ESTEEM

SECURE WIRELESS NETWORKING

ESTeem User's Manual

Horizon Series

Manual Revision 3.1

(Horizon Firmware Version 202208101311 or later)

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PRODUCT WARRANTY

Electronic Systems Technology, Inc. dba ESTeem Wireless Modems, (hereinafter ESTeem) expressly warrants its products as free of manufacturing defects for a period of one year from the date of sale to first user/customer. THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED AND THERE IS EXPRESSLY EXCLUDED ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. NO OTHER WARRANTY GIVEN BY ANY EMPLOYEE, AGENT, DISTRIBUTOR OR OTHER PERSON WITH RESPECT TO THE PRODUCT SHALL BE BINDING ON ESTEEM.

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ESTeem's liability shall be limited to refunding of purchase price, repair or replacement of product. IN NO EVENT SHALL ESTEEM HAVE LIABILITY FOR CONSEQUENTIAL, INCIDENTAL, SPECIAL OR EXEMPLARY DAMAGES CAUSED DIRECTLY OR INDIRECTLY BY THE PRODUCT, INCLUDING BUT NOT LIMITED TO ANY INTERRUPTION OF SERVICES, LOSS OF BUSINESS OR ANTICIPATORY PROFITS. IN NO EVENT SHALL ESTEEM BE LIABLE FOR ANY DAMAGES WHATSOEVER IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT.

In the event that a unit or part requires replacement or factory servicing, the following conditions apply:

a) Customer must obtain from ESTeem an authorized RMA (Return Materials Authorization) Number before shipment of product or parts to ESTeem for any reason;

b) If the whole unit is shipped, it must be in its original carton and shipping components, or a carton and shipping components supplied by ESTeem, or it parts only are shipped, they must be packaged and cushioned so as to prevent damage in transit and shipped freight prepaid;

PRODUCT WILL BE CONSIDERED OUT OF WARRANTY IF:

a) If the product is damaged due to improper or abnormal use, abuse, mishandling, accident or improper maintenance or failure to follow operating instruction;

b) If the product is defective as a result of sand, dirt, or water damage;

c) If any factory-sealed enclosure has been opened or shows evidence of an attempt to be opened;

d) If defects or damage are caused by the use of unauthorized parts or unauthorized service;

e) If the product has had its serial numbers altered or removed.

Warranty repair form must be accompanied by proof of user's purchase of unit. Product must be shipped to the manufacturer at the following address:

ESTeem Secure Wireless Networking
415 North Roosevelt Street
Kennewick, Washington USA 99336

ADDITIONAL SERVICE:
If ESTeem releases an improvement update to firmware internal to the ESTeem unit during the 90-day period after the unit was purchased by the first user/customer, ESTeem will update the applicable unit with the revised version at no charge other than for UPS handling and shipping to and from your location to the ESTeem factory. Return of any such item must be accompanied with proof of purchase.

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CHAPTER 1
INTRODUCTION

BEFORE YOU BEGIN

Thank you and congratulations on your purchase of the ESTeem Horizon series wireless Ethernet radio! This manual was written to help both the first time and advanced user of the Horizon to configure the wireless modem for your application. If this is your first time configuring the Horizon and you would like to get going as soon as possible, all product documentation and utilities can be found at the Getting Started page of the ESTeem web site at www.esteem.com/gettingstarted.

Figure 1: ESTeem Horizon Series

The ESTeem Horizon Series of wireless Ethernet networking hardware are very sophisticated networking devices. 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:

- 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
- If using routing protocols, you must be able to identify and configure the network routers, gateways and firewalls
- You must be familiar with using web browser software such as Google Chrome, Firefox or Internet Explorer

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.

HORIZON OVERVIEW

The ESTeem Horizon is a series of wireless LAN transceivers that can be used to build many types of Wireless Local Area Networks (WLAN). The Horizon radios can provide RF data rates up to 300 Mbps for complex Ethernet networks and all have an RS-232 serial port for legacy device support. The Horizon radios are very sophisticated networking devices that can be configured for multiple modes of operation depending upon the needs of the wireless and wired LAN system. The following configuration modes 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 4 of this User's Manual or call Customer Support at 509-735-9092.

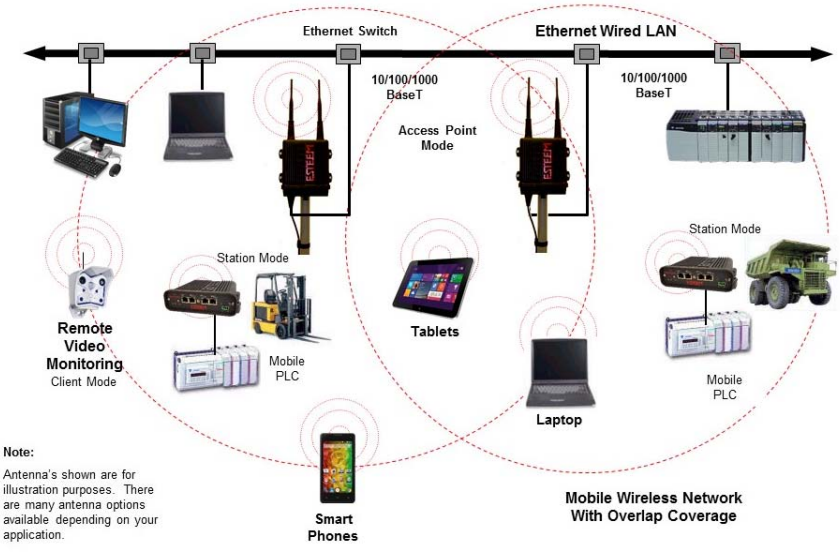


Figure 2: Access Point Bridge Diagram

CONFIGURATION MODES

The Horizon can be configured for multiple modes of operation without any changes to the hardware. The following are brief descriptions of the configuration modes. For detailed descriptions and suggested applications for each mode, please refer to Chapter 4.

Access Point Modes

When the Horizon is configured as an Access Point it will provide a wireless bridge for mobile clients such as Horizon or Model 195E modems in client modes or Wi-Fi devices. Multiple Access Points can be physically connected to the same network (LAN) or through a radio link using the Access Point Peer mode to provide overlapping, seamless Ethernet communication for mobile devices.

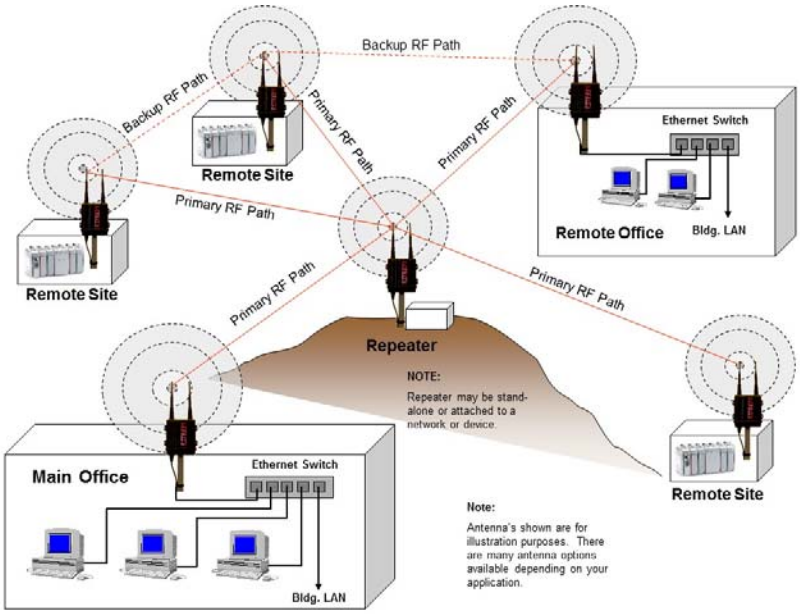


Figure 3: Peer Mode Diagram

1. **Access Point Bridge Mode**

   An ESTeem Horizon radio in Access Point Bridge mode will both provide wireless access to mobile clients (Access Point) and bridge all Ethernet data connected to the Ethernet ports. The AP Bridge mode will pass all network traffic between connected devices including global network broadcasts. (See Figures 2 & 3)

2. **Access Point Router Mode**

   In this mode the ESTeem Horizon will function as a router between wired Ethernet networks, connected to the Horizon's Ethernet port, and the wireless clients in the network. As in all standard router configurations, the wireless and wired Ethernet networks will need to be on separate subnets. The Horizon in Access Point Router mode will pass network traffic for connected devices but will block global network broadcasts from the wired network. This mode of operation should be used instead of the Access Point Bridge mode when a separation between networks is required or the ESTeem is connected to larger LAN Networks that will continuously send global network broadcasts (Figure 3).

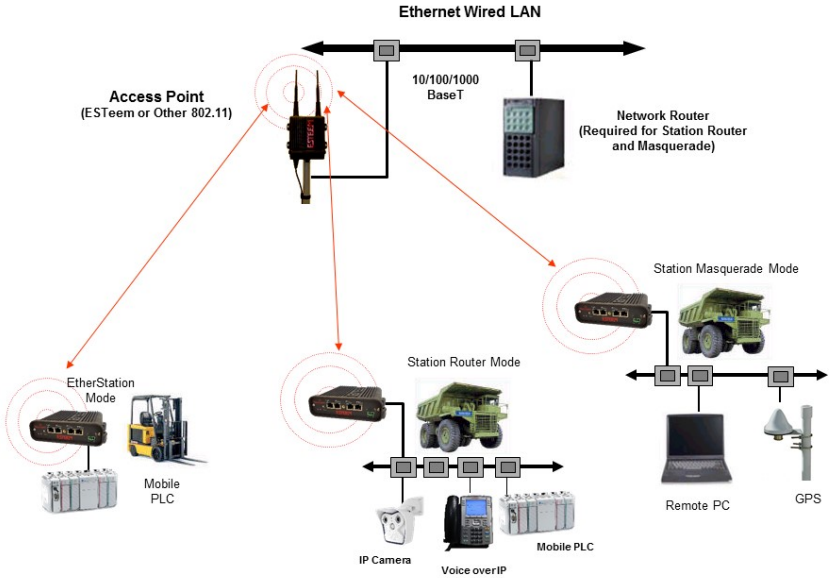


Figure 4: Access Point Masquerade Diagram

3. **Access Point Masquerade Mode**

The Access Point Masquerade mode is a special use of the Access Point mode where the Horizon will connect mobile clients into a single static IP address on a wired network. Data requests from the wireless network will be processed through the Access Point Masquerade modem, but any request from the wired Ethernet network to devices on the wireless network will be rejected similar to the operation of a "firewall". The Horizon will hide all the IP addresses connected on the wireless link. You would use this mode of operation if Horizon is connected directly to the Internet with a static IP address (DSL, T1, etc.) and you want the wireless clients to access the information through the Horizon (Figure 4). This mode should also be used for attaching the Horizon to a network where few IP addresses are available or a firewall for the wireless clients is required.

Access Point Peer (IndustrialMESH) Mode

The Access Point Peer connection is a unique enhancement of the ESTeem Horizon series. The Access Point peer can be used with any of the above Access Point modes. With this feature enabled, the Access Points do not have to be hardwired together on the same physical LAN to provide seamless Ethernet communication for roaming clients. In addition to greatly extending the Access Point canopy range, the Horizon will also bridge any Ethernet device or Ethernet network connected to the unit over this same wireless Ethernet network. This mode gives the user the features of a point to multi-point bridge network but also allows the Horizon in the Client mode to simultaneously roam under the network canopy.

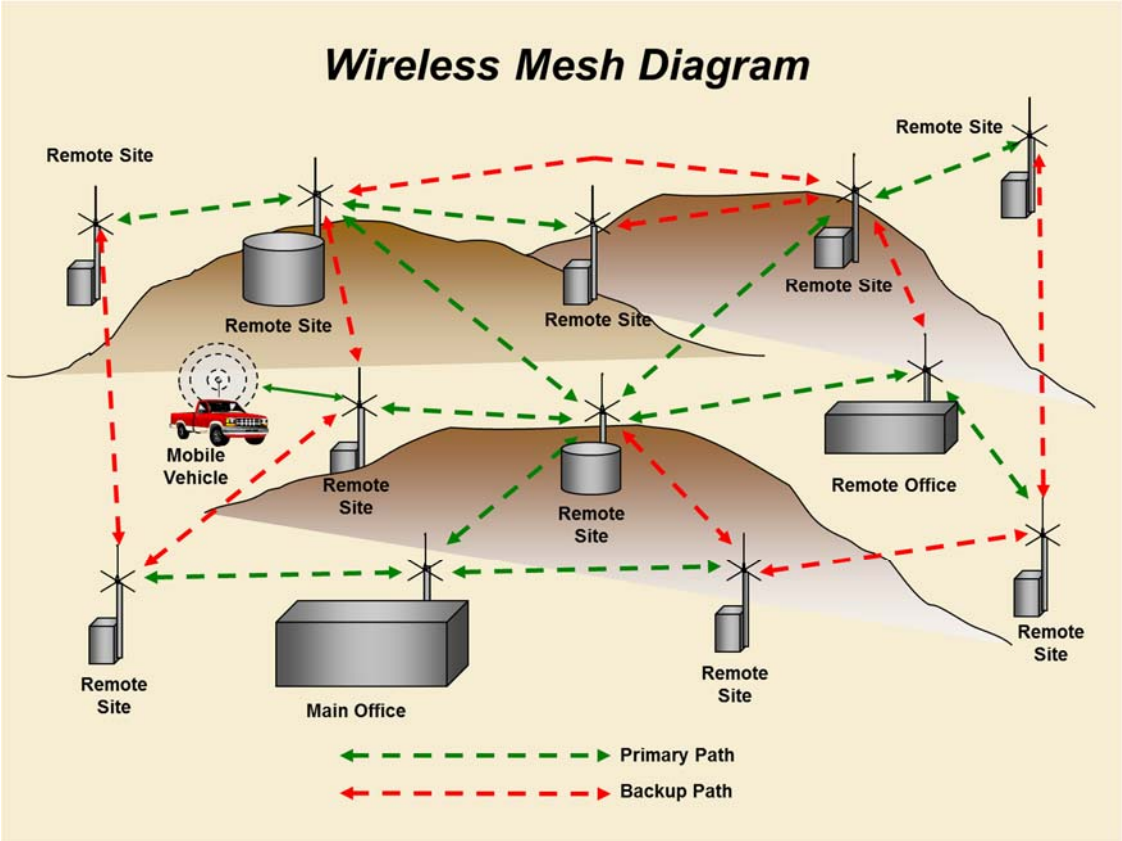


Figure 5: Mesh Network Diagram

Self-Healing Mesh Network (IndustrialMESH)

If multiple Access Point Repeater routes are configured to the same destination ESTeem, the Horizon will create a "self-healing" mesh network by automatically re-routing data through alternate paths to reach its destination if the primary path is inoperable. The routing and priority of alternate paths is completely user configurable. (See Figure 5)

Station (Client) Modes

1. **Station Bridge Mode**

A Horizon radio configured in Station Bridge mode will allow multiple connected Ethernet devices to access to the wireless network in a mobile mode. The Horizon will seamlessly roam under the radio canopy of Access Points and can provide greatly increased range for mobile Ethernet applications such as vehicles, forklifts, cranes, etc (Figures 2-4). The Station Bridge mode will automatically bridge multiple Ethernet devices connected to a single radio and will pass all Ethernet traffic from those devices including global and multicast traffic.

2. **EtherStation Mode**

When the Horizon is configured in the EtherStation mode and attached to a single Ethernet Device, the Horizon will emulate an 802.11 wireless card in functionality for communication as a mobile client. The Horizon will seamless roam under the radio canopy of Access Points and can provide greatly increased range over a Wireless LAN Card for mobile Ethernet devices such as vehicles, forklifts, cranes, etc (Figures 2-4).

3. **Station Router Mode**

The Station Router mode will also function as a mobile client, but will allow multiple Ethernet devices to be connected to a single Horizon (Figure 4) with Ethernet routing functions. The Horizon will function as a router between the wireless client mode and the wired Ethernet devices connected to the Ethernet port. Similar in configuration to the Access Point Router mode, the wireless and wired Ethernet networks will need to be on separate subnets. To communicate from wireless network to devices on the wired Station Router network, a separate router (connected to the Ethernet side of the Access Point) is required. This mode would be used where multiple Ethernet devices will be connected to a single Horizon in a mobile client application and the connected Ethernet devices will need to be accessible from the Access Point's LAN network.

4. **Station Masquerade Mode**

The Station Masquerade mode is another case multiple devices will be connected to a single ESTeem in a mobile or client application. However, unlike the Station Router mode, the Station Masquerade will consolidate all connected Ethernet devices to a single IP address on the network. The devices connected to the Station Masquerade will be able to access information from both the wireless and wired LAN, but will be inaccessible the other way similar in application to a firewall. This mode would be used where multiple Ethernet devices will be connected to a single Horizon in a mobile application and the IP addresses for each device will be hidden from the LAN connected to the AP. See Figure 4.

RS-232 Serial Applications

The ESTeem Horizon is installed with an RS-232 data port for serial data applications run over the broadband link (Figure 6). The serial over broadband network can be used in a point-to-point or point-to-multi-point application for networking serial (RS-232C) devices, providing serial connections to legacy hardware in a new Ethernet network or providing for high-bandwidth devices (such as Video or Voice over IP) in an existing serial network.

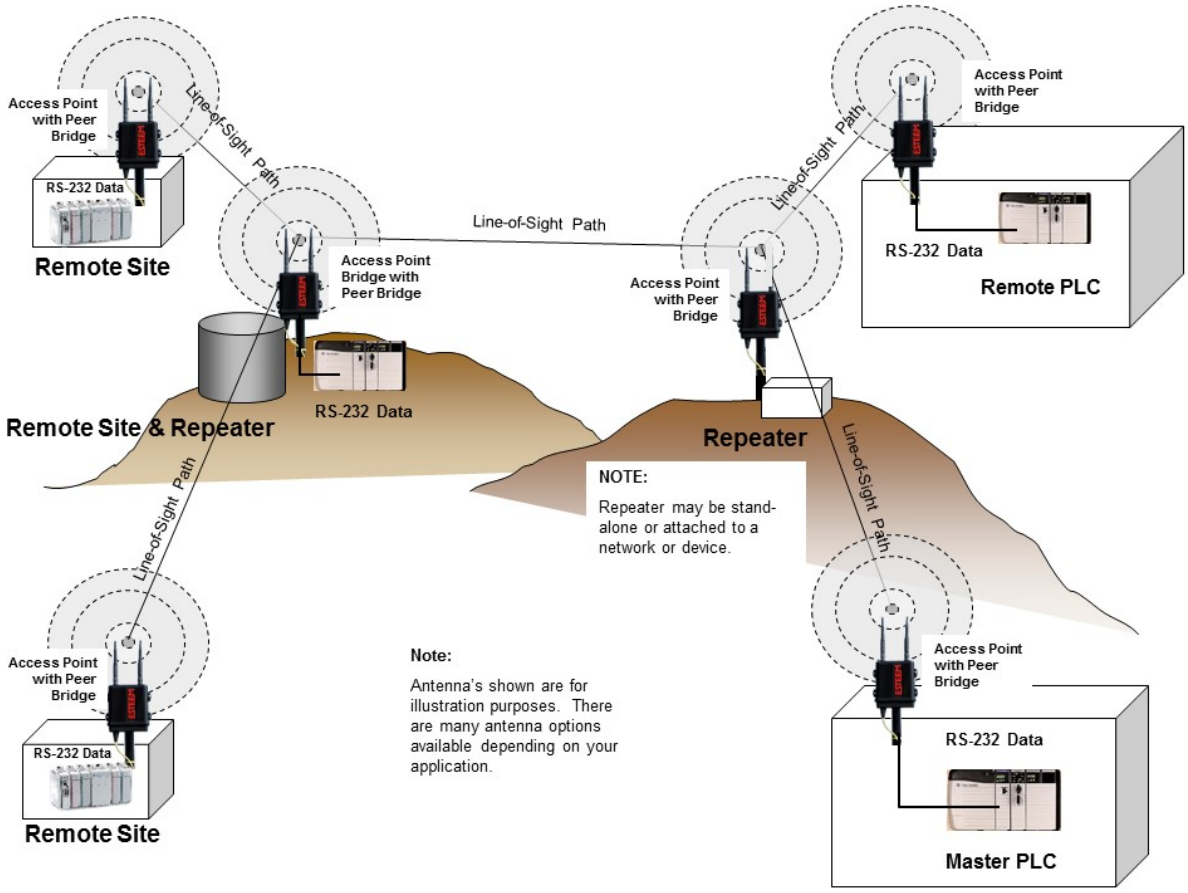


Figure 6: Multi-point Serial Diagram

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 Horizon for operation in a wireless network:

Phase 1 - Determine the correct mode of operation for the Horizon in the wireless network. The ESTeem Horizon is a sophisticated networking device that can be configured for multiple modes of operation. Determining the correct mode of operation for the ESTeem Horizon 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 Horizon can be programmed for the wireless network. The ESTeem Horizon can also be programmed through the internal Web interface (discussed in detail in Chapter 5) in a step-by-step setup process.

Phase 3 - Install the ESTeem hardware and test communication. After the ESTeem Horizon programming, install the hardware in each remote location. Chapter 8 of this User's Manual describes the antenna specifications, mounting options and the configuration of the pole mounting hardware for the ESTeem. For instructions on testing and troubleshooting the wireless link, refer to Appendix E (Troubleshooting).

HORIZON HARDWARE LAYOUT

To begin the configuration, unpack the ESTeem Horizon 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 Horizon's network may have different hardware components based upon the final installation location (i.e. Outdoor, Indoor, Point-to-point or Muti-Point). Antenna types, cable lengths, power supplies may be different, but the following items will be required for basic setup:

Horizon Radio

Antenna (AA20DMEg Displayed)

Power Supply (AA175.5 Displayed)

(2) Ethernet Cables

ESTeem Software Utilities (esteem.com/gettingstarted)

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

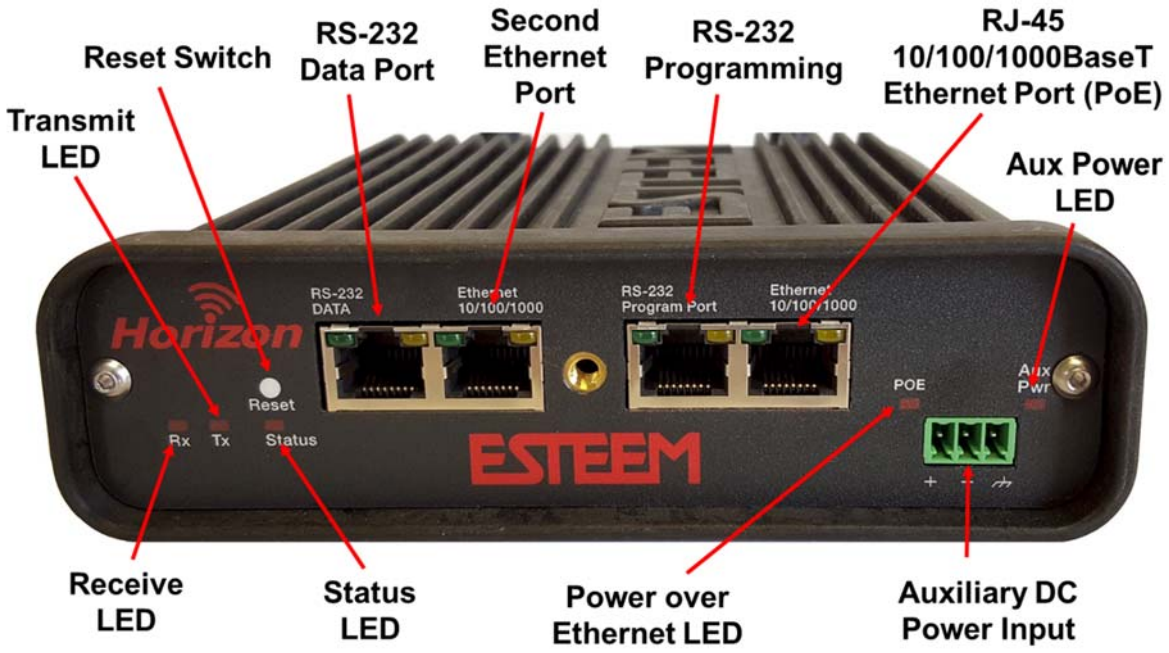


Figure 1: Horizon Front Panel Overview

Figure 2: Horizon Antenna Overview

HORIZON HARDWARE CONFIGURATION

The following steps should be completed to begin configuration of the ESTeem Horizon:

1. Connect the antenna to the antenna connector on the Horizon (Figure 3). For a single antenna use Antenna Port 1 and connect both if using dual antennas.

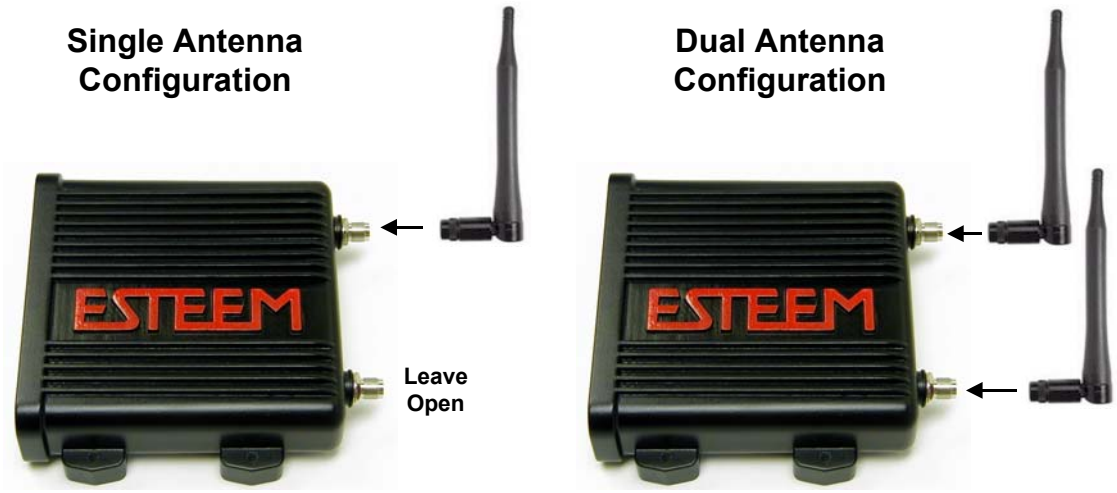


Figure 3: Antenna Configuration Diagram

2. Assemble the Horizon hardware as shown in Figure 4.

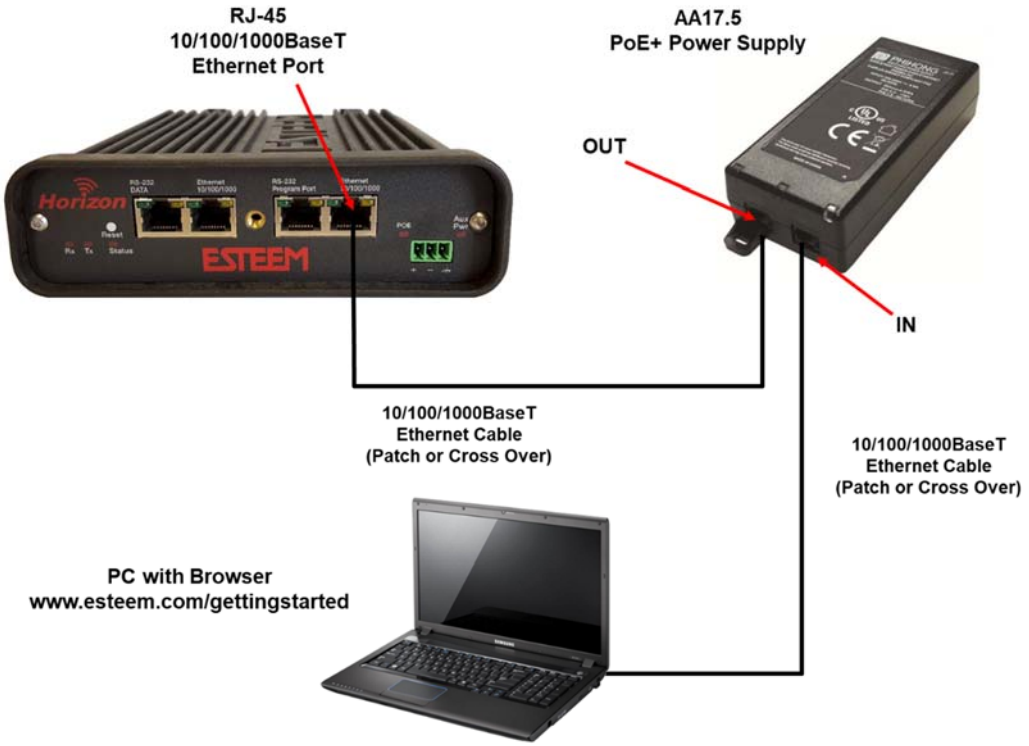


Figure 4: Hardware Configuration Diagram

Technical Tips:

1. Configure the Horizon prior to mounting.

2. Attach antenna to the Horizon before powering up.

CHAPTER 3
EXAMPLE APPLICATIONS

MODES OF OPERATION

The ESTeem Horizon is a sophisticated wireless networking device that can be configured for multiple modes of operation. 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.

Ethernet Bridge Mode (AP Bridge)

The most commonly used mode of operation with the ESTeem Horizon is the Ethernet bridge mode. The Ethernet bridge mode will connect two or more ESTeem Horizon's while passing all network traffic that arrives in both the wireless and connected Ethernet ports; including all global network traffic (Figure 1). This mode will work in most wireless applications of the Horizon to wirelessly connect two or more remote Ethernet devices or networks. The Ethernet bridge mode is also used in repeating (Figure 2) and in self-healing Mesh networks (Figure 3) for fixed (non-mobile) applications.

Example Applications

- Building to building remote wireless LAN networks
- Point to point wireless Ethernet communication devices
- Multi-point wireless Ethernet networks
- Remote Supervisory Control and Data Acquisition (SCADA) networks
- Redundant, self-healing Mesh networks
- Fixed locations with mobile ESTeem Horizon's

Applications Where Ethernet Bridge Mode Not Used

- Mobile applications (see Mobile Clients)
- Connections to large Ethernet traffic networks such as large office buildings or plant networks (see Router modes)

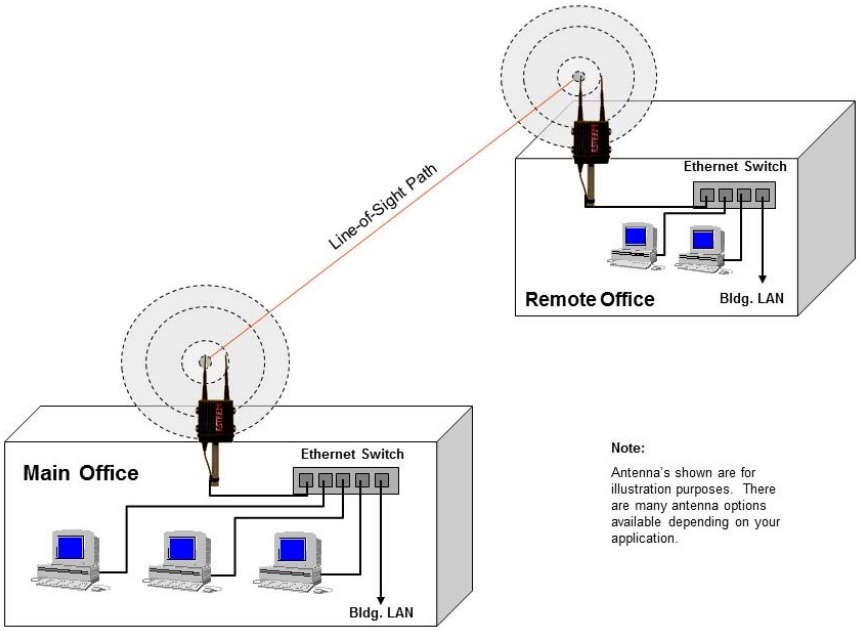


Figure 1: Point to Point Example

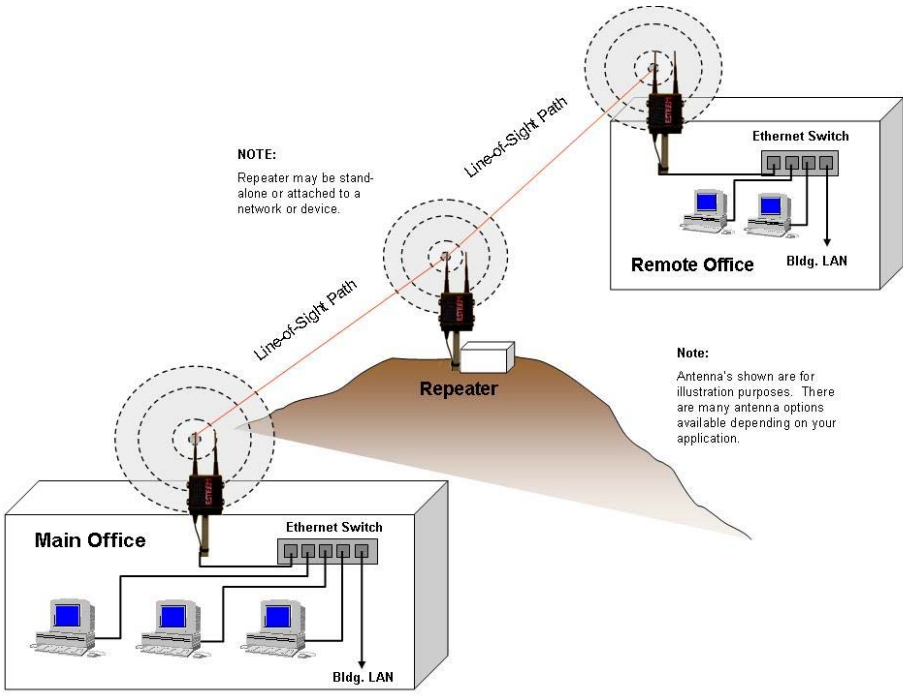


Figure 2: Ethernet Bridge with Repeater

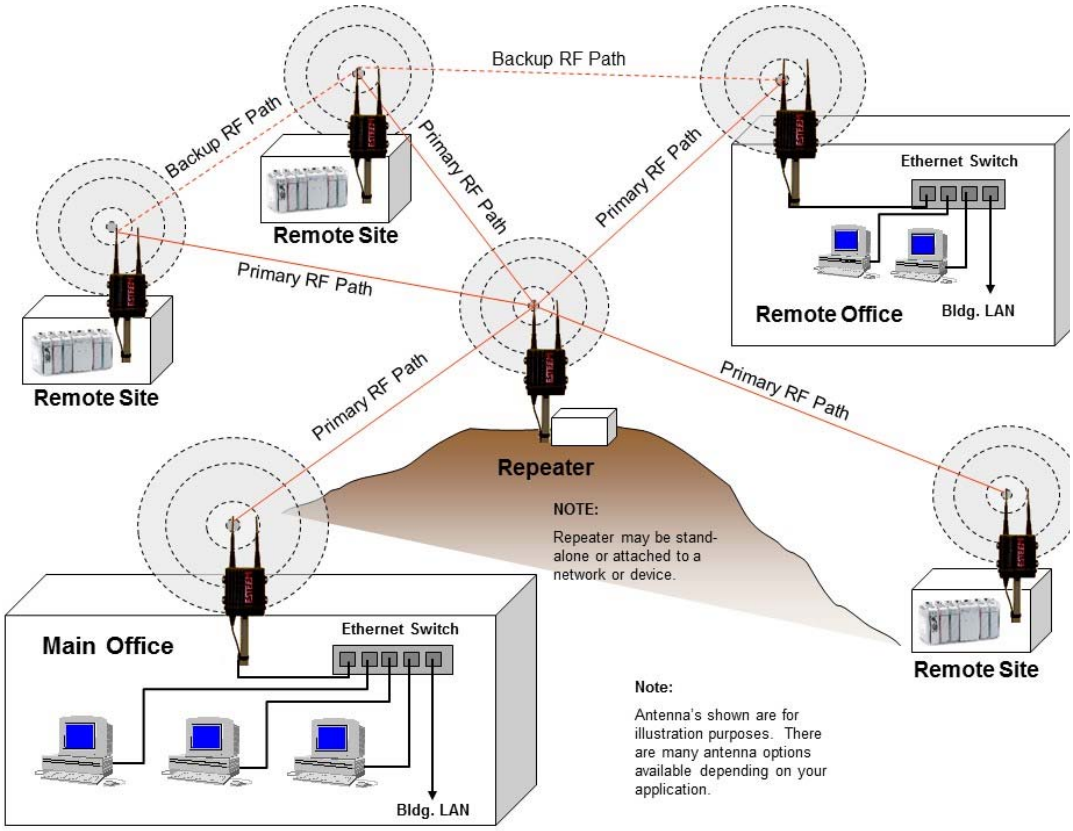


Figure 3: Multipoint Bridge with Mesh Networking

Router Modes (AP Router and AP Masquerade)

The ESTeem Horizon can be configured as a network router or network firewall between the Ethernet LAN connection and the wireless network of remote locations. The router modes are used to limit the network traffic from a busy Ethernet network connection to only those specific IP address used on the wireless network (see Figure 4). The Ethernet router mode (AP Router) will allow bi-directional communication from the Ethernet LAN connection to the wireless network. The Ethernet firewall mode (AP Masquerade) will allow Ethernet devices in the wireless network to request information from the Ethernet LAN network and receive a response, but no traffic can be generated from the Ethernet LAN side.

Example Applications

- Wireless Ethernet networks connected to large company or plant Ethernet LAN networks (AP Router)
- Wireless Ethernet networks with a requirement for network isolation from the plant or company network (AP Router)
- Shared Ethernet connection to direct Internet service (DSL, Cable, T1, etc.) (AP Masquerade)

Applications Where Ethernet Router Mode Not Used

- Mobile applications (see Mobile Clients)
- Simple network connections only using a single IP network subnet (see Ethernet Bridge modes)

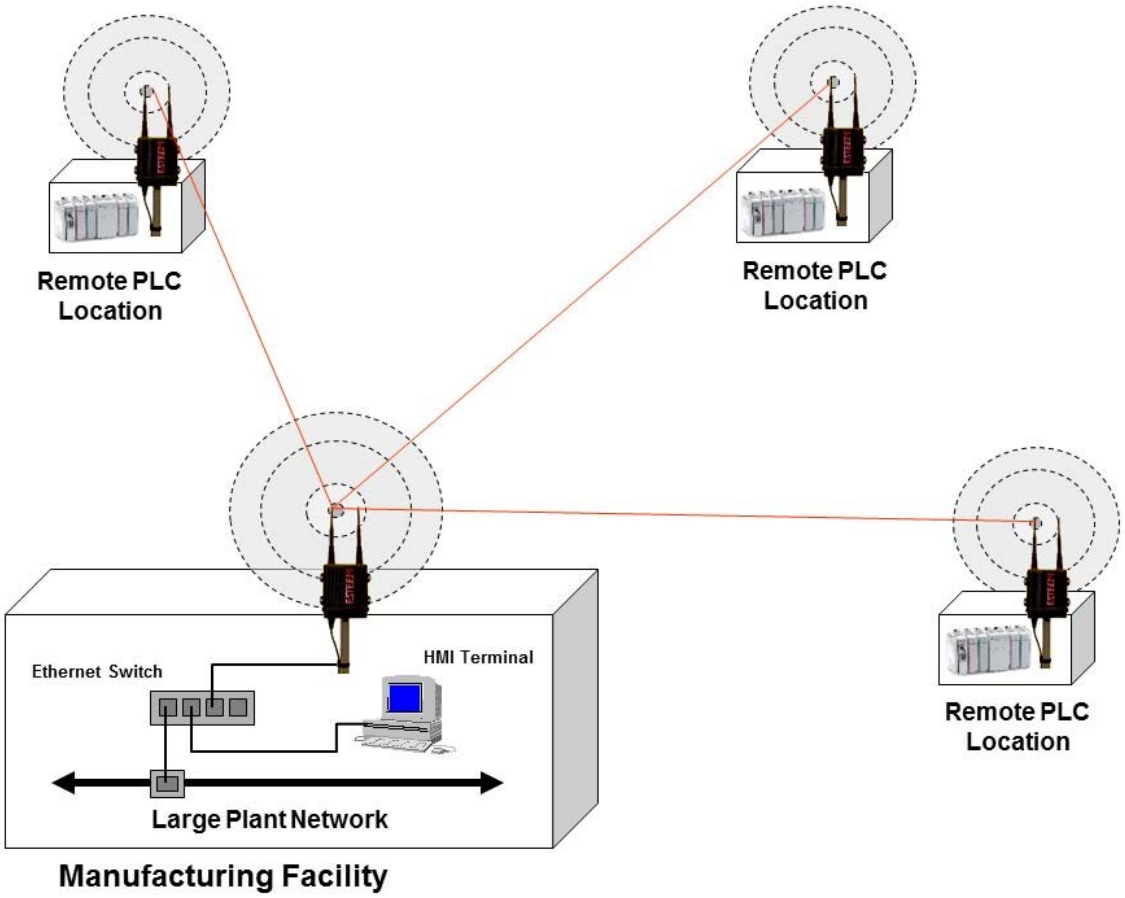


Figure 4: Router Mode Example

Mobile Client Modes (Station Bridge, EtherStation, Station Router or Station Masquerade)

The ESTeem Horizon can also be configured to function as a mobile client. The client modes allow the Horizon to seamlessly roam between fixed Access Points. These Access Points can either be ESTeem Horizon wireless modems configured in one of the three Access Point modes (AP Bridge, AP Router or AP Masquerade – see above). The client modes will allow mobile Ethernet devices to connect to each other or to an Ethernet LAN through the fixed AP (Figure 5).

If you are connecting the Horizon to multiple Ethernet devices in a mobile mode, most commonly the Station Bridge modem will be used. The Station Bridge will allow bi-directional communication between the Ethernet devices connected to the Horizon and the wireless network for all packet types including global and broadcast packets. Station Router or Station Masquerade will also support multiple Ethernet devices but will help limit the Ethernet traffic on the mobile network as required. The EtherStation mode is used to connect a single Ethernet device to the ESTeem Horizon.

Example Applications

- Mobile applications where the Horizon will change links often between fixed Access Points
- Long range mobile client networks
- Public safety applications for police, fire and EMS

Applications Where Mobile Client Mode Not Used

- Fixed locations using Ethernet Bridging or Routing
- Wireless Ethernet networks with repeaters

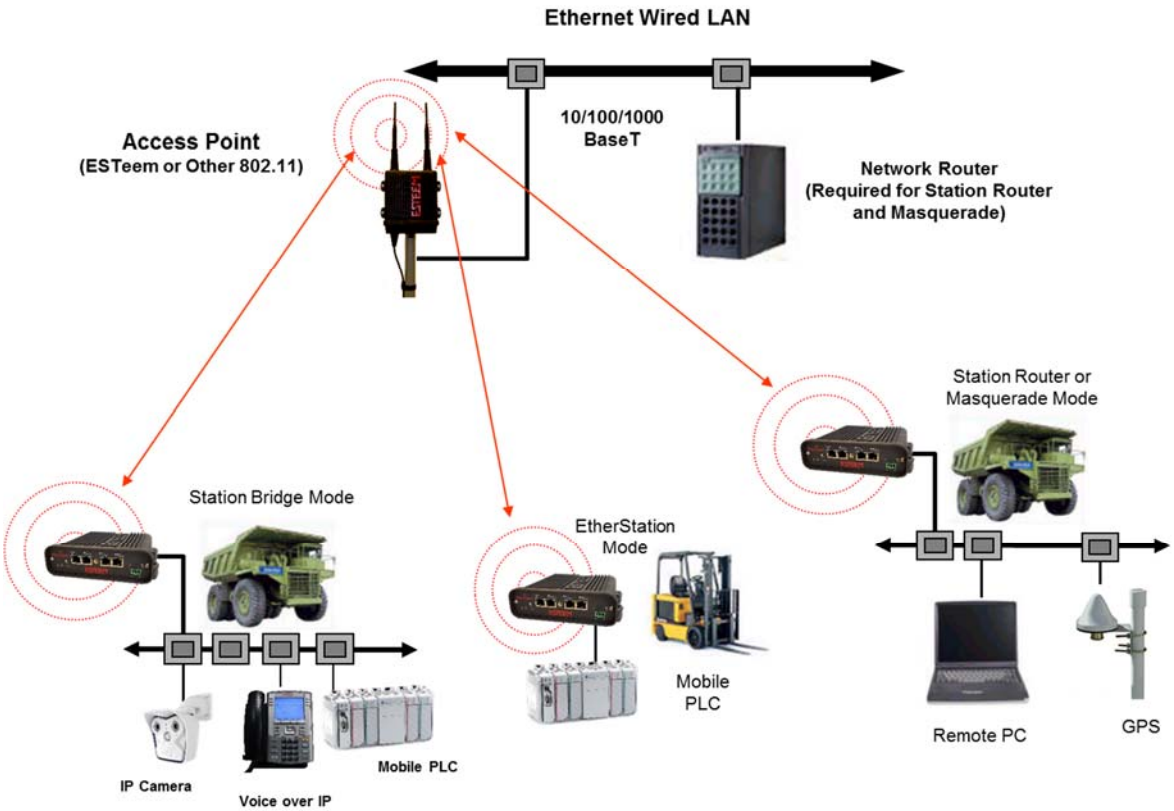


Figure 5: Mobile Client Mode Example

WiFi 802.11 Access Point Modes (Horizon 2.4 and Horizon 5.8 Only)

The ESTeem Horizon 2.4 GHz and Horizon 5.8 GHz can be configured as a high power 802.11 Access Point (AP). The IEEE 802.11n/g/b Access Point (AP) functionality is available in all three of the Access Point modes (AP Bridge, AP Router or AP Masquerade). The Access Point mode will provide either a single wireless connection (Figure 6) or overlapping coverage (Figure 7) to create a "canopy" of wireless coverage for 802.11 devices. The ESTeem Horizon in AP mode can function as both an Ethernet bridge or router and 802.11 AP simultaneously (Figure 8).

There is a new feature in the Horizon series called the Dual Network SSID. This feature will give the Horizon a second SSID, separate wireless network and use a unique Ethernet port for each network. This feature can be used for having an isolated control system and WiFi access within a single Horizon radio network by steering each to a unique Ethernet interface. See Chapter 7 for complete details and instructions.

Example Applications

- Industrial, long range 802.11 (Wi-Fi) networks
- Hybrid networks of Ethernet bridging/routing and mobile client access

Applications Where Access Point (AP) Mode Not Used

- Mobile applications

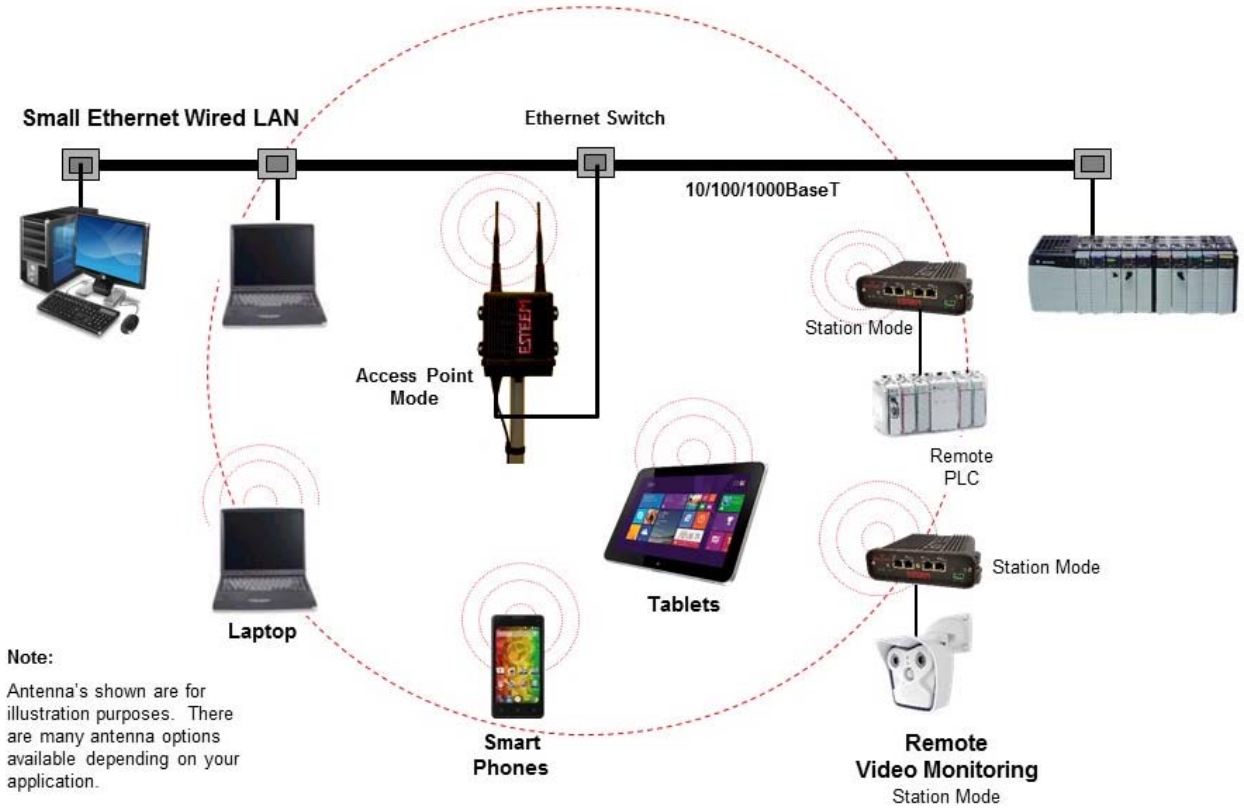


Figure 6: Single Access Point Network

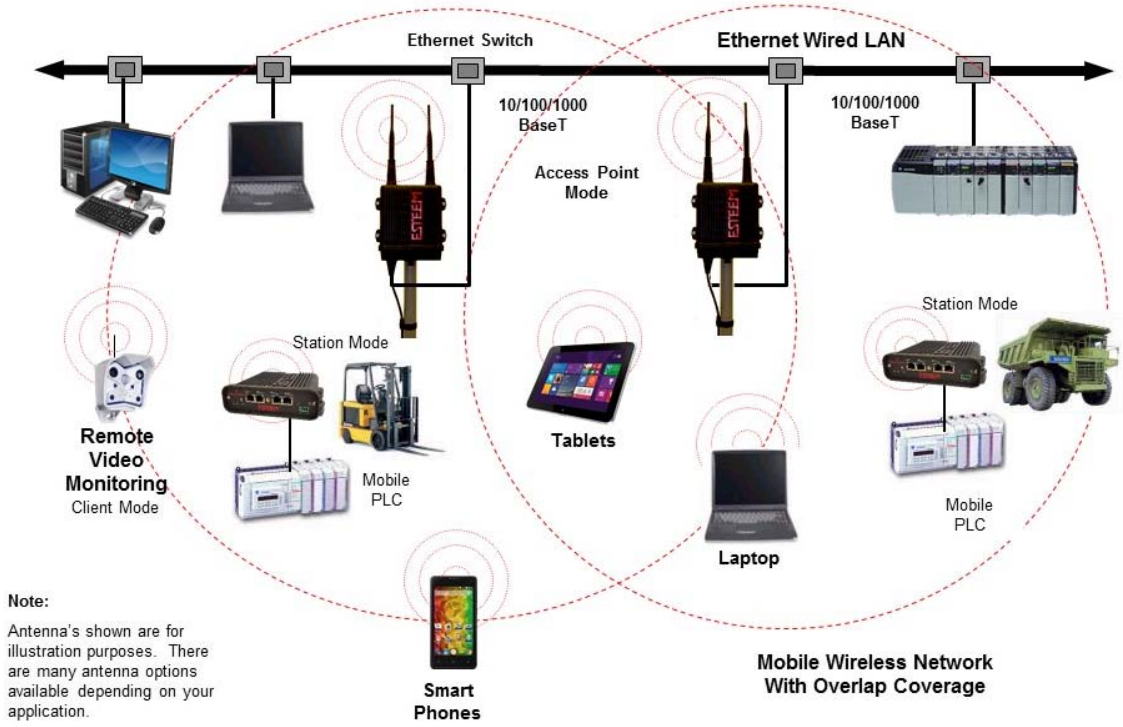


Figure 7: Overlapping Access Point Coverage

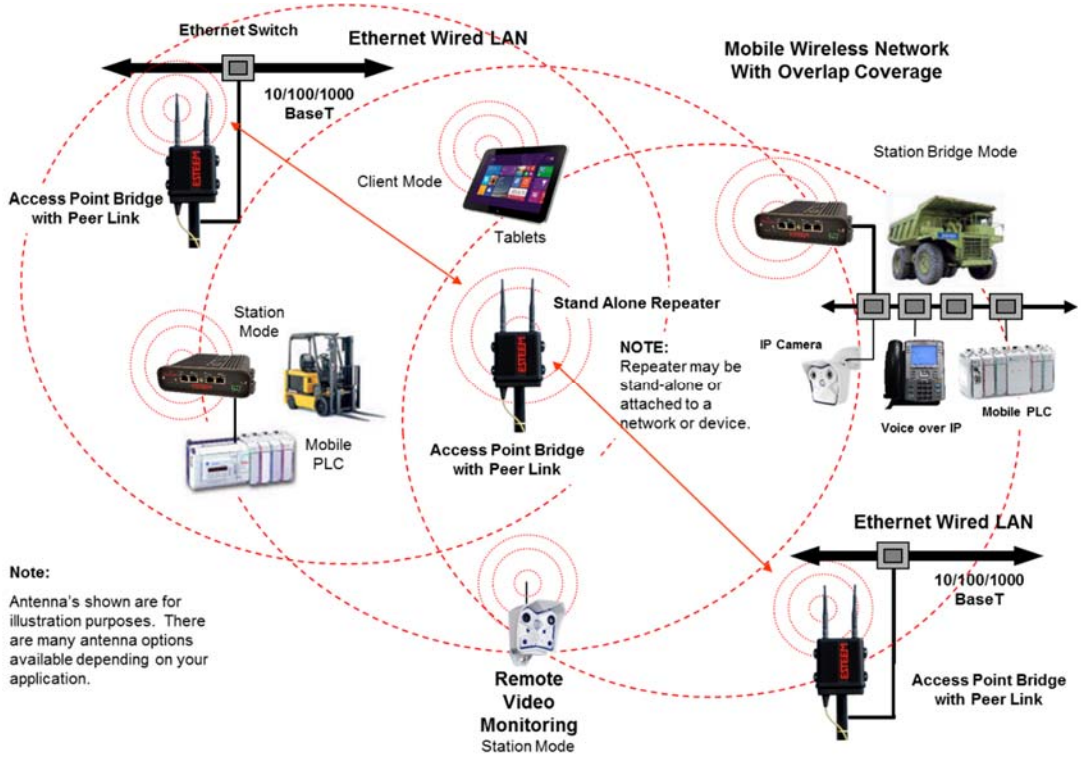


Figure 8: Access Point and Ethernet Bridge

PROGRAMMING EXAMPLES

Once the mode of operation for the ESTeem has been determined, you are now ready to program the Horizon for use. The Horizon radios will be programmed through the internal web browser accessed by the IP address for each radio. The default IP address programmed in each Horizon radio is listed on the Quality Assurance (QA) sheet in the following format:

Default IP Address = 172.16.8.1xx (where xx is the last two digits of the serial number)
Default IP Subnet = Class B Net Mask (255.255.0.0)
Example = Horizon serial number Z-25673 would have the default IP address of 172.16.8.173

Enter the IP address of the Horizon to program in the address line of the browser or use the Discovery Utility (see Chapter 5 for details) to change the IP to match the computer's IP subnet. The following examples will use the default IP addresses assigned at the factory.

