TI Designs: TIDA-00586

Gauge Booster Pack

TI Designs

TI Designs provide the foundation that you need including methodology, testing and design files to quickly evaluate and customize the system. TI Designs help you accelerate your time to market.

Design Resources

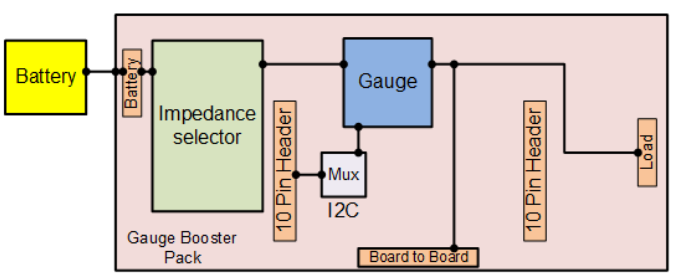
TIDA-00586	Design Folder
bq27421YZFR-G1A	Product Folder
TS3A44159PWR	Product Folder

TI E2E™ Community

Ask The Analog Experts

WEBENCH® Design Center

Block Diagram



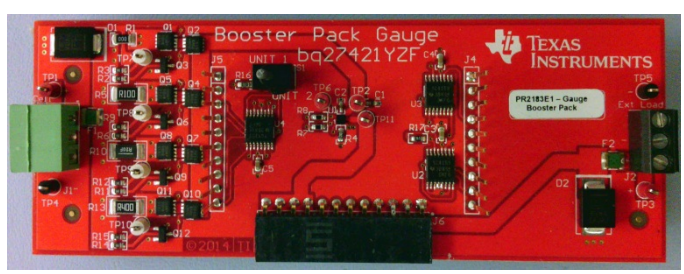
Design Features

- bq27421 Gauge Booster Pack
- Series Impedance array
- Use this booster pack board with any Launchpad
- Use both booster pack boards (charger and gauge) with a TM4C DK-TM4C129X Launchpad for a complete battery management solution
- Resettable fuse and reverse polarity protection on the board for power out and battery connections
- Complete Li-Ion gauge solution on a booster pack board
- Promotes a fast learning curve to understand gauging
- Connect your own controller board or a Launchpad to:
  - Test your code
  - Gauge your battery while charging and discharging

Featured Applications

- Battery Operated Instruments
- Hand Held Electronics
- IoT (Internet of Things)

Board Image



1 Key System Specifications

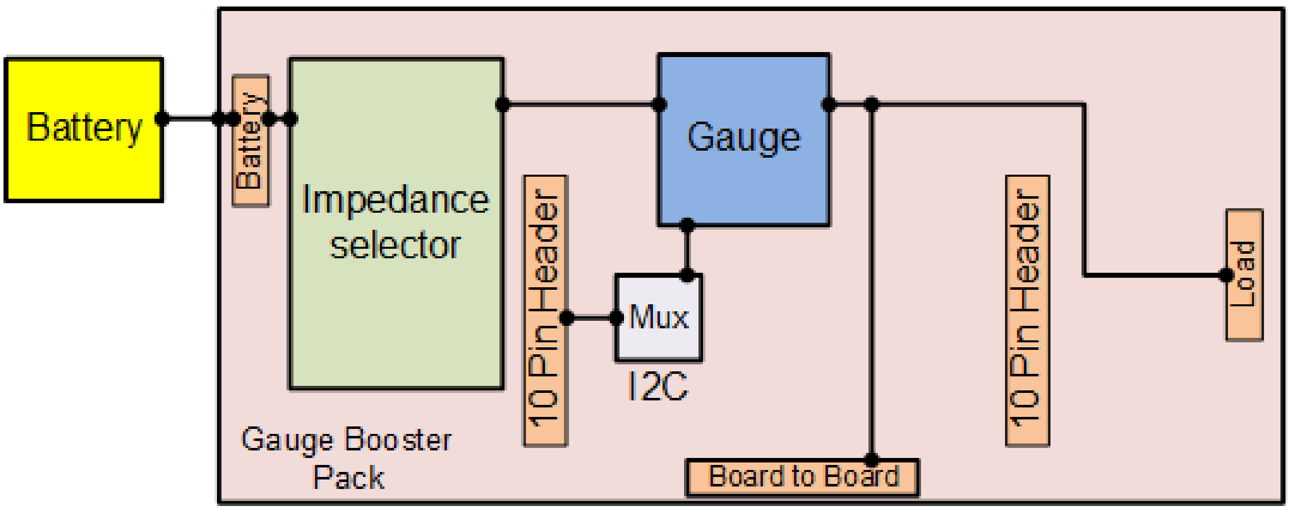
Gauge			
bq27241	**Value**	**Ref**	**Description**
Vbat	4.197	Vdc	Cell voltage at 100% SOC
Vdd	1.801	Vdc	LDO out supply pin
Icc	90	uA	Normal mode current
Isd	0.4	uA	Shutdown mode current
I2C	400	kHz	Fast mode Communications
Impedance array			
R1	0	Ohm	
R5	100	mOhm	
R10	200	mOhm	
R13	400	mOhm	
Selection	**Binary**	**Resistance**	
0	0000	open	
1	0001	0.400000	
2	0010	0.200000	
3	0011	0.133333	
4	0100	0.100000	
5	0101	0.080000	
6	0110	0.066667	
7	0111	0.057143	
8	1xxx	0.000001	

2 System Description

The booster pack series of boards allows the user to connect the desired circuitry directly to a Launchpad for easy test and code development. All Launchpad's have a standard header pin configuration. The standardized headers make it possible to use different Launchpad's with different Booster Packs to build, test and create new designs very quickly.

The bq27421 Gauge Booster Pack board was designed to provide a means to test and develop with the bq27421 gauge IC in a simple easy to use booster pack board. You can connect your battery directly to the battery connector of the gauge board and connect your charger of choice and/or system to the load connector.

There is a two port mux on this board that will allow the user to stack two gauge booster pack boards on the same Launchpad and by using a chip select method one Launchpad can control both gauge booster pack boards at the same time. If you choose not to use the mux you can simply set the mux ID switch to the desired position and set chip select one time for the one board. Use the ICD to power the extra circuity on the gauge board. Or use the external USB input. There is a board to board connector on this board that will allow you to pug in the Charger Booster Pack board (TIDA-00587) then connect both of them to the TM4C Launchpad providing a complete charger and gauge battery management system. The gauge uses I2C to communicate with the Launchpad.

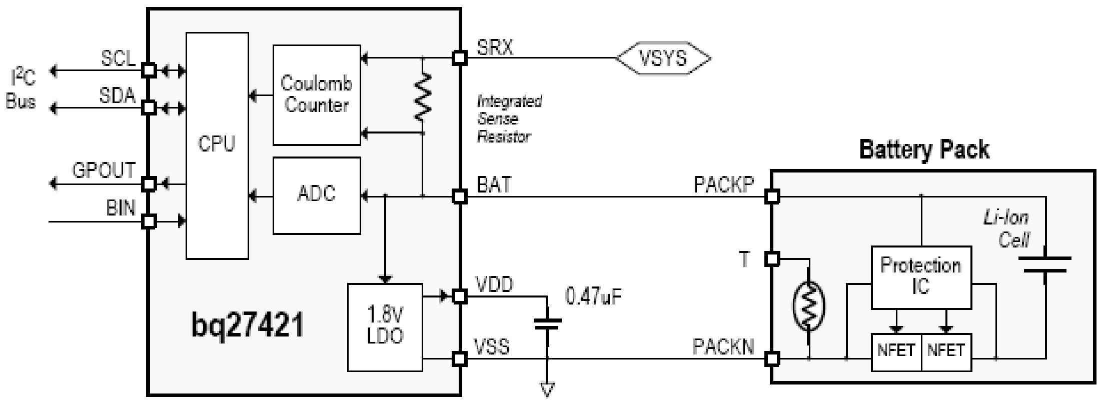


2.1 Bq27421

The Texas Instruments bq27421-G1 is an easy to configure microcontroller peripheral that provides system-side fuel gauging for single-cell Li-Ion batteries. The device requires minimal user configuration and system microcontroller firmware development.

The bq27421-G1 uses the patented Impedance Track™ algorithm for fuel gauging, and provides information such as remaining battery capacity (mAh), state-of-charge (%), state-of-health (%), and battery voltage (mV).

