FreeWave®
Spread Spectrum
Wireless Data Transceiver

User Manual

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Quick Start

This manual covers the operation of both the 900 MHz and 2.4 GHz spread spectrum transceivers manufactured by FreeWave Technologies. For the most part operation of the products is identical, where operating differences exist every effort has been made to clearly identify which product family is being referred to.

When purchased as a pair the FreeWave® Wireless Data Transceivers are shipped from the factory pre-configured to operate together in point-to-point applications. The Transceivers are preset for high speed data communications and to communicate only with each other.

FreeWave will potentially operate in virtually any environment where RS232 data communications occur. The transceiver functions as a 9 pin null modem cable. If FreeWave is to be used in an application where a null modem cable is used (such as communication between two computers), then FreeWave can be connected directly. If FreeWave is to be used to replace a straight-through RS232 cable, then a null modem cable must be placed between the transceiver and the DCE instrument to which it is connected.

To establish communications between a pair of FreeWave Wireless Data Transceivers just received from the factory:

1. Set the baud rate on each transceiver to match the baud rate of the instrument to which it is attached. Please note that when you are setting the transceiver's baud rate you are setting its RS232 data rate, which must match the rate for the instrument to which it is attached. This in turn means that the baud rate does not have to be on the same setting for the two transceivers.
2. Verify that the RS232 connector on the cable supplied will fit the RS232 interface on the instrument to which it is being connected. The cable supplied will fit a 9 pin male RS232 connector, any other format will need an adapter or different cable.
3. Screw the included whip antennas in the modem (DGR-115 model only), ensuring they are snug and properly seated. Any FreeWave transceiver may be operated without an antenna for benchtop testing without concern for damaging the product.
4. Connect the Transceiver to the instrument with the RS232 cable and attach the power adapter to the Transceiver. Shortly after both modems are plugged in they should establish a communications link with each other and your connection is complete!

Note: *The terms Modem and Transceiver are used interchangeably in this manual and in the text of the setup menu. While the words have different meanings, the two terms should be treated as one and the same for the purposes of use of the FreeWave product.*

Tuning Transceiver Performance

FreeWave allows you to tune several parameters to optimize its performance for your particular application. All adjustments are done through the FreeWave setup program, a user interface which eliminates the need for setup diskettes, DIP switch settings, or custom software.

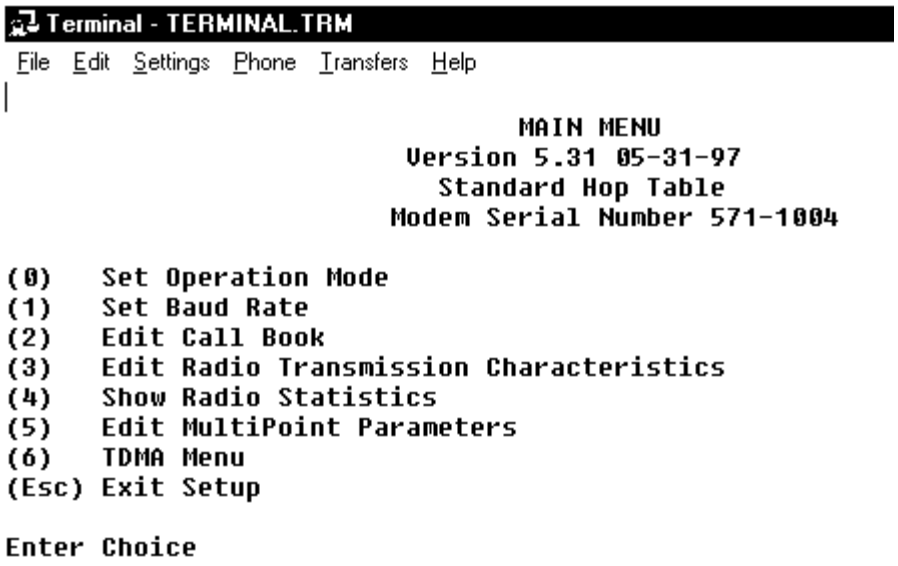
The setup program is invoked by connecting FreeWave to any terminal program, setting the baud rate for that terminal to 19200 baud, and putting the transceiver into setup mode (on most models this is done by pressing the Setup button). While any terminal which can be set to 19200 baud will work, examples for this manual were generated using the Terminal application from Microsoft Windows 3.1 or Hyperterminal.

Table 1: Setup Menu Terminal Settings

Parameter	Setting
Baud Rate	19200
Data Bits	8
Parity	None
Stop Bits	1
Parity Check	None / Off
Carrier Detect	None / Off

When the setup program is invoked all three LEDs on the FreeWave front panel will turn green and will remain green for the entire time the Transceiver is in setup mode. The main menu screen for the setup program is shown in Figure 1:

Figure 1: **Initial Menu**



The initial menu provides the Transceiver's unique serial number and the set of choices for editing the operational parameters and viewing the performance data.

(0) Set Operation Mode

When item (0) is selected the Operation Mode Menu appears as shown in figure 2. The Operation Mode option is used to designate the method in which the particular FreeWave Transceiver will be used. FreeWave operates in a Master to Slave configuration; therefore, any Transceivers which are intended to operate together must be set up as such. In a point-to-point setup, either the master or slave may be used on either end of the communications link without any performance degradation. One consideration when setting up the Transceivers is that a number of parameters are controlled by the settings in the master; therefore, you may wish to deploy the master on the communications end where you will have easier access to the transceiver.

Figure 2: FreeWave Operation Mode Menu

```
                                MAIN MENU
                          Version 5.31 05-31-97
                            Standard Hop Table
                         Modem Serial Number 571-1004

(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
(Esc) Exit Setup

Enter Choice
                                SET MODEM MODE
                         Modem Mode is   6

(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
(Esc) Exit to Main Menu

Enter Choice
```

Operation Mode Selections

(0) Point-to-Point Master
As mentioned previously, FreeWave operates in a Master/Slave configuration. When designated as a master in point-to-point mode the Transceiver, will call any or all slaves it is instructed to call in the call book. The master determines the settings used for all Radio Transmission Characteristics, regardless of the settings in the slaves and/or repeaters. A quick method of identifying a master is to power up the Transceiver. Prior to establishing a communication link with a slave or repeater all three of the master's LEDs will be solid red.

(1) Point-to-Point Slave
When set up as a slave a FreeWave Transceiver will communicate with any master in its call book, either directly or through one or two repeaters. When functioning as a slave, the Entry to Call feature in the Transceiver's call book (Figure 5) is not operational. The slave will communicate with any master on the list that calls.

(2) Point-to-Multipoint Master

The FreeWave Transceiver may be set to run in Multipoint mode, which allows one master to simultaneously be in communication with numerous slaves. A Point-to-Multipoint Master will communicate only with other transceivers designated as Point-to-Multipoint Slaves or Point-to-Multipoint Repeaters.

Please refer to the next chapter 'Multipoint Operation', for more information on running a Multipoint network.

(3) Point-to-Multipoint Slave

Setting (3) allows the transceiver to operate as a slave in a Multipoint network.

Please refer to the next chapter - 'Multipoint Operation' for more information on running a Multipoint network.

(4) Point-to-Point Slave/Repeater
Option 4 allows you to designate the transceiver to act as either a slave or a repeater, depending upon the instructions received from the master for the specific communications session. When a transceiver is placed in an ideal location, this setting offers the flexibility of using that transceiver as an end point in the communication link (slave) or to extend the link to a point further (repeater). These functions are not, however, available simultaneously (the transceiver cannot act as both a slave and a repeater at the same time).

A word of caution: A transceiver designated as a repeater has no security features, as explained below. When a transceiver is designated as a Point-to-Point Slave/Repeater, it will allow any master to use it as a repeater.

(5) Point-to-Point Repeater
FreeWave allows the use of up to two repeaters in a communications link, significantly extending the operating range. When designated as a repeater a

Transceiver behaves as a pass-through link. All settings for the call book, baud rate, and radio transmission characteristics are disabled. A repeater will connect with any master which calls it (the repeater must still be set up in the master's call book).

The use of one repeater in a communications link will reduce the top data throughput available when compared to a direct master to slave link (generally on the order of 50%). This impact is generally noticed only when using the Transceivers at 115.2 KBaud. The throughput does not decrease further if two repeaters are used.

(6) Point-to-Point Slave/Master Switchable

Mode 6 is a versatile option which allows the transceiver to be controlled entirely through software commands. When in mode 6, a number of key parameters in FreeWave's user interface may be changed either directly (as if using the Windows Terminal program) or through the use of script files. In addition, when the transceiver is in mode 6 and not calling a slave it will be a slave itself and accept any appropriate calls from other transceivers.

In mode 6:

- The transceiver remains in slave mode until called by another Transceiver in its Call Book or instructed to call another transceiver through an ATDT command. The master will disconnect when DTR goes low.
- The user may change settings in the user interface without using the setup button (this may be of particular value if the transceiver is not in an easily accessible location).
- Predetermined script files may be used which allow any of the Transceiver's settings to be changed upon execution of that file. This, in turn, allows the user to establish push button command sets which will instruct the Transceiver to call a predetermined slave.

