LRS455 Wireless Data Transceiver

LRS455-C-U
LRS455-T-U
LRS455-CE-U
LRS455-TE-U

Covering Firmware 1.72

User Manual and Reference Guide

Part Number: LUM0016AB
Revision: D
Last Updated: 04/02/2012

Safety Information

The products described in this manual can fail in a variety of modes due to misuse, age, or malfunction. Systems with these products must be designed to prevent personal injury and property damage during product operation and in the event of product failure.

Warning! ***Do not*** remove or insert diagnostics cable while circuit is live unless the area is known to be free of ignition concentrations of flammable gases or vapors.

Warranty

FreeWave Technologies, Inc. warrants your FreeWave® Wireless Data Transceiver against defects in materials and manufacturing for a period of three years from the date of shipment. In the event of a Product failure due to materials or workmanship, FreeWave will, at its option, repair or replace the Product. The Product must be returned to FreeWave upon receiving a Return Material Authorization (RMA) for evaluation of Warranty Coverage.

In no event will FreeWave Technologies, Inc., its suppliers, and its licensors be liable for any damages arising from the use of or inability to use this Product. This includes business interruption, loss of business information, or other loss which may arise from the use of this Product. Please be advised that OEM customer's warranty periods may vary.

Warranty Policy may **not apply**:

1. If Product repair, adjustments or parts replacements is required due to accident, neglect, unusual physical, electrical or electromagnetic stress.
2. If Product is used outside of FreeWave specifications.
3. If Product has been modified, repaired, or altered by Customer unless FreeWave specifically authorized such alterations in each instance in writing. This includes the addition of conformal coating.

Special Rate Replacement Option

A special rate replacement option is offered to non-warranty returns or upgrades. The option to purchase the replacement unit at this special rate is only valid for that RMA. The special replacement rate option expires if not exercised within 30 days of final disposition of RMA.

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FreeWave's Wireless Data Transceivers are designed and manufactured in the United States of America.

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UL Notifications

Models LRS455-C-U, LRS455-CE-U, LRS455-T-U, LRS455-TE-U are suitable for use in Class 1, Division 2, Groups A, B, C, and D or non-hazardous locations only.

Warning! Do not remove or insert diagnostics cable while circuit is live unless the area is known to be free of ignition concentrations or flammable gases and vapors.

Input voltage for the above models is +6.0 to +27.0 VDC.

Important: UL approved devices must be connected to a single Class 2 power source.

FCC Notifications

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: 1) This device may not cause harmful interference and 2) this device must accept any interference received, including interference that may cause undesired operation.

This device must be installed and operated as supplied by FreeWave Technologies, Inc.. Any changes or modifications made to the device without the express written approval of FreeWave Technologies, Inc. may void the user's authority to operate the device.

Warning! The LRS455 transceivers have a maximum transmitted output power of 2 W. It is recommended that the transmit antenna be kept at least 18.3 cm away from nearby persons to satisfy FCC RF exposure requirements.

Whenever any FreeWave Technologies, Inc. module is placed inside an enclosure a label must be placed on the outside of that enclosure which includes the module's FCC ID.

Note: The LRS455 transceivers are approved for use in Canada within the 450 MHz to 470 MHz band.

Document Revision History

Date	Rev Letter	Updates Made
04/02/2012	D	Updated Appendix A to contain the correct information and known limitations for firmware versions 1.71 and 1.72.
03/19/2012	C	The following information has been updated: • As of March 19, 2012, the warranty length for LRS455 series radios has been extended to three years, as indicated in the warranty statement on page ii. • Removed reference to 115.2 Kbaud in "Max Packet Size and Min Packet Size" on page 31. 115.2 Kbaud does not apply to LRS455 models.
02/17/2012	B	Added information about decreased throughput when adding Repeaters to a narrow-band network to the following sections: • "Choosing Point-to-Point or Point-to-MultiPoint Operation" on page 2. • "Repeaters" on page 38. • "Data Communication Link Examples" on page 53. Updated Baud Rate parameter description on page 27 to indicate that Flow Control should be considered if using a baud rate higher than 9600 bps.
01/09/2012	A	Added the following information: • Tool Suite procedures throughout. • Power supply connection information on on page 12. • Firmware revision information is available in Appendix A. Updated document's organization. Updates included but are not limited to the following: • Document is now broken into chapters to help make information easier to find. See the table of contents. • All parameters that you can set on the transceiver are now listed in alphabetical order in the Parameter Reference chapter.

Table Of Contents

Preface

This document includes the following information regarding the FreeWave LRS455 transceiver:

- A basic introduction to the transceiver and how to determine the mode you want to run it in.
- Considerations and quick starts for your network design, including charts of LED displays.
- Steps to setting up and programming the transceiver using Tool Suite and HyperTerminal.
- A reference section that details each parameter that you can set on the transceiver.
- Steps to view statistics about an transceiver's performance.
- Examples of how FreeWave transceivers can exist in a network with other transceivers.
- Pin out and mechanical drawings.

For information about the firmware releases that apply to the transceiver, see Appendix A.

Notational Conventions

This guide uses the following notational conventions:

- **Bold** - Indicates items that you select, parameter settings, and parameter names.
-  **Warning!** - Indicates a situation that might cause damage to your radio, data, or network.
-  - Provides time saving or informative suggestions about using the product.

The term "radio" and "transceiver" are used throughout this manual to refer to the LRS455-CU.

Contacting FreeWave Technical Support

For up-to-date troubleshooting information, check the Support page at www.freewave.com.

FreeWave provides technical support Monday through Friday, 7:30 AM to 5:30 PM Mountain Time (GMT -7). Call toll-free at 1.866.923.6168, within Colorado call 303.381.9200, or contact us through email at moreinfo@freewave.com.

Documentation Feedback

Your feedback is important to us! FreeWave Technologies, Inc. is committed to continually improving the quality of our documentation. If you have any comments or suggestions about this document, send them to us at techpubs@freewave.com. Please include the title of the document or the document's part number in your email.

Chapter 1: Introduction

FreeWave transceivers operate in virtually any environment where serial data communications occur. A pair of transceivers function as a 9-pin null modem cable. If the FreeWave transceivers are to be used in an application where a null modem cable is used, such as communication between two computers, then the FreeWave transceivers can be connected directly. If FreeWave transceivers are to be used to replace a straight-through RS232 cable, then a null modem cable must be placed between the transceiver and the DTE instrument to which it is connected.

Warning! Do not connect the LRS455 series radios to DC power without terminating the antenna port to a suitable load, such as a 50 ohm antenna, or an attenuator with a power rating greater than or equal to 2 W. Powering up without a load attached will damage your radio and void the warranty.

Choosing a Location for the Transceivers

Placement of the FreeWave transceiver is likely to have a significant impact on its performance. The key to the overall robustness of the radio link is the height of the antenna. In general, FreeWave units with a higher antenna placement will have a better communication link. In practice, the transceiver should be placed away

from computers, telephones, answering machines, and other similar equipment. The RS232 cable included with the transceiver usually provides ample distance for placement away from other equipment. FreeWave offers directional and Omni directional antennas with cable lengths ranging from 3 to 200 feet. When using an external antenna, placement of that antenna is critical to a solid data link. Other antennas in close proximity are a potential source of interference. Use the Radio Statistics to help identify potential problems.

The Show Radio Statistics page is found in option 4 in the main HyperTerminal menu or in the Diagnostic information in Tool Suite. An adjustment as little as 2 feet in antenna placement can resolve some noise problems. In extreme cases, such as when interference is due to a Pager or Cellular Telephone tower, the band pass filters that FreeWave offers may reduce this out-of-band noise.

Choosing Point-to-Point or Point-to-MultiPoint Operation

Note: In an LRS455 radio network, you can use only one Repeater.

A Point-to-Point network is best suited when your network consists of one Master and one Slave transceiver.

Important: Adding a Repeater to a network reduces the throughput by 50%. For example, Over-the-Air throughput in a network running at 2-Level GFSK and with the **Repeater** parameter disabled is 9600 bps. With the **Repeater** parameter enabled, the Over-the-Air throughput drops to 4400 bps.

The LRS455 radios are narrowband radios and have a limited channel size based on the license obtained from the FCC. Therefore, the radios can experience a dramatic impact in throughput if Repeaters are implemented in the network. If you have large amounts of data to transfer and choose to enable Repeaters in your network, you must optimize polling host / RTU settings must to accommodate for the lower throughput. Polling host / RTU optimization settings include reducing block/packet sizes and increasing overall time-out parameters.

In a Point-to-MultiPoint network (also referred to as MultiPoint network) the Master transceiver is able to simultaneously communicate with numerous Slaves. In its simplest form, a MultiPoint network functions with the Master broadcasting its messages to all Slaves. If requested by the Master, the Slaves respond to the Master when given data by the device connected to the data port. This response depends on your setup. You can extend the reach of a licensed network with up to one Repeater. As with Repeaters in a Point-to-Point network, adding Repeaters to a network cuts the throughput by half.

It is important to note the differences between Point-to-Point and MultiPoint networks.In a Point-to-Point network all packets are acknowledged, whether sent from the Master to the Slave or from the Slave to the Master. In a MultiPoint network, you determine the set number of times outbound packets from the Master or Repeater to Slaves or other Repeaters are sent. The receiving transceiver, Slave or Repeater, accepts the first packet received that passes the 32 bit CRC. However, the packet is not acknowledged. On the return trip to the Master, all packets sent are acknowledged or retransmitted until they are acknowledged. Therefore, the return link in a MultiPoint network is generally very robust.

Traditionally, a MultiPoint network is used in applications where data is collected from many instruments and reported back to one central site. The architecture of such a network is different from Point-to-Point applications. The following parameters influence the number of transceivers that can exist in a MultiPoint network:

1. Size of the blocks of data. The longer the data blocks, the fewer number of deployed Slaves can exist in the network.

2. Baud rate. The data rate between the transceiver and the device to which it is connected could limit the amount of data and the number of transceivers that can exist in a network
3. The amount of contention between Slaves. Polled Slaves vs. timed Slaves.
4. Use of Repeaters. Using the **Repeater** setting in a MultiPoint network decreases overall network capacity by 50%.

For example, if the network polls Slaves once a day to retrieve sparse data, several hundred Slaves could be configured to a single Master. However, if each Slave transmits larger amounts of data or data more frequently, then fewer Slaves can link to the Master while receiving the same network performance. When larger amounts of data are sent more frequently, the overall network bandwidth is closer to capacity with fewer Slaves.

For examples and additional information about data communication links, see the Examples of Data Communication Links section later in this document.

Point-to-MultiPoint Network Quick Start

The following is a quick start guide for setting up two transceivers in Point-to-MultiPoint mode. This mode allows for a Master to communicate with several Slaves simultaneously.

Point-to-MultiPoint Network Quick Start (Tool Suite):

1. Connect the transceiver to the serial port of a computer either through a serial cable or using the diagnostics cable. Make sure to connect the radio to a power source (+6.0 to +27.0 VDC).

Warning! Do not connect the LRS455 series radios to DC power without terminating the antenna port to a suitable load, such as a 50 ohm antenna, or an attenuator with a power rating greater than or equal to 2 W. Powering up without a load attached will damage your radio and void the warranty.

2. Open a Tool Suite session, select the **Configuration** application, and ensure the correct port is selected in the **Com Port** field in the upper left of the Configuration ribbon.
3. From the Networks section of the Configuration ribbon, select the network in which the radio resides or click **Add Network** to create a new network in Tool Suite.
4. Click **Read Radio** in the Configuration ribbon to read the radio's current settings.
   - If you are using a diagnostics cable to connect to the radio, the radio automatically goes into Setup mode.
   - If you are using a data cable to connect to the radio, you are prompted to press the radio's Setup button to put the radio in Setup mode. If you are using a board-level radio, use the interrupt line to short pin 2 and 4.
   - When in Setup mode, all three LEDs on the radio display solid green.
5. Select the Operation Mode tab.

   In the **Modem Mode** field, select **2** to set the radio as a Point-to-MultiPoint Master or select **3** to set the radio as a Point-to-MultiPoint Slave.

   Note: A network can have only one Master.
6. Select the Baud Rate tab.

Change the **Baud Rate**, **Data Parity**, and **Modbus RTU** to match the device that the radio is to be attached to.

7. Select the Transmission Characteristics tab.

   Set the following parameters so they are identical on all radios in the network:

   - **Tx Frequency**
   - **Rx Frequency**
   - **Max Packet Size**
   - **Min Packet Size**
   - **RF Data Rate** (Only **RF Data Rate 4** and **5** are approved by the FCC for use in the United States.)

   Changing these settings from the factory defaults may help to eliminate interference from other FreeWave networks.

8. Select the MultiPoint Parameters tab.

   In the **Network ID** field, set the value to any value between **1** and **4095**, except **255**. FreeWave recommends setting the **Network ID** to the last three or four digits of the Master radio's serial number, as this is a number you can look up if necessary. This value must be the same in all radios in the network.

Point-to-MultiPoint Network Quick Start (HyperTerminal):

1. Connect the transceiver to the serial port of a computer either through a serial cable or via the diagnostics cable. Make sure to connect the radio to a power source (+6.0 to +27.0 VDC).

Warning! Do not connect the LRS455 series radios to DC power without terminating the antenna port to a suitable load, such as a 50 ohm antenna, or an attenuator with a power rating greater than or equal to 2 W. Powering up without a load attached will damage your radio and void the warranty.

2. Open a HyperTerminal session and use the following settings when connecting the radio. You can also use Setup Terminal within Tool Suite if HyperTerminal is unavailable.
   - Connect to COMx (where 'x' is the number of the Com port being connected).
   - Set the following:
     - **Data Rate** - 19,200
     - **Data Bits** - 8
     - **Parity** - none
     - **Stop bits** – 1
     - **Flow control** – none
3. If you are using the data cable, press the **Setup** button on the radio or use the interrupt line to short pin 2 and 4. If using the diagnostics cable, press **Shift-U** (capital U).
   - The three LEDs on the radio should all turn green, indicating Setup mode.
   - The Main menu displays on the screen.

