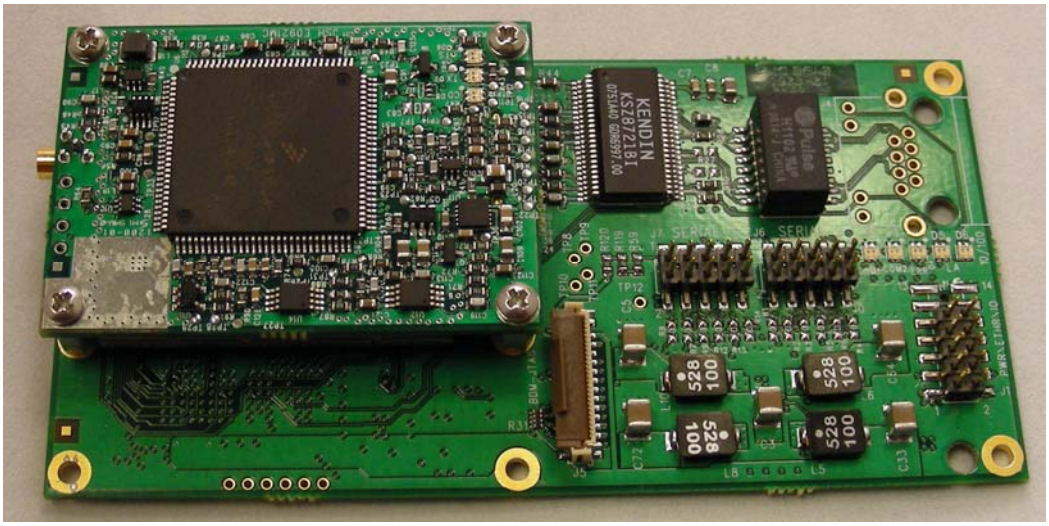
IP Mega-Mini User Manual

Version
1.0
LUM0013AA Rev A



Covering Firmware v. 2.11c (Initial Release)

IP Mega-Mini User Manual

SPREAD SPECTRUM WIRELESS DATA TRANSCEIVER USER MANUAL

WARRANTY

FreeWave Technologies warrants your FreeWave Wireless Data Transceiver against defects in materials and manufacturing for a period of two years from the date of purchase. In the event of a Product failure due to materials or workmanship, FreeWave will, at its discretion, repair or replace the Product.
In no event will FreeWave Technologies Inc., its suppliers, and its licensors be liable for any damages arising from the use of or inability to use this Product. This includes business interruption, loss of business information, or other loss which may arise from the use of this Product. Please be advised that OEM customer's warranty periods may vary.
Warranty Policy may **not apply**:
1. If Product repair, adjustments or parts replacements is required due to accident, neglect, unusual physical, electrical or electromagnetic stress.
2. If Product is used outside of FreeWave specifications.
3. If Product has been modified, repaired or altered by Customer unless FreeWave specifically authorized such alterations in each instance in writing. This includes the addition of conformal coating.

The Warranty period begins from the date of shipment and is defined per the Standard Warranty Policy stated above.

Special Rate Replacement Option:
A special rate replacement option is offered to non-warranty returns or upgrades. The option to purchase the replacement unit at this special rate is only valid for that RMA, (Return Material Authorization). The special replacement rate option expires if not exercised within 30 days of final disposition of RMA.

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IP Mega-Mini User Manual

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FCC NOTIFICATIONS

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: 1) This device may not cause harmful interference and 2) this device must accept any interference received, including interference that may cause undesired operation. This device must be operated as supplied by FreeWave Technologies, Inc. Any changes or modifications made to the device without the express written approval of FreeWave Technologies may void the user's authority to operate the device.

CAUTION: The model number MM2-P-T has a maximum transmitted output power of 955mW. It is recommended that the transmit antenna be kept at least 23 cm away from nearby persons to satisfy FCC RF exposure requirements.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. 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. However, there is no guarantee that interference will not occur in a particular installation. 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:

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

Note: Whenever any FreeWave Technologies module is placed inside an enclosure a label ***must*** be placed on the outside of that enclosure which includes the module's FCC ID.

IMPORTANT NOTICE

The MM2-P-T referenced in this manual **is** compatible over-the-air with the FGRplus RE radio. It **cannot** link over-the-air with the HTP-900RE.

An HTplus can interface with an MM2-P-T through a hard-wired Ethernet or serial connection **ONLY**. For a serial-to-serial connection between an HTplus and an MM2-P-T, or between an MM2-P-T and a FreeWave serial radio, a Null Modem adapter and a M-to-M Gender Changer must be used. For an Ethernet-to-Ethernet connection, a straight through Ethernet cable can be used, as the port on the MM2-P-T is an auto-crossover port.

The HTplus radios and the MM2-P-T radios will not link with each other, nor will they pass data to each other via RF.

IP Mega-Mini User Manual

Table of Contents

Choosing Point-to-Point or Point-to-Multipoint Operation

A Point-to-Point network is limited to one Gateway and one Endpoint transceiver. Up to 4 Repeaters may be added to extend the reach of the network, but no other Gateway or Endpoint may be added.

In a Point-to-Multipoint network (also referred to as a Multipoint network) the transceiver, designated as a Gateway, is able to simultaneously communicate with numerous Endpoints. In its simplest form, a Multipoint network functions with the Gateway broadcasting its messages to all Endpoints and the Endpoints responding to the Gateway when given data by the device connected to the data port.

It is important to note the differences between Point-to-Point and Multipoint networks. In a Point-to-Point network all packets are acknowledged, whether sent from the Gateway to the Endpoint or from the Endpoint to the Gateway. In a Multipoint network, outbound packets from the Gateway or Repeater to an Endpoint or other Repeaters are sent a set number of times determined by the user. The receiving transceiver, Endpoint or Repeater, will accept the first packet received that passes the 32 bit CRC. However, the packet is not acknowledged. On the return trip to the Gateway, all packets sent are acknowledged or retransmitted until they are acknowledged. Therefore, the return link in a Multipoint network is generally very robust.

Traditionally, a Multipoint network is used in applications where data is collected from many instruments and reported back to one central site. As such, the architecture of such a network is different from Point-to-Point applications. The number of radios in a Multipoint network is influenced by the following parameters:

- Size of the blocks of data. The longer the data blocks, the smaller the network capacity.
- Baud rate.
- The amount of contention between Endpoints. Polled Endpoints vs. timed Endpoints.
- Use of Repeaters. Using the Repeater setting in a Point-to-Point or a Point-to-Multipoint network will decrease overall network capacity by at least 50%.

For example, if the network will be polling Endpoints once a day to retrieve sparse data, several hundred Endpoints could be configured to a single Gateway. However, if each Endpoint will be transmitting data at greater levels, then fewer Endpoints should be linked to the Gateway. The overall network will be closer to capacity with fewer Endpoints.

For examples and additional information on data communication links, see the section Examples of Data Communication Links on page 60.

FreeWave Basic IP Setup:

This section describes how to either set or determine the IP address of the MM2-P-T (hereafter, "IP Mini") radio.

To determine or set the IP address of an IP Mini radio, plug a serial cable into SERIAL 1 (J7) (the left port), with the radio disconnected from the power. Then, follow the below instructions to open and setup HyperTerminal.

Accessing HyperTerminal's Setup Menu

Note: The following screen shots are taken from a computer using Windows XP. The display may vary slightly if using different operating systems.

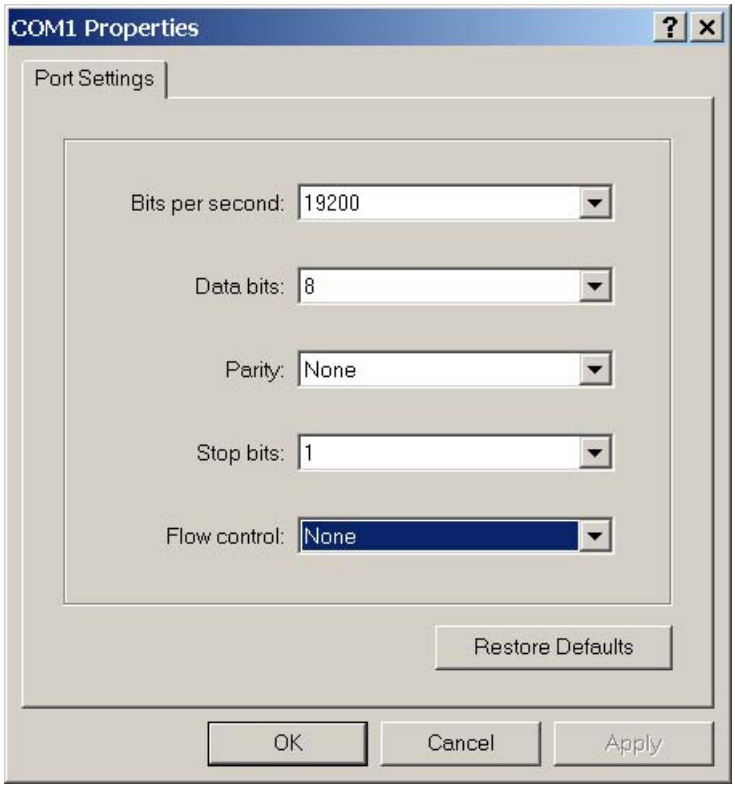
Click on the **Start** button. A cascading menu appears. Select **Programs**, **Accessories**, **Communications** and then **HyperTerminal**. A window appears similar to the following:

Double-click on the **Hypertrm.exe** icon. The following window appears.

In the Name text box, type in a descriptive name. Select an icon from the Icon selection box. Click on the **OK** button. The following "Connect To" dialog box appears:

Select the connection type to be used from the **Connect using** drop-down menu. In most cases the connection type will be either **Direct to Com1** or **Direct to Com2**.

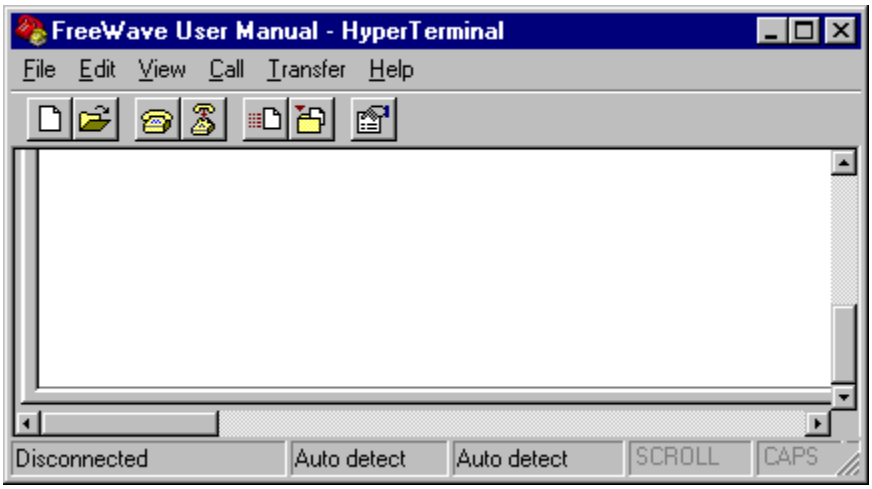
Click on the **OK** button. The Properties dialog box appears for the selected connection type.



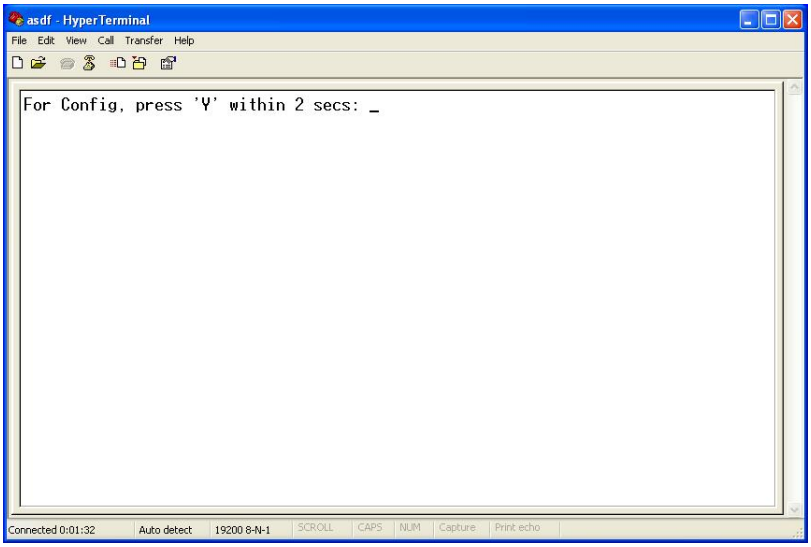
The following are the port settings which must be set for a proper connection:

Port Setting	Menu Option to Select
Bits per second	19200
Data bits	8
Parity	None
Stop bits	1
Flow control	None

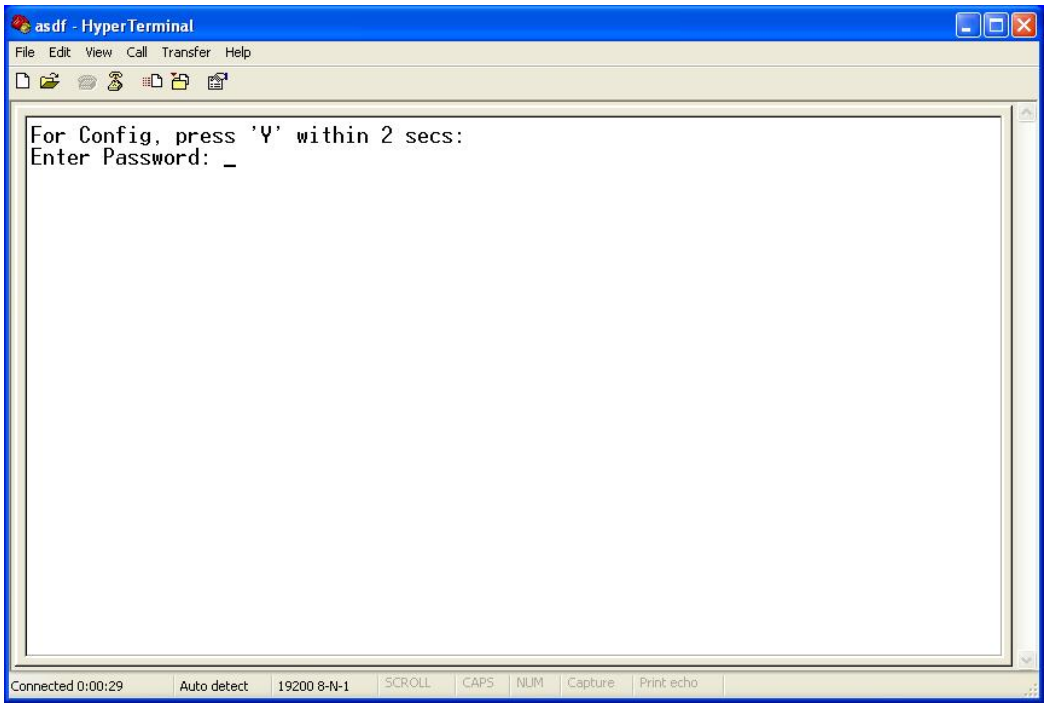
After selecting the appropriate menu items for each setting, click on the **OK** button. The following HyperTerminal dialog box appears:



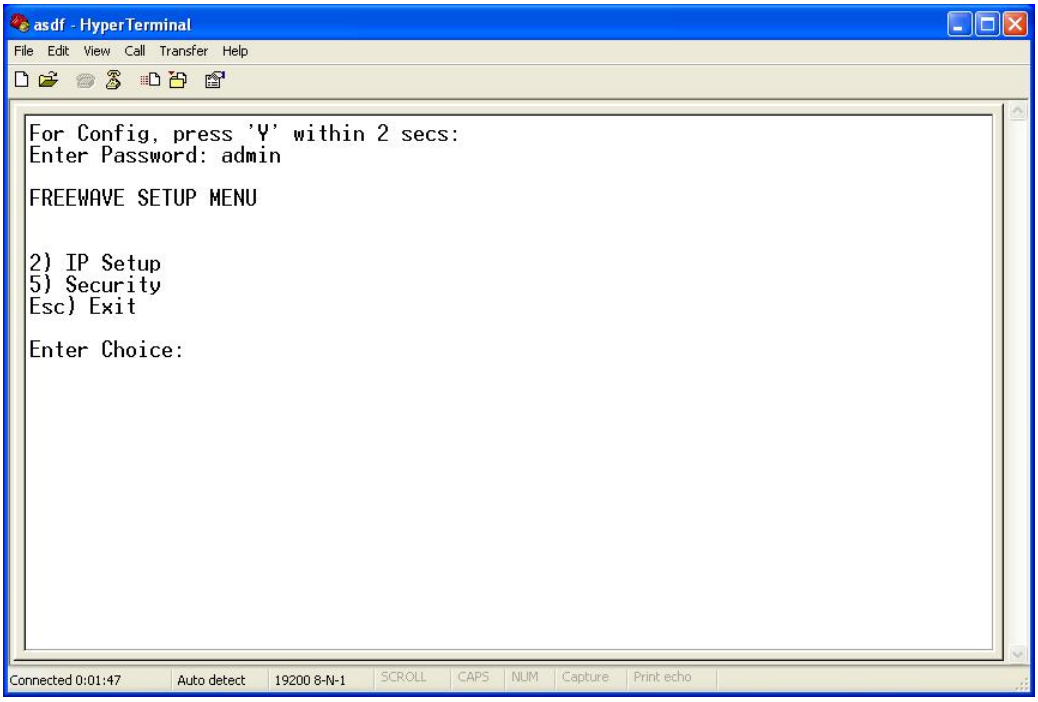
Connect power to the radio. After a few seconds, the following screen should appear in the HyperTerminal window:



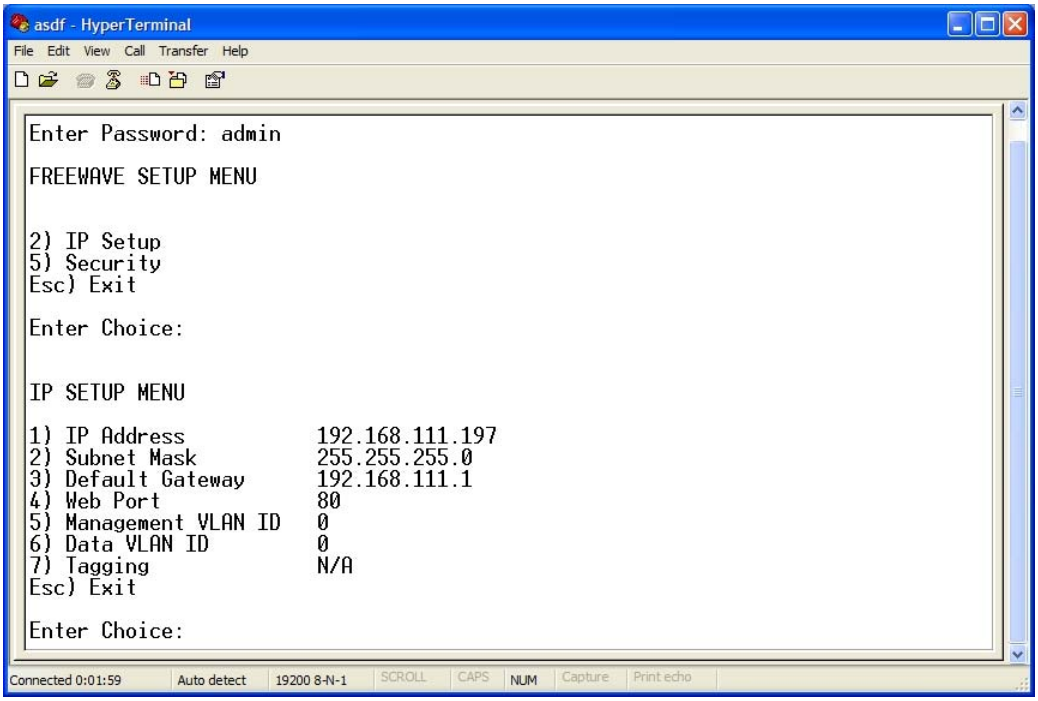
Enter a 'Y' or a 'y' **within 2 seconds** to go into the IP setup of the radio. Any other key will exit, allowing the radio to complete the boot-up. Upon entering a 'Y', a password prompt will appear:



Entering the Administrator password (factory default is **admin**) will bring up the Basic Setup Menu:



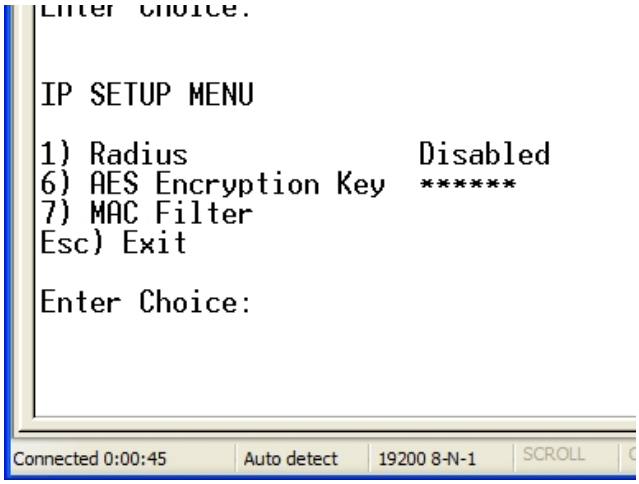
Choosing option 2 will bring up the IP Setup menu:



From this menu, the various IP Address and VLAN settings can be changed.

