bq24351EVM for Li-Ion Charger Front-End Protection IC

This user's guide describes the features, setup, and operation of the bq24351EVM evaluation module. Included are the bill of materials, board layout, and schematic.

Contents

List of Figures

List of Tables

1 Introduction

1.1 General Description

The bq24351 evaluation module (EVM) is a complete charger module for evaluating a charger front-end protection and charger solution using the bq24351 and bq2057C devices. It is designed to deliver up to 560 mA of charge current to Li-ion or Li-polymer applications. The charger front-end protection current is designed to 1.2 A.

The bq24351 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 bq24351 data sheet (SLUSA62).

1.2 EVM Features

- Evaluation module for bq24351 DSG
- Evaluation module for bq2057C charger integrated circuit (IC)
- Input operating range for bq24351 4.5 V–26 V
- Input overvoltage protection.
- Input overcurrent protection.
- Battery overvoltage protection.
- LED indication for status signals.
- Test points for key signals available for testing purposes. Easy probe hook-up
- Jumpers available. Easy to change connections

1.3 I/O Description

Jack	Description
J1–DC+	AC adapter, positive output
J1–DC–	AC adapter, negative output, ground
J2–FAULT	Reserved for other ICs
J2–VBAT	bq24351 VBAT pin
J2–GATDRV	bq24351 GATDRV pin
J2–CHGIN	bq24351 CHGIN pin
J3–BATEN	Reserved for ohter ICs
J3–OUT	bq24351 OUT pin
J3–BAT+	Battery positive output
J3–GND	Ground
J4–BAT+	Connect to battery positive output
J4–BAT–	Connect to battery negative output, ground

1.4 Controls and Key Parameters Setting

Jack [1]	Description	Factory Setting
JP1	If on, high-side sensing resistor is disabled	Jumper on
JP2	Reserved for other ICs	Jumper (BATEN, GND) on
JP3	bq24351 GATDRV pin	Jumper off
JP4	bq2057C BAT pin connection to bq24351	Jumper on
JP5	bq2057C VCC pin connection to bq24351	Jumper on
JP6	bq2057C CC pin connection to bq24351	Jumper on
JP7	If on, low-side current-sensing resistor is disabled	Jumper off

(1) Short JP1, JP4, JP5, and JP6, and disconnect JP7 to use onboard bq2057C as charger; to use external charger to control bq24351, disconnect JP1, JP4, JP5, and JP6 and short JP7.

1.5 Recommended Operating Conditions

Symbol	Description	MIN	TYP	MAX	Unit
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	0.05	0.56	1	A
Operating junction temperature range, T_J		0		125	°C

2 Test Summary

2.1 Definitions

This procedure details how to configure the evaluation board. On the test procedure, the following naming conventions are followed. See the 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 points 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 show locations 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 15 V at 2 A is required.

2.2.2 Load 1

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

2.2.3 Load 2

A 10-V (or above), 2-A (or above) electronic load that can operate in 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 meter must be capable of measuring 2-A+ current.

2.2.5 Wire Gauge

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

2.3 Equipment Setup

1. Set PS 1 for 0 V ±100 mVdc, 2 ± 0.1 A current limit, and then disable the output.
2. Connect the output of PS 1 to J1 (DC+, DC–).
3. Connect a voltage meter across J1 (DC+, DC–).
4. Connect the output of load 1 in series with a current meter (multimeter) to J2 (CHGIN) and J3 (GND). Turn on the power of load 1. Set the load current to 1.5 A ±50 mA, but disable the output.
5. Connect the output of load 2 in series with a current meter (multimeter) to J4 (BAT+, BAT–).
6. Connect a voltage meter across J4 (BAT+, BAT–).
7. Set the voltage of load 2 to 3.6 V ±0.1 V, and disable output of load 2.
8. JP1: ON, JP2 (BATEN, GND): ON, JP3: OFF, JP4: ON, JP5: ON, JP6: ON, JP7: OFF.

After the preceding steps have been taken, the test setup for HPA666 (bq24351 DSG EVM) appears as is shown in Figure 1.

