



# ESTeem

INDUSTRIAL WIRELESS SOLUTIONS

## AirScope™ Spectrum Analyzer User's Manual

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## Overview

The ESTeem AirScope™ is a radio frequency (RF) spectrum analyzer system that uses your PC, AirScope Analysis software and hardware to provide real-time spectrum analysis, streaming capture and wireless network analysis from a 70 MHz to 6 GHz contiguous frequency range. The AirScope is in a highly portable package that is ideal for field testing or troubleshooting.

Throughout this User's Manual "**Technical Tips**" have been added to help in programming and answer some common questions.

The AirScope software is a Java™ based application compatible with any computer operating system (Window, Linux, etc). and has two primary modes of operation:

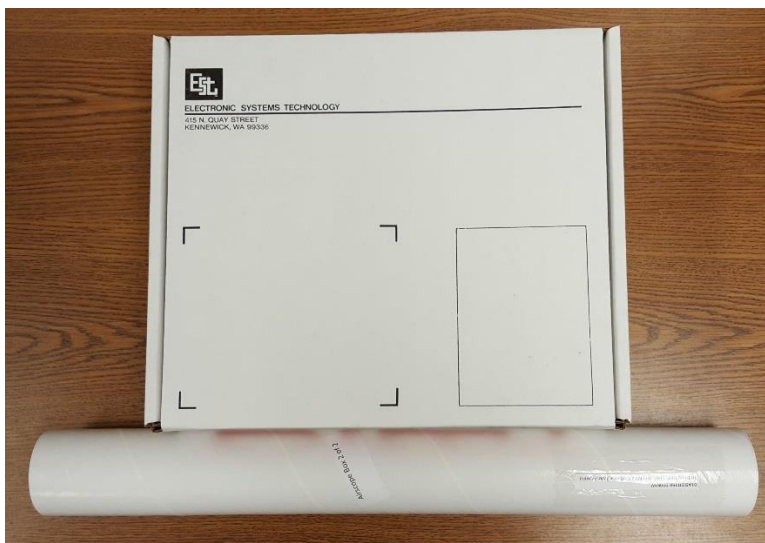
Spectrum Analyzer – The spectrum analyzer mode provides a tool to visually identify receive signal levels, background noise, sources of interference and RF emitters that are transmitted between 70 MHz and 6 GHz. The software user interface is similar in layout to a standard lab instrument with the frequency on the horizontal axis and the amplitude on the vertical axis.

**Technical Tip:** All features and configuration options for the spectrum analyzer will be listed in this manual, but a basic understanding on how to interpret the display of the analyzer will be required as that is outside the scope of this document.

Site Survey – The site survey mode is an automated testing feature where a single or multiple frequencies can be easily tested simultaneously. This site survey mode is used to help select the best frequency band bands (900 MHz, 2.4 GHz , etc.) and channel of operation by reporting all wireless transmitters in the RF environment. This simple to use interface will test the RF spectrum, save the test results for future review and create test reports on the frequency channel tested.

## AirScope Hardware and Layout

The AirScope system is shipped in two packages shown in Figure 1.



**Figure 1: AirScope Packaging**

The Airscope system has the following individual components (Figure 2):

## Box #1

- (1) ESTeem AirScope Radio
- (1) AA179 12VDC Power Supply
- (1) GPS Antenna
- (1) AA09.2 Ethernet Patch Cable
- (1) High-Frequency Tri-Band Antenna Element (2.4 GHz/4.9GHz/5.8GHz)
- (1) 20db In-line RF Attenuator
- (1) Magnetic Antenna Base (Used for both antenna elements)

## Round Tube

- (1) Low Frequency Tri-Band Antenna Element (150 MHz/220 MHz/450 MHz/900 MHz)

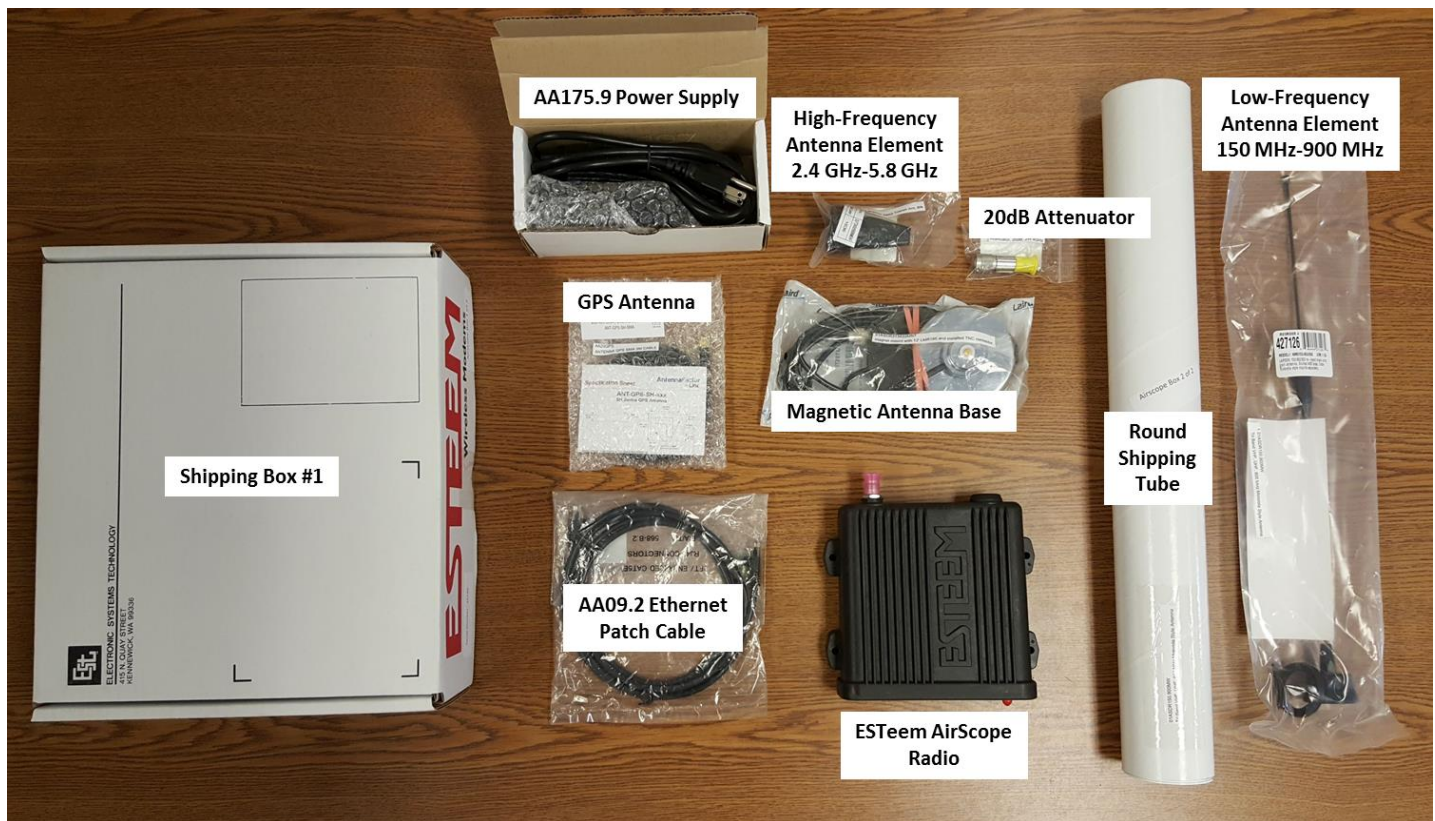


Figure 2: AirScope Contents

Verify all components are included with your AirScope system. If any items are missing, please contact customer support at 509-735-9092 or [support@esteem.com](mailto:support@esteem.com).



