User's Guide

SLUUBL3A–June 2017–Revised October 2017

bq25606 PWR772 Evaluation Module

This user's guide provides detailed testing instructions for the bq25606 evaluation module (EVM). Also included are descriptions of the necessary equipment, equipment setup, test procedures, the printed-circuit board layouts, schematics, and the bill of materials (BOM).

Throughout this user's guide, the abbreviations *EVM*, *bq25606EVM*, *PWR772*, and the term *evaluation module* are synonymous with the bq25606 evaluation module, unless otherwise noted.

Contents

1 Introduction 2
  1.1 EVM Features 2
  1.2 I/O Descriptions 2
2 Test Summary 3
  2.1 Equipment 3
  2.2 Equipment Setup 3
  2.3 Test Procedure 5
3 PCB Layout Guideline 6
4 Board Layout 7
5 Schematic 9
6 Bill of Materials 10

List of Figures

1 Original Test Setup for bq25606 EVM 4
2 bq25606EVM Top Overlay 7
3 bq25606EVM Top Solder Mask 7
4 bq25606EVM Top Layer 7
5 bq25606EVM Signal Layer 1 7
6 bq25606EVM Signal Layer 2 7
7 bq25606EVM Bottom Layer 7
8 bq25606EVM Bottom Solder Mask 8
9 bq25606EVM Bottom Overlay 8
10 Schematic for bq25606EVM-772 9

List of Tables

1 Device Data Sheets 2
2 EVM Connections 2
3 EVM Jumper Connections and Shunt Installation 2
4 Recommended Operating Conditions 3
5 bq25606EVM-772 BOM 10

Trademarks

All trademarks are the property of their respective owners.

1 Introduction

1.1 EVM Features

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

Table 1. Device Data Sheets

Device	Data Sheet	EVM Label	Variant
bq25606	SLUSCK6	BQ25606EVM-772	004

The bq25606 evaluation module (EVM) is a standalone charger module without I^2C control.

1.2 I/O Descriptions

Table 2 lists the jumper connections available on this EVM.

Table 2. EVM Connections

Jack	Description
J1-VAC	Input positive terminal
J1-GND	Ground Input: negative terminal (ground terminal)
J2-PMID	PMID pin connection
J2-GND	Ground
J3	Output mini-USB port
J4-SYS	Connected to system
J4-GND	Ground
J5-BATSNS_ICHG	BATSNS or ICHG pin connection
J5-BAT	Connected to battery pack positive node
J5-GND	Ground
J6	I2C 4-pin connector
J7	USB-TO-GPIO connector (Not populated)

Table 3 lists the EVM jumper connections.

Table 3. EVM Jumper Connections and Shunt Installation

Jack	Description	bq25606 Setting
JP1	PSEL pin selection	Not installed
JP2	$\overline{\text{CE}}$ pin setting: pull low to enable the charge	Installed
JP3	OTG pin setting: pull high to enable OTG mode	Short OTG to GND
JP4	STAT, $\overline{\text{PG}}$, $\overline{\text{CE}}$, INT, and OTG pins pullup source (SYS or BAT)	Short to SYS
JP5	TS pin to GND	Not installed
JP6	TS resistor divider pullup source (REGN) connection	Installed
JP7	Internal 10 kΩ to GND to TS pin	Installed
JP8	BATSNS selection	Not installed
JP9	$\overline{\text{QON}}$ and VSET pin setting	Not installed
JP10	STAT pin setting	Installed
JP11	Add SYS cap	Not installed
JP12	SDA and $\overline{\text{PG}}$ pin setting	Installed
JP13	D+ and PSEL to J3	Not Installed
JP14	D– and $\overline{\text{PG}}$ to J3	Not Installed
JP15	D– and $\overline{\text{PG}}$ pin setting	Not installed
JP16	Add VBUS cap	Not installed

Table 3. EVM Jumper Connections and Shunt Installation (continued)

Jack	Description	bq25606 Setting
JP17	Add PMID cap	Not installed
JP18	Add AT cap	Not installed
S1	$\overline{\text{QON}}$ control	Default open
S2	Switch to short indicator LEDs	Default open

Table 4 lists the recommended operating conditions for this EVM.

