displayed, even if they have no IP address. Any devices found will be displayed on the screen along with the IP address (if any), the netmask the MAC address and the DHCP host name.

Double-clicking on a device with an IP address of 0.0.0.0 will bring up the following dialog box.

Enter the desired IP address and the default netmask will automatically be entered as shown below. A new Host Name may be entered if desired; however, the MAC Address cannot be changed.

Click OK and the IP address will be entered in the CR-SEH and will be displayed in the IP Hunter window as shown below.

HTML Setup (Browser Session)

Once an address has been assigned, double-click on the IP number to launch an HTML setup session in a browser window. The login screen will display as shown below.

Enter the default Username, "admin" and the default Password, "Cirronet" (case sensitive).

(The password will be displayed as dots only for security purposes.)

Click on OK and the main browser window is displayed.
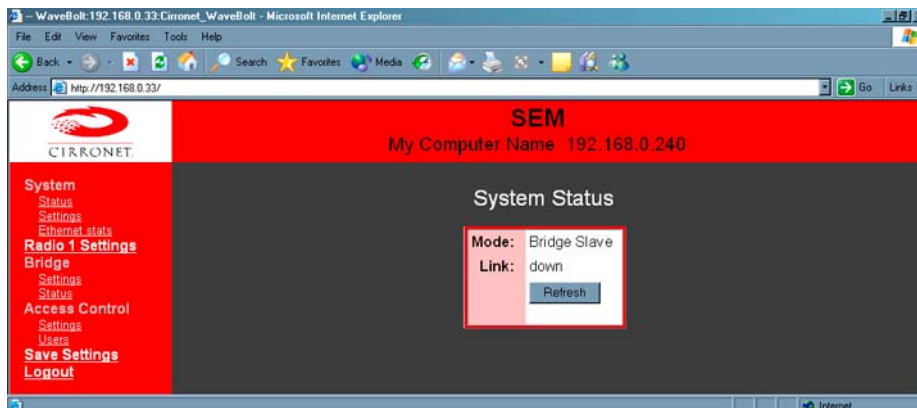
System Status

This dialog shows the Mode (Master or Slave) and Link (Up/Down) status of each device. (Clicking on Refresh should be used when System Settings have been adjusted to display current status.)

System Settings
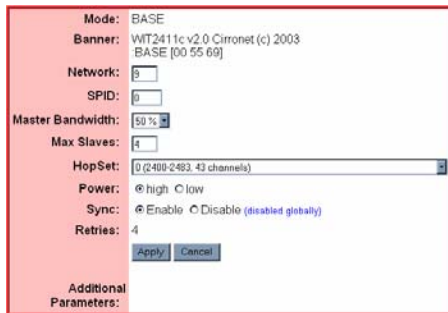
This dialog allows the user to change the Hostname, set the Default Route, enter DNS entries or change the Outmax (upload/download ratio for the radio) setting. If the CR-SEH is to transmit data to devices not on its subnet, a default router must be specified. To set the default routing address, enter it in the Default Route field. Click on Apply to invoke changes, click on Cancel to discard.

System Ethernet Stats

This dialog displays statistics related to the transmission and reception of wired Ethernet data.
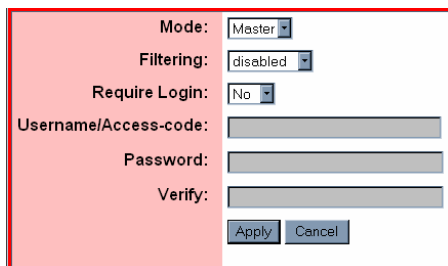
Radio Settings

This dialog identifies the radio and current operating mode. It also allows the user to configure radio parameters for the Network, SPID, Master Bandwidth, Max Slaves, HopSet, Power, Sync and Retries. Details on these settings are provided in the section on Radio Commands.

Bridge Settings

This dialog allows the user to set the Mode, (Master or Slave), any Filtering (see the section on Filtering below) and whether or not a Login is required. Selecting "No" grays out the Username/Access-code, Password and (Password) Verify fields. Selecting "Yes" allows entries to be entered into the fields. Details on these settings are provided in the section on Bridge Commands.

Bridge (Connection) Status

This dialog displays statistics related to the connected radios including UserName (if no username is assigned, N/A will display), IP Address, Radio ID and Packet/Error Information.

