



Axiom and BBX Broadband – Quick Start Guide

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Important Notice

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FCC Notification Statement (United States)

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: 1) This device may not cause harmful interference and 2) this device must accept any interference received, including interference that may cause undesired operation. This device must be operated as supplied by Intuicom, Inc. Any changes or modifications made to the device without the express written approval of Intuicom may void the user's authority to operate the device.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part

15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a

residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Introduction

The purpose of this manual is to walk the reader through the steps to connect and program Intuicom Broadband family of products.

Intuicom no longer provides a CD with the software on it. Instead users are asked to go to our website to download the software.

Download BroadbandPro™ Enterprise here: <https://www.intuicom.com/broadband/broadbandpro-enterprise-software/>

Installing BroadbandPro™ Enterprise Software

For complete step by step instructions on how to download and install the BroadbandPro™ Enterprise Software please refer to the Intuicom BroadbandPro™ Enterprise Installation Guide.

Important - Fully configure all units in a laboratory or shop environment prior to deployment. Documenting and configuring all radios in a wireless network prior to deployment rules out configuration problems when troubleshooting links. Ruling out configuration errors allows installers to focus on power settings and aiming during installation.

WARNING: All Intuicom products are thoroughly tested in the lab prior to shipment. We cannot guarantee that products will not be damaged internally during shipping. For this reason, **DO NOT** deploy radios until they have been powered up in a laboratory or shop and an initial configuration loaded onto the unit. If there are any problems with Intuicom products please contact Intuicom for a RMA (Return Material Authorization) number and ship the unit back to Intuicom for repair.

WARRANTY NOTE: DO NOT attempt to open the enclosure for any of the BBX and Axiom products. Intuicom seals all units prior to shipment and breaking of the seal will void the warranty.

Connecting Broadband Radios

Intuicom BX products are shipped with a Power over Ethernet (PoE) injector and power supply to power the radio. The Axiom products are 802.3af/at compliant and can be powered by an 802.3af/at switch or by PoE Injector which is 802.3af/at compatible. Intuicom provides an 802.3af/at injector with the Axiom products. A hardened injector can be purchased for additional cost.

If you are working with a BBX product the PoE injector consists of two parts, the power supply which is a black rectangular box, with a 110AC plug attached to one end, and a 24V barrel connector attached to the other. Second part is the injector that is an aluminum block with two RJ45 ports and a male barrel connector on it. Power and data ports are designated by a sticker on the side of the aluminum housing.

BBX Connections – Plug in the power to 110AC LAST! Connect one end of an Ethernet cable (patch cable) to the RJ45 connector closest to the barrel connector (marked DATA+PWR), and the other end Ethernet cable to the BX unit. Next, connect a second Ethernet cable to the other RJ45 port on the side of the injector marked DATA, and the other end of the second Ethernet cable to the PC running BroadbandPro™ Enterprise, or a switch. Finally connect the barrel connector of the power supply to the PWR outlet on the injector, and last plug the 110AC into power.

If you are working with the Axiom products the PoE injector consists of a single black box with two RJ45 female connectors on one end, and a 110AC power cord plugged into the other. The two RJ45 ports are labeled P+D/Out, and Data/IN.

Axiom Connections - Plug the 110AC power cord into the injector, wait to plug the 110AC cord into the outlet or power strip. Connect an Ethernet Patch cable to the P+D/Out port on the injector and the other end of the Ethernet cable into the Axiom unit. Plug a second Ethernet cable into the Data/IN port on the injector and the other end into your PC or a switch connected to your PC. Last plug the 110AC power cord into the power outlet.

Connection overview illustrations for the various product lines are depicted on the following pages.

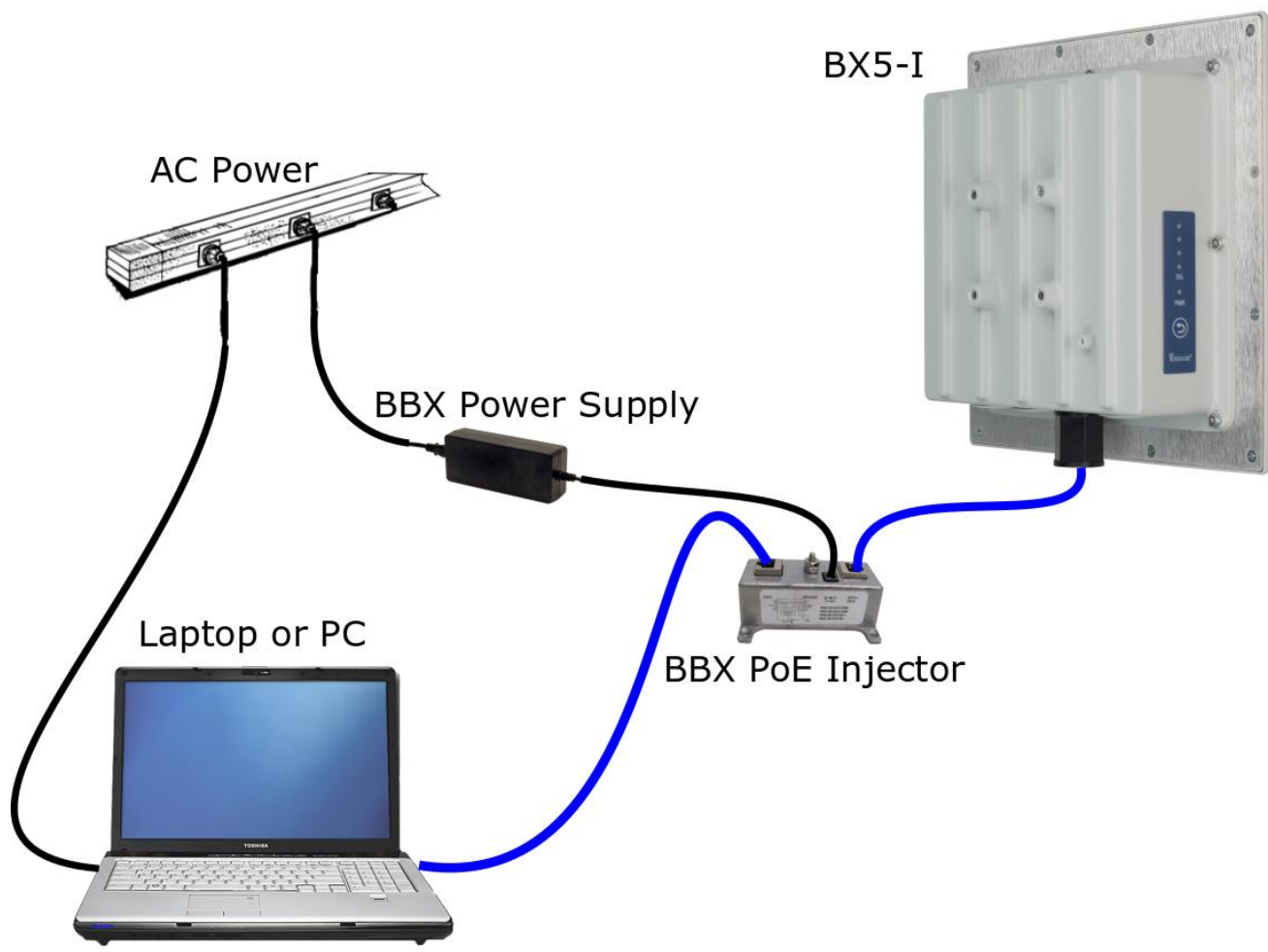
ALL PRODUCT PICTURES ARE FOR ILLUSTRATION PURPOSES ONLY. ACTUAL PRODUCT MAY VARY DUE TO ENHANCEMENTS AND UPGRADES.

BBX Connections

Intuicom manufactures the BBX product line in three broadband frequencies, the 2.4GHz spectrum, the 5.8GHz spectrum and for the Public Safety Band 4.9GHz licensed spectrum.

If you have purchased an integrated, standalone, or dual unit for use in any of the above spectrums, the connection overview will look similar to this:

BBX Connection Overview

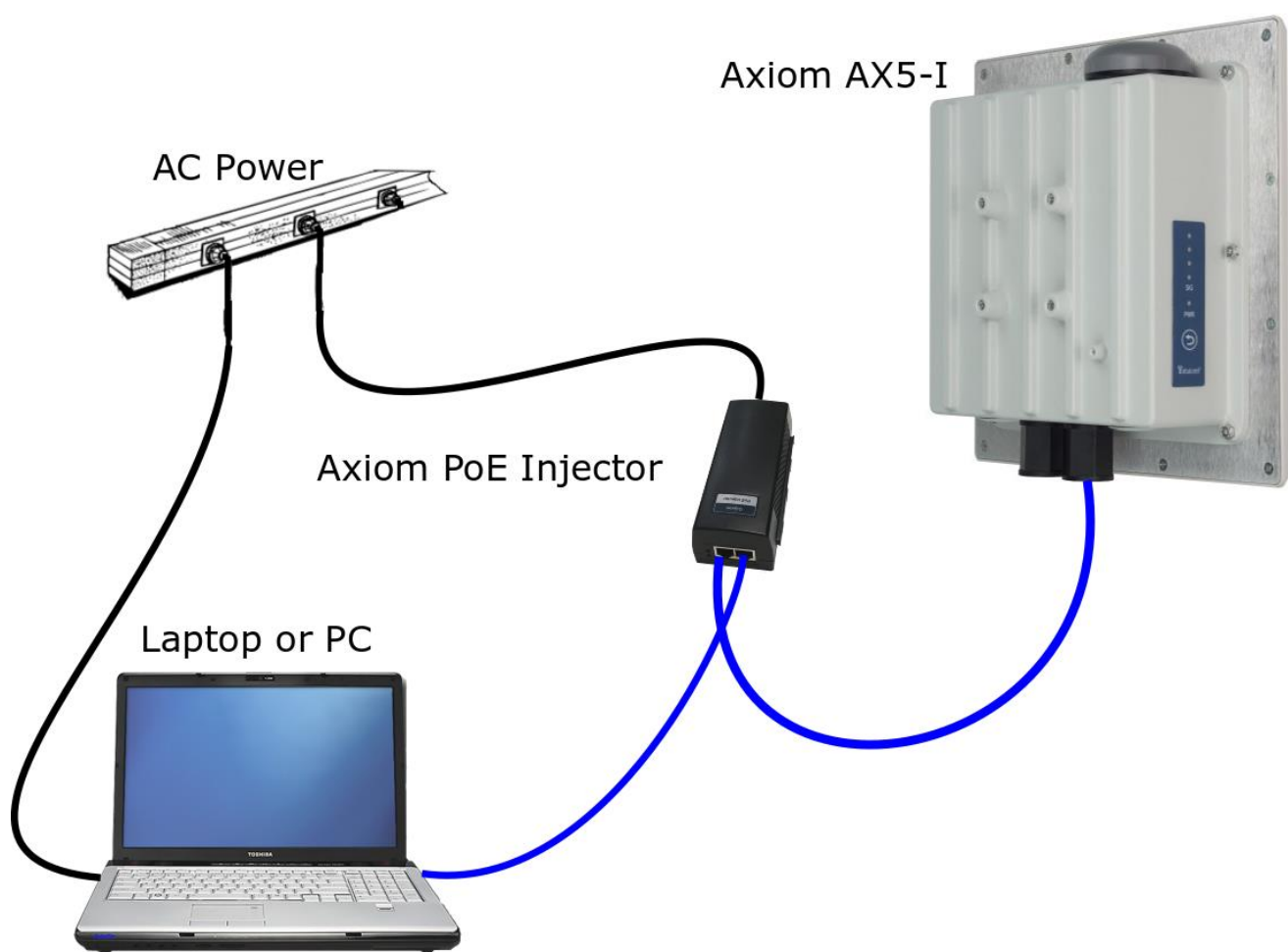


Axiom Connections

The Axiom product line has a serial port connection next to the Ethernet port. This is an RJ45 female connection, like the Ethernet port. Shipped from the factory, the serial port comes with black cap screwed into the connector sleeve and the Ethernet port is left open. Use the open port and DO NOT remove the cap from the serial port unless you need it for your deployment.

Just like the BBX product line, the Axiom product line comes in 5.8, 2.4, and 4.9GHz radios, and it also comes in single and dual radio units. The connection overview for the various models of Intuicom's Axiom product line will be very similar to the diagram below.

Axiom Connection Overview



PoE Injectors

Axiom Standard PoE Injector

The Axiom product line is 802.3af/at compatible and can be powered by an 802.3af/at PoE switch or with the included black PoE injector.

The difference between 802.3af and 802.3af/at is that 802.3af switches and injectors put out up to 15Watts of power, whereas 802.3af/at switches and injectors put out up to 30Watts of power. These standards are backwards compatible where 802.3af/at will power 802.3af devices.

The following is a list of the PoE standards that will power Intuicom products.