Table 4. Recommended Operating Conditions

Symbol	Description	MIN	TYP	MAX	Unit
Supply voltage, V_{VBUS}	Input voltage from AC adapter	3.9	5.0	13.5	V
Battery voltage, V_{BAT}	Voltage applied at V_{BAT} terminal	0	4.208	4.4	V
I_{BAT}	Fast charging current	0		3.0	A
	Discharging current through internal MOSFET	6.0			A
Supply current, I_{IN}	Maximum input current from AC adapter input	0		3.0	A

2 Test Summary

2.1 Equipment

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

1. Power supply: Power supply #1 (PS#1): 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. Load #1:
   - (4-quadrant supply, constant voltage < 4.5 V) A 0–20 V, 0–5 A, > 30-W system, DC electronic load and setting as constant voltage load mode

   or
   - Kepco load: BOP 20–5M, DC 0 to ±20 V, 0 to ±5 A (or higher)
3. Load #2: Use with Boost Mode, VAC to GND load, 10 Ω, 5 W or greater.
4. Meters:
   - Six Fluke 75 multimeters, (equivalent or better)

   or
   - Four equivalent voltage meters and two equivalent current meters. The current meters must be capable of measuring 5-A+ current

2.2 Equipment Setup

Use the following list to set up the equipment:

1. Set PS#1 for 5-V DC, 3-A current limit and then turn off the supply.
2. Connect the output of PS#1 in series with a current meter (multimeter) to J1 (VAC and GND). It is recommended to connect one voltage meter across TP24 and TP27 to measure the input current sensing resistor voltage. The sensing resistor is 10 mΩ.
3. Connect one voltage meter across TP21 (VAC) and TP18 (GND), connect another voltage meter across TP1 (VBUS) and TP18 (GND).
4. Turn on Load #1, set to constant voltage mode and output to 2.5 V. Turn off (disable) load. Connect load to J5 (BAT and GND).
5. Connect one voltage meter across TP9 (BAT) and TP17 (GND) to measure the battery voltage and another voltage meter across TP28 and TP29 to measure the battery current sensing resistor voltage. The sensing resistor is 10 mΩ. An alternate method is to use the optional current meter in series to measure the battery current.

