ESTEEM

SECURE WIRELESS NETWORKING

ESTeem User's Manual
Models 195M-195H-195C

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ESTeem *Secure Wireless Networking*

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ESTeem Wireless Modems
415 North Roosevelt Street
Kennewick, Washington USA 99336

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Phone: (509) 735-9092 - Email: support@esteem.com   Revised: 4 January 2024

Before You Begin

Thank you and congratulations on your purchase of the ESTeem Model 195M (150-174 MHz), 195H (217-220 MHz) or 195C (450-470 MHz) Wireless Radio Modem! This manual was written to help both the first time and advanced user of the 195M/H/C to configure the wireless modem for your application.

The ESTeem 195M/H/C wireless modems are programmed through their Ethernet interface for both serial and Ethernet applications. To keep the manual usably short, many of the application descriptions and programming details assume the user has a good working knowledge of the following network concepts:

Figure 1: ESTeem Model 195M/H/C

•	General Ethernet networking and the configuration of LAN topologies

•	Common Ethernet terminology and acronyms

•	TCP/IP network protocol structure and how to configure TCP/IP networks and subnets

•	How to identify and set the TCP/IP address on your computer

•	Have administrator privileges to the computer and network you are configuring

•	You must be familiar with using web browser software such as Chrome, Edge, or Firefox

> Throughout this User's Manual are "***Technical Tips***" in boxes like this that have been added to help answer the most commonly asked questions.

If you are unfamiliar with any of the above networking concepts, you may need to contact your network administrator for assistance.

Model 195M/H/C Overview

The ESTeem Model 195M/H/C are wireless transceivers that can be used to build many types of Wireless Local Area Networks (WLAN). The ESTeem 195M/H/C series has multiple serial (RS-232, RS-422 and RS-485), Ethernet and 4-20mA sensor interfaces. The Model 195M/H/C can be configured for multiple modes of operation depending upon the needs of the wireless and wired network. The following interface configurations are provided as an overview of the basic network types, as all possible network configurations cannot be listed. For further help in selecting the correct network type, please refer to Chapter 3 of this User's Manual or call Customer Support at 509-735-9092.
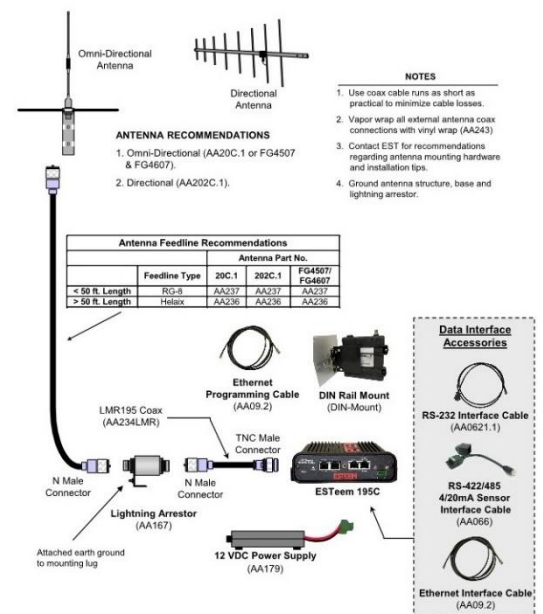
Figure 2: Cabinet Mount Configuration

Serial Applications

A Model 195M/H/C can be configured for point-to-point, multipoint or PLC emulations through software configuration changes. The following are brief descriptions of the Serial Device Interface (SDI) configuration modes. For detailed descriptions and suggested applications for each mode, please refer to Chapter 3.

RS-232 – The ESTeem 195M/H/C has two (2) RS-232 data ports. One RS-232 port (Port 4) is available for use when the ESTeem 195M is remote pole mounted, but only supports the basic three wire (Transmit, Receive and Ground) connection without any handshaking. The second RS-232 port (Port 3) has full hardware handshaking through the request to send (RTS) and clear to send (CTS) lines. Both RS-232 ports are software configurable from 2,400 to 115,000 bps.

RS-422 – The ESTeem 195M/H/C has a single RS-422 data port (Port 2). The RS-422 data port is shared on the front panel with the 10/100 Mbps Ethernet interface. The RS-422 interface is typically used for long distances in serial applications up to 4,000 feet distant using baud rates software configurable from 2,400 to 115,000 bps.

RS-485 – The ESTeem 195M/H/C has a single, two-wire RS-485 data port (Port 1). The RS-485 data port is shared on the front panel with the 4-20mA sensors. The RS-485 interface is typically used for long distances to 4,000 feet at baud rates software configurable from 2,400 to 115,000 bps.
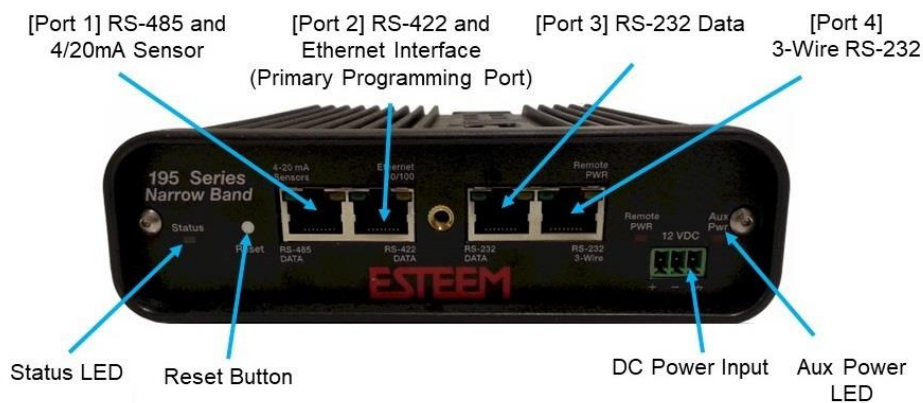
Figure 3: ESTeem 195M/H/C Front Pannel

Ethernet Applications

The ESTeem 195M/H/C has a 10/100 Mbps Ethernet interface (Port 2) that is used as both a data port and the primary programming port. The primary use will be as a slow speed (12.5 Kbps) Ethernet bridge to remote locations to gather data from remote Ethernet devices. Each of these modes of operation are described in detail in Chapter 5.

Sensor Applications

The ESTeem 195M/H/C has four (4) 4-20mA sensor inputs. The sensor inputs can be read out of the 195M/H/C though their ModbusTCP address, a software command, or the Model 195M/H/C configuration utility. For complete details on the configuration and operation of the sensor input, please refer to Appendix B – Interface Ports.

Legacy - Model 192 Applications

The ESTeem 195C can be integrated with our legacy ESTeem Model 192C or Model 192CHP, while the 195M can be integrated with Models 192M or 192MHP networks. The procedure for integrating the new 195C or 195M in an existing Model 192 network can be found in Appendix C of this User's Manual.

To begin setup of your wireless Ethernet network, continue to Chapter 2 - Staring Out of this User's Manual.

Overview

There are three main phases to prepare the ESTeem 195M, 195H or 195C for operation in a wireless network:

Phase 1 - Determine the correct mode of operation for the ESTeem in the wireless network. The ESTeem 195M/H/C has multiple modes of operation and determining the correct mode of operation is the first step. Chapter 3 of this User's Manual details the modes of operation and applications where each would be used.

Phase 2 - Program the ESTeem for operation in the wireless network. Once the correct mode of operation for the ESTeem has been determined, the 195M/H/C will be programmed for the wireless network. To simplify the programming of the Model 195M/H/C, ESTeem has created a software utility called the ESTeem 195 Narrow Band Configuration Utility which is used to configure the wireless radios for use in the network. The configuration utility is a software feature of the ESTeem Software Suite and can be downloaded from the ESTeem web site (www.esteem.com). See Software Configuration section below or Chapter 6 (Utilities and Features) of this User's Manual will guide you in the installation of the software and detailed operating guide.

Phase 3 - Install the ESTeem hardware and test communication. After the ESTeem Model 195M/H/C's programming, install the hardware in each remote location. Chapter 7 of this User's Manual describes the antenna specifications, mounting options and the configuration of the pole mounting hardware for the ESTeem. For instructions using the link diagnostic tool for testing and troubleshooting the wireless link, refer to Chapter 6 (Utilities and Features).

The following basic hardware layouts, configurations and software installations will allow you to proceed with the programming and testing of the wireless network.

Model 195M/H/C Hardware Layout

To begin the configuration, unpack the ESTeem Model 195M/H/C shipping boxes and locate the items below for initial configuration. Take a few minutes to inventory your equipment before you proceed. Report any missing or damaged items to Customer Support (509-735-9092) as soon as possible. Each node in your ESTeem Model 195M/H/C's network may have different hardware components based upon the final installation location (i.e. Outdoor, Indoor, Point-to-point or Multi-Point). Antenna types, cable lengths, power supplies may be different, but the following items will be required for basic setup:

Model 195M/H/C

Power Supply (AA179 Displayed)

Test Antenna (AA19C Displayed)
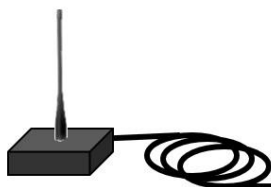
Ethernet Cable

Figure 1: 195M/H/C Example Hardware

Note: Your accessory model numbers may vary from the above, but you will need to locate each of above items to continue configuration.

Model 195M/H/C Hardware Configuration

The following steps should be completed to begin configuration of the ESTeem Model 195M/H/C:

1.   Connect the antenna cable to the TNC connection on the ESTeem Model 195M/H/C (Figure 1).

2.   Connect the power supply and Ethernet cable to the ESTeem Model 195M/H/C. Complete the Software Configuration below and proceed to Chapter 3 to begin programming.

Technical Tips:

1. Attach antenna to the Model 195M/H/C before powering up.

2. Configure the Model 195M/H/C prior to mounting.
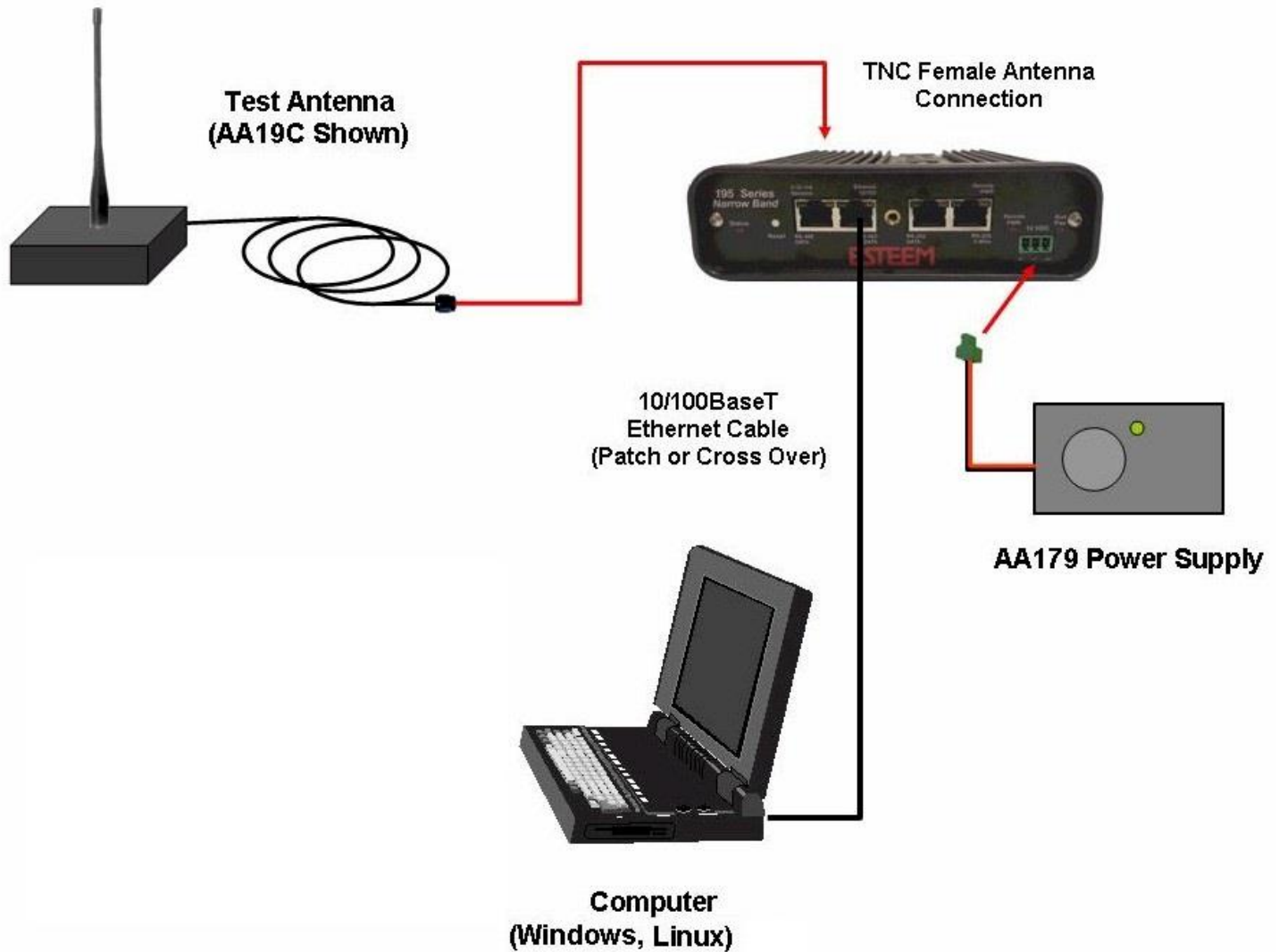
Figure 2: Basic Configuration Setting

Software Configuration

The ESTeem Narrowband Configuration Utility (a component of the ESTeem Software Suite) will allow easy access to the configuration, monitoring, and diagnostics for the ESTeem Model 195M, 195H and 195C.

Installation

> ***Technical Tip:*** If your computer is configured for DHCP and not attached to the network, you will need to assign a static IP address to program the 195M/H/C.

The ESTeem Software Suite can be downloaded for free from the ESTeem web site (https://www.esteem.com). Once the Software Suite is downloaded run the installer and complete that process.

1. Once the Software Suite has been installed, navigate to the location it was installed at and run the Discovery Utility. The Discovery Utility is used to identify and access the radio before configuration.
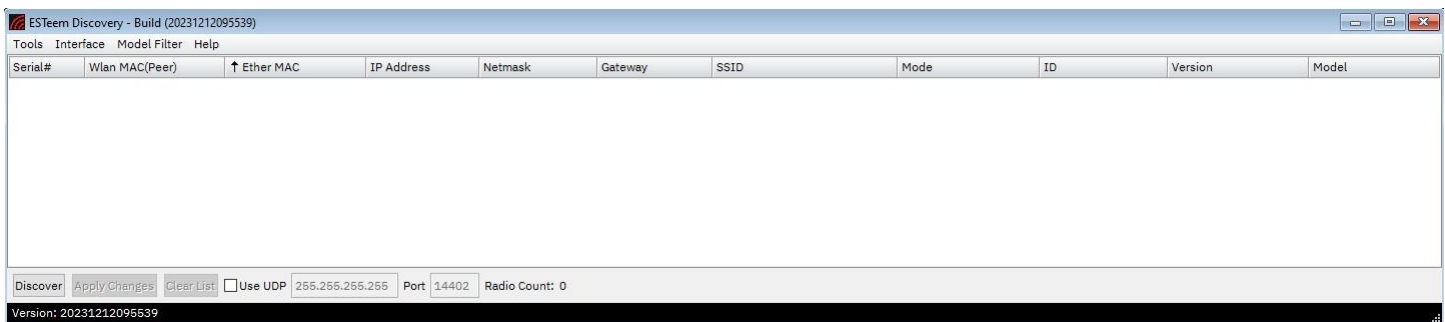
Figure 3: ESTeem Discovery Utility

2. Connect the ESTeem 195M/H/C radio to your computer either directly to the Ethernet card or through a Switch using a CAT-5e Ethernet cable. The Ethernet port supports Auto-Negotiation, so either a patch cable or crossover cable will work. Press the *Discover* button. This Discovery Utility and ESTeem Narrowband Configuration Utility will be used throughout the remainder of the User's Manual.
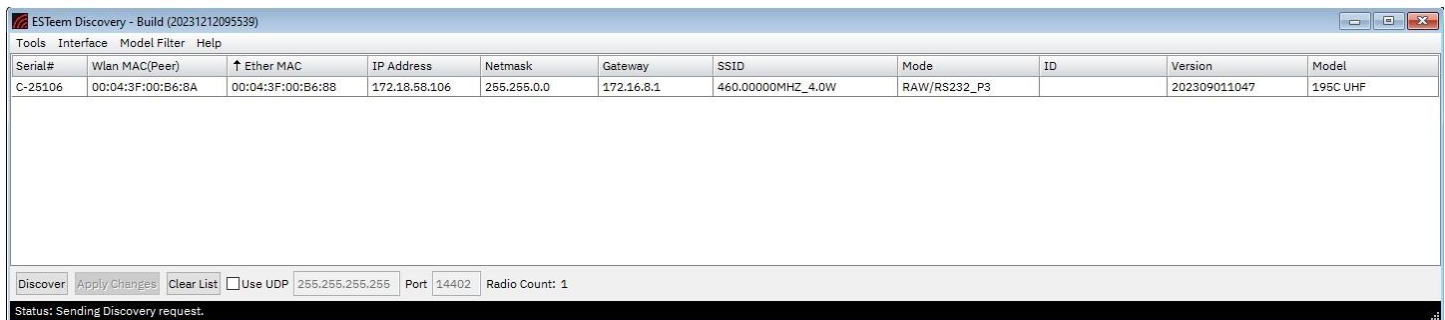
Figure 4: Discovery Found Radio

3. After pressing the Discover button, the ESTeem 195M/H/C will be displayed (Figure 4). If the ESTeem is not on the same IP subnet as the computer, double click on the IP, Netmask, or Gateway and make the necessary changes and press the Enter key to secure the changes. Press the Apply Changes button when complete.

4. If changes were made to the IP address, you will need to press the Discover button again to show the changes. Right-mouse click on the radio and select the Configure Radio option to begin programming.
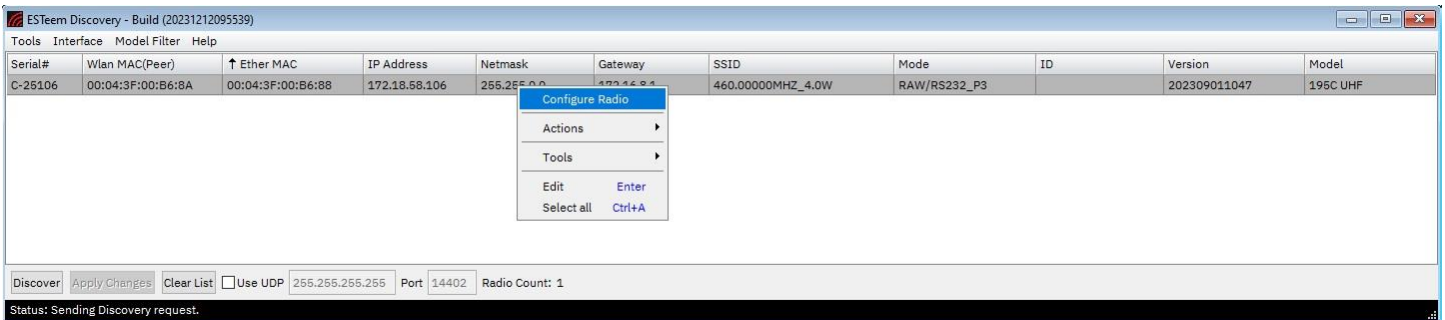
Figure 5: Opening Configuration Software

Model 195M/H/C Front Panel Layout

The single Status LED has multiple colors representing the following:

Off – No Activity

Blue – Model 195M/H/C has not seen a disconnect packet.

Red – Model 195M/H/C is transmitting an RF packet.

Green – Model 195M/H/C is receiving an RF packet that it can decode.

