



# xArray installation and operations guide

## version 5.2

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# 1 Requirements, Certifications, and Warnings

## 1.1 Products Covered by this Guide

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

**Table 1.1: xArray Gateway Part Numbers**

| Gateway | Communication Code | Part Number         |
|---------|--------------------|---------------------|
| xArray  | FCC                | IPJ-REV-R680-USA1M1 |
| xArray  | ETSI               | IPJ-REV-R680-EU11M1 |
| xArray  | Japan              | IPJ-REV-R680-JP21M1 |

## 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.

### **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 Environmental Requirements**

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

## **1.5 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-A2002-000, the available AC power cords are:

- IPJ-A2051-USA (for North America)
- IPJ-A2051-EU1 (for European Union)
- IPJ-A2051-JPN (for Japan)

## 1.6 Before You Begin



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



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

## 1.7 About this Guide

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

### 1.7.1 Intended Audience

The intended audience for this guide is anyone installing an xArray. 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/uhfc1g2>.

### 1.7.2 Other Documents of Interest

This guide is part of a larger documentation set that supports xArray 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, which includes Impinj’s custom LLRP extensions.
- *RShell Reference Manual* describes the syntax and command language for the xArray RShell console.
- *Octane SNMP Guide* provides monitoring and reference information for working with the SNMP MIBs related to xArray.
- *Firmware Upgrade Reference Manual* includes detailed procedures, reference information for upgrading firmware installed on single xArrays, and procedures for creating a metafile to automate upgrading of multiple xArrays.
- *Speedway Revolution Embedded Developer’s Guide* provides a description of the Speedway Revolution platform and a view of its architecture for software engineers designing custom application software for the Reader.

## 2 Introduction

The xArray Gateway is a fixed infrastructure RFID reader system that provides always-on, wide-area monitoring of RAIN RFID tagged items (<http://www.rainrfid.org>) within a facility. It is designed for large-scale item-level applications in many industries, including, but not limited to, retail, healthcare, and manufacturing. Mounted overhead, the xArray Gateway provides real-time Item Intelligence events, including each item's identity, location, and authenticity.



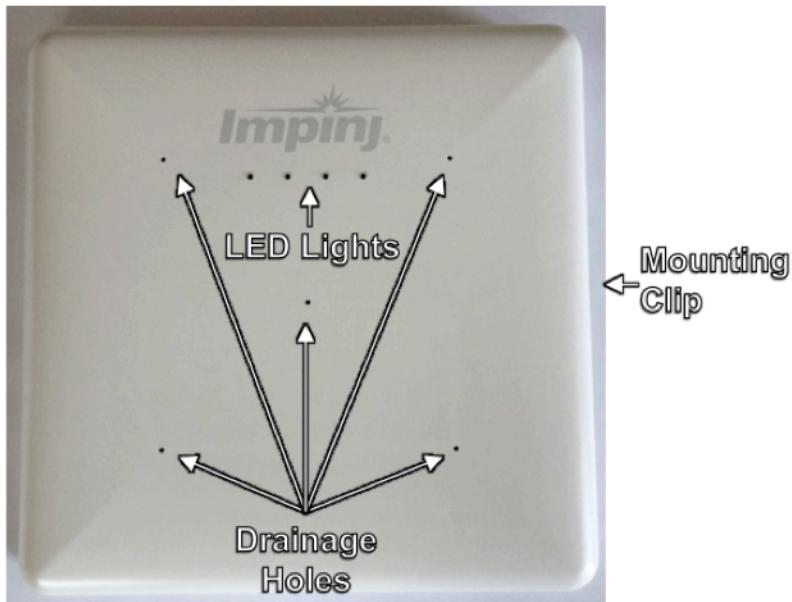
**Figure 2.1 xArray Gateway Typical Overhead Mounting**

Key features and capabilities of your new xArray Gateway include:

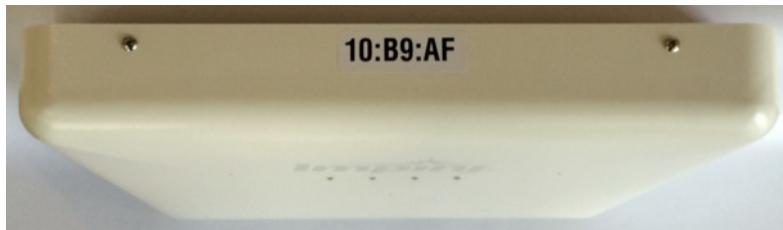
- A single xArray can monitor up to 1,500 sq. ft. (139m<sup>2</sup>) using Monza R6 based tags.
- Intelligent item locating with 5 ft (1.5m) or better spatial resolution of (x,y) location.
- Low profile design fits into standard ceiling tile grid and blends into decor.
- Exceptional performance is provided by 2-D array with 52 dual-polarized antenna beams.
- 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. xArray contains a SpeedwayR RFID reader that allows you to use all of the same software tools and LLRP API, with additional extensions specific to xArray.

### 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. Drainage holes in the radome are one design element that allows xArray to provide a IEC IP52 level of water protection. 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.



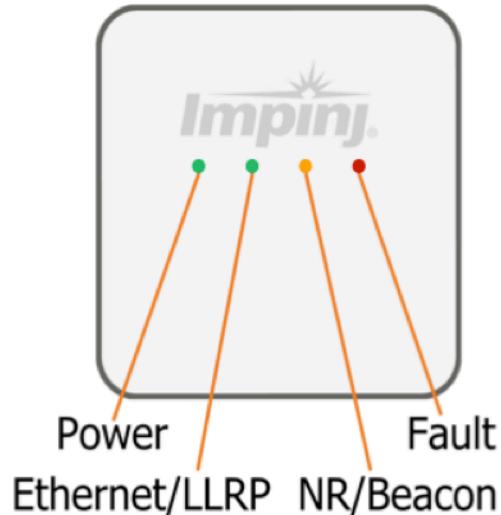
**Figure 3.1 Radome side view of xArray**



**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. Figure 3.3 summarizes what each LED signifies during boot, operation, and fault conditions.

- **Power**
  - On when power is supplied
- **Ethernet/LLRP:**
  - Off during startup, until ready
  - Blinks when ready for connection
  - On solid when connected to host
- **NR/Beacon**
  - On briefly at startup
  - On solid when turned on by LLRP
- **Fault**
  - On briefly at startup
  - On solid when fault condition occurs

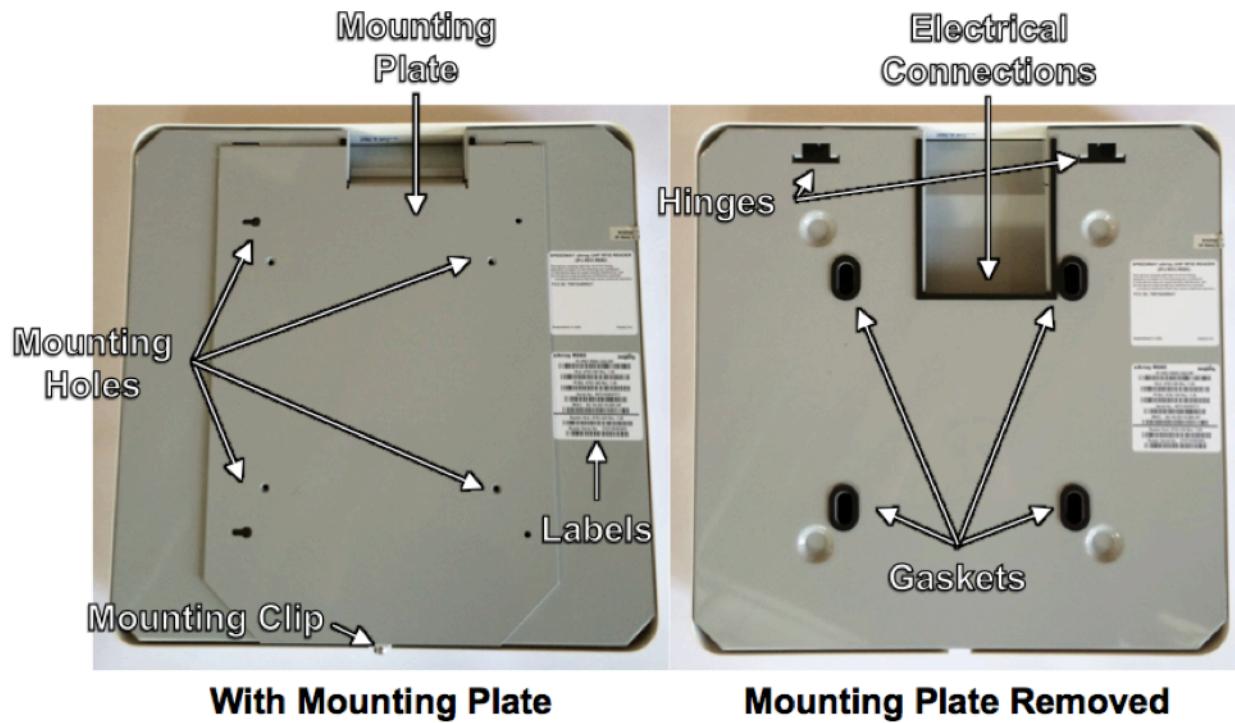


**Figure 3.3 LED Light Behavior**

Additional information about the LEDs and the meaning of their blink patterns are provided in Appendix B - xArray Ports and LEDs.