- Option 1 will change the IP Address of the radio
- Option 2 will change the Subnet Mask (also called Netmask) of the radio.
- Option 3 will change the Default Gateway of the radio.
- Option 4 will change the port number of the radio's Web-based configuration screens.
- Option 5 will change the Management VLAN ID assigned to the radio.
- Option 6 will change the Data VLAN ID assigned to the radio.
- Option 7, **Tagging**, will display "N/A" unless VLAN IDs are entered. Once VLAN IDs have been assigned, choosing option 7 will toggle the option between **Tagged** and **UN-Tagged**.

Selecting option 5 from the main Setup Menu will bring up the Security menu:



From this menu, some of the various security options can be changed.

- Option 1 will toggle RADIUS authentication between **Enabled** and **Disabled**.
- Option 6 will edit the AES Encryption Key.
- Option 7 will prompt for MAC addresses. Entering an address will enable the MAC filtering (*see **p. 42***).

Exiting the Setup Menu will initiate a reboot of the radio.

FreeWave Discovery Server

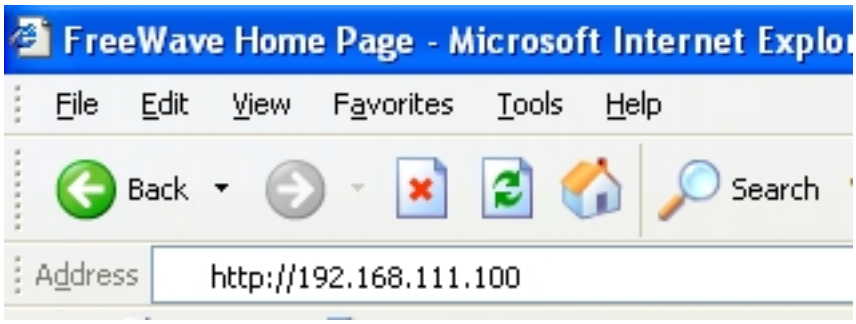
The IP Address of an IP Mini radio can also be set using the FreeWave Discovery Server. For more information on the FreeWave Discovery Server, please see **Appendix E** (***p. 74***).

Resetting Radio to Default Settings:

Follow the steps for accessing Basic IP Setup as indicated on pages 9—14. When the "**Enter Password:**" prompt appears, the password "**default**" can be entered. The radio will then reboot, and all of the radio settings will be reset to the factory defaults (*see **p.58***).

Accessing Setup:

This section will discuss how to setup the settings in an IP Mini radio.
Plug the radio into either a computer or a switch/router using a RJ-45 cable. Open a web browser (IE, Netscape, Firefox, etc.) and type the IP address of the radio into the address bar. For example, to access an IP Mini radio with an IP address of 192.168.111.90, type "http://192.168.111.90" into the address bar of the web browser. A static IP address on the same subnet may need to be assigned to the router/switch and/or the computer to access the radio (*see* **Appendix D, *p. 73***). The default IP address from the factory is **192.168.111.100**.



A prompt for a user name and password will appear. The default username for the Administrator login is '**admin**' and the password is '**admin**'. The default username for the Guest login is '**guest**' and the password is '**guest**'.

The Administrator login has full permission to change all settings on the radio, including Firmware upgrades. The Guest login can only view the settings. The Guest login can see the Status, IP Setup, Serial Gateway Setup, and Radio Setup pages. The Guest login cannot save any changes, cannot see the Security or Tools pages, and cannot reboot the radio.

Status:

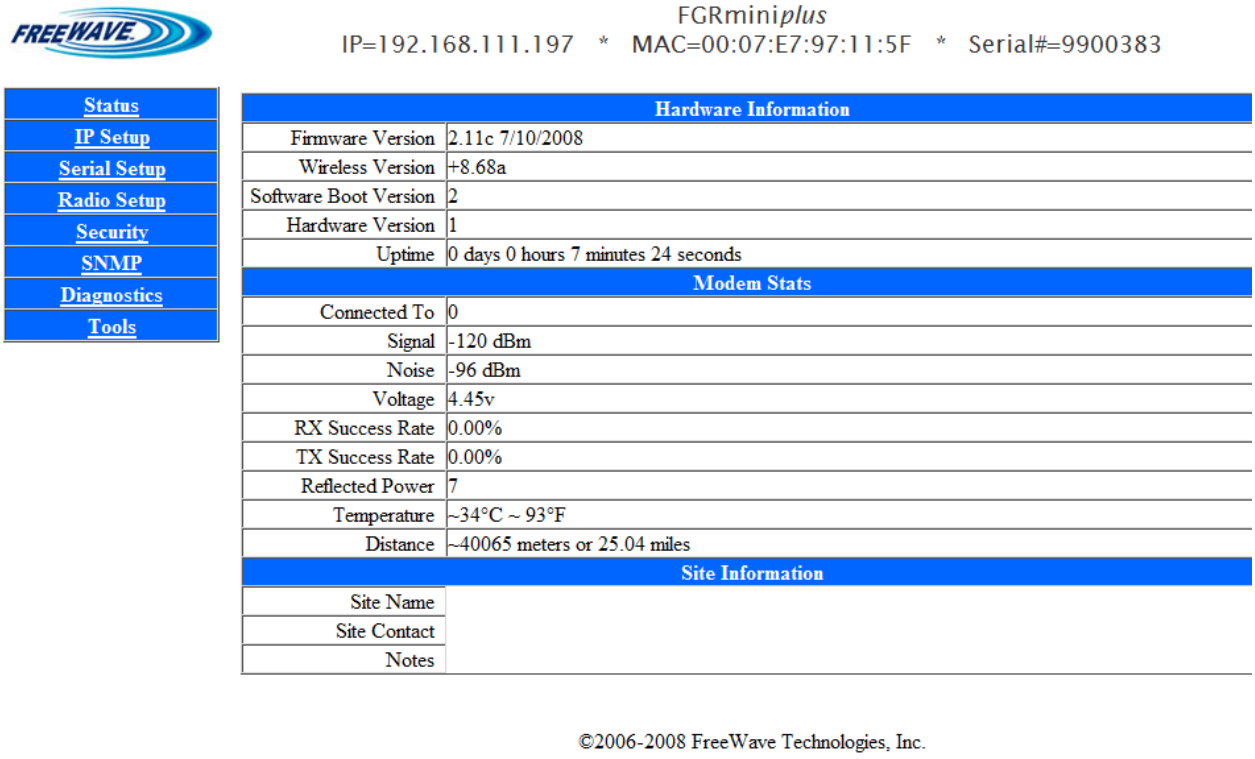
This page will include all of the device information. Nothing on this screen is user adjustable. This page will not automatically refresh.

Hardware Information

This is displayed at the top of every page in the radio setup. It displays the model name of the radio, the radio's IP Address, the radio's MAC address, and the radio's Serial Number.

Firmware Version

This displays the current version number of the firmware revision installed on the radio.



Wireless Version

This displays the current version number of the Radio Frequency module's firmware.

Software Boot Version & Hardware Version

These settings are for internal FreeWave use. When speaking with a Technical Support representative, they may ask for this information.

Uptime

This is the total time the radio has been running since the last reboot.

Connected To

This field will display the serial number of the radio's upstream connection (i.e. the Gateway or a Repeater). This statistic will display a '0' in a Multipoint Gateway.

Signal

The Signal field indicates the level of received signal at this transceiver. The signal source is the transceiver that transmits to it. The number is an average of the received signal levels measured at each frequency in the transceiver's frequency hop table. For a reliable link, the margin between Signal and Noise should be at least 30dBm. Low average signal levels can often be corrected with higher gain antennas, better antenna placement and/or additional Repeaters.
Note: Please consult the install manual for antenna and FCC requirements.

Noise

The Noise field indicates the level of background noise and interference at this transceiver. The number is an average of the noise levels measured at each frequency in the transceiver's frequency hop table. Ideally, noise levels should be below –80dBm and the difference between the average signal level and average noise level should be 30dBm or more. Noise levels significantly higher than this are an indication of a high level of interference that may degrade the performance of the link. High noise levels can often be mitigated with band pass filters, antenna placement or antenna polarization.

Voltage

This displays the voltage of the power being supplied to the radio.

RX Success Rate

This statistic shows the percentage of packets successfully received by this radio. This statistic will show '0.00%' in a Multipoint Gateway. This statistic is only valid in a Multipoint network. FreeWave recommends a minimum of 75% for proper radio operation.

TX Success Rate

This statistic shows the percentage of packets sent by the radio that successfully reached the upstream radio (i.e. the Gateway or a Repeater). This statistic will show '0.00%' on a Multipoint Gateway or Multipoint Repeater. This statistic is only valid on Multipoint Endpoint ra-

dios. FreeWave recommends a minimum of 75% for proper radio operation.

Reflected Power

This is a measurement of the transmitted power that is reflected back into the transceiver from mismatched antennas, mismatched cables, or loose connections between the transceiver and the antenna. A reading of 0-5 is **good**. 5-29 is **acceptable to marginal**. 30+ is **unacceptable** and indicates that the connections should be inspected for loose connections and cable quality.

Temperature

This indicates the current operating temperature of the radio in both degrees Celsius and degrees Fahrenheit.

Distance

This is the distance between this radio and the radio to which it is directly linked. Distances greater than 3/5 of a mile are typically accurate to within 100 feet. Shorter distances are not reported accurately.

Site Name / Site Contact / Notes

These are user-defined fields. The values for these fields can be entered under the Tools page.

Important note

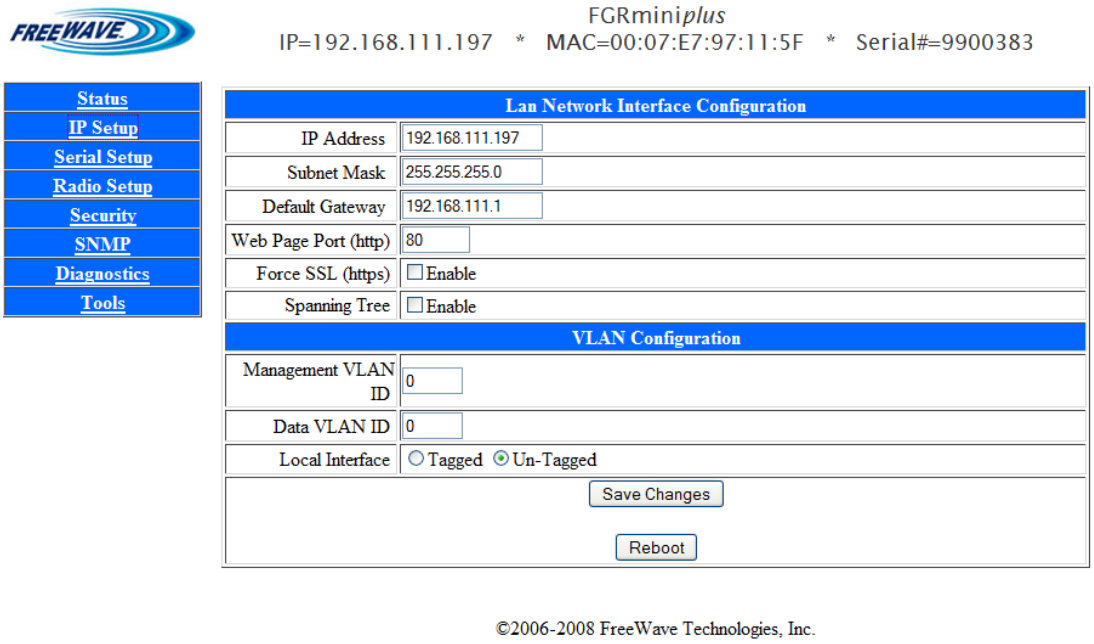
When changing settings in the radio, **Save Changes** must be selected after every page and a **Reboot** must occur when changes in the radio are complete. If this is not done, the settings will not be changed.

IP Setup:

This page is used to setup the IP address, Subnet Mask, and Default Gateway of the radio. Please check with a Network Administrator before adjusting these settings. These settings are also available through **Basic IP Setup** (*see* ***p. 9***) or the **Discovery Server** (*see* ***p. 74***).

IP Address / Subnet Mask / Default Gateway

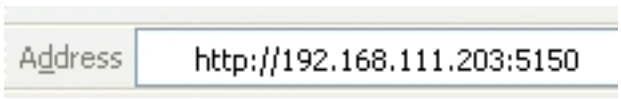
A unique IP address will need to be assigned to each IP Mini radio modem. The IP addresses must be in the proper subnet. A Network Administrator will be able to assign the proper IP addresses for the radios. Putting multiple devices on the network with the same IP address can cause the whole network to crash. It is also possible to have a transparent bridge with an IP address of 255.255.255.255 but serial port functionality, the Security features, and access to the Web-based setup pages will be lost. To reassign a valid IP address, follow the instructions in **Basic IP Setup** (*see* ***p. 9***) or use the **Discovery Server** (*see* ***p. 74***). The Subnet Mask and Default Gateway are normally assigned by a network administrator.



Web Page Port

This setting allows the assigned port for the Web interface Setup pages to be changed. The default setting is port 80, the standard Web page port. If this setting is changed from port 80, the proper port number must be included when accessing the Setup pages:
http://<IP address>:<Port>, where **<IP address>** is the IP address of the IP Mini radio, and **<Port>** is the port number assigned in the IP Setup page. Any valid TCP port can be entered from 1 to 65535. If an invalid TCP port is entered, the IP Mini will default the Web Page Port setting to 80. In the example below, the Web Page port was changed to 5150.

Example:



Force SSL

Checking the **Enable** box will redirect any HTTP requests to the configuration pages through an HTTPS link using SSL. Web page performance will be slower with this option enabled, due to the encryption requirements. The radio does not have to be rebooted for this setting to take effect.

Spanning Tree

Checking the **Enable** box will cause a Gateway radio to utilize Spanning Tree Protocol (IEEE 802.1D). This will eliminate the possibility of the radios creating a network loop, which can cause network-wide problems. FreeWave Technologies recommends leaving Spanning Tree **unchecked**, unless Spanning Tree Protocol is required by your application.

Management VLAN ID

Computers and devices using the VLAN ID entered here will be able to access the radio's Setup screens and serial ports via Ethernet.

Data VLAN ID

Data using this VLAN ID will be allowed to come into or be sent out of the radio's local Ethernet port.

Local Interface

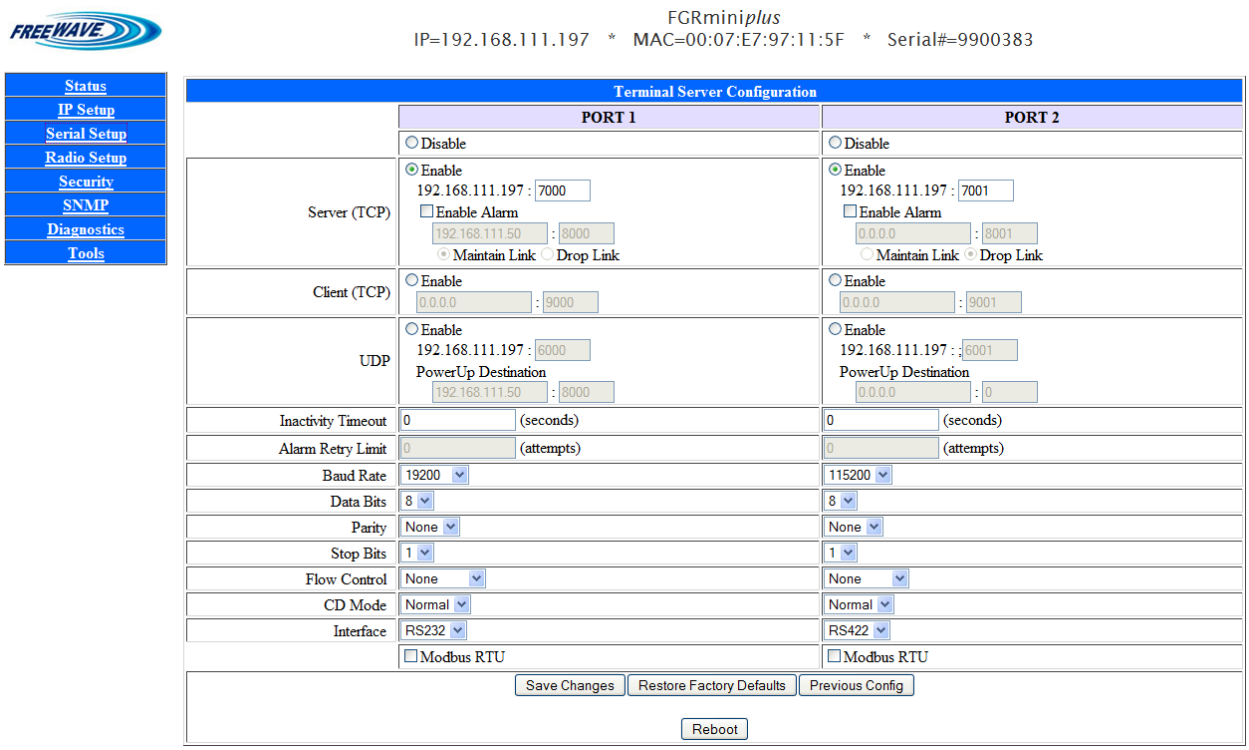
Tagged: If the data coming into the radio's local Ethernet port is tagged with a VLAN ID, select this option. The radio will bridge the data, leaving the VLAN ID as-is.

Un-Tagged: If the data coming into the radio's local Ethernet port is **not** tagged with a VLAN ID, select this option. The radio will accept the data, tag it with the VLAN ID entered in the **Data VLAN ID** field, and send it across the radio link. Data arriving at this radio and being sent out of the local Ethernet port will have any VLAN tag removed before being sent out of the port.

****NOTE**** Not every network needs or uses VLAN IDs. The **Management VLAN ID** setting and the **Data VLAN ID** setting are normally kept at **0**. Changes to these settings should be approved by a Network Administrator.

