TI Design: TIDA-00688
50mA Wireless Charger Booster Pack

TI Designs

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Design Resources

<table>
<thead>
<tr>
<th>TI Design</th>
<th>Description</th>
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<tbody>
<tr>
<td>TIDA-00688</td>
<td>Design Folder</td>
</tr>
<tr>
<td>bq51003</td>
<td>Product Folder</td>
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<tr>
<td>bq25100</td>
<td>Product Folder</td>
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<tr>
<td>bq29707</td>
<td>Product Folder</td>
</tr>
<tr>
<td>TPS62736</td>
<td>Product Folder</td>
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</table>

Design Features

- Wireless Charger Booster Pack 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

Featured Applications

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

Board Image
## Key System Specifications

### Wireless Receiver

<table>
<thead>
<tr>
<th>Value</th>
<th>Suffix</th>
<th>Test</th>
<th>Setup</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.004</td>
<td>Vdc</td>
<td>Output voltage of the RX</td>
<td>Measure Pin 1 of J1 to ground</td>
</tr>
<tr>
<td>150</td>
<td>mA</td>
<td>Max load current from the wireless RX</td>
<td>Place a an electronic load on J1 and measure max current</td>
</tr>
<tr>
<td>27.6</td>
<td>C</td>
<td>Wireless RX circuit thermal rise at max charge from ambient temperature 22.8°C</td>
<td>Measure the ambient temperature under no load then load to max charge current for 15 minutes</td>
</tr>
</tbody>
</table>

### Charger

<table>
<thead>
<tr>
<th>Value</th>
<th>Suffix</th>
<th>Test</th>
<th>Setup</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.042</td>
<td>Vdc</td>
<td>Measured BT1 voltage</td>
<td>Insert the LR2032 coin cell and place a current meter across J1, Remove J5 and J7</td>
</tr>
<tr>
<td>27</td>
<td>mA</td>
<td>Charge current while charging from RX</td>
<td>Measure current through J1</td>
</tr>
<tr>
<td>26</td>
<td>mA</td>
<td>Max charge current into BT1</td>
<td>Measure current into BT1</td>
</tr>
<tr>
<td>34</td>
<td>uA</td>
<td>Idle current from charger into fully charged BT1</td>
<td>Place on TX and charge till full, monitor the current through J1</td>
</tr>
<tr>
<td>2.36</td>
<td>mA</td>
<td>Charger term current high</td>
<td>Measure the current when the charger goes into terminate</td>
</tr>
<tr>
<td>4.2</td>
<td>Vdc</td>
<td>Charger term voltage high</td>
<td>Measure the voltage when the charger goes into terminate</td>
</tr>
<tr>
<td>4.2</td>
<td>mA</td>
<td>Pre-charge current</td>
<td>Discharge to 2V then turn on the charger and measure the current going into BT1</td>
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<tr>
<td>2</td>
<td>Vdc</td>
<td>Pre-charge threshold</td>
<td>Connect sourcemeter and power supply at 5V to charger in. Adjust sourcemeter from 3V down to 1.5V determine pre-charge threshold</td>
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</tbody>
</table>

