

## Description

The P9235A-RB-EVK Evaluation Board demonstrates the features of the P9235A-RB 5W Wireless Power Transmitter (TX). It is intended to evaluate the functionality and performance of the P9235A-RB when combined with a power receiver in a wireless charging system. The P9235A-RB-EVK offers the flexibility to select parameters, such as the over-current limit threshold, LED pattern, and external temperature sensing function using a graphical user interface (GUI). The printed circuit board (PCB) has four layers.

The P9235A-RB Evaluation Board is designed to function with the P9222-R Receiver Evaluation Board, which is ordered separately (see [www.idt.com/p9222-r-evk](http://www.idt.com/p9222-r-evk) for details). It can also be used with the user's WPC-1.2.4 compliant receiver.

The high-efficiency, turnkey reference design is supported by comprehensive online digital resources to significantly accelerate the design-in effort and enable rapid prototyping. The total active area is optimized to 21 × 21 mm.

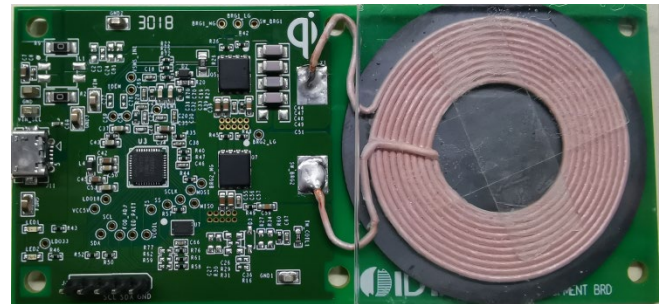
## Kit Contents

- P9235A-RB-EVK Evaluation Board

## Features

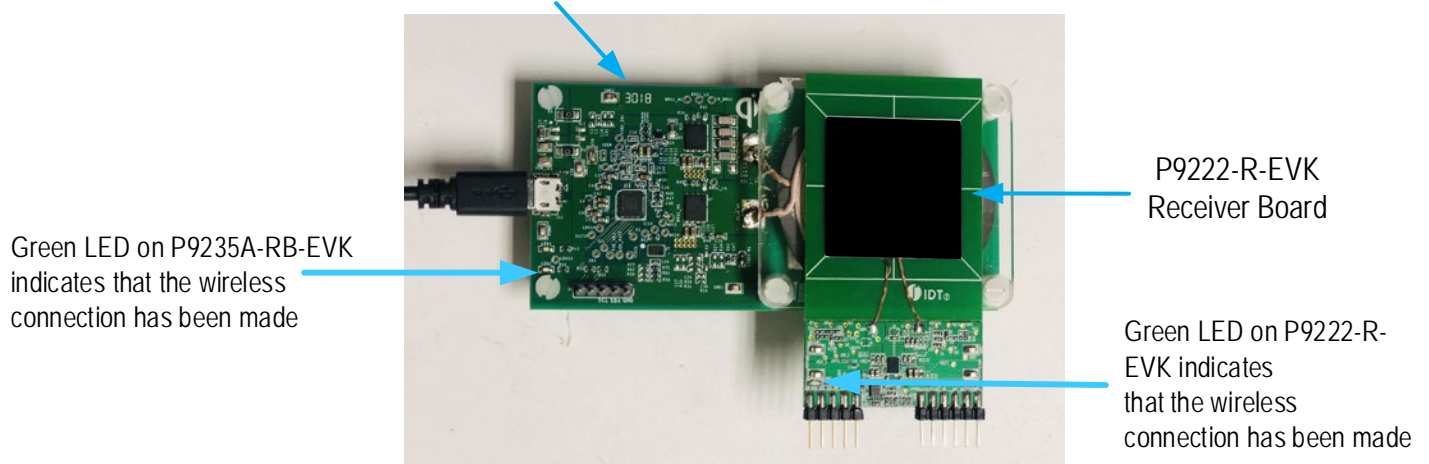
- P9235A-RB Evaluation Board provides support for WPC-1.2.4
- Power capability: 5W receiver output for 5V/2A input
- Adjustable FOD thresholds and LED behaviors via graphical user interface
- Passed WPC A11a Coil configuration Pre - Qi certification tests on NOK9 with the default configuration
- Passes EN303417 Specification with default configuration
- On-board external Flash that enables users to customize the design configuration
- Fully assembled with test points and coil fixture

P9235A-RB-EVK Evaluation Board



## P9235A-RB Transmitter Board Connected to P9222-R-EVK

P9235A-RB Transmitter Evaluation Board



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# 1. Setup

## 1.1 Required or Recommended User Equipment

The following additional lab equipment is required for using the kit:

- P9222-R-EVK Receiver Evaluation Board or any WPC-1.2.4 compliant receiver
- 5V power supply or 5V/2A AC USB adaptor<sup>[a]</sup> provided by the user
- REA USB to I2C Dongle (sold separately)

## 1.2 Software Installation, Dongle Connectivity, and FLASH Programming with GUI

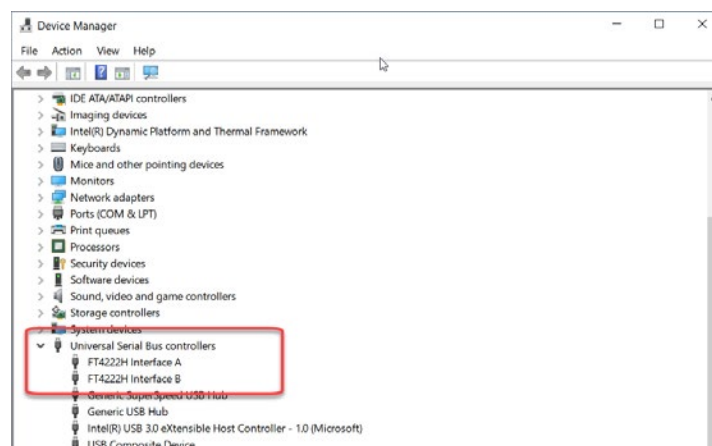
Visit the P9235A-RB-EVK webpage and download latest version of the *P9235A-RB Wireless Power Pro GUI*, USB drivers, and the *P9235A-RB A11a Configuration Flash HEX File*. The software provides an intuitive GUI for reading and writing to P9235A-RB SRAM registers and for generating custom user configurations for the external Flash.

### 1.2.1 Software Installation

Follow these procedures to install the software:

1. Do not connect the USB-to-I2C dongle before installing the software.
2. Run the downloaded USB Drivers Setup executable file and follow the user prompts to install the USB drivers.
3. After finishing the setup of the USB drivers, connect one of the USB-to-I2C dongles to the USB port. Wait for a few moments to let Windows® map the drivers for the dongle.
4. Open the Device Manager from the Windows control panel and check the devices listed under “Universal Serial Bus controllers” section. “FT4222H Interface A” and “FT4222H Interface B” should appear in this section as shown in Figure 1.
5. Download and extract the *P9235A-RB Wireless Power Pro GUI SWR* compressed file. To launch the GUI, click on the “Renesas Wireless Power P9235A-RB” Application.

Figure 1. Windows Device Manager Display for Troubleshooting the USB Connection



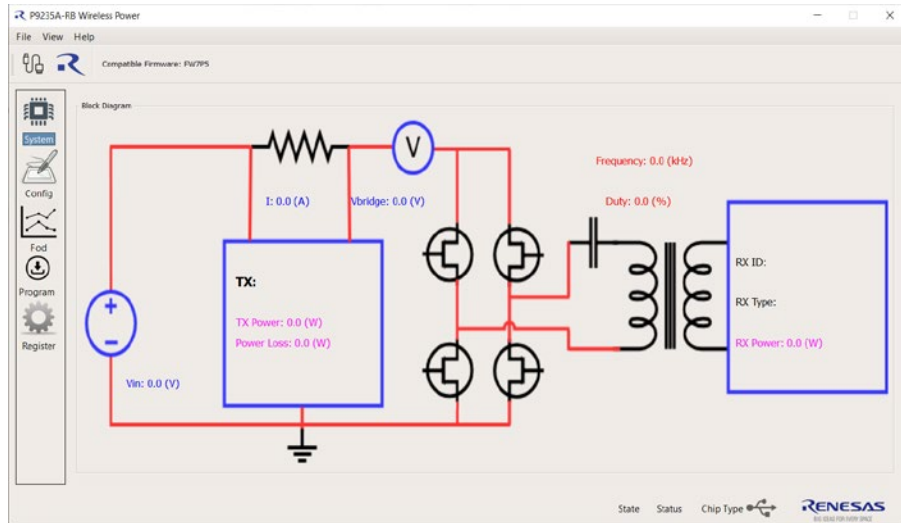
<sup>[a]</sup> A recommended 5V/2A AC USB adaptor is noted below, or use an equivalent adaptor.  
[https://www.amazon.com/EasyAcc-Universal-Travel-Charger-Adapter/dp/B00A9P05AM/ref=sr\\_1\\_3?ie=UTF8&qid=1418662587&sr=8-3&keywords=easyacc+charger](https://www.amazon.com/EasyAcc-Universal-Travel-Charger-Adapter/dp/B00A9P05AM/ref=sr_1_3?ie=UTF8&qid=1418662587&sr=8-3&keywords=easyacc+charger)

### 1.2.2 Dongle Connectivity

Follow these procedures to establish GUI connectivity to the P9235A-RB-EVK:

1. Launch the GUI Program – Renesas Wireless Power P9235A-RB. The initial screen of the GUI is shown in Figure 2.

Figure 2. System Tab of GUI



2. Set up the P9235A-RB Evaluation Board by plugging the 5V adapter into J11 (Micro-USB connector), or the user's power supply into VIN (see Figure 8).
3. Connect the USB to I2C Dongle to the computer and launch the P9235A-RB Wireless Power Pro GUI. Once the dongle is detected, the message "Dongle Detected" will appear on the GUI. If the message does not appear, unplug and plug the USB cable at the user's computer.
4. Connect the USB to I2C dongle header to J4 of the P9235A-RB-EVK as shown in the Figure 3.

