FreeWave Technologies

Multipoint Diagnostics Program

User Manual

Version 2.16

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1   Introduction

This Diagnostics System allows you to monitor the performance of a FreeWave Technologies Multipoint* network. It helps you identify actual or potential problems, quickly and conveniently, with little or no interference to the normal operation of the network. It also allows you to change remotely most settings of any modem.

This Diagnostics System includes:
- A FreeWave Multipoint network
- A Computer running a Diagnostics Application
- A connection between the Diagnostics Computer and the Master radio.

*) You may use this Diagnostics System in a Point-to-point network if you temporarily reprogram it as a Multipoint network.

2   Hardware set-up

To use this application, you need to a diagnostics computer able to access the FreeWave network.

2.1   Diagnostics Computer

The Diagnostics Computer may be an additional computer; or it may be the computer already connected to the FreeWave network's Master radio (as long as it has an extra RS-232 port available, and it can run this application simultaneously).
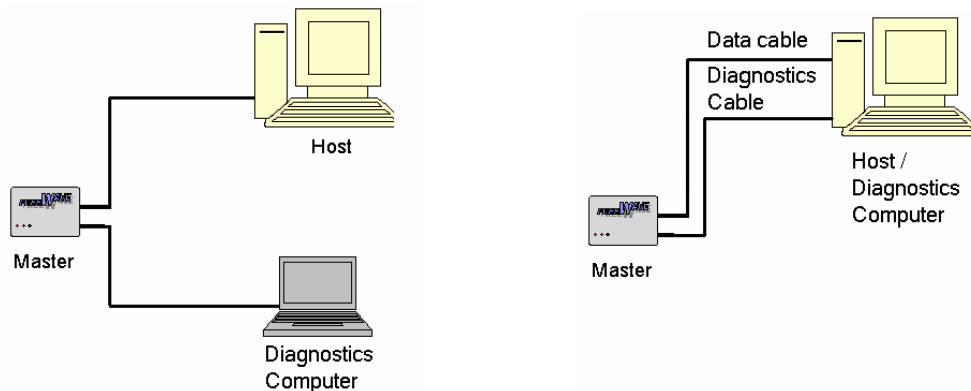
The diagnostics computer's operating system must be Windows ('95, NT 4.0 or later).

Obtain the Diagnostics application (DIAG216.exe) from FreeWave Technologies (either on the User's Manual CD or by e-mail).
Create a new folder (such as "FreeWave Diagnostics") on the Diagnostics Computer. Place the Diagnostic application in this folder. The Diagnostic application will also store certain files in this folder. You may want to create a shortcut to the Diagnostic application on the desktop.

2.2   Accessing the FreeWave Network

The Diagnostics Computer may access the FreeWave network Master radio in one of 3 ways:
- directly through the Diagnostics Port using RS232 (FGR series only)
- through an Ethernet network using UDP/IP (FGR series Ethernet Radio only)
- through a Terminal Server and a network (LAN, Internet,…) using TCP/IP

2.2.1   Direct access through the Diagnostics Port (FGR series Master)

If the network's Master radio is a series FGR radio, you connect the diagnostics computer to its Diagnostics Port.

> Note: Do not confuse the Diagnostics Function with the Set-Up Mode. While the Set-up Mode may use either the Diagnostics Port or the Data Port, the Diagnostics Function may only use the Diagnostics port.

Two different Diagnostics cables are available, one for enclosed radios, and one for board level radios. To acquire a diagnostics cable, contact FreeWave Technologies.

2.2.1.1   Diagnostics Cable for enclosed radio

For an enclosed FGR series, FGRM Series, and Ethernet board-level radios, the diagnostics connection is through its dedicated Diagnostics port, using the diagnostics cable ASC0409DC.
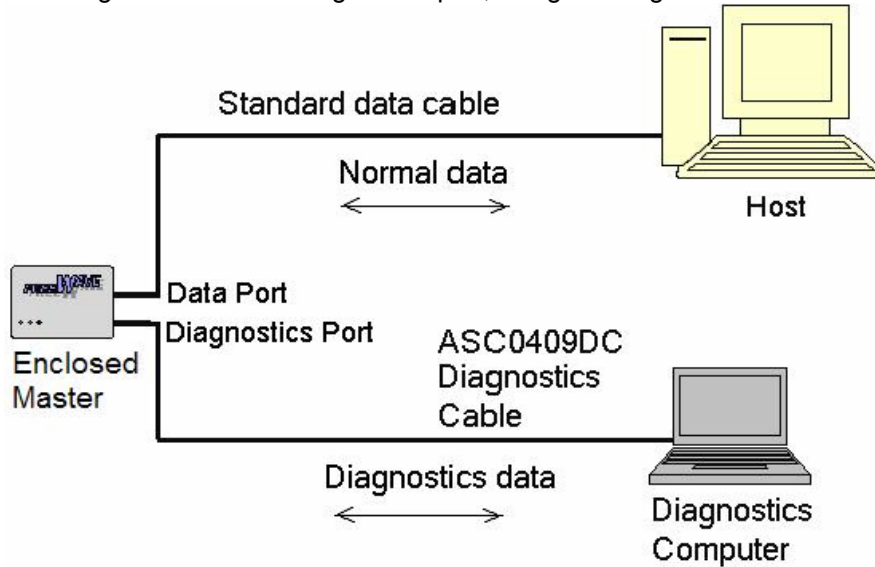
2.2.1.2   Diagnostics Cable for Board level radio

For full sized and non-Ethernet board-level FGR series Radios, the diagnostics connection is through a black 20-pin port on the board using diagnostics cable ASC2009DC.

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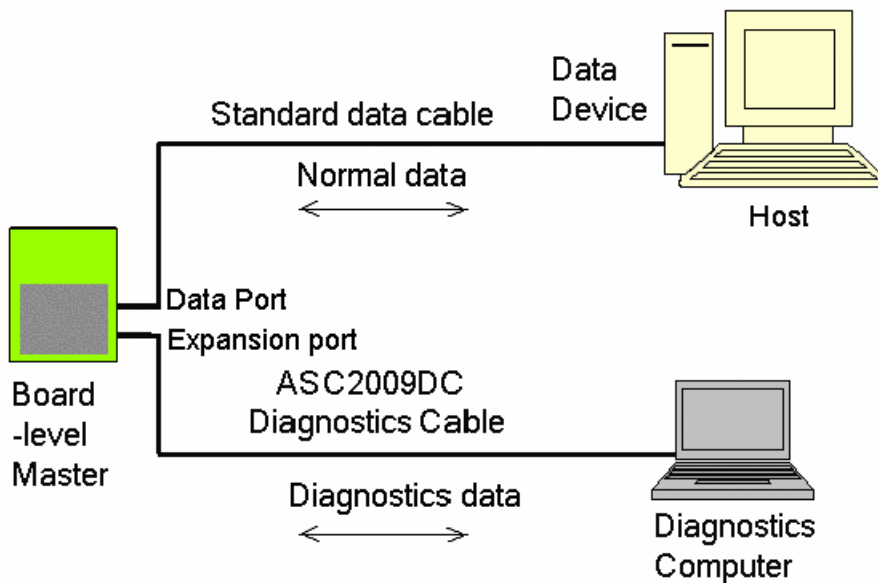
2.2.2　Direct access through an Ethernet network

The Diagnostics application can communicate directly with an Ethernet Master Radio through an Ethernet network (such as a LAN) or even over the Internet. Both the Master Radio and the Diagnostic computer must be connected to an Ethernet network, which typically is already the case when the Master Radio is an Ethernet model. You must assign the Ethernet Master Radio an IP address, just for diagnostic purposes (this in NOT the IP address of any device that communicates through the FreeWave network). In this case, the protocol used is UDP /IP (not TCP/IP), and no special cables are required.
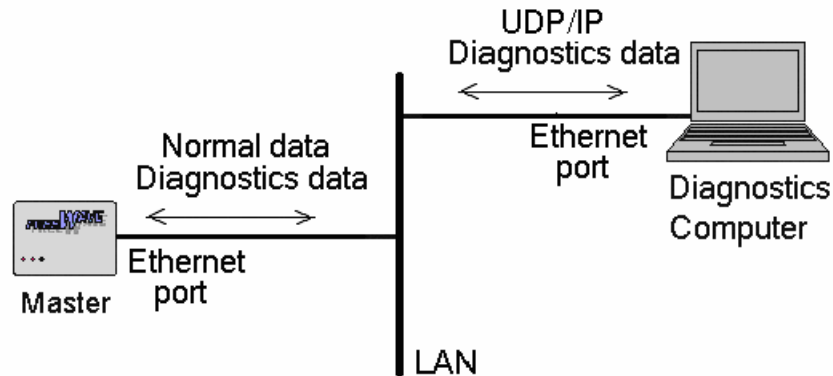
2.2.3　Indirect access through a Terminal Server

Even if the Master Radio is not an Ethernet model, you may still access it through an Ethernet network. You will need an additional device: a commercially available Terminal Server. This device is an Internet server with one or more RS232 serial ports on one end, and an Ethernet port at the other end. In this case, the Diagnostics Application uses the TCP/IP protocol (not UDP/IP).

You will need to obtain a Diagnostics Cable from FreeWave to send diagnostics from the Master to the Terminal Server.

These two examples show the connections for FGR series Master radios, and for hosts connected either directly to the Master, or through the LAN/Internet.

FGR master, RS232 host
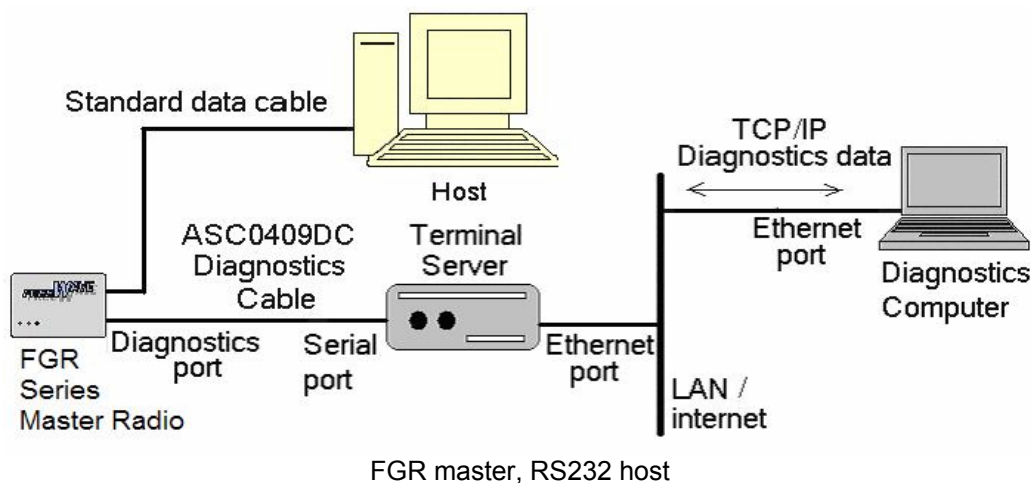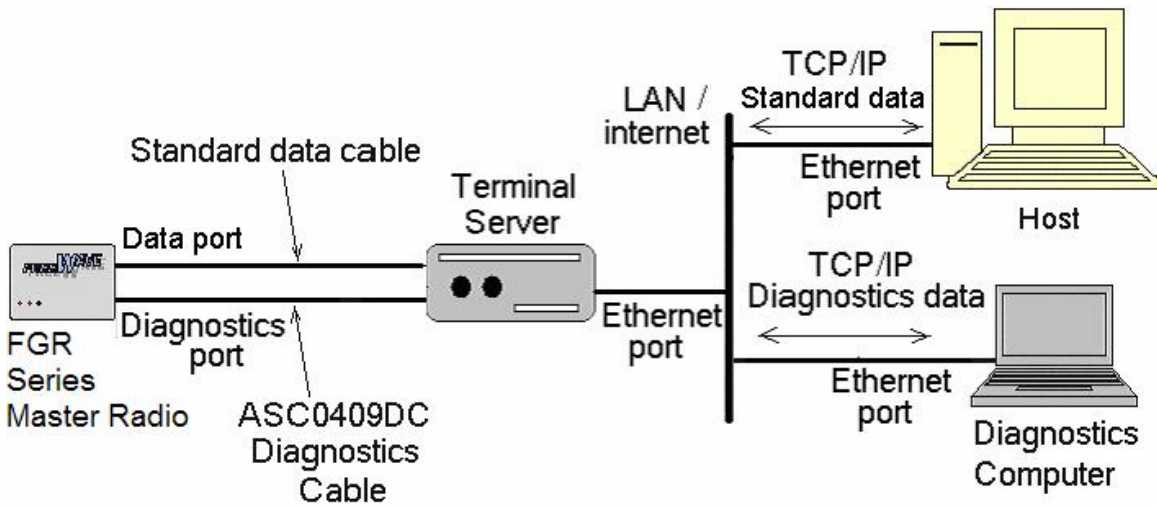
FGR master, Ethernet host. Note that you use 2 Terminal Server serial ports.

Later, you'll enter the IP address of the Terminal Server in the "Chg IP Address" menu of the Diagnostics Application. Afterwards, the Diagnostics Application will ask you for a port number; you will enter the number of the Terminal Server's port to which you connected the Diagnostics cable.

2.3   Limitations

Only radios whose firmware is at least at level 2.29 (900 MHz) or 1.58 (2.4 GHz) will support diagnostics. (Certain features require even later firmware versions, as noted in this manual).
While FreeWave radios will operate in the network regardless of the revision level of their firmware, this application will be able to access, monitor and remotely set-up only radios whose firmware supports diagnostics. Otherwise, this application will be limited to displaying the serial numbers of such radios. Also, this application cannot access radios (even if they support diagnostics) through repeaters whose firmware does not support diagnostics.
In the field, you may update the firmware of any 2.4 GHz radio or any 900 MHz radio with serial number 571-0001 and higher. You will need to send older radios back to FreeWave for a hardware upgrade. Contact FreeWave Technologies for more information.

While running diagnostics on a network has little or no effect on it, we strongly recommend that you interrupt the normal data flow in a radio before using the Diagnostics Application to change any of the radio's settings.

3   Radio set-up

3.1   Set-up the Master

To use diagnostics, you must set-up the Master directly through its Set-up mode.
- Ensure that the packets have at least 32 bytes
- Turn on diagnostics and set a polling rate
- Assign it an IP address (if using UDP/IP)

3.1.1   Invoke the Set-Up mode

Connect a terminal to the Master radio (see the Main Manual for more information on this). Invoke the set-up mode (in most cases, you do this by pressing the "Set-up" button; else, see the Main Manual for details on how to do this with your particular radio).

The terminal will show the Main Menu.

```
                        MAIN MENU
                   Version 2.47 5-24-2005
                    Standard Hop Table
                 Modem Serial Number 919-1968

(0)    Set Operation Mode
(1)    Set Baud Rate
(2)    Edit Call Book
(3)    Edit Radio Transmission Characteristics
(4)    Show Radio Statistics
(5)    Edit MultiPoint Parameters
(6)    TDMA Menu
(8)    Chg Password
(Esc) Exit Setup
```

3.1.2   Ensure that the packet is big enough

Diagnostics require that the packet size be at least 32 bytes. The radio calculates the minimum packet size from the "Min Packet Size" and the "RF Data Rate" settings. (See the Main Manual for a complete discussion on this.)