### 3.3V Regulator

<table>
<thead>
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<th>Suffix</th>
<th>Test</th>
<th>Setup</th>
</tr>
</thead>
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<tr>
<td>3.322</td>
<td>Vdc</td>
<td>Measured 3.3V out</td>
<td>Replace J7 and measure the output voltage of U4</td>
</tr>
<tr>
<td>3.322</td>
<td>Vdc</td>
<td>3.3V with BT1 at max voltage</td>
<td>Remove the coin cell, connect a power supply to BT1, adjust from low to high</td>
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<tr>
<td>60</td>
<td>mA</td>
<td>Abs max current on 3.3V regulator</td>
<td>Connect source meter to 3.3V</td>
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<tr>
<td>3.302</td>
<td>Vdc</td>
<td>3.3V with 50mA current with BT1 at max</td>
<td>Connect a source meter and increase the load</td>
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<tr>
<td>3.36</td>
<td>Vdc</td>
<td>3.3V with BT1 at min voltage</td>
<td>Remove the coin cell, connect a power supply to BT1, adjust from high to low</td>
</tr>
<tr>
<td>3.2</td>
<td>Vdc</td>
<td>3.3V with a 50mA current with BT1 at min</td>
<td>Connect a source meter (Set to drop out voltage) and increase the load</td>
</tr>
<tr>
<td>3.49</td>
<td>Vdc</td>
<td>VIN_OK on threshold</td>
<td>Remove coin cell, connect a source meter to BT1. Sweep low to high</td>
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<tr>
<td>3.47</td>
<td>Vdc</td>
<td>VIN_OK off threshold</td>
<td>Remove coin cell, connect a source meter to BT1. Sweep high to low</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
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<td>---</td>
</tr>
<tr>
<td>0</td>
<td>Vdc</td>
<td>3.3V disable</td>
<td>Remove J7 measure output of 3.3V regulator</td>
</tr>
<tr>
<td>23.6</td>
<td>C</td>
<td>3.3V circuit thermal rise at 50mA (22.8C ambient)</td>
<td>Measure the ambient temperature under no load then load to max current for 15 minutes with BT1 at min</td>
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</table>

### 5V Regulator

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

<table>
<thead>
<tr>
<th></th>
<th>Vdc</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>4.29</td>
<td>Protection voltage max</td>
<td>Remove coin cell, connect a source meter to BT1. Sweep low to high</td>
<td></td>
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<tr>
<td>2.79</td>
<td>Protection voltage min</td>
<td>Remove coin cell, connect a source meter to BT1. Sweep high to low</td>
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<tr>
<td>102</td>
<td>mA</td>
<td>Protection current</td>
<td>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</td>
</tr>
</tbody>
</table>

### System

<table>
<thead>
<tr>
<th></th>
<th>mV</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>2.0058</td>
<td>Measure ADC_IN</td>
<td>ADC_IN voltage ~1/2 of BT1 (loaded network from 1Meg multi-meter impedance)</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>uA</td>
<td>quiescent current of total circuit no load</td>
<td>measure the current from the battery to support all of the circuits</td>
</tr>
</tbody>
</table>
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 a very low cost PCB receiver coil.

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.
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.
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 is a Maxell LIR2032 rechargeable Lithium-Ion Battery. (NOTE: The CR2032 Lithium is not rechargeable! DO NOT USE ANY OTHER COIN CELL BATTERY IN THIS DEVICE). The maximum charge current is 30mA. The maximum constant current 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.

2.7 PCB Coil

The coil for this TI Design is a PCB trace routed coil. (The only cost for this coil is for the PCB material or space on the board) This coil was load tested to 150mA. 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%. 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.

2.8 Charger
2.9 **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 but not with the attached coil. It’s up to the user to select a proper coil, modify the parallel and series capacitors as required, change the current limit of the wireless receiver, 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.

2.10 **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 or the protector will disconnect the battery for over current.

2.11 **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.

2.12 **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.

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>OVP (V)</th>
<th>OVP DELAY (s)</th>
<th>OVP REC DELAY (ms)</th>
<th>UVP (V)</th>
<th>UVP DELAY (ms)</th>
<th>UVP REC DELAY (ms)</th>
<th>OCC (V)</th>
<th>OCC DELAY (ms)</th>
<th>OCC REC DELAY (ms)</th>
<th>OCD (V)</th>
<th>OCD DELAY (ms)</th>
<th>OCD REC DELAY (ms)</th>
<th>SCD (V)</th>
<th>SCD DELAY (µs)</th>
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<tbody>
<tr>
<td>bq29707</td>
<td>4.280</td>
<td>1</td>
<td>12</td>
<td>2.800</td>
<td>96</td>
<td>8</td>
<td>0.000</td>
<td>6</td>
<td>8</td>
<td>0.000</td>
<td>16</td>
<td>8</td>
<td>0.3</td>
<td>250</td>
</tr>
</tbody>
</table>

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 a acceptable level before the battery pack can be used for normal operation. Zero voltage charging is allowed if 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.