Access Control Settings

This dialog allows the setting of login preference, "admin" (default), "enable" or "guest". Setting "admin" allows the user rights to change parameters; setting "guest" limits the access to RF Tools only. After changing the Console setting, click Apply to invoke the changes. Click on Cancel to discard any changes.

Clicking on Enable IP address control and then Apply brings up the dialog below.

Enable IP address Control

This dialog is used to designate the Allowed IP addresses from which the SEH will accept a telnet session request. Simply enter an IP address in the "Allowed IP address" field and click "Add IP address. Only IP addresses designated by this dialog can access the device when IP address control is Enabled.

Access Control Users

This dialog allows the modification of logins and the ability to add new users.

Note: Click on Save Settings to store the system configuration changes in non-volatile FLASH memory. The user may either click on "Reset" to reboot the processor, click on "Logout" to end the browser session or simply close the browser window.

Console Port

The CR-SEH can be configured in two other ways. The first is through the console port. The settings for the console port are 38400 baud, 8 data bits, 1 stop bit, and no parity. The WinSEM program can be used to set up the CR-SEH through the Console port. The appropriate serial port must be selected in WinSEM, but the program will automatically set up the serial port. After a few seconds the CR-SEH firmware version is displayed followed by the **SEM>** prompt.

To set the IP number of the CR-SEH, use the *ip* command.

```
ip <xxx.xxx.xxx.xxx> {yyy.yyy.yyy.yyy}
```

Where x is the new IP address and y is the optional netmask number.

Once a valid IP address has been entered in the CR-SEH, a second method to configure the CR-SEH is through a telnet session. Most telnet programs work with the CR-SEH. Windows 95/98/NT/2000/ME have a telnet program that works with the CR-SEH. A telnet session can be started by clicking on Start->Run if you have Windows 95/98/NT/2000 and the TCP/IP client has been installed. For a CR-SEH with an IP address of 192.168.0.254, enter the following information in the dialog box:

```
telnet 192.168.0.254
```

Note: If IP Address control has been enabled, the telnet session must be initiated from an IP Address that is on the Allowed IP Address list.

A telnet window will open up. The first line is the version of the CR-SEH firmware followed by the prompt:

```
SEM>
```

If the CR-SEH is to transmit data to devices not on its subnet, a default router must be specified. To enter the default routing address use the *route* command.

```
route add default <xxx.xxx.xxx.xxx> {yyy.yyy.yyy.yyy}
```

Where x is the IP address of the gateway device and y is the optional netmask number.

To configure a CR-SEH as a master device, use the *bridge* command:

```
bridge master<CR>
```

Store the changed configuration parameters in non-volatile memory with the *save* command:

```
save<CR>
```

The CR-SEH will report back the time it took to the save the information. Reset the CR-SEH by typing:

```
reset<CR>
```

The CR-SEH can also be reset by cycling power. Whenever a reset is executed on the CR-SEH, the telnet session will be lost. It will take the CR-SEH about 30 seconds to reinitialize after a reset or after cycling power.

Note: Failure to save and reset will result in the factory defaults being used.

Filtering

The CR-SEH includes provision for filtering of multicast and broadcast packets. In many networks, there are sufficient multicast and/or broadcast packets to slow the overall performance of the CR-SEH. Based on the number of broadcast and multicast packets, they can consume a substantial amount of the RF bandwidth. By turning filtering on, the CR-SEH will ignore these packets and limit transmission to packets with specific device addresses. In some instances, it is desirable to have the CR-SEH transmit the multicast and broadcast packets; in such cases, filtering should be disabled. Note that filtering broadcast packets also filters multicast packets but filtering multicast packets does not filter broadcast packets. To filter broadcast and multicast packets use the bridge filter command:

```
bridge filter bcast<CR>
```

Refer to the section *Bridge Commands* for details of the filter commands.

DHCP

A DHCP server can set the CR-SEH IP address as well as the default route IP address. This is accomplished by setting the desired default route IP address in the DHCP server using Option 3. A DHCP server will not overwrite a previously entered default router IP address in the CR-SEH. If a DHCP server is not used to set the default router IP address, one must be entered using the *route* command. See the previous section for details of the route command. If an IP address has previously been entered into the CR-SEH but a DHCP server is to be used to assign an IP address, it will be necessary to set the IP address in the CR-SEH to 0.0.0.0 using the `ip` command.

