User's Guide

BQ25616, BQ25616J BMS026 Evaluation Module

ABSTRACT

This user's guide provides detailed testing instructions for the BQ25616 and BQ25616J evaluation modules (EVM). Also included are descriptions of the necessary equipment, equipment setup, and procedures. The reference documentation also contains the printed-circuit board layouts, schematics, and the bill of materials (BOM).

Throughout this user's guide, the abbreviations *EVM*, *BQ25616EVM, BQ25616JEVM, BMS026*, and the term *evaluation module* are synonymous with the BMS026 evaluation module, unless otherwise noted.

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Trademarks

1 Introduction

1.1 EVM 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
BQ25616	SLUSDF7	BQ25616EVM	001
BQ25616J	SLUSDF7	BQ25616JEVM	002

The BMS026 evaluation module (EVM) is a complete charger module for evaluating the standalone single-cell NVDC charger using any of the devices above.

This EVM features adjustable input current limit, charging current, and charging voltage. The EVM also has the abilty to test the D+/D- input source type detection, external input over-voltage protection, and simulate battery high and low temperature conditions.

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(2) – VAC	Positive rail of the charger input voltage.
J1(1) – GND	Ground.
J2(1) – SYSTEM	Positive rail of the charger system output voltage, typically connected to the system load.
J2(2) – GND	Ground.
J3(1) – PMID	Positive rail of the charger output voltage for power bank applications in reverse boost mode (OTG). This output also shares the rail with the VIN input rail in forward buck mode.
J3(2) – GND	Ground.
J4	Input source Micro B USB port.
J5-BATSNS_ICHG	BATSNS or ICHG pin connection.
J5(3) – ICHG	ICHG pin external connection.
J5(2) – BATTERY	Positive rail of the charger battery input, connected to the positive terminal of the external battery.
J5(1) – GND	Ground.
J6	USB2ANY 10-pin connector.
J7	I2C 4-pin connector for the EV2300/2400 interface board.

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

Table 1-3. EVM Jumper, Shunt and Switch Installation

Jack	Description	BQ25616 Setting	BQ25616J Setting
JP1	VBUS additional capacitance connection.	Not Installed	Not Installed
JP2	SYS additional capacitance connection.	Not Installed	Not Installed
JP3	PMID additional capacitance connection.	Not Installed	Not Installed
JP4	BAT additional capacitance connection.	Not Installed	Not Installed
JP5	I/O Pullup rail selection. Selection has either BAT or SYS as the pullup rail for /CE, STAT, OTG, and /PG pins.	Short PULLUP to SYS	Short PULLUP to SYS
JP6	Micro B USB input D+ connection to charger D+ pin.	Installed	Installed
JP7	ICHG to BAT or BATTERY connection.	Not Installed	Not Installed
JP8	ICHG resistor setting connection. Must be connected for charging to operate correctly.	Installed	Installed
JP9	Micro B USB input D+ connection to charger D+ pin.	Installed	Installed
JP10	PSEL pin input current selection. Connect this to HIGH on PSEL enabled chargers to select 500 mA default input current limit. Connect this to LOW on PSEL enabled chargers to select 2.4-A default input current limit.	Not Installed	Not Installed
JP11	REGN connection to TS network. Must be connected for thermistor sensing to operate correctly.	Installed	Installed
JP12	ILIM resistor setting connection. Must be connected for 'Unknown Adapter' input current limiting to operate correctly.	Installed	Installed
JP13	STAT pin LED indicator connection. This indicates the current charger Status.	Installed	Installed
JP14	/PG pin LED indicator connection. On /PG enabled chargers, this indicates the Power Good status	Installed	Installed
JP15	ICHG, ILIM, AGND header connection point.	Not Installed	Not Installed
JP16	Thermistor NORMAL temperature setting. Connect jumper to simulate charger entering TNORMAL (T2-T3) temperature region.	Installed	Installed
JP17	/CE pin connection to ground to enable charging. When removed, /CE pin pulls up to disable charge.	Installed	Installed
JP18	Thermistor HOT temperature setting. Connect jumper to simulate charger entering THOT (>T5) temperature region.	Not Installed	Not Installed
JP19	D- to /PG rail connection	Not Installed	Not Installed
JP20	OTG pin connection to ground to disable OTG boost mode. When removed, OTG boost mode is enabled only in battery-only operation.	Installed	Installed
JP21	VSET pin setting connection. Leave floating to set VBATREG to 4.208V. Connect to 10-kOhm to ground to set VBATREG to 4.100V. Connect to ground directly to set VBATREG to 4.352V	Not Installed	Not Installed
S1	/QON pin pull-down. No function.	Not Populated	Not Populated
S2	STAT and /PG LED bypass switches.	1-4: Open, 2-3: Open	1-4: Open, 2-3: Open

Table 1-4 lists the recommended operating conditions for this EVM.

Table 1-4. Recommended Operating Conditions

Symbol	Description	MIN	TYP	MAX	Unit
V_{VBUS}, V_{VAC}	Input voltage applied to VAC and VBUS pins	4.0		13.5	V
V_{BAT}	Battery voltage applied to BAT pin			4.35	V
I_{VBUS}	Input current into VBUS			3.2	A
I_{SW}	Output current (SW)			3.2	A
I_{BAT}	Fast charging current			3.0	A
	RMS Discharging current through internal BATFET			6.0	A

2 Test Summary

2.1 Equipment

This section includes a list of supplies required for testing this EVM.