Amber – Model 195M/H/C is receiving an RF signal from a source it cannot decode. This could be RF noise or another radio transmitter on the same frequency of the 195M/H/C.
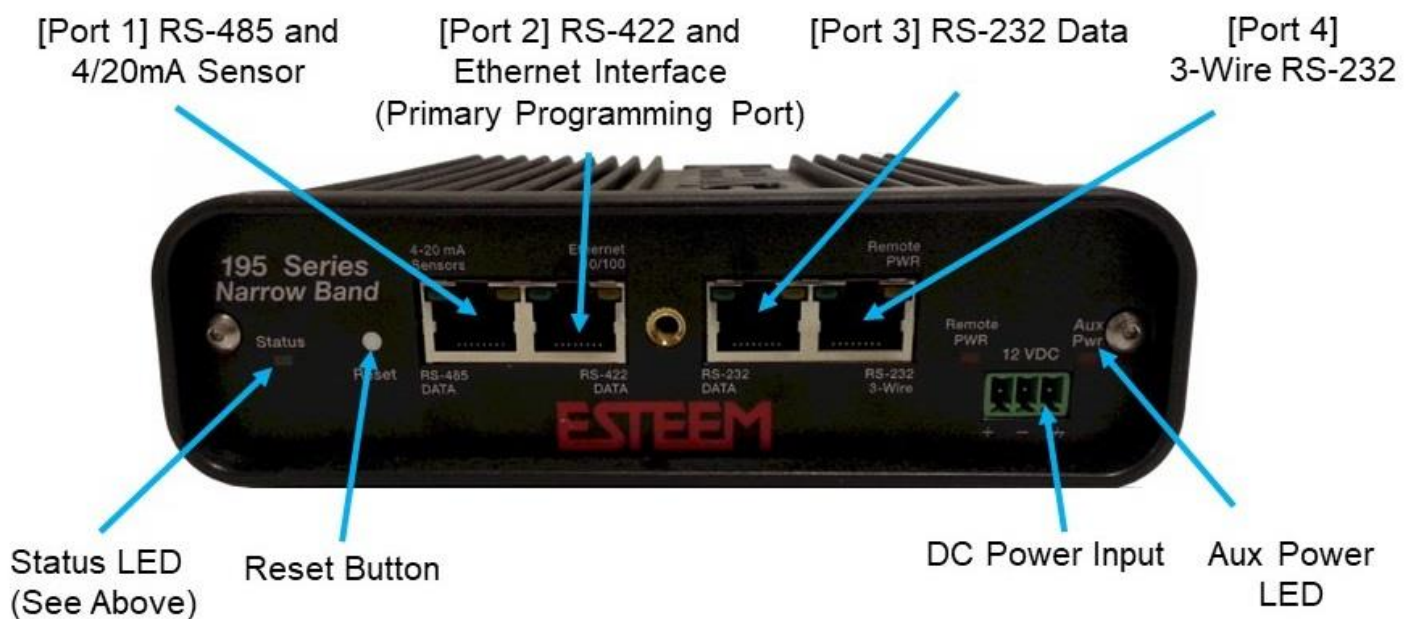
Figure 6: Front Panel

Modes of Operation

The ESTeem Model 195M, 195H and 195C can be configured for multiple serial and Ethernet applications. Determining the correct mode of operation for the ESTeem is the first step in creating a reliable wireless network. This chapter will explain each mode of operation, provide example applications and detailed programming information for each mode. Please review the following modes of operations. If you do not see an example of your application, please contact ESTeem support at 509-735-9092 for help in selecting your mode of operation.

Transparent Point to Point Application

The most used mode of operation with the ESTeem Model 195 series (195M/H/C) is the transparent mode. The transparent mode will pass serial or Ethernet data between two (or more) wireless radios as if they were connected by a cable. Point to point operation is when two serial or Ethernet devices are transferring information between either other, directly or through a repeater (Figures 1 and 2). The type of serial data interface (RS-232, RS-422, or RS-485) on either end of the wireless link is configurable and can be independent on each side. For example, the Main Office in Figure 1 can be configured for RS-232 operation, while the serial port at the remote site can be configured for RS-485.

> **Technical Tip:** The 195M/H/C series radios can support either a serial (RS-232, RS-422 & RS-485) or an ethernet interface connection but does NOT translate between protocols. The 195 radios cannot be used for serial at one side of the connection and ethernet at the opposite side.

Example Applications

•   Point to point serial interfaces (RS-232, RS-422 or RS-485)

•   Point to point wireless Ethernet communication devices

•   Remote Supervisory Control and Data Acquisition (SCADA) networks

Applications Where Transparent Mode Not Used

•   Multiple Remote Locations

•   PLC Emulation Networks (see PLC Emulation below)

•   Connections to large Ethernet traffic networks such as large office buildings or plant networks
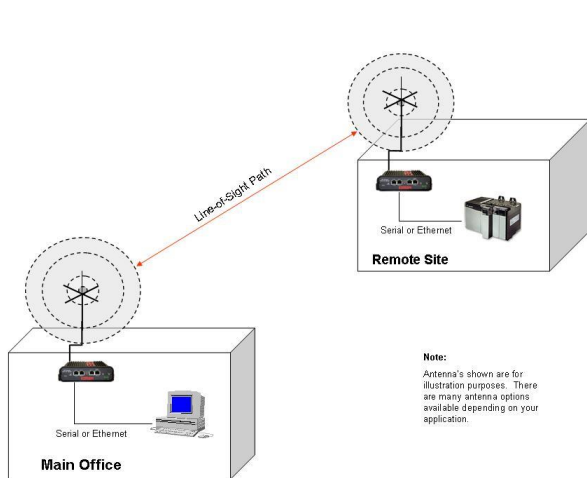
Figure 1: Point to Point Example
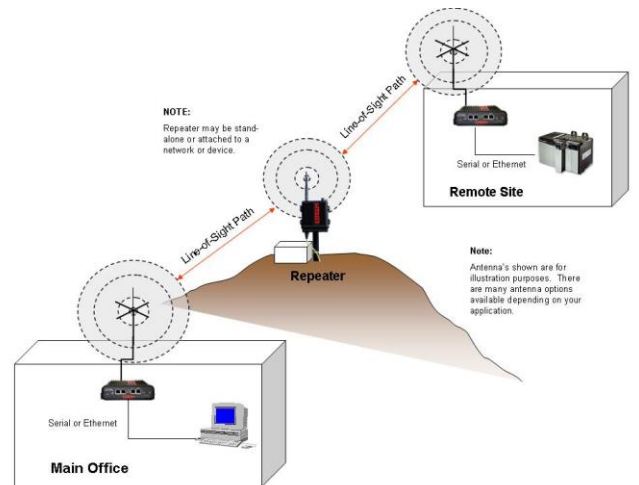
Figure 2: Point to Point through Repeater Example

Transparent Multipoint Application

The ESTeem 195M, 195H and 195C can be configured multipoint transparent operation (Figure 3). Like point-to-point applications, the 195M/H/C can support multiple serial data interfaces (RS-232, RS-422, RS-485 or Ethernet) on either end of the wireless link. These wireless links are independent of each other and configurable.

Example Applications

•   Point to multipoint serial networks (RS-232, RS-422 or RS-485)

•   Point to multipoint wireless Ethernet communication devices

Applications Where Transparent Mode Not Used

•   PLC Emulation Networks (see PLC Emulation below)

•   Simple network connections (see transparent point to point)
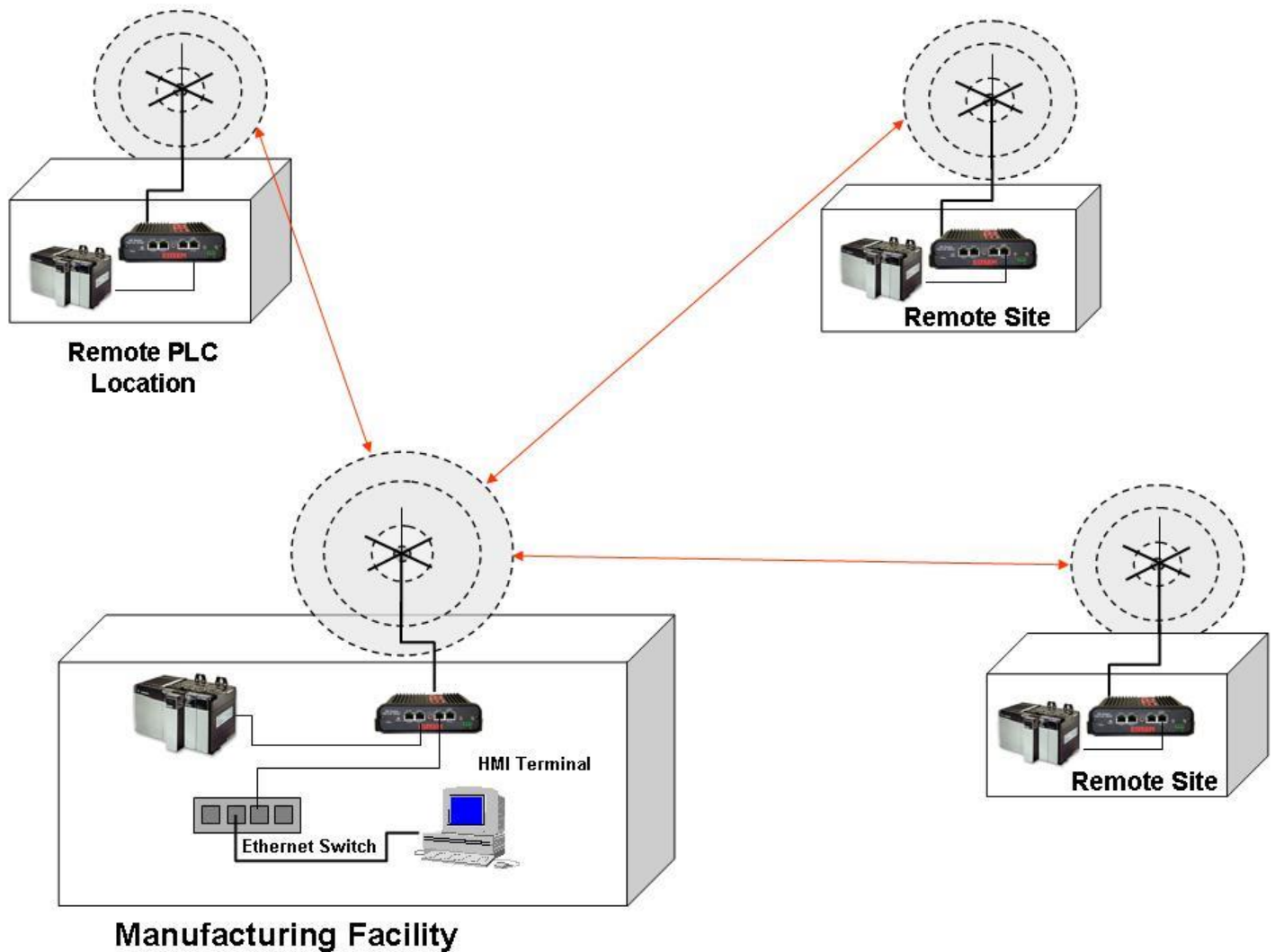
Figure 3: Point to Multipoint Example

PLC Emulation Applications

The ESTeem 195M, 195H and 195C can support PLC based networks in both point to point and multipoint applications. The PLC emulation driver allows the ESTeem to identify the destination address in the PLC message block and change the ESTeem destination address to match. This PLC emulation allows the ESTeem 195M/H/C to support multiple repeaters in a network (Figure 4). If repeaters are used with PLC emulation, the route and append table will also need configured (see Chapter 4 for complete details).

PLC Protocols Supported

- Rockwell Automation/Allen-Bradley DF1 Full-Duplex

- Rockwell Automation/Allen-Bradley DF1 Half-Duplex

- Rockwell Automation/Allen-Bradley DF1 Radio Modem

- Modbus RTU/ASCII

- Opto-22

- DNP3
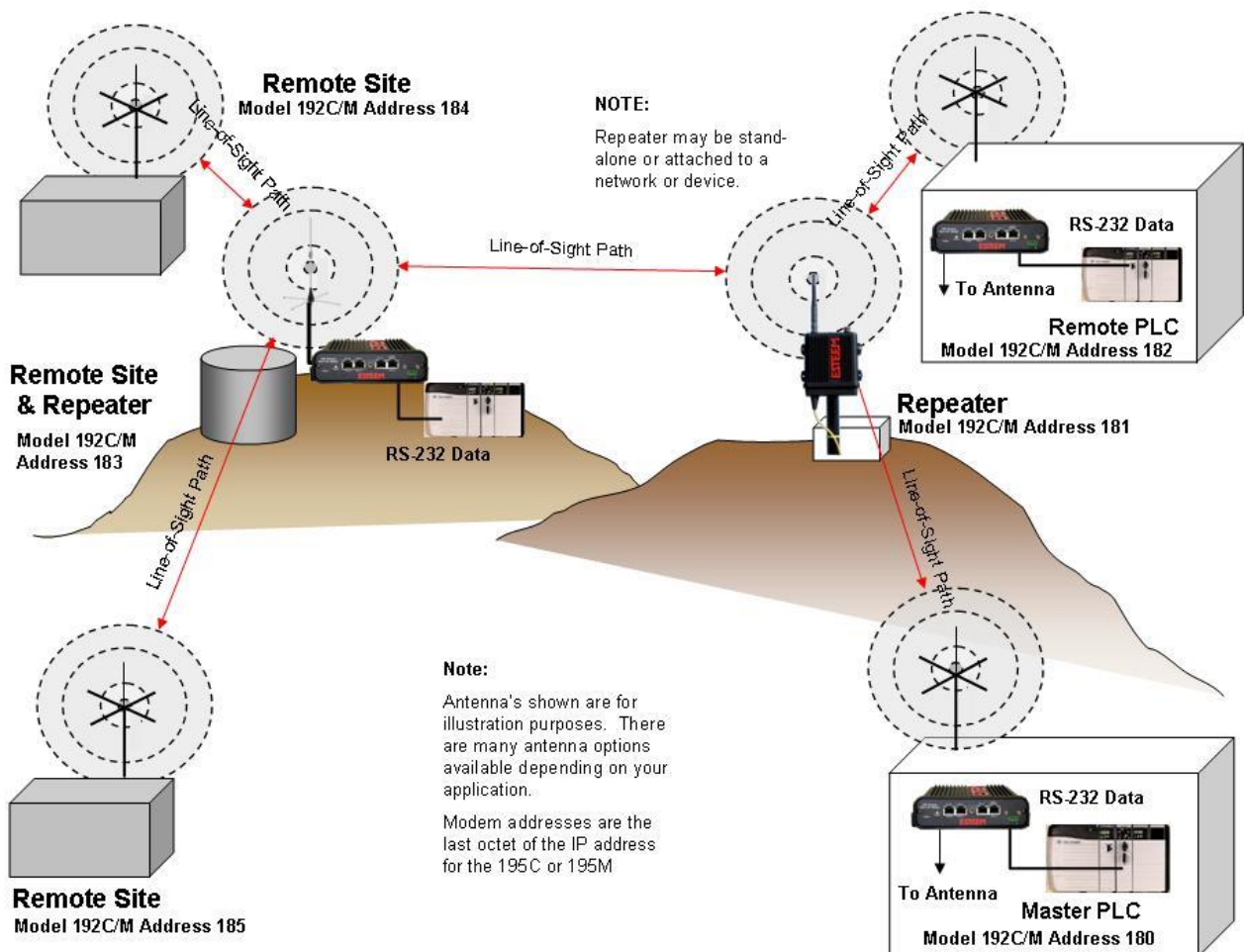
Figure 4: Multipoint PLC Emulation Example

Programming Examples

Once the mode of operation for the ESTeem has been determined, you are now ready to program the Model 195C, 195M, or 195H for use. ESTeem has created a simplified programming utility called the 195 Narrow Band Configuration Tool. This configuration utility is a component of the ESTeem Software Suite and will be used in all the following programming examples.

> **Technical Tip:** The 195 Narrowband Configuration Tool communicates with the 195M/H/C through the Ethernet interface. If Ethernet or RS-422 (Shared ports with the Ethernet programming port) are the data interface for the wireless link, configure the 195M/H/C as shown below first. Once configured and reset change to the correct data cable.

Finding ESTeem 195M/H/C with Discovery

Each of the example applications will use the 195 Narrow Band Configuration Utility to program the ESTeem 195M/H/C. The radio can also be programmed by Telnet to the Ethernet port using the radio's IP Address. Please refer to Appendix A (Software Commands) for a complete list of software commands used for configuration.

1. Verify the basic hardware configuration from Chapter 2 and open the Discovery Utility (Figure 5). Press the *Discover* button to continue.
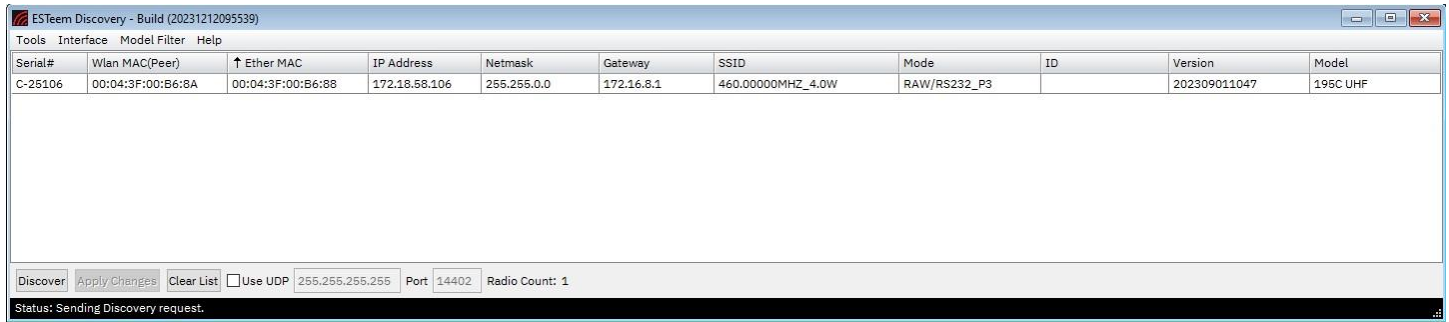
Figure 5: ESTeem Discovery Utility

2. The ESTeem 195M/H/C will be displayed (Figure 5) in the Discovery. If the ESTeem 195M/H/C is not on the same IP subnet as the computer, double click on the IP address and Netmask to make the necessary changes. Press the Apply Changes button when complete.

3. If changes were made to the IP address you will need to press the Discover button again to show the changes. Right-mouse click on the ESTeem 195M/H/C and select 195NB Setup Tool button to begin programming.
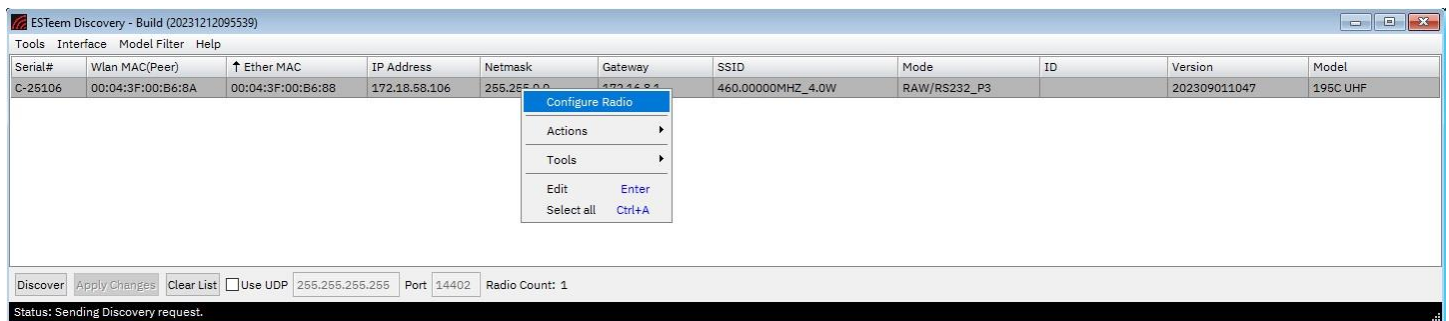
Figure 6: Opening Radio Configuation Software

Point to Point Transparent Example 1 (Figure 1)

(2) ESTeem Model 195C
Transparent RS-232 Wireless Link
RS-232 Data Rate (19,200 bps, No Parity, 8 data bits, 1 stop bit)
465.500 MHz Operating Frequency
Main Office Address – 172.16.10.180
Remote Site Address – 172.16.10.181

> **Technical Tip:** The unit address of the ESTeem 195C, 195M or 195H is the last octet of the IP address. This single address is used when configuring the destination and routing. Example – Main Address IP = 172.16.10.180. Unit address = 180.