To check this, from the Main Menu, press '3' on the terminal ("Edit Radio Transmission Characteristics")

The terminal will show the "Radio Parameters" menu.

```
                        RADIO PARAMETERS

 WARNING: Do not change parameters without reading manual

 (0)    FreqKey         5
 (1)    Max Packet Size 8
 (2)    Min Packet Size 9
 (3)    Xmit Rate       1
 (4)    RF Data Rate    2
 (5)    RF Xmit Power   9
 (6)    Slave Security  0
 (7)    RTS to CTS      0
 (8)    Retry Time Out 255
 (9)    Lowpower Mode   0
 (A)    High Noise      0
 (B)    MCO Speed       0
 (C)    RemoteLED       0
 (Esc) Exit to Main Menu
```

Note the value of the "RF Data Rate" setting (item 4).

Then note the value of the "Min Packet Size" setting (item 2). With an "RF Data Rate" of '2' the "Min Packet Size" value must be '3' or more. With an RF rate of '3' the "Minimum Packet Size" value must be '6' or more.

If you need to increase the minimum packet size, press '2" on the terminal ("Min Packet Size").

> **NOTE**: If you change this setting, you must also change it in all the other radios in the network, and you must connect a terminal directly to those radios to do so (you can't do this over the network using the Diagnostics Computer).

The terminal will show the "Min Packet" menu.

```
Enter Min Packet (0-9)
```

Enter '3' (if the "RF Data Rate" is '2') or '6'(if the "RF Data Rate" is '3').

Press "Esc" to return to the "Main Menu".

3.1.3 Set the Diagnostics rate

Now you need to specify the rate at which the Master reports to the Diagnostics Computer. This rate is inversely proportional to the value ('1' to '63') entered in the "Diagnostics" menu. With a setting of '1', the Master reports after every slot (that is, every time it hops to another channel). This results in a lot of data. Normally, the Master and the Diagnostics Computer are connected directly, so that's not a problem. However, if they are connected through some other sort of a link, that link's throughput may be insufficient. In that case, increase this setting to reduce the rate at which the Master reports to the Diagnostics computer. With the maximum setting ('63'), the update rate is slow, but the link is not stressed.

You set the Diagnostics rate in the Master. (This setting has no effect in any other radio.)

To do so, from the "Multi-Point Settings" Menu, press 'B' to select the " Diagnostics " menu.

```
Enter the Diagnostics Rate(0-63)
```

Code	Function
0	Diagnostics mode off
1	Diagnostics data sent every slot
2	Diagnostics data sent every other slot
n	Diagnostics data sent every nth slot
63	Diagnostics data sent every 63rd slot

The factory default is "0" (Diagnostics Off).

Press '1', or whatever rate you want, then press Enter.

3.1.4 Assign an IP address

If you are going to access the Diagnostics of an Ethernet Master Radio directly through UDP/IP, you will need to assign it an IP address. NOTE: this IP address is only for diagnostics, and is unrelated to the IP address of any device connected to the network.

From the Main Menu select "Set Operation Mode" ('0').
From the Operation Mode menu, select "Ethernet" ('F').
Form the Ethernet menu, select "IP Address" ('4').
Enter the IP address that you'll use to access diagnostics.
Later, you'll enter this address in the "Chg IP Address" menu of the Diagnostics application.

See the Ethernet addendum for more information.

3.2 Set up the other radios in the network

If you changed the Master's "Min Packet Size", you must duplicate that setting in the other radios in the network, through their Set-Up mode (this requires a direct connection to the radio: it can't be done over the network from the Diagnostics Computer). Instructions on invoking the Set-up mode and changing the "Min Packet Size" setting are in the previous section.

4   Communications set-up with the Master

In the Diagnostics computer, start the Diagnostics application (DIAG216.EXE). It will start from "Screen 0", with no diagnostics data and with the message "No Connection" (bottom left).
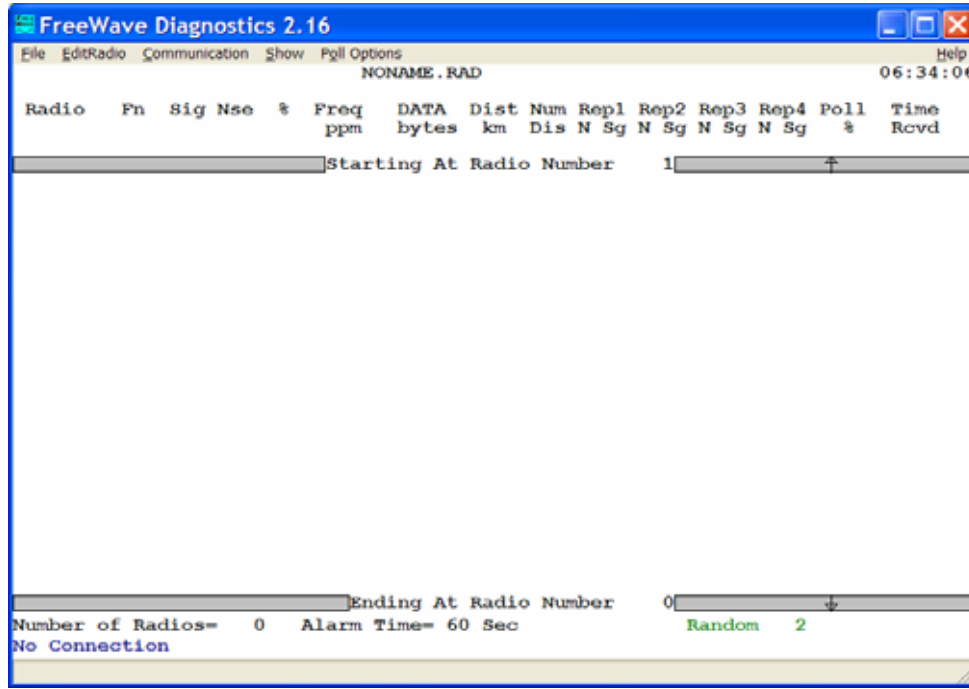
So you must establish a connection between the Diagnostics Application and the Master radio.

As mentioned, the Diagnostics Computer may access the Master radio in one of 3 ways:
- directly through Serial Ports using RS232
- directly through an Ethernet network using UDP/IP (Ethernet Master Radio only)
- indirectly through a Terminal Server and a network (LAN, Internet,…) using TCP/IP

This is how you set up the Diagnostics application for each method.

4.1   Direct access through Serial Ports

To access the FreeWave network through a Serial Port (Data Port or Diagnostics Port), you need to:
- Connect the Master Radio to the Diagnostics computer using a Diagnostics cable;
- Select the Serial Port to which you connected the Diagnostics cable;
- Open that Serial Port.

The Diagnostics Computer can use any of its Serial Ports (COM1 to COM8). The default is COM1. You can change the port with the "Communication" / "**Chg Comm Port**" menu.
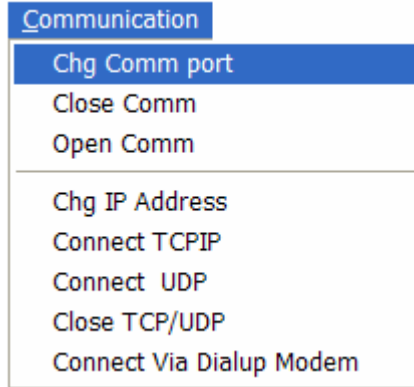
A dialog opens. The presently selected port is highlighted.
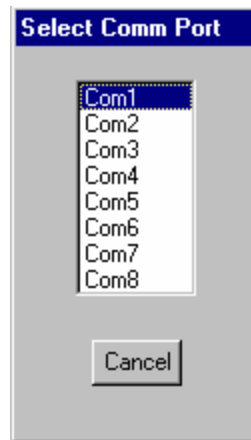
Select the Serial Port, or press "Cancel" to retain the previous selection.

Then, open the port with the "Communication" / "**Open Comm**" menu.
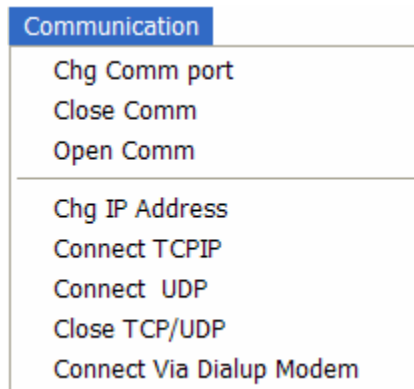
The bottom right corner of the screen changes to:
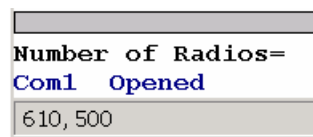
This doesn't necessarily mean that the Diagnostics Application has established communications with the Master radio. If it does so, you'll see that the Application starts filling "Screen 0" with a list of the radios in the network.

4.2   Direct access through an Ethernet network

To access an Ethernet Master Radio directly, you need to:
- Assign an IP address to the Master Radio (described in the "Software Set-up" section above)
- Connect the Master Radio to the Ethernet network
- Connect the Diagnostics Computer to the Ethernet network
- Have the Diagnostics Computer create a connection to the Internet (this application will not create an Internet connection)
- Specify the IP address of the Master Radio
- Start the UDP/IP connection

Specify the IP address of the Master Radio with the "Communications"/"Chg TCIP Address" menu.
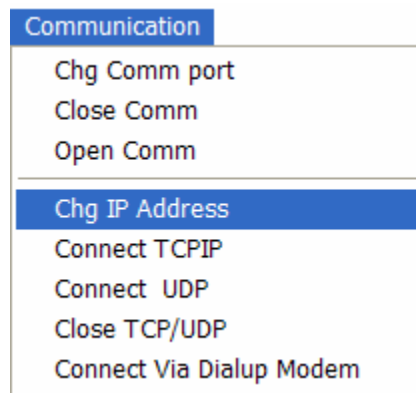
A dialog opens.
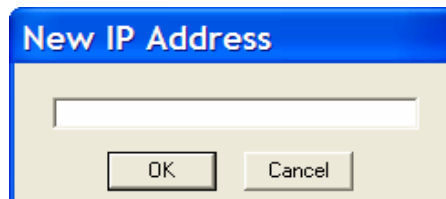
Enter the new IP address of the Master Radio and click "OK".

A new dialog opens.
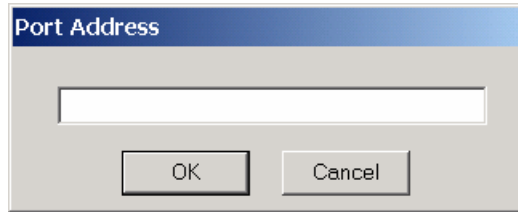
Just click "OK" (the Master Radio doesn't use a Port Number).

Establish the IP connection with the "Communications"/"**Connect UDP**" menu.
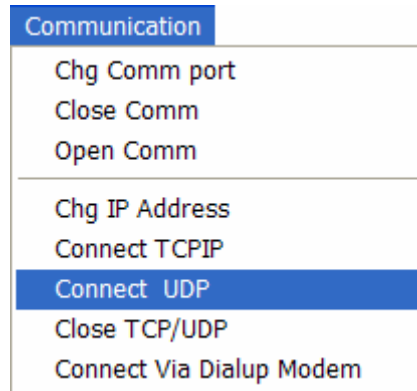
This Application will try to establish the connection for about one minute. During that time, the Application stops responding to your actions. If the IP connection is not established within this time-out period, the Diagnostic Application restarts responding to your commands, and the "No Connection" message remains on the screen.

If the connection is established, the Application displays the IP addres in the lower left corner of the screen.

The Application saves the IP (Internet Protocol) settings when you save the Network file (see "Saving the Network List").

4.3   Indirect access through a Terminal Server

To access the Master Radio through a Terminal Server, you need to:
- Connect the Master Radio to the Internet through the Terminal Server.
- Connect the Diagnostics Computer to the Internet
- Have the Diagnostics Computer create a connection to the Internet (this application will not create an Internet connection by itself)
- Specify the IP address of the Terminal Server;
- Specify the port number of the Terminal Server;

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- Start the TCP/IP connection

Specify the IP address of the Terminal Server with the "Communications"/"**Chg TCIP Address**" menu.

Communication
Chg Comm port
Close Comm
Open Comm
Chg IP Address
Connect TCPIP
Connect UDP
Close TCP/UDP
Connect Via Dialup Modem

A dialog opens.

New IP Address

74.247.34.86

[OK]   [Cancel]

Enter the new IP address of the Terminal Server and click "OK".

A new dialog opens.

Port Address

4123

[OK]   [Cancel]
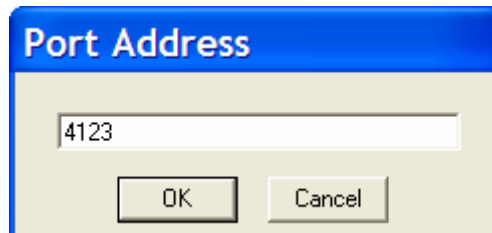
Enter the port number of the Terminal Server to which you connected the diagnostics data and click "OK". (If you are using a 'Y' diagnostics cable, that is the port to which you connected the end labeled "Diagnostics Computer".)

Establish the IP connection with the "Communications"/"**Connect TCPIP**" menu.
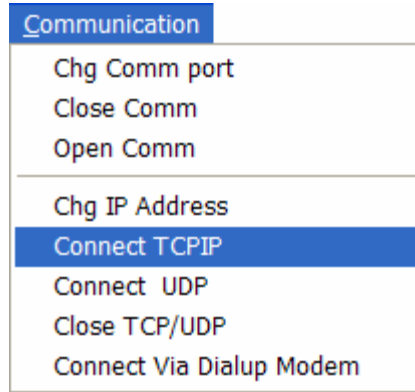
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Communication

Chg Comm port
Close Comm
Open Comm

Chg IP Address
Connect TCPIP
Connect UDP
Close TCP/UDP
Connect Via Dialup Modem

This Application will try to establish the connection for about one minute. During that time, the Application stops responding to your actions. If the IP connection is not established within this time-out period, the Diagnostic Application restarts responding to your commands, and the "No Connection" message remains on the screen.

If the connection is established, the Application displays the IP address in the lower left corner of the screen.

Number of Radios=   8
74.247.34.86

Start   FreeWave Diagnostic...

The Application saves the IP (Internet Protocol) settings when you save the Network file (see "Saving the Network List").

5   Managing the Network List
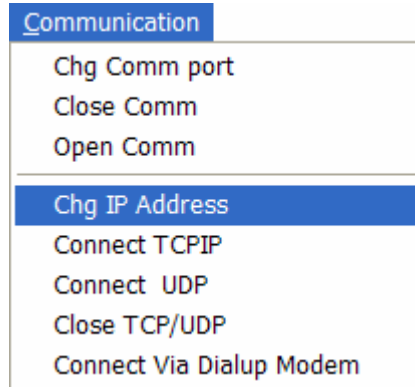
5.1   Adding radios to the list

The Diagnostics Application prepares a list of the radios in the network automatically.

You may also retrieve a network list from a file that you saved previously.

And you may add, edit or delete radios manually.

Note that, once a radio is included in the list, it will not be automatically removed from it. If you remove a radio from the network, you may also want to remove it manually from the list.

5.1.1   Adding a radio automatically

Once the Diagnostics Application has established a connection with the Master Radio, it begins compiling a list of the radios in its network automatically. As it finds a radio, it adds that radio to its Network List, in the order that it finds them. As it discovers that a radio is a Repeater, it assigns it a "R #" number, in the order that it finds them. It also assigns all the radios a default name: "New Radio".