### 3.1 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 3.4 shows the xArray rear mounting side with and without the detachable mounting plate.



**Figure 3.4** Mounting (rear) side of xArray

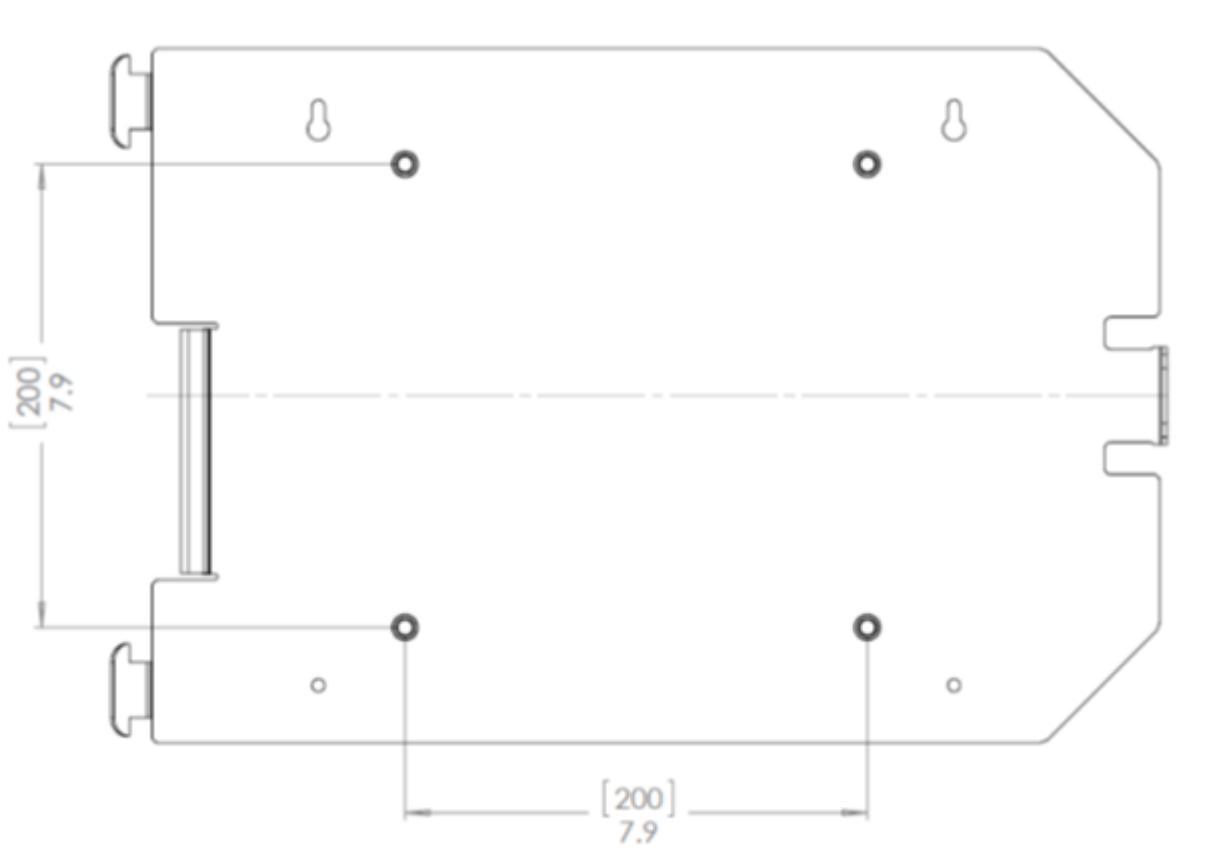
The xArray is designed to have two mounting configurations, which are described in this section.

### 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.

Figure 3.5 shows the xArray for mounting configuration 1.

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

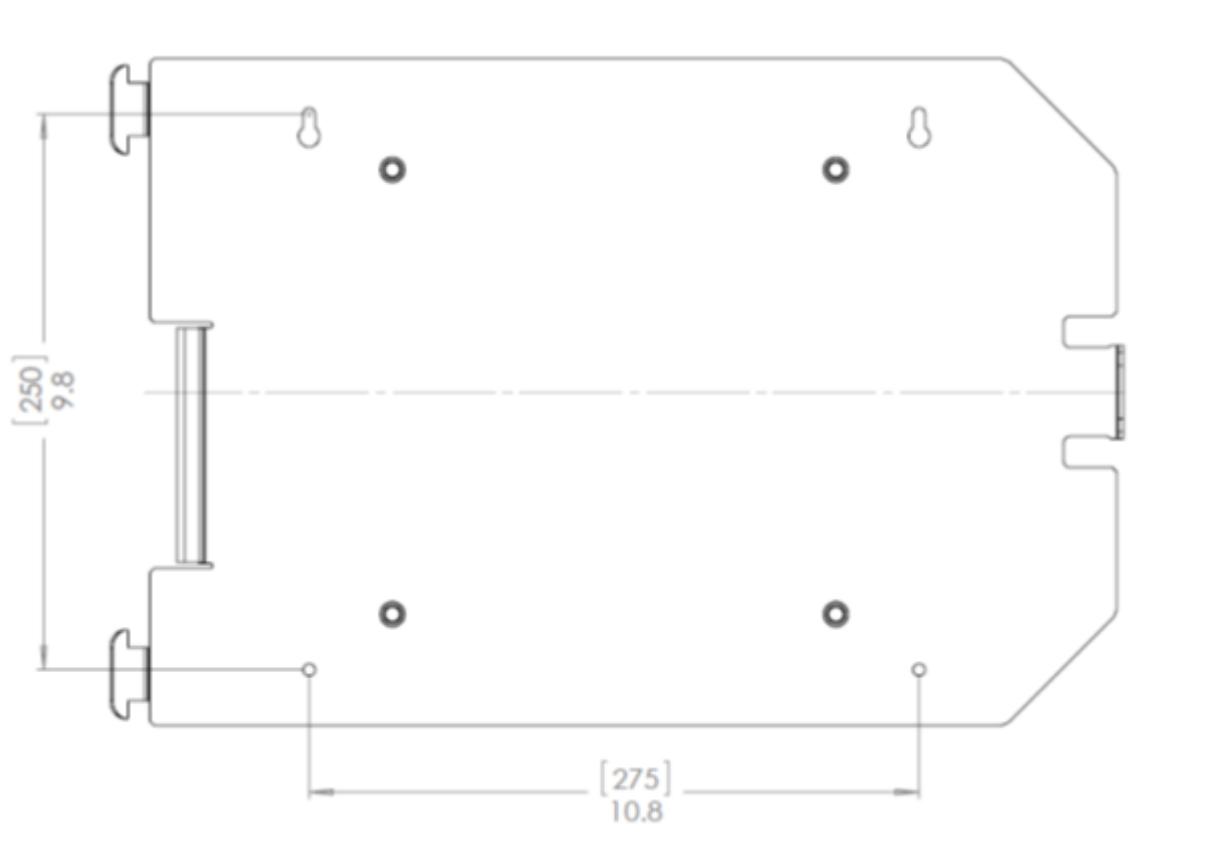


**Figure 3.5 xArray Mounting Configuration 1**

**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 3.6 shows the xArray for mounting configuration 2.



**Figure 3.6 xArray Mounting Configuration 2**

**Note:** The mounting plate CAD drawing is available for download on the Impinj support portal at [support.impinj.com](http://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 3.7.
- Rotate the xArray into final position against the mounting plate, and securely lock it into position using the mounting clip.

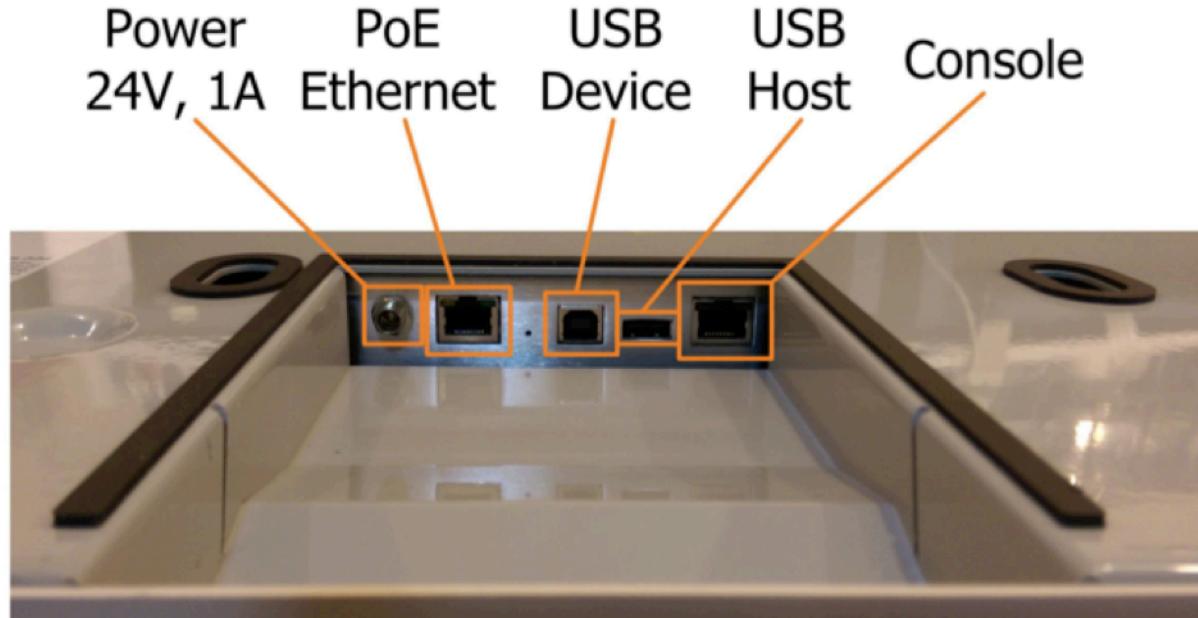


Figure 3.7 Electrical and Network Connections

## 4 Powering and Connecting xArray

This section describes how to provide power and establish network connectivity to the xArray Gateway.

