



xArray/xSpan Installation and Operations Guide

Version 5.10.0

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1 Requirements, Certifications, and Warnings

1.1 Products Covered by this Guide

This guide pertains to Impinj xArray/xSpan Gateways with the following part numbers:

Table 1.1: xArray Gateway Part Numbers

Gateway	Communication Code	Part Number
xArray	FCC	IPJ-REV-R680-USA
xArray	ETSI	IPJ-REV-R680-EU1
xArray	Japan	IPJ-REV-R680-JP2
xArray	GX1	IPJ-REV-R680-GX1
xArray	GX2	IPJ-REV-R680-GX2
xArray	GX3	IPJ-REV-R680-GX3

Table 1.2: xSpan Gateway Part Numbers

Gateway	Communication Code	Part Number
xSpan	FCC	IPJ-REV-R660-USA
xSpan	ETSI	IPJ-REV-R660-EU1
xSpan	Japan	IPJ-REV-R660-JP2
xSpan	GX1	IPJ-REV-R660-GX1
xSpan	GX2	IPJ-REV-R660-GX2
xSpan	GX3	IPJ-REV-R660-GX3

1.2 Federal Communications Commission (FCC) Compliance

This equipment was tested and complies 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 commercial environment. This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions, the equipment may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation and cause harmful interference to radio or television reception. To determine if this equipment causes harmful interference to radio or television reception, turn the equipment off and on. You are encouraged to try to correct the interference by one or more of the following:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Consult the dealer or a qualified radio/TV technician for assistance.

Per FCC 15.19(a)(3) and (a)(4)

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.
- (2) This device must accept any interference received, including interference that may cause undesired operation.

Per FCC 15.21

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Minimum Separation Distance



This device has been evaluated for compliance with FCC and IC RF exposure limits in a mobile configuration. At least 34 cm of separation distance between the device and the user's body must be maintained at all times. This device must not be used with any other antenna or transmitter that has not been approved to operate in conjunction with this device.

Industry Canada (IC) Compliance

Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

The term “IC” before the radio certification number only signifies that Industry of Canada technical specifications were met.

Industrie Canada (IC) Conformité

Son fonctionnement est soumis aux deux conditions suivantes:

1. Cet appareil ne doit pas provoquer d’interférences.
2. Cet appareil doit accepter toute interférence, y compris celles pouvant causer un mauvais fonctionnement de l’appareil.

L’expression “IC” avant le numéro de certification radio signifie seulement que l’industrie des spécifications techniques Canada ont été respectées.

1.3 CE Marking and European Economic Area (EEA)

RFID devices designed for use throughout the EEA must have a maximum radiated transmit power of 2W ERP in the frequency range of 865.6-867.6 MHz. For other EEA restrictions on RFID device use, refer to the *Impinj Declaration of Conformity (DoC)* located at support.impinj.com.

1.4 National Communications Commission (NCC - Taiwan) Administrative Rules for Low-power Radio-Frequency Devices

This device complies with the following items of NCC related rules:

Article 12

Without permission granted by the NCC, any company, enterprise, or user is not allowed to change frequency, enhance transmitting power or alter original characteristics as well as performance to approved low-power radio frequency devices.

Article 14

The low-power radio frequency devices shall not influence aircraft security and interfere with legal communications. If found, the user shall cease operating immediately until no interference is achieved. The said legal communications means radio communications is operated in compliance with the Telecommunications Act. The low-power radio frequency devices must be susceptible with the interference from legal communication or ISM radio wave radiated devices.

1.5 Environmental Requirements

Operating temperature: -20 to 50C (non-condensing)

1.6 Power Requirements



Warning: This product may be powered by an IEEE 802.3af (Power over Ethernet) compliant power source that is certified by the appropriate agencies, or with a listed/certified power supply marked LPS or Class 2, with 24Vdc output, rated minimum 2.5A.

The use of alternative power supply will invalidate any approval given to this device and may be dangerous.



Attention: Ce produit peut être alimenté par un IEEE 802.3af (Power over Ethernet) source d'alimentation conforme qui est certifié par les organismes appropriés, ou avec une alimentation inscrite/certifié LPS ou classe 2 marquée, avec une sortie 24V, 2,5A nominal minimal. L'utilisation d'une autre alimentation annule toute autorisation liée à cet appareil et peut être dangereuse.

When supplied by the Impinj-approved listed/certified power supply model number IPJ-A2003-000, the available AC power cords are:

- IPJ-A2051-USA (for North America)
- IPJ-A2051-EU1 (for European Union)
- IPJ-A2051-JPN (for Japan)
- IPJ-A2051-BRA (for Brazil)
- IPJ-A2051-CHN (for China)
- IPJ-A2051-ARG (for Argentina)
- IPJ-A2051-AUS (for Australia, New Zealand)
- IPJ-A2051-RSA (for South Africa)
- IPJ-A2051-UK1 (for UK, Singapore, Malaysia)

1.7 Before You Begin



Warning: Please read this document in its entirety before operating the xArray/xSpan Gateway, as serious personal injury or equipment damage may result from improper use. Unauthorized opening of the xArray/xSpan Gateway enclosure voids the warranty.



Avertissement: S'il vous plaît lire ce document dans son intégralité avant d'utiliser le xArray/xSpan Gateway, comme des blessures graves ou des dommages matériels peuvent résulter d'une mauvaise utilisation. Ouverture non autorisée du lecteur xArray/xSpan Gateway boîtier annule la garantie.

1.8 About This Guide

This guide provides instructions for installing, connecting, configuring, operating, upgrading, and troubleshooting the xArray/xSpan Gateway. To shorten the length of this guide, the content focuses on the installation and operation of one xArray/xSpan.

1.8.1 Intended Audience

The intended audience for this guide is anyone installing an xArray/xSpan. The assumed primary users of this guide are systems engineers and IT personnel with experience and basic knowledge of:

- Software development
- Hardware systems integration
- Network connectivity

This guide also assumes that the user has a high-level understanding of RFID, RFID systems management, and a basic familiarity with the EPCglobal Gen 2 specification, which can be found at <http://www.gs1.org/gsmp/kc/epcglobal/uhfci2>.

1.8.2 Other Documents of Interest

This guide is part of a larger documentation set that supports xArray/xSpan as follows:

- *LTK Programmer's Guide* provides software engineers with guidelines and best practices for working with the Low Level Reader Protocol (LLRP) Toolkit. Software engineers can also access language-specific reference guides and sample applications illustrating the scenarios discussed in the Programmer's Guide.

- *Octane LLRP* is intended for software engineers and describes the LLRP capabilities supported by xArray and xSpan, which includes Impinj's custom LLRP extensions.
- *RShell Reference Manual* describes the syntax and command language for the xArray/xSpan RShell console.
- *Octane SNMP Guide* provides monitoring and reference information for working with the SNMP MIBs.
- *Firmware Upgrade Reference Manual* includes detailed procedures, reference information for upgrading firmware installed on Impinj Gateway products, and procedures for creating a metafile to automate upgrading of multiple devices.
- *Impinj Reader and Gateway Embedded Developer's Guide* provides a description of the Speedway platform and a view of its architecture for software engineers designing custom application software for the Reader.

2 Introduction

The xArray/xSpan Gateways are fixed infrastructure RFID reader systems that provides always-on, wide-area monitoring of RAIN RFID tagged items (<http://www.rainrfid.org>). The xArray/xSpan Gateways are designed for large-scale item-level applications in many industries. The xArray provides real-time Item Intelligence events, including each item's identity, location, and authenticity. The xSpan's small size is optimal for mounting on walls or ceilings to monitor tag movement through doors or portals.

Key features and capabilities of your new Impinj RFID Gateway include:

- A single xArray can monitor up to 1,500 ft² (139 m²) using Monza R6 based tags while a xSpan can monitor up to 1,000 ft² (93 m²).
- Intelligent item locating using xArray with 5 ft (1.5 m) or better spatial resolution of (x,y) location.
- Low profile design fits into standard ceiling tile grid and blends into decor.
- Maximum transmit power and performance is achieved by using IEEE 802.3af PoE. There is no need for optional AC to DC power module.
- Easy programming using Octane SDK, LLRP and Impinj extensions. Either Gateway contains a Speedway RFID reader that allows you to use all of the same software tools and LLRP API, with additional extensions specific to xArray/xSpan.

3 xArray Product Tour

The xArray Gateway radiates RF energy from the radome side, as shown in Figure 3.1. This plastic cover protects the phased array antenna elements. On the side of the radome is a large label with the last 6 octets of the xArray Ethernet MAC address. This label is designed to be visible from below when the xArray is mounted overhead, which allows easy identification.



1. LED Lights
2. Mounting Clip

Figure 3.1 Radome Side View of xArray

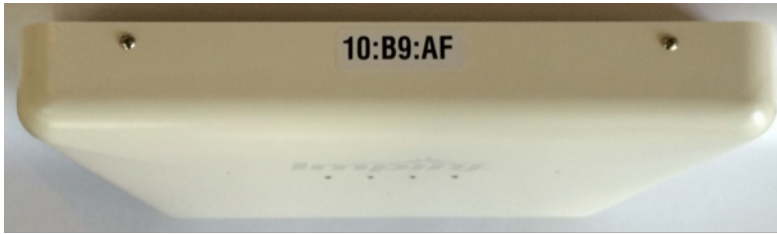


Figure 3.2 Side View Showing MAC Address

The four LEDs that are visible from the radome side help you identify the operation state of the xArray. The tables below summarize what each LED signifies during boot, operation, and fault conditions. The xArray Gateway has four LEDs to indicate operational status, their position.

3.1 xArray Status Lights

Each LED has its own blink patterns to convey status to the user. Table 3.1 documents the defined patterns for the xArray Ethernet/LLRP LED. Table 3.2 documents the defined patterns for the xArray NR/Beacon LED. Table 3.3 documents the defined patterns for the xArray Fault LED.

Table 3.1 xArray Ethernet/LLRP LED

LED State	xArray State
OFF	During startup
Blinking (GREEN)	Ready for an LLRP host connection
Solid (GREEN)	LLRP host connected

Table 3.2 xArray NR/Beacon LED

LED State	xArray State
Blink (ORANGE)	Briefly during startup
OFF	(Default)
ON (ORANGE)	When turned ON by LLRP command

Table 3.3 xArray Fault LED

LED State	xArray State
Blink (RED)	Briefly during startup

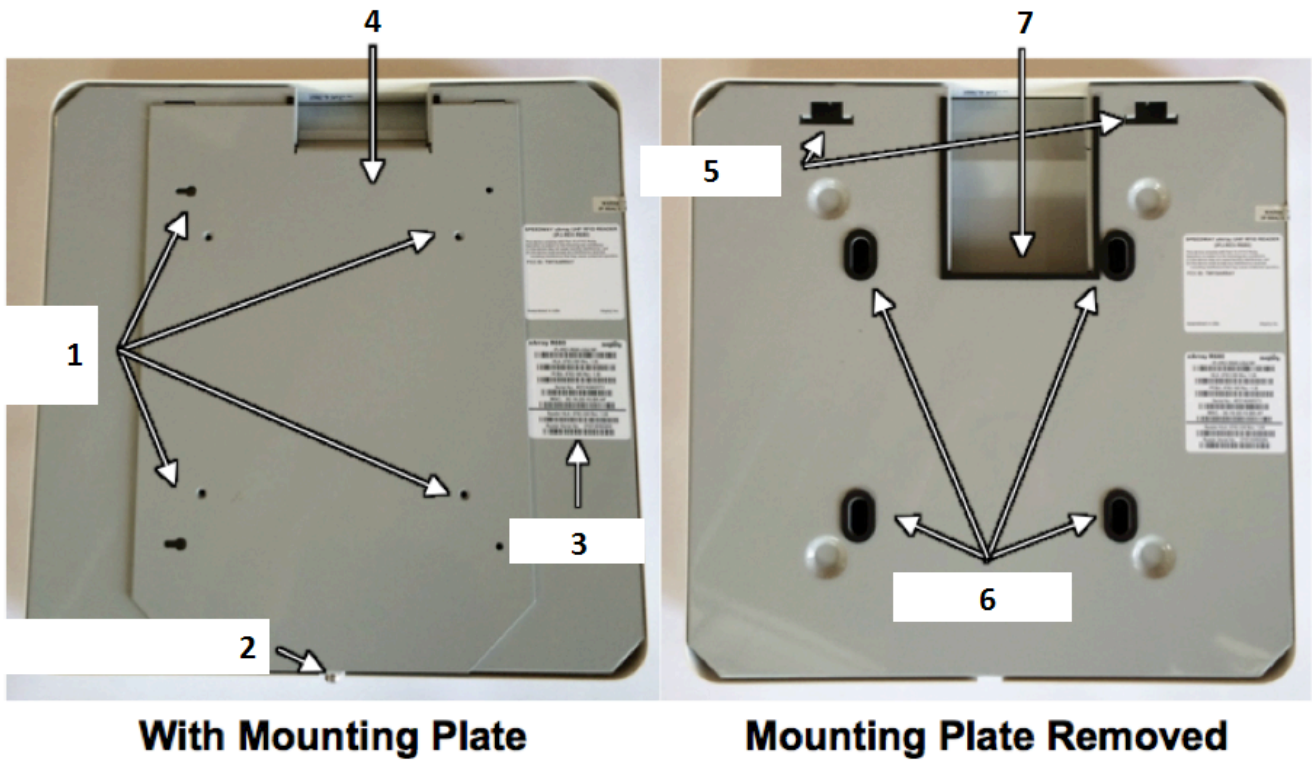
LED State	xArray State
OFF	Normal (no faults)
ON (RED)	Fault condition occurred

Table 3.4 xArray Operations and Associated LED Behavior

xArray Operation		LED	Expected Behavior
Power (power on), normal completion	Power applied, attempting to start boot code	Power Status	Solid red Off
Ethernet/LLRP normal completion	LLRP Connection	Eth/LLRP Status	Solid red Off
NR/Beacon	Programmable light	NR/Beacon Status	Solid red Off
Fault	Failure	Fault Status	Solid red Off

3.2 Mounting the xArray using Detachable Mounting Plate

The mounting side of xArray is all metal, which allows the mounting to be in contact with Environmental Air Handling Space (EAHS), in accordance with Section 300-22(c) of the National Electric Code. Figure 3.3 shows the xArray rear mounting side with and without the detachable mounting plate.



1. Mounting Holes
2. Mounting Clip
3. Labels
4. Mounting Plate
5. Hinges
6. Gaskets
7. Electrical Connections

Figure 3.3 Mounting (Rear) Side of xArray

The xArray is designed to have two mounting configurations, which are described in this section.