The Application finds radios in two ways:
- If a radio happens to communicate within the network, the Diagnostics Application notices it and it to the list
- If you selected "Random polling", the Diagnostics Application keeps on generating random Serial Numbers and asks the Master to call them. If a radio by that Serial Number happens to be in the network, and it responds to the call, the Diagnostics Application notices it and it to the list. This allows the Diagnostics Application to eventually find any radio that is capable of communicating with the Master.

The Diagnostics Application starts in the "Random polling" mode. Random Polling is an inefficient way to poll the network's radios, because there are 10,000,000 possible Serial Numbers, and the network has relatively few radios. So, once the list of radios is complete, it is far better to just poll the radios that are known to be in the network by selecting the "Sequential Polling" mode.

5.1.2   Adding a radio manually

You may add to the Network List a radio that wasn't discovered automatically by the Application. You must know its Serial Number.

Select the "EditRadio" / "AddRadio" menu, or press 'A' on your keyboard.
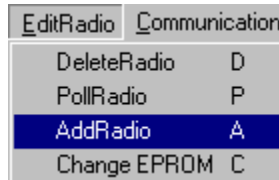
A dialog opens.
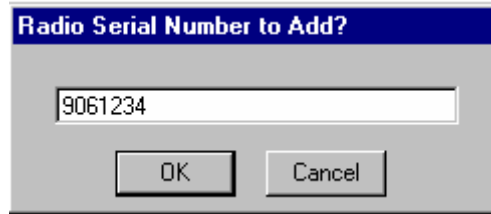
Enter the radio 's seven-digit Serial Number. <u>Do not enter any other character</u> (such as spaces or hyphens) or this application will truncate the number.
Click OK.

A second dialog opens.
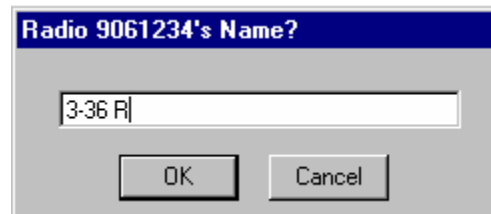
Optionally, enter a name for the radio, up to 8 characters long (any character is OK).
(This name is purely for your convenience.)
Click OK.

5.1.3 Retrieving a Network List

If you previously saved a Network List, you may retrieve it (instead of letting the Diagnostics Application create the list from scratch). This has the advantage of being faster and it keeps you from having to re-enter the radios' names. This also retrieves the IP (Internet Protocol) settings.

Select the "File" / "Open Network File" menu or press alt-F-O. (Despite what the menu says, pressing 'O' doesn't work).
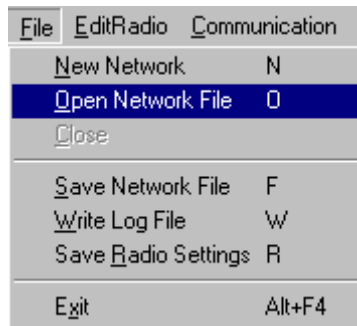
The Windows' standard Open File dialog opens.
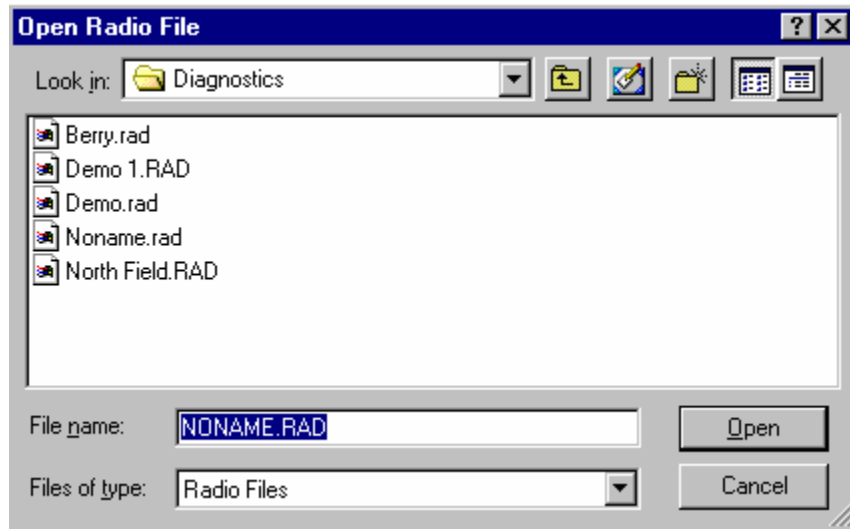
Find and select and open the Network List file you want, using standard Windows methods. (If you type the file name, you don't need to enter the ".rad" extension.)

5.2   Editing a radio's name

The only data about a radio that you can edit is its name. You do need to know the radio's Serial Number. Follow the same procedure used to add a radio, and enter the new name.

5.3   Deleting a radio

If you remove a radio from the network, the Diagnostics Application will not automatically remove it from the Network List. Instead, you must remove it manually. To do so, you do need to know the radio's Serial Number.

Select the "EditRadio" / "DeleteRadio" menu, or press 'D' on your keyboard.
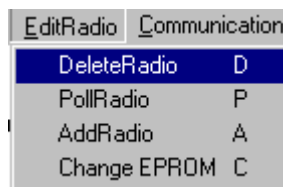
A dialog opens.
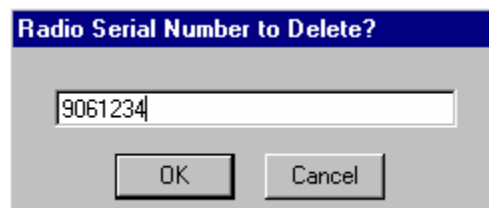
Enter the radio 's seven-digit Serial Number. <u>Do not enter any other character</u>.

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Click OK.

The Application removes that radio from the Network List.

5.4   Saving the Network List

Once the Network List of radios is complete, you may save it. You will them be able to retrieve the Network List the next time you need to analyze the same network. This has the advantage of being faster and you won't have to re-enter the radios' names. This also saves the IP (Internet Protocol) settings.

Select the "File" / "Save Network File" menu or pressing 'F' on your keyboard or alt-F-S (Note: despite what the menu says, it's 'S', not 'F'!).
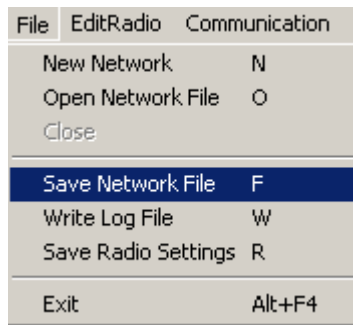
The Windows' standard Save File dialog opens. Come-up with a name for the network and use it as this file's name. Save the Network List file using standard Windows methods (it's not necessary to enter the ".rad" extension).
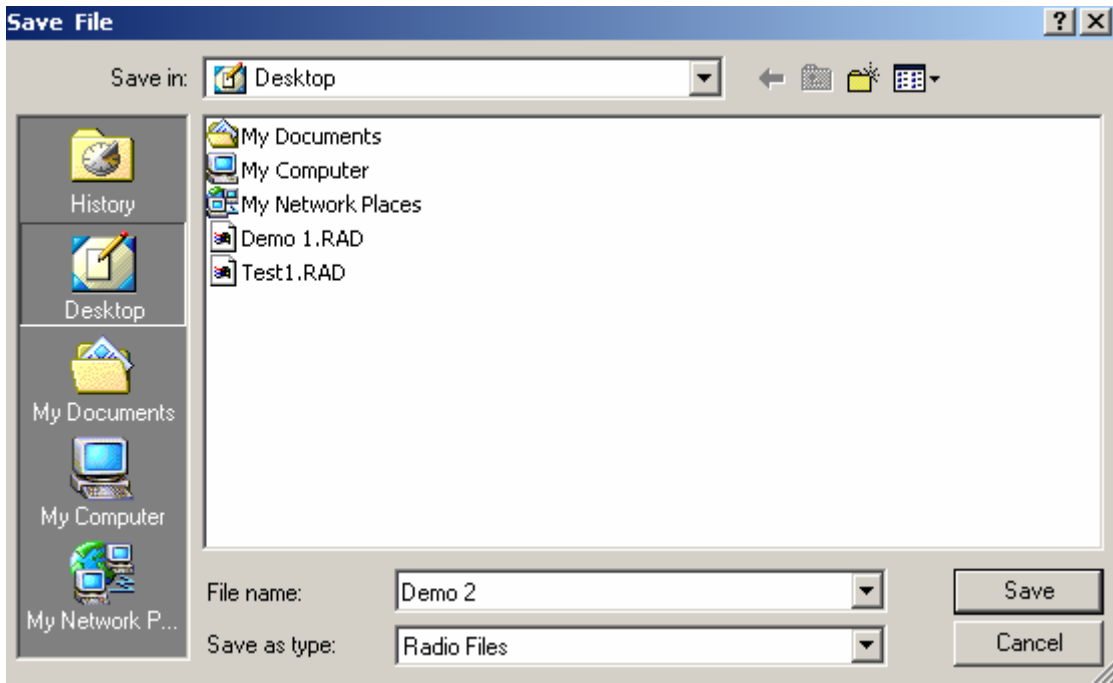
6   Gathering and saving Data

The Diagnostics Application gathers data from the radios in the network through polling. Specifically, it gives the Master Radio the Serial Number of a radio to call. If the radio with that Serial Number is accessible by the Master, the Application asks it about its settings, performance and conditions.

6.1   Polling method

There are 3 polling methods: Random, Sequential and manual.

Initially, the Application polls random Serial Numbers; this allows the Diagnostics Application to eventually find any radio that is capable of communicating with the Master. Random Polling is inefficient because there are 10,000,000 possible Serial Numbers, and the network has relatively few radios. Once the Network List is complete, it is far better to just poll the radios that are known to be in the network through Sequential Polling.

In either case, you may manually poll a specific radio, if you know its Serial Number.

6.1.1 Random Polling

There is no menu item for this option. Instead, you select Random Polling by pressing 'R' on your keyboard.

The application will poll all the possible Serial Numbers, randomly.

6.1.2   Sequential Polling

There is no menu item for this option. Instead, you select Sequencial Polling by pressing 'S' on your keyboard.

The application will poll all the radios in the Network List, sequentially.

6.1.3   Manual Polling

Select the "EditRadio" / "PollRadio" menu or press 'P' on your keyboard.

A dialog opens:
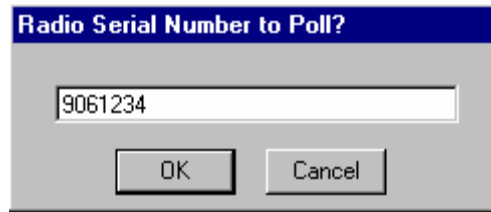
Enter the radio 's seven-digit Serial Number. <u>Do not enter any other character</u> (such as spaces or hyphens) or this application will truncate the number.
Click OK.

The Application will poll that specific radio.

6.2   Saving data

The Diagnostics Application saves files with logs of the networks performance.

6.2.1   Generating a Diagnostics Log

When first opened, this Application creates a "Current.log" file (replacing any such file that may have already been present). Every minute, the Application automatically logs events and diagnostics data into this file.

You may also create a file with a snapshot in time of that log: select the "File" / "Write Log File" menu or press 'W' on your keyboard or alt-F-W.

The Application with create a "xxxxxxxxx.log" file with that snap shot. The name of the file is based on when the snapshot was taken (month, day, hour, minute). For example, the file 09072146.log was created at 21:46 (9:46 PM) on September 7.

You can open these files with any text editor or word processor. The following example of a log file was opened in WordPad.

```
                        Diagnostics FGR Version 2.16
                    C:\Demo2.RAD
                        08-20-2005  12:44:35        424

Radio      Name  Fn    ID   Rev Temp VTG  RCD Sig Nse  %   Freq   Data   Dist Num Rep1 Rep2 Rep3 Rep4 Poll    Time
                                   C    V                   ppm   bytes        Dis N Sg N Sg N Sg N Sg   %     Rcvd

9191968           M           47  29  13.6         44           0                                        12:44:35

9191812 SR1       R2   9999  47  29  13.8  LHL  89 57  99 -0.1    0   0.3   0  1 88                  100 12:42:06
9191814 Rep1      R1   9999  47  30  13.7  LHL  95 31 100  0.2    0   0.4   0  0 98                  100 12:42:52
9192125 SR Slave  S    9999  47  27  13.1  LHL  98 71 100 -1.1    0   0.2   0  2 98 1 87             100 12:43:02
9192159 R1 Slave  S    9999  47  30  13.3  LHL  85 62  92  0.2    0   0.4   0  1 75                  100 12:43:55

Number Radios=4
```

6.2.2 Saving Radio Settings and plot data

You can save the settings of the presently selected radio, and the data gathered from it over time, into a file.

Select the "File" / "Save Radio Settings" menu or press alt-F-R (Note that pressing 'R' on the keyboard doesn't work). The application will switch to Screen 2.
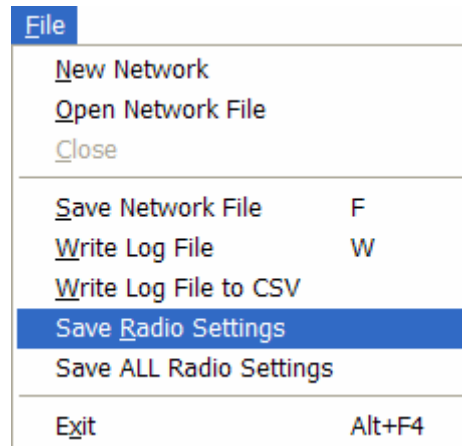
This Application will create a file named "yyyyyyy.dat" where "yyyyyyy" is the serial number of the selected radio. If you are in Screen 0 or 1, that's the radio that is at the top of the radio list. (Since the Master is above the list, you can't save the Master's settings from Screen 0 or 1.)

You can't open these files by double-clicking them because of the unfortunate choice of extension (".dat") which is reserved by Windows. Instead, you must open them from within a text editor.

This is an example of such a file opened in Notepad.

Remote Radio Setup Settings
Radio Number 0 Serial   9065064 NAME:MASTER

0	Modem Mode	2
1	Baud Rate	48
2	Baud High Byte	0
3	RS232 Mode	16
4	MODBus RTU	255
5	Retry TimeOut	255
6	Xtal Tune	53
7	SlicerThreshold	144
8	Frequency	131
9	Freqkey	5
10	Max Packet Size	8
11	RF Data Rate	3
12	Min Packet Size	9
13	Xmit Power	255
14	RTS/CTS Control	0
15	Hop table size	112
16	Number Repeaters	1
17	Master Repeat	2
18	Max Slave Retry	9
19	Retry Odds	9
20	DTR Connect	0
21	Repeater Freq	0
22	LowPower	255
23	PPS Enable	255
24	Slave/Repeater	255
25	Master Sync	255
26	Network ID High	2
27	Network ID Low	232
28	SubNet ID	255
29	Radio ID High	255
30	Radio ID low	255
31	Freq Table	0
32	Diagnostics	0
33	Radio ID Super	255
34	Reflected Power	0
35	High Noise	255
36	Turn On Delay	255
37	Turn Off Delay	255
38	Xmit Power Cal.	168

7   Interpreting the Data

This application uses five separate screens to display diagnostics data. These screens provide comprehensive monitoring of all radio network settings including automatic logging of data from each radio in the network. Screen 2 also allows you to change the operating settings of any radio in the network from the Master radio.

