FGR2-PE User Manual

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FGR2-PE User Manual

SPREAD SPECTRUM WIRELESS DATA TRANSCEIVER USER MANUAL

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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.
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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.

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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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FGR2-PE 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 FGR2-PE 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.

UL Notification

The FGR2-PE UL certification is pending.

FGR2-PE User Manual

IMPORTANT NOTICE

The FGR2-PE radio is compatible over-the-air with the FGRplusRE and the MM2-P-T radios.

The FGR2-PE radio is **NOT** compatible over-the-air with any other FreeWave radio products.

FGR2-PE User Manual

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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 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 75.

FreeWave Basic Setup via the Serial Port:

This section describes how to either set or determine the IP address of the FGR2-PE radio. To determine or set the IP address of an FGR2-PE radio, plug a serial cable into **COM 1** (the left port), with the radio disconnected from the power. Then, follow the instructions below 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.

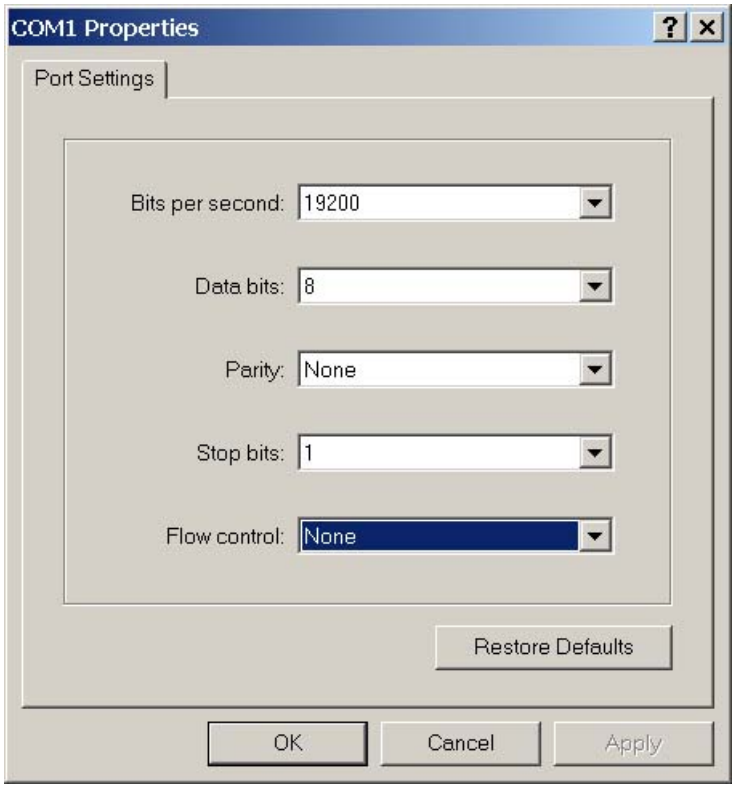
Click on the **Start** button. A cascading menu appears. Select **Programs**, **Accessories**, **Communications** and then **HyperTerminal**. A window appears similar to the following:

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**.

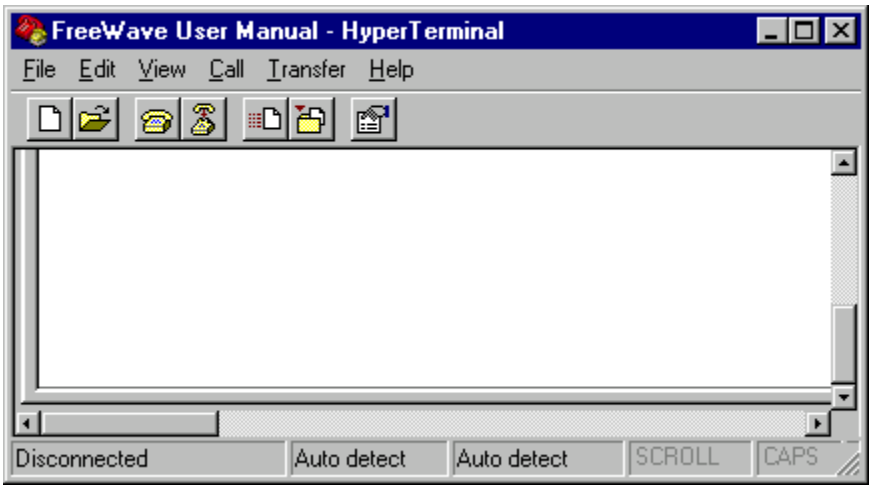
Click on the **OK** button. The Properties dialog box appears for the selected connection type.



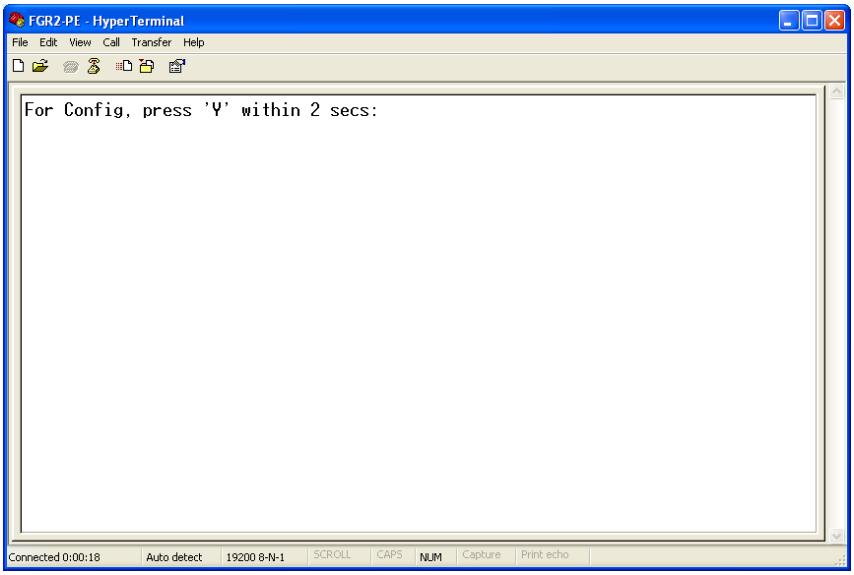
The following are the port settings which must be set for a proper connection:

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

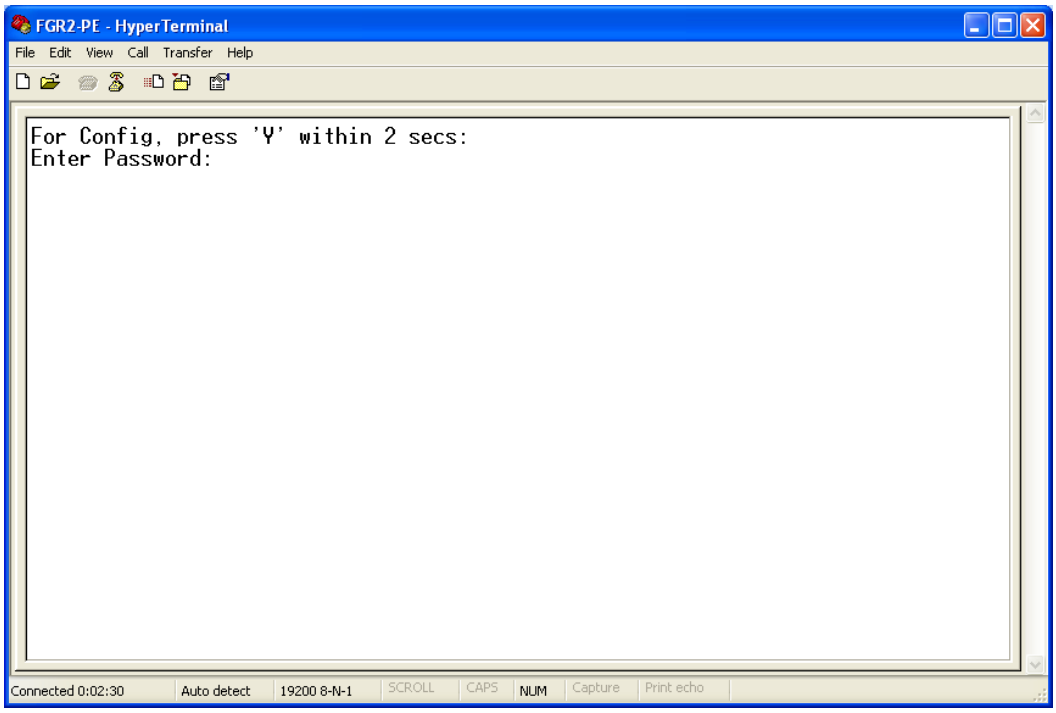
After selecting the appropriate menu items for each setting, click on the **OK** button. The following HyperTerminal dialog box appears:



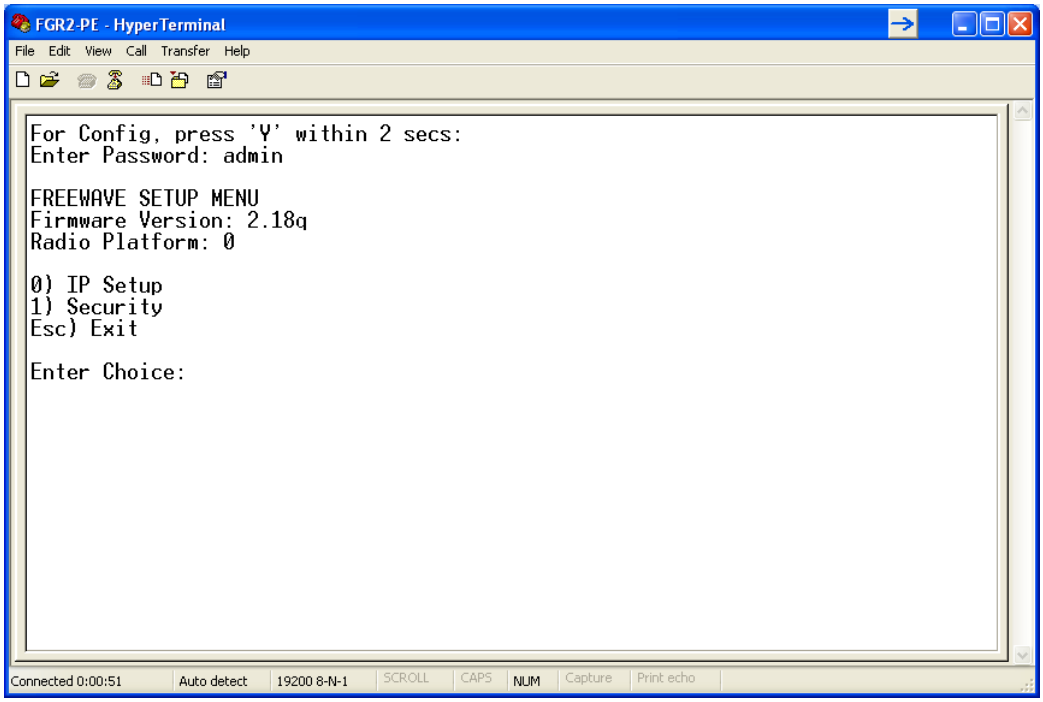
Connect power to the radio. After a few seconds, the following screen should appear in the HyperTerminal window:



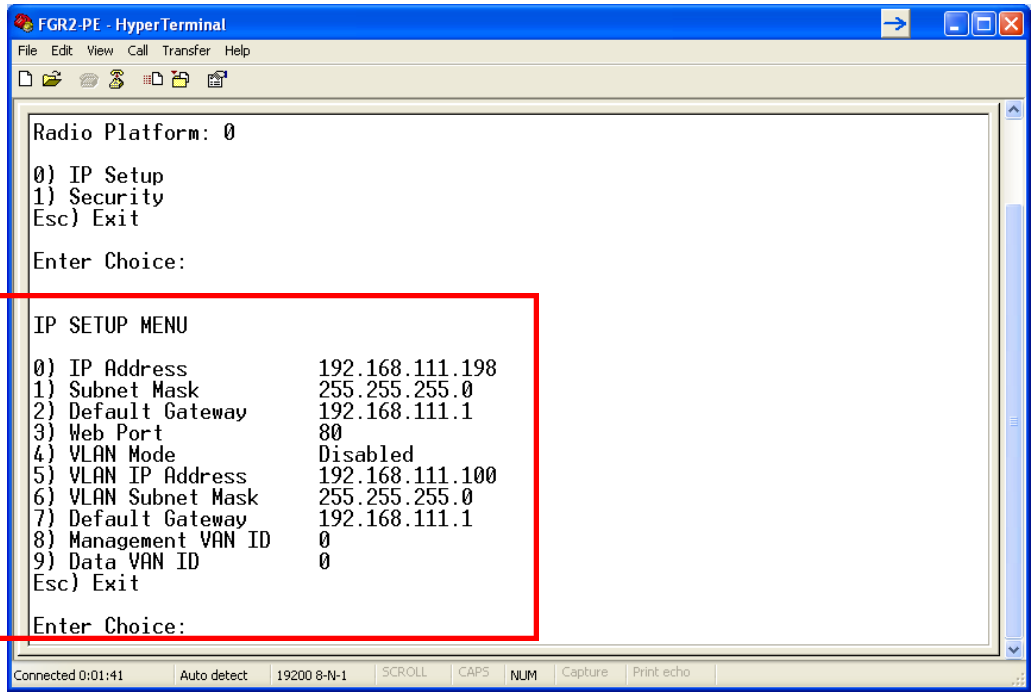
Enter a 'Y' or a 'y' **within 5 seconds** (even though the text says 2 seconds) to go into the IP setup of the radio. Any other key will exit, allowing the radio to complete the boot-up. Upon entering a 'Y', a password prompt will appear:



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



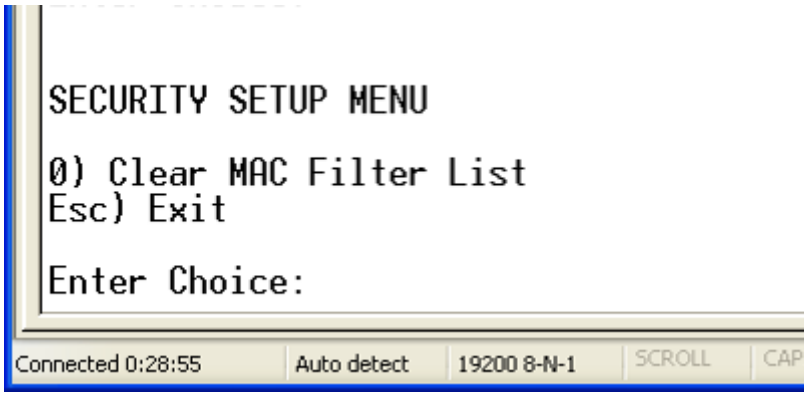
Choosing option 0 will bring up the IP Setup menu:



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

- Option 0 will change the IP Address of the radio. (*see p. 23*)
- Option 1 will change the Subnet Mask (also called Netmask) of the radio. (*see p. 23*)
- Option 2 will change the Default Gateway of the radio. (*see p. 23*)
- Option 3 will change the port number of the radio's Web-based configuration screens. (*see p. 24*)
- Option 4 will change the VLAN Mode (Disabled, Tagged, Untagged) of the radio. (*see p. 24*)
- Option 5 will change the Data VLAN IP Address. (*see p. 24*)
- Option 6 will change the Data VLAN Subnet Mask. (*see p. 24*)
- Option 7 will change the Data VLAN Default Gateway. (*see p. 25*)
- Option 8 will change the Management VLAN ID. (*see p. 25*)
- Option 9 will change the Data VLAN ID. (*see p. 25*)

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 0 clears out the MAC Filter list, setting the radio back to allowing all Ethernet traffic.

