User's Guide

SLVUAB0A–October 2014–Revised January 2015

bq500215 bqTESLA Wireless Power TX EVM

The bqTESLA™ wireless power transmitter evaluation module from Texas Instruments is a high-performance, easy-to-use development module for the design of wireless power solutions. The bq500215 EVM evaluation module (EVM) provides all the basic functions of a Qi-compliant, wireless charger pad. The 12-V input, single coil transmitter enables designers to speed the development of their end-applications. The EVM supports both the WPC 1.0 and WPC 1.1 receivers and will support output power up to 5 W. The bq500215 EVM will operate with any Qi WPC 1.1 RX. When paired with the bq51025 RX EVM (bq51025EVM-649), receiver output power of up to 10 W is possible.

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1 Applications

The bq500215EVM-648 evaluation module demonstrates the transmitter portion of the bqTESLA™ wireless power system. This transmitter EVM is a complete transmitter-side solution that powers a bqTESLA receiver. The EVM requires a single 12-V power supply capable of up to 2.0 A to operate and combines the transmitter electronics, input power circuit, LED indicators, and the transmitting coil on the single printed-circuit board (PCB). The open design allows easy access to key points of the electrical schematic.

This EVM has the following features:

- Proprietary 10 W charging capability with TI's bq51025 receiver
- Qi-Certified WPC1.1 solution for 5-W operation
- 12-V input and fixed operating frequency
- Enhanced Foreign Object Detection (FOD) with FOD ping detecting objects prior to power transfer
- WPC 1.1 FOD and WPC 1.0 Parasitic Metal Object Detection (PMOD)
- Transmitter-coil mounting pad providing the correct receiver interface
- Compact power section design using the CSD97374 NexFET power stage
- Standard WPC A29-type transmitter coil with no magnet
- LED and audio indication of power transfer

2 bq500215EVM-648 Electrical Performance Specifications

Table 1 provides a summary of the EVM performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 1. bq500215EVM-648 Electrical Performance Specifications

Parameter		Notes and Conditions	Min	Typ	Max	Unit
Input Characteristics						
V_{IN}	Input voltage		11.50	12.0	12.5	V
I_{IN}	Input current	V_{IN} = Nom, I_{OUT} = 1.4 A at 7 V		1.0		A
	Input no-load current	V_{IN} = Nom, I_{OUT} = 0 A		90		mA
	Input stand-by current	V_{IN} = Nom		4		mA
Output Characteristics – Receiver bq51025EVM-649						
V_{OUT}	Output voltage	V_{IN} = Nom, I_{OUT} = 1.4A , V_{OUT} = 7 V	6.7	7.0	7.3	V
	Output ripple	V_{IN} = Nom, I_{OUT} = 1.0 A, V_{OUT} = 7 V			200	mV_{PP}
I_{OUT}	V_{IN} = Min to Max	V_{IN} = Min to Max, V_{OUT} = 7 V	0		1.4	A
Systems Characteristics						
F_S	Switching frequency	During power transfer		130		kHz
ηpk	Peak efficiency	V_{IN} = Nom, P Out RX = 7.0 W		81		%
η	Full-load efficiency	V_{IN} = Nom, I_{OUT} = Max		80		%

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3 Modifications

See the datasheet (SLUSBZ1) when changing components.

Use LED Mode – Resistor R9 to change the behavior of the status LED, D5, D7, and D9. The standard value is 100 kΩ for control option 7, see the datasheet for additional settings.

NTC – Connector JP3 provides the option for connecting a negative temperature coefficient (NTC) sensor for thermal protection, see the datasheet for additional settings.

FOD – R8 threshold and R49 FOD_Cal (see Section 6.2.2.7)

FOD_Ping – R47 and R48 (see Section 6.2.2.7)

PMOD – R16 threshold and disable (see Section 6.2.2.7)

4 Connector and Test Point Descriptions

4.1 *Input/Output Connections*

The connection points are described in Section 4.1.1 through Section 4.1.5.

4.1.1 J1 – V_{IN}

Input power 12 V ±500 mV, return at J2.

4.1.2 J2 – GND

Return for input power, input at J1.

4.1.3 J3 –JTAG

Factory use only.

4.1.4 J4 – Serial Interface

I^2C interface connection to communicate with the IC. Used with bqTESLA TX Tuning Tool to monitor behavior.

4.1.5 JP1 – FOD / PMOD Enable

Shorting jumper must be installed to enable FOD and PMOD functions. See the datasheet for additional details.

4.1.6 JP2 – LED Mode

External connection for LED MODE resistor, if R9 is removed. When shorted, IC will disable LED and inhibit low power mode, useful for troubleshooting

4.1.7 JP3 – NTC

The connection point for the external temperature sensor. See the datasheet for more information.

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4.2 Test Point Descriptions

The test points are described in Section 4.2.1 through Section 4.2.32.

4.2.1 TP1 – FP_RES

FOD ping circuit setting, see data sheet for more information.

4.2.2 TP2 – Drive A

Output from Power Section A of H-Bridge, U2.

4.2.3 TP3 – Coil Monitor L / C

Coil signal at junction between transmitter coil and resonant capacitors.

4.2.4 TP4 -– Low Noise Analog Ground

Low noise ground test point (TP)

4.2.5 TP5 -– Low Noise Analog Ground

Low noise ground TP

4.2.6 TP6 -– Unused IC Pin 27

Low noise ground TP

4.2.7 TP7 – Demodulation Comm + Output

Primary communications channel, input to bq500215, U1 from demodulation circuit.

4.2.8 TP8 -– I_Sense

Input current-sense voltage, scale 1 V = 1 A.

4.2.9 TP9 – RAIL+

Sample voltage from rail converter output, input to bq500215 rail control ckt .

4.2.10 TP10 – Unused IC Pin 29

Unused pin.

4.2.11 TP11 – Unused IC Pin 57

Unused pin.

4.2.12 TP12 – Low Noise Analog Ground

Low noise ground TP

4.2.13 TP13 – Unused IC Pin 56

Unused pin.

4.2.14 TP14 – FP_DECAY

FOD ping circuit setting, see data sheet for more information.

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4.2.15 TP15 – Drive B

Output from Power Section B of H-Bridge, U3.

4.2.16 TP16 – FOD_Cal

FOD calibration resistor test point, connected to pin 22 of bq500215.

4.2.17 TP17 – Low Noise Analog Ground

Low noise ground TP

4.2.18 TP18 – Rail Output Voltage

Output voltage from rail buck converter that feeds H-Bridge Power Section.

4.2.19 TP19 – PWM_RAIL

Digital input to rail converter Power Section from bq500215. Signal is PWM, used to control rail voltage.

4.2.20 TP20 – DPWM-A Signal

Digital output signal from bq500215 to H-Bridge drive for U2.

4.2.21 TP21 – DPWM-B Signal

Digital output signal from bq500215 to H-Bridge drive for U3.

4.2.22 TP22 – BUZ_DC

DC output when power transfer is started. Can be used to drive a DC style buzzer or LED. See data sheet for more information.

4.2.23 TP23 – Unused IC Pin 28

Unused pin.

4.2.24 TP24 – Unused IC Pin 6

Unused pin.

4.2.25 TP25 – Unused IC Pin 5

Unused pin.

4.2.26 TP26 – Unused IC Pin 4

Unused pin.

4.2.27 TP27 – Unused IC Pin 34

Unused pin.

4.2.28 TP28 – Unused IC Pin 35

Unused pin.

4.2.29 TP29 – Unused IC Pin 41

Unused pin.

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4.2.30 TP30 – Unused IC Pin 42

Unused pin.

4.2.31 TP31 – V33FB

Reserved, leave this pin open.

4.2.32 TP32 – Unused IC Pin 33

Unused pin.

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5 Schematic and Bill of Materials

This section includes the schematics and bill of materials for the EVM.

Figure 1 through Figure 3 illustrate the schematics for this EVM.