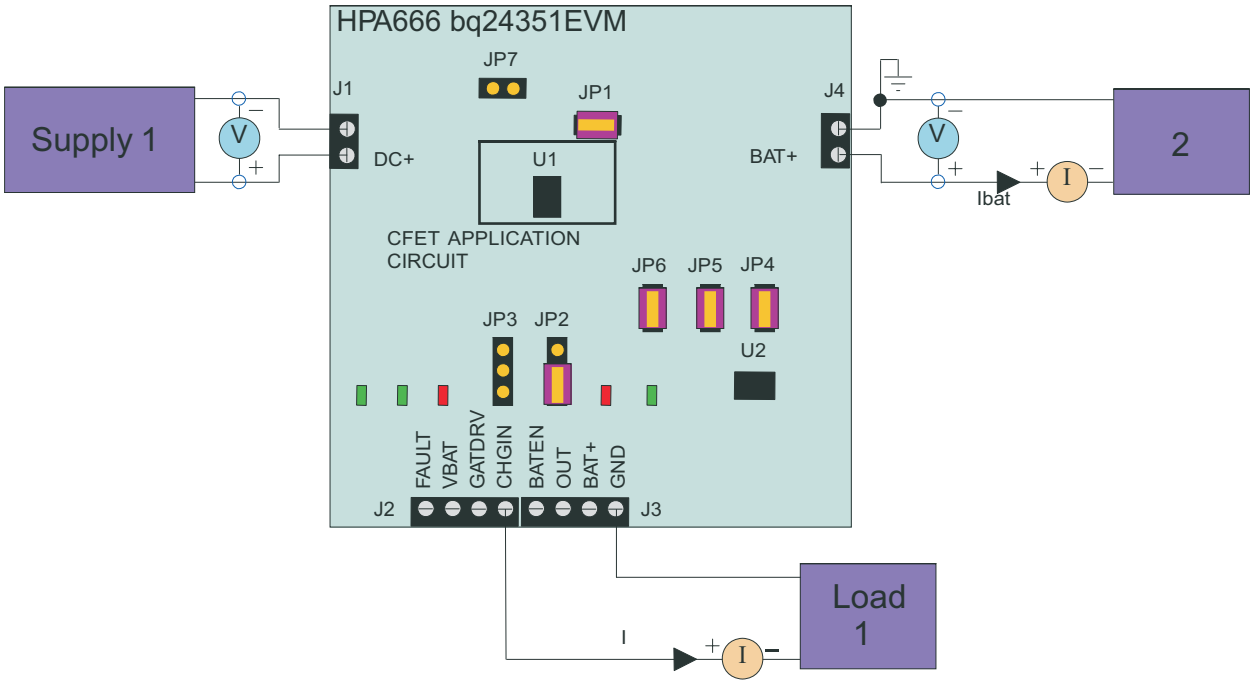

Figure 1. Original Test Setup for HPA666 (bq24351 DSG EVM)

2.4 Procedure

2.4.1 Charger Current and Voltage Regulation

1. Ensure that steps in Section 2.3 are followed.
2. Enable output of PS 1.
3. Increase the output voltage of PS 1 to 5 V ±0.1 V.
4. Enable the output of load 2.
   Measure → V(J2(OUT)) = 3.6 V ±200 mV
   Measure → Ibat = 560 mA ±70 mA
   Observe → D2 on, D3 on, D6 off, D7 on.

2.4.2 CFET Input Overvoltage Protection

1. Increase the voltage of PS 1 to 11 V ±0.1 V.
   Observe → D2 on, D3 off, D6 off, D7 off.
2. Decrease the voltage of PS 1 to 5 V ±0.1 V.
   Observe → D2 on, D3 on, D6 off, D7 on.

2.4.3 CFET Load Overcurrent Protection

1. Enable the output of load 1.
   Observe → D2 on, D3 off, D6 off, D7 off.
2. Disable the output of load 1.
   Observe → D2 on, D3 on, D6 off, D7 on.
3. Decrease the voltage of PS 1 to 0 V ±0.1 V.