802.3af – 15 Watts

AX5-I & E
AX4-I & E
AX2-I & E
AX5ac-I & E

802.3af/at – 30 Watts

AX55-DI & DE
AX55ac-DI & DE
AX5ac5ac-DI & DE
AX54-DI & DE
AX54-DI & DE
AX52-DI & DE
AX44-DI & DE
AX45ac-DI & DE
AX42-DI & DE
AX22-DI & DE
AX25ac-DI & DE

Standard Axiom Injector

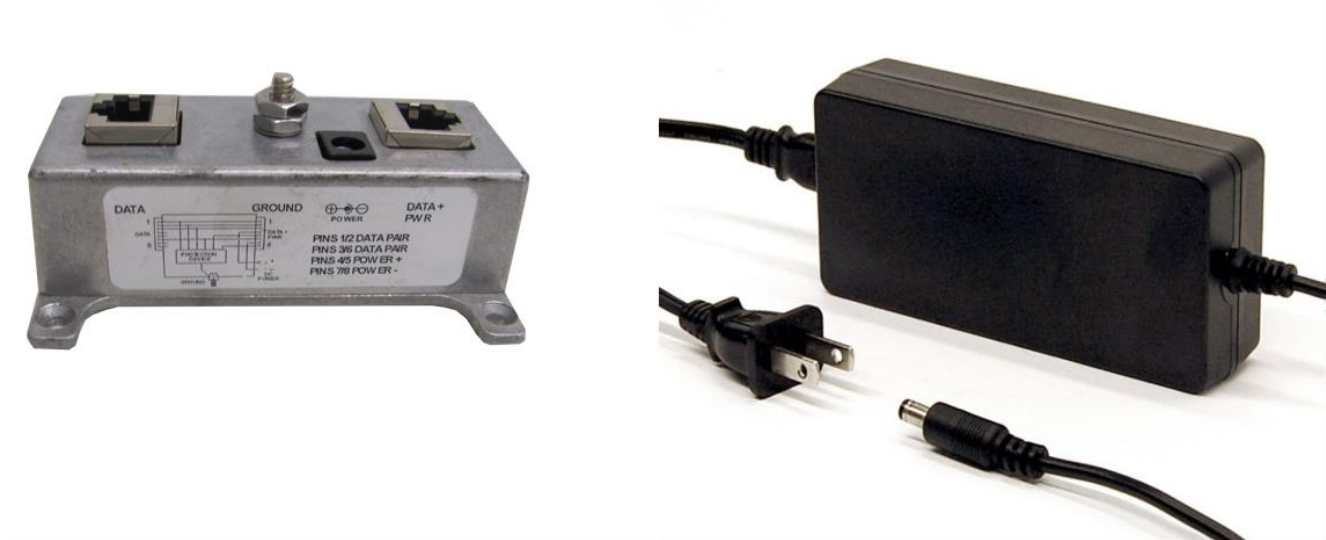


BBX PoE Injector Information

Intuicom BBX product line uses a Passive PoE injector. These injectors put out power on different pins in the RJ45 connector than the IEEE 802.3af/at standard. This means that **a BBX Passive injector will not power an Axiom product**. This also means that you must use the injector and power supply that comes with the BBX products regardless of the switch you are using with the radio, because an 802.3af/at switch will not power the BBX products.

Additionally, an Axiom Standard PoE injector or a Hi-Power injector will not power BBX products.

BBX Injector and Power Supply



Hi Power PoE Injector

If the requirements for your project are that PoE injectors must be hardened for all equipment, the Hi-Power PoE injector that will power the entire Axiom product line can be purchased at an additional cost. Please contact your Intuicom Sales Representative for additional information.

Hi Power PoE Hardened Injector



Programming Wireless Connections

After you have connected a Broadband radio to power and to your laptop you will need to program it for a wireless connection.

Although the Axiom and the BBX products have their differences. Both the BBX products and the Axiom products are identical in terms of wireless components and programming.

For initial programming when the PC is directly connected to the radio you will need to set the IP Address of your PC to the same range as the radios.

The default IP Address of all Intuicom BBX and Axiom products is 192.168.0.100, with a 255.255.255.0 Subnet Mask, and a 192.168.0.1 default Gateway. This means you will need to set the IP Address of the LAN Adapter on your computer to an address within the range of 192.168.0.X where X is something other than 1, 100, or 255.

Intuicom recommends setting the IP Address of the LAN adapter on your PC to 192.168.0.10.

Windows Tip

You cannot ping a device connected to your windows PC unless the IP Address of your computer is in the same range as the device you are trying to ping or access.

Problem: When changing IP Address on Intuicom radios from default to the desired range, users have to change the IP Address of their LAN adapter after every IP Address change on a radio.

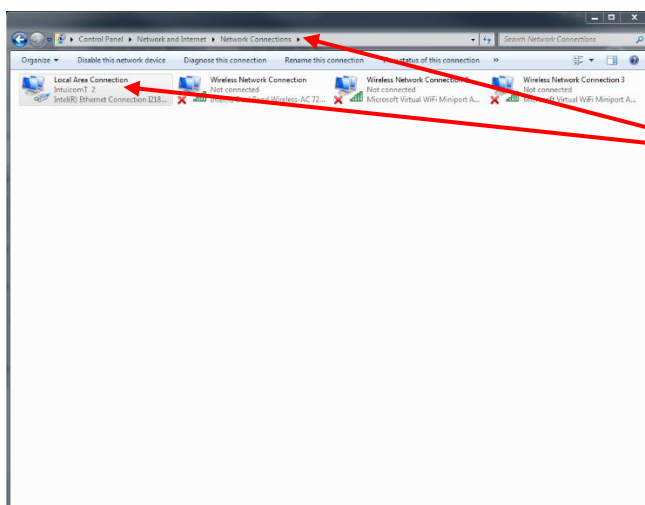
Example: You are programming the radios to 10.24.X.X addresses using a 255.255.0.0 subnet mask. You already have a 10.24.25.30 IP Address statically set on your LAN adapter connected to the radios.

Task: You need to connect a radio to your computer that is new and at default IP configuration and program it to the 10.24.X.X range.

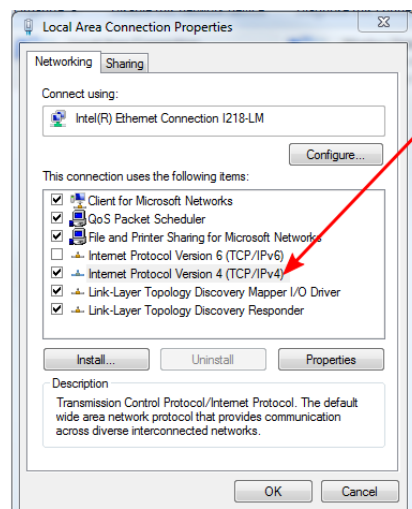
Fix: Navigate to Control Panel – Network and Internet – Network Connections window of your computer, and right click on your Local Area Connection that is connected to the radio, and double click on TCP/IP v4 Properties.

Leave the 10.24.25.30 address already programmed on your adapter there, and below the DNS address boxes click on the rectangular button named “Advanced...” and below the box labeled IP addresses click the “Add” button and type in the IP address 192.168.0.10 with a 255.255.255.0 subnet mask. After you click “Add” button, so the IP address window now has two addresses in it, your original 10.24.25.30, and the 192.168.0.10 address, click OK three times, on each window all the way out and close the Network Connections window.

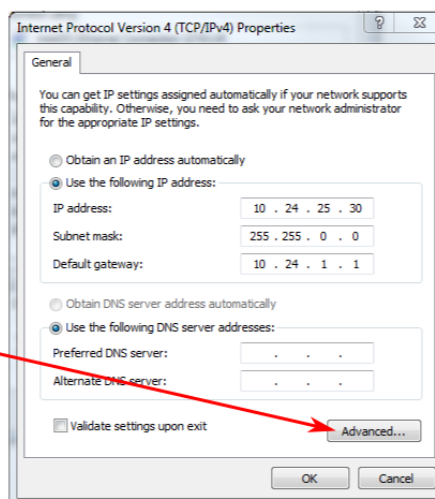
After you have completed this you will be able to ping and log into the radios at default IP address, and once you have changed them to the new IP address, you will still be able to ping and log into them without having to change the IP address on your network adapter.



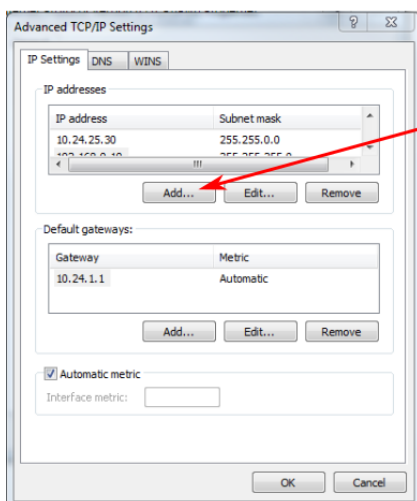
Navigate to the "Network Connections" Window and right click the Local Area Connection and select properties



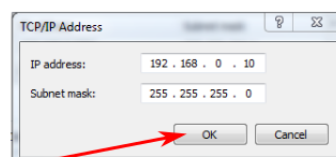
Double-Click on Internet Protocol Version 4 (TCP/IPv4)



Click-Advanced



Click-Add



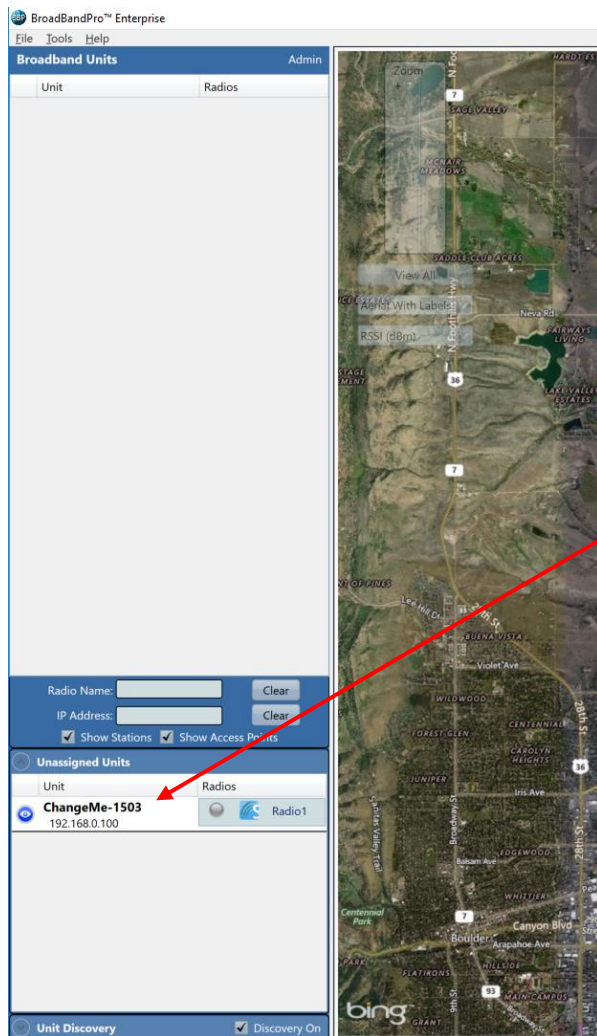
Click-OK

Required Settings

With BroadbandPro™ Enterprise installed and the IP Addresses correctly set on the Network Adapter of your computer, you are ready to proceed with programming the radios for a wireless connection.

With the radio plugged directly into your PC, open up BroadbandPro™ Enterprise software and log in as administrator.

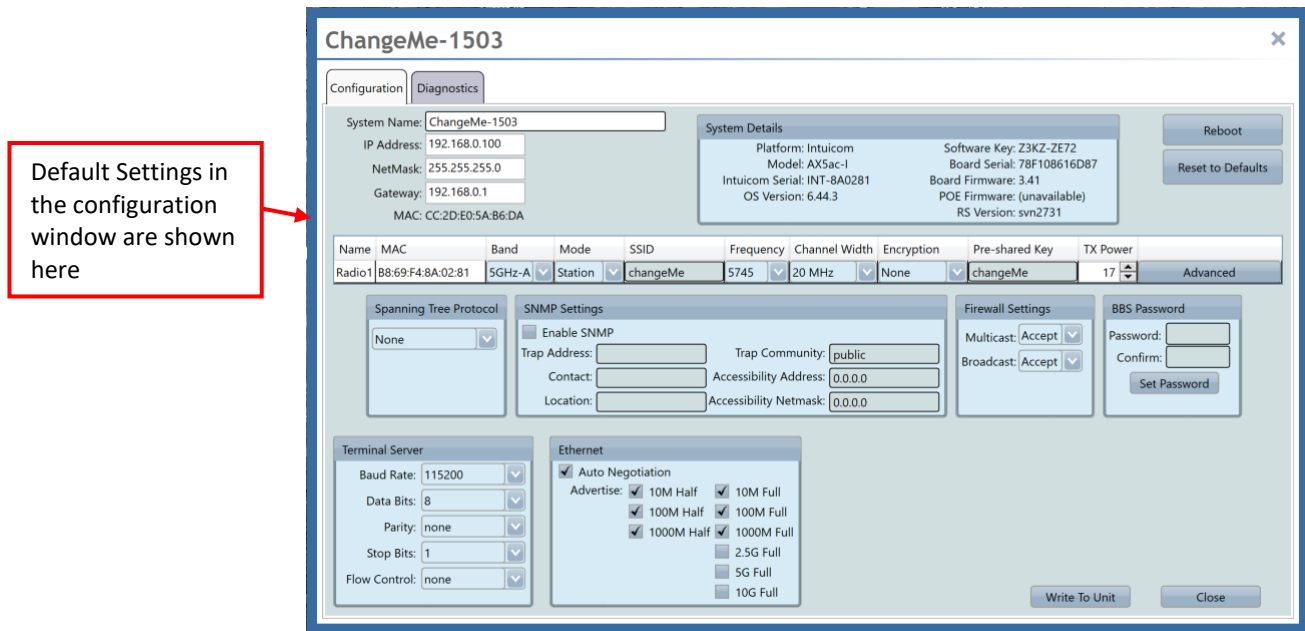
The radio will automatically be discovered and the software should look like the following screen shot.



Radio will appear under unassigned units. Double click on the unit to open the configuration window.

Hover your mouse anywhere over in the radio box and double click to open the configuration window.

Once the configuration window opens the following screen will be displayed.