1. **Power Supplies:** 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.
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/0-5A >30-W DC electronic load set in a constant voltage loading mode.
   Load #2 (Electronic or Resistive Load): 10 Ω, 5 W (or higher)
3. **Meters:** (6x) "Fluke 75" multi-meters, (equivalent or better).
   Alternative Option: (4x) equivalent voltage meters and (2x) equivalent current meters. The current meters must be capable of measuring at least 5-A.

2.2 Equipment Setup

Use the following instructions to set up the equipment:

1. Review EVM connections in Table 1-2.
2. Set PS1 for 5-V DC, 3-A current limit and then turn off the supply.
3. Connect the output of PS1 in series with a current meter to J1 (VAC and GND).
4. Connect a voltage meter across TP7 (VBUS) and TP25 (PGND), or across J1.
5. Turn on Load #1, set to constant voltage mode, and output to 3.7-V. Disable Load. Connect Load in series with a current meter (multimeter), ground side, to J5 (BATTERY and GND) as shown in Figure 2-1.
6. Connect one voltage meter across TP15 (BAT) and TP24 (PGND), or across J4-2 and J4-1 as shown in Figure 2-1.
7. Connect one voltage meter across TP14 (SYS) and TP24 (PGND), or across J2-1 and J2-2 as shown in Figure 2-1.
8. Install shunts as shown in Table 1-3.

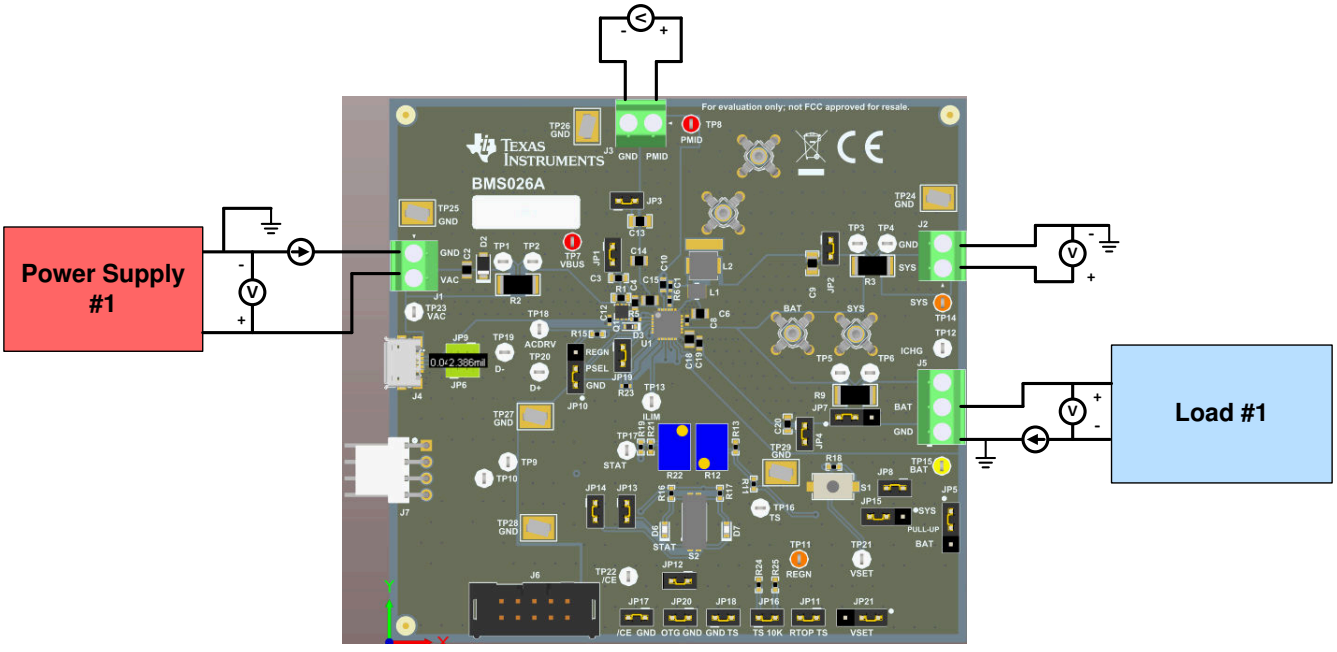

Figure 2-1. Original Test Setup for BMS026 EVM

2.3 Test Procedure

2.3.1 Initial Settings

1. Ensure Section 2.2 steps have been followed.
2. Adjust R22 potentiometer to increase input current limit to the maximum value. To do this, turn R22 clockwise until a click is heard.
3. Turn on PS1
   - Measure → VSYS (SYS-TP14 and PGND-TP24) = 4.20V±0.3V

Note

Completely disconnect Load #1 from BAT pin if different voltage value is seen.

2.3.2 Charge Mode Verification

1. PS1 should be on from Section 2.3.1.
2. Enable Load #1.
3. Adjust R12 potentiometer to increase the charge current limit to 1A
   - Measure → IBAT (current into Load #1) = 1.0A±25mA
   - Record IBAT measurement
4. Change Load #1 to 2.5V
   - Measure → VSYS (SYS-TP14 and PGND-TP24) = 3.65V±0.3V
   - Measure → IBAT (current into Load #1) = 5% of previous IBAT result ≈ 50mA±15mA

2.3.3 Boost Mode Verification

1. Turn off and disconnect PS1.
2. Set Load #1 to 3.7V and 2A current limit.

Note

If Load #1 connected from BATTERY-J5(2) to PGND-J5(1) is not a four quadrant supply, remove Load #1 and use PS1 (disconnected previously), set to 3.7V, 2A current limit and connect across BATTERY-J5(2) to PGND-J5(1).