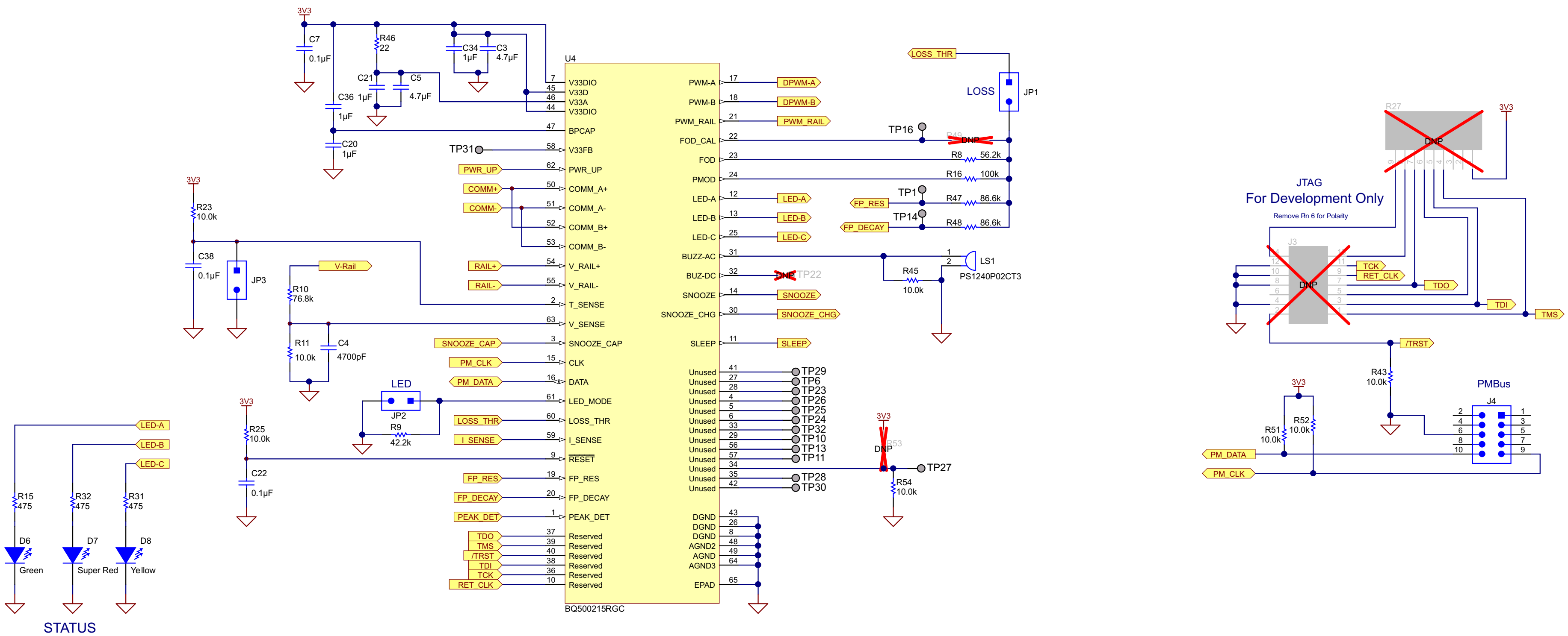

Figure 1. bq500215EVM-648 Schematic, Page 1 of 3

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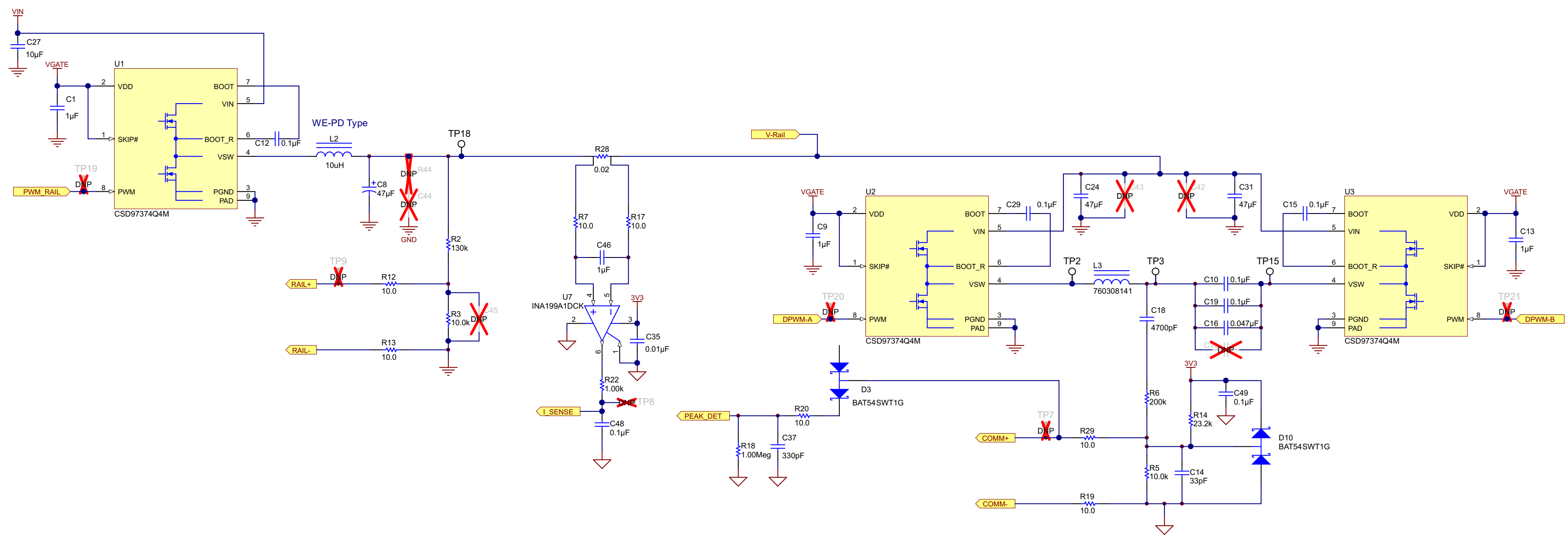

Figure 2. bq500215EVM-648 Schematic, Page 2 of 3

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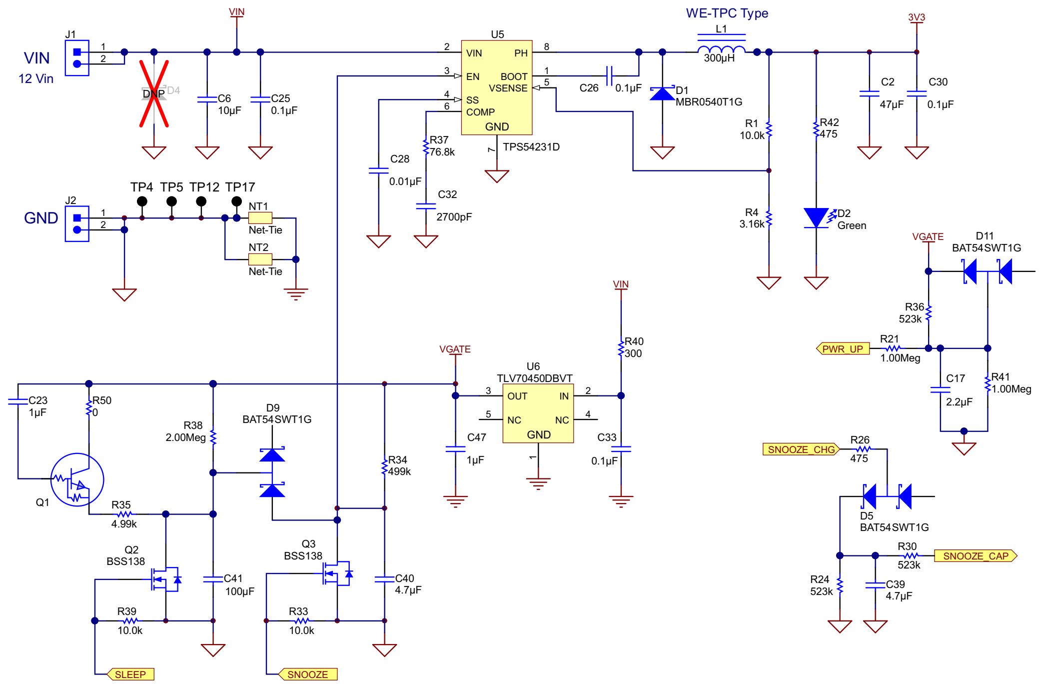

Figure 3. bq500215EVM-648 Schematic, Page 3 of 3

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Table 2 contains the BOM for this EVM.

