

IPJ-RS2000-1, IPJ-RS2000-2 Electrical, Mechanical, & Thermal Specification

Indy® RS2000 Overview

Indy RS2000 is a completely integrated RAIN RFID reader module based on the market-leading Indy R2000 reader chip. It is a turnkey embedded solution that enables high performance with lower system costs. It can be easily added to an embedded system, requiring only connections to a power source, digital communication with a host, and an antenna. The package design allows it to be attached to a PCB using standard surface mount technology (SMT), with no need for additional connectors or mounting hardware. The Indy RS2000 is the easiest way to embed high performance UHF RFID reader capability.



Air Interface Protocol	RAIN RFID EPCglobal UHF Class 1 Gen2 / ISO 18000-63 (formerly 18000-6C) Supports dense reader mode (DRM)
Tx Output Power	Range: +10 to +31.5 dBm (+30 dBm maximum in Japan) Default: +30 dBm
Antenna Ports	4 antenna ports total: <ul style="list-style-type: none">• 2 connectorized ports• 2 surface mount ports
Dimensions	38 mm by 52 mm by 4 mm
Package Type	35 pin surface mount package (SMT compatible)
Rx Sensitivity	-74 dBm (1% packet error rate). Assumes operation in RF mode 1, and a 15 dB antenna return loss at 31.5 dBm output power.
DC Power Supply	3.2 to 5.25 Volts
Supported Regions	Worldwide regional support. All major regions supported. See section 7 - Regulatory Information for a complete list.
Compliance	Certified: FCC and Canada modular operation, RoHS 2011/65/EU compliant

1 Table of Contents

INDY® RS2000 OVERVIEW	1
1 TABLE OF CONTENTS	2
1.1 FIGURES	2
1.2 TABLES	3
2 INTRODUCTION	4
2.1 KEY FEATURES OF THE INDY RS2000	5
3 SYSTEM BLOCK DIAGRAM	6
4 PIN LISTING AND SIGNAL DEFINITIONS	8
5 IMPINJ RADIO INTERFACE (IRI)	10
5.1 IRI OVERVIEW	10
5.2 RS2000 MODULE FIRMWARE – APPLICATION AND BOOTLOADER IMAGES	11
6 ELECTRICAL SPECIFICATIONS	12
6.1 ABSOLUTE MAXIMUM RATINGS	12
6.2 OPERATING CONDITIONS	12
6.3 DEVICE FUNCTIONAL SPECIFICATIONS	13
6.4 UHF GEN 2 RFID RADIO SPECIFICATIONS	14
6.5 DEVICE INPUT AND OUTPUT SPECIFICATIONS	15
6.6 SUPPORTED REGIONS	16
6.7 EPC CLASS-1 GENERATION-2 OPERATION	19
7 REGULATORY INFORMATION	19
7.1 MODULAR FCC AND IC CERTIFICATION	19
7.2 ETSI CERTIFICATION	20
8 PACKAGE AND ASSEMBLY INFORMATION	21
8.1 PACKAGE MASS	21
8.2 PACKAGE DIMENSIONS AND FLATNESS	21
8.3 RS2000 MODULE 3D MODEL	24
8.4 PCB FOOTPRINT	25
8.5 THERMAL CONSIDERATIONS	28
8.6 SMT REFLOW INFORMATION	28
9 RELATED DOCUMENTATION	31
10 DOCUMENT CHANGE LOG	31
11 NOTICES	32

1.1 Figures

FIGURE 2-1: RS2000 SYSTEM INTEGRATION	5
FIGURE 3-1: EXAMPLE RS2000 BLOCK DIAGRAM	6
FIGURE 4-1: INDY RS2000 PIN LISTING.....	8
FIGURE 5-1: HOST AND READER FIRMWARE STACK	11
FIGURE 8-1: RS2000 PACKAGE DIMENSIONS, TOP, FRONT, AND SIDE VIEWS	22
FIGURE 8-2: RS2000 ELECTRICAL CONNECTION AND MOUNTING FEATURE LOCATIONS	23
FIGURE 8-3: RS2000 EDGE PAD DIMENSION DETAIL A	23
FIGURE 8-4: RS2000 LABEL	24
FIGURE 8-5: RS2000 MODULE 3D MODEL PERSPECTIVE RENDER	25
FIGURE 8-6: RS2000 RECOMMENDED ETCHED COPPER FOOTPRINT – ALL PADS	26
FIGURE 8-7: RS2000 RECOMMENDED ETCHED COPPER FOOTPRINT – SINGLE PAD.....	26
FIGURE 8-8: RS2000 RECOMMENDED PASTEMASK FOOTPRINT – ALL PADS	27

FIGURE 8-9: RS2000 RECOMMENDED PASTEMASK FOOTPRINT – SINGLE PAD	27
FIGURE 8-10: RECOMMENDED SOLDER REFLOW PROFILE FOR THE INDY RS2000	29
FIGURE 8-11: RS2000 SMT REFLOW WEIGHT 3D RENDER.....	29
FIGURE 8-12: RS2000 SMT REFLOW WEIGHT DRAWING	30

1.2 Tables

TABLE 4-1: INDY RS2000 – PIN LISTING AND SIGNAL DEFINITIONS	8
TABLE 4-2: INDY RS2000 – ANTENNA LISTING AND IRI CONSTANTS	10
TABLE 6-1: INDY RS2000 – ABSOLUTE MAXIMUM RATINGS	12
TABLE 6-2: INDY RS2000 – OPERATING CONDITIONS	12
TABLE 6-3: INDY RS2000 – SUPPLY CURRENT SPECIFICATIONS	13
TABLE 6-4: INDY RS2000 – STARTUP AND WAKEUP TIME	14
TABLE 6-5: INDY RS2000 – RF RECEIVER SPECIFICATIONS	14
TABLE 6-6: INDY RS2000 – RF TRANSMITTER SPECIFICATIONS	14
TABLE 6-7: INDY RS2000 – DIGITAL INTERFACE SPECIFICATION	15
TABLE 6-8: INDY RS2000 – REGIONAL SUPPORT	16
TABLE 6-9: INDY RS2000 – GEN2 FUNCTIONALITY	19
TABLE 6-10: INDY RS2000 – INVENTORY PERFORMANCE	19
TABLE 8-1: INDY RS2000 – LABEL MARKING DETAILS	24
TABLE 9-1: RELATED DOCUMENTATION	31
TABLE 10-1: DOCUMENT CHANGE LOG	31

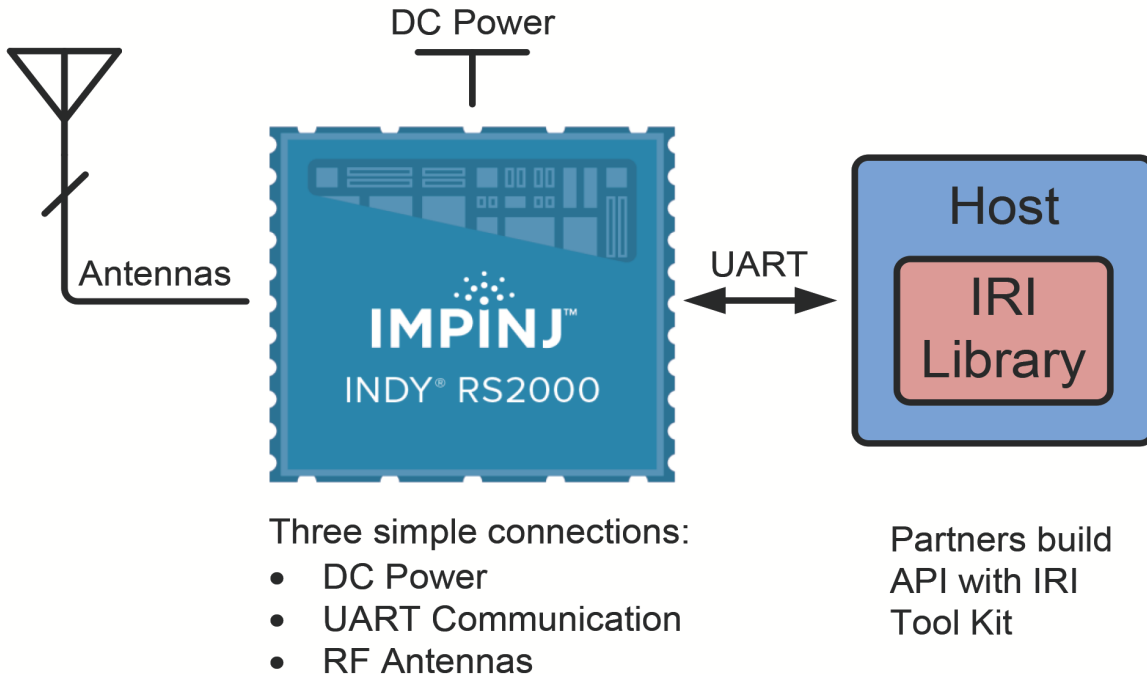
2 Introduction

The Indy® RS2000 reader surface mount module is a completely integrated reader solution for EPC Gen2 / ISO18000-63 or RAIN RFID applications. RS2000 was developed to make embedding high performance UHF RFID reader capability easy. RS2000 builds on market-leading Indy reader chip technology and integrates all of the necessary components into a small package. RS2000 requires no external reader components, is fully tested and meets regulatory requirements. RS2000 comes in a surface mount package designed to work as a SMT (surface mount technology) compatible component in a standard PCB manufacturing process, which eliminates costly mechanical hardware, RF cables and human assembly that are typically required with embedded readers on the market today. RS2000 is a turnkey solution that will enable quick and easy embedding of RFID with low development risk and fast time-to-market.

