User's Guide

BQ25300, BQ25302, BQ25303J Evaluation Module

ABSTRACT

This user's guide provides detailed testing instructions for the BQ25300, BQ25302, BQ25303J evaluation module (EVM). Also included are descriptions of the necessary equipment, equipment setup, procedures, the printed-circuit board layouts, schematics, and the bill of materials (BOM).

Throughout this user's guide, the abbreviations *EVM*, *BMS005*, and the term *evaluation module* are synonymous with the BQ2530X evaluation module, unless otherwise noted.

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Trademarks

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1 Introduction

The BQ2530xEVM is an evaluation kit for the BQ2530x integrated battery charge management IC.

1.1 EVM Features

For detailed features and operation, refer to Table 1-1 for the device and data sheet.

Table 1-1. Device Data Sheet

Device	Data Sheet	EVM Label	Variant
BQ25300	SLUSCZ2	BQ25300EVM	001
BQ25302	SLUSCZ3	BQ25302EVM	002
BQ25303J	SLUSDT8	BQ25303JEVM	006

The BMS005 evaluation module (EVM) is a complete charger module for evaluating an integrated, standalone, synchronous buck battery charger using the device listed above.

1.2 I/O Descriptions

Table 1-2 lists the input and output connections available on this EVM and their respective descriptions.

Table 1-2. EVM I/O Connections

Jack	Description
J1(1) – GND	Ground
J1(2) – EXT_TS	Connect to thermistor of external battery
J1(3) – BATTERY	Positive rail of the charger battery input, connected to the positive terminal of the external battery
J2(1) – GND	Ground
J2(2) – VIN	Positive rail of the charger input voltage

Table 1-3 lists the jumper and shunt installations available on this EVM and their respective descriptions.

Table 1-3. EVM Jumper and Shunt Installation

Jack	Description	BQ2530X Setting
SH-JP1	EN pull-up rail selection. 1-2 pulls EN up to external VDD (EN_CTRL either REGN or external voltage source depending on JP3 configuration). 2-3 pulls EN down to GND.	JP1 2-3 Installed
SH-JP2	POL pull-up rail selection. 1-2 POL pull down to GND.	Shunt Not Installed
SH-JP3	EN external VDD rail selection (EN_CTRL). 1-2 pulls EN_CTRL to external voltage supply connected to JP3-1. 2-3 pulls EN_CTRL to REGN.	Shunt Not Installed
SH-JP4	Set charge regulation voltage of BQ25306 to 4.2 V	Jumper Not Installed
SH-JP5	Set charge regulation voltage of BQ25306 to 8.4 V	Jumper Not Installed
SH-JP6	VSET Short to GND. For charge regulation voltage corresponding to this setting, refer to data sheet of the respective battery charger IC shown in Table 1-1.	Installed
SH-JP7	VSET Resistor pull down to GND of 10.2 kΩ. For charge regulation voltage corresponding to this setting, refer to data sheet of the respective battery charger IC shown in Table 1-1.	Shunt Not Installed
SH-JP8	VSET Resistor pull down to GND of 51.1 kΩ. For charge regulation voltage corresponding to this setting, refer to data sheet of the respective battery charger IC shown in Table 1-1.	Shunt Not Installed
SH-JP9	ICHG Resistor pull down to GND with 40.2 kΩ to set charge current to 1 A.	Installed
SH-JP10	ICHG Resistor pull down to GND with 20 kΩ to set charge current to 2 A.	Shunt Not Installed

For recommended operating conditions, refer to data sheet of the respective battery charger IC shown in Table 1-1.

2 Test Setup and Results

2.1 Equipment

This section includes a list of supplies required to perform tests on this EVM.

1. Power Supply #1 (PS1): A power supply capable of supplying 5 V at 3 A is required. While this part can handle larger voltage and current, it is not necessary for this procedure.

   Power Supply #2 (PS2): A power supply capable of supplying 5 V at 1 A is required.
2. **Loads:** Load #1 (4-Quadrant Supply, Constant Voltage < 4.5 V): A "Kepco" Load, BOP, 20-5M, DC 0 to ±20 V, 0 to ±5 A (or higher).
   Alternative Option: A 0–20 V/0–5 A, > 30-W DC electronic load set in a constant voltage loading mode.
3. **Meters:** (4x) "Fluke 75" multimeters (equivalent or better).
4. No software is required to test this part.

