Features

- Fully-functional wireless power receiver and transmitter for plug-and-play prototyping
- High efficiency transfer up to 79% at 5V/600mA
- Three coil size options meet various application requirements
  - 30 mm diameter for 3W applications
  - 20 mm diameter for 2W applications
  - 15 mm diameter for 1W applications
- Low BOM cost and high density PCB design for ultra-compact applications
- Receiver (Rx) has 4-layer, performance-optimized PCB reference layout for copying to system board
- Transmitter (Tx) has 2-layer, performance-optimized PCB reference layout for copying to system board
- 5.0V @ up to 0.6A output targets for wearable and many other lower power applications
- Only 2 high-voltage capacitors necessary for Rx
- LED indicator to indicate power transfer on both Rx and Tx boards
- Break-away coil mount enables fast prototyping
- Programmable output voltage from 4.5V to 6V
- Over temperature protection and programmable over current protection on Rx board
- Selectable Tx input current limit capability for USB protection.
- Programmable LED pattern on the Tx board
- Supported by an extensive library of digital resources to ease design-in effort
- Application notes, datasheets, manuals, guides, videos, layout files, and other digital resources can be found at: www.IDT.com/WP3W-RK

Kit Contents

- Fully-assembled P9027LP-R-EVK and P9235A-R-EVK reference boards fitted with 2W coils
- Two additional coil sets for 1W and 3W output power
- 1.5 ft. USB cable

Description

IDT's wireless power reference kit targets applications ranging from 0.5 to 3W. The reference kit is comprised of both the transmitter (P9235A-R-EVK) and the receiver (P9027LP-R-EVK) with three different coil size options supporting applications with different form factors and power levels. The high-efficiency, turnkey reference design is supported by comprehensive online, digital resources to significantly ease design-in effort and enable rapid prototyping.

The receiver design is based on the P9027LP-R, a highly integrated, high efficiency solution suited to a wide range of compact applications requiring up to 600mA load current. The layout has been optimized on a 4-layer PCB, compliant with wearable device layout rules and form factors. The ultra-compact form factor is ideal for rapid product prototyping. The active area of the P9027LP-R-EVK board is 5.7 mm x 5.7 mm and is ideal for small form factor and thermally-constrained applications.

The transmitter design is based on the P9235A-R and can be powered from a micro-USB or other input voltage from 4.5V to 5.5V. The P9235A-R is based on a flexible 32-bit ARM® Cortex®-M0 processor with integrated full bridge power stage drivers and on-chip simultaneous voltage and current demodulation. It provides a low component count solution on an optimized 2-layer hardware reference layout intended for seamless copy/paste to a customer application board. The active area of the P9235A-R board is 22.7mm x 21.2mm and is ideal for space-constrained, low power transmitter designs.

Figure 1. Kit Photograph

Hardware Overview

Figure 2. P9027LP-R-EVK Reference Board Illustration Top Layer

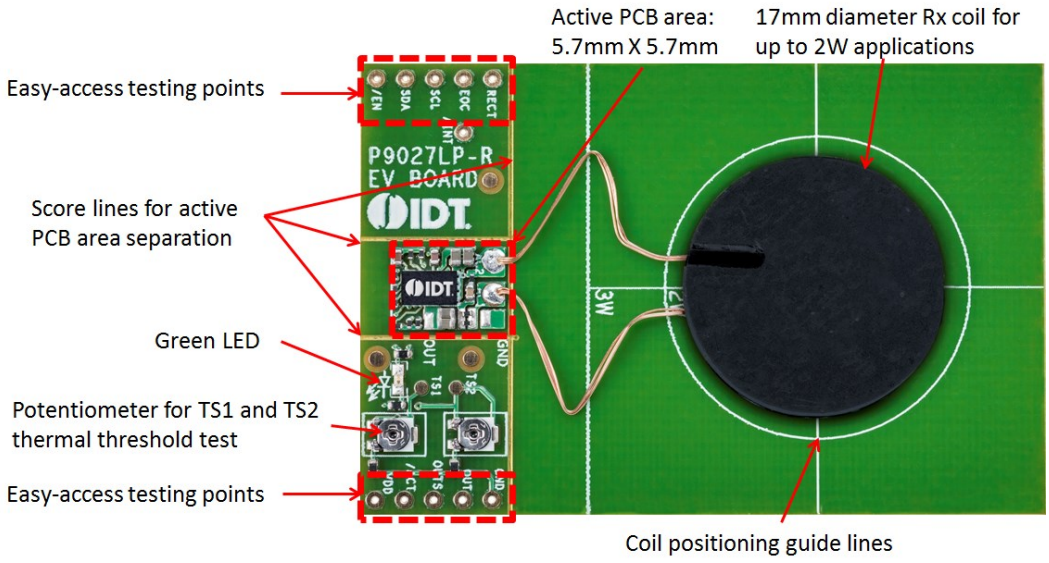


Figure 3. P9235A-R-EVK Reference Board Illustration Top Layer

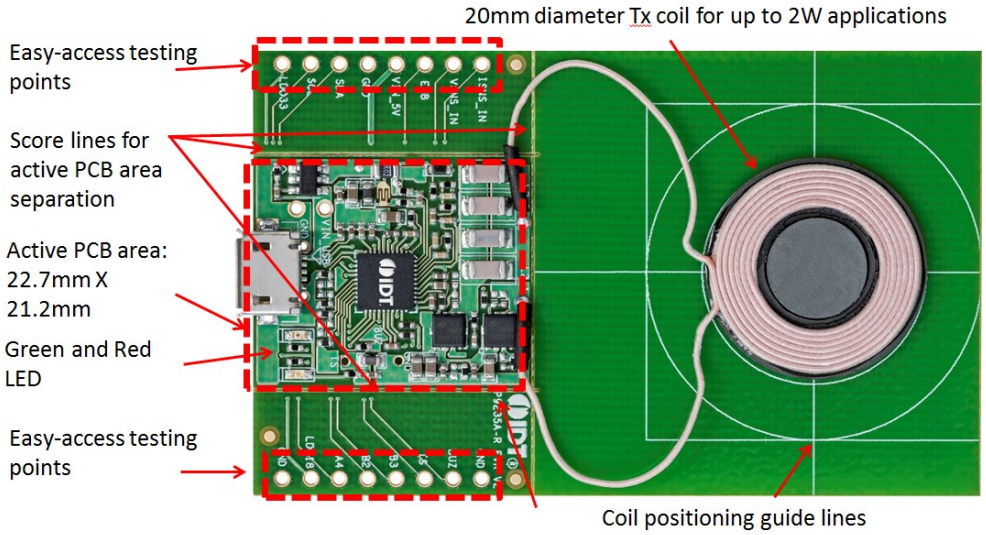
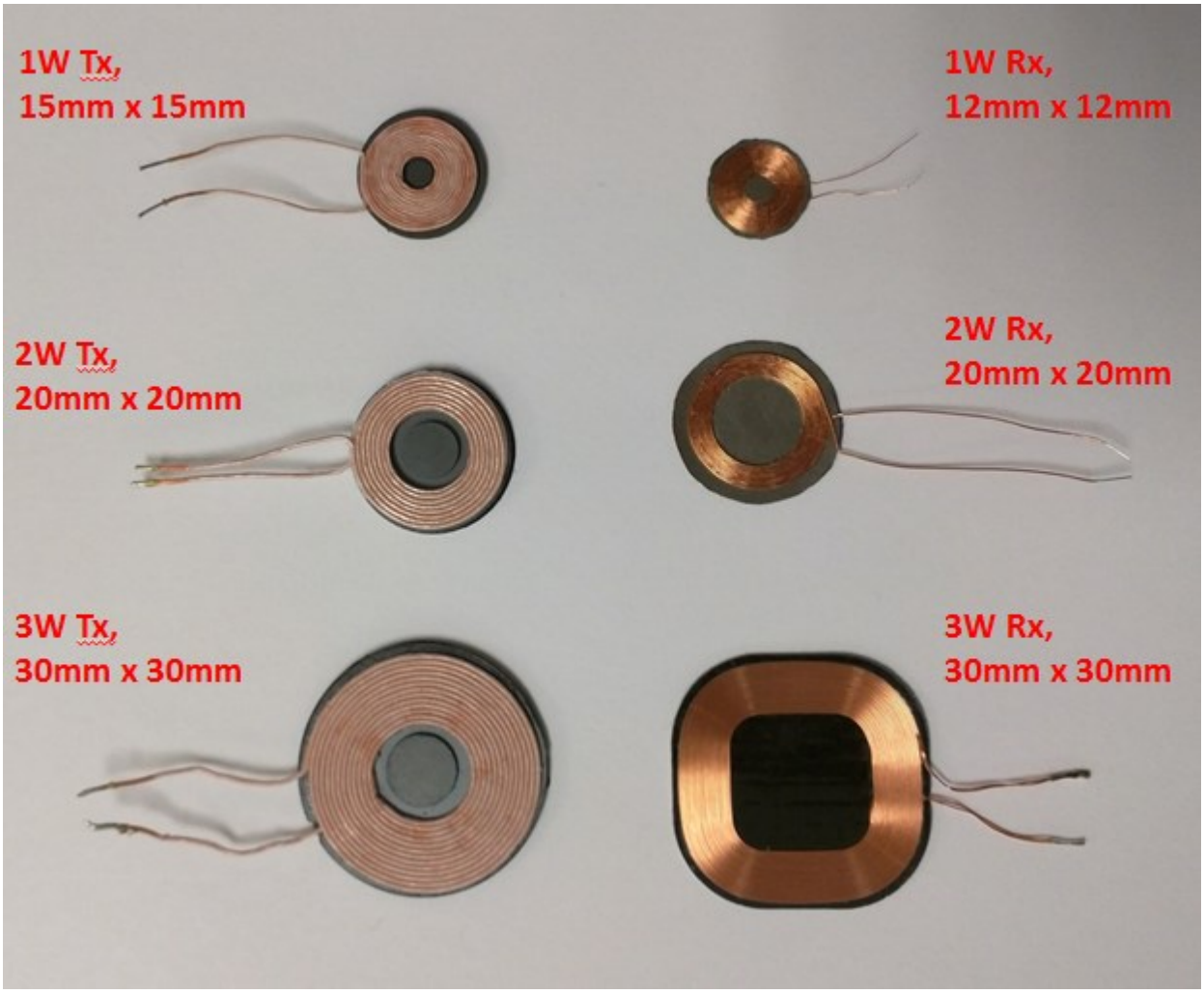