The 195 Series Narrow Band Configuration Tool provides a graphical interface to the software commands for the ESTeem 195M/H/C. The General tab is the default when the Configure Radio (Figure 6) button is pressed in the Discovery Program. All the basic configuration parameters can be entered in this window (Figure 7). Most basic information such as the current frequency of operation, address and port configuration will be read from the 195M/H/C and displayed.

Main Office Configuration

1. The current address will be set to the last octet of the IP address. The Main Office address will be set to 180.

2. While on the first page of the General configuration utility set the following options then press Next.

- Set the data interface to the RS-232 DATA port (Port 3).
- Set the operating frequency to 456.500 MHz
- Set the remote address to the last octet in Remote Site address (181).

3. Configure the Serial interface as needed. Press Next.

4. Set the operating mode to Transparent. Press Next.

Figure 7: Main Configuration Page

Once all the above software commands are adjusted to their correct parameters, press the Write Config button to send the changes to the 195C, 195M or 195H. The radio will reset and be ready for operation on the selected serial port.

Remote Site Configuration

1. While on the first page of the General configuration utility set the following options then press Next.

- Set the data interface to the RS-232 DATA port (Port 3).
- Set site address to 181.
- Set the operating frequency to 456.500 MHz.
- Set the destination address to the last octet in Main Office address (180).

2. Configure the Serial interface as needed and press Next, then set the operating mode to Transparent and press Next.

Figure 8: Point to Point Remote Config

Once all the above software commands are adjusted to their correct parameters, press the Write Config button to send the changes to the 195C, 195M or 195H. The radio will reset and be ready for operation on the selected serial port.

Point to Point Transparent Example 2 (Figure 2)

(3) ESTeem Model 195C
Transparent RS-232 Wireless Link
RS-232 Data Rate (19,200 bps, No Parity, 8 data bits, 1 stop bit)
465.500 MHz Operating Frequency
Main Office Address – 172.16.10.180
Remote Site Address – 172.16.10.181
Repeater Site Address – 172.16.10.200

The addition of a repeater to a point-to-point link is as simple as including the repeater address in the destination (Figure 9). The following are configuration page examples for each site in the network.

<u>Main Office Configuration</u>

1. While on the first page of the General configuration utility set the following options then press Next.

- Set the data interface to the RS-232 DATA port (Port 3).
- Set site address to 180.
- Set the operating frequency to 456.500 MHz.
- Set the destination to the Remote Site address including the repeater (200,181). The 195M/H/C RF link will follow the exact path as written in this field.   For example, the data will first be sent to address 200 and then repeated to address (181).

2. Configure the Serial interface as needed and press Next, then set the operating mode to Transparent and press Next.
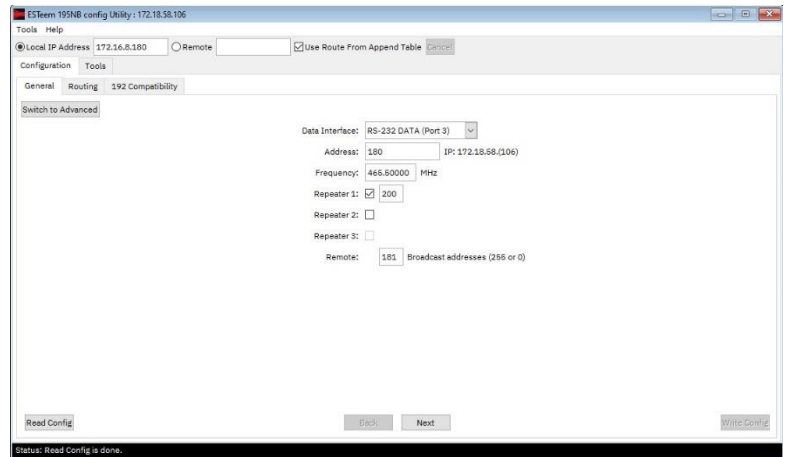
Figure 9: Main Office Radio Configuration

Once all the above software commands are adjusted to their correct parameters, press the Write Config button to send the changes to the 195C, 195M or 195H. The radio will reset and be ready for operation on the selected serial port.

Complete the configuration for the remote site and repeater as shown in Figures 10 and 11.

Figure 10: Peer-Repeater-Peer Remote Setup

Figure 11: Peer-Repeater-Peer Repeater Setup

Multipoint Transparent Example 1 (Figure 3)

(4) ESTeem Model 195C
Transparent RS-485 Wireless Link
(19,200 bps, No Parity, 8 data bits, 1 stop bit)
465.500 MHz Operating Frequency
Manufacturing Facility Address – 172.16.10.180
Remote Site Addresses – 172.16.10.183-172.16.10.186

> **Technical Tip:** To send to multiple remote locations at once use a global "Remote" address of 255.

The following are examples of the configuration pages needed for point to multipoint operation. The only difference from a point-to-point application is that a special global Destination Address (Address = 255) is used. Setting the address to 255 on the Destination will allow all remote locations to receive the data simultaneously and pass through the configured serial data interface.

Manufacturing Facility Configuration

1. While on the first page of the General configuration utility set the following options then press Next.

- Set the data interface to the RS-485 DATA port (Port 1).
- Set site address to 180.
- Set the operating frequency to 456.500 MHz
- Set the destination to the Global/Broadcast address 255.

2. Configure the Serial interface as needed and press Next, then set the operating mode to Transparent and press Next.
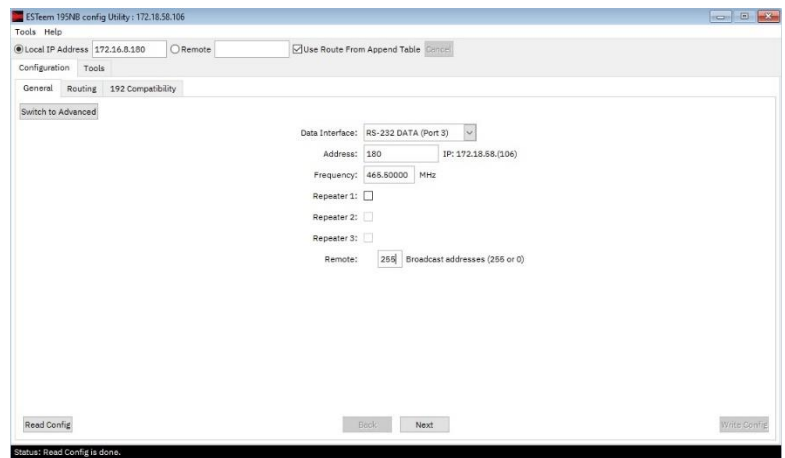
Figure 12: Peer to Multipoint Transparent
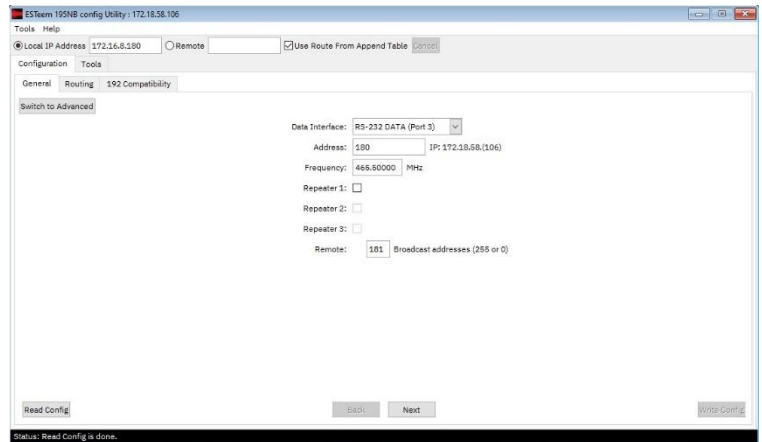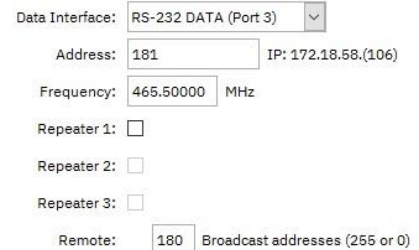
Once all the above software commands are adjusted to their correct parameters, press the Write Config button to send the changes to the 195C, 195M or 195H. The radio will reset and be ready for operation on the selected serial port. The configuration for the remote sites in the network will be very similar with only the address being different for each wireless radio. Complete the configuration for the remote sites as shown in Figure 13.

Figure 13: Multipoint Transparent Remote

PLC Emulation Example 1 (Figure 4)

(6) ESTeem Model 195C
Allen Bradley DF1 Half-Duplex (BCC) Emulation
465.500 MHz
Main Office Address – 172.16.10.180
Repeater Address – 172.16.10.181
Remote Site Addresses – 172.16.10.182-172.16.10.185

The following are configuration page examples for PLC emulation mode. The PLC emulation driver allows the ESTeem to identify the destination address in the PLC message block and change the ESTeem destination address to match. This PLC emulation allows the ESTeem 195M/H/C to support multiple repeaters in a network (Figure 4). **If repeaters are used with PLC emulation, the route and append table will also need configured.**

> *Technical Tip:* The unit address of the ESTeem 195M/H/C **must match** the connected PLC when operating with a **serial interface** in PLC emulation mode.
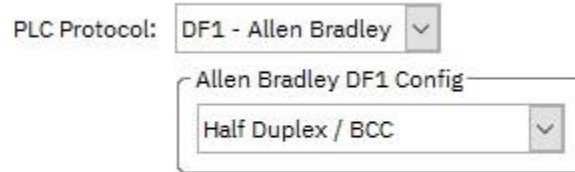
Figure 14: PLC Settings in General Configuration

Master Configuration

1. While on the first page of the General configuration utility set the following options then press Next.

   - Set the data interface to the RS-232 DATA port (Port 3).
   - Set site address to 180.
   - Set the operating frequency to 456.500 MHz
   - Set the destination to any remote site address (address 181 used for example).

2. Configure the Serial interface as needed and press Next, then set the operating mode to Allen Bradley DF1, Half Duplex with BCC error checking and press Next.

3. Once all the above software commands are adjusted to their correct parameters, press the Write Config button to send the changes to the 195C, 195M or 195H.

To set up the Master Site to use repeaters as shown in Figure 4, move to the Routing tab in the configuration utility. We'll use the Basic configuration tool and Figure 15 will be displayed.
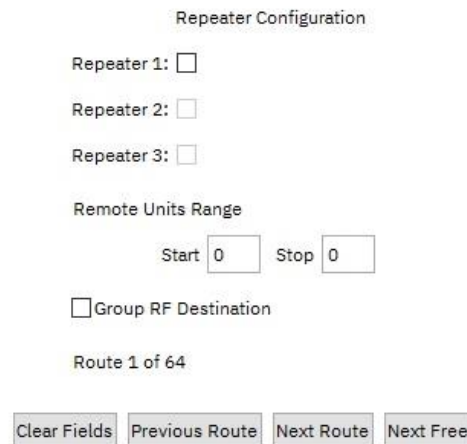
Figure 15: Basic view of Routing Entry

Master Site Repeater Configuration

Only the master site in a PLC Emulation network will have the repeater routing information. PLC Emulation Example 1 (Figure 4) uses two ESTeem 195M/H/C radios as repeaters. There is a stand-alone repeater at IP address 172.16.10.181 (Address 181). Using the Basic view, check the box next to repeater 1 to enable the repeater for this entry and fill in as mentioned above. (Figure 16) The append entry is created for a group of address from the Start address to the Stop address. Refer to Figure 4 and note address 182 and 183 (repeater and a remote site) will use the repeater (address 181). Enter the start address of 182 and the stop address of 183. Then click Next Route and do the same for the next entry with a second repeater site that is also a remote location at IP address 172.16.10.183 (Address 183) and a Start and Stop ID of 184 and 185 respectively.
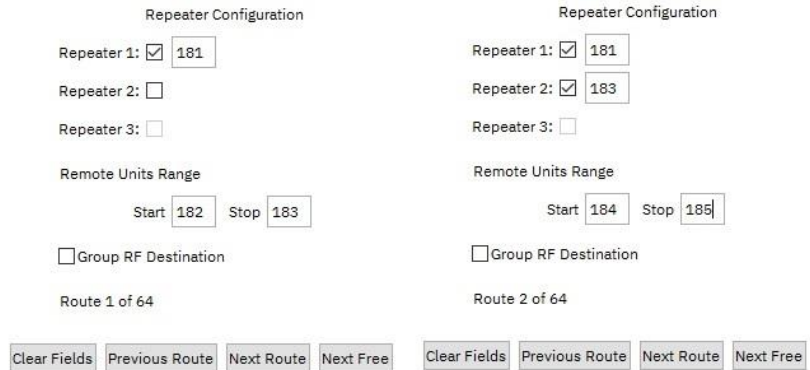
Figure 16: Routing Entry Examples

Once all repeater entries have been completed, press the Write Config button to save the values in the Master Site. For further detail on repeaters and their configuration, please refer to Chapter 4 of this User's Manual.

Remote Site Configuration (Remote Site 184 for Example)

The remote site configuration will be similar on all remote locations. Only the address and destination address will change.

1. While on the first page of the General configuration utility set the following options then press Next.

   - Set the data interface to the RS-232 DATA port (Port 3).
   - Set site address to 184.
   - Set the operating frequency to 456.500 MHz
   - Set the destination address as the path to the Master site (183,181,180). See Figure 17.

2. Configure the Serial interface as needed and press Next, then set the operating mode to Allen Bradley DF1, Half Duplex with BCC error checking and press Next.

Once all the above software commands are adjusted to their correct parameters, press the Write Config button to send the changes to the 195C, 195M or 195H. The radio will reset and be ready for operation on the selected serial port.
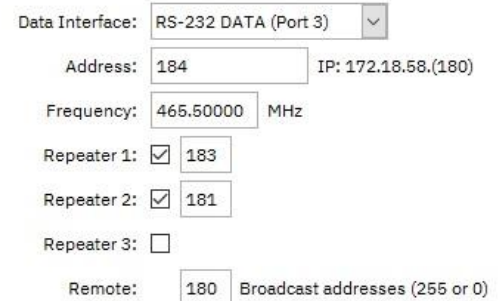
Figure 17: Remote Site Routing Configuration

Any ESTeem Model 195M, 195H or 195C in the wireless network can be used as a repeater to reach a remote location. Manually entering repeater routes in a terminal for testing a connection (connect command) or remote programming (program command) is as simple as adding the routing in the address with the repeaters identified by commas. For example, using Figure 1, if your computer is connected to the ESTeem 195M/H/C at the Master Station and you want to connect to address 21, your command would be "connect 3,21". Also, if you wished to connect to address 30 from the Master Station your command would be "connect 3,20,40,30".

Configuring Route and Append Tables

When using the PLC emulation modes, the repeater configuration will be different for the Master and Remote locations in a network. You will need to configure the repeater routing table for the Master ESTeem only. The Master ESTeem is the ESTeem connected to the PLC that is initiating communication to remote PLCs through other remote stations. Do not program the repeater configuration in the repeating ESTeems or the remote ESTeems.

Figure 1 shows a complex, 16 node site with four (4) repeater routes. This example will illustrate the terms used in the utility and how they correspond to the stations in your site.

Look in Figure 1 and note that four of the ESTeems will relay the radio signal for other ESTeems (addresses 3, 5, 20 and 40). These are the repeater routes. A total of four repeater routes will need to be completed for this site.

Route 1: To complete the first repeater route entry, refer to Figure 1 and find repeater address 5 (Route 1). The ESTeem/PLC addresses that use this route are addresses 25-28. In the 195 Narrowband Configuration Utility select the Routing tab (Figure 2 will be displayed). In Repeater 1 entry, enter the repeater address (Address 5). Lower on the page find Remote Units Range and enter the address group that will use this repeater site (Figure 3).
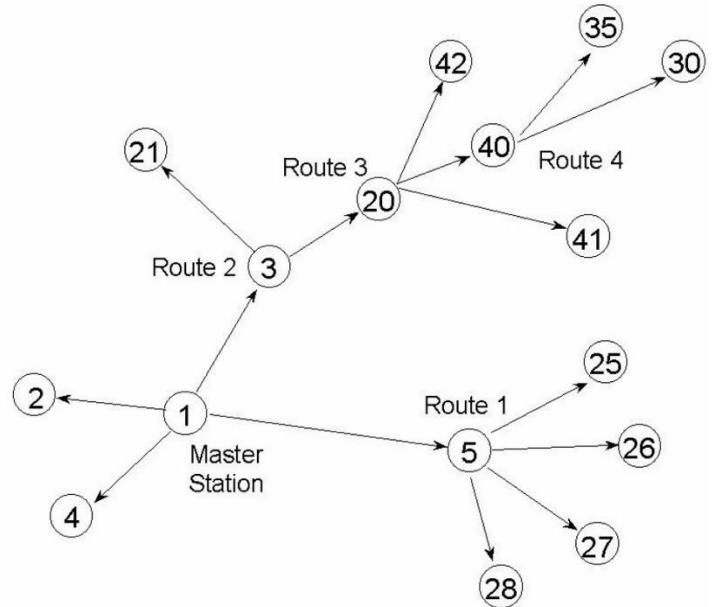
Figure 1: Repeater Example

> **Technical Tip:** The maximum number of memory locations for any ESTeem is 64. When possible, try and group as many addresses together as you can to save available memory locations.

Figure 2: Route Entry Basic View

Figure 3: Route 1 Entry Example

Note: ESTeem addresses are input to the Append Entry (Remote Units Range) section in blocks of two numbers. The two numbers represent a range of addresses for a given route. The numbers could be input to cover a range of addresses (such as 25,28 contain all addresses from 25 through 28) or input to cover a single address (such as 25,25 would only attach address 25 to this route).

Route 2: Refer to Figure 1 and find Route 2. This route has a repeater address of 3 and addresses 20 through 21 use this route. Note: Although address 20 is a repeater for another route, it requires an ESTeem address and needs to be counted. Type 3 in the first repeater block, 20 in the first address field and 21 in the second (Figure 4).

Route 3: Refer to Figure 1, Route 3 and notice there are two repeaters in this route (addresses 3 and 20). A repeater route always follows the address path from the master station. The first repeater address from the master in this route is address 3. Type 3 in the first repeater block. The second repeater from the master is address 20. Type 20 in the second repeater block. Addresses 40 through 42 use this route. Type 40 in the first address field, 42 in the second (Figure 5).
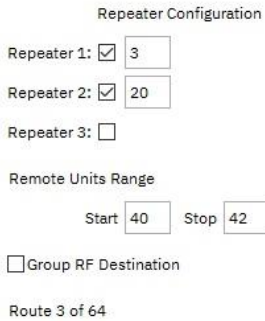
Figure 5: Route 3 Configuration

Figure 4: Route 2 Configuration

Route 4: This fourth route uses a total of three repeaters. Follow the address route from the master and notice that the first repeater is address 3. Type 3 in the first repeater block. The second address from the master in this route is address 20. Type 20 in the second repeater block. The third repeater address from the master is address 40. Type 40 in the third repeater block. (Figure 6). Notice that the two addresses that use this repeater route are not sequential, putting 30 in the first block and 35 in the second would allocate addresses 31-34 to this route. In this example we will input each address separately. On the first line type 30 in both blocks and on the second line use the same repeater route numbers and type 35 in both blocks.