Mounting Configuration 1

Configuration 1 requires the xArray mount plate to be attached to a Vesa 200 mm mount. The threaded inserts are designed to hold a M6 bolt. The equation below lists the minimum and maximum bolt length for your setup.

- Bolt Length Minimum = 7.6 mm + Thickness of Vesa Mount
- Bolt Length Maximum = 12.0 mm + Thickness of Vesa Mount

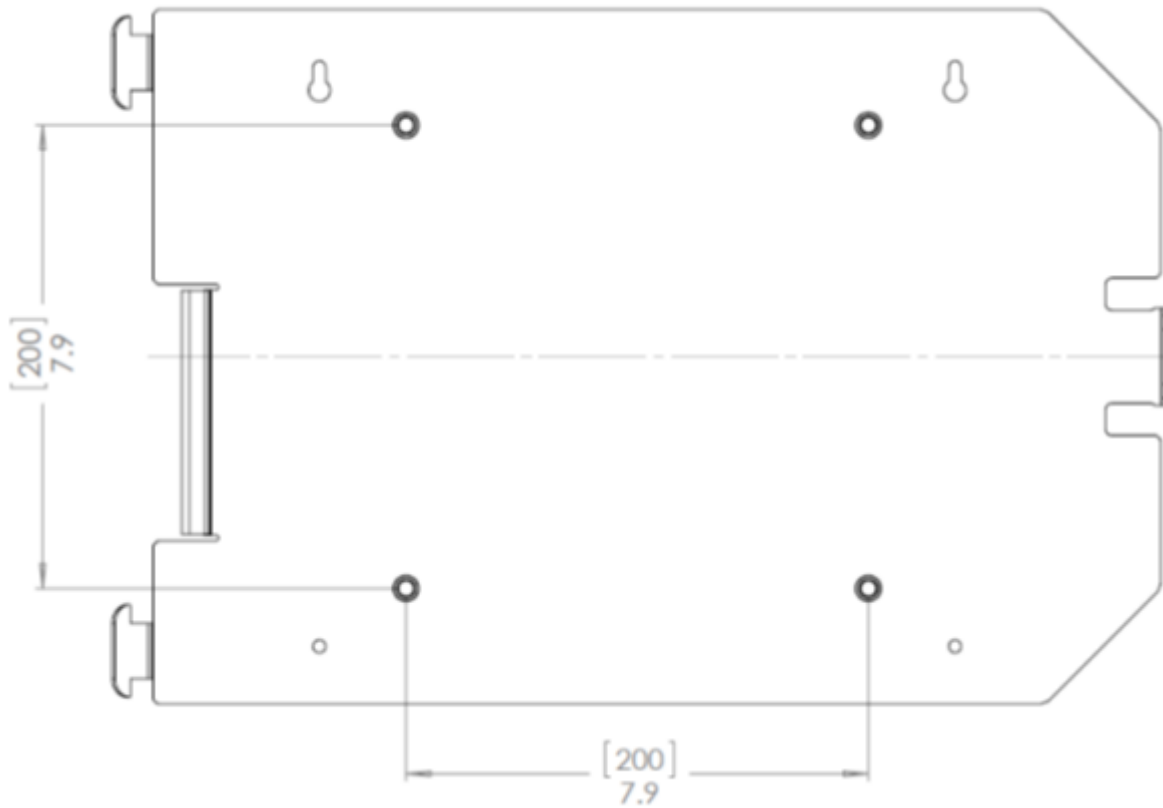


Figure 3.4 Mounting Configuration 1 for xArray

Mounting Configuration 2

Configuration 2 allows you to bolt the xArray mount plate to any structure. The clearance holes in the mount plate (shown below) can accommodate a M5 Bolt (Metric) or a #10 Bolt (SAE).

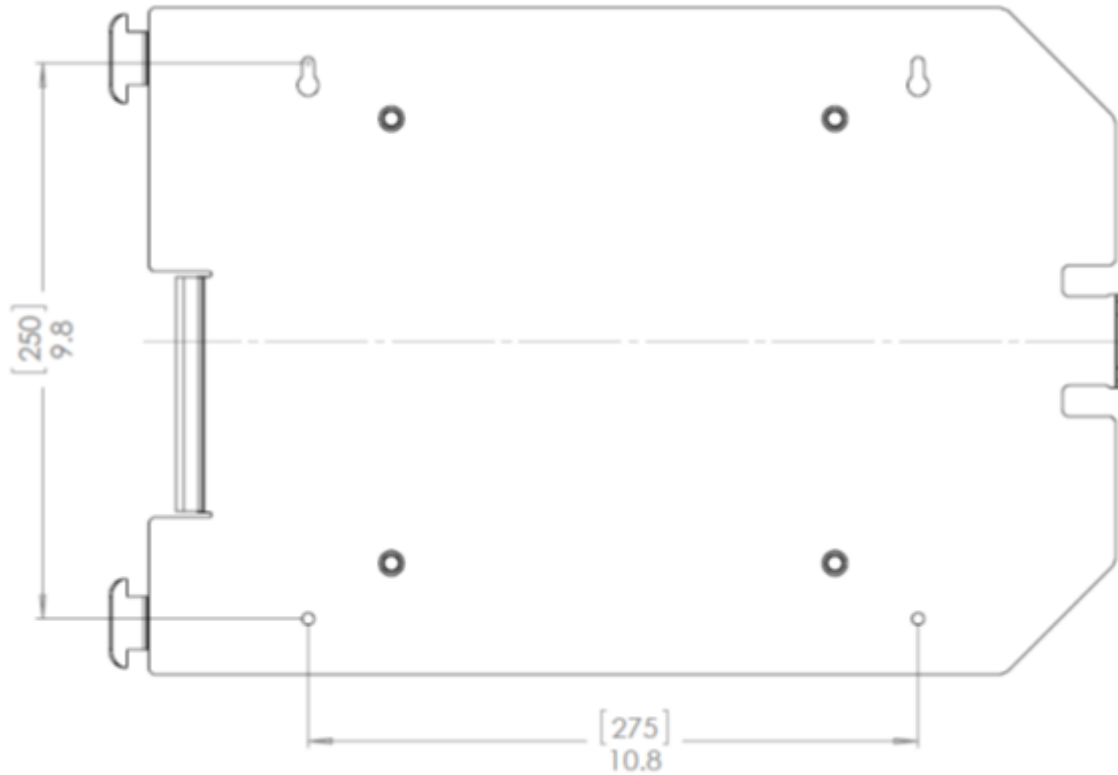
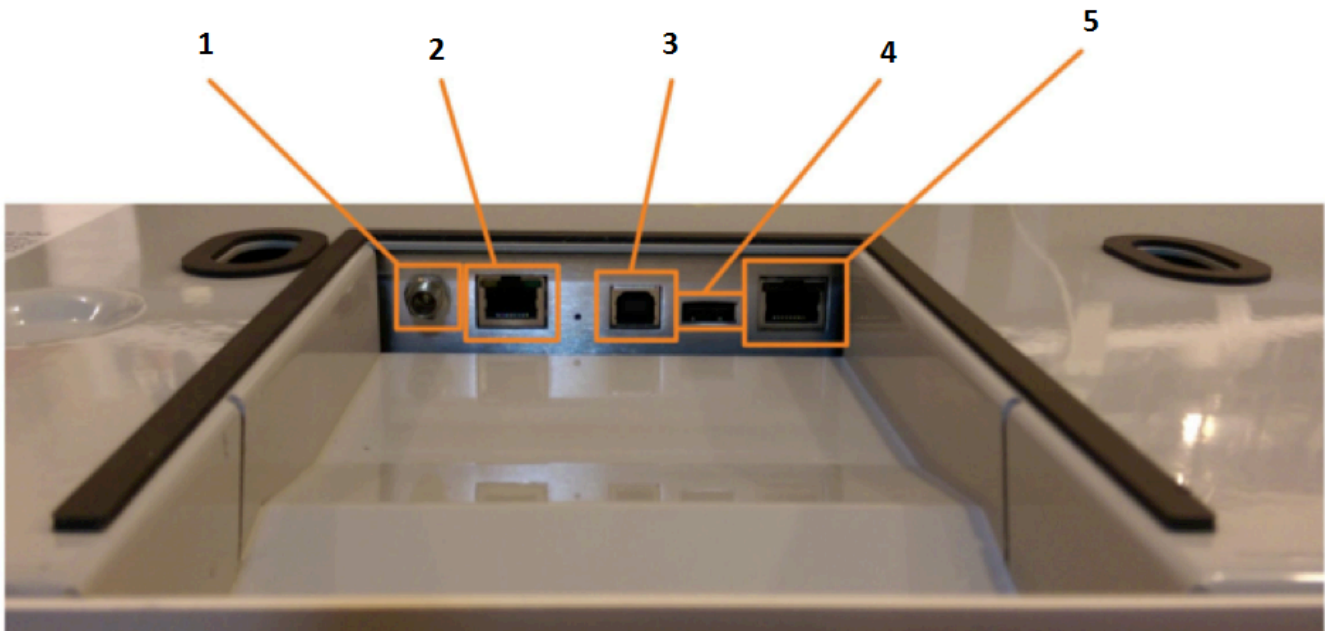


Figure 3.5 xArray Mounting Configuration 2

Note: The mounting plate CAD drawing is available for download on the Impinj support portal at support.impinj.com.

After you have completed the mounting configuration that you want to use, complete the following tasks:

- After the mounting plate is securely attached to the ceiling, hang the xArray using the hinges.
- In this hanging position, the Ethernet and +24V power (if used instead of PoE) cables can be attached as shown in figure 3.6.
- Rotate the xArray into final position against the mounting plate, and securely lock it into position using the mounting clip.

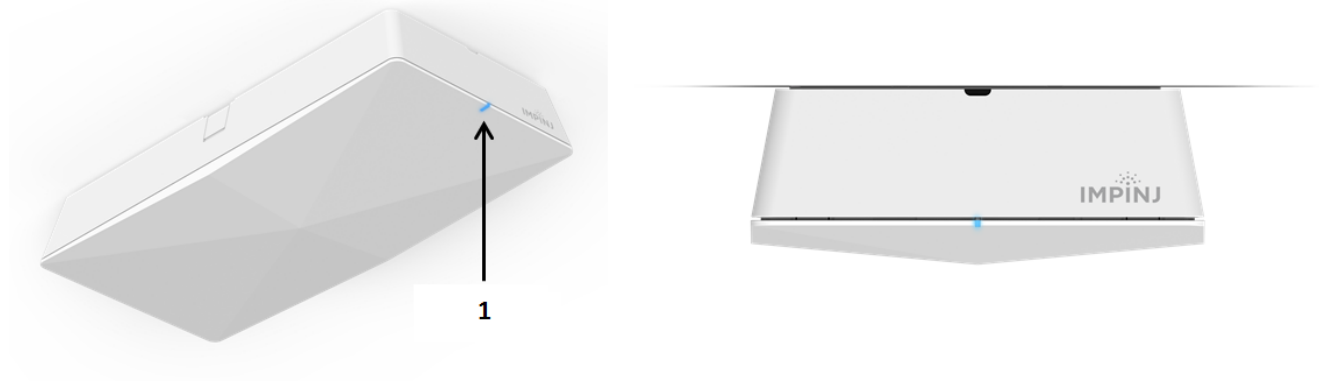


1. Power 24V, 1A
2. PoE Ethernet
3. USB Device *(note: Usage not required for normal functionality)*
4. USB Host *(note: Used for software updates via USB thumb drive)*
5. Console *(note: Not intended for customer use.)*

Figure 3.6 Electrical and Network Connections for xArray

4 xSpan Product Tour

The xSpan Gateway radiates RF energy from the radome side, as shown in Figure 4.1. The xSpan Gateway ships with a MAC address label the user can optionally apply for unit identification.



1. LED Light

Figure 4.1 LED Location of xSpan

The single multi-color LED is positioned on one side of xSpan, allowing easy viewing when mounted overhead or on a wall. Figure 4.2 summarizes LED operation during boot, operation, and fault conditions.

Table 4.1 xSpan LED Status Light Behavior

LED State	xSpan State
OFF	OFF (no power supplied)
RED - Solid	Powered
YELLOW - Solid	Ready
BLUE - Solid	Connected
RED - Blinking	Fault condition occurred
Blue - Blinking	Beaconing

Note: The LED will remain in the Solid Yellow state if there is no network connection or the network cable is faulty.

4.1 Mounting the xSpan using Detachable Mounting Plate

xSpan provides a detachable mounting plate for overhead or wall mounting options. The mounting plate is designed to have two mounting configurations, which are described in this section. The xSpan Gateway can be securely locked in the installed mounting position with parts included in the box. A security screw (SHCS-6-32-0.25 IN - TORX) and security screw tool (TORX L-KEY T15 SIZE) are included in the xSpan accessory kit. To lock in place, install the security screw in the position shown below. Once installed, the xSpan latch is disabled and the xSpan Gateway unit cannot be removed from the mounting plate.

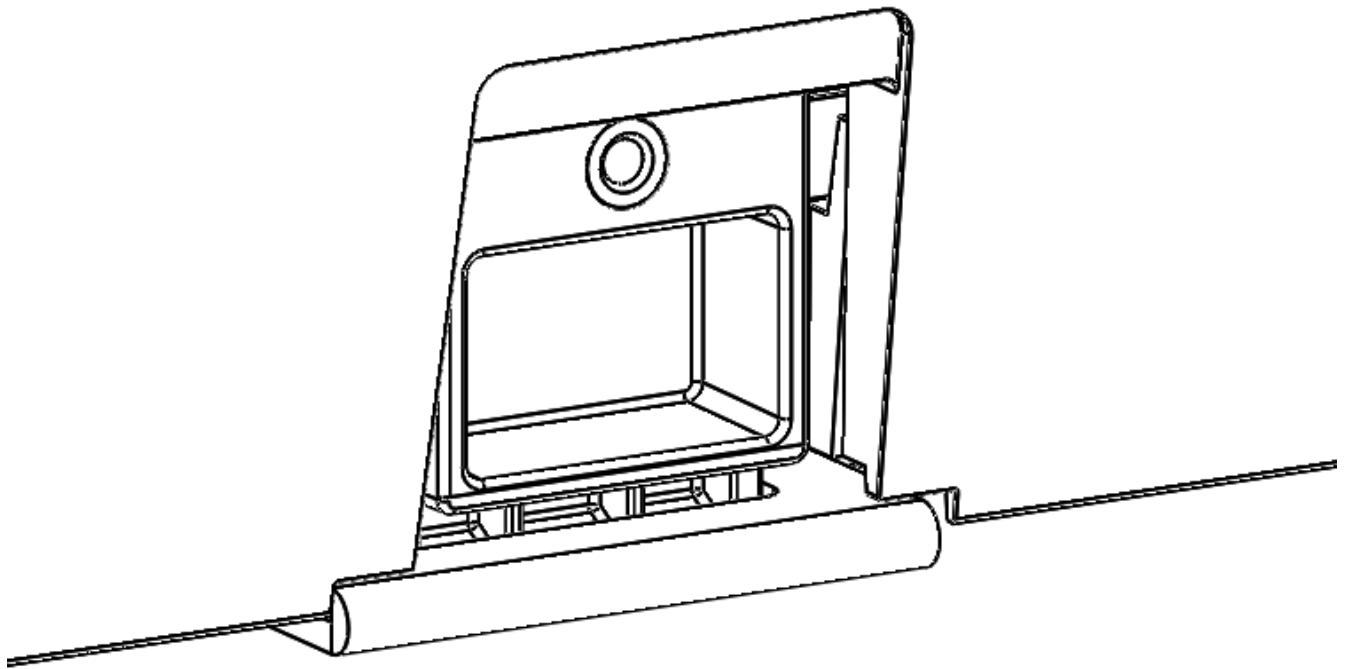


Figure 4.3 Latching Mechanism with Security Locking Feature for xSpan

Mounting Configuration 1

Configuration 1 requires the xSpan mount plate to attach to a Vesa 75 mm mount. xSpan is supplied with mounting screws.

