Using the FGR-115MB in Mirrored Bit Applications

The FreeWave Technologies FGR-115MB Spread Spectrum transceiver is a special version of the FGR-Series product family. It provides additional features that are optimized for use with Schweitzer Engineering Labs Mirrored Bit Communications in high-speed protective relay and other applications. The FGR-115MB is a cost-effective, reliable, and secure alternative to optical fiber, metallic pilot wire and other communications technologies for Mirrored Bit communications.

The FGR-115MB contains all of the features and functions of the standard FGR-Series 900 MHz spread spectrum product family and may be used in any other application where the standard products can be used with the exception of applications using either Ethernet or the optional TDMA mode. Ethernet and TDMA are not available on the FGR-115MB.

For use in Mirrored Bit applications, specific settings must be made to the FGR-115MB as described in this addendum. The three parts of this addendum explain the setup of a point-to-point Mirrored Bit link, the setup of a Mirrored Bit link with one repeater hop, and troubleshooting techniques for mirrored bit links. Refer to the FGR-115RC User Manual for more information on programming the FGR-115MB for applications where Mirrored Bit communication is not used.

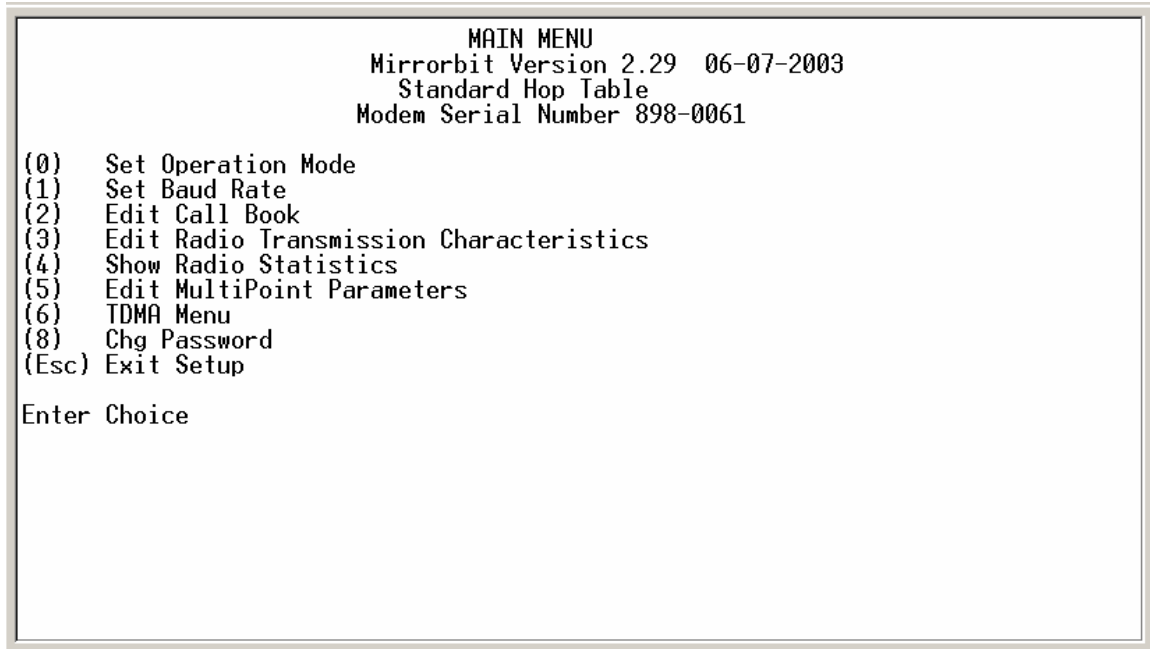### Part 1. Programming a point-to-point Mirrored Bit Link

Connect an ASC0409 DC Programming/Diagnostics cable from the Diagnostics port on the FGR-115MB to the serial port on the programming terminal. Set up the programming terminal as described in the FGR-Series user manual. Invoke the setup menu by pressing the SETUP button on the radio's rear panel or by sending an uppercase U from the programming terminal. Programming must be done through the Diagnostics port. The programming menu will not be displayed through the radio's RS-232 port.

RS-232 port (main)

SETUP button

Diagnostics port
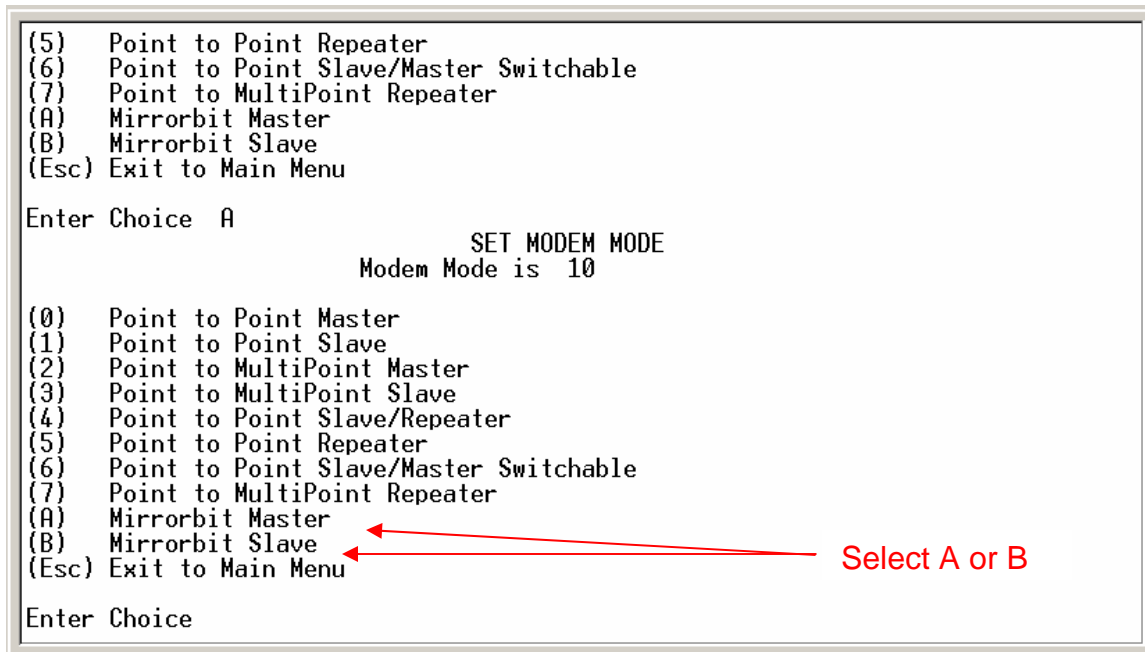
Figure 1. FGR-115MB rear panel

The radio's main menu will be displayed as shown in Figure 2 below. The three LEDs on the radio's front panel will be green. When the radio is in setup mode, the radio link is disconnected and data will not pass through the link.

Figure 2. Main Menu

```
                        MAIN MENU
               Mirrorbit Version 2.29  06-07-2003
                      Standard Hop Table
                 Modem Serial Number 898-0061

(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

Enter Choice
```

1.1 Set Operation Mode

Enter a 0 (zero) to open the Set Operation Mode menu. The menu will be displayed as shown in Figure 3 below.   A point-to-point Mirrored Bit communication link requires two radios. One radio must be set to be the Mirrorbit Master (an entry of A in the Operation Mode menu). The other radio must be the Mirrorbit Slave (an entry of B). Although the entry is made as either an A or B, the Modem Mode indication at the top of the menu page will be 10 for Mirrorbit Master or 11 for Mirrorbit Slave. When the entry has been made, press ESC to return to the main menu.

Figure 3. Operation Mode Menu

```
(5)   Point to Point Repeater
(6)   Point to Point Slave/Master Switchable
(7)   Point to MultiPoint Repeater
(A)   Mirrorbit Master
(B)   Mirrorbit Slave
(Esc) Exit to Main Menu

Enter Choice  A
                           SET MODEM MODE
                       Modem Mode is  10

(0)   Point to Point Master
(1)   Point to Point Slave
(2)   Point to MultiPoint Master
(3)   Point to MultiPoint Slave
(4)   Point to Point Slave/Repeater
(5)   Point to Point Repeater
(6)   Point to Point Slave/Master Switchable
(7)   Point to MultiPoint Repeater
(A)   Mirrorbit Master              ◄─────────
(B)   Mirrorbit Slave        ◄─────────          Select A or B
(Esc) Exit to Main Menu

Enter Choice
```

1.2 Set Baud Rate

Enter 1 from the Main Menu to open the Set Baud Rate menu. The menu will be displayed as shown in Figure 4 below. For Mirrored Bit operation, the Baud Rate on each radio must be set to either 9,600 or 38,400 (entry 4 or 6 in the Baud Rate menu). These are the only baud rate selections that are valid for Mirrored Bit operation. Each radio must be set to match the baud rate of the Mirrored Bit device to which it is connected and both radios must be set to the same baud rate. For optimum Mirrored Bit performance, a baud rate of 38,400 is recommended.