### 4.1 Supplying Power to the xArray

You have two choices for powering the xArray:

- 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 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 requirements, see Table 4.1.

**Table 4.1 Cat 5e/6 cable that meets xArray requirements**

| Cable Description                            | Product Information   |
|--|---|
| <b>100 meter cable</b><br><b>&lt; 10 Ohm</b> | <ul style="list-style-type: none"><li>• <a href="http://belkinbusiness.com/products/a7j304-1000-blu-cat5e-stranded-bulk-cable-4pr24awg-1000-blue">http://belkinbusiness.com/products/a7j304-1000-blu-cat5e-stranded-bulk-cable-4pr24awg-1000-blue</a></li><li>• <a href="http://www.southwire.com/ProductCatalog/XTEInterfaceServlet?contentKey=prodcatsheetcat5e">http://www.southwire.com/ProductCatalog/XTEInterfaceServlet?contentKey=prodcatsheetcat5e</a></li><li>• <a href="http://resources.tessco.com/attachments/516583_4656914_10_5EN5_BLUE_CPK.aspx.pdf">http://resources.tessco.com/attachments/516583_4656914_10_5EN5_BLUE_CPK.aspx.pdf</a></li><li>• <a href="http://www.alphawire.com/en/Products/Cable/Xtra-Guard-Performance-Cable/Xtra-Guard-Industrial-Ethernet/76020">http://www.alphawire.com/en/Products/Cable/Xtra-Guard-Performance-Cable/Xtra-Guard-Industrial-Ethernet/76020</a></li><li>• <a href="http://www.alphawire.com/en/Products/Cable/Xtra-Guard-Performance-Cable/Xtra-Guard-Industrial-Ethernet/760">http://www.alphawire.com/en/Products/Cable/Xtra-Guard-Performance-Cable/Xtra-Guard-Industrial-Ethernet/760</a></li></ul> |
| <b>50 meter cable</b><br><b>&lt; 10 Ohm</b>  | <ul style="list-style-type: none"><li>• <a href="http://www.farnell.com/datasheets/1311844.pdf">http://www.farnell.com/datasheets/1311844.pdf</a></li></ul>   |

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

**! Important:** We recommend that you do not connect both a POE and a listed/certified power supply to xArray. If an xArray is receiving power via PoE and the xArray detects that an listed/certified power supply has been connected, the xArray reboots and switches to the listed/certified power supply source. If, however, the xArray is receiving power via an listed/certified power supply and detects the connection to a PoE-enabled network switch, nothing changes. The xArray 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.

## 4.2 Connecting xArray to a TCP/IP Network

The xArray internal processor runs Linux OS (2.6.38), 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:

- xArrays by default are configured to use DHCP. The default host name is xarray-XX-XX-XX, where XX-XX-XX is the last three bytes of the xArray's MAC address. The large label on the side of the radome, as described in Section 3, provides these three bytes. Alternately, you can read the MAC address directly from the product label on the mounting side of the xArray.
- If you don't have a DHCP server, **OR** when the PC is connected directly to the xArray via Ethernet cable, the xArray defaults to a fixed IP address, **169.254.1.1**. If this address is not available, the xArray then randomly selects a fixed IP address in the **169.254.xxx.xxx** link local address range.
- You can configure xArray 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's command line interface (Rshell). For more information about using RShell to configure network settings, see section 6.1.2.

## 4.3 Verifying Network Connectivity to xArray

After the xArray 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, as shown in Figure 3.3. The next step is to access xArray's Management web page to verify connectivity and to see the status of the xArray.

**To browse to the xArray Management web page**

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

**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>
- xArray supports the discovery of the xArray host name by using Bonjour Print Services. If your DHCP server doesn't resolve the xArray host name, you might have to install Bonjour on your Windows PC. You can download Bonjour Print Services from <http://support.apple.com/kb/d1999>.

When you have successfully opened the xArray internal web page, you should see a dialog box where you can enter the user name and password. Use the xArray'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 xArray Management web page displays, as shown in Figure 4.1. Review this web page to verify the regulatory region, serial number, software version, IP address, and other key parameters of your xArray Gateway.

The screenshot shows the xArray Management Web page with the following sections:

- READER**:

|             |   |
|-------------|---|
| Reader Name | xArray-10-D7-98                         |
| Uptime      | 0 Days, 17 hours, 8 minutes, 37 seconds |
| System Time | Thu Dec 18 20:45:51 UTC 2014            |
| LLRP Status | Disconnected                            |
| RFID Status | Idle                                    |
| STP Status  | Not Activated                           |
- READER UPGRADE**:

|                       |   |
|-----------------------|---|
| Upgrade Status        | Ready   |
| Last Operation Status | N/A   |
| Select Upgrade File   | <input type="button" value="Choose File"/> No file chosen |
| Upgrade Now           | <input type="button" value="Upgrade"/>                    |
- DETAILS**:

|                   |                   |
|-------------------|-------------------|
| Model Name        | xArray R680       |
| Regulatory Region | FCC Part 15.247   |
| MAC Address       | 00:16:25:10:D7:98 |
| Software Version  | 5.2.0.16          |
| Hardware Version  | 240-004-000       |
| Serial Number     | 370-13-31-0117    |
- READER REBOOT**:

|                 |                                       |
|-----------------|---------------------------------------|
| Reboot Status   | Ready To Reboot                       |
| Press to Reboot | <input type="button" value="Reboot"/> |
- NETWORK**:

|                   |              |
|-------------------|--------------|
| IP Address        | 10.0.9.206   |
| Network Mask      | 255.255.0.0  |
| Default Route     | 10.0.0.20    |
| Broadcast Address | 10.0.255.255 |
- QUICK LINKS**:
  - [www.impinj.com](http://www.impinj.com)
  - [support.impinj.com](http://support.impinj.com)
  - [Speedway Installation & Operations Guide](#)
  - [Third party software licenses](#)
  - [End User's License Agreement](#)

**Impinj** logo is displayed in the bottom right corner.

Figure 4.1 xArray Management Web page

## 4.4 Connect using Serial Console Port

To connect xArray 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.
3. Power up the xArray and wait for the boot sequence to complete. For more information, see section 4.1.
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**.

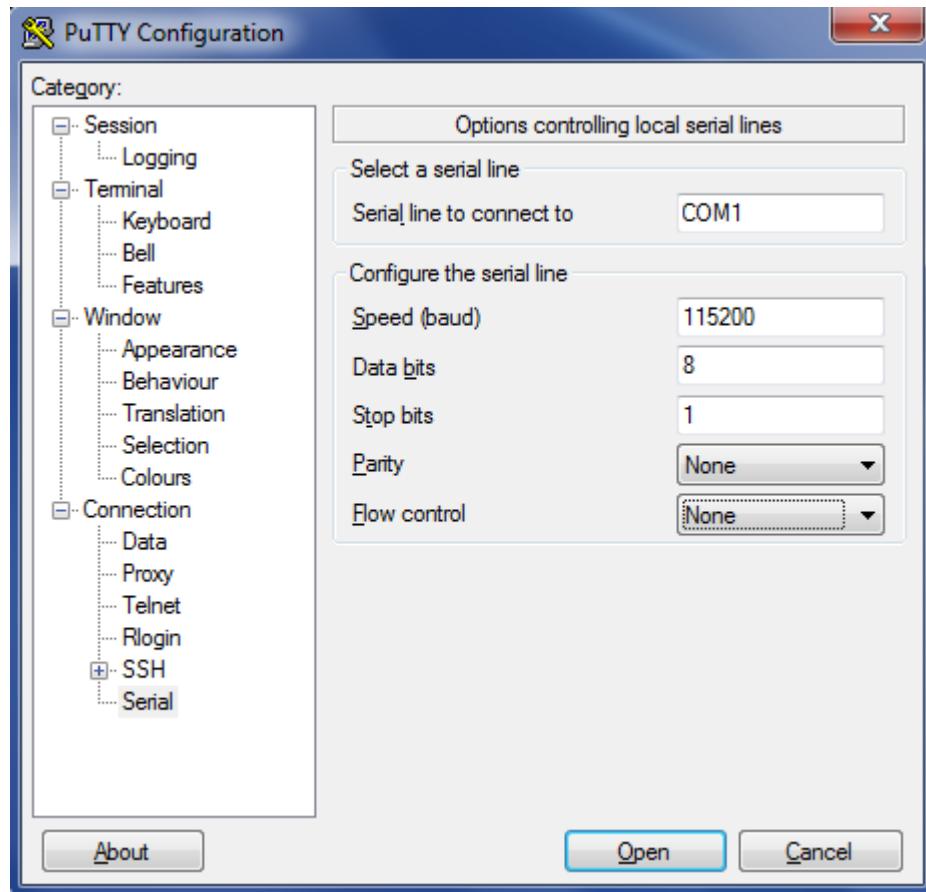


Figure 4.2 Putty Configuration Settings

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



Figure 4.3 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 xArray. For additional information, see **Using RShell to Configure Network Settings for the xArray** in section 6.1.2.
12. When you have completed configuration of the appropriate network settings, connect the xArray 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 from **static** to **dynamic**. For more information, see **Using RShell to Configure Network Settings for the xArray** in section 6.1.2.