2.2 Equipment Setup

1. Review EVM connections in Table 1-2.
2. Set PS1 for 5-V DC, 2-A current limit and then turn off the supply.
3. Set PS2 for 3-V DC, 2-A current limit and then turn off the supply.
4. Connect the output of PS1 to J2 (VBUS and PGND) as shown in Figure 2-1.
5. Connect a voltage meter across TP4 (VBUS) and TP9 (PGND), or across J2.
6. Turn on Load #1 as shown in Figure 2-1, set to constant voltage mode, and output to 2.5 V. Disable Load.
7. Connect one voltage meter across TP5 (BAT) and TP11 (PGND) or across J1-3 and J1-1 as shown in Figure 2-1.
8. Connect one voltage meter across TP2 (PMID) and TP10 (PGND).
9. Connect the output of PS2 to TP7 (TS) and TP12 (PGND) as shown in Figure 2-1.
10. Install shunts as shown in Table 1-3.

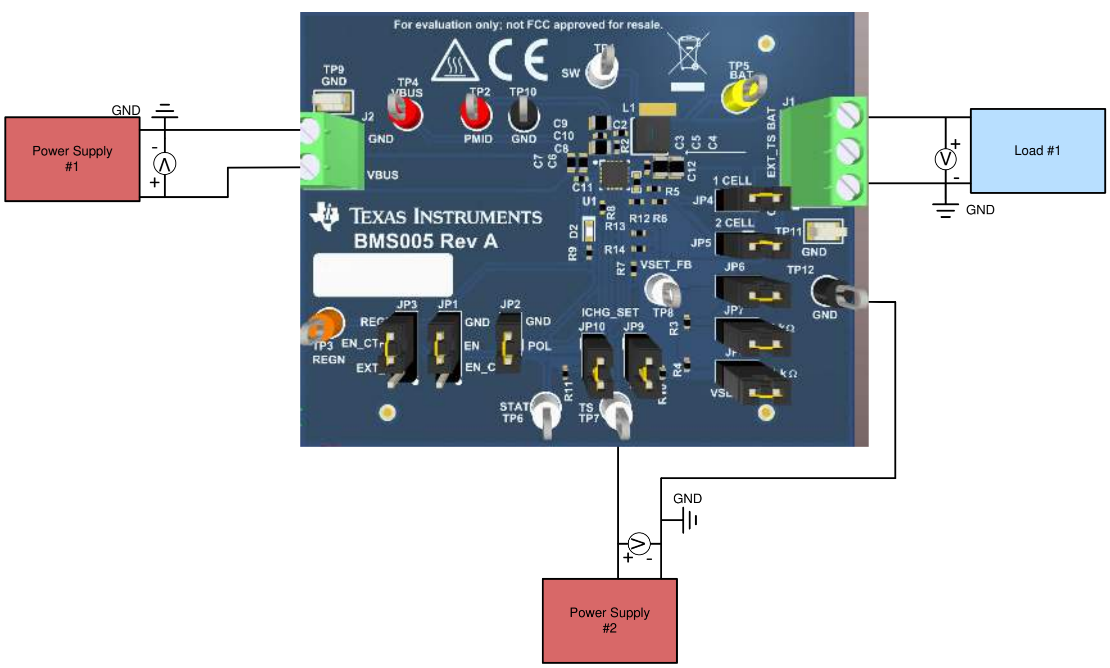


Figure 2-1. Original Test Setup for BMS005

2.3 Test Procedure

2.3.1 Initial Settings

Use the following steps to enable the BQ2530X EVM test setup:

1. Make sure Section 2.2 steps have been followed.
2. Turn on PS1.
   - **Measure** → VPMID (PMID-TP2 and PGND-TP10) = 5.00 V ± 0.3 V.
   - Completely disconnect PS1 from J2 if different voltage value is seen on PMID.

Note

Completely disconnect Load #1 from BATTERY connections if different value is seen.

2.3.2 Precharge Mode Verification

1. Turn on PS2
2. Enable Load #1 and take measurements as follows:
   a. **Measure** → VBAT (BAT-TP5 and PGND-TP11) = 2.5 V ± 0.1 V
   b. **Observe** → STAT LED (D2) on
   c. **Measure** → IBAT for respective battery charger IC from Table 2-1.