Figure 4. Tx and Rx Coil Pairs for 1W, 2W and 3W Applications



Usage Guide

These reference boards are designed to demonstrate the performance and functionality of the P9027LP-R and P9235A-R as a fully-functional wireless power receiver and transmitter pair. This solution is suitable for wearable devices as well as other end products that require up to 3W output power from the wireless power receiver. In most cases, these boards can be imported into an existing customer system for evaluation and prototyping. The WP3W-RK evaluation kit is based on the WPC Qi standard protocol but targets 'paired' transmitter-receiver solutions – sometimes called end-to-end customer applications where the receiver is only expected to work with a known transmitter.

Quick-Start Guide

Follow these simple steps to power-up and begin using the P9027LP-R-EVK and P9235A-R-EVK boards:

1. Power up the P9235A-R-EVK board by connecting the USB cable to either a notebook computer or a USB adaptor with 5V output (preferred) or a power supply

2. Verify that the red and green LED flashes once, respectively, – the P9235A-R-EVK board is up and running now

3. Place the P9027LP-R-EVK board on top of the P9235A-R-EVK board with the coil of the P9027LP-R-EVK facing down and centered on the coil of the P9235A-R-EVK board. The green LED on the P9027LP-R-EVK board indicates that it has been successfully powered up.

4. Optional: Solder two 28-gauge wires to the OUT and GND pins on P9027LP-R-EVK board. Connect these two wires to an electronic load.

5. Set the electronic load current to zero initially and then gradually increase the load current up to 400mA with the attached 2W coils

Output Power

The output of the P9027LP-R-EVK's LDO regulator has a plated via labeled OUT, and the DC ground return path is labeled GND. The output provides a nominal 5.0 V with 400mA output current capability using the attached 20mm diameter coil. When switched to the 30mm diameter coil (supplied in the kit), it can provide up to 600mA output current. The plated vias have a 15 mil diameter, allowing for 28-gauge wire or smaller.

P9027LP-R Board LED Power Indicator

The P9027LP-R-EVK is equipped with a single green LED power indicator connected from OUT to ACTB. This LED will be illuminated when the system reaches the desired operating point and enables the DC voltage output. This LED is entirely optional and is included for evaluation purposes only. When illuminated, it draws less than 1 mA of current from the output. If desired, the brightness of the LED can be increased by lowering the value of resistor R3.

P9027LP-R Board Test Point Accessibility

The P9027LP-R-EVK reference board was designed so that the core layout could be easily "dropped-in" to an existing system board design. For this reason, all of the necessary inputs and outputs are placed toward the edge of the board to eliminate uncertainty in escape routing. For more information about copying the digital layout files, refer to application note AN-933.

When prototyping with this board, it is important to use a low-resistance wire that is rated for the expected output current. This will avoid damage to the wire and minimize voltage drops on its way to the load.

Coil Spacer (Upside-down Coil)

A good wireless power transfer system should maintain a small separation gap between the transmitter coil and the receiver coil. For the reference board, the receiver coil has been mounted upside-down on the P9027LP-R-EVK board. The PCB area under the Rx coil is used as a spacer (0.5mm) to simulate the thickness of a wearable device case, and there is no copper conductor. While the coil itself is protected by non-conductive encapsulation, it is recommended to use some type of spacer to achieve optimal power transfer efficiency.

Similarly a 0.8mm plastic spacer is placed on top of the Tx coil to simulate the casing of a final transmitter product. With both spacers the total distance between the coils is about 1.5mm.

Separating the Coil from the Spacer

The P9027LP-R-EVK reference board has been precisely tuned for the stock coil attached to the board. The PCB has been designed with a score line enabling users to snap-off of the active PCB section. When doing so, carefully peel the coil off from the Rx PCB. Once the coil is off, it is recommended to use scissors to cut the active board area along the score lines. To see a video demonstration, visit: www.IDT.com/WP3W-RK.

If it is necessary to extend the length of the coil leads when working on prototype, it's best to unsolder them from the PCB prior to separating the active PCB area from the rest of the board.