***Note**: All AT commands issued to the transceiver in Mode 6 must be in ALL CAPS.*

Table 2: AT Script File Commands

Script File Command	Function Controlled
ATXF_	Frequency Key
ATXT_	Max Packet Size
ATXD_	Min Packet Size
ATXX_	Transmit Rate
ATXR_	RF Data Rate
ATXP_	RF Transmit Power
ATDT_	Position in Call Book to Call
ATD_	Allows specific FreeWave Serial Number to be entered to call
ATXC_	Used in conjunction with the ATD command, instructs transceivers which repeater path to follow
ATXS	Instructs Transceiver to go into Setup Mode

Using Mode 6 to call a transceiver not listed in the Call Book

Mode 6 will accept the command ATD####### where ####### is any arbitrary modem serial number such as 5551234. Upon receipt of this command the modem will call that modem even though the number is not in the sending modem's Call Book. The modem will use the repeater(s) specified in the Call Book. This means it is now possible to call an unlimited number of slaves through script files in mode 6 and have up to 10 different repeater combinations.

To use the new features the following steps should be followed:

1. If one or two repeaters are to be used they must first be set up in the Call Book. This would be done by setting up a number to call (this may be a dummy number) through the repeater(s) which you wish to use.

2. Issue the command ATXC# where # corresponds to the position in the Call Book where the repeater(s) is/are located.

3. Issue the command ATD####### where ####### is the serial number of the transceiver with which you are attempting a link. The transceiver will link first to the repeater(s) specified and then to the slave transceiver.

4. If you wish to link to a different slave, this time without using a repeater, it is imperative that you reissue the ATXC# command, with # being either a position in the Call Book that contains no repeaters or the letter A. When the command ATXCA is issued the modem is instructed to Call All and no repeaters are used.

The Slave security may be disabled so that a modem operating as a slave (Modes 1,4, and 6) will connect to any modem calling it regardless of whether the calling modem is in the slave's Call Book. This feature is necessary when there are more than 10 transceivers which may call into a slave and will allow any of the units in the system to call in. An entry exists in the Edit Radio Characteristics Menu so that this feature can be enabled or disabled.

(7) Point-to-Multipoint Repeater

Setting (7) allows the transceiver to operate as a repeater in a Multipoint network.

Please refer to the next chapter, 'Multipoint Operation', for more information on running a Multipoint network.

Multipoint Operation

In a Multipoint system a transceiver designated as a master is able to simultaneously be in communication with numerous slaves. In its simplest form, a Multipoint network functions with the master broadcasting its messages to all slaves and slaves responding to the master as appropriate.

Traditionally, a Multipoint network is used in applications where data is collected from many instruments and reported back to one central site. As such, the architecture of such a system is completely different from point-to-point applications. The theoretical maximum number of slaves that can be configured into a Multipoint network is a function of the data throughput needed from each of the slaves. For example, if the network will be polling slaves once a day to retrieve sparse data, several hundred slaves could be configured to a single master. If, on the other hand, each slave will be transmitting data at greater levels then fewer slaves may be connected to the master (the overall system will be closer to capacity with fewer slaves). The theoretical limit of a Multipoint system is influenced by the following parameters:

1. Size of the blocks of data. The longer the data blocks the smaller the system capacity.
2. RS232 baud rate.
3. The amount of contention between slaves.
4. Use of repeaters. A single repeater in a Multipoint network will decrease overall system capacity by 50%; more than one repeater does not further decrease network capacity.

Setting Multipoint Parameters

(0) Number Repeaters

In a Multipoint network it is critical for timing purposes to know whether or not there are repeaters in the network. Any transceiver that is used as a repeater essentially becomes a master to the slaves and other repeaters to which it is communicating. Therefore, the user must identify whether or not the network contains repeaters. This is done by assigning a value in parameter (0), Number Repeaters. The value should be 0 if there are no repeaters in the network and 1 if repeaters are present. This parameter does not need to be set in the slaves in a Multipoint system.

(1) Master Packet Repeat

In point-to-point operation the FreeWave transceivers acknowledge every data packet transmitted. In a Multipoint network, transmissions from a master to the slaves are not acknowledged by the slaves. This is to prevent system overload. If the slaves acknowledged all data transmissions from the master in a large Multipoint system, then all system capacity would be spent having the master listen for acknowledgments from the slaves. Because the transmission is not acknowledged by the slaves 100% confidence does not exist that every slave has received every message from the master. To address this issue the user may modify option (1) Master Packet Repeat, assigning a value between 0 (the packet is transmitted once) to 9 (the packet is repeated 9 times). For networks with solid RF links, this parameter would be set at the lower end of the scale (0-1). If the

network has some weak or marginal links it would be set toward the higher values. If a slave receives a packet from a master more than once it will discard the repeated packets received.

(2) Max Slave Retry

(3) Retry Odds

While packets transmitted from the master to the slaves in a Multipoint network are not acknowledged, packets transmitted from slaves to the master are. However, it is possible that more than one slave will attempt to transmit to the master at the same time, and it is therefore important that a protocol exists to resolve contention for the master between slaves. This is addressed through parameters (2) Max Slave Retry and (3) Retry Odds. The Max Slave Retry setting defines how many times (0 to 9) the slave will attempt to retransmit a packet to the master before beginning to use a back-off algorithm. Once the slave has unsuccessfully attempted to transmit the packet the number of times specified in Max Slave Retry it will attempt to transmit to the master on a random basis. The Retry Odds parameter determines the probability that the slave will attempt to retransmit the packet to the master; a low setting will assign low odds to the slave attempting to transmit and conversely a high setting will assign high odds. An example of how this parameter might be used would be when considering two different slaves in a Multipoint network, one close in with a strong RF link and the other far from the master with a weak link. It may be desirable to assign a higher Retry Odd to the slave with the weaker link to give it a better chance of competing with the closer slave for the master's attention.

(4) DTR Connect

Another parameter in a Multipoint network is (4) DTR Connect. When set at 1 the slave will connect to the master if it is free when the DTR line goes high on the 9 pin RS232 connector. In setting 2 the transceiver will accumulate data in its buffer and transmit in a burst when the buffer is full. This mode is valuable when a network has many low data rate devices and it is desirable to increase overall network capacity. In setting 0 the transceiver will transmit when RS232 data is received.

(5) Repeater Frequency

The repeater's hopping pattern must also be set in a Multipoint network; this is accomplished with parameter (5) Repeater Frequency. Setting this parameter is in contrast with point-to-point mode where the repeater automatically uses the master's hopping pattern. The repeater may be programmed to either use the master's hopping pattern (selection 0) or its own (selection 1).

(6) NetWork ID

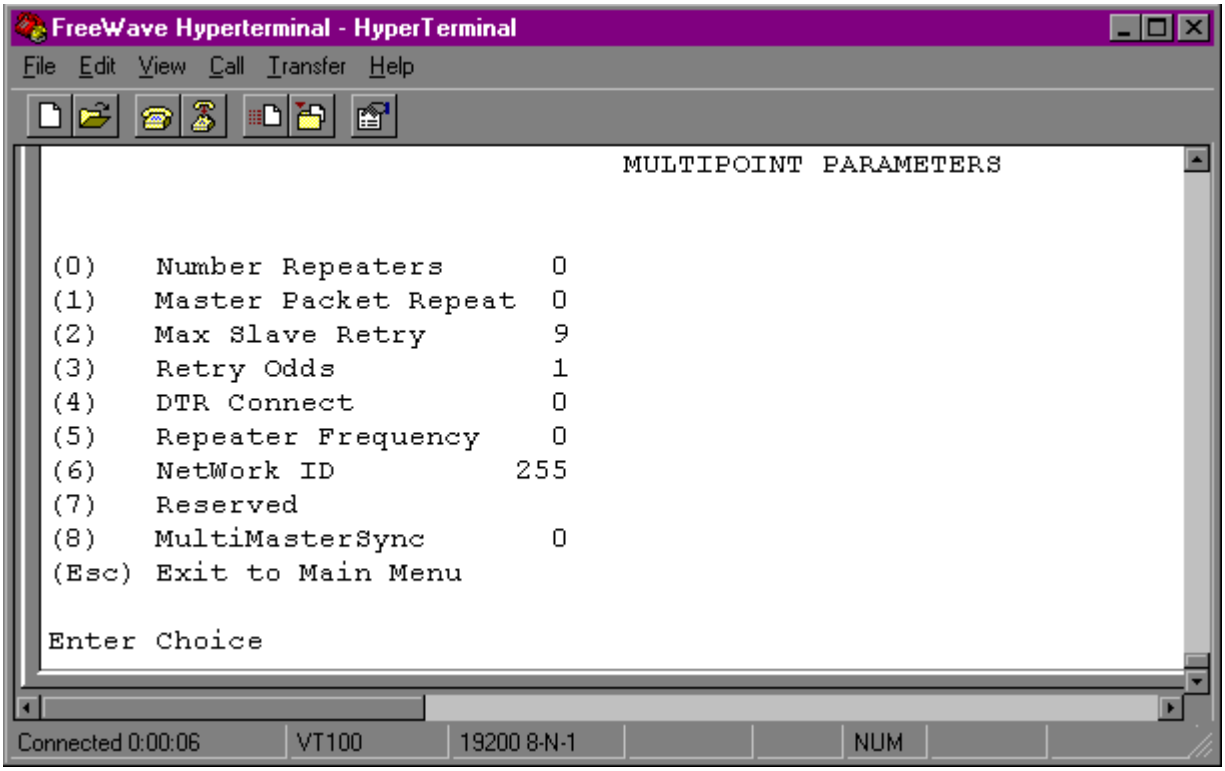
Option (6) NetWork ID allows multipoint networks to be established without the use of the Call Book. If the NetWork ID is set to any value lower than the default (255) the slaves in the multipoint network will communicate with the first

multipoint master or repeater heard with the same NetWork ID. When the NetWork ID is used multipoint masters and repeaters may be replaced without reprogramming all of the slaves in the network. In addition, this allows a slave to establish communications with different Masters (though not at the same time) without having the serial numbers in the Call Book. This is very useful in mobile multipoint applications.