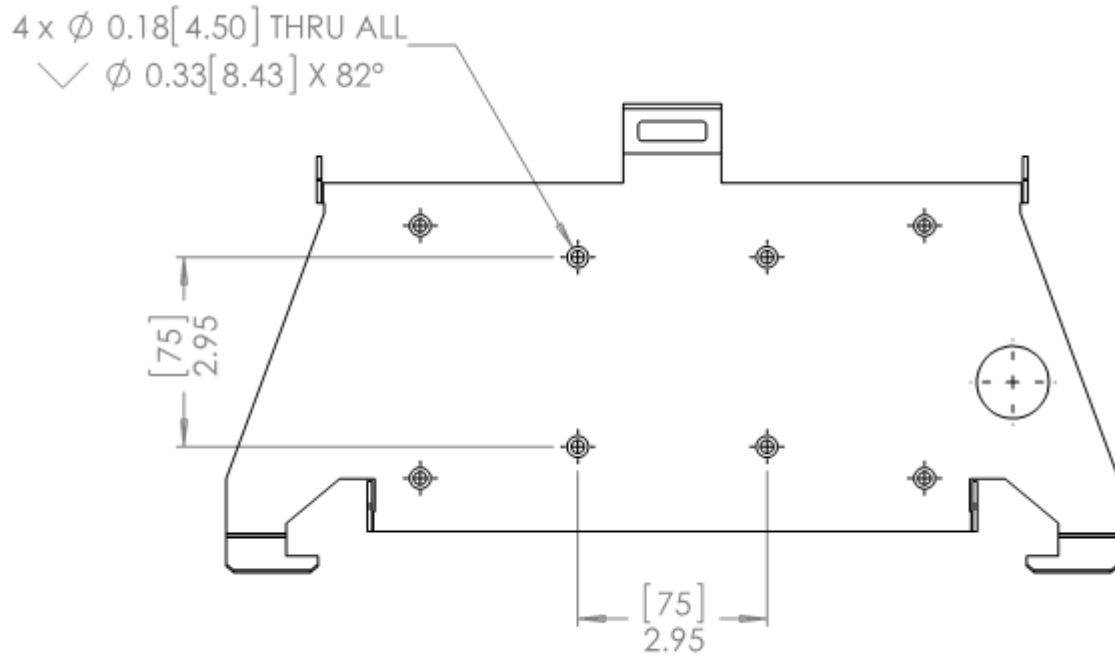


Figure 4.4 Mounting Configuration 1 for xSpan

Mounting Configuration 2

Configuration 2 allows you to bolt the xSpan mount plate to any structure. The clearance holes in the plate can accommodate a M4 (Metric) or #8 Bolt (SAE).

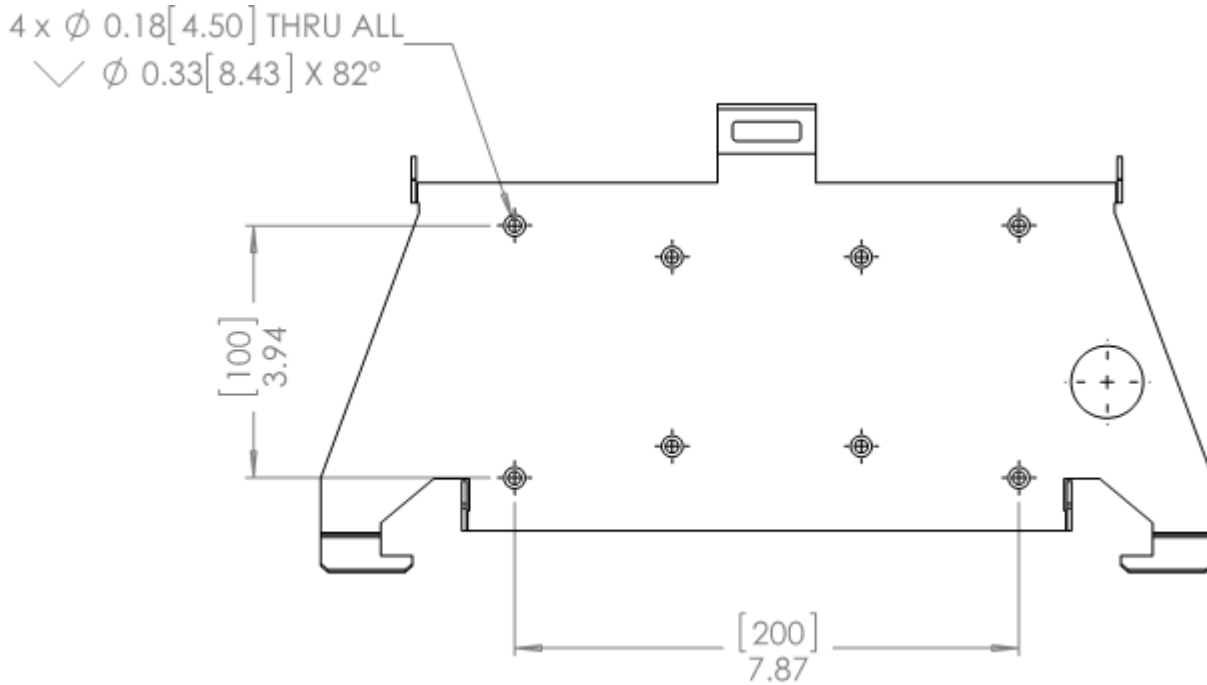
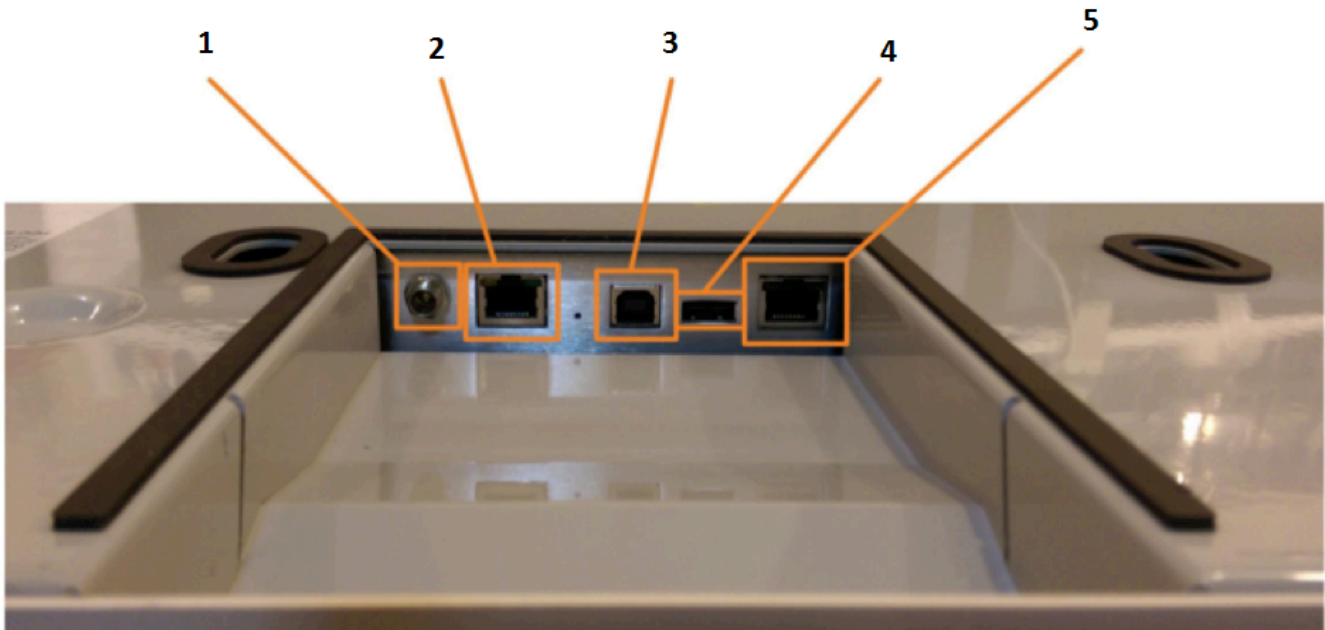


Figure 4.5 Mounting Configuration 2 for xSpan



1. Power 24V, 1A
2. PoE Ethernet
3. USB Device (*note: Usage not required for normal functionality.*)
4. USB Device
5. PoE Ethernet

4. USB Host (*note: Used for software updates via USB thumb drive.*)
5. Console (*note: Not intended for customer use.*)

Figure 4.6 Electrical and Network Connections for xSpan

5 Powering and Connecting

This section describes how to provide power and establish network connectivity to the xArray/xSpan Gateways.

5.1 Supplying Power

You have two choices for powering the Gateway products:

- IEEE 802.3af (Power over Ethernet) compliant source
- Listed/certified power supply, marked LPS or Class 2, with 24Vdc output, rated minimum 2.5A

Note: xArray/xSpan operates at the Class 3 limit for PoE power, and requires that the maximum resistance of the Ethernet cable is 10 Ohms or less (for 100 meter length cable). For a list of cables that meet xArray/xSpan requirements, see Table 5.1.

Table 5.1 Cat 5e, 6, 6A, 7 Cable That Meets Requirements

Cable Description	Product Information
100 meter cable < 10 Ohm	Cabling used must be ISO/IEC 11801 or ANSI/TIA/EIA-568 certified.
50 meter cable < 10 Ohm	Cabling used must be ISO/IEC 11801 or ANSI/TIA/EIA-568 certified.

With either option, the boot sequence begins when power is supplied to the Gateway. This sequence typically completes within 30 seconds. Once the boot sequence finishes, the Gateway accepts commands, but not before. The Power and Status LEDs on the Gateway alert you of the status.

Note, on Cisco Catalyst series switches the Ethernet PoE port will automatically disable itself if the reader has a listed/certified power supply connected. In this situation, the Cisco port must be set to PoE = “never”, using the following Cisco configuration commands.

In this example slot 5, port 2 is being set to PoE = “never”.

```
Switch# configure terminal Switch(config)# interface fastethernet 5/2 Switch(config-if)# power inline never Switch(config-if)# end Switch#
```

! Important: We recommend that you do not connect both a PoE and a listed/certified power supply to xArray/xSpan. If the Gateway device is receiving power via PoE and detects

that an listed/certified power supply has been connected, the Gateway reboots and switches to the listed/certified power supply source. If, however, the Gateway is receiving power via an listed/certified power supply and detects the connection to a PoE-enabled network switch, nothing changes. The Gateway continues to receive power from the listed/certified power supply. The listed/certified power supply always takes precedence over PoE because the listed/certified power supply is capable of higher power if both sources are connected.

5.2 Connecting to a TCP/IP Network

The xArray/xSpan internal processor runs Linux OS, which offers robust network support. When you want to establish TCP/IP network connectivity for deployment or out-of-box evaluation you have a range of options, including:

- Either Gateway by default are configured to use DHCP. The default host name is xarray-XX-XX-XX or xspan-XX-XX-XX, where XX-XX-XX is the last three bytes of the Gateway's MAC address. The large label on the side of the xArray radome (optional on xSpan), provides these three bytes. Alternately, you can read the MAC address directly from the product label on the mounting side of the Gateway.
- If you don't have a DHCP server, **OR** when the PC is connected directly to the device via Ethernet cable, the Gateway defaults to a fixed IP address, **169.254.1.1**. If this address is not available, the device then randomly selects a fixed IP address in the **169.254.xxx.xxx** link local address range.
- You can configure xArray/xSpan to a fixed IP address. This option requires configuration via SSH session over TCP/IP, or a serial connection via console port in order to access xArray/xSpan's command line interface (Rshell). For more information about using RShell to configure network settings, see section 5.1.2.

5.3 Verifying Network Connectivity

After the Gateway device is powered and on a TCP/IP network, verify that the left-most LED is GREEN and the second to the left LED is BLINKING GREEN on the radome for xArray or the single LED on xSpan is blinking Blue. The next step is to access Gateway's Management web page to verify connectivity and to see the status of the device. **To Browse to the xArray/xSpan Management Web Page**

- From a PC or Mac on the same TCP/IP network, use your browser of choice to browse to the Management web page using the web address <http://xarray-XX-XX-XX> or <http://xspan-XX-XX-XX>, where XX-XX-XX is the last three bytes of the MAC address.

- Alternately, you can use the IP address of the Gateway. You might know the IP address because the Gateway was configured to a fixed IP address, or it was determined by using a console port RShell session, or because you discovered the IP address that was assigned by your DHCP router. For these cases, use the web address <http://<IP address of Gateway>>.

Notes:

- If you are not on an enterprise network, you might need to add **.local** to the address. For example:
<http://xarray-XX-XX-XX.local>
or <http://<IP address>.local>
- Either Gateway supports the discovery of the host name by using Bonjour Print Services. If your DHCP server doesn't resolve the Gateway host name, you might have to install Bonjour on your Windows PC. You can download Bonjour Print Services from <http://support.apple.com/kb/dl1999>.

When you have successfully opened the Gateway internal web page, you should see a dialog box where you can enter the user name and password. Use the xArray/xSpan's default user name and password:

user name: root
password: impinj

Note: For more information about changing the default password, see the *RShell Reference Manual*.

After your login has been verified, the Management web page displays, as shown in Figure 5.1. Review this web page to verify the regulatory region, serial number, software version, IP address, and other key parameters of your Gateway.

