USER MANUAL

MTTplus-900

WiFi Air Expert Test Module for MTTplus Modular Platform

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1.0 About This User Manual

Every effort was made to ensure that the information contained in this user manual is accurate. Information is subject to change without notice and we accept no responsibility for any errors or omissions. In case of discrepancy, the web version takes precedence over any printed literature. The content in this manual may vary from the software version installed in the unit.

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This user manual is suitable for novice, intermediate, and experienced users and is intended to help you successfully use the features and capabilities of the V300, RXT, MTTplus and FX OTDR series. It is assumed that the user has basic computer experience and skills, and is familiar with Optical Fiber, telecommunication concepts, terminology, and safety.

For more technical resources, visit the VeEX, Inc. web site at www.veexinc.com.

If you need assistance or have questions related to the use of this product, call or e-mail our customer care department for customer support. Before contacting our customer care department, you must have your product serial number and software version ready. Please provide this number when contacting VeEX customer service.

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2.0 Introduction to MTTplus-900

VeEX's WiFi Air Expert provides the tools for reliable, repeatable install procedures that go beyond RF layer analysis. It provides complete performance testing that measures the end user experience under traffic load.

The Air Expert Module for the MTTplus platform is equipped with 802.11ac Wave 1 3x3:3 WiFi capabilities to discover the network's Access Points, Clients and Channels. It surveys coverage problems with signal, noise levels and utilization tracking. A dedicated spectrum analyzer assists in the troubleshooting of WiFi and non-WiFi interference affecting performance and the V-Perf function provides traffic Download/ Upload test to a wired Ethernet responder to evaluate the WiFi network's capacity under load.

2.1.1 Module Highlights

- Supports detection and connection to 802.11a/b/g/n/ac devices
- Discovers networks and lists Access Points, Clients and Channels in tabular and graphical format
- AP detailed capabilities discovery including SSID, BSSID, channels, security, supported data rates, signal and noise levels, co-channel and adjacent APs and associated clients
- Survey coverage problems with signal and noise levels tracking
- Analyze Channel usage by utilization and number of APs
- Discover associated and non-associated WiFi Clients present in the network
- Locate rogue APs and clients with directional antenna
- One button Auto-Test evaluates the health of the WiFi network with analysis of security, coverage, interference, top talkers and connectivity with configurable AP list
- Connectivity testing with DHCP connection to APs, Ping, Trace Route and ARPWiz
- Verify network performance with dual ended V-Perf Upload/ Download throughput testing
- Optional Ethernet 10/100/1000-T and 1000-X ports to verify end-to-end throughput performance
- Directional antenna to locate and track a specific AP or client
- Optional dual band 2.4 GHz and 5 GHz spectrum analyzer to easily discover and identify WiFi and non-WiFi interference
- Optional V-Probe Responder Accessory for throughput performance testing

2.1.2 Package Contents

- MTTplus-900 WiFi Air Expert module for the MTTplus platform
- WiFi Directional Antenna
- Carrying Pouch for MTTplus Module
- Ethernet cable (available with purchase of RJ45 10/100/1000Base-T and SFP 1000Base-X hardware options)

- Omnidirectional antenna for WiFi Spectrum Analyzer (available with purchase of WiFi Spectrum Analyzer option)

3.0 Safety Information

Safety precautions should be observed during all phases of operation of this instrument. The instrument has been designed to ensure safe operation however please observe all safety markings and instructions. Do not operate the instrument in the presence of flammable gases or fumes or any other combustible environment. VeEX Inc. assumes no liability for the customer's failure to comply with safety precautions and requirements.

Optical Connectors

The test sets display a laser warning icon when the laser source is active to alert the user about a potentially dangerous situation. It is recommended to:

1. Deactivate the laser before connecting or disconnecting optical cables or patchcords.
2. Never look directly into an optical patchcord or an XFP's or SFP's connector interface while the laser is enabled. Even though XFP and SFP optical transceivers are typically fitted with Class 1 lasers, which are considered eye safe, optical radiation for an extended period can cause irreparable damage to the eyes.
3. Never use a fiber microscope to check the optical connectors when the laser source is active.

Electrical Connectors

Telephone lines may carry dangerous voltages. Always connect the electrical test ports to known test interfaces which carry low level signals.

4.0 Basic Operations

For information on Basic Operations, Home menu, Launching Test Applications, and other features specific to the MTTplus Host Chassis, refer to the MTTplus Platform Manual.

The following sections describe basic operations for the MTTplus-900 module.

4.1 Test Port Interfaces and Antennas

4.1.1 WiFi Module Connector Panel

The MTTplus-900 WiFi Air Expert Module connector panel is displayed in the picture below.

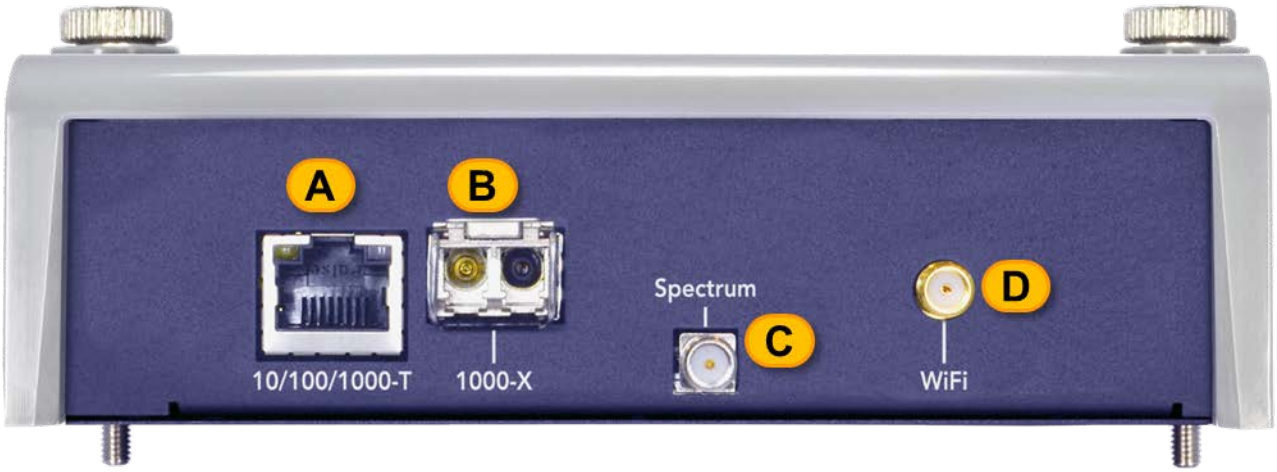


Figure 1: WiFi Module Connector Panel

***Note:** Ethernet RJ45 10/100/1000Base-T and Ethernet SFP 1000Base-X are optional interfaces and may not be available on the connector panel.

A. *Ethernet RJ45 10/100/1000Base-T: Optional interface for 10/100/1000Base-T Ethernet test.

- For Ethernet interface operation, refer to 13.0 Ethernet Setup.

B. *Ethernet SFP 1000Base-X: Optional interface for fiber 1000Base-X Ethernet test.

- For Ethernet interface operation, refer to 13.0 Ethernet Setup.

C. *Spectrum: Optional interface for SMA Male connector for WiFi Spectrum Analyzer.

- For Spectrum Analyzer operation, refer to 10.0 Spectrum Analyzer menu.

D. WiFi: SMA Male connector for WiFi directional antenna. For normal WiFi operation use the 3x internal WiFi antennas. The directional antenna is only used for the WiFi AP or Client Locate functions (refer to 8.2 AP Locate Function and 9.2 Client Locate Function).

4.1.2 WiFi Module External Antennas

4.1.2.1 WiFi Spectrum Analyzer Antenna

Figure 2: Dipole WiFi Spectrum Analyzer Antenna

The WiFi Spectrum Analyzer is a dipole antenna that connects to the Spectrum connector on the panel (see 4.1.1 WiFi Module Connector Panel). WiFi Spectrum Analyzer is an optional interface and may not be present on the connector panel.

- Antenna Type: Dipole
- Frequency: 2.4-2.5 GHz / 4.9-5.8 GHz
- Connector: SMA (female) 50 Ohms
- Gain: 2 dBi/2.5dBi
- VSWR: 2
- Polarization: Linear Vertical
- Pattern Type: Omni-Directional
- Antenna Length: 109mm

4.1.2.2 WiFi Directional Antenna

Figure 3: Directional Antenna

For the WiFi AP or Client Locate function, it is possible to use a directional antenna connected to the WiFi connector from the connector panel (refer see 4.1.1 WiFi Module Connector Panel). The directional antenna is only used for the WiFi AP or Client Locate functions (see 8.2 AP Locate Function and 9.2 Client Locate Function) and only if the Setup menu Locate Antenna setting is configured for External (refer to 6.1 WiFi Setup).

- Antenna Type: Mini Patch directional
- Frequency range: 2.4 to 2.5 GHz, 5.1 to 5.9 GHz
- Peak Gain: 5 dBi
- Polarization: Vertical
- Connector: SMA (female) 50 Ohms

Note: For normal WiFi operation use the 3x internal WiFi antennas.

4.1.3 WiFi Module Internal Antennas

For all WiFi operations with the exception of the Spectrum Analyzer and Locate functions, the Air Expert uses 3 internal antennas.

Internal antenna specification:

- Frequency range: 2.4 to 2.49 GHz
- 4.9 to 5.9 GHz
- Peak Gain: 3.3 dBi @2.44 GHz,3.8 dBi at 5.2 GHz,5.4 dBi at 5.8 GHz

4.2 Home Menu and Navigation

The MTTplus Air Expert Test Module runs automatically when turning on the MTTplus platform. The Air Expert starts up on the Home Menu.

Figure 4: Home Menu

A. Test Applications

The Active Test Application icon indicates the Test Module currently loaded on the MTTplus platform. For the MTTplus-900 Air Expert, the icon indicates MTT WiFi.

The Background Test Application icon opens up the utilities menu. Refer to the MTTplus platform manual for information on the utilities functions.

B. Top Icons

C. Test Application Menu

Use the icon for each item to access the corresponding menu interface.

D. Function Keys

The function keys control the test in progress and vary depending on the test selected

4.2.1 Top Icons

Note: The Top Icons described below are only displayed in WiFi Test Mode. They are not displayed when the Air Expert is used in Ethernet (10/100/1000Base-T or 1000Base-X) Test Mode.

Figure 5: WiFi Top Icons

A. Antennas: Displays the number of internal antennas in use: 3x3, 2x2, 1x1. This is configurable from **Setup** (see 6.1 WiFi Setup).

B. AP: Displays the number of APs (SSIDs) discovered during the Scan. From the Home menu, tap on this icon to open up the AP Scan results table. Displays “---“ if no AP is detected or AP Scan test has not been started.

C. Clients: Displays the number of Clients discovered during the Client Scan. From the Home menu, tap on this icon to open up the Client Scan results table. Displays “---“ if no Client is

detected or Client Scan test has not been started.

D. Connection: This icon displays the connection status to the AP. From the Home menu, tap on this icon to open up the IP Connect menu.

The Connection icon can take on the following statuses:

No AP connection

Successful AP association but no IP connection

AP association or IP connection failed

Successful AP association and IP connection

E. Scan: Displays the status of the AP/Client Scan or Auto-Test. If the Scan is stopped, this icon disappears.

4.3 Test Application Menu

4.3.1 WiFi Test Mode Home Menu

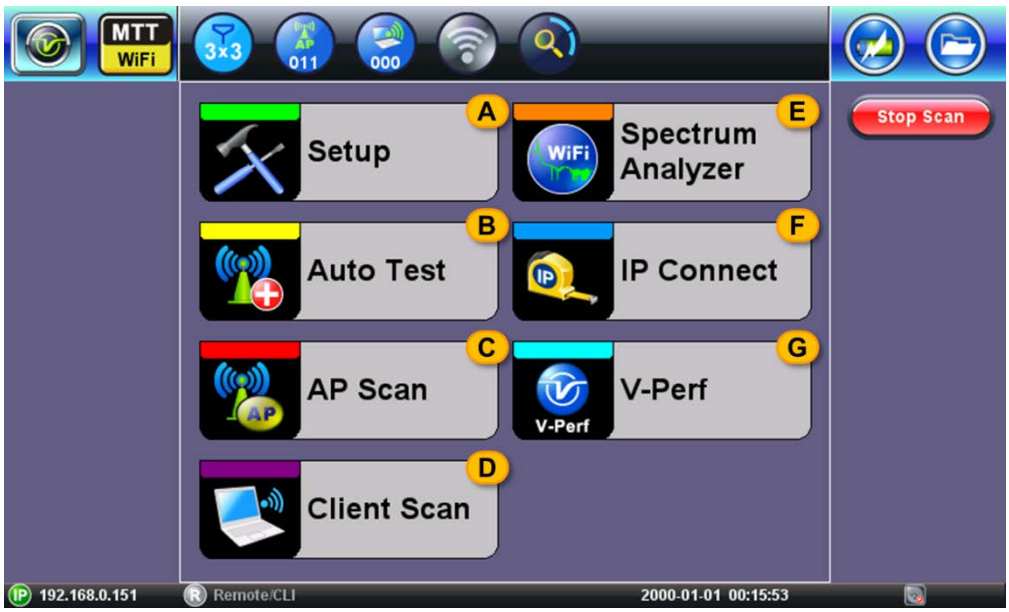


Figure 6: WiFi Test Home Menu

A. Setup: Open the Setup menu to configure WiFi and Ethernet tests setup and measurement configuration, including threshold values (see 6.1 WiFi Setup).

B. Auto Test: Open the Auto Test menu to configure and run the Auto test (see 7.0 Auto Test).

C. **AP Scan**: Open the AP Scan menu to access: AP scan results (shown as a table and graph), level tracking function, locate function, and channel utilization scan results (see 8.0 AP Scan Menu).

D. **Client Scan**: Open the Client Scan menu to access the Clients scan results table and locate function (see 9.0 Client Scan menu).

E. **Spectrum Analyzer**: Open the Spectrum Analyzer menu to access the Spectrum Analyzer results. Note that this function requires hardware option. See 10.0 Spectrum Analyzer menu.

F. **IP Connect**: Open the IP Connect menu to access the **Connect to an AP** function and IP testing functions: Ping, Trace Route, ARPWiz (see 11.0 IP Connect menu).

G. **V-Perf**: Open the V-Perf menu to access the V-Perf throughput performance testing function. Note that prior IP connection must be established (see 12.0 V-Perf menu).

4.3.2 Ethernet Test Mode Home Menu

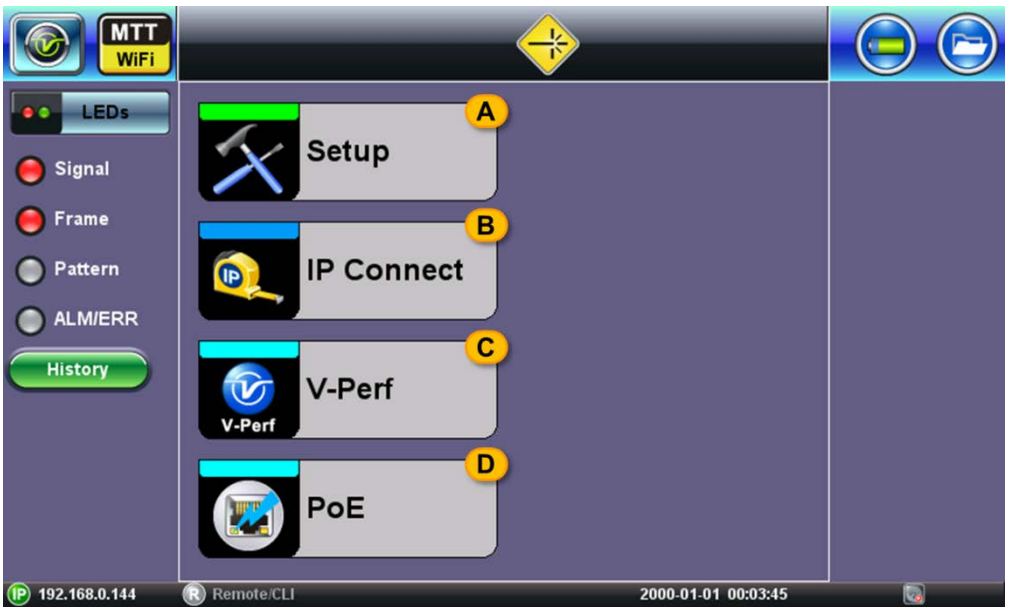


Figure 7: Ethernet Mode Home Menu

A. **Setup**: Open the Setup menu to configure WiFi and Ethernet test setup and measurement configurations, including threshold values (see 13.0 Ethernet Setup).

B. **IP Connect**: Open the IP Connect menu to access static or DHCP connection to the network, and IP testing functions: Ping, Trace Route, ARPWiz (see 14.0 Ethernet IP Connect).

C. **V-Perf**: Open the V-Perf menu to access the V-Perf throughput performance testing function. Note that prior IP connection must be established. See 15.0 Ethernet V-Perf.

D. **PoE**: Open the PoE menu to access the Power over Ethernet Testing function. See 16.0 Power over Ethernet (PoE) Test.

5.0 Utilities

Refer to the MTTplus Platform Manual for information about all Utilities and Tools available.

6.0 Setup

Use the Setup icon

from the home menu to access and configure WiFi and Ethernet tests and setup and measurement configurations including threshold values.
For WiFi Setup, refer to 6.1 WiFi Setup.
For Ethernet Setup, refer to 13.0 Ethernet Setup.

6.1 WiFi Setup

Figure 8: WiFi Setup Menu

- **Profile:** Save the setup and measurements in a new test profile or recalls an existing test profile. The *Default* test profile brings back the Air Expert's default test settings. The *Last configuration* profile is used at boot up.
- **Port:** From the drop-down menu, select the test mode. The module can be configured for WiFi utilization, Ethernet Copper port 10/100/1000T, or Ethernet Fiber port 1000X utilization.
- **Country:** From the drop-down menu, select the country of operation. Allowed channels in the 2.4 GHz and 5 GHz frequency bands are regulated. For example, in the United-States, 802.11 channels are regulated by the FCC. If the United States is selected in the Setup menu, channels 12, 13, and 14 are not authorized by the FCC. Therefore, if the Air Expert detects an AP configured on one of these channels, it will be flagged as an error. In World mode, the unit accepts all channels.
- **Active Probe**: From the drop-down menu, select *ON* or *OFF*. If Active Probe setting is *ON*, the Air Expert transmits probe requests on all channels. If Active Probe setting is *OFF*, the Air Expert does not transmit probe requests and relies on beacon frames transmitted by APs to discover the network.
- **Auto Scan**: From the drop-down menu, select *ON* or *OFF*. If Auto Scan setting is *ON*, the Air Expert automatically starts AP Scan at boot up. If Auto Scan setting is *OFF*, the Air Expert does

not start AP Scan at boot up. The function has to be manually started using the **Start Scan** function key

.

- **Max AP Discovered**: From the text box, edit the Max number of APs that will be displayed in the AP Scan results function, this setting can be configured from 100 to 300. An AP consists of a unique SSID/BSSID combination. Devices broadcasting multiple SSIDs are considered as multiple APs.
- **Internal Antenna**: Select the number antennas to use for the tests. The unit has 3 antennas, but the user can choose to operate the unit as a 1 antenna, 2 antenna, or 3 antenna client device. This setting can be used to educate customers about the maximum capabilities achievable by their client devices.
- **Locate Antenna**: From the drop-down menu, select *Internal* or *External*. This setting determines if the internal or external directional antenna will be used for the AP or Client Locate functions (see 8.2 AP Locate Function and 9.2 Client Locate Function). This setting is only used for the Locate function. For all other functions, only the internal antennas are used.
- **Location Label**: From the drop-down menu, select *OFF* or *ON*. When enabled this setting allows to add a location label during the Signal level tracking function (see 8.4.1 Signal Level Tracking with Location Label).
- **Label Type**: From the drop-down menu, select *Residential*, *Business*, or *Custom*. This setting is only available if Location Label setting is *ON*. Press the magnifying glass icon to view or edit the location labels.

Figure 9: Residential Location Label editing

The **Residential** and **Business Location Label** lists comes with 14 pre-populated location labels reflecting the most common places to run the site survey. Each can be further edited or overwritten using the magnifying glass icon . Press the **More** key to access 14 additional custom labels or press **OK** to close the list. The Custom label list has 28 fully customizable location labels and can be used for locations that do not fall under the Residential or Business categories.

6.2 WiFi Measurement Setup

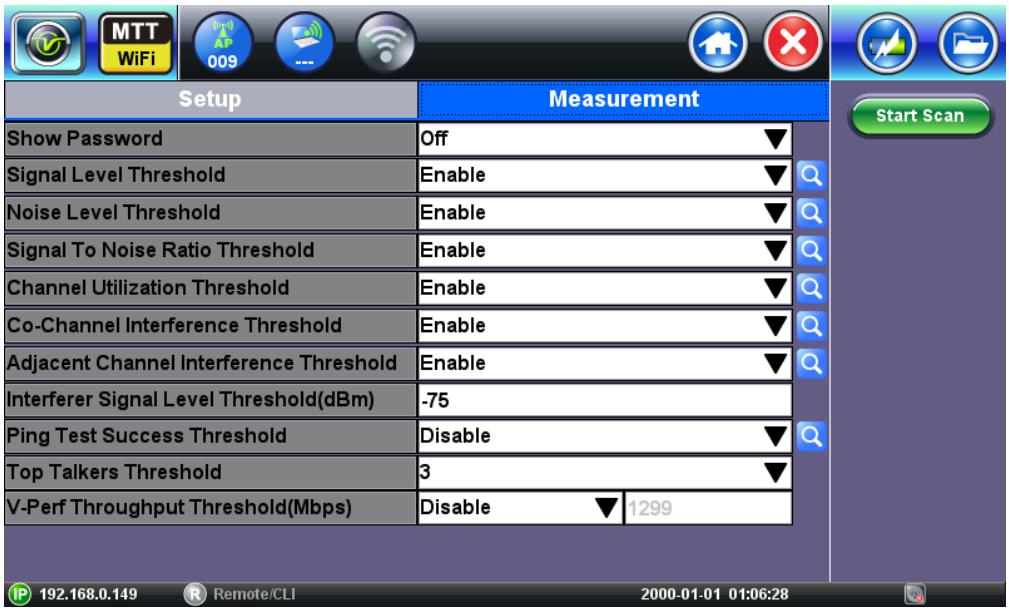


Figure 10: WiFi Measurement Setup Menu

- **Show Password**: From the drop-down menu, select *ON* or *OFF*.
  - *ON*: The WiFi password is shown in plain text in the IP setup menu.
  - *OFF*: The WiFi password is hidden in the IP setup menu.
- **Signal Level Threshold**: From the drop-down menu, select *Enable* or *Disable*.
  - *Enable*: The values in the threshold setting will be used to display pass, warning, and fail results in the Coverage Auto-test and AP scan menus.
  - *Disable*: Signal levels will be ignored in the Auto-test and AP scan menus.
- **Noise Level Threshold**: From the drop-down menu, select *Enable* or *Disable*.
  - *Enable*: The values in the threshold setting will be used to display pass, warning, and fail results in the Coverage Auto-test and AP scan menus.
  - *Disable*: Noise levels will be ignored in the Auto-test and AP scan menus.
- **Signal to Noise Ratio Threshold**: From the drop-down menu, select *Enable* or *Disable*.
  - *Enable*: The values in the threshold setting will be used to display pass, warning, and fail results in the Coverage Auto-test and AP scan menus.
  - *Disable*: SNR will be ignored in the Auto-test and AP scan menus.
- **Channel Utilization Threshold**: From the drop-down menu, select *Enable* or *Disable*.
  - *Enable*: The values in the threshold setting will be used to display pass, warning, and fail results in the Coverage Auto-test and AP scan menus.
  - *Disable*: Utilization will be ignored in the Auto-test and AP scan menus.
- **Co-Channel Interference Threshold**: From the drop-down menu, select *Enable* or *Disable*.
  - *Enable*: The values in the threshold setting will be used to display pass, warning and fail results in the Interference Auto-test.
  - *Disable*: Co-Channel Interference will be ignored in the Interference Auto-test.

- **Adjacent Channel Interference Threshold**: From the drop-down menu, select *Enable* or *Disable*.
    - *Enable*: The values in the threshold setting will be used to display pass, warning, and fail results in the Interference Auto-test.
    - *Disable*: Adjacent Channel Interference will be ignored in the Interference Auto-test.
- **Interferer Signal Level Threshold**: Use the text box to edit the value. Enter a value from -10 dBm to -95 dBm. If an AP's signal level falls below this threshold, it will be ignored in the Co-Channel or Adjacent Channel Interference Auto-test.
- **Ping Test Success Threshold**: From the drop-down menu, select *Enable* or *Disable*.
    - *Enable*: The values in the threshold setting will be used to display pass, warning, and fail results in the Connectivity Check Auto-test.
    - *Disable*: Ping Test will be ignored in the Connectivity Check Auto-test**.**
- **Top Talkers Threshold**: From the drop-down menu, select 3, 5, or 10. Select the number of **Top Talkers** that will be considered in the Top Talkers Auto-Test.

6.3 Threshold Configuration

Threshold testing compares user established threshold values with measured data, returning Pass, Warning, and Fail results that reveal network quality. Because Pass, Warning, and Fail results are determined from threshold values, changing threshold values will alter test results.

How to Configure Threshold Values

1. Tap on the magnifying glass icon to edit threshold settings.
2. To edit a value, tap on the white text box to open up the number editor. Type the desired value and press **Apply**.
3. When the Threshold values are configured, select the **Close** key to return to the previous screen.

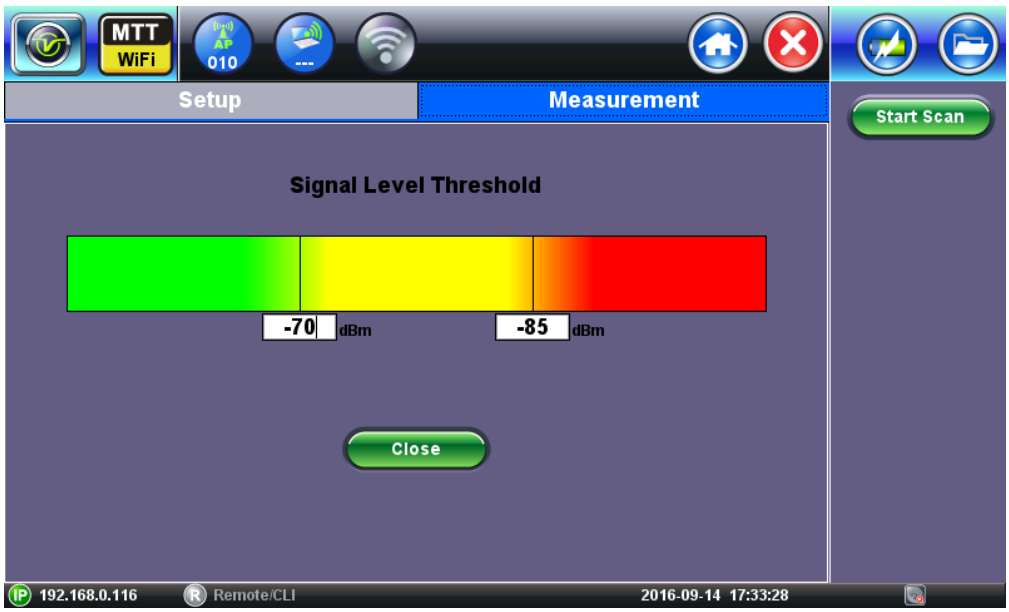


Figure 11: Signal Level Threshold screen appears, after tapping on the magnifying glass icon.

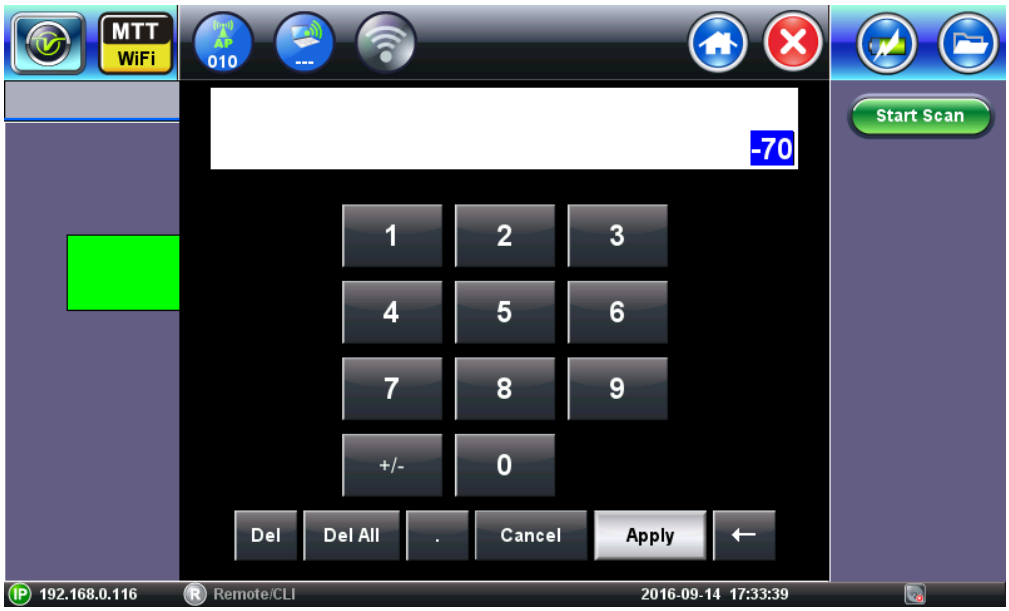


Figure 12: In this example, -70 was selected to be modified.

Threshold Statuses

Threshold results are presented as Pass, Warning, and Fail statuses:

- **Pass**: Measured data is above the **green** threshold value.
- **Warning**: Measured data is in the **yellow** range.
- **Fail**: Measured data is below the **red** threshold configuration.

Threshold	Status Description
Signal Level	Measures AP Signal Level and returns Pass, Warning, or Fail result. *Applicable Screens*: Coverage Auto-test, AP scan menus.
Noise Level	Measures AP Noise Level and returns Pass, Warning, or Fail result. *Applicable Screens*: Coverage Auto-test, AP scan menus.
Signal to Noise Ratio	Measures AP Signal to Noise Ratio and returns Pass, Warning, or Fail result. *Applicable Screens*: Coverage Auto-test, AP scan menus.
Channel Utilization	Measures Channel Utilization % and returns Pass, Warning, or Fail result. *Applicable Screens*: Coverage Auto-test, AP scan menus
Co-Channel Interference	Compares the number of APs sharing the same channel with the AP under test. Returns Pass, Warning, or Fail result. *Applicable Screens*: Interference Auto-test. **Note**: Only APs whose signal level is greater than the Interferer Signal Level Threshold value are considered for this test. Other APs sharing the

	same channel but with a signal level lower than the level threshold value are ignored.
Adjacent Channel Interference	Compares the number of APs on a channel adjacent to the AP under test. Returns Pass, Warning, or Fail result. *Applicable Screens*: Interference Auto-test. **Note**: that only APs whose signal level is greater than the Interferer Signal Level Threshold value are considered for this test. Other APs on an adjacent channel but with a signal level lower than the level threshold value are ignored.
Interferer Signal Level	APs signal levels above the Interferer Signal Level Threshold value are included toward the Co-channel and Adjacent channel interference count. APs signal levels below the threshold value are ignored.
Ping Test Success	Measures % of Ping Packets loss and returns Pass, Warning, or Fail result. *Applicable Screens*: Connectivity Check Auto-test.
Top Talkers	Select the number of top talkers that will be included in the Auto-Test Top Talkers report. The Top Talkers report classifies the channels and APs by Utilization.

7.0 Auto Test

Use the Auto Test icon

from the home menu to access the Auto Test menu.
WiFi performance is highly dependent on environmental factors. RF signals can be attenuated or blocked by physical obstacles like large metallic objects or concrete walls. Neighboring APs with high traffic load can reduce performance, and non-WiFi interference sources, such as cordless phones, video cameras or baby monitors, can disrupt WiFi transmission.

Since environmental factors will vary from location to location, no two installs will face the same challenges. Yet it is important to follow a repeatable install procedure to ensure consistency in the service level provided to the end user.

The Air Expert Auto Test function provides an automated, reliable, and repeatable installation routine.

7.1 Auto Test Setup

From the Auto Test Setup menu, users can select which tests are being done during the test routine. Individual tests can be enabled or disabled by adding or removing the check mark respectively. At least one test must be enabled.