4. Press **0** to access the Operation Mode menu.
   - Press **2** to set the radio as a Point-to-MultiPoint Master or press **3** to set the radio as a Point-to-MultiPoint Slave.
   - Press **Esc** to return to the Main menu.

   Note: A network can have only one Master.
5. Press **1** in the Main menu.
   - Change the **Baud Rate**, **Data Parity**, and **Modbus RTU** to match the device that the radio is to be attached to.
   - Press **Esc** to return to the Main menu.
6. Press **3** in the Main menu.

   Set the following parameters so they are the same on all radios in the network:
   - **FreqKey** (Tx Frequency and Rx Frequency)
   - **Max Packet Size**
   - **Min Packet Size**
   - **RF Data Rate** (Only **RF Data Rate 4** and **5** are approved by the FCC for use in the United States.)

   The **Tx Frequency** and **Rx Frequency** options, or Frequency Key, are located in the F submenu after you press **0** to access the Frequency Key menu in Main menu **3**.

   Changing these values may help to eliminate interference from other FreeWave networks.
   - Press **Esc** to return to the Main menu.
7. Press **5** in the Main menu.
   - Set the **Network ID** value to any value between **1** and **4095**, except **255**. FreeWave recommends setting the **Network ID** to the last three or four digits of the Master radio's serial number, as this is a number you can look up if necessary.
   - Ensure this value is the same on every radio in the network.
8. Press **Esc** to exit the Setup menu and resume normal radio operation.

Point-to-MultiPoint Operation LEDs

	Master			Slave			Repeater		
Condition	Carrier Detect (CD)	Transmit (Tx)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (Tx)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (Tx)	Clear to Send (CTS)
Powered, not linked	Solid red bright	Solid red dim	Off	Solid red bright	Off	Blinking red	Solid red bright	Off	Blinking red
Repeater and Slave linked to Master, no data	Solid red bright	Solid red dim	Off	Solid green	Off	Solid red bright	Solid green	Solid red dim	Solid red bright
Repeater and Slave linked to Master, Master sending data to Slave	Solid red bright	Solid red dim	Off	Solid green	Off	Solid red bright	Solid green	Solid red dim	Solid red bright
Repeater and Slave linked to Master, Slave sending data to Master	Solid green RCV data or Solid red bright	Solid red dim	Intermittent flash red	Solid green	Intermittent flash red	Solid red bright	Solid green	Solid red bright	Solid red bright
Master with diagnostics program running	Solid red bright	Solid red dim	Intermittent flash red	Solid green	Intermittent flash red	Solid red bright	Solid green	Solid red bright	Solid red bright

* in an idle condition, the CTS LED is solid red with a solid link, as the link weakens the CTS LED on the Repeater and Slave begins to blink

Point-to-Point Network Quick Start

To establish communications between a pair of FreeWave transceivers just received from the factory, complete the steps described below for each transceiver.

Point-to-Point Network Quick Start (Tool Suite):

1. Connect antennas to the transceivers.
2. Connect the transceiver to the serial port of a computer either through a serial cable or using the diagnostics cable. Make sure to connect the radio to a power source (+6.0 to +27.0 VDC).

Warning! Do not connect the LRS455 series radios to DC power without terminating the antenna port to a suitable load, such as a 50 ohm antenna, or an attenuator with a power rating greater than or equal to 2 W. Powering up without a load attached will damage your radio and void the warranty.

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3. Open a Tool Suite session, select the **Configuration** application, and ensure the correct port is selected in the **Com Port** field in the Configuration ribbon.
4. From the Networks section of the Configuration ribbon, select the network in which the radio resides or click **Add Network** to create a new network in Tool Suite.
5. Click **Read Radio** in the Configuration ribbon to read the radio's current settings.
   - If you are using a diagnostics cable to connect to the radio, the radio automatically goes into Setup mode.

- If you are using a data cable to connect to the radio, you are prompted to press the radio's Setup button to put the radio in Setup mode. If you are using a board-level radio, use the interrupt line to short pin 2 and 4.
- When in Setup mode, all three LEDs on the radio display solid green.

6. Select the Operation Mode tab.

   In the **Modem Mode** field, select to set the radio in Point-to-Point mode. For example, set one radio as a Point-to-Point Master (Mode 0) and the other as a Point-to-Point Slave (Mode 1). For more information about modem modes, see "Modem Mode" on page 34.

   Note: A network can have only one Master.

7. Select the Baud Rate tab.

   Change the **Baud Rate**, **Data Parity**, and **Modbus RTU** to match the device that the radio is to be attached to.

8. Select the Transmission Characteristics tab.

   Set the following parameters so they are identical on all both radios in the network:

   - **Tx Frequency**
   - **Rx Frequency**
   - **Max Packet Size**
   - **Min Packet Size**
   - **RF Data Rate** (Only **RF Data Rate 4** and **5** are approved by the FCC for use in the United States.)

   Changing these values from the factory defaults may help to eliminate interference from other FreeWave networks.

9. Select the Call Book tab.

   Enter the Slave serial number in the Master's Call Book. Enter the Master's Serial number in the Slave's Call Book, or disable Slave Security (in the Slave). For more information about setting up the Call Book see "About the Call Book" on page 21.

   Shortly after both transceivers are plugged in, they should establish a communications link with each other and the connection is complete. Using the table below, verify that the radios are operating as expected.

Point-to-Point Network Quick Start (HyperTerminal):

1. Connect antennas to the transceivers.
2. Connect the transceiver to the serial port of a computer either through a serial cable or using the diagnostics cable. Make sure to connect the radio to a power source (+6.0 to +27.0 VDC).

Warning! Do not connect the LRS455 series radios to DC power without terminating the antenna port to a suitable load, such as a 50 ohm antenna, or an attenuator with a power rating greater than or equal to 2 W. Powering up without a load attached will damage your radio and void the warranty.

3. Open a HyperTerminal session and use the following settings in connecting the radio. You can also use Setup Terminal within Tool Suite if HyperTerminal is unavailable.

- Connect to COMx (where 'x' is the number of the port being connected).
- Set the following:
  - **Data Rate** - 19,200
  - **Data Bits** - 8
  - **Parity** - none
  - **Stop bits** – 1
  - **Flow control** – none

4. If you are using the data cable, press the **Setup** button on the radio or use the interrupt line to short pin 2 and 4. If using the diagnostics cable, press **Shift-U** (capital U).
   - The three LEDs on the radio should all turn green, indicating Setup mode.
   - The Main menu displays on the screen.
5. Press **0** to access the Operation Mode menu.
   - Press **0** to set the radio as a Point-to-Point Master or press **1** to set the radio as Point-to-Point slave. For more information about the available operation modes, see "Modem Mode" on page 34.
   - Press **Esc** to return to the Main menu.
6. Press **1** in the Main menu.
   - Change the **Baud Rate**, **Data Parity**, and **Modbus RTU** to match the device that the radio is to be attached to.

     When setting the transceiver's baud rate, its RS232 data rate is set. The baud rate does not have to be the same setting for the two transceivers in the Point-to-Point network.
   - Press **Esc** to return to the Main menu.
7. Press **2** in the Main menu to update the Call Book.

   Enter the Slave serial number in the Master's Call Book. Enter the Master's Serial number in the Slave's Call Book, or disable Slave Security (in the Slave). For more information about setting up the Call Book see "About the Call Book" on page 21.
8. Press **3** in the Main menu.

   Set the following parameters so they are identical on all both radios in the network Point-to-Point network:
   - **Tx Frequency**
   - **Rx Frequency**
   - **Max Packet Size**
   - **Min Packet Size**
   - **RF Data Rate** (Only **RF Data Rate 4** and **5** are approved by the FCC for use in the United States.)

   The **Tx Frequency** and **Rx Frequency** options, or Frequency Key, are located in the F submenu after you press 0 to access the Frequency Key menu in menu 3.

Note: Changing these values from the factory defaults may help to eliminate interference from other FreeWave networks.

Shortly after both transceivers are plugged in, they should establish a communications link with each other and the connection is complete. Using the table below, verify that the radios are operating as expected.

9. Press **Esc** to exit the Setup menu and resume normal radio operation.

Point-to-Point Operation LEDs

	Master			Slave			Repeater		
Condition	Carrier Detect (CD)	Transmit (Tx)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (Tx)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (Tx)	Clear to Send (CTS)
Powered, no link	Solid red bright	Solid red bright	Solid red bright	Solid red bright	Off	Blinking red	Solid red bright	Off	Blinking red
Linked, no Repeater, sending sparse data	Solid green	Intermittent flash red	Intermittent flash red	Solid green	Intermittent flash red	Intermittent flash red	n/a	n/a	n/a
Master calling Slave through Repeater	Solid red bright	Solid red dim	Solid red bright	Solid red bright	Off	Blinking red	Solid red bright	Off	Blinking red
Master linked to Repeater, not to Slave	Flashing orange	Solid red dim	Solid red bright	Solid red bright	Off	Blinking red	Solid Red bright	Solid red dim	Solid red bright
Repeater linked to Slave	Solid green	Intermittent flash red	Intermittent flash red	Solid green	Intermittent flash red	Intermittent flash red	Solid green	Intermittent flash red	Intermittent flash red
Mode 6 - waiting for ATD command	Solid red bright	Off	Blinking red	Solid red bright	Off	Blinking red	n/a	n/a	n/a
Setup Mode	Solid green	Solid green	Solid green	Solid green	Solid green	Solid green	Solid green	Solid green	Solid green

Chapter 2: Setting Up and Programming Transceivers

This chapter provides details about setting up and programming your transceiver using the setup tools available.

Note: The terms modem and transceiver are used interchangeably in this manual and in the text within the setup tools. While the words have different meanings, the two terms should be treated as one and the same when referring to FreeWave products.

After the transceiver is powered and connected with a cable to the programming computer, you can use Tool Suite or HyperTerminal to access and program the device.

You can use the following setup tools to configure the settings on your transceiver:

- **Tool Suite** - Tool Suite is the newest configuration software and replaces EZConfig, and is the recommended method for programming your transceivers.

  It provides a group of tools for configuring the devices in your network and for monitoring your network's performance. Using the Configuration application within Tool Suite, you can program changes to your transceiver's settings. Tool Suite is available on the *User Manual and System Tools* CD and is also available for download from www.freewave.com.

  For more information about using Tool Suite, see the *Tool Suite User Manual* available on the *User Manual and System Tools* CD or by selecting **File > Help** in the Tool Suite software.

- **HyperTerminal** - HyperTerminal is an emulation program that offers the same configuration options that are available in the Configuration application in Tool Suite.

  If you run versions of the Windows operating system prior to Windows 7, HyperTerminal is included in the operating system installation. However, if you are running Windows 7 or newer, HyperTerminal is no longer available. If you prefer the HyperTerminal interface, the Setup Terminal application within Tool Suite provides the same interface that is available using HyperTerminal.

For more information about using HyperTerminal, see "Accessing the Setup Menu Using HyperTerminal " on page 14.

Powering the Transceiver

To provide power to the transceiver, connect it to a positive supply with +6.0 to +27.0 VDC (typically, +12 VDC).

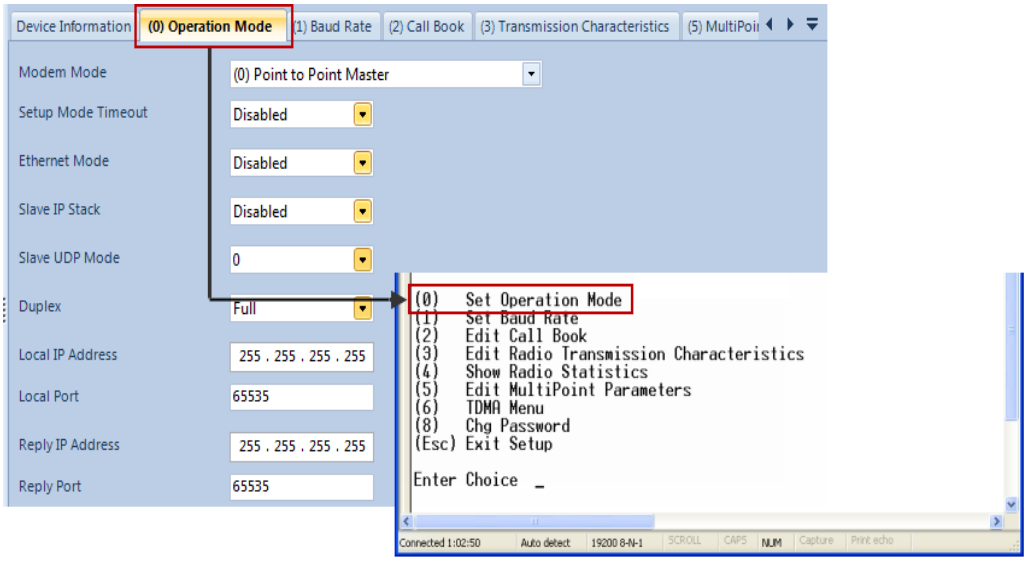
Using a dedicated power supply line is preferred. The power supply you use must provide more current than the amount of current drain listed in the "LRS455 Specifications" on page 58 for the voltage you are using. For example, if you are using +12 VDC, the power supply must provide above the drain that is required for transmit using +12 VDC.

Warning! Do not connect the LRS455 series radios to DC power without terminating the antenna port to a suitable load, such as a 50 ohm antenna, or an attenuator with a power rating greater than or equal to 2 W. Powering up without a load attached will damage your radio and void the warranty.

If the power supply line runs outside the radio enclosure, use electrostatic discharge (ESD) protectors to protect the radio from electric shock, and transient voltage suppressors (TVS) to protect from an over-voltage situation. Using both helps to ensure long-term, reliable operation. FreeWave does not supply these items, however, they can be purchased at most electronic supply stores.

