TI Design: TIDA-00881
50mA Wireless Charger with 19mm Coil BoosterPack Reference Design

TEXAS INSTRUMENTS

TI Designs

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Design Resources

TIDA-00881	Design Folder
bq51003	Product Folder
bq25100	Product Folder
bq29707	Product Folder
TPS62736	Product Folder

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Design Features

- Wireless Charger BoosterPack designed for any low power Launchpad
- Coin Cell storage to 50mA
- Qi Compatible - Recharge the battery from any Qi transmitter
- 3.3Vdc buck to power the Launchpad
- 5V boost to power support circuitry
- Stackable design allows for creating a complete solution
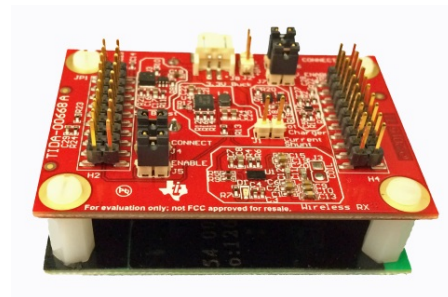- Standard off the shelf receiver coil

Featured Applications

- Factory Automation and Process Control
- Sensors and Field Transmitters
- Building Automation
- Portable Instruments
- IoT (Internet of Things)
- Wearables
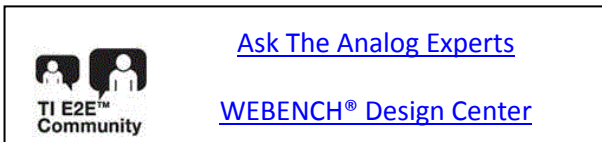
Block Diagram
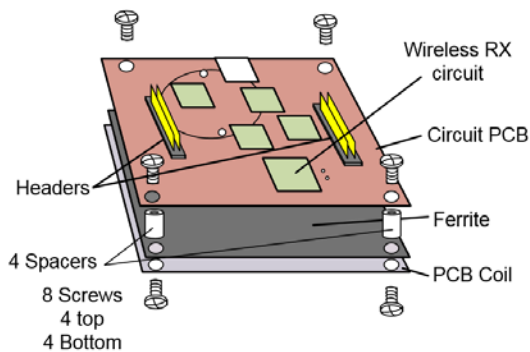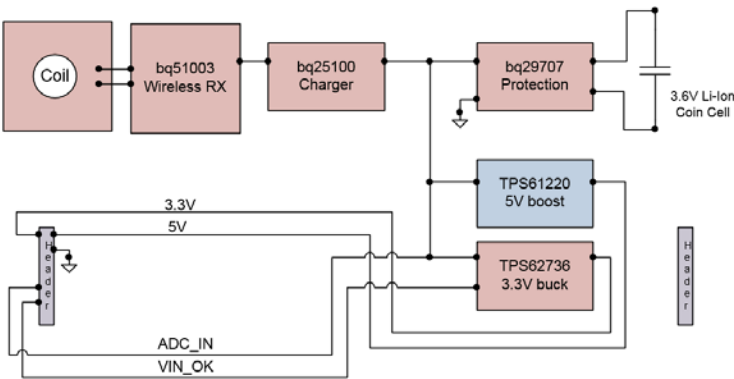
Board Images

1 Key System Specifications

Wireless Receiver

Value	Suffix	Test	Setup
5.004	Vdc	Output voltage of the RX	Measure Pin 1 of J1 to ground
60	mA	Max load current from the wireless RX	Place a an electronic load on J1 and measure max current
27.5	C	Wireless RX circuit thermal rise at max charge from ambient temperature 22.8C	Measure the ambient temperature under no load then load to max charge current for 15 minutes

Charger

4.120	Vdc	Measured BT1 voltage	Insert the LR2032 coin cell and place a current meter across J1, Remove J5 and J7
27.2	mA	Charge current while charging from RX	Measure current through J1
26	mA	Max charge current into BT1	Measure current into BT1
34	uA	Idle current from charger into fully charged BT1	Place on TX and charge till full, monitor the current through J1
2.360	mA	Charger term current high	Measure the current when the charger goes into terminate
4.200	Vdc	Charger term voltage high	Measure the voltage when the charger goes into terminate
4.200	mA	Pre-charge current	Discharge to 2V then turn on the charger and measure the current going into BT1
2.000	Vdc	Pre-charge threshold	Connect sourcemeter and power supply at 5V to charger in. Adjust sourcemeter from 3V down to 1.5V determine pre-charge threshold

3.3V Regulator

3.329	Vdc	Measured 3.3V out	Replace J7 and measure the output voltage of U4
3.327	Vdc	3.3V with BT1 at max voltage	Remove the coin cell, connect a power supply to BT1, adjust from low to high
60	mA	Abs max current on 3.3V regulator	Connect source meter to 3.3V
3.302	Vdc	3.3V with 50mA current with BT1 at max	Connect a source meter and increase the load
3.36	Vdc	3.3V with BT1 at min voltage	Remove the coin cell, connect a power supply to BT1, adjust from high to low
3.2	Vdc	3.3V with a 50mA current with BT1 at min	Connect a source meter (Set to drop out voltage) and increase the load
3.49	Vdc	VIN_OK on threshold	Remove coin cell, connect a source meter to BT1. Sweep low to high
3.47	Vdc	VIN_OK off threshold	Remove coin cell, connect a source meter to BT1. Sweep high to low

0	Vdc	3.3V disable	Remove J7 measure output of 3.3V regulator
23.6	C	3.3V circuit thermal rise at 50mA (22.8C ambient)	Measure the ambient temperature under no load then load to max current for 15 minutes with BT1 at min

5V Regulator

5.031	Vdc	Measured 5V out	Replace J5 and measure the output voltage of U3
5.0249	Vdc	5V with BT1 at max voltage	Remove the coin cell, connect a power supply to BT1, adjust from low to high
5.021	Vdc	5V with BT1 at min voltage	Remove the coin cell, connect a power supply to BT1, adjust from high to low
5.072	Vdc	5V with 50mA current with BT1 at min voltage	Connect a source meter and increase the load
5.051	Vdc	5V with 50mA current with BT1 at max voltage	Connect a source meter and increase the load
75	mA	Abs max current on 5V regulator	Connect source meter to 5V
3.57	Vdc	5V disable (Input voltage minus forward diode drop when off)	Remove J5 measure output of 5V regulator
23.4	C	5V circuit thermal rise at 50mA (22.8C ambient)	measure the ambient temperature under no load then load to max current for 15 minutes with BT1 at min

Protector

4.29	Vdc	Protection voltage max	Remove coin cell, connect a source meter to BT1. Sweep low to high
2.79	Vdc	Protection voltage min	Remove coin cell, connect a source meter to BT1. Sweep high to low
101	mA	Protection current	Remove coin cell, connect a power supply to BT1, connect source meter to 5V and increase the load thru the protection circuit to test max current

System

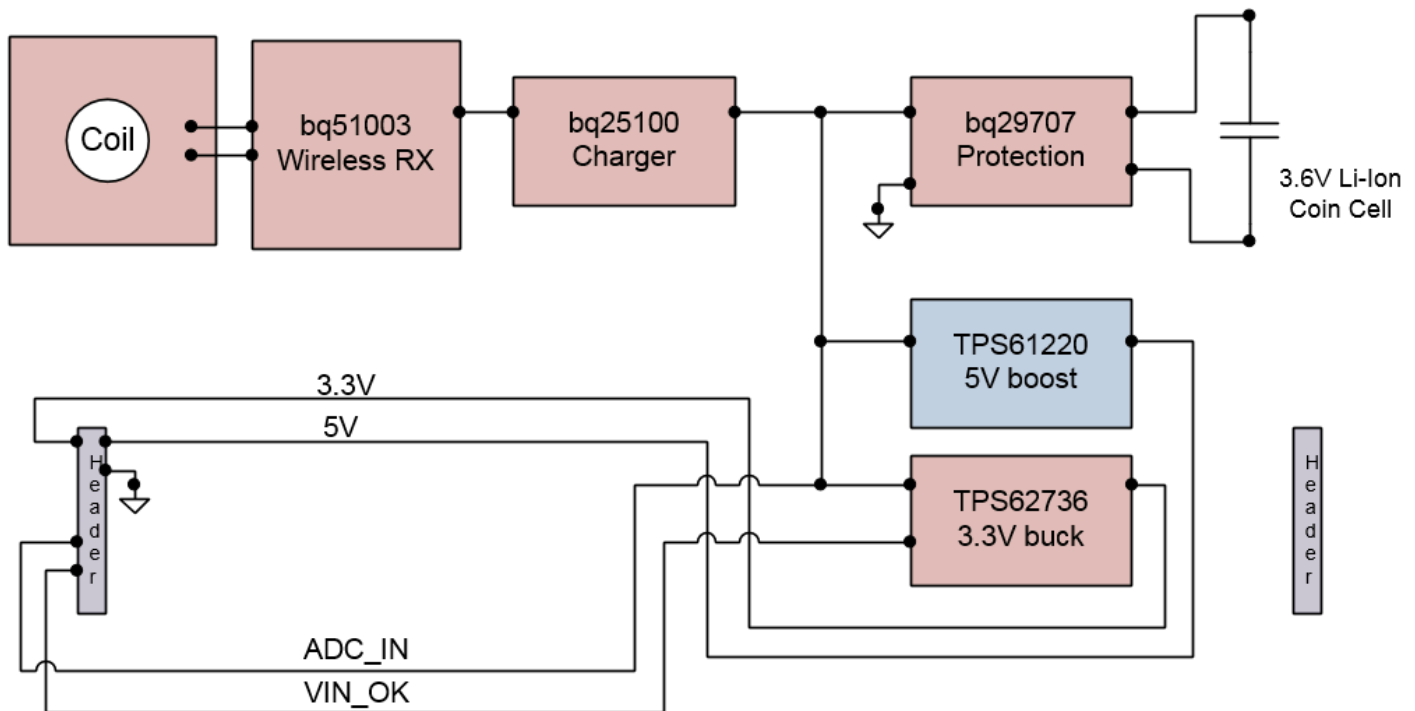|			
2.0058	mV	Measure ADC_IN	ADC_IN voltage ~1/2 of BT1 (loaded network from 1Meg multi-meter impedance)
31	uA	quiescent current of total circuit no load	measure the current from the battery to support all of the circuits

