



ThinkRF WSA5000

Wireless Signal Analyzer

Version 3.6

User Guide

Aug 2014

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Preface

This preface describes the audience for, the organization of, and conventions used in this document. It also identifies related documentation and explains how to access electronic documentation.

Audience

This document is written for technical people who have basic understanding, familiarity and experience with network test and measurement equipment.

Conventions

This section describes the conventions used in this document.



Note: This symbol means **take note**. Notes contain helpful suggestions or references to additional information and material.



Caution: This symbol means **be careful**. In this situation, you might do something that could result in equipment damage or loss of data.



Warning: This symbol means **danger**. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with the standard practices for preventing accidents.

Obtaining the Latest Documentation and Software

Please regularly visit our website's resource page at <http://www.thinkrf.com/documentation> to obtain the latest documentation, and our website's releases page at <http://www.thinkrf.com/download> to obtain the latest releases of new firmware and software.

Document Feedback

Please send your comments about this document or our other documentation to support@thinkrf.com.

Thank you, we appreciate your comments.

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The ThinkRF Support website provides online documents for resolving technical issues with ThinkRF products at this URL: <http://www.thinkrf.com/documentation>.

For all customers who hold a valid end-user license, ThinkRF provides technical assistance 9 AM to 5 PM Eastern Time, Monday to Friday. Contact us at **support@thinkrf.com** or by calling **+1.613.369.5104**.

Before contacting support, please have the following information available:

- WSA5000 serial number which is located on the identification label on the WSA5000's underside.
- The product version.
- The firmware version running on the WSA5000.
- Versions of ThinkRF software you are using, potentially including the API libraries to third-party applications.
- The operating system and version you are using.

Overview of the ThinkRF WSA5000

The WSA5000 Wireless Signal Analyzer is a high-performance software-defined RF receiver, digitizer and analyzer. It is designed for stand-alone, remote and/or distributed wireless signal analysis, monitoring and intelligence applications.

ThinkRF has patent-pending software-defined RF receiver technology that provides industry leading combined sensitivity, tuning range, instantaneous bandwidth and scan rate. Additionally, the WSA5000 provides real-time sophisticated triggering, search and loss-less capture of signals of interest using an integrated patent-pending digital signal processing engine.

The WSA5000 is ideal for monitoring, management and surveillance of transmitters, whether they are in-building or spread across a geographic area. Applications include but are not limited to spectrum analysis, wireless network management and interference mitigation; cognitive radio and white space spectrum sensing, enterprise wireless signal intrusion detection (WSID); government spectrum licensing monitoring and enforcement; technical security counter measures (TSCM) and military communications and signals intelligence.

The WSA5000 Wireless Signal Analyzer provides Gigabit Ethernet for stand-alone, remote and distributed applications. ThinkRF conforms to standardized protocols and provides APIs designed for easy integration with third-party applications. Standard protocols include the Standard Commands for Programmable Instruments (SCPI) protocol for controlling and obtaining status from the WSA5000 and the VITA 49 Radio Transport (VRT) protocol for digitized data and its associated context information.

APIs are provided for interfacing and performing data acquisition and as well as for spectral analysis with MATLAB® applications. Digitized RF signals (I/Q data) are passed directly to MATLAB®, and/or MATLAB® communications system or signal processing toolboxes.

Applications can also be built within the PyRF development framework. PyRF is built on the Python programming language and is open-source under BSD licensing. PyRF handles the low-level details of real-time acquisition, signal processing and visualization, and provides feature rich libraries, example applications and source code, all specific to the requirements of signal analysis.

Getting Familiar with the ThinkRF WSA5000

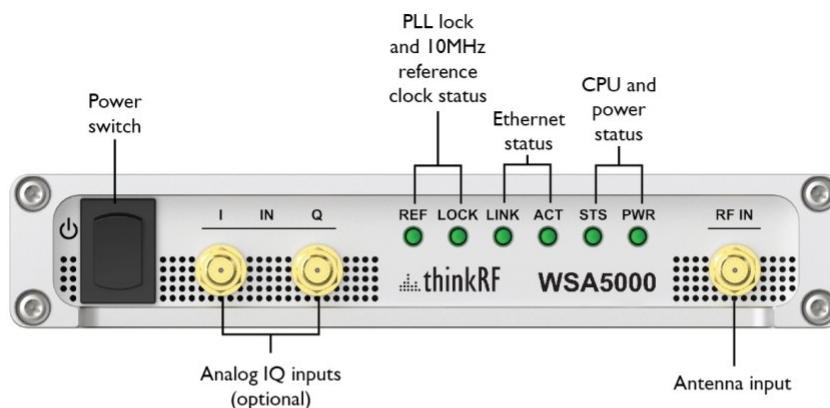
This section provides information about the WSA5000's front and rear panels, connection ports and identification label.



Note: The type and placement of connectors and components on the panels may vary depending upon the product variant and version.

The Front Panel

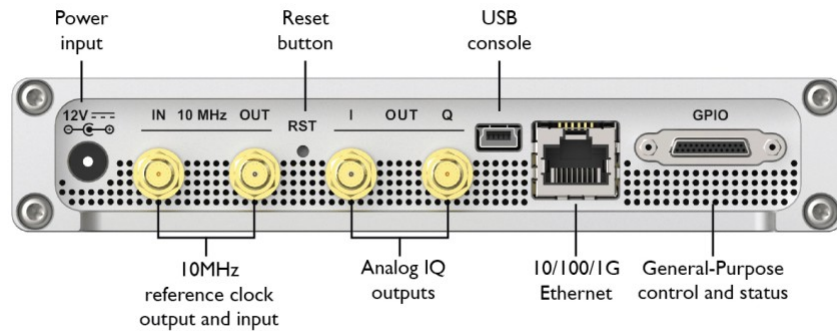
The following figure shows the front panel of the WSA5000. The front panel contains the power switch, status LEDs and input connectors for the RF antenna and analog IQ.



Note: The WSA5000-208 and -220 include Analog IQ inputs, Analog IQ outputs and 10 MHz reference clock output, and the WSA5000-108 does not.

The Rear Panel

The following figure shows the WSA5000 rear panel. The rear panel contains power input, and digital ports for Ethernet, USB console and GPIO, and analog I/Q outputs, 10 MHz reference clock I/O and hardware reset push-button.



The Underside

The underside of the ThinkRF WSA5000 provides an identification label, as illustrated below for product version 1 and 2. The label on your product may vary depending on your product variant and version. The main difference is that for product version 2 and above, a version number is listed beside the S/N value. This product version number is important for identifying which firmware image can be used to update your product (see [Updating the WSA5000's Firmware](#)).

Product Version 1:



Product Version 2:



Installing the ThinkRF WSA5000

Ensure that you read and understand the following information about safety and electrostatic discharge before you unpack and install the WSA5000.



Warning: Only trained and qualified personnel should be allowed to install or replace this equipment. Read the installation instructions before you connect the system to its power source.

Preventing Electrostatic Discharge Damage

Electrostatic Discharge (ESD) is a single-event, rapid transfer of electrostatic charge between two objects, such as an operator and a piece of electrical equipment. ESD can occur when a high electrostatic field develops between two objects in close proximity. ESD occurs when electronic components are improperly handled and is one of the major causes of device failures in the semiconductor industry.

Electrostatic discharge is more likely to occur with the combination of synthetic fibers and dry atmosphere. Always follow these steps to prevent ESD.



Warning: Never open the front or rear panels of the WSA5000 as personal injury may result and opening the chassis will void the warranty. There are no user-serviceable parts inside. Always contact ThinkRF support for service.



Caution: To prevent ESD, wear an ESD-preventive wrist strap that you provide, ensuring that it makes good skin contact.



Caution: Do not touch any exposed contact pins or connector shells of interface ports that do not have a cable attached. If cables are connected at one end only, do not touch the exposed pins at the unconnected end of the cable.

Unpacking the Box

The following table lists the items that come with your WSA5000. If any of the items are missing or damaged, please contact your ThinkRF customer service representative.

ThinkRF WSA5000 Shipping Box Contents:

- WSA5000 Wireless Signal Analyzer
 - Power adapter and cable
 - Straight-through Ethernet cable
 - USB console cable
 - Antenna
 - Quick start guide
 - Precautions note
-



Note: The antenna is included for your convenience and only intended to perform adequately across a limited frequency range.

Connecting the Antenna, Ethernet and Power Cables



Caution: Never connect a transmitter directly to the receiver with a cable.



Caution: Do not over-tighten the antenna connector on the jack. Using a wrench, pliers or even your hand to over-tighten the antenna can cause permanent damage to the receiver.

1. Screw the antenna on to the WSA5000 "RF IN" antenna input SMA jack. Carefully turn the antenna screw by hand until it encounters resistance. See [SMA Connectors](#) section for the maximum allowable input and cautions.
2. Connect one end of the Ethernet cable to the WSA5000's Ethernet port and the other end to an Ethernet port on your router or PC.
3. Connect the WSA5000 to its power adapter.



Warning: Use only the power adapter provided with the unit.

4. Plug the power adapter into a power outlet.
 5. Push the power switch towards the power symbol to power the unit on.
-



Note: See [Status Indicator LEDs](#) section for description of the WSA5000's status.

Selecting Where to Mount the WSA5000



Caution: To prevent damage to the WSA5000 radio receiver, do not install or operate the WSA5000 within 2 feet (60 cm) of devices such as Wi-Fi access points that transmit more than +15 dBm power.

Connecting to the WSA5000

The WSA5000 is a network device and typically all communications with the WSA5000 are via a Gigabit Ethernet connection, either directly to a computer or across an IP network. The WSA5000's Gigabit Ethernet connection provides control and status of the WSA5000 using SCPI commands and data using the VRT protocol.

This section provides instruction for different methods of connecting to the WSA5000 via its Ethernet port and obtaining its IP address.

