Impinj R700 Antenna Hub User Guide

Version 8.0

http://www.impinj.com

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1 Introduction

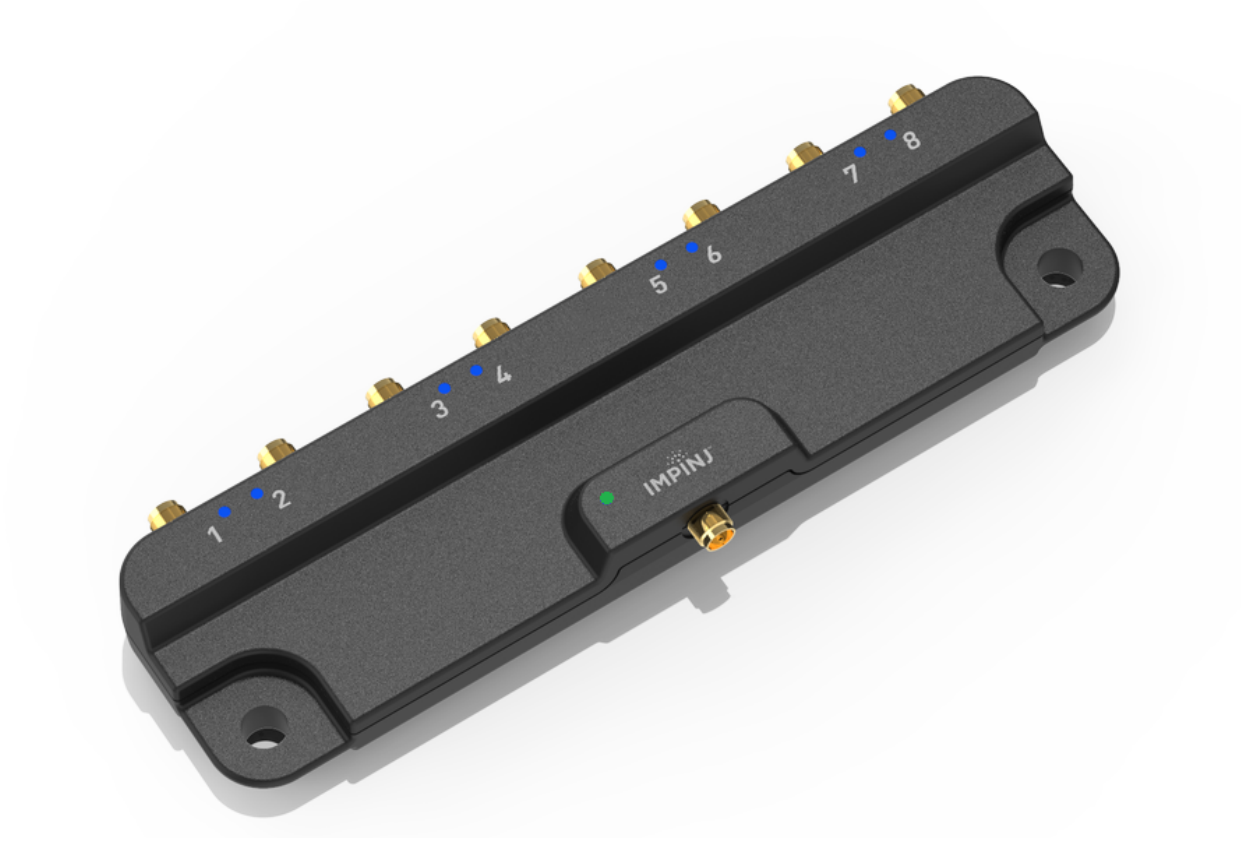
This guide describes the installation, setup, and operation of the Impinj R702 Antenna Hub.

Currently there is only one model.

Impinj Antenna Hub model and part numbers

Model	Part Number	Features
R702	IPJ-A60100-000	Eight ports, single-wire connection

The Impinj R702 Antenna Hub attaches to an R700 RAIN reader antenna port and allows up to eight individual antennas to be operated through that one port. The single port connection supports power, control, and data signals for simple setup. Up to four antenna hubs can be attached to a single R700 reader for a total of up to 32 individual antennas on a single reader.



Impinj R702 Antenna Hub shown from the top

The Impinj R702 Antenna Hub is compatible with Impinj R700 RAIN RFID readers. The compatible SKUs are listed below.