Tool Suite and HyperTerminal

If you are using HyperTerminal, the tabs for a device in Tool Suite mirror the Setup main menu selections. For example, option **0** from the Setup main menu in HyperTerminal is **Set Operation Mode**. The corresponding configuration tab for the device in Tool Suite is **(0) Operation Mode**.



You can also use the Setup Terminal application within Tool Suite to use and view the HyperTerminal menus. It displays the same menus and provides the same programming settings as you see using HyperTerminal.

Throughout this document, if the setup procedure in HyperTerminal is different than the procedure in Tool Suite, the HyperTerminal instructions are also included.

Using Tool Suite to Connect to and Program Transceivers

To read and program a transceiver using Tool Suite, you need to connect the radio to a desktop computer or a laptop that runs the Tool Suite software.

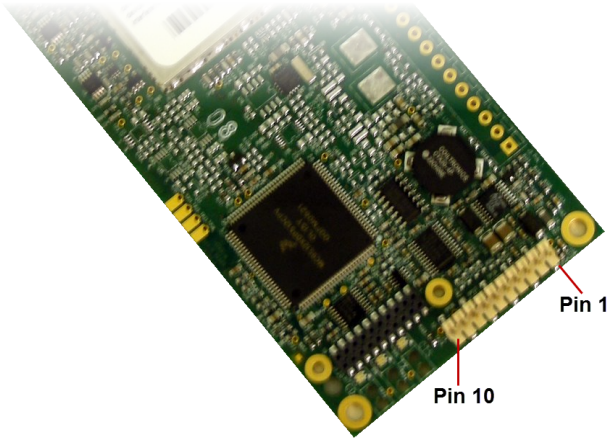
1. Connect a serial or diagnostic cable between the computer or laptop and the transceiver.

   Using a diagnostic cable is recommended.

2. Connect the power supply to the transceiver and the power source and turn on the transceiver.
3. To place the transceiver in Setup mode, press the Setup button on the back of the FreeWave transceiver. If connected to the diagnostics port, type **U** (Capital 'U') to invoke the Setup menu.

   To place the transceiver in Setup mode in board-level transceivers:

   - Short pins 2 & 4 (Brown to Black) on the white 10 pin header next to the LEDs.



   - If using a Data Cable (Freewave part number: ASC3610DB or ASC3610DJ), press the Setup button. If using the gray ribbon Diagnostic Cable (part number: AC2009DC), or the black Diagnostic Cable (part number: ASC0409DC), press Shift-U (capital U).

   All three LEDs on the transceiver light green and stay green as long as the transceiver is in Setup mode.

4. With the radio connected to the computer and in Setup mode, in Tool Suite, click **Configuration** in the Application pane to display the Configuration application.

5. Click **Read Radio** in the Configuration ribbon to read the transceiver's current settings.

   You can also use Tool Suite to set up a template version of a transceiver. Templates include settings that apply to more than one transceiver in your network. For more information about using templates, see the *Tool Suite User Manual* available from the **File > Help** menu within the application.

6. Make the necessary parameter changes and do one of the following to send the changes to the transceiver:

   - To send only the parameters you have changed , within the Configuration application, in the Network Title ribbon, click **Quick**. This option is only available if you clicked Read Radio and are not sending parameter settings from a template to the transceiver.
   - To send all the settings for all parameters, within the Configuration application, in the Network Title ribbon, click **All**.
   - To set a device back to its factory default settings, within the Configuration application, in the Network Title ribbon, click **Default**.

For more information about using Tool Suite, see the *Tool Suite User Manual* available on the *User Manual and System Tools* CD or by selecting **File > Help** in the Tool Suite software.

Accessing the Setup Menu Using HyperTerminal

Note: The screen shots in the following sections represent HyperTerminal in Windows XP. The display may vary slightly if you are using a different operating system.

1. Click the Windows Start button and select **Programs > Accessories > Communications**, and then **HyperTerminal**.

   A window similar to the following displays:

2. Double-click the **Hypertrm.exe** icon.

   The following window displays:

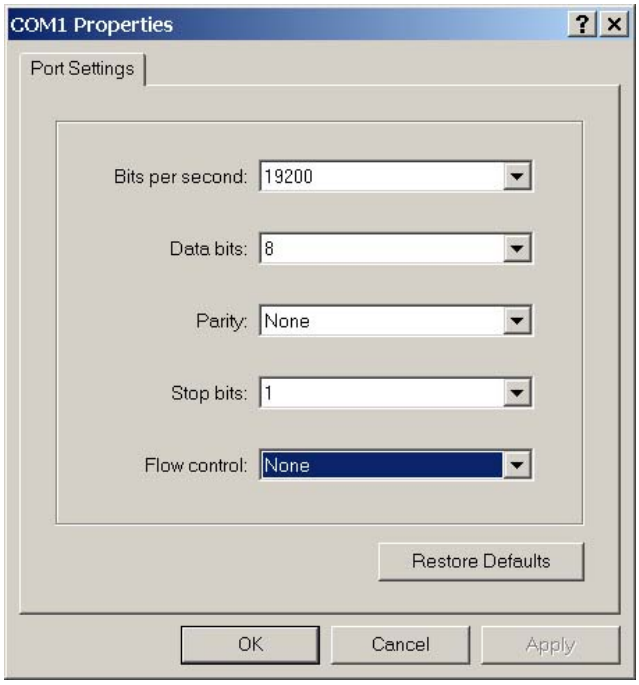
3. In the **Name** field, enter a descriptive name for the connection and select an icon from the Icon selection box.
4. Click **OK**.

   The Connect To dialog box displays.

5. In the **Connect Using** field, select the connection type to use.

   Select the active Com Port to which the radio is connected. In most cases the connection type will either **Direct to Com1** or **Direct to COM2**.
6. Click **OK**.

   The Properties dialog box displays for the selected connection type.

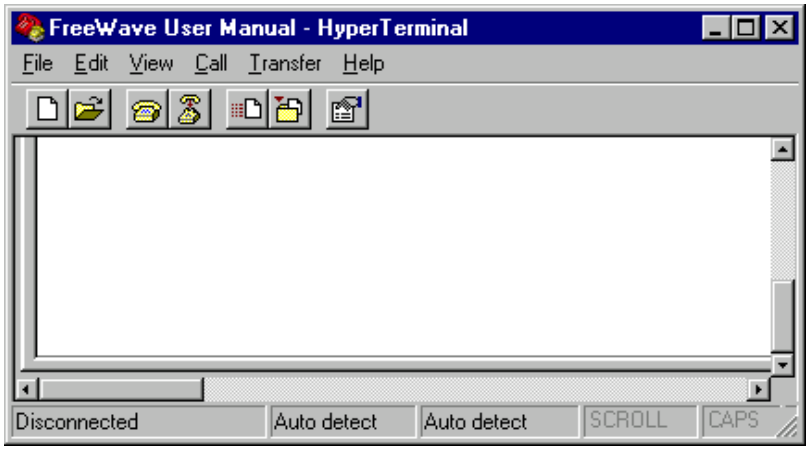


Enter the following port settings for a proper connection:

Port Setting	Select
Bits per second	19200
Data bits	8
Parity	None
Stop bits	1
Flow control	None

7. After selecting the option for each setting, click **OK**.

   The following HyperTerminal dialog box displays:

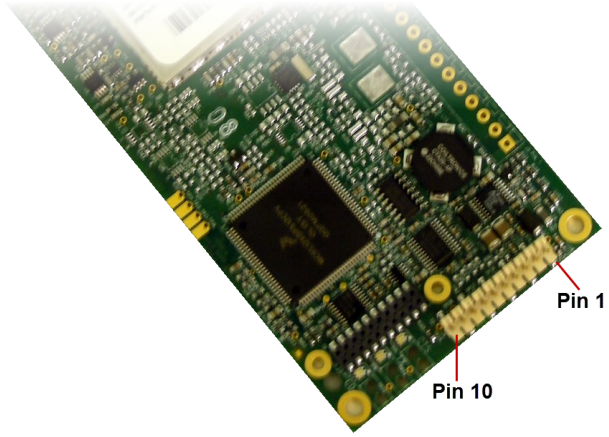


8. From the **File** menu, select **Save** to save the HyperTerminal connection settings

Important: To make changes to the connection properties, you must first disconnect the terminal session.

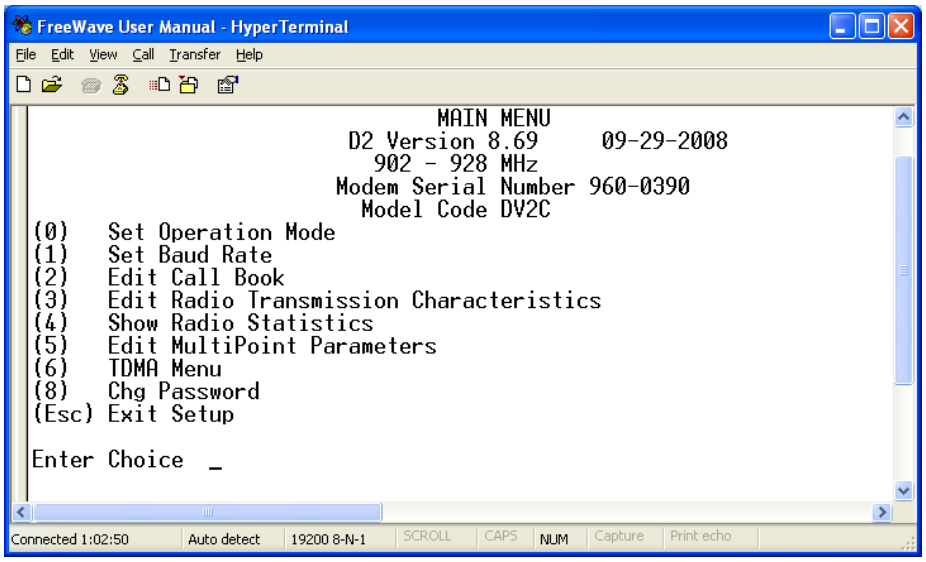
9. To connect HyperTerminal to the transceiver, press the Setup button on the back of the FreeWave transceiver. If connected to the diagnostics port, type **U** (Capital 'U') to invoke the Setup menu.

   - Short pins 2 & 4 (Brown to Black) on the white 10 pin header next to the LEDs. If using a Data Cable (P/N ASC3610DB or ASC3610DJ), press the Setup button.



   - If using the gray ribbon Diagnostic Cable (P/N AC2009DC), or the black Diagnostic Cable (P/N ASC0409DC), press Shift-U (capital U) to invoke the Setup menu.

   When Setup is invoked, the FreeWave Setup Main Menu displays in the HyperTerminal dialog box. All three LEDs on the transceiver light green and stay green as long as the transceiver is in Setup mode.



   As you navigate through the Setup menu and make changes to the parameters, the parameters are sent to the transceiver ***immediately***.

Connecting and Disconnecting from HyperTerminal

The HyperTerminal dialog box displays several icons in the toolbar. To reconnect to HyperTerminal, you need to disconnect your current session. Click the Disconnect  icon, and then click the Call  icon to reconnect. If the settings have not been saved they must be re-selected when HyperTerminal reconnects to the transceiver.

Troubleshooting HyperTerminal

The following are some common issues encountered while using HyperTerminal.

> **Important:** When a change is made to the HyperTerminal settings in an open terminal sessions, the connection must be disconnected then reconnected before the settings take effect.

Nothing displays on the screen after pressing the Setup button on the transceiver.

This usually indicates one of two things; either the wrong COM port is selected or a null modem cable is being used. Follow the steps below to change the COM ports.

1. Click the **Disconnect** icon.
2. From the **File** menu, select **Properties**.
3. Click the **Connect To** tab and verify that the correct COM port is selected.
4. Click **OK** to close the Properties dialog box.
5. Click the **Call** icon.
6. Return the transceiver to Setup mode. The Setup menu screen displays.

In addition, if the radio has been previously configured, you could be using the wrong port to access the Setup menu. For more information, see "Setup Port" on page 43. Try connecting to the other port.

Gibberish displays on the screen after pressing the Setup button.

This usually indicates a Baud Rate problem. Follow the steps below to change Baud Rate. The problem may also be that the transceiver under test is a TTL version or has been set to RS485 and not RS232. If the radio is TTL or in RS485 mode, ensure that you are connected through the Diagnostic port. Gibberish before the Setup button is pressed indicates Diagnostics in enabled in a Master.

1. Click the **Disconnect** icon.
2. From the **File** menu, select **Properties**.
3. Click **Configure**, change the following and click **OK**:
   - **Baud Rate** to **19200**
   - **Data Bits** to **8**
   - **Parity** to **None**
   - **Stop Bits** to **1**
   - **Flow Control** to **1**

4. Click **OK** to close the Properties dialog box.
5. Click the **Call** icon.
6. Return the transceiver to Setup mode. The Setup menu screen displays.

The Setup menu displays on the screen, but nothing happens when keys on the keyboard are pressed.

This usually indicates flow control is turned on in a three-wire connection (Rx, Tx, and Gnd). Follow the steps below if the connection uses a three-wire connection.

1. Click the **Disconnect** icon.
2. From the **File** menu, select **Properties**.
3. Click **Configure**, change the **Flow Control** to **None**, and click **OK**.
4. Click **OK** to close the Properties dialog box.
5. Click the **Call** icon.
6. Return the transceiver to Setup mode. The Setup menu screen displays.

A connection exists, HyperTerminal is receiving data, and some data is correct, but the remaining data is in unrecognizable characters.

This usually indicates a parity mismatch. To resolve this issue, ensure that the parity of the transceiver and the parity of HyperTerminal are set the same. HyperTerminal's parity settings are under Properties and the FreeWave parity is found under the Baud Rate in the Setup menu.