The following diagrams show the connection of the AirScope diagram and the front cover:

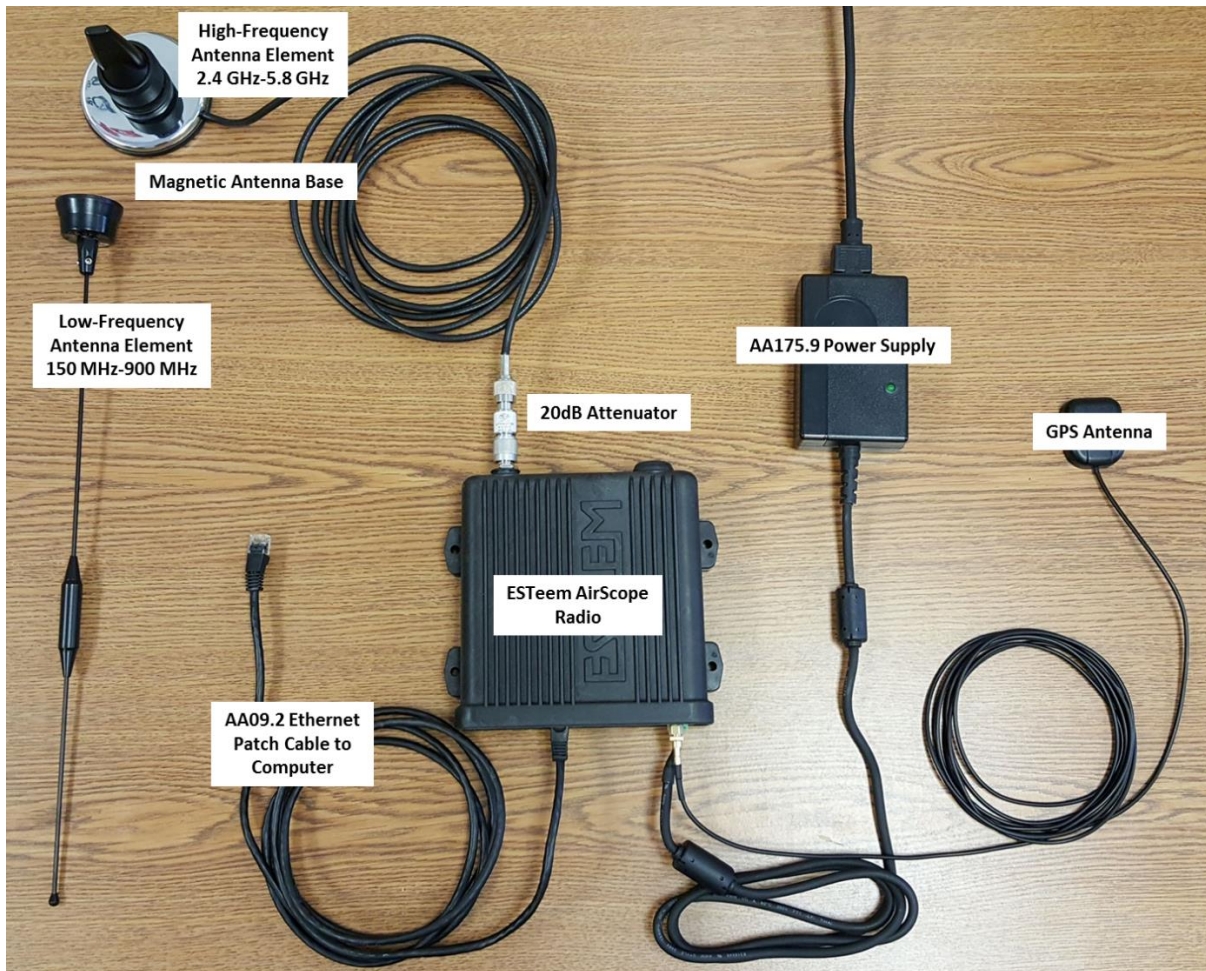


Figure 3: AirScope Connection Diagram



Figure 4: AirScope Front Cover

## Software Configuration

The AirScope spectrum analyzer system uses two software utilities for operation; the ESTeem Discovery Utility and the AirScope Analysis. The ESTeem Discovery Utility will set the TCP/IP address in the AirScope to operate in the same IP subnet as the computer. The second utility is the AirScope Analysis software that provides the user interface for the spectrum analyzer. Both utilities are Java™ based applications compatible with any computer operating system (Window, Linux, etc).

### ESTeem Discovery Utility

The ESTeem Discovery Utility will allow you to configure the IP address on the AirScope to match your network regardless of its current IP subnet.

**Technical Tip:** If your computer is configured for DHCP and not attached to the network, you will need to assign a static IP address for operating the AirScope.

#### Discovery Installation

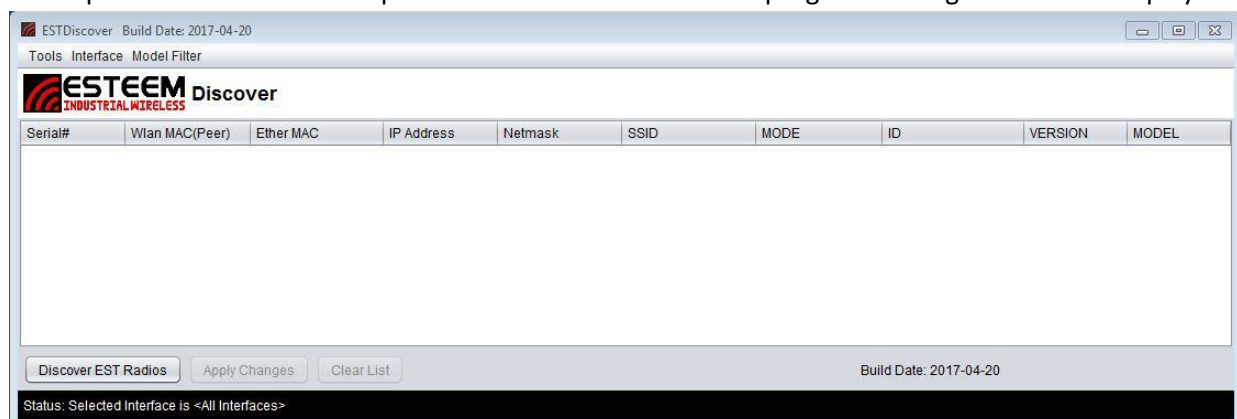
The Discovery Utility can be downloaded from the ESTeem web site (<http://www.esteem.com>) or is available on the Software Resource media that was shipped with the AirScope.

- Both software utilities are Java™ based applications compatible with any computer operating system (Window, Linux, etc). The applications require 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.*

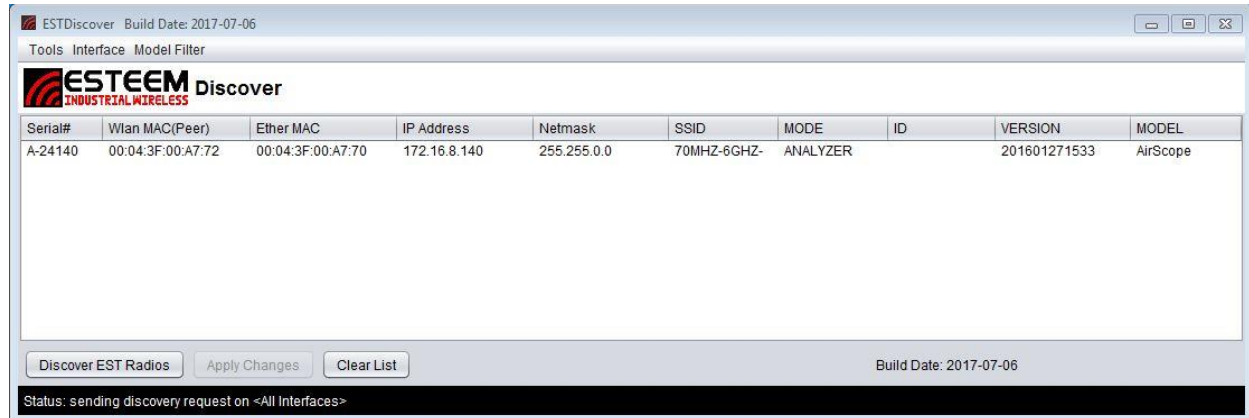
**WinPcap** – Downloadable from <http://www.winpcap.org/>. The version required will be based upon your operating system.

- 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 ESTeem.exe program and Figure 5 will be displayed.