The Setup Port must be set to 2 (Diag only). To change the Setup Port, select Setup Port (menu item D). The Setup Port menu will be displayed as shown in Figure 5 below. Enter 2 (For Diag Only) as shown.

When the baud rate and Setup Port entries have been made, press ESC to return to the main menu.
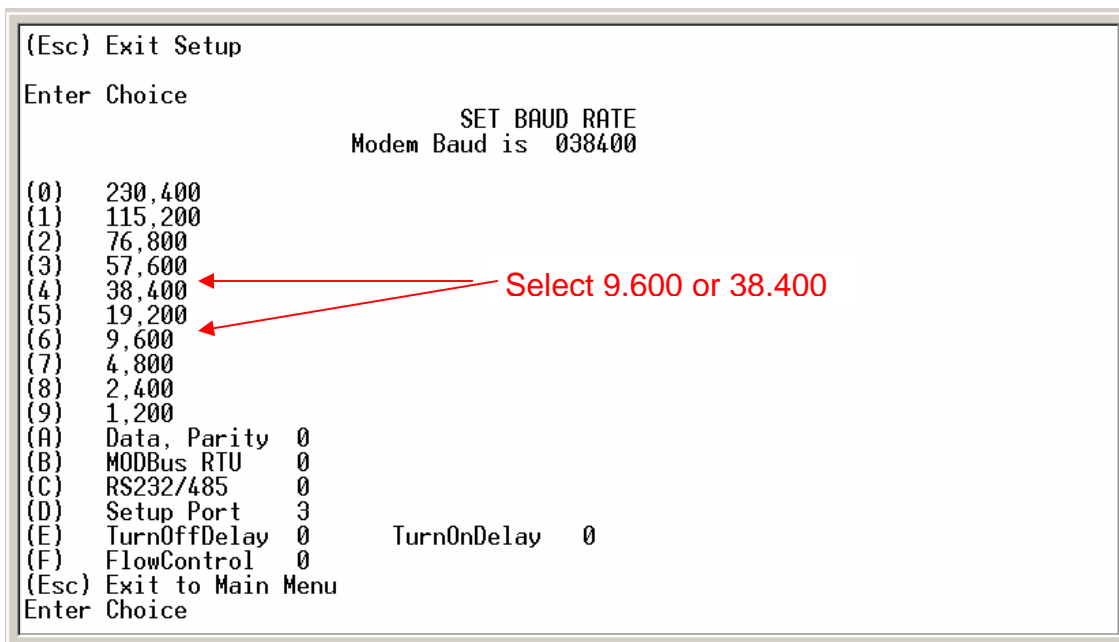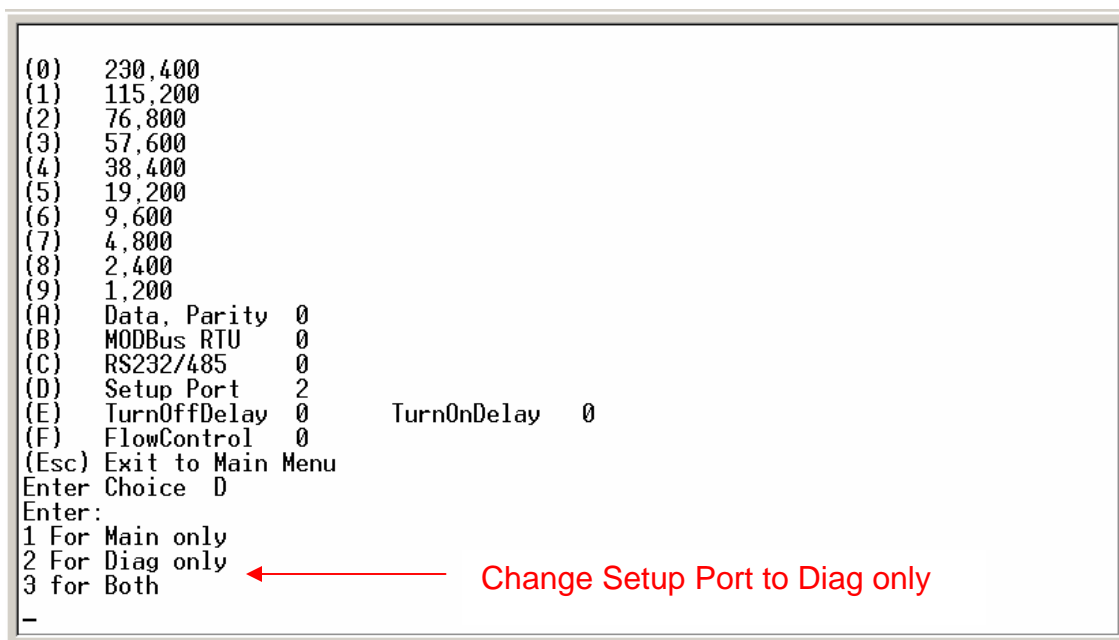
Figure 4. Baud Rate Menu

```
(Esc) Exit Setup

Enter Choice
                              SET BAUD RATE
                          Modem Baud is  038400

(0)    230,400
(1)    115,200
(2)    76,800
(3)    57,600                    ◄──────── Select 9.600 or 38.400
(4)    38,400
(5)    19,200
(6)    9,600
(7)    4,800
(8)    2,400
(9)    1,200
(A)    Data, Parity   0
(B)    MODBus RTU     0
(C)    RS232/485      0
(D)    Setup Port     3
(E)    TurnOffDelay   0        TurnOnDelay   0
(F)    FlowControl    0
(Esc) Exit to Main Menu
Enter Choice
```

Figure 5. Setup Port Menu

```
(0)    230,400
(1)    115,200
(2)    76,800
(3)    57,600
(4)    38,400
(5)    19,200
(6)    9,600
(7)    4,800
(8)    2,400
(9)    1,200
(A)    Data, Parity   0
(B)    MODBus RTU     0
(C)    RS232/485      0
(D)    Setup Port     2
(E)    TurnOffDelay   0        TurnOnDelay   0
(F)    FlowControl    0
(Esc) Exit to Main Menu
Enter Choice  D
Enter:
1 For Main only
2 For Diag only      ◄──────── Change Setup Port to Diag only
3 for Both
_
```

1.3 Edit Call Book

Enter 2 from the Main Menu to open the Edit Call Book menu. When using a pair of FGR-115MB radios in a Mirrored Bit application, each radio **_must_** have the other radio's serial number as the first entry in its Call Book with no entries in the Repeater1 and Repeater2 columns as shown in Figure 6 below. In addition, the Mirror Bit Master must be programmed to call the first entry in its Call Book.

To make a call book entry, enter a 0 (zero) and, at the prompt, enter the seven-digit serial number of the other radio in the link. Do not enter the dash character. At the Enter Repeater1 prompt, press ESC to complete the entry. Do not use the Repeater1 and Repeater2 prompts to enter repeater serial numbers. Refer to Part 2 of this addendum for instructions on programming Mirrored Bit repeaters.

The Mirrored Bit Slave will not establish communication with the master by turning Slave Security off. The Slave must have the Mirrored Bit Master's serial number as the first entry in its call book.

