User's Guide

SLUUBC8A–August 2015–Revised May 2016

bq2512x Evaluation Module

The bq2512x evaluation module (EVM) is a high-performance, easy-to-use development kit for the design of a compact, flexible, high-efficiency, lower power management solution for single-cell, Li-ion and Li-polymer batteries used in wearables and low-power portable applications.

This user's guide details both the bq25120EVM and bq25121EVM features, test summary, and test results. Also included are the EVM schematic, bill of materials, and PCB board layouts.

PCB Configurations

Device	PCB
bq25120	PWR731
bq25121	PWR812

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1 Introduction

1.1 bq2512x IC Features

The bq2512x is a highly-integrated battery charge management IC that integrates the most common functions for wearable devices: linear charger, regulated output, load switch, manual reset with timer, and battery voltage monitor. The low quiescent current during operation and shutdown enables maximum battery life. The device supports charge currents from 5 mA to 300 mA. The input current limit, charge current, PWM output voltage, LDO output voltage, and other parameters are programmable through the I^2C interface. The battery is charged using a standard Li-Ion charge profile with three phases: precharge, constant current, and constant voltage.

1.2 bq2512x EVM Features

The bq2512x EVM is a complete battery power management module for evaluating compact, highly-integrated, flexible, high efficiency, linear charging solution for single cell, Li-Ion and Li-Polymer battery-powered systems used in wearables and low-power portable applications. Key EVM features include:

- Configurable 300-mA buck regulator (1.8-V default)
- 700-nA typical I_Q with PWM enabled
- 0.5% accurate battery voltage regulation (configurable from 3.6 V to 4.65 V in 10-mV steps)
- Configurable termination current down to 500 µA
- 2.5 mm × 2.5 mm WCSP package and 6 external components for minimum solution
- Power path management for powering the system and charging the battery
- Power path management enables < 150 nA ship mode battery quiescent current for longest shelf life
- Push-button wake-up and reset with adjustable timers
- Battery charger operates from 3.4 V – 5.5 V V_{IN} (5.5-V OVP / 20-V tolerant)
- I^2C control of key parameters

1.3 Schematic

Figure 1 illustrates the EVM schematic.

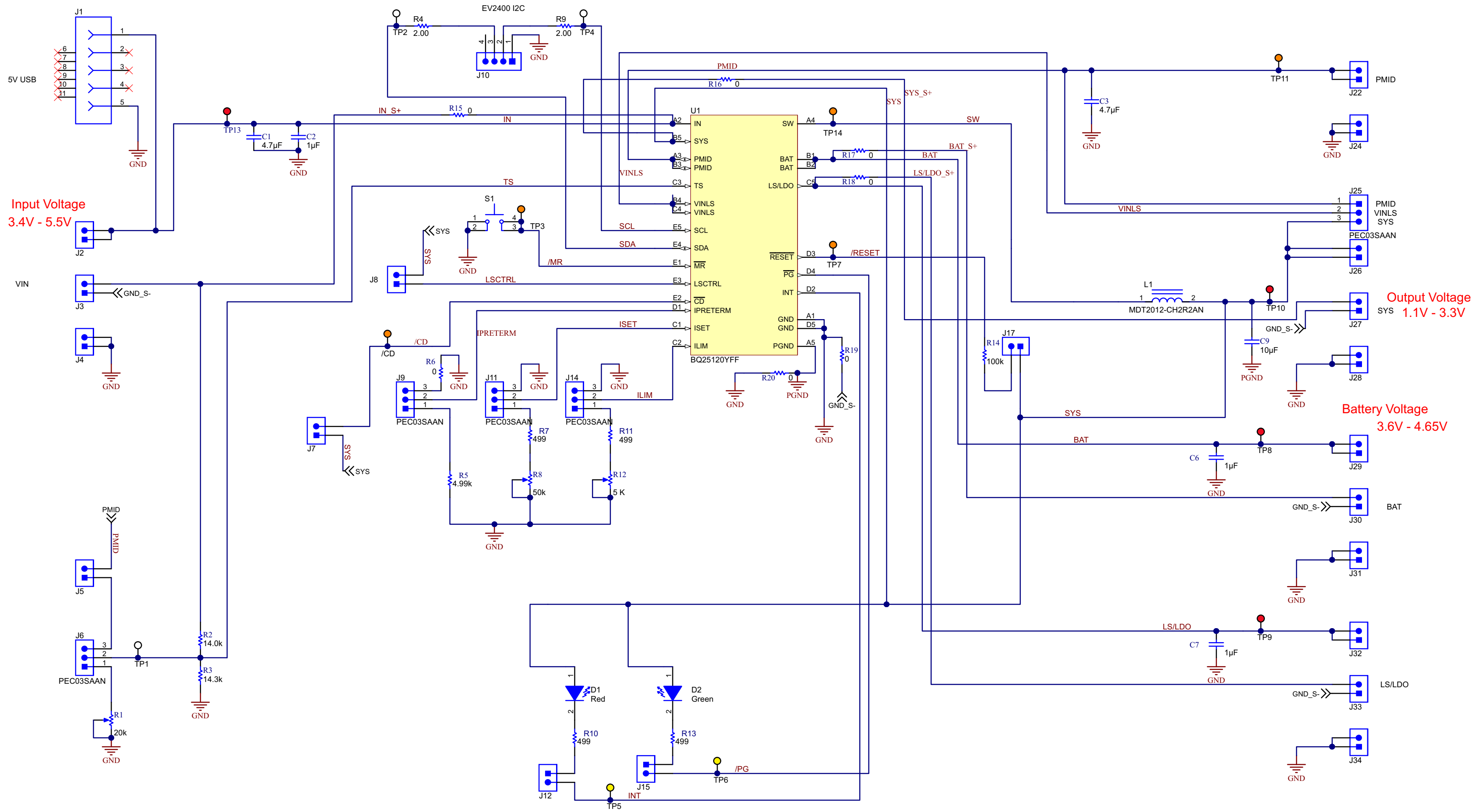

Figure 1. bq2512xEVM Schematic (bq25120 Represented)

1.4 I/O Description

Table 1 lists the descriptions of the IO connectors on the PCB.