(8) MultiMaster Synch

(8) MultiMaster Synch is reserved for applications (either point to point or multipoint) with concentrations of Master units where it is necessary to reduce interference between the Masters. Please contact FreeWave Technologies for more information.

Figure 3: Multipoint Parameters



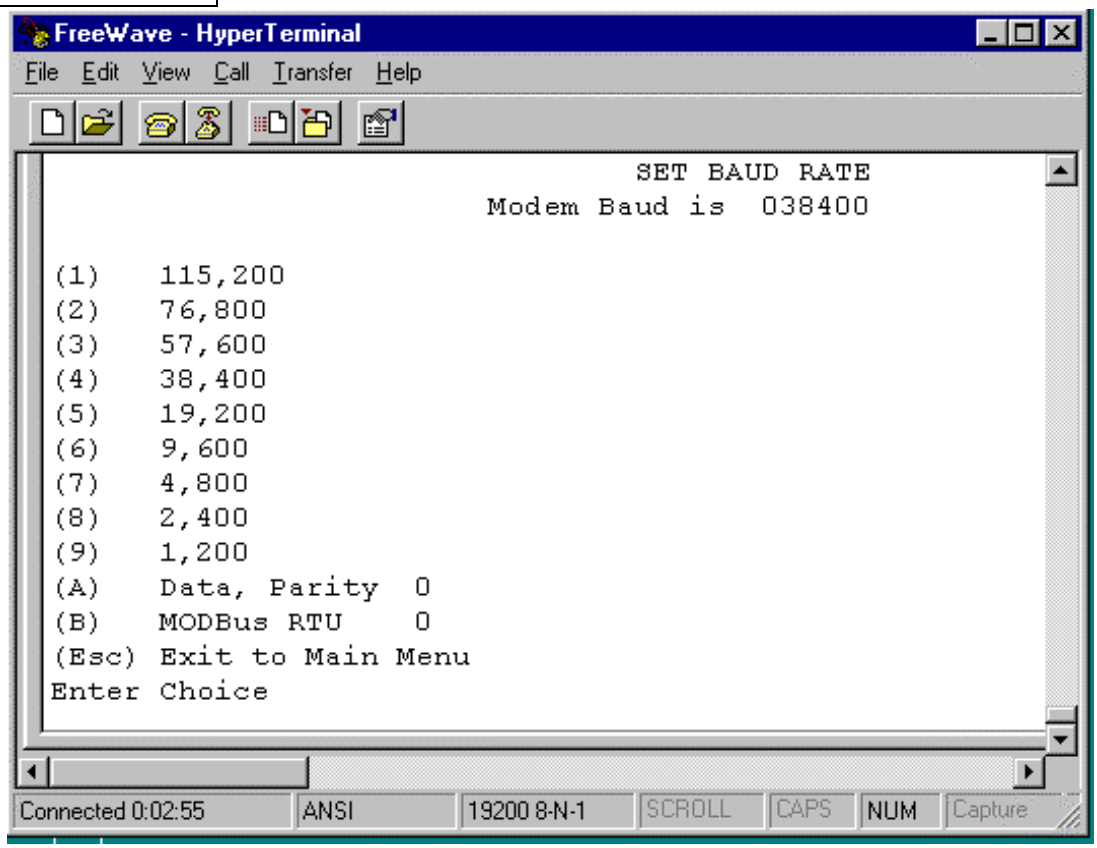
Baud Rate Selections

(1) Set Baud Rate

When item (1) is selected you will be able to change the Transceiver's RS232 baud rate - the communication rate between the Transceiver and the instrument to which it is connected. It is important to note that this is independent of the baud rate for the other Transceiver(s) in the communication loop. For example, FreeWave may be used in an application to send data from remote process instrumentation to an engineer's computer. In this application the baud rate for the Transceiver on the instrumentation might be set to 9600, and the Transceiver on the computer might be set to 57,600 or 115,200.

In general, it is desirable to set the baud rate to the highest level supported by the device to which it is connected. However, please note that this may actually result in slower data communications in certain circumstances (see the Troubleshooting section).

Figure 4: Baud Rate, Word Length, & Modbus



The Baud Rate section of the user interface provides two other important parameters, the ability to change the transceiver's word length and to put it into ModBus RTU mode.

(2) Data Word Length and Parity

There are six data word length and parity configurations available to be used with FreeWave transceivers. The default setting is **0** (8,N,1) and is the most commonly used serial communications protocol.

Data word length and parity selections available:

Table 3: Data Word Length and Parity Selections

Menu Setting	Data Bits	Parity	Stop Bits
0	8	None	1
1	7	Even	1
2	7	Odd	1
3	8	None	2
4	8	Even	1
5	8	Odd	1

(3) ModBus RTU

Support for ModBus RTU protocol is available. The default setting for ModBus RTU is **0** (not enabled).

To enable the ModBus RTU mode:

1. In the **Set Baud Rate** menu enter **(B)** and then select **1**

2. In the **Set Multi Point Parameters** menu, set **Master Packet Repeat** to **3**.

***Note**: When using the transceivers in ModBus RTU mode the Master Packet Repeat must be set to 3 regardless of whether the transceivers are being used in Point to Point or Multipoint mode.*

Call Book Selections

(2) Edit Call Book

The Call Book is an innovative feature in FreeWave which offers both security and flexibility in use. The Call Book accomplishes this by allowing the user to determine with which other FreeWave Transceivers a given Transceiver will communicate, based on the serial numbers for both the master and slave. The transceiver's serial number is encoded in the microprocessor and identified on the bottom label of the unit. The instructions provided in this section are for point-to-point mode only. Use of the Call Book for Multipoint systems is explained later in this chapter.

For two FreeWave Transceivers to communicate in point-to-point mode, three events must occur:

1. The serial number for the master must be listed in the slave's Call Book.
2. The serial number for the slave must be listed in the master's Call Book.
3. The master must be programmed to call the slave.

As shown in figure 5, the Call Book allows users to set up a list of up to 10 FreeWave Transceivers with whom they can communicate, designate up to 2 repeaters to be used in communicating with a given transceiver, and tell the master which slave to call. To direct the master to call a slave the user must be in the Call Book Menu. A specific slave may be called by entering C at the prompt, followed by the menu number corresponding to that slave. To call any available slave in the list the user should enter C and then A (for All).

Note: *To call a slave through one or two repeaters you must call that slave directly (as opposed to using the Call All option). When Call All is selected the master is not able to connect with any slaves through repeaters. This is because the master calls every slave in the list when instructed to call all and will connect with the first slave to respond. When calling through a repeater, the master must first call that repeater and establish a communications link with it prior to making contact with the slave.*

Figure 5: Call Book Menu

```
                          Standard Hop Table
                       Modem Serial Number 571-1004

(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
(Esc) Exit Setup

Enter Choice
                                    MODEM CALL BOOK
                                    Entry to Call is 00
Entry    Number     Repeater1    Repeater2
(0)     570-0432
(1)     565-1258     564-1102
(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
```

Entering or Modifying numbers in the Call Book

Entering or modifying serial numbers in the Call Book is a straightforward process. When in the Call Book menu enter the position number (0 - 9) you wish to edit. You will be prompted for the new number (formatting is automatic, you do not need to enter the dash). Once the number is entered (unless it is 000-0000) you will be asked for the number for the repeaters to be used. If no repeaters are to be used then enter the escape key; your entry will be complete and you will be back in the Call Book menu screen. If you enter a repeater number you will then be prompted for the number of the second repeater to use. If a second repeater is being used then enter the number at this time, if not then enter the escape key. Once again the modem will retain your entries, as shown in the updated Call Book menu screen.

Important: It is important that the Call Book slots (0 - 9) are filled sequentially beginning with 0, the first slot in the book. Serial numbers do not need to be entered in numerical order, however, there must not be any 000-0000 numbers in the middle of the list of good serial numbers. The reason for this is that when a

master is instructed to Call All available slaves it will call all slaves listed until it reaches the first phone number of 000-0000. If a valid serial number is entered after the all zero number it will not be recognized as a valid number to call by the master.

Programming The Call Book in Multipoint Systems

In a Multipoint system the slaves and repeaters are not listed in the master's Call Book. When establishing such a system, it is necessary only to have the master's serial number in each slave's and repeater's Call Book, and to have each repeater's serial number in the Call Book of each slave which may potentially communicate through it.