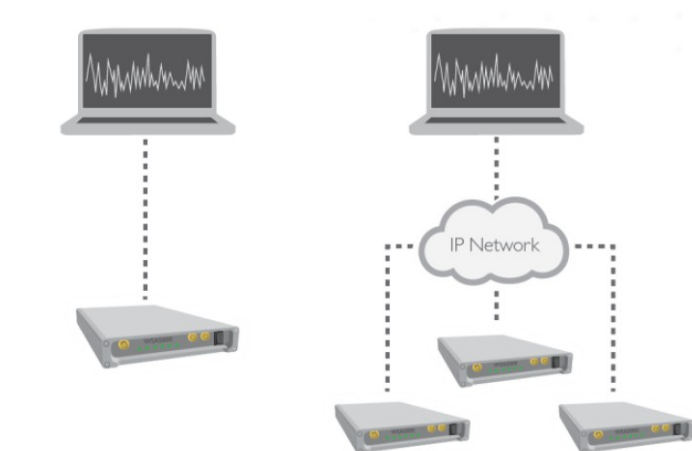
Deciding on Your Network Topology and IP Address Allocation



Note: To connect with the WSA5000 via its Ethernet port, you must decide on both the topology of your network connection and how your WSA5000 obtains its IP address.

As illustrated in the following picture, the WSA5000 supports any IP network topology connected via its Ethernet port including:

- a direct connection to a computer across an RJ-45 Ethernet cable as per the [Connecting the WSA5000 Directly to a Computer](#) section;
- a connection across a routed local network, whether on the same subnet or across different subnets or across a routed wide-area network such as the Internet, as per the [Connecting to the WSA5000 Across a Network](#) section.



The WSA5000 also supports different methods of obtaining its IP address including:

- dynamic IP address allocation via the Dynamic Host Configuration Protocol (DHCP), which is applicable to a routed network topology that has a DHCP server;
- dynamic IP address allocation via the Automatic Private IP Addressing (APIPA) protocol (otherwise known as Auto-IP) which is applicable where a DHCP

server is not available. This method allows a direct connection to a computer that supports Auto-IP or to a local network using a switch. With Auto-IP, a host network device randomly assigns itself a link-local address in the 169.254.x.y subnet when it fails to contact a DHCP server. Many operating systems (OSs), including Windows, support Auto-IP;

- static IP address allocation, which is applicable to any network topology.

Changing the WSA5000's Method of IP Address Allocation

This section provides the instruction for reconfiguring one IP address allocation type to another.



Note: The WSA5000 is configured for dynamic IP address allocation by factory default.

If your WSA5000 is configured for dynamic IP allocation, then it may be reconfigured for static IP address allocation using either its web administration or USB console. Using the administration console in this scenario requires first a connection to the WSA5000 via its Ethernet port, which in turn requires dynamic allocation of its IP either by DHCP or Auto-IP.

If your WSA5000 is configured for static IP allocation, then it may be reconfigured for dynamic IP address allocation using its administration or USB console or via a hardware reset. Using the hardware reset to reconfigure to dynamic IP allocation is the simplest method and is described in the [Reset to Factory Settings](#) section. Using the administration console requires a connection to the WSA5000 via its Ethernet port.

Connection to the WSA5000 using dynamic or static IP allocation is described in the following sections. The console usage is described in the [Administration Console](#) or [Using the USB Console](#) section.

Connecting the WSA5000 Directly to a Computer

This section provides instruction on connecting the WSA5000 directly to a computer via their Ethernet ports using an Ethernet cable.

In order to connect directly to a WSA5000, the host PC might require a spare Ethernet interface that is not otherwise used as its primary network connection. For example, you may use a wireless connection for primary network connectivity or obtain a second Ethernet card or USB adapter to connect to the WSA5000.

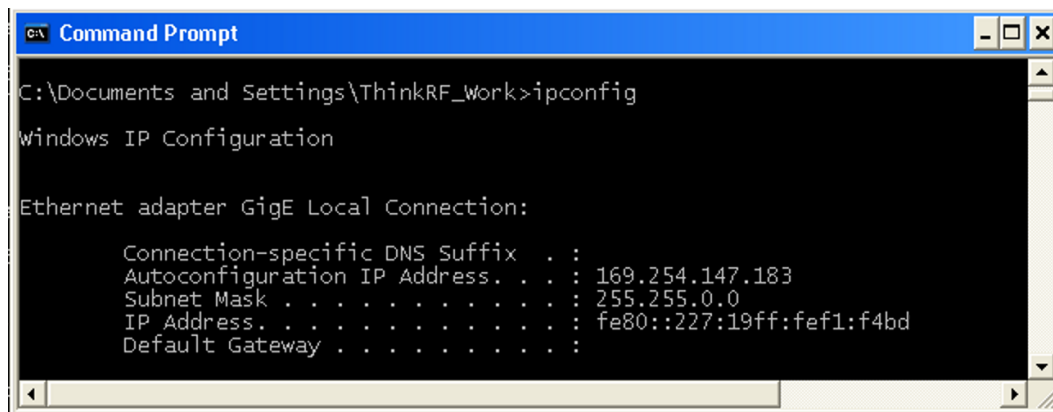
To connect the WSA5000 directly to your computer:

1. Decide on whether you will be using static or dynamic IP allocation. Regardless of which method you choose, both your PC's and the WSA5000's Ethernet interface must be configured for the same method of IP allocation. If necessary, configure your WSA5000 to your chosen method of IP allocation following the instruction in the [Changing the WSA5000's Method of IP Address Allocation](#) section.



Note: Auto-IP support is only provided in WSA5000 with firmware v4.0 or higher. Update your unit with the correct firmware before using the Auto-IP capability.

2. Connect the provided Ethernet cable to both your PC's and the WSA5000's Ethernet ports.
3. Power up the WSA5000 and wait a minute for it to complete booting.
4. Check to ensure that either your PC's or the WSA5000's LINK indicator is illuminated. If it is not then your PC may not support automatic crossover on its Ethernet connection and you may require an RJ-45 crossover Ethernet cable as specified in the [Hardware Reference](#) section.
5. If you're using static IP allocation then skip to the next step. Otherwise, wait for a minute or longer for the host PC to setup the Auto-IP as it would attempt to contact a DHCP server first. Then verify the host PC's IP configuration. For example, with a Windows OS, open a command window and type **ipconfig** to show the IP addresses assigned to each interface. The Ethernet interface should show a 169.254.x.y address as seen in the following picture as an example.



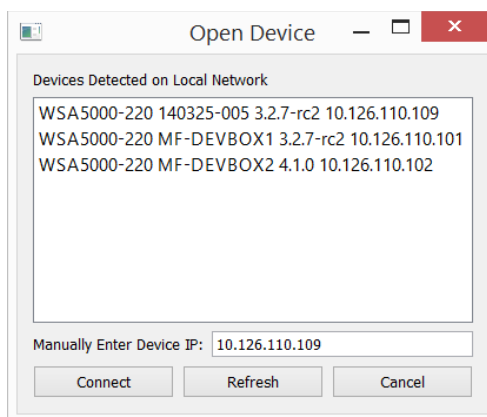
```
C:\Documents and Settings\ThinkRF_Work>ipconfig

Windows IP Configuration

Ethernet adapter GigE Local Connection:

    Connection-specific DNS Suffix  . : 
    Autoconfiguration IP Address. . . : 169.254.147.183
    Subnet Mask . . . . . : 255.255.0.0
    IP Address. . . . . : fe80::227:19ff:fef1:f4bd
    Default Gateway . . . . . :
```

6. Use the PyRF Discovery tool or the RTSA GUI (as shown in the following figure), both provided by ThinkRF, to determine the WSA5000's assigned IP address. In order for the Discovery tool to locate the WSA5000, both your computer and the WSA5000 must be configured for the same subnet. If you are using Auto-IP dynamic IP allocation, then they will both be on the same 169.254.x.y subnet. If you are using static IP and the Discovery tool cannot locate the WSA5000, then you need to have prior knowledge of its static IP address or use the USB console.



7. The assigned IP address may now be used to communicate with the WSA5000.



Note: Link-local addresses used for Auto-IP are non-routable, so communications is limited to devices within the local subnet. This restriction may be an issue when running virtual machines (e.g. Mac Parallels, VirtualBox, etc.) that may be connected through virtual routers to the host PC's physical network interface.



Note: After obtaining a link-local address, the WSA5000 continues to request a DHCP address. If a DHCP server responds at a later time, the link-local address is overwritten with the offered IP address. This new address is retained until the network cable is physically unplugged or the WSA5000 is restarted.

Connecting to the WSA5000 Across a Network

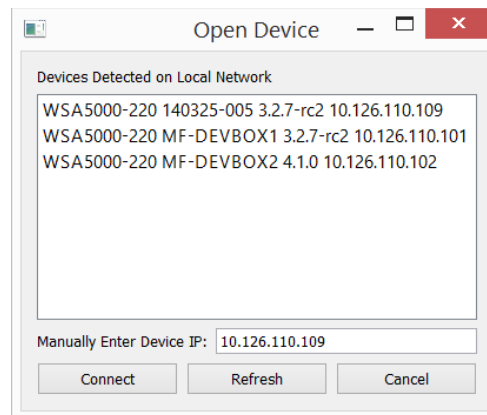
This section provides instruction on connecting the WSA5000 to a computer across a routed local network whether on the same subnet or across different subnets or across a routed wide-area network such as the Internet.

To connect the WSA5000 across a network:

1. Decide on whether you will be using static or dynamic IP allocation. Both your PC and the WSA5000 do not need to be configured for the same method of IP allocation; although to locate your WSA5000 using ThinkRF's Discovery tool requires that they be on the same subnet. If necessary, configure your WSA5000 to your chosen method of IP allocation following the instruction in the [Changing the WSA5000's Method of IP Address Allocation](#) section. If you are using dynamic IP allocation then your router or your network must support a DHCP server.
2. Connect the provided Ethernet cable to both your router's and the WSA5000's Ethernet ports.
3. Power up the WSA5000 and wait a minute for it to complete booting. The sequence of connecting and powering on are inconsequential.