Compatible R700 readers

Reader Model	Part Number	Region Code
R700	IPJ-R700-141	FCC
R700	IPJ-R700-241	ETSI

Reader Model	Part Number	Region Code
R700	IPJ-R700-341	FGX
R700	IPJ-R700-441	JP

The Impinj R702 Antenna Hub is compatible with the same antennas that are approved for direct connection to R700 ports. There are two sets of approved antennas, one for EU lower band frequencies (865-867 MHz) and one for FCC andEU upper band and similar regions (902-927 MHz and 916-918 MHz).

Certified antennas for higher frequency regions like FCC and EU Upper Band

- 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-A0311EU1) 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/COMMAAN-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.

Certified antennas for EU Lower Band

- 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.

1.1 Other Documents of Interest

This guide is part of a larger documentation set that supports Impinj RAIN RFID readers. The document set includes two that will be of particular interest for understanding how to intall and operate the Impinj R702 Antenna Hub:

- ***Impinj R700 Installation and Operations Guide***, which provides an overview of how to install and control the R700 reader.
- ***Impinj RShell Reference Manual***, which covers how to configure the reader using a remote command-line shell.

Note that this document will provide focused directions for installation and operation of the antenna hub, but please refer to the above documents for additional background and details.

2 Overview

The Impinj R702 Antenna Hub effectively converts a single antenna port on an R700 reader into eight seperate antenna ports. With an antenna hub on each of the four R700 ports, this provides up to 32 antenna ports on a single reader.

The additional antenna ports allow for a deployed solution with greater variety of antenna styles which are appropriate for potentially different tag reading scenarios. The additional antenna ports can also provide coverage over a larger physical space, depending on the arrangement of the antennas.

2.1 Multiplexing

The Impinj R702 Antenna Hub converts a single antenna port into eight ports through a process called multiplexing. The antenna hub switches quickly from port to port, and the data from each addressed port is processed on the reader serially, and each tag read is associated with the port that read it.

The single reader port is shared in very small time slices, so that each antenna port behaves as though it has dedicated access to the reader port.

There is a very small time delay when switching from one antenna port to another, less than 25 milliseconds, so the maximum read capacity of all eight antenna ports will add up to be slightly less than for a reader port without an antenna hub attached. This small decrease in raw reading throughput is the trade-off for the increase in the number and potential diversity of antennas and physical coverage in space.

2.2 Port Numbering

Without a hub attached, an R700 reader has ports numbered 1 to 4. Those four ports are addressed directly when performing RFID reading operations, and it is possible to attempt read operations on ports that do not have an attached antenna. No harm is done to the reader in this case, but there will be no resulting tag reads from those empty ports.

With one or more antenna hubs attached to an R700 reader, the ports will now be numbered from 1 to 32.

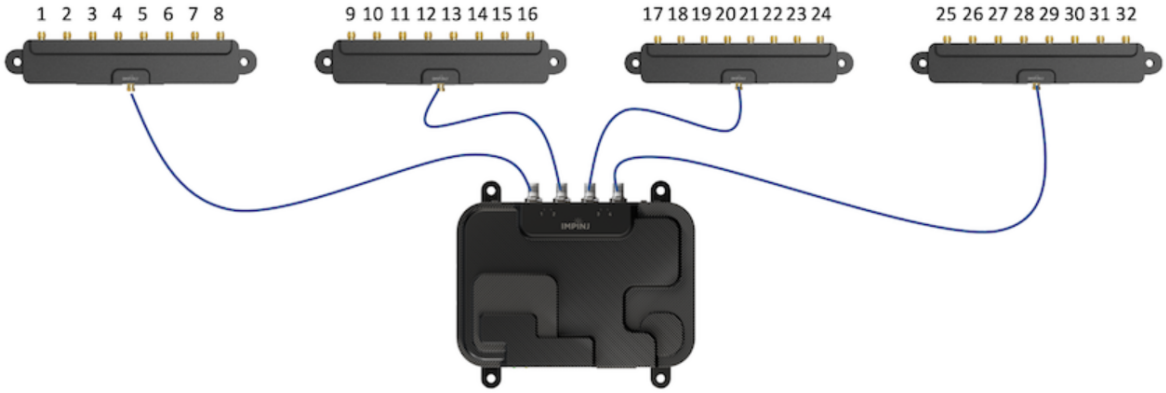
If four antenna hubs are attached to the read 32, and they are still all addressable, but some of those numbered ports will behave as though they do not have an attached antenna.