The following example shows the Call Books of a multipoint system comprised of a master, repeater, and slave in which the slave can communicate either through the repeater or directly to the master:

Multipoint Master Call Book (Unit Serial Number 555-0001)

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

No serial number entries are necessary in the master's Call Book
The master's Call Book may be programmed to call any entry

Multipoint Repeater Call Book (Unit Serial Number 555-0002)

Entry	Number	Repeater1	Repeater2
(0)	555-0001		
(1)	000-0000		

Multipoint Slave Call Book (Unit Serial Number 555-0003)

Entry	Number	Repeater1	Repeater2
(0)	555-0001		
(1)	555-0002		
(2)	000-0000		

At times it may be desirable to force a slave to go through a specific multipoint repeater. If this is the case that slave's Call Book should contain only the serial number for the repeater in the upper left hand corner.

Note: *If the network ID option is used no entries are needed in the Call Book of any of the transceivers in a multipoint system.*

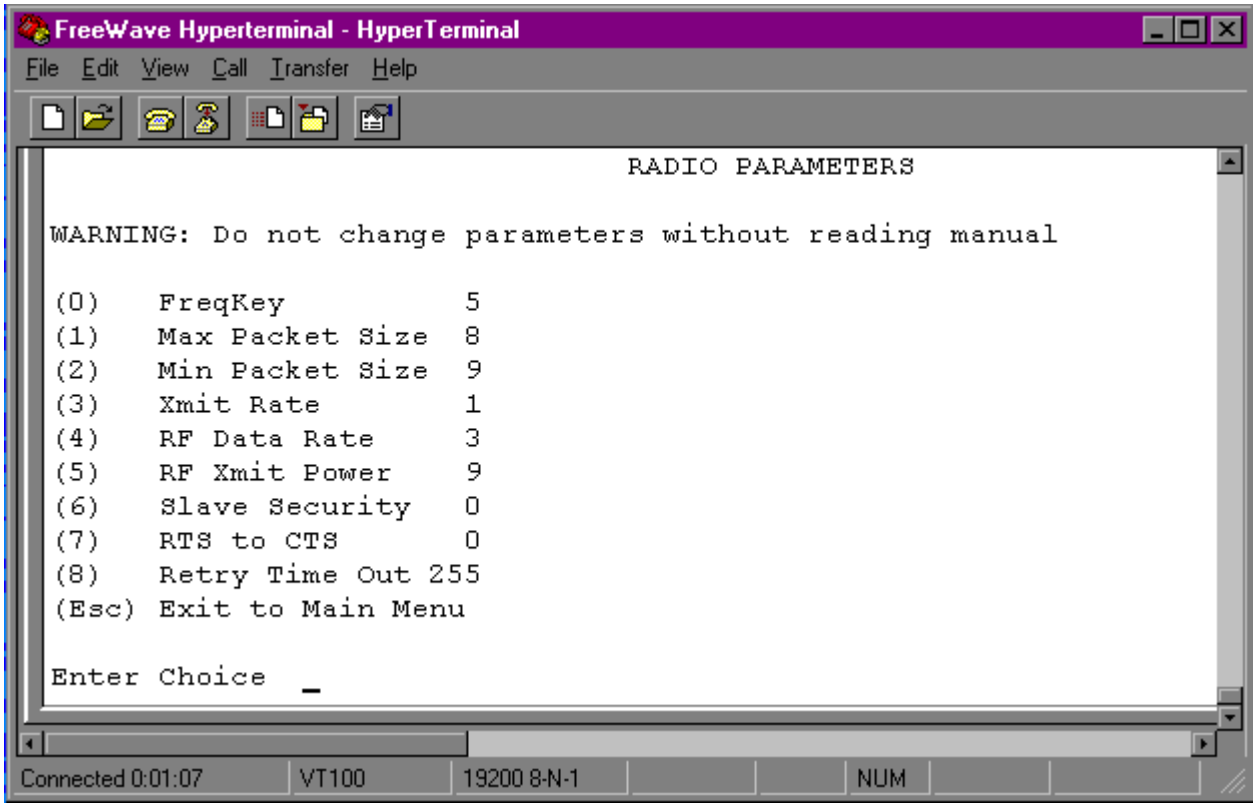
Radio Transmission Parameters

(3) Edit Radio Transmission Characteristics

When item (3) is selected in the main menu the screen in figure 6 appears, which allows the user to modify the radio transmission characteristics of the Transceivers. As stated in the warning, these parameters are for the sophisticated user who has a good understanding of the principles of radio data transmission. They should be changed only after consulting this manual.

In a point to point mode the radio parameters set in the Master will override the settings for the slave and repeater(s) in the link for all but RF Xmit Power, Slave Security, and Retry Time Out.

Figure 6: Radio Parameters Menu



(0) FreqKey

900MHz

Selection (0) in the Radio Parameters menu allows the user to modify the hopping patterns of the Transceivers to minimize the interference with other FreeWave Transceivers in operation in the area. For instance, if there were 10 pairs of FreeWave transceivers in operation within a factory or refinery, changing the Frequency Key would ensure that they would not jump onto the same frequencies at the same time for the same length of time.

There are 15 choices available for the Frequency Key (0-9 and A-E), representing 15 different pseudo-random patterns.

2.4GHz

The Frequency Key for the FreeWave Technologies 2.4GHz transceivers offers the ability to select more than just a different pseudo random hop table, but also the portion of the band which the transceiver will use. Because this feature offers the ability to select which portion of the spectrum will be used it is critical that all radios in a link, whether point to point or point to multipoint, use the same selections.

Frequency Key

Selections 0-E provide 15 different pseudo random hop tables, similar to the 900 MHz transceiver.

Selection F allows the user to set the Hop Table parameters. The user is then presented with 3 additional choices

Selection 0 allows the user to determine which portion of the band to use:

Table 4: 2.4 GHz Frequency Band Selections Available

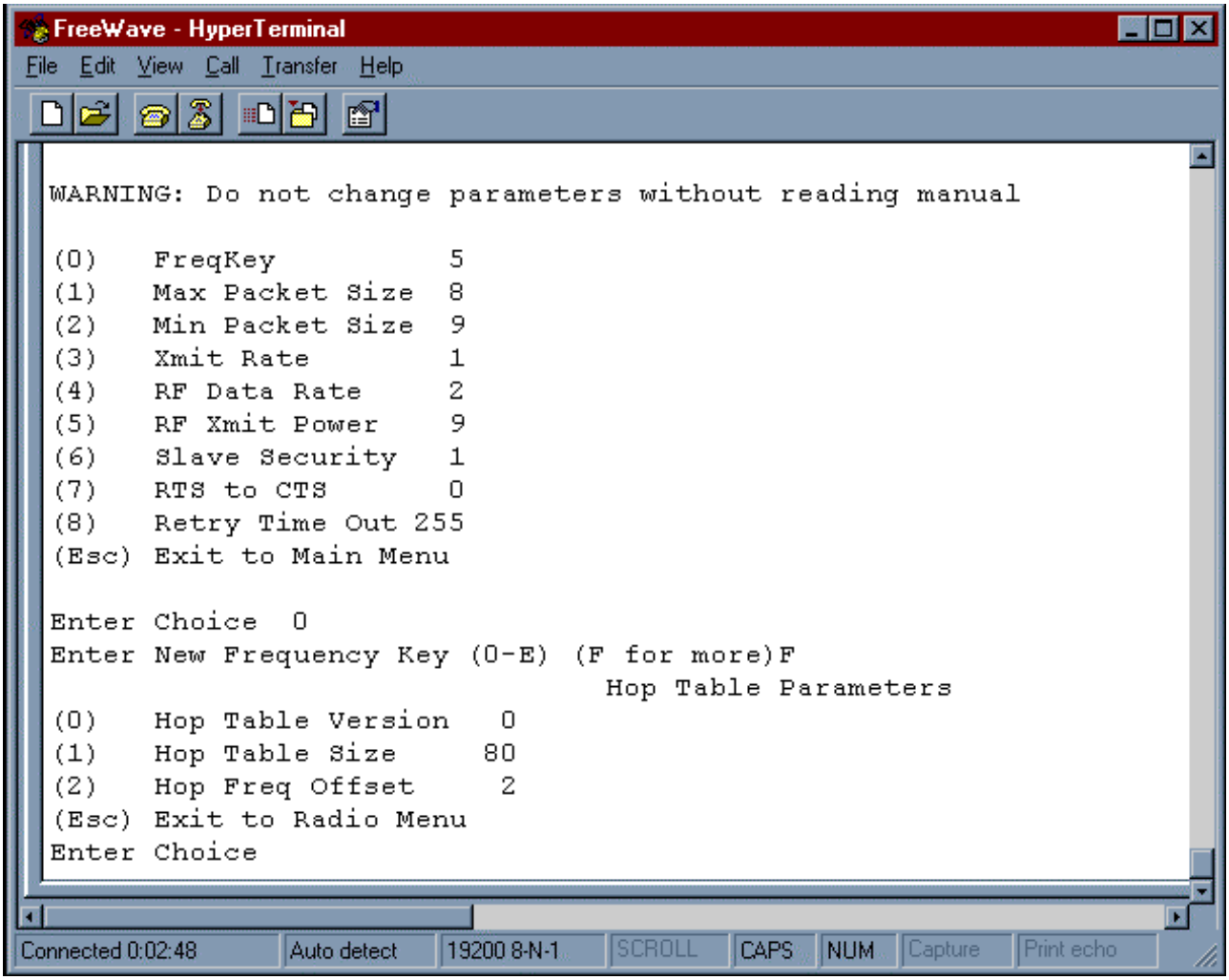
Selection	Band Use
0	Entire band, 2.400 - 2.4835 GHz
1	Entire band, but offset frequencies from selection 0
2	Lower 1/3rd of band
3	Middle of band
4	Upper 1/3rd of band
5	2 outer 1/3rds of band, avoids the middle

Thus, 2 networks could be set up side by side using the entire band without collisions by setting one network up with selection 0 and the second network with selection 1.