## 5 Using xArray with ItemTest

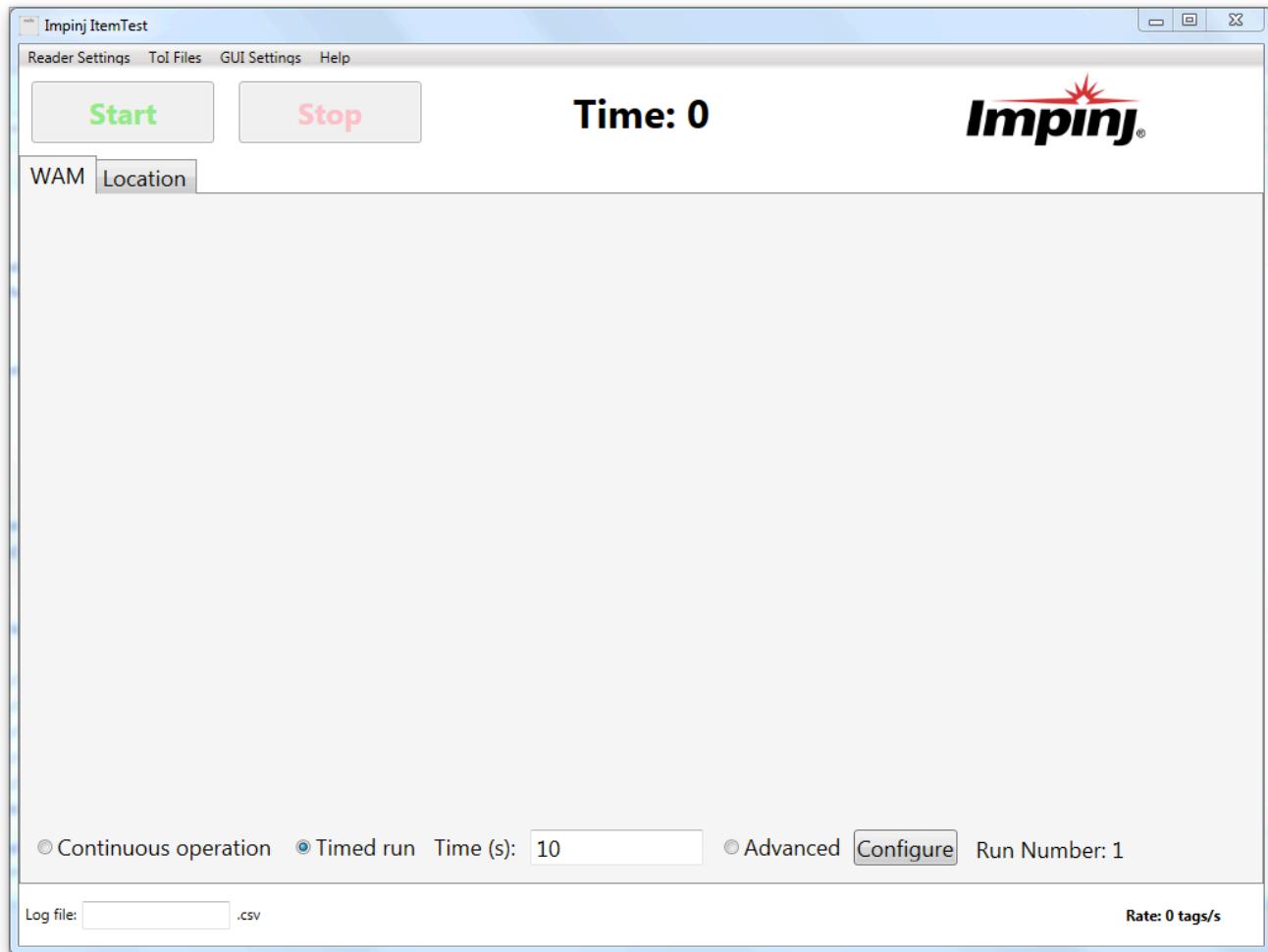
ItemTest is a simple, easy-to-use, Windows-compatible application that you can use to evaluate the performance of one or several xArray Gateways. This chapter describes how to install, configure, and perform basic testing on the xArray with ItemTest. ItemTest supports use case testing of Wide Area Monitoring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

### 5.1 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.

### 5.2 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 5.1.



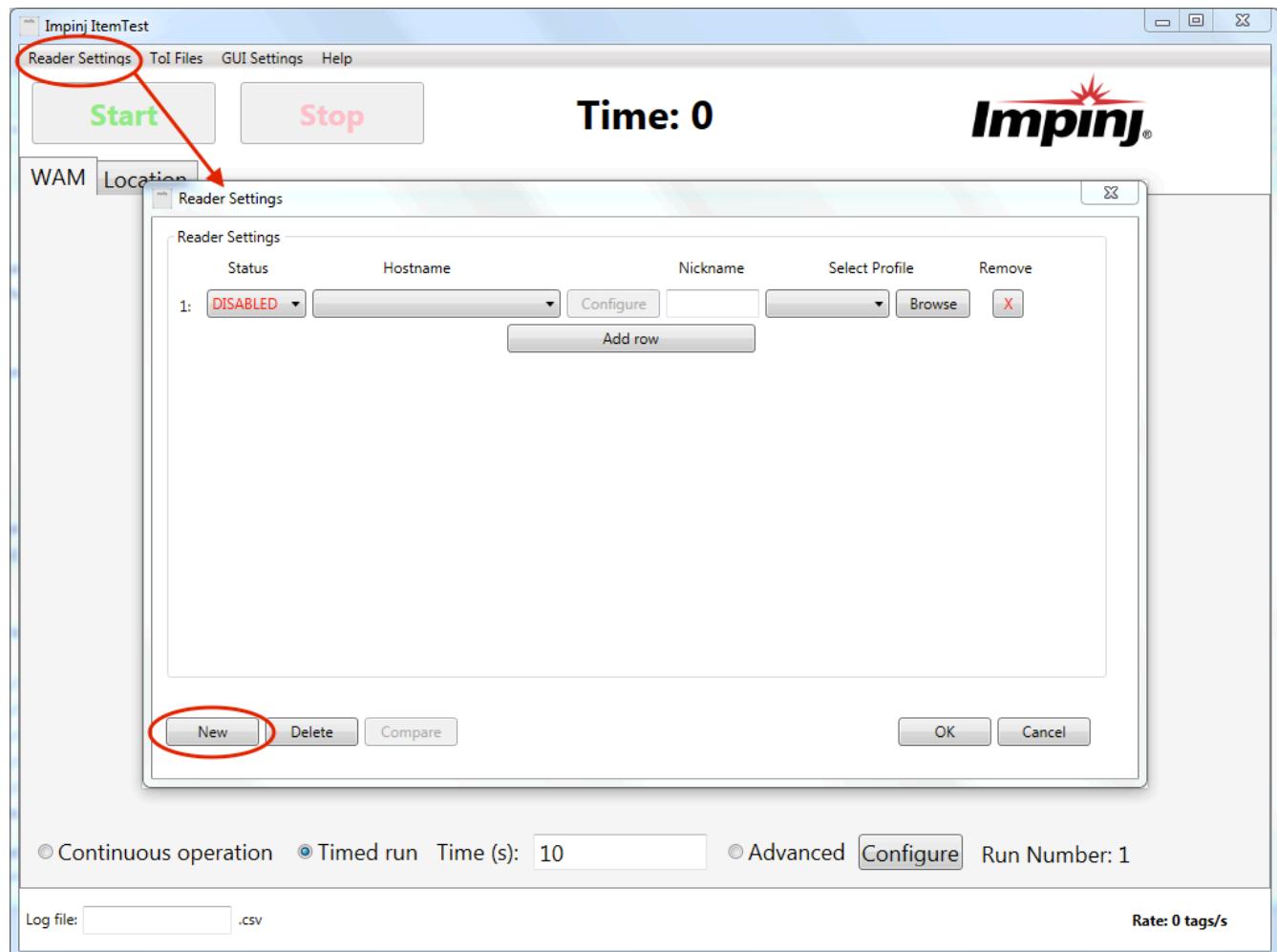
**Figure 5.1 ItemTest Opening Screen**

### 5.3 Connect and Configure the xArray

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

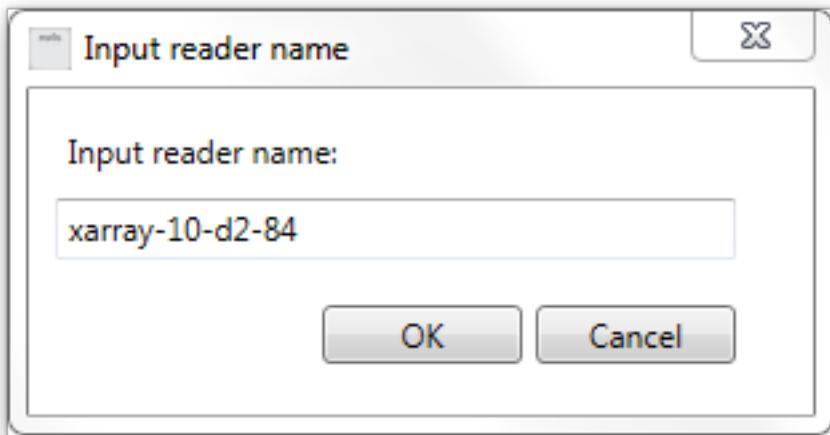
#### To connect and configure your xArray Gateway