Table 2-1. Precharge Current Measurement

	BQ2530XEVM
IBAT	100 mA ± 50 mA

2.3.3 Fast Charge Mode Verification

1. Change Load #1 to 3.7 V and take measurements as follows:
   a. **Measure** → VBAT (BAT-TP5 and PGND-TP11) = 3.7 V ± 0.1 V
   b. **Observe** → STAT LED (D2) on
   c. **Measure** → IBAT for respective battery charger IC from Table 2-2

Table 2-2. Fast Charge Current Measurement

	BQ2530XEVM
IBAT	1000 mA ± 100 mA

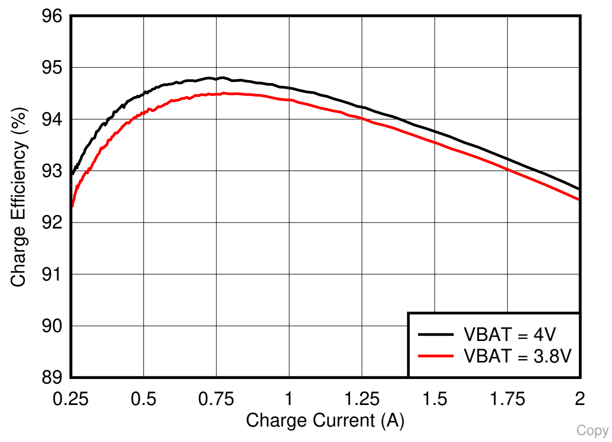
2.3.4 Battery Temperature Monitoring Verification

1. Turn on PS2 and take measurements as follows:
   a. **Measure** → VTS (TS-TP7 and PGND-TP12) = 3 V ± 0.1 V
   b. **Observe** → STAT LED (D2) on
   c. **Measure** → IBAT for respective battery charger IC from Table 2-2.
2. Change PS2 to 4.5 V and take measurements as follows:
   a. **Measure** → VTS (TS-TP7 and PGND-TP12) = 4.5 V ± 0.1 V
   b. **Observe** → STAT LED (D2) blinking at 1 Hz to indicate a fault
   c. **Measure** → IBAT = 0 A ± 10 mA
   d. Battery charger is operating in COLD

   For more information on TS threshold refer to data sheet of respective battery charger IC in Table 1-1.
3. Change PS2 to 0V and take measurements as follows:
   a. **Measure** → VTS (TS-TP7 and PGND-TP12) = 0 V ± 0.1 V
   b. **Observe** → STAT LED (D2) blinking at 1 Hz to indicate a fault
   c. **Measure** → IBAT = 0 A ± 10 mA
   d. Battery charger is operating in HOT

   For more information on TS threshold refer to data sheet of respective battery charger IC in Table 1-1.

2.3.5 Evaluation Results



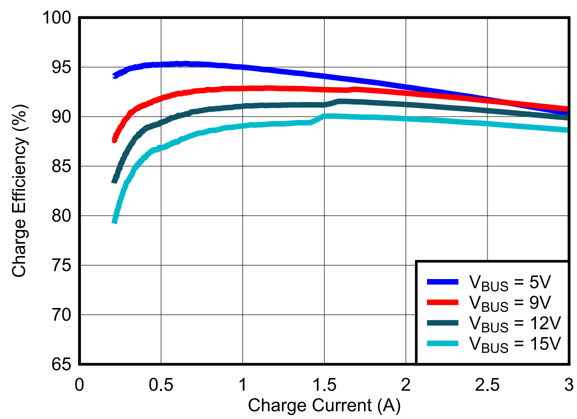
f_{SW} = 1.2 MHz

V_{BUS} = 5 V

Inductance 1 µH

Inductor DCR = 14.6 mΩ

Figure 2-2. BQ25302EVM 1-Cell Battery Charge Efficiency vs. Charge Current



f_{SW} = 1.2 MHz

V_{BAT} = 3.8 V

Inductance = 2.2 uH

Inductor DCR = 20 mΩ

Figure 2-3. BQ25300EVM, BQ25303JEVM 1-Cell Battery Charge Efficiency vs. Charge Current