Battery fuel gauging with the bq27421-G1 requires connections only to PACK+ (P+) and PACK– (P–) for a removable battery pack or embedded battery circuit. The tiny 9-pin 1,62 × 1,58 mm × 0,5 mm pitch CSP package is ideal for space constrained applications.



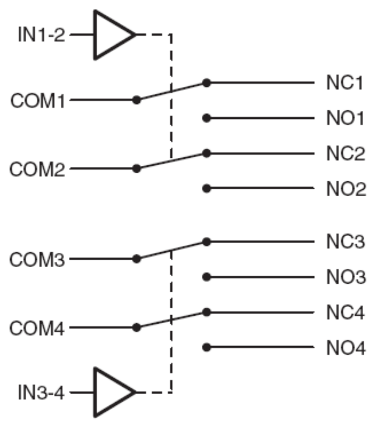
2.2 TS3A44159

The TS3A44159 is a quad single-pole double-throw (SPDT) analog switch with two control inputs, which is designed to operate from 1.65 V to 4.3 V. This device is also known as a dual double-pole double-throw (DPDT) configuration. It offers low ON-state resistance and excellent ON-state resistance matching with the break-before-make feature, to prevent signal distortion during the transferring of a signal from one channel to another. The device has an excellent total harmonic distortion (THD) performance and consumes very low power. These features make this device suitable for portable audio applications.

FUNCTION TABLE

IN	NC TO COM, COM TO NC	NO TO COM, COM TO NO
L	ON	OFF
H	OFF	ON

LOGIC DIAGRAM



3 Getting Started

The charger boost pack design can be broken down into key operations or functions. Each area will be isolated and described to help a user understand the full functionality of this board.

3.1 Gauge

The bq27421-G1 accurately predicts the battery capacity and other operational characteristics of a single Lithium based rechargeable cell. It can be interrogated by a system processor to provide cell information, such as state of- charge (SOC).

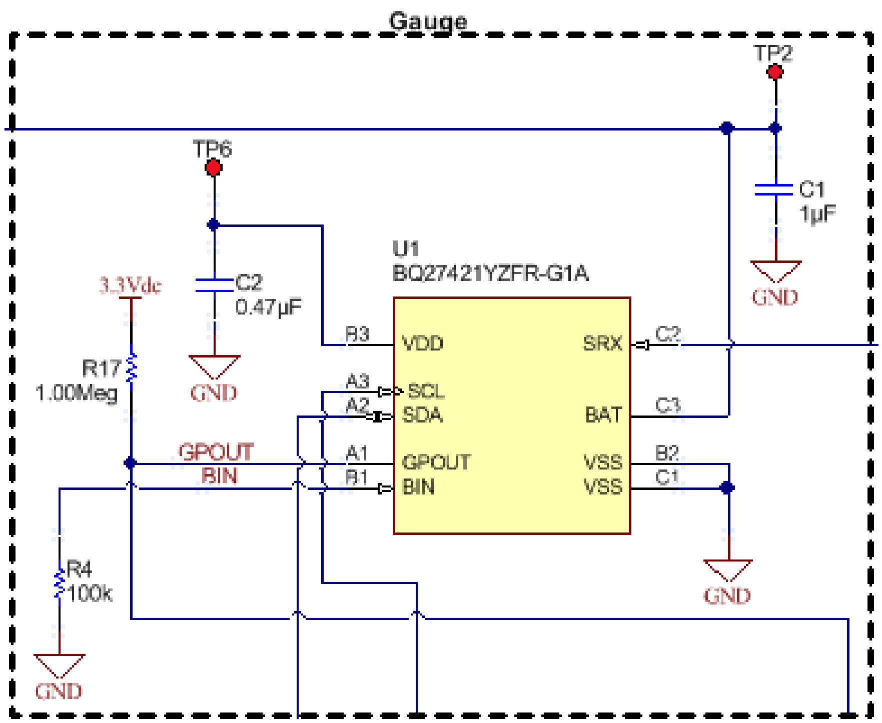
Information is accessed through a series of commands, called *Standard Commands*. Further capabilities are provided by the additional *Extended Commands* set. Both sets of commands, indicated by the general format *Command( )*, are used to read and write information contained within the bq27421-G1 control and status registers, as well as its data locations. Commands are sent from system to gauge using the bq27421-G1's I2C serial communications engine, and can be executed during application development, system manufacture, or end-equipment operation.

The key to the bq27421-G1's high-accuracy gas gauging prediction is Texas Instrument's proprietary Impedance Track™ algorithm. This algorithm uses cell measurements, characteristics, and properties to create state-of charge predictions that can achieve high accuracy across a wide variety of operating conditions and over the lifetime of the battery.

The bq27421-G1 measures charge/discharge activity by monitoring the voltage across a small-value sense resistor. When a cell is attached to the bq27421-G1, cell impedance is computed, based on cell current, cell open-circuit voltage (OCV), and cell voltage under loading conditions.

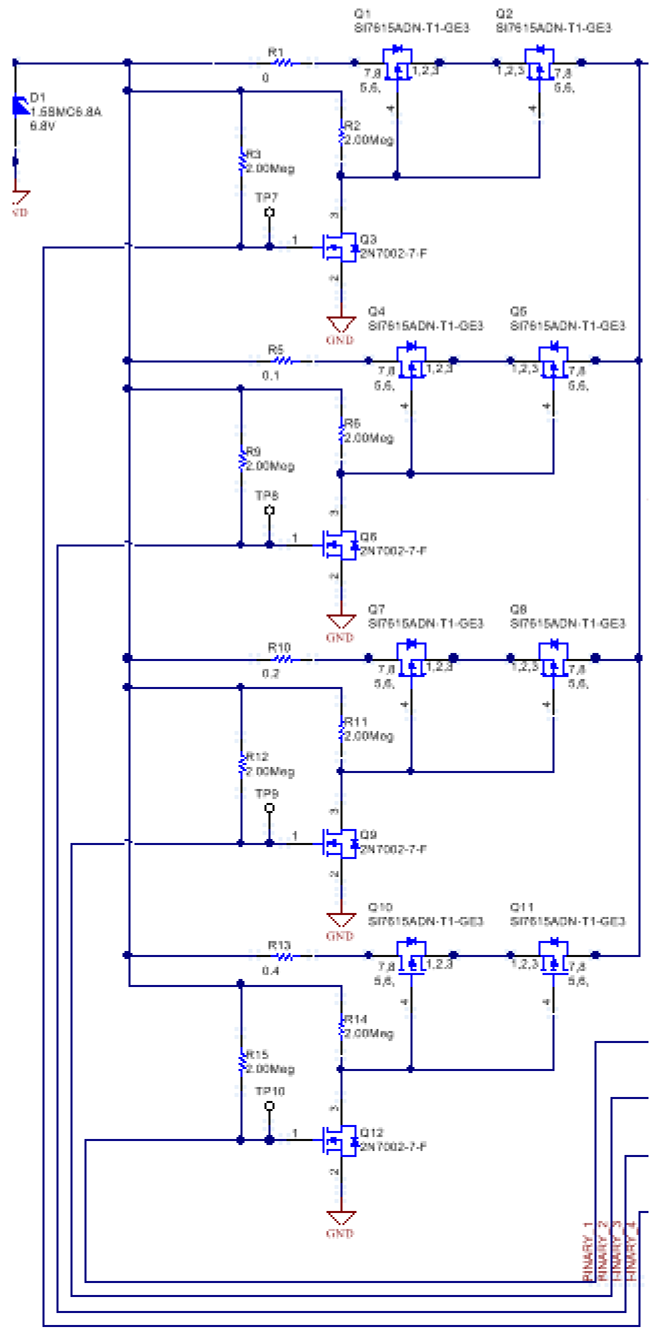
The bq27421-G1 uses an integrated temperature sensor for estimating cell temperature. Alternatively, the host processor can provide temperature data for the bq27421-G1.

To minimize power consumption, the bq27421-G1 has several power modes: INITIALIZATION, NORMAL, SLEEP, HIBERNATE and SHUTDOWN. The bq27421-G1 passes automatically between these modes, depending upon the occurrence of specific events, though a system processor can initiate some of these modes directly. More details are found in the *bq27421-G1 Technical Reference Manual (SLUUAC5)*.