Figure 6. Edit Call Book Menu

```
(C)     Change Entry to Use (0-9) or A(ALL)
(Esc)   Exit to Main Menu
Enter all zeros (000-0000) as your last number in list
0
Enter New Number 898-0063
Enter Repeater1 (ESC=no repeater used)

                              MODEM CALL BOOK
                              Entry to Call is 00
Entry    Number      Repeater1    Repeater2
(0)      898-0063
(1)      000-0000
(2)      000-0000
(3)      000-0000
(4)      000-0000
(5)      000-0000
(6)      000-0000
(7)      000-0000
(8)      000-0000
(9)      000-0000
(C)     Change Entry to Use (0-9) or A(ALL)
(Esc)   Exit to Main Menu
Enter all zeros (000-0000) as your last number in list
_
```
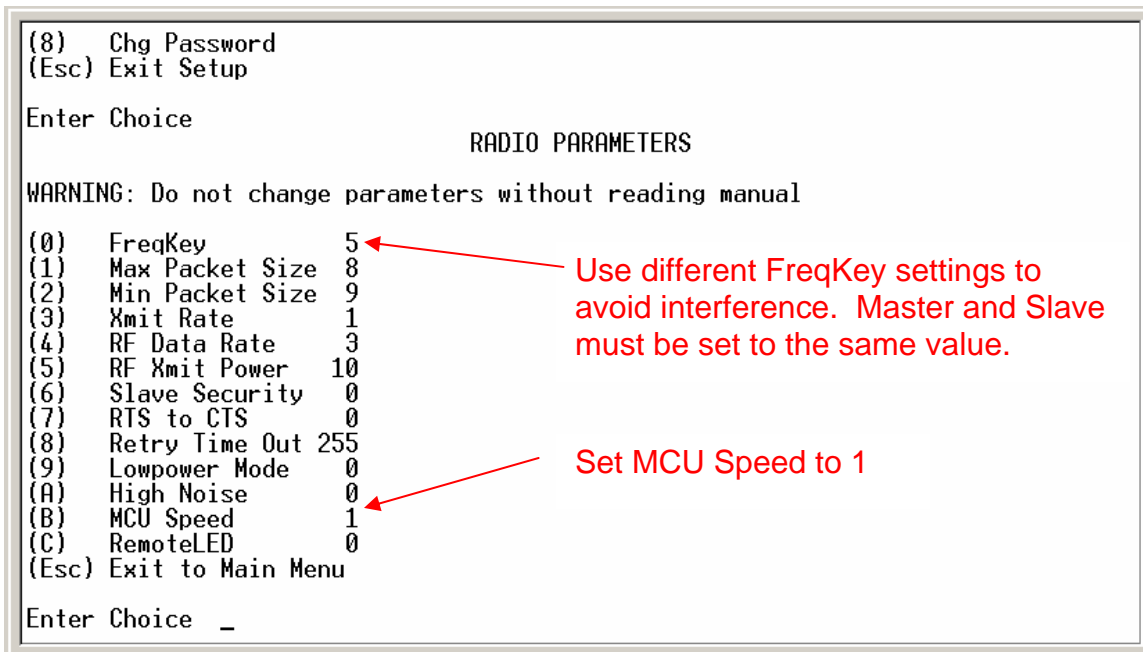
When the call book entry is complete, press ESC to return to the main menu.

1.4 Edit Radio Transmission Characteristics

From the Main Menu, enter 3 to open the Edit Radio Transmission Characteristics Menu as shown in Figure 7 below. All values in the Radio Parameters menu must be identical for the Mirrored Bit master and the Mirrored Bit slave radios with the exception of RF Xmit Power (menu item 5) and High Noise (menu item A). For more information on these functions refer to the FreeWave FGR-Series User Manual. MCU Speed (menu item B) must be set to 1. If more than one pair of FreeWave 900MHz transceivers are operating in close proximity they must be set to different Frequency Keys (menu item 0). This is also necessary if the radios are to be configured as a Mirrored Bit repeater. Refer to Part 2 of this addendum for instructions on programming a Mirrored Bit repeater.

Unlike the DGR-Series Mirrored Bit radios, it is not necessary to change Hop Table Size on the FGR-115MB for Mirrored Bit operation. Hop Table Size should be left at its standard setting of 112.

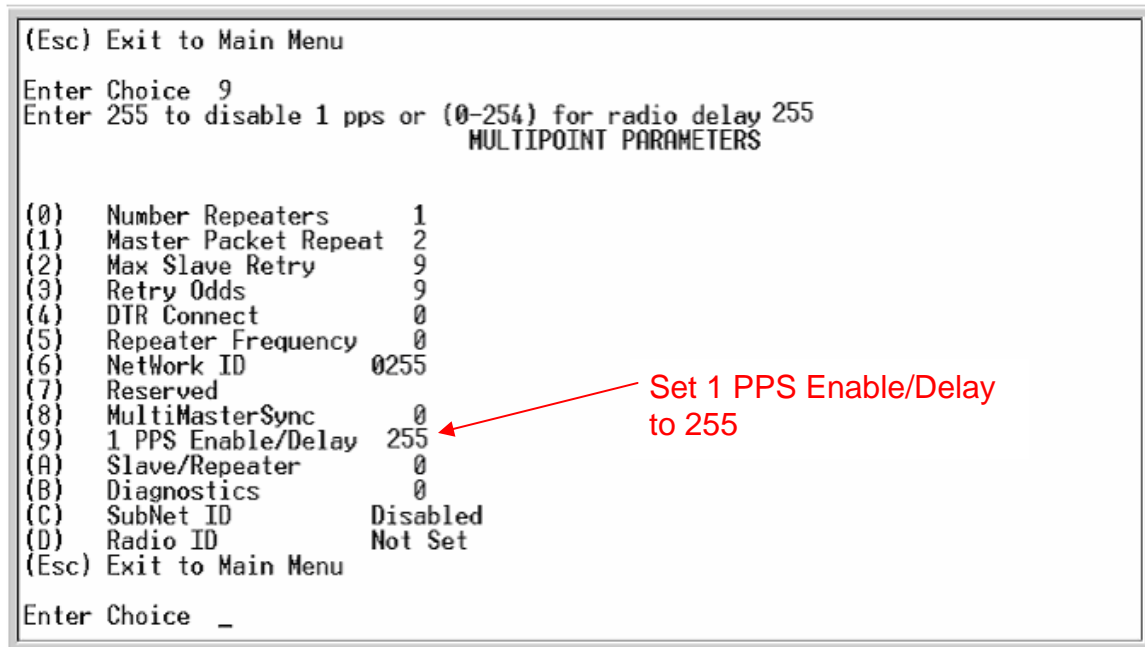**Figure 7. Radio Transmission Characteristics Menu**


```
(8)   Chg Password
(Esc) Exit Setup

Enter Choice
                              RADIO PARAMETERS

WARNING: Do not change parameters without reading manual

(0)   FreqKey          5        Use different FreqKey settings to
(1)   Max Packet Size  8        avoid interference.  Master and Slave
(2)   Min Packet Size  9        must be set to the same value.
(3)   Xmit Rate        1
(4)   RF Data Rate     3
(5)   RF Xmit Power    10
(6)   Slave Security   0
(7)   RTS to CTS       0
(8)   Retry Time Out 255
(9)   Lowpower Mode    0        Set MCU Speed to 1
(A)   High Noise       0
(B)   MCU Speed        1
(C)   RemoteLED        0
(Esc) Exit to Main Menu

Enter Choice  _
```

When the radio parameters entries are complete, press ESC to return to the main menu.

1.5 Edit MultiPoint Parameters

From the Main Menu, enter 5 to open the Edit MultiPoint Parameters Menu as shown in Figure 8 below. For Mirrored Bit operation without a repeater, 1 PPS

Enable/Delay must be set to 255. If 1 PPS Enable/Delay is set to any other value, change it to 255. Press ESC to return to the main menu.

Figure 8. Edit MultiPoint Parameters Menu

```
(Esc) Exit to Main Menu

Enter Choice  9
Enter 255 to disable 1 pps or (0-254) for radio delay 255
                          MULTIPOINT PARAMETERS


(0)   Number Repeaters     1
(1)   Master Packet Repeat 2
(2)   Max Slave Retry      9
(3)   Retry Odds           9
(4)   DTR Connect          0
(5)   Repeater Frequency   0
(6)   NetWork ID        0255
(7)   Reserved
(8)   MultiMasterSync      0
(9)   1 PPS Enable/Delay  255
(A)   Slave/Repeater       0
(B)   Diagnostics          0
(C)   SubNet ID        Disabled
(D)   Radio ID         Not Set
(Esc) Exit to Main Menu

Enter Choice  _
```

Set 1 PPS Enable/Delay to 255

Press ESC again to exit the setup menu and return the FGR-115MB to operation mode. The Mirrored Bit link is now ready to transmit Mirrored Bit data. Connect the antenna connector on each radio to its antenna system. Connect the comm. Port on each radio to its Mirrored Bit device using a straight through RS-232 cable. (An RS-232 gender changer may be required to connect the RS-232 cable to the Mirrored Bit device.) Refer to Part 3, troubleshooting, if the link does not function properly.