Performance Characteristics

Figure 5. Typical Efficiency Curve for 30mm Coil

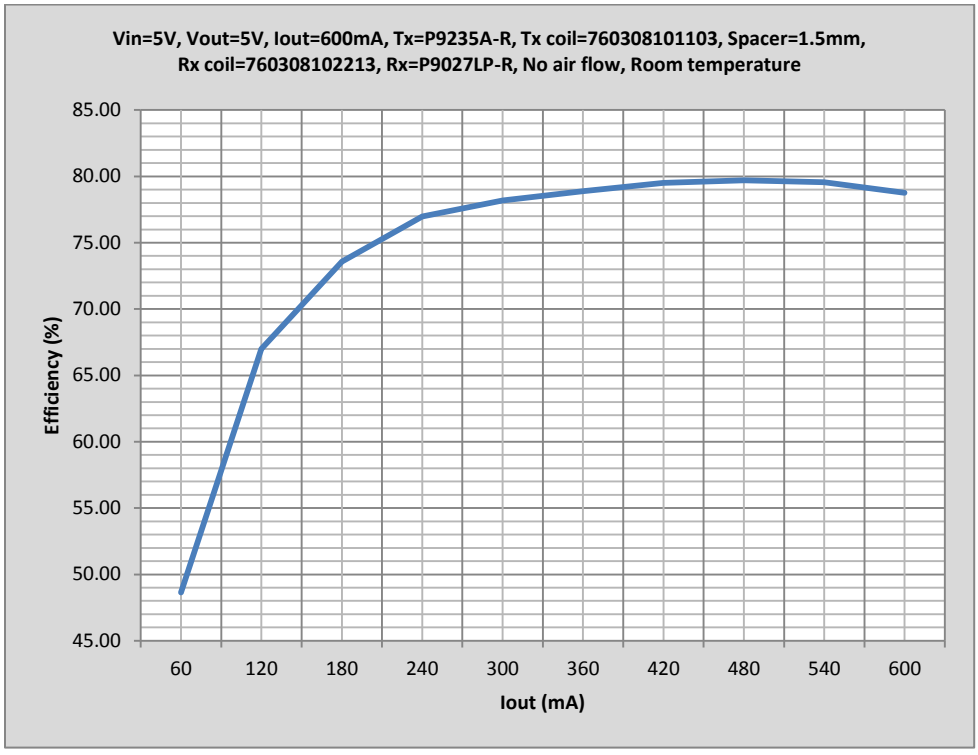


Figure 6. Load Regulation for 30mm Coil

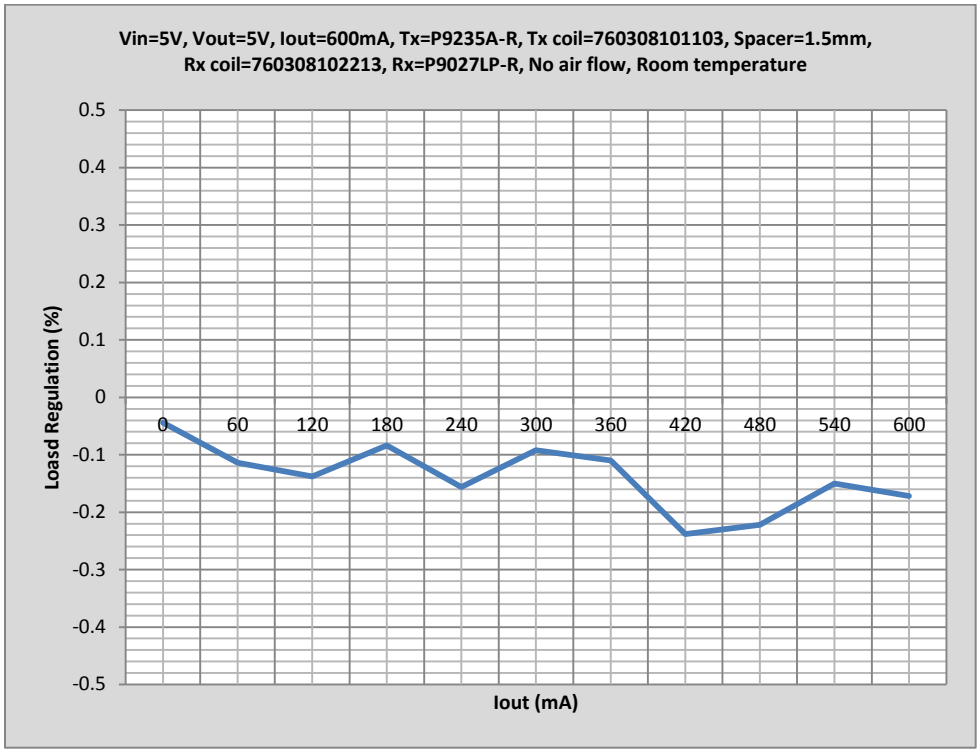


Figure 7. Typical Efficiency Curve for 20mm Coil

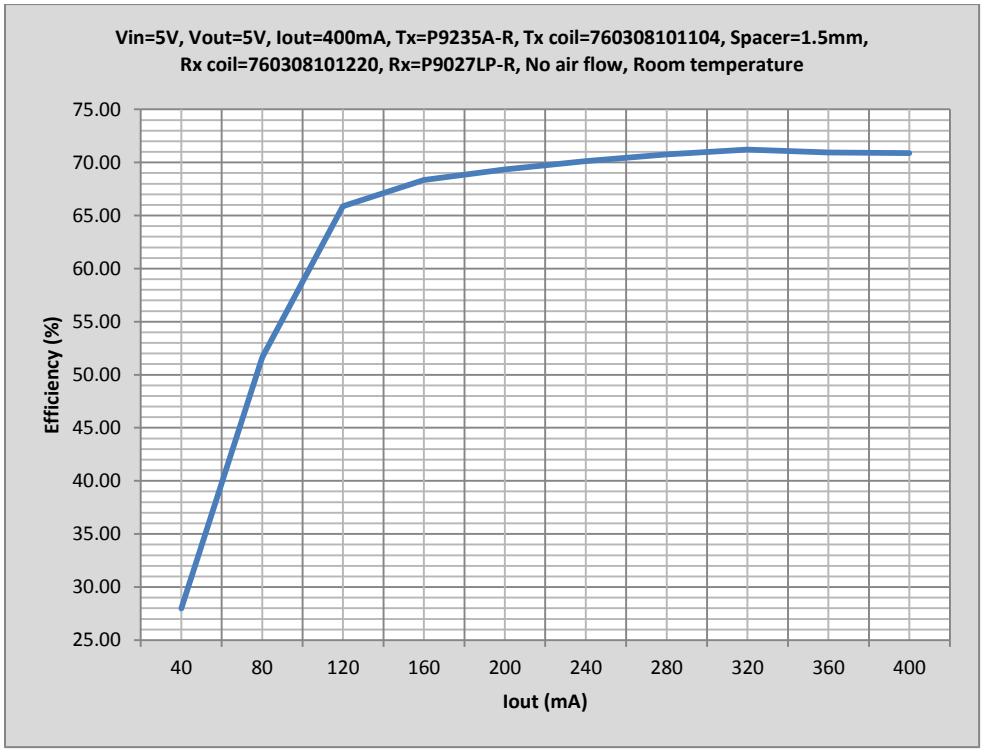


Figure 8. Load Regulation for 20mm Coil

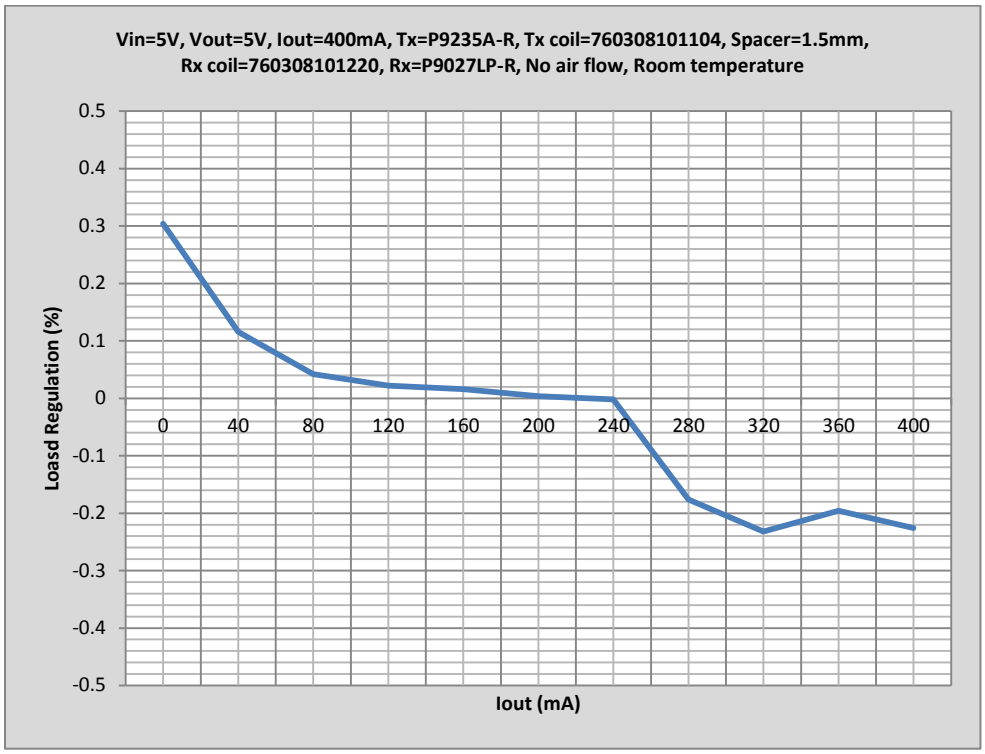
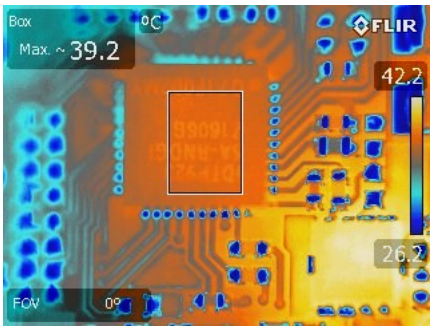
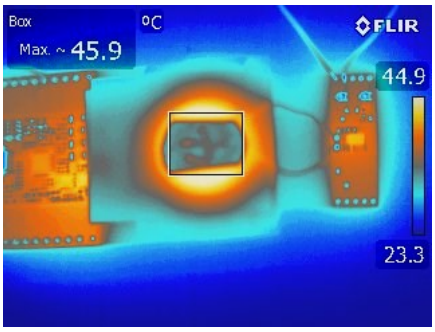


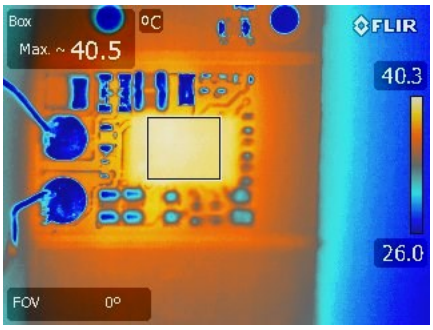
Figure 9. 5V/400mA Thermal Images Using 20mm Coil



P9235A-R: 39.2 Degree C



Coil: 45.9 Degree C



P9027LP-R: 40.5 Degree C

Figure 10. 0 to 400mA Step Load Response (Ch1=Vrect, Ch2=VSNS, Ch3=Vout, Ch4=Iout)

Figure 11. No Load Start-up by Tx Input Power (Ch1=Vrect, Ch2=VIN, Ch3=Vout,Ch4=Iout)

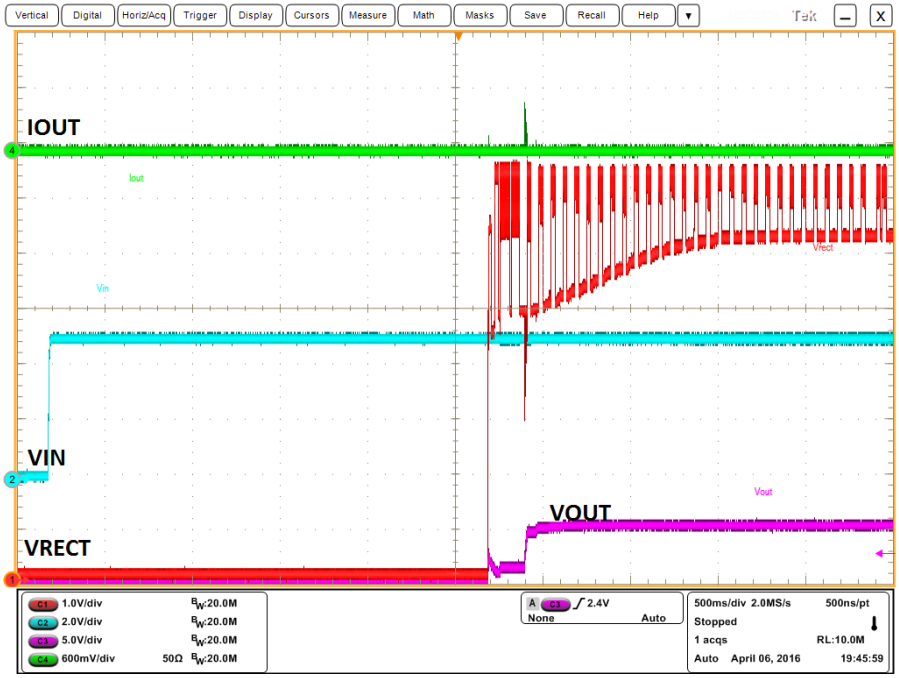


Figure 12. 600mA Full Load Start-up by Tx Input Power (Ch1=Vrect, Ch2=VIN, Ch3=Vout,Ch4=Iout)