ChangeMe-1503

Configuration | Diagnostics

System Name: ChangeMe-1503

IP Address: 192.168.0.100

NetMask: 255.255.255.0

Gateway: 192.168.0.1

MAC: CC:2D:E0:5A:B6:DA

System Details

Platform: Intuicom
Model: AX5ac-I
Intuicom Serial: INT-8A0281
OS Version: 6.44.3

Software Key: Z3KZ-ZE72
Board Serial: 78F108616D87
Board Firmware: 3.41
POE Firmware: (unavailable)
RS Version: svn2731

Reboot
Reset to Defaults

Name	MAC	Band	Mode	SSID	Frequency	Channel Width	Encryption	Pre-shared Key	TX Power
Radio1	B8:69:F4:8A:02:81	5GHz-A	Station	changeMe	5745	20 MHz	None	changeMe	17

Advanced

Spanning Tree Protocol: None

SNMP Settings

Enable SNMP: ☐

Trap Address:

Trap Community: public

Contact:

Accessibility Address: 0.0.0.0

Location:

Accessibility Netmask: 0.0.0.0

Firewall Settings

Multicast: Accept

Broadcast: Accept

BBS Password

Password:

Confirm:

Set Password

Terminal Server

Baud Rate: 115200

Data Bits: 8

Parity: none

Stop Bits: 1

Flow Control: none

Ethernet

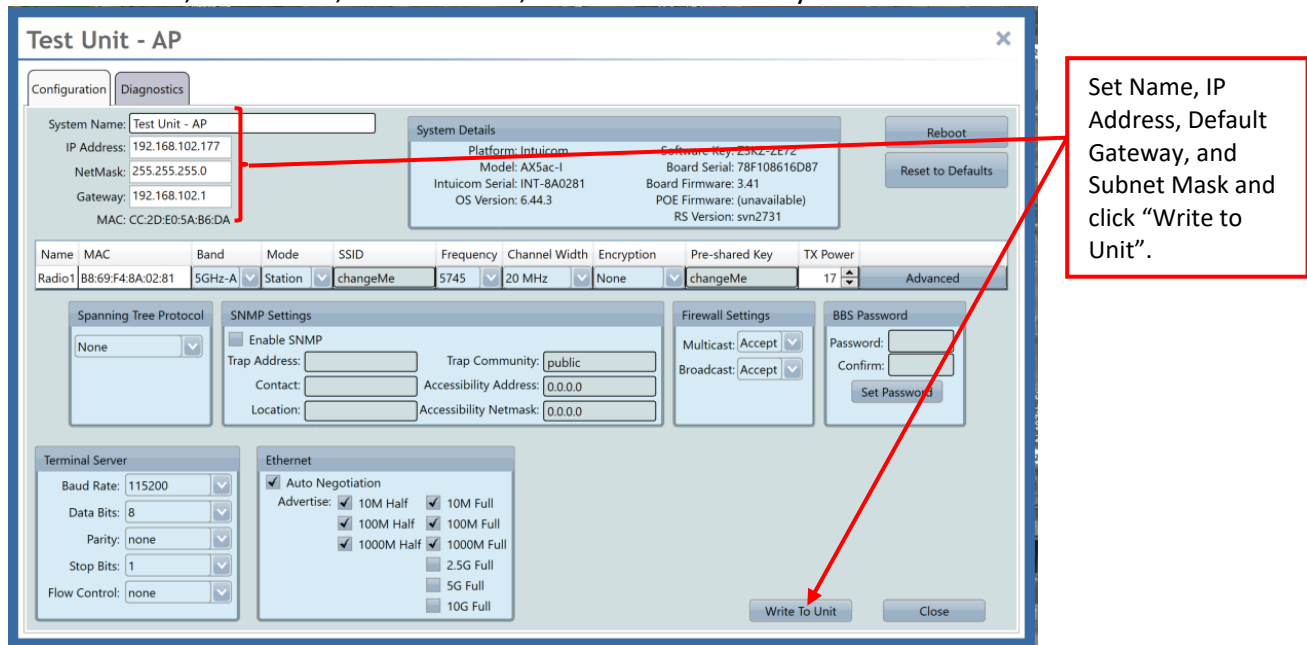
Auto Negotiation: ☒

Advertise: ☒ 10M Half ☒ 10M Full ☒ 100M Half ☒ 100M Full ☒ 1000M Half ☒ 1000M Full

2.5G Full ☐ 5G Full ☐ 10G Full ☐

Write To Unit Close

Set the Name, IP Address, Subnet Mask, and Default Gateway and click write to unit.



Test Unit - AP

Configuration | Diagnostics

System Name: Test Unit - AP

IP Address: 192.168.102.177

NetMask: 255.255.255.0

Gateway: 192.168.102.1

MAC: CC:2D:E0:5A:B6:DA

System Details

Platform: Intuicom
Model: AX5ac-I
Intuicom Serial: INT-8A0281
OS Version: 6.44.3

Software Key: Z3KZ-ZE72
Board Serial: 78F108616D87
Board Firmware: 3.41
POE Firmware: (unavailable)
RS Version: svn2731

Reboot
Reset to Defaults

Name	MAC	Band	Mode	SSID	Frequency	Channel Width	Encryption	Pre-shared Key	TX Power
Radio1	B8:69:F4:8A:02:81	5GHz-A	Station	changeMe	5745	20 MHz	None	changeMe	17

Advanced

Spanning Tree Protocol: None

SNMP Settings

Enable SNMP: ☐

Trap Address:

Trap Community: public

Contact:

Accessibility Address: 0.0.0.0

Location:

Accessibility Netmask: 0.0.0.0

Firewall Settings

Multicast: Accept

Broadcast: Accept

BBS Password

Password:

Confirm:

Set Password

Terminal Server

Baud Rate: 115200

Data Bits: 8

Parity: none

Stop Bits: 1

Flow Control: none

Ethernet

Auto Negotiation: ☒

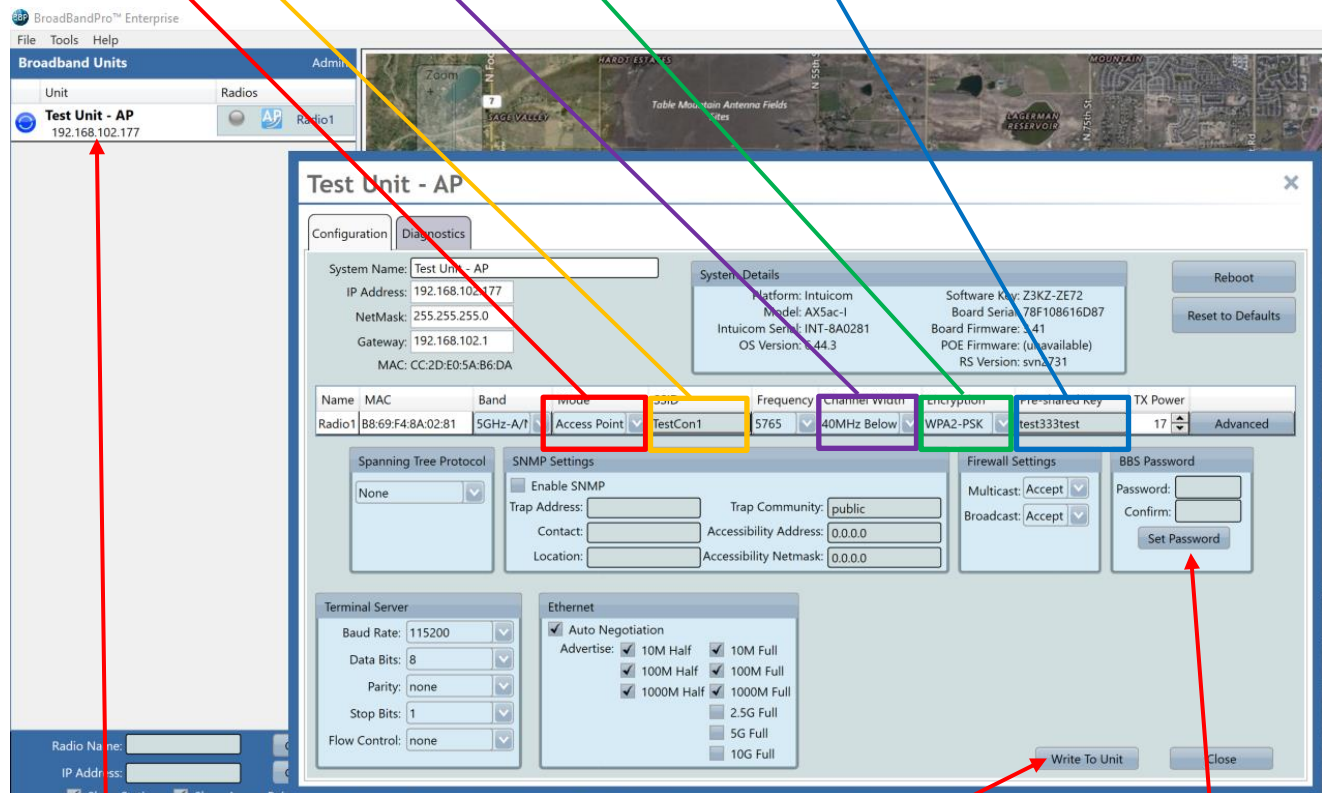
Advertise: ☒ 10M Half ☒ 10M Full ☒ 100M Half ☒ 100M Full ☒ 1000M Half ☒ 1000M Full

2.5G Full ☐ 5G Full ☐ 10G Full ☐

Write To Unit Close

Next step is to program the wireless settings on the radio.

Set the **Mode**, **SSID**, **Channel Width**, **Encryption**, and **Pre-shared Key**.



Once the radio is configured as an Access Point it will move up to the Broadband Units section.

Once settings are complete click "Write to Unit"

Click "Advanced" for the next step

After you have written the above settings to the radio, click on the rectangular button labeled "Advanced" next to the transmit power setting, and the Advanced Settings window will come up.

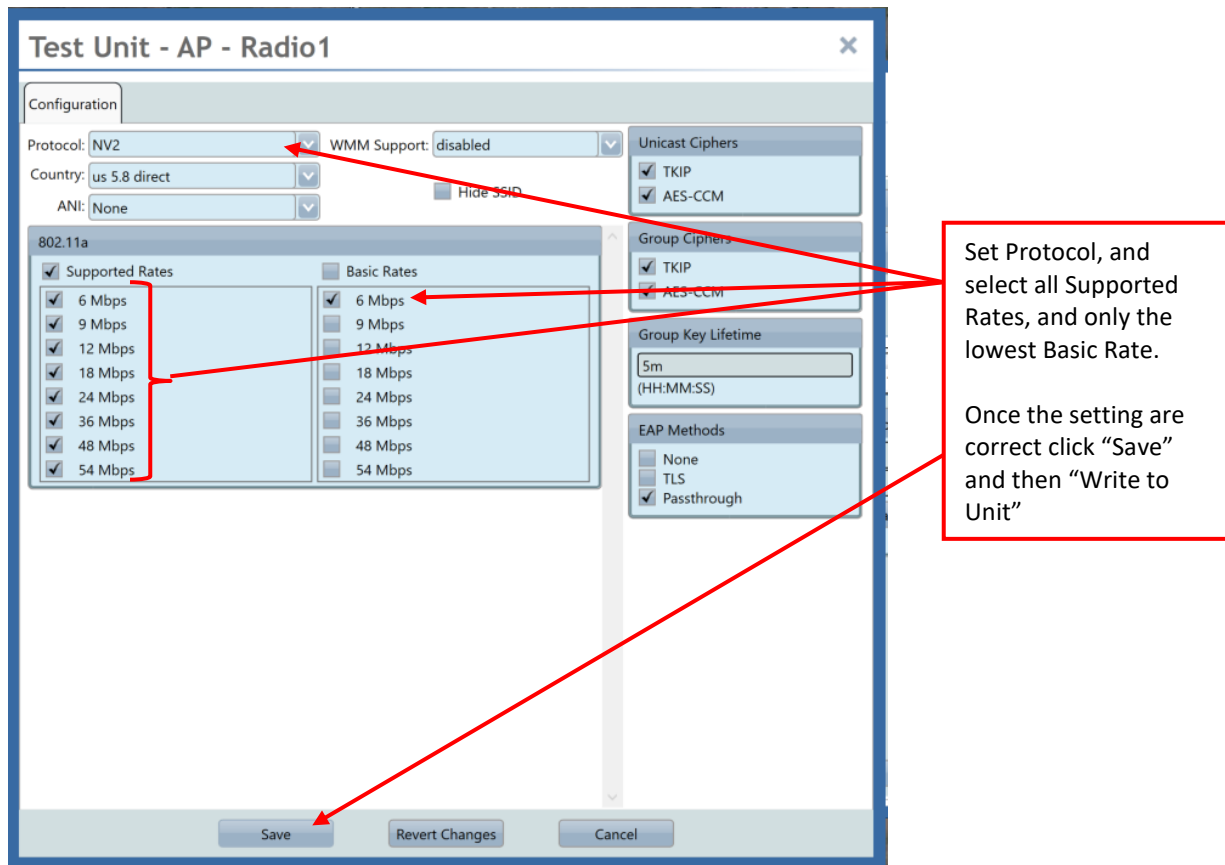
Settings on the Advanced Settings window that are of importance are the Protocol, as well as the Supported and Basic rates.

One of the settings that must match for radios to form a wireless connection is the protocol. In the Advanced Settings screen, the setting at the top left of the window is Protocol. The drop down contains five selections which are, 802.11, NV2, Nstreme, Any, and Unspecified.

Intuicom does not recommend using Any, or Unspecified as a wireless protocol setting. It is recommended that a single protocol be used for wireless connectivity.

For most wireless connections Intuicom suggests using the NV2 protocol. With the exception of the Axiom AC radios, for those the suggested protocol is 802.11.

We also recommend that all the supported rates are selected and only the lowest basic rate is selected.