CR-SEH Operation

Overview
CR-SEH devices are wireless Ethernet modems that perform bridging functions in point-to-point or point-to-multipoint configurations. CR-SEH products are designed to connect remote network segments together while keeping the data traffic between the network segments to a minimum. CR-SEH products use MAC-layer addresses to learn on which network segment a device is located.

A master CR-SEH can connect up to 60 remote slave CR-SEHs. The CR-SEH is a single channel device with an over-the-air data rate of 1.23Mbps providing up to 500Kbps full duplex data throughput. The radio modems in the CR-SEHs are factory configured with optimum settings for typical point-to-point applications. The radio parameters can be configured to optimize data throughput, latency and range for whatever the application. In addition, the radios in the CR-SEHs can be configured to allow multiple CR-SEH networks to be co-located.

Security Modes
The CR-SEH provides several security modes that protect against unauthorized control of the CR-SEH and unauthorized access to the network to which the CR-SEH is connected.

The first security feature is the need for a password to connect to a CR-SEH remotely through a telnet session. The password is enabled and cannot be disabled. When a telnet session is initiated, a password must be entered to gain access to the command line mode of the CR-SEH. The default password is "Cirronet" (no quotes, case sensitive) but should be changed immediately. When you change the password, please make note of it and save it in a secure location as there is no way to recover lost passwords. Another feature is available to limit the ability to initiate telnet and web sessions with the CR-SEH. The **access ip add** command is used to add specific IP addresses from which telnet sessions will be allowed. Up to 10 IP addresses can be entered. This featured is defaulted OFF and is enabled through the **access ip enable** command.

The same password required for a telnet session may also be required for a serial connection to the console port. The default for this feature is Off. It is set using the **access console enable** command. When enabled, the same password used for the telnet session will be required to gain access to the command line interface of the CR-SEH through the console port.

Similar to the telnet/console password is the FTP password. This password is always required and cannot be disabled. The default password is "Cirronet" (no quotes, case sensitive) but should be changed immediately. When you change the password, please make note of it and save it in a secure location as there is no way to recover lost passwords.

To provide security from unauthorized CR-SEHs gaining access to a CR-SEH network, an access code/password feature is available. This features requires slave CR-SEHs to authenticate with the master before being granted access to the network. This feature is defaulted OFF and is set up using the **bridge login**, **bridge access** and **bridge password** commands.

Details of all the security-related commands are found in the *Bridge Commands* and *Security Commands* sections of this manual.

Point-to-Point Mode
In point-to-point operation, one CR-SEH is configured as the Master and the other is configured as a Slave. While this is necessary for operation, it does not matter which CR-SEH is the master and which is the slave. The radio in the master operates as the base radio. Configuring the CR-SEH as the master automatically configures the radio in the master as a base radio. Similarly, configuring a CR-SEH as a slave automatically configures the slave radio as a remote radio.

When a master CR-SEH is powered on, it becomes active immediately, even if no slave CR-SEHs are detected. It will attempt to send packets addressed to devices that it thinks are not on its local network. When a slave CR-SEH is powered on, it listens for a master CR-SEH and attempts to register with the radio in the master. This detection and registration process typically takes 2 seconds. During this time, no packets will be sent or received over the RF link by the slave.

If the application is such that more than one point-to-point link needs to located in the same area, each master/slave pair must be assigned different network numbers. This will allow the CR-SEHs to identify the appropriate other CR-SEH to which they should communicate. Because different network numbers have different hopping sequences, this also allows various pairs to operate in the same area without interfering with each other. Refer to the section on radio commands for details on setting network numbers.

Point-to-Multipoint Mode

In point-to-multipoint mode multiple slave CR-SEHs link with a single master CR-SEH. Similar to the point-to-point mode, each slave must register with the master, a process that typically takes 2 seconds. All of the radio addressing and registration occurs automatically and is transparent to the application. A maximum of 60 slave CR-SEHs can be connected to a master CR-SEH. The amount of data a slave can transmit depends on the number of slaves connected and the hop duration of the radio network. Because packets from one slave that are intended for another slave must pass through the master CR-SEH, the master CR-SEH should always be allocated 50% of the data throughput, even at the expense of some throughput for the slaves. This is the factory default configuration.