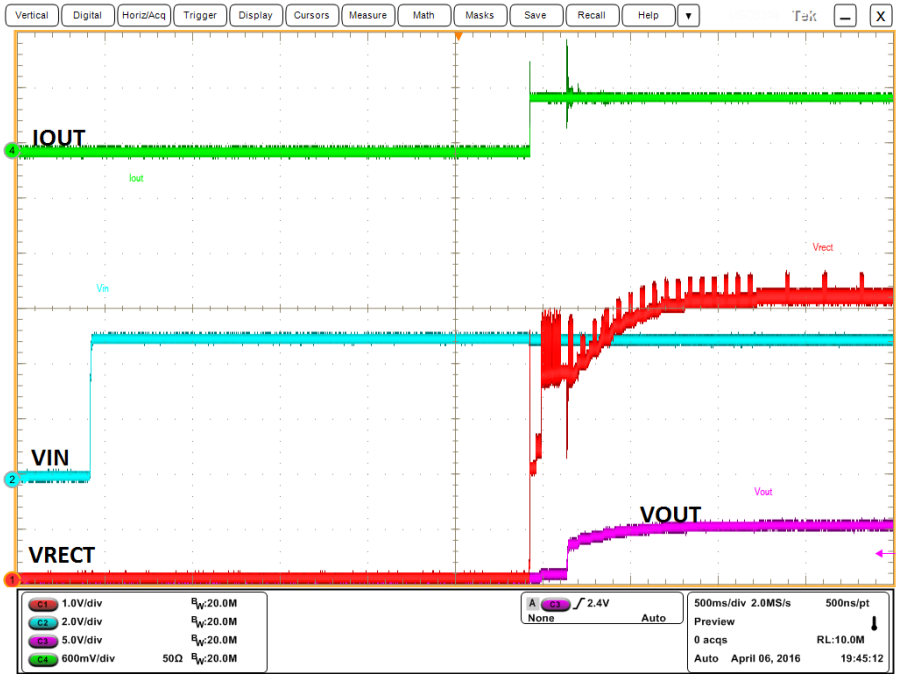


Figure 13. No Load Start-up by Rx Enable Signal (Ch2=EN, Ch3=Vout, Ch4=Iout)

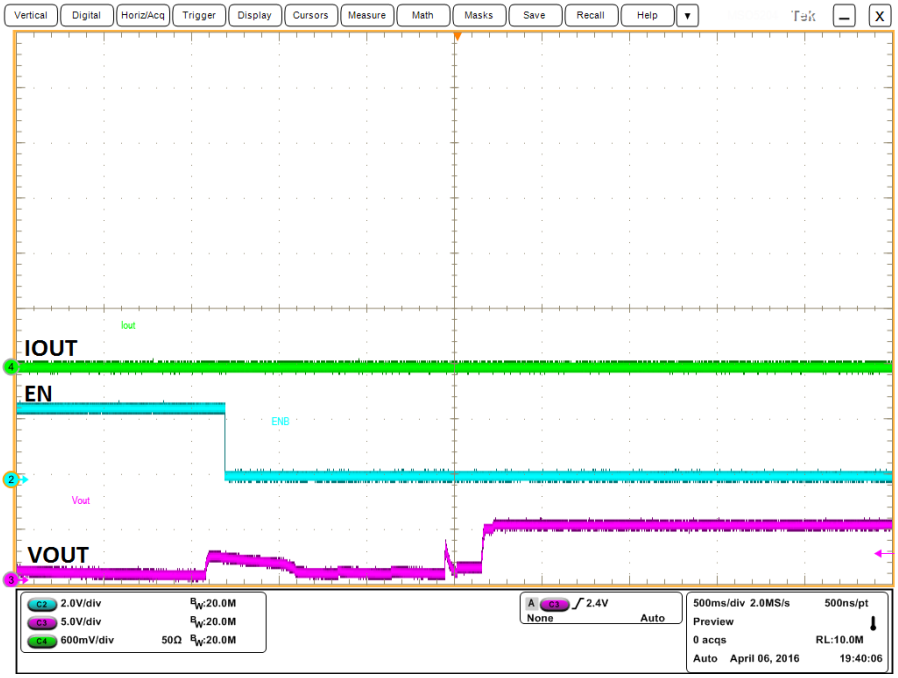


Figure 14. 600mA Full Load Start-up by Rx Enable Signal (Ch2=EN, Ch3=Vout, Ch4=Iout)

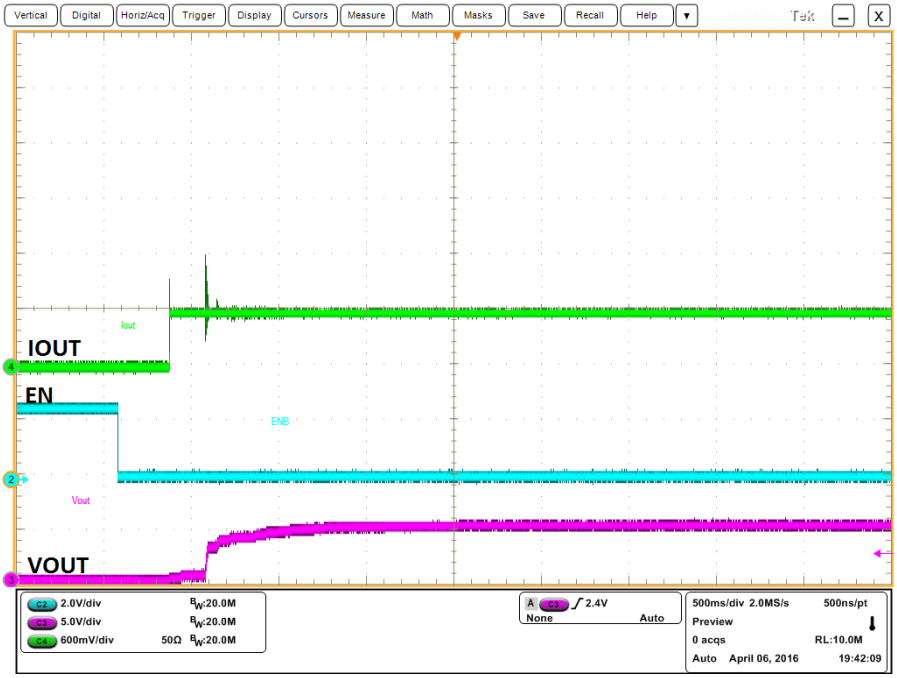


Figure 15. Rx Over Temperature Protection (Ch1=Vrect, Ch2=Vin, Ch3=Vout, Ch4=INT)

