



UHF Gen 2 RFID Speedway® Revolution

# Installation and Operations Guide



**SPEEDWAY®**  
REVOLUTION

## Products Covered by this Guide

This guide pertains to readers with the following part numbers:

**Table i: Speedway Revolution Reader Part Numbers**

Reader	Communication Code	Part Number
Speedway R220	FCC	IPJ-REV-R220-USA1M1
Speedway R420	FCC	IPJ-REV-R420-USA1M1
Speedway R220	ETSI	IPJ-REV-R220-EU11M1
Speedway R420	ETSI	IPJ-REV-R420-EU11M1
Speedway R220	Various	IPJ-REV-R220-GX11M1
Speedway R420	Various	IPJ-REV-R420-GX11M1
Speedway R220	Various	IPJ-REV-R220-GX21M1
Speedway R420	Various	IPJ-REV-R420-GX21M1
Speedway R420	Japan	IPJ-REV-R420-JP21M1
Speedway R640	FCC	IPJ-REV-R640-FCC1M1
Speedway R640	ETSI	IPJ-REV-R640-EU11M1
Speedway R640	Various	IPJ-REV-R640-GX11M1



## 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.



**Caution:** Changes to this product or modifications not expressly approved by the party responsible for compliance could void your authority to operate per FCC Part 15.

## 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.

This device has been designed to operate with the [antenna\(s\)](#) listed on page 35 that have a maximum gain of 6 dB. Antennas not included in this list or having a gain greater than 6 dB are strictly prohibited for use with this device. The required antenna impedance is 50 ohms. To reduce potential radio interference to other users, the antenna type and its gain should be chosen so that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication. The term "IC" before the radio certification number only signifies that Industry of Canada technical specifications were met.



## 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, please refer to the Impinj Declaration of Conformity (DoC) located at [support.impinj.com](http://support.impinj.com).

## Environmental Air Handling Space (EAHS) Applications

This device is suitable for use in Environmental Air Handling Space (EAHS) in accordance with Section 300-22(c) of the National Electric Code.

Cables, antennas, power adaptors, PoE (Power Injectors), or other devices shall not be installed in the Environmental Air Handling Space unless they are suitable for use in the EAHS per UL 2043.

## Before You Begin

 **Warning:** Please read this document in its entirety before operating the Speedway Revolution Reader, as serious personal injury or equipment damage may result from improper use. Unauthorized opening of the Speedway Revolution Reader enclosure voids the warranty. To safeguard personnel, be sure to position all antenna(s) according to the specified requirements for your regulatory region. For details, see Appendix A: [Information Specific to Regions of Operation](#) on page 34.

## Table of Contents

Federal Communications Commission (FCC) Compliance .....	ii
Industry Canada (IC) Compliance .....	iii
CE Marking and European Economic Area (EEA) .....	iii
Environmental Air Handling Space (EAHS) Applications .....	iii
Before You Begin.....	iii
<b>Chapter 1: Introduction .....</b>	<b>1</b>
<b>About this Guide .....</b>	<b>1</b>
Intended Audience .....	1
Other Documents of Interest.....	1
Impinj Support Information.....	2
<b>Introduction to Speedway® Revolution.....</b>	<b>3</b>
<b>Speedway xPortal – Integrated Portal Reader.....</b>	<b>4</b>
<b>Speedway Antenna Hub – .....</b>	<b>4</b>
<b>Requirements for Using Speedway Revolution .....</b>	<b>5</b>
Environmental Requirement .....	5
Hardware Requirements .....	5
Power Requirements .....	5
Supported Operating Environments .....	5
Supported Communication Protocol .....	6
Antenna Requirements .....	6
<b>Chapter 2: Installing and Connecting Speedway Revolution .....</b>	<b>7</b>
<b>Speedway Revolution Ports and LEDs .....</b>	<b>7</b>
<b>Installing and Connecting the Reader .....</b>	<b>8</b>
<b>Detailed Installation Procedures.....</b>	<b>9</b>
Step 1: Position the Speedway Revolution Reader and (optionally) Mount the Reader .....	9
Step 2: Connect the Antenna(s) to the Speedway Revolution Reader.....	10
Step 3: Power the Reader .....	10
Step 4: Connect Speedway Revolution to the Network .....	11
Step 5: Configure the Region Setting on the Reader .....	14
Step 6: Test the Installed Reader .....	15
<b>Chapter 3: Configuring and Monitoring Speedway Revolution.....</b>	<b>16</b>

<b>Configuring Speedway Revolution.....</b>	<b>16</b>
Device Configuration .....	16
RF Configuration.....	17
<b>Monitoring Speedway Revolution.....</b>	<b>22</b>
Viewing Network Parameters and Statistics .....	22
Viewing RFID Parameters and Statistics .....	23
Configuring and Viewing Speedway Revolution Logs .....	24
Viewing the State of the Speedway Revolution Device .....	24
<b>Chapter 4: Upgrading the Speedway Revolution Firmware.....</b>	<b>25</b>
A Brief Overview of the Speedway Revolution Firmware .....	25
Upgrading the Firmware .....	25
Upgrading the Firmware with a USB Drive .....	26
Preparing the USB Drive for upgrade .....	27
Using the USB Drive .....	27
Upgrading the Firmware through the Impinj Management Web UI .....	27
To fall back to the previous image .....	29
<b>Chapter 5: Troubleshooting .....</b>	<b>30</b>
Returning to the Default Configuration .....	30
To use RShell to return the Reader to its default configuration and leave CAP intact	
30	
To use the Default Restore button on the Reader to restore to its default configuration .....	30
<b>Submitting Diagnostic Data for Analysis by Impinj Technical Support.....</b>	<b>32</b>
To capture data to a Reader Diagnostic Data file: .....	32
<b>Appendix A: Information Specific to Regions of Operation .....</b>	<b>34</b>
<b>Operation in North America .....</b>	<b>34</b>
Frequency Plan.....	34
Antenna Requirements .....	34
<b>Operation in European Union .....</b>	<b>36</b>
Frequency Plan.....	36
Antenna Requirements .....	36
<b>Operation in Other Global Regions .....</b>	<b>37</b>
Approved Antennas .....	38
Consult with your registered reseller or Impinj provider for guidance on antenna selection for your region .....	38

<b>Operation in Japan .....</b>	<b>47</b>
Frequency Plan.....	47
<b>Appendix B: GPIO Details .....</b>	<b>49</b>
<b>Appendix C: Speedway xPortal Installation .....</b>	<b>51</b>
RF Beam Pattern .....	51
Mounting the xPortal.....	51
Conduit Attachment .....	53
<b>Appendix D: Speedway Antenna Hub Installation .....</b>	<b>57</b>
Speedway Antenna Hub Solution Checklist .....	57
Setting Up a Speedway Antenna Hub System .....	57
Hub Feature Enable and Diagnostics Using the Web-UI.....	59

# Chapter 1: Introduction

## About this Guide

This guide provides detailed instructions for installing, connecting, configuring, operating, upgrading, and troubleshooting the Speedway Revolution or xPortal Reader. To shorten the length of this guide, the content focuses on the installation and operation of one Reader.

## Intended Audience

The intended audience for this guide is anyone installing a Speedway Revolution or xPortal Reader. 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.

## Other Documents of Interest

This guide is part of a larger documentation set that supports Speedway Revolution. The document set includes the following seven documents:

- **Speedway Revolution Getting Started Guide** is a one-page guide included with the Speedway Revolution Reader. It provides basic information about the hardware and instructions for obtaining additional documentation, firmware upgrades and downloads, and other support software.
- **Impinj 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 Speedway Revolution, which includes Impinj's custom LLRP extensions.  
**✓ Note:** Octane is the name for the Speedway Revolution firmware.
- **RShell Reference Manual** describes the syntax and command language for the Speedway Revolution RShell Console.
- **Octane SNMP Guide** provides monitoring and reference information for working with the SNMP MIBs related to Speedway Revolution (the standard TCP/IP networking MIB (MIB-II) and a subset of the standard EPCglobal RM MIB).
- **Firmware Upgrade Reference Manual** includes detailed procedures, reference information for upgrading firmware installed on single Readers, and procedures for creating a metafile to automate upgrading of multiple Readers.
- **Speedway Revolution Embedded Developer's Guide** provides a high-level description of the Speedway Revolution platform and a high-level view of its architecture for software engineers designing custom application software for the Reader.

## Impinj Support Information

Visit the Impinj Support Web site at [support.impinj.com](http://support.impinj.com) for information about technical assistance. For guidelines on capturing data for analysis by Impinj technical support personnel, see on page 32.

# Introduction to Speedway® Revolution



Speedway® Revolution is a stationary, small form factor, UHF Gen2 RFID tag Reader. It provides network connectivity between tag data and enterprise system software. Speedway Revolution offers many key features that increase application flexibility:

Figure 1.0 Speedway Revolution Reader

- **Low Power Usage**

With a low power design, Speedway Revolution is capable of using Power over Ethernet (PoE). Using PoE simplifies deployment and dramatically reduces costs and greenhouse gas emissions of your RFID infrastructure. Using PoE does not compromise Speedway Revolution performance. It delivers the full 30 dBm transmit power

✓ **Note:** Using an AC/DC power module, the maximum transmit power is +32.5 dBm. Speedway Revolution supports the IEEE standard 802.3af for PoE.

- **Compact Form Factor**

The compact size of Speedway Revolution, 7.4 x 6.9 x 1.2 inches or 18.8 x 17.5 x 3 cm, eases installation in tight spaces and embedded applications.

- **Two Models Available**

Impinj offers two Speedway Revolution models, with different high performance monostatic antenna port configurations. The transmitter and receiver use the same port. The model R220 is a two-port configuration and the R420, shown above, is a four-port configuration.

- **High Performance Features**

Speedway Revolution uses a variety of high performance features making it possible to read more than 1100 tags per second. Features include Autoset, Low Duty Cycle, dynamic antenna switching, inventory search modes that improve tag population management, and receive sensitivity filtering for read-zone confinement.

- **Ease of Use Features**

Speedway Revolution uses industry-standard application interfaces; this simplifies integration with RFID middleware or custom software solutions. It also offers enterprise-class management and monitoring capability.

- **Robust Reader Design**

Speedway Revolution uses a single circuit board design that delivers field-proven, enterprise-class quality and reliability.

## Speedway xPortal – Integrated Portal Reader



The newest member of the Speedway family is xPortal an integrated portal Reader. xPortal incorporates the Speedway Revolution Reader with innovative Dual-Linear Phased Array (DLPA) antenna technology in a compact, easy-to-install package. The Speedway xPortal delivers superior performance and unmatched installation versatility for RFID read points at doorways, hallways and general zone coverage in retail, office, hospitality, and healthcare environments.

The configuring and using the xPortal is identical to the Speedway R220 or R420 Readers. The following sections also apply to the xPortal. [Appendix C, Speedway xPortal Installation](#), provides the unique installation and cable hookup instructions [I](#) on page 51.

The xPortal is an integrated solution with the maximum Reader-transmit power set at the factory to comply with country of operation regulations. For use in the USA or Canada under FCC rules, this is 28.5 dBm with xPortal's 7.5dBi antenna gain.

Figure 1.2 Speedway xPortal-Reader

## Speedway Antenna Hub –



Figure 1.3 Speedway Antenna Hub

The Speedway Antenna Hub allows the expansion of each Speedway R420 antenna port into 8-time-multiplexed antenna ports for a total of 32 ports per Speedway R420 Reader. Hub control is instrumented through a GPIO adaptor and tightly integrated with the Octane firmware (release 4.10 or higher) to deliver superior antenna switching performance.

The antenna hub has a typical insertion loss of

1.2 dB and this loss can be factored into the user's transmit power setting in the same manner as cable loss.

The configuration and use of the antenna hub is described in Appendix D.

## Requirements for Using Speedway Revolution

### Environmental Requirement

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

### Hardware Requirements

- TCP/IP network equipment is required to connect the Reader to a PC (Windows, Mac, or Linux), or other network terminal.
- Connecting to the Reader console port requires a Cisco type management cable (RJ-45 to DB9) and either a RS-232 serial port or serial to USB adapter on the PC.
- Impinj-approved UHF RFID antenna or antennas, including associated RF cable or cables with RP-TNC male connector interface.

### Power Requirements

This product is intended to be supplied with a Listed/Certified power supply, marked LPS or Class 2, with 24Vdc output, rated minimum 2.5A. Use of alternative power supply will invalidate any approval given to this device and may be dangerous.

When supplied from an IEEE802.3af (Power over Ethernet) compliant power source which is certified by the appropriate agencies, the RF transmit power is limited to +30dBm. When supplied by the Impinj approved Listed/Certified power supply model number **IPJ-A2002-000**, the RF transmit power supports upto +32.5dBm. Operating above +30 dBm requires professional installation to comply with radio regulatory laws in many countries. See Appendix A: [Information Specific to Regions of Operation](#) on page 34 for details.

Available AC power cords for the **IPJ-A2002-000** power supply are:

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

### Supported Operating Environments

This section describes the environments in which you can access the Speedway Revolution RShell console used for configuring, monitoring, and maintaining the Reader. The tools you use when accessing the RShell console depend on how you connect your PC to the Reader: serial connection (RS-232) or Ethernet connection (SSH/Telnet). On PCs running Microsoft Windows, you can now use Putty for both types of connections.

**Table 1.1: Supported Operating Environments**

Interface	Protocol	Recommended Tools	
		Microsoft Windows	Linux
Ethernet	SSH-Port 22 Telnet-Port 23	Putty <sup>1</sup>	SSH or Telnet
Serial	RS-232	Putty (version 0.60 and higher supports serial)	Minicom

1. <http://www.chiark.greenend.org.uk/~sgtatham/putty/>

## Supported Communication Protocol

For client control of the Reader, Speedway Revolution supports the EPCglobal Low Level Reader Protocol (LLRP) v1.0.1. LLRP is an EPCglobal standard interface allowing communication with the Reader, which in turn reads EPCglobal Gen 2 RFID tags.

## Antenna Requirements

Depending on the Reader model you are installing, Speedway Revolution is equipped with two (R220) or four (R420) independent, bidirectional, and full duplex TX/RX monostatic antenna ports.

Antenna requirements vary by regulatory region. For details about the requirements in a specific region, see the relevant antenna section in Appendix AAppendix AAppendix AAppendix A: Information Specific to Regions of Operation on page 34.

# Chapter 2: Installing and Connecting Speedway Revolution

This chapter provides details about the Speedway Revolution I/O ports and status LEDs, and explains how to install the Reader and connect it to your network.

## Speedway Revolution Ports and LEDs

The following graphic illustrates the I/O ports located on the Speedway Revolution Reader. This graphic illustrates a Speedway R420, which includes four antenna ports visible in Figure 2.2.

✓ **Note:** Both Speedway R420 and R220 models have the same exterior ports with one exception; the R220 includes two antenna ports and the Speedway R420 includes four antenna ports.