Ideal for applications requiring long read range of large tag populations, RS2000's small form factor enables a diverse range of applications, such as inventory management, portal readers, POS solutions, access control, process control in industrial automation, medical equipment, and performance handheld readers. RS2000 is capable of reading hundreds of tags per second at distances greater than 10 meters when using a 6 dBi reader antenna and far field passive tags.

This document includes interface, functional, performance, mechanical and environmental specifications. Host communication specifications (e.g. firmware upgrade and host interface protocol) and Impinj Radio Interface (IRI) documentation is provided in the latest Indy ITK Release. RS2000 uses the IRI™ (Impinj Radio Interface) to communicate with host systems. The ITK (IRI Tool Kit) enables developers to build on a variety of embedded host platforms by providing the following: documentation, image loader, IRI library, sample C code and project files. The IRI Tool Kit can be found in the latest Indy ITK Release package and can be downloaded from the restricted documents and downloads section at support.impinj.com. Please create an account and subscribe to receive automatic updates to the latest documentation and releases. Contact your local Impinj representative if you have trouble creating an account or accessing this site.

Figure 2-1: RS2000 System Integration



2.1 Key features of the Indy RS2000

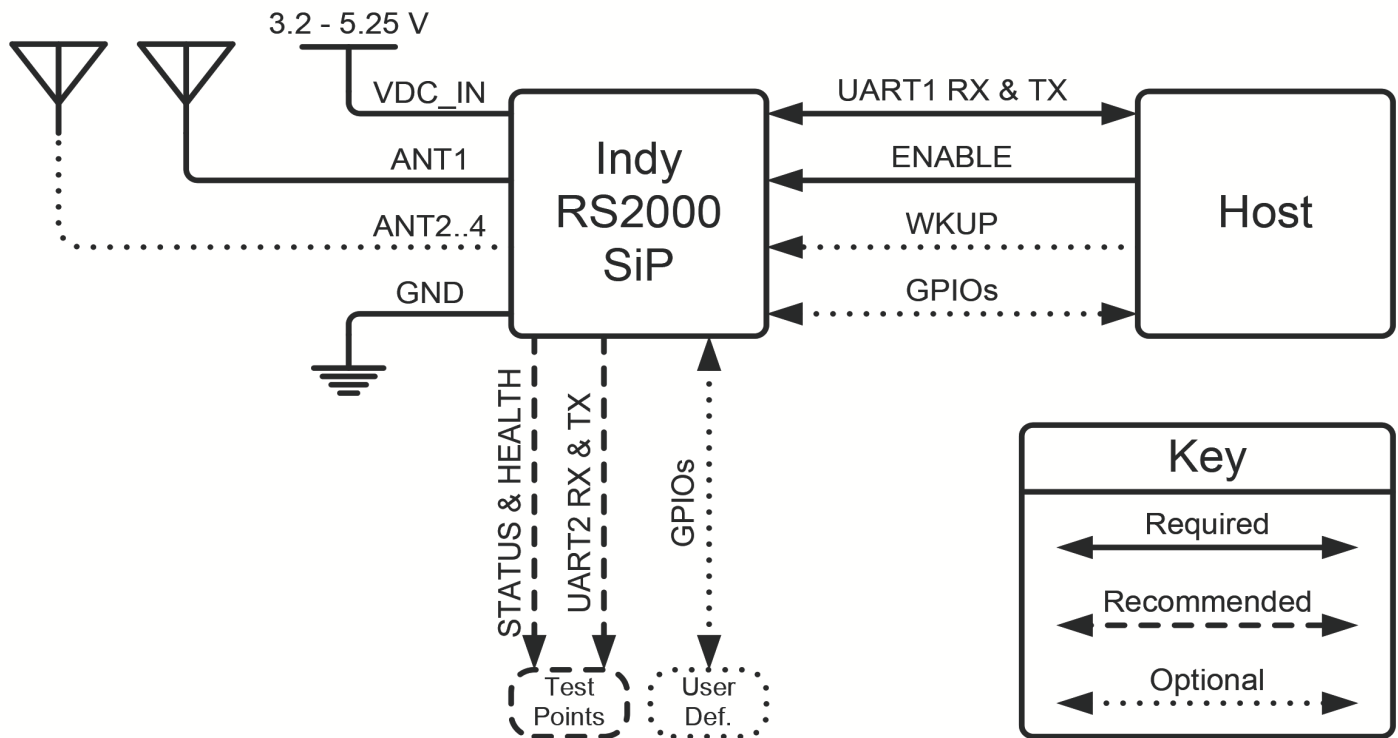
- Fully tested turnkey solution
- Maximum output power is 31.5 dBm
- 4 mono-static RF ports, both SMT and U.FL connections
- -74 dBm Rx sensitivity, assuming 15 dB antenna return loss. The Rx performance improves with better antenna return loss.
- Part of Impinj's platform, ensuring better performance when using Impinj's Monza® UHF RFID tag chips (enabling FastID, Tag Focus and QT)
- Inventory (FastID, Tag Population Estimate, Select, Session, Target)
- Access (Read, Write, Lock, Kill, BlockPermalock, and QT)
- Shielded to prevent unwanted radiation and provide noise immunity in embedded environments
- 38.5 mm by 52.5 mm by 4.3 mm surface mount package with SMT compatibility
- Mechanical provisions for heat dissipation
- Field upgradability via firmware updates. Gen2v2 will be firmware upgradable.
- UART serial interface using IRI (Impinj Radio Interface)
- Test features (CW, PRBS, custom regions, channel lists, and fixed frequency)

3 System Block Diagram

An example Indy RS2000 system-level block diagram for an embedded application is shown in Figure 3-1. This figure shows the electrical connections that may and must be made to control the RS2000. In the figure, the required connections are illustrated with solid lines. Recommended and optional connections are illustrated with different dotted and dashed line patterns. They are also listed below.

For more detail on pin characteristics and behaviors, see the [RS2000 Hardware User's Guide](#).

Figure 3-1: Example RS2000 Block Diagram



Required connections:

- VDC_IN and GND are required to power the RS2000.
- ANT1, ANT2, ANT3, or ANT4 are required to connect to UHF RFID antennas. Only one is required for RFID activity, but up to four may be used.
- UART1 Tx and Rx are required to communicate with the system host.
- ENABLE is used to enable or disable operation of the part. If this pin is driven low, the power supplies in the part will be disabled. RS2000 may be reset by toggling this pin. This pin must be driven high to enable the part.

Recommended connections:

- UART2 Tx and Rx may be used to examine debug information. This information can prove extremely useful when attempting to solve technical difficulties.

- HEALTH toggles to indicate successful operation of the RS2000. Connection to an LED provides a visual indication of whether or not an error condition exists.
- STATUS toggles to provide an indication when the RS2000 is in active mode (for example, inventorying tags). Connection to an LED provides a visual indicator of the device's activity.

Optional connections:

- GPIOs allow interaction with the RS2000 as both digital inputs and outputs. They may be used to trigger inventory, generate events based on inventory activity, or provide general-purpose user-controlled digital I/O.
- WKUP provides a mechanism to wake up the RS2000 from the low power Sleep mode. WKUP is also used to force entry into the Impinj firmware bootstrap. If unused, this pin should be tied to logic low.

No connect:

- CLK_OUT, DTEST0 and DTEST1 connections are reserved for Impinj use only.