Figure 3. Connecting the Dongle and Verifying GUI Connectivity.

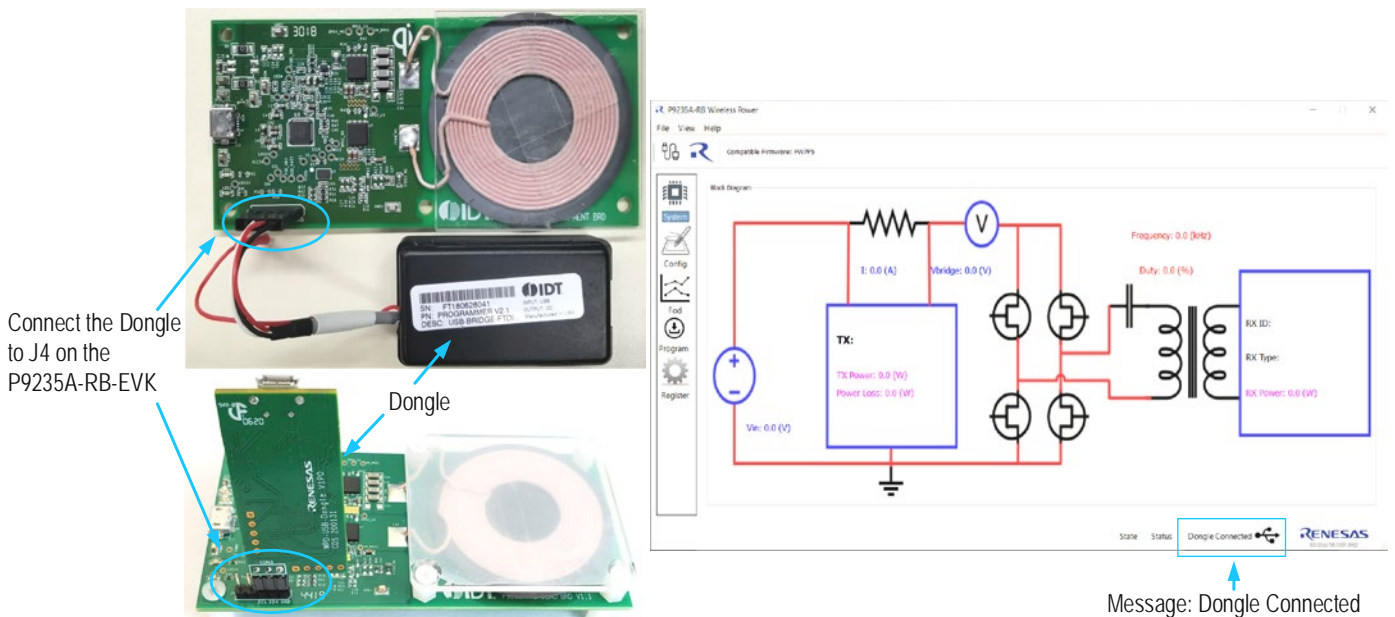
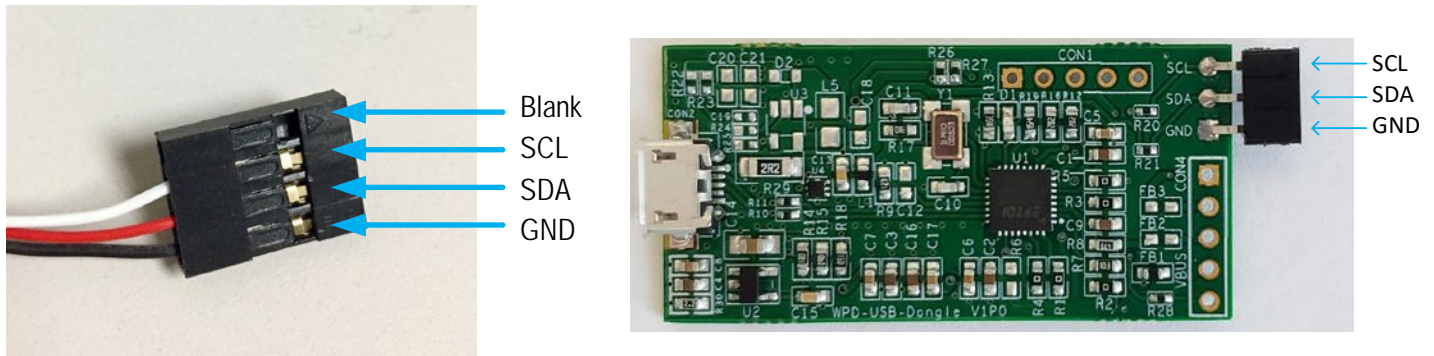
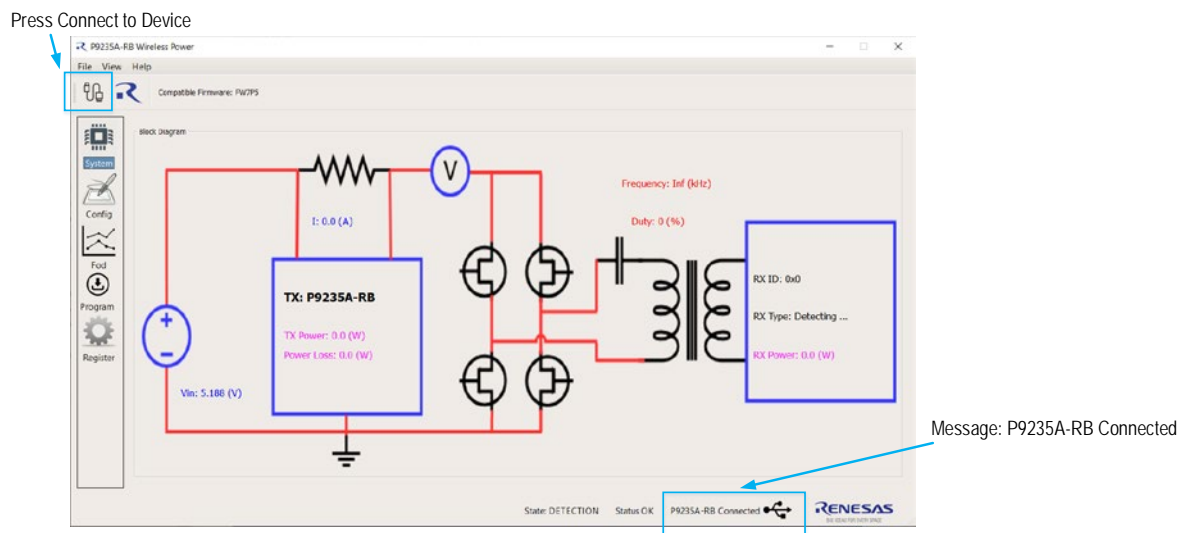


Figure 4. USB to I2C Dongle Header of “USB-FTDI-V2-1” (FTDI) Dongle and “WPD-USB-Dongle”



5. Press the “Connect to Device” button in the P9235A-RB Wireless Pro GUI to connect to the P9235A-RB-EVK. Once the P9235A-RB-EVK is recognized, the message “P9235A-RB Connected” will appear (see Figure 5). Note: To disconnect: Under the File Drop-down menu → disconnect.

Figure 5. P9235A-RB-EVK Successfully Connected to GUI

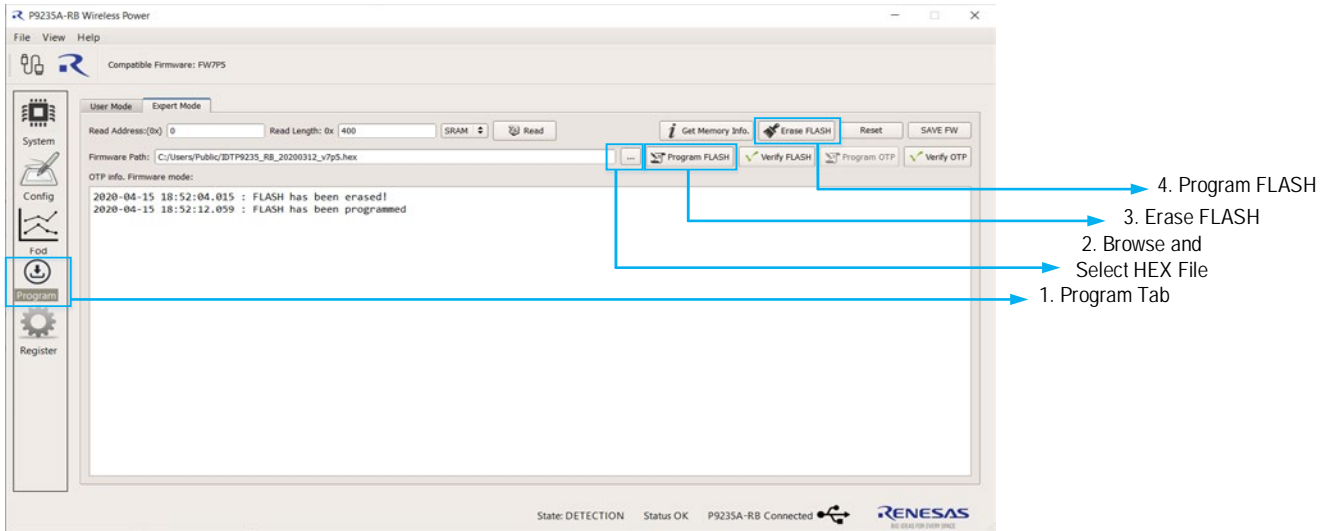


### 1.2.3 Using GUI to Write to FLASH

To update the P9235A-RB-EVK firmware, follow the steps below and refer to Figure 6:

1. Enter the Program Tab of the GUI by pressing Program.
2. Browse and select the firmware Hex file in the Firmware Path.
3. Press Erase FLASH and accept the prompted messages.
4. Press Program FLASH and accept the prompted messages.
5. (Optional). Power cycle the P9235A-RB, then press Verify FLASH and accept the prompted messages.