3. Remove shunt JP20 to enable boost mode.
4. Connect Load #2 across VAC-J1(2) and GND-J1(1).
   - Measure → VBUS (VBUS-TP7 and PGND-TP25) = 5.0V±0.2V
5. Turn off and disconnect power supply.
6. Remove Load #2 from connection.
7. Reconnect shunt JP20.

2.3.4 Helpful Tips

- 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 VAC/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. If a battery thermistor is not available, make sure shunt jp16 is in place.
- 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
- For precise measurements of input and output currents, especially battery charging current regulation near termination, the current meter in series with the battery or battery simulator should not be set to auto-range and may need be removed entirely. An alternate method for measuring charge current is to either use an oscilloscope with hall effect current probe or by a differential voltage measurement across the relevant sensing resistors populated on the BMS026 EVM.

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 PGND pin connections and use the shortest copper trace connection or PGND 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 PGND plane.
4. Route and connect analog ground (AGND) separately from the power ground (PGND).Connect AGND and PGND together using a power pad as the single ground connection point or use a 0-Ω resistor to tie.
5. Use a single ground connection to tie PGND to the charger ANGD just beneath the IC. Use ground copper pour but avoid power pins to reduce inductive and capacitive noise coupling.
6. Place decoupling capacitors next to the IC pins and make the trace connection as short as possible.
7. Note the importance that the exposed power pad on the backside of the IC package be soldered to the PCB ground. Make sure that there are sufficient thermal vias directly under the IC connecting to the ground plane on the other layers.
8. The via size and number is enough for a given current path.

See the EVM design for the recommended component placement with trace and via locations. For the QFN information, see *Quad Flatpack No-Lead Logic Packages* and *QFN/SON PCB Attachment*.

4 Board Layout

Figure 4-1 through Figure 4-8 show the EVM PCB layout images.