Connecting to the WSA5000

4. Check to ensure that either your router's or the WSA5000's LINK indicator is illuminated.
5. If your WSA5000 is behind a firewall or a router with firewall capability then your network's DHCP server is likely assigning private IP addresses (e.g. 192.168.x.x, 10.x.x.x, 172.x.x.x) and the firewall is likely providing some form of network address translation (NAT) function. If this is the case and if you require access to the WSA5000 from outside your firewall, then you will likely have to configure the firewall to allow port forwarding on port 37000 and 37001. If necessary, consult with your network administrator.
6. Use the PyRF Discovery tool or the RTSA GUI (as shown in the following figure), both provided by ThinkRF, to determine the WSA5000's assigned IP address. In order for the Discovery tool to locate the WSA5000, both your computer and the WSA5000 must be configured for the same subnet. If you are using DHCP then you may have to query your router's allocation tables to determine the IP that is allocated to your WSA5000's MAC address. If you are using static IP and the Discovery tool cannot locate the WSA5000, then you need to have prior knowledge of its static IP address or use the USB console. If necessary, consult with your network administrator.



7. The assigned IP address may now be used to communicate with the WSA5000.

Administration Console

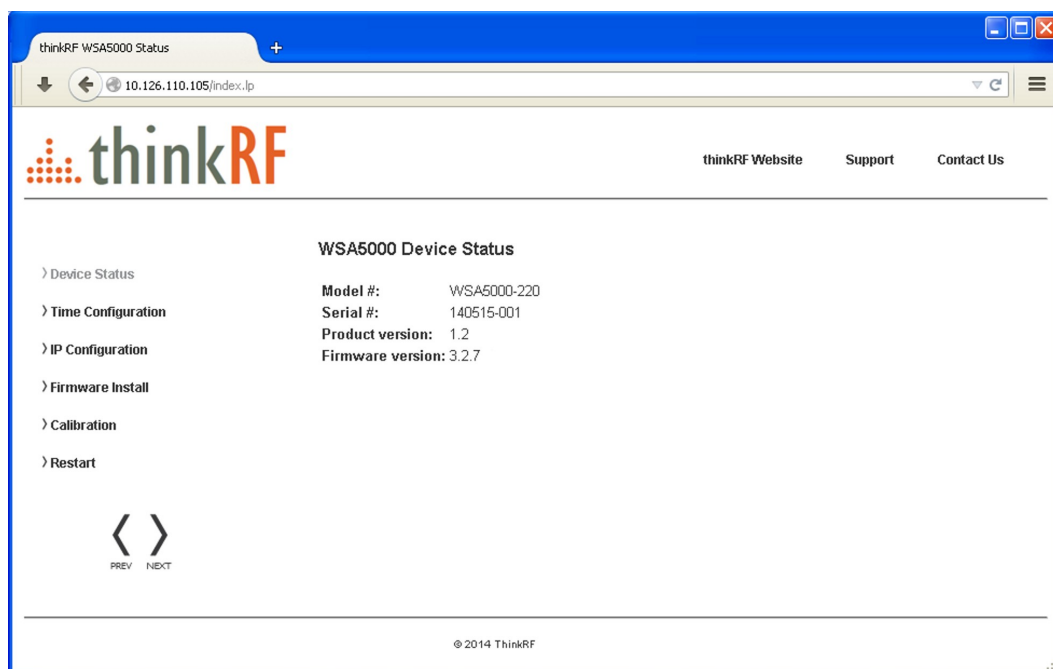
This section provides instruction on connecting to the WSA5000 via its web-based administration console. The administration console provides the ability to:

- obtain status information from the WSA5000;
- change date and time configuration;
- change IP configuration;
- upgrade the WSA5000's software/firmware;
- upload customized calibrations settings;
- and/or reset the WSA5000.

All of these functions may be performed via the network either locally or remotely.

Connecting via Your Web Browser

Connect to the WSA5000's administration console by entering the IP address of your WSA5000 into a web browser's web address dialog. The following "Status" web page should appear providing information on the WSA5000's MAC address, hardware and software versions.



Note that if you have product version 1 with firmware image v3.2.6 or earlier, the "Product version" field would be labeled as "Hardware version". This field is important for selecting the correct firmware image to update, i.e. product version 1 can only be updated with firmware v3.2.7 or lower; and product version 2 with firmware v4.0.0 or higher.

Configuring the WSA5000's Time

The WSA5000 provides for setting its time either manually or as per the PC's time or via an NTP server.



Note: The WSA5000 stores its time based on the UTC Coordinated Universal Time zone and otherwise has no notion of local time-zones. Conversely, the web dialog translates and displays the WSA5000's time based on the local time-zone setting of the PC.

1. Click on the "Time Configuration" link in the left column menu of the administrative console web page. The following "WSA5000 Device Time Configuration" web page should appear.
2. Select the time synchronization source.
3. If "Enter time manually" is selected then enter the date and time based on your local time-zone.
4. If "Use current PC time" is selected then the data and time fields will be populated automatically.

thinkRF WSA5000 Time Configuration

10.126.110.105/timeConfiguration.jsp

thinkRF Website Support Contact Us

WSA5000 Device Time Configuration

Note that all times and dates are displayed on this page according to your local timezone, but the WSA5000 stores all time data in UTC format.

Current WSA5000 system time: 2014-07-21 09:31:02

Time sync source

☒ Enter time manually

Year: 2014

Month (1-12): 07

Day (1-31): 21

Hours (0-23): 09

Minutes: 30

Seconds: 33

☐ Use current PC time

☐ NTP

NTP server 1:

NTP server 2:

NTP server 3:

Time sync mode

☒ One-time

☐ Continuous

Apply

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5. If "NTP" is selected, enter at least one NTP server IP address and select whether the time be synced just this one time or continuously. If "continuously" is selected, the WSA5000's time is synchronized to the NTP server on a continuous and regular basis, the regularity of which is optimally determined automatically.
6. Click the "Apply" button.

Configuring the WSA5000's IP Address

The WSA5000 provides options for selecting whether the WSA5000's IP address is obtained dynamically using DHCP or is set manually to a static address.



Caution: Please note that if the WSA5000's IP address is set to static IP then the only way to communicate with the WSA5000 is via that IP address. If you mistakenly enter the wrong IP address and/or subnet mask, or forget the IP address, then you can change the IP configuration [Using the USB Console](#) or perform a [Reset to Factory Settings](#).

1. Click on the "IP Configuration" link in the left column menu of the administrative console. The following "WSA5000 Device IP Configuration" web page should appear. Once the "Apply" is clicked, the new configuration will take effect immediately and the current configuration and web page will no longer be valid.

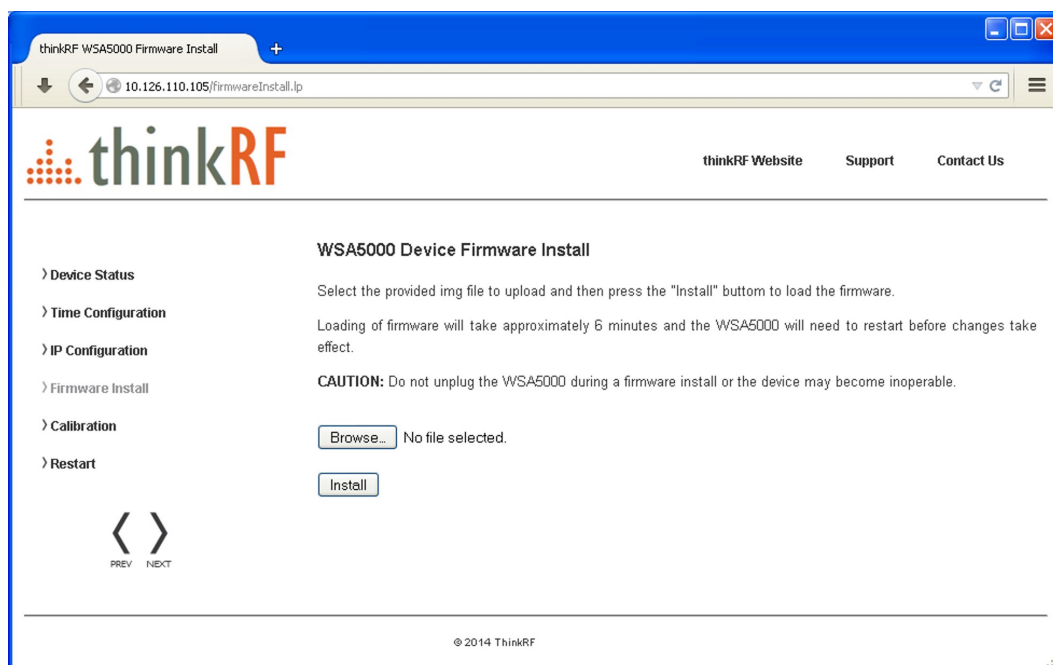
Updating the WSA5000's Firmware

This section will step you through updating the WSA5000's firmware. The firmware install file contains firmware images associated with the WSA5000's FPGA, Linux operating system and the embedded application. The process of updating will copy the new images to the WSA5000 in addition to and without erasing the current installed images. The new install will only take effect upon the WSA5000 being restarted.



Note: Updating firmware might over-write any user-defined calibrated values, see [Customizing the WSA5000's Calibration](#) for more information.

1. Click on the "Firmware Install" link in the left column menu of the administrative console. The following "Firmware Install" web page should appear.