Once all repeater routes are addressed, press the Write Config button to save to the connected ESTeem 195C, 195M or 195H.
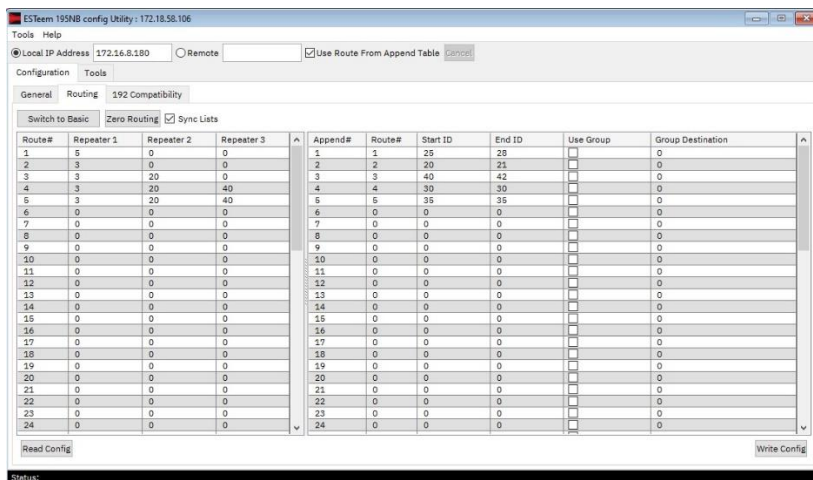
Figure 6: Route 4 Configuration

Figure 7: Advanced (List) View of Routing Entries

Reading Route and Append Tables

To find the saved route and append tables in an ESTeem 195 Narrowband click on the Routing tab of the Model 195 Narrowband Configuration Utility and press the Read Config button. Figure 7 displays the saved Routes and Appends for the wireless network shown in Figure 1 after Switch to Advanced is clicked.

Clearing Route and Append Tables

To clear route and append tables in an ESTeem 195 Narrowband click on the Routing tab of the Model 195 Narrowband Configuration Utility and press the Zero Routing button.

Configuring the 195M/H/C series radios for wireless Ethernet communications is much different from a standard Ethernet Bridge that passes all Ethernet traffic. By default, the 195M/H/C will pass **no traffic** across the wireless link until a Routing entry for a specific IP address has been configured. This allows the low bandwidth radios to exclusively limit the traffic across the wireless network to those Ethernet devices specifically identified in the configuration. This bulletin will take you through an example of how-to set up wireless links as well as how to test the wireless network through Diagnostics.

> *Technical Tip:* The ESTeem 195M/H/C have a low (12.5-50Kbps) RF data rate which should be considered when being used to bridge large Ethernet networks.

RJ45 Pin No.	Wire Color	Wire Diagram	10Base-T Signal 100Base-TX Signal
1	White/Orange		Transmit +
2	Orange		Transmit -
3	White/Green		Receive +
4	Blue		Unused
5	White/Blue		Unused
6	Green		Receive -
7	White/Brown		Unused
8	Brown		Unused

Figure 1: Ethernet Interface & Pinout

Network Diagram

A diagram of the network layout, with all IP Addresses that will need to communicate across the wireless network identified, will greatly help to configure the radio network. Identifying all Ethernet devices that will send data across the network is key. Any device that is not specifically given a route will NOT be sent through the radio.

In this example Test Diagram (Figure 2), will be a polled system with communication being initiated by PLC 1. PLC 2 and 3 will only be communicating with PLC 1 and will not need to talk to each other. Your network diagram may be much more complicated than this simple example, but the following steps will still apply and must be done to each radio individually before installation.

A. Create a network diagram for your wireless network to include all Ethernet devices by their IP address.
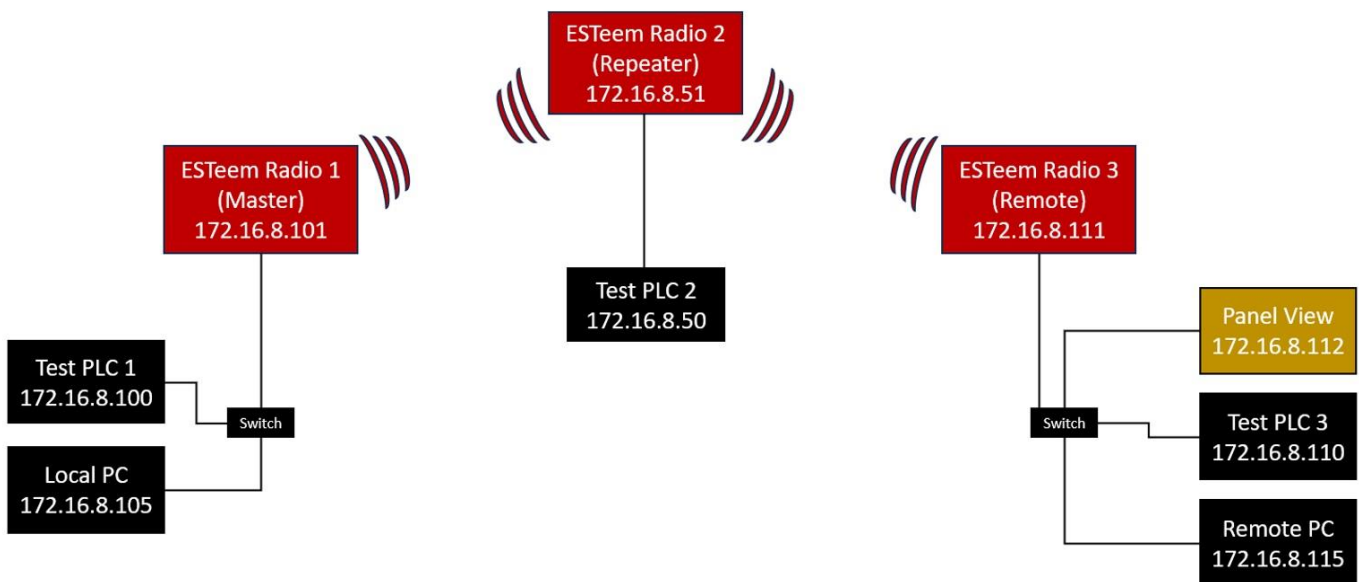
Figure 2: Example Network Diagram

Configuring Basic Settings

The following examples shown will be for Radio 1 in the Example Network. This "Configuration: General" tab in the 195 Series Narrow Band Configuration Tool sets up the basic operating parameters for the radio. This basic configuration will follow these basic steps for Radio 2 and Radio 3.

A. Set the Data Interface to Ethernet 10/100 (Port 2).

B. Enter the IP Address for Radio 1 (In this example 172.16.8.101).

C. Set the operating frequency for the wireless network. (If using an unlicensed MURS channel, leave at default for now and set up MURS after the initial General configuration).

D. Press the "Next" button to proceed to the next page of the tool (Figure 3).
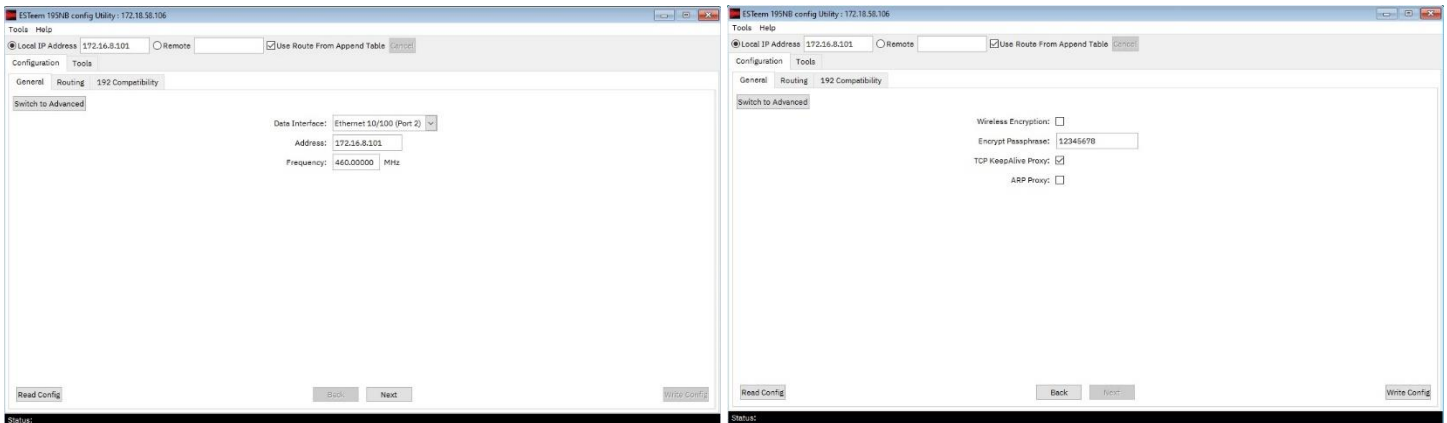
Figure 3: Ethernet Configuration Page

E. Wireless Encryption is disabled by default. Encryption can be enabled by checking this box. If enabled for one radio in the network, all radios must be configured with the same Passphrase to match.

F. TCP KeepAlive Proxy is On, and ARP Proxy is Off by default in our example.

G. Press the "Write Config" button to load and save the configuration in Radio 1.

H. If using a MURS channel go to the MURS tab and configure before moving on to the Routing tab.

Configuring Routing Settings (Radio 1-Master)

This section will configure the required routes and append entries to enable wireless Ethernet traffic to pass between the radios and the connected Ethernet devices (PLCs and Local/Remote PCs).

Note: The Panel View connected to Radio 3 (Figure 1) is a local Ethernet device that will NOT be communicating over this wireless network. ONLY devices using the wireless network for communication will be added to the Routing configuration.

A. Click the Routing tab and press the "Read Routes" button. (Figure 4)

B. Enter the Destination ESTeem IP for Radio 2 (Repeater) 172.16.8.51. There are no repeaters for this direct link so leave Repeater 1 unchecked. Enter the Remote Device IP Addresses for this link as 172.16.8.50 – 172.16.8.51 (Radio and connected PLC). Press "Next Route" button.
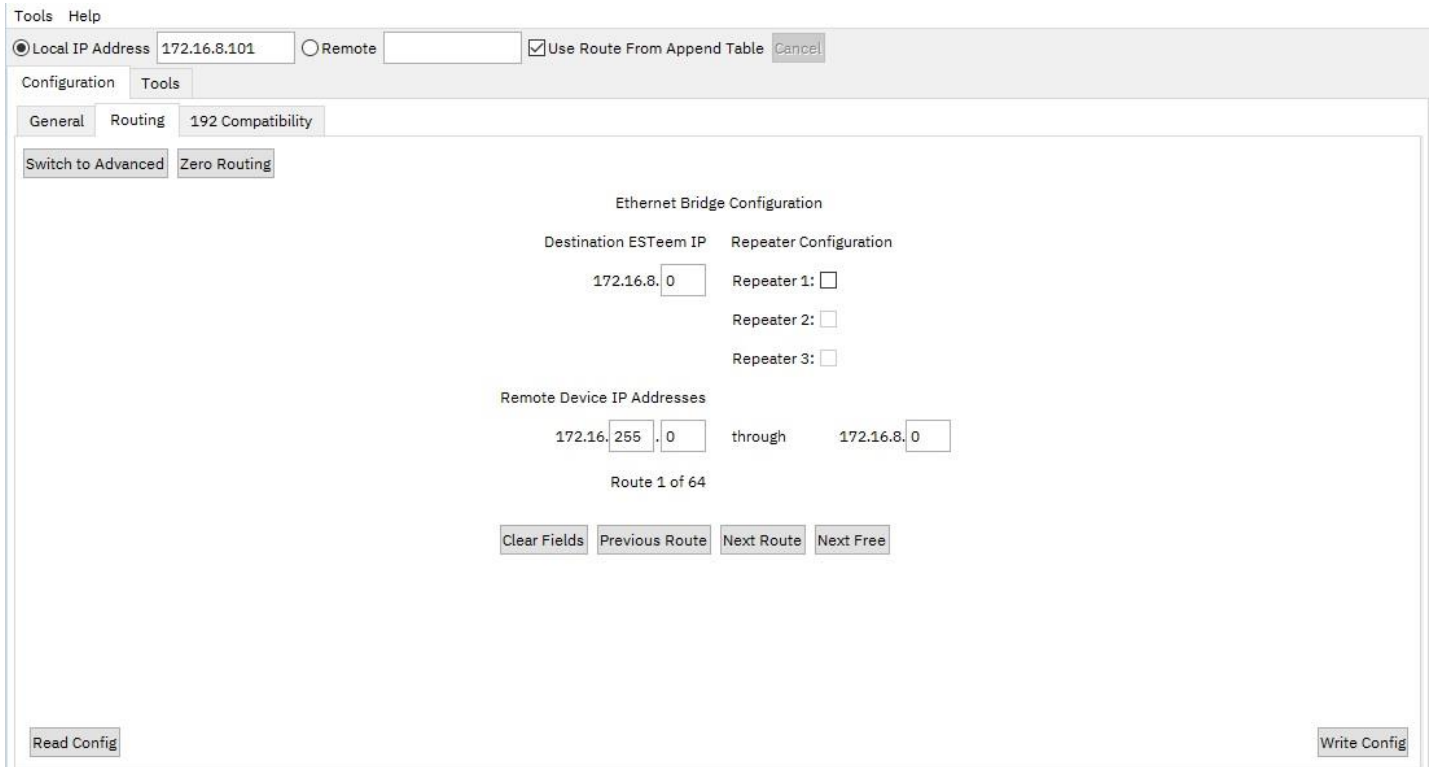
Figure 4: Routing Simple Setup

C.   Enter the Destination ESTeem IP for Radio 3 (Remote) 172.16.8.111. There is 1 Repeater for this route, check the box next to Repeater 1 and enter the IP Address for Radio 2 (172.16.8.51). There are three Remote Device IP Addresses entries needed for this link, **however** 172.16.8.110 – 172.16.8.115 would include ALL addresses from 110 through 115 and **cannot** be used as this would include the Panel View. This will take two separate Routing entries to complete. Enter the first entry as 172.16.8.110 – 172.16.8.111. Press "Next Route" button.

D.   Enter the second Routing entry. Enter the Destination ESTeem IP for Radio 3 (Remote) 172.16.8.111. There is 1 Repeater for this route, check the box next to Repeater 1 and enter the IP Address for Radio 2 (172.16.8.51). The Remote Device IP Addresses for this link are 172.16.8.115 – 172.16.8.115. Press "Next Route" button. (Figure 5)
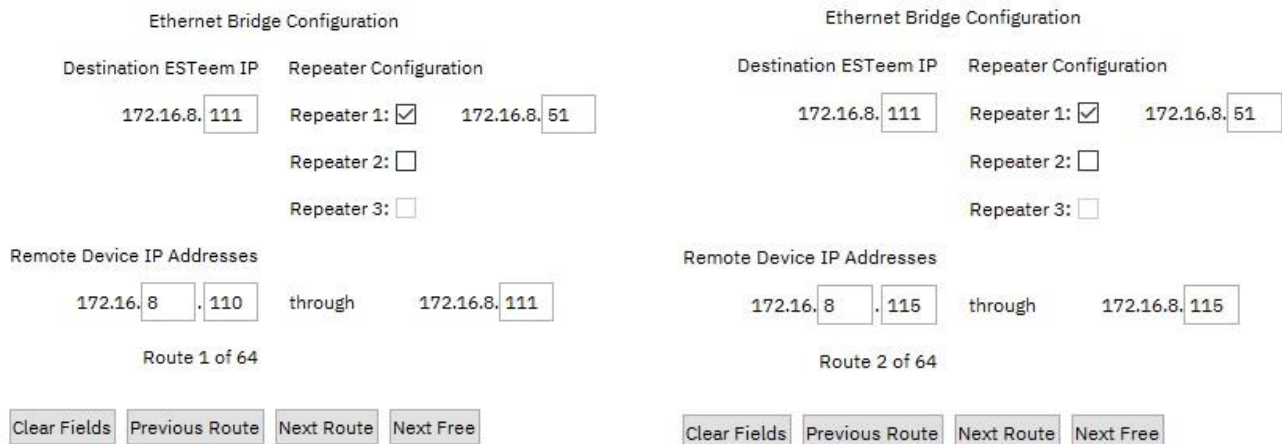
Figure 5: Radio 1 Routing Example

Repeat Configurations for Radio 2 and Radio 3

The configuration for Radios 2 & 3 will be the same with the following changes in each radio's General and Routing entries. Then proceed to testing with the diagnostics.

Figure 6: Radio 2 Settings

Figure 7: Radio 3 Settings

Testing Communications

Testing each communication link is a 2-step process. The first test will be using the Diagnostics test in the configuration utility. The Diagnostic test will test the radio-to-radio communication links. The second test will then pass Ethernet data across the radio network.

A. Click the Tools Tab then Diagnostics and Press "Add Radio(s)" button.

B. Enter Radio 2 as the Remote Address (172.16.8.51). Press "Add & Next" button.

C. Enter Radio 3 as the Remote Address (172.16.8.111). Check the box for Repeater 1 and enter the address of Radio 2 (172.16.8.51). Press "Add & Close" button (Figure 8).
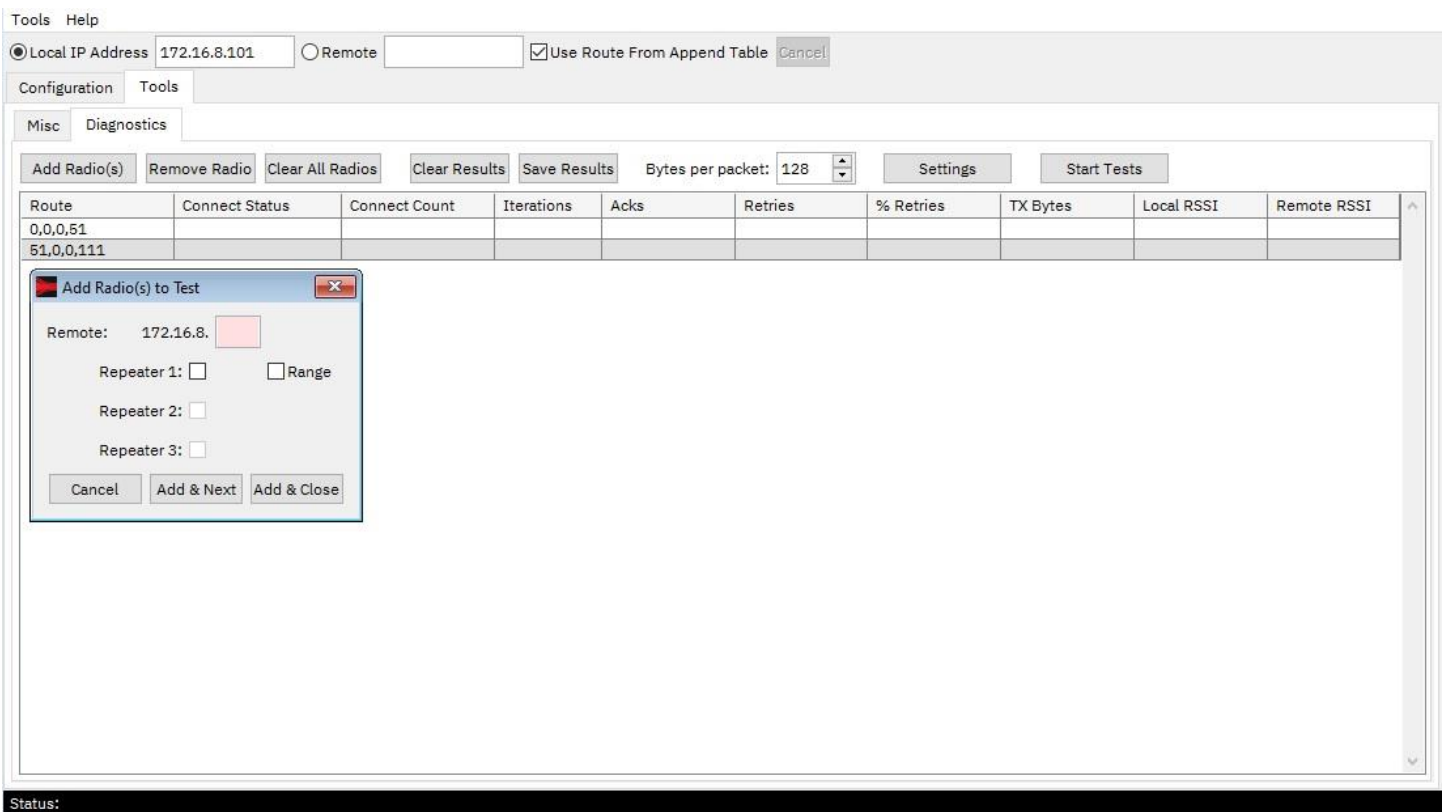
Figure 6: Diagnostic Example

D. Press "Start Tests" button and note the Iterations and Acks. Iterations are the number of tests and Acks are the number of successful tests. Once this is completed all the radio links are working.

