User's Guide
SLUU292–September 2007

bq2431x DSJ EVM (HPA251) for Li+ Charger Front-End Protection IC

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- Battery overvoltage protection
- LED indication for status signals
- Test points for key signals available for testing purpose. Easy probe hook-up
- Jumpers available. Easy to change connections

1.2 General Description

The bq2431x evaluation module is a complete charger module for evaluating a charger front-end protection and charger solution using the bq2431x and bq24080 devices. It is designed to deliver up to 700 mA of charge current to Li-ion or Li-polymer applications. The charger front-end protection current is designed to 1000 mA.

The bq2431x protects the charging system against three types of failures: input overvoltage when the AC adapter fails to regulate its voltage; load overcurrent when failures such as a short circuit occur in the charging system; and battery overcharge.

For details, see the bq2431x data sheet (SLUS763).

1.3 I/O Description

Jack	Description
J1-OUT	CFE OUT pin
J1-DC–	CFE VSS pin, ground
J1-BAT+	Connect to battery positive output
J1-$\overline{\text{FAULT}}$	CFE $\overline{\text{FAULT}}$ pin
J2-CHGIN	bq24080 IN pin, connect to external power supply positive output
J2-DC–	bq24080 VSS pin, ground
J3-BAT+	Connect to battery positive output
J3-BAT–	Connect to battery negative output, ground
J4-DC+	AC adapter, positive output
J4-DC–	AC adapter, negative output, ground

1.4 Controls and Key Parameters Setting

Jack	Description	Factory Setting
JMP1	CFE OUT pin is connected to bq24080 IN pin	Jumper Off
JMP2	CFE input voltage is indicated by LED	Jumper On
JMP3	CFE output voltage is indicated by LED	Jumper On
JMP4	CFE $\overline{\text{CE}}$ pin is connected to 5 V	Jumper On
JMP5	Bq24080 STAT1 pin is indicated by LED	Jumper On
JMP6	Bq24080 STAT2 pin is indicated by LED	Jumper On
JMP7	Bq24080 $\overline{\text{PG}}$ pin is indicated by LED	Jumper On
JMP8	Bq24080 $\overline{\text{CE}}$ pin is connected to 5 V	Jumper On

1.5 Recommended Operating Conditions

Symbol	Description	Min	Typ	Max	Unit	Notes
Supply voltage, V_{IN}	Input voltage from AC adapter input	4.5	5	26	V	
Battery voltage, V_{BAT}	Voltage applied at VBAT terminal of J4	0	3 - 4.2	5	V	
Supply current, I_{AC}	Maximum input current from AC adapter input	0		1.5	A	
Charge current, I_{chrg}	Battery charge current	0.07	0.7	1	A	
Operating junction temperature range, T_J		0		125	°C	

2 Test Summary

2.1 Definitions

This procedure details how to configure the HPA251 evaluation board. On the test procedure, the following naming conventions are followed. See the HPA251 schematic for details.

VXXX :	External voltage supply name (VIN, VBAT, VOUT)
LOADW:	External load name (LOADR, LOADI)
V(TPyyy) :	Voltage at internal test point TPyyy. For example, V(TP1) means the voltage at TP1.
V(Jxx):	Voltage at jack terminal Jxx
V[TP(XXXXX)]:	Voltage at test point *XXXXX*. For example, V(ACDET) means the voltage at the test point which is marked as *ACDET*.
V(XXX, YYY):	Voltage across point XXX and YYY
I[JXX(YYY)]:	Current going out from the YYY terminal of jack XX
Jxx(BBB):	Terminal or pin BBB of jack xx
Jxx ON :	Internal jumper Jxx terminals are shorted.
Jxx OFF:	Internal jumper Jxx terminals are open.
Jxx (-YY-) ON:	Internal jumper Jxx adjacent terminals marked as *YY* are shorted.
Measure:	A,B Check specified parameters A, B. If measured values are not within specified limits, the unit under test has failed.
Observe:	A,B Observe if A, B occur. If they do not occur, the unit under test has failed.

Assembly drawings have location for jumpers, test points, and individual components.