Serial Setup:

This is where the port numbers and data settings for each serial port can be assigned. These settings need to match the device to which each port is connected. The ports are independent of each other: they can have different baud rates, parity, protocol, etc. To access either port, a client will need to call the IP address of the radio plus the port number. If both ports are disabled, the Basic IP Setup will still work through **SERIAL 1** (J7).



Disable

Choosing this radio button disables the associated serial port, preventing it from accepting data or a TCP connection.

Server (TCP)

Selecting the **Enable** radio button in this section enables the entered port on the radio as a TCP terminal server (its default mode). The IP address of the radio is shown under the radio button. The port number box comes after the IP address, and is user-configurable. This port number will be the TCP port that the radio listens to for connection requests. Any valid TCP port from **1** to **65535** can be entered. In the picture above, Port 1 is set for port 7000.

Enable Alarm

Checking this box enables the associated port on the radio as an alarm client. To use this function, the **Server** port number box must also be configured. The radio will act as a terminal server on the port specified in the port number box. *(see also:* **Server**, *above)* If

there is no TCP connection to the **Server** IP address and port number, and serial data is received on the local serial port, the radio will become a client and make a connection to the IP address and port number specified in the **IP Address** and **Port Number** boxes under the **Enable Alarm** checkbox. Choosing **Maintain Link** will keep the connection to the remote IP Address and port number active until the radio is rebooted or the server side drops the link. Choosing **Drop Link** will cause the outgoing connection to be dropped as soon as the serial data is sent.

Client (TCP)

Choosing this radio button enables the radio to act as a TCP client to the entered IP address and port number. Upon power-up, the radio will create a persistent outgoing TCP connection to the listed IP address and port number. Any data set to the associated serial port on the radio is automatically directed to the listed IP address and port number.

UDP

Selecting the **Enable** radio button in this section enables the entered port on the radio as a UDP terminal server. The IP address of the radio is shown under the radio button. The port number box comes after the IP address, and is user-configurable. This port number will be the UDP port that the radio listens to for requests. Once a request comes into that port, the radio will send any incoming serial data to the IP address of the requesting device. The radio will continue doing so until a new device makes a request on that UDP port. The radio will always send the serial data to the address of the last successful requesting device.

PowerUp Destination

In this section, an IP Address and Port Number can be entered. Before an incoming UDP request has been received, the IP Address and Port number entered here will be where the radio sends any serial data coming into its serial port. Once a UDP request is received, the radio will operate as listed above.

Inactivity Timeout

This setting controls how long an incoming connection must be idle (i.e. no data being transferred) before the radio drops the connection. This setting is in seconds. A setting of "0" means that the radio will never disconnect an idle connection—all disconnects will need to come from the client-side.

Alarm Retry Limit

This setting is the number of times the radio will attempt to create an outgoing TCP connection when acting as an alarm client (*see **Enable Alarm, p. 21***). When the radio reaches the number of retries listed in this setting without a successful connection, it will cease trying and act as if no alarm was received. The incoming data will be flushed from the radio's data buffer. If new incoming data is received, the radio will attempt to connect again. A setting of "0" means that the radio will continuously try to connect to the alarm server until the radio is rebooted.

Baud Rate

This setting is the communication rate between the serial port on the radio and the instrument to

which it is connected. It is important to note that this is independent of the baud rate for any other transceivers in the network. It is also independent of the other serial port on the radio. For example, a pair of transceivers may be used in an application to send data from remote process instrumentation to an engineer's computer. In this application, the baud rate for the transceiver on the instrumentation might be set to 9600, and the transceiver on the engineer's computer might be set to 57,600. A serial radio may be attached to one port and an RTU/PLC/End Device attached to the other. In this case, one port might be set at 115,200 and the other might be set at 9,600. It is usually most desirable to set the baud rate to the highest level supported by the device to which it is connected. In certain circumstances, however, this may actually result in slower data communications (i.e.: trying to run higher baud rates [38400 and higher] without flow control).

Data Bits

This option sets the number of data bits the serial port will send. This should match the number of data bits the connected device requires or is set to. The available settings are: **5**, **6**, **7**, and **8**.

Parity

This option sets the parity type the serial port will use. This should match the parity required by the connected device's settings. The available settings are: **None**, **Even**, and **Odd**.

Stop Bits

This option sets the number of stop bits the serial port will send. This should match the number of stop bits required by the connected device's settings. The available settings are: **1** and **2**.

Flow Control

This option sets whether hardware flow control will be used on this serial port. The available settings are:

None Uses software flow control (XON / XOFF)
Hardware Hardware flow control (RTS / CTS)

CD Mode

This controls the function of the CD line on the serial port.

Normal CD is asserted when a TCP connection to the associated port is made, and de-asserted when the TCP connection is closed. Most serial devices will use this option.

Keyed CD asserts 500 µs before transmit, and de-asserts 1 ms after the transmission of the first bit of the last byte of data. This option should be used with serial devices that require the CD line to be asserted prior to the transmission of data.

Please see Appendix C (***p. 72***) for a wiring example.

Interface

This option sets the serial protocol the serial port will use. This should be set to **RS232**. **The IP Mini can only handle RS232 protocol on its serial ports.** See **page 63** for pinout information.

Modbus RTU

This option adjusts for Modbus RTU timing. When enabled, the radio will gather data on the serial port until there is a break in the data due to Modbus RTU timing. The data is then sent as one large TCP packet.

Diagnostics Link *(not shown)*

Clicking on the **Diagnostics** link at the bottom of this page will open a new window which displays Terminal Server Diagnostics. For each serial port, the current status of the Terminal Server is listed first (Waiting, Connected, etc.).
The **TCP** line shows the amount of data received (rx) and transmitted (tx) to and from the Terminal Server. This amount is in bytes.
The **Serial** line shows the amount of data received (rx) and transmitted (tx) to and from the serial port. This amount is in bytes.

Serial Port 1	
Waiting For Client to Connect on port 7000	
TCP	rx= 0, tx= 0
Serial	tx= 0, rx= 0

Serial Port 2	
Waiting For Client to Connect on port 7001	
TCP	rx= 0, tx= 0
Serial	tx= 0, rx= 0

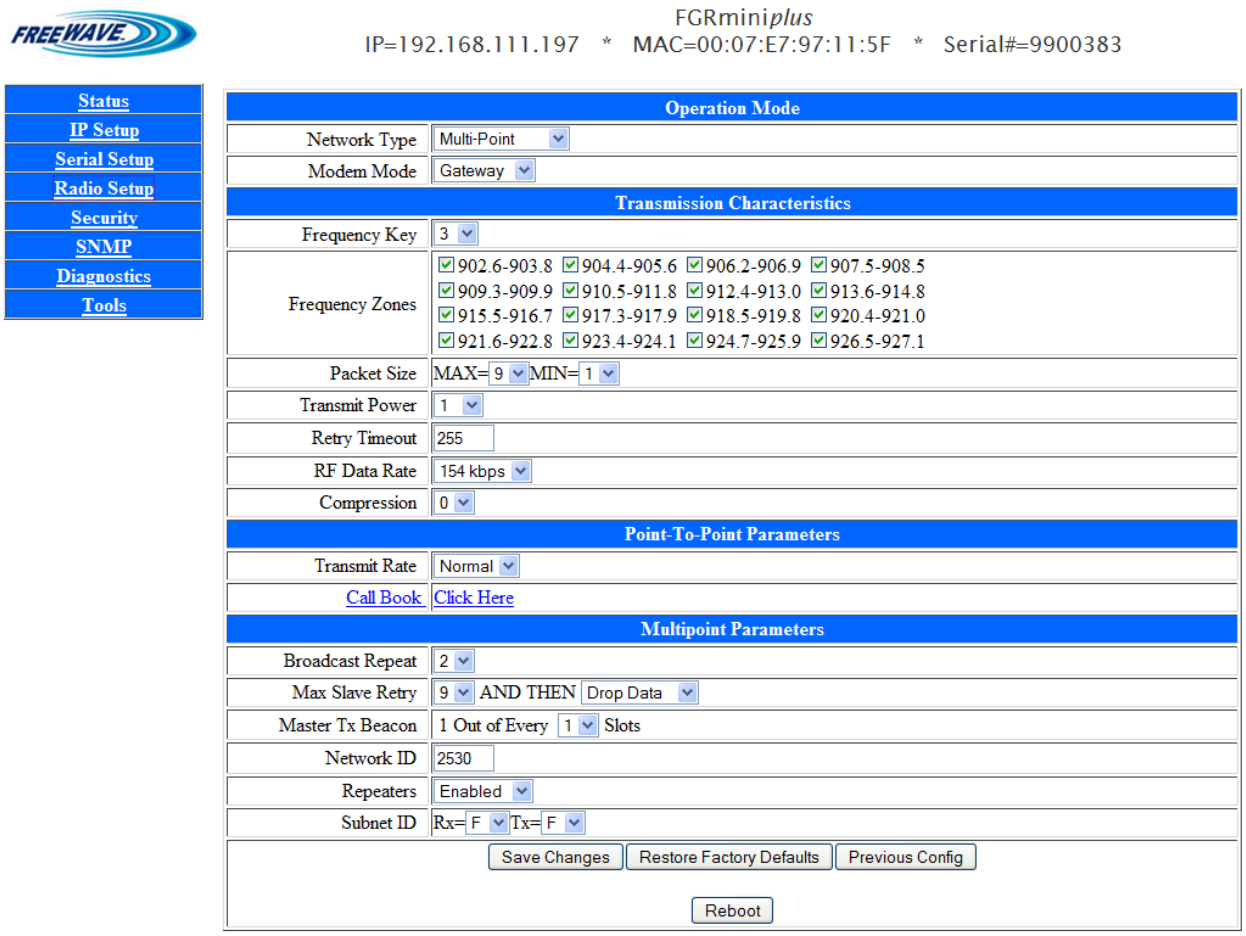
Radio Setup:

This page is where the radio's Operation Mode, Transmission Characteristics, Multipoint Parameters, and the Call Book can be set up.

When setting the operation mode, there are two menus: Network Type and Modem Mode. The Network Type is either Point-To-Point or Multi-Point. The Modem Mode is either Gateway (Master), Repeater, or Endpoint (Slave).

In Point-To-Point mode, the repeater is not an Endpoint/Repeater. The Call Book must also be used in Point-To-Point mode.

In Point-To-Multipoint mode, either the Call Book or Network ID can be used. Any Repeater in a Point-To-Multipoint network will be a Endpoint/Repeater.



Network Type / Modem Mode

The Network Type and Modem Mode options designate the method FreeWave transceivers use to communicate with each other. FreeWave IP Mini transceivers operate in a Gateway to Endpoint configuration. Before the transceivers can operate together, they must be set up to properly communicate.

In a Point-to-Point configuration, the Gateway Mode should be used on the end which will be connected to the LAN. When setting up the transceiver, remember that a number of parameters are controlled by the settings in the Gateway. Therefore, deploying the Gateway on the communications end where it will be easier to access is strongly advised.

Operation Mode	Description
Point-to-Point & Gateway	This mode designates the transceiver as the Gateway in Point-to-Point mode. The Gateway may call any or all Endpoints designated in its Call Book. A quick method of identifying a Gateway is to power the transceiver. Prior to establishing a communication link with a Endpoint or Repeater, all three of the Gateway's lower LEDs (CD, TX, CTS) will be solid red.
Point-to-Point & Endpoint	This mode designates the transceiver as an Endpoint in Point-to-Point mode. The Endpoint communicates with any Gateway in its Call Book—either directly or through up to four Repeaters. When functioning as a Endpoint, the **Entry to Call** feature in the transceiver's Call Book is not operational.
Multipoint & Gateway	This mode designates the transceiver as a Gateway in Multipoint mode. This mode allows one Gateway transceiver to simultaneously be in communication with numerous Endpoints and Repeaters. A Point-to-Multipoint Gateway communicates only with other transceivers designated as Point-to-Multipoint Endpoints or Point-to-Multipoint Repeaters.
Multipoint & Endpoint	This mode designates the transceiver as an Endpoint in Multipoint mode. This mode allows the Endpoint to communicate with a Multipoint Gateway. The Endpoint may communicate with its Gateway through one or more Repeaters.
Point-to-Point & Repeater	FreeWave allows the use of up to four Repeaters in a Point-to-Point communications link, significantly extending the operating range. When designated as a Point-to-Point Repeater, a transceiver behaves as a pass-through link. All settings for the call book, baud rates and radio transmission characteristics are disabled. A Repeater will connect with any Gateway that calls it. The Repeater must be set up properly in the Gateway's call book. **This Network Type and Modem Mode should be the ones used when operating the IP Mini as a terminal server only (no RF connectivity). Adding a repeater to the radio network results in greatly reduced throughput—over 50% less.**
Multipoint & Repeater	This option allows the transceiver to operate as an Endpoint/Repeater in a Multipoint network. **Adding a repeater to the radio network results in greatly reduced throughput—over 50% less. Some advanced features of the IP Mini radios do not operate in networks containing Repeaters. FreeWave Technologies does not recommend the use of Repeaters.**

Transmission Characteristics

The Transmission Characteristics section of the Radio Setup page allows the user to modify several different parameters in the transceiver. Many of these parameters must be maintained throughout the network for proper functionality.

Note: This section is **only** for the advanced user who has a good understanding of the principles of radio data transmission.

In a Point-to-Point network, the settings for the Endpoints and Repeaters that are not determined by the Gateway are **Transmit Power, Retry Time Out**, and **Compression**. All other settings are determined by the Gateway radio's settings.

Frequency Key

The Frequency Key setting in the Radio Setup menu allows the user to modify the hopping patterns of the transceiver. There are 15 choices available for the Frequency Key setting (0-9 and A-E), representing 15 different pseudo-random hop patterns. This is to minimize the interference with other FreeWave transceivers operating in the area. For instance, if there were 10 pairs of FreeWave transceivers operating on different networks in close proximity, setting a different Frequency Key value reduces the chance that transceivers will hop to the same frequency at the same time. If two networks were to hop to the same frequency, the next hop would be to a different frequency for both networks.

Additional network separation can be gained by adjusting the Max and Min packet sizes.

Frequency Zones

The idea of frequency zoning is to divide the available band (902MHz to 928 MHz) into smaller bands, in this case 16 smaller bands each consisting of 7 or 8 frequency channels. These 16 Zones are listed in the **Frequency Zones** section of the **Radio Setup** page. A checkmark indicates that zone will be used by the radio. A blank box indicates the radio will not use those frequencies. The zones listed are in MHz. The radio requires at least one zone active to operate. If all Frequency Zones are de-selected, the radio will operate as if all zones were selected.

Any Endpoint or Endpoint/Repeater radios will take their Frequency Zone settings from the Gateway radio, regardless of Network Type. Therefore, it is only necessary to change this section on the Gateway radio.

Packet Size

The Max and Min Packet Size settings and the RF Data Rate determine the number of bytes in the packets. Throughput can be enhanced when packet sizes are optimized. In Point-to-Point mode, the Max and Min Packet Settings will not have material impact on throughput unless 92 Kbps is desired. However, this may have an impact on latency. For example, if small amounts of data are sent and large packet sizes are selected, there would be a certain amount of time "wasted" between each packet.

The following tables provide the information to determine optimum setting values.

The default settings for Max packet size, Min packet size, and RF Data Rate on the IP Mini are 9, 1, and 115 Kbps, respectively.

The following tables define the Minimum packet size (in bytes) by way of charting the Min Packet Size setting versus the RF Data Rate setting. Using the default settings, the actual minimum packet size for the radios, in bytes, is 12.

Minimum Packet Size Definition IP Mini		
Min Setting	**Min Packet Size (bytes) RF Data Rate = 154 Kbps**	**Min Packet Size (bytes) RF Data Rate = 115 Kbps**
0	15	8
1	21	12
2	26	16
3	31	20
4	37	24
5	42	28
6	47	32
7	53	36
8	58	40
9	63	44

The following table defines the Maximum packet size (in bytes) by way of charting the Min Packet Size setting versus the Max Packet Size setting where the RF Data Rate is set to 154 kbps.

Maximum Packet Size Definition (bytes) with RF Data Rate of 154 kbps										
	Max Setting									
Min Setting	0	1	2	3	4	5	6	7	8	9
0	15	37	58	79	101	122	143	165	186	207
1	21	42	63	85	106	127	149	170	191	213
2	26	47	69	90	111	133	154	175	197	218
3	31	53	74	95	117	138	159	181	202	223
4	37	58	79	101	122	143	165	186	207	229
5	42	63	85	106	127	149	170	191	213	234
6	47	69	90	111	133	154	175	197	218	239
7	53	74	95	117	138	159	181	202	223	245
8	58	79	101	122	143	165	186	207	229	250
9	63	85	106	127	149	170	191	213	234	255

The following table defines the Maximum packet size (in bytes) by way of charting the Min Packet Size setting versus the Max Packet Size setting where the RF Data Rate is set to 115 kbps. Using the default settings, the actual maximum packet size, in bytes, is 156.

Maximum Packet Size Definition (bytes) with RF Data Rate of 115 kbps										
	Max Setting									
Min Setting	0	1	2	3	4	5	6	7	8	9
0	8	24	40	56	72	88	104	120	136	152
1	12	28	44	60	76	92	108	124	140	156
2	16	32	48	64	80	96	112	128	144	160
3	20	36	52	68	84	100	116	132	148	164
4	24	40	56	72	88	104	120	136	152	168
5	28	44	60	76	92	108	124	140	156	172
6	32	48	64	80	96	112	128	144	160	176
7	36	52	68	84	100	116	132	148	164	180
8	40	56	72	88	104	120	136	152	168	184
9	44	60	76	92	108	124	140	156	172	188

Referencing the default settings, the Gateway will transmit up to 156 bytes on every hop. If fewer than 156 bytes are transmitted, the balance is allocated to the Endpoint's transmission, plus the quantity in the Min Packet Size Setting. For example: if a Gateway transmits 100 bytes, the Endpoint will then have a total of 68 bytes available [56 ("leftover bytes") + 12 (Min packet size)].

Transmit Power

This option sets the transmit power of the radio. A setting of **10** is approximately 1W of output power from the radio.

Setting	Power (in mW)
0	5
1	10
2	35
3	80
4	140
5	230
6	330
7	480
8	600
9	800
10	1000

Retry Time Out

The Retry Time Out parameter in an Endpoint or Repeater sets the delay the unit will wait before dropping the connection to a Gateway or Repeater in Multipoint mode. The factory default is set at the maximum of 255. The maximum setting means that if 1 packet in 255 is sent successfully from the Gateway to the Endpoint or Repeater, the link will be maintained. The minimum setting is 8. This allows an Endpoint or Repeater to drop a connection if less than 1 in 8 consecutive packets is successfully received from the Gateway.

The function in the Gateway is effectively the same. With a setting of 255, the Gateway will allow an Endpoint or Repeater to stay connected as long as 1 packet in 255 is successfully received at the Gateway.

The Retry Time Out parameter is useful when a Multipoint network has a roving Gateway or Endpoint(s). As the link gets weaker, a lower setting will allow a poor link to break in search of a stronger one.

Note: Setting Retry Time Out to 20 is recommended in areas where several FreeWave networks exist. This setting will allow Endpoints and Repeaters to drop the connection if the link becomes too weak, while at the same time prevent errant disconnects due to interference from neighboring networks.

While intended primarily for Multipoint networks, the Retry Time Out parameter may also be modified in Point-to-Point networks. However, the value in Point-to-Point mode should not be set to less than 151.

RF Data Rate

IP Mini transceivers have two settings for the RF Data Rate: 154 Kbps and 115 Kbps. RF Data Rate should not be confused with the serial port Baud Rate. A setting of 154 Kbps should be used when the transceivers are close together and data throughput needs to be optimized. A setting of 154 Kbps must also be used when the full throughput of 92 Kbps is necessary. A setting of 115 Kbps should be used when the transceivers are farther away and a solid data link is preferred over data throughput.