3 PCB Layout Guideline

1. It is critical that the exposed thermal pad on the back side of the bq24351 package be soldered to the printed-circuit board (PCB) ground. Ensure that sufficient thermal vias are located underneath the IC, connecting to the ground plane on the other layers.
2. The high-current charge paths into ACIN and from the CHGIN and OUT pins must be sized appropriately for the maximum charge current in order to avoid excessive voltage drops in these traces.
3. Decoupling capacitors for ACIN and CHGIN must be placed to make the interconnections to the IC as short as possible.
4. Resistors for VBAT pin must be placed close to the corresponding IC pins and make the interconnections to the IC as short as possible.

4 Bill of Materials, Board Layout, and Schematic

4.1 Bill of Materials

Table 1. Bill of Materials

bq24351	RefDes	Value	Description	Size	Part Number	MFR
1	C1	1 µF	Capacitor, ceramic, 35-V, X5R, 10%	603	Std	Std
3	C2, C3, C5	1 µF	Capacitor, ceramic, 10-V, X7R, 10%	603	Std	Std
1	C4	0.1 µF	Capacitor, ceramic, 16-V, X7R, 10%	805	Std	Std
1	C6	0.1 µF	Capacitor, ceramic, 10-V, X7R, 10%	603	Std	Std
1	C7	220 µF	Capacitor, electrolytic, 25-V, 20%	0.327 inch × 0.327 inch (8.3 mm × 8.3 mm)	UUD1E221MNL1GS	Nichicon
1	D1	BZT52C6V8S	Diode, zener, 200-mW, 6.8-V	SOD-323	BZT52C6V8S	General
3	D2, D3, D6	Green	Diode, LED, green, 2.1-V, 20-mA, 6-mcd	603	LTST-C190GKT	LITE-ON
2	D4, D7	Red	Diode, LED, red, 2.1-V, 20-mA, 6-mcd	603	LTST-C190CKT	Lite-On
1	D5	BAT54C	Diode, dual Schottky, 200-mA, 30-V	SOT23	BAT54C	Vishay/LITE-ON
2	J1, J4	ED1514/2DS	Terminal block, 2-pin, 6-A, 3.5-mm	0.27 inch × 0.25 inch (6.86 mm × 6.35 mm)	ED1514/2DS	OST
2	J2, J3	ED1516/4DS	Terminal block, 4-pin, 6-A, 3.5-mm	0.55 inch × 0.25 inch (14 mm × 6.35 mm)	ED1516/4DS	OST
5	JP1, JP4, JP5, JP6, JP7	PEC02SAAN	Header, 2-pin, 100-mil (2.54-mm) spacing	0.100 inch (2.54 mm) × 2	PEC02SAAN	Sullins
2	JP2, JP3	PTC03SAAN	Header, male 3-pin, 100-mil (2.54-mm) spacing, (36-pin strip)	0.100 inch (2.54 mm) × 3	PTC03SAAN	Sullins
5		929950-00	Shorting jumpers, 2-pin, 100-mil (2.54-mm) spacing		929950-00	3M/ESD
2	R1, R2	0	Resistor, chip, 1/16-W, 1%	402	Std	Std
0	R3, R4	0	Resistor, chip, 1/16-W, 1%	402	Std	Std
2	R5, R6	200 kΩ	Resistor, chip, 1/16-W, 5%	402	Std	Std
2	R7, R8	200 kΩ	Resistor, chip, 1/16-W, 5%	603	Std	Std
2	R9, R10	0.2 Ω	Resistor, metal film, 1/4-W, 1%	1206	Std	Std
1	R11	20 kΩ	Resistor, chip, 1/16-W, 5%	603	Std	Std
1	R12	100 kΩ	Resistor, chip, 1/16-W, 5%	603	Std	Std
1	R13	100 Ω	Resistor, chip, 1/16-W, 5%	603	Std	Std
1	R14	6.2 kΩ	Resistor, chip, 1/16-W, 5%	603	Std	Std
4	R15, R16, R17, R18	1.5 kΩ	Resistor, chip, 1/16-W, 5%	603	Std	Std
1	R19	51 Ω	Resistor, chip, 1/16-W, 5%	603	Std	Std
4			6-32 NYL nuts	NY HN 632	H620-ND	Building Fasteners
4	ST1, ST2, ST3, ST4	4816	Standoff, M/F, hex 6-32 NYL, 0.500 inch (12.7 mm)	sf_thvt_325_rnd	4816	Keystone
8	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	White	Test point, white, thru hole, color-keyed	0.100 × 0.100 inch (2.54 mm × 2.54 mm)	5002	Keystone
1	TP9	White	Test point, white, thru hole, color-keyed	0.100 × 0.100 inch (2.54 mm × 2.54 mm)	5001	Keystone
1	U1	bq24351DSG	IC, overvoltage and overcurrent charger front-end	SON-8	bq24351DSG	TI
1	U2	bq2057CSN	IC, charge management, one- or two-cell Li-Ion or Li-Pol charger	SOIC(SN)	bq2057CSN	TI
1	—	HPA666	PCB, 2.8-inch × 2.8-inch × 0.062-inch (7.11-cm × 7.11-cm × 1.58-mm)		PCB	Any