6. Install shunts as shown in Table 3.

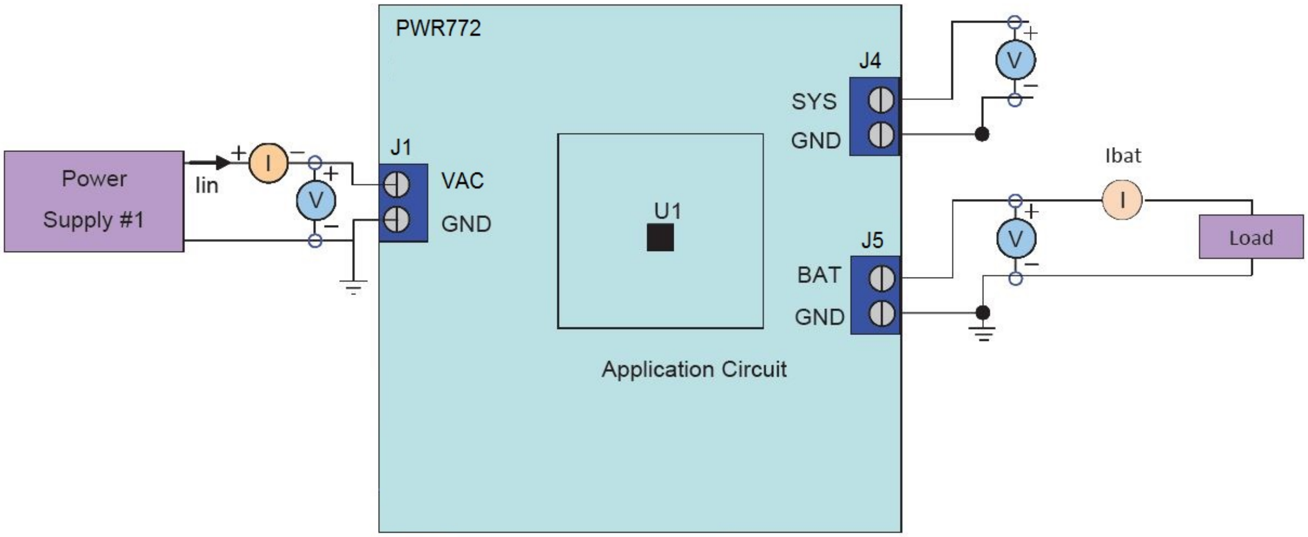

Figure 1. Original Test Setup for bq25606 EVM

2.3 Test Procedure

2.3.1 Charger Mode Verification

1. Enable Load #1 from Section 2.2, Step 4.
2. Measure the voltage across J4 and J5 as follows:
   - Measure → V(TP8(SYS), TP17(GND)) = 3.65 V (typical)
   - Measure → V(TP9(BAT), TP17(GND)) = 2.5 V (typical)
   - Measure → IBAT (= pre-charge current)
3. Change Load #1 to 3.7 V
   - Measure → V(TP8(SYS), TP17(GND)) = 3.8 V (typical)
   - Measure → V(TP9(BAT), TP17(GND)) = 3.7 V (typical)
   - Measure → IBAT (= fast charge current)
4. Adjust R10 to change charging current.
5. Adjust R11 to change input current limit.
6. Turn off and disconnect Load #1.
7. Turn off and disconnect PS#1.

2.3.2 Boost Mode Verification

1. Do not install JP3.
2. If the constant voltage load connected from BAT to GND is not a four-quadrant supply (sources current), remove the load and use the power source disconnected in step 1, set to 3.7 V and 2-A current limit and connect between BAT and GND.
3. Apply 10 Ω (5 W or greater) across J1 VAC(+) to GND(–).
4. Verify V_{VBUS} to GND since VBUS is the actual boost mode output voltage.
   Measure → V_{VBUS} = 5.15 V (Typical)
5. Turn off and disconnect power supply.
6. Remove 10-Ω resistor at VAC.

2.3.3 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 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 shunts JP6 and JP7 are 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 BAT 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 charge current and battery 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 place a 1% or better, thermally capable (for example, 0.010 Ω in 1210 or larger footprint) resistor in series between the BAT pin and battery and measure the voltage across that resistor. The bq25606EVM has the sensing resistors onboard.

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. Route analog ground separately from the power ground. Connect analog ground and connect power ground separately. Connect analog ground and power ground together using a power pad as the single ground connection point or use a 0-Ω resistor to tie analog ground to power ground.
5. Use a single ground connection to tie the charger power ground to the charger analog ground 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. 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.
8. The via size and number should be 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 2 through Figure 9 show the EVM PCB layout images.

