User's Guide
BQ25306 (BMS005) Evaluation Module

![TEXAS INSTRUMENTS]

ABSTRACT

This user's guide provides detailed testing instructions for the BQ25306 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*, *BQ25306EVM, BMS005*, BMS005-004 and the term *evaluation module* are synonymous with the BQ25306 evaluation module, unless otherwise noted.

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Trademarks
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1 Introduction

The BQ25306EVM is an evaluation kit for the BQ25306 integrated battery charge management IC.

1.1 Features

For detailed features and operation, refer to Table 1-1 for a list of devices and their data sheets.

Table 1-1. Device Data Sheets

Device	Data Sheet	EVM Label	Variant
BQ25306	SLUSDC7	BQ25306EVM	BMS005-004

The BMS005 evaluation module (EVM) is a complete charger module for evaluating an integrated, standalone, synchronous buck battery charger using any of the devices 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	BQ25306 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 4.2V	Installed
SH-JP5	Set charge regulation voltage of BQ25306 to 8.4V	Shunt Not Installed
SH-JP6	VSET Short to GND. For charge regulation voltage corresponding to this setting, refer to datasheet of the respective battery charger IC shown in Table 1-1.	Jumper Not Installed
SH-JP7	VSET Resistor pull down to GND of 10.2kΩ For charge regulation voltage corresponding to this setting, refer to datasheet of the respective battery charger IC shown in Table 1-1.	Jumper Not Installed
SH-JP8	VSET Resistor pull down to GND of 51.1kΩ For charge regulation voltage corresponding to this setting, refer to datasheet of the respective battery charger IC shown in Table 1-1.	Jumper Not Installed
SH-JP9	ICHG Resistor pull down to GND with 40.2kΩ to set charge current to 1A. Populate both SH-JP9 and SH-JP10 to program 3A charge current.	Installed
SH-JP10	ICHG Resistor pull down to GND with 20kΩ to set charge current to 2A. Populate both SH-JP9 and SH-JP10 to program 3A charge current.	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 0–20V/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, set to constant voltage mode, and output to 2.5-V. Disable Load. Connect Load to J1-3 (BAT) and J1-1 (PGND) as shown in Figure 2-1.
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
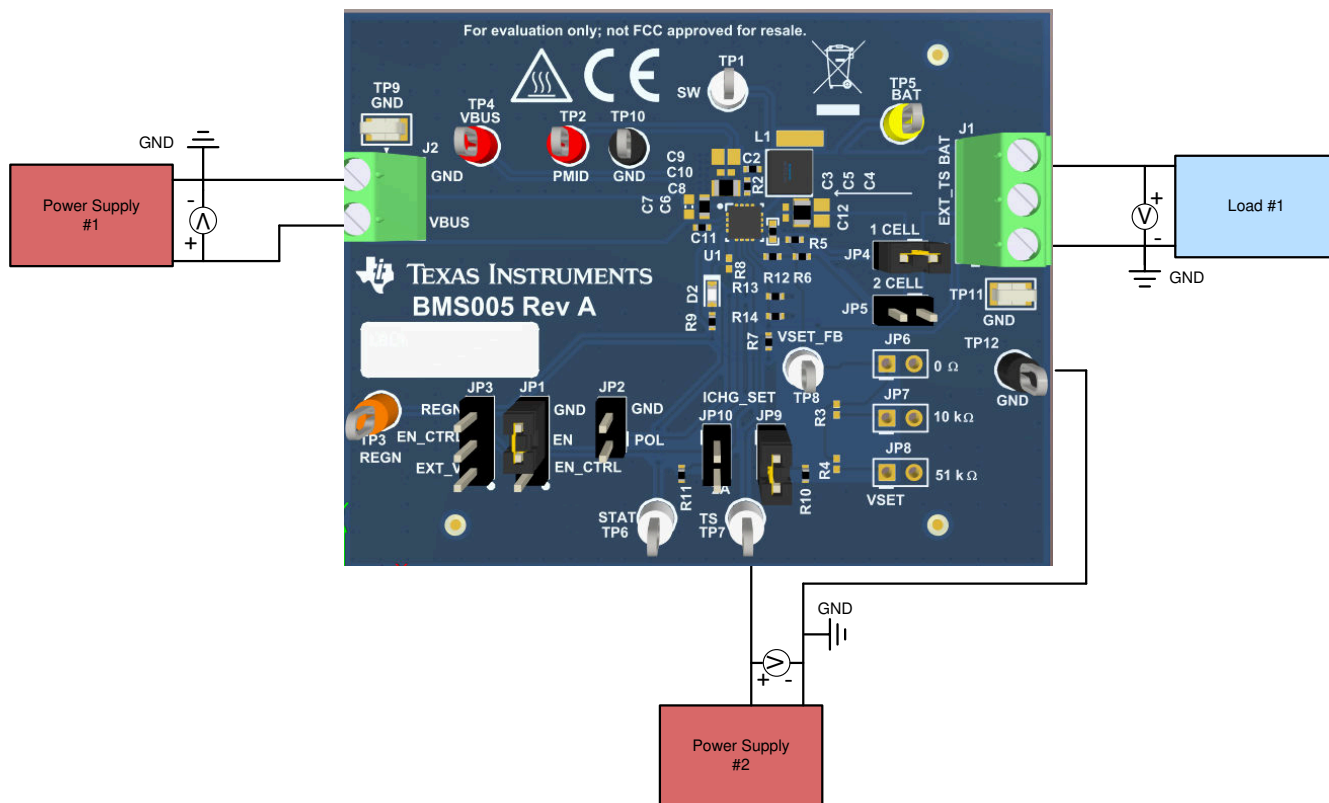10. Install shunts as shown in Table 1-3.