3.2 Impedance Array

The Impedance array consists of 4 resisters in parallel, each with its own switch. Using a binary logic setup the user can turn on or off each switch to place a resister in parallel with another resister or by itself. There are 8 possible configurations. (Zero Ohms - 400mOhms) This allows for placing a resistance in series with the cell under test. By turning all of the switches off you have a disconnect method that will open the circuit. This can be used as a safety mechanism to disconnect the battery from the system under test in the event of an emergency. It's up to the user to program their code to use this feature.



Why would you want to place a resistance in series with a cell? We call it artificially aging a cell. What we know is that a cell's impedance will effectively double in about 3-6 months into its life cycle. That means that after about a year the cells impedance will double again.

The cells we used to test the Gauge Booster Pack have a new impedance of about 100mOhms. That means that in about 6 months of normal use this cell will have an impedance of about 200mOhms and after 1 year its impedance will be about 400mOhms.

If we place a 300Mohm resistance in series with the cell, its behavior will be similar to a cell that is 1 year old. Now this is an over simplification of an aging cell but gives a very good resemblance for testing.

So now the gauge will show that the cell is older?
Not yet because the gauge still has an impedance table that says that this is not an old battery. After we add the impedance in series with the cell we have to update the impedance table to reflect the additional impedance. Then the gauge will properly track the SOC, SOH and the capacities of the artificially aged cell under test.

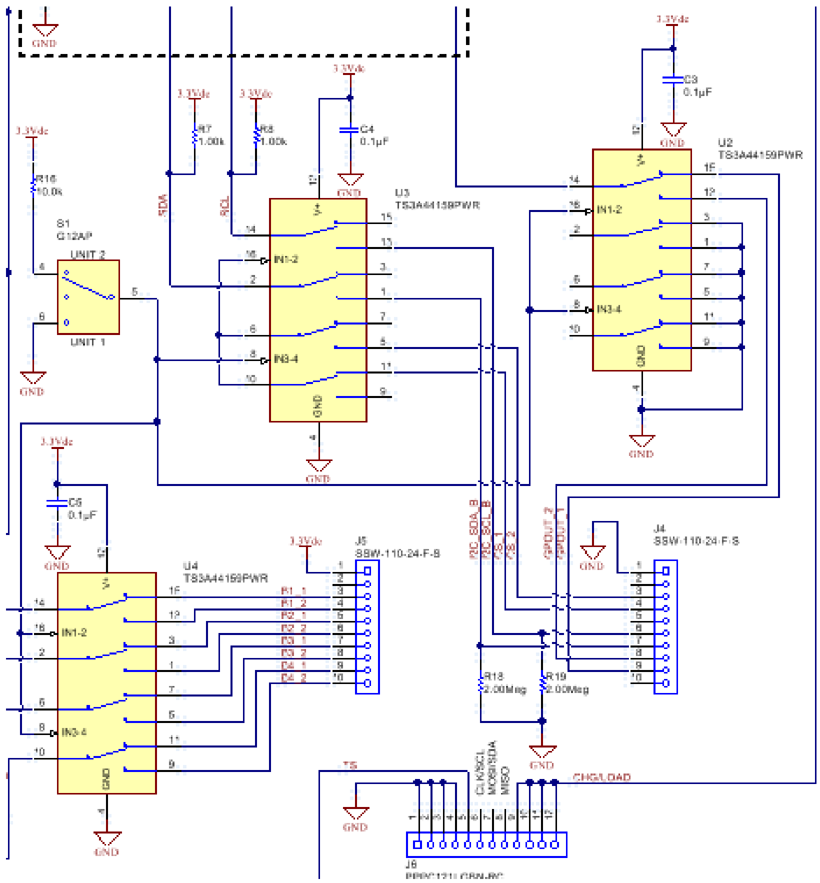
In order to add the Impedance you must rewrite the tables. When you write the table you must add the impedance plus the series impedance divided by four as the new value.

impedance_1 = impedance_1 + (series_impedance/4);
impedance_2 = impedance_2 + (series_impedance/4);
impedance_3 = impedance_3 + (series_impedance/4);

This must be done for all 14 register values in the table.

3.3 Mux

The mux is a series of analog switches that will allow two gauge boards to be stacked. By providing two chip selected paths the selected board can see the communications based on the board ID selected. The user can set one board to chip select 1 and a second board to chip select 2. This will allow communications with both boards by using only a single chip select line per board. You do not have to steer the communication lines this is done for you in the mux. If you have only one board then select the unit ID and use the proper chip select pin. The mux controls the communications lines for the gauge and the impedance binary control lines.   When designing in the gauge circuit into your design you do not need the mux circuitry. This is an advanced option for the booster pack series.



3.4 Input / Output and Protection

There is a PTC and a protection TVS diode on the Input and output connectors of this board. The TVS diode will protect the circuit from transient voltages above 6.8V and reverse polarity. You must remove the Input TVS (D1) if you plan on operating the input voltage up to the max of 10.5Vdc. The PTC is a Polyswitch resettable fuse rated at 1.9A hold and 4.9A trip current. The PTC will open on currents that short the current flow in the input or output connectors. Once the short has been eliminated the PTC will reset. This protects this circuit and your circuit against high currents and shorts.

Warning: There is no cell or battery protection on this board. It is up to the user to provide the proper protection based on the cell or battery used and the type of testing that this board is intended for.

3.5 Headers

There are two 10 pin headers that use standardized pin functions. Below is the pin connections used for the charger booster pack.

Booster Pack 20Pin (Gauge)			
J6	**IC Pin Name**	**Function**	**IC Pin #**
A1	3.3V_Main		
A2	PD0/AIN15		C2
A3	PJ0/U3RX	B1_1	C8
A4	PJ1/U3TX	B1_2	E7
A5	PT0	B2_1	W10
A6	PT1	B2_2	V10
A7	PA2/SSI0CLK	B3_1	T6
A8	PS6	B3_2	U10
A9	PS7	B4_1	R13
A10	PB5	B4_2	B6

J9	**IC Pin Name**	**Function**	**IC Pin #**
B1	GND		
B2	PD1/T0CCP0		C1
B3	PJ3	CS_2	F16
B4	PE4	CS_1	A5
B5	RESET		
B6	PA4/I2C7SCL	I2C_B_SCL	V4
B7	PA5/I2C7SDA	I2C_B_SDA	W4
B8	PH5	GPOUT_2	T2
B9	PP6	GPOUT_1	B8
B10	PD5		B4

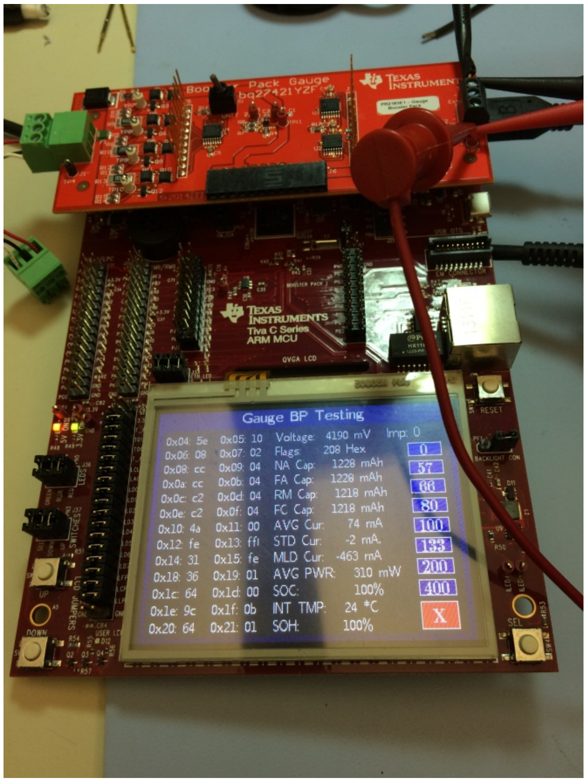
4 Test Setup

4.1 Test Equipment

- TDS2024B Tektronix Scope
- 189 Fluke Multi-meter
- 2400 Keithley Source Meter
- DI-158U Dataq Data Acquisition Module
- 1 TM4C Launchpad (code written in C using TI's CCS studio)
- 5V 2A USB wall power supply
- 3.6V LI-ION battery pack rated at 1260mAh

4.2 Description of the test setup

A utility set of C code was written to allow the use of the TM4C Launchpad as a test platform. The gauge booster pack was attached to the Launchpad and the ID was set to unit 1. A battery was connected to the left input connector. A charger and load was connected to the right Load/Chg connector. The Impedance selector was set to zero Ohms at the beginning of the test.

