Industrial Modem RF115
RS-485 RF Modem Modules
Optional RF Antennas

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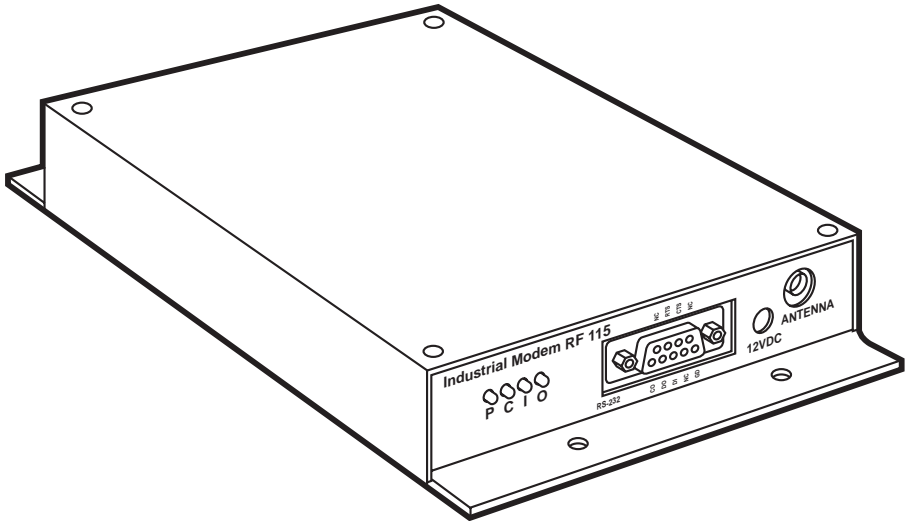
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AND

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This equipment generates, uses, and can radiate radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio communication. It has been tested and found to comply with the limits for a Class A computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when the equipment is operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be necessary to correct the interference.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This digital apparatus does not exceed the Class A limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of Industry Canada.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la classe A prescrites dans le Règlement sur le brouillage radioélectrique publié par Industrie Canada.

NORMAS OFICIALES MEXICANAS (NOM)
ELECTRICAL SAFETY STATEMENT

INSTRUCCIONES DE SEGURIDAD

1. Todas las instrucciones de seguridad y operación deberán ser leídas antes de que el aparato eléctrico sea operado.

2. Las instrucciones de seguridad y operación deberán ser guardadas para referencia futura.

3. Todas las advertencias en el aparato eléctrico y en sus instrucciones de operación deben ser respetadas.

4. Todas las instrucciones de operación y uso deben ser seguidas.

5. El aparato eléctrico no deberá ser usado cerca del agua—por ejemplo, cerca de la tina de baño, lavabo, sótano mojado o cerca de una alberca, etc..

6. El aparato eléctrico debe ser usado únicamente con carritos o pedestales que sean recomendados por el fabricante.

7. El aparato eléctrico debe ser montado a la pared o al techo sólo como sea recomendado por el fabricante.

8. Servicio—El usuario no debe intentar dar servicio al equipo eléctrico más allá a lo descrito en las instrucciones de operación. Todo otro servicio deberá ser referido a personal de servicio calificado.

9. El aparato eléctrico debe ser situado de tal manera que su posición no interfiera su uso. La colocación del aparato eléctrico sobre una cama, sofá, alfombra o superficie similar puede bloquea la ventilación, no se debe colocar en libreros o gabinetes que impidan el flujo de aire por los orificios de ventilación.

10. El equipo eléctrico deber ser situado fuera del alcance de fuentes de calor como radiadores, registros de calor, estufas u otros aparatos (incluyendo amplificadores) que producen calor.

11. El aparato eléctrico deberá ser connectado a una fuente de poder sólo del tipo descrito en el instructivo de operación, o como se indique en el aparato.

12. Precaución debe ser tomada de tal manera que la tierra fisica y la polarización del equipo no sea eliminada.

13. Los cables de la fuente de poder deben ser guiados de tal manera que no sean pisados ni pellizcados por objetos colocados sobre o contra ellos, poniendo particular atención a los contactos y receptáculos donde salen del aparato.

14. El equipo eléctrico debe ser limpiado únicamente de acuerdo a las recomendaciones del fabricante.

15. En caso de existir, una antena externa deberá ser localizada lejos de las lineas de energia.

16. El cable de corriente deberá ser desconectado del cuando el equipo no sea usado por un largo periodo de tiempo.

17. Cuidado debe ser tomado de tal manera que objectos liquidos no sean derramados sobre la cubierta u orificios de ventilación.

18. Servicio por personal calificado deberá ser provisto cuando:

   A: El cable de poder o el contacto ha sido dañado; u

   B: Objectos han caído o líquido ha sido derramado dentro del aparato; o

   C: El aparato ha sido expuesto a la lluvia; o

   D: El aparato parece no operar normalmente o muestra un cambio en su desempeño; o

   E: El aparato ha sido tirado o su cubierta ha sido dañada.

Contents

1. Specifications

Range— 20 miles (32.2 km)

RS-232 Data Throughput (Uncompressed)— 1200 baud to 115.2 kbps (half-duplex) or 57.6 kbps (full duplex)

RS-232 Interface— Asynchronous, full or half-duplex

System Gain— 135 dB

Minimum Receiver Decode Level— -110 dBm @ 10-4 raw BER; -108 dBm @ 10-6 raw BER

Operating Frequency— 902 to 928 MHz

Modulation Type— Spread Spectrum, GFSK

Spreading Code— Frequency Hopping

Hop Patterns— 15 (user-selectable)

Output Power— 0.1 to 1 watt, selectable

Error Detection— 32-bit CRC with packet retransmit

Antenna— 3-inch whip provided. Non-standard SMA connector allows use of external directional or omnidirectional antennas.