2.3.6 Helpful Tips

1. BQ2530XEVM is configured by default to operate with TS in normal range. If external thermistor is available, connect external thermistor at J1(2)-EXT_TS and J1(1)-PGND, and remove R14.
2. The leads and cables to the various power supplies, batteries and loads have resistance. The current meters also have series resistance. The charger dynamically reduces charge current depending on the voltage sensed at its VBUS pin (using the VINDPM feature), BAT pin (as part of normal termination), and TS pin (through its battery temperature monitoring feature via battery thermistor). Therefore, voltmeters must be used to measure the voltage as close to the IC pins as possible instead of relying on the digital readouts of the power supply.
3. When using a source meter that can source and sink current as your battery simulator, TI highly recommends adding a large (1000+ µF) capacitor at the EVM BATTERY and GND connectors in order to simulate a real battery. Configuring the source meter for 4-wire sensing eliminates the need for a separate voltmeter to measure the voltage at the BAT pin.
   When using 4-wire sensing, always ensure that the sensing leads are connected in order to prevent accidental overvoltage by the power leads.

3 PCB Layout Guideline

Minimize the switching node rise and fall times for minimum switching loss. Proper layout of the components minimizing high-frequency current path loop is important to prevent electrical and magnetic field radiation and high-frequency resonant problems. This PCB layout priority list must be followed in the order presented for proper layout:

1. Place the input capacitor as close as possible to the PMID pin and GND pin connections and use the shortest copper trace connection or GND plane.
2. Place the inductor input terminal as close to the SW pin as possible. Minimize the copper area of this trace to lower electrical and magnetic field radiation but make the trace wide enough to carry the charging current. Do not use multiple layers in parallel for this connection. Minimize parasitic capacitance from this area to any other trace or plane.
3. Put an output capacitor near to the inductor and the IC. Tie ground connections to the IC ground with a short copper trace connection or GND plane.
4. Place decoupling capacitors next to the IC pins and make the trace connection as short as possible.
5. It is critical that the exposed power pad on the backside of the IC package be soldered to the PCB ground. Ensure that there are sufficient thermal vias directly under the IC connecting to the ground plane on the other layers.
6. The via size and number should be enough for a given current path.
7. For more layout guidelines and recommendations refer to the data sheet of the respective battery charger IC.
8. See the EVM design for the recommended component placement with trace and via locations. For the QFN information, refer to *Quad Flatpack No-Lead Logic Packages Application Report* and *QFN and SON PCB Attachment Application Report*.

4 Board Layout, Schematic, and Bill of Materials

4.1 Board Layout

The board layout is shown in Figure 4-1 to Figure 4-6.