In frequency hopping technology, the following applies; the shorter the hop duration, the lower the data latency but also the lower the throughput. This is because the overhead required is the same regardless of the hop duration. Thus at shorter hop durations, the overhead is a larger percentage of the hop time. Longer hop durations provide more throughput but have a higher data latency. If data from a slave appears just after the slave's designated transmit time, the slave will have to wait one hop duration before it can transmit the data. As the hop durations of the CR-SEH products are very short, ranging from 10ms to 17ms, the better approach is to pick the hop duration to maximize data throughput without unnecessarily penalizing latency.

The factory configuration is set up that the master will have one-half of the bandwidth reserved for it. The slave devices split the remaining time equally and transmit as much as the can each hop. The amount of time remaining will depend on the hop duration. The table below gives data throughputs for multiple slaves based on the default hop duration for a CR-SEH.

Slaves	Hop Duration	Slave Throughput	Master Throughput	Aggregate Throughput
1	30ms	420Kbps	420Kbps	840Kbps
2	30ms	210Kbps	420Kbps	840Kbps
3	30ms	140Kbps	420Kbps	840Kbps
4	30ms	105Kbps	420Kbps	840Kbps

If the application has more slave devices, or if it is desirable to increase the throughputs of the slaves at the expense of the master CR-SEH, contact Cirronet technical support for more details.

Co-located Networks

The radio architecture in the CR-SEH allows multiple networks to be located in the same area without interfering with each other. Depending on the scenario, either the network and/or the sync commands are

used to distinguish between networks of CR-SEHs and to prevent interference between the CR-SEH networks.

If the master CR-SEHs are not located close to each other (> 30 feet or 10 meters apart), simply assigning different network numbers to the various networks of CR-SEHs will allow the networks to co-exist without interference. The network number selects one of 63 different hopping patterns, where the hopping pattern is the pseudo-random sequence of frequencies over which the CR-SEHs hop. Because the different networks are using different sequences they will transmit on the same frequency at the same time only rarely. These infrequent collisions are not sufficient to reduce the throughput in any meaningful way.

If the master CR-SEHs are to be located close together, the CR-SEHs allow the masters to be synchronized as to when they send to slaves and when they receive from slaves. This synchronization is allowed by the FCC in the United States. The FCC does not allow synchronizing of the hop sequences to avoid all collisions. The CR-SEH accomplishes the send/receive synchronization through use of the Sync ports. The Sync ports of the CR-SEH masters are connected using standard RJ-11 cables. There is a Sync In and a Sync Out port to allow daisy-chaining of CR-SEH masters. One of the CR-SEH masters is designated the Sync Master using the `sync master` command. Synchronization is enabled in the Sync Master and all connected master CR-SEHs using the `sync enable` command. The `sync wire` command must be issued to turn on the Sync ports. Refer to the *Radio Commands* section for details.

Note: When synchronization is used in the United States, the hop fcc parameter must be left enabled. Disabling this parameter will violate FCC rules governing spread spectrum radios.

CR-SEH Command Set

The CR-SEH supports a series of commands that allow for configuring the Ethernet interface as well as the radio parameters of the on-board WIT2411. These commands can be entered during a telnet session or by using the WinSEM utility when the SEM> prompt is displayed. The commands are grouped into System, Bridge, Security, Ethernet and Radio command sets. The commands are summarized here with detailed explanations following.

System Commands

Command	Description
`help`	Displays command help screen
`arp -a`	Displays arp table
`    -d <ipaddr>`	Deletes arp entry
`    -s <ipaddr> <eaddr>`	Adds arp entry
`default`	Sets CR-SEH configuration to factory default settings
`echo`	Toggles user screen echo mode
`ip [`	Displays current CR-SEH IP address
`     <ipaddr> <netmask>]`	Sets CR-SEH IP address and optionally the netmask
`ping <ipaddr>`	Pings TCP/IP host
`reset`	Resets the CR-SEH activating changed configuration parameters
`route [ help`	Displays help screen for command
`      add <default> <gwaddr>` `                  <netmask>`	Adds IP address and netmask to route list
`      del <ipaddr>`	Deletes IP address from route list
`      list ]`	Lists route IP addresses
`save`	Stores current configuration to memory
`sys   help`	Displays sys help screen
`      mode`	Displays Master/Slave mode of the CR-SEH