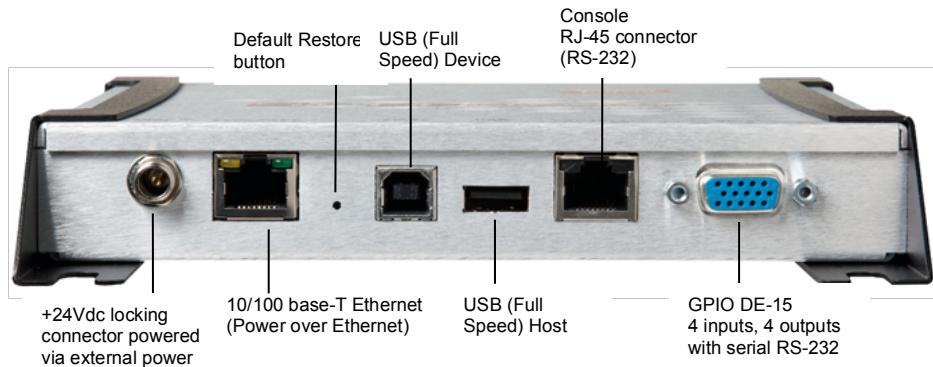


Figure 2.1 Speedway Revolution R420 Port Connections

✓ **Note:** See Appendix B [Appendix B: GPIO Details](#) for functional and electrical specifications and details for each pin of the GPIO DE-15 connectors on page 49. Antenna ports and LED status indicators are located on the back panel of the Reader. The Speedway R420 graphic below illustrates their locations:

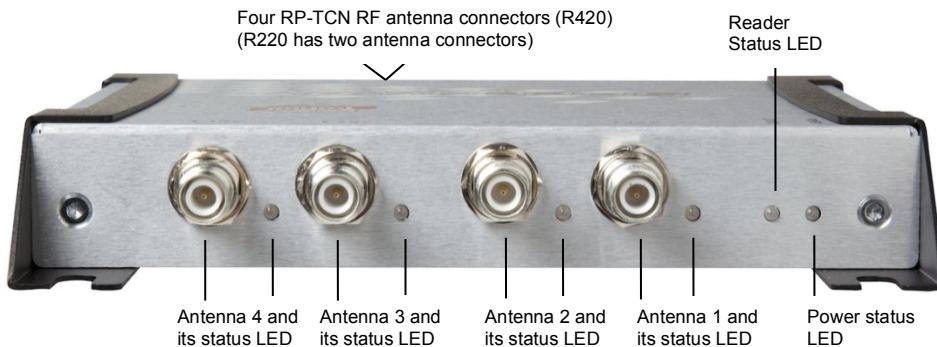


Figure 2.2 Speedway Revolution R420 Antenna Ports and Status LEDs

The following table describes the LED behavior for various Reader states:

**Table 2.1: Reader Operations and Associated LED Behavior**

Reader Operation	LED	Expected Behavior	
Startup (power on), normal completion	Power applied, attempting to start boot code	Power	Solid red
		Status	Off
	Bootloader calling firmware image	Power	Solid green
		Status	Off
	Bootloader completed successfully, Reader is ready	Power	Solid green
		Status	Solid green
Startup (reset), normal completion	Default Restore button pressed	Power	Turns off
		Status	Off
	Default Restore button pressed for 3 seconds	Power	Blinks once (red), indicates a configuration default restore will occur
	Default Restore button pressed for 10 seconds	Power	Blinks twice (red), indicates a factory default restore will occur. Resets Reader configuration and removes CAP (if present).
Startup (failure)	Hardware problems detected, unable to boot	Power	Continuous blinking red
		Status	Off
Upgrade activity	Upgrading the firmware during boot process	Status	Alternates between red and green
Detection of antenna activity	Detects no activity on antenna port	Antenna	Off
	Detects antenna transmission activity on antenna port	Antenna	Solid green
Inventory activity	Performing an inventory operation	Status	Blinks orange, blinks faster as tag volume increases
LLRP activity	Active LLRP connection	Status	Double blink pattern (green)
	Disconnected operation	Status	Single blink pattern (green)

## Installing and Connecting the Reader

The primary installation and connection steps for Speedway Revolution are:

1. Position the Reader appropriately for your environment. This may or may not involve mounting the Reader.
2. Connect the antenna(s) to the appropriate ports on the Reader.

3. Connect power to the Reader.
4. Connect the Reader to the network.
5. Configure region setting on the Reader (not required if FCC or ETSI).
6. Test the Reader installation by reading tags.

## Detailed Installation Procedures

This section provides the details for each installation and connection step.

### Step 1: Position the Speedway Revolution Reader and (optionally) Mount the Reader

Choose the appropriate location for the Reader. Ideally you should always keep the unit away from direct sunlight, high humidity, extreme temperatures, and sources of electromagnetic interference. Any combination of these conditions may degrade performance or shorten the life of the unit. Additionally, you need to account for the bend radius of the coaxial cable at the antenna connection points – if mounting close to another perpendicular object. The Speedway Reader supports Power over Ethernet (PoE) and can obtain its electrical power with data via standard cable in an Ethernet network.

If you plan to power the reading using an external universal power supply, confirm there is a standard 120 or 220 VAC outlet nearby. Depending on your environment, you may need to mount the Reader to a wall or another object.

#### To mount the Speedway Revolution Reader:

1. Locate the four mounting slots on the Reader, as illustrated below:

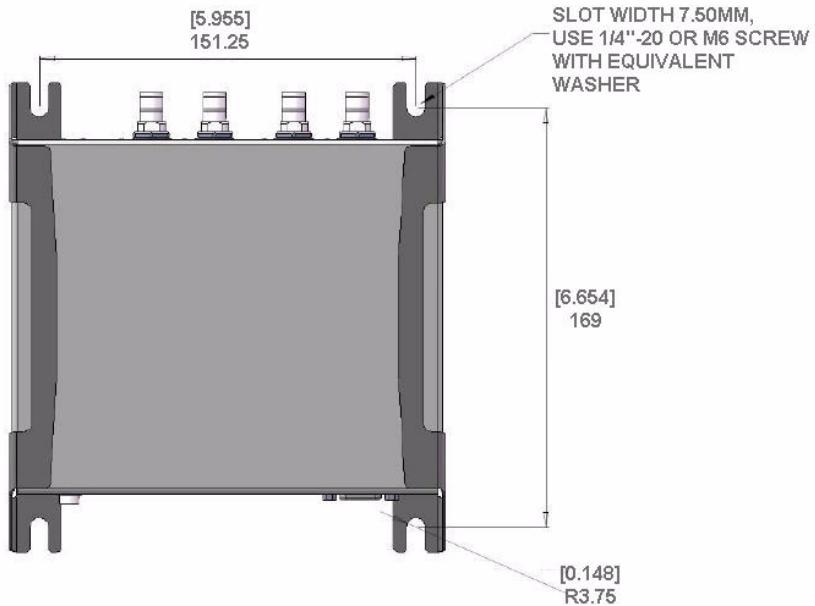


Figure 2.3 Speedway Revolution Mounting Locations

2. Using  $\frac{1}{4}$  inch diameter bolt with 20 threads per inch ( $\frac{1}{4}$ -20) or M6 screws, secure the unit: mount the Reader either horizontally or vertically.

 **Caution:** If there is any chance of dust or water exposure, you should mount the Reader so that the Ethernet, USB, Console and GPIO ports are facing down to prevent ingress.

## Step 2: Connect the Antenna(s) to the Speedway Revolution Reader

Depending on the Speedway Revolution model you are installing, the Reader has either two antenna ports (R220) or four antenna ports (R420). Each port is independent, bidirectional, and full duplex TX/RX (monostatic).

 **Warning:** You must use Impinj-approved antennas with Speedway Revolution. See Appendix A: [Information Specific to Regions of Operation](#) on page 34 for a detailed list of approved vendors. Using any other antenna may adversely affect performance or damage the Reader. Speedway Revolution requires professional installation to correctly set the TX power for the RF cable and antenna selected.

### To connect the antenna(s) to Speedway Revolution:

1. Position each Reader antenna, keeping the following points in mind:
  - Position the antenna(s) to achieve the most effective and efficient tag reads.
  - Position the antenna(s) to maximize operator safety. Personnel should remain at a safe distance at all times. See Appendix A: [Information Specific to Regions of Operation](#) on page 34 for the specific requirements for your regulatory region.
2. Mount the antenna(s) according to the instructions provided by the antenna manufacturer.
3. Attach the antenna cable(s) to the antenna port(s) on the Reader. Choose any port for any antenna.

Finger-tighten each connection, making sure the connection is secure. The antenna cable is properly tightened when you are no longer able to twist the cable inside the connector.

 **Note:** A loose connection negatively impacts the performance of the antenna.

 **Caution:** Impinj designed the Speedway Revolution antenna ports to be self-terminating. It is important that you do **not** terminate unused antenna ports. Leave them unconnected.

## Step 3: Power the Reader

You have two choices for powering Speedway Revolution:

- Power over Ethernet (PoE)
- External universal power supply

If your network switch is PoE-enabled, the Reader will power on when you connect it to the network.

If you are using an external universal power supply, connect the AC power plug into a suitable 100–240 VAC, 50–60 Hz power outlet.

The boot sequence begins in either case when power is supplied to the Reader. This sequence typically completes within 30 seconds. Once the boot sequence finishes, the Reader accepts commands, not before. The [Power and Status LEDs](#) on the Reader alert you the status. See Table 2.1 on page 8 for details.

 **Important:** If a Reader is receiving power via PoE and the Reader detects that an external universal power supply has been connected, the Reader reboots and switches to the external universal power supply source. If, however, the Reader is receiving power via an external universal power supply and detects the connection to a PoE-enabled network switch, nothing changes. The Reader continues to receive power from the external supply.

The external universal power supply always takes precedence over PoE because the universal power supply is capable of higher power if both sources are connected.

## Step 4: Connect Speedway Revolution to the Network

You are now ready to connect the installed Speedway Revolution to your network. You have two options:

- If your network supports DHCP, you can connect the Reader directly to your Ethernet network. Once the Reader is powered, immediately communicate with it via Telnet (TCP/IP).
- If your network does not support DHCP, you will need to connect a PC directly to the Reader using an RS-232 serial connection. Use the Reader's RShell command line interface to configure a static IP address for the Reader. Once completed, you will be able to connect the Reader to your Ethernet network.

Beginning with Octane 4.8 release WiFi is supported using an adapter connected to the USB port on Speedway Revolution. Only WiFi adapters using the Realtek 8187 chipset/driver are supported. Contact Impinj to obtain a list of compatible WiFi USB adapters brands/models and the **RShell Reference Manual** for details on how to configure.

Details for completing each connection option are discussed below. Before proceeding, make note of the Reader's factory default network settings.

**Table 2.2: Default Network Settings**

Settings	Description
Hostname	SpeedwayR-XX-XX-XX where XX-XX-XX is the last three bytes of the Reader's MAC address (which is printed on the version label attached to the Reader case).
DHCP	Enabled. The Reader also reports its hostname to the DHCP server.

### To connect Speedway Revolution to the Ethernet network:

- Using a standard Ethernet cable, connect the RJ-45 connector on the Reader to a LAN drop or network switch. A typical network configuration is illustrated below:

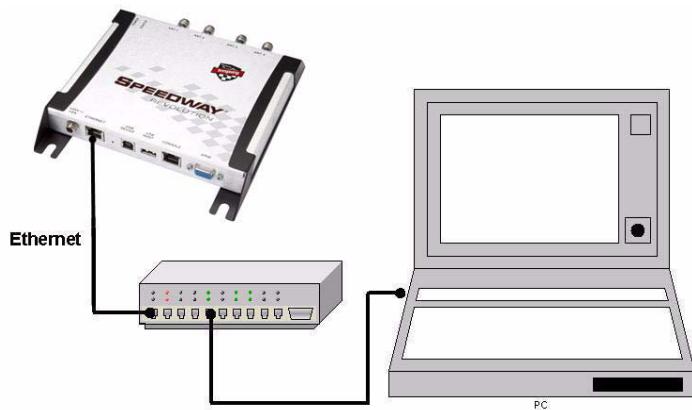


Figure 2.4 Connecting Speedway Revolution to the Ethernet Network

✓ **Note:** If you need to connect a PC directly to the Ethernet port, you can use a standard Ethernet cable. A crossover cable is not necessary.

#### Debugging Ethernet network connection:

Steps to try if you encounter difficulty in connecting to the Reader over TCP/IP:

1. "ping" the Reader, i.e. ping speedwayr-10-28-42.local (for Revolution). If you are on an enterprise network it is usually not required to use '.local'
2. If the ping is NOT successful, it will likely return one of these three error messages:
  - "Ping request could not find host"
  - "Request timed out"
  - "Destination host unreachable"

The likely cause is that your PC doesn't have Bonjour Print Services installed. Refer to <http://support.apple.com/kb/dl999> for installation instructions.

#### To connect Speedway Revolution to your PC over a serial connection:

1. Confirm 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. Using a Cisco style Console cable RJ-45 to DB9, Impinj part number IPJ-A4000-000, connect your PC's valid/active COM port to the serial port on the Reader as illustrated below:

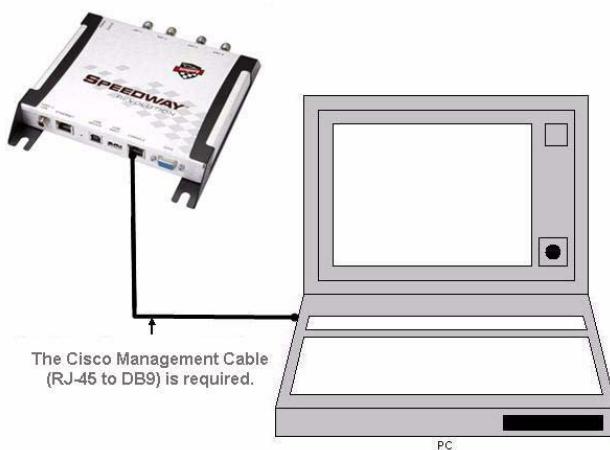


Figure 2.5 Speedway Revolution Serial Connection

3. Power up the Reader and wait for the boot sequence to complete. (See Step 3: [Power the Reader](#) on page 10.)
4. On the PC, run the Putty application and select the **Serial** connection option. Verify that **Serial line to connect to** is set to **COM1** (may be another COM port if you are using a serial to USB adapter)
5. Set **Speed** to **115200**.
6. Set **Flow control** to **None**.