Ethernet Bridge Mode Example 1 (Figure 9)

Point to Point Ethernet Bridge

(2) ESTeem Horizon 2.4 GHz
Serial Numbers: Z-25673 (Main Office) and Z-25674 (Remote Office)

Main Office

1. Open the Horizon 2.4 GHz web configuration manager by either selecting "Configure Radio" from the Discovery Utility or typing the IP address in the address line of the web browser.

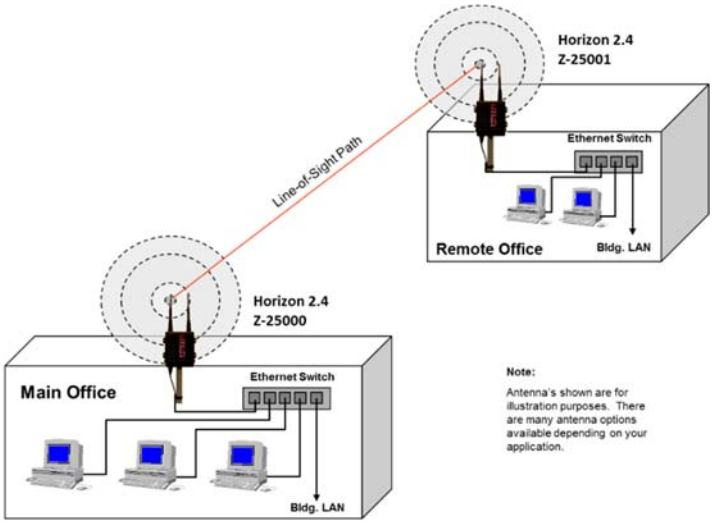


Figure 9: Point to Point Ethernet Bridge Example

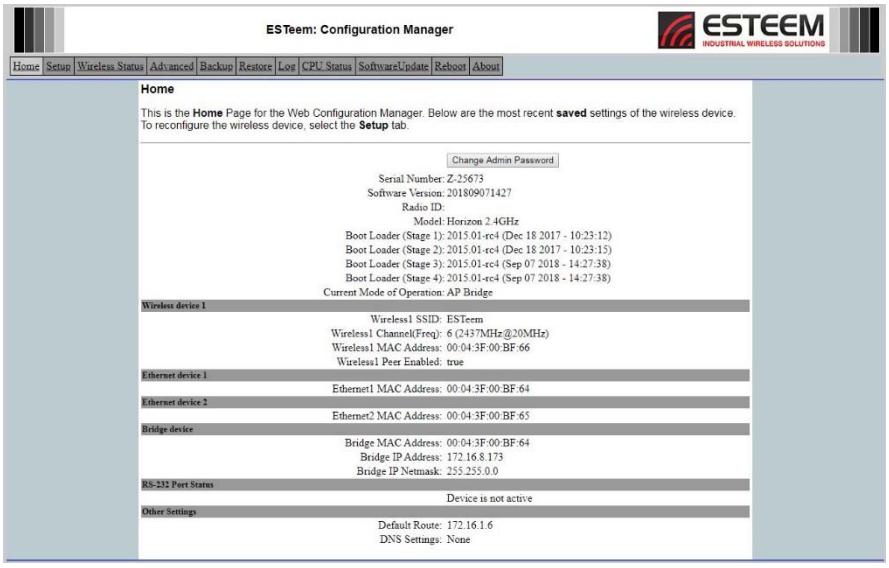


Figure 10: Horizon Home Page

2. If this is the first configuration of the radio, enter the default Username “admin” and Password which is the Serial Number of the radio. Press the Enter key or the “Log in” button on the browser to open the Home page of the radio (Figure 10).

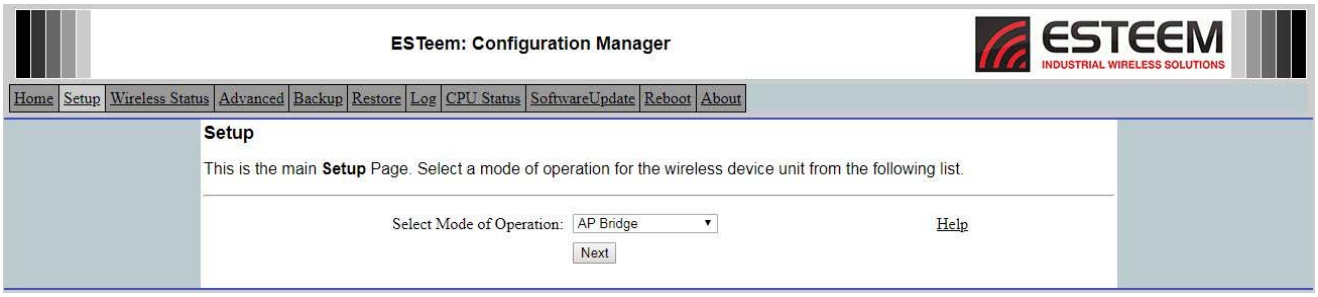


Figure 11: Mode of Operation

3. Select the Setup tab from the menu. This first menu will set the mode of operation for the Horizon radio. For this example, use the drop-down arrow and select AP Bridge (Figure 11). Press the “Next” button to continue.
4. This next screen (Figure 12) sets the DHCP setting for the Ethernet port on the radio. The Ethernet port on the Horizon radio can be configured as either a DHCP client or server as required. The root bridge will be used when Mesh configuration is added to the network (see Chapter 7). To use a fixed IP address, as in this example, select the Off radial and press the “Next” button to continue.

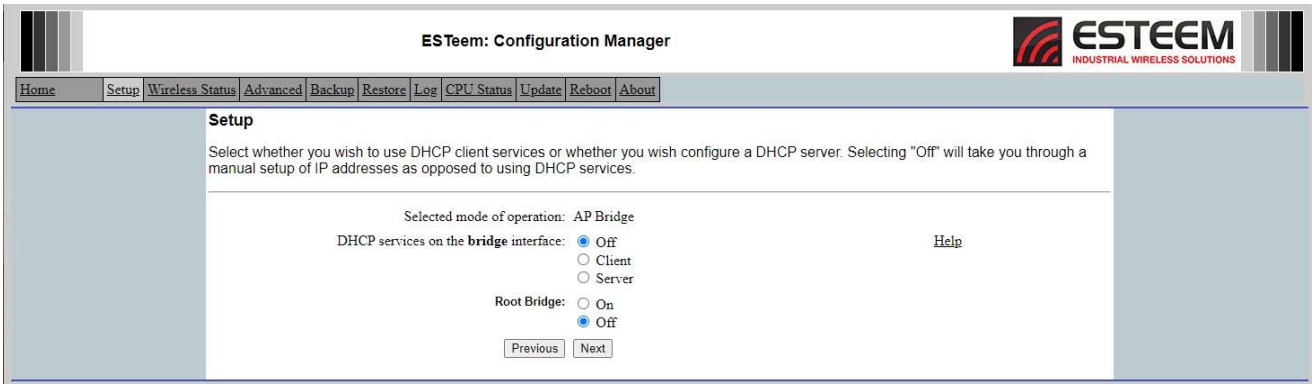


Figure 12: DHCP Settings

5. Enter the IP address, IP Netmask and default route IP (gateway) address for the radio being programmed (Figure 13). Press the “Next” button to proceed.

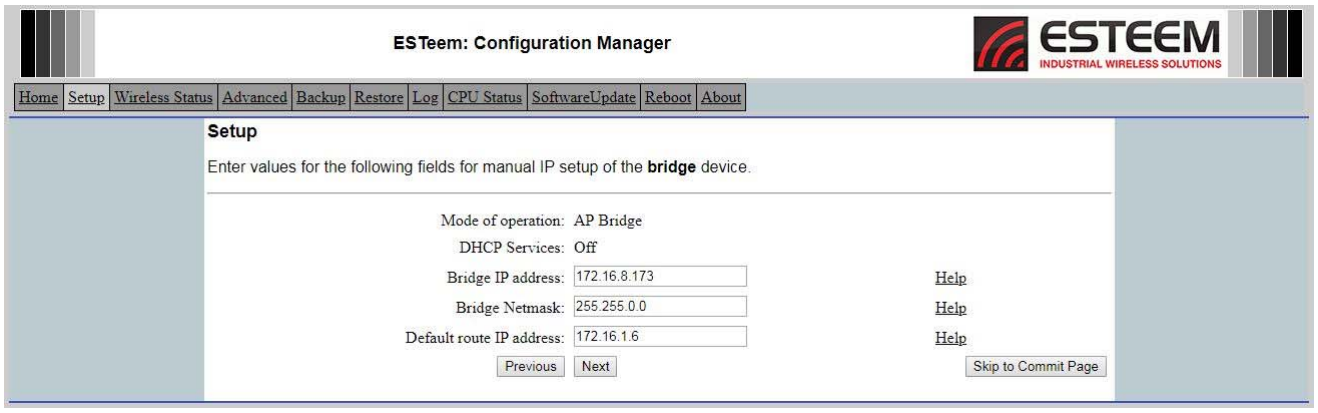


Figure 13: IP Addressing

6. The next screen is the configuration for the RF Channel Bandwidth and setting the maximum distance (Figure 14). The RF channel bandwidth is how wide a frequency channel the Horizon radio will operate. Changes to the channel bandwidth will affect RF data rates and compatibility with WiFi or older radio series. All radios in the same network must use the same bandwidth. Set the maximum (max) distance setting to the furthest wireless link with which the Horizon being programmed

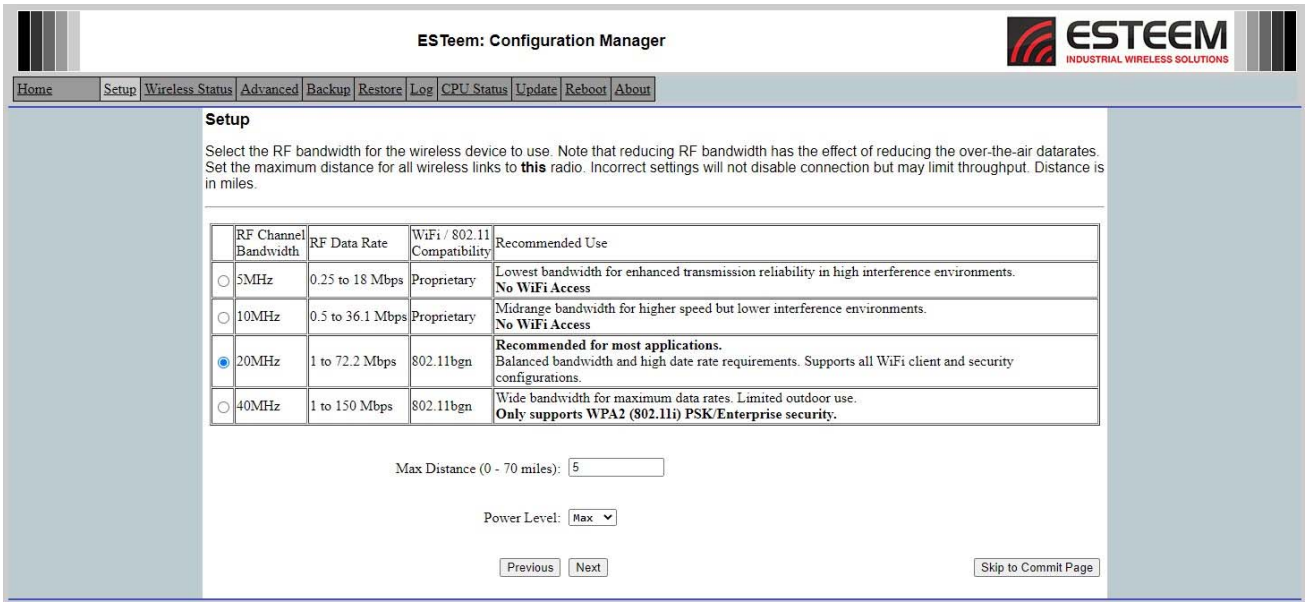


Figure 14: RF Channel Bandwidth

will communicate. If there are more than one remote radio connections, set the max distance to the furthest radio link. Press the "Next" button to proceed.

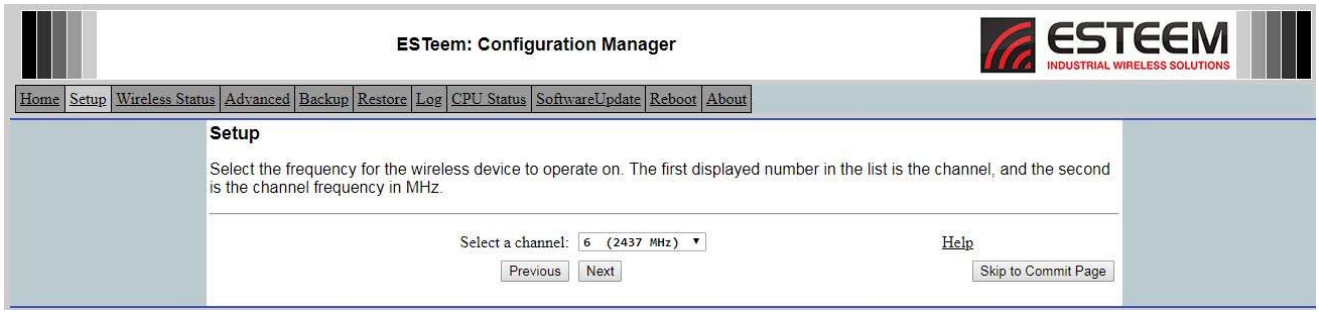


Figure 15: RF Frequency Channel

7. Select the radio frequency channel for operation. All radios in the same network must use the same frequency channel. For this example, Channel 6 (2.437 GHz) is selected (Figure 15). Press the "Next" button to proceed.

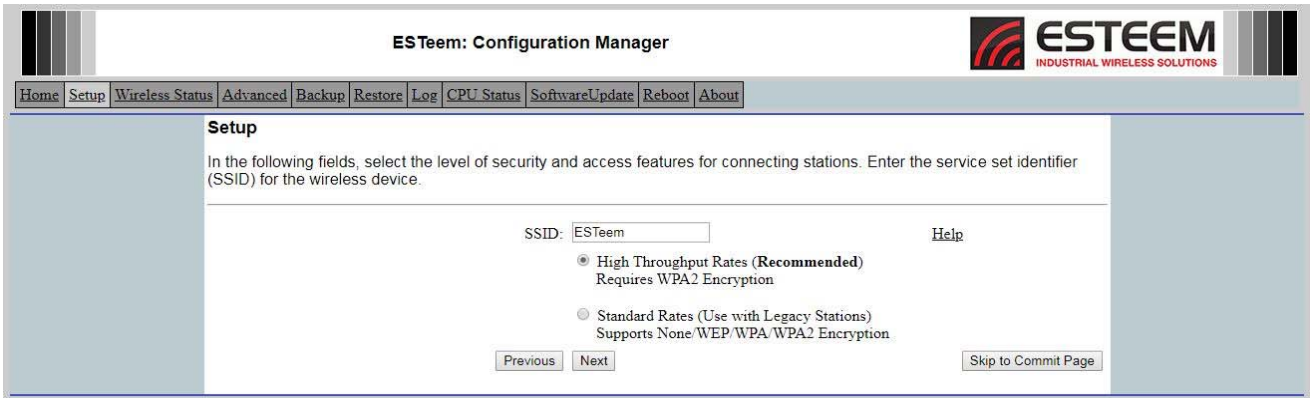


Figure 16: SSID

8. The next screen (Figure 16) will set the SSID (network name) and Encryption level for mobile devices connecting to the Horizon radio as an Access Point (AP). Even if there are no mobile devices in the network, the AP configuration must be completed. The SSID can be any letter and number combination up to 32 characters and is case sensitive. The recommendation is to use the High Throughput Rates for mobile clients. If older ESTeem models or WiFi clients must be supported, select the Standard Rates. Press the "Next" button to proceed.

9. If High Throughput Rates was selected on the previous screen, Figure 17 will be displayed. Select the appropriate level of encryption for the mobile clients (see Appendix D – Security for full details) using either Pre-Shared Key (PSK) or Enterprise. The Protected Management Frames is a new feature available for WPA2 client devices and must match both the client and

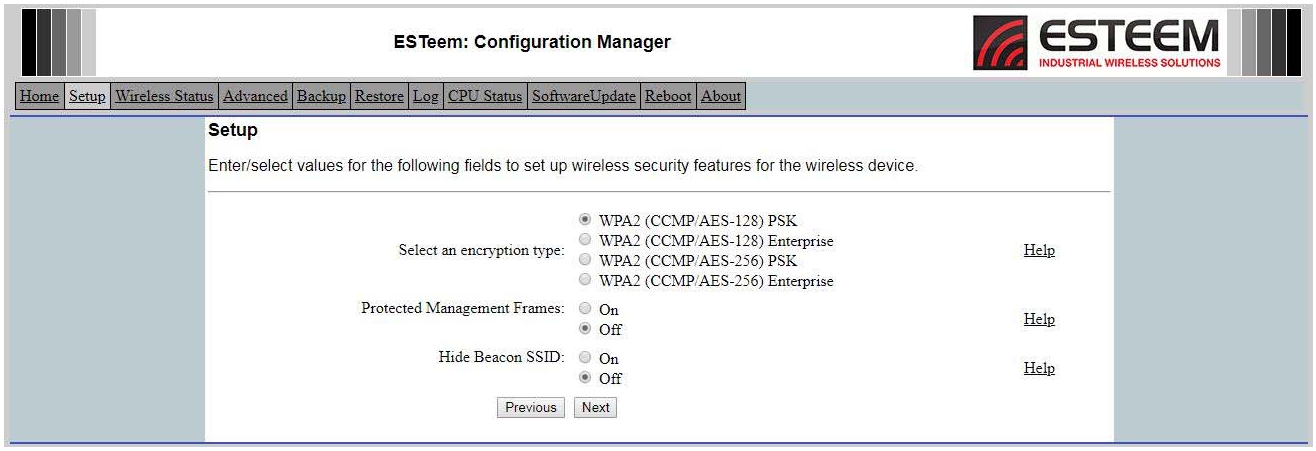


Figure 17: AP Encryption Level

AP (either ON or OFF). The Hide Beacon SSID will keep the Horizon radio from broadcasting its own SSID to mobile devices. For this example, mobile clients will not be used so all setting will be left at default. Press the "Next" button to proceed.

10. If using the default setting of PSK from the previous screen, the passphrase entry will be displayed (Figure 18). For security, the default passphrase will be unique for each radio. The passphrase is used to generate an encryption key on both the AP and client device and must be entered exactly the same. For this example, mobile clients will not be used so all setting will be left at default. Press the "Next" button to proceed.

Figure 18: Passphrase Entry

11. The Access Control List (ACL) configuration is the next screen (Figure 19). This is last AP configuration screen for the Horizon and will be left at default for this example. The ACL is a very powerful tool by allowing (or denying) specific mobile clients to connect to the Horizon as an AP. The mobile client's unique MAC address can be entered in the list and then set to allow (or deny) only those in the list. This configuration will only affect mobile clients, so it is not required to enter any Horizon radio

Technical Tip: To disable **ALL** mobile client access including WiFi clients, set the ACL to "allow only those station MAC s in the list below" and leave the list blank. The Horizon will then reject all client requests.

in the network configured as an AP. For this example, mobile clients will not be used so all setting will be left at default. Press the "Next" button to proceed.

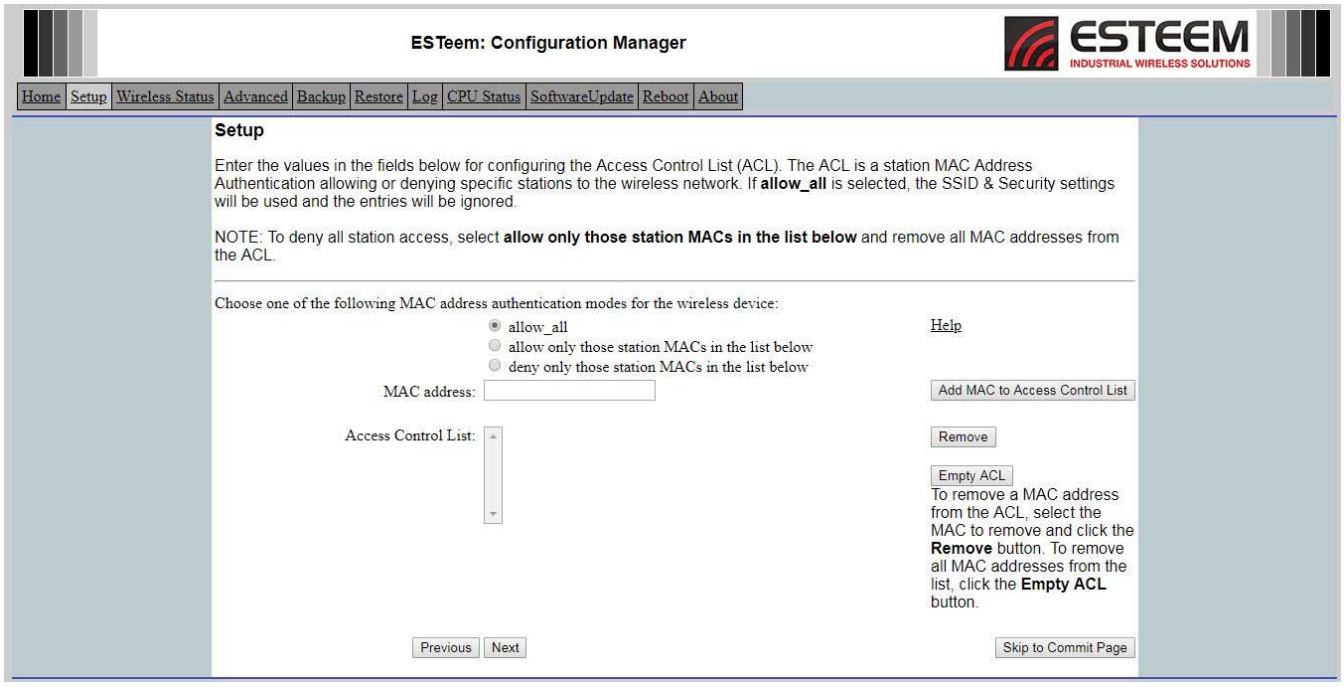


Figure 19: Access Control List

12. The next screen to be displayed will be the Peer Configuration (Figure 20). Most applications with the Horizon radios will be between fixed (non-mobile) stations configured as Access Points (Bridge, Router or Firewall). The peer configuration will create a wireless link between Horizon radios configured as AP's. This example application is to create a wireless Ethernet bridge between two (2) Horizon 2.4 GHz radios both configured in AP Bridge mode. Each radio will be a "peer" of the other. The peer capability must be enabled and for this example application, the Main Office will enter the Remote Office's Horizon as a peer link. Press the "Add" button on the right of the screen to proceed.

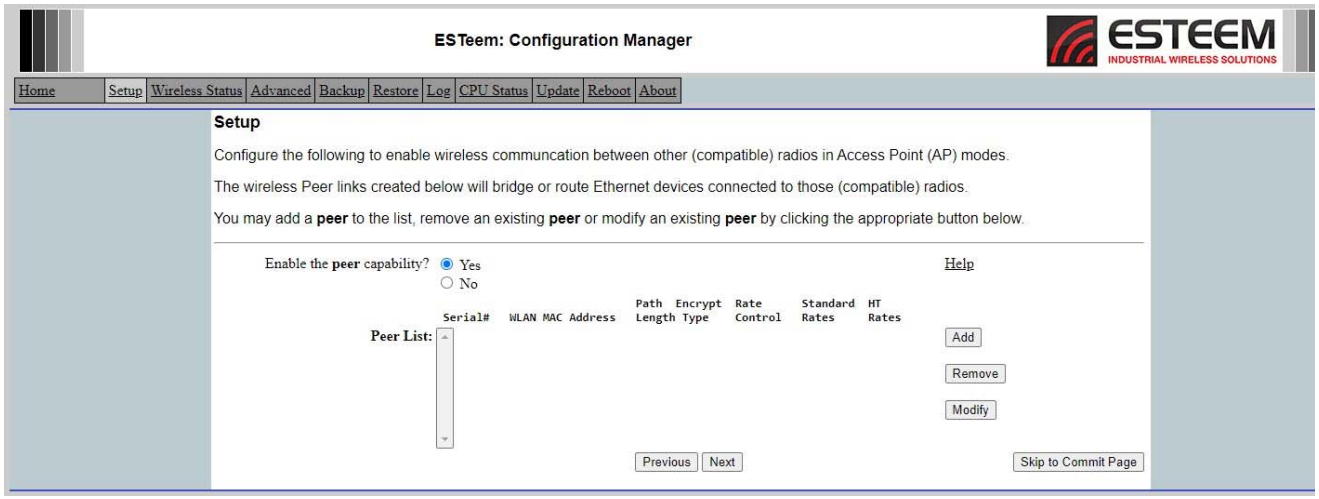


Figure 20: Peer Configuration

13. The peer entry screen will be displayed (Figure 21). From this page all setting for this peer link can be adjusted. The serial number or wireless MAC (WLAN MAC) of the opposite Horizon will be entered in the first field. The serial number can be either the complete number containing the "Z-" (i.e. Z-25674) or just the numbers as shown in Figure 21. The path length will only need adjustment in certain cases in a Mesh network (see Chapter 7 – Bridge/Meshing for full details). The Rate Control will need to be set to Horizon as the remote is also a Horizon series radio (not a legacy ESTeem 195E radio). The encryption type and key must be identical on both sides of the peer link. The Encryption key can be manually entered or generated by using a Link ID and Passphrase, which must be the same on both radios. For this example, the default key will be used so press the "Default Key" button and the "Create Peer" button to continue.

> ***Technical Tip:*** If the WLAN MAC address is entered in the peer field, the hexadecimal digits must be separated by full colons. Example – 00:04:3f:01:02:03

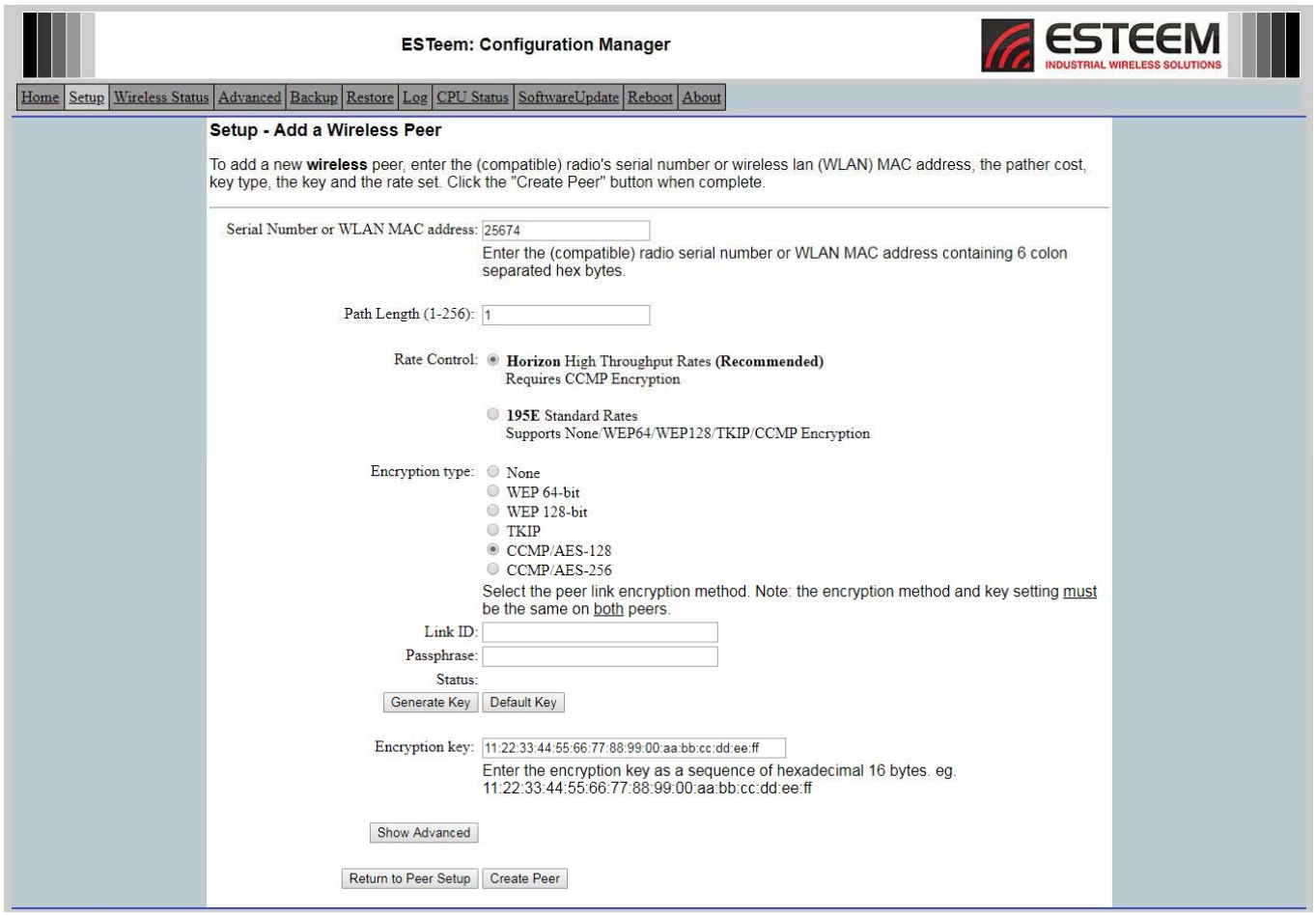


Figure 21: Peer Configuration

14. The main Peer Configuration screen will again be displayed but will now contain an entry Horizon radio peer created in step 13 (Figure 22). If more than one peer is required, press the "Add" button and complete the entry for each peer connection. Only radios directly connected (not mobile devices or other radios through repeater sites) to the Horizon will need to be entered in the peer list. Press the "Next" button to proceed.

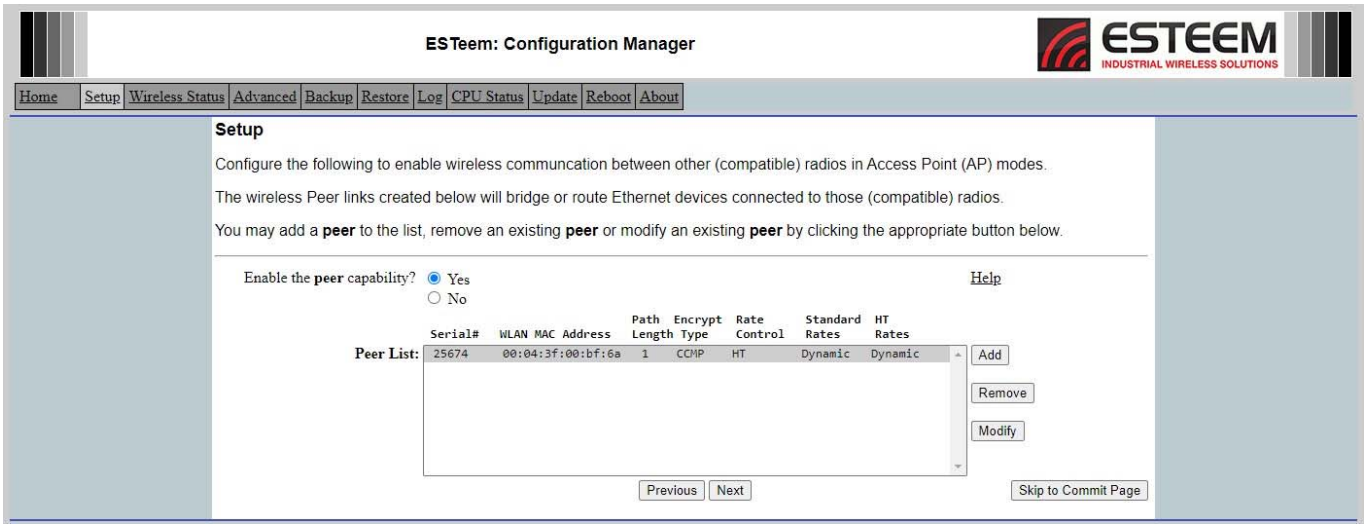


Figure 22: Completed Peer Entry

15. The final configuration page will be displayed (Figure 23). The Radio ID is a simple text name for the radio that will help identify it in the larger network. The Discovery Tools and Remote Assistance can be disabled if required for security. Once all entries and selections have been made, press the "Commit Changes" button to complete the programming of the Horizon. The radio will reboot and be ready for operation in approximately 45 seconds.

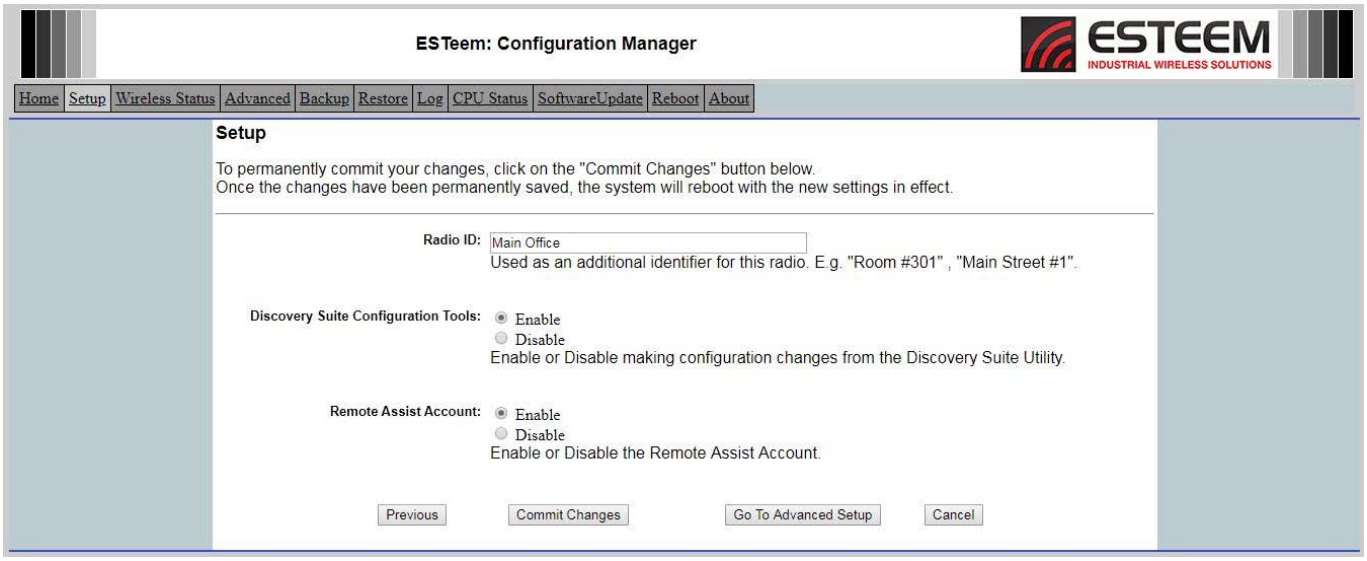


Figure 23: Completed Peer Entry

Remote Office

The configuration of the Horizon for the Remote Office will be almost identical to the configuration for the Main Office. Only a unique Bridge IP address will be entered on Step #5 and the Peer configuration screen for the Remote Office Horizon radio will contain the serial number of the Main Office (Figure 24).

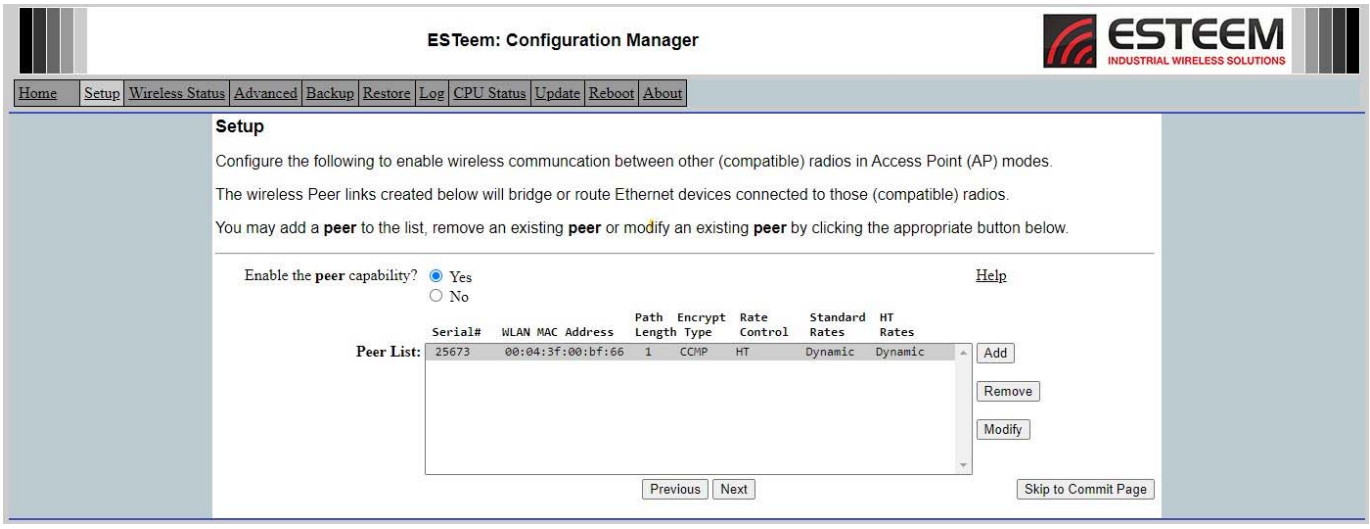


Figure 24: Remote Office Peer Configuration

Once both Horizon radios have been programmed and finished rebooting, the Peer link and the Ethernet bridge link will be enabled. The Status LED on the face of both Horizon radios will illuminate and Ethernet devices can be accessed across the radios. For detailed analysis on the radio connection, consult Appendix F – Troubleshooting for full details.

Point to Point with Repeater Ethernet Bridge

(3) ESTeem Horizon 2.4 GHz
Serial Numbers:
Z-25673 (Main Office)
Z-25674 (Remote Office)
Z-25675 (Repeater)

Building on the point to point Ethernet Bridge example above, adding a repeater to the wireless network is simple as changing the Peer configuration to include the Horizon radio used as a repeater. All three radios in this example will be configured in AP Bridge mode.

Using the above procedure for point to point configuration, program each radio in the network as described with the following changes to the Peer configuration in each radio:

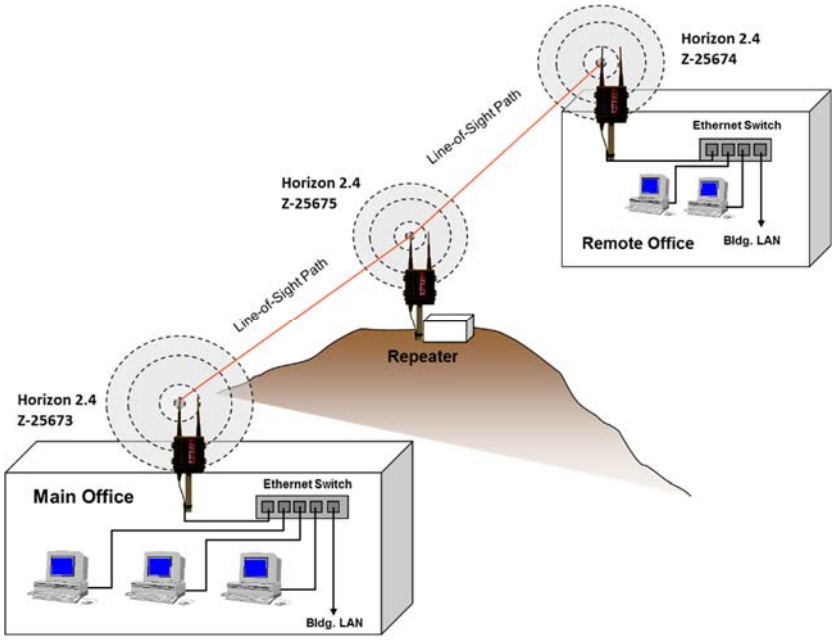


Figure 25: Point to Point Ethernet Bridge with Repeater Example

Main Office

The main office's Peer will be the Horizon radio at the repeater site (Z-25675) and configured as the network's Root Bridge. Typically, only a single radio in the network will be configured as the Root Bridge. Figure 26 shows the Root Bridge page configuration and Figure 27 show the completed Peer configuration for the Main Office in this example.

Technical Tip: The Peer links in the Horizon radio are configured for the **direct** radio links only. For example, in Figure 25 the Main and Remote Offices will list the Repeater as a Peer link (not each other), but the Repeater will list both the Main and Remote Offices as Peer links. Once configured, all three locations can Bridge Ethernet traffic on a single network.

Remote Office

The Remote Office's Peer will also be the Horizon radio at the repeater site (Z-25675). Figure 27 shows the completed Peer configuration for the Remote Office in this example.

Repeater

The Repeater site will have both the Main and Remote Offices as Peer connections. Figure 28 shows the completed Peer configuration for the Repeater site.

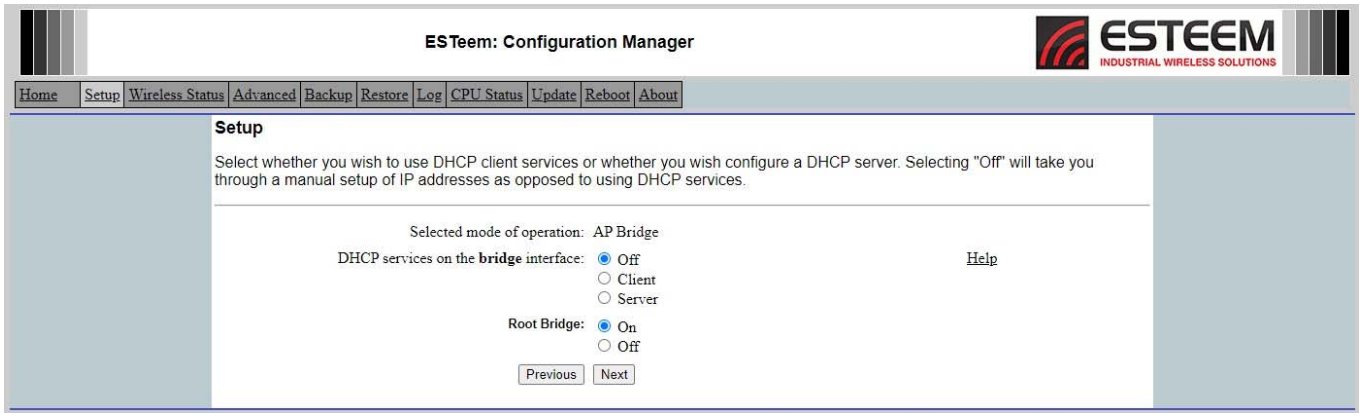


Figure 26: Main Office to Repeater Peer Configuration

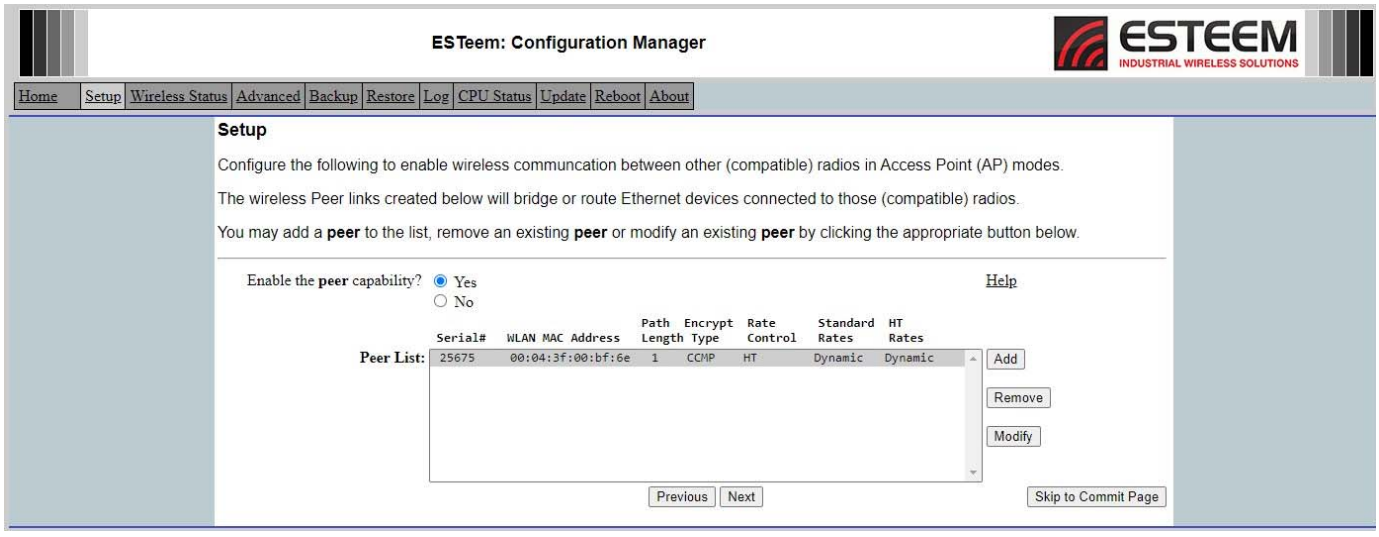


Figure 27: Remote Office to Repeater Peer Configuration

Once configured, all three radios and their attached Ethernet devices will be on a common Ethernet network.

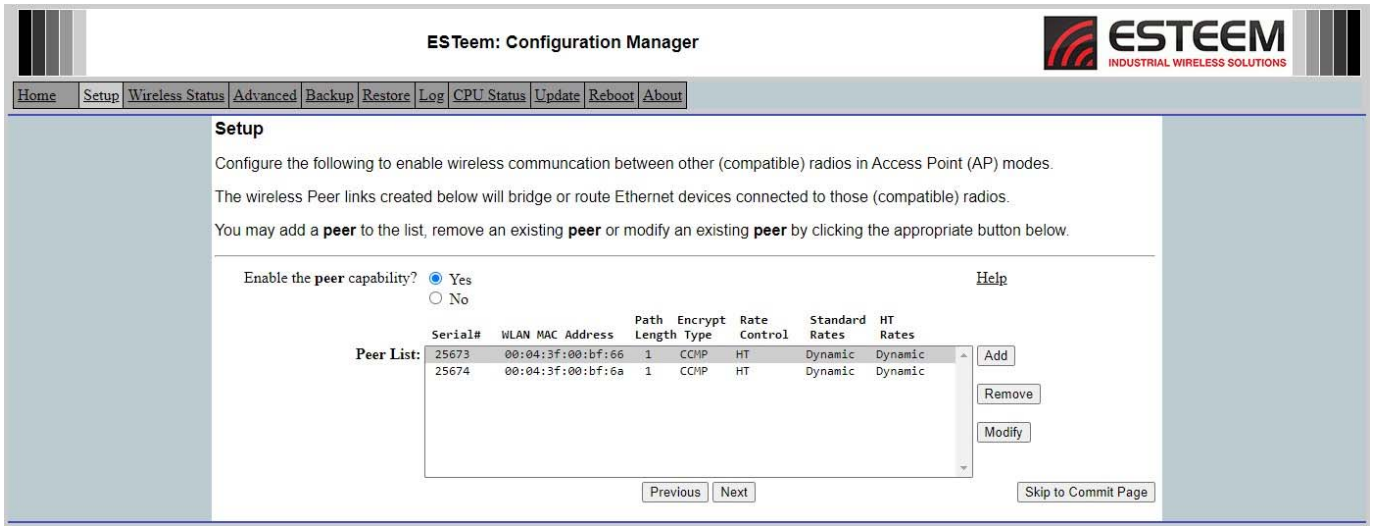


Figure 28: Repeater Site Peer Configuration

Ethernet Bridge Mode Example 3 (Figure 3)

Point to Multipoint with Mesh Repeater Links

The configuration of the Horizon radios in a multipoint Mesh network is identical as done above in a point-to-point or repeater network. Add Peer links to each Horizon for the directly connected radios in the network. For a complete description on how to configure the Horizon radios in a Mesh network, please refer to Chapter 7 – Bridging and Mesh Networking.