2.2 Equipment

2.2.1 Power Supplies

Power Supply #1 (PS#1): a power supply capable of supplying 20 V at 2 A is required.
Power Supply #2 (PS#2): a power supply capable of supplying 5 V at 1 A is required.

2.2.2 Load #1

A 10-V (or above), 2-A (or above) electronic load that can operate at constant current mode

2.2.3 Load #2

A 10-V (or above), 2-A (or above) electronic load that can operate at constant voltage mode

2.2.4 Meters

Four Fluke 75 multimeters, (equivalent or better)
Or: Three equivalent voltage meters and one equivalent current meter. The current meters must be capable of measuring 2-A+ current.

2.2.5 Wire Gauge

All wires connected to EVM input power supply and output load should use at least AWG 22. The maximum current is up to 1 A.

2.3 Equipment Setup

A. Set the power supply #1 for 0 V ±100 mVDC, 2 ±0.1-A current limit and then disable the output.
B. Connect the output of power supply #1 to J4 (DC+, DC–).
C. Connect a voltage meter across J4 (DC+, DC–).
D. Set the power supply #2 for 3.7 V ±100 mVDC, 0.2 ±0.1-A current limit and then disable the output.

E. Connect power supply#2 to J1 (BAT+, DC–).
F. Connect a voltage meter across J1 (BAT+, DC–).
G. Connect the output of the Load #1 in series with a current meter (multimeter) to J1 (OUT, DC–). Ensure that a voltage meter is connected across J1 (OUT, DC–). Turn on the power of the Load #1. Set the load current to 0.75 A ±100 mA but disable the output.
H. JMP1: OFF, JMP2: ON, JMP3: ON, JMP4: ON, JMP5: ON, JMP6: ON, JMP7: ON, JMP8: ON.

After the preceding steps, the test setup for HPA251 (bq2431x DSG EVM) is as shown in Figure 1.

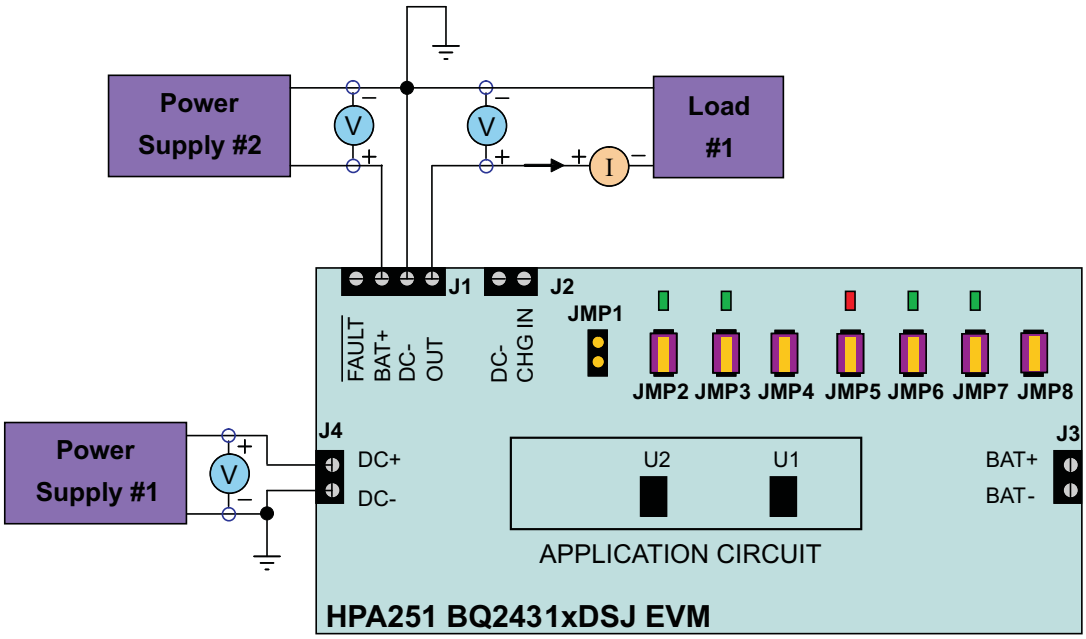


Figure 1. Original Test Setup for HPA251 (bq2431x DSJ EVM)

2.4 Procedure

2.4.1 CFE ENABLE and Voltage Regulation

1. Ensure that the preceding Equipment Setup steps are followed.
2. Enable output of PS#2.
3. Enable output of PS#1.
4. Increase the output voltage of PS#1 to 5 V ±0.1 V.
   Measure → V(J1(OUT)) = 0 V ±500 mV
   Observe → D2 on, D3 off.
5. Uninstall JMP4 (enable U2).
   Measure → V(J1(OUT)) = 5 V ±200 mV.
   Observe → D2 on, D3 on.