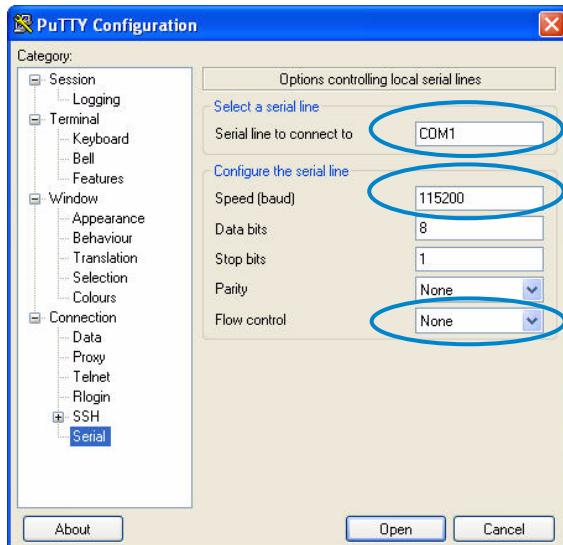


Figure 2.6 Putty Configuration Settings

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

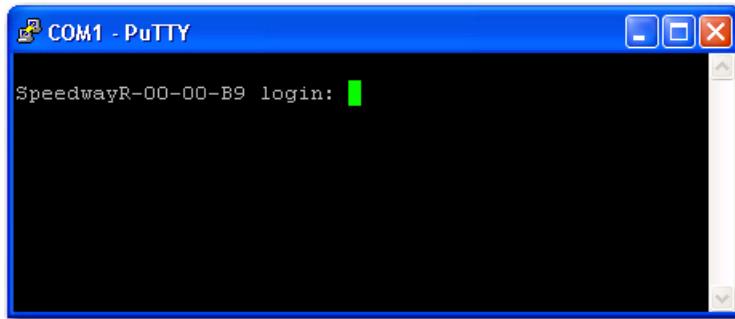


Figure 2.7 COM1 Putty Login Prompt

9. Log in with the following default credentials unless you customized them:  

```
user name: root
password: impinj
```
  10. When the RShell command line prompt displays, begin configuring the network settings for the Reader. See [Using RShell to Configure Network Settings](#) for Speedway Revolution on page 16 for details.
  11. When you have completed configuration of the appropriate network settings, [connect the Reader to your Ethernet network](#) as described on page 11.
- ✓ **Note:** If you decide to connect to DHCP after connecting serially, remember to use RShell to change the IP address on the Reader from static to dynamic. See [Using RShell to Configure Network Settings](#) for Speedway Revolution on page 16 for details.

## Step 5: Configure the Region Setting on the Reader

GX1 or GX2 Reader models that support multiple countries required that the professional installer set the specific region of operation. Note FCC or ETSI Readers cannot be altered and only operate per the regulatory laws in USA/Canada, or European Union.

**⚠ Warning:** The RF settings must match the country/region of operating to comply with local laws and regulations. You, the user, are responsible to ensure operation with the correct RF settings and are solely responsible for any fines and other damages due to incorrect or non-compliant country/region settings on your Reader.

Out of the box, GX1 and GX2 Readers have no region configured (null region) and will not transmit RFID signals. The region can be selected and set using the Reader's http interface (web browser) or using RShell. The procedure to set region via web interface is as follows:

1. Connect to the Reader using a web browser `http://<reader name or IP address>`.  
Examples: `http://speedwayr-10-00-DD` or `http://10.0.10.44`.
2. Log in to the Reader;  
user name: root  
password: impinj
3. Select one of the available regions from the drop down list, see figure 2.8  
**✓ Note:** if you do not see your country or region listed, contact Impinj regarding current regulatory approval status.
4. Click the **REBOOT** button. When changing the Reader's operating region, the effect of the change does not take effect until the next reboot. Attempting RFID operations on the Reader after changing the region but before rebooting will result in undefined behavior.



Figure 2.8 Change Regulatory Region Web Interface

Alternately, the following RShell commands will set or change a GX1 or GX2 region of operation:

```
show system region – shows the configured region and list of selectable regions.  
config system region X – set the region to region number X, example config  
system region 15, sets region on GX1 to Singapore.
```

## Step 6: Test the Installed Reader

Confirm connections and functionality is correct by reading tags. Using the MultiReader, a Windows PC test application from Impinj, you can quickly verify Reader operation by configuring various Reader parameters and running simple inventory operations. For details about how to access and [use MultiReader](#), see page 17.

# Chapter 3: Configuring and Monitoring Speedway Revolution

This chapter provides a high-level view of the configuration and monitoring options available for Speedway Revolution.

## Configuring Speedway Revolution

You can think of Speedway Revolution configuration in two categories: configuring the device itself and configuring the Reader's RF behavior. This chapter provides the basics for each type of configuration.

### Device Configuration

RShell is a proprietary command line management interface for configuring and managing network settings, firmware upgrades, and other device-oriented operations. This chapter introduces the RShell commands for installing and connecting the Reader. RShell Reference Manual provides full details and syntax for all RShell commands.

✓ **Note:** RShell is a machine interface and is almost always backward-compatible with previous Speedway Revolution versions. Existing inputs and outputs will never change. When adding new commands, new optional arguments will be added at the end.

### Using RShell to Configure Network Settings for Speedway Revolution

You can often get up and running with little or no configuration using the default configuration settings in Speedway Revolution. If you are not using DHCP to assign IP addresses, you will need to configure a few of the Reader's network settings.

The following procedure outlines the RShell commands you may need for connecting the Reader to your network.

#### To configure the Reader's network settings:

1. Open the [RShell console](#) (see page 12 for details).
2. View the Reader's current configuration settings by entering the `show network summary` command at the RShell command prompt:

```
> show network summary
Status='0,Success'
PrimaryInterface='eth0'
ActiveInterface='eth0'
Hostname='SpeedwayR-00-00-B9'
connectionStatus='Connected'
ipAddressMode='Dynamic'
ipAddress='10.0.10.41'
ipMask='255.255.0.0'
gatewayAddress='10.0.0.10'
broadcastAddress='10.0.255.255'
LLAstatus='enabled'
```

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 Reader to the network via the Speedway Revolution Ethernet port.

## RF Configuration

Configuring your Reader's RF behavior depends entirely on your implementation approach. You may be using a custom software application, middleware running on a server, or some other approach. MultiReader (see below) is an example of a PC client application.

Regardless of the application you're 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 Reader. LLRP controls the configuration of the antenna transmit power, the receive sensitivity, the operating Reader, and more. For details about LLRP, see one or more of 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 supported by Speedway Revolution. It also describes custom LLRP extensions added by Impinj.
- **Impinj LTK Programmer's Guide:** 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 illustrating the scenarios discussed in the Programmer's Guide.

## Using MultiReader to Configure and Test Speedway Revolution

Impinj provides a simple, easy-to-use LLRP application for configuring and testing the basic RF behavior of Speedway Revolution. The MultiReader application is available from the Impinj support Web site at [support.impinj.com](http://support.impinj.com). MultiReader version 6.6.4 supports features available with Octane 4.10.X firmware. To use MultiReader, your computer must be running Microsoft Windows XP.

✓ **Note:** MultiReader will install and operate on Windows7, but is not fully tested and supported. We recommend MultiReader for test purposes only. MultiReader is now available from "downloads" at [support.impinj.com](http://support.impinj.com).

This section covers connecting to and configuring a Reader's RF parameters using MultiReader. It also provides a high-level description of each parameter.

### To configure and test a Reader from within MultiReader:

1. Install and launch the MultiReader application. The following screen displays:

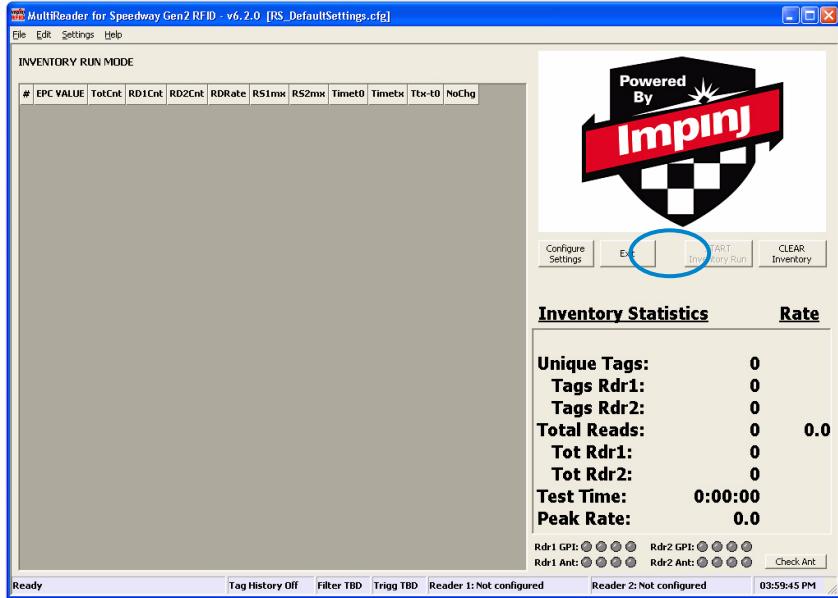


Figure 3.1 MultiReader initial screen

2. Select Configure Settings. The Reader Settings screen displays:

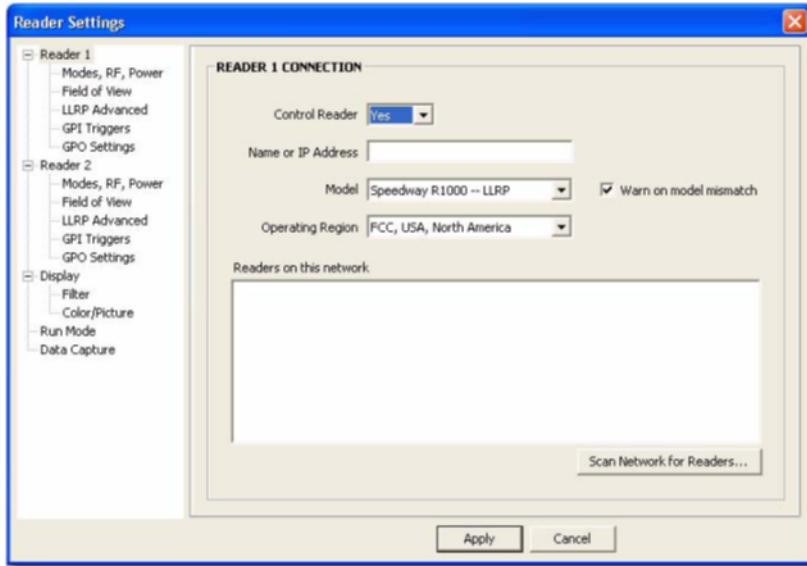
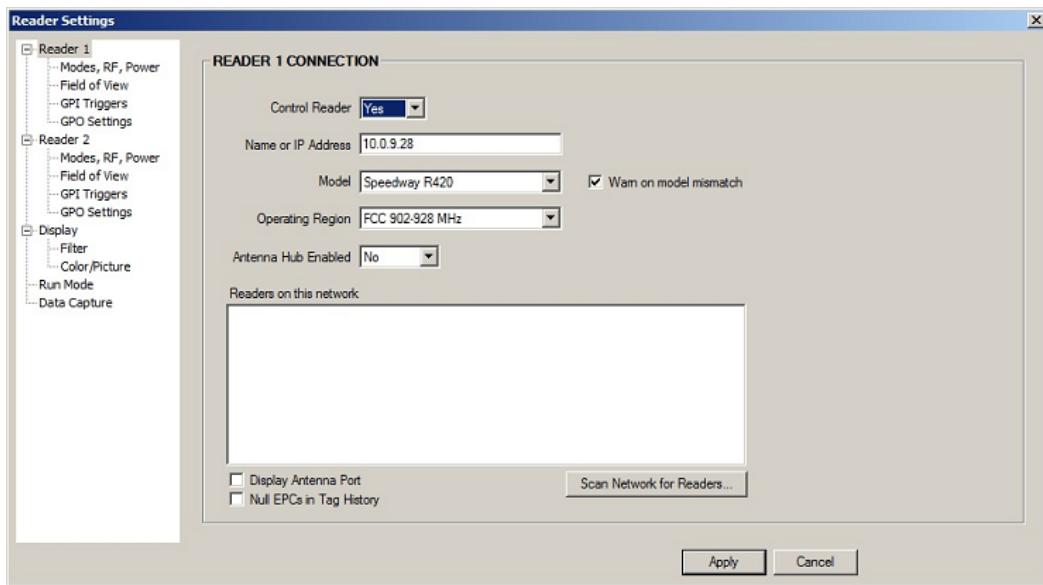


Figure 3.2 MultiReader Reader Settings Connection Screen

3. Connect to the Reader by typing the Reader's IP address or hostname in the **Name or IP Address** field.



You can determine the name and the IP address via the RShell show network summary command.

**Note:** The show network summary command provides the dynamic values returned by DHCP or LLA if the current configuration is dynamic. The local hostname resolution feature (mDNS) gives the reader a local hostname in addition to an IP address as its network identity. On an isolated network that lacks DNS service but has mDNS enabled, a Reader with hostname speedwayr-00-01-02, for example, may be reached using speedwayr-00-01-02.local.

4. In Model, select the appropriate Speedway Revolution model (either Speedway R220 or Speedway R420). If you want MultiReader to issue a warning if it detects a model other than what is configured, confirm Warn on the model mismatch checkbox is selected. (Model mismatch is selected by default.)
5. If the Antenna Hub feature is enabled on the Reader, be sure to set Antenna Hub Enabled to **Yes**.