`      outmax`
 	
`             (Master only)`
	Sets maximum number of bytes Master CR-SEH can transmit per hop. Range is from 1 to 1500
	    Default = 250

`version`	Diplays CR-SEH firmware version

help   Displays a list of all the CR-SEH commands. Most commands that require a parameter also have a help mode that displays the help screen for that command.

arp   Manipulates the address resolution procedure table. This command is provided primarily as a debugging tool for setting up networks. **ipaddr** is the device IP address and **eaddr** is the physical Ethernet address of the device

default	Resets CR-SEH configuration parameters to factory default settings. This command does not reset the radio parameters. Use the `radio default` command to reset the radio parameters. See the section on *Radio Commands* for details.
echo	Toggles the user screen mode to echo characters typed by the user. Default is on. If echo is turned off, characters typed will not be displayed on the screen unless echoed by the terminal program.
ip	Sets the IP address of the CR-SEH. The default IP address is 0.0.0.0. When specified `netmask` sets the netmask number. The default netmask is 255.255.255.0.
ping	Sends inquiry packets to TCP/IP host specified in `<ipaddr>` and displays the amount of time that elapsed before a response was received. Continuously sends requests until a key is pressed.
reset	Resets the CR-SEH and loads saved parameters into active memory. Also causes the CR-SEH to reinitialize which can take 30 seconds. If reset is issued before the save command, the new parameters are lost and the last saved parameters are used.
route	Displays and manipulates gateway IP addresses to route IP traffic off the subnet. *Default* sets the first gateway attempted.
save	Saves changed parameters in non-volatile memory to be loaded on power up. Must be issued before the reset command or cycling power to have changed parameters take effect. (An exception is the `sys outmax` command which becomes active immediately after it is entered.)
sys	`mode` displays whether CR-SEH is configured as a Master or Slave. Setting Master or Slave mode is performed using the bridge command. Refer to the section *Bridge Commands* for details. `outmax` controls how data is presented to the CR-SEH radio. This command should not be used without advice from Cirronet Technical Support.
version	Displays the CR-SEH firmware version.

Bridge Commands

Command		Description
bridge	help	Displays help screen for command
	access <accesscode>	Sets access code to allow slave CR-SEH onto to Master's network. Slave accesscode must match accesscode of desired Master
	filter [disable, bcast, mcast, show]	Selects filtering operation and level.
	login [enable|disable]	Enables/disables accesscode/password login authentication. Must be set in master and slave
	master	Sets CR-SEH as Master bridge
	password <pwrd>	Sets login password. Slave password must match password of desired Master CR-SEH
	slave	Sets CR-SEH as Slave bridge (default)
	status (Master only)	Displays status of active connections

access   Sets the **accesscode** portion of the **accesscode/password** pair to allow slave CR-SEHs to connect to a master CR-SEH. **accesscode** must match the **accesscode** in the master CR-SEH.

filter   Selects Ethernet traffic filtering mode.

filter disable turns filtering off. **filter bcast** filters out broadcast and multicast packet while **filter mcast** filters out just multicast packets. **filter show** displays the filter settings.

login   Turns the authentication login requirement off and on. When on, Enabled, an accesscode and password must be entered in the slave CR-SEH that matches the accesscode and password of the master CR-SEH with which the slave CR-SEH wants to establish a connection. Note that the network number of the CR-SEHs must also agree. See the section *Radio Commands* for details on the network number. This feature prevents unauthorized CR-SEHs from connecting to a CR-SEH network.

master   Sets the CR-SEH as the Master CR-SEH.

password   Sets the **password** portion of the **accesscode/password** pair to allow slave CR-SEHs to connect to a master CR-SEH. Password must match the password in the master CR-SEH.

slave   Sets the CR-SEH as a Slave CR-SEH.

status   Displays the status of active slave CR-SEH connections. (Only available in the master CR-SEH.)