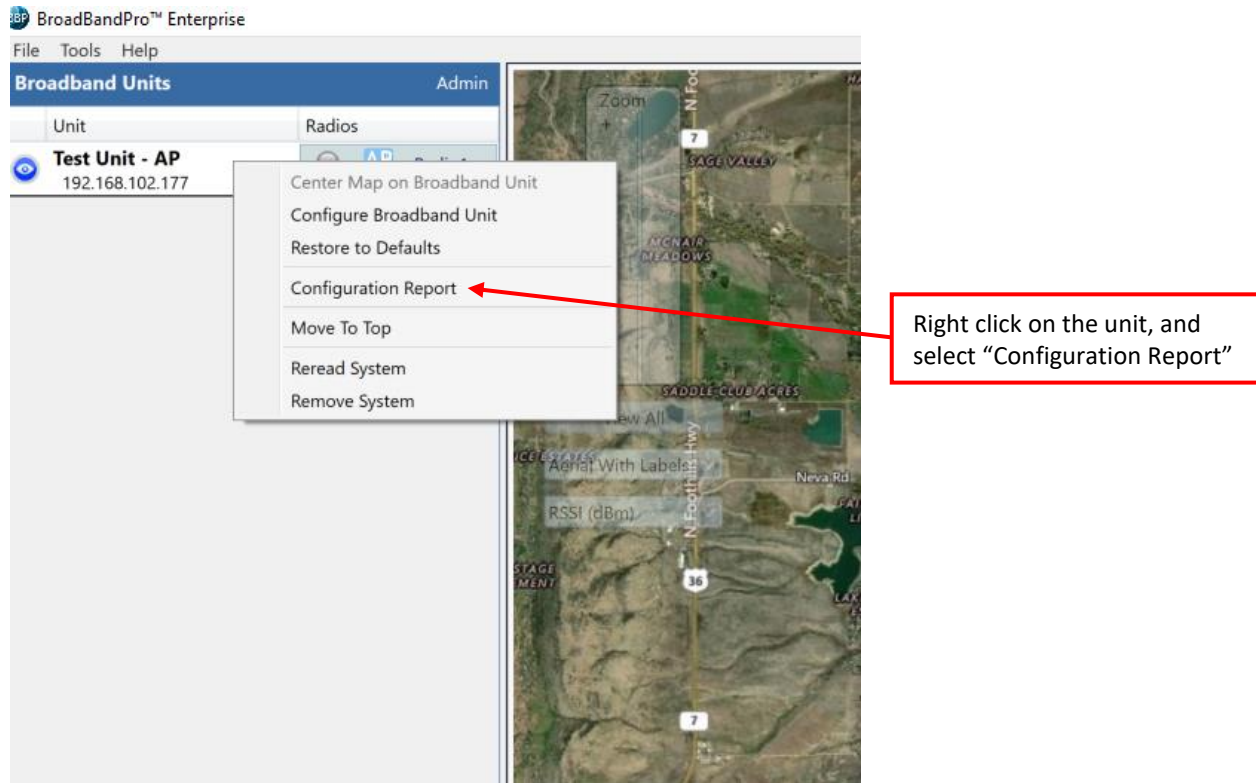
Once the advance settings are correct click Save, and then from the configuration window click Write to Unit.

At this point the Access Point radio should be fully configured and ready to plug in another unit to configure as the Station to the Access Point.

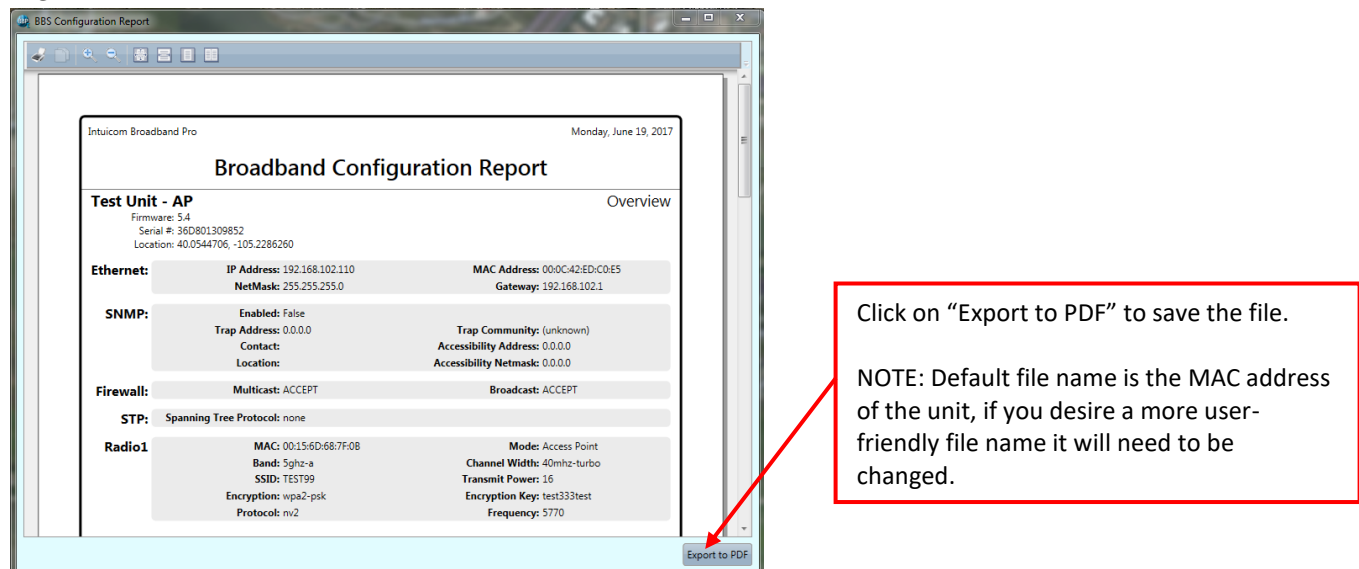
There are two ways that users can configure the station.

First method is to document the settings of the Access Point that was previously configured and then connect the Station radio to the PC and configure it step by step following the above instructions with the only exception being that the Mode is set to Station.

To document the settings of a radio in BroadbandPro™ Enterprise right click on the unit in the column on the left and select “Configuration Report”.



After you click on the “Configuration Report” link the report will pop up and in the lower left corner of the window is a link to “Export to PDF”. Click on this link to save the Configuration report as a PDF file.



Drag and Drop Configuration

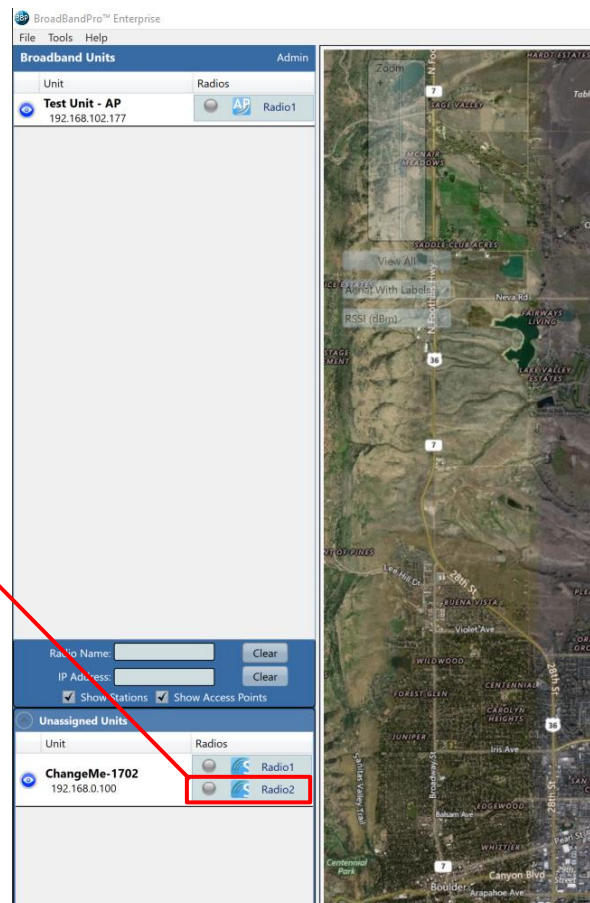
The second option for configuring a Station radio is to use a switch or hub between the PC and radio, this will allow you to connect to the first radio and configure it as an Access Point by following the previous instructions, and then plug in the Station radio at default configuration to the same switch, and drag and drop it onto the Access Point radio. See illustration below.



By connecting up both radios to the switch you will be able to see both in the BroadbandPro™ Enterprise Software, and take advantage of the drag and drop feature that will allow you to program all the wireless settings with two simple steps.

With the default radio plugged into the switch as well as the preconfigured Access Point, the software will appear like the screen shot that follows.

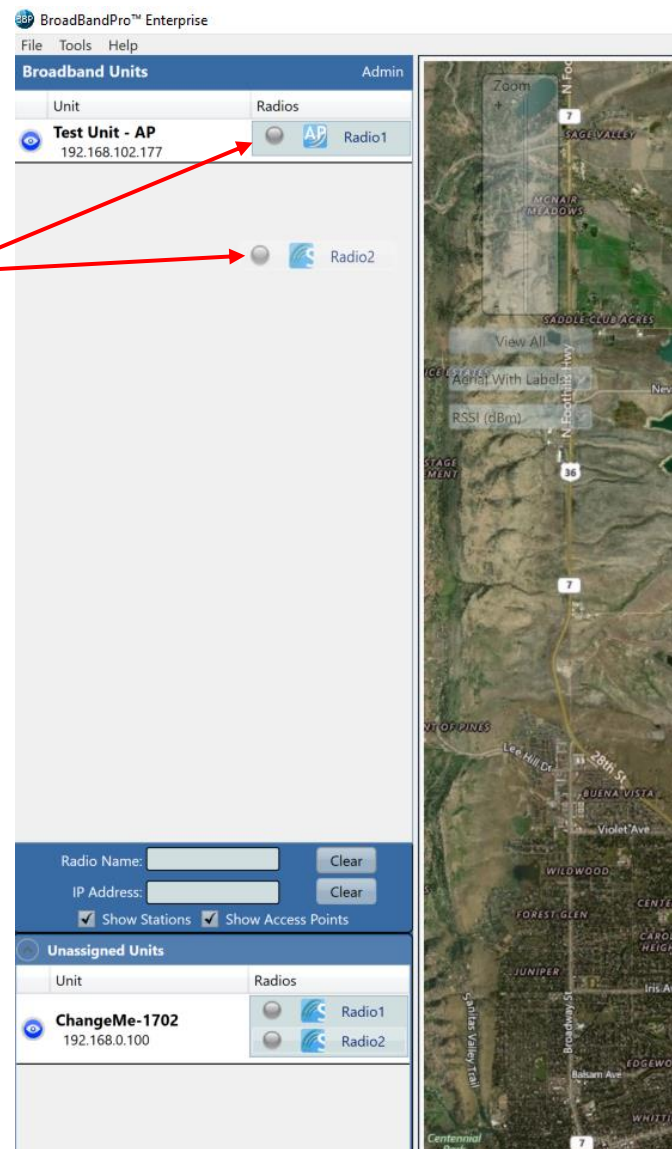
Once the default unit appears under Unassigned Units, click anywhere in the light blue area with the gray dot, the "S" icon where it reads "Radio1" or "Radio2" and drag the radio up and drop it on the radio you wish to connect it with.



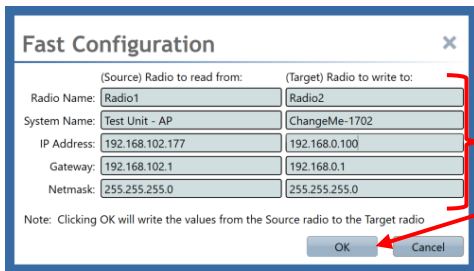
NOTE: The Radio is dragged and dropped onto the radio that you want to connect it with. This is done this way so that users can drag multiple radios to the appropriate radio they want to connect it with. An example is if you are using a Dual unit with two radios in it, you will need to drag the radio in the station to the appropriate radio in the Dual where you want it to connect, or vice versa.

Simply click and hold and drag the radio up to the Access Point radio where you want it to connect, and drop it. A dialogue box will pop up, and you will need to fill out the unit Name, IP Address, Subnet Mask and Default Gateway and click “OK”. Once you have clicked OK, all the wireless settings that have been programmed into the Access Point will be automatically written to the Station unit.

Drag the radio up and match up the gray dot on the Access Point radio you want to connect with, to the gray dot on the station radio you want to write the settings to and release the mouse button.



When the “Fast Configuration” window pops up, set the name and network settings and click “OK”



Fast Configuration

(Source) Radio to read from: (Target) Radio to write to:

Radio Name:	Radio1	Radio2
System Name:	Test Unit - AP	ChangeMe-1702
IP Address:	192.168.102.177	192.168.0.100
Gateway:	192.168.102.1	192.168.0.1
Netmask:	255.255.255.0	255.255.255.0

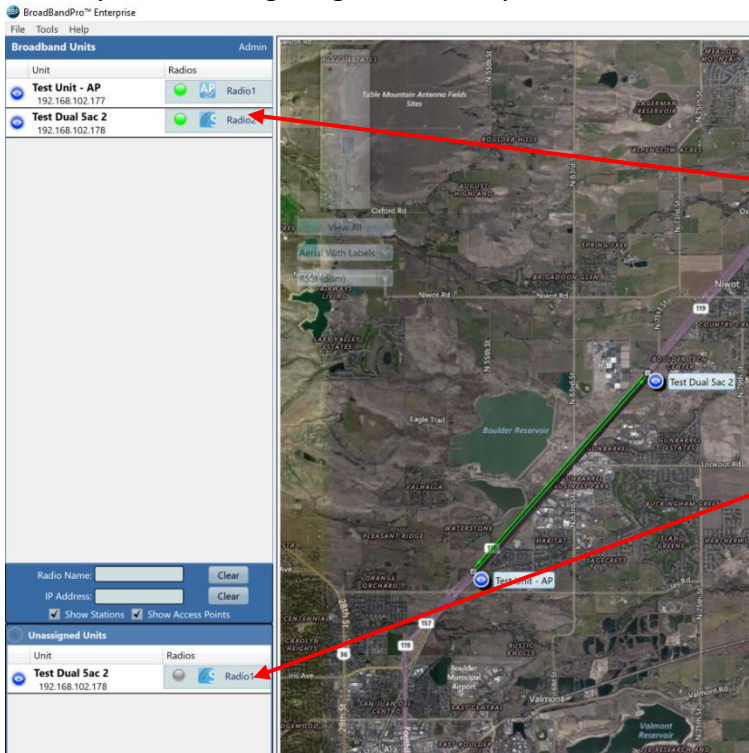
Note: Clicking OK will write the values from the Source radio to the Target radio

OK Cancel

Fill out the System Name, IP Address, Gateway, and Netmask and click "OK" write the settings along with all wireless setting from the Access Point to the Station unit.

Once the radio has the settings written to it, it will pop up under the Broadband Units column and display as a Station with the S icon on it.

WARNING: Once the wireless settings have been written to the station unit, if two radios are close enough together to form a wireless link you will then have a loop, as both units are connected to the switch as well as the wireless connection. To keep this from taking down the local area network where you are configuring the radios, you will need to unplug one of the two radio from the switch.



Newly programmed Station after drag and drop configuration will display in the "Broadband Units" column.

NOTE: When a radio is set up as a Station and it is not connected to an Access Point it will remain under Unassigned Units until it is connected to an Access Point. This applies to any radio in a dual unit as well as single units.

If you have a large deployment with Access Point radios that will have multiple stations connected to each unit, the drag and drop feature of BroadbandPro™ Enterprise software will save a considerable amount of time with programming the radios.

