IMPINJ™

SpeedwayR Installation and Operations Guide

Version 7.6

Contents

1 Products Covered by this Guide

This guide pertains to readers with the following part numbers and communication codes:

Table 1: Impinj Speedway Reader Part Numbers

Reader	Communication Code	Part Number
Speedway R220	FCC	IPJ-REV-R220-USA
Speedway R420	FCC	IPJ-REV-R420-USA
Speedway R220	ETSI	IPJ-REV-R220-EU1
Speedway R420	ETSI	IPJ-REV-R420-EU1
Speedway R220	Various	IPJ-REV-R220-GX1
Speedway R420	Various	IPJ-REV-R420-GX1
Speedway R220	Various	IPJ-REV-R220-GX2
Speedway R420	Various	IPJ-REV-R420-GX2
Speedway R420	Australia	IPJ-REV-R420-GX3
Speedway R420	Japan	IPJ-REV-R420-JP2
Speedway R640	FCC	IPJ-REV-R640-FCC
Speedway R640	ETSI	IPJ-REV-R640-EU1
Speedway R640	Various (see Notice)	IPJ-REV-R640-GX1
Speedway R640	Australia (see Notice)	IPJ-REV-R640-GX3
Speedway R120	FCC	IPJ-REV-R120-USA
Speedway R120	ETSI	IPJ-REV-R120-EU1
Speedway R120	China	IPJ-REV-R120-GX2
Speedway R420	ETSI	IPJ-REV-R420-EU2

NOTICE: The Impinj xPortal has begun the end-of-life process. Please see the EOL product notice for details.

NOTICE: The Impinj Speedway R120 has begun the end-of-life process. Please see the EOL product notice for details.

1.1 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.

Attention: Les modifications apportées à ce produit ou modifications pas expressément approuvés par la partie responsable de la conformité peuvent annuler votre droit à utiliser par 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 in section 9 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.

Industrie Canada (IC) Conformité

Son fonctionnement est soumis aux deux conditions suivantes:

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

Cet appareil a été conçu pour fonctionner avec l'antenne (s) énumérées à la section 9 qui ont un gain maximum de 6 dB. Antennes pas inclus dans cette liste ou présentant un gain supérieur à 6 dB sont strictement interdits pour utilisation avec cet appareil. L'impédance d'antenne requise est de 50 ohms. Afin de réduire le risque d'interférence avec d'autres utilisateurs, le type d'antenne et son gain doivent être choisis de telle sorte que la puissance isotrope rayonnée équivalente (PIRE) ne soit pas supérieure à celle permise pour une communication réussie. expression "IC" avant le numéro de certification radio signifie seulement que l'industrie des spécifications techniques Canada ont été respectées.

1.2   CE Marking and European Economic Area (EEA)

RFID devices designed for use throughout the EEA operate in two approved frequency bands: (1) 865.6-867.6MHz limited to maximum radiated transmit power of 2W ERP, and (2) 916.1-918.9MHz limited to maximum radiated transmit power of 4W ERP. For other EEA restrictions on RFID device use, please refer to the Impinj Declaration of Conformity (DoC) located at support.impinj.com.

1.3   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.

2   Before You Begin

⚠ **Warning:** Please read this document in its entirety before operating the Speedway reader, as serious personal injury or equipment damage may result from improper use. Unauthorized opening of the Speedway 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 in section 9.

⚠ **Avertissement:** S'il vous plaît lire ce document dans son intégralité avant d'utiliser le Speedway reader, comme des blessures graves ou des dommages matériels peuvent résulter d'une mauvaise utilization. Ouverture non autorisée du lecteur Speedway boîtier annule la garantie. Pour protéger le personnel, n'oublier pas de placer tous antenne (s) conformément aux exigences spécifiées pour votre région régulatrice. Pour plus de détails, voir l'Annexe A: Informations spécifiques aux régions de fonctionnement à la section 9.

3   Introduction

3.1   About this Guide

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

3.2   Intended Audience

The intended audience for this guide is anyone installing a Speedway 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.

3.3   Other Documents of Interest

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

- ***Impinj Speedway Revolution Getting Started Guide*** is a one-page guide included with the Speedway 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 that illustrate the scenarios discussed in the Programmer's Guide.
- ***Impinj Octane LLRP*** is intended for software engineers and describes the LLRP capabilities supported by Speedway, which includes Impinj's custom LLRP extensions.

Note: Octane is the name for the Speedway firmware.

- ***Impinj RShell Reference Manual*** describes the syntax and command language for the Speedway RShell Console.
- ***Impinj Octane SNMP Guide*** provides monitoring and reference information for working with the SNMP MIBs (Management Information Base), which is related to Speedway (the standard TCP/IP networking MIB (MIB-II) and a subset of the standard EPCglobal RM MIB).
- ***Impinj 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.
- ***Impinj Reader and Gateway Embedded Developer's Guide*** provides a high-level description of the Speedway platform and a high-level view of its architecture. This guide is intended for software engineers who design custom application software for the reader.

3.4   Document Conventions

Throughout this document, references are made to both standard and extended LLRP messages, parameters, and fields. To help visually distinguish between these different types, Table 3.1 provides details on the conventions that are used.

Table 3.1 Document Style Conventions

Type	Example	Style
LLRP message	IMPINJ_ENABLE_EXTENSIONS	CAPS_UNDERSCORES
LLRP parameter	*AntennaConfiguration*	Italics Camel Case
LLRP field	*ResetToFactoryDefault*	Italics Camel Case
Enumerated field value	'Upon N Tags or End of AISpec'	'Single-Quoted String'
File name	**'ImpinjDef.xml'**	'Single-quoted bold'
LTK function	***getLLRPStatus***	Bold italics case matches programming syntax
LTK class names	**CIMPINJ_TCS_RESPONSE**	Bold case matches programming syntax

3.5   Impinj Support Information

Visit the Impinj Support Web site at support.impinj.com for information about technical assistance. For guidelines about capturing data for analysis by Impinj technical support personnel, see section 8.2, **Submitting Diagnostic Data for Analysis by Impinj Technical Support**.

4   Introduction to Speedway®

Speedway® is a stationary, small form factor, UHF Gen2 RFID tag reader.

Figure 4.1 Speedway reader

The reader provides network connectivity between tag data and enterprise system software. Speedway offers many key features that increase application flexibility:

- **Low Power Usage**

  With a low power design, Speedway is capable of using Power over Ethernet (PoE/PoE+). Using PoE simplifies deployment and dramatically reduces costs and greenhouse gas emissions of your RFID infrastructure. Using PoE does not compromise Speedway performance. It is recommended that either the external Universal power supply or Power-over-Ethernet should be used to power the Speedway, not both.

Note: Speedway supports the IEEE standard for PoE and PoE+. When powered by PoE/PoE+, the maximum transmit power varies by region and Speedway reader PCBA version number according to the following table. Note that EU2 requires PoE+.

Speedway Reader Model and HLA Version	USA, GX1, GX2, GX3	EU1	JP2	EU2
R220 and R420 HLA 1.xx	30.0 dBm PoE 32.5 dBm AC/DC	30.0 dBm PoE 31.5 dBm AC/DC	30.0 dBm PoE 30.0 dBm AC/DC	N/A N/A
R220 and R420 HLA 2.xx	31.5 dBm PoE 32.5 dBm AC/DC	30.0 dBm PoE 31.5 dBm AC/DC	30.0 dBm PoE 30.0 dBm AC/DC	N/A N/A
R220 and R420 HLA 3.xx	31.5 dBm PoE 32.5 dBm AC/DC	30.0 dBm PoE 31.5 dBm AC/DC	30.0 dBm PoE 30.0 dBm AC/DC	33.0 dBm PoE 33.0 dBm AC/DC
R120 HLA 2.xx without Antenna Hub	30.0 dBm PoE 30.0 dBm AC/DC	30.0 dBm PoE 30.0 dBm AC/DC	30.0 dBm PoE 30.0 dBm AC/DC	N/A N/A

Speedway Reader Model and HLA Version	USA, GX1, GX2, GX3	EU1	JP2	EU2
R120 HLA 2.xx with Antenna Hub	31.5 dBm PoE 32.5 dBm AC/DC	30.0 dBm PoE 31.5 dBm AC/DC	30.0 dBm PoE 30.0 dBm AC/DC	N/A N/A

- **Compact Form Factor**

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

- **Three Models Available**

  Impinj offers three Speedway models, with different high performance monostatic antenna port configurations. The transmitter and receiver use the same port. The model R120 is a one-port configuration, the R220 is a two-port configuration and the R420, shown above, is a four-port configuration.

- **High Performance Features**

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

- **Robust Reader Design**

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

4.1   Speedway xPortal – Integrated Portal Reader

The Speedway xPortal is an integrated portal reader that incorporates the Speedway 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.

Figure 4.2 Speedway xPortal-reader

The configuration and use of the xPortal is identical to the Speedway R120, R220 or R420 readers. The information in this document also applies to the xPortal. For installation and cable hookup instructions that are unique to xPortal, see Appendix C, Speedway xPortal Installation.

The xPortal is an integrated solution, with the maximum reader-transmit power set at the factory to comply with the regulations for the country of operation. For use in the USA or Canada under

FCC rules, the maximum reader-transmit power is 28.5 dBm with xPortal's 7.5dBi antenna gain.

4.2 Speedway Antenna Hub

Figure 4.3 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 is tightly integrated with the Octane firmware (release 4.10 or higher) to deliver superior antenna switching performance.

The Speedway R120 Port Pack allows expansion of the single Speedway R120 antenna port into a total of 8 time-multiplexed anntenna ports. Hub control is instrumented through a GPIO adaptor and integrated with the Octane firmware (release 4.10 or higher) in an manner similar to the Speedway Antenna Hub.

The antenna hubs have a typical insertion loss of 1.2 dB. This loss can be factored into the user's transmit power setting in the same manner as cable loss.

For information about the configuration and use of the Antenna Hubs, see Appendix D: Speedway Antenna Hub Installation.

4.3 Requirements for Using Speedway

4.3.1 Environmental Requirement

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

4.3.2 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 are required, including associated RF cable or cables with an RP-TNC male connector interface.

4.3.3 Power Requirements

⚠️ **Warning:** This product is intended to be supplied with a Listed/Certified power supply, marked LPS or Class 2, with 24Vdc output, rated minimum 2.1A. Use of alternative power supply will invalidate any approval given to this device and may be dangerous.

⚠️ **Avertissement:** Ce produit est conçu pour être alimenté avec une alimentation Mis / certifiés, marqué LPS ou de classe 2, avec sortie 24V, 2,1 A nominal minimum. Utilisation d'une autre alimentation annule toute autorisation liée à cet appareil et peut être dangereuse.

The RF transmit power is limited by the type of power supplied (PoE, PoE+ or compliant power source that is certified by the appropriate agencies). Refer to the table of transmit power limits by supply type in section 4.

Operating above +30 dBm requires professional installation to comply with radio regulatory laws in many countries. For more information, see **Appendix A: Information Specific to Regions of Operation**.

Available AC power cords for the Impinj-approved Listed/Certified power supply model number **IPJ-A2003-000** 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)

4.3.4 Supported Operating Environments

This section describes the environments in which you can access the Speedway RShell console that is used for configuring, monitoring, and maintaining the reader. The tools that you use when you access the RShell console depend on how you connect your PC to the reader, either by a serial connection (RS-232) or by an Ethernet connection (SSH). On computers running Microsoft Windows, you can now use Putty for both types of connections.

Table 4.1: Supported Operating Environments

Interface	Protocol	Recommended Tools	
		Microsoft Windows	**Linux**
Ethernet	SSHPort 22	Putty [1]	SSH
Serial	RS-232	Putty (version 0.60 and higher supports serial)	Minicom

[1] http://www.putty.org/

4.3.5 Supported Communication Protocol

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

4.3.6 Antenna Requirements

Depending on the reader model you are installing, Speedway is equipped with one (R120), 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 for a specific region, see the relevant antenna section in Appendix A: Information Specific to Regions of Operation.

5   Installing and Connecting Speedway

This section provides details about Speedway I/O ports and status LEDs. It also explains how to install the reader and connect it to your network.

5.1   Speedway Ports and LEDs

The following graphic illustrates the I/O ports located on the Speedway reader. This graphic shows a Speedway R420, which includes four antenna ports, as shown in Figure 5.1.

Note: Speedway R420, R220 and R120 models have the same exterior ports with one exception: the Speedway R120 includes one antenna port, the Speedway R220 includes two antenna ports and the Speedway R420 includes four antenna ports.
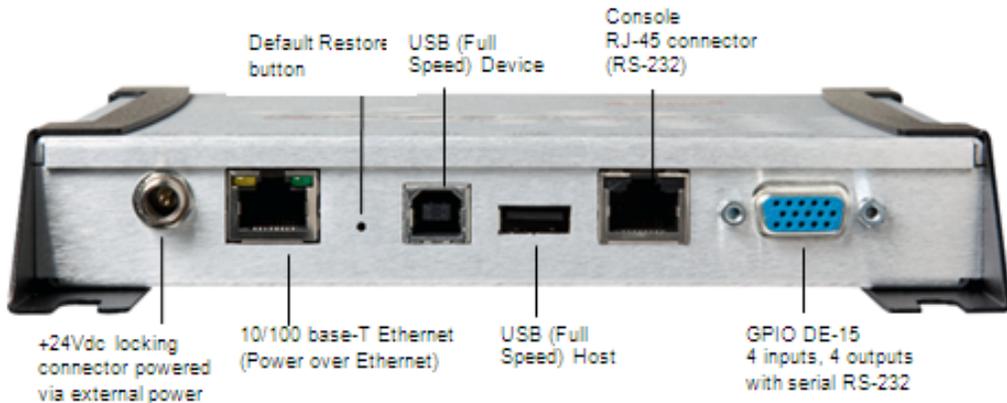
Figure 5.1 Speedway R420 Port Connections

Note: See **Appendix B: GPIO Details** for functional and electrical specifications, and for details about each pin of the GPIO DE-15 connectors.

Antenna ports and LED status indicators are located on the back panel of the reader. The Speedway R420 graphic below illustrates their locations:
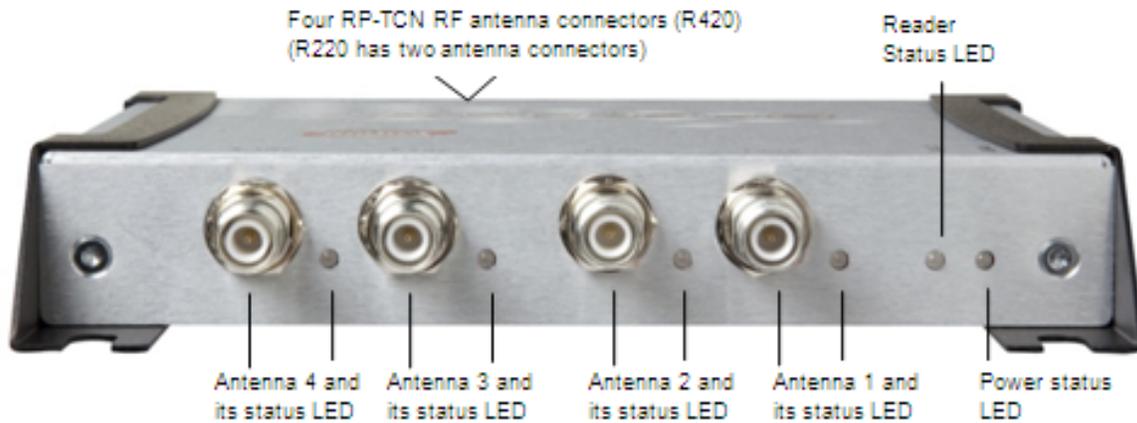
Figure 5.2 Speedway R420 Antenna Ports and Status LEDs

Section 5.1.1 describes the three primary LED categories and their blink patterns.