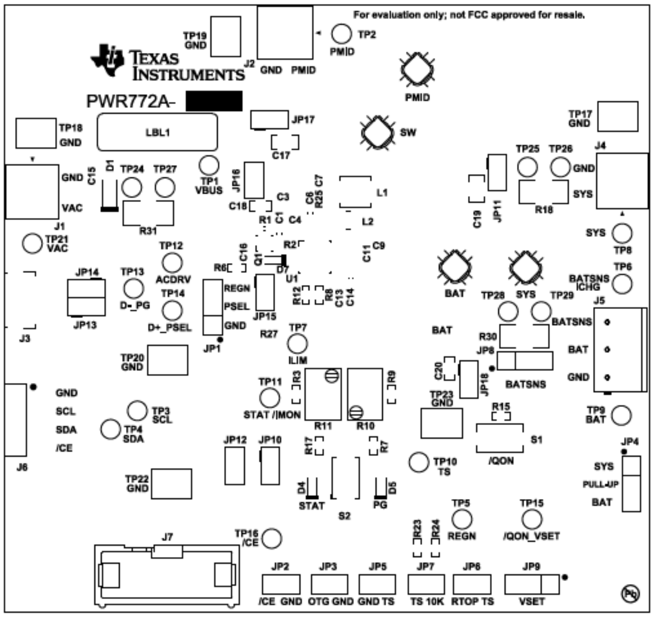

Figure 2. bq25606EVM Top Overlay

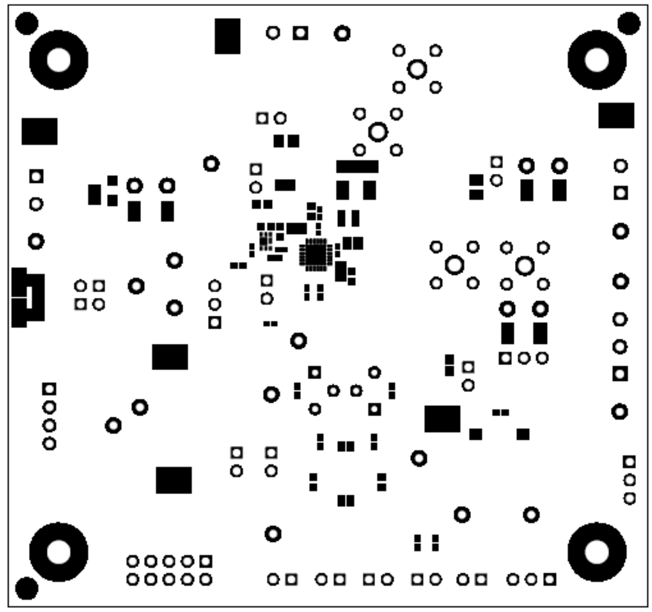

Figure 3. bq25606EVM Top Solder Mask

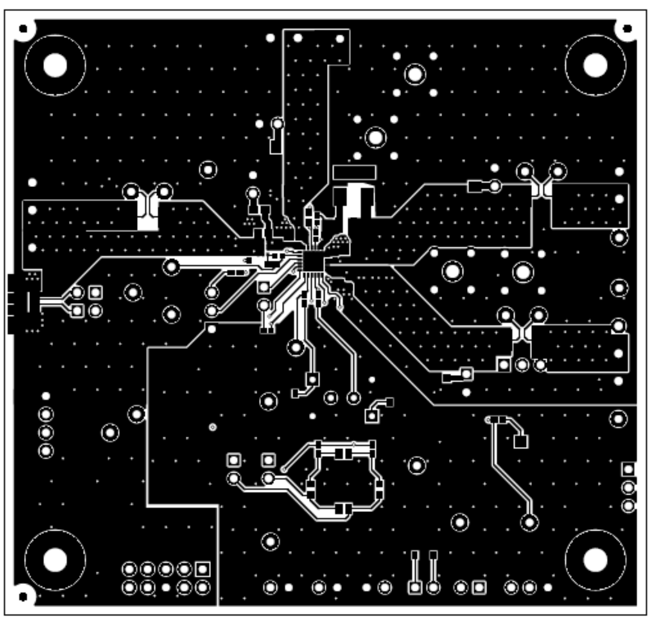

Figure 4. bq25606EVM Top Layer

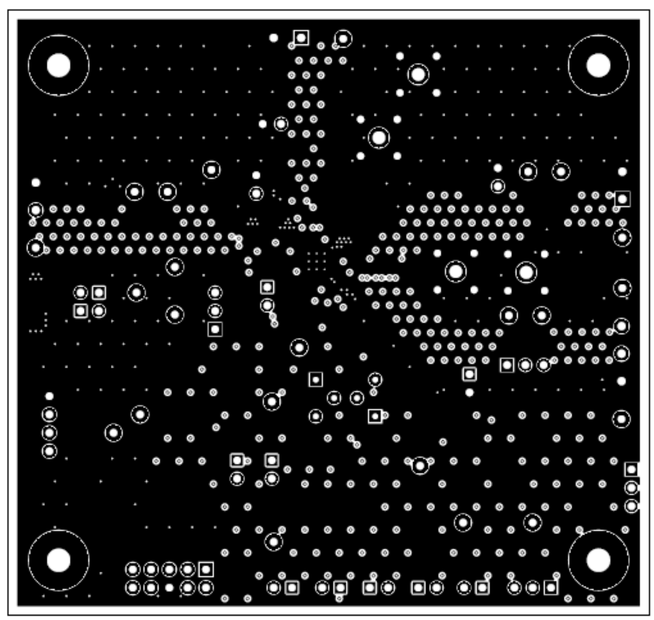

Figure 5. bq25606EVM Signal Layer 1

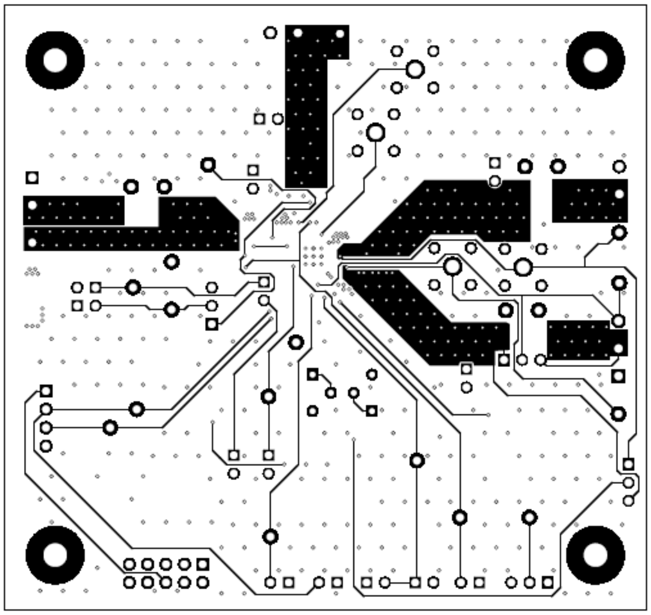