It is possible to have a mix of antenna hubs and directly-connected antennas on the same reader, and these directly connected antennas do not change the numbering of the antenna ports.

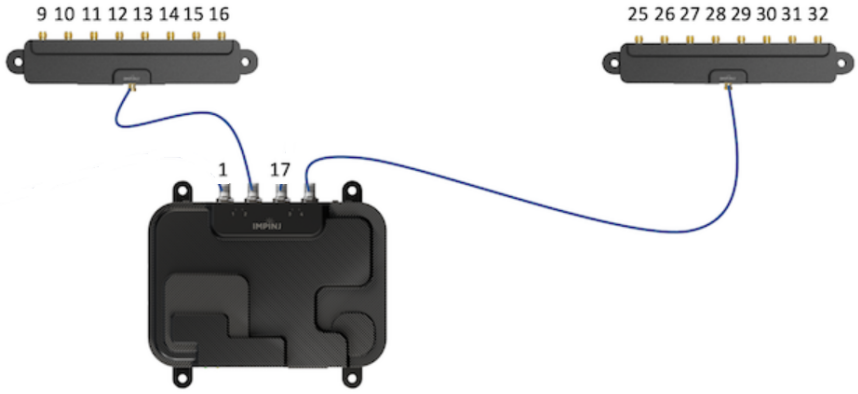
The following sequence of diagrams shows how antenna ports are numbered on an R700 reader depending on how antenna hubs are attached.

If there are no attached antenna hubs, the reader ports are numbered from 1 to 4, as below:

If four antenna hubs are attached, one for each R700 reader port, the antenna ports are numbered from 1-32, and all ports correspond to an actual hardware connection.

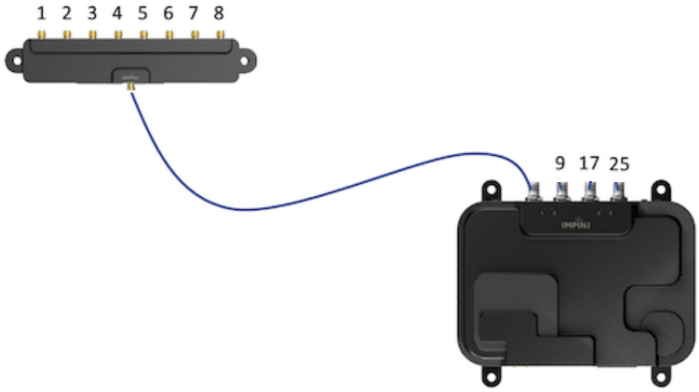


If only two hubs are attached, there are still 32 numbered ports, but not all of the ports correspond to a physical connection. For the reader ports that do not have a hub attached, they take on the first number in the series that would have been associated with a hub. In the diagram below, the first reader port does not have an attached hub. If it did have a hub, the antenna ports on that hub would have been numbered from 1-8, so without a hub the antenna port takes the number 1.



Likewise, the third reader port in the diagram above also does not have an attached antenna hub. If it did have an attached hub, the antenna ports would have been numbered from 17-24. Since there is no attached hub, the unadorned reader port is assigned the number 17.

And finally, if there is only a single antenna hub attached to an R700 reader, there are still 32 numbered ports, but only the ports on the hub have contiguous numbers. In the diagram below, the first port has an attached hub, so it takes on the sequence of numbers from 1 to 8. The remaining reader ports do not have attached hubs, so they are assigned the first number from the corresponding unattached series.



2.3 Power Limits

The addition of an Impinj R702 Antenna Hub adds a small insertion loss to the transmitted signal, approximately 1.7dB. This loss should be included in the calculations for keeping broadcast power within the limits of the RAIN RFID operating region, and can be treated in the same way as cable loss.

Note: The Impinj R702 Antenna Hub has 30dB or better isolation between ports, but it is still possible to read tags on non-enabled ports if the reader transmit power is set at the highest limit.

Please refer to the ***Impinj R700 Installation and Operations Guide*** for more details about the power limit calculations.

3 Installation

Installation of the Impinj R702 Antenna Hub is simple due to the single-wire connection design.