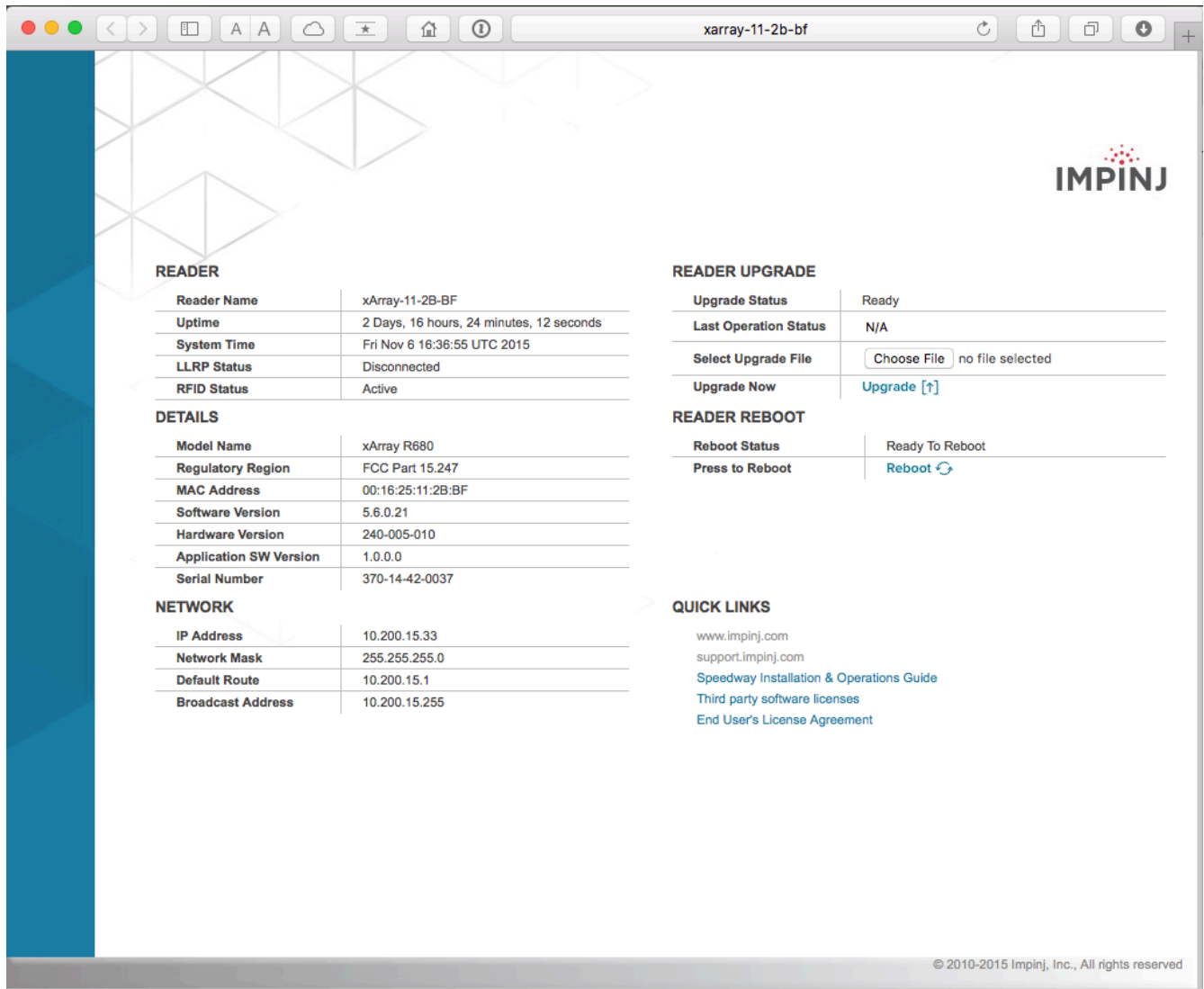


Figure 5.1 Gateway Management Web page

5.4 Connect using Serial Console Port

Note: The console port is intended for debug/local network access. This is not intended for customer use under normal operation

To Connect Gateway to Your PC Over a Serial Connection

1. Confirm that you have the latest version of Putty, a free and reliable SSH, Telnet, and serial client. Version 0.60 or higher contains support for serial connections.

2. Use a Cisco style Console cable RJ-45 to DB9, Impinj part number IPJ-A4000-000, to connect your PC's valid/active COM port to the serial port on the xArray/xSpan.
3. Power up the Gateway and wait for the boot sequence to complete. For more information, see section 5.1.
4. On the PC, run the Putty application and select the **Serial connection** option.
5. On the **Putty Configuration** page, verify that **Serial line to connect to** is set to **COM1**. If you are using a serial to USB adapter, this field can be set to a different COM port.
6. Set **Speed** to **115200**.
7. Set **Flow control** to **None**.

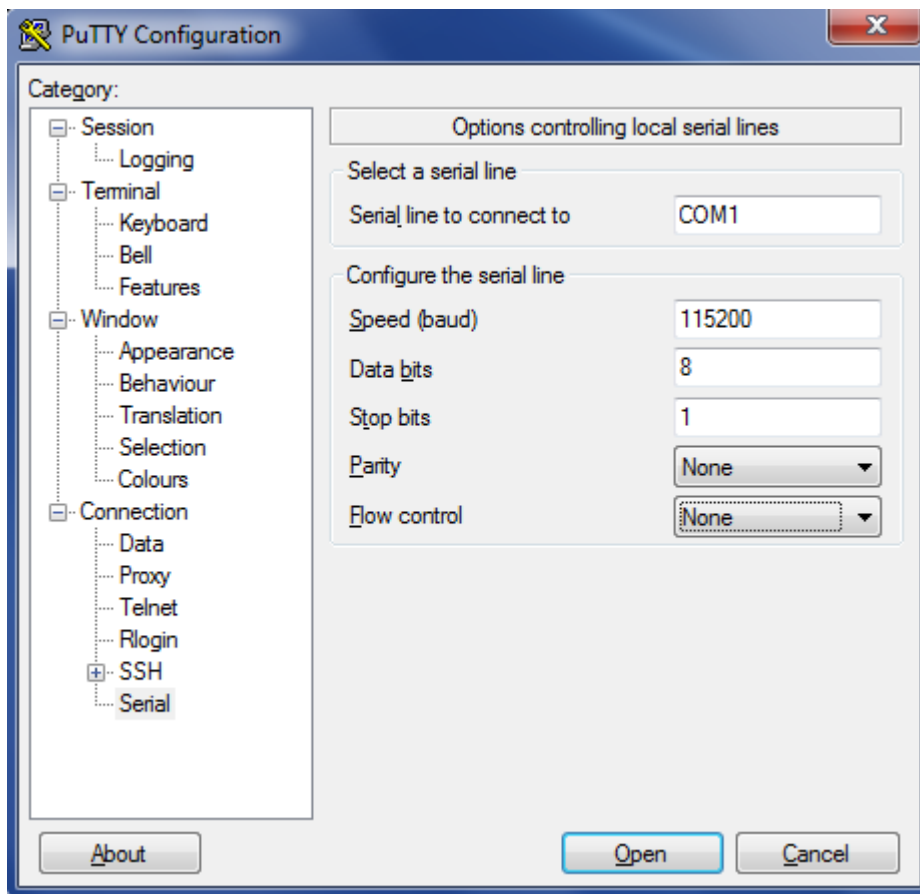


Figure 5.2 Putty Configuration Settings

8. Select **Open**. The RShell console window opens.
9. Press **Enter**. The RShell login prompt displays.

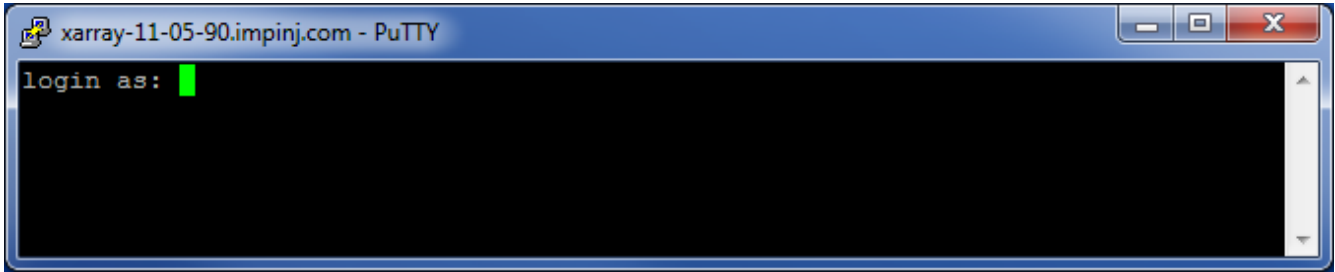


Figure 5.3 COM1 Putty Login Prompt

10. Log in with the following default credentials, unless you customized them:
 - user name: **root**
 - password: **impinj**
11. When the RShell command line prompt displays, begin configuring the network settings for the Gateway. For additional information, see **Using RShell to Configure Network Settings** in section 5.1.2.
12. When you have completed configuration of the appropriate network settings, connect the xArray/xSpan to your Ethernet network.

Note: If you decide to connect to DHCP after you have connected serially, remember to use RShell to change the IP address on the xArray/xSpan from **static** to **dynamic**. For more information, see **Using RShell to Configure Network Settings** in section 5.1.2.

6 Using xArray/xSpan with ItemTest

ItemTest is a simple, easy-to-use, Windows-compatible application that you can use to evaluate the performance of one or several Gateways. This chapter describes how to install, configure, and perform basic testing on xArray/xSpan with ItemTest. ItemTest supports use case testing of Wide Area Monitoring (Inventory) or Location with multiple Gateways. You can find the complete *ItemTest User Guide* by opening the Help menu in ItemTest, and then clicking **Open User Guide**.

6.1 Download ItemTest

Download ItemTest from the Impinj support Web site at support.impinj.com. To use ItemTest, your computer must be running Microsoft Windows 7 or later.

6.2 Install and Launch ItemTest

Launch the Installer from the ItemTest download. Follow the step-by-step instructions to install ItemTest on your PC. After a successful installation, double-click **ItemStart** to start the application. You should see the opening screen as shown in Figure 6.1.

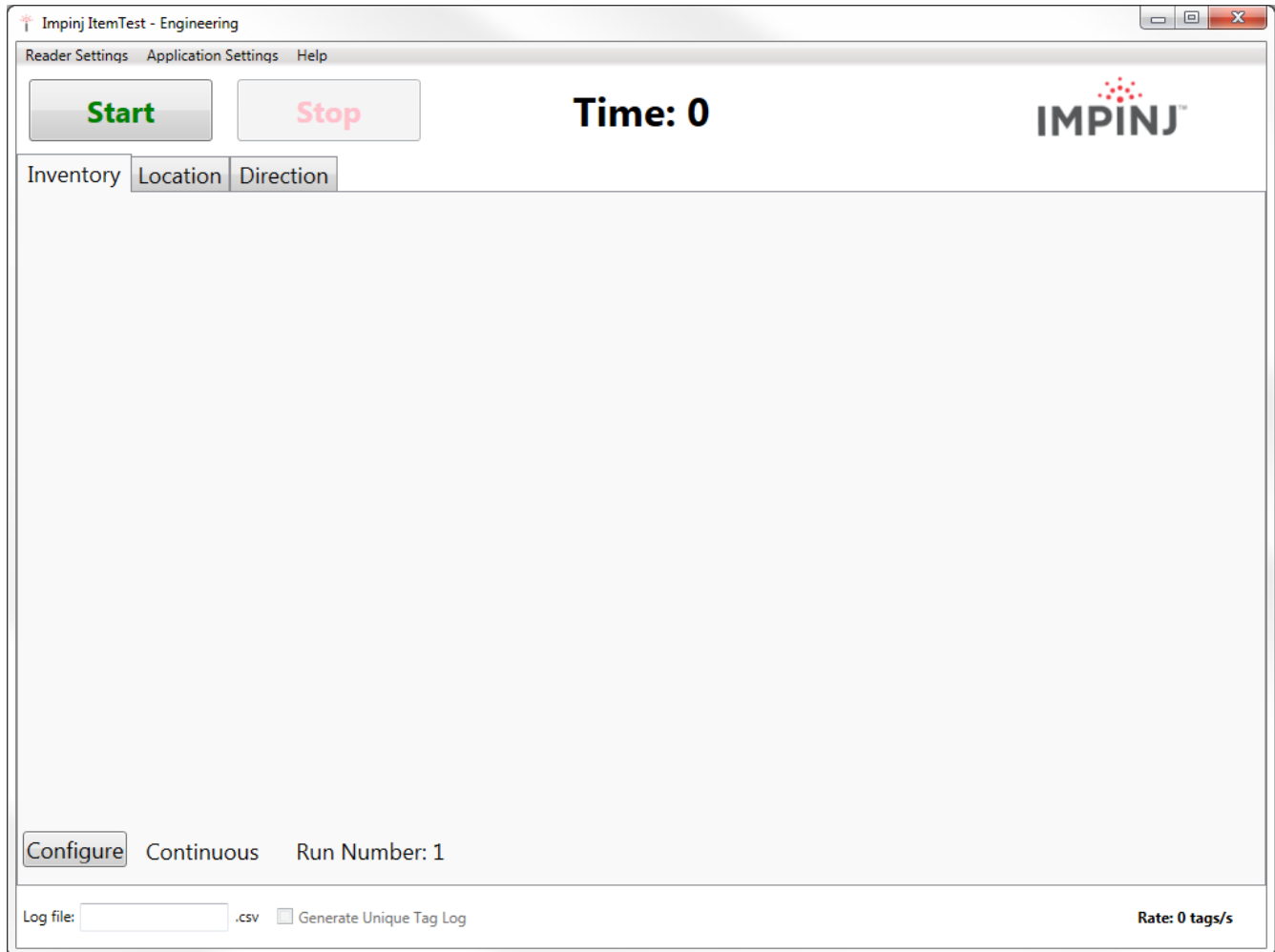


Figure 6.1 ItemTest Opening Screen

6.3 Connect and Configure the Gateway

Now that ItemTest is running, the next step is to connect and configure your Gateway device, using the following procedure.