Connector— RS-232 9-pin female

Unit Address— Unique, factory-set

Operating Modes— Point-to-point, point-to-multipoint, store and forward repeater

Operating Environment— -40 to +167°F (-40 to +75°C)

FCC Identifier— KNY-DGR-115

DOC (Canada) Identifier— 2329 101 340A

Approvals — CE, UL®

Power Requirements— 10.5 to 18 VDC, Center pin positive, AC wall adapter provided

Power Consumption— 180 mA Transmit, 100 mA Receive, 120 mA Average

Input Power — MDR100A-R4: 120 VAC, 60 Hz, 16W; MDR100AE-R4, MDR100AE-AUS: 230 VAC, 50 Hz, 110 mA

Output Power — MDR100A-R4: 12 VDC, 800 mA; MDR100AE-R4, MDR100AE-AUS: 12 VDC, 1000 mA

Size— 1.4"H x 5"W x 7.8"D (3.6 x 12.7 x 19.8 cm)

Weight— 1.8 lb. (0.8 kg)

2. Introduction

The Industrial Modem RF115 (part number MDR100A-R4) is a high-performance wireless modem designed for heavy-duty industrial data communications in the 902- to 928-MHz license-free band. It uses advanced frequency-hopping technology to achieve reliable noise- and interference-immune operation. The modem operates in a number of different modes to satisfy a broad range of communications requirements.

The modem can operate in virtually any environment where you would use normal RS-232 data communications. A pair of these modems works as a 9-pin null-modem cable. If you use the modems in an application that would normally use a null-modem cable (such as communication between two computers), you can directly connect both modems. If you use the two modems to replace a straight-through RS-232 cable, place a null-modem cable between one of the modems and the DCE instrument to which it is connected.

Your package includes:

- Industrial Modem RF115

- Fixed whip antenna

- Wallmount power adapter

- This user manual

You can convert the modem's DB9 RS-232 connector to RS-485 using the RS-485 Modem Module 2-wire (part number MD3310-R2) or the RS-485 Modem Module 4-wire (part number MD3311-R2).

A variety of optional RF antennas are also available (ordered separately):

- Omnidirectional with Bracket Mount with 10-ft. cable (MDR151-0010-R2)

- Omnidirectional with Bracket Mount with 25-ft. cable (MDR151-0025-R2)

- Omnidirectional with Bracket Mount with 50-ft. cable (MDR151-0050-R2)

- Omnidirectional with Bracket Mount with 100-ft. cable (MDR151-0100-R2)

- Yagi (Unidirectional) with Bracket Mount with 25-ft. cable (MDR152-0025-R3)

- Yagi (Unidirectional) with Bracket Mount with 50-ft. cable (MDR152-0050-R3)

- Yagi (Unidirectional) with Bracket Mount with 100-ft. cable (MDR152-0100-R3)

3. Quick Start

Follow these steps to establish full-duplex communications between a pair of new Industrial Modems:

1. Following the configuration procedures described in **Chapter 4**, set one of the modems to be a point-to-point slave and enter the Call Book numbers of the master and slave in each other's call list.

2. Set the baud rate on each modem to match the baud rate of the instrument to which it is attached. Note that when you are setting the modem's baud rate you are setting *only* the data rate between the modem and the instrument to which it is attached. The baud rate does *not* have to be the same for the two modems.

3. Verify that the RS-232 connector on the cable supplied will fit the RS-232 interface on the instrument to which it is being connected. The cable supplied will fit a 9-pin male RS-232 connector. Any other format will need an adapter or a different cable.

4. Screw the included whip antenna into the modem, making sure that it is snug and properly seated.

5. Connect the modem to the instrument with the RS-232 cable and attach the power adapter to the modem. Shortly after both modems are plugged in, they should establish a communications link, and your connection is complete.

4. Configuration

The modem lets you set several parameters to suit your particular application. All adjustments are done through the modem setup program, a user interface that eliminates the need for setup diskettes, DIP-switch settings, or custom software.

The setup program is invoked by connecting the modem to any terminal program, setting the baud rate for that terminal to 19,200 baud, and using a small pointed object to press the Setup button on the front panel of the modem. While any terminal that can be set to 19,200 baud will work, all examples for this manual were generated using the Terminal application from Microsoft® Windows® 3.1.

Table 4-1. Setup Menu Terminal Settings

Parameter	Setting
Baud Rate	19,200
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 modem's front panel will turn green and will remain green for the entire time the modem is in setup mode. The main menu screen for the setup program is shown in Figure 4-1.

NOTE

The terms "modem" and "transceiver" are used interchangeably in the text of the setup menu. Both terms refer to your Industrial Modem RF115.

```
┌──────────────────────────────────────────────────────────┐
│ ▭                          Terminal-TERMINAL.TRM          │
│ File   Edit   Settings   Phone   Transfers   Help         │
├──────────────────────────────────────────────────────────┤
│                         MAIN MENU                          │
│                         Version 3.0                        │
│                Modem Serial Number 554-0002                │
│                                                            │
│   (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                       │
│   (Esc)   Exit Setup                                       │
│                                                            │
│   Enter Choice   █                                         │
```
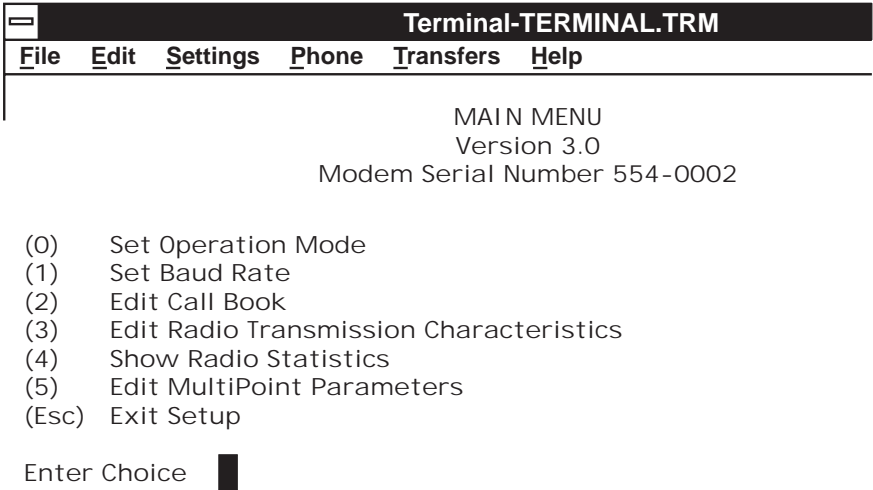
Figure 4-1. The Modem Initial Menu.