1. Click the **Disconnect** icon.
2. From the **File** menu, select **Properties**.
3. Click **Configure**, change the **Parity** to **None**, and click **OK**.
4. Click **OK** button to close the Properties dialog box.
5. Click the **Call** icon.
6. Return the transceiver to Setup mode. The Setup menu screen displays.

Basic Steps to Programming Serial Transceivers

Use the following basic steps to program any FreeWave transceiver.

1. Be familiar with your network and know if you have a Point-to-Point or Point-to-MultiPoint configuration.

   Most FreeWave networks are Point-to-MultiPoint.
2. Connect the transceiver to the configuration tool, such as Tool Suite or HyperTerminal of your choice.
3. Set the transceiver's operation mode, whether it is a Slave, Repeater, Master, and so on and the network type it is in.
4. Program the receiver, ensuring that all devices in a MultiPoint network have the same settings for the following parameters:

- **Frequency Key**
- **Max Packet Size**
- **Min Packet Size**
- **RF Data Rate**
- **Network ID**

5. Establish the Call Book settings if you are configuring a Point-to-Point network or set the Network IDs and any Subnet IDs if you are configuring a Point-to-MultiPoint network..

   FreeWave recommends using Network IDs instead of the Call Book in MultiPoint networks. If a large MultiPoint network is implemented using the Call Book with **Slave Security** enabled and the Master radio is damaged, you are required to physically reprogram each Slave radio in the network, which can be a time consuming process.

   If you are using a Network ID, see "Network ID" on page 36

MultiPoint Network Considerations

When installing MultiPoint networks it is important to do some up front planning. Unlike Point-to-Point networks, a Point-to-MultiPoint network requires several parameters are set consistently on all transceivers in the network. This includes **RF Data Rate**, **Min and Max Packet Size**, **Network ID**, and the **Frequency Key**.

Note: If several independent MultiPoint networks are to be located in close proximity the planning becomes more critical. In such cases, it becomes very important to include as much frequency and time diversity as possible through use of different **Min and Max Packet Size**. In some instances the use of the **MultiMaster Sync** option may be required.

Upgrading Transceivers to the Latest Firmware

If Tool Suite is connected to a transceiver, and a new version of the firmware is available for that transceiver model, an indication displays within the Configuration application's Device Information tab within Tool Suite.

For more information about using Tool Suite, see the *Tool Suite User Manual* available on the *User Manual and System Tools* CD or by selecting **File > Help** in the Tool Suite software.

Note: You can only use Tool Suite to upgrade firmware on a serial transceiver that is connected directly to the computer using the diagnostic cable. You cannot complete an over-the-air upgrade using Tool Suite.

Use the steps below to upgrade a transceiver to the latest firmware:

1. With the transceiver connected to your computer through the Com port, open Tool Suite and click **Configuration** in the Applications pane to display the Configuration application.

   If you are using a USB-to-serial converter cable, a firmware upgrade can take a long time to complete. FreeWave recommends using only USB-to-serial cables that include the FTDI Chip Set. This inclusion is listed on the cable's packaging.

2. Click **Upgrade Radio** in the Firmware section of the Configuration ribbon.
3. Click **Yes** at the prompt to proceed or **No** to cancel without installing the new firmware.

Tool Suite identifies and displays the firmware version that is loaded on the connected device and displays the latest version of firmware available for that model.

4. Click **Yes** to proceed with the upgrade, or **No** to exit.

   The system displays the progress of the firmware upgrade. After the firmware upgrade is complete, a message displays that the firmware upgrade was successful.

About the Call Book

The Call Book is required in Point-to-Point networks. The instructions provided in this section are for Point-to-Point mode only. Use of the Call Book for MultiPoint networks is explained later in this chapter.

Important: While the Call Book is an option in Point-to-MultiPoint networks, FreeWave strongly recommends using the **Network ID** feature in most applications. If a large MultiPoint network is implemented using the Call Book and you want to add a transceiver to the network, or need to replace a transceiver, you must physically travel to all transceivers in the network and enter the new serial number in the transceiver's Call Book.

Using the Call Book offers both security and flexibility in determining how FreeWave transceivers communicate with each other.

You must set the following for two FreeWave transceivers to communicate in Point-to-Point mode:

1. The Master's serial number must be listed in the Slave's Call Book or Slave Security is turned off in the Slave .
2. The Slave's serial number must be listed in the Master's Call Book .
3. The Master must be programmed to call the Slave.

The Call Book allows you to incorporate up to 10 FreeWave transceivers, designate 1 to 4 Repeaters to use with each transceiver, and designate which Slave the Master calls. To set the **Entry to Call** option, select the number in the **Entry to Call** field, select **All** to direct the Master to call all Slaves.

Note: To set the **Entry to Call** option in HyperTerminal, enter **C** at the Call Book menu, followed by the menu number corresponding to that Slave. To call any available Slave in the list, enter **C** then enter **A** to direct the Master to **Call All**.

It is important that the Call Book slots (0-9) are filled sequentially starting with slot 0. When a Master is instructed to **Call All**, it calls all Slaves listed until it reaches the first serial number of 000-0000 (or a blank slot). If a serial number is entered after the all zero number or as a Repeater, the Master does not recognize it as a valid number.

Note: When entering numbers into the Call Book, you need only define Repeaters in the Master's Call Book. The Slave Call Book only requires the Master's serial number. A Repeater need not have anything listed in its Call Book.

Programming Point-to-MultiPoint Call Book

In a MultiPoint network, the Slaves and Repeaters are not listed in the Master's Call Book. A Slave must have the Master and any Repeater it is going to use in its Call Book.

Note: If the **Network ID** feature is used in a MultiPoint network, no entries are needed in the Call Book of any of the transceivers.

The following examples show the Call Books of a MultiPoint network 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 900-0001)

Entry	Number	Repeater 1
(0)	000-0000	
(1)	000-0000	

No serial number entries are necessary in the Master's Call Book.

MultiPoint Repeater Call Book (Unit Serial Number 900-0002)

Entry	Number	Repeater 1
(0)	900-0001	
(1)	000-0000	

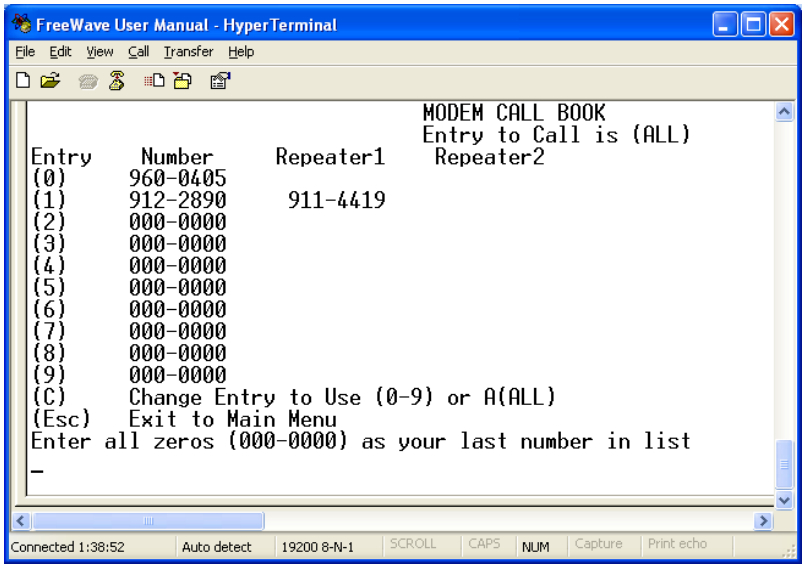
MultiPoint Slave Call Book (Unit Serial Number 900-0003)

Entry	Number	Repeater 1
(0)	900-0001	
(1)	900-0002	
(2)	000-0000	

At times, you may want to force a Slave to go through a specific MultiPoint Repeater. In this scenario, the Slave's Call Book should contain only the serial number for that Repeater as the entry on line 0.

To set the Call Book in HyperTerminal:

1. Select **(2) Call Book** from the main Setup menu to display the following window:



2. Enter the number or letter associated with the option you want to select.
3. Enter the seven-digit serial number of the transceiver being called.
4. The system prompts for Repeater 1's serial number. If no Repeaters are being used, press **Esc** and continue with step 6. Otherwise, enter the 7-digit serial number of the Repeater.
5. The system prompts for Repeater 2's serial number. Enter the 7-digit serial number of the second Repeater. If only one Repeater is being used, press **Esc**.

   The system refreshes the transceiver's Call Book menu with the new changes.
6. Press **Esc** to return to the Main menu.

To set the call book in Tool Suite:

1. In the Tool Suite Configuration application, select the device to program and click the **(2) Call Book** tab.
2. In the **Number** column in **Row 0**, enter the seven-digit serial number of the transceiver being called.
3. In the **Repeater 1** column, enter Repeater 1's seven-digit number. If no Repeaters are being used, leave the column empty.
4. In the **Repeater 2** column, enter the second Repeater's seven-digit number. If only one Repeater is being used, leave the column empty.
5. If Repeaters are being used, select the appropriate **Entry to Call** option in the Master's Call Book.

   To apply the changes, select either the Quick or All icon. Tool Suite applies the changes to the transceiver.

Chapter 3: Parameter Reference

This chapter contains the following information as it applies to each parameter that you can set for the transceivers described in this manual

parameter name (as you see it in Tool Suite or HyperTerminal)

Tool Suite Tab:	The name of the tab the parameter is grouped under within Tool Suite.
Setup Terminal Menu:	The name of the menu and the submenu the parameter is grouped under within Tool Suite's Setup Terminal and within HyperTerminal.
Network Type:	Point-to-Point, Point-To-MultiPoint, or Both
Default Setting:	The factory default setting for the parameter.
Options:	The options to which the parameter can be set.
Description:	A description of what the parameter is and how it applies to the transceiver in your network.

The available parameters are listed below in alphabetical order.

Important: Parameters in the Transmission Characteristics tab in Tool Suite (the Edit Radio Characteristics menu in Setup Terminal and HyperTerminal) are for users with advanced knowledge of FreeWave transceivers and radio communication networks.

1 PPS Enable Delay

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) Edit MultiPoint Parameters > (9) 1 PPS Enable/Delay
Network Type:	Point-to-MultiPoint
Default Setting:	255
Options:	255 to disable 1 PPS
	0 to 254 to enter the delay
Description:	The **1 PPS Enable/Delay** setting allows the radio network to propagate a 1PPS signal from the Master to all Slaves in a MultiPoint network. When this parameter is enabled a properly generated pulse applied on the DTR line of the Master provides a 1 PPS pulse on the CD line of any Slave in the network

Follow the steps below to use the **1 PPS Enable/Delay** feature.

To setup 1PPS Enable/Delay:

1. Set the **1 PPS Enable/Delay** parameter to **0** in the Master.

   The Master must have a 1 PPS pulse on the DTR pin.
2. Enable the **1 PPS Enable/Delay** parameter on the Slaves. Slaves are calibrated at the factory.

To calibrate a Slave in 1PPS Enable/Delay mode:

1. Trigger an oscilloscope on the 1 PPS pulse on the DTR line of the Master.
2. Monitor the CD line of the Slave.
3. If the timing on the Slave differs from the Master it may be adjusted via the value in the Slave's **1 PPS Enable/Delay** parameter. The difference in time between each incremental integer value is 542.534 nS. Changing the parameter to higher values decreases the Slave time delay and changing the parameter to lower values increases the time delay.

When properly calibrated the CD line of a Slave radio outputs a pulse that goes high for about 2 ms in synch with the 1 PPS pulse on the Master radio. The output on the Slave occurs within 20 microseconds of the input to the Master.

Important: When **1 PPS** is enabled, the Master must have a 1 PPS pulse on its DTR pin, otherwise the RF network does not function.

Baud Rate

Tool Suite Tab:	Baud Rate
Setup Terminal Menu:	(1) Set Baud Rate
Network Type:	Both
Default Setting:	115200
Options:	600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200, 230400
Description:	The actual baud rate for the transceiver's data port. This setting is the communication rate between the transceiver and the instrument to which it is connected, and is independent of the baud rate for the other transceivers in the network. Set the baud rate to the highest level supported by the device to which it is connected. With a poor radio link, however, this may actually result in slower data communications. For example, a pair of transceivers may be used in an application to send data from remote process instrumentation to the engineer's computer. In this application, the baud rate for the transceiver on the instrumentation might be set to 9600, and the transceiver on the engineer's computer might be set to 57,600. With a **Baud Rate** setting of 9600 or higher, FreeWave recommends using the **Flow Control** lines. For more information, see "Flow Control" on page 29.

Note: The *setup port* **Baud Rate** always defaults to **19,200** regardless of how the *data port* Baud Rate is set. The only exception is Mode 6. For more information, see application note #5476, *Mode 6*.

Data Parity

Tool Suite Tab:	Baud Rate
Setup Terminal Menu:	(1) Set Baud Rate > (A) Data Parity
Network Type:	Both
Default Setting:	0 (8, N, 1)
Options:	See table below
Description:	Six data word length and parity configurations are available for use with FreeWave transceivers. The default setting is **8-None-1** and is the most commonly used serial communications protocol.

The following table describes each option:

Option	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

Diagnostics

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) Edit MultiPoint Parameters > (B) Diagnostics
Network Type:	Point-to-MultiPoint
Default Setting:	1
Options:	Any number between 0 and 128
Description:	Allows diagnostics data in the Network Diagnostics application within Tool Suite to be viewed at the Master in parallel with application data. The setting in this parameter determines how many slots out of 128 are dedicated to diagnostics. For example, if you set to 10, 1 out of every 10 data slots is for diagnostics data; if you set to 100, 1 out of every 100 data slots is for diagnostics data. Diagnostics is always secondary to actual transmitted data.

The diagnostic program ***must*** be run from the Master transceiver. Diagnostics requires the following:

- A setting of this parameter on the Master between 1 and 128.
- A second computer or serial connection to run the diagnostics software.
- A diagnostics cable. (Available from FreeWave.)
- Diagnostics software. (Available on the *User Manual and System Tools CD*.)