**Note:** The Antenna Hub feature is only available on the Speedway Revolution R420. The show anthub summary command indicates if the Antenna Hub has been enabled on the Speedway Revolution. For MultiReader to work correctly, the feature status on the Speedway Revolution **must match**

6. Configure the key RF parameters described below:
7. Under Reader 1, on the left side of the Reader Settings dialog box, select Modes, RF, and Power. The following screen displays:

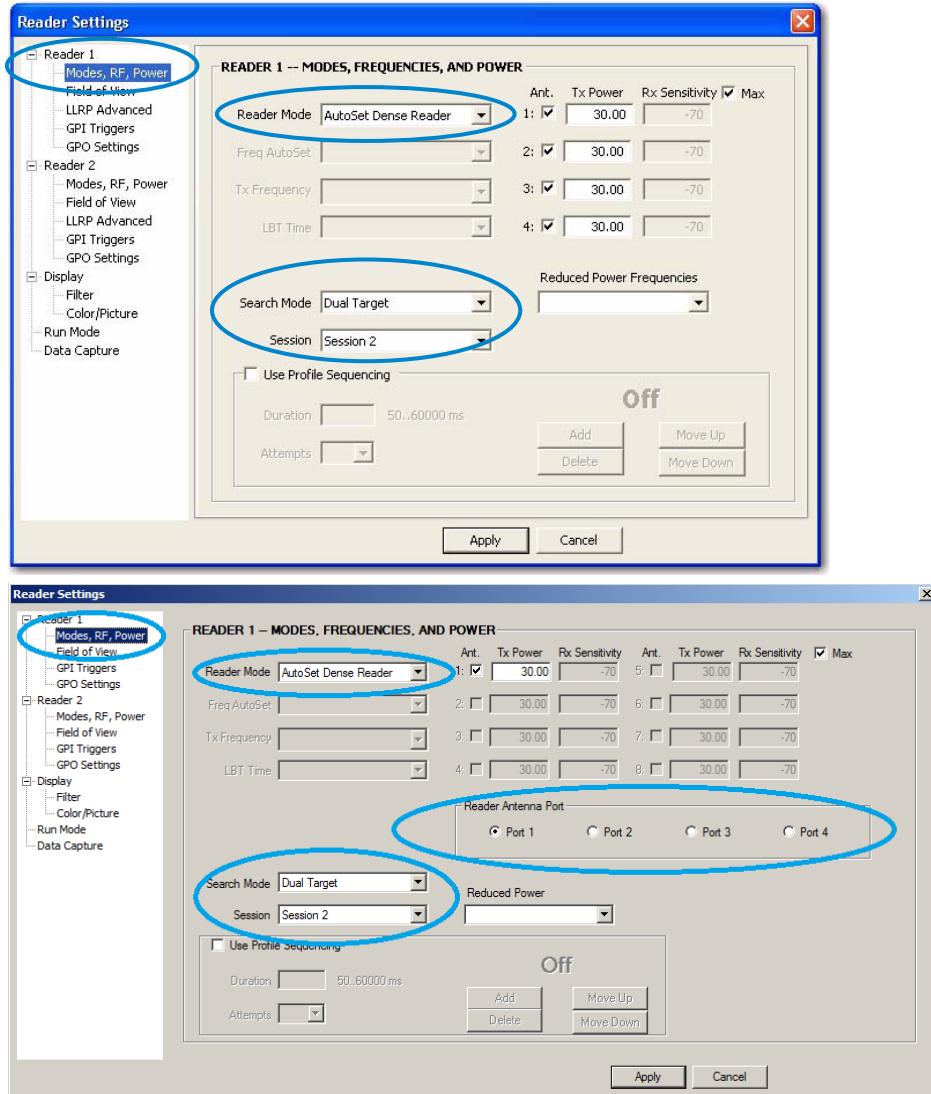


Figure 3.3 MultiReader Reader Settings Settings Screen

8. **In Reader Mode, select AutoSet Dense Reader.** The Reader Mode specifies the rules to use for communication between the Reader and tag. With AutoSet Dense enabled, the Reader automatically senses the environment and adjusts the mode accordingly.
9. **In Search Mode, select Dual Target.** In Session, select Session 1. Search Mode and Session work together to control when and how often the Reader reads a tag.

The high-level functional description for the Reader is: Each tag contains a flag that is flipped from A to B or from B to A when it is read. The Session value controls how long the flag retains its value before reverting back to the original tag value. Search Mode controls which flag values the Reader reads and, in some cases, what happens to the flag value once the tag is read.

With Dual Target, the Reader reads all the tags with A flags, after reading the tags the Reader flips each tag to B. When there are no more A tags to read, the Reader reads all the B tags, flipping each one to A after it has been read. It continues this

process back and forth from A to B and back to A. Session 1 ensures a persistence period that prevents tags from reverting before they have all been read.

10. The Reader Antenna Port allows you to specify which physical ANT port (2 ports on a R220, or 4 ports on a R420/R640) on the Speedway Revolution you are modifying. When the Antenna Hub feature is disabled, each ANT port represents one antenna. When the Antenna Hub feature is enabled, each ANT port will represent up to 8 distinct antennae. This depends on whether or not an Antenna Hub has been detected on that port. If no hub is detected, then the port represents a single antenna.
11. On the right of the screen is a checkbox for each of the Reader's antenna ports. By default, all antennas are enabled. Deselect the checkbox for any port without a connected antenna. Leaving all ports enabled does no harm, but increases processing time because the Reader reads all enabled ports. The Reader verifies the presence of an antenna before attempting to activate it.
12. Set the appropriate transmit power, **Tx Power**, and receive sensitivity, **Rx Sensitivity**, for each enabled antenna. See Figure 3.3

Transmit power controls the power of the signal leaving the antenna and the signal range. The optimal setting depends on many things:

- how you are powering the Reader
- cable length connecting the antenna to the Reader
- number of antennas in the area
- distance anticipated between the antenna and the tags

Use the default value of 30 dBm for testing purposes.

Receive sensitivity controls the tag signal threshold below which the Reader ignores the tag. This parameter mitigates stray reads. Stray tags often have a weaker signal than the tags to be read. The **Max** checkbox is selected by default, and tells the Reader to read all tags, regardless of the tag's signal strength. This is known as its Received Signal Strength Indicator—or RSSI.

When configuring a specific receive sensitivity, deselect the **Max** checkbox, and then type the value you want for each connected antenna. The maximum sensitivity is -80.

Remember, you are configuring the Reader to test your installation. Adjust these settings later when you begin using the Reader in a live RFID operation if desired.

13. Select **Apply**. MultiReader displays a progress bar as it connects to the Reader. When the connection completes, the following status displays at the bottom of the application:



Figure 3.4 MultiReader Status Display

14. Test your Reader installation. Place one or more tags in the read-zone of one or more of the attached antennas. Select **START Inventory**. Tag reads appear in the large gray area on the left:

INVENTORY RUN MODE											
#	EPC VALUE	TotCnt	RD1Cnt	RD2Cnt	RDRate	RS1mx	RS2mx	Timet0	Timetx	Ttx-t0	NoChg
1	3008-33B2-DDD9-06C0-0002-0017	355	355	0	16.2	-66	---	0.000	21.846	21.846	2
2	3008-33B2-DDD9-06C0-0002-0008	355	355	0	16.2	-41	---	0.000	21.846	21.846	2
3	3008-33B2-DDD9-06C0-0002-0004	355	355	0	16.2	-58	---	0.000	21.846	21.846	2
4	3008-33B2-DDD9-06C0-0002-0000	293	293	0	13.4	-67	---	0.000	21.846	21.846	1
5	3008-33B2-DDD9-06C0-0002-0005	112	112	0	5.5	-68	---	0.483	20.831	20.347	13

Figure 3.5 MultiReader Tag Inventory Display

In this case, the Reader detected five tags. Because the search mode is **Dual Target**, the Reader continuously reads the tags, first reading the A flags, and then reading the B flags. Notice in the image above that one of the tag entries is a pinkish color. The tag entry changes to red when a tag is not actively read. For example, if you change the Search Mode to **Single Target with Suppression**, the Reader reads each tag only once. All five entries would quickly turn red and stay red as shown below.

INVENTORY RUN MODE											
#	EPC VALUE	TotCnt	RD1Cnt	RD2Cnt	RDRate	RS1mx	RS2mx	Timet0	Timetx	Ttx-t0	NoChg
1	3008-33B2-DDD9-06C0-0002-0008	1	1	0	0.0	-44	---	0.000	0.000	0.000	323
2	3008-33B2-DDD9-06C0-0002-0004	1	1	0	0.0	-61	---	0.000	0.000	0.000	323
3	3008-33B2-DDD9-06C0-0002-0017	1	1	0	0.0	-67	---	0.000	0.000	0.000	323
4	3008-33B2-DDD9-06C0-0002-0000	1	1	0	0.0	-70	---	0.000	0.000	0.000	323
5	3008-33B2-DDD9-06C0-0002-0005	1	1	0	0.0	-70	---	0.197	0.197	0.000	322

Figure 3.6 MultiReader Tag Inventory Aging Display

If you see tag data appearing in MultiReader, your Reader is most likely installed correctly and the antennas are functioning properly. If you do not see all the tags you placed in the read-zone, try moving the tags to a slightly different location or orientation.

15. Select **STOP Inventory Run** to stop the tag inventory process.

## Monitoring Speedway Revolution

Use RShell to monitor the Reader health and performance when Speedway Revolution is up and running. This section presents the primary RShell commands for viewing the network and RFID statistics, plus the Reader logs. For details about these commands, see the RShell Reference Manual.

Speedway Revolution also supports industry standard SNMP, with MIB2 and EPCglobal Reader Management MIB. For more information, see the Octane SNMP Guide.

### Viewing Network Parameters and Statistics

Use the RShell `show network` command to display networking parameters and statistics. Using this command with the indicated parameters, you can view the following information:

Table 3.1: Show network Command Parameters

Parameter	Displayed Information
-----------	-----------------------

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
Parameter	Displayed Information
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*.

## Viewing RFID Parameters and Statistics

Use the RShell `show rfid stat` command to display a Reader's RFID parameters and statistics. Using this command with the appropriate parameter, you can view information shown in the Parameter and display table below.

**Table 3.2: Partial listing of show rfid stat parameters**

Parameter	Displayed Information
ReaderOperationalStatus	Indicates whether RFID applications are running on the Reader
Antenna<n>OperationalStatus	Indicates if an antenna is physically connected to the Reader and operating properly. Note that <n> indicates the antenna port on the Reader (1-4).
Antenna<n>EnergizedTime	Indicates the time that antenna<n> has been powered, in milliseconds.
Antenna<n>UniqueInventory-Count	Indicates the number of unique tags seen at antenna<n>
Antenna<n>TotalInventory-Count	Indicates the total inventory count for antenna<n>
Antenna<n>ReadCount	Indicates the number of tags read at antenna<n> that matched the configured filters.
Antenna<n>FailedReadCount	Indicates the number of tags where a read was attempted at antenna<n> because the tag matched the configured filter, but the read failed.

Table 3.2 shows a sample of the available RFID statistics. For the full list as well as syntax details, see the *RShell Reference Manual*.

✓ **Note:** View Statistics on the LLRP interface between the Reader and a client by entering the `show rfid llrp stat` command. The *RShell Reference Manual* provides details.

## Configuring and Viewing Speedway Revolution Logs

Speedway Revolution uses the standard Syslog protocol to forward its logged events to a remote Syslog server. The Reader stores the logged events in its file system, accumulating and retaining this information across reboots. Logs are classified into three categories: Management, RFID, and 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 Reader 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 Reader always retains logs of **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. 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.

## Viewing the State of the Speedway Revolution Device

To display information about the current state of the Reader itself, use the RShell show system command. Using this command allows viewing the following statistics:

- A summary of system information—`show system summary`
- Platform memory usage and available application space—`show system cpu`
- Generic platform statistics—`show system platform`

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

# Chapter 4: Upgrading the Speedway Revolution Firmware

Speedway Revolution contains firmware known as Octane. The current version of Octane is 4.10. This chapter details manually upgrading a single Reader.

In addition to supporting upgrade procedures, Speedway Revolution 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 chapter, while returning to [factory defaults](#) is explained in Chapter 5 on page 30.

## A Brief Overview of the Speedway Revolution Firmware

To minimize downtime and maximize the robust handling of possible upgrade failures, Speedway Revolution contains dual images of its firmware. When requesting a firmware image upgrade, the Reader continues to operate using the primary image. In the background, Speedway Revolution upgrades the secondary image. When the upgrade completes, the Reader reboots to the newly upgraded image. Speedway Revolution 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 *Embedded Developer's Guide*.

The three partitions in firmware are:

1. **System Operating Partition (SOP)**—The SOP is the primary system partition of the Speedway Revolution Reader. 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.
2. **System Persistent Partition (SPP)**—Files in this partition are automatically generated and maintained by the software running on the Reader. It contains the Reader configuration (network settings, LLRP configuration, log settings, and so on), Reader logs, and debug information used by Impinj engineers.
3. **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.

## Upgrading the Firmware

Speedway Revolution provides three methods for upgrading:

1. Using RShell, command line interface.
2. Copying the firmware to a USB memory drive and plugging into the Reader's host port.
3. Via the web interface.

## Upgrading the Firmware using RShell:

1. Obtain the firmware upgrade file from the Impinj support Web site, [support.impinj.com](http://support.impinj.com). The upgrade file extension is **.upg**. (Example: *octane\_4\_10\_0.upg*).
2. Place the upgrade file on a server (http, tftp, or ftp) accessible by the Reader you are upgrading.
3. Using the Putty application, connect the Reader using telnet, SSH or serial and 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/reader/image/
octane_4_10_0.upg
> config image upgrade ftp://anonymous:abc@myserver/
ftpdirecotry/octane_4_10_0.upg.upg
> tftp://server/octane_4_10_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 may see are:

```
WaitingForImageFileTransfer
WaitingForCommitImage
WaitingToActivateImmediate
```

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

The LastOperation parameter should be WaitingToActivateImmediate and the LastOperationStatus should be WaitingForManualReboot.

7. Reboot the Reader by issuing the following command:

```
> reboot
```

Speedway Revolution reboot process displays messages in the RShell console as it goes through each stage of the process. The reboot completes then the Reader login prompt displays on the console. The Reader status light displays solid green. [LED Reader reboot behavior](#) details are provided on page 8.

## Upgrading the Firmware with a USB Drive

Speedway Revolution running Octane 4.4 and later supports upgrading the firmware using a USB drive.

First, obtain the firmware upgrade file from the Impinj support Web site, [support.impinj.com](http://support.impinj.com). The upgrade file extension is **.upg**. (Example: *octane\_4\_8\_0.upg*).

## Preparing 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 Reader will use the most recently modified file.
4. Remove the USB drive from your computer.

## Using the USB Drive

1. Confirm that the Reader is ready for upgrade with both the Power and Status LEDs illuminated.
2. Insert the USB drive into the "USB Host" port on the Reader. Within 5-10 seconds, the Reader will begin upgrading the Reader and the Power LED will blink amber. If the Power LED remains solid green, the Reader 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.
5. Remove the USB drive from the "USB Host" port and reboot the Reader.

During the upgrade process, the Reader 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 Readers.

If the firmware upgrade process fails the Power LED will blink red. Remove the USB drive reboot the Reader and check the "status.log" file for the reason of the failure.

## Upgrading the Firmware through the Impinj Management Web UI

1. Connect to the Reader using a web browser `http://<reader name or IP address>`.  
Examples: `http://speedwayr-10-00-DD` or `http://10.0.10.44`.
2. Log in to the Reader;  
user name: `root`  
password: `impinj`
3. Click the **Browse** button and then select the firmware upgrade **.upg** file.
4. Click the **Upgrade** button.
5. After the upgrade is complete, click the reset button.