Figure 6. FLASH Programming Procedure



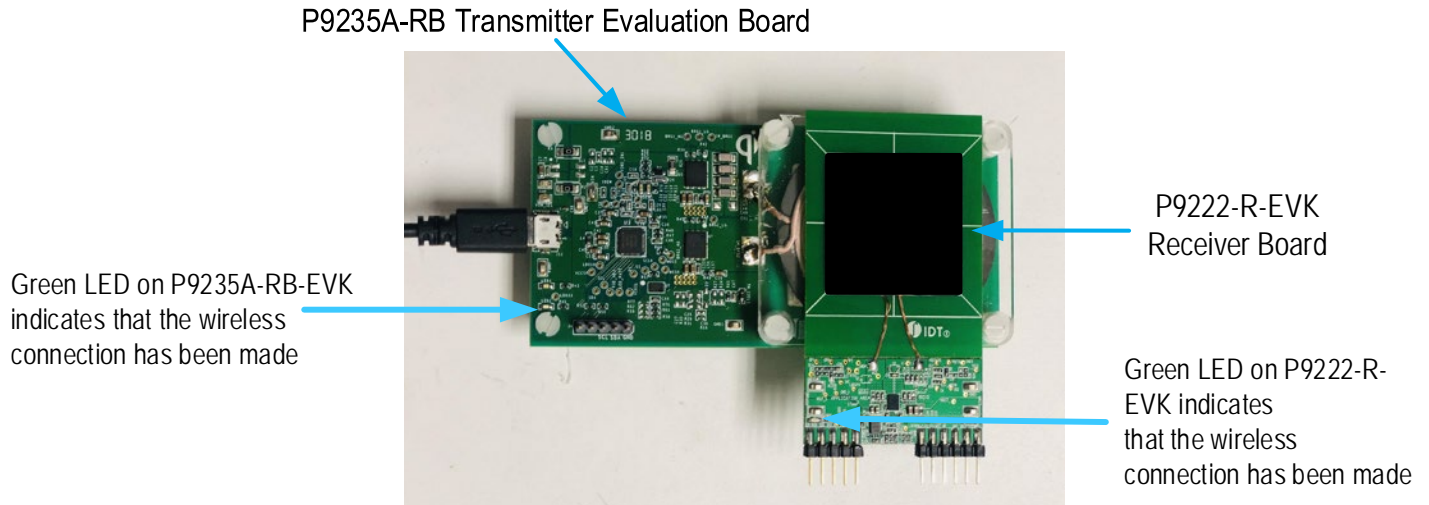
### 1.3 Kit Hardware Connections

Complete the following procedure to set up the kit as shown in Figure 7.

1. Set up the P9235A-RB Evaluation Board by plugging the 5V/2A adapter or the user's power supply into J11 (Micro-USB connector). Refer to Figure 8.
2. If using the P9222-R-EVK Evaluation Board as the receiver, connect wires to the VOUT and GND test points on the P9222-R-EVK receiver to allow measuring the output voltage and applying a load.
3. Place the P9222-R-EVK or the user's receiver on the transmitter (TX) pad with the components facing up as shown in Figure 7.
4. Verify that the two green LEDs identified in Figure 7 are illuminated indicating that coupling has been established.



Figure 7. Evaluation Kit Connections using the P9222-R Receiver Evaluation Board



## 2. Usage Guide

The P9235A-RB-EVK firmware provides great flexibility to customize operating parameters for custom applications. Default values of the P9235A-RB-EVK operating parameters, such as Digital Ping Frequency, FOD parameters, coil over-temperature sensing, and over current limit are configurable in the firmware, and are loaded from the external Flash memory. Based on the end application, the P9235A-RB operating parameters can be configured by either writing to internal SRAM registers via the I2C interface, or by creating a new user configuration HEX file that can be generated within the *P9235A-RB Wireless Power Pro GUI*. Once the new user configuration HEX file is generated, the Flash memory can be erased and reprogrammed with the *P9235A-RB Wireless Power Pro GUI*. To customize P9235A-RB-EVK operating parameters in real-time, use the *P9235A-RB Wireless Power Pro GUI* software along with the USB to I2C dongle connected to J4 Header.

### 2.1 Overview of the P9235A-RB-EVK

Figure 8. P9235A-RB V1P1 Evaluation Board Features

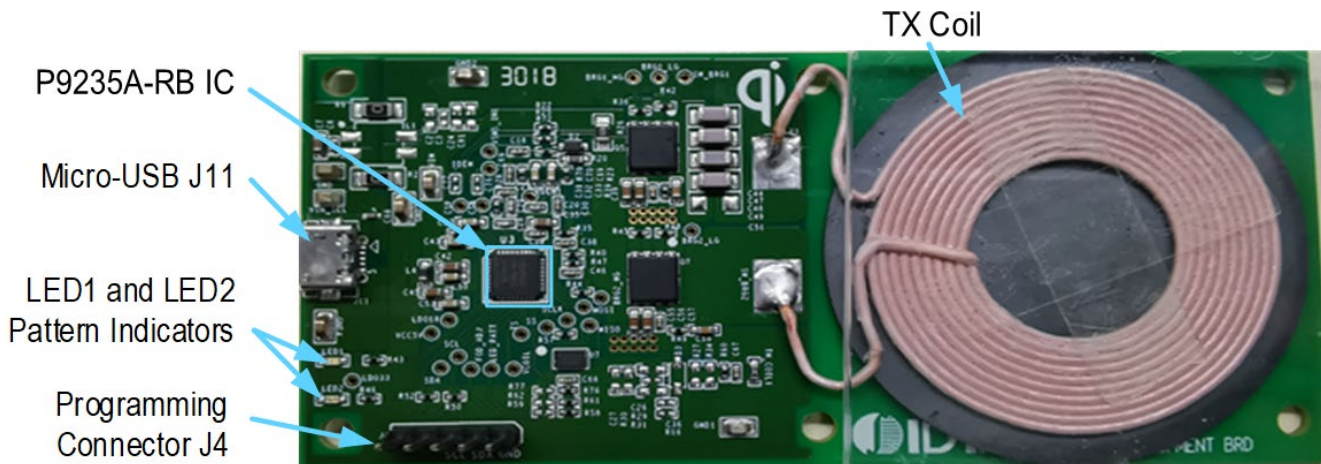
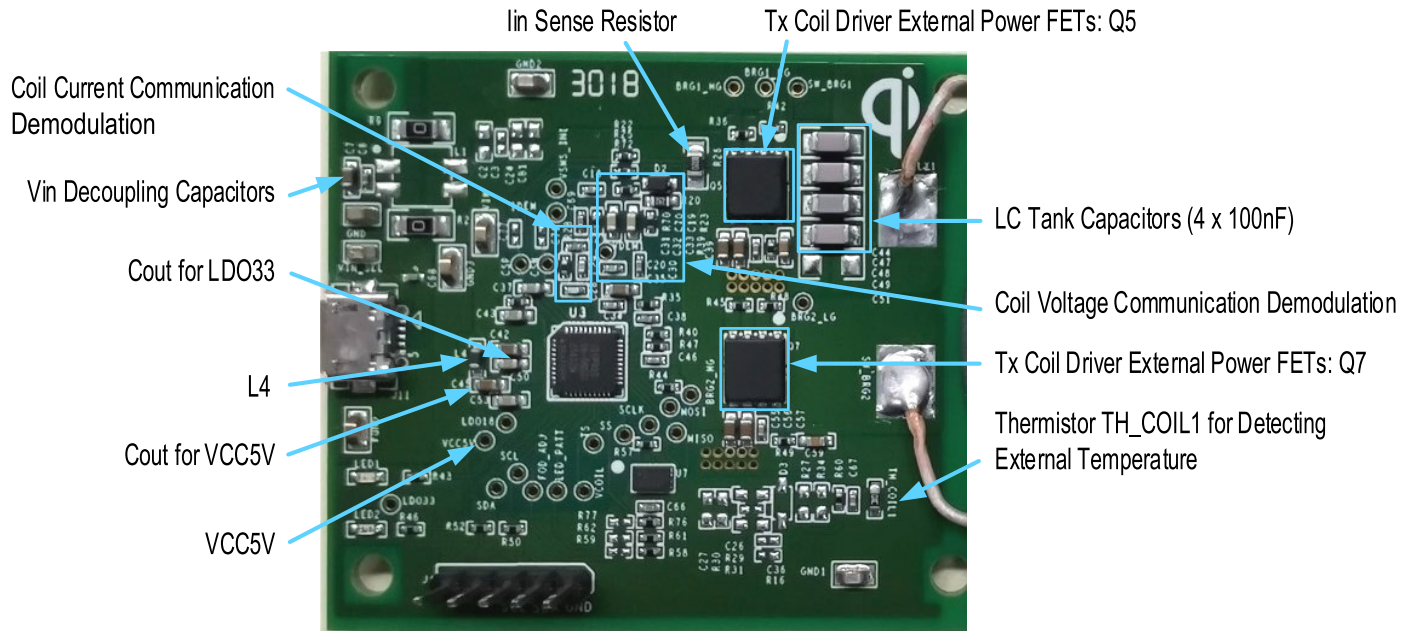


Figure 9. P9235A-RB Evaluation Board Details



## 2.2 Programming Interface

The P9235A-RB offers a pre-programmed bootloader that must be used in conjunction with an external flash memory containing control firmware. The master P9235A-RB accesses the slave external memory using a standard SPI interface (SCLK, MISO, MOSI, and  $\overline{SS}$  pins) to upload the firmware from the flash memory into the P9235A-RB internal SRAM. This architecture gives the user the flexibility to change the firmware in the external flash to meet application-specific requirements. Renesas also provides firmware to implement standard WPC coil configurations, such as the A11a addendum.