4 Pin Listing and Signal Definitions

Figure 4-1: Indy RS2000 Pin Listing

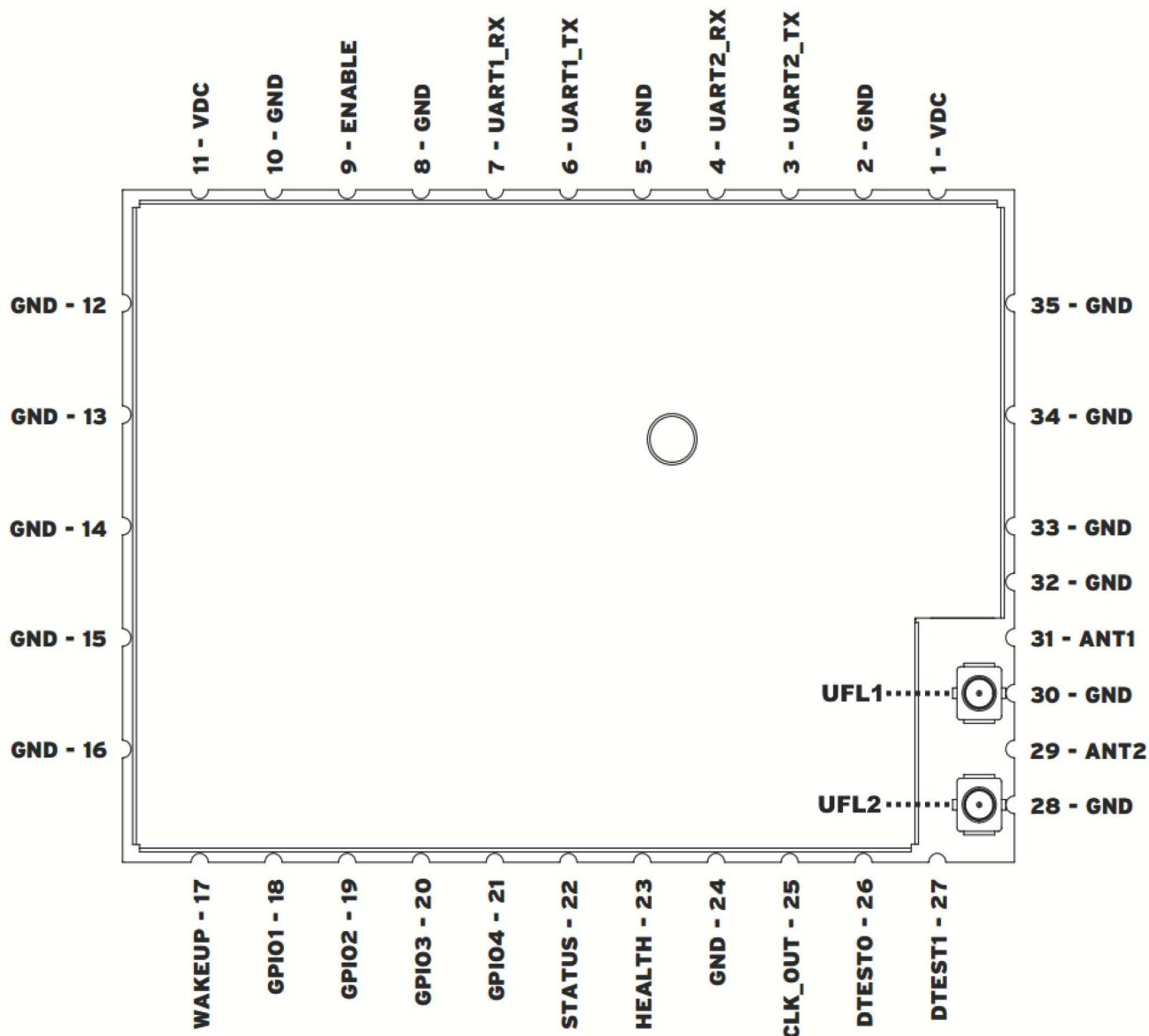


Table 4-1: Indy RS2000 – Pin Listing and Signal Definitions

Pin #	Pin Name	Pin Type	Description
1	VDC_IN	Power	DC voltage supply (3.2 – 5.25 V)
2	GND	Power	Ground
3	UART2-TX	Digital Output	RS2000 Debug UART Tx to host
4	UART2-RX	Digital Input	RS2000 Debug UART Rx from host
5	GND	Power	Ground
6	UART1-TX	Digital Output	RS2000 UART Tx to host

Pin #	Pin Name	Pin Type	Description
7	UART1-RX	Digital Input	RS2000 UART Rx from host
8	GND	Power	Ground
9	ENABLE	Digital Input	Module enable, active high. Puts RS2000 in Shutdown mode when logic low.
10	GND	Power	Ground
11	VDC_IN	Power	DC voltage supply (3.2 – 5.25 V)
12	GND	Power	Ground
13	GND	Power	Ground
14	GND	Power	Ground
15	GND	Power	Ground
16	GND	Power	Ground
17	WKUP	Digital Input	Wakeup from sleep on rising edge
18	GPIO1	Digital I/O	General purpose I/O
19	GPIO2	Digital I/O	General purpose I/O
20	GPIO3	Digital I/O	General purpose I/O
21	GPIO4	Digital I/O	General purpose I/O
22	STATUS	Digital Output	RS2000 status indication
23	HEALTH	Digital Output	RS2000 health indication
24	GND	Power	Ground
25	CLK_OUT	No Connect	Reserved for Impinj production test
26	DTEST0	No Connect	Reserved for Impinj production test
27	DTEST1	No Connect	Reserved for Impinj production test
28	GND	Power	Ground
29	ANT2	RF	SMT antenna port 2
30	GND	Power	Ground
31	ANT1	RF	SMT antenna port 1
32	GND	Power	Ground
33	GND	Power	Ground
34	GND	Power	Ground
35	GND	Power	Ground
UFL-1	UFL1	RF	UFL antenna port 1

Pin #	Pin Name	Pin Type	Description
UFL-2	UFL2	RF	UFL antenna port 2

Table 4-2: Indy RS2000 – Antenna Listing and IRI Constants

Antenna Connection	Antenna Number	Generic Antenna Constant	RS2000 Specific Antenna Constant
ANT1	1	E_IPJ_ANTENNA_1	E_IPJ_ANTENNA_RS2000_SMT_1
ANT2	2	E_IPJ_ANTENNA_2	E_IPJ_ANTENNA_RS2000_SMT_2
UFL1	3	E_IPJ_ANTENNA_3	E_IPJ_ANTENNA_RS2000_UFL_1
UFL2	4	E_IPJ_ANTENNA_4	E_IPJ_ANTENNA_RS2000_UFL_2

5 Impinj Radio Interface (IRI)

5.1 IRI Overview

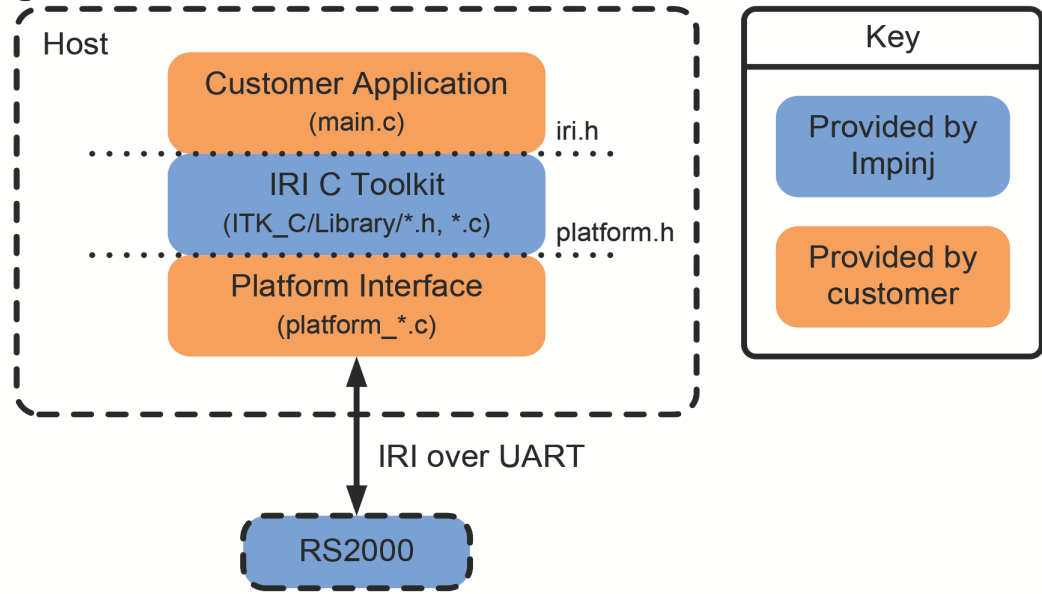
The Indy RS2000 uses IRI to enable communications; this is enabled with the IRI Tool Kit. The IRI Tool Kit includes documentation, IRI API, and sample C code. The IRI Tool Kit is intended to enable a broad set of host platforms due to its ease of use and portability.

Communication with the RS2000 via IRI occurs in two states:

1. Configuration (synchronous)
 - a. All communications are commands and responses
 - b. Start and Stop commands cause transition to the Listen state
2. Listen (asynchronous)
 - a. Host is in a listening mode and polls to obtain tag reports

Customer applications can be enabled on a variety of embedded systems with hosts ranging in size from small microcontrollers to large microprocessors. The IRI Tool Kit is structured to ease portability by separating platform specific code from functional reader operation; this is illustrated in Figure 5-1 below.

Figure 5-1: Host and Reader Firmware Stack



Please refer to the documentation included in the Indy ITK Release package for complete details on communicating with the Indy RS2000 using IRI. The latest Indy ITK Release package, which includes the IRI Tool Kit, can be downloaded at support.impinj.com.

5.2 RS2000 Module Firmware – Application and Bootloader Images

The RS2000 is populated with firmware in its non-volatile memory, which defines the behaviour of the module and implements its RAIN RFID and supporting functionalities. The firmware is split into two segments, a bootloader and an application. The bootloader allows updates to the application, and can recover operation if the application is corrupted somehow. The application implements the RAIN RFID functionality and other “mission mode” behaviors. The application on a module can be updated, but the bootloader version is fixed.

All modules are programmed with a production version of the bootloader and application image during manufacturing. These versions could be as old as the first production image for the part, or as new as the latest version. Due to the nature of our distribution model, Impinj cannot guarantee which version of bootloader and application image will be loaded on a particular set of modules. Impinj recommends all customers update modules to the latest version of the application image during production test of their hardware, and add field update functionality to their hardware. Modules will not run application images that are older than their bootloader.