1. Select the **Reader Settings** menu, which opens the **Reader Settings** window, as shown in Figure 5.2.



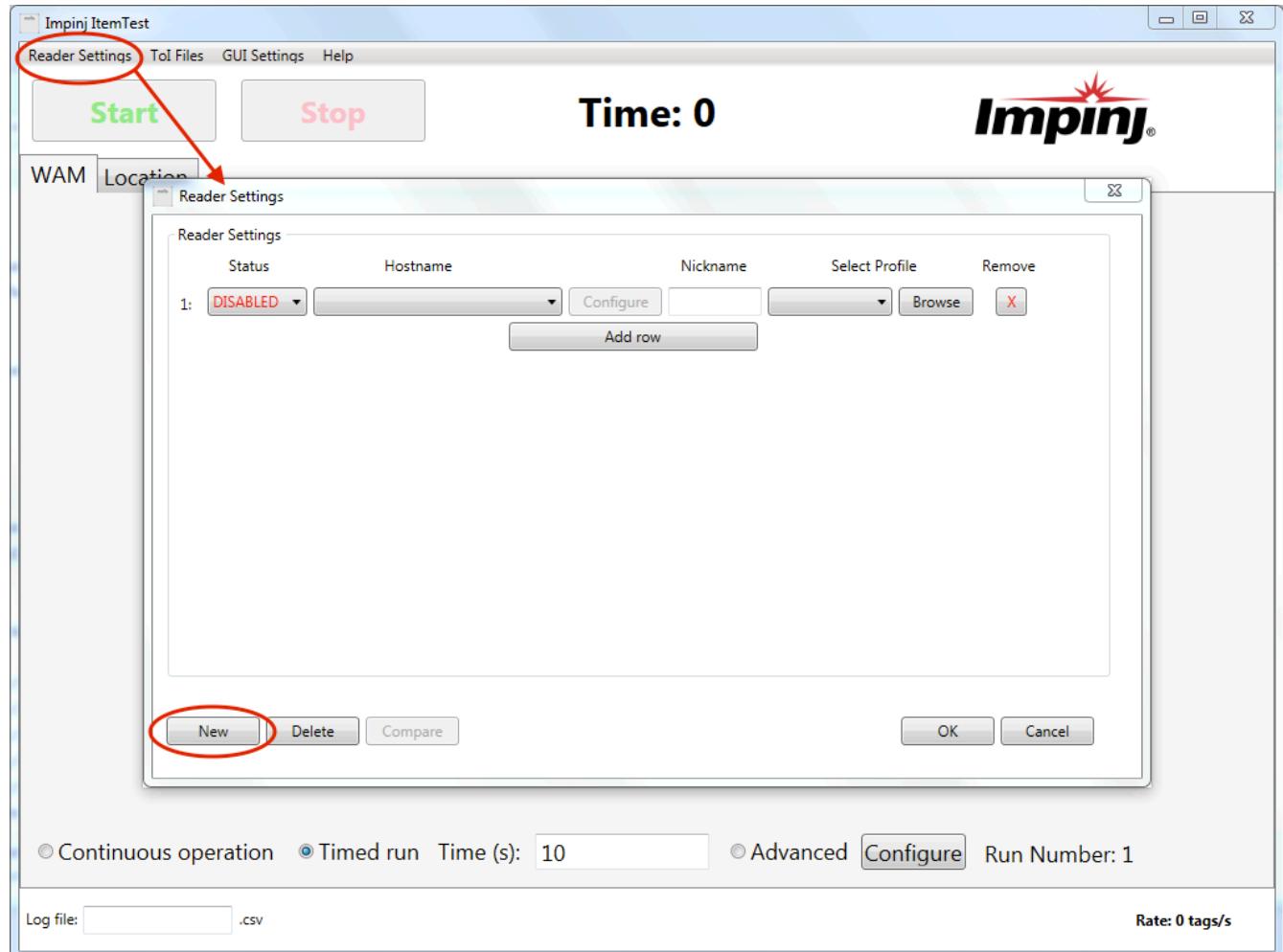
**Figure 5.2 ItemTest - Reader Settings Screen**

2. On the **Reader Settings** page, click **New** to add a new xArray configuration. The **Input reader name** dialog opens, as shown in Figure 5.3.



**Figure 5.3 ItemTest - Input Reader Name**

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

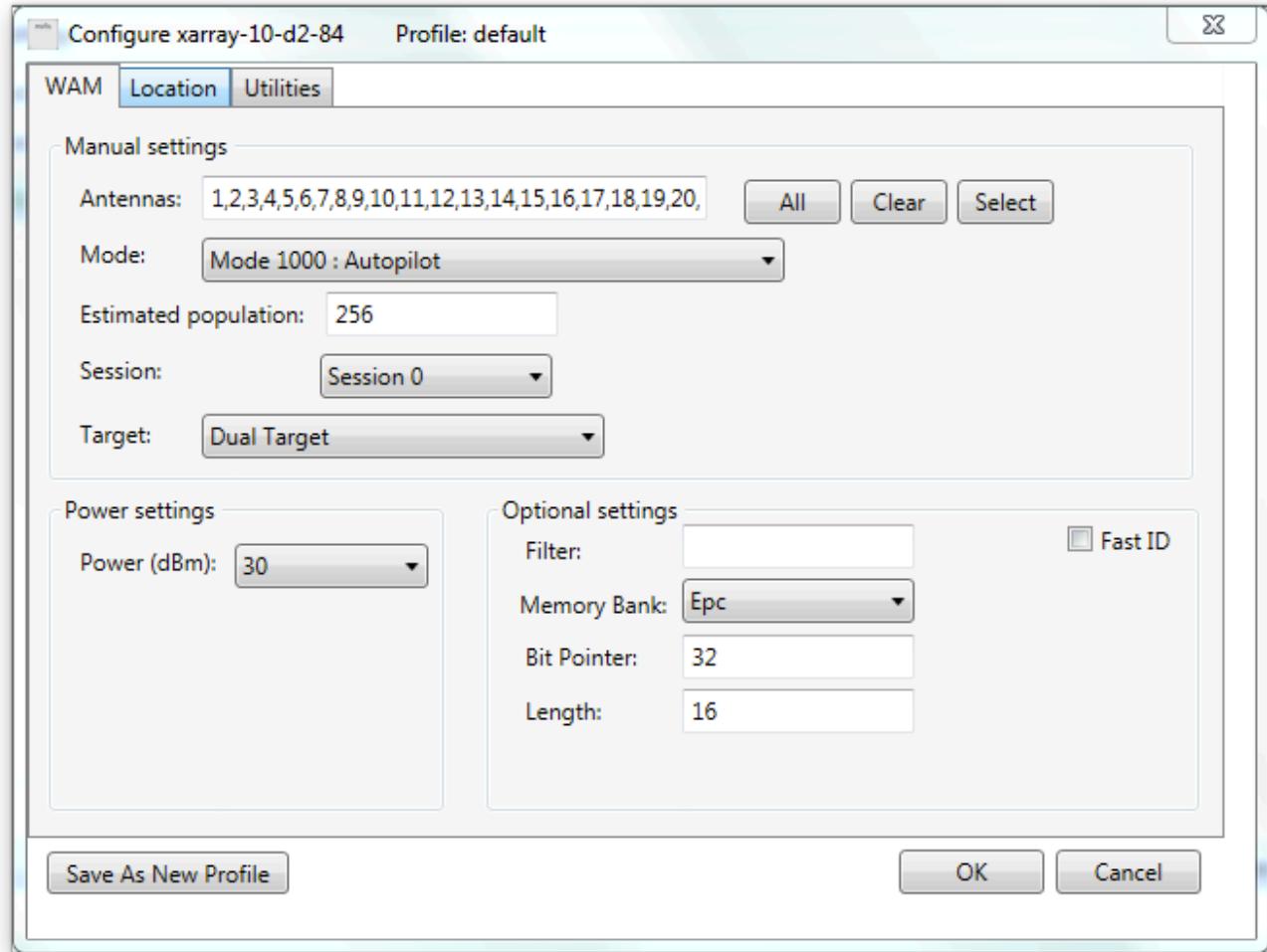


**Figure 5.4 ItemTest - Add and Enable Reader Settings**

Now you can configure the xArray for Wide Area Monitoring (WAM).