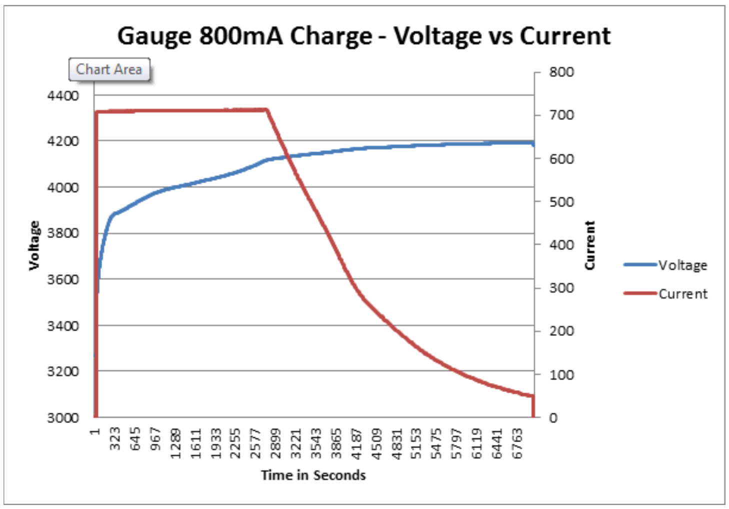


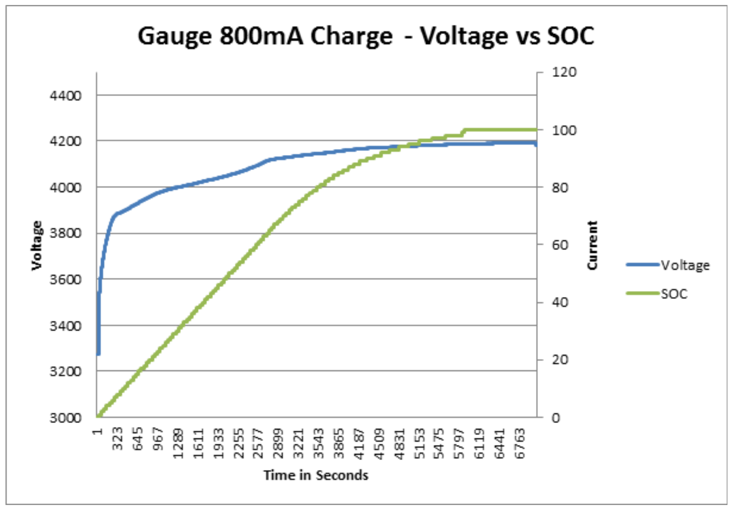
5 Test Data

The following description explains the test plots that show the process of charging and discharging using the gauge booster pack.

5.1 800mA Charge

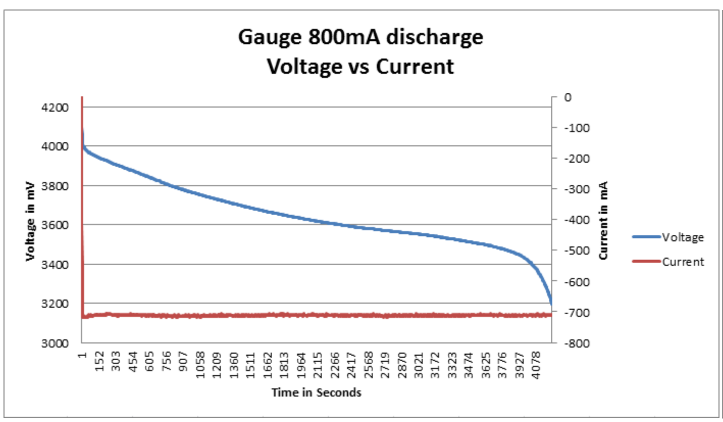
The first test is a charge. This was a full charge from 0% SOC to 100% and was terminated by the charger with no input from the Launchpad or other source. Plot one show's the voltage to current relationship during the charge and the second plot show the voltage to SOC relationship during the charge cycle.

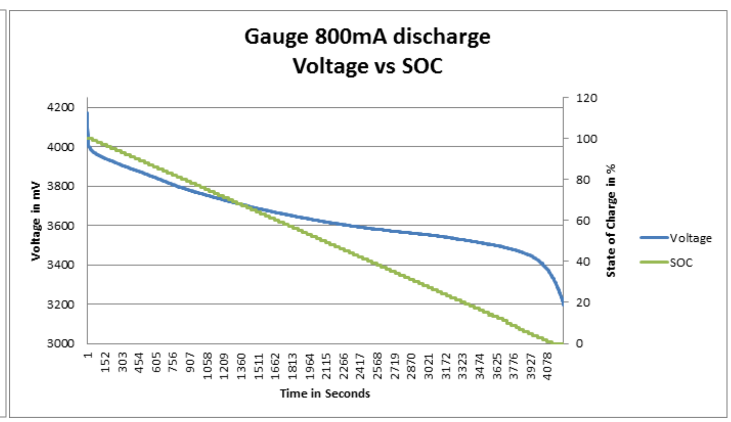




5.2 800mA Discharge

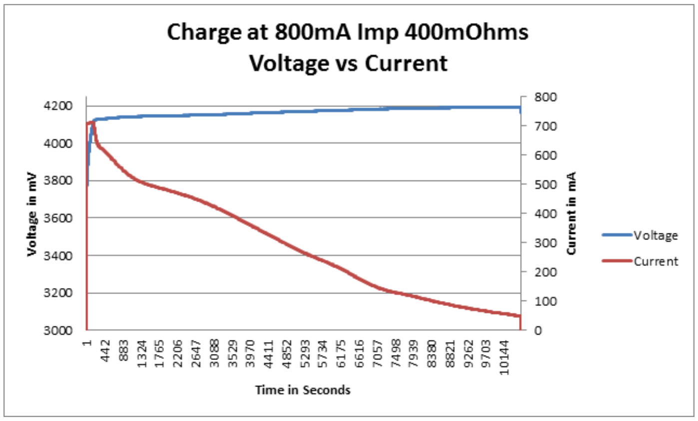
The second test is a discharge test. This was a full discharge from 100% SOC to the designated minimum discharge voltage of 3.2V. Plot one show's the voltage to current relationship during the discharge and the second plot show the voltage to SOC relationship during the discharge cycle.

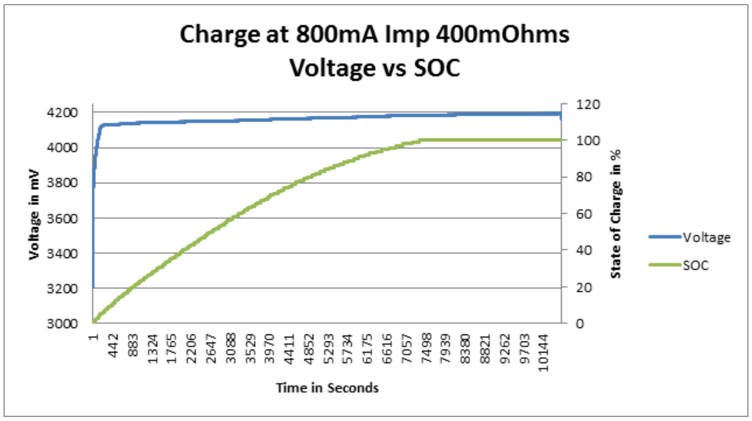




5.3 800mA Charge at 400mOhms

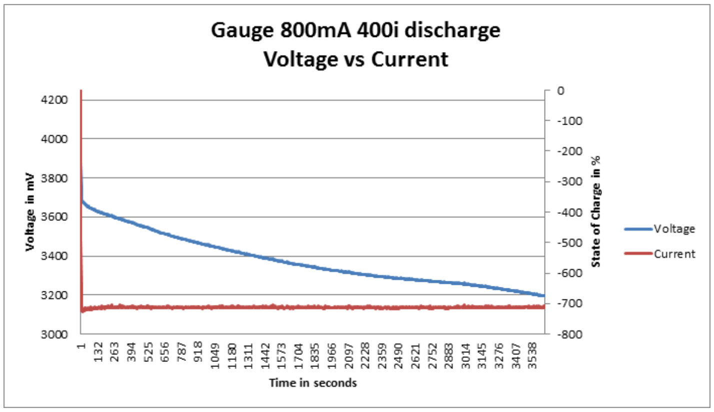
The third test is a charge with the cell aged 1 year. (See the impedance array section to understand artificial aging) This was a full charge from 0% SOC to 100% and was terminated by the charger with no input from the Launchpad or other source. Plot one show's the voltage to current relationship during the charge and the second plot show the voltage to SOC relationship during the charge cycle.