When using the setup program, the escape key will get you out of the current screen to the previous screen and will eventually reset the modem to its operational mode. If the modem fails to respond to keystrokes, unplug the unit, wait a few seconds, and plug it back in.

The initial menu provides the modem'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 4-2. The Operation Mode option is used to designate whether the modem will be a master or a slave. (You need one master and at least one slave in any setup.) 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 modems 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 modem.

```
┌──────────────────────────────────────────────────────────────┐
│ ▭                    Terminal-TERMINAL.TRM                     │
├──────────────────────────────────────────────────────────────┤
│ File   Edit   Settings   Phone   Transfers   Help             │
└──────────────────────────────────────────────────────────────┘
```

MAIN MENU
Version 3.0
Modem Serial Number 554-0002

(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
(Esc)   Exit Setup

Enter Choice   0

SET MODEM MODE
Modem Mode is   2

(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

Figure 4-2. The Operation Mode Menu.

5. Operation Mode Selections

(0) Point-to-Point Master

As mentioned previously, the modem operates in a master/slave configuration. When designated as a master in point-to-point mode, the modem 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 repeaters.

A quick method of identifying a master is to power on the modem. Before 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, the modem 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 modem's Call Book is not operational. The slave will communicate with any master on the list that calls.

(2) Point-to-Multipoint Master

The modem 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 modems designated as point-to-multipoint slaves or point-to-multipoint repeaters.

Please refer to **Chapter 6** for more information on running a multipoint network.

(3) Point-to-Multipoint Slave

Setting (3) allows the modem to operate as a slave in a multipoint network.

Please refer to **Chapter 6** for more information on running a multipoint network.

(4) Point-to-Point Slave/Repeater

Option 4 allows you to designate the modem to act as either a slave or a repeater, depending on the instructions received from the master for the specific communications session. When a modem is placed in an ideal location, this setting offers the flexibility of using that modem 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 modem cannot act as both a slave and a repeater at the same time).

NOTE

A modem designated as a repeater has no security features, as explained below. When a modem 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

The modem allows the use of up to two repeaters in a communications link, significantly extending the operating range. When designated as a repeater, a modem 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 that 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 (about 50%). This impact is generally noticed only when using the modems at 115.2 kbps. The throughput does not decrease further if two repeaters are used.

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

Mode 6 allows the modem to be controlled entirely through software commands. When in mode 6, a number of key parameters in the user interface may be changed either directly (with Windows HyperTerminal or some other terminal emulator) or through the use of script files. In addition, when the modem is in mode 6 and isn't calling a slave, it will be a slave itself and accept any appropriate calls from other modems.

In mode 6:

• The modem remains in slave mode until called by another modem in its Call Book or instructed to call another modem through an **ATDT** command. The master will disconnect when DTR goes low.

• The user may change settings in the user interface without using the reset button (this may be of particular value if the modem is not in an easily accessible location).

• Predetermined script files may be used that allow any of the modem's settings to be changed upon execution of that file. This, in turn, allows the user to establish pushbutton command sets that will instruct the modem to call a predetermined slave.

The features of mode 6 will be explained using pcANYWHERE® 1.0 for Windows as the software interface.

The following steps demonstrate how to establish a pcANYWHERE entry using the modem:

1. Enter a new entry under **Call A Host PC**. Give this entry a name that will be easily remembered (such as Office Computer).

2. Establish a hardware setup entry for the modem with the settings shown in Table 5-1.

Table 5-1. Mode 6 Hardware Settings

Modem	Direct Connect
Data Rate	Matches baud rate on the modem
Flow Control	RTS/CTS
Parity	None

Advanced Hardware Settings:

Connection started by (calling PC)	Always connected
Connection ended by (calling PC)	Always connected
Connection started by (host PC)	Carrier Detect
Connection ended by (host PC)	Carrier Detect
DTR signal state	Always on
RTS signal state	Always on

Instruct pcANYWHERE to run a script file after connection (under advanced host PC settings). This script file will allow any of the parameters shown in Table 5-2 to be changed and will program the modem to call the appropriate entry in its Call Book.

Figure 5-1 provides an example of how the commands in the script file should be written. This script file does the following:

- Sets the Minimum Packet Size to position 2

- Sets the Transmit Rate to 1

- Sets the Maximum Packet Size to position 9

- Sets the Frequency Key to 9

- Sets the RF Data Rate to 2

- Sets the Transmit Power to 9 (full power)

- Programs the modem to call position 2 in its Call Book. This entry corresponds with the pcANYWHERE entry with which we are trying to establish a connection.

When pcANYWHERE is instructed to call a host PC corresponding to an entry that has been established with the above instructions, the following should occur:

- pcANYWHERE should go into terminal mode.

- A series of OKs should appear in the terminal window (one OK for each line of the script file being run). If this does not occur, the baud rate on the modem might be different from the data rate set on pcANYWHERE.

- The word Connect will appear when the modem has established connection to the slave (or the first repeater, if appropriate).

- The computer that the modem is calling will appear on the screen as the connection is completed.

```
pcANYWHERE Editor-[C:\WINAW\ATDT2.SCR]
 File   Edit   Search   Options   Tools   Window   Help

set dtr on
send line "ATXD2"
send line "ATXX1"
send line "ATXT9"
send line "ATXF9"
send line "ATXR2"
send line "ATXP9"
send line "ATDT2"
end terminal
```

Figure 5-1. Mode 6 Script File.

Table 5-2. Mode 6 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 RF115 Serial Number to be entered to call
ATXC_	Used in conjunction with the ATD command, instructs Modems which repeater path to follow
ATXS	Instructs Modem to go into Setup Mode

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

Mode 6 will accept the command **ATD#######**, where ####### is any arbitrary modem serial number, such as 5XX1234. 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 features:

1. If you will use one or two repeaters, they must first be set up in the Call Book. Do this by setting up a number to call (this may be a dummy number) through the repeater(s) that you will 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 modem with which you are attempting a link. The modem will link first to the repeater(s) specified and then to the slave modem.