Figure 9 shows a typical Mirrored Bit installation between an SEL 351R and 351S using FGR-115MB radios. Many other configurations are possible.

Figure 9. Typical Mirrored Bits Installation
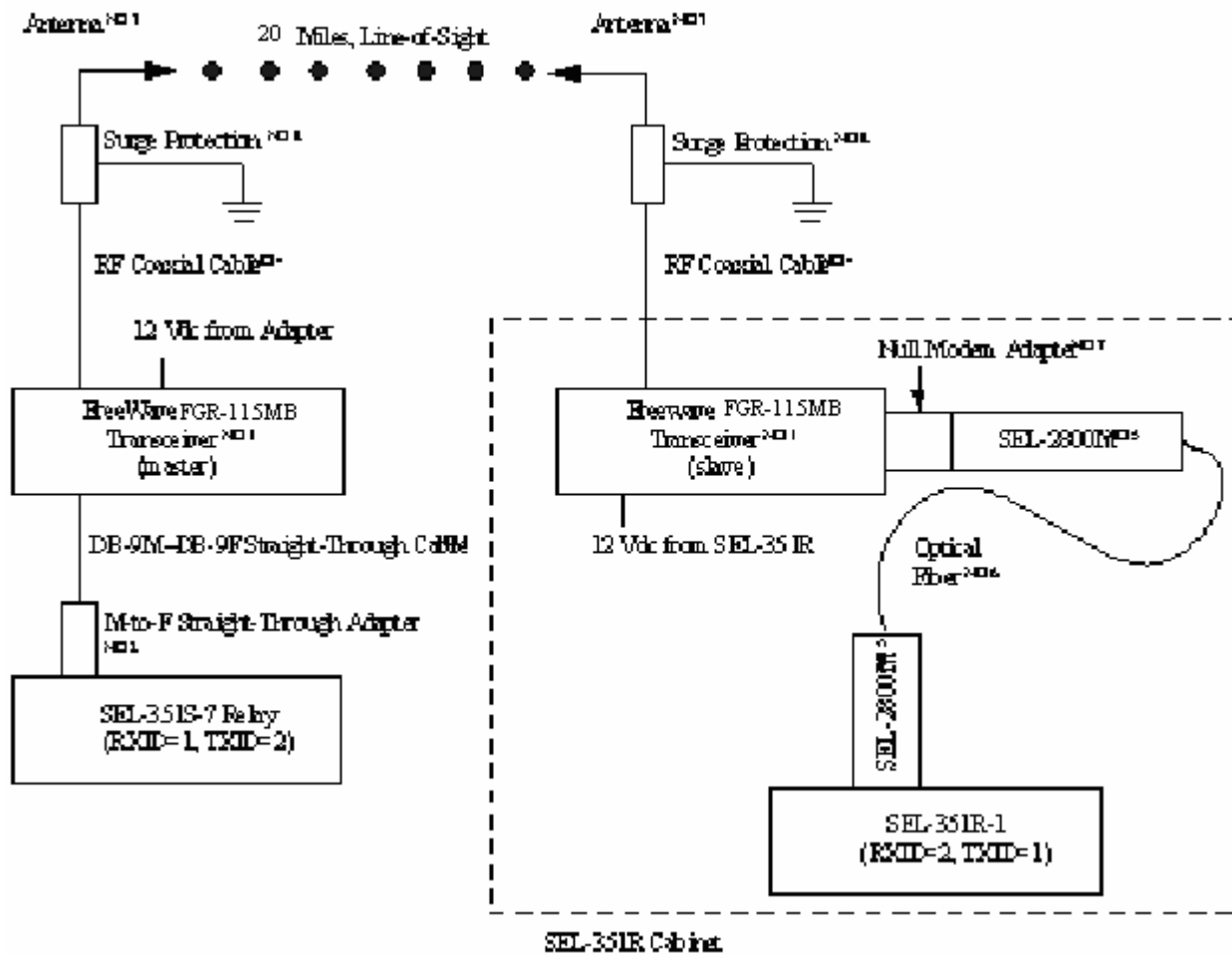
Typical Equipment List

The following equipment list details the typical components and connections for each end of a Mirrored Bit link, as shown in Figure 9 above. A pole, tower, or other means of elevating the antenna is not shown. SEL relays or other Mirrored Bit devices are not included.

Typical Equipment List

Qty	Item	Description	Approx. Cost
2	900 MHz Spread-Spectrum Transceiver	FreeWave Technologies, Inc. Model FGR-115MB. 6 to 30 volt dc power, 1 W output, 20+ miles line-of-sight, 120 Vac-to-12 Vdc adapter, 6' DB-9M-to-DB-9F straight-through cable and DB-9 male-to-male gender changer included. (An SEL C285 cable can be used directly without adaptors if desired.)	$1,350
2	Yagi Antenna	FreeWave Technologies, Inc. [1] Model EAN0900YC. 10 dB, directional, 26" long.	$195
2	Low-Loss RF Cable	FreeWave Technologies, Inc. [2] Model ASC1004NN. 100' length	$185
2	Fiber-Optic Transceiver	SEL [3] Model SEL-2800M. EIA-232 DB-9M-to-Fiber-Optic Transceiver.	$102
1	Fiber-Optic Cable	SEL [3] Model C800FZ. Terminated Cable, 25' or less (other lengths available)	$60
1	DB-9 Null Modem Adapter	FreeWave Technologies, Inc Model ECD0009NM 9 pin male to 9 pin female Null Modem Adapter, or equivalent (one end is male, one end is female)	$7
2	Surge Protection	Northern Technologies, Model QWS-920N [4]. N Type M-to-F ¼ shorting stub coaxial protector tuned for 870 - 970 MHz. www.northern-tech.com (800) 727-9119	$135

Notes:

1. Other antennas are available.

2. Other RF cable lengths are available.

3. Other fiber-optic transceivers and cable may be used. Note, the fiber-optic transceivers are not required, but provide complete isolation between the radio and antenna and the relay.

4. Other surge protection may be used (PolyPhaser, etc.). FreeWave recommends northern Technologies for use with their radios.

Other Notes

1. In Mirrored Bits mode, the FGR-115MB may be used with a number of different SEL devices, please contact SEL at www.selinc.com for a complete list of supported devices.

2. When the FGR-115MB is used for Mirrored Bits communication, one repeater may be used in the link. Refer to Programming A Mirrored Bits repeater in this addendum for more information.

3. When the FGR-115MB is used for Mirrored Bits communication, it is not compatible with the models DGR-115RU or DGR-115RXU Mirrored Bit radios if these radios are also being used for Mirrored Bits communications. Otherwise, the FGR-115MB is compatible with any DGR or FGR-Series radios when used in standard point-to-point or point-to-multipoint modes.

Part 2. Programming a Mirrored Bit Repeater

Unlike a standard FreeWave point-to-point or point-to-multipoint repeater, which requires only one radio, a Mirrored Bit repeater uses two radios in a "back-to-back" configuration. One of these radios is a Mirrored Bit slave and the other radio is a Mirrored Bit master. Each of these radios communicates with another radio at another location in a point-to-point Mirrored Bit link. The master at the repeater site communicates with a remote Mirrored Bit slave radio. The slave at the repeater site communicates with a remote Mirrored Bit master radio. **Follow the instructions in Part 1 of this addendum to first set up each of the separate Mirrored Bit links.** Set each of the separate Mirrored Bit links on a different frequency key to minimize interference at the repeater site. Follow the instructions in Part 2 *only* for the radios to be installed at the repeater site.

2.1 Set Baud Rate

Enter 1 from the Main Menu to open the Set Baud Rate menu as shown in Figure 10 below. For Mirrored Bit repeater operation, the Baud Rate on each radio in the repeater pair must be set to 230,400 (entry 0 (zero) in the Baud Rate menu). This is the only baud rate selection that is valid for Mirrored Bit repeater operation. Do not change the baud rate settings of the other radios that will be linked to the master and slave radios at the repeater site. These radios must be set to match the baud rate of the Mirrored Bit devices to which they are connected and both of these radios must be set to the same baud rate.