**Figure 5: ESTeem Discovery Utility**

3. Connect the AirScope's Ethernet 10/100 port (Figure 4) 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 EST Radios* button.
4. The AirScope will be displayed (Figure 6). If the AirScope 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.



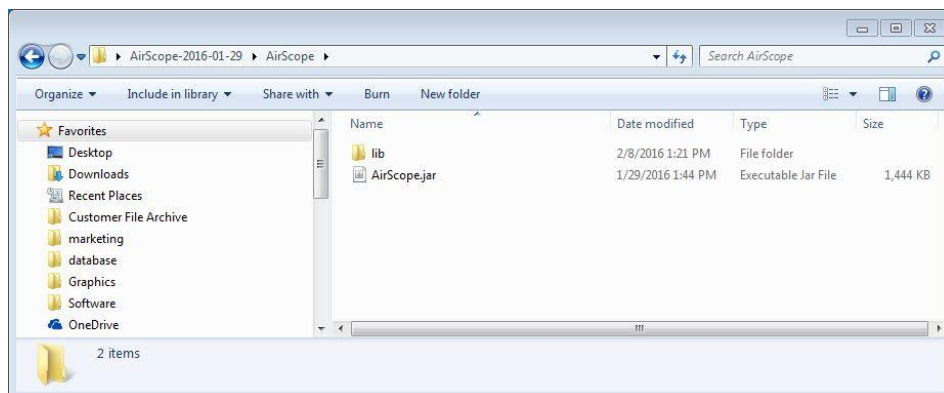
**Figure 6: ESTeem Discovery Utility**

5. If changes were made to the IP address, you will need to press the Discover EST Radios button again to show the changes after the AirScope has rebooted. Verify the AirScope is in the same IP subnet as the computer and proceed to AirScope Analysis software installation.

### AirScope Analysis Installation

The current software release for the AirScope is available from the ESTeem web site ([www.esteem.com](http://www.esteem.com)) or can be directly downloaded from our FTP site at the URL: <ftp://ftp.esteem.com/AirScope%20Spectrum%20Analyzer/>

The single compressed (.zip) file contains all software and support files to run the utility. Once the .zip file is extracted to the computer, a single folder with both the library files and the Java executable (AirScope.jar) will be created (Figure 7).

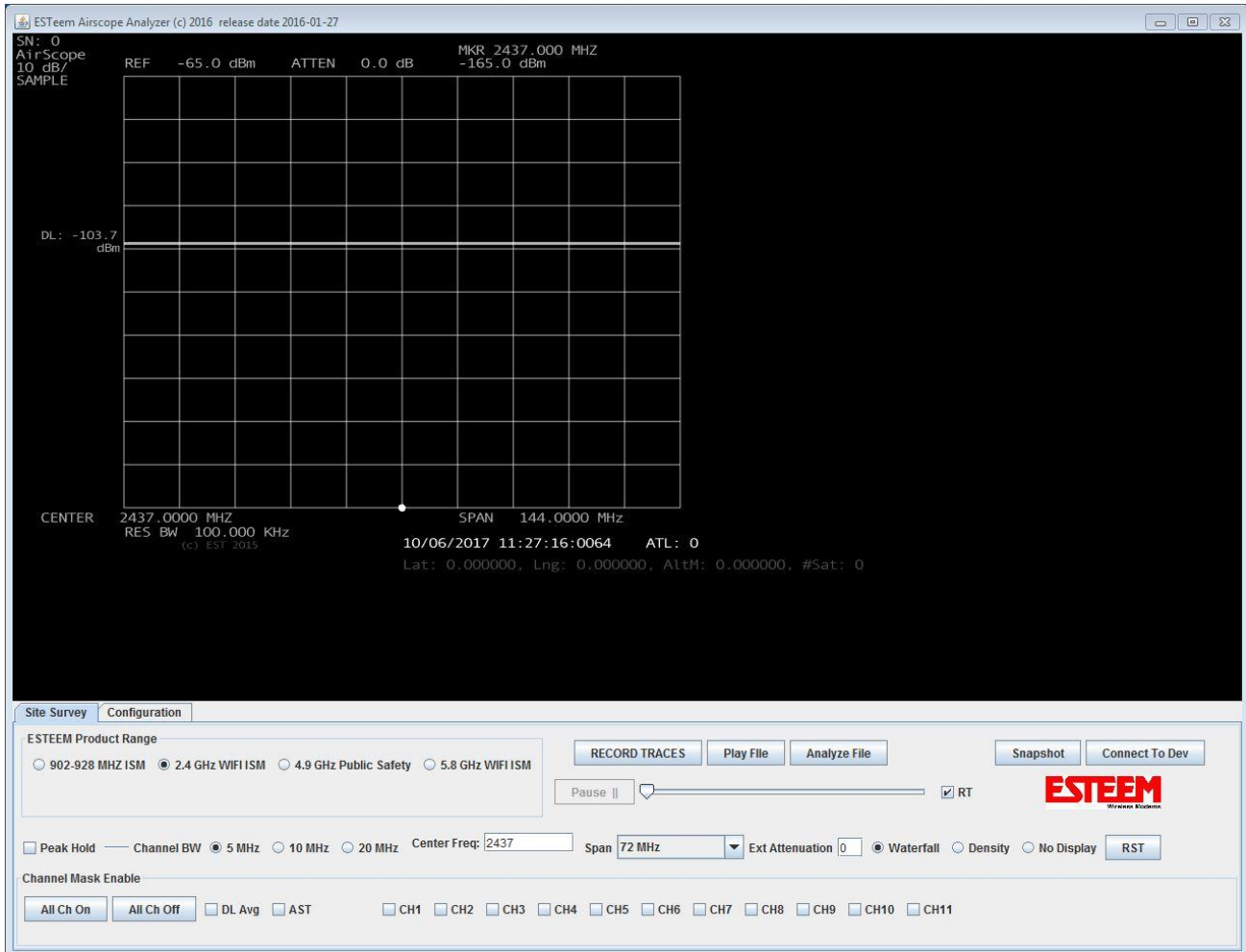


**Figure 7: AirScope Utility Folder**



### AirScope Software Configuration

To start the AirScope software, double-click on the AirScope.jar file and the window in Figure 8 will be displayed.



**Figure 8: AirScope Main Window**

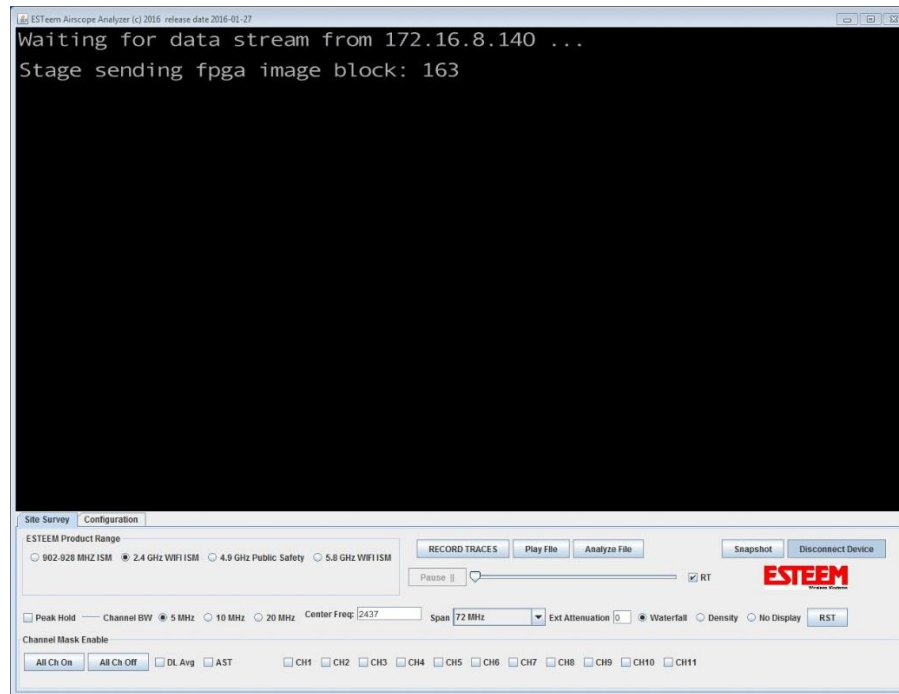
Select the Configuration Tab (Figure 8) and enter the IP address assigned to the AirScope. Press the “Save Config” button (Figure 9) and the screen will flash the message “Configuration Saved”.