3.1 Required Accessories

A complete operating configuration requires an Impinj R700 reader (see the list of compatible models above), as well as other accessories which are all sold separately:

1. SMA to R-TNC cable, part number IPJ-A3002-000
2. One or more antennas, see list of certified models above
3. Additional RF cable

3.2 Connecting Cables

1. Power off the Impinj R700 reader
2. Connect the antenna hub to the reader
   - Use the SMA to R-TNC cable
   - The SMA end goes to the hub, at the single connector next to the Impinj logo
   - The R-TNC end goes to an open port on the R700 reader
3. Connect one or more antennas to the antenna hub
   - The RF cable will need an SMA connector on the hub side
   - Unused hub antenna ports can be left empty
   - Termination of unused antenna ports is optional

3.3 Mounting the Antenna Hub

The Impinj R702 Antenna Hub has two quarter-inch mounting holes in the body for attaching the hub to a suitable surface, if needed. Note that it may be necessary to temporarily remove any RF cables when mounting the unit.

4 Activation

The antenna hub feature must be enabled on the reader before it can be used. The feature can be controlled from both the reader web interface and from the RShell command-line interface.

4.1 Prequisites

The antenna hub feature requires Octane firmware version 7.4 or higher. Please refer to the ***Impinj Octane Firmware Upgrade Reference Manual*** for the detailed instructions on how to determine the current firmware version on the reader and how to upgrade to version 7.4 or higher.

Controlling the Impinj R700 reader also requires a working network connection between the reader and a client computer. This network connection must also provide power to the reader, in the form of Power over Ethernet (PoE) or Power over Ethernet Plus (PoE+). Please refer to the ***Impinj R700 Installation and Operations Guide*** for detailed instructions for the network connection.

It will also be necessary to know the IP address or hostname in order to control the reader over the network connection using either approach. The easiest method is to use the hostname of the reader. By default, the reader hostname follows the pattern `impinj-XX-XX-XX`, where the X characters are replaced by the last three pairs of hexadecimal numbers in the reader MAC address. The reader MAC address is printed on labels affixed to the reader and on the shipping box.

4.2 Activating through the WebUI

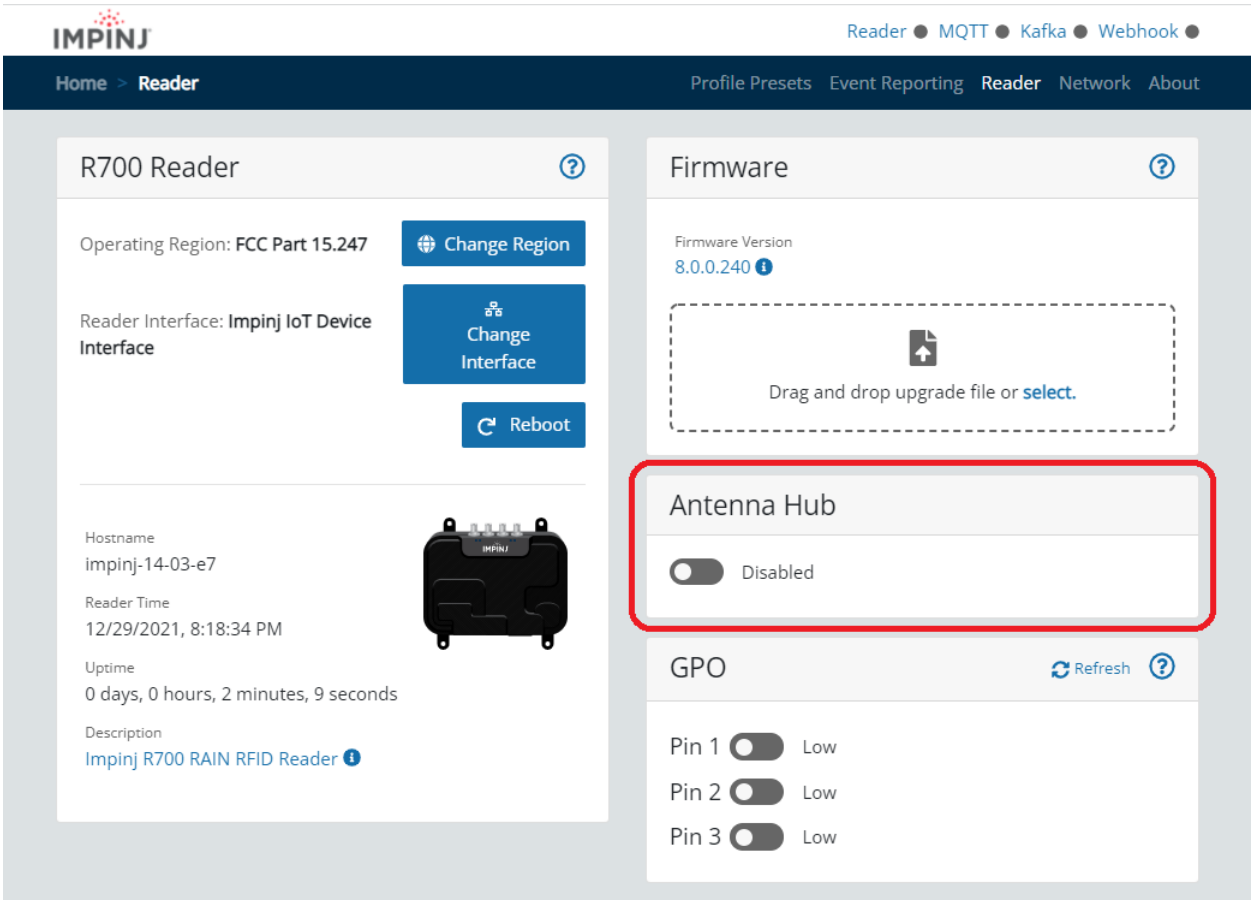
To enable the antenna hub feature on an Impinj R700 reader using the WebUI (web user interface), use a web browser to navigate to the built-in web server running on the reader, log in, click a button, and then reboot.