The latest version of the application image for each module can be downloaded in the [ITK](#), and all previous production versions of module firmware can be downloaded from the [ITK Archive](#).

Non-volatile memory can also be used for “stored settings” functionality, which allows a device to have configuration for the module stored on-board, requiring little to no configuration at startup.

6 Electrical Specifications

6.1 Absolute Maximum Ratings

The absolute maximum ratings (see Table 6-1) define limitations for electrical and thermal stresses. These limits prevent permanent damage to the Indy RS2000. Operation outside maximum ratings may result in permanent damage to the device.

Table 6-1: Indy RS2000 – Absolute Maximum Ratings

Parameter	Min.	Max.	Unit	Conditions
Supply voltage	-0.3	5.5	V	VDC_IN pin relative to GND
IO voltage, part enabled	-0.3	3.7	V	Non-VDC_IN pin voltages relative to GND
IO voltage, part disabled	-0.3	0.4	V	Non-VDC_IN pin voltages relative to GND
RF input power	-	+31.5	dBm	Incident to pins 29, 31, UFL-1, UFL-2 (RF)
Storage temperature	-35	+100	°C	
Humidity	-	95	% RH	Non-condensing
ESD immunity	-	2	kV	Human-body model, all I/O pads
Package moisture sensitivity level 3	-	-	-	Indy RS2000 from open trays must be baked before going through a standard solder reflow process (48 hours at 125 °C or 24hrs at 150 °C)

6.2 Operating Conditions

This section describes operating voltage, frequency, and temperature specifications for the Indy RS2000 during operation.

Table 6-2: Indy RS2000 – Operating Conditions

Parameter	Min.	Max.	Unit	Conditions
Supply	3.2	5.25	V	VDC_IN relative to GND
Ambient Temperature	-20	+60	°C	
Internal PA Temperature	-20	+85	°C	PA Temperature can be measured using the IRI communication interface. See the ITK-C “Get Temperature” Configuration Example for details. Note The RS2000 will automatically stop inventory operations when the PA temperature exceeds +85 °C.

Parameter	Min.	Max.	Unit	Conditions
Frequency 1	902	928	MHz	Both IPJ-RS2000-1 and IPJ-RS2000-2, See section 7 - Regulatory Information for regional support
Frequency 2	865	868	MHz	IPJ-RS2000-1, See section 7 - Regulatory Information for regional support
Frequency 3	916	924	MHz	IPJ-RS2000-2, See section 7 - Regulatory Information for regional support

6.3 Device Functional Specifications

RS2000 module current consumption typical data is shown in Table 6-3. Current consumption data shown is typical, but will vary due to part-to-part variation and operating conditions. Operating conditions such as temperature, supply voltage, and RFID activities will affect module current consumption. Increased temperature will cause the current consumption to increase assuming constant transmit power, and the increased transmit power error specifications can also cause the module to consume more power. The module will consume more current at lower supply voltages, as the power supply inside the module includes buck and boost regulators. Finally, switching between operating modes, even between different phases of an inventory operation will cause inrush current consumption, which can exceed the typical value by as much as 50%.

Table 6-3: Indy RS2000 – Supply Current Specifications

Parameter	Typ.	Unit	Description
Supply Current			Current consumed by RS2000 via VDC_IN pin
Active mode – 5 V supply	1600	mA	+31.5 dBm transmit power Inventorying tags
Active mode – 5 V supply	1400	mA	+30 dBm transmit power Inventorying tags
Active mode – 5 V supply	1160	mA	+20 dBm transmit power Inventorying tags
Active mode – 5 V supply	1140	mA	+10 dBm transmit power Inventorying tags
Idle mode – low latency	900	mA	Ready to receive IRI packets. Lower latency to return to Active mode.
Idle mode – standard latency	20	mA	Ready to receive IRI packets. Note: wakes up periodically to assess hardware state
Standby mode	10	mA	GPIO activity, WKUP rising edge, or ENABLE reset required to wakeup part.

Parameter	Typ.	Unit	Description
Sleep mode	8	mA	WKUP rising edge or ENABLE reset required to wakeup part.
Shutdown mode	0.5	μA	ENABLE pin low

Table 6-4: Indy RS2000 – Startup and Wakeup Time

Parameter	Min.	Typ.	Max.	Unit	Description
Startup Time		50		ms	Time to receive IRI packets after power supply cycle or ENABLE pin initiated startup, no stored settings.
Wakeup Time					Time to receive IRI packets after wakeup event
Idle - Low Latency		15		ms	Time to radio on from Low Latency Idle
Idle - Standard Latency		20		ms	Time to radio on from Standard Idle
Standby		50		ms	GPIO activity, WKUP rising edge, or ENABLE reset required to wakeup part, no stored settings.
Sleep		50		ms	WKUP rising edge or ENABLE reset required to wakeup part, no stored settings.

6.4 UHF Gen 2 RFID Radio Specifications

Table 6-5: Indy RS2000 – RF Receiver Specifications

Parameter	Min.	Typ.	Max.	Unit	Conditions
Frequency 1	902		928	MHz	Both SKUs, See section 7 - Regulatory Information for regional support
Frequency 2	865		868	MHz	IPJ-RS2000-1, See section 7 - Regulatory Information for regional support
Frequency 3	916		924	MHz	IPJ-RS2000-2, See section 7 - Regulatory Information for regional support
Input impedance		50		Ω	
Input match		-10		dB	S11
Rx sensitivity		-74		dBm	RF mode 1, 1% packet error rate, assuming 15 dB antenna return loss at 31.5 dBm output

Table 6-6: Indy RS2000 – RF Transmitter Specifications

Parameter	Min.	Max.	Unit	Notes
Tx Power	+10	+31.5	dBm	Meets worldwide regulatory constraints (except Japan)
Tx Power	+10	+30	dBm	Meets Japan regulatory constraints

Parameter	Min.	Max.	Unit	Notes
Tx Power Error				Difference between desired Tx power and actual Tx power at a given ambient temperature
Room temp:				
30 ≤ P _{TX} ≤ 31.5 dBm	-0.5	0.5	dB	10 to 30 deg C
27 ≤ P _{TX} < 30 dBm	-0.75	0.75	dB	
10 ≤ P _{TX} < 27 dBm	-1.0	1.0	dB	
High temp:				
30 ≤ P _{TX} ≤ 31.5 dBm	-0.75	0.75	dB	30 to 60 deg C
27 ≤ P _{TX} < 30 dBm	-1.0	1.0	dB	
10 ≤ P _{TX} < 27 dBm	-1.5	1.5	dB	
Low temp:				
30 ≤ P _{TX} ≤ 31.5 dBm	-1.0	1.0	dB	-20 to 10 deg C
27 ≤ P _{TX} < 30 dBm	-1.25	1.25	dB	
10 ≤ P _{TX} < 27 dBm	-1.75	1.75	dB	
Tx ACPR				When configured for ≤30 dBm transmit power.
1 st Adjacent		-30	dBch	Refer to Gen 2 dense-interrogator transmit mask spec for definition of channel bandwidths and measurement regions.
1 st Alternate		-60	dBch	
2 nd Alternate		-65	dBch	
Return Loss	0	12	dB	No damage into open RF port at 31.5 dBm at any phase angle
Frequency 1	902	928	MHz	Both SKUs, See section 7 - Regulatory Information for regional support
Frequency 2	865	868	MHz	IPJ-RS2000-1 SKU, See section 7 - Regulatory Information for regional support
	916	924	MHz	IPJ-RS2000-2 SKU, See section 7 - Regulatory Information for regional support

6.5 Device Input and Output Specifications

Table 6-7: Indy RS2000 – Digital Interface Specification

Parameter	Min.	Typ.	Max.	Unit	Conditions
ENABLE					
V _{IL}			0.4	V	
V _{IH}	1.2			V	
Hysteresis voltage		200		mV	
Internal pull-down resistor		100		kΩ	
Reset pulse width	25			μs	
WKUP					
V _{IL}			0.8	V	

Parameter	Min.	Typ.	Max.	Unit	Conditions
V _{IH}	2.0			V	
Hysteresis voltage		150		mV	
Internal pull-down resistor		10		kΩ	
Digital inputs					
V _{IL}			0.8	V	
V _{IH}	2.0			V	
Hysteresis voltage		150		mV	
Pull-up and pull-down resistor	70	100	130	kΩ	
Digital outputs					
V _{OL}	0.0		0.15	V	
V _{OH}	3.15		3.3	V	
Drive current (sink or source)	2			mA	
UART					
Default baud rate		115.2		kbaud	
Configurable baud rate	9.6		921.6	kbaud	
Data bits		8		bits	
Parity bit		None			
Stop bits		1		bits	

Note Tag read rates can be limited by host communication interface baud rate. The default baud rate of 115,200 Baud will limit the tag read rate to approximately 300 tags per second.