CR-SEH Security Commands

Command	Description
access help	Displays command help screen
console [enable|disable]	Enables/disables password requirement for direct console communications.
ip [help	Displays command help screen
add <ipaddr>	Sets IP addresses (up to 10) from which telnet sessions will be accepted
delete <ipaddr>	Deletes ipaddr from list of allowed telnet initiators
disable	Turns off telnet initiator limitation
enable	Turns on telnet initiator limitations
show]	Displays telnet initiator limitations settings
show	Displays console and IP setting
ftpw	Changes the password for FTP sessions
password <pwd>	Changes the password for telnet/console sessions

access   Group of commands that limit access to the CR-SEH through the console port and telnet sessions. Note that there is no command to enable or disable the telnet session password. It is always enabled.

console enable sets the requirement that a password be entered when starting a console connection. The password is set using the **password** command. The default setting is disabled. **console disable** removes the password requirement.

ip enable sets limitations set on initiating a telnet session to the CR-SEH. When enabled, only network devices with IP addresses on the list of IP addresses added can initiate a telnet session with the CR-SEH. Up to 10 IP addresses can be added to the list. The list is modified with the **add** and **delete** subcommands. **ip disable** allows telnet sessions to be initiated from any IP address (a password will still be required). **show** will display the setting of the ip command and the list of IP addressed entered when enabled.

ftpw   This command changes the password required to initiate an FTP session with the CR-SEH. The default password is "Cirronet" (without quotes). It is not possible to disable this password.

password   This command changes the password required to initiate a telnet session with the CR-SEH and initiate a serial connection through the console port when enabled. The default password is "Cirronet" (without quotes). It is not possible to disable the password requirement for a telnet session, but it is possible to disable the password requirement for the console connection.

Radio Commands

Command	Description
hop [help	Displays help screen for command
fcc [enable|disable]	Enable/disable FCC hop synchronization
length <hoplen>	Sets/displays hop dwell time in radio and CR-SEH
sequence [43|15]	Informs CR-SEH of number of frequencies in radio hop pattern
set <pattern> (Master only)	Sets/displays the hop pattern to be used. This is required in countries with limited spectrum.
slave [help	Displays help screen for command
disconnect <id-id-id>	Disconnects slave CR-SEH with the radio serial number entered
list] (Master only)	Displays slaves currently registered with the CR-SEH
sync [help	Displays help screen for command
disable	Turns sync off (default)
enable	Turns sync on
master	Sets CR-SEH as sync master
override	Toggles master backup override
settings	Displays synchronization settings
slave	Sets CR-SEH as sync slave
wire] (Master only)	Sets synchronization mode to use RJ-11 wire ports

hop   Used to set the hop dwell time or the number of frequencies in the hop pattern of the radio in the CR-SEH. Master only.

The **fcc** command enables the FCC rules regarding synchronization of frequencies when CR-SEH masters are co-located and synced using the sync signals. The sync signals synchronize the CR-SEH masters such that they will transmit at the same time. FCC rules in the US allow synchronization in time but not frequency. That is, the master CR-SEHs cannot by synchronized in such a way that they would never transmit on the same frequency. While this only happens so infrequently that throughput is not substantially impacted, FCC rules do not allow this mode of operation. Other countries' rules do allow spread spectrum radios to be synchronized in time and frequency. If the co-located CR-SEH masters are deployed in such a country, the **fcc disable** command can be issued to allow synchronization in frequency. The co-locate CR-SEH masters must have their sync ports connected for this to have any affect. The default is **fcc enabled**.

The parameter entered for **length** is the decimal value of the number of 625 μsec ticks in the desired dwell time. A value of **48** (decimal) corresponds to a hop dwell time of 30 msec

and is the default. **24** is the minimum value and **48** is the maximum value. The dwell time is changed to optimize the data throughput for a given installation.

set selects a limited frequency band to be used. The default value is 1 which uses the entire frequency. For operation in France use a value of 8 and for Israel and Canada, use a value of 9. The CR-SEH radio also has 6 hop sets that avoid 802.11b channels. This allows the CR-SEH to operate in environments with an 802.11b network without interfering with the 802.11b network. The table below provides details of the hop sets.