To Connect and Configure Your Gateway

1. Select the **Reader Settings** menu, which opens the **Reader Settings** window, as shown in Figure 6.2.

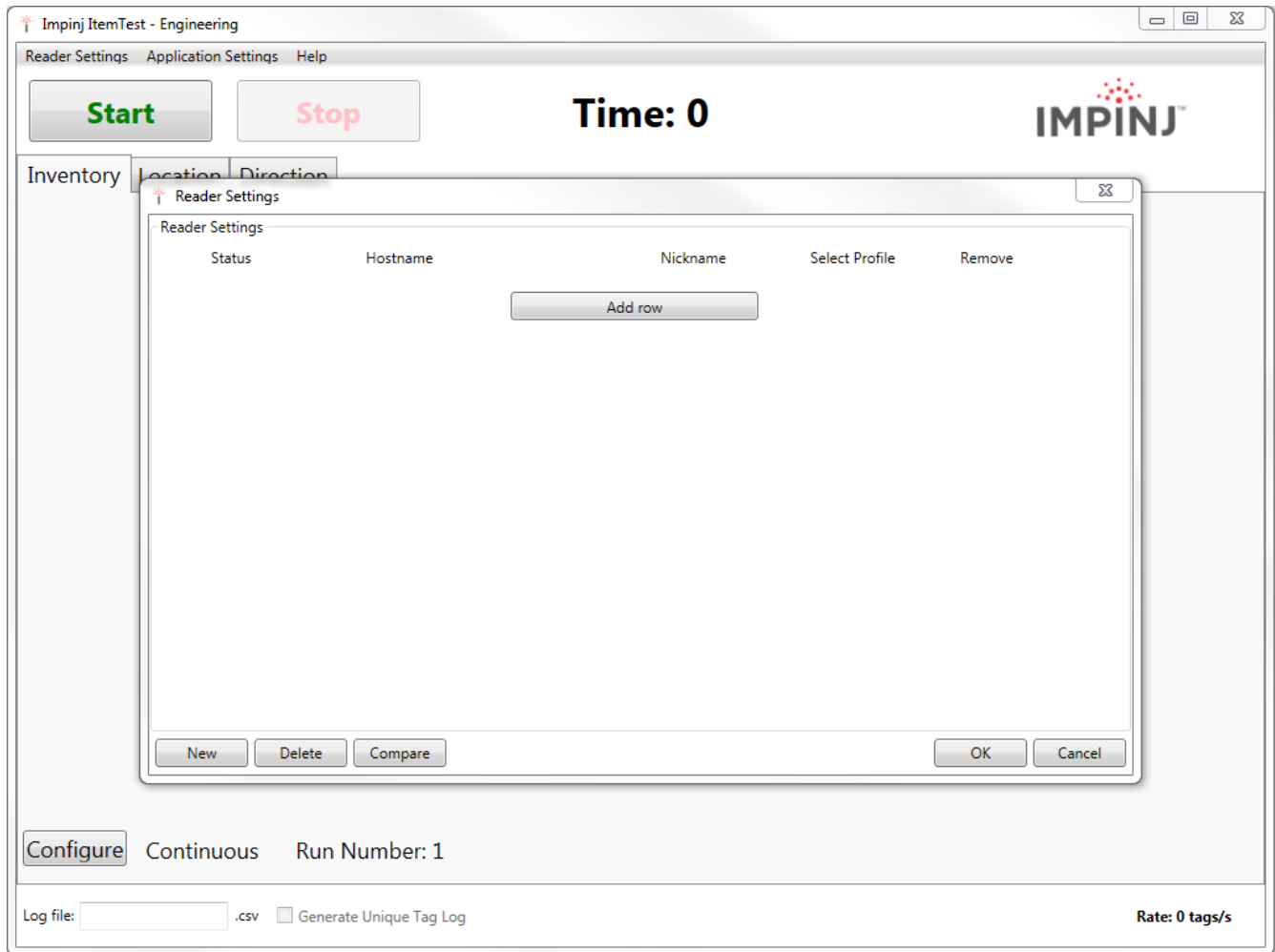


Figure 6.2 ItemTest - Reader Settings Screen

2. On the **Reader Settings** page, click **New** to add a new Gateway configuration. The **Input reader name** dialog opens, as shown in Figure 6.3.

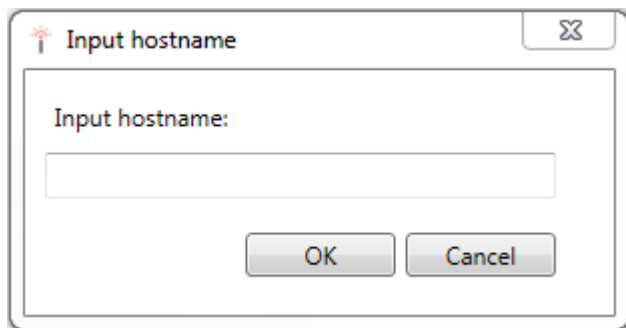


Figure 6.3 ItemTest - Input Reader Name

3. In **Reader name**, type the Reader Gateway hostname or IP address.
4. Click **OK**. ItemTest establishes a TCP/IP connection to your gateway.
5. On the **Reader Settings** page, select **ENABLED** from the **Status** drop down menu to enable the xArray/xSpan.
6. If required, continue to add additional xArray, xSpan, or SpeedwayR readers for operation and testing.

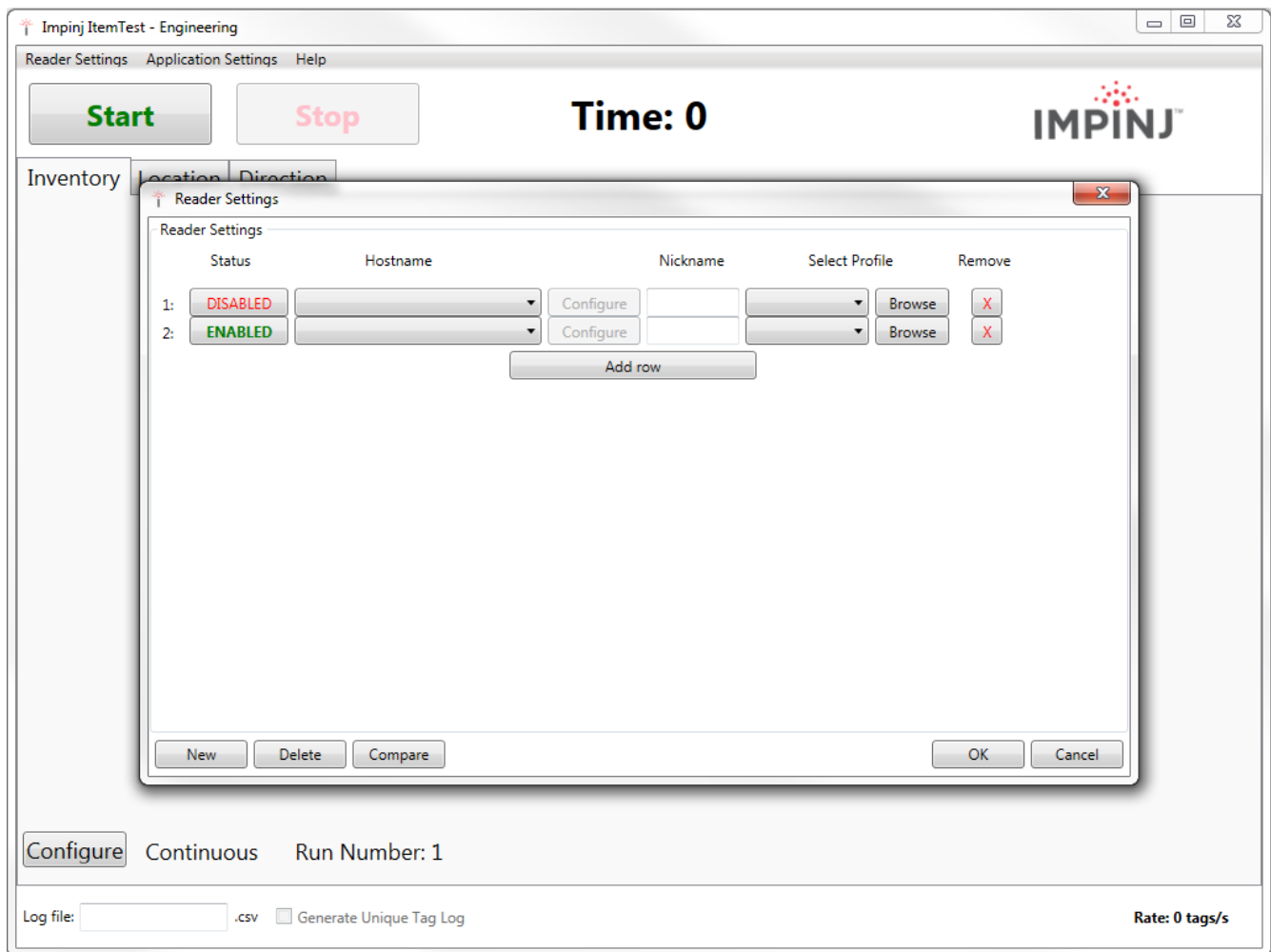


Figure 6.4 ItemTest - Add and Enable Reader Settings

Now you can configure the xArray/xSpan for Inventory (Inventory).

To Configure the Gateway for Inventory

1. On the **Reader Settings** page, click **Configure**.

2. Make sure that you open the **Inventory** tab (not **Location** or **Utilities**), as shown in figure 6.5.

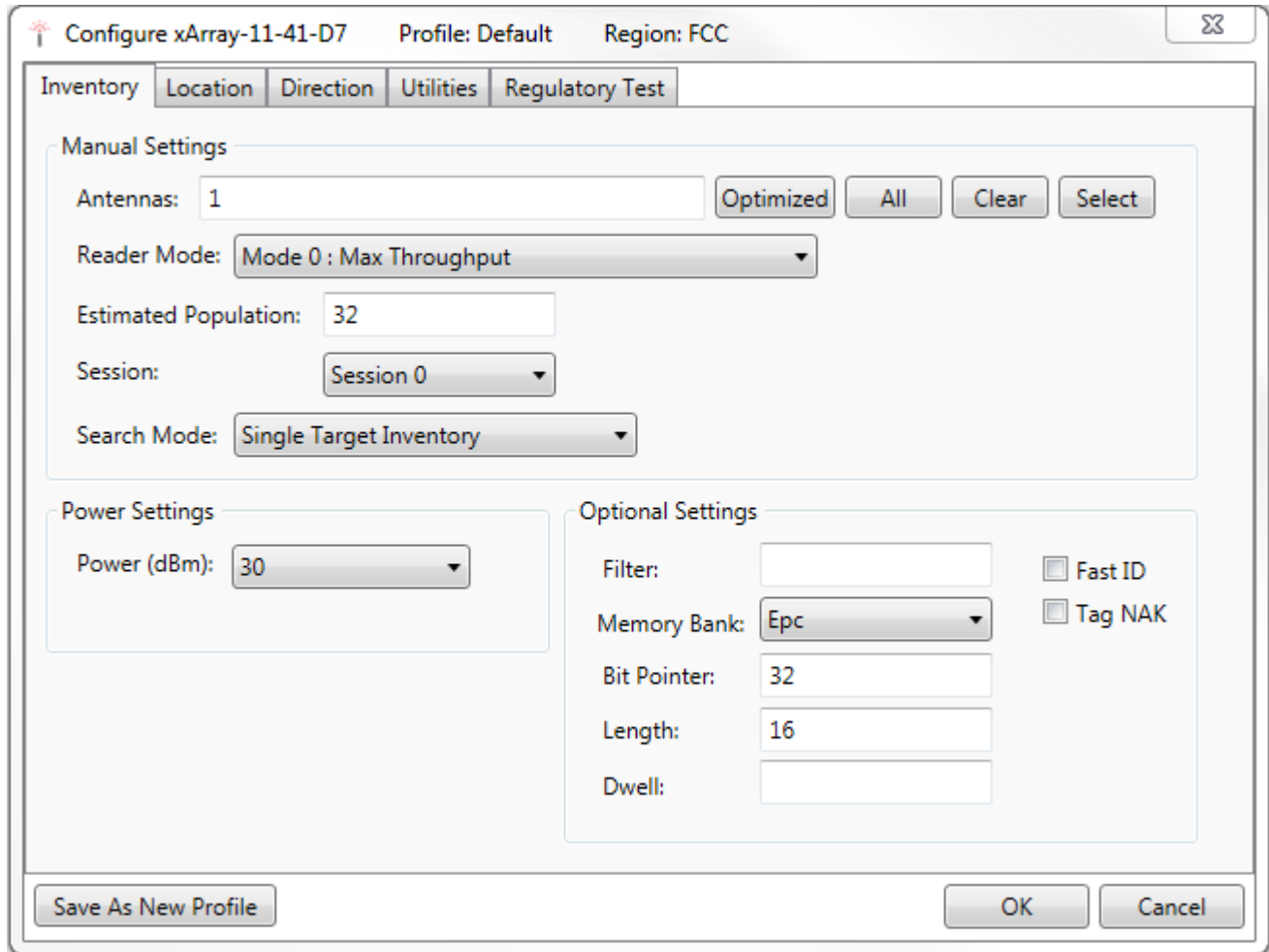


Figure 6.5 Configure Gateway for Inventory

3. To allow the Gateway to read from all available beams, on the **Inventory** tab, click **All** after the **Antennas** field.
4. For this initial test, set **Mode** to **Mode 1000:Autopilot** and **Target** to **Dual Target**. Keep the default settings for all other parameters.

6.4 Run Inventory or Location Tests with ItemTest

Now that the Gateway is connected, enabled, and configured for Inventory, you can run ItemTest to test your xArray/xSpan.

To Test the Gateway for Inventory

1. On the ItemTest main window, click **Start**.
2. By default, ItemTest starts and collects tag read reports for the Gateway for 10 seconds. The results are displayed in tabular form, as shown in Figure 6.6.
3. To run continuous operations, starting and stopping as you want, click **Configure** on the bottom left corner of the ItemTest main page. The inventory read rate in tags/second is displayed in the lower right corner. This window has a “Continuous-Runs Forever” radio button that can be selected. Continuous operation is selected by default.

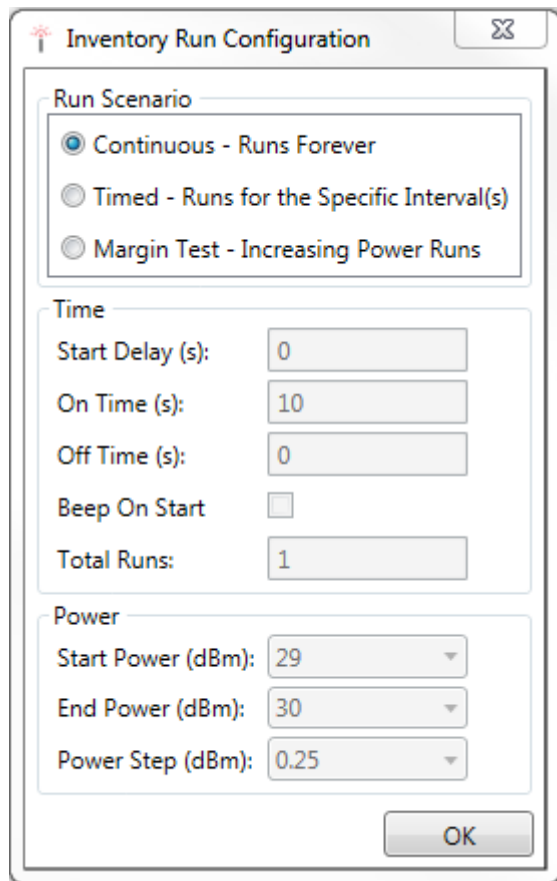


Figure 6.6 Inventory Results

To Test the xArray for Location

The second tab on the ItemTest main screen is for Location results, which is only available on xArray. Before you test for Location, configure the xArray to maximize the number of tag reads, as described in the following procedure.