Section 5.1.2 describes the LED behavior for various reader operation scenarios.

5.1.1   Speedway Reader LED Blink Patterns

The Speedway reader has several LEDs to indicate reader operational status. The three primary LED categories are power, reader status, and antenna status. Each LED has its own blink patterns to convey status to the user. Table 5.1 documents the defined patterns for the Power LED. Table 5.2 documents the defined patterns for the reader Status LED. Table 5.3 documents the defined patterns for the Antenna Status LEDs.

Table 5.1 Power LED Patterns

LED State	Reader State
Solid RED (after power-on or reset)	Power applied, attempting to start boot code
OFF	Default Restore button pressed
One short RED blink	Configuration Default Restore detected
Two short RED blinks	Factory Default Restore detected
Blinking RED (4 Hz)	Unable to boot (see console for details)
Solid GREEN	Done booting, starting application image
Blinking ORANGE (1Hz)	USB flash drive upgrade in progress
Blinking RED (2 Hz)	USB flash drive upgrade failure

Table 5.2 Reader Status LED Patterns

LED State	Reader State
OFF	Application image booting, RFID not available
Alternating RED and GREEN	Application image booting, RFID not available, File system operation in progress (after upgrade)
Solid GREEN	Application image booted, RFID available, No LLRP connection
Two short GREEN blinks	Active LLRP connection
One short GREEN blink	No LLRP connection, LLRP ROSpec configured and enabled
Blinking ORANGE	Inventory active, blinking rate increases with an increased number of tags in the reader FOV

Table 5.3 Antenna Status LED Patterns

LED State	Reader State
OFF	Antenna inactive
Solid GREEN	Antenna actively transmitting

5.1.2 LED behavior in scenarios for Startup, Upgrade, Detection, Inventory, and LLRP

The tables in this section describe the LED behavior for various reader operation scenarios.

Table 5.4 Startup (power on), normal completion

Reader Operation	LED	Expected Behavior
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

Table 5.5 Startup (reset), normal completion

Reader Operation	LED	Expected Behavior
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)

Table 5.6 Startup (failure)

Reader Operation	LED	Expected Behavior
Hardware problems detected unable to boot	Power: Status:	Continuous blinking red Off

Table 5.7 Upgrade Activity

Reader Operation	LED	Expected Behavior
Upgrading the firmware during boot process	Status:	Alternates between red and green

Table 5.8 Detection of antenna activity

Reader Operation	LED	Expected Behavior
Detects no activity on antenna port	Antenna:	Off
Detects antenna transmission activity on antenna port	Antenna:	Solid green

Table 5.9 Inventory activity

Reader Operation	LED	Expected Behavior
Performing an inventory operation	Status:	Blinks orange, blinks faster as tag volume increases

Table 5.10 LLRP activity

Reader Operation	LED	Expected Behavior
Active LLRP connection	Status:	Double blink pattern (green)
Disconnected operation	Status:	Single blink pattern (green)

5.2   Installing and Connecting the Reader

The primary installation and connection steps for Speedway 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, ETSI, Japan, or Australia).
6. Test the reader installation by reading tags.

5.3   Detailed Installation Procedures

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

5.3.1   Step 1: Position the Speedway 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 might 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 it is mounted close to another perpendicular object. The Speedway reader supports Power over Ethernet (PoE/PoE+) and can obtain its electrical power with data via standard cable in an Ethernet network.

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

To mount the Speedway reader:

1. Locate the four mounting slots on the reader, as shown in Figure 6.
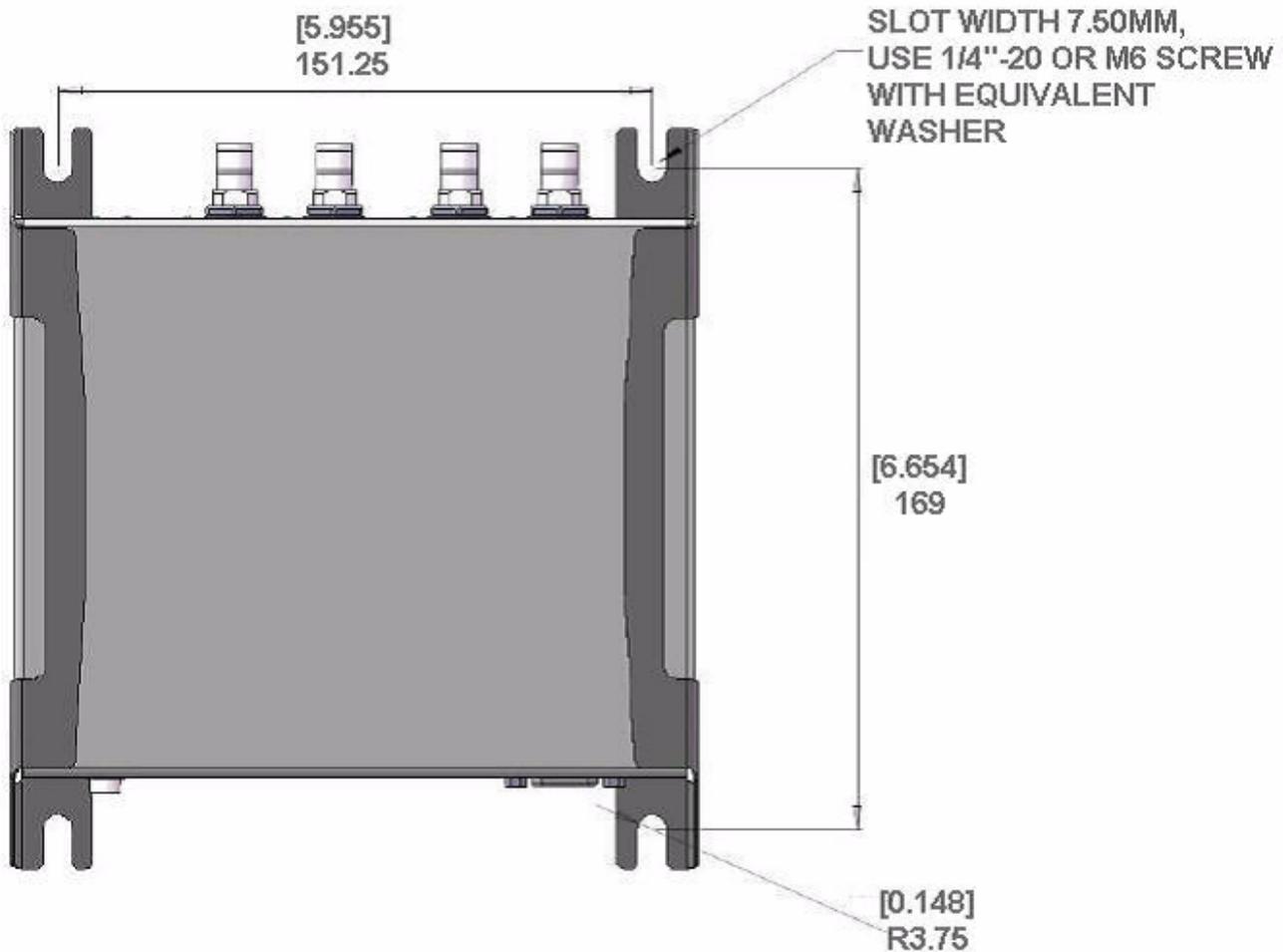
Figure 5.3 Speedway Mounting Locations

2. Use a ¼ inch diameter bolt with 20 threads per inch (¼–20) or M6 screws to secure the unit. You can 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.

⚠ **Attention:** Si il n'y a aucune chance de poussière ou d'eau exposition, vous devez monter le lecteur de sorte que les ports Ethernet, USB, console et GPIO sont orientés vers le bas pour empêcher la pénétration.

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

Depending on the Speedway model you are installing, the reader has either one antenna port (R120), 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.
See Appendix A: Information Specific to Regions of Operation in section 9 for a detailed list of approved vendors. Using any other antenna may adversely affect performance or damage the reader. Speedway requires professional installation to correctly set the TX power for the RF cable and antenna selected.

⚠️ **Avertissement:** Vous devez utiliser des antennes Impinj-approuvés avec Speedway. Voir l'Annexe A: Informations Spécifiques aux Régions de l'Opération à la secton 9 pour une liste détaillée des fournisseurs approuvés. Utilisation de toute autre antenne peut affecter les performances ou endommager le lecteur. Speedway exige installation professionnelle pour définir correctement la puissance d'émission pour le câble RF et une antenne sélectionné.

⚠️ **Warning:** You must use 50 ohm impedance cable. Select good quality, low loss cable with high quality connectors. Maintaining return loss better than 10dB is required.

⚠️ **Avertissement:** Vous devez utiliser un câble dimpédance de 50 ohms. Sélectionnez un câble de bonne qualité à faible perte avec des connecteurs de haute qualité. Maintenir une perte de retour meilleure que 10 dB est requis.

To connect the antenna(s) to the reader:

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. For the specific requirements for your regulatory region, see Appendix A: Information Specific to Regions of Operation.

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.
4. 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 antenna ports to be self-terminating. It is important that you do **not** terminate unused antenna ports. Leave them unconnected.	⚠️ **Avertissement:** Impinj conçu les ports antenne de Speedway à auto-terminaison. C'est important que vous ne résiliez **pas** ports d'antenne pas utilisés Laisser-les sans rapport.

5.3.3 Step 3: Power the Reader

You have two choices for powering Speedway:

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

If your network switch is PoE-enabled, the reader powers on when you connect it to the network.

If you are using a listed/certified power supply, connect the AC power plug into a suitable 100–240 VAC, 50–60 Hz power outlet.

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

In this example slot 5, port 2 is being set to POE = "never".

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

The boot sequence begins in either case when power is supplied to the reader. This sequence typically completes within 30 seconds. After the boot sequence finishes, the reader accepts commands, not

before. The Power and Status LEDs on the reader alert you to the status. For more information, see section 5.1 **Speedway Ports and LEDs**.

! **Important:** We recommend that you do not connect both a POE and a listed/certified power supply to the reader. If a reader is receiving power via PoE and the reader detects that a listed/certified power supply has been connected, the reader reboots and switches to the listed/certified power supply source. If, however, the reader is receiving power via a listed/certified power supply and detects the connection to a PoE-enabled network switch, nothing changes. The reader continues to receive power from the listed/certified power supply. The listed/certified power supply always takes precedence over PoE because the listed/certified power supply is capable of higher power if both sources are connected.

5.3.4   Step 4: Connect the Speedway Reader to the Network

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

- If your network supports DHCP, you can connect the reader directly to your Ethernet network. After the reader is powered, immediately communicate with it via SSH (TCP/IP).
- If your network does not support DHCP, or if you want to connect a PC directly to the reader via Ethernet cable, the reader defaults to the following fixed IP address: 169.254.1.1. If this address is already in use, the reader will select a random fixed IP address in the 169.254.xxx.xxx link local address range. You can also connect to the reader by using an RS-232 serial connection via the Console port. Use the reader's RShell command- line interface to configure a static IP address for the reader. After that is completed, you can connect the reader to your Ethernet network.

Starting with the Octane 5.10 release, connecting to the reader via an IPv6 address is supported. In a dual network environment (where both an IPv4 and IPv6 address are assigned to the reader), Octane will preferentially choose the IPv6 address for the LLRP connection. However, if the IPv6 address is not available when the reader is booting (but the IPv4 address is available), then Octane may choose the IPv4 address. You can confirm which IP address Octane is using for the LLRP connection via either the Web UI or the RShell console (using the "show network summary" command).

Details about how to complete each connection option are described in Table 5.11. Before proceeding, make note of the reader's factory default network settings.

Table 5.11: Default Network Settings

Settings	Description
Hostname	SpeedwayR-XX-XX-XX where XX-XX-XX is the last three MAC address (which is printed on the version label attache

Settings	Description
DHCP	Enabled. The reader also reports its hostname to the DHCP server. **Note**: When the reader is plugged into a network that doesn't have a DHCP server **OR** when the PC is connected directly to the reader via Ethernet cable, the reader defaults to a fixed IP address (169.254.1.1). If this address is not available, the reader then randomly selects a fixed IP address in the 169.254.xxx.xxx link local address range.

To connect the Speedway reader 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 shown in Figure 5.4.

Figure 5.4 Connecting the Speedway reader 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.

To troubleshoot Ethernet network connections

Use the following steps to troubleshoot problems with connecting to the reader over TCP/IP:

1. "Ping" the reader, for example **ping speedwayr-10-28-42.local** (for the Speedway reader). If you are on an enterprise network, you usually don't have to use '.local'

   When the reader is directly connected to the PC, make sure the PC is on the same subnet as the reader. For example, if the reader's IP address is 169.254.1.1, set the PC's IP address somewhere in the 169.254.xxx.xxx address range.