The maximum available throughput available to an IP Mini radio is:

- 70 kbps at an RF Data Rate of 115 kbps
- 92 kbps at an RF Data Rate of 154 kbps

Note: In Multipoint networks, the RF Data Rate must be set identically in all transceivers. Any transceiver with an RF Data Rate different from the Gateway will not establish a link. In Point to Point networks the Gateway's settings take precedence over the Endpoint.

Compression

This option enables or disables data compression within the IP Mini radio. The settings are:
0: Compression is disabled
1: A compression algorithm is used which slightly compresses most types of data, resulting in a moderate increase in throughput—approximately 20%
2: A compression algorithm is used which attempts to greatly compress data. For compressible data (text, uncompressed images, etc.) this can result in a significant throughput increase—approximately 50%. For uncompressible or already compressed data (JPEGs, MP3, ZIPs, etc.), however, this mode will most likely **REDUCE** the throughput.

NOTE: When **Compression = 2**, Peer-to-Peer throughput (i.e. Endpoint-to-Endpoint, Endpoint-to-Repeater, or Repeater-to-Endpoint throughput) is **GREATLY** reduced. FreeWave technologies does not recommend using **Compression = 2** if Peer-to-Peer functionality is needed.

Point-to-Point Parameters

The items in this section are mainly set in Point-to-Point Networks, although they do have some usage in Multipoint networks.

Transmit Rate

There are two settings for the Transmit Rate parameter. The setting for normal operation of the transceiver is **Normal**. The rate of **Diagnostics** is useful to qualitatively gauge signal strength in Point-to-Point mode. When set to **Diagnostics**, the transceivers will transmit back and forth continuously regardless of whether they have any actual data or not. In Point-to-Point operation,

a Transmit Rate of **Diagnostics** should be used only as a diagnostic tool and not for normal operation. The strength of the signal may be gauged by the Clear to Send LED. A solid red CTS LED indicates a strong signal; a blinking CTS LED indicates a weaker signal.

Call Book:

Call Book			
Entry To Call	Gateway --> Repeater 1 --> Repeater 2 -->		
All	EndPoint Serial Number	1st Repeater Serial Number	2nd Repeater Serial Number
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			

(Use EndPoint Value of 9999999 For Repeater Links Of 3 or More)

Save Changes

Clear

The Call Book is required to be used in Point-to-Point networks. While the call book is an option in Point-to-Multipoint networks, the Network ID feature is strongly recommended in most applications.

The instructions provided in this section are for Point-to-Point mode only. Use of the Call Book for Multipoint networks is explained later in this chapter.

Using the Call Book offers both security and flexibility in determining how FreeWave transceivers communicate with each other.

Three settings must be made for two FreeWave transceivers to communicate in Point-to-Point mode:

The Gateway's Serial Number must be listed in the Endpoint's Call Book.

The Endpoint's Serial Number must be listed in the Gateway's Call Book.

The Gateway must be programmed to call the Endpoint.

The Call Book allows users to incorporate up to 10 FreeWave transceivers, designate 1 to 4 Repeaters to be used with each transceiver, and designate which Endpoint the Gateway will call. If a call book entry utilizes 3 or 4 repeaters, then the total number of available Endpoint entries will be reduced, as an extra Call Book line would be in use for the Repeaters. To set the **Entry to Call** option, select the radio button next to the Serial Number of the Radio that will be called.

Note: To call a Endpoint through one or more Repeaters, that Endpoint must be called individually. With Call All selected, the Gateway will not connect with any Endpoints through Repeaters. The Gateway calls every Endpoint in the list and will connect with the first Endpoint that responds. When calling through a Repeater, the Gateway must first call that Repeater and establish a communication link with it prior to making contact with the Endpoint.

Programming Point-to-Point Extended Call Book to Use Three or Four Repeaters

In a Point-to-Point configuration the IP Mini radios can utilize up to 4 Repeaters (*see* **Errata***, p. 67*). To use 3 or 4 Repeaters, program the Call Book with the Endpoint's Serial Number, followed by the first 2 Repeaters. On the next line enter 9999999 as the transceiver to call. When prompted for the Repeaters enter the third and fourth Repeaters in the link.

Call Book

Entry To Call	Gateway --> Repeater 1 --> Repeater 2 -->		
All	EndPoint Serial Number	1st Repeater Serial Number	2nd Repeater Serial Number
0	8841111	8842222	8843333
1	9999999	8844444	8845555
2			
3			
4			
5			
6			
7			
8			
9			

(Use EndPoint Value of 9999999 For Repeater Links Of 3 or More)

Save Changes

Clear

The illustration above depicts a Point-to-Point link where an Endpoint is called through 4 Repeaters. In this example the Gateway is calling the Endpoint, 8841111, through Repeater 1, 8842222, then Repeater 2, 8843333, then Repeater 3, 8844444, and finally Repeater 4, 8845555. It is the entry of serial number 9999999 in line 1 that instructs the Gateway to continue calling through the Repeaters programmed on that line.

It is important that the Call Book slots (0-9) are filled sequentially starting with slot 0. When a Gateway is instructed to Call All, it will call all Endpoints listed until it reaches the first blank entry. If a valid serial number is entered after the blank entry or as a Repeater, it will not be recognized as a valid number by the Gateway.

Programming Point-to-Multipoint Call Book

In a Multipoint network, the Endpoints and Repeaters are not listed in the Gateway's Call Book. An Endpoint must have the Gateway and any Repeater it is going to use in its Call Book.

Note: If the Network ID feature is used in a Multipoint network, no entries are needed in the Call Book of any of the transceivers. See the Network ID feature on **page 37**.

The following example shows the Call Books of a Multipoint network comprised of a Gateway, Repeater and Endpoint in which the Endpoint can communicate either through the Repeater or directly to the Gateway:

Multipoint Gateway Call Book (Unit Serial Number 884-1111)

Entry	Number	Repeater1	Repeater2
(0)	000-0000		
(1)	000-0000		

No serial number entries are necessary in the Gateway's Call Book.

Multipoint Repeater Call Book (Unit Serial Number 884-2222)

Entry	Number	Repeater1	Repeater2
(0)	884-1111		
(1)	000-0000		

Multipoint Endpoint Call Book (Unit Serial Number 884-3333).

Entry	Number	Repeater1	Repeater2
(0)	884-1111		
(1)	884-2222		
(2)	000-0000		

At times it may be desirable to force an Endpoint to go through a specific Multipoint Repeater. In this scenario, the Endpoint's Call Book should contain only the Serial Number for that Repeater as the entry on line 0.

Programming Point-to-Multipoint Extended Call Book

In a Multipoint network, an Endpoint can be programmed to roam between Gateways and Repeaters using the Multipoint Extended Call Book function. An Endpoint with its Call Book configured as below will communicate with any transceiver whose serial number appears in any of the three columns. This functionality is enabled by setting Network ID to 255. Then, in the Call Book, enter 9999999 as the last entry in the first and second columns, and set **Entry to Call** to ALL.

Call Book

Entry To Call	Gateway --> Repeater 1 --> Repeater 2 -->		
All	EndPoint Serial Number	1st Repeater Serial Number	2nd Repeater Serial Number
0	8841111	8842222	8843333
1	8844444	8845555	8846666
2	8847777	8848888	8849999
3	8840000	8840101	8840202
4	8840303	8840505	8840606
5	8840707	8840808	8840909
6	8841010	8841212	8841313
7	8841414	8841515	8841616
8	8841717	8841818	8841919
9	9999999	9999999	8842020

(Use EndPoint Value of 9999999 For Repeater Links Of 3 or More)

Save Changes

Clear

Multipoint Network

When installing Multipoint networks it is important to do some up-front planning. Unlike Point-to-Point networks, a Point-to-Multipoint network requires that several parameters are set consistently on all transceivers in the network. This includes **RF data rate**, **Min** and **Max Packet Size**, and **Frequency Key**.

Note: If several independent Multipoint networks are to be located in close proximity, the planning becomes more critical. In such cases, it becomes very important to include as much frequency and time diversity as possible through use of different Frequency Key and Packet Sizes.

Multipoint Parameters

Broadcast Repeat

In a Point-to-Multipoint network, Endpoints do not acknowledge transmissions from the Gateway. If Endpoints did acknowledge all data transmissions, in a large network the Gateway would soon become overwhelmed with acknowledgments from the Endpoints. Without acknowledgements, there is not 100% confidence that every Endpoint has received every packet. To address this issue, the user may modify the Broadcast Repeat setting, assigning a value between 0 (the packet is transmitted once) to 9 (the packet is transmitted 10 times). For networks with solid RF links, this parameter should be set to a low value such as 1 or 2. If a network has some weak or marginal links it should be set with higher values. If an Endpoint receives a good packet from a Gateway more than once, it will discard the repeated packets. Similarly, once a Multipoint Repeater receives a good packet from the Gateway, it will discard any further repeated packets. In turn, the Repeater will send the packet out to the next Repeater or Endpoint(s) the number of times corresponding to its own Broadcast Repeat setting. Increasing the Broadcast Repeat setting will increase the probability of a packet getting through. With Packetized Protocol, a high Broadcast Repeat setting is desirable in a network with no radios set as a Repeater. The Packetized Protocol feature allows a Gateway radio's outgoing packets to be acknowledged, so the Gateway will only repeat if necessary. In a radio network that contains radios set as a Repeater, Packetized Protocol will not be in effect. Increasing the Broadcast Repeat setting will increase the probability of a packet getting through, but will also increase latency and decrease Gateway-to-Repeater and Gateway-to-Endpoint throughput in the network because each packet from the Gateway or Repeater is being sent multiple times. Therefore, it is important to find the optimal mix between network robustness, throughput, and latency. In general, a setting of 2 to 3 will work well for most well designed networks.

Note: The Broadcast Repeat may be set to 0 if the user software is capable of, or requires, acknowledgment. In this case, if a packet is sent by the Gateway and not received by the Endpoint, the user software will control the retries as needed.

Broadcast Repeat in Multipoint Networks with Repeaters

The Broadcast Repeat parameter must also be set in Multipoint Repeaters, since a Repeater will

appear as a Gateway to an Endpoint. Therefore, the Repeater will send the packet out the number of times corresponding to its own Broadcast Repeat parameter. If this parameter is set improperly, the reliability of the overall network may be diminished. For example, if a Gateway's Broadcast Repeat setting is 3, the link between the Gateway and Repeater should be robust. If the Repeater's Broadcast Repeat is set to 0, this could cause marginal communications between the Repeater and the Endpoints. The Endpoints communicating through this Repeater will only receive the initial packet from the Gateway with no repeats. Therefore, if the packet is not received on the first try, the Endpoint will not respond as expected. The Repeater's Broadcast Repeat setting should not be set any **higher** than the Gateway's—it is all right to set it lower.

Max Slave Retry

This setting controls how the Endpoint retries sending its data when it fails to receive an acknowledgement from the Gateway. The number in the first dropdown box is how many times in a row the Endpoint will retry. After that number of retries has been reached, the Endpoint will then take the action listed in the second dropdown box:

Try Forever: The Endpoint will wait a brief amount of time before starting again with the data retries. It will keep retrying the same packet of data over and over until it succeeds.

Drop Data: The Endpoint will throw away the current data it failed to send. The pattern begins again upon receipt of new data.

Drop Link: The Endpoint will drop its radio link with the Gateway or Repeater for a brief amount of time and then re-link.

Master Tx Beacon

This setting controls the Gateway radio's duty-cycle during idle times. By default, the Gateway transmits every frame, whether there is "payload" data or not. Adjusting the number in the dropdown box higher will cause the Gateway to skip transmit frames when it has no other data to send. This can reduce the power usage from the Gateway during idle times. If data does come into the Gateway radio, the Gateway will transmit that data regardless of this setting. This setting needs to be the same in every radio: Gateway, Repeater, and Endpoint. **NOTE: In any network that has radios with a firmware version lower than 2.10, this setting must be '1 out of every 1 Slots'. NOTE: In a radio network that has the Repeaters option set to "Enabled", this setting must be set to '1 out of every 1 slots'.**

Network ID

Network ID allows Multipoint networks to be established without using the Call Book. The default setting of 255 enables the Call Book. To enable Network ID the value must be set between 0 and 4095 (excluding 255). Since the Network ID does not use serial numbers, Multipoint Gateways and Repeaters may be replaced without reprogramming all of the Endpoints in the network. Endpoints will link with the first Gateway or Repeater that it hears that has a matching Network ID. The Network ID function should be used in conjunction with the Subnet ID feature (If necessary).

Without having the serial numbers in the Call Book, an Endpoint may establish communications with different Gateways, though not at the same time. This is very useful in mobile Multipoint applications.

Repeaters

In a Multipoint network, it is critical to transmission timing to configure this parameter correctly. The value should be Disabled if there are no Repeaters in the network and Enabled if any number of Repeaters are present. This parameter should be set to the same value in all transceivers in a Multipoint network.

Note: Many advanced features of the IP Mini radio do not function correctly in networks where Repeaters are Enabled. For best operation, FreeWave Technologies does not recommend the use of single-radio Repeaters.

Subnet ID

The Subnet ID function only works in Multipoint Networks utilizing the Network ID option. In a Multipoint Network, an Endpoint or Repeater will connect with the first Repeater or Gateway that it hears with the same Network ID. There are scenarios, however, where communications need to be forced to follow a specific path. Subnet ID is particularly helpful to force two Repeaters in the same network to operate in series rather than in parallel, or if desired, to force Endpoints to communicate to a specific Repeater for load balancing purposes. There are two components to the Subnet ID:

Rx Subnet ID: This setting identifies to which transceiver a Repeater or Endpoint will listen.

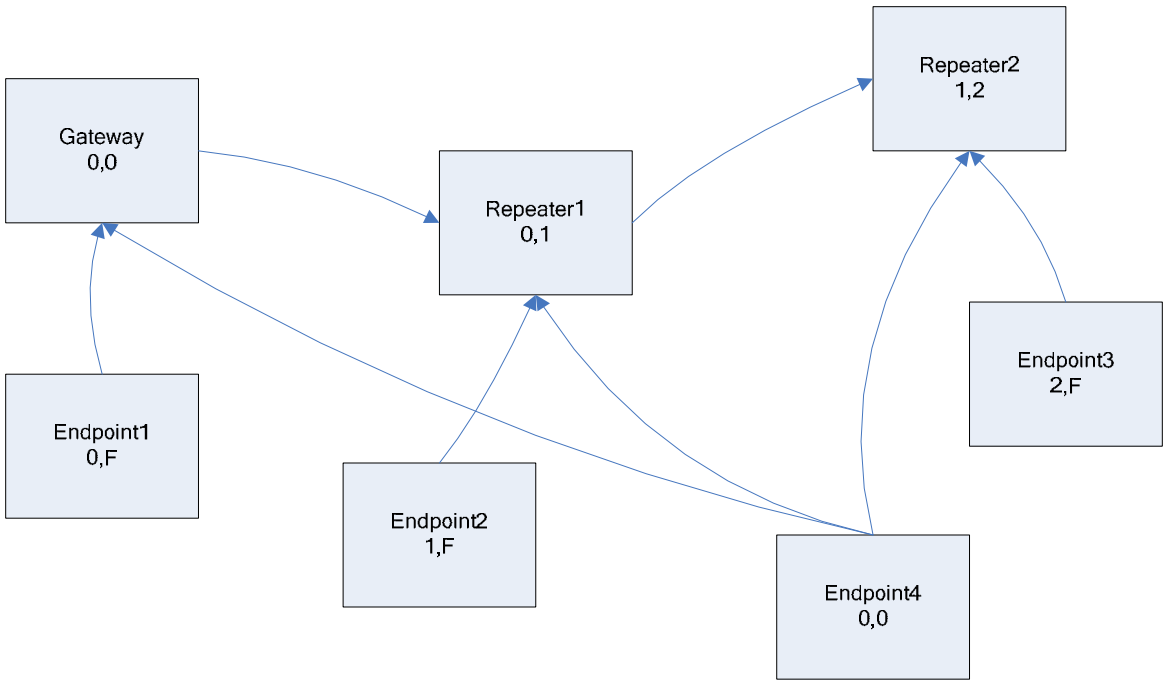
Tx Subnet ID: This setting identifies the ID on which this device transmits, and in turn which devices will listen to it. *The Tx Subnet ID parameter is relevant for Multipoint Repeaters only.*

The default (disabled) setting for both Rx and Tx is F.

Notes: A Gateway set to a Subnet ID of Rx = F, Tx = F will transmit and receive on 0. The Gateway may be set to use alternate Subnet ID values. Changing these settings on the Gateway is not recommended, under normal circumstances.
In some Multipoint Networks, the Frequency Key will be at the same setting for all transceivers. In other networks, where parallel Repeaters are introduced, the Frequency Key value will need to change. See the Frequency Key section (***p. 27***) for more information.

If both Rx Subnet ID and Tx Subnet ID are set to 0, this is known as **Roaming** mode. This setting will allow a mobile Endpoint to roam from subnet to subnet and possibly from network to network.

This drawing depicts a Network in which Subnet IDs are used to force communications. In this example, Repeater1 *must* talk directly to the Gateway and Repeater2 *must* talk directly to Repeater1. Endpoints 1, 2, and 3 are forced along the direction of the solid lines. Endpoint 4 may link to the first Gateway or Repeater it hears. (Rx, Tx)



The respective Subnet ID diagram and settings are shown below.

Subnet IDs for the above example:

Transceiver	Rcv Subnet ID	Xmit Subnet ID	Other Information
Gateway	F	F	The Gateway uses 0,0.
Gateway	0-F	0-F	The Xmit Subnet ID value may be set in the Gateway. The default settings (F, F) actually use 0, 0. The Rcv Subnet ID on the Gateway has no affect on the network.
Repeater1	0	1	A 0 will force the transceiver to link only to the Gateway.
Repeater2	1	2	Rcv SubnetID = 1 forces communication through Repeater1. Repeater1 transmits on SubnetID 1.
Endpoint1	0	0 or F	Rcv SubnetID = 0 forces communication through Gateway.
Endpoint2	1	0 or F	Rcv SubnetID = 1 forces communication through Repeater1.
Endpoint3	2	0 or F	Rcv SubnetID = 2 forces communication through Repeater2.
Endpoint4	0	0	The 0, 0 setting allows the Endpoint to link with the first Gateway or Repeater it hears with the correct Network ID.

Overlapping Multipoint Networks

Overlapping Multipoint networks may be set up effectively with FreeWave transceivers when several key parameters are set correctly. Overlapping Multipoint networks are defined as networks using different Gateways which share or overlap in a specific geographic area. It may also include co-located transceivers configured into different networks.