The *P9235A-RB Wireless Power Pro GUI* can be used for programming the external flash file. The W25X20CLUXIG is the recommended external flash memory. Smaller memory sizes in W25X family can be used depending on the total firmware size. For recommended flash memories, please consult Renesas.

## 2.3 Overview of the P9235A-RB Wireless Power Pro GUI

### 2.3.1 System (Block Diagram) Tab

The System Tab of *P9235A-RB Wireless Power Pro GUI* offers a dynamic visual block diagram to expand the knowledge base of the wireless power system. This tab provides real-time information of input voltage, input current, transmitted power, power level of the receiver received, power loss, operating frequency, operating duty, receiver identification number, and power contract type.

### 2.3.2 Config (Configuration) Tab

The Config Tab of *P9235A-RB Wireless Power Pro GUI* offers users the flexibility to change operating parameters. Operating parameters, such as Digital Ping Frequency/Duty, Operating Frequency/Duty limits, Rx Detection Sensitivity to lower quiescent currents in standby, over-current sensing thresholds, LED1/2 patterns in specific events, Coil over-temperature sensing thresholds, and Error mode alarm timer, can be configured in real-time. For a more a detailed list of configurable parameters, launch the *P9235A-RB Wireless Power Pro GUI*. Once the settings are of user's choice, a new configuration HEX file can be generated. The user must press Configure to RAM before generating a new HEX file.

### 2.3.3 FOD (Foreign Object Detection) Tab

The FOD Tab of *P9235A-RB Wireless Power Pro GUI* allows users to adjust the FOD thresholds in real-time. Based on experimentation of at least three points with and without a foreign object present, a graphic visualization aid is provided to help with the tuning process. The FOD threshold can be auto-generated by usage of the Auto Calculate button, or it can be manually generated by the Manual Adjust button. Once the settings are of user's choice, a new configuration HEX file can be generated. The user must press Configure to RAM before generating a new HEX file.

### 2.3.4 Program (Programming FLASH/OTP) Tab

The Program Tab of the *P9235A-RB Wireless Power Pro GUI* allows users to program FLASH and/or OTP memory. The FLASH and/or OTP memory of the P9235A-RB-EVK can be verified with a loaded HEX file in the Firmware Path. From an already programmed P9235A-RB, the firmware Hex file can also be extracted and saved to a local target.

### 2.3.5 Register (Manually Register Read/Write and Logging) Tab

The Register Tab of the *P9235A-RB Wireless Power Pro GUI* offers users to manually log registers up to 32 bits to a maximum of 10 registers at any time. Data Rate and Log Display Format is configurable. Manually Read and Write is also offered in this section.

### 2.3.6 Generating a New HEX File

It is recommended to complete the following steps when generating a HEX file:

1. Program the P9235A-RB-EVK with the latest HEX Configuration File from the website. Begin with a golden base hex file. It is not recommended to daisy chain the HEX files.
2. Read defaults before overwriting any parameters by pressing Read Configurations.
3. Enter desired field value and press Configure to RAM.
4. Confirm acceptance of the desired field value by pressing Read Configurations.
5. Press Generate HEX firmware to create a new HEX file.

## 2.4 External Temperature Sensing – TS

The P9235A-RB includes an optional temperature sense input pin, TS, used to monitor a remote temperature, such as for a coil or a battery charger.

The TS pin voltage can be calculated by **Error! Reference source not found.**

$$V_{TS} = V_{LDO33} \times \frac{NTC}{(NTC + R60)} \tag{Equation 1}$$

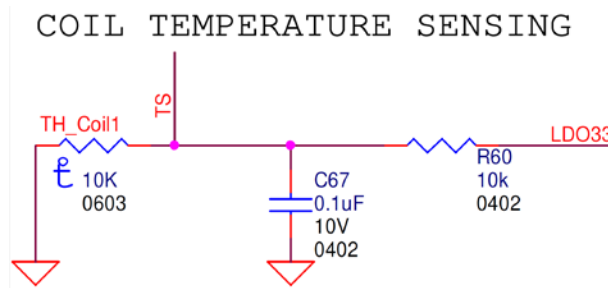
Where:

*NTC* Thermistor's resistance (TH\_COIL1)

*R60* Pull-up resistor connected to the 3.3V supply voltage on the P9235A-RB Evaluation Board

The over-temperature shutdown is triggered if the voltage on the TS pin is lower a threshold. Launch the *P9235A-RB Wireless Power Pro GUI* to view defaults. The TH\_COIL1 is not populated on the P9235A-RB Evaluation Board.

Figure 10. TH\_COIL1 and R60 Schematic Location



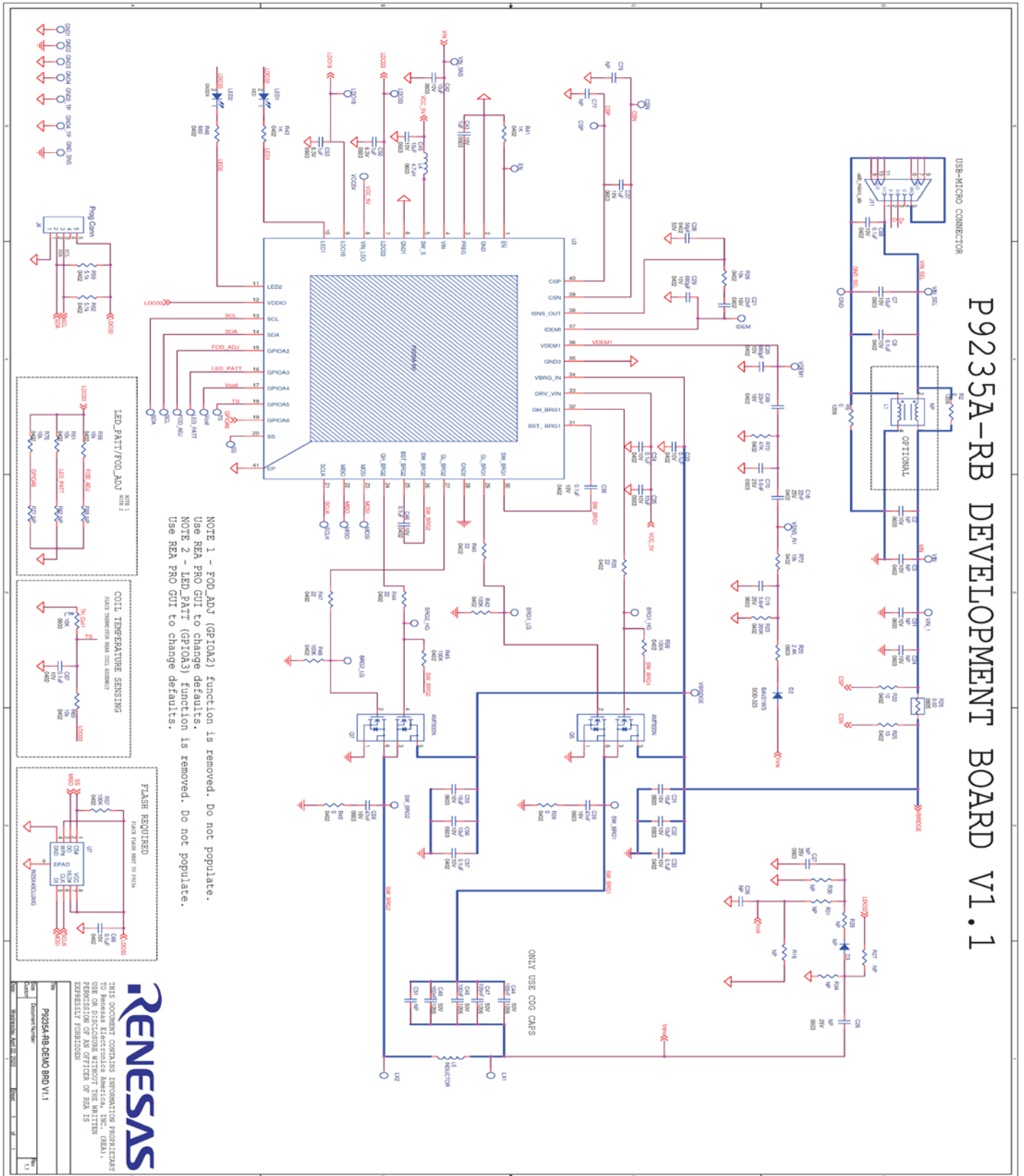
## 2.5 Transmitter Coil

The following coil is recommended for use with the P9235A-RB transmitter for 5W applications for optimum performance. The recommended vendor has been tested and verified.