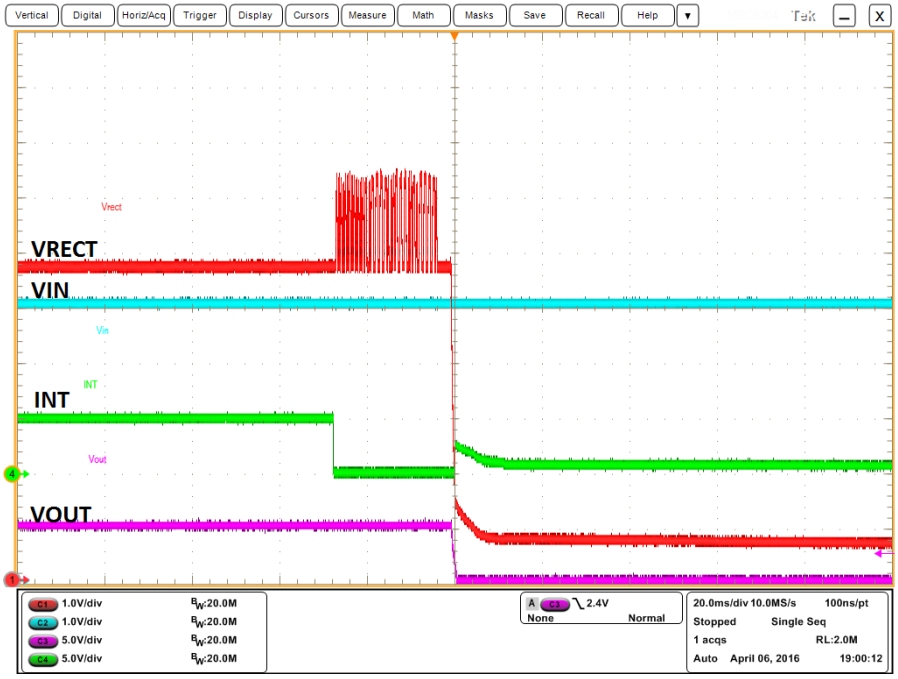
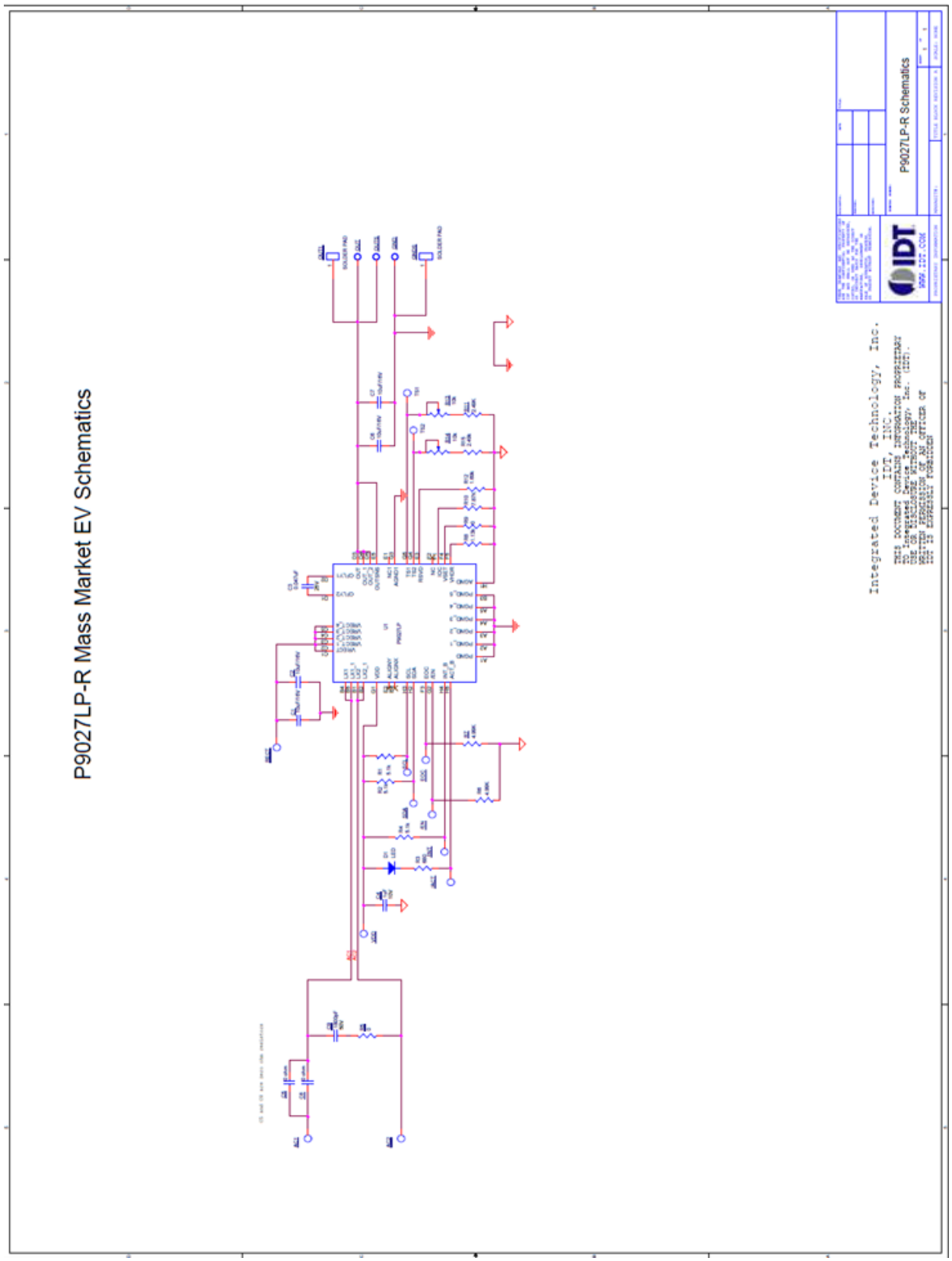


Figure 16. Rx Over Current Protection (Ch1=Vrect, Ch2=Iout, Ch3=Vout, Ch4=INT)

P9027LP-R-EVK Schematic

Figure 17. P9027-R-EVK Board Schematic



P9027LP-R-EVK Component Map and Bill-of-Materials (BOM)

Figure 18. P9027LP-R-EVK Component Map

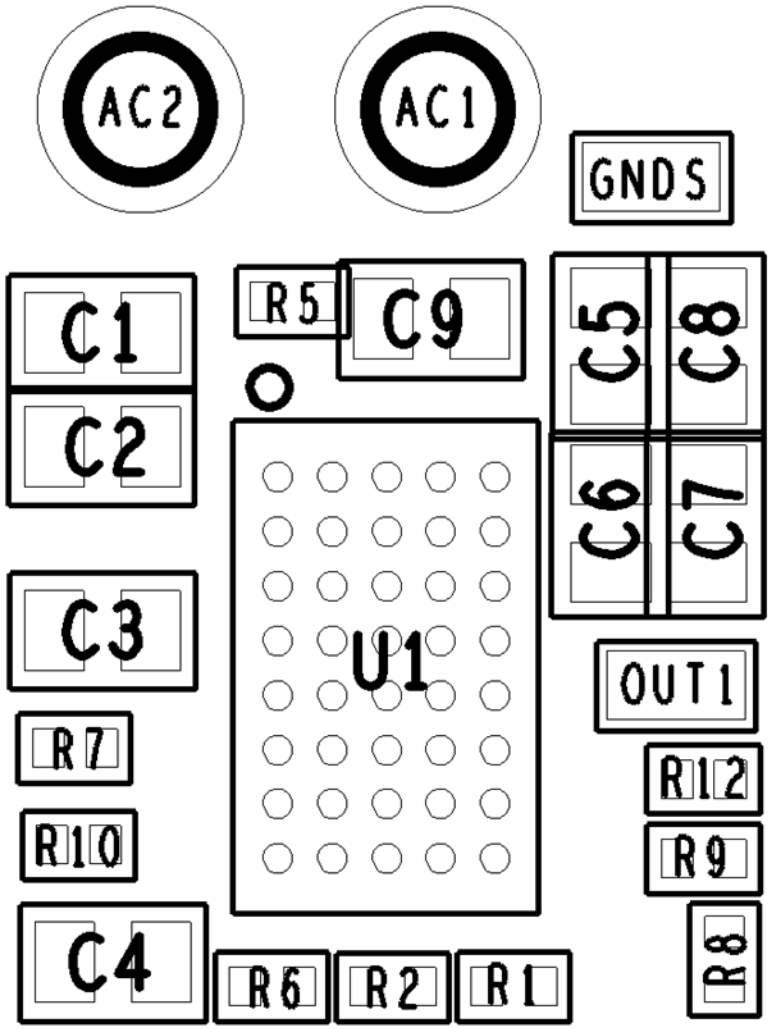


Table 1: P9027LP-R-EVK Bill-of-Materials

Item	Qty.	Reference	Description	PCB Footprint	MFG Part Number
1	4	C1, C2,C6,C7	CAP 10uF/10V	402	CL05A106MP5NUNC
2	2	*C5, *C8	RES 0.0 OHM	402	ERJ-2GE0R00X
3	1	C4	CAP 1UF/25V	402	C1005X5R1E105M050BC
4	1	C3	CAP 0.047UF/25V	402	C1005X7R1E473M050BC
5	1	C9	CAP 1800PF/50V	402	GRM155R71H182KA01D
6	2	*R1,*R2	RES 5.11k	201	ERJ-1GEF5111C
7	1	*R3	RES 680	402	ERJ-2GEJ681X
8	1	R4	RES 5.1k	402	ERJ-2GEJ512X
9	2	*R5, *R9	RES 0.0 OHM	201	ERJ-1GE0R00C
10	2	R6, R7	RES 4.99K	201	ERJ-1GEF4991C
11	1	R8	RES 1.13K	201	ERJ-1GEF1131C
12	1	R10	RES 7.87K	201	ERJ-1GEF7871C
13	2	*R11,*R15	RES 2.49K	402	ERJ-2RKF2491X
14	1	R12	RES 1.69K	201	ERJ-1GEF1691C
15	2	*R13, *R14	Potential meter 10k	2.2mmX2.1mmx0.8mm	PVA2A103A01R00
16	1	*D1	LED Indicator	402	LED RED 0402 SMD
17	1	U1	Wireless Power Rx IC	2.24x3.62mm WLCSP, 0.4mm pitch size	P9027LP-R
18	1	See Table 2 for inductance value	Rx coil		See Table 2 for part numbers

*Components are optional depending on application.

A standard bill-of-materials (BOM) spreadsheet can be found at www.IDT.com/WP3W-RK .

Table 2: Rx Coil Specification and Part Numbers

Output Power	Vendor	Part Number	Inductance	DCR	Dimension
1 W	TDK	WR121220-27M8-ID	8.32 uH	0.98 Ω	Ø12 mm
	SunLord	SWA12R12H08C01B	8.50 uH	0.38 Ω	Ø12 mm
2W	TDK	WR202010-18M8-ID3	11.0 µH	0.40 Ω	Ø20 mm
	Wurth Electronics	760308101220	12.60 µH	0.27 Ω	Ø17 mm
	SunLord	SWA20R20H08C01B	12.0 µH	0.29 Ω	20 mm x 20 mm
3 W	TDK	WR303050-12F5-ID1	8.20 µH	0.30 Ω	30 mm x 30 mm
	Wurth Electronics	760308102213	7.90 µH	0.26 Ω	29 mm x 29 mm
	SunLord	SWA30R30H08C01B	8.20 uH	0.33 Ω	30 mm x 30 mm

P9027LP-R-EVK Layout

Figure 19. P9027LP-R-EVK Layout (Top Layer)