When collecting diagnostics from an LRS455 network, FreeWave recommends setting the diagnostics polling rate to 400 ms or higher.

For more information about Diagnostics, contact FreeWave Technical Support.

DTR Connect

The **DTR Connect** parameter is not supported in LRS455 radios.

Flow Control

Tool Suite Tab:	Baud Rate
Setup Terminal Menu:	(2) Set Baud Rate > (F) FlowControl
Network Type:	Both
Default Setting:	(0) None
Options:	• **(0) None** - No flow control CTS is active and de-asserts when buffering in 98% full. Can pass XON/XOFF data but does not use it in any way. • **(1) RTS** - Uses standard RTS/CTS control lines. • **(2) DTR**
Description:	Specifies the hardware flow control for the data port on the transceiver. FreeWave recommends using **Flow Control** if you are using a baud rate higher than 9600 bps in a narrow-band licensed network.

Hop Table Size

Note: This setting must be the same on all transceivers in the network.

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Radio Transmission Characteristics > (0) FreqKey > F > 2
Network Type:	Both
Default Setting:	16
Options:	Any number between 1 and 16
Description:	Defines how many separate channels a given network uses.

Local Access

Not for use at this time.

Low Power Mode

Note: This setting applies to only Multipoint Slaves using a serial protocol.

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Radio Transmission Characteristics > (9) Low Power Mode
Network Type:	Point-to-MultiPoint
Default Setting:	0
Options:	Any number between 0 and 31. The higher the number, the greater the decrease in power consumption.

Description: Allows a MultiPoint Slave to consume less power, primarily by dimming the transceiver's LEDs.

When set to **2** through **31**, the transceiver sleeps between slots. For example, at a setting of **2** the transceiver sleeps 1 out of 2 slots; at a setting of **3** the transceiver sleeps 2 out of 3 slots, and so on.

When the transceiver is asleep, it hears nothing from the Master.

The following table shows the changes at different **Low Power Mode** settings. The actual current draw depends on many factors. The table below gives only a qualitative indication of supply current savings. A low number reduces latency and a high number reduces current consumption.

Setting	Description
0	Low power, disabled
1	LEDs dimmed, transceiver remains awake, transceiver is listening to the Master's transmissions on every slot, and transceiver's data port is shut down if the RTS line is deasserted (low). In this case, the transceiver needs to be awakened before it is able to send data to the Master.
2	LEDs dimmed, transceiver sleeps every other slot.
3	LEDs dimmed, transceiver sleeps 2 of 3 slots.
4-31	LEDs dimmed, transceiver sleeps the number of slots corresponding to the setting. For example, with a setting of 31 the transceiver sleeps 30 of 31 slots.

Note the following about the **Low Power Mode** parameter:

- Power savings occur only when the Slave is linked. No power savings occur when the Slave is transmitting data. **Low Power Mode** is of little value when a Slave has a constant, high throughput. **MCU Speed** must be set to **0** and **RF Data Rate** must be set to **3** for **Low Power Mode** to operate properly.
- To communicate to an RS232 port of a transceiver that is in **Low Power Mode**, the RTS line must be held high to wake it up. The transceiver wakes up within approximately 20 milliseconds of when RTS goes high.
- If the RTS line on the Slave is held high, the transceiver remains in normal operation regardless of the **Low Power Mode** setting. After RTS is dropped the transceiver reverts to Low Power Mode.
- If the transceiver has the **DTR Connect** option in the MultiPoint Parameters tab set to **1** or **2** and if the **Low Power Mode** is enabled (set to **1-31**), the RTS line on the transceiver must be asserted for the **DTR Connect** feature to operate properly.

  To realize full power savings in **Low Power Mode**, the serial port must be deactivated between operation. To do that the RTS line must be asserted. However, since RS485 and RS422 operation uses the RTS line as part of the data bus, it cannot be asserted to wake-up the radio. Therefore, FreeWave recommends that all radios set to RS485 or RS422, use a **Low Power Mode** setting of **0**.
- The diagnostic pins must be disabled or terminated to a cable for the Sleep current in Lower Power Mode to match the specifications. To disable the diagnostic pins, ensure the following are set:

- In the Baud Rate tab, the **Setup Port** parameter is set to **1 (Main Only)**.
- In the MultiPoint Parameters tab, the **Diagnostics** parameter is set to **0 (Off)**.

Master Packet Repeat

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) Edit Multipoint Parameters > (1) Master Packet Repeat
Network Type:	Point-to-MultiPoint
Default Setting:	2
Options:	Any number between 0 and 9
Description:	In a Point-to-MultiPoint network, Slaves do not acknowledge transmissions from the Master. If Slaves did acknowledge all data transmissions, in a large network, the Master would soon become overwhelmed with acknowledgments from the Slaves. Without acknowledgements, 100% confidence every Slave has received every packet cannot be met. To address this issue, you can modify the **Master Packet Repeat** parameter, assigning a value between **0** (the packet is transmitted once) to **9** (the packet is transmitted 10 times). FreeWave recommends a setting of **1** or **2** in a licensed network.

For networks with solid RF links, this parameter should be set to a low value such as **0** or **1**. If a network has some weak or marginal links it should be set with higher values. If a Slave receives a good packet from a Master more than once it discards the repeated packets. Similarly, after a MultiPoint Repeater receives a good packet from the Master, it discards any further repeated packets. In turn, the Repeater sends the packet out to the next Repeater or Slaves the number of times corresponding to its own **Master Packet Repeat** setting.

Increasing the **Master Packet Repeat** setting increases the probability of a packet getting through, but also increases latency in the network because each packet from the Master or Repeater is being sent multiple times. Therefore, it is important to find the optimal mix between network robustness, throughput, and latency. In general, a setting of **0** to **1** works well for most well designed networks.

Note: The **Master Packet Repeat** may be set to **0** if the user software is capable of, or requires acknowledgment. In this case, if the Master sends a packet that the Slave does not receive, the user software controls the retries as needed.

Max Packet Size and Min Packet Size

Note: In MultiPoint networks, the **Max Packet Size** and **Min Packet Size** must be set identically in all transceivers. In Point-to-Point networks the Master's setting takes precedence over the Slave.

Tool Suite Tab:	Transmission Characteristics

Setup Terminal Menu:	(3) Edit Transmission Characteristics > (1) Max Packet Size and (2) Min Packet Size
Network Type:	Both
Default Setting:	Max Packet Size = 8
	Min Packet Size = 9
Options:	Any number between 0 and 9
Description:	The **Max** and **Min Packet Size** settings and the RF Data Rate determine the number of bytes in the packets. Throughput can be enhanced when packet sizes are optimized.

The following tables provide the information to determine optimum setting values:

Minimum Packet Size Definition	
Min Setting	**Min Packet Size**
1	16
2	32
3	48
4	64
5	80
6	96
7	112
8	128
9	144

Maximum Packet Size (2 Level FSK)	
Max Setting	**Max Packet Size**
0	32
1	48
2	64
3	80
4	96
5	112
6	128
7	135
8	135
9	135

Maximum Packet Size (4 Level FSK)	
Max Setting	**Max Packet Size**
0	32
1	48
2	64
3	80
4	96
5	112
6	128
7	144
8	160
9	176

Max Slave Retry

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) Edit MultiPoint Parameters > (2) Max Slave Retry
Network Type:	Point-to-MultiPoint
Default Setting:	9
Options:	Any number between 0 and 9
Description:	Defines how many times the Slave attempts to retransmit a packet to the Master before beginning to use a back-off algorithm (defined by the **Retry Odds** parameter). Slave retries stop when the slave receives an acknowledgement from the Master.

Min Packet Size

See "Max Packet Size and Min Packet Size" on page 31.

Modbus RTU

Tool Suite Tab:	Baud Rate
Setup Terminal Menu:	(1) Set Baud Rate > (B) Modbus RTU
Network Type:	Both
Default Setting:	0 (Disabled)
Options:	Any number between 0 to 9

Description: The **Modbus RTU** setting is a port delay. This setting can be used with several different timing sensitive protocols, such as Modbus RTU and DNP3. A setting other than **0** causes the radio to wait for an amount of time "gathering" data before sending out the radio link.

- When set to **0** (Disabled), the radio sends data out through its radio link as soon as the data is received into the serial port.
- When set to **1**, the radio waits for a number of slots equal to two times the **Master Packet Repeat** setting before waits for 6 slots, gathering data up the whole time. At the end of the 6 slots, the radio sends all received data in one "burst." This is the appropriate setting for most Modbus RTU devices.
- When set to **2** and higher, the radio waits for a number of slots calculated using the following formula:

  (Modbus RTU setting + Master Packet Repeat setting + 1) x 2

  For example, in a radio where the **Modbus RTU** setting is **2** and the Master Packet Repeat setting is **3**, the radio waits for (2 + 3 + 1) x 2, or 12 slots.

Note: When using the transceiver in **Modbus RTU** mode, the **Master Packet Repeat** setting must match in every transcever, regardless of whether the network is in Point-to-Point or MultiPoint mode.

Modem Mode

Tool Suite Tab: Operation Mode

Setup Terminal Menu: (0) Set Operation Mode

Network Type: Both

Default Setting: Point-to-Point Slave

Options: See below

Description: The **Modem Mode** designates the method FreeWave transceivers use to communicate with each other. FreeWave transceivers operate in a Master-to-Slave configuration. Before the transceivers can operate together, they must be set up to properly communicate.

The network type must match for all transceivers in a network. For example, if you are configuring a Point-to-MultiPoint network, ensure the **Modem Mode** selection for transceiver in the network starts with Point-to-MultiPoint (options **2**, **3**, and **7**).

In a Point-to-Point configuration, Master or Slave mode may be used on either end of the communication link without performance degradation. When setting up the transceiver, remember that the Master's settings control a number of parameters. Therefore, deploying the Master on the communications end where it is easier to access is advised, but not necessary.

Note: To set a transceiver as a Point-to-MultiPoint Slave/Repeater, enable the **Slave/Repeater** parameter in the MultiPoint Parameters tab. For more information, see "Slave/Repeater" on page 43.

Operation Mode	Description
Point-to-Point Master (0)	This mode designates the transceiver as the Master in Point-to-Point mode. The Master may call any or all Slaves designated in its Call Book. In Point-to-Point mode the Master determines the setting used for most of the radio transmission characteristics, regardless of the settings in the Slave and/or Repeaters. The settings not determined by the Master are: • RF Xmit Power • Slave Security • Retry Time Out • Hop Table settings To identify a Master, power the transceiver. Prior to establishing a communication link with a Slave, all three of the Master's LEDs are solid red.
Point-to-Point Slave (1)	This mode designates the transceiver as a Slave in Point-to-Point mode. The Slave communicates with any Master in its Call Book—either directly or through one Repeater. When functioning as a Slave, the Entry to Call feature in the transceiver's Call Book is not operational. Set **Slave Security** to **1** to bypass the Call Book in the Slave. For more information, see "Slave Security" on page 44.
Point–to-MultiPoint Master (2)	This mode designates the transceiver as a Master in MultiPoint mode. This mode allows one Master to communicate simultaneously with numerous Slaves. A Point-to-MultiPoint Master communicates only with other transceivers designated as Point-to-MultiPoint Slaves or Point-to-MultiPoint Repeaters.
Point-to-MultiPoint Slave (3)	This mode designates the transceiver as a Slave in MultiPoint mode. This mode allows the Slave to communicate with a MultiPoint Master. The Slave may communicate with its Master through one Repeater.
Point-to-Point Slave/Repeater (4)	This mode designates the transceiver to act as either a Slave or Repeater—depending on the instructions from the Master. The transceiver cannot act as both a Slave and a Repeater at the same time. True Slave/Repeater functionality is only available in a MultiPoint mode. Adding a Repeater to a network cuts the network throughput by 50%. **Note:** Point-to-Point Slave/Repeaters have no security features. When a transceiver is designated a Point-to-Point Slave/Repeater, it allows any Master to use it as a Repeater.

Operation Mode	Description
Point-to-Point Repeater (5)	FreeWave allows the use of one Repeater in a Point-to-Point 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 rates, and radio transmission characteristics are disabled. A Repeater connects with any Master that calls it. The Repeater must be set up properly in the Master's Call Book. Adding a Repeater to a network cuts the network throughput by 50%.
Point-to-Point Slave/Master Switchable (6)	Mode 6 allows the transceiver to be controlled entirely through software commands. A number of key parameters in the FreeWave user interface may be changed either directly with a program such as Windows Terminal or through the use of script files. Additionally, when the **Point-to-Point Slave/Master Switchable** option is selected and the transceiver is not calling a Slave, it functions as a Slave and accepts any appropriate calls from other transceivers. For more information, see application note #5476, *Mode 6*.
Point-to-MultiPoint Repeater (7)	This mode allows the transceiver to operate as a Repeater in a MultiPoint network. You can have one Repeater in an LRS455 network. Adding a Repeater to a network cuts the network throughput by 50%.

Multi-Master Sync

Although this option is available, **Multi-Master Sync** does not apply to licensed band radios. Setting this parameter has no effect in a licensed band radio.

Network ID

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) Edit MultiPoint Parameters > (6) Network ID
Network Type:	Point-to-MultiPoint
Default Setting:	255, which enables the Call Book
Options:	Any value between 0 and 4095 (excluding 255)
Description:	Use the **Network ID** to establish MultiPoint networks without using the Call Book. To enable the **Network ID**, the value must be set between **0** and **4095** (excluding 255, which disables the **Network ID**). Because the **Network ID** does not use serial numbers, MultiPoint Masters and Repeaters may be replaced without reprogramming all of the Slaves in the network. Slaves link with the first Master or Repeater that it hears that has a matching the **Network ID**. The **Network ID** function should be used in conjunction with the **Subnet ID** feature (if necessary) to route data through the transceiver network. Without having the serial numbers in the Call Book, Slaves may establish

communications with different Masters, though not at the same time. This is very useful in mobile MultiPoint applications.