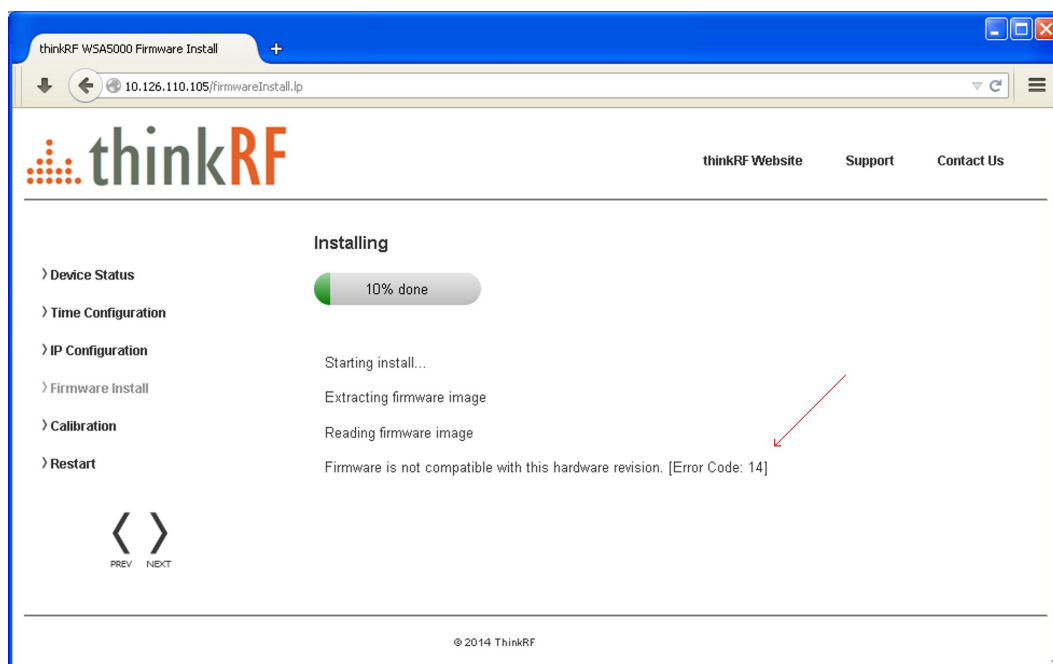


Warning: Do not unplug the WSA5000 during a firmware update or the device may become inoperable.

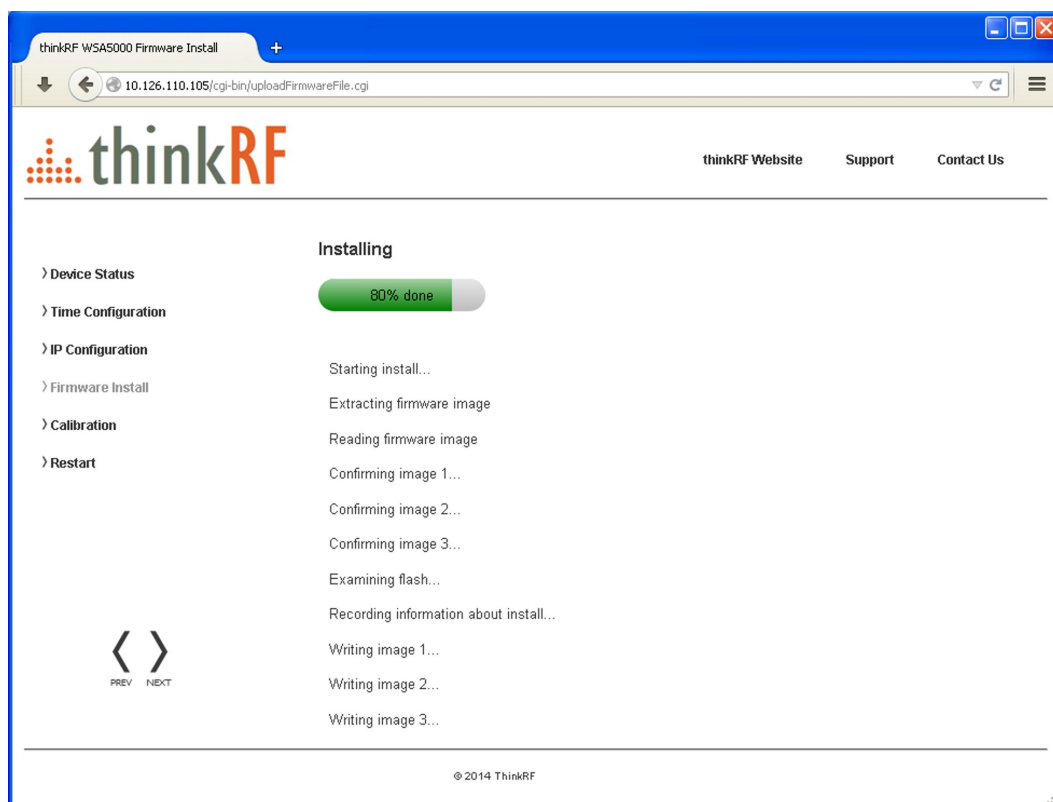
2. Enter or browse to the location of the "ThinkRF_WSA5000_firmware_vx.y.z.img" (or similar *.img) firmware image file and then click the "Install" button.



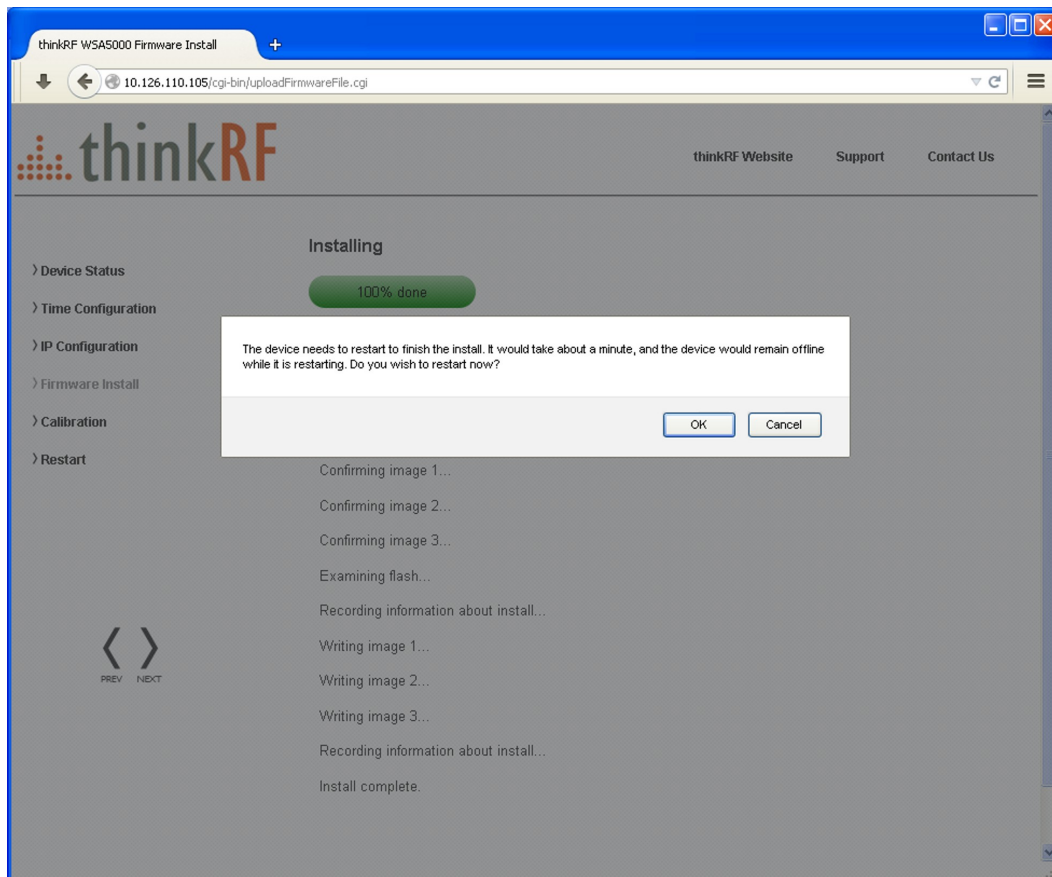
Note: Make sure the correct firmware image is selected for the right product version. Firmware v4.0.0 or higher can only be used for product version 2; any earlier firmware version would be for product version 1. If a firmware is selected for the wrong product version, the following image with an error message will appear and the installation process would stop.



When the firmware image for the intended product version is installed, the following "Firmware Install" web page should appear which will step through the progression of the firmware being uploaded and installed.



3. Upon completion, the following web dialog box should appear. Press the "OK" button to restart the WSA5000 or "Cancel" to defer restarting until a later time.



Note: If the WSA5000 is not restarted immediately after a firmware install process, then the newly installed firmware will take effect upon the next restart of the WSA5000 regardless of whether it is a software restart or a power-on reset.

In addition, the boot up might take over a minute when there are new changes to the calibration setup or auto-ip connection method is used.

Customizing the WSA5000's Calibration

The WSA5000 supports user-defined calibration settings if you do not want to use ThinkRF's default calibration settings. This allows you to calibrate the WSA5000's RFE with reference levels based on, for examples - frequency ranges, temperature ranges, and insertion loss of the attenuator that are specific to your own applications.

See [Appendix A](#) for instructions on creating a custom calibration file. You can upload your own calibration settings through the WSA5000 administration console using the instructions described in the following section.

Uploading a Custom Calibration File

You can upload your custom calibration settings file to the WSA5000 via the administrative console (see [Appendix A](#) for instructions on creating a custom calibration file).

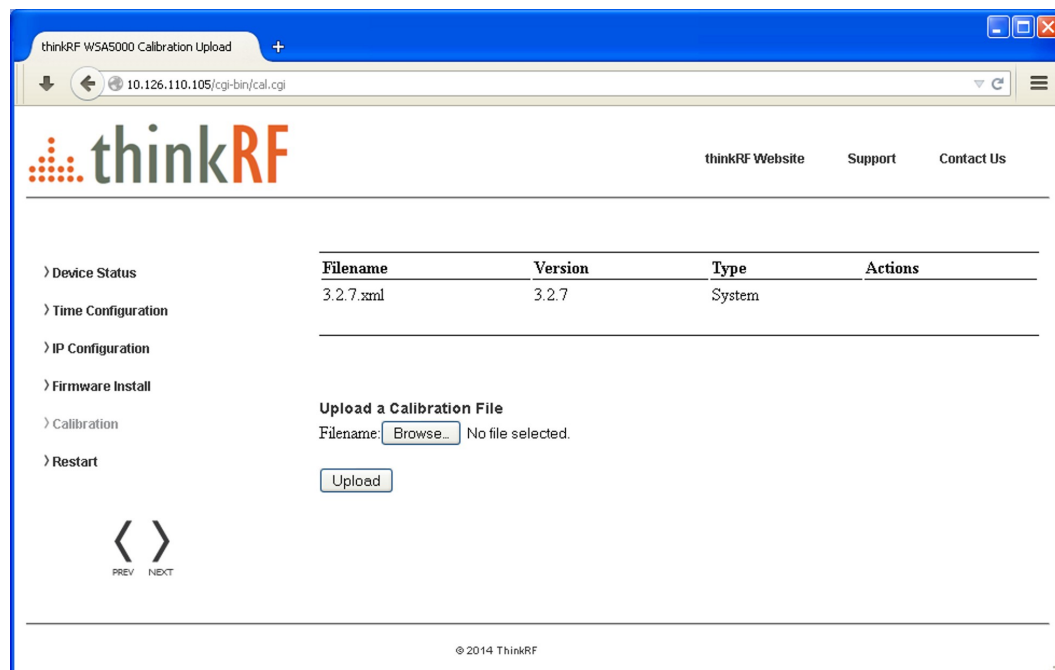


Note: You must restart the WSA5000 for the new calibration settings to take effect.