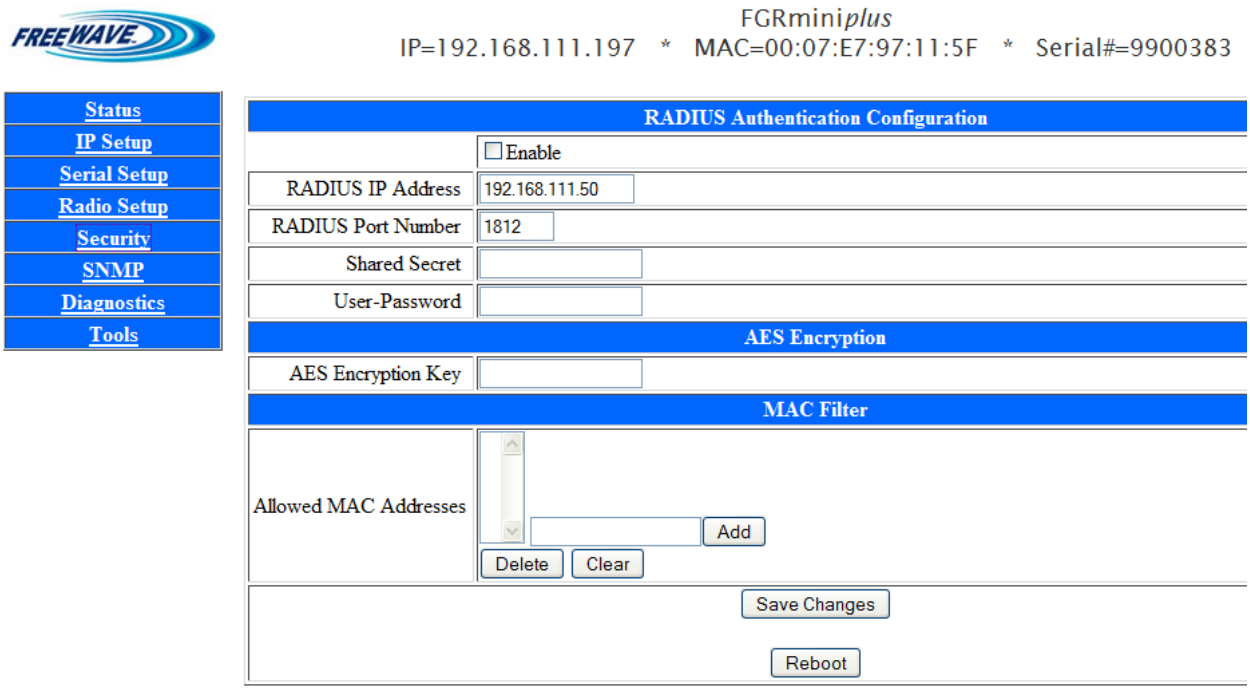
Co-located Multipoint networks require the following parameters be unique for each network:

- Network ID, unless using Call Book
- Frequency Key
- Max Packet Size
- Min Packet Size

For more questions about the installation of Point-to-Multipoint networks, please contact FreeWave Technical Support at (303) 444-3862.

Security:

On this page, the RADIUS authentication information and the AES encryption key can be set.



RADIUS Authentication Configuration

The IP Mini radio has the capability to require Endpoint and Multipoint Repeater radios to authenticate to a central RADIUS server before being able to send or receive Ethernet data. The radios comply with the RADIUS standards set forth in RFC 2138.

RADIUS authentication allows the administrator control over which radios will be allowed to participate on the Ethernet network. Without authentication, an Endpoint or Multipoint Repeater radio will not be allowed to send or receive Ethernet data across its RF link.

Enable

Checking this box enables RADIUS authentication from the Endpoint radios through the Gateway radio. This option is controlled from the Gateway radio only. It has no functionality on Endpoint or Repeater radios.

Enabling RADIUS authentication on the Gateway will require all of its Endpoints and Multipoint Repeaters to authenticate to a central RADIUS server. The RADIUS server must be connected to the same LAN segment as the Gateway radio.

The radios will not accept any authentication packets through their own Ethernet port.

If the radios cannot contact the RADIUS server, no Ethernet traffic will be sent across their Ethernet port. The Setup pages of the radios can be accessed by connecting over the radio link through the Gateway. If the radios are denied access by the RADIUS server, Ethernet traffic will neither be sent via the Ethernet port, nor via the radio link.

RADIUS IP Address

The IP address of the RADIUS server should be entered in this box. DNS names are not accepted. This option is controlled from the Gateway radio only. It has no functionality on Endpoint or Repeater radios.

RADIUS Port Number

The port number of the RADIUS server's authentication port should be entered here. This option is controlled from the Gateway radio only. It has no functionality on Endpoint or Repeater radios.

Shared Secret

The appropriate secret for the RADIUS server should be entered in this box. This option is used on Endpoint and Multipoint Repeater radios only. It has no functionality on Gateway radios.
The IP address of the Endpoint radios should be entered in the RADIUS server's "Clients" file. Each radio will act as a client when accessing the RADIUS server.

User-Password

The appropriate password for the radio should be entered in this box. This option is used on Endpoint and Multipoint Repeater radios only. It has no functionality on Gateway radios.
An entry for the radio should be created in the RADIUS server's "Users" file. The radio will always report its serial number, minus any hyphens, as the username.

AES Encryption Key

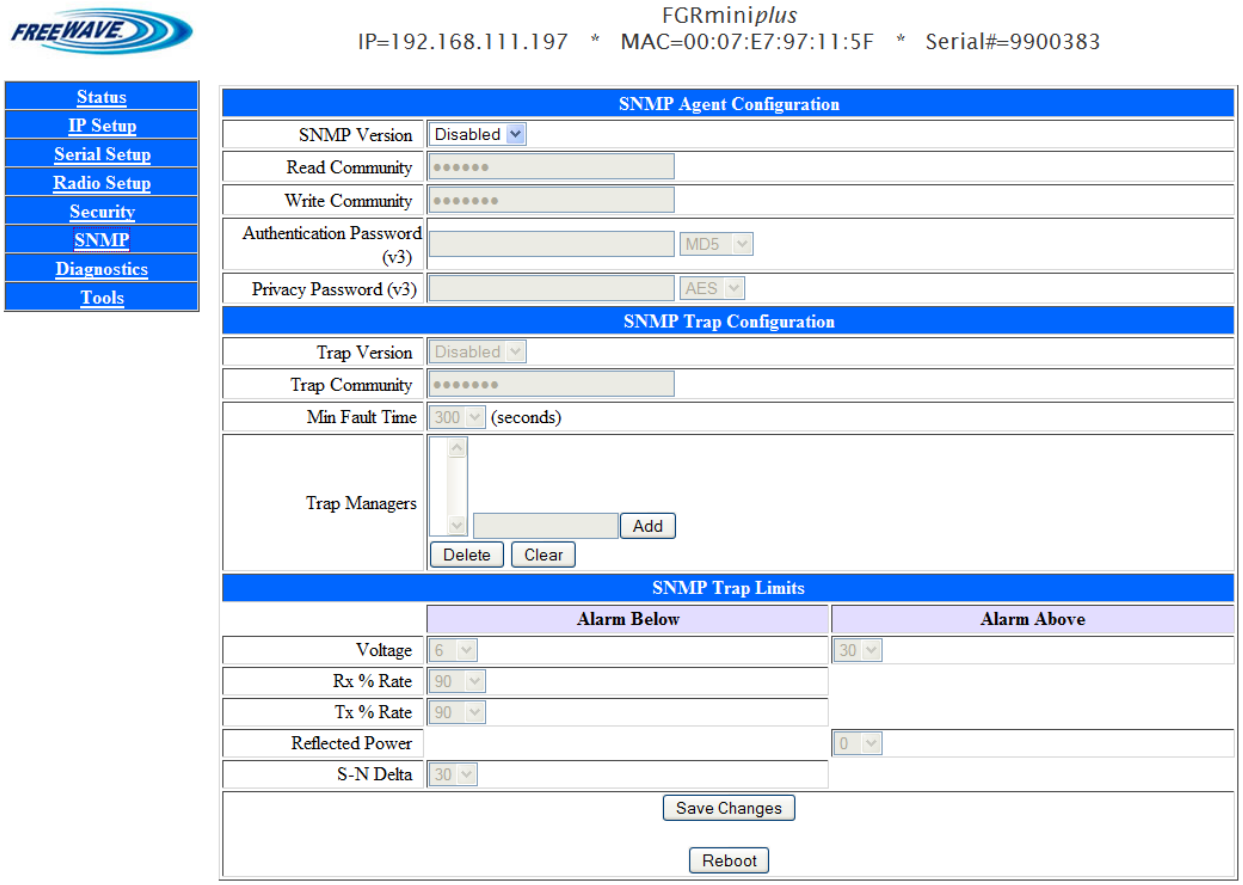
A user-defined encryption key for the 128-bit AES encryption is entered in this box. Up to 16 alphanumeric characters can be entered for the encryption key. The encryption key must be the same on every radio in the FreeWave network.
128-bit AES encryption is always enabled, although the encryption key may be blank.

Allowed MAC Addresses

In this section, MAC filtering can be enabled. Entering a hardware (MAC) address in the box and clicking the **Add** button will put that MAC address into the "allowed" list. Each group of digits in the MAC address should be separated by a colon (:). This list is specific for each radio. Only devices with MAC addresses in the "allowed" list will be permitted to communicate over the Ethernet port of the radio. Any other traffic will be refused.
Selecting a MAC address in the "allowed" list and clicking the **Delete** button will remove that address from the list.
Clicking the **Clear** button will remove every entry in the "allowed" list.
If the **Allowed MAC Addresses** section is blank, all traffic will be allowed.

SNMP:

This page is where the SNMP management features of the IP Mini radio can be set. The IP Mini radio supports SNMP versions 1, 2, and 3. All of the SNMP-manageable objects for Free-Wave's IP Mini radios are contained in a single MIB file: FREEWAVE-TECHNOLOGIES-MIB. This file is available from FreeWave Technologies upon request.



SNMP Agent Configuration

In this section, the proper SNMP version, Communities, and Passwords required by the SNMP Agent are entered.

SNMP Version

In this dropdown box, the desired version of SNMP can be selected. The available options are **v1-v2** and **v3**

Read Community

In this box, the SNMP Community name that has Read access should be entered.

Write Community

In this box, the SNMP Community name that has Write access should be entered.

Authentication Password (v3)

This option is only available when using SNMP v3. The password needed for SNMP v3 authentication should be entered in the text box. The proper encryption algorithm for the SNMP Agent should be selected in the dropdown box. The available options are **MD5** and **SHA1**.

Privacy Password (v3)

This option is available only when using SNMP v3. The password needed for SNMP v3 privacy should be entered in the text box. The proper encryption algorithm for the SNMP Agent should be selected in the dropdown box. The available options are **AES** and **DES**.

SNMP Trap Configuration

In this section, the version, Community, timing, and Managers for the available SNMP Traps are set.

Trap Version

In this dropdown box, the Trap Version supported by the SNMP Agent should be selected. The available options are **v1**, **v2**, and **Disabled**.

Trap Community

In this box, the SNMP Community name that has Trap access should be entered.

Min Fault Time

In this dropdown box, the amount of time a trap condition must be continuously present before an SNMP Trap is sent to the Trap Manager(s) is set. This amount of time is in seconds. The available options are **30**, **60**, **90**, **120**, **150, 180**, **210**, **240**, **270**, and **300** seconds.

Trap Managers

This list contains the IP Addresses of the authorized SNMP Trap Managers. In the text box next to the list, the IP Address of a Trap Manager can be entered. Clicking the **Add** button will add that IP Address to the Trap Managers list. When an IP Address in the list is selected, clicking the **Delete** button will remove that address from the list. Clicking the **Clear** button will remove all addresses from the Trap Manager List.

SNMP Trap Limits

In this section, the limits for any available SNMP Traps can be set.

Voltage

This is a Trap for the supply voltage of the radio. The Trap Condition will be present if the voltage drops below the **Alarm Below** voltage, or is above the **Alarm Above** voltage. The available settings are the whole numbers between **6** and **30**. The numbers are in volts DC.

Rx% Rate
This is a Trap for the Receive Percent of the radio. The Trap Condition will be present if the Receive Percent drops below the **Alarm Below** percentage. The available settings are from **50** to **100**, in increments of 5. The numbers are in percent.

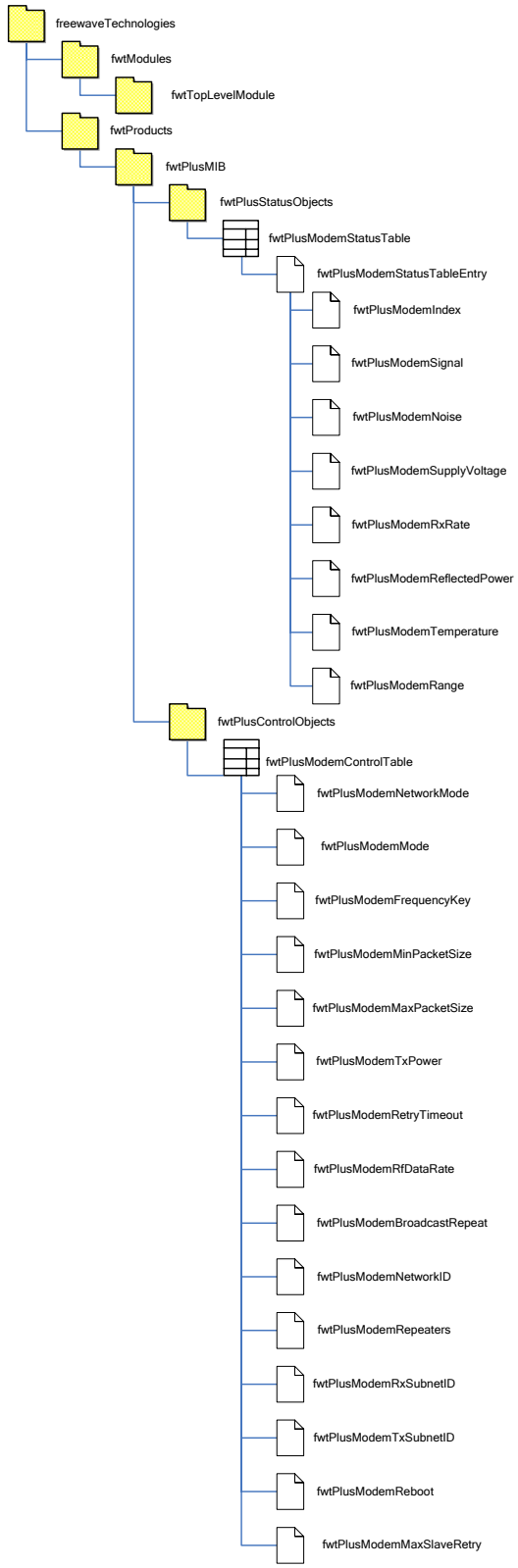
Tx% Rate
This is a Trap for the Transmit Percent of the radio. The Trap Condition will be present if the Transmit Percent drops below the **Alarm Below** percentage. The available settings are from **50** to **100**, in increments of 5. The numbers are in percent.

Reflected Power
This is a Trap for the Reflected Power of the radio. The Trap Conditions will be present if the Reflected Power is above the number set in the **Alarm Above** box. The available settings are from **0** to **40**, in increments of 2.

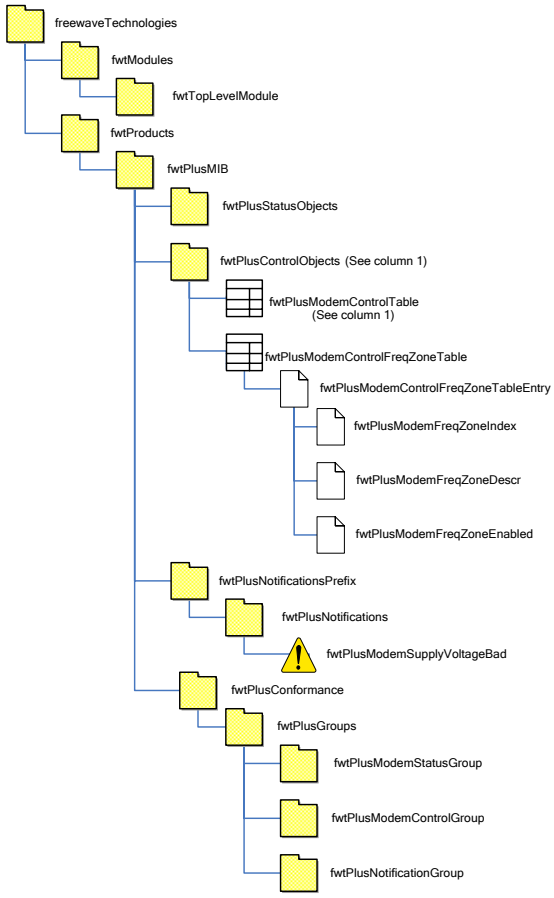
S-N Delta
This is a Trap for the calculated difference between the Signal level and the Noise level of the radio. The Trap Condition will be present if the Delta drops below the amount set in the **Alarm Below** box. The available settings are from **10** to **40**, in increments of 5. The numbers are in dB.

Object Tree for FREEWAVE-TECHNOLOGIES-MIB

Column 1



Column 2



Object List for FREEWAVE-TECHNOLOGIES-MIB

Object	Description	Access	Syntax
fwtPlusModemIndex	An index used to identify a specific radio modem within the system.	Not Accessible	Unsigned32
fwtPlusModemSignal	The received signal level for this radio modem, in dBm.	Read Only	Integer 32
fwtPlusModemNoise	The detected noise for this radio modem, in dBm.	Read Only	Integer 32
fwtPlusModemSupplyVoltage	The supply voltage to this radio modem, in units of one hundredth of a volt.	Read Only	Hundredth
fwtPlusModemRxRate	The current receive rate as a percentage of the maximum, in units of one hundredth of a percent.	Read Only	Hundredth
fwtPlusModemReflectedPower	The current amount of reflected RF power.	Read Only	Unsigned32
fwtPlusModemTemperature	The current temperature of this radio modem in degrees Celsius.	Read Only	Integer 32
fwtPlusModemRange	The current approximate range of this radio modem from its peer, in meters.	Read Only	Unsigned32
fwtPlusModemNetworkMode	The network mode to be used by a radio modem.	Read/Write	INTEGER { pointToPoint (1) , multipoint (2) }
fwtPlusModemMode	The modem mode to be used by a radio modem.	Read/Write	INTEGER { gateway (1) , repeater (2) , endpoint (3) }
fwtPlusModemFrequencyKey	The frequency key to be used by a radio modem.	Read/Write	Unsigned32 (0..14)
fwtPlusModemMinPacketSize	The minimum packet size to be used by a radio modem.	Read/Write	Unsigned32 (0..9)

Object List for FREEWAVE-TECHNOLOGIES-MIB

Object	Description	Access	Syntax
fwtPlusModemMaxPacketSize	The maximum packet size to be used by a radio modem.	Read/Write	Unsigned32 (0..9)
fwtPlusModemTxPower	The transmit power to be used by a radio modem.	Read/Write	Unsigned32 (0..10)
fwtPlusModemRetryTimeout	How many times a radio modem should try to transmit a packet before timing out.	Read/Write	Unsigned32 (0..255)
fwtPlusModemRFDateRate	The RF data rate to be used by a radio modem. Permissible values are 867 & 614 for HT series and 154 & 115 for FGR series radios.	Read/Write	Unsigned32
fwtPlusModemBroadcastRepeat	The number of times a Gateway will send out a packet of information before moving on to the next.	Read/Write	Unsigned32 (0..9)
fwtPlusModemNetworkID	A numerical ID that radios use to decide which network they are allowed to link to.	Read/Write	Unsigned32 (0..4095)
fwtPlusModemRepeaters	Allows for repeaters in the network, or not.	Read/Write	INTEGER { enabled (1) , disabled (2) , }
fwtPlusModemRxSubnetID	A numerical ID that radios use to decide which subnet they are allowed to link to.	Read/Write	Unsigned32 (0..15)
fwtPlusModemTxSubnetID	A numerical ID that radios use to decide which subnet they will transmit on.	Read/Write	Unsigned32 (0..15)
fwtPlusModemReboot	Set to 1 to reboot radio. This will force any changes to take effect.	Read/Write	INTEGER (0..1)

Object List for FREEWAVE-TECHNOLOGIES-MIB

Object	Description	Access	Syntax
fwtPlusModemMaxSlaveRetry	The maximum number of times an End-point can attempt to deliver data to the Gateway before it discards the data.	Read/Write	Unsigned32 (0..9)
fwtPlusModemFreqZoneIndex	An index used to identify a specific frequency zone for a specific radio modem.	Not Accessible	Unsigned32
fwtPlusModemFreqZoneDescr	A textual description of a specific frequency zone for a specific radio modem.	Read Only	DisplayString
fwtPlusModemFreqZoneEnabled	If the value of this object is true(1) then the referenced frequency zone is enabled for the relevant radio modem; if the value of this object is false(2), then the frequency zone is disabled.	Read/Write	TruthValue