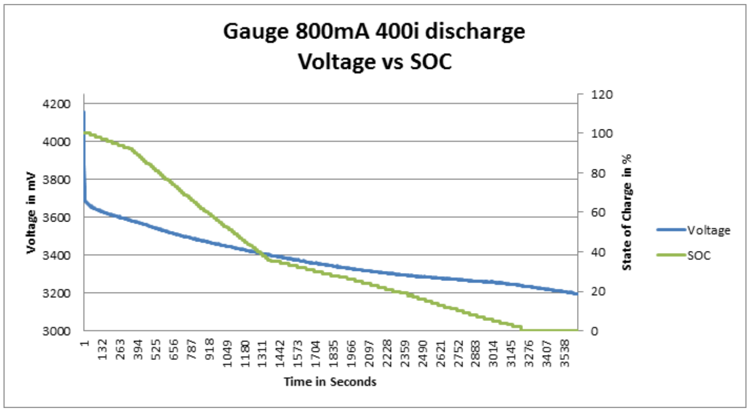




5.4 800mA Discharge at 400mOhms

The fourth test is a discharge test with the cell aged 1 year. (See the impedance array section to understand artificial aging) This was a full discharge from 100% SOC to the designated minimum discharge voltage of 3.2V. Plot one show's the voltage to current relationship during the discharge and the second plot show the voltage to SOC relationship during the discharge cycle.

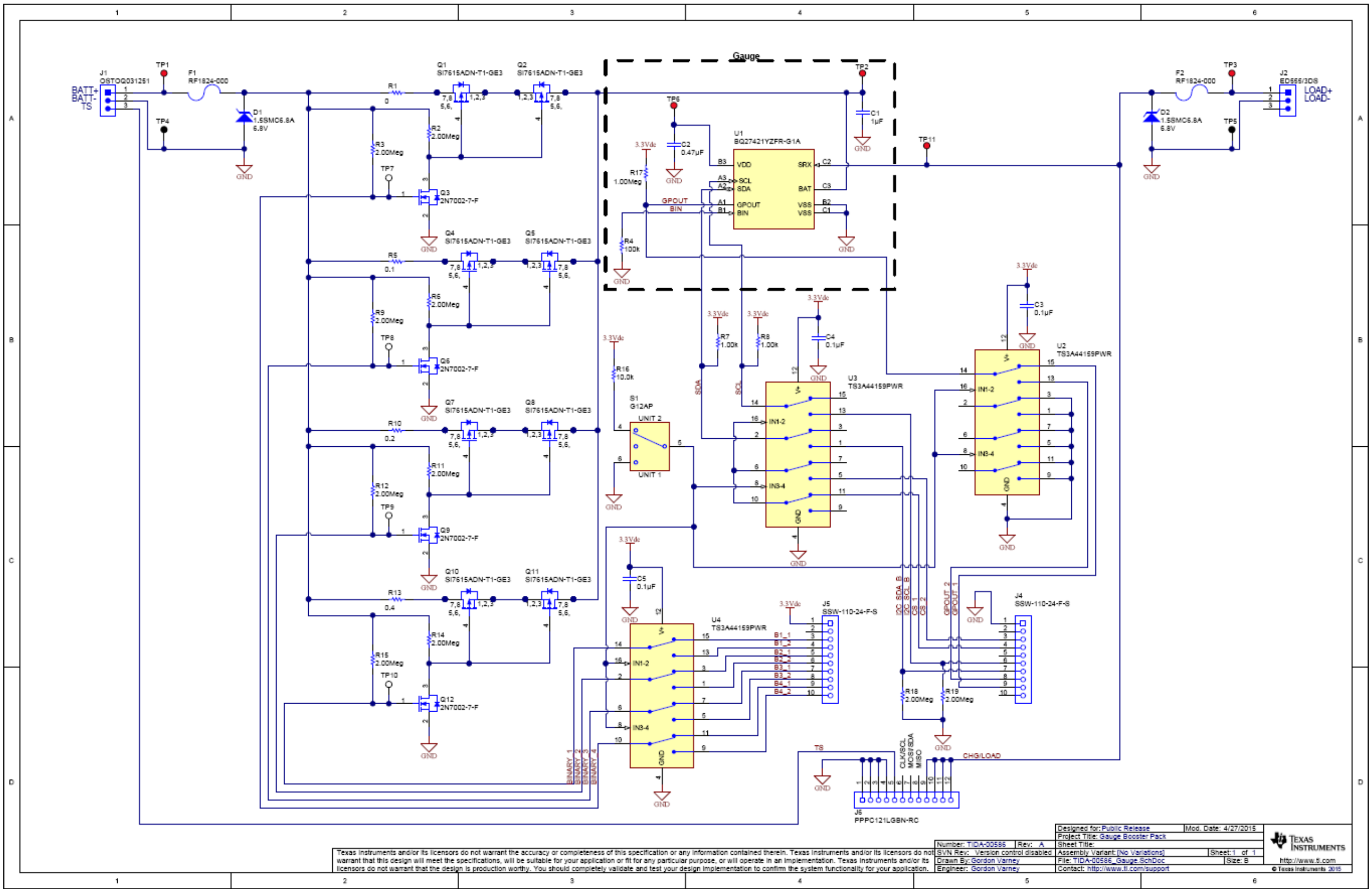




6 Design Files

6.1 Schematics

To download the Schematics for each board, see the design files at http://www.ti.com/tool/TIDA-00586