1. To configure the xArray to maximize the number of tag reads, click the **Location** tab on the **Configure xArray** page, shown in Figure 6.7.
2. On the **Location** tab, under **Gen 2 parameters**, set the **Mode** to **Mode 0: Max Throughput**, and then click **OK**.

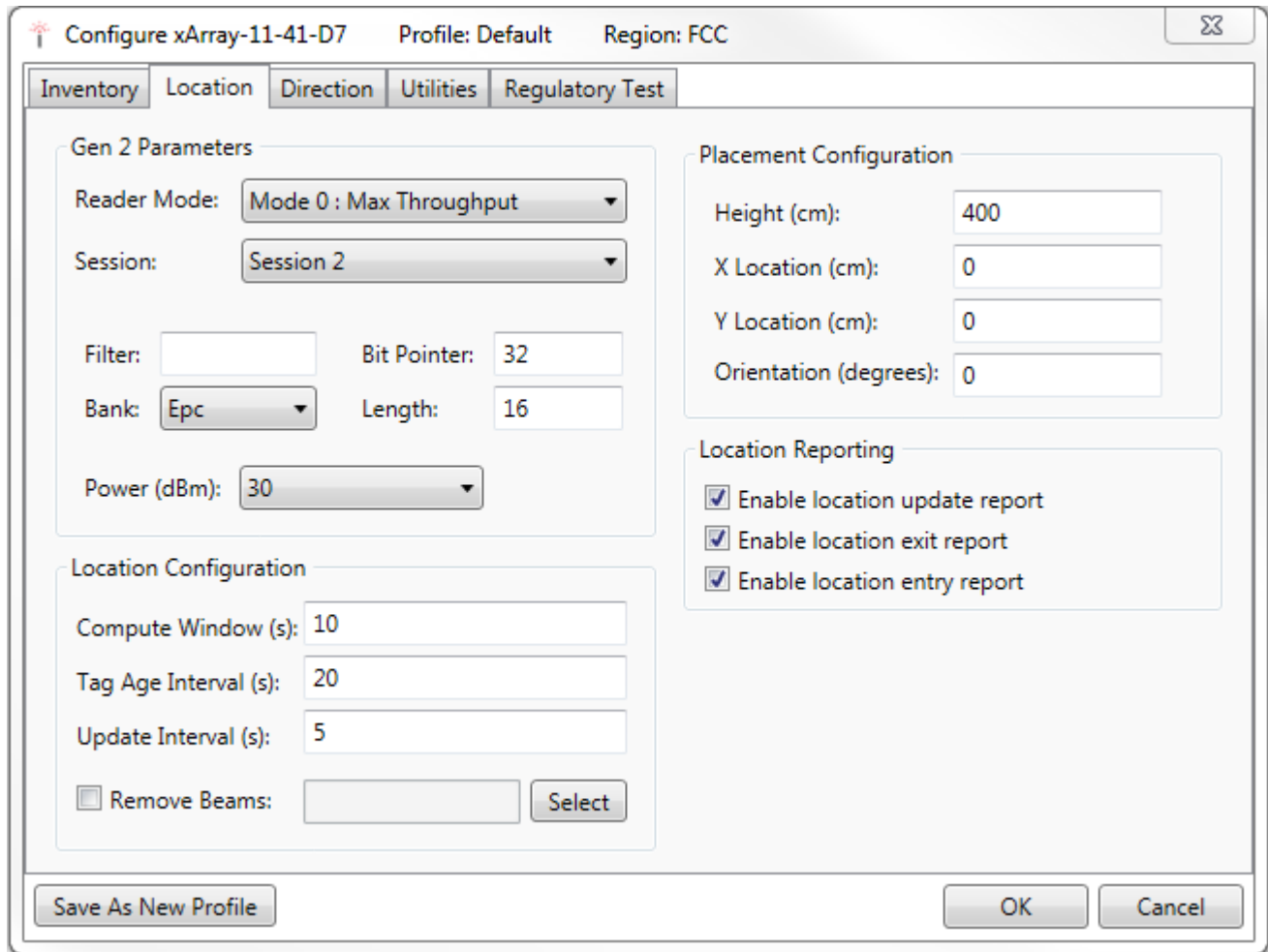


Figure 6.7 Location Configure Tab

3. On the ItemTest main page, click the **Location** tab, and then click **Start**.
4. Using tag reads from each of the 52 beams, xArray calculates the location of the tags and reports in X and Y coordinates. The ItemTest Location page displays these results, as shown in Figure 6.8.

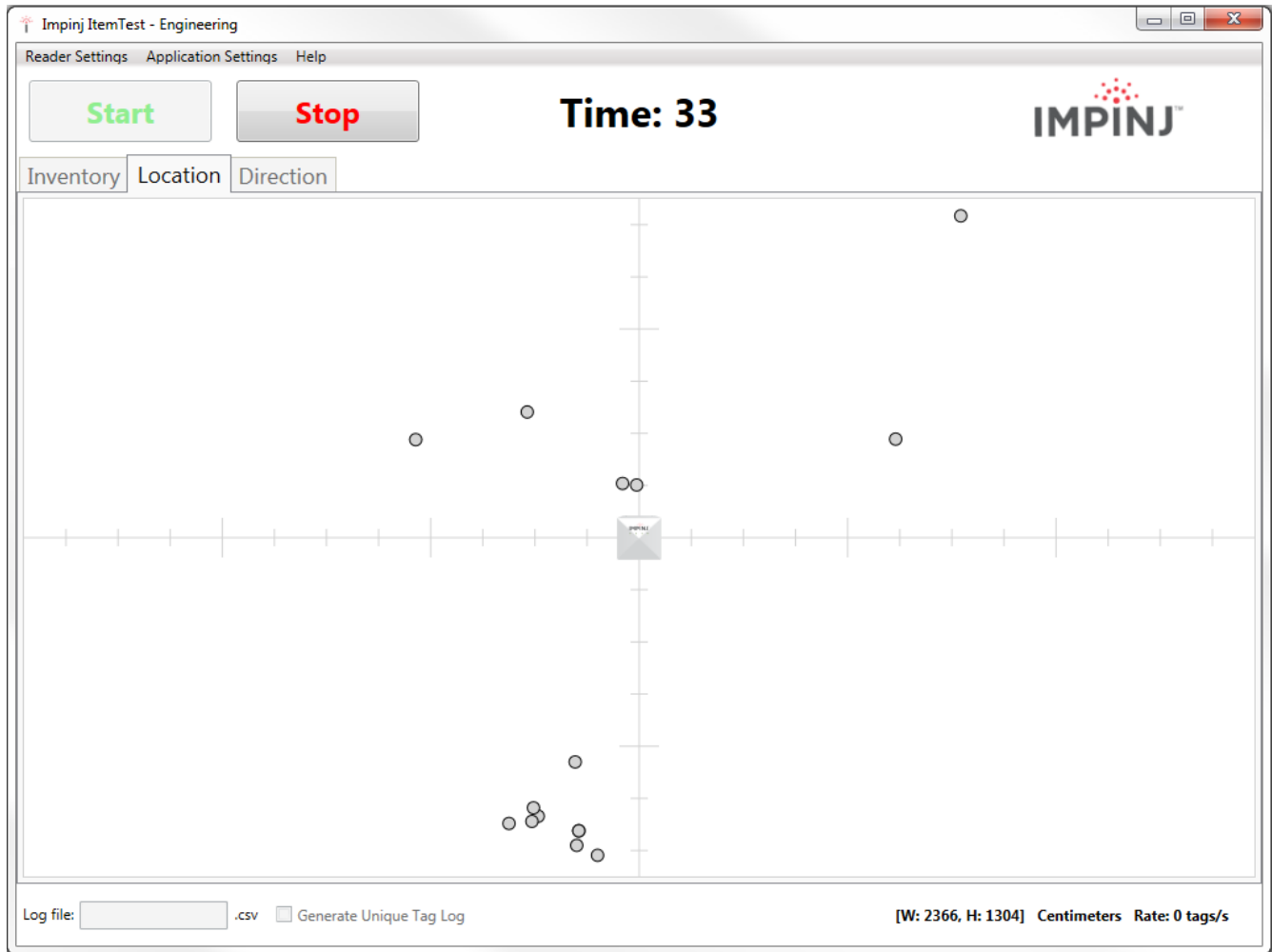


Figure 6.8 Location Results

These are the basic operations of ItemTest. You can find many other features that allow you to explore and verify the RFID item intelligence performance of the xArray Gateway and Speedway Reader products. Note that ItemTest is optimized for testing Inventory and Location.

6.5 Run Direction Tests with ItemTest

To Test the xArray for Direction

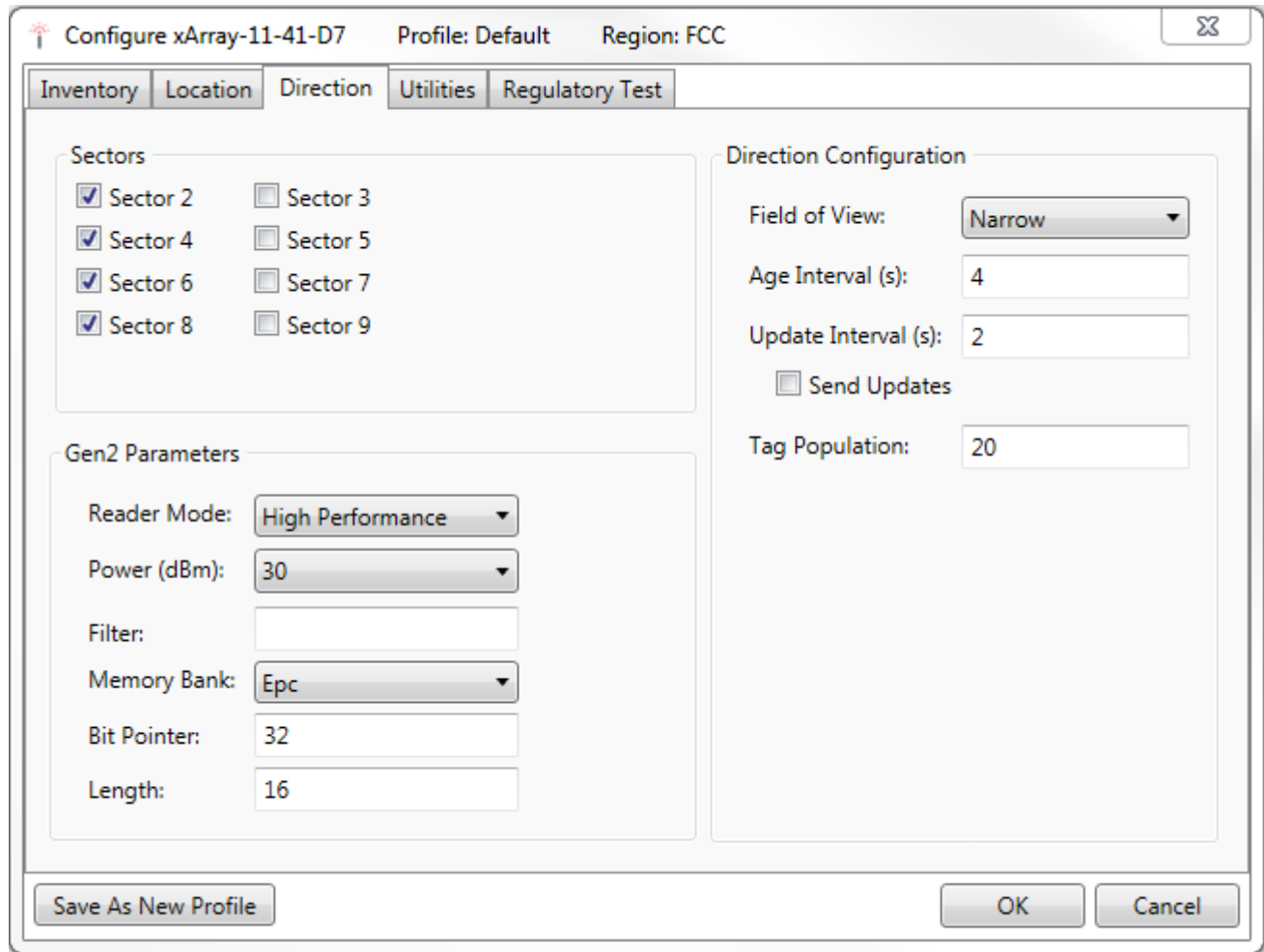


Figure 6.9 Direction Configuration Screen

Direction is similar to location, except less granular. Rather than enabling individual beams, whole sectors are enabled or disabled. Direction mode will report when a tag enters a sector, updates within a sector, and exits a sector, giving users the ability to know if tags have transitioned from one sector to another (and therefore from one physical area to another), or have transitioned out of range of the xArray or xSpan.