Figure 2-1. Original Test Setup for BMS005-004

2.3 Test Procedure

2.3.1 Initial Settings

Use the following steps for enable the EVM test setup:

Make sure Section 2.1 steps have been followed. Turn on PS1

- **Measure** → VPMID (PMID-TP2 and PGND-TP10) = 5.00V ± 0.3V
- 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

Enable Load #1 and take measurements as follows

1. **Measure** → VBAT (BAT-TP5 and PGND-TP11) = 2.5V ± 0.1V
2. **Observe** → STAT LED (D2) on
3. **Measure** → IBAT for respective battery charger IC from Table 2-1

Table 2-1. Precharge Current Measurement

	BQ25306EVM
IBAT	100mA ± 50mA

2.3.3 Fast Charge Mode Verification

1. Change Load #1 to 3.8V and take measurements as follows:
   a. **Measure** → VBAT (BAT-TP5 and PGND-TP11) = 3.8V ± 0.1V
   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

	BQ25306EVM
IBAT	1000mA ± 100mA

2.3.4 Battery Temperature Monitoring Verification

1. Connect PS2 across TS-TP7 and PGND-TP12. Turn on PS2 and take measurements as follows:
   a. **Measure** → VTS (TS-TP7 and PGND-TP12) = 3V ± 0.1V
   b. **Observe** → STAT LED (D2) on
   c. **Measure** → IBAT for respective battery charger IC from Table 2-2
2. Change PS2 to 4V and take measurements as follows:
   a. **Measure** → VTS (TS-TP7 and PGND-TP12) = 4V ± 0.1V
   b. **Observe** → STAT LED (D2) blinking at 1Hz to indicate a fault
   c. **Measure** → IBAT = 0A ± 10mA
   d. Battery charger is operating in COLD
      i. For more information on TS threshold refer to Table 1-1
3. Change PS2 to 1V and take measurements as follows:
   a. **Measure** → VTS (TS-TP7 and PGND-TP12) = 1V ± 0.1V
   b. **Observe** → STAT LED (D2) blinking at 1Hz to indicate a fault
   c. **Measure** → IBAT = 0A ± 10mA
   d. Battery charger is operating in HOT
      i. For more information on TS threshold refer to Table 1-1