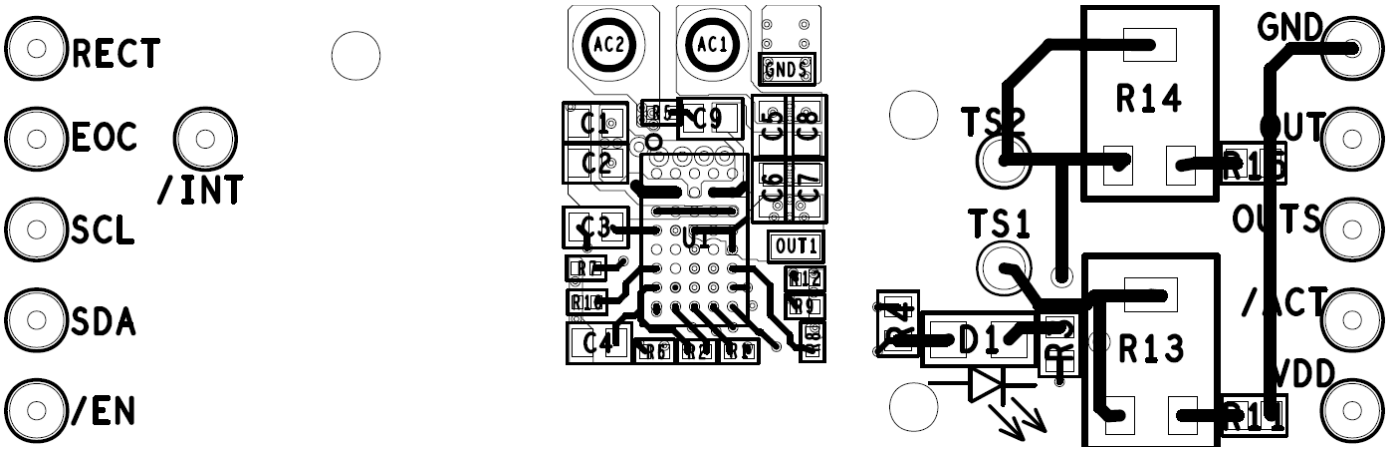


Figure 20. P9027LP-R-EVK Layout (Inner Layer 1)

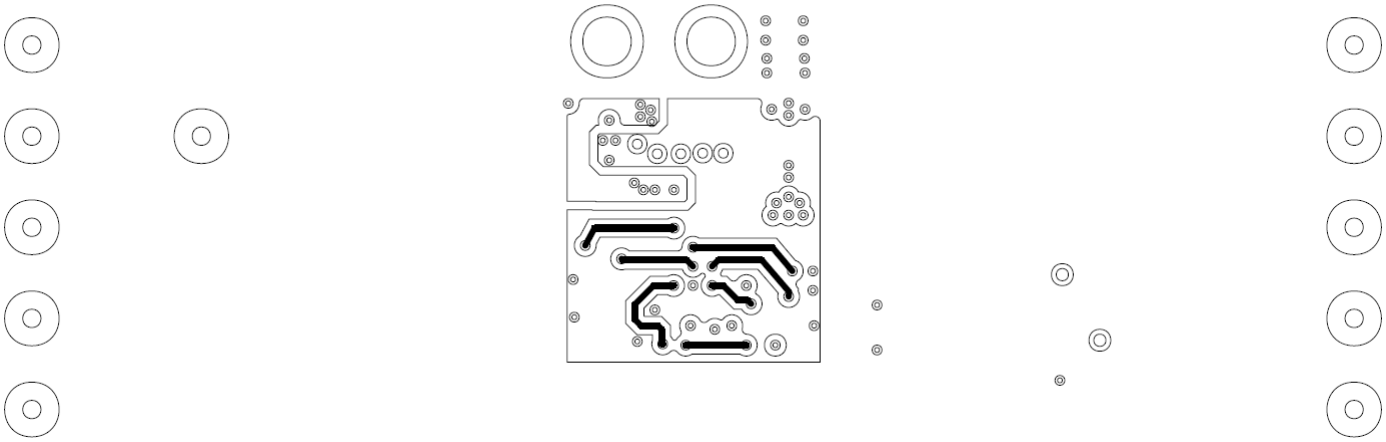


Figure 21. P9027LP-R-EVK Layout (Inner Layer 2)

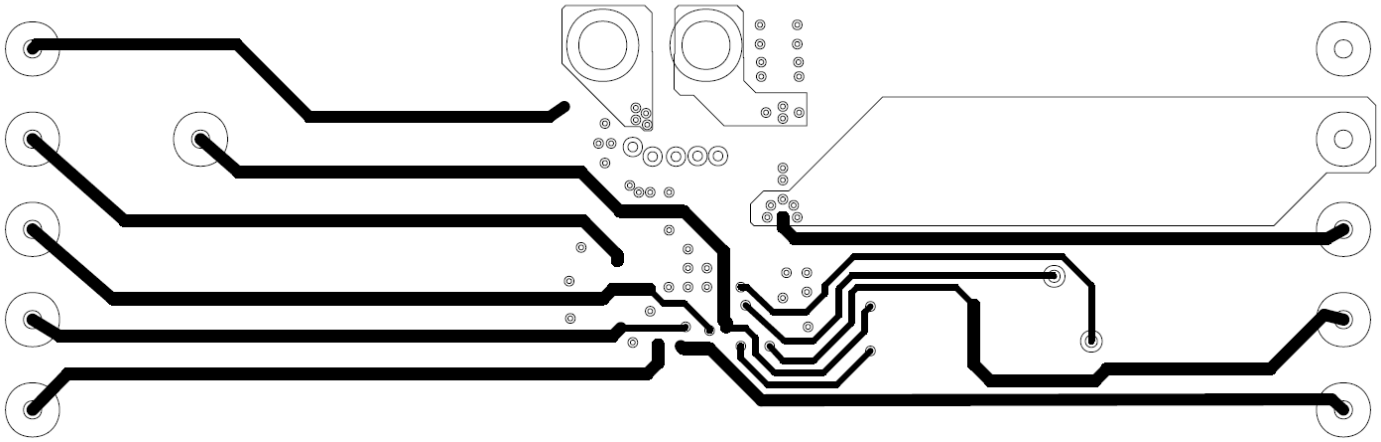
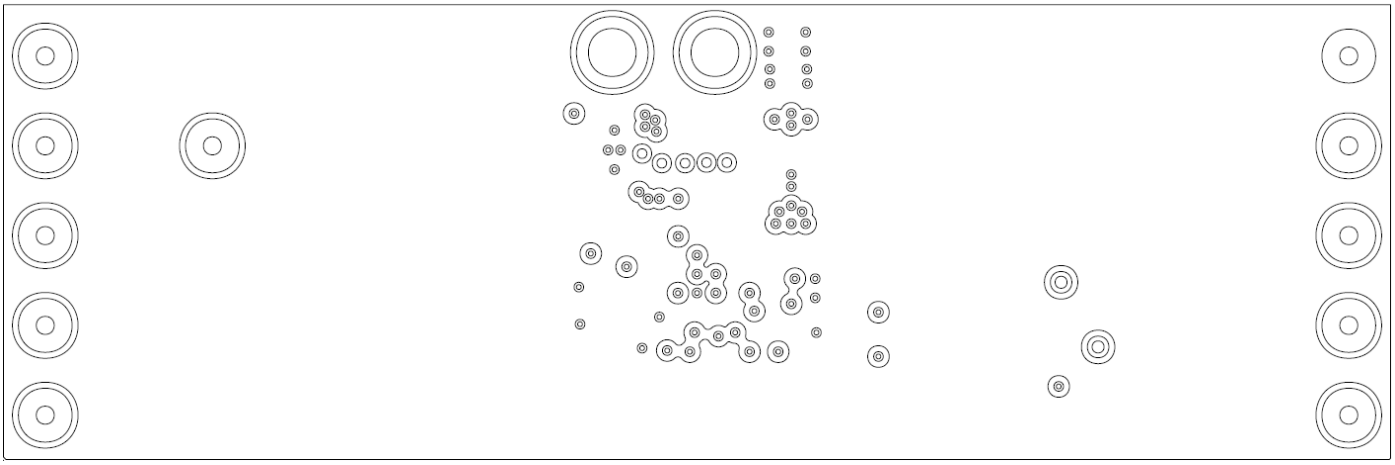
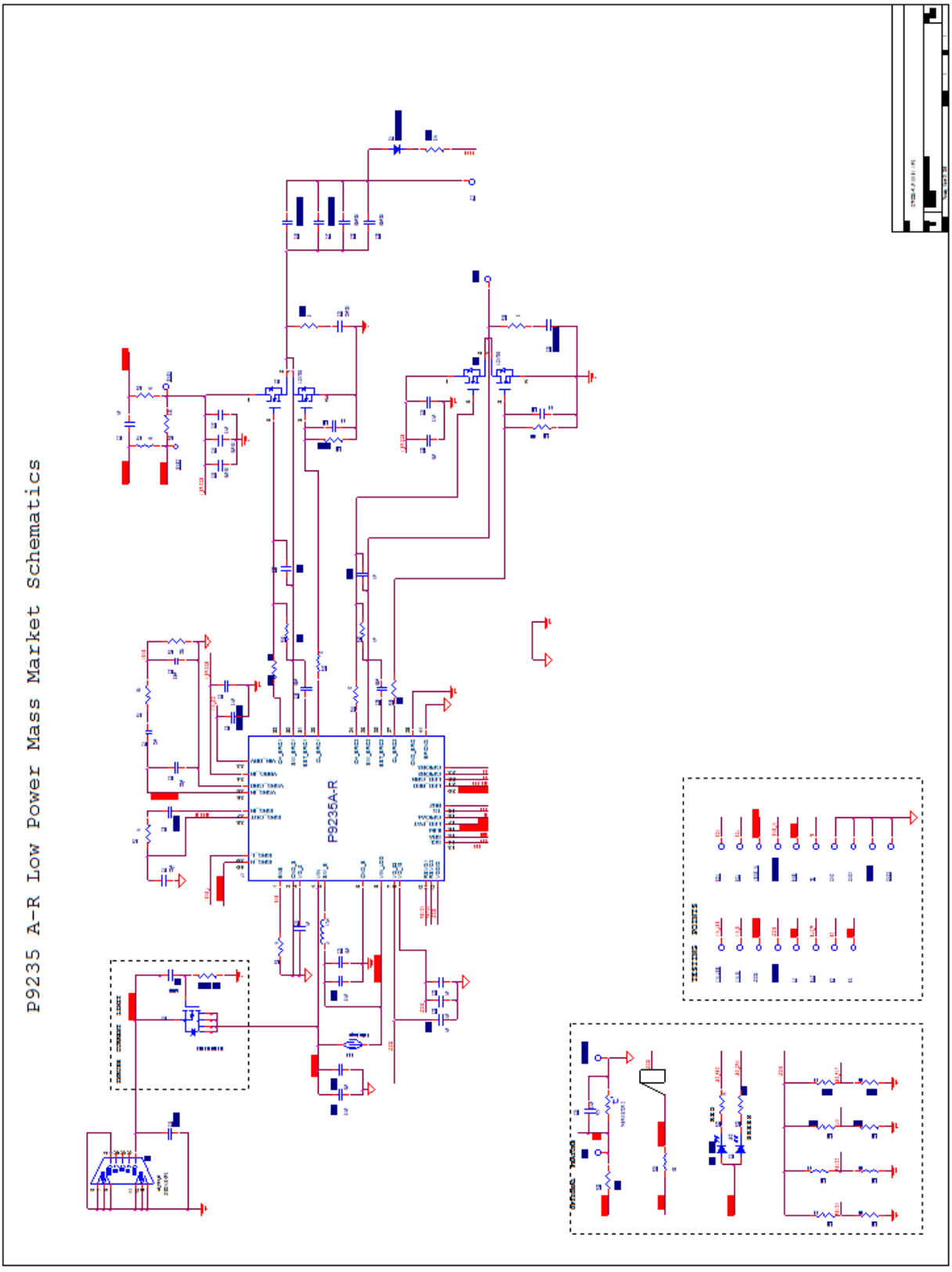