4. If you want to link to a different slave, this time without using a repeater, reissue the **ATXC#** command, where # is 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 modems that may call in to 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.

Changing the User Interface settings in Mode 6

When in Mode 6, the settings in the modem's user interface may be changed directly without using the reset button. To do this:

1. Enter a new entry under Call Online Service (such as RF115 Setup).

2. Establish a hardware setup entry for the modem with the settings shown in Table 5-3 on the next page.

3. Instruct pcANYWHERE to run a script file after connection (under advanced Host PC settings). This script file should contain the following lines:

SEND STRING "ATXS"
END TERMINAL

When pcANYWHERE is instructed to call the entry corresponding to the modem setup, it should go into Terminal mode and then display the modem user interface. The LEDs on the modem will all be solid green, indicating setup mode. Parameters in the menu may be modified as they normally would. When you're done with the setup menu, exit in the normal manner by pressing the escape key until the LEDs change back to the Mode 6 state (or if you cannot see the LEDs, simply press the escape key 2 or 3 times when in the Main Menu). The pcANYWHERE terminal should then be closed and the session ended.

NOTE

If the modem user interface is not exited completely before the pcANYWHERE session is ended, the modem will remain in setup mode.

Table 5-3. Mode 6 Hardware Settings for Setup Mode

Terminal Emulation	ANSI
File Transfer Protocol	XMODEM
Hardware Setup Name	Direct Connect
Hardware Setup Options:	
Modem	Direct Connect
Data Rate	Matches baud rate on the RF115
Flow Control	RTS/CTS
Parity	None
Advanced Settings:	
Connection Started by (Calling PC)	Always Connected
Connection Ended by (Calling PC)	Always Connected
Connection Started by (Host PC)	Carrier Detect
Connection Ended by (Host PC)	Carrier Detect
DTR Signal State	Always On
RTS Signal State	Always On

(7) Point-to-Multipoint Repeater

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

Please refer to **Chapter 6** for more information on running a Multipoint network.

6. Multipoint Operation

In a multipoint system, a modem 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. 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 greater the system capacity.

2. RS-232 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.

6.1 Setting Multipoint Parameters

In a multipoint network, it is critical to know how many modems are being used as repeaters. Any modem that is used as a repeater essentially becomes a master to the slaves and other repeaters to which it is communicating. Therefore, you must first identify how many repeaters are connected to the master by assigning a value in parameter **(0) Number Repeaters**. This parameter must also be set for each repeater in the system (that is, if a repeater is connected to one or more other repeaters). This parameter does not need to be set for Multipoint slaves.

In point-to-point operation, the modems 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, you can 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, set this parameter at the lower end of the scale (0 or 1). If the network has some weak or marginal links, set it toward the higher values. If a slave receives a packet from a master more than once, it will discard the repeated packets received.

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, more than one slave might attempt to transmit to the master at the same time, so a protocol must exist 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. You might want to assign higher retry odds to the slave with the weaker link to give it a better chance of competing with the closer slave for the master's attention.

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 RS-232 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 you want to increase overall network capacity. In setting 0, the transceiver will transmit when RS-232 data is received.

The repeater's hopping pattern must also be set in a multipoint network; do this 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).

For more information on parameter **(6) Network ID**, see **Section 6.2**. Parameter 7 is reserved for future use. For more information on parameter (**8**) **MultiMasterSync Mode**, see **Section 6.3**. Parameter **(9) 1 PPS Enable/Delay** is an invalid parameter and should not be used.

```
┌──┐
│  │                    Terminal-TERMINAL.TRM
└──┘
 File   Edit   Settings   Phone   Transfers   Help

 (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    5

                          MULTIPOINT PARAMETERS


 (0)      Number Repeaters        0
 (1)      Master Packet Repeat    1
 (2)      Max Slave Retry         2
 (3)      Retry Odds              3
 (4)      DTR Connect             0
 (5)      Repeater Frequency      0
 (6)      Network ID              255
 (7)      Reserved
 (8)      MultiMasterSync Mode 0
 (9)      1 PPS Enable/Delay      255
 (Esc)  Exit to Main Menu

 Enter Choice   ▐
```

Figure 6-1. Multipoint Parameters.

6.2 Network ID

The Network ID allows the user to set a network of units up with an ID instead of using addressing. This may be useful when a large number of slaves are in use. In a large system, if a master or repeater needs to be replaced or repeaters need to be added to add slaves, it would not be necessary to change the address in all of the units affected. All that would need to be done is to set the Network ID of the units that are being added to the system.

For example, say you have a system that involves slave units that are mobile and use a series of repeaters to maintain contact with the master. If more repeaters need to be added to extend the system, using the Network ID would let you add the repeaters without having to add the new repeaters' addresses in the slave call books. As soon as you set the new repeaters to the system's Network ID, they would be ready to install.

When setting up the Network ID, note that the default Network ID is 255. This setting disables the Network ID (the modems will use their "Call Book" menu for addressing). To enable the Network ID, change the setting to a number between 0 and 254. When this is done, the units will use the Network ID and no longer use the "Call Book" addressing system. Note that the Network ID must be the same in all of the units in a given system. Any unit that does not have the same Network ID as the other units in a system will not communicate in that system. If a master (only one per system), repeater, or slave needs to be added (or replaced) in the system, set the Network ID to be the same as the other units in the network (make sure the other configuration parameters match) and it is ready to work in the system.

6.3 MultiMasterSync Mode

The MultiMasterSync Mode allows a configuration to have more than one master unit. This section describes the setup and operation of the MultiMasterSync mode. This mode synchronizes the transmitter with several co-located transceivers (in either point-to-point or multipoint operation), thereby eliminating the possibility of receiver overload. This firmware must be Version 5.26 (or higher) for units with addresses of 571 (see the first 3 digits of the "Modem Serial Number" in the sample screen shown below) or Version 5.19c for units with addresses of 570.