2.3.5 Evaluation Results

This section contains efficiency data for BQ25306 at both 1-cell and 2-cell Li-ion battery configuration, specifically on the BQ25306EVM.
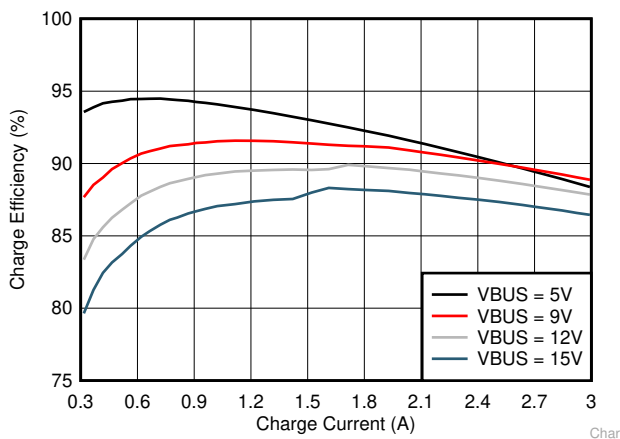
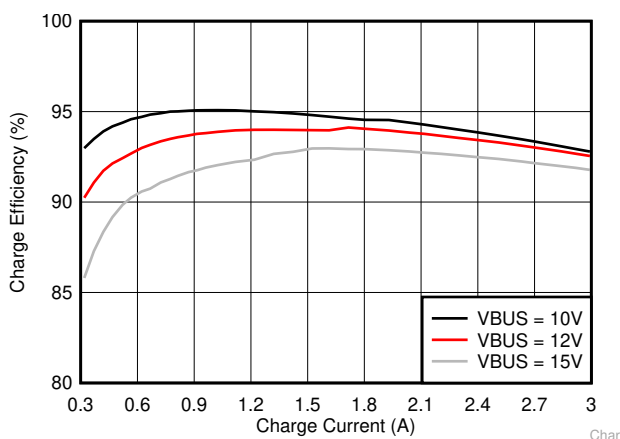**Figure 2-2. BQ25306EVM 1-Cell Efficiency**

Figure 2-3. BQ25306EVM 2-Cell Efficiency

2.3.6 Helpful Tips

1. BQ25306EVM 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 prevent oscillations at the BAT pin due to mismatched impedances of the charger output and source meter input within their respective regulation loop bandwidths. 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 datasheet 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.

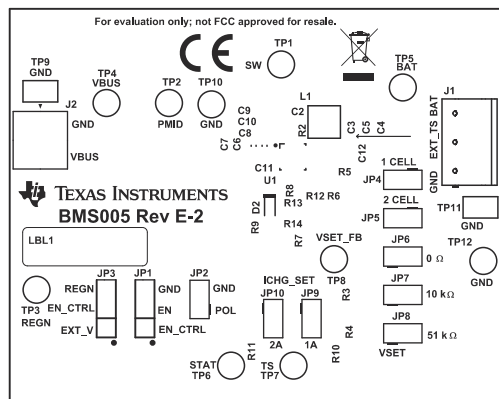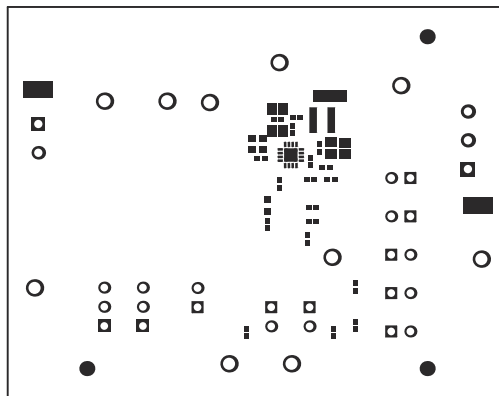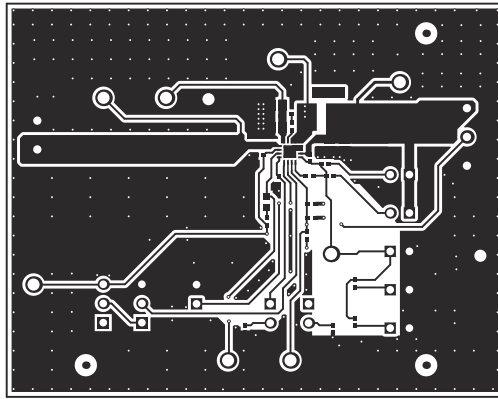**Figure 4-1. Top Overlay**