2.13 Jumper

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

2.13.1 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.

2.13.2 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 resistor 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 Charge Plot

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

4.5 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-00668
## 5.2 Bill of Materials

<table>
<thead>
<tr>
<th>Designator</th>
<th>Description</th>
<th>Manufacturer</th>
<th>PartNumber</th>
<th>Quantity</th>
</tr>
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<td>Any</td>
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<td>Any</td>
<td>PR2228E1-C01</td>
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<td>BT1</td>
<td>Battery Holder, CR2032, Retainer clip, TH</td>
<td>Memory Protection Devices</td>
<td>BS-7</td>
<td>1</td>
</tr>
<tr>
<td>C1, C13, C15</td>
<td>CAP, CERM, 4700 pf, 50 V, +/-10%, X8R, 0402</td>
<td>TDK</td>
<td>C1005XR1H472K</td>
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<td>C2, C19</td>
<td>CAP, CERM, 0.47 µF, 25 V, +/-10%, X7R, 0603</td>
<td>Murata</td>
<td>GRM18BB71E474KA12D</td>
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<td>Murata</td>
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<td>C4, CS</td>
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<td>C6, C9, C10, C20, C28</td>
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<td>Kemet</td>
<td>C0402C103I5RACTU</td>
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<tr>
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<td>CAP, CERM, 0.022 µF, 16 V, +/-10%, X7R, 0402</td>
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<td>C8</td>
<td>CAP, CERM, 4.7 µF, 16V, +/-10%, X5R, 0603</td>
<td>Murata</td>
<td>GRM18BR61C475KAAJ</td>
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<tr>
<td>C11, C12</td>
<td>CAP, CERM, 220 pF, 50 V, +/-5%, COG/NPO, 0402</td>
<td>Murata</td>
<td>GRM155C1H21A01D</td>
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<tr>
<td>C17, C18, C22, C24, C25</td>
<td>CAP, CERM, 10 µF, 6.3 V, +/-20%, X7R, 0603</td>
<td>Kemet</td>
<td>C0603C106M93ACTU</td>
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<tr>
<td>Coin 1</td>
<td>Inductor, Wirewound, Ferrite, 10 µH, 0.47 A, 0.435 ohm, SMD</td>
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<tr>
<td>L1, L2</td>
<td>Inductor, Shielded, Ferrite, 4.7 µH, 1.2 A, 0.14 ohm, SMD</td>
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<tr>
<td>Q1</td>
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<td>Texas Instruments</td>
<td>CSDR5301Q2</td>
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<tr>
<td>R1, R6</td>
<td>RES, 10.0 k, 1%, 0.063 W, 0402</td>
<td>Vishay-Dale</td>
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<tr>
<td>R11</td>
<td>RES, 110 k, 1%, 0.063 W, 0402</td>
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<tr>
<td>R12</td>
<td>RES, 8.06 M, 1%, 0.063 W, 0402</td>
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<td>R13, R21</td>
<td>RES, 0, 5%, 0.063 W, 0402</td>
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<tr>
<td>R14</td>
<td>RES, 140 k, 1%, 0.063 W, 0402</td>
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<tr>
<td>R16</td>
<td>RES, 4.53 M, 1%, 0.063 W, 0402</td>
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<td>CRCW0402453M1FKED</td>
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<tr>
<td>R18</td>
<td>RES, 221, 1%, 0.063 W, 0402</td>
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<td>CRCW0402221R0FKED</td>
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<tr>
<td>R19</td>
<td>RES, 2.21 k, 1%, 0.063 W, 0402</td>
<td>Vishay-Dale</td>
<td>CRCW0402221K0FKED</td>
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<tr>
<td>R20</td>
<td>RES, 0.82, 1%, 0.125 W, 0402</td>
<td>Panasonic</td>
<td>ERI-2BQFR82X</td>
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<tr>
<td>R22</td>
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<td>SH-1J, SH-14, SH-J5, SH-J6, SH-J7</td>
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<td>3M</td>
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<tr>
<td>U1</td>
<td>Highly Integrated Wireless Receiver Qi (WPC v1.1) Compliant Power Supply, YFP00028APAL</td>
<td>Texas Instruments</td>
<td>BQS1033YFP</td>
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<td>U2</td>
<td>400 mA Single-Input, Single Cell Li-Ion Battery Chargers, YFP0006AFAV</td>
<td>Texas Instruments</td>
<td>BQ25100YFP</td>
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<tr>
<td>U3</td>
<td>LOW INPUT VOLTAGE STEP-UP CONVERTER IN 6 PIN SC-70 PACKAGE, DCK0006A</td>
<td>Texas Instruments</td>
<td>TPS5120DCX</td>
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<td>U4</td>
<td>Programmable Output Voltage Ultra-Low Power Buck Converter With up to 50 mA Output Current, RGY0014A</td>
<td>Texas Instruments</td>
<td>TPS562736GYR</td>
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<td>U5</td>
<td>Cost-Efficient Voltage and Current Protection Integrated Circuit for Single-Cell Li-Ion/Li-Polymer Batteries, DSE0006A</td>
<td>Texas Instruments</td>
<td>BQ29707DSER</td>
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</table>
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 0.1\(\mu\)F 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 M\(\Omega\)hm. 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-00668
### ALL ARTWORK VIEWED FROM TOP SIDE