2   System Description

This is a 50mA Wireless Charger Booster Pack and is designed to be a complete low power battery management and power supply solution for use with Launchpad's and other development boards. This booster pack design was created with a Qi compatible wireless receiver circuit and an off the shelf 19mm receiver coil. This design is based on the TIDA-00668 and uses the TID-00668 PCB and the TIDA-00668-C02 alternate coil PCB.

By placing the booster pack on any Qi Wireless compatible transmitter you will have the ability to recharge the coin cell at any time even while connected to the Launchpad and in operation. Use this booster pack with your favorite TI Launchpad development board to power your design from a small rechargeable Lithium Ion coin cell battery.

The buck converter will provide 3.3Vdc for the Launchpad power and an additional switching boost converter will supply 5V to run accessories. The total max current is 50mA from the battery. Make sure the combined 3.3V and 5V currents do not exceed the maximum current capabilities of the coin cell.

The battery is protected by the bq29707 protection IC. The battery is disconnected if the battery voltage goes over 4.28V or under 2.8V or if the peak current goes over 100mA.

2.1 bq51003

The bq51003 is an advanced, integrated, receiver IC for wireless power transfer in portable applications. The device provides the AC/DC power conversion while integrating the digital control required to comply with the Qi v1.1 communication protocol. Together with the bq500210 transmitter controller, the bq51003 enables a complete contact-less power transfer system for a wireless power supply solution. By using near-field inductive power transfer, the receiver coil embedded in the portable device receives the power transmitted by the transmitter coil via mutually coupled inductors. The AC signal from the receiver coil is then rectified and regulated to be used as a power supply for down-system electronics. Global feedback is established from the secondary to the transmitter in order to stabilize the power transfer process via back-scatter modulation. This feedback is established by using the Qi v1.1 communication protocol supporting up to 2.5-W applications.

The device integrates a low-impedance full synchronous rectifier, low-dropout regulator, digital control, and accurate voltage and current loops.

Wireless Receiver Simplified Block Diagram

2.2 bq25100

The bq2510x series of devices are highly integrated Li-Ion and Li-Pol linear chargers targeted at space-limited portable applications. The high input voltage range with input overvoltage protection supports low–cost unregulated adapters.

The bq2510x has a single power output that charges the battery. A system load can be placed in parallel with the battery as long as the average system load does not keep the battery from charging fully during the 10 hour safety timer.

The battery is charged in three phases: conditioning, constant current and constant voltage. In all charge phases, an internal control loop monitors the IC junction temperature and reduces the charge current if an internal temperature threshold is exceeded.

The charger power stage and charge current sense functions are fully integrated. The charger function has high accuracy current and voltage regulation loops and charge termination. The pre-charge current and termination current threshold are programmed via an external resistor on the bq2510x. The fast charge current value is also programmable via an external resistor.

Charger Simplified Block Diagram
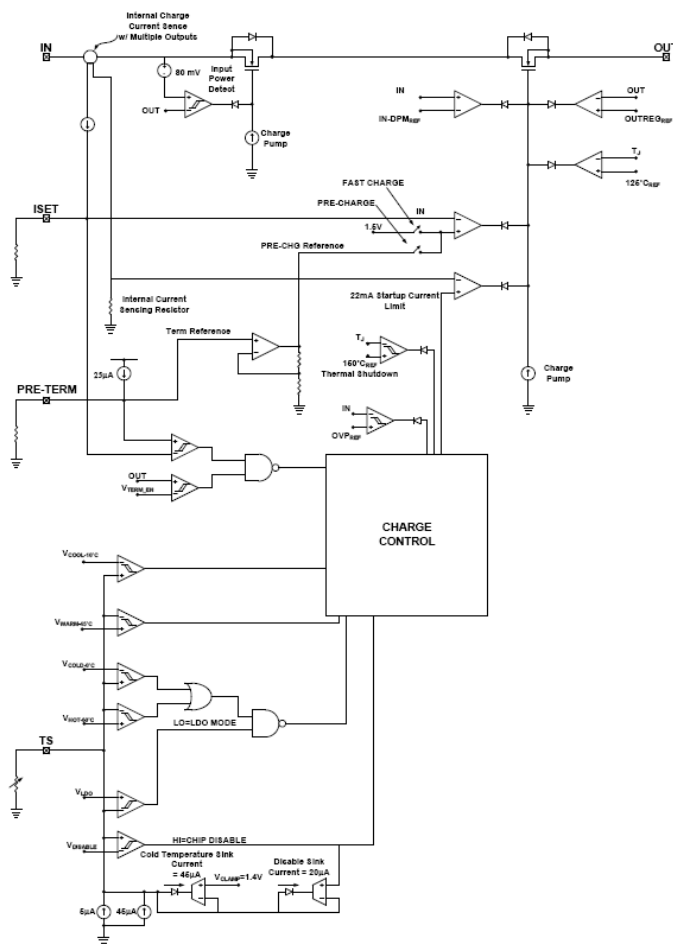
2.3 bq29707

The bq297xy battery cell protection device provides an accurate monitor and trigger threshold for overcurrent protection during high discharge/charge current operation or battery overcharge conditions.

The bq297xy device provides the protection functions for Li-Ion/Li-Polymer cells, and monitors across the external power FETs for protection due to high charge or discharge currents. In addition, there is overcharge and depleted battery monitoring and protection. These features are implemented with low current consumption in NORMAL mode operation.

Protector Simplified Block Diagram
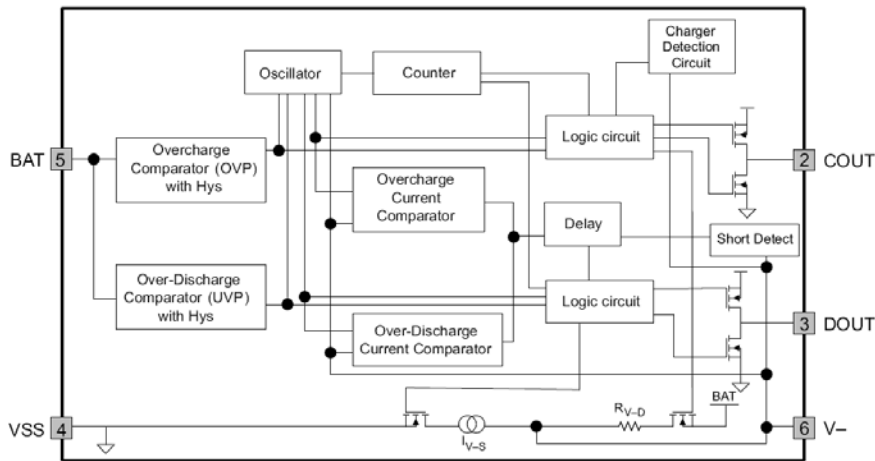
2.4 TPS62736

The TPS6273x family provides a highly integrated ultra-low power buck converter solution that is well suited for meeting the special needs of ultra-low power applications such as energy harvesting. The TPS6273x provides the system with an externally programmable regulated supply to preserve the overall efficiency of the power-management stage compared to a linear step-down converter. This regulator is intended to step-down the voltage from an energy storage element such as a battery or super capacitor to supply the rail to low-voltage electronics. The regulated output has been optimized to provide high efficiency across low-output currents (<10 µA) to high currents (200 mA).

The TPS6273x integrates an optimized hysteretic controller for low-power applications. The internal circuitry uses a time-based sampling system to reduce the average quiescent current.