Table 2. Bill of Materials[(1)]

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1, C9, C13, C20, C21, C34, C36, C47	8	1uF	CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603	0603	GRM188R71C105KA12D	MuRata
C2	1	47uF	CAP, CERM, 47uF, 6.3V, +/-10%, X5R, 1206	1206	GRM31CR60J476KE19L	MuRata
C3, C5, C39, C40	4	4.7uF	CAP, CERM, 4.7uF, 10V, +/-10%, X5R, 0603	0603	CGB3B1X5R1A475K055AC	TDK
C4, C18	2	4700pF	CAP, CERM, 4700pF, 50V, +/-10%, X7R, 0603	0603	GRM188R71H472KA01D	MuRata
C6, C27	2	10uF	CAP, CERM, 10uF, 35V, +/-10%, X7R, 1210	1210	GRM32ER7YA106KA12L	MuRata
C7, C12, C15, C22, C25, C26, C29, C30, C33, C38, C48, C49	12	0.1uF	CAP, CERM, 0.1uF, 50V, +/-10%, X7R, 0603	0603	GRM188R71H104KA93D	MuRata
C8	1	47uF	CAP, TA, 47uF, 16V, +/-20%, 0.6 ohm, SMD	3528	F951C476MBAAQ2	AVX
C10, C19	2	0.1uF	CAP, CERM, 0.1uF, 100V, +/-5%, C0G/NP0, 1812	1812	C1812C104J1GACTU	Kemet
C14	1	33pF	CAP, CERM, 33pF, 50V, +/-5%, C0G/NP0, 0603	0603	GRM1885C1H330JA01D	MuRata
C16	1	0.047uF	CAP, CERM, 0.047uF, 100V, +/-5%, C0G/NP0, 1812	1812	C4532C0G2A473J200KA	TDK
C17	1	2.2uF	CAP, CERM, 2.2uF, 25V, +/-10%, X5R, 1206	1206	GRM316R61E225KA12D	MuRata
C23, C46	2	1uF	CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603	0603	C1608X7R1C105K	TDK
C24, C31	2	47uF	CAP, CERM, 47uF, 25V, +/-20%, X5R, 1206	1206	C3216X5R1E476M160AC	TDK
C28, C35	2	0.01uF	CAP, CERM, 0.01uF, 50V, +/-10%, X7R, 0603	0603	GRM188R71H103KA01D	MuRata
C32	1	2700pF	CAP, CERM, 2700pF, 50V, +/-5%, C0G/NP0, 0603	0603	GRM1885C1H272JA01D	MuRata
C37	1	330pF	CAP, CERM, 330pF, 50V, +/-5%, C0G/NP0, 0603	0603	GRM1885C1H331JA01D	MuRata
C41	1	100uF	CAP, CERM, 100uF, 6.3V, +/-20%, X5R, 1206	1206	GRM31CR60J107ME39L	MuRata
D1	1	40V, 0.5A	Diode, Schottky, 40V, 0.5A, SOD-123	SOD-123	MBR0540T1G	ON Semiconductor
D2, D6	2	Green	LED, Green, SMD	LED_0603	150060VS75000	Wurth Elektronik eiSos
D3, D5, D9, D10, D11	5	30V	Diode, Schottky, 30V, 0.2A, SOT-323	SOT-323	BAT54SWT1G	Fairchild Semiconductor
D7	1	Super Red	LED, Super Red, SMD	LED_0603	150060SS75000	Wurth Elektronik eiSos
D8	1	Yellow	LED, Yellow, SMD	LED_0603	150060YS75000	Wurth Elektronik eiSos
L1	1	300uH	Inductor, Shielded, 300uH, 0.13A, 4.1 ohm, SMD	4.8x1.8x4.8mm	744042331	Wurth Elektronik eiSos
L2	1	10uH	Inductor, Shielded Drum Core, Ferrite, 10uH, 2.6A, 0.0515 ohm, SMD	10x3x10mm	7447713100	Wurth Elektronik eiSos
L3	1	10uH	Inductor, Wirewound, 10uH, 9A, 0.028 ohm, TH	54.4x6.5x54.4mm	760308141	Wurth Elektronik eiSos
LS1	1		Buzzer, Piezo, 4kHz, 12.2mm, TH	12.2x4.0mm	PS1240P02CT3	TDK
Q1	1	DTC114YUA	Transistor, Digital NPN, 50 V, 100 mA	SC-70	DTC114YUAT-106	Rohm
Q2, Q3	2	50V	MOSFET, N-CH, 50V, 0.22A, SOT-23	SOT-23	BSS138	Fairchild Semiconductor
R1, R3, R5, R11, R23, R25, R33, R39, R43, R45, R51, R52	12	10.0k	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R2	1	130k	RES, 130k ohm, 1%, 0.1W, 0603	0603	CRCW0603130KFKEA	Vishay-Dale
R4	1	3.16k	RES, 3.16k ohm, 1%, 0.1W, 0603	0603	CRCW06033K16FKEA	Vishay-Dale
R6	1	200k	RES, 200k ohm, 1%, 0.1W, 0603	0603	CRCW0603200KFKEA	Vishay-Dale
R35	1	4.99k	RES, 4.99k ohm, 1%, 0.1W, 0603	0603	CRCW06034K99FKEA	Vishay-Dale
R8	1	56.2k	RES, 56.2 k, 1%, 0.1 W, 0603	0603	CRCW060356K2FKEA	Vishay-Dale

(1) Unless otherwise noted in the Alternate PartNumber and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.