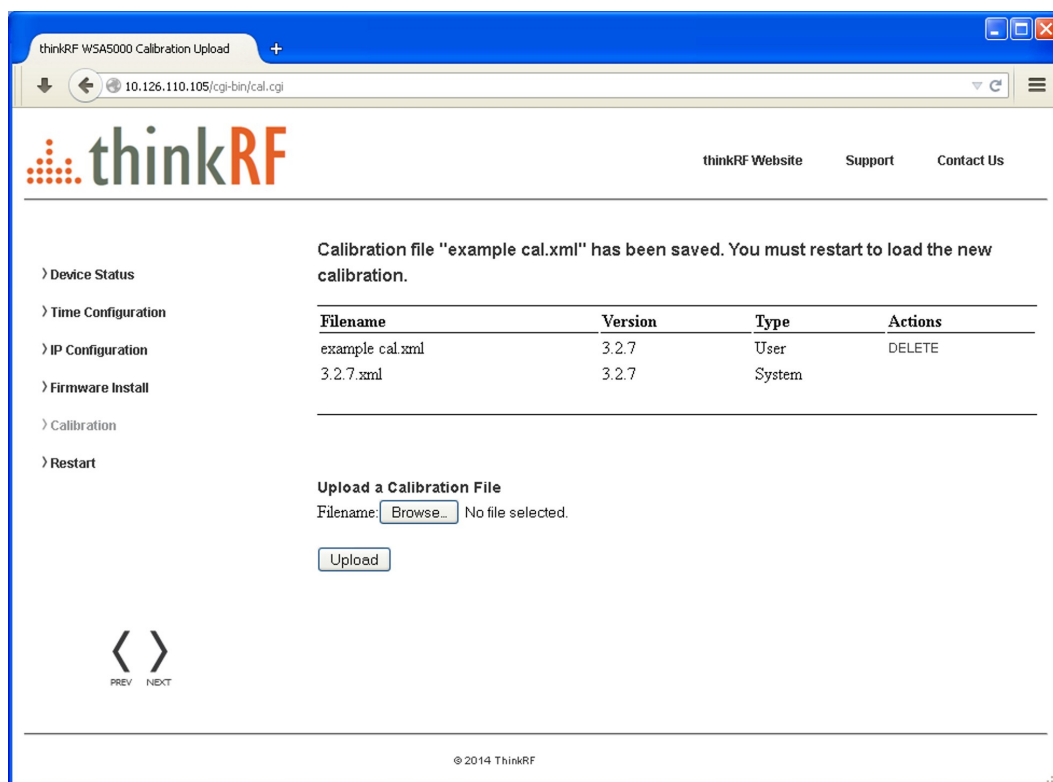


Note: Custom calibrated values might get over-written by a new firmware update. After restarting the unit once the firmware update is done, check the Calibration tab of the administration console to see which calibration file source is listed on the top of the Filename list (ie. "System" or your customized file).

1. Click the "Calibration" link in the left column menu of the administrative console web page. The "WSA5000 Device Calibration" page will appear.

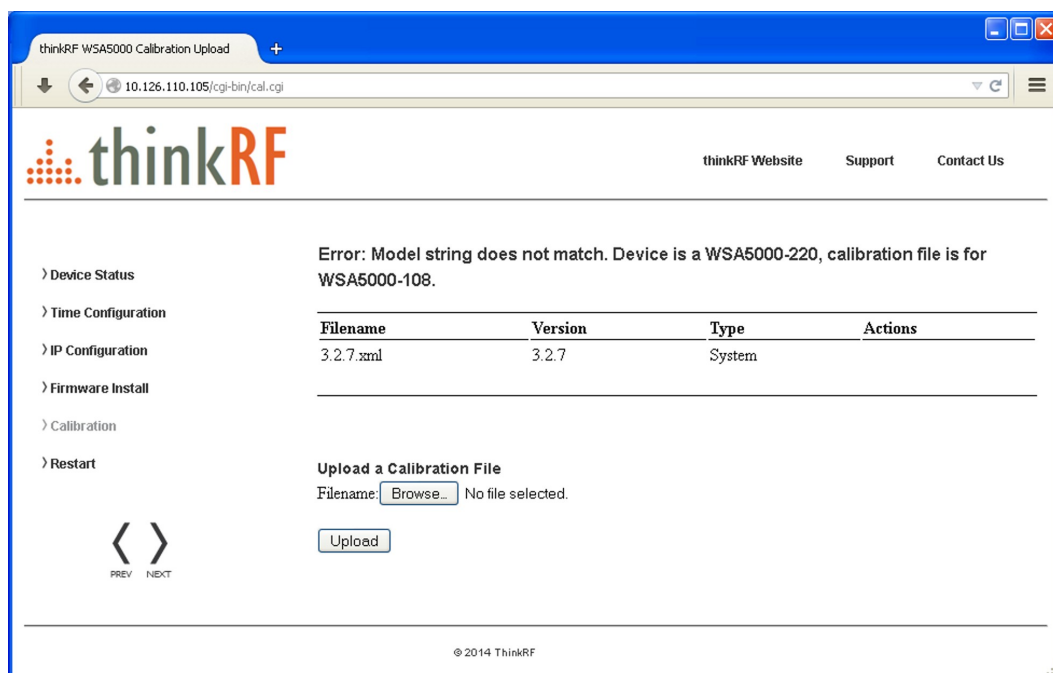


2. Click "Browse". An Explorer window will open on your PC.
3. Navigate to the location of the desired file and click "Open". The selected file name appears beside the "Browse" button in the Administration console.
4. Click "Upload". When successful, the custom calibration file is uploaded to the WSA5000 and appears in the list of calibration files. The most recent uploaded file will be listed at the top of the table.



5. Restart the WSA5000 by using the administrative console or toggling the power switch. The boot up will take longer than usual after the restart as the embedded system applies the new calibrated values.

However, if a tag or its value is incorrectly created in the custom file, an error, when detected, will be displayed with the appropriate message and the file will not be uploaded. See the following picture for example.



Calibration File Source Selection

When more than one calibration settings file are present in the system, the WSA5000 selects the calibration source using the following priority:

1. Firmware version specified in the calibration file
2. Calibration file source with the following priority going from higher to lower:
 - a. User-defined file
 - b. ThinkRF's factory defaults (from factory calibration)
 - c. ThinkRF's system defaults (from firmware update)
3. Created date and time of the calibration file (as listed in the <created> field)

For example, if two calibration files have the same firmware version, then the file source is compared. If the source is the same, then the created date and time is compared. The most recent date will be used.

Any calibration data that is not specified or missing in the new calibration file will be retrieved from the calibration file of the next highest priority.

Restoring the Default Calibration Settings

You can restore the calibration settings to system defaults at any time by deleting all custom calibration files from the system. You will not be able to delete the system calibration file.

1. In the "WSA5000 Calibration Upload" page, select a custom calibration file from the list and click "DELETE" in the **Actions** column.
2. Repeat step 1 for all custom calibration files on the system.

- Restart the WSA5000 either by using the web administrative console or toggling the power switch. The default calibration settings take effect upon device restart.

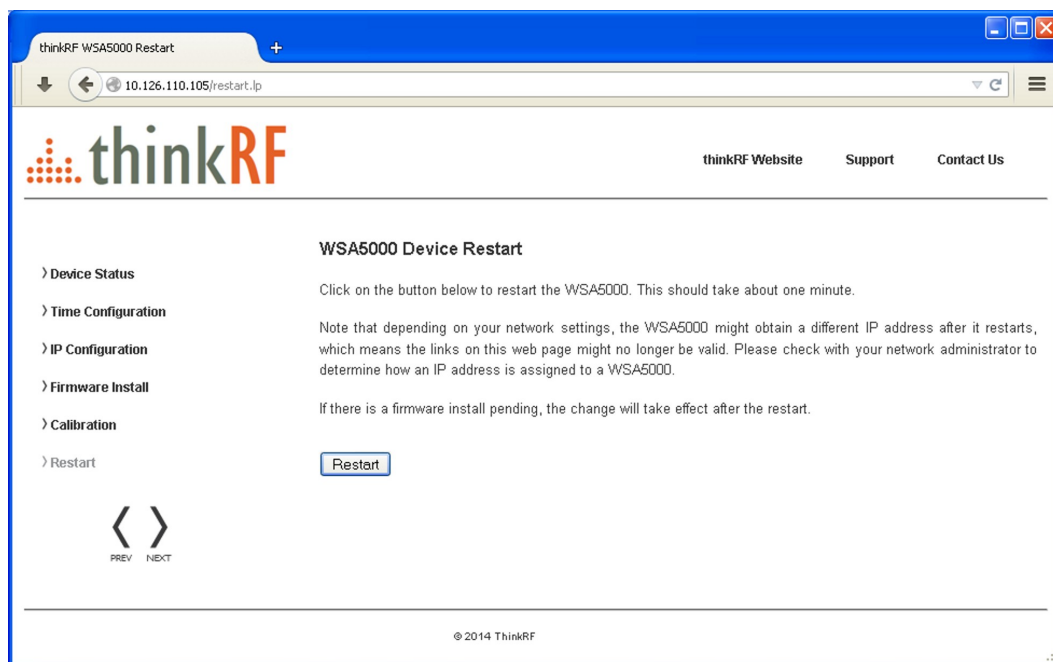


Note: Performing a [Reset to Factory Settings](#) will also reset all the calibration data to either factory defaults or system defaults following the file source selection priority mentioned above.

Restarting the WSA5000

The WSA5000 may be restarted via its internet connected administration console. Performing this type of restart is equivalent to a power-on reset.