3.3V Buck Simplified Block Diagram
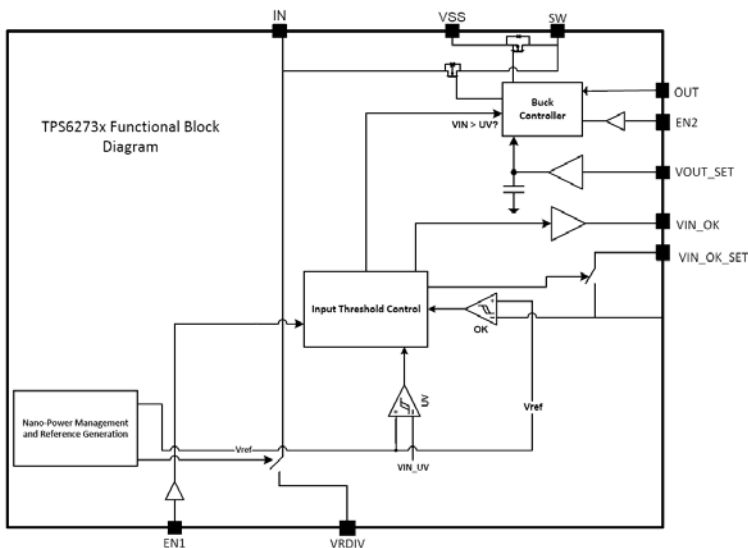
Getting Started

The 50mA Wireless Charger Booster Pack can be a great addition to your design development. Having a good understanding of some of the key features is very important. Before you start, take the time to understand these important concepts.

2.5 Coin Cell

The coin cell in this design is a Maxell LIR2032 rechargeable Lithium-Ion Battery. **(NOTE: The CR2032 Lithium coin cell is not rechargeable! DO NOT USE THE CR2032 OR ANY OTHER COIN CELL BATTERY IN THIS DEVICE)**. The maximum charge current for the LIR2032 is 30mA. The maximum constant current load is 50mA and the maximum peak current is 60mA. These specifications come from the battery manufacture. You should become familiar with this battery and it's limitations before using it in a design.

2.6 Wireless Receiver

A wireless system consists of a charging pad (transmitter or primary) and the secondary-side equipment (receiver or secondary). There is a coil in the charging pad and in the secondary equipment which are magnetically coupled to each other when the secondary is placed on the primary. Power is then transferred from the transmitter to the receiver via coupled inductors (e.g. an air-core transformer). Controlling the amount of power transferred is achieved by sending feedback (error signal) communication to the primary (that is, to increase or decrease power).

The receiver communicates with the transmitter by changing the load seen by the transmitter. This load variation results in a change in the transmitter coil current, which is measured and interpreted by a processor in the charging pad.

The output of the wireless receiver is 5Vdc which is supplied to the input of the charger circuit.

PRINCIPLE OF OPERATION
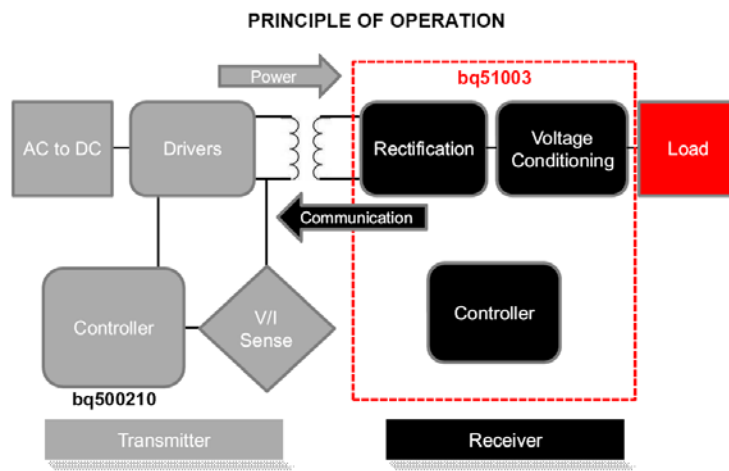
2.7 19mm Receiver Coil

The coil for this TI Design is a Wurth Electronics 19mm coil. This is an off the shelf ready available coil. This coil was used because it is a direct compatible drop in to replace the PCB routed coil used in the TIDA-00668 50mA Wireless charger BoosterPack. No parts were changed in order to use this coil. This coil was load tested to 60mA. The charger will only draw 27mA max. This leaves plenty of head room for current transients and startup currents. The efficiency of the PCB coil is only about 40%. Higher current is capable from this coil by trimming the series and parallel capacitors in the receiver circuit, but was not needed for this design. Based on the max charge current of 27mA the transmitter current

will be about 66mA for a loss of 38mA. Due to the low power nature of this design the loss is acceptable. There is very little heating of the coil due to losses due to the low power use of this design.

2.8   External Battery

The use of an external battery is possible with the external battery connector supplied on the board. There are a few design concerns when using an external battery. First it is the responsibility of the designer to make sure that all safety precautions are met for your design. The max charge current from the bq25100 is 250mA and the max charge voltage is 4.2Vdc. The Wireless receiver can supply currents greater than the 250mA with the attached coil but not with the resister values selected. It's up to the user to modify the parallel and series capacitors as required, change the current limit of the wireless receiver by changing the resister values according to the data sheet. Change the charger current limit and the protection current limit if it desired to use this circuit at a higher current. With an external battery with a C-Rate above 200mAh the 3.3V regulator and the 5V regulator can supply up to 100mA each. It is possible to use a larger battery without changing the circuit board. Your battery will charge at 26mA.

2.9   3.3V and 5.0V regulators

This design has a 3.3V buck regulator. The output voltage is resister programmed for 3.3Vdc. The regulator can supply up to 100mA of current, however the coin cell can only supply 50mA, so it is up to the user to make sure that there circuit does not draw more than the maximum current that the battery can supply. The 3.3Vdc buck will not turn on until the VBAT reaches 3.5Vdc. The 5V regulator is a boost circuit. It runs off of the coin cell. The regulator will operate down to the 2.8V cutoff of the protector. The output voltage of the boost regulator is resister programmable and is set to 5.00V. The max output current is 70mA. Because this is a boost converter the input current will always be higher than the output. At about 3V input the current will be high enough to limit the output current to about 30mA. Do not plan to use more than the 30mA on the output of the boost regulator or the protector will disconnect the battery for over current.

2.10   Charger

The bq2510x is a highly integrated family of single cell Li-Ion and Li-Pol chargers. The charger can be used to charge a battery, power a system or both. The charger has three phases of charging: pre-charge to recover a fully discharged battery, fast-charge constant current to supply the charge safely and voltage regulation to safely reach full capacity. The charger is very flexible, allowing programming of the fast-charge current and Pre-charge/Termination Current. The charger runs on the 5V input from the wireless receiver. The output current of the charger is set to about 26mA and a pre-charge of about 4mA. The termination current is about 2mA. All of this is resister programmable and can be changed if needed.

2.11   Protection

This bq29707 device is a primary protector for a single-cell Li-Ion/Li-Polymer battery pack. The device uses a minimum number of external components to protect for overcurrent conditions due to high discharge/charge currents in the application. In addition, it monitors and helps to protect against battery pack overcharging or depletion of energy in the pack. See the chart below for the functional levels of protection.

PART NUMBER	OVP (V)	OVP DELAY (s)	OVP REC DELAY (ms)	UVP (V)	UVP DELAY (ms)	UVP REC DELAY (ms)	OCC (V)	OCC DELAY (ms)	OCC REC DELAY (ms)	OCD (V)	OCD DELAY (ms)	OCD REC DELAY (ms)	SCD (V)	SCD DELAY (µs)
bq29707	4.280	1	12	2.800	96	8	0.090	6	8	0.090	16	8	0.3	250

In the condition when a fault is triggered, there are timer delays before the appropriate action is taken to turn OFF either the CHG or DSG FETs. There is also a timer delay for the recovery period once the threshold for recovery condition is satisfied. There is also a feature called zero voltage charging that enables depleted cells to be charged to an acceptable level before the battery pack can be used for normal operation. Zero voltage charging is allowed until the charger voltage is above 1.7 V.

When the battery is connected for the first time, the discharging circuit may not be enabled. In this case, short the V– pin to the VSS pin. Reference the two green arrows on the board.

Alternatively, set the unit on a wireless transmitter.

2.12 Jumpers

This section will help the user to set up and configure the wireless charger booster pack for basic and custom applications

2.12.1 Regulators

J2 are battery test pins. Never place a jumper across this connector as it will be a direct short.

J3 is the coil connector. We are soldering directly to the PCB on this board.

J7 is the enable pin for the 5V Regulator. Remove this jumper and the 5V Regulator will not start up.

J6 will disconnect the output of the 5V regulator from the header pins. These pins can also be used to measure current out of the 5V regulator by adding a current shunt or meter in series

J5 is the enable pin for the 3.3V Regulator. Remove this jumper and the 3.3V Regulator will not start up.