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Table 2. Bill of Materials[1] (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R9, R16	2	100k	RES, 100k ohm, 1%, 0.1W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R10, R37	2	76.8k	RES, 76.8k ohm, 1%, 0.1W, 0603	0603	CRCW060376K8FKEA	Vishay-Dale
R7, R17, R12, R13, R19, R20, R29	7	10.0	RES, 10.0 ohm, 1%, 0.1W, 0603	0603	CRCW060310R0FKEA	Vishay-Dale
R14	1	23.2k	RES, 23.2k ohm, 1%, 0.1W, 0603	0603	CRCW060323K2FKEA	Vishay-Dale
R15, R26, R31, R32, R42	5	475	RES, 475 ohm, 1%, 0.1W, 0603	0603	CRCW0603475RFKEA	Vishay-Dale
R18, R21, R41	3	1.00Meg	RES, 1.00Meg ohm, 1%, 0.1W, 0603	0603	CRCW06031M00FKEA	Vishay-Dale
R22	1	1.00k	RES, 1.00k ohm, 1%, 0.1W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale
R24, R30, R36	3	523k	RES, 523k ohm, 1%, 0.1W, 0603	0603	CRCW0603523KFKEA	Vishay-Dale
R28	1	0.02	RES, 0.02 ohm, 0.5%, 0.5W, 1206	1206	LVK12R020DER	Ohmite
R34	1	499k	RES, 499k ohm, 1%, 0.1W, 0603	0603	CRCW06034993KFKEA	Vishay-Dale
R38	1	2.00Meg	RES, 2.00Meg ohm, 1%, 0.1W, 0603	0603	CRCW06032M00FKEA	Vishay-Dale
R40	1	300	RES, 300 ohm, 5%, 0.1W, 0603	0603	CRCW0603300RJNEA	Vishay-Dale
R46	1	22	RES, 22 ohm, 0.5%, 0.1W, 0805	0805	RR1220Q-220-D	Susumu Co Ltd
R47, R48	2	86.6k	RES, 86.6 k, 1%, 0.1 W, 0603	0603	CRCW060386K6FKEA	Vishay-Dale
R49	0	Open	Open	0603	Open	
R50	1	0	RES, 0 ohm, 5%, 0.1W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R53	0	Open	Res, 10.0k ohm, 1%, 0.1W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R54	1	10.0k	Res, 10.0k ohm, 1%, 0.1W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
U1, U2, U3	3		Synchronous Buck NexFET Power Stage, DPC0008A	DPC0008A	CSD97374Q4M	Texas Instruments
U4	1		10-W WPC v1.1 Compliant Wireless Power Controller, RGC0064B	RGC0064B	BQ500215RGC	Texas Instruments
U5	1		Buck Step Down Regulator with 3.5 to 28 V Input and 0.8 to 25 V Output, -40 to 150 degC, 8-Pin SOIC (D), Green (RoHS & no Sb/Br)	D0008A	TPS54231D	Texas Instruments
U6	1		Single Output LDO, 150 mA, Fixed 5 V Output, 2.5 to 24 V Input, with Ultra-Low IQ, 5-pin SOT-23 (DBV), -40 to 125 degC, Green (RoHS & no Sb/Br)	DBV0005A	TLV70450DBVT	Texas Instruments
U7	1		Voltage Output, High or Low Side Measurement, Bi-Directional Zerø-Drift Series Current-Shunt Monitor, DCK0006A	DCK0006A	INA199A1DCK	Texas Instruments
C11	0	0.047uF	CAP, CERM, 0.047uF, 100V, +/-5%, C0G/NP0, 1812	1812	C4532C0G2A473J200KA	TDK
C42, C43, C44	0	47uF	CAP, CERM, 47uF, 25V, +/-20%, X5R, 1206	1206	C3216X5R1E476M160AC	TDK
C45	0	0.01uF	CAP, CERM, 0.01uF, 50V, +/-10%, X7R, 0603	0603	GRM188R71H103KA01D	MuRata
D4	0	NoPop	Diode, Schottky, 40V, 0.5A, SOD-123	SOD-123	MBR0540T1G	ON Semiconductor
R27	0	10k	RES, 10k ohm, 2%, 0.2W, TH	9x1 ResNetwork	4309R-101-103LF	Bourns
R44	0	0.51	RES, 0.51 ohm, 1%, 0.25W, 0805	0805	CRM0805-FX-R510ELF	Bourns

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6 Test Setup

6.1 Equipment

6.1.1 bqTESLA™ Receiver

Use the bq51025EVM-649, 10-W EVM. If a low power Qi-compliant receiver such as bq51020EVM-520 or bq51013BEVM-764 is used, then the maximum output power will be 5 W. Note that the following test set-up only discusses the bq51025EVM-649 configuration.

6.1.2 Voltage Source

The input voltage source must provide a regulated DC voltage of 12 V and deliver at least 2.0-A continuous load current; current limit must be set to 3 A.

CAUTION

To help assure safety integrity of the system and minimize risk of electrical shock hazard, always use a power supply providing suitable isolation and supplemental insulation (double insulated). Compliance to IEC 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, Part 1, General Requirements, or its equivalent is strongly suggested, including any required regional regulatory compliance certification approvals. Always select a power source that is suitably rated for use with this EVM as referenced in this user manual.

External Power Supply Requirements:

Nom Voltage:12.0 VDC

Max Current: 3.0 A

Efficiency Level V

External Power Supply Regulatory Compliance Certifications: Recommend selection and use of an external power supply which meets TI's required minimum electrical ratings in addition to complying with applicable regional product regulatory/safety certification requirements such as (by example) UL, CSA, VDE, CCC, PSE, and so forth.

6.1.3 Meters

Monitor the output voltage at the bq51025EVM-649 test point TP7 with a voltmeter. Monitor the input current into the load with an appropriate ammeter. You can also monitor the transmitter input current and voltage, but the meter must use the averaging function for reducing error, due to communications packets.

6.1.4 Loads

A single load is required at 7 V with a maximum current of 1.4 A. The load can be resistive or electronic.

6.1.5 Oscilloscope

Use a dual-channel oscilloscope with appropriate probes to observe the RECT signal at bq51025EVM-649 TP3 and other signals.

6.1.6 Recommended Wire Gauge

For proper operation, use 22-AWG wire when connecting the EVM to the input supply and the bq51025EVM-649 to the load.

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6.2 Equipment Setup

- With the power supply OFF, connect the supply to the bqTESLA transmitter.
- Connect the V_{IN} positive power source to J1, and connect the negative terminal of the V_{IN} source to J2.
- Do not place the bqTESLA receiver on the transmitter. Connect a load to J3 with a return to J4, monitor current through the load with the ammeter, and monitor the voltage to the load at J3. All voltmeters must be Kelvin connected (at the pin) to the point of interest.

6.2.1 Equipment Setup Diagram

The diagram in Figure 4 shows the test setup.

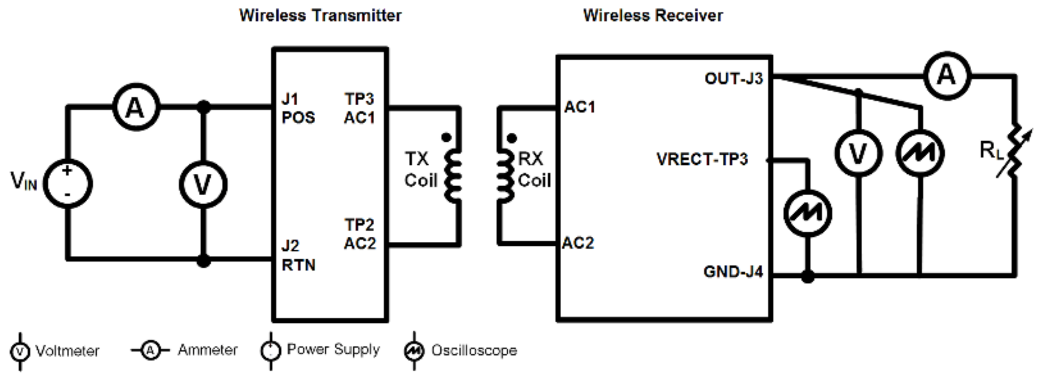

Figure 4. Equipment Setup

6.2.2 EVM Procedures

This section provides guidance for a few general test procedures to exercise the functionality of the presented hardware. Some key notes follow:

6.2.2.1 Start-Up No Receiver

Turn on V_{IN}, and observe that the green power LED, D2, will flash. Status LEDs D6, D7, and D8 are OFF until the power transfer starts.

Apply the scope probe to the test point, TP15, and observe single-pulse bursts approximately every 500 ms. This is a digital ping to begin communications with a receiver placed on the TX coil.

6.2.2.2 Apply Receivers

Place the bq51025EVM-649 EVM on the top of the transmitting coil. Align the centers of the receiving and transmitting coils across each other. In the next few seconds, observe that the status LED, D5, flashes green, indicating that communication between the transmitter and the receiver is established and that power transfer has started.

- The status LED, D6, flashes a green light during power transfer.
- Typical output voltage is 7 V, and the output current range is 0 mA to 1.4 A.
- Observe a continuous sine-wave on the test point TP15 when power transfer is active; the frequency is 130 kHz.
- Make tests and measurements applicable to a normal 7-V power supply.

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6.2.2.3 Efficiency

Measure the system efficiency by measuring the output voltage, output current, input voltage, and input current and calculate efficiency as the ratio of the output power to the input power. Connect voltage meters at the input and output of TX and RX (see Figure 4). Average the input current; the comm pulses modulate the input current, distorting the reading. Figure 5 shows efficiency.