- Referring to the previous "Status" web page, click on the "Device Restart " link in the left column. The following "Restart" web page should appear.
- Click on the "Restart" button.



Note: Depending on your network settings, the WSA5000 might obtain a different IP address after it restarts which will result in the links to the web pages no longer being valid. Please check with your network administrator to determine the IP address of the WSA5000. This might happen only when the unit is not in static IP mode or a factory reset has been done to the unit.



Note: If the WSA5000's firmware has been previously installed without being restarted, then the most recently installed firmware will take effect after the restart is applied.

Reset to Factory Settings

If for any reason you cannot connect to the WSA5000 via the Ethernet, then performing this following procedure will reset the WSA5000's IP configuration to obtain an IP address dynamically using DHCP.

The reset will also set the reference level calibration back to factory default values.

Follow the steps below to reset your box.

1. Power off the WSA5000 by toggling its power switch
2. Power on the WSA5000
3. Wait approximately 15 seconds
4. Momentarily press and release the reset button (locate in [The Rear Panel](#)) by inserting a paper clip or similar object
5. Wait for the unit to completely boot up (another ~30 seconds) and run the PyRF discovery tool to determine the unit's IP or use the USB Console to verify the network settings (see [Using the USB Console](#) section).

Using the USB Console

This section provides instruction on connecting to the WSA5000 via its USB console. The USB console provides control and status of the WSA5000 using SCPI commands. Typical applications may include configuring and querying the WSA5000's network IP or controlling and querying the WSA5000 in an external digitizer application.



Note: The WSA5000's USB console allows for the communication of SCPI commands and status. It does not support the transfer of VRT data nor does it support the web administration console.

Installing the USB Drivers on Your PC

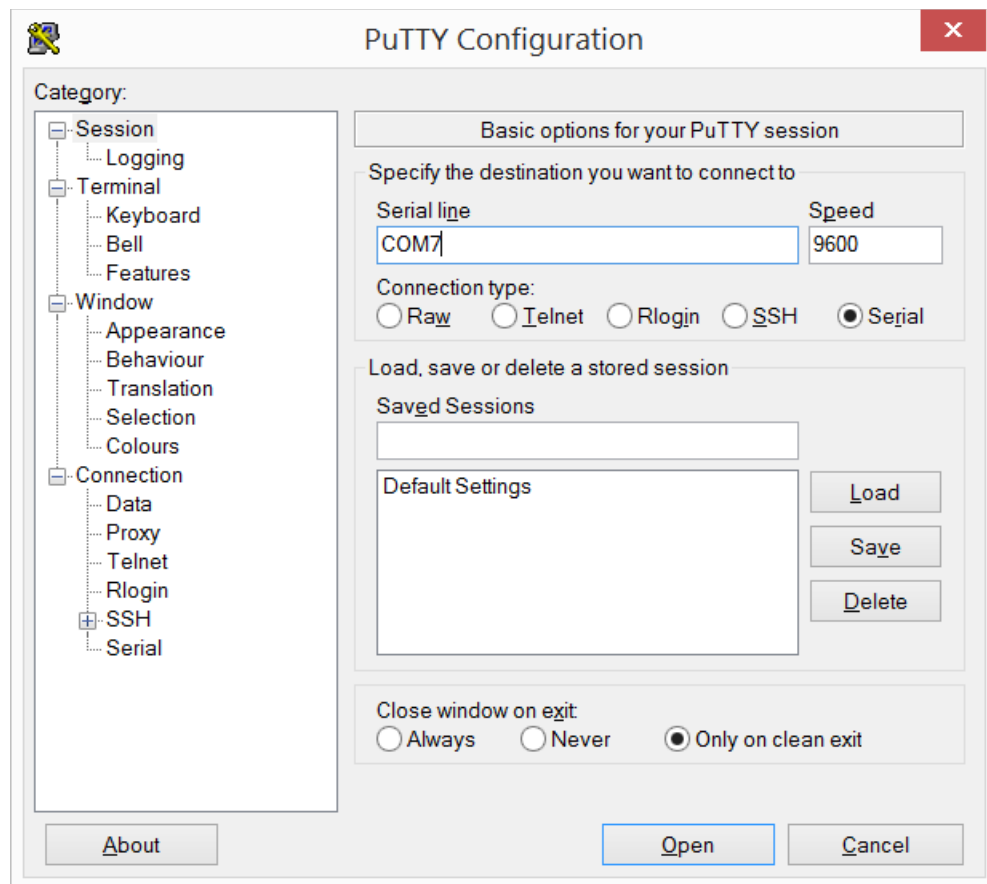
The WSA5000 USB console uses a Silicon Labs CP210x USB to UART Bridge Virtual COM Port driver, which may require configuration of drivers on your PC.

1. Power on the WSA5000 and wait approximately 30 seconds to allow it to boot up.
2. Connect the USB cable to the WSA5000's USB console port and your PC's USB port.
3. Depending on the version of your PC's Windows OS, your PC should automatically detect the WSA5000 as a new USB device and install the appropriate driver. Check to ensure that the driver is properly installed by inspecting **Control Panel > Device Manager > Ports (COM & LPT)**, at which a "Silicon Labs CP210x USB to UART Bridge (COM7)" (or equivalent COM#) should appear without error. If the driver has not appeared or has errors, then proper drivers may be found at <http://www.silabs.com/products/mcu/pages/usbtouartbridgevcpcdrivers.aspx>.
4. With the USB to UART Bridge drivers installed, again take note of the COM port number that it has been assigned by inspecting **Control Panel > Device Manager > Ports (COM & LPT)**.

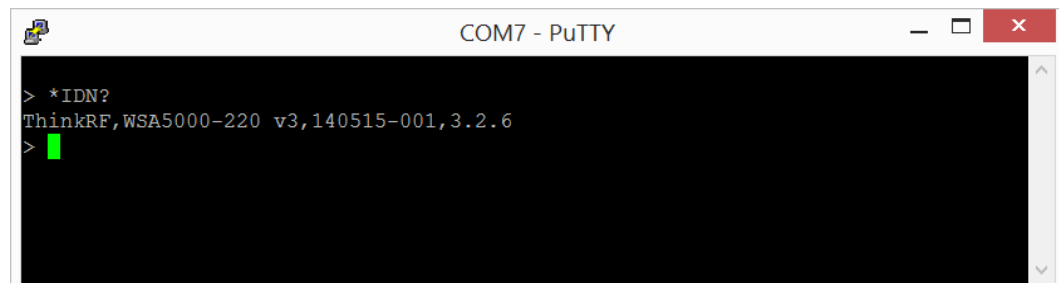
Connecting to the USB Console

Connection to the USB console requires a serial terminal program on your PC. The following provides an example using PuTTY from <http://www.putty.org/>.

1. Follow the instructions above to install the USB drivers on your PC.
2. Launch your terminal program (i.e. PuTTY) on your PC.
3. Configure your terminal program to connect via the COM port associated to the USB to UART Bridge (as seen in the terminal configuration panel image below). If using a different serial terminal program, ensure the serial settings used are **baud speed (bits per second) 9600; data bits 8; stop bit 1; parity none; and flow control none**.



4. Open the terminal session.
5. Press the “Enter” key and a “>” cursor should appear in the terminal window. If the cursor does not appear then the USB to UART Bridge may be expecting a typical VT100 terminal response. Repeatedly press “Ctrl+C” and “Enter” until the cursor appears. The cursor may take several seconds to appear.
6. Enter `*IDN?` command and press the “Enter” key. The WSA5000 should return a message with its device identification such as “ThinkRF, WSA5000...” and as per the illustration below.



7. Refer to the WSA5000 Programmer's Guide that is associated with the firmware release of your WSA5000 for the SCPI commands to use with your WSA5000 via the USB console terminal window. The firmware release version of your

WSA5000 will be noted in the device identification string reported by the “*IDN?” SCPI command.

Configuring the WSA5000's IP Address via the USB Console

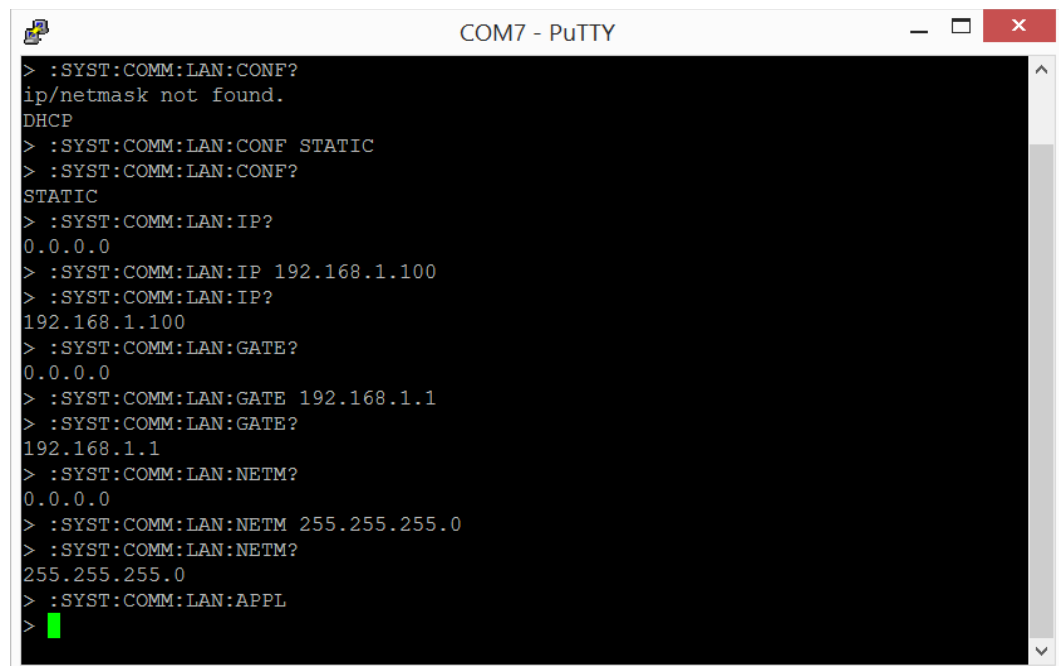
The WSA5000 provides options for selecting whether the WSA5000's IP address is obtained dynamically using DHCP or is set manually to a static address.