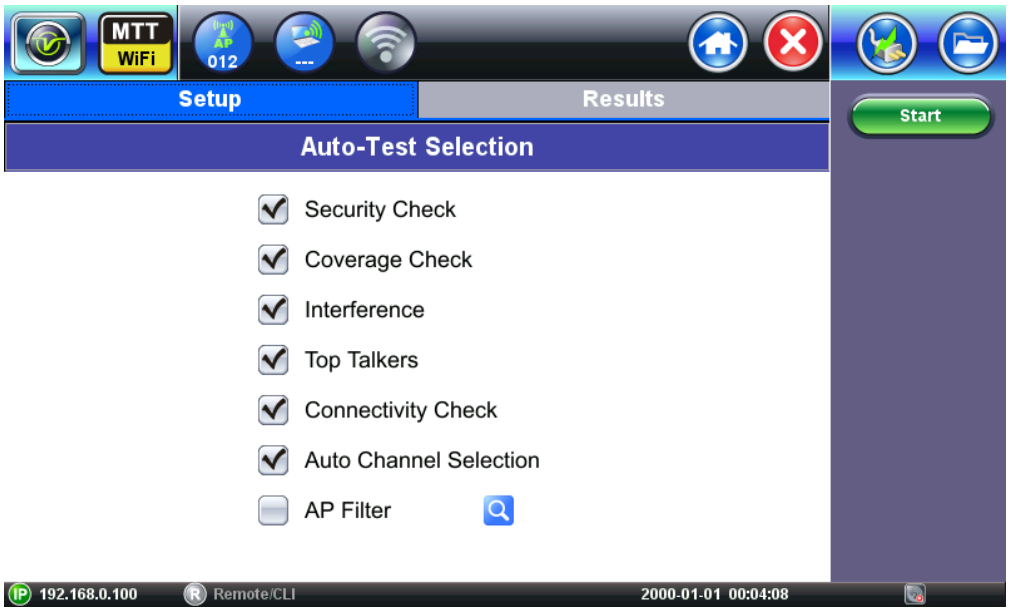


Figure 13: Auto-Test Selection Menu

- **Security Check:** During the Security Check (see 7.2.3 Security Check Auto-Test), the Air Expert verifies that no illegal channels are used on the network. It also detects hidden networks and encryption status.

- **Coverage Check:** During the Coverage Check (see 7.2.4 Coverage Check Auto-Test), the Air Expert identifies APs and Channels with low signal, SNR, high noise, and high utilization.
- **Interference Test:** During the Interference test (7.2.5 Interference Auto-Test), the Air Expert identifies APs with co-channel and adjacent channel interference.
- **Top Talkers**: During the Top Talkers test (7.2.6 Top Talkers Auto-Test), the Air Expert identifies the networks' top talkers APs and Channels in terms of utilization and number of clients.
- **Connectivity Check:** During the Connectivity Check (7.2.7 Connectivity Check Auto-Test), the Air Expert associates and connects to the APs under test and runs a Ping test to the Gateway's IP address.
- ***Note***: If Connectivity Check Auto-Test is enabled, you will be prompted to enter password information to connect to all APs under test. Ensure that the AP filter is enabled and only the AP from the network under test is selected.
- **Auto Channel Selection**: During the Auto Channel Selection test (see 7.2.8 Auto Channel Selection), the Air Expert analyzes the 2.4 GHz and 5 GHz frequency bands in terms of numbers of APs, channel utilization, and noise levels to determine the most suitable channels for deployments on new APs.
- **AP Filter**: See 7.1.1 AP Filter Setup.

7.1.1 AP Filter Setup

When enabled, the AP Filter allows users to select the list of APs that will be included in the Auto-test. When disabled, all APs detected by the Auto-Test scan function are included in the Auto-test Pass/Warning and Fail results.

Why is AP Filter necessary? When analyzing the WiFi environment, the Auto-Test Scan function detects APs belonging to the network under test, but also APs that belong to neighboring offices or buildings. In order to focus the Auto-Test Pass/Warning and Fail results to APs belonging to the networks under test, use the AP filter to select *only* the SSIDs from the APs belonging to the network under test.

Configuring the AP Filter List

1. Access the AP Filter list by using the magnifying glass icon and place a check mark next to the SSIDs belonging to the network under test.

2. Press the red "**X**" to close the AP filter selection and return to the Setup menu.

3. Tap on the check box next to AP Filter to enable it.

Note that the AP filter list is first populated by running a regular AP scan (refer to 8.0 AP Scan Menu). Make sure to run an AP scan prior to setting up AP Filter.

Note: If **Connectivity Check** Auto-Test is enabled, you will be prompted to enter password information for connection to all APs under test. Ensure that the AP filter is enabled and only the AP from the network under test are selected.

Figure 14: AP Filter Selection

7.2 Auto-Test Results

After pressing **Start** , the Auto-Test Summary results tab is automatically displayed. Additional details are accessible in individual auto tests tabs.

7.2.1 Auto-Test Results Summary

The Auto-Test Summary screen gives a summary for each of the individual Auto-test categories.

Tap on the test category to go directly to the corresponding tab and review detailed results.

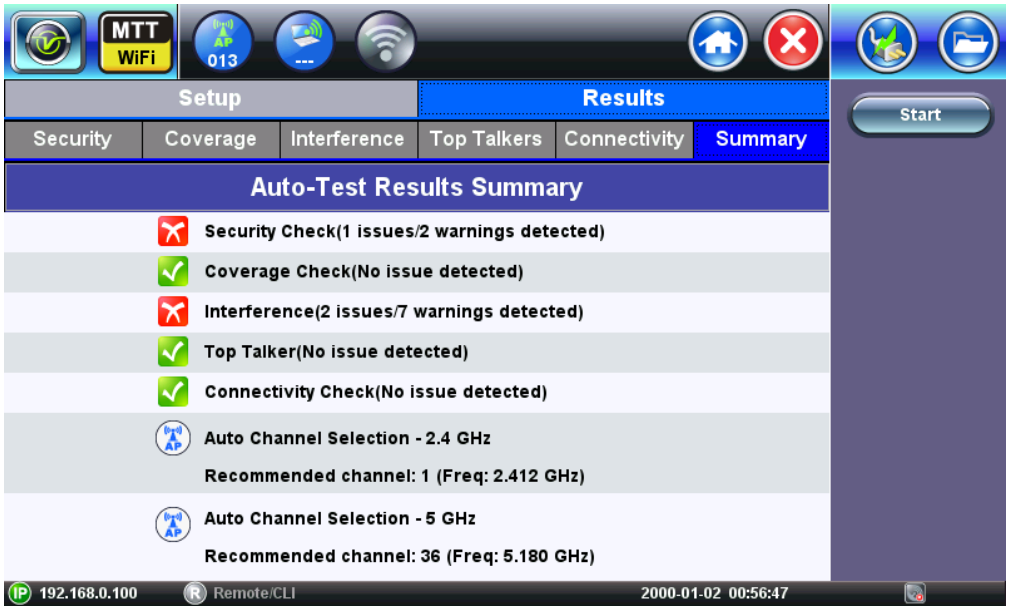


Figure 15: Auto Test Summary

For each test category, one of the following icons is displayed. If no icon is displayed, the test was disabled in the setup menu:

A pass icon indicates the test passes without warning or failure.

A warning icon indicates that at least one warning condition has been detected for the test. Tap on the icon to go to the corresponding results tab.

A fail icon indicates that at least one failure condition has been detected for the test. Tap on the icon to go to the corresponding results tab.

The AP icon indicates the results of the Auto-channel selection test (see 7.2.8 Auto Channel Selection).

7.2.2 Auto-Test Results Navigation

Use the + icon to expand the results and get additional details.

Use the – icon to close the detailed results.

Use the Up and Down arrow keys to scroll through the available results pages.

7.2.3 Security Check Auto-Test

The following tests are performed during the Auto-Test Security Check:

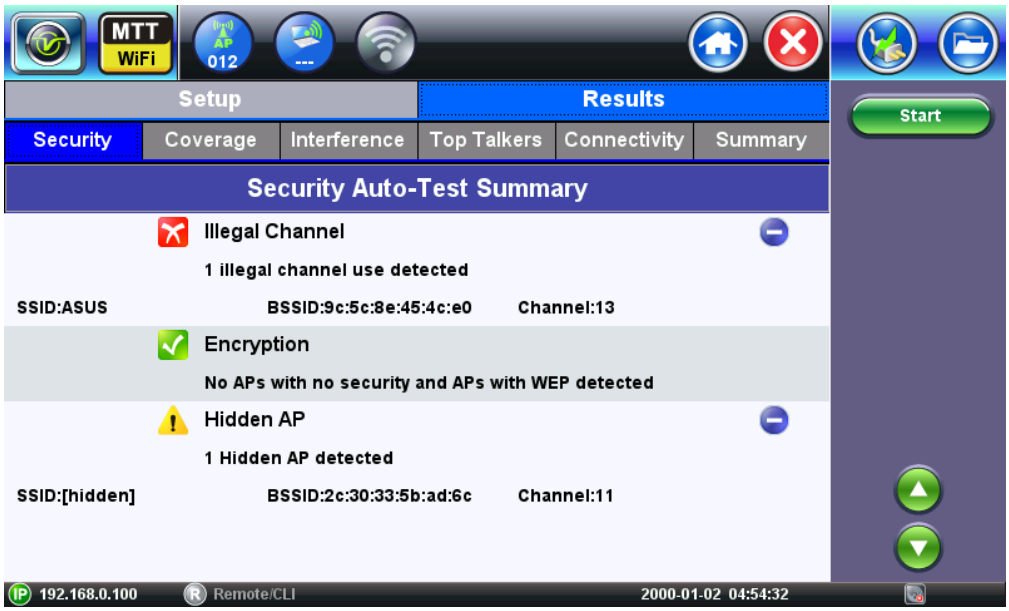


Figure 16: Security Auto-Test Results

- **Illegal Channel**: Detects WiFi channels in the 2.4 GHz and 5 GHz frequency band that are not authorized for the country selected in the Setup menu (see 6.1 WiFi Setup). For example, if the United States is selected in the Setup menu, channels 12, 13 and 14 are not authorized by the

FCC. Therefore if the Illegal Channel test detects an AP configured on one of these channels, it will be flagged as an error.

- **Encryption**: Detects APs that do not have encryption enabled or is using WEP. WEP is a weak security mechanism and shouldn't be used. Note that if AP Filter is enabled (see 7.1.1 AP Filter Setup), only APs selected in the filter list are taken into account for this test.
- **Hidden AP**: Occasionally, network managers prefer to hide the AP's SSID for security reasons. In that instance, a blank SSID name or "[hidden]" is displayed instead. The Hidden AP test displays a warning for all Hidden APs detected in the network.

7.2.4 Coverage Check Auto-Test

The following tests are performed during the Auto-Test Coverage Check. Test results are compared with Threshold values configured in the Setup menu (see 6.3 Threshold Configuration).

Note: If **AP Filter** is **enabled** (see 7.1.1 AP Filter Setup), only APs selected in the filter list are taken into account for these tests.

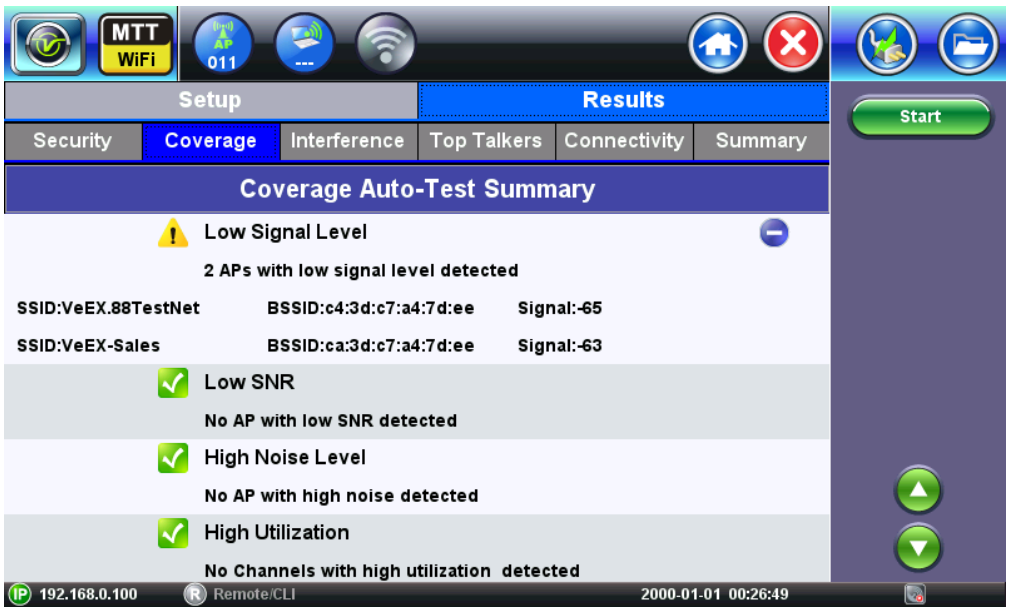


Figure 17: Coverage Auto-Test Results

- **Low Signal Level**: Detects APs whose signal level is below the Signal Level Threshold as configured in the Setup menu.
- **Low SNR**: Detects APs whose SNR is below the SNR Threshold as configured in the Setup menu.
- **High Noise Level**: Detects APs whose noise level is higher than the Noise Level Threshold as configured in the Setup menu.
- **High Utilization**: Detects channels whose utilization level is higher than the Utilization Threshold as configured in the Setup menu.

7.2.5 Interference Auto-Test

The following tests are performed during the Auto-Test Interference Check. Test results are compared with Threshold values configured in the Setup menu (see 6.3 Threshold Configuration).

Note:

- If **AP Filter** is **enabled** (see 7.1.1 AP Filter Setup), only APs selected in the filter list are tested for interference, but all APs detected in the Auto-Test scan exceeding the Interferer Signal Level Threshold value are examined as possible sources of interference.
- Only APs whose signal level is greater than the Interferer Signal Level Threshold value are examined as possible sources of interference for this test. Other APs sharing on the same, overlapping, or adjacent channels, but with a signal level lower than the threshold value are not considered a source of interference.

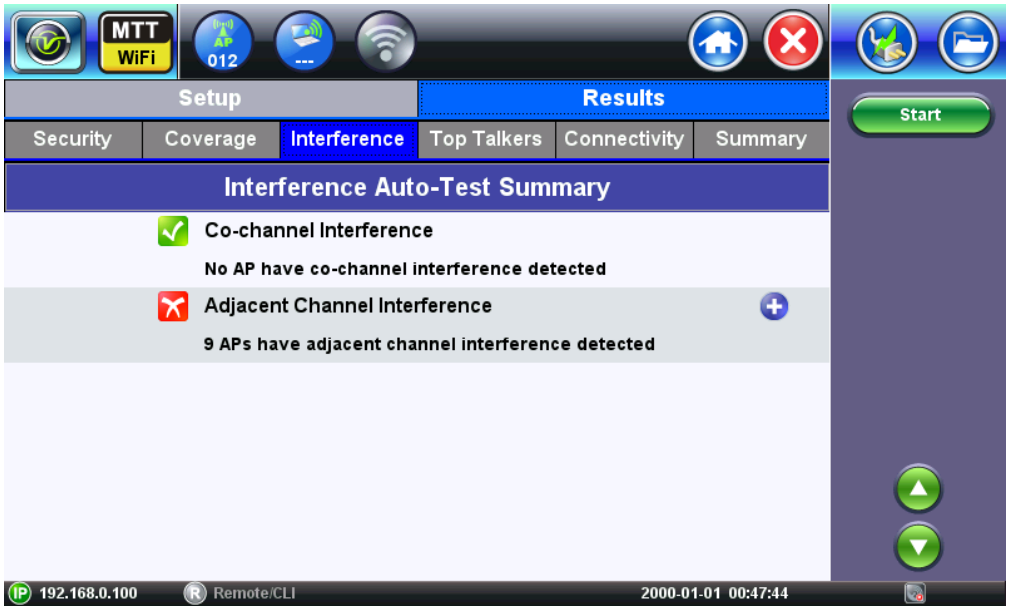


Figure 18: Interference Auto-Test Results

- **Co-channel Interference**: Detects APs configured on the same channel. If this number exceeds the Co-channel Interference Threshold value configured in the Setup menu, an error or warning is detected.
- **Adjacent Channel Interference**: Detects APs configured on adjacent/overlapping channels. If this number exceeds the Adjacent Channel Interference Threshold value setup in the in the Setup menu, an error or warning is detected.

7.2.6 Top Talkers Auto-Test

The following tests are performed during the Auto-Test Top Talkers Check. The numbers of Top Talkers reported in these tests are configured in the Setup menu (see 6.3 Threshold Configuration).

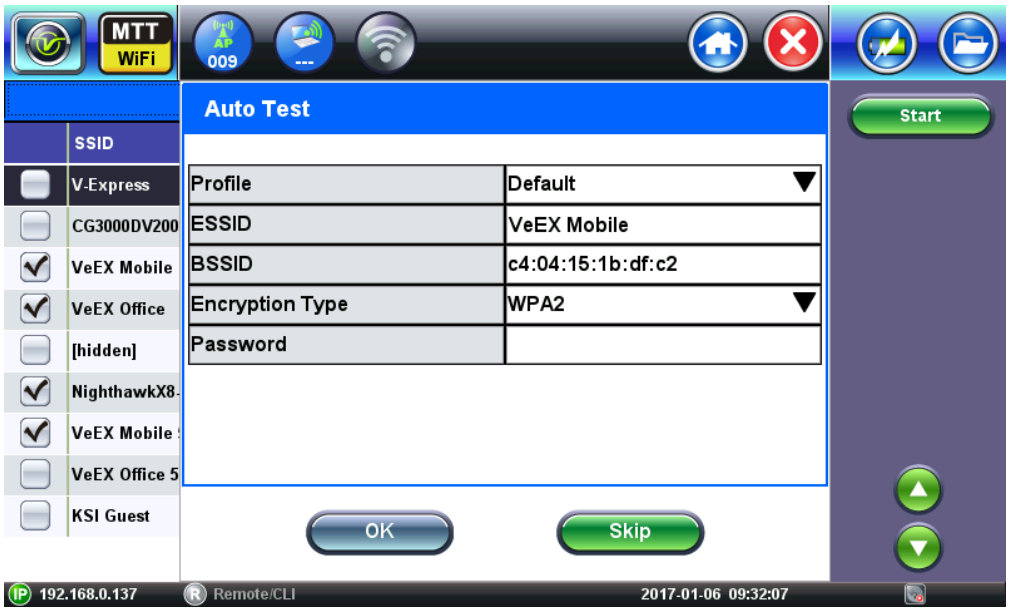
Figure 19: Top Talkers Auto-Test Results

- **Utilization**: Reports the Channels with the highest utilization %. All channels in the 2.4 GHz and 5 GHz frequency band are analyzed.
- **Top APs**: Reports the Channels where the most APs are configured. All channels in the 2.4 GHz and 5 GHz frequency band are analyzed.
- **Top Users**: Reports the APs with the most associated clients. Note that not all APs report this information. If this information is not reported by the AP, it will be ignored during the test.
- **Top Talkers**: Reports the APs with the highest utilization % (BSS load). Note that not all APs report this information. If this information is not reported by the AP, it will be ignored during the test.
- ***Note***: If AP Filter is enabled (see 7.1.1 AP Filter Setup), only APs selected in the filter list are taken into account for these tests.

7.2.7 Connectivity Check Auto-Test

The following tests are performed during the Auto-Test Connectivity Check:

Note: This test requires **AP Filter enabled** (see 7.1.1 AP Filter Setup), only APs selected in the filter list are tested for connectivity. If passwords are required, the user will be prompted to enter this information.



- **Connection**: Reports the results of associating and connecting to the AP under test, including the assigned IP address.
- **Ping**: Reports the results of the Ping test. 5 Ping requests are sent to the Gateway's IP address. The results PASS if the % of Ping success exceeds the threshold configured in the Setup menu (see 6.3 Threshold Configuration) or Fails otherwise.

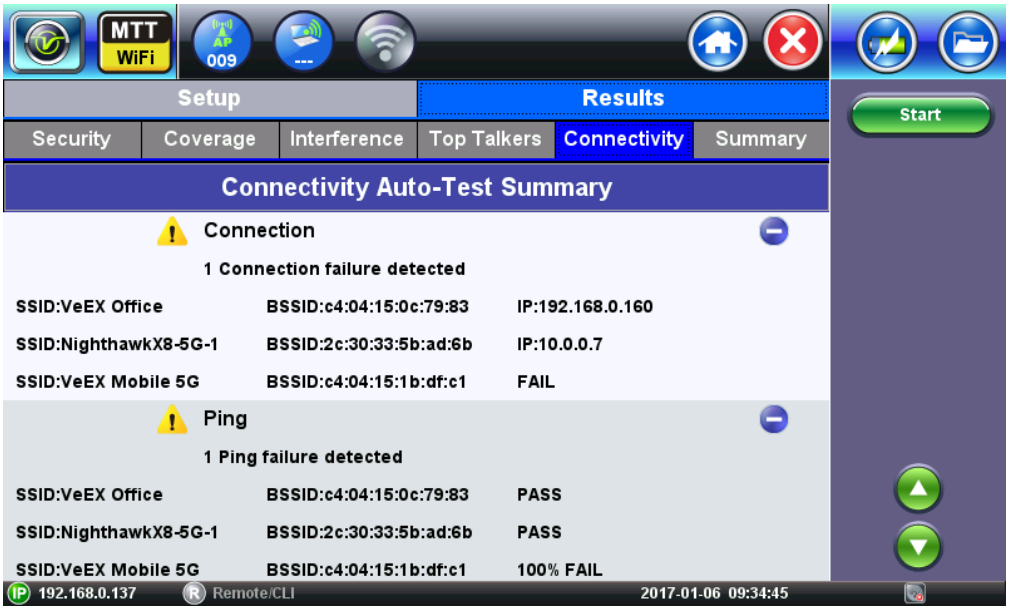


Figure 20: Connectivity Auto-Test Results

7.2.8 Auto Channel Selection

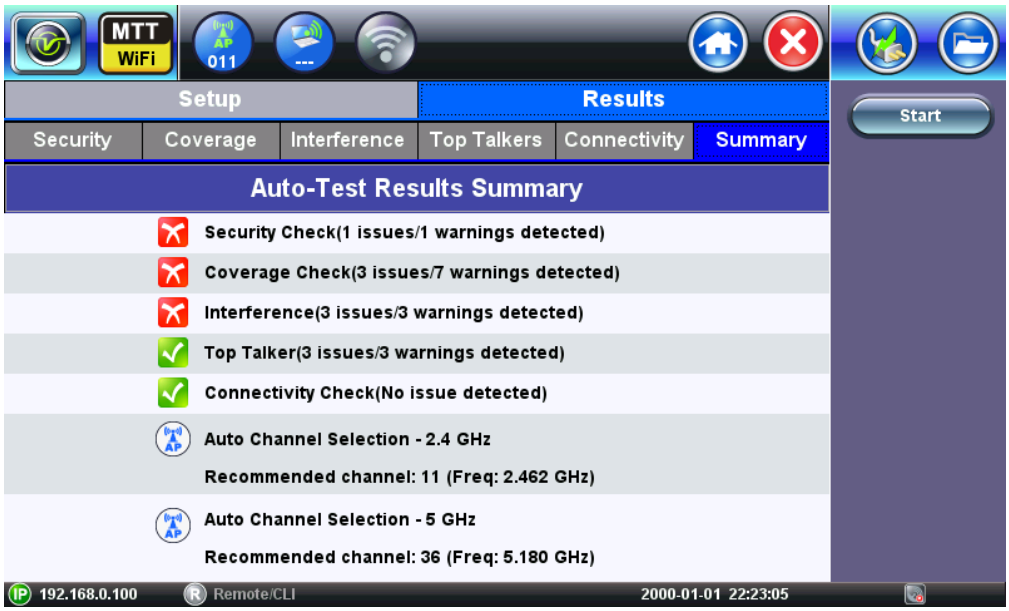


Figure 21: ACS Auto Test Results

Auto Channel Selection (ACS) results are reported in the Auto-Test Summary screen.

ACS analyzes the 2.4 GHz and 5 GHz frequency bands. It analyzes the number of APs, Co-channel and adjacent channels interference as well as current utilization and noise levels on all the channels in order to recommend the best channel for a new AP deployment.

In the 2.4 GHz frequency band, the ACS algorithm recommends a channel between 1 and 11.

In the 5 GHz frequency band, the ACS algorithm recommends a channel between 36 and 165. Note that the DFS channels are excluded from this test.

Refer to Appendix A: 2.4 GHz and 5 GHz Technology Overview for information about WiFi frequency bands and channels.

Note that AP channel configuration, utilization, and noise levels are highly variable, therefore ACS recommendations can vary over time.

8.0 AP Scan Menu

Use the AP Scan

icon from the home menu to access the AP Scan menu. The AP scan menu displays the results of the network scan in table and graphical format, as well as advanced testing features like Signal and Noise level tracking and AP location function.

8.1 AP Scan Table

- AP Scan Table displays discovered WiFi Access Points. Results are added while the network scan is running.
- Results are populated based on probe responses and beacon frames received on the scanned channels. Refer to the Setup menu (6.1 WiFi Setup) configuration regarding Active Probe configuration to enable/disable probe requests.
- By default a maximum number of 100 SSIDs are displayed on the table. This parameter can be updated to display up to 300 SSIDs. Refer to the Setup menu's **Max AP Discovered** setting (6.1 WiFi Setup) to change the display number.
- Entries not active for more than 2 minutes are aged out of the table.

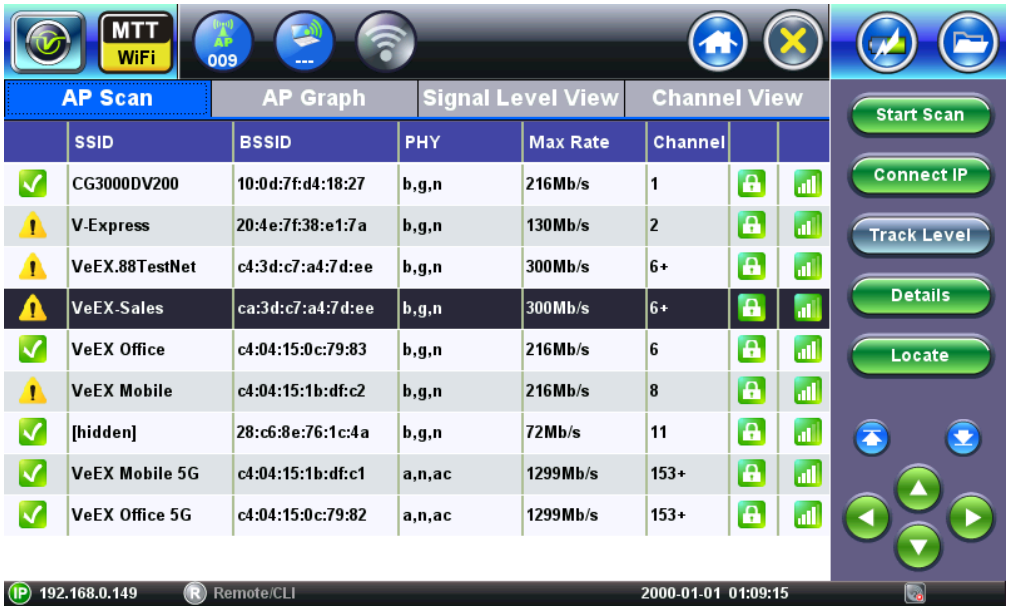


Figure 22: AP Scan Table

8.1.1 AP Scan Table Navigation

Discovered AP scan measurements are displayed in a table format. Common table navigation features and function keys are featured on these home screens.

Table Navigation

- Use the Up and Down arrow keys to scroll through rows of the table.
- Use the Left and Right arrow keys to scroll through the columns and view additional scan metrics.
- Press on Page Up/ Page Down arrow keys to move through each page of the table.

Table Sorting

Tap on any column header to sort the table in ascending or descending order by the column selected. Up and down arrow keys indicate that the table is sorted in ascending and descending order respectively.

Note that while the scan is running, new detected entries may be added in a non-sorted fashion. The sorting works best when the scan is stopped.

	SSID	BSSID	PHY	Max Rate	Channel		
	CG3000DV200	10:0d:7f:d4:18:27	b,g,n	216Mb/s	1		
	NighthawkX8-5G-	2c:30:33:5b:ad:6b	a,n,ac	1733Mb/s	48+		
	V-Express	20:4e:7f:38:e1:7a	b,g,n	130Mb/s	2		
	VeEX Mobile	c4:04:15:1b:df:c2	b,g,n	216Mb/s	5		

Figure 23: AP Scan Table sorted by ascending SSID name

	SSID	Signal Level	Noise Level	SNR	# Clients	BSS Load
	VeEX Mobile 5G	-40	-100	60	5	6.67%
	VeEX Office	-42	-48	6	7	17.65%
	NighthawkX8-5G-	-43	-98	55	1	0.39%
	VeEX Office 5G	-43	-100	57	4	6.67%

Figure 24: AP Scan Table sorted by descending Signal Level

Selecting a Row

Tap on any of the table's rows to select it. Selected rows are highlighted in black. In the example below, SSID VeEX Office is selected. Selecting an SSID gives access to additional functions, through the right hand side function keys.

	VeEX Mobile 5G	-40	-100	60	5	6.67%
	VeEX Office	-42	-48	6	7	17.65%
	NighthawkX8-5G-	-43	-98	55	1	0.39%
	VeEX Office 5G	-43	-100	57	4	6.67%

Figure 25: SSID Table Selection

8.1.2 AP Scan Table Function Keys

The function keys are located on the right hand side of the screen and allow access to advanced functions. Different function keys are available depending on whether the network scan is running.

Function Keys displayed while the network scan is running:

- **Stop Scan**: Stops ongoing network scan. The AP Scan table, Graph, and Channel View results are no longer updated.
- **Details**: Opens up a pop-up window with additional details for the currently selected SSID.

Function Keys displayed while the network scan is stopped:

- **Start Scan**: Clears the previous network scan results and starts a new network scan.
- **Connect IP**: Shortcut to the IP Connect menu for connection to the currently selected SSID. Refer to section 11.2 Connect AP.
- **Track Level**: Starts Signal Level tracking function (see 8.4 Signal Level View) for the currently selected SSID. Shortcut to the Signal Level View screen.
- **Details**: Opens up a pop up window with additional details for the currently selected SSID (see 8.1.4 AP Scan Details Window).
- **Locate**: Opens up the Locate function for the currently selected SSID (see 8.2 AP Locate Function).

8.1.3 AP Scan Table Fields and Measurements

The following measurements are displayed in the AP Scan Table results. Results are updated every second while the network scan is running. All channels in the 2.4GHz and 5 GHz frequency bands are scanned. Results are populated based on probe responses and beacon frames received on the scanned channels. Refer to the Setup menu (6.1 WiFi Setup) configuration regarding Active Probe configuration to enable/disable probe requests.

AP Scan Table Measurement Descriptions

For each SSID, a Pass or Warning icon is displayed to indicate the summary of the SSID's status.

A **Pass** icon indicates that no configuration issue or threshold crossing level is detected for the SSID.

A **Warning** icon indicates that a configuration issue or threshold crossing level is detected for the SSID. Tap on **Details**

to read the description of the warning condition.

- **SSID**: Service Set Identifier advertised by the Access Point. The SSID is the logical name used to identify the network. SSID is configured by the network manager. Occasionally network managers prefer to hide the AP's SSID for security reasons. In that case, a blank SSID name or "[hidden]" are displayed instead.
- **BSSID**: Basic Service Set Identifier for the AP. The BSSID is a 48-bit unique MAC address of the AP's network interface.
- **PHY:** 802.11 standard version supported by the SSID. 802.11 b,g,n operate on the 2.4 GHz frequency band. 802.11 a,n,ac operate on the 5 GHz frequency band.
- **Max Rate**: Maximum Phy rate in Mbps supported by the SSID.
- **Channel:** Channel number used by the SSID. Channels 1 to 13 are in the 2.4 GHz band. Channels 36 to 165 are in the 5 GHz frequency band. If channel bonding is used with 40 MHz or 80 MHz channel width, "+" is displayed next to the main channel number. Tap on **Details**

to view additional channels.

- **Lock icon:** Indicates the status of the SSID's security configuration.

  No Security enabled on SSID

  WEP Security enabled on SSID

  WPA or WPA2 enabled on SSID

- **Signal Bar icon:** Indicates Received Signal level status.

  Signal Level < -70 dBm

  -70 dBm < Signal Level < -60 dBm

  -60 dBm < Signal Level < -50 dBm

  -50 dBm < Signal Level < -40 dBm

  Signal Level > -40 dBm

- **Signal Level:** Received Signal Level from the SSID measured in dBm.
- **Noise Level:** Noise Level measured on the channel in dBm.
- **SNR:** Signal to Noise Ratio for the SSID measured in dB.
- **# Clients:** Number of clients associated to the SSID. Note that not all APs report this information. If this information is not reported by the AP, the field displays N/A.
- **BSS Load:** Basic Service Set traffic load as reported by the AP. Note that not all APs report this information. If this information is not reported by the AP, the field displays N/A.

8.1.4 AP Scan Details Window

Selecting an SSID from the AP Scan Table and pressing the **Details** key Details opens up a pop-up window. Fields displayed on the Details window may or may not be present depending on the information being advertised by the AP.

Press the **OK** key to close the Details window and return to previous screen.

Press the **More** key to view the next page of the Details window.

If a Warning sign is associated with the SSID, a box describing the causes for warning is displayed on the first page of the Details screen.