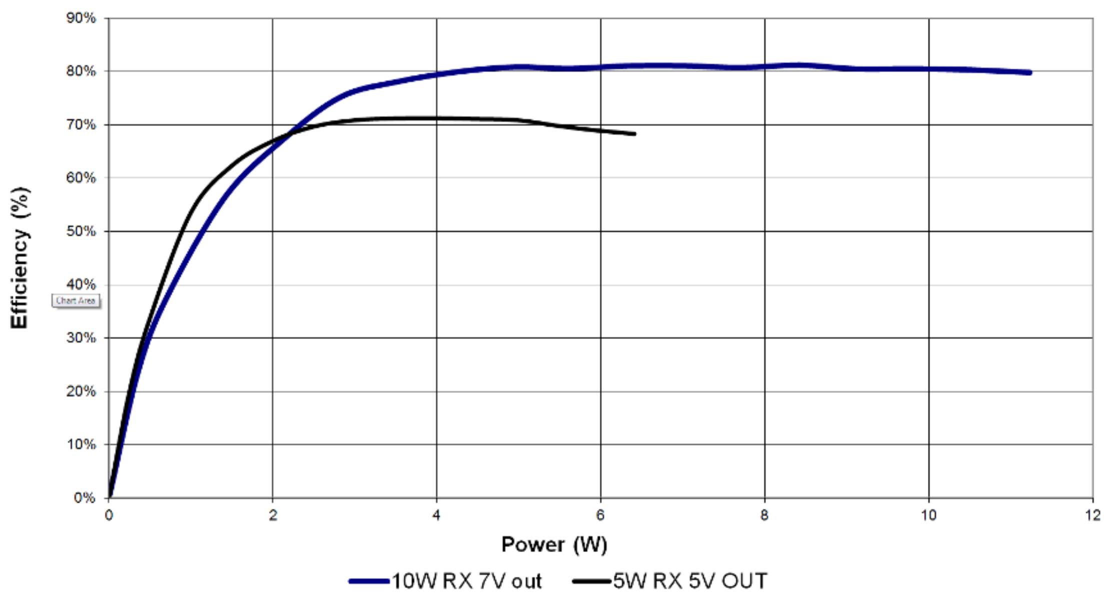

Figure 5. Efficiency versus Power, bq500215EVM-648 Transmitter and bq51025EVM-649 Receiver

6.2.2.4 LED Behavior

D2 – Green power on LED driven by 3.3-V DC-to-DC converter. During STANDBY (no RX) flash at half second rate. During power transfer ON, also ON during fault condition.

D6 – Green status driven by bq500215 (LED-A). Blink during power transfer, slow blink for 5 W (Qi) about once a second and fast blink for 10 W (bq50025 RX) about twice a second.

D7 – Red status driven by bq500215 (LED-B). When the receiver sends *Charge Complete (EPT01)* LED is ON for about 5 seconds then off.

D8 – Yellow status driven by bq500215 (LED-C). On during fault condition and blinks during FOD warning.

NOTE: Status LED behavior is controlled by LED mode resistor R9, 100 kΩ for mode 7. See the data sheet for additional options and configurations of LED D6, D7, and D8.

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6.2.2.5 Start Up Receiver Placed on Transmitter

The Transmitter will send a digital ping about every 500 ms. If a receiver is present it will power up and reply then begin power transfer. Below is a scope capture of the bq500215 EVM beginning a power transfer with bq51025 EVM.

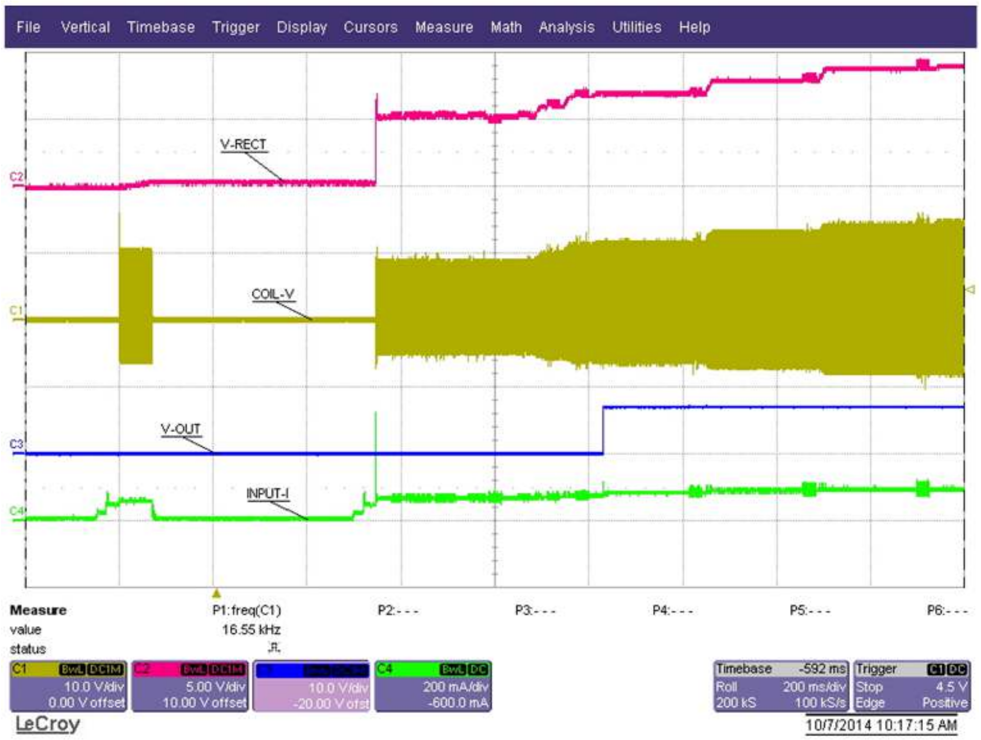

Figure 6. Start Up

6.2.2.6 Thermal Protection, NTC

Thermal protection is provided by an NTC resistor connected to JP3. At 1 V on the sense side (U1-2), the thermal fault is set, and the unit is shut down, The status LED, D8, illuminates orange. The typical resistor value for fault is 850 Ω. The system tries to restart in 5 minutes.

6.2.2.7 Foreign Object Detection (FOD) / Parasitic Metal Object Detection (PMOD)

The bq500215 EVM supports multiple levels of protection against eating metal objects placed in the magnetic field during power transfer. PMOD is used for older WPC 1.0 version receivers and FOD is used for WPC 1.1 or greater.

The first level is a short FOD ping that detects most objects before any power transfer is initiated, analysis of the impulse response is used. Resistors R47 and R48 are used to tune this function, see data sheet for additional information.

The second level is power loss accounting, a comparison between power transmitted to the receiver (RX) with the power the RX reported receiving, difference is loss power possibly going into a foreign object. The transmitter determines the power sent to the RX by measuring input power and calculating internal losses. The RX measures the power it received and also calculates losses. The RX sends this information to the driver (TX) in a digital word, message packet. Unaccounted for power loss is presumed to be a foreign object on the charging pad. Should this lost power exceed the threshold set by R8, a FOD fault is set and power transfer is stopped.

Three key measurements for the TX FOD calculation:

- **Input Power** – Product of input voltage and current. Input voltage is measured at Pin 63 though R10 and R11. Input current is measured using sense resistor R28 and current sense amp U7. Both

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measurements must be very accurate.

- **Power Loss in Transmitter** – This is an internal calculation based on the operating point of the transmitter. The calculation is adjusted using FOD_Cal resistor, R99. This calculation changes with external component changes in the power path such as MOSFETs, resonate capacitors, and TX coil. Recalculation of R49 and R8 is required.
- **Receiver Reported Power** – The receiver calculates and reports power it receives in the message packet *Received Power Packet*.