J4 will disconnect the output of the 3.3V regulator from the header pins. These pins can also be used to measure current out of the 3.3V regulator by adding a current shunt or meter in series.

2.12.2 Shunt

J1 is the current shunt between the Wireless receiver and the input of the charger. Place an amp meter across these pins to measure the current into the system from the wireless receiver.

R21 is a zero Ohm resister and can be removed to fully disconnect the 5V input from the energy storage. This will also remove the quiescent current of the regulator. Add a current shunt or meter in series with the pads of this part to measure current in and out of the 5V regulator. To fully isolate the 5V regulator, also remove J7 and J6.

3   Test Setup

Description of the test setup

Test equipment:

- TDS2024B Tektronix Scope
- 189 Fluke Multi-meter
- 2400 Keithley Source Meter
- E3649A Agilent Programmable Power Supply
- DI-158U Dataq Data Acquisition Module
- 2 - 1 Ohm 1% 5W Precision shunts
- Texas Instruments bq500212AEVM-550 Wireless Transmitter
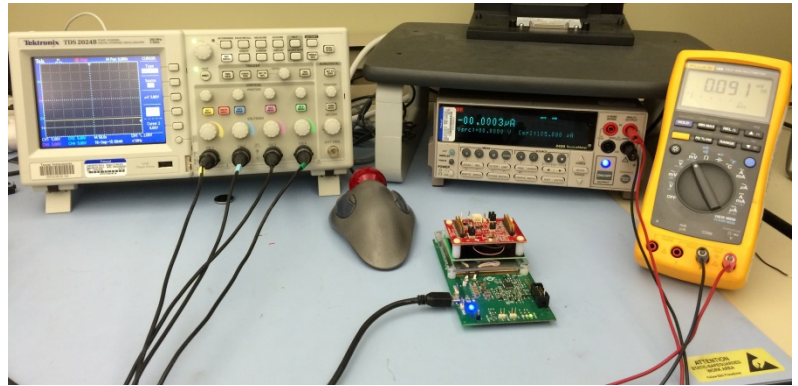
The use of a precision multi-meter along with a 1 Ohm shunt will make a great current measuring solution. Set the meter to the DC milli-volt scale and read the current as milli and micro Amps. Example: 1mV = 1mA

The source meter and power supply was used to supply voltages to test the regulators, the charger, and as a load to test current limits and regulation in the circuits.

The data acquisition module has an adjustable gain that will allow measuring in the micro volts range. 1 channel was used with the shunt to measure the input current the second channel was used to measure charge and discharge current and the other 2 channels were used to measure Voltage for, VBAT and the regulators. After the cycle was finished the data was saved as a CSV file and imported into Excel for processing and plotting.

The wireless transmitter EVM was used to provide power to the wireless receiver circuit.

All measured test results are in the Key System Specifications section of this document.

4 Test Data

The following description explains the test plots and scope captures that

4.1 Low voltage threshold while discharging

Green   5V
Pink   3.3V
Blue   VBAT_OK
Yellow Battery

The load was 27mA constant current on the 3.3V regulator. At 2.8V the protector began attempting to disconnect the battery and fully disconnected when the load pulled the battery below the threshold for duration longer than the protector delay.
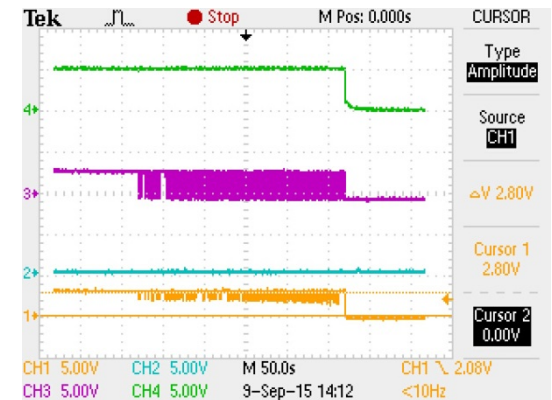
4.2 VIN_OK threshold while discharging

Green   5V
Pink   3.3V
Blue   VBAT_OK
Yellow Battery

The load was 27mA constant current on the 3.3V regulator. The battery was discharged until the 3.3V regulator set VBAT_OK low to show that the battery voltage was close to the 3.3V output. VBAT_OK dropped out at 3.4V. Note: the 3.3V regulator will continue to supply an unregulated output until the battery reaches 2.8V.
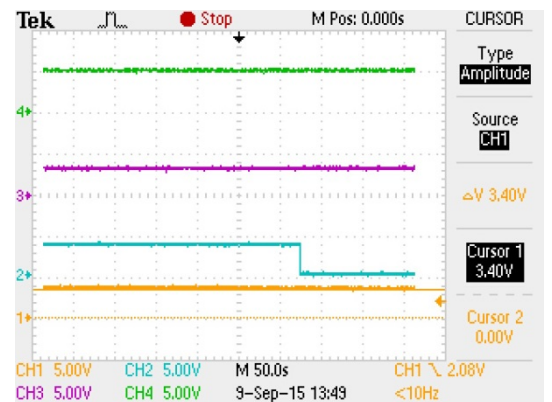
4.3 Reset Protection Circuit

Green   5V
Pink   3.3V
Blue   VBAT_OK
Yellow Battery

After the low voltage disconnect by the protector the battery voltage recovered to 3.47V but the protector has not reset.
Place the module onto the wireless transmitter to start the charger. This will reset the protector and the 3.3V and the 5V regulators will recover. The VBAT_OK will toggle high to show that the battery is now good.
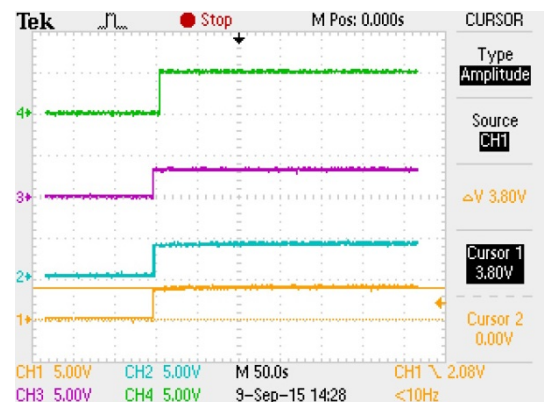
4.4   Wireless Receiver Startup

This is a plot of the wireless receiver startup for voltage output
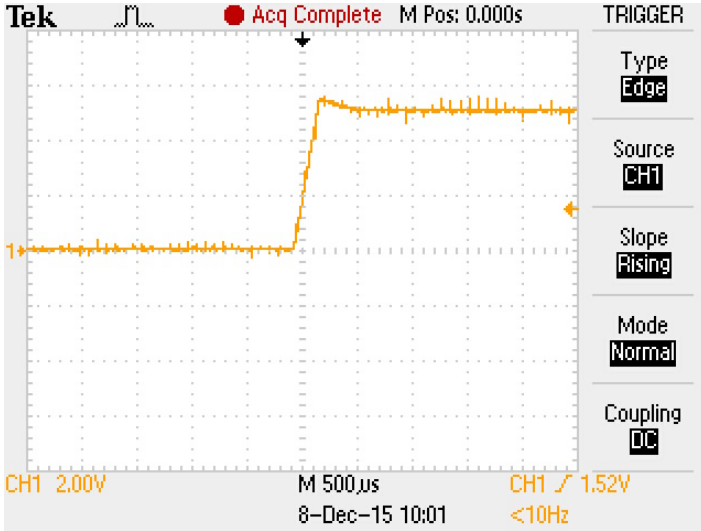
This plot shows the wireless receiver startup for current output
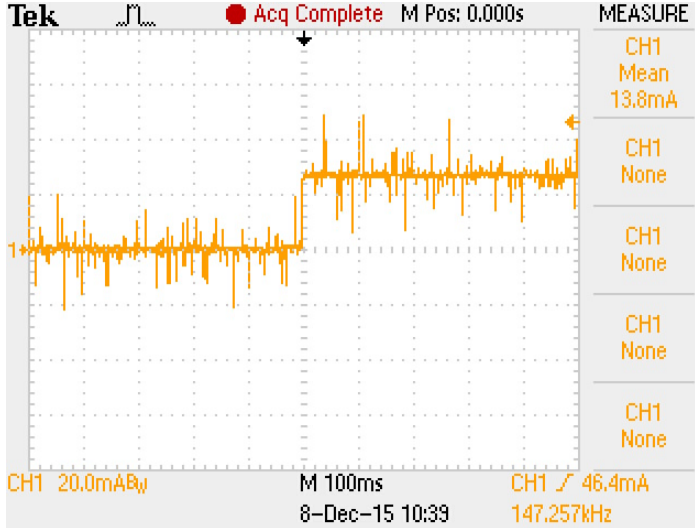
4.5   Charge Plot