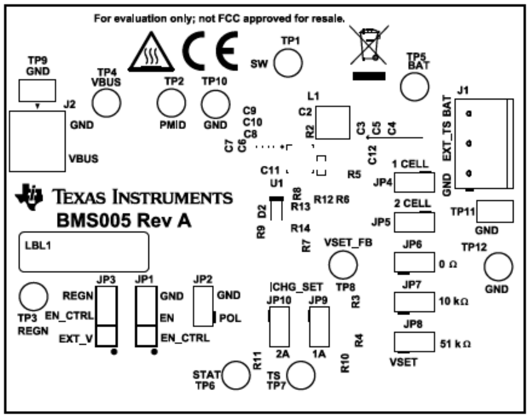


Figure 4-1. Top Overlay

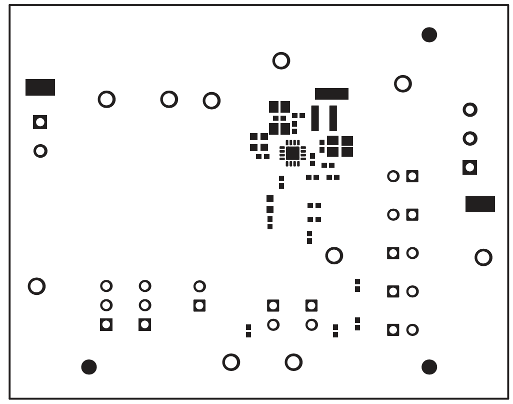


Figure 4-2. Top Solder

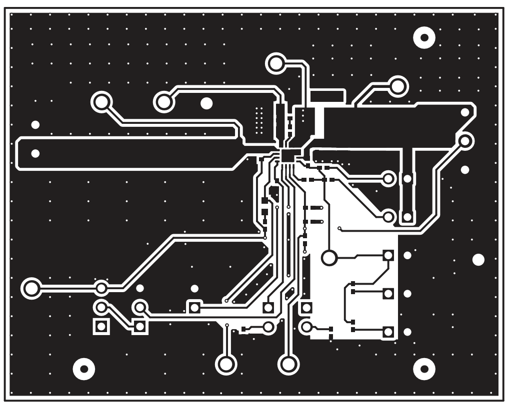


Figure 4-3. Top Layer

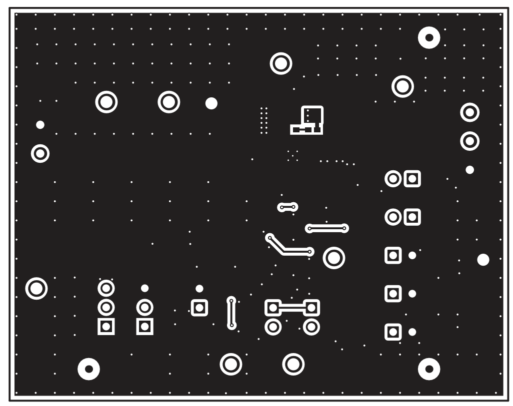


Figure 4-4. Bottom Layer

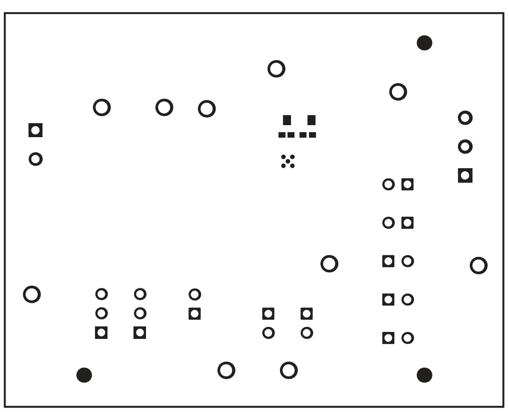


Figure 4-5. Bottom Solder

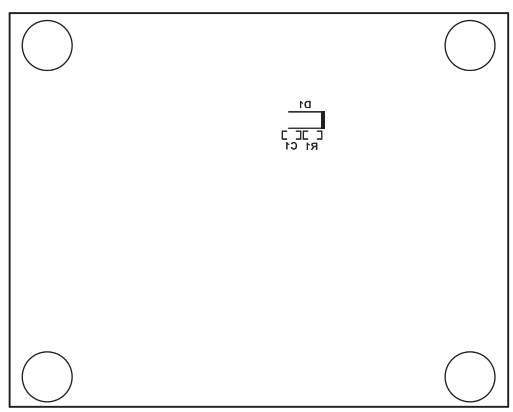


Figure 4-6. Bottom Overlay

4.2 Schematic

The BQ2530XEVM schematic is shown in Figure 4-7. For inductor selection refer to below Table 4-1

Table 4-1. BQ2530X Inductor Selection

EVM	L1				
	Value	Description	Package Reference	PartNumber	Manufacturer
BQ25302EVM	1uH	SMD Power Inductor	SMD, 4mm x 4mm	MAPM0420LA1R0M-LF	Microgate
BQ25300EVM	2.2uH	SMD Power Inductor	SMD, 4mm x 4mm	MAPM0420LA2R2M-LF	Microgate
BQ25303JEVM	2.2uH	SMD Power Inductor	SMD, 4mm x 4mm	MAPM0420LA2R2M-LF	Microgate