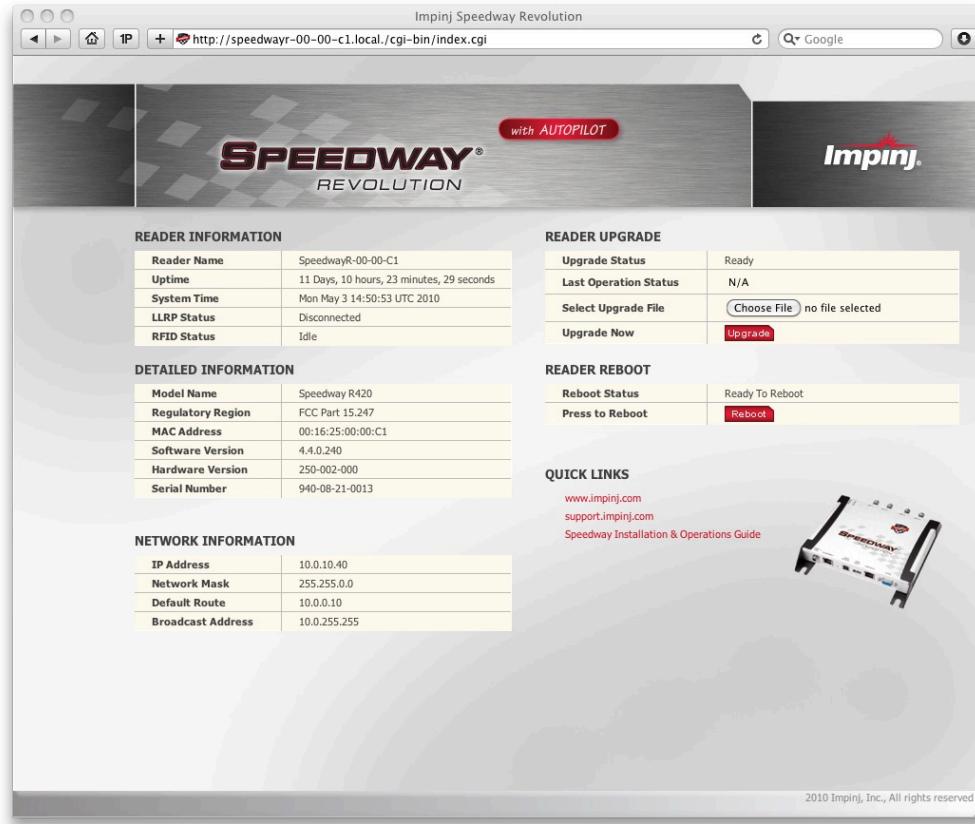


Figure 4.1 Speedway Revolution Management Web Page

READER UPGRADE	
<b>Upgrade Status</b>	Ready
<b>Last Operation Status</b>	N/A
<b>Select Upgrade File</b>	<input type="button" value="Choose File"/> no file selected
<b>Upgrade Now</b>	<input type="button" value="Upgrade"/>

READER REBOOT	
<b>Reboot Status</b>	Ready To Reboot
<b>Press to Reboot</b>	<input type="button" value="Reboot"/>

Figure 4.2 Close-up of Reader Upgrade and Reboot Section of Management Web Page

## To fall back to the previous 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 Reader automatically reboots and returns to the login prompt.

2. Log in to the Reader. 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'`.

# Chapter 5: Troubleshooting

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

## Returning to the Default Configuration

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

**! Important:** Configuration Default Restore returns the Reader configuration to its default state. It leaves any custom applications installed in the CAP intact. To restore the Reader to its default state **and** remove any CAP contents, use Factory Default Restore. See the **Warning** on page 31.

There are two ways to return Speedway Revolution to its defaults:

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

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

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

### To use the Default Restore button on the Reader 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 Reader while applying power to the Reader.
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 Reader will boot up normally with the default configuration.



Figure 5.1 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 Reader's custom application partition (CAP) if one exists. The Reader 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.

The following table lists the default configuration values:

**Table 5.1: 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	speedwayr-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
LLRP Outbound Service	Enabled
LLRP Outbound Servers	None
LLRP Outbound Retry Secs	5
LLRP Outbound Timeout Secs	2

## Submitting Diagnostic Data for Analysis by Impinj Technical Support

If Speedway Revolution is exhibiting RF behavior differing from what you expect and you are unable to determine the cause, you may want to submit relevant data for analysis by Impinj Technical Support. Using the Impinj MultiReader application, you can easily capture data relating to the problem scenario. By creating and providing a Reader Diagnostic Data file, Impinj's Technical Support team can troubleshoot your issue.

### To capture data to a Reader Diagnostic Data file:

1. Open [MultiReader](#) and connect to the appropriate Speedway Revolution reader. See page 16 for details.
2. Select **Configure Settings** to open the **Reader Settings** screen.
3. Verify that you are viewing the connection settings for Reader 1. If you are not, select **Reader 1** in the menu on the left.
4. In **Control Reader**, select **No**.

This setting value tells MultiReader that you do not want the MultiReader configuration controlling the Reader. Changing this value is important because you most likely want to capture data for a Reader operation that is being controlled by your application.

If, however, you want to capture an RF scenario that is controlled by MultiReader, set **Control Reader** to **Yes**.

5. In the menu on the left, select **Data Capture**. The following screen displays:

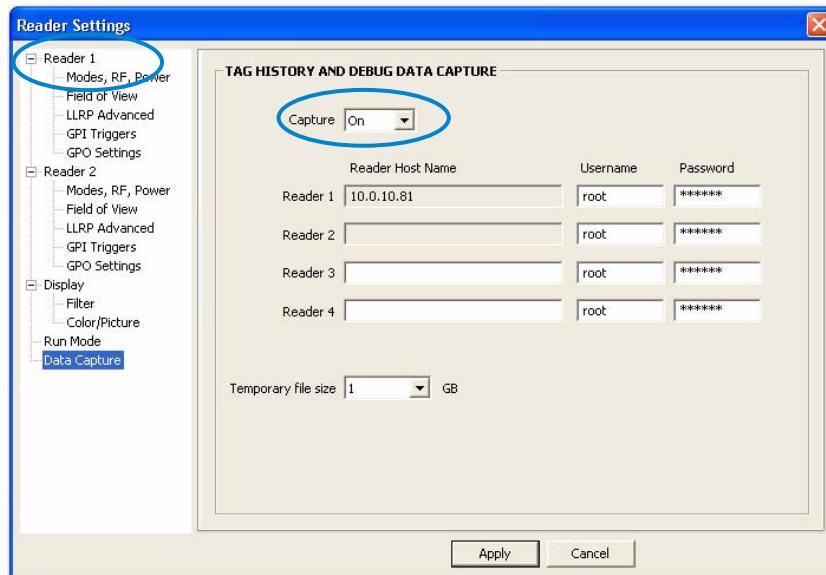


Figure 5.2 Reader Settings, Tag History & Debug Data Capture

Reader 1 is populated with the IP address. Login parameters are also populated. If these values are incorrect, change them here. You can capture data for up to four Readers simultaneously. In this example, we are capturing data one Reader.

6. Confirm that **Capture** is set to **On**.
7. Select **Apply**.

MultiReader connects to the Reader and begins "listening" for any RF activity. The Reader captures data surrounding any RF activity it detects.

8. Perform the RF activity to submit for analysis.
9. Select **File** in the upper left corner of the application.  
This completes the capture activity.
10. Select **Save Debug Data....** A browse window opens.
11. Enter a file name and save the file in the desired location.
12. Send the *.rdd* file containing binary data to Impinj Technical Support.  
Visit the Impinj support Web site, [support.impinj.com](http://support.impinj.com), for submission details or talk with your Impinj representative.

✓ **Note:** Another option is to create a network trace using Wireshark, a free protocol analyzer download from the Internet.

# Appendix A: Information Specific to Regions of Operation

Speedway Revolution is designed to work in various regulatory regions. This appendix contains frequency ranges and antenna requirements specific to each supported region.

## Operation in North America

### Frequency Plan

The FCC specifies frequency hopping across the North American spectrum allocated to UHF RFID (902-928 MHz, with hopping occurring between 902.75-927.25 MHz in 500 kHz steps). The frequency plan is further explained in the table below:

**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

## Antenna Requirements

### Positioning

Position the antenna's surface at least 25 centimeters away from personnel working in the area. This is an FCC positioning requirement. 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*

### Installation

Speedway Revolution is capable of up to +32.5 dBm conducted power on the housing RF connector and requires professional installation.

### Power

Speedway Revolution may only be operated with Impinj-approved antennas and can radiate no more than 36 dBm EIRP per FCC Part 15.247 regulations. The Speedway Revolution output power may be increased to provide the maximum allowable EIRP subject to a

maximum conducted power allowance of 30 dBm at the antenna connector. The maximum allowable output power of the Reader can be set to satisfy both the conductor and radiated maximum criteria. The expression for the maximum Reader power setting is:

Maximum power setting (in dBm) = the Smaller of:

(36 – Composite Antenna Gain (in dBm)) OR (30 + Cable Loss (in dBm))

where the composite antenna gain comprises the maximum linear antenna gain in dBi minus any cable loss between the Reader and antenna in dB. Approved antenna vendors, model numbers, and associated gain are listed in the next section.

**✓ Note:** The composite antenna gain comprises the maximum linear antenna gain in dBi minus any cable loss between the Reader and antenna in dB. Approved antenna vendors, model numbers, and associated gain are listed in the next section.

### Approved Antennas

- Laird Technologies model number S9028PCL/R (left- or right-hand CP), with integrated 8 foot pigtail to RP-TNC male connector; 6 dBi composite gain
- Impinj model number IPJ-A0301-USA (Mini-Guardrail) with SMA female connector; -15 dBi gain
- Impinj model number IPJ-A0310-USA Threshold Antennas (IPJ-A0311-USA and IPJ-A0311-EU1) with 12 inch integrated pigtail to BNC male connector, 6 dBi composite gain.
- Impinj model number IPJ-A0400-USA, CSL CS-777-2 (Brickyard) with 7 foot integrated pigtail to RP-TNC male connector; 2 dBi composite gain
- Impinj model number IPJ-A0401-USA or IPJ-A0402-USA (both Guardwall) with 6 foot integrated pigtail to RP-TNC male connector; 6 dBi composite gain
- Impinj model number IPJ-A0404-000, Matchbox antenna with 20cm integrated pigtail to SMA connector; -20 dBi composite gain.
- MA/COM MAAN-000246-FL1 integrated RFID floor-mounted stand (multiple configurations available, 2 or 4 antennas left-hand and right-hand CP) with 8 foot integrated pigtail to RP-TNC male connector; 6 dBi composite gain
- MA/COM MAAN-000246-WL1 integrated RFID wall-mounted stand (multiple configurations available, 2 antennas left-hand and right-hand CP) with 8 foot integrated pigtail to RP-TNC male connector; 6 dBi composite gain
- MTI MT-262006/TLH (left-hand CP) or MT-262006/TRH (right-hand CP) with RPTNC female connector (antennas available in IP54 or IP67 ratings); 6 dBi gain
- MTI MT-262013/NLH (left-hand CP) or MT-262013/NRH (right-hand CP) with Ntype female connector (antennas available in IP54 or IP67 ratings); 4.5 dBi gain
- MTI MT-262013/TLH (left-hand CP) or MT-262013/TRH (right-hand CP) with RPTNC female connector (antennas available in IP54 or IP67 ratings); 4.5 dBi gain
- Sensormatic Electronics Corp. model number IDANT20TNA25 with 25 foot Belden 7806A RG-58 coaxial cable (0.1 dB per foot loss) to RP-TNC male connector; 5.5 dBi composite gain
- Sensormatic Electronics Corp. model number IDANT10CNA25 with 25 foot Belden 7806A coaxial cable (0.1 dB per foot loss) to RP-TNC male connector; 3.5 dBi composite gain
- Sensormatic Electronics Corp. model number IDANT10CNA25 with 6 foot Belden 7806A coaxial cable (0.1 dB per foot loss) to RP-TNC male connector; 5.4 dBi composite gain

**⚠ Warning:** The use of any antenna not listed above may damage the Reader or adversely affect performance.

## Operation in European Union

### Frequency Plan

For European operation, the Speedway Revolution Readers support the frequency plan listed in Table A.2 and are compliant with the ratified ETSI EN 302 208 specification v.1.2.1. This specification states that no listen-before-talk is performed, the maximum continuous transmit time on a channel is four seconds, and the Reader enforces the 100 ms 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

### Antenna Requirements

#### Power

European regulations allow a maximum radiated power of 33 dBm ERP (Effective Radiated Power) for high power RFID systems. The maximum Speedway Revolution output power is determined by the following equation:

$$\text{Maximum power setting (in dBm)} = 33 - \text{Antenna Gain (in dBd)} + \text{Cable loss (in dB)}$$

For example, for an application with an antenna gain of 6 dBd and cable loss of 2 dB, the Reader output power can be set no higher than  $33-6+2 = 29$  dBm. The maximum transmit power of Speedway Revolution is 31.5dBm measured at the RF antenna port.

**✓ Note:** It is important to apply the antenna gain expressed in dBd (dB with respect to a dipole), which is equivalent to the isotropic antenna gain (in dBi) minus 2.15 dB. Additionally, the antenna gain used to set the output power must be the maximum linear gain of the applicable antenna. Approved antenna vendors, model numbers, and associated gain are listed in the next section.

#### Approved Antennas

- Laird Technologies Model Number S8658PCL/R (left- or right-hand CP) with integrated pigtail to RP-TNC male connector; 3.85 dBd gain
- Impinj Model Number IPJ-A0400-EU1, CSL CS-777-1 (Brickyard) with 7 foot integrated pigtail to RP-TNC male connector; 0 dBd composite gain
- MTI MT-242032/NLH (left-hand CP) or MT-242032/NRH (right-hand CP) with Ntype female connector (antennas available in IP54 or IP67 ratings); 1.85 dBd gain

- Sensormatic Electronics Corp. Model number IDANT10CEU25 (left-hand CP only) with 6 foot Belden 7806A coaxial cable (0.1 dB per foot loss) to RP-TNC male connector; 3.25 dBd composite gain



**Warning:** The use of any antenna not listed above may damage the Reader or adversely affect performance.

## Operation in Other Global Regions

For operation and use in the Rest of the World (ROW), there are two models, GX1 or GX2. Please [contact Impinj](#) to learn which countries and regions are currently certified.

### Installation

Because Speedway Revolution is capable of up to +32.5 dBm conducted power on the housing RF connector, **professional installation is required**.

### Operation in China, Israel, Indonesia, Malaysia, Singapore, and Vietnam

Regulations in these countries allow a maximum radiated power of 33 dBm ERP (Effective Radiated Power) for high power RFID systems. The maximum Speedway Revolution output power is determined by the following equation:

$$\text{Maximum power setting (in dBm)} = 33 - \text{Antenna Gain (in dBd)} + \text{Cable loss (in dB)}$$

For example, for an application with an antenna gain of 6 dBd and cable loss of 2 dB, the Reader output power can be set no higher than  $33 - 6 + 2 = 29$  dBm. The maximum transmit power of Speedway Revolution is 32.5dBm measured at the RF antenna port.

**Note:** It is important to apply the antenna gain expressed in dBd (dB with respect to a dipole), which is equivalent to the isotropic antenna gain (in dBi) minus 2.15 dB. The antenna gain used to set the output power must be the maximum linear gain of the applicable antenna. Approved antenna vendors, model numbers, and associated gain are listed in the following section.