2.4.2 CFE Input Overvoltage Protection

1. Increase the voltage of PS#1 to 8 V ±0.1 V
   Measure → V(J1(OUT)) = 0 V ±500 mV.
   Observe → D2 on, D3 off.
2. Decrease the voltage of PS#1 to 5 V ±0.1 V.
   Observe → D2 on, D3 on.

2.4.3 CFE Load Overcurrent Protection

1. Enable the output of the Load #1.
   Observe → D2 on, D3 on.
2. Increase the current of Load #1 to 1.2 A ±0.1 A.
   Observe → D2 on, D3 off.
3. Turn off Load #1.
4. Decrease the voltage of PS#1 to 0 V ±0.1 V.

2.4.4 CFE Battery Overvoltage Protection

1. Increase the output voltage of PS#1 to 5V± 0.1V.
   Observe → D2 on, D3 on.
2. Increase the voltage of PS #2 to 4.6 V ±0.1 V.
   Observe → D2 on, D3 off.
3. Decrease the voltage of PS #2 to 3.7 V ±0.1 V.
   Observe → D2 on, D3 on.
4. Turn off all the power supplies and loads. Remove all connection between test board and power supplies or loads.

2.4.5 Charge IC Test Setup

1. Set the power supply #1 for 0 V ±100 mVDC, 2-A ±0.1-A current limit and then disable the output.
2. Connect the output of power supply #1 to J2 (CHG IN, DC–).
3. Connect a voltage meter across J2 (CHG IN, DC–).
4. Set the voltage of Load #2 to 3.6 V ±0.1 V, disable output of Load #2.
5. Connect output of the Load #2 in series with a current meter (multimeter) to J3 (BAT+, BAT–). Ensure that a voltage meter is connected across J3 (BAT+, BAT–).
6. JMP1: OFF, JMP2: ON, JMP3: ON, JMP4: ON, JMP5: ON, JMP6: ON, JMP7: ON, JMP8: ON
7. After the preceding steps, the test setup for HPA251 (bq2431x DSJ EVM) is as shown in Figure 2.

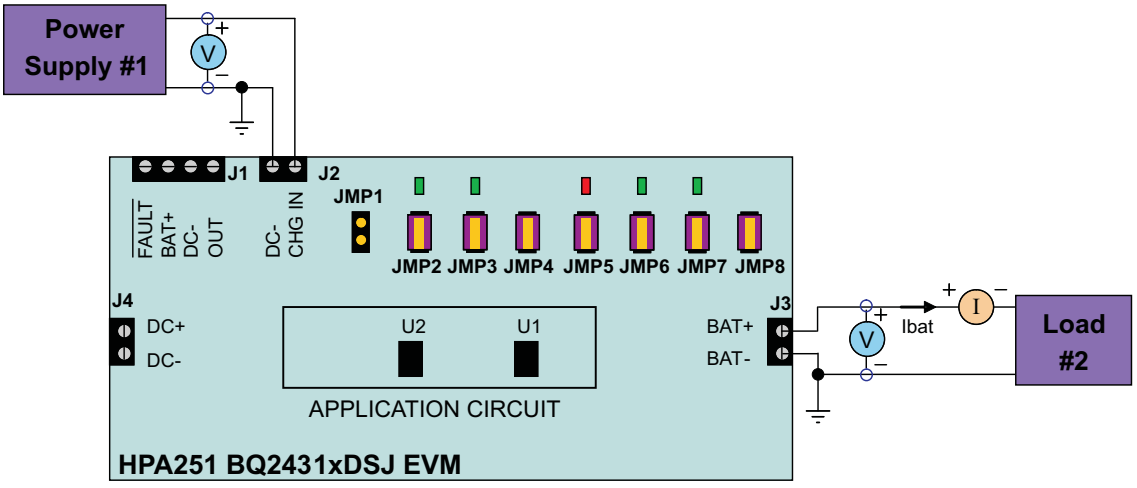


Figure 2. Charger IC Test Setup for HPA251 (bq2431x DSJ EVM)