- "Screen 0" and "Screen 1" report the performance of all the radios in the network.
- "Screen 2" display the settings of a given radio and allow you to change them.
- "Graphics 3" plots the performance of a given radio over time
- "Graphics 4" plots the conditions of a given radio over time

Select a Screen with the "Show" menu, or simply type its number on the keyboard.

Show	
Screen0	0
Screen1	1
Screen2	2
Graphics3	3
Graphics4	4
Names	N
Serial Numbers	S
RSSI dBuv	B
RSSI regularl	R
Metric km,C	
American mi,F	

7.1   Identifying Radios

In the following discussion you need to understand that there are as many as <u>six</u> ways of identifying a particular radio.

- Serial number (such as "123-4567"), a unique number permanently assigned to each mode at the factory.
- Radio ID (such as "1234") which you may assign to a radio, for your own convenience (not necessarily a unique number).
- Name (such as "Repeater 2") which you may want to define within the Diagnostics Application.
- Radio Number (a.k.a: "Radio Number") (such as Radio # 0, which is the Master, and Radio #1, which is listed in the top-most line in Screens '0' and '1'). The Diagnostics Application assigns this number sequentially, as it discovers radios, and as you manually enter radios in it.
- Repeater Number (such as "R 3", which is the 3rd Repeater in Screens '0' and '1'). The Diagnostics Application assigns this number sequentially, as it discovers that a radio is a Repeater.
- Repeater Order (such as "Rep1"; when the Diagnostics Application shows the record of a given Slave, it places in the "Rep1" field the Repeater Number of the Repeater that is directly linked to that Slave).

Of these, only the Serial Number and the Radio ID are actually physically located in a radio. All the others exist only within the Diagnostics Application, and are exclusively for use of that application.

This can be <u>very confusing</u>! Yet, if you can master this, it will let you use the full power of the Diagnostics Application.

For example:
You have a radio to which the factory assigned the Serial Number of "**123-4567**", and into which you stored the Radio ID of "**1234**". You program this radio as a Repeater and place it in service within a Network. It is directly linked to the Master and to a Slave.
You start the Diagnostics application, which discovers this radio after discovering 3 other radios (plus the Master), so it assigns it the Radio Number '**4**' and displays its record in the 4th line of the Radio List in Screens '0' and '1'.
Within the Diagnostics Application, you name this radio "**Repeater 3**".
The Diagnostics Application realizes that another radio is a Repeater, then it realizes that this radio is a Repeater too, so it calls it "**R 2**".
In the Diagnostics Application, in the list of radios, you look at the record for the Slave #5. In the "**Rep1**" column, you see that the Slave uses this radio as a repeater.
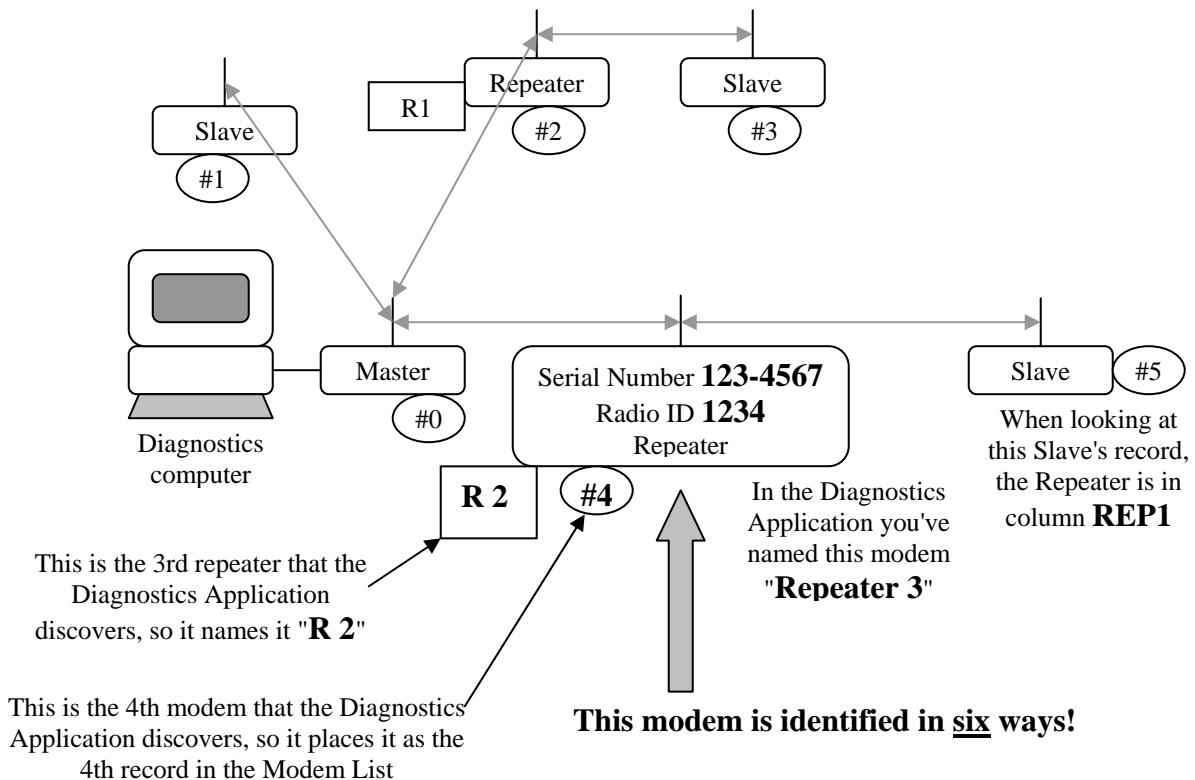
This radio is identified as:
- Serial Number **123-4567**
- Radio ID **1234**
- in the **Rep1** column of Radio #5
- "**Repeater 3**"
- "**R 2**"
- **#4** in the Radio List

7.2   Selecting display preferences
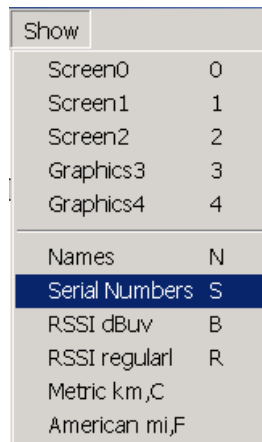
The Diagnostics Application gives you a few choices for its displays.

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7.2.1 Displaying Radio Serial Numbers or Names

In Screens 0 and 1 you have a choice of displaying the radio's Serial Numbers or the names you assigned to them.
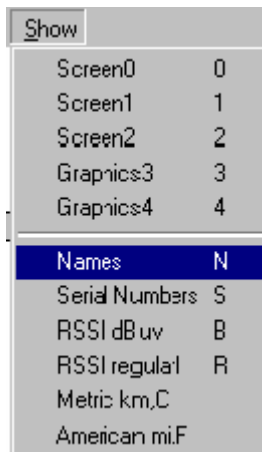
Use the 'N' key on your keyboard to toggle between the two displays.

To display Serial Numbers, select the "Show" / "Serial Numbers" menu (warning: pressing 'S' doesn't work: as a matter of fact, 'S' has a totally different function!)

Show	
Screen0	0
Screen1	1
Screen2	2
Graphics3	3
Graphics4	4
Names	N
Serial Numbers	S
RSSI dBuv	B
RSSI regularl	R
Metric km,C	
American mi,F	

To display names, select the "Show" / "Names" menu (Note: pressing 'N' doesn't do what the menu implies; instead, pressing 'N' toggles between "Serial Numbers" and "Names").

Show	
Screen0	0
Screen1	1
Screen2	2
Graphics3	3
Graphics4	4
Names	N
Serial Numbers	S
RSSI dBuv	B
RSSI regularl	R
Metric km,C	
American mi,F	

7.2.2 Selecting Signal Units

In Screens 0 and 1, the units for Signal Strength and Noise Level are either standard (just as they would be displayed in the Radio's Statistics Menu), or in dBµV.

Note that the units in Screen 3 are standard (you can't display dBµV in that plot).

Select the "Show"/"RSSI regularl" menu to select standard units.

Show	
Screen0	0
Screen1	1
Screen2	2
Graphics3	3
Graphics4	4
Names	N
Serial Numbers	S
RSSI dBuv	B
RSSI regularl	R
Metric km,C	
American mi,F	

Select the "Show"/"RSSI dBuv" menu to select dBµv units.

Show	
Screen0	0
Screen1	1
Screen2	2
Graphics3	3
Graphics4	4
Names	N
Serial Numbers	S
RSSI dBuv	B
RSSI regularl	R
Metric km,C	
American mi,F	

7.2.3 Selecting Imperial ("American") Or Metric Units

In Screens 0 and 1, the units for Distance and Temperature are either Imperial ("American"), or metric.

Note that Screen 4 displays temperature in Celsius (that plot can't display Fahrenheit).

Select the "Show"/"Metric km,C" menu to select metric units (distance in Kilometers, temperature in degrees Celsius).

Show	
Screen0	0
Screen1	1
Screen2	2
Graphics3	3
Graphics4	4
Names	N
Serial Numbers	S
RSSI dBuv	B
RSSI regularl	R
Metric km,C	
American mi,F	

Select the "Show"/"American mi,F" menu to select Imperial ("American") units (distance in miles, temperature in degrees Fahrenheit).

Show	
Screen0	0
Screen1	1
Screen2	2
Graphics3	3
Graphics4	4
Names	N
Serial Numbers	S
RSSI dBuv	B
RSSI regularl	R
Metric km,C	
American mi,F	

7.3 Reading Screen 0

Diagnostic Screen 0 reports the RF performance of each individual radio link in the network.

7.3.1 Network file

This is the name of the file (and its path) from which the present network info was taken.
Typically, you give each network a name. When you set-up this application to monitor that network, you can then save your work in a file, and typically you would use that network's name as the file name.
For a new, unsaved network, this application displays "NONAME.RAD".

7.3.2 System Clock

This is the present time of day.

7.3.3 Master Radio line

This screen displays a line for each radio it monitors. The top-most line, above the bar, is for the Master Radio. This line displays fewer items than the other lines, as a lot of the data are relative to the Master, so are meaningless in the context of the Master itself.

7.3.4   List of radios

Below the bar is a list of all the radios other than the Master. Just below the bar is a line for what we'll refer to as radio number 1; below that is a row for radio 2; etcetera. The radios are listed in the order that this application detected them, or in the order you entered them by hand.

7.3.5   Scroll bars

Two bars at the top are buttons that let you scroll up the list on radios. Similarly, two bars at the bottom are buttons that let you scroll down. The Master radio line remains in place (it is not scrolled). When the list is scrolled all the way down, the top-most line is for radio number '1'. Else, the text in the middle of the top scroll bar tells you the number of the radio in top-most line.

Up to 33 radios plus the master radio may be displayed on a single page of Screen 0. Scroll bars at the top and the bottom of the page allow the radio list to be scrolled up or down to display additional radios.   The upper scroll bar contains the message "Starting At Radio Number" followed by the network number of the radio listed immediately below the upper scroll bar. The lower scroll bar contains the message "Ending At Radio Number" followed by the network number of the radio immediately above the lower scroll bar. The radio list may be scrolled up or down by moving the mouse pointer to either scroll bar and clicking on the bar. The display may also be scrolled up or down by pressing the up or down arrow keys on the keyboard.

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The following discussion describes the items in each radio's line.

7.3.6 Radio's Serial Number or Name ("Radio")

This is the Serial Number or the name of the radio. Press the 'N' key to toggle between the two display modes, or use the "Show"/"Names" and "Show"/"Serial Numbers" menus to select which one is displayed. When the applications itself finds a radio, it names it "New radio". See Paragraph 3.7 <<<<< for instructions on renaming radios.

Radio names and serial numbers are saved in the network file.

7.3.7 Radio's function ("Fn")

This is the function of the radio within the network.

       M   Master Radio
       S   Slave Radio
       R n   Repeater Radio (n is a number assigned by this application).

This application automatically assigns a number to each repeater. The numbers are assigned in the order that the Diagnostic application detects each repeater. Although a radio may be programmed to be a repeater, it will be indicated as a slave until the Diagnostic application detects other radios that are linked through it into the network.

7.3.8 Radio link signal strength ("Sig")

This is the strength of the signal that this radio receives. For repeaters, this refers just to its radio link towards the Master. The units are either standard (just as they would be displayed in Radio Statistics Menu), or in dBμV. Use the "Show"/"RSSI regul" and the "Show"/"RSSI dBuv" menus to select the units. For reliable radio performance under all conditions, the signal level should be at least 40 (in standard units). (RSSI = Received Signal Strength Indicator.)

7.3.9 Radio link noise level ("Nse")

This is the average level of the noise that this radio receives when the radio(s) to which it's linked are not transmitting. The units are the same as for the signal strength. For reliable radio performance under all conditions, this value should be at least 30 (in standard units) <u>below</u> the signal strength reading. If the difference is less than 30, this application displays this value in red.

7.3.10 Receive success rate ("%")

This is the percentage of data packets that this radio successfully received on the first try. If this radio is a repeater, this refers to the radio link towards the Master. This value should be at least 75%. If it's less than 75%, the application highlights this value in red.

7.3.11 Radio frequency error ("Freq ppm")

This is the error of the radio's radio frequency with respect to the Master. This value should be within ± 10 ppm. If this value exceeds ± 5 ppm, this application will highlight it in red. If all the values are biased in one direction, chances are that it's the Master that is off!

Length of
radio link

how

Bytes
transmitted

Total number of
disconnects

NO   AD

```
se    %    Freq      DATA    Dist  Num Rep1 Rep2
           ppm       bytes    mi   Dis N Sg N Sg
10                       0
       Starting At Radio  Number       1
19   99    1.5        71   0.7    0  0 60
15   99    1.5       101   0.7    0  0 54
17   99    2.6        99   0.7    0  0 58
14  100   -0.3       106   0.7    0  1 79
```

7.3.12 Bytes transmitted ("DATA bytes")

This is the number of bytes that this radio generated itself and transmitted (since this application started monitoring this radio). Since plain Repeaters do not generate data themselves, but just repeat data from another radio, for them this count is '0'. However, if this radio is a Slave/Repeater, this count is just for the data that it transmitted while operating as a Slave.

7.3.13 Length of radio link ("Dist")

This is the distance between this radio and the radio to which it is directly linked. So, if this radio is linked directly to the Master, this is the distance to the Master. Otherwise, this is the distance to the first repeater that it uses. Distances greater than 1 km are typically accurate to within 30 meters. Shorter distances are not reported accurately. The units are km or miles; use the "Show"/"Metric km/C" menu to select km, and the "Show"/"American mi/F" menu to select miles.