**Figure 9: AirScope Main Window**

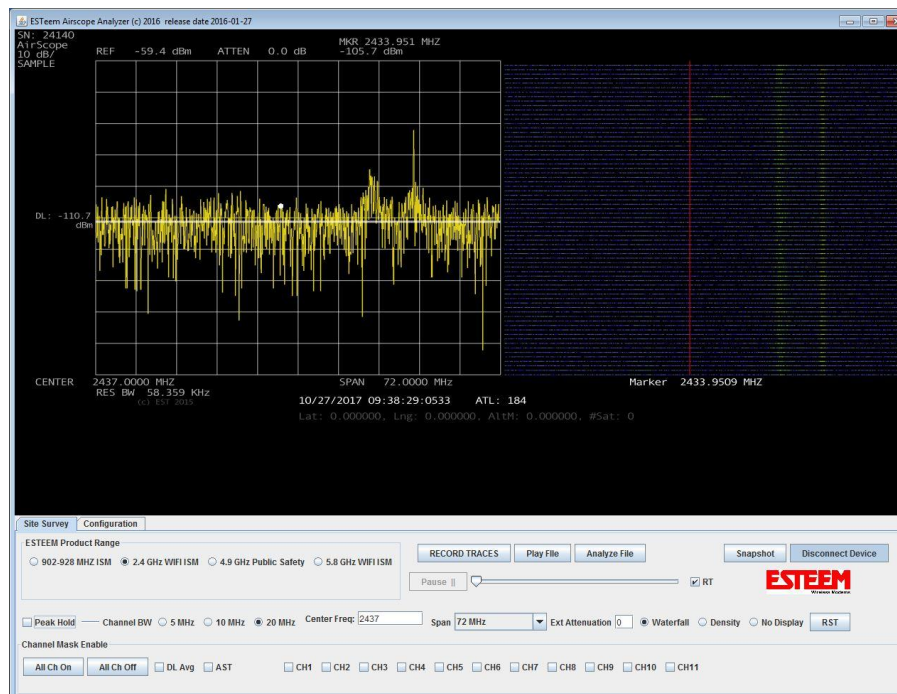


Return to the Site Survey tab (Figure 8) and press the “Connect to Device (Connect to Dev)” button. The software will then connect to the AirScope radio device and download the software image (Figure 10).



**Figure 10: AirScope Loading Software**

Once the software image is loaded the analyzer will activate and load the waterfall or density display on the right side of screen (Figure 11). The AirScope is now ready for operation.



**Figure 11: AirScope Operating**

## Modes of Operation

There are two primary modes of operation for the ESTeem AirScope analyzer:

**Spectrum Analyzer** – The spectrum analyzer mode is will display radio frequencies operating between 70 MHz and 6 GHz in real-time. The interface is simplified and many of the adjustments normally required in a spectrum analyzer such as resolution bandwidth (RBW), video bandwidth (VBW) and reference are automatically configured based upon the Center Frequency, Span selected and peaks of the incoming signal level. The spectrum analyzer mode is used to view a specific frequency and the surrounding band.

**Site Survey** – The site survey mode is an automated testing feature where a single or multiple frequencies can be easily tested simultaneously. This site survey mode is used to help select the best frequency band bands (900 MHz, 2.4 GHz, etc.) and channel of operation by reporting all wireless transmitters in the RF environment. This simple to use interface will test the RF spectrum, save the test results for future review and create test reports on the frequency channel tested.

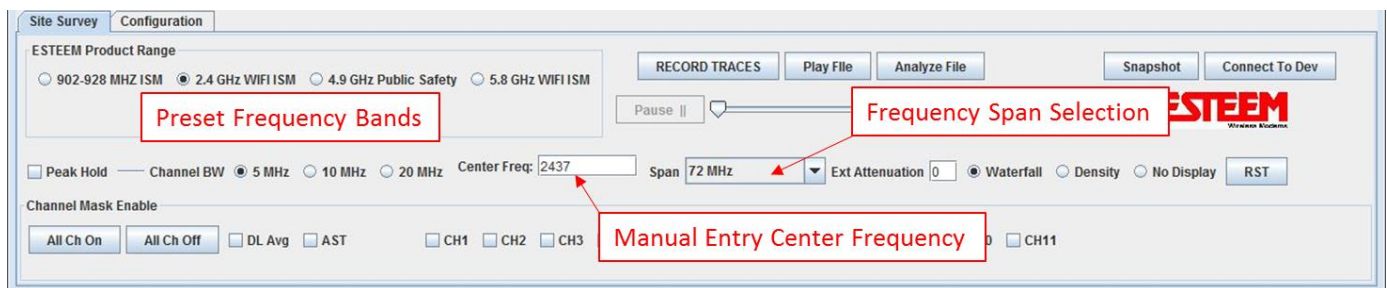
## Spectrum Analyzer Mode Configuration

To configure the spectrum analyzer in the ESTeem AirScope for use simply set the center frequency and select the Span. The span will set the total frequency displayed on the scope image. For example, if the AirScope is set for the default 2.4 GHz WiFi ISM band (as in Figure 11) the center frequency will be automatically set for 2.437 GHz and the span for 72 MHz. This configuration will allow viewing the entire 2.4GHz WiFi spectrum with the left edge of the display at 2.401 GHz and the right edge at 2.473 GHz.

### Setting Center Frequency

The center frequency can be adjusted in the AirScope by either selecting one of the frequency ranges for the ESTeem products (900 MHz, 2.4 GHz, 4.9 GHz or 5.8 GHz) or by manually entering in the “Center Frequency” block and press the Enter button on the computer (Figure 12).

**Technical Tip:** The center frequency is entered in MHz in the AirScope. If 2.437 GHz is desired enter as 2437 MHz.



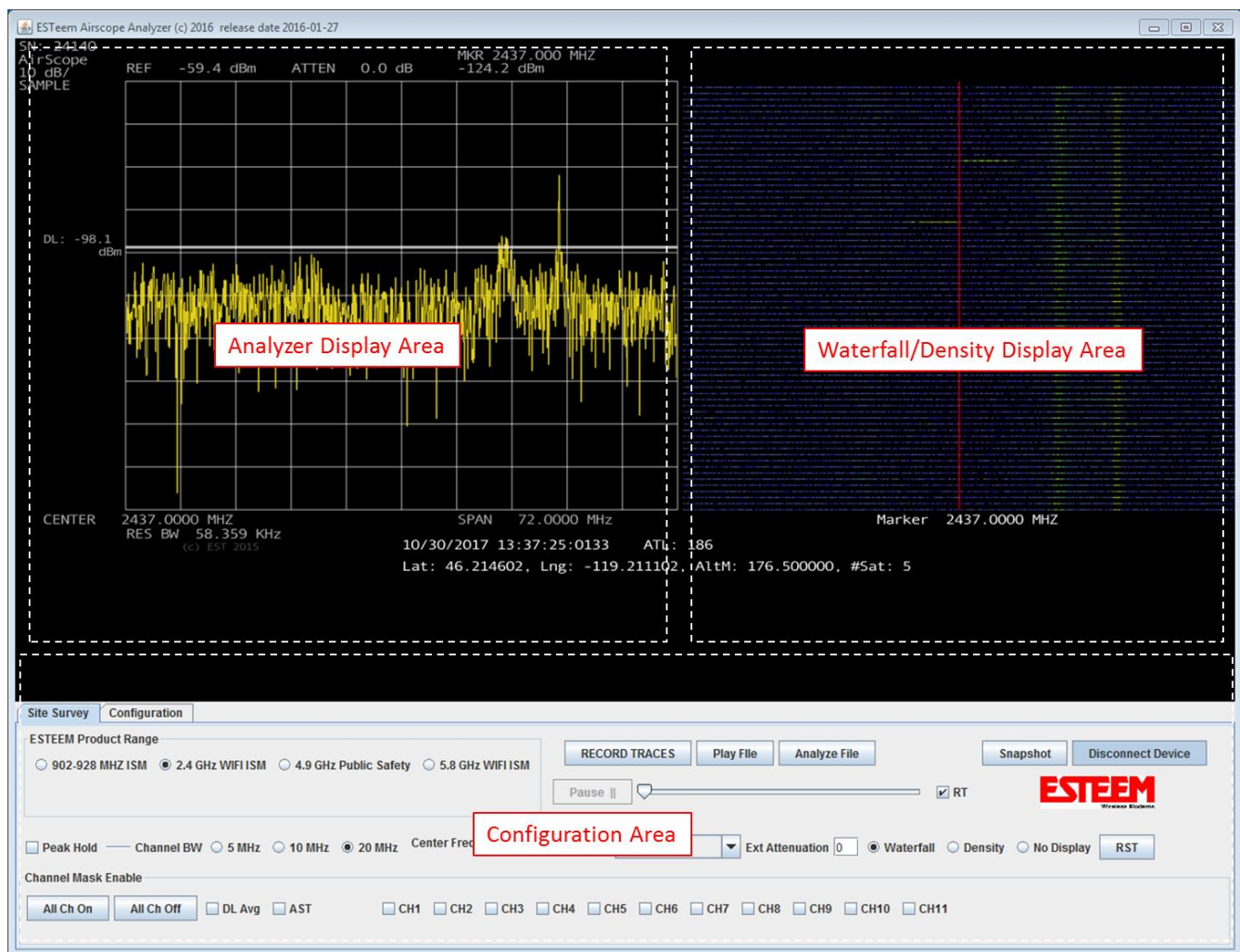
**Figure 12: Entering Center Frequency**