6.6 Supported Regions

Table 6-8: Indy RS2000 – Regional Support

Region	Supported by SKU
Argentina	Both SKUs
Australia (920-926 MHz)	Both SKUs
Brazil (902-907 MHz)	Both SKUs
Brazil (915-928 MHz)	Both SKUs
Canada	Both SKUs
Chile	Both SKUs
Colombia	Both SKUs

Region	Supported by SKU
Costa Rica	Both SKUs
Dominican Republic	Both SKUs
Hong Kong (920-925 MHz)	Both SKUs
Indonesia	Both SKUs
Israel	Both SKUs
Korea (917-921 MHz)	Both SKUs
Malaysia (919-923 MHz)	Both SKUs
Mexico	Both SKUs
New Zealand (921-928 MHz)	Both SKUs
Panama	Both SKUs
Peru	Both SKUs
Philippines	Both SKUs
Russian Federation (916-921 MHz)	Both SKUs
Singapore (920-925 MHz)	Both SKUs
South Africa (915-919 MHz)	Both SKUs
Taiwan (922-928 MHz)	Both SKUs
Thailand	Both SKUs
United States	Both SKUs
Uruguay	Both SKUs
Venezuela	Both SKUs
Vietnam (920-925 MHz)	Both SKUs
China (920-925 MHz)	IPJ-RS2000-2
Japan (916-921 MHz)	IPJ-RS2000-2
Armenia	IPJ-RS2000-1
Austria	IPJ-RS2000-1
Azerbaijan	IPJ-RS2000-1
Belgium	IPJ-RS2000-1
Bosnia and Herzegovina	IPJ-RS2000-1
Bulgaria	IPJ-RS2000-1
Croatia	IPJ-RS2000-1

Region	Supported by SKU
Cyprus	IPJ-RS2000-1
Czech Republic	IPJ-RS2000-1
Denmark	IPJ-RS2000-1
Estonia	IPJ-RS2000-1
Finland	IPJ-RS2000-1
France	IPJ-RS2000-1
Germany	IPJ-RS2000-1
Greece	IPJ-RS2000-1
Hungary	IPJ-RS2000-1
Iceland	IPJ-RS2000-1
India	IPJ-RS2000-1
Ireland	IPJ-RS2000-1
Italy	IPJ-RS2000-1
Latvia	IPJ-RS2000-1
Lithuania	IPJ-RS2000-1
Luxembourg	IPJ-RS2000-1
Macedonia	IPJ-RS2000-1
Malta	IPJ-RS2000-1
Moldova	IPJ-RS2000-1
Netherlands	IPJ-RS2000-1
Norway	IPJ-RS2000-1
Oman	IPJ-RS2000-1
Poland	IPJ-RS2000-1
Portugal	IPJ-RS2000-1
Romania	IPJ-RS2000-1
Saudi Arabia	IPJ-RS2000-1
Serbia	IPJ-RS2000-1
Slovak Republic	IPJ-RS2000-1
Slovenia	IPJ-RS2000-1
Spain	IPJ-RS2000-1

Region	Supported by SKU
Sweden	IPJ-RS2000-1
Switzerland	IPJ-RS2000-1
Turkey	IPJ-RS2000-1
United Arab Emirates	IPJ-RS2000-1
United Kingdom	IPJ-RS2000-1

6.7 EPC Class-1 Generation-2 Operation

For details on the link profiles supported by RS2000, please see the [Indy ITK Release Documentation](#).

Table 6-9: Indy RS2000 – Gen2 Functionality

Parameter	Description
Select	Support for 2 Select commands
Inventory	FastID, TagFocus, Tag Population Estimate, Select, Session, and Target
Access	Read, Write, Lock, Kill, BlockPermalock, and QT

Table 6-10: Indy RS2000 – Inventory Performance

Parameter	Min.	Typ.	Max.	Unit	Conditions
Inventory Rate (RF Mode 1: 25 us Tari, M4, 250 kHz)		150		Tags/sec	1 Tag with tag population estimate = 1
		40		Tags/sec	1 Tag with tag population estimate = 16
		130		Tags/sec	16 Tags with tag population estimate = 16
Inventory Rate (RF Mode 3: 6.25 us Tari, FM0, 400 kHz)		300		Tags/sec	1 Tag with tag population estimate = 1
		250		Tags/sec	20 Tag with tag population estimate = 32
		260		Tags/sec	100 Tags with tag population estimate = 128

Note Tag read rates can be limited by host communication interface baud rate. The default baud rate of 115,200 Baud will limit the tag read rate to approximately 300 tags per second.

7 Regulatory Information

7.1 Modular FCC and IC Certification

The Indy RS2000 (IPJ-RS2000) has been certified for modular operation by FCC and Industry Canada in certain specific configurations using the following IDs. Use of these IDs requires specific text be added to product labeling and product Hardware User's

Guides. See the [Indy RS2000 Hardware User's Guide](#) for more details on labeling specifics.

FCC ID: TWYIPJRS2000

IC ID: 6324A-IPJRS2000

7.2 ETSI Certification

The RS2000-1 SKU is designed to operate within ETSI guidelines. However, ETSI does not offer modular certifications, and thus Impinj cannot offer a modular certification for the module.

To demonstrate that the RS2000-1 SKU can achieve ETSI certification, Impinj has generated the document Indy RS500 and RS2000 ETSI Compliance, which can be downloaded from support.impinj.com.

8 Package and Assembly Information

This section provides mechanical drawings and critical dimensions needed for PCB layout and housing design, as well as SMT assembly information.

8.1 Package Mass

The mass of the RS2000 module is approximately 12.0 grams, or about 0.42 ounces.

8.2 Package Dimensions and Flatness

Package dimensions are shown in Figure 8-1.

All dimensions are in millimeters.

Dimension tolerances (unless otherwise specified):

X = 1.0

X.X = 0.5

X.XX = 0.25

X.XXX = 0.125

Hole = 0.075

Angular: MACH 0.5

Bend: 1.0 Degree

Figure 8-1 shows the dimensions of the module. Figure 8-2 and Figure 8-3 show the locations and dimensions of the exposed conductors on the underside of the PCB that allow electrical and mechanical connections to the motherboard.

The thickness of the PCB, and thus the castellated plated through-holes is 32.8 mils nominal.

The flatness of the module deviates by a maximum of 0.45 mm from perfectly planar, measured per IPC-A610F.

Figure 8-4 shows the label on the top of the module. The serial number is printed as text and also as a 2D barcode on the module label, along with other information about the module. The serial number is made up of information about the device specific to its manufacturing. Details of the serial number makeup are shown in Table 8-1.