#### To configure the xArray for Wide Area Monitoring

1. On the **Reader Settings** page, click **Configure**.
2. Make sure that you open the **Wide Area Monitoring** tab (not **Location** or **Utilities**), as shown in figure 5.5.



**Figure 5.5 Configure xArray for Wide Area Monitoring**

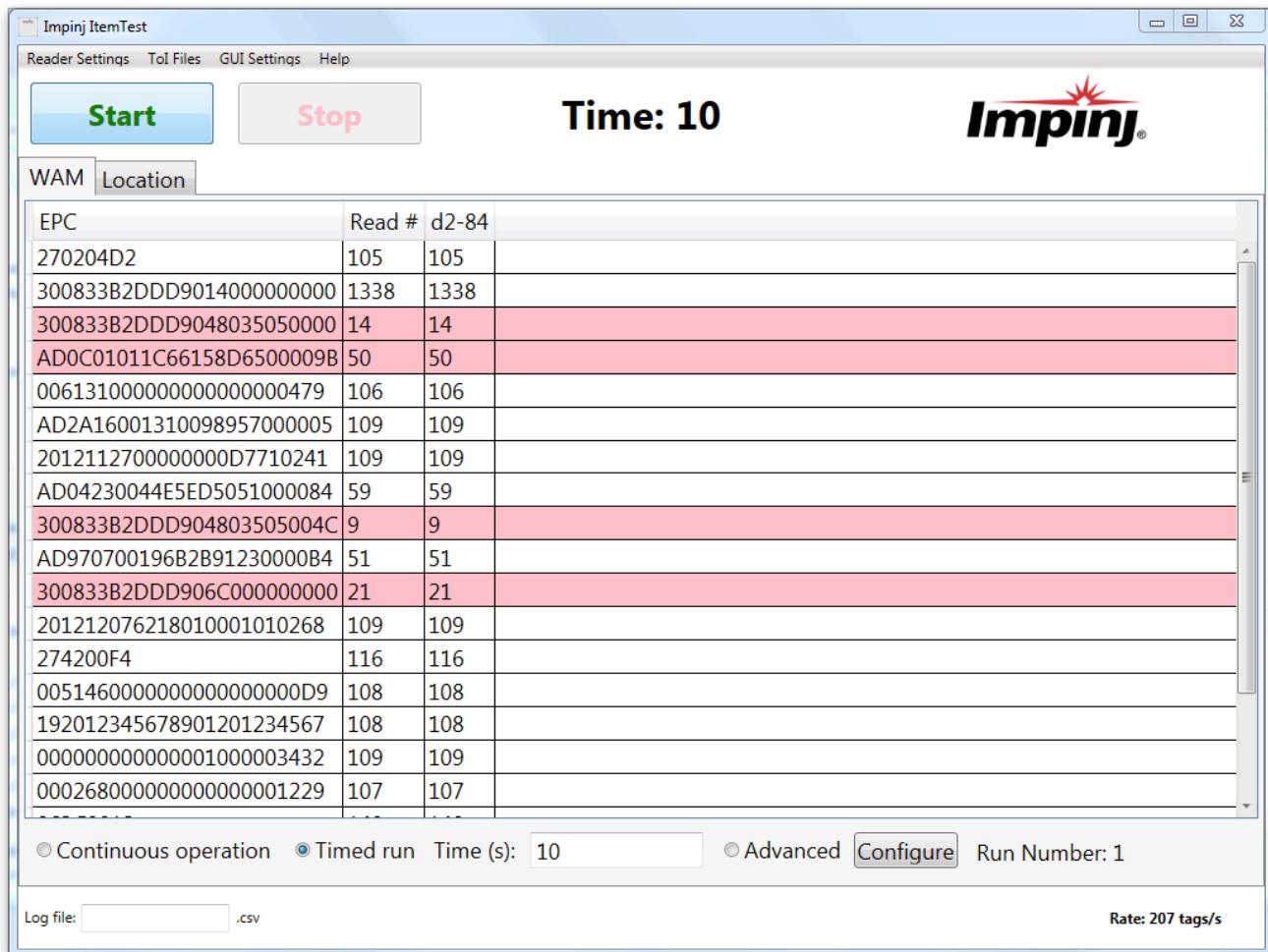
3. To allow the xArray to read from all 52 beams, on the **Wide Area Monitoring** tab, click **All** after the **Antennas** field.
4. For this initial test, set **Mode** to **Mode 1000:Autopilot** and **Target** to **Dual Target**. Keep the default settings for all other parameters.

## 5.4 Run Wide Area Monitoring or Location Tests with ItemTest

Now that the xArray is connected, enabled, and configured for WAM, you can run ItemTest to test your xArray.

### To test the xArray for WAM

1. On the ItemTest main window, click **Start**.
2. By default, ItemTest starts and collects tag read reports for the xArray for 10 seconds. The results are displayed in tabular form, as shown in Figure 5.6.
3. To run continuous operations, starting and stopping as you want, click **Continuous operations** on the ItemTest main page. The inventory read rate in tags/second is displayed in the lower right corner.



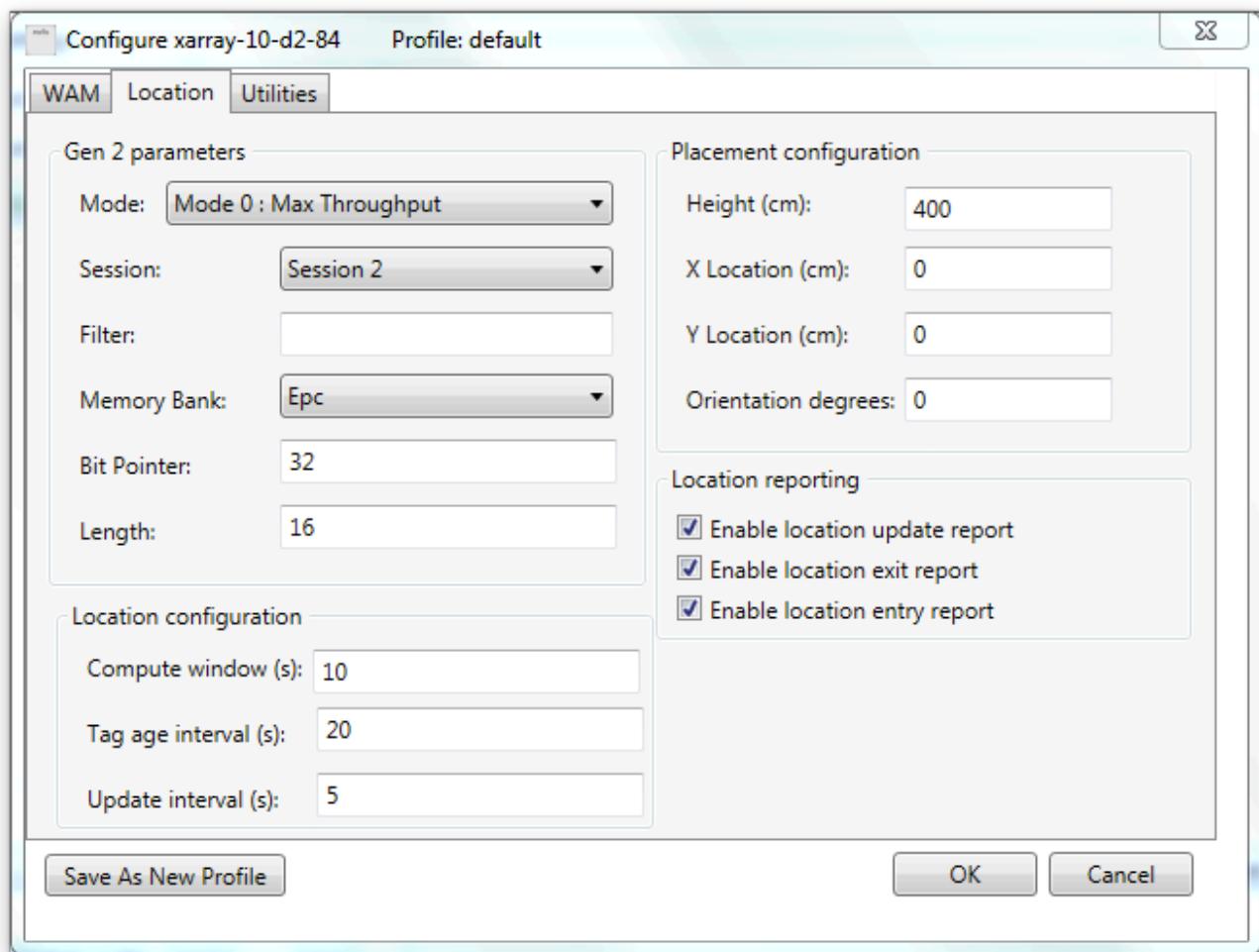
**Figure 5.6** Wide Area Monitoring results