E. Conduct a practical test moving Ethernet traffic over the wireless network. This can be done by TCP/IP Ping tests to verify the operation of communications between PLC's.

ESTeem Discovery Utility & 195 Narrowband Configuration Utility

The Discovery Utility is a software program contained within the ESTeem Software Suite. The ESTeem Discovery Utility will allow you to configure the IP address of the ESTeem 195 Narrowband radio to match your network regardless of its current IP subnet. This utility will also easily open the 195 Narrowband Configuration Utility and automatically connect to the radio that has been Discovered.

The ESTeem Narrowband Configuration Utility allows access to the configuration, monitoring, and diagnostics for the ESTeem Model 195M, 195H and 195C. The Narrowband Configuration Utility is a software program contained within the ESTeem Software Suite.

> **Technical Tip***:* If your computer is configured for DHCP and not attached to the network, you will need to assign a static IP address to program the 195M/H/C.

<u>Installation</u>

The Software Suite can be downloaded free of charge from the ESTeem web site (http://www.esteem.com). The Discovery Utility is a C++ based application compatible with Windows and Linux computer operating systems.

1. Once the above program has been installed, navigate to the location on your computer where the file was installed and open estDiscovery.exe. You can also use the Start Menu with Windows and find the ESTeem Software Suite folder to easily open any of the Utilities, whichever way the utility is opened Figure 1 will be displayed.
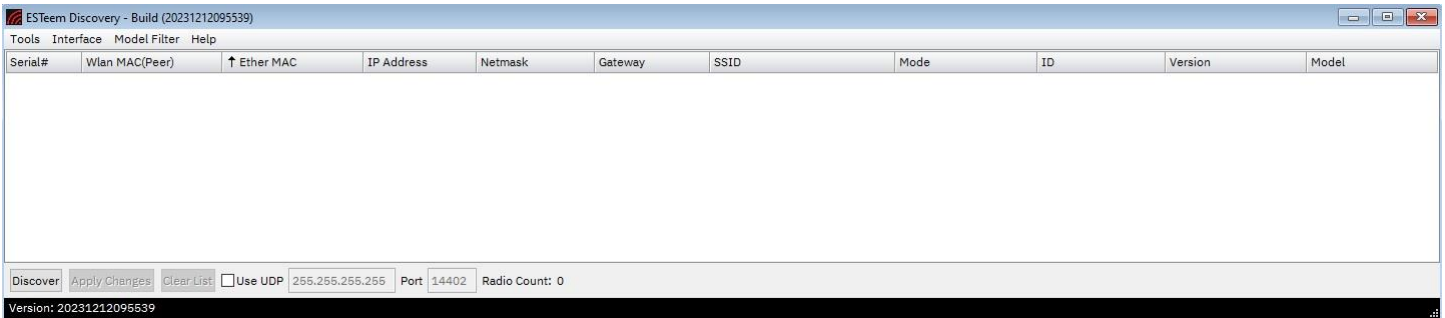
Figure 1: ESTeem Discovery Utility

2. Connect the ESTeem radio to your computer either directly to the Ethernet port or through a Switch using an Ethernet cable. The Ethernet port supports Auto-Negotiation, so either a patch cable or crossover cable will work. Press the 'Discover' button.

3. The ESTeem radio will be displayed (Figure 2). If the ESTeem radio is not on the same IP subnet as the computer, double click on the IP or Netmask and make the necessary changes. Press the 'Apply Changes' button when complete.
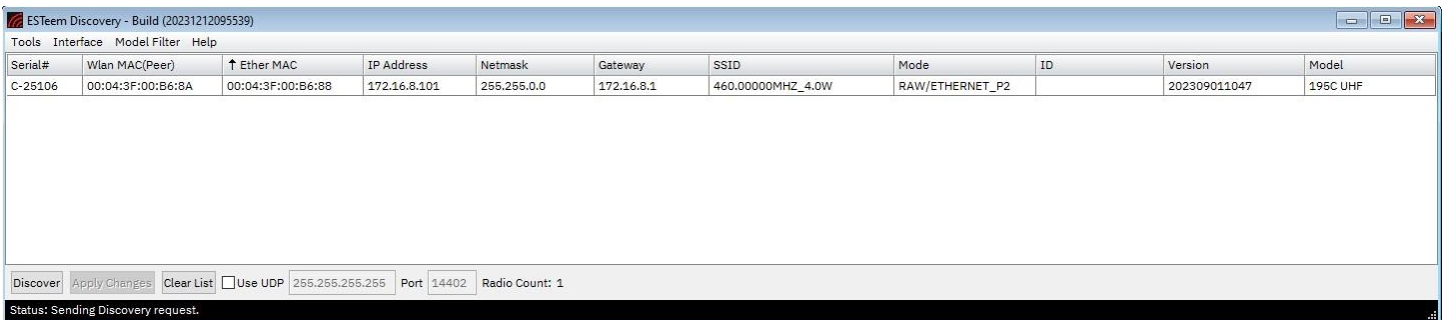
Figure 2: Discovered Example Radio

4. If changes were made to the IP address, you will need to press the 'Discover' button again to show the changes. Right-mouse click on the ESTeem radio (Figure 3) and select "Configure Radio" option to begin programming.
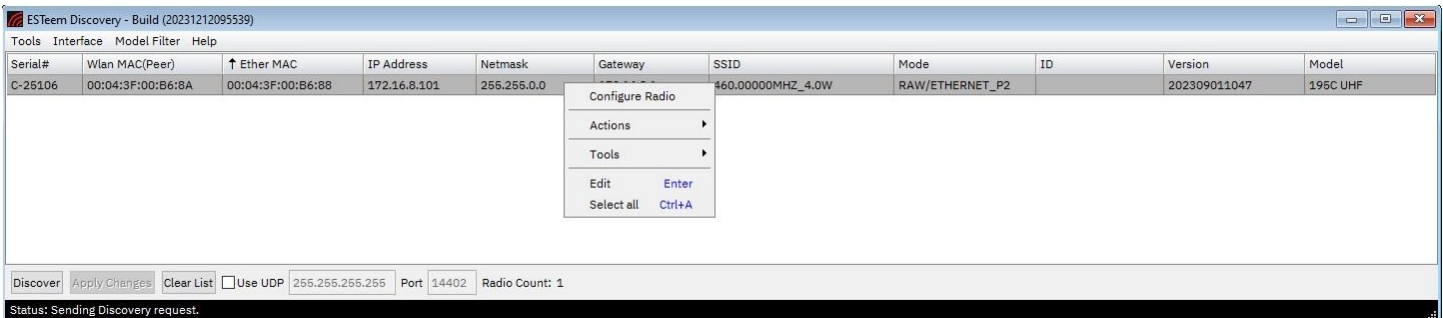
Figure 3: Right-Click Menu

195 Narrowband Configuration Tool

Configuration: General

The General tab is the default page entered when the 195 Narrowband Configuration Utility is opened. If the utility was opened through the Discovery program, the current configuration parameters for the radio will be displayed (Figure 4). If the radio's information is not displayed, check the Local IP Address at the top of the Utility and press the 'Read Config' button to continue.

Half of the radio's configuration can be entered from the General tab as shown in all programming examples from Chapter 4. Setting the radio's address, remote, frequency, port settings and operating mode are all available from this General Tab. Any changes made on these pages will be saved to the radio when the 'Write Config' button is pressed and will be lost if the tab is left before pressing the 'Write Config' button.
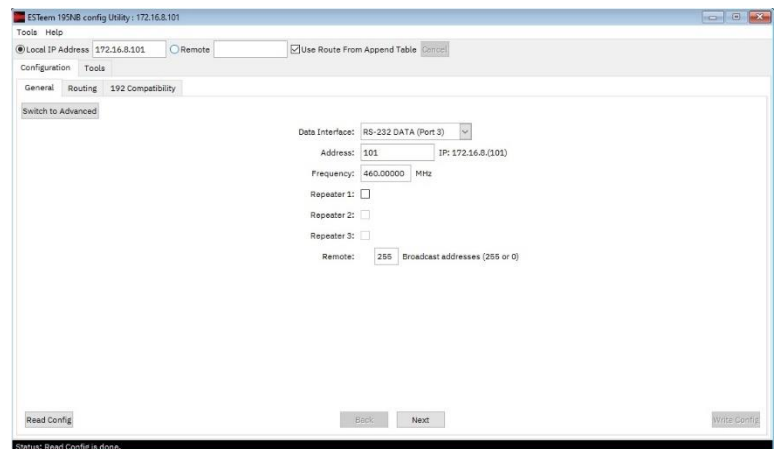
Figure 4: General Tab

Remote Configuration

The software commands can read in the same way from a remote ESTeem Narrowband through the wireless network. At the top of the utility, next to the Local IP Address field is a "Remote" field. If this is selected a direct path entry or repeater route can be used to read and write configurations. If the repeater routes are already defined for the network (using the Routing tables), you can just enter the destination address and check the "Use Route from Append Table" box. Any software command displayed after reading the configuration can be modified. Once the commands have been changed, press the 'Write Config' button. The radio will save the changes and reboot.

Advanced

The 'Switch to Advanced' button will allow you direct access to all of the individual commands in the ESTeem Narrowband Radios. The following describes the different sections and how they are used.

All - Display the status of all software commands (Figure 5)

Changed – Display commands changed from factory default.

Radio – Radio configuration commands

Serial – Serial configuration commands

PLC – PLC emulation commands

Networking – Ethernet network commands

Sensor – 4-20mA configuration commands

System – System configuration commands

Other – Miscellaneous configuration commands

Figure 5: Advanced Configuration

Reset Unit

Pressing the Reset Unit button performs the same action as pressing the Reset button on the face of the radio. The radio will discard any unsaved commands and read the program from the non-volatile memory. This can be performed on a remote radio as well.

Factory Defaults

Pressing the 'Factory Defaults' button will temporarily reset the software commands to factory default settings (see Appendix A for all default values). Factory Default settings will not be saved unless 'Write Config' button is pressed.

Configuration: Routing

The Routing tab gives access to the Route and Append tables of the radio. These can be configured using the Basic view or Advanced view. A detailed description of how to configure these options can be found in Chapter 4 – Repeating Examples or Chapter 5 – Ethernet Applications depending on your need.

Configuration: Model 192 Compatibility

The 195C and 195M require "training" to operate with legacy ESTeem Model 192C, 192CHP, 192M or 192MHP wireless radios. The training process and network installation procedures are found in Appendix C (Model 192 Integration) of this User's Manual.

Tools: Misc

'Modbus'

The ESTeem 195M/H/C supports ModbusTCP protocol for access to multiple operating parameters in the wireless radio. Receiving signal strengths, background noise, input voltage, and packet transmissions are a few of the parameters available through the open ModbusTCP protocol. There are multiple methods for extracting the data from the 195M/H/C, but the Modbus Monitor Utility has simple a data interface. Pressing the Start button will start the data monitor of the local ESTeem radio or the remote defined in the Routing tab (Figure 6).

Note: For remote Modbus Monitoring, the route to the remote locations MUST be defined in the Route and Append tables. See Chapters 4 and 5 for routing configuration.
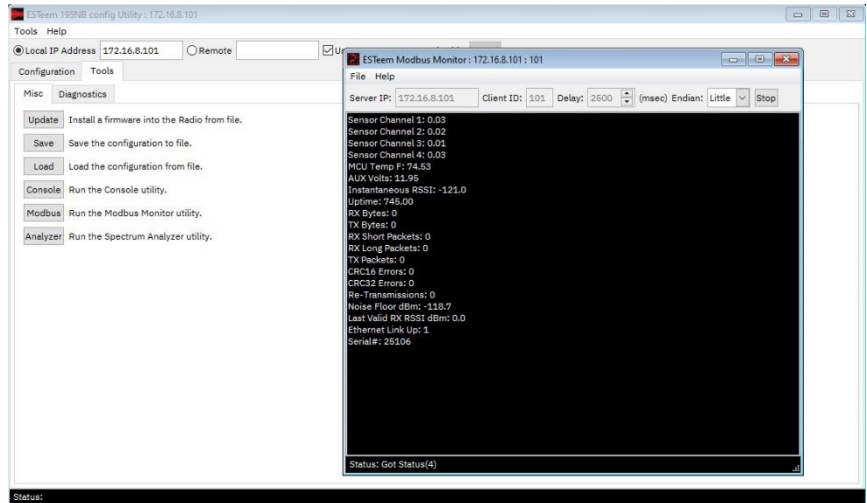
Figure 6: Modbus Monitoring

The 195 Narrowband Configuration Utility will update the current status of the operating parameters until the Stop button is pressed. If multiple repeaters are required to access a remote or the Modbus monitoring is used on a busy network, the Modbus Timeout parameter may need to be adjusted.

The following are the Modbus registers supported in the ESTeem 195C/H/M on Port 502. Registers are mapped as 32-bit floating point (2 registers each):

Register	Example	Description
1000	0.029145	4-20 mA Channel 1
1002	0.023357	4-20 mA Channel 2
1004	0.013176	4-20 mA Channel 3
1006	0.032828	4-20 mA Channel 4
1008	68.246094	MCU temperature (in °F)
1010	11.898932	Auxiliary voltage
1012	-123.000000	Instantaneous RSSI from any signal on the operating frequency (in dBm)
1014	474.000000	Radio uptime (in seconds *unless adjusted)
1016	12672.000000	Total RX received (in bytes)
1018	6833.000000	Total TX sent (in bytes)
1020	4.000000	Number of header blocks / short packets (UA, SABM, etc) received
1022	99.000000	Number of long packets (> 1 block) received
1024	103.000000	Number of transmitted packets
1026	0.000000	Number of failed error correction on headers
1028	0.000000	Number of failed error correction on data
1030	0.000000	Number of re-transmits (if retries and acks enabled)
1032	-124.189369	Average noise floor (in dBm)
1034	-58.000000	RSSI of last valid packet received from ESTeem 192/195 (in dBm)
1036	1.000000	Ethernet link up/down (1 = up / 0 = down)
1038	25106.000000	Model Serial Number

Example of using modpoll utility with 195 Narrowband Radio (reference - https://www.modbusdriver.com/modpoll.html)

modpoll -l 2000 -o 2 -m tcp -r 1000 -c 19 -t3:float -a 10 172.18.9.5

-l 2000	Poll Rate in Milliseconds
-o 2	Timeout in Seconds
-m tcp	Modbus/TCP Protocol
-r 1000	Start Register
-c 19	Number of Registers to Read
-t3:float	32-bit Floating Point Type 3
-a 10	Target Client Address
172.18.9.5	Server IP Address

To read Modbus data (such as the 4-20mA sensors in our example below) across a 195M/H/C radio network, the "Server IP Address" is the IP address of the local connected radio, and the "Target Client Address" is the last octet (single Byte Modbus address) of the remote radio's IP Address (see Figure 7 for example). You can use this method to easily query any of the remote radio's Modbus registers.
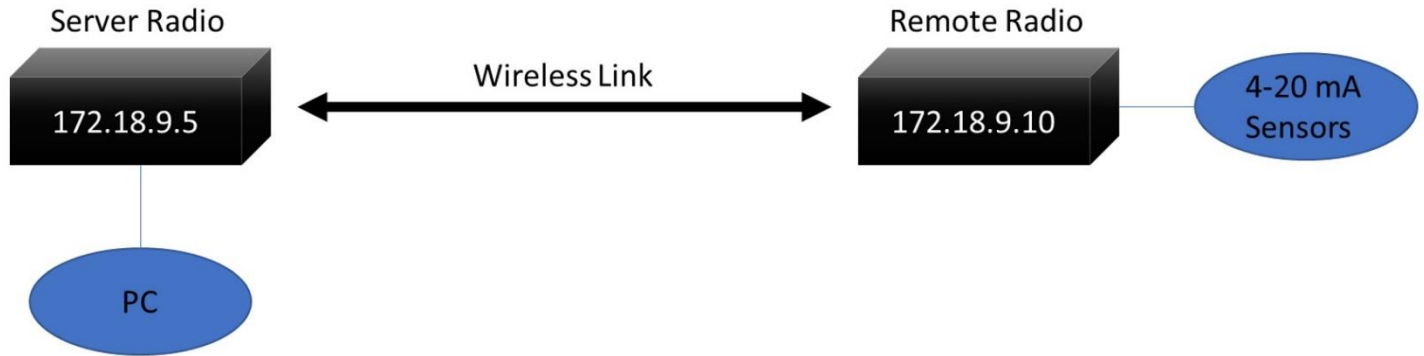
Figure 7: Example Modbus/4-20mA Sensor Read

Save & Load

The 195 Narrowband configurations can be saved as a file to the computer. This file can then be later opened and saved to another 195 Narrowband. To save the configuration of the selected radio, press the 'Save' button. To load a previously saved configuration to an ESTeem 195 Narrowband press the Load button.

Update

The 195C, 195M and 195H firmware is updated by pressing the 'Update' button on the Misc tab of the Tools tab of the Utility. The latest firmware version img file can be found on our website at https://www.esteem.com/firmware/ .

Figure 8: Firmware Update

Console

The 195 Narrowband Configuration Utility has a console option to allow direct access to enter and modify software commands. The console uses PuTTY to connect via Telnet to the 195 Narrowband when the Console button is pressed. If communication is lost to the radio (on reset) you may have to press the Connect button to reopen the console window.

Analyzer

A feature of the ESTeem 195 Narrowband Configuration Utility is the built-in spectrum analyzer found in the Tools: Misc tab. A spectrum analyzer is used to visually represent the radio spectrum around a programmed frequency. The analyzer displays the signal amplitude on the vertical axis and the frequency on the horizontal axis.

The software utility uses the ESTeem 195 Narrowband receiver to visually display the radio activity in the operating frequency band. The 195C can be used to analyze 450-470 MHz frequency band, the 195H can be used for the 217-220 MHz frequency, and the 195M can be used for the 150-174 MHz frequency. The analyzer has proven very accurate when compared to the results of a bench model analyzer.