7.3.14 Total number of disconnects ("Num Dis")

This is the total number of times that this radio lost its connection to the network (since this radio was turned on or since its Set-up mode was ended).
A disconnect may be due to:
- a poor radio link path,
- temporary removal from operation of any radio in the complete path,
- using this application to change some other radio's setting.
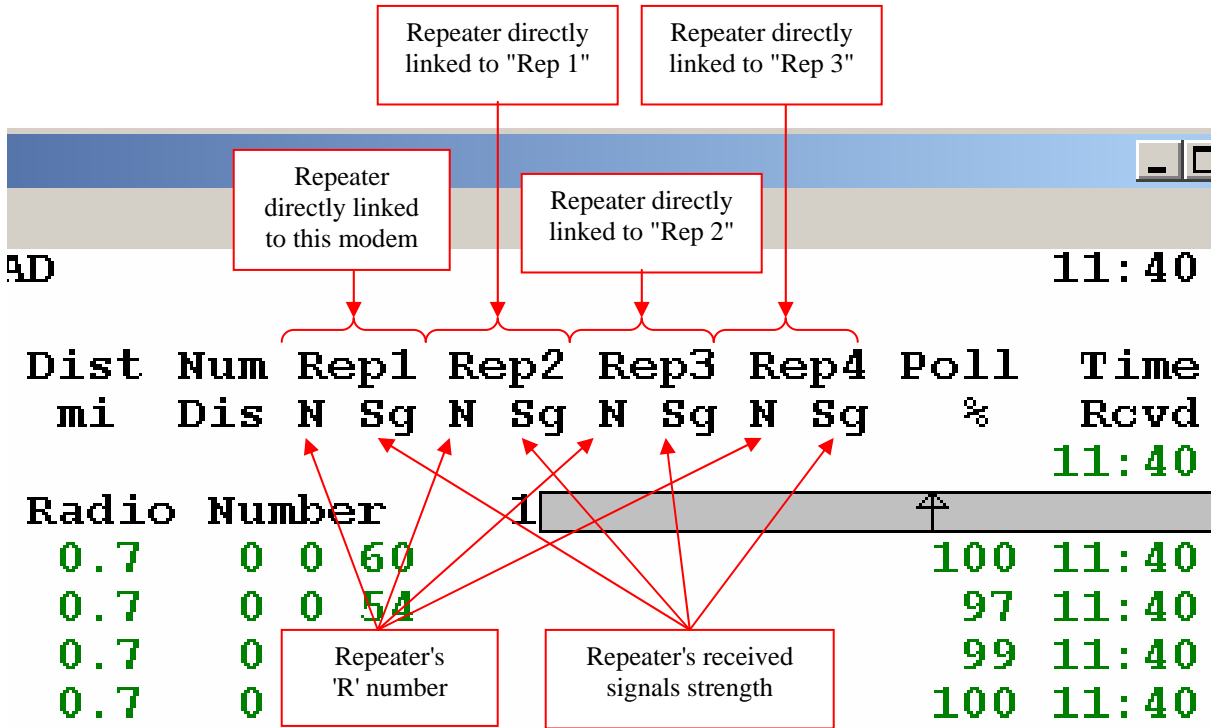
7.3.15 Repeater info ("Rep n" "N" "Sg")

This is the path that this radio uses to communicate with the Master. "Rep 1" refers to the radio (Master or repeater) to which this radio is directly linked. "Rep 2" is the repeater (not the master) to which "Rep 1" is directly linked, and so forth. Use this table to see what each column refers to.

# of repeaters	"Rep1"	"Rep2"	"Rep3"	"Rep4"
0	Master			
1	Repeater			
2	Rep. closest to slave	Other rep.		
3	Rep. closest to slave	2nd rep.	3rd rep.	
4	Rep. closest to slave	2nd rep.	3rd rep.	4th rep.
5+	Rep. closest to slave	2nd rep.	3rd rep.	4th rep.

Up to 4 radios are shown (the 4 radios "closest" to this radio). You can still see the rest of the path: first see which radio is listed under the "Rep 4" column (say it's "R 7"); then, in the "Fn" column, find that repeater ("R 7" in this example); that line will show you the rest of the path, from that repeater, towards the Master.

The next drawings show some examples of networks and how they may be numbered.

Diagnostics
computer

Master

Slave

"Rep 1"

We're looking
at this radio

Diagnostics
computer

Master

Rep.

Slave

"Rep 2"

"Rep 1"

We're looking
at this radio

Diagnostics
computer

Master

Rep.

Rep.

Rep.

Slave

"Rep 4"

"Rep 3"

"Rep 2"

"Rep 1"

We're looking
at this radio

Diagnostics
computer

Master

Rep.

Rep.

Rep.

Rep.

Rep.

Slave

Data on this
repeater are
not shown

"Rep 4"

"Rep 3"

"Rep 2"

"Rep 1"

We're looking
at this radio

Diagnostics
computer

Master

Rep.

Rep.

Rep.

Rep.

Rep.

Slave

"Rep 4"

"Rep 3"

"Rep 2"

"Rep 1"

We're looking
at this radio

Diagnostics
computer

Master

Rep.

Rep.

Rep.

Rep.

Rep.

Slave

"Rep 1"

We're looking
at this radio

Each "Rp n" column has 2 items: "N" (number) and "Sg" (signal).

"N":
This is the number of the next repeater down the path. For example, 'N' = '3' means that if you look for whichever radio has "R 3" in the "Fn" column, you'll see the complete information about that radio. 'N' = '0' refers to the Master (in the top line, just above the scroll bars).
Please don't confuse repeater "R 3" with "Rep 3": repeater "R 3" is the 3rd repeater that this application happens to have found, while "Rep 3" is the 3rd radio down the path, from this radio towards the Master.

"N" of Rep 1" is 1,
so "Rep 1" must be radio "R 1"

Master   Rep.   Slave

Rep1,   We're looking
"R 1"   at modem #4

"N" of Rep 1" is 0,
so "Rep 1" must be the Master

Master   Rep.   Slave

Rep1,   We're looking at
Master   radio #3, "R 1"

In the example above, serial number 906-0510 has been detected as a repeater and assigned repeater number "R 1". Serial number 906-4441 is linked into the network through repeater "R 1" as shown in the Rep1 column. All of the other radios in the network, including repeater "R 1", are connected directly to the master as indicated by the '0' in their Rep1 column.

"Sg":
This is the signal strength received by the next radio down the line (towards the Master). So, in the "Rep 1" column is the strength of the signal that the "Rep 1" radio receives from this radio. And, in the "Rep2" column, this is the strength of the signal that the next radio receives from repeater "Rep 1".

Time of latest
diagnostics response

Diagnostics
response rate

Help

11:40:22

```
t Num Rep1 Rep2 Rep3 Rep4 Poll   Time
  Dis N Sg N Sg N Sg N Sg   %    Rcvd
                                11:40:22
io Number   1
7   0 0 60                 100 11:40:18
7   0 0 54                  97 11:40:19
7   0 0 58                  99 11:40:20
7   0 1 79                 100 11:40:21
```

7.3.16 Diagnostics response rate ("Poll %")

This is the percentage of the time that the radio reported back diagnostics data when polled. If the radio is used to transmit a lot of data as part of its normal operation, it will have less time to respond to the Master polling it for diagnostics data; in that case, the diagnostics response rate will decrease. If this value is 0, it may be because this radio is disconnected from the network.

7.3.17 Time of latest diagnostics response ("Time Rcvd")

This is the time (measured using the System Clock) when this radio last replied to diagnostics polling. If the lag in response exceeds the Alarm Time (see "Alarm Time" below, paragraph 6.1.19), the application highlights this value in red.

```
┌─ FreeWave Diagnostics 2.02a ──────────────────────────────────── _ □ X ─┐
│ File  EditRadio  Communication  Show                                 Help │
│                          NONAME.RAD                            11:40:22   │
│                                                                           │
│  Radio    Fn  Sig Nse   %   Freq    DATA   Dist Num Rep1 Rep2 Rep3 Rep4 Poll   Time │
│                              ppm    bytes   mi  Dis N Sg N Sg N Sg N Sg   %    Rcvd │
│  9064692  M       10                  0                                     11:40:22 │
│  [        ]                    Starting At Radio Number     1[        △    ]         │
│  9041280  S   74  19  99    1.5     71   0.7   0 0 60                  100  11:40:18 │
│  9066569  S   56  15  99    1.5    101   0.7   0 0 54                   97  11:40:19 │
│  9060510  R 1 68  17  99    2.6     99   0.7   0 0 58                   99  11:40:20 │
│  9064441  S   70  14 100   -0.3    106   0.7   0 1 79                  100  11:40:21 │
│                                                                           │
```
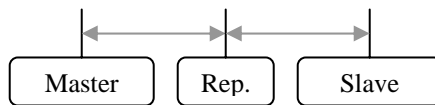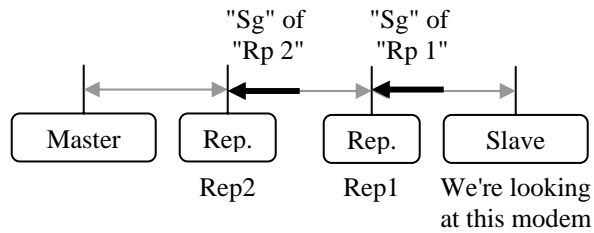
Number of Radios

Alarm time

Poll status indicators: ignore

```
│  [                              ] Ending At Radio Number    4[        ↓    ]         │
│                                                                           │
│  Number of Radios=    4    Alarm Time=   60 Sec              Sequen   1      Slot= 60 │
│  Com1   Opened                                    Num=    20 Type=   3 Value=-3456   │
│  303, 67                                                                   │
└───────────────────────────────────────────────────────────────────────────┘
```

7.3.18 Number of Radios ("Number of Radios")

This is the total number of radios in the list, not counting the Master. (Remember that a radio may be listed even if it is no longer in the network, as radios must be deleted from the list manually.)

7.3.19 Alarm Time

This is the maximum acceptable time without a diagnostics response from a given radio (see "Time of latest diagnostics poll" above, paragraph 6.1.17). After that time, the application highlights in red that radio's "Time Rcvd" time. The default is 60 seconds. Use the '+' and '-' keys of your computer's numeric keypad to change this value.

7.3.20 Poll Status Indicators

The counters and indexes displayed on the lower right corner of the display are troubleshooting indicators for use by FreeWave Technologies. They serve no purpose in the Diagnostic application other than to provide an indication that the program is running correctly. One of the indicators will display Random or Sequen depending on the polling method that is active, either random or sequential. The number display next to the indicator indicates where the diagnostic program is in the polling process. If Sequen is displayed, the number indicates which radio number in the list is currently being polled.

7.4   Reading Screen 1

This screen is very similar to "Screen 0". It provides additional information about the radios, such as the status of their data port lines (RS-232 only) and information on their operating environment. Some fields in this screen are the same as in "Screen 0", so this section describes only the fields that are unique to "Screen 1". (For information on the other fields, see Section 6.1.)

ID	Rev	Freq ppm	Data bytes	Dist mi	Temp F	VTG V
30207	79		0		91	14.9
		Starting At Radio Number				
30207	73	1.8	71	0.8	84	13.7
30207	73	1.4	101	0.7	86	13.1
29968	79	2.6	99	0.7	86	13.5
29953	79	0.1	106	0.7	88	14.9

Radio ID — Firmware rev. — Modem temperature — Supply voltage. — NONAME.RAD — stics 2.02 — unication Show

7.4.1 Radio ID ("ID")

This is the radio ID that was set with this radio's Set-Up mode ("multipoint settings" menu, 'D' sub-menu). You may use this number to identify the radio's site or to track a device connected to it. The default is 65535.

7.4.2 Firmware Revision ("Rev")

This is an indirect indication of the version of the firmware installed in this radio. Freewave technical support can convert this number to the actual revision level.

7.4.3 Radio temperature ("Temp")

This is the operating temperature of this radio. The units are degrees Celsius (default) or Fahrenheit; use the "Show"/"Metric km/C" menu to select Celsius, and the "Show"/"American mi/F" menu to select Fahrenheit. All FreeWave radios are 100% tested for operation over a temperature range of –40 C to +75C (-40F to +167F).

7.4.4 Supply voltage ("Vtg")

This is the supply voltage of this radio, in Volts.

		State of the CTS output		Number of diagnostics requests received		
	State of the RTS input		State of the DTR input			14:11:17

Temp F	VTG V	RTS	CTS	DTR	Polls Rcvd	Time Rcvd
91	14.9					14:11:17
o Number	1					
84	13.7	L	H	L	1968	14:11:17
86	13.1	L	H	L	1956	14:11:13
86	13.5	L	H	L	1999	14:11:14
88	14.9	L	H	L	1996	14:11:15
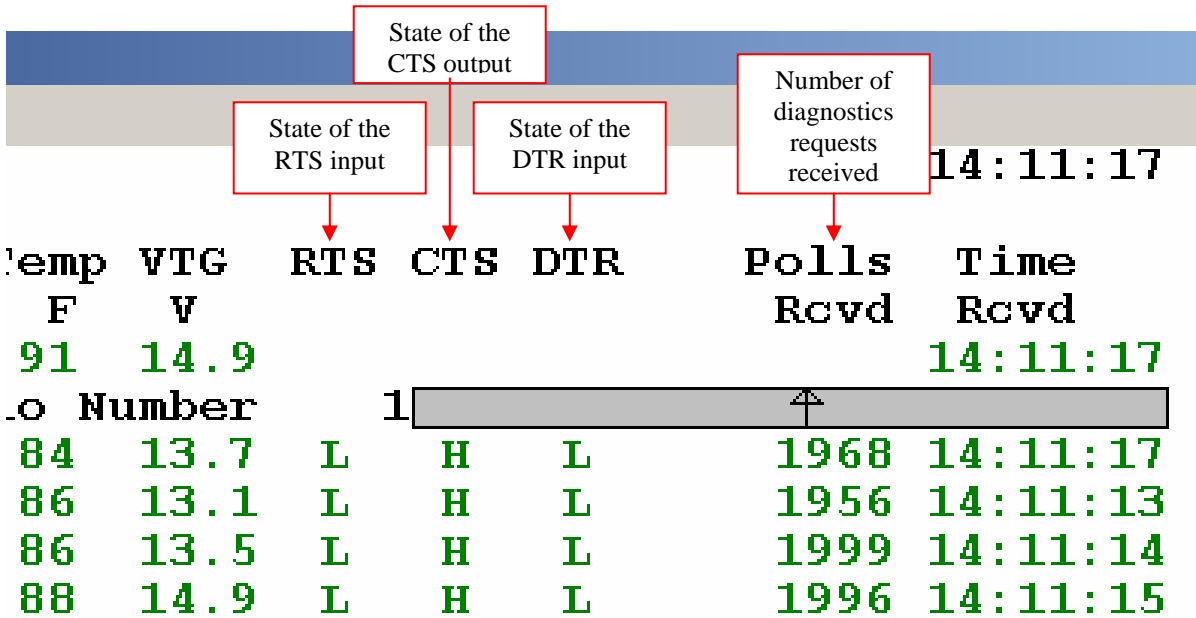
7.4.5 State of RS232 port lines ("RTS", "CTS", "DTR")

These are the states of the RTS, and DTR inputs and the CTS output of this radio's Data Port.
'H' means a high state (~ 10 V, asserted, logic '0') and 'L' means a low state (~-10 V, deasserted,
logic '1'). Note that in inverted-TTL models, this screen reports '0' if the line is high (5 V) and
viceversa.
In RS485 radios only the state of the DTR input is reported.
In Ethernet radios there are no such inputs, so these reports are meaningless.

7.4.6 Number of diagnostics requests received ("Polls Rcvd")

This is the total number of replies to diagnostic polling that the master received from this radio,
since this application started. (Remember that, in a multipoint network, a master may miss some
messages from another radio.)