Figure 8-1: RS2000 Package Dimensions, Top, Front, and Side Views

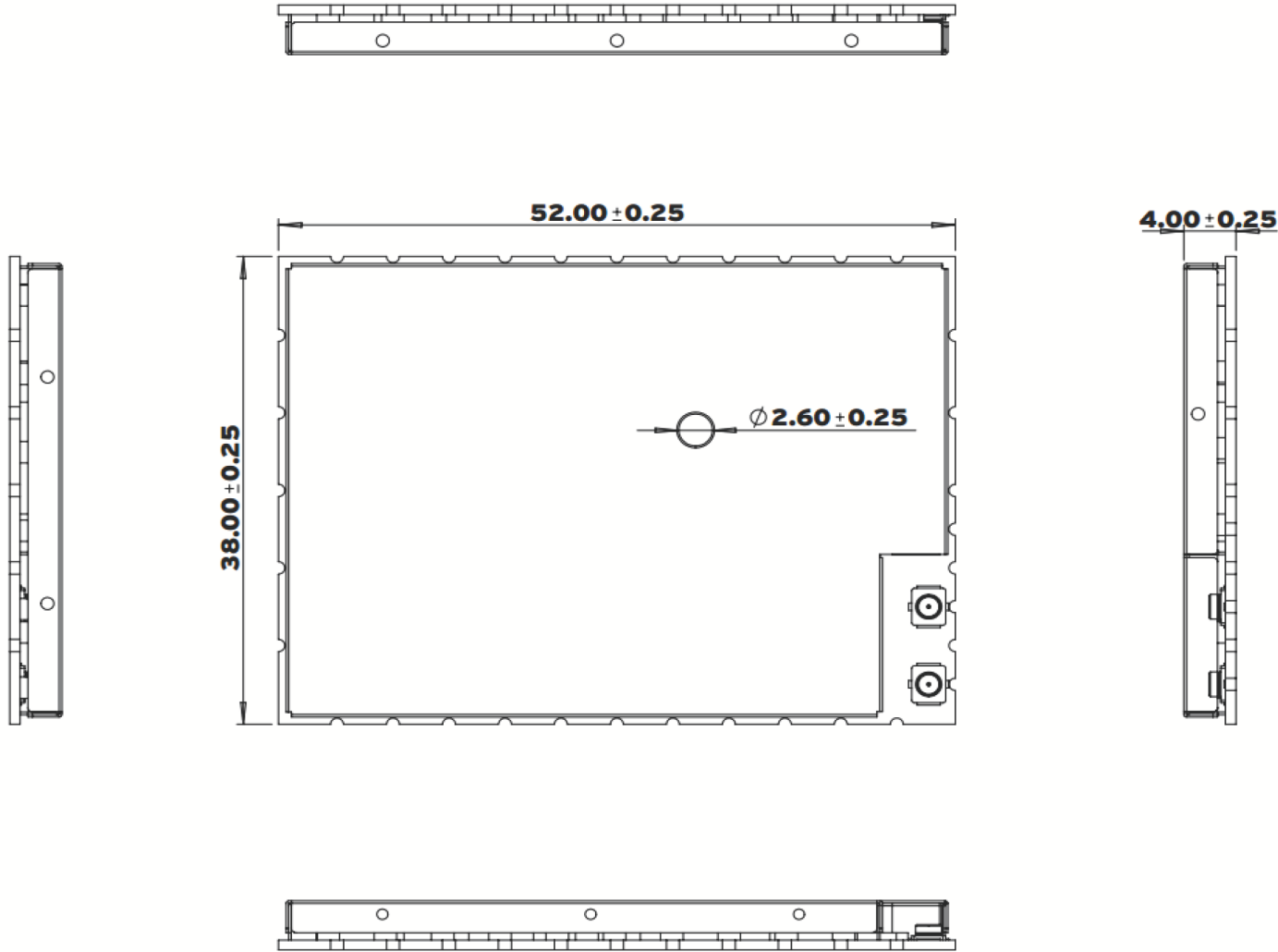


Figure 8-2: RS2000 Electrical Connection and Mounting Feature Locations

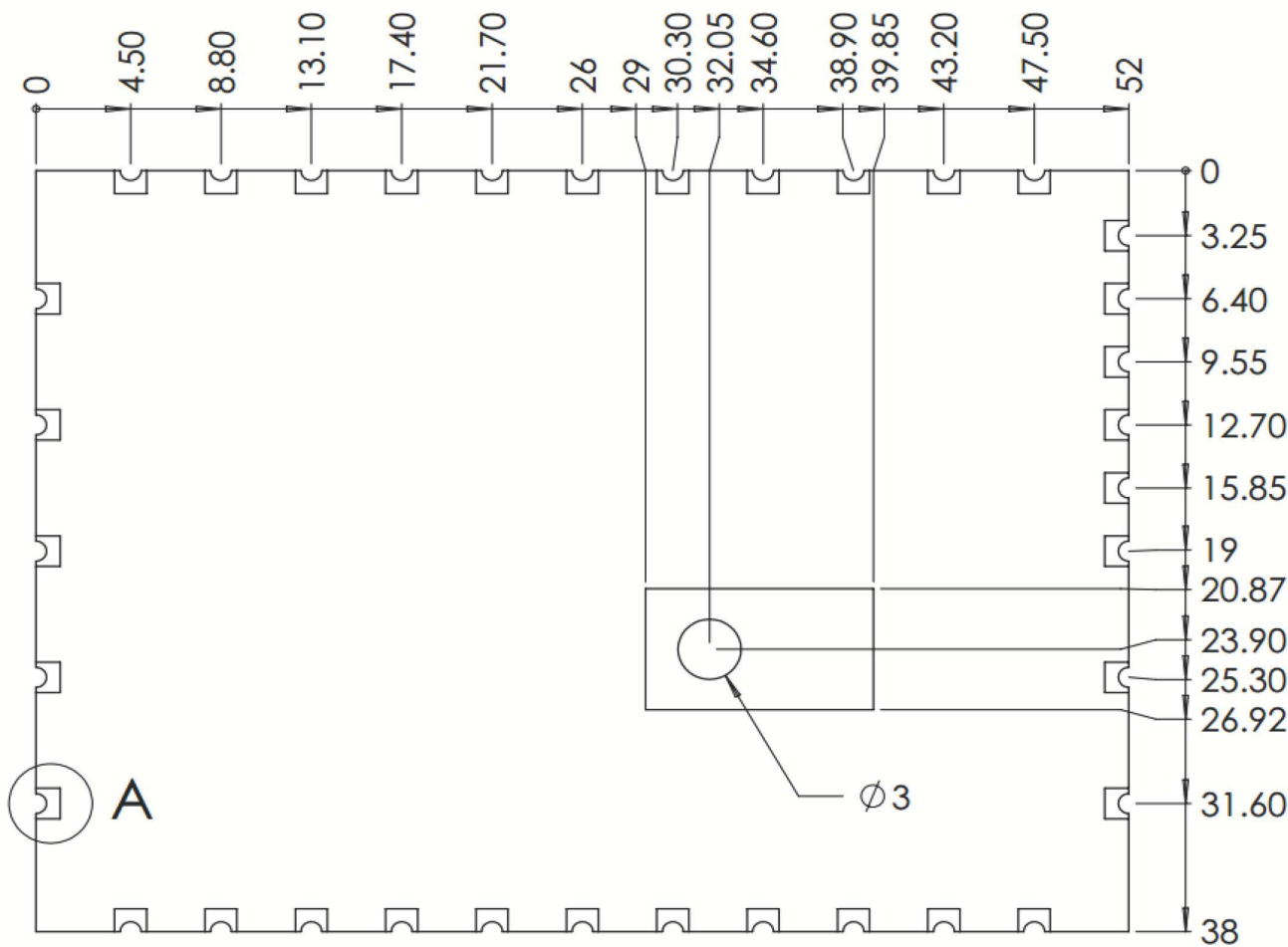


Figure 8-3: RS2000 Edge Pad Dimension Detail A

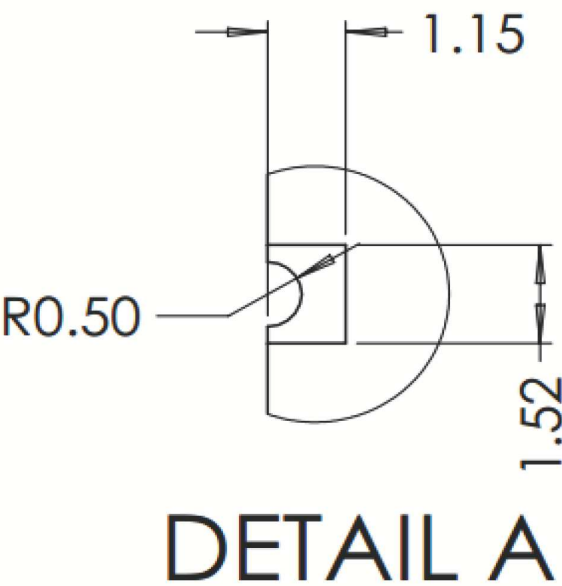


Figure 8-4: RS2000 Label



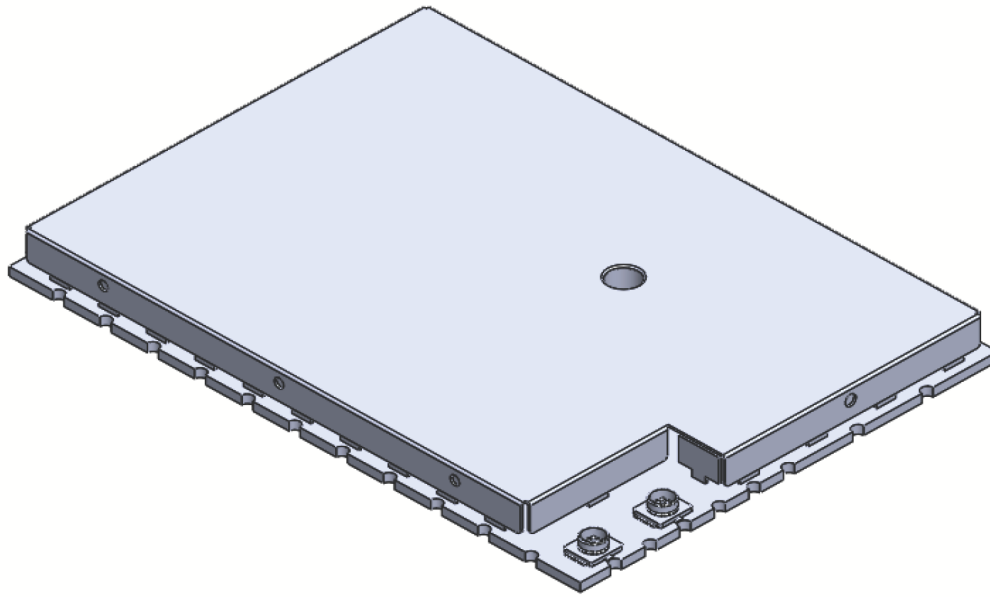
Table 8-1: Indy RS2000 – Label Marking Details

Digits	Meaning
U	SKU code: 1 = IPJ-RS2000-1 2 = IPJ-RS2000-2
XX	SKU code: 01 = IPJ-RS2000-1 02 = IPJ-RS2000-2
RRR	Revision of the module
ZZ	Lot number
WW	Workweek produced
YY	Year produced
AAAA	Serial number within the lot
VV	Impinj SKU Code

8.3 RS2000 Module 3D Model

Impinj has created a 3D model of the RS2000 for visualization and dimensional planning purposes. A perspective render of the 3D model is shown in Figure 8-5. A STEP format version of this 3D model can be downloaded from support.impinj.com.

Figure 8-5: RS2000 Module 3D Model Perspective Render



8.4 PCB Footprint

Recommended footprint copper and pastemask dimensions are shown in Figure 8-6 and Figure 8-8. Dimensions for the individual pads are shown in Figure 8-7 and Figure 8-9.