Setting up the MultiMasterSync mode:

1. For the MultiMasterSync mode to operate, the minimum and maximum packet sizes and the RF data rate must be set identically on all modems in the system. These parameters are found in submenu 3 (Radio Transmission Characteristics). For example, the min./max. factory-default setting is 2 for the minimum and 9 for the maximum. All units in the system must be configured with these same settings. The min./max. numbers can be anything the user needs, but all modems must be configured to match.

2. Set the Frequency Key of the "Grand Master" to 0, as shown below.

```
                        Version 5.27 03-14-97
                         Standard Hop Table
                      Modem Serial Number 571-0990

        (0)     Set Operation Mode
        (1)     Set Baud Rate
        (2)     Edit Call Boook
        (3)     Edit Radio Transmission Characteristics
        (4)     Show Radio Statistics
        (5)     Edit MultiPoint Parameters
        (6)     TDMA Menu
        (Esc)   Exit Setup
        Enter Choice   3


        RADIO PARAMETERS

        WARNING: Do not change parameters without reading manual

        (0)     FreqKey             0
        (1)     Max. Packet Size    9
        (2)     Min. Packet Size    2
        (3)     Xmit Rate           1
        (4)     RF Data Rate        3
        (5)     RF Xmit Power       9
        (6)     Slave Security      1
        (7)     RTS to CTS          0
        (8)     Retry Time Out      255
        (Esc)   Exit to Main Menu
```

3. Set the "Xmit Rate" of the Grand Master to 0.

```
RADIO PARAMETERS

WARNING: Do not change parameters without reading manual

(0)     FreqKey              0
(1)     Max. Packet Size     9
(2)     Min. Packet Size     2
(3)     Xmit Rate            0
(4)     RF Data Rate         3
(5)     RF Xmit Power        9
(6)     Slave Security       1
(7)     RTS to CTS           0
(Esc)   Exit to Main Menu
```

4. This completes the setup for the Grand Master. The Submasters must be set up with a Frequency Key other than zero. Use a different key for each Submaster.

```
                Version 5.27 03-14-97
                  Standard Hop Table
            Modem Serial Number 571-0990

(0)     Set Operation Mode
(1)     Set Baud Rate
(2)     Edit Call Boook
(3)     Edit Radio Transmission Characteristics
(4)     Show Radio Statistics
(5)     Edit MultiPoint Parameters
(6)     TDMA Menu
(Esc)   Exit Setup
Enter Choice   3

RADIO PARAMETERS

WARNING: Do not change parameters without reading manual

(0)     FreqKey              1
(1)     Max. Packet Size     9
(2)     Min. Packet Size     2
(3)     Xmit Rate            1
(4)     RF Data Rate         3
(5)     RF Xmit Power        9
(6)     Slave Security       1
(7)     RTS to CTS           0
(Esc)   Exit to Main Menu
```

5. The last parameter that needs to be set is MultiMasterSync. This parameter is set to 1 for all Submasters and left at zero (the factory default) for the Grand Master.

```
                    Version 5.27 03-14-97
                    Standard Hop Table
                Modem Serial Number 571-0990

(0)      Set Operation Mode
(1)      Set Baud Rate
(2)      Edit Call Boook
(3)      Edit Radio Transmission Characteristics
(4)      Show Radio Statistics
(5)      Edit MultiPoint Parameters
(6)      TDMA Menu
(Esc)    Exit Setup
Enter Choice   5


                 MULTIPOINT PARAMETERS


WARNING: Do not change parameters without reading manual

(0)      Number Repeaters           0
(1)      Master Packet Repeat       0
(2)      Max. Slave Retry           9
(3)      Retry Odds                 1
(4)      DTR Connect                0
(5)      Repeater Frequency         0
(6)      Network ID               255
(7)      Reserved
(8)      MultiMasterSync            0
(Esc)    Exit to Main Menu
Enter Choice   8
Enter 1 for Master Sync,  0 Otherwise
                 MULTIPOINT PARAMETERS

(0)      Number Repeaters           0
(1)      Master Packet Repeat       0
(2)      Max. Slave Retry           9
(3)      Retry Odds                 1
(4)      DTR Connect                0
(5)      Repeater Frequency         0
(6)      Network ID               255
(7)      Reserved
(8)      MultiMasterSync            1
(Esc)    Exit to Main Menu
```

6. The serial number of the Grand Master must be entered into the callbook of all Submaster modems. Enter it in the next line after the slave serial number. This completes the setup procedure.

7. Baud Rate Selections

(1) Set Baud Rate

When item (1) is selected, you will be able to change the modem's RS-232 baud rate—the communication rate between the modem and the instrument to which it is connected. This is independent of the baud rate for the other modem(s) in the communication loop. For example, the modem 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 modem on the instrumentation might be set to 9600, and the modem on the computer might be set to 57,600 or 115,200.

Set the baud rate to the highest level supported by the device to which it is connected. However, this may actually result in slower data communications in certain circumstances. Your baud-rate options are shown below, along with word structure and Modbus RTU. Note that changes to the speed or structure will take effect after you're out of configuration mode. Defaults are 19,200 for speed, 8 Data Bits/No Parity/1 Stop Bit for word structure, and Disabled for Modbus RTU.

```
(1)   115,200
(2)   76,800
(3)   57,600
(4)   38,400
(5)   19,200
(6)   9600
(7)   4800
(8)   2400
(9)   1200
(A)   Data, Parity    0 ─────────────────────►  0 = 8 Bits   No     1
(B)   Modbus RTU      0 ──► 0 = Disable          1 = 7 Bits   Even   1
                            1 = Enable           2 = 7 Bits   Odd    1
                                                 3 = 8 Bits   No     2
                                                 4 = 8 Bits   Even   1
                                                 5 = 8 Bits   Odd    1
```