When the baud rate entry has been made, press ESC to return to the main menu.

Figure 10. Set Baud Rate Menu

```
(Esc) Exit to Main Menu
Enter Choice  0

                              SET BAUD RATE
                        Modem Baud is   230400

(0)    230,400      ←──────────────      Set to 230,400
(1)    115,200
(2)    76,800
(3)    57,600
(4)    38,400
(5)    19,200
(6)    9,600
(7)    4,800
(8)    2,400
(9)    1,200
(A)    Data, Parity  0
(B)    MODBus RTU     0
(C)    RS232/485      0
(D)    Setup Port     2
(E)    TurnOffDelay   0        TurnOnDelay    0
(F)    FlowControl    0
(Esc) Exit to Main Menu
Enter Choice
```
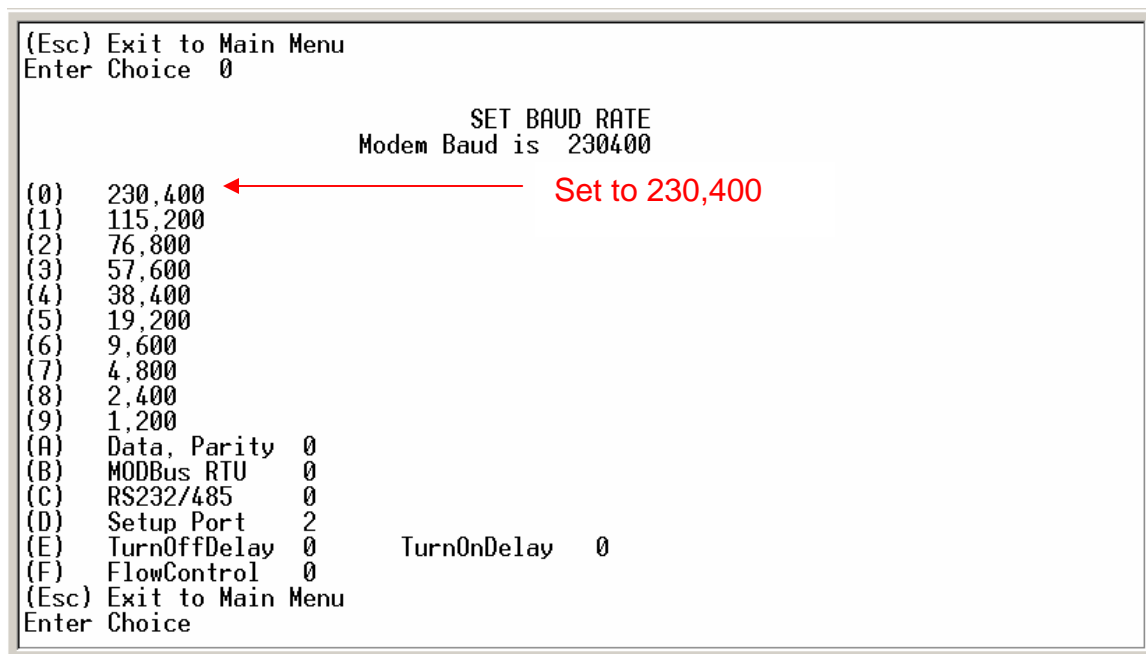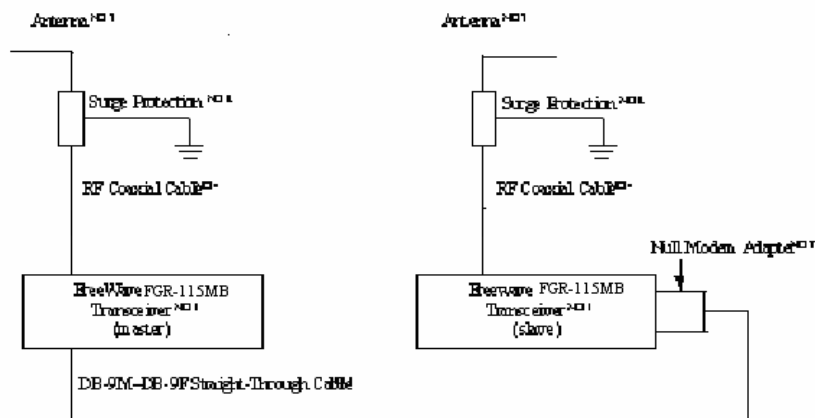
2.2 Edit Multipoint Parameters

Enter 5 from the Main Menu to open the Edit Multipoint Parameters menu as shown in Figure 11 below. For Mirrored Bit repeater operation 1 PPS Enable/Delay (Menu Item 9) must be changed from its normal setting of 255 to a new setting of 0. Do not change the 1 PPS Enable/Delay settings of the other radios that will be linked to the master and slave radios at the repeater site.

Figure 11. Edit MultiPoint Parameters Menu

```
(Esc) Exit to Main Menu

Enter Choice  9
Enter 255 to disable 1 pps or (0-254) for radio delay 0
                        MULTIPOINT PARAMETERS


(0)    Number Repeaters    1
(1)    Master Packet Repeat   2
(2)    Max Slave Retry     9
(3)    Retry Odds          9
(4)    DTR Connect         0
(5)    Repeater Frequency   0
(6)    NetWork ID        0255
(7)    Reserved
(8)    MultiMasterSync      0              Set to 0
(9)    1 PPS Enable/Delay   0  ◄──────
(A)    Slave/Repeater       0
(B)    Diagnostics          0
(C)    SubNet ID        Disabled
(D)    Radio ID         Not Set
(Esc) Exit to Main Menu

Enter Choice  _
```

When 1 PPS Enable/Delay has been set to 0, press ESC to return to the Main Menu. Press ESC again to exit the setup menu and return the radio to operation mode.

Connect the data ports on the master and slave radios at the repeater site with an RS-232 null modem cable. Connect both radios to their separate antenna systems. The radios are now ready to function as a Mirrored Bit repeater. See Figure 12 below. If Mirrored Bit communications cannot be established through the repeater, refer to Part 3, troubleshooting, at the end of this addendum.

Figure 12. Mirrored Bit Repeater Configuration

Typical Equipment List for Mirrored Bit Repeater

Qty	Item	Description	Approx. Cost
2	900 MHz Spread-Spectrum Transceiver	FreeWave Technologies, Inc. Model FGR-115MB. 6 to 30 volt dc power, 1 W output, 20+ miles line-of-sight, 120 Vac-to-12 Vdc adapter, 6' DB-9M-to-DB-9F straight-through cable and DB-9 male-to-male gender changer included. (An SEL C285 cable can be used directly without adaptors if desired.)	$1,350
2	Yagi Antenna	FreeWave Technologies, Inc. [1] Model EAN0900YC. 10 dB, directional, 26" long.	$195
2	Low-Loss RF Cable	FreeWave Technologies, Inc. [2] Model ASC1004NN. 100' length	$185
1	DB-9 Null Modem Adapter	FreeWave Technologies, Inc Model ECD0009NM 9 pin male to 9 pin female Null Modem Adapter, or equivalent (one end is male, one end is female)	$7

Qty	Item	Description	Approx. Cost
2	Surge Protection	Northern Technologies, Model QWS-920N [4]. N Type M-to-F ¼ shorting stub coaxial protector tuned for 870 - 970 MHz. www.northern-tech.com (800) 727-9119	$135

Notes:

1. Other antennas are available.

2. Other RF cable lengths are available.

3. Other surge protection may be used (PolyPhaser, etc.). FreeWave recommends northern Technologies for use with their radios.

Part 3. Troubleshooting

The front panel LEDs are very useful in quickly determining the current condition of the FGR-115MB. The table below shows the most common conditions.