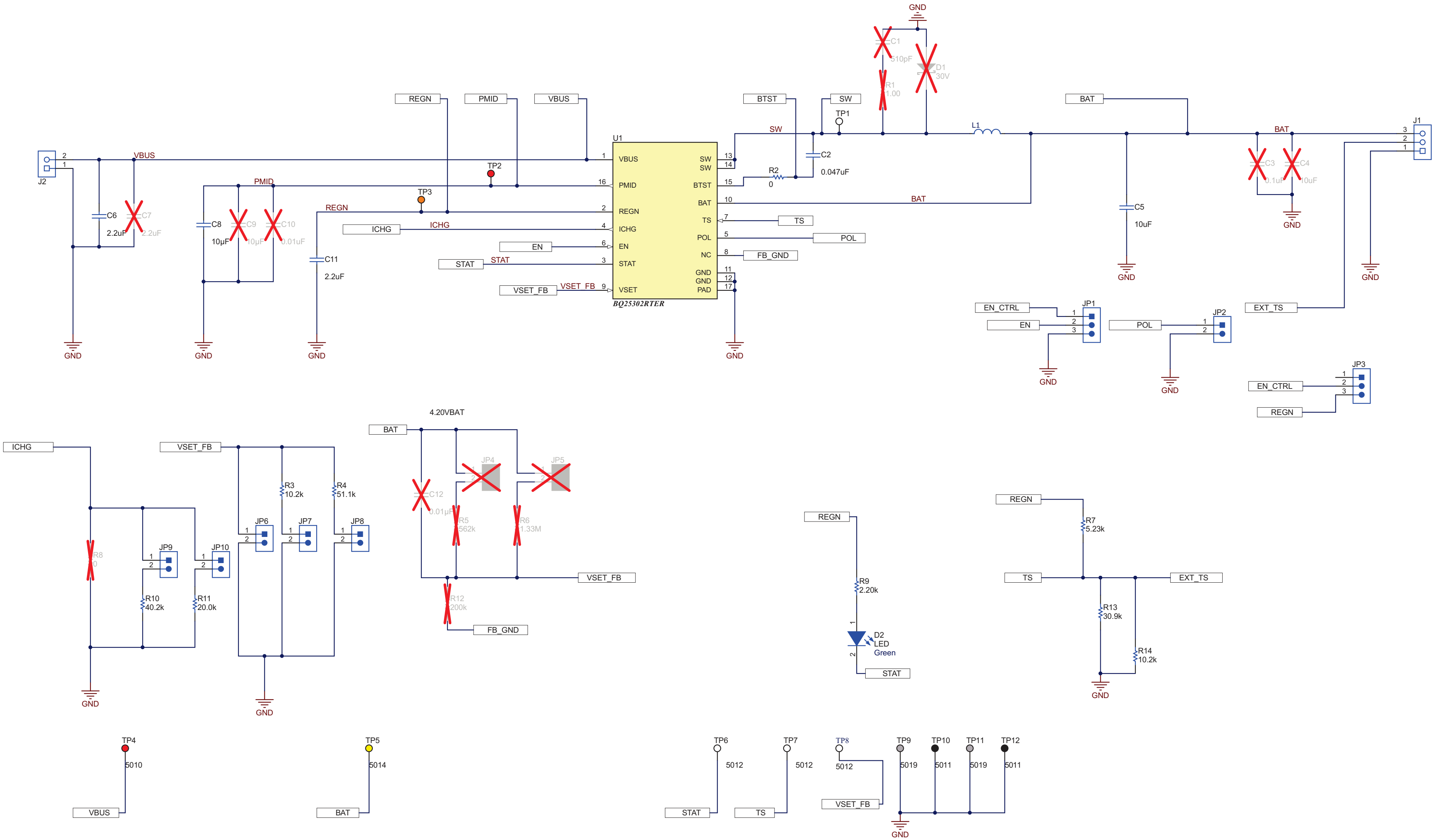


Figure 4-7. Schematic

Note

- On BQ25300EVM BQ25300 IC instead of BQ25302 IC is installed.
- On BQ25303JEVM BQ25303J IC instead of BQ25302 IC is installed.

4.3 Bill of Materials

Table 4-2 lists the BQ25302EVM BOM.