Notification Object	Description	Objects
fwtPlusModemSupplyVoltageBad	This notification is generated when the supply voltage for a radio modem goes out of specification.	fwtPlusModemSupplyVoltage

Object List for FREEWAVE-TECHNOLOGIES-MIB

Group Object	Description	Objects
fwtPlusModemStatusGroup	A collection of objects concerned with the current status of a radio modem	fwtPlusModemSignal fwtPlusModemNoise fwtPlusModemSupplyVoltage fwtPlusModemRxRate fwtPlusModemReflectedPower fwtPlusModemTemperature fwtPlusModemRange
fwtPlusModemControlGroup	A collection of objects concerned with the current status of a radio modem	fwtPlusModemNetworkMode fwtPlusModemMode fwtPlusModemFrequencyKey fwtPlusModemMinPacketSize fwtPlusModemMaxPacketSize fwtPlusModemTxPower fwtPlusModemRetryTimeout fwtPlusModemRFDataRate fwtPlusModemBroadcastRepeat fwtPlusModemNetworkID fwtPlusModemRepeaters fwtPlusModemRxSubnetID fwtPlusModemTxSubnetID fwtPlusModemReboot fwtPlusModemMaxSlaveRetry fwtPlusModemFreqZoneDescr fwtPlusModemFreqZoneEnabled

Diagnostics

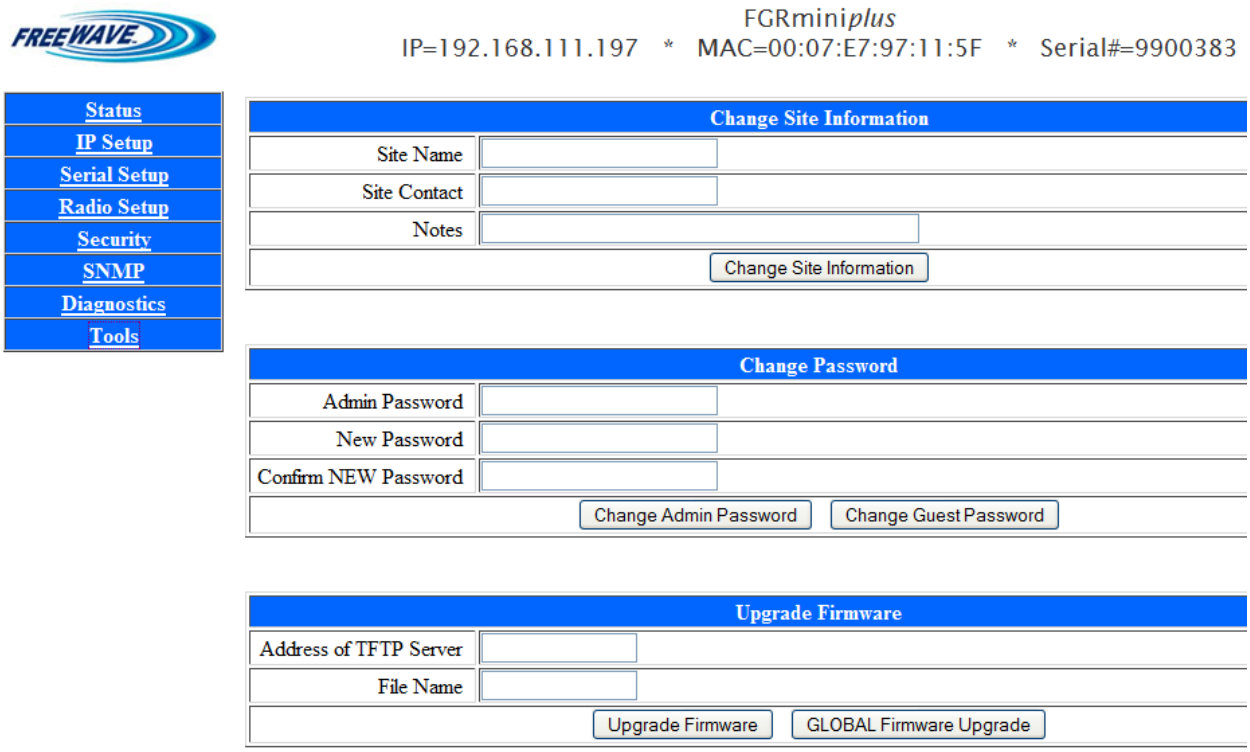
Clicking the **Diagnostics** link will open the Diagnostics page in a separate window. This page displays the serial number of the Gateway or Repeater that this radio is connecting to (in a Point-to-Multipoint Gateway, this header always says, "I am currently NOT connected"). This page also displays each frequency the radio is using, along with the Signal, Noise, Signal-to-Noise Delta, and % Receive Rate for each individual frequency (*see **p. 17** for statistic descriptions*).

I am Currently connected to 8841328

Frequency Information By Channel				
Frequency (MHz)	Signal (dBm)	Noise (dBm)	Delta (dBm)	% Rcv Rate
902.5536	-25	-97	72	93.00%
903.1680	-25	-97	72	93.00%
903.7824	-25	-98	73	100.00%
904.3968	-25	-98	73	100.00%
905.0112	-25	-99	74	100.00%
905.6256	-25	-98	73	100.00%
906.2400	-25	-100	75	100.00%
906.8544	-25	-100	75	93.00%
907.4688	-25	-100	75	100.00%
908.0832	-25	-100	75	100.00%
908.6976	-25	-100	75	100.00%
909.3120	-25	-99	74	100.00%
909.9264	-25	-100	75	100.00%
910.5408	-25	-101	76	100.00%
911.1552	-25	-98	73	93.00%
911.7696	-25	-100	75	100.00%
912.3840	-25	-99	74	100.00%
912.9984	-25	-98	73	93.00%
913.6128	-25	-99	74	93.00%
914.2272	-25	-100	75	100.00%
914.8416	-25	-100	75	100.00%
915.4560	-25	-100	75	100.00%
916.0704	-25	-101	76	100.00%
916.6848	-25	-101	76	100.00%
917.2992	-25	-101	76	100.00%
917.9136	-25	-100	75	100.00%

Tools:

This page will allow the editing of the Site Information, changing of the login Password, and upgrading of the radio's Firmware.



Site Name / Site Contact / Notes

Any text entered in these fields will show on the Status page. They can be used to help identify the radio, technical contact, etc.

Change Password

This section is used to change the login password for the Admin and Guest accounts. The current Admin password must be entered in the **Admin Password** field. The new password is entered in the **New Password** field, and re-entered in the **Confirm NEW Password** field. Clicking the **Change Admin Password** button will change the Admin password to the one entered in the **New Password** field. Clicking the **Change Guest Password** button will change the Guest password to the one entered in the **New Password** field.

Upgrade Firmware

The IP Mini downloads its firmware updates via TFTP. To update the firmware, two things are required: the IP address of a TFTP server that contains the upgrade file, and the file name of the upgrade file.

Address of TFTP Server
Enter the IP address of the TFTP server that contains the upgrade file here. Only an IP address is accepted.

File Name
Enter the file name of the firmware upgrade file here. The file name must exactly match what is stored on the TFTP server.

Upgrade Firmware
Clicking this button begins the Firmware update process on this radio. The radio will download the Firmware file from the specified TFTP Server, load the file to memory, and then reboot. Once this button is clicked, status messages will be displayed on the webpage in place of the **Tools** page.

GLOBAL Firmware Upgrade
Clicking this button on a Gateway radio begins the Firmware update process on the Gateway radio. The radio will download the Firmware file from the specified TFTP Server. The Gateway will then send a copy of the Firmware update to all connected Endpoint and Multipoint Repeater radios. This Firmware information is sent to each radio in 1 KB sections. Each radio must successfully receive every section, or it will not upgrade its Firmware. Increasing the **Broadcast Repeat** setting (*see **p. 36***) will increase the probability of success, but will slow down the overall process. Once the Gateway radio has sent the Firmware upgrade file, radios that successfully received the Firmware upgrade will load the file to memory, and then reboot. The reboot times are randomized within a short window, to keep every radio from restarting at the same time. The Gateway radio itself will not be upgraded.
If the **GLOBAL Firmware Upgrade** button is selected on an Endpoint or a Multipoint Repeater, that individual radio will be not be upgraded, but it will send the upgrade file to its Gateway radio, which will be upgraded. No other radios will receive the file.

For locations that do not have a pre-existing TFTP server, please contact FreeWave for a copy of **FreeWave TFTP**. *(see* **Appendix B***, **p. 68**)*

Operation LEDs

COM LEDs

Condition	Communications Port 1 or 2 (COM1/COM2)
Data Streaming into Rx	Solid red bright*
Data Streaming out Tx	Solid red bright*

Error LEDs

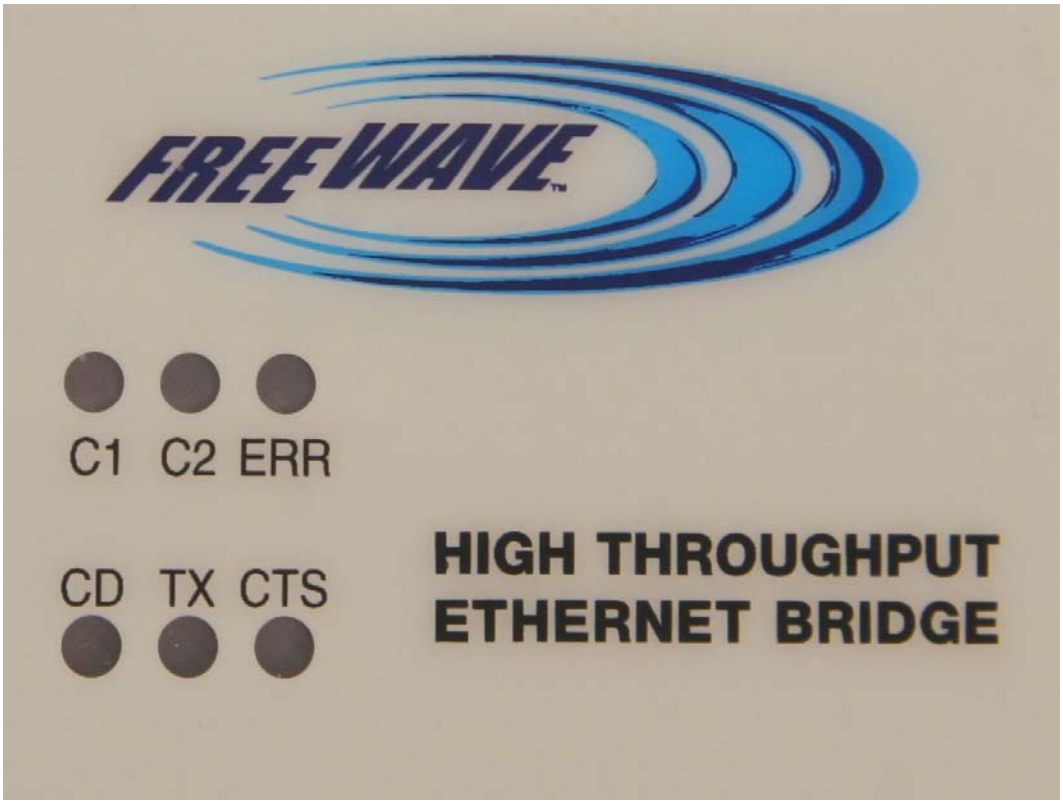
Condition	Error Light (ERR)
Buffer Overflow Locally	Solid red bright*
Buffer Overflow in Network	Solid green bright*

Ethernet Port Lights

Status	L LED (Link)	A LED (Activity)
Linked, Data Activity	Solid Green bright (100BaseT)*/Solid Orange Bright (10BaseT)*	Solid Green bright*
Linked, Data Activity	Solid Green bright (100BaseT)*/Solid Orange Bright (10BaseT)*	Blinking Green*
Linked, No Data Activity	Solid Green bright (100BaseT)*/Solid Orange Bright (10BaseT)*	Off *
Not Linked. Check that cable is in good condition and plugged in.	Off *	Off *

Authentication-related LEDs

Condition	LED pattern
Endpoint has not linked with Gateway	Solid bright red * **ERR** LED
Endpoint cannot contact RADIUS server	Solid bright red * **ERR** LED
Endpoint was denied authentication from the RADIUS server	Alternating red and green */* **ERR** LED
Endpoint AES encryption key does not match Gateway encryption key	Alternating red and green */* **ERR** LED



Radio Front Panel

Point-to-Multipoint Operation LEDs.

	Gateway			Endpoint			Repeater		
Condition	Carrier Detect (CD)	Transmit (TX)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (TX)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (TX)	Clear to Send (CTS)
Powered, not linked	Solid red bright*	Solid red dim*	Off *	Solid red bright*	Off *	Blinking red	Solid red bright*	Off *	Blinking red Θ
Repeater and Endpoint linked to Gateway, no data	Solid red bright*	Solid red dim*	Off *	Solid green*	Off *	* Solid red bright*	Solid green*	Solid red dim*	* Solid red bright*
Repeater and Endpoint linked to Gateway, Gateway sending data to Endpoint	Solid red bright*	Solid red dim*	Off *	Solid green*	Off *	* Solid red bright*	Solid green*	Solid red dim*	* Solid red bright*
Repeater and Endpoint linked to Gateway, Endpoint sending data to Gateway	Solid green* RCV data or Solid red bright*	Solid red dim*	Intermit-tent flash red »o«	Solid green*	Intermit-tent flash red »o«	* Solid red bright*	Solid green*	Solid red bright*	* Solid red bright*
Gateway with diagnos-tics program running	Solid red bright*	Solid red dim*	Intermit-tent flash red »o«	Solid green*	Intermit-tent flash red »o«	* Solid red bright*	Solid green*	Solid red bright*	* Solid red bright*

- Clear to Send LED will be solid red* with a solid link, as the link weakens the Clear to Send LED light on the Repeater and Endpoint will begin to flash Θ.

Point-to-Point Operation LEDs

	Gateway			Endpoint			Repeater		
Condition	Carrier Detect (CD)	Transmit (TX)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (TX)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (TX)	Clear to Send (CTS)
Powered, no link	Solid red bright *	Solid red bright*	Solid red bright*	Solid red bright*	Off *	Blinking red Θ	Solid red bright*	Off *	Blinking red Θ
Linked, no Re-peater, sending sparse data	Solid green*	Intermittent flash red »o«	Intermittent flash red »o«	Solid green*	Intermittent flash red »o«	Intermit-tent flash red »o«	n/a	n/a	n/a
Gateway calling Endpoint through Repeater	Solid red bright*	Solid red dim*	Solid red bright*	Solid red bright*	Off *	Blinking red Θ	Solid red bright*	Off *	Blinking red Θ
Gateway linked to Repeater, not to Endpoint	Flashing orange »o«	Solid red dim*	Solid red bright*	Solid red bright*	Off *	Blinking red Θ	Solid red bright*	Solid red dim*	Solid red bright*
Repeater linked to Endpoint	Solid green*	Intermittent flash red »o«	Intermittent flash red »o«	Solid green*	Intermittent flash red »o«	Intermit-tent flash red »o«	Solid green*	Intermittent flash red »o«	Intermit-tent flash red »o«
Mode 6 - waiting for ATD com-mand	Solid red bright*	Off *	Blinking red Θ	Solid red bright*	Off *	Blinking red Θ	n/a	n/a	n/a
Setup Mode	Solid green*	Solid green*	Solid green*	Solid green*	Solid green*	Solid green*	Solid green*	Solid green*	Solid green*

Choosing a Location for the Transceivers

Placement of the FreeWave transceiver is likely to have a significant impact on its performance. The key to the overall robustness of the radio link is the height of the antenna. In general, FreeWave units with a higher antenna placement will have a better communication link. In practice, the transceiver should be placed away from computers, telephones, answering machines and other similar equipment. The 6-foot Ethernet cable included with the transceiver usually provides ample distance for placement away from other equipment. To improve the data link, FreeWave Technologies offers directional and Omni-directional antennas with cable lengths ranging from 3 to 200 feet. When using an external antenna, placement of that antenna is critical to a solid data link. Other antennas in close proximity are a potential source of interference; use the Radio Statistics to help identify potential problems. The Radio Statistics are found on the Basic Information Page. An adjustment as little as 2 feet in antenna placement can resolve some noise problems. In extreme cases, such as when interference is due to a Pager or Cellular Telephone tower, a band pass filter may reduce this out-of-band noise.

Factory Default Settings

FreeWave IP Mini transceivers are shipped from the factory with the following Default Settings:

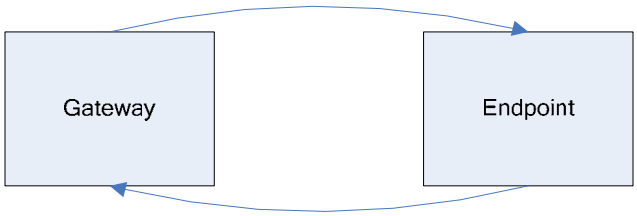
IP Setup	Default	
IP Address	192.168.111.100	
Subnet Mask	255.255.255.0	
Default Gateway	192.168.111.1	
Web Page Port	80	
Force SSL	Unchecked	
Spanning Tree	Unchecked	
Serial Gateway Setup	**Port 1**	**Port 2**
Server (TCP)	Selected / 7000	Selected / 7001
Enable Alarm	Unchecked / 0.0.0.0:8000	Unchecked / 0.0.0.0:8001
Client (TCP)	Not Selected / 0.0.0.0:9000	Not Selected / 0.0.0.0:9001
UDP	Not Selected / 0.0.0.0:6000	Not Selected / 0.0.0.0:6001
Inactivity Timeout	0	0
Alarm Retry Limit	0	0
Baud Rate	19200	19200
Data Bits	8	8
Parity	None	None
Stop Bits	1	1
Flow Control	None	None
CD Mode	Normal	Normal
Interface	RS232	RS232
Modbus RTU	Unchecked	Unchecked
Radio Setup	**Default**	
Network Type	Point-to-Point	
Modem Mode	Gateway	
Frequency Key	5	
Frequency Zones	All checked	
Packet Size	Max = 9, Min = 1	
Transmit Power	10	
Retry Timeout	255	
RF Data Rate	115 Kbps	
Compression	0	

Transmit Rate	Normal
Multipoint Parameters	**Default**
Broadcast Repeat	3
Max Slave Retry	9 / Try Forever
Master Tx Beacon	1
Network ID	255
Repeaters	Disabled
Subnet ID	Rx=F, Tx=F
Call Book	Empty
Security	**Default**
RADIUS Authentication Enable	Unchecked
RADIUS IP Address	Blank
RADIUS Port Number	1812
Shared Secret	Blank
User-Password	Blank
AES Encryption Key	Blank
Allowed MAC Addresses	Blank
SNMP	**Default**
SNMP Version	Disabled
Read Community	Blank
Write Community	Blank
Authentication Password	Blank
Privacy Password	Blank
Trap Version	Disabled
Trap Community	Blank
Min Fault Time	300
Trap Managers	Blank
Voltage	Alarm Below: 6 Alarm Above: 30

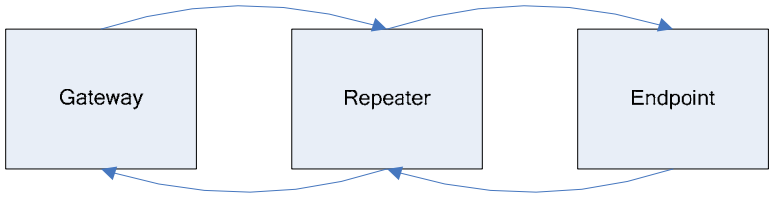
SNMP	Default
Rx % Rate	Alarm Below: 90
TX % Rate	Alarm Below: 90
Reflected power	Alarm Above: 0
S-N Delta	Alarm Below: 30

Examples of Data Communication Links

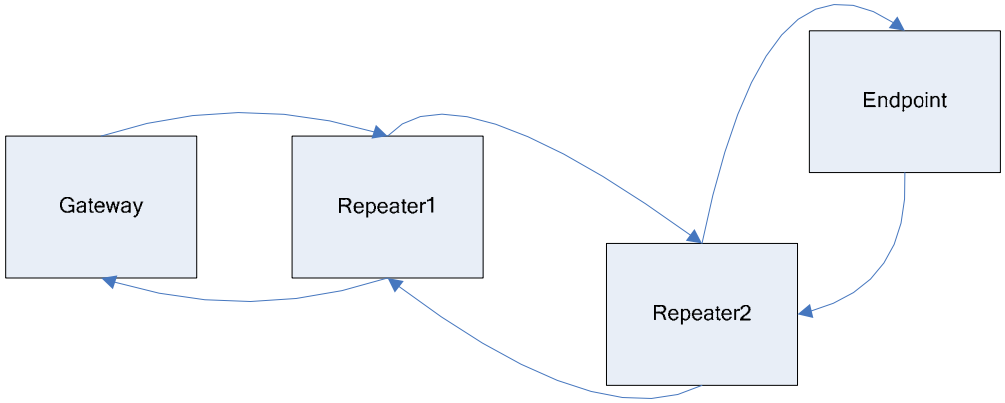
FreeWave transceivers' versatility allows data communication links to be established using a variety of different configurations.
The example below shows the most common and straightforward link; a Gateway communicating to an Endpoint in a Point-to-Point link.