Table 1. Description of the IO Connectors on PCB

Header or Terminal Block	Description
J1 - USB power input	Micro USB connector for USB input power
J2 - IN (Force line)	Headers for extra connections to IN-Force
J3 - IN/GND (Sense line)	Headers for IN-Sense and GND
J4 - GND	Headers for extra connections to GND
J5 - TS to PMID	Headers for TS pin to be pulled up to PMID
J6 - TS	Headers for TS pin to be connected either to PMID or external resistor
J7 - CD	Headers for /CD pin to be pulled up to SYS pin
J8 - LS/CTRL	Headers for LS/CTRL pin to be pulled up to SYS pin
J9 - IPRETERM	Headers for IPRETERM pin to be connected to an external resistor or shorted to GND
J10 - EV2400	The 4-wire connector for EV2400 communication interface
J11 - ISET	Headers for ISET pin to be connected to an external resistor or shorted to GND
J12 - INT	Headers for INT pin to be pulled up to SYS pin through a LED light
J14 - ILIM	Headers for ILIM pin to be connected to an external resistor or shorted to GND
J15 - /PG	Headers for /PG pin to be pulled up to SYS pin through a LED light
J17 - /RESET	Headers for /RESET pin to be pulled up to SYS pin through a 100-kΩ resistor
J22 - PMID	Headers for extra connections to PMID
J24 - GND	Headers for extra connections to GND
J25 - PMID/VINLS/SYS	Headers for PMID/VINLS/SYS connections
J26 - SYS	Headers for extra connections to SYS-Force
J27 - SYS/GND (Sense line)	Headers for SYS-Sense and GND
J28 - GND	Headers for extra connections to GND
J29 - BAT	Headers for extra connections to BAT-Force
J30 - BAT/GND (Sense line)	Headers for BAT-Sense and GND
J31 - GND	Headers for extra connections to GND
J32 - LS/LDO	Headers for extra connections to LS/LDO-Force
J33 - LS/LDO (Sense line)	Headers for LS/LDO-Sense and GND
J34 - GND	Headers for extra connections to GND

1.5 Test Points

Table 2 provides descriptions of the test points.

Table 2. Test Points Description

Test Points	Description
TP1	TS pin
TP2	SDA pin
TP3	/MR pin
TP4	SCL pin
TP5	INT pin
TP6	/PG pin
TP7	/RESET pin
TP8	BAT pin
TP9	LS/LDO pin
TP10	SYS pin
TP11	PMID pin
TP13	IN pin
TP14	SW pin
TP /CD	/CD pin

1.6 Default Settings

The bq2512xEVM module has provided the capability of changing key parameters using I^2C and the EV2400 communication interface. However, I^2C communication is not required for this device to operate. The module is programmed to the default settings as is described in Table 3, Table 4 shows the initial jumper positions on the PCB.

Table 3. Default Settings

Parameter	Options	bq2512x
BAT_UVLO	2.2 V to 3.4 V (200-mV step)	3.0 V
VSYS	1.1 V to 3.3 V (100-mV step)	1.8 V
LS/LDO	LS, 0.8 V to 3.3 V (100-mV step)	LS
VBREG	3.6 V to 4.65 V (10-mV step)	4.2 V
ICHG	5 mA to 300 mA	10 mA
IPRETERM	500 µA to 50 mA	2 mA
Input ILIM	50 mA to 400 mA (50-mA step)	100 mA
VIN_DPM_ON	On or Off	On
VIN_DPM Threshold	4.2 V to 4.9 V	4.6 V
Auto Charge	On or Off	On
Safety Timer	30 min, 3 hr, 9 hr, Disabled	3 hr

Table 4. Initial Jumper Position

J6	J9	J11	J12	J14	J15	J25
TS = TS_Pot	ITERM = GND	ISET= GND	Installed	ILIM = GND	Installed	VINLS = PMID

1.7 Recommended Operating Conditions

The recommended operating conditions are shown in Table 5.

Table 5. Recommended Operating Conditions(1)(2)

		MIN	NOM	MAX	Unit
V_{IN}	IN voltage range	3.4	5	20	V
	IN operating voltage range, recommended	3.4	5	5.5	
V_{BAT}	VBAT operating voltage range			5.5(1)	V
V_{VINLS}	VINLS voltage range for Load Switch	0.8		5.5(2)	V
V_{VINLS}	VINLS voltage range for LDO	2.2		5.5	V
I_{IN}	Input Current, IN input			400	mA
I_{SW}	Output Current from SW, DC			300	mA
I_{PMID}	Output Current from PMID, DC			300	mA
$I_{LS/LDO}$	Output Current from LS/LDO			100	mA
I_{BAT}, I_{SYS}	Charging and discharging using internal battery FET			300	mA
T_J	Operating junction temperature range	-40		125	°C

(1) Any voltage greater than shown should be a transient event.
(2) These inputs will support 6.6 V for less than 10% of the lifetime at $V_{(BAT)}$ or V_{IN}, with a reduced current and/or performance.

2 Test Summary

This section describes the test configuration of the bq2512xEVM evaluation module for bench evaluation.

2.1 Recommended Test Equipment

2.1.1 Power Supplies

1. Power Supply #1 (PS#1): a power supply capable of supplying 5 V at 1 A is required.
2. Power Supply #2 (PS#2): a power supply capable of supplying 5 V at 1 A is required.