See 8.1.5 AP Scan Warning Conditions, for descriptions of warning conditions.

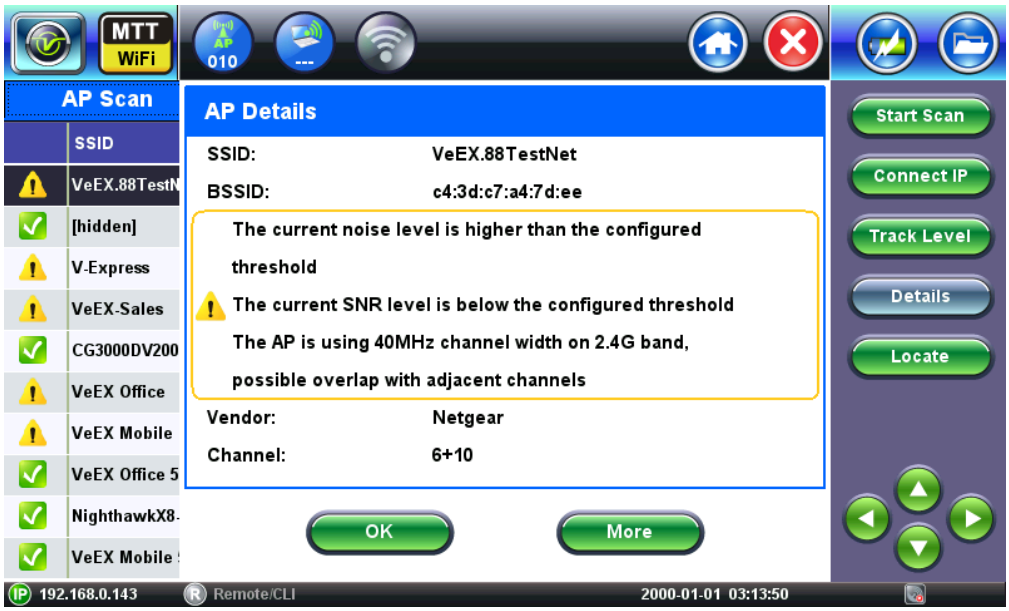


Figure 26: AP Scan Details Window

- **SSID**: Service Set Identifier advertised by the Access Point. The SSID is the logical name used to identify the network. SSID is configured by the network manager. Occasionally network managers prefer to hide the AP's SSID for security reasons. In that case, a blank SSID name or "[hidden]" are displayed instead.
- **BSSID**: Basic Service Set Identifier for the AP. The BSSID is a 48-bit unique MAC address of the AP's network interface.
- **Vendor**: AP's manufacturer name. If this information is not reported by the AP, the field is blank.
- **Channel:** Channel number used by the SSID. Channels 1 to 13 are in the 2.4 GHz band. Channels 36 to 165 are in the 5 GHz frequency band. If channel bonding is used with 40 MHz or 80MHz channel, then all channel numbers are listed.
- **Security:** SSID's security protocol.
- **PHY:** 802.11 standard version supported by the SSID. 802.11 b,g,n standards operate on the 2.4 GHz frequency band. 802.11 a,n,ac standards operate on the 5 GHz frequency band.
- **Max/Min Rate**: Maximum and Minimum Phy rate in Mbps advertised by the SSID.
- **Signal**: Received Signal Level from the SSID measured in dBm. If Signal Level threshold is enabled in the Measurement setup menu, the color (**Green**/**Yellow**/**Red**) reflects the threshold crossing status.
- **Noise**: Noise Level measured on the channel in dBm. If Noise Level threshold is enabled in the Measurement setup menu, the color (**Green**/**Yellow**/**Red**) reflects the threshold crossing status.
- **SNR**: Signal to Noise Ratio for the SSID measured in dB. If Signal to Noise Ratio threshold is enabled in the Measurement setup menu, the color (**Green**/**Yellow**/**Red**) reflects the threshold crossing status.
- **Co-channel**: Number of SSIDs detected configured on the same channel.
- **Overlapping**: Number of SSIDs detected whose bandwidth overlaps with the current channel.
- **Country code**: Country Code advertised by the AP. This field is set to N/A if the AP does not advertise a country code.

- **Reported Clients**: Number of clients connected to the AP as reported by the AP. This field is blank if the AP does not report the number of clients.
- **Guard Interval**: Interval between consecutive transmissions. Legacy guard interval is 800ns. Short guard interval is 400ns.
- **Channel Width:** Legacy 802.11 channel width is 20 MHz. 802.11n allows 20 MHz or 40 MHz channel width. 802.11ac allows 20 MHz, 40 MHz, 80 MHz or 160 MHz channel width.
- **Number of streams:** 802.11n and 802.11ac using MIMO technology, allow multiple data streams (also called spatial streams). 802.11n allows up to 4 data streams. 802.11ac allows up to 8 spatial streams.
- **BSS load:** Basic Service Set traffic load. The BSS is constituted from the AP and its associated clients. This field is blank if the AP does not report the BSS load.

8.1.5 AP Scan Warning Conditions

If a Warning sign is associated with the SSID. A box describing the causes for warning is displayed on the first page of the **Details** screen. One or multiple causes could trigger a warning. If multiple causes are present, they are all listed in the warning box.

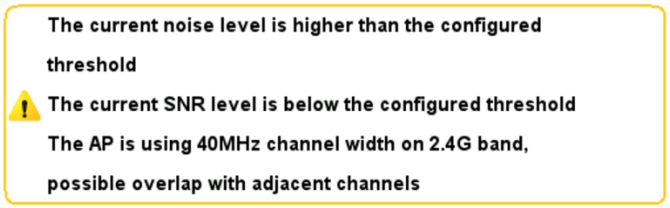


Figure 27: AP Scan Details screen Warning Box

Two main causes of warnings are possible:

- Threshold warnings
- Configuration warnings

Threshold warnings are triggered for the following reasons:

- **Signal Level warning**: If the Signal Level Threshold is enabled in the Measurement Setup menu and the current measured signal level is below the green level threshold.
- **Noise Level warning**: If the Noise Level Threshold is enabled in the Measurement Setup menu and the current measured noise level is above the green level threshold.
- **SNR Level warning**: If the Signal to Noise Level Threshold is enabled in the Measurement Setup menu and the current measured SNR is below the green level threshold.

For more information on enabling/disabling Signal, Noise, and SNR Levels, refer to 6.2 WiFi Measurement.

Configuration warnings are triggered for the following reasons:

- **Not recommended channel:** *The AP is not on a recommended channel, possible overlap with standard channels (1,6,11).* In the 2.4 GHz band, WiFi channels are only separated by 5 MHz, but each AP requires 20 MHz bandwidth. Only APs configured on channels 1, 6 or 11 do not overlap with adjacent channels. Overlapping channels create ACI (Adjacent Channel Interference) and can reduce performance.

- **40 MHz bandwidth**: *The AP is using 40 MHz channel width on 2.4G band, possible overlap with adjacent channels.* In the 2.4 GHz band, WiFi channels are only separated by 5 MHz. The 802.11n standard allows bonding channels to create a 40 MHz wide channel. However, 40 MHz channels are not recommended on the 2.4GHz bandwidth as they can overlap with APs configured on adjacent channels. Overlapping channels create ACI (Adjacent Channel Interference) and can reduce performance.
- **Illegal channel**: *The AP is configured on an illegal channel for the country.* Allowed channels in the 2.4 GHz and 5 GHz frequency bands are regulated. For example, in the United States, 802.11 channels are regulated by the FCC. This message indicates that an illegal channel has been detected for the country configured in the Setup menu (see 6.1 WiFi Setup).
- **Security**: *The AP is using WEP or has no security.* The AP does not have encryption enabled or is using WEP. WEP is a weak security mechanism and shouldn't be used.

8.2 AP Locate Function

From the AP Scan Table, select an SSID from the list, and select the **Locate** function key

, to open up the Locate function for the SSID selected.

- The Locate function is used to track the physical location of an Access Point. It measures the signal level of the traffic received from the SSID under test and updates the display every 0.5 seconds.
- To use this function, walk around the facility and monitor changes in Signal Level. A strong signal level (-20dBm or greater) indicates close proximity to the AP under test.
- This function can be used with the external directional antenna. Refer to 4.1.2.2 WiFi Directional Antenna, for information on the external direction antenna. Alternatively, it can be used with the unit's internal antennas.
- For antenna selection, refer to 6.1 WiFi Setup.

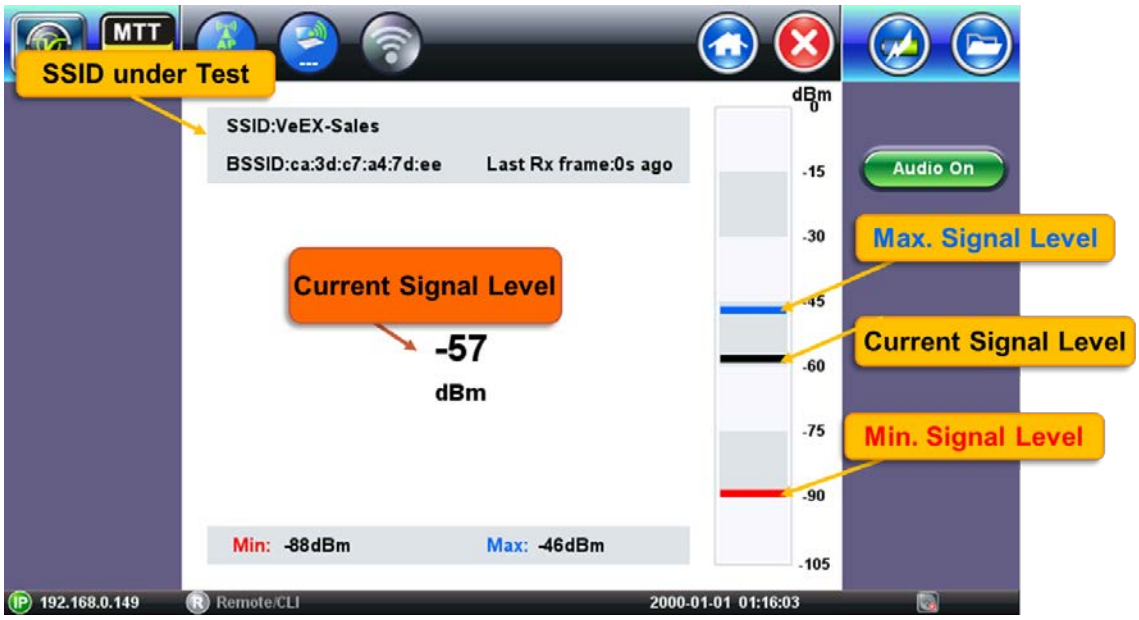


Figure 28: AP Locate Function

- **SSID:** Service Set Identifier advertised by the Access Point. The SSID is the logical name used to identify the network. SSID is configured by the network manager. Occasionally network managers prefer to hide the AP's SSID for security reasons. In that case, a blank SSID name or "[hidden]" are displayed instead.
- **BSSID:** Basic Service Set Identifier for the AP. The BSSID is a 48-bit unique MAC address of the AP's network interface.
- **Last RX frame:** The Locate function's Signal level measurement is based on the Signal level measured on frames received from the SSID under test. If frames are being received on a continuous basis, this counter displays 0s ago, meaning that traffic is currently received. If frames are not being received on a continuous basis, this counter displays the duration since the last frame was received.
- **Min:** Minimum Signal level in dBm detected since the beginning of the test. This is the low watermark level.
- **Current:** Current signal level in dBm measured updated every 0.5 s.
- **Max:** Maximum Signal level in dBm detected since the beginning of the test. This is the high watermark level.

8.3 AP Graph

AP Graph displays the discovered WiFi Access Points in a graphical format. Results are added while the network scan is running.

Results are populated based on probe responses and beacon frames received on the scanned channels. Refer to 6.1 WiFi Setup, for information regarding Active Probe configuration to enable/disable probe requests.

By default a maximum number of 100 SSIDs are displayed on the table. This parameter can be updated to display up to 300 SSIDs; refer to the Setup menu's **Max AP Discovered** setting (6.1 WiFi Setup).

Entries not active for more than 2 minutes are aged out of the table.

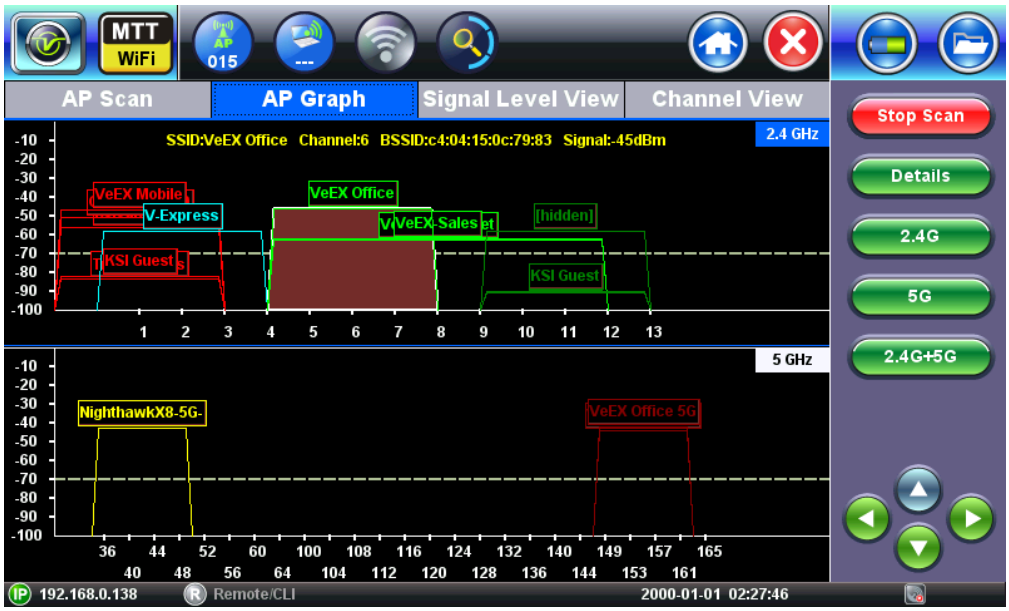


Figure 29: AP Graph 2.4GHz + 5GHz

8.3.1 AP Graph Navigation

Graph Pane Selection

By default, AP Graph displays both the 2.4 GHz and the 5 GHz frequency bands. To navigate from the 2.4 GHz graph pane to the 5 GHz graph pane, tap on the corresponding label 5 GHz. When the graph pane is selected, the corresponding label is highlighted in Blue 5 GHz.

Graph Pane Navigation

- Use the Up and Down arrow keys to scroll through Access Points detected on the same channel.
- Use the Left and Right arrow keys to scroll through Access Points on adjacent channels.
- The AP currently selected is highlighted in red and the SSID is displayed at the top of the graph.

8.3.2 AP Graph Function Keys

The function keys located on the right hand side of the screen:

- **Stop** or **Start Scan**: Stops ongoing network scan. The AP Scan table, Graph and Channel View results are no longer updated. When the scan is stopped, the **Start Scan** button will replace it. Pressing **Start** clears the previous network scan results and starts a new network scan.
- **Details**: Opens up a pop up window with additional details for the currently selected SSID (see 8.1.4 AP Scan Details Window).
- **2.4G:** Displays Graph of 2.4 GHz frequency band on full screen.
- **5G**: Displays Graph of 5 GHz frequency band on full screen.

- **2.4G+5G**: Displays both 2.4 GHz and 5 GHz frequency band on split screen.

8.3.3 AP Scan Graph Results

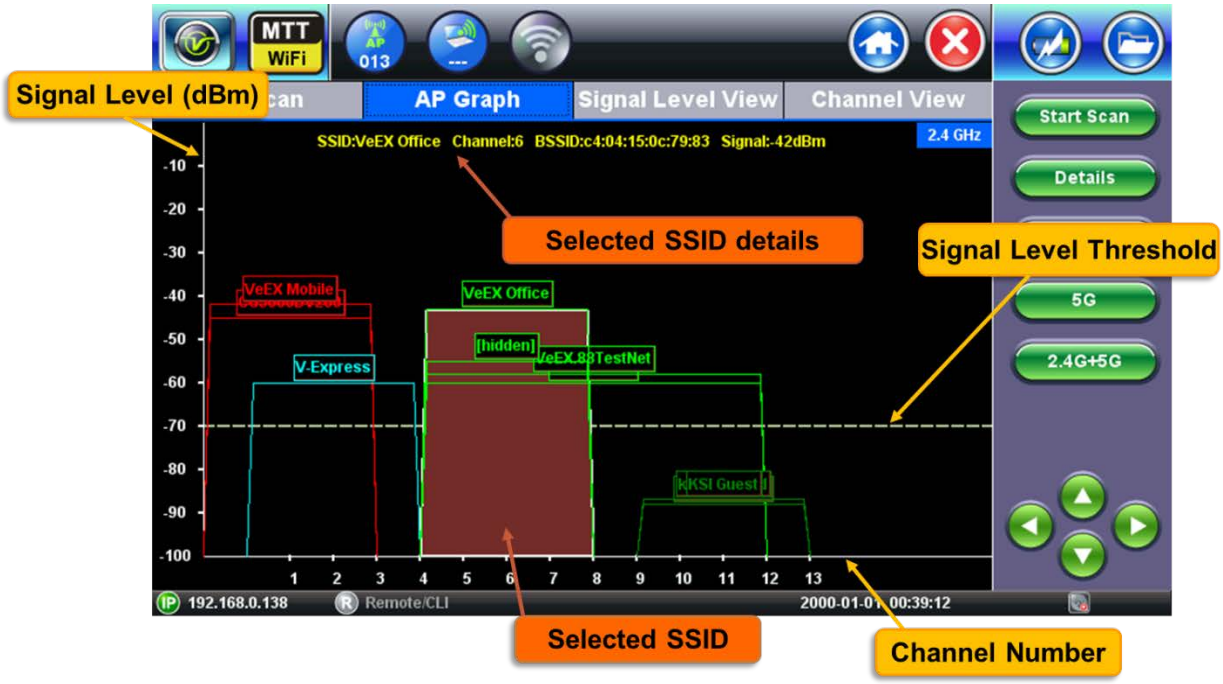


Figure 30: 2.4 GHz AP Graph

The AP Scan graph representation indicates the channel width of the AP (20 MHz, 40 MHz, or more) and provides a view of co-channel APs (APs on the same channel) and adjacent APs (APs on overlapping channel).

The x-axis displays the channel number; the y-axis displays the signal level (in dBm).

For each selected SSID, additional information is displayed at the top of the graph.

A dotted line indicates the Signal Level threshold as configured in the Setup menu (refer to 6.3 Threshold Configuration).

8.4 Signal Level View

- From the AP Scan Table, select an SSID from the list and select the **Track Level** function key

, to start tracking the Signal/Noise level and SNR for the SSID selected
- The Track Level function runs a site survey by updating the measurements every second for the SSID under test
- The Results can be viewed in Graph or Table format
- The Signal/Noise level and SNR for the SSID under test are recorded for 15 minutes

- If Location Label is enabled in the Setup menu (refer to 6.1 WiFi Setup), one of the pre-populated or custom location labels will be added to the Signal level recording

8.4.1 Signal Level Tracking with Location Label

Figure 31: Location Label selection

- When starting Track Level function, if Location Label is enabled in the WiFi Setup menu (see 6.1 WiFi Setup), a pop-up window appears with a list of possible locations where the measurement starts. The Residential list is populated with names of common site survey locations for a residential installation. The Business list is populated with names of common site survey locations for office installation. The Custom list can be populated with custom location names.
- Tap on the corresponding check box to make the selection and press **OK** to select the labels or **More** for additional labels.
- The Track Level function starts recording the Signal/Noise level and SNR values for the SSID under test. A measurement is made every second.

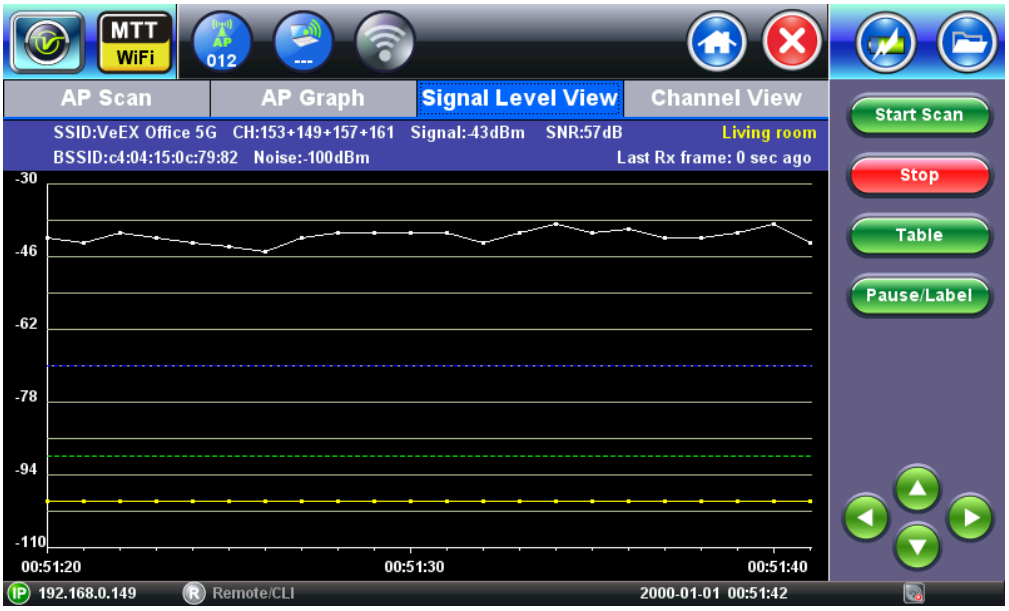


Figure 32: Signal Level tracking with Location Label

- When moving on to the next location to survey, press the **Pause/Label** function key

to pick a new location name from the list. Signal Level recording resumes with the new location label.

8.4.2 Signal Level View Navigation

Signal Level View Graph Navigation

- Use the Up and Down arrow keys to scroll through SSIDs detected in the AP Scan table. **Warning**: If the Signal Level tracking is currently running, pressing the Up and Down arrow keys will start tracking the new SSID and stop the previous one.
- Use the Left and Right arrow keys to scroll through the time x-axis, measured in seconds. The time span per screen is 22 seconds. Pressing left or right on the arrow keys moves the time span by 5 seconds.

Signal Level View Table Navigation

- Use the Page Up/ Page Down arrow keys scroll through the table page by page.
- Use the Up and Down arrow keys scroll through the table row by row.
- Use the Left and Right arrow keys to scroll through SSIDs detected in the AP Scan table. **Warning**: If the Signal Level tracking is currently running, pressing the Left and Right arrow keys will start tracking the new SSID and stop the previous one.

8.4.3 Signal Level View Function Keys

The function keys are located on the right side of the screen. Different function keys are available depending on whether Signal Level tracking is running.

Function Keys displayed while Signal Level tracking is running:

- **Start Scan**: Starts a new AP network scan. **Warning**: Starting the network AP will stop the current Signal Level tracking in progress.
- **Stop**: Stops in progress Signal Level tracking.
- **Table** or **Graph**: Table displays Signal Level view in table format; Graph displays it in graph format.
- **Pause/Label**: If **Location Label** is enabled in the Setup menu (see 6.1 WiFi Setup), this function key is used to pause the test and select a new location label. Refer to 8.4.1 Signal Level Tracking with Location Label for details.

Function Keys displayed when Signal Level tracking is off:

- **Start scan**: Starts a new AP network scan. **Warning**: Starting the network AP will stop the current Signal Level tracking in progress.
- **Track Level**: Start Signal level tracking for the currently selected SSID.
- **Table** or **Graph**: Table displays Signal Level view in table format; the Graph key displays it in graph format.
- **Locate**: Opens up the **Locate** function for the currently selected SSID (see 8.2 AP Locate Function).

8.4.4 Signal Level View Fields and Measurements

Signal Level View Graph Measurements

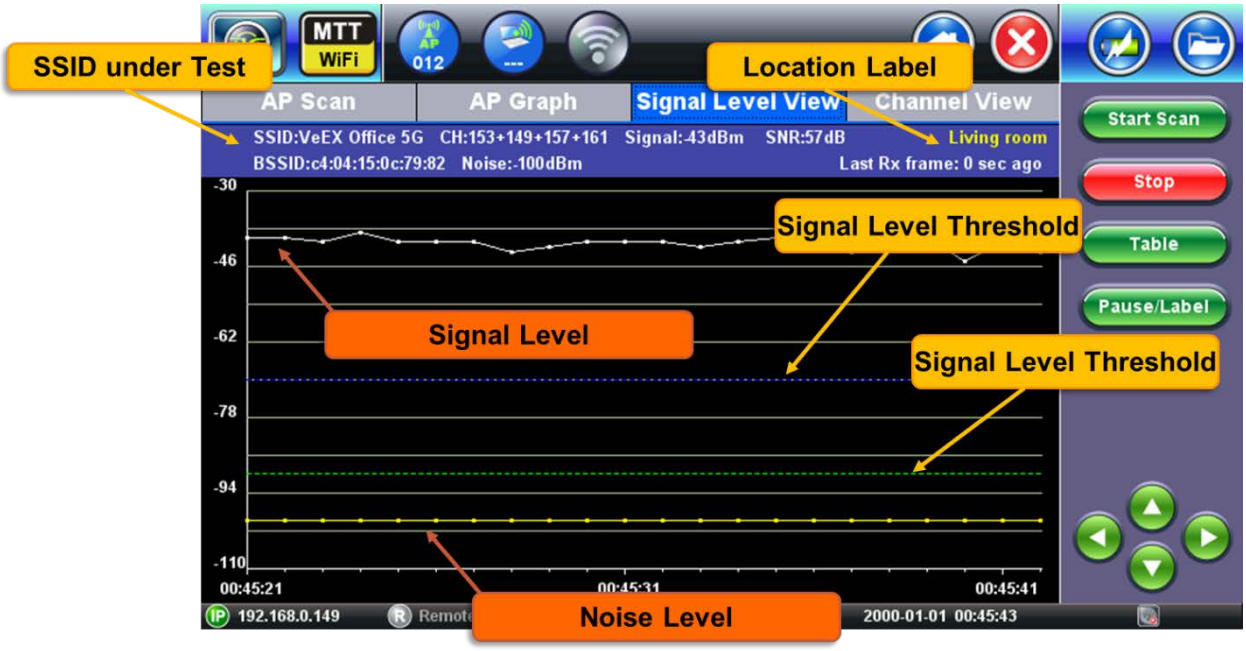


Figure 33: Signal Level View Graph

The Signal Level View graph shows the Signal level and Noise level updated every second for the SSID under test.

The Signal level in dBm is measured every second for the SSID under test.

The Noise level in dBm is measured every second on the channel.

The x-axis displays time in HH:MM:SS format; the y-axis displays levels in dBm.

For the current measurement, the following information is displayed at the top of the graph: **SSID** under test, **Channel number**, **Signal Level**, **SNR**, **BSSID** under test, **Noise Level**. **Location Label** is included if it is enabled in the Setup menu (see 8.4.1 Signal Level Tracking with Location Label).

Last Rx frame counter: The Signal level tracking measurement is based on the Signal level measured on frames received from the SSID under test. If frames are being received on a continuous basis, this counter displays 0 sec ago, meaning that traffic is currently received. If frames are not being received on a continuous basis, this counter displays the duration since the last frame was received.

A dotted line indicates the Signal Level and Noise Level threshold as configured in the Setup menu (see 6.2 WiFi Measurement Setup).

Note that the Signal level view keeps only a period of 15 minute measurements.

Signal Level View Table Measurements

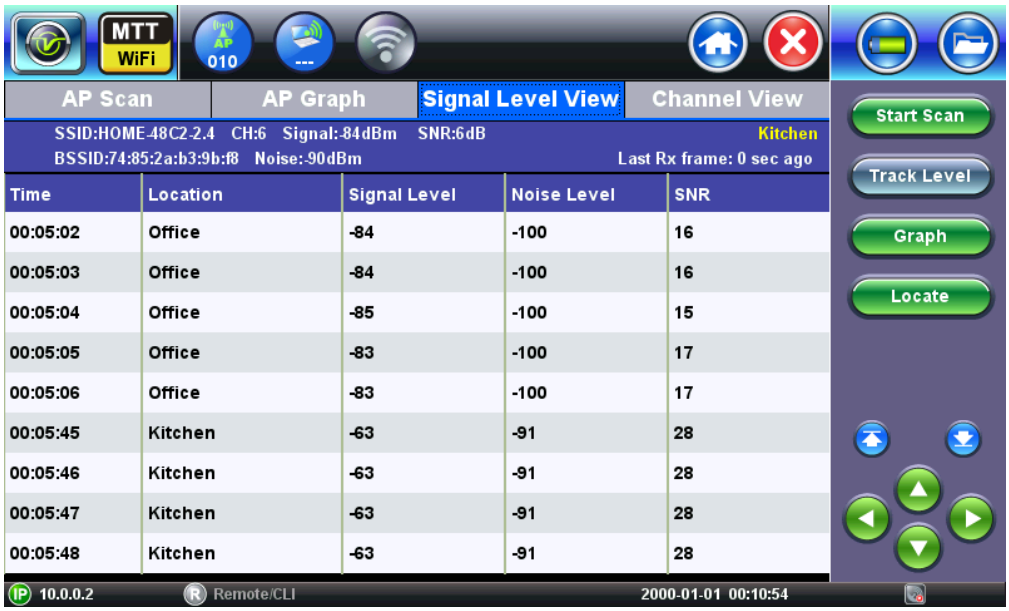


Figure 34: Signal Level View Table view

The following measurements are displayed in the Signal Level View Table. Results are updated every second while level tracking is running.

- **Time:** Time in HH:MM:SS format when the measurement was taken
- **Location:** Optionally it includes a location label, if Location Label is enabled in the Setup menu (refer to 6.1 WiFi Setup)
- **Signal Level:** The Signal level in dBm is measured every second for the SSID under test
- **Noise Level:** The Noise level in dBm is measured every second on the channel
- **SNR**: Signal to Noise Ratio for the SSID measured in dB measured every second

For the current measurement, the following information is displayed at the top of the graph: **SSID** under test, **Channel number**, **Signal Level**, **SNR**, **BSSID** under test, **Noise Level**. **Location Label** is included if it is enabled in the Setup menu (see 6.1 WiFi Setup).

Last Rx frame counter: The Signal level tracking measurement is based on the Signal level measured from frames received from the SSID under test. If frames are being received on a continuous basis, this counter displays 0 sec ago, meaning that traffic is currently received. If frames

are not being received on a continuous basis, this counter displays the duration since the last frame was received.

8.5 Channel View

- Channel View graph and table display the 2.4 GHz and 5 GHz frequency band channels utilization. Results are updated while the network scan is running.
- Channel **Utilization** measures the percentage of time that the RF channel is detected as “busy” and that the radio could not initiate communication due to RF interference. The channel can be detected as “busy” because of WiFi transmissions by APs on the channel or non-WiFi interference on the same frequency as the channel under test.
- Results are updated every second.

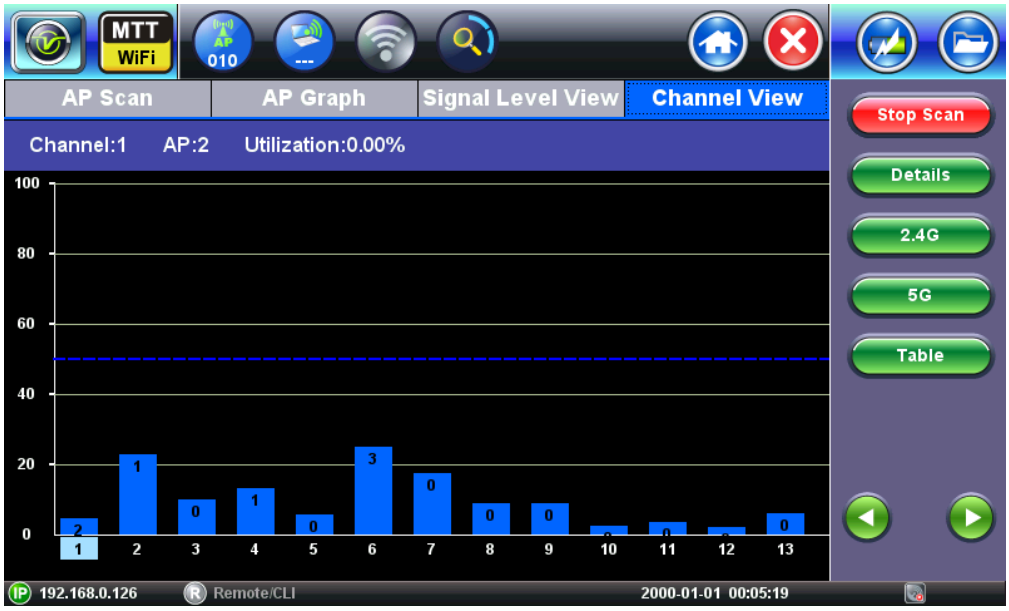


Figure 35: Channel View Graph

8.5.1 Channel View Navigation

Channel View Graph Navigation

- Use the Left and Right arrow keys to scroll through channels in the 2.4 GHz and 5 GHz frequency band or tap on the channel.
- The channel currently selected is highlighted in light blue. In Figure 38: Channel View Graph, Channel 1 is selected.