2.4.6 Charge IC Test

1. Enable output of Load #2.
2. Enable output of PS#1.
3. Increase the voltage of PS #1 to 5 V ±0.1 V.

Observe → D4 off, D5 off, D6 on.

4. Uninstall JMP8 (enable U1).
   Measure → Ibat = 700 mA ±70 mA.
   Observe → D4 on, D5 off, D6 on.
5. Disable the output of Load #2.
6. Disable the output of PS#1, and remove PS #1 from J2.

2.4.7 CFE and Charge IC Chipset Test Setup

1. Connect the output of power supply #1 to J4 (DC+, DC–).
2. Connect a voltage meter across J4 (DC+, DC–).
3. JMP1: ON, JMP2: ON, JMP3: ON, JMP4: OFF, JMP5: ON, JMP6: ON, JMP7: ON, JMP8: OFF.
4. After the preceding steps, the test setup for HPA251 (bq2431x DSJ EVM) is as shown in Figure 3.

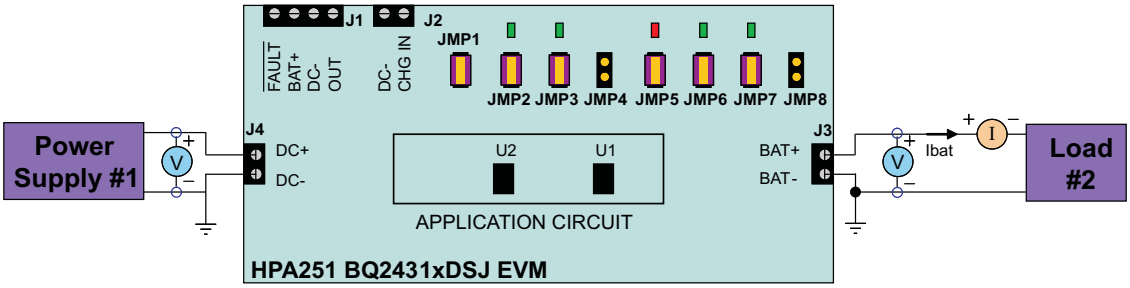


Figure 3. Chipset Test Setup for HPA251 (bq2431x DSJ EVM)

2.4.8 CFE and Charge IC Chipset Test

1. Enable output of Load #2.
2. Enable output of PS#1.
   Measure → Ibat = 700 mA ±70 mA.
   Observe → D2 on, D3 on, D4 on, D5 off, D6 on.

3 PCB Layout Guideline

1. It is critical that the exposed power pad on the backside of the bq2430x/1x package be soldered to the PCB ground. Ensure that sufficient thermal vias are right underneath the IC, connecting to the ground plane on the other layers.
2. The high-current charge paths into IN and from OUT pins must be sized appropriately for the maximum charge current in order to avoid voltage drops in these traces.
3. Decoupling capacitors for IN, OUT should be placed so that the interconnections to the IC are as short as possible.
4. Resistors for ILIM and VLIM must be placed close to the corresponding IC pins so that the interconnections to the IC are as short as possible.