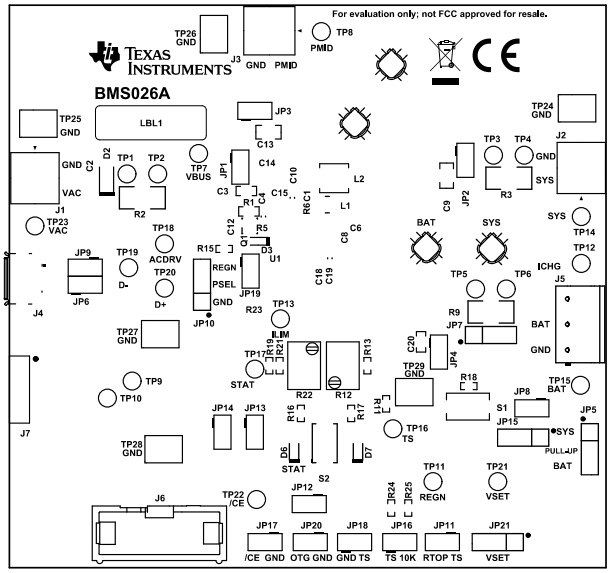

Figure 4-1. BMS026 EVM Top Overlay

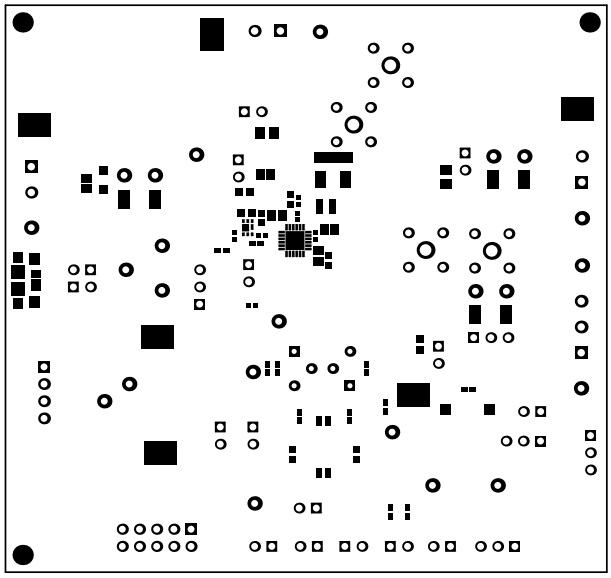

Figure 4-2. BMS026 EVM Top Solder Mask

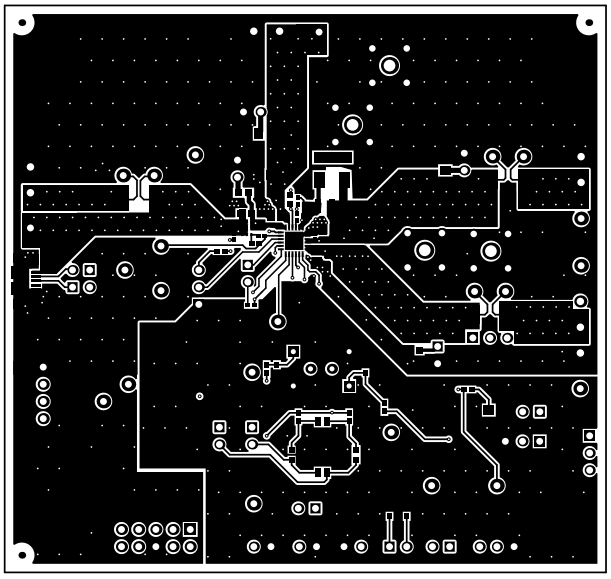

Figure 4-3. BMS026 EVM Top Layer

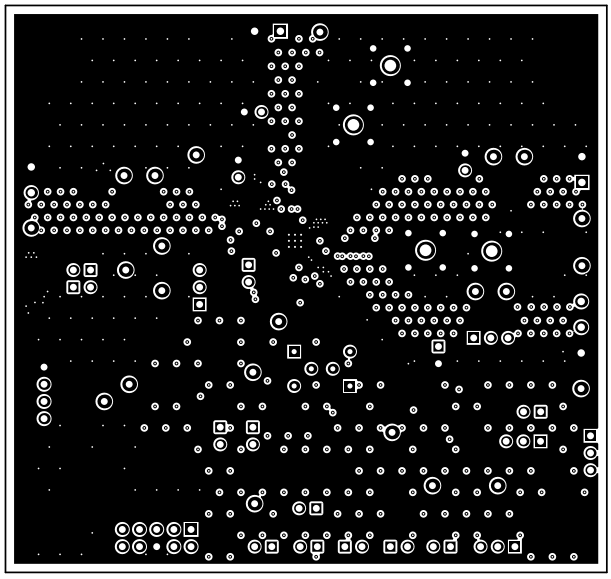

Figure 4-4. BMS026 EVM Signal Layer 1

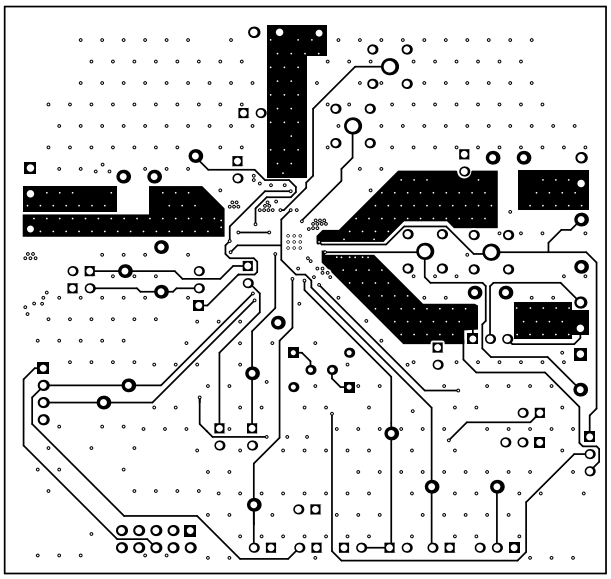

Figure 4-5. BMS026 EVM Signal Layer 2

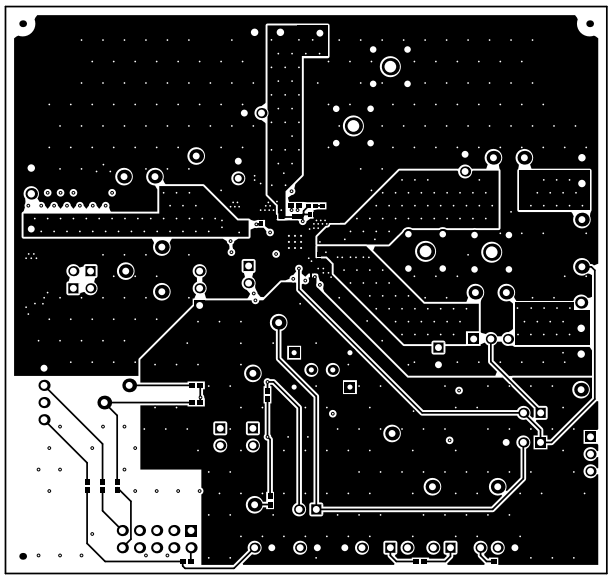

Figure 4-6. BMS026 EVM Bottom Layer

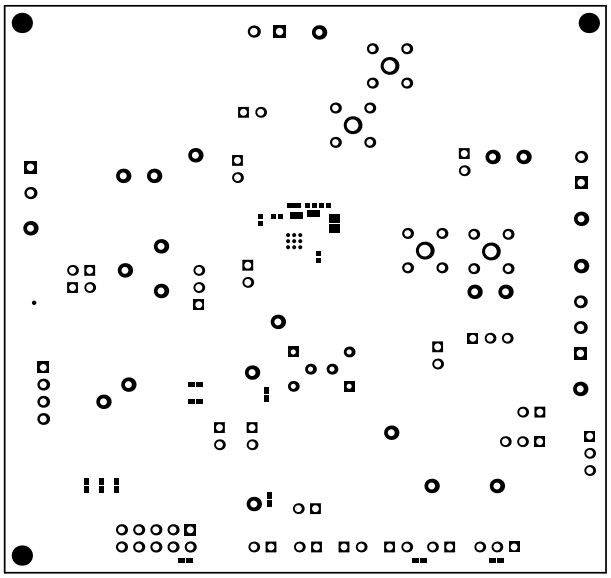

Figure 4-7. BMS026 Bottom Solder Mask

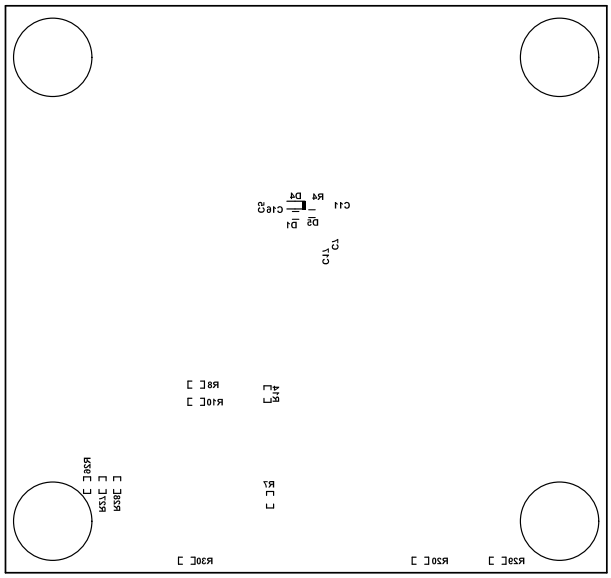

Figure 4-8. BMS026 Bottom Overlay

5 Schematic

Figure 5-1 shows the schematic for the BQ25616EVM.