To reach the reader's internal web server using a web browser, use the reader hostname and any local domain: `http:\\impinj-XX-XX-XX[.your-domain]`.

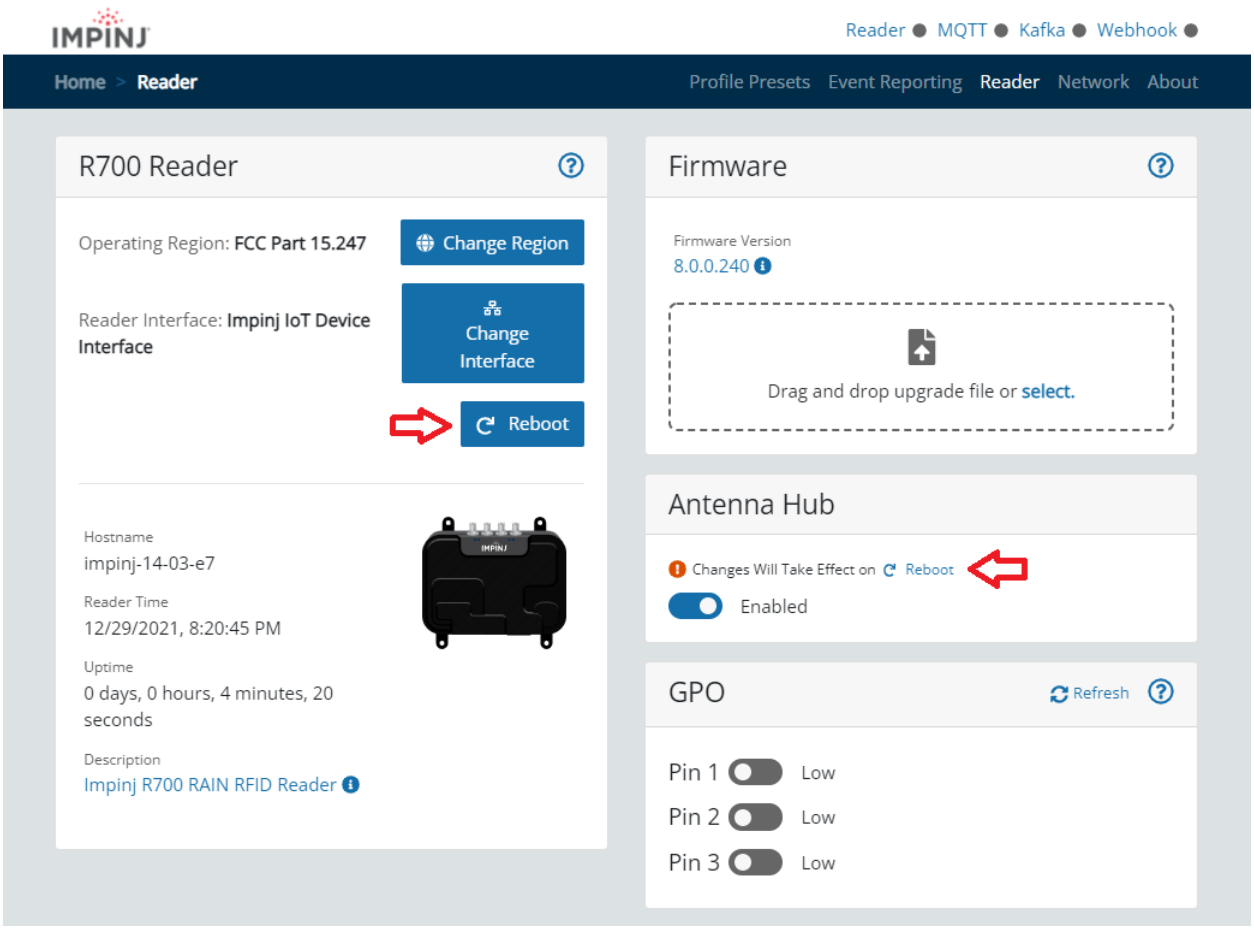
The default ports work fine for HTTP or HTTPS, as long as they are enabled, so no need to specify the port.