Ethernet Router Mode Example (Figure 4)

Point to Multipoint Router Mode

The configuration for the Horizon radios in a Router or Masquerade mode will be very similar to the point-to-point or repeater network as described above. The only difference in the configuration will be in the IP addressing. The Horizon in router/masquerade mode will ask for two IP address as the Ethernet port and wireless interface must be different IP Subnets. Each interface will be configured separately for DHCP, IP address and Gateway. The Ethernet interface will be shown as "**ethernet**" and the radio interface will be shown as "**wireless**" in the configuration menu. All other configuration pages and descriptions will be identical to the above description.

ROUTER ADDRESSING EXAMPLES

The following are examples of the IP addressing and subnets required for the ESTeem Router modes.

Point to Point Access Point Router to Station Router

Figure 28: AP Router Addressing Example

Stand-Alone Access Point Router and Single Station Router

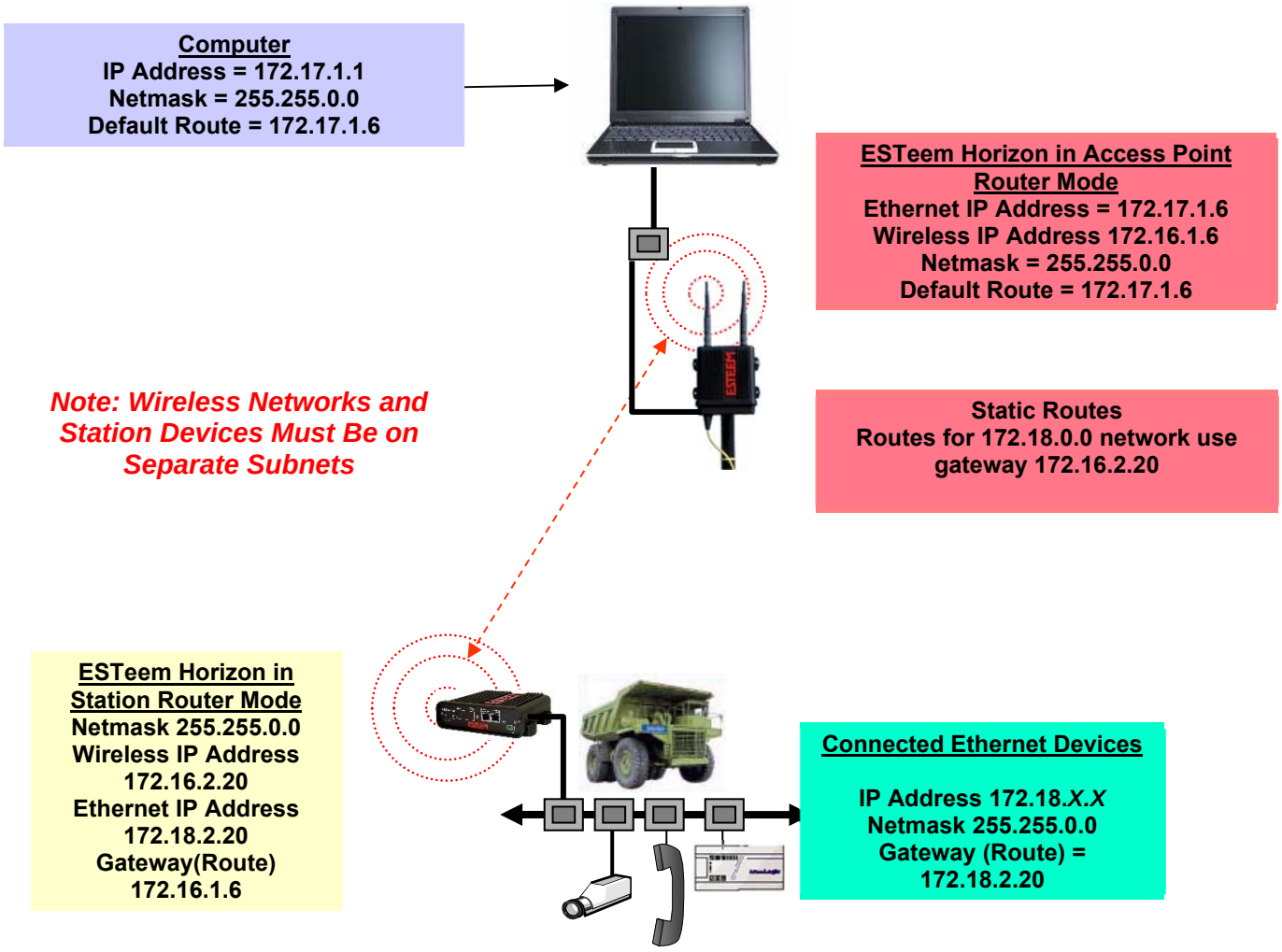


Figure 29: Station Router Addressing Example

Stand-Alone Access Point Router with Multiple Station Routers

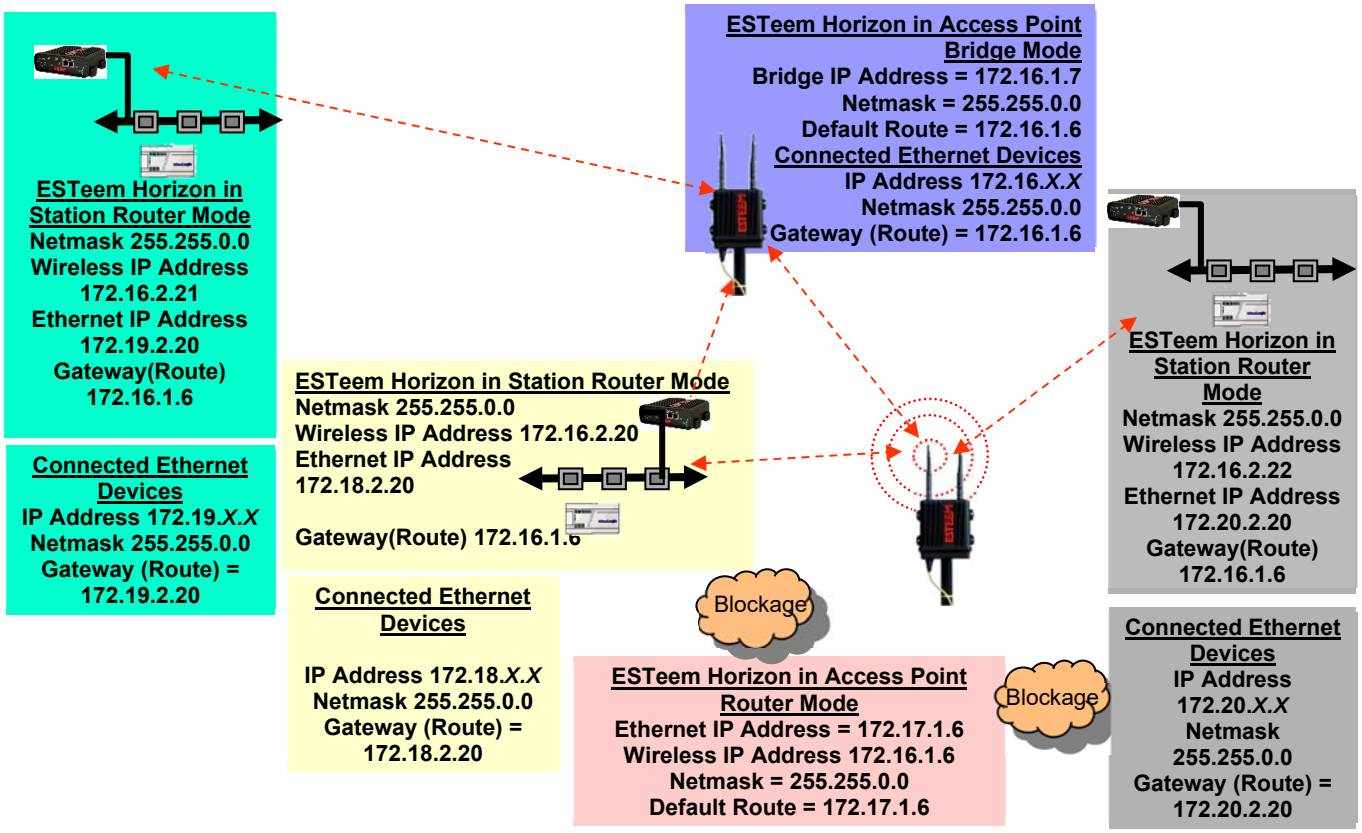


Figure 30: Complete Router Addressing Example

ESTeem Discovery Utility

The ESTeem Discovery Utility will allow you to configure the IP address on the Horizon radio to match your network regardless of its current IP subnet. This utility will also allow you to update the software in the Horizon and open the web configuration for that wireless modem.

> ***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 Horizon.

Installation

The Discovery Utility can be downloaded from the ESTeem web site (http://www.esteem.com).

1. The Discovery Utility is a Java™ based application compatible with any computer operating system (Window, Linux, Mac, etc). The application requires two (2) additional support files to operate:

   Java – Downloadable from http://www.java.com. The version required will be based upon your operating system.
   Note: The installation and updates from Java may try and install additional web browser toolbars. Uncheck the optional installation if they are not desired.
   Npcap – Downloadable from https://nmap.org/download.html. Select the latest stable version of the utility for your operating system. The Npcap free addition is supported up to Windows version 10. The version required will be based upon your operating system.

2. Once both the above programs have been installed, save the estDiscover.exe file to any location on your computer such as the Desktop. Double click the estDiscover.exe program and Figure 1 will be displayed.

Figure 1: ESTeem Discovery Utility

3. Connect the Horizon modem 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.

4. The ESTeem Horizon will be displayed (Figure 2). If the ESTeem Horizon is not on the same IP subnet as the computer, double click on the IP and/or Netmask and make the necessary changes. Press the *Apply Changes* button when complete.

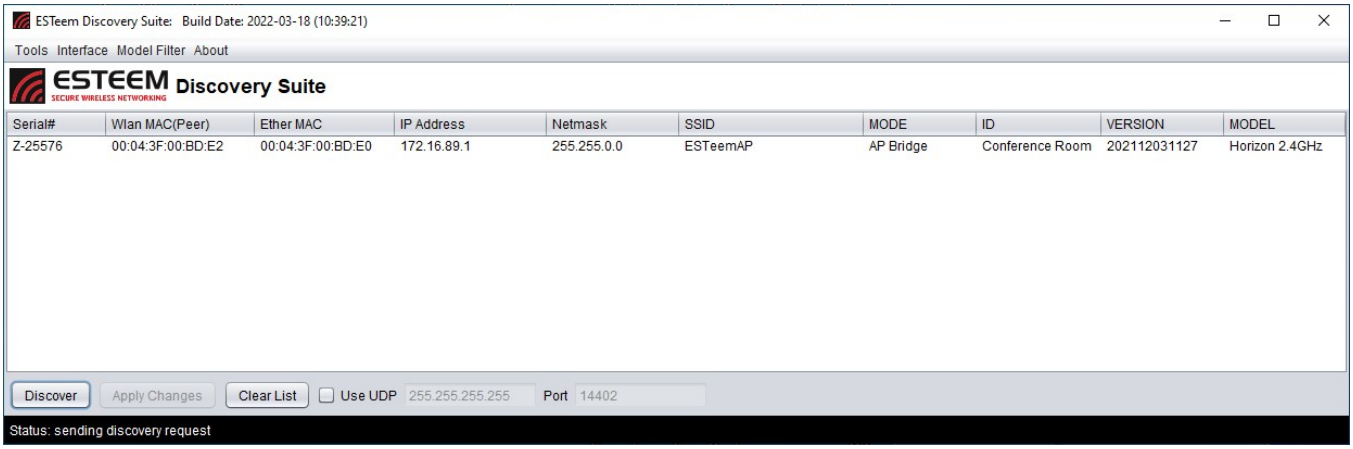


Figure 2: Horizon Found

5. 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 Horizon and select *Configure Radio* button to begin programming (Figure 3).

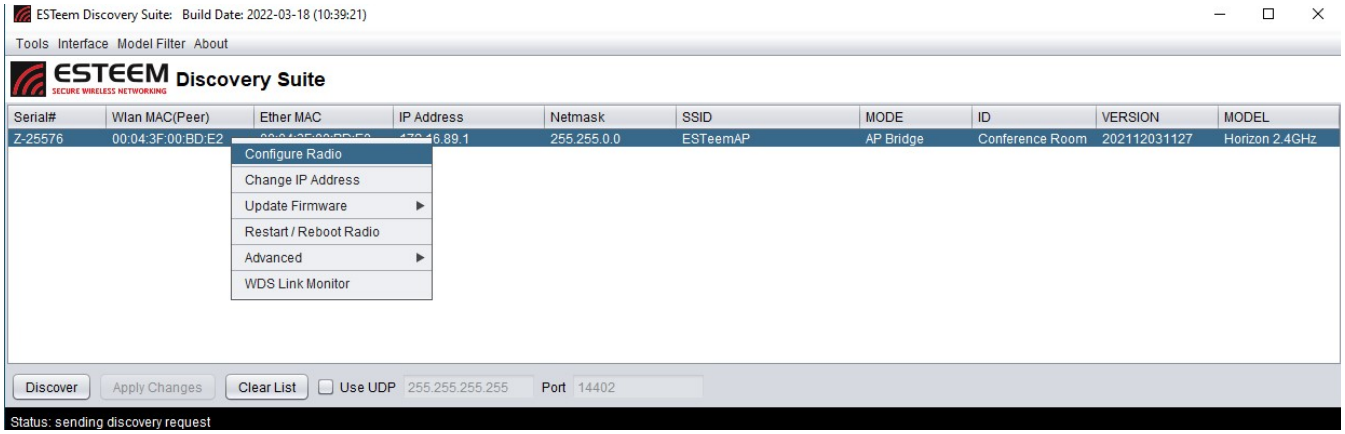


Figure 3: Opening Radio Configuration Software

Firmware Updates

To update firmware on any ESTeem Horizon that is shown on the Discovery program, "right-mouse" click on the Horizon's MAC address and select Update Firmware from the menu (Figure 4)**.** There are two firmware update options available, "Normal" and "Congestion Aware". Select Normal for most updates and use Congestion Aware when sending the update over the wireless link on a busy network. Once you locate the update file, select the Open button and the Horizon will update, validate and then reboot with the updated operating system.

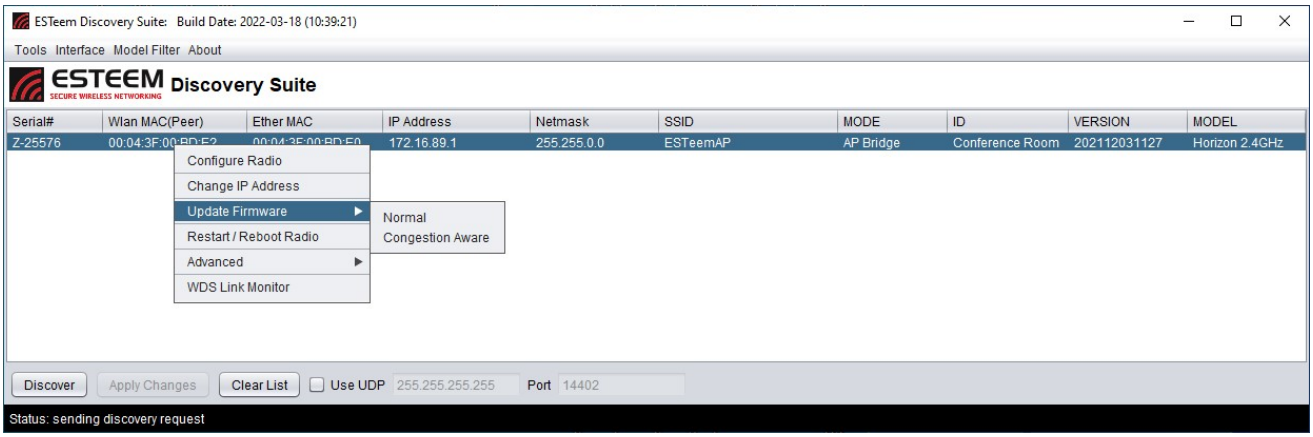


Figure 4: Discovery Features Menu

Opening Web Browser

To quickly open a web browser page to the IP address programmed in the Horizon, "right-mouse" click on the Horizon's MAC address and select Configure radio from the menu (Figure 3). If your computer is configured for the same IP subnet at the ESTeem Horizon wireless modem, you will be asked to sign in with the Username and Password (Figure 5). You can now begin programming the Horizon for your application.

Technical Tip: The default Username is "admin" (all lower case), the password is the radio's serial number.

Example
Username: admin
Password: Z-25000

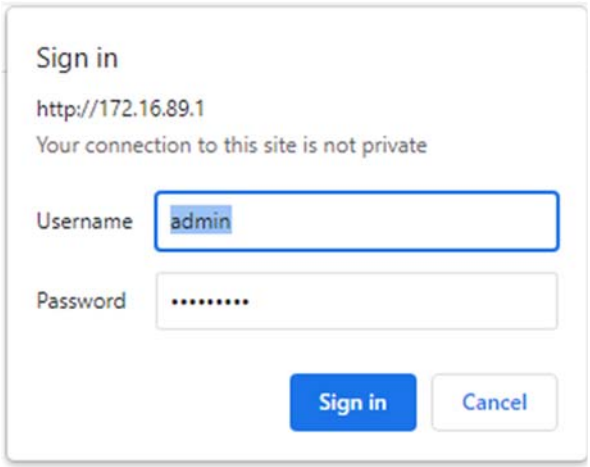


Figure 5: ESTeem Web Page Log-on Screen

SETTING LOCAL TIME

The ESTeem Horizon will be shipped from the factory with the internal real-time clock set to Pacific Time. To change the clock settings to the local time for accurate log file entries:

2. Select **Advanced** from the top Menu, select **Global Settings>Set System Time** (Figure 6) from the menu and press the Next button to continue.

3. Select the correct date and time from the drop-down menus (Figure 7) and press the Set System Time and Reboot button to save the time to the real time clock.

> ***Technical Tip:*** The "Set System Time and Reboot" option does **NOT** commit previously made changes. Be sure to use the "Commit and Reboot" option before setting the time.

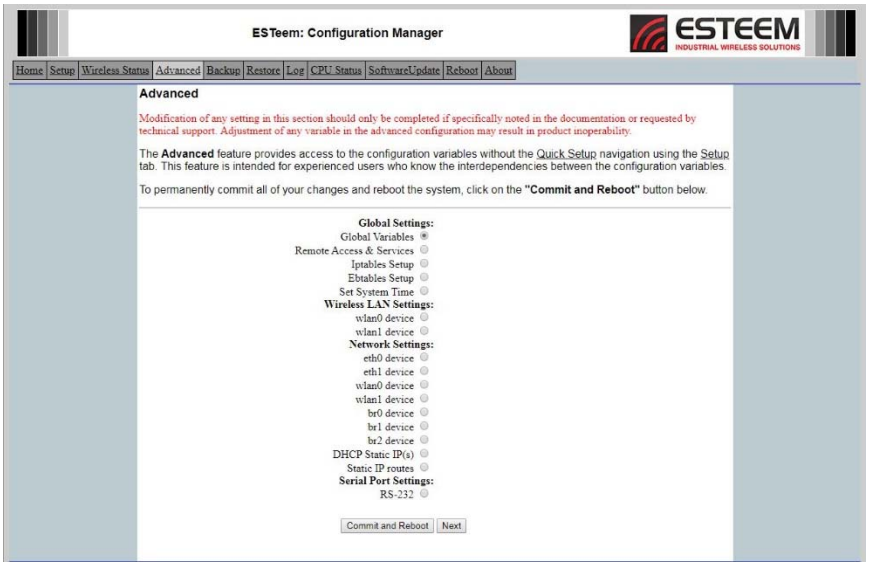


Figure 6: Advanced Features Screen

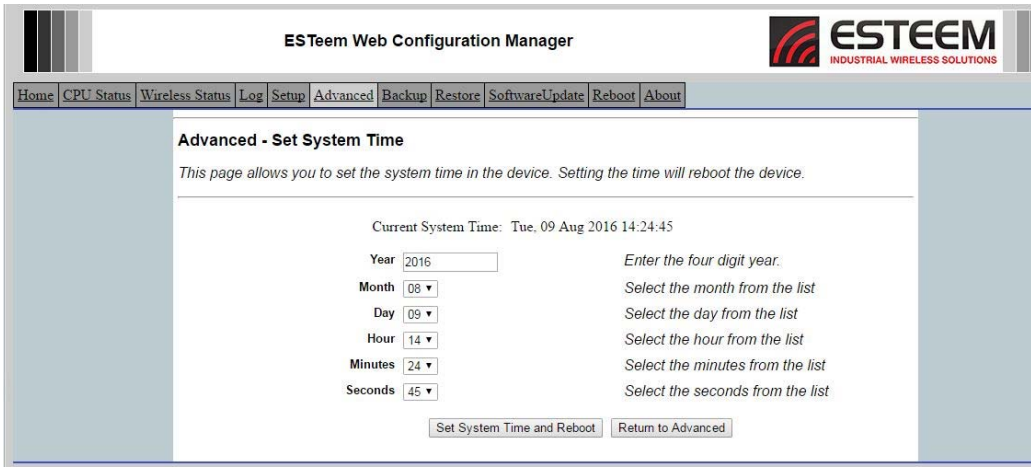


Figure 7: Advanced Features Screen

CONFIGURING TIME SERVER

Enabling NTP time synchronization services on the Horizon will allow usage of time services from upstream services to keep the time on the system accurate.

To allow time synchronization, the Horizon must be configured with the NTP Daemon enabled and the appropriate IP address of the upstream network NTP server.

1. Select **Advanced** from the menu items and **Remote Access & Services** (Figure 8).

2. Press the Next button and Figure 8 will be displayed. Select **NTP Service** then click Setup.

3. There are 3 NTP configuration options available within the Horizon radio; **NTP Master, NTP Server,** and **NTP Client.**

    a. ***NTP Master.*** The radio will use the time set within the radio itself as the Master NTP Time and will act as a NTP Server to Clients.
    b. ***NTP Server.*** The radio will connect to another upstream NTP Server and act as a relay of that information by allowing clients to connect to itself.
    c. ***NTP Client.*** The radio will connect to an upstream NTP Server to get it's NTP information.

4. The next step in configuring NTP services is to enter the IP address or the host name of the upstream NTP server (if applicable).

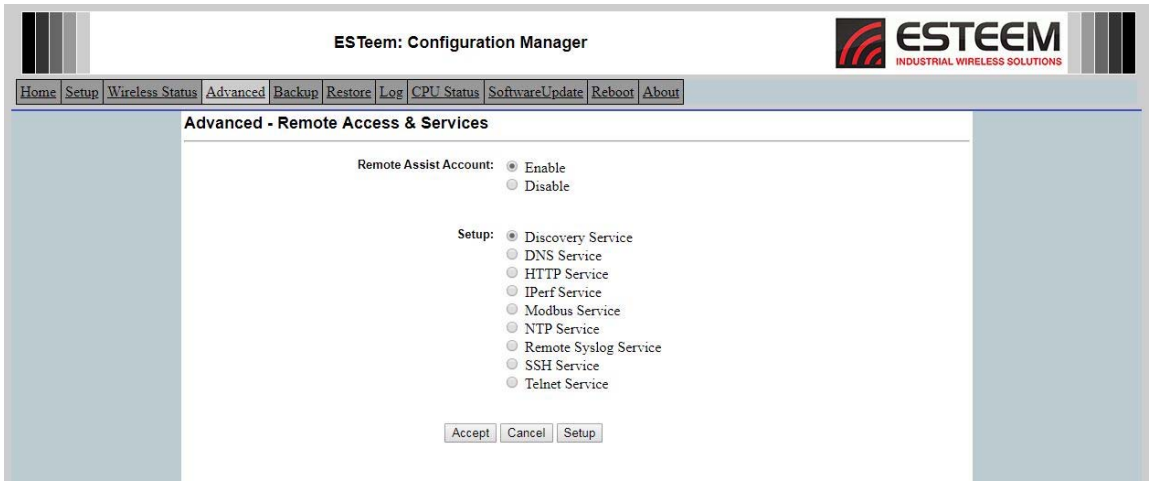


Figure 8: Remote Access & Services Settings

5. The last option on this page allows you to create a whitelist as to who can receive the NTP data if this radio is in either Server or Master mode.
6. After all configurations have been set choose "Accept" then "Accept" on the following page to get back to the Main Advanced menu screen. "Commit and Reboot" to save your changes.

VLAN OPERATION

Virtual LAN (VLAN) systems are rapidly becoming the desired configuration on larger Ethernet networks. The ESTeem Horizon software will allow the Ethernet modems to transparently pass the VLAN packets for these networks. The Horizon currently cannot be used as a VLAN switch but will pass VLAN tagged Ethernet packets through the wireless bridge.

Modbus Monitoring

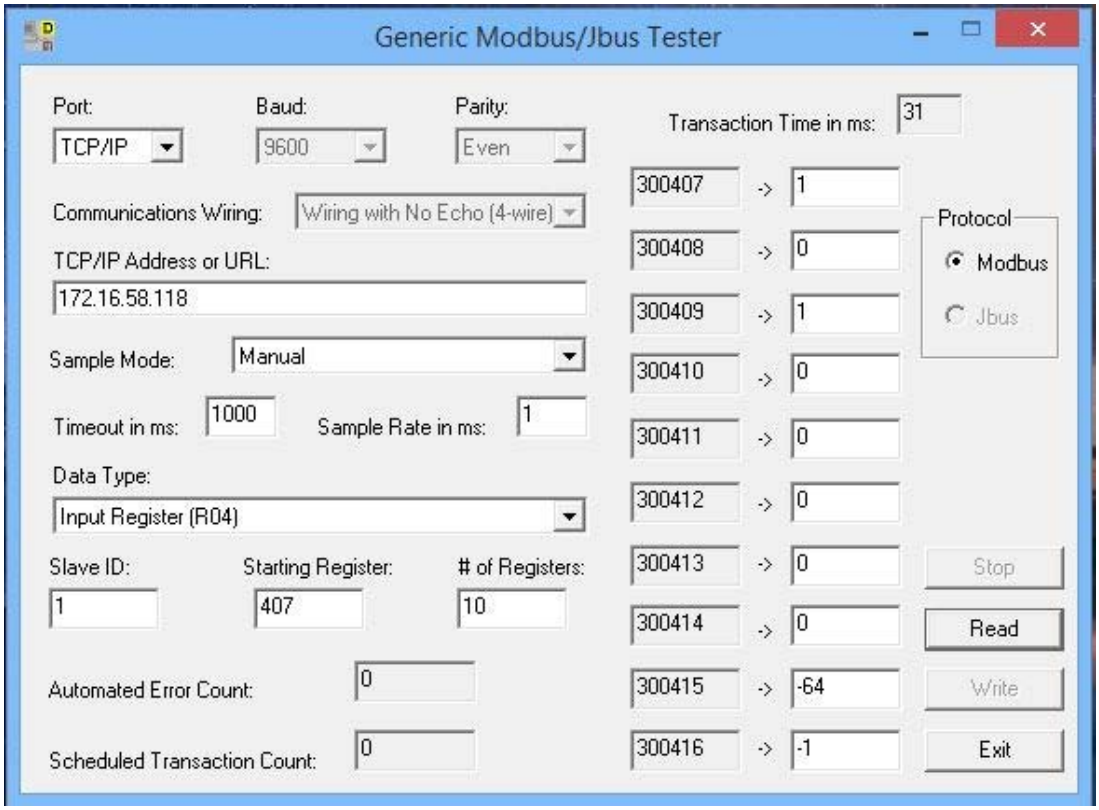


Figure 9: Modbus Test Utility Example

The ESTeem Horizon Series supports ModbusTCP protocol for access to multiple operating parameters in the wireless modem and RF network health status. Frequency, bandwidth, receive signal strength, RF data rates and GPS data (with GPS option installed) are a few of the registers available through the open ModbusTCP protocol. With Horizon firmware version 201701131128 or later, this data can be obtained by polling the registers directly or using available utilities (Fig. 9)

The following are the Modbus registers supported in the ESTeem Horizon Series on Port 502. Registers are read through Modbus function 4 (read input registers) as little-endian 32-bit floating point integers (2 registers each) by default. These can be adjusted to big-endian in the Advanced menu of the radio.

Radio Information

Function	Register	Example	
4	0	2412	Frequency
4	2	20	Channel Bandwidth
	5 – 199		Reserved

GPS Information (GPS Option required)

Function	Register	Example	
4	201	17094900	Time (hh:mm:ss:ff)
4	203	17	Hours (hh)
4	205	9	Minutes (mm)
4	207	49	Seconds (ss)
4	209	0	Factional Seconds (ff)
4	211	9	Total Sync'd Satellites
4	213	1	GPS Fixed
4	215	0	HDOP
4	217	141	Altitude Meters
4	219	-119	Longitude Degrees Integer
4	221	209786666	Longitude Degrees Fractional
4	223	46	Latitude Degrees Integer
4	225	214503333	Latitude Degrees Fractional
4	227	46214503	Longitude Degrees x 10e6
4	229	-119209786	Latitude Degrees x 10e6
4	231	0	East = 1 West = 0
4	233	119	Longitude Degrees
4	235	12	Longitude Minutes
4	237	5872	Longitude Fractional Minutes
4	239	1	North = 1 South = 0
4	241	46	Latitude Degrees
4	243	12	Latitude Minutes
4	245	8702	Latitude Fractional Minutes
4	247	5120254	Northing Integer
4	249	213	Northing Fractional
4	251	329555	Easting Integer
4	253	252	Easting Fractional
4	255	11	Zone Number
4	257	84	Zone Letter
	259 – 399		Reserved

Global Peer Information

Function	Register		
4	401		Reserved
4	403		Reserved
4	405		Reserved
4	407		Ant1 Enabled = 1 Disabled = 0
4	409		Ant2 Enabled = 1 Disabled = 0
4	411		Ant3 Enabled = 1 Disabled = 0 (currently not used)
4	413		Ant4 Enabled = 1 Disabled = 0 (currently not used)
4	415		Ant 1 RSSI
4	417		Ant 2 RSSI
4	419		Ant 4 RSSI (currently not used)
4	421		Ant 4 RSSI (currently not used)
4	423		Current Peer Radio Time
4	425		Last Received Packet Time
4	427		Last Received Data Rate / 10 For Precision
	429 – 439		Reserved

Individual Peer Link Information

Function	Register		
4	441		Peer MAC First 2 Bytes [XX:XX:00:4F]
4	443		Peer MAC Last 4 Bytes [03:A9:00:90]
4	445		Peer Port Forwarding = 1 Blocking = 0
4	447		Ant1 Enabled = 1 Disabled = 0
4	449		Ant2 Enabled = 1 Disabled = 0
4	451		Ant3 Enabled = 1 Disabled = 0 (currently not used)
4	453		Ant4 Enabled = 1 Disabled = 0 (currently not used)
4	455		Ant 1 RSSI
4	457		Ant 2 RSSI
4	459		Ant 4 RSSI (currently not used)
4	461		Ant 4 RSSI (currently not used)
4	463		Current Peer Radio Time
4	465		Last Received Packet Time
4	467		Last Received Data Rate / 10 For Precision
	469 – 479		Reserved

Individual Peer #2 Link Information (repeatable up to 128 Peers)

Function	Register		
4	481		Peer MAC First 2 Bytes
4	483		Peer MAC Last 4 Bytes
4	485		Peer Port Forwarding = 1 Blocking = 0
4	487		Ant1 Enabled = 1 Disabled = 0
4	489		Ant2 Enabled = 1 Disabled = 0
4	491		Ant3 Enabled = 1 Disabled = 0 (currently not used)
4	493		Ant4 Enabled = 1 Disabled = 0 (currently not used)
4	495		Ant 1 RSSI
4	497		Ant 2 RSSI
4	499		Ant 4 RSSI (currently not used)
4	501		Ant 4 RSSI (currently not used)
4	503		Current Peer Radio Time
4	505		Last Received Packet Time
4	507		Last Received Data Rate / 10 For Precision
	509 – 519		Reserved

Horizon Series Packet Monitor

1. Access the ESTeem Web page using your computer's Web Browser. Select **Advanced** Tab. From the **Wireless LAN Setting** section, select **WLAN0 Device** (Figure 10) and push the "Next" button.

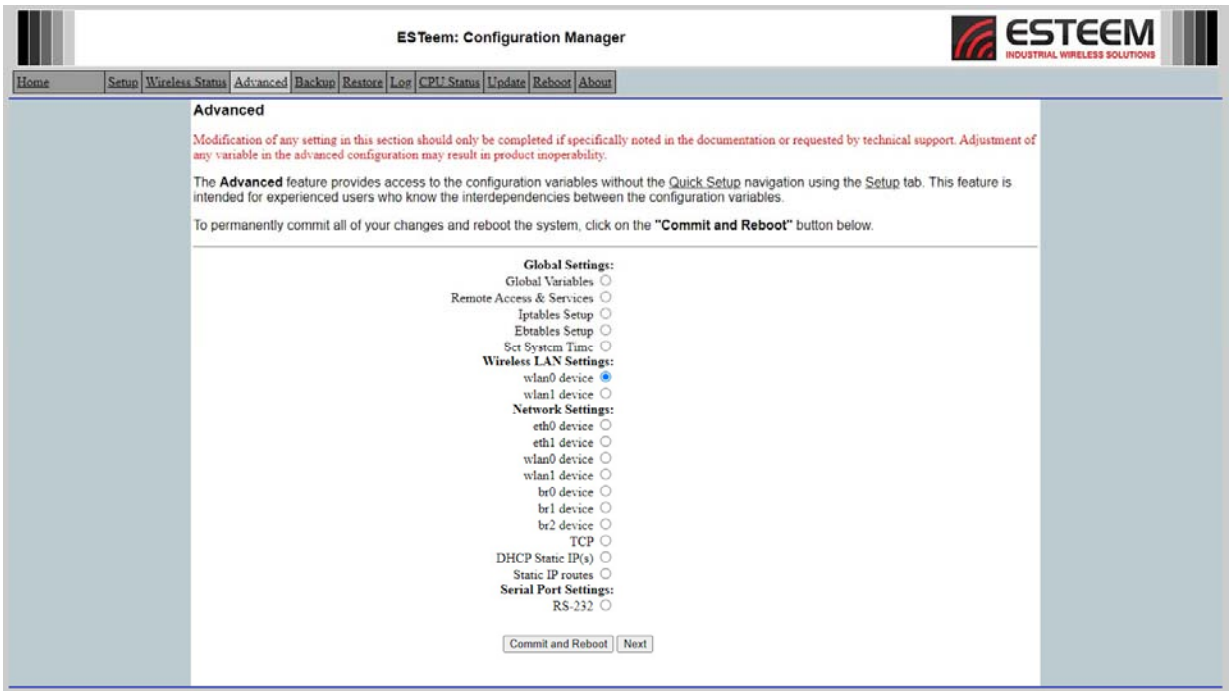


Figure 10: Advanced Screen

2. Select **Packet Monitor** (Figure 11) and push the "**Setup"** button

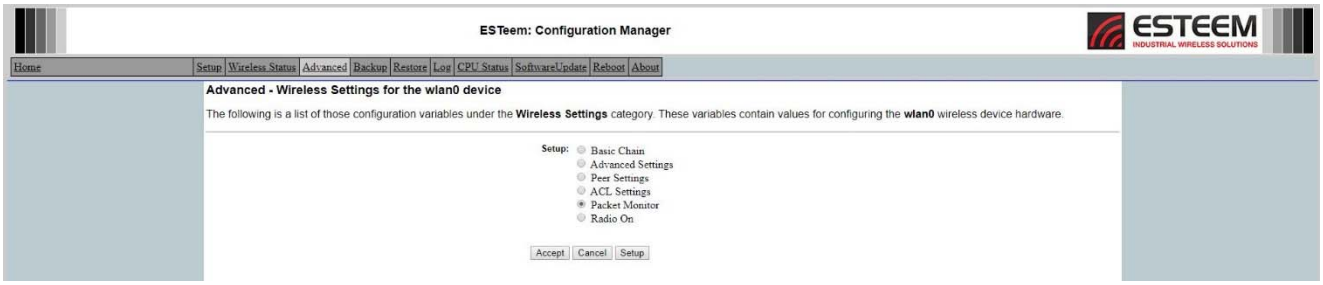


Figure 11: Packet Monitor

3. Download the Wireshark Plugin by clicking on the **Click Here** (Figure 12).

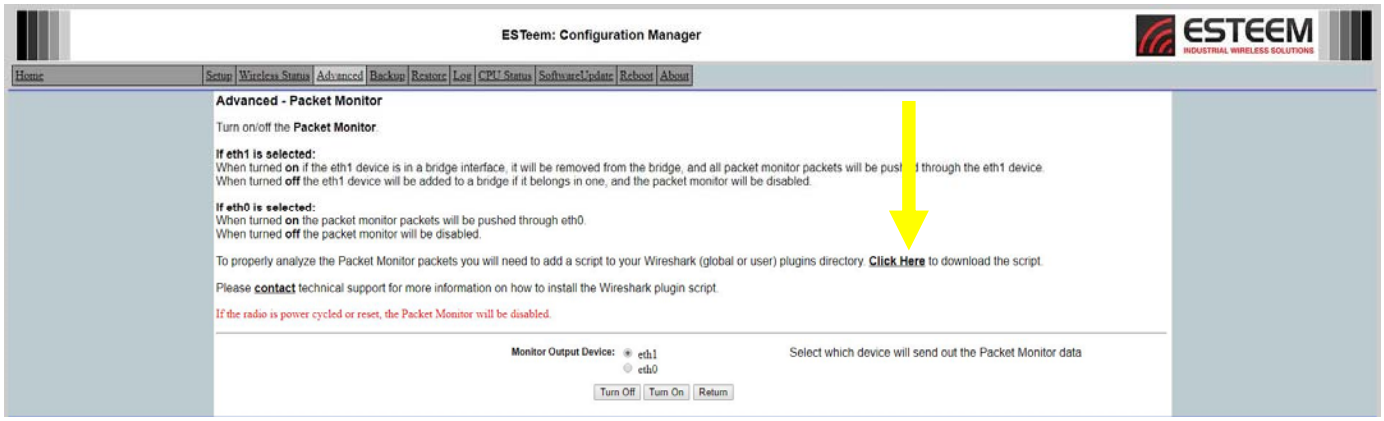


Figure 12: Wireshark Plugin

4. Select the **Monitor Output Device** (Figure 13). Typically, eth1 is used allowing the ESTeem Horizon to remain connected to an active device

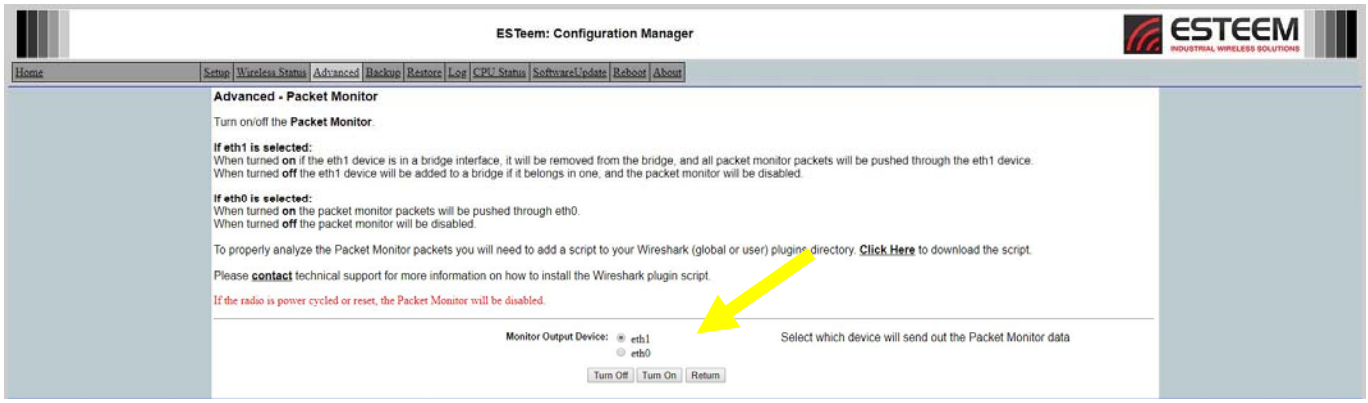


Figure 13 : Monitor Output Device

eth1 eth0

5. Press the "**Turn On"** button
6. Install the latest version of Wireshark from [www.wireshark.org.](http://www.wireshark.org)

7. Copy the downloaded **est_eth2rtap.lua** script into C:\Users*username*\AppData\Roaming\Wireshark directory (Figure 5)

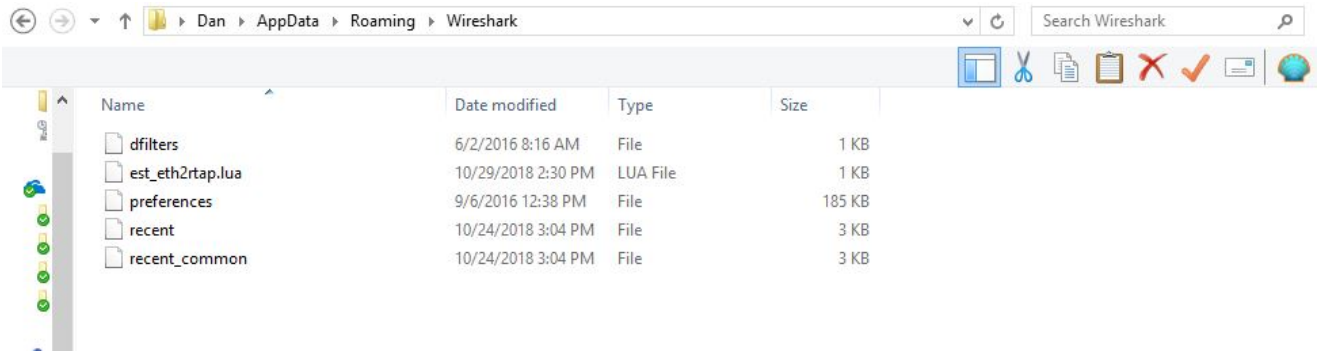


Figure 5: WireShark directory

8. Open WireShark and select (double click) **Ethernet** as the Capture Source Interface to begin monitoring (Figure 6)

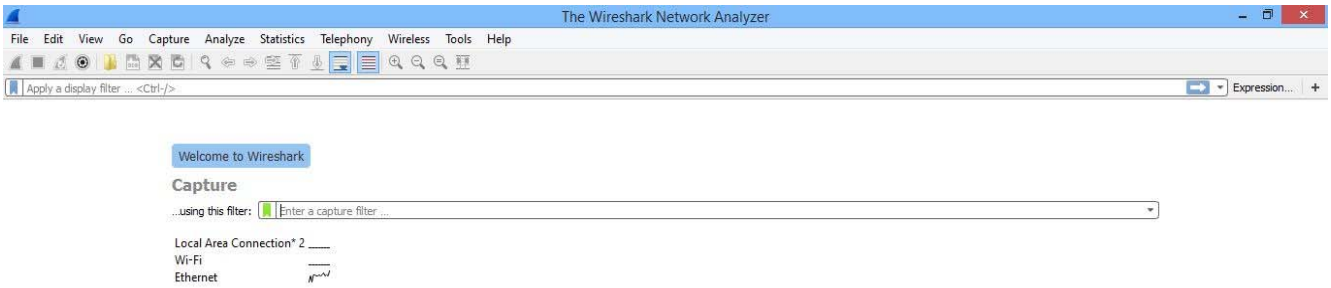


Figure 6: WireShark Capture Options

Flat File Scraping – Horizon Status Page

With ESTeem Horizon firmware version 202112031127 or newer, a flat file of the wireless status page can be "scraped" using a specific "wget" command. This command will vary based upon your computer operating system so if this feature is required in your application, please contact ESTeem support at support@esteem.com or 509-735-9092.

IGMP SNOOPING

Internet Group Management Protocol (IGMP) Snooping allows the ESTeem Horizon to operate more efficiently in networks with high Multicast (UDP, etc.) traffic. IGMP Snooping will define the destination for the Multicast traffic and send the data to the correct wireless Ethernet modem, not the entire network. This limiting of Multicast traffic to specific destinations greatly increases the overall network efficiency.

The problem with using multicast traffic over a wireless connection is that multicast packets do not require an Acknowledge on the protocol layer. If the wireless network misses a data packet on the RF network, that multicast data packet is lost.

Theory of Operation

There are two types of Ethernet packets on a network, unicast and multicast. Unicast is intended for exactly one recipient (and ignored by all others). Multicast is intended to be received by multiple recipients. Interested parties can listen for multicast packets, but most nodes ignore it. In any case, the network medium is still utilized no matter how many nodes are listening. Broadcast packets are a special type of multicast traffic which all nodes always receive. These are particularly useful for global announcements (Hey, I'm Alice!) and queries (Hey, I'm Alice and I'm looking for Bob!). More relevantly, it is how hosts on a network find out each other's addresses and are crucial to the proper functioning of a network.

As the network grows physically, it encounters some growing pains. The first is more physical, relating to the cabling limitations. Bridges solve this problem by joining two physical networks together, so they appear to be a single large network. Through use of bridges, a network can scale to hundreds or even thousands of hosts. There is a downside, however. Well before the physical limitations of bridging hit, you start to run into efficiency problems, as all traffic must travel everywhere on the network. The raw carrying capacity of this shared medium, often referred to as bandwidth, is the second scaling problem.
Smart bridges, or switches, help alleviate the bandwidth problem by only passing traffic across the bridge if the destination host was on the other side. This greatly increases the capacity and efficiency of the network by allowing two pairs of hosts communicating simultaneously on each side of the switched bridge. Only when the packet needs to go to the other side is both mediums utilized simultaneously for the same packet.

Unfortunately, broadcast and multicast traffic by its very nature must always be relayed across the bridge. While the number of network nodes may grow linearly, the multicast traffic tends to grow exponentially. This isn't generally a problem for wired networks, as they have a considerable amount of bandwidth to spare, but wireless networks have, at best, an order of magnitude less bandwidth to begin with. If a wireless network is bridged with a wired network, while the absolute numbers are the same, a much higher proportion of the wireless network's available bandwidth is used up by multicast traffic. This effect is further magnified if multiple wireless repeaters are in use.

The preferred way of dealing with excess multicast traffic is to put the wireless network on a different sub-network (subnet) and use a router to join it to the wired network. This ensures that only unicast traffic intended for the wireless network crosses over, as multicast and broadcast traffic stays within its local subnet. Normally this is fine, but there are times where you need multicast traffic to span subnets. For IP traffic, this can be obviated by using a multicast-capable router, but for legacy multicast protocols that were not designed to be routed, another solution must be found.

CHAPTER 5
WEB CONFIGURATION

The ESTeem Horizon Web Configuration Manager is an internal web server that will allow setup, monitoring and diagnostics of all operating parameters in the Horizon. The Horizon can be configured using any current web browser software such as Microsoft Edge, FireFox or Google Chrome®.

Logging on to the ESTeem Web Interface

1. Using your Web Browser connect to the Horizon Web Interface with the IP Address that you have assigned it in Chapter 3.

2. You will now see the Log-on Menu on Figure 1. To enter the Horizon Home Menu you will need to log into the system with a User Name and Password.

3. For the User Name enter **admin** and press the Enter key (<Enter>)**.** The User Name is defined at the factory and is not changeable.

4. Enter your unique Password and press the Enter key (<Enter>). The password is configurable but will be unique for all radios. The default password is the complete (alphanumeric) radio's serial number (ie Z-25000).

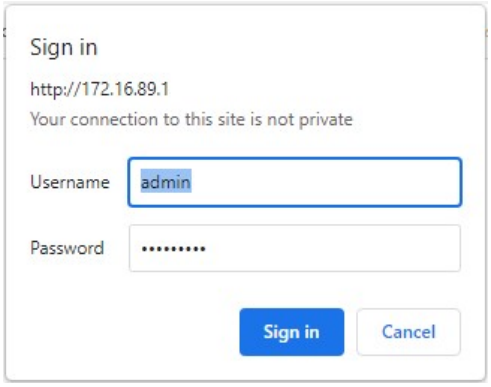


Figure 1: ESTeem Web Page Log-on Screen

Technical Tip: If this is the first time the Horizon has been programmed and the Password was not changed from the factory default values, the factory default Password is the radio's serial number. (e.g. Z-25000)

5. After Log-in the next screen displayed will be the Horizon Home page (Figure 2). This example screen shows the Home Menu screen.

Note: Throughout the Configuration Manager are Help Screens that can be accessed for further information on each item.

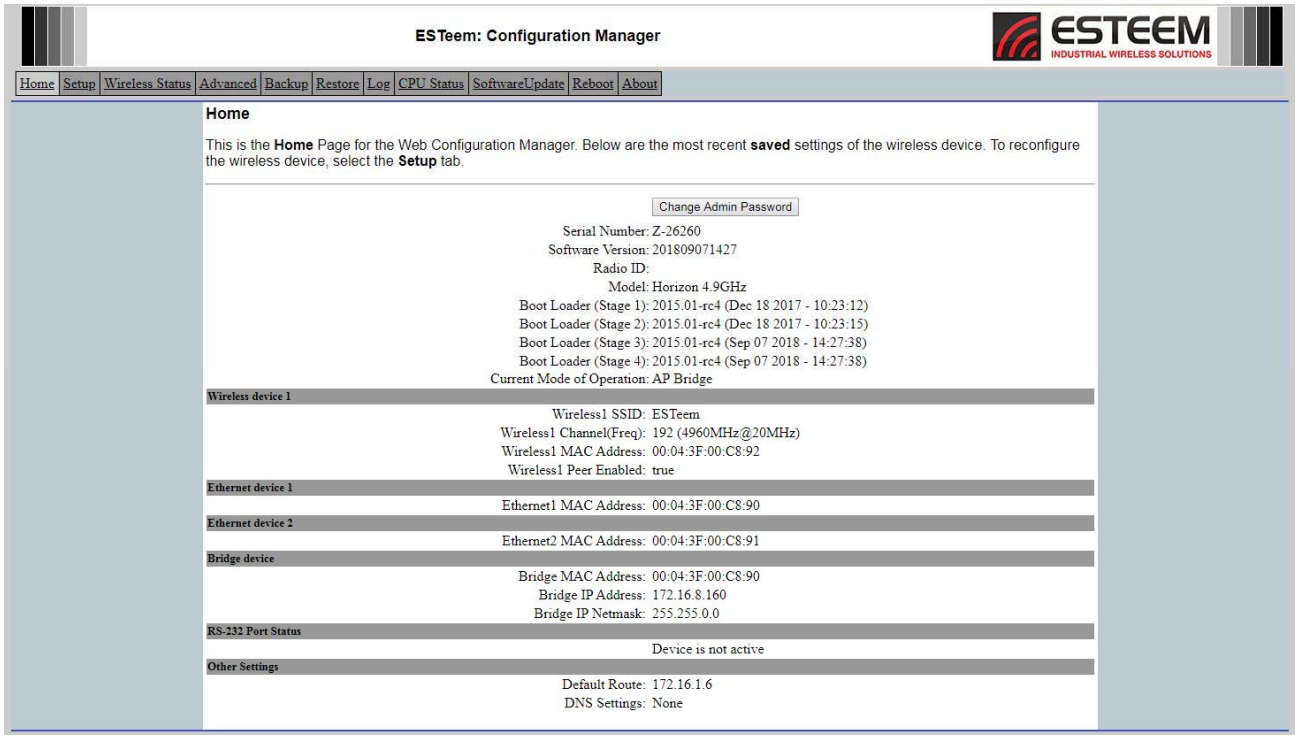


Figure 2: Home Screen

WEB CONFIGURATION MANAGER SECTIONS

The following sections will describe the features in each of the main and sub menu items in the web pages. For step-by-step examples of how to configure the Horizon in different Modes of Operation, please refer to Chapter 3 – Example Applications.