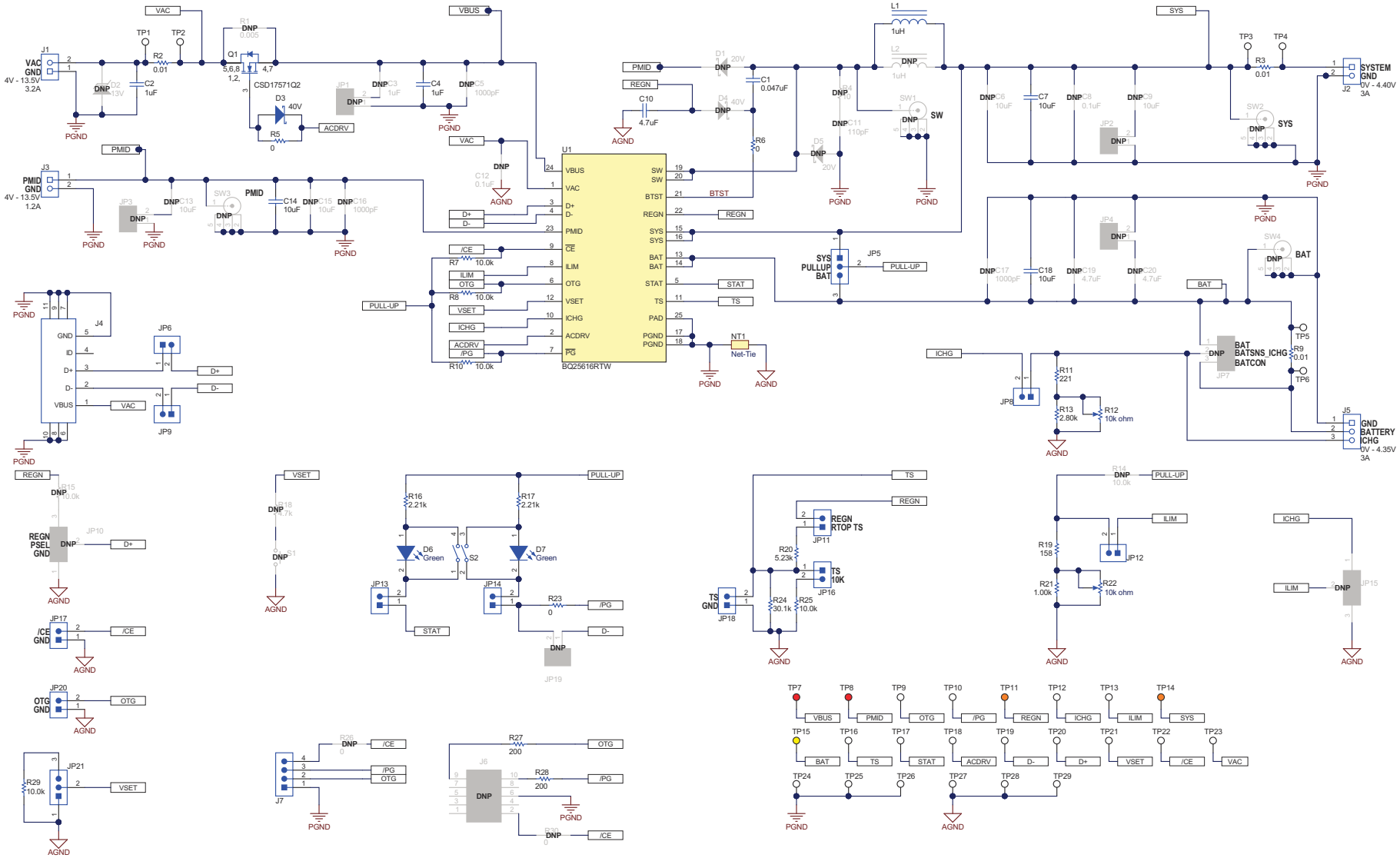

Figure 5-1. BQ25616EVM Schematic

Figure 5-2 shows the schematic for the BQ25616JEVM

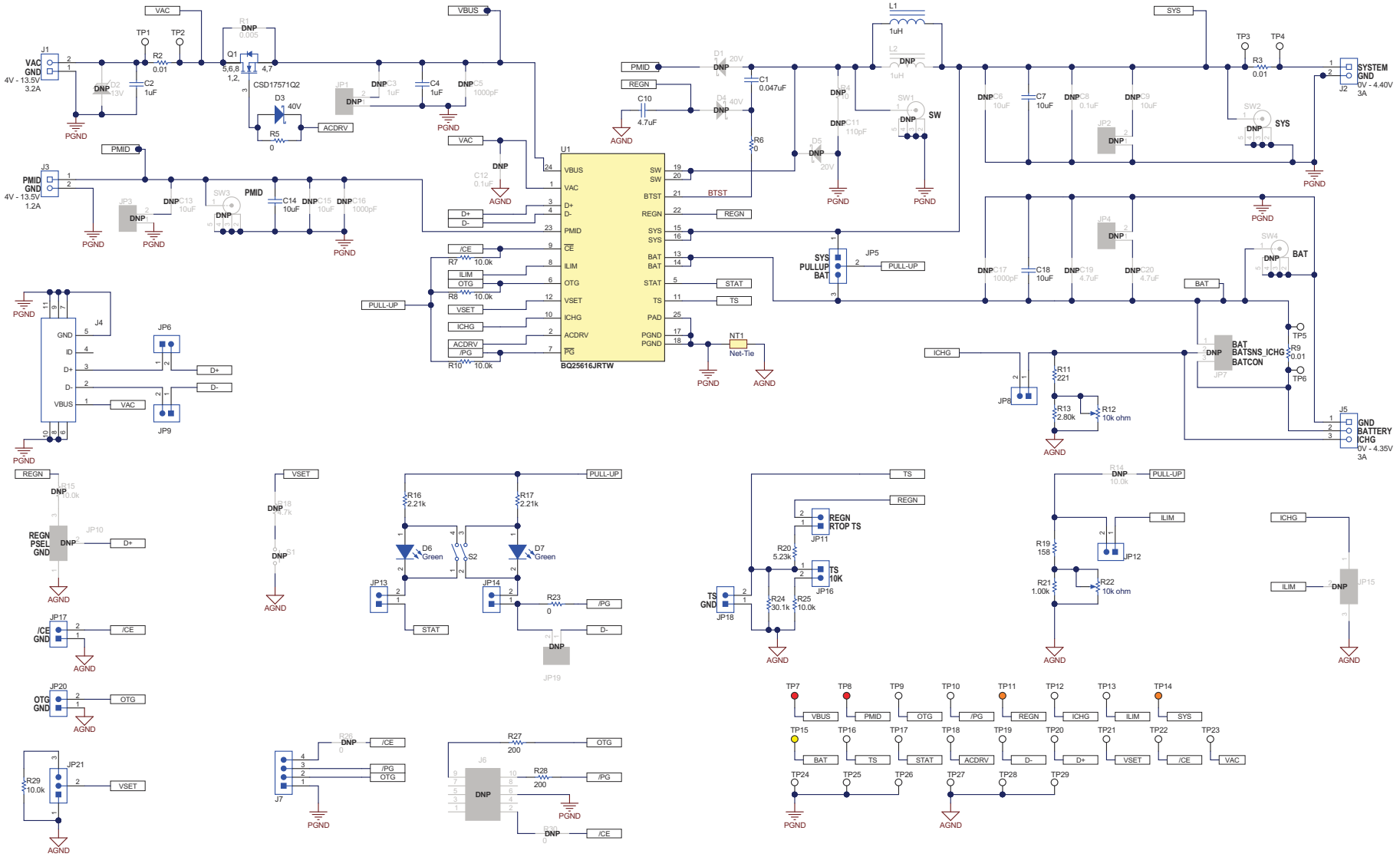

Figure 5-2. BQ25616JEVM Schematic

6 Bill of Materials

Table 6-1 lists the BQ25616EVM BOM.

Table 6-1. BQ25616EVM Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber(1)	Alternate Manufacturer(1)
!PCB1	1		Printed Circuit Board		BMS026	Any		
C1	1	0.047µF	CAP, CERM, 0.047 µF, 25 V, +/- 10%, X7R, 0402	0402	GRM155R71E473KA88D	MuRata		
C2	1	1µF	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0805	0805	GRM219R71E105KA88D	MuRata		
C4	1	1µF	CAP, CERM, 1 µF, 35 V, +/- 10%, X5R, 0603	0603	GMK107BJ105KA-T	Taiyo Yuden		
C7	1	10µF	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	0805	GRM21BR71A106KA73L	MuRata		
C10	1	4.7µF	CAP, CERM, 4.7 µF, 16 V, +/- 10%, X5R, 0603	0603	GRM188R61C475KAAJD	MuRata		
C14	1	10µF	CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805	0805	GRM21BR61E106KA73L	MuRata		
C18	1	10µF	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	0805	GRM21BR71A106KE51L	MuRata		
D3	1	40V	Diode, Schottky, 40 V, 0.38 A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.		
D6, D7	2	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On		
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M		
J1, J2, J3	3		Conn Term Block, 2POS, 3.81mm, TH	2POS Terminal Block	1727010	Phoenix Contact		
J4	1		Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	MICRO USB CONN, R/A	1981568-1	TE Connectivity		
J5	1		Terminal Block Receptacle, 3x1, 3.81mm, R/A, TH	Term Block, 3 pos	1727023	Phoenix Contact		
J7	1		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	0022053041	Molex		
JP5, JP21	2		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