2. If the ping is NOT successful, you will probably see one of these three error messages:

   - "Ping request could not find host"
   - "Request timed out"
   - "Destination host unreachable"

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

To connect a Speedway reader to your PC over a serial connection

1. Confirm that you have the latest version of Putty, a free and reliable SSH, and serial client. Putty version 0.60 or later contains support for serial connections.
2. Use a Cisco style Console cable RJ-45 to DB9, Impinj part number IPJA4000000, to connect your PC's valid/active COM port to the serial port on the reader, as shown in Figure 5.5.
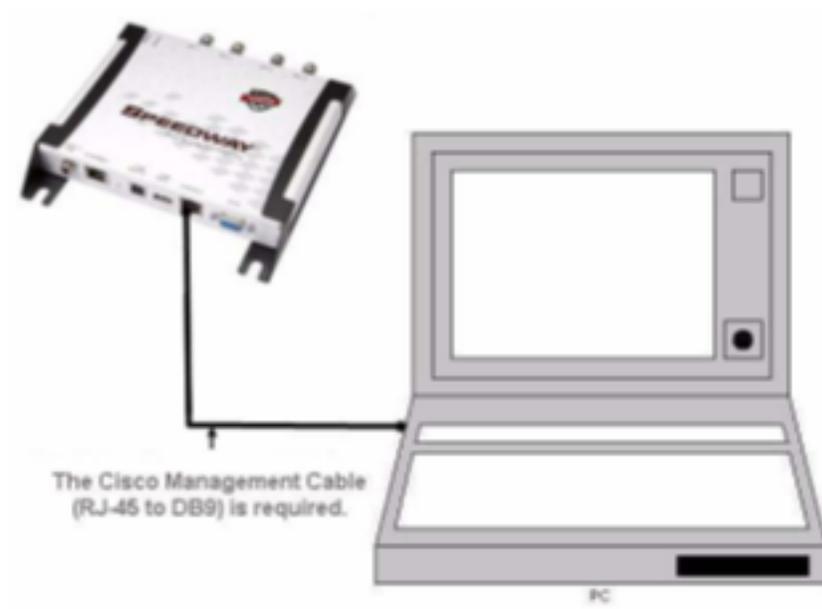
Figure 5.5 Speedway Serial Connection

3. Power up the reader and wait for the boot sequence to complete. For more information, see Section 5.3 **Step 3: Power the reader**.
4. On the PC, run the Putty application and adjust the session options to use the Serial connection type, and set the Serial line to **COM1**. Note: If you are using a serial to USB adapter, this field can be set to a different COM port.
5. Set **Speed** to **115200**.
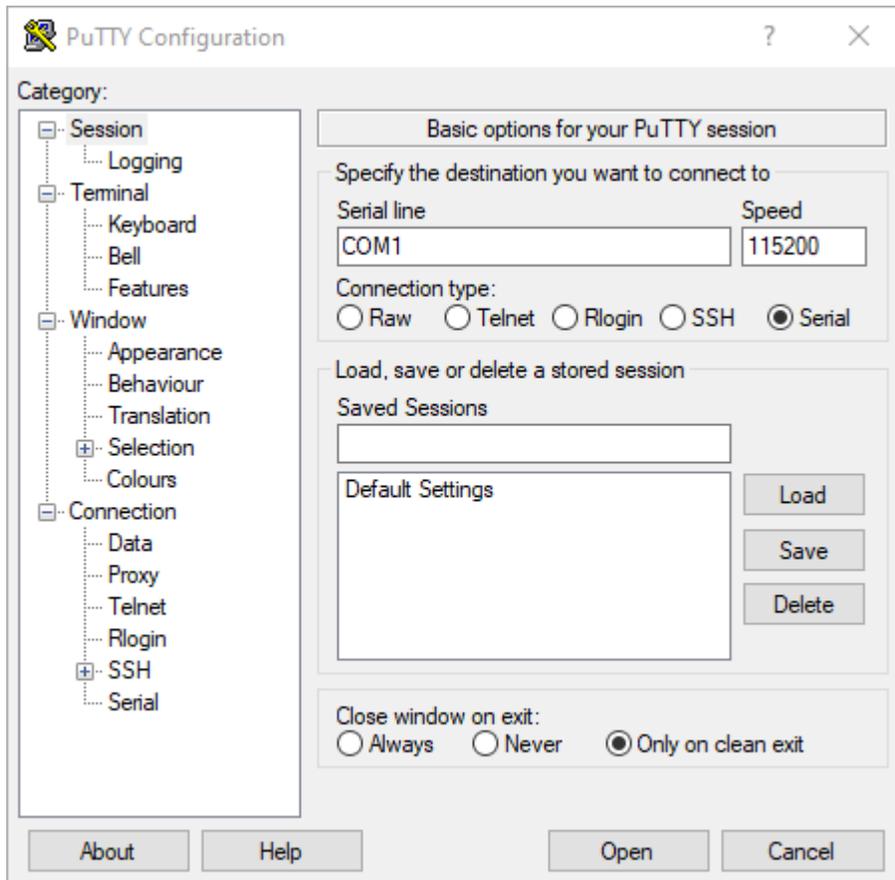
Figure 5.6 Putty Session Settings

6. In the left-hand **Category** panel of the Putty application, click on the **Serial** category. The right-hand panel will display the options for controlling local serial lines. The general session settings will populate the appropriate fields.
7. Set **Flow control** to **None**, and then click **Open**.

Figure 5.7 Putty Serial Settings

8. On the RShell console window, press **Enter**. The RShell login prompt displays.

Figure 5.8 COM1 Putty Login Prompt

9. At the RShell login prompt shown in Figure 5.8, log in with the following default credentials, unless you have customized them:

user name: root

password: impinj

10. **When the RShell command-line prompt displays, begin configuring the** network settings for the reader. For more information, see Section 6.1.1 **Using RShell to Configure Network Settings for Speedway**.

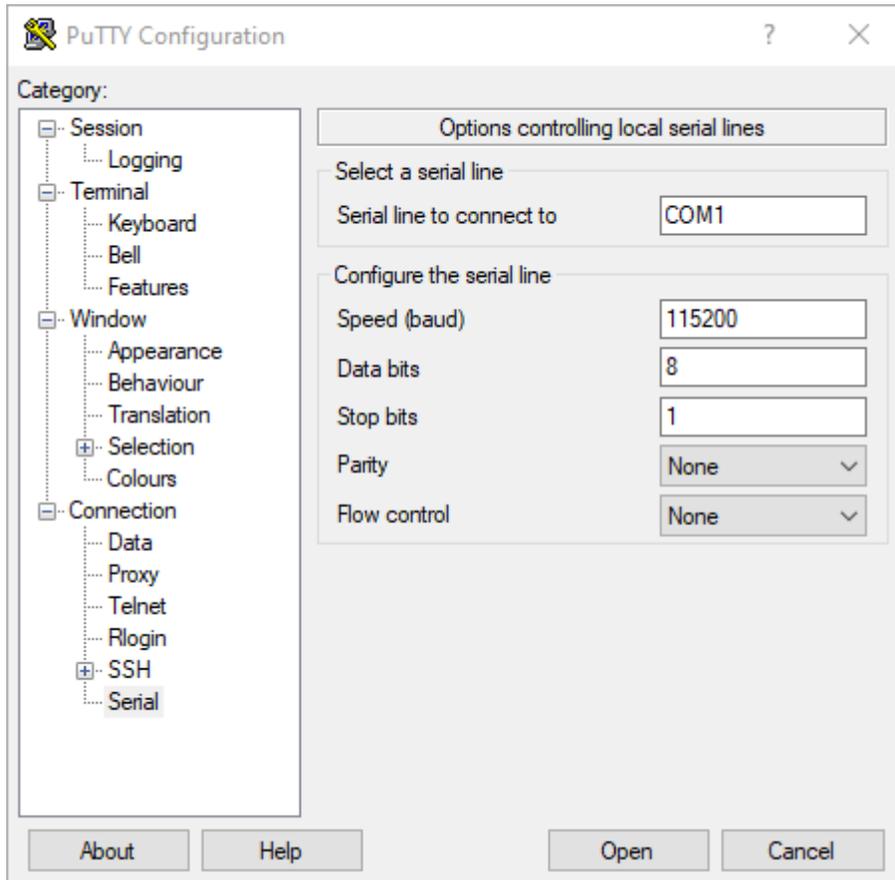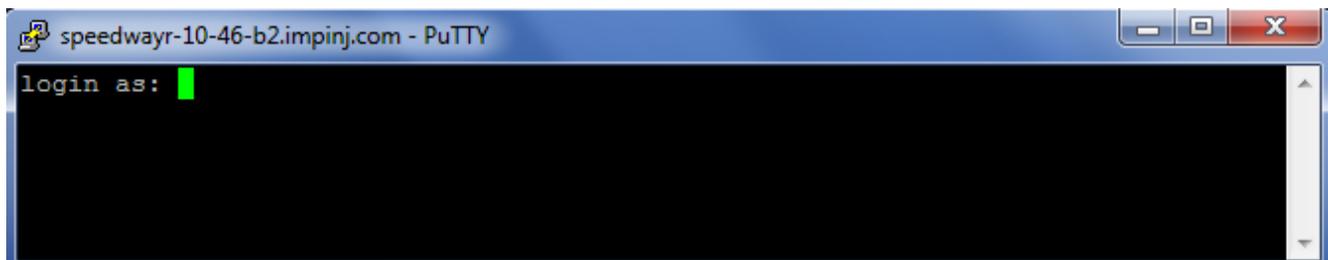11. **When you have completed configuration of the appropriate network** settings, connect the reader to your Ethernet network. For more information about how to do this, see section 5.3.4 **Step 4: Connect the Speedway reader to the Network**.

    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. For more information, see Section 6.1.1 **Using RShell to Configure Network Settings for Speedway**.

5.3.5   Step 5: Configure the Region Setting on the Reader

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

⚠ **Warning:** The RF settings must match the country/region of operation 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.

⚠ **Avertissement:** Les paramètres RF doivent correspondre au pays / région d'exploitation se conformer aux lois et règlements locaux. Vous, l'utilisateur, sont chargés d'assurer le fonctionnement avec les paramètres RF correctes et sont seuls responsables de toutes les amendes et autres dommages imputables à des manipulations ou les paramètres de pays / région non-conformes sur votre lecteur.

Out of the box, GX1 and GX2 readers are not configured with a region (null region) and will not transmit RFID signals. The region can be selected and set by using the reader's HTTP interface in a web browser, or by using RShell.

To set the region for a reader by using a web interface

1. Connect to the reader by using a web browser using the following format:

   http://<*reader name* or *IP address*>.

Examples:

- http://speedwayr-10-00-DD
- http://10.0.10.44.

2. Log in to the reader using the following credentials;

    user name: root

    password: impinj

3. Select one of the available regions from the dropdown list, as shown in Figure 5.9.

    Note: If you don't see your country or region listed, contact Impinj to find out about current regulatory approval status.

4. On the **Change Regulatory Region** dialog, click **Reboot**. When you change the reader's operating region, the change does not take effect until the next reboot. If you attempt RFID operations on the reader after you change the region but before you reboot the reader, you will get unexpected behavior.

CHANGE REGULATORY REGION

Available Regions	Korea 917-921 MHz
Press to Update	Korea 917-921 MHz
	China 920-925 MHz
	South Africa 915-919 MHz
	None - RFID Disabled

ANTENNA HUB

Feature Status	Disabled
Press to Enable	Enable Antenna Hub

Figure 5.9 Change Regulatory Region Web Interface

To set the region for a reader by using RShell commands

Alternately, you can use the following RShell commands to set or change a GX1 or GX2 region of operation:

```
> show system region
```

– shows the configured region and a list of selectable regions.

```
> config system region X
```

– set the region to region number X. For example, to set the GX1 region to Singapore, type config system region 15.

5.3.6   Step 6: Test the Installed Reader

Confirm that connections and functionality are correct by reading tags. You can quickly verify reader operation by using ItemTest, a Windows PC test application from Impinj. To use ItemTest, you configure various reader parameters and then run simple inventory operations. For more information about how to access and use ItemTest, see **Using ItemTest to Configure and Test Speedway** in section 6.1.2.

6   Configuring and Monitoring Speedway

This section provides a high-level overview of the configuration and monitoring options available for Speedway reader.

6.1   Configuring Speedway Reader

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

6.1.1   Device Configuration

RShell is a proprietary command-line management interface used to configure and manage network settings, firmware upgrades, and other device-oriented operations. This section introduces the RShell commands to use to install and connect the reader. The **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 versions. Existing inputs and outputs will never change. When new commands are added, new optional arguments are added at the end.

Using RShell to Configure Network Settings for Speedway

You can often get up and running with little or no configuration if you use the default configuration settings in Speedway. However, 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 might need to connect the reader to your network.

To configure the reader's network settings

1. Open the RShell console. For more information, see the procedure "To connect a Speedway reader to your PC over a serial connection" in section 5.3.4.
2. View the reader's current configuration settings by entering the *show network summary* command at the RShell command prompt as shown in the following example:

```
> 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'
```

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, however the other parameters are optional. The default value is used if an optional parameter is omitted from the ip command.

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

   - **Enabling DHCP**

     ```
     > config network ip dynamic
     ```

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

   - **Configuring NTP Servers**

     ```
     > config network ntp add <NTP SERVER ADDRESS>
     ```

4. After successfully configuring all required network settings, connect the reader to the network through the Speedway Ethernet port.

6.1.2   RF Configuration

How you configure your reader's RF behavior depends entirely on your implementation approach. You might be using a custom software application, middleware running on a server, or some other approach. ItemTest, described in the next section, 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 more information about LLRP, see the following documents:

- **LLRP Standard** This document provides the specifics of the LLRP standard ratified by EPCglobal. http://www.epcglobalinc.org/standards/llrp/llrp_1_0_1-standard-20070813.pdf
- **Octane LLRP** This document provides details of the LLRP capabilities that are supported by Speedway. It also describes custom LLRP extensions added by Impinj.
- **Impinj LTK Programmer's Guide** This 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 that illustrate the scenarios discussed in the Programmer's Guide.

Using ItemTest to Configure and Test Speedway

Impinj provides a simple, easy-to-use LLRP application to use to configure and test the basic RF behavior of Speedway. The ItemTest application is available from the Impinj support Web site at support.impinj.com. ItemTest supports features that are available with Octane 5.X and 6.X firmware. To use ItemTest, your computer must be running a minimum of Windows 7 and have .NET Framework 4.6.1 installed.

Note: ItemTest must be installed and operated by a user with administrator privileges.

This section describes how to connect to and configure a reader's RF parameters by using ItemTest. It also provides a high-level description of each parameter.

To configure and test a reader by using ItemTest

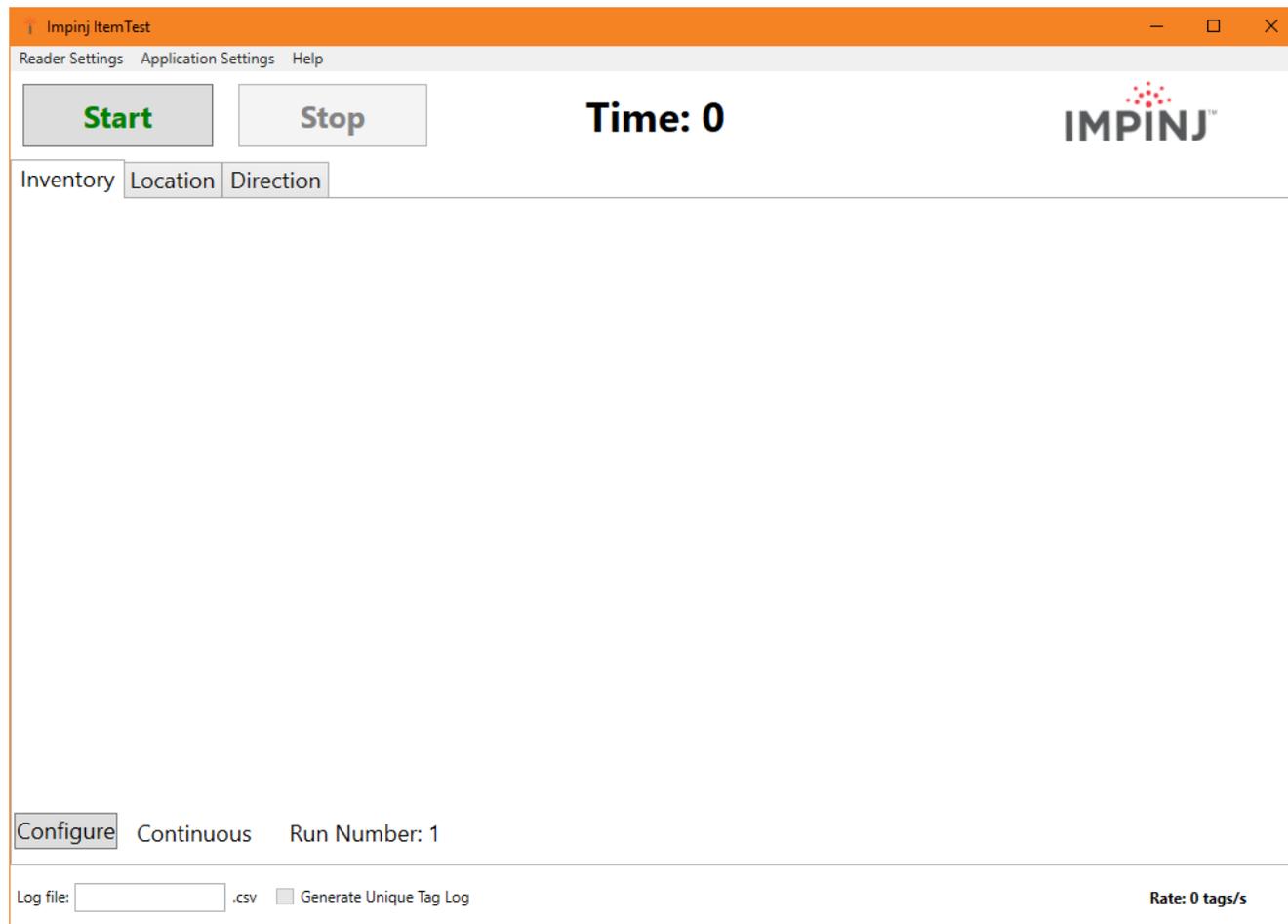1. Install and launch the ItemTest application. The screen shown in Figure 6.1 displays.