The software spectrum analyzer has many of the standard features you would find on a laboratory grade analyzer. The following is a summary of the configuration parameters:
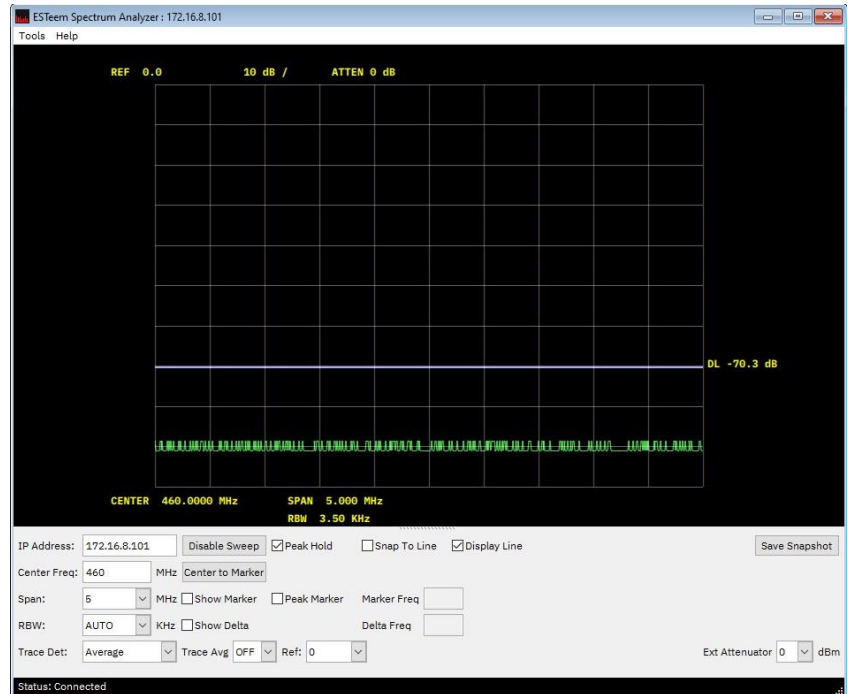
Figure 9: Spectrum Analyzer Utility

- *Center Frequency* – This frequency value can be entered with a keyboard or used as a drop down. The center frequency represents the center line in the analyzer.
- *Span* – The span is the total frequency bandwidth shown on screen. For example, in Figure 9, the span is set to 5 MHz. The analyzer is broken up into a 10 x 10 grid. The total frequency span of 5 MHz would represent 500 KHz (5MHz/10) per division.
- *Reference Level* – The reference level is the value for the top line of the analyzer. The reference level in conjunction with adding or removing external attenuation will allow for measurements of both small and high-power signals.
- *Ext Atten* – External attenuation. This number will need to be adjusted if an external attenuator is used.
- *Display Line* – Displays horizontal line on screen with signal measurement (Figure 9).
- *Peak Hold* – This will keep the last trace draw on the screen. This is valuable for measuring quick transmissions over time.
- *Trace Det* – Trace detection
- *Trace Avg* – Trace averaging
- *RBW* – Resolution Bandwidth
- *Marker* – The marker is a visual reference tool for analyzing points on the screen. When the marker check box is set, clicking on the screen will place a yellow diamond marker that can be moved to any point on the screen. The frequency and signal level at the marker location will be shown in the upper right of the screen.
- *Marker Delta* – Checking this box will display a second marker (Figure 12) and show the difference (delta) in frequency and signal strength from the first marker.

Press the 'Enable Sweep' button once to turn on the analyzer and it will change to 'Disable Sweep' to turn it off.

Tools: Diagnostics

The diagnostic menu tests the wireless communication between multiple ESTeem 195 Narrowband or Model 192 series wireless radios. The diagnostic test will send multiple sized data packets to the test addresses listed and measure the receive signal strength wireless link.

Press the 'Add Radio(s)' button to enter the destination ESTeem address or a range can be entered by selecting the Range box, press 'Add & Close' when done adding radios (Example 20-26 is all addresses 20 through 26). Pressing the Start Tests button once will begin the testing and pressing again will stop the testing. (Figure 10)
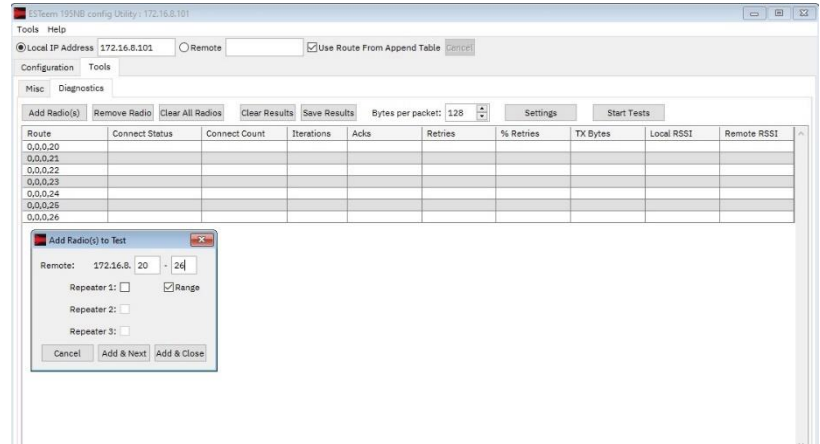
Figure 10: Diagnostic Example Setup

Configuration: Multi-Use Radio Service (MURS) – Model 195M Only

The FCC has set aside five frequency channels in the VHF band for Multi-Use Radio Service (MURS) operation. By operating on these frequencies and following the specific rules such as limited power (2 Watts) and height (60 Feet), the Model 195M can be used without obtaining an FCC site license.

MURS Channels

Channel 1	151.820 MHz
Channel 2	151.880 MHz
Channel 3	151.940 MHz
Channel 4	154.570 MHz
Channel 5	154.600 MHz

Figure 11: MURS Configuration

Notes:

1. The highest point of any MURS antenna must not be more than 18.3 meters (60 feet) above the ground or 6.10 meters (20 feet) above the highest point of the structure on which it is mounted.
2. RF output power is limited to 2 Watts.
3. Repeater operation is not allowed.

The ESTeem Model 195M supports operation within the MURS frequency bands. Select the MURS tab in the configuration utility (Figure 11) and set the frequency of operation. The output power of the radio will be set at 2 watts and the repeater routing table will be disabled.

ESTeem offers different types of antennas ranging from 1/4 wave to 5/8 wave in physical size. The user choice is dependent on the application.

Communications in the VHF and UHF bands are normally over **"Line of Sight (LOS)"**. Looking from the antenna of one wireless radio you must be able to see the antenna of the wireless radio you wish to communicate with. If a large object obstructs the line of sight view it is unlikely that satisfactory communications will result. This means you must relocate the antennas or use the repeating feature and a second radio to go over or around the object.

The Model 195C, 195M, and 195H products are allowed by the FCC to use high gain directional antennas.

It is noted that a 1/4 wave antenna that does not have ground plane radials and requires a ground plane to operate at maximum efficiency. This can simply be a conducting surface under the antenna that is a ¼ wavelength in diameter. For the Model 195C (450-470 MHz) this is approximately 6.5 inches. A conducting surface can be anything from the rooftop of an automobile to a file cabinet.

Coax Cables

To minimize signal loss, the overall length of the coaxial cable should be as short as possible. To avoid corrosion select coaxial cable manufacturers with tinned copper braid, where possible. Listed below are representative cable losses in db/100ft at the VHF and UHF frequencies:

Frequency (MHz)	RG-58u	LMR 195	RG-8 (solid)	LMR600	1/2" Heliax
150-174	-3.8	-4.4	-1.2	-0.964	-0.88
217-220	-5.4	-5.4	-1.7	-1.4	-0.95
450-470	-9	-7.8	-3	-1.72	-1.45

In a severe noise environment, it may be desirable to use a double shield type of coax cable such as RG 214/U.

Note:

- *Premade coax cables can be purchased from the factory.*

- *A 3 dB loss means you have lost 1/2 of your signal.*

- *A 3 dB gain means you have doubled (x2) your signal.*

- *Keep the antenna feedline as short as possible to minimize losses.*

- *Extreme care must be taken when attaching coax connectors to the antenna feedlines. If there is any error in making this connection the output of the transmitter will be greatly reduced.*

Weather Proofing Coax Connections

1. Lightly coat the threads of the connectors with silicone lubricant prior to assembly (See Note 1) and hand tighten. Make sure to use the silicon sparingly so when assembled, any excess does not get on center conductor. Care should be taken not to get any lubricant on the center conductor.

2. Wrap the connector assembly with a non-adhesive silicone tape, EST part number AA243, for weather proofing.
   a. Clean surface to be wrapped. Cut off length to be used.
   b. Peel back a short length of protective film. Keep the tape clean and dry.
   c. Begin with one complete overlap of tape onto itself.
   d. STRETCH CoaxWrap while continuing to wrap object with "half-laps", removing clear film as you go (Figure 1). For greater pressure resistance, use 2 or more tightly wrapped layers.
   e. The end of tape at final wrap should be completely positioned onto itself.

Figure 1: Installation Example

Note: CoaxWrap's bond begins to cure immediately upon contact with itself. Repositioning or removal is not recommended after 2 minutes of wrapping.

3. Apply an electrical coating (sealing agent), over the vapor barrier patch for added protection. Examples of sealing agents include the below options.
   a. Dow Corning RTV 3140 or equivalent.
   b. CoaxWrap, CW10B or equivalent.
   c. SCOTCHKOTE, 3 M Company, or equivalent.

Grounding

All building mount antennas require attachment to good earth ground for optimum efficiency. Contact a reputable local communications shop for procedures for your area.

Lightning Arrestors

Lightning arrestors should be used on all external building mount antennas for personal protection and to minimize damage to the transceiver during lightning storms. The units should be installed as per manufacturer's instructions provided with the device.

Enabling Transmitter for SWR Testing

The ESTeem 195C, 195M and 195H are packet burst wireless radios, so measurement of the forward and reflected power during operation is difficult. To enable the transmitter for measurement with a directional wattmeter, enter the following software command:

radio on/off – Transmitter enable command

Model 195C Cabinet Mount
Outdoor Fixed Base Hardware Diagram

Omni-Directional
Antenna

Directional
Antenna

NOTES

1. Use coax cable runs as short as practical to minimize cable losses.

2. Vapor wrap all external antenna coax connections with vinyl wrap (AA243)

3. Contact EST for recommendations regarding antenna mounting hardware and installation tips.

4. Ground antenna structure, base and lightning arrestor.

ANTENNA RECOMMENDATIONS

1. Omni-Directional (AA20C.1 or FG4507 & FG4607).

2. Directional (AA202C.1).

Antenna Feedline Recommendations				
		Antenna Part No.		
	Feedline Type	20C.1	202C.1	FG4507/ FG4607
< 50 ft. Length	RG-8	AA237	AA237	AA237
> 50 ft. Length	Helaix	AA236	AA236	AA236

Ethernet
Programming Cable
(AA09.2)

DIN Rail Mount
(DIN-Mount)

Data Interface Accessories

RS-232 Interface Cable
(AA0621.1)

LMR195 Coax
(AA234LMR)

TNC Male
Connector

ESTeem 195C

RS-422/485
4/20mA Sensor
Interface Cable
(AA066)

N Male
Connector

N Male
Connector

Lightning Arrestor
(AA167)

Attached earth ground
to mounting lug

12 VDC Power Supply
(AA179)

Ethernet Interface Cable
(AA09.2)

Model 195M Cabinet Mount
Outdoor Fixed Base Hardware Diagram

Omni-Directional Antenna

Directional Antenna

ANTENNA RECOMMENDATIONS
1. Omni-Directional (AA20M)
2. Directional (AA202M)

NOTES

1. Use coax cable runs as short as practical to minimize cable losses.

2. Vapor wrap all external antenna coax connections with vinyl wrap (AA243)

3. Contact EST for recommendations regarding antenna mounting hardware and installation tips.

4. Ground antenna structure, base and lightning arrestor.

Antenna Feedline Recommendations

	Feedline Type	AA20M	AA202M
		Antenna Part No.	
< 50 ft. Length	RG-8	AA235	AA237
> 50 ft. Length	Helaix	AA238	AA236

Ethernet Programming Cable (AA09.2)

DIN Rail Mount (DIN-Mount)

Data Interface Accessories

RS-232 Interface Cable (AA0621.1)

LMR195 Coax (AA234LMR)

TNC Male Connector

N Male Connector

ESTeem 195M

RS-422/485 4/20mA Sensor Interface Cable (AA066)

N Male Connector

Lightning Arrestor (AA167)

Attached earth ground to mounting lug

12 VDC Power Supply (AA179)

Ethernet Interface Cable (AA09.2)

Model 195H Cabinet Mount
Outdoor Fixed Base Hardware Diagram

Omni-Directional Antenna

Directional Antenna

N Male Connector

ANTENNA RECOMMENDATIONS
1. Omni-Directional (AA20H).
2. Directional (AA202H).

NOTES

1. Use coax cable runs as short as practical to minimize cable losses.

2. Vapor wrap all external antenna coax connections with vinyl wrap (AA243)

3. Contact EST for recommendations regarding antenna mounting hardware and installation tips.

4. Ground antenna structure, base and lightning arrestor.

Antenna Feedline Recommendations			
		Antenna Part No.	
	Feedline Type	AA20H	AA202H
< 50 ft. Length	RG-8	AA237	AA237
> 50 ft. Length	Helaix	AA236	AA236

Ethernet Programming Cable (AA09.2)

DIN Rail Mount (DIN-Mount)

Data Interface Accessories

RS-232 Interface Cable (AA0621.1)

LMR195 Coax (AA234LMR)

TNC Male Connector

N Male Connector

N Male Connector

ESTeem 195H

RS-422/485 4/20mA Sensor Interface Cable (AA066)

Lightning Arrestor (AA167)

Attached earth ground to mounting lug

12 VDC Power Supply (AA179)

Ethernet Interface Cable (AA09.2)

Listed below in alphabetical order are the definitions of the ESTeem software commands. All software commands are entered lowercase.

? or help

help	Displays the modem model as well as the certification, FCC ID, Canadian DOC ID and serial number of the modem and sub help menus.
help all	Displays all commands switches and arguments.
help change	Displays only the commands that are changed from factory default.
help radio	Displays radio commands switches and arguments.
help serial	Displays serial commands switches and arguments.
help plc	Displays plc commands switches and arguments.
help networking	Displays networking commands switches and arguments.
help sensor	Displays sensor commands switches and arguments.
help system	Displays system commands switches and arguments.

192compat (on/off)

This function sets the compatibility with legacy Model 192 products. The software command lowers the data rate to match the Model 192 (9,600 bps) running in narrow band configuration.

Factory Default = off

a_bctrl (1 - 6)

This function selects the Rockwell Automation (Allen-Bradley) DF1 controller protocol. Full emulation is enabled with the PLC Protocol (plcproto) software command.

1 =	Full Duplex DF1 with CRC Error Checking
2 =	Full Duplex DF1 with BCC Error Checking
3 =	Half Duplex DF1 with CRC Error Checking
4 =	Half Duplex DF1 with BCC Error Checking
5 =	Radio Modem Protocol with CRC Error Checking
6 =	Radio Modem Protocol with BCC Error Checking

Factory Default = 1.

append (l#, r#, a1, a2, g)

The append command allows you to read or change the append entries in the route/append table of the radio.

l # =	Location of appended address in memory. Lines numbers from 1 to 64.
r # =	Appended route number. Route numbers 1 to 64.
a1 =	Address of first destination node. Address numbers from 1 to 254.
a2 =	Address of last destination node. Address numbers from 1 to 254.
g =	Group feature is enabled by inserting a 1 in this field.

Factory Default = 0.
Note: This command is used in conjunction with the ROUTE Command.

arpproxy (on/off)

The arpproxy command enables the ARP Proxy for Ethernet communications. See Chapter 5 for full details on Ethernet communication.

Factory Default = off

autolf (on/off)

This option when enabled will add a line feed character to the end of serial packets coming into the radio before sending over the RF.

Factory Default = off

baud (2400 - 1000000)

This command sets the baud rate for the serial device interface (SDI). The other commands to configure the serial port are the data bits, parity and stop bits.

Factory Default = 19200

blversion

This is a non-configurable option that displays the radio's currently installed Bootloader version.

ch(1-4)_slope (-360 - 360)

This allows you to set the default slope value for the 4 different channels of the 4-20mA sensor in the radio.

Factory Default = 1

ch(1-4)_offset (-360 - 360)

This allows you to set the default offset value for the 4 different channels of the 4-20mA sensor in the radio.

Factory Default = 0

chspace (1 - 4)

This command will set the channel spacing for the ESTeem 195M/H/C.

1 =   6.25 kHz channel spacing
2 =   12.5 kHz channel spacing
3 =   25.0 kHz channel spacing (Model 195H Exclusive)
4 =   50.0 kHz channel spacing (Model 195H Exclusive)

Factory Default = 2 (12.5 kHz channel spacing)

conn_retry (0 - 99)

This function sets the number of times the radio will attempt to retry the initial connect command if a connection is not made.

Factory Default = 10

connect (r1, r2, r3, da)

This command performs the connect to a destination ESTeem. This function supports a direct connect or a connect through a maximum of three repeater nodes.

r1 =   ESTeem address (0 to 254) of repeater 1.
r2 =   ESTeem address (0 to 254) of repeater 2.
r3 =   ESTeem address (0 to 254) of repeater 3.
da =   Destination address (1 to 254).

crash_mode (0 - 3)

This command will enable the radio to produce a crash dump if the radio crashes for any reason. What the radio does with this crash dump is determined by the value set to crash_mode.

0 =   Disabled
1 =   Crash Dump is saved in memory.
2 =   Crash Dump is sent out Ethernet.
3 =   Crash Dump is both saved and sent.

Factory Default = 1

csthresh (-150 - 0)

The cstresh command sets a value in the radio (in dBm) for the carrier sense threshold. Which tells the radio when to NOT send a transmission because another radio is attempting to use the frequency.

Factory Default = -80

databits (7 - 8)

This command sets data bits in the serial device interface. This command is used with baud, parity and stopbits commands.

Factory Default = 8

delim(1 - 2) (-1 - 255)

This command sets the delimiter flags the serial device interface. This configures what symbols the radio looks for to end the packet and set over RF. If both delimiters are set the radio will only transmit when it sees delim1 followed by delim2. These are hex values represented in Decimal with -1 being Disabled.

Factory Default = -1

deviation (800 - 4490)

This sets the radio receiver deviation value. This setting is only changed when the radio has 192 Compatibility enabled and is changed automatically through the training process.

Factory Default = 2000

disconnect

The disconnect command. The execution of this command immediately initiates a disconnect request with the currently connected node.

factory

The factory default command. The execution of this command causes the ESTeem to restore the command table values from factory values that are stored permanently in memory. This will allow the user the ability to restore the ESTeem to factory conditions during testing or set up. Unless the save command is used the settings will revert to last saved settings on reset.

frequency (150.000 - 174.000), (217.000 - 220.000), or (440.000 - 470.000)

This command programs the frequency of operation in the ESTeem 195M/H/C. The frequency is entered in MHz. Available frequency ranges for each model listed below:

Model 195M = 150.000-174.000 MHz |Default = 161.000 MHz
Model 195H = 217.000-220.000 MHz | Default = 218.00 MHz
Model 195C = 440.000-470.000 MHz | Default = 460.00 MHz

gw_addr (IP Address)

This command sets the Gateway address in the ESTeem 195M/H/C.

Factory Default = 172.16.8.1

hard_reset

The immediate software reset command for the ESTeem. This reset will happen immediately upon sending the command.

ident

This command sets the modem identification for the ESTeem 195M/H/C. This is a simple alpha-numeric value set in the modem for easy identification in the network. This command can take up to 12 characters long and could be used for site name, location, or any value to easily identify.

Factory default = <blank>

ip_addr (IP Address)

This command sets the IP address for the ESTeem 195M/H/C.

Factory Default = 172.16.8.1xx (where xx is the last two numbers of the serial number).

keepalive_proxy (on/off)

This command enables the Keep Alive Proxy within the radio. When active the radio will watch for a successful keepalive packet, once one passes through, the radio will answer for the device instead of passing the packet over RF.

Factory Default = on

long_packet_delay (0 - 3000)

This command sets the delay time of long packet communication for the radio. Long packet communication would be considered data, either serial or ethernet between radios.

Factory Default = 2

maxbsywait (150 - 250)

The maxbsywait command sets the limit for the time the modem will wait when a carrier is detected. The units of time are 1/50th of a second.

Factory Default = 150

modbus_tcp_endian (0 - 1)

This setting changed the endian state of the Modbus TCP protocol.

0 =   Little Endian
1 =   Big Endian

Factory Default = 0

modbus_mode (0 - 1)

This setting changes which mode of Modbus the radio will use when the plcproto is set to Modbus RTU/ASCII.

0 =   RTU
1 =   ASCII

Factory Default = 0

modbus_rtu_timeout (0 - 16777215)

This sets the amount of time the radio will wait for a valid modbus packet before dumping the data received on the serial port when in Modbus RTU Mode.

Factory Default = 30

multid (on/off)

This setting puts the radio in a MultID mode brought forward from the Model 192 radios. When in this mode data must be sent to the radio with the intended receive radio's address imbedded in the front of the data packet.

Factory Default = off

murs_chan (1 - 5)

These settings are the available MURS channels for the Model 195M radio only. The radio will only operate on the selected MURS channel when murs_mode is set to on.