Figure 6. bq25606EVM Signal Layer 2

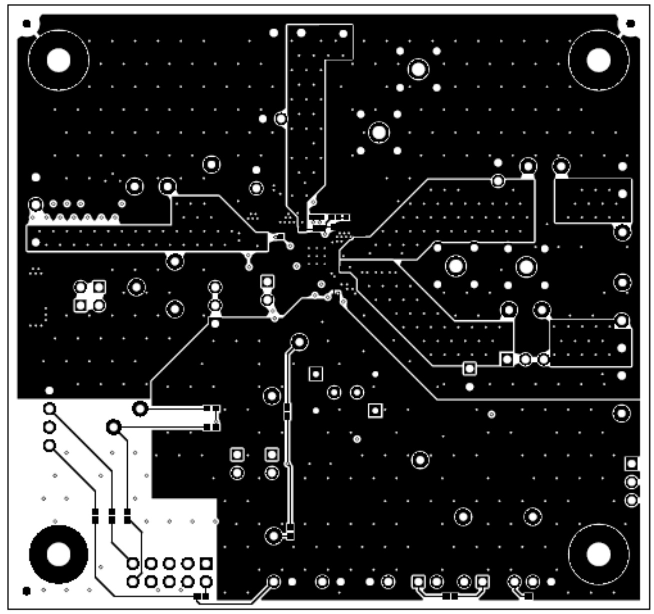

Figure 7. bq25606EVM Bottom Layer

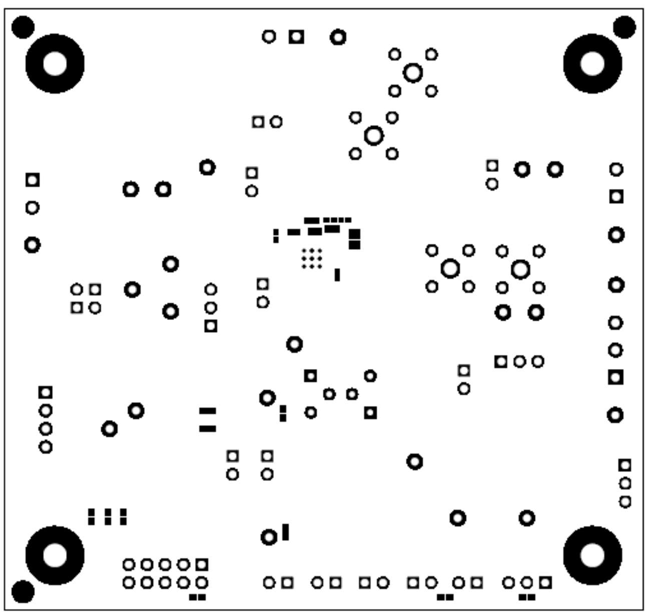

Figure 8. bq25606EVM Bottom Solder Mask

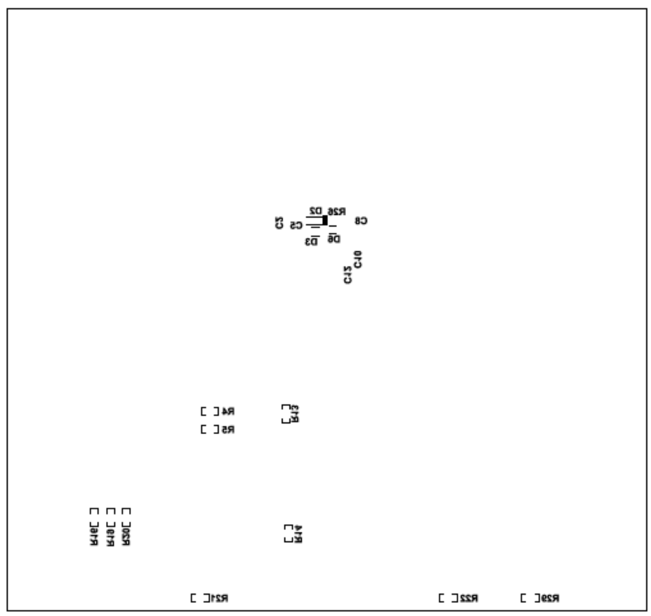

Figure 9. bq25606EVM Bottom Overlay

5 Schematic

Figure 10 shows the schematic for the bq25606 EVM.