Channel View Table Navigation

- Use the Up and Down arrow keys to scroll through channels in the 2.4 GHz and 5 GHz frequency band or tap on the row.
- The channel currently selected is highlighted in blue.
- Use the Page Up and Page Down arrow keys to move to the next page in the 2.4 GHz and 5 GHz frequency band.

Table Sorting

Tap on any column header to sort the channel table in ascending or descending order by the column selected. An up arrow next to the header signifies ascending order and a down arrow represents descending order.

Channel	# of APs	Best Signal	Avg. Utilization ↓	Overlapping APs	Max Overlap
112	0	N/A	51.94%	0	N/A
161	0	N/A	49.18%	2	-37dBm
124	0	N/A	48.09%	0	N/A
116	0	N/A	46.68%	0	N/A
149	0	N/A	32.62%	2	-37dBm

Figure 36: Channel Table sorted by decreasing Utilization %

Channel	# of APs	Best Signal	Avg. Utilization	Overlapping APs	Max Overlap
1	1	-46dBm	18.73%	2	-46dBm
11	4	-60dBm	8.10%	2	-60dBm
6	3	-44dBm	43.92%	2	-44dBm
4	1	-41dBm	22.94%	5	-41dBm
2	1	-59dBm	20.30%	5	-59dBm

Figure 37: Channel Table sorted by increasing number of overlapping APs

Table Selection

Tap on any of the table rows to select it. Selected rows are highlighted in black. In the example below, SSID VeEX Office is selected. Selecting a channel gives access to additional functions. The functions are accessed through the right side function keys.

4	1	-41dBm	22.94%	5	-41dBm
5	0	N/A	23.25%	6	-41dBm
6	3	-44dBm	43.92%	2	-44dBm
7	0	N/A	29.76%	8	-41dBm

Figure 38: Channel Table selection

8.5.2 Channel View Function Keys

The function keys are located on the right hand side of the screen and allow access to advanced functions.

- **Stop Scan** or **Start Scan**: Stop Scan stops ongoing network scan. The AP Scan table, Graph, and Channel View results are no longer updated. Start Scan clears the previous network scan results and starts a new network scan.
- **Details**: Opens up a pop up window with additional details for the currently selected Channel (see 8.5.4 Channel View Details Window).
- **2.4G:** Displays Graph of 2.4GHz frequency band.
- **5G**: Displays Graph of 5GHz frequency band.
- **Table** or **Graph**: **Table** displays channel utilization in table format. The Graph key

displays channel utilization as a graph.

8.5.3 Channel View Fields and Measurements

2.4 GHz Frequency Band

For information on the 2.4 GHz WiFi frequency band refer to Appendix A: 2.4 GHz and 5 GHz Technology Overview.

5 GHz Frequency Band

For information on the 5 GHz WiFi frequency band refer to Appendix A: 2.4 GHz and 5 GHz Technology Overview.

Channel View Graph Measurements

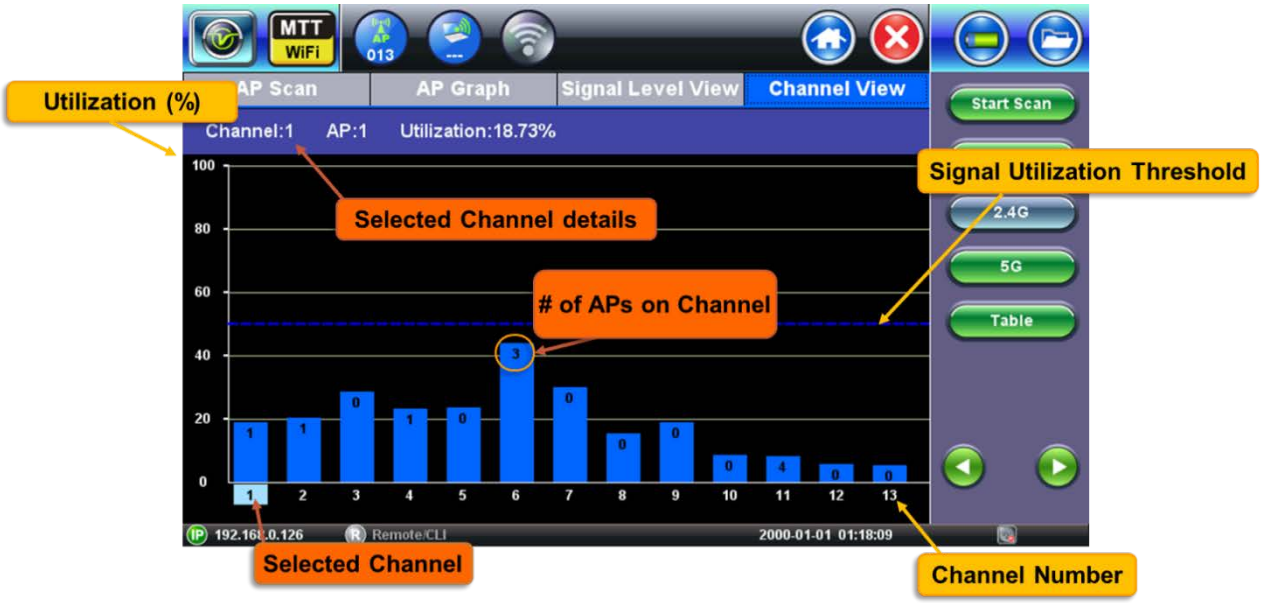


Figure 39: Channel Utilization Graph

The Channel Utilization graph indicates the channel utilization and number of APs detected on each channel in a bar graph format.

Channel Utilization measures the percentage of time that the RF channel is detected as “busy” and that the radio could not initiate communication due to RF channel interference. The channel could be detected as “busy” because of WiFi transmissions by APs on the channel or non-WiFi interference on the same frequency as the channel under test.

The x-axis displays the channel number, the y-axis displays utilization (in %). The number included in each bar graph displays the number of APs detected on each channel.

For each selected channel, additional information is displayed at the top of the graph.

A dotted line indicates the utilization threshold as configured in the Setup menu (see 6.3 Threshold Configuration).

Channel View Table Measurements

The following measurements are displayed on the Channel View Table results. Results are updated every second while the network scan is running. All channels in the 2.4 GHz and 5 GHz frequency bands are scanned.

- **Channel #:** Channel number in the 2.4 GHz and 5 GHz frequency bands.
- **# of APs:** Number of Access Points/SSID detected on the channel.
- **Best Signal:** Strength in dBm of the strongest signal of the APs located on the channel. Displays “N/A” if no AP is located on the channel.
- **Avg. Utilization:** Average channel utilization in % over the duration of the test. Channel Utilization measures the percentage of time that the RF channel is detected as “busy” and that the radio could not initiate communication. The channel could be detected as “busy” because of WiFi transmissions by APs on the channel or non-WiFi interference on the same frequency as the channel under test.
- **Overlapping APs:** Number of Access Points/SSIDs whose spectrum overlap on the channel.

- **Max Overlap**: Signal level in dBm of the strongest overlapping AP. Displays “N/A” if there are no overlapping APs on the channel.

8.5.4 Channel View Details Window

Selecting a Channel from the Channel View Graph or Table and pressing the **Details** function key

opens up a pop-up window with additional details.

Fields displayed on the details window may or may not be present depending on the information being advertised by the AP.

Press **OK** to close the Details window and return to previous screen.

Press **More** to view the next page of the Details window.

Figure 40: Channel View Details screen

- **Channel #:** Channel number in the 2.4 GHz and 5 GHz frequency bands.
- **# of APs:** Number of Access Points/SSID detected on the channel.
- **Best Signal:** Strength in dBm of the strongest signal of the APs located on the channel. Displays “N/A” if no AP is located on the channel.
- **Overlapping APs:** Number of Access Points/SSIDs whose spectrum overlap on the channel.
- **Max Overlap**: Signal level in dBm of the strongest overlapping AP. Displays “N/A” if there are no overlapping APs on the channel.
- **Min Freq:** Channel’s lower frequency in GHz. WiFi Channels are 20 MHz wide.
- **Center Freq:** Channel’s center frequency in GHz. WiFi Channels are 20 MHz wide.
- **Max Freq:** Channel’s upper frequency in GHz. WiFi Channels are 20 MHz wide.
- **Avg. Utilization:** Average channel utilization in % over the duration of the test. Channel Utilization measures the percentage of time that the RF channel is detected as “busy” and that the radio could not initiate communication. The channel could be detected as “busy” because of WiFi transmissions by APs on the channel or non-WiFi interference on the same frequency as the channel under test.

- **List of co-channel APs:** List of SSIDs of the APs located on the channel and their signal level in dBm.
- **List of Overlapping APs:** List of SSIDs of the APs located on overlapping channels and their signal level in dBm.

9.0 Client Scan menu

Use the Client Scan

icon from the home menu to access the Client Scan menu. The Client scan menu displays the results of the network client scan in table format, as well as advanced testing features like Client location function.

9.1 Client Scan Table

- The Client Scan Table displays the discovered associated and non-associated WiFi clients/stations. Results are added while the client scan is running.
- Results are populated based on 802.11 frames originating or destined to WiFi clients.
- Each WiFi channel in the 2.4 GHz and 5 GHz frequency band is monitored for a period of 100ms in a round robin fashion.
- Entries not active for more than 2 minutes are aged out of the table.

Figure 41: Client Scan Table

9.1.1 Client Scan Table Navigation

Refer to section 8.1.1 AP Scan Table Navigation for information on how to navigate, sort, and select table features.

9.1.2 Client Scan Table Function Keys

The function keys are located on the right hand side of the screen and allow access to advanced functions. Different function keys are available depending on whether the network scan is running.

Function Keys displayed while the network scan is running:

- **Stop Scan**: Stops ongoing client scan. The Client Scan table is no longer updated.
- **Details**: Opens up a pop-up window with additional details for the currently selected WiFi client.

Start and Location function keys become available when the network scan is stopped:

- **Start Scan**: Clears the previous client scan results and starts a new scan.
- **Locate**: Opens up the Locate function for the currently selected WiFi client. Refer to 9.2 Client Locate Function for details.

9.1.3 Client Scan Table Measurement Descriptions

The following measurements are displayed in the Client Scan Table results. For each client, a Pass or Warning icon is displayed to indicate the summary of the client's status.

A pass icon indicates that no configuration issue or threshold crossing level is detected for the client.

A warning icon indicates that a configuration issue or threshold crossing level is detected for the client. Tap on **Details**

to read the description of the warning condition.

- **MAC**: 48-bit unique MAC (Hardware) address of the detected client.
- **Associated AP SSID**: Service Set Identifier of the network to which the WiFi client is associated. If the WiFi client is not associated to any network, this field displays "not associated".
- **Max AP Rate**: Maximum Phy rate in Mbps supported by the AP to which the client is associated. If the client is not associated, this field displays "N/A".
- **Channel:** Channel number used by the SSID to which the client is associated. If Channels 1 to 13 are in the 2.4 GHz band. Channels 36 to 165 are in the 5 GHz frequency band. If the client is not associated, this field displays N/A.
- **Lock icon:** Indicates the status of the SSID's security configuration. This field displays "—" if the client is not associated.

No Security enabled on SSID

WEP Security enabled on SSID

WPA or WPA2 enabled on SSID

- **Signal Bar icon:** Indicates received signal level status. Note that although the Air Expert measures the signal level of incoming 802.11 frames, it may not be representative of the signal level as seen by the AP, unless the measurements are taken next to the AP under test.

Out of range: The client information came from an 802.11 frame transmission from the AP to the client but the client transmissions are not detected by the Air Expert because they are out of range.

Signal Level < -70 dBm

-70 dBm < Signal Level < -60 dBm

-60 dBm < Signal Level < -50 dBm

-50 dBm < Signal Level < -40 dBm

Signal Level > -40 dBm

- **#Packets (100ms/channel)**: Number of 802.11 packets received from the client. This value is sampled as each channel in the 2.4 GHz and 5 GHz frequency band is monitored for a period of 100ms in a round robin fashion.
- **Signal Level:** Received signal level from the client measured in dBm. Note that although the Air Expert measures the signal level of incoming 802.11 frames, it may not be representative of the signal level as seen by the AP, unless the measurements are taken next to the AP under test. This field displays "—" if the client is out of range. This means that the client information came from an 802.11 frame transmission from the AP to the client, but the client transmissions are not detected by the Air Expert because they are out of range.

9.1.4 Client Scan Details Window

Selecting a client from the Client Scan Table and pressing **Details** Details opens up a pop-up window with additional details. Fields displayed on the details window may or may not be present depending on the information being advertised by the client and AP.

Press the **OK** key to close the Details window and return to previous screen.

Press the **More** key to view the next page of the Details window.

If a Warning sign is associated with the client, a box describing the causes for warning is displayed on the first page of the Details screen. See 9.1.5 Client Scan Warning Conditions for description of warning conditions.

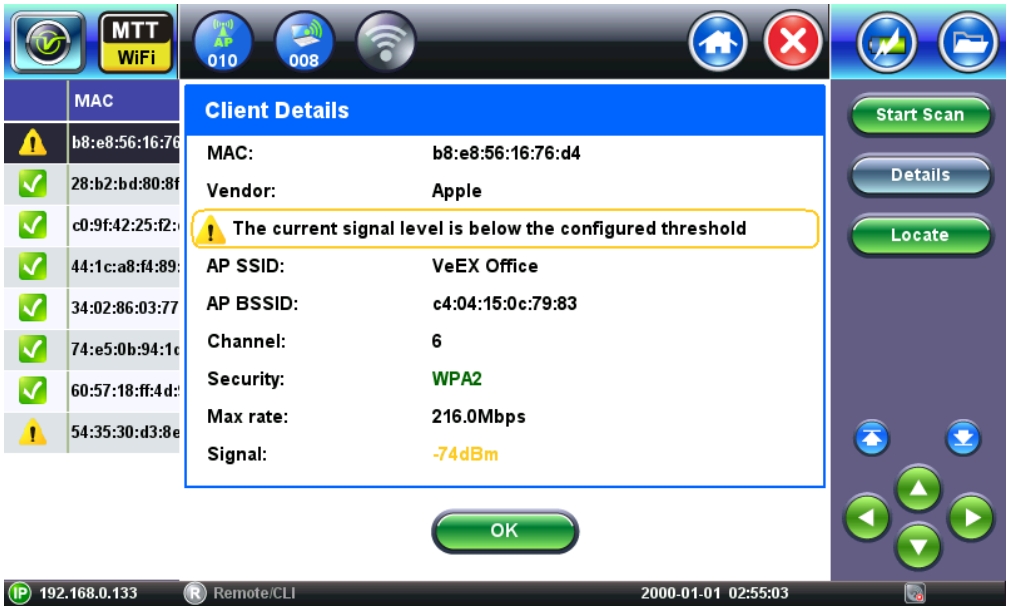


Figure 42: Client Scan Details Window

- **MAC:** 48-bit unique MAC (Hardware) address of the client.
- **Vendor:** Hardware vendor manufacturer. Displays “N/A” when this information is not available.
- **AP SSID**: Service Set Identifier of the network to which the WiFi client is associated. If the WiFi client is not associated to any network, this field displays “not associated”.
- **AP BSSID**: Basic Service Set Identifier of the network to which the WiFi client is associated. The BSSID is a 48-bit unique MAC address of the AP’s network interface. If the WiFi client is not associated to any network, this field displays “not associated”.
- **Channel:** Channel number used by the SSID to which the client is associated. Channels 1 to 13 are in the 2.4 GHz band. Channels 36 to 165 are in the 5 GHz frequency band. If the client is not associated, this field displays “N/A”.
- **Security:** SSID’s security protocol.
- **Max AP Rate**: Maximum Phy rate in Mbps supported by the AP to which the client is associated. If the client is not associated, this field displays “N/A”.
- **Signal**: Received signal level from the client measured in dBm. Note that although the Air Expert measures the signal level of incoming 802.11 frames, it may not be representative of the signal level as seen by the AP, unless the measurements are taken next to the AP under test. This field displays “—“ if the client is out of range. This means that the client information came from an 802.11 frame transmission from the AP to the client but the client transmissions are not detected by the Air Expert because they are out of range.
- **Probed SSID**: Lists the SSIDs that the Client is probing for.

9.1.5 Client Scan Warning Conditions

If a Warning sign is associated with the client, a box describing the causes for warning is displayed on the first page of the Details screen. One or multiple causes could trigger a warning. If multiple causes are present, they are all listed in the warning box.

Figure 43: Client Scan Details screen Warning Box

Two main causes of warnings are possible:

- Threshold warnings
- Configuration warnings

A Threshold warning is triggered for the following reason:

- **Signal Level warning**: If Signal Level Threshold is enabled in the Setup menu (see 6.1 WiFi Setup) and the current measured signal level is below the green level threshold. Note that the Air Expert measures the signal level of incoming 802.11 frames. It may not be representative of the signal level as seen by the AP, unless the measurements are taken next to the AP under test.

Configuration warning is triggered for the following reason:

- **Security**: *“The AP is using WEP or has no security.”* The AP does not have encryption enabled or is using WEP. WEP is a weak security mechanism and shouldn’t be used.

9.2 Client Locate Function

- From the Client Scan Table, select a client from the list, and select the Locate function key

, to open up the Locate function for the client selected.
- The Locate function is used to track the physical location of the client. It measures the signal level of the traffic received from the client under test and updates the display every 0.5 seconds.
- To use this function, you must walk around the facility and monitor changes in signal level. A strong signal level (-20 dBm or greater) indicates close proximity to the client under test.
- This function can be used with the external directional antenna (see 6.1 WiFi Setup) or the unit's internal antennas.

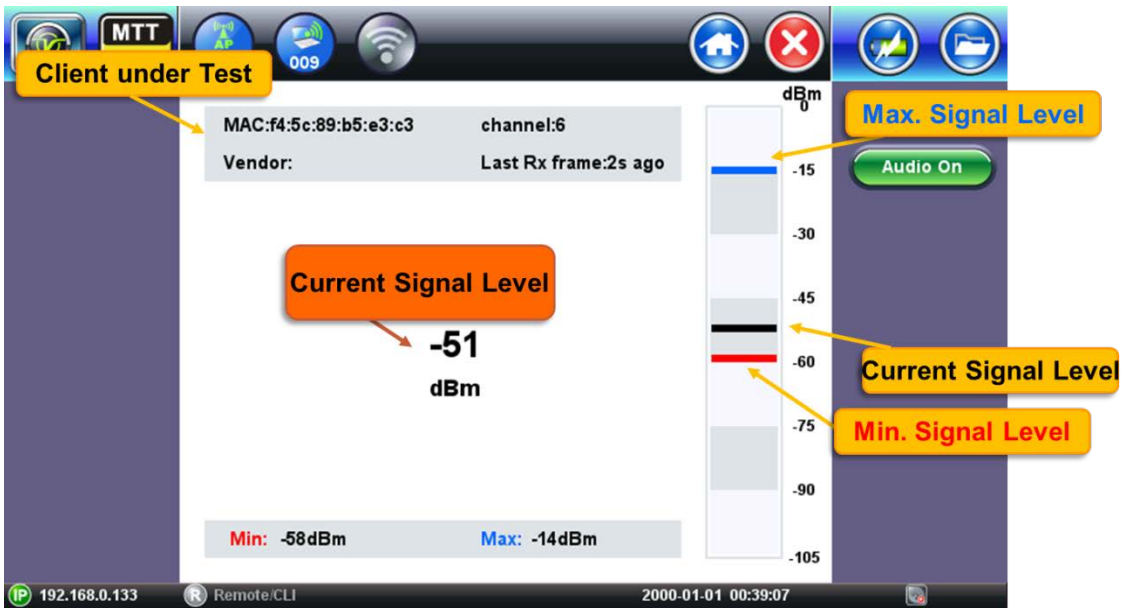


Figure 44: Client Locate Function

- **MAC**: 48-bit unique MAC (Hardware) address of the client.
- **Vendor**: Hardware vendor manufacturer. Displays "N/A" when this information is not available.
- **Last RX frame:** The Locate function's Signal Level measurement is based on the signal level measured on frames received from the client under test. If frames are being received on a continuous basis, this counter displays 0 s ago, meaning that traffic is currently received. If frames are not being received on a continuous basis, this counter displays the duration since the last frame was received.
- **Min:** Minimum signal level in dBm detected since the beginning of the test. This is the low watermark level.
- **Current:** Current signal level in dBm measured.
- **Max:** Maximum signal level in dBm detected since the beginning of the test. This is the high watermark level.

10.0 Spectrum Analyzer menu

Use the Spectrum Analyzer

icon from the home menu to access the Spectrum Analyzer menu. The Spectrum Analyzer is a hardware option for the MTTplus-900 Air Expert module. It displays all RF spectrum activity in the WiFi 2.4 GHz and 5 GHz bands as well as WiFi and non-WiFi sources of interference (e.g.: cordless phones, microwave ovens, Bluetooth devices, etc.). The Spectrum Analyzer application:

- Helps determine the best available WLAN channels quickly for optimal performance
- Helps to visualize and locate RF signals in the 2.4 GHz and 5 GHz spectrums
- Discover and remedy competing access points
- Optimize WLAN networks by locating and eliminating non-WiFi interference sources

10.1 WiFi Spectrum Analyzer Specifications

The WiFi Spectrum Analyzer requires connecting an external antenna to the connector marked “Spectrum”, located on the connector panel on top of the module (see 4.1.1 WiFi Module Connector Panel).

Spectrum Analyzer specifications:

- Frequency Range: 2.400 to 2.495 GHz and 5.150 to 5.850 GHz
- Amplitude Range: -100 to -6.5 dBm
- Amplitude Resolution: 0.5 dBm
- Resolution Bandwidth: 214.286 KHz in 2.4 GHz band, 464.286 KHz in 5 GHz band
- Sweep Time: (2.4 GHz) 507 msec
- (low 5 GHz) 1242 msec
- (mid 5 GHz) 1587 msec
- (high 5 GHz) 641 msec

The Spectrum Analyzer option is shipped with a dipole omni-directional antenna:

- Antenna Type: Dipole
- Frequency: 2.4-2.5 GHz / 4.9-5.8 GHz
- Connector: SMA (female) 50 Ohms
- Gain: 2 dBi/2.5dBi
- VSWR: 2
- Polarization: Linear Vertical
- Pattern Type: Omni-Directional
- Antenna Length: 109mm

10.2 Spectrum Analyzer Default View

The WiFi Spectrum Analyzer automatically starts up as the default view for the 2.4 GHz frequency band.

Tap on **5 GHz Band**

to switch to monitoring the 5 GHz frequency band. Refer to Appendix A: 2.4 GHz and 5 GHz Technology Overview for information on the 5 GHz frequency band.

The default view displays the Levels Graph (see 10.3 Levels Graph) and Density Graph (see 10.4 Density Graph), and Waterfall View (see 10.5 Waterfall Graph) on a single screen. To access these views with more details, tap on the corresponding function keys on the right.

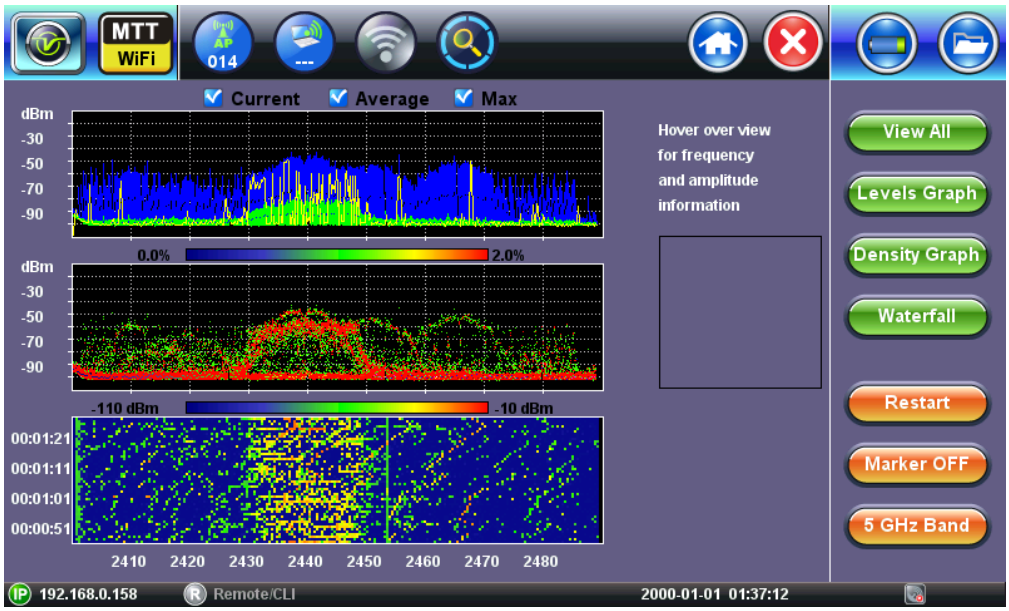


Figure 45: Spectrum Analyzer default view

10.2.1 Spectrum Analyzer Default View Function Keys

The function keys are located on the right hand side of the screen and allow access to advanced functions.

- **View All**: Switches the screen view to display all 3 spectrum analyzer views on a single screen (Levels Graph, Density Graph, Waterfall).
- **Levels Graph**: Switches the screen view to display the Levels Graph (see 10.3 Levels Graph).
- **Density Graph**: Switches the screen view to display the Density Graph (see 10.4 Density Graph).
- **Waterfall**: Switches the screen view to display the Waterfall view (see 10.5 Waterfall Graph).

- **Restart:** Clears all previous measurements and restarts the spectrum measurement.

- **Marker ON** or **OFF**: Toggle function key to enable/disable the Marker function.
- **5 GHz Band** or **2.4 GHz Band**: Toggle function key to switch between monitoring the 5 GHz frequency band and 2.4 GHz frequency band.

10.2.2 Using the Marker Function

The Marker ON/OFF Toggle function key is used to enable/disable the Marker function.
When enabled, the Marker allows the user to tap on any of the graphs and display the corresponding measurements.

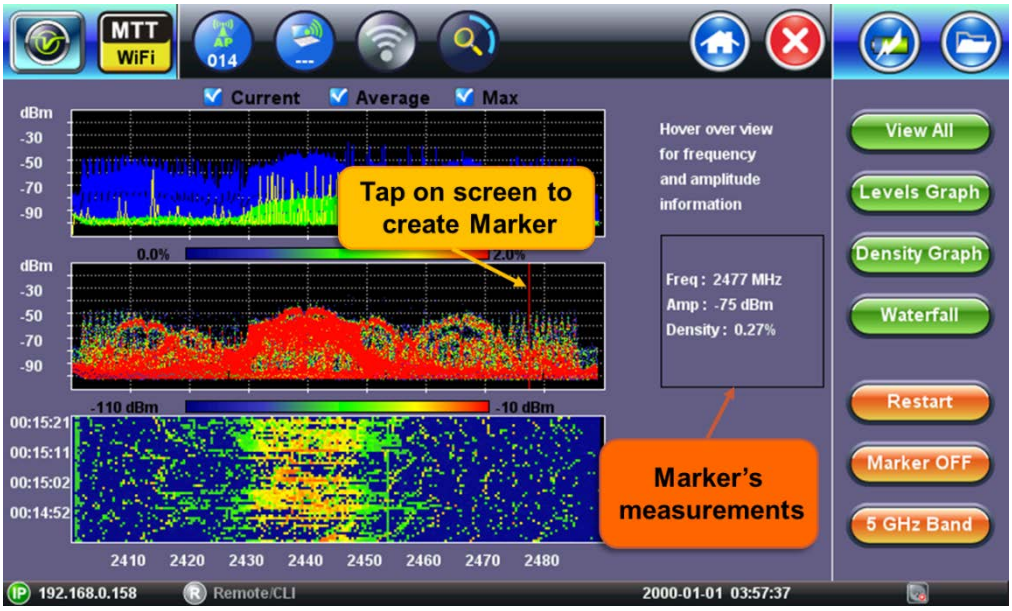


Figure 46: Marker enabled

10.3 Levels Graph

The Levels Graph displays the current, average, and maximum signal amplitude for each of the frequencies under test.

- The x-axis displays the WiFi channel number. In the 2.4 GHz frequency band, channels 1 to 13 are displayed; in the 5 GHz frequency band, channels 36 to 165. For more information on WiFi channels refer to Appendix A: 2.4 GHz and 5 GHz Technology Overview.
- The y-axis displays the signal's strength in dBm from -100 dBm to -10 dBm.
- By default, the current (yellow), average (green) and maximum (blue) signal levels are displayed simultaneously. Use the checkboxes (Current, Average, and Max) to add or remove level measurements from the views.
- Use the Marker function (see 10.2.2 Using the Marker Function) to view the level values for the frequency.
- Use the Show AP function (see 10.3.1 Using the Show AP Function) to view the AP scan information overlaid on the spectrum graph.

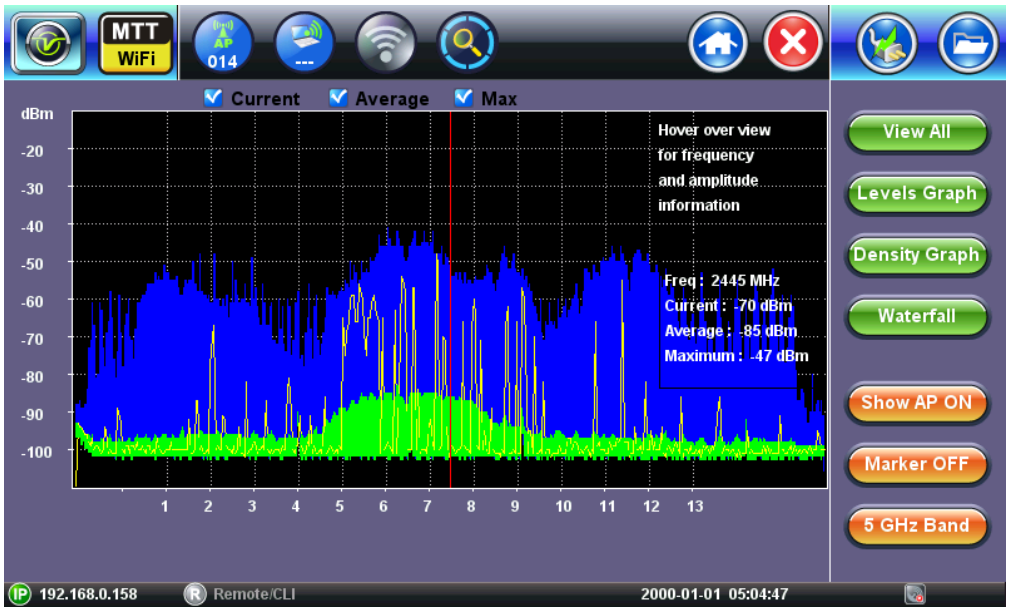


Figure 47: Spectrum Analyzer Levels Graph

The screen below is an example of the Levels graph showing only average signal level measurement.

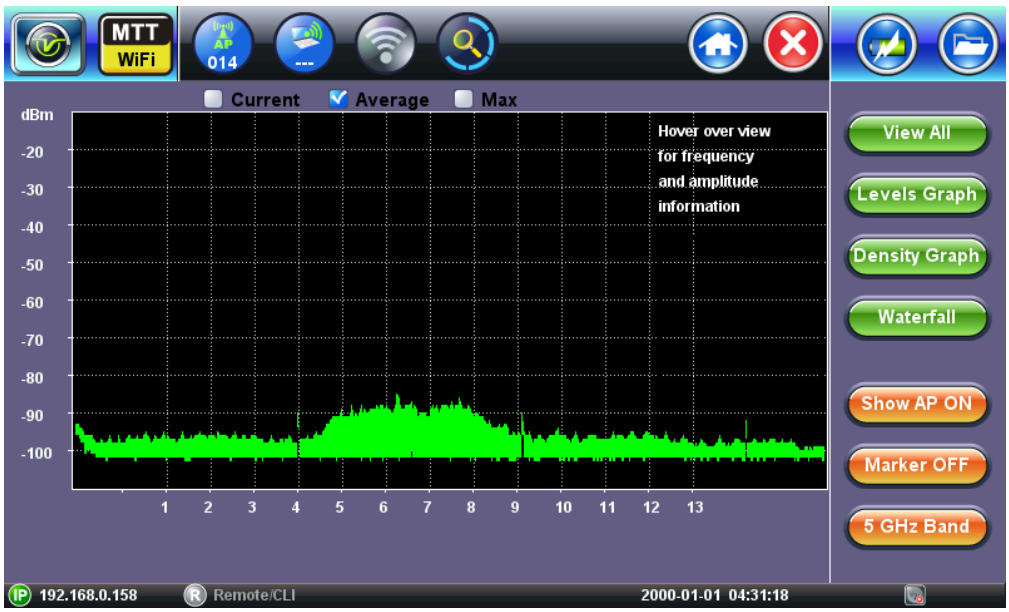


Figure 48: Level Graph Average Signal Level

10.3.1 Using the Show AP Function

The Show AP ON/OFF toggle function key is available in the Levels Graph and Density Graph views.