### Operation in Australia, Brazil, Hong Kong, New Zealand, Taiwan, Thailand, Uruguay, and Latin America

Regulations in Australia, Brazil, Hong Kong, New Zealand, Taiwan, Thailand, Uruguay, and Latin America allow maximum radiated power of 36 dBm EIRP. The Speedway Revolution output power may be increased to provide the maximum allowable EIRP subject to a maximum conducted power allowance as well. The maximum conducted power at the antenna connector can be no more than 30 dBm. The maximum allowable output power of the Reader can be set to satisfy both the conductor and radiated maximum criteria. The expression for the maximum Reader power setting is:

$$\text{Maximum power setting (in dBm)} = \text{the Smaller of:}$$

$$(36 - \text{Composite Antenna Gain (in dBm)}) \quad \text{OR} \quad (30 + \text{Cable Loss (in dBm)}),$$

where the composite antenna gain comprises the maximum linear antenna gain in dBi minus any cable loss between the Reader and antenna in dB. Approved antenna vendors, model numbers, and associated gain are listed in the next section.

## Approved Antennas

Consult with your registered reseller or Impinj provider for guidance on antenna selection for your region

- Laird Technologies model number S9028PCL/R (left- or right-hand CP), with integrated 8 foot pigtail to RP-TNC male connector; 6 dBi composite gain
- Impinj model number IPJ-A0301-USA (Mini-Guardrail) with SMA female connector; -15 dBi gain
- Impinj model number IPJ-A0310-USA (Threshold-T Antenna) with 12 inch integrated pigtail to BNC male connector, 6 dBi composite gain.
- Impinj model number IPJ-A0400-USA, CSL CS-777-2 (Brickyard) with 7 foot integrated pigtail to RP-TNC male connector; 2 dBi composite gain
- Impinj model number IPJ-A0401-USA or IPJ-A0402-USA (both Guardwall) with 6 foot integrated pigtail to RP-TNC male connector; 6 dBi composite gain
- Impinj model number IPJ-A0404-000, Matchbox antenna with 20cm integrated pigtail to SMA connector; -20 dBi composite gain.
- MA/COM MAAN-000246-FL1 integrated RFID floor-mounted stand (multiple configurations available, 2 or 4 antennas left-hand and right-hand CP) with 8 foot integrated pigtail to RP-TNC male connector; 6 dBi composite gain
- MA/COM MAAN-000246-WL1 integrated RFID wall-mounted stand (multiple configurations available, 2 antennas left-hand and right-hand CP) with 8 foot integrated pigtail to RP-TNC male connector; 6 dBi composite gain
- MTI MT-262006/TLH (left-hand CP) or MT-262006/TRH (right-hand CP) with RP-TNC female connector (antennas available in IP54 or IP67 ratings); 6 dBi gain
- MTI MT-262013/NLH (left-hand CP) or MT-262013/NRH (right-hand CP) with N-type female connector (antennas available in IP54 or IP67 ratings); 4.5 dBi gain
- MTI MT-262013/TLH (left-hand CP) or MT-262013/TRH (right-hand CP) with RP-TNC female connector (antennas available in IP54 or IP67 ratings); 4.5 dBi gain
- Sensormatic Electronics Corp. model number IDANT20TNA25 with 25 foot Belden 7806A RG-58 coaxial cable (0.1 dB per foot loss) to RP-TNC male connector; 5.5 dBi composite gain
- Sensormatic Electronics Corp. model number IDANT10CNA25 with 25 foot Belden 7806A coaxial cable (0.1 dB per foot loss) to RP-TNC male connector; 3.5 dBi composite gain
- Sensormatic Electronics Corp. model number IDANT10CNA25 with 6 foot Belden 7806A coaxial cable (0.1 dB per foot loss) to RP-TNC male connector; 5.4 dBi composite gain

 **Warning:** The use of any antenna not listed above may damage the Reader or adversely affect performance.

## Frequency Plans

The GX1 Reader operates over a subset of the FCC North American spectrum (902–928 MHz, with specific frequency and channel usage dictated by regulations of each country. Frequency hopping spread spectrum (FHSS) is used, with the exception of Israeli where only a single channel is available. The specific frequency plans by country are listed in the tables that follow.

**Table A.3 Australia operating frequency band is 920 to 926 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	36	920.25 MHz
2	37	920.75 MHz
3	38	921.25 MHz
4	39	921.75 MHz
5	40	922.25 MHz
6	41	922.75 MHz
7	42	923.25 MHz
8	43	923.75 MHz
9	44	924.25 MHz
10	45	924.75 MHz
11	46	925.25 MHz
12	47	925.75 MHz

**Table A.4 Brazil operating frequency band is 902-907.5 and 915-928 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	1	902.750
2	2	903.250
3	3	903.750
4	4	904.250
5	5	904.750
6	6	905.250
7	7	905.750
8	8	906.250
9	9	906.750
10	10	907.250
11	26	915.250
12	27	915.750
13	28	916.250
14	29	916.750

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
15	30	917.250
16	31	917.750
17	32	918.250
18	33	918.750
19	34	919.250
20	35	919.750
21	36	920.250
22	37	920.750
23	38	921.250
24	39	921.750
25	40	922.250
26	41	922.750
27	42	923.250
28	43	923.750
29	44	924.250
30	45	924.750
31	46	925.250
32	47	925.750
33	48	926.250
34	49	926.750
35	50	927.250

**Table A.5 Hong Kong operating frequency band is 920 to 925 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	36	920.25 MHz
2	37	920.75 MHz
3	38	921.25 MHz
4	39	921.75 MHz
5	40	922.25 MHz
6	41	922.75 MHz
7	42	923.25 MHz

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
8	43	923.75 MHz
9	44	924.25 MHz
10	45	924.75 MHz

**Table A.6 Indonesia operating frequency band is 923 to 925 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	42	923.25 MHz
2	43	923.75 MHz
3	44	924.25 MHz
4	45	924.75 MHz

**Table A.7 Israel operating frequency band is 915 to 917 MHz with 500 kHz channel spacing with a single channel**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	28	916.25 MHz

**Table A.8 Malaysia operating frequency band is 919 to 923 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	34	919.25 MHz
2	35	919.75 MHz
3	36	920.25 MHz
4	37	920.75 MHz
5	38	921.25 MHz
6	39	921.75 MHz
7	40	922.25 MHz
8	41	922.75 MHz

**Table A.9 New Zealand operating frequency band is 921.5 to 928 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	40	922.25 MHz
2	41	922.75 MHz
3	42	923.25 MHz
4	43	923.75 MHz
5	44	924.25 MHz
6	45	924.75 MHz
7	46	925.25 MHz
8	47	925.75 MHz
9	48	926.25 MHz
10	49	926.75 MHz
11	50	927.25 MHz

**Table A.10 Philippines operating frequency band is 918 to 920 MHz with 500 kHz channel spacing.**

LLRP Channel Number	Center Frequency (MHz)
1	918.25 MHz
2	918.75 MHz
3	919.25 MHz
4	919.75 MHz

**Table A.11 Singapore operating frequency band is 920 to 925 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	36	920.25 MHz
2	37	920.75 MHz
3	38	921.25 MHz
4	39	921.75 MHz
5	40	922.25 MHz
6	41	922.75 MHz
7	42	923.25 MHz

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
8	43	923.75 MHz
9	44	924.25 MHz
10	45	924.75 MHz

**Table A.12 Taiwan operating frequency band is 922 to 928 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	40	922.25 MHz
2	41	922.75 MHz
3	42	923.25 MHz
4	43	923.75 MHz
5	44	924.25 MHz
6	45	924.75 MHz
7	46	925.25 MHz
8	47	925.75 MHz
9	48	926.25 MHz
10	49	926.75 MHz
11	50	927.25 MHz
12	-	927.75 MHz

**Table A.13 Thailand operating frequency band is 920 to 925 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	36	920.25 MHz
2	37	920.75 MHz
3	38	921.25 MHz
4	39	921.75 MHz
5	40	922.25 MHz
6	41	922.75 MHz
7	42	923.25 MHz
8	43	923.75 MHz
9	44	924.25 MHz

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
10	45	924.75 MHz

**Table A.14 Uruguay operating frequency band is 916 to 928 MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	28	916.25 MHz
2	29	916.75 MHz
3	30	917.25 MHz
4	31	917.75 MHz
5	32	918.25 MHz
6	33	918.75 MHz
7	34	919.25 MHz
8	35	919.75 MHz
9	36	920.25 MHz
10	37	920.75 MHz
11	38	921.25 MHz
12	39	921.75 MHz
13	40	922.25 MHz
14	41	922.75 MHz
15	42	923.25 MHz
16	43	923.75 MHz
17	44	924.25 MHz
18	45	924.75 MHz
19	46	925.25 MHz
20	47	925.75 MHz
21	48	926.25 MHz
22	49	926.75 MHz
23	50	927.25 MHz

**A.15 Vietnam operating frequency band is 920 to 925MHz with 500 kHz channel spacing.**

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	36	920.25 MHz
2	37	920.75 MHz
3	38	921.25 MHz
4	39	921.75 MHz
5	40	922.25 MHz
6	41	922.75 MHz
7	42	923.25 MHz
8	43	923.75 MHz
9	44	924.25 MHz
10	45	924.75 MHz

**Table A.16: Frequency Plan for Latin America**

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

The GX2 Reader supports China, Korea, and Republic of South Africa region. The specific frequency plans by country are listed in the tables that follow.

**Table A.17 China operating frequency band is 920.5 to 924.5MHz with 250kHz channel spacing.**

Frequency plan is compliant to the State Radio Regulatory Commission (SRRC) of China.

LLRP Channel Number	Center Frequency (MHz)
1	920.625 MHz
2	920.875 MHz
3	921.125 MHz
4	921.375 MHz
5	921.625 MHz
6	921.875 MHz
7	922.125 MHz
8	922.375 MHz
9	922.625 MHz
10	922.875 MHz
11	923.125 MHz
12	923.375 MHz
13	923.625 MHz
14	923.875 MHz
15	924.125 MHz
16	924.375 MHz

**Table A.18 Korea operating frequency band is 917 to 920.8MHz with 200kHz channel bandwidth.**

LLRP Channel Number	Center Frequency (MHz)
1	917.3 MHz
2	917.9 MHz
3	918.5 MHz
4	919.1 MHz
5	919.7 MHz
6	920.3 MHz

**Table A.19 Republic of South Africa operating frequency band is 915.4 to 919MHz with 200kHz channel bandwidth.**

LLRP Channel Number	Center Frequency (MHz)
1	915.6 MHz
2	915.8 MHz
3	916.0 MHz
4	916.2 MHz
5	916.4 MHz
6	916.6 MHz
7	916.8 MHz
8	917.0 MHz
9	917.2 MHz
10	917.4 MHz
11	917.6 MHz
12	917.8 MHz
13	918.0 MHz
14	918.2 MHz
15	918.4 MHz
16	918.6 MHz
17	918.8 MHz

## Operation in Japan

### Frequency Plan

Speedway Revolution 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.20: Frequency Plan for Japan**

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

## **Power**

Speedway Revolution may only be operated with Impinj-approved antennas and can radiate no more than 36 dBm EIRP per the Japan RFID regulations. The Speedway Revolution output power is limited per the Japan RFID regulations to 30dBm.

## **Approved Antennas**

Contact your value-added distributor that you obtained your Speedway Revolution Reader for current list of approved antennas for use in Japan.

## Appendix B: GPIO Details

Speedway Revolution includes a multipurpose I/O port that contains an RS-232 serial port, four opto-isolated inputs, four opto-isolated outputs, and a +5V supply. You access these features through a DE15 connector mounted on the side of the Reader.

The four opto-isolated inputs have a range of 0–30V. The Reader treats an input of 0–0.8V as a logic 0, and an input of 3–30V as a logic 1. The Reader has a per-input debounce interval that is configurable via LLRP. (See the document titled Octane LLRP for more information). This value dictates the minimum pulse width of an input. Impinj recommends that external devices guarantee a minimum pulse width of at least 100 milliseconds.

The Reader also provides four opto-isolated outputs. For the GPIO outputs to function, an external user supply must be connected between V+, and V-. The maximum voltage for this supply is 30V. When the user configures a selected GPIO output via LLRP to output logic 0, an isolated FET switch within the Reader effectively shorts that output to V- with a current sink capability of up to 200mA. When the user configures a selected GPIO output to logic 1, the selected output is pulled to V+ through a 10K resistor. If GPIO isolation is not required, the Reader provides a +5V supply and a ground pin on the DE-15 that can be connected to V+ and V-.

Figure B.1 shows the detailed function of each pin of the GPIO DE-15 connector.

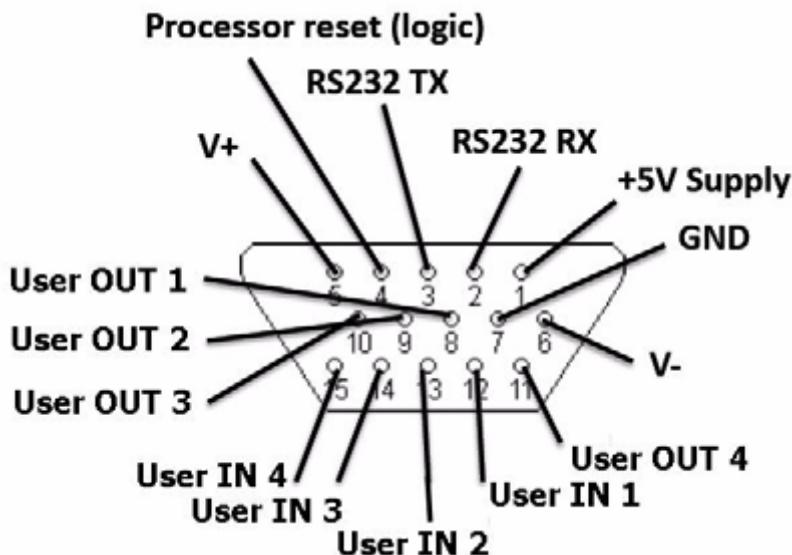


Figure B.1 DE-15 GPIO Port Functions

✓ **Note:** As described above, both the input and output pins are opto-isolated.

A GPIO box accessory (IPJ-A5000-000) is available from your authorized reseller or systems integrator. Additional information on this product is available at [www.impinj.com](http://www.impinj.com).

 **Warning:** Do not attach a lightstack or other output device that requires a Revolution output to sink more than 200mA. Attaching non-approved devices will result in unrecoverable damage to the Reader and is not covered by warranty as it is outside the specified operating parameters.

Tables B.1 and B.2 explain the function of each pin.