<table>
<thead>
<tr>
<th>BOARD #</th>
<th>TIDA-00668</th>
<th>REV: A</th>
<th>SUN REV: Not In VersionControl</th>
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<tbody>
<tr>
<td>LAYER NAME = Bottom Solder</td>
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### ALL ARTWORK VIEWED FROM TOP SIDE

<table>
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<th>BOARD #</th>
<th>TIDA-00668</th>
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PCB Coil Layers

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## Table 1: 50mA Wireless Charger Booster Pack

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5.5 Booster Pack Pins

The Booster Pack pin configuration is in the table below

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<tr>
<th>Pin</th>
<th>J29 Pin Name</th>
<th>Function</th>
<th>IC Pin #</th>
<th>Pin</th>
<th>J30 Pin Name</th>
<th>Function</th>
<th>IC Pin #</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>3.3V_MAIN</td>
<td></td>
<td>2</td>
<td>C1</td>
<td>5V</td>
<td></td>
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<tr>
<td>3</td>
<td>A2</td>
<td>Analog In</td>
<td></td>
<td>4</td>
<td>C2</td>
<td>GND</td>
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<tr>
<td>5</td>
<td>A3</td>
<td>UART_RX</td>
<td></td>
<td>6</td>
<td>C3</td>
<td>D18</td>
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<tr>
<td>7</td>
<td>A4</td>
<td>UART_TX</td>
<td></td>
<td>8</td>
<td>C4</td>
<td>D17</td>
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</tr>
<tr>
<td>9</td>
<td>A5</td>
<td>SPI_CS/GPIO</td>
<td></td>
<td>10</td>
<td>C5</td>
<td>D16</td>
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<tr>
<td>11</td>
<td>A6</td>
<td>Analog In</td>
<td>Battery_ADC</td>
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<tr>
<td>13</td>
<td>A7</td>
<td>SPI_CLK</td>
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<td>14</td>
<td>C7</td>
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<tr>
<td>15</td>
<td>A8</td>
<td>GPIO P1.3</td>
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<td>16</td>
<td>C8</td>
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<tr>
<td>17</td>
<td>A9</td>
<td>GPIO P3.4</td>
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<td>C9</td>
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<tr>
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<td>A10</td>
<td>I2C/SCL</td>
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<td>20</td>
<td>C10</td>
<td>D11</td>
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<tr>
<td>21</td>
<td>A11</td>
<td>I2C/SDA</td>
<td></td>
<td>22</td>
<td>C11</td>
<td>D10</td>
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</table>

5.6 Altium Project

To download the Altium project files for each board, see the design files at http://www.ti.com/tool/TIDA-00668
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