Description
The P9235A-RB-EVK Mass-Market 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. The printed circuit board (PCB) has four layers.

The P9235A-RB Evaluation Board is designed to function with the P9225-R Receiver Evaluation Board, which is ordered separately (see www.idt.com/p9225-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 expedite the design-in effort and enable rapid prototyping. The total active area is optimized to 21mm x 21mm.

Features
- P9235A-RB Evaluation Board provides support for WPC-1.2.4
- Power capability: 5W for 5V input
- Adjustable over-current protection (OCP) threshold
- Adjustable temperature shutdown
- Two programmable LED status indicators
- Supports 5V input voltage
- Secured authentication (16-bit private key and 16-bit random number)
- Fully assembled with test points and coil fixture

Kit Contents
- P9235A-RB-EVK Mass-Market Evaluation Board

P9235A-RB Transmitter Board Connected to P9225-R-EVK

P9235A-RB Transmitter Evaluation Board
Transmitter Coil
P9225-R-EVK Receiver Board

Green LEDs illuminate when connection has been established
VOUT and GND Test Points
Important Notes

Disclaimer
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(i) delivered hardware or software
(ii) non-observance of instructions contained in this manual and in any other documentation provided to user, or
(iii) misuse, abuse, use under abnormal conditions, or alteration by anyone other than IDT.

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Restrictions in Use
IDT’s P9235A-RB-EVK Mass-Market Evaluation Board and the P92xx 5-15W Wireless Power Pro software are designed for evaluation purposes only. The P9235A-RB-EVK Mass-Market Evaluation Board and software must not be used for module production or production test setups.

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1. Setup

1.1 Required or Recommended User Equipment

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

- P9225-R-EVK Receiver Evaluation Board or any WPC-1.2.4 compliant receiver
- 5V power supply or 5V/2A AC adaptor USB adaptor provided by the user
- IDT Dongle (sold separately)

1.2 User Computer Requirements and Software Installation

1.2.1 Computer Requirements

A Windows®-based computer is required for interfacing with the kit and configuring the part. The user must have administrative rights on the computer to download and install the software for the P9235A-RB-EVK.

The computer must meet the following requirements:

- Windows® 7 or higher version
- Internet access

1.2.2 Software Installation

Follow these procedures for the P9225-R/P9235A-RB software installation:

Step 1: Obtain the P92xx 5-15W Wireless Power Pro graphical user interface (GUI) software from IDT (see contact information on the last page) or the distributor, and install the software according to the P92xx 5-15W Wireless Power Pro GUI User Manual, which is available upon request from IDT.

Step 2: Use the dongle to connect the P9235A-RB-EVK with the user's computer as shown in Figure 1.

Figure 1. Connecting the Dongle

Connect the Dongle to J4 on the P9235A-RB-EVK
1.3 Kit Hardware Connections

Follow these procedures to set up the kit as shown on page 1.

1. Set up the P9235A-RB Evaluation Board by plugging the 5V adapter or the user’s power supply into J11 (Micro-USB connector). Refer to Figure 2.

2. If using the P9225-R-EVK Evaluation Board as the receiver, connect wires to the VOUT and GND test points on the P9225-R-EVK receiver to allow measuring the output voltage and applying a load.

3. Place the P9225-R-EVK or the user’s receiver on the transmitter (TX) pad with the components facing up as shown on page 1.

4. Verify that the two green LEDs identified in Figure 2 are illuminated indicating that coupling has been established.

2. Usage Guide

2.1 Overview of the P9235A-RB-EVK

Figure 2. P9235A-RB V1P1 Evaluation Board Features
Figure 3. P9235A-RB Evaluation Board Details

Coil Current Communication Demodulation
Vin Decoupling Capacitors
Cout for LDO33
L4
Cout for VCC5V
VCC5V
Resistors R59 and R58 for ILIMIT and FOD_ADJ
In Sense Resistor
Tx Coil Driver External Power FETs: Q5
LC Tank Capacitors (4 x 100nF)
Coil Voltage Communication Demodulation
Tx Coil Driver External Power FETs: Q7
Thermistor TH_COIL1 for Detecting External Temperature
R62 and R61 for LED_PAT
2.2 LED Pattern

The P9235A-RB-EVK uses two LEDs (LED1 and LED2 as shown in Figure 2) to indicate the power transfer status, faults, and operating modes. The LEDs are connected to the LED1 and LED2 pins as shown on the P9235A-RB-EVK schematics (see section 3). The LED patterns can be selected by setting the voltage on the LED_PAT pin via the resistor divider R61 and R62; see Table 1 for the options. On the P9235A-RB-EVK, the LED_PAT pin is pulled up to 3.3V through R61. R62 is unpopulated; therefore, option 7 is the default option.