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

FreeWave Discovery Server

The IP Address of a FGR2-PE radio can also be set using the FreeWave Discovery Server. For more information on the FreeWave Discovery Server, please see **Appendix D** *(p. 89)*.

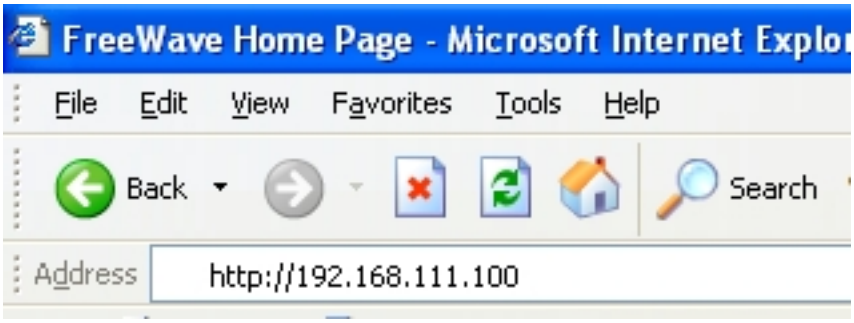
Resetting Radio to Default Settings:

Follow the steps for accessing Basic IP Setup as indicated on pages 11—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.73*).

Accessing Setup via the Built-in Web Server:

This section will discuss how to setup the settings in the FGR2-PE radio.

Plug the radio into either a computer or a switch/router using an 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 FGR2-PE 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 C**, p. 88*). 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**', the password is '**admin**'. The default username for the Guest login is '**guest**', 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 Maintenance/Tools pages, and cannot reboot the radio.

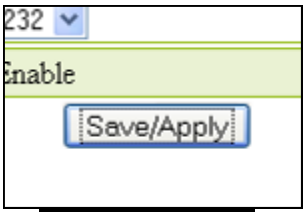
Navigating the FGR2-PE interface

Along the left side of all screens in the Web-based interface of the FGR2-PE is the **Pages List**. Clicking the items in this list allows navigation to the different configuration pages available in the FGR2-PE. The currently selected page is highlighted in teal.

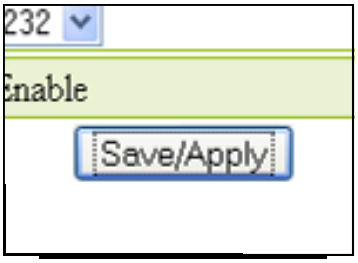
Pages List and Reboot button

Below the **Pages List** is the **Reboot button**. Clicking this button forces a reboot of the radio.

When making changes on the various settings in the FGR2-PE, it is necessary to click the **Save/Apply button** before navigating away from that page or rebooting the radio. No changes will take effect until the **Save/Apply button** is clicked. When the changes have been successfully saved and applied, the message "Change Succeeded" will appear beneath the **Reboot button**.



Save/Apply button



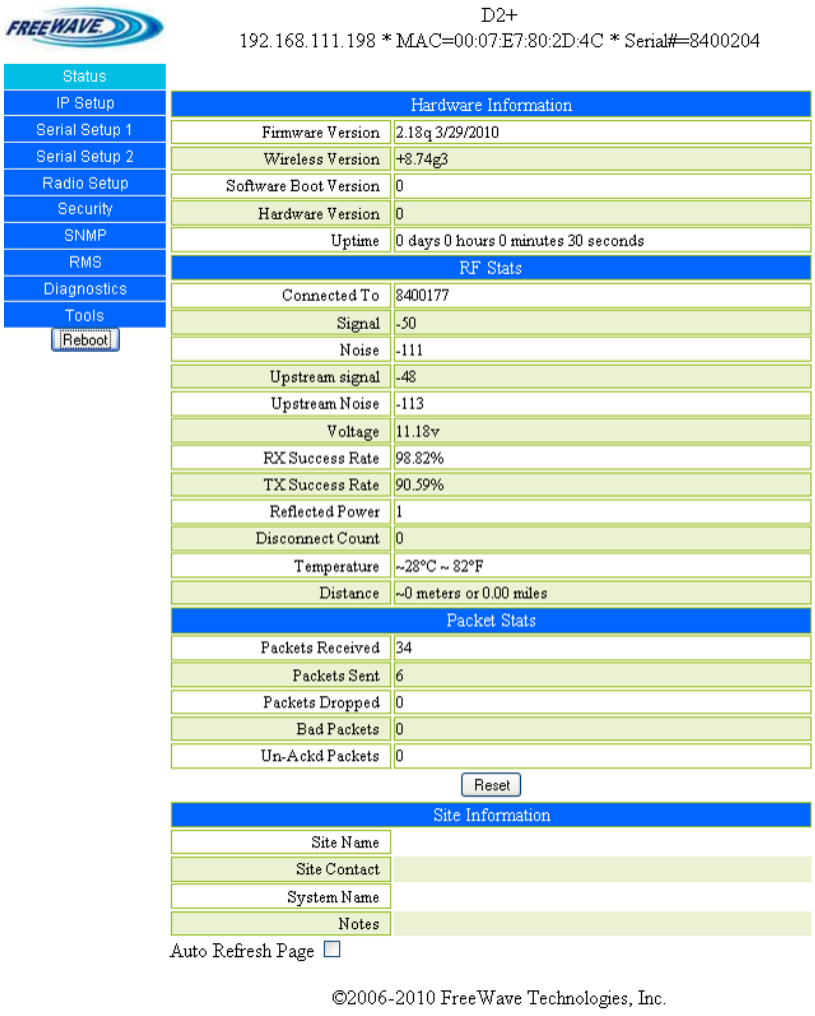
Change Succeeded message

Some settings changes (such as changes to the **IP Setup** section) require a reboot to complete the changes. When such a change is made, the "Change Succeeded" message changes to include a link labeled "Reboot Required". Clicking either the "Reboot Requiured" link or the **Reboot button** will reboot the radio and apply the requested changes. If the user does not reboot the radio right away, the requested changes will not be made until the radio is rebooted.

Reboot required message

Status:

This page will include all of the device status information. Nothing on this screen is user adjustable. This page updates every 10 seconds.



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 (hardware) 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.

RF Stats

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 this transceiver (shown in the **Connected To** field). 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 the average signal level and average noise level should be 30dBm or more. 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.

Upstream Signal

The Upstream Signal field indicates the level of the signal received by the upstream radio (listed in the **Connected To** field) from this transceiver. The number is an average of the received signal levels measured at each frequency in the upstream radio's frequency hop table. This statistic is only valid in a Multipoint Endpoint or Multipoint Repeater.

Upstream Noise

The Upstream Noise field indicates the level of the RF noise at the upstream radio (listed in the **Connected To** field). The number is an average of the noise levels measured at each frequency in the upstream radio'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. This statistic is only valid in a Multipoint Endpoint or Multipoint Repeater.

Voltage

This displays the voltage level 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 radios. 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.

Disconnect Count

This statistic show the number of times the radio has lost its RF connection to its upstream radio. This statistic is not valid in Multipoint Gateways or Point-to-Point Repeaters.

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.

Packet Stats

Packets Received

This statistic shows the number of Ethernet packets the radio has received over its radio link.

Packets Sent
This statistic shows the number of Ethernet packets the radio has sent over its radio link.

Packets Dropped
This statistic shows the number of Ethernet packets the radio has thrown away due to its data buffer being full.

Bad Packets
This statistic shows the number of Ethernet packets the radio has thrown away due to a bad CRC checksum.

Un-Acked Packets
This statistic shows the number of Ethernet packets sent using a broadcast MAC address. These packets are unacknowledged by the destination device.

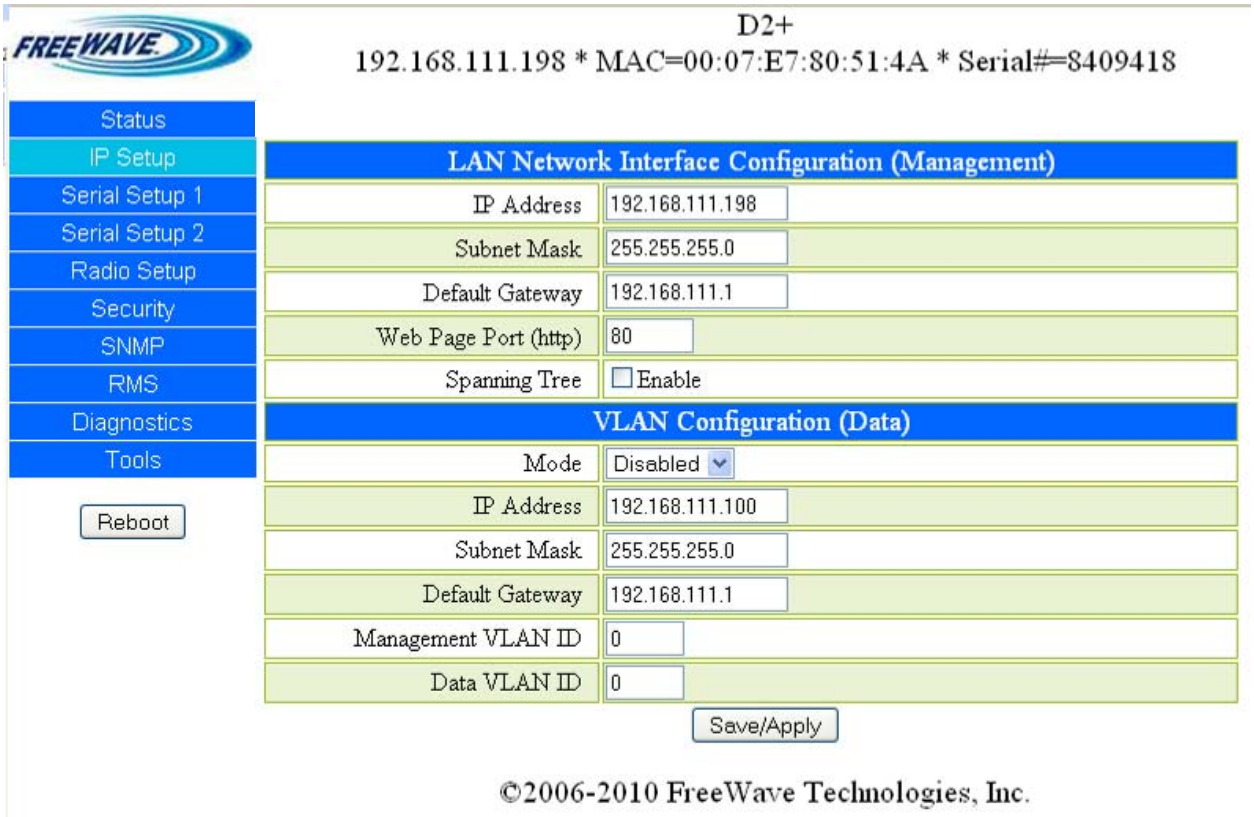
Reset Button
Clicking this button will reset all of the statistics in the **Ethernet Stats** section to 0. Power-cycling or rebooting the radio will also reset all the statistics.

Site Information
Site Name / Site Contact / System Name / Notes
These are user-defined fields. The values for these fields can be entered under the Tools page.

Auto Refresh Page
Checking this box causes the Status page to refresh its information every 10 seconds. By default, this box is not checked and the Status page does not refresh. Navigating away from the Status page will cause this box to revert to its unchecked default.

IP Setup:

This page will be used to setup the IP address, Subnet Mask, and Default Gateway of the radio. Please check with a Network Administrator before adjusting these settings. Many of these settings are also available through **Basic IP Setup** (*see p. 11*) or the **Discovery Server** (*see p. 89*).



LAN Network Interface Configuration (Management)

IP Address / Subnet Mask / Default Gateway

A unique IP address will need to be assigned to each FGR2-PE 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. 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. 10*) or use the **FreeWave Discovery Server** *(see p. 89)*. The Subnet Mask and Default Gateway are normally assigned by a network administrator. **NOTE:** Putting multiple devices on the network with the same IP address can cause the whole network to crash.

When the VLAN **Mode** option (*see p. 24*) is set to *Tagged* ***or*** *Untagged*, this IP information will be assigned to the Management portion of the radio (Setup pages, SNMP, Discovery Server). Any communication with the FGR2-PE's Setup pages, SNMP, or changes via the Discovery Server will need to be addressed to this IP address and tagged with the **Management VLAN ID**.

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 FGR2-PE 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 FGR2-PE radio will default the Web Page Port setting to 80. In the example below, the Web Page port was changed to 5150.

Example:

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. Spanning Tree Protocol does use radio bandwidth, as any Spanning Tree radios are constantly communicating their network "location." FreeWave Technologies recommends leaving Spanning Tree **unchecked**, unless Spanning Tree Protocol is required by your application.

VLAN Configuration (Data)

Mode

This drop-down selects whether VLAN will be active and which mode will be utilized.

- **Disabled:** VLAN will not be used.
- **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.
- **Untagged:** 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

IP Address

When the VLAN **Mode** is set to *Tagged* or *Untagged*, the IP Address entered here will be assigned to the Data portion of the radio (Ethernet port traffic and terminal server communication). Any data destined for the FGR2-PE's serial port or its Ethernet port will need to be addressed to this IP address and tagged with the **Data VLAN ID**.

Subnet Mask

The appropriate subnet mask for the Data VLAN IP address (*above*) should be entered in this box.

Default Gateway

The appropriate default gateway for the Data VLAN IP address (*p. 24*) should be entered in this box.

Management VLAN ID

Computers and devices using the VLAN ID entered here will be able to access the radio's Setup Pages, receive SNMP information, send SNMP commands, and view the radio via the Free-Wave Discovery Server.

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 and will be allowed to access the serial ports via the terminal server.

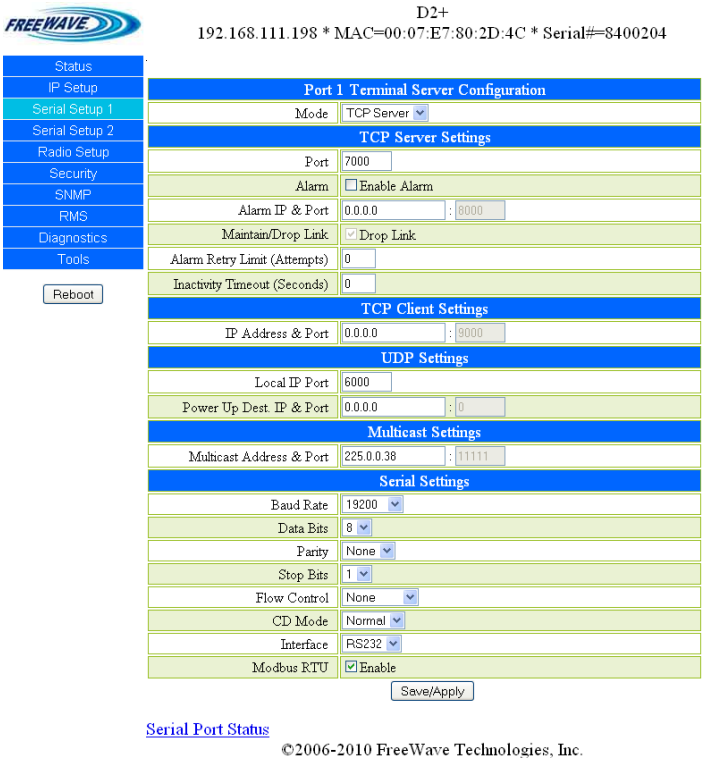
****NOTE**** Not every network needs or uses VLAN IDs. The **Mode** setting is normally kept at **Disabled**. Changes to these settings should be approved by a Network Administrator.