2.1.2 Load

Testing with an actual battery is the best way to verify operation in the system. If a battery is unavailable, then a source meter like a Keithley 2420, capable of both sourcing and sinking current, or a circuit similar to the one shown in Figure 2 can simulate a battery when connected to PS#2.

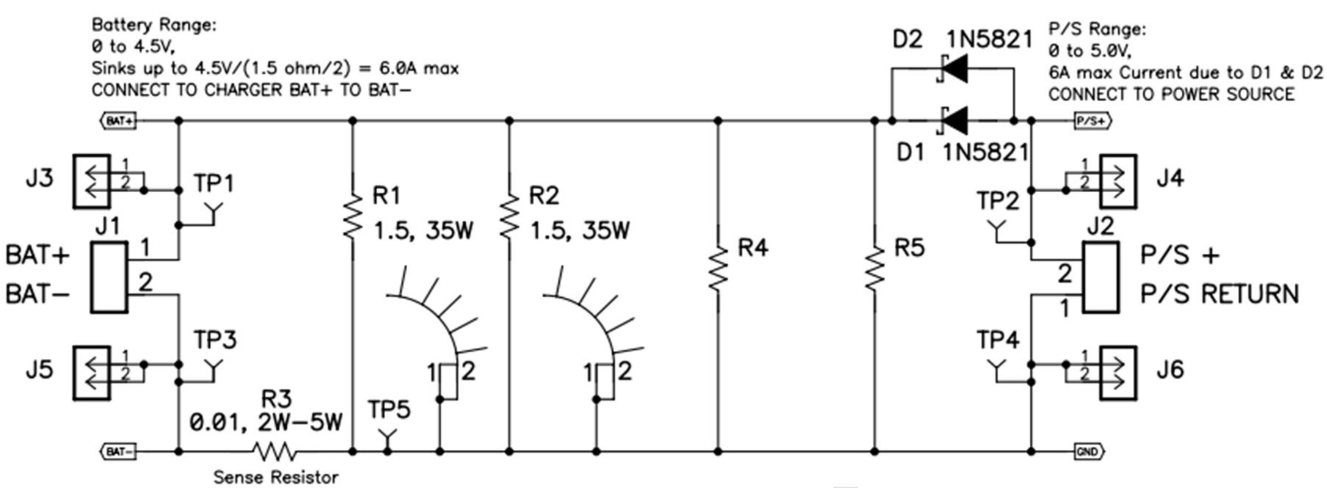

Figure 2. BAT Load (PR1010) Schematic

2.1.3 Meters

Three voltage meters and two current meters. The current meters must be able to measure at least 0.5-A current.

2.1.4 Tool/Software GUI (Optional)

The following optional items can be used for testing:

1. EV2400 Communication Interface Board
2. bqStudio Software GUI

2.2 Recommended Test Equipment Setup

The following guidelines provide the recommended test equipment setup:

1. Set power supply #1 (PS#1) for 5 V ±100 mV DC, 1-A current limit and then turn off supply. Set power supply #2 (PS#2) for 3.5 V and then turn off supply.
2. Connect the positive output of PS#1 through a current meter (CM#2) to IN (J2) and negative output to GND (J34).
3. Connect a voltage meter (VM#1) across J2 and J34.
4. Connect the PR1010 BAT+ terminal of PR1010 in series with a current meter (CM#1) to BAT (J29). Connect PR1010 BAT – to GND (J34). Connect the P/S+ and P/S return side of PR1010 to PS#2, set the voltage to 3.5 V ±50 mV, then disable PS#2.
5. Connect a voltage meter (VM#2) across BAT (J29) and GND (J34).
6. Connect a DMM (VM#3) across SYS (SYS_S+ of J27) and GND (GND_S– of J27).
7. Configure jumpers as shown in Table 4.

After the preceding steps are accomplished, the test setup for PWR731 is as shown in Figure 3. The setup is similar for PWR812 with the bq25121.

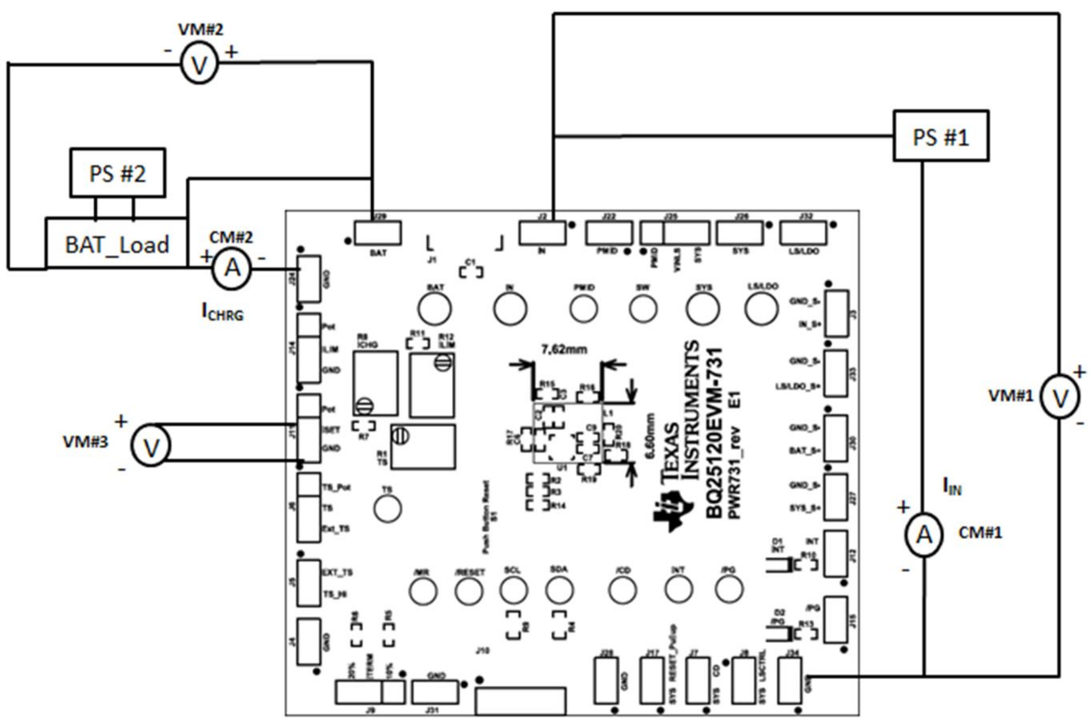

Figure 3. Test Setup (PWR731 for bq2512xEVM-731 Shown)