Selection 1 allows the user to set the size (number of frequencies) of the hop table to use. The range available is from a minimum of 50 to a maximum of 80.

Selection 2 allows the user to select a frequency offset, whereby the frequencies used are offset by 115.2 KHz from other frequency selections in the same portion of the band. For example, if 2 networks are operating side by side in the lower 1/3rd of the band using 50 frequencies, with one set to Frequency Offset of 0 and the other to Frequency Offset of 1, the frequencies used in the different hopping patterns will be offset by 115.2 KHz

Figure 7: Frequency Key & Hop Table Options, 2.4 Ghz



(1) Max Packet Size and (2) Min Packet Size

Selections (1) and (2) allow the user to designate the size of the packets (in bytes) used by the transceiver in its communication link. This may be of particular value when using FreeWave with different communications software packages; you may find that throughput is optimized when packet sizes are restricted by the transceiver. It should be noted, however, that in Point to Point modes the Max and Min Packet Settings will not have any material impact on throughput unless 115.2 KBaud is desired.

The combination of Max and Min Packet Size Settings determines the allocation of the communication link from the Master to the Slave and vice versa. With a given Max Packet Setting the master will transmit up to that number of bytes on every hop. If fewer than that number of bytes is transmitted the balance is allocated to the slave's transmission, in addition to the quantity in the Min Packet Size Setting.

Packet size is determined by a combination of the setting entered by the user and the RF Data Rate. Tables 5, 6, and 7 provide the packet sizes for each different combination of settings.

Table 5: Min Packet Size Settings (Bytes)

Setting	Min Packet Size RF Data Rate = 2	Setting	Min Packet Size RF Data Rate = 3
0	16	0	8
1	21	1	12
2	26	2	16
3	32	3	20
4	37	4	24
5	42	5	28
6	48	6	32
7	53	7	36
8	58	8	40
9	64	9	44

Table 6: Max Packet Size Settings (Bytes)
RF Data Rate = 2

	Max Setting									
Min Setting	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	15	36	58	79	100	121	143	164	185	206
1	20	42	63	84	105	127	148	169	190	212
2	26	47	68	90	111	132	153	175	196	217
3	31	52	74	95	116	137	159	180	201	222
4	36	58	79	100	121	143	164	185	206	228
5	42	63	84	105	127	148	169	190	212	233
6	47	68	90	111	132	153	175	196	217	238
7	52	74	95	116	137	159	180	201	222	244
8	58	79	100	121	143	164	185	206	228	249
9	63	84	95	127	148	169	190	212	233	254

Table 7: Max Packet Size Settings (Bytes)
RF Data Rate = 3

	Max Setting									
Min Setting	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	8	24	40	56	72	88	104	120	136	152
1	12	28	44	60	76	92	108	124	140	156
2	16	32	48	64	80	96	112	128	144	160
3	20	36	52	68	84	100	116	132	148	164
4	24	40	56	72	88	104	120	136	152	168
5	28	44	60	76	92	108	124	140	156	172
6	32	48	64	80	96	112	128	144	160	176
7	36	52	68	84	100	116	132	148	164	180
8	40	56	72	88	104	120	136	152	168	184
9	44	60	76	92	108	124	140	156	172	188

(3) Xmit Rate

There are two settings for the Transmit Rate parameter. For normal operation FreeWave should be set at Transmit Rate 1. Transmit Rate 0 is useful to qualitatively gauge signal strength. When set to Transmit Rate 0 the Transceivers will transmit data back and forth continuously, and the strength of the signal may be gauged by the Clear to Send LED. A solid red Clear to Send LED indicates a strong signal, the less the LED is on the weaker the signal.

Because the Transceivers transmit continuously when Transmit Rate is set to 0 (whether or not they have data to send) they use radio frequency spectrum unnecessarily. Therefore, Transmit Rate 0 should be used only as a diagnostic tool and not for normal operation.

(4) RF Data Rate

FreeWave has two settings for the RF Data Rate (not to be confused with the RS232 Baud Rate). Setting 2 should be used when the transceivers are close together and data throughput is to be optimized. Setting 2 must also be used when full throughput of 115.2 KBaud is necessary. Setting 3 should be used when the transceivers are farther away and a solid data link is preferred over data throughput.

Note: *When using the transceivers in Multipoint mode, the RF Data Rate setting must be identical for all units in the system. Any transceiver with a different RF Data Rate than the master will not establish a communication link.*

(5) RF Xmit Power

FreeWave offers users the ability to modify the Transmission Power of the Transceiver. By reducing the Transmission Power when appropriate, users can ensure the Transceivers do not overwhelm each other when used in close proximity. There are 9 power settings available (1-9) which are roughly linear, therefore a setting of 9 is full power or 1 Watt and 1 is ~10% power or 100 mW. The following guidelines should be followed when setting the RF Transmission Power:

Table 8: Power Transmit Settings

Setting	Power Level	Used When
1 - 3	Low	Pair or pairs of transceivers operating within same or adjoining rooms.
4 - 6	Medium	More than one pair of modems operating within same facility.
7 - 9	Full	Normal operation extending beyond a facility.

(6) Slave Security

With option 6 the user may disable the transceiver's security so it will accept a call from any other FreeWave unit. The default setting is 0 where security is enforced (the caller's serial number must be in the slave's Call Book), with a setting of 1 security is disabled.

As mentioned in mode 6, Slave Security must be set to one when the unit is operating in a point-to-point system where it may need to accept calls from more than 10 different FreeWave Transceivers. However, it is important to note that when Slave Security is set to 1 the Transceiver will accept calls from any other FreeWave Transceiver, and additional system security measures should be taken to prevent unauthorized access.

(7) RTS to CTS

Menu selection 7 in the Radio Parameters provides the option of allowing the RTS line (pin 7) on the Master modem to control the CTS line (pin 8) of the Slave. This pass-through control can be enabled in point-to-point mode as well as point-to-multipoint. In the latter the Master RTS line will control all Slaves' CTS lines. When this mode is enabled the CTS line ceases to function as flow control. Therefore it is not recommended to enable this feature when operating at RS-232 speeds above 38.4 kB.

To enable this mode, enter 7 in the Radio Parameters menu. An entry of 1 will enable the RTS-CTS control, 0 will disable it.

Just before the time the Master is scheduled to transmit a packet, it will sense the state of the RTS line. If the state has changed, the Master will then transmit a message to the Slave with the new status. This transmission will occur regardless of data to be sent or not. In the former case the RTS status message will be sent in addition to the data. In point-to-point mode the Master will continue sending the new status message until it receives an acknowledgment from the

Slave. In point-to-multipoint mode the Master will repeat the message the number of times equal to the Master Packet Repeat number in the Multipoint Setup menu.

Because the Master transmit time is completely asynchronous to the occurrence of any change of the RTS line, the latency time from RTS to CTS is variable. The maximum time, however, is determined by the frequency of Master transmission times. This frequency is determined by the Maximum Packet Size and Minimum Packet Size parameters in the Radio Parameter menu. Setting both parameters to their maximum of 9 and 9 will produce a maximum latency time of approximately 25 mS. At their minimum numbers the time will be approximately 10 mS. Please note that this latency can go up significantly if packets are lost between the Master and Slave. In point-to-multipoint mode there is no absolute guarantee that the state change will be communicated to all Slaves in the unlikely event that all repeated packets from the master do not get through to all Slaves.

(8) Retry Time Out

The Retry Time Out parameter allows the user to determine when a slave will drop a connection to a master or repeater in multipoint mode. The default setting is 255, meaning that if one packet in 255 from the master is sent successfully to the slave it will maintain a link. The lowest setting is 8, at which a slave will drop a connection much more quickly.

The Retry Time Out parameter is useful when a multipoint system is used with a moving master or slaves. As the link gets weaker, a lower setting will allow a transceiver to drop a link and search for a stronger connection.

While intended primarily for multipoint systems, the Retry Time Out parameter may also be modified in point to point systems. In point to point mode the Retry Time Out should not be set to a value of less than 151.

Radio Statistics

Option (4) in the main menu allows the user to view data transmission statistics which have been gathered by the Transceiver during the most recent session. This is of value when the user wishes to look at signal strength, noise levels, bytes transmitted, bytes received, and the distance of the link between transceivers. Statistics are gathered during each data link and are reset when the next link begins.

Ideally, noise levels should be below 30, and the difference between the average signal level and average noise level should be 15 or more. High noise levels tend to indicate other sources of RF interference, while low signal levels indicate a weak link. The former might be addressed through antenna placement or the use of filters or amplifiers (please call FreeWave Technologies for more information). The latter (a weak signal) might be addressed through better antenna placement on one or both ends, use of higher gain antennas, use of repeaters, or use of amplifiers.