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

4.2 Board Layout

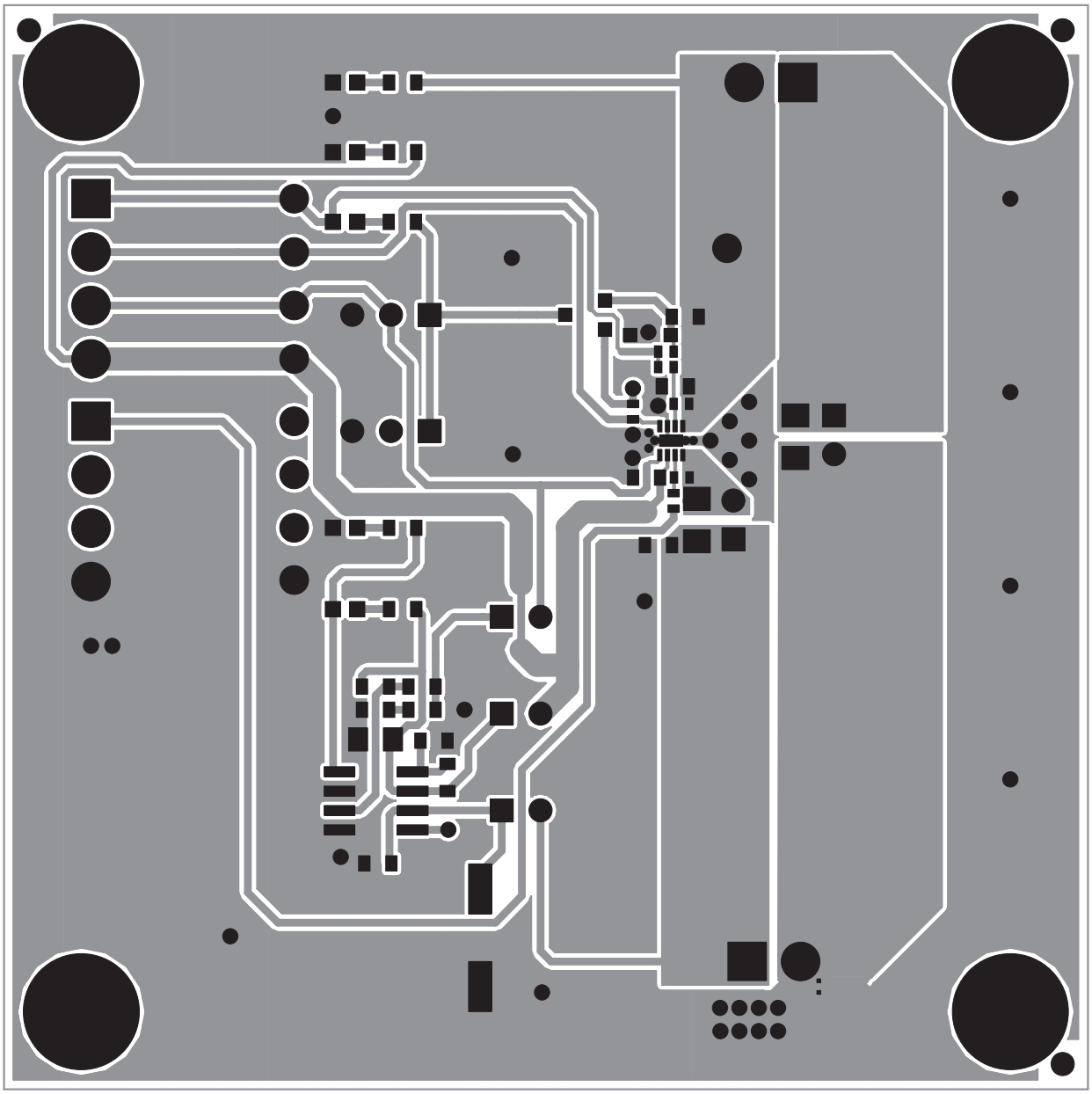