Table 1. Selecting the LED Pattern

<table>
<thead>
<tr>
<th>Option #</th>
<th>R61 [KΩ]</th>
<th>R62 [KΩ]</th>
<th>Description</th>
<th>LED #/Color</th>
<th>Operational Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LED Status</td>
<td>Standby</td>
</tr>
<tr>
<td>1</td>
<td>Open</td>
<td>10</td>
<td>Dual-LED, Standby on, Blink</td>
<td>LED1 – RED</td>
<td>Off</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>0.232</td>
<td>Dual-LED, Standby on, Blink</td>
<td>LED2 – GREEN</td>
<td>Off</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>0.732</td>
<td>Single-LED, Standby on, No Blink</td>
<td>LED1 – RED</td>
<td>Off</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>0.732</td>
<td>Single-LED, Standby on, No Blink</td>
<td>LED2 – GREEN</td>
<td>Off</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>1.27</td>
<td>Single-LED, Standby on, No Blink</td>
<td>LED1 – RED</td>
<td>Off</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>1.27</td>
<td>Single-LED, Standby on, No Blink</td>
<td>LED2 – GREEN</td>
<td>Off</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>1.87</td>
<td>Dual-LED, Standby-Off, No Blink</td>
<td>LED1 – RED</td>
<td>Off</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>1.87</td>
<td>Dual-LED, Standby-Off, No Blink</td>
<td>LED2 – GREEN</td>
<td>Off</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>2.55</td>
<td>Dual-LED, Standby-Off, No Blink</td>
<td>LED1 – RED</td>
<td>Off</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>2.55</td>
<td>Dual-LED, Standby-Off, No Blink</td>
<td>LED2 – GREEN</td>
<td>Off</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>3.32</td>
<td>Dual-LED, Standby-Off, No Blink</td>
<td>LED1 – RED</td>
<td>Off</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>3.32</td>
<td>Dual-LED, Standby-Off, No Blink</td>
<td>LED2 – GREEN</td>
<td>Off</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td>4.22</td>
<td>Reserved</td>
<td>LED1 – RED</td>
<td>Off</td>
</tr>
<tr>
<td>7</td>
<td>Open</td>
<td></td>
<td>Reserved</td>
<td>LED2 – GREEN</td>
<td>Off</td>
</tr>
</tbody>
</table>

Note: The tolerance of R61 and R62 as shown in Table 1 is ±1%.
Figure 4. R61 and R62 Schematic Location

Figure 5. R61 and R62 PCB Location
2.3 OCP and FOD Tuning

The over-current protection (OCP) is designed to protect the transmitter from operating conditions that could potentially cause damage or unexpected behavior from the system. The input current is continuously monitored during the power transfer stage. If the input current goes above the OCP threshold of the programmed current limit, the P9235A-RB will shut down the TX and restart again. ILIM/FOD_ADJ (pin 15) is used to turn on/off the FOD function. When ILIM/FOD_ADJ voltage is greater than 2.4V, FOD is enabled, and vice versa. The OCP threshold is always set to 2400mA. On the P9235A-RB-EVK, the ILIM/FOD_ADJ pin is pulled up to 3.3V through R58. R59 is unpopulated, so the FOD function is enabled.

Figure 6. R58 and R59 Schematic Location

Figure 7. R58 and R59 PCB Location
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 Equation 1.

\[ V_{TS} = V_{LDO33} \times \frac{NTC}{(NTC + R_{60})} \]  

Where

- \( NTC \)  Thermistor’s resistance (TH_COIL1)
- \( R_{60} \)  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 than 0.65V. The RTH1 is not populated on the P9235A-RB Evaluation Board.

Figure 8. RTH1 and R60 Schematic Location

![Schematic Location](image)

Figure 9. RTH1 and R60 PCB Location

![PCB Location](image)
2.5 Programming Interface

The initial state of the P9235A-RB is blank. It cannot function without firmware. There are two types of firmware: one-time programmable memory (OTP) and flash memory. The OTP file is burned into the P9235A-RB memory. For the flash file, the bootloader (part of the flash file) is burned into the P9235A-RB memory; the other part of the flash file is programmed into the flash chip (U7) on the P9235A-RB-EVK. The P92xx 5-15W Wireless Power Pro GUI can be used for programming the OTP or the flash file. For programming details and instructions, refer to the P92xx 5-15W Wireless Power Pro GUI User Manual.