The FOD threshold on the EVM is set to 400 mW, R8 is set to 56.2 kΩ. Increasing R8 increases the threshold and reduces the sensitivity to foreign objects.

This loss threshold is determined after making a measurement of transmitter performance using a FOD calibration receiver similar to a unit manufactured by Avid® Technology. Contact Texas Instruments for the FOD calibration procedure for bq500215.

The PMOD threshold on the EVM is set to 600 mW, R16 is 100 kΩ. Removing R16 disables this function.

6.2.2.8 Thermal Performance

This section shows a thermal image of the bq500215EVM-648. A 1400-mA load is used at the receiver output, bq51025EVM-649. Output power is approximately 10 W, 1.4 A at 7 V.

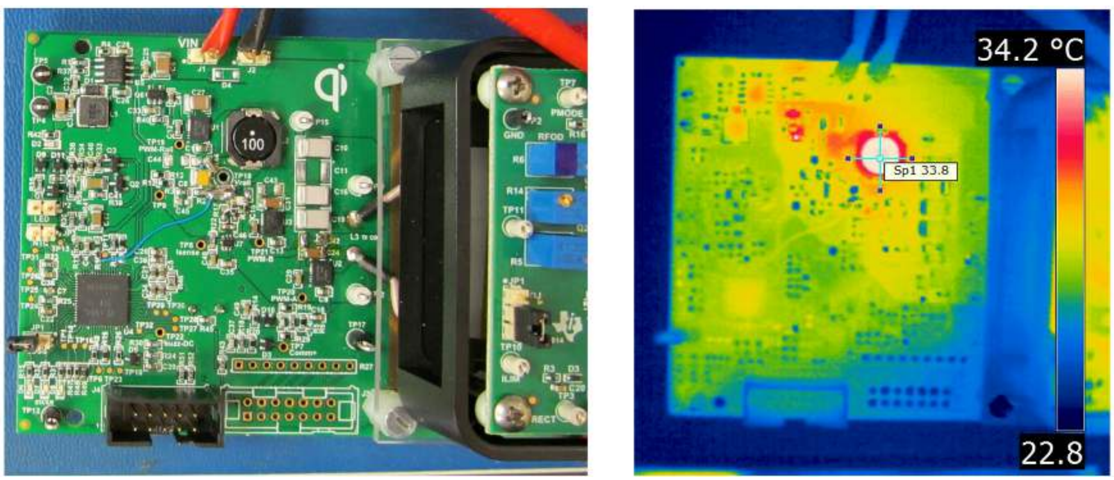

Figure 7. Thermal Performance

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7 bq500215EVM-648 Assembly Drawings and Layout

Figure 8 through Figure 13 show the design of the bq500215EVM PCB. The EVM has been designed using a 4-layer, 2-oz, copper-clad circuit board, 13.2 cm × 7.24 cm with all components in a 4.0-cm x 5.0-cm active area on the top side and all active traces to the top and bottom layers to allow the user to easily view, probe, and evaluate the bq500215 control IC in a practical application. Moving components to both sides of the PCB or using additional internal layers offers additional size reduction for space-constrained systems. Gerber files are available for download from the EVM product folder (bq500215EVM-648).

A 4-layer PCB design is recommended to provide a good low-noise ground plane for all circuits. A 2-layer PCB presents a high risk of poor performance. Grounding between the bq500215 GND pin 47, 36, and 32 and filter capacitor returns C19, C1, C5, and C3 should be a good low-impedance path.

Coil Grounding – A ground plane area under the coil is recommended to reduce noise coupling into the receiver. The ground plane for the EVM is slightly larger than the coil footprint and grounded at one point back to the circuit area.

Note: The clear plastic cover thickness (0.93 in or 2.4 mm) is the z-gap thickness for the transmitter.