This plot shows a normal charge cycle with battery voltage and battery current.
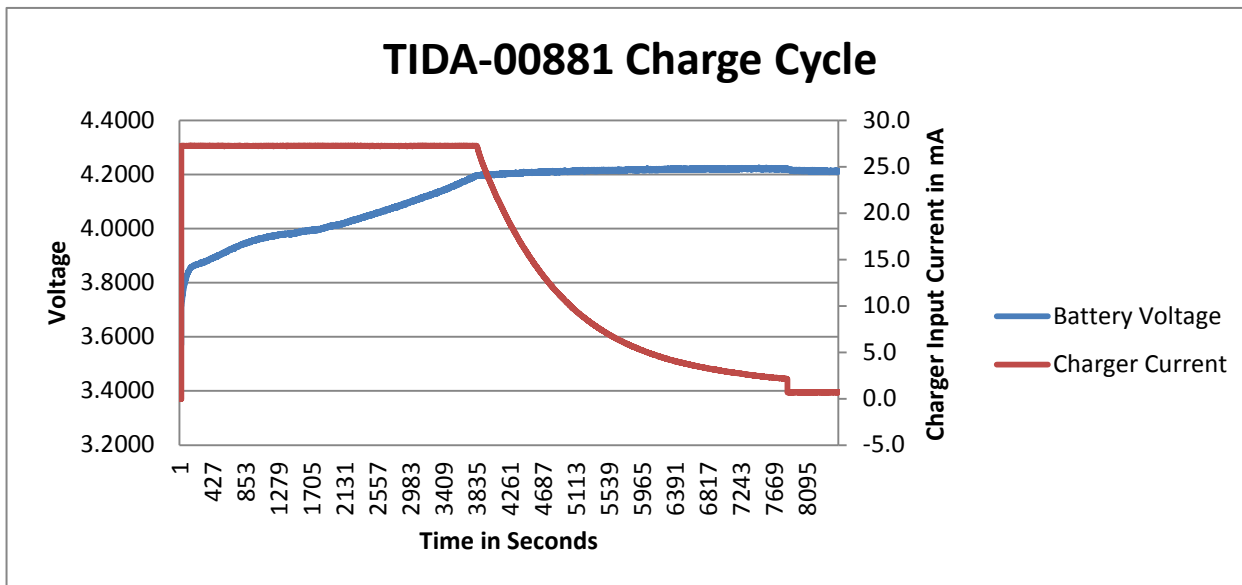
4.6   Discharge Plot

This is a basic discharge plot. The load was connected to the 5V regulator. The load was a constant current 27mA. This plot shows the load current, the 5V regulator voltage and the Battery voltage. The output of the 5V regulator held constant until the battery reached 2.8V.
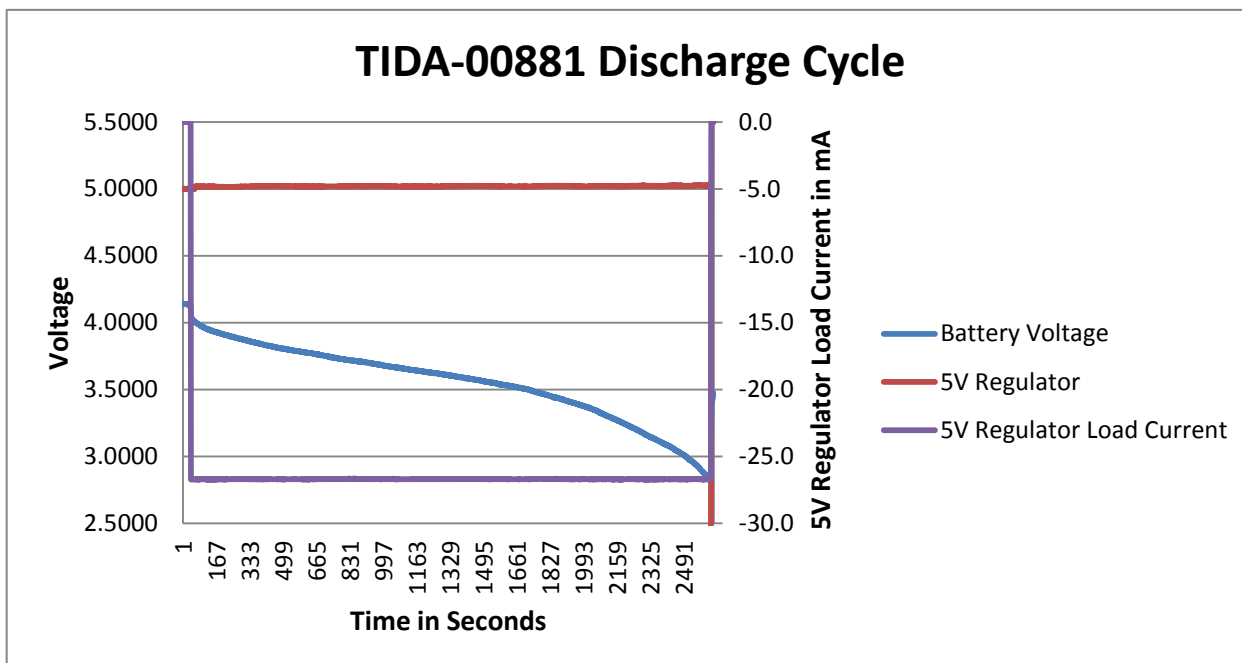
5   Design Files

5.1   Schematics

To download the Schematics for each board, see the design files at http://www.ti.com/tool/TIDA-00881
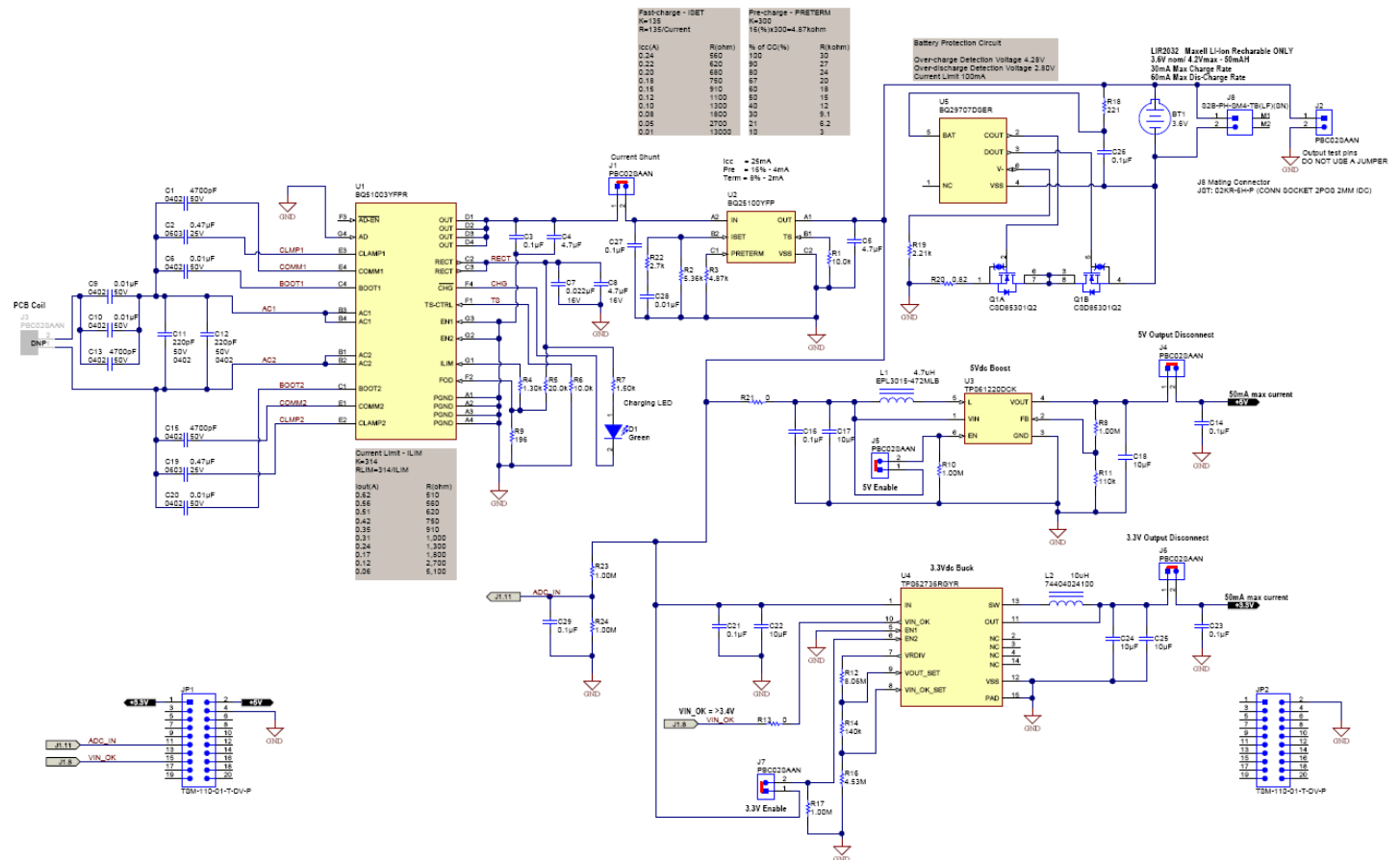
NOTE: TIDA-00881 uses the PCB from TIDA-00668 and the external coil PCB TIDA-00668-C02