### Setting Frequency Span

The frequency span is adjusted in the AirScope by either selecting one of the frequency ranges for the ESTeem products (900 MHz, 2.4 GHz, 4.9 GHz or 5.8 GHz) or pressing the drop-down arrow next to the Frequency Span selection (Figure 12). When selecting the ESTeem Product Range for the 900 MHz, 2.4 GHz, 4.9 GHz or 5.8 GHz the AirScope will automatically set the Span to display the complete frequency range for each product. The wider the frequency span selected will show more of the surrounding frequencies but may limit the resolution when viewing a specific channel.

### Analyzer Screen Layout

A key element of using the spectrum analyzer is understand the display. Figure 13 below shows the complete spectrum analyzer screen layout.

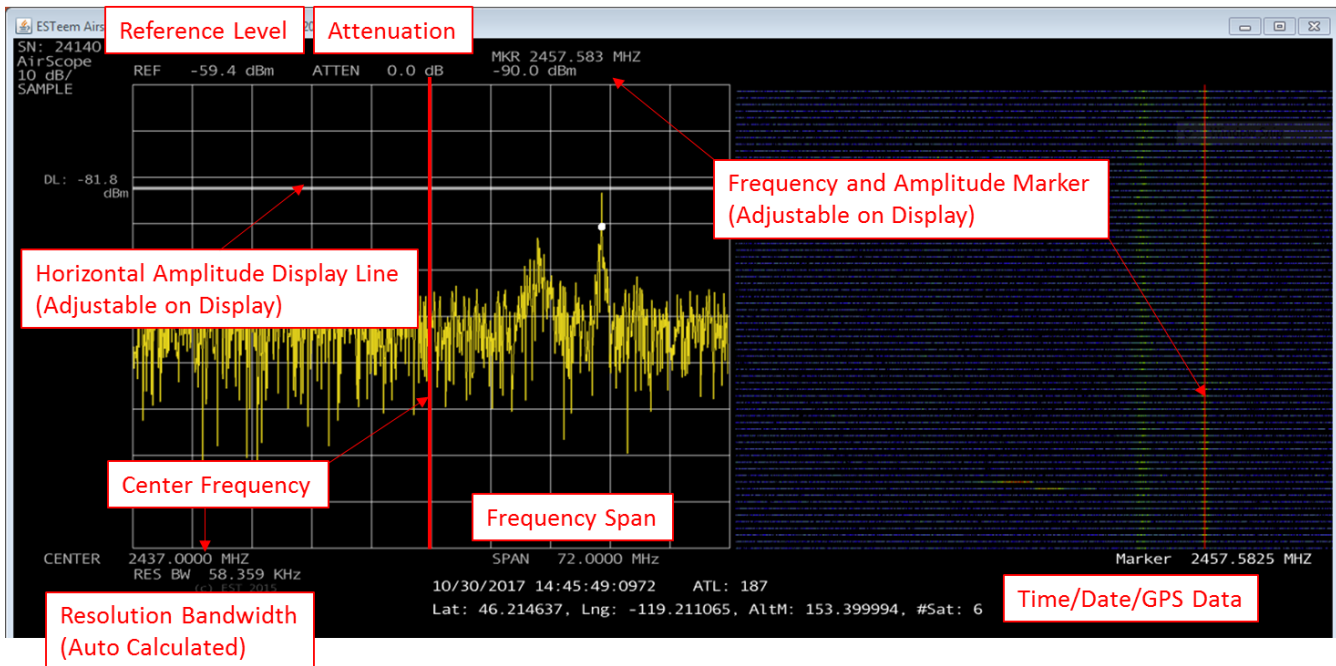


**Figure 13: AirScope Screen Layout**

The screen can be divided into three general areas:

The **Analyzer Display Area** is where the spectrum analyzer provides a plot or trace of signal amplitude against frequency. Spectrum analyzers look at incoming signals from the RF connector in the frequency domain and thus display the amplitude of signals on the vertical scale, and the frequency of the signals on the horizontal scale. The

horizontal axis of the analyzer is linearly calibrated by the frequency with the higher frequency being at the right-hand side of the display.



**Figure 14: Analyzer Screen Layout**

**Reference Level** – This level is the amplitude of the top horizontal line on the analyzer. The reference level is automatically adjusted by the AirScope based upon the levels of the incoming signals. The horizontal deviations are 10dB per division (shown in upper left of display).

**Attenuation** – This attenuation level in decibels (dB) is configured in the external attenuation (Ext Attenuation) of the setup screen when the 20dB attenuator (Figures 2&3) is used. The attenuator is used when high signal levels will enter the analyzer directly by connecting to a high-gain antenna. This attenuation level will adjust the reference level on the analyzer.

**Horizontal Amplitude Display Line** – This horizontal line can be used to help measure the amplitude of an incoming signal. This line can be adjusted directly on the analyzer display by left-clicking and moving with the computer mouse. For example, in figure 14 the display line is placed on the peak of the signal at 2.457 GHz with an amplitude of -81.8dBm.

**Center Frequency** – The display will show the center frequency set during the analyzer configuration. The center line (highlighted red in Figure 14) is the center frequency on the analyzer where lower frequencies are to the left and higher frequencies are to the right.

**Frequency Span** – The screen will show the frequency span set during the analyzer configuration.

**Technical Tip:** There are a total of 10 divisions on the analyzer screen that make up the frequency span. For example, if the span is 72 MHz there will be 7.2 MHz per division.



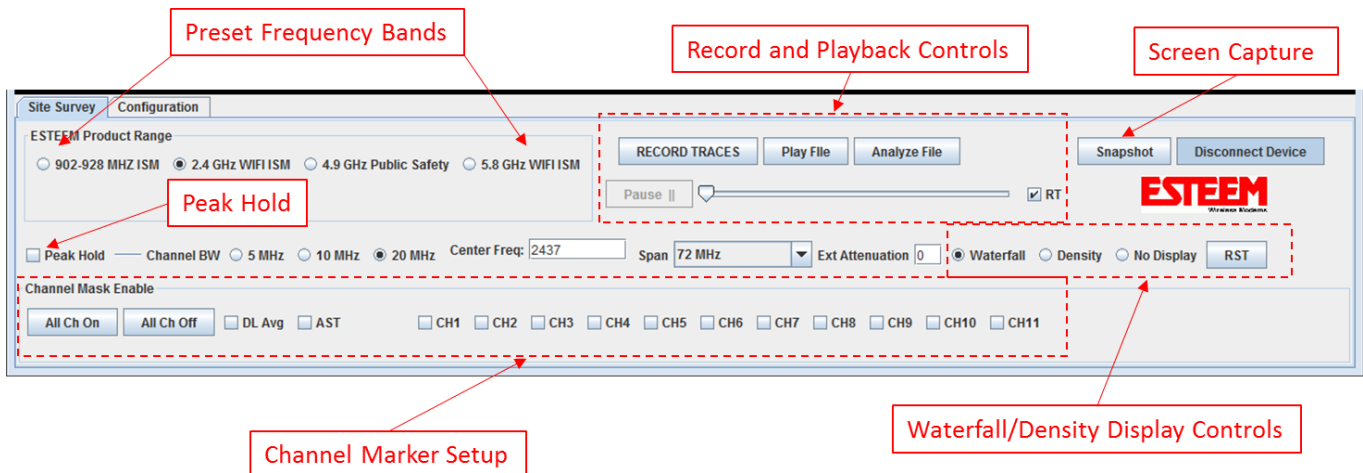
**Resolution Bandwidth** – This value is automatically adjusted in the analyzer based upon the center frequency and span selected.