2.3 Software GUI (When I²C Communication is Used)

When using I²C communication, implement the following steps with the software GUI:

1. Install the bqStudio software GUI.
2. Connect the EV2400 interface board to the EVM (as shown in Figure 4) http://www.ti.com/tool/EV2400.
3. Open Software GUI and go to "Field View" page (as shown in Figure 5).
4. Change the parameters in the pull-down menu or check/uncheck the selection box.

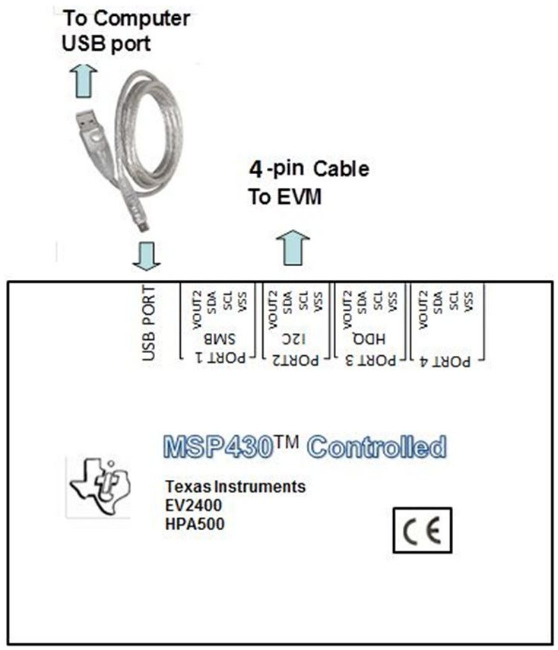

Figure 4. EV2400 Interface Box Connection

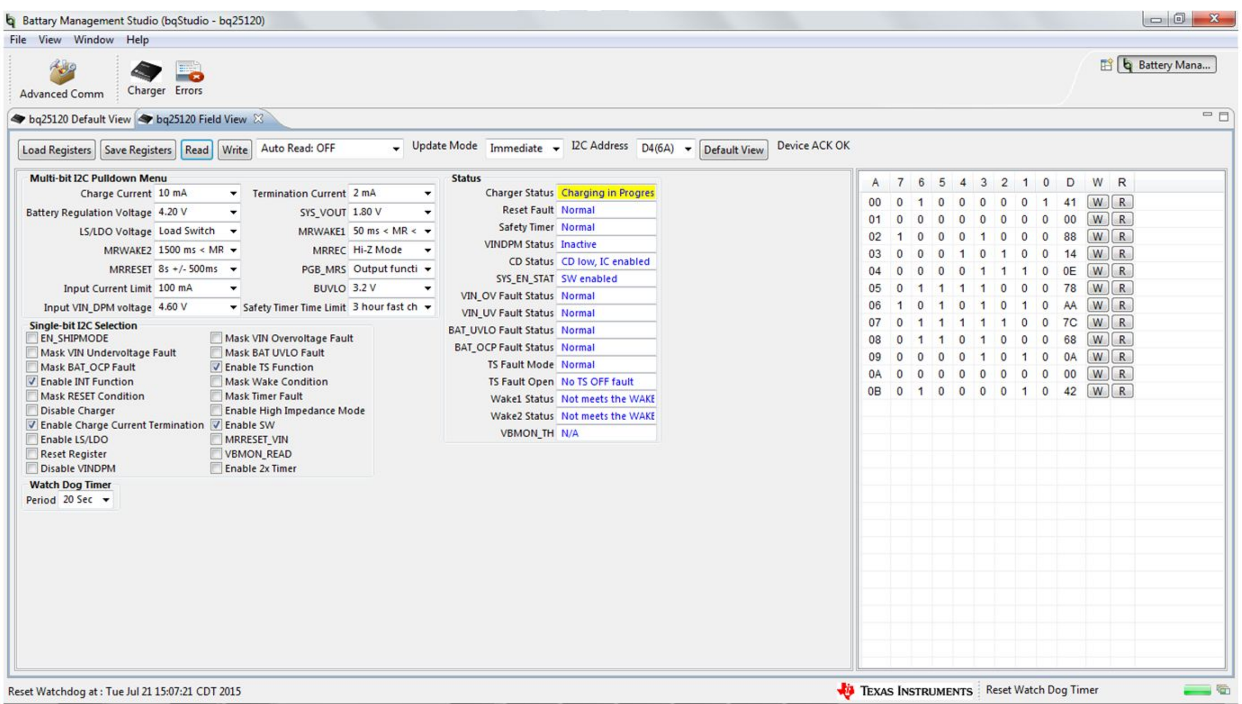

Figure 5. bq2512x Software GUI

3 Test Procedure

3.1 Set the Potentiometers

1. Set VM#3 DMM to measure resistance
2. Install J11 to POT
3. Install J14 to POT
4. Turn the potentiometer R8 until the measure on VM#3 → R[J11 (ISET), J11(GND)] = 2 kΩ.
5. Move the positive side of VM#3 DMM to J14 (ILIM).
6. Turn the potentiometer R12 until the measure on VM#3 → R[J14(ILIM), J14(GND)] = 499 Ω.
7. Move the positive side of VM#3 DMM to J6 (TS).
8. Turn the potentiometer R1 until the measure on VM#3 → R[J6 (TS), J14(GND)] = 5.5 kΩ – 6.5 kΩ.
9. Move the positive side of VM#3 DMM to J27 (SYS_S+).
10. Set VM#3 DMM to measure voltage.