Save/Apply Button

Clicking this button saves any settings changes in the **IP Setup** page, and applies those changes to the radio. Before the changes become active, the radio requires a reboot. Navigating away from the **IP Setup** page without clicking this button discards any changes.

Serial Setup 1 and Serial Setup 2:

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 Port 1. Each serial port is configured on its own page.



Port 1/Port 2 Terminal Server Configuration

Mode

This drop-down box selects the operating mode of the radio's terminal server. The available modes are described below.

Disable

Selecting this mode disables the associated serial port, preventing it from accepting data or a TCP connection.

TCP Server

Selecting this mode enables the radio as a TCP terminal server (its default mode). The number entered in the **Port** box in the **TCP Server Settings** section will be the TCP port that the radio listens to for connection requests. In the picture above, the server is set for port 7000.

TCP Client

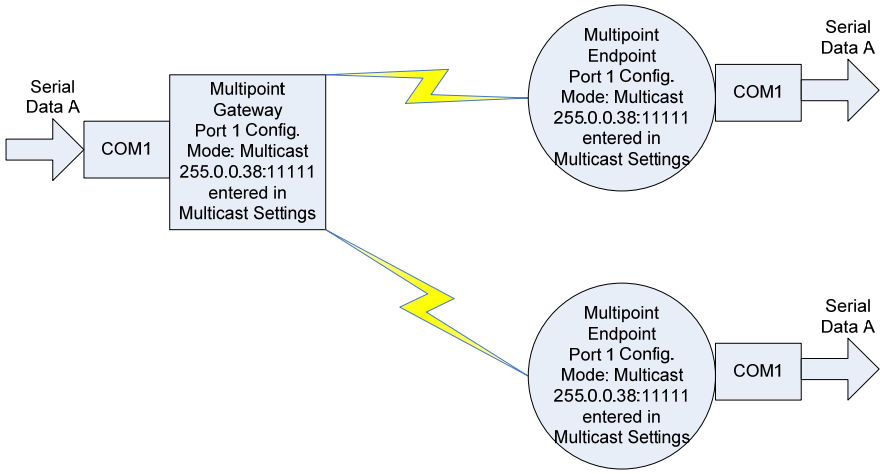
Selecting this mode causes the radio to act as a TCP client to the IP address and port number entered in the **TCP Client Settings** section. Upon booting up, the radio will create a persistent outgoing TCP connection to the entered IP address and port number. Any data sent to the associated serial port on the radio is automatically directed to the entered IP address and port number.

UDP

Selecting this mode enables the radio as a UDP terminal server using the port number entered in the **UDP Settings** section. The port number entered in the **UDP Settings** section 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.

Multicast

Selecting this mode will allow a one-to-many connection from the Multipoint Gateway's serial port to the interested Multipoint Repeaters' and/or Endpoints' serial ports.



In a Multipoint Gateway radio, selecting this mode will cause the radio to act as an IP Multicast Sender on the Multicast address and port entered in the **Multicast Settings** section.

In a Multipoint Repeater or Multipoint Endpoint, selecting this mode will register that radio's interest for any Multicast packets sent from the Multicast address and port entered in the **Multicast Settings** section.

TCP Server Settings

Port

The number entered in this box will be the TCP port the radio listens to for incoming TCP connections. Any valid TCP port number (0—65535) may be entered in this box.

Alarm

Checking the **Enable Alarm** box enables the port as an alarm client. To use this function, the **Alarm IP & Port** boxes must also be configured. The radio will act as a terminal server on the

port specified in the **Port** box *(see also:* **Port**, *p. 27)*. If there is no current TCP connection to this port 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 **Alarm IP & Port** line.

Alarm IP & Port

This line sets the IP address and TCP port number the radio will connect to when it becomes a client per the **Alarm** setting (above). The IP address is entered in the box to the left of the colon. The TCP port number is entered in the box to the right of the colon. The port number must be set to a valid TCP port (0—65535).

Maintain/Drop Link

Checking the **Drop Link** checkbox will cause the outgoing connection to the **Alarm IP & Port** to be dropped as soon as the serial data is sent. Unchecking the **Drop Link** checkbox 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.

Alarm Retry Limit (Attempts)

This setting is the number of times the radio will attempt to create an outgoing TCP connection when acting as an alarm client (*see* **Alarm**, *above*). 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.

Inactivity Timeout (Seconds)

This setting controls how long an incoming TCP 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.

TCP Client Settings

IP Address & Port

This line sets the IP address and TCP port number the radio will create a connection to upon boot-up, when the radio is set to the **TCP Client** mode (*see* **TCP Client**, *p. 27).* The IP address is entered in the box to the left of the colon. The TCP port number is entered in the box to the right of the colon. The port number must be set to a valid TCP port (0—65535).

UDP Settings

Local IP Port

The port number entered in this box is the UDP port the radio will listen to for connections

when the Mode is set to **UDP**. The port number must be set to a valid UDP port (0—65535).

Power Up Dest. IP & Port

In this line, an IP Address and Port Number can be entered. In a radio set to a Mode of **UDP**, Before an incoming UDP request has been received by the radio, 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. The IP address is entered in the box to the left of the colon. The UDP port number is entered in the box to the right of the colon. The port number must be set to a valid UDP port (0—65535).

Multicast Settings

Multicast Address & Port

This line sets the IP address and port number that will be used for Multicast. In a Multipoint Gateway, this will be the sending address. In Multipoint Endpoints and Multipoint Repeaters, this will be the address they register interest in (*see* **Multicast**, *p. 27*). The IP address is entered in the box to the left of the colon. The UDP port number is entered in the box to the right of the colon. The port number must be set to a valid UDP port (0—65535).

Any IP addresses used in this line must be designated Multicast addresses (**224.0.0.0** to **239.255.255.255**).

Serial Settings

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.

Interface

This option sets the serial protocol the serial port will use. This should match the protocol required by the connected device. The available settings are: **RS232**, **RS485**, and **RS422**. See page 78 for pinout information.

Modbus RTU

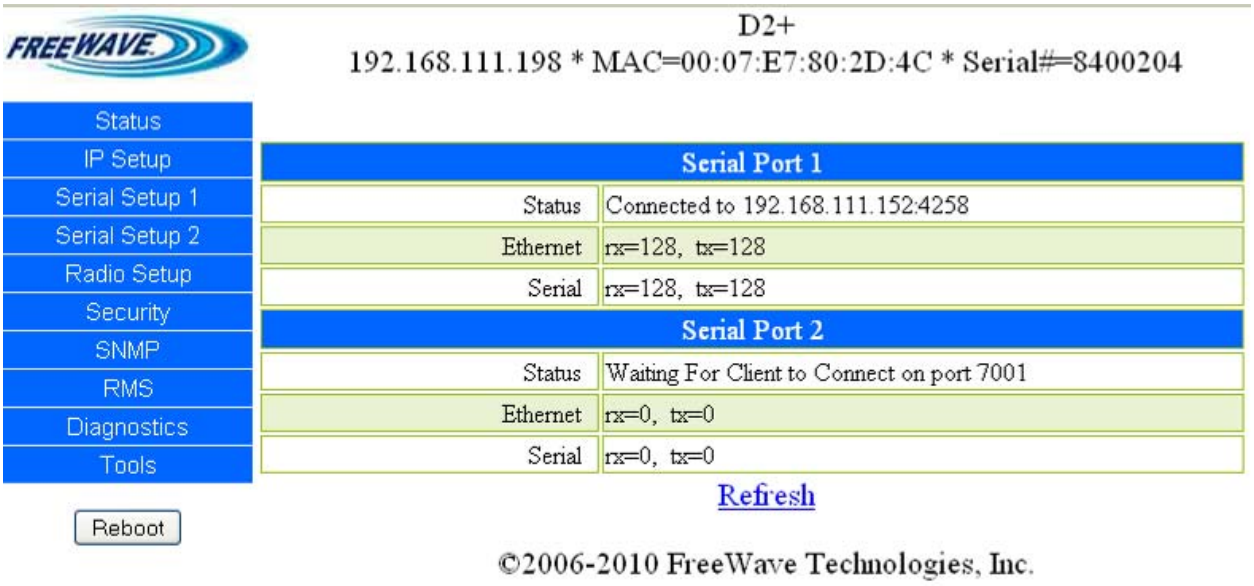
This option adjusts for Modbus RTU timing. When enabled, the radio will gather data on the serial port until there is a break in the data due to Modbus RTU timing (every 256 bytes). The data is then sent as one TCP packet.

Save/Apply Button

Clicking this button saves any settings changes in the **Serial Setup 1** or **Serial Setup 2** pages, and applies those changes to the radio. Navigating away from the **Serial Setup 1** page or the **Serial Setup 2** page without clicking this button discards any changes.

Serial Port Status

Clicking on the **Serial Port Status** link at the bottom of this page will open a new window (shown below) which displays Terminal Server Diagnostics. For each serial port, the current status of the Terminal Server is listed first (Waiting, Connected, etc.).



The **Ethernet** line shows the amount of data received (rx) and transmitted (tx) from the terminal server. Received (rx) data indicates data received on the radio from the serial port. Transmitted (tx) data indicates data sent from the radio out the serial port. This amount is in bytes.

The **Serial** line shows the amount of data received (rx) and transmitted (tx) from the serial port. Received (rx) data indicates data coming from the connected device into the serial port. Transmitted (tx) data indicates data sent out the serial port to the connected device. This amount is in bytes.

This page updates every 5 seconds.

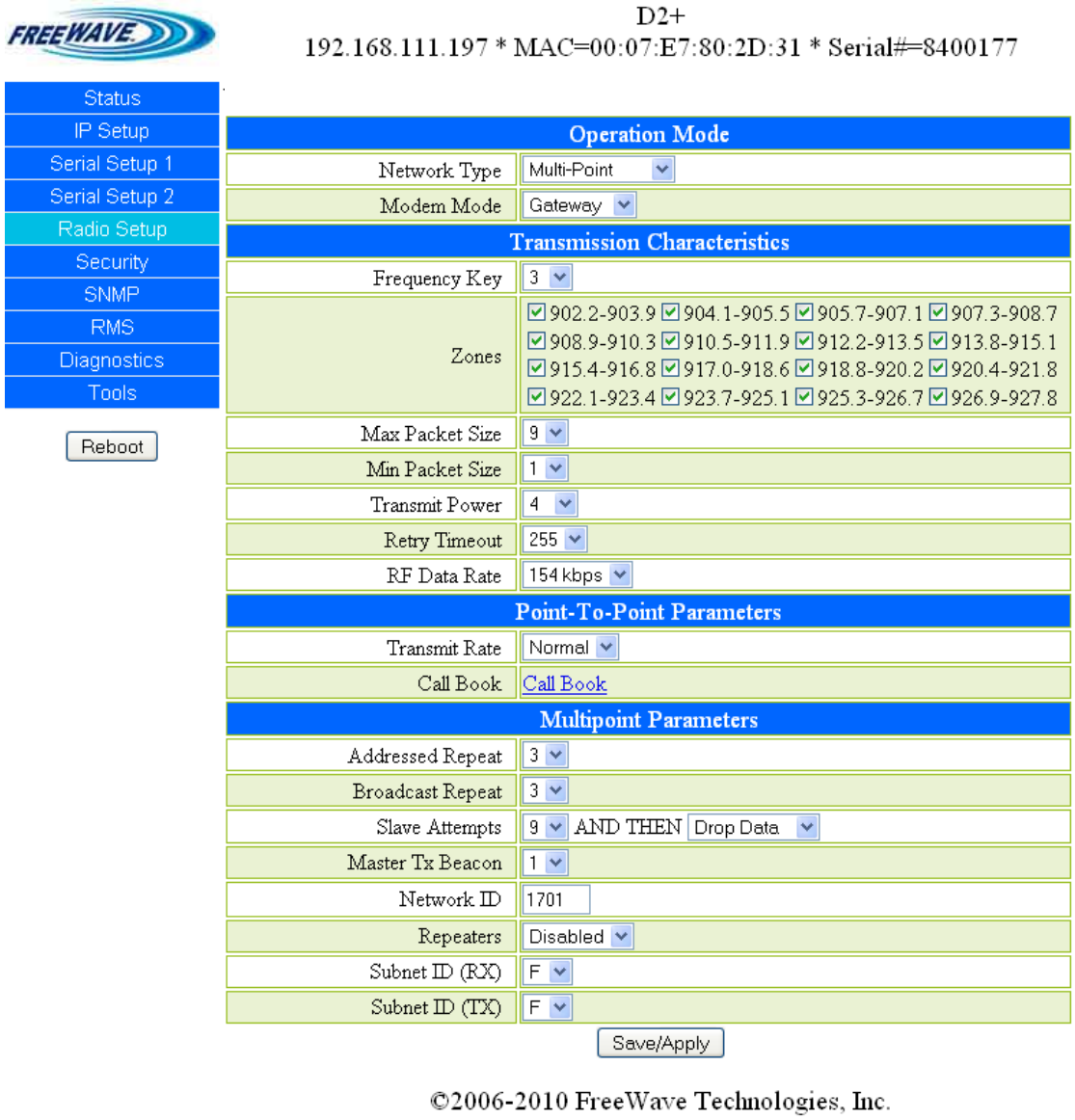
Radio Setup:

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 Point-To-Multipoint. The Modem Mode is either Gateway, Repeater, or Endpoint.

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 an Endpoint/Repeater.



Operation Mode

Network Type / Modem Mode

The Network Type and Modem Mode options designate the method FreeWave transceivers use to communicate with each other. FreeWave FGR2-PE transceivers operate in a Gateway to Endpoint configuration. Before the transceivers can operate together, they must be set up to properly communicate.

In a standard 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 an 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 an 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 Multipoint Gateway communicates only with other transceivers designated as Multipoint Endpoints or Multipoint Repeaters.
Multipoint & End-Point	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 (Single-radio 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 FGR2-PE 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 (Single-radio 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 FGR2-PE radio do not operate in networks containing Repeaters. FreeWave Technologies does not recommend the use of single-radio 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** and **Retry Time Out**. All other settings in a Point-to-Point network 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 for each pair 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 by chance, 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.

Zones

The idea of frequency zoning is to divide the available band (902 MHz 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 **Zones** line 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, this section should only be changed on the Gateway radio.

Max Packet Size & Min 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 the full 92 Kbps data rate 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 FGR2-PE are 9, 1, and 154 Kbps, respectively.