When enabling this function, the AP scan graph (8.3 AP Graph) information is overlaid on the spectrum graph. Information about the SSIDs detected in the scan function using beacon frames information is displayed on the spectrum. This allows users to compare WiFi network information (from the Scan function) with spectrum information, which facilitates identifying WiFi vs. non WiFi interference sources.

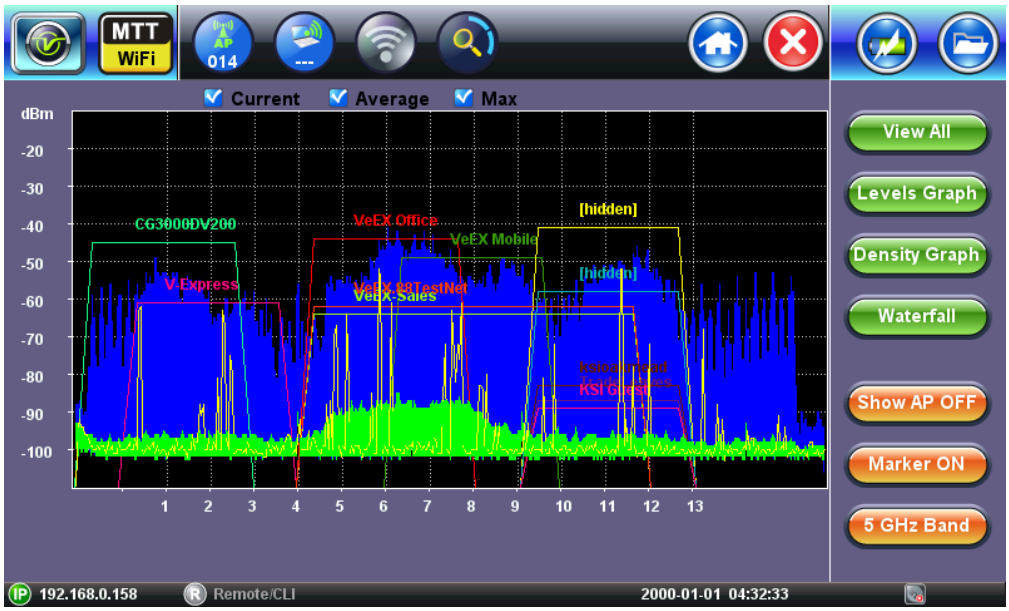


Figure 49: Spectrum Analyzer Levels Graph with AP overlay

10.4 Density Graph

The Density Graph displays the RF signal amplitude and utilization for each of the frequencies under test.

- The x-axis displays the WiFi channel number. In the 2.4 GHz frequency band: channels 1 to 13. In the 5 GHz frequency band: channels 36 to 165. For more information on WiFi channels refer to Appendix A: 2.4 GHz and 5 GHz Technology Overview.
- The y-axis displays the signal's strength in dBm from -100 dBm to -10 dBm.
- The graph's color indicates the utilization % (i.e. how often RF signals are detected) for each frequency.
    - Blue color data points indicate very low utilization
    - Green color data points indicate low utilization
    - Yellow color data points indicate moderate utilization
    - Red color data points indicate high utilization
- Use the Marker function (10.2.2 Using the Marker Function) to view the level and utilization values for the frequency.
- Use the Show AP function (10.3.1 Using the Show AP Function) to view the AP scan information overlaid on the spectrum graph.
- Use the Signature function (10.4.1 Using the Signature Function) to identify interferers' signatures.

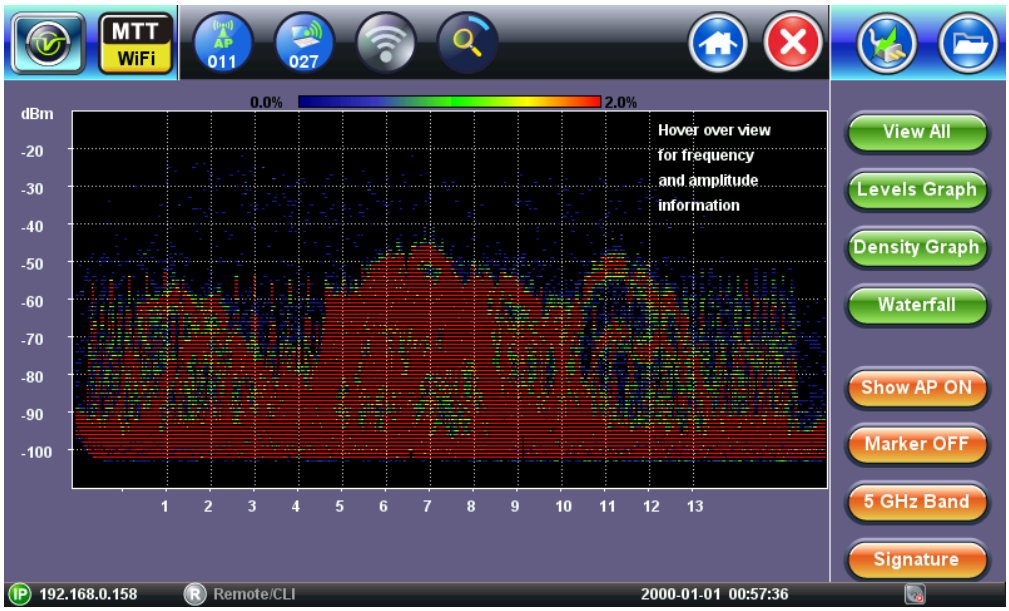


Figure 50: Spectrum Density Graph

10.4.1 Using the Signature Function

WiFi and non-WiFi sources of RF signal in the 2.4 GHz and 5 GHz frequency bands emit a spectrum that is often recognizable by its shape. This shape is called a “signature”. By recognizing a signature on the density spectrum, users can identify the device type source of interference.

The MTTplus-900 has a library of standard WiFi and non-WiFi signature shapes that are accessible through the Signature function key

available in the Density Graph view.

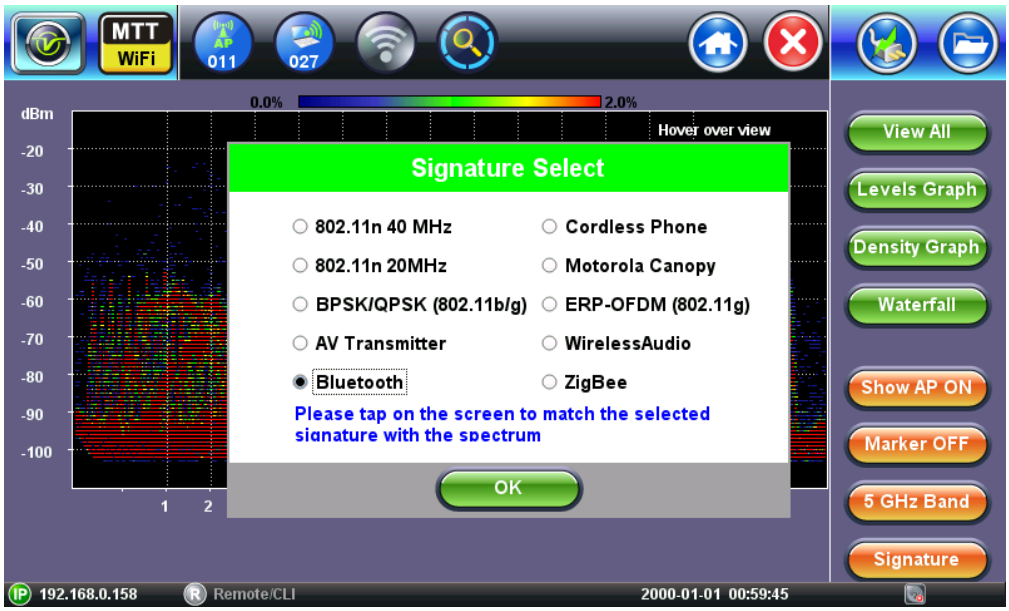


Figure 51: Interference Signatures Library

To use this function:

1. Select a suspected source of interference from the list and press **OK**

2. Tap on the density view graph over the suspected frequency range. The green signature shape appears in any area that is tapped.

3. If the signature's shape matches the interference, then the source of interference has been identified. If the signature's shape does not match the interference, select another device type from the signature's list and repeat the operation.

Note that the height (amplitude) of the signature's shape should not be taken into account when making the selection, as it only reflects the strength, i.e. proximity to the interference source.

For descriptions of common interference sources refer to 10.4.2 Common WiFi Interferers.

The following figure shows a Bluetooth interference signature overlaid on the density spectrum.

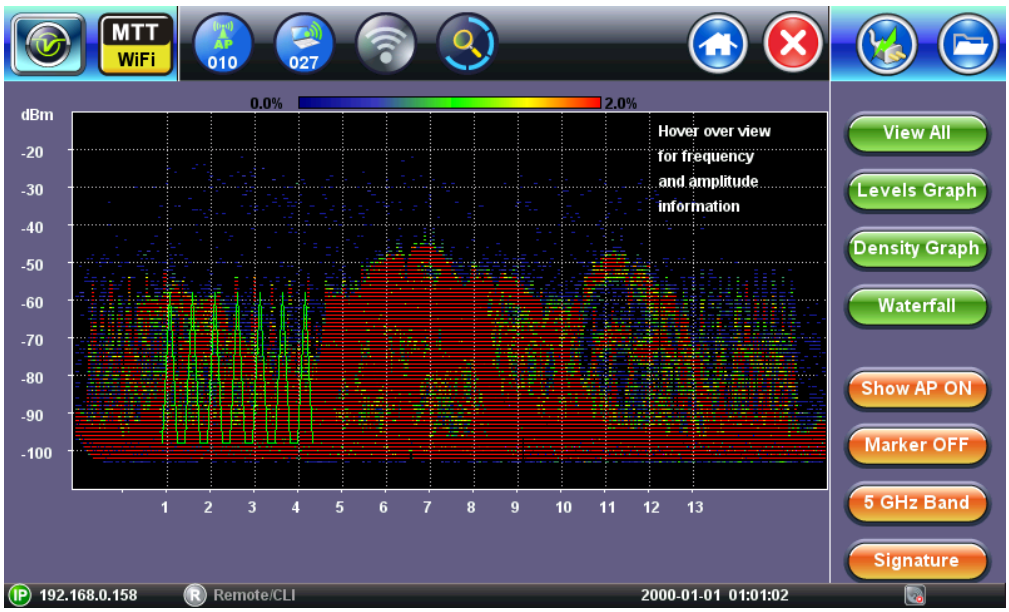


Figure 52: Bluetooth Interference with Density Graph

10.4.2 Common WiFi Interferers

The following common WiFi or non-WiFi interference sources are available in the Signature Library:

- **802.11n 20 MHz**
  802.11n devices with channel width of 20 MHz are present in the 2.4 GHz and 5 GHz frequency bands. Their shape is characterized by a flat top extending by 10 MHz on each side the center channel's frequency. Note that 802.11ac devices have the same shape, but can only operate in the 5 GHz frequency band.

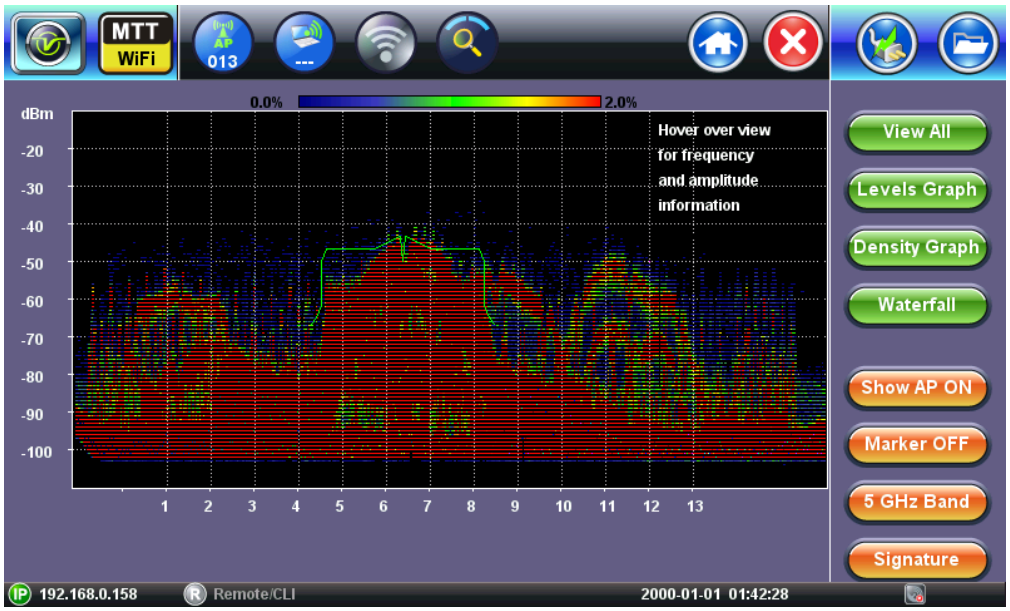


Figure 53: 802.11n 20 MHz Signature

- **802.11n 40 MHz**
  802.11n devices with channel width of 20 MHz are present in the 2.4 GHz and 5 GHz frequency bands. Their shape is characterized by a flat top extending by 20 MHz on each side the center channel's frequency. Note that 802.11ac devices have the same shape, but can only operate in the 5 GHz frequency band.

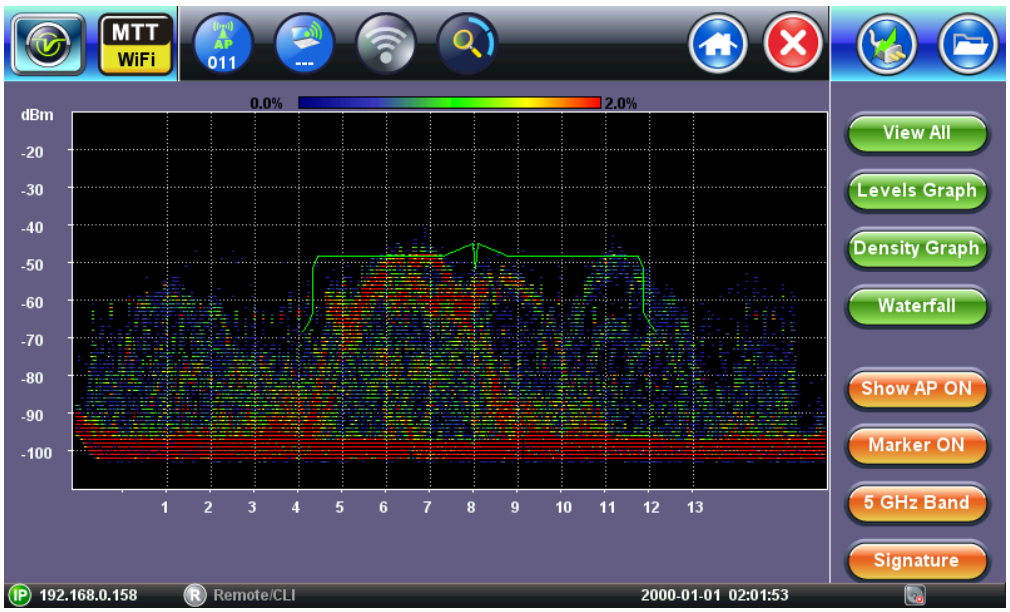


Figure 54: 802.11n 40 MHz Signature

- **BPSK/QPSK (802.11b/g)**
  802.11b/g devices using older technology of BPSK/QPSK are present only in the 2.4 GHz frequency band. Their shape is characterized by a rounded top with a total channel width of 22 MHz.

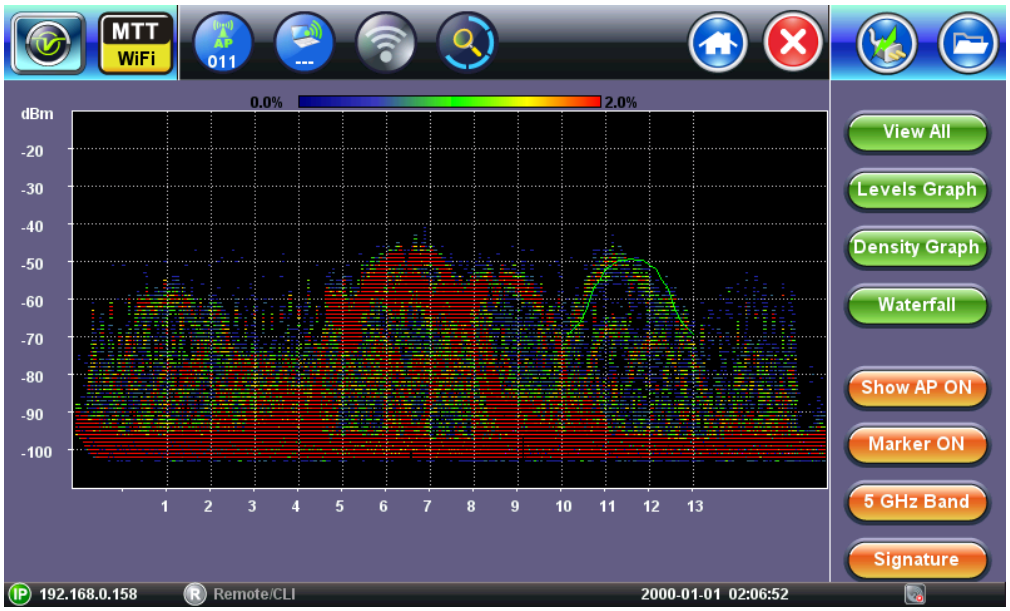


Figure 55: 802.11n/g BPSK/QPSK Signature

- **AV Transmitter**
  Non-WiFi Audio Video transmitters, typically used by security cameras create a spike like interference in the 2.4 GHz frequency band.

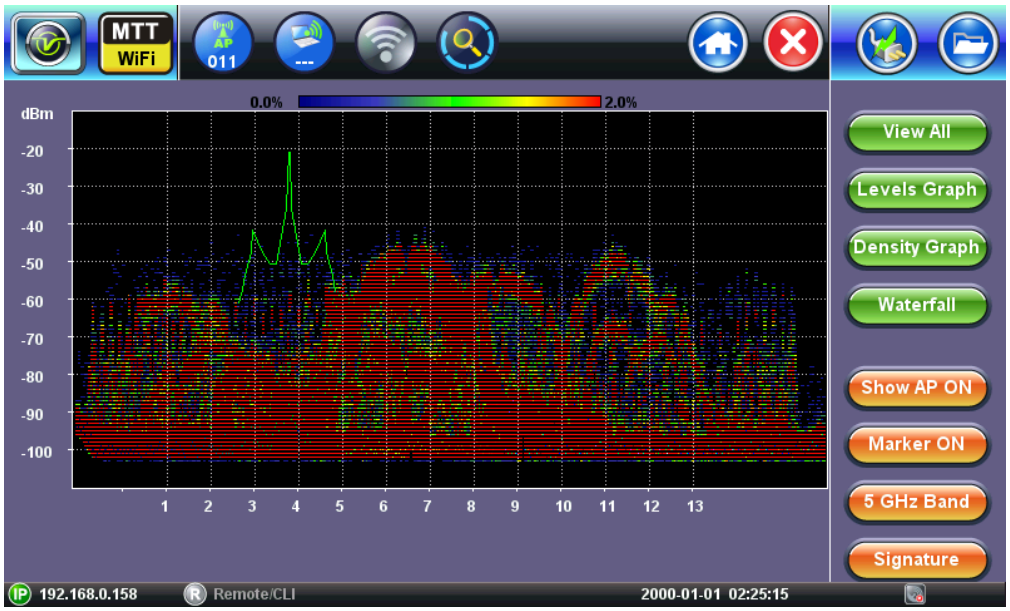


Figure 56: AV transmitter Signature

- **Bluetooth**
  Bluetooth devices are frequency hopping across the 2.4 GHz frequency band. Their signature appears as a series of peaks across the spectrum.

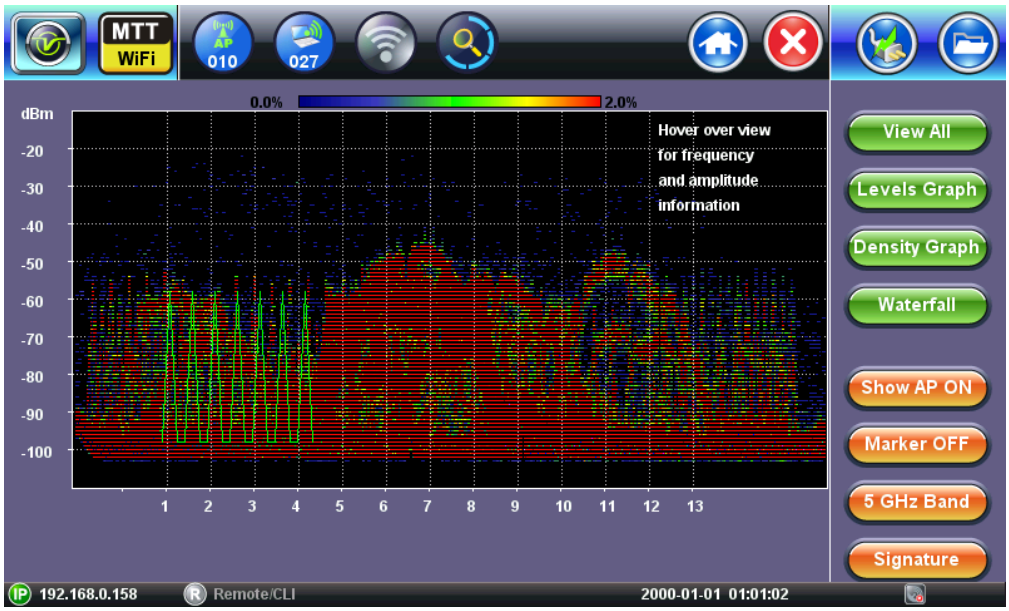


Figure 57: Bluetooth Signature

- **Cordless Phone**
  Cordless phones can operate in the 2.4 GHz frequency band. Some cordless phones will use frequency hopping over the frequency band, switching frequency many times per second. Others will transmit over a single frequency with a width of about 2 MHz, but use a new frequency at each use. Generally cordless phones are disruptive because they emit with high power.

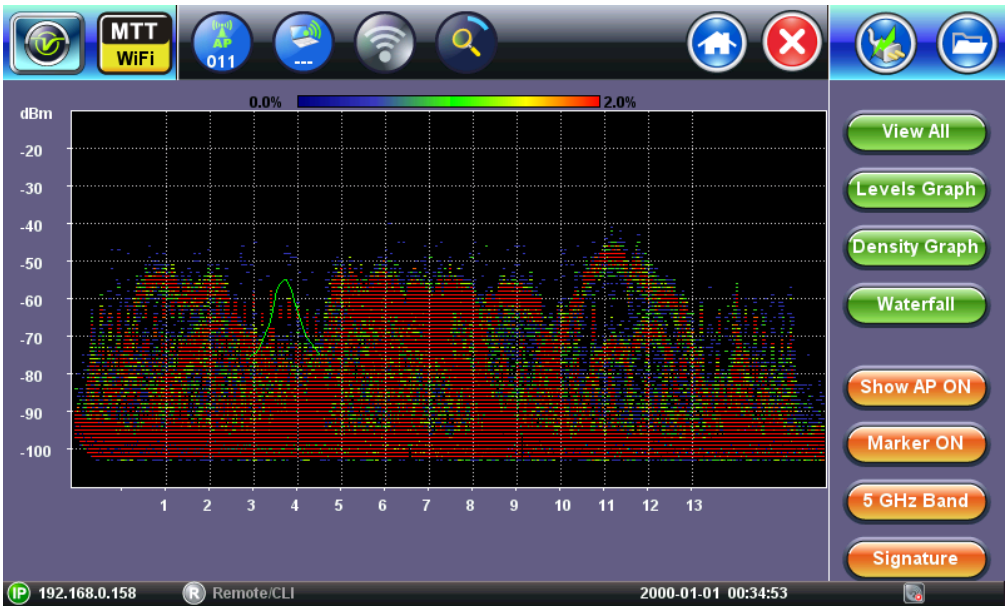


Figure 58: Cordless Phone Signature

- **Motorola Canopy**
  Proprietary Motorola wireless communication systems can operate in the 2.4 GHz and 5 GHz frequency band.

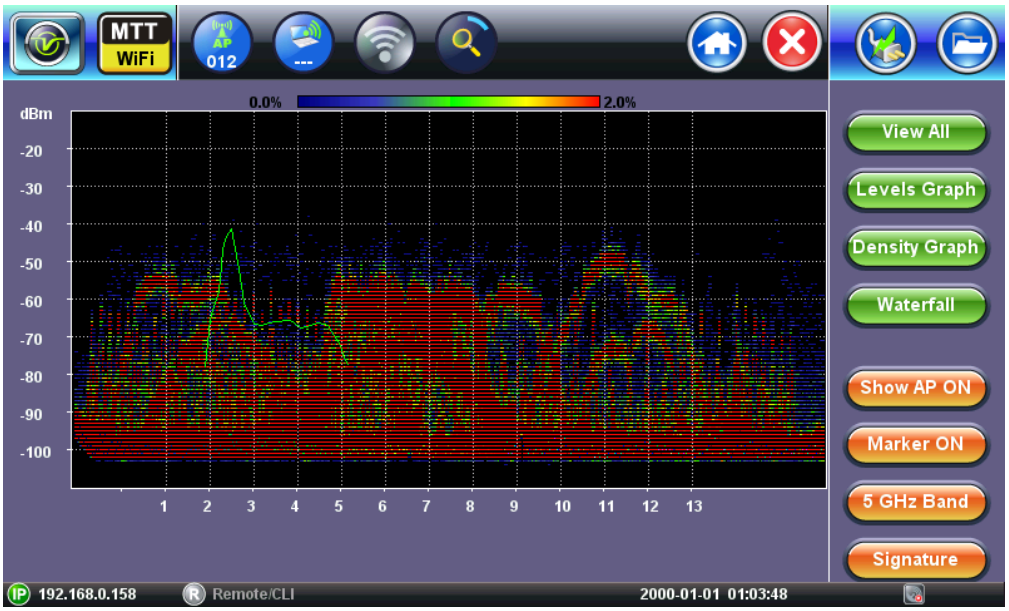


Figure 59: Motorola Canopy Signature

- **ERP-OFDM (802.11g)**
  802.11g ERP-OFDM spectrum signature looks very similar to 802.11n or 802.11ac spectrum but only operates in the 2.4 GHz frequency band and uses only 20 MHz channel width.

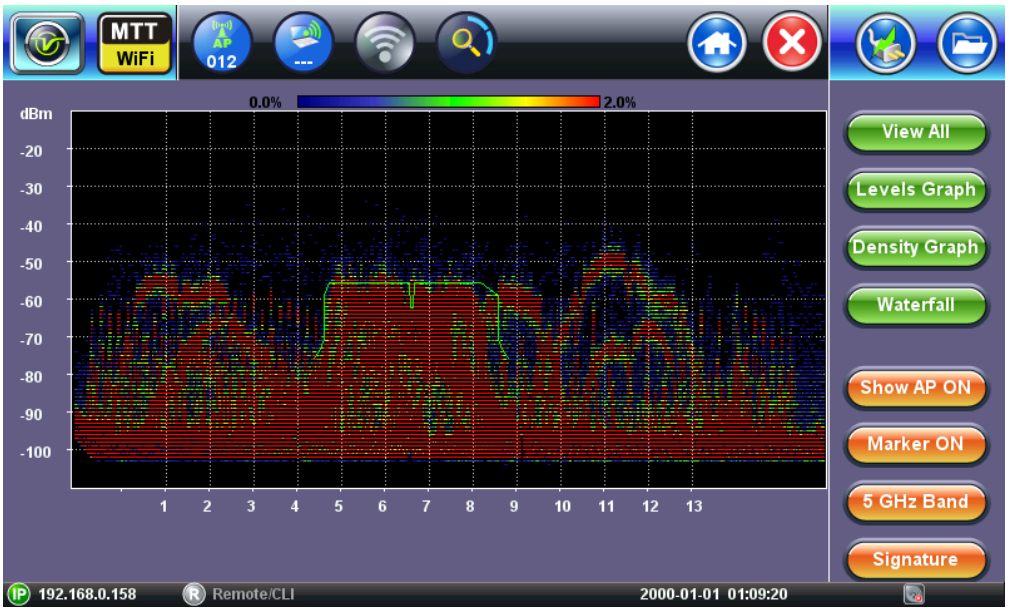


Figure 60: ERP-OFDM (802.11g)

- **Wireless Audio**
  Wireless audio systems transmit audio to remote speakers using the 2.4 GHz frequency band with a spectral width of 10 MHz.

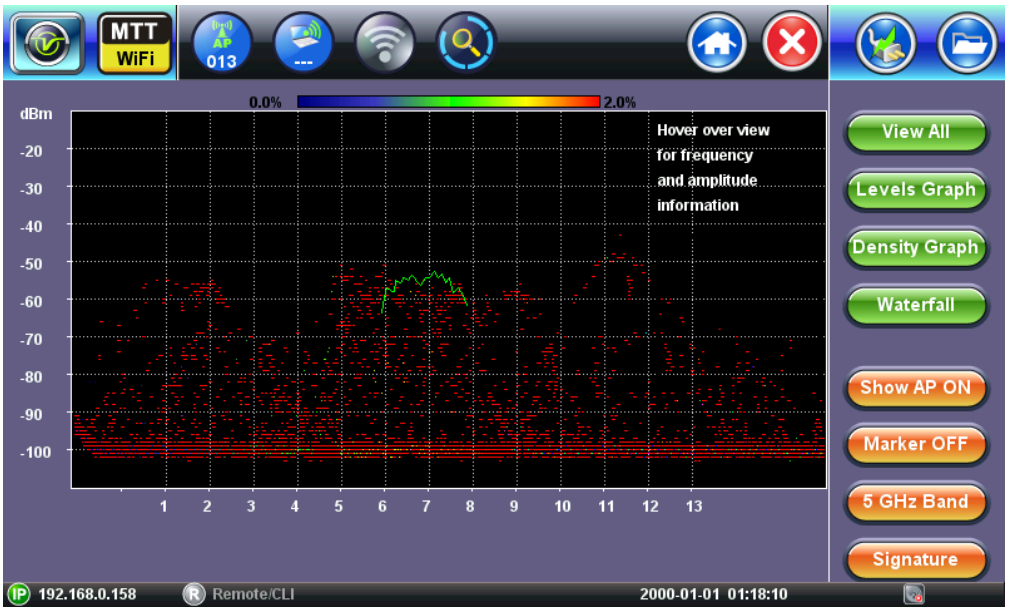


Figure 61: Wireless Audio Signature

- **ZigBee**
  ZigBee PAN (Personal Area Network) communication protocol is based on standard IEEE 802.15.4. It is used for low-power and low-bandwidth uses, often used in home automation, industrial, or medical devices. It operates in the 2.4 GHz frequency band with a spectrum width of 5 MHz.

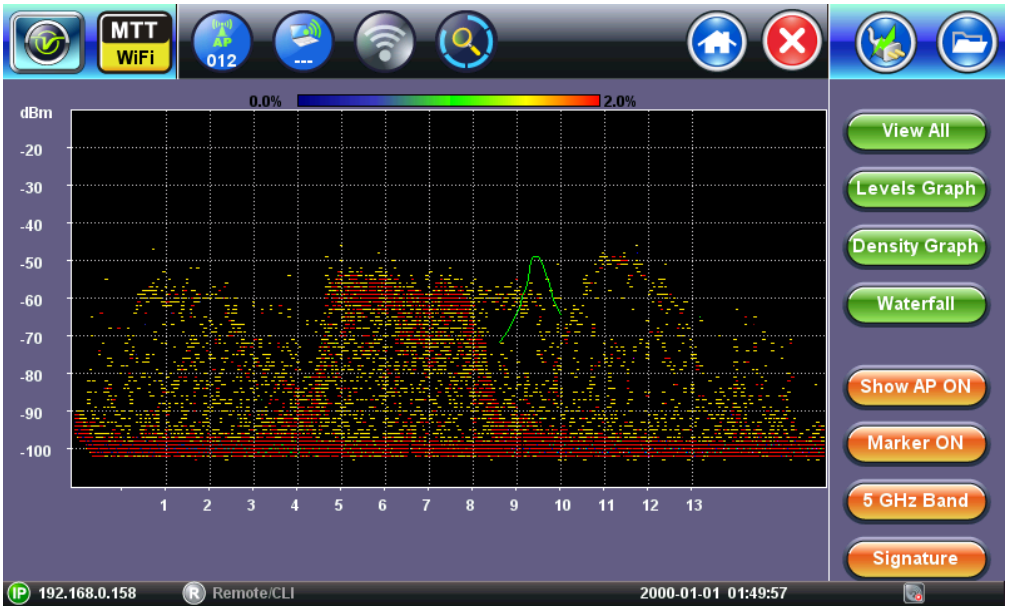


Figure 62 ZigBee Signature

10.5 Waterfall Graph

The Waterfall View displays the frequency spectrum over time for the frequencies in the 2.4 GHz and the 5 GHz frequency bands. The color scale represents the signal strength. The waterfall view is particularly useful to detect intermittent interference or interference where frequency changes over time (hopping).