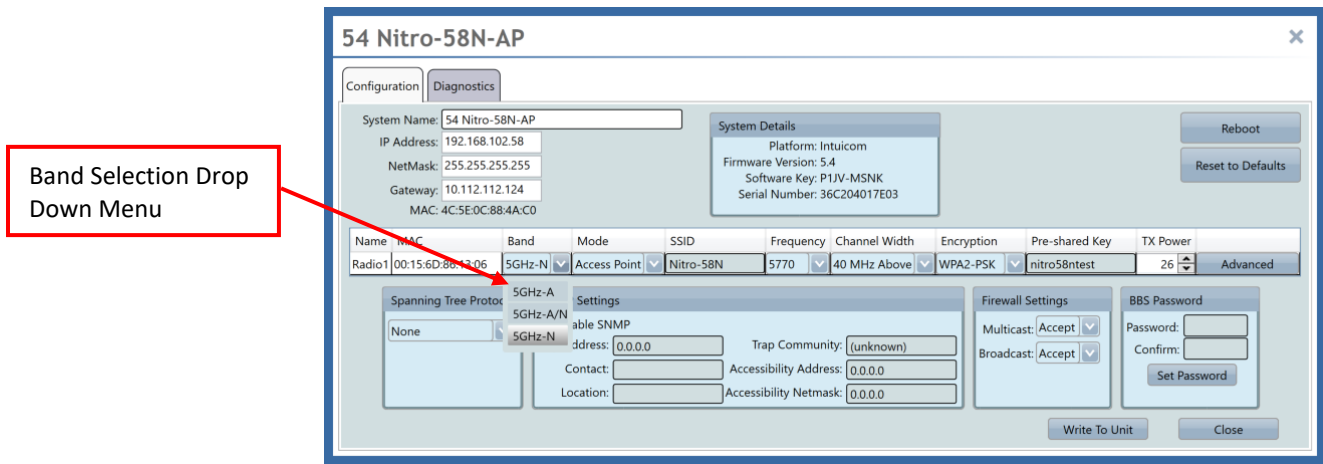
At this point the radios should be configured and ready to deploy. By preconfiguring radios in the lab or shop, when deploying them the only things that will need to be adjusted are the Transmit Power and physical alignment.

Additional Information

A few additional details that will make it easier for users to program Intuicom radios for the first time are covered here in this section.

Band Settings

In the main configuration window, the “Band” now has a drop down with different selections.



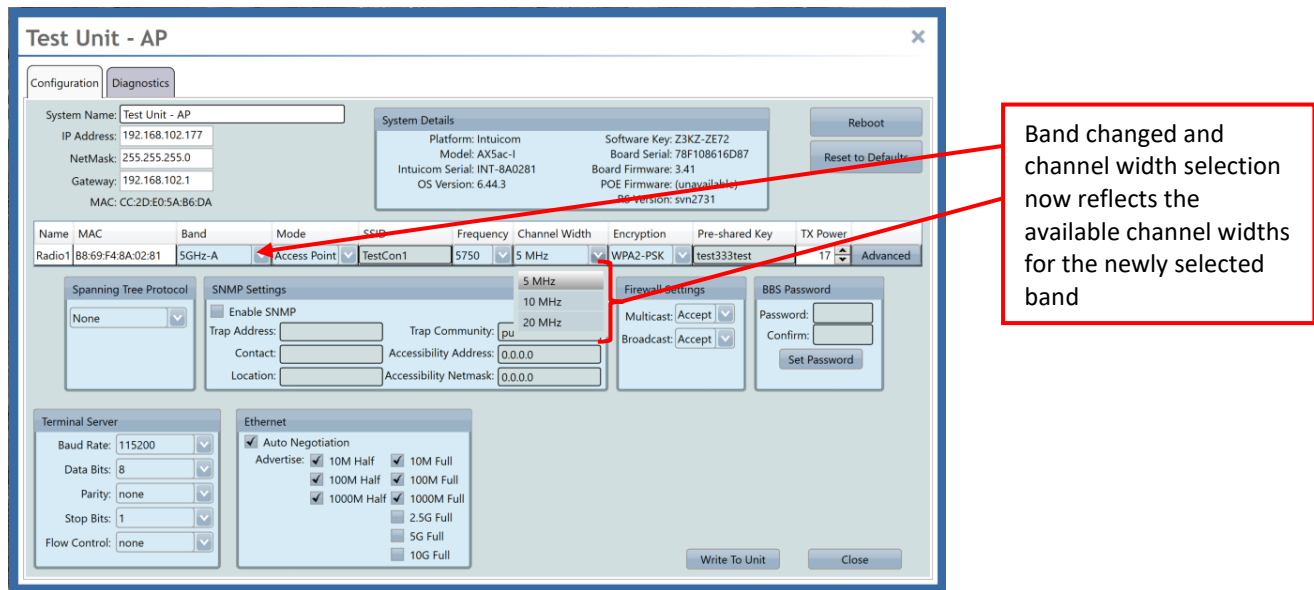
The Following table shows the different band selections that are available in the legacy and new broadband products available from Intuicom. Products are listed by family type which includes all models for the type designation. For example, the BBS family of products includes BBS-AP58, BBS-AP585858, BBS-AP5858, BBS-SA58, and BBS58. The reason that these are listed by product family is because each family of products contains the same radio modules so the band selection for all the products will be the same.

Product	Available Bands
BBX5 Family	5GHz-A, 5GHz-A/N, and 5GHz-N
BBX2 Family	2GHz-B, 2GHz-G, 2GHz-N, 2GHz-B/G, 2GHz-G/N
BBX4 Family	5GHz-A, 5GHz-A/N, and 5GHz-N
AX5 Family	5GHz-A, 5GHz-A/N, and 5GHz-N
AX2 Family	2GHz-B, 2GHz-G, 2GHz-N, 2GHz-B/G, 2GHz-G/N
AX4 Family	5GHz-A, 5GHz-A/N, and 5GHz-N
AX5ac Family	5GHz-A, 5GHz-N, 5GHz-AC, 5GHz-A/N, 5GHz-N/AC, and 5GHz-A/N/AC
Legacy Product	Available Bands
BBS 58 Family	5GH-A
Nitro 58 Family	5GHz-A
Nitro 58n Family	5GHz-A, 5GHz-A/N, and 5GHz-N
BBS 24 Family	2GHz-B, 2GHz-G, and 2GHz-B/G (Only G Rates available for programming)
BBS 49 Family	5GHz-A

For most installations, the default Band setting will work. The typical reason for changing the band is to program the Axiom or the BBX products to connect to a legacy product like the BBS-58 or Nitro-58 product. For these installations, the 5GHz-A band will be the appropriate selection.

Additionally, when changing the band from the default selection the Channel Width drop down will change to reflect the available settings for the new band setting.

The example below is using an Axiom 5ac radio. The band has been changed to 5GHz-A and the Channel Width drop-down menu now reflects the available channel widths for the selected band



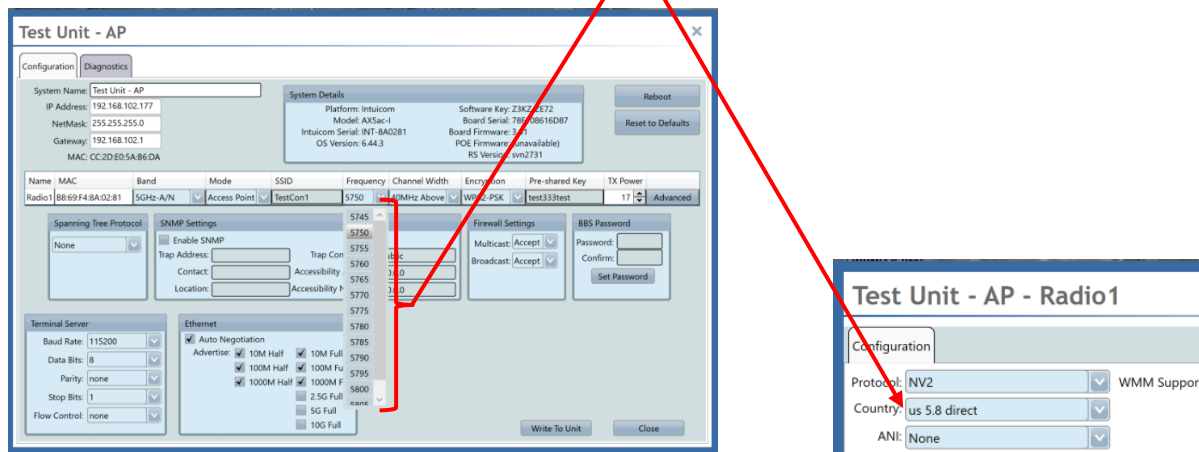
The screenshot shows the 'Test Unit - AP' configuration window. The 'Configuration' tab is active. The 'System Name' is 'Test Unit - AP'. The 'IP Address' is '192.168.102.177', 'NetMask' is '255.255.255.0', and 'Gateway' is '192.168.102.1'. The 'MAC' is 'CC:2D:E0:5A:B6:DA'. The 'System Details' section shows the platform as 'Intuicom', model as 'AX5ac-1', and board serial as '78F108616D87'. The 'Band' is set to '5GHz-A' and the 'Channel Width' is set to '5 MHz'. A red box highlights the 'Band' and 'Channel Width' settings, with a callout indicating that the channel width selection now reflects the available options for the newly selected band.

Frequency Selections

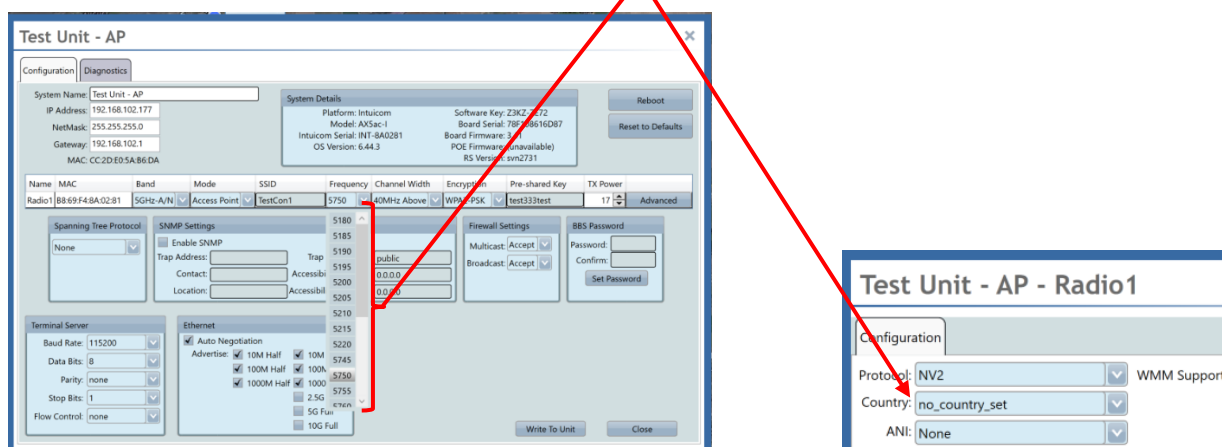
When different channel widths are selected the Frequency, drop-down menu will also change to reflect the available frequencies for the band and channel width selected.

When using the 5GHz (BX5, AX5, or AX5ac) radios changing the country code on the Advanced settings window will also change the list of available frequencies in the drop-down menu to include the available frequencies in the 5175 to 5260 range. This may be necessary so that multiple radios at a single location can be programmed to not interfere with each other when 40 MHz wide channels are being used.

On the Advanced settings window when us 5.8 direct country code is selected the Frequency drop down list displays the range from 5745 to 5805 which is the available range for the 40MHz Above channel selection.



On the Advanced settings window when no_country_set country code is selected the Frequency drop down list displays the range from 5180 to 5220 as well as the 5745 to 5805 which is the available ranges for the 40MHz Above channel selection.



NOTE: This does not apply to 4.9 and 2.4 GHz radios, as these spectrums only have one range.

WARNING - When selecting the frequency for any wireless link the setting on the Access Point is what the radios will use when they communicate, and the setting on the Station if it is not set to the same frequency as the Access Point, will be incorrect. Additionally, if you have an Access Point set to "no_country_set" and it is programmed to use the a frequency in the 5175-5260 range, while the Station is set to US 5.8 Direct and programmed to use a frequency in the 5740-5830 range the wireless link will not connect. This is because the Station does not have the same frequencies available as the Access Point. They must be programmed with the same country code and frequency range to establish a connection.

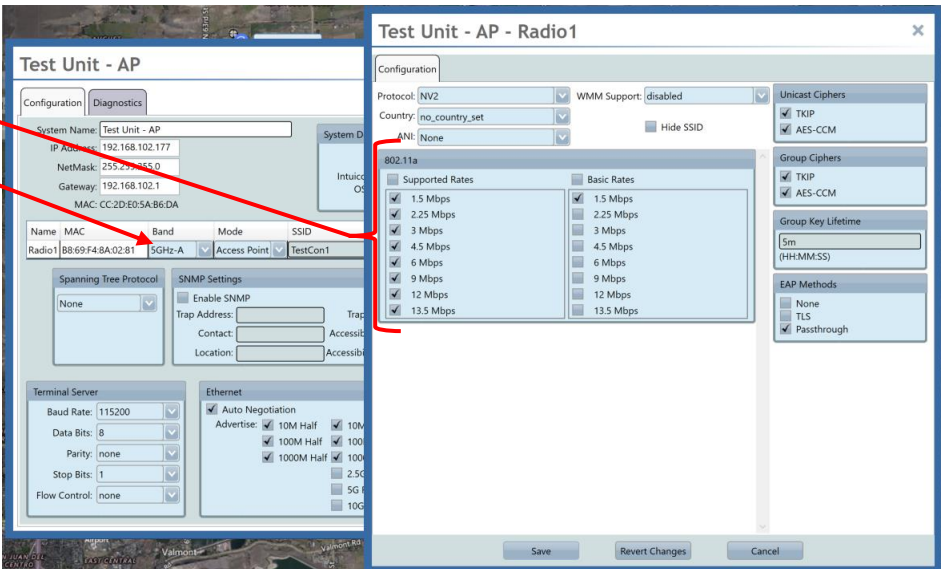
Data Rates

5GHz-A Data Rates

On the Advanced settings window the data rates selections have changed in order to reflect the available data rates for the new products. The top data rates menu allows the selection of the 802.11a data rates. These are the data rates that are used when the band selection is set to any setting that includes 5GHz-A band.