7.5   Reading Screen 2: "Remote Radio Setup Settings"

This screen displays a single radio's settings and allows you to edit them.
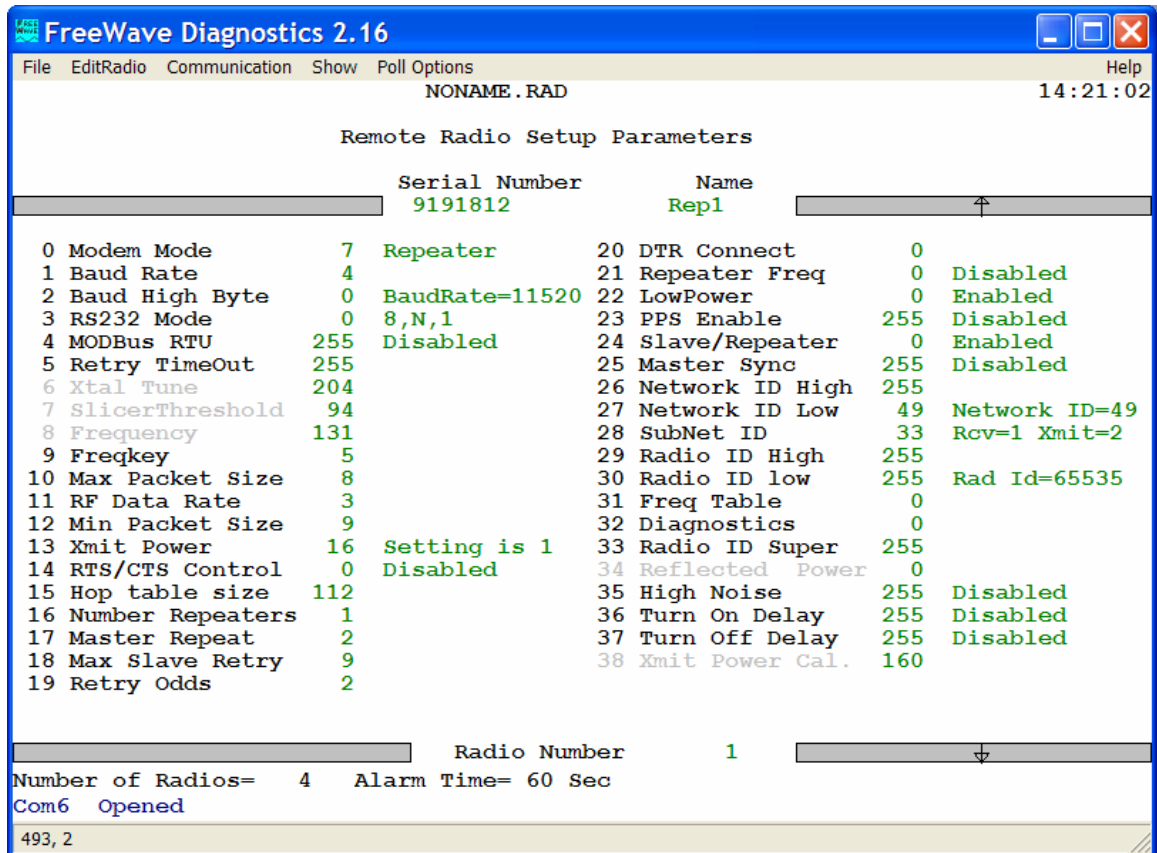
Note: If the firmware version of the Master is earlier than 5.68 (900 MHz) or 1.60 (2.4 GHz), you will not be able to view or edit its settings with this application.

7.5.1   Selecting a particular Radio

To select another radio, scroll through the radio list, either by clicking on the gray scroll bars, or by pressing the diagnostics computer keyboard's "up" and "down" arrow keys. When you reach either end of the list, it restarts from the opposite end.

At the top, this screen displays the Serial Number of this radio, and the name you gave it.
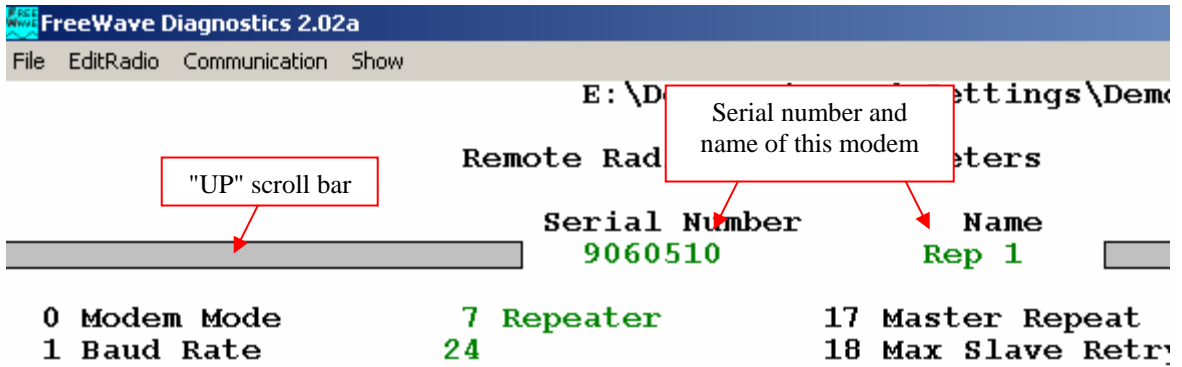
At the bottom, this screen displays the order of this radio within the radio list (of the previous screens). Specifically, '0' refers to the Master.
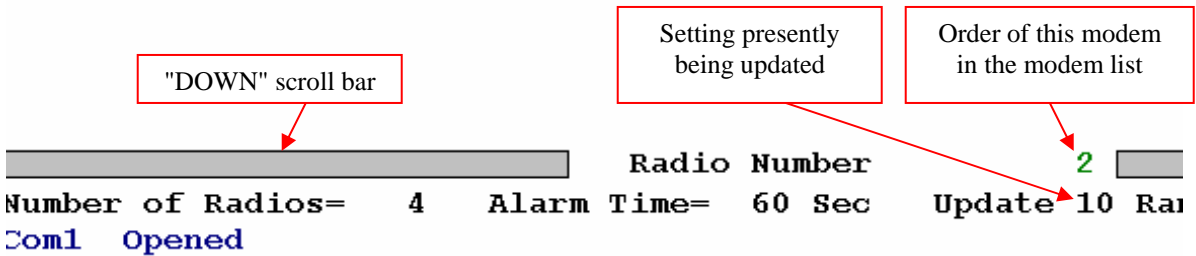
7.5.2 Settings' display

Initially, this application uses "XXX" for the value of each setting.
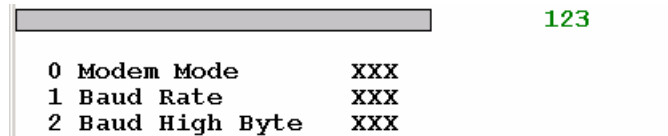
Then, as the radio reports a setting, the application displays its value.
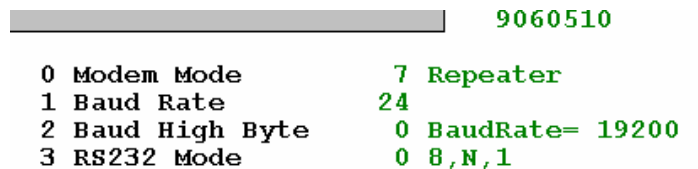
This process is slower if the network is transferring a lot of data. You can request that this radio reports its settings more rapidly by pressing 'P' on the diagnostics computer keyboard.

Each setting is marked with a number, 0 to 38. (This screen handles only the most important 34 settings.) At the bottom right, this screen shows which setting is presently being updated.

7.6 Reading Screen 3, Signal Quality over Time

This Screen displays a rolling graph of the performance over time of a single radio.
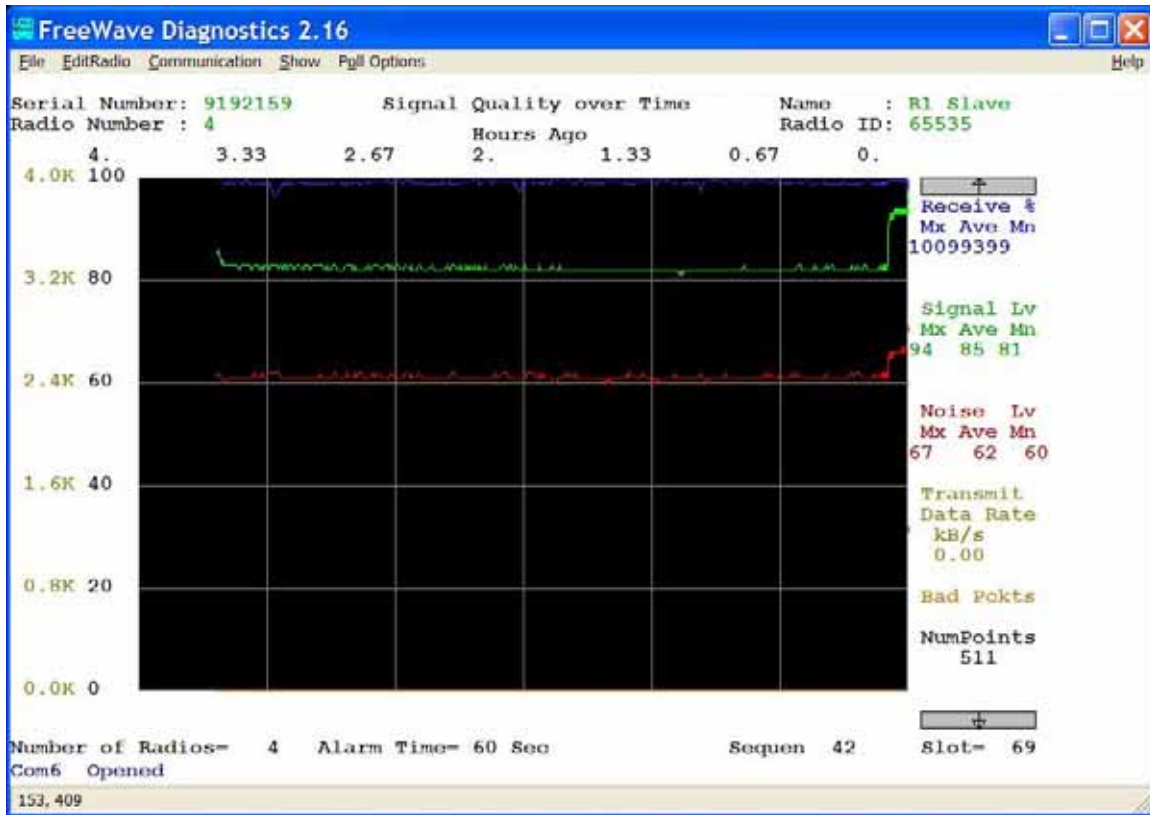
7.6.1 Selecting a particular Radio

To select another radio, scroll through the radio list, either by clicking on the gray scroll bars, or by pressing the computer "up" and "down" arrow keys. When you reach either end of the list, it restarts from the opposite end.

At the top left, this screen displays the Serial Number of this radio, and the order of this radio within the radio list (of the '0' and '1' screens). Specifically, '0' refers to the Master.

At the top right, this screen displays the name you to this radio, and its Radio ID.
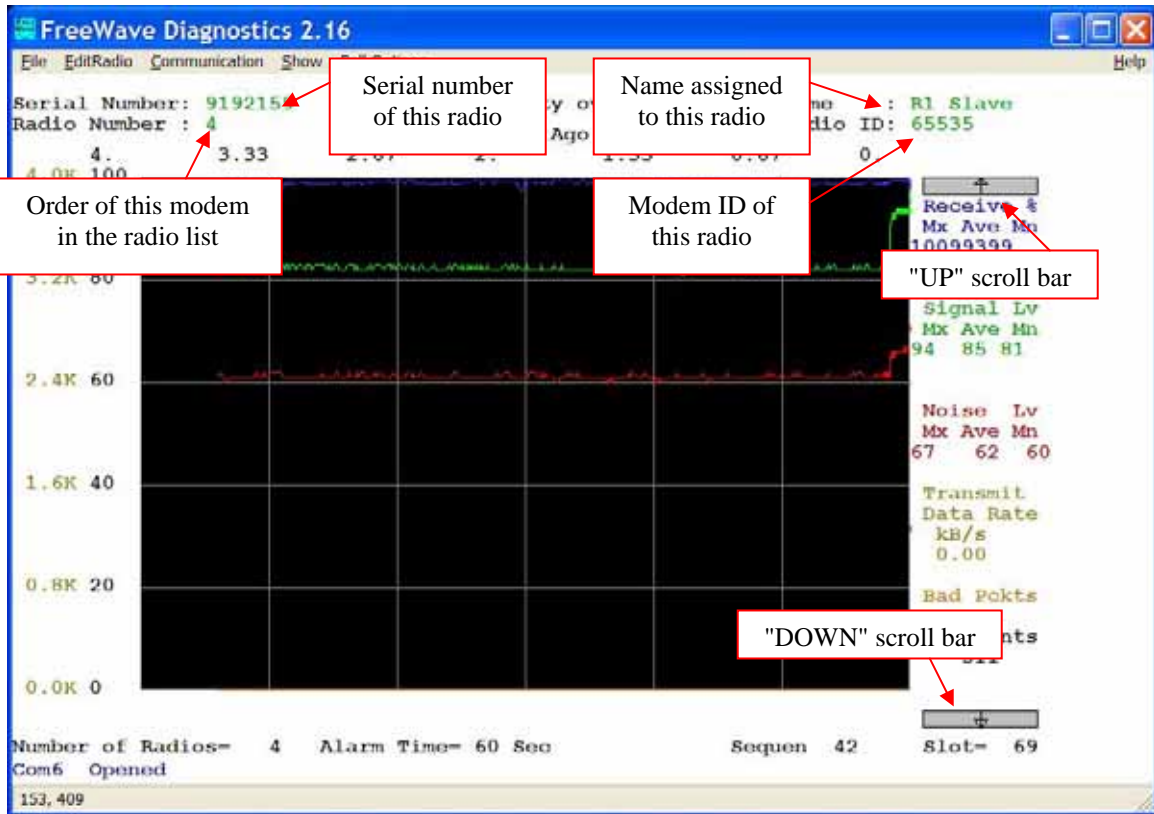
7.6.2   Horizontal time scale

This application starts gathering data when you first start it. It displays this data starting from the right edge, and then rolls to the left. The right edge of the graph is always "now". Each time the traces reach the left end, the application changes the horizontal time scale by a factor of 2, so that all the data are displayed in a single screen. The numbers at the top of the graph indicates the horizontal time scale (in minutes or hours); '0' is on the right, because that's always 0 hours (or minutes) ago.
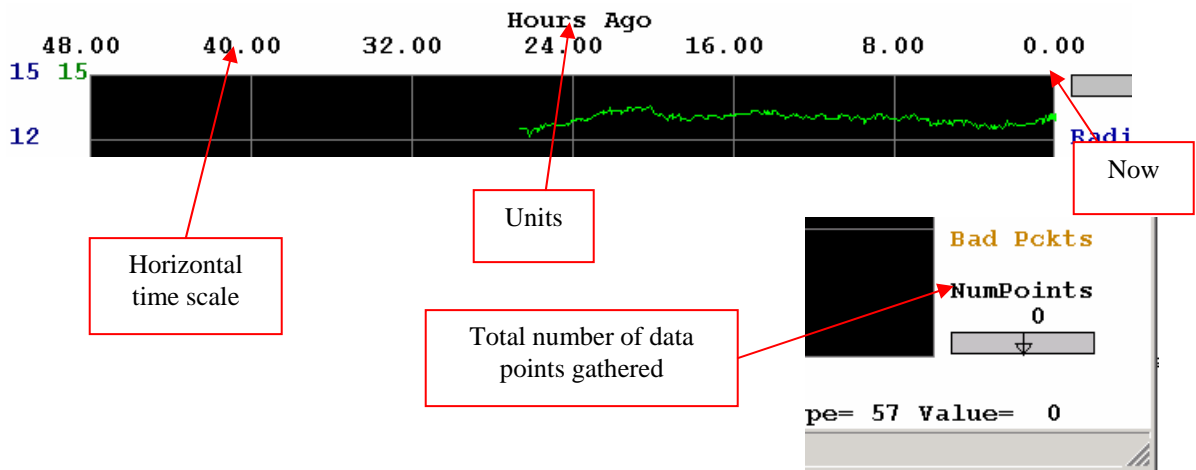
7.6.3 Variables displayed