Home Menu

The Home Menu will be the default web page for the Horizon Web Configuration Manager (Figure 2). This section will display the current configuration summary for the Horizon and allow changing of the default password. This page will also display the Radio ID field that can be used to easily identify the Horizon you are programming. This Radio ID field can be set to any text combination for example, location name, GPS coordinates or addresses. The Radio ID will be displayed on the Home Page, when using the Discovery Utility and in the Wireless Status menu. The Radio ID can be set on the last page of the configuration menu (see Chapter 3 – Example Applications) or through the Advanced Menu as shown below:

Setting the Radio ID

1. The Radio ID field can be adjusted under the *Global Variables* of the Advanced Menu tab (Figure 3). Select Global Variables and press the *Next* button. Figure 4 will be displayed.

2. Enter the text you would like displayed in the Radio ID field (Figure 4). When complete, press the *Save Settings* button and the *Commit Changes* button on the next screen to save the name to the Horizon.

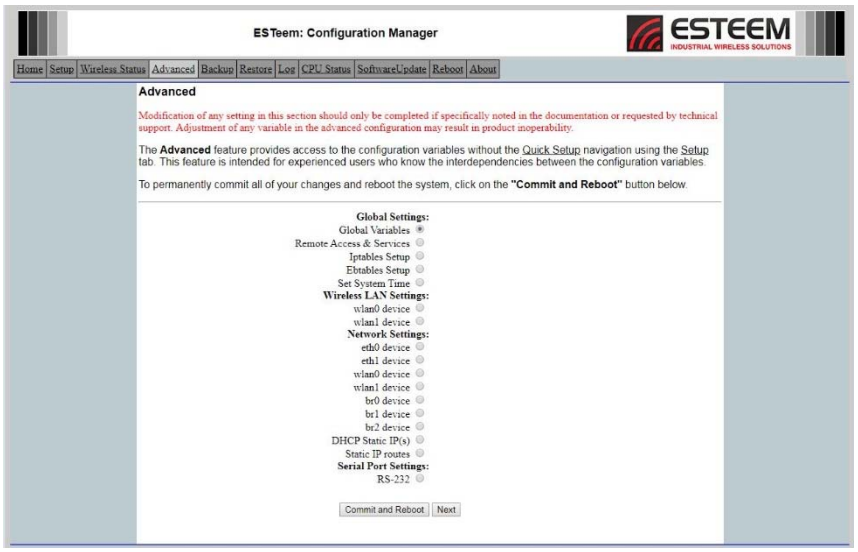


Figure 3: Advanced Global Settings Screen

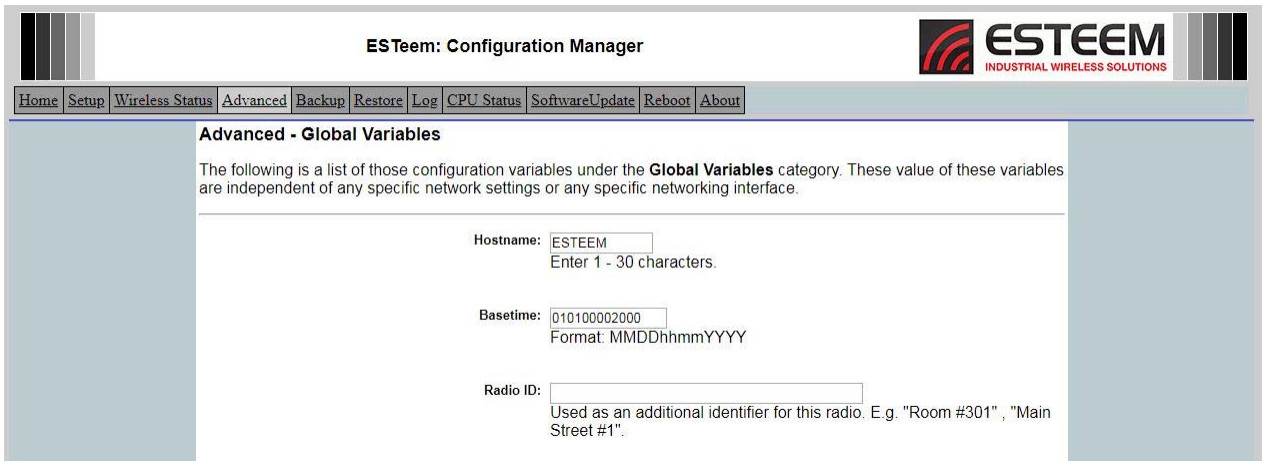


Figure 4: Radio ID Field in Global Variables Screen

Setup

The Setup screen allows the step-by-step configuration of the Horizon using the Web Configuration Manager (Figure 5). Please see Chapter 3 for complete description on Modes of Operation and example system configurations.

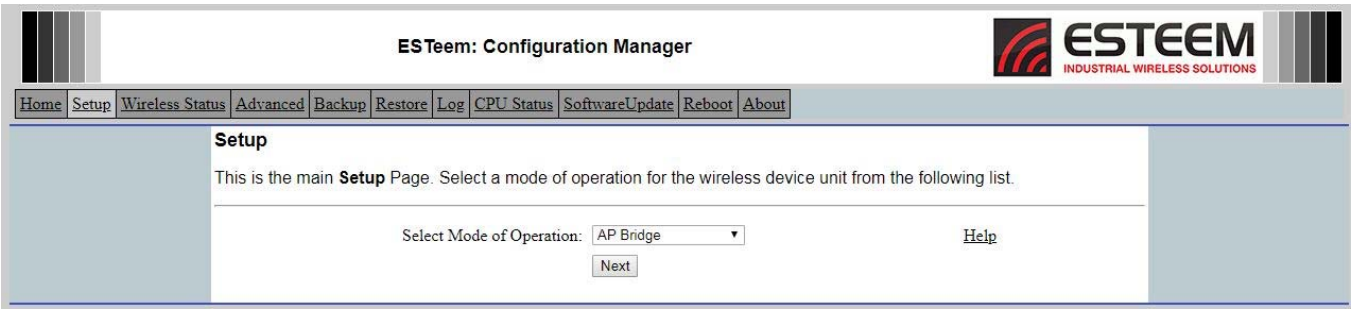


Figure 5: Setup Screen

Wireless Status

The Wireless Status submenu lists the connected wireless devices (Horizon's or 802.11 clients), their signal strength, data rate and time of last packet sent. Press the Wireless Status tab and Figure 6 will be displayed. For a detailed analysis of the information provided in this table, please review Appendix E – Troubleshooting.

Associated Station – This section will list all the associated stations that are attached to the Access Point. These could be other Horizon's in one of the three Client modes or 802.11 devices.
Peers – This section will list all connected Horizon peers (Ethernet Bridge links) by their Wireless MAC address. For detailed information on peer links, bridging and wireless Mesh, see Chapter 7 – Wireless Bridging and Mesh Features.
Access Points – This section will list all other 802.11 Access Points that are sharing the operating channel (frequency) of the Horizon. You can also note that the Peers listed above are also included in this list.
Uncategorized Entries – Other MAC addresses on the network not associated with the wireless network.

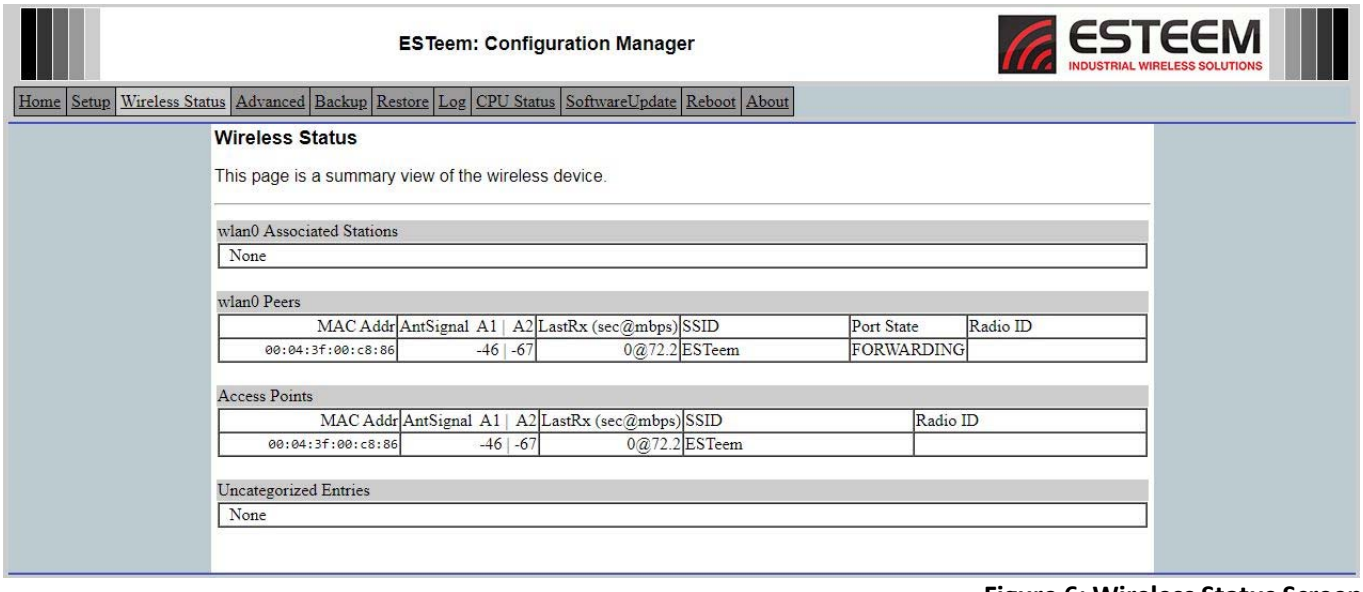


Figure 6: Wireless Status Screen

Advanced Configuration Menu

The Advanced screen allows the user to access all configuration parameters. The parameters are grouped based upon their variable. **It is recommended that only advanced users of the Horizon enter this section unless instructed by ESTeem technical support**. See Figure 7.

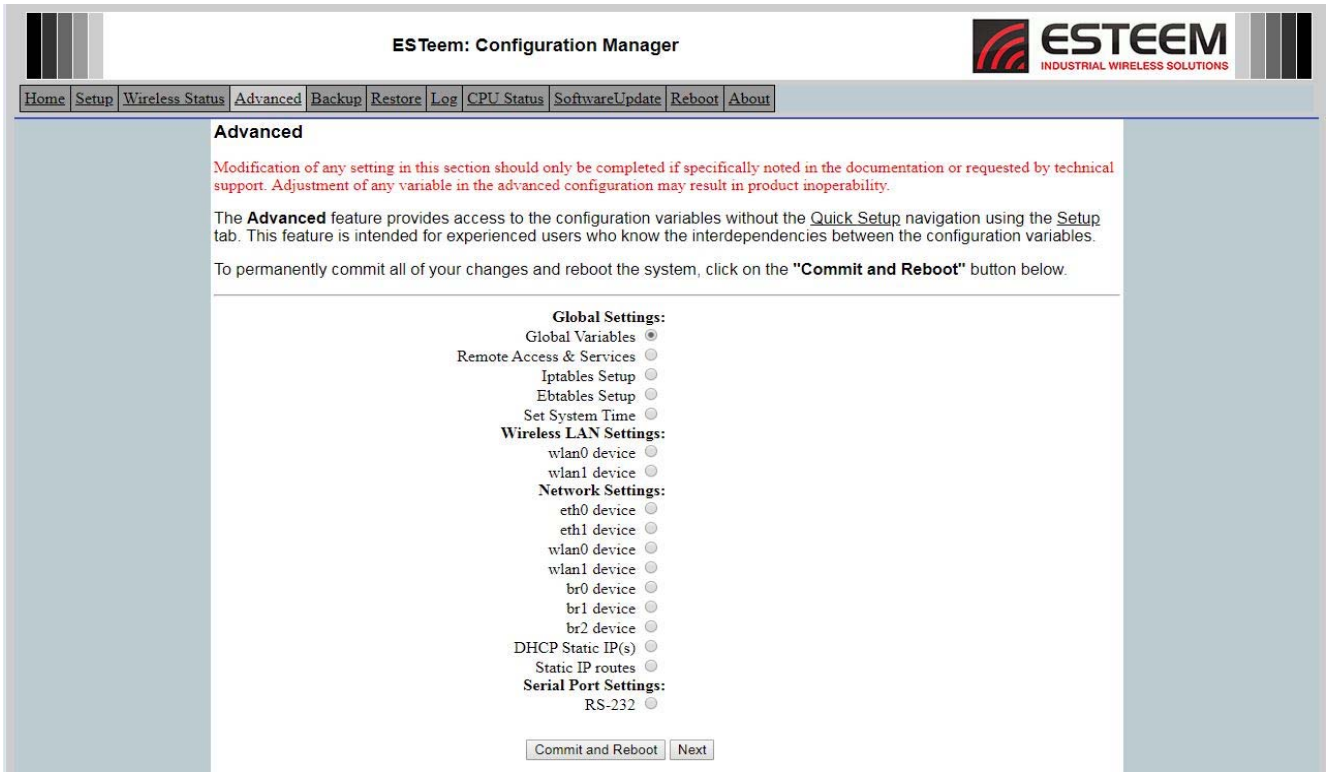


Figure 7: Advanced Features Screen

Backup

The Backup Screen saves the current configuration in the Horizon to a file on the computer or Internal Memory Card (Figure 8). Pressing the Local PC button will create a configuration file that can be saved to the computer. This saved file can then be later opened, if necessary, by the Restore menu to quickly replace a Horizon with a spare modem. Saving to the Internal Memory Card can be used for a quick radio replacement by making a "Clone" of the Horizon radio (see Appendix E – Troubleshooting for complete instructions on how to clone a radio).

Technical Tip: Most firmware updates will render previous saved files obsolete. Make sure to update any saved configurations after a firmware update.

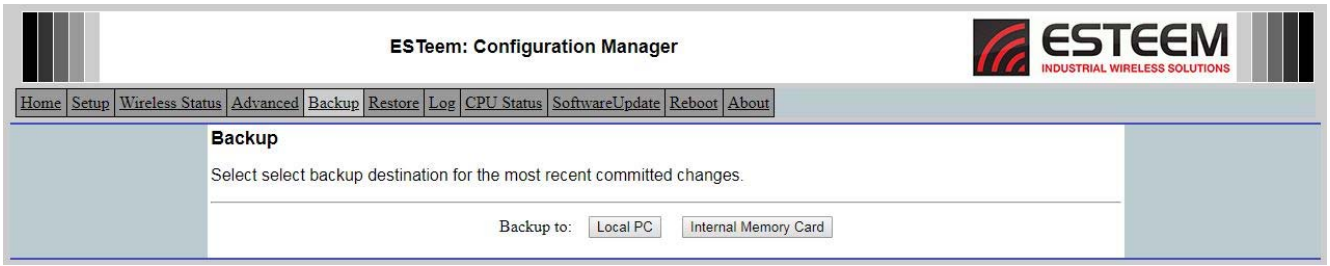


Figure 8: Backup Screen

Restore Configuration

The Restore screen is used to restore the Horizon to factory defaults, return to the last saved configuration or to access the configuration files that were backed up to the computer or memory card. See Figure 9.

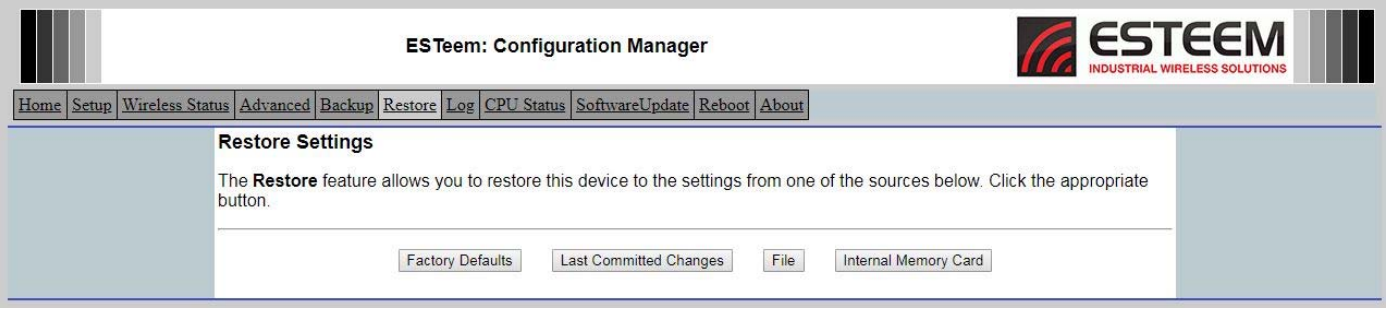


Figure 9: Restore from Local File Screen

Factory Default – Returns the Horizon to all factory default values. This includes returning the radio to the default radio password.

Last Committed Changes – This button will remove any changes to the modem that have been done since the last committed changes. The last committed changes will be read from the Flash file and reset in the Horizon.

File – Pressing this button will bring up a selection of where the restore file was saved on the computer during the Backup. Select "Choose File" to browse for files saved on a local computer. Figure 10 will be displayed. Select "Standard" to restore the radio using the saved configuration file but maintain the factory configured MAC addresses or select "Clone" to restore the Horizon radio as a clone of the saved configuration.

Internal Memory Card – Pressing this button will load the configuration saved on the Internal Memory Card. Figure 10 will be displayed. Select "Standard" to restore the radio using the saved configuration file but maintain the factory configured MAC addresses or select "Clone" to restore the Horizon radio as a clone of the saved configuration.

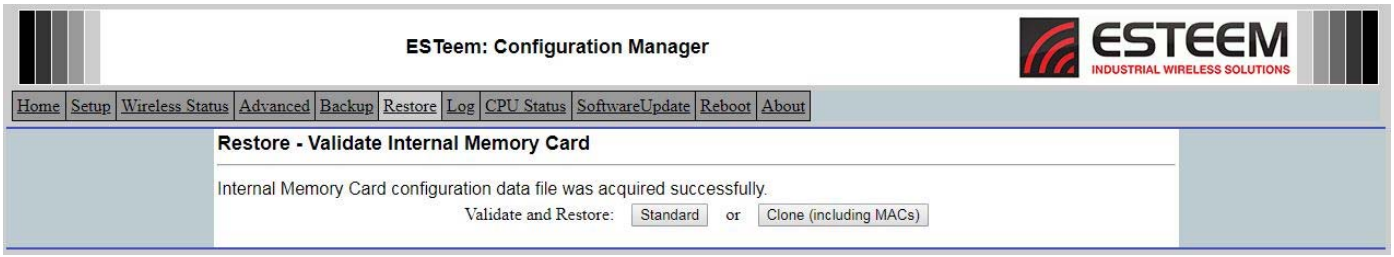


Figure 10: Restore Standard or Clone

System Log

The Log Screen is a trouble-shooting tool that shows the current log of Horizon system messages. See Figure 11. The System Details button will display a more detailed system diagnostic that may be requested by ESTeem technical support.

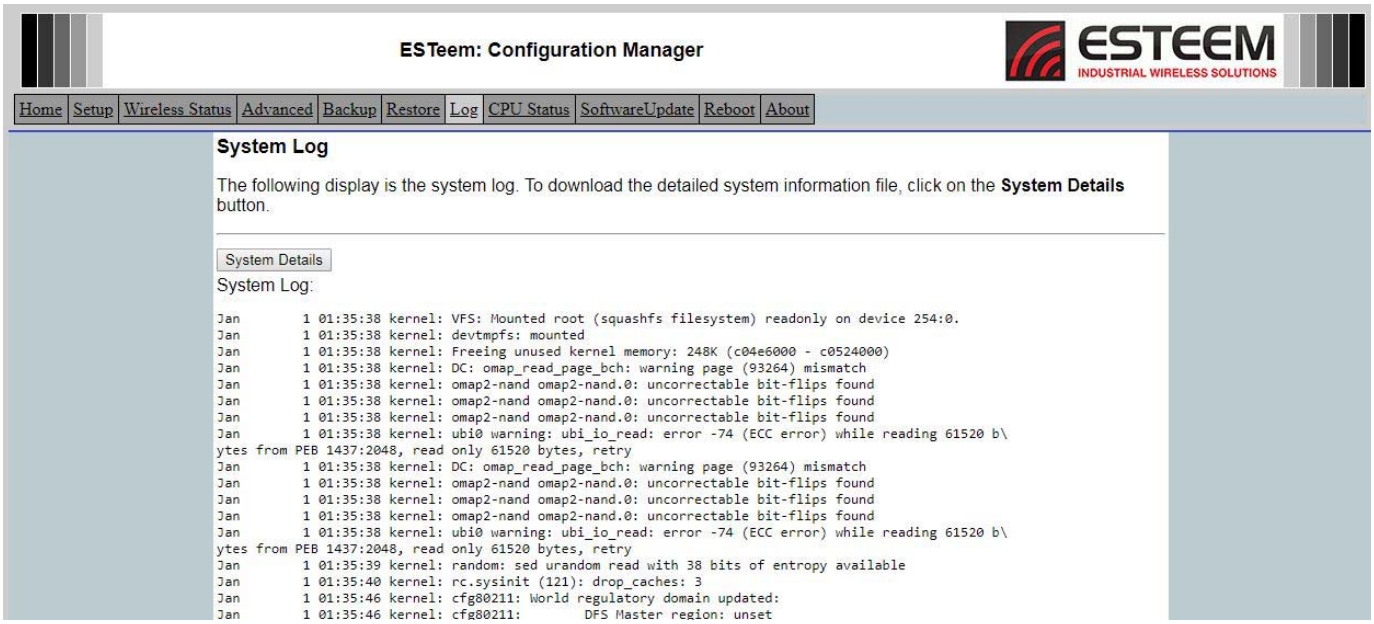


Figure 11: System Log Screen

CPU Status

The Status Menu provides a summary of the current mode of operation, system time, processor usage, internal temperature and status of the communication links to other wireless devices. An example is shown below in Figure 12. Most of the communication troubleshooting is done in the Wireless Status tab.

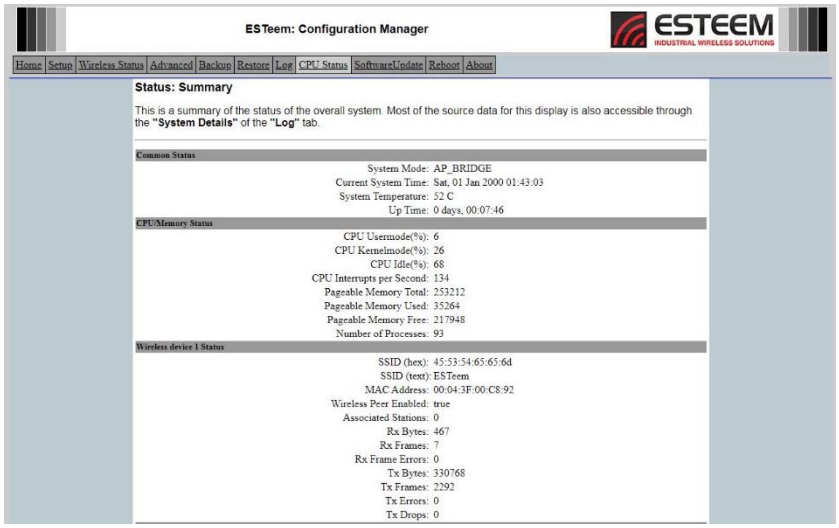


Figure 12: Status Screen

Software Update Screen

The Software Update feature allows the user to update the latest Horizon operating system software from a file supplied by the factory or the Internet to the Horizon's flash memory. To upload from a file on your computer, select *Upload via web browser* and a file selection window will be displayed. To upload directly from the Internet, select *Download from an http or ftp URL* and enter the site address. See Figure 13.

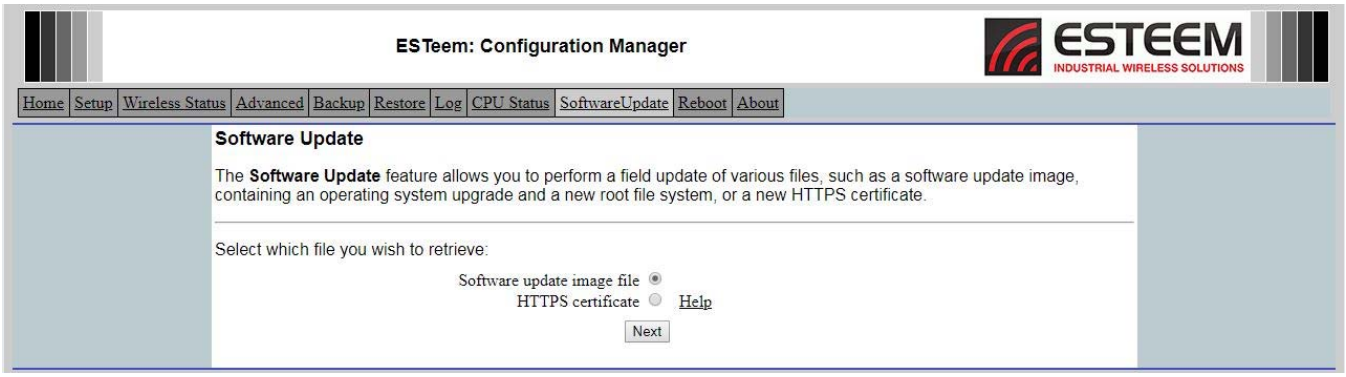


Figure 13: Software Update Screen

System Reboot Screen

The Reboot screen allows the user to reset the Horizon. See Figure 14.

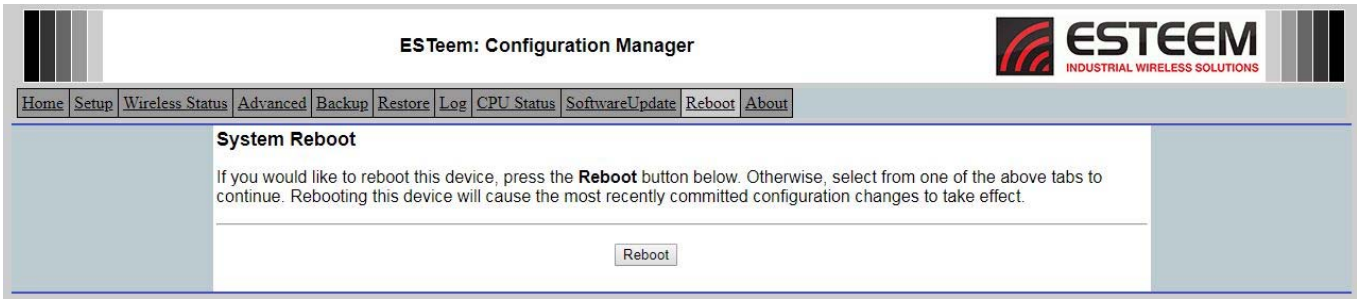


Figure 14: System Reboot Screen

Using The RS-232 Programming Port

The RS-232 Programming Port will provide a limited set critical programming features such as setting the IP address or restoring the Horizon radio to factory faults. Any terminal emulation program that can run with VT100 emulation can be used for this configuration of the ESTeem Horizon. Any RS-232 terminal program (such as PuTTY - http://www.putty.org) will work. Configure your RS-232 port for a Baud Rate to 115,200, Data Bits to 8, Parity to None, Stop Bits to 1 and Handshaking to None (115200,N,8,1). Once your Horizon has an IP address, you can attach the ESTeem to your network and use the Web Configuration Manager (Chapter 5 for complete details) for further programming.

Programming Using the RS-232 Programming Port

1. Connect the serial cable (EST P/N: AA0621.1) between the RS-232 connector (RJ-45) on the Horizon's RS-232 Programming Port to the serial port on the computer.

2. If your computer is configured properly, you will see the ESTeem Horizon booting sequence on your Terminal Emulation program. Once the ESTeem boot sequence is complete (approximately 60 seconds) you will receive this message:

   "Please press Enter to active this console."

   If you don't see this message press the Reset button on the front panel of the Horizon and/or check the programming of your RS-232 port.

3. Press the Enter key and you will be at the Configuration Menu Horizon login prompt. See Figure 1.

4. To enter the Horizon Main Menu you will need to log into the system with a login name and password.

5. If this is not the first time configuration of the Horizon, see your network systems administrator for the password.

6. At the Horizon login prompt type ***admin*** for the login name and press the Enter key (<Enter>). ***The login name is defined at the factory and is not changeable by the user.*** ***Note that all characters are lower case.***

If this is the first time the Horizon has been programmed or the Password was not changed from the factory default values, the factory default password is also ***admin***. Enter the serial number of the radio for the password and press the Enter key (<Enter>).

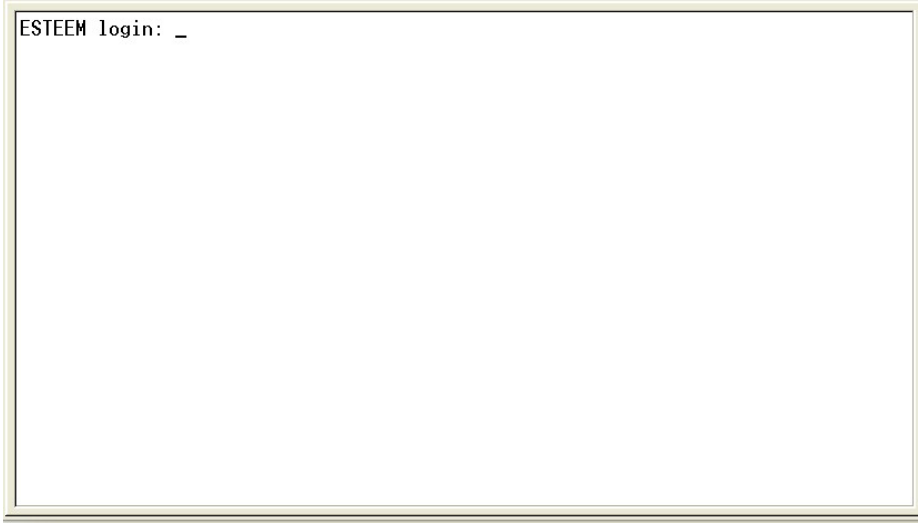


Figure 1: RS-232 Port Log-in Screen

7. To set the IP address in the ESTeem Horizon, type the letter “A” and press the Enter key. Enter the value for the IP address, Netmask and default route pressing the Enter key after each entry.

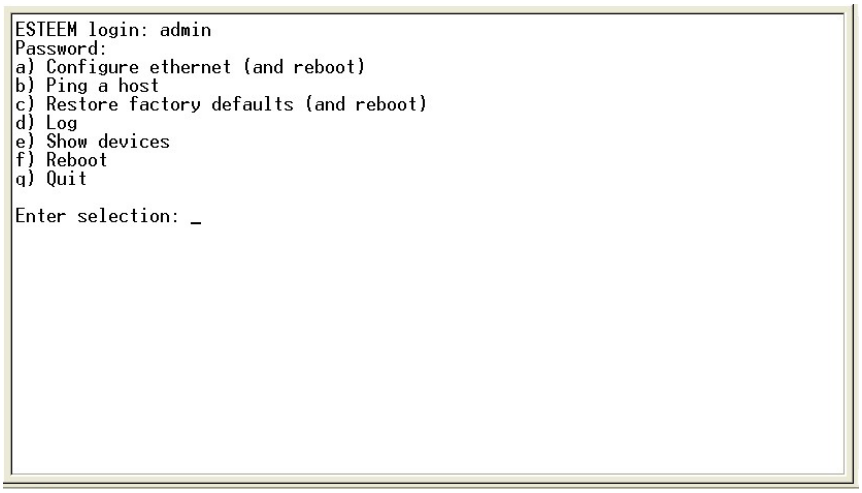


Figure 2: RS-232 Welcome Screen

8. After the basic parameters have been entered into the Horizon you will need to commit the changes to the Horizon (Figure 3). Press the C key and then Enter. The changes will be saved to flash memory. You can use programming features in the ESTeem Web Configuration Manager to configure the unit for your application.

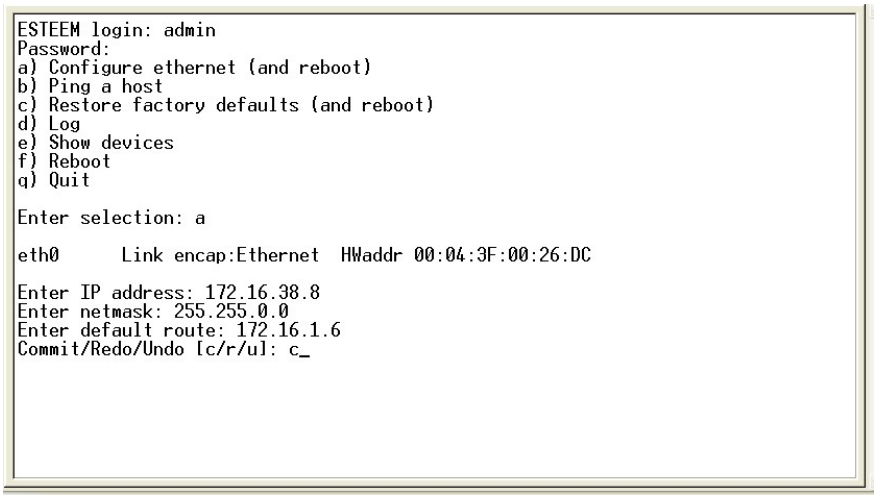


Figure 3: RS-232 Welcome Screen

Using The RS-232 Data Port

The ESTeem Horizon has a serial data port that can provide RS-232 communication between two or more serial devices using the wireless broadband link. The serial data is encapsulated and transferred as a standard Ethernet packet over an operating Horizon wireless Ethernet system. The configuration for a serial Horizon network will be the same as an Ethernet or a serial (RS-232) based communication network.

The serial interface option can be used to link two or more serial devices in a new or existing system. The serial data has very little impact on the network bandwidth and will allow for both Ethernet and serial applications simultaneously. A possible application would be installation of the Horizon in an existing serial based network that was looking for future upgrade to an Ethernet based system. Another would be using the high-bandwidth Ethernet connections to provide a link to remote video hardware while also providing a serial link to the existing PLC in a SCADA type application.

Serial Connections

The RJ-45 serial data port is the far-left port on the face of the Horizon (Figure 4). Using the ESTeem AA0621.1 interface cable, the Horizon can be connected to a standard DTE-device (PC) with a male 9-pin Sub-D connector. The complete cable configuration is available in Appendix C – Interface Ports.

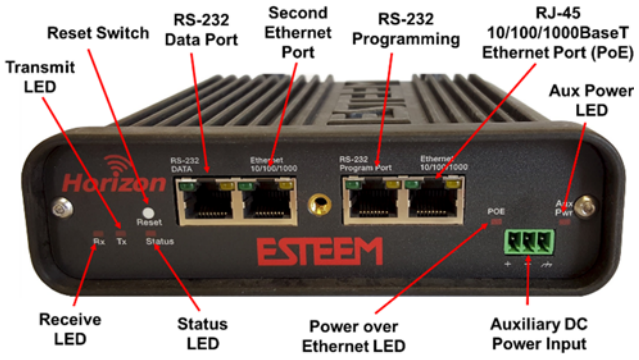


Figure 4: Horizon Front Panel Overview

Serial Configuration

Configuration of the serial port is done in **Advanced>Serial Port Settings**. Select **Serial Port Settings>RS-232** and press the *Next* button, the Serial Port Setup screen (Figure 5) will be displayed. Each section in the Serial Port Setup screen is described in detail with the following:

Data Serial Port
Enabling the serial data port allows the modem to send RS-232 data over the broadband wireless connection established with the ESTeem repeater peers. The modem can be configured in a point-to-point or point-to-multipoint system. Select *Yes* if you wish to enable the serial data port.

Serial Mode
There are two distinct modes of operation for the serial port in the Horizon. The Redirector mode will provide two-way serial communication between two or more serial devices, while the Terminal Server mode will allow serial communication to a specific remote site by connecting through telnet or SSH. Select one of the following modes of operation:

Full Redirector Mode - This mode allows bi-directional RS-232 data communication with other ESTeem Horizon's. The RS-232 data transmission will appear transparent to the connected devices as if a serial cable is connected between the two ports. This mode will also be used in a multi-point serial network were all serial devices will need bi-directional communication (Figure 6).

Terminal Server Mode - This mode of operation translates RS-232 serial data into a network-oriented terminal protocol, such as telnet or SSH. This mode would be selected if an interactive RS-232 session at remote locations is desired over the wireless Ethernet link.

Serial Baud Rate
Select the data rate of the RS-232 connection to match your serial device.

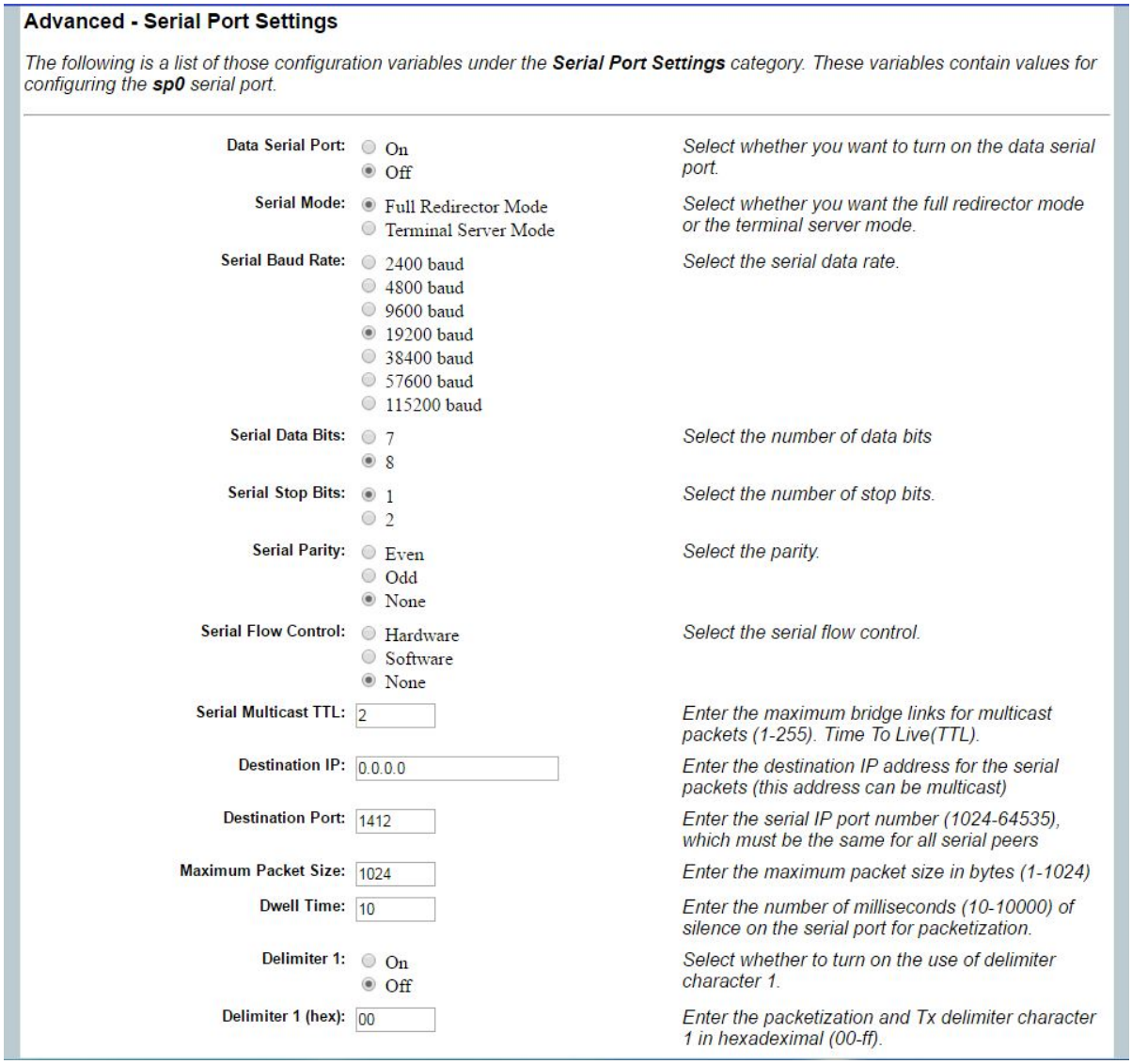


Figure 5: Serial Configuration Screen

Serial Data Bits

Select the number of data bits on the RS-232 connection to match your serial device.

Serial Stop Bits

Select the number of stop bits on the RS-232 connection to match your serial device.

Serial Parity

Select the parity of the RS-232 connection to match your serial device.

Serial Flow Control
Select the type of data flow control used on the RS-232 connection. The ESTeem can support Hardware flow control (RTS/CTS control lines) or Software Flow Control (XON/XOFF). Select None if no serial flow control is necessary.

Serial Multicast TTL (Maximum Bridge Links for Multicast Packets)
This value sets the maximum number of Ethernet bridge links that the multicast packets will be sent through when used in a multi-point system. A multi-point serial network uses multicast packets (UDP) to send the data to more than one remote ESTeem. You want to limit the number of network bridge links that these UDP packets will be passed through to make the network more efficient.

If you are using multiple ESTeem repeater links to send the serial data to remote locations, the value for the maximum bridge link needs to be increased to a number greater than the longest repeater chain. For example, if you are using four repeater (peer) links to send the serial data between two or more sites the number will need to be five (5) or greater (Figure 4).

Destination IP Address
The ESTeem configured for the correct destination IP and port number will send and receive the serial data from another modem. Set the destination IP address for the ESTeem where the serial data will be sent. If sending to more than one ESTeem (Multipoint) set to a multicast address (i.e 224.0.0.1).

Note: If you are using the ESTeem Horizon in a multipoint application (multicast), you must have default Gateway configured in the ESTeem set to the IP address of the Root Bridge modem.

Destination Port
The ESTeem configured for the correct destination IP and port number will send and receive the serial data from another modem. Set the IP port numbers to match where the serial data will be sent. The serial data will not be sent if both the IP address and port number is not correct.

Maximum Packet Size
This number represents the maximum size of the serial data packet in bytes. If the number of bytes of data in the serial port buffer exceeds the maximum packet size before the timer or delimiter character is reached, the ESTeem will send forward the serial packet. For example, if the maximum packet size is set to a value of 100, when the serial port receives 100 bytes the data will be sent through the wireless connection.

Dwell Time (Number of Milliseconds for Packetization)
This number represents the time the ESTeem will hold data in the serial data buffer before sending to the remote ESTeem. This feature is generally used if the serial data does not have a consistent packet length or delimiter character. For example, if the number of milliseconds is set to a value of 10 the ESTeem will monitor the incoming serial data stream and any break in characters longer than 10 milliseconds will cause the data will be sent through the wireless connection.

Delimiter Characters
Enabling and specifying a delimiter character will transmit the data in the serial buffer when the delimiter character is recognized in the serial data stream. There are two unique delimiter characters that can be configured and enabled independently.

Modem Control Lines
Enabling this feature will allow the ESTeem in the Terminal Server mode to read and generate modem control lines to the connected device.

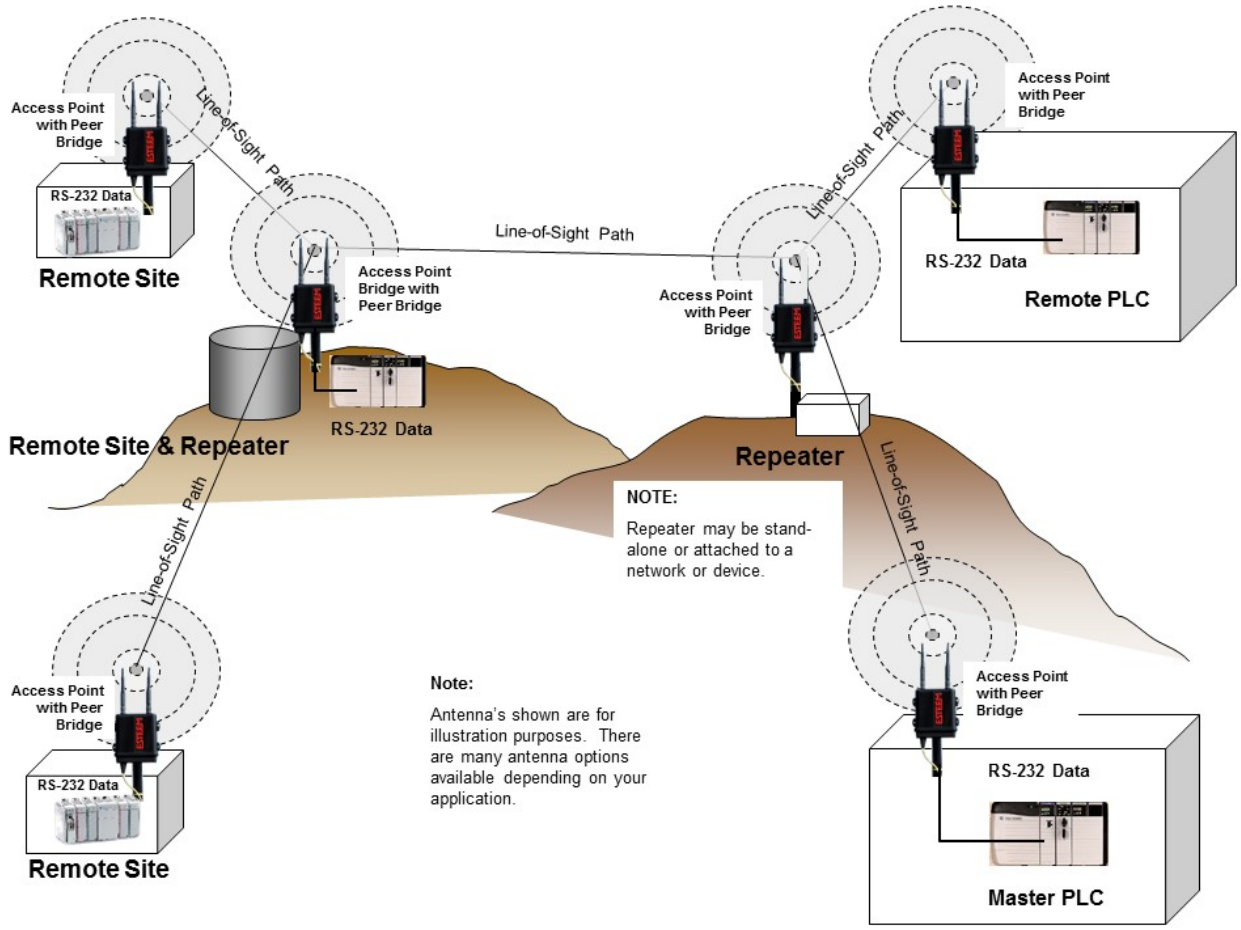


Figure 6: Serial Full Redirector Example

To increase the wireless network's area of coverage for both indoor and outdoor applications, the Horizon utilizes a custom meshing feature that allows increased coverage areas without the added expense of hard cabling or adding an additional point to point radio link.

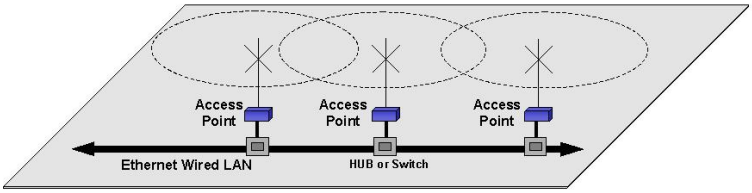


Figure 1: Conventional Access Point Diagram

With a conventional IEEE 802.11 (Wi-Fi) Access Point (AP) network, all of the APs have to be interfaced to a common network either by hardwire, see Figure 1, or a separate, dedicated RF backbone. The Horizon radios can create this RF backbone, bridge Ethernet networks connected to the wired Ethernet port and provide the wireless canopy for mobile clients simultaneously.

When programmed in any of the three Access Point (AP) Modes (Bridge, Router or Masquerade), the Horizon will create a wireless network with other Horizon units in radio range that are programmed in the Peer table during setup. This feature adds the increased functionality of repeaters to the typical Ethernet Bridge configuration.

ESTeem IndustrialMESH Network

One of the most powerful features of the wireless Peer configuration between Access Points (AP's) is the ability to input multiple communication routes and designate the priority for each of these routes to create a wireless Mesh network. The ESTeem Horizon will automatically change communication routes in the network if a route has failed. The new route will be based upon the priority level set during configuration. This wireless Meshing technology allows the RF network to "self-heal" if any of the communication paths fail.

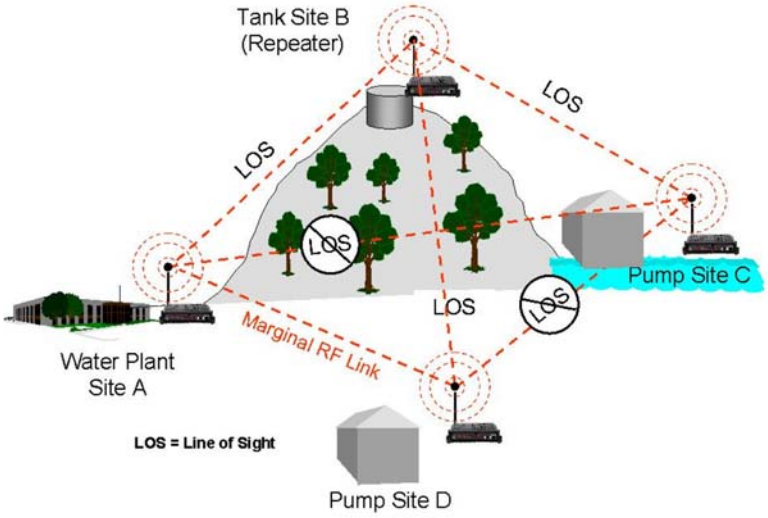


Figure 2: Small Mesh Network Diagram

The routing priority is manually set during the configuration of the Horizon. A manual path configuration is far superior to standard "self-discovery" networks, because you have direct control over the best RF paths and can easily identify any failed routes for easy troubleshooting. For example, Figure 2 shows a typical wireless Ethernet system used in the Water/Waste Water Industry. The problem with a standard "self-discovery" Mesh network is the selection of routes. Notice that the communication between the Water Plant (Site A) and Pump Site D has a marginal link, but it is the most direct route between the Ethernet devices.

This scenario poses the question, which path will the network select? The ESTeem Mesh Network takes out the guessing games by allowing the user to select and prioritize all communication routes in the system. In our example we would want the primary link to go through Tank B (Repeater) and use the direct link only if this primary link fails. The following sections will show how this completed.