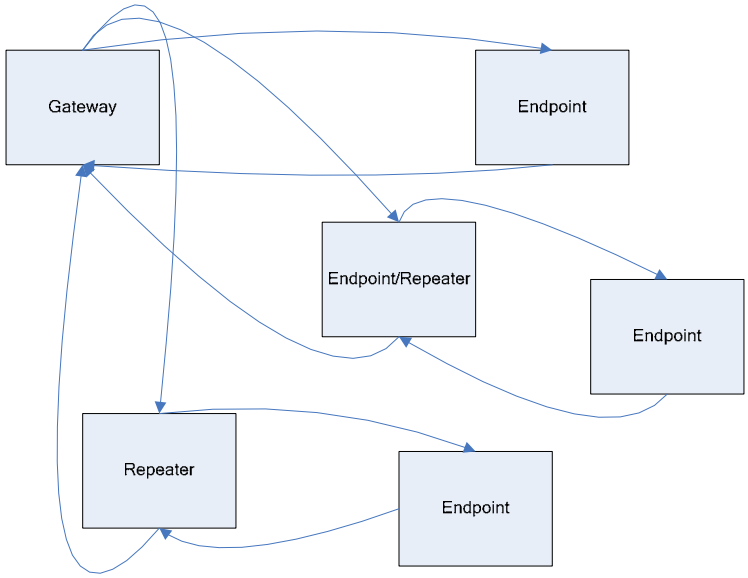
The example below shows how a link might be set up using a Repeater. The Repeater may be located on a hilltop or other elevated structure enhancing the link from the Gateway to the Endpoint. In this configuration, it may be desirable to use an external Omni-directional antenna at the Repeater. Yagi antennas may be used at both the Gateway and Endpoint transceivers.
When a Repeater is used, the RF throughput is cut in half.



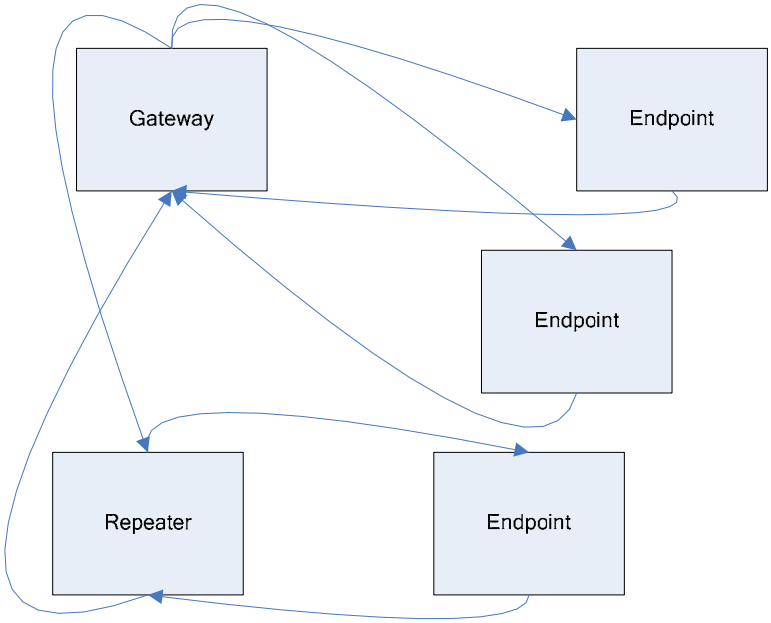
The example below shows a link with two Repeaters between the Gateway and Endpoint. With two Repeaters there is clearly more flexibility in getting around obstacles and greater total range is possible. Once again, it would be desirable to use external Omni-directional antennas with the Repeaters, and attaching a Yagi to the Gateway and Endpoint to increase the range of the link.
When two Repeaters are used there is no further degradation in the RF throughput of the link.



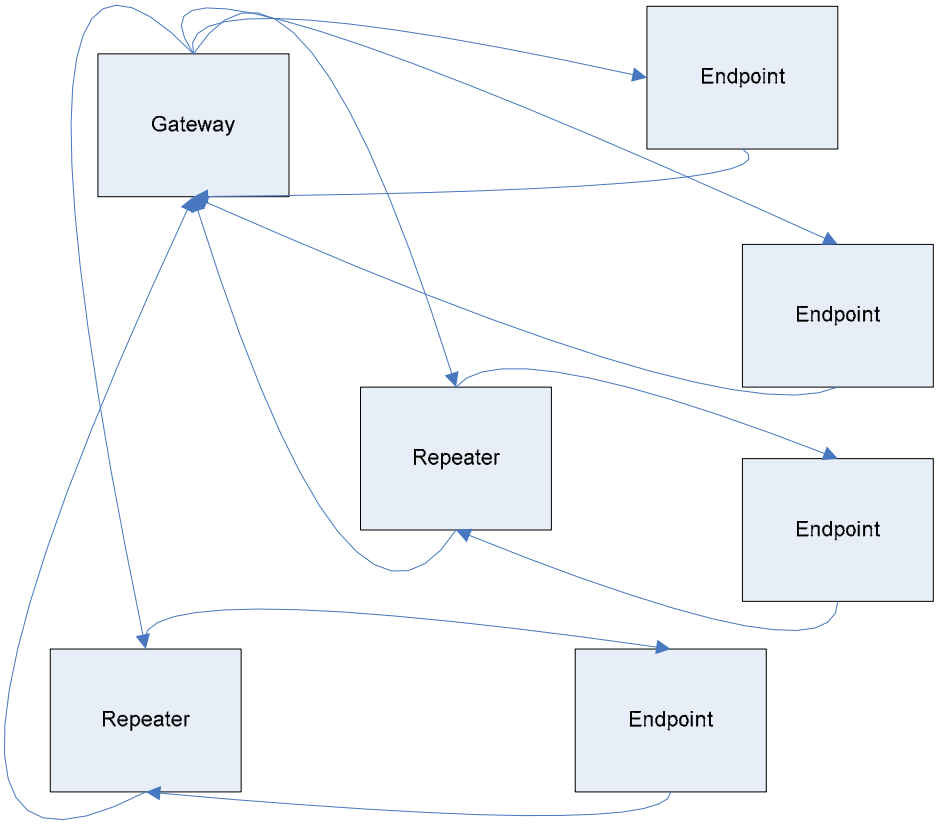
The example below shows a configuration where a Gateway routinely calls a number of Endpoints at different times. The Gateway is communicating with a transceiver designated as a Endpoint/Repeater that is connected to a remote device. Since this device is placed in an elevated location, the transceiver may also be used as a Repeater when it is not used as a Endpoint. At any time the Gateway may call any of the Endpoints, establish a connection, and send and receive data.



The next example depicts a standard Point-to-Multipoint network. From the Gateway, any data is broadcast to all three Endpoints, one of which receives it through a Multipoint Repeater. The data is in turn sent out of the data port of each of the three Endpoint. The end device should be configured to interpret the data and act on it if necessary.

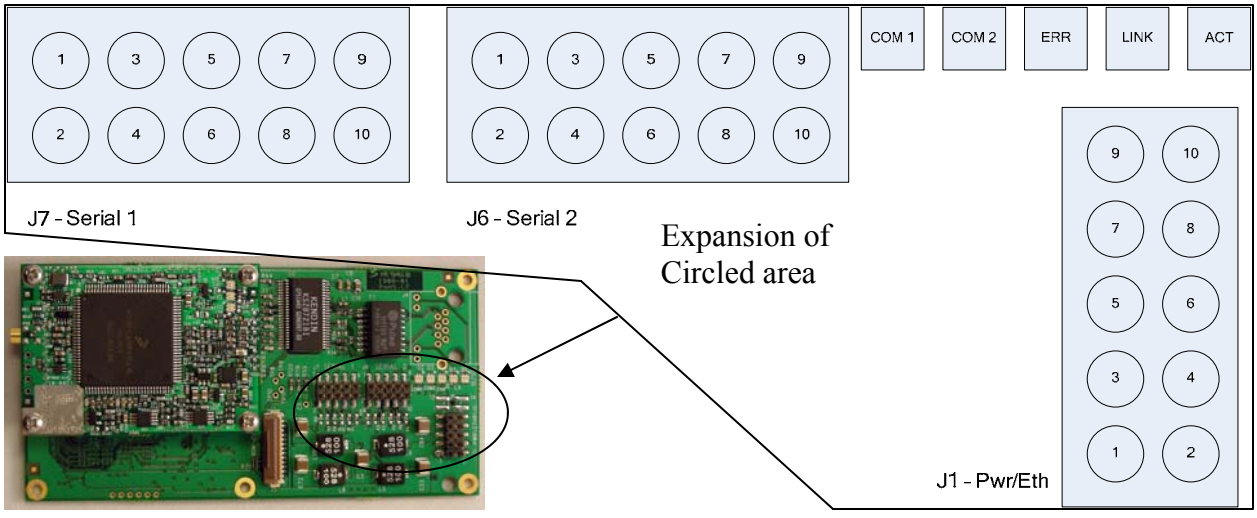


The last example is a Point-to-Multipoint network which uses one of the sites as an Endpoint/ Repeater. This network functions in the same manner as a standard Multipoint network with Repeaters. However, the number of radios may be reduced with the use of the Multipoint Endpoint/Repeater feature.



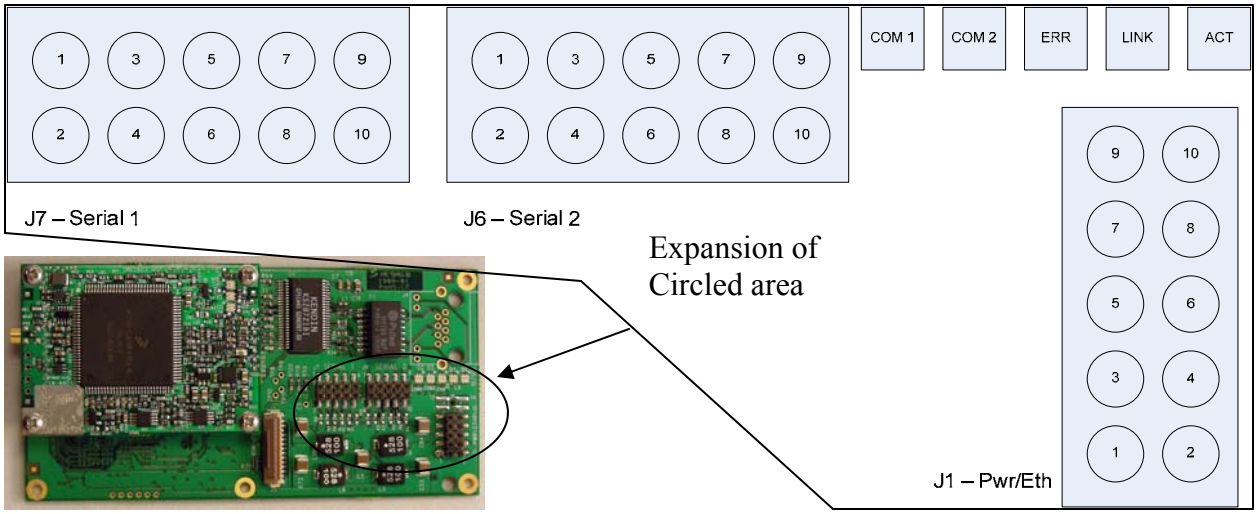
RS232 Pin Assignments (J6, J7)

Pin		Assignment	Signal	Definition
1	DSR	Data Set Ready	Output	Always high when the radio is powered. Indicates power is on to the radio.
2	CD	Carrier Detect	Output	Used to show an RF connection between transceivers.
3	RTS	Request to Send	Input	The transceiver does not recognize RTS for flow control. RTS is used as a control line in RTS/CTS mode.
4	TXD	Transmit Data	Output	Used to transmit data bits serially from the transceivers to the system device.
5	CTS	Clear to Send	Output	Indicates to the system device connected to the transceiver that the transceiver is ready to receive data. When asserted, the transceiver will accept data. When de-asserted, the transceiver will not accept data. CTS should always be used for data rates above 38.4KB or there will be a risk of lost data, if an RF link is not very robust.
6	RXD	Receive Data	Input	Used to receive data bits serially from the system device connected to the transceivers.
7	GND	Ground		Signal return for all signal lines shared with Pin 10.
8	DTR	Data Terminal Ready	Input	Used only for DTR Connect.
9	NC	Not Connected	N/A	This pin is not used.
10	GND	Ground		Signal return for all signal lines shared with Pin 7.



Power/Ethernet Pin Assignments (J1)

Pin		Assignment	Signal	Definition
1	B+	Power input	Input	3.0—5.0 VDC power input
2	Gnd	Ground	N/A	Ground, shared with pin 5 and pin 8
3	N/A	N/A	N/A	Reserved for future use
4	N/A	N/A	N/A	Reserved for future use
5	Gnd	Ground	N/A	Ground, shared with pin 2 and pin 8
6	Rx-	Receive Minus	Input	Receive minus line for Ethernet
7	Rx+	Receive Plus	Input	Receive plus line for Ethernet
8	Gnd	Ground	N/A	Ground, shared with pin 2 and pin 5
9	Tx-	Transmit Minus	Output	Transmit minus line for Ethernet
10	Tx+	Transmit Plus	Output	Transmit plus line for Ethernet



Technical Specifications

Transmitter				
Frequency Range	902—928 MHz (FHSS) (DTS)			
Output Power	10 mW to 1 W			
Range—Line of Sight	60 Miles			
Modulation	2 Level GFSK			
RF Data Rate	Selectable, 115 kbps or 154 kbps			
Occupied Bandwidth	230 kHz			
Hopping Patterns	15, user selectable			
Frequency Zones	16 Zones			
RF Connector	MMCX			
Receiver				
Sensitivity	-108 dBm for BER $1x10^{-4}$			
IF Selectivity	40 dB at fc +/- 230 kHz			
RF Selectivity	50 dB at 896 MHz, 935 MHz			
Dynamic Range	+10 dBm 3rd Order Intercept Point at Input Connector			
Data Transmission				
Error Detection	32 bit CRC, retransmit on error			
Data Encryption	128 bit AES			
Authentication	RADIUS			
Data Interface	Ethernet, 2x RS-232			
Protocol	Ethernet: IEEE 802.3 CPIP, DHCP, ICMP, UDP, ARP multicast TFTP; Serial: RS-232			
Data Connector	Ethernet: 10/100 Base T auto-crossover; 2x DE-9 Serial			
Data Throughput	92 kbps			
Power Requirements				
Operating Voltage	3.0 to 5.0 VDC			
Currrent (mA)	**Mode**	**3 VDC**	**3.3 VDC**	**5 VDC**
	Transmit	800	1000	1000
	Receive	250	250	250
	Idle	150	150	150
General Information				
Operating Temperature Range	-40° C to +85° C—**Every radio 100% factory tested over this range**			
Dimensions	101 mm L x 51 mm W x 13 mm H			
Weight	42 g			
Humidity	0 to 95%, non-condensing			

FreeWave Technical Support

For up-to-date troubleshooting information check the Support page at http://www.freewave.com.

FreeWave provides Technical Support, Monday through Friday, 7:30 AM to 5:30 PM, Mountain Time (GMT -7) Call us toll-free at **1-866-923-**6168, locally at 303-381-9200 or email us at moreinfo@freewave.com.

Appendix A—Errata

Known Issues:

IP Mini 2.11c—INITIAL RELEASE

- Point-to-Point Repeaters are not functional.
- In Multipoint links, during Endpoint to Endpoint transfers, the destination Endpoint will sometimes lose its link. It will recover on its own.
- **RS-422** and **RS-485** options are available under **Serial Setup/Interface**, but these modes are not supported in the IP Mini.

Appendix B—FreeWave TFTP Server Users Manual

Installation

Requires Microsoft Windows 98/2000/XP with Microsoft Windows Installer 2.0 or higher. To install FreeWave TFTP Server, execute the "fwTFTP Install.msi" program. If the defaults are accepted, the program will be installed in the "C:\Program Files\FreeWave Technologies\fwTFTP" folder.
The installer will automatically create an uninstall entry in the Add or Remove Programs list. To uninstall this software, open "Add or Remove Programs" in the Windows Control Panel, select "TFTP Server" from the list, then click Remove to uninstall it.

Using the Server

The illustration on the next page (Figure 1) shows the basic layout of the server. The icons at the top of the window control the server.

- To stop the server, click the **Stop server** button. No TFTP clients will be able to connect to the server, and any existing connections will be dropped.
- To restart the server, click the **Start server** button.
- To clear the log, click the **Clear log** button. This will clear the log display and also erase the log file.
- To configure the server, click the **Configure** button. This will open the configuration window described in Figure 2.
- To terminate the server program, close the TFTP Server window just like any other program: by clicking the close icon at the upper right of the window. All existing client connections will be dropped when the program closes. *Note that the log file will not be erased when the program is restarted. Only the **Clear log** button will erase the log.*

The top half of the window is a list of active client connections. Each connection shows the IP address of the client and the UDP port number the server is using to communicate with the client. The Action column shows what the client is doing. The progress column shows a green progress bar that indicates the progress of file transfers. The Kbytes/sec column shows the current transfer speed.