#### To test the xArray for Location

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

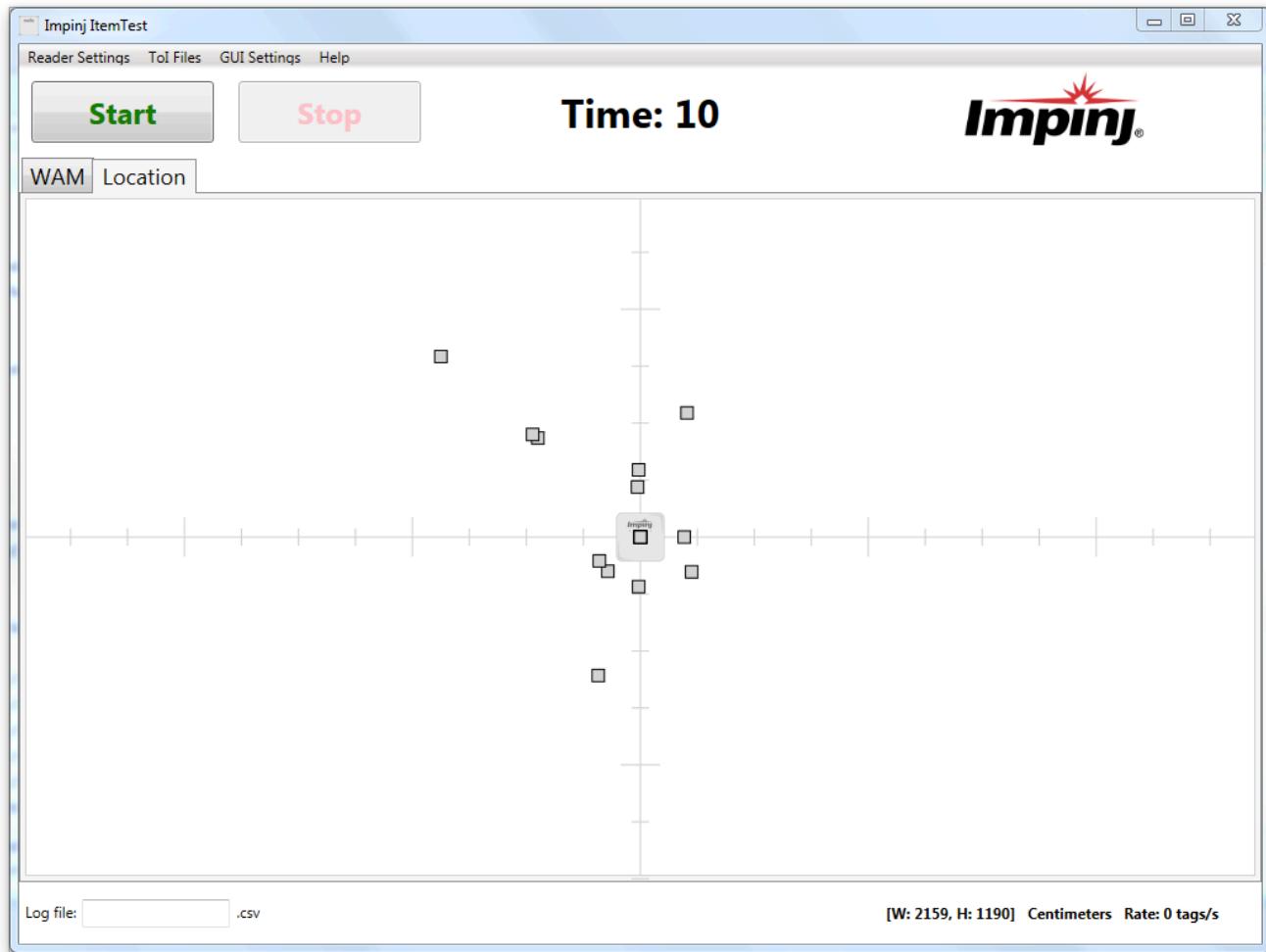
1. To configure the xArray to maximize the number of tag reads, click the **Location** tab on the **Configure xArray** page, shown in Figure 5.7.

2. On the **Location** tab, under **Gen 2 parameters**, set the **Mode** to **Mode 0: Max Throughput**, and then click **OK**.



**Figure 5.7 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 5.8.



**Figure 5.8 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 Revolution Reader products. Note that ItemTest is optimized for testing WAM and Location and doesn't replace Multireader, which is Impinj's original PC reader application for Speedway Revolution. Multireader is the only product that supports the Gen2 access commands of Write, Lock, and Kill, and the Reader-specific features, such as GPIO.

## 6 Configuring and Monitoring xArray

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

### 6.1 Configuring the xArray

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

#### 6.1.1 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 xArray. The *RShell Reference Manual* provides full details and syntax for all RShell commands.

#### 6.1.2 Using RShell to Configure Network Settings for xArray

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

**To configure the xArray's network settings:**

1. Open the RShell console as described in section 4.4.
2. View the xArray'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'  
LLAStatus='enabled'  
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.

- Enabling DHCP  
**> config network ip dynamic**
- Configuring NTP Servers  
**> config network ntp add <NTP SERVER ADDRESS>**

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

### 6.1.3 RF Configuration

How you configure your xArray'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 WAM 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](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 Speedway Revolution. 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.

## 6.2 Monitoring xArray

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

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

### 6.2.1 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 6.1: Show network Command Parameters**

| Parameter | Displayed Information                |
|-----------|--------------------------------------|
| dhcp      | Summary of DHCP client configuration |
| dhcp      | Summary of DNS settings              |
| icmp      | ICMP statistics                      |
| 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*.

### 6.2.2 Viewing RFID Parameters and Statistics

> **show rfid stat**

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

**Table 6.2: Partial listing of show rfid stat parameters**

| Parameter                 | Displayed Information  |
|---------------------------|--|
| ReaderOperationalStatus   | Indicates whether RFID applications are running on the xArray.   |
| 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 6.2 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*.

### 6.2.3 Configuring and Viewing xArray Logs

xArray uses the standard Syslog protocol to forward its logged events to a remote Syslog server. The xArray 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 xArray 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 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**

#### 6.2.4 Viewing the State of the xArray Device

To display information about the current state of the xArray 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*.

## 7 Upgrading the xArray Firmware

xArray contains firmware known as Octane. The current version of Octane is 5.2. This chapter describes the process of manually upgrading a single xArray.

In addition to supporting upgrade procedures, xArray 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.

### 7.1 A Brief Overview of the xArray Firmware

To minimize downtime and maximize the robust handling of possible upgrade failures, xArray contains dual images of its firmware. When requesting a firmware image upgrade, the xArray continues to operate using the primary image. In the background, xArray upgrades the secondary image. When the upgrade completes, the xArray reboots to the newly upgraded image. xArray 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 xArray 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 xArray. It contains the xArray configuration (network settings, LLRP configuration, log settings, and so on), xArray 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.

### 7.2 Upgrading the Firmware

xArray 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's host port.
- Using the Impinj Reader Management web page.

### 7.2.1 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 you are upgrading.
3. Using the Putty application, connect the xArray bu 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 xArray by issuing the following command:

```
> reboot
```

The xArray reboot process displays messages in the RShell console as it goes through each stage of the process. The reboot completes, then the xArray login prompt displays on the console. The xArray status light displays solid green. The behavior details of the xArray reboot LEDs are provided in **Appendix B - xArray Ports and LEDs**.

### 7.2.2 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 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 xArray 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. Within 5-10 seconds, the xArray will begin upgrading the xArray and the Power LED will blink amber. If the Power LED remains solid green, the xArray 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 xArray.

During the upgrade process, the xArray 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.

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

### **7.2.3 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 xArray 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 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**.

## *xArray installation and operations guide*

The screenshot shows the xArray Management Web Page. At the top, there's a header with navigation icons and the URL "xarray-10-d7-98/cgi-bin/index.cgi". Below the header is a banner featuring the "SPEEDWAY REVOLUTION" logo with "with AUTOPILOT" and the Impinj logo.

**READER**

|             |   |
|-------------|---|
| Reader Name | xArray-10-D7-98                         |
| Uptime      | 0 Days, 17 hours, 8 minutes, 37 seconds |
| System Time | Thu Dec 18 20:45:51 UTC 2014            |
| LLRP Status | Disconnected                            |
| RFID Status | Idle                                    |
| STP Status  | Not Activated                           |

**DETAILS**

|                   |                   |
|-------------------|-------------------|
| Model Name        | xArray R680       |
| Regulatory Region | FCC Part 15.247   |
| MAC Address       | 00:16:25:10:D7:98 |
| Software Version  | 5.2.0.16          |
| Hardware Version  | 240-004-000       |
| Serial Number     | 370-13-31-0117    |

**NETWORK**

|                   |              |
|-------------------|--------------|
| IP Address        | 10.0.9.206   |
| Network Mask      | 255.255.0.0  |
| Default Route     | 10.0.0.20    |
| Broadcast Address | 10.0.255.255 |

**READER UPGRADE**

|                       |   |
|-----------------------|---|
| Upgrade Status        | Ready   |
| Last Operation Status | N/A   |
| Select Upgrade File   | <input type="file"/> Choose File No file chosen |
| Upgrade Now           | <b>Upgrade</b>                                  |

**READER REBOOT**

|                 |                 |
|-----------------|-----------------|
| Reboot Status   | Ready To Reboot |
| Press to Reboot | <b>Reboot</b>   |

**QUICK LINKS**

- [www.impinj.com](http://www.impinj.com)
- [support.impinj.com](http://support.impinj.com)
- [Speedway Installation & Operations Guide](#)
- [Third party software licenses](#)
- [End User's License Agreement](#)