5.2 Bill of Materials

Designator	Description	Manufacturer	PartNumber	Quantity
PCB1	Printed Circuit Board Main PCB	Any	TIDA-00668	1
PCB2	Printed Circuit Board Coil PCB	Any	PR2228E1_C02	1
BT1	Battery Holder, CR2032, Retainer clip, TH	Memory Protection Devices	BS-7	1
C1, C13, C15	CAP, CERM, 4700 pF, 50 V, +/- 10%, X8R, 0402	TDK	C1005X8R1H472K	3
C2, C19	CAP, CERM, 0.47 µF, 25 V, +/- 10%, X7R, 0603	MuRata	GRM188R71E474KA12D	2
C3, C14, C16, C21, C23, C26, C27, C29	CAP, CERM, 0.1uF, 10V, +/-10%, X7R, 0402	MuRata	GRM155R71A104KA01D	8
C4, C5	CAP, CERM, 4.7 µF, 10 V, +/- 10%, X5R, 0402	TDK	C1005X5R1A475K050BC	2
C6, C9, C10, C20, C28	CAP, CERM, 0.01 µF, 50 V, +/- 5%, X7R, 0402	Kemet	C0402C103J5RACTU	5
C7	CAP, CERM, 0.022 µF, 16 V, +/- 10%, X7R, 0402	TDK	C1005X7R1C223K	1
C8	CAP, CERM, 4.7 µF, 16 V, +/- 10%, X5R, 0603	MuRata	GRM188R61C475KAAJ	1
C11, C12	CAP, CERM, 220 pF, 50 V, +/- 5%, C0G/NP0, 0402	MuRata	GRM1555C1H221JA01D	2
C17, C18, C22, C24, C25	CAP, CERM, 10 µF, 6.3 V, +/- 20%, X5R, 0603	Kemet	C0603C106M9PACTU	5
Coil 1	Wireless coil	Wurth	760308103206	1
D1	LED, Green, SMD	Lite-On	LTST-C190GKT	1
Ferrite 1	Ferrite shield WE-FSFS	Wurth	354005	1
FID1, FID2, FID3	Fiducial mark. There is nothing to buy or mount.	N/A	N/A	3
H1, H2, H3, H4, H5, H6, H7, H8	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	B&F Fastener Supply	NY PMS 440 0025 PH	8
HS5, HS6, HS7, HS8	Standoff, Hex, 0.375"L #4-40 Nylon	Keystone	1902B	4
J1, J2, J3, J4, J5, J6, J7	Header, 100mil, 2x1, Gold, TH	Sullins Connector Solutions	PBC02SAAN	7
J8	Header (shrouded), 2mm, 2x1, R/A, SMT	JST Manufacturing	S2B-PH-SM4-TB(LF)(SN)	1
JP1, JP2	Header, 100mil, 10x2, Tin, SMT	Samtec	TSM-110-01-T-DV-P	2
L1	Inductor, Shielded, Ferrite, 4.7 µH, 1.2 A, 0.14 ohm, SMD	Coilcraft	EPL3015-472MLB	1
L2	Inductor, Wirewound, Ferrite, 10 µH, 0.47 A, 0.435 ohm, SMD	Wurth Elektronik	74404024100	1
L3	Inductor, Wirewound, Ferrite, Wireless receiver coil 19mm Round	Wurth Elektronik	760308101214	1
Q1	MOSFET, N-CH, 20 V, 6.7 A, SMD, 2.0x2.0, Height 0.8mm	Texas Instruments	CSD85301Q2	1
R1, R6	RES, 10.0 k, 1%, 0.063 W, 0402	Vishay-Dale	CRCW040210K0FKED	2
R2	RES, 5.36 k, 1%, 0.063 W, 0402	Vishay-Dale	CRCW04025K36FKED	1
R3	RES, 4.87 k, 1%, 0.063 W, 0402	Vishay-Dale	CRCW04024K87FKED	1
R4	RES, 1.30 k, 1%, 0.063 W, 0402	Vishay-Dale	CRCW04021K30FKED	1
R5	RES, 20.0 k, 1%, 0.063 W, 0402	Vishay-Dale	CRCW040220K0FKED	1
R7	RES, 1.50 k, 1%, 0.063 W, 0402	Vishay-Dale	CRCW04021K50FKED	1
R8, R10, R17, R23, R24	RES, 1.00 M, 1%, 0.063 W, 0402	Vishay-Dale	CRCW04021M00FKED	5
R9	RES, 196, 1%, 0.063 W, 0402	Vishay-Dale	CRCW0402196RFKED	1
R11	RES, 110 k, 1%, 0.063 W, 0402	Vishay-Dale	CRCW0402110KFKED	1
R12	RES, 8.06 M, 1%, 0.063 W, 0402	Vishay-Dale	CRCW04028M06FKED	1
R13, R21	RES, 0, 5%, 0.063 W, 0402	Vishay-Dale	CRCW04020000Z0ED	2
R14	RES, 140 k, 1%, 0.063 W, 0402	Vishay-Dale	CRCW0402140KFKED	1
R16	RES, 4.53 M, 1%, 0.063 W, 0402	Vishay-Dale	CRCW04024M53FKED	1
R18	RES, 221, 1%, 0.063 W, 0402	Vishay-Dale	CRCW0402221RFKED	1
R19	RES, 2.21 k, 1%, 0.063 W, 0402	Vishay-Dale	CRCW04022K21FKED	1
R20	RES, 0.82, 1%, 0.125 W, 0402	Panasonic	ERJ-2BQFR82X	1
R22	RES, 2.7 k, 5%, 0.063 W, 0402	Vishay-Dale	CRCW04022K70JNED	1
SH-J1, SH-J4, SH-J5, SH-J6, SH-J7	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA	5
U1	Highly Integrated Wireless Receiver Qi (WPC v1.1) Compliant Power Supply, YFP0028APAL	Texas Instruments	BQ51003YFPR	1
U2	400 mA Single-Input, Single Cell Li-Ion Battery Chargers, YFP0006AFAV	Texas Instruments	BQ25100YFP	1
U3	LOW INPUT VOLTAGE STEP-UP CONVERTER IN 6 PIN SC-70 PACKAGE, DCK0006A	Texas Instruments	TPS61220DCK	1
U4	Programmable Output Voltage Ultra-Low Power Buck Converter With Up to 50 mA Output Current, RGY0014A	Texas Instruments	TPS62736RGYR	1
U5	Cost-Effective Voltage and Current Protection Integrated Circuit for Single-Cell Li-Ion/Li-Polymer Batteries, DSE0006A	Texas Instruments	BQ29707DSER	1

5.3   PCB Layout Recommendations

Layout Guidelines

  As for all switching power supplies, the PCB layout is an important step in the design, especially at high peak currents and high switching frequencies. If the layout is not carefully done, the boost charger and buck converter could show stability problems as well as EMI problems. Therefore, use wide and short traces for the main current path and for the power ground paths. The input and output capacitors as well as the inductors should be placed as close as possible to the IC. For the boost charger the first priority is the output capacitors, including the 0.1uF bypass capacitor (CBYP). Next the input capacitor should be placed as close as possible between VIN and VSS. Last in priority is the boost charger's inductor, which should be placed close to LBOOST and VIN. For the buck converter, the output capacitor COUT should be placed as close as possible between VOUT and VSS. The buck converter inductor (L2) should be placed as close as possible between the switching node LBUCK and VOUT. It is best to use vias and bottom traces for connecting the inductors to their respective pins instead of the capacitors.

  To minimize noise pickup by the high impedance voltage setting nodes the external resistors should be placed so that the traces connecting the midpoints of each divider to their respective pins are as short as possible. When laying out the non-power ground return paths (for example, from resistors and CREF), it is recommended to use short traces as well, separated from the power ground traces and connected to VSS. This avoids ground shift problems, which can occur due to superimposition of power ground current and control ground current. The PowerPAD should not be used as a power ground return path.

  The remaining pins are either NC pins that should be connected to the PowerPAD as shown below or digital signals with minimal layout restrictions.

  During board assembly, contaminants such as solder flux and even some board cleaning agents can leave residue that may form parasitic resistors across the physical resistors/capacitors and/or from one end of a resistor/capacitor to ground, especially in humid, fast airflow environments. This can result in the voltage regulation and threshold levels changing significantly from those expected per the installed components. Therefore, it is highly recommended that no ground planes be poured near the voltage setting resistors or the sample and hold capacitor. In addition, the boards must be carefully cleaned, possibly rotated at least once during cleaning, and then rinsed with de-ionized water until the ionic contamination of that water is well above 50 MOhm. If this is not feasible, then it is recommended that the sum of the voltage setting resistors be reduced to at least 5X below the measured ionic contamination.