The following table defines 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 21.

Minimum Packet Size Definition FGR2-PE		
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. Using the default settings, the actual maximum packet size, in bytes, is 213.

Maximum Packet Size Definition with RF Date Rate of 154 kbps (in bytes)										
	Max Setting (Blank area = Not Recommended)									
Min Setting	0	1	2	3	4	5	6	7	8	9
0								165	186	207
1								170	191	213
2							154	175	197	218
3							159	181	202	223
4							165	186	207	229
5							170	191	213	234
6						154	175	197	218	239
7						159	181	202	223	245
8						165	186	207	229	250
9						170	191	213	234	255

Referencing the default settings, the Gateway will transmit up to 213 bytes on every hop. If fewer than 213 bytes are transmitted by the Gateway, 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 134 bytes available [113 (“leftover bytes”) + 21 (Min packet size)].

Maximum Packet Size Definition with RF Date Rate of 115 kbps (in bytes)										
	Max Setting (Blank area = Not Recommended)									
Min Setting	0	1	2	3	4	5	6	7	8	9
0						88	104	120	136	152
1						92	108	124	140	156
2					80	96	112	128	144	160
3					84	100	116	132	148	164
4					88	104	120	136	152	168
5					92	108	124	140	156	172
6				80	96	112	128	144	160	176
7				84	100	116	132	148	164	180
8				88	104	120	136	152	168	184
9				92	108	124	140	156	172	188

The above 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.

Transmit Power

This option sets the transmit power of the radio. A setting of **10** is approximately 1W of output power in an FGR2-PE.

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 received successfully by that radio, 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 different link.

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

FGR2-PE 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 in an FGR2-PE radio, assuming optimum signal strength, 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 RF Data Rate settings take precedence over the Endpoint.

Point-to-Point Parameters

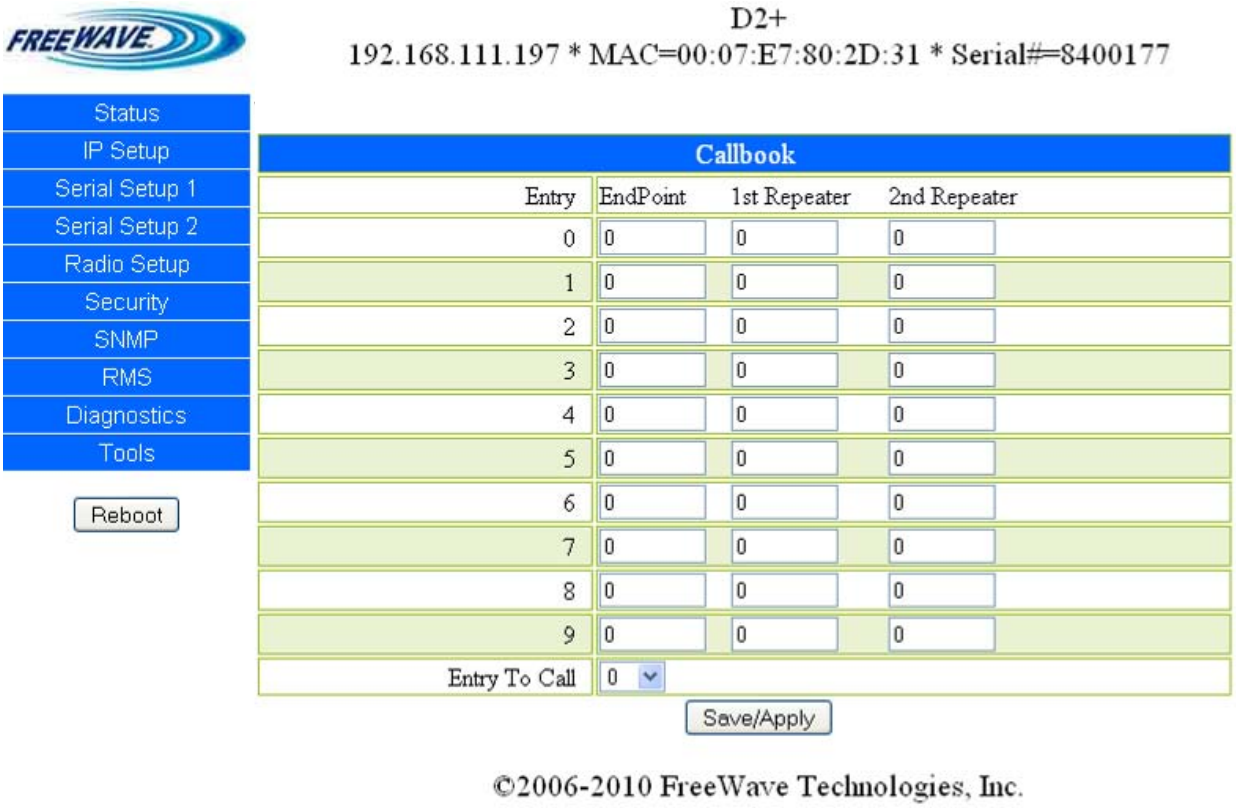
The items in this section are mainly set in Point-to-Point Networks, although they do have some usage in Multipoint networks.

Transmit Rate

There are two settings for the Transmit Rate parameter. The setting for normal operation of the transceiver is **Normal**. The Transmit 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, whether or not the radios have received any actual data. 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 (CTS) LED. A solid red CTS LED indicates a strong signal; a blinking CTS LED indicates a weaker signal.

Call Book

Clicking the **Call Book** link opens the **Call Book** page.



Use of the Call Book is required 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 on **page 41** of this manual.

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 (**EndPoint** column).
- The Endpoint's Serial Number must be listed in the Gateway's Call Book (**EndPoint** column).
- The Gateway must be programmed to call the Endpoint (**Entry to Call** drop-down box).

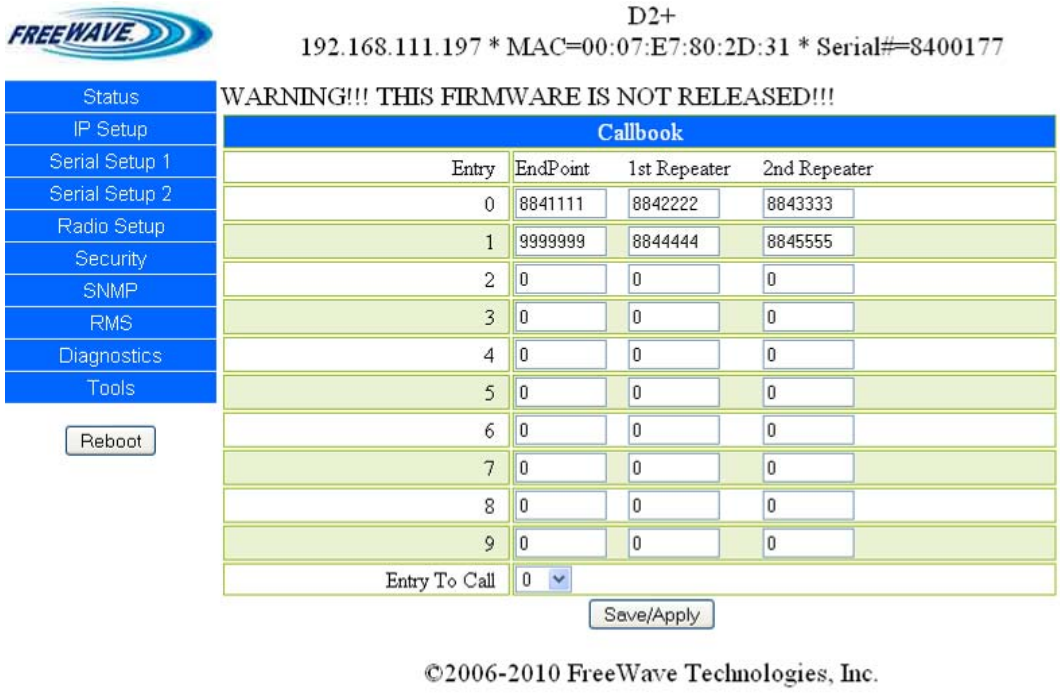
The Call Book allows users to incorporate up to 10 FreeWave transceivers, designate 1 to 4 Repeaters to be used with each transceiver, and designate which Endpoint the Gateway will call.

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 Repeaters #3 and #4. To set the **Entry to Call** option, choose the appropriate Entry number in the **Entry to Call** drop-down.

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.

Note: To call a Endpoint through one or more Repeaters, that Endpoint must be called individually. The line containing the Endpoint and Repeaters must be specifically selected in **Entry to Call**. With **Call All** selected, the Gateway will not connect with any Endpoints through Repeaters. This is because, when **Call All** is selected, 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 FGR2-PE radios can utilize up to 4 Repeaters. 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.

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, **884-1111**, through Repeater 1, **884-2222**, then Repeater 2, **884-3333**, then Repeater 3, **884-4444**, and finally Repeater 4, **884-5555**. 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.

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 45** of this manual. 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	EndPoint Serial Number	1st Repeater Serial Number	2nd Repeater Serial Number
(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)

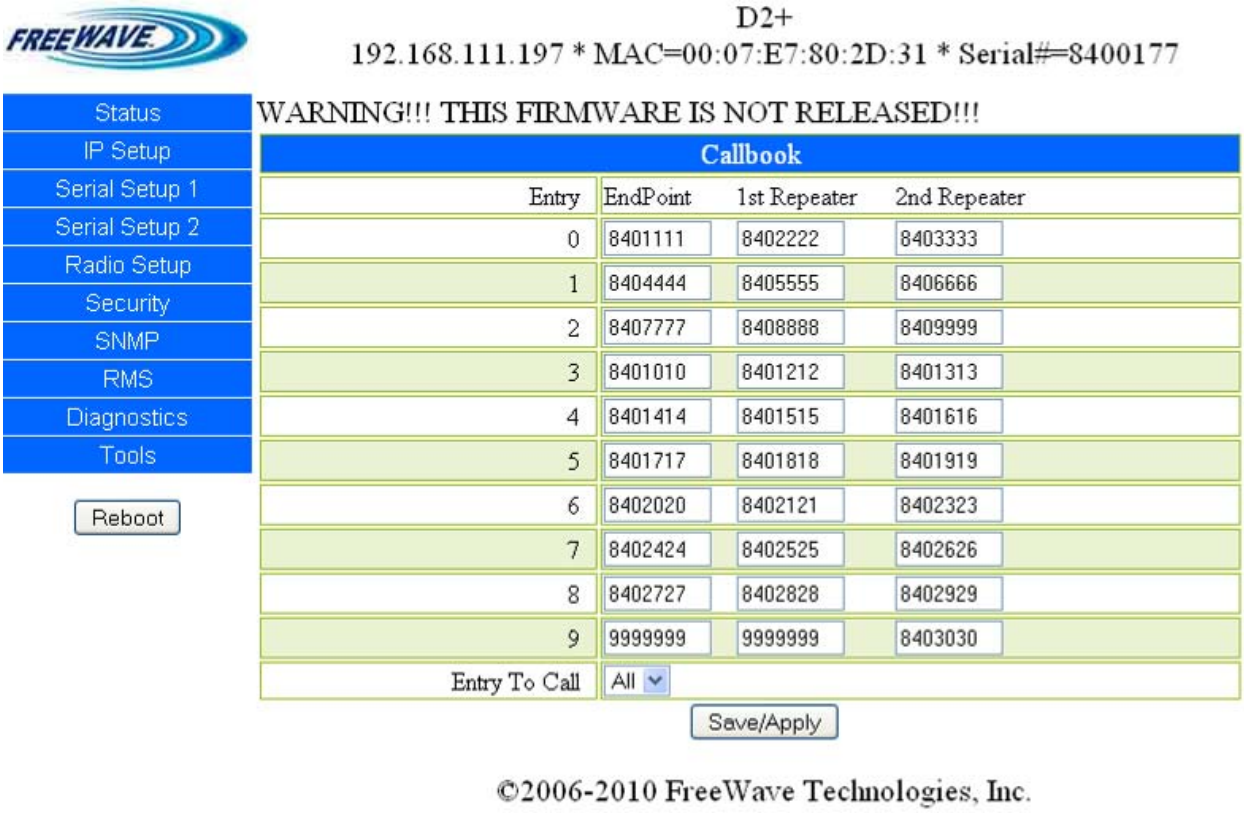
Entry	EndPoint Serial Number	1st Repeater Serial Number	2nd Repeater Serial Number
(0)	884-1111		
(1)	000-0000		

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

Entry	EndPoint Serial Number	1st Repeater Serial Number	2nd Repeater Serial Number
(0)	884-1111		
(1)	884-2222		
(2)	000-0000		

At times it may be desirable to force a 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 **EndPoint** and **1st Repeater** columns, and set **Entry to Call** to ALL.

Save/Apply Button

Clicking this button saves any settings changes in the **Call Book** page, and applies those changes to the radio.

Multipoint Networks

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

Addressed Repeat

In a Multipoint network where the **Repeaters** option is set to **Disabled**, most packets from the Gateway will be addressed to a specific MAC address. This allows the destination device to send an acknowledgement back to the Gateway that the packet was received successfully. The **Addressed Repeat** setting determines the maximum number of times the gateway will repeat its data packet if it does not receive an acknowledgement from the destination device. This is a "smart" repeat—the Gateway will only repeat its data if it does not receive an acknowledgement. Changing this setting to a higher number can increase the reliability of weaker radio links while keeping the maximum possible throughput for that link.
This setting **must** match between the **Gateway** and all **Repeaters**. This setting is ignored in **Endpoint** radios.

Broadcast Repeat

In a Multipoint network, Endpoints do not acknowledge transmissions from the Gateway that are addressed for broadcast MAC addresses. If Endpoints did acknowledge all broadcast MAC address 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.

In a radio network that contains radios set as a Repeater, **all** packets from the Gateway are considered broadcast MAC address packets. Increasing the Broadcast Repeat setting in this type of network will increase the probability of a packet getting through, but it will also increase la-

tency 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.
This setting **must** match between the **Gateway** and all **Repeaters**. This setting is ignored in **Endpoint** radios.

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. This setting should never be set higher on a Repeater than on its Gateway.

Slave Attempts

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:

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.

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.

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. Choosing a number larger than 1 in the drop-down box will cause the Gateway to skip that number of 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 FGRplus radios with a firmware version lower than 2.10, this setting must be 1.

NOTE: In a radio network that has the Repeaters option set to "Enabled", this setting must be set to 1.

Network ID

Network ID allows Multipoint networks to be established without using the Call Book. The default setting of 255 means "Disabled", and mandates using the Call Book instead of **Network ID**. 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).
Using Network ID instead of the Call Book, an Endpoint may establish communications with different Gateways, though not at the same time. This is can be 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 needs to be set in the **Gateway** radio only.