3.2 Charge Disabled

1. Install the jumper on J7 – connect CD to SYS
2. Enable PS#1 and PS#2
3. Observe D2 is on, D1 is off
4. Measure on VM#3 → V[J27(SYS_S+) J14(GND)] = 1.8V ±50 mV
5. Measure on CM#2 → ICHRG ≤ 0–1 mA
6. Measure on CM#1 → IIN < 2 mA
7. Disable PS#1 and PS#2

3.3 Charge Current Regulation

1. Remove the jumper on J7 – disconnect CD to SYS
2. Enable PS#1 and PS#2
3. Observe D2 is on, D1 is on
4. Adjust PS#2 so that the voltage measured by VM#2, across BAT and GND, measures 3.5 V
5. Adjust the PS#1 so that VM#1 still reads 5.0 V ±100 mV
6. Measure on VM#3 → V[J27(SYS_S+) J14(GND)] = 1.8 V ±50 mV
7. Measure on CM#2 → ICHRG = 90–110 mA
8. Measure on CM#1 → IIN = 93–113 mA
9. Disable PS#1 and PS#2

3.4 Ship Mode (Optional if I^2C Control not Used)

1. Enable PS#1 and PS#2
2. Open the software GUI
3. Go to Field View of the GUI and then read all the registers. All the default register values should be shown in the register map (as shown in Figure 3).
4. Measure on CM#2 → ICHRG = 9–11 mA
5. Install the jumper on J7 – connect CD to SYS
6. Disable PS#1
7. Measure on CM#2 → ICHRG = 5–7 µA
8. Check the box in front of “EN_SHIPMODE” in the software GUI

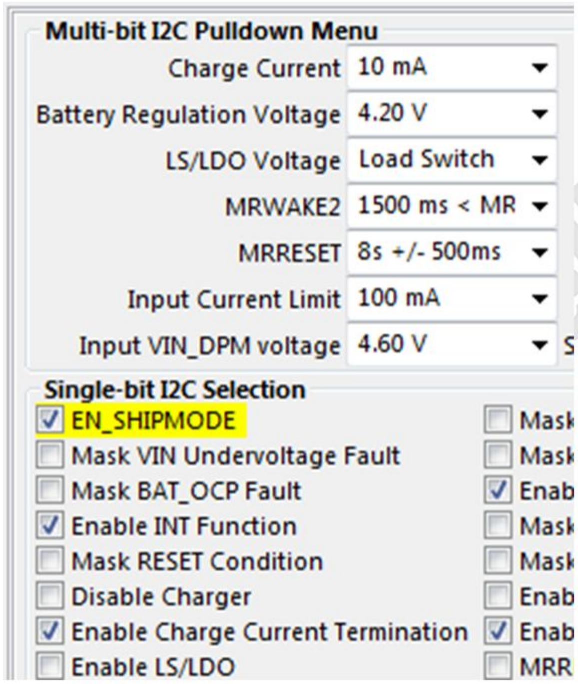

Figure 6. Select EN_SHIPMODE

9. Measure on CM#2 → ICHRG < 100 nA
10. Disable PS#2

4 Helpful Hints

The following steps provide useful information when using the EVM:

1. The leads and cables to the various power supplies have resistance. The current meters also have series resistance. Therefore, voltmeters must be used to measure the voltage as close to the IC pins as possible instead of relying on each supply's digital measurement.
2. When using a source meter as your battery simulator, it is highly recommended to configure the source meter for 4-wire sensing, eliminating the need for a separate voltmeter to measure the voltage at the OUT pin.
3. To observe the taper current as the battery voltage approaches the set regulation voltage, allow the battery to charge, or if using BAT_Load (PR1010), slowly increase the PS#2 voltage powering BAT_Load (PR1010). Use VM#2 across OUT and GND to measure the battery voltage seen by the IC.
4. To find out more details about battery I_Q and how to measure it on power supplies, please refer to the application note: *IQ: What it is, what it isn't, and how to use it* (SLYT412)

5 Bill of Materials and Board Layout

This section provides the bq2512x EVM bill of materials (BOM) and the printed-circuit board (PCB) layout illustrations.

5.1 Bill of Materials

Table 6 lists the EVM BOM.