**Time/Date/GPS** – Below the active display is the date, time and GPS information.

**Frequency and Amplitude Marker** - This vertical line can be used to help identify the frequency of a specific incoming signal. This line can be moved directly on the analyzer display by left-clicking and moving with the computer mouse in the waterfall/density display area.

The **Waterfall/Density Display Area** is where the spectrum analyzer provides a history of previous signals received by either their on-air duration (waterfall) or by their relative activity (density). The waterfall/density screens run active with the analyzer display. See Waterfall and Density displays below for further detail.

The **Configuration Area** is where all adjustments and setup for both the spectrum analyzer and site survey mode is completed.



**Figure 15: Configuration Screen Layout**

**ESTeem Product Range** – Movement of the radial in the ESTeem product range will automatically configure the analyzer's center frequency and frequency span to view the selected frequency of operation. For example, to view the entire 902-928 MHz range used by the ESTeem products, move the radial in the product range to "902-928 MHz ISM" and the center frequency will adjust to 915 MHz and the span will change to 36 MHz to capture the entire band.

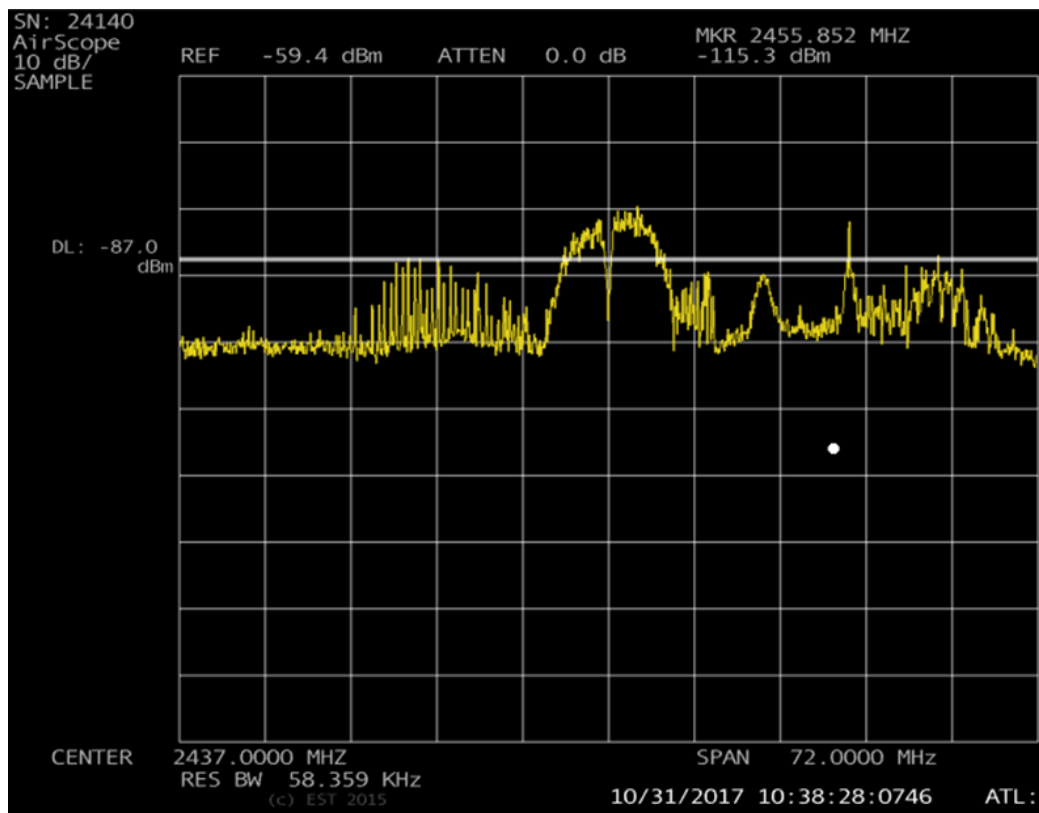
**Record and Playback Controls** – This section controls saving and playing back the spectrum analysis.

- **Record Traces** – This button will open a dialog window to save the spectrum analysis and begin the capture of all RF activity in the configured radio band.
- **Play File** – This button will play a previously captured file
- **Analyze File** – This button will begin the report generator on the captured data to create a frequency analysis on any captured data. The created PDF report will be saved in the same file directory as the captured data.
- **Pause/Playback** – These controls provide movement forward and back in time of the saved file.
- **Real Time (RT)** – This button selection will play the analysis back in real time of the capture.

**Snapshot** – This button will take and save a screenshot of the current activity on the spectrum analyzer

**Connect/Disconnect from Device** – This button is used to link or disconnect the computer to the AirScope analyzer.

**Peak Hold** – The peak hold is a very valuable tool for swept frequency measurements where it shows the history of peak values across the frequency axis. Peak hold shows the maximum level the signal reaches across the frequency band. It is very helpful in identifying the peak and shape of fast moving (quick radio transmissions) that occur in a spectrum. Using the peak hold and the channel masks will greatly help in identifying open frequency channels.



**Figure 16: Peak Hold**

Figure 16 shows the 2.4 GHz spectrum plot (used in all previous graphics) with the peak hold set box checked. You can see activity much clearer on the center frequency and intermittent activity on the lower frequencies.

**Center Frequency** – This is the center frequency displayed on the analyzer. This value is either set by selecting an ESTeem product range or entering the frequency manually.

**Span** – This will adjust the frequency “width” shown on the screen. The larger the span selected will show more of the surrounding frequency activity at the cost of precise frequency measurement.

**External Attenuation** – Enter the value of the external attenuator used during the measurement in dB. The AirScope was shipped with a 20dB attenuator that will generally be used in high noise areas or when connecting to a high-gain radio antenna.

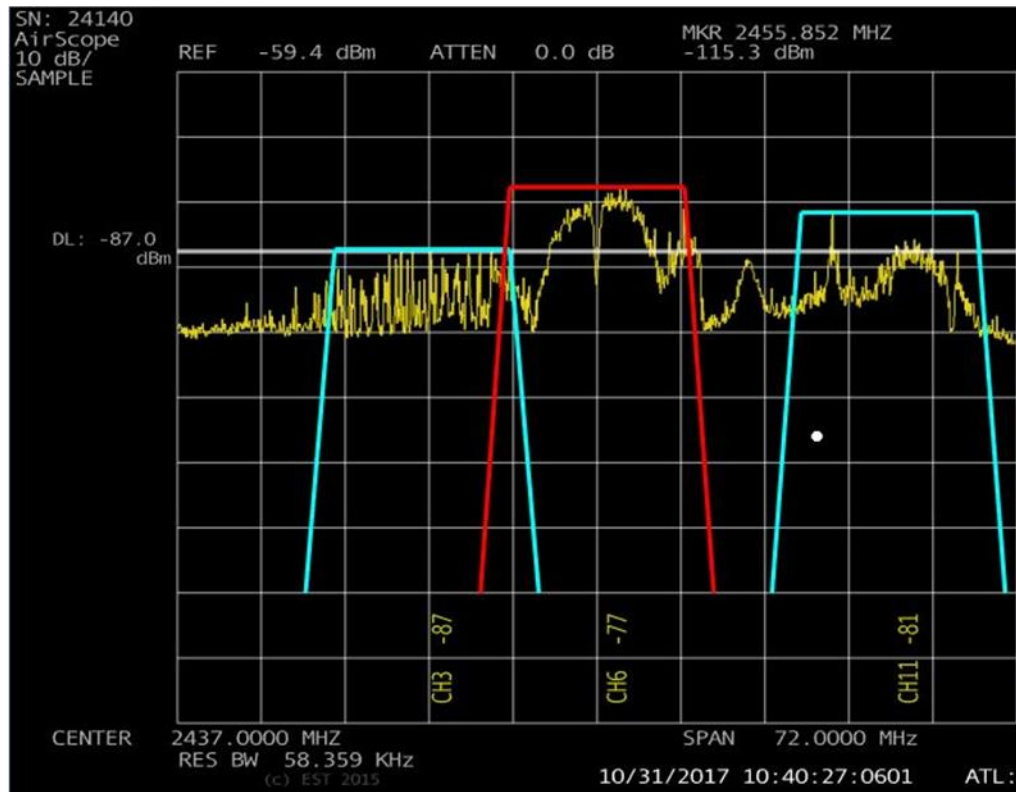
**Waterfall/Density Display Controls** – This section will adjust the Waterfall/Density Display area (Figure 13)