8. Call Book Selections

(2) Edit Call Book

The Call Book allows the user to determine with which other modems a given modem will communicate, based on the serial numbers for both the master and slave. The modem'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 modems 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 8-1, the Call Book allows you to set up a list of up to 10 modems with which the modem can communicate, designate up to 2 repeaters to be used in communicating with a given modem, 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, 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 before making contact with the slave.

```
┌─────────────────────────────────────────────────────────┐
│ ▬                  Terminal-TERMINAL.TRM                  │
├─────────────────────────────────────────────────────────┤
│ File   Edit   Settings   Phone   Transfers   Help        │
├─────────────────────────────────────────────────────────┤
│                      DGR 900S MAIN MENU                   │
│                  Modem Serial Number 554-0024             │
│                                                           │
│   (0)    Set Operation Mode                               │
│   (1)    Set Baud Rate                                    │
│   (2)    Edit Call Book                                   │
│   (3)    Edit Radio Transmission Characteristics          │
│   (4)    Show Radio Statistics                            │
│   (Esc)  Exit Setup                                       │
│                                                           │
│   Enter Choice   2                                        │
│                                                           │
│                            MODEM CALL BOOK                │
│                            Entry to Call is 04            │
│                                                           │
│   Entry  Number      Repeater 1    Repeater 2            │
│   (0)    555-0025                                          │
│   (1)    555-0017    555-0011                             │
│   (2)    555-0013                                          │
│   (3)    555-0025    555-0018                             │
│   (4)    555-0001    555-0011                             │
│   (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  │
└─────────────────────────────────────────────────────────┘
```

Figure 8-1. The Modem Call Book Menu.

8.1 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 to 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 to 0000), you will be asked for the number for the repeaters to be used. If no repeaters are to be used, press 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, press the number at this time; if not, press the escape key. Once again the modem will retain your entries, as shown in the updated Call Book menu screen.

NOTE

Fill the Call Book slots (0 - 9) 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.

8.2 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, you must have the master's serial number in each slave's and repeater's Call Book, and each repeater's serial number in the Call Book of each slave that may potentially communicate through it.

The following example shows the Call Books of a multipoint system made up of a master, repeater, and slave. The slave can communicate either through the repeater or directly to the master.

Multipoint Master Call Book (Unit Serial Number 5XX-0001, for example)

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 5XX-0002, for example)

Entry	Number	Repeater1	Repeater2
(0)	5XX-0001		
(1)	000-0000		

Multipoint Slave Call Book (Unit Serial Number 5XX-0003, for example)

Entry	Number	Repeater1	Repeater2
(0)	5XX-0001		
(1)	5XX-0002		
(2)	000-0000		

9. Radio-Transmission Parameters

(3) Edit Radio Transmission Characteristics

When item (3) is selected in the main menu, the screen in Figure 9-1 appears. This screen allows you to modify the radio-transmission characteristics of the Modems. 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.

The radio parameters between any Modems in communication will be determined by the settings for the master (except when in Multipoint mode; see **(4) RF Data Rate** in this section). While the settings may be modified for the slave(s) and/or repeaters, they will be overridden by the master's parameters.

```
┌─────────────────────────────────────────────────────────────────┐
│ ▭                      Terminal-TERMINAL.TRM                       │
│ File    Edit    Settings    Phone    Transfers    Help            │
├───────────────────────────────────────────────────────────────────┤
│                             MAIN MENU                             │
│                       Version 4.56  02-20-96                      │
│                         Standard Hop Table                        │
│                    Modem Serial Number 554-0002                   │
│                                                                   │
│   (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                               │
│   (Esc)  Exit Setup                                               │
│                                                                   │
│   Enter Choice    3                                               │
│                                                                   │
│                         RADIO PARAMETERS                          │
│                                                                   │
│   WARNING:  Do not change parameters without reading manual       │
│                                                                   │
│   (0)    FreqKey           5                                      │
│   (1)    Max Packet Size   8                                      │
│   (2)    Min Packet Size   2                                      │
│   (3)    Xmit Rate         1                                      │
│   (4)    RF Data Rate      3                                      │
│   (5)    RF Xmit Power     9                                      │
│   (6)    Slave Security    0                                      │
│   (7)    RTS to CTS        0                                      │
│   (8)    Retry Time Out    255                                    │
│   (Esc)  Exit to Main Menu                                        │
└───────────────────────────────────────────────────────────────────┘
```

Figure 9-1. The RF115 Radio Parameters Menu.

(0) FreqKey

Selection (0) in the Radio Parameters menu allows you to modify the hopping patterns of the modems. This is important for minimizing the interference with other RF115 modems operating in the same area. For instance, if there were 10 pairs of modems operating 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 through 9 and A through E). We recommend that you maintain a list of the settings for each master to ensure that each is set to a different hopping pattern.

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

Selections (1) and (2) allow the user to designate the size of the packets used by the modem in its communication link. This may be of particular value when using the modem with different communications software packages; you may find that throughput is optimized when packet sizes are restricted by the modem.

Packet size is determined by a combination of the setting entered by the user and the RF Data Rate. In addition, the Max Packet Size is a function of the setting selected for the Min Packet Size. Tables 9-1, 9-2, and 9-3 provide the packet sizes for each different combination of settings.

Table 9-1. Minimum Packet Size Settings

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 9-2. Max. Packet Size Settings RF Data Rate=2

Min. Setting	Max. Setting									
	0	1	2	3	4	5	6	7	8	9
0	16	32	48	64	80	96	112	128	144	160
1	21	37	53	69	85	101	117	133	149	165
2	26	42	58	74	90	106	122	138	154	170
3	32	48	64	80	96	112	128	144	160	176
4	37	53	69	85	101	117	133	149	165	181
5	42	58	74	90	106	122	138	154	170	186
6	48	64	80	96	112	128	144	160	176	192
7	53	69	85	101	117	133	149	165	181	197
8	58	74	90	106	122	138	154	170	186	202
9	64	80	96	112	128	144	160	176	192	208

Table 9-3. Max. Packet Size Settings RF Data Rate=3

Min. Setting	Max. 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, the modem should be set at Transmit Rate 1. Transmit Rate 0 is useful for estimating the signal strength. When set to Transmit Rate 0, the modems will transmit 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 fainter the LED is, the weaker the signal.

Because the modems 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

The modem has two settings for the RF Data Rate (not to be confused with the RS-232 Baud Rate). Use Setting 2 when the modems are close together and you want to optimize data throughput. Use Setting 3 when the modems are farther away and you prefer a solid data link over data throughput.