Table 6. bq2512xEVM Bill of Materials

Item #	Designator	Qty	Value	Part Number	Manufacturer	Description	Package Reference
1	!PCB	1		PWR812	Any	Printed Circuit Board	
2	C1, C3	2	4.7uF	GRM188R61E475KE11D	Murata	CAP, CERM, 4.7 µF, 25 V, +/- 10%, X5R, 0603	0603
3	C2	1	1uF	C1005X5R1E105K050BC	TDK	CAP, CERM, 1 µF, 25 V, +/- 10%, X5R, 0402	0402
4	C6, C7	2	1uF	GRM155R61A105KE15D	Murata	CAP, CERM, 1 µF, 10 V, +/- 10%, X5R, 0402	0402
5	C9	1	10uF	CL05A106MP5NUNC	Samsung Electro-Mechanics	CAP, CERM, 10 µF, 10 V, +/- 20%, X5R, 0402	0402
6	D1	1	Red	LTST-C190CKT	Lite-On	LED, Red, SMD	Red LED, 1.6x0.8x0.8mm
7	D2	1	Green	LTST-C190GKT	Lite-On	LED, Green, SMD	1.6x0.8x0.8mm
8	H12, H13, H14, H15	4		SJ61A1	3M	Bumpon, Cylindrical, 0.312 X 0.200, Black	Black Bumpon
9	J1	1		105017-0001	Molex	Receptacle, Micro-USB-B, Right Angle, SMD	Micro USB receptacle
10	J2, J3, J4, J5, J7, J8, J12, J15, J17, J22, J24, J26, J27, J28, J29, J30, J31, J32, J33, J34	20		PEC02SAAN	Sullins Connector Solutions	Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin
11	J6, J9, J11, J14, J25	5		PEC03SAAN	Sullins Connector Solutions	Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin
12	J10	1		22-05-3041	Molex	Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header
13	L1	1	2.2uH	LQM21PN2R2MGH	Murata	Inductor, Multilayer, Ferrite, 2.2 µH, 0.7 A, 0.125 ohm, SMD	2.0x1.0x1.2mm
14	LBL1	1		THT-14-423-10	Brady	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W
15	R1	1	20k	3266W-1-203LF	Bourns	Trimmer, 20k ohm, 0.25W, TH	4.5x8x6.7mm
16	R2	1	14.0k	CRCW040214K0FKED	Vishay-Dale	RES, 14.0k ohm, 1%, 0.063W, 0402	0402
17	R3	1	14.3k	CRCW040214K3FKED	Vishay-Dale	RES, 14.3k ohm, 1%, 0.063W, 0402	0402
18	R4, R9	2	2.00	CRCW06032R00FKEA	Vishay-Dale	RES, 2.00 ohm, 1%, 0.1W, 0603	0603
19	R5	1	4.99k	CRCW04024K99FKED	Vishay-Dale	RES, 4.99 k, 1%, 0.063 W, 0402	0402
20	R6, R15, R16, R17, R18, R19, R20	7	0	CRCW04020000Z0ED	Vishay-Dale	RES, 0, 5%, 0.063 W, 0402	0402

Table 6. bq2512xEVM Bill of Materials (continued)

Item #	Designator	Qty	Value	Part Number	Manufacturer	Description	Package Reference
21	R7, R10, R11, R13	4	499	CRCW0402499RFKED	Vishay-Dale	RES, 499 ohm, 1%, 0.063W, 0402	0402
22	R8	1	50k	3266W-1-503LF	Bourns	Trimmer, 50k ohm, 0.25W, TH	4.5x8x6.7mm
23	R12	1	5 K	3266W-1-502LF	Bourns	Trimmer, 5k ohm, 0.25W, TH	4.5x8x6.7mm
24	R14	1	100k	CRCW0402100KFKED	Vishay-Dale	RES, 100k ohm, 1%, 0.063W, 0402	0402
25	S1	1		KST221JLFS	C&K Components	Switch, Tactile, SPST-NO, SMT	Switch, 6.2X5X6.2 mm
26	SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP5, SH-JP6, SH-JP7	7	1x2	969102-0000-DA	3M	Shunt, 100mil, Gold plated, Black	Shunt
27	TP1, TP2, TP4	3	White	5002	Keystone	Test Point, Miniature, White, TH	White Miniature Testpoint
28	TP3, TP7, TP11, TP14, TP15	5	Orange	5003	Keystone	Test Point, Miniature, Orange, TH	Orange Miniature Testpoint
29	TP5, TP6	2	Yellow	5004	Keystone	Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint
30	TP8, TP9, TP10, TP13	4	Red	5005	Keystone	Test Point, Compact, Red, TH	Red Compact Testpoint
31	U1	1		BQ25121YFPR	Texas Instruments	700-nA Low IQ Highly Integrated Battery Charge Management Solution for Wearables and IoT, YFP0025BABD	YFP0025BABD
32	FID1, FID2, FID3, FID4, FID5, FID6	0		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	Fiducial

5.2 Board Layouts

5.2.1 PWR731 Layouts

Figure 7 through Figure 16 illustrate the PWR731 EVM PCB board layouts.