2.6 Transmitter Coil

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

Table 2. Recommend Coil Manufacturer

<table>
<thead>
<tr>
<th>Output Power</th>
<th>Vendor</th>
<th>Part Number</th>
<th>Inductance at 100kHz</th>
<th>DCR at 20°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>5W</td>
<td>SUNLORD</td>
<td>MQQTC505030S6R3</td>
<td>6.3µH</td>
<td>38mΩ</td>
</tr>
</tbody>
</table>
3. P9235A-RB Evaluation Board V1P1 Schematic
### 4. Bill of Materials (BOM)

#### Table 3. P9235A-RB-EVK BOM

<table>
<thead>
<tr>
<th>Item</th>
<th>Reference</th>
<th>Value</th>
<th>Description</th>
<th>Part Number</th>
<th>PCB Footprint</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C7, C31, C32, C35, C42, C45, C55, C56</td>
<td>10µF</td>
<td>CAP CER 10UF 10V X5R 0603</td>
<td>GRM188R61A106KE69D</td>
<td>0603</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>C8, C30, C33, C34, C38, C46, C57, C66, C67, C68</td>
<td>0.1µF</td>
<td>CAP CER 0.1UF 10V X7R 0402</td>
<td>GRM155R71A104KA01D</td>
<td>0402</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>C18</td>
<td>22nF</td>
<td>CAP CER 0.022UF 25V X5R 0402</td>
<td>GCM155R71E223KA55J</td>
<td>0402</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>C19, C70</td>
<td>5.6nF</td>
<td>CAP CER 5600PF 25V X7R 0603</td>
<td>GRM188R71E562KA01D</td>
<td>0603</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>C20, C29</td>
<td>680pF</td>
<td>CAP CER 680PF 10V X7R 0402</td>
<td>8.85012E+11</td>
<td>0402</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>C21, C69</td>
<td>22nF</td>
<td>CAP CER 0.022UF 16V X5R 0402</td>
<td>GRM155R61C223KA01D</td>
<td>0402</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>C28</td>
<td>56pF</td>
<td>CAP CER 56PF 50V C0G/NP0 0402</td>
<td>GRM155C1H560FA01D</td>
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<td>8</td>
<td>C37, C43</td>
<td>1µF</td>
<td>CAP CER 1UF 10V X5R 0603</td>
<td>GRM188R61A105KA61D</td>
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<td>9</td>
<td>C39, C59</td>
<td>47nF</td>
<td>CAP CER 0.047UF 16V X7R 0603</td>
<td>GRM188R71C473KA01D</td>
<td>0603</td>
<td>2</td>
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<tr>
<td>10</td>
<td>C44, C47, C48, C49</td>
<td>100nF</td>
<td>CAP CER 0.1UF 50V C0G/NP0 1206</td>
<td>GRM31C5C1H104JA01L</td>
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<tr>
<td>11</td>
<td>C50, C53</td>
<td>1µF</td>
<td>CAP CER 1UF 6.3V X5R 0603</td>
<td>GRM188R61A105KA61D</td>
<td>0603</td>
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</tr>
<tr>
<td>12</td>
<td>D2</td>
<td>BAV21WS</td>
<td>DIODE GEN PURP 200V 200MA SOD323</td>
<td>BAV21WS-7-F</td>
<td>SOD-323</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>GND1, GND2, GND3, GND4, VIN_SEL, VIN, GND</td>
<td>TP</td>
<td>TEST POINT PC MINIATURE SMT</td>
<td>5015</td>
<td>test_pt_sm_13</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>J4</td>
<td>Prog Conn</td>
<td>BERGSTIK II .100&quot; SR STRAIGHT</td>
<td>68000-105HLF</td>
<td>sip5</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>J11</td>
<td>5P</td>
<td>CON 005 F RA OTH PC NLK SRW 800 MINIUSB</td>
<td>90080004</td>
<td>usb_micro_ab</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>LED1</td>
<td>LED</td>
<td>LED RED CLEAR 0603 SMD</td>
<td>150060RS75000</td>
<td>0603</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>LED2</td>
<td>LED</td>
<td>LED GREEN CLEAR 0603 SMD</td>
<td>150060GS75000</td>
<td>0603</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>L4</td>
<td>4.7µH</td>
<td>FIXED IND 4.7UH 620MA 550 MOHM</td>
<td>LQM18PN4R7MFRL</td>
<td>0603</td>
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<tr>
<td>19</td>
<td>Q5, Q7</td>