- The x-axis displays the WiFi channel number. In the 2.4 GHz frequency band: channels 1 to 13. In the 5 GHz frequency band: channels 36 to 165. For more information on WiFi channels refer to section Appendix A: 2.4 GHz and 5 GHz Technology Overview.
- The y-axis displays the timestamp. The screen displays 2 minutes of spectrum.
- The signal's strength is indicated by the color.
    - Blue color data points indicate very low signal level.
    - Green color data points indicate low signal level.
    - Yellow color data points indicate moderate signal level.
    - Red color data points indicate high signal level.
- Use the Marker function (10.2.2 Using the Marker Function) to view the level values for the frequency.

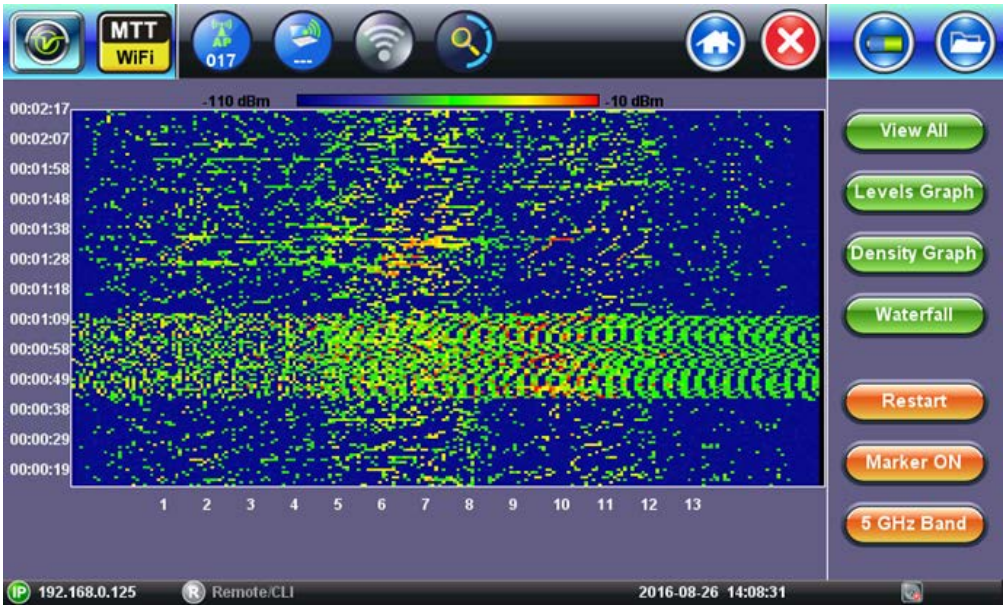


Figure 63: WiFi Spectrum Analyzer Waterfall View

11.0 IP Connect menu

Use the IP Connect icon

from the home menu to access the IP Connect menu. The IP Connect menu displays the results of the network scan. After selecting and connecting to an AP, Ping test, Trace Route test and ARPWiz function are available.

11.1 AP Scan Table

- AP Scan Table displays discovered WiFi Access Points. Results are added while the network scan is running.
- For information about the AP Scan table refer to 8.1 AP Scan Table.

Figure 64: AP Scan Table in IP connect menu

11.1.1 AP Scan Table Navigation

Refer to section 8.1.1 AP Scan Table Navigation for information on how to navigate, sort, and select table features.

11.1.2 AP Scan Table Function Keys

The function keys are located on the right hand side of the screen and allow access to advanced functions. Different function keys are available depending on whether the network scan is running.

Function Keys displayed while the network scan is running:

- **Stop Scan**: Stops ongoing network scan. AP Scan table, Graph and Channel View results are no longer updated.

- **Details**: Opens up a pop-up window with additional details for the currently selected SSID (see 8.1.4 AP Scan Details Window)

Start Scan and Connect AP function keys become available when the network scan is stopped:

- **Start Scan**: Clears the previous network scan results and starts a new network scan.
- **Connect AP**: Opens up a pop-up menu for connection to the currently selected SSID (see 11.2 Connect AP).

11.2 Connect AP

The Connect AP function allows the MTTplus-900 to associate to the selected SSID. The supported encryption types are: None (No encryption), WEP, WPA and WPA2. If the encryption type requires a password, a password should be entered prior to pressing the **Connect** key

.

11.2.1 Connect AP Configuration

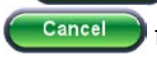
Figure 65: AP Connect configuration screen

- **Profile:** Select connection configuration from an existing profile or save your configuration to a new profile.
- **ESSID:** Service Set Identifier advertised by the Access Point. The SSID is the logical name used to identify the network. SSID is configured by the network manager. Occasionally network managers prefer to hide the AP's SSID for security reasons. In that case, a blank SSID name or *[hidden]* are displayed instead.

- **BSSID**: Basic Service Set Identifier for the AP. The BSSID is a 48-bit unique MAC address of the AP's network interface.
- **Encryption Type:** Automatically detected security encryption type supported by the AP. The supported encryption types are: None (No encryption), WEP, WPA and WPA2.
- **Password**: Tap on the field to edit the WiFi password. The WiFi password will be displayed in clear text on the user interface unless Show Password is set to *OFF* in Setup. In that case, the password will be hidden. Refer to 6.2 WiFi Measurement Setup for configuration.

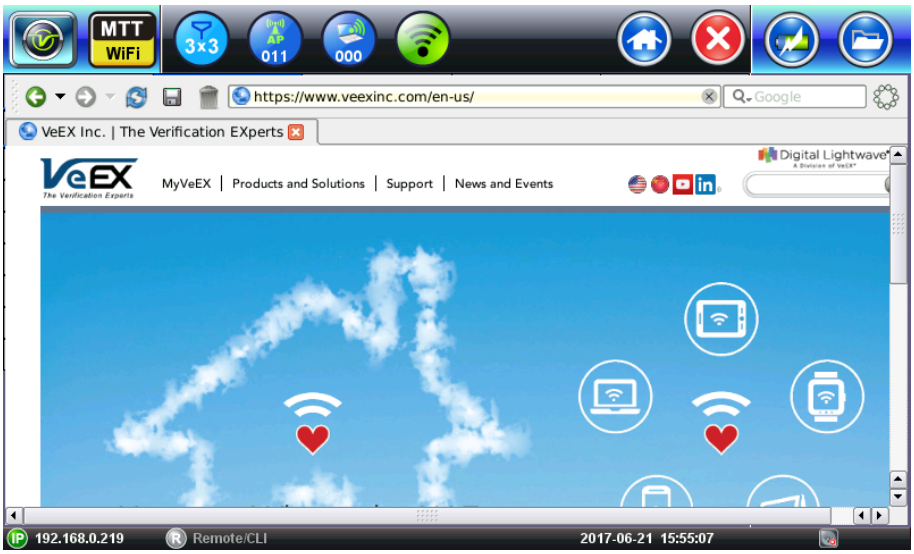
Press **Connect**

to start the connection process to the selected AP.

Press **Cancel** 

to cancel operation and return to previous screen.

- **Captive Portal login**: If connectivity requires a Captive portal login, the unit will automatically detect the captive portal and load the web browser. User can enter further credentials on the web page to gain access to the Internet.



11.2.2 AP Connection Status

The AP connection table's first column displays the status of the connection to the AP and the configuration profile status.

Figure 66: AP Connect profile icons

The following status can be displayed:

This icon indicates that the connection credentials for the AP are saved to a profile.

This icon indicates that the connection credentials for the AP are not saved to a profile.

This icon indicates that the AP authentication/association is successful, but no IP address has been assigned to the test set.

This icon indicates that the AP authentication/association is successful and an IP address has been assigned to the test set.

This icon indicates that the AP authentication/association is not successful or the IP address assigned has failed.

11.2.3 AP Connection: Authentication and Association

After pressing **Connect**

the test set will attempt to authenticate and associate with the SSID under test using the credentials entered on the connection screen. This step ensures that the test set, acting as a WiFi client, becomes a member of the BSS (Basic Service Set).

Figure 67: Connection Status: Successful Association

Successful Authentication

In the event of a successful authentication and association, the Connection Status screen displays the following information:

- **Connection Status**: “Associated.” Indicates the test set acting as a WiFi client has successfully authenticated and associated to the SSID under test.
- **ESSID**: Service Set Identifier advertised by the Access Point. The SSID is the logical name used to identify the network. SSID is configured by the network manager. Occasionally network managers prefer to hide the AP’s SSID for security reasons. In that case, a blank SSID name or “[hidden]” are displayed instead.
- **BSSID:** Basic Service Set Identifier for the AP. The BSSID is a 48-bit unique MAC address of the AP’s network interface.
- **PHY:** 802.11 standard version supported by the SSID. 802.11 b, g, n operate on the 2.4 GHz frequency band. 802.11 a, n, ac operates on the 5GHz frequency band.
- **Max Rate:** Maximum Phy rate in Mbps supported by the SSID.
- **Channel:** Channel number used by the SSID. Channels 1 to 13 are in the 2.4 GHz band. Channels 36 to 165 are in the 5 GHz frequency band. If channel bonding is used with 40 MHz or 80 MHz channel width the sign “+” is displayed next to the main channel number. Open up the details screen to view additional channels.
- **Encryption:** SSID’s security protocol.
- **Signal:** Received Signal Level from the SSID measured in dBm. If Signal Level threshold is enabled in the Measurement setup menu, the color (**Green**/**Yellow**/**Red**) reflects the threshold crossing status.
- **Noise:** Noise Level measured on the channel in dBm. If Noise Level threshold is enabled in the Measurement setup menu, the color (**Green**/**Yellow**/**Red**) reflects the threshold crossing status.

Press the **OK** function key OK to close the Connection Status Window and proceed to the **Connect Net** key Connect Net to obtain an IP address (see 11.2.4 AP Connection: IP Connection).

Figure 68: Failed AP Connection

Unsuccessful Authentication

In the event of an unsuccessful authentication or association, the Connection Status screen displays the following information:

- **Connection Status**: A “Failed” status indicates the test set acting as a WiFi client has failed authentication or association to the SSID under test.

Press the **OK** function key to close the Connection Status Window or press the **More** key to obtain additional information on cause of failure.

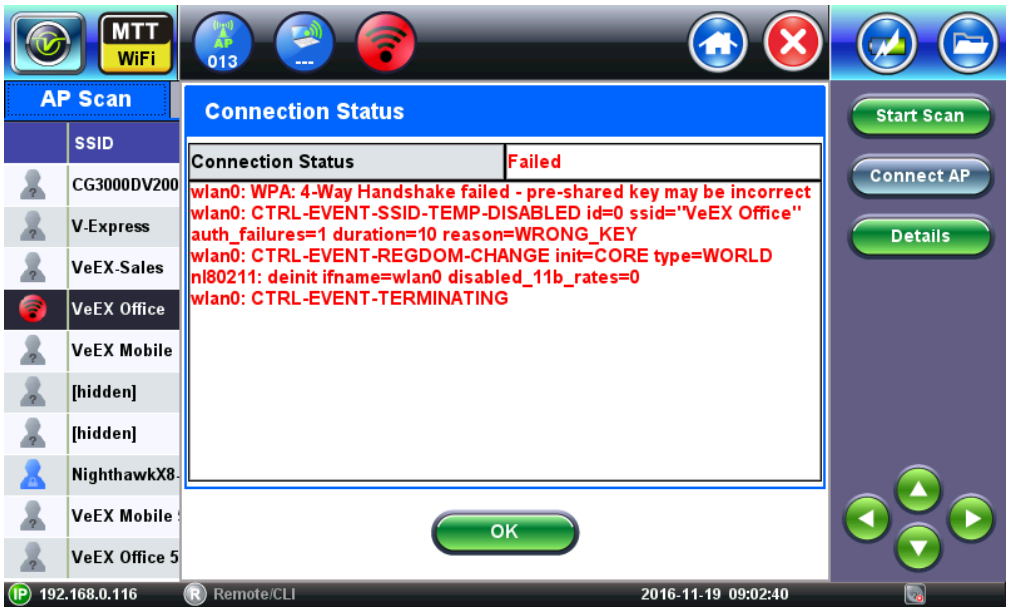


Figure 69: Failed AP connection details

Additional information in the Connection Status page provides details on causes of the failed requests.

In the example above, failure is due to the “Wrong Key” (wrong password).

11.2.4 AP Connection: IP Connection

After successful authentication and association (see 11.2.3 AP Connection: Authentication and Association), use the **Connect Net** function key

to obtain an IP address. By default DHCP connection is attempted.

To view or modify IP connection parameters, use the Network configuration tab (see 11.3 Network Configuration).

11.3 Network Configuration

After completing the successful authentication and association step (see 11.2.3 AP Connection: Authentication and Association), use the **Network** tab to set up the IP connection parameters.

Figure 70: Network DHCP Configuration

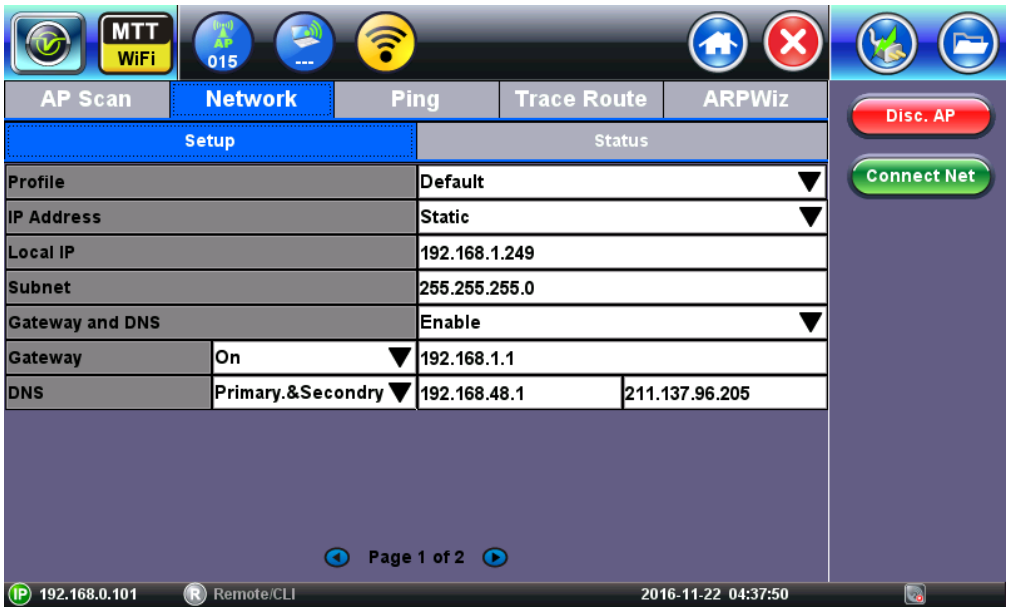


Figure 71: Network Static Configuration

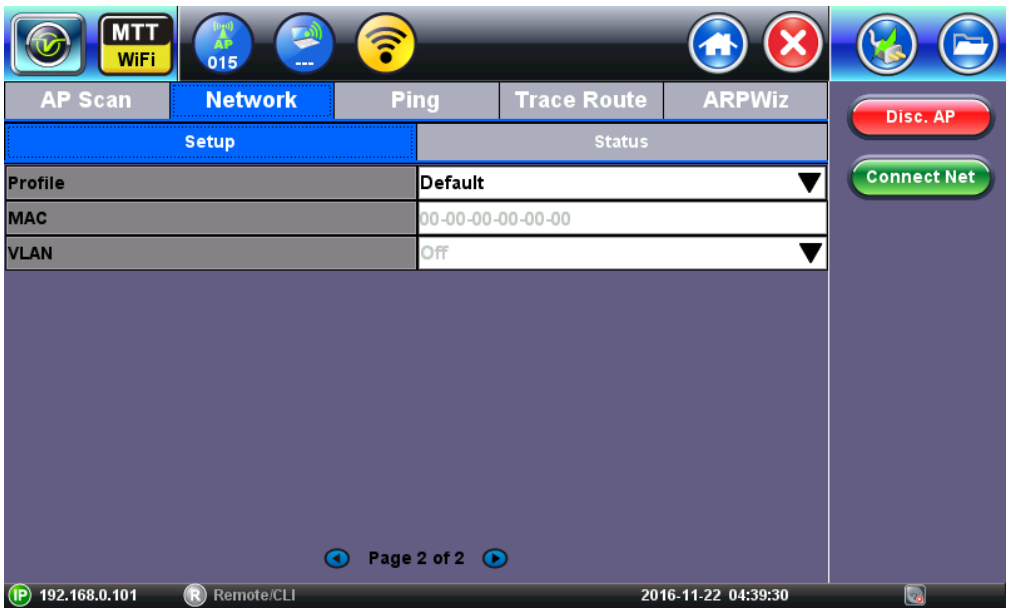


Figure 72: Network Configuration Page 2

The following parameters are configurable in the Network Setup menu:

- **Profile:** Select to save IP configuration as a Profile or use the default profile.
- **IP address:** Select from *Static* or *DHCP*. If Static is selected, the user will manually enter the IP address parameters (local IP, Gateway IP and DNS server IP). If DHCP is selected, the unit will obtain IP address parameters from the DHCP server.
- **Local IP:** IPv4 address of the test set.
- **Subnet:** Enter the subnet mask.
- **Gateway and DNS:** *Enable* or *Disable*. If set to enable, Gateway and DNS fields become available.

- **Gateway:** *Off* or *On*. IPv4 address of the network gateway.
- **DNS:** *Off*, *Primary*, or *Primary & Secondary*. If set to Primary or Primary & Secondary, a DNS IP is required in order to use the URL as a destination.
- **MAC:** Displays the MAC address of the WiFi interface. This field is not editable.
- **VLAN:** VLAN tagging is not enabled on the WiFi interface. This field is not editable.

11.4 Network Status

After successful authentication and association (see 11.2.3 AP Connection: Authentication and Association), use the **Connect Net** function key Connect Net to obtain an IP address.

The Network Status Page displays assigned IP address and network parameters.

Ensure the Status is “Successful” before continuing with any IP tests.

If the connection fails, go back to the setup screen to verify that the parameters are entered correctly.

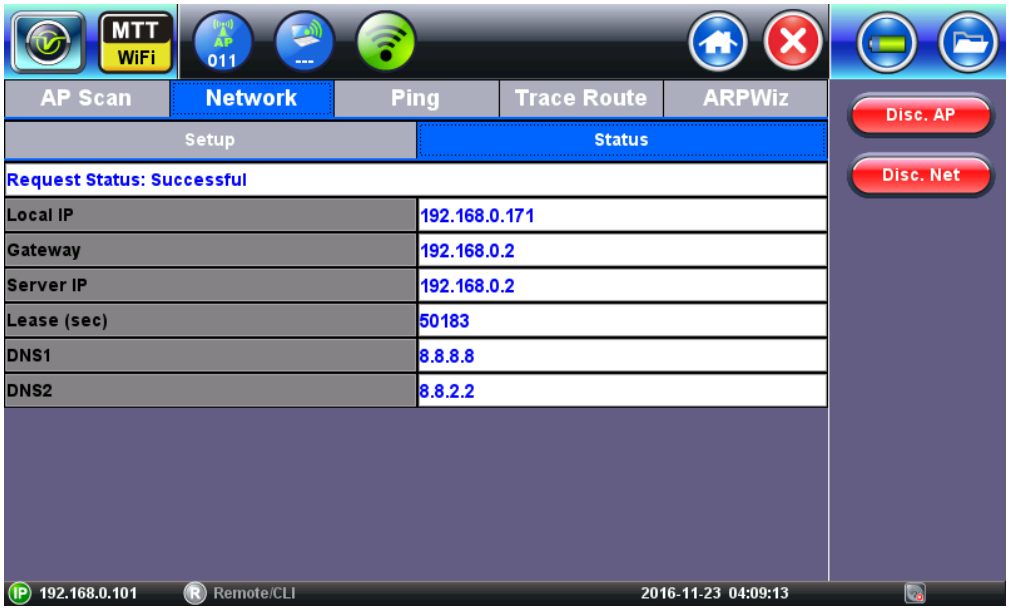


Figure 73: Network Status

Network Status Field Descriptions

- **Local IP:** Indicates that an IP address has successfully been assigned
- **Gateway:** Indicates the IP address of the network gateway
- **Server IP:** Indicates the IP address of the DHCP server
- **Lease (sec):** Indicates the lease duration that the IP address has been assigned by the DHCP server
- **DNS1:** Indicates the IP address of the Primary DNS server
- **DNS2:** Indicates the IP address of the Secondary DNS server

11.5 Ping

Ping is a popular computer network tool used to test whether a particular host is reachable across an IP network. A ping is performed by sending an echo request or ICMP (Internet Control Message Protocol) to the echo response replies.

11.5.1 Ping Setup

The following parameters can be set up for the Ping test:

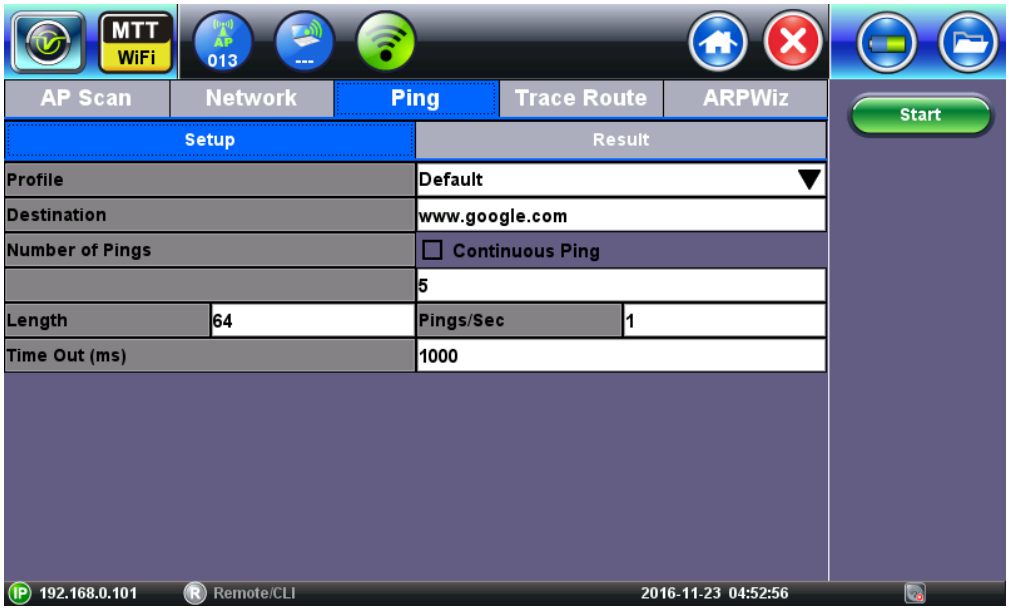


Figure 74: Ping Test Setup

- **Profile:** Save the Ping test configuration to a profile or use default settings.
- **Destination:** Enter the destination IP address or URL to ping.
- **Number of Pings:** Press the field and use the alphanumeric keypad to enter the number of ping attempts that will be performed to reach the network device.
- ***Note***: If **Continuous Ping** is selected, the user is not required to enter the number of pings. The test set will continuously ping the target host until the user presses **Stop**

.
- **Length:** Use the alphanumeric keypad to enter the length of the ICMP echo request packet transmitted.
- **Ping/Sec:** Use the alphanumeric keypad to enter the Ping repetition rate (Ping/second), up to 10 pings per second.
- **Time Out:** Time-to-Live (TTL) in milliseconds. Use the alphanumeric keypad to enter the maximum time allowed (in ms, up to 99999ms) between an ICMP ping and echo response.

Once the parameters are configured, press **Start**

to begin the test.

11.5.2 Ping Result

Pressing **Start**

will take you to the **Result** tab and start the Ping test. The following results are displayed for the Ping test:

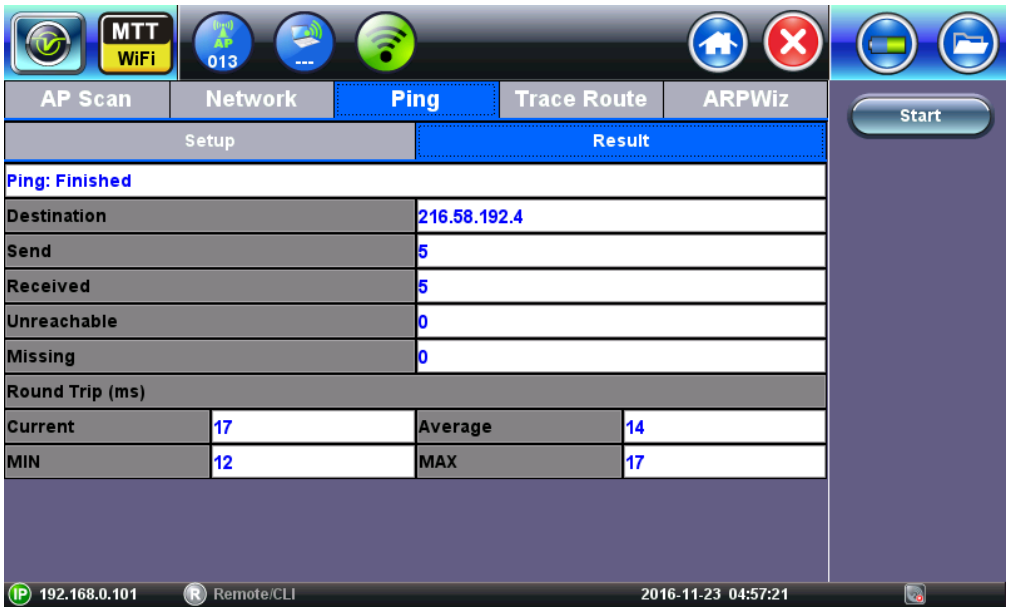


Figure 75: Ping Test Results

- **Ping status:** In Progress, Finished, Destination unreachable, or Fail.
- **Destination:** Indicates the destination IP address.
- **Sent, Received, Unreached, Missing:** Number of pings sent, received, unreached or missing. A Ping is counted missing if no response is received before timeout. A ping is counted unreached if an echo response is received with host unreachable set.

PING also estimates the round-trip time in milliseconds:

- **Current:** The current time for a ping request to be answered.
- **Average:** The average time recorded for a ping request to be answered.
- **Max:** The maximum time recorded for a ping request to be answered.
- **Min:** The minimum time recorded for a ping request to be answered.

11.6 Trace Route

Trace Route is a common method used to find the route to the destination IP address or URL. It is often used to identify routing problems and unreachable destinations. All the remote IP addresses and their response times are displayed indicating possible network congestion points.

11.6.1 Trace Route Setup

The following parameters can be setup for the trace route test:

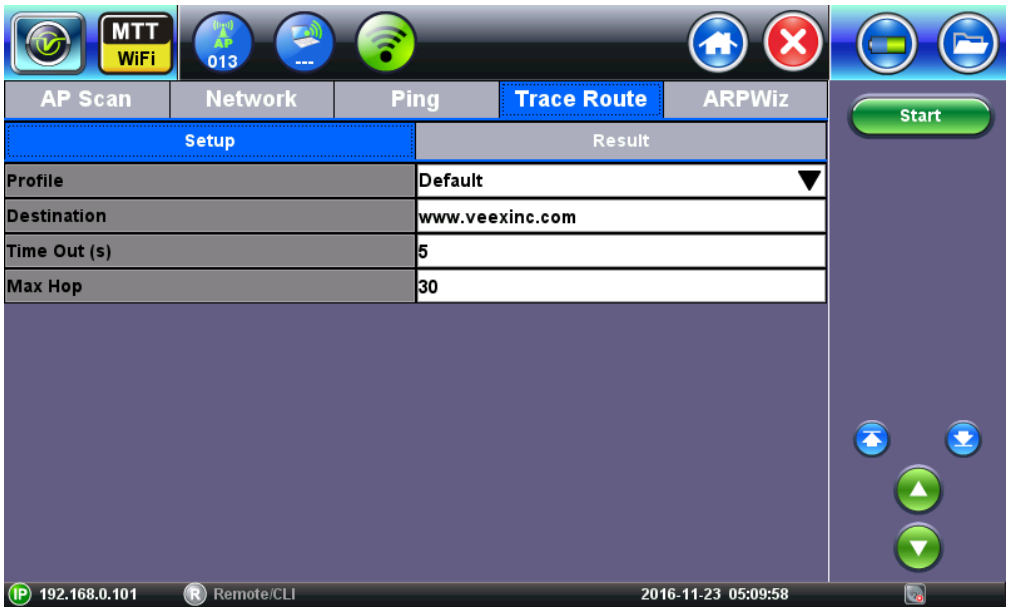


Figure 76: Trace Route Setup

- **Profile:** *Delete*, *Save*, *Save as...*, *Default*. Select Default to recall a trace route file or create a new test.
- **Destination:** Enter the IP address or URL of the network device to be detected.
- **Time Out:** Enter the maximum time allowed between an ICMP echo and response at each hop.
- **Max Hop:** Enter the maximum number of network devices the packet is allowed to transit.

Once the parameters are configured, press **Start**

to begin the test.

11.6.2 Trace Route Result

Pressing **Start**

will take you to the **Result** tab and start the Trace Route test. The following results are displayed for the Trace Route test:

Figure 77: Trace Route Results

- **Hop:** Order of the routers on the route
- **TTL(ms):** Time to reach each router on the route
- **Address:** Address of each router on the route
- **Note**: If there is no response from a particular hop, an asterisk will be displayed

11.7 ARPWiz

ARPWiz verifies the status of each IP address in the user selected range by using ARP (Address Resolution Protocol).

11.7.1 ARPWiz Setup

The following parameters can be setup for the ARPWiz test:

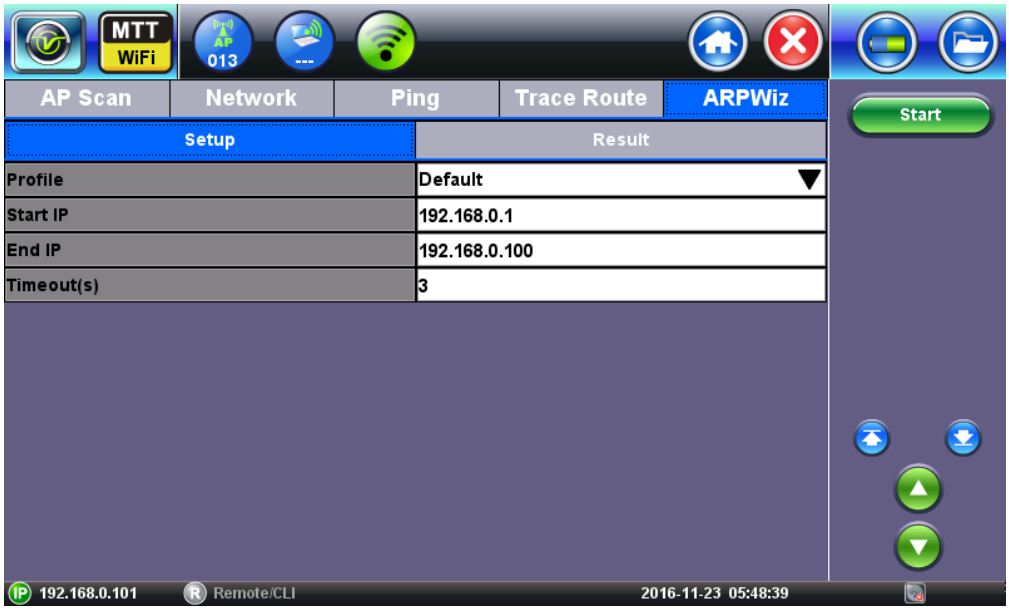


Figure 78: ARPWiz Setup

- **Profile:** Drop-down selections are *Default*, *Delete*, *Save*, *Save As...*
- **Begin IP:** Set the start address for the desired IP range using the numeric keypad
- **End IP:** Set the end address for the desired IP range using the numeric keypad
- **Timeout(s):** Timeout duration for the ARP response

Once the parameters are configured, press **Start**

to begin the test.

11.7.2 ARPWiz Result

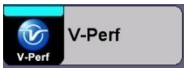
Pressing **Start**

will take you to the **Result** tab and start the ARPWiz test. The following results are displayed for the ARPWiz test:

Figure 79: ARPWiz Result

- **Destination Address:** IP address responding to ARP message
- **Response Time (ms):** Time for ARP response message
- **MAC Address:** MAC (Hardware) address of the device responding to ARP message
- **Note**: If there is no response from a particular IP address, it is omitted from the table

12.0 V-Perf

Use the V-Perf icon 

from the home menu to access the V-Perf menu.

Note that the Air Expert needs to be connected to an AP and network before accessing the V-Perf menu (see 11.0 IP Connect). The V-Perf test is a dual ended Layer 4 throughput performance test. It uses TCP or UDP traffic to evaluate upload/download performance on the air interface.