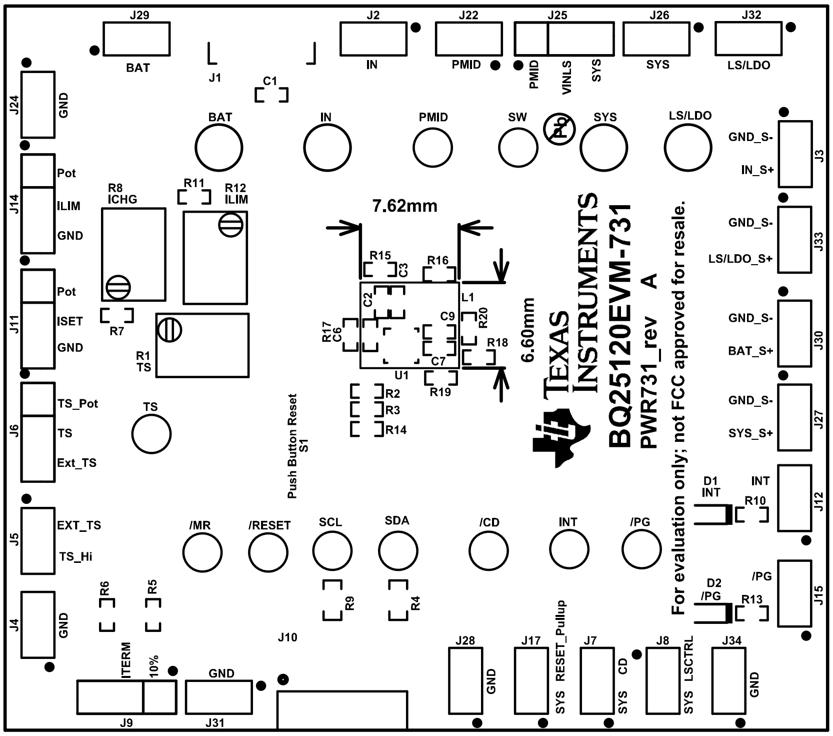

Figure 7. Top Overlay

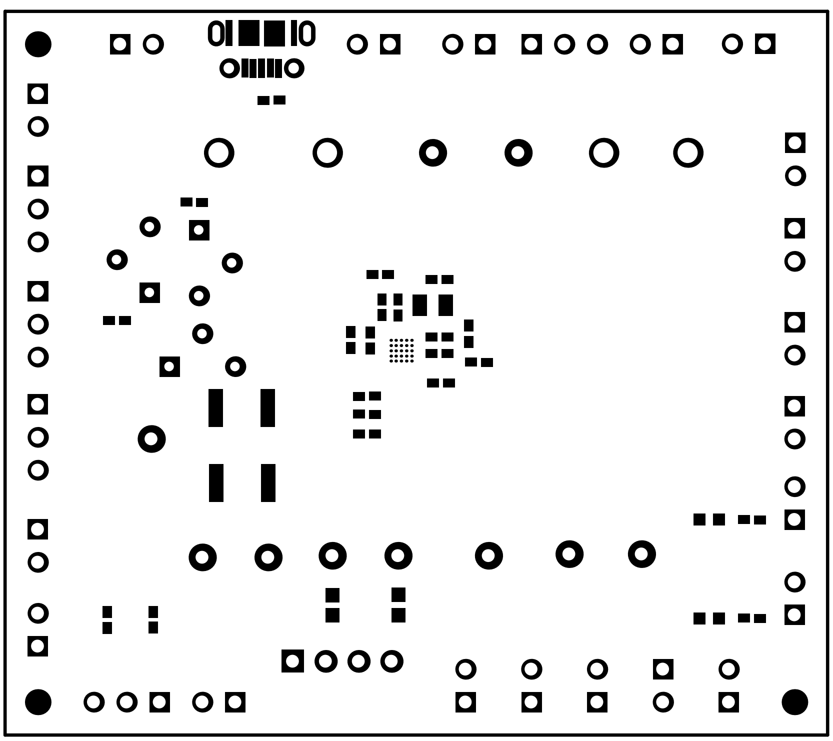

Figure 8. Top Solder Mask

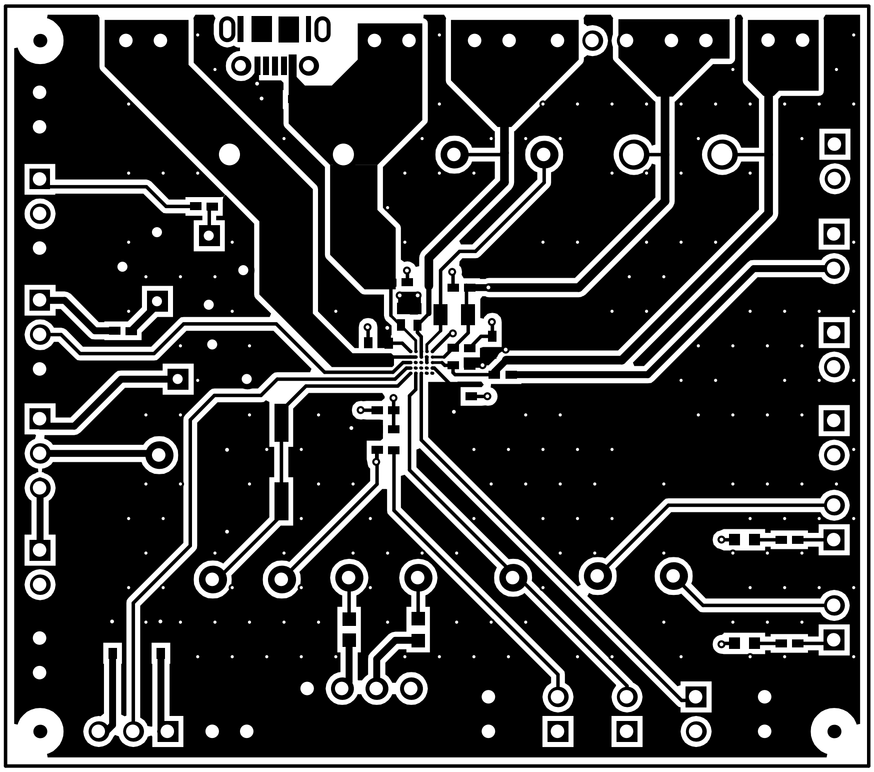

Figure 9. Top Layer