Figure 22. P9027LP-R-EVK Layout (Bottom Layer)



P9235A-R-EVK Schematic

Figure 23. P9235A-R-EVK Board Schematic



P9235A-R-EVK Component Map and Bill-of-Materials (BOM)

Figure 24. P9235A-R-EVK Component Map

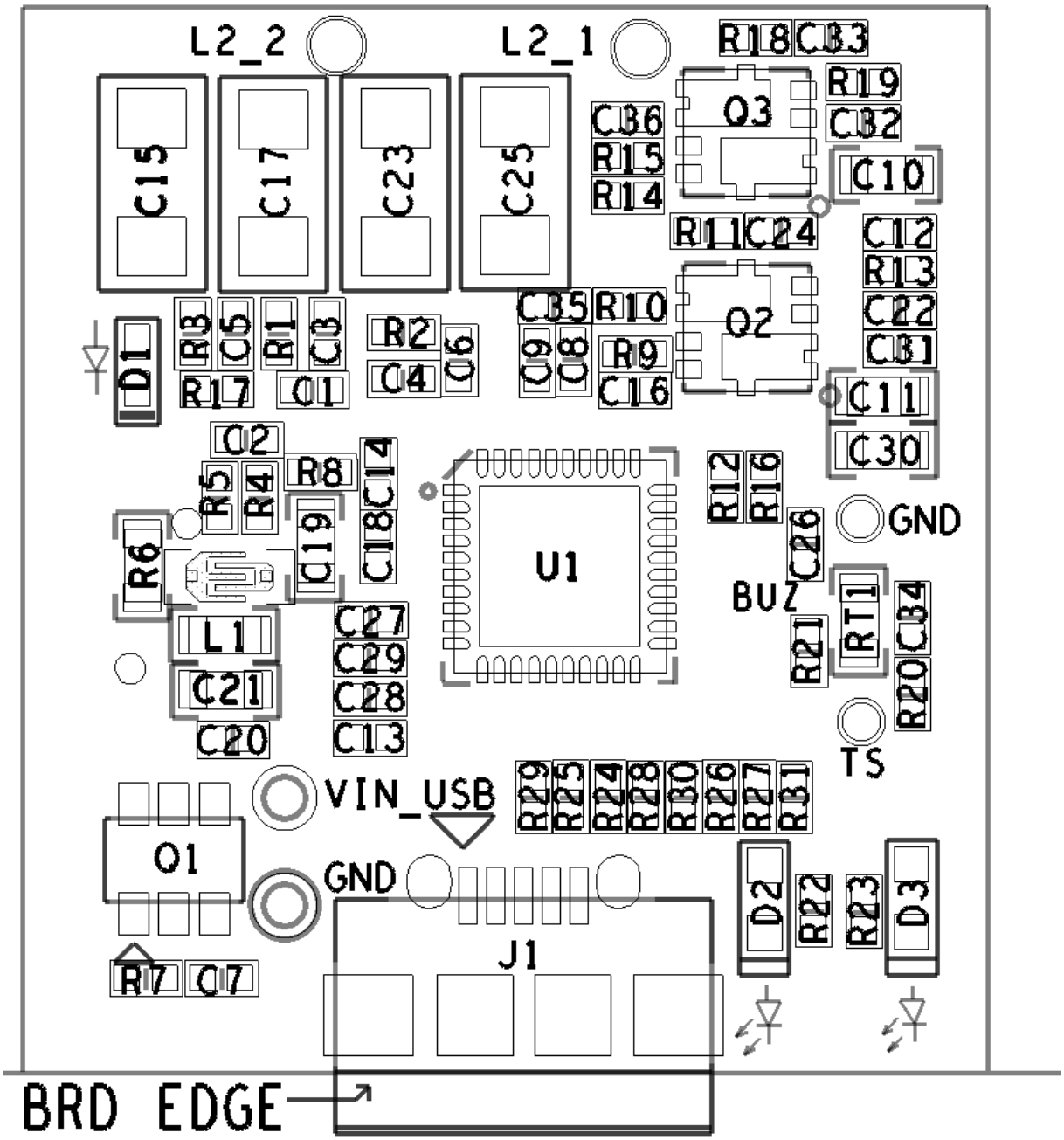


Table 3: P9235A-R-EVK BOM

Item	Qty	Reference	Description	PCB Footprint	MFG Part Number
1	3	C1,C24,C33	22nF/50V	0402	C0402C223K5RACTU
2	1	C2	1uF/10V	0402	C0402C105M8PACTU
3	2	C3,C4	220pF/50V	0402	CL05B221KB5NNNC
4	1	C5	5.6nF/50V	0402	CL05B562KB5NNNC
5	1	C6	6.8nF/50V	0402	CL05B682JB5NNNC
6	5	C9,C12,C13,C18,C31	0.1uF/25V	0402	TMK105BJ104KV-F
7	1	C8	10uF/10V	0402	CL05A106MP5NUNC
8	5	C10,C11,C19,C21,C30	10uF/25V	0603	CL10A106MA8NRNC
9	4	C7,C14,C27,C29	1uF/10V	0402	CL05A105KP5NNNC
10	4	C15,C17,C23,C25	100nF/50V	1206	C3216C0G1H104J160AA
11	2	C16,C26	100nF	0402	C1005X6S1V104K050BB
12	3	C20,C34,C28	0.1uF/10V	0402	C0402C104K8RACTU
13	4	C22,C32,C35,C36	NP	0402	
14	1	D1	DIODE	SOD523PD	CMOD3003
15	1	D2	Red LED	0603_diode	150 060 RS7 500 0
16	1	D3	Green LED	0603_diode	150 060 GS7 500 0
17	1	J1	5P	USB_micro_ab	10104111-0001LF
18	1	L1	4.7uH	0603	CIG10W4R7MNC
19	1	L2	See Table 3 for coil specification	Tx coil	See Table 3 for coil part numbers
20	1	Q1	80mOhm/4.5V	SOT23-6	FDC654P
21	2	Q2,Q3	20mOhm/6A Dual N-Channel MOSFETs	DFN3mmX3mm	AON7810
22	1	R1	10K %1	0402	RCG040210K0FKED
23	1	R20	10k	0402	CRCW040210K0JNED
24	3	R2,R8,R22	1k	0402	RC0402FR-071KL
25	1	R3	220k	0402	RC0402FR-07220KL
21	2	R4,R5	10	0402	RT0402DRE0710RL
27	1	R6	0.02	0603	WSL0805R0200FEA
28	1	RT1	THERMISTOR	0603	ERT-J1VG103FA
29	4	R9,R12,R14,R16	12	0402	ERJ-2GEJ120X
30	6	R10,R15,R24,R25,R26,R27	NP	0402	

Item	Qty	Reference	Description	PCB Footprint	MFG Part Number
31	2	R11,R18	0 OHMS RESISTOR	0402	RC0402JR-070RL
32	3	R7,R13,R19	100k	0402	ERJ-2GEJ104X
33	1	R17	5.1k	0402	MCR01MRTJ512
34	1	R21	100	0402	RC0402JR-07100RL
35	1	R23	680	0402	RC0402JR-07680RL
36	4	R28,R29,R30,R31	47k	0402	ERJ-2GEJ473X
37	1	U1	Wireless Power Tx IC	QFN_40ld_5x5m	P9235A-R

*Components are optional depending on application.