Figure 6.1 ItemTest initial screen

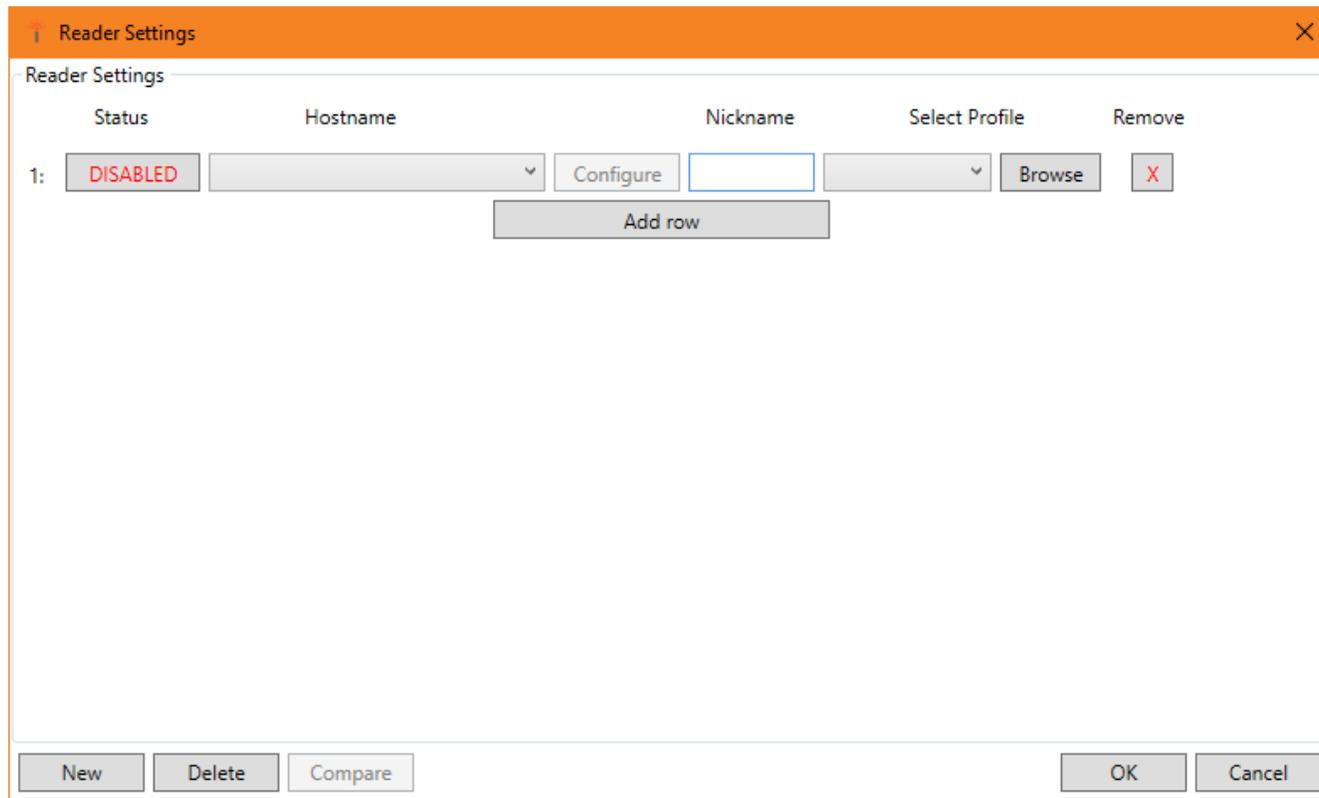2. Click **Reader Settings**. The **Reader Settings** screen displays.

Figure 6.2 ItemTest Reader Settings Connection Screen

3. On the **Reader Settings** page, in the bottom left, click **New**. In the **Input Hostname** field, type the reader's IP address or hostname. Then click **OK**.

   Note: You can find out the name and the IP address by using the RShell ***show network summary*** command. The ***show network summary*** command provides the dynamic values that are 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 that has mDNS enabled, a reader with hostname **speedwayr000102**, for example, can be reached using **speedwayr000102.local**.
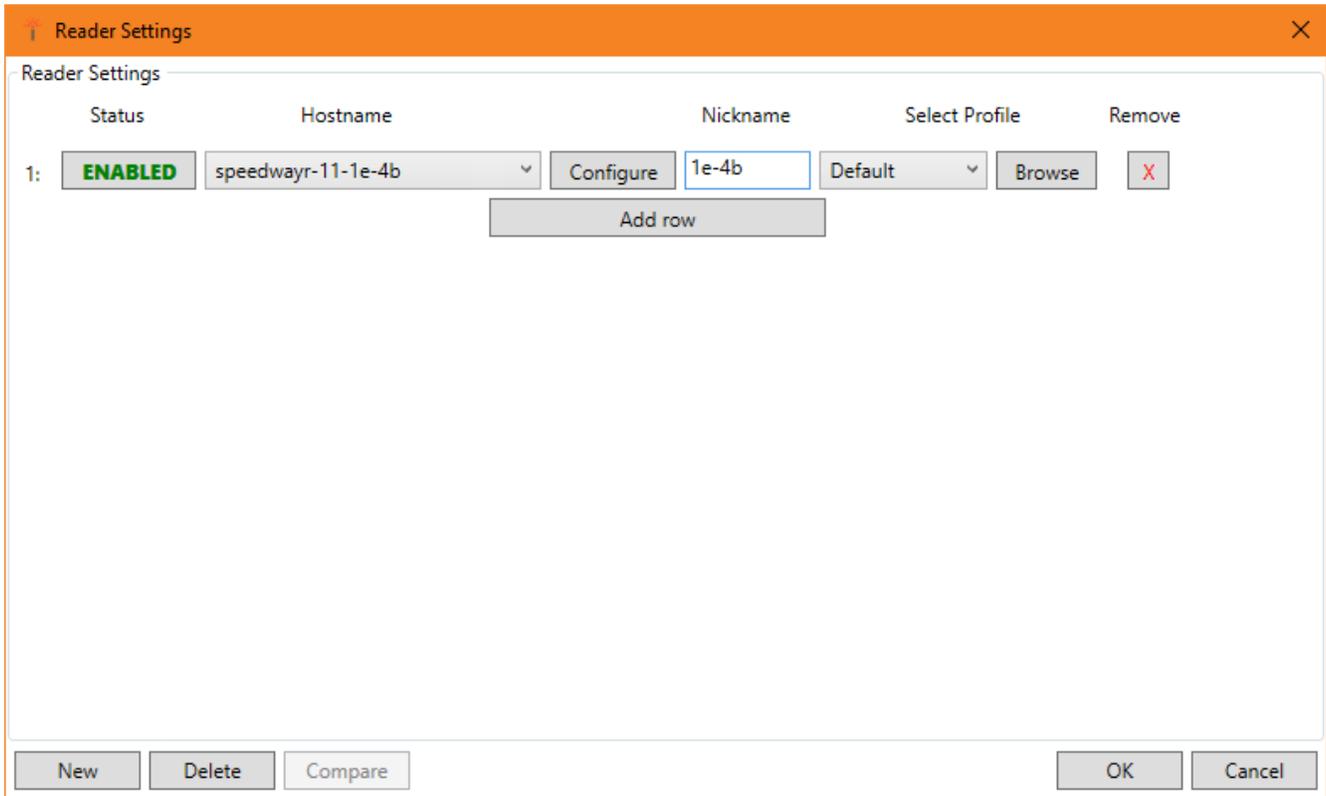
Figure 6.3 ItemTest Reader Settings Connection Screen with Name

4. In the **Reader Settings** dialog box, click **Configure**, The page shown in Figure 6.4 displays.
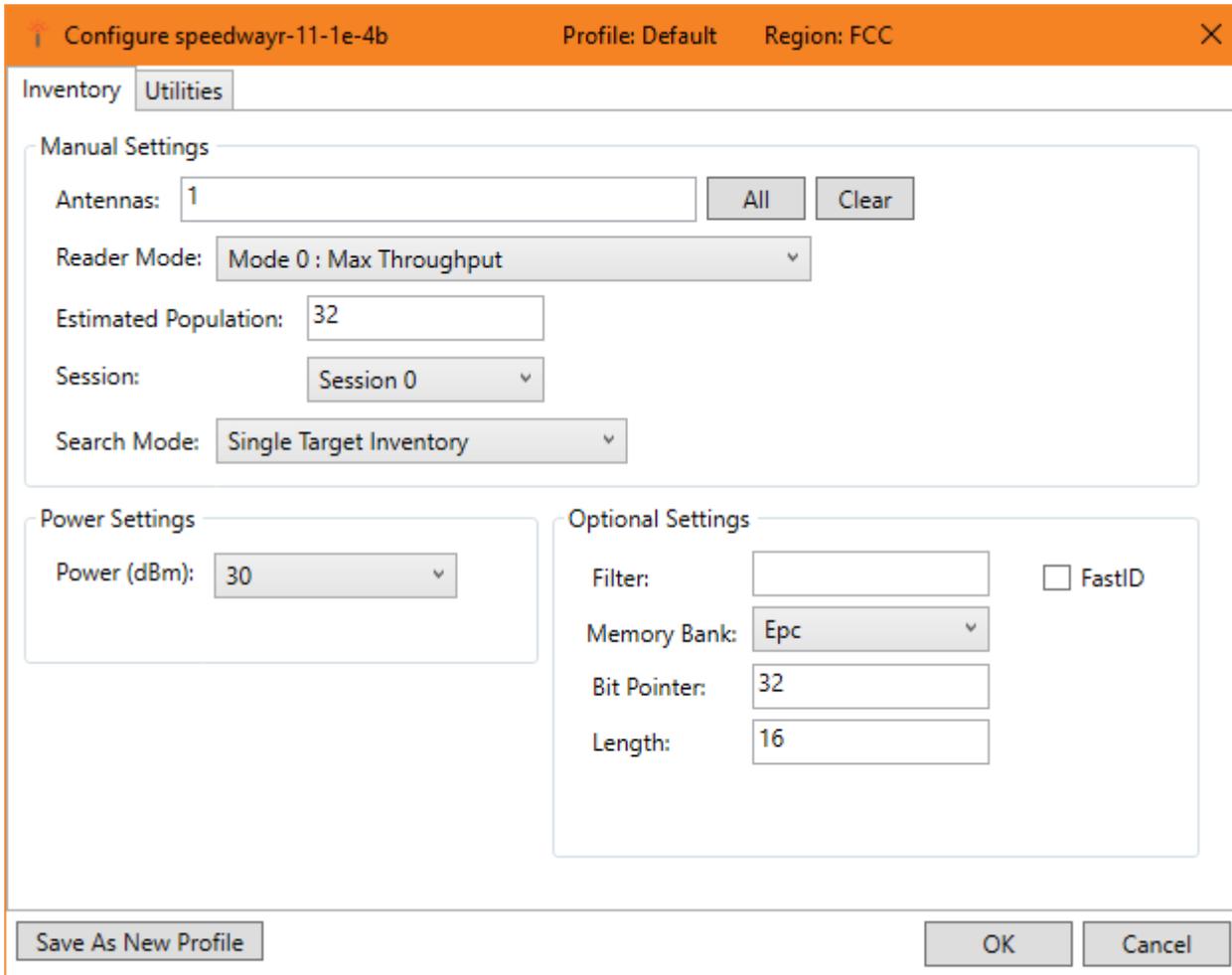
Figure 6.4 ItemTest Reader Settings Screen

6. If the Antenna Hub feature is enabled on the reader, **Antenna Hub Enabled** will be displayed in red to the right of the antenna configuration.

   Note: The Antenna Hub feature is only available on the Speedway R120 (via the Antenna Hub Port Pack) and R420 (via the Antenna Hub).

7. In **Reader Mode**, select **Mode 1000: AutoSet Dense Reader**. The Reader Mode specifies the rules to use for communication between the reader and the tag. When you enable AutoSet Dense, the reader automatically senses the environment and adjusts the mode accordingly.

8. In **Session**, select **Session 1**. In **Search Mode**, select **Dual Target**.

   Here's how **Session** and **Search Mode** work together to control when and how often the reader reads a tag. 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 after the tag is read.

When you set **Session** to **Dual Target**, the reader reads all the tags that have A flags. Then, 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 that there i is a persistence period that prevents tags from reverting before they have all been read.

9. At the top, is a text box to list the antenna ports to enable on the reader. By default, the first antenna is listed. Enter in the antennas that you wish to use as a comma separated list. You can click **All** to have all possible antennas listed. It isn't a problem if you leave all ports enabled, but it does increase processing time because the reader reads all enabled ports. The reader verifies the presence of an antenna before attempting to activate it.

10. Select the desired transmit power under **Power Settings**. Then select **OK**. For more information, see Figure 6.4.

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

    - how you are powering the reader
    - length of the cable that connects 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.

    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 you need to.