Standard Intuicom setting still applies as we suggest to select all the Supported Rates and only the lowest basic rates as a good starting point.

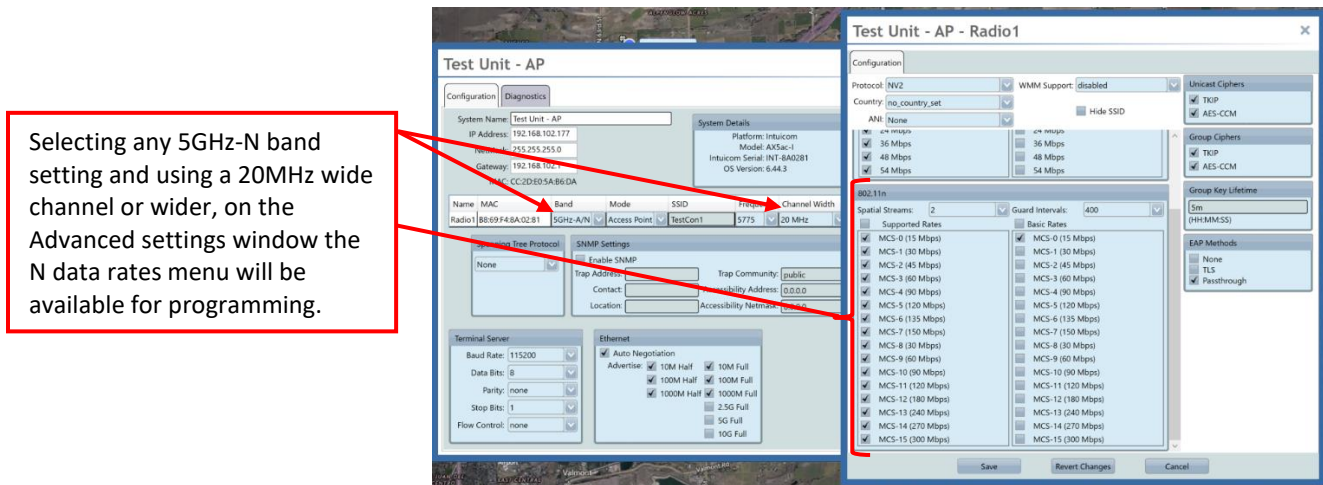
Any band selection with 5GHz-A in the band will display the 802.11a data rates menu. This is the menu that will be used to program the data rates for 802.11a radio connections.



The screenshot shows the Intuicom configuration interface. The main window is titled 'Test Unit - AP' and contains various configuration tabs like Configuration, Diagnostics, and System. The 'Radio1' window is open, showing the '802.11a' data rates menu. The 'Band' dropdown is set to '5GHz-A'. The 'Supported Rates' section is checked, and the 'Basic Rates' section is also checked. The 'Radio1' window also shows other settings like Protocol, Country, and WMM Support.

5GHz-N Data Rates

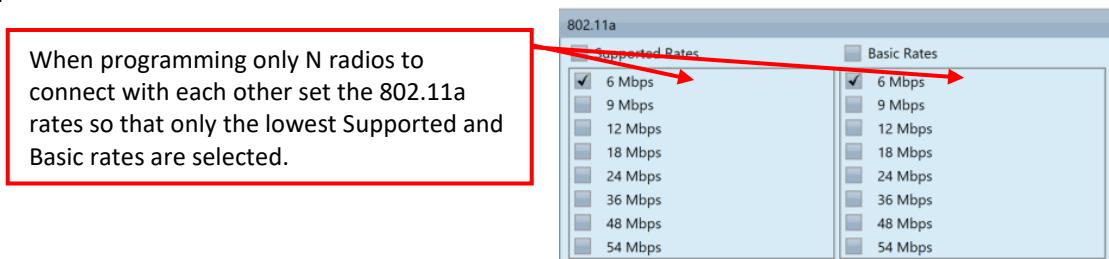
If you select any band that includes 5GHz-N then the data rates menus will change and the 802.11n Data Rates menu will be displayed. **NOTE:** If you select 5GHz-A/N the 802.11n menu will not appear when you have 5MHz and 10MHz wide channel widths selected. **Only 20MHz and wider channels use the 802.11n data rates.**



Intuicom recommends that all of the Supported Rates should be selected with only the lowest Basic Rate as a good starting point.

If you are connecting N radios only together then Intuicom suggests unchecking all the 802.11a data rates for both Supported and Basic rates with the exception of the lowest setting for both.

Example:



NOTE: If you are programming N radios to connect to both A and N radios then you will need to check off all or some of the 802.11a data rates because these are what the A radios will use when connected to an N radio.

N Data Rates are listed as MCS rates. These data rates are termed HTMCS which stands for High Throughput Multiple Coding System. It is these data rates that allow the 40MHz Above or Below channel widths to run up to 300Mbps maximum throughput.

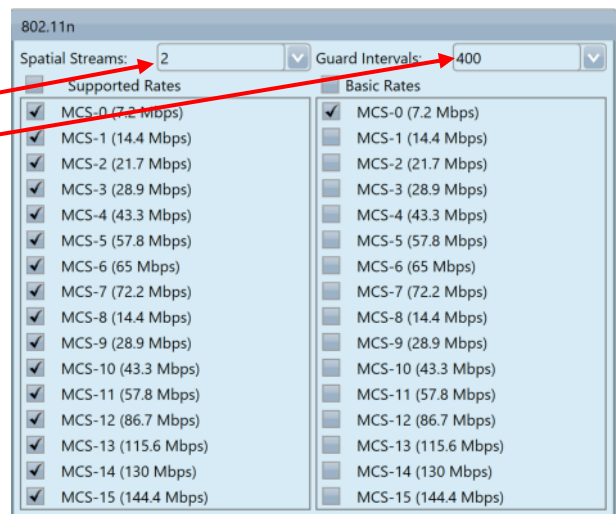
Additional N Data Rate Settings

There are two other settings in the 802.11n menu that need to be addressed:

First – Spatial Streams – when set to 1 only MCS 0 through 7 are available. When set to 2 MCS 0 through 15 are available. For high throughput wireless links always set this to “2” from the drop-down menu.

Second – Guard Interval – N radios have two antennas, a horizontal and vertical antenna in one. The Guard Interval is the amount of time in nano seconds that the radio takes to switch from one antenna to the other. The two selections are 400ns and 800ns – The faster the switching time between antennas the higher the throughput on the wireless link. For high throughput wireless links always set this setting to 400.

For highest throughput on the wireless link set Spatial Streams to 2, and Guard Interval to 400.



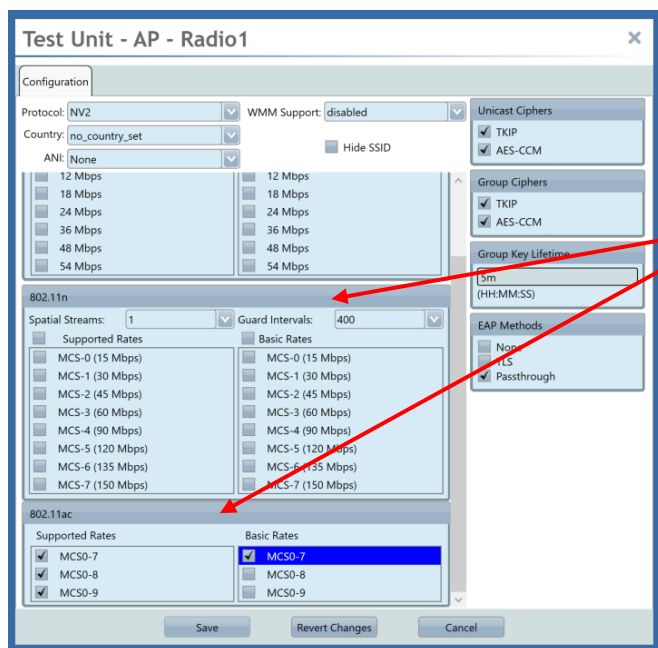
5GHz-AC Data Rates

If you select any band that includes 5GHz-AC then the data rates menu will change and the 802.11ac data rates menu will appear. This will appear below the 802.11n menu discussed in the previous section.

When the AC band is selected you will notice that the 5, 10, and 20MHz wide channel selections disappear. This is because they are not available when using the 802.11ac band. On the Advanced window at the bottom below the 802.11n data rates the 802.11ac data rates will appear.

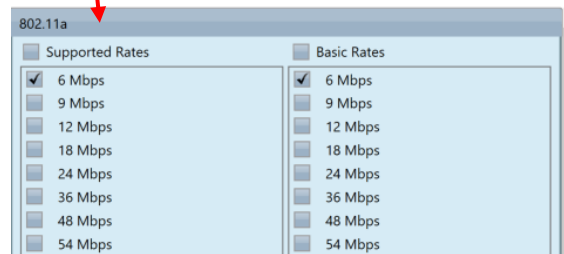
In a similar manner to how the N data rates are configured you will need to deselect all the 802.11a rates with the exception of the lowest basic and supported rates. Additionally, deselect all the 802.11n data rates, and check off all the supported 802.11ac rates and only the lowest basic rate.

NOTE: Best bandwidth results were achieved using the 802.11 protocol, and matching MCS0-7 on both the basic and supported rates, leaving MCS0-8 and MCS0-9 unselected.



For the 802.11ac Data Rates select all the Supported Rates and only the lowest Basic Rates.

Deselect all the 802.11n Data Rates
Select only the lowest 802.11a Supported and Basic Rates (cut off on the screen shot – See below)

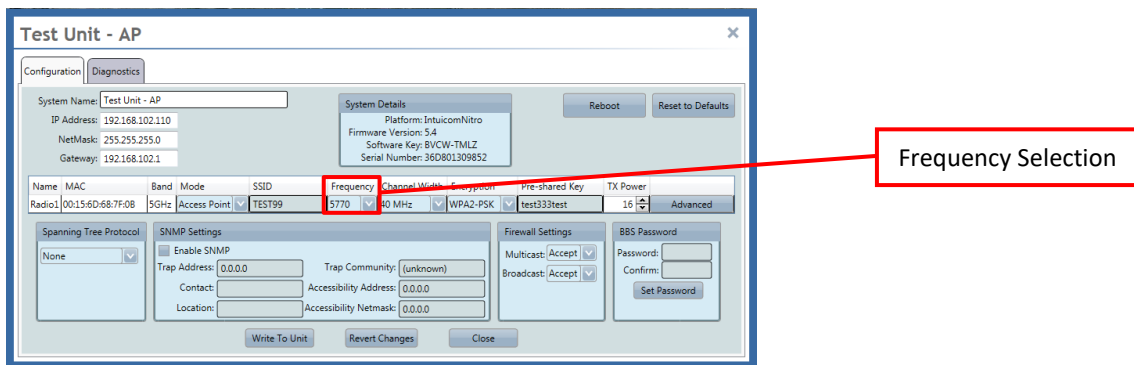


Frequency Separation

If your deployment has multiple Access Point radios in a single location, or more than one radio at an intersection you will need to know how to program the radios so that the frequencies are separated and do not interfere with each other.

Intuicom recommends a 5MHz separation between each radio IF possible.

In the previous “Frequency Selection” section of this document the change in available frequencies was explained. In this section we will cover how to program the frequencies. The frequency drop-down menu is shown in the image below.



In the “Required Settings” section of this document programming of the radios was covered and one of the settings that is required to form a wireless link between two radios is “Channel Width”. The channel width selection has grown with the addition of 802.11n and 802.11ac radios, combined with new regulations allowing 802.11n channel widths in the 2.4GHz and 4.9GHz spectrums. The following is a list of new and legacy Intuicom products and the available channel widths for each.

New	802.11a Channel Widths	802.11n Channel Widths	802.11ac Channel Widths
BBX5	5, 10MHz	20, 40MHz Above & Below	None
BBX2	5, 10MHz	20, 40MHz Above & Below	None
BBX4	5, 10MHz	20, 40MHz Above & Below	None
AX5	5, 10MHz	20, 40MHz Above & Below	None
AX2	5, 10MHz	20, 40MHz Above & Below	None
AX4	5, 10MHz	20, 40MHz Above & Below	None
AX5ac	None	20, 40MHz Above & Below	20/60MHz Above 40/40MHz Above 60/20MHz Above 20/60MHz Below
Legacy	802.11a Channel Widths	802.11n Channel Widths	802.11ac Channel Widths
BBS-58	5, 10, 20, 40MHz	None	None
Nitro-58	5, 10, 20, 40MHz	None	None
BBS-24	5, 10, 20, 40MHz	None	None
BBS-49	5, 10, 20, 40MHz	None	None
Nitro-58n	5, 10MHz	20, 40MHz Above & Below	None

802.11a Frequency Selections

For the 802.11a radios the association between channel width and frequency is pretty simple. Whatever frequency you use, it is at the center of the channel width you selected.

Example: Frequency of 5760 using a 40 MHz wide channel means that the radio will be using from 5740 to 5780 for communications. If it were a 20MHz wide channel at 5760 it would be using 5750 to 5770 frequency range for communications.

An example of frequency selections for 4 different radios in a single location using 20MHz wide channels is shown below:

5735

Radio1 = 5745 Center
5755
Separation = 5 MHz

Radio2 = 5760
5770 Center
5780
Separation = 5 Mhz

Radio3 = 5785
5795 Center
5805
Separation = 5 MHz

Radio4 = 5810
5820 Center
5830

802.11n Frequency Selections

For 802.11n radios the association between channel width and frequency is a bit more complicated. For the 5, 10, & 20MHz wide channel widths the explanation of the 802.11a frequency separation applies. The difference comes in when using the 40MHz Above or 40MHz Below setting.