Many advanced features of the FGR2-PE radio are restricted in networks where the "Repeaters" option is set to 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 with a Subnet ID of Tx=F Rx=F, 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 which transceiver a Repeater or Endpoint will listen to.
- **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 Gateways and Repeaters only.*

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

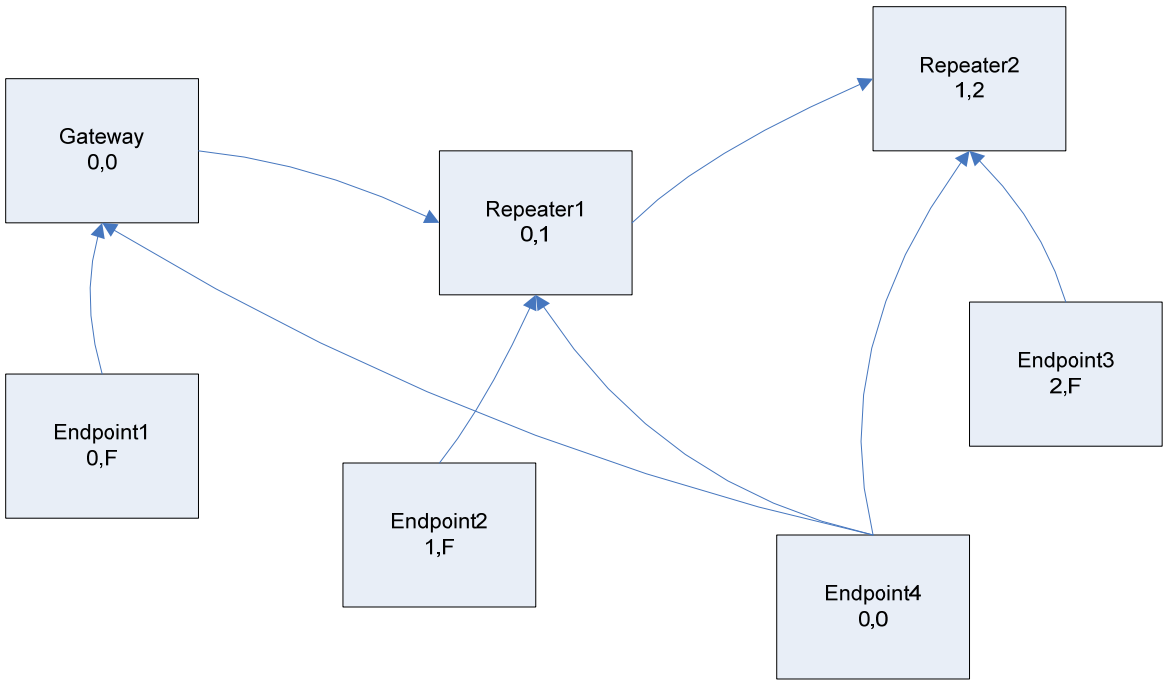
Notes:

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. 34)* for more information.

If both the Rx Subnet ID and the 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; Repeater2 *must* talk directly to Repeater1. Endpoints 1, 2, and 3 are forced along the direction of the solid lines. Endpoint4 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	Rx Subnet ID	Tx Subnet ID	Other Information
Gateway	F	F	The Gateway uses 0,0.
Gateway	0-F	0-F	The Tx Subnet ID value may be set in the Gateway. The default settings (F, F) actually use 0, 0. The Rx Subnet ID on the Gateway has no effect on the network.
Repeater1	0	1	A 0 will force the transceiver to link only to the Gateway.
Repeater2	1	2	Rx SubnetID = 1 forces communication through Repeater1. Repeater1 transmits on SubnetID 1.
Endpoint1	0	F	Rx SubnetID = 0 forces communication through Gateway.
Endpoint2	1	F	Rx SubnetID = 1 forces communication through Repeater1.
Endpoint3	2	F	Rx 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.

Save/Apply Button

Clicking this button saves any settings changes in the **Radio Setup** page, and applies those changes to the radio. Navigating away from the **Radio Setup** page without clicking this button discards any changes.

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.

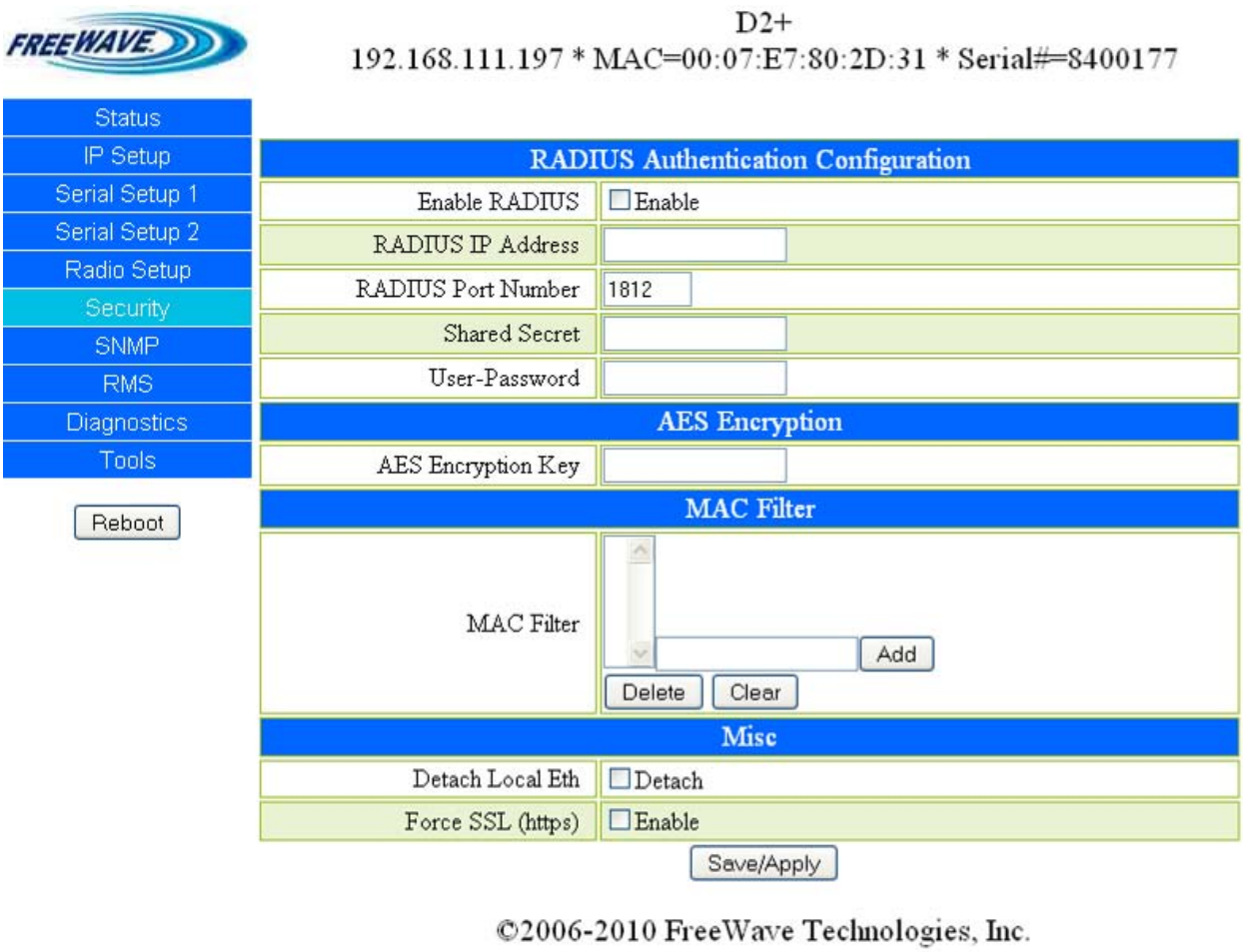
Co-located Multipoint networks require the following parameters be unique for each network:

- 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, MAC filtering, and the AES encryption key can be set.



RADIUS Authentication Configuration

The FGR2-PE radios have the capability to require Endpoint or 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. The authentication method used in the FGR2-PE radios is **PAP**.

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 RADIUS

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

nected to the same LAN segment the Gateway radio is connected to.
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 Multipoint Repeater radios.

RADIUS Port Number

The port number of the RADIUS server's authentication port should be entered here. By default, the port number is set to 1812. This option is controlled from the Gateway radio only. It has no functionality on Endpoint or Multipoint Repeater radios.

Shared Secret

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

User-Password

The RADIUS password for the radio should be entered in this box. 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 its username.
This option is used on Endpoint and Multipoint Repeater radios only. It has no functionality on Gateway radios.

AES Encryption

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.

MAC Filter

MAC Filter

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 **MAC Filter** list. This list is specific for each radio. Only devices with MAC addresses in the **MAC Filter** 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 **MAC Filter** list and clicking the **Delete** button will remove that address from the list.

Clicking the **Clear** button will remove every entry in the **MAC Filter** list.

If the **MAC Filter** list is blank, all traffic will be allowed.

Detach Local Eth

Checking the **Detach** box disables the physical Ethernet port on the radio. With this setting enabled, the radio can only be contacted via the radio link.

Force SSL (https)

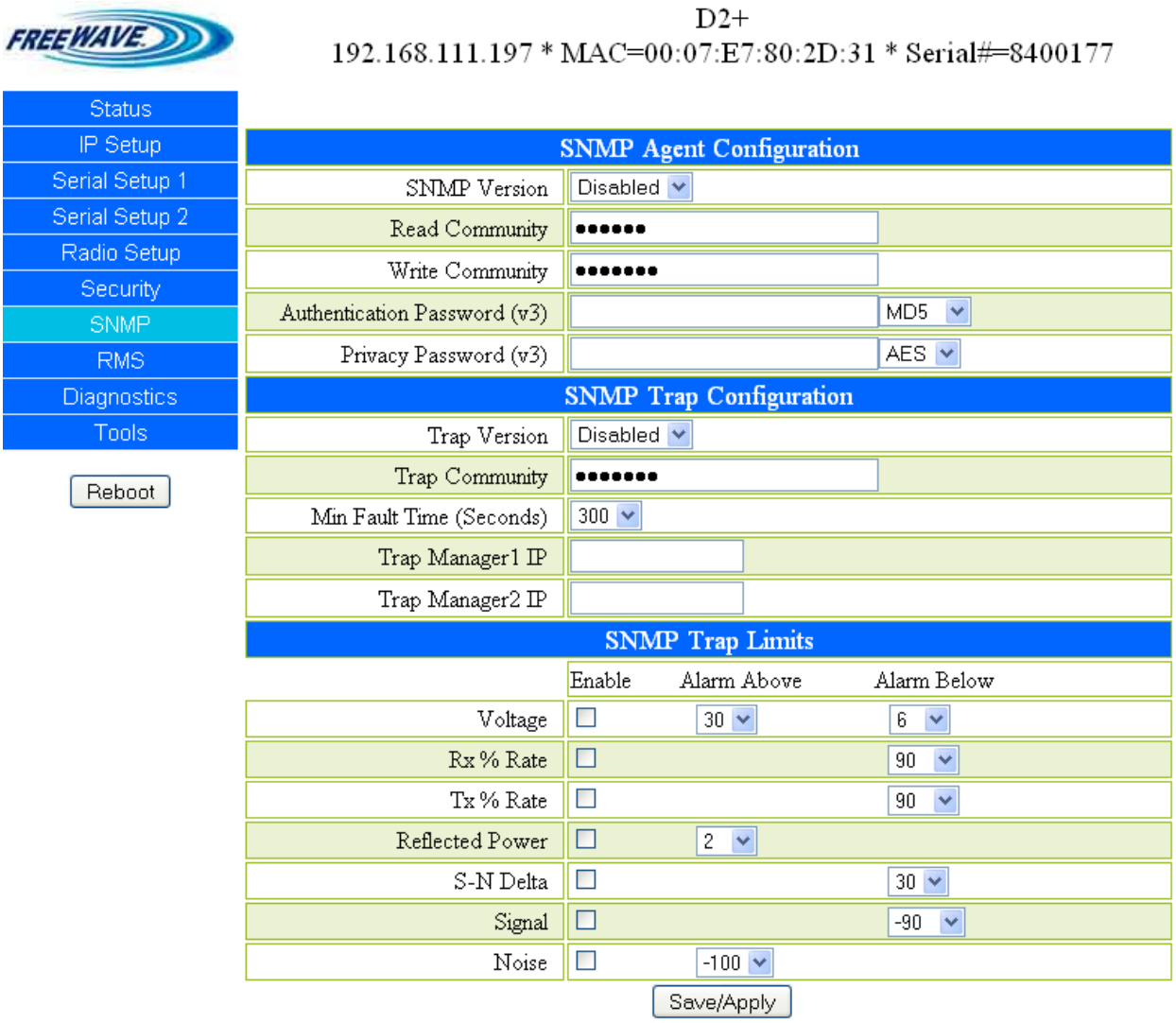
Checking the **Enable** box will redirect any HTTP requests to the configuration pages through an HTTPS link using SSL. Web page performance will be slower with this option enabled, due to the encryption requirements.

Save/Apply Button

Clicking this button saves any settings changes in the **Security** page, and applies those changes to the radio. Before the changes become active, the radio requires a reboot. Navigating away from the **Security** page without clicking this button discards any changes.

SNMP:

This page is where the SNMP management features of the FGR2-PE radio can be set. The FGR2-PE radio supports SNMP versions 1, 2, and 3. All of the SNMP-manageable objects for FreeWave's FGR2-PE 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 **v3** is selected in the **SNMP Version** setting. 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 only available when **v3** is selected in the **SNMP Version** setting. 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 (Seconds)
This dropdown box sets the amount of time a trap condition must be continuously present before an SNMP Trap is sent to the Trap Manager(s). The amount of time is in seconds. The available options are **30**, **60**, **90**, **120**, **150, 180**, **210**, **240**, **270**, and **300** seconds.

Trap Manager 1 IP & Trap Manager 2 IP
These boxes contain the IP Addresses of the authorized SNMP Trap Managers. DNS names are not accepted in these boxes.

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. Checking the **Enable** box will enable this specific Trap. 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. Checking the **Enable** box will enable this specific Trap. The Trap Condition will be present if the Receive Percent drops below the **Alarm Below** percentage. The available settings are whole numbers 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. Checking the **Enable** box will enable this specific Trap. The Trap Condition will be present if the Transmit Percent drops below the **Alarm Below** percentage. The available settings are whole numbers 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. Checking the **Enable** box will enable this specific Trap. The Trap Conditions will be present if the Reflected Power is above the number set in the **Alarm Above** box. The available settings are whole numbers from **0** to **40**, in increments of 2. The numbers are in J-Units.

S-N Delta

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

Signal

This is a Trap for the Signal level reported by the radio. Checking the **Enable** box will enable this specific Trap. The Trap Condition will be present if the Signal level drops below the amount set in the **Alarm Below** box. The available settings are negative whole numbers between **–100** and **–70**, in increments of 5. The numbers are in dB.