Figure 2. Top Layer

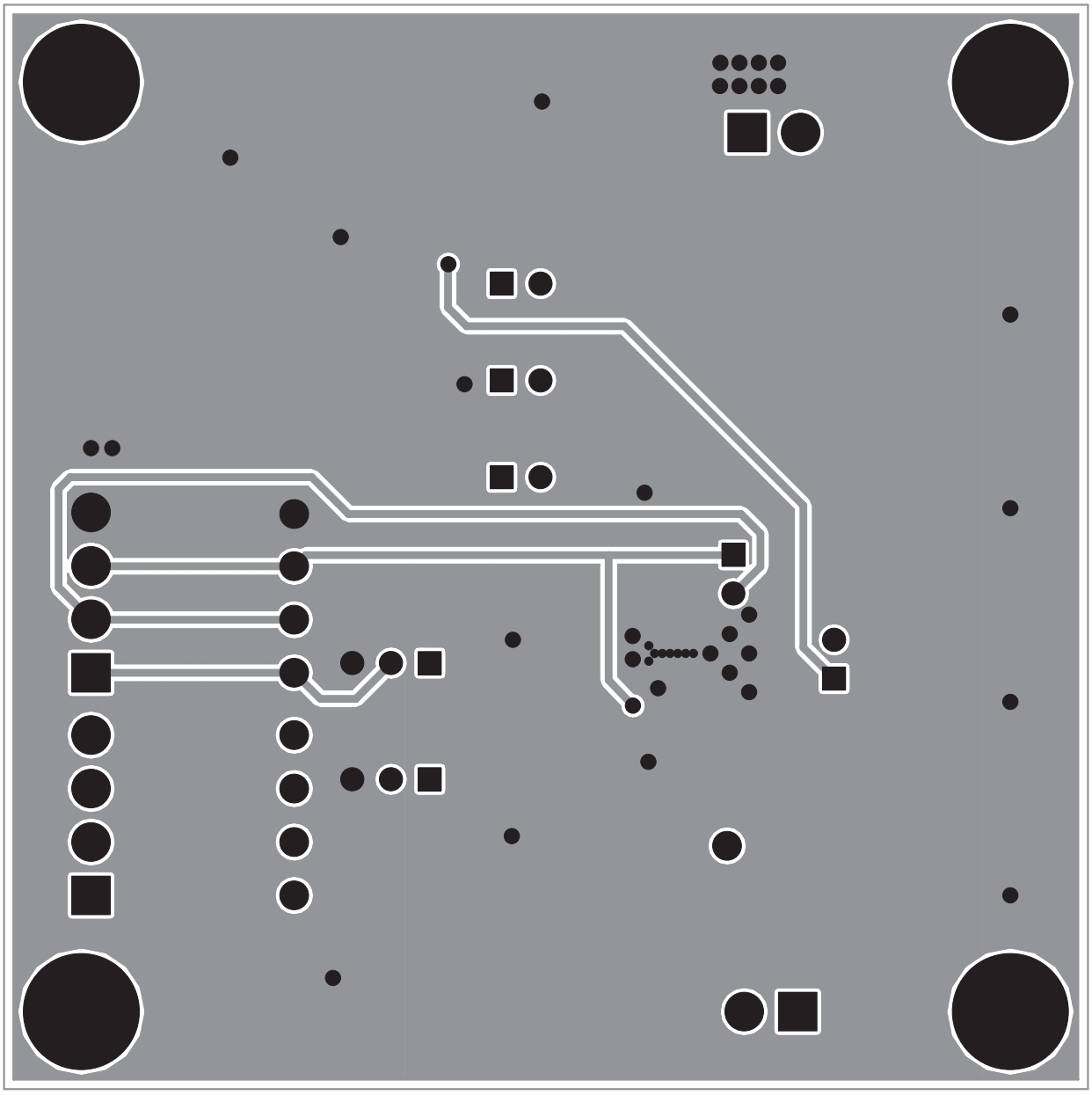

Figure 3. Bottom Layer

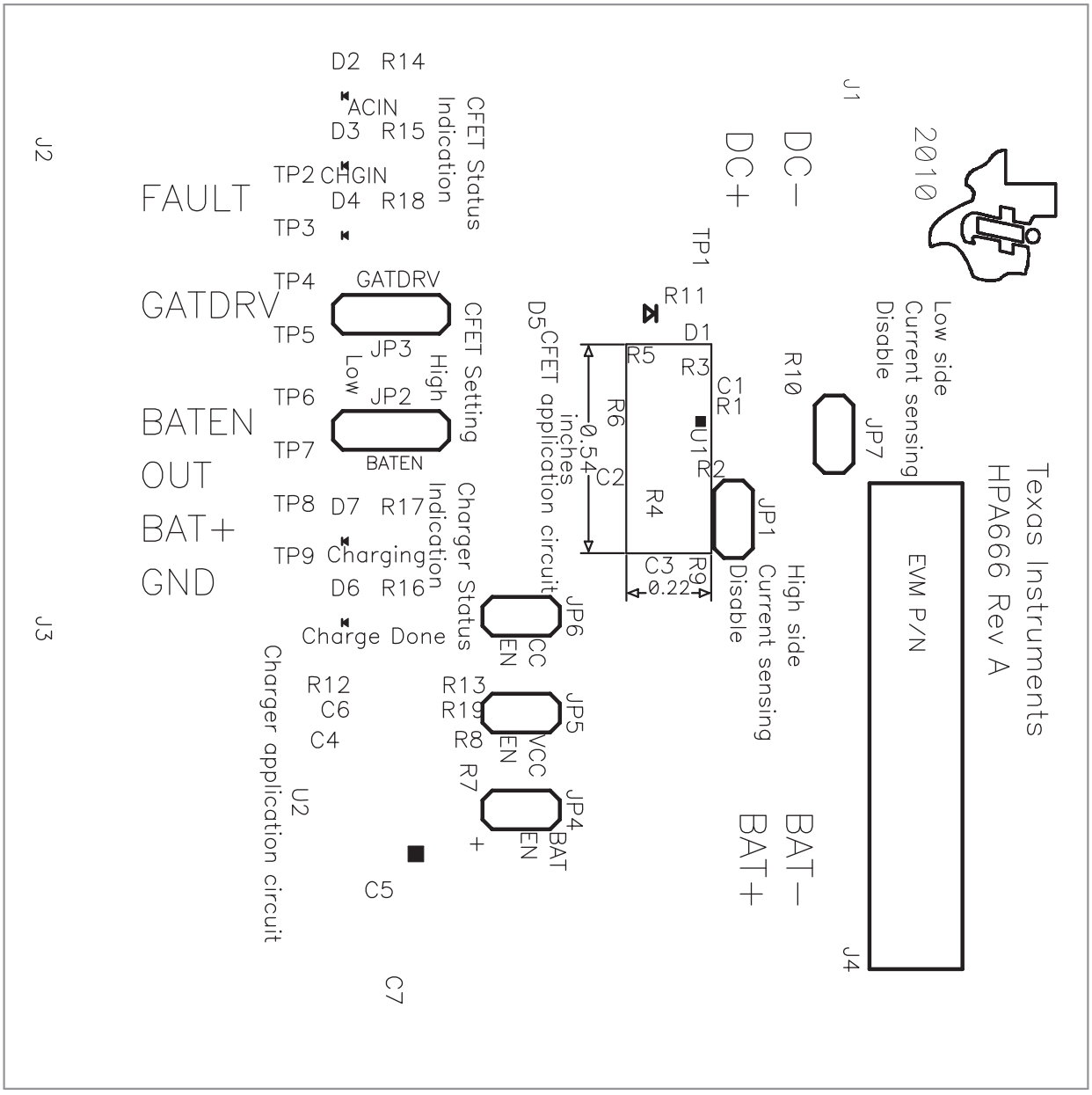