V-Perf dual-ended test is compatible with iPerf3 servers and MTTplus-900 Air Expert or companion V-Probe responders, connected directly on Ethernet port on the back of the AP/Router to perform WiFi to Ethernet data throughput tests. The test can also be performed to a cloud-based server, qualifying WiFi and Broadband access bandwidth in one step.

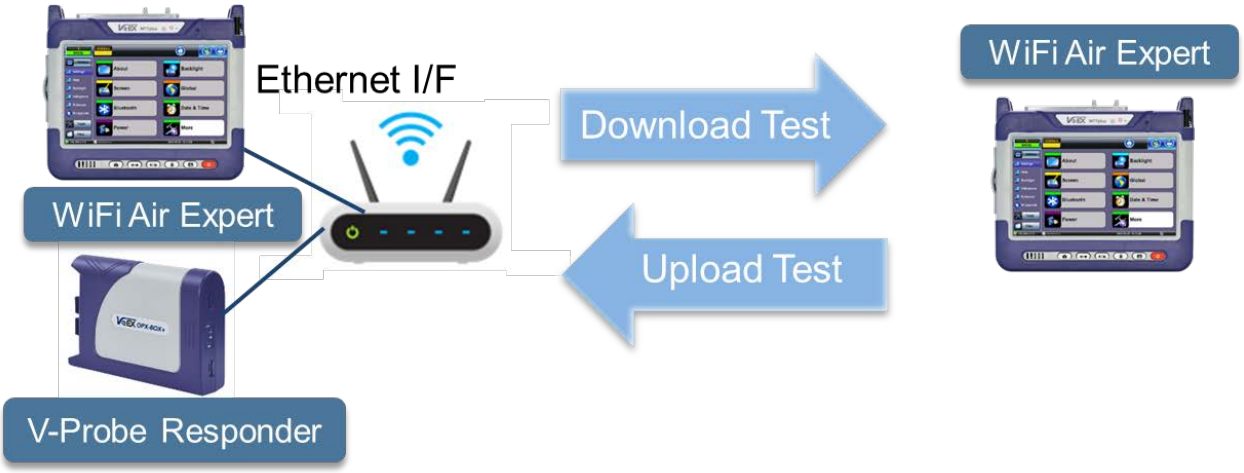


Figure 80: V-Perf Test

V-Perf is a dual ended throughput test that validates whether TCP/UDP parameters in the network are set up correctly. Test traffic is generated between a unit acting as a server and a unit acting as a client. As shown in *Figure 80: V-Perf Test*, a unit acting as a server should be connected on the wired Ethernet network, preferably directly to the Access Point. A unit acting as a client should be connected on the WiFi interface. Throughput performance is then tested in the client to server direction (Upload Test) and in the server to client direction (Download Test). If throughput performance is poor, the test can help identify possible issues. Once this is verified, other tools such as Spectrum Analyzer should be used in conjunction to identify if there is any interference, signal degradation, noise, or any other issues.

12.1 V-Perf Configuration Settings

For V-Perf configuration on the Ethernet Interface refer to 15.0 Ethernet V-Perf.

Figure 81: V-Perf Client Setup

- **Profile:** Save the V-Perf test setup in a new test profile or recall an existing test profile. The *Default* test profile brings back the Air Expert's default test settings. The *Last configuration* profile is used at boot up.
- **Auto Save:** Enable or Disable the unit from automatically saving V-Perf test results.
- **V-Perf Mode:** From the drop-down menu, select *Client* or *Server*. In Server mode, the unit accepts incoming client test connections. In Client mode, the unit initiates a test connection to the server. The client unit controls test parameters like protocol type, test direction, and duration. At the end of the test, client and server units exchange test results, available on both units. The WiFi unit is configured as a client by default.
- **Server IP:** Enter the Server's IP address.
- **Server Port**: Enter the Server's Port number (defaults to 5201).
- **Protocol**: From the drop-down menu, select *TCP* or *UDP*. The TCP protocol provides reliable packet delivery with sequence number and acknowledgement. TCP will request frame retransmission and adapt its throughput to ensure that there is no packet loss. The TCP protocol is used by applications that require reliability such as FTP. The UDP protocol is a connectionless protocol that does not provide reliable packet delivery. It is used by time sensitive applications that can tolerate frame loss such as VoIP.
- **Transfer Direction**: From the drop-down menu, select *Client to Server* or *Server to Client*. In the Client to Server transfer direction, test data is transferred in the Upload direction (from WiFi interface to wired interface). In the Server to Client transfer direction, test data is transferred in the Download direction (from wired interface to WiFi interface).
- **TCP Streams**: Displayed for TCP protocol only. Enter the number of parallel TCP client sessions to be used for the test, from 1 to 5. Note that the transmitted bandwidth is the total of TCP Streams x Throughput Bandwidth.
- **Throughput Test Mode**: From the drop-down menu, select *Duration* or *File Size*. In Duration mode, the test will run for the duration configured in the Duration field. In File Size mode, the test will transfer a number of bytes as configured in the File Size field.

- **Duration (s)**: Only displayed if the Throughput Test Mode is set to Duration. Enter duration in seconds for the test. The minimum duration is 10 seconds; the maximum duration is 1800 seconds.
- **File Size**: Only displayed if the Throughput Test Mode is set to File Size. Enter the number of bytes to be transferred for the file in Mbytes or Gbytes.
- **Throughput Bandwidth (Mbit/s)**: Tap on the data field to enter the data throughput rate for the test. Or press on the magnifying glass icon to open up the application selection window.

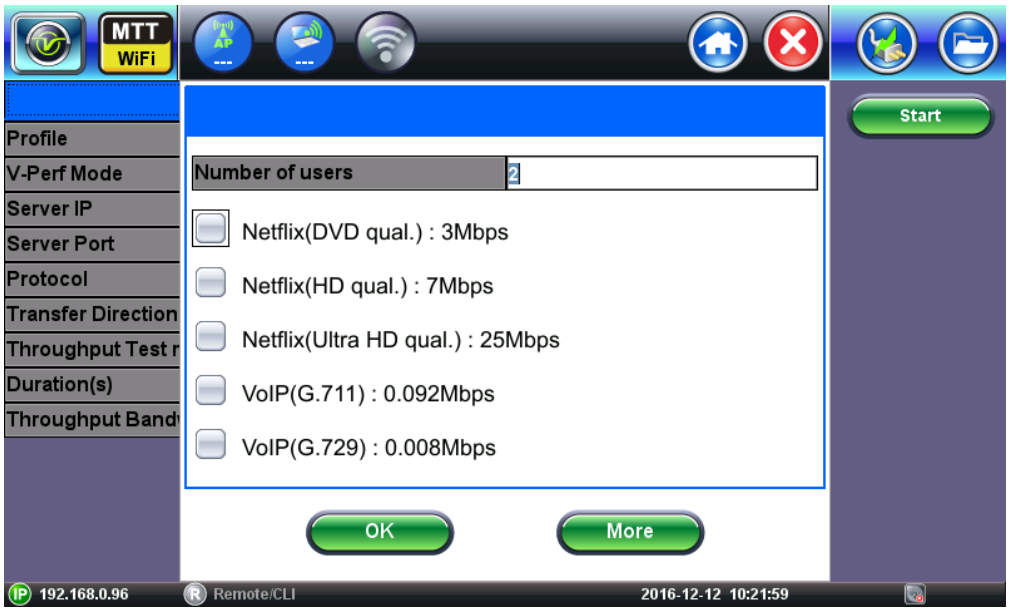


Figure 82: V-Perf Throughput rate application selection window

- **Application Selection Window**: For throughput bandwidth selection, the user can select the target application and the number of users. As a result, the bandwidth will be adjusted to reflect the expected data rate for the target application and the number of simultaneous users. For example, in order to test if Standard Quality Netflix streams with 2 simultaneous users can be downloaded, select from the application window the Netflix (DVD qual.) and set number of users = 2 and press **OK** . The Throughput Bandwidth field will automatically be updated to reflect that the test will run at 2x 3 Mbps = 6 Mbps to simulate 2 simultaneous Netflix streams.
- **V-Perf Throughput Threshold**: From the drop-down menu, select *Enable* or *Disable*. If V-Perf Throughput Threshold setting is enabled, the values in the threshold setting will be used to display pass or fail results in V-Perf Throughput test results. If V-Perf Throughput Threshold setting is Disabled, V-Perf throughput measurements won't be evaluated against Pass/Fail threshold in the V-Perf Test Results.

After configuration, press **Start** to start the V-Perf Test. The Results Summary screen is automatically displayed.

For information on running V-Perf and Quick V-Perf tests with V-Probe and configuring V-Probe settings, refer to Appendix B: V-Probe Operation and Configuration.

12.2 V-Perf Test Results

After Starting the test, the V-Perf Summary results tab is automatically displayed. Additional details are accessible in the **Graph** and **Details** tab.

12.2.1 V-Perf Summary Results

The V-Perf summary result's page is separated in three sections. The top section displays the current test status. The left section displays a summary dial graphic and the right section displays a summary of the test measurements.

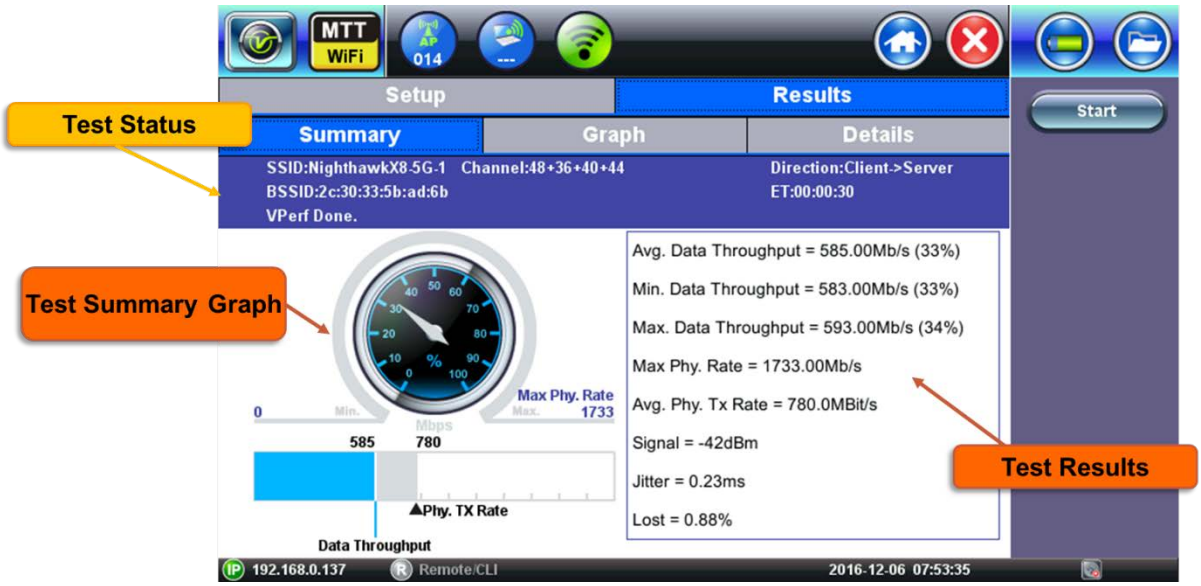


Figure 83: V-Perf Summary Result's Tab

- **Test Status:** The following items are displayed on the test status bar.
- **SSID**: Service Set Identifier advertised by the Access Point. The SSID is the logical name used to identify the network. SSID is configured by the network manager. Occasionally network managers prefer to hide the AP's SSID for security reasons. In that case, a blank SSID name or "[hidden]" are displayed instead.
- **Channel**: Channel number used by the SSID. Channels 1 to 13 are in the 2.4 GHz band. Channels 36 to 165 are in the 5 GHz frequency band. If channel bonding is used with 40 MHz or 80 MHz channel width "+" is displayed next to the main channel number.
- **BSSID**: Basic Service Set Identifier for the AP. The BSSID is a 48-bit unique MAC address of the AP's network interface.
- **Current test status**: While the test is running, this field displays the IP address and Port numbers used by the Client and Server. When the test is completed, this field displays "VPerf Done." If the test fails to start, the field displays an error message.
- In case of test failure, verify if the server's IP address and port number configured in Setup (12.1 V-Perf Configuration Settings) are accurate. Also make sure that the V-Perf server is currently running.

- **Test Direction:** In the Client to Server transfer direction, test data is transferred in the Upload direction (from WiFi interface to wired interface). In the Server to Client transfer direction, test data is transferred in the Download direction (from wired interface to WiFi interface).
- **Test Elapsed Time**: Displays the test elapsed time counter in the HH:MM:SS format.
- **Test Results:** The following items are displayed on the test results summary section.
- **Avg. Data Throughput**: While the test is running, the Avg. Data Throughput field displays per-second average value of data throughput (UDP or TCP) in Mbps. At the end of the test, this field displays the average value of data throughput (UDP or TCP) in Mbps over the entire duration of the test. In addition to the data throughput in Mbps, the value is also displayed as a percentage of the Maximum AP Phy Rate.
- **Min. Data Throughput**: Displays the lowest per-second data throughput measurement in Mbps; the value is also displayed as a percentage of the Maximum AP Phy Rate.
- **Max. Data Throughput**: Displays the highest per-second data throughput measurement in Mbps; the value is also displayed as a percentage of the Maximum AP Phy Rate.
- ***Max AP Phy. Rate**: Displays the Maximum AP Phy Rate. It is the theoretical maximum physical layer rate supported by the Access Point. This rate is based on the number of MIMO streams and channel width advertised by the AP in the beacon frames. Note that this does not reflect the actual rate at which the WiFi client transmits or receives data.
- ***Avg. Phy Tx Rate**: Displays the Average physical layer transmission rate for the WiFi frames. The transmission rate depends on the AP and Client capabilities, as well as the RF environment. The MTTplus-900 WiFi Air Expert Maximum Phy Rate is 1299 Mbps.
- ***Avg. Phy Rx Rate**: Displays the Average physical layer reception rate for the WiFi frames. The reception rate depends on the AP and Client capabilities, as well as the RF environment. The MTTplus-900 WiFi Air Expert Maximum Phy Rate is 1299 Mbps.

*Refer to 12.2.2 Data Rate vs Phy Rate for details.

- **Signal**: Per-second Signal level measured in dBm. A lower signal level will result in lower Tx and Rx Phy rates.
- **Jitter**: Only displayed for UDP tests; average UDP packet jitter.
- **Lost**: Only displayed for UDP test; percentage of lost UDP packets.

If Auto-save is set to Enabled, test results are automatically saved as a file once the test is stopped. For information on accessing and managing saved files, refer to *Viewing Saved Files and Results* in the V300 Common Functions manual.

84: The file name of the results is displayed during Auto-save.

Test Summary Graph

Test summary results are displayed in the form of a speedometer dial and bar graph.

The **speedometer dial graph** shows the current TCP/UDP data rate as a percentage of the Maximum Phy data rate advertised by the AP. The dial graph is graduated from 0 to 100% in 10% increments. 0% represents a data rate of 0 Mbps and 100% represents the Max Phy rate advertised by the AP. Depending on the APs capabilities, this value will vary.

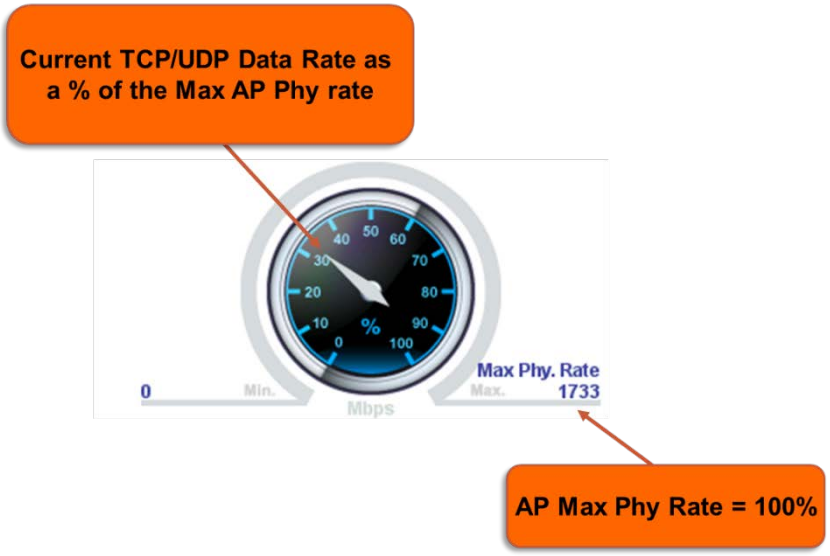


Figure 85: V-Perf Speedometer Graph

The **bar graph** displays current UDP/TCP throughput rate and Phy Tx. or Rx. Rates in Mbps. scaled from 0 Mbps (min) up to the Max AP Phy rate in Mbps.

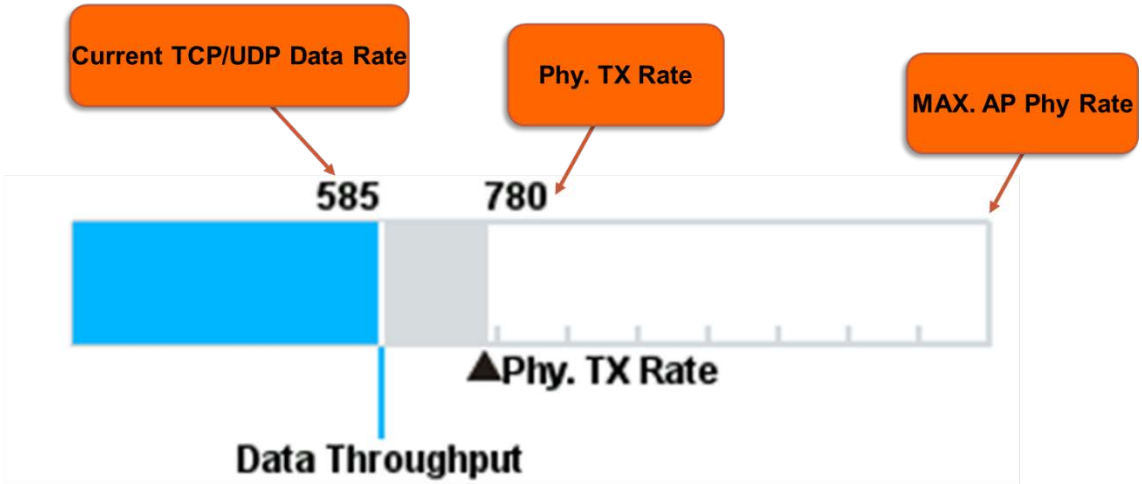


Figure 86: V-Perf Throughput Bar graph

If the V-Perf Throughput Threshold is enabled from the **Setup** menu (see 12.1 V-Perf Configuration Settings), the dial and bar graph will take on a green or red color to indicate Pass or Fail statuses.

- **Green**: Indicates that the throughput rate is higher than the threshold setting, therefore the test passes.
- **Red**: Indicates that the throughput rate is lower than the threshold setting, therefore the test fails.
- **Blue**: Indicates that no Pass/Fail throughput threshold is configured. V-Perf Throughput Threshold is disabled from the **Setup** menu.

Figure 87: V-Perf Speedometer with Threshold

Figure 88: V-Perf Throughput bar chart with threshold

12.2.2 Data Rate vs. Phy Rate

When comparing achieved TCP or UDP data rates to the WiFi Physical Layer rate, the following considerations should be taken into account:

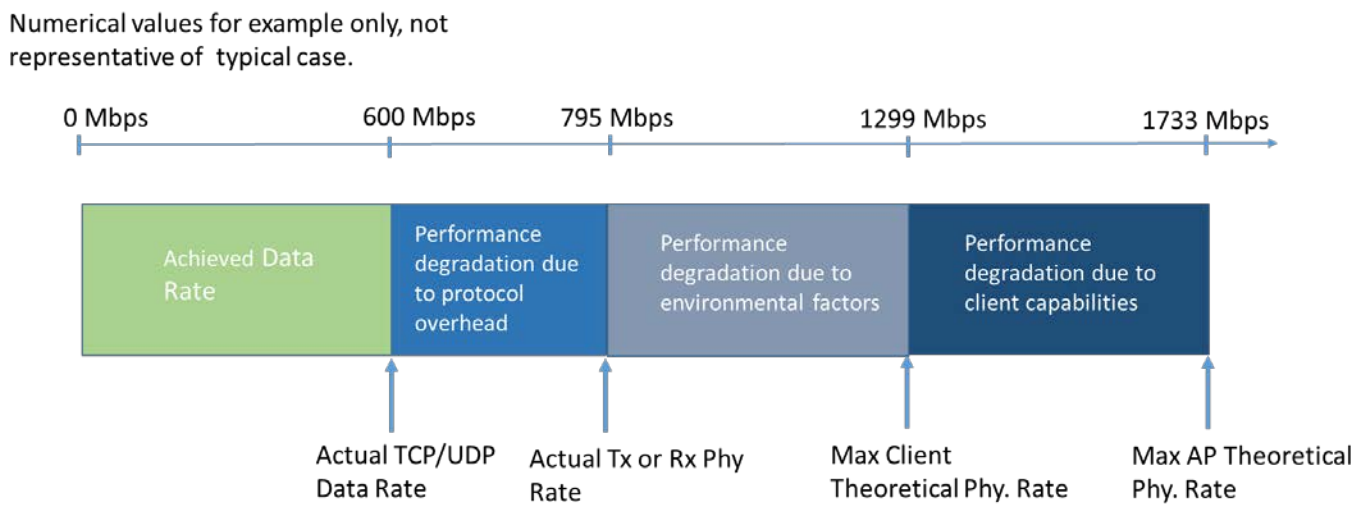


Figure 89: Achieved Data rate vs. Max Phy rate

- The Maximum Phy Rate advertised by the Access Point is the *theoretical maximum* physical layer rate supported. For example, an 802.11ac 4x4:4 AP configured with 80 MHz channel width can achieve up to 1733 Mbps Phy rate. WiFi clients often have lower physical layer rate capabilities; they are often limited to 1 or 2 antennas or do not support the latest 802.11ac standard.
- The MIMO (Multiple Input Multiple Output) technology (802.11n, 802.11ac) allows multiple parallel data streams.
- The number of MIMO streams depends on the number of device antennas (AP and Client).
- The WiFi channel width depends on AP/Client capabilities and configuration.
- In order to educate customers about maximum capabilities of clients, the Air Expert can be configured to emulate 1 antenna, 2 antenna, or 3 antenna clients. Refer to WiFi Setup for setup instructions.

		Channel Width		
	Bit Rates	20 MHz	40 MHz	80 MHz
Number of Streams	1 stream	87 Mbps	200 Mbps	433 Mbps
	2 streams	173 Mbps	400 Mbps	866 Mbps
	3 streams	289 Mbps	600 Mbps	1300 Mbps

Figure 90: Maximum bit rates for various channel widths and streams

- When configured as 3x3 device, the Maximum Phy Rate supported by the MTTplus-900 WiFi Air Expert is 1299 Mb/s (3x3:3) on an 802.11ac link with 80 MHz channel width.
- The Max Phy rate is only achievable in *ideal environmental conditions*. Distance between the WiFi AP and the Client will further reduce the Phy Tx and Rx rates. Attenuation from the environment or interference sources (from WiFi, non WiFi sources) will also reduce the performance.

- Other users connected on the same AP, or an AP sharing the same channel or adjacent channel, will also share available bandwidth and further reduce performance as WiFi frames can only be transmitted when the channel is not utilized.
- The TCP and UDP data rate are expected to be around 60 to 65% of the Phy rate due to IP and TCP/UDP protocol overhead and WiFi physical layer and protocol layer overhead. In addition, when running iPerf3 on a server, the server's hardware and operating system's performance can further degrade the achieved TCP/UDP throughput.

These considerations combined make it difficult to predict the actual data throughput on a WiFi network. Network operators should focus instead into setting a target data rate SLA based on the applications used and test against these values, rather than trying to achieve the absolute maximum throughput.

12.2.3 V-Perf Graph Results

The Graph tab displays Throughput graph results by default. Jitter and Loss graphs can be accessed by tapping on their corresponding function keys. The top section displays the current test status. The bottom section displays graph results.

The **X-axis** for Throughput, Jitter, and Loss graphs represent time in HH:MM:SS format.

The **Y-axis** changes depending on the graph selected.

Use the Left and Right arrow keys to scroll through the x-axis.

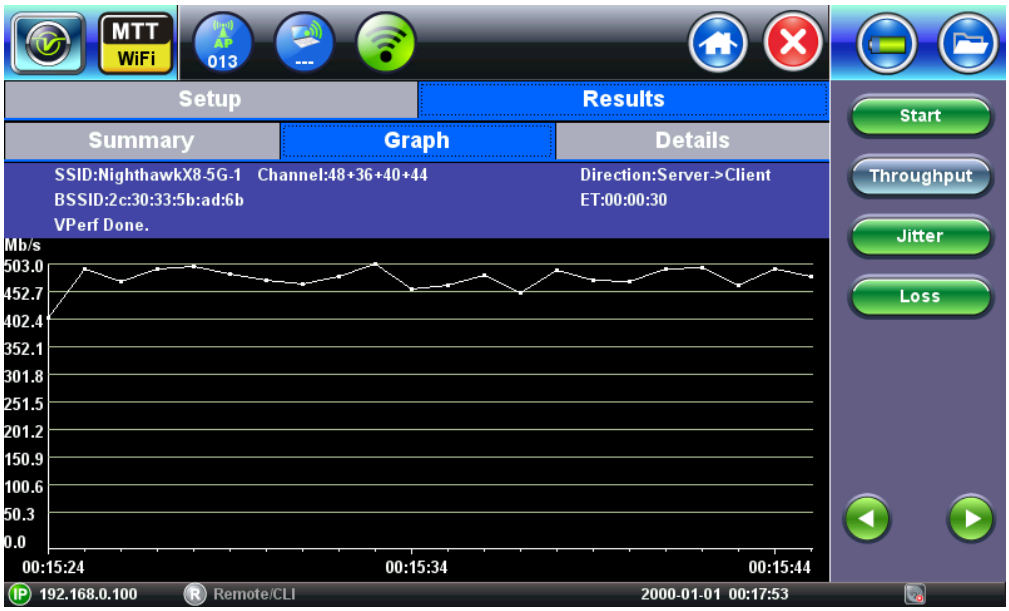


Figure 91: V-Perf Throughput Graph Results

Test Status: The following items are displayed on the test status bar.

- **SSID**: Service Set Identifier advertised by the Access Point. The SSID is the logical name used to identify the network. SSID is configured by the network manager. Occasionally network managers prefer to hide the AP's SSID for security reasons. In that case, a blank SSID name or "[hidden]" are displayed instead.
- **Channel**: Channel number used by the SSID. Channels 1 to 13 are in the 2.4 GHz band. Channels 36 to 165 are in the 5 GHz frequency band. If channel bonding is used with 40 MHz or 80 MHz channel width "+" is displayed next to the main channel number.
- **BSSID**: Basic Service Set Identifier for the AP. The BSSID is a 48-bit unique MAC address of the AP's network interface.
- **Current test status**: While the test is running, this field displays the IP address and Port numbers used by the Client and Server. When the test is completed, this field displays "VPerf Done." If the test fails to start, the field displays an error message.
- In case of test failure, verify if the server's IP address and port number configured in Setup (see 12.1 V-Perf Configuration Settings) are accurate. Also make sure that the V-Perf server is currently running.
- **Test Direction:** In the Client to Server transfer direction, test data is transferred in the Upload direction (from WiFi interface to wired interface). In the Server to Client transfer direction, test data is transferred in the Download direction (from wired interface to WiFi interface).
- **Test Elapsed Time**: Displays the test elapsed time counter in the HH:MM:SS format.

Throughput Graph

The V-Perf Graph results page displays the current TCP or UDP throughput rate as a line graph. The following items are displayed on the Throughput Graph:

- **X-axis**: Time in HH:MM:SS format.
- **Y-axis**: Current Throughput in Mbps updated each second.

Jitter Graph

The V-Perf Throughput Jitter graph displays the current packet jitter, updated each second.

Access the Jitter Graph by pressing the **Jitter** function key

.

Jitter graph is only available in UDP Server to Client Mode (download).

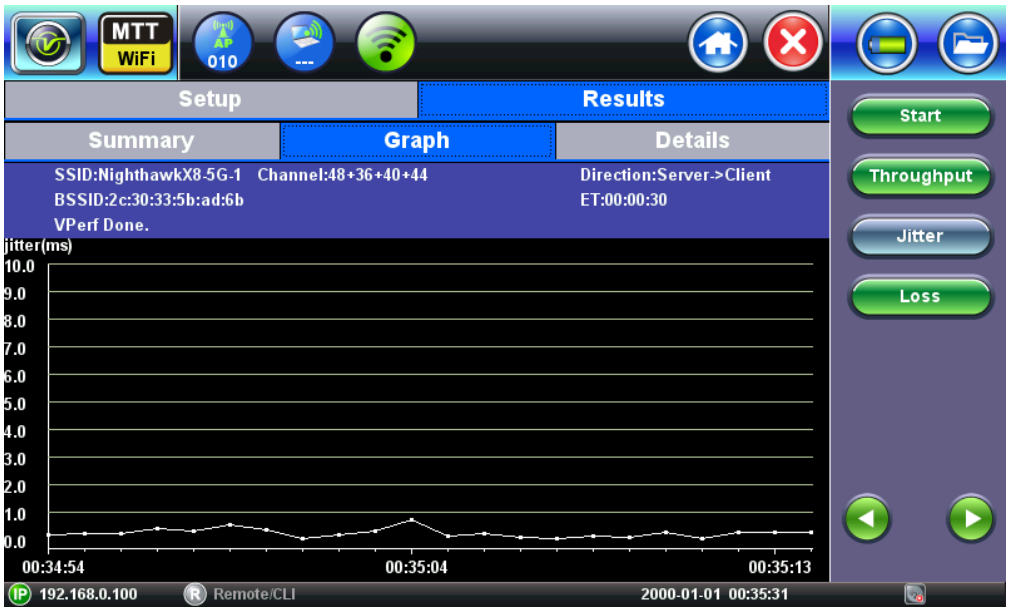


Figure 92: V-Perf Throughput Jitter Graph

- **X-axis**: Time in HH:MM:SS format.
- **Y-axis**: Packet Jitter in ms updated each second.

Loss Graph

The V-Perf Throughput Loss graph displays the current received packet loss, updated each second. Access the Loss Graph by pressing the **Loss** function key

.

Loss graph is only available in UDP Server to Client Mode (download).

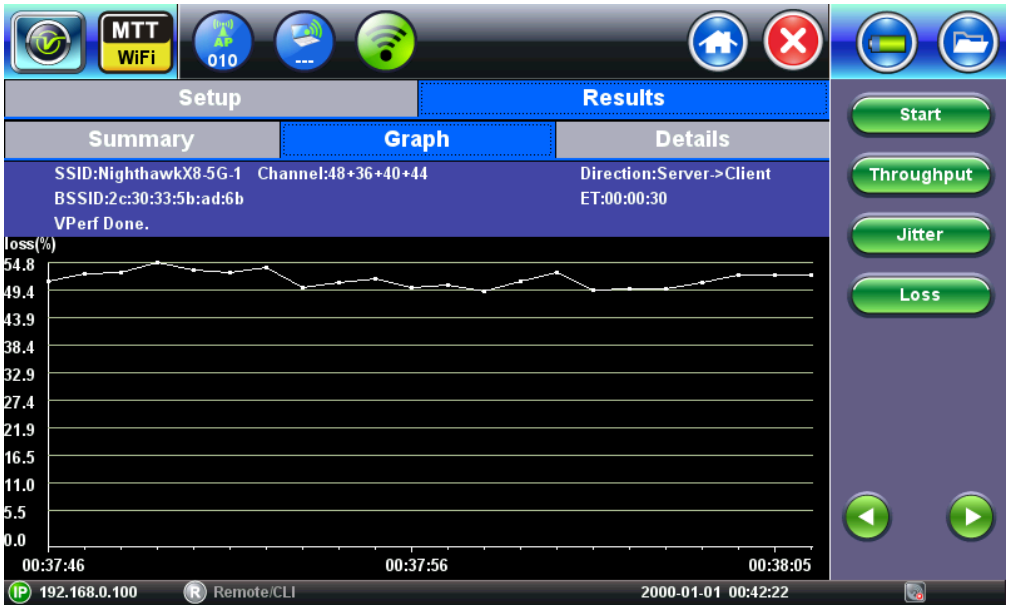


Figure 93: V-Perf Throughput Loss Graph

- **X-axis**: Time in HH:MM:SS format.
- **Y-axis**: Received Packet Loss % updated each second.

12.2.4 V-Perf Details Results

The V-Perf Details results page displays the current TCP or UDP throughput results in a per-second format. The top section displays the current test status. The bottom section displays the throughput results details table.

Figure 94: V-Perf Throughput Details

Test Status: The following items are displayed on the test status bar.