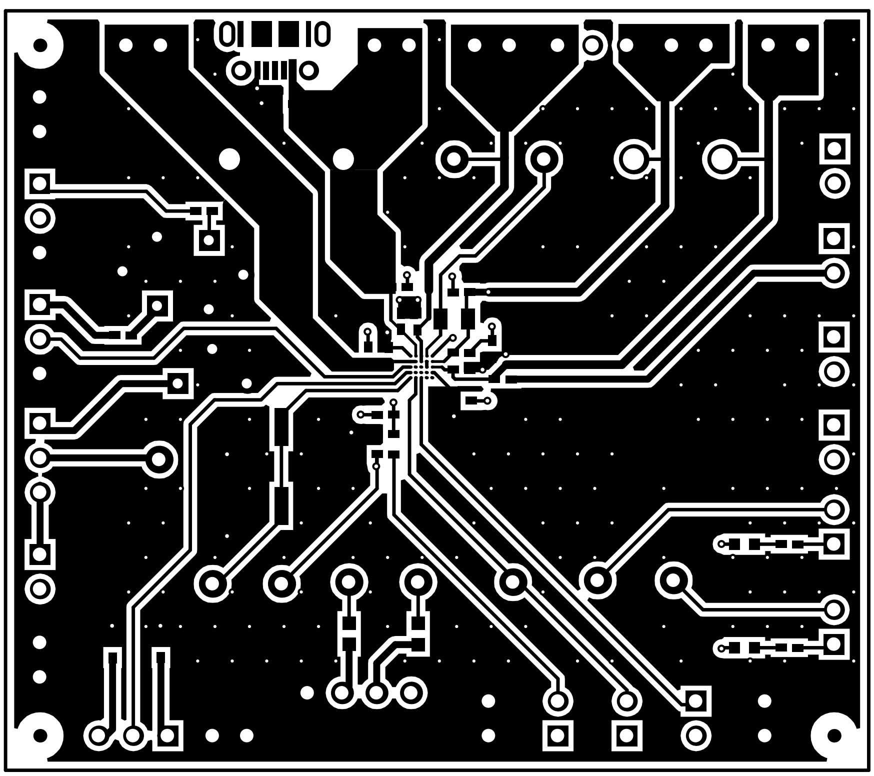

Figure 10. Signal Layer 1

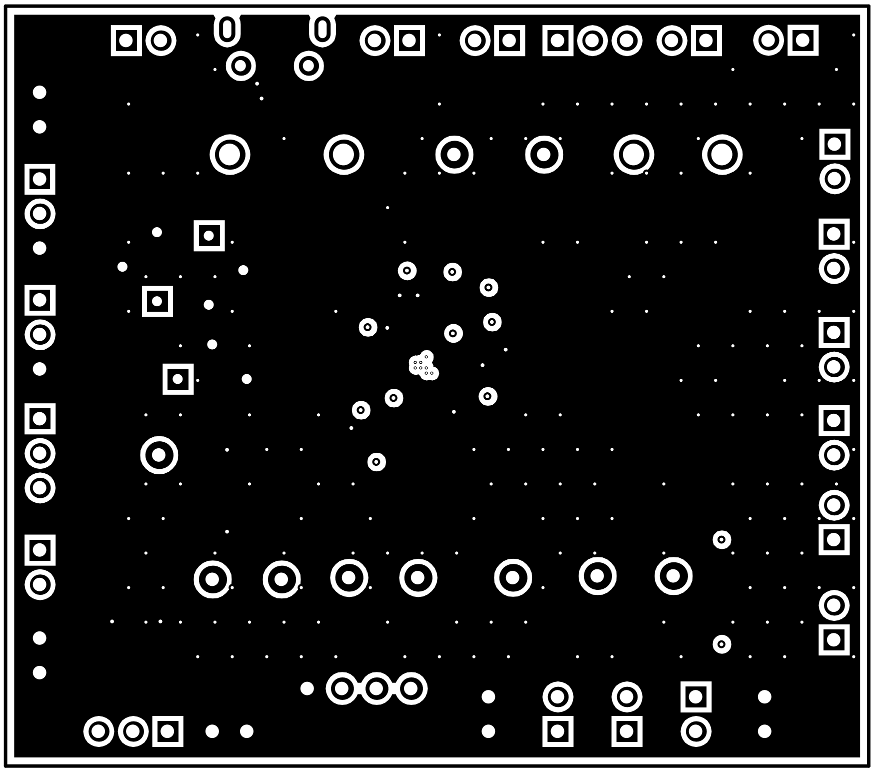

Figure 11. Signal Layer 2

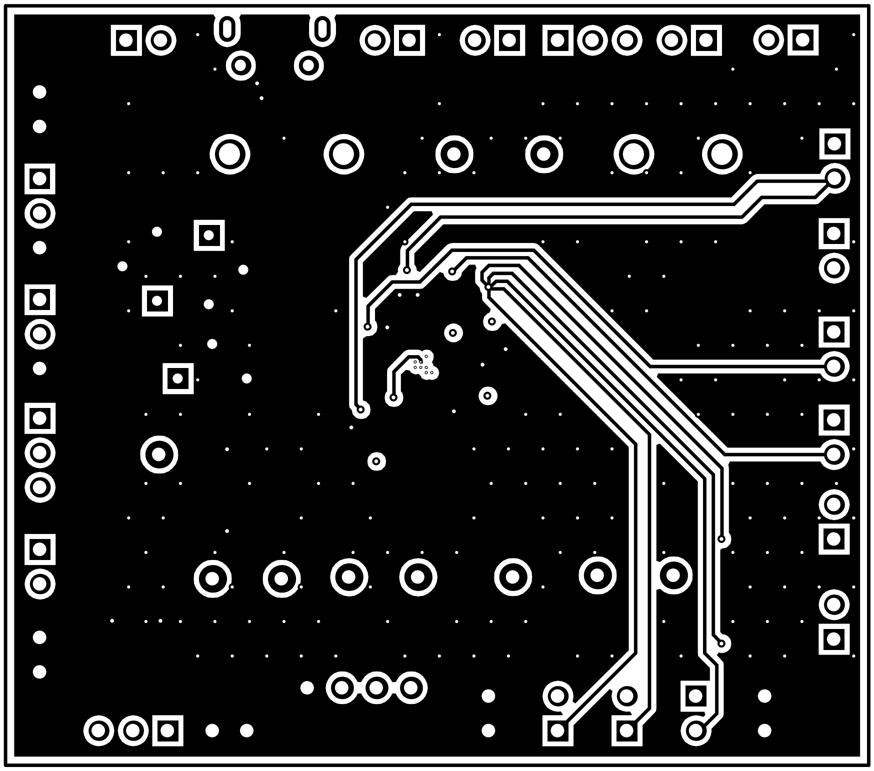

Figure 12. Bottom Layer