After navigating to the reader URL, the web server will prompt for user credentials. If these credentials have been customized, use those values, otherwise use the default values (Username: root, Password: impinj).

After the successful login, the reader displays the main WebUI page, which provides helpful reader status and controls. The control for enabling the antenna hub feature is located on the right side of the main web page as shown in the figure below.

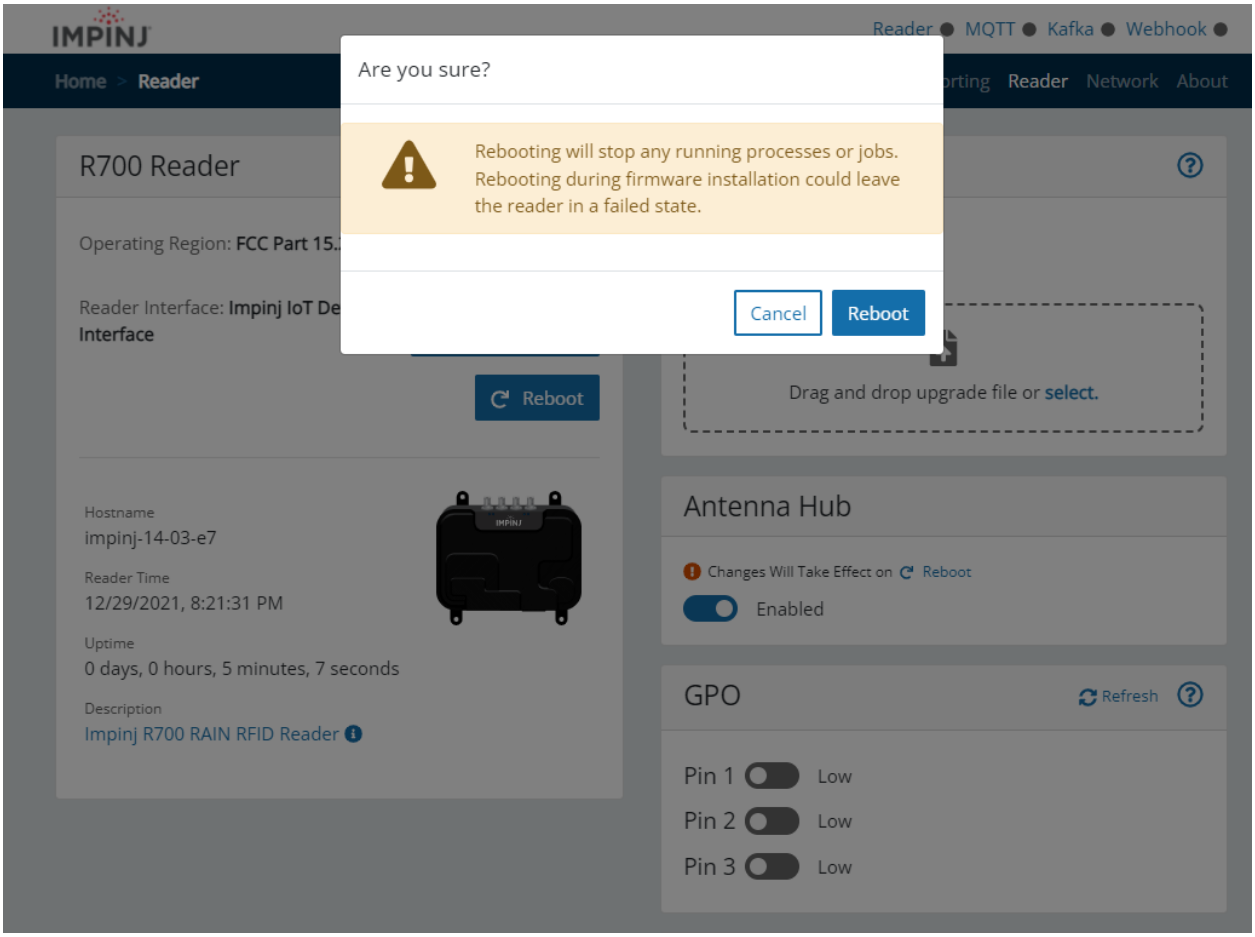


Click the sliding toggle button that that is currently labelled 'Disabled'. If the slider quickly toggles back to the disabled state it is an indication that the reader did not detect any attached antenna hubs. If one or more antenna hubs are detected, the toggle will switch to the 'Enabled' state, but will include a small text alert that indicates that "Changes Will Take Effect on Reboot", as shown in the figure below.