Figure 4-2. Top Solder

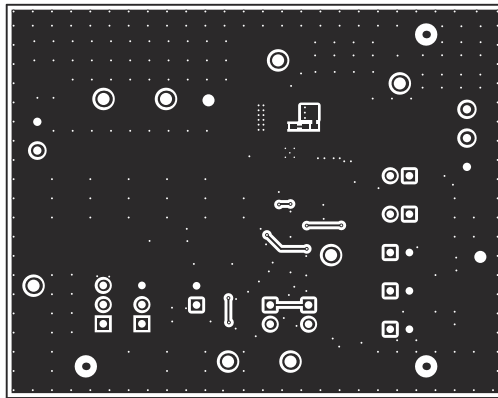**Figure 4-3. Top Layer**

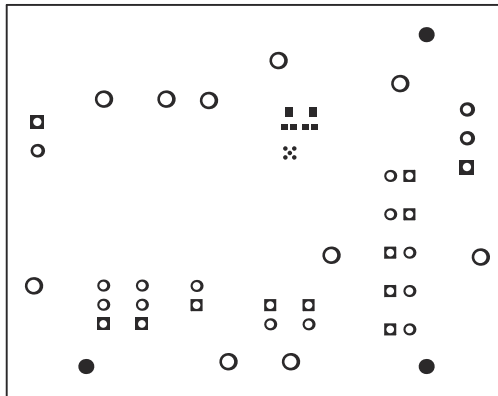**Figure 4-4. Bottom Layer**
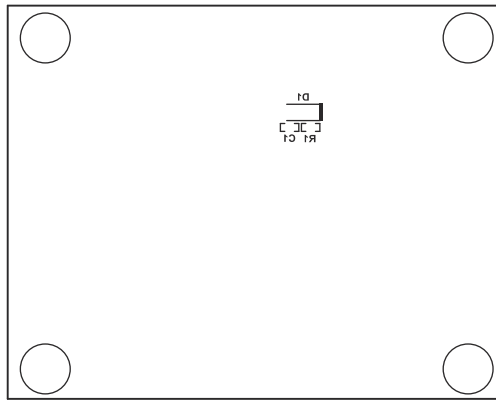

Figure 4-5. Bottom Solder

Figure 4-6. Bottom Overlay

4.2 Schematic

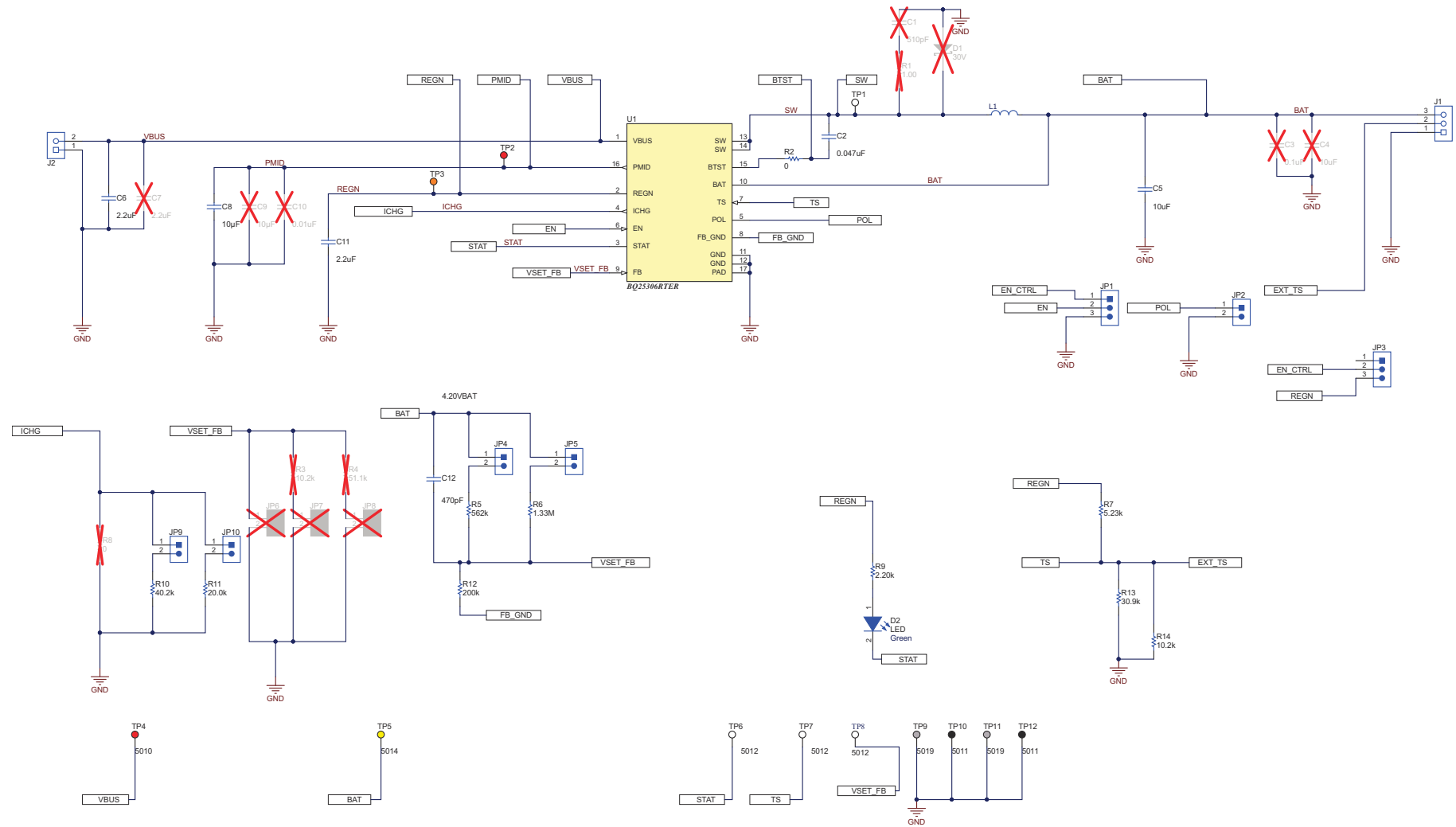The BQ25306 schematic is shown in Figure 4-7.