1 =	151.820 MHz
2 =	151.880 MHz
3 =	151.940 MHz
4 =	154.570 MHz
5 =	154.600 MHz

Factory Default = 2

murs_mode (on/off)

This setting only affects the Model 195M and when enabled will lock the radio to 2W output power max and will only operate on one of the selected MURS Channels from the murs_chan setting in the radio.

Factory Default = off

netmask (IP Address)

The netmask command sets the IP netmask for the ESTeem 195M/H/C. This command is used in conjunction with the ip_addr and gw_addr commands to complete IP address for the ESTeem.

Factory Default = 255.255.0.0

network (0 - 255)

Network identification code. This is used to program a common code for all modems in the customers network so that another facility on your frequency using the same addresses will not interfere with your equipment.

Factory Default = 37

packdump (0 - 31)

This function enables monitoring of the data sent through the configured serial device interface (SDI). This troubleshooting tool can be used to verify the operation of the wireless network by looking at both serial devices exchanging data.

Factory default = 0

packleng (1 - 1500)

This command defines the length of the data packet in bytes.

Factory Default = 1500

packmon (on/off)

This command places the ESTeem in the packet monitor mode. The packet monitor modem will allow the user to monitor all wireless packets by their source, destination, and repeaters. Please refer to ESTeem Packet Monitor Engineer Report for complete details on the operation of this feature.

Factory Default = off

parity (0 - 2)

This command defines the parity setting on the serial device interface. This command is used in conjunction with baud, databits, and stopbits to set the complete serial configuration.

0 =	None
1 =	Even
2 =	Odd

Factory Default = 0

passp (1 - 64 characters)

This software command will use the characters in the Passphrase to generate the AES encryption key and is used in conjunction with the rf_encrypt command. The key is generated from 1 - 64 characters entered after the passp command (example: passp 12345678) and is case sensitive. Typing the passp command without any arguments will display the current Passphrase.

Factory Default = 12345678

plcproto (0 - 4)

This command defines the PLC protocol emulation used on the selected serial device interface.

0 =	Transparent
1 =	Rockwell Automation DF1
2 =	Modbus RTU/ASCII Protocol
3 =	Opto22 Protocol
4 =	DNP3 Protocol

Factory Default = 0

program (0 - 254, 0 - 254, 0 - 254, 1 - 254)

This command is used to remote program another ESTeem unit. It is configured like the connect command. Example program 10 (Unit 10 is the address of the remote unit). Remote programming can be completed through repeaters. When a connection has been made with the remote ESTeem the RPG: prompt will appear. The RPG: prompt is the command prompt of the remote modem.

radio (on/off)

This command enables the radio transmitter. The ESTeem radio transmitter will cycle on and off when enabled for tuning and antenna testing procedures.

Factory Default = off

reset

The software reset command for the ESTeem. This reset will happen 2 seconds after sending the command for the radio to finish processing any other commands.

reset_interval (0 - 4294967295)

This will enable an automatic reboot within the radio that happens after the uptime reaches the configured number of minutes.

Factory Default = 0 (Off)

retry (0 - 99)

The retry command number. This is the number specifying the number of retries, retransmission of frames, that are not acknowledged. Frames are retransmitted 'retry' times before operation is aborted.

Factory Default = 6

rf_encrypt (on/off)

This software command will enable over-the-air wireless encryption at 128-bit AES. All ESTeem 195M/H/C in the same wireless network must have the same encryption settings and passphrase. See software command passphrase (passp) to set the encryption key.

on =   Enabled
off =   Disabled

Factory Default = off

rfpower (1 - 8)

This command sets the output power on the ESTeem 195M/H/C radio modem. Each increase in value represents 0.5 watts of output power. *The 195H radio has only 2 power levels, 1 Watt and 2 Watts.

1 =   0.5 Watts
2 =   1.0 Watts
3 =   1.5 Watts
4 =   2.0 Watts
5 =   2.5 Watts
6 =   3.0 Watts
7 =   3.5 Watts
8 =   4.0 Watts

Factory default = 8 (4 Watts)

route (l#, r1, r2, r3)

The route sets up the route table in the ESTeem. This command is used in conjunction with the append command to configure the routing table in the ESTeem 195M/H/C wireless modem. See Chapter 4 (Repeating) for complete details.

l# =   User defined route number. Route numbers 1 to 64 may be used.
r1 =   Address of first repeater. Address numbers from 1 to 254 may be used.
r2 =   Address of second repeater. Address numbers from 1 to 254 may be used.
r3 =   Address of third repeater. Address numbers from 1 to 254 may be used.

rssi

This command will display the status of the received signal strength indication (RSSI).   The values displayed in dBm. Instantaneous, Noise Floor, Last Valid (dBm)

s/n

This command will display the currently set Serial Number of the radio. This is not a configurable value.

save

The save command. The execution of this command stores the current command values and switches.

Note: Please wait approximately two seconds after executing the SAVE command before turning off power to the ESTeem.

sdi

Sets the serial device interface (sdi) for the ESTeem 195 Narrowband.

0 =   None
1 =   RS-232 Port 4 (3 wire RS-232 only with remote power)
2 =   RS-232 Port 3 (Full RS-232 with hardware handshaking)
3 =   RS-485 Port 1
4 =   RS-422 Port 2
5 =   Ethernet 10/100

Note: Port pin-out information found in Appendix B (Interface Ports)

Factory Default = 2

setcon (r1, r2, r3, da)

This command defines the destination address for the ESTeem to perform a connect when data arrives in the configured serial device interface (sdi). This function supports a direct connect or a connect through a maximum of three repeaters.

r1 =   ESTeem address (0 to 254) of repeater 1.
r2 =   ESTeem address (0 to 254) of repeater 2.
r3 =   ESTeem address (0 to 254) of repeater 3.
da =   Destination address (1 to 255).

short_packet_delay (0 - 3000)

This command sets the delay of short packet communications for the radio. Short packets consist of connect and acknowledgement packets.

Factory Default = 10

sread

This command will report back the current value of the 4-20mA sensors on the radio. This can be used to help tune the radio's sensors to your needs with the ch_offset and ch_slope commands.

stopbits (1 - 2)

This command sets the number of stop bits for the serial device interface. This command is used with baud, parity, databits to configure the serial port on the ESTeem.

Factory Default = 1

termt (0 - 5000)

The serial device interface receive termination timer value. This value is the time after the last serial data bit is received in the serial buffer that the modem will wait for further data. If additional data is received from the device, the ESTeem will make an RF packet and send it to the remote ESTeem.

Factory Default = 10

tx_buffs (0 - 6)

Number of milliseconds the ESTeem 195 Narrowband will hold open the buffer after receiving serial or Ethernet data packet before transmitting to remote.

Factory Default = 6

tx_delay (0 - 10000)

Number of milliseconds the ESTeem 195M/H/C will wait after receiving serial or Ethernet data packet before transmitting to remote.

Factory Default = 10

uptime_div (1 - 31536000)

This value is divided into the default uptime (seconds) if you want to read the uptime as a larger number (minutes [60], hours [3,600], days [86,400], etc.)

Factory Default = 1 (Seconds)

uptime

This command will display the current amount of time the radio has been powered up. By default this value is in seconds.

version

This command will display the current firmware version, boot loader version and firmware CRC.

xhflow (0 - 1)

This command enables hardware flow control for the serial ports of the radio.

0 =   Off
1 =   On

Factory Default = 0

Interface Ports

The ESTeem Model 195C, 195M, and 195H have multiple data ports available for use. Each data interface is accessible through one of the four RJ-45 ports in the front panel of the Model 195 Narrowband (Figure 1). During the configuration of the modem, one of these ports is configured as the serial data interface (SDI). All data ports not configured as the SDI are available for console programming. This chapter will provide the pinouts and configuration of each communication and sensor port.

4-20mA Sensor (Port 1)	
RJ-45 Pin	**Signal**
1	Sensor 1
2	Sensor 2
7	Sensor 3
8	Sensor 4
3	Sensor 12VDC 50mA

Ethernet (Port 2)	
RJ-45 Pin	**Signal**
1	Transmit +
2	Transmit -
3	Receive +
6	Receive -

RS-232-Remote Power (Port 4)	
RJ-45 Pin	**Signal**
1	TXD - Transmit Data (Input)
3	RXD - Receive Data (Output)
2 & 6	Signal Ground (GND)
4 & 5	Remote Power + (48VDC)
7 & 8	Remote Power – (48VDC)

RS-485 (Port 1)	
RJ-45 Pin	**Signal**
6	RS-485A (-)
5	RS-485B (+)
4	Ground

RS-422 (Port 2)	
RJ-45 Pin	**Signal**
5	RS-422-A (RX-)
4	RS-422-B (RX+)
7	RS-422-Z (TX-)
8	RS-422-Y (TX+)

RS-232 (Port 3)	
RJ-45 Pin	**Signal**
1	DSR - Data Set Ready (Output)
2	DCD - Data Carrier Detect (Output)
3	DTR - Data Terminal Ready (Input)
4	Signal Ground (GND)
5	RXD - Receive Data (Output)
6	TXD - Transmit Data (Input)
7	CTS -Clear to Send (Output)
8	RTS - Request to Send (Input)

Figure 1: Interface Port Pinouts

Ethernet Port (Port 2)

The ESTeem Model 195M, 195H, and 195C have a Full and Half-Duplex Auto-negotiation interface supporting both 10 Mbps and 100 Mbps (10/100BaseT). The port is compatible with TIA/EIA-568B cable configuration (Figure 2). A standard Ethernet patch cable (AA09.2) can be used to interface the 195 Narrowband to a computer. The Ethernet port is used for both programming and data transfer.

RJ45 Pin No.	Wire Color	Wire Diagram	10Base-T Signal 100Base-TX Signal
1	White/Orange		Transmit +
2	Orange		Transmit -
3	White/Green		Receive +
4	Blue		Unused
5	White/Blue		Unused
6	Green		Receive -
7	White/Brown		Unused
8	Brown		Unused

Figure 2: Ethernet Pinout

RS-232C Data Ports (Ports 3 and 4)

The ESTeem Model 195M/H/C have two RS-232C data interfaces on the front panel. Port 3 has a full RS-232 interface with handshake, while Port 4 has only Transmit, Receive and Ground. Port 4 will generally be used only when the 195M/H/C is pole mounted with remote power. To interface the 195M/H/C to the serial port on the computer, you will need serial cable (AA0621.1) with the pin-out in Figure 3.

ESTeem Model 195M/H/C Port 3
(ESTeem Model AA0621.1 Cable)

RJ-45 Pin No.	Function	DB-9 Pin No.
1	Data Set Ready (DSR)	6
2	Data Carrier Detect (DCD)	1
3	Data Terminal Ready (DTR)	4
4	Signal Ground (GND)	5
5	Receive Data (RxD)	2
6	Transmit Data (TxD)	3
7	Clear to Send (CTS)	8
8	Request to Send (RTS)	7

Figure 3: RS-232 Cable Pinout

RS-485 and RS-422 Data Ports (Ports 1 and 2)

The ESTeem Model 195M/H/C has a single, two-wire RS-485 interface in Port 1 and a single, four-wire RS-422 interface in Port 2. To ease access to these ports the AA066 (Figure 3) cable adapter is available. The RJ-45 interface can be inserted into either Port 1 (RS-485) or Port 2 (RS-422) and the corresponding signal lines (Figure 1) can be inserted in the screw terminals.

Note: Verify the screw terminal cover is attached to the cable before termination.

4-20mA Sensor Inputs (Port 1)

The ESTeem Model 195M/H/C has four independent 4-20mA input sensors that can be read through either ModbusTCP protocol (See Chapter 6) or through the "sread" software command from a serial port. For detailed information on scaling or modifications to sensor reading, please refer to Appendix A of the manual, or contact ESTeem customer support at 509-735-9092 if you still have questions.

Figure 4: AA066 Cable Adapter

Model Series 192 Integration

The ESTeem Model 195M and 195C were designed to be downward compatible with the legacy ESTeem Model 192 series of wireless modems. The Model 192 series had been in production since 1996 with several generational changes in the product lifespan. The manufacturing variations throughout this time require that a new ESTeem Model 195M/C be "trained" to communicate with an existing Model 192 network. This training process (described below) will allow the Model 195M/C to recognize any change in deviation in the older radios and adjust accordingly.

Technical Tip: The ESTeem Model 192 network **MUST** be configured for narrow band (12.5 kHz) operation before Model 195M/C integration.

If an ESTeem 195M/C is added to an existing Model 192 network, it is highly recommended the Model 195M/C is installed at a remote location and not the Master or Repeater location of the Model 192 network (Figure 1). If the 195M/C is required to be used as the Master or Repeater site, "train" the radio modem to one of the remote locations and then test all wireless links from that location.

The Model 195M/C configuration utility can be used to provide local signal strength (RSSI) information but cannot gather information from a Model 192 because the process uses ModbusTCP protocol only available in the 195M/C. The ESTeem Model 192 configuration utility's diagnostic can be used to test the operation of the wireless network but must be run from the Model 192 side of the wireless network. For example, in Figure 1, the diagnostic utility (Polling Test) must be run from the Master SCADA location.
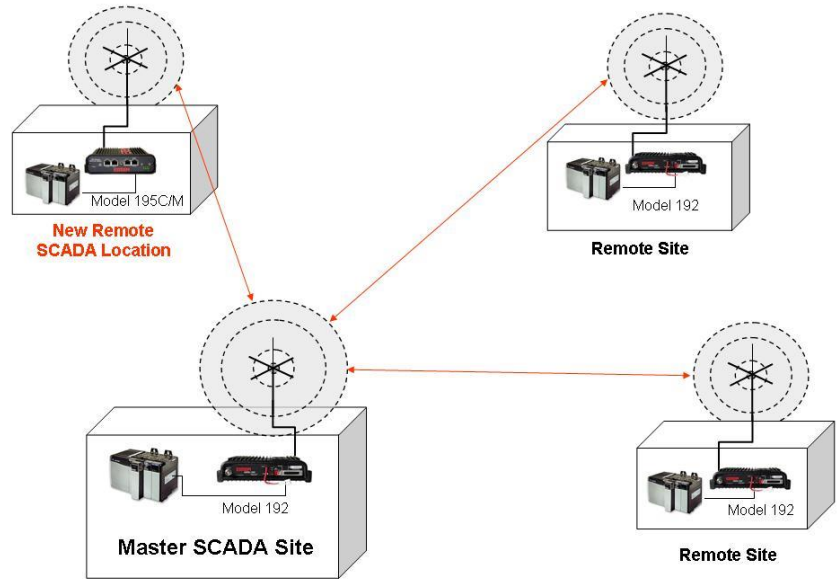
Figure 1: Model 192 Integration Diagram

Configuring Model 195M/C for Model 192
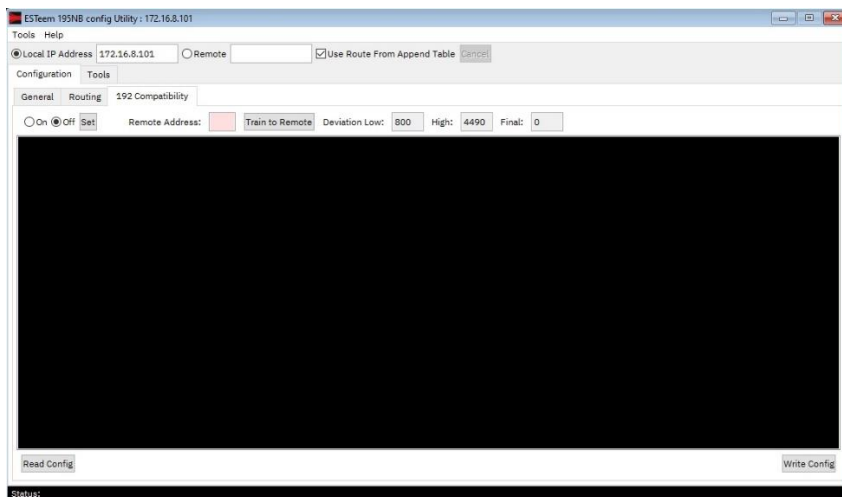
Figure 2: 192 Compatibility Configuration

The ESTeem Model 195C and 195M must be set to 192 compatibility mode to communicate with an ESTeem Model 192. To configure compatibility, select the 192 Compatibility tab (Figure 2) and set 192 Compatibility to ON then press the 'Set' button. This will set the software command (192compat on) for 192 compatibility.

The ESTeem Model 195C and 195M must then be "trained" to communicate with an ESTeem Model 192. Enter the remote address of the Model 192 and press the Train to Remote button. The Model 195M/C will begin training to the remote ESTeem and will save the configuration once complete (Figure 2). Verify the communication using the 195M/C Diagnostics.

INFORMATION TO USERS

WARNING: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generated, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their expense.

To ensure compliance to FCC non-interference regulations, peripherals attached to this modem require shielded I/O cables.

If this equipment does cause interference to radio or television, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Re-orient the radio/TV-receiving antenna.
2. Re-orient the modem antenna.
3. Relocate the modem with respect to the radio/TV-receiving antenna.
4. Plug the power supply for the modem into a different outlet so that the modem and radio/TV receiver are on different branch circuits.
5. Verify that the modem chassis is connected to an earth ground.
6. Attach a split bead (FAIR-RITE PN 2643164251) to the RS-232 cable.

If necessary, the user should consult the dealer or an experienced radio/TV technician for additional suggestions. The user may find the following booklet prepared by the FCC helpful.

"How to Identify and Resolve Radio-TV Interference Problems"

This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402 - Stock No. 004-000-00245-4. Application forms for the license are available from the nearest office of the FCC.

Electronic Systems Technology maintains a list of consultants that provide professional services at a reasonable cost to assists the users in licensing.

Max Power Density Calculation

(Numerical power gain divided by the spherical area around the separation distance)

$$Pd = (P * N) / (4 * Pi * D^2)$$

Example: The 195M has a maximum conducted output power close to 7 Watts. The highest gain antenna EST currently offers for use with this modem is specified with a gain factor of 8 dBd (10.15 dBi). Therefore, ignoring cable and connector losses, the maximum power density for the specified minimum safe separation distance of **170 cm** (uncontrolled environments):

$$Pd = (7000 * 10.351) / (4 * 3.14 * 170 * 170) = \textbf{0.198 mW/cm}^2 = \textbf{1.98 W/m}^2$$

Please contact EST technical support if you need assistance with calculations for various power levels, antennas and minimum safe separation distances.