NOTE

When using the modems in Multipoint mode, the RF Data Rate setting must be identical for all units in the system. Any modem with an RF Data Rate different from the master's will not establish a communication link.

(5) RF Xmit Power

You can modify the transmission power of the modem. By reducing the transmission power when appropriate, you can ensure that the modems do not overwhelm each other when used in close proximity. There are 10 power settings available (0-9). The settings are roughly linear: A setting of 9 is full power (1 watt) and 0 is 10% power (100 mW). Follow the guidelines on the next page when setting the RF Transmission Power:

Table 9-4. Power Transmit Settings

Setting	Power Level	Used When
0 - 3	Low	Pair or pairs of modems 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, you can disable the modem's security so it will accept a call from any other modem. With a setting of 0 (the default), 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 (see page 15), Slave Security must be set to 1 when the modem is operating in a point-to-point system where it may need to accept calls from more than 10 different modems. However, when Slave Security is set to 1, the modem will accept calls from any other RF115 modem, and additional system security measures should be taken to prevent unauthorized access.

(7) RTS to CTS

Menu selection 7 in the Radio Parameters allows 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, we do not recommend enabling this feature when operating at RS-232 speeds above 38.4 kbps.

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 whether there is data to be sent or not. (If there is data to be sent, 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 unrelated 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 will produce a maximum latency time of approximately 25 ms. At their minimum numbers, the time will be approximately 10 ms. This latency can go up significantly if packets are lost between the master and slave. In point-to-multipoint mode, there can be no absolute guarantee that the state change will not 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" setting in the Radio Parameters screen is the number of hops through which the slave (or repeater) radio will look for its master without receiving a recognized packet after recognizing its master.

When a slave (or repeater) modem is powered up, it will go into "hunt" mode. When in hunt mode, it will hunt for a data packet that it recognizes as a valid packet from a device that it is configured to communicate with (through addressing). The master unit will start broadcasting data packets when it is powered up. When a slave (or repeater) recognizes a data packet, it will link up with the sending unit by way of an acknowledgment packet and turn its carrier on. In a point-to-point system, the master will then turn its carrier on. In a multipoint system, the master's carrier will only come on when it is receiving data from a slave. If the slave (or repeater) does not receive a valid packet within a certain number of hops, it will go back into hunt mode.

The default number of hops that a slave (or repeater) will wait without receiving a valid packet before going into hunt mode is 255. The "Retry Time out" setting allows that to be turned down as low as 8 hops. This may be useful in situations involving moving equipment. When a device that is mobile has a radio link that may need to connect with more than one master or repeater, once it loses the link with one master (or repeater) it can quickly pick another. Note that in point-to-point, the Retry Time out cannot be set below 150.

Show Radio Statistics

Option (4) in the main menu allows you to view data-transmission statistics that have been gathered by the modem during the most recent session. This is useful when you want to look at signal strength, noise levels, bytes transmitted, bytes received, and the distance of the link between modems. 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 Technical Support 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.

NOTE

This technique can only be accurately used in point-to-point mode from the master.

10. The Modem Location

Placement of your modem is likely to have a significant impact on its performance. In general, the rule of thumb with the modem is that the higher up the antenna, the better the communication link. You should also place the modem away from computers, telephones, answering machines, and other similar equipment. A 6-foot RS-232 cable will usually provide ample room for placement away from other equipment. To improve the data link, the modem is offered with a directional or omnidirectional external antenna 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 modem is located close to pager or cellular-telephone transmission towers, the modem offers a band-pass filter to reduce the out-of-band noise.

The standard enclosure for the modem does not provide protection against water or environmental hazards, and will fade when placed in direct sunlight. For outdoor applications, use a weather-resistant enclosure.

11. Modem Radio Diagnostic LEDs

The four LEDs on the modem's front panel provide information on the operation
of the modem:

P Power

C Carrier

I Data In (of the port)

O Data Out (of the port)

The **Power** LED indicates that the modem is powered up and ready to operate.

The **Carrier** LED indicates that the modem has established a link. In point-to-point
mode, all of the modems in the system will have their carriers on when a
communications link is established. In multipoint mode, the master's carrier will
only come on when a slave or repeater is broadcasting to it. The slaves and
repeaters will have a carrier LED lit when they have established a link with the
master. Data does not need to be moving, nor does the modem need any
handshaking lines, for the carrier to be established.

The **I** and **O** LEDs indicate data is moving in and out of the port. These LEDs are
tied to the communications port and not the RF section of the modem.

12. Using an External Antenna

In certain circumstances, you might want to extend the range of the modem by using an external antenna in place of the standard whip antenna. The modem is equipped with a non-standard external jack allowing the use of a directional Yagi or omnidirectional antenna. When using an external antenna, the whip antenna must be removed.

The use of an external antenna may radically improve the results obtained with RF115 modems. You'll want to obtain line of sight with the antennas, and changes in placement height of as little 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 the modem must be provided by Black Box. We offer a variety of omnidirectional and directional external antennas. These antennas allow versatility in the modem's deployment, extending its range and allowing it to get around obstructions. Please contact Technical Support if your application indicates the need for external antennas.

Choose from the following:

- Omnidirectional with Bracket Mount with 10-ft. cable (MDR151-0010-R2)

- Omnidirectional with Bracket Mount with 25-ft. cable (MDR151-0025-R2)

- Omnidirectional with Bracket Mount with 50-ft. cable (MDR151-0050-R2)

- Omnidirectional with Bracket Mount with 100-ft. cable (MDR151-0100-R2)

- Yagi (Unidirectional) with Bracket Mount with 25-ft. cable (MDR152-0025-R3)

- Yagi (Unidirectional) with Bracket Mount with 50-ft. cable (MDR152-0050-R3)

- Yagi (Unidirectional) with Bracket Mount with 100-ft. cable (MDR152-0100-R3)

WARNING

Any antennas placed outdoors must be properly grounded. Use extreme caution when installing antennas and follow all instructions included with the antennas. Lightning-protection equipment is strongly recommended.