Noise

This is a Trap for the Noise level reported by the radio. Checking the **Enable** box will enable this specific Trap. The Trap Condition will be present if the Noise level rises above the amount

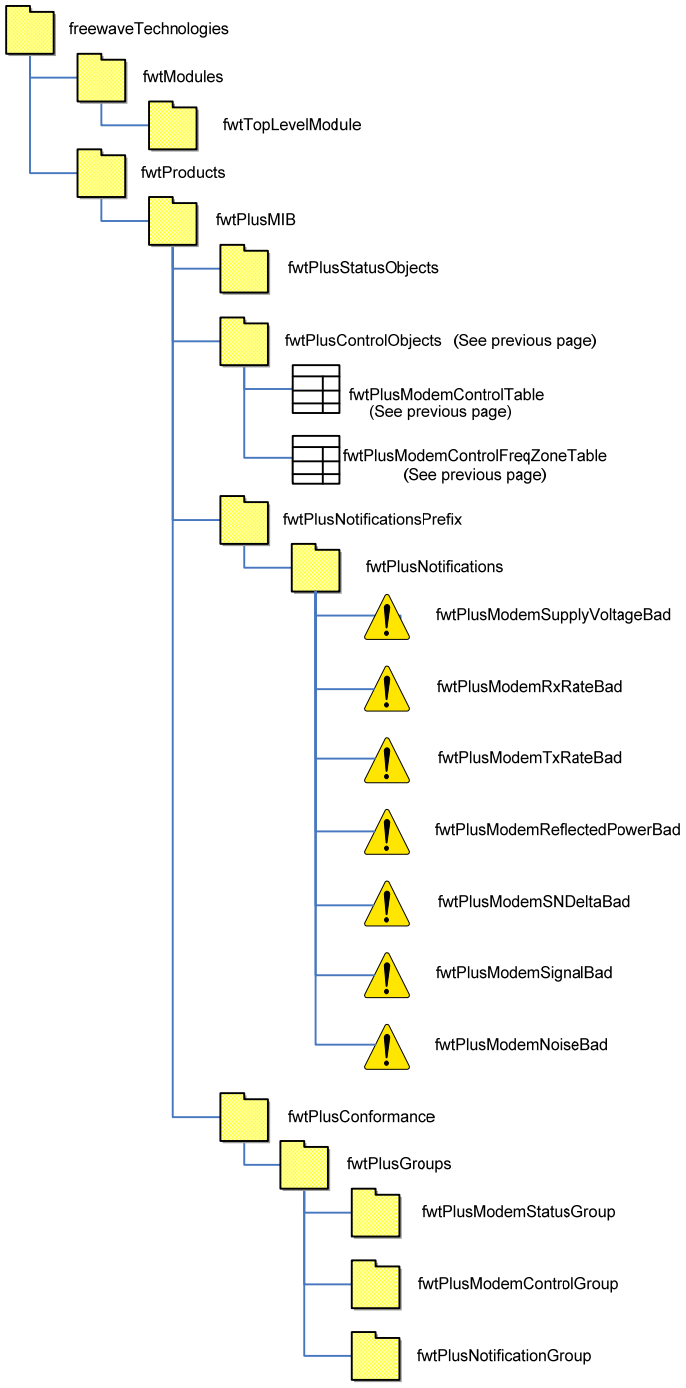
set in the **Alarm Above** box. The available settings are **–100** to **–70**, in increments of 5. The numbers are in dB.

Save/Apply Button

Clicking this button saves any settings changes in the **SMNP** page, and applies those changes to the radio. Navigating away from the **SMNP** page without clicking this button discards any changes.

Object Tree for FREEWAVE-TECHNOLOGIES-MIB

Object Tree for FREEWAVE-TECHNOLOGIES-MIB (continued)



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
fwt ModemTemperature	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
fwtPlusModemTxRate	The current transmit rate as a percentage of the maximum, in units of one hundredth of a percent.	Read Only	Hundredth
fwtPlusModemSNDelta	The current margin (absolute) between the received signal and the noise at this radio.	Read Only	Integer32
fwtPlusModemVendorString	The name of the vendor of this radio modem.	Read Only	DisplayString
fwtPlusModemConnectedTo	The serial number of the radio that we currently have an RF link with.	Read Only	Integer32

Object List for FREEWAVE-TECHNOLOGIES-MIB

Object	Description	Access	Syntax
fwtPlusModemUpstreamSignal	The received signal level that the upstream radio receives from this radio, in dBm.	Read Only	Integer32
fwtPlusModemUpstreamNoise	The Noise level that the upstream radio receives from this radio, in dBm.	Read Only	Integer32
fwtPlusModemDisconnectCount	The Number of times this radio has lost its RF link.	Read Only	Unsigned32
fwtPlusModemPacketRxCount	The Number of ethernet packets the radio has received over its RF link.	Read Only	Unsigned32
fwtPlusModemPacketTxCount	The Number of ethernet packets the radio has sent over its RF link.	Read Only	Unsigned32
fwtPlusModemDroppedCount	The Number of ethernet packets the radio has dropped	Read Only	Unsigned32
fwtPlusModemBadCount	The Number of BAD/corrupt ethernet packets the radio has received over its RF link.	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)
fwtPlusModemRFDataRate	The RF data rate to be used by a radio modem. Permissible values are 1200,867,614,154,115 depending on the radio 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)
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)

Object List for FREEWAVE-TECHNOLOGIES-MIB

Object	Description	Access	Syntax
fwtPlusModemSystemName	A textual identifier for a given system.	Read/Write	DisplayString (SIZE (0..32))
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

Object List for FREEWAVE-TECHNOLOGIES-MIB

Group Object	Description	Objects
fwtPlusModemSupplyVoltageBad	This notification is generated when the supply voltage for a radio modem goes out of specification.	fwtPlusModemSupplyVoltage fwtPlusModemVendorString fwtPlusModemSystemName
fwtPlusModemRxRateBad	This notification is generated when the receive rate for a radio modem goes out of specification.	fwtPlusModemRxRate fwtPlusModemVendorString fwtPlusModemSystemName
fwtPlusModemTxRateBad	This notification is generated when the transmit rate for a radio modem goes out of specification.	fwtPlusModemTxRate fwtPlusModemVendorString fwtPlusModemSystemName
fwtPlusModemReflectedPowerBad	This notification is generated when the reflected power for a radio modem goes out of specification.	fwtPlusModemReflectedPower fwtPlusModemVendorString fwtPlusModemSystemName
fwtPlusModemSNDeltaBad	This notification is generated when the Signal to Noise delta for a radio modem goes out of specification.	fwtPlusModemSNDelta fwtPlusModemVendorString fwtPlusModemSystemName
fwtPlusModemSignalBad	This notification is generated when the Signal to Noise delta for a radio modem goes out of specification.	fwtPlusModemSNDelta fwtPlusModemVendorString fwtPlusModemSystemName
fwtPlusModemNoiseBad	This notification is generated when the Noise for a radio modem goes out of specification.	fwtPlusModemNoise fwtPlusModemVendorString fwtPlusModemSystemName

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 fwtPlusModemTxRate fwtPlusModemSNDelta fwtPlusModemVendorString fwtPlusModemConnectedTo fwtPlusModemUpstreamSignal fwtPlusModemUpstreamNoise fwtPlusModemDisconnectCount fwtPlusModemPacketRxCount fwtPlusModemPacketTxCount fwtPlusModemPacketDroppedCount fwtPlusModemPacketBadCount
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 fwtPlusModemSystemName fwtPlusModemFreqZoneDescr fwtPlusModemFreqZoneEnabled

RMS:

The settings on the RMS page are utilized in FreeWave Redundant Master System units. For details on these settings, please see the manual for the FreeWave Redundant Master System.

Diagnostics

The **Diagnostics** page displays the signal level, noise level, signal-to-noise delta, and receive rate for each frequency available to the radio. The serial number of the Gateway or Repeater that this radio is connecting to appears above the chart (In a Point-to-Multipoint Gateway, this header always says, "**I am currently NOT connected.**"). This chart on this page displays each frequency the radio is using in MHz), along with the Signal (in dBm), Noise (in dBm), Signal-to-Noise Delta, and % Receive Rate for each individual frequency (*see pp. 20—21 for statistic descriptions*).

D2+
192.168.111.198 * MAC=00:07:E7:80:2D:4C * Serial#=8400204

Status
IP Setup
Serial Setup 1
Serial Setup 2
Radio Setup
Security
SNMP
RMS
Diagnostics
Tools

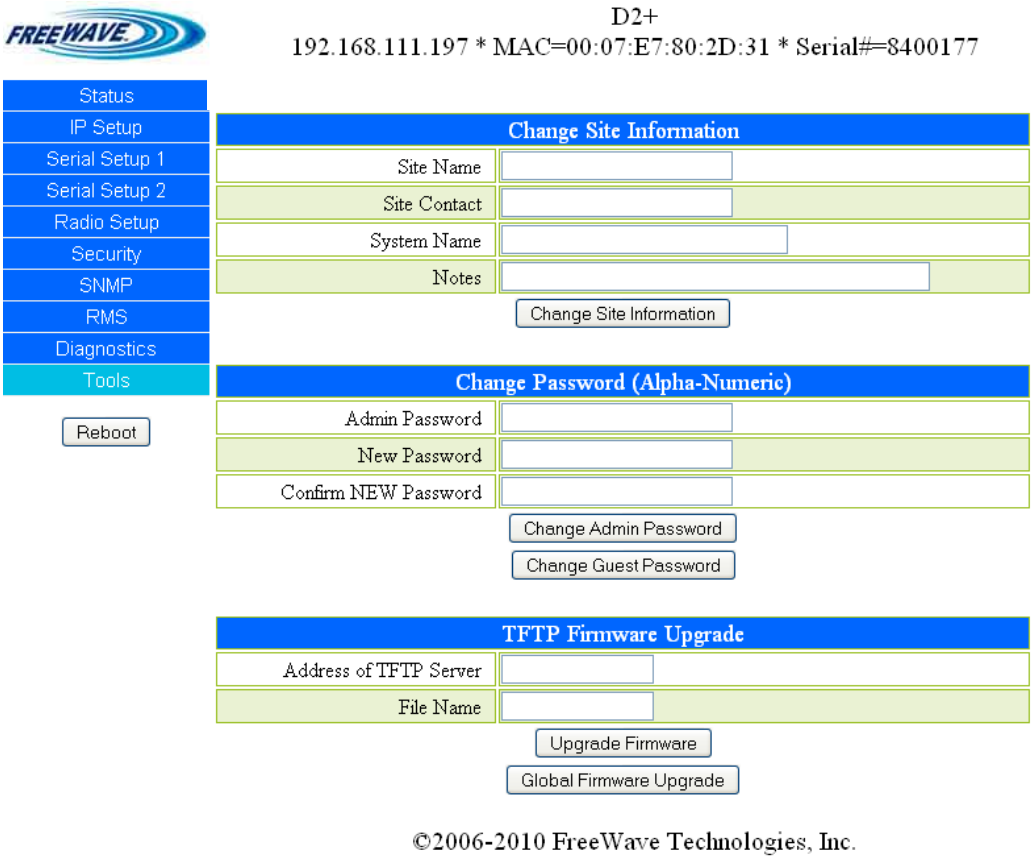
Reboot

I am Currently connected to 8400177

Frequency Information By Channel				
Frequency (MHz)	Signal (dBm)	Noise (dBm)	Delta	%Rcv Rate
902.0160	-111	-120	9	100.00%
902.2464	-111	-120	9	100.00%
902.4768	-112	-120	8	100.00%
902.7072	-110	-120	10	100.00%
902.9376	-110	-120	10	100.00%
903.1680	-109	-120	11	100.00%
903.3984	-109	-120	11	100.00%
903.6288	-109	-120	11	100.00%
903.8592	-108	-120	12	100.00%
904.0896	-109	-120	11	100.00%
904.3200	-109	-120	11	100.00%
904.5504	-109	-120	11	100.00%
904.7808	-110	-120	10	100.00%
905.0112	-111	-120	9	100.00%
905.2416	-111	-120	9	100.00%
905.4720	-112	-120	8	100.00%
905.7024	-112	-120	8	100.00%
905.9328	-112	-120	8	100.00%
906.1632	-112	-120	8	100.00%
906.3936	-113	-120	7	100.00%
906.6240	-113	-120	7	100.00%
906.8544	-113	-120	7	100.00%
907.0848	-113	-120	7	100.00%
907.3152	-113	-120	7	100.00%
907.5456	-113	-120	7	100.00%
907.7760	-113	-120	7	100.00%
908.0064	-113	-120	7	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.



Change Site Information

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

Site Name

25 characters are allowed in this field. Any text entered here appears next to **Site Name** on the **Status Page**.

Site Contact

25 characters are allowed in this field. Any text entered here appears next to **Site Contact** on the **Status Page**.

System Name

32 characters are allowed in this field. Any text entered here appears next to **System Name** on the **Status Page**.

Notes

50 characters are allowed in this field. Any text entered here appears next to **Notes** on the **Status Page**.

Change Password (Alpha-Numeric)

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.

TFTP Firmware Upgrade

The FGR2-PE radio 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 Button

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 Button

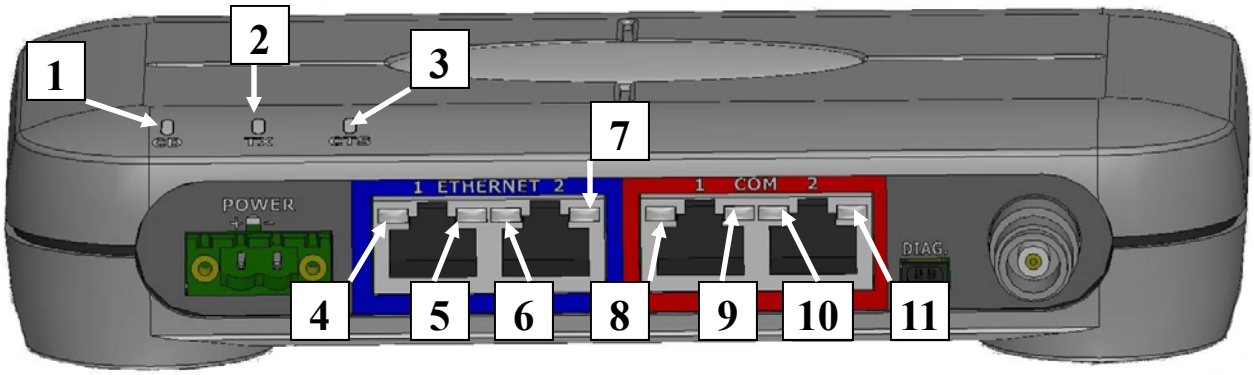
Clicking this button on a Gateway radio begins the Firmware update process on the Gateway radio. The radio will download the Firmware file from the specified TFTP Server. The Gateway will then send a copy of the Firmware update to all connected Endpoint and Multipoint Repeater radios. This Firmware information 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. 43*) will increase the probability of success, but will slow down the overall process. 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 during a Global Up-

grade.