Configuration

The configuration of the wireless paths is completed during setup of the Access Point modes. All three Access Point modes support repeating and Meshing features. You can also configure the Mesh networking directly through the web configuration setup (Chapter 5). Figure 3 shows an example peer table from the setup menus. For the Horizon to communicate with another Horizon, select Yes must at ***Enable Peer Capability***. Next, the Serial Number or Wireless LAN (WLAN) MAC address of each Horizon that will have direct communications must be added to the Peer List. Finally, ***enabling the link*** allows the corresponding Horizon to be

included in the communication routing. Mobile clients do not require input in the repeater peer table. If multiple Mesh routes are configured, you will also need to set the values for Priority and Path Length (explained in Rapid Spanning Tree below). For multiple examples of repeater configurations, please refer to Chapter 3 of this user's manual.

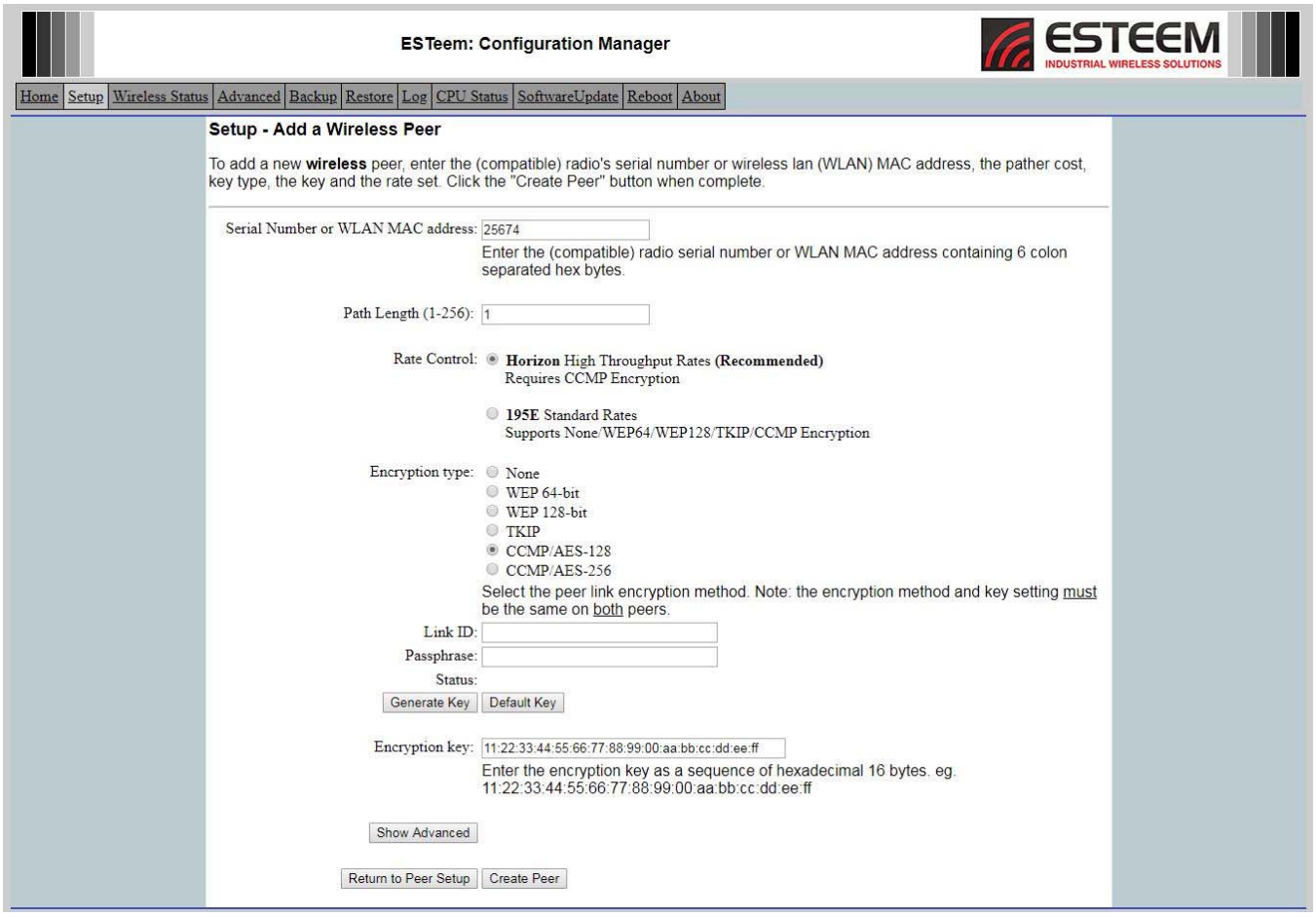


Figure 3: Repeater Configuration Example

Rapid Spanning Tree Protocol (RSTP)

The ESTeem Horizon uses standard Ethernet Rapid Spanning Tree Protocol (RSTP) to determine the radio routing structure of the wireless network. The primary purpose of RSTP is to make sure that "network loops" are not created. A network loop is having two communication paths to the same destination where the remote device would receive the same data multiple times. If there were no way to control the data flow, this data would be constantly passed around this loop causing a "packet storm" that would shut down the entire network. The Spanning Tree Protocol will block all these redundant links.

The RSTP operation begins by determining which Ethernet device on the network will be the Root Bridge. All Ethernet networks have a Root Bridge that is selected by the lowest MAC address. All path lengths are evaluated against this Root Bridge device to determine routing and which paths will be blocked. On a wired Ethernet network, the location of the Root Bridge is not really important, but in a wireless network selection of the Root Bridge is critical to the wireless network routing. Let's use one of the Example network diagrams from Chapter 3 to continue the discussion (Figure 4).

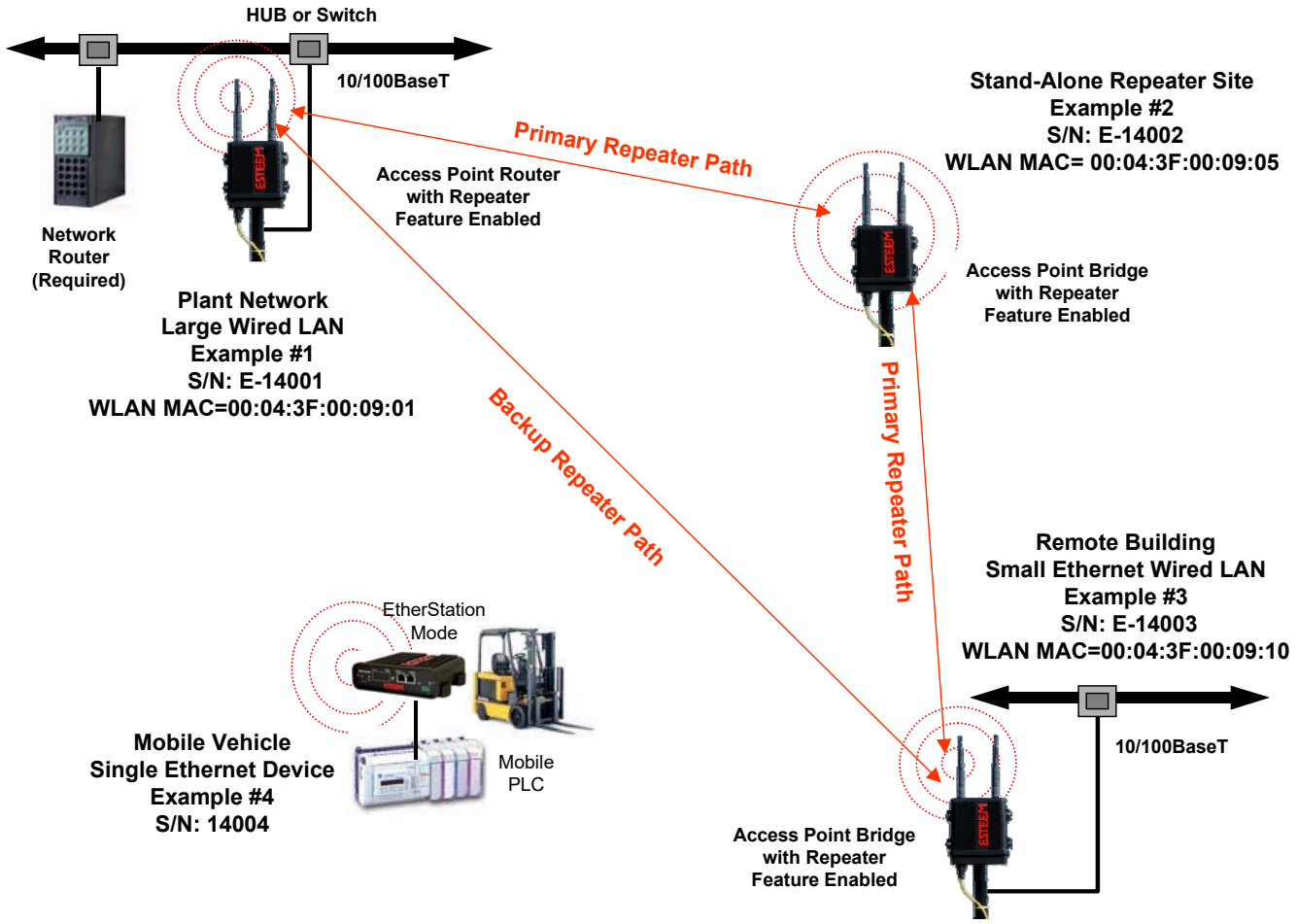


Figure 4: Programming Example #1 Diagram

RSTP Phases

The following sections describe the process of the RSTP in the ESTeem Horizon as how it would happen in the above example.

Learning Phase - Once properly configured, each Horizon will begin to search out the other Horizon units in radio range that are programmed in the AP Repeater Peer table. All Horizon's will calculate their routes to every Horizon in the network based upon the lowest "path length" to the Root Bridge. Path length is the total number of wireless links (repeater peer links) to transmit a packet through the wireless network to the Root Bridge. ***Note: The Root Bridge in a network should be the Horizon where the majority of the data flow is processed.*** In every wireless network of two or more radios, the Root Bridge should be user defined. If not defined, the Horizon with the lowest MAC address will be designated as the Root Bridge.

In Figure 4, the Plant network (Example 1) is the most logical location for the Root Bridge based upon the amount of data flow. Setting this site as the root bridge is discussed below in Root Bridge.

Blocking and Forwarding Phase – To ensure you do not have a network loop situation due to redundant paths in your wireless network, the Model Horizon will recognize and disable (block) one or more redundant links and provide back up links should the primary link fail. This establishes a wireless mesh network with a series of forwarding links, based upon the shortest path length to the Root Bridge.

For example, looking at Figure 4, the Remote Building has two routes to the Root Bridge (Plant Network – Example #1); directly to the site and through the repeater. The direct link between the two sites is the shortest route (lowest Path Length) and will be selected as the primary route unless overridden by manually changing the Path Length in the configuration.

Path Length

If more than one communication path to the Root Bridge is found, the Horizon must determine which route to take based upon the lowest Path Length. The default path length to all links in the Horizon network is 1. If the Path Lengths are equal then the lowest MAC address will determine the priority route. In the ESTeem Mesh Network we want to directly control all data flow so do **not** want the routes to be automatically determined.

Looking again at our Example in Figure 4, if we made no changes to the default path length of 1 (note values in Figure 3) the lowest path length would be direct from the Remote Building to the Root Bridge (Plant Network).

Link Description	Total Path Length
Direct from Remote Building	1
Remote Build to Root Bridge Through Repeater	2 (Length 1 to repeater + Length 1 to Master = 2)

To configure the Horizon to select the repeater as the primary radio path, set the path length value for the direct link greater than 2 (such as a value of 3) to make this the primary radio path. The lowest path length will identify the highest priority. The Model Horizon will use this routing, but also switch to direct communication if the repeater were to disappear.

Root Bridge

In any Access Point Repeater network consisting of more than two sites, one Model Horizon should be designated as the Root Bridge. Only one Model Horizon can be designated as the Root Bridge in a given network and should be located where the majority of the Ethernet data flow is processed. This site may be the Master location in a SCADA network or could be configured at a repeater site. Selection is important because all Model Horizon's **NOT** configured as the Root Bridge will choose routing based upon the Path Length to the Root Bridge. If you have any question as to which site in your AP Repeater application should be the Root Bridge, contact ESTeem Customer Support at 509-735-9092 or e-mail your application to support@esteem.com.

The Root Bridge will be selected in one of two ways: the Root Bridge can be manually set (recommended) during the configuration of the Repeater Peer table (Figure 3) **or** the Root Bridge designation will default to the lowest MAC address of all the Model Horizon's in the network. The manual Root Bridge configuration is located in the "Advanced Settings" section.

Redundant Backup

The ESTeem Horizon configured in Access Point mode will automatically function as a redundant backup if two Horizons are installed at the same location (Figure 7). If two Horizons are connected to the same switch, one of the Horizons will be **Blocked** when the Rapid Spanning Tree Protocol is completed. The network will continue to use this route until any problem with the original Model Horizon is detected and the second Horizon will begin operation at that site.

Redundant Master Configuration

The configuration in Figure 7 will also provide a redundant backup for the Master Site (Root Bridge). Configure both Horizons as Root Bridges (see above) giving the primary Root Bridge a value of 1 and the secondary Root Bridge a value of 2.

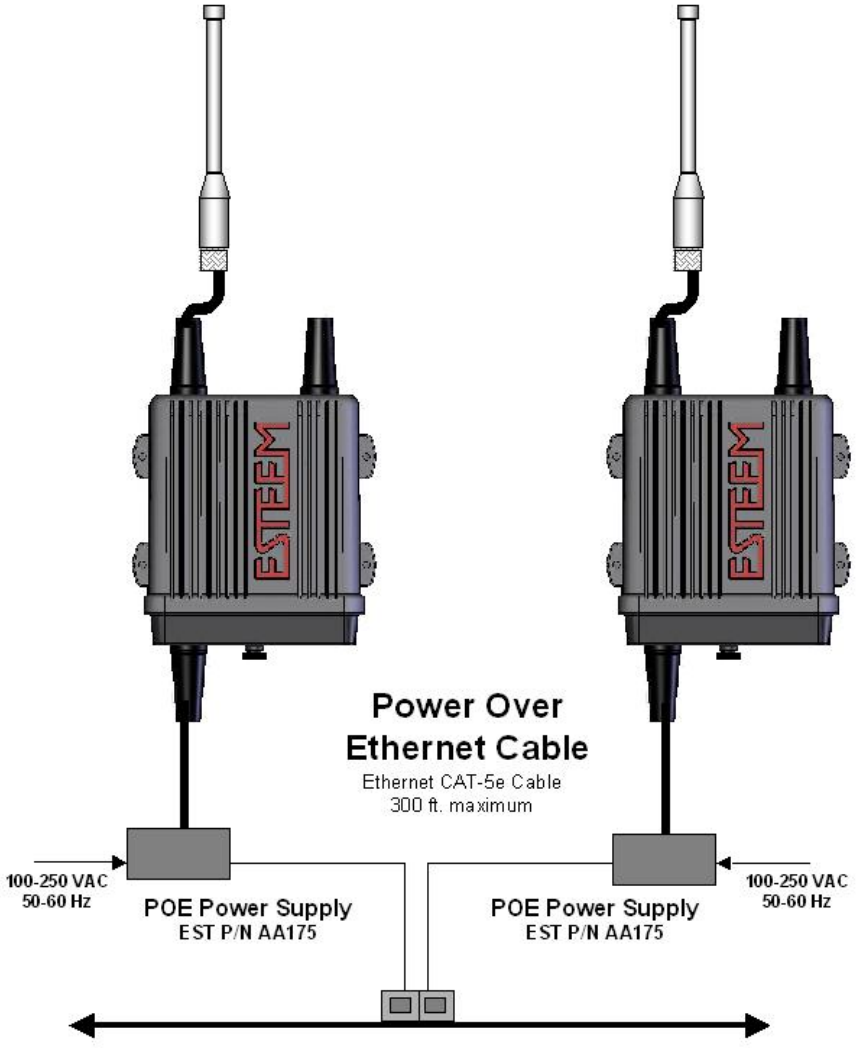
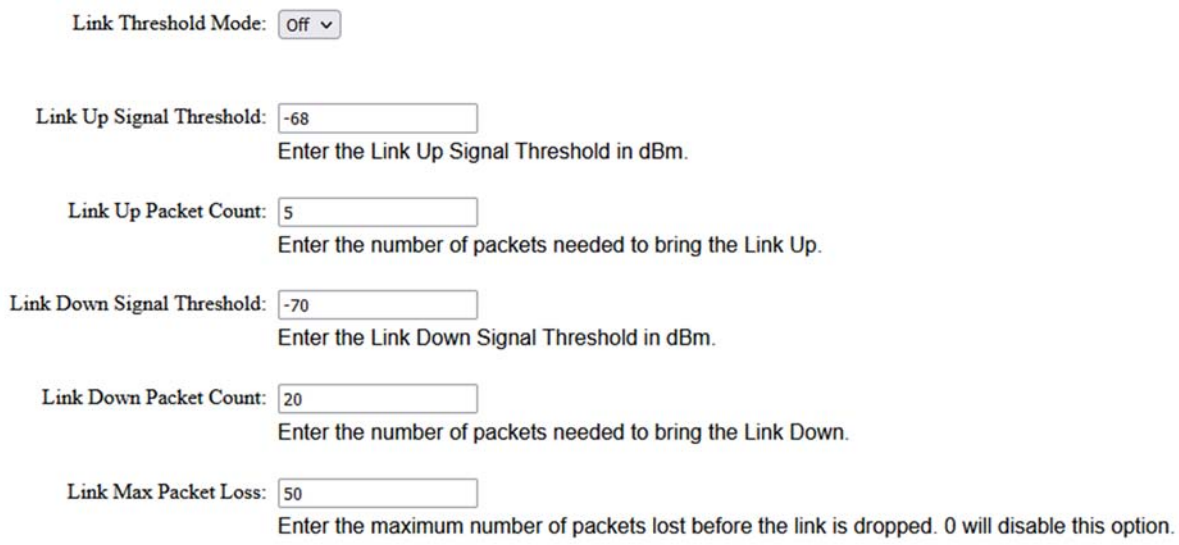


Figure 7: Redundant Backup Diagram

Link Threshold (Dynamic MESH) Mode

The ESTeem Horizon has an Advanced Option when setting up the Peer List where the Link Threshold Mode can be enabled. Once enabled the peer link will enable and disable based on the set receive signal strength threshold values in the advanced peer options. This works functionally like a mobile client radio connection but can still function as an Access Point for other mobile devices giving the network maximum flexibility.

This mode requires significant configuration as the thresholds for each link must be manually configured to meet the network requirements. Each link will need the enable (Link Up) and shutoff (Link Down) receive signal levels configured by measuring the signal strengths at the closest and farthest distance each radio will travel. Once these values are measured, they will need to be enabled for each Peer link. For help with this configuration, please contact ESTeem support at support@esteem.com or by calling 509-735-9092.



Twin Bridge Network (Dual SSID)

There is a new feature in the Horizon series called the Twin Bridge Network. This feature will give the Horizon a second SSID, separate wireless network (if required) and use a unique Ethernet port for each network connection. This feature can be used for providing a WiFi guest account or having an isolated control system and WiFi access within a single Horizon radio network with an "air-gap" by steering each to a unique Ethernet interface.

Figure 8 shows an example of how the second SSID function could be used. The first SSID "ESTeemWiFi" can be used in and around the Master and remote facilities to provide wireless access to mobile clients in the network. This first SSID will be directed to Ethernet port #1 (ETH0) on Horizon by default. The second SSID "ESTeemControl" would be used exclusively for providing a wireless Ethernet network for the control hardware and would use the 2nd Ethernet port (ETH1) by default. The two wireless networks are configured independently and there is no "cross talk" between the networks.

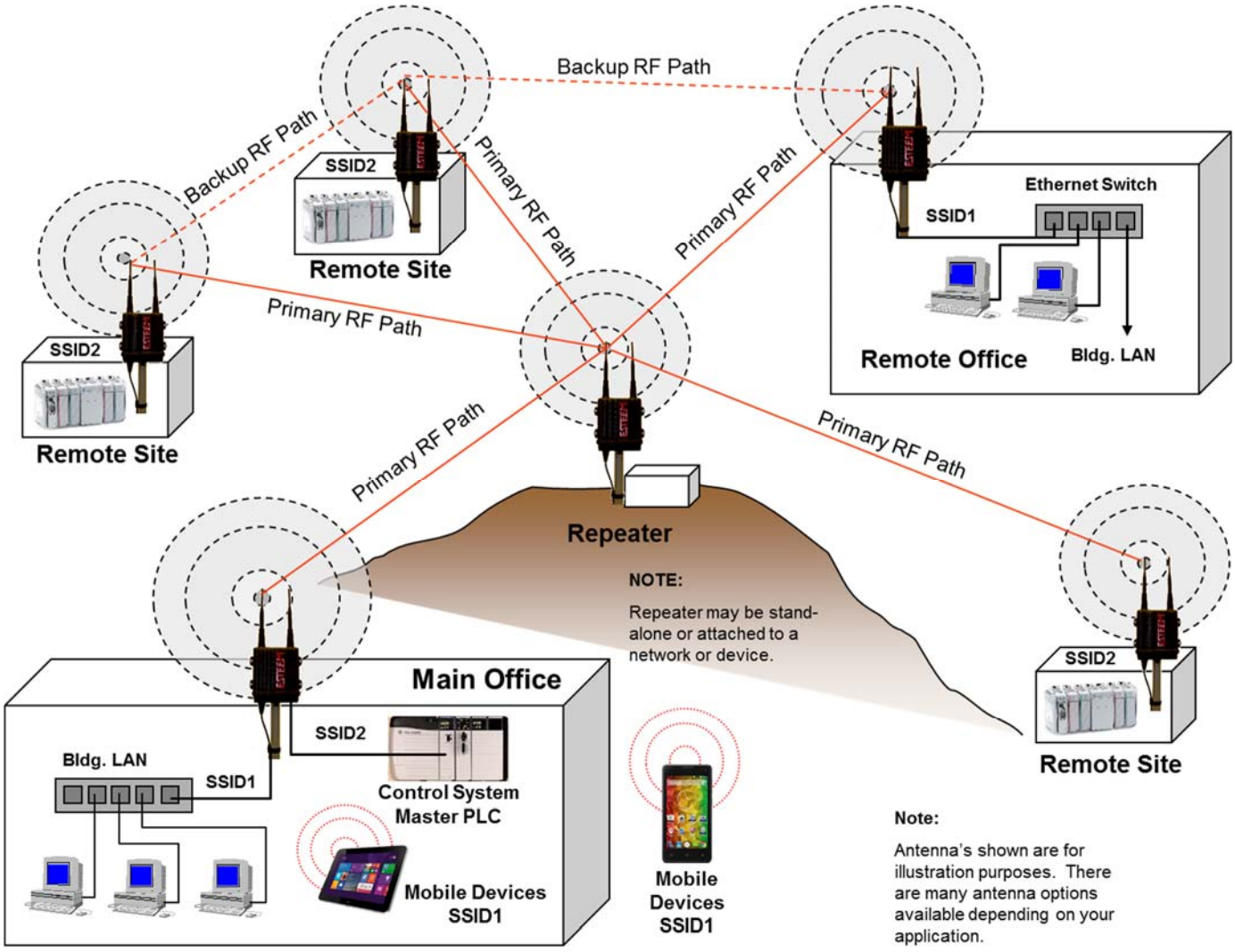


Figure 8: Redundant Backup Diagram

This Twin Bridge networking feature only works in the AP Bridge mode of operation and requires that each AP Bridge network be configured on a unique IP subnet. The configuration of the second SSID is done through the Advanced Tab (Figure 9) by selecting

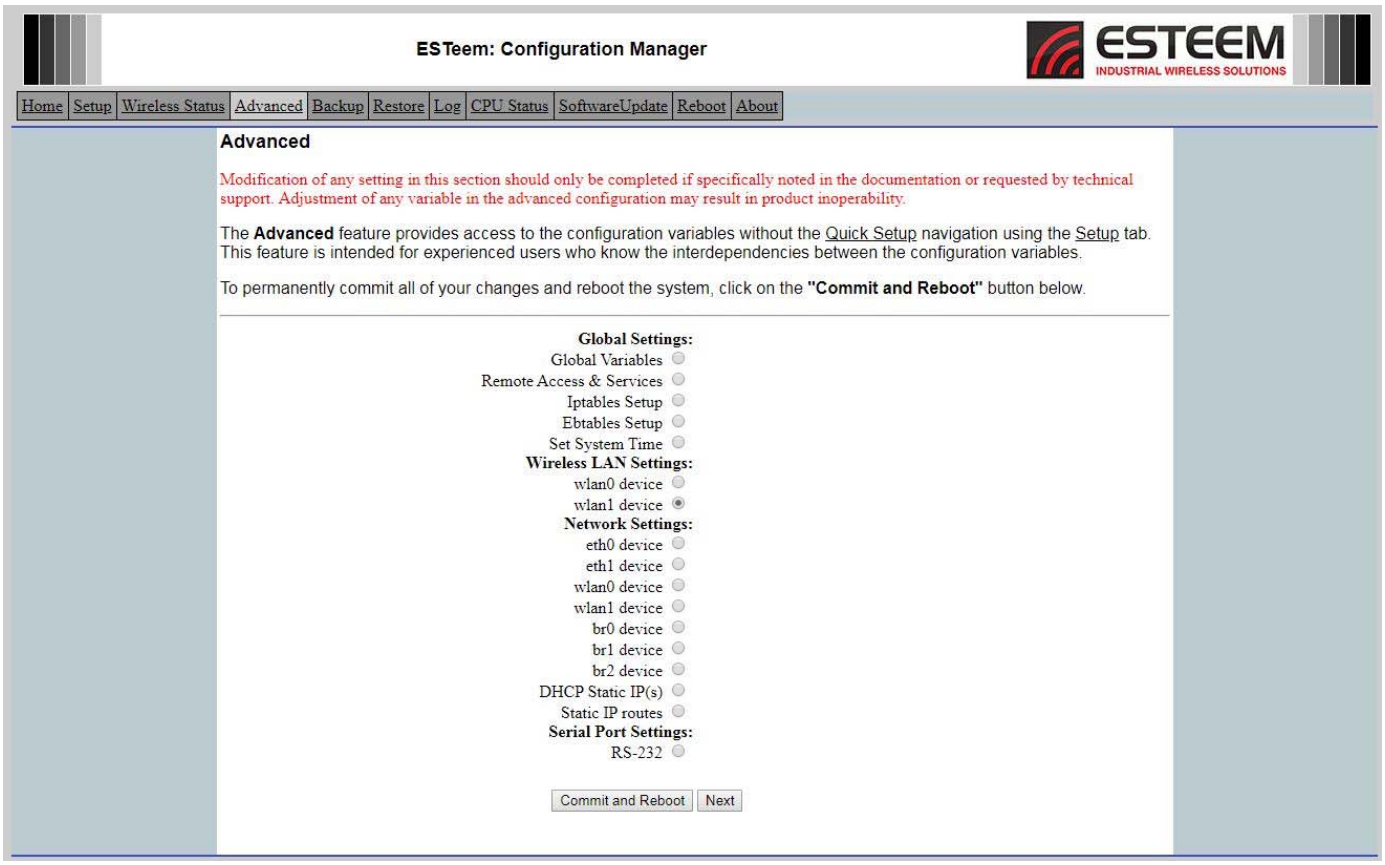


Figure 9: Advanced Menu

Wireless LAN Settings>wlan1 device. Select the Enable wlan1=On (Figure 10) and press the "Setup" button with the Basic Chain selected to complete the configuration. The configuration of the second SSID is an identical step by step as described in Chapter 3 – Example Applications for AP Bridge mode. This second wireless network will operate simultaneously with the first AP Bridge SSID configured in the Setup tab.

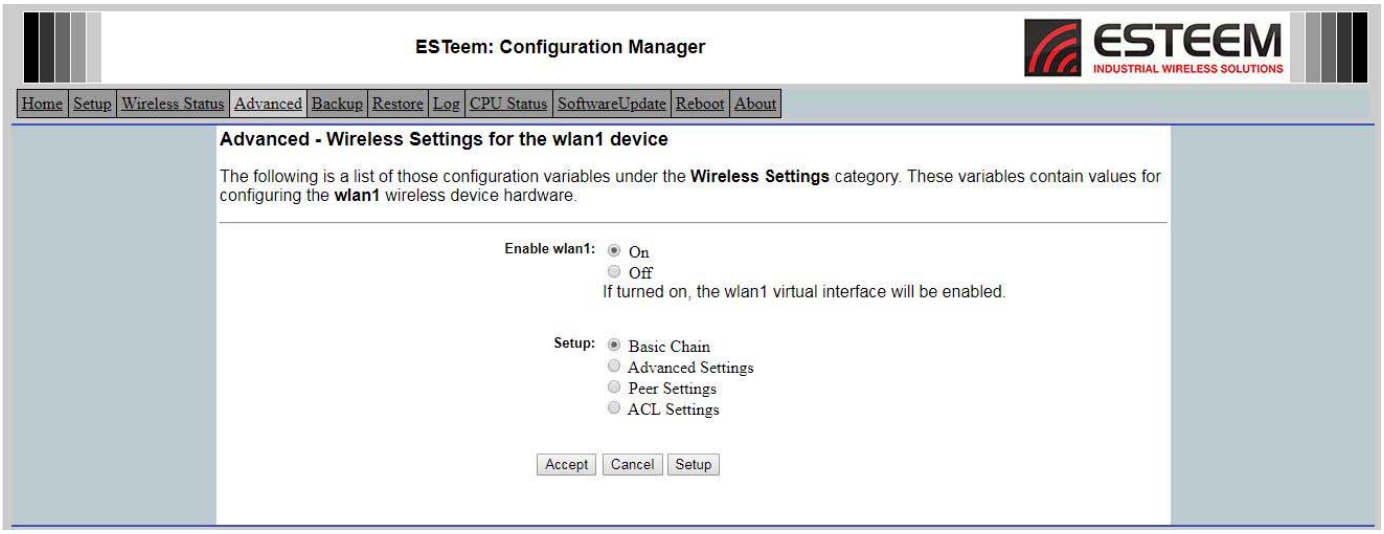


Figure 10: wlan1 Interface Configuration

Horizon 2.4 GHz Antenna and Cable Configurations

ESTeem offers different types of antennas for both indoor and outdoor configurations. To reduce potential radio interference to other users, the antenna type and its gain should be chosen so that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

This radio transmitter ESTeem Horizon 2.4 GHz (HVIN: 216AN) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le present emetteur radio ESTeem HVIN: 216AN a ete approuve par Industrie Canada pour fonctionner avec les types d'antenne enumeres ci-dessous et ayant un gain admissible maximal et l'impedance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est superieur au gain maximal indique, sont strictement interdits pour l'exploitation de l'emetteur.

Warning: ***Only the tested cable lengths and antennas provided by ESTeem meet the FCC maximum peak output power requirements. Any other combination of antennas or coax cables is not authorized. This device has been designed to operate in a pole mount configuration with the antennas listed below, having a maximum gain of 6 dB in a multi-point system or 145dB in a point to point network. Antennas not included in this list or having a gain greater 6 dB in a multi-point system or 15dB in a point to point network are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.***

Part Number: AA20DMEg

- Omni-directional direct mount antenna, 5 dBi gain.
- Indoor and outdoor applications.
- There must be a minimum separation distance of 24 cm. from the antenna to the user. ***See Warnings.***

Part Number: AA20Eg

- Omni-directional pole mount antenna, 8 dBi gain with 18 in. integral feedline and connector.
- Point to point and point to multi-point outdoor applications.
- Antenna port B is not used in this configuration.
- There must be a minimum separation distance of 24 cm. from the antenna to the user. ***See Warnings.***
-

Part Number: AA206Eg

- Directional pole mount antenna, 14 dBi gain with 18 in. integral feedline and connector.
- Point to point applications only.
- Maximum Output Power of 250mWatts (Power Level = Low Power)
- Antenna port B is not used in this configuration.
- There must be a minimum separation distance of 50 cm. from the antenna to the user. ***See Warnings.***

Transmit/Receive Antenna Port 1 **Receive Only Antenna Port 2**

Warnings:

Only pre-made coax cables from the factory used in conjunction with either the AA20Eg and AA206Eg directional antennas meet all FCC Section 15.247(b) EIRP maximum power requirements.

Use of the AA206Eg, directional antenna is limited to fixed point to point applications only. In accordance FCC Section 15.247(b)iii, this antenna must be professionally installed. The installer must ensure the system is used exclusively for fixed, point-to-point applications and the ESTeem Horizon is set for 0.25 Watts output power (Power Level = Min).

Horizon 2.4 GHz-MIMO Antenna and Cable Configurations

ESTeem offers different types of antennas for both indoor and outdoor configurations. To reduce potential radio interference to other users, the antenna type and its gain should be chosen so that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

This radio transmitter ESTeem Horizon 2.4 GHz-MIMO (ICID: 7442A-R11E2HPND) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le present emetteur radio ESTeem Horizon 2.4GHz-MIMO (ICID: 7442A-R11E2HPND) a ete approuve par Industrie Canada pour fonctionner avec les types d'antenne enumeres ci-dessous et ayant un gain admissible maximal et l'impedance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est superieur au gain maximal indique, sont strictement interdits pour l'exploitation de l'emetteur.

Warning: Only the tested cable lengths and antennas provided by ESTeem meet the FCC & IC maximum peak output power requirements. Any other combination of antennas or coax cables is not authorized. This device has been designed to operate in a pole mount configuration with the antennas listed below, having a maximum gain of 13 dB in a multi-point system or 19dB in a point to point network. Antennas not included in this list or having a gain greater 13 dB in a multi-point system or 19dBi in a point to point network are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

Part Number: AA20DMEg

- Omni-directional direct mount antenna, 5 dBi gain.
- Indoor and outdoor applications.
- There must be a minimum separation distance of 24 cm. from the antenna to the user. ***See Warnings.***

Part Number: AA20Eg-Dual

- Omni-directional pole mount antenna, 13 dBi gain with dual 18 in. integral feedline and connector.
- Point to point and point to multi-point outdoor applications.
- There must be a minimum separation distance of 50 cm. from the antenna to the user. ***See Warnings.***

Part Number: AA206Eg-Dual

- Directional pole mount antenna, 19 dBi gain with dual 18 in. integral feedline and connector.
- Point to point and point to multipoint outdoor applications.
- There must be a minimum separation distance of 50 cm. from the antenna to the user. ***See Warnings.***

Transmit/Receive Antenna Port 1 **Transmit/Receive Antenna Port 2**

Warnings:

Only pre-made coax cables from the factory used in conjunction with either the AA20Eg-Dual and AA206Eg-Dual directional antennas meet all FCC Section 15.247(b) EIRP maximum power requirements.

To comply with the FCC exposure compliance requirements, a separation distance of at least 24-50cm must be maintained between the antenna and all persons.

Horizon 900 MHz Antenna and Cable Configurations

ESTeem offers different types of antennas for both indoor and outdoor configurations. This device has been designed to operate with the antennas listed below, and having a maximum gain of 7 dB. Antennas not included in this list or having a gain greater than 7 dB are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

This radio transmitter ESTeem Horizon 900 MHz (HVIN: 216AD) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le present emetteur radio ESTeem HVIN: 216AD a ete approuve par Industrie Canada pour fonctionner avec les types d'antenne enumeres ci-dessous et ayant un gain admissible maximal et l'impedance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est superieur au gain maximal indique, sont strictement interdits pour l'exploitation de l'emetteur.

Warning: Only the tested cable lengths and antennas provided by EST meet the FCC and DOC maximum peak output power requirements. Any other combination of antennas or coax cables is not authorized. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

Part Number: AA20DMs

- Omni-directional direct mount antenna, 2 dBi gain.
- Indoor and outdoor applications.
- There must be a minimum separation distance of 23 cm. from the antenna to the user. ***See Warnings.***

Part Number: AA20Es900

- Omni-directional external pole mount antenna, 7 dBi gain with 3-ft. integral feedline and connector.
- Outdoor applications.
- There must be a minimum separation distance of 23cm. from the antenna to the user. ***See Warnings.***

Part Number: AA203Es900

- Directional pole mount antenna, 7 dBi gain with 3-ft. integral feedline and connector.
- Point to point and point to multi-point outdoor applications.
- There must be a minimum separation distance of 23 cm. from the antenna to the user. ***See Warnings.***

Transmit/Receive Antenna Port 1 **Receive Only Antenna Port 2**

Notes:

Antenna Port A is a transmit and receive port for use in all applications.

Antenna Port B is a receive only port and is used for dual diversity antennas applications only. This port is not used for point to point applications.

Warnings:

Only pre-made coax cables from the factory used in conjunction with either the AA20Es900 omni-directional and AA203Es900 directional antennas meet all FCC Section 15.247(b) EIRP maximum power requirements.

Horizon 4.9 GHz Antenna and Cable Configurations

ESTeem offers different types of antennas for indoor, outdoor and mobile configurations.

Part Number: AA191Ep

- Omni-directional, vehicle mount, 5.5dBi gain antenna.
- Mobile vehicle mount applications.
- The AA191Ep antenna must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Part Number: AA20DMEp

- Omni-directional direct mount antenna, 5 dBi gain.
- Indoor and outdoor applications.
- The AA20DMp antenna must be fixed-mounted on outdoor permanent structures with a separation distance of at least 20 cm from all persons during normal operation and must not be co-located or operating in conjunction with any other antenna or transmitter.

Part Number: AA20Ep

- Omni-directional pole mount antenna, 10 dBi gain
- Antenna port B is not used in this configuration.
- The AA20Ep antenna must be fixed-mounted on outdoor permanent structures with a separation distance of at least 20 cm from all persons during normal operation and must not be co-located or operating in conjunction with any other antenna or transmitter.

Part Number: AA204Ep

- Directional pole mount antenna, 21 dBi gain with 3-ft. integral feedline and connector.
- Antenna port B is not used in this configuration.
- The AA204Ep antenna must be fixed-mounted on outdoor permanent structures with a separation distance of at least 60 cm from all persons during normal operation and must not be co-located or operating in conjunction with any other antenna or transmitter.

Transmit/Receive Antenna Port 1 **Receive Only Antenna Port 2**

Horizon 5.8 GHz Antenna and Cable Configurations

ESTeem offers different types of antennas for both indoor and outdoor configurations. This device has been designed to operate with the antennas listed below, and having a maximum gain of 22 dBi. Antennas not included in this list or having a gain greater than 22dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

Warning: This radio transmitter ESTeem Horizon 5.8 GHz contains FCC ID TV7R11E5HND and only the tested cable lengths and antennas provided by EST meet the FCC maximum peak output power requirements. Any other combination of antennas or coax cables is not authorized. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

Part Number: AA20DMEa
- Omni-directional direct mount antenna, 3 dBi gain.
- Indoor and outdoor applications.
- There must be a minimum separation distance of 23 cm. from the antenna to the user. ***See Warnings.***

Part Number: AA20Ea
- Omni-directional external pole mount antenna, 10 dBi gain with 18-inch integral feedline and connector.
- Outdoor applications.
- There must be a minimum separation distance of 23 cm. from the antenna to the user. ***See Warnings.***

Part Number: AA205Ea
- Directional linear panel, pole mount antenna, 22 dBi gain with 18-inch integral feedline, bandpass filter and connector.
- Point to point and point to multi-point outdoor applications.
- There must be a minimum separation distance of 50 cm. from the antenna to the user. ***See Warnings.***

Part Number: AA20Ea-Dual (MIMO)
- Dual polarity omni-directional external pole mount antenna (MIMO), 13 dBi gain with (2) 18-inch integral feedline and connector.
- Outdoor applications.
- There must be a minimum separation distance of 23 cm. from the antenna to the user. ***See Warnings.***

Part Number: AA205Ea-Dual (MIMO)
- Dual polarity directional linear panel, pole mount antenna, 24 dBi gain with (2) 18-inch integral feedline, bandpass filter and connector.
- Point to point and point to multi-point outdoor applications.
- There must be a minimum separation distance of 50 cm. from the antenna to the user. ***See Warnings.***

Transmit/Receive Antenna Port 1 **Transmit/Receive Antenna Port 2**

Warnings:

Only pre-made coax cables from the factory used in conjunction with either the omni-directional and directional antennas meet all FCC Section 15.247(b) EIRP maximum power requirements.

To comply with the FCC exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna and all persons.

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 (See Note 2 and instructions below).
   a) Clean surface to be wrapped. Cut off length to be used.
   b) Peel back a short length of protective film. Keep 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) End of tape at final wrap should be completely positioned onto itself.

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 (See Note 3).

NOTES:

1. Dow Corning RTV-3140 or equivalent.

2. CoaxWrap, CW10B or equivalent.

3. SCOTCHKOTE, 3-M Company, or equivalent.

ANTENNA DIVERSITY

The dual diversity antenna configuration on the Horizon allows the radio to operate more efficiently in areas with high reflections (such as indoors or in a city) without direct line of sight (LOS) between the antennas. One of the most difficult conditions to control in a radio system is the effect of a destructive reflected radio signal called mutipathing. Multipathing occurs when waves emitted by the transmitter travel along a different path and interfere destructively with waves traveling on a direct line-of-site path. The phenomenon occurs because waves traveling along different paths may be completely out of phase when they reach the antenna, thereby canceling each other out. The dual diversity antenna configuration places a physical distance between the antennas where one reflected signal will be out of phase, but the second will be not. The ESTeem Horizon will sample both antennas and select the best receive signal. Both antenna ports are active by default in the Horizon series.

Assembling The AA195PM Two Hole Outdoor Pole Mounting Kit

The AA195PM mounting kit contains everything required for pole mounting and weatherproofing the ESTeem Horizon for outdoor installations. The Horizon with AA195PM mounting kit can be directly mounted to a round pole from 1.25" to a diameter of 2.25" OD. Any mounting structure greater than 2" requires hose clamp strapping run through the Pole Mount Brackets. The mounting kit requires the following assembly:

1. If you purchased an AA195PM mounting kit with your Horizon, the kit will be packed in the same packing box as the ESTeem (Figure 4).

2. Remove and inventory the two (2) Pole Mounting Brackets, one (1) Two-Hole Face Plate Cover (with single port cover installed), one (1) Heat Shield and (1) AA195PM Hardware bag from the packing box (Figure 4). Report any missing or damaged items to ESTeem Customer Support (Phone 509-735-9092) as soon as possible for replacement.

3. Inventory the AA195PM Hardware bag for all the components listed in Figure 5.

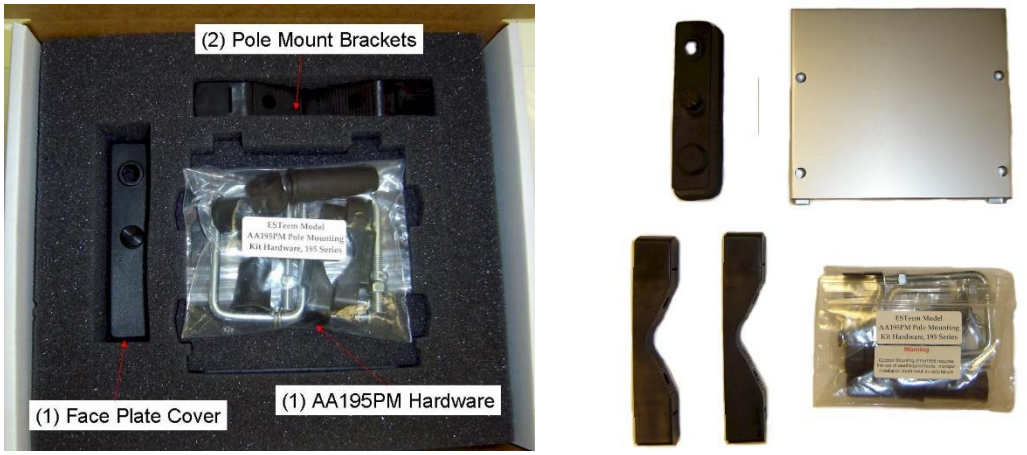


Figure 4: Packet Box Contents

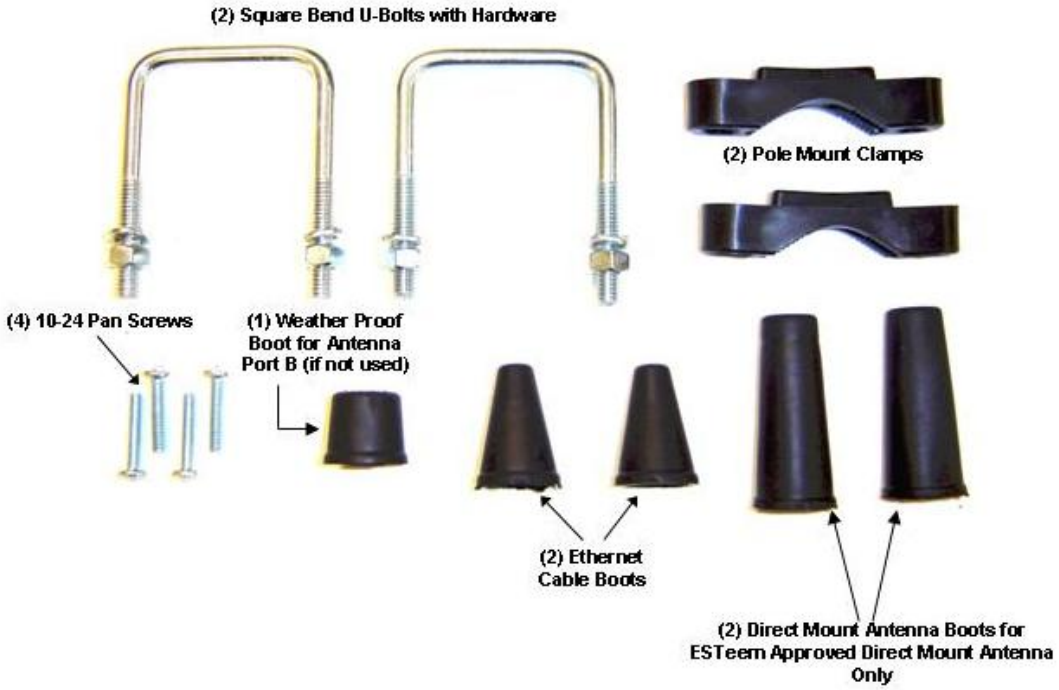


Figure 5: AA195PM Hardware Contents

4. Assemble the two Pole Mounting Brackets with the included U-bolts, hardware and Pole Mount Clamps. Reference Figure 6.

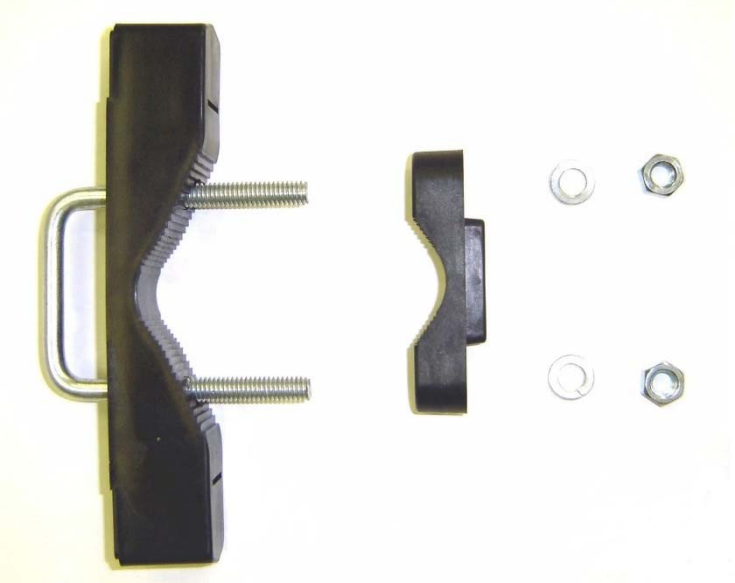


Figure 6: Pole Mount Assembly

5. Place the four supplied 10-24 x 1" Phillips Pan Head screws through the mounting holes of the Heat Shield and attach to the top of the ESTeem Horizon (Figure 7).

6. Attach the two Pole Mounting Brackets to the ESTeem Horizon with the 10-24 x 1" Phillips Pan Head screws through the top of the heat shield. Reference Figure 8 (Heat Shield removed for detail).

Figure 7: Heat Shield Attachment

7. Assemble the outdoor rated CAT-5e Ethernet cable (Not Provided) with the supplied Ethernet Cable Boot (Figure 9).

Figure 8: Pole Mount Connection to Case
(Heat Shield Removed for Detail)

Figure 9: Ethernet Cable Assembly

8. Feed the CAT-5e Ethernet connector(s) through the Face Plate Cover and secure the Ethernet Cable Boot to the cover. Reference Figure 10.

NOTE: The Ethernet cable boot must be installed before the RJ-45 end is installed. If using the ESTeem AA09.1 outdoor Ethernet cable, verify that the Ethernet cable boot end is routed toward the ESTeem Horizon.

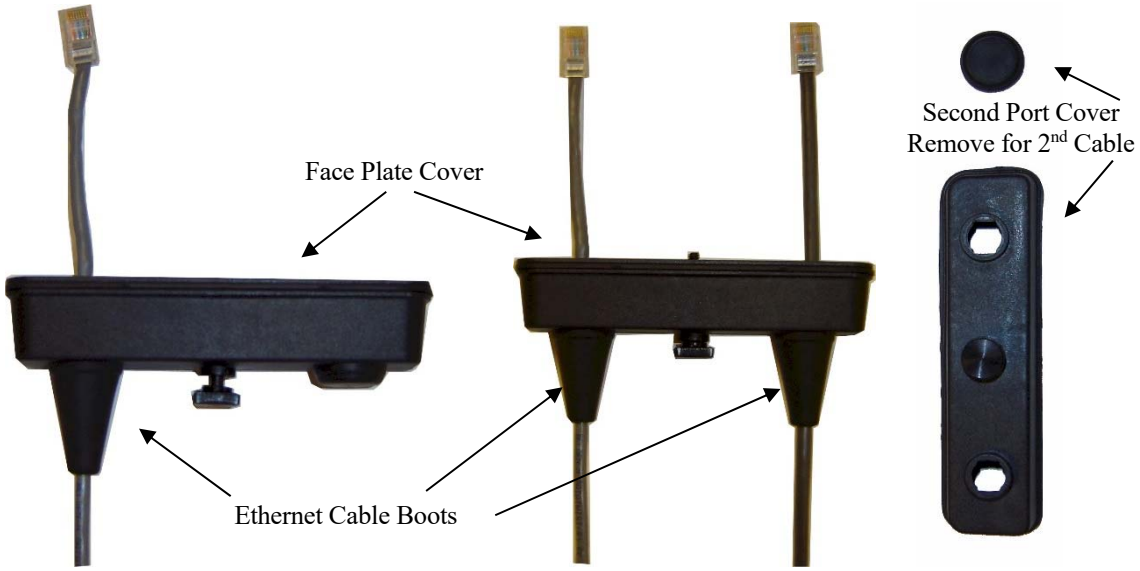


Figure 10: Ethernet Cable Routing

9. Route the CAT-5e Ethernet cable through the molded strain-relief fins in the Face Plate Cover (Figure 11) to secure the cable and provide strain-relief for the connector. If a second Ethernet cable is installed, remove the second port cover and route cable.

Figure 11: Face Plate Cover Strain Relief

10. Plug the CAT-5e Ethernet cable to the Horizon's Ethernet port and secure the Face Plate Cover with the attached thumb screw. Verify that the weatherproof seal on the Face Plate Cover is sealed against the outer rim of the Horizon. Reference Figure 12.