Table 1. Recommend Coil Manufacturer

Output Power	Vendor	Part Number	Inductance at 100kHz	DCR at 20°C
5W	SUNLORD	MQQTC505030S6R3 ( A11Coil)	6.3μH	38mΩ

### 3. P9235A-RB Evaluation Board V1P1 Schematic



## 4. Bill of Materials (BOM)

Table 2. P9235A-RB-EVK BOM

Item	Reference	Value	Description	Part Number	PCB Footprint	Quantity
1	C7, C31, C32, C35, C42, C45, C55, C56	10 $\mu$ F	CAP CER 10UF 10V X5R 0603	GRM188R61A106KE69D	0603	8
2	C8, C30, C33, C34, C38, C46, C57, C66, C67, C68	0.1 $\mu$ F	CAP CER 0.1UF 10V X7R 0402	GRM155R71A104KA01D	0402	10
3	C18	22nF	CAP CER 0.022UF 25V X5R 0402	GCM155R71E223KA55J	0402	1
4	C19, C70	5.6nF	CAP CER 5600PF 25V X7R 0603	GRM188R71E562KA01D	0603	2
5	C20, C29	680pF	CAP CER 680PF 10V X7R 0402	8.85012E+11	0402	2
6	C21, C69	22nF	CAP CER 0.022UF 16V X5R 0402	GRM155R61C223KA01D	0402	2
7	C28	56pF	CAP CER 56PF 50V C0G/NP0 0402	GRM1555C1H560FA01D	0402	1
8	C37, C43	1 $\mu$ F	CAP CER 1UF 10V X5R 0603	GRM188R61A105KA61D	0603	2
9	C39, C59	47nF	CAP CER 0.047UF 16V X7R 0603	GRM188R71C473KA01D	0603	2
10	C44, C47, C48, C49	100nF	CAP CER 0.1UF 50V C0G/NP0 1206	GRM31C5C1H104JA01L	1206	4
11	C50, C53	1 $\mu$ F	CAP CER 1UF 6.3V X5R 0603	GRM188R61A105KA61D	0603	2
12	D2	BAV21WS	DIODE GEN PURP 200V 200MA SOD323	BAV21WS-7-F	SOD-323	1
13	GND1, GND2, GND3, GND4, VIN_SEL, VIN, GND	TP	TEST POINT PC MINIATURE SMT	5015	test_pt_sm_13 5x70	7
14	J4	Prog Conn	BERGSTIK II .100" SR STRAIGHT	68000-105HLF	sip5	1
15	J11	5P	CON 005 F RA OTH PC NLK SRW 800 MINIUSB	90080004	usb_micro_ab	1
16	LED1	LED	LED RED CLEAR 0603 SMD	150060RS75000	0603	1
17	LED2	LED	LED GREEN CLEAR 0603 SMD	150060GS75000	0603	1
18	L4	4.7 $\mu$ H	FIXED IND 4.7UH 620MA 550 MOHM	LQM18PN4R7MFRL	0603	1
19	Q5, Q7	AM7930N	Dual N-Channel 30-V (D-S) MOSFET	AM7930N	DFN-5X6-8Ld-N1	2
20	R2, R9	0 $\Omega$	RES SMD 0 OHM JUMPER 1/4W 1206	RC1206JR-070RL	1206	2
21	R20	2.4k $\Omega$	RES SMD 2.4K OHM 1% 1/10W 0603	RC0603FR-072K4L	0603	1
22	R22, R25	10 $\Omega$	RES SMD 10 OHM 0.5% 1/16W 0402	RT0402DRE0710RL	0402	2
23	R23	200k $\Omega$	RES SMD 200K OHM 1% 1/10W 0402	ERJ-2RKF2003X	0402	1
24	R26	0.02 $\Omega$	RES 0.02 OHM 1% 1/8W 0805	PF0805FRM7P0R02L	0805	1
25	R28, R58, R60, R61, R72, R76	10k $\Omega$	RES SMD 10K OHM 1% 1/16W 0402	RC0402FR-0710KL	0402	6
26	R35, R40, R44, R47	22 $\Omega$	RES SMD 22 OHM 1% 1/10W 0402	RC1005F220CS	0402	4
27	R36, R42, R45, R48, R57	100k $\Omega$	RES SMD 100K OHM 1% 1/16W 0402	RC0402FR-07100KL	0402	5

Item	Reference	Value	Description	Part Number	PCB Footprint	Quantity
28	R39, R49	0	RES SMD 0 OHM JUMPER 1/16W 0402	RC0402JR-070RP	0402	2
29	R41, R43	1k $\Omega$	RES SMD 1K OHM 5% 1/16W 0402	RC0402JR-071KL	0402	2
30	R46	680 $\Omega$	RES SMD 680 OHM 5% 1/16W 0402	RC0402JR-07680RL	0402	1
31	R50, R52	5.1k $\Omega$	RES SMD 5.1K OHM 5% 1/16W 0402	RC0402JR-075K1L	0402	2
32	R70	47k $\Omega$	RES SMD 47K OHM 1% 1/16W 0402	RC0402FR-0747KL	0402	1
33	TH_Coil1	10k $\Omega$	NTC THERMISTOR 10K OHM 1% 0603	ERT-J1VG103FA	0603	1
34	U3	P9235A-RB	Wireless power transmitter	P9235A-RB	qfn40_5x5_N	1
35	U7	W25X40CLUXIG	IC FLASH 4MBIT 104MHZ 8USON	W25X40CLUXIG TR	uson_2x3_8LD	1