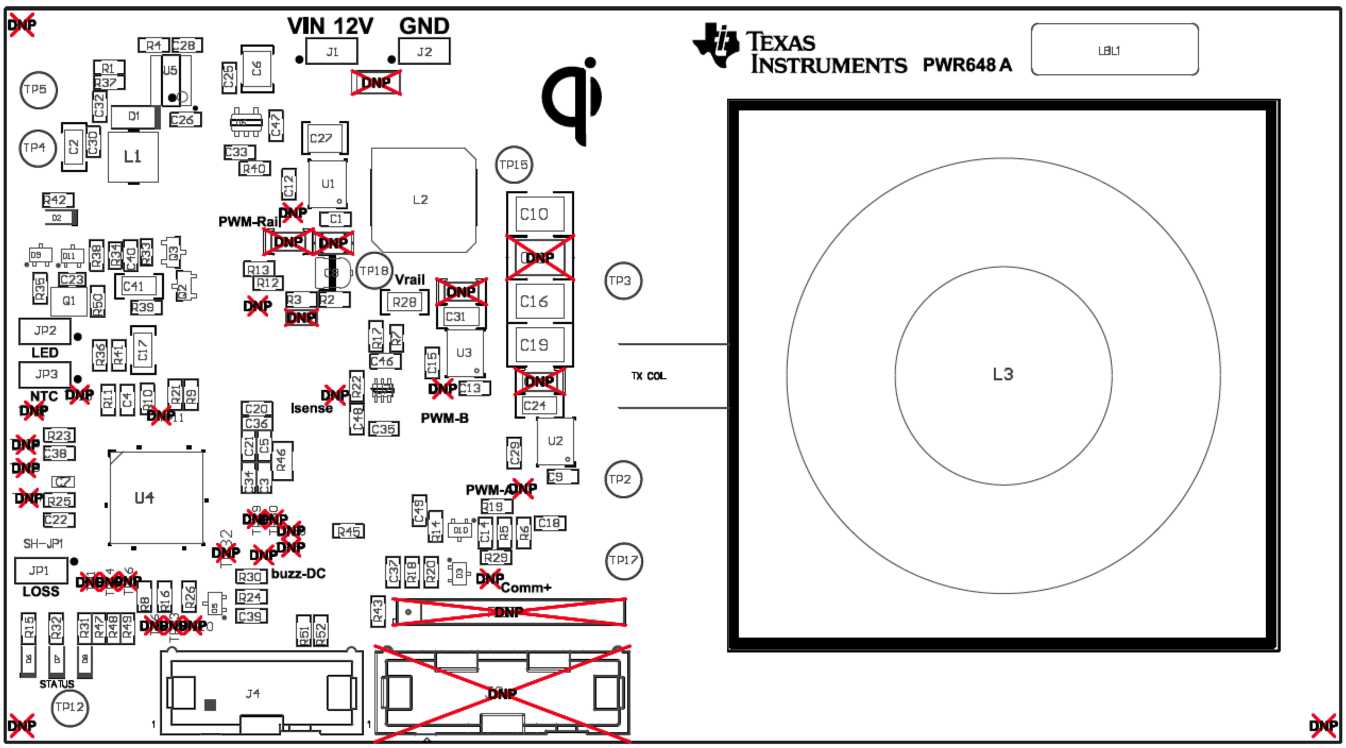

Figure 8. Assembly Top

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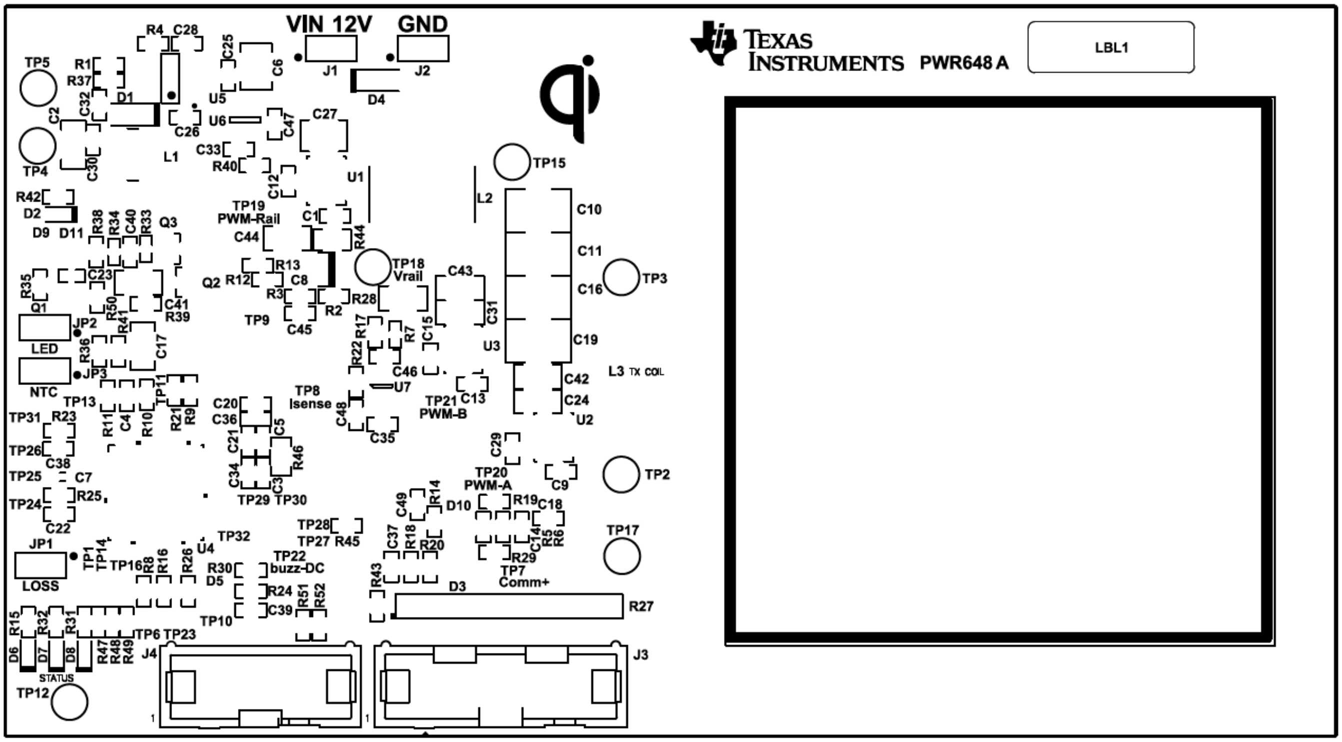

Figure 9. Top Silk

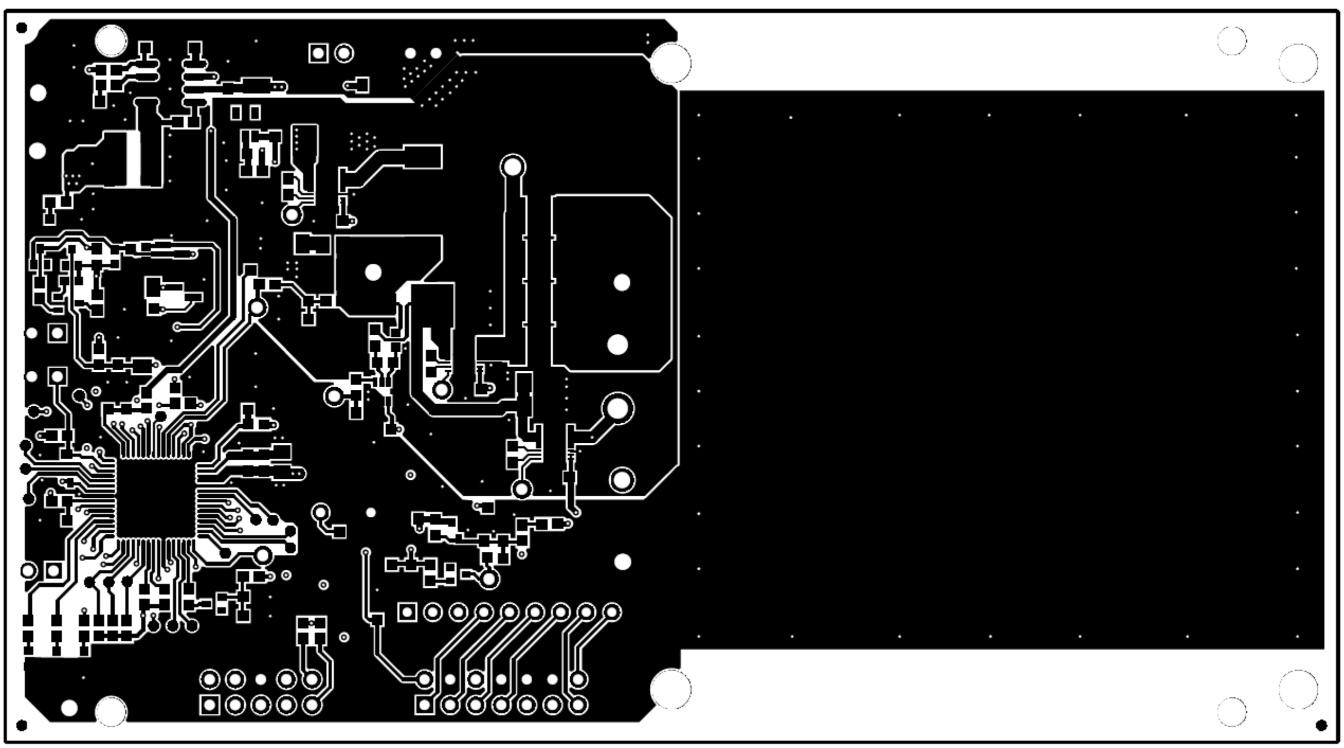

Figure 10. Top Layer

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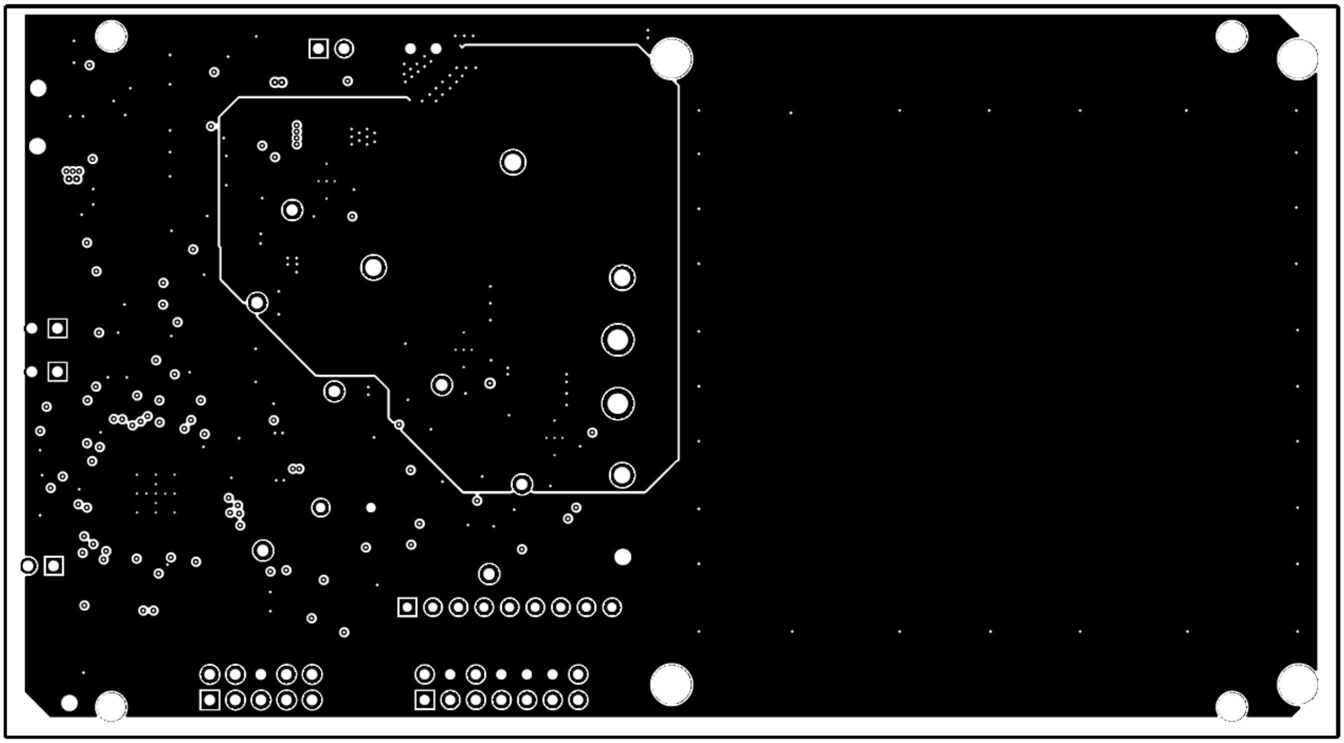