13. RS-232 Pin Assignments

Table 13-1. RS-232 Pin Assignments

<u>Pin</u>	<u>Assignment</u>
1	Carrier Detect
2	Transmit Data
3	Receive Data
4	Data Terminal Ready
5	Ground
6	Data Set Ready
7	Ready To Send
8	Clear to Send
9	Ground

14. Data Communications Settings

The device to which the modem is connected should be configured to match the settings shown in Table 14-1.

Table 14-1. Data Communications Parameter Settings

Parameter	Setting
Baud Rate	Match to the RF115
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

15. Establishing Data-Communication Links with the Modem

The modem'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 the modem and get around obstacles.

Figure 15-1 shows the most common and straightforward link, a master communicating to a slave in a dedicated link.
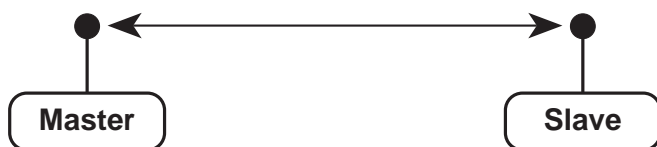
Figure 15-1. Master Communicating to a Slave in a Dedicated Link.

Figure 15-2 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, you might want to use an external omnidirectional antenna on the repeater; to extend the range, you could use Yagi antennas on either or both of the master and slave.

When a repeater is used, the RF speed is cut in half, making 115-kbps uncompressed throughput unachievable. The baud rate, however, may still be set at 115200.
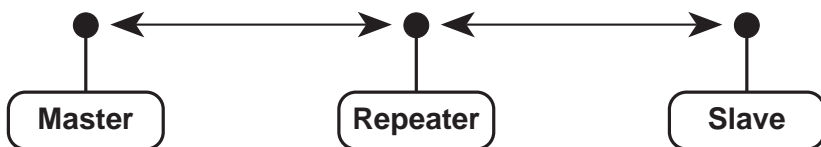
**Figure 15-2. Setting Up a Link Using a Repeater.**

Figure 15-3 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.

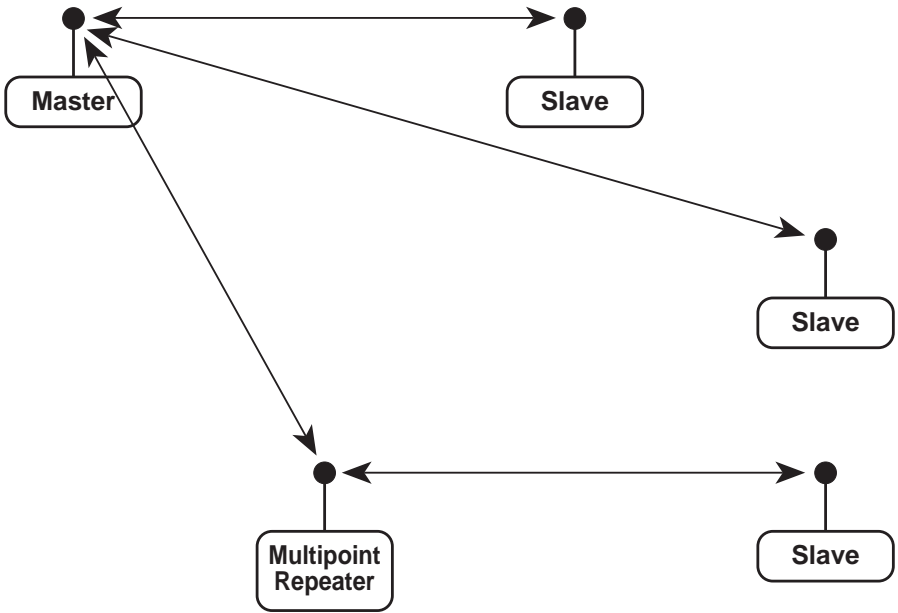When two repeaters are used, there is no further degradation in the RF speed of the link.
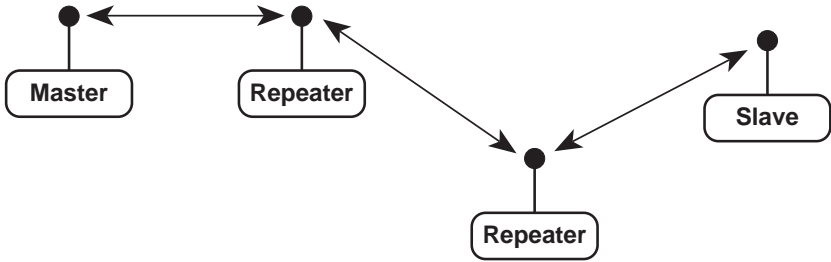
Figure 15-3. Link with Two Repeaters Between the Master and Slave.

Figure 15-4 shows a setup where a master routinely calls a number of slaves at different times. The master is communicating with a modem 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 modem 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.
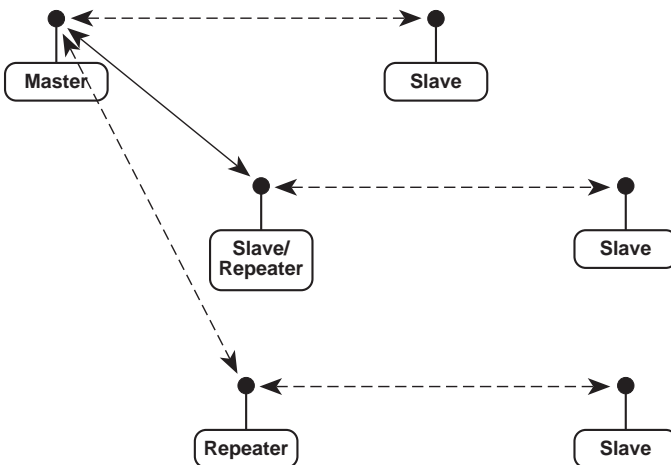
Figure 15-4. Master Calling a Number of Slaves.

Figure 15-5 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 RS-232 port of each of the three slaves.

Figure 15-5. Standard Point-to-Multipoint System.

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