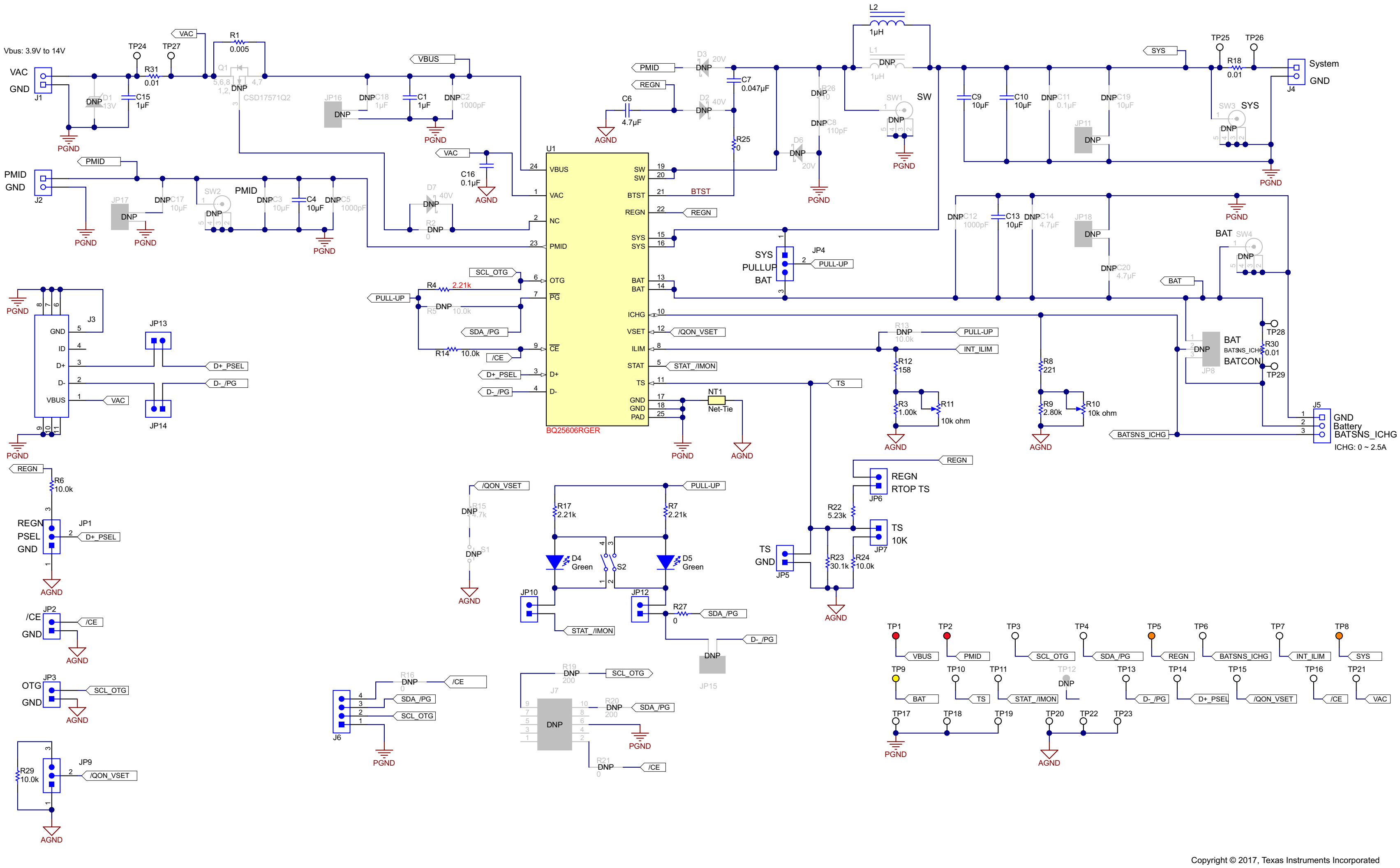

Figure 10. Schematic for bq25606EVM-772

6 Bill of Materials

Table 5 lists the bq25606EVM-772 BOM.