The graph plots 5 variables:
- "Receive %": the percentage of packets that are successfully received the first time
- "Signal Lv": the signal strength, in standard units (dBµV is not available)
- "Noise Lv": the background noise level, in standard units
- "Transmit Data Rate": the number of kilobytes that this radio transmits*, per seconds
- "Bad Pckts": portion of packets received that are bad

*) For repeaters, this is only that data that is locally generated (non-zero only when a Slave/Repeater is operating as a Slave). Repeaters with older firmware include also the data that they repeat.
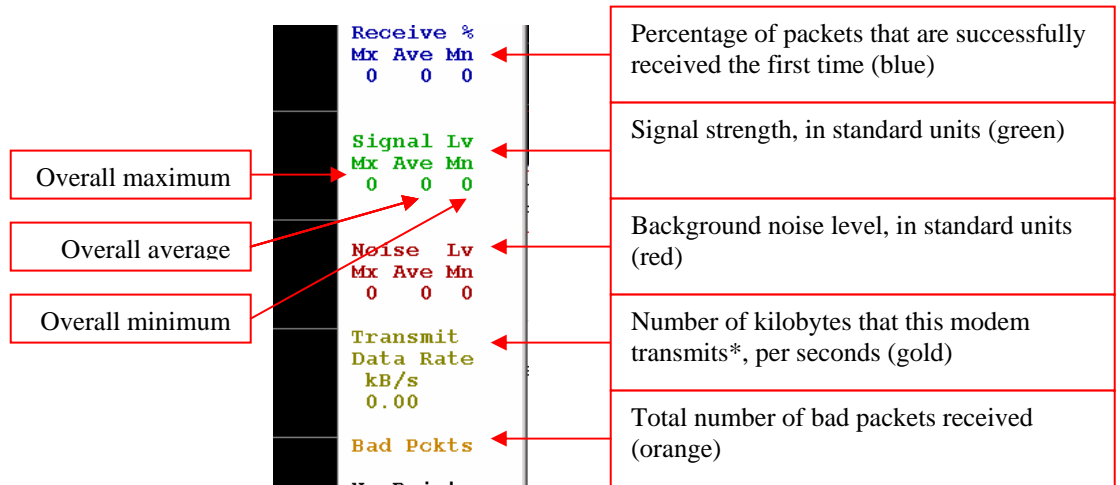
The first 3 variables display the overall minimum, maximum and average.

7.6.4 Vertical scale

The graph has 2 vertical scales. The gold colored scale ("0.0K " to "4.0K") is for the Transmit Data Rate. The black scale ("0" to "100") is for all the other variables.

Scale for "Transmit Data Rate"

Scale for all others
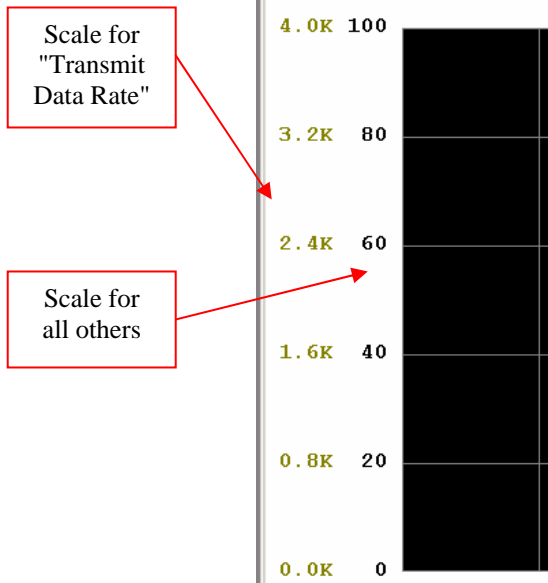
7.7　Reading Screen 4: "Temp, Voltage, PPM Over Time"

This Screen displays a rolling graph of the operating parameters over time of a single radio. It is mostly identical to the previous screen, except for the variables that it plots.　This section describes only those differences.　For information on the rest, see the previous section.
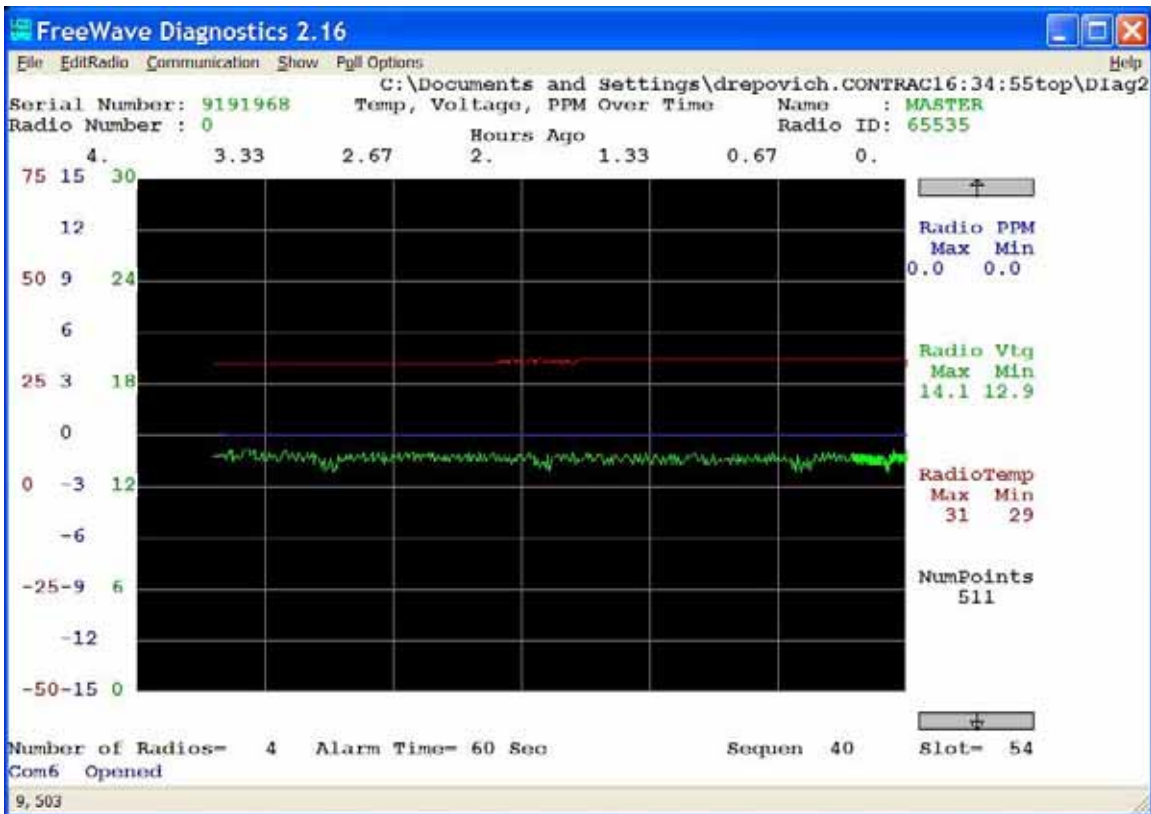
7.7.1　Variables displayed

The graph plots 5 variables:
- "Radio PPM": Error in the radio's radio frequency with respect to the Master [ppm]
- "Radio Vtg": the voltage of the radio's power supply {Volts]
- "RadioTemp": the temperature of the radio [C]

Error in the modem's radio frequency with respect to the Master (blue)

Overall maximum

Overall minimum

Modem supply voltage (green)

Modem temperature (red)

```
Radio PPM
  Max  Min
-12.8-12.8

Radio Vtg
  Max  Min
  0.0  0.0

RadioTemp
  Max  Min
  499  499
```
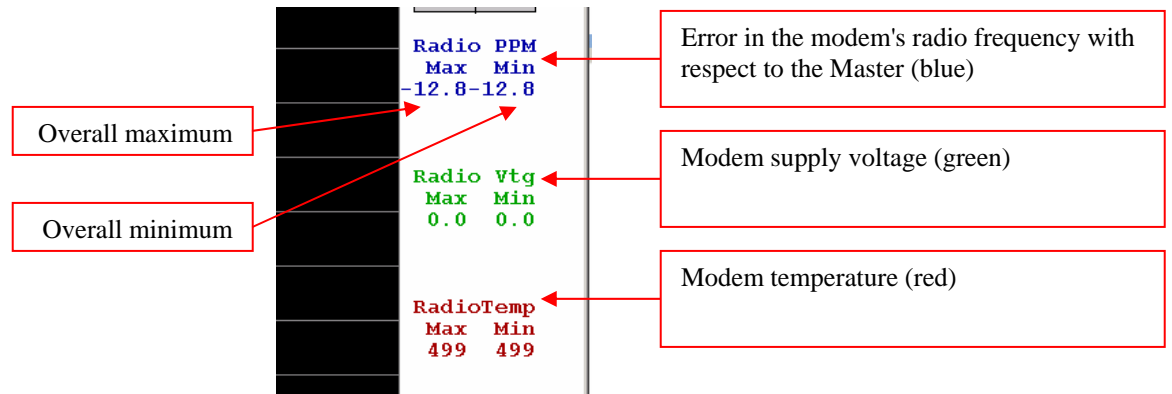
7.7.2　Vertical scale

The graph has 3 vertical scales. The green scale (0 to 15) is for the voltage of the radio's power supply [Volts]. The blue scale (-15 to 15) is for the error in the radio's radio frequency [parts per million]. The red scale (-50 to 75) is for the temperature of the radio [degrees Celsius].

Modem supply voltage [Volts] (green)

Error in the modem's radio frequency [parts per million] (blue)

Modem temperature [degrees C] (red)

```
75 15 15

   12

50  9 12

    6

25  3  9

    0

 0 -3  6

   -6

-25 -9  3

  -12

-50-15  0
Number of Radios=    4    Alarm
```

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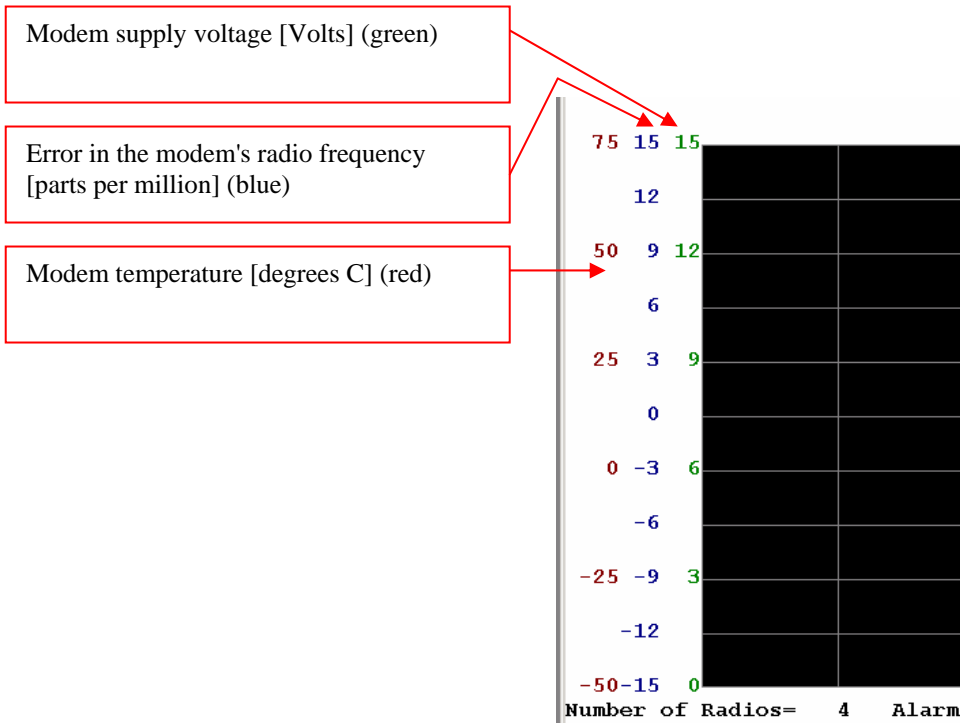
8   Editing the Radio's Settings
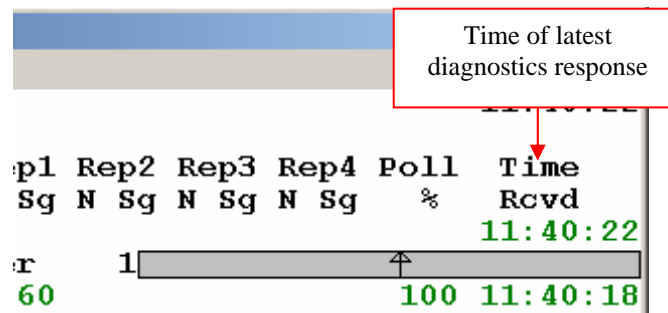
You can change the selected radio's settings through Screen 2.

You can only change one setting at a time. We strongly recommend that you interrupt the normal data flow through a radio while changing any of its settings.

8.1   Strategy

You should stop using that radio to transfer data until you're done editing its settings. That's because the radio disconnects itself from the network when you do that. Afterwards, if the radio is able to reestablish the link, it will do so automatically.

> **Tip**: To see whether or not a radio is connected, go to Screen 0 and look at its "Time Rcvd" field, to see how long it's been since the radio sent diagnostics data.

You should verify that a change has been successful before you do another change.

Certain settings must match in the whole network, so you must change them in every radio in the network. Start from the Slaves, and work your way inward toward the Master; if you went the other way you wouldn't be able to reach the "outer" radios to change their settings.
Verify each change before attempting to change a different setting.