Thermal Considerations

Implementation of integrated circuits in low-profile and fine-pitch surface-mount packages typically requires special attention to power dissipation. Many system-dependent issues such as thermal coupling, airflow, added heat sinks and convection surfaces, and the presence of other heat-generating components affect the power dissipation limits of a given component.

Three basic approaches for enhancing thermal performance are listed below.
• Improving the power-dissipation capability of the PCB design
• Improving the thermal coupling of the component to the PCB
• Introducing airflow in the system

For more details on how to use the thermal parameters in the dissipation ratings table please check the Thermal Characteristics Application Note (SZZA017) and the IC Package Thermal Metrics Application Note (SPRA953).

5.4   Layout Prints

To download the Layout Prints for each board, see the design files at http://www.ti.com/tool/TIDA-00881
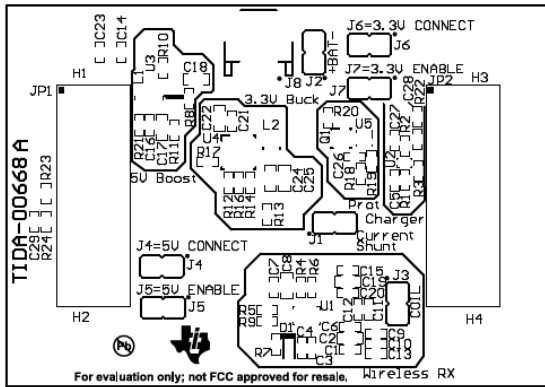
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Top Overlay			
PLOT NAME = Top Overlay	GENERATED : 9/11/2015 12:55:49 PM		TEXAS INSTRUMENTS
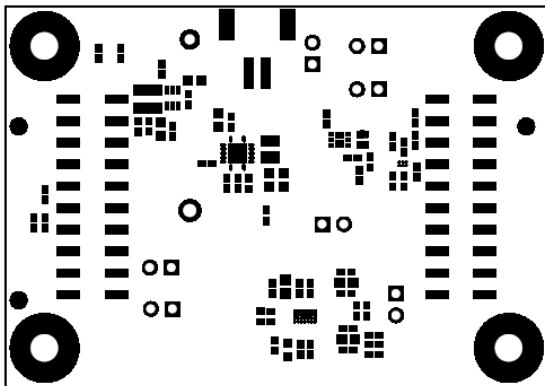
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Top Solder			
PLOT NAME = Top Solder Mask	GENERATED : 9/11/2015 12:55:50 PM		TEXAS INSTRUMENTS
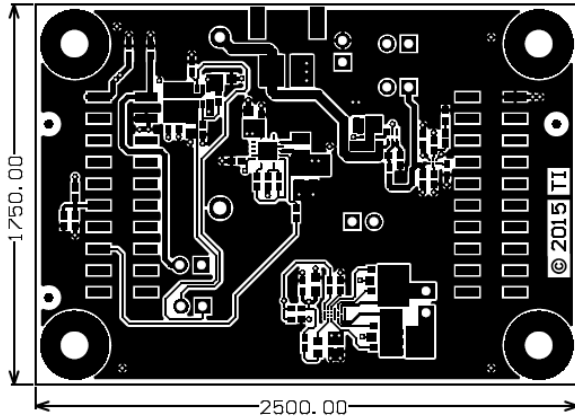
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Component Side 1			
PLOT NAME = Top Layer	GENERATED : 9/11/2015 12:55:51 PM		TEXAS INSTRUMENTS
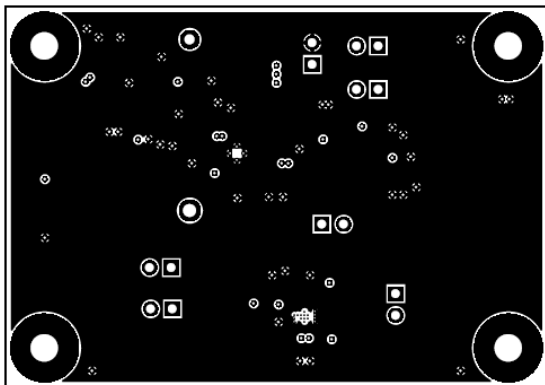
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME =			
PLOT NAME = MidLayer1	GENERATED : 9/11/2015 12:55:52 PM		TEXAS INSTRUMENTS
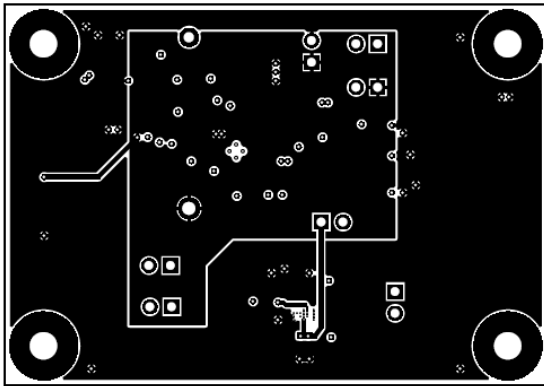
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME =			
PLOT NAME = MidLayer2	GENERATED : 9/11/2015 12:55:53 PM		TEXAS INSTRUMENTS
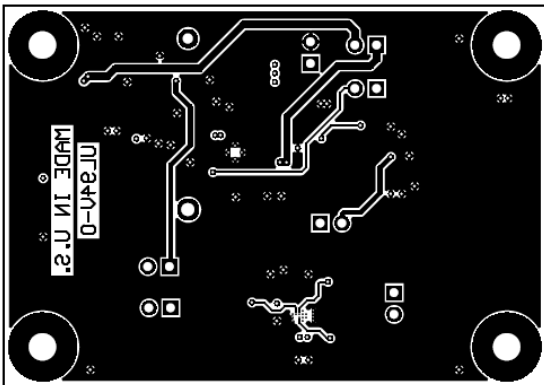
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Solder Side 4			
PLOT NAME = Bottom Layer	GENERATED : 9/11/2015 12:55:54 PM		TEXAS INSTRUMENTS
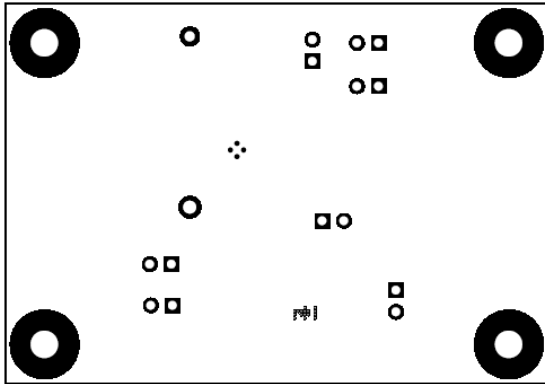
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Bottom Solder			
PLOT NAME = Bottom Solder Mask	GENERATED : 9/11/2015 12:55:55 PM		TEXAS INSTRUMENTS
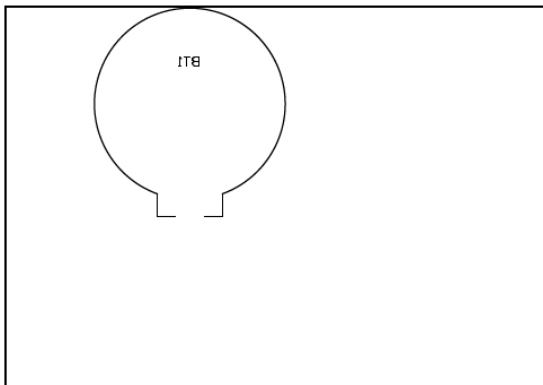
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Bottom Overlay			
PLOT NAME = Bottom Overlay	GENERATED : 9/11/2015 12:55:56 PM		TEXAS INSTRUMENTS
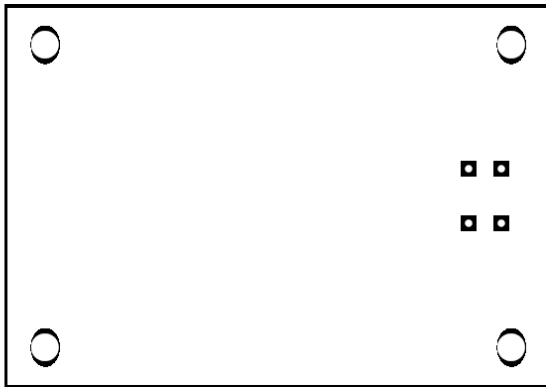
![TEXAS INSTRUMENTS logo]