Table 5. bq25606EVM-772 BOM

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB	1		Printed circuit board		PWR772	Any		
C1	1	1 µF	Capacitor, ceramic, 1 µF, 35 V, ± 10%, X5R, 0603	0603	GMK107BJ105KA-T	Taiyo Yuden		
C4	1	10 µF	Capacitor, ceramic, 10 µF, 25 V, ± 10%, X7S, 0805	0805	GRM21BC71E106KE11L	Murata		
C6	1	4.7 µF	Capacitor, ceramic, 4.7 µF, 16 V, ± 10%, X5R, 0603	0603	GRM188R61C475KAAJ	Murata		
C7	1	0.047 µF	Capacitor, ceramic, 0.047 µF, 25 V, ± 10%, X7R, 0402	0402	GRM155R71E473KA88D	Murata		
C9, C10, C13	3	10 µF	Capacitor, ceramic, 10 µF, 10 V, ± 10%, X7R, 0805	0805	GRM21BR71A106KE51L	Murata		
C15	1	1 µF	Capacitor, ceramic, 1 µF, 25 V, ± 10%, X7R, 0805	0805	GRM219R71E105KA88D	Murata		
C16	1	0.1 µF	Capacitor, ceramic, 0.1 µF, 25 V, ± 10%, X7R, 0402	0402	GRM155R71E104KE14D	Murata		
D4, D5	2	Green	LED, Green, SMD	1.6 × 0.8 × 0.8 mm	LTST-C190GKT	Lite-On		
J1, J2, J4	3		Connector Terminal Block, 2 POS, 3.81 mm, TH	2 POS Terminal Block	1727010	Phoenix Contact		
J3	1		Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	7.5 × 2.45 × 5 mm	0473460001	Molex		
J5	1		Terminal Block Receptacle, 3 × 1, 3.81 mm, R/A, TH	Term Block, 3 pos	1727023	Phoenix Contact		
J6	1		Header (friction lock), 100 mil, 4x1, R/A, TH	4 × 1 R/A Header	22-05-3041	Molex		
JP1, JP4, JP9	3		Header, 100 mil, 3 × 1, Tin, TH	Header, 3 PIN, 100 mil, Tin	PEC03SAAN	Sullins Connector Solutions		
JP2, JP3, JP5, JP6, JP7, JP10, JP12, JP13, JP14	9		Header, 100 mil, 2 × 1, Tin, TH	Header, 2 PIN, 100 mil, Tin	PEC02SAAN	Sullins Connector Solutions		
L2	1	1 µH	Inductor, 1 µH, 3.2 A, 0.028 Ω, SMD	2.5 × 2 mm	MPIM252010F1R0M-LF	Microgate		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W × 0.200" H - 10,000 per roll	PCB Label 0.650" H × 0.200" W	THT-14-423-10	Brady		
R1	1	0.005	Resistor, 0.005, 1%, 0.25 W, AEC-Q200 Grade 1, 0603	0603	ERJ3LWFR005V	Panasonic		
R3	1	1.00 k	Resistor, 1.00 k, 1%, 0.063 W, 0402	0402	CRCW04021K00FKED	Vishay-Dale		
R4, R7, R17	3	2.21 k	Resistor, 2.21 k, 1%, 0.063 W, 0402	0402	CRCW04022K21FKED	Vishay-Dale		
R6, R14, R24, R29	4	10.0 k	Resistor, 10.0 k, 1%, 0.063 W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R8	1	221	Resistor, 221, 1%, 0.063 W, 0402	0402	CRCW0402221RFKED	Vishay-Dale		
R9	1	2.80 k	Resistor, 2.80 k, 1%, 0.063 W, 0402	0402	CRCW04022K80FKED	Vishay-Dale		
R10, R11	2	10 kΩ	Trimmer, 10 kΩ, 0.25W, TH	4.5 × 8 × 6.7 mm	3266W-1-103LF	Bourns		
R12	1	158	Resistor, 158, 1%, 0.063 W, 0402	0402	CRCW0402158RFKED	Vishay-Dale		
R18, R30, R31	3	0.01	Resistor, 0.01, 1%, 1 W, 2010	2010	WSL2010R0100FEA18	Vishay-Dale		
R22	1	5.23 k	Resistor, 5.23 k, 1%, 0.063 W, 0402	0402	CRCW04025K23FKED	Vishay-Dale		
R23	1	30.1 k	Resistor, 30.1 k, 1%, 0.063 W, 0402	0402	CRCW040230K1FKED	Vishay-Dale		
R25, R27	2	0	Resistor, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
S2	1		Switch, SPST, 2 POS, 25 mA, 24 VDC, SMD	3.71 × 5.8 mm	218-2LPST	CTS Electrocomponents		
SH-JP2, SH-JP3, SH-JP4, SH-JP6, SH-JP7, SH-JP10, SH-JP12, SH-JP13, SH-JP14	9	1 × 2	Shunt, 100 mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec

Table 5. bq25606EVM-772 BOM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
TP1, TP2	2		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone		
TP3, TP4, TP6, TP7, TP10, TP11, TP13, TP14, TP15, TP16, TP21, TP24, TP25, TP26, TP27, TP28, TP29	17		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone		
TP5, TP8	2		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone		
TP9	1		Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone		
TP17, TP18, TP19, TP20, TP22, TP23	6		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone		
U1	1		BQ25606RGER, RGE0024H (VQFN-24)	RGE0024H	bq25606RGER	Texas Instruments	bq25606RGET	Texas Instruments
C2, C5, C12	0	1000 pF	Capacitor, ceramic, 1000 pF, 50 V, ± 5%, C0G/NP0, 0402	0402	GRM1555C1H102JA01D	Murata		
C3, C17	0	10 µF	Capacitor, ceramic, 10 µF, 25 V, ± 10%, X5R, 0805	0805	GRM21BR61E106KA73L	Murata		
C8	0	110 pF	Capacitor, ceramic, 110 pF, 25 V, ± 5%, C0G/NP0, 0402	0402	GRM1555C1E111JA01D	Murata		
C11	0	0.1 µF	Capacitor, ceramic, 0.1 µF, 25 V, ± 20%, X7R, 0402	0402	C1005X7R1E104M050BB	TDK		
C14, C20	0	4.7 µF	Capacitor, ceramic, 4.7 µF, 16 V, ± 10%, X5R, 0603	0603	GRM188R61C475KAAJ	Murata		
C18	0	1 µF	Capacitor, ceramic, 1 µF, 35 V, ± 10%, X5R, 0603	0603	GMK107BJ105KA-T	Taiyo Yuden		
C19	0	10 µF	Capacitor, ceramic, 10 µF, 10 V, ± 10%, X7R, 0805	0805	GRM21BR71A106KE51L	Murata		
D1	0	13 V	Diode, TVS, Uni, 13 V, W, SOD-123W	SOD-123W	PTVS13VS1UR,115	NXP Semiconductor		
D2, D7	0	40 V	Diode, Schottky, 40 V, 0.38 A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.		
D3, D6	0	20 V	Diode, Schottky, 20 V, 1 A, 152AD	152AD	NSR10F20NXT5G	ON Semiconductor		
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
H1, H2, H3, H4	0		Machine Screw, Round, #4 - 40 × 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	BampersandF Fastener Supply	-	-
H5, H6, H7, H8	0		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone	-	-
J7	0		Header (shrouded), 100 mil, 5x2, High-Temperature, Gold, TH	5 × 2 Shrouded header	N2510-6002-RB	3M		
JP8	0		Header, 100 mil, 3 × 1, Tin, TH	Header, 3 PIN, 100 mil, Tin	PEC03SAAN	Sullins Connector Solutions		
JP11, JP15, JP16, JP17, JP18	0		Header, 100 mil, 2 × 1, Tin, TH	Header, 2 PIN, 100 mil, Tin	PEC02SAAN	Sullins Connector Solutions		
L1	0	1 uH	Inductor, Wirewound, 1 µH, 4 A, 0.041 Ω, SMD	4.06 × 4.06 mm	74437321010	Wurth Elektronik		
Q1	0	30 V	MOSFET, N-CH, 30 V, 22 A, DQK0006C (WSON-6)	DQK0006C	CSD17571Q2	Texas Instruments		
R2, R16, R21	0	0	Resistor, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
R5, R13	0	10.0 k	Resistor, 10.0 k, 1%, 0.063 W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R15	0	4.7 k	Resistor, 4.7 k, 5%, 0.063 W, 0402	0402	CRCW04024K70JNED	Vishay-Dale		
R19, R20	0	200	Resistor, 200, 1%, 0.063 W, 0402	0402	CRCW0402200RFKED	Vishay-Dale		
R26	0	10	Resistor, 10, 5%, 0.063 W, 0402	0402	CRCW040210R0JNED	Vishay-Dale		
S1	0		Switch, Normally open, 2.3-N force, 200-k operations, SMD	KSR	KSR221GLFS	CampersandK Components		

Table 5. bq25606EVM-772 BOM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
SH-JP1, SH-JP5, SH-JP8, SH-JP9, SH-JP11, SH-JP15, SH-JP16, SH-JP17, SH-JP18	0	1 × 2	Shunt, 100-mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
SW1, SW2, SW3, SW4	0		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix		
TP12	0		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone		

Revision History

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

Changes from June 2, 2017 to September 30, 2017 **Page**

- Changed *Schematic for bq25606EVM-772* 9
- Changed bq25606EVM-772 BOM 10

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265