## 5. Board Layout

Figure 11. Silkscreen – Top of Board

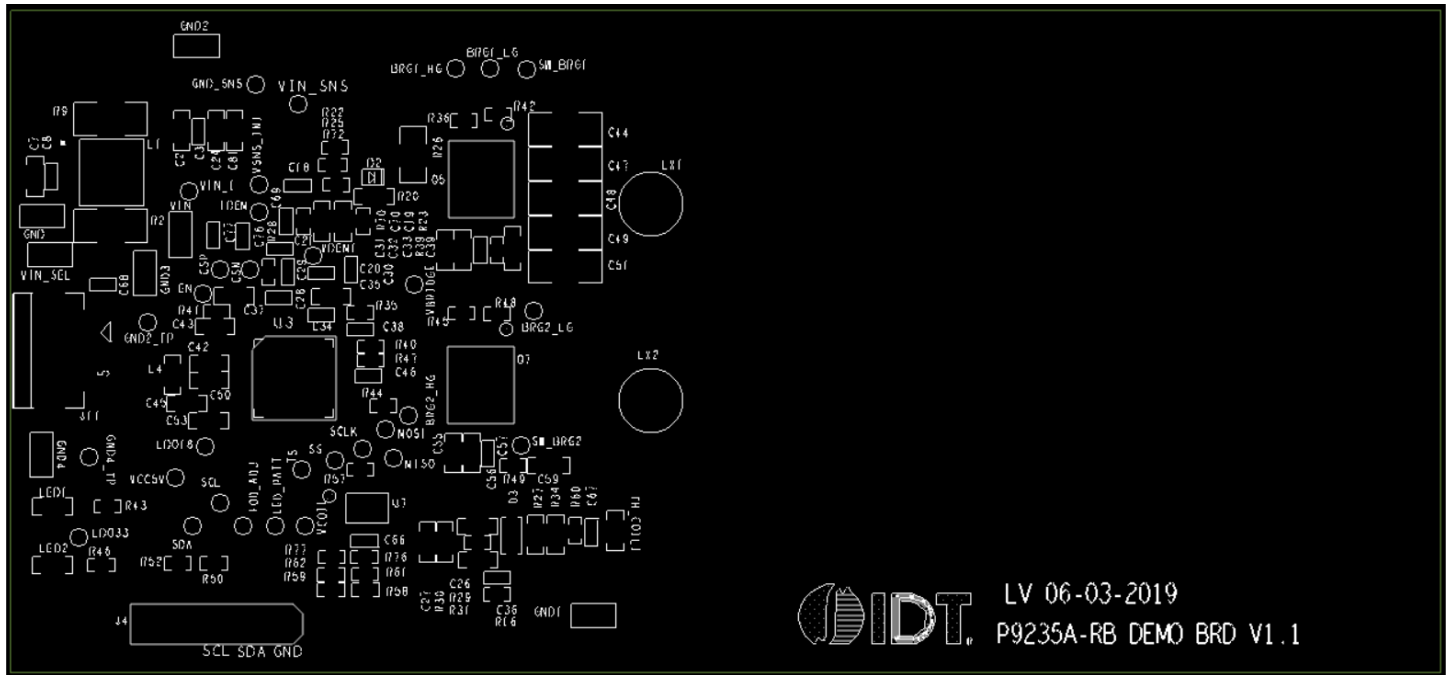


Figure 12. Copper – Top Layer

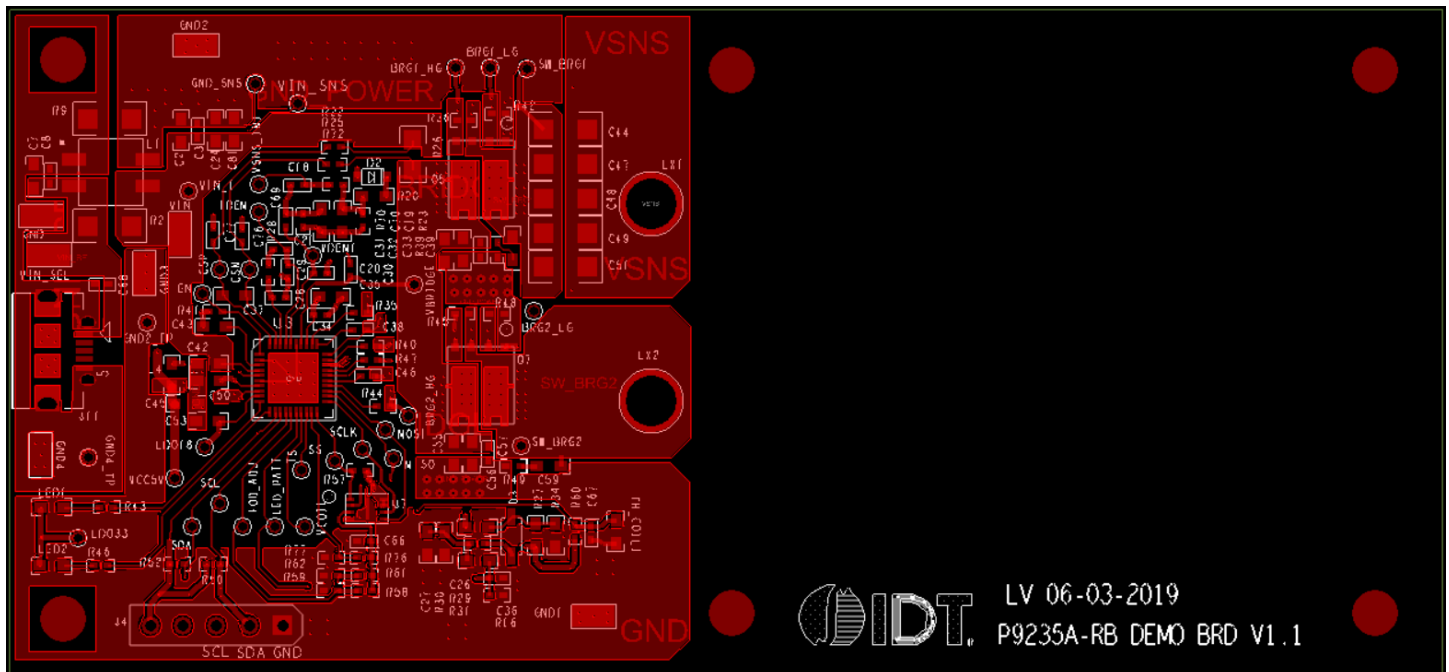




Figure 13. Copper L1 Layer

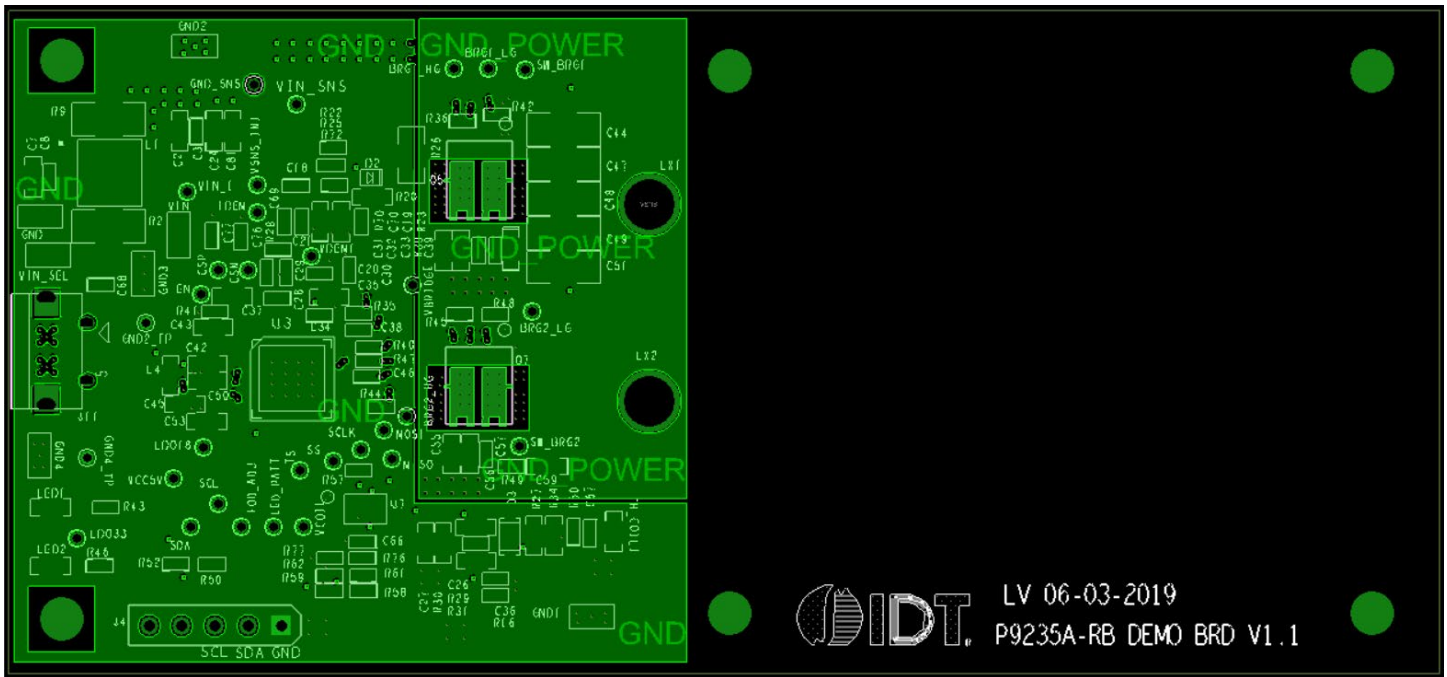


Figure 14. Copper L2 Layer

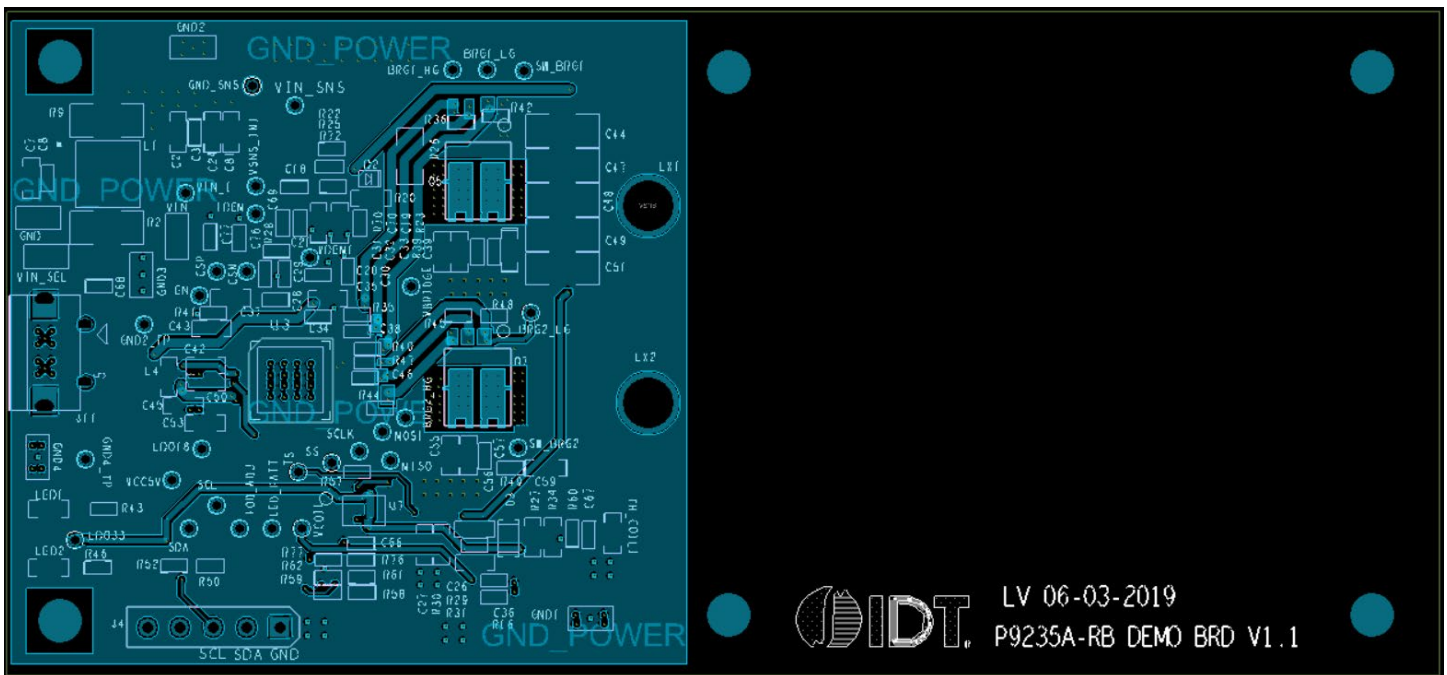
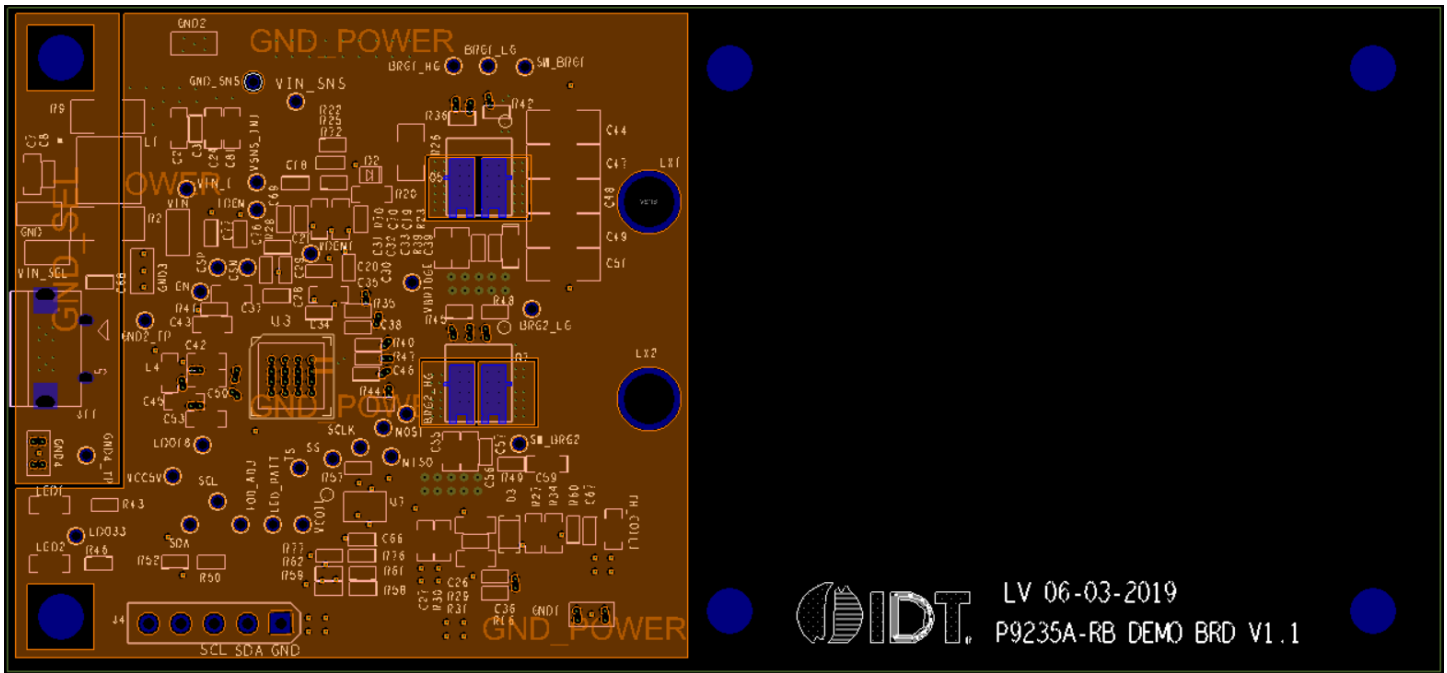