11. Attach the antenna connector boots as show in Figure 13 for either dual attached antennas or external antennas. You are now ready to mount the ESTeem Horizon

Figure 12: Face Plate Cover Installed on ESTeem

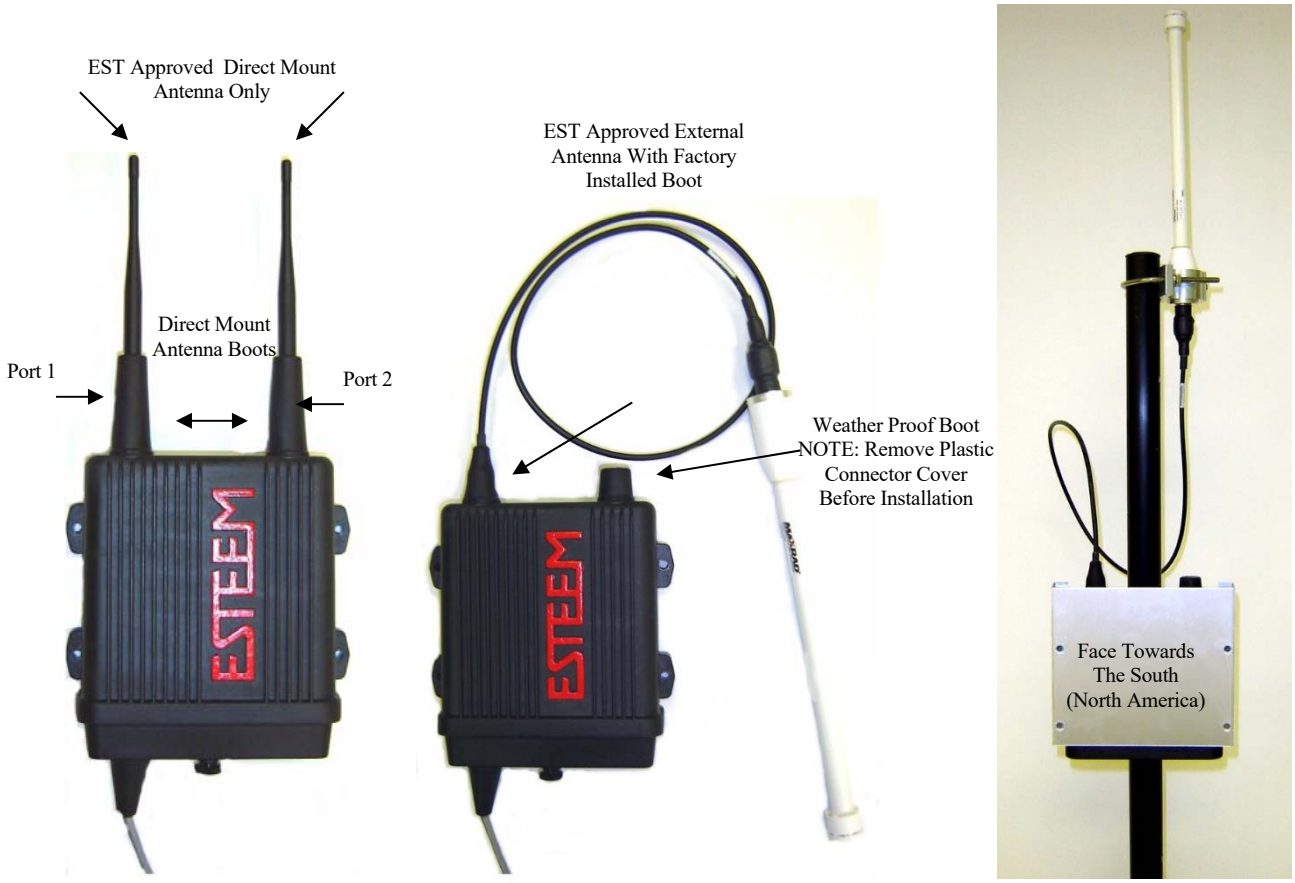


Figure 13: Completed AA195PM Mounts

Caution: Outdoor mounting of the Horizon requires the use of weatherproof boots. Improper installation could result in radio failure.

Caution: Always mount the Horizon vertically with the antenna ports on top.

Horizon Pole Mount Grounding Procedures

Mounting the Horizon series radio modem outdoors requires proper grounding procedures to prevent damage to both the radio hardware and the connected Ethernet and Serial peripherals. The case on the Horizon series wireless modem is electrically conductive, but the AA195 Pole Mount kit provides isolation from the connected structure. To bring the Horizon case to a ground potential with Earth ground and eliminate any static buildup on the case itself, the shield on the Ethernet cable is used to provide the ground connection.

Outdoor Ethernet Cable

A critical component of this grounding protection system is the ESTeem AA09.1 outdoor, shielded CAT-5E Ethernet cable. This cable provides three, necessary elements; Ethernet data, DC Power over Ethernet (PoE) applications, and a ground from the Horizon case to the AA166 surge protector. The Ethernet cable is outdoor rated and protected from UV breakdown.

Installation

The following diagram outlines all the critical components and connections in the Horizon series system. The Earth ground connection to the surge protector must be installed to comply with local Electrical code requirements.

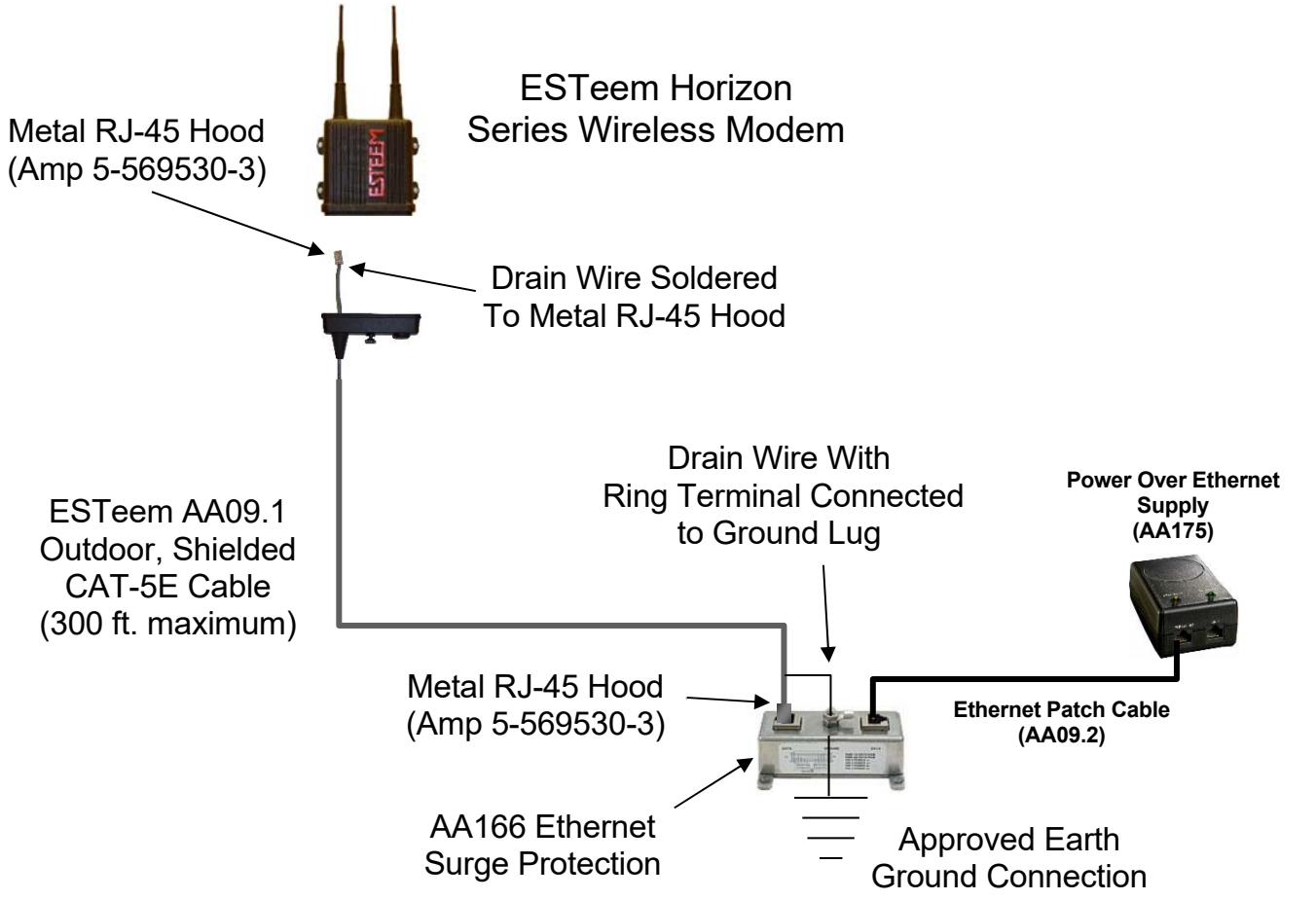


Figure 14: Pole Mount Installation Diagram

Fresnel Zone

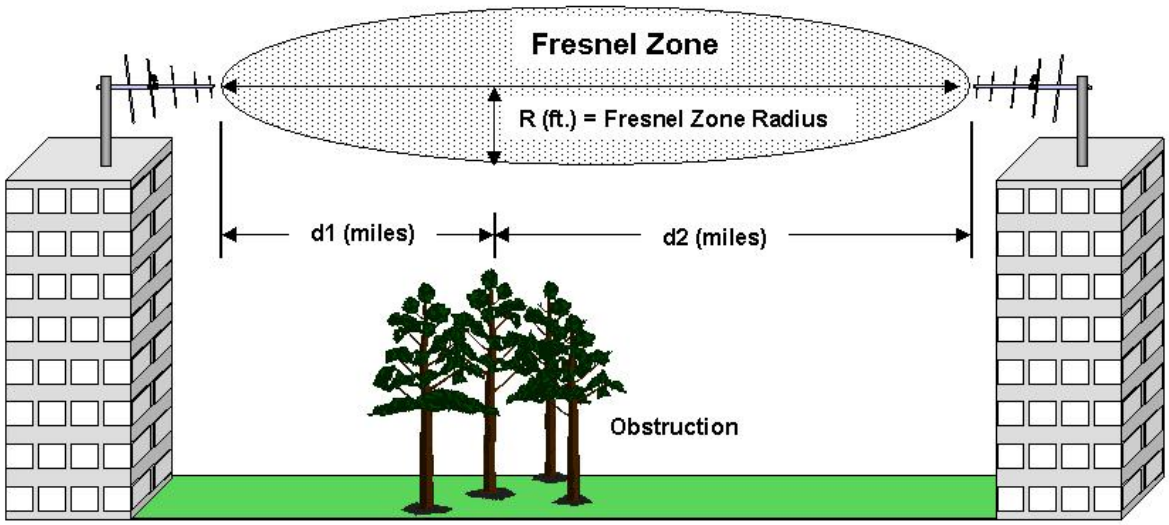


Figure 15: Fresnel Zone Diagram

The Fresnel zone shows the ellipsoid spread of the radio waves around the visual line-of-sight after they leave the antenna (see Figure 15). This area must be clear of obstructions or the signal strength will be reduced due to signal blockage. Typically, 20% Fresnel Zone blockage introduces little signal loss to the link. Beyond 40% blockage, signal loss will become significant. This calculation is based on a *flat earth.* It does not take into account the curvature of the earth. It is recommended for RF path links greater than 7 miles to have a microwave path analysis done that takes the curvature of the earth and the topography of the terrain into account.

Fresnel Zone Radius = 72.1 SQRT [(d1d2) / (F (d1 + d2)]

Units
Fresnel Zone Radius in feet.
d1 and d2 in statue miles
F in GHz

APPENDIX A
LICENSING INFORMATION

Information to Users

The equipment has been tested and found to comply with the limits for both the FCC Class B digital device (pursuant to Part 15 of the FCC rules) and Industry Canada (IC) CAN ICES-3 (B)/NMB-3(B).

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

Caution: Changes or modifications to this equipment not expressly approved by ESTeem Wireless Modems for compliance could void the user's authority to operate the equipment.

IC Statement
"This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device."

"Cet appareil est conforme avec Industrie Canada exempts de licence standard RSS (s). Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris celles pouvant causer un mauvais fonctionnement de l'appareil."

Emissions Information

Horizon 2.4 GHz (Model 216An)
HVIN: 216AN
Direct Sequence/OFDM Spread Spectrum Device
(USA) FCC ID: **ENPHZN216AN**
(Canada) IC No: **2163A-216AN**

Horizon 2.4 GHz MIMO (Model 216An-mm)
Direct Sequence/OFDM Spread Spectrum Device
(USA) FCC ID: **TV7R11E2HPND**
(Canada) IC No: **7442A-R11E2HPND**

Horizon 900 MHz (Model 216Ad)
HVIN: 216AD
Direct Sequence/OFDM Spread Spectrum Device
(USA) FCC ID: **ENPHZN216AD**
(Canada) IC No: **2163A-216AD**

Horizon 4.9 GHz (Model 216Ap)
Direct Sequence/OFDM Spread Spectrum Device
(USA) FCC ID: **ENPHZN216AP**

Horizon 5.8 GHz (Model 216Aa-lp)
OFDM Spread Spectrum Device
(USA) FCC ID: **TV7R11E5HND**

FEDERAL COMMUNICATIONS COMMISSION FIELD OFFICES

ALASKA
1011 E. Tudor Rd.
Rm 240 Box 2955
Anchorage, AK 99510

CALIFORNIA
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Ceritos Corporate Tower
18000 Studebaker Rd., Room 660
Cerritos, CA 90701-3684

San Francisco Office (SF)
5653 Stoneridge Drive, Suite 105
Pleasanton, CA 94588-8543

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Denver Office (DV)
215 S. Wadsworth Blvd., Suite 303
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Miami, FL 33130

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HAWAII
7304 Prince Kuhi
Federal Building
Honolulu, HI

ILLINOIS
Chicago Office (CG)
Park Ridge Office Ctr., Room 306
1550 Northwest Highway
Park Ridge, IL 60068-1460

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New Orleans Office (OR)
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Metarie, LA 70001

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Baltimore, MD

MASSACHUSETTS
Boston Office (BS)
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Quincy, MA 02169-7495

MICHIGAN
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MINNESOTA
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316 N Robert St.
St. Paul, MN

MISSOURI
Kansas City Office (KC)
520 NE Colbern Road
Second Floor
Lee's Summit, MO 64086

NEW YORK
1307 Federal Building
111 W. Huron
Buffalo, NY 14202

NEW YORK
New York Office (NY)
201 Varick Street, Suite 1151
New York, NY 10014-4870

OREGON
1782 Federal Building
1220 SW 3rd Avenue
Portland, OR 97204

PENNSYLVANIA
Philadelphia Office (PA)
One Oxford Valley Office Bld.
Room 404
2300 E. Lincoln Hwy
Langhorne, PA 19047-1859

PUERTO RICO
747 Federal Building
Carlo Chardon Ave.
Hato Rey, PR 00918

TEXAS
Dallas Office (DL)
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)
11410 NE 122nd Way
Room 312
Kirkland, WA 98034-6927

ETHERNET INTERFACE

The ESTeem Horizon's Ethernet Port is a Full and Half-Duplex Auto-negotiation interface supporting 10Mbps, 100Mbps and 1Gbps (10/100/1000BaseT). The Ethernet port is compliant with IEEE 802.3at-2009 Power Over Ethernet Plus (PoE+) to provide both data and power over the same CAT-5E grade Ethernet cable. The port is compatible with TIA/EIA-568B cable configuration (Figure 1).

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

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		+ Power
5	White/Blue		+ Power
6	Green		Receive -
7	White/Brown		- Power
8	Brown		- Power

Figure 1: Ethernet Pin Layout

A second Ethernet port is included with the ESTeem Horizon. This second Ethernet port can be configured to bridge to the primary Ethernet port or configured to communicate on the Wireless or Ethernet side of the Horizon in router mode. This secondary Ethernet port can also be isolated to a unique network using the Twin-Bridge feature (see Chapter 7 – Bridging and Mesh Networking for full details)

CONFIGURING DHCP SERVER

The ESTeem Horizon Ethernet port supports both client and server Dynamic Host Configuration Protocol (DHCP). Figure 2 shows the DHCP host configuration screen that will be shown if DHCP server is selected in the setup screens. Enter the values that match the DHCP configuration for your network.

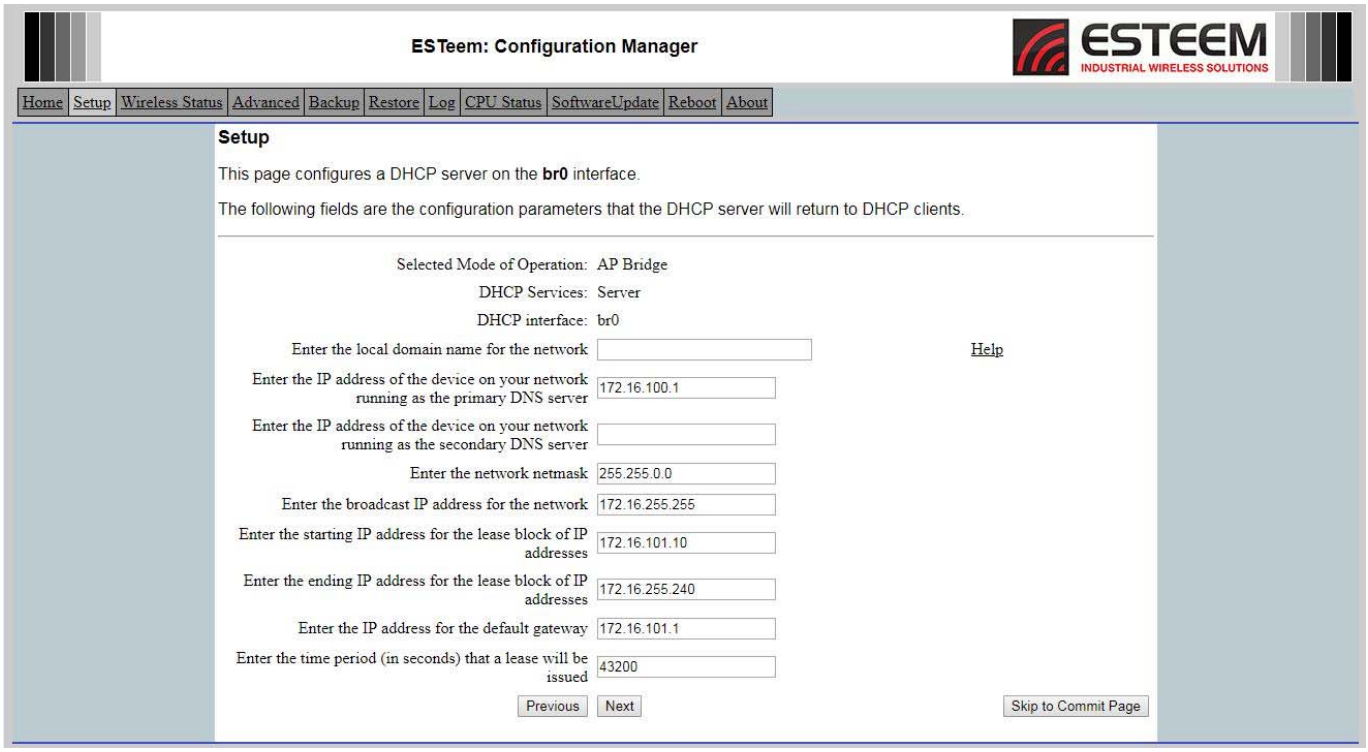


Figure 2: DHCP Server Configuration

RS-232C Programming Port Configuration

The ESTeem Horizon uses a proprietary RS-232C interface in a RJ-45 connector on the front panel. To interface the Horizon to the serial port on the computer, you need ESTeem cable AA0621 that combines a standard Ethernet patch cable to a 9-pin Female adapter.

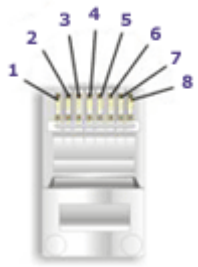
The RS-232 Programming Port on the ESTeem Horizon can be used to access the configuration menu in the ESTeem for system and network configuration. The ESTeem communications port operates at 38,400 bps, No Parity, 8 Data Bits and 1 Stop Bit (38,400,N,8,1). Configure your terminal program to match these settings.

Horizon Serial Port Interface

RS-232 Programming Port Pin-Out Table

ESTeem Model AA0621
RS-232C Port Pin-Out Table

RJ-45 Pin No.	Function	DB-9 Pin No.
4	Signal Ground (GND)	**5**
5	Receive Data (RxD)	**2**
6	Transmit Data (TxD)	**3**



Ethernet Pin-out

RS-232C Data Port Configuration

The ESTeem Horizon has an RS-232C data interface in a RJ-45 connector on the front panel. See Chapter 6 for further information on serial data port configuration. To interface the Horizon to the serial port on the computer, you need serial cable with the following pin-out:

ESTeem Model AA0621
RS-232C Port Pin-Out Table

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 Sent (CTS)	**8**
8	Request to Sent (RTS)	**7**

Horizon Frequencies of Operation

In a wireless Ethernet network all of the ESTeem Horizon must be set to the same radio frequency of operation (channel) and bandwidth. The following table shows the channels and corresponding frequencies of operation for each model of ESTeem. The frequency of operation is selectable when configuring the mode of operation of the Horizon (reference Chapter 3).

Technical Tip: The shaded frequency channels are available for 802.11 (Wi-Fi) client use. All other non-shaded channels are proprietary.

Channel Number	Frequency	Bandwidths
Horizon 900 MHz		
4	907 MHz	5/10 MHz
5	912 MHz	5/10/20 MHz
6	917 MHz	5/10/20 MHz
7	922 MHz	5/10 MHz
Horizon 2.4 GHz		
1	2412 MHz	5/10/20/40 MHz
2	2417 MHz	5/10/20/40 MHz
3	2422 MHz	5/10/20/40 MHz
4	2427 MHz	5/10/20/40 MHz
5	2432 MHz	5/10/20/40 MHz
6	2437 MHz	5/10/20/40 MHz
7	2442 MHz	5/10/20/40 MHz
8	2447 MHz	5/10/20/40 MHz
9	2452 MHz	5/10/20/40 MHz
10	2457 MHz	5/10/20/40 MHz
11	2462 MHz	5/10/20/40 MHz

Channel Number	Frequency	Bandwidths
Horizon 4.9		
192	4960 MHz	20 MHz
196	4980 MHz	20 MHz
Horizon 5.8		
149	5745 MHz	5/10/20/40 MHz
150	5750 MHz	5/10/20/40 MHz
151	5755 MHz	5/10/20/40 MHz
152	5760 MHz	5/10/20/40 MHz
153	5765 MHz	5/10/20/40 MHz
154	5770 MHz	5/10/20/40 MHz
155	5775 MHz	5/10/20/40 MHz
156	5780 MHz	5/10/20/40 MHz
157	5785 MHz	5/10/20/40 MHz
158	5790 MHz	5/10/20/40 MHz
159	5795 MHz	5/10/20/40 MHz
160	5800 MHz	5/10/20/40 MHz
161	5805 MHz	5/10/20/40 MHz
162	5810 MHz	5/10/20/40 MHz
163	5815 MHz	5/10/20/40 MHz
164	5820 MHz	5/10/20/40 MHz
165	5825 MHz	5/10/20/40 MHz

Figure 1: Radio Frequency Channel Selection

RF Data Rate Configuration

The RF data rate of the Horizon can be programmed for operation at multiple data rates. The RF data rate can be set for a fixed rate or a specific range that is dynamically scaled by the Horizon from monitoring the received signal quality. Dynamic scaling means that the Horizon will operate at the highest RF data rate that is programmed into unit. If the received data quality drops below the required minimums for reliable communications, the Horizon will reduce the data rate to the next lowest step to increase signal quality. Conversely if the signal quality increases above the minimums the Horizon will increase the RF data rate the next highest level.

The ESTeem Horizon is set at the factory to operate at maximized scaling speed data rates and should not need adjustment. The RF Data Rate is programmed in the Horizon through the **Advanced Menu>Wireless LAN Settings>wlan0 device>Advanced Settings** and the value for **Communication Rates and 802.11n Communication Rate Index:**. In the example shown in Figure 2 the RF Date Rate is programmed to dynamic scale all data rates (recommend factory default setting). To set the values for the data rate, check the box next to the listed data rate to enable this rate for operation.

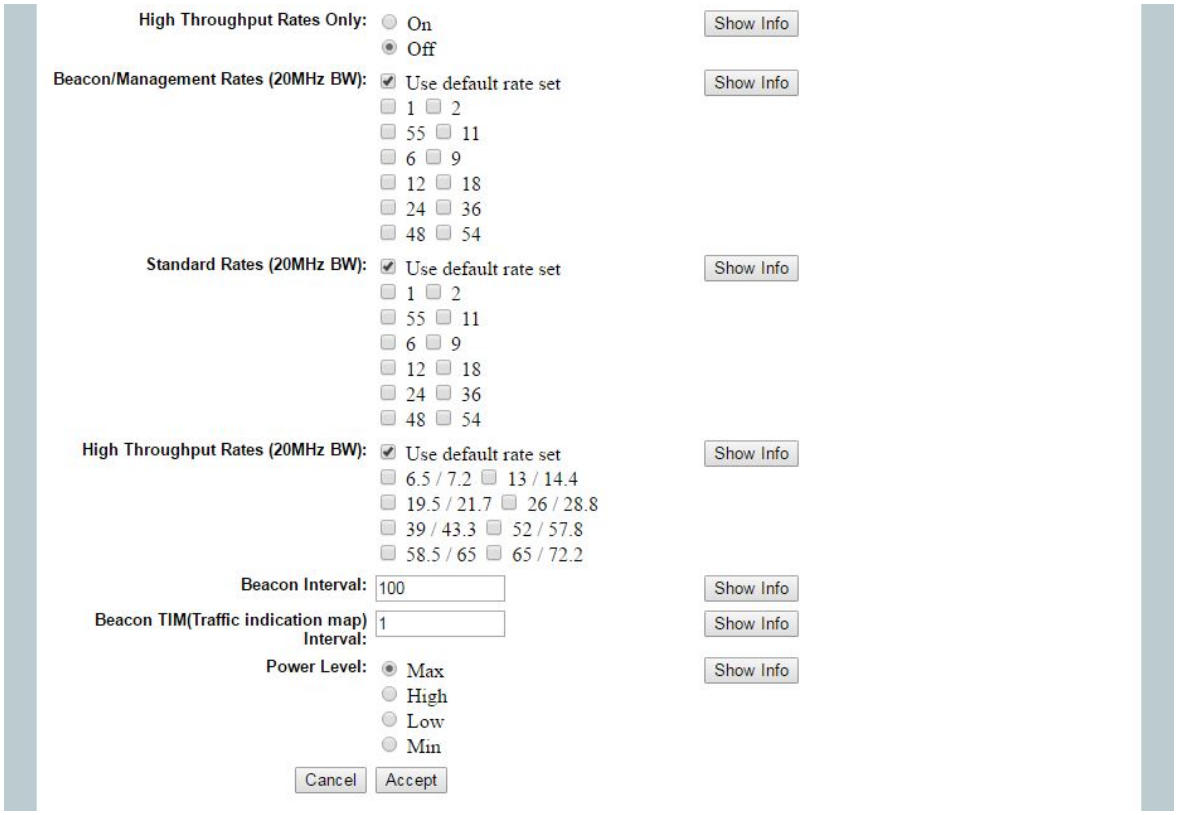


Figure 2: Advanced Data Rate Selection

RF Bandwidths

The Horizon radios have adjustable RF bandwidths for operation. Reducing the RF bandwidth increases the number of available channels and the radio's ability to reject RF interference. Different models of the Horizon series will have different available bandwidths depending upon the frequency of operation. For example, Figure 3 shows the configuration of the Horizon 2.4 GHz's available bandwidths.

NOTE: All ESTeem radios in the same network MUST be on the same frequency channel and use the same bandwidth selection.

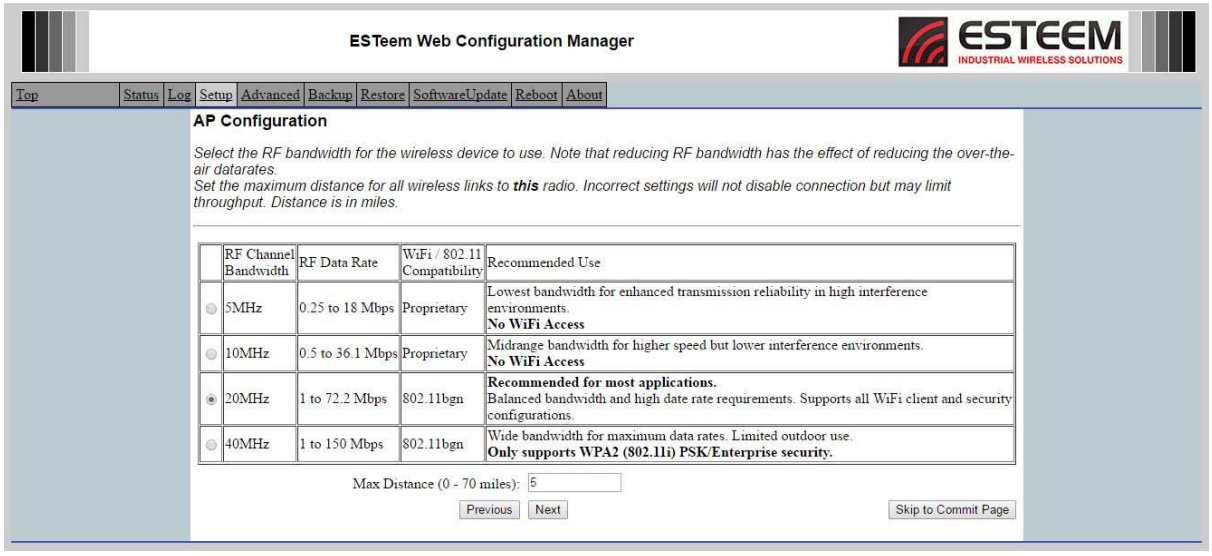


Figure 3: Horizon 2.4 GHz Bandwidth Selection

Data Rates and Throughput

The Horizon series radios are designed to dynamically change their data rate based upon their current receive signal strength and background noise to achieve the highest throughput. It is highly recommended to allow the Horizon to dynamically scale to the best data rate given the operation conditions. The following tables show the data rates the Horizon radios will use and the receive signal strength required for each level.

Glossary

Legacy Index – This index shows the data rates the Horizon radios will use when operating at legacy 802.11 (802.11g, 802.11b or 802.11a) rates and to communicate with the older ESTeem Model 195E series radio modems.

HT MCS Index – High Throughput (HT) Modulation and Coding Scheme (MCS) index value list gives every combination of "number of spatial streams + modulation type + coding rate" that is possible. In practice the achievable MCS value will depend on a large number of variables such as receive signal strength, available bandwidth, RF background noise and other users on a given channel. The MCS value will only tell the 'over the air' data rate of a link and not define what the actual usable throughput (see below).

DSSS – Direct Sequence Spread Spectrum. This is a legacy modulation type used in 802.11b wireless networks.

OFDM – Orthogonal Frequency-Division Multiplexing is the latest modulation scheme used as a digital multi-carrier modulation method. A large number of closely spaced orthogonal sub-carrier signals are used to carry data on several parallel data streams or channels to achieve the higher throughputs of the 802.11n protocols.

Modul.(Modulation) - The modulation is how the data is transported on the carrier frequency. There are multiple types of modulation used in the Horizon hardware and they are listed on the following charts strictly for reference.

Coding Rate - This is an indication of how much of the data stream is actually being used to transmit usable data. This is expressed as a fraction with the most efficient rate being 5/6 or 83.3% of the data stream being used.

Guard Interval – The Guard Interval (GI) is effectively a very short pause between packet transmission to allow for any false information to be ignored. The longer Guard Interval can improve reliability in more saturated wireless networks. The interval shown is in nanoseconds (ns) or one billionth of a second (x10-9).

Bandwidth - Also known as channel width, this is how much of the frequency spectrum is being used to transport data. The maximum bandwidth used by the Horizon series is 40MHz. The table shows values for available bandwidth by model which directly correlate to the radio throughput. For example, a 10MHz channel will provide half the Data Rate of a 20MHz.

Signal – This is the amount of receive signal strength required to achieve a given data rate. Many factors such as radio background noise and other users in a frequency channel will greatly affect the amount of signal strength required. The values provided are to be used as a reference for line of sight (LOS) path-loss calculations.

RF Rate – This is the rate at which one radio transmits data from one to another.

Throughput – The displayed throughput is an approximation of the effective data rate of a radio system compared to sending Ethernet data over standard wire. This number takes into account factors like RF packet overhead, retries, and latency of the radio.

dBm – Decibels in reference to a milliwatt (mW). This is a standard unit of receive signal strength.

Mbps – Mega (million) bits per second. The standard unit of data rate used in high speed wireless devices.

Horizon 900 MHz Data Rate Chart #1

Legacy Index	DSSS or OFDM	Modul.	Coding		20 MHz Bandwidth				10 MHz Bandwidth		
					Signal	RF Rate	Throughput		Signal	RF Rate	Throughput
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
6	OFDM	BPSK	1/2		-86	**6.00**	1.88		-89	**3.00**	0.94
9	OFDM	BPSK	3/4		-85	**9.00**	4.22		-88	**4.50**	2.11
12	OFDM	QPSK	1/2		-83	**12.00**	3.75		-86	**6.00**	1.88
18	OFDM	QPSK	3/4		-81	**18.00**	8.44		-84	**9.00**	4.22
24	OFDM	16-QAM	1/2		-78	**24.00**	7.50		-81	**12.00**	3.75
36	OFDM	16-QAM	3/4		-74	**36.00**	16.88		-77	**18.00**	8.44
48	OFDM	64-QAM	2/3		-70	**48.00**	20.00		-73	**24.00**	10.00
54	OFDM	64-QAM	3/4		-69	**54.00**	25.31		-72	**27.00**	12.66
HT MCS Index	**Spatial Streams**	**Modul.**	**Coding**	**Guard Interval**	**20 MHz Bandwidth**				**10 MHz Bandwidth**		
					Signal	RF Rate	Throughput		Signal	RF Rate	Throughput
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
0	1	BPSK	1/2	800ns	-81	**6.50**	2.23		-84	**3.25**	1.12
0	1	BPSK	1/2	400ns	-81	**7.20**	2.48		-84	**3.60**	1.24
1	1	QPSK	1/2	800ns	-80	**13.00**	4.47		-83	**6.50**	2.23
1	1	QPSK	1/2	400ns	-80	**14.40**	4.95		-83	**7.20**	2.48
2	1	QPSK	3/4	800ns	-78	**19.50**	10.05		-81	**9.75**	5.03
2	1	QPSK	3/4	400ns	-78	**21.70**	11.19		-81	**10.85**	5.59
3	1	16-QAM	1/2	800ns	-76	**26.00**	8.94		-79	**13.00**	4.47
3	1	16-QAM	1/2	400ns	-76	**28.90**	9.93		-79	**14.45**	4.97
4	1	16-QAM	3/4	800ns	-73	**39.00**	20.11		-76	**19.50**	10.05
4	1	16-QAM	3/4	400ns	-73	**43.30**	22.33		-76	**21.65**	11.16
5	1	64-QAM	2/3	800ns	-69	**52.00**	23.83		-72	**26.00**	11.92
5	1	64-QAM	2/3	400ns	-69	**57.80**	26.49		-72	**28.90**	13.25
6	1	64-QAM	3/4	800ns	-65	**58.50**	30.16		-68	**29.25**	15.08
6	1	64-QAM	3/4	400ns	-65	**65.00**	33.52		-68	**32.50**	16.76
7	1	64-QAM	5/6	800ns	-64	**65.00**	37.24		-67	**32.50**	18.62
7	1	64-QAM	5/6	400ns	-64	**72.20**	41.36		-67	**36.10**	20.68

Horizon 900 MHz Data Rate Chart #2

Legacy Index	DSSS or OFDM	Modul.	Coding		5 MHz Bandwidth		
					Signal	RF Rate	Throughput
					dBm	Mbps	Mbps
6	OFDM	BPSK	1/2		-92	**1.50**	0.47
9	OFDM	BPSK	3/4		-91	**2.25**	1.05
12	OFDM	QPSK	1/2		-89	**3.00**	0.94
18	OFDM	QPSK	3/4		-87	**4.50**	2.11
24	OFDM	16-QAM	1/2		-84	**6.00**	1.88
36	OFDM	16-QAM	3/4		-80	**9.00**	4.22
48	OFDM	64-QAM	2/3		-76	**12.00**	5.00
54	OFDM	64-QAM	3/4		-75	**13.50**	6.33
HT MCS Index	**Spatial Streams**	**Modul.**	**Coding**	**Guard Interval**	**5 MHz Bandwidth**		
					Signal	RF Rate	Throughput
					dBm	Mbps	Mbps
0	1	BPSK	1/2	800ns	-87	**1.63**	0.56
0	1	BPSK	1/2	400ns	-87	**1.80**	0.62
1	1	QPSK	1/2	800ns	-86	**3.25**	1.12
1	1	QPSK	1/2	400ns	-86	**3.60**	1.24
2	1	QPSK	3/4	800ns	-84	**4.88**	2.51
2	1	QPSK	3/4	400ns	-84	**5.43**	2.80
3	1	16-QAM	1/2	800ns	-82	**6.50**	2.23
3	1	16-QAM	1/2	400ns	-82	**7.23**	2.48
4	1	16-QAM	3/4	800ns	-79	**9.75**	5.03
4	1	16-QAM	3/4	400ns	-79	**10.83**	5.58
5	1	64-QAM	2/3	800ns	-75	**13.00**	5.96
5	1	64-QAM	2/3	400ns	-75	**14.45**	6.62
6	1	64-QAM	3/4	800ns	-71	**14.63**	7.54
6	1	64-QAM	3/4	400ns	-71	**16.25**	8.38
7	1	64-QAM	5/6	800ns	-70	**16.25**	9.31
7	1	64-QAM	5/6	400ns	-70	**18.05**	10.34

Horizon 2.4 GHz Data Rate Chart #1

Legacy Index	DSSS or OFDM	Modul.	Coding		20 MHz Bandwidth				40 MHz Bandwidth		
					Signal	RF Rate	Throughput				
					dBm	Mbps	Mbps				
1	DSSS	BPSK	1/11		-91	**1.00**	0.06				
2	DSSS	QPSK	1/11		-90	**2.00**	0.11		**Legacy Rates Not Supported**		
5.5	DSSS	CCK	4/8		-89	**5.50**	1.72		**at 40 MHz Bandwidth**		
11	DSSS	CCK	4/8		-86	**11.00**	3.44				
6	OFDM	BPSK	1/2		-90	**6.00**	1.88				
9	OFDM	BPSK	3/4		-89	**9.00**	4.22				
12	OFDM	QPSK	1/2		-87	**12.00**	3.75				
18	OFDM	QPSK	3/4		-85	**18.00**	8.44				
24	OFDM	16-QAM	1/2		-82	**24.00**	7.50				
36	OFDM	16-QAM	3/4		-78	**36.00**	16.88				
48	OFDM	64-QAM	2/3		-74	**48.00**	20.00				
54	OFDM	64-QAM	3/4		-73	**54.00**	25.31				
HT MCS Index	**Spatial Streams**	**Modul.**	**Coding**	**Guard Interval**	**20 MHz Bandwidth**				**40 MHz Bandwidth**		
					Signal	RF Rate	Throughput		Signal	RF Rate	Throughput
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
0	1	BPSK	1/2	800ns	-85	**6.50**	2.23		-82	**13.50**	4.64
0	1	BPSK	1/2	400ns	-85	**7.20**	2.48		-82	**15.00**	5.16
1	1	QPSK	1/2	800ns	-84	**13.00**	4.47		-81	**27.00**	9.28
1	1	QPSK	1/2	400ns	-84	**14.40**	4.95		-81	**30.00**	10.31
2	1	QPSK	3/4	800ns	-82	**19.50**	10.05		-79	**40.50**	20.88
2	1	QPSK	3/4	400ns	-82	**21.70**	11.19		-79	**45.00**	23.20
3	1	16-QAM	1/2	800ns	-80	**26.00**	8.94		-77	**54.00**	18.56
3	1	16-QAM	1/2	400ns	-80	**28.90**	9.93		-77	**60.00**	20.63
4	1	16-QAM	3/4	800ns	-77	**39.00**	20.11		-74	**81.00**	41.77
4	1	16-QAM	3/4	400ns	-77	**43.30**	22.33		-74	**90.00**	46.41
5	1	64-QAM	2/3	800ns	-73	**52.00**	23.83		-70	**108.00**	49.50
5	1	64-QAM	2/3	400ns	-73	**57.80**	26.49		-70	**120.00**	55.00
6	1	64-QAM	3/4	800ns	-69	**58.50**	30.16		-66	**121.50**	62.65
6	1	64-QAM	3/4	400ns	-69	**65.00**	33.52		-66	**135.00**	69.61
7	1	64-QAM	5/6	800ns	-68	**65.00**	37.24		-65	**135.00**	77.34
7	1	64-QAM	5/6	400ns	-68	**72.20**	41.36		-65	**150.00**	85.94

Horizon 2.4 GHz Data Rate Chart #2

Legacy Index	DSSS or OFDM	Modul.	Coding		5 MHz Bandwidth Signal	5 MHz Bandwidth RF Rate	5 MHz Bandwidth Throughput		10 MHz Bandwidth Signal	10 MHz Bandwidth RF Rate	10 MHz Bandwidth Throughput
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
1	DSSS	BPSK	1/11		-97	**0.25**	0.01		-94	**0.50**	0.03
2	DSSS	QPSK	1/11		-96	**0.50**	0.03		-93	**1.00**	0.06
5.5	DSSS	CCK	4/8		-95	**1.38**	0.43		-92	**2.75**	0.86
11	DSSS	CCK	4/8		-92	**2.75**	0.86		-89	**5.50**	1.72
6	OFDM	BPSK	1/2		-96	**1.50**	0.47		-93	**3.00**	0.94
9	OFDM	BPSK	3/4		-95	**2.25**	1.05		-92	**4.50**	2.11
12	OFDM	QPSK	1/2		-93	**3.00**	0.94		-90	**6.00**	1.88
18	OFDM	QPSK	3/4		-91	**4.50**	2.11		-88	**9.00**	4.22
24	OFDM	16-QAM	1/2		-88	**6.00**	1.88		-85	**12.00**	3.75
36	OFDM	16-QAM	3/4		-84	**9.00**	4.22		-81	**18.00**	8.44
48	OFDM	64-QAM	2/3		-80	**12.00**	5.00		-77	**24.00**	10.00
54	OFDM	64-QAM	3/4		-79	**13.50**	6.33		-76	**27.00**	12.66
HT MCS Index	**Spatial Streams**	**Modul.**	**Coding**	**Guard Interval**	**5 MHz Bandwidth Signal**	**5 MHz Bandwidth RF Rate**	**5 MHz Bandwidth Throughput**		**10 MHz Bandwidth Signal**	**10 MHz Bandwidth RF Rate**	**10 MHz Bandwidth Throughput**
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
0	1	BPSK	1/2	800ns	-91	**1.63**	0.56		-88	**3.25**	1.12
0	1	BPSK	1/2	400ns	-91	**1.80**	0.62		-88	**3.60**	1.24
1	1	QPSK	1/2	800ns	-90	**3.25**	1.12		-87	**6.50**	2.23
1	1	QPSK	1/2	400ns	-90	**3.60**	1.24		-87	**7.20**	2.48
2	1	QPSK	3/4	800ns	-88	**4.88**	2.51		-85	**9.75**	5.03
2	1	QPSK	3/4	400ns	-88	**5.43**	2.80		-85	**10.85**	5.59
3	1	16-QAM	1/2	800ns	-86	**6.50**	2.23		-83	**13.00**	4.47
3	1	16-QAM	1/2	400ns	-86	**7.23**	2.48		-83	**14.45**	4.97
4	1	16-QAM	3/4	800ns	-83	**9.75**	5.03		-80	**19.50**	10.05
4	1	16-QAM	3/4	400ns	-83	**10.83**	5.58		-80	**21.65**	11.16
5	1	64-QAM	2/3	800ns	-79	**13.00**	5.96		-76	**26.00**	11.92
5	1	64-QAM	2/3	400ns	-79	**14.45**	6.62		-76	**28.90**	13.25
6	1	64-QAM	3/4	800ns	-75	**14.63**	7.54		-72	**29.25**	15.08
6	1	64-QAM	3/4	400ns	-75	**16.25**	8.38		-72	**32.50**	16.76
7	1	64-QAM	5/6	800ns	-74	**16.25**	9.31		-71	**32.50**	18.62
7	1	64-QAM	5/6	400ns	-74	**18.05**	10.34		-71	**36.10**	20.68

Horizon 2.4 GHz MIMO Data Rate Chart #1

Legacy Index	DSSS or OFDM	Modul.	Coding		20 MHz Bandwidth Signal dBm	RF Rate Mbps	Throughput Mbps		40 MHz Bandwidth
1	DSSS	BPSK	1/11		-91	**1.00**	0.06		
2	DSSS	QPSK	1/11		-90	**2.00**	0.11		
5.5	DSSS	CCK	4/8		-89	**5.50**	1.72		**Legacy Rates Not Supported at 40 MHz Bandwidth**
11	DSSS	CCK	4/8		-86	**11.00**	3.44		
6	OFDM	BPSK	1/2		-93	**6.00**	1.88		
9	OFDM	BPSK	3/4		-91	**9.00**	4.22		
12	OFDM	QPSK	1/2		-91	**12.00**	3.75		
18	OFDM	QPSK	3/4		-88	**18.00**	8.44		
24	OFDM	16-QAM	1/2		-87	**24.00**	7.50		
36	OFDM	16-QAM	3/4		-82	**36.00**	16.88		
48	OFDM	64-QAM	2/3		-78	**48.00**	20.00		
54	OFDM	64-QAM	3/4		-73	**54.00**	25.31		

HT MCS Index	Spatial Streams	Modul.	Coding	Guard Interval	20 MHz Bandwidth Signal dBm	RF Rate Mbps	Throughput Mbps		40 MHz Bandwidth Signal dBm	RF Rate Mbps	Throughput Mbps
0	1	BPSK	1/2	800ns	-94	**6.50**	2.23		-91	**13.50**	4.64
0	1	BPSK	1/2	400ns	-94	**7.20**	2.48		-91	**15.00**	5.16
1	1	QPSK	1/2	800ns	-85	**13.00**	4.47		-82	**27.00**	9.28
1	1	QPSK	1/2	400ns	-85	**14.40**	4.95		-82	**30.00**	10.31
2	1	QPSK	3/4	800ns	-82	**19.50**	10.05		-79	**40.50**	20.88
2	1	QPSK	3/4	400ns	-82	**21.70**	11.19		-79	**45.00**	23.20
3	1	16-QAM	1/2	800ns	-80	**26.00**	8.94		-77	**54.00**	18.56
3	1	16-QAM	1/2	400ns	-80	**28.90**	9.93		-77	**60.00**	20.63
4	1	16-QAM	3/4	800ns	-80	**39.00**	20.11		-77	**81.00**	41.77
4	1	16-QAM	3/4	400ns	-80	**43.30**	22.33		-77	**90.00**	46.41
5	1	64-QAM	2/3	800ns	-78	**52.00**	23.83		-75	**108.00**	49.50
5	1	64-QAM	2/3	400ns	-78	**57.80**	26.49		-75	**120.00**	55.00
6	1	64-QAM	3/4	800ns	-73	**58.50**	30.16		-70	**121.50**	62.65
6	1	64-QAM	3/4	400ns	-73	**65.00**	33.52		-70	**135.00**	69.61
7	1	64-QAM	5/6	800ns	-68	**65.00**	37.24		-65	**135.00**	77.34
7	1	64-QAM	5/6	400ns	-68	**72.20**	41.36		-65	**150.00**	85.94
8	2	BPSK	1/2	800ns	-94	**13.00**	4.47		-91	**27.00**	9.28
8	2	BPSK	1/2	400ns	-94	**14.40**	4.95		-91	**30.00**	10.31
9	2	QPSK	1/2	800ns	-85	**26.00**	8.94		-82	**54.00**	18.56
9	2	QPSK	1/2	400ns	-85	**28.80**	9.90		-82	**60.00**	20.63
10	2	QPSK	3/4	800ns	-82	**39.00**	20.11		-79	**81.00**	41.77
10	2	QPSK	3/4	400ns	-82	**43.40**	22.38		-79	**90.00**	46.41
11	2	16-QAM	1/2	800ns	-80	**52.00**	17.88		-77	**108.00**	37.13
11	2	16-QAM	1/2	400ns	-80	**57.80**	19.87		-77	**120.00**	41.25
12	2	16-QAM	3/4	800ns	-80	**78.00**	40.22		-77	**162.00**	83.53
12	2	16-QAM	3/4	400ns	-80	**86.60**	44.65		-77	**180.00**	92.81
13	2	64-QAM	2/3	800ns	-78	**104.00**	47.67		-75	**216.00**	99.00
13	2	64-QAM	2/3	400ns	-78	**115.60**	52.98		-75	**240.00**	110.00
14	2	64-QAM	3/4	800ns	-73	**117.00**	60.33		-70	**243.00**	125.30
14	2	64-QAM	3/4	400ns	-73	**130.00**	67.03		-70	**270.00**	139.22
15	2	64-QAM	5/6	800ns	-68	**130.00**	74.48		-65	**270.00**	154.69
15	2	64-QAM	5/6	400ns	-68	**144.40**	82.73		-65	**300.00**	171.88