Table 4-2. BQ25302EVM Bill of Materials

Designator	Quantity	Value	Description	Package Reference	PartNumber	Manufacturer	Alternate Part Number(1)	Alternate Manufacturer (1)
!PCB1	1		Printed Circuit Board		BMS005	Any		
C2	1	0.047µF	CAP, CERM, 0.047 µF, 25 V, ±10%, X7R, 0402	0402	GRM155R71E473KA88D	MuRata		
C5	1	10µF	CAP, CERM, 10 µF, 16 V, ±20%, X7R, 0805	0805	EMK212BB7106MG-T	Taiyo Yuden		
C6	1	2.2µF	CAP, CERM, 2.2 µF, 35 V, ±10%, X5R, 0603	0603	GRM188R6YA225KA12D	MuRata		
C8	1	10µF	CAP, CERM, 10 µF, 25 V, ±10%, X5R, 0805	0805	CC0805KKX5R8BB106	Yageo		
C11	1	2.2µF	CAP, CERM, 2.2 µF, 16 V, ±10%, X5R, 0402	0402	GRM155R61C225KE11D	MuRata		
D2	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On		
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.25 X 0.075, Clear	75x250 mil	SJ5382	3M		
J1	1		Terminal Block Receptacle, 3x1, 3.81mm, R/A, TH	Term Block, 3 pos	1727023	Phoenix Contact		
J2	1		Conn Term Block, 2POS, 3.81mm, TH	2POS Terminal Block	1727010	Phoenix Contact		
JP1, JP3	2		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
JP2, JP6, JP7, JP8, JP9, JP10	6		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
L1	1	1uH	SMD power inductor, 14.6mΩ DCR	SMD2, 4mm x 4mm	MAPM0420LA1R0M-LF	Microgate		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady		
R2	1	0	RES, 0, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America		
R3, R14	2	10.2k	RES, 10.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K2FKED	Vishay-Dale		
R4	1	51.1k	RES, 51.1 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040251K1FKED	Vishay-Dale		
R7	1	5.23k	RES, 5.23 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04025K23FKED	Vishay-Dale		
R9	1	2.20k	RES, 2.20 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K20FKED	Vishay-Dale		
R10	1	40.2k	RES, 40.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040240K2FKED	Vishay-Dale		
R11	1	20.0k	RES, 20.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040220K0FKED	Vishay-Dale		

Table 4-2. BQ25302EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	PartNumber	Manufacturer	Alternate Part Number(1)	Alternate Manufacturer (1)
R13	1	30.9k	RES, 30.9 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04023 0K9FKED	Vishay-Dale		
SH-JP1, SH-JP6, SH-JP9	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M
TP1, TP6, TP7, TP8	4		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone		
TP2, TP4	2		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone		
TP3	1		Test Point, Multipurpose, Orange, TH	Orange Multipurpose Testpoint	5013	Keystone		
TP5	1		Test Point, Multipurpose, Yellow, TH	Yellow Multipurpose Testpoint	5014	Keystone		
TP9, TP11	2		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone		
TP10, TP12	2		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone		
U1	1		Standalone 5V/2.0A Single Cell Battery Charger, RTE0016C (WQFN-16)	RTE0016C	BQ25302RTE R	Texas Instruments	BQ25302RTE T	Texas Instruments
C1	0	510pF	CAP, CERM, 510 pF, 25 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1 E511JA01D	MuRata		
C3	0	0.1µF	CAP, CERM, 0.1 µF, 50 V, ±10%, X7R, 0402	0402	C1005X7R1H 104K050BB	TDK		
C4	0	10µF	CAP, CERM, 10 µF, 16 V, ±20%, X7R, 0805	0805	EMK212BB71 06MG-T	Taiyo Yuden		
C7	0	2.2µF	CAP, CERM, 2.2 µF, 35 V, ±10%, X5R, 0603	0603	GRM188R6Y A225KA12D	MuRata		
C9	0	10µF	CAP, CERM, 10 µF, 25 V, ±10%, X5R, 0805	0805	CC0805KKX5 R8BB106	Yageo		
C10	0	0.01µF	CAP, CERM, 0.01 µF, 50 V, ±10%, C0G/NP0, 0402	0402	GCM155R71 H103KA55D	MuRata		
C12	0	0.01µF	CAP, CERM, 0.01 µF, 16 V, ±10%, X7R, 0402	0402	C0402C103K 4RACTU	Kemet		
D1	0	30V	Diode, Schottky, 30 V, 1 A, SOD-123	SOD-123	B130LAW-7-F	Diodes Inc.		
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
JP4, JP5	0		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
R1	0	1.00	RES, 1.00, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021 R00FKED	Vishay-Dale		
R5	0	562k	RES, 562 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04025 62KFKED	Vishay-Dale		

Table 4-2. BQ25302EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	PartNumber	Manufacturer	Alternate Part Number[(1)]	Alternate Manufacturer [(1)]
R6	0	1.33Meg	RES, 1.33 M, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021M33FKED	Vishay-Dale		
R8	0	0	RES, 0, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America		
R12	0	200k	RES, 200 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402200KFKED	Vishay-Dale		
SH-JP2, SH-JP3, SH-JP4, SH-JP5, SH-JP7, SH-JP8, SH-JP10	0	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M

(1) Unless otherwise noted in the Alternate PartNumber and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.

5 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (October 2020) to Revision A (February 2021) **Page**

- Added BQ25300EVM and BQ25303JEVM..1

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