4 Bill of Materials, Board Layout, and Schematics

4.1 Bill of Materials

bq24314 -001	bq24316 -002	RefDes	Value	Description	Size	Part Number	MFR
3	32	C1, C2, C5	1 µF	Capacitor, Ceramic, 16-V, X7R, 10%	805	Std	Std
0	0	C3	OPEN	Capacitor, Ceramic, 35-V, X7R, 10%	805	Std	Std
1	1	C4	1 µF	Capacitor, Ceramic, 35-V, X7R, 10%	805	Std	Std
1	1	D1	BZT52C5V1S	Diode, Zener, 200 mW, 5.1V	SOD-323	BZT52C5V1S	General
4	4	D2, D3, D5, D6	Green	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	603	LTST-C190GKT	Liteon
1	1	D4	Red	Diode, LED, Red, 1.8-V, 20-mA, 20-mcd	603	LTST-C190CKT	Liteon
1	1	J1	ED1516	Terminal Block, 4-pin, 6-A, 3,5mm	0.55 x 0.25 inch	ED1516	OST
3	3	J2–J4	ED1514	Terminal Block, 2-pin, 6-A, 3,5mm	0.27 x 0.25 inch	ED1514	OST
8	8	JMP1–JMP8	PTC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PTC36SAAN	Sullins
8	8	JMP1–JMP8	929950-00	Shorting jumpers, 2-pin, 100mil spacing,		929950-00	3M/ESD
1	1	R1, R4	20k	Resistor, Chip, 1/16-W, 5%	603	Std	Std
1	1	R2	24.9k	Resistor, Chip, 1/16W, 1%	603	Std	Std
1	1	R3	1.13k	Resistor, Chip, 1/16-W, 1%	603	Std	Std
2	2	R5, R6	100k	Resistor, Chip, 1/16W, 5%	603	Std	Std
1	1	R7	6.2k	Resistor, Chip, 1/16-W, 5%	603	Std	Std
5	5	R8–R12	1.5k	Resistor, Chip, 1/16-W, 5%	603	Std	Std
1	1	U1	bq24080DRC	IC, Single Chip, Li Ion/Li POL, Charger	DRC10	bq24080DRC	TI
1	0	U2	bq24314DSJ	IC, Li+ Charger Front-End Protection	DSJ12	bq24314DSJ	TI
0	1	U2	bq24316DSJ	IC, Li+ Charger Front-End Protection	DSJ12	bq24316DSJ	TI
1	1	--	HPA251	PCB, 1.2 In x 3 In x 0.031 In		PCB	Any

Notes: 1. Number 0 in left-side columns means do not use this component.
2. OPEN in value column means do not use this component
3. Std in part number column means standard manufacturer's part number.
4. Std in MFR column means standard manufacturer.