6.2 Bill of Materials

Texas Instruments

Bill of Materials

TI DESIGNS
Gauge Booster Pack
TIDA-00586

Designator	Description	Manufacturer	PartNumber	Quantity
!PCB1	Printed Circuit Board	Any	TIDA-00586	1
C1	CAP, CERM, 1uF, 10V, +/-10%, X5R, 0402	MuRata	GRM155R61A105KE15D	1
C2	CAP, CERM, 0.47uF, 6.3V, +/-10%, X5R, 0402	MuRata	GRM155R60J474KE19D	1
C3	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0603	Kemet	C0603C104K3RACTU	1
C4	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0603	Kemet	C0603C104K3RACTU	1
C5	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0603	Kemet	C0603C104K3RACTU	1
D1	Diode, TVS, Uni, 6.8V, 1500W, SMC	Littelfuse	1.5SMC6.8A	1
D2	Diode, TVS, Uni, 6.8V, 1500W, SMC	Littelfuse	1.5SMC6.8A	1
F1	Fuse, Resettable, 1.9A, 6V, SMD	TE Connectivity	RF1824-000	1
F2	Fuse, Resettable, 1.9A, 6V, SMD	TE Connectivity	RF1824-000	1
FID1	Fiducial mark. There is nothing to buy or mount.	N/A	N/A	1
FID2	Fiducial mark. There is nothing to buy or mount.	N/A	N/A	1
FID3	Fiducial mark. There is nothing to buy or mount.	N/A	N/A	1
J1	Header, 3x1 3.5mm, TH	On-Shore Technology	OSTOQ031251	1
J2	Terminal Block, 6A, 3.5mm Pitch, 3-Pos, TH	On-Shore Technology	ED555/3DS	1
J4	Connector, Receptacle, 100mil, 10x1, Gold plated, TH	Samtec	SSW-110-24-F-S	1
J5	Connector, Receptacle, 100mil, 10x1, Gold plated, TH	Samtec	SSW-110-24-F-S	1
J6	Header, 12x1, 100mil, R/A, TH	Sullins Connector Solutions	PPPC121LGBN-RC	1
LBL1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	Brady	THT-14-423-10	1
Q1	MOSFET, P-CH, -20V, -22.1A, PowerPAK 1212	Vishay-Siliconix	SI7615ADN-T1-GE3	1
Q2	MOSFET, P-CH, -20V, -22.1A, PowerPAK 1212	Vishay-Siliconix	SI7615ADN-T1-GE3	1
Q3	MOSFET, N-CH, 60V, 0.17A, SOT-23	Diodes Inc.	2N7002-7-F	1
Q4	MOSFET, P-CH, -20V, -22.1A, PowerPAK 1212	Vishay-Siliconix	SI7615ADN-T1-GE3	1
Q5	MOSFET, P-CH, -20V, -22.1A, PowerPAK 1212	Vishay-Siliconix	SI7615ADN-T1-GE3	1
Q6	MOSFET, N-CH, 60V, 0.17A, SOT-23	Diodes Inc.	2N7002-7-F	1
Q7	MOSFET, P-CH, -20V, -22.1A, PowerPAK 1212	Vishay-Siliconix	SI7615ADN-T1-GE3	1
Q8	MOSFET, P-CH, -20V, -22.1A, PowerPAK 1212	Vishay-Siliconix	SI7615ADN-T1-GE3	1
Q9	MOSFET, N-CH, 60V, 0.17A, SOT-23	Diodes Inc.	2N7002-7-F	1
Q10	MOSFET, P-CH, -20V, -22.1A, PowerPAK 1212	Vishay-Siliconix	SI7615ADN-T1-GE3	1
Q11	MOSFET, P-CH, -20V, -22.1A, PowerPAK 1212	Vishay-Siliconix	SI7615ADN-T1-GE3	1
Q12	MOSFET, N-CH, 60V, 0.17A, SOT-23	Diodes Inc.	2N7002-7-F	1
R1	RES, 0 ohm, 5%, 0.25W, 1206	Vishay-Dale	CRCW12060000Z0EA	1
R2	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
R3	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
R4	RES, 100k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603100KFKEA	1
R5	RES, 0.1 ohm, 1%, 1W, 2010	Stackpole Electronics Inc	CSRN2010FKR100	1
R6	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
R7	RES, 1.00k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031K00FKEA	1
R8	RES, 1.00k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031K00FKEA	1
R9	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
R10	RES, 0.2 ohm, 1%, 1W, 2010	Stackpole Electronics Inc	CSRN2010FKR200	1
R11	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
R12	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
R13	RES, 0.4 ohm, 1%, 1W, 2010	Stackpole Electronics Inc	CSRN2010FKR400	1
R14	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
R15	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
R16	RES, 10.0k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060310K0FKEA	1
R17	RES, 1.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031M00FKEA	1
R18	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
R19	RES, 2.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06032M00FKEA	1
S1	Switch, Toggle, SPDT 1Pos, TH	NKK Switches	G12AP	1
TP1	Test Point, Miniature, Red, TH	Keystone	5000	1
TP2	Test Point, Miniature, Red, TH	Keystone	5000	1
TP3	Test Point, Miniature, Red, TH	Keystone	5000	1
TP4	Test Point, Miniature, Black, TH	Keystone	5001	1
TP5	Test Point, Miniature, Black, TH	Keystone	5001	1
TP6	Test Point, Miniature, Red, TH	Keystone	5000	1
TP7	Test Point, Miniature, White, TH	Keystone	5002	1
TP8	Test Point, Miniature, White, TH	Keystone	5002	1
TP9	Test Point, Miniature, White, TH	Keystone	5002	1
TP10	Test Point, Miniature, White, TH	Keystone	5002	1
TP11	Test Point, Miniature, Red, TH	Keystone	5000	1
U1	System-Side Impedance Track Fuel Gauge With Integrated Sense Resistor, YZF0009AKAL	Texas Instruments	BQ27421YZFR-G1A	1
U2	0.45 ohm QUAD SPDT ANALOG SWITCH QUAD-CHANNEL 2:1 MULTIPLEXER/DEMULTIPLEXER WITH TWO CONTROLS, PW0016A	Texas Instruments	TS3A44159PWR	1
U3	0.45 ohm QUAD SPDT ANALOG SWITCH QUAD-CHANNEL 2:1 MULTIPLEXER/DEMULTIPLEXER WITH TWO CONTROLS, PW0016A	Texas Instruments	TS3A44159PWR	1
U4	0.45 ohm QUAD SPDT ANALOG SWITCH QUAD-CHANNEL 2:1 MULTIPLEXER/DEMULTIPLEXER WITH TWO CONTROLS, PW0016A	Texas Instruments	TS3A44159PWR	1
ZZ2	This is the mating Plug for Connector J1	On-Shore Technology	OSTTJ0311530	1

6.3 PCB Layout Recommendations

The Single-Cell Gas Gauge circuit has minimal components in the reference design. This design is for a 1-cell application.

6.3.1 High-Current Path

The high-current path begins at the PACK+ terminal of the battery pack. The charge current travels through PCB to the BAT pin and the internal current sense resister and out the SRX pin, it finds its way through the lithium-ion cell and cell connections, the sense resistor, protection FETs and then returns to the PACK– terminal (see the reference design schematic at the end of this document). In addition, some components are placed across the PACK+ and PACK– terminals to reduce effects from electrostatic discharge. Keep all traces and connections in the current path as low of an impedance as possible.

6.3.2 Power Supply Decoupling

Power supply decoupling is important for optimal operation of the single cell gas gauges.

6.3.2.1 VDD

A single 0.1-µF ceramic decoupling capacitor from VDD to VSS must be placed adjacent to the IC pins.

6.3.2.2 BAT

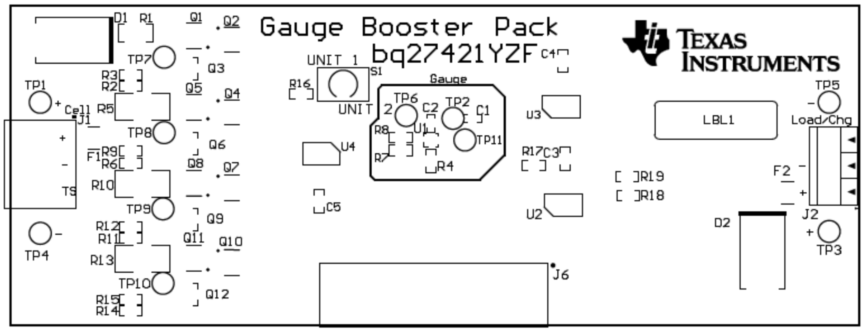
The BAT pin is the LDO regulator input, battery voltage input, and coulomb counter input and is typically connected to the PACK+ terminal. A single 0.1-µF ceramic decoupling capacitor from BAT to VSS must be placed adjacent to the IC pins.

6.3.2.3 SRX

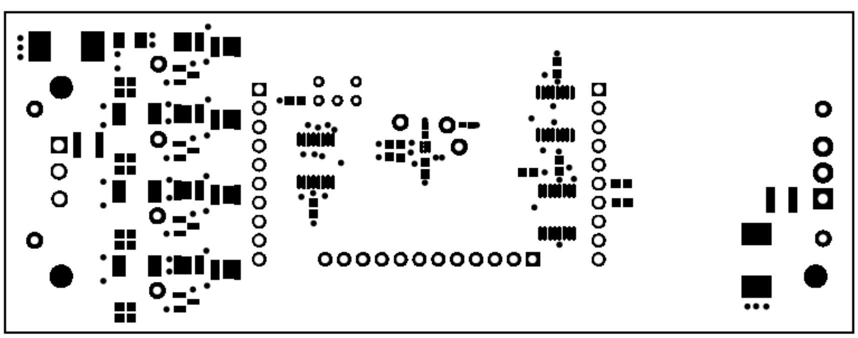
The SRX pin is Integrated high-side sense resistor and coulomb counter input typically connected to system power rail VSYS.