The 802.11n radios are 2x2 MIMO (multiple in multiple out) radios. Which on a mechanical level means that the radio module has two antenna connectors on it, and the antenna has two connectors on it, and the antennas are literally two in one, where they have vertical (Channel0) and horizontal (Channel1) antennas built into one device. This setup relates to channel width when selecting the 40MHz Above or Below settings where each component of the antenna (vertical or horizontal) has a 20MHz wide channel associated with it. The relationship of the frequency selection is that the first 20MHz wide vertical channel (Channel0) is centered around the selected frequency and the additional 20MHz wide channel (Channel1) is either above it or below it depending on the selection.

Example: Selecting 5750 using 40MHz Above selection means that the vertical channel (Channel0) is using 5740-5760 for communications, and the horizontal channel (Channel1) is using from 5760-5780. So, the radio is using from 5740-5780 for communications.

An example of frequency selections for 2 802.11n radios at a single location using 40MHz wide channels is given below is given below.

Radio1 @40MHz Below =	5740	
Channel1	5750	
	5760	
	5760	
Channel0	5770	Center
	5780	
10MHz Separation		
Radio2 @40MHz Above =	5790	
Channel0	5800	Center
	5810	
	5810	
Channel1	5820	
	5830	

From the example above you can see that two 802.11n radios both set to 40MHz wide channels will use up almost the entire upper band of the 5.8GHz spectrum. If there is a need to add a third radio at the same location, the use of the country code “no_country_set” covered in the previous “Frequency Selection” section of this document will need to be utilized in order to open up the lower portion of the 5.8GHz spectrum for use. This will provide enough spectrum to separate 3 radios and keep them from interfering with each other.

If you are daisy chaining wireless links down a road from intersection to intersection every three links will require the reuse of frequencies. The assumption being that links are far enough apart that by the time a frequency is reused it is far enough away from the first radio link using that frequency that interference is minimal to none at all.

802.11n Radios and 2.4GHz Frequency Seperation

The 2.4GHz spectrum runs from 2407MHz up to 2467MHz. When setting the channel width to 40MHz Above your selections are limited to 2422 to 2437, and when setting the channel width to 40MHz Below your selections are limited to 2442 to 2457. Given these selections it is impossible to have two 2.4 GHz radios using 40MHz wide channels at a single location without them interfering with each other.

Example: Radio1 @ 40MHz Above set to 2422 runs from 2412-2452, Radio2 @ 40MHz Below set at 2457 runs from 2567-2427. This means both radios will be using the 2452-2427 portion of the spectrum and interfering with each other.

Intuicom suggests using 5, 10, and 20MHz wide channel widths when deploying multiple 2.4GHz radios at a single location to ensure channel separation is achieved.

802.11n Radios and 4.9GHz Frequency Separation

Much like the 2.4GHz spectrum the 4.9GHz public safety spectrum is quite narrow. The spectrum runs from 4940-4990MHz. Likewise, when using a 40MHz Above channel width your frequency selection is limited to 4950-4960, and when you are using a 40MHz Below setting your selection is limited to 4970-4980. So again, there is no way to separate two radios at a single location using the 40MHz wide channel widths.

Example: Radio1 @ 40MHz Above set at 4950 runs from 4940-4980, and Radio2 @ 40MHz Below set at 4980 runs from 4950-4990. This means that from 4980-4950 the radios will be interfering with each other.

Again: Intuicom suggests using 5, 10, and 20MHz wide channel widths when deploying multiple 4.9GHz radios at a single location to ensure channel separation is achieved.

802.11ac Frequency Separation

For the 802.11ac radios to achieve the 866Mbps throughput over the wireless link requires the use of 80MHz wide channels. These are also 2x2 MIMO radios and use 2 channels per antenna to achieve the higher data rates. So, the frequency usage depending on the channel selection can be quite complicated. A table of the channel widths and the frequency usage is shown below.

Examples: Frequency Usage

20/60MHz Above @ 5765 Frequency Setting =

	5755	
Channel0	5765	Center
	5775	
Channel1	5785	
	5795	
Channel2	5805	
	5815	
Channel3	5825	
	5835	

40/40MHz Above @ 5765 Frequency Setting =

	5735	
Channel0	5745	
	5755	
Channel1	5765	Center
	5775	
Channel2	5785	
	5895	
Channel3	5805	
	5815	

60/20MHz Above @ 5785 Frequency Setting =

	5735	
Channel0	5745	
	5755	
Channel1	5765	

		5775	
	Channel2	5785	Center
		5795	
	Channel3	5805	
		5815	
20/60MHz Below @ 5805 Frequency Setting =		5735	
	Channel0	5745	
		5755	
	Channel1	5765	
		5775	
	Channel2	5785	
		5795	
	Channel3	5805	Center
		5815	

As you can see the 5.8GHz upper band runs from 5730-5850 and is only 120MHz so it is not possible to run two radios in the upper 5.8GHz spectrum without interfering with each other. Setting the radio to “no_country_set” as explained in the “Frequency Selections” section of this document will allow the use of the lower band and a radio can be programmed to function in that spectrum which would allow to 802.11ac radios at a single location and allow them to establish communications without interfering with each other.

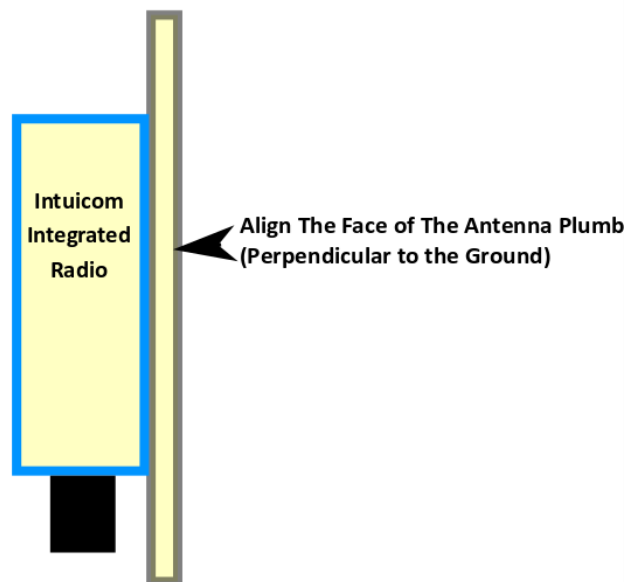
As stated earlier, when the channel width is selected the frequency selection will change to reflect the available frequencies for that channel width.

Link Optimization

Aiming the Radios

For most installations Intuicom recommends setting the face of the antenna to plumb before starting to adjust the direction of the antenna. Of course, this is not a hard rule, and tower installations, towers on top of mountains, and installations of this type will have declination and inclination angles off of plumb. However, typically Intuicom has run a link analysis on these installations and can provide the correct inclination and declination angles to align the radios. Typical steps to align two panel antennas follows below the diagram.

Antenna Alignment



Antenna Alignment Steps

With the radio programmed and connected turn the Tx Power up to maximum or 2 settings below to start.

- 1) Aim the radio as close to the desired direction as possible.
- 2) Set the radio antenna face plumb to the ground.
- 3) Check RSSI Indicator lights and in very small increments move the radio back and forth maintaining the plumb face until you get the most RSSI indicator lights to come on as possible.
- 4) Open BroadbandPro™ Enterprise software and on the right side of the interface select the Link Statistics Tab, and check the signal strength.
- 5) In very small increments move the antenna left or right and once a small adjustment has been made watch the signal strength in the software (wait 30 to 40 seconds for the software to refresh) and see if the adjustment made a difference in signal strength. Repeat the procedure until the strongest signal strength reading is obtained.
- 6) Once the left and right alignment has been optimized if it is necessary adjust the up or down alignment in very small increments until the optimum signal strength is achieved.

- 7) Lock down the radio by tightening the bolts on the mount being careful not to move the radio when doing so.

NOTE-1: Typical inclination and declination angles for installations with 1000-foot elevation difference between radios is only 5 to 6 degrees (very small angle off of plumb). For installations where the height differential is 100 feet or less the inclination angles are typically one to three tenths of a degree (.1-.3) which is basically plumb – or the bubble in a level slightly off center. So be careful not to over adjust the inclination and declination angles.

NOTE-2: Alignment takes time and the procedure may have to be repeated numerous times until the optimum RSSI Reading is obtained.

Tx/Rx RSSI Readings

RSSI stands for Receive Signal Strength Indicator. Tx is the strength of the signal that the radio is sending, and Rx is the strength it is receiving.

Signal strength is measured on a negative scale so -50 is stronger than -60. The closer to zero the stronger the signal.

Rule - If you are logged into a radio and the Tx signal is low turn up the power on the radio that you are logged into. If the Rx signal is low, turn up the power on the radio that is remote from the one you are logged into.

Optimum Signal Strength is -50 dB.

The closer you can get the signal strength to -50 reading the better. -40 to -50 is a hot signal but acceptable. -50 is the sweet spot, and -50 to -70 is an acceptable reading.

WARNING - Any RSSI reading stronger than -40 is too hot and will cause problems with the link and may damage the radio. Tx Powers should be adjusted so that signal strengths are at least in the -40dB range.

Channel Width and Signal Strength

The wider the channel the higher the bandwidth. However, the wider channels will lower your signal strength over a link when compared to the narrow channel widths.

An example of this is say you have a two-mile link, radios are aligned, and Tx Power is set to maximum. If you set the radios on a 5MHz wide channel the signal strength reading you get will typically be 5 to 10 dB stronger than the same link using a 40MHz wide channel. So, what this means to the installer is that if you are looking to get the signal strength as close to -50 reading as possible, long links may require you to drop the channel width setting down to get as close to the optimum reading as possible.

Conversely, if you have two radios close together and with the Tx Power set quite low your signal strength is still too strong, you may need to increase the channel width to decrease the signal strength.

Typical rule to remember is that long links or links with less than optimum clear line of sight will use narrow channel widths, and short links or those with perfectly clear line of sight will allow the use of the wider channel widths.

Intuicom recommends the best channel width setting is the one that allows the signal strength reading as close to the -50dB reading as possible.

The following is a general distance to channel width suggestion, in table format, and how to read the signal strength and adjust the channel width accordingly below it.

Distance between Broadband Radios	Channel Width
1 Block to a mile	40 MHz Channel
1 Mile to 3 Miles	20 MHz Channel
3 Miles to 5 Miles	10 MHz Channel
5 Miles or more	5 MHz Channel

Once in the field. Bump up the Tx Power to 26 – Maximum.

- 1) Check the RSSI. If the range is -50 to -60 leave it like that.
- 2) RSSI Range -60 to -90 choose a lower channel width until the RSSI is -40 to -60 if possible. If you cannot obtain a -60 signal strength, adjust the radio alignment at max Tx Power to achieve the strongest signal possible.
- 3) RSSI Range -40 to -50 Reduce the Tx Power or increase the Channel Width
- 4) RSSI Range -20 to -40 Increase Channel width and reduce Tx Power

****The goal is to get as close to -50 on the Tx RSSI and Rx RSSI.

CCQ Reading

CCQ stands for Client Connections Quality. This is the error checking reading on the wireless link. The value is a percentage, and it is the percentage of packets that are sent over the wireless link without retransmit. Therefore, a reading of 100% means that all the packets are making it across the wireless link and not having to be retransmitted. This is as close to a copper cable with no congestion on it as you can get. On the other end of the scale, a link with a CCQ of 20 is a bad link and the radios are having to retransmit 80% of the packets to get them across the wireless link.

Intuicom recommends a CCQ reading as close to 100 as possible.

There are three factors that effect CCQ.

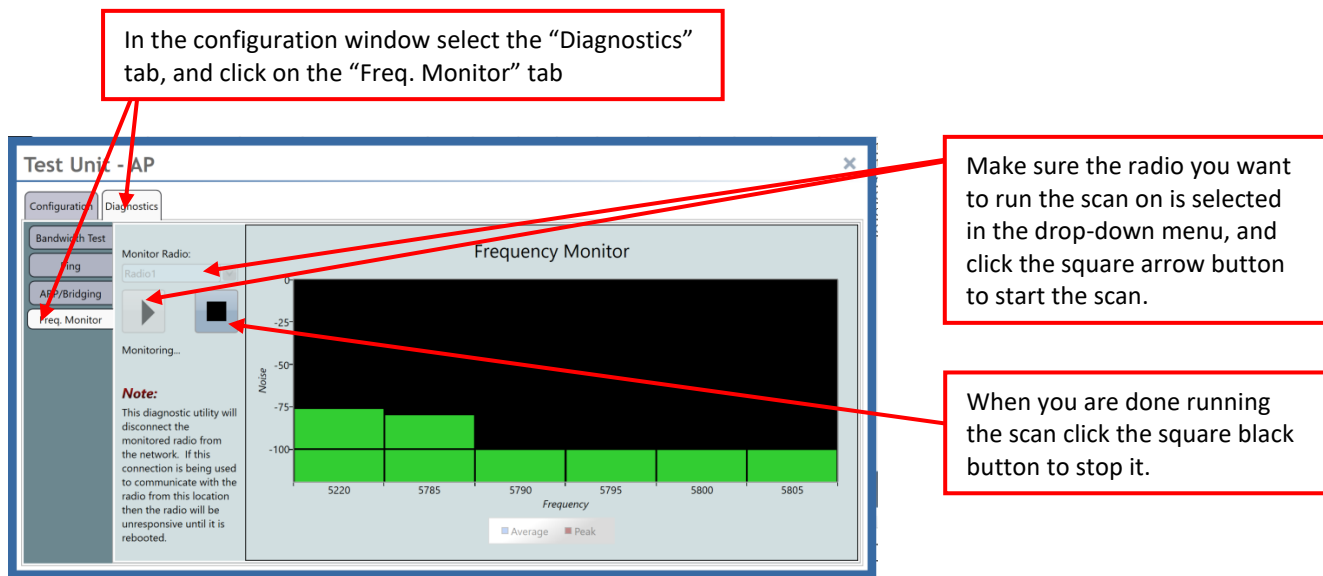
- 1) Antenna Alignment – If the antennas are not properly aligned the CCQ reading will drop.
- 2) Radio Frequency Interference – If there is a lot of RF noise on the same frequency the radio is using the CCQ reading will be low.
- 3) Signal Strength – If the signal strength is weak and the radio cannot negotiate higher data rates due to the weak signal, the CCQ will drop.

Antenna Alignment is covered in the previous section of this document.