14. Test your reader installation. Place one or more tags in the read-zone of one or more of the attached antennas. On the ItemTest application screen, click **Start**. Tag reads appear under **Inventory**, as shown in Figure 6.5.
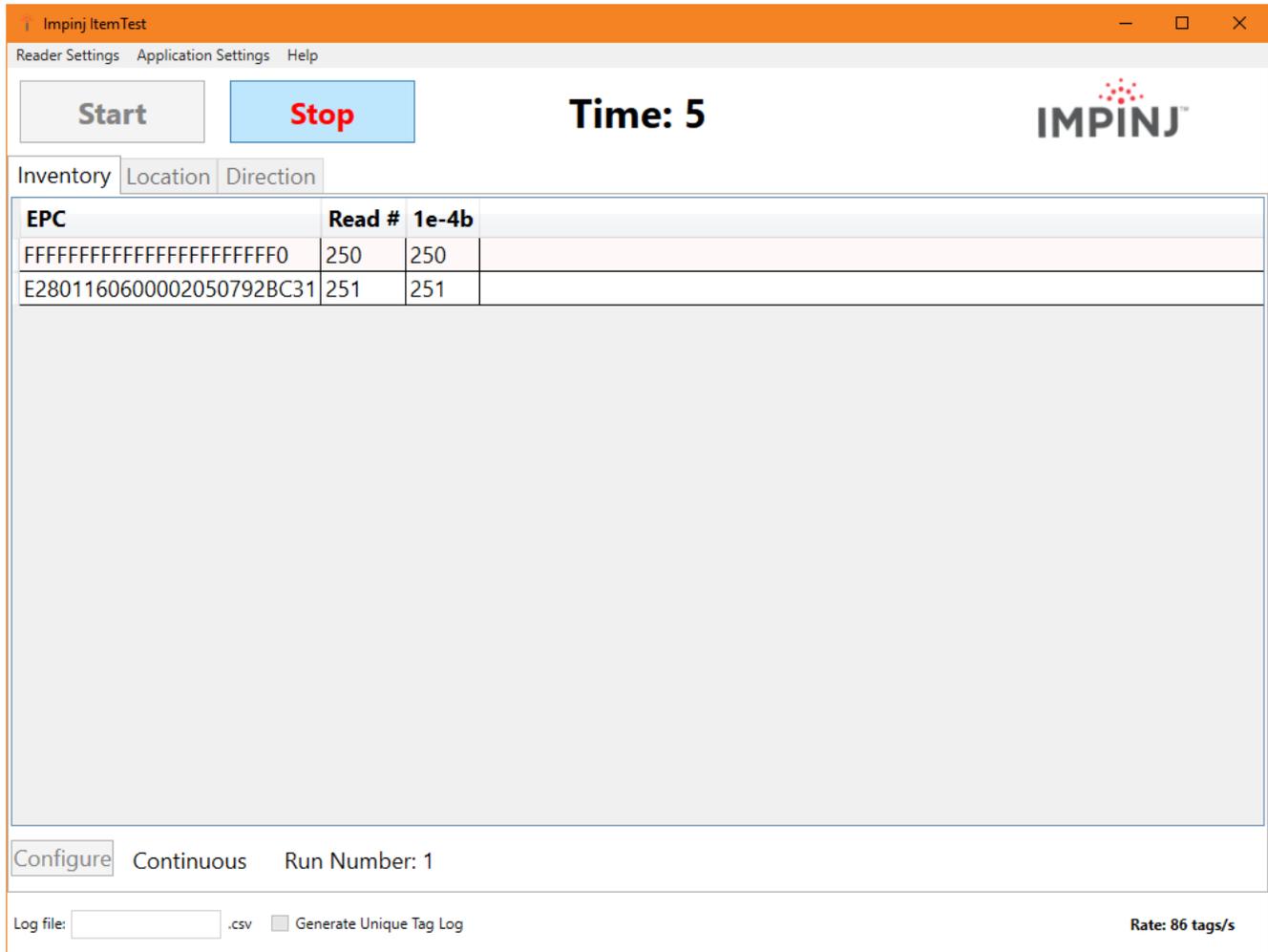
Figure 6.5 ItemTest Tag Inventory Display

In this case, the reader detected two 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 Figure 6.6 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. Both entries would quickly turn red and stay red as shown in Figure 6.6.
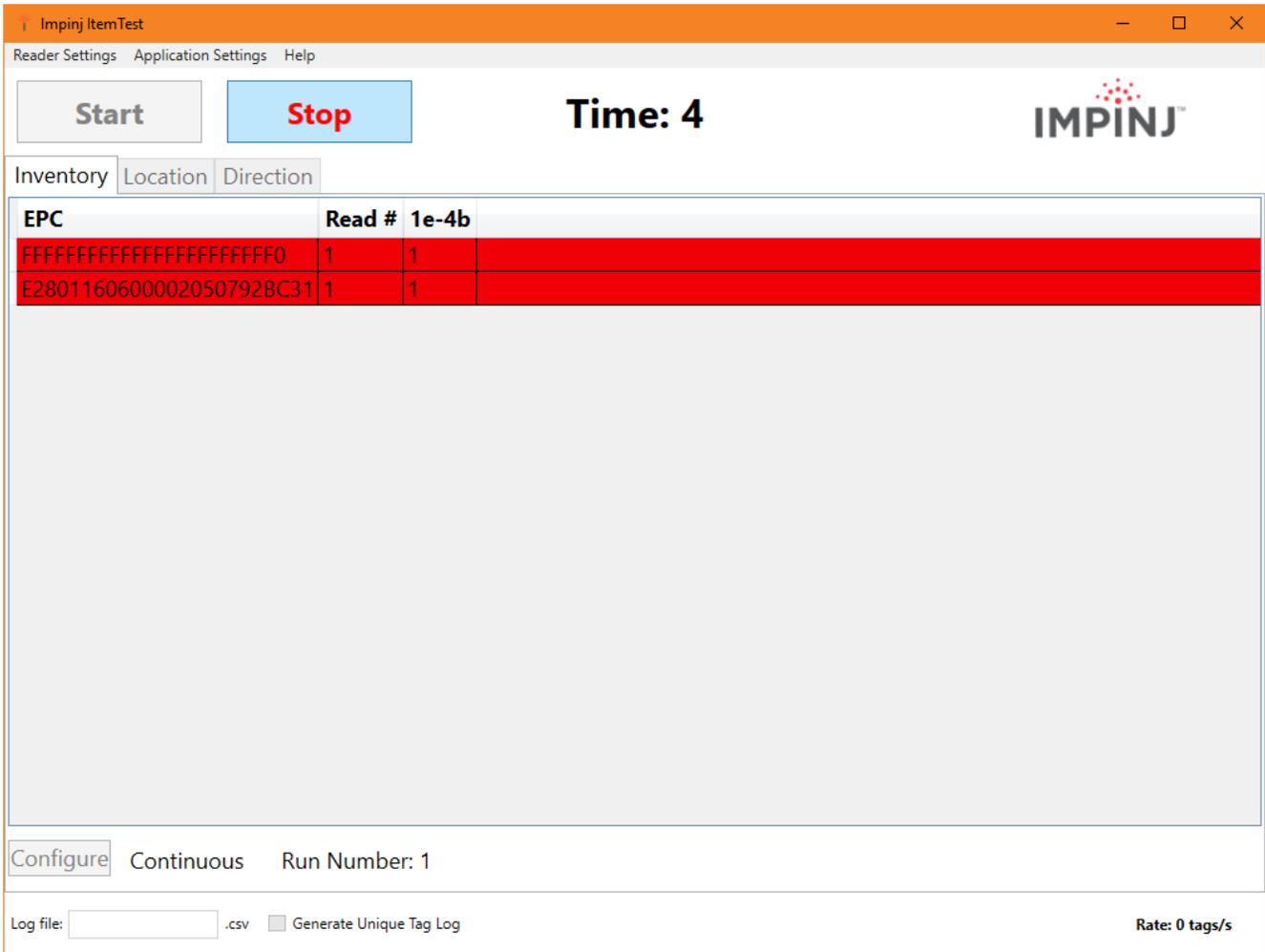
Figure 6.6 ItemTest Tag Inventory Aging Display

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

15. Click **Stop** to stop the tag inventory process.

6.2   Monitoring Speedway

Use RShell to monitor the health and performance of the reader when Speedway is up and running. This section presents the primary RShell commands to use for viewing network and RFID statistics, in addition to the reader logs. For more information about these commands, see the *RShell Reference Manual.*

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

6.2.1   Viewing Network Parameters and Statistics

Use the RShell **show network** command to display networking parameters and statistics. When you use this command with the parameters shown in Table 6.1, you can see the following information:

Table 6.1 Show network Command Parameters

Parameter	Displayed Information
dhcp	Summary of DHCP client configuration
dhcp	Summary of DNS settings
icmp	ICMP statistics
ip	IP statistics
ntp	Summary of NTP settings
summary	Summary of network settings
tcp	TCP statistics
udp	UDP statistics

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

6.2.2   Viewing RFID Parameters and Statistics

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 6.2: Description of show rfid stat Command Parameters

Parameter	Description
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, a value of 1-4.
Antenna<n>EnergizedTime	Indicates the elapsed time that anntenna<n> has been powered, in milliseconds.

Parameter	Description
Antenna<n>UniqueInventory-Count	Indicates the number of unique tags counted 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 6.2 shows a sample of the commands available to get RFID statistics. For the full list as well as syntax details, see the *RShell Reference Manual*.

Note: You can see statistics for the LLRP interface between the reader and a client by using the **show rfid llrp stat** command. For more information, see the *RShell Reference Manual*.

6.2.3   Configuring and Viewing Speedway Logs

Speedway 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
- 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 that 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 events with **Error** level or higher in an independent log.

Use the **RShell config logging** command to configure options for storing and forwarding logged events. Use the **show logging** command to display the logging configuration as well as the actual logged information in text form. For more information about these commands, see the *RShell Reference Manual.*

6.2.4   Viewing the State of the Speedway Reader

To display information about the current state of the reader itself, use the RShell **show system** command. When you use this command, you can see 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 information about the **show system** command, see the *RShell Reference Manual.*

7 Upgrading the Speedway Firmware

Speedway contains firmware known as Octane. The current version of Octane is version 7.6. This section describes how to manually upgrade a single reader.

In addition to supporting upgrade procedures, Speedway also provides methods for reverting firmware to a previous valid image and restoring firmware to factory default settings. The procedure for reverting to the previous valid image is explained in this section. The procedure for returning to factory defaults is explained in Section 8 "Troubleshooting".

7.1 A Brief Overview of the Speedway Firmware

To minimize downtime and maximize the robust handling of possible upgrade failures, Speedway contains dual images of its firmware. When a firmware image upgrade is requested, the reader continues to operate using the primary image. In the background, Speedway upgrades the secondary image. When the upgrade completes, the reader reboots to the newly upgraded image. Speedway 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 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 that runs 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)**—This partition contains custom application software, other items required by the custom application (extra libraries or tools, and configuration files), and custom application logs.

7.2 Upgrading the Firmware

Speedway provides three methods for upgrading:

- Using RShell, the command line interface.

- **Copying the firmware to a USB memory drive, and plugging it into the** reader's host port.

- Using the Impinj Speedway Reader Management web page.

7.2.1   Upgrading the firmware by using RShell

Use this procedure to use RShell to upgrade the firmware:

1. Obtain the firmware upgrade file from the Impinj support Web site, `support.impinj.com`. The upgrade file extension is **.upg**. (Example: **octane-7.4.0.240.upg**).

2. Place the upgrade file on a server (http or sftp) that is accessible by the reader you are upgrading.

3. Using the Putty application, connect to the reader using by SSH or serial, and then log in.

4. From the RShell command prompt, issue the following command:

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

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

For example:

```
> config image upgrade http://usacorp/rfid/reader/image/octane-7.4.0.240.upg
> config image upgrade sftp://anonymous:abc@myserver/sftpdirecotry/octane-7.4.0.240.upg
```

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

   ```
   > show image summary
   ```

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

   WaitingForImageFileTransfer
   WaitingForCommitImage
   WaitingToActivateImmediate

The upgrade is complete when the UpgradeStatus parameter value is

Ready

The **LastOperation** parameter should be set to **WaitingToActivateImmediate** and the **LastOperationStatus** should be set to **WaitingForManualReboot**.

7. Reboot the reader by issuing the following command:

```
> reboot
```

The Speedway reboot process displays messages in the RShell console as it goes through each stage of the process. The reboot completes, and then the reader login prompt displays on the console. The reader status light displays solid green. For more information, see the tables in Section 5 **Speedway Ports and LEDs**.

7.2.2   Upgrading the Firmware by using a USB Drive

A Speedway reader that runs Octane 4.4 and later supports upgrading the firmware by using a USB drive.

First, obtain the firmware upgrade file from the Impinj support Web site, support.impinj.com. The upgrade file extension is .***upg***. (Example: *octane-7.4.0.240*).

To prepare the USB drive for the upgrade

1. Insert a USB drive into your computer.

2. Create a directory named **impinj** in the root of the USB drive, and create the subdirectories **revolution**, **upgrade**, and **images**. The names of these directories are case sensitive and must all be lower case.

3. Copy the desired firmware upgrade .***upg*** file into the directory:

```
\impinj\revolution\upgrade\images\
```

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.

To use the USB drive to update the reader

1. Confirm that the reader is ready for upgrade, and that the Power and Status LEDs are 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 changes to solid green.
4. 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.

7.2.3   Upgrading the Firmware through the Reader Management Web Page

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

1. Connect to the reader using a web browser and navigate to http://<reader name or IP address>.

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

2. Log in to the reader using the following credentials:

    user name: **root**

    password: **impinj**

3. **Click the Choose File 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 7.1 Speedway Reader Management Web Page

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

7.2.4   Reverting to the previous image

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

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

   ```
   > config image fallback
   ```

   When the command completes successfully, the 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'.

8 Troubleshooting

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

8.1 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** below.

There are two ways to return Speedway to its defaults:

1. Issue an RShell command.
2. Press the **Default Restore** button on the device. This removes any installed CAP.

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, and CAP applications are intact.

To use the Default Restore button on the reader to restore to its default configuration and remove any CAP

1. Power off the reader.
2. 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 the reader is powered off.
3. Be sure to be pressing the **Default Restore** button while plugging in power to the reader.
4. Release the Default Restore button when the LED blinks red once. The reader will boot up normally with the default configuration.

Figure 8.1 Default Restore button

⚠ **Warning:** Pressing the Default Restore button for 10 seconds or more will cause a factory default restore to occur. The factory default restore removes the 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.

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

Table 8.1 lists the default configuration values.

Table 8.1: Default Configuration Values

Parameter	Default Value
User	root
Password	impinj
Upgrade Retrieve Mode	Manual
Logging	No syslog servers
Management Logging Level	Error
RFID Logging Level	Error
System Logging Level	Error

Parameter	Default Value
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

8.2 Submitting Diagnostic Data for Analysis by Impinj Technical Support

If Speedway is exhibiting RF behavior that is different from what you expect and you are unable to determine the cause, you might want to submit relevant data for analysis by Impinj Technical Support. You can use the Impinj ItemTest application to easily capture data related 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 ItemTest and connect to the appropriate Speedway reader. For more information, see Figure 6.1 earlier in this document.