**Table B1: DB-15 Connector Pin-Out**

Pin	I/O Name	I/O Function
1	+5V Supply	Reader supplied (not isolated) power source
2	RS-232 RX	For auxiliary serial port functions
3	RS-232	TX For auxiliary serial port functions
4	Processor Reset	Reserved for future use. . Do not connect this pin to any signal
5	V+	Power source for isolated outputs
6	V-	Return for isolated inputs and outputs
7	Ground	Reader (not isolated) return
8	User OUT 1	Isolated output 1 (active pull down to V-)
9	User OUT 2	Isolated output 1 (active pull down to V-)
10	User OUT 3	Isolated output 3 (active pull down to V-)
11	User OUT 4	Isolated output 4 (active pull down to V-)
12	User IN 1	Isolated input 1
14	User IN 3	Isolated input 3
15	User IN 4	Isolated input 4

**Table B.2: GPIO Interface Electrical Specification**

Pin	Parameter	Description	Min	Max	Unit	Conditions
+5V Supply	IO	Output current		200	mA	
User IN 1-4	VIH	HIGH level input voltage	3	30	V	
User IN 1-4	VIL	LOW level input voltage	0	0.8	V	
User IN 1-4	VLI	Input current		5	mA	24V input
User IN 1-4	VI	Input voltage range	0	30	V	No damage
User Out 1-4	VOH	Output high voltage		V+*	V	10K pullup
User Out 1-4	VOL	Output low voltage		(V-) +0.5	V	100mA load
User Out 1-4	VI	Supply voltage range (V+ - V-)		30	V	

\*User-supplied voltage

## Appendix C: Speedway xPortal Installation

This section covers three unique aspects of using the xPortal product

1. RF Beam Pattern
2. Mounting the xPortal assembly
3. Attaching cables via Conduit

### RF Beam Pattern

The Speedway xPortal has antenna beams that point upwards and downwards. This increases the total area covered by the portal. The unit is intended to be mounted at waist height on the wall. The lower beam covers the tag populations near the floor, while the upper beam reads tags at the top of tall pallets. Tags located at waist height are likely to be read by both beams.

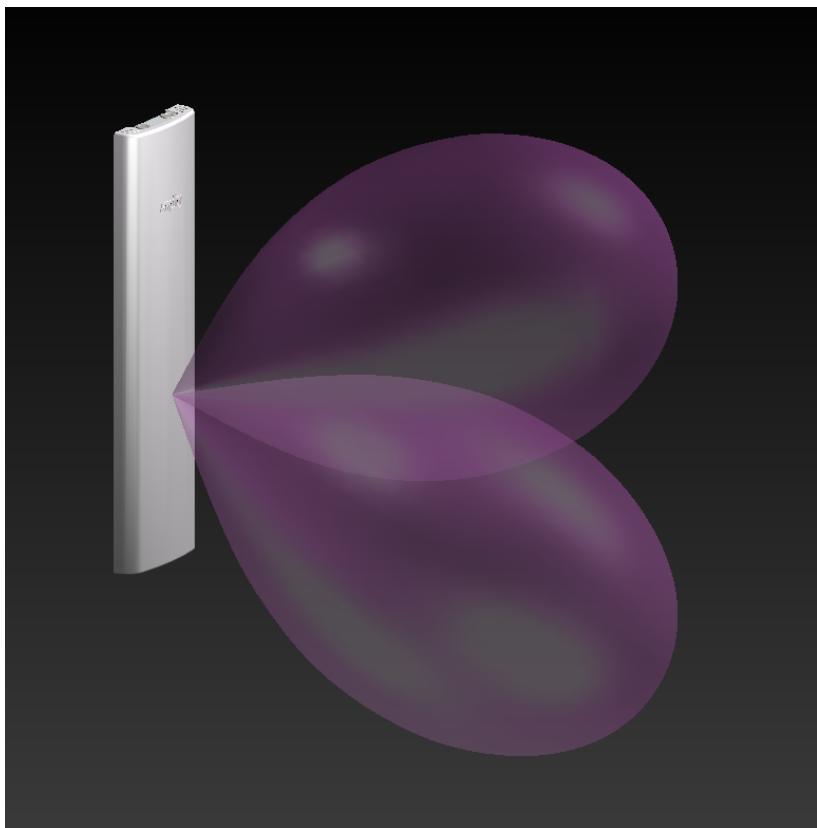


Figure C.1 xPortal Simulated RF Beam Patterns

### Mounting the xPortal

Referring to Figure C.3, the xPortal has many different mounting options:

1. Vesa mounts (<http://www.vesa.org/>) is a standard LCD screen / computer monitor mounting pattern. There are many off-the-shelf brackets, arms, and stands that use the hole pattern shown in the red square on the [Figure C.2](#).

- 8 total holes with M4 threads
  - Outer square pattern is 100mm on each side
  - Inner square pattern is 75 mm on each side
  - $\frac{1}{4}$  inch diameter bolt with 20 threads per inch ( $\frac{1}{4}$ -20) internally threaded studs
2. Common hardware using  $\frac{1}{4}$ -20 hardware. This hardware is typically employed in most T-slot extrusion designs (see <http://www.8020.net/>). Show in the Green circles on the figure.
  3. Keyhole slots and through-holes. Holes are sized to allow clearance for  $\frac{1}{4}$ -20 screws. These holes allow you to mount the unit flush to a wall. Shown in the Blue ovals on the figure.

It is your responsibility to determine if the chosen screws can support the weight of the xPortal. Since the xPortal weighs approximately 6.5 pounds (3kg), it can be installed on drywall without needing to locate studs.

The yellow circles on the figure highlight two knock-outs that can be removed if you wish to run cables into the unit directly from the wall. This provides a very clean installation, with no cables visible from the front.

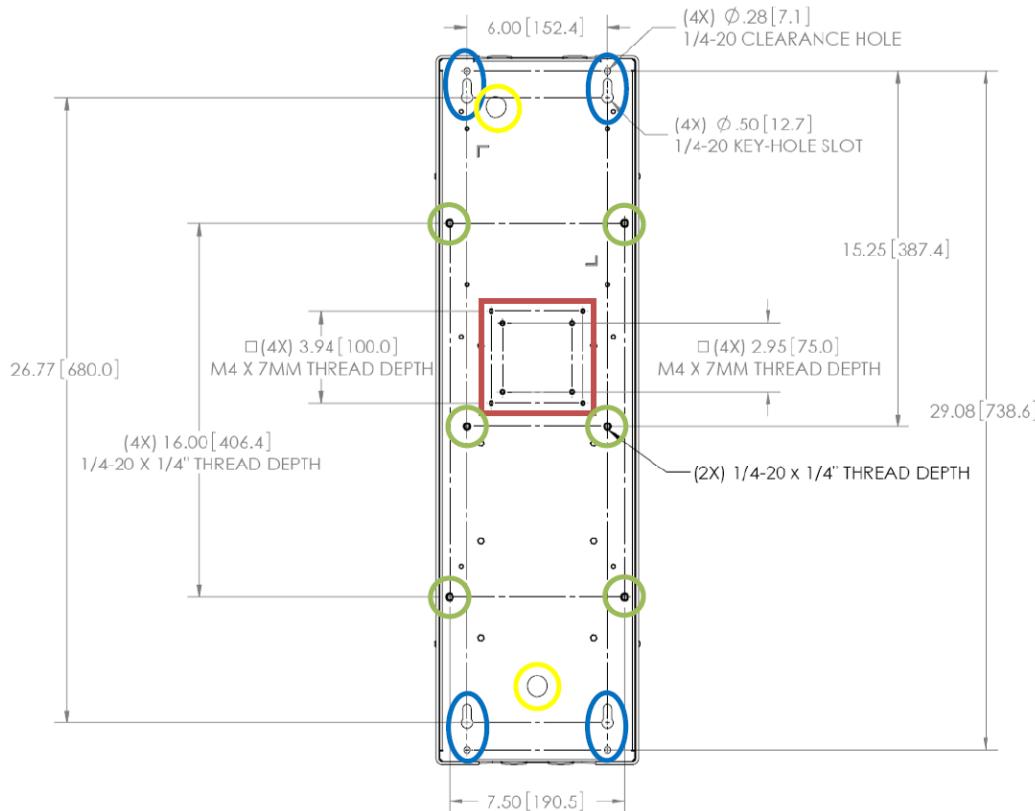


Figure C.2 xPortal Mounting Hole Types and Locations

## Conduit Attachment

The round openings in the top and bottom of xPortal are designed so you can run metallic conduit directly to the unit. This allows Ethernet or power cables to be protected by standard EMT (electrical metallic tubing). The holes are sized for  $\frac{1}{2}$  inch trade size conduit connectors, or where metric conduit is used, 16mm trade size. Larger sizes of conduit (such as  $\frac{3}{4}$  inch) can be used with the proper adapters. See example Figure 3 below.

The following photos highlight the usage options.

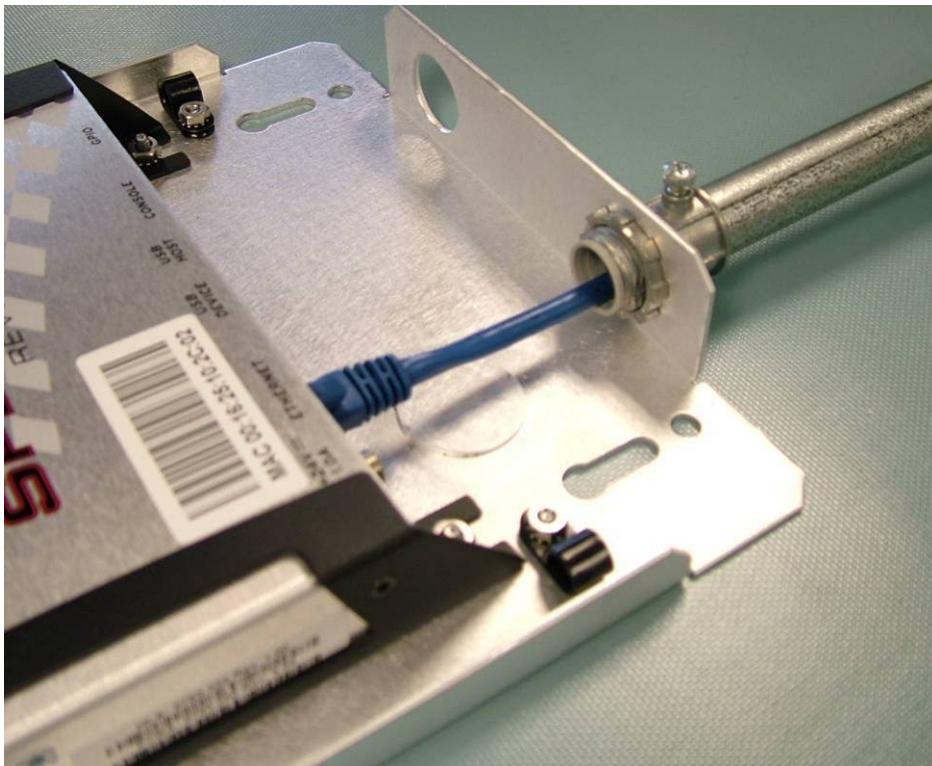


Figure C.3  $\frac{1}{2}$  inch conduit with a threaded nut flange connector



Figure C.4 Threaded 1/2 inch conduit connector

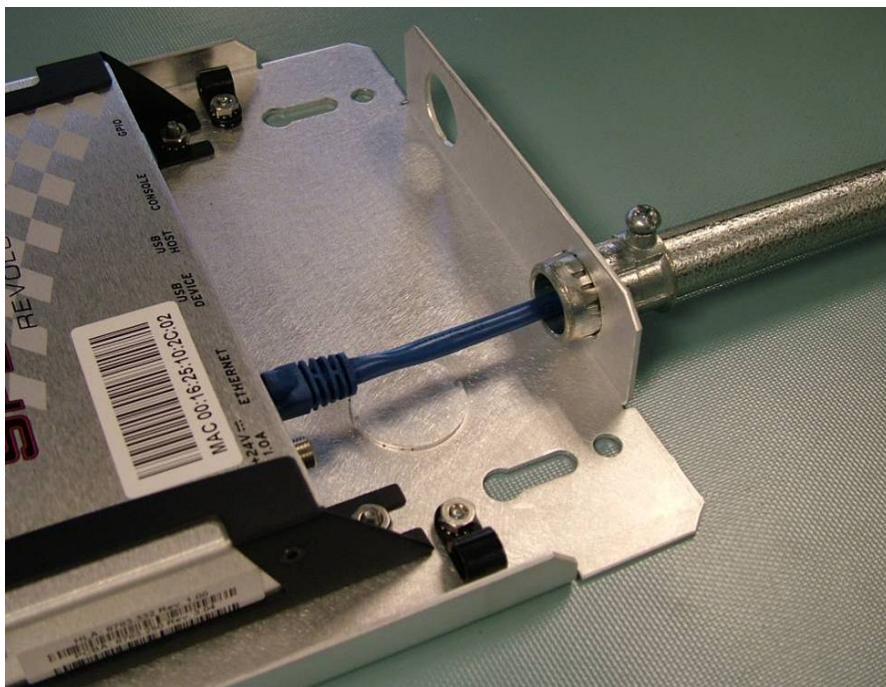


Figure C.5 1/2 inch conduit with a snap in flange connector



Figure C.6 Snap in 1/2 inch conduit connector

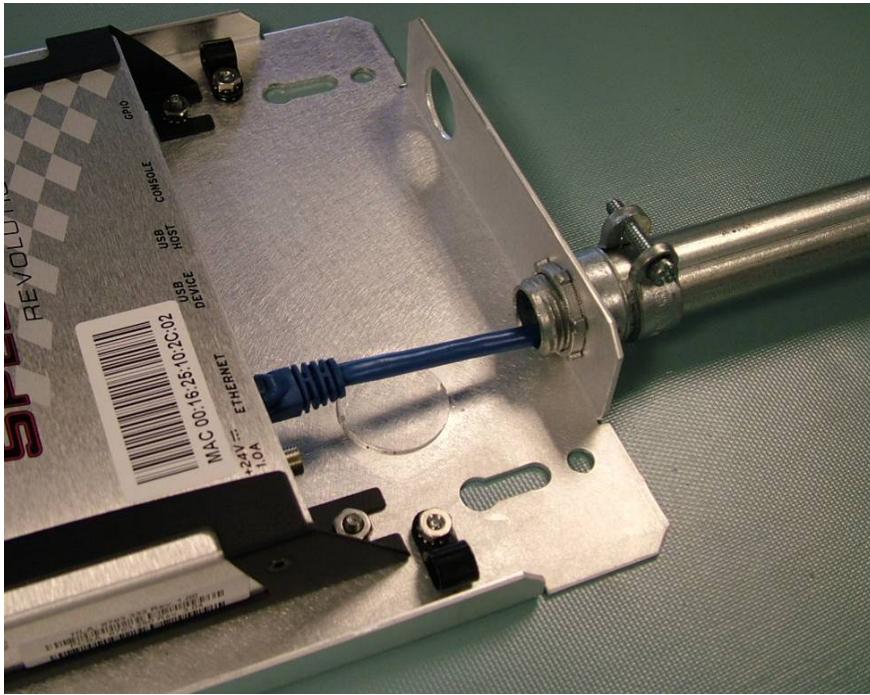


Figure C.7 A squeeze connector for the larger 3/4 inch conduit size. The connector has a nut and threads sized for the 1/2 inch conduit hole.



Figure C.8 ¾ inch conduit squeeze connector, with a threaded interface to ½ inch conduit hole.