Transceiver Location

Placement of your FreeWave unit is likely to have a significant impact on its performance. In general the rule of thumb with FreeWave is that the higher the placement of the antenna the better the communication link - height is everything! In practice you should also place the transceiver away from computers, telephones, answering machines, and other similar equipment. The included 6 foot RS232 cable will usually provide ample room for placement away from other equipment. To improve the data link, FreeWave Technologies offers directional and omnidirectional antennas with cable lengths ranging from 10 to 100 feet.

When using an external antenna, placement of that antenna is critical to a solid data link. Other antennas in close proximity are a potential source of interference; use the Radio Statistics to help identify potential problems. It is also possible that slight adjustments in antenna placement (as little as 2 feet) will solve noise problems. In extreme cases, such as when the transceiver is located close to Pager or Cellular Telephone transmission towers, FreeWave offers a band pass filter to reduce the out of band noise.

The standard enclosure for the DGR-115 does not provide protection against water or environmental hazards, and will fade when placed in direct sunlight. For outdoor applications the DGR-115H should be used. The DGR-115H provides a weather resistant enclosure, allowing placement of the Transceiver in more demanding environmental conditions. The DGR-115H must be mounted in a vertical position to be weather resistant. An optional mounting bracket (part number MBRK/115H) is available to mount the transceiver to a tower or mast. The DGR-115H requires the use of an external antenna.

Front Panel LEDs

The LEDs on FreeWave's front panel provide important information on the operation of the transceiver. Compare the status of a Transceiver's LEDs with the table below to aid you in the troubleshooting process.

Table 9: LED Status in Point to Point Mode

Point to Point Communications

	Master			Slave			Repeater		
Condition	**CD**	**TR**	**CTS**	**CD**	**TR**	**CTS**	**CD**	**TR**	**CTS**
Powered, disconnected	SR	SR	SR	SR	O	BR	SR	O	BR
Connected, no repeater, sending sparse data	SG	IF	IF	SG	IF	IF			
Master calling slave through repeater	SR	SD	SR	SR	O	BR	SR	O	BR
Master connected to repeater, not to slave	FO	SD	SR	SR	O	BR	SR	SD	SR
Repeater connected to slave	SG	IF	IF	SG	IF	IF	SG	IF	IF
Mode 6, disconnected	SR	O	BR	SR	O	BR			
Setup Mode	SG	SG	SG	SG	SG	SG	SG	SG	SG

Legend:

BR	Blinking Red
FO	Flashing Orange
IF	Intermittent Flash Red
O	Off
SD	Solid Red, Dim
SG	Solid Green
SR	Solid Red, Bright

LED:

CD	Carrier Detect LED
CTS	Clear to Send LED
TR	Transmit LED

Table 10: LED Status in Multipoint Mode

MultiPoint Communications

	Master			Slave			Repeater		
Condition	**CD**	**TR**	**CTS**	**CD**	**TR**	**CTS**	**CD**	**TR**	**CTS**
Powered, disconnected	SR	SD	O	SR	O	BR	SR	O	BR
Repeater and slave connected to master, no data	SR	SD	O	SG	O	SR	SG	SD	SR
Repeater and slave connected to master, sending data	SR	SD	IF	SG	IF	SR	SG	SD	SR

Legend:

BR	Blinking Red
FO	Flashing Orange
IF	Intermittent Flash Red
O	Off
SD	Solid Red, Dim
SG	Solid Green
SR	Solid Red, Bright

LED:

CD	Carrier Detect LED
CTS	Clear to Send LED
TR	Transmit LED

Using an External Antenna

All FreeWave Technologies spread spectrum transceivers require the use of an external antenna other than the model DGR-115. The Transceivers are equipped with an external jack allowing the use of a directional Yagi or omnidirectional antenna. When using an external antenna the whip antenna on the DGR-115 must be removed.

The use of an external antenna may radically improve the results obtained with FreeWave Transceivers. It is highly desirable to obtain line of sight with the antennas, and changes in placement height of as few as a couple of feet may make the difference between no link and one that is solid and reliable.

Per FCC regulations, any antenna used with FreeWave must be provided by FreeWave Technologies. FreeWave Technologies offers a variety of omnidirectional and directional external antennas, with both bracket and magnetic mounts. These antennas allow versatility in FreeWave's deployment, extending its range and allowing it to get around obstructions.

If external directional antennas are used FCC regulations concerning effective radiated power limitations must be followed. Table 11 provides the maximum output power settings for a 1 watt DGR-115/115H product given antenna gain and cable loss combinations.

Table 11: Output Power Settings at given Antenna Gain & Cable Loss Combinations, 900 MHz.

		Cable Loss			
		1dB	2dB	3dB	4dB
Antenna Gain	10dB	6	7	8	9
	8dB	8	9	9	9
	6dB	9	9	9	9

WARNING: Any antennas placed outdoors must be properly grounded. Use extreme caution when installing antennas and follow all instructions included with the antennas.

The use of external antennas subjects the transceiver to greater exposure to direct lightning strikes.

Long RS232 cable runs should also be avoided in areas with increased lightning activity or static electricity unless they are properly isolated from the transceiver. Nearby lightning strikes or elevated levels of static electricity may lead to voltage spikes on the line, causing failure in the transceiver's RS232 interface.

Table 12: RS232 Pin Assignments

RS232 Pin Assignments

Pin	Assignment	Signal
1	Carrier Detect	Output
2	Transmit Data	Output
3	Receive Data	Input
4	DTR	Input
5	Ground	
6	Data Set Ready	Output
7	RTS	Input
8	Clear to Send	Output
9	Ground	

Definitions:

Pin 1: Carrier Detect (CD) — Used to show that there is an RF connection between modems.

Pin 2: Transmit Data (TX) — This is used to transmit data bits serially from the modem to the system device connected to the modem.

Pin 3: Receive Data (RX) — This is used to receive data bits serially from the system device to the modem device connected to the modem.

Pin 4: Data Terminal Ready (DTR) — The modem only uses this line in Point-to-Point Slave/Master switchable mode (refer to Operation Mode Selections) or for DTR Connect (refer to Multipoint Operation).

Pin 5: Ground (GND) — Signal return for all signal lines shared with Pin 9.

Pin 6: Data Set Ready (DSR) — Always high when the radio is powered from the 2.5mm power connector. Indicated power is on to the radio. Also, this pin can be used for +12Volts when powering the modem directly through the RS-232 port. Note: This is not used on the OEM module.

Pin 7: Request to Send (RTS) — The modem does not recognize RTS for flow control. RTS is used as a control line in RTS/CTS mode (refer to Radio Transmission Parameters).

Pin 8: Clear to Send (CTS) — This signal is used to tell the system device connected to the modem that the modem is ready to receive data. When

	asserted, the modem will accept data, when deasserted the modem will not accept data. This should always be used for data rates above 38.4KB or there will be a risk of lost data if an RF link is not very robust.
Pin 9: Ground (GND)	Signal return for all signal lines shared with Pin 5.

DGRO Small Footprint Series Pinout

The DGRO Small Footprint Series transceivers are available in both TTL and RS232 versions.

The TTL versions use reverse polarity from standard RS-232 at 0 to 5 Volt levels. All pin descriptions are the same as the RS-232 pin descriptions above except for B+, Interrupt, and different pin numbering. The RS232 versions use standard RS232 polarity and voltage levels.

Pin 1: B+ Power input.

Pin 2: Interrupt (INT) – Input – A 0 volt level on this pin will switch the radio into setup mode.

Table 13: DGRO Series Pinout

Pin	Assignment
1	B+ input
2	Interrupt (Ground to invoke menu)
3	DTR
4	Ground
5	Transmit Data
6	Ground
7	Receive Data
8	Carrier Detect
9	RTS
10	Clear to Send

Note: *Pin 1 on the DGRO-115 board level transceiver is the pin farthest from the three LEDs and pin 10 is closest to the LEDs.*

DGR-115W Waterproof Enclosure Pinout

Table 14: DGR-115W Pinout

Pin	Color	Function	Signal
1	Brown	Carrier Detect	Output
2	Red	Transmit Data	Output
3	Orange	Receive Data	Input
4	Yellow	DTR	Input
5	Green	Ground	Signal Ground
6	Blue	Data Set Ready	Output
7	Violet	RTS	Input
8	Gray	Clear to Send	Output
9	White	Power Ground	Power Ground
10	Black	B+	Power Input
11	Shield	Shield Ground	Shield Ground

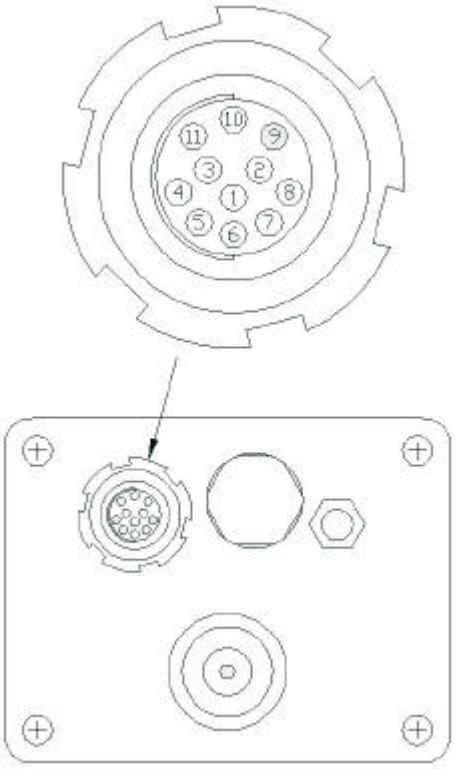


Figure 8: Waterproof Connector

Data Communications Settings

The device to which FreeWave is connected should be configured to match the settings shown in Table 15.