Figure 4. Top Silk Screen

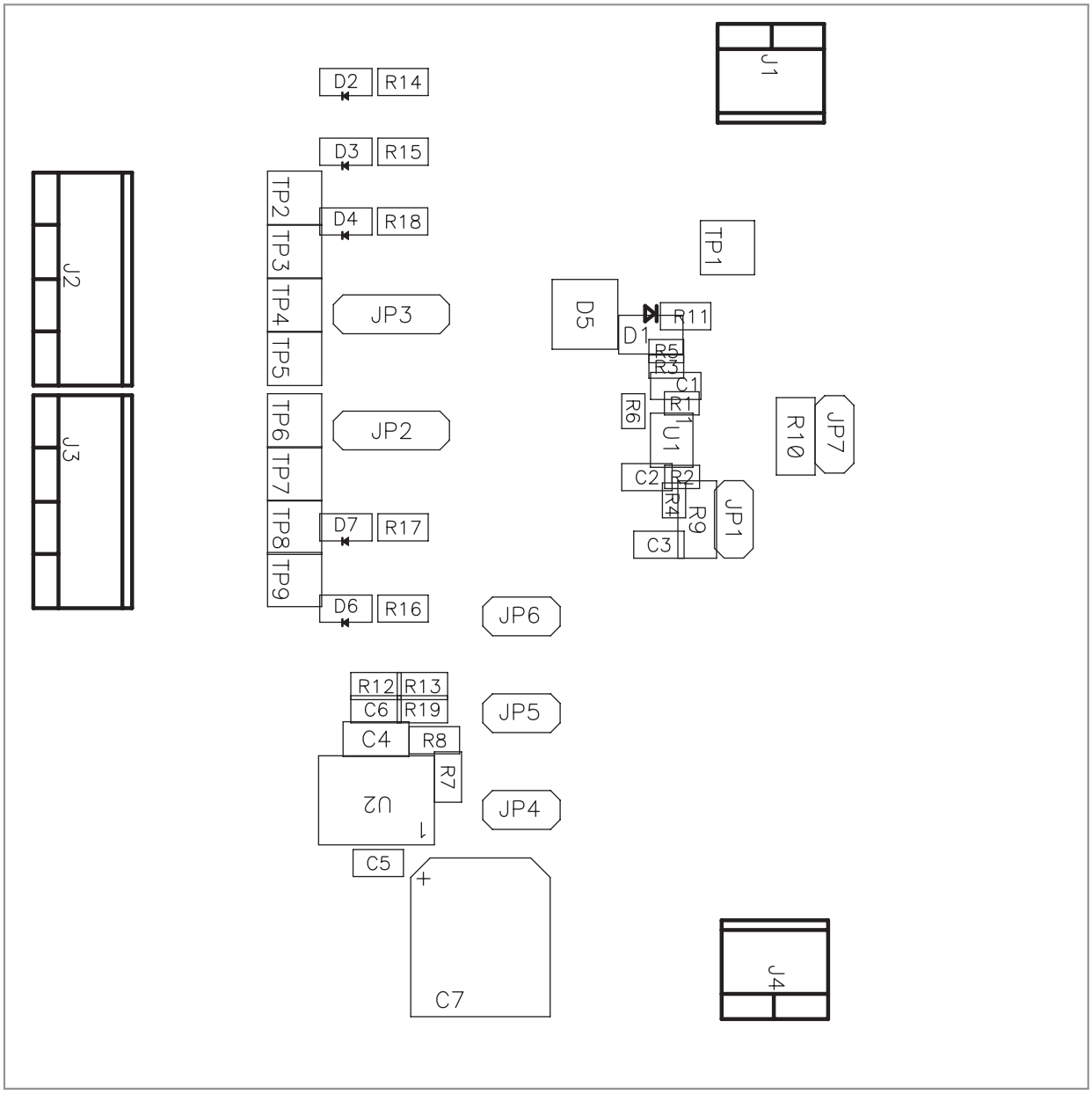

Figure 5. Top Assembly

4.3 Schematic