Figure 15. Copper Bottom



## 6. List of Registers for Default Configuration

The P9235A-RB uses the standard I<sup>2</sup>C slave implementation protocol to communicate with a host AP or other I2C peripherals. The communication protocol is implemented by using 8 bits for data and 16 bits for addresses. The default slave address of the P9235A-RB is 0x61h.

The following tables list address locations, field names, available operations (R or RW), default values, and functional descriptions of internally accessible SRAM registers contained within the P9235A-RB. The registers are loaded each time the device is powered and cannot be changed except by new firmware programmed into the external Flash device. The SRAM registers are available to make setting changes after the device is powered. These changes are reset to default when the power is cycled or the device is reset. Below are the commonly used SRAM registers for the system configuration or debug.

### 6.1 Identification Registers

Table 3. Chip ID Register, Chip\_ID\_L (0x6C0), Chip\_ID\_H (0x6C1)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06C0 [7:0]	Chip_ID_L	R	0x35	Chip ID low byte.
0x06C1 [7:0]	Chip_ID_H	R	0x92	Chip ID high byte.

Table 4. Firmware Major Version, Major\_Version\_L (0x6CC), Major\_Version\_H (0x6CD)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x6CC [15:0]	Major_Version	R	0x07	Firmware major version high byte.

Table 5. Firmware Minor Version, Minor\_Version\_L (0x6CE), Minor\_Version\_H (0x6CF)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x6CE [15:0]	Minor_Version	R	0x05	Firmware minor version high byte.

Table 6. Transmitter Manufacture ID, TX\_MF\_ID\_L (0x83D), TX\_MF\_ID\_H (0x83E)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x83D [15:0]	TX_MF_ID	R	0x00	Transmitter manufacture ID low byte. Default value can be configured using the P9235A-RB Wireless Pro GUI.

## 6.2 State and Status Registers

Table 7. Transmitter Current State, TX\_State (0x6E0)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06E0 [7:0]	TX_State	R	0x00	0 = Startup 1 = Idle 2 = Rx Detection 4 = Digital Ping 5 = Identification Packet 7 = Configuration 9 = Power Transfer 11 = Remove Power 12 = Restart 13 = Negotiation 15 = Renegotiation

Table 8. Transmitter Current Status, TX\_Status (0x6E1)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06E1 [7:0]	TX_Status	R	0x00	0 = OK 1 = FOD 2 = Charge Complete 4 = No Response 5 = Internal Fault 6 = Over Temperature 7 = Over Current 8 = Full Charge 9 = Other EPT 10 = Negotiation Failure 12 = VIN Out of Range 13 = UVLO 14 = Power Limit

### 6.3 System Read-Only Registers

Table 9. Transmitter Coil Current, Coil\_Current\_L (0x6E2), Coil\_Current\_H (0x6E3)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06E2[15:0]	Coil_Current	R	0x00	Coil Voltage ADC reading in mA.

Table 10. Transmitter Coil Voltage, Coil\_Voltage\_L (0x6E4), Coil\_Voltage\_H (0x6E5)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06E4[15:0]	Coil_Voltage	R	0x00	Coil Voltage ADC reading in mV.

Table 11. Transmitter Peak Coil Voltage, Peak\_Coil\_Voltage\_L (0x6E6), Peak\_Coil\_Voltage\_H (0x6E7)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06E6[15:0]	Peak_Coil_Voltage	R	0x00	Peak Coil Voltage ADC reading in mV.

Table 12. Coil Temperature, Coil\_Temperature\_L (0x6E8), Coil\_Temperature\_H (0x6E9)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06E8[15:0]	Coil_Temperature	R	0x00	Thermistor ADC reading in mV. Typically, Thermistor is placed near the coil to measure coil temperature.

Table 13. Operating Duty Cycle, PWM\_Duty\_L (0x6EA), PWM\_Duty\_H (0x6EB)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06EA[15:0]	PWM_Duty	R	0x00	$(\text{PWM\_Duty})/510 \times 100 = \text{DUTY CYCLE (\%)}$ . Duty cycle changes based on the CEP packets from the receiver.

Table 14. Operating Frequency, PWM\_Period\_Count\_L (0x6EC), PWM\_Period\_Count\_H (0x6ED)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06EC[15:0]	PWM_Period_Count	R	0x00	$60000 / \text{PWM\_PERIOD\_COUNT} = \text{Operating Frequency in kHz}$ . Operating frequency changes based on the CEP packets from the receiver.

Table 15. Bridge Configuration, Full\_Bridge\_Flag (0x6EE)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06EE[7:0]	Full_Bridge_Flag	R	0x00	0 = Full-Bridge 1 = Half-Bridge

Table 16. Exit ID, Exit\_ID (0x6EF)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06EF[7:0]	Exit_ID	R	0x00	Shows the reason for exiting the power transfer state. Used for internal debugging purposes.

Table 17. Transmitted Power, TX\_Power\_L (0x6F0), TX\_Power\_H (0x6F1)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06F0[15:0]	Tx_Power	R	0x00	Power transmitted in mW.

Table 18. Receiver Received Power, RX\_Power\_L (0x6F2), RX\_Power\_H (0x6F3)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06F2[15:0]	Rx_Power	R	0x00	Received Power in mW from the RPP packet received from the Receiver.

Table 19. Power Loss, Power\_Loss\_L (0x6F4), Power\_Loss\_H (0x6F5)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06F4[15:0]	Power_Loss	R	0x00	Calculated Power loss in mW based on the Transmitted Power and Receiver Received Power register values.

Table 20. FOD Threshold, FOD\_Threshold\_L (0x6F6), FOD\_Threshold\_H (0x6F7)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x06F6[15:0]	FOD_Threshold	R	0x00	FOD Threshold $(GAIN \times RPP)/100 + OFFSET$ Gain and Offset values change based on the RPP packet received from the Receiver. Value is in mW. FOD alarm triggers when FOD Threshold < Power Loss.