Terms
P = RF Power milliwatts
Gi = Antenna gain relative to isotropic = Gd + 2.15
Gd = Antenna gain relative to dipole = Gi - 2.15
N = Numerical gain of antenna
D = Distance in centimeters
Pd = Power density in mW/cm²

North American Power Density Limits

FCC Part 47 Section 1.1309 Limits (Controlled Environments / Occupational Exposure)
150-220 MHz (195M & 195H)   1 mW/cm²
450 MHz (195C) 1.5 mW/cm²

FCC Part 47 Section 1.1309 Limits (General Population / Uncontrolled exposure)
150-220 MHz (195M & 195H)   0.2 mW/cm²
450 MHz (195C) 0.3 mW/cm²

Canadian Safety Code 6 Limits (Controlled Environments)
150-174 MHz (195M)   10 W/m²
450 MHz (195C) 15 W/m²

Canadian Safety Code 6 Limits (Uncontrolled Environments)
150-174 MHz (195M)   2 W/m²
450 MHz (195C) 3 W/m²

RF EXPOSURE WARNING: A minimum separation must be maintained between the user and nearby antenna at the following distances:

EXPOSITION RF AVERTISSEMENT: Un minimum de séparation doit être maintenue entre l'utilisateur et à proximité antenne aux distances suivantes:

Radio Model	Antenna Model/Gain	FCC Minimum Separation Distance Controlled Environment	Industry Canada Minimum Separation Distance Controlled Environment	FCC Minimum Separation Distance Uncontrolled Environment	Industry Canada Minimum Separation Distance Uncontrolled Environment
195C 9 Watts Max	AA19C (0 dBd)	35 cm	0.35 m	77 cm	0.77 m
195C 9 Watts Max	AA20C.1 (3.2 dBd)	50 cm	0.5 m	111 cm	1.11 m
195C 9 Watts Max	AA202C.1 (9 dBd)	97 cm	0.97 m	216 cm	2.16 m
195M 7 Watts Max	AA19M (0 dBd)	31 cm	0.31 m	68 cm	0.68 m
195M 7 Watts Max	AA20M (3.0 dBd)	43 cm	0.43 m	96 cm	0.96 m
195M 7 Watts Max	AA202M (8 dBd)	76 cm	0.76 m	170 cm	1.7 m
195H 2 Watts Max	AA19H (0 dBd)	17 cm	N/A	36 cm	N/A
195H 2 Watts Max	AA20H (3 dBd)	23 cm	N/A	50 cm	N/A
195H 2 Watts Max	AA202H (9 dBd)	46 cm	N/A	103 cm	N/A

Type Acceptance and RF Emissions Information

Model 195C

12.5 KHz Channel Spacing, 9,600-12,500 bps
FCC Type Acceptance No: ENPESTEEM195C
12.5 KHz Channel Emissions Designator: 8K59F1D
6.25 KHz Channel Emissions Designator: 4K37F1D

Industry Canada Type Acceptance: 2163A-192195C
12.5 KHz Channel Emissions Designator: 8K59F1DDN
6.25 KHz Channel Emissions Designator: 4K37F1DDN

Model 195M

12.5 KHz Channel Spacing, 9,600-12,500 bps
FCC Type Acceptance No: ENPESTEEM195M
12.5 KHz Channel Emissions Designator: 8K59F1D
6.25 KHz Channel Emissions Designator: 4K37F1D

Industry Canada Type Acceptance: 2163A-192195M
12.5 KHz Channel Emissions Designator: 8K59F1DDN
6.25 KHz Channel Emissions Designator: 4K37F1DDN

Model 195H

FCC Type Acceptance No: ENPESTEEM195H
50 KHz Channel Emissions Designator: 28K4F1D
25 KHz Channel Emissions Designator: 11K9F1D
12.5 KHz Channel Emissions Designator: 7K09F1D
6.25 KHz Channel Emissions Designator: 4K30F1D

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Portland, OR 97204

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Langhorne, PA 19047-1859

PUERTO RICO
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Carlo Chardon Ave.
Hato Rey, PR 00918

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9330 LBJ Freeway, Room 1170
Dallas, TX 75243-3429

5636 Federal Building
515 Rusk Avenue
Houston, TX 77002

WASHINGTON DC
Columbia Office (CF)
9300 East Hampton Drive
Capitol Heights, MD 20743

WASHINGTON
Seattle Office (ST)
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Overview

The ESTeem Models 195M, 195H and 195C support multiple security settings and an over-the-air, wireless encryption at 128-bit AES. All network security must be multi-layered as one level of security is never enough to make sure that data does not end up in the wrong hands. Please review the following security levels and decide what is the most appropriate for your network. The ESTeem 195M/H/C has incorporated the following security measures:

AES-CCMP (128-bit)

AES-CCMP (Advanced Encryption Standard-Counter Mode CBC-MAC Protocol) is the encryption algorithm used in the IEEE 802.11i and WPA-2 security protocols. This national encryption standard uses a 128 bit-AES block cipher and CCMP technique to ensure the highest level of security and integrity available on a wireless network. AES-CCMP incorporates two sophisticated cryptographic techniques (counter mode and CBC-MAC) and adapts them to Ethernet frames to provide a robust security protocol between the mobile client and the access point. AES itself is a very strong cipher, but counter mode makes it difficult for an eavesdropper to spot patterns, and the CBC-MAC message integrity method ensures that messages have not been tampered with.

rf_encrypt (on/off) - This software command will enable an over-the-air, wireless encryption at 128-bit AES. All ESTeem 195M/H/C in the same wireless network must have the same encryption settings and keys.

passp <Passphrase> - This software command will use the characters in the Passphrase to generate the AES encryption key. The key is generated from 1-64 characters entered after the passp command (example: passp 12345678) and is case sensitive. Typing the passp command without any arguments will display the current Passphrase.

ESTeem 195C Specifications	
Transmitter/Receiver	
Frequency of Operation (Software Selectable)	440 to 470 MHz (6.25kHz / 12.5 kHz Channel Spacing)
Frequency Stability, -30C to +60C	+/- 2.5ppm
RF Data Rate Vs. Channel Spacing	(4.8Kbps @ 6.25kHz) and (12.5Kbps @ 12.5kHz)
Tx Output Power (Software Adjustable)	0.5 to 4 Watts
Tx Output Impedance	50 ohms
Rx Sensitivity	-110 dBm
Rx Adjacent Channel Rejection	> 55 dB
Modulation	4-Level GFSK
Forward Error Correction	TCM, Coding Rate 3/4
Data Error Detection	32-Bit Cyclic Redundancy Check
FCC ID (USA)/Industry Canada Type Acceptance	ENPESTEEM195C / 2163 192 195C
LED Indicators	Power (12V-Aux), Status Multi-Color LED (Tx, Rx, Rx-Valid, Rx-Error), RS-232 , RS-485, RS-422 Tx/Rx
Data Packet Information	
Radio Addressing	1-254 Total Units, Digi-repeating allows up to 3 repeaters between end-points
Data Packet Size	1-1500 Bytes
Serial Data Interface Buffer Size	8Kbytes Tx / 8Kbytes Rx
Power Requirements	
Receive / Without Ethernet Link	120 ma @ 12 VDC
Receive / With Ethernet Link	160 ma @ 12 VDC
Transmit @ 4 Watts RF Output	1540 ma @ 12 VDC
External DC Input Power	10.8 to 15 VDC
Ethernet Port (10/100)	RJ-45 Female
Serial Data Interfaces (RS-232, RS-422 & RS-485 selectable)	RJ-45 Female
Antenna Input/Output	TNC Female Connector
Protocols	
Serial Data Interface, Master PLC mode protocols supported repeater function	Allen Bradley DF1, Opto22, Modbus RTU/ASCII, and Transparent protocols
Ethernet Interface protocols supported for remote access via ARP proxy	ICMP Echo (ping), Modbus/TCP (Aux Voltage, 4-20mA readings, RSSI, MCU Core Temperature), Remote Configuration
Ethernet Interface protocols (direct access only)	Telnet, IP Configuration, Firmware upgrades
Mechanical / Environmental	
Temperature Range	-30° to +60° C
Humidity	95% Non-condensing
Dimensions	1.9 in. H x 6.7 in. W x 6.2 in. L
Weight	1.25 lbs.
Product Warranty	1 Year
Options	
Outdoor Pole Mount Kit	AA195PM
RJ-45 To DB9 Serial Adaptor	AA0621.1
RJ-45 To Terminal Block Adaptor	AA066
Antennas/Surge Protectors/Cables, etc.	Contact factory for various options (market@esteem.com or 509-735-9092)
Security	AES-128

Antenna Specifications

Model No:	AA19C
Antenna Type:	Omni-Directional, ½ Wave
Applications:	Mobile Mount.
Frequency:	450 to 470 MHz - AA19C
	400 to 420 MHz - AA19F
Polarization:	Vertical
Impedance:	50 ohms
Gain:	0 dBd
VSWR:	< 2 to 1
Front To Back Ratio:	n/a
Horizontal Beamwidth:	n/a
Vertical Beamwidth:	60 degrees
Antenna Material:	Rubber duck whip.
Mounting Hardware:	Magnetic base.
Antenna Connector:	TNC with 12 feet integral RG-58 cable.
Antenna Envelope:	16 in. length. Magnetic base 3.5 in. by 3 in by 1 in.
Weight:	1 lb. 5 oz.

Model No:	AA20C.1
Antenna Type:	Omni-Directional, DC grounded, Collinear 5/8 wave over 1/2 wave.
Applications:	Fixed base or mobile mounting. L shaped mounting bracket may be removed for panel mounting. Ground plane radials may be removed depending on application.
Frequency:	450 to 470 MHz - AA20C.1
Polarization:	Vertical
Impedance:	50 ohms
Gain:	3.2 dBd
VSWR:	< 1.5
Front To Back Ratio:	n/a
Horizontal Beamwidth:	n/a
Vertical Beamwidth:	30 degrees
Antenna Material:	Stainless steel whip and ground plane radials. All other hardware anodized metal.
Mounting Hardware:	Stainless steel clamps for mounting to ¾ in. to 1 /2 in. pipe with right angle mount or direct mount.
Antenna Connector:	N-Type Female
Antenna Envelope:	37 ½ in. length by 16 in width with ground plane radials.
Weight:	2 lbs.

Antenna Specifications

Model No:	AA202C.1
Antenna Type:	Directional, DC grounded, 5 element Yagi.
Applications:	Fixed base.
Frequency:	440 to 470 MHz
Polarization:	Vertical or Horizontal
Impedance:	50 ohms
Gain:	9 dBd
VSWR:	< 1.5
Front To Back Ratio:	20 dB
Horizontal Beamwidth:	59 degrees
Vertical Beamwidth:	53 degrees
Antenna Material:	High strength aluminum with gold chromate finish.
Mounting Hardware:	Heavy duty U bolts for mounting up to 2 1/8 in. pipe with right angle mount or direct panel mount.
Antenna Connector:	N-Type Female
Maximum Power Input:	300 Watts
Antenna Envelope:	34.5 in. length by 13.25 in. width
Windload (RWV):	100 mph
Weight:	1.68 lbs.

ESTeem 195M Specifications	
Transmitter/Receiver	
Frequency of Operation (Software Selectable)	150 to 174 MHz (6.25kHz / 12.5 kHz Channel Spacing)
Frequency Stability, -30C to +60C	+/- .38ppm
RF Data Rate Vs. Channel Spacing	(4.8Kbps @ 6.25kHz) and (12.5Kbps @ 12.5kHz)
Tx Output Power (Software Adjustable)	0.5 to 4 Watts
Tx Output Impedance	50 ohms
Rx Sensitivity	-110 dBm
Rx Adjacent Channel Rejection	> 55 dB
Modulation	4-Level GFSK
Forward Error Correction	TCM, Coding Rate 3/4
Data Error Detection	32-Bit Cyclic Redundancy Check
FCC ID (USA)/Industry Canada Type Acceptance	ENPESTEEM195M / 2163 192 195M
LED Indicators	Power (12V-Aux), Status Multi-Color LED (Tx, Rx, Rx-Valid, Rx-Error), RS-232 , RS-485, RS-422 Tx/Rx
Data Packet Information	
Radio Addressing	1-254 Total Units, Digi-repeating allows up to 3 repeaters between end-points
Data Packet Size	1-1500 Bytes
Serial Data Interface Buffer Size	8K bytes Tx / 8K bytes Rx
Power Requirements	
Receive / Without Ethernet Link	120 ma @ 12 VDC
Receive / With Ethernet Link	160 ma @ 12 VDC
Transmit @ 4 Watts RF Output	1540 ma @ 12 VDC
External DC Input Power	10.8 to 15 VDC
Ethernet Port (10/100)	RJ-45 Female
Serial Data Interfaces (RS-232, RS-422 & RS-485 selectable)	RJ-45 Female
Antenna Input/Output	TNC Female Connector
Protocols	
Serial Data Interface, Master PLC mode protocols supported repeater function	Allen Bradley DF1, Opto22, Modbus RTU/ASCII, and Transparent protocols
Ethernet Interface protocols supported for remote access via ARP proxy	ICMP Echo (ping), Modbus/TCP (Aux Voltage, 4-20mA readings, RSSI, MCU Core Temperature), Remote Configuration
Ethernet Interface protocols (direct access only)	Telnet, IP Configuration, Firmware upgrades
Mechanical / Environmental	
Temperature Range	-30° to +60° C
Humidity	95% Non-condensing
Dimensions	1.9 in. H x 6.7 in. W x 6.2 in. L
Weight	1.25 lbs.
Product Warranty	1 Year
Options	
Outdoor Pole Mount Kit	AA195PM
RJ-45 To DB9 Serial Adaptor	AA0621.1
RJ-45 To Terminal Block Adaptor	AA066
Antennas/Surge Protectors/Cables, etc.	Contact factory for various options (market@esteem.com or 509-735-9092)
Security	AES-128

Antenna Specifications

Model No:	AA19M
Antenna Type:	Omni-Directional, ½ Wave over ¼ Wave
Applications:	Mobile Mount.
Frequency:	150-174 MHz
Polarization:	Vertical
Impedance:	50 ohms
Gain:	0 dBd
VSWR:	< 1.5 to 1
Front To Back Ratio:	n/a
Horizontal Beamwidth:	n/a
Vertical Beamwidth:	60 degrees
Antenna Material:	Rubber duck whip.
Mounting Hardware:	Magnetic base.
Antenna Connector:	TNC with 12 feet integral RG-58 cable.
Antenna Envelope:	11 in. length. Magnetic base 3.5 in. by 3 in by 1 in.
Weight:	1 lb. 5 oz.

Model No:	AA20M
Antenna Type:	Omni-Directional, DC grounded, Collinear 5/8 wave
Applications:	Fixed base or mobile mounting. L shaped mounting bracket may be removed for panel mounting. Ground plane radials may be removed depending on application.
Frequency:	150 to 175 MHz
Polarization:	Vertical
Impedance:	50 ohms
Gain:	3.0 dBd with ground plane radials
VSWR:	< 1.5
Front To Back Ratio:	n/a
Horizontal Beamwidth:	n/a
Vertical Beamwidth:	60 degrees
Antenna Material:	Stainless steel whip and ground plane radials. All other hardware anodized metal.
Mounting Hardware:	Stainless steel clamps for mounting to ¾ in. to 1.5 in. pipe with right angle mount or direct mount.
Antenna Connector:	UHF Female (SO-239)
Antenna Envelope:	61 in. length by 43.5 in. width with ground plane radials
Weight:	2 lbs.

Antenna Specifications

Model No:	AA202M
Antenna Type:	Directional, 6 element yagi.
Applications:	Fixed base mounting.
Frequency:	150 to 174 MHz
Polarization:	Vertical or Horizontal
Impedance:	50 ohms
Gain:	8 dBd
VSWR:	< 1.2:1
Front To Back Ratio:	12-18 dB
Horizontal Beamwidth:	80 degrees
Vertical Beamwidth:	58 degrees
Antenna Material:	.250" – 6061-T6 Aluminum
Mounting Hardware:	Heavy duty U bolts for mounting up to 2 1/8 in. pipe with right angle mount or direct panel mount.
Antenna Connector:	N-Type Female
Maximum Power Input:	150 Watts
Antenna Envelope:	61 in. length by 41 in. width
Wind Surface Area (sqr. ft)	0.82
Windload (RWV):	100 mph
Weight:	5 lbs.

SECURE WIRELESS NETWORKING

ESTeem 195H Specifications	
Transmitter/Receiver	
Frequency of Operation (Software Selectable)	217 to 220 MHz (6.25kHz, 12.5 kHz, 25 kHz and 50 kHz Channel Spacing)
Frequency Stability, -30C to +60C	+/- 0.415 ppm
RF Data Rates Vs. Channel Spacing	(4.8Kbps @ 6.25kHz), (12.5Kbps @ 12.5kHz), (25Kbps @ 25kHz), and (50Kbps @ 50kHz)
Tx Output Power (Software Adjustable)	1 or 2 Watts
Tx Output Impedance	50 ohms
Rx Sensitivity	(-114 dBm @ 6.25kHz), (-111 dBm @ 12.5kHz), (-108 dBm @ 25kHz), and (-105 dBm @ 50kHz)
Rx Adjacent Channel Rejection	> 55 dB
Modulation	4-Level GFSK
Forward Error Correction	TCM, Coding Rate 3/4
Data Error Detection	32-Bit Cyclic Redundancy Check
FCC ID	ENPESTEEM195H
LED Indicators	Power (12V-Aux), Status Multi-Color LED (Tx, Rx, Rx-Valid, Rx-Error), RS-232 , RS-485, RS-422 Tx/Rx
Data Packet Information	
Radio Addressing	1-254 Total Units, Digi-repeating allows up to 3 repeaters between end-points
Data Packet Size	1-1500 Bytes
Serial Data Interface Buffer Size	8K bytes Tx / 8K bytes Rx
Power Requirements	
Receive / Without Ethernet Link	120 ma @ 12 VDC
Receive / With Ethernet Link	160 ma @ 12 VDC
Transmit @ 2 Watts RF Output	1350 ma @ 12 VDC
External DC Input Power	10.8 to 15 VDC
Ethernet Port (10/100)	RJ-45 Female
Serial Data Interfaces (RS-232, RS-422 & RS-485 selectable)	RJ-45 Female
Antenna Input/Output	TNC Female Connector
Protocols	
Serial Data Interface, Master PLC mode protocols supported repeater function	Allen Bradley DF1, Opto22, Modbus RTU/ASCII, and Transparent protocols
Ethernet Interface protocols supported for remote access via ARP proxy	ICMP Echo (ping), Modbus/TCP (Aux Voltage, 4-20mA readings, RSSI, MCU Core Temperature), Remote Configuration
Ethernet Interface protocols (direct access only)	Telnet, IP Configuration, Firmware upgrades
Mechanical / Environmental	
Temperature Range	-30° to +60° C
Humidity	95% Non-condensing
Dimensions	1.9 in. H x 6.7 in. W x 6.2 in. L
Weight	1.25 lbs.
Product Warranty	1 Year
Options	
Outdoor Pole Mount Kit	AA195PM
RJ-45 To DB9 Serial Adaptor	AA0621.1
RJ-45 To Terminal Block Adaptor	AA066
Antennas/Surge Protectors/Cables, etc.	Contact factory for various options (market@esteem.com or 509-735-9092)
Security	AES-128

Antenna Specifications

Model No:	AA20H
Antenna Type:	Omni-Directional, ¼ Wave
Applications:	Base or Repeater Locations
Frequency:	217-220 MHz
Polarization:	Vertical
Impedance:	50 ohms
Gain:	3.0 dBd with ground radials
VSWR:	< 1.5 to 1
Front To Back Ratio:	n/a
Horizontal Beamwidth:	n/a
Vertical Beamwidth:	40 degrees
Antenna Material:	Stainless steel whip and ground plane radials
Mounting Hardware:	Stainless steel clamps for pipe mount
Antenna Connector:	UHF Female (SO-239)
Antenna Envelope:	43 in. length with 43 in. width with ground plane radials.
Weight:	2 lbs.

Model No:	AA202H
Antenna Type:	Directional, 6 element yagi.
Applications:	Fixed base mounting.
Frequency:	215-225 MHz
Polarization:	Vertical or Horizontal
Impedance:	50 ohms
Gain:	9 dBd
VSWR:	< 1.2:1
Horizontal Beamwidth:	66 degrees
Vertical Beamwidth:	52 degrees
Antenna Material:	.250" – 6061-T6 Aluminum
Mounting Hardware:	Heavy duty U bolts for mounting up to 2 1/8 in. pipe with right angle mount or direct panel mount.
Antenna Connector:	N-Type Female
Maximum Power Input:	150 Watts
Antenna Envelope:	54 in. length by 27 in. width
Wind Surface Area (sqr. ft)	0.82
Windload (RWV):	100 mph
Weight:	5 lbs.

Antenna Specifications

Model No:	TS327775
Antenna Type:	Omni-Directional, Heavy Duty Fiberglass
Applications:	Fixed base or Repeater Locations
Frequency:	217-222 MHz
Polarization:	Vertical
Impedance:	50 ohms
Gain:	5.0 dBd
VSWR:	< 2.0
Front To Back Ratio:	n/a
Horizontal Beamwidth:	n/a
Vertical Beamwidth:	18 degrees
Antenna Material:	Heavy duty fiberglass radome with a thick walled 6061-T6 aluminum mounting base.
Mounting Hardware:	Hard coat anodized mounting base with galvanized mounting hardware.
Antenna Connector:	N-Female Bulkhead
Antenna Envelope:	151 in. length by 5 in. width
Weight:	12 lbs.