A **Network ID** of four characters is recommended. For example, the last four digits of the Master's serial number. Avoid using numbers that coincide with nearby landmarks or highways. Using the last four digits of the Master's serial number helps to ensure the **Network ID** is unique and does not overlap with other nearby FreeWave networks.

Operation Mode

See "Modem Mode" on page 34

Radio ID

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) Edit MultiPoint Parameters > (D) Radio ID
Network Type:	Point-to-MultiPoint
Default Setting:	Blank
Options:	Any 4 digit, user-defined number
Description:	Use this option to designate a transceiver with an arbitrary, user-defined, 4-digit number that identifies the transceiver in Diagnostics mode. This setting does not change the communication of the transceiver.

Radio Name

Tool Suite Tab:	Device Information or MultiPoint Parameters
Setup Terminal Menu:	(5) Edit MultiPoint Parameters > (G) Radio Name
Network Type:	Both
Default Setting:	Blank
Options:	Any combination of letters and numbers up to 20 characters
Description:	Use this parameter to give a transceiver a name, such as its location. Naming transceivers can be helpful to identify a device when running network diagnostics. This setting does not change the communication of the transceiver.

Remote LED

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Radio Transmission Characteristics > (C) Remote LED

Network Type: Both

Default Setting: (0) Local Only

Options:
- **(0) Local Only** - Only the LEDs on the radio board are enabled.
- **(1) Remote and Local** - LEDs on the radio board and remote LEDs through the diagnostic port are enabled.
- **(2) Remote Only** - LEDs on the radio board are disabled. Remote LEDs through the diagnostic port are enabled.

Description: If you are using a transceiver with the optional 24-pin connector, you can use this option to connect Remote LEDs through the diagnostics port.

When using Remote LEDs, the center (Tx) LED does not turn Green when in Setup mode. This line is not pinned out.

If you are using an enclosed radio, set the Remote LED parameter to either **Remote Only** or **Remote and Local**. If you leave the setting at **Local Only**, you will not be able to see the LEDs.

Repeaters

Important: Adding a Repeater to a network reduces the throughput by 50%. For example, Over-the-Air throughput in a network running at 2-Level GFSK and with the **Repeater** parameter disabled is 9600 bps. With the **Repeater** parameter enabled, the Over-the-Air throughput drops to 4400 bps.

The LRS455 radios are narrowband radios and have a limited channel size based on the license obtained from the FCC. Therefore, the radios can experience a dramatic impact in throughput if Repeaters are implemented in the network. If you have large amounts of data to transfer and choose to enable Repeaters in your network, you must optimize polling host / RTU settings must to accommodate for the lower throughput. Polling host / RTU optimization settings include reducing block/packet sizes and increasing overall time-out parameters.

Note: This parameter needs to be set in the MultiPoint Master only. The setting has no effect if set on a Slave.

Tool Suite Tab: MultiPoint Parameters

Setup Terminal Menu: (5) Edit MultiPoint Parameters > (0) Number Repeaters

Network Type: Point-to-MultiPoint

Default Setting: (1) Enabled

Options: (0) Disabled

(1) Enabled

In Setup Terminal, you can set the number of Repeaters in your network. Typically, this setting is 1 if you have any Repeaters in your network.

	Note: In a licensed-band network, you can only have one Repeater.
Description:	Indicates if any number of Repeaters exist in the network.

Retry Odds

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) Edit MultiPoint Parameters > (3) Retry Odds
Network Type:	Point-to-MultiPoint
Default Setting:	9
Options:	Any number between 0 and 9
Description:	While packets transmitted from the Master to the Slaves in a MultiPoint network are not acknowledged, packets transmitted from Slaves to the Master are. It is possible, that more than one Slave attempts to transmit to the Master at the same time. Therefore, it is important that a protocol exists to resolve contention for the Master between Slaves. This is addressed through the **Max Slave Retry** and **Retry Odds** parameters. After the Slave has unsuccessfully attempted to transmit the packet the number of times specified in the **Max Slave Retry** parameter, it attempts to transmit to the Master on a random basis. The **Retry Odds** parameter determines the probability that the Slave attempts to retransmit the packet to the Master; a low setting assigns low odds to the Slave attempting to transmit. Conversely, a high setting assigns higher odds.

An example of how this parameter might be used would be when considering two different Slaves in a MultiPoint network, one with a strong RF link and the other with a weak RF link to the Master. If a Slave has a week or poor link, set **Retry Odds** to **0**, as it may become a "chatty" Slave and lockup your network, causing a loss of communication.

When **Retry Odds** is set to **0**, after the Slave has exhausted the number of retries set in the **Max Slave Retry** parameter and still not gained the Master's attention, the Slave's data buffer is purged. A **Retry Odds** set to **0** is recommended for most networks.

Retry Timeout

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (8) Retry Time Out
Network Type:	Both
Default Setting:	255
Options:	Any number between 0 and 255 in MultiPoint networks. Any number between 151 and 255 in Point-to-Point networks.
Description:	The **Retry Time Out** parameter in a Slave or Repeater sets the delay the

unit waits before dropping the connection to a Master or Repeater. The factory default is set at the maximum of **255**. The maximum setting means that if 1 packet in 255 is sent successfully from the Master to the Slave or Repeater, the link is maintained. The minimum setting is **8**. This allows a Slave or Repeater to drop a connection if less than 1 in 8 consecutive packets is successfully received from the Master. The function in the Master is effectively the same. With a setting of **255**, the Master allows a Slave or Repeater to stay connected as long as 1 packet in 255 is successfully received at the Master.

The **Retry Time Out** parameter is useful when a MultiPoint network has a roving Master or Slave(s). As the link gets weaker, a lower setting allows a poor link to break in search of a stronger one.

Note: Setting **Retry Time Out** to **20** is recommended in areas where several FreeWave networks exist. This recommended setting allows Slaves and Repeaters to drop the connection if the link becomes too weak, while at the same time prevent errant disconnects due to interference from neighboring networks.

While intended primarily for MultiPoint networks, the **Retry Time Out** parameter may also be modified in Point-to-Point networks. However, the value in Point-to-Point mode should not be set to less than 151.

RF Data Rate

Note: In MultiPoint networks, the **RF Data Rate** must be identical in all transceivers. Any transceiver with an **RF Data Rate** different from the Master will not establish a link. In Point-to-Point networks the Master's settings take precedence over the Slave.

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (4) RF Data Rate
Network Type:	Both
Default Setting:	(4) 12.5 kHz 4 level
Options:	• **(4)** - With an occupied bandwidth of 12.5 kHz and modulation level of 4-level GFSK. With an **RF Data Rate** of **4**, the maximum over-the-air operating speed is 19,200 bps. **RF Data Rate 4** is not compatible with firmware versions 1.69 and older. • **(5)** - With an occupied bandwidth of 12.5 kHz and a modulation level of 2-level GFSK. With an **RF Data Rate** of **5**, the maximum over-the-air operating speed is 9600 bps.
Description:	The LRS455 transceivers have two settings for the RF Data Rate (4, 5). RF Data Rate is the over-the-air data rate between radios in your network, and should not be confused with the serial port Baud Rate. **Note:** Although additional RF Data Rates are available, only RF Data Rates 4 and 5 are FCC approved. Use setting **4** when the transceivers are close together and data

throughput needs to be optimized. Use setting **5** when the transceivers are farther away and a solid data link is preferred over data throughput.

RTS to CTS

The **RTS to CTS** parameter is not supported in LRS455 radios.

Rx Frequency

Note: In the Master, this setting must be the same as the **Tx Frequency** setting in the Slaves..

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (0) Frequency Key > F > 0
Network Type:	Both
Default Setting:	435
Options:	Any frequency between 435 and 470 MHz. For more information, see "Frequency List" on page 59.
Description:	The transceivers must be programmed to operate on the appropriate frequency. To program the transceiver for single-channel operation, enter the frequency, in Megahertz, into the **Tx Frequency** and **Rx Frequency** fields. By default, the radio is set for single-channel operation. If the transceivers are to operate in Frequency Division Duplex, the **Tx Frequency** and **Rx Frequency** fields have different frequencies assigned.

You can define the Tx Frequency and Rx Frequency for multiple channels using Setup Terminal or HyperTerminal.

To set the radio to a single channel:

1. Place the radio in Setup Mode and connect to it in Setup Terminal.
2. From the main Setup menu, select **(3) Edit Transmission Characteristics > (0) FreqKey > F > 1**.
3. At the Enter Frequency Channel to Use prompt, enter the frequency channel to use between 0 and 15.
4. Press **Esc** to return to the Radio Parameters menu.
5. Press **Esc** again to return to the main Setup menu.

To set the radio to hop channels:

1. Place the radio in Setup Mode and connect to it in Setup Terminal.
2. From the main Setup menu, select **(3) Edit Transmission Characteristics > (0) FreqKey > 0**.

3. Press **Esc** to return to the Radio Parameters menu.
4. Press **Esc** again to return to the main Setup menu.

To edit frequencies for multiple channels:

1. Place the radio in Setup Mode and connect to it in Setup Terminal.
2. From the main Setup menu, select **(3) Edit Transmission Characteristics > (0) FreqKey > F > 0**.
3. At the Channel Number prompt, enter the channel number you want to set and press **Enter**.
4. At the Xmit Chan prompt, enter the Tx Frequency between 0000 and 05600 and press **Enter**.
5. At the Rcv Chan prompt, enter the Rx Frequency between 0000 and 56000 and press **Enter**.
6. Press **Esc** to return to the Radio Parameters menu.
7. Press **Esc** again to return to the main Setup menu.

Serial Interface

Tool Suite Tab:	Baud Rate
Setup Terminal Menu:	(1) Set Baud Rate > (C) RS232/485
Network Type:	Both
Default Setting:	(0) RS232
Options:	• **(0) RS232** - Also used for TTL. • **(1) RS422/Full Duplex RS485 - Modbus RTU** mode must be enabled and **Turn Off Delay** set to at least **4**. • **(2) Half Duplex RS485** - **Modbus RTU** mode must be enabled and **Turn Off Delay** set to at least **4**. • **(3) DOT**- DOT causes the CD line to indicate when data is transmitted on the serial port from the transceiver. When the transceiver is not sending data to the serial port, CD is de-asserted. When the radio is sending data to the serial port, CD is asserted. The CD line no longer has any radio link state functionality. **Turn Off Delay** works as described in all transceivers. **Turn On Delay** works as described on any Slave or Slave/Repeater - it has no functionality on the Master.
Description:	Use this option to set the protocol of the data port. In TTL RF board products this setting must be **0**. If set to anything other than **0**, the **Setup Port** must be set to **Diagnostics Only**.

Setup Mode Timeout

Tool Suite Tab:	Operation Mode
Setup Terminal Menu:	(1) Set Baud Rate > (D) Setup Port

Network Type:	Both
Default Setting:	(0) Disabled
Options:	(0) Disabled, (1) Enabled
Description:	When enabled, this options adds a timeout feature to the transceiver being in Setup mode. If the transceiver goes into Setup mode and does not receive legitimate menu selections or programming information within 3 to 5 seconds, it exits Setup and resumes its previous mode.

Setup Port

Important: Do not change this setting unless the correct programming cable is available for the new setting.

Tool Suite Tab:	Baud Rate
Setup Terminal Menu:	(1) Set Baud Rate > (D) Setup Port
Network Type:	Both
Default Setting:	(3)
Options:	**(1) Main Only** - Programming and reading a transceivers setup information is done through the data port pins only. **(2) Diagnostics Only** - Programming and reading a transceivers setup information is done through the diagnostic port only. If the **Serial interface** is set to anything other than RS232, then the **Setup Port** must be set to **Diagnostics Only**. **(3) Both** - Programming and reading a transceivers setup information is done through either the main data port or the diagnostics port.
Description:	Determines which port on the radio, Main or Diagnostics, is used to access the parameter settings in Tool Suite or enter the Setup main menu in Setup Terminal or HyperTerminal.

Setup mode is invoked by sending a "U" (**Shift-U**) to the Diagnostics port or by pressing/toggling the Setup button/switch, if available.

OEM boards may also enter Setup mode when Pin 2 is grounded. The data port on OEM models use a 2-row, 2 mm female connector. The diagnostic cable for this port (ASC2009DC) is available from FreeWave.

Slave/Repeater

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) MultiPoint Parameters > (A) Slave/Repeater
Network Type:	Point-to-MultiPoint
Default Setting:	(0) Disabled

Options:	(0) Disabled, (1) Enabled
Description:	The **Slave/Repeater** mode allows a transceiver in a MultiPoint network to switch between Slave and Repeater functions. When in this mode, a transceiver repeats any packets sent across the network as well as uses the data port. Thus, where one Repeater and one Slave may be required in another vendor's network, FreeWave networks require only one transceiver. To operate a transceiver as a MultiPoint Slave/Repeater, the **Modem Mode** in the Operation Mode tab must be set to **Point to MultiPoint Repeater** and the **Slave/Repeater** parameter enabled.

Slave Security

Note: Slave Security has no effect in Point-to-MultiPoint networks where the **Network ID** is used instead of the Call Book.

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (6) Slave Security
Network Type:	Point-to-Point
Default Setting:	(0) On
Options:	(0) On, (1) Off
Description:	Slave security allows Slave transceivers to accept transmissions from a Master not included in the Call Book. The default setting of **0** (On), means only Masters in the Slaves' Call Book may link to that Slave. **Slave Security** may be disabled (setting of **1**) allowing any Master to call the Slave.

Slave Security must be set to **1** when the unit is operating in Mode 6 Slave/Master Switchable or a Point-to-Point network where the Slave may need to accept calls from more than 10 different Masters. When **Slave Security** is set to **1**, the transceiver accepts calls from any other FreeWave transceiver. Additional network security measures may be taken to prevent unauthorized access, such as changing default settings for **Frequency** and **Hop Table**.