2. Select **Reader Settings** then **Configure** for the specific reader.

3. Select the **Utilities** tab.

4. Choose an RDD file name and the desired capture window in minutes.

5. Select **Start RDD** to begin the capture session.

   ItemTest connects to the reader and begins "listening" for any RF activity. The reader captures data surrounding any RF activity it detects.
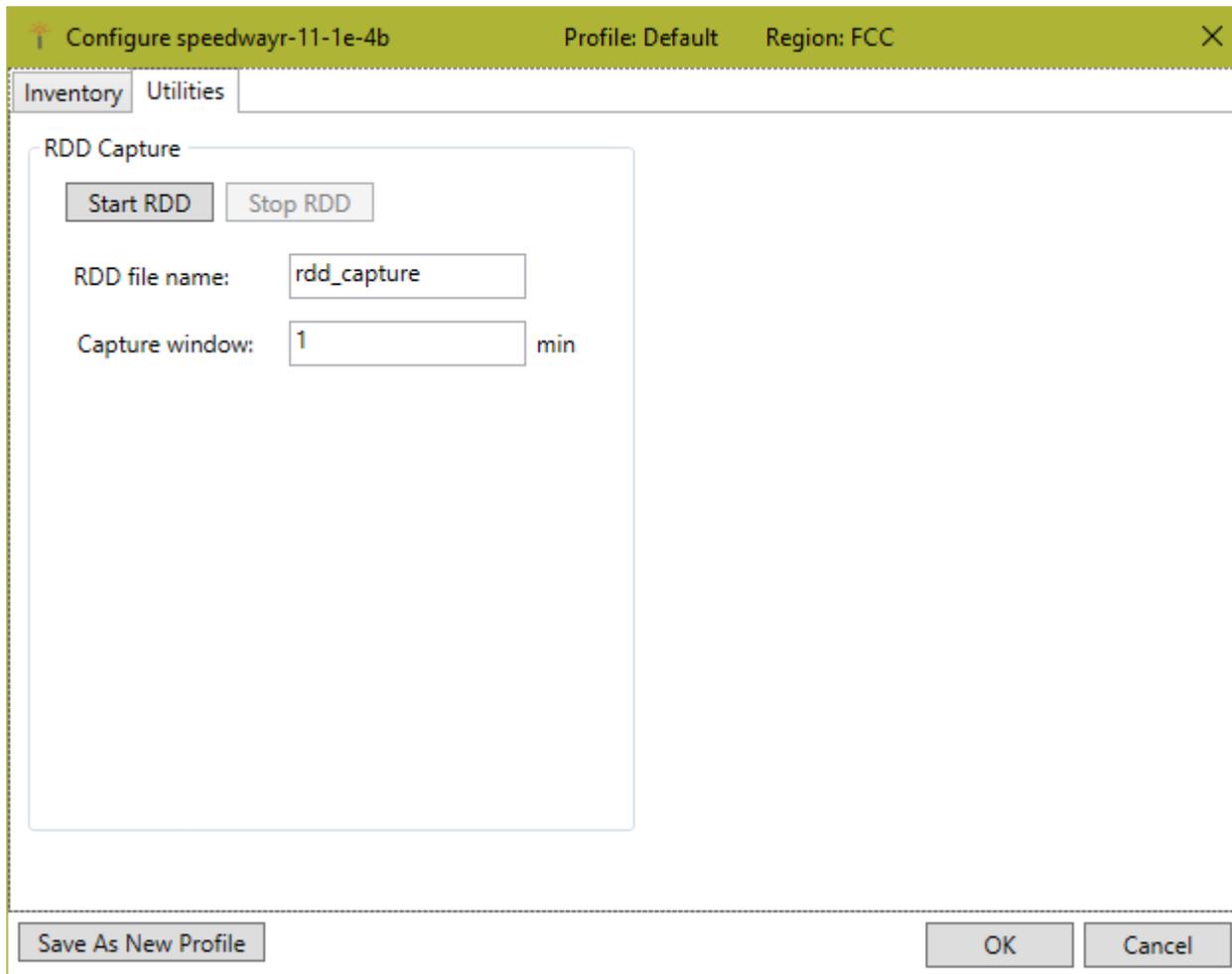
Figure 8.2 Reader Settings, Tag History & Debug Data Capture

6. Select **Stop RDD** to stop the session. The rdd file will be saved in the **rdd** folder where you installed ItemTest.

   This completes the capture activity.

7. **Send the *.rdd* file that contains binary data to Impinj Technical** Support.

   Visit the Impinj support Web site, `support.impinj.com`., for submission details or talk with your Impinj representative.

Note: Another option to capture diagnostic data is to create a network trace by using Wireshark, a free protocol analyzer download from the Internet.

9 Appendix A: Information Specific to Regions of Operation

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

9.1 Operation in North America

9.1.1 Frequency Plan

The FCC specifies frequency hopping across the North American spectrum (USA, Canada, and Mexico) allocated to UHF RFID (902-928 MHz) using FHSS (frequency-hopping spread spectrum). 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

9.1.2 Antenna Requirements

Positioning

FCC Maximum Permissible Exposure (MPE) guidelines require the antenna's surface to be at least 25 centimeters away from personnel working in the area. For more information, 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*

Canadian ISED Maximum Permissible Exposure Guidelines require the antenna's surface to be at least 35 centimeters from personnel working in the area. For more information see Radio Standards Specification RSS-102 Issue 5 dated April 2018

Installation

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

Power

When paired with an antenna, Speedway may radiate no more than 36dBm EIRP per FCC Part 15.247 regulations. The Speedway output power can 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.

Speedway may be operated with any antenna which has been certified by Impinj for FCC compliance in conjunction with the reader. Alternatively, an antenna may be used in lieu of a certified antenna if it is of the same type with equal or lower gain. The reader may not be operated with any antenna that is neither certified nor of the same type/gain as that of a certified antenna. Certified antennas, including vendor, model number, and associated gain are listed in the next section.

Certified 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 pigtall 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

- Impinj model number IPJ-A1100-USA (Times-7 model A5010, part # 60001 or 60003) with SMA female connector; 8.5 dBi composite gain

- Impinj model number IPJ-A1200-USA (Times-7 model A5020, part # 60010) with SMA female connector; 5.5 dBi composite gain

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

⚠️ **Avertissement:** L'utilisation de toute antenne ne figurent pas ci-dessus peut endommager le lecteur ou affecter les performances.

9.2 Operation in European Union (lower frequency band) and United Arab Emirates (UAE)

9.2.1 Frequency Plan

For European operation, the Speedway readers support the frequency plan listed in Table A.2 and are compliant with the current ETSI EN 302 208 specification for the 865.6-867.6MHz frequency band. Impinj implements the four-channel high power plan that doesn't use listen-before talk, the maximum continuous transmit time on a channel is four seconds, and the reader enforces the 100 milliseconds off time before reusing the same channel.

Table A.2: Frequency Plan for European Union

LLRP Channel Number	Transmit Channel Number	Center Frequency (MHz)
1	4	865.7
2	7	866.3
3	10	866.9
4	13	867.5

9.2.2 Antenna Requirements

Power

EU and UAE regulations allow a maximum radiated power of 33 dBm ERP (Effective Radiated Power) for high power RFID systems. The maximum Speedway 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 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

- Impinj model number IPJ-A1100-EU1 (Times-7 model A5010, part # 60002 or 60004) with SMA female connector; 6.35 dBd gain

- Impinj model number IPJ-A1200-EU1 (Times-7 model A5020, part # 60011) with SMA female connector; 3.35 dBd gain

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

⚠️ **Avertissement:** L'utilisation de toute antenne ne figurent pas ci-dessus peut endommager le lecteur ou affecter les performances.

9.3   Operation in European Union (upper frequency band)

9.3.1   Frequency Plan

For European operation, the Speedway readers support the frequency plan listed in Table A.3 and are compliant with the current ETSI EN 302 208 draft specification for the 916.1-918.9MHz frequency band.

Table A.3: Frequency Plan for European Union

LLRP Channel Number	Transmit Channel Number	Center Frequency (MHz)
1	3	916.3
2	6	917.5
3	9	918.7

9.3.2   Antenna Requirements

Power

EU regulations for upper frequency band allow a maximum radiated power of 36 dBm ERP (Effective Radiated Power) for high power RFID systems. The maximum Speedway output power is determined by the following equation:

$$\text{Maximum power setting (in dBm)} = 36 - \text{Antenna Gain (in dBd)} + \text{Cable loss (in dB)}$$

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 36-6+2 = 32 dBm. The maximum transmit power of Speedway EU2 reader is 33dBm 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

The EU upper frequency band is contained within the FCC approved band. For approved antennas refer to the list under the North America operation (FCC) section above.

9.4   Operation in Other Global Regions

For operation and use in the Rest of the World (ROW), there are three models, GX1, GX2, or GX3. Please contact Impinj to learn which countries and regions are currently certified.

Installation

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

Operation in China, Indonesia, and Malaysia

Regulations in these countries allow a maximum radiated power of 33 dBm ERP (Effective Radiated Power) for high power RFID systems. The maximum Speedway 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 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 Singapore and Vietnam

Regulations in these countries allow a maximum radiated power of 500mw ERP within the specified frequency band without additional licenses. The user is required to apply for and obtain approval from the local regulatory agency for each use case where the radiated power is between 500mW to 2000mW ERP. In Singapore contact Infocomm Media Development Authority (IMDA) to request a license for 500-2000mW operation. In Vietnam contact the Authority of Radio Frequency Management (ARFM) to request a license for 500-2000mW operation. The maximum Speedway output power for 2000mW ERP is determined by the following equation:

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

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.

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 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:

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.

9.4.1 Approved Antennas

Approved antennas for global operation are listed under the North America section above.

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

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

⚠ **Avertissement:** L'utilisation de toute antenne ne figurent pas ci-dessus peut endommager le lecteur ou affecter les performances.

Frequency Plans

The GX1 and GX3 readers 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. The specific frequency plans by country are listed in the tables that follow.

Table A.4 Australia (GX3) 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
10	45	924.75 MHz

Table A.5 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	902.75
2	2	903.25
3	3	903.75
4	4	904.25
5	5	904.75
6	6	905.25
7	7	905.75
8	8	906.25
9	9	906.75
10	10	907.25
11	26	915.25
12	27	915.75
13	28	916.25
14	29	916.75
15	30	917.25
16	31	917.75
17	32	918.25
18	33	918.75
19	34	919.25
20	35	919.75
21	36	920.25
22	37	920.75
23	38	921.25
24	39	921.75
25	40	922.25
26	41	922.75
27	42	923.25
28	43	923.75
29	44	924.25
30	45	924.75
31	46	925.25
32	47	925.75
33	48	926.25

34	49	926.75
35	50	927.25

Table A.6 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
8	43	923.75 MHz
9	44	924.25 MHz
10	45	924.75 MHz

Table A.7 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.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
8	43	923.75 MHz
9	44	924.25 MHz
10	45	924.75 MHz

Table A.12 Taiwan operating frequency band is 920 to 928 MHz with 500 kHz channel spacing.

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	37	920.75 MHz
2	38	921.25 MHz
3	39	921.75 MHz
4	40	922.25 MHz
5	41	922.75 MHz
6	42	923.25 MHz
7	43	923.75 MHz
8	44	924.25 MHz
9	45	924.75 MHz
10	46	925.25 MHz
11	47	925.75 MHz
12	48	926.25 MHz
13	49	926.75 MHz
14	50	927.25 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
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

Table A.15 Vietnam operating frequency band is 920 to 923MHz with 500 kHz channel spacing.

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
1	37	920.75 MHz
2	38	921.25 MHz
3	39	921.75 MHz
4	40	922.25 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
. . .	. . .	. . .

LLRP Channel Number	FCC Channel Number	Center Frequency (MHz)
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

9.5   Operation in Japan

9.5.1   Frequency Plan

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

Approved Antennas

Contact your value-added distributer that you obtained your Speedway reader for current list of approved antennas for use in Japan.

9.6 Operation in India

9.6.1 Frequency Plan

For India, the Speedway readers support the frequency plan listed in Table A.21 and are compliant with the Government of India Ministry of Communications & IT Department of Telecommunication rules.

Table A.21: Frequency Plan for India

Transmit Channel Number	Center Frequency (MHz)
1	865.1
4	865.7
7	866.3
10	866.9

9.6.2 Antenna Requirements

Power

Regulations in India allow maximum radiated power of 36 dBm EIRP. The Speedway output power may be increased to provide the maximum allowable EIRP. The expression for the maximum reader power setting is:

Maximum power setting (in dBm) = 36 - Antenna Gain (in dBi) + Cable loss (in dB)

Approved Antennas

Contact your value-added distributer that you obtained your Speedway reader from for current list of approved antennas for use in India.

10   Appendix B: GPIO Details

Speedway 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.
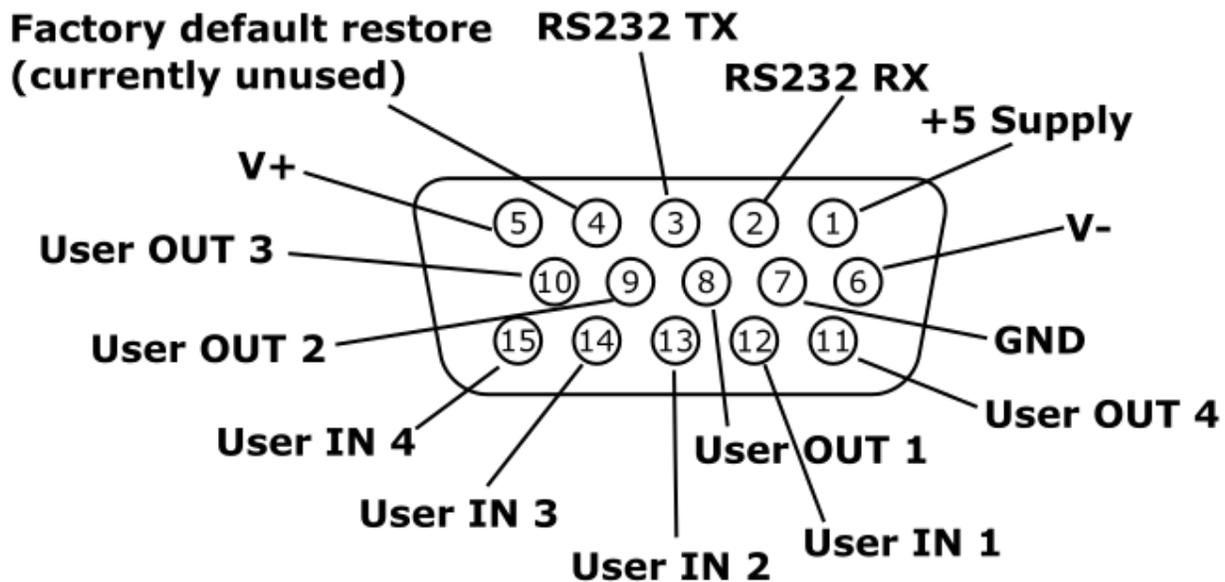
Figure B.1 DE-15 GPIO Port Functions

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.

⚠️ **Warning:** Do not attach a lightstack or other output device that requires reader 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.

⚠️ **Avertissement:** Ne pas fixer d'lightstack ou tout autre périphérique de sortie qui nécessite une sortie de la lecteur à s'enfoncer de plus de 200mA. Connexion de périphériques non autorisés entraînera des dommages irréparables pour le lecteur et n'est pas couvert par la garantie car il est en dehors des paramètres de fonctionnement spécifiées.

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

Table B.1: 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
13	User IN 2	Isolated input 2
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

11   Appendix C: Speedway xPortal Installation

NOTICE: The Impinj xPortal has begun the end-of-life process. Please see the EOL product notice for details.