Figure 11. Inner Layer 1

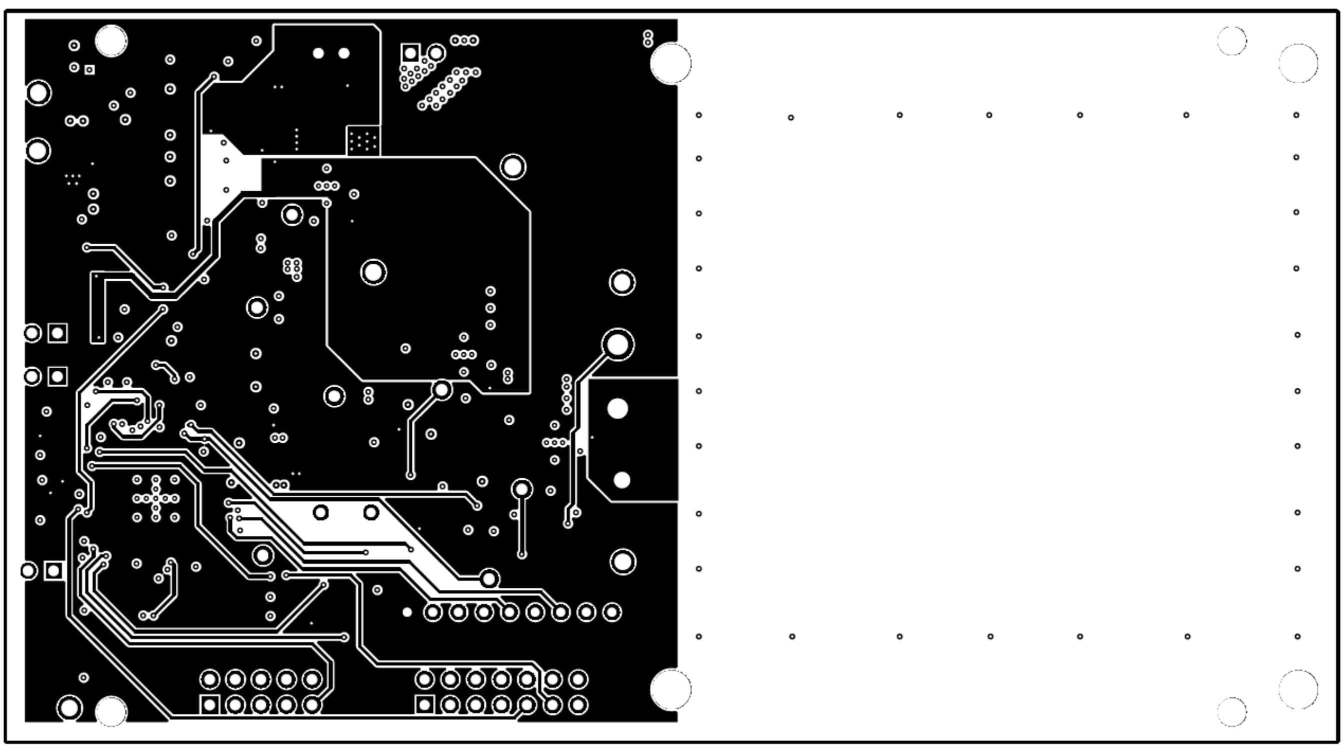

Figure 12. Inner Layer 2

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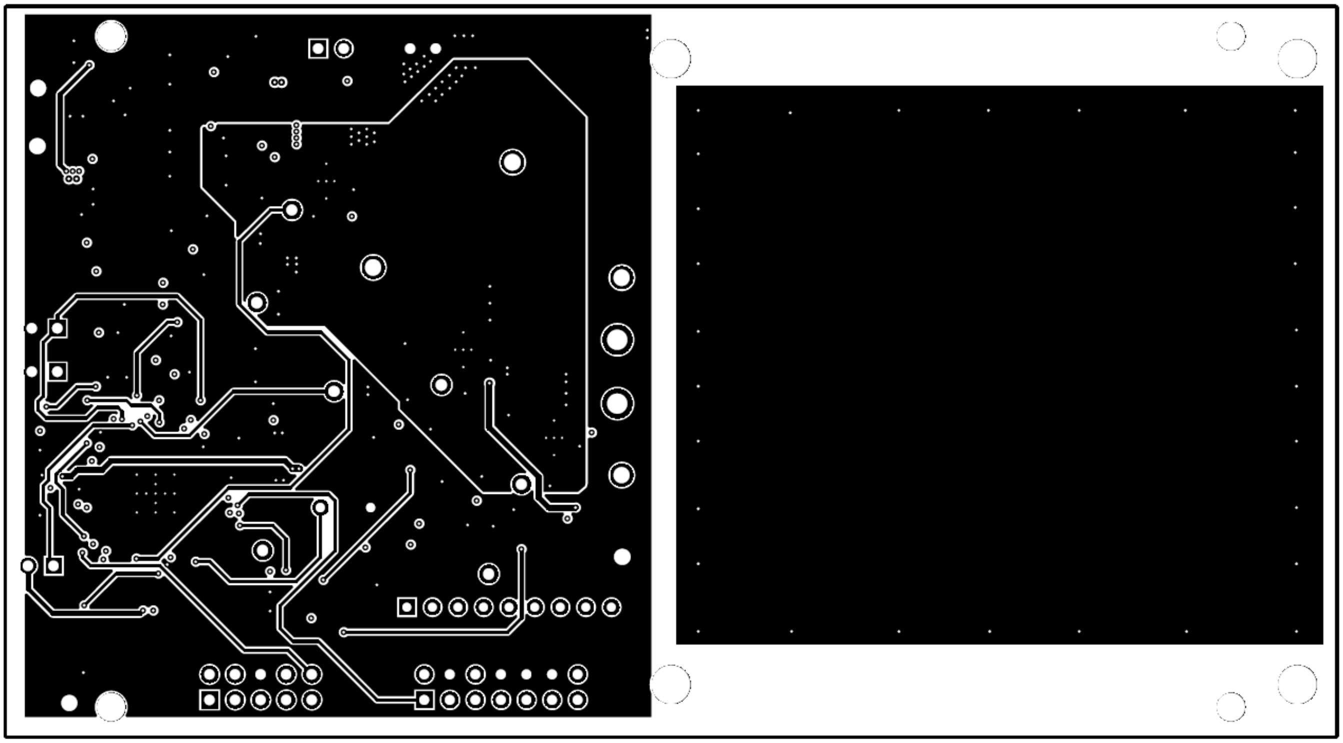

Figure 13. Bottom Layer

8 Reference

For additional information about the bq500215EVM-648 low-power, wireless, power evaluation kit from Texas Instruments, visit the product folder on the TI Web site at http://www.ti.com/product/bq500215

Revision History

Changes from Original (October 2014) to A Revision	Page
• Changed schematics and bill of materials in the *Schematic and Bill of Materials* section.	7

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
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