Subnet ID

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) Edit MultiPoint Parameters > (C) Subnet ID
Network Type:	Point-to-MultiPoint using a Network ID
Default Setting:	F, F
Options:	Any number between 0 and 9 or any letter between A and F.
Description:	In a MultiPoint Network, a Slave or Repeater connects with the first Repeater or Master that it hears with the same **Network ID**. However,

where communications need to be forced to follow a specific path, use the **Subnet ID**.

Two components exist with regard to the Subnet ID:

- **Rx** - This setting identifies which transceiver a Repeater or Slave listens to. Setup Terminal, this is the **Rcv Subnet ID**.
- **Tx** - This setting identifies the ID on which this device transmits, and in turn which devices listen to it. The **Xmt Subnet ID** parameter is relevant for MultiPoint Repeaters ***only***. In Setup Terminal, this is the **Xmt Subnet ID**.

The default (disable) setting for both **Rx** and **Tx** is **F**, which is a good visual way to indicate that the device is the final in the line and does not use a subnet ID. A MultiPoint Slave with a **Subnet ID** of **F**,**F** does not roam from one Repeater or network to the next, it only links to a Master or Repeater that has either a **Transmit Subnet** of **0** or an **F**,**F Subnet ID**.

Setting both **Rx** and **Tx Subnet ID** to **0** allows a mobile Slave to roam from subnet to subnet, and possible from network to network, provided the **Network ID**, **Max and Min Packet Size**, and **RF Data Rates** are the same between networks.

Transmit Power

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (5) RF Xmit Power
Network Type:	Both
Default Setting:	10
Options:	Any number between 0 and 10
Description:	Sets the output power of the radio. You can control the output transmit power up to 2 W (+33 dBm). For use in applications requiring greater than 70% transmit duty cycle, the radios must be attached to an appropriate heat sink. **Note:** When testing transceivers at your facility and they are in close proximity to one another, set the **Transmit Power** to a low number. When you deploy transceivers to the field, raise the **Transmit Power** number accordingly

The following table shows RF transmit output versus the RF Xmit Power setting.

RF Xmit Power	RF Tx Power (dBm)
10	+33
9	+32
8	+31
7	+30
6	+29

RF Xmit Power	RF Tx Power (dBm)
5	+28
4	+27
3	+26
2	+25
1	+24
0	+23

Transmit Rate

Note: This setting must be the same on transceivers in your network.

Tool Suite Tab: Transmission Characteristics

Setup Terminal Menu: (3) Edit Transmission Characteristics > (3) Xmit Rate

Network Type: Both

Default Setting: (1) Normal

Options: Any number between 0 to 9

Description: FreeWave transceivers use a Master Transmit Beacon to provide low current consumption in the Slave transceivers. The Slaves turn their receiver off when no data is being passed. This setting allows the duty cycle of the Master Transmit Beacon to be changed. A setting of **0** is the highest duty cycle and **9** is the lowest duty cycle.

If you are not polling for data that frequently, or you are not installing new devices often, you might want to lower your duty cycle, and therefore would set this field to **9**.

Turn Off Delay

Tool Suite Tab: Baud Rate

Setup Terminal Menu: (1) Edit Baud Rate > Turn Off Delay

Network Type: Both

Default Setting: 0

Options: Any number between 0 and 9

Description: Specifies the time after the end of transmission of a character to the RS485 bus that the transceiver stops driving the bus and releases the bus to other devices. The units are ¼ of a character with a range of 0 to 9. An entry of 4 means a delay equivalent to the duration of a full character. The default is zero delay.

For data rates of 1200 bits/S or slower, avoid setting the **Turn Off Delay** parameter higher than **4**. At those rates the functionality of the microprocessor changes so that a **Turn Off Delay** of **5** has the same effect as if set to **1**, and a setting of **6** has the same effect as **2**, and so on.

Note: Turn Off Delay must be set to a value of at least **4** for RS422 and RS485 operation.

Turn On Delay

Tool Suite Tab:	Baud rate
Setup Terminal Menu:	(1) Set Baud rate > (E) Turn On Delay
Network Type:	Both
Default Setting:	0 ms
Options:	Any number between 1 and 9
Description:	Sets the delay between when the line drivers are turned on and when the data leaves the data port.

Tx Frequency

Note: In the Master, this setting must be the same as the **Rx Frequency** setting in the Slaves..

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (0) FreqKey
Network Type:	Both
Default Setting:	435
Options:	Any frequency between 435 and 470 MHz. For more information, see "Frequency List" on page 59.
Description:	The transceivers must be programmed to operate on the appropriate frequency. To program the transceiver for single channel operation, enter the frequency, in Megahertz, into the **Tx Frequency** and **Rx Frequency** fields. If the transceivers are to operate in Frequency Division Duplex, the **Tx Frequency** and **Rx Frequency** fields have different frequencies assigned.

The **Tx Frequency** field in the Tool Suite Configuration application handles only a single channel. To set multiple channels, use Setup Terminal or HyperTerminal. For information, see the instructions in "Rx Frequency" on page 41.

Use Break to Access Setup

Note: This setting is typically only used in OEM scenarios.

Tool Suite Tab:	Baud Rate
Setup Terminal Menu:	(2) Set Baud Rate > (G) Use break to access setup
Network Type:	Both
Default Setting:	(0) Disabled
Options:	• **(0) Disabled** • **(1) Enabled** - The Setup menu is set at 19200 bps. • **(2) Enabled** - The setup menu is set at the radio's current baud rate. This setting is only available through Setup Terminal or HyperTerminal.
Description:	Enables a break command to put the radio into Setup mode over the data port. To send a break character the end device must hold the Tx data line in the space voltage level for longer than 1 character time. If a character is defined as having 1 start bit, 8 data bits, and 1 stop bit, the character time is 10 bits, thus the Tx data line must be held in the space voltage level for a period of time longer than 10 bits.

Chapter 4: Viewing Radio Statistics

When you read a radio the system displays data transmission statistics the transceiver has gathered during the most recent session. This information is valuable when you need to know the signal strength and noise levels of the link. Statistics are gathered during each data link and are reset when the next link begins.

In addition, you can view more data transmission characteristics in the Network Diagnostics application. For information about running network diagnostics using Tool Suite, see the *Tool Suite User Manual*.

To display the radio statistics in Tool Suite:

1. In the Tool Suite Configuration application, click **Read Radio**, and then click the Device Information tab.
2. Review the radio characteristics. Each characteristic is described in detail in the sections below.

   You can also view the same statistics using the Setup Terminal option in Tool Suite.

To display the Radio Transmission Characteristics in HyperTerminal:

1. Select **(4) Show Radio Statistics** from the Setup main menu to display the following window:

   Review the radio characteristics. Each characteristic is described in detail in the sections below.

Master-Slave Distance

The physical distance between the slave radio and the master radio in your network. This number is measured in meters and is more accurate at distances over 2.5 miles.

Number of Disconnects

Anytime the link between the Master and the Slave is broken and the radios lose Carrier Detect, it is recorded in this value.

The value indicates the total number of disconnects that have occurred from the time the transceiver is powered on until the radio is put into Setup mode. Under ideal operating conditions, the number of disconnects should be **0**. One or more disconnects may indicate a weak link, the presence of severe interference problems on any of the radios in the link.

Note: In Tool Suite, the disconnect information is available in the Summary View in the Network Diagnostics application.

Noise Level

The **Noise Level** indicates the level of background noise and interference at this transceiver. The number is an average of the noise levels measured at each frequency in the transceiver's frequency hop table.

The individual measurement values at each frequency hop channel are shown in the frequency table. If you are viewing statistics in the Setup Terminal application or through HyperTerminal, press **Enter** when the Radio Statistics menu displays to view the frequency table.

Ideally, noise levels should be below **-112 dBm** and the difference between the average signal level and average noise level should be **26** or more. Noise levels significantly higher than this are an indication of a high level of interference that may degrade the performance of the link. High noise levels can often be mitigated with band pass filters, antenna placement or antenna polarization.

Antenna Reflected Power

Not currently supported.

Signal Level

The **Signal Level** indicates the level of received signal at this transceiver. For each of these, the signal source is the transceiver that transmits to it. The number is an average of the received signal levels measured at each frequency in the transceiver's frequency hop table.

The individual measurement values at each frequency hop channel are shown in the frequency table. If you are viewing statistics in the Setup Terminal application or through HyperTerminal, press **Enter** when the Radio Statistics menu displays to view the frequency table.

For a reliable link, the margin should be at least 26 dB. Low average signal levels can often be corrected with higher gain antennas or better antenna placement.

Note: See the installation manual for antenna and FCC requirements.

Rate %

The **Rate %** measures the percentage of data packets that were successfully transmitted from the Master to the Slave. A number of **75** or higher indicates a robust link that provides very good performance even at high data transmission rates. A number of **74** or lower indicates a weak or marginal link that provides lower data throughput.

Radio Temperature

The **Radio Temperature** value is the current operating temperature of the transceiver in degrees Celsius. For proper operation, a FreeWave transceiver must be in the temperature range of -30° to +60° C.

Chapter 5: Data Communication Link Examples

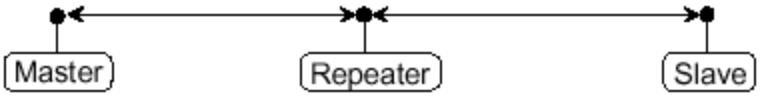
FreeWave transceivers' versatility allows data communication links to be established using a variety of different configurations.

The example below shows the most common and straight forward link; a Master communicating to a Slave in a Point-to-Point link.

The example below shows how a link might be set up using a Repeater. The Repeater may be located on a hilltop or other elevated structure enhancing the link from the Master to the Slave. In this configuration, it may be desirable to use an external Omni directional antenna at the Repeater. Yagi antennas may be used at both the Master and Slave transceivers.

In an LRS455 radio network, you can use only one Repeater.

Note: When a Repeaters is used, the RF throughput is cut by 50%.

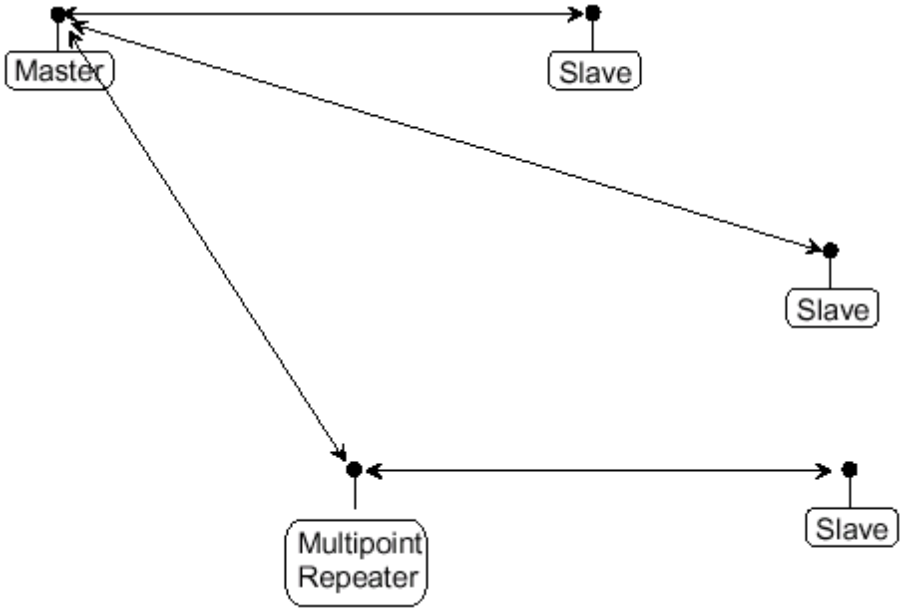


Important: Adding a Repeater to a network reduces the throughput by 50%. For example, Over-the-Air throughput in a network running at 2-Level GFSK and with the **Repeater** parameter disabled is 9600 bps. With the **Repeater** parameter enabled, the Over-the-Air throughput drops to 4400 bps.

The LRS455 radios are narrowband radios and have a limited channel size based on the license obtained from the FCC. Therefore, the radios can experience a dramatic

impact in throughput if Repeaters are implemented in the network. If you have large amounts of data to transfer and choose to enable Repeaters in your network, you must optimize polling host / RTU settings must to accommodate for the lower throughput. Polling host / RTU optimization settings include reducing block/packet sizes and increasing overall time-out parameters.

The next example depicts a standard Point-to-MultiPoint network. From the Master, any data is broadcast to all three Slaves, one of which receives it through a MultiPoint Repeater. The data is in turn sent out of the serial port of each of the three Slaves. The end device should be configured to interpret the serial message and act on it if necessary.



Chapter 6: Additional Transceiver Information

This section contains additional important information about the FreeWave transceivers described in this manual.

- Operational RS422 and RS485 Information
- RS422 and RS485 full duplex pin-outs
- RS485 half duplex pin-outs
- Frequency list
- Specifications

Operational RS422 and RS485 Information

For RS422 and RS485, the FreeWave transceiver can drive 32 standard unit loads and loads the bus with only 1/8 unit load. This means you can tie up to 256 devices on the bus if all of the line receivers have 1/8 unit load.

RS422 is used for 4-wire or full duplex communication with one Master and multiple Slaves. The FreeWave Master transceiver keeps the line driver asserted at all times. The maximum line length is 4,000 feet using two, 120 ohm twisted pair cables with a fifth wire for data common.

RS485 full duplex using 4-wire plus common is the same as RS422, except the system can have multiple Masters on the bus.

The most common operation of RS485 is a two-wire comprised of a 120 ohm impedance single twisted pair. In this system the loading of the FreeWave transceiver is as described above which allows up to 256 1/8 unit load units on the bus. Maximum line length is also 4,000 feet with a third wire required for data common. The FreeWave transceiver checks the line to be certain no other device is transmitting before enabling the line driver for data transmission.