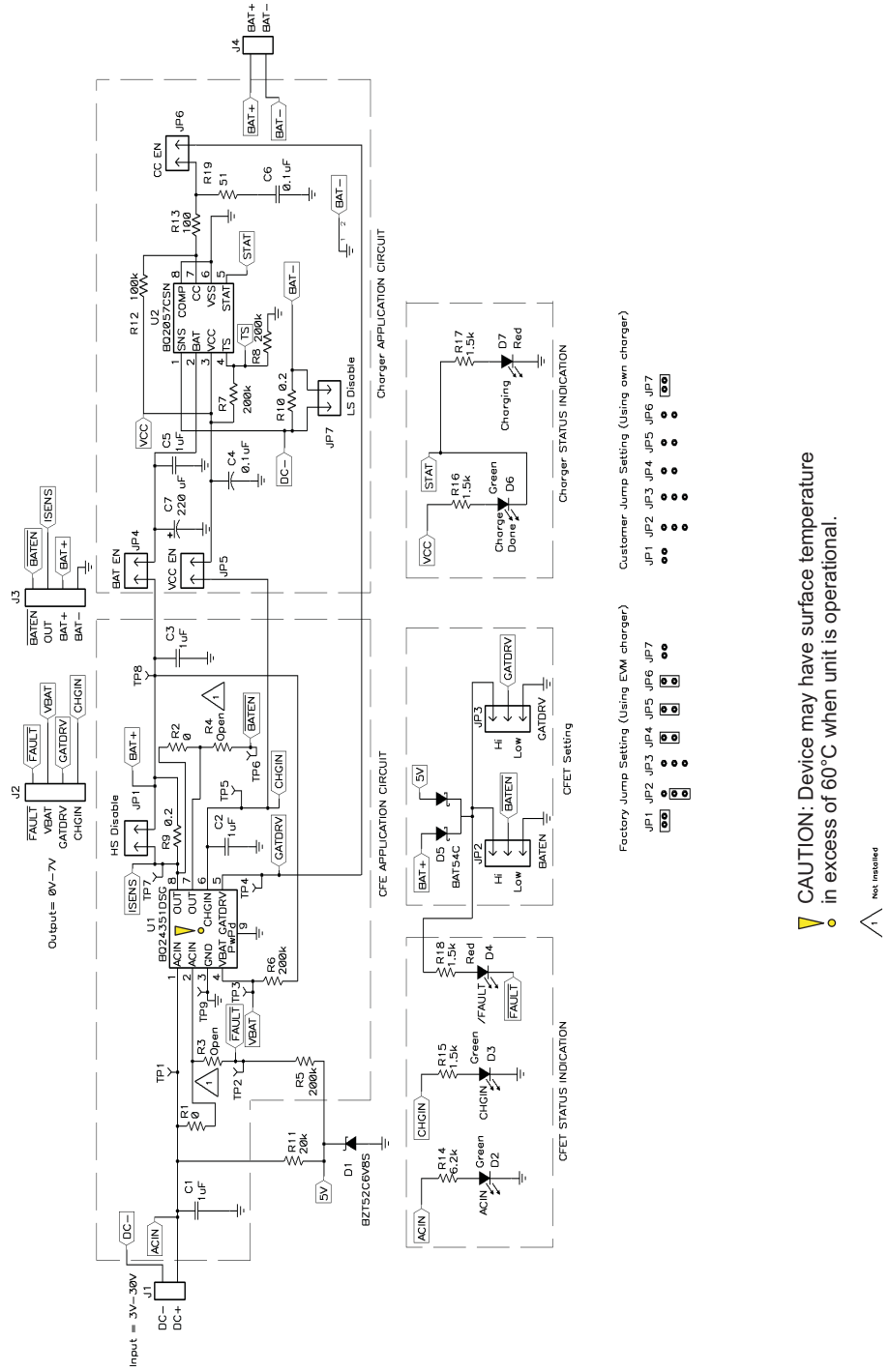

Figure 6. bq24351 Schematic

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EVM Warnings and Restrictions

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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