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Coil PCB Layers

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Top Solder			
PLOT NAME = Top Solder Mask	GENERATED : 12/3/2015 11:01:56 AM		TEXAS INSTRUMENTS
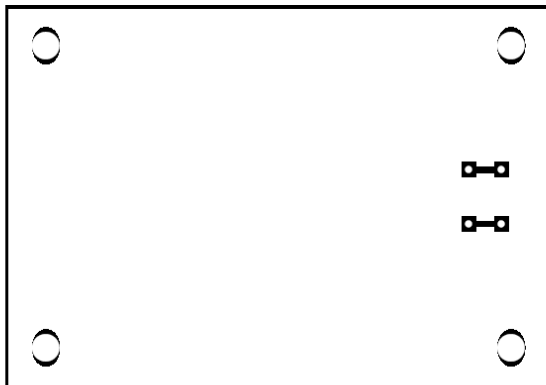
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Top Layer			
PLOT NAME = Top Layer	GENERATED : 12/3/2015 11:01:57 AM		TEXAS INSTRUMENTS
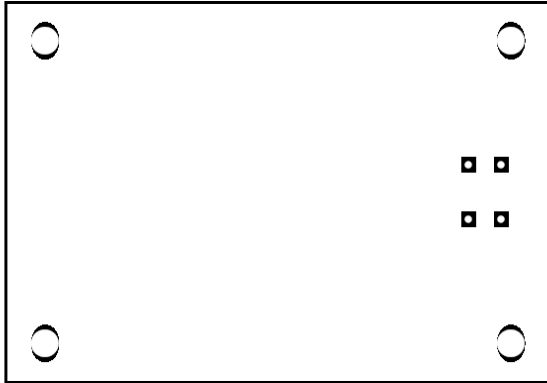
e

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Bottom Layer			
PLOT NAME = Bottom Layer	GENERATED : 12/3/2015 11:01:59 AM		TEXAS INSTRUMENTS
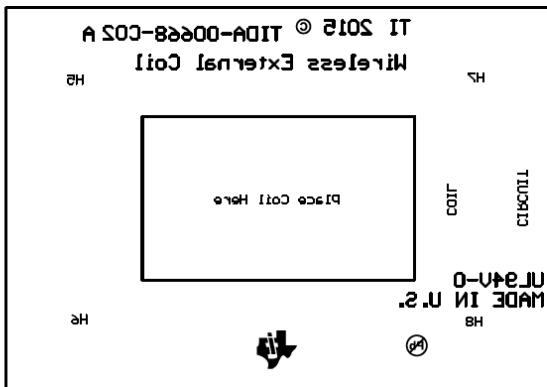
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Bottom Overlay			
PLOT NAME = Bottom Overlay	GENERATED : 12/9/2015 10:55:39 AM		TEXAS INSTRUMENTS
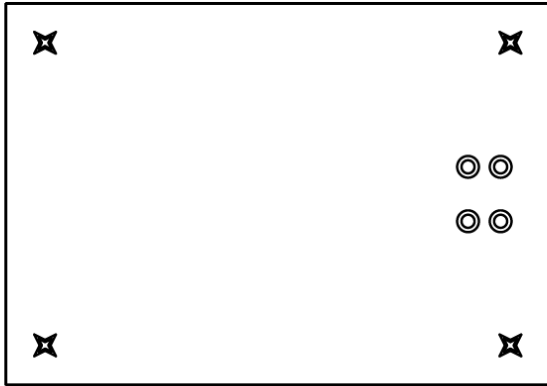
Symbol	Quantity	Finished Hole Size	Plated	Hole Type
✖	4	126.00mil (3.200mm)	NPTH	Round
⦿	4	32.00mil (0.813mm)	PTH	Round
	8 Total			

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Drill Drawing			
PLOT NAME = Drill Drawing	GENERATED : 12/9/2015 10:55:40 AM		TEXAS INSTRUMENTS
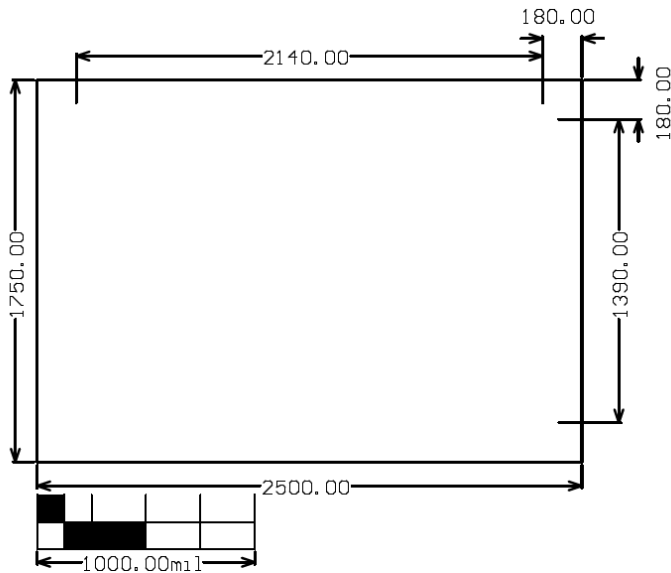
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00668	REV: A	SVN REV: Not In VersionControl
LAYER NAME = M2 Board Dimensions			
PLOT NAME = Board Dimensions	GENERATED : 12/9/2015 10:55:41 AM		TEXAS INSTRUMENTS

5.5 Booster Pack Pins

The Booster Pack pin configuration is in the table below

Low Power Wireless Booster Pack 40Pin																			
Pin	J29	Pin Name	Function	IC Pin #	Pin	J29	Pin Name	Function	IC Pin #	Pin	J30	Pin Name	Function	IC Pin #	Pin	J30	Pin Name	Function	IC Pin #
1	A1	3.3V_Main			2	C1	5V			1	D20				2	B20	GND		
3	A2	Analog In			4	C2	GND			3	D19				4	B19	PWM/GPIO		
5	A3	UART/RX			6	C3				5	D18				6	B18	SPI CS/GPIO		
7	A4	UART/TX			8	C4				7	D17				8	B17	GPIO		
9	A5	GPIO			10	C5				9	D16				10	B16	RESET	RST	
11	A6	Analog In	Battery ADC		12	C6				11	D15				12	B15	SPI/MOSI		
13	A7	SPI CLK			14	C7				13	D14				14	B14	SPI/MISO		
15	A8	GPIO P3.4	VBAT_OK		16	C8				15	D13				16	B13	SPI/CS/DISPLAY		
17	A9	I2C/SCL			18	C9				17	D12				18	B12	SPI/CS/Other		
19	A10	I2C/SDA			20	C10				19	D11				20	B11	GPIO P1.3	VOUT_EN	

5.6 Altium Project

To download the Altium project files for each board, see the design files at http://www.ti.com/tool/TIDA-00881
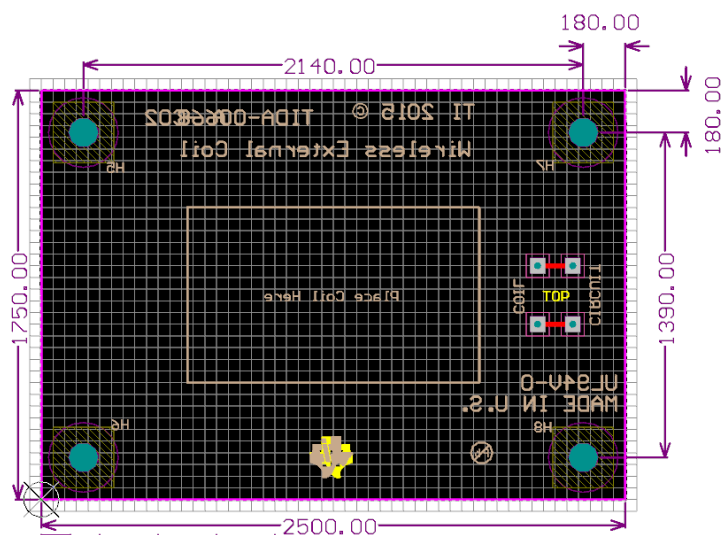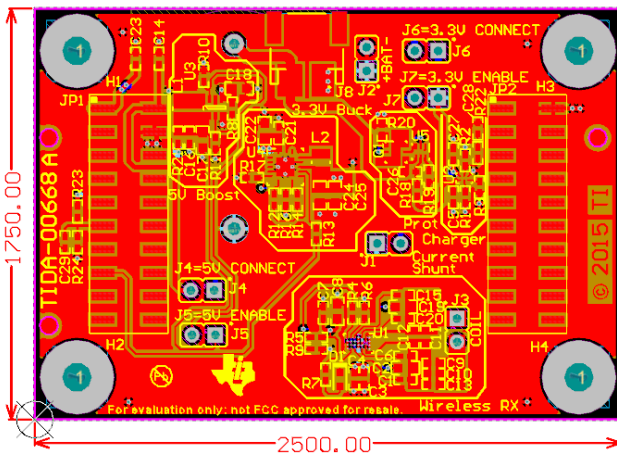
IMPORTANT NOTICE FOR TI REFERENCE DESIGNS