4.2 Board Layout

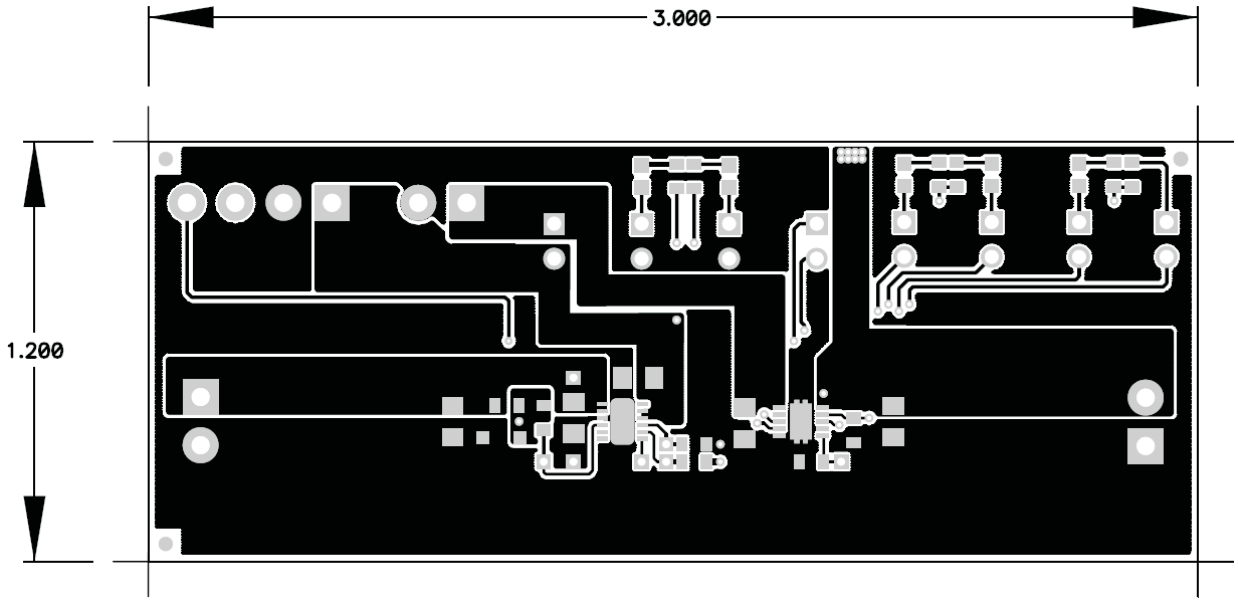


Figure 4. Top Layer

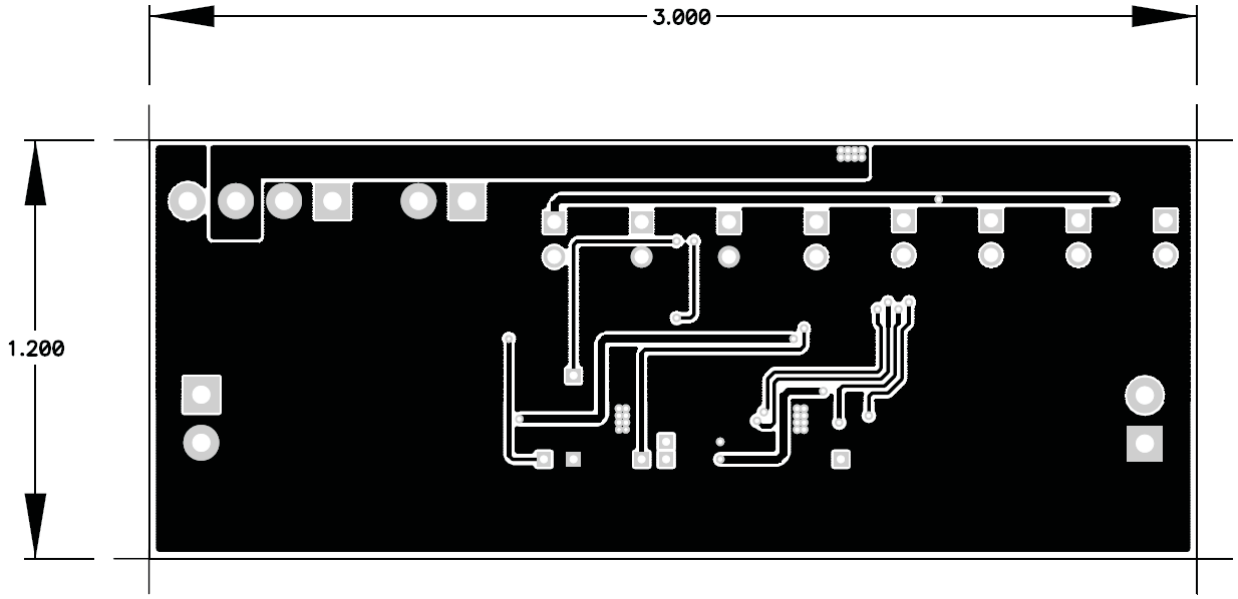


Figure 5. Bottom Layer

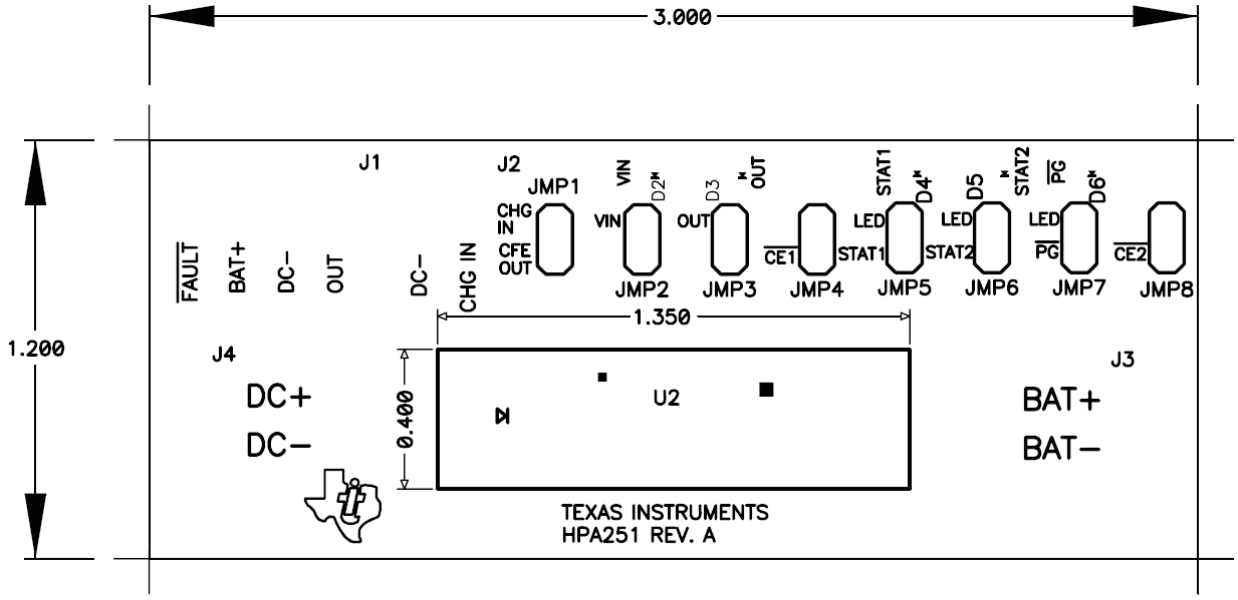


Figure 6. Top Silkscreen

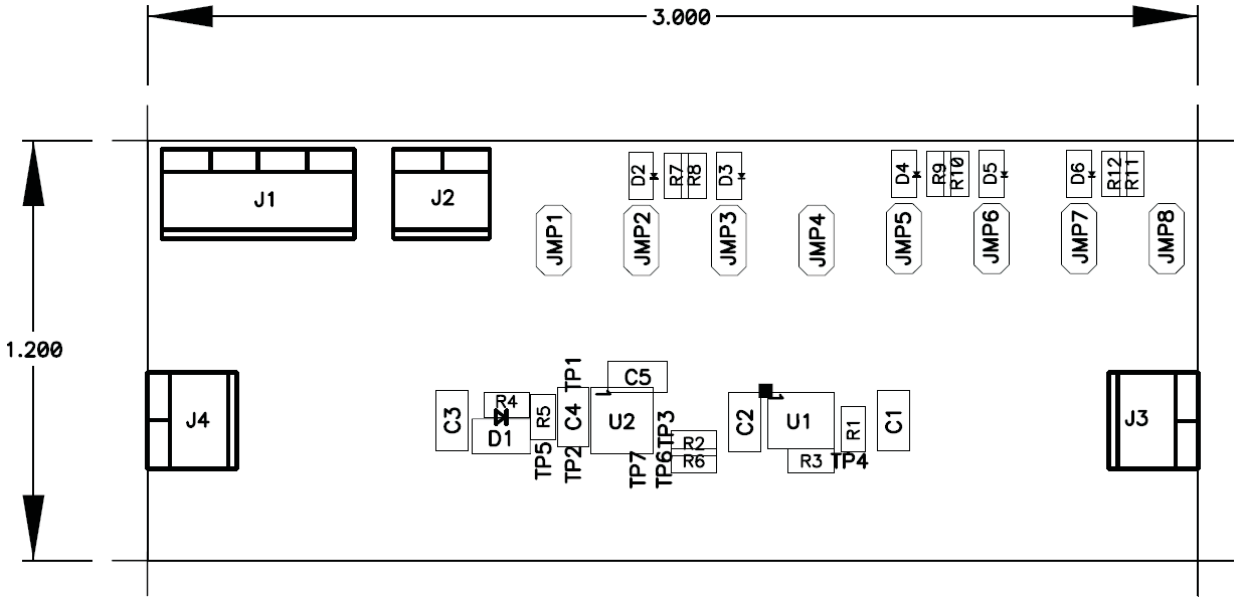