Hop Set	Frequency Range	802.11b Channels Avoided	# of Channels
0	2400 – 2483MHz	None	43
1	2430 – 2483MHz	2412MHz, 2417MHz	27
2	2400 – 2410, 2440 – 2483MHz	2422MHz, 2427MHz	27
3	2400 – 2420, 2450 – 2483MHz	2432MHz, 2437MHz	27
4	2400 – 2430, 2460 – 2483MHz	2442MHz, 2447MHz	27
5	2400 – 2440, 2470 – 2483MHz	2452MHz, 2457MHz	27
6	2400 – 2450, 2480 – 2483MHz	2462MHz, 2467MHz	27
7	Reserved		
8	2422 – 2447MHz (France, Israel)		15
9	2453 – 2479MHz (Canada, Mexico)		15

The frequency of the 802.11b channel avoided refers to the center frequency of the 802.11b channel.

slave   **list** displays the serial numbers of the radios in the CR-SEHs that are currently registered with the CR-SEH. **disconnect** terminates the connection between the master CR-SEH and the slave CR-SEH with the radio serial identification number entered. The radio serial identification number must be entered with the "-"'s and can be found using **list**.

sync   These commands set the operation of the synchronization signal used in co-located CR-SEH networks. The default mode is the sync OFF. Sync is enabled by selecting a synchronization **master**. Synchronization will occur over the RS-485 SYNC lines. One co-located master CR-SEH must be configured as the sync master. If sync has been enabled, the other co-located master CR-SEHs will listen for a sync signal from the sync master. If no sync is heard, a co-located master CR-SEH will make itself a sync master and provide a sync signal. This is called the master backup override mode. **override** toggles the master backup override on and off. The default mode is ON. In standalone CR-SEH installations, synchronization is not required and should be left disabled.

The following commands are issued by typing **radio** and then the subcommand followed by the subcommand parameters if any.

Command		Description
radio	help	Displays command list
	banner	Displays power on banner for the radio in the CR-SEH
	defaults	Resets the radio parameters to the factory shipped values
	masterbw [10..80] (Master only)	Displays master to slave bandwidth in percentage
		Sets master to slave bandwidth in 10 percent increments between 10 and 80 percent. Remainder of bandwidth is shared among slaves for slave to master communication
		Default = 50
	maxslaves [0..60] (Master only)	Displays value currently in use
		Sets the maximum number of slaves the master will allow to register.
		Default = 60
	network [0..63]	Displays current CR-SEH network number
		Sets the network number for the CR-SEH
		Default = 0
	power [low|high]	Displays radio output setting: low = 10dBm; high = 18dBm (Default)
		Sets radio output power
	show	Displays radio parameters that have been modified from factory settings
	spid [0..254]	Displays service provider ID
		Sets service provider ID
		Default = 0

help   Displays list of sub-commands under the *radio* command.

banner   Displays the power on banner of the radio inside the CR-SEH.

defaults   Replaces any modified parameters with the factory default values.

masterbw   Sets the percentage of the total RF bandwidth to be allocated to the Master transmissions. Ranges from 80 percent to 10 percent in 10 percent increments. Default is 50 percent. The RF bandwidth not allocated to the Master transmissions is shared among the slave CR-SEHs for transmissions to the Master.

maxslaves   Sets a limit to the number of slaves CR-SEHs that a master CR-SEH can have registered simultaneously. The default is 60 but the parameter can range from 1 to 60. If more than **maxslaves** slave CR-SEHs attempt to connect to the access point, they will be denied access.

network	The radio in the CR-SEH has 64 preprogrammed hopping patterns or network numbers. By using different network numbers, nearby co-located networks can avoid interfering with each other's transmissions. Even if both networks tried to use the same frequency, on the next hop they would be at different frequencies. `nwt` can range from 0 to 63.
power	This command sets the transmit output power level of the CR-SEH radio. The default is 1 which corresponds to +18dBm or 65 milliWatts. The other setting is 0 which corresponds to +10dBm or 10 milliWatts. This command is useful in the European Union where the transmit power is limited to +20dBm including antenna gain. Setting the transmit power to +10dBm allows up to 10dBi of antenna gain to be used.
show	This command displays a list of the current radio parameters including the network number, maxremotes and the sys outmax value.
spid	The CR-SEH has 64 different network numbers (hopping patterns) allowing multiple networks of CR-SEHs to be co-located while keep the networks segregated. In some situations, particularly in outdoor deployments, there may be other entities using CR-SEHs. In most cases, the network number will be sufficient to keep the networks separate. However, it may not be possible to coordinate network numbers with an unknown third party. In this instance, the service provider ID or `spid` provides an additional 255 codes to distinguish networks. This feature is particularly useful if the slave CR-SEHs are setup to connect to the first master they hear. While they can link with a CR-SEH with any network number, they cannot link with a CR-SEH with the wrong `spid`.