Radio Frequency Interference can be overcome using two methods. One, make sure that radios are programmed not to interfere with each other, this is covered in the “Frequency Separation” section of this document. Second, use the frequency monitor in BroadbandPro™ Enterprise and program the radio frequency to a setting that reveals low noise in the spectrum.

To use the frequency monitor in BroadbandPro™ Enterprise open the configuration window for the radio you are programming and at the top of the window click on the “Diagnostics” tab. In the left column click on the “Freq. Monitor”, make sure the radio in the unit you want to run the spectrum scan on is selected in the drop-down menu, and click the square arrow button to start the monitor.

WARNING – Do not start the spectrum scan on a radio that you are logged into across a wireless link. Once the scan starts running the radio will drop its connections and you will need to go to the radio location and power cycle the radio to shut the scan off.



In the above example frequencies 5220 and 5785 are showing a high noise level of -75dB, while frequencies 5790, 5795, 5800, and 5805 are showing acceptable noise level or around -100 to -110dB.

NOTE: Typical noise floor is around -115dB – Between -100dB and -120dB or weaker.

Signal Strength is typically optimized by aligning the radios and adjusting the Tx power on the radio to get as close to the -50dB reading as possible.

If you are in a situation in which the link you are working on has been aligned correctly, programmed around interference, channel width is optimized, and you have the Tx power set to the maximum of 28dB, and the RSSI reading is low (-65 to -85dB range). Consequently, the CCQ reading is low, to improve it, you can adjust the data rates selection to increase the CCQ.

To adjust the Data Rates to improve the CCQ follow the steps below:

- 1) Look at the Link Stats tab and identify the link you are working on (highlighted in blue below).

Radio (AP)	MAC Address	Mode	Radio (ST)	TxRSSI	RxRSSI	TxCCQ	RxCCQ	TxRate	RxRate	TxPwr	RxPwr	Distance	Uptime	SNR	Azimuth	TxPackets	RxPackets
6432 Quad- Radio1	D4:CA:6D:03:D1:76	Access Point	6432 BBS-5824: Radio2	-28 dBm	-32 dBm	100	99	12Mbps	12Mbps	16	16	1 km	5w5d1h55m24s	74	1A*	3666325	1370406
6432 Quad- Radio2	D4:CA:6D:03:D1:76	Access Point	6408 BBS-5824: Radio2	-44 dBm	-40 dBm	99	99	3Mbps	3Mbps	17	16	1 km	5w5d1h55m23s	51	297A*	3699612	1303942
6432 Quad- Radio4	D4:CA:6D:03:D1:76	Access Point	5.4 Demo Quad- Radio2	-53 dBm	-57 dBm	74	100	24Mbps	24Mbps	24	27	1 km	1w5d4m7s	43	181A*	665086	959029
5.4 Demo Quad- Radio1	00:15:6D:6A:84:3D	Access Point	54Net1911: Radio1	-37 dBm	-35 dBm	100	99	2.2Mbps	2.2Mbps	22	22	1 km	5w5d01:55:02	66	269A*	4045502	1684580
5.4 Demo Quad- Radio4	00:15:6D:6A:84:3D	Access Point	6432 BBS-SA5858: Radio1	-47 dBm	-45 dBm	100	29	48Mbps	24Mbps	21	21	1 km	00:00:56	46	179A*	403	337
X94-54-BBS49: Radio1	00:15:6D:44:50:7F	Access Point	6432 BBS-SA4949: Radio1	-49 dBm	-55 dBm	98	100	18.0Mbps	18.0Mbps	49	8	3 km	9w6d00:56:22	48	360A*	3334188	12855300

Look at TxRate and RxRate

- 2) Look at the TxRate and RxRate columns and take note of the minimum data rates that the radios have negotiated on the wireless link. (In the example above it is 18 Mbps) If the data rates are mismatched use the lowest rate.
- 3) Open up the configuration window and click on the “Advanced” button to bring up the Advanced settings window.
- 4) On the data rates window deselect all the upper data rates down to the lowest reading from the link stats tab, and Save and Write the settings to the radio. Do this to the Access Point and the Station.

802.11a

☐ Supported Rates
 ☐ Basic Rates

☒ 3 Mbps
 ☒ 3 Mbps

☒ 4.5 Mbps
 ☒ 4.5 Mbps

☒ 6 Mbps
 ☐ 6 Mbps

☒ 9 Mbps
 ☐ 9 Mbps

☒ 12 Mbps
 ☐ 12 Mbps

☒ 18 Mbps
 ☐ 18 Mbps

☐ 24 Mbps
 ☐ 24 Mbps

☐ 27 Mbps
 ☐ 27 Mbps

Deselect the upper data rates and save and write the settings to the radio.

After you have written the settings to both Access Point and station radio, look at the “Link Stats” tab and monitor the connection and watch the CCQ. It should climb up to the 90 to 100 percent range. This may take a few minutes for the reading to stabilize and climb to its maximum value. If the CCQ value does not come up into the 90-100 percent range, try deselecting one more data rate on both radios and see if that gets it up into the desired range.

NOTE: If you have an Access Point with multiple Stations, you will need to adjust the Access Point and all the Stations to the lowest data rate negotiated on the worst link to the Access Point in order to improve the CCQ on the worst connection, which will drive it up to 100% or close to it on all the connections.

This exact same logic and procedure can be used on the 802.11n data rates, as well as the 802.11ac data rates. For those radios program the data rates and previously shown in the Data Rates section of this document, and then look at the “Link Stats” tab in BroadbandPro™ Enterprise, note the highest data rate achieved across the wireless link, and in the 802.11n data rates window deselect the MCS rates up to the highest on both radios to improve the CCQ.

On the Axiom AC radios the best CCQ was obtained by matching the basic and supported data rates at the MCS0-7 setting.

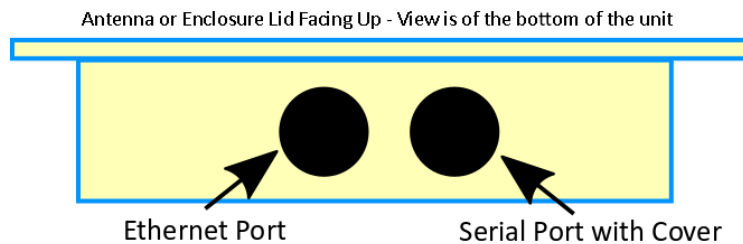
Conclusion

The steps and information contained in this document should provide the basic information needed to connect and program Intuicom Broadband products. If further information is needed please contact Intuicom technical support listed in Appendix C of this document.

Appendix A – Axiom Serial Port

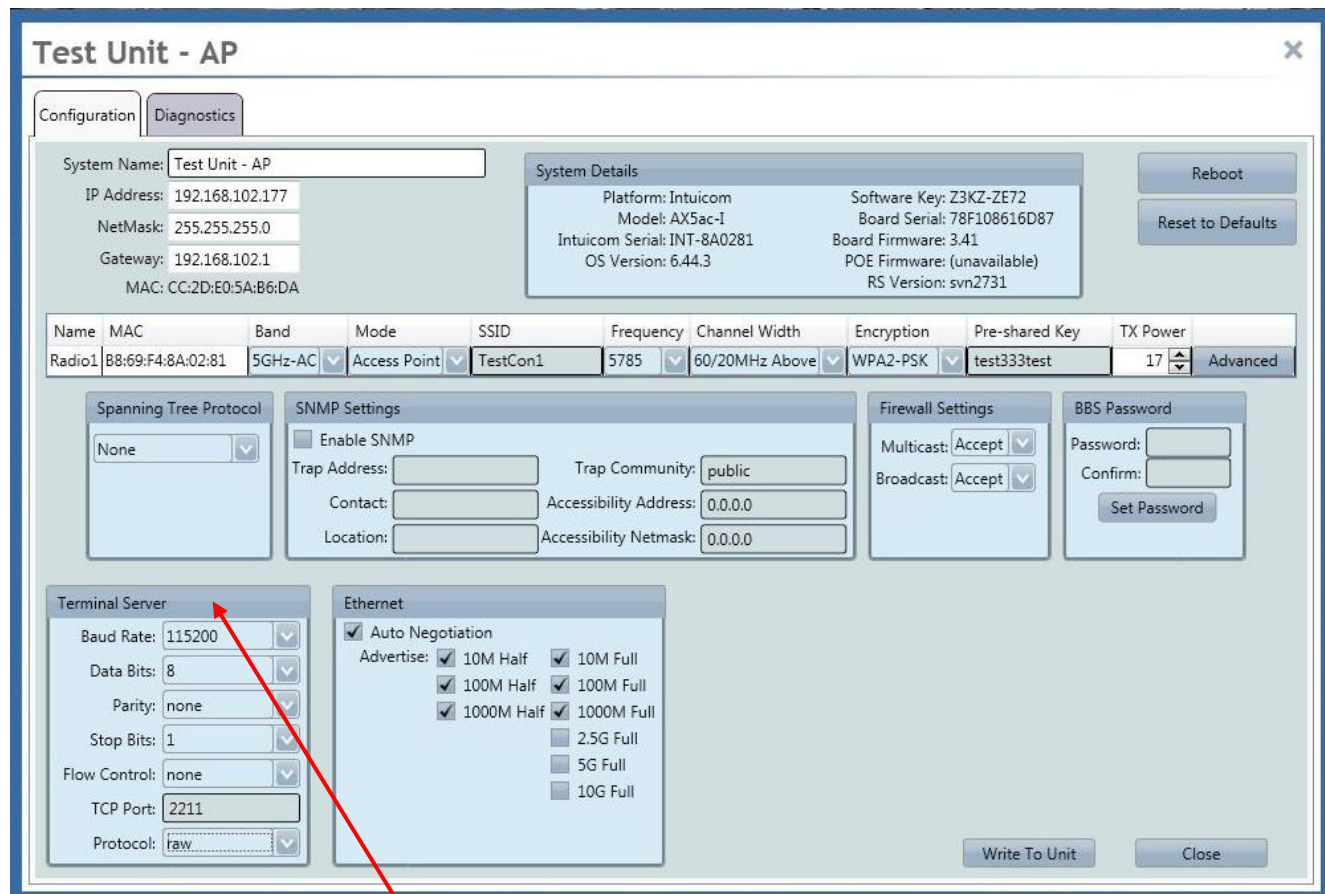
The Axiom radios come with one Ethernet port and one Serial port. When looking at the bottom of the unit the serial port is located on the viewers left. It is the RJ45 connector that has a plug in it. It should also be labeled Serial so the user knows which port is the serial port. See diagram below.

Axiom Serial Port Location



Configuring Serial Port Settings

Configuration of the serial port is done on the configuration window in BroadbandPro™ Enterprise software. The serial port is only capable of TCP connections and does not support UDP or Multicast connections.



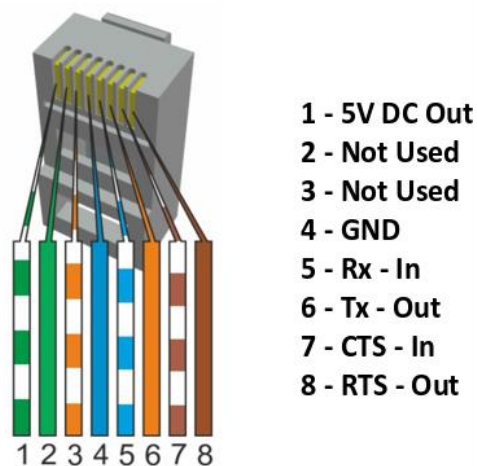
You will need to set the Baud Rate, Data Bits, Parity, Stop Bit, and flow control to match the device you plug into the serial port. You can also change the TCP port if needed. Typically the Protocol is set to raw, however, rfc2217 setting is also available if needed.

Once you have set up the Serial Port and connected a device to it, the device will be access via the IP Address and the TCP port number.

Serial Port Cable

The Serial Port is connected with an RJ45 connector. The pinout on the connector is as follows.

Axiom Serial Port Pin Out



Appendix B – Axiom Power On Reset Button

Power On Reset Procedure

Both the BBX and Axiom radios have a RSSI Indicator strip with a Power indicator light and power on reset button. The power on reset button can be used to restore the radio to factory default settings. The reset procedure is as follows.

- 1) Power down the radio
- 2) Press and hold the Reset Button and while holding it apply power to the radio.
- 3) Continue to hold the button down until you hear a single beep, followed by a double beep and then you can release it.

NOTE: If you cannot hear the radio beeps simply hold the button down for one minute and 30 seconds and then release it.

Upon completion of the Power On Reset procedure the radio should boot up and default configuration. See page 12 of this document for default settings.

RSSI Indicators – Single Radio Units

The Axiom single radio units and the BBX units (all single radio units) have an RSSI Indicator strip on the side of the radio. For the single radio units this indicator displays the signal strength connection that is established to the radio. Installers can use these indicators to obtain a preliminary alignment of the antenna.

Procedure is the align the antenna until the maximum number of green lights is obtained. Once the antenna has been aligned by adjusting the aim until the maximum number of green lights are on, then installers will need to finalize the aim by following the procedure outlined on page 34 of this document.



RSSI Indicators – Dual Radio Units

For the Axiom Dual Radios, the Power On Reset button has a dual use. The first use is explained above on how to use this button to restore the radio to factory defaults. After the radio has been powered up and is connected this same button is used to change the RSSI indicators between Radio1 and Radio2 in the unit.

When the radio powers up by default the RSSI indicator strip is reading and displaying the signal strength for Radio1.

By depressing the Power On Reset button once, two of the green indicator lights will flash – This is indicating that the RSSI indicator strip is now displaying the signal strength for Radio2 in the unit. By depressing the Power On Reset button again (once), a single green light will flash indicating that it is now reading the signal strength from Radio1.

When depressing the Power On Reset button while the radio is powered on, you can change which radio in the unit the indicator strip is displaying the signal strength for. You will be able to tell which radio it is displaying as upon pressing the button if one light flashes you are looking at Radio1, and if two lights flash you are looking at Radio2.

Appendix C – Intuicom Technical Support

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Boulder, CO 80301 USA
(303) 449-4330 ext 235
(720) 587-9190
dbraddon@intuicom.com

Appendix D – Limited Warranty

LIMITED WARRANTY TO END-USERS Intuicom, Inc.
4900 Nautilus Ct., Ste. 100
Boulder, CO 80301

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