- **Waterfall** – Used to display the waterfall capture
- **Density** – Used to display the channel density
- **No Display** – Used to turn off both waterfall and density display
- **Reset Button** – Press to start a new waterfall or density capture

**Display Line Average (DL Avg)** – causes a display line to be drawn at the average power level for each sweep.

**Automatic Sweep Threshold (AST)** – This button enables the sweep to be triggered when a signal crosses a continuously updated threshold (automatic). This allows the user to see much more of the content (like fast signal beacons) because the sweep is synchronized to bursts of RF energy that are above the average level.

**Channel Marker Setup** – A powerful feature of the AirScope are the frequency channel markers and how they help in identifying interference or selecting an open frequency channel. In Figure 17 the channel markers were enabled on the peak hold scan used in Figure 16. This was completed by selecting 20 MHz Channel Bandwidth (BW) used in the 2.4 GHz band and then selecting the channels that overlap carriers. Looking at Figure 16, there is frequency activity on channels 3, 6 and 11 and the signal strength is identified. Using this information and the Density charts (shown later in this manual) will greatly help select the best channel for operation.



**Figure 17: Channel Markers**

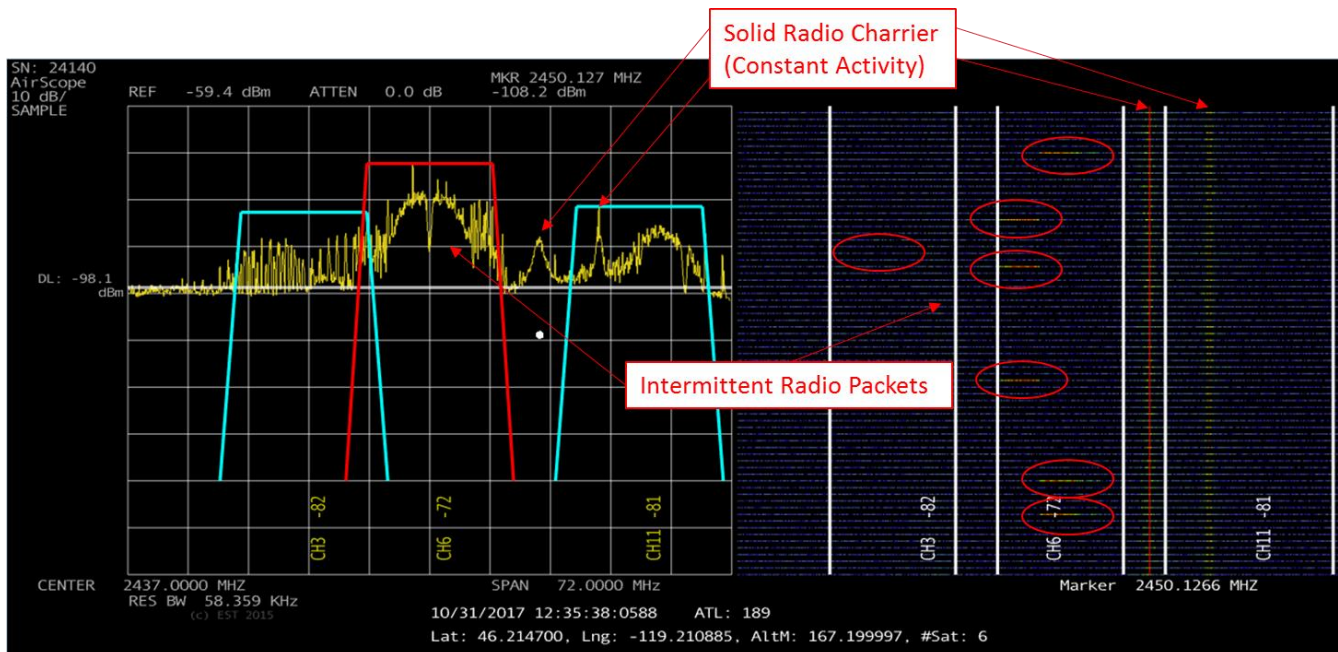
**Channel Bandwidth (BW)** – This sets with width of the channel markers used to identify and test for open frequencies in the radio spectrum. Different frequency bands have various bandwidth selections. Please refer to your radio's documentation for availability.

**All Channels On/All Channels Off** – This will enable or disable all channel markers available in the frequency band. This can be very helpful when trying to determine the current frequencies in use. The channels can also be enabled or disabled by selecting the channels themselves.

### Waterfall vs Density Display

The waterfall and channel density display are both methods of identifying the history of frequencies in use with the AirScope spectrum analyzer.

The waterfall display is a moving bitmap showing the "history" of the last recorded spectra. As time proceeds, old samples will be scrolled off the bottom of the screen. The intensity (amplitude) of a particular frequency affects the color of a pixels in this bitmap.

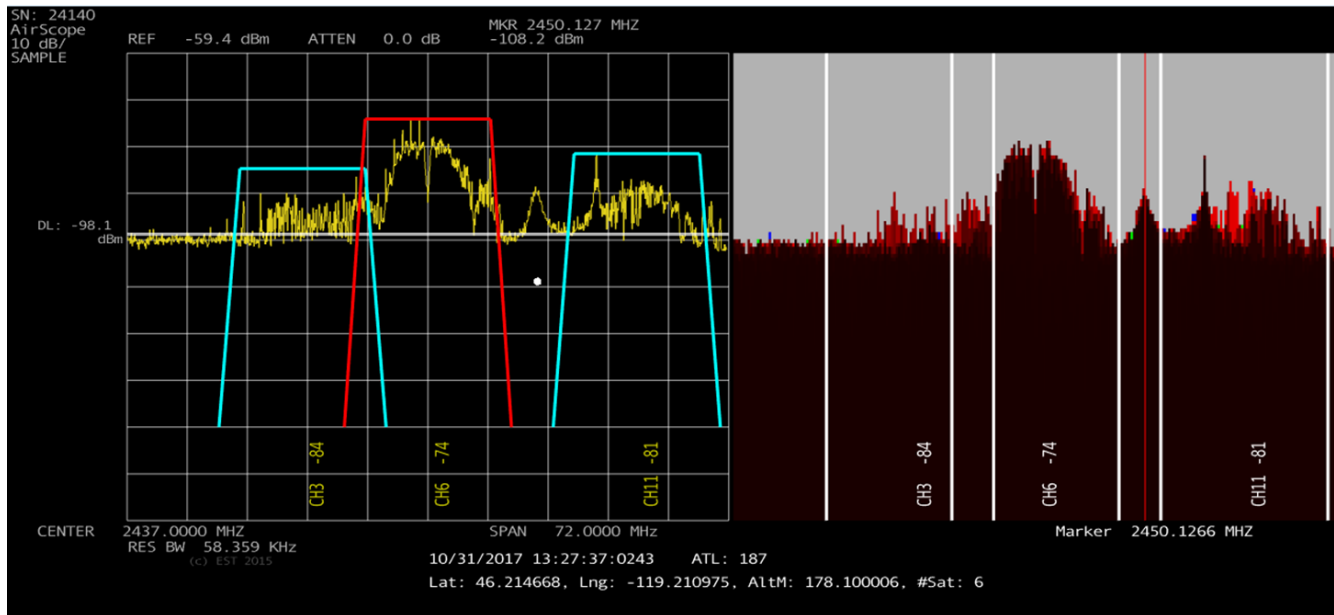


**Figure 18: Waterfall Display**

Figure 18 shows how the activity captured on the spectrum analyzer display is represented in the waterfall display. There are two constant carriers shown with high activity. There is also WiFi packet activity captured and show within the Channel 6 channel mask.