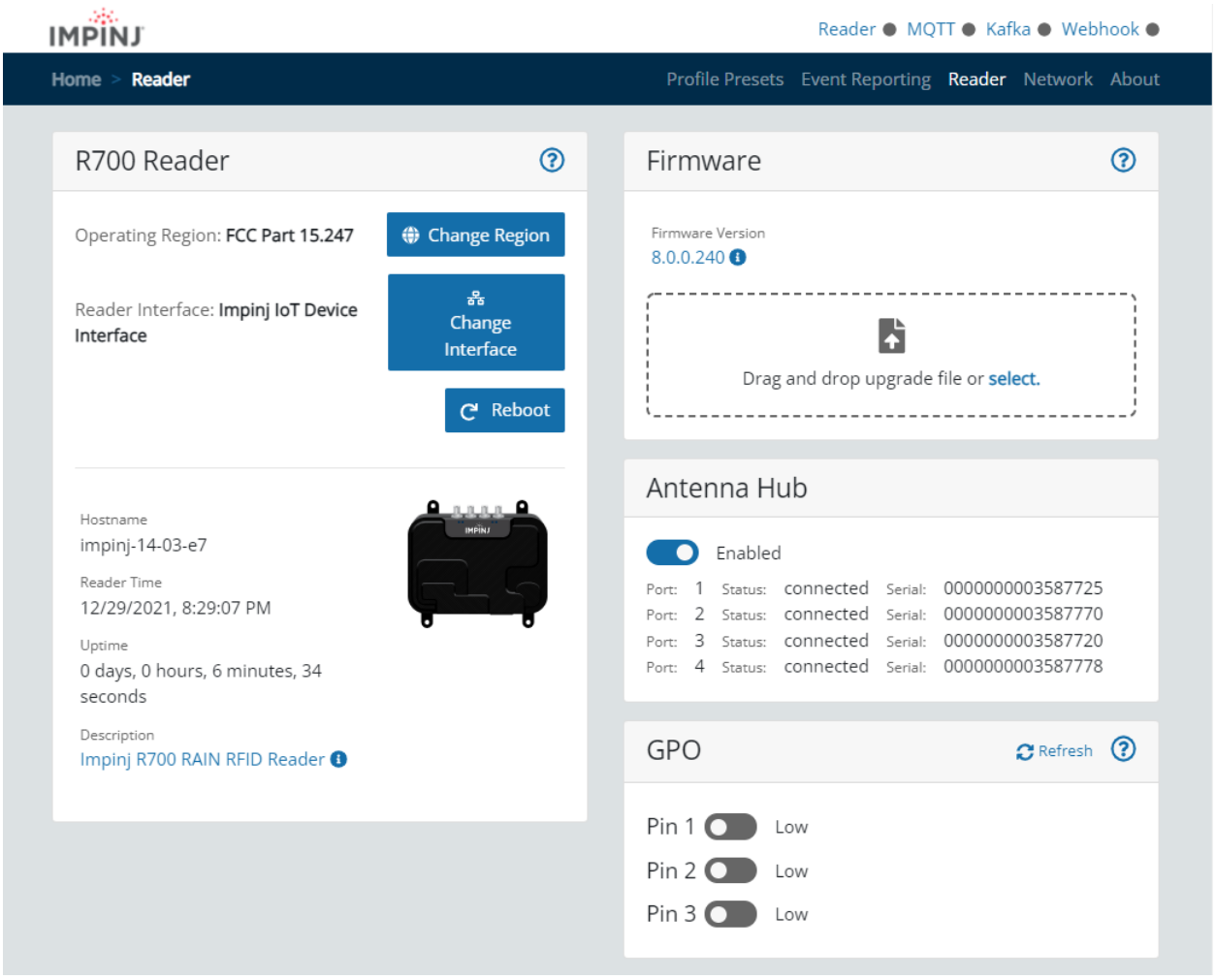


To complete the activation of the feature, click either the 'Reboot' link in the alert text next to the sliding toggle or the 'Reboot' button in the left-most panel, indicated by the red arrows in the annotated figure above.

After clicking either the reboot link or button, the server will display a dialog prompt to confirm the reboot process.



The reboot process will take up to a minute, but then the web page will automatically refresh and show that the antenna hub feature is now fully enabled, with a list of reader antenna ports and the serial number for each detected connected antenna hub.



4.3 Activating through RShell

To enable the antenna hub feature on an Impinj R700 reader using the RShell (Reader Shell) command-line interface, use an SSH client to open a connection to the reader, issue a command, and then reboot.

To connect to the reader using RShell, use the administrator username, reader hostname and any local domain:

```
ssh [username]@impinj-XX-XX-XX[.your-domain]
```

The default administrator username is 'root', and remember that the IP address can be used directly, so another example might look like the following:

```
ssh root@192.168.254.16
```

The default port of 22 works fine, so no need to specify the port.

The shell will prompt for the password for the administrator account. The default is 'impinj'.

Once successfully past the login, RShell presents a prompt:

```
>
```

The RShell program presents options in a series of menus, and entering either `help` or `?` will display the current menu level and valid options. Commands can also be entered directly at the top level.

To check the current status of the antenna hub feature on the reader, enter `show feature anthub` at the top menu level. An example session might look like the following:

```
> show feature anthub
Status='0,Success'
anthubKeyStatus='Activated'
anthubStatus='Disabled'
```

If the feature is not currently enabled, enter the command `config feature enable anthub` from the top menu level. The system should respond with an indication that the change was made but that a reboot is required to complete the process, like this:

```
> config feature enable anthub
Status='14,Success-Reboot-Required'
```

Rebooting the reader is a simple matter of entering the `reboot` command. The reboot doesn't happen immediately, so it provides enough time to exit from the RShell program.