JP6, JP8, JP9, JP11, JP12, JP13, JP14, JP16, JP17, JP18, JP20	11		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
L1	1	1µH	Inductor, 1 µH, 3.2 A, 0.028 ohm, SMD	2.5x2mm	MPIM252010F1R0M-LF	Microgate		

Table 6-1. BQ25616EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber(1)	Alternate Manufacturer(1)
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		
Q1	1	30V	MOSFET, N-CH, 30 V, 22 A, DQK0006C (WSON-6)	DQK0006C	CSD17571Q2	Texas Instruments		None
R2, R3, R9	3	0.01	RES, 0.01, 1%, 1 W, 2010	2010	WSL2010R0100FEA18	Vishay-Dale		
R5, R6, R23	3	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
R7, R8, R10, R25, R29	5	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R11	1	221	RES, 221, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402221RFKED	Vishay-Dale		
R12, R22	2	10k ohm	Trimmer, 10k ohm, 0.25W, TH	4.5x8x6.7mm	3266W-1-103LF	Bourns		
R13	1	2.80k	RES, 2.80 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K80FKED	Vishay-Dale		
R16, R17	2	2.21k	RES, 2.21 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K21FKED	Vishay-Dale		
R19	1	158	RES, 158, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402158RFKED	Vishay-Dale		
R20	1	5.23k	RES, 5.23 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04025K23FKED	Vishay-Dale		
R21	1	1.00k	RES, 1.00 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K00FKED	Vishay-Dale		
R24	1	30.1k	RES, 30.1 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040230K1FKED	Vishay-Dale		
R27, R28	2	200	RES, 200, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402200RFKED	Vishay-Dale		
S2	1		Switch, SPST, 2 Pos, 25mA, 24VDC, SMD	3.71x5.8mm	218-2LPST	CTS Electrocomponents		
SH-JP5, SH-JP6, SH-JP8, SH-JP9, SH-JP11, SH-JP12, SH-JP13, SH-JP14, SH-JP16, SH-JP17, SH-JP20	11	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M