## Appendix D: Speedway Antenna Hub Installation

### Speedway Antenna Hub Solution Checklist

Before starting, make sure that you have all the necessary and following items:

- 1 Speedway Antenna Hub (IPJ-A6001-000) Required components (available separately):
- 1 Speedway Revolution R420 Reader with Octane firmware v4.10 or higher (IPJ-REV-R420)
- 1 GPIO Adapter for Antenna Hub (IPJ-A6051-000)
- RF Cables (various)
- Cat5 cables for control channel (not sold by Impinj)
- Antennas (various)
- MultiReader software version 6.8 or higher
- Optional – up to 3 additional Antenna Hubs

### Antenna Port Numbering:

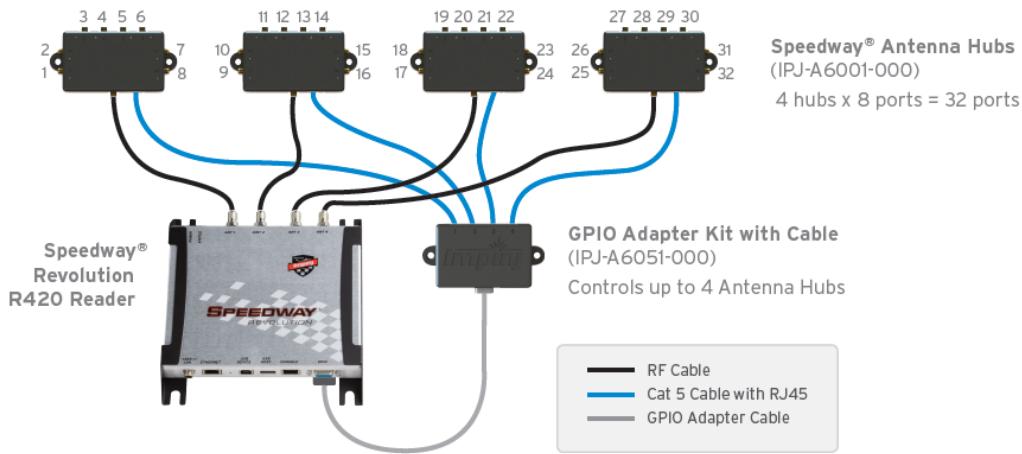


Figure D.1 Speedway R420 Reader with four antenna hubs and GPIO adaptor for a total of 32 RF antenna ports.

### Setting Up a Speedway Antenna Hub System

- 1) Check the Firmware Version on your Speedway R420 Reader.
  - a) Connect to Reader WebUI using a web browser  
`http://<reader name or IP address>`
  - b) Log in to the Reader. The Default credentials are:

```
user name: root
password: impinj
```

c) Note the "Software Version" shown on the WebUI. If it is 4.10.0.240 or later, then no additional action is required. Otherwise, ask your authorized Impinj partner or reseller for the latest Octane firmware release and upgrade using the "Reader Upgrade" utility in the WebUI.

2) Enable the Antenna Hub Feature.

- a) In the WebUI, click on the "Enable" button in the Antenna Hub section to enable the feature. You will need to manually reboot the Reader (click on the reboot button in the WebUI) for the changes to take effect.
- b) The Antenna Hub environment can also be enabled from Rshell using the command below and then rebooting the Reader:

```
>config feature enable anthub
```

3) Connect the cables.

- a) All cable connections should be made with the Reader powered off.
- b) Use RF cables for RF signal connections.
  - a. Requires cables with SMA male connectors for the Antenna Hub connection and R-TNC female connectors for the Reader connections.
  - b. Attach the RF cable to the appropriate Reader antenna port and Antenna Hub input port.
- NOTE: Antenna Hub ports are marked 1 through 8 to show the port ordering. These port markings correspond to a different antenna number sequence when connected to the Reader and GPIO Adapter ports 2, 3, or 4 (as referenced in the diagram).
- c. Connect the appropriate RF cables between the Antenna Hub output ports and antennas.
- d. Leave unused ports empty or terminated.
- c) Connect GPIO Adapter with Digital signal cables.
  - a. Use the cable provided with the GPIO Adapter to connect the Reader at its GPIO port to the GPIO Adapter.
  - b. Use standard Cat5 cable to connect the GPIO Adapter and Antenna Hub using the RJ-45 connectors.

**IMPORTANT:** Check that the Reader antenna port number and GPIO Adapter output port number match at the same Antenna Hub (For example, Reader antenna port 1 and GPIO Adapter port 1 are connected to the same Antenna Hub). The system will not operate correctly with mismatched wiring.

- d) Power the Reader and confirm the Antenna Hub LEDs light in sequence verifying that the Reader is enabled and operating.
- e) Click **Check connections** in the WebUI Antenna Hub page for help with any connection issues.

4) Affix the Antenna hub or hubs.

- a) Mount the hub using  $\frac{1}{4}$  inch mounting holes.

b) It may be necessary to temporarily disconnect RF cables. The Reader must be powered off to access the mounting holes.

#### 5) Next Steps

- a) Set up the Reader following instructions in the Speedway Revolution Installation and Operations Guide.
- b) Develop your controlling application using the LLRP Toolkit.
- c) Visit <http://support.impinj.com> for helpful information and recommendations.

### Hub Feature Enable and Diagnostics Using the Web-UI

1. Connect the Reader using a web browser `http://<reader name or IP address>` to enable features and diagnostic tools

Examples: `http://speedwayr-10-00-DD` or `http://10.0.10.44`.

2. Log in to the Reader;

user name: `root`

password: `impinj`

When the Antenna Hub feature is enabled, the Antenna Hub section on the main Reader web page will display **Enabled**. Click **Show** for the Antenna Hub Page.

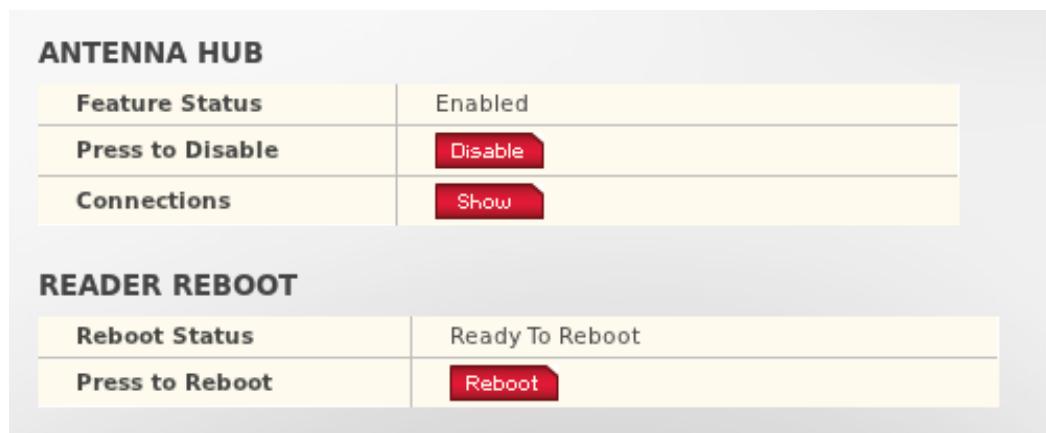


Figure D.2 Close-up of Antenna Hub Section of Management Web Page

Click **Show** for the Antenna Hub web page and click the **Check Connections** button to query the Antenna Hub connection state. This causes the Reader to query each port for a connected Antenna Hub status. Click **Stop Checking** to stop querying the Reader for connection states.

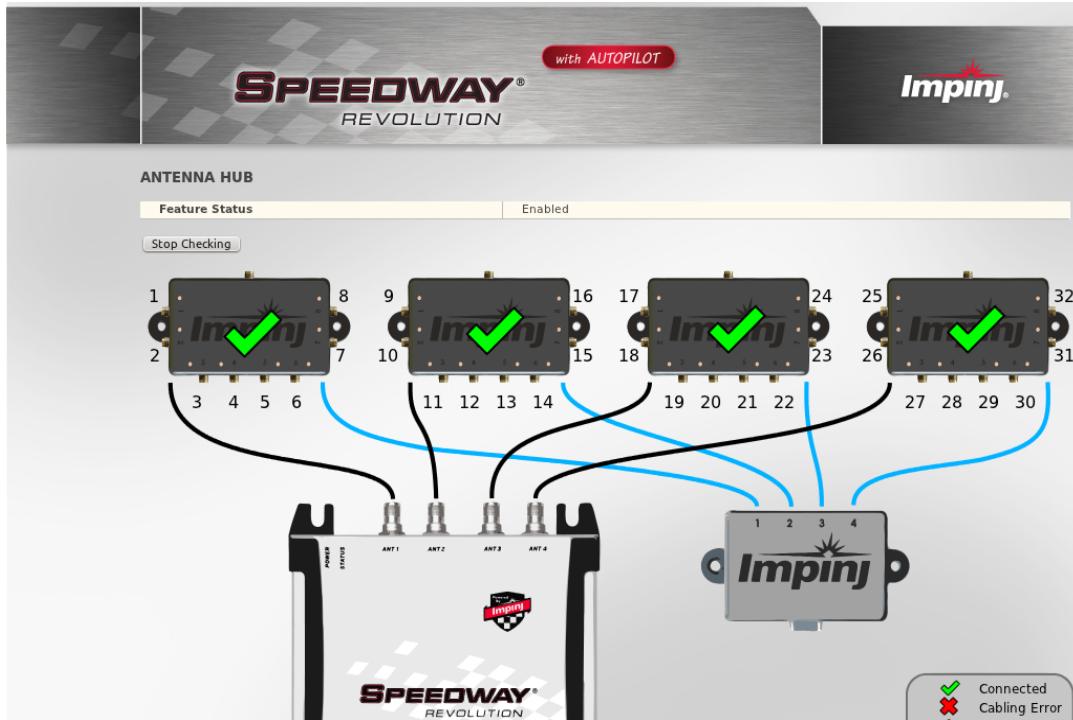


Figure D.3 Four Antenna Hubs Detected

The bottom of the Antenna Hub page displays the details about each Antenna Hub, or **Disconnected** for unused GPIO Adapter ports.

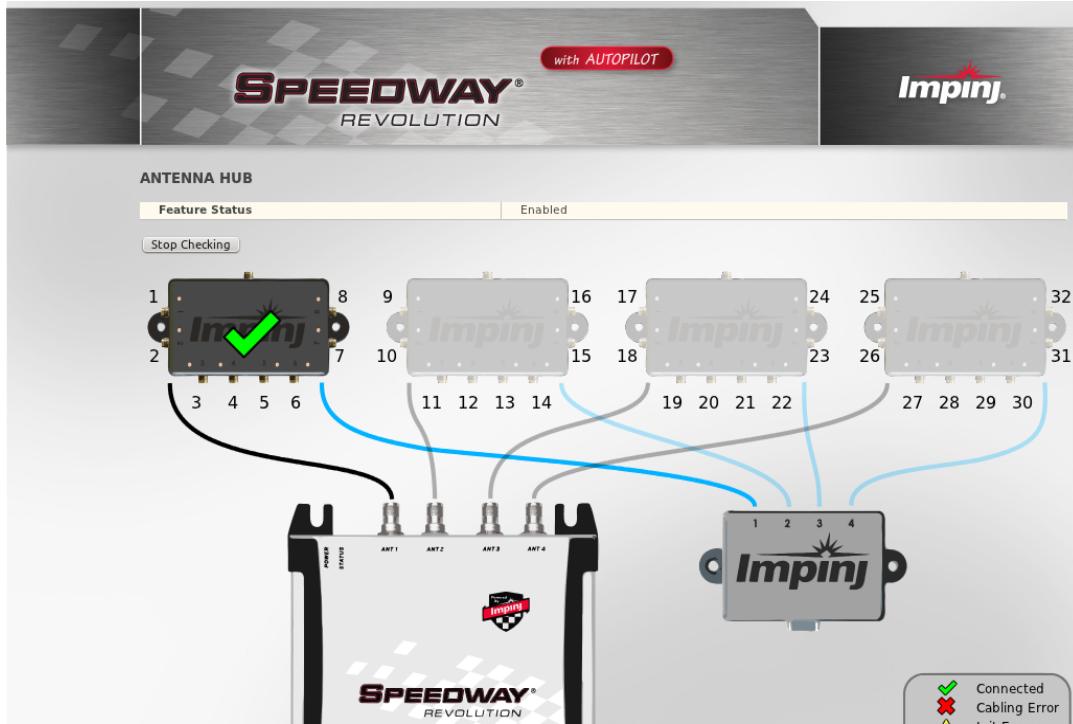


Figure D.4 One Antenna Hub Detected

If an Antenna Hub displays an error or is not connected properly, the green check on the connected Antenna Hub will be replaced by a red X or caution icon as explained in the key on the bottom right of the page.

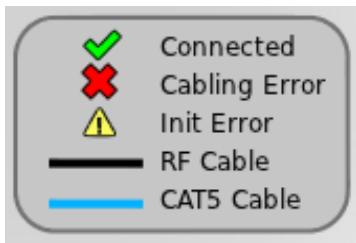


Figure D.4 Antenna Hub Confirmations

The table below describes the Antenna Hub icons and their meanings.

Table D-1 Antenna Hub Connection Icons

Icon	Icon Label	Meaning
✓	Connected	The cable is correctly connected.
✗	Cabling Error	The cable is either not connected or incorrectly connected.
⚠	Init Error	An error occurred while initializing the hub.
—	RF Cable	Connect RF cables at indicated locations
—	Cat5 Cable	Connect Cat5 cables at indicated locations.

## Notices:

Copyright © 2013, Impinj, Inc. All rights reserved.

Impinj gives no representation or warranty, express or implied, for accuracy or reliability of information in this document. Impinj reserves the right to change its products and services and this information at any time without notice.

EXCEPT AS PROVIDED IN IMPINJ'S TERMS AND CONDITIONS OF SALE (OR AS OTHERWISE AGREED IN A VALID WRITTEN INDIVIDUAL AGREEMENT WITH IMPINJ), IMPINJ ASSUMES NO LIABILITY WHATSOEVER AND IMPINJ DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATED TO SALE AND/OR USE OF IMPINJ PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT.

NO LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY PATENT, COPYRIGHT, MASK WORK RIGHT, OR OTHER INTELLECTUAL PROPERTY RIGHT IS GRANTED BY THIS DOCUMENT.

Impinj assumes no liability for applications assistance or customer product design. Customers should provide adequate design and operating safeguards to minimize risks.

Impinj products are not designed, warranted or authorized for use in any product or application where a malfunction may reasonably be expected to cause personal injury or death or property or environmental damage ("hazardous uses") or for use in automotive environments. Customers must indemnify Impinj against any damages arising out of the use of Impinj products in any hazardous or automotive uses.

Impinj, GrandPrix™, Indy®, Monza®, Octane™, QT®, Speedway®, STP™, and True3D™ are trademarks or registered trademarks of Impinj, Inc. All other product or service names are trademarks of their respective companies.