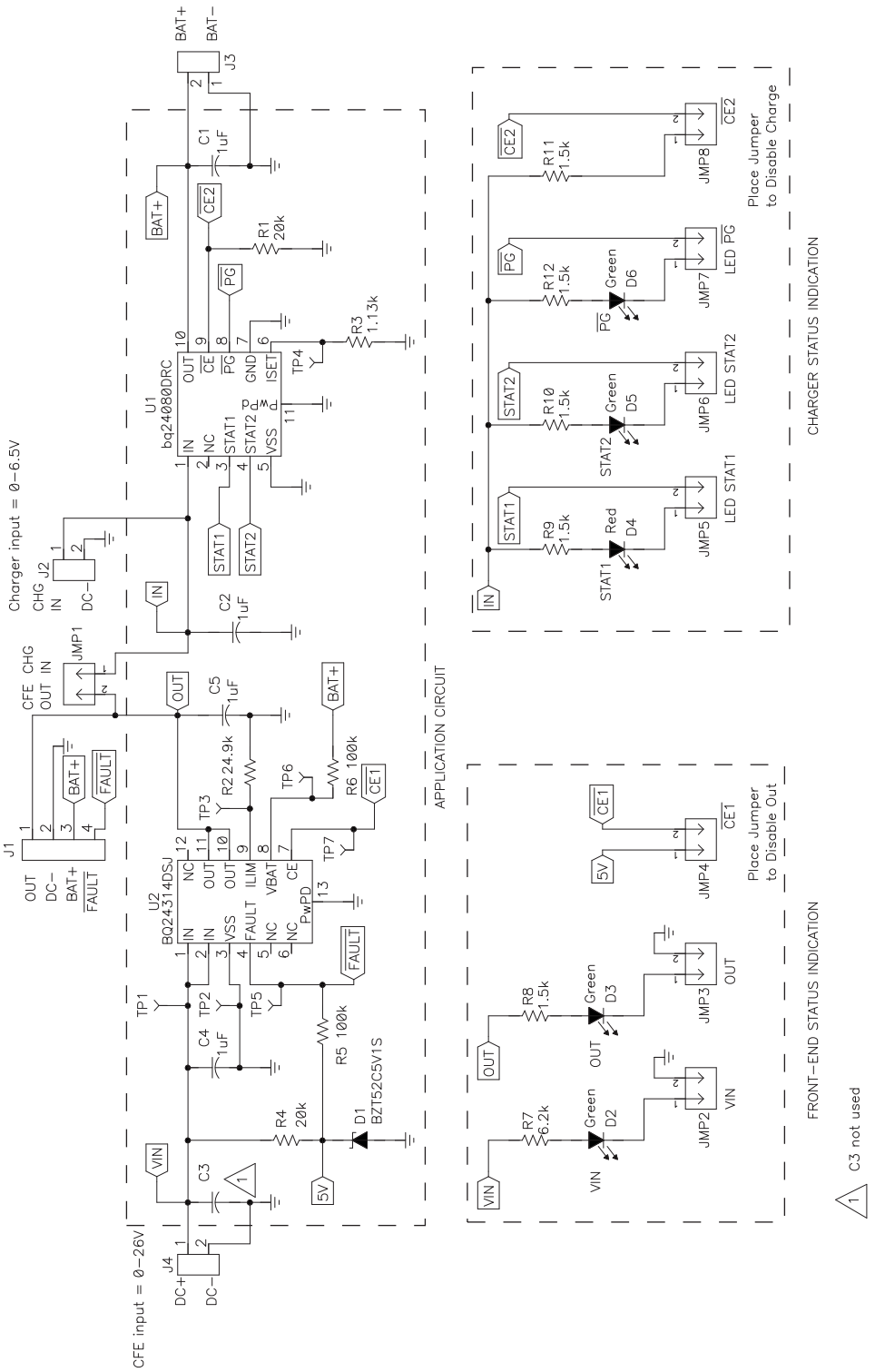


Figure 7. Top Assembly

4.3 Schematic

The bq2431x DSJ EVM schematic follows.



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It is important to operate this EVM within the input voltage range of 4.5 V to 26 V and the output voltage range of 0 V to 4.2 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 70°C. The EVM is designed to operate properly with certain components above 125°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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