Table 6-1. BQ25616EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber(1)	Alternate Manufacturer(1)
TP1, TP2, TP3, TP4, TP5, TP6, TP9, TP10, TP12, TP13, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23	18		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone		
TP7, TP8	2		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone		
TP11, TP14	2		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone		
TP15	1		Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone		
TP24, TP25, TP26, TP27, TP28, TP29	6		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone		
U1	1		BQ25616RTW, RTW0024P (PVQFN-24)	RTW0024P	BQ25616RTW	Texas Instruments		Texas Instruments
C3	0	1µF	CAP, CERM, 1 µF, 35 V, +/- 10%, X5R, 0603	0603	GMK107BJ105KA-T	Taiyo Yuden		
C5, C16, C17	0	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	0402	GRM1555C1H102JA01D	MuRata		
C6, C9	0	10µF	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	0805	GRM21BR71A106KE51L	MuRata		
C8	0	0.1µF	CAP, CERM, 0.1 µF, 25 V, +/- 20%, X7R, 0402	0402	C1005X7R1E104M050BB	TDK		
C11	0	110pF	CAP, CERM, 110 pF, 25 V, +/- 5%, C0G/NP0, 0402	0402	GRM1555C1E111JA01D	MuRata		
C12	0	0.1µF	CAP, CERM, 0.1 µF, 25 V, +/- 10%, X7R, 0402	0402	GRM155R71E104KE14D	MuRata		
C13	0	10µF	CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805	0805	GRM21BR61E106KA73L	MuRata		
C15	0	10µF	CAP, CERM, 10 µF, 25 V, +/- 10%, X7S, 0805	0805	GRM21BC71E106KE11L	MuRata		
C19, C20	0	4.7µF	CAP, CERM, 4.7 µF, 16 V, +/- 10%, X5R, 0603	0603	GRM188R61C475KAAJ	MuRata		
D1, D5	0	20V	Diode, Schottky, 20 V, 1 A, 152AD	152AD	NSR10F20NXT5G	ON Semiconductor		

Table 6-1. BQ25616EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber(1)	Alternate Manufacturer(1)
D2	0	13V	Diode, TVS, Uni, 13 V, 21.5 Vc, SOD-123W	SOD-123W	PTVS13VS1UR, 115	NXP Semiconductor		
D4	0	40V	Diode, Schottky, 40 V, 0.38 A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.		
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
J6	0		Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	5x2 Shrouded header	N2510-6002-RB	3M		
JP1, JP2, JP3, JP4, JP19	0		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
JP7, JP10, JP15	0		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
L2	0	1µH	Inductor, Wirewound, 1 µH, 4 A, 0.041 ohm, SMD	4.06x4.06mm	74437321010	Wurth Elektronik		
R1	0	0.005	RES, 0.005, 1%, 0.25 W, AEC-Q200 Grade 1, 0603	0603	ERJ3LWFR005V	Panasonic		
R4	0	10	RES, 10, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210R0JNED	Vishay-Dale		
R14, R15	0	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R18	0	4.7k	RES, 4.7 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K70JNED	Vishay-Dale		
R26, R30	0	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
S1	0		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C&K Components		
SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP7, SH-JP10, SH-JP15, SH-JP18, SH-JP19, SH-JP21	0	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M
SW1, SW2, SW3, SW4	0		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix		

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

Table 6-2 lists the BQ25616JEVM BOM.

Table 6-2. BQ25616JEVM Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber(1)	Alternate Manufacturer(1)
!PCB1	1		Printed Circuit Board		BMS026	Any		
C1	1	0.047µF	CAP, CERM, 0.047 µF, 25 V, +/- 10%, X7R, 0402	0402	GRM155R71E473KA88D	MuRata		
C2	1	1µF	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0805	0805	GRM219R71E105KA88D	MuRata		
C4	1	1µF	CAP, CERM, 1 µF, 35 V, +/- 10%, X5R, 0603	0603	GMK107BJ105KA-T	Taiyo Yuden		
C7	1	10µF	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	0805	GRM21BR71A106KA73L	MuRata		
C10	1	4.7µF	CAP, CERM, 4.7 µF, 16 V, +/- 10%, X5R, 0603	0603	GRM188R61C475KAAJD	MuRata		
C14	1	10µF	CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805	0805	GRM21BR61E106KA73L	MuRata		
C18	1	10µF	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	0805	GRM21BR71A106KE51L	MuRata		
D3	1	40V	Diode, Schottky, 40 V, 0.38 A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.		
D6, D7	2	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On		
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M		
J1, J2, J3	3		Conn Term Block, 2POS, 3.81mm, TH	2POS Terminal Block	1727010	Phoenix Contact		
J4	1		Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	MICRO USB CONN, R/A	1981568-1	TE Connectivity		
J5	1		Terminal Block Receptacle, 3x1, 3.81mm, R/A, TH	Term Block, 3 pos	1727023	Phoenix Contact		
J7	1		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	0022053041	Molex		
JP5, JP21	2		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
JP6, JP8, JP9, JP11, JP12, JP13, JP14, JP16, JP17, JP18, JP20	11		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
L1	1	1µH	Inductor, 1 µH, 3.2 A, 0.028 ohm, SMD	2.5x2mm	MPIM252010F1R0M-LF	Microgate		