The electrical connections between the module and the motherboard it is mounted to are made using the castellated plated through-holes around the edge of the module, whose dimensions are shown above in Figure 8-2 and Figure 8-3.

The thickness of the PCB, and thus the castellated plated through-holes is 32.8 mils nominal.

Figure 8-6: RS2000 Recommended Etched Copper Footprint – All Pads

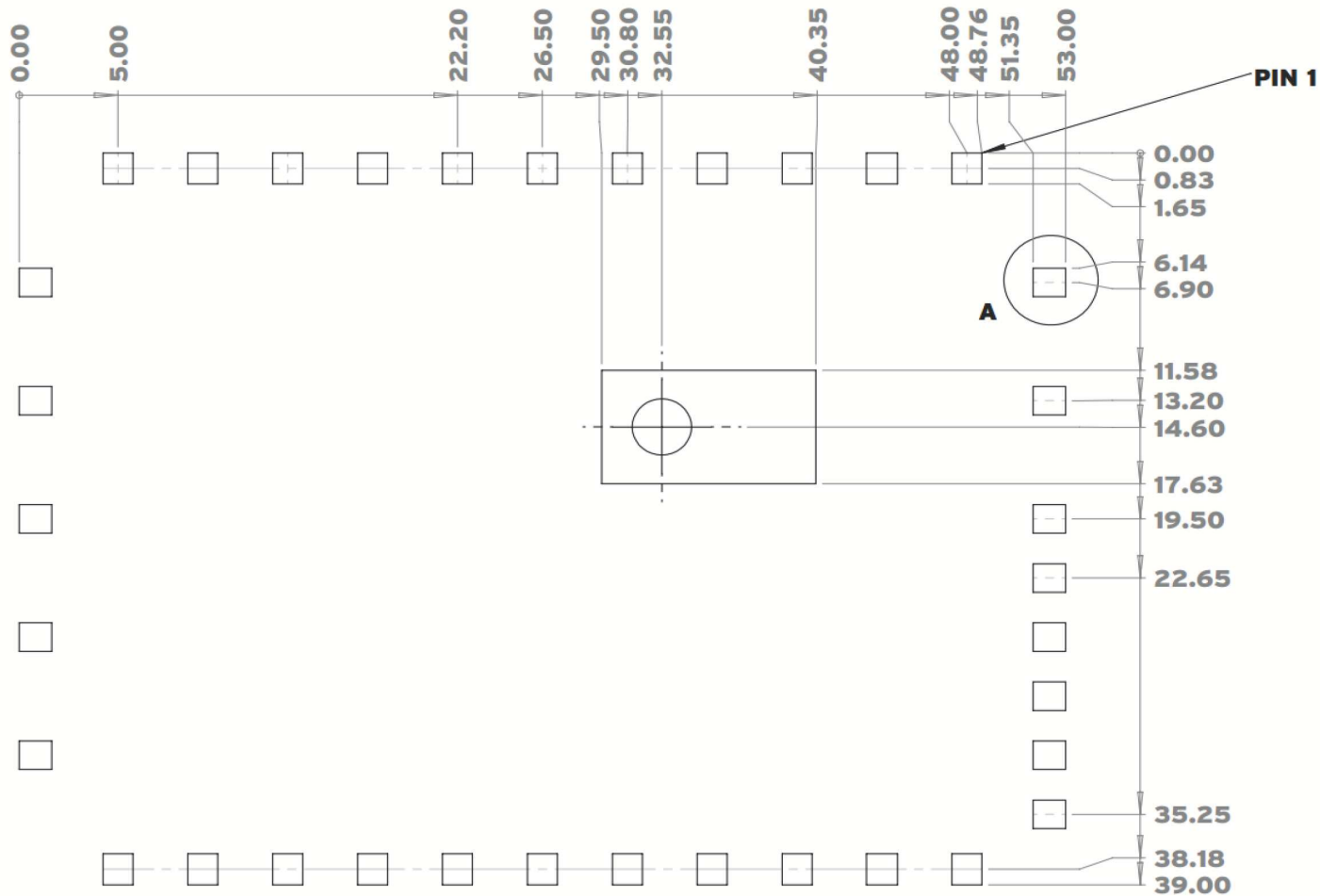
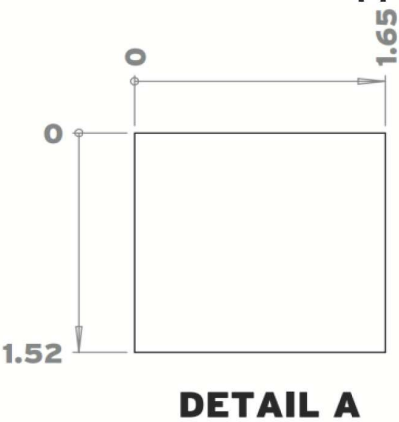


Figure 8-7: RS2000 Recommended Etched Copper Footprint – Single Pad



Technical drawing of a PCB layout showing dimensions and component footprints. The drawing includes a top view with dimensions in millimeters (mm) and a side view showing the profile of the components.

Top View Dimensions:

- Horizontal dimensions (from left to right): 0.00, 6.15, 23.35, 27.65, 32.06, 35.68, 39.68, 49.15, 50.15, 52.50, 55.30.
- Vertical dimensions (from top to bottom): 0.00, 1.40, 2.80, 7.05, 8.05, 14.13 ± 0.25 , 14.35, 17.38 ± 0.25 , 20.65, 23.80, 41.30.
- Feature B is indicated by a circle and a leader line.
- A dimension of $\phi 2.00$ is shown for a circular feature.

Side View Dimensions:

- Vertical dimensions (from top to bottom): 0.00, 1.40, 2.80, 7.05, 8.05, 14.13 ± 0.25 , 14.35, 17.38 ± 0.25 , 20.65, 23.80, 41.30.

Component Footprints:

- Rectangular footprints are shown along the top and bottom edges.
- Circular footprints are shown in the center of the layout.
- Feature B is a circular feature with a diameter of $\phi 2.00$.

DETAIL B

27

8.5 Thermal considerations

The RS2000 has two features designed to improve thermal performance. The first is a thermal pad on the underside of the module, which can improve the thermal connection to the PCB it is attached to. This pad should be connected to a plane on the PCB as shown in the recommended footprint in Figure 8-6. The second feature is a screw-hole through the module that allows improved thermal conduction to a chassis or heat-sink. This screw hole accommodates a machine screw up to metric size M2.5, or SAE size #2. It is shown in Figure 8-1.

The exposed conductive pad on the backside of the module is connected to the signal ground of the RS2000.

For more details on improving thermal performance, see the [RS2000 Hardware User's Guide](#).

8.6 SMT Reflow Information

The recommended reflow profile for RS2000 is shown in Figure 8-10. This profile is based on the Koki S3X58-M406-3 solder paste, with more specific requirements to ensure proper reflow of the RS2000 module.

The RS2000 requires a weight be placed on top of it during an automated SMT process in manufacturing. This is primarily due to its size and thermal expansion characteristics during the reflow process, but also improves reflow reliability given the flatness of the module, as specified in section 8.2. This is not an uncommon industry practice with large components. Impinj does not recommend reflowing the RS2000 without the recommended weight because it may lead to poor solder joints and defects. Impinj has created a reference design for a machined aluminum weight. A render of the weight is shown in Figure 8-11, and a dimension drawing is shown in Figure 8-12. For a STEP 3D-model and more detailed dimension drawing, see this article on support.impinj.com.