Table 15: Data Communication Settings

Parameter	Setting
Baud Rate	Match to FreeWave
Data Bits	8
Parity	None
Stop Bits	1
Parity Check	None / Off
Carrier Detect	None / Off
Flow Control	RTS/CTS / Hardware
Connection Started by	Carrier Detect
Connection Ended by	Carrier Detect
DTR Signal	Always On
RTS Signal	Always On

Establishing Data Communication Links

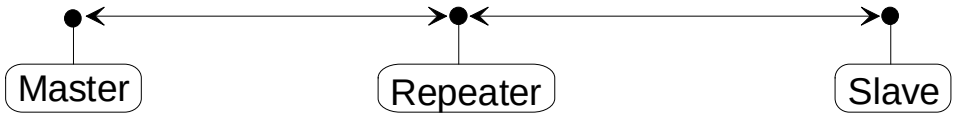
FreeWave's versatility allows data communication links to be established using a variety of different configurations. This, in turn, makes it possible to extend the range of FreeWave and get around obstacles.

Diagram (A) shows the most common and straightforward link, a master communicating to a slave in a dedicated link.

(A)

Diagram (B) depicts how a link might be set up using a repeater. The repeater may be sitting on a hilltop or other elevated structure to link the master to the slave. In this setup it may be desirable to use an external omnidirectional antenna on the repeater; to extend the range Yagi antennas could be used on either or both of the master and slave.

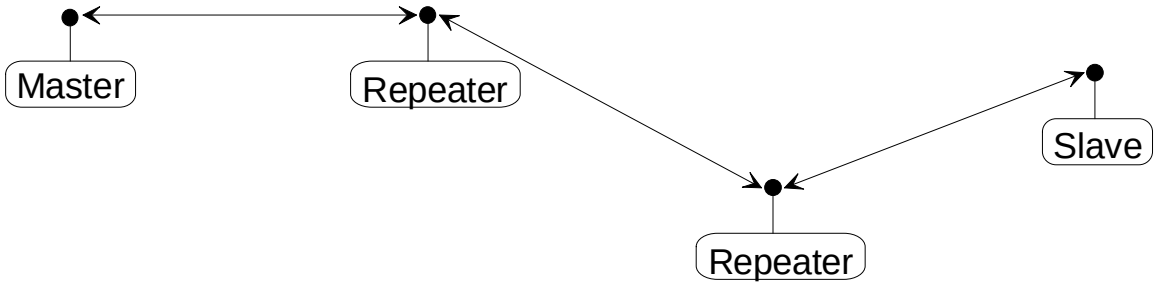
When a repeater is used the RF speed is cut in half, making 115 KBaud uncompressed throughput unachievable. The baud rate, however, may still be set at 115200.



(B)

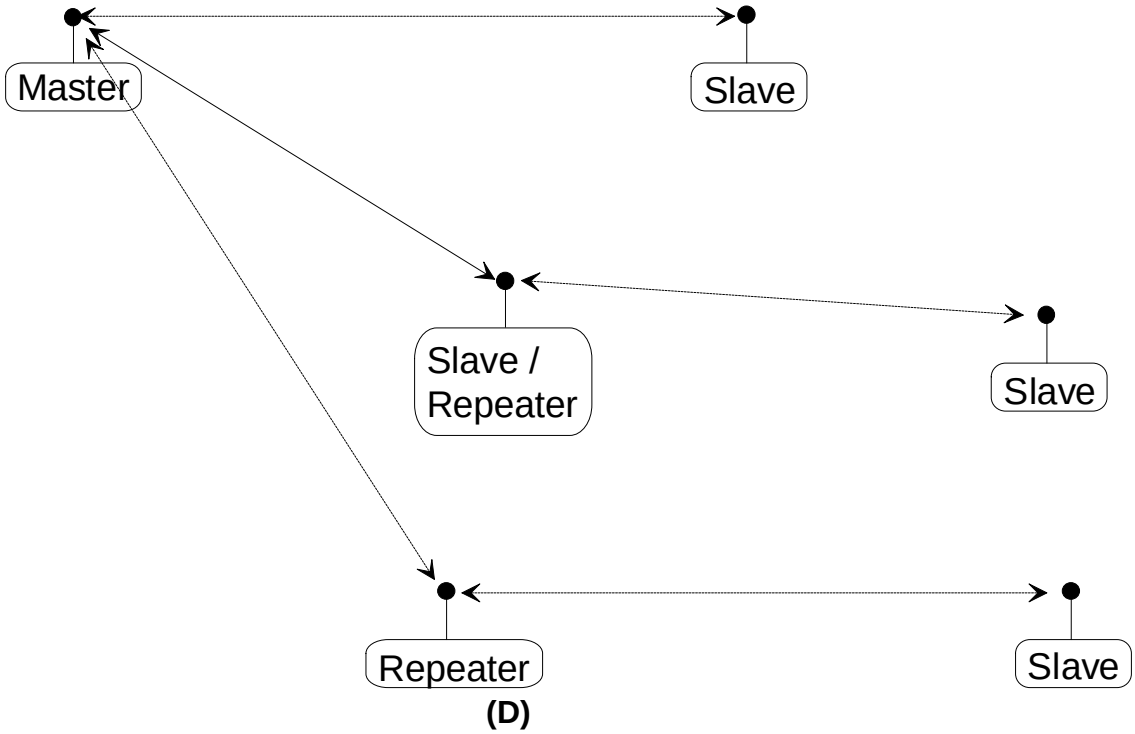
Diagram (C) shows a link with two repeaters between the master and slave. With two repeaters there is clearly more flexibility in getting around obstacles and greater total range is possible. Once again, it would be desirable to use external omnidirectional antennas with the repeaters, and attaching a Yagi to the master and slave would increase the range of the link.

When two repeaters are used there is no further degradation in the RF speed of the link.

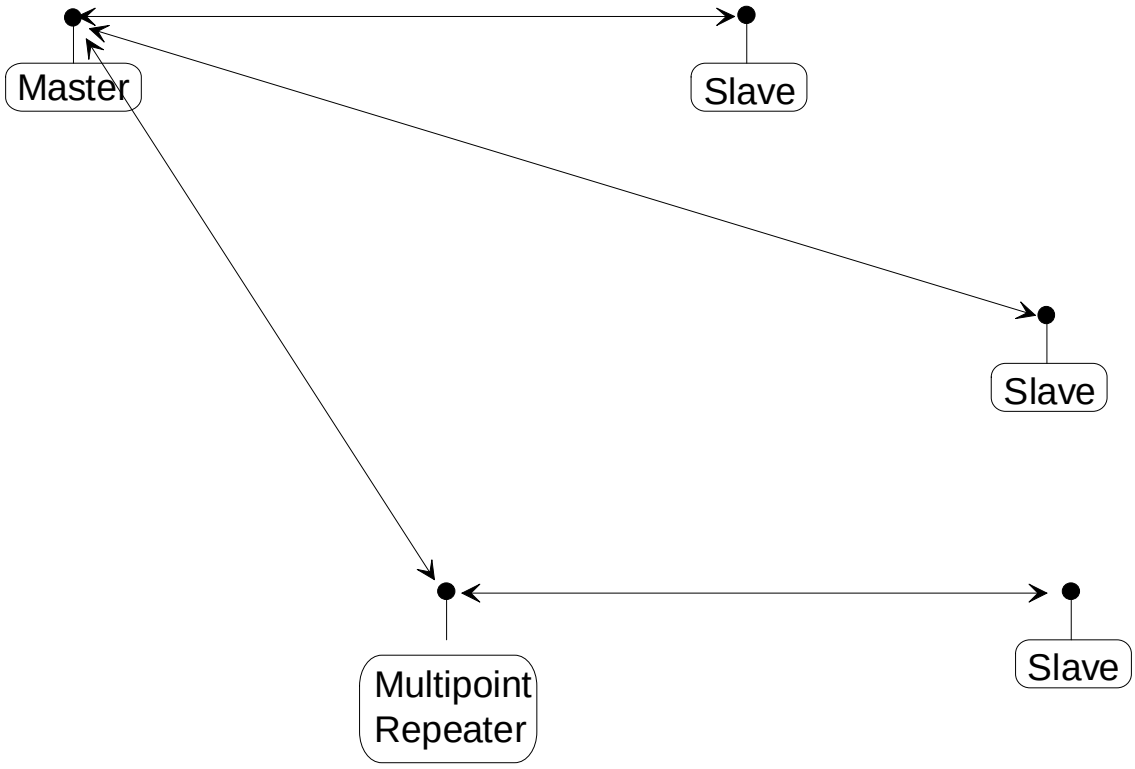


(C)

In example (D) a setup is shown where a master routinely calls a number of slaves at different times. The master is communicating with a transceiver designated as a slave/repeater which is connected to a remote instrument in the field. Since this instrument is placed in an elevated location, the transceiver may also be used as a repeater when it is not used as a slave. At any time desirable the master may call any of the slaves, establish a connection, and retrieve and send data.