```
> reboot
Status='0,Success'
> exit
```

After the reader reboots, the antenna hub feature will be fully enabled.

A call to the RShell show feature command will confirm it:

```
> show feature anthub
Status='0,Success'
anthubKeyStatus='Activated'
anthubStatus='Enabled'
```

5 Troubleshooting

There are two distinct ways to troubleshoot the Impinj R702 Antenna Hub -- one at the time of activation, and one during operation.

5.1 Checking Connections

To troubleshoot the antenna hub connections, there is a built-in diagnostic available from the reader WebUI. This process can help verify that the hub has been installed correctly.

Connect to the built-in web server on the reader as described above in the Activating through the WebUI section, and after enabling the feature, simply observe the list of reader antenna ports and detected antenna hubs.

If no hubs are detected at all, the feature will not enable, as indicated by the sliding toggle button returning almost immediately to the 'Disabled' state.

If one or more of the hubs fail to show in the list after a reboot, simply start over: power off the reader, check that the hubs are securely connected, power the reader back on and observe the connection status per port.

5.2 LED Behavior

To troubleshoot active operation of the Impinj R702 Antenna hub, use the LED lights on the hub to determine status.

There are two categories of LED lights on the antenna hub:

1. A single green LED at the base of the hub, where the input RF cable connects.
2. Eight blue LEDs, one next to each numbered antenna port.

The following table outlines how the LEDs change with different hub states:

Mode/State	Green Hub LED	Blue Antenna LEDs
Hub disabled	OFF	OFF
Hub enabled	Solid GREEN	OFF
Active RFID	OFF	Blinking ON/OFF

The blue antenna LEDs will light up during active RFID inventory operation if they are included in the specification, whether an antenna is attached or not. As mentioned earlier, this does not harm the antenna hub or the reader, but it does take time to multiplex these null read operations.

When an attached antenna is reading tags, the multiplex operation can switch antennas faster and this leads to changing patterns in the rate of the blinking blue LEDs. These changing patterns can help provide a sense of the tag data traffic as it passes through the antenna hub.

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