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. 84)*

Operation LEDs



Legend

1. CD
2. TX
3. CTS
4. Ethernet 1 10 baseT Link/Activity
5. Ethernet 1 100 baseT Link
6. Ethernet 2 10 baseT Link/Activity
7. Ethernet 2 100 baseT Link
8. COM 1 Data (C1)
9. Error 1 (E1)
10. COM 2 Data (C2)
11. Error 2 (E2)

Boot-up Sequence

As the radio powers up, the following LED sequence occurs:

- C1 lights solid green*
- C2 lights solid green*, C1 remains lit
- E2 lights solid green*, C1 and C2 remain lit
- C1 turns off
- C2 turns off
- E2 turns off

COM LEDs

Condition	CCOM 1 or COM 2 (C1/C2)
Data Streaming into Rx	Solid green bright*
Data Streaming out Tx	Solid green bright*

Error LEDs

Condition	Error Lights (E1 / E2)
Radio Buffer Overflow	E1 LED is Solid green*
Network Collision, Corrupt Ethernet Packet	E2 LED is Solid green*

Ethernet Port Lights

Status	10 baseT Link/Activity LED	100 baseT Link LED
Linked, Data Activity	Blinking/Flickering Green *	Solid Green (100baseT)*/Off (10baseT)
Linked, No Data Activity	Solid Green*	Solid Green (100baseT)*/Off (10baseT)
Not Linked. Check that cable is in good condition and plugged in.	Off	Off

Authentication-related LEDs

Condition	LED pattern
Endpoint cannot contact RADIUS server	Solid green* **E1** LED
Endpoint was denied authentication from the RADIUS server	Alternating green* **E1** and **E2** LED
Endpoint AES encryption key does not match Gateway encryption key	Alternating green* **E1** and **E2** LED

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 Status Page. An adjustment of 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 FGR2-PE transceivers are shipped from the factory with the following Default Settings:

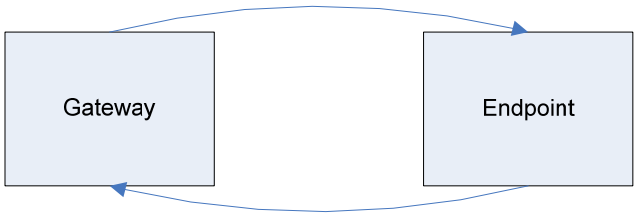
IP Setup	Default	
IP Address	192.168.111.100	
Subnet Mask	255.255.255.0	
Default Gateway	192.168.111.1	
Web Page Port	80	
Spanning Tree	Unchecked	
Serial Setup	**Serial Setup 1**	**Serial Setup 2**
Mode	TCP Server	TCP Server
Port	7000	7001
Alarm	Not Checked	Not Checked
Alarm IP & Port	0.0.0.0 : 8000	0.0.0.0 : 8001
Maintain/Drop Link	Not Checked	Not Checked
Alarm Retry Limit (Attempts)	0	0
Inactivity Timeout (Seconds)	0	0
IP Address & Port	0.0.0.0 : 9000	0.0.0.0 : 9001
Local IP Port	6000	6001
Power Up Dest. IP & Port	0.0.0.0 : 0	0.0.0.0 : 0
Multicast Address & Port	225.0.0.38 : 11111	225.0.0.38 : 22222
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	Checked	Checked
Radio Setup	**Default**	
Network Type	Point-to-Point	
Modem Mode	Gateway	
Frequency Key	5	
Frequency Zones	All checked	
Max Packet Size	9	
Min Packet Size	1	

Transmit Power	10
Retry Timeout	255
RF Data Rate	154 kbps
Point-to-Point Parameters	**Default**
Transmit Rate	Normal
Multipoint Parameters	**Default**
Addressed Repeat	3
Broadcast Repeat	3
Slave Attempts	9 / Try Forever
Master Tx Beacon	9
Network ID	255
Repeaters	Disabled
Subnet ID (RX)	F
Subnet ID (TX)	F
Security	**Default**
Enable RADIUS	Unchecked
RADIUS IP Address	Blank
RADIUS Port Number	1812
Shared Secret	Blank
User-Password	Blank
AES Encryption Key	Blank
MAC Filter	Blank
Detach Local Eth	Unchecked
Force SSL (https)	Unchecked
SNMP	**Default**
SNMP Version	Disabled
Read Community	Public
Write Community	Private
Authentication Password	Blank / MD5
Privacy Password	Blank / AES
Trap Version	Disabled

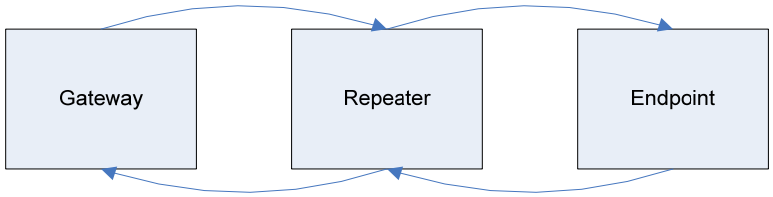
SNMP	Default
Trap Community	Blank
Min Fault Time	300
Trap Manager1 IP	Blank
Trap Manager2 IP	Blank
Voltage	Alarm Above: 30 Alarm Below: 6
Rx % Rate	Alarm Below: 90
Tx % Rate	Alarm Below: 90
Reflected Power	Alarm Above: 2
S-N Delta	Alarm Below: 30
Signal	Alarm Below: -90
Noise	Alarm Above: -100
RMS	**Default**
Mode	Disabled
Paired Radio IP	Blank
Min Fault Time (Seconds)	10
Voltage	Alarm Above: 30 Alarm Below: 6
Reflected Power	Alarm Above: 2

Examples of Data Communication Links

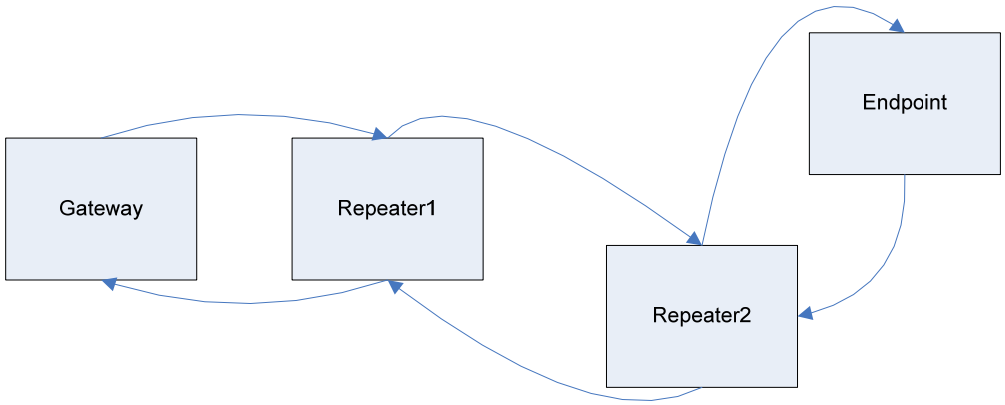
FreeWave transceivers' versatility allows data communication links to be established using a variety of different configurations.
The example below shows the most common and straightforward link; a Gateway communicating to a Endpoint in a Point-to-Point link.



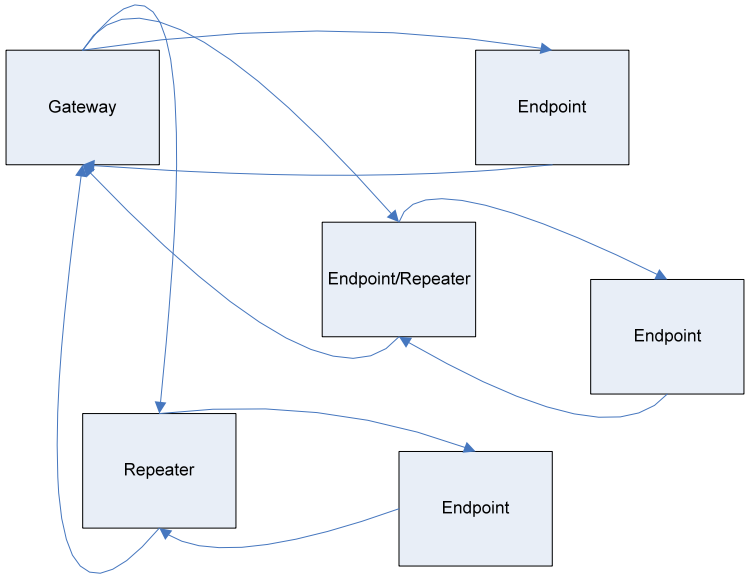
The example below shows how a link might be set up using a Repeater. The Repeater may be located on a hilltop or other elevated structure enhancing the link from the Gateway to the Endpoint. In this configuration, it may be desirable to use an external Omni-directional antenna at the Repeater. Yagi antennas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



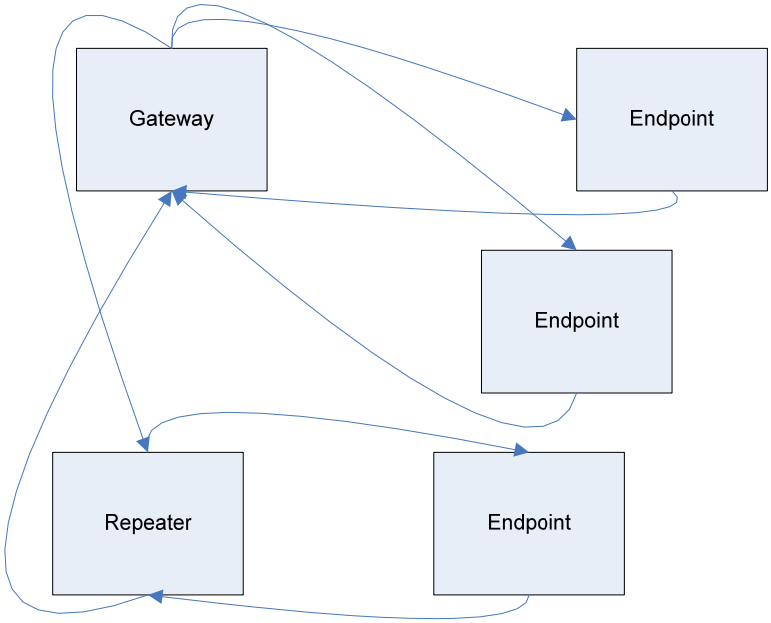
The example below shows a link with two Repeaters between the Gateway and Endpoint. With two Repeaters there is clearly more flexibility in getting around obstacles and greater total range is possible. Once again, it would be desirable to use external Omni-directional antennas with the Repeaters, and 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.



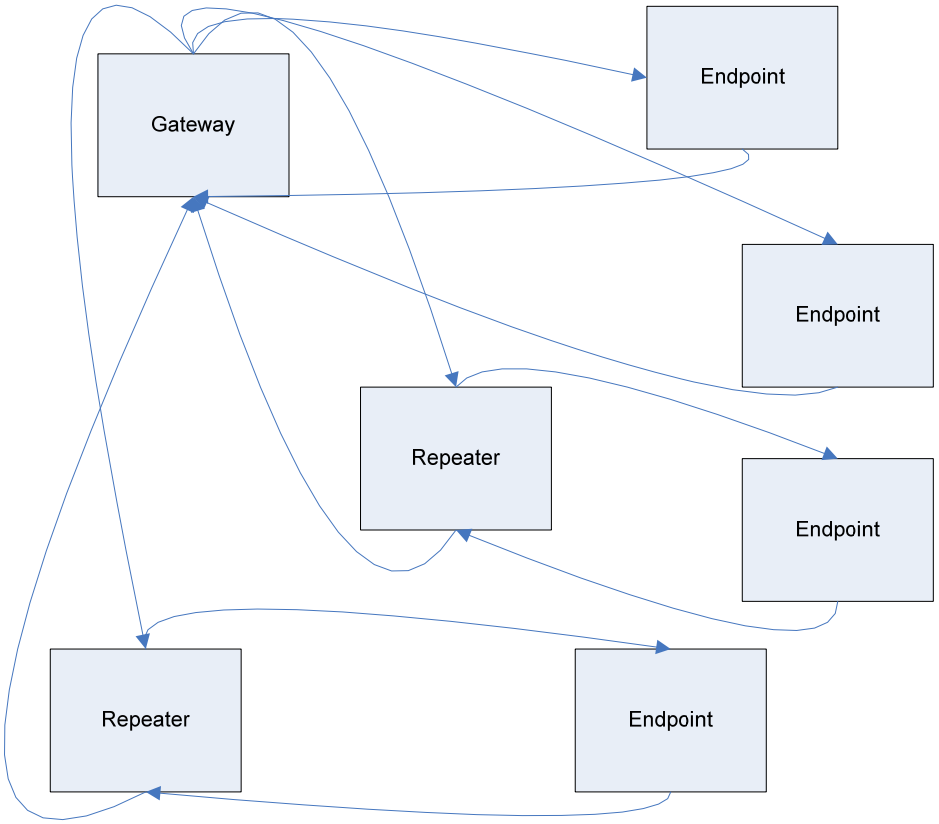
The example below shows a configuration where a Gateway routinely calls a number of Endpoints at different times. The Gateway is communicating with a transceiver designated as a Endpoint/Repeater that is connected to a remote device. Since this device is placed in an elevated location, the transceiver 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 serial port of each of the three Endpoint. The end device should be configured to interpret the serial message 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.



Operational RS-422 and RS-485 Information

For both RS-422 and RS-485, the FreeWave transceiver can drive 32 standard unit loads and loads the bus with only 1/8 unit load. This means the user can tie up to 256 devices on the bus if all of the line receivers have 1/8 unit load.

RS-422 is used for 4-wire or full duplex communication with one Gateway and multiple End-points. The FreeWave Gateway transceiver keeps the line driver asserted at all times. The maximum line length is 4,000 feet using two 120 ohm twisted pair cables with a 5th wire for data common.

RS-485 full duplex using 4 wire plus common is the same as RS-422, except the system can have multiple Gateways on the bus.

The most common operation of RS-485 is a two-wire comprised of a 120 ohm impedance single twisted pair. In this system the loading of the FreeWave transceiver is as described above which allows up to 256 1/8 unit load units on the bus. Maximum line length is also 4,000 feet with a third wire required for data common. The FreeWave transceiver will check the line to be certain no other device is transmitting before enabling the line driver for data transmission.

There is no provision for handshaking in any of the above modes of operation, so data rates of 57.6 KBaud and above are not recommended without a protocol that can handle error detection properly.

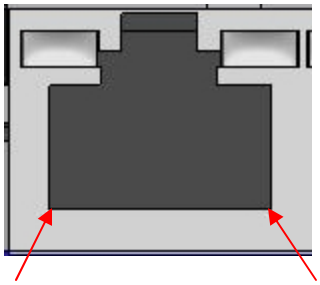
RS-422 and RS-485 Full Duplex Pin-Outs

Function	COM 1/2 RJ45 Pin Number
RX+	5
RX-	8
TX+	6
TX-	7
Signal Ground	4

RS-485 Half Duplex Pin-Outs

Function	COM 1/2 RJ45 Pin Number
Wire to both pins for Bus +	Short 5 and 6
Wire to both pins for Bus -	Short 7 and 8
Signal Ground	4

RJ-45 Ethernet connector on the FGR2-PE



COM 1 and COM 2 RJ45 Pin Assignments

Pin		Assignment	Signal	Definition
1	DSR	Data Set Ready	Output	Always high when the radio is powered from the Phoenix power connector. Indicates power is on to the radio.
2	CD	Carrier Detect	Output	Used to show an RF connection between transceivers.
3	DTR	Data Terminal Ready	Input	Not used.
4	GND	Ground		Signal return for all signal lines.
5	RX	Receive Data	Input	Used to receive data bits serially from the system device connected to the transceiver.
6	TX	Transmit Data	Output	Used to transmit data bits serially from the transceiver to the system device.
7	CTS	Clear to Send	Output	This signal is used to tell 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. This 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.
8	RTS	Request to Send	Input	The transceiver does not recognize RTS for flow control.