When setting the transceiver to RS485, enable **Modbus** and set **Master Packet Repeat** to **3** in the transceiver(s) that use RS485. Also set **TurnOff Delay** to **4**.

The **TurnOffDelay** setting in the menu is used to control the length of time the transmitter driver stays asserted after data transmission has finished. This is needed to allow the last transmitted character to reach the end of a long line and is normally set to one character length of time. This setting also allows three complete reflections to the end of the line to ensure the ringing on the line has fully dampened before releasing the bus to another device. Shorter line lengths may use shorter delays, but four one-quarter-character delay times are recommended. In Modbus, a **TurnOffDelay** setting of **0** causes internal timing errors.

There is no provision for hand shaking in any of the above modes of operation, so data rates above 9600 bps in **RF Data Rate = 5** and above 19200 bps in **RF Date Rate = 4** are not recommended without a protocol that can handle error detection properly.

RS422 and RS485 Full Duplex Pin-Outs

Function	Bare Board Pin Number	DB-9 Pin Number
RX+	7	3
RX-	9	7
TX+	5	2
TX-	10	8
Signal Ground	4 or 6	5

RS485 Half Duplex Pin-Out

Function	Bare Board Pin Number	DB-9 Pin Number
Wire to both bins for Bus +	Short 5 and 7	Short 2 and 3
Wire to both pins for Bus -	Short 9 and 10	Short 7 and 8
Signal Ground	4 or 6	5

RS232 Pin Assignments

Pin		Assignment	Signal	Definition
1	CD	Carrier Detect	Output	Used to show an RF connection between transceivers.
2	TX	Transmit Data	Output	Used to transmit data bits serially from the transceivers to the system device.
3	RX	Receive Data	Input	Used to receive data bits serially from the system device connected to the transceivers.
4	DTR	Data Terminal Ready	Input	Used only in transceivers in Point-to-Point Slave/Master switchable mode or for DTR Connect.
5	GND	Ground		Signal return for all signal lines shared with Pin 9.

Pin		Assignment	Signal	Definition
6	DSR	Data Set Ready	Output	Always high when the radio is powered from the 2.5 mm power connector. Indicated power is on to the radio. Also, this pin can be used for +12 Volts when powering the transceivers directly through the RS232 port. **Note:** This is not used on the OEM module.
7	RTS	Request to Send	Input	The transceiver does not recognize RTS for flow control. RTS is used as a control line in RTS/CTS mode.
8	CTS	Clear to Send	Output	This signal is used to tell the system device connected to the transceiver that the transceiver is ready to receive data. When asserted, the transceiver accepts data, when de-asserted, the transceiver does not accept data. This should always be used for data rates above 38.4 KB or there is a risk of lost data if an RF link is not very robust.
9	GND	Ground		Signal return for all signal lines shared with Pin 5.

RF Board Pin-Out

The LRS455 series transceivers are available in both TTL and RS232 versions.

The TTL versions use reverse polarity from standard RS232 at 0 to 5 Volt levels. All pin descriptions and pin numbering are the same as the RS232 version. The RS232 versions use standard RS232 polarity and voltage levels for all of the RS232 signal lines (DTR, Transmit Data, Receive Data, Carrier Detect, RTS, and Clear to Send) and TTL standard polarity and voltage level for the Interrupt pin.

Pin 1: B+ Power input.

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

Pin	Assignment	Color on ACS3610xx cable
1	B+ input	Red
2	Interrupt (temporarily ground to invoke menu)	Brown
3	Data Terminal Ready (DTR)	Orange
4	Ground	Black
5	Transmit Data (TXD)	Yellow
6	Ground	Black
7	Receive Data (RXD)	Green
8	Carrier Detect (DCD)	Blue
9	Request to Send (RTS)	Violet (purple)
10	Clear to Send (CTS)	Gray

Note: Pin1 on the board-level transceivers is the pin farthest from the three LEDs and pin 10 is the closest to the LEDs.

LRS455 Specifications

* Specifications may change at any time without notice.

Specification			
Frequency	435-470 MHz		
Transmitter			
Output power	Programmable up to 2 W		
Range	70 miles with clear line of sight		
Modulation	2 and 4 level GFSK		
Occupied bandwidth	12.5 kHz		
Frequency Channels	5600 Channels @ 6.25 kHz		
Receiver			
Sensitivity	(2 level) -112 dBm at 9,600 bps and BER 10^{-6} (4 level) -100 dBm at 19,200 bps BER 10^{-6}		
Data Transmission			
Error Detection	32 bit CRC, Retransmit on error		
Link Throughput	9.6 Kbps at 2 level GFSK 19.2 Kbps at 4 level GFSK		
Data Interface	RS232/422/485 or TTL		
Data Connector	Board Level: 10 pin header with locking ramp, 0.1 inch spacing power/data connector.Enclosed: DB9		
Diagnostics			
Connector	Board Level: Separate 20-pin connector | Enclosed: 3-pin PCB header		
Power Requirement			
Operating Voltage	+6.0 to +27.0 VDC		
Current Drain	**Mode**	**+6 VDC**	**+12 VDC**	**+27 VDC**
	Transmit	1.5 A	0.75 A	0.34 A
	Receive	200 mA	100 mA	45 mA
	Idle	50 mA	25 mA	12 mA
General Information			
Operating Temperature	-30 °C to + 60 °C		
Dimensions	128 L x 61.8 W x 19.7 H (mm) | Enclosed: 173 L x 112 W x 35 H (mm)		
Weight	74.4 g | Enclosed: 605 g		
External Antenna Connector	SMA (board level), TNC (enclosure)		
Humidity	0 to 95% non-condensing		

Frequency List

The LRS455 transceivers tune from 435 MHz to 470 MHz with a tuning resolution of 6.25 KHz. This gives a total of 5600 available channels. Using the license allowed frequency, the channel number can be determined using the following formula.

$$\text{Channel number} = F^{MHz}\,(160) - 69600$$

Note: This is a partial list. If the required frequency is not listed use the F^{MHz} formula to obtain the appropriate channel number.

Channel#	Frequency	Channel #	Frequency	Channel #	Frequency
0	435.000	2060	447.875	4120	460.750
20	435.125	2080	448.000	4140	460.875
40	435.250	2100	448.125	4160	461.000
60	435.375	2120	448.250	4180	461.125
80	435.500	2140	448.375	4200	461.250
100	435.625	2160	448.500	4220	461.375
120	435.750	2180	448.625	4240	461.500
140	435.875	2200	448.750	4260	461.625
160	436.000	2220	448.875	4280	461.750
180	436.125	2240	449.000	4300	461.875
200	436.250	2260	449.125	4320	462.000
220	436.375	2280	449.250	4340	462.125
240	436.500	2300	449.375	4360	462.250
260	436.625	2320	449.500	4380	462.375
280	436.750	2340	449.625	4400	462.500
300	436.875	2360	449.750	4420	462.625
320	437.000	2380	449.875	4440	462.750
340	437.125	2400	450.000	4460	462.875
360	437.250	2420	450.125	4480	463.000
380	437.375	2440	450.250	4500	463.125
400	437.500	2460	450.375	4520	463.250
420	437.625	2480	450.500	4540	463.375
440	437.750	2500	450.625	4560	463.500
460	437.875	2520	450.750	4580	463.625
480	438.000	2540	450.875	4600	463.750
500	438.125	2560	451.000	4620	463.875

Channel#	Frequency	Channel #	Frequency	Channel #	Frequency
520	438.250	2580	451.125	4640	464.000
540	438.375	2600	451.250	4660	464.125
560	438.500	2620	451.375	4680	464.250
580	438.625	2640	451.500	4700	464.375
600	438.750	2660	451.625	4720	464.500
620	438.875	2680	451.750	4740	464.625
640	439.000	2700	451.875	4760	464.750
660	439.125	2720	452.000	4780	464.875
680	439.250	2740	452.125	4800	465.000
700	439.375	2760	452.250	4820	465.125
720	439.500	2780	452.375	4840	465.250
740	439.625	2800	452.500	4860	465.375
760	439.750	2820	452.625	4880	465.500
780	439.875	2840	452.750	4900	465.625
800	440.000	2860	452.875	4920	465.750
820	440.125	2880	453.000	4940	465.875
840	440.250	2900	453.125	4960	466.000
860	440.375	2920	453.250	4980	466.125
880	440.500	2940	453.375	5000	466.250
900	440.625	2960	453.500	5020	466.375
920	440.750	2980	453.625	5040	466.500
940	440.875	3000	453.750	5060	466.625
960	441.000	3020	453.875	5080	466.750
980	441.125	3040	454.000	5100	466.875
1000	441.250	3060	454.125	5120	467.000
1020	441.375	3080	454.250	5140	467.125
1040	441.500	3100	454.375	5160	467.250
1060	441.625	3120	454.500	5180	467.375
1080	441.750	3140	454.625	5200	467.500
1100	441.875	3160	454.750	5220	467.625
1120	442.000	3180	454.875	5240	467.750
1140	442.125	3200	455.000	5260	467.875
1160	442.250	3220	455.125	5280	468.000
1180	442.375	3240	455.250	5300	468.125

Channel#	Frequency	Channel #	Frequency	Channel #	Frequency
1200	442.500	3260	455.375	5320	468.250
1220	442.625	3280	455.500	5340	468.375
1240	442.750	3300	455.625	5360	468.500
1260	442.875	3320	455.750	5380	468.625
1280	443.000	3340	455.875	5400	468.750
1300	443.125	3360	456.000	5420	468.875
1320	443.250	3380	456.125	5440	469.000
1340	443.375	3400	456.250	5460	469.125
1360	443.500	3420	456.375	5480	469.250
1380	443.625	3440	456.500	5500	469.375
1400	443.750	3460	456.625	5520	469.500
1420	443.875	3480	456.750	5540	469.625
1440	444.000	3500	456.875	5560	469.750
1460	444.125	3520	457.000	5580	469.875
1480	444.250	3540	457.125	5600	470.000
1500	444.375	3560	457.250		
1520	444.500	3580	457.375		
1540	444.625	3600	457.500		
1560	444.750	3620	457.625		
1580	444.875	3640	457.750		
1600	445.000	3660	457.875		
1620	445.125	3680	458.000		
1640	445.250	3700	458.125		
1660	445.375	3720	458.250		
1680	445.500	3740	458.375		
1700	445.625	3760	458.500		
1720	445.750	3780	458.625		
1740	445.875	3800	458.750		
1760	446.000	3820	458.875		
1780	446.125	3840	459.000		
1800	446.250	3860	459.125		
1820	446.375	3880	459.250		
1840	446.500	3900	459.375		
1860	446.625	3920	459.500		

Channel#	Frequency		Channel #	Frequency		Channel #	Frequency
1880	446.750		3940	459.625			
1900	446.875		3960	459.750			
1920	447.000		3980	459.875			
1940	447.125		4000	460.000			
1960	447.250		4020	460.125			
1980	447.375		4040	460.250			
2000	447.500		4060	460.375			
2020	447.625		4080	460.500			
2040	447.750		4100	460.625			

Appendix A: Firmware Updates

As of this document's release, the following firmware has been released for the model numbers to which this document applies. The latest firmware versions are available on the FreeWave Web site at www.freewave.com. You can also view the latest firmware available for most models in Tool Suite.

The sections below describe the updates and any known limitations in each firmware revision for the LRS455-CU series transceivers. The most recent version is listed first.

Version 1.72

Release Date:	November 2011
Additions/Updates:	Enhanced AFC implementation.
Known Limitations:	• **RF Data Rate 4** is not compatible with firmware version 1.69e or older. • Local Diagnostics in Tool Suite release 2.8.5.0 is not currently supported. You can read a static capture of data by reading the radio within Tool Suite and viewing statistics in the Device Information tab. • VSWR is not currently supported.

Version 1.71

Release Date:	May 2011
Additions/Updates:	• Point-to-Point Repeaters ***are*** supported. • **RF Data Rate 4** is compatible with firmware version 1.70, but not earlier versions. • Fixes to support VCO Range testing.
Known Limitations:	• **RF Data Rate 4** is not compatible with firmware version 1.69e or older. • Local Diagnostics in Tool Suite release 2.8.5.0 is not currently supported. You can read a static capture of data by reading the radio within Tool Suite and viewing statistics in the Device Information tab. • VSWR is not currently supported.

Version 1.70

Release Date:	February 2011
Additions/Updates:	No details provided.
Known Limitations:	• Point-to-Point Repeaters are ***not*** supported. • **RF Data Rate 4** is not compatible between version 1.70 and older firmware versions. • If using **RF Data Rate 4**, all radios in your network must be upgraded to maintain communication.

Version 1.69d9

Release Date:	March 2010
Additions/Updates:	Various bug fixes. No additional detail provided.
Known Limitations:	Setting **Master Packet Repeat** to **0** and **Modbus RTU** to **1** results in a large data transmission delay. **Master Packet Repeat** should be set to **1** or higher if the **Modbus RTU** setting is enabled.

Version 1.67o

Release Date:	August 2010
Additions/Updates:	Various bug fixes. No additional detail provided.
Known Limitations:	Setting **Master Packet Repeat** to **0** and **Modbus RTU** to **1** results in a large data transmission delay. **Master Packet Repeat** should be set to **1** or higher if the **Modbus RTU** setting is enabled.

Version 1.67L

Release Date:	January 2010
Additions/Updates:	• Low duty cycle fixes. • Low duty cycle changes. • Multipoint changes - Slaves no longer transmit when linking.
Known Limitations:	None

Version 1.67i

Release Date:	August 2009
Additions/Updates:	Fixed upgrade issue.
Known Limitations:	None

Version 1.67h

Release Date:	August 2009
Additions/Updates:	Diagnostic fixes.
Known Limitations:	None

Version 1.66e

Release Date:	July 2009
Additions/Updates:	• Timing fix. • Low beacon duty cycle for xmit rate added.
Known Limitations:	None

Version 1.66

Release Date:	April 2009
Additions/Updates:	Inital Release
Known Limitations:	None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