Horizon 2.4 GHz MIMO Data Rate Chart #2

Legacy Index	DSSS or OFDM	Modul.	Coding		5 MHz Bandwidth				10 MHz Bandwidth		
					Signal	RF Rate	Throughput		Signal	RF Rate	Throughput
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
1	DSSS	BPSK	1/11		-100	**0.25**	0.01		-97	**0.50**	0.03
2	DSSS	QPSK	1/11		-91	**0.50**	0.03		-88	**1.00**	0.06
5.5	DSSS	CCK	4/8		-91	**1.38**	0.43		-88	**2.75**	0.86
11	DSSS	CCK	4/8		-88	**2.75**	0.86		-85	**5.50**	1.72
6	OFDM	BPSK	1/2		-99	**1.50**	0.47		-96	**3.00**	0.94
9	OFDM	BPSK	3/4		-97	**2.25**	1.05		-94	**4.50**	2.11
12	OFDM	QPSK	1/2		-97	**3.00**	0.94		-94	**6.00**	1.88
18	OFDM	QPSK	3/4		-94	**4.50**	2.11		-91	**9.00**	4.22
24	OFDM	16-QAM	1/2		-93	**6.00**	1.88		-90	**12.00**	3.75
36	OFDM	16-QAM	3/4		-88	**9.00**	4.22		-85	**18.00**	8.44
48	OFDM	64-QAM	2/3		-84	**12.00**	5.00		-81	**24.00**	10.00
54	OFDM	64-QAM	3/4		-79	**13.50**	6.33		-76	**27.00**	12.66
HT MCS Index	**Spatial Streams**	**Modul.**	**Coding**	**Guard Interval**	**5 MHz Bandwidth**				**10 MHz Bandwidth**		
					Signal	RF Rate	Throughput		Signal	RF Rate	Throughput
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
0	1	BPSK	1/2	800ns	-100	**1.63**	0.56		-97	**3.25**	1.12
0	1	BPSK	1/2	400ns	-100	**1.80**	0.62		-97	**3.60**	1.24
1	1	QPSK	1/2	800ns	-91	**3.25**	1.12		-88	**6.50**	2.23
1	1	QPSK	1/2	400ns	-91	**3.60**	1.24		-88	**7.20**	2.48
2	1	QPSK	3/4	800ns	-88	**4.88**	2.51		-85	**9.75**	5.03
2	1	QPSK	3/4	400ns	-88	**5.43**	2.80		-85	**10.85**	5.59
3	1	16-QAM	1/2	800ns	-86	**6.50**	2.23		-83	**13.00**	4.47
3	1	16-QAM	1/2	400ns	-86	**7.23**	2.48		-83	**14.45**	4.97
4	1	16-QAM	3/4	800ns	-86	**9.75**	5.03		-83	**19.50**	10.05
4	1	16-QAM	3/4	400ns	-86	**10.83**	5.58		-83	**21.65**	11.16
5	1	64-QAM	2/3	800ns	-84	**13.00**	5.96		-81	**26.00**	11.92
5	1	64-QAM	2/3	400ns	-84	**14.45**	6.62		-81	**28.90**	13.25
6	1	64-QAM	3/4	800ns	-79	**14.63**	7.54		-76	**29.25**	15.08
6	1	64-QAM	3/4	400ns	-79	**16.25**	8.38		-76	**32.50**	16.76
7	1	64-QAM	5/6	800ns	-74	**16.25**	9.31		-71	**32.50**	18.62
7	1	64-QAM	5/6	400ns	-74	**18.05**	10.34		-71	**36.10**	20.68
8	2	BPSK	1/2	800ns	-100	**3.25**	1.12		-97	**6.50**	2.23
8	2	BPSK	1/2	400ns	-100	**3.60**	1.24		-97	**7.20**	2.48
9	2	QPSK	1/2	800ns	-91	**6.50**	2.23		-88	**13.00**	4.47
9	2	QPSK	1/2	400ns	-91	**7.20**	2.48		-88	**14.40**	4.95
10	2	QPSK	3/4	800ns	-88	**9.75**	5.03		-85	**19.50**	10.05
10	2	QPSK	3/4	400ns	-88	**10.85**	5.59		-85	**21.70**	11.19
11	2	16-QAM	1/2	800ns	-86	**13.00**	4.47		-83	**26.00**	8.94
11	2	16-QAM	1/2	400ns	-86	**14.45**	4.97		-83	**28.90**	9.93
12	2	16-QAM	3/4	800ns	-86	**19.50**	10.05		-83	**39.00**	20.11
12	2	16-QAM	3/4	400ns	-86	**21.65**	11.16		-83	**43.30**	22.33
13	2	64-QAM	2/3	800ns	-84	**26.00**	11.92		-81	**52.00**	23.83
13	2	64-QAM	2/3	400ns	-84	**28.90**	13.25		-81	**57.80**	26.49
14	2	64-QAM	3/4	800ns	-79	**29.25**	15.08		-76	**58.50**	30.16
14	2	64-QAM	3/4	400ns	-79	**32.50**	16.76		-76	**65.00**	33.52
15	2	64-QAM	5/6	800ns	-74	**32.50**	18.62		-71	**65.00**	37.24
15	2	64-QAM	5/6	400ns	-74	**36.10**	20.68		-71	**72.20**	41.36

Horizon 4.9 GHz Data Rate Chart

Legacy Index	DSSS or OFDM	Modul.	Coding		20 MHz Bandwidth Signal	RF Rate	Throughput
					dBm	Mbps	Mbps
6	OFDM	BPSK	1/2		-94	**6.00**	1.88
9	OFDM	BPSK	3/4		-92	**9.00**	4.22
12	OFDM	QPSK	1/2		-91	**12.00**	3.75
18	OFDM	QPSK	3/4		-88	**18.00**	8.44
24	OFDM	16-QAM	1/2		-87	**24.00**	7.50
36	OFDM	16-QAM	3/4		-82	**36.00**	16.88
48	OFDM	64-QAM	2/3		-78	**48.00**	20.00
54	OFDM	64-QAM	3/4		-73	**54.00**	25.31

HT MCS Index	Spatial Streams	Modul.	Coding	Guard Interval	20 MHz Bandwidth Signal	RF Rate	Throughput
					dBm	Mbps	Mbps
0	1	BPSK	1/2	800ns	-94	**6.50**	2.23
0	1	BPSK	1/2	400ns	-94	**7.20**	2.48
1	1	QPSK	1/2	800ns	-85	**13.00**	4.47
1	1	QPSK	1/2	400ns	-85	**14.40**	4.95
2	1	QPSK	3/4	800ns	-82	**19.50**	10.05
2	1	QPSK	3/4	400ns	-82	**21.70**	11.19
3	1	16-QAM	1/2	800ns	-80	**26.00**	8.94
3	1	16-QAM	1/2	400ns	-80	**28.90**	9.93
4	1	16-QAM	3/4	800ns	-80	**39.00**	20.11
4	1	16-QAM	3/4	400ns	-80	**43.30**	22.33
5	1	64-QAM	2/3	800ns	-78	**52.00**	23.83
5	1	64-QAM	2/3	400ns	-78	**57.80**	26.49
6	1	64-QAM	3/4	800ns	-73	**58.50**	30.16
6	1	64-QAM	3/4	400ns	-73	**65.00**	33.52
7	1	64-QAM	5/6	800ns	-68	**65.00**	37.24
7	1	64-QAM	5/6	400ns	-68	**72.20**	41.36

Horizon 5.8 GHz Data Rate Chart #1

Legacy Index	DSSS or OFDM	Modul.	Coding		20 MHz Bandwidth Signal	RF Rate	Throughput		40 MHz Bandwidth
					dBm	Mbps	Mbps		
6	OFDM	BPSK	1/2		-93	**6.00**	1.88		
9	OFDM	BPSK	3/4		-91	**9.00**	4.22		
12	OFDM	QPSK	1/2		-91	**12.00**	3.75		**Legacy Rates Not Supported**
18	OFDM	QPSK	3/4		-88	**18.00**	8.44		**at 40 MHz Bandwidth**
24	OFDM	16-QAM	1/2		-87	**24.00**	7.50		
36	OFDM	16-QAM	3/4		-82	**36.00**	16.88		
48	OFDM	64-QAM	2/3		-78	**48.00**	20.00		
54	OFDM	64-QAM	3/4		-73	**54.00**	25.31		
HT MCS Index	**Spatial Streams**	**Modul.**	**Coding**	**Guard Interval**	**20 MHz Bandwidth Signal**	**RF Rate**	**Throughput**		**40 MHz Bandwidth Signal**	**RF Rate**	**Throughput**
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
0	1	BPSK	1/2	800ns	-94	**6.50**	2.23		-91	**13.50**	4.64
0	1	BPSK	1/2	400ns	-94	**7.20**	2.48		-91	**15.00**	5.16
1	1	QPSK	1/2	800ns	-85	**13.00**	4.47		-82	**27.00**	9.28
1	1	QPSK	1/2	400ns	-85	**14.40**	4.95		-82	**30.00**	10.31
2	1	QPSK	3/4	800ns	-82	**19.50**	10.05		-79	**40.50**	20.88
2	1	QPSK	3/4	400ns	-82	**21.70**	11.19		-79	**45.00**	23.20
3	1	16-QAM	1/2	800ns	-80	**26.00**	8.94		-77	**54.00**	18.56
3	1	16-QAM	1/2	400ns	-80	**28.90**	9.93		-77	**60.00**	20.63
4	1	16-QAM	3/4	800ns	-80	**39.00**	20.11		-77	**81.00**	41.77
4	1	16-QAM	3/4	400ns	-80	**43.30**	22.33		-77	**90.00**	46.41
5	1	64-QAM	2/3	800ns	-78	**52.00**	23.83		-75	**108.00**	49.50
5	1	64-QAM	2/3	400ns	-78	**57.80**	26.49		-75	**120.00**	55.00
6	1	64-QAM	3/4	800ns	-73	**58.50**	30.16		-70	**121.50**	62.65
6	1	64-QAM	3/4	400ns	-73	**65.00**	33.52		-70	**135.00**	69.61
7	1	64-QAM	5/6	800ns	-68	**65.00**	37.24		-65	**135.00**	77.34
7	1	64-QAM	5/6	400ns	-68	**72.20**	41.36		-65	**150.00**	85.94
8	2	BPSK	1/2	800ns	-94	**13.00**	4.47		-91	**27.00**	9.28
8	2	BPSK	1/2	400ns	-94	**14.40**	4.95		-91	**30.00**	10.31
9	2	QPSK	1/2	800ns	-85	**26.00**	8.94		-82	**54.00**	18.56
9	2	QPSK	1/2	400ns	-85	**28.80**	9.90		-82	**60.00**	20.63
10	2	QPSK	3/4	800ns	-82	**39.00**	20.11		-79	**81.00**	41.77
10	2	QPSK	3/4	400ns	-82	**43.40**	22.38		-79	**90.00**	46.41
11	2	16-QAM	1/2	800ns	-80	**52.00**	17.88		-77	**108.00**	37.13
11	2	16-QAM	1/2	400ns	-80	**57.80**	19.87		-77	**120.00**	41.25
12	2	16-QAM	3/4	800ns	-80	**78.00**	40.22		-77	**162.00**	83.53
12	2	16-QAM	3/4	400ns	-80	**86.60**	44.65		-77	**180.00**	92.81
13	2	64-QAM	2/3	800ns	-78	**104.00**	47.67		-75	**216.00**	99.00
13	2	64-QAM	2/3	400ns	-78	**115.60**	52.98		-75	**240.00**	110.00
14	2	64-QAM	3/4	800ns	-73	**117.00**	60.33		-70	**243.00**	125.30
14	2	64-QAM	3/4	400ns	-73	**130.00**	67.03		-70	**270.00**	139.22
15	2	64-QAM	5/6	800ns	-68	**130.00**	74.48		-65	**270.00**	154.69
15	2	64-QAM	5/6	400ns	-68	**144.40**	82.73		-65	**300.00**	171.88

Horizon 5.8 GHz Data Rate Chart #2

Legacy Index	DSSS or OFDM	Modul.	Coding		5 MHz Bandwidth				10 MHz Bandwidth		
					Signal	RF Rate	Throughput		Signal	RF Rate	Throughput
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
6	OFDM	BPSK	1/2		-99	**1.50**	0.47		-96	**3.00**	0.94
9	OFDM	BPSK	3/4		-97	**2.25**	1.05		-94	**4.50**	2.11
12	OFDM	QPSK	1/2		-97	**3.00**	0.94		-94	**6.00**	1.88
18	OFDM	QPSK	3/4		-94	**4.50**	2.11		-91	**9.00**	4.22
24	OFDM	16-QAM	1/2		-93	**6.00**	1.88		-90	**12.00**	3.75
36	OFDM	16-QAM	3/4		-88	**9.00**	4.22		-85	**18.00**	8.44
48	OFDM	64-QAM	2/3		-84	**12.00**	5.00		-81	**24.00**	10.00
54	OFDM	64-QAM	3/4		-79	**13.50**	6.33		-76	**27.00**	12.66
HT MCS Index	Spatial Streams	Modul.	Coding	Guard Interval	5 MHz Bandwidth				10 MHz Bandwidth		
					Signal	RF Rate	Throughput		Signal	RF Rate	Throughput
					dBm	Mbps	Mbps		dBm	Mbps	Mbps
0	1	BPSK	1/2	800ns	-100	**1.63**	0.56		-97	**3.25**	1.12
0	1	BPSK	1/2	400ns	-100	**1.80**	0.62		-97	**3.60**	1.24
1	1	QPSK	1/2	800ns	-91	**3.25**	1.12		-88	**6.50**	2.23
1	1	QPSK	1/2	400ns	-91	**3.60**	1.24		-88	**7.20**	2.48
2	1	QPSK	3/4	800ns	-88	**4.88**	2.51		-85	**9.75**	5.03
2	1	QPSK	3/4	400ns	-88	**5.43**	2.80		-85	**10.85**	5.59
3	1	16-QAM	1/2	800ns	-86	**6.50**	2.23		-83	**13.00**	4.47
3	1	16-QAM	1/2	400ns	-86	**7.23**	2.48		-83	**14.45**	4.97
4	1	16-QAM	3/4	800ns	-86	**9.75**	5.03		-83	**19.50**	10.05
4	1	16-QAM	3/4	400ns	-86	**10.83**	5.58		-83	**21.65**	11.16
5	1	64-QAM	2/3	800ns	-84	**13.00**	5.96		-81	**26.00**	11.92
5	1	64-QAM	2/3	400ns	-84	**14.45**	6.62		-81	**28.90**	13.25
6	1	64-QAM	3/4	800ns	-79	**14.63**	7.54		-76	**29.25**	15.08
6	1	64-QAM	3/4	400ns	-79	**16.25**	8.38		-76	**32.50**	16.76
7	1	64-QAM	5/6	800ns	-74	**16.25**	9.31		-71	**32.50**	18.62
7	1	64-QAM	5/6	400ns	-74	**18.05**	10.34		-71	**36.10**	20.68
8	2	BPSK	1/2	800ns	-100	**3.25**	1.12		-97	**6.50**	2.23
8	2	BPSK	1/2	400ns	-100	**3.60**	1.24		-97	**7.20**	2.48
9	2	QPSK	1/2	800ns	-91	**6.50**	2.23		-88	**13.00**	4.47
9	2	QPSK	1/2	400ns	-91	**7.20**	2.48		-88	**14.40**	4.95
10	2	QPSK	3/4	800ns	-88	**9.75**	5.03		-85	**19.50**	10.05
10	2	QPSK	3/4	400ns	-88	**10.85**	5.59		-85	**21.70**	11.19
11	2	16-QAM	1/2	800ns	-86	**13.00**	4.47		-83	**26.00**	8.94
11	2	16-QAM	1/2	400ns	-86	**14.45**	4.97		-83	**28.90**	9.93
12	2	16-QAM	3/4	800ns	-86	**19.50**	10.05		-83	**39.00**	20.11
12	2	16-QAM	3/4	400ns	-86	**21.65**	11.16		-83	**43.30**	22.33
13	2	64-QAM	2/3	800ns	-84	**26.00**	11.92		-81	**52.00**	23.83
13	2	64-QAM	2/3	400ns	-84	**28.90**	13.25		-81	**57.80**	26.49
14	2	64-QAM	3/4	800ns	-79	**29.25**	15.08		-76	**58.50**	30.16
14	2	64-QAM	3/4	400ns	-79	**32.50**	16.76		-76	**65.00**	33.52
15	2	64-QAM	5/6	800ns	-74	**32.50**	18.62		-71	**65.00**	37.24
15	2	64-QAM	5/6	400ns	-74	**36.10**	20.68		-71	**72.20**	41.36

SETTING RF POWER LEVEL

The ESTeem Horizon peak power is adjustable in output power from the **Setup** menu when also setting the radio's bandwidth and max distance.

Max (Maximum)	Full Power
Hi (High)	75% Power
Lo (Low)	50% Power
Min (Minimum)	25% Power

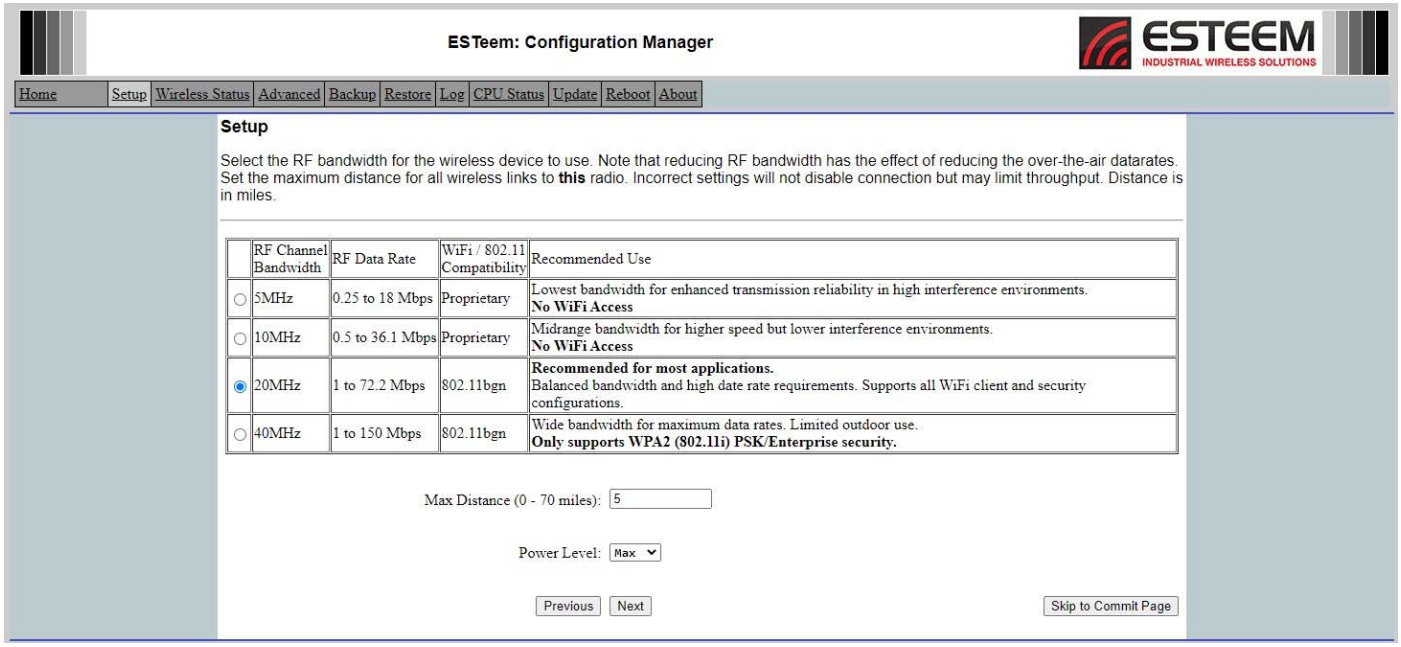


Figure 4: Power Level Settings

APPENDIX D
SECURITY

OVERVIEW

The security for the ESTeem Horizon, like all network security, must be multi-layered. 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.

AES-CCMP 256/128 bit (802.11i and WPA-2)

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. The ESTeem Horizon series supports AES encryption at 256-bit and 128-bit levels. The 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. The ESTeem Horizon is compatible as either an Access Point or client in either WPA2 or IEEE 802.11i security systems.

Wi-Fi Protected Access 2 with Preshared Key (WPA2 PSK)
WPA2 PSK uses a common passphrase (preshared key) between the Access Point (AP) and the client to begin a secure communication session. This passphrase must be entered exactly the same in both the Access Point and the client. This passphrase is used to authenticate communication session between the AP and client to begin the secure wireless networking session.

Wi-Fi Protected Access 2 with Enterprise Server (WPA Enterprise)
Like WPA2 PSK, WPA2 Enterprise verifies the authenticity of the Access Point and client, but uses an 802.1x backend authentication server handling the authentication decision. The most commonly type of authentication server is a RADIUS server. The ESTeem Horizon can be configured to operate with an established RADIUS server on the network.

WPA

Wi-Fi Protected Access with Preshared Key (WPA PSK)
WPA, which uses 802.1x, was introduced in 2003 to improve on the authentication and encryption features of WEP. All authentication is handled within this access point device. WPA has two significant advantages over WEP:

1. An encryption key differing in every packet. The TKIP (Temporal Key Integrity Protocol) mechanism shares a starting key between devices. Each device then changes their encryption key for every packet. It is extremely difficult for hackers to read messages even if they have intercepted the data.
2. Certificate Authentication (CA) can be used, blocking a hacker posing as a valid user.

Wi-Fi Protected Access with Enterprise Server (WPA Enterprise)
Like WPA PSK, WPA Enterprise verifies the authenticity of the Access Point and client, but uses an 802.1x backend authentication server handling the authentication decision. The most commonly type of authentication server is a RADIUS server. The ESTeem Horizon can be configured to operate with an established RADIUS server on the network.

WPA is server/client relationship from a software driver on a computer's wireless LAN (WLAN) card to an Access Point. The scope of WPA is limited in use to this configuration only. The ESTeem Horizon can support WPA Enterprise and PSK as an Access Point, but the level of security on the Bridging layer is configured separately.

128-BIT WEP

The 128 WEP uses a particular algorithm called RC4 encryption to encode and decode traffic that is based on a 104-bit encryption key and a 24-bit Initialization Vector (IV). RC4 starts with a relatively short encryption key (104 bits) that is expanded into a nearly infinite stream of keys to accompany the stream of packets.

The basic concept of RC4 is good, but the way it's implemented in WEP leaves it open to compromise. The researchers that test the integrity of the system usually focus on one piece of the implementation, the Initialization Vector (IV).

The IV (24 bits) is the algorithm component that's supposed to keep expanded keys from repeating. From the researcher's point of view, a high-volume access point is mathematically guaranteed to reuse the same key stream at least once a day. When this happens, it's called an IV collision this becomes a soft spot to enter the system.

The researchers aren't saying that it's easy to break into the system, or that it's being done on a regular basis, only that it is possible and administrators should consider ways to reduce the possibility

Access Control List (ACL)

The ACL is one of the simplest yet most secure methods of network security. The ACL is a configurable MAC filter in the Horizon series that can be set to allow specific MAC address on the wireless network by individual address or address ranges. The same filter can also be set to reject individual MAC addresses or address ranges.

The MAC address is a unique, 6 hexadecimal field address assigned at the manufacturer that can not be changed. The MAC address is traceable through the IEEE governing body to the manufacturer and is the "fingerprint" for all Ethernet devices.

Using a combination of the encryption and the ACL filter provide the ESTeem an extremely secure wireless networking layer.

Disabling Broadcast Probes and Hiding SSID

A simple but very effective way of securing a network is to make the network difficult to find. By disabling broadcast probes and hiding the Service Set Identification (SSID), wireless and network "sniffers" will not be able to find your ESTeem Horizon network. To gain access to the wireless network, you would be required to have the SSID and all security loaded in the WLAN card software prior to entering the network.

Protected Management Frames

This new feature protects stations against forged management frames spoofed from other devices that might otherwise disrupt a valid user session. Protected Management Frames (PMF) are negotiated between the client and AP. Because the management frames are encrypted it is required that WPA2 is enabled in wireless service configuration.

Proprietary Bridge Communication

Although the ESTeem Horizon is compatible with the open communication standards IEEE 802.11g and 802.11b, the repeater communication between the units is a proprietary communication link. No other manufacturer of wireless hardware can access the ESTeem repeater network when bridging between Ethernet networks. This proprietary communication layer, in combination with the other security settings, allows you as the user to reject wireless clients into the network if so desired. When used in conjunction with the Access Control List the 802.11g and 802.11b client access can be removed.

The security level of the bridge communication link is configurable for WEP, TKIP or CCMP(AES) and is completely independent of the client access level or any other communication link level. For example, an ESTeem Horizon can be configured for WPA-2 Enterprise for client level access, communicate to another ESTeem Horizon using a CCMP bridge link and also communicate 128-Bit WEP to our older ESTeem Model 195 series radio modems all running simultaneously.

Masquerade Modes

When the ESTeem Horizon is configured in either the Access Point Masquerade or the Client Masquerade modes, the wireless modem functions as a network firewall. If access to the wired network is the greatest concern, place the ESTeem in the Masquerade mode and the wireless network will be completely isolated from the wired Ethernet network.

Advanced Security Options

The Horizon series radios have multiple security options available that can further limit access to the radios and wireless network:

Administration Password – The administration password in each Horizon radio can be changed from default by pressing the "Change Admin Password" button on the Home page on the web configuration manager. The password will support between 5-255 characters.

Disabling Discovery Changes – On the last page of the Setup menu chain and in the Advanced>Remote Access & Services>Discovery Service in the Horizon radio, access to the radio through the Discovery Utility can be limited. By default, the Discovery utility can change parameters in the Horizon radio such as the IP address, updating firmware, changing modes of operation and read/write configuration files. The advanced configuration will allow limiting access to a Horizon radio to either read only (Passive Mode) or disability access completely. As an additional security measure, the IP address and port number can be bound within the radio.

Disable Remote Access - On the last page of the Setup menu chain and in the Advanced>Remote Access & Services, the Horizon radio can be configured to turn off remote assistance that will disable the ability for ESTeem Technical Support to access the radio through a remote session.

Disabling Port Access – In the Advanced>Remote Access & Services menu the web interface (HTTP), SSH and Telnet port access can be disabled. As an additional security measure, the IP address and port number for each of interfaces can be bound within the radio.

Increasing Network Security

The following are a few suggestions to help improve the overall security of your wireless network:

1. Enable the security. If you research all of the articles regarding hackers, they have gotten into the user's network due to the security not being enabled.

2. Set the ACL filter to include only those MAC address of the wireless Ethernet device being used on the network.

3. Make sure the keys are not reused in your company, since reuse increases the statistical likelihood that someone can figure the key out and change the default password on your access point or wireless router

4. As a network administrator, you should periodically survey your company using a tool like NetStumbler to see if any "rogue" access points pop up within your company without authorization. All of your hard work to "harden" your wireless network could be wasted if a rogue AP was plugged into your network behind the firewall.

5. Many access points allow you to control access based on the MAC address of the NIC attempting to associate with it. If the MAC address of your NIC isn't in the table of the access point, you won't associate with it. And while it's true that there are ways of spoofing a MAC address that's been sniffed out of the air, it takes an additional level of sophistication to spoof a MAC address. The downside of deploying MAC address tables is that if you have a lot of access points, maintaining the tables in each access point could be time consuming. Some higher-end, enterprise-level access points have mechanisms for updating these tables across multiple access points of the same brand.

6. Consider using an additional level of authentication, such as Remote Access Dial in User Service (RADIUS), before you permit an association with your access points through WPA and WPA2 Enterprise.

7. If you're deploying a wireless router, think about assigning static IP addresses for your wireless NICs and turn off Dynamic Host Configuration Protocol (DHCP). If you're using a wireless router and have decided to turn off DHCP, also consider changing the IP subnet. Many wireless routers default to the 192.168.1.0 network and use 192.168.1.1 as the default router.

8. Only purchase Access Points that have flashable firmware. There are a number of security enhancements that are being developed, and you want to be sure that you can upgrade your access point.

9. A simple security technique is to have the administrator periodically change the key for the system i.e. weekly, monthly, etc.

Testing Communication Link

After you have configured at least two of the Horizon wireless Ethernet modems for operation, you can verify communication with each the following steps:

Status Light

The quickest source of link status is to view the Status LED on the face of the Horizon (Figure 1). If the Status light is solid, the Horizon has a connection to another Horizon listed in the Peer Table.

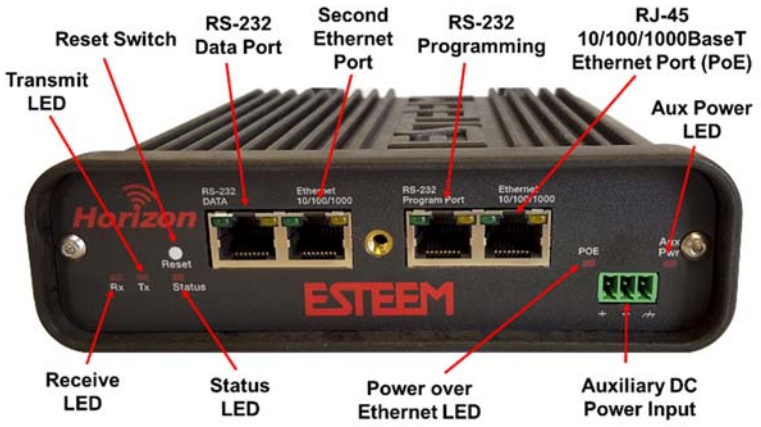


Figure 1: Connection Status Light

Wireless Status Screen

To view detailed information on the status of the communication link (such as connection speed, signal strength and last update time) you can open the Wireless Status Tab from the Web Interface (Figure 2).

Wireless Status

This page is a summary view of the wireless device.

wlan0 Associated Stations

MAC Addr	AntSignal A1 | A2	LastRx (sec@mbps)
c6:c2:fb:32:6b:c3	-60 | -61	0@144.4
12:e1:ea:16:e6:21	-61 | -70	38@1
62:6a:06:f6:89:73	-62 | -63	1@1
62:a4:eb:ea:27:6d	-65 | -62	0@1

wlan1 Associated Stations

MAC Addr	AntSignal A1 | A2	LastRx (sec@mbps)
be:d9:50:90:e8:b1	-65 | -60	5@24

wlan0 Peers

MAC Addr	AntSignal A1 | A2	LastRx (sec@mbps)	SSID	Port State	Radio ID	Peer Device
00:04:3f:00:bf:66	-43 | -55	0@72.2	ESTeemTB	FORWARDING	Test Bench	wlan0wds0

wlan1 Peers

MAC Addr	AntSignal A1 | A2	LastRx (sec@mbps)	SSID	Port State	Radio ID	Peer Device

Access Points

MAC Addr	AntSignal A1 | A2	LastRx (sec@mbps)	SSID	Radio ID
00:04:3f:00:bf:66	-43 | -54	0@72.2	ESTeemTB	Test Bench
a8:9a:93:a9:39:c6	-76 | -79	0@1	UniWest_SE	
b0:a7:37:45:41:d9	-52 | -53	0@6	DIRECT-roku-649	
fc:ec:da:62:e5:62	-92 | -95	18@1	wines	

Figure 2: Wireless Status

Associated Stations (wlan0 & wlan1) – Associated stations are either Horizon radios configured for Station mode or connected WiFi clients if using the Horizon 2.4, Horizon 2.4-MIMO or Horizon 5.8 GHz. If the ESTeem Twin Bridge feature is enabled, both the radio's SSIDs (wlan0 & wlan1) connected clients will be shown by their connection (Figure 2)

Peers (wlan0 & wlan1) – The Peer Table will display all connected Horizons configured as a Peer link to this ESTeem by their Wireless (WLAN) MAC address. If using the Twin Bridge feature, both bridge link Peers will be shown by their respective configuration.

Received Signal Strength – The AntSignal column will display the receive signal strength for each of the two antenna ports. The first antenna port is listed as A1 while the second port is listed as A2. You may receive a signal level on A2 although no antenna is attached. This signal strength value is listed in dBm.

Last RX and Data Rate – This is the time of the last received data packet. When monitoring the status menu, it is important to note the time the last transmission was updated so you are not looking at "stale" data. A value of 0 in the time represents a current (less than 1 second) receive value. The current data rate of the last data packet received will also be shown by the Horizon. The speed is displayed in Mbps. For example, in Figure 2 a LastRx value of 0@72.2 represents an RF packet received within the last second running at 72.2Mbps.

Note: The ESTeem Horizon uses spread spectrum technology that analyzes each data packet for signal strength and data quality (strength vs. noise). The higher your signal, the more background noise you can sustain without causing degradation in the data transfer. This is also true for lower signal strengths with a very low background noise. These values are provided for guidance and if you have any questions about the values in your application, please contact ESTeem Customer Support at 509-735-9092 or e-mail your application to support@esteem.com.

SSID – This is SSID configured for the opposite ESTeem peer.

Port State – This is the active port state for the peer link. The description will be from the state of the Spanning Tree such as FORWARDING or BLOCKING on an active connection or DISABLED if the remote radio has not been heard from in 10 seconds (default). Note – This time value can be adjusted in the "Advanced" configuration of the Peer link.

Radio ID – This is Modem ID for the opposite ESTeem peer.

Peer Device – This value will help associate an ESTeem peer by Radio ID and MAC address with the bridge link defined in the radio's log file. The log file output can be viewed in the "Log" tab in that web interface.

Cloning Radio

A new feature in the Horizon Series radios is the ability to "clone" one radio to another by using a saved configuration file or by changing the ESTeem memory module from one unit to another. This feature will allow the copy of all settings and identifiers (Peers, SSID, Channel, IP Address, Serial Number, and even MAC Address) from one radio to another radio so that a radio can be replaced in the field with no programming changes required in the other network radios. The radio does this by saving a copy of these settings to the backup file saved to a PC or to the ESTeem memory module card that can be removed and placed into another Horizon Series radio.

> ***Technical Tip*** *- By configuring the radio as a clone, the MAC addresses will be changed in the radio to match those within the backup file. The cloned radio will operate as a copy of the backup image in the network, but if the original radio is returned to the network the cloned radio* ***must*** *be removed or reset to factory defaults. Having two radios with the same MAC addresses in the wireless network will cause a network wide failure.*

To clone one radio to another, verify the two radios are of the same model and firmware version. This information can be found on the "Top" page of the Web Configuration Tool or included on the Quality Assurance paperwork shipped with each radio. When restoring the radio from a backup image (in either a saved data file or from the ESTeem memory module) an option to restore as a Clone will be displayed (Figure 3). If selected the radio will reboot as a copy of the radio in the data file.

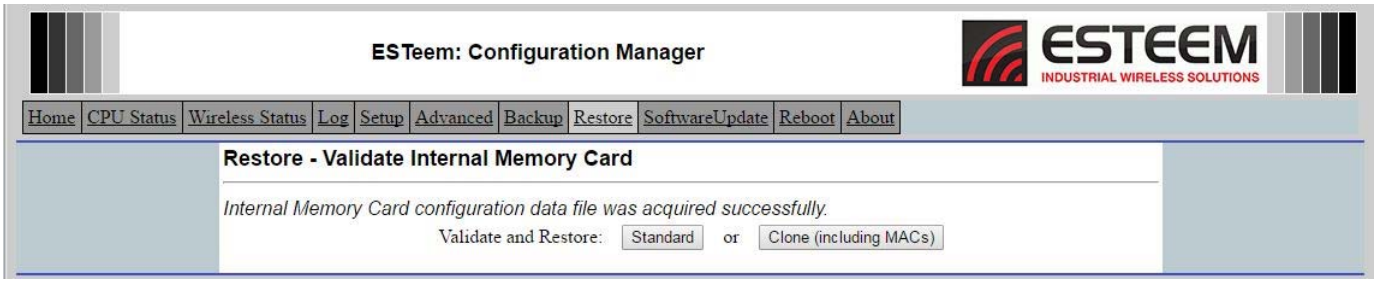


Figure 3: Restore as Clone Option

Moving Memory Module for Cloning

The first step to clone a radio is to remove the faceplate from the front of the Horizon by removing the two 5/64 hex nuts (Figure 4).

Next, locate the ESTeem Memory Module (microSD card) installed in the radio (Figure 4). The card can be found behind the TX/RX LEDs next to the reset switch. The microSD card has a locking mechanism. To retrieve the card, press in (towards the back of the radio) firmly and then pull out card. (See Figure 5).

Figure 4: Horizon Front Panel

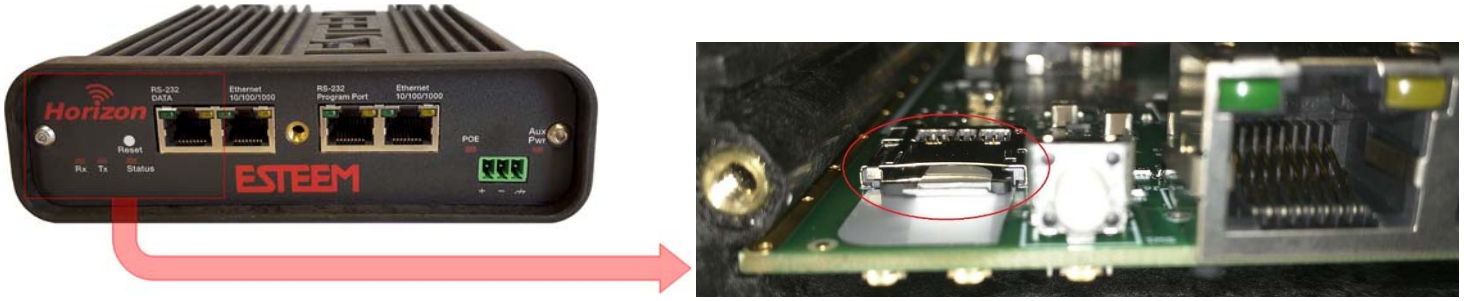


Figure 5: Memory Module Location

Once the Horizon's memory module has been changed, restore the radio as a "Clone" copy of the replaced radio as shown above.

When connecting to a cloned radio through the Web Configuration Manager, you will notice the "This is a cloned device" warning label on all pages of the Web Configuration Tool. (See Fig 6).

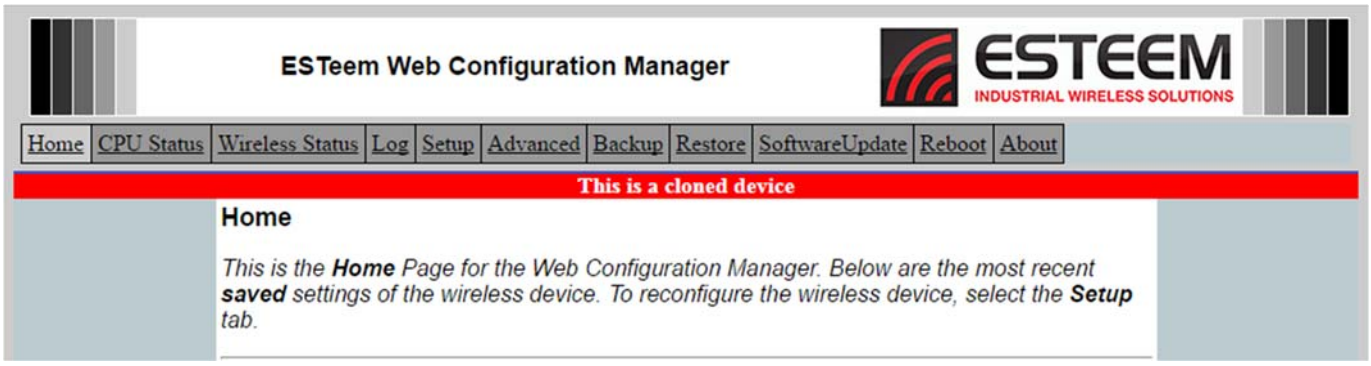


Figure 6: Cloned Device Warning

To revert the cloned radio's setting back prior to becoming a clone, select the Advanced menu then select Cloning Setup and press Next button at the bottom of the page. From this page you will see a "remove clone data" button that when pressed will remove the clone data from BOTH the radio and the microSD Card.

If at any point changes are made to the cloned radio's configuration and saved, the "This is a cloned device warning" warning will go away and the option of reverting to a previous save will no longer be available in the Advanced menu. The radio can still be reset to Factory Defaults and reprogrammed as required.

EtherStation Troubleshooting

The EtherStation mode of operation allows a single Ethernet device to connect to the Horizon radio and operate as a mobile client connecting to a network of Access Points (AP's). Once the Horizon is configured in EtherStation mode, it no longer has its own IP address and will clone the MAC address of the connected device. This cloning is done by either entering the device's MAC address or selecting MAC Autosense in the EtherStation configuration (Figure 7).

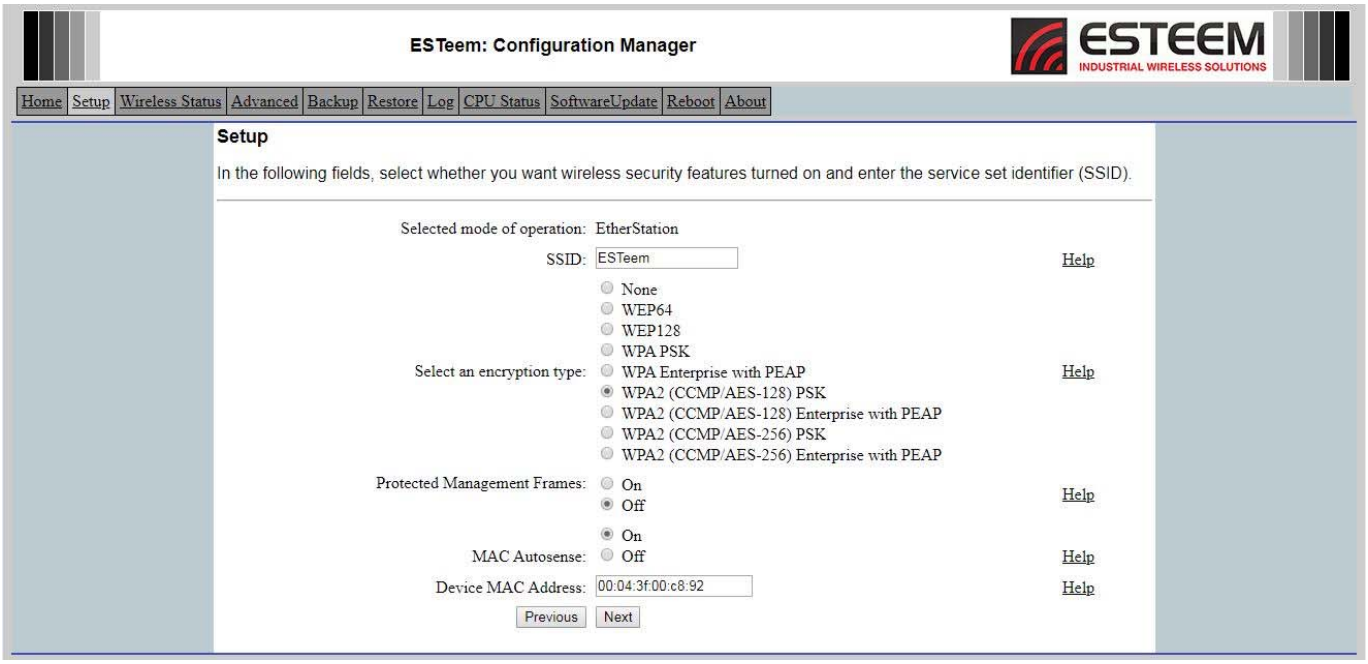


Figure 7: EtherStation Configuration

EtherStation Monitoring and Status – The Horizon configured in EtherStation mode will no longer have an IP address on the primary Ethernet port. To review the status or make any changes to the configuration, the Horizon's secondary Ethernet port (when in EtherStation mode) will be set to a default IP address of 172.16.8.1 (255.255.0.0) and can be accessed through any web browser. This monitoring IP address can also be reconfigured under **Advanced>Network Settings>eth1** device after the radio has been configured for EtherStation.

Horizon Wireless Network Customization & "Data Shaping"

In most Horizon wireless networks, no customization or "data shaping" will be necessary but there are multiple options available if required. Network customization would only be required if looking to provided specific data rates to remote locations or minimum data rates (for each site) in very large wireless networks. The following are specific settings available in the Horizon radios that can be customized to fit an exact network requirement. ESTeem support can help guide which tool would work best for the challenges of your wireless network.

Peer Link Advanced Settings

When configuring a peer link in a Horizon radio (Chapter 3 & Chapter 7 for full configuration details) and pressing "Show Advanced" button, multiple configuration options will be displayed (Figure 8). The following parameter changes can help customize the wireless link:

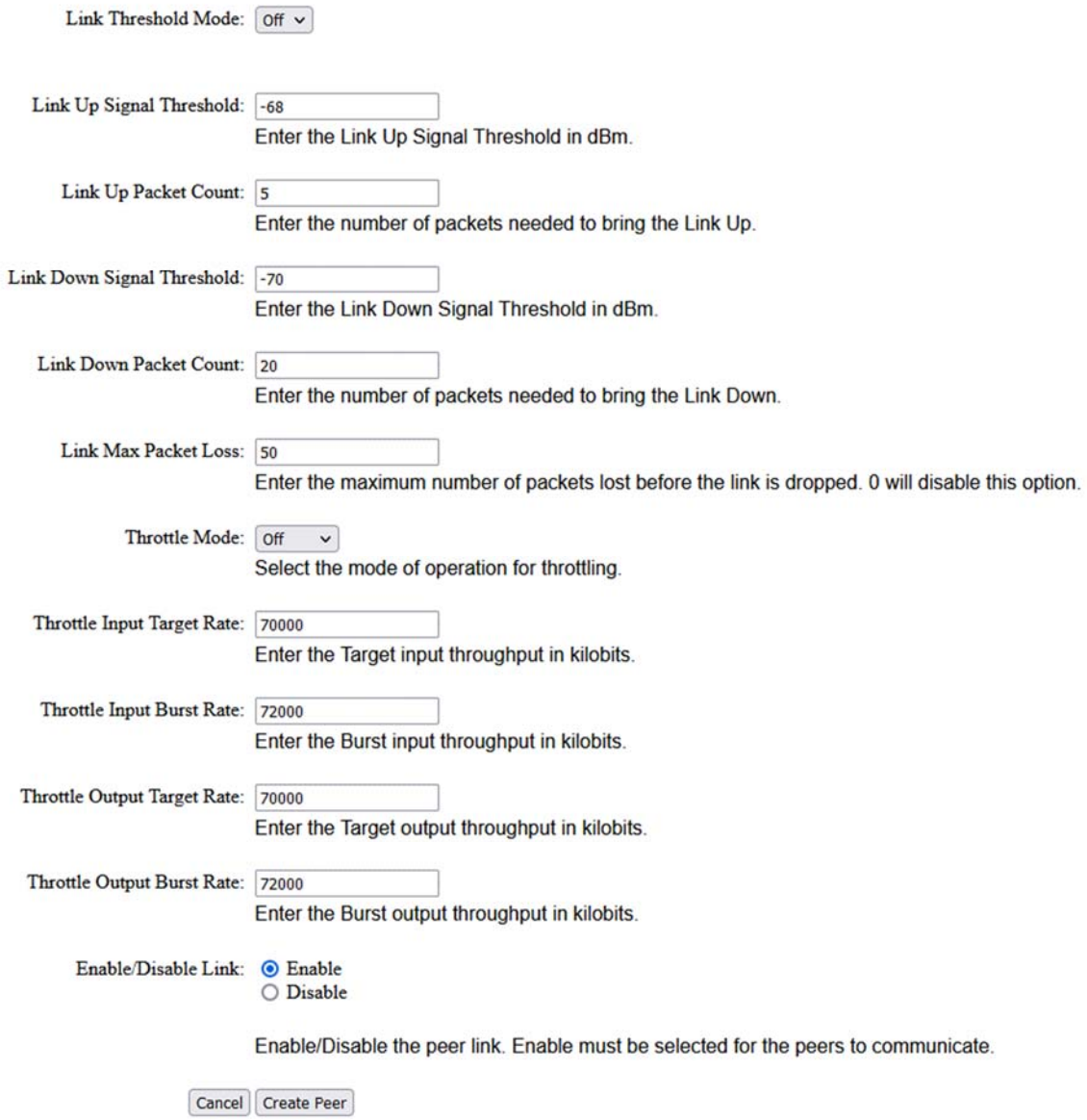


Figure 8: Advanced Peer Configuration

Standard Rates & High Throughput Rates

The Dynamic setting will allow the radio to monitor the receive signal strength and adjust the data rate as required, but these can also be configured to limit data rates to specific remote sites. To limit the RF data rate, uncheck the Dynamic speed setting and only check the RF speeds up to and including the desired rate.

For example, you may want to limit the RF throughput to a single peer in a large wireless network. If you wanted to limit a remote link to never get above 7.2Mbps, check the 1, 2, 5.5, 6 & 6.5/7.2 Mbps boxes. Adding these lower data rates will allow the radio to operate anywhere between 1 and 7.2Mbps as the RF environment will allow. If only a single RF data rate is selected, then if the radio can not maintain that rate due to receive signal or noise the link will be lost.

Link Threshold

Also known as Dynamic Mesh, this setting will enable and disable the peer link based upon the received signal strength and number of packets set in the Threshold and Packet Count options respectively. Using this you can create a peer network with mobile clients that will have fluctuating RSSI values.

Timeout

On very large RF networks the timeout setting may need to be adjusted. The default setting is 10,000 ms (10 seconds). If a very large RF network has adjusted the Beacon Interval (detailed below) to optimize timing, adjust the Timeout setting to be greater than the maximum time to beacon all remote sites.

Throttle Mode

In very rare occurrences the precise amount of data throughput can be configured for each wireless link, Ethernet interface, and wireless interface in a process called “data shaping”. Using the multiple throttle configurations seen in Figure 8, each interface can be shaped to perform as required in very specific configurations. These settings should only be used if familiar with the Horizon radios operation or as directed by ESTeem support.

Beacon Intervals

The Horizon radios use spanning tree protocols to control the operation of the radios in a Mesh configuration. A key setting in very large wireless networks is the ability to directly control how often the radios will send a control (beacon) message between each other to made changes in the Mesh network. By default, the beacon interval is randomly configured (Figure 9) so that all radios in a wireless network will not attempt to communicate at the same time. In larger wireless networks, the beacon interval can be manually adjusted to account for the large number of remote radios in a network. As with all settings in this Customization section, these settings should only be adjusted upon advice from ESTeem support or if recommended in the wireless network design.

The adjustment for the beacon interval can be found in the web interface in **Advanced>Wireless LAN Settings>wlan0 device>Advanced Settings**. Each remote site should have a Beacon TIM in the network to avoid overlap.

Figure 9: Beacon Interval Settings

This configuration can also be greatly simplified by using the ESTeem Networking Suite (ENS) software. If all sites in the wireless network are and selected, use the right-mouse key and select **Bulk>Beacon Settings** (Figure 10) and Figure 11 will be displayed.

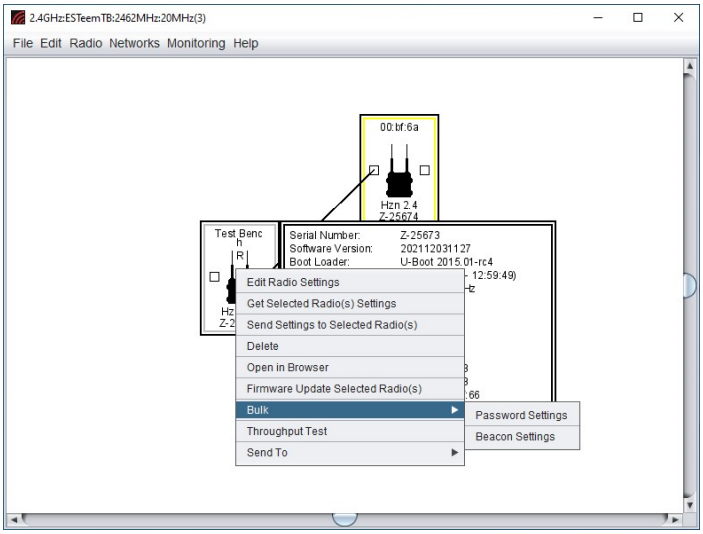


Figure 10: ENS Bulk Beacon Settings

The Bulk Beacon Setting Menu (Figure 11) will allow the ENS configuration software to do the randomization of the remote radio's beacon interval. Uncheck the Beacon Random Adjuster and check the Radio Interval Adjustment, verify the number of radios and select the number of steps between each. When pressing OK, the beacon interval to each radio will be programmed differently in the ENS configuration.

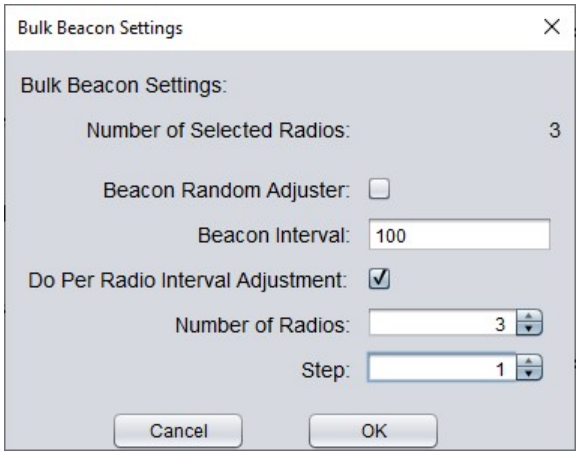


Figure 11: ENS Beacon Adjuster Menu

TROUBLESHOOTING TIPS

General (Applicable to All Modes of Operation)

Where do I find the latest firmware version number? – We have the latest version number of the Horizon firmware listed on the ESTeem Web site (www.esteem.com) under the Horizon product page.