Edit a Slave first

Edit another Slave

Edit this repeater next

Edit this repeater next

Edit the Master last

This link breaks

This link breaks

This link restarts

This link breaks

This link restarts

This link restarts

This link breaks

This link restarts
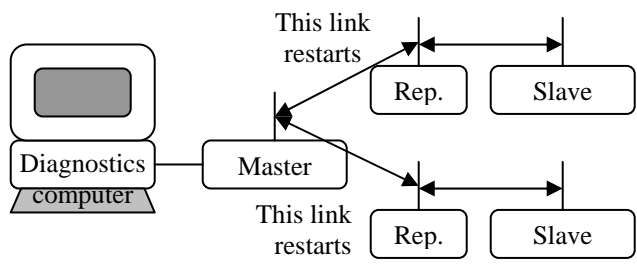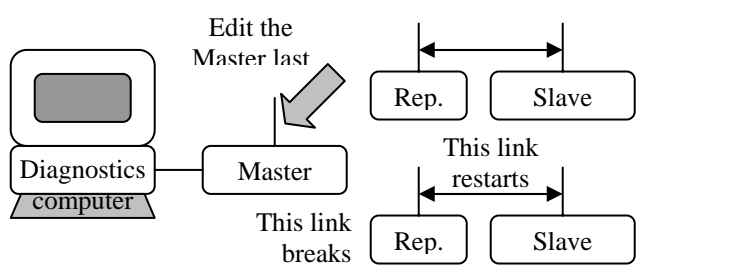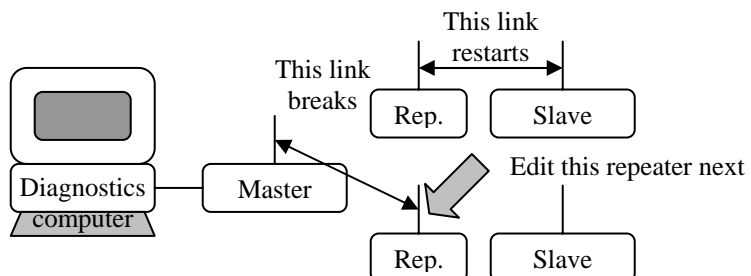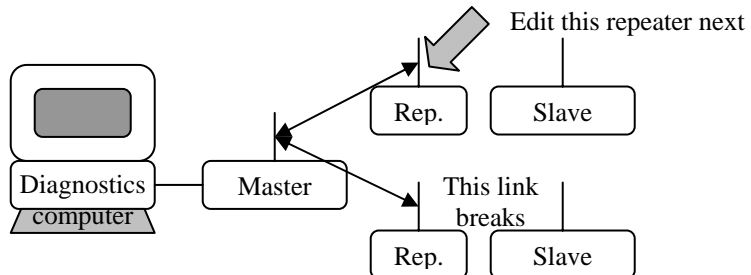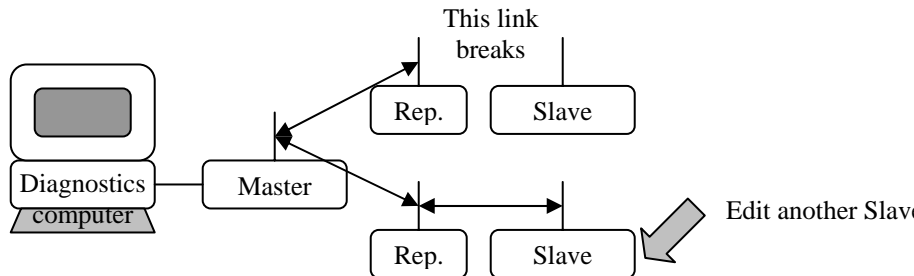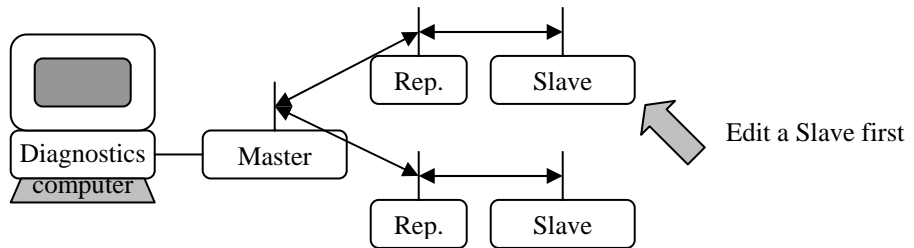
8.2   Changing a Radio's Settings

To change a setting in a radio, use Screen 2 and select that radio (using the arrow keys on your keyboard, or clicking the scroll bars).

Select the "EditRadio" / "Change EPROM" menu (or press the 'C' key).
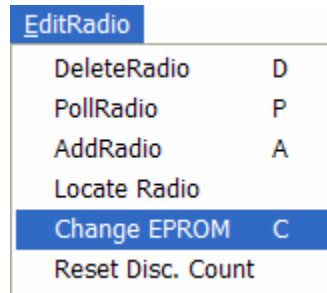
A dialog appears.
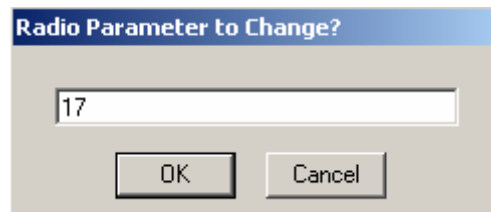
Enter the number of the setting you want to edit (0 to 38) and click "OK".

A new dialog appears.
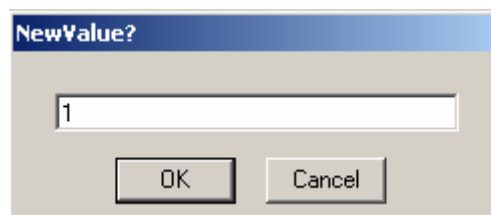
Enter the new value of the setting and click "OK"

8.3   Details about the Settings

Changing these settings is similar to changing them through a radio's "Set-Up" mode, with following differences.
- This application only lets you see and edit 34 of the radio's settings.
- These settings are all available from a single screen (instead of a hierarchy of menus)
- Three of these settings are not editable and are not reported in the "Set-up" mode.
- You enter the Radio ID with 3 bytes instead of 4 decimal digits.
- Some settings appear different in this Application than they do in the Set-up menu

Please refer to the Main Manual for an explanation of the significance of each setting displayed in this screen, and what values are acceptable for each setting.

8.3.1 Risky changes

Changing certain parameters through this application is somewhat risky, as you may not be able to reestablish communication and therefore you may not undo a change (as you could if you had direct access to the radio through its "Set-Up" mode).

```
 0 Modem Mode        XXX          20 DTR Connect       XXX
 1 Baud Rate         XXX          21 Repeater Freq     XXX
 2 Baud High Byte    XXX          22 LowPower          XXX
 3 RS232 Mode        XXX          23 PPS Enable        XXX
 4 MODBus RTU        XXX          24 Slave/Repeater    XXX
 5 Retry TimeOut     XXX          25 Master Sync       XXX
 6 Xtal Tune         XXX          26 Network ID High   XXX
 7 SlicerThreshold   XXX          27 Network ID Low    XXX
 8 Frequency         XXX          28 SubNet ID         XXX
 9 Freqkey           XXX          29 Radio ID High     XXX
10 Max Packet Size   XXX          30 Radio ID low      XXX
11 RF Data Rate      XXX          31 Freq Table        XXX
12 Min Packet Size   XXX          32 Diagnostics       XXX
13 Xmit Power        XXX          33 Radio ID Super    XXX
14 RTS/CTS Control   XXX          34 Reflected  Power  XXX
15 Hop table size    XXX          35 High Noise        XXX
16 Number Repeaters  XXX          36 Turn On Delay     XXX
17 Master Repeat     XXX          37 Turn Off Delay    XXX
18 Max Slave Retry   XXX          38 Xmit Power Cal.   XXX
19 Retry Odds        XXX
```

8.3.2 Xtal tune / SlicerThreshold / Frequency

These 3 settings report data that are not editable and are not even reported in the normal "Set-up" mode. They are not described neither here nor in the Main Manual. They are only useful to a FreeWave Technologies technician.

```
 6 Xtal Tune          60
 7 SlicerThreshold   150
 8 Frequency         131
 9 Freqkey             5
```

8.3.3   Settings that appear different from the Set-UP menu

The following settings are the same as when using the Set-UP mode, but the numbers displayed are different. See the Main Manual for information of what these settings mean. Here we just describe how they are set differently from the Set-Up menu.

8.3.3.1   Baud Rate

Baud rate is set using two parameters: 1- Baud Rate and 2- Baud High Byte.

Baud Rate	Set-up Menu setting	Diagnostics setting	
		2- Baud High Byte	**1- Baud Rate**
1200	9	1	128
2400	8	0	192
4800	7	0	96
9600	6	0	48
19200	5	0	24
38400	4	0	12
57600	3	0	8
76800	2	0	6
115200	1	0	4
230400	0	0	2

8.3.3.2   RS232 Mode

Data Bits, Parity, Stop Bits	Set-up Menu setting	Diagnostics setting
8,None, 1	0	0
7,Even, 1	1	2
7, Odd, 1	2	3
8, None, 2	3	16
8, Even, 1	4	18
8, Odd, 1	5	19

8.3.3.3   MODBus RTU

MODBus RTU	Set-up Menu setting	Diagnostics setting
Enabled	1	0
Disabled	0	255

8.3.3.4   Xmit Power

Set Up	Diagnostics	Set Up	Diagnostics	Set Up	Diagnostics	Set Up	Diagnostics
0	0	3	48	6	96	9	144
1	16	4	64	7	112	10	160
2	32	5	80	8	128		

8.3.3.5   RTS/CTS Control

RTS/CTS Control	**Set-up Menu setting**	**Diagnostics setting**
Enabled	1	255
Disabled	0	0

8.3.3.6   Repeater Freq

Repeater Frequency	**Set-up Menu setting**	**Diagnostics setting**
Enabled	1	255
Disabled	0	0

8.3.3.7   LowPower

Repeater Frequency	**Set-up Menu setting**	**Diagnostics setting**
Disabled	0	255
LEDs dimmed	1	1
LEDs dimmed, radio sleeps every other slot	2	2
LEDs dimmed, radio sleeps 2 of 3 slots	3	3
LEDs dimmed, radio sleeps number of slots corresponding to setting.	…	…
LEDs dimmed, radio sleeps 62 of 63 slots.	63	63

8.3.3.8   PPS Enable

PPS Enable	**Set-up Menu setting**	**Diagnostics setting**
Enabled	1	255
Disabled	0	0

8.3.3.9   Slave/Repeater

Slave Repeater	**Set-up Menu setting**	**Diagnostics setting**
Enabled	1	0
Disabled	0	255

8.3.3.10 Master Sync

Master Sync	**Set-up Menu setting**	**Diagnostics setting**
Enabled	1	0
Disabled	0	255

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8.3.3.11 Network ID

Network ID	Set-up Menu setting	Diagnostics setting	
		High Byte	Low Byte
0 to 255	Network ID	255	Network ID
256 to 511	Network ID	0	Network ID - 256
512 to 767	Network ID	1	Network ID - 512
768 to 1023	Network ID	2	Network ID - 768
1024 to 1279	Network ID	3	Network ID - 1024
1280 to 1535	Network ID	4	Network ID - 1280
1536 to 1791	Network ID	5	Network ID - 1536
1792 to 2047	Network ID	6	Network ID - 1792
2048 to 2303	Network ID	7	Network ID - 2048
2304 to 2559	Network ID	8	Network ID - 2304
2560 to 2815	Network ID	9	Network ID - 2560
2816 to 3071	Network ID	10	Network ID - 2816
3072 to 3327	Network ID	11	Network ID - 3072
3328 to 3583	Network ID	12	Network ID - 3328
3584 to 3839	Network ID	13	Network ID - 3584
3840 to 4095	Network ID	14	Network ID - 3840

Note: Radios with firmware versions earlier than 5.68 (900 MHz) or 1.62 (2.4 GHz) will not accept Network ID values larger than 255.

8.3.3.12 SubNet ID

SubNet ID	Set-up Menu setting	Diagnostics setting
01h to FFh	01h to FFh	1 to 255

Diagnostics requires you to enter this value as a decimal number. Slip the hex value that you would enter in the Set-Up Menu into two nibbles. For example, if the value you would enter in the Set-Up menu is "E3", the high nibble is 'E' and the low nibble is '3'. Use this table to convert the 2 nibbles to the corresponding decimal number.

Receive Subnet ID (X_: high nibble)																
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	N/A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
3	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
4	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
5	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
6	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
7	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
8	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
9	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
A	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
B	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
C	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
D	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
E	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
F	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

Transmit Subnet ID (_X: low nibble)

8.3.3.13 Radio ID

The Diagnostics Application lets you set any number below 2^24. While the radio's Set-up mode will display this entire number, it will only let you enter numbers up to 9999.

Radio ID	Set-up Menu setting	Diagnostics setting		
		Super Byte	**High Byte**	**Low Byte**
0 to 255	Radio ID	0	0	Radio ID
256 to 9999	Radio ID	0	INT((Radio ID MOD 65535) / 256)	Radio ID MOD 256
10000 to 65535	Not available	0	INT((Radio ID MOD 65535) / 256)	Radio ID MOD 256
65536 to 16777215	Not available	INT(Radio ID / 65535)	INT((Radio ID MOD 65535) / 256)	Radio ID MOD 256

Unfortunately, the way you set-up this number through the Diagnostics Application is awkward, as you must enter it one byte at a time, using 3 entries:

- Super byte: "33 Radio ID Super".
- High byte: "29 Radio ID High".
- Low byte: "30 Radio ID Low".

Each entry takes a value between 0 and 255.

$$\text{Radio ID} = 65535 * \text{Super byte} + 256 * \text{High byte} + \text{Low byte}.$$
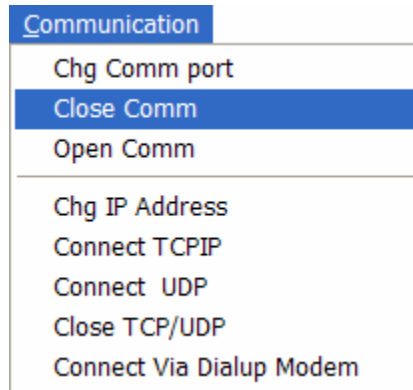
8.3.3.14 32 Diagnostics

| Diagnostics	Set-up Menu setting	Diagnostics setting
Enabled	1 to 63	1 to 63
Disabled	0	255

9   Ending the session

When done, you need to end the communication with the Master.

If the communication was directly through the serial port, close the port with the "Communication" / "Close Comm" menu.

If the communication was directly through an Ethernet Network (either TCP/IP or UDP/IP), close the connection with the "Communication" / "Close TCP/UPD" menu.
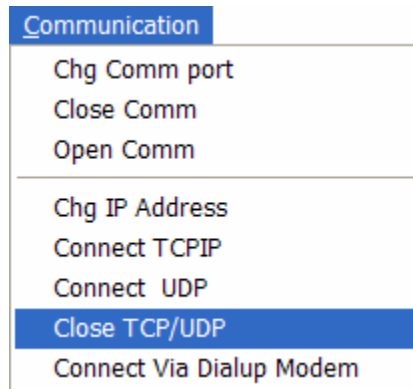
Quit the application with the "File" / "Exit" menu or press alt-F4 or alt-F-X.

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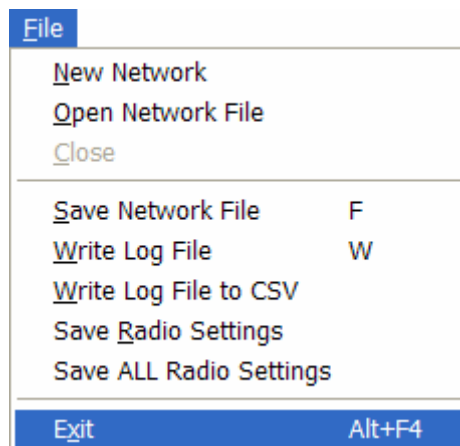
10 Troubleshooting

To run the diagnostic program, make sure that:
- The network is Point-to-multipoint.
- The Diagnostics computer is able to access the FreeWave network
  - either through its Master (through a Diagnostics Cable)
  - or through the Internet.
- The Diagnostics application (DIAG216.EXE) is installed and running on the Diagnostic computer.
- The Diagnostics setting in the Master radio is set to a value between 1 and 63, inclusive.