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

11.1   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.
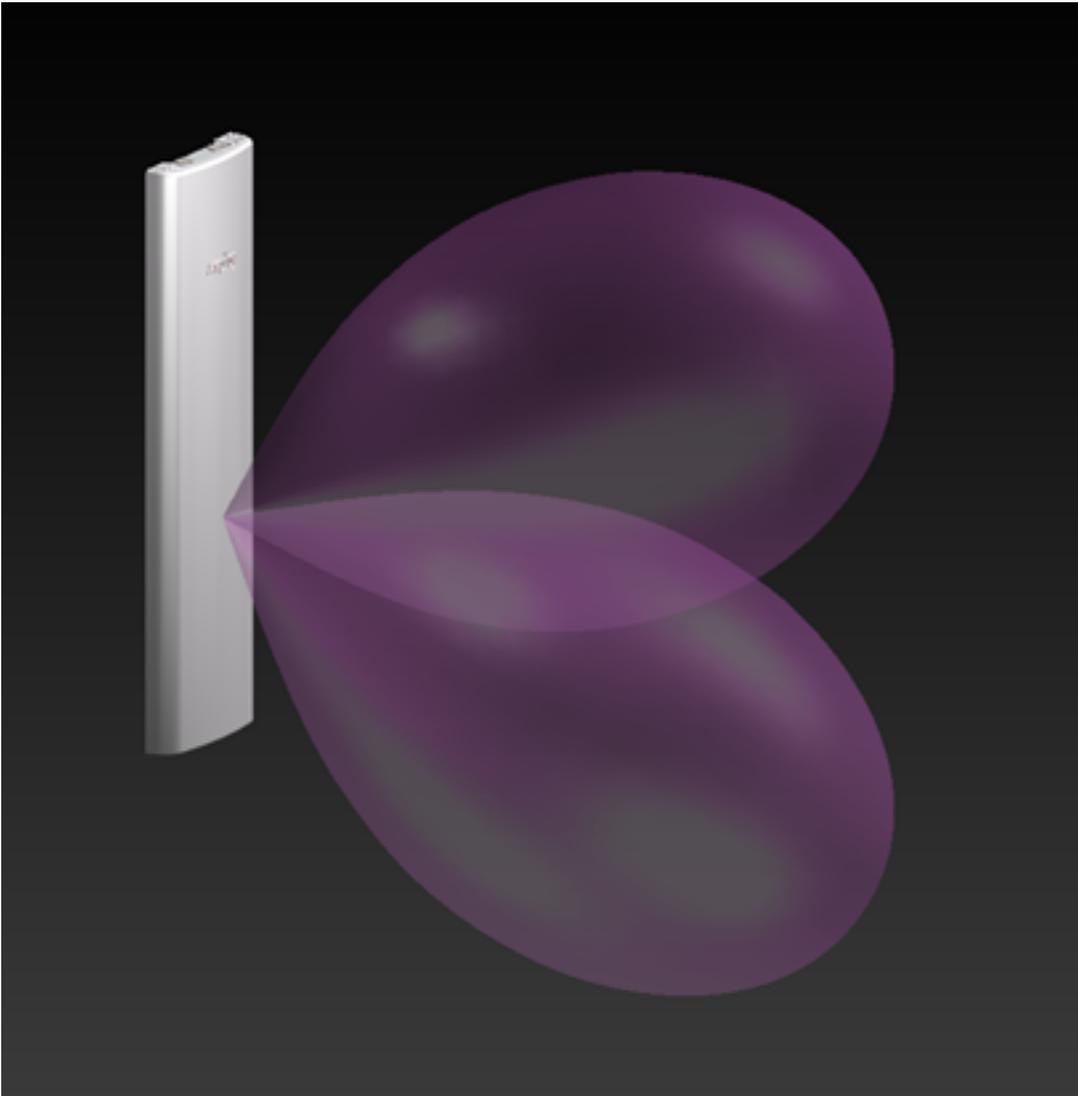
Figure C.1 xPortal Simulated RF Beam Patterns

11.2   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
- ¼ inch diameter bolt with 20 threads per inch (¼-20) internally threaded studs

2. Common hardware using ¼-20 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 ¼-20 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.
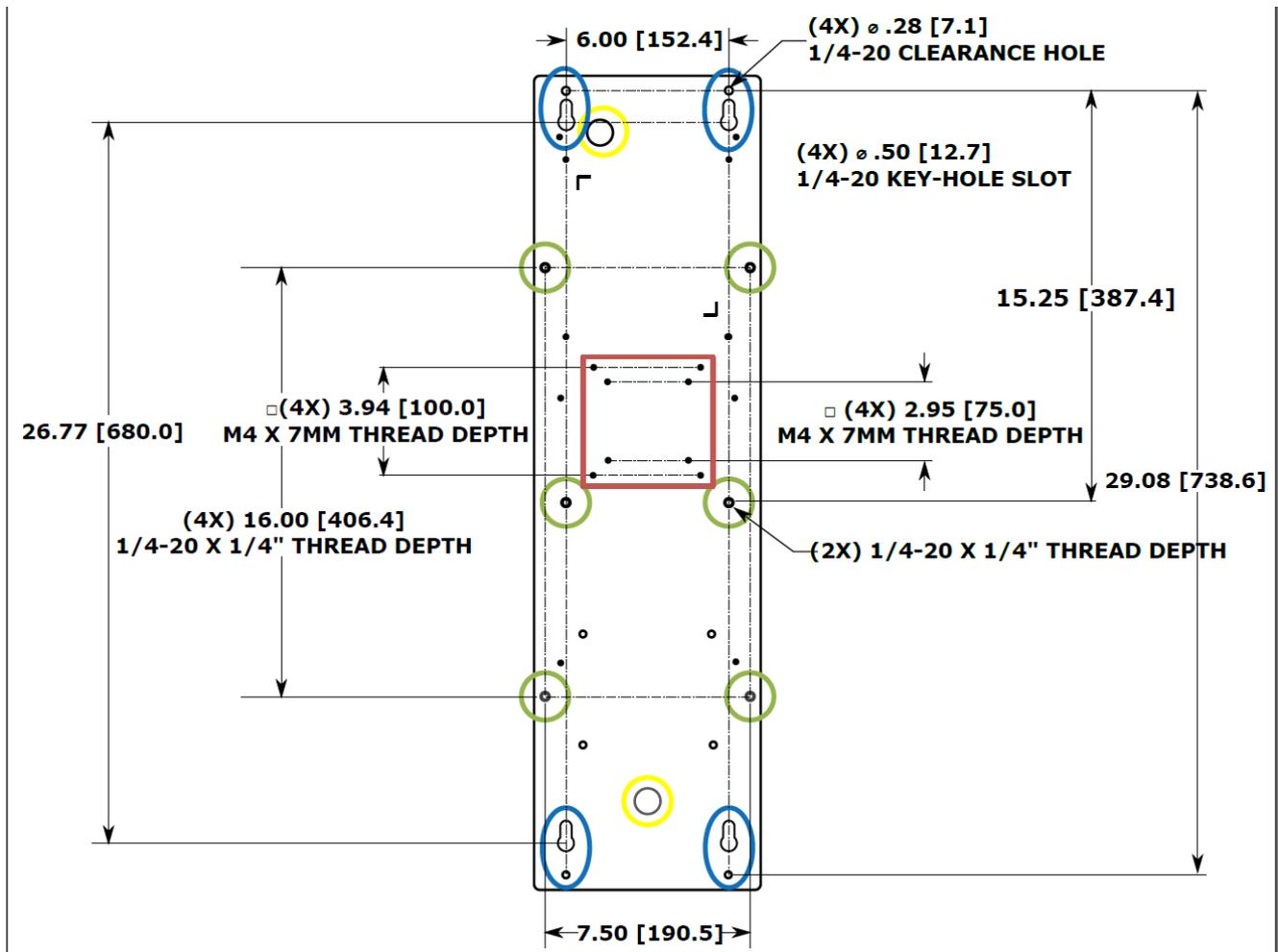
Figure C.2 xPortal Mounting Hole Types and Locations

11.3   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 ½ inch trade size conduit connectors, or where metric conduit is used, 16mm trade size. Larger sizes of conduit (such as ¾ inch) can be used with the proper adapters. See example Figure 3 below.

The following photos highlight the usage options.
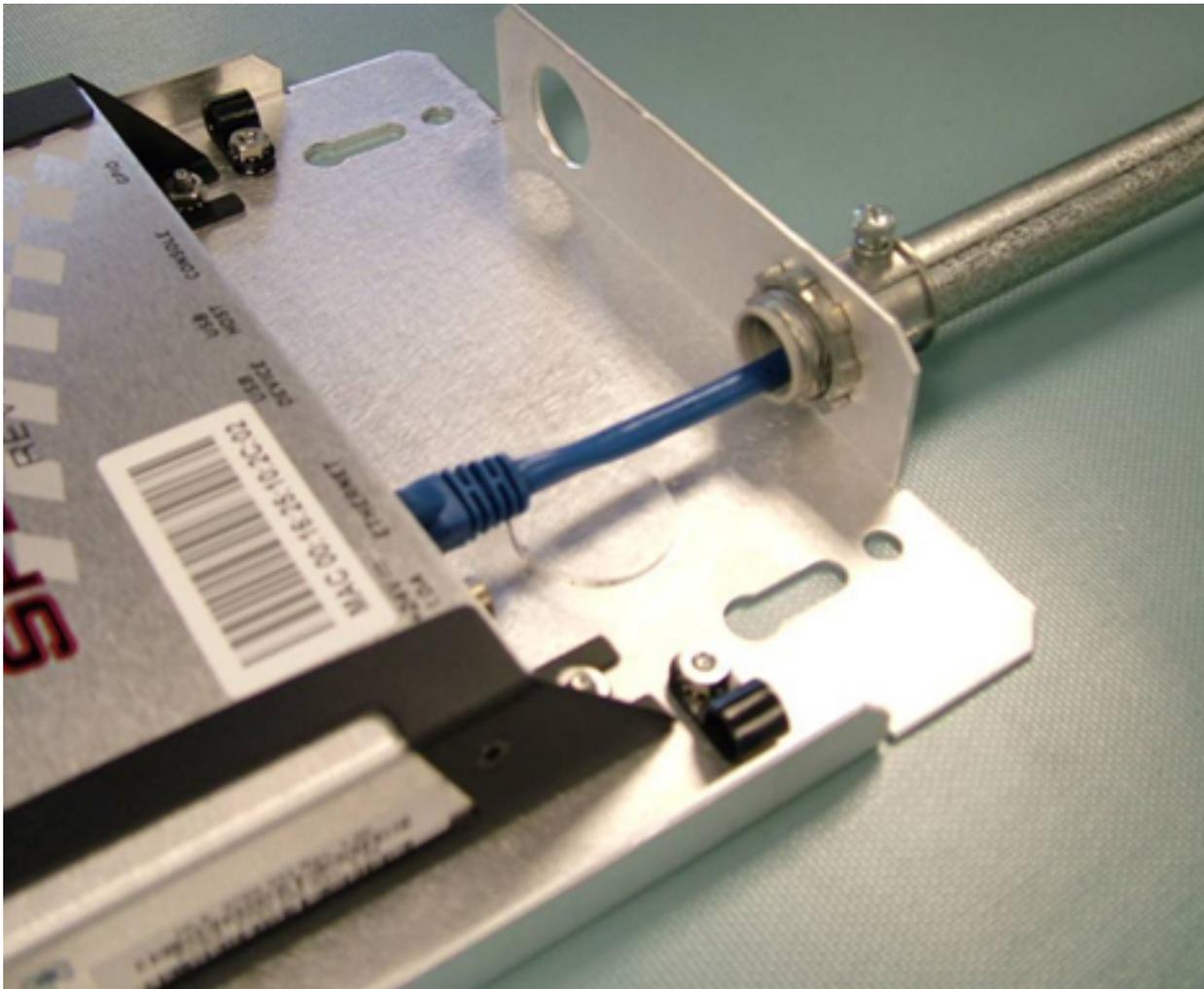
Figure C.3 ½ inch conduit with a threaded nut flange connector

Figure C.4 Threaded ½ inch conduit connector
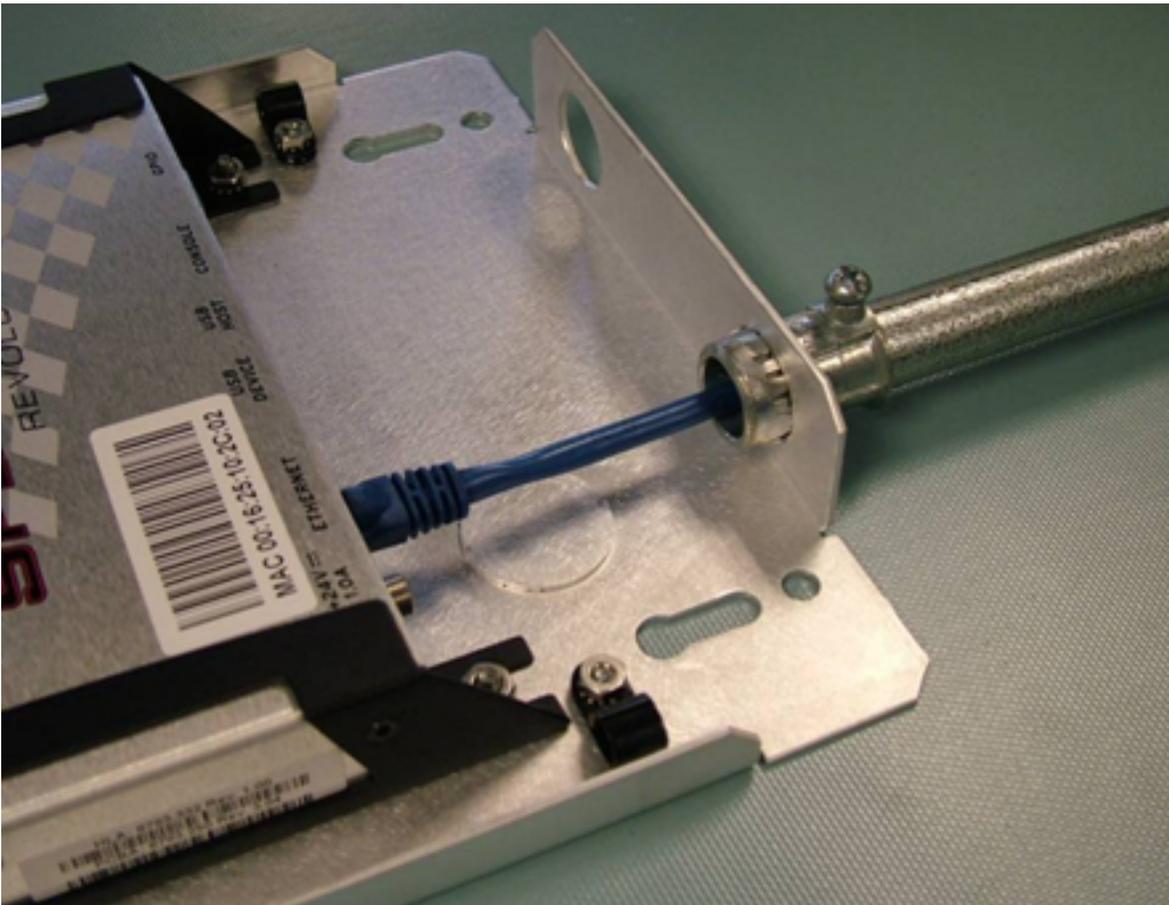
Figure C.5 ½ inch conduit with a snap in flange connector