Table 6-2. BQ25616JEVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber(1)	Alternate Manufacturer(1)
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		
Q1	1	30V	MOSFET, N-CH, 30 V, 22 A, DQK0006C (WSON-6)	DQK0006C	CSD17571Q2	Texas Instruments		None
R2, R3, R9	3	0.01	RES, 0.01, 1%, 1 W, 2010	2010	WSL2010R0100 FEA18	Vishay-Dale		
R5, R6, R23	3	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402000 0Z0ED	Vishay-Dale		
R7, R8, R10, R25, R29	5	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K 0FKED	Vishay-Dale		
R11	1	221	RES, 221, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402221 RFKED	Vishay-Dale		
R12, R22	2	10k ohm	Trimmer, 10k ohm, 0.25W, TH	4.5x8x6.7mm	3266W-1-103LF	Bourns		
R13	1	2.80k	RES, 2.80 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K8 0FKED	Vishay-Dale		
R16, R17	2	2.21k	RES, 2.21 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K2 1FKED	Vishay-Dale		
R19	1	158	RES, 158, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402158 RFKED	Vishay-Dale		
R20	1	5.23k	RES, 5.23 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04025K2 3FKED	Vishay-Dale		
R21	1	1.00k	RES, 1.00 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K0 0FKED	Vishay-Dale		
R24	1	30.1k	RES, 30.1 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040230K 1FKED	Vishay-Dale		
R27, R28	2	200	RES, 200, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402200 RFKED	Vishay-Dale		
S2	1		Switch, SPST, 2 Pos, 25mA, 24VDC, SMD	3.71x5.8mm	218-2LPST	CTS Electrocomponents		
SH-JP5, SH-JP6, SH-JP8, SH-JP9, SH-JP11, SH-JP12, SH-JP13, SH-JP14, SH-JP16, SH-JP17, SH-JP20	11	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M

Table 6-2. BQ25616JEVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber(1)	Alternate Manufacturer(1)
TP1, TP2, TP3, TP4, TP5, TP6, TP9, TP10, TP12, TP13, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23	18		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone		
TP7, TP8	2		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone		
TP11, TP14	2		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone		
TP15	1		Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone		
TP24, TP25, TP26, TP27, TP28, TP29	6		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone		
U1	1		BQ25616JRTW, RTW0024P (PVQFN-24)	RTW0024P	BQ25616JRTW	Texas Instruments		Texas Instruments
C3	0	1µF	CAP, CERM, 1 µF, 35 V, +/- 10%, X5R, 0603	0603	GMK107BJ105KA-T	Taiyo Yuden		
C5, C16, C17	0	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	0402	GRM1555C1H102JA01D	MuRata		
C6, C9	0	10µF	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	0805	GRM21BR71A106KE51L	MuRata		
C8	0	0.1µF	CAP, CERM, 0.1 µF, 25 V, +/- 20%, X7R, 0402	0402	C1005X7R1E104M050BB	TDK		
C11	0	110pF	CAP, CERM, 110 pF, 25 V, +/- 5%, C0G/NP0, 0402	0402	GRM1555C1E111JA01D	MuRata		
C12	0	0.1µF	CAP, CERM, 0.1 µF, 25 V, +/- 10%, X7R, 0402	0402	GRM155R71E104KE14D	MuRata		
C13	0	10µF	CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805	0805	GRM21BR61E106KA73L	MuRata		
C15	0	10µF	CAP, CERM, 10 µF, 25 V, +/- 10%, X7S, 0805	0805	GRM21BC71E106KE11L	MuRata		
C19, C20	0	4.7µF	CAP, CERM, 4.7 µF, 16 V, +/- 10%, X5R, 0603	0603	GRM188R61C475KAAJ	MuRata		
D1, D5	0	20V	Diode, Schottky, 20 V, 1 A, 152AD	152AD	NSR10F20NXT5G	ON Semiconductor		

Table 6-2. BQ25616JEVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber(1)	Alternate Manufacturer(1)
D2	0	13V	Diode, TVS, Uni, 13 V, 21.5 Vc, SOD-123W	SOD-123W	PTVS13VS1UR, 115	NXP Semiconductor		
D4	0	40V	Diode, Schottky, 40 V, 0.38 A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.		
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
J6	0		Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	5x2 Shrouded header	N2510-6002-RB	3M		
JP1, JP2, JP3, JP4, JP19	0		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
JP7, JP10, JP15	0		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
L2	0	1µH	Inductor, Wirewound, 1 µH, 4 A, 0.041 ohm, SMD	4.06x4.06mm	74437321010	Wurth Elektronik		
R1	0	0.005	RES, 0.005, 1%, 0.25 W, AEC-Q200 Grade 1, 0603	0603	ERJ3LWFR005V	Panasonic		
R4	0	10	RES, 10, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210R0JNED	Vishay-Dale		
R14, R15	0	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R18	0	4.7k	RES, 4.7 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K70JNED	Vishay-Dale		
R26, R30	0	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
S1	0		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C&K Components		
SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP7, SH-JP10, SH-JP15, SH-JP18, SH-JP19, SH-JP21	0	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M
SW1, SW2, SW3, SW4	0		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix		

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

7 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 2023)	Page
• Changed *Board Layout* images	7

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

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