6.4 Layout Prints

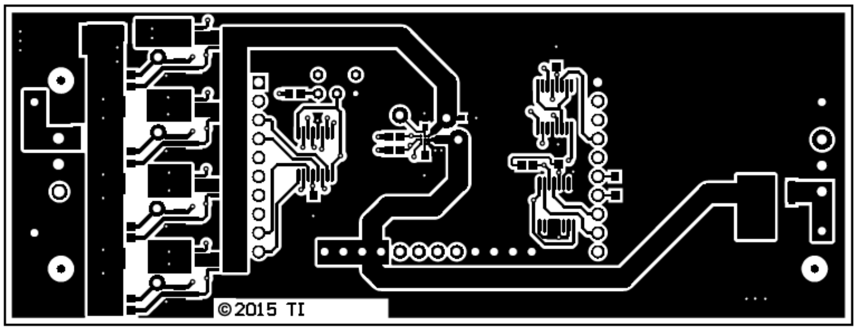
To download the Layout Prints for each board, see the design files at http://www.ti.com/tool/TIDA-00586



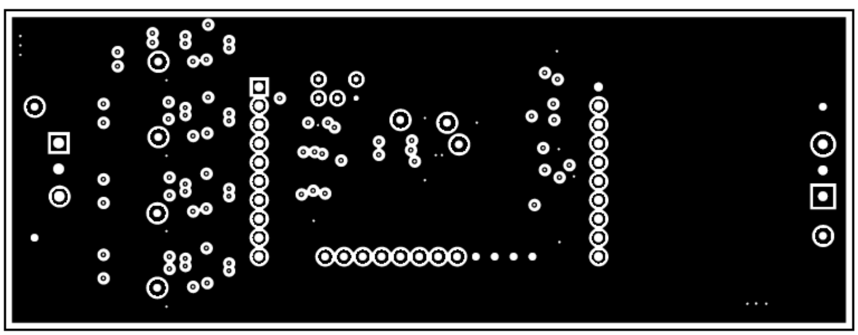
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00586	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Top Overlay			
PLOT NAME = Top Overlay	GENERATED : 6/22/2015 12:14:41 PM		TEXAS INSTRUMENTS



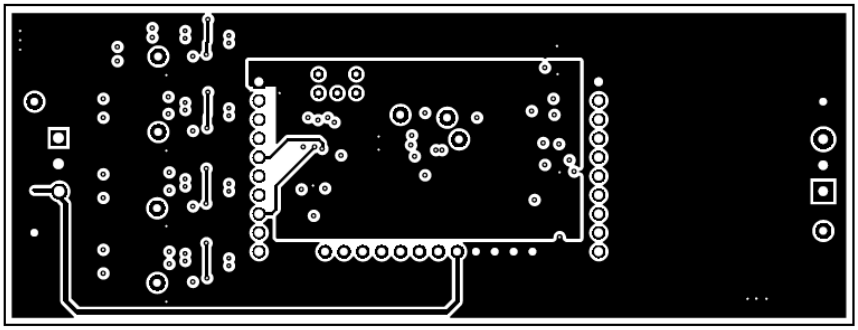
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00586	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Top Solder			
PLOT NAME = Top Solder Mask	GENERATED : 6/22/2015 12:14:42 PM		TEXAS INSTRUMENTS



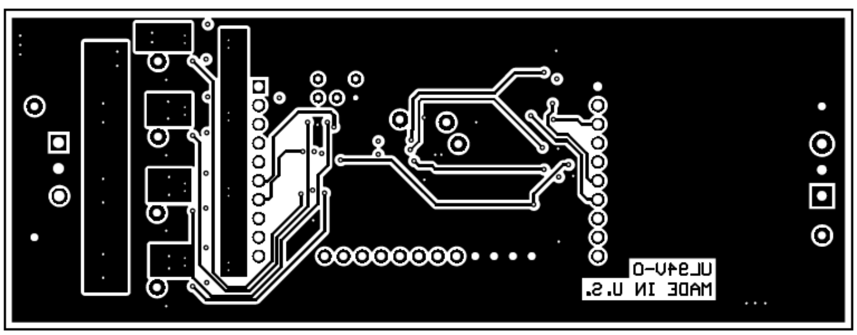
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00586	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Top Layer			
PLOT NAME = Top Layer	GENERATED : 6/22/2015 12:14:43 PM		TEXAS INSTRUMENTS



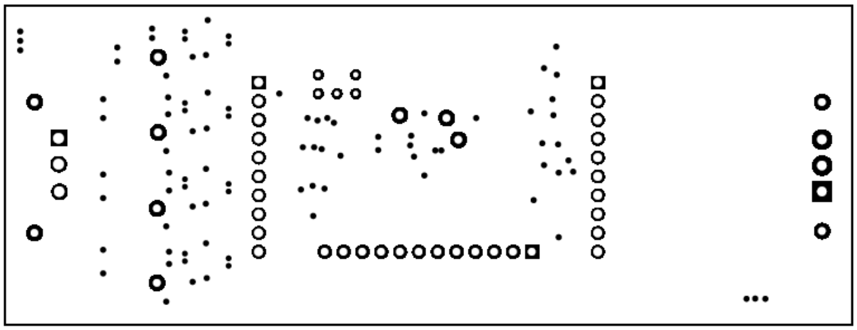
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00586	REV: A	SVN REV: Not In VersionControl
LAYER NAME = M1 Board Outline			
PLOT NAME = Middle Layer 1	GENERATED : 6/22/2015 12:14:43 PM		TEXAS INSTRUMENTS



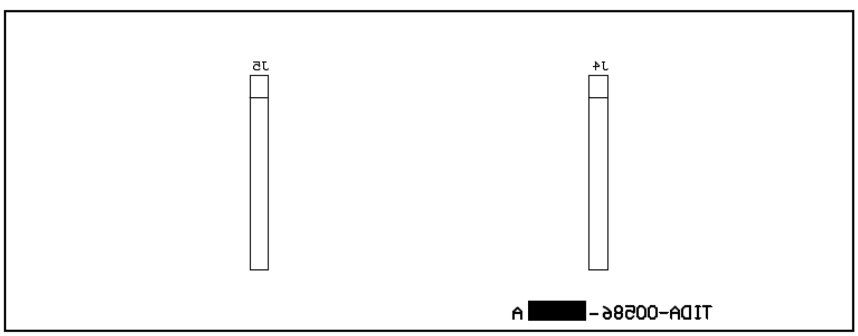
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00586	REV: A	SVN REV: Not In VersionControl
LAYER NAME = M1 Board Outline			
PLOT NAME = Middle Layer 2	GENERATED : 6/22/2015 12:14:44 PM		TEXAS INSTRUMENTS



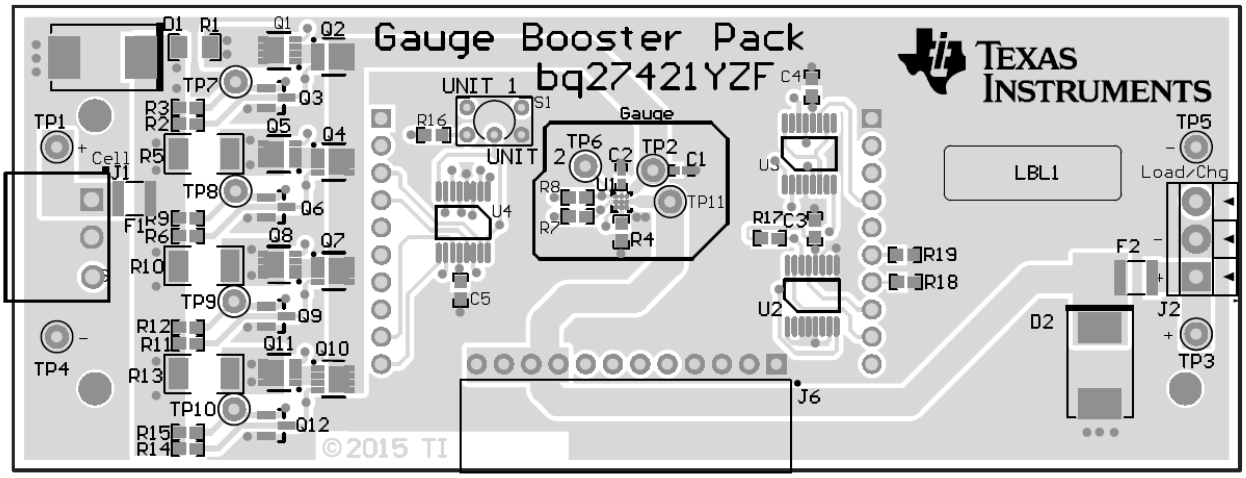
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00586	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Bottom Layer			
PLOT NAME = Bottom Layer	GENERATED : 6/22/2015 12:14:46 PM		TEXAS INSTRUMENTS