Condition	Master			Slave		
	CD	TR	CTS	CD	TR	CTS
Powered and connected	SG	SR	SR	SG	SR	SR
Powered and connected, weak link	SG	SR	IF	SG	SR	IF
Powered, disconnected	SR	SR	SR	SR	O	BR
Powered and connected but on different Freq Keys	SG/ SR (altern ating)	SR (on and off)	IF	SG	IF	SR
Setup Mode	SG	SG	SG	SG	SG	SG

Legend:

BR	Blinking Red
IF	Intermittent Flash Red
O	Off
SG	Solid Green
SR	Solid Red, Bright

Symptom	Possible Cause	Solution
Radio is not linked, CD LED is red.	Radio on other end of link is not powered	Apply power to other radio
	Radio on other end of link in setup mode	Check that other radio is not in setup mode.
	Incorrect programming	Recheck programming
	Obstructions blocking signal path	Relocate antennas to provide clearer radio path or consider using a repeater.
	Excessive interference	Turn on High Noise feature in Radio Parameters Menu.
	Excessive interference	Install EBF900 bandpass filter
Radio is linked but no communications between Mirrored Bit devices	Incorrect baud rate or comm. Port settings	Recheck that baud rate settings on Mirrored Bit devices match baud rate setting on radios. Verify that Mirrored Bit devices are set to 9600 or 38400 bps and MB8A protocol.
	Radio connected to wrong port on Mirrored Bit device	Make sure that radios are connected to correct port on Mirrored Bit device.
	Incorrect serial cable connection	Check that radios are connected to Mirrored Bit devices with straight through RS-232 cable. If fiber optic transceiver is used, make sure that null modem adapter is used between radio and transceiver.
	If repeater is used, cable connection between repeater radios is incorrect	Connect serial ports on radios at repeater site with null modem cable.

Mirrored Bit communications log shows numerous errors	Local noise and interference Unavailability log is less than .001. See Figure 13 below	Check Unavailability Mirrored Bit device comm. Log. Noise and interference will cause numerous short-term errors but will not affect reliability of communications. Typical outage will last less than 10 ms. Unavailability will be less than .001.
	Excessive local interference, Unavailability log shows more than .001.	Check radio performance with point-to-point diagnostics program. Use High Noise feature or EBF900 filter or both. Check for noise sources in area.
	Failure log shows outages lasting longer than 50 ms	Check radio performance with point-to-point diagnostics program. Use High Noise feature or EBF900 filter or both. Check for noise sources in area. Relocate antennas to reduce interference or to increase signal strength. Change antenna polarization. Make sure distance between sites does not exceed maximum operating range of radios. Consider using a repeater.

Figure 13. SEL Communications Log.

```
STATION A

FID=SEL-351S-6-R110-V0-Z005005-D20021106        CID=66ED
Summary for Mirrored Bits channel A

For 10/20/03 21:17:40.045 to 10/21/03 15:30:25.776

    Total failures      2                  Last error  Parity error
    Relay Disabled      1
    Data error          0                  Longest Failure     0.008 sec.
    Re-Sync             0
    Underrun            0                  Unavailability  0.000000
    Overrun             0
    Parity error        1
    Framing error       0                  Loop-back      0
    Bad Re-Sync         0


    Failure                 Recovery
 #  Date      Time          Date      Time           Duration  Cause
 1  10/21/03  06:47:10.043  10/21/03  06:47:10.051     0.008   Parity error
 2  10/20/03  21:17:40.045  10/20/03  21:17:40.045     0.000   Relay Disabled

=>
```

Point-to-Point Diagnostics

The FreeWave Point-to-Point Diagnostics Program allows continuous monitoring of the performance of a Mirrored Bit link without disrupting the operation of the link. The program is included on the CD-ROM containing the FGR-115MB user manual and this addendum. The program may be run on either the Mirror Bit master or the Mirror Bit slave radio.

Locate the diagnostics program on the disk file and open the program. Connect the ASC0409DC Programming/Diagnostics cable between the Diag port of the FGR-115MB and the Comm Port on the computer. Select the Communication menu and click Open Comm if the comm. Port to be used is Comm 1. Otherwise, click on Chg Comm port to select a comm. Port other than Comm 1.
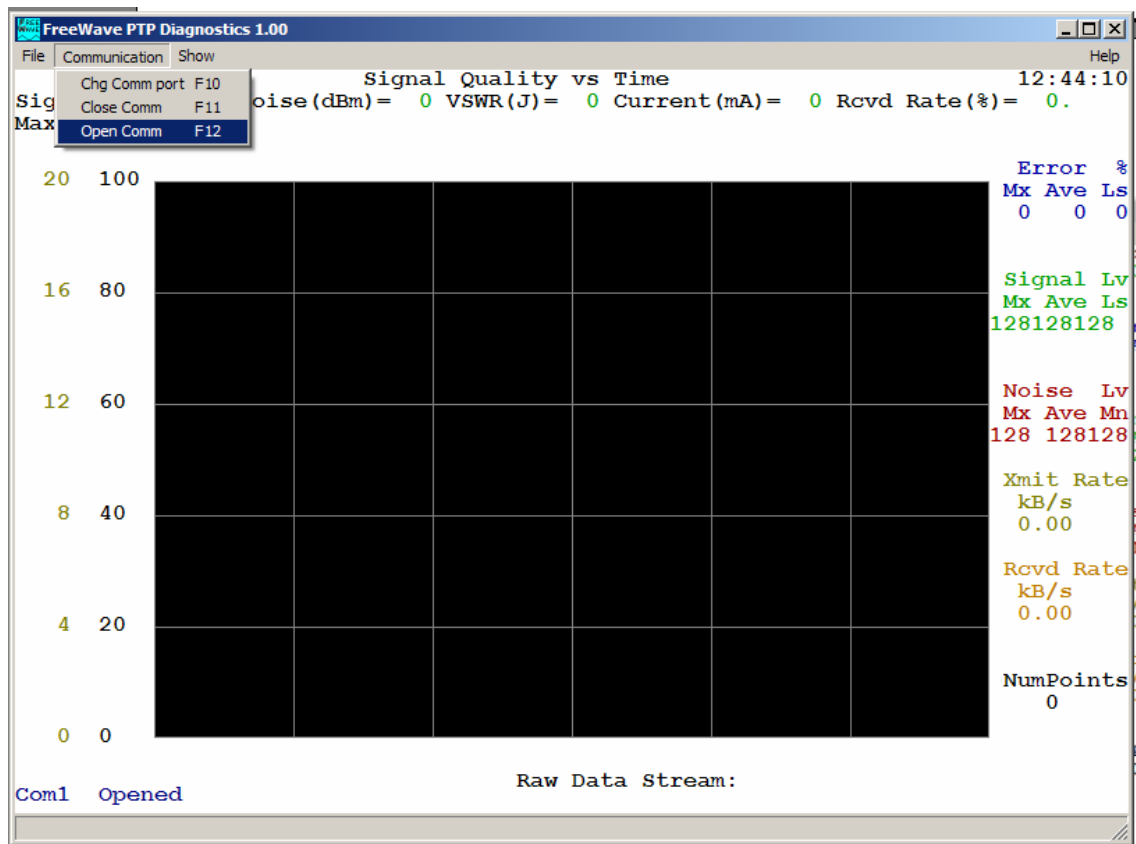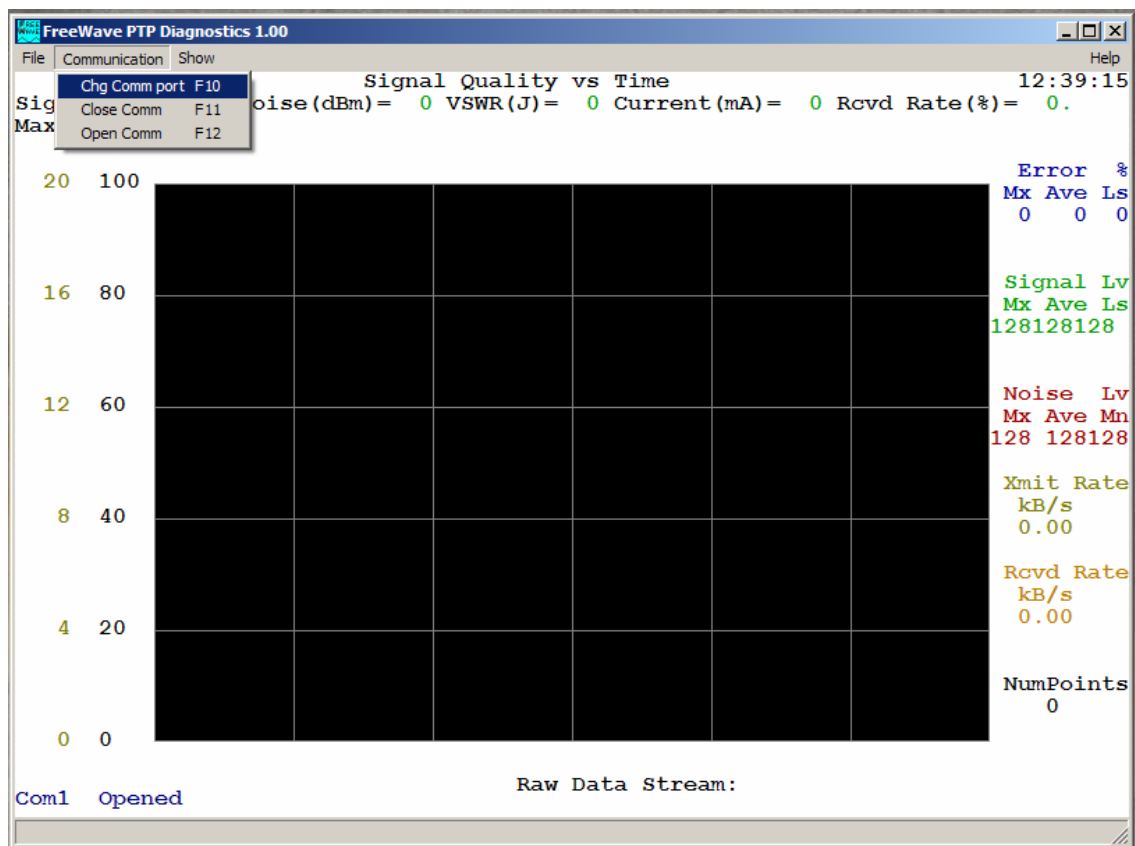
To change the comm. Port select Chg Comm port.