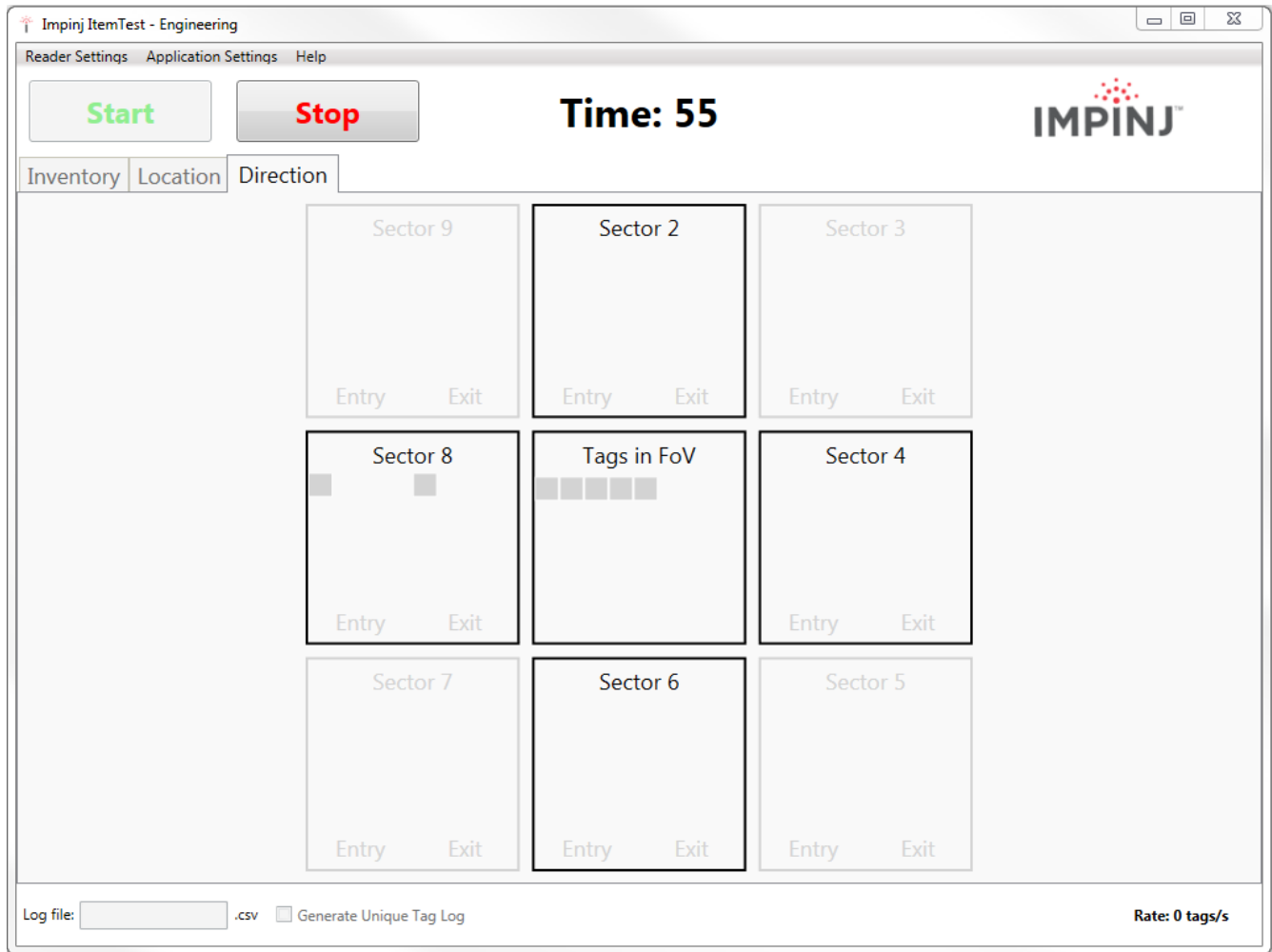


Figure 6.10 xArray Direction Results

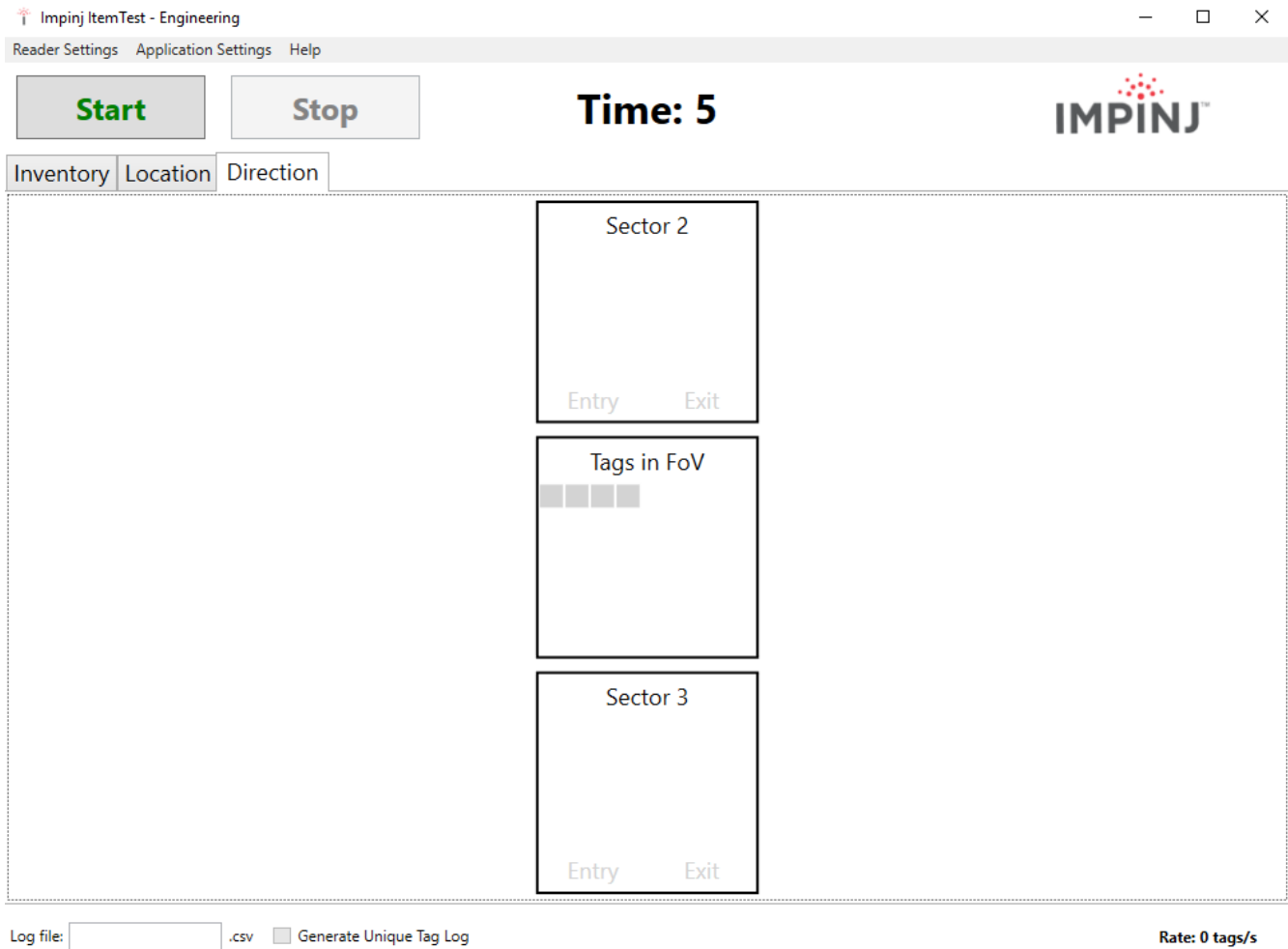


Figure 6.11 xSpan Direction Results

The xArray has 9 sectors, and each sector is configured like a slice in an 8 piece pizza. Starting with the sector 2 slice, the sector number increases by one when walking the pizza in a clockwise fashion. Sector 1 is a special piece, in the center. With the xArray, it is not valid to enable two adjacent sectors, and it's also not possible to disable sector 1. The xArray rule for adjacent sectors does not apply for the xSpan, which only has 3 sectors, which are arranged in a line, with sector 1 in the center. The selected direction sectors for the xSpan in ItemTest are not configurable.

Product By Product Feature Support for ItemTest

The following table identifies which ItemTest features are supported by each specific Gateway device:

Table 6.1 Feature to Product Table

	Inventory	Direction	Location
Speedway	X		
xSpan	X	X (1 axis)	
xArray	X	X (2 axis)	X (x,y)

7 Configuring and Monitoring

This section provides a view of the configuration and monitoring options available for the Gateway.

7.1 Configuring the Gateway

There are two categories of Gateway configuration, configuring the device itself and configuring the Gateway's RF behavior. This chapter provides the basics for each type of configuration.

7.1.1 Device Configuration

RShell is the command line management interface to use for configuring and managing network settings, firmware upgrades, and other device-oriented operations. This chapter introduces the RShell commands you can use to install and connect the Gateway. The *RShell Reference Manual* provides full details and syntax for all RShell commands.

7.1.2 Using RShell to Configure Network Settings

You can often get up and running with little or no configuration by using the default configuration settings in your Gateway device. If you are not using DHCP to assign IP addresses, you will need to configure a few of the Gateway's network settings. The following procedure outlines the RShell commands you might need to connect the Gateway to your network.

To configure the network settings:

1. Open the RShell console as described in section 5.4.
2. View the Gateway's current configuration settings by entering the **show network summary** command at the RShell command prompt, as shown in the following code sample:

```
> show network summary
Status='0,Success'
PrimaryInterface='eth:eth0'
ActiveInterface='eth:eth0'
Hostname='xarray-10-46-B2'
connectionStatus='Connected'
ipAddressMode='Dynamic'
ipAddress='10.0.11.27'
ipMask='255.255.0.0'
gatewayAddress='10.0.0.10'
```

```
broadcastAddress='10.0.255.255'  
MACAddress='00:16:25:10:46:B2'  
HTTPService='active'  
>
```

3. Configure the appropriate TCP/IP parameters for your environment. The applicable commands are:

- Setting Hostname
> **config network hostname <HOSTNAME>**
- Setting Static IP Address
> **config network ip static <IP ADDRESS> <NETMASK> <GATEWAY>**

Note: The IP address is required; the other parameters are optional. The default value is used if an optional parameter is omitted from the **ip** command. **Note:** The reader **MUST** be rebooted for this command to take effect.

- Enabling DHCP
> **config network ip dynamic**

Note: The reader **MUST** be rebooted for this command to take effect.

- Configuring NTP Servers
> **config network ntp add <NTP SERVER ADDRESS>**

4. After successfully configuring all required network settings, connect the xArray/xSpan to the network via its Ethernet port.

7.1.3 RF Configuration

How you configure your Gateway's RF behavior depends entirely on your implementation approach. You might be using a custom software application, middleware running on a server, or some other approach. ItemTest, described in Section 5, is an example of a PC client application used for implementation. Regardless of the application you are using, the underlying protocol is the same Low-Level Reader Protocol (LLRP).

LLRP is a standard, asymmetric, binary protocol used for communication between a client application and the xArray. LLRP controls the configuration of the antenna transmit power (in Inventory mode), the receive sensitivity, the operating Gateway, and so on. For more information about LLRP, see the the following documents:

- *LLRP Standard*: This document provides the specifics of the EPCglobal-ratified LLRP standard. http://www.epcglobalinc.org/standards/llrp/llrp_1_0_1-standard-20070813.pdf
- *Octane LLRP*: Provides details of the LLRP capabilities that are supported by Impinj Readers and Gateways. It also describes custom LLRP extensions added by Impinj.
- *LTK Programmer's Guide*: This document is intended for software engineers and provides guidelines and best practices for working with the LLRP Toolkit. In addition, software engineers can access language-specific reference guides and sample applications that illustrate the scenarios discussed in the *LTK Programmer's Guide*.

If you are a .NET or Java programmer, Impinj offers two different, easy to use Octane SDKs that simplify programming, with no need to learn LLRP. For Linux, a Java-based Octane SDK is available. For Windows, there is a .NET Octane SDK.

7.2 Monitoring

Use RShell to monitor the xArray/xSpan health and performance when the device is up and running. This section presents the primary RShell commands for viewing the network and RFID statistics, as well as the xArray/xSpan logs. For more information about these commands, see the *RShell Reference Manual*.

Either Gateway also supports industry standard SNMP, with MIB2 and EPCglobal Gateway Management MIB. For more information, see the *Octane SNMP Guide*.

7.2.1 Viewing Network Parameters and Statistics

Use the RShell **show network** command to display networking parameters and statistics. Use this command with the indicated parameters to view the following information:

```
> show network <parameter>
```

Table 7.1: "show network" Command Parameters

Parameter	Displayed Information
dhcp	Summary of DHCP client configuration
dhcp	Summary of DNS settings
icmp	ICMP statistics

Parameter	Displayed Information
ip	IP statistics
ntp	Summary of NTP settings
summary	Summary of network settings
tcp	TCP statistics
udp	UDP statistics

For details about the specific settings and statistics available for each of these parameters, see the *RShell Reference Manual*.

7.2.2 Viewing RFID Parameters and Statistics

> **show rfid stat**

Use the RShell **show rfid stat** command to display the RFID parameters and statistics for an Gateway. Use this command with the appropriate parameter to view the information shown in Table 6.2.

Table 7.2: Partial Listing of “show rfid stat” Parameters

Parameter	Displayed Information
ReaderOperationalStatus	Indicates whether RFID applications are running on the xArray or xSpan.
Antenna1OperationalStatus	Indicates if an antenna is physically connected to the Gateway and operating properly. Note that “1” indicates the antenna port 1.
Antenna1EnergizedTime	Indicates the time that antenna 1 has been powered, in milliseconds.
Antenna1ReadCount	Indicates the number of tags read at antenna 1 that matched the configured filters.
Antenna1FailedReadCount	Indicates the number of tags where a read was attempted at antenna 1 because the tag matched the configured filter, but the read failed.

Table 7.2 shows just a sample of the available RFID statistics. For the full list of statistics, as well as syntax details, see the *RShell Reference Manual*.

Note: View Statistics for the LLRP interface between the xArray and a client by entering the **show rfid llrp stat** command. For more information, see the *RShell Reference Manual*.

7.2.3 Configuring and Viewing Logs

xArray/xSpan uses the standard Syslog protocol to forward its logged events to a remote Syslog server. The Gateway stores the logged events in its file system, accumulating and retaining this information across reboots. Logs are classified into three categories:

- Management
- RFID
- System

All logged events have an associated severity level. There are eight possible levels listed in decreasing order from most severe to least severe:

1. Emergency
2. Alert
3. Critical
4. Error
5. Warning
6. Notice
7. Info
8. Debug

Configure the log levels you want to display. The Gateway then retains only the events with a severity greater than or equal to the configured level. For example, if you choose a logging level of Warning, then the logs will contain the following levels: Warning, Error, Critical, Alert, and Emergency.

Note: Regardless of the configured log level, the xArray/xSpan always retains logs of events with Error level or higher in an independent log.

Use the RShell **config logging** command to configure options for the storage and forwarding of logged events.

> **config logging**

Use the **show logging** command to display the logging configuration as well as the actual logged information in text form. For details about these commands, see the *RShell Reference Manual*.

Use the following command to show a summary of the current logging levels:

> **show logging summary**

7.2.4 Viewing the State of the Gateway Device

To display information about the current state of the Gateway device itself, use the RShell **show system** command.

> **show system**

Use this command to view the following statistics:

- **show system summary** - A summary of system information.
- **show system CPU** - Platform memory usage and available application space
- **show system platform** - Generic platform statistics

For more details about the **show system** command, see the *RShell Reference Manual*.

8 Upgrading the Gateway Firmware

xArray or xSpan contains firmware known as Octane. This chapter describes the process of manually upgrading a single device.

In addition to supporting upgrade procedures, either Gateway also provides methods for reverting firmware to a previous valid image and restoring firmware to factory default settings. The procedure for reverting to the previous valid image is explained in this section, while the process of returning to factory defaults is described in Section 8.2.