- **SSID**: Service Set Identifier advertised by the Access Point. The SSID is the logical name used to identify the network. SSID is configured by the network manager. Occasionally network managers prefer to hide the AP's SSID for security reasons. In that case, a blank SSID name or "[hidden]" are displayed instead.
- **Channel**: Channel number used by the SSID. Channels 1 to 13 are in the 2.4 GHz band. Channels 36 to 165 are in the 5 GHz frequency band. If channel bonding is used with 40 MHz or 80 MHz channel width, "+" is displayed next to the main channel number.
- **BSSID**: Basic Service Set Identifier for the AP. The BSSID is a 48-bit unique MAC address of the AP's network interface.
- **Current test status**: While the test is running, this field displays the IP address and Port numbers used by the Client and Server. When the test is completed, this field displays "VPerf Done." If the test fails to start, the field displays an error message.
- In case of test failure, verify if the server's IP address and port number configured in Setup (see 12.1 V-Perf Configuration Settings) are accurate. Also make sure that the V-Perf server is currently running.
- **Test Direction:** In the Client to Server transfer direction, test data is transferred in the Upload direction (from WiFi interface to wired interface). In the Server to Client transfer direction, test data is transferred in the Download direction (from wired interface to WiFi interface).
- **Test Elapsed Time**: Displays the test elapsed time counter in HH:MM:SS format.

Detailed Table Results: The following measurements are displayed on the Table results. Results are updated every second while level tracking is running.

- **Time:** Display in HH:MM:SS format when the measurement was taken.
- **Throughput:** Displays per-second average value of data throughput (UDP or TCP) in Mbps.
- **Phy Tx bit Rate:** Displayed in Client to Server test direction. Displays the per-second average physical layer transmission rate for the WiFi frames. The transmission rate depends on the AP and Client capabilities, as well as the RF environment. Refer to 12.2.2 Data Rate vs Phy Rate for details. The MTTplus-900 WiFi Air Expert Maximum Phy Rate is 1299 Mbps.
- **Phy Rx bit Rate:** Displayed in Server to Client test direction. Displays the per-second average physical layer reception rate for the WiFi frames. The reception rate depends on the AP and Client capabilities, as well as the RF environment. Refer to 12.2.2 Data Rate vs Phy Rate for details. The MTTplus-900 WiFi Air Expert Maximum Phy Rate is 1299 Mbps.
- **Signal Level**: Received Signal Level from the SSID measured in dBm.

Table Scrolling

- Use the Page Up/ Page Down arrow keys to scroll through the table page by page.
- Use the Up and Down arrow keys to scroll through the table row by row.

13.0 Ethernet Setup

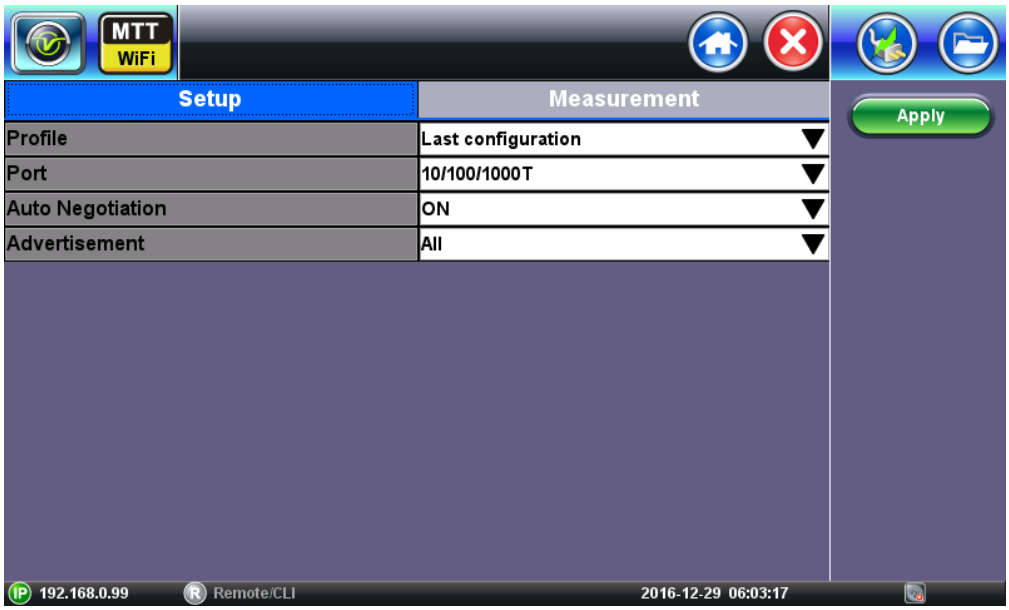


Figure 95: Ethernet Setup screen

Setup

The following port and test interface settings are available when 10/100/1000T or 1000X are selected in the **Port** field:

- **Profile:** Save the setup and measurements in a new test profile or recalls an existing test profile. The *Default* test profile brings back the Air Expert's default test settings. The *Last configuration* profile is used at boot up.
- **Port:** From the drop-down menu, select the test mode. The module can be configured for WiFi utilization, Ethernet Copper port 10/100/1000T, or Ethernet Fiber port 1000X utilization.
- **Auto Negotiation:** *On* or *Off*. Matches the test set's negotiation settings to those of the link partner.
    - *Speed* (only when Auto Negotiation is Off): 10 Mbps, 100 Mbps.
    - *Duplex* (only when Auto Negotiation is Off): Half or Full.
    - *Advertisement* (only when Auto Negotiation is On): Default-All or Custom. Custom options include 10/100/1000M Half or 10/100/1000M Full.

Press **Apply**

when finished to apply setup configurations.

14.0 Ethernet IP Connect

Figure 96: Ethernet IP Connect menu

Use the IP Connect icon

from the home menu to access the IP Connect menu. The Ethernet IP Connect functions work similarly to the WiFi IP Connect functions. Refer to the following sections for more information on IP Connect functions:

11.3 Network Configuration
11.4 Network Status
11.5 Ping
11.6 Trace Route
11.7 ARPWiz

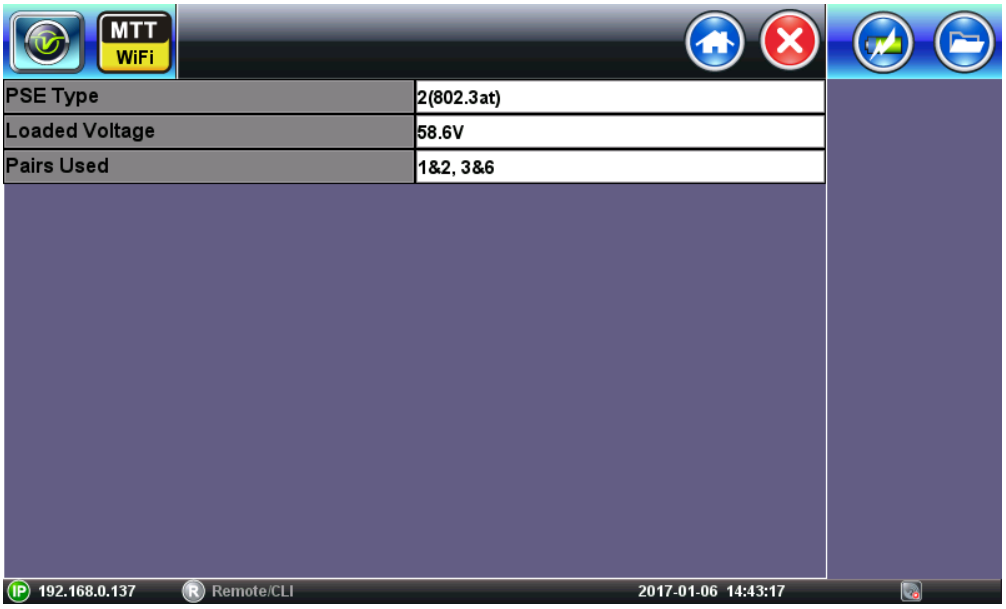
15.0 Ethernet V-Perf

The Ethernet V-Perf function works in the same way as the WiFi V-Perf function. For more information on the V-Perf menu, refer to 12.0 V-Perf menu.

16.0 Power over Ethernet (PoE) Test

PoE technology is used to provide both data and power over the same Ethernet cable. It is widely used in WiFi networks as WiFi Access Points or repeaters.

For PoE test, a CAT5,5E or 6 cable should be connected to the RJ45 connector on the Air Expert's connector panel (refer to 4.1.1 WiFi Module Connector Panel). The Air Expert Module emulates a PD (Powered Device) in order to provide PoE measurements.



The following measurements are reported:

- **PSE Type**: Determine the PSE (Power Source Equipment) Type. The type detected are PoE (802.3af standard) or PoE+ (802.3at standard). Display N/A is not PoE detected.
- **Loaded Voltage**: Measure the Voltage provided in Volts.
- **Pairs Used**: Displays the wire Pairs used for PoE.

17.0 Warranty and Software

Warranty Period: The warranty period for hardware, software and firmware is one (1) year from the date of shipment to the customer. The warranty period for battery pack, LCD, LCD touch panel, LCD protective cover, and accessories (including, but not limited to patch cords, AC adaptor, SFP, USB adaptors, carrying case, carrying pouch) is limited to one (1) year.

Hardware Coverage: VeEX Inc. warrants hardware products against defects in materials and workmanship. During the warranty period, VeEX Inc. will, at its sole discretion, either

- Repair the products
- Replace hardware which prove to be defective

provided that the products that the customer elects to replace are returned to VeEX Inc. by the customer, along with Proof of Purchase, within thirty (30) days of the request by the customer, freight prepaid.

Software Coverage: VeEX Inc. warrants software and firmware materials against defects in materials and workmanship. During the warranty period, VeEX Inc. will, at its sole discretion, either

- Repair the products
- Replace software and/or firmware which prove to be defective

provided that the products that the customer elects to replace are returned to VeEX Inc. by the customer, along with proof of purchase, within thirty (30) days of the request by the customer, freight prepaid.

Additionally, during the warranty period, VeEX Inc. will provide, without charge to the customer, all fixes, patches and enhancements to the purchased software, firmware and software options. VeEX Inc. does not warrant that all software or firmware defects will be corrected. New enhancements attached to a software option require the option to be purchased (at the time of order or the time of upgrade) in order to benefit from such enhancements.

Limitations: The warranty is only for the benefit of the customer and not for the benefit of any subsequent purchaser or licensee of any merchandise (hardware, software, firmware and/or accessories).

Revoking the warranty: VeEX Inc. does not guarantee or warrant that the operation of the hardware, software or firmware will be uninterrupted or error-free. The warranty will not apply in any of the following cases:

- Improper or inadequate maintenance by the customer
- Damage due to software installed by the customer on the unit without prior authorization (written) from VeEX Inc.
- Unauthorized alteration or misuse

- Damage occurred from operating the unit outside of the environmental specifications for the product
- Improper installation by the customer

18.0 Product Specifications

The most recent product specifications can be found on the VeEX web site at www.veexinc.com.

19.0 Certifications and Declarations

Declaration of Conformity

What is CE?

The CE marking is a mandatory European marking for certain product groups to indicate conformity with the essential health and safety requirements set out in European Directives. To permit the use of a CE mark on a product, proof that the item meets the relevant requirements must be documented.

Use of this logo implies that the the unit conforms to requirements of European Union and European Free Trade Association (EFTA). EN61010-1

For a copy of the CE Declaration of Conformity relating to VeEX products, please contact VeEX customer service.

ROHS Statement

What is RoHS?

RoHS is the acronym for Restriction of Hazardous Substances. Also known as Directive 2002/95/EC, it originated in the European Union and restricts the use of specific hazardous materials found in electrical and electronic products. All applicable products imported into the EU market after July 1, 2006 must pass RoHS compliance.

For more information about RoHS as it relates to VeEX Inc, go to the VeEX web site at www.veexinc.com.

20.0 About VeEX

VeEX Inc., the Verification EXperts, is an innovative designer and manufacturer of test and measurement solutions addressing numerous technologies. Global presence through a worldwide distribution channel provides uncompromised product support.

Visit us online at www.veexinc.com for the latest updates and additional documentation.

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Appendix A 2.4 GHz and 5 GHz Technology Overview

2.4 GHz Frequency Band

The 2.4 GHz frequency band contains channels 1 to 13. Channel 1 starts at frequency 2.402 GHz and stops at frequency 2.422 GHz. The center frequency is 2.412 GHz.

Channels in the 2.4 GHz frequency band are 5 MHz apart and 20 MHz wide.

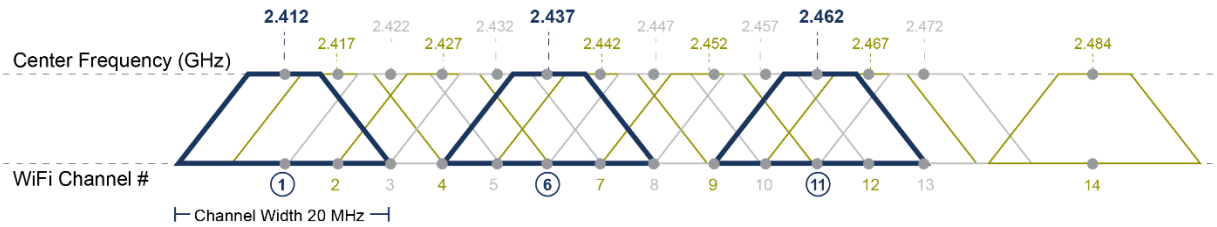


Figure 97: 2.4 GHz Frequency Band

Access Points located on channels 1, 6, or 11 are the only non-overlapping channels on the 2.4 GHz frequency band.

IEEE 802.11n standard allows 40 MHz wide channels. An access point using 40 MHz wide channel uses 2 bonded channels (e.g. channels 6+10).

5 GHz Frequency Band

The 5 GHz frequency band contains channels 36 to 165.

The channels' center frequencies range from 5.180 GHz to 5.825 GHz. The channels are 20 MHz wide and there is no overlap between adjacent channels, which means less possible interference from neighboring Access Points. Channel 36 is the first channel in the spectrum, ranging from 5.170 to 5.190 GHz, and centered at 5.180 GHz.

The 5 GHz band is further sub-divided into four ranges: UNII-1, UNII-2, UNII-2 extended, and UNII-3 bands. Most Wi-Fi devices support UNII-1 (channels 36 to 48) and UNII-3 (channels 149 to 165) only for indoor use. The FCC and other regulatory bodies allow the use of the UNII-2 and 2e bands for indoor and outdoor use, provided that the device's radio can support Dynamic Frequency Selection (DFS) and Transmitter Power Control (TPC). DFS and TPC are designed to detect and adjust Wi-Fi channels automatically if military or weather radar systems are present in order to avoid interfering with these systems.

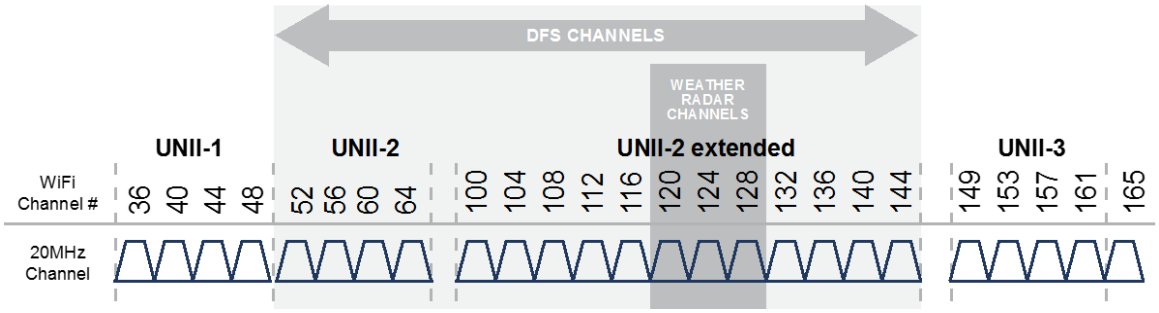


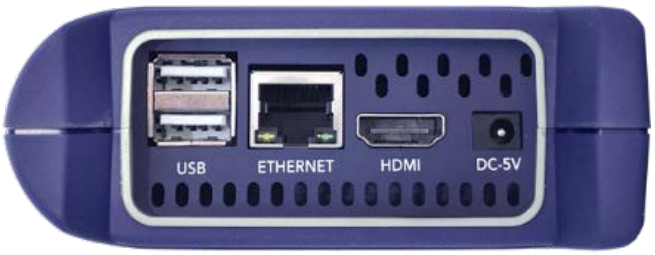
Figure 98: Channels in the 5 GHz Frequency Band

IEEE 802.11n standard allows channels 40 MHz wide, while 802.11ac standard allows channels 40 MHz, 80 MHz, or 160 MHz wide. An access point using an 80 MHz wide channel uses 4 bonded channels (e.g. channels 36+40+44+48).

Appendix B V-Probe Operation and Configuration

The V-Probe Responder is a companion accessory to the MTTplus-900 Air Expert. It is used as a remote server to establish V-Perf TCP/UDP connections and validate that the network is configured correctly for seamless passing of TCP & UDP traffic to an Access Point (AP). For this test, the V-Probe responder is connected directly to the Ethernet port on the back of the AP/Router. The MTTplus-900 Air Expert is connected to the WiFi air interface to perform WiFi to Ethernet data throughput tests.

B.1 Interface Panel



Ports:

- **USB**: Used for loading unlocking/factory reboot utility. Refer to Factory Reset for information on connection troubleshooting.
- **Ethernet**: 10/100/1000Base-T test interface and management interface. LEDs indicate Ethernet connection and traffic status.
  - Amber LED = Ethernet link up. If the LED is off the Ethernet link is down.
  - Green LED = Traffic (Tx or Rx). If the LED is off, there is no traffic.
- **HDMI**: Not in use.
- **DC-5V**: Connect the VeEX DC 5V charger to the DC-5V port to power the unit.

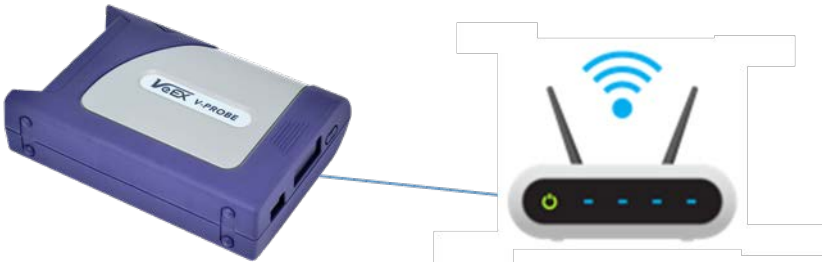
B.1.1 Front Panel

Power key: We recommend using the power key to shut down the unit. If the unit is shut down by disconnecting the power cable, it could result in data corruption. Note that the power key cannot be used to power on the unit. The unit automatically powers on after connecting the charger.

B.2 Connecting V-Probe to MTTplus-900

Note: The Default setting of the V-Probe is set to DHCP mode and iPerf3 TCP/UDP Server mode; no additional configuration is required to start running a test.

Before running V-Perf or Quick V-Perf tests with V-Probe, connect it to any of the Wi-Fi AP or router ports via the Ethernet RJ-45 port. V-Probe will obtain an IP address from its DHCP server.



To get the Air Expert module to detect the V-Probe IP address, connect the MTTplus-900 Air Expert module to the same network (from 10/100/1000Base-T interface or WiFi air interface) and use V-Probe > Discovery function.

B.3 Running V-Perf Tests to V-Probe

B.3.1 Running a V-Perf Test to a V-Probe

Note: Before running V-Perf, make sure that V-Probe is connected to a Wi-Fi AP or router Ethernet port and has a DHCP IP address assigned to it.

1. From the V-Perf main menu, tap **V-Probe** then **Discover**. The unit will discover the V-Probe automatically if it is in the same subnet.

2. Select the discovered V-Probe. If any V-Probe parameters need to be changed, tap on the magnifying glass icon . If any V-Probe IP settings need to be modified, tap on the world icon to open the V-Probe web browser. Alternatively, type the V-Probe IP address into a PC web browser to open the web page.

3. Tap **Start Test**. The V-Perf Test page will open up, displaying the Results window/gauge.

B.3.2 Running a Quick V-Perf Test to a V-Probe

The Quick V-Perf test is a fully automated V-Perf test that works with V-Probe. When configured on the same subnet, the V-Probe is discovered automatically by the MTTplus-900 Air Expert. As soon as V-Probe is discovered, the V-Perf WiFi Throughput test is automatically launched. The V-Perf test results can be saved automatically at the end of the test.

Note: Before running V-Perf, make sure that V-Probe is connected to a Wi-Fi router and has an assigned DHCP IP address.

1. Connect the MTTplus-900 to the Access Point under test from the AP Scan table accessed from the **AP Scan** icon on the home menu. Refer to 11.2 Connect AP for more information on connecting to an Access Point.

   Default parameters can be modified under V-Perf from the main menu to run a longer test. This may be desirable if observing the gauge to troubleshoot problems live during walkthroughs of the premise.

2. After successful authentication and association, tap on **Quick V-Perf** to start the Automated V-Perf Discovery/Test Application. It will Auto-Discover the connected V-Probe in the network and start the test with default settings, whether running the test over WiFi or copper.

B.4 V-Probe Configuration

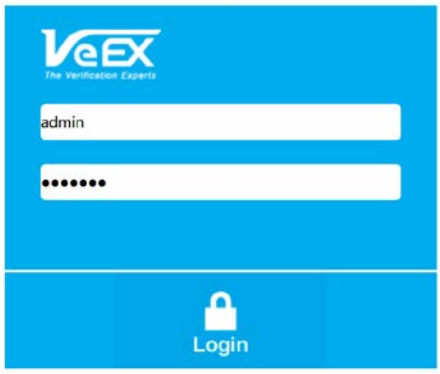
B.4.1 V-Probe Configuration from a PC Web Browser

The V-Probe software can be upgraded through a PC web browser. Other V-Probe settings that can be modified via web are the IP and V-Perf settings. System changes like device reboot and factory reset are also available.

1. To find the V-Probe IP address, tap on **V-Probe** > **Discover** (from the Air Expert Module User Interface) to use the Discovery function when in DHCP mode.

   Note: Default out of box IP address settings is DHCP for V-Probe.

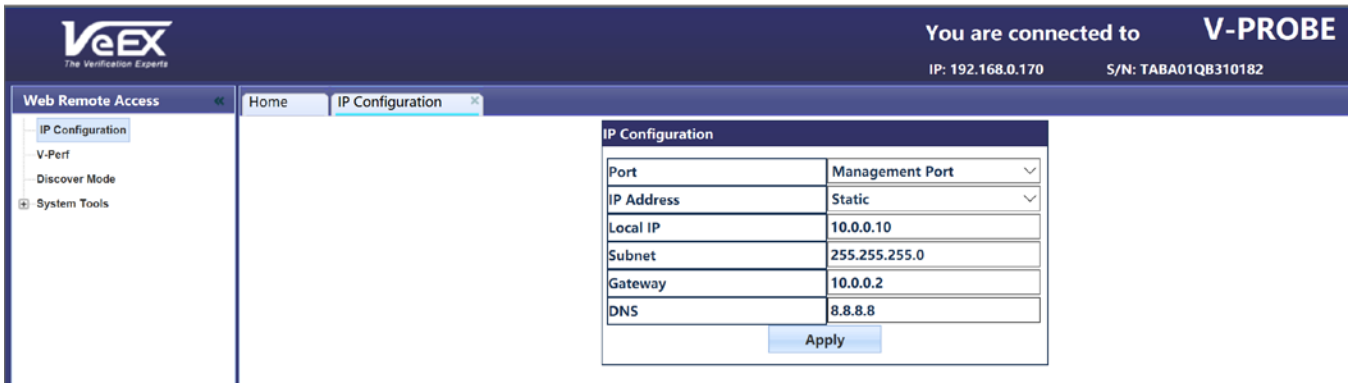
2. Connect to V-Probe by typing its IP address into a PC web browser. Enter your log in information. Refer to the label on V-Probe for password information.



3. To change V-Perf settings, click on **V-Perf**.
4. To change the IP address, click on **IP Configuration** > **Static**. Enter the Local IP address, subnet, Gateway & DNS, then click **Apply**.
5. You will be prompted to reboot the unit. Click **Reboot** to do so. Connect to V-Probe with the new IP address via the MTTplus-900 or web browser.

B.4.2 V-Probe IP Configuration

1. From the V-Probe home page, select **IP Configuration**. V-Probe supports DHCP (Default) and Static IP address configuration.
2. For static, enter Local IP, Subnet, Gateway, and DNS information.
3. After configuring settings, press **Apply**.



Note: When the unit is configured to Static IP, make sure to write down the configured IP address for your records. Regardless of configured IP address, V-Probe is always accessible via IP address 192.168.100.250.

B.4.3 V-Perf Test Configuration

By Default V-Probe is configured as a V-Perf Server with iPerf3 Compatibility and Port number 5201. Settings can be changed by going to the V-Perf page from the web browser.

- Compatibility mode: Iperf3 or Iperf 2
- Port number: configurable port number

Press **Apply** when finished to apply changes.

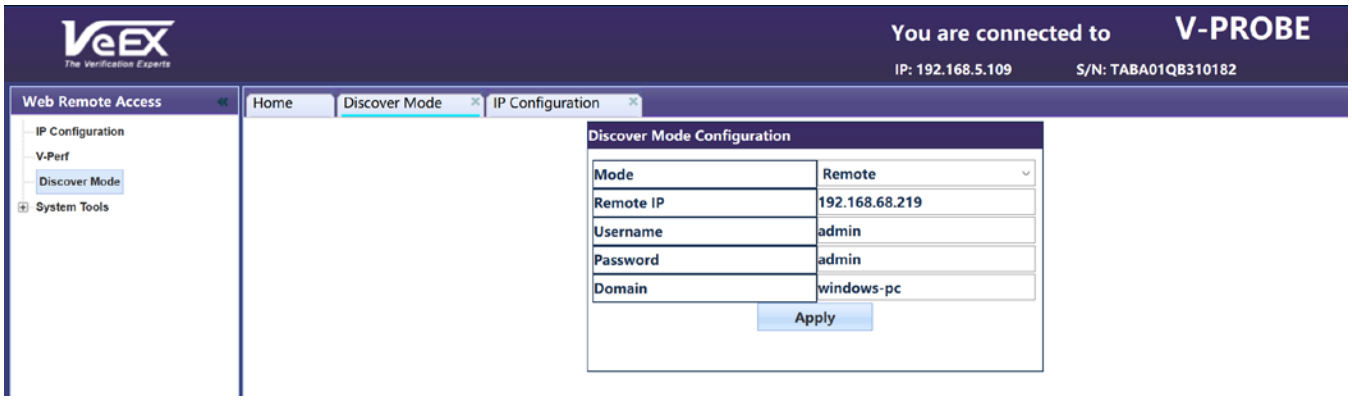
B.5 Discover Mode

For dual ended V-Perf testing, the Air Expert needs to detect V-Probe, which can be done through Local and Remote Discovery.

Local Discovery should be used when V-Probe and Air Expert are in the same network.

Remote Discover should be used when V-Probe and Air Expert are on remote networks.

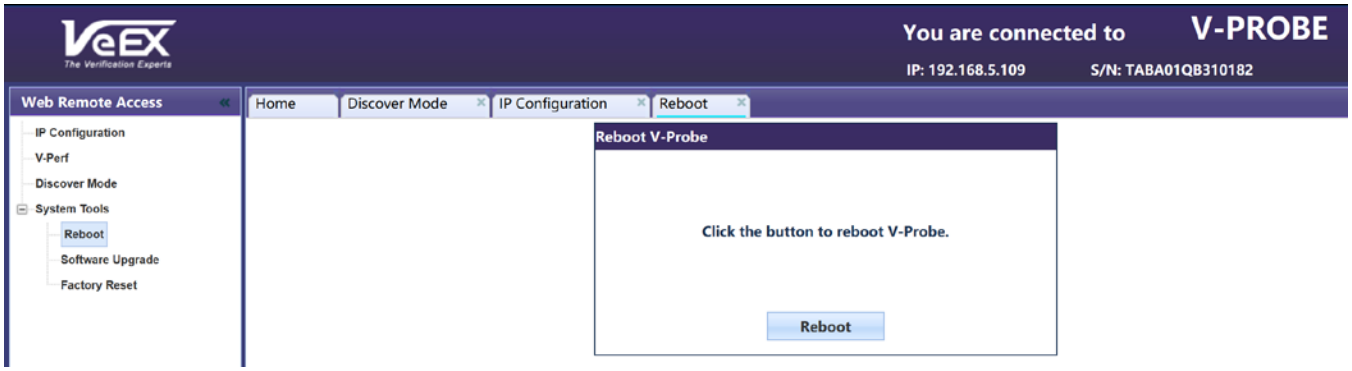
Contact VeEX customer support for information about XMPP server configuration.



B.6 System Tools

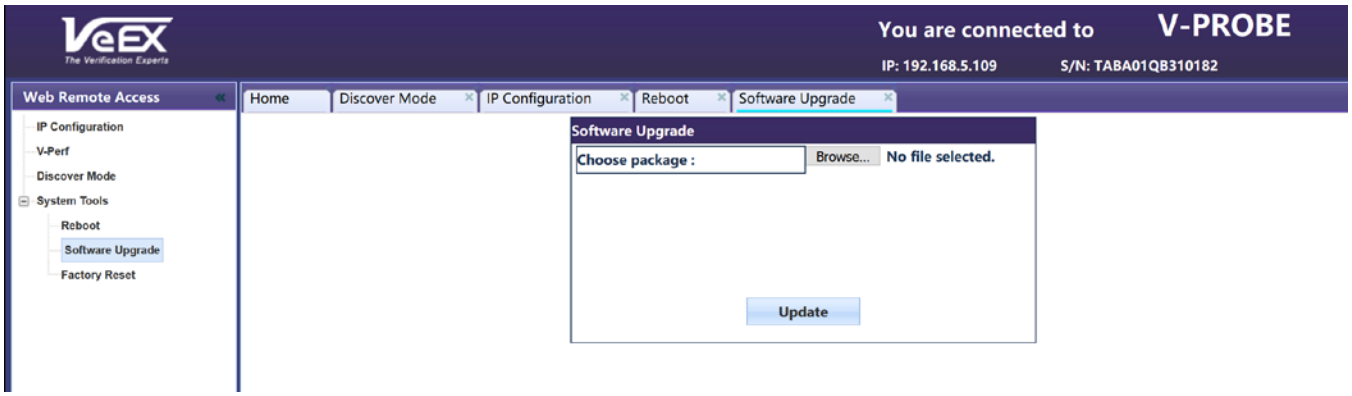
B.6.1 Reboot

Click on System Tools > **Reboot.** You will be prompted to reboot the unit. Click on **Reboot** to do so.

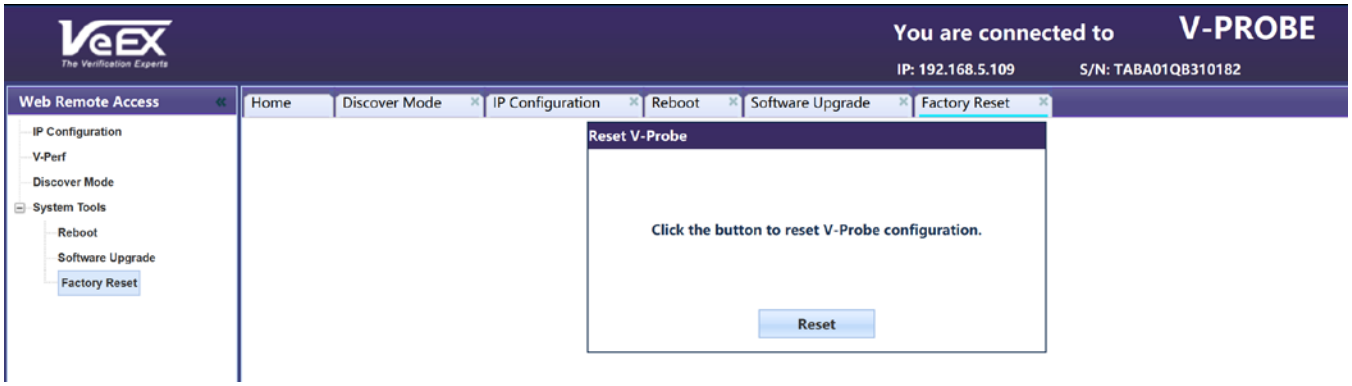


B.6.2 Software Upgrade

1. Download the V-Probe software file from VeEX's website and save it locally on your PC.
2. Connect to the V-Probe's IP address from the web browser. Click on **System Tools** > **Software Upgrade**.
3. Browse to your PC's folder where the V-Probe software is stored.
4. Click **Update** to start the software upgrade process.
5. Refresh you web browser's page when the upgrade process is complete and connect to the V-Probe.



B.6.3 Factory Reset



1. To reset V-Probe to the factory setting DHCP IP address, download the “vprobe_factory.key” software from the VeEX website.
2. Install “vprobe_factory.key” on the root directory of the USB stick.
3. Insert the USB stick into the V-Probe USB port on the connector panel.
4. Power on V-Probe by connecting the charger.
5. V-Probe will be reset to factory default.

B.7 Safe Shut Down

To safely shut down V-Probe, press the power key on the front panel, then disconnect the charger. Safely shutting down the V-Probe is recommended. Removing the power supply prior to safely shutting down could result in data corruption.