Technical Specifications
FGR2-PE 900 MHz Transceiver Specifications

Specification	
Frequency Range	902 to 928 MHz (FHSS)
Transmitter	
Output Power	5 mW to 1 W (+30 dBm)
Range—Line-of-Sight	Point-to-Point: 60 miles, Point-to-Multipoint: 60 miles
Modulation	2 level GFSK
Occupied Bandwidth	230.4 kHz
Hopping Channels	112
Frequency Zones	16 zones, 7—8 channels per zone
RF Connector	TNC Female
Receiver	
Sensitivity	-110 dBm for 10^{-4} bit error rate at 115 Kbps -106 dBm for 10^{-4} bit error rate at 154 Kbps
Selectivity	20 dB at fc ± 230 kHz
System Gain	140 dB
Data transmission	
Over-the-air data rate	96 Kbps sustained throughput* 48 Kbps sustained throughput with Repeaters*
Error detection	32 Bit CRC, retransmit on error
Data encryption	128-bit AES encryption, proprietary 256-bit Dynamic Key Substitution, SSL
Authentication	RADIUS, HTTP Password
Data interface	RS-232/RS422/RS485 300bps to 115.2Kbps, async, full duplex (2 ports) Ethernet 10/100BaseT, auto-sensing, auto-MDIX
Protocol	Ethernet: IEEE 802.3 TCP/IP, DHCP, ICMP, UDP, ARP, multicast TCP
Data Connector	Ethernet: 2x RJ45, Serial 2x RJ45
Power requirements	
Operating Voltage	6 to 30 VDC

Current (mA)

Mode	6 VDC	12 VDC	30 VDC
Transmit	1.1 A	550 mA	220 mA
Receive	252 mA	150 mA	63 mA
Idle	140 mA	71 mA	32 mA

* At 100% receive success rate. RF Data Rate setting of 154 Kbps.

	FGR2-PE (continued)
Operating Temperature Range	-40° C to +75° C
Dimensions	6.8 in L x 3.8 in W x 1.4 in H (17.3 cm L x 9.6 cm W x 3.5 cm H)
Weight	1.3 lbs. (0.6 kg)
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:

FGR2-PE v. 2.19

- Initial Release

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.

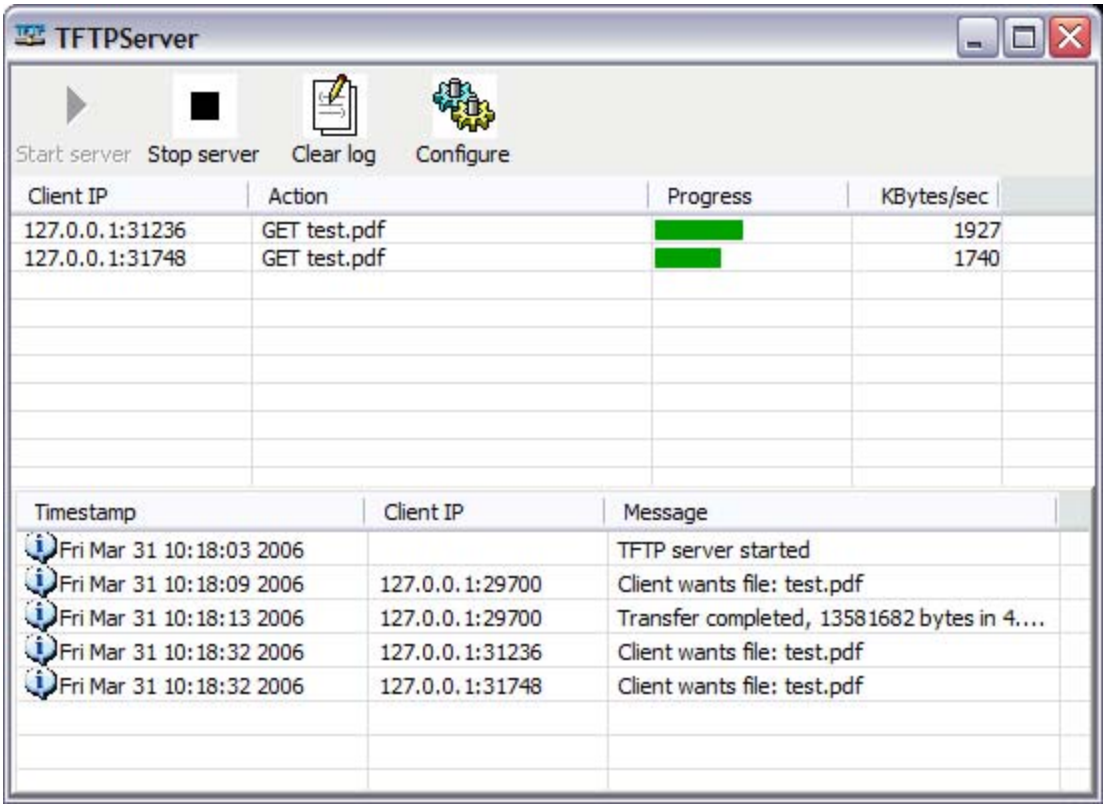


Figure 1: TFTP Server Window

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

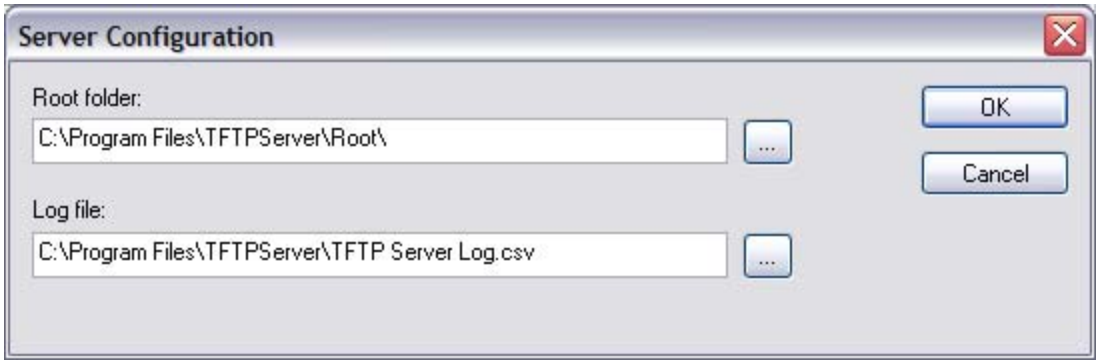


Figure 2: Server Configuration Window

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—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.

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 1

Figure 2

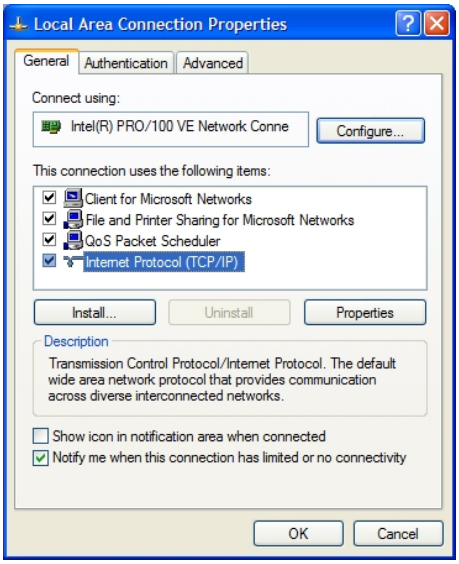


Figure 3

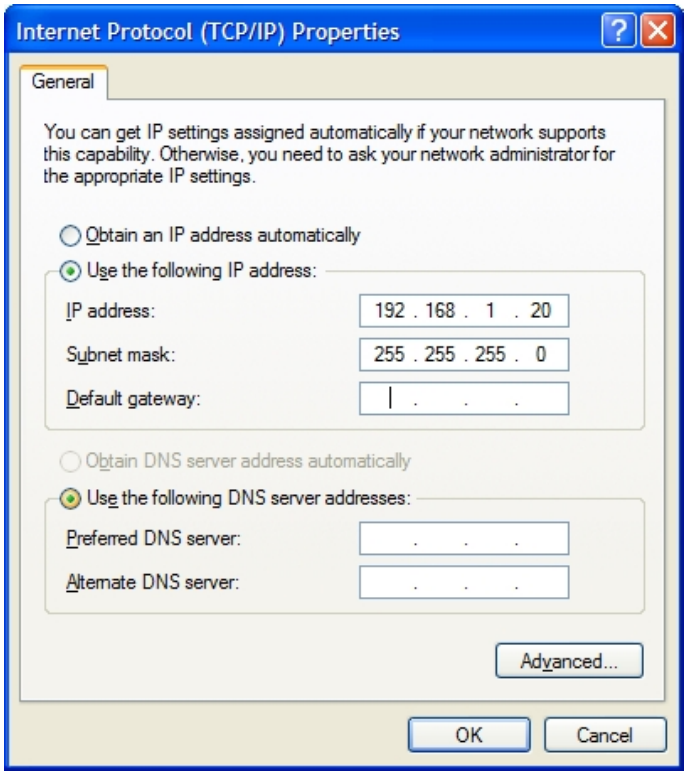
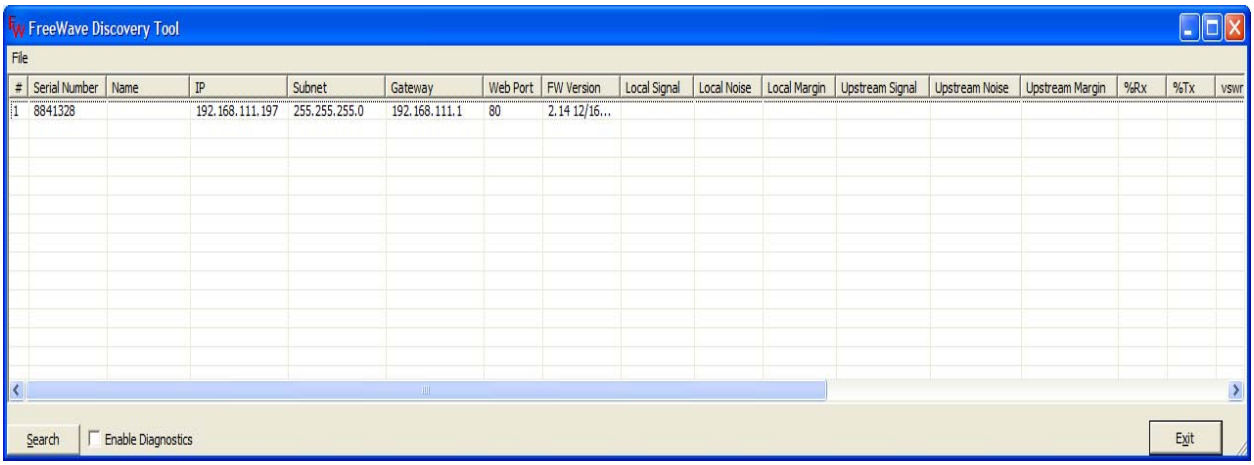


Figure 4

Appendix D—FreeWave Discovery Server v. 1.5

Plus-style radios with a Firmware version of 2.8 or higher will report its 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 Plus-style 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.

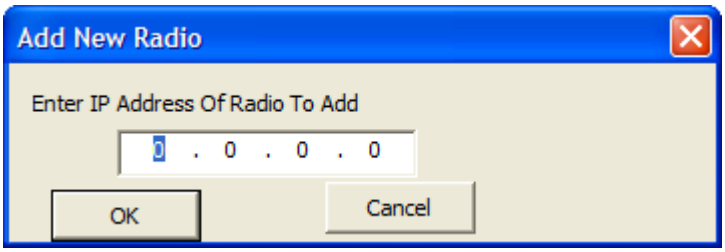
Firewall software, such as Windows Firewall and McAfee Personal Firewall can prevent the Discovery Server from operating properly. FreeWave Technologies recommends disabling any Firewall software prior to running the Discovery Server.

In firmware versions 2.13 and higher, Endpoint and Multipoint Repeater radios can only be discovered if the PC running Discovery Server is connected on the Gateway side of the radio network. If connected to an Endpoint or Multipoint Repeater in this situation, only that radio and the Gateway will be reported.

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 would be entered into the box, and then the **OK** button is clicked. Press the **CANCEL** button to close the window without entering an IP Address.

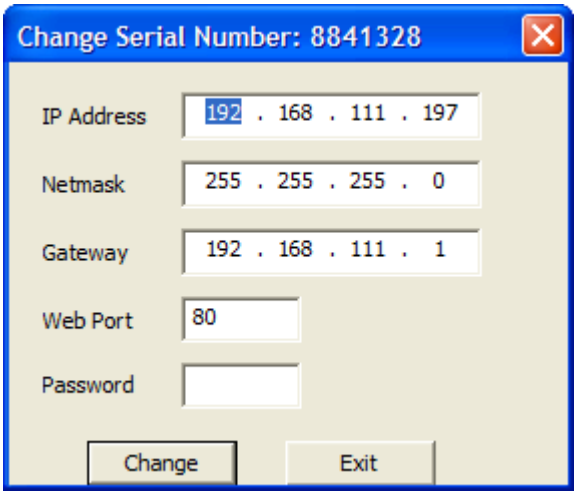
Delete

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.

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. ***NOTE:*** *Radios with a firmware version of 2.14 and lower will only accept 'admin' as the valid password. This is corrected in newer versions of firmware..*

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.

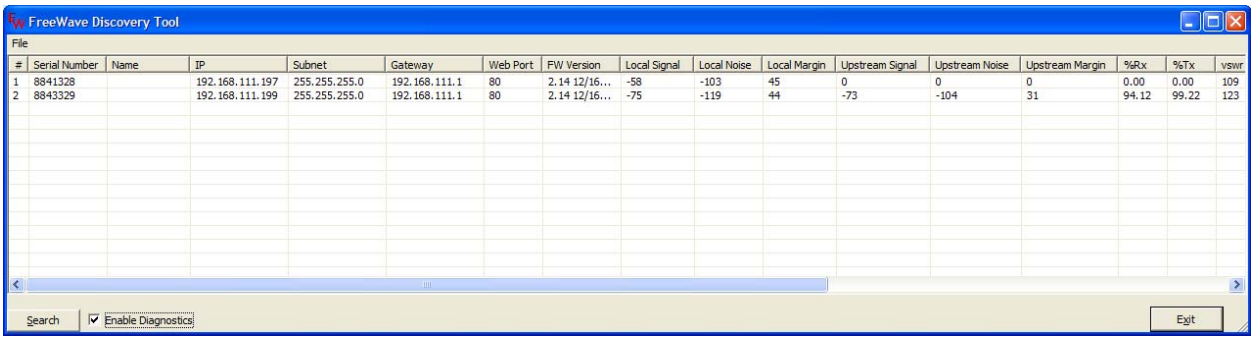
Import Network File

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: **Local Signal**, **Local Noise**, **Local Margin**, **Upstream Signal**, **Upstream Noise**, **Upstream Margin**, **% Rx**, **% Tx**, **VSWR (Reflected Power)**, **Temp**, **Voltage**, **Distance**, and **Connected To**. Specifics on these statistics can be found on **pages 20—21** 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. The **Upstream** statistics will only show in radios with a firmware version of 2.13 or higher.