To start the program, select Open Comm.
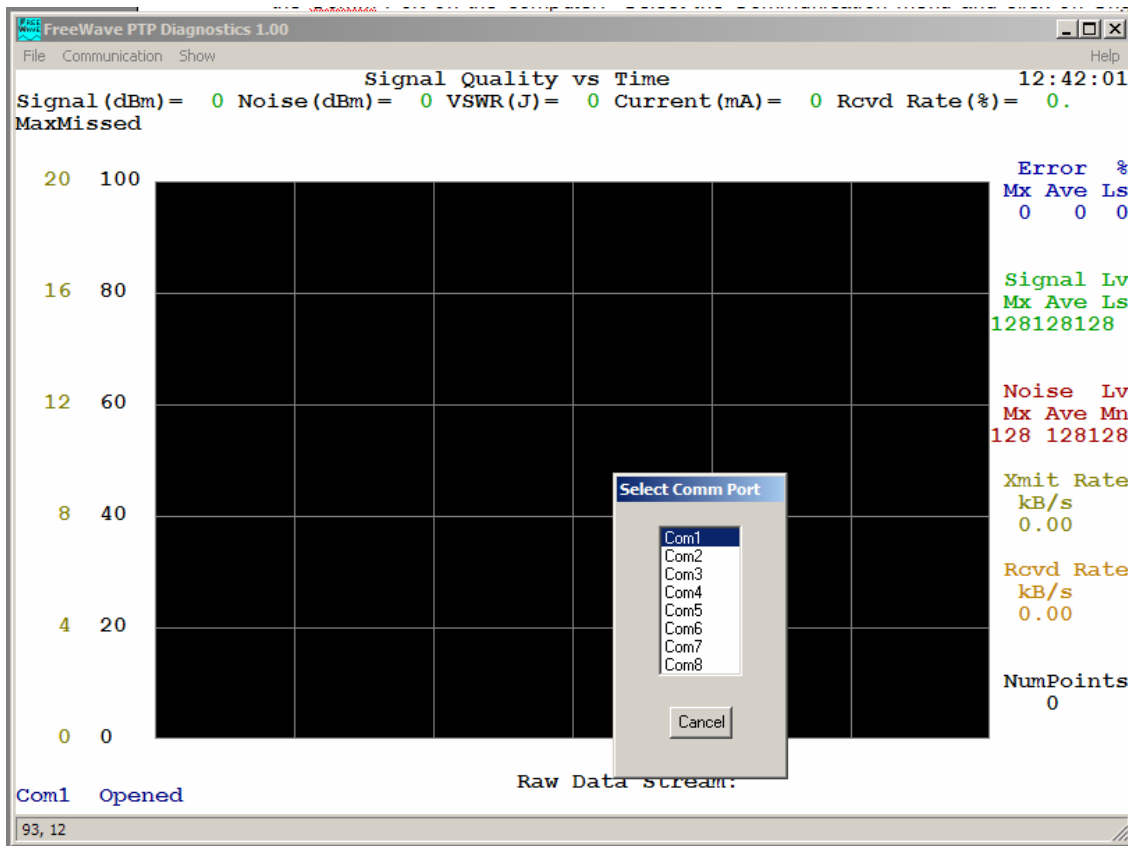
Select any comm. Port from 1 to 8.

The diagnostics program displays three screens of information. Navigation to each screen is done by entering the number of the screen, 1, 2, or 3.
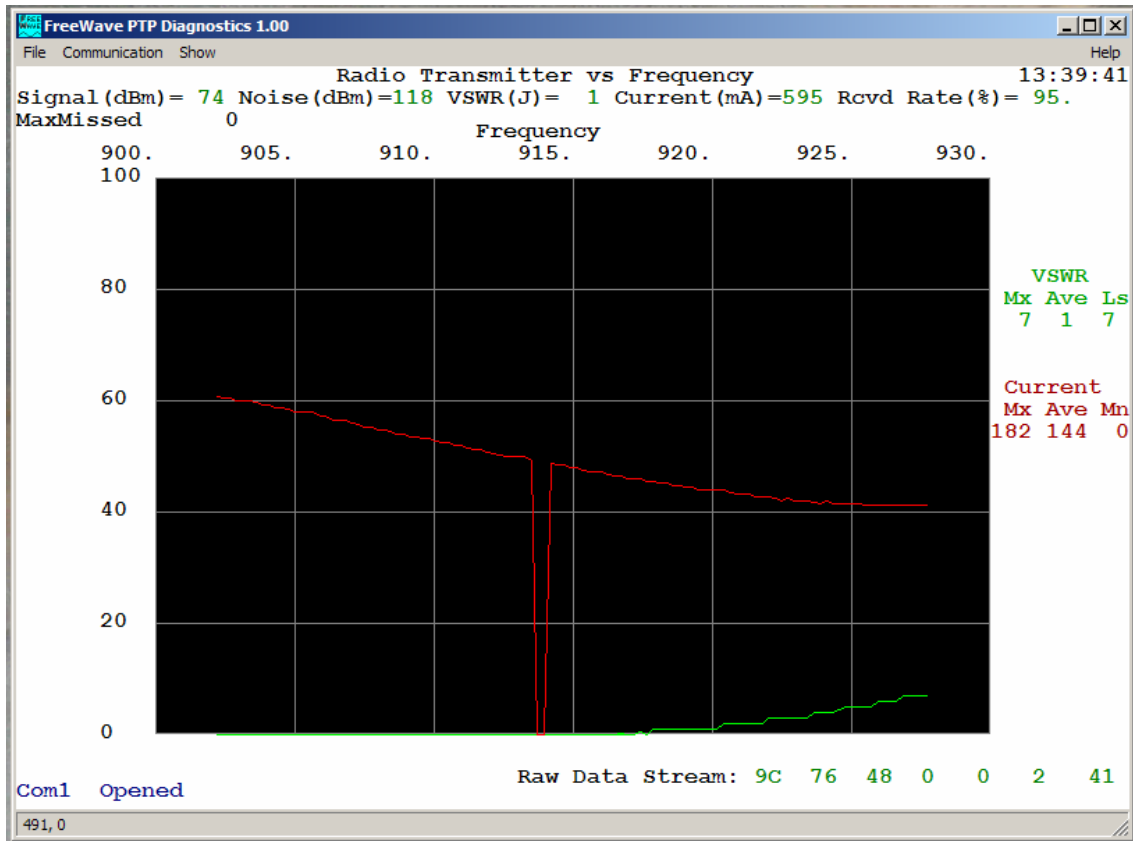
Diagnostics Screen 1

Screen 1 displays real-time graphs of antenna reflected power (VSWR) versus frequency (green line) and transmit current versus frequency (red line).

A reflected power indication of 20 or higher indicates a possibly defective antenna system.

The transmit current will vary with the radio's dc supply voltage. Typical values are 350 ma at 6 volts dc, 175 ma at 12 volts dc and 90 ma at 24 volts dc.