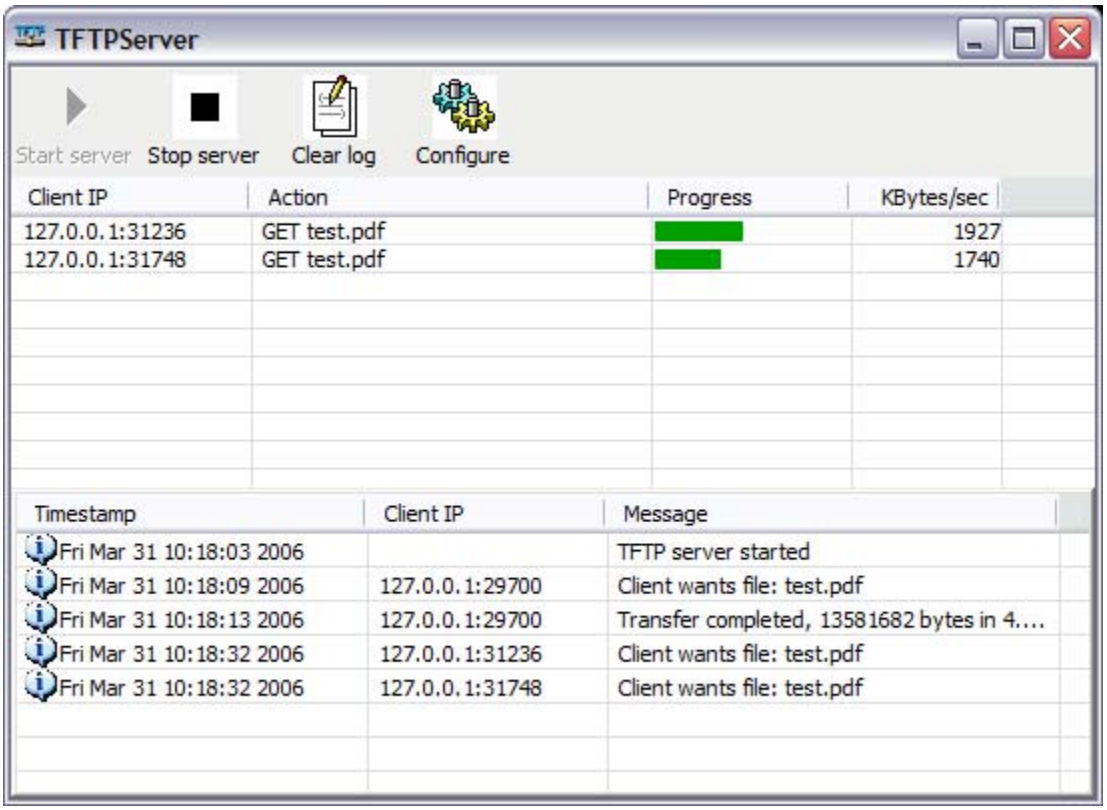


Figure 1: TFTP Server Window

The bottom half of the window is the log display. It shows log entries since the program was started. To the left of the timestamp is an icon to indicate the type of log entry. There are three types of log entries: Information (indicated by an 'i' in a balloon), Warning (indicated by a yellow warning sign), and Error (indicated by a red circle with an 'x' in it). Each log entry is time-stamped and includes the IP address and UDP port of the client as well as a descriptive message indicating the reason for the log entry.

Server Configuration

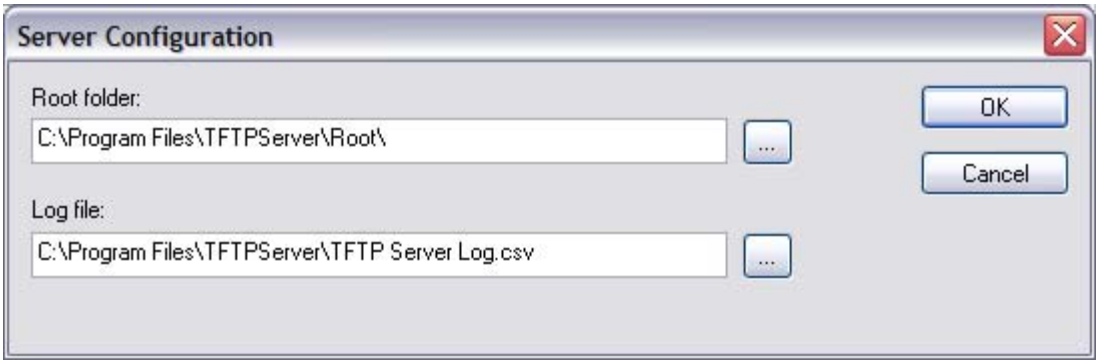


Figure 2: Server Configuration Window

Root folder

The root folder is where TFTP clients access their files. By default, the root folder is named Root and is created under the FreeWave TFTP Server folder in the Windows Program Files folder. The root folder can be directed to any other folder or drive on the computer by either typing in a path in the Root folder box or by clicking the "…" icon to the right to open a directory browser. Note that clients can only access files from the root folder or from subdirectories in the root folder.

Clients see the root folder as their root path. For example, if a client asks for a file named "sample.txt", the server will send the file if it is located in the server's root folder. If there is a folder in the root folder named Examples and it contains a file named "image.bmp", then the TFTP client would access that file using the path "examples/image.bmp".

Both forward and backward slashes are allowed to separate directory and file names. Filenames are case-insensitive. That is, the server does not check letter case when looking for files. "EXAMPLE", "Example", and "example" are all the same as far as the server is concerned.

Log file

The log file is created by default in the FreeWave TFTP Server program folder and is named "Log.csv". The log file can be moved, if desired, by either entering the desired filename in the log file path box or by clicking the "…" button to the right which will open a file browser. This is a CSV (Comma-Separated Value) format file and can be imported into Microsoft Excel for viewing or printing. The first line of the file contains column headers, and is followed by one line for each entry in the log.

Troubleshooting

Windows XP

If the Windows Firewall is enabled, the notice displayed in Figure 3 will appear when FreeWave TFTP Server is run for the first time. To allow the server to run under Windows XP, simply click the "Unblock" button. This issue does not occur if the Windows Firewall has been disabled.

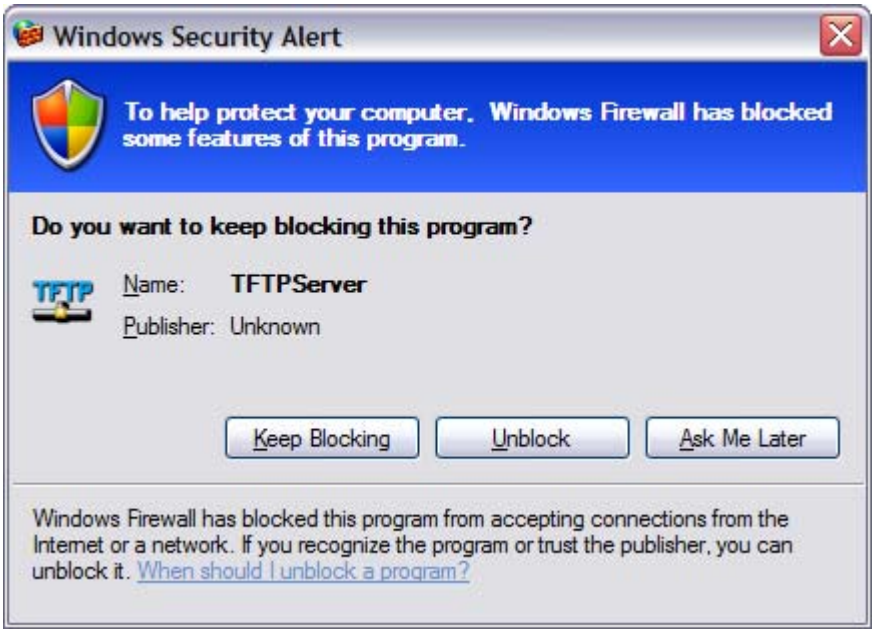
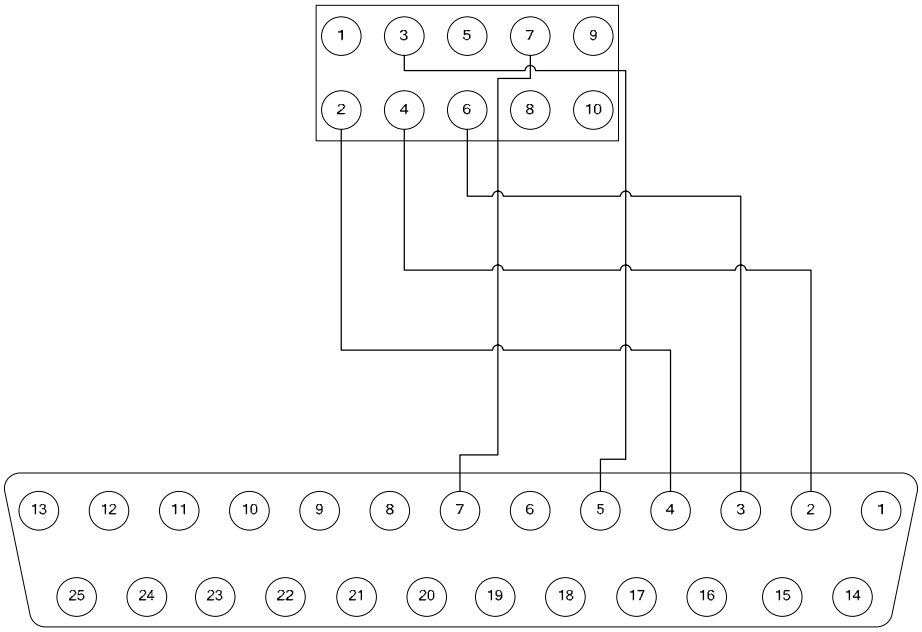


Figure 3: Windows Firewall Security Alert

Appendix C—Wiring Example—IP Mini to MDS 9710

Function	IP Mini Pin Number	MDS 9710 Pin Number
CD	2	4 (RTS)
TX	4	2
RX	6	3
Signal Ground	7	7
RTS	3	5 (CTS)



Appendix D—Changing the IP Address in Windows XP

NOTE: These instructions are for Windows XP. The displayed widows and available option may be different under other Operating Systems.

Figure 1

1. Click on **Start / Control Panel** or **Start / Settings / Control Panel**.
2. Double-click the **Network Connections** icon. *(Figure 1)*
3. Right-click on **Local Area Connection** and then click **Properties**. (*Figure 2)* NOTE: Depending on the Network setup, different icons may appear here. Please contact the IT Department if there are issues finding the proper icon.
4. Click on **Internet Protocol (TCP/IP)** to highlight it, then click the **Properties** button. *(Figure 3)*
5. Select the **Use the following IP address** radio button, and enter an appropriate IP address. Hit the **Tab** key, and Windows XP will enter a **Subnet Mask** of 255.255.255.0 automatically. They may be changed if necessary. Usually, the **Default Gateway**, **Preferred DNS Server**, and **Alternate DNS Server** entries can be left blank when the computer is being used solely for radio configuration. *(Figure 4)* If there are questions about these entries, please contact the IT Department.

Figure 2

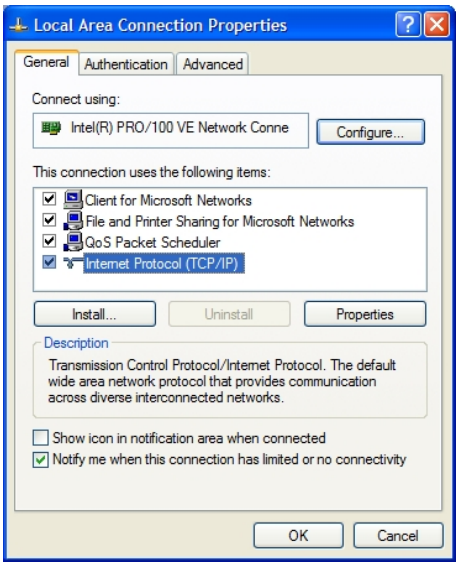


Figure 3

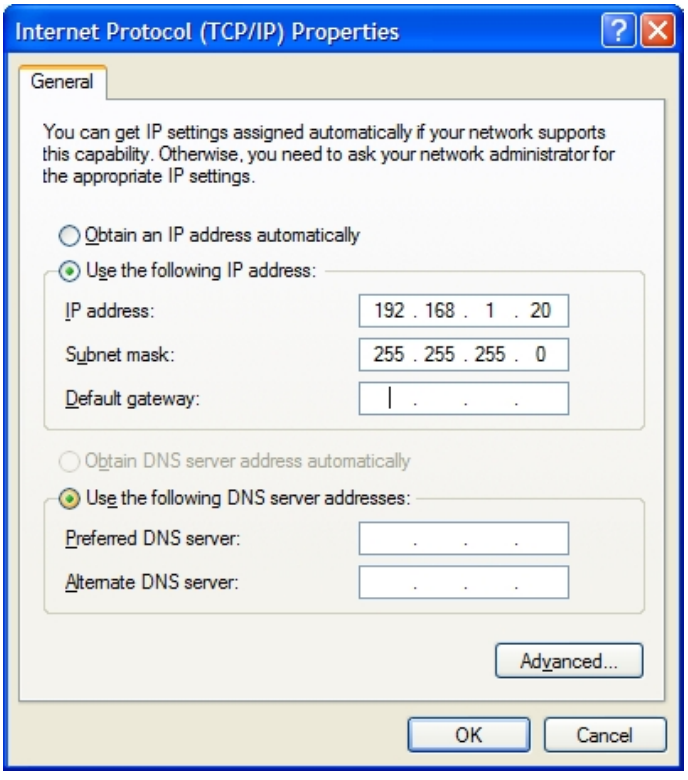
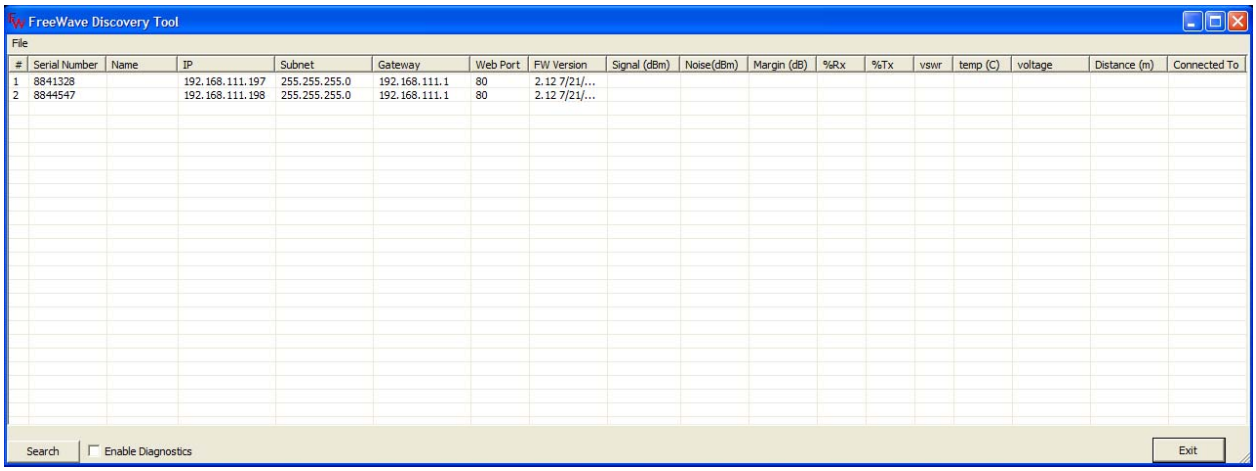


Figure 4

Appendix E—FreeWave Discovery Tool v. 1.4

IP Mini radios with a Firmware version of 2.8 or higher will report their IP Address and other information to the FreeWave Discovery Tool, a free utility available from FreeWave.



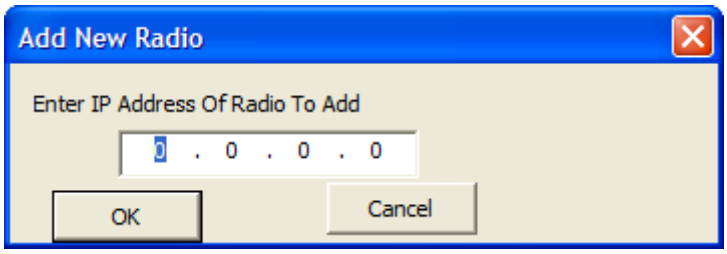
Upon running the program, it will automatically attempt to discover any IP Mini radios connected via Ethernet. The radios broadcast this information, so they should be successfully discovered as long as they have a physical Ethernet connection to the network. Depending on an IT department's policies, broadcasts may be blocked through any routers, so the radio may need to be on the same LAN segment as the PC running the FreeWave Discovery Tool.

Firewall software, such as Windows Firewall and McAfee Personal Firewall can prevent the Discovery Server from operating properly. FreeWave Technologies recommends disabling any Firewall software prior to running the Discovery Server.

The FreeWave Discovery Tool will show the Serial Number, Radio Name (if assigned), IP Address, Subnet Mask, Default Gateway, Web Port, and Firmware Version for each discovered radio.

Choosing a radio from the discovered list and right-clicking on it will bring up a Context Menu with the following items: **Add**, **Delete**, **Open Web Page**, and **Change Basic Settings**.

Add



This option allows a radio to be manually added to the discovery list by its IP Address. The IP Address of the radio should be entered into the box, and then the **OK** button should be clicked.

Press the **CANCEL** button to close the window without entering an IP Address.

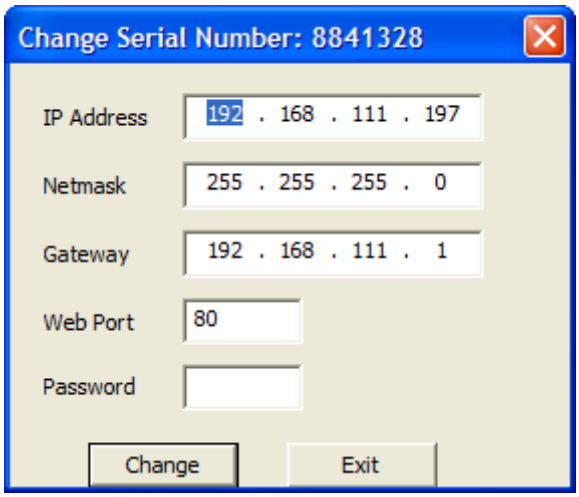
Delete

Selecting this option will delete the selected entry from the Discovery Server list. If the radio is still connected to the Ethernet link, the entry will reappear upon the radio's next broadcast or upon clicking the **Search** button.

Open Web Page

Choosing this option opens the computer's default web browser and enters the selected radio's IP Address in the address bar. If the computer can communicate with that IP Address via HTTP, the radio's login information will come up. Logging in will display the radio's settings pages.

Change Basic Settings



Selecting this option brings up a window that allows the changing of the basic IP settings of the radio. In this section, the **IP Address**, **Netmask (Subnet Mask)**, **Gateway**, and **Web Port** can be changed. If changes are made, the Administrator password for the radio must be entered in the **Password** box and then the **Change** button should be clicked. If the password is correct, the radio will reboot and apply the requested changes. Otherwise, the radio will ignore the change request.

File Menu

The following options appear on the **File** menu in the Discovery Server Window: **Export to CSV**, **Save Network File**, **Import Network File**, **Clear Radio List**, and **Exit**.

Export to CSV

This menu options saves the current radio entries in a comma-delimited (.CSV) file. The file contains all the information currently displayed in the Discovery Server program, including Radio Name and all the Diagnostic columns.

Save Network File

This menu option saves the current radio list as a Network File (.PNF) that can be imported into other copies of the Discovery Server. The Network File only saves a list of the radio IP Addresses—no other information is saved.

Import Network File

This menu option loads a selected Network File (.PNF) into the Discovery Server. Only the radio IP Addresses will be displayed until a broadcast is received from the listed radios (when the radios are rebooted, or when the **Search** button is clicked) or until the **Diagnostics** box is checked.

Exit

Selecting this menu option closes the FreeWave Discovery Server

Enable Diagnostics

Checking this box will cause the Discovery Server to request diagnostics information from any discovered radio. Diagnostics will only be reported from radios with a firmware version of **2.11** and higher. The following diagnostics information is listed in the Discovery Server: **Signal**, **Noise**, **Margin** (difference between signal and noise), **% Rx**, **% Tx**, **VSWR**, **Temp**, **Voltage**, **Distance**, and **Connected To**. Specifics on these statistics can be found on **page 17** of this manual. Diagnostics will be regularly updated as long as the **Enable Diagnostics** box is checked. When that box is unchecked, the last reported diagnostic information remains in the window, but it is no longer updated.