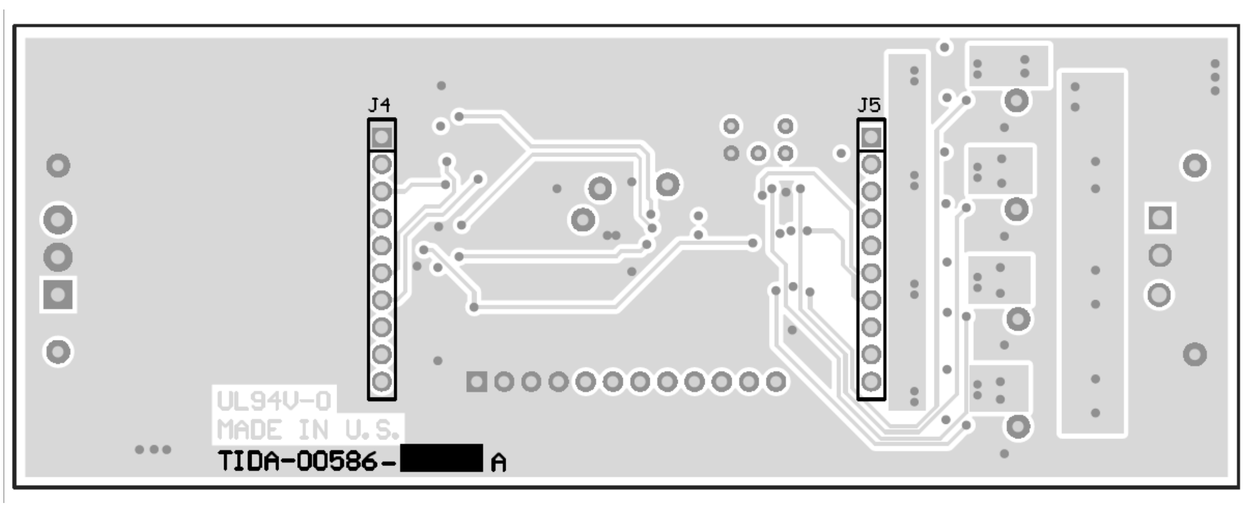


ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00586	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Bottom Solder			
PLOT NAME = Bottom Solder Mask	GENERATED : 6/22/2015 12:14:46 PM		TEXAS INSTRUMENTS



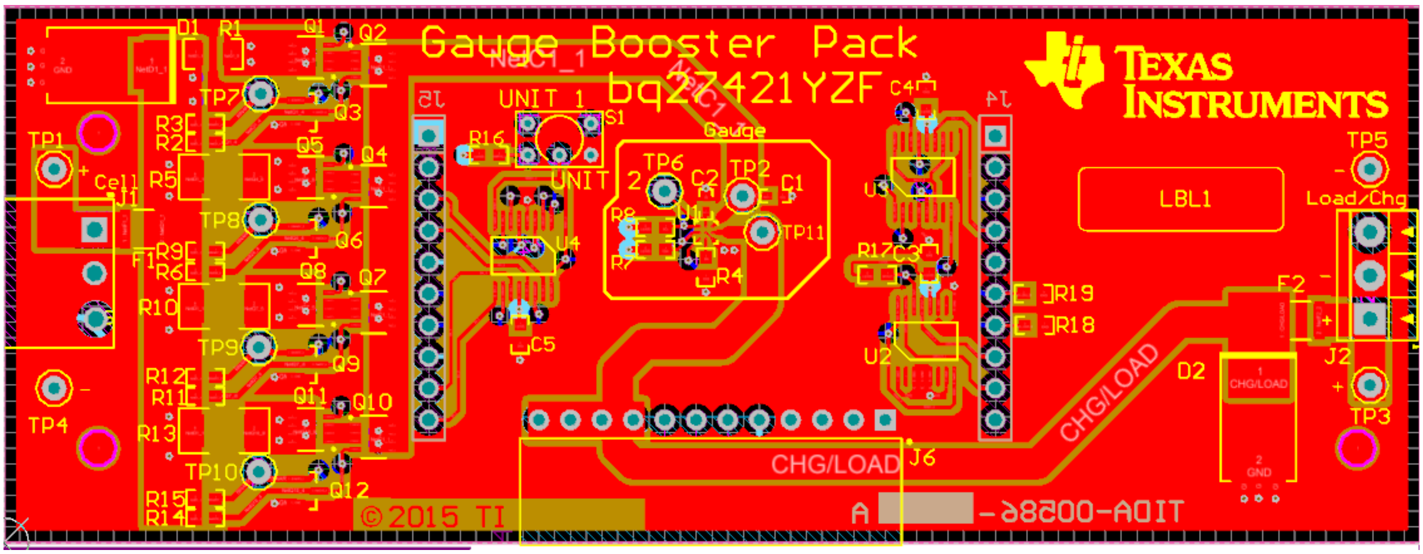
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: TIDA-00586	REV: A	SVN REV: Not In VersionControl
LAYER NAME = Bottom Overlay			
PLOT NAME = Bottom Overlay	GENERATED : 6/22/2015 12:14:47 PM		TEXAS INSTRUMENTS

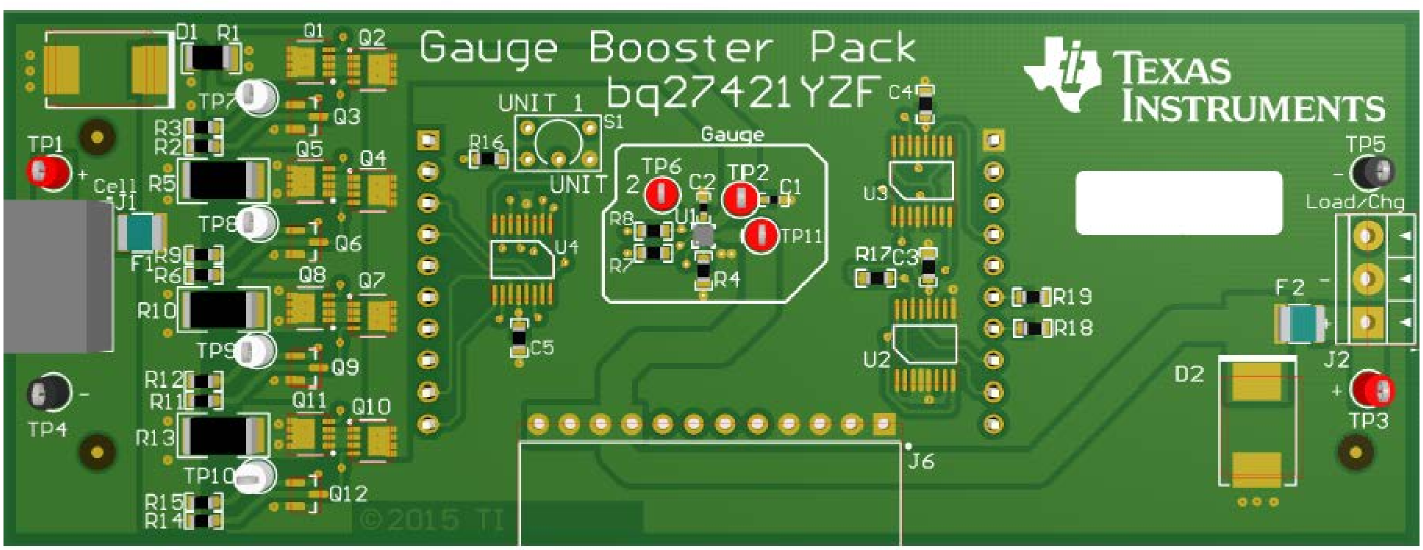

Gauge Booster Pack
bq27421YZF
Texas Instruments
UNIT 1
UNIT 2
Gauge
LBL1
Load/Chg
Cell
©2015 TI


J4
J5
UL94V-0
MADE IN U.S.
TIDA-00586-[redacted] A

6.5 Altium Project

To download the Altium project files for each board, see the design files at http://www.ti.com/tool/TIDA-00586





Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265