Figure C.6 Snap in ½ inch conduit connector
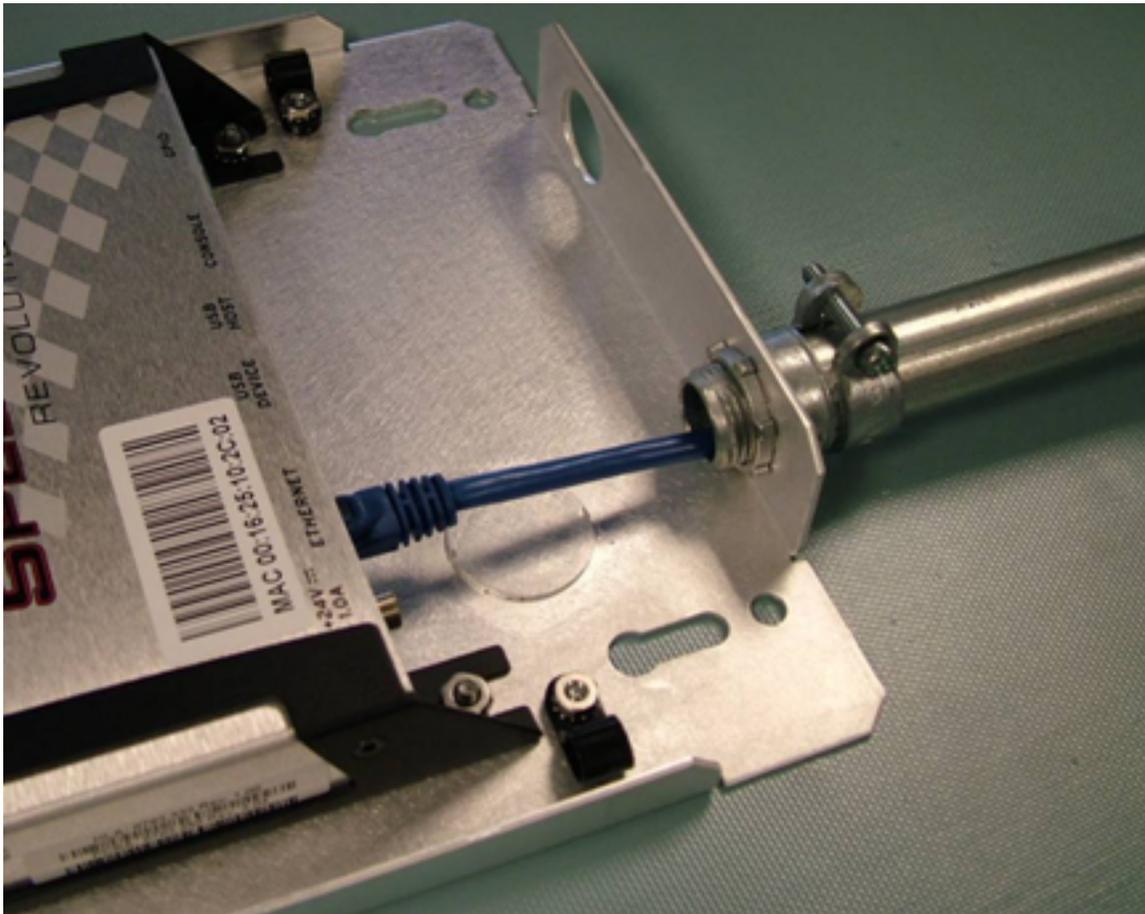
Figure C.7 A squeeze connector for the larger ¾ inch conduit tubing size. The connector has a nut and threads sized for the ½ inch conduit hole.

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

12 Appendix D: Speedway Antenna Hub Installation

12.1 Speedway R420 Antenna Hub Solution Checklist

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

- 1 Speedway Antenna Hub (IPJ-A6001-000) required components (available separately):
- 1 Speedway 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)
- ItemTest software version 1.6 or higher
- Optional – up to 3 additional Antenna Hubs
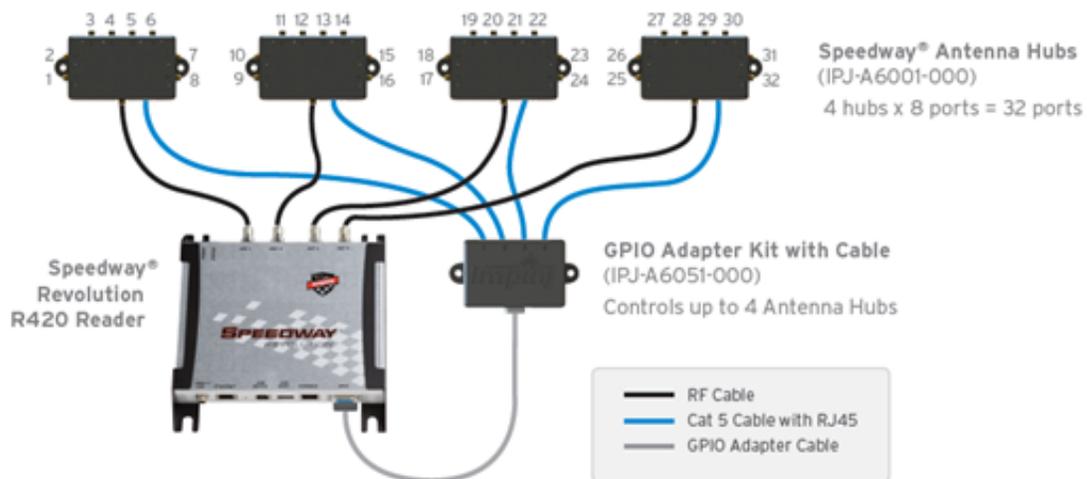
Figure D.1 Speedway R420 reader with four antenna hubs and GPIO adaptor for a total of 32 RF antenna ports.

12.2   Speedway R120 Antenna Hub Solution Checklist

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

- 1 Speedway R120 Port Pack (IPJ-A6120-000) required components (available separately):
- 1 Speedway R120 reader with Octane firmware v5.12 or higher (IPJ-REV-R120)
- RF Cables (various)
- Cat5 cables for control channel (not sold by Impinj)
- Antennas (various)
- ItemTest software version 1.6 or higher

12.3   Setting Up a Speedway Antenna Hub System

1. Check the Firmware Version on your Speedway R120 or R420 reader.

   a) Connect to the Reader Management web page 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) Take note of the "Software Version" shown on the Reader Management web page. 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 on the Reader Management web page.

2. Enable the Antenna Hub Feature.

   a) On the Reader Management web page, click on the "Enable" button in the Antenna Hub section to enable the feature. You will need to manually reboot the reader by clicking **Reboot** on the Reader Management web page for the changes to take effect.

   b) **The Antenna Hub environment can also be enabled from RShell by 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.

- Requires cables with SMA male connectors for the Antenna Hub connection and R-TNC female connectors for the reader connections.
- 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).
- Connect the appropriate RF cables between the Antenna Hub output ports and antennas.
- Leave unused ports empty or terminated.

    c) Connect GPIO Adapter with Digital signal cables.

- Use the cable provided with the GPIO Adapter to connect the reader at its GPIO port to the GPIO Adapter.
- 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** on the Antenna Hub page in the Reader Management web page for help with any connection issues.

4. Affix the Antenna hub or hubs.

    a) Mount the hub using $^1/_4$ inch mounting holes.

    b) It might 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 Section 5.3 in this document.

    b) Develop your controlling application using the LLRP Toolkit.

    c) Visit http://support.impinj.com for helpful information and recommendations.

IMPORTANT: Power must be cycled to all attached Antenna Hubs after enabling or disabling the Antenna Hub feature on Speedway Revolution to ensure proper operation.

12.4   Hub Feature Enable and Diagnostics Using the Reader Management Web Page

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**

3. 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.

ANTENNA HUB

Feature Status	Enabled
Press to Disable	Disable Antenna Hub
Connections	Show Connections

READER REBOOT

Reboot Status	Ready To Reboot
Press to Reboot	Reboot ⟳

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

4. 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.
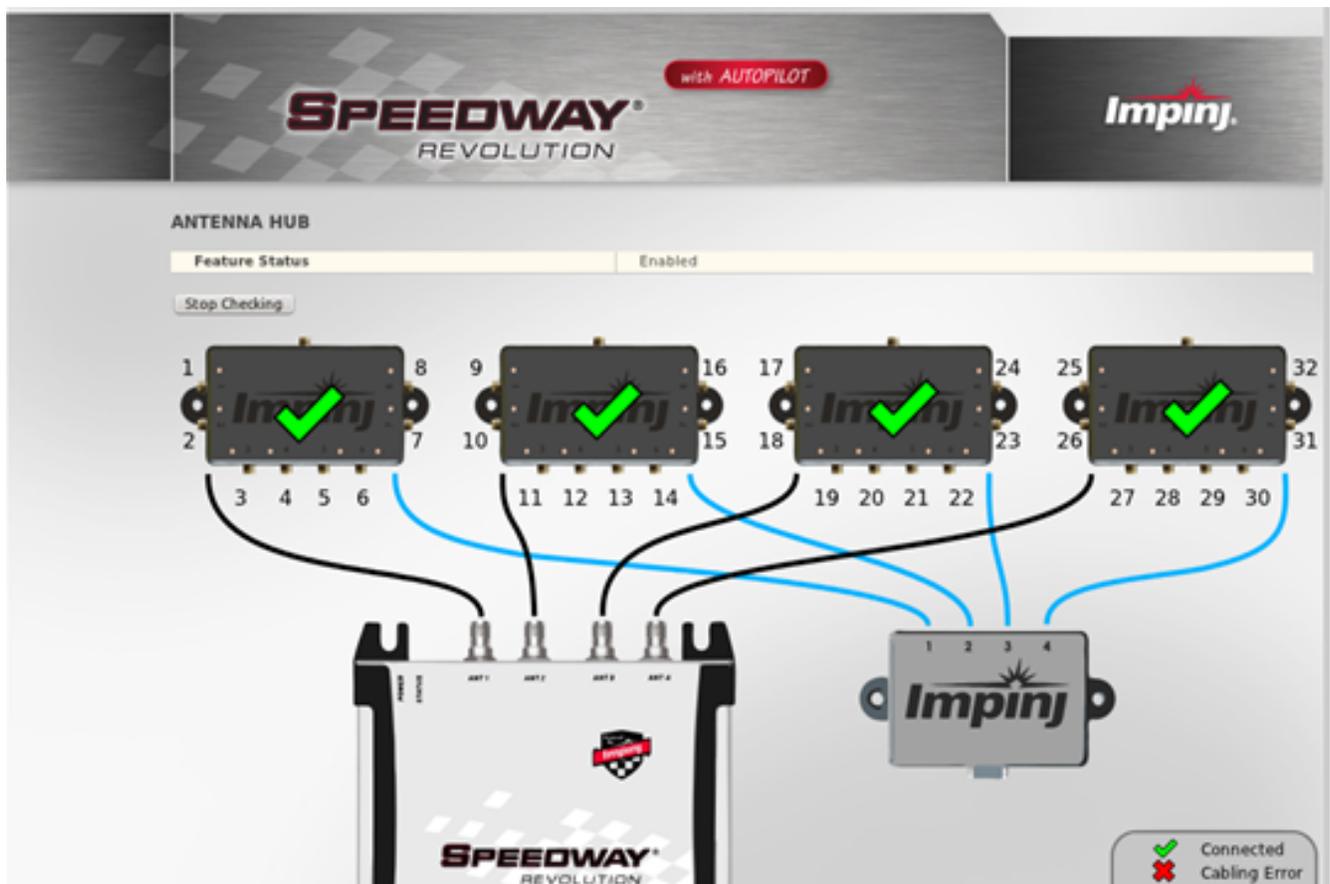
Figure D.3 Four Antenna Hubs Detected

The bottom of the Antenna Hub page displays the details about each Antenna Hub, or **Disconnected** for unused GPIO Adapter ports.
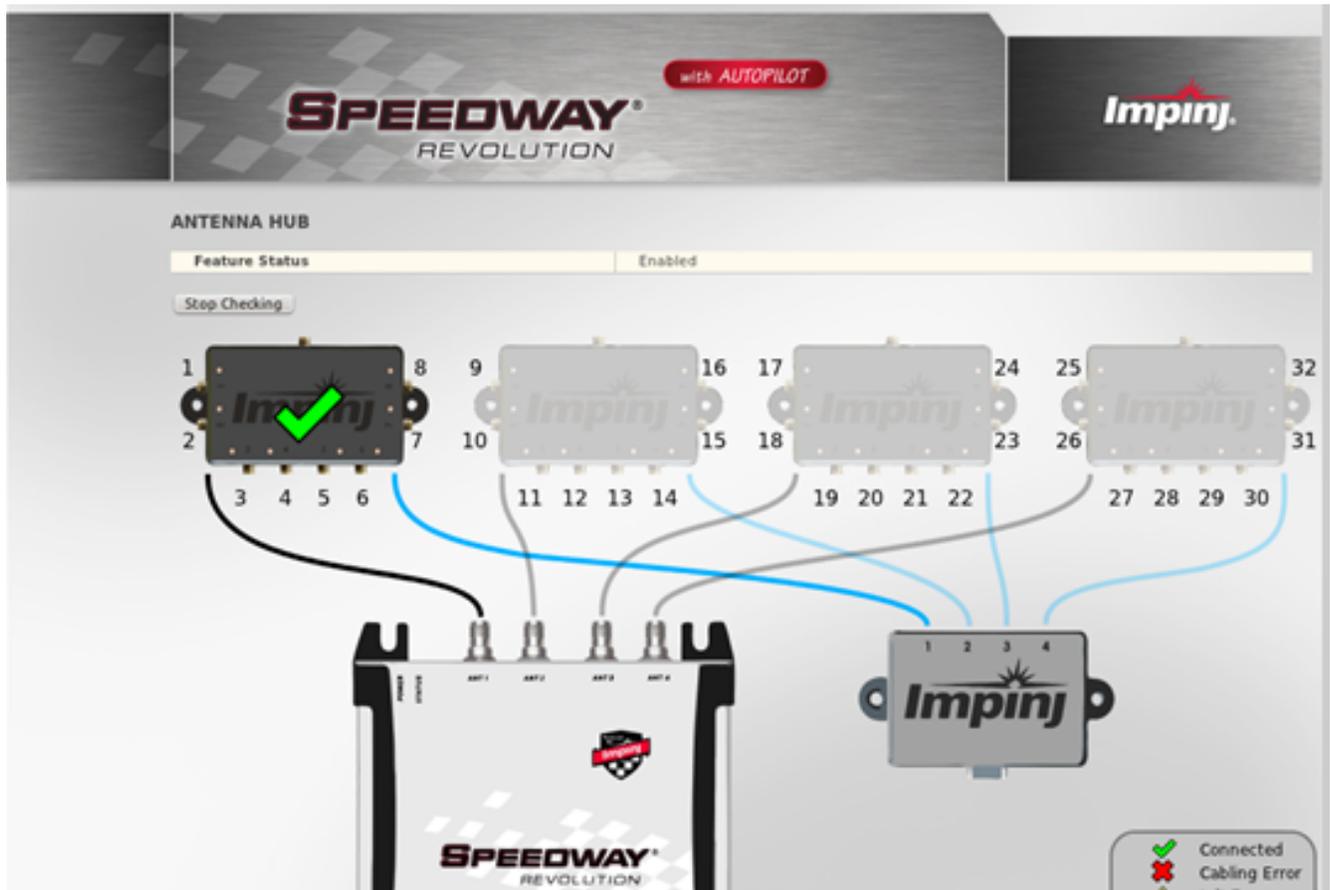
Figure D.4 One Antenna Hub Detected

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.
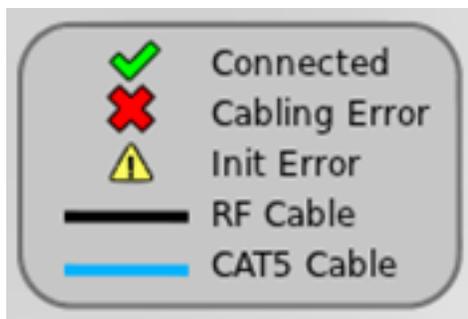
Figure D.5 Antenna Hub Confirmations

Table D.1 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 hu
▬	RF Cable	Connect RF cables at indicated locations.
▬	Cat5 Cable	Connect Cat5 cables at indicated location

13 Notices