Figure 8-10: Recommended Solder Reflow Profile for the Indy RS2000

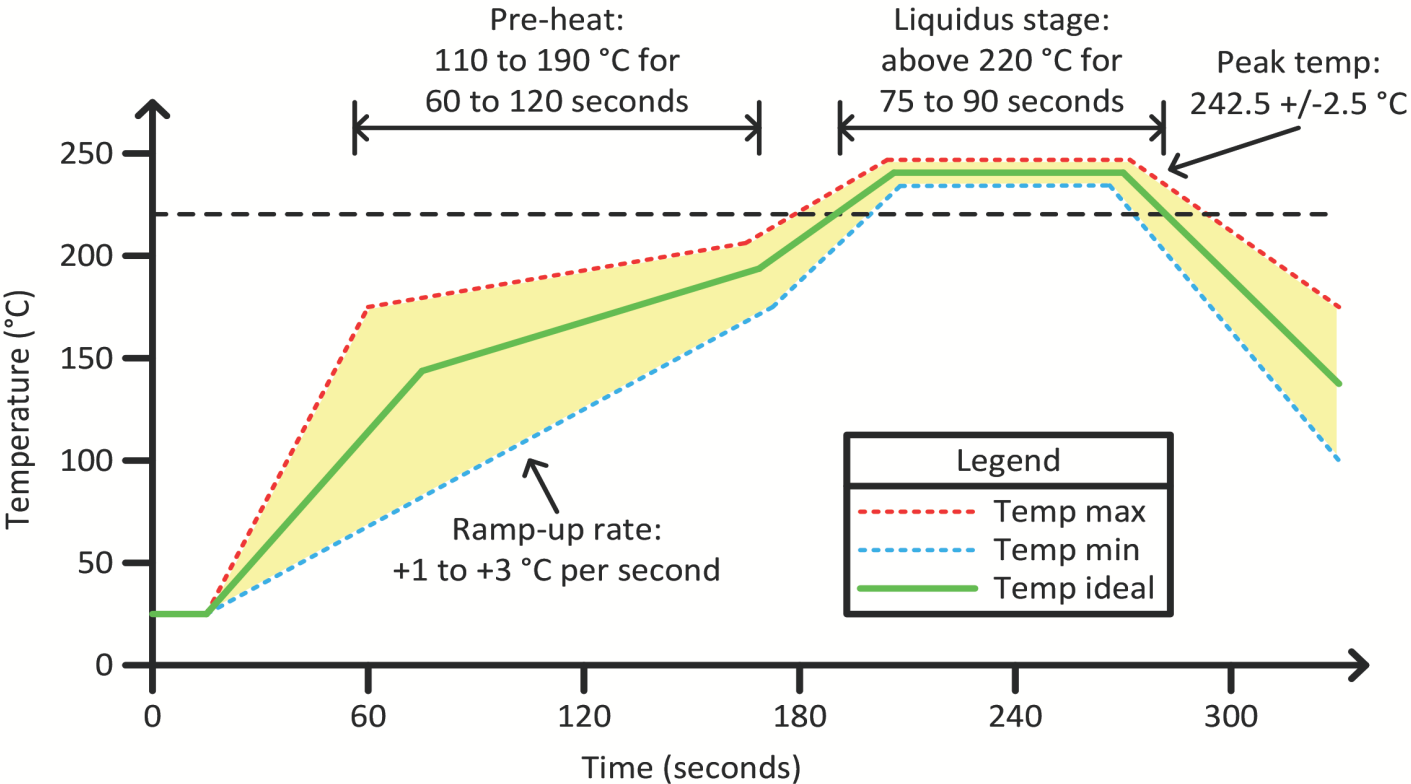


Figure 8-11: RS2000 SMT Reflow Weight 3D Render

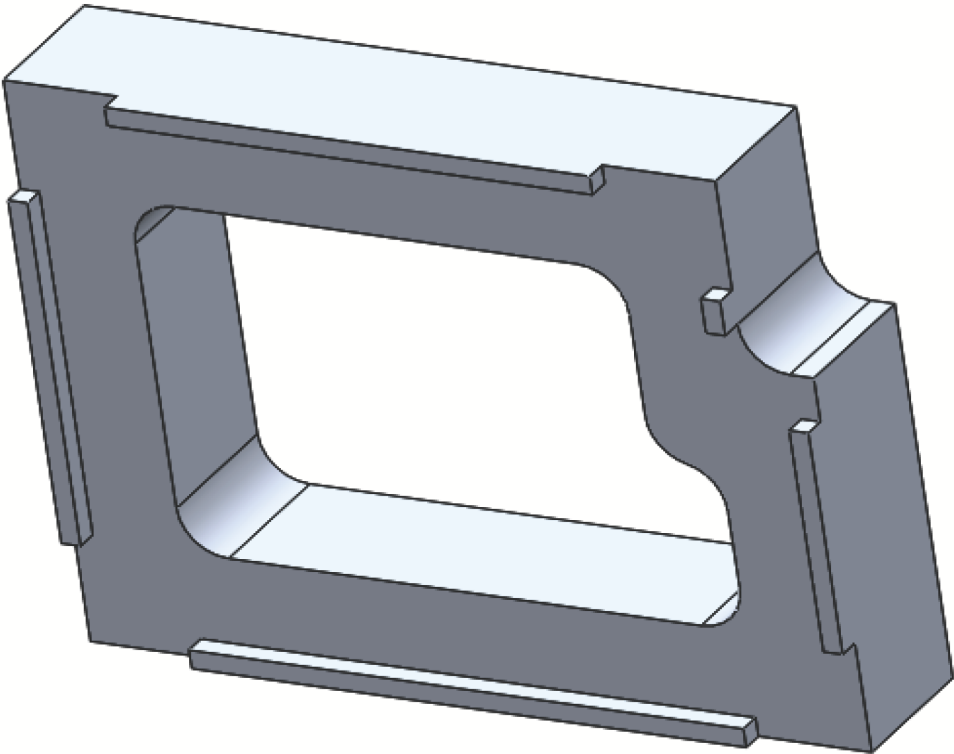
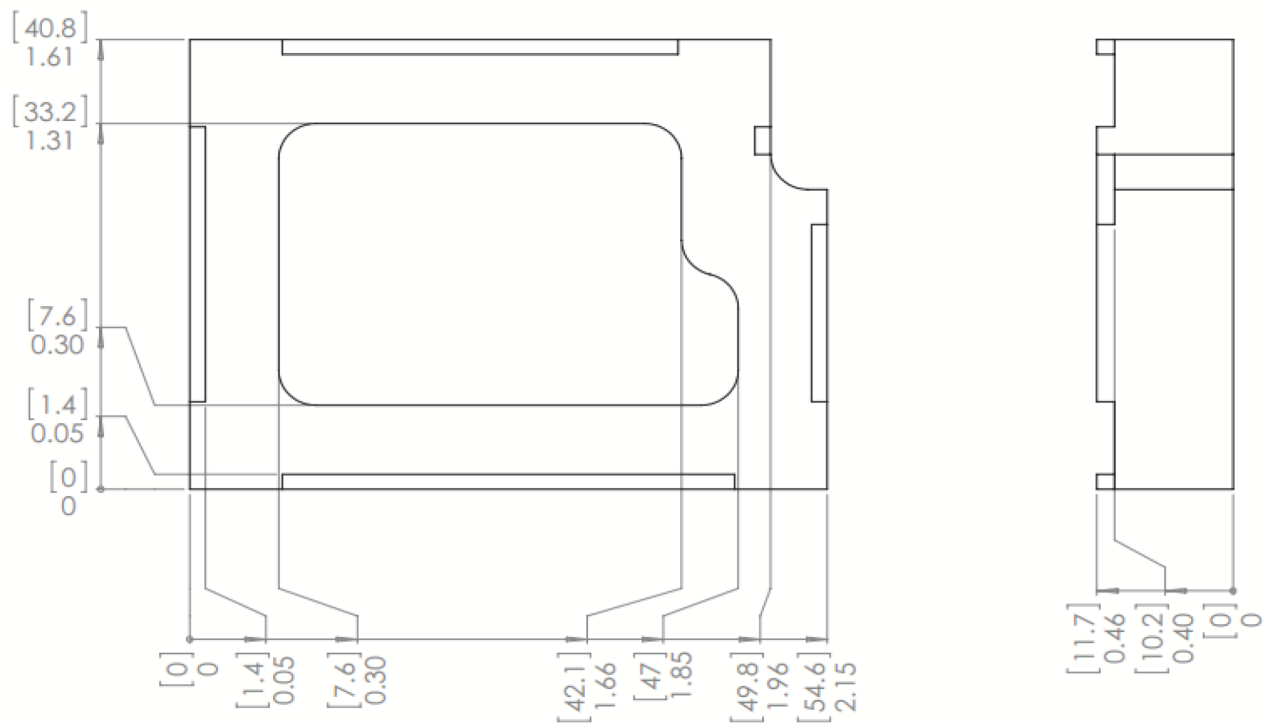


Figure 8-12: RS2000 SMT Reflow Weight Drawing



Note All dimensions in mm. See drawing on support.impinj.com for more details.

9 Related Documentation

Table 9-1 contains a list of documentation related to this datasheet and the Indy reader products.

Table 9-1: Related Documentation

Indy Reader Module Brochure
RS2000 Hardware User's Guide
RS2000 Development Kit Files
RS2000 and RS500 STEP format 3D Models
RS2000 SMT Reflow Weight
Indy RS500 and RS2000 ETSI Compliance
Indy ITK Release (Requires support profile access)
Indy ITK Documentation
RS500 Datasheet
RS500 and RS2000 IRI Blog Posts
Indy Reader Chip Brochure
Indy R2000 Reader Chip Datasheet

10 Document Change Log

Table 10-1: Document Change Log

Version	Date	Description
1.0	3/4/2016	Production release
1.1	5/19/2016	Clarified electrical specifications Added STEP models and SMT assembly weight information Added ETSI compliance document information
1.2	8/10/2016	Clarified thermal and TX ACPR specifications Added detail on PCB layout and module dimensions
1.3	9/13/2017	Clarified SMT reflow guidelines in section 8.6 Added module underside drawing in Figure 8-2 and Figure 8-3 Removed VIL Min and VIH Max specifications from tables in section 6.5 Added firmware notes in section 5.2
1.4	6/20/2018	Added spec for package flatness in section 8.2 Updated module vocabulary Added Mode 3 tag read rates to Table 6-10

11 Notices

Copyright © 2018, Impinj, Inc. All rights reserved.

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

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

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

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

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

These products may be covered by one or more U.S. patents. See <http://www.impinj.com/patents> for details.

Indy is a trademark of Impinj, Inc. All other product or service names are trademarks of their respective companies.