(D)



(E)

Example (E) depicts a standard point-to-multipoint system. In this example any data sent from the master is broadcast to all three slaves, one of which receives it through a multipoint repeater. The data is in turn sent out of the RS232 port of each of the three slaves.

Other Settings

A number of parameters other those shown in the setup menu may be set on FreeWave transceivers. The parameters below may be set with DOS based software available by contacting FreeWave Technologies.

Frequency Banks

The transceiver may be modified to use different portions of the 902-928 MHz band. The current frequency banks available are:

Table 16: Frequency Banks, 900 MHz

Name	Band
Australian	915-928 MHz
International Hop Table	902-928 MHz, 16 fewer frequencies than full US set
Taiwan	916-920 MHz
New Zealand	921-928 MHz
Notch	Uses 902-928 with center frequencies of 911-919 notched out

Note: *Once a transceiver's hop table is changed from the full US version to any other table it cannot be set back unless the transceiver is returned to the factory. This is to comply with the US Bureau of Export Administration regulations.*

Baud Rate

The transceiver's RS232 baud rate may be set to 300, 600, or 900 baud.

Setup Timeout

When enabled this mode invokes a timeout feature for the Setup Menu. If the transceiver goes into setup and does not receive a legitimate menu selection within 3 to 5 seconds it will go back out of setup and into its previous mode.

Technical Specifications

Specification		
Frequency:	902 to 928 MHz	2.400 to 2.4835 GHz
Transmitter:		
Output Power	1 W (+30 dBm) at 9.5 to 14.0 V 400 mW (+26 dBm) at 7.5 to 9.5 V	500 mW (+27 dBm) at 9.5 to 14.0 V 400 mW (+26 dBm) at 7.5 to 9.5 V
Range*	20 miles	20 miles
Modulation	GFSK, 120 kBs – 170 kBs	GFSK, 120 kBs – 170 kBs
Occupied Bandwidth	230 kHz	230 kHz
Receiver:		
Sensitivity	-108 dBm at 10-6 raw BER	-108 dBm at 10-6 raw BER
Selectivity	40 dB at fc ± 230 kHz 60 dB at fc ±460 kHz	40 dB at fc ± 230 kHz 60 dB at fc ±460 kHz
Data Transmission:		
Error Detection	32 Bit CRC, resend on error	32 Bit CRC, resend on error
Data Encryption	Substitution, dynamic key	Substitution, dynamic key
Link Throughput	115 KBaud	115 Kbaud
Interface	RS-232 1200 Baud to 115.2 KBaud, asynch, full duplex	RS-232 1200 Baud to 115.2 KBaud, asynch, full duplex
Power Requirements:		
Transmit current	650 ma at 12V for 1W 600 ma at 8.5V for 400mW	650 ma at 12V for 500mW 600 ma at 8.5V for 400mW
Receive current	100 ma at 12V	100 ma at 12V
Idle current	65ma at 12 V	65ma at 12 V
Operating Modes:	Point-to Point Point-to-Multipoint Peer-to-Peer Store and Forward Repeater	Point-to Point Point-to-Multipoint Peer-to-Peer Store and Forward Repeater
Operating Environment	-40°C - +75°C	-40°C - +65°C

* Line of sight distance with unity gain antenna at 900 MHz, 5 dB omni at 2.4 GHz.
** Throughput measured assuming 75% frequency availability.

	DGR-115	**DGR-115H**	**DGR-115R / DGMR-115R**	**DGR-115W / DGMR-115W**
Enclosure	Plastic	Milled Aluminum	Extruded Aluminum	Extruded Aluminum Waterproof
Dimensions	41mmH x 99mmW x 188mmL	28mmH x 102mmW x 205mmL	57mmH x 74mmW x 165mmL	60mmH x 78mmW x 165mmL
Weight	340 grams	560 grams	441 grams	496 grams
Power Requirements	• 9.5 - 18.0 VDC • Center Pin Positive • AC Wall Adapter Provided • May also be powered through Pin 6 of DB9 connector.	• 9.5 - 18.0 VDC • Center Pin Positive • AC Wall Adapter Provided • May also be powered through Pin 6 of DB9 connector.	• 9.5 - 14.0 VDC • Center Pin Positive • AC Wall Adapter Provided • May also be powered through Pin 6 of DB9 connector. • 6.0-14.0 VDC* • 15.0-32.0 VDC*	• 9.5 - 14.0 VDC • 6.0-14.0 VDC* • 15.0-32.0 VDC*
Antenna	3 inch whip provided. Reverse thread SMA connector for external antenna.	Reverse thread female SMA connector. External antenna required.	N type female connector. External antenna required.	N type female connector. External antenna required.
FCC Identifier	KNY-DGR-115	KNY-DGR-115	KNY-205-108213 (900) KNY-209228624168 (2.4)	KNY-205-108213 (900) KNY-209228624168 (2.4)
DOC Identifier	2329 101 340A	2329 101 340A	2329 102 336A (900) 2329391130A (2.4)	2329 102 336A (900) 2329391130A (2.4)

* Voltages available in different models.

Troubleshooting

"I am using FreeWave to communicate between two PCs. I am using pcANYWHERE, which is set to direct connection. Both pcANYWHERE and the modem are set to 115.2 KBaud, yet throughput is considerably lower."

The communication link between two computers may be slowed considerably by the UART used in the serial port of one or both computers. If you suspect that the serial port on the computer will not support high speed communications, then try reducing the baud rate for that end of the connection (both on the computer and the Transceiver) to see if throughput improves.

"I have two transceivers, one configured as a master and the other as a slave. When they are plugged in, the LEDs indicate they are receiving power, and yet they will not connect. Why not?"

There are several reasons why this may occur:

- The Transceivers are running at full power and are too close to each other. If the Transceivers are within 5-10 feet of each other and will not link try either reducing the RF power to 1 on each or moving one unit to another room. (This problem occurred on the initial generation of product with the 555 serial number prefix. It has been addressed in transceivers with serial numbers 556 and higher.)
- The Transceivers are not in each other's Call Books.
- The number of the slave is in the master's Call Book, but the master's menu is not set to call that number.
- There are several phone numbers in the Call Book, the master is set to Call All, and is connecting with another transceiver in the list first.
- The master is set to Call All and the phone number of the Transceiver with which you are trying to communicate is preceded by a setting of 000-0000.

"I am able to link to a remote unit within line of sight when the Transceiver I have is outside. However, as soon as I walk inside with it I lose the link, even if I place the Transceiver by the window which faces the remote unit."

Many modern buildings use energy efficient glass which wreaks havoc on RF signals. This glass contains a metal film which is very effective in blocking all radio waves. If your situation is as described above the preferable solution is to install an antenna outdoors.

"I have several transceivers set up to communicate with each other in a point-to-multipoint mode, yet they are not establishing contact."

In a Multipoint system there are two critical parameters which must be set correctly to establish a communications link:

1. The slave's Call Book must contain the serial number or Network ID of the master and/or repeaters to which it will be communicating.

2. All radios must be set to run at the same RF data rate. Unlike point-to-point systems, slaves in a Multipoint system do not change their RF data rate to match the master's rate.

"In bench testing several units in a Multipoint system, it appears that they are not communicating through the Multipoint repeater. When all units are powered the slaves' Carrier Detect lights are green, indicating a connection, yet when I unplug the repeater those slaves set up to communicate through that repeater remain connected."

In a Multipoint system a slave will attempt to communicate with any master or repeater (which looks like a master in a Multipoint system) that is in its Call Book. Therefore, it may be that the slaves are communicating with the repeater when it is powered, and when it is unplugged they are establishing a link with the master. To test whether or not this is what is occurring go into the Call Book of the slaves which are set up to communicate through the repeater and remove the master's serial number. When all units are powered the slaves' Carrier Detect lights should be green, when the repeater is unplugged the slaves should lose contact and Carrier Detect should turn red.

"My transceivers have established a solid connection as indicated by the LEDs, yet the application I am running is not transmitting and/or receiving data correctly."

The quickest acid test in a situation like this is to try to get the application up and running using an RS232 null modem cable before deploying FreeWave in the field. FreeWave essentially functions as a null modem cable. If the application will not work with a hard wire connection then it will not work with FreeWave, and the problem lies within the application or other hardware (such as the computer serial ports).

"I have 2 DGR-115 transceivers set up between two computers and have been unsuccessful in my attempts to establish a link using LapLink."

At various times difficulty using FreeWave with LapLink has been documented by FreeWave Technologies. The cause, while not confirmed, is believed to be due to LapLink changing baud rates, which FreeWave does not support. If you encounter this problem it is recommended that you test the link with a terminal program such as Windows 3.1 Terminal, Hyperterminal, or Procomm. If either of these applications is used and characters typed on one computer appear on the screen of the other computer in the link, then the transceivers are functioning properly.

For up to date troubleshooting information check the FAQ page at www.freewave.com.

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Antenna Installation Drawing