The dip in the middle of the graph represents frequencies on which data is not transmitted. For this reason, the displayed values at these frequencies are always displayed as zero and should be ignored.

Diagnostics Screen 1

Diagnostics Screen 2

Screen 2 displays real-time graphs of percent receive rate versus frequency (blue line), received signal level versus frequency (green line), noise level versus frequency (red line) and peak noise level versus frequency (yellow line).

For reliable Mirrored Bit operation, an average receive rate of 80% or higher is recommended. The receive rate is effected by received signal strength and by noise and interference.

The average signal level indicates how well that this radio hears the radio on the other end of the link. The values displayed are – dBm. A displayed value of 100 is higher than a value of 110. The program does not display the minus sign. For reliable Mirrored Bit operation, a level of 90 or higher is recommended.

The noise level is also displayed in –dBm. For reliable Mirrored Bit operation, a noise level at least 20 below the average signal level is recommended.

The peak noise trace captures and holds the transient noise that is detected by the radio. This provides an indication of interference sources in the area even if the interference is not steady state.

Diagnostics Screen 2
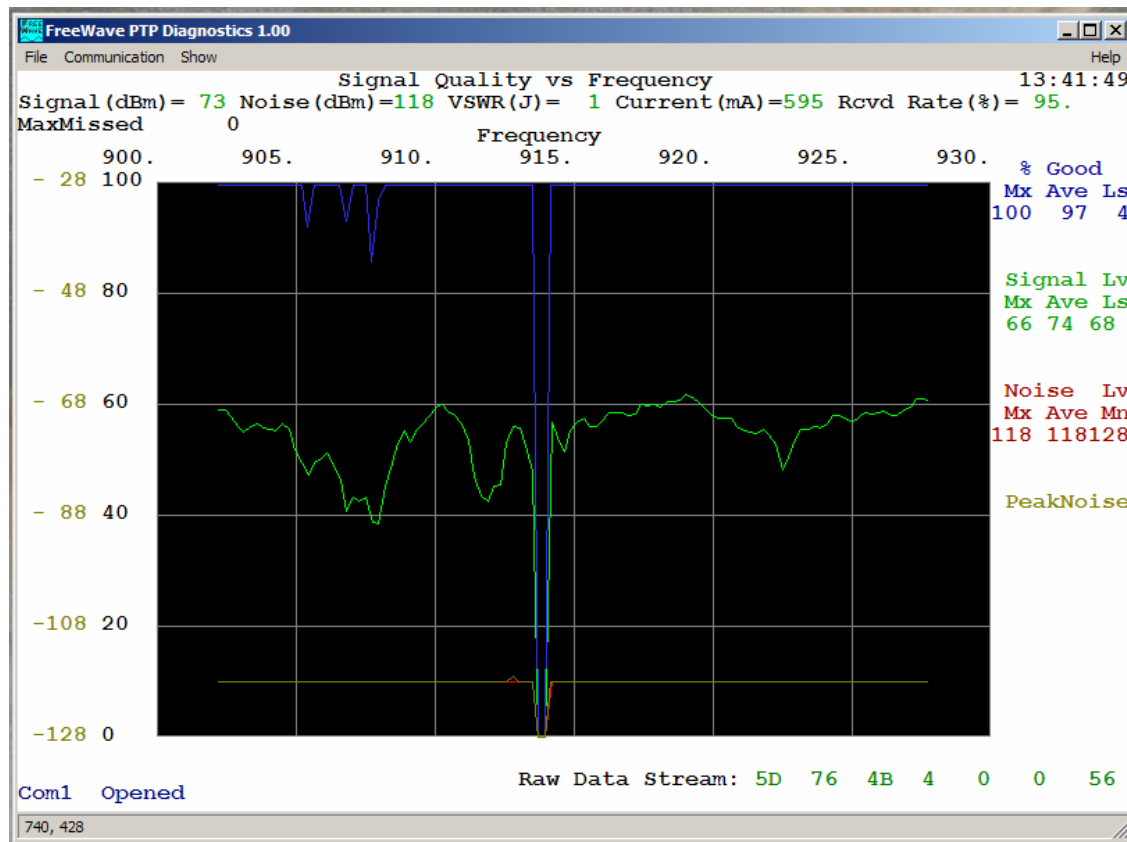
Diagnostics Screen 3

Screen 3 of the diagnostics program provides a continuous plot of radio link performance versus time. The time scale begins when the diagnostics program is started (time 0) and automatically rescales as the program runs with the most recent data on the left end of the plot.

Error % (blue line) records the percentage of bad packets that were received and discarded. This is the inverse of the percent good shown in screen 2.
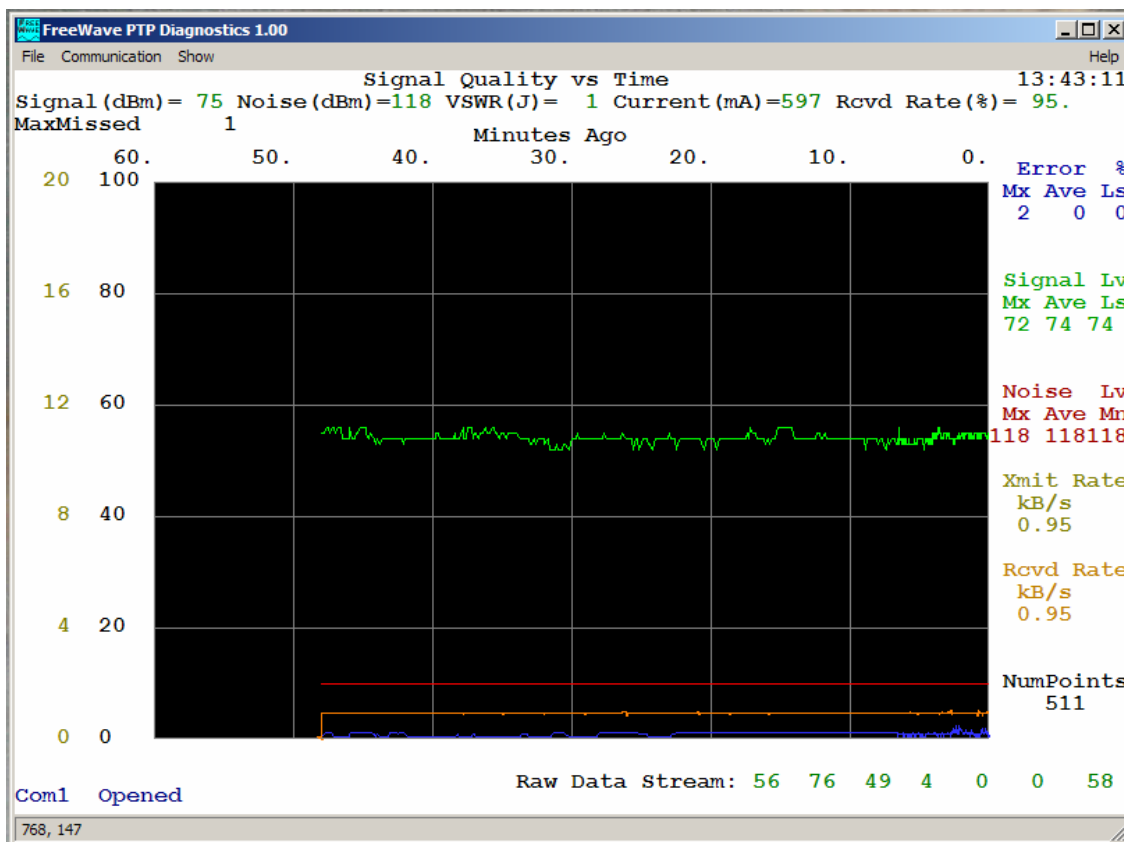
Signal Lv, (green line) is the received signal strength in –dBm.

Noise Lv, (red line) is the noise level at the radio's input in -dBm.

Xmit Rate, (brown line) is the transmitted data transfer speed in kB/sec.

Rcvd Rate, (orange line) is the received data transfer speed in kB/sec.

Diagnostics Screen 3

Contacting FreeWave

FreeWave Technologies
1880 S. Flatiron Ct.
Boulder, CO 80301
Phone: (800) 548-5616
Fax: (303) 786-9948
www.freewave.com

Technical Support Center hours 8 AM to 5 PM Mountain Time Monday through Friday.