Specifications

Model	CR-SEH	CR-SEHX
Data Throughput	420Kbps full duplex point to point	
Total over-the-air bandwidth	1.23Mbps	
Network Interface	10/100BaseT	
CR-SEH Network Topologies	Point-to-Point or Multipoint	
RF Output Power	10/100mW with included whip antenna	
RF Modulation	Frequency hopping, up to 64 user selectable hopping patterns	
Frequency Range	2400MHz to 2483.5MHz	
Operating Voltage Range	9VDC to 26VDC	12VDC +/- 10%
Enclosure	Polycarbonate	Network Interface Unit – Polycarbonate Remote Radio Unit – NEMA 4X UV- stabilized polycarbonate
Dimensions	Network Interface Unit 201 x 144 x 53 mm 7.9" x 5.7" x 2.1"	Remote Radio Unit 266 x 246 x 59mm 10.5" x 9.4" x 2.3 (CR-SEHX only)
Operating Temperature	Network Interface Unit -30°C to +70°C	Remote Radio Unit -40°C to +70°C
Humidity	0 to 95% humidity, non-condensing	
Licensing	Type certified for Worldwide License-free operation under FCC Part 15.247 and EN300328	

Connectors

Power	2-Pin Terminal
Ethernet	RJ-45
Console Port	RJ-11
Antenna	Reverse TNC Male
Sync (2)	RJ-11
Remote Radio (CR-SEHX only)	16-Pin Terminal

Indicators

Power
Ethernet Transmit Data
Ethernet Receive Data
Ethernet Link Status
RF Link Status
RF Transceiver OK

Troubleshooting

Ethernet Link LED is not on.
Check the power LED on the CR-SEH. Check the Ethernet cable, making sure that it is fully connected. Check the gender of the Ethernet cable. The CR-SEH can drive CAT5 cable to a maximum length of 100 meters. If a longer cable length is needed a signal regenerating device must be placed in line.

Cannot telnet to CR-SEH.
Check the power LED on the CR-SEH. Check the Ethernet cable, making sure that it is fully connected. Make sure the CR-SEH has a valid, unique IP number on the network. If you are attempting to telnet to the CR-SEH through a router, make sure that the correct address has been entered in the routing table. If the telnet security is enabled, make sure a device with an IP address on the allowed list is being used to initiate the telnet session.

The CR-SEH does not respond through the Console Port.
Check that a straight through serial cable is being used if connected to a PC. If you are not using WinSEM, verify that the host serial port is set for 38.4Kbps, 8 data bits, 1 stop bit and no parity. If you are using a terminal program, make sure that it is set up to transmit carriage returns when entered from the keyboard. If the console security feature is enabled, the correct password must be entered at the prompt to gain access to the CR-SEH command line.

Bridges do not link (RF Link LED is not on).
Check that one bridge is configured as a master. Also check that the bridges are set to the same network number.

Technical Support
Technical Support is available from Cirronet from 8:30am to 5:30pm Eastern Time, Monday through Friday. Contact Technical Support at (678) 684-2000 or by email at tech_sup@cirronet.com.

Warranty

Seller warrants solely to Buyer that the goods delivered hereunder shall be free from defects in materials and workmanship, when given normal, proper and intended usage, for twelve (12) months from the date of delivery to Buyer. Seller agrees to repair or replace at its option and without cost to Buyer all defective goods sold hereunder, provided that Buyer has given Seller written notice of such warranty claim within such warranty period. All goods returned to Seller for repair or replacement must be sent freight prepaid to Seller's plant, provided that Buyer first obtain from Seller a Return Goods Authorization before any such return. Seller shall have no obligation to make repairs or replacements which are required by normal wear and tear, or which result, in whole or in part, from catastrophe, fault or negligence of Buyer, or from improper or unauthorized use of the goods, or use of the goods in a manner for which they are not designed, or by causes external to the goods such as, but not limited to, power failure. No suit or action shall be brought against Seller more than twelve (12) months after the related cause of action has occurred. Buyer has not relied and shall not rely on any oral representation regarding the goods sold hereunder, and any oral representation shall not bind Seller and shall not be a part of any warranty.

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