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Figure 7.1 xArray Management Web Page

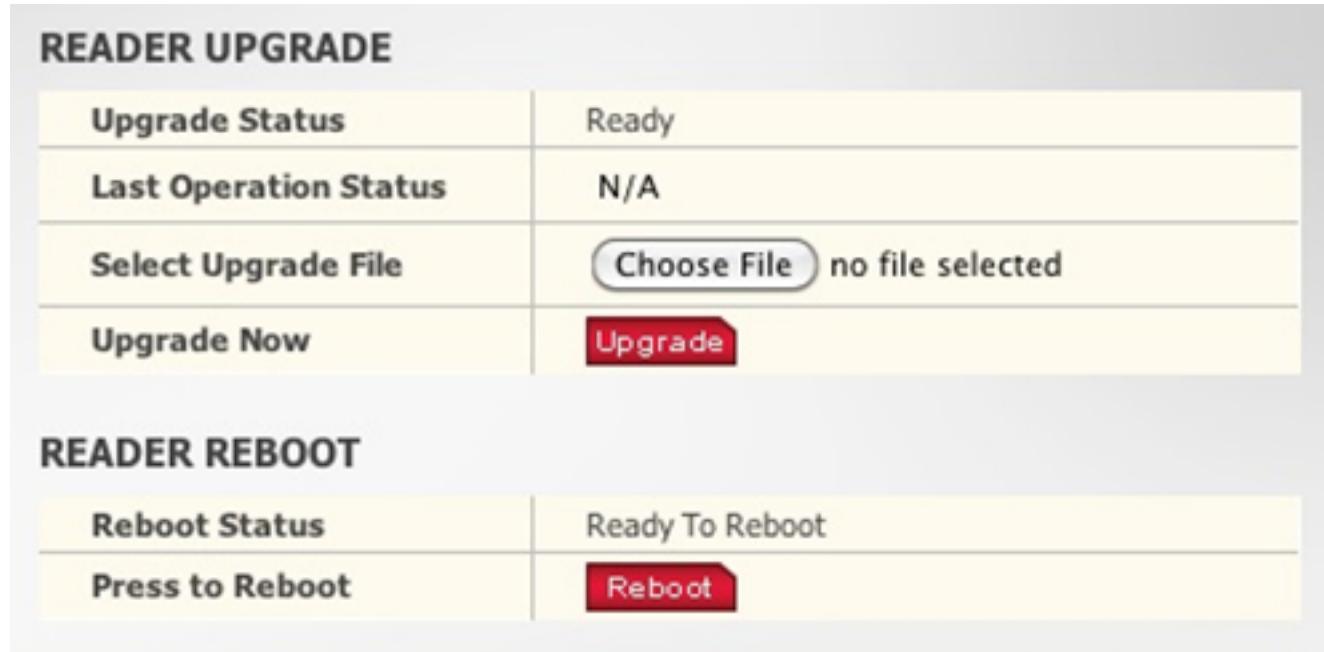


Figure 7.2 Close-up of xArray Upgrade and Reboot Section of Management Web Page

#### 7.2.4 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 xArray automatically reboots and returns to the login prompt.

2. Log in to the xArray. 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.

## 8 Troubleshooting

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

### 8.1 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 8.3.

### 8.2 Returning to the Default Configuration

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

**! Important:** Configuration Default Restore returns the xArray configuration to its default state. It leaves any custom applications installed in the CAP intact. To restore the xArray 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 xArray to its defaults:

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

#### To use RShell to return the xArray 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 xArray automatically reboots and returns to the login prompt.

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

#### To use the Default Restore button on the xArray 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 xArray while the xArray 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 will boot up normally with the default configuration.



**Figure 8.1 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 8.1: 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<br>(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  |
| LLRP Outbound Service      | Enabled  |
| LLRP Outbound Servers      | None   |
| LLRP Outbound Retry Secs   | 5  |
| LLRP Outbound Timeout Secs | 2  |

## 8.3 Submitting Diagnostic Data for Analysis by Impinj Technical Support

If xArray 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.

## 9 Appendix A: Information Specific to Regions of Operation

xArray is designed to work in various regulatory regions. This appendix contains frequency ranges specific to each supported region.

### 9.1 Operation in North America

#### 9.1.1 Frequency Plan

Operation in North America (USA, Canada and Mexico) follow FCC regulations and frequency allocation, with hopping occurring between 902.75-927.25 MHz in 500 KHz steps. The frequency plan is further explained in Table A.1.

**Table A.1: Frequency Plan for North America**

| Transmit Channel Number | Center Frequency (MHz) |
|-------------------------|------------------------|
| 1                       | 902.75                 |
| 2                       | 903.25                 |
| 3                       | 903.75                 |
| 4                       | 904.25                 |
| ...                     | ...                    |
| 49                      | 926.75                 |
| 50                      | 927.25                 |

#### 9.1.2 xArray Requirements

##### Positioning

FCC Maximum Permissible Exposure (MPE) guidelines require that the antenna's surface be at least 25 centimeters away from personnel working in the area. For more details, see the following FCC bulletins:

- FCC OET Bulletin 65: Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

- FCC OET Bulletin 56: Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields

## 9.2 Operation in European Union

### 9.2.1 Frequency Plan

For European operation, the xArray supports the frequency plan listed in Table A.2 and are compliant with the ratified ETSI EN 302 208 specification v.1.4.1. Impinj implements the four channel high power plan that doesn't use listen-before-talk, the maximum continuous transmit time on a channel is four seconds, and xArray enforces the 100 milliseconds off time before reusing the same channel.

**Table A.2: Frequency Plan for European Union**

| Transmit Channel Number | Center Frequency (MHz) |
|-------------------------|------------------------|
| 4                       | 865.7                  |
| 7                       | 866.3                  |
| 10                      | 866.9                  |
| 13                      | 867.5                  |

## 9.3 Operation in Japan

### 9.3.1 Frequency Plan

xArray operates within the new 915.7 to 920.9MHz band recently approved for use in Japan. The four high power channels that do not require carrier sense (LBT) are supported as listed in the table that follows.

**Table A.3: Frequency Plan for Japan**

| LLRP Channel Number | Center Frequency (MHz) |
|---------------------|------------------------|
| 1                   | 916.8                  |
| 2                   | 918.0                  |
| 3                   | 919.2                  |
| 4                   | 920.4                  |



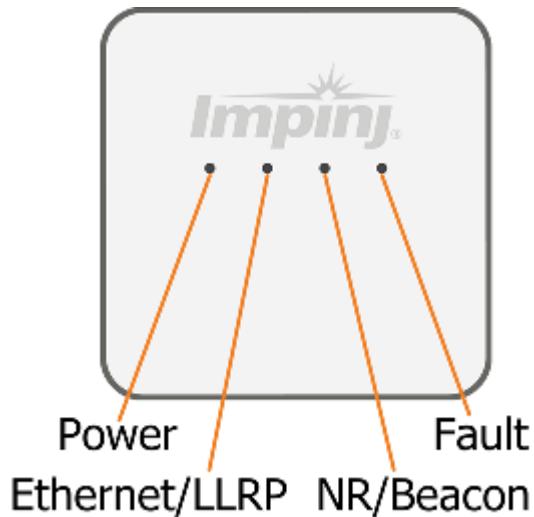
## 10 Appendix B - xArray Ports and LEDs

Figure B.1 illustrates the I/O ports located on the xArray. This graphic illustrates an xArray, which includes four antenna ports that are visible.



**Figure B.1 xArray Connections**

The xArray Gateway has four LEDs to indicate operational status, their position is shown in Figure B.2. The Power LED is ON (GREEN) when power is applied.



**Figure B.2 xArray Status Lights**

Each LED has its own blink patterns to convey status to the user. Table 5.1 documents the defined

patterns for the xArray Ethernet/LLRP LED. Table B.2 documents the defined patterns for the xArray NR/Beacon LED. Table B.3 documents the defined patterns for the xArray Fault LED.

**Table B.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 B.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 B.3 xArray Fault LED**

| LED State   | xArray State             |
|-------------|--------------------------|
| Blink (RED) | Briefly during startup   |
| OFF         | Normal (no faults)       |
| ON (RED)    | Fault condition occurred |

Table B.4 describes the LED behavior for various xArray states.

**Table B.4 xArray Operations and Associated LED Behavior**

| xArray Operation                                     | LED  | Expected Behavior  |                  |
|--|--|--------------------|------------------|
| Power (power on),<br>normal<br>completion            | Power applied,<br>attempting to start boot<br>code | Power<br>Status    | Solid red<br>Off |
| Ethernet/LLRP<br>normal<br>completion<br>version 5.2 | LLRP Connection                                    | Eth/LLRP<br>Status | Solid red<br>Off |

| xArray Operation |                    | LED       | Expected Behavior |
|------------------|--------------------|-----------|-------------------|
| NR/Beacon        | Programmable light | NR/Beacon | Solid red         |
|                  |                    | Status    | Off               |
| Fault            | Failure            | Fault     | Solid red         |
|                  |                    | Status    | Off               |

## 11 Document Revision History

| Date       | Revision | Comments         |
|------------|----------|------------------|
| 12/16/2014 | 5.2.0    | Original Release |

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**Notices:**

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