A standard bill-of-materials (BOM) spreadsheet can be found at www.IDT.com/WP3W-RK.

Table 4: Tx Coil Specification and Part Numbers

Output Power	Vendor	Part number	Inductance	DCR	Dimension
1W	TDK	WT151512-22F2-ID	6.49 uH	0.17 Ω	Ø15 mm
	SunLord	SWA15T15H20C01B	6.30 uH	0.12 Ω	Ø15 mm
2W	TDK	WT202012-15F2-ID	6.20 uH	0.10 Ω	Ø20 mm
	Wurth Electronics	760308101104	6.30 uH	0.11 Ω	Ø20 mm
	SunLord	SWA20N20H20C01B	6.30 uH	0.15 Ω	Ø20 mm
3W	TDK	WT303012-13F2-ID	6.30 uH	0.12 Ω	Ø30 mm
	Wurth Electronics	760308101103	6.50 uH	0.15 Ω	Ø30 mm
	SunLord	SWA30N30H20C01B	6.25 uH	0.14 Ω	Ø30 mm

P9235A-R-EVK Layout

Figure 25. P9235A-R-EVK Layout (Top Layer)

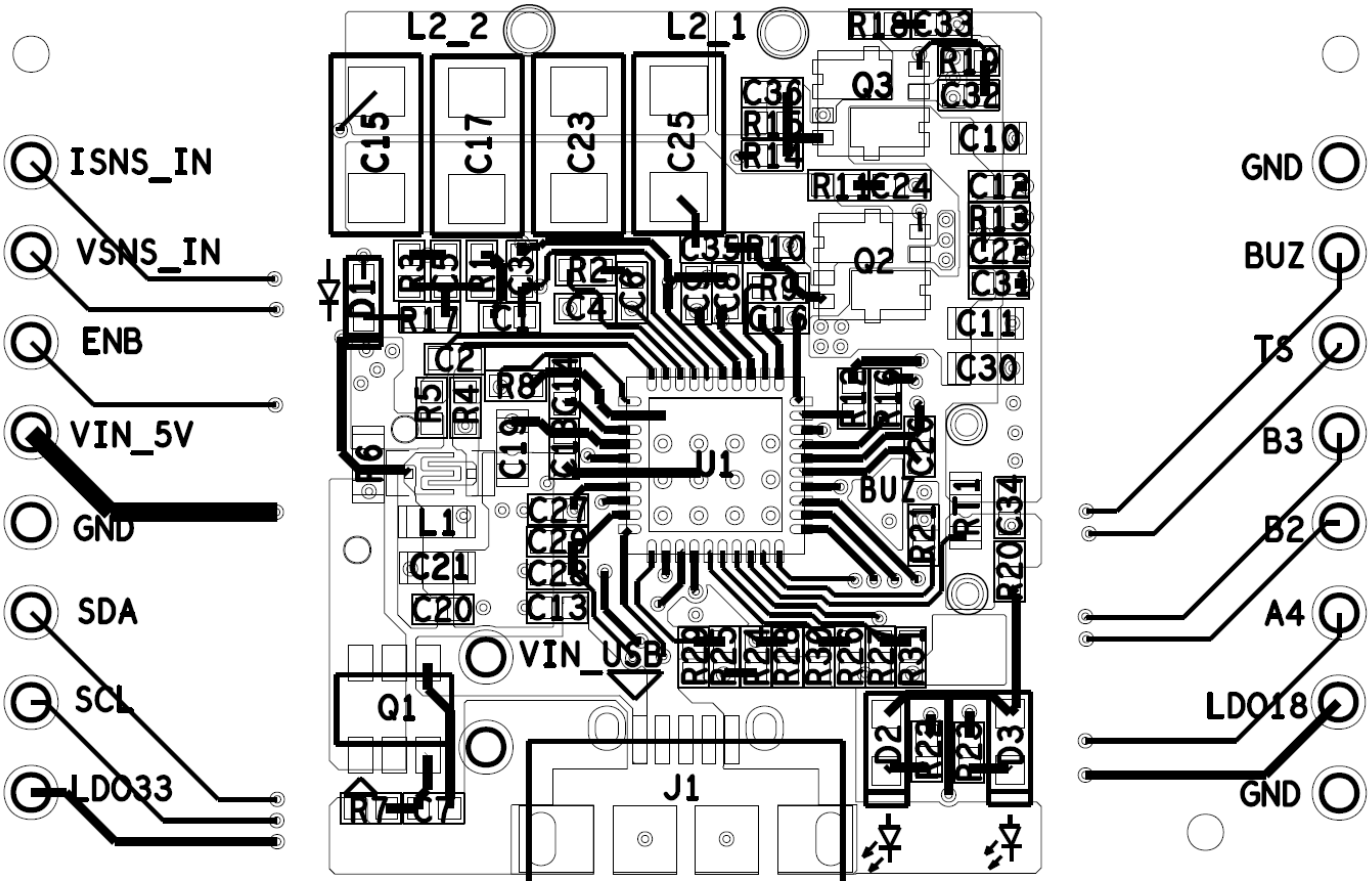
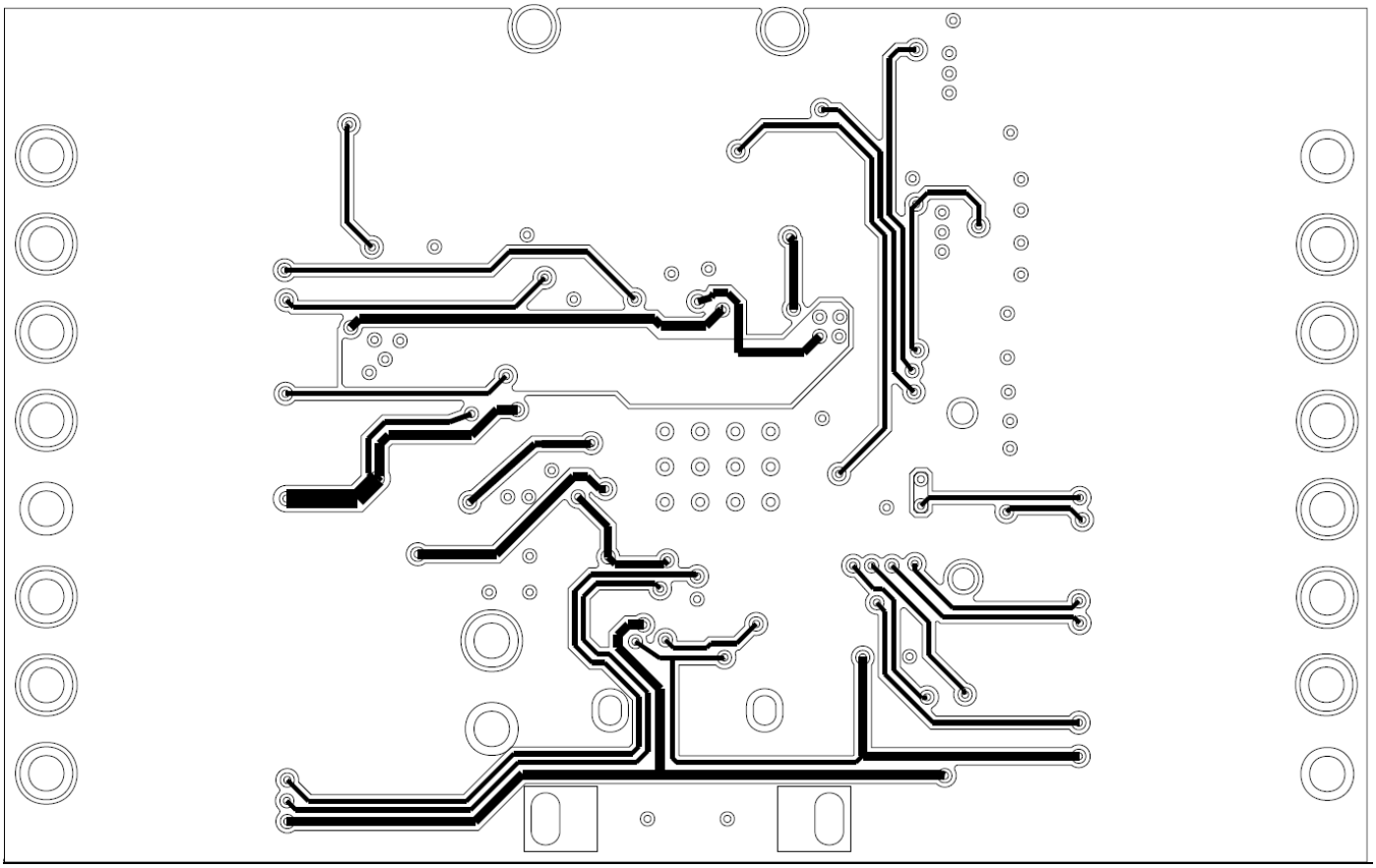


Figure 26. P9235A-R-EVK Layout (Bottom Layer)



Ordering Information

Orderable Part Number	Package	Shipping Packaging
WP3W-RK	Reference Kit	Box

Revision History

Revision Date	Description of Change
May 16, 2016	Initial release.

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