## 6.4 Configuration Registers

Table 21. Input under voltage Threshold, VIN\_Low\_Threshold\_L (0x600), VIN\_Low\_Threshold\_H (0x601)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0600[15:0]	VIN_Low	R/W	0x109A	Input under voltage protection threshold. Default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 22. Input over voltage Threshold, VIN\_High\_Threshold\_L (0x602), VIN\_High\_Threshold\_H (0x603)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0602[15:0]	VIN_High	R/W	0x3E80	Input over voltage protection threshold. Default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 23. Over Temperature Protection Recovery Threshold, OTP\_Low\_Threshold\_L (0x604), OTP\_Low\_Threshold\_H (0x605)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0604[15:0]	OTP_Low	R/W	0x0600	Over temperature protection (OTP) recovery threshold. Thermistor voltage needs to go <i>above</i> this value to restart the normal operation. Value in ADC count. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 24. Over Temperature Protection Trigger Threshold, OTP\_High\_Threshold\_L (0x606), OTP\_High\_Threshold\_H (0x607)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0606[15:0]	OTP_High	R/W	0x0440	Over temperature protection (OTP) trigger threshold. Thermistor voltage needs to go <i>below</i> this value to trigger OTP. Value in ADC count. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 25. Input Over Current Protection Threshold, Ilim\_Threshold\_L (0x614), Ilim\_Threshold\_H (0x615)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0614[15:0]	LPOCP_LIMIT_LV	R/W	0x0929	Input over current protection (OCP) trigger threshold in mA. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 26. Over Current Protection Disable, Ilim\_Disable (0x083A)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x083A[7:0]	OCP_Disable	R/W	0	Disables Over Current Protection (OCP). To be used only in development stage. Do not use final production. OCP Enabled = 0 OCP Disabled = 1

Table 27. Digital Ping Frequency, PWM\_Period\_Count\_Ping\_L (0x60C), PWM\_Period\_Count\_Ping\_H (0x60D)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x060C[15:0]	PWM_Period_Count_Ping	R/W	0x19B	$60000 / (\text{PWM\_PERIOD\_CNT\_Ping}) = \text{Digital Ping Frequency in kHz}$ . The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 28. Digital Ping Interval, DPING\_Interval (0x610)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0610[7:0]	DPING_Interval	R/W	0x0A	Controls the number of analog pings between digital pings. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 29. Analog Ping Threshold, RXDET\_Threshold\_L (0x61A)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x061A[7:0]	RXDET_THD	R/W	0x30	Analog Ping detection threshold. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 30. Digital Ping Interval, ANAPING\_Interval\_L (0x0624), ANAPING\_Interval\_H (0x0625)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0624[15:0]	ANAPING_Interval	R/W	0x012C	Controls the interval in between Analog Pings. Value is in milli seconds. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 31. Minimum Operating Frequency, PWM\_Period\_Count\_Min\_L (0x608), PWM\_Period\_Count\_Min\_H (0x609)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0608[15:0]	PWM_Period_Count_Min	R/W	0x0222	$60000 / \text{PWM\_Period\_Count\_Min} = \text{Minimum Operating Frequency in kHz}$ . The default value can be configured using the P9235A-RB Wireless Pro GUI.



Table 32. Maximum Operating Frequency, PWM\_Period\_Count\_Max\_L (0x60A), PWM\_Period\_Count\_Max\_H (0x60B)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x060A[15:0]	PWM_Period_Count_Max	R/W	0x019B	60000 / PWM_Period_Count_Max= Minimum Operating Frequency in kHz. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 33. FOD Region 1 Threshold, FOD\_POWER[0]\_L (0x0820), FOD\_POWER[0]\_H (0x0821)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0820[15:0]	FOD_POWER[0]	R/W	0x03E8	Threshold that separates region 0 and region 1 for FOD Protection in mW. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 34. FOD Region 2 Threshold, FOD\_POWER[1]\_L (0x0822), FOD\_POWER[1]\_H (0x0823)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0822[15:0]	FOD_POWER[1]	R/W	0x1A5E	Threshold that separates region 1 and region 2 for FOD Protection in mW. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 35. FOD Region 0 Gain, FOD\_GAIN[0]\_L (0x0824), FOD\_GAIN[0]\_H (0x0825)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0824[15:0]	FOD_GAIN[0]	R/W	0x04B0	Gain used in FOD threshold calculation in region 0. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 36. FOD Region 1 Gain, FOD\_GAIN[1]\_L (0x0826), FOD\_GAIN[1]\_H (0x0827)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0826[15:0]	FOD_GAIN[1]	R/W	0x04B0	Gain used in FOD threshold calculation in region 1. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 37. FOD Region 2 Gain, FOD\_GAIN [2]\_L (0x0828), FOD\_GAIN[2]\_H (0x0829)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0828[15:0]	FOD_GAIN[2]	R/W	0x04B0	Gain used in FOD threshold calculation in region 2. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 38. FOD Region 0 Offset, FOD\_OFFSET [0]\_L (0x082A), FOD\_OFFSET[0]\_H (0x082B)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x082A[15:0]	FOD_OFFSET[0]	R/W	0x015E	Offset used in FOD threshold calculation in region 0 in mW. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 39. FOD Region 1 Offset, FOD\_OFFSET [1]\_L (0x082C), FOD\_OFFSET[1]\_H (0x082D)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x082C[15:0]	FOD_OFFSET[1]	R/W	0x015E	Offset used in FOD threshold calculation in region 1 in mW. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 40. FOD Region 2 Offset, FOD\_OFFSET [2]\_L (0x082E), FOD\_OFFSET [2]\_H (0x082F)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x082E[15:0]	FOD_OFFSET[2]	R/W	0x015E	Offset used in FOD threshold calculation in region 2 in mW. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 41. Foreign Object Detection(FOD) Protection Disable, FOD\_Disable (0x083B)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x083B[7:0]	FOD_Disable	R/W	0	Disables FOD Protection. To be used only in development stage. Do not disable in final production. FOD Enabled = 0 FOD Disabled = 1

Table 42. Green LED On Time in Standby Mode, Green\_On\_Time [0]\_L (0x0630), Green\_On\_Time [0]\_H (0x0631)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0630[15:0]	Green_On_Time[0]	R/W	0x00	Green LED on time in Standby Mode. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 43. Green LED On Time in Power Transfer State, Green\_On\_Time [1]\_L (0x0632), Green\_On\_Time [1]\_H (0x0633)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0632[15:0]	Green_On_Time[1]	R/W	0x03E8	Green LED on time in Power Transfer State. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 44. Green LED On Time in Alarm State, Green\_On\_Time [2]\_L (0x0634), Green\_On\_Time [2]\_H (0x0635)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0634[15:0]	Green_On_Time[2]	R/W	0x00	Green LED on time in Alarm State. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 45. Green LED On Time in Charge Complete State, Green\_On\_Time [3]\_L (0x0636), Green\_On\_Time [3]\_H (0x0637)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0636[15:0]	Green_On_Time[3]	R/W	0x01F4	Green LED on time in Charge Complete State. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 46. Green LED Off Time in Standby Mode, Green\_Off\_Time [0]\_L (0x0638), Green\_Off\_Time [0]\_H (0x0639)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0638[15:0]	Green_Off_Time[0]	R/W	0x00	Green LED off time in Standby Mode. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 47. Green LED Off Time in Power Transfer State, Green\_Off\_Time [1]\_L (0x063A), Green\_Off\_Time [1]\_H (0x063B)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x063A[15:0]	Green_Off_Time[1]	R/W	0x00	Green LED off time in Power Transfer State. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 48. Green LED Off Time in Alarm State, Green\_Off\_Time [2]\_L (0x063C), Green\_Off\_Time [2]\_H (0x063D)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x063C[15:0]	Green_Off_Time[2]	R/W	0x00	Green LED off time in Alarm State. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Table 49. Green LED Off Time in Charge Complete State, Green\_Off\_Time [3]\_L (0x063E), Green\_Off\_Time [3]\_H (0x063F)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x063E[15:0]	Green_Off_Time[3]	R/W	0x01F4	Green LED off time in Charge Complete State. The default value can be configured using the P9235A-RB Wireless Pro GUI.

Note: Red LED has the same set of timer registers as described for Green LED between (0x0630 – 0x063F). RED LED timer registers starts at 0x0640 and ends at 0x064F. They are in the same order as Green LED timers.

Table 50. Charge Complete Sleep Timer, Charge\_Complete\_Sleep\_Timer\_L (0x0652), Charge\_Complete\_Sleep\_Timer\_H (0x0653)

Address and Bit	Register Field Name	R/W	Default Value	Function and Description
0x0652[15:0]	Charge_Complete_Sleep_Timer	R/W	0x30	Sleep timer for which transmitter turns off when it receives a Charge Complete End of Power Transfer (EPT) packet. Value in seconds. The default value can be configured using the P9235A-RB Wireless Pro GUI.

## 7. Ordering Information

Orderable Part Number	Description
P9235A-RB-EVK	P9235A-RB-EVK Evaluation Board
WPD-USB-DONGLE	USB-to-I2C dongle (FTDI). It is not included in the P9235A-RB-EVK evaluation kit, and must be ordered separately. USB-FTDI-V2.1 and WPD-USB-DONGLE have the same functionality and can be used interchangeably.

## 8. Revision History

Revision Date	Description of Change
April 30, 2020	<ul style="list-style-type: none"> <li>▪ Updated receiver EVK to P9222-R, Overview of P9235A-RB section, OTP section, Register Map, Application Schematic, Board Layout Images and WPD-USB-Dongle Images.</li> <li>▪ Added GUI Figures 2, 3, 4, 5, and 6.</li> <li>▪ Added Dongle Connectivity, recommended TA adapter link, Using GUI to Write to Flash, Overview of the P9235A-RB Wireless Power Pro GUI sections, and WPD-USB-DONGLE / USB-FTDI-V2.1 Orderable Part Number.</li> <li>▪ Removed LED Pattern, FOD Adjust, and OCP Adjust sections as these features are moved to GUI.</li> </ul>
February 21, 2019	Initial release.

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