The Channel Density display shows the accumulation of radio packets over time. In contrast to the waterfall display which shows activity in real time, the density display will help guide frequency selection by how much a channel is being used and not just IF it is being used. Figure 19 shows a similar plot to the activity in the waterfall display in Figure 18.





**Figure 19: Channel Density Display**

The density display is designed to view the spectrum and identify active channels compared to all other signals in the scanned spectrum. The color range will change through the following colors:

Gray>Purple>Blue>Green>Yellow>Red>Maroon>Black

Looking at Figure 19 we can again identify the highest users in the spectrum on the fixed carrier because they are shown in black. The next highest density is the WiFi channel active on Channel 6. The intermittent signals on Channel 3 show with the least density in bright red.



**Figure 20: Configuration Tab Layout**

### General AirScope Configuration (Figure 20)

**Trace Area Fill** – Select this option to fill the area below the trace line in the scope display. This can make viewing easier in low light settings.

**Color Scheme** – The AirScope has multiple color schemes available. Changing the color scheme may help when viewing on differing computers or different light conditions. This change is cosmetic only.

**My PC Performance** – The AirScope has a high-speed Ethernet interface to the computer and requires computer resources to operate. If the display is pausing, change the performance to match the PC.

### Site Survey Mode Configuration

The Site Survey mode in the ESTeem AirScope is an automated utility that will scan selected frequency bands and create a report of the active signal density. The site survey mode is used to test specific locations' (with single or multiple frequency bands) activity to determine what is the most open frequency band and frequency channel within that band. The reports generated will use the same signal density method as shown above.

To configure the AirScope for Site Survey mode, select the Configuration tab on the analyzer software and Figure 21 will be displayed. Select the radio bands to test by checking or unchecking the box next to the frequency. Next, select the time the analyzer will stay on each frequency band by entering the Band Dwell Time in seconds. Figure 21 shows an example configuration for the testing of the 2.4 GHz and 5.8 GHz WiFi bands. The Dwell Time has been adjusted 30 seconds.



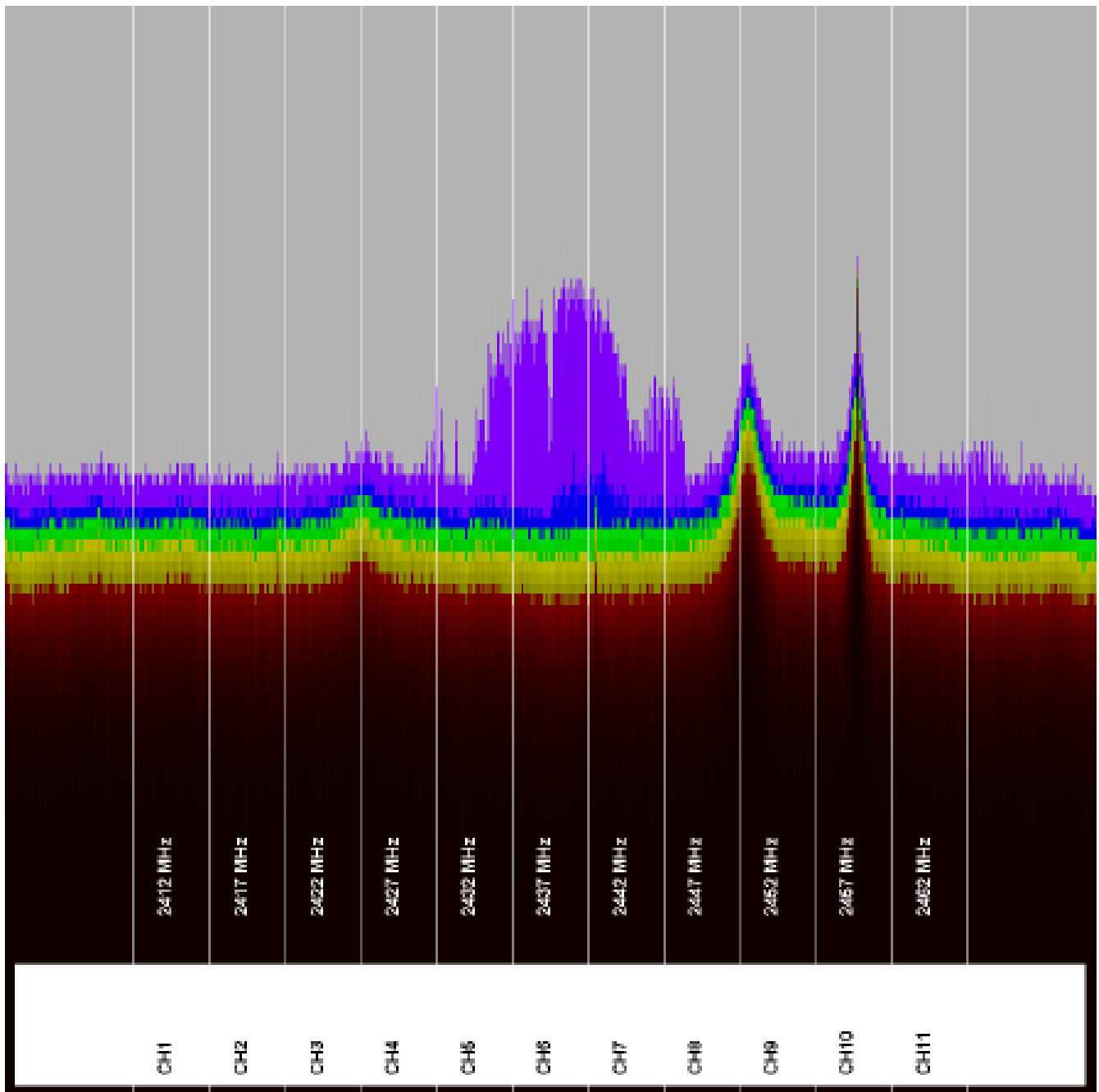
The screenshot shows the 'Configuration' tab of the AirScope software. It features a 'WiFi Bands' section with four entries: '902-928 MHz Range' (unchecked), '2.4 GHz Range' (checked), '4.96 GHz Range' (unchecked), and '5.8 GHz Range' (checked). A 'Band Dwell Time (sec)' field is set to '30'. Below this, there are options for 'Trace Area Fill' (unchecked), 'Color Scheme' (set to 'Yellow'), and 'My PC performance is' (radio buttons for High, Mid, and Low, with 'Mid' selected). There are also radio buttons for 'RF Gain' (Low, High, and Auto, with 'Auto' selected). An 'IP address' field is set to '172.16.8.140', and a 'Save Config' button is located at the bottom right.

**Figure 21: Configuration Tab Layout**

To start the site survey, go to the Site Survey tab and press the RECORD TRACES button. The AirScope will record 30 seconds of activity on the 2.4 GHz frequency bands and then change to the 5.8 GHz frequency band and record 30 seconds. The AirScope will continue recording until the END TRACES button is pressed. There is no time limit on how much activity is recorded as long as the computer has storage capability.

### Site Survey Report

The site survey report files are generated in Adobe PDF by pressing the Analyze File button and then selecting the captured site survey file created above. Once the report generator has completed, the AirScope software will create a report for each of the frequency bands selected. Figure 22 shows a sample of the recorded information using the same setup as used throughout this User's Manual.



**Figure 22: Sample 2.4 GHz Activity Report**