How and when do I update the Horizon firmware? - You should only update the Horizon firmware if you are having a specific problem and it is recommended that you do so by ESTeem Customer Support personnel. All the update instructions and files are located on the ESTeem FTP site at the following address:
ftp://www.esteem.com/Horizon

Do all firmware versions have to be the same to communicate between the Horizon? – It is not necessary for all the firmware versions to be the same revision to communication, but the later version may have added features that the other versions will not recognize.

What characters are valid for WEP Key entry? - Only the Hexadecimal characters 0-9 and A-F are valid for key entry.

What ESTeem Utility version is required to program the Horizon? – The ESTeem Utility program is not required to program the Horizon. The Horizon can be programmed using any Terminal Emulation program (such as Windows HyperTerminal) and any web browser program.

What is the speed and duplex configuration on the Horizon – The Horizon is an auto-negotiation full/half-duplex 10/100 Base-T interface. Ether a cross-over or patch cable is supported.

Access Point Mode

Wireless LAN cards are not connecting – Verify that the wireless LAN cards are set to Infrastructure Mode, have a matching SSID (or ESSIS) set the same as the Horizon and that all encryption codes are the same.

My Wireless LAN card shows a solid connection, but I can not pass any data – Verify the encryption and the ACL setting on the Horizon match the wireless LAN card.

Access Point Peer Mode

How long does it take to re-establish the Wireless Ethernet Network? - If a communication link is lost and the Wireless Network needs to re-establish the repeater routes, the time can take up to 10 seconds.

Should the AP Repeater Mode be used on mobile equipment? - The AP Repeater mode should be used on equipment that will not change the Repeater Route as it moves. For example, if a mobile device such as a crane can communicate directly to another ESTeem and will not loose the link in its travel, the AP Repeater Mode could be used. If the device requires two ESTeem Horizon's (Base and Repeater) to maintain communication across its complete travel, the Station Modes should be used on the mobile device. The problem will be in the time that the mobile ESTeem will take to transfer between the two sites. In Access Point Repeater mode the transfer can take up to 30 seconds, while the EtherStation mode will transfer without a packet loss.

Does WEP have to be used? – The WEP does not have to be enabled for the modems to communicate, but all modems must be configured the same way.

Correct configuration, but cannot establish communications. – In addition to the network configuration, all Horizon modems configured in the AP mode must share the same SSID and be on the same frequency channel. The most likely cause of the error

is the WLAN MAC address is not configured in **both** Horizon's repeater tables. If only one side is configured, everything will appear to be correct but no communication will function.

EtherStation

How do I access the Horizon web page in EtherStation Mode? The Horizon does not have an active web browser on the primary Ethernet port when configured in EtherStation mode. You can access the ESTeem with the ESTeem Discovery Program, through the RS-232 port or through the secondary Ethernet port set a fixed IP address of 172.16.8.1 (255.255.0.0).

What IP address do I configure the ESTeem in EtherStation mode? – The Horizon will not have an IP address in EtherStation mode.

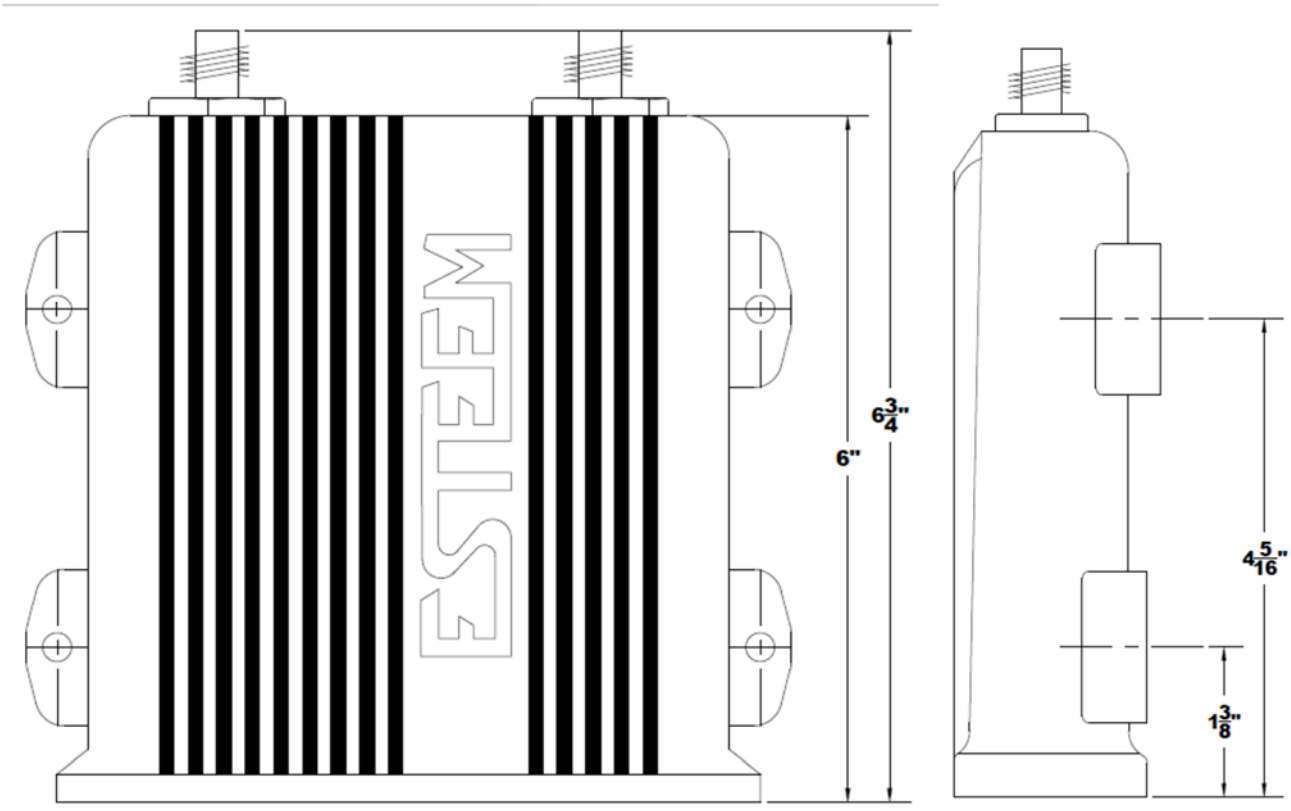
I can not link my device into the wireless network – If the MAC address was entered manually and not set to Autosense (Figure 7 above), verify that the MAC address of the device is **exactly** the same as configured in the Horizon. The MAC address must have colons between the values.

Can I connect my Horizon in EtherStation mode to a HUB or Ethernet Switch? – No. The modem must be connected directly to the Ethernet device for which it is programmed. In EtherStation mode the Horizon can only service ONE Ethernet device.

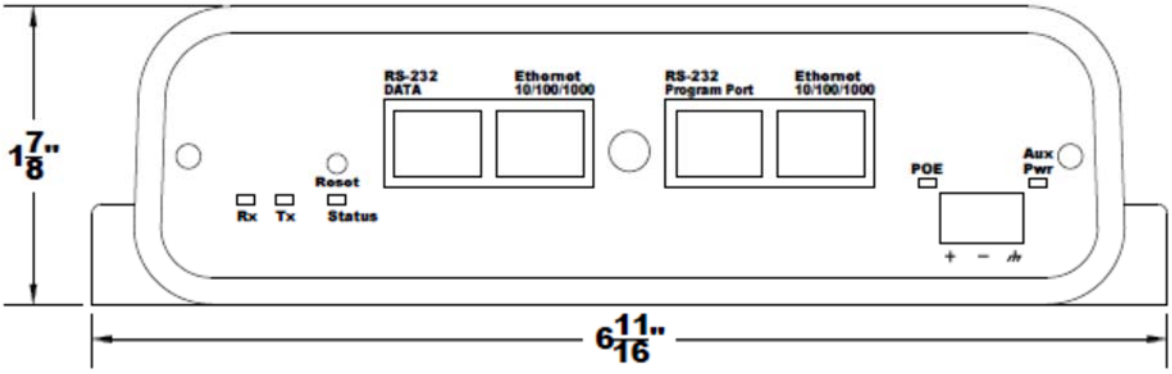
Horizon 2.4 GHz Specifications

ESTeem Horizon 2.4 Specifications	
Transmitter/Receiver	
Frequency of Operation (Software Selectable)	2.412 to 2.462 GHz (11-channels)
RF Data Rate	1 to 150 Mbps
Tx Output Power (Software Selectable)	1 Watt (30dBm)
Channel Bandwidth	5 MHz, 10 MHz, 20 MHz or 40 MHz
Tx Output Impedance	50 ohms
Rx Sensitivity	-97 dBm
FCC Type Acceptance	ENPHZN216AN
Industry Canada Type Acceptance	2163A-216AN
LED Indicators	Power (On/Off) - Status (On/Off) - Transmitter (On/Off) - Reciever (On/Off)
Power Requirements	
Receive	600ma @ 12 VDC
Transmit	1.25A @ 12 VDC
PoE Power Supply	(IEEE 802.3at,30 watts) (opt)
External Power Input	10 to 16 VDC @ 1.5A
Input/Output Connectors	
Ethernet Port 1 (10/100)	RJ-45 Female
Ethernet Port 2 (10/100)	
802.11 Compatibility	802.11n/g/b
RS-232C Data Port (2,400 to 115.2 K baud)	RJ-45 Female
RS-232C Programming Port (115,200,N,8,1)	
Antenna Input/Outputs	TNC Reverse Female
External DC Input Power	Mini-Combicon, 3-pin Female
Case	
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
Other	
Outdoor Pole Mt. Kit	AA195PM (NEMA4 Rating When Used)
PoE+ Power Supply	AA175.5 (opt)
Security	WPA2, WPA, AES-128/256, TKIP, WEP-64/128 MAC ID filter

Horizon Case Specifications



Top View **Side View**



Front View

Antenna Specifications

Model: AA20DMEg
Applications: Horizon 2.4 direct case mount
Antenna Type: Omni-Directional, Sleeve dipole
Frequency: 2400 to 2500 MHz
Polarization: Vertical
Impedance: 50 ohms
Gain: 5.5 dBi
VSWR: < 2:1
Power: 10 W
Front To Back Ratio: n/a
Horizontal Beamwidth: 360 Deg
Vertical Beamwidth: 60 Deg
Antenna Material: Polyurethane Plastic Radome
Recommended Mounting Hardware: n/a
Antenna Connector: TNC-R Male
Antenna Envelope: 8.1 in. length by .54 in. width
Temperature: -20 to +60 C°
Weight: 33 grams

Caution

Omni-directional antenna should not be located within 20 cm of personnel.

Model No:	AA20Eg
Antenna Type:	Omni-Directional, DC grounded
Applications:	Fixed base.
Frequency:	2400 to 2483 MHz
Polarization:	Vertical
Impedance:	50 ohms
Gain:	8 dBi
VSWR:	< 1.5:1 Typical
Horizontal Beamwidth:	360 degrees
Vertical Beamwidth:	16 degrees
Antenna Material:	White UV inhibited fiberglass
Mounting Hardware:	Pole mounting bracket, supplied
Antenna Connector:	TNC-R Male with 18in. pig tail
Maximum Power Input:	100 Watts
Antenna Envelope:	20.3 in. length by 1.25 in. diameter
Wind Survival:	135 mph
Weight:	1.4 lbs.

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna and all persons.

Antenna Specifications

Model No:	AA206Eg
Applications:	Fixed base mounting
Antenna Type:	2.4 GHz ISM, Panel, Directional, DC Grounded
Frequency:	2400-2500 MHz
Polarization:	Vertical or Horizontal
Impedance:	50 ohms
Gain:	14 dBi
VSWR:	< 2:1 nominal
Front to Back Ratio:	>19 dB
Horizontal Beamwidth:	38 degrees @ ½ power
Vertical Beamwidth:	38 degrees @ ½ power
Antenna Material:	White UV protected PVC
Recommended Mounting Hardware:	Heavy-Duty elevation and tilt mounting hardware for masts to 2.16 (5.5cm) in. O.D.
Antenna Connector:	TNC-R Male with 18 in. pig-tail
Wind Survival:	93 mph
Antenna Envelope:	6.61 in. x 6.61 in x 1.41 in. (168x168x36mm)
Weight:	0.93 lbs. (0.42 kg)

Caution

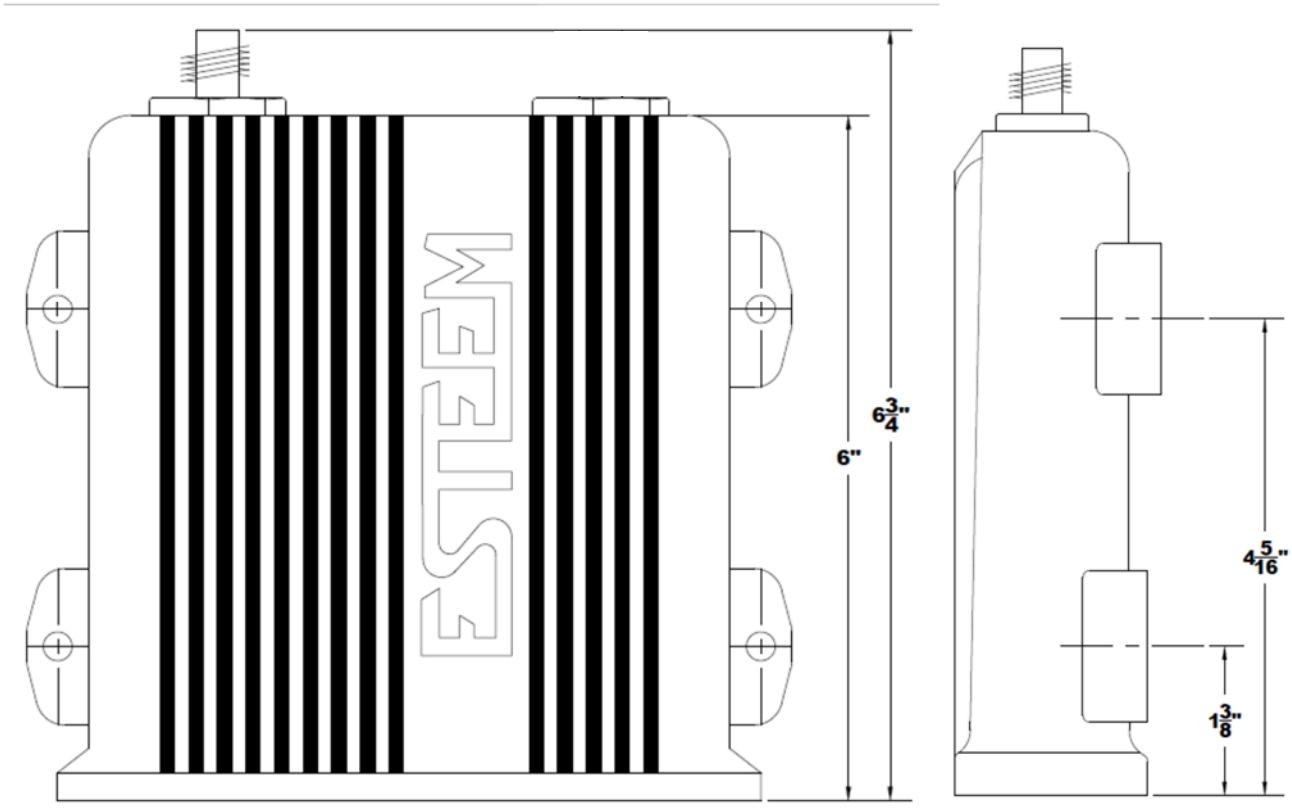
To comply with the FCC exposure compliance requirements, a separation distance of at least 50 cm must be maintained between the antenna and all persons.

Use of the AA206Eg, directional panel antenna is limited to fixed point-to-point applications only. In accordance with FCC Section 15.247(b)iii, this antenna must be professionally installed. The installer must ensure the system is used exclusively for fixed, point-to-point applications and the ESTeem Horizon 2.4 GHz is set for 0.25 Watts output power (Power Level = Min).

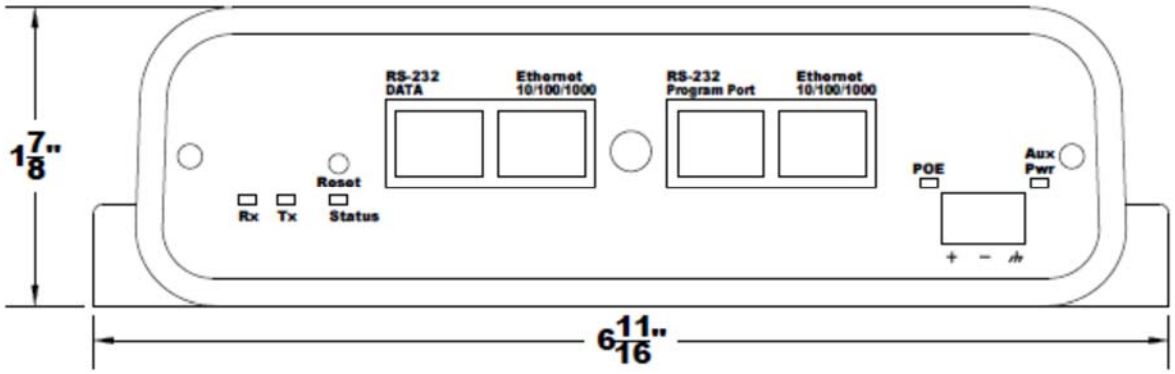
Horizon 900 MHz Specifications

ESTeem Horizon 900 Specifications	
Transmitter/Receiver	
Frequency of Operation (Software Selectable)	902-928 MHz (4-channels)
RF Data Rate	1 to 72.2 Mbps
Tx Output Power (Software Selectable)	1 Watt (30dBm)
Channel Bandwidth	5 MHz, 10 MHz or 20 MHz
Tx Output Impedance	50 ohms
Rx Sensitivity	-93 dBm
FCC Type Acceptance	ENPHZN216AD
Industry Canada Type Acceptance	2163A-216AD
LED Indicators	Power (On/Off) - Status (On/Off) - Transmitter (On/Off) - Receiver (On/Off)
Power Requirements	
Receive	600ma @ 12 VDC
Transmit	1.25A @ 12 VDC
PoE Power Supply	(IEEE 802.3at,30 watts) (opt)
External Power Input	10 to 16 VDC @ 1.5A
Input/Output Connectors	
Ethernet Port 1 (10/100/1000)	RJ-45 Female
Ethernet Port 2 (10/100/1000)	
802.11 Compatibility	n/a
RS-232C Data Port (2,400 to 115.2 K baud)	RJ-45 Female
RS-232C Programming Port (115,200,N,8,1)	
Antenna Input/Outputs	TNC Reverse Female
External DC Input Power	Mini-Combicon, 3-pin Female
Case	
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
Other	
Outdoor Pole Mt. Kit	AA195PM (NEMA4 Rating When Used)
PoE Power Supply	AA175.5 (opt)
Security	WPA2, WPA, AES-128/256, TKIP, WEP-64/128 MAC ID filter

Horizon 900 MHz Case Specifications



Top View **Side View**



Front View

Antenna Specifications

Model: AA20DMEs
Applications: Direct case mount
Antenna Type: Omni-Directional, Sleeve dipole
Frequency: 902-928 MHz
Polarization: Vertical
Impedance: 50 ohms
Gain: 2 dBi
VSWR: < 2:1
Antenna Material: Polyurethane Plastic Radome
Antenna Connector: TNC-R Male
Antenna Envelope: 7.7 in. length by .54 in. width
Temperature: -20 to +65 C°
Weight: 35 grams

Caution

Omni-directional antenna should not be located within 20 cm of personnel.

Model No: AA20Es900 (AA20Es900N)
Antenna Type: Omni Directional, DC Grounded
Applications: Fixed base
Frequency: 902 to 928 MHz
Polarization: Vertical
Impedance: 50 ohms
Gain: 5 dB
VSWR: 1.5:1 Typical
Vertical Beamwidth: 22 degrees @ ½ power
Antenna Material: Brass radiator, UV inhibited fiberglass enclosed
Mounting Hardware: Base to Mast, Supplied heavy duty mount.
Maximum Power Input: 150 Watts
Wind Survival: 100 mph
Bending Moment: 14.2 ft-lbs. @ 100 mph
Antenna Connector: TNC-R Male with 36in. pig-tail. (N-Male with 36 in pig-tail)
Antenna Envelope: 48 in. L x 1-5/16 in. Dia.

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 23 cm must be maintained between the antenna and all persons.

Antenna Specifications

Model No: AA203Es900 (AA203Es900N)
Antenna Type: Directional, DC grounded
Applications: Fixed base.
Frequency: 900 to 930 MHz
Polarization: Vertical or Horizontal
Impedance: 50 ohms
Gain: 6 dBd
VSWR: < 2:1 Nominal
Front to Back Ratio: 15 dB
Horizontal Beamwidth: 90 degrees @ ½ power
Vertical Beamwidth: 70 degrees @ ½ power
Antenna Material: **A**luminum
Mounting Hardware: Stainless mast up to 2 3/8" pipe (included).
Antenna Connector: TNC-R Male with 12 inch pigtail with ESTeem weatherproof boot. (N-Female)
Maximum Power Input: 300 Watts
Antenna Length: 18 inch
Wind Rating: 125 mph
Wind Load: 8.8 lbs.

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 23 cm must be maintained between the antenna and all persons.

Model No: AA206Es900N
Antenna Type: Directional, Panel, DC grounded
Applications: Fixed base.
Frequency: 902 to 928 MHz
Polarization: Vertical or Horizontal
Impedance: 50 ohms
Gain: 11 dBi
VSWR: < 2 Nominal
Front to Back Ratio: > 35 dB
Horizontal Beamwidth: 60 degrees @ ½ power
Vertical Beamwidth: 40 degrees @ ½ power
Antenna Material: White UV protected PVC
Mounting Hardware: Heavy duty, elevation and tilt adjustable mounting up to 2.16 in. pipe (included).
Antenna Connector: N-Female
Maximum Power Input: 50 Watts
Antenna Envelope: 13.7 in. x 13.7 in x 1.38 in. (348x348x35mm)
Wind Survival: 93 mph (150km/h)
Weight: 2.78 lbs. (1.26kg)

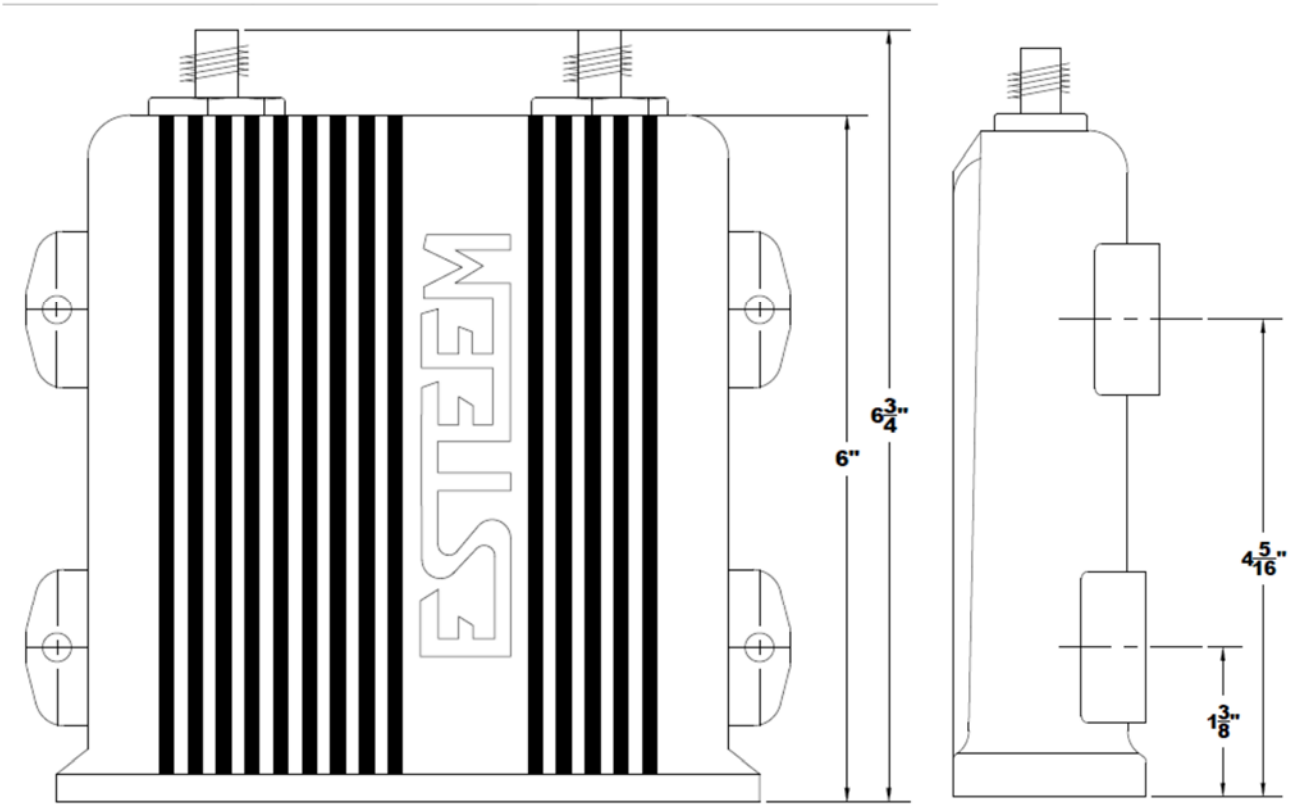
Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 23 cm must be maintained between the antenna and all persons.

Horizon 4.9 GHz Specifications

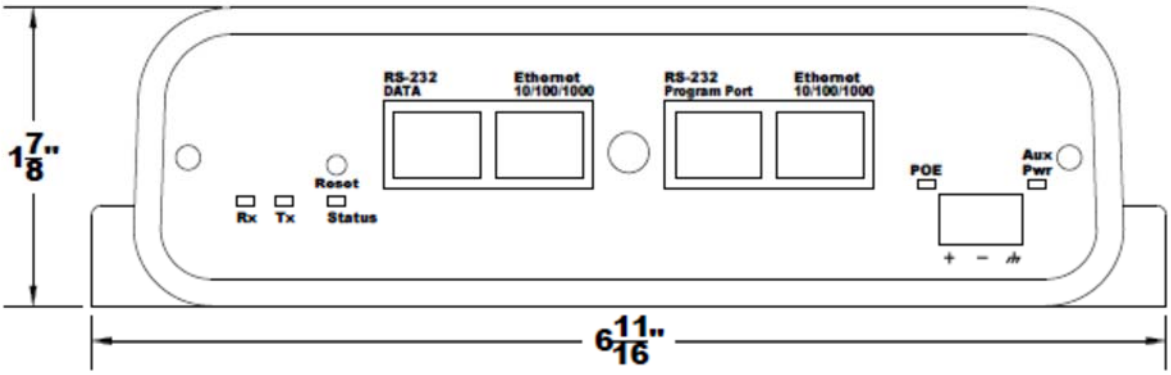
ESTeem Horizon 4.9 Specifications	
Transmitter/Receiver	
Frequency of Operation (Software Selectable)	4.960 to 4.980 GHz (2-channels)
RF Data Rate	6 to 72.2 Mbps
Tx Output Power (Software Selectable)	1 Watt (30dBm)
Tx Output Impedance	50 ohms
Channel Bandwidth	20 MHz
Rx Sensitivity	-94 dBm
FCC Type Acceptance	ENPHZN216AP
Industry Canada Type Acceptance	Not Approved
LED Indicators	Power (On/Off) - Status (On/Off) - Transmitter (On/Off) - Receiver (On/Off)
Power Requirements	
Receive	600ma @ 12 VDC
Transmit	1.25A @ 12 VDC
PoE Power Supply	(IEEE 802.3at,30 watts) (opt)
External Power Input	10 to 16 VDC @ 1.5A
Input/Output Connectors	
Ethernet Port 1 (10/100/1000)	RJ-45 Female
Ethernet Port 2 (10/100/1000)	
802.11 Compatibility	n/a
RS-232C Data Port (2,400 to 115.2 K baud)	RJ-45 Female
RS-232C Programming Port (115,200,N,8,1)	
Antenna Input/Outputs	TNC Female
External DC Input Power	Mini-Combicon, 3-pin Female
Case	
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
Other	
Outdoor Pole Mt. Kit	AA195PM (NEMA4 Rating When Used)
PoE Power Supply	AA175.5 (opt)
Security	WPA2, WPA, AES-128/256, TKIP, WEP-64/128 MAC ID filter

Horizon 4.9 GHz Case Specifications



Top View

Side View



Front View

Antenna Specifications

Model No: AA191Ep
Antenna Type: Omni-Directional, Vehicle Mount
Applications: Mobile
Frequency: 4.940 to 4.990 GHz
Polarization: Vertical
Impedance: 50 ohms
Gain: 5.5 dBi
VSWR: < 1.5 to 1
Antenna Material: Black Radome
Mounting Hardware: Base Included
Antenna Connector: TNC Male with 17 foot LMR-195
Antenna Envelope: 12 in. length (maximum)
Weight: < 1 lbs.

Caution

Omni-directional antenna should not be located within 20 cm of personnel.

Model: AA20DMEp
Applications: Horizon 4.9 GHz direct case mount
Antenna Type: Omni-Directional, Sleeve dipole
Frequency: 4.940 to 4.990 GHz
Polarization: Vertical
Impedance: 50 ohms
Gain: 5.5 dBi (3 dBd)
VSWR: < 2:1
Power: 10 W
Antenna Material: Polyurethane Plastic Radome
Antenna Connector: TNC Male
Flexibility: +/- 20 °
Antenna Envelope: 8.28 in. length by .54 in. width
Temperature: -40 to +70 C°
Weight: 33 grams

Caution

Omni-directional antenna should not be located within 20 cm of personnel.

Antenna Specifications

Model No: AA204Ep
Applications: Fixed base mounting
Antenna Type: Directional, Single Linear Polarized Panel, DC grounded
Frequency: 4.94-4.99 & 5.15-5.875 GHz
Polarization: Vertical or Horizontal
Impedance: 50 ohms
Gain: 23 dBi nominal
VSWR: < 1.5:1 nominal
Front to Back Ratio: >40 dB
Horizontal Beamwidth: 10 degrees @ ½ power
Vertical Beamwidth: 10 degrees @ ½ power
Antenna Material: Gray UV Stabilized ABS Plastic radome with aluminum backplane
Recommended Mounting Hardware: Included zinc planted steel mounting bracket provides easy azimuth and elevation adjustment for pole mounting on masts between 1.4 in and 1.97 in. diameter.
Antenna Connector: TNC-Male with 2.5 ft. pig-tail and weather boot
Maximum Power Input: 30 Watts
Antenna Envelope: 13.8 in. length by 13.8 in. height by 1.0 in. depth
Weight: 3.52 lbs.

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 60 cm must be maintained between the antenna and all persons.

Model No: AA20Ep
Application: Fixed base mounting
Antenna Type: Omni-Directional, DC grounded
Frequency: 4900-5000 MHz
Polarization: Vertical
Impedance: 50 ohms
Gain: 9 dBi
VSWR: 2:1 maximum
Vertical Beamwidth: 12 degrees
Recommended Mounting Hardware: FB2 Bracket
Antenna Connector: TNC-Male Connector with ESTeem Weatherproof Boot
Maximum Power Input: 25 Watts
Wind Survival: 125 mph
Antenna Height: 14 in.
Radome: White Fiberglass
Weight: 0.75 lbs.

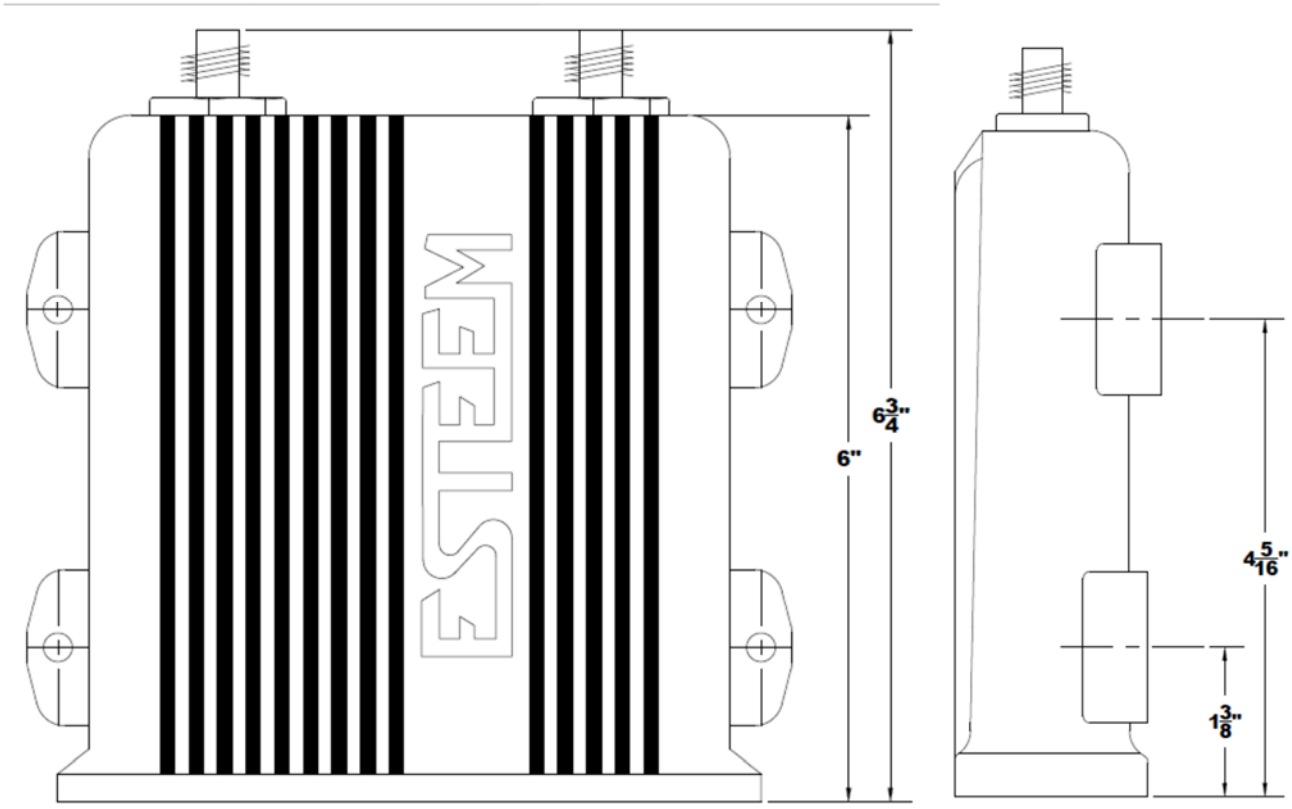
Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna and all persons.

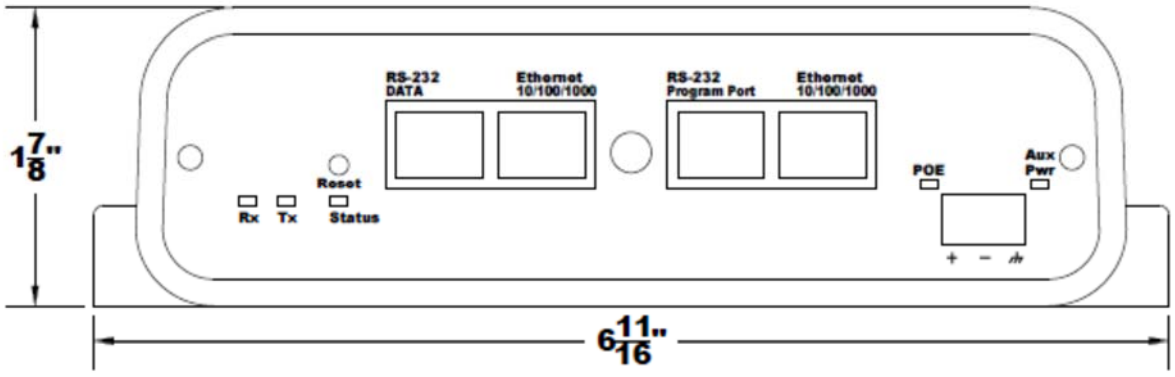
Horizon 5.8 GHz Specifications

ESTeem Horizon 5.8 Specifications	
Transmitter/Receiver	
Frequency of Operation (Software Selectable)	5.745 to 5.825 GHz (17-channels)
RF Data Rate	6 to 300 Mbps
Tx Output Power (Software Selectable)	250 mW (24dBm)
Channel Bandwidth	5 MHz, 10 MHz, 20 MHz or 40 MHz
Tx Output Impedance	50 ohms
Rx Sensitivity	-93 dBm
FCC Type Acceptance	TV7R11E5HND
Industry Canada Type Acceptance	Not Approved
LED Indicators	Power (On/Off) - Status (On/Off) - Transmitter (On/Off) - Receiver (On/Off)
Power Requirements	
Receive	250 ma @ 12 VDC
Transmit	1.25 A @ 12 VDC
PoE Power Supply	(IEEE 802.3at,30 watts) (opt)
External Power Input	10 to 16 VDC @ 1.5 A
Input/Output Connectors	
Ethernet Port 1 (10/100/1000)	RJ-45 Female
Ethernet Port 2 (10/100/1000)	
802.11 Compatibility	802.11n/a
RS-232C Data Port (2,400 to 115.2 K baud)	RJ-45 Female
RS-232C Programming Port (115,200,N,8,1)	
Antenna Input/Outputs	TNC Reverse Female
External DC Input Power	Mini-Combicon, 3-pin Female
Case	
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
Other	
Outdoor Pole Mt. Kit	AA195PM (NEMA4 Rating When Used)
PoE Power Supply	AA175.5 (opt)
GPS Location	Optional (Factory Installed)
Security	WPA2, WPA, AES-128/256, TKIP, WEP-64/128 MAC ID filter

Horizon 5.8 GHz Case Specifications



Top View **Side View**



Front View

Antenna Specifications

Model: AA20DMEa
Applications: Horizon 5.8 GHz direct case mount
Antenna Type: Omni-Directional, Sleeve dipole
Frequency: 4.900 to 5.875 GHz
Polarization: Vertical
Impedance: 50 ohms
Gain: 3 dBi
VSWR: < 2.0:1
Power: 2 W
Vertical Beamwidth: 50 Degrees
Antenna Material: Black, PU, ABS, UV Resistant
Antenna Connector: TNC-R Male
Antenna Envelope: 6.38 in. length by .57 in. width
Temperature: -10 to +55 C°
Weight: 0.06 lbs

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna and all persons.

Model No: AA20Ea
Antenna Type: Omni Directional, DC Grounded
Applications: Fixed base
Frequency: 5.7-5.8 GHz
Polarization: Vertical
Impedance: 50 ohms
Gain: 10 dBi
VSWR: <1.5:1 Typical
Vertical Beamwidth: 10 degrees @ ½ power
Recommended Mounting Hardware: Pole Mounting Bracket, Supplied
Antenna Connector: TNC male reverse polarity with 18 in. pigtail and weatherproof boot
Maximum Power Input: 20 Watts
Wind Survival: 125 mph
Antenna Envelope: 17.9 L in. x .825 OD
Equivalent Flat Plate Area: .05 sq. ft
Lateral Thrust at Rated Wind: 4.83 lbs feet
Radome: UV Stable, Black Fiberglass
Weight: 0.43 lbs.

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna and all persons.

Antenna Specifications

Model No: AA205Ea
Applications: Fixed base mounting
Antenna Type: Directional, Single Linear Polarized Panel, DC grounded
Frequency: 4.94-4.99 & 5.15-5.875 GHz
Polarization: Vertical or Horizontal
Impedance: 50 ohms
Gain: 23 dBi nominal
VSWR: <1.5:1 nominal
Front to Back Ratio: > 40 dB
Horizontal Beamwidth: 10 degrees @ ½ power
Vertical Beamwidth: 10 degrees @ ½ power
Antenna Material: Gray UV Stabilized ABS Plastic radome with aluminum backplane
Recommended Mounting Hardware: Included zinc planted steel mounting bracket provides easy azimuth and elevation adjustment for pole mounting on masts between 1.4 in and 1.97 in. diameter.
Antenna Connector: TNC male with 2.5 ft. pig-tail and weatherproof boot.
Maximum Power Input: 30 Watts
Antenna Envelope: 13.8 in. length by 13.8 in. height by 1.0 in. depth
Operating Temperature: -40 to +158 F.
Weight: 3.52 lbs.

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 113 cm must be maintained between the antenna and all persons.

Model No: AA20Ea-Dual
Applications: Fixed base mounting. MIMO
Antenna Type: Omni-Directional, DC grounded
Frequency: 5.15-5.825 GHz
Polarization: Dual Linear
Impedance: 50 ohms
Gain: 13 dBi
VSWR: <1.5:1 typical
Vertical Beamwidth: 7 degrees
Recommended Mounting Hardware: Pole Mounting Bracket, Supplied
Antenna Connector: (2) TNC male reverse polarity with 18 in. pigtail and weatherproof boot
Maximum Power Input: 50 Watts
Wind Survival: 125 mph
Antenna Envelope: 24 in. L x 2.05 in.
Bending Moment: 4.4 ft-lbs.
Equivalent Flat Plate Area: .06 sq. ft.
Lateral Thrust at Rated Wind: 5.2 lbs feet
Radome: White UV resistant fiberglass
Operating Temperature: -45 to +65°C
Weight: 7 lbs.

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna and all persons.

Antenna Specifications

Model No: AA205Ea-Dual
Applications: Fixed base mounting.
Antenna Type: Directional, Linear Polarized Panel, DC grounded
Frequency: 4.94 - 5.875 GHz
Polarization: Dual Linear – Vertical and Horizontal
Impedance: 50 ohms
Gain: 24 dBi nominal
VSWR: <1.5:1 nominal
Front to Back Ratio: ≥ 40 dBi
Horizontal Beamwidth: 8 degrees @ ½ power
Vertical Beamwidth: 8 degrees @ ½ power
Antenna Material: UV stabilized ABS plastic, gray
Recommended Mounting Hardware: Articulating Bracket provided for wall mounting or masts between 0.75 in and 3.0 in. O.D.
Antenna Connector: (2) TNC male reverse polarity with 18 in. pig-tail and weatherproof boot.
Maximum Power Input: 30 Watts
Antenna Envelope: 15.2 in. length by 15.2 in. height by 2.0 in. depth
Operating Temperature: -45 to +65°C.
Weight: 4.1 lbs.

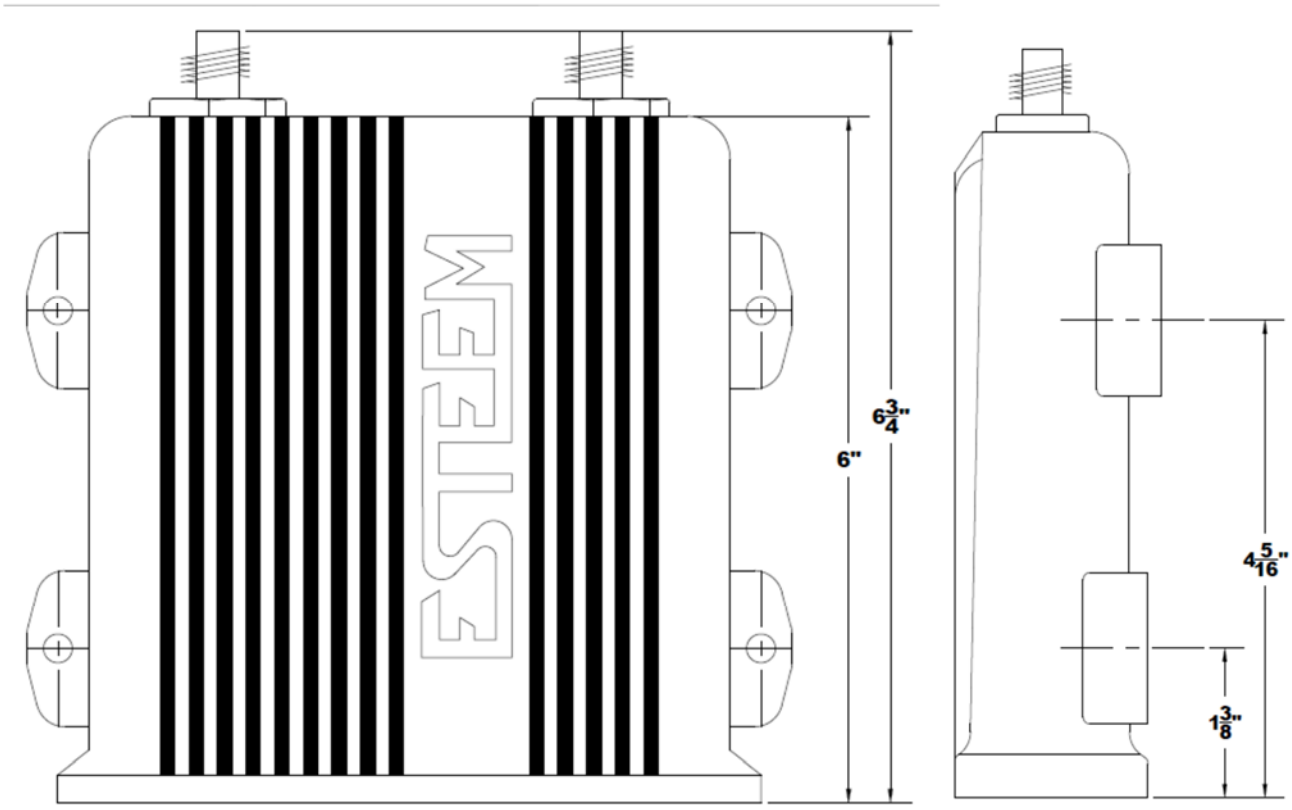
Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 50 cm must be maintained between the antenna and all persons.

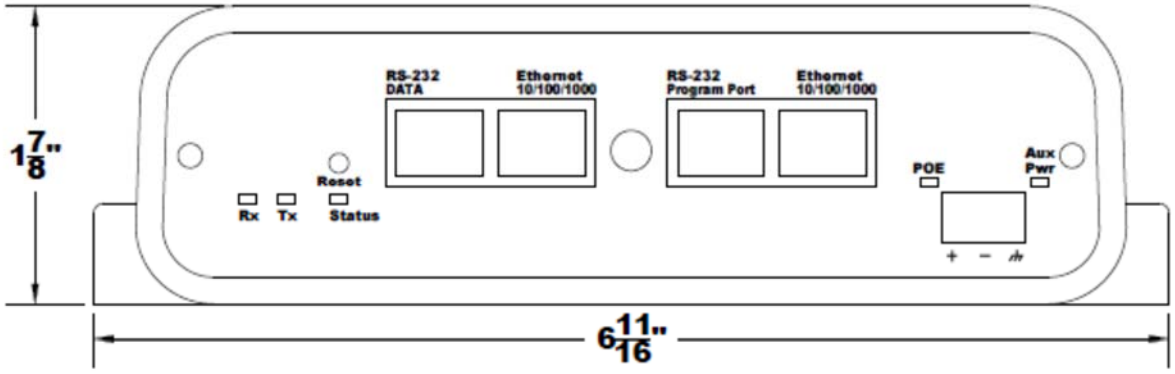
Horizon 2.4 GHz MIMO Specifications

ESTeem Horizon 2.4-MIMO Specifications	
Transmitter/Receiver	
Frequency of Operation (Software Selectable)	2.412 to 2.462 GHz (11-channels)
RF Data Rate	1 to 300 Mbps
Tx Output Power (Software Selectable)	500 mW (27 dBm)
Channel Bandwidth	5 MHz, 10 MHz, 20 MHz or 40 MHz
Tx Output Impedance	50 ohms
Rx Sensitivity	-93 dBm
FCC Type Acceptance	TV7R11E2HPND
Industry Canada Type Acceptance	7442A-R11E2HPND
LED Indicators	Power (On/Off) - Status (On/Off) - Transmitter (On/Off) - Receiver (On/Off)
Power Requirements	
Receive	250 ma @ 12 VDC
Transmit	1.25 A @ 12 VDC
PoE Power Supply	(IEEE 802.3at,30 watts) (opt)
External Power Input	10 to 16 VDC @ 1.5 A
Input/Output Connectors	
Ethernet Port 1 (10/100/1000)	RJ-45 Female
Ethernet Port 2 (10/100/1000)	
802.11 Compatibility	802.11n/g/b
RS-232C Data Port (2,400 to 115.2 K baud)	RJ-45 Female
RS-232C Programming Port (115,200,N,8,1)	
Antenna Input/Outputs	TNC Reverse Female
External DC Input Power	Mini-Combicon, 3-pin Female
Case	
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
Other	
Outdoor Pole Mt. Kit	AA195PM (NEMA4 Rating When Used)
PoE Power Supply	AA175.5 (opt)
GPS Location	Optional (Factory Installed)
Security	WPA2, WPA, AES-128/256, TKIP, WEP-64/128 MAC ID filter

Horizon 2.4 GHz MIMO Case Specifications



Top View **Side View**



Front View

Antenna Specifications

Model: AA20DMEg
Applications: Horizon 2.4 direct case mount
Antenna Type: Omni-Directional, Sleeve dipole
Frequency: 2400 to 2500 MHz
Polarization: Vertical
Impedance: 50 ohms
Gain: 5.5 dBi
VSWR: < 2:1
Power: 10 W
Front To Back Ratio: n/a
Horizontal Beamwidth: 360 Deg
Vertical Beamwidth: 60 Deg
Antenna Material: Polyurethane Plastic Radome
Recommended Mounting Hardware: n/a
Antenna Connector: TNC-R Male
Antenna Envelope: 8.1 in. length by .54 in. width
Temperature: -20 to +60 C°
Weight: 33 grams

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna and all persons.

Model No: AA20Eg-Dual (AA20EgN-Dual)
Applications: Fixed base mounting. MIMO
Antenna Type: Dual Polarity Omni-Directional, DC grounded
Frequency: 2.4 - 2.5 GHz
Polarization: Dual Linear
Impedance: 50 ohms
Gain: 13 dBi
VSWR: <1.5:1 typical
Vertical Beamwidth: 7 degrees
Recommended Mounting Hardware: Pole Mounting Bracket, Supplied
Antenna Connector: (2) TNC male reverse polarity with 18 in. pigtail and weatherproof boot (2x N-Female)
Maximum Power Input: 50 Watts
Wind Survival: 125 mph
Antenna Envelope: 48 in. L x 3 in.
Radome: Fiberglass
Weight: 10 lbs.

Caution

Omni-directional antenna should not be located within 20 cm of personnel.

Antenna Specifications

Model No: AA206Eg-Dual (AA206EgN-Dual)
Applications: Fixed base mounting.
Antenna Type: Directional, Linear Polarized Panel, DC grounded
Frequency: 2.4 – 2.5 GHz
Polarization: Dual Linear – Vertical and Horizontal
Impedance: 50 ohms
Gain: 19 dBi nominal
VSWR: <2 nominal
Horizontal Beamwidth: 20 degrees @ ½ power
Vertical Beamwidth: 20 degrees @ ½ power
Antenna Material: UV protected PVC
Recommended Mounting Hardware: Included mounting bracket for mast to 2.16 in. O.D.
Antenna Connector: (2) TNC male reverse polarity with 18 in. pig-tail and weatherproof boot. (2 x N-Female)
Windload: 100km/h (62 miles/hour)
Antenna Envelope: 16.1 in. length by 16.1 in. height by 1.2 in. depth
Operating Temperature: -45 to +80°C.
Weight: 4.2 lbs.

Caution

To comply with the FCC exposure compliance requirements, a separation distance of at least 50 cm must be maintained between the antenna and all persons.