<td>AM7930N</td>
<td>Dual N-Channel 30-V (D-S) MOSFET</td>
<td>AM7930N</td>
<td>DFN-5X6-8Ld-N1</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>R2, R9</td>
<td>0Ω</td>
<td>RES SMD 0 OHM JUMPER 1/4W 1206</td>
<td>RC1206JR-070RL</td>
<td>1206</td>
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</tr>
<tr>
<td>21</td>
<td>R20</td>
<td>2.4kΩ</td>
<td>RES SMD 2.4K OHM 1% 1/16W 0603</td>
<td>RC0603FR-072K4L</td>
<td>0603</td>
<td>1</td>
</tr>
<tr>
<td>22</td>
<td>R22, R25</td>
<td>10Ω</td>
<td>RES SMD 10 OHM 0.5% 1/16W 0402</td>
<td>RT0402RE0710RL</td>
<td>0402</td>
<td>2</td>
</tr>
<tr>
<td>23</td>
<td>R23</td>
<td>200kΩ</td>
<td>RES SMD 200K OHM 1% 1/10W 0402</td>
<td>ERJ-2RKF2003X</td>
<td>0402</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>R26</td>
<td>0.02Ω</td>
<td>RES 0.02 OHM 1% 1/8W 0805</td>
<td>PF0805FRM7P0R02L</td>
<td>0805</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>R28, R58, R60, R61, R72, R76</td>
<td>10kΩ</td>
<td>RES SMD 10K OHM 1% 1/16W 0402</td>
<td>RC0402FR-0710KL</td>
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<td>6</td>
</tr>
<tr>
<td>26</td>
<td>R35, R40, R44, R47</td>
<td>22Ω</td>
<td>RES SMD 22 OHM 1% 1/10W 0402</td>
<td>RC1005F220CS</td>
<td>0402</td>
<td>4</td>
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<tr>
<td>27</td>
<td>R36, R42, R45, R48, R57</td>
<td>100kΩ</td>
<td>RES SMD 100K OHM 1% 1/16W 0402</td>
<td>RC0402FR-07100KL</td>
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<td>Item</td>
<td>Reference</td>
<td>Value</td>
<td>Description</td>
<td>Part Number</td>
<td>PCB Footprint</td>
<td>Quantity</td>
</tr>
<tr>
<td>------</td>
<td>-----------</td>
<td>-------</td>
<td>------------------------------</td>
<td>------------------</td>
<td>---------------</td>
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<tr>
<td>28</td>
<td>R39, R49</td>
<td>0</td>
<td>RES SMD 0 OHM JUMPER 1/16W 0402</td>
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<td>R41, R43</td>
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<td>RES SMD 1K OHM 5% 1/16W 0402</td>
<td>RC0402JR-071KL</td>
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<td>680Ω</td>
<td>RES SMD 680 OHM 5% 1/16W 0402</td>
<td>RC0402JR-07680RL</td>
<td>0402</td>
<td>1</td>
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<td>31</td>
<td>R50, R52</td>
<td>5.1kΩ</td>
<td>RES SMD 5.1K OHM 5% 1/16W 0402</td>
<td>RC0402JR-075K1L</td>
<td>0402</td>
<td>2</td>
</tr>
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<td>32</td>
<td>R70</td>
<td>47kΩ</td>
<td>RES SMD 47K OHM 1% 1/16W 0402</td>
<td>RC0402FR-0747KL</td>
<td>0402</td>
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</tr>
<tr>
<td>33</td>
<td>TH_Coil1</td>
<td>10kΩ</td>
<td>NTC THERMISTOR 10K OHM 1% 0603</td>
<td>ERT-J1VG103FA</td>
<td>0603</td>
<td>1</td>
</tr>
<tr>
<td>34</td>
<td>U3</td>
<td>P9235A-RB</td>
<td>Wireless power transmitter</td>
<td>P9235A-RB</td>
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5. Board Layout

Figure 10. Silkscreen – Top of Board

Figure 11. Copper – Top Layer
Figure 12. Copper L1 Layer

Figure 13. Copper L2 Layer
Figure 14. Copper Bottom
6. Ordering Information

<table>
<thead>
<tr>
<th>Orderable Part Number</th>
<th>Description</th>
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<td>P9235A-RB-EVK</td>
<td>P9235A-RB-EVK Evaluation Board</td>
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7. Revision History

<table>
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<th>Revision Date</th>
<th>Description of Change</th>
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<tr>
<td>February 21, 2019</td>
<td>Initial release.</td>
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