Figure 4-7. BQ25306 Schematic

4.3 Bill of Materials

The BQ25306 BOM is listed in Table 4-1.

Table 4-1. BQ25306 Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	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	GRM155R71E473K A88D	MuRata		
C5	1	10µF	CAP, CERM, 10 µF, 16 V, ±20%, X7R, 0805	0805	EMK212BB7106M G-T	Taiyo Yuden		
C6	1	2.2µF	CAP, CERM, 2.2 µF, 35 V, ±10%, X5R, 0603	0603	GRM188R6YA225K A12D	MuRata		
C8	1	10µF	CAP, CERM, 10 µF, 25 V, ±10%, X5R, 0805	0805	CC0805KKX5R8BB 106	Yageo		
C11	1	2.2µF	CAP, CERM, 2.2 µF, 16 V, ±10%, X5R, 0402	0402	GRM155R61C225K E11D	MuRata		
C12	1	470pF	CAP, CERM, 470 pF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 0402	0402	GCM155R71H471K A37D	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, JP4, JP5, JP9, JP10	5		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
L1	1	2.2uH	SMD power inductor, 2.2uH, 35mΩ DCR	SMT_4MM_4MM	MAPM0420LA2R2 M-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		
R5	1	562k	RES, 562 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402562KF KED	Vishay-Dale		
R6	1	1.33M	RES, 1.33 M, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021M33F KED	Vishay-Dale		
R7	1	5.23k	RES, 5.23 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04025K23F KED	Vishay-Dale		

Table 4-1. BQ25306 Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number[1]	Alternate Manufacturer[1]
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		
R12	1	200k	RES, 200 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402200KFKED	Vishay-Dale		
R13	1	30.9k	RES, 30.9 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040230K9FKED	Vishay-Dale		
R14	1	10.2k	RES, 10.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K2FKED	Vishay-Dale		
SH-JP1, SH-JP4, 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 14V/2.0A Dual Cell Battery Charger, RTE0016C (WQFN-16)	RTE0016C	BQ25306RTER	Texas Instruments	BQ25306RTET	Texas Instruments
C1	0	510pF	CAP, CERM, 510 pF, 25 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1E511JA01D	MuRata		
C3	0	0.1µF	CAP, CERM, 0.1 µF, 50 V, ±10%, X7R, 0402	0402	C1005X7R1H104K050BB	TDK		
C4	0	10µF	CAP, CERM, 10 µF, 16 V, ±20%, X7R, 0805	0805	EMK212BB7106MG-T	Taiyo Yuden		
C7	0	2.2µF	CAP, CERM, 2.2 µF, 35 V, ±10%, X5R, 0603	0603	GRM188R6YA225KA12D	MuRata		

Table 4-1. BQ25306 Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number[1]	Alternate Manufacturer[1]
C9	0	10µF	CAP, CERM, 10 µF, 25 V, ±10%, X5R, 0805	0805	CC0805KKX5R8BB 106	Yageo		
C10	0	0.01µF	CAP, CERM, 0.01 µF, 50 V, ±10%, C0G/NP0, 0402	0402	GCM155R71H103K A55D	MuRata		
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		
JP6, JP7, JP8	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	CRCW04021R00F KED	Vishay-Dale		
R3	0	10.2k	RES, 10.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K2F KED	Vishay-Dale		
R4	0	51.1k	RES, 51.1 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040251K1F KED	Vishay-Dale		
R8	0	0	RES, 0, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America		
SH-JP2, SH-JP3, SH-JP5, SH-JP6, 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 * (March 2020) to Revision A (December 2020)	Page
• Changed from Advance Information to Production Data.. 2	

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