8.1 A Brief Overview of the Firmware

To minimize downtime and maximize the robust handling of possible upgrade failures, xArray/xSpan contains dual images of its firmware. When requesting a firmware image upgrade, the Gateway continues to operate using the primary image. In the background, the device upgrades the secondary image. When the upgrade completes, the device reboots to the newly upgraded image. Either Gateway retains the previous firmware version in case there are problems with the upgrade.

There are three individual partitions within each firmware image that logically organize the system software. Although you do not need a full understanding of this architecture to perform a simple manual upgrade, it is a good idea to be familiar with its structure at a high level. For a more in-depth discussion of the firmware and how firmware is organized, see the *Speedway Embedded Developer's Guide*.

The three partitions in firmware are:

- **System Operating Partition (SOP)** - The SOP is the primary system partition of the gateway. It contains the Linux kernel, FPGA firmware, RFID management software, Reader management software (RShell), logging management software, firmware upgrade control, system watchdog software, and the factory default data.
- **System Persistent Partition (SPP)** - Files in this partition are automatically generated and maintained by the software running on the Gateway. It contains the device configuration (network settings, LLRP configuration, log settings, and so on), device logs, and debug information used by Impinj engineers.
- **Custom Application Partition (CAP)** - CAP partition contains custom application software, other items required by the custom application (extra libraries or tools, and configuration files), plus custom application logs.

8.2 Upgrading the Firmware

xArray/xSpan provides three methods for upgrading:

- Using RShell, the command line interface.
- Copying the firmware to a USB memory drive and plugging it into the xArray/xSpan's host port.
- Using the Impinj Reader Management web page.

8.2.1 Upgrading the Firmware using RShell

Use this procedure to use RShell to upgrade the firmware.

1. Obtain the firmware upgrade file from the Impinj support Web site, support.impinj.com. The upgrade file extension is **.upg**. (Example: octane_5_2_0.upg).
2. Place the upgrade file on a server (http, tftp, or ftp) that can be accessed by the xArray/xSpan you are upgrading.
3. Using the Putty application, connect the Gateway by using telnet, SSH or serial and that log in.
4. From the RShell command prompt, issue the following command:

```
> config image upgrade <URI>
```

where <URI> is the server location and name of the upgrade file.

For example:

```
> config image upgrade http://usacorp/rfid/gateway/image/octane_5_2_0.upg
> config image upgrade ftp://anonymous:abc@myserver/ftpdirecotry/octane_5_2_0.upg.upg
> tftp://server/octane_5_2_0.upg
```

5. After starting the upgrade, view the upgrade status at any time by issuing the following command:

```
> **show image summary**
```

6. This command provides a display of the current upgrade status, the last operation, the status of the last operation, and information about the primary and secondary images. Reissue the **show image summary** command if you want to track the upgrade status. Some status values you might see are:

WaitingForImageFileTransfer

WaitingForCommitImage

WaitingToActivateImmediate

The upgrade is complete when the **UpgradeStatus** parameter value is **Ready**.

The **LastOperation** parameter should be set to **WaitingToActivateImmediate**.

The **LastOperationStatus** should be **WaitingForManualReboot**.

7. Reboot the Gateway by issuing the following command:

```
> reboot
```

The Gateway reboot process displays messages in the RShell console as it goes through each stage of the process. The reboot completes, then the gateway login prompt displays on the console. The Gateway status light displays solid green. The behavior details of the xArray reboot LEDs are provided in **xArray product Tour**.

8.2.2 Upgrading the Firmware with a USB Drive

Obtain the firmware upgrade file from the Impinj support Web site, support.impinj.com. The upgrade file extension is **.upg**. (Example: octane_5_2_0.upg). This upgrade process has two steps, preparing the USB drive for upgrade, and then using the USB drive to upgrade the firmware.

To Prepare the USB Drive for Upgrade

1. Insert a USB drive into your computer.
2. Create an impinj directory in the root of the USB drive along with the subdirectories revolution, upgrade, and images. The names of the directory are case sensitive and must all be lower case.
3. Copy the desired firmware upgrade .upg file into the \\impinj\\revolution\\upgrade\\images\\ directory.

Note: If multiple .upg files exist in the images directory, the xArray/xSpan will use the most recently modified file.

4. Remove the USB drive from your computer.

To Upgrade By Using the USB Drive

1. Confirm that the Gateway is ready for upgrade, with both the Power and Status LEDs illuminated.
2. Insert the USB drive into the “USB Host” port on the xArray/xSpan. Within 5-10 seconds, the Gateway will begin upgrading the device and the Power LED will blink amber. If the Power LED remains solid green, the Gateway likely cannot locate the images directory and **.upg** file on the USB drive.
3. The upgrade process completes in 20-60 seconds and then the Power LED will change to solid green.
4. Remove the USB drive from the USB Host port and reboot the Gateway.

During the upgrade process, the Gateway will attempt to append information to a status.log file in the impinj\\revolution\\upgrade directory. The status.log file is intended to provide an audit trail for the upgrade of one or more xArrays/xSpans.

If the firmware upgrade process fails, the Power LED will blink red. If this happens, remove the USB drive, reboot the xArray/xSpan, and check the status.log file for the reason of the failure.

8.2.3 Upgrading the firmware through the Impinj Management Web UI

You can also upgrade the firmware by accessing the Impinj Reader Management web page, and running the upgrade from the management web page.

1. Connect to the Gateway using a web browser <http://<gateway name or IP address>>. Examples: <http://speedwayr-10-00-DD> or <http://10.0.10.44>.
2. Log in to the xArray/xSpan using the default user name and password:

 user name: **root**
 password: **impinj**
3. Click **Choose File**, and then select the firmware upgrade **.upg** file.
4. Click **Upgrade**
5. After the upgrade is complete, click **Reboot**.

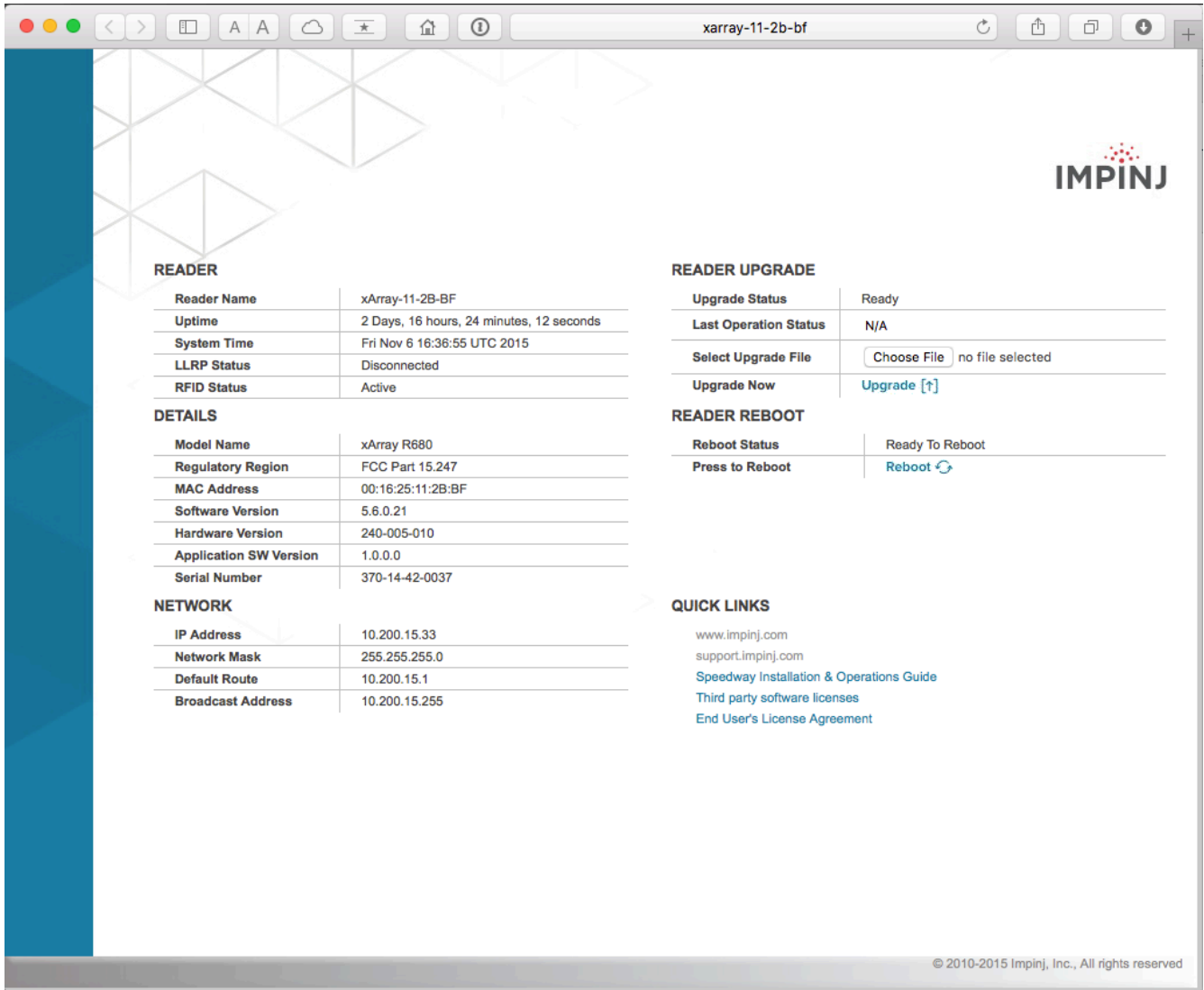


Figure 8.1 Gateway Management Web Page

READER UPGRADE

Upgrade Status	Ready
Last Operation Status	N/A
Select Upgrade File	<input type="button" value="Choose File"/> no file selected
Upgrade Now	Upgrade [↑]

READER REBOOT


Reboot Status	Ready To Reboot
Press to Reboot	Reboot 

Figure 8.2 Close-up of Gateway Upgrade and Reboot Section of Management Web Page

8.2.4 Reverting to the Previous Image

Use the following procedure if you need to revert to the pre-upgrade image.

1. To revert to the pre-upgrade image, enter the following command from the RShell prompt:

> config image fallback

When the command completes successfully, the device automatically reboots and returns to the login prompt.

2. Log in to the Gateway. The pre-upgrade image is now running.

Note: If there is no valid previous image, the response to the config image fallback command is Status=8, Permission-Denied.

9 Troubleshooting

If you experience a problem with xArray/xSpan, this brief chapter presents a few suggestions to correct the issue.

9.1 Impinj Support Information

Visit the Impinj Support Web site at support.impinj.com for information about technical assistance. For guidelines about capturing data for analysis by Impinj technical support personnel, see section 9.3.

9.2 Returning to the Default Configuration

If you are experiencing a problem with the xArray/xSpan and are having difficulty pinpointing the cause, it is useful to return the Gateway to a known state. We recommend resetting to the default configuration. Then try your Gateway again.

! Important: Configuration Default Restore returns the device configuration to its default state. It leaves any custom applications installed in the CAP intact. To restore the device to its default state **and** remove any CAP contents, use Factory Default Restore. for additional information, see the **Warning** in this section.

There are two ways to return Gateway device to its defaults:

- Issue an RShell command.
- Push the **Default Restore** button on the device.

To use RShell to return the device to its default configuration and leave CAP intact

1. At the RShell prompt, enter the following command:

```
> config image default
```

When the command completes successfully, the device automatically reboots and returns to the login prompt.

2. Log in to the Gateway. The Gateway is now running with the default configuration. CAP applications are intact.

To use the Default Restore button on the xArray/xSpan to restore to its default configuration

1. Use an object with a sharp tip, such as a probe or paper clip, to press and hold the **Default Restore** button on the back of the Gateway while the Gateway is powered on.
2. Continue holding the **Default Restore** button for 3 seconds after the Power LED light turns off, but not longer than 10 seconds.
3. Release the **Default Restore** button when the LED blinks red once. The xArray/xSpan will boot up normally with the default configuration.



1. Default Restore Button: Insert and hold sharp point here for 3 seconds. Release before 10 seconds.

Figure 9.1 Default Restore Button



Warning: Pressing the Default Restore button for 10 seconds or more will cause a factory default restore to occur. The factory default restore removes the Gateway's custom application partition (CAP) if one exists. The Gateway returns to the original, factory shipped state. It is important to avoid accidentally removing the CAP. There may be situations where CAP removal is necessary.



Avertissement: Appuyer sur le Défaut Bouton Restaurer pendant 10 secondes ou plus entraîne une restauration. D'usine par défaut de se produire restaurer la valeur par défaut supprime partition d'application personnalisée du lecteur (CAP) s'il existe. Le lecteur retourne à l'état usine original expédié. C'est important d'éviter de supprimer accidentellement la CAP. Il peut y avoir des situations où l'enlèvement de la CAP est nécessaire.

The following table lists the default configuration values:

Table 9.1: Default Configuration Values

Parameter	Default Value
User	root
Password	impinj
Upgrade Retrieve Mode	Manual
Logging	No syslog servers
Management Logging Level	Error
RFID Logging Level	Error
System Logging Level	Error
Network Mode	Dynamic (DHCP)
DHCP Send Hostname	On
Hostname	xarray-xx-xx-xx or xspan-xx-xx-xx (where xx-xx-xx are the last three digits of the MAC address)
Static DNS Servers	None
Static NTP Servers	None
LLRP Inbound Port	5084
LLRP Inbound Service	Enabled

Parameter	Default Value
LLRP Outbound Service	Enabled
LLRP Outbound Servers	None
LLRP Outbound Retry Secs	5
LLRP Outbound Timeout Secs	2

9.3 Submitting Diagnostic Data for Analysis by Impinj Technical Support

If xArray/xSpan is exhibiting RF behavior that differs from what you expect, and you are unable to determine the cause, you might want to submit relevant data for analysis by Impinj Technical Support. Use the Impinj ItemTest application to capture data relating to the problem scenario. By creating and providing a Gateway Diagnostic Data file, Impinj’s Technical Support team can troubleshoot your issue.

To find information and detailed instructions about capturing data in ItemTest, use the instructions in the *ItemTest User Guide*. You can find the *ItemTest User Guide* by doing the following:

1. Open **ItemTest**.
2. Click **Help**, and then click **Open User Guide**.
3. Follow the instructions in the *ItemTest User Guide* to capture the data that you need.

10 Document Revision History

Date	Revision	Comments
12/16/2014	5.2.0	Original Release
4/2/2015	5.2.2	Updated to add GX1 and GX2 SKUs
6/15/2015	5.4.0	Minor update for Octane 5.4.0
12/21/2015	5.6.2	Minor update for Octane 5.6.2
9/28/2016	5.8.0	Update to include xSpan and Octane 5.8.0

11 Notices

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