Caution: Please note that if the WSA5000's IP address is set to static IP then the only way to communicate with the WSA5000 is over the network via that IP address or via the USB console. Hence, if you mistakenly enter the wrong IP address and/or subnet mask, or forget the IP address, then you can query/reconfigure the IP settings via the USB console as described below or perform a [Reset to Factory Settings](#) (page 28) to reset the IP back to the factory DHCP default configuration.

1. Follow the instructions above to install the USB drivers on your PC and connect to the USB console.
2. Refer to the illustration below as an example, enter the following SCPI commands substituting in the appropriate IP address configuration for your WSA5000:

```
:SYST:COMM:LAN:CONF?  
:SYST:COMM:LAN:CONF STATIC  
:SYST:COMM:LAN:IP?  
:SYST:COMM:LAN:IP <IP address>  
:SYST:COMM:LAN:GATE?  
:SYST:COMM:LAN:GATE <gateway address>  
:SYST:COMM:LAN:NETM?  
:SYST:COMM:LAN:NETM <netmask address>  
:SYST:COMM:LAN:APPL
```



```
> :SYST:COMM:LAN:CONF?
ip/netmask not found.
DHCP
> :SYST:COMM:LAN:CONF STATIC
> :SYST:COMM:LAN:CONF?
STATIC
> :SYST:COMM:LAN:IP?
0.0.0.0
> :SYST:COMM:LAN:IP 192.168.1.100
> :SYST:COMM:LAN:IP?
192.168.1.100
> :SYST:COMM:LAN:GATE?
0.0.0.0
> :SYST:COMM:LAN:GATE 192.168.1.1
> :SYST:COMM:LAN:GATE?
192.168.1.1
> :SYST:COMM:LAN:NETM?
0.0.0.0
> :SYST:COMM:LAN:NETM 255.255.255.0
> :SYST:COMM:LAN:NETM?
255.255.255.0
> :SYST:COMM:LAN:APPL
> █
```

Status Indicator LEDs

The WSA5000 has status indicator LEDs as illustrated and described in the following.



Power (PWR) Indicator LED

The PWR indicator LEDs indicate that the input and internal power voltages are correct.

PWR Status LED	Internal Power Status
Off	Not receiving power from power adapter
Green	All internal power conditions are good
Orange or Red	One or more of the internal power conditions are not present or corrupted

Status (STS) Indicator LED

The STS indicator LED indicate the status of the WSA5000 as it boots from power-on and/or reset and the network activity.

STS Indicator LED	Boot Error Condition
Off	Not applicable
Slow blink orange	Network (DHCP) failure
Solid orange	Hardware failure
Slow blink red	Firmware failure
Fast blink red	Hardware failure
Slow blink green	Busy
Solid green	Ready for connection

10 MHz Reference (REF) Clock Source and Lock Indicator LED

Referring to the above illustration, the REF LED indicates whether the WSA5000 is using the internally generated 10 MHz reference clock or an external reference clock provided via the 10 MHz IN SMA connector, and whether that selected reference clock source is of sufficient quality for the internal PLL to lock to it.

REF LED	10 MHz Reference Clock Source
Solid green	Internal clock reference selected (and provided via the 10 MHz IN SMA connector) and PLL has successfully locked to it
Slow blink green	External clock reference selected and PLL has successfully locked to it
Slow blink red	External clock reference selected but PLL cannot lock to it
Solid red	Internal clock reference selected but PLL cannot lock to it

RF Chain PLLs LOCK Indicator LED

Referring to the above illustration, the LOCK LED indicates whether the clock sources in the selected RF chain are of sufficient quality for the internal PLLs to lock on them.

LOCK LED	Reference Clock Quality
Green	All PLLs in the current RF chain have locked to their corresponding frequencies
Red	One or more PLLs in the current RF chain have not locked to their corresponding frequencies

Ethernet LINK Status and ACT Indicator LEDs

The Ethernet LINK status and ACT indicator LEDs indicate the status of the Ethernet connection.

LINK Status LEDs	Ethernet Link Status
Off	No Ethernet link connection
Orange	10/100 Mbit Ethernet link connection
Green	GigE Ethernet link connection

ACT Indicator LEDs	Ethernet Activity
Off	No Ethernet activity
Green	Ethernet transmit or receive activity

Hardware Reference

This section provides physical and performance specifications and port and cable pinouts for the WSA5000.

System Specifications

The following table outlines the physical specifications for the WSA5000.

Description	Design Specification
Dimensions (H x W x D)	9.8 x 6.5 x 1.2 in. (24.9 x 16.5 x 3.1 cm)
Weight	3 lb. (1.4 kg)
Digital interface ports	Ethernet 10/100/1000, USB 2.0 console, micro-DB25 GPIO
Analog interface ports	RF IN, I and Q IN, I and Q OUT, 10 MHz REF IN and OUT
Input supply voltage	12 VDC +/- 5%
Input supply current	1.8 A maximum
Operating temperature	32 to 122°F (0 to 50°C)

SMA Connectors

The SMA connectors on the front and back panels are all female jacks with 50Ω nominal impedance. The following table outline the maximum and minimum power level restrictions on the SMA connectors.



Caution: Injecting signal levels that exceed the specifications described in the following table will result in permanent damage to the receiver.

Connector Name	Direction	Max Power Level	Min Power Level
RF IN ¹	in	+10 dBm – with attenuation -10 dBm – without attenuation	N/A
10 MHz IN ^{2,3}	in	0 dBm	-10 dBm
10 MHz OUT	out	N/A	N/A
IQ IN	in	0 dBm	N/A
IQ OUT	out	N/A	N/A

¹ It is recommended that the output of a signal source be verified with the use of a power meter prior to connecting the source directly to the **RF IN** connector. Until it can be determined the front-end attenuator is in the circuit (see the INPUT:ATT? command of the Programmer's Guide), it is best to inject signals lower than -10 dBm. Additionally, any external signal sources connected to

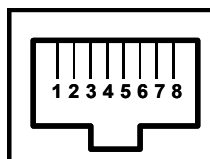
Hardware Reference

RF IN must be turned on only after powering on the WSA5000 and turned off prior to powering down the WSA5000.

² The 10 MHz reference input must be powered down prior to powering down the WSA5000.

³ To set the WSA to use the external 10 MHz reference, SOURCE:REF:PLL EXT command of the Programmer's Guide.

Ethernet RJ-45 Port Pinout



Pin	Signal
1	BI_DA+
2	BI_DA-
3	BI_DB+
4	BI_DC+
5	BI_DC-
6	BI_DB-
7	BI_DD+
8	BI_DD-

GPIO Port Pinout

The GPIO (General Purpose Input/Output) port supports extended hardware capability including SPI (Serial Peripheral Interface) bus, I²C serial interface, PPS (Pulse Per Second) input, external triggering input/output and specific radio front end control and status.



Caution: Improper use of the GPIO may cause irreparable damage to the WSA5000. Do not use the GPIO without prior consultation with ThinkRF's service organization.

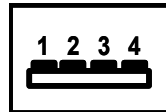
Pin	Direction	Voltage	Signal
1	bidirectional	3.3 V	I ² C SDA
2	bidirectional	3.3 V	I ² C SCL
3	out	3.3 V	TRIG OUT
4	in	3.3 V	TRIG IN
5	in	3.3 V	Reserved
6	in	3.3 V	Reserved

Pin	Direction	Voltage	Signal
7	out	3.3 V	Reserved
8	out	3.3 V	Reserved
10	out	3.3 V	SPI SEL
11	out	3.3 V	SPI SCLK
12	out	3.3 V	SPI MOSI
13	in	3.3 V	SPI MISO
14	in	3.3 V	PPS/EXT IN
16	out	3.3 V	EXT OUT
17-20	bidirectional	3.3 V	EXT IO D[3-0], respectively
23-25	power	6 V	VCC
9,15,21-22	ground	0 V	GND



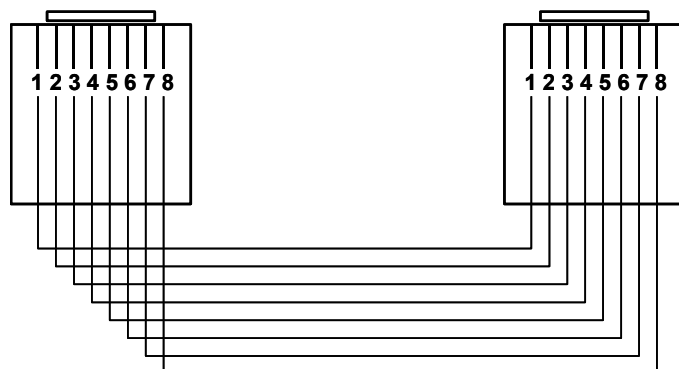
Note: The functionality of the EXT IN/OUT/IO pins is application specific and thus could vary. Refer to ThinkRF's Application Notes or contact ThinkRF support for more information.

USB Console Port Pinout

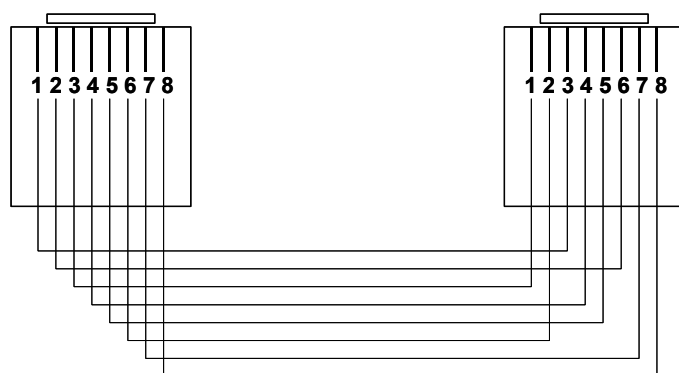


Pin	Signal
1	+5 VDC
2	Data -
3	Data +
4	Ground

RJ-45 Straight-Through Ethernet Cable



RJ-45 Crossover Ethernet Cable



Appendix A: Creating a Custom Calibration File

The calibration settings for the WSA5000 are stored in an XML file. The file name must have a **.xml** extension. You can create your own calibration file in compliance with the structure and format described below (descriptions of the XML tags follow). ***Replace the italicized texts with the appropriate values.***

```
<cal>
  <created>YYYY/MM/DD HH:MM:SS</created>
  <model>WSAXXXX-XXX</model>
  <prodrev>X</prodrev>
  <firmware>X.Y.Z</firmware>
  <version>2</version>
  <inputmode>
    <rfe_mode>
      <freqrange start="start_value" stop="stop_value">
        <freq value="freq_value_1">ref_level_1</freq>
        <freq value="freq_value_2">ref_level_2</freq>
        ... so on for more frequency steps ...
      </freqrange>
      ... so on for more frequency ranges ...
      <temprange start="start_value" stop="stop_value">
        <temp value="temp_value_1">ref_level_1</temp>
        <temp value="temp_value_2">ref_level_2</temp>
        ... so on for more temperature steps ...
      </temprange>
      ... so on for more temperature ranges ...
    </rfe_mode>
    ... so on for more RFE modes ...
  </inputmode>

  <vga_path>
    <gainrange start="start_value" stop="stop_value">
      <gain value="gain_value_1">ref_level_1</gain>
      <gain value="gain_value_2">ref_level_2</gain>
      ... so on for more gain steps ...
    </gainrange>
    ... so on for more gain ranges ...
    <temprange start="start_value" stop="stop_value">
      <temp value="temp_value_1">ref_level_1</temp>
      <temp value="temp_value_2">ref_level_2</temp>
      ... so on for more temperature steps ...
    </temprange>
    ... so on for more temperature ranges ...
  </vga_path>

  <attenuator>
    <freqrange start="start_value" stop="stop_value">
      <freq value="freq_value_1">ref_level_1</freq>
      <freq value="freq_value_2">ref_level_2</freq>
```

Appendix A: Creating a Custom Calibration File

```
... so on for more frequency steps ...
</freqrange>
... so on for more frequency ranges ...
<temprange start="start_value" stop="stop_value">
  <temp value="temp_value_1">ref_level_1</temp>
  <temp value="temp_value_2">ref_level_2</temp>
  ... so on for more temperature steps ...
</temprange>
... so on for more temperature ranges ...
</attenuator>
</cal>
```

The following table describes the XML tags in the calibration settings XML document. The tags are grouped by levels with the higher level tags are sub-elements of the lower level tags (e.g. <temp> is a sub-element of <temprange> which is a sub-element of <attenuator>).

XML Tag	Description
Root Level Tag:	
<cal>	The calibration information, the root element.
Level One Tags:	
<created>	The date and time the file was created using the format YYYY/MM/DD HH:MM:SS (e.g., 2014/06/07 13:25:50).
<model>	The model number of the WSA unit, expressed as WSAXXXX-XXX (e.g., WSA5000-220). This information is available on the "Device Status" page of the WSA administration console.
<prodrev>	The product revision of the WSA unit in the format listed on the "Device Status" page of the WSA administration console (e.g., 1.2).
	This tag is to be used with products with firmware v3.2.7 or higher. If you have older firmware image, it is recommended that to upgrade your unit to the latest version. If upgrade is not possible, use <hwrev> instead.
<firmware>	The firmware version installed on the WSA unit in the format listed on the "Device Status" page of the WSA administration console (e.g., 3.2.6 or 4.1.0).
<version>	The version of the XML file format, expressed as an integer. For units with firmware v3.2.7 and higher, use version 2; otherwise, use version 1.
<inputmode>	The input modes starting point. This section contains the sub-elements for each supported RFE mode.
<rfe_mode>	The RFE mode to be calibrated. Replace rfe_mode with the appropriate RFE tag name <zif>, <sh>, <shn>, <dd>, <hdr>, or <iqin>.
	This section contains - at least one frequency range <freqrange> element and one or

XML Tag	Description
	<p>more frequency <code><freq></code> sub-elements per range; and</p> <ul style="list-style-type: none"> - at least one temperature range <code><temprange></code> element and one or more temperature <code><temp></code> sub-elements per range.
<code><vga_path></code>	<p>The VGA (variable-gain amplifier) path to be calibrated. Replace vga_path with tag name <code><vgai></code> or <code><vgaq></code> for the I or Q path, respectively.</p> <p>This section contains</p> <ul style="list-style-type: none"> - at least one gain range <code><gainrange></code> element and one or more gain <code><gain></code> sub-elements per range; and - at least one a temperature range <code><temprange></code> element and one or more temperature <code><temp></code> sub-elements per range.
<code><attenuator></code>	<p>The attenuation path to be calibrated.</p> <p>This section contains</p> <ul style="list-style-type: none"> - at least one frequency range <code><freqrange></code> element and one or more frequency <code><freq></code> sub-elements per range; and - at least one temperature range <code><temprange></code> element and one or more temperature <code><temp></code> sub-elements per range.
Level Two Tags:	
<code><freqrange></code>	<p>The frequency range to be calibrated. You must specify values for the “start” (lower bound) and “stop” (upper bound) attributes in Hz.</p> <p>To be used with <code><inputmode></code> and <code><attenuator></code> sections only.</p>
<code><gainrange></code>	<p>The VGA's gain range to be calibrated. You must specify values for the “start” (lower bound) and “stop” (upper bound) attributes in dB.</p> <p>To be used with <code><vga_path></code> section only.</p>
<code><temprange></code>	<p>The temperature range to be calibrated. You must specify values for the “start” (lower bound) and “stop” (upper bound) attributes in Celcius.</p>
Level Three Tags:	
<code><freq></code>	<p>Specify a frequency value (in Hz) and a reference level (in dBm, expressed as a float value). The reference value for any frequencies between two specified frequency intervals will be linearly extrapolated.</p> <p>To be used with <code><freqrange></code> section only.</p>
<code><gain></code>	<p>Specify a gain value (in dB) and a reference level (in dBm, expressed as a float value). The reference value for any gains between two specified gain intervals will be linearly extrapolated.</p> <p>To be used with <code><gainrange></code> section only.</p>

XML Tag	Description
<code><temp></code>	Specify a temperature value (in Celcius) and a reference level (in dBm, expressed as a float value). The reference value for any temperatures between two specified temperature intervals will be linearly extrapolated.
	To be used with <code><temprange></code> section only.



Note: You do not need to specify values for all RFE modes, VGA or attenuator and ranges in the calibration file. Only the calibration settings of the specified mode(s) will be overwritten by the customized settings.

Example XML Calibration File

This example calibration file specifies the calibration reference level values for frequencies between 0 to 2 GHz, different temperature ranges, VGA's gain ranges between -10 to 30 dB.

You can specify different values for the ranges or the level three tag elements; they do not have to be the same as shown in this example.

```
<cal>
  <created>2014/07/09 12:34:45</created>
  <model>WSA5000-108</model>
  <prodrev>1.2</prodrev>
  <firmware>4.1.0</firmware>
  <version>2</version>

  <inputmode>
    <sh>
      <temprange start="-40" stop="85">
        <temp value='-10'>-1</temp>
        <temp value='0'>3</temp>
        <temp value='15'>6</temp>
        <temp value='33'>8</temp>
      </temprange>
      <freqrange start="0" stop="20e9">
        <freq value='100e6'>5</freq>
        <freq value='500e6'>7.1</freq>
        <freq value='10e9'>18.2</freq>
        <freq value='20e9'>8.2</freq>
      </freqrange>
    </sh>

    <zif>
      <freqrange start="0" stop="20e9">
        <freq value='100e6'>6</freq>
        <freq value='500e6'>8.1</freq>
        <freq value='10e9'>14.5</freq>
      </freqrange>
    </zif>
  </inputmode>
</cal>
```

```

        <freq value='20e9'>9.5</freq>
    </freqrange>
    <temprange start="-40" stop="85">
        <temp value='-40'>-4</temp>
        <temp value='0'>1</temp>
        <temp value='35'>4</temp>
        <temp value='85'>7</temp>
    </temprange>
</zif>

<hdr>
    <freqrange start="0" stop="20e9">
        <freq value='100e6'>14</freq>
        <freq value='500e6'>28.1</freq>
        <freq value='10e9'>23.1</freq>
        <freq value='20e9'>29.5</freq>
    </freqrange>
    <temprange start="-30" stop="40">
        <temp value='-11'>-2</temp>
        <temp value='0'>2</temp>
        <temp value='13'>4</temp>
        <temp value='32'>5</temp>
    </temprange>
</hdr>

<iqin>
    <freqrange start="0" stop="0">
        <freq value="0">17</freq>
    </freqrange>
    <temprange start="-40" stop="85">
        <temp value='25'>1</temp>
    </temprange>
</iqin>
</inputmode>

<vgai>
    <gainrange start="-10" stop="30">
        <gain value='-10'>0.9</gain>
        <gain value='0'>0.5</gain>
        <gain value='10'>-0.7</gain>
        <gain value='20'>-1.3</gain>
    </gainrange>
    <temprange start="-40" stop="85">
        <temp value='-40'>-4</temp>
        <temp value='0'>1</temp>
        <temp value='35'>4</temp>
        <temp value='85'>7</temp>
    </temprange>
</vgai>
<vgaq>
    <gainrange start="-10" stop="30">
        <gain value='-10'>1.2</gain>
        <gain value='0'>0.8</gain>
        <gain value='10'>-0.6</gain>

```

Appendix A: Creating a Custom Calibration File

```
<gain value='20'>-1.2</gain>
</gainrange>
<temprange start="-40" stop="85">
  <temp value='-40'>-3</temp>
  <temp value='0'>1</temp>
  <temp value='35'>3</temp>
  <temp value='85'>6</temp>
</temprange>
</vgaq>

<attenuator>
  <freqrange start="0" stop="20e9">
    <freq value='100e6'>19.4</freq>
    <freq value='500e6'>20.1</freq>
    <freq value='2e9'>20.3</freq>
  </freqrange>
  <temprange start="-40" stop="85">
    <temp value="-40">-10</temp>
    <temp value="25">0</temp>
    <temp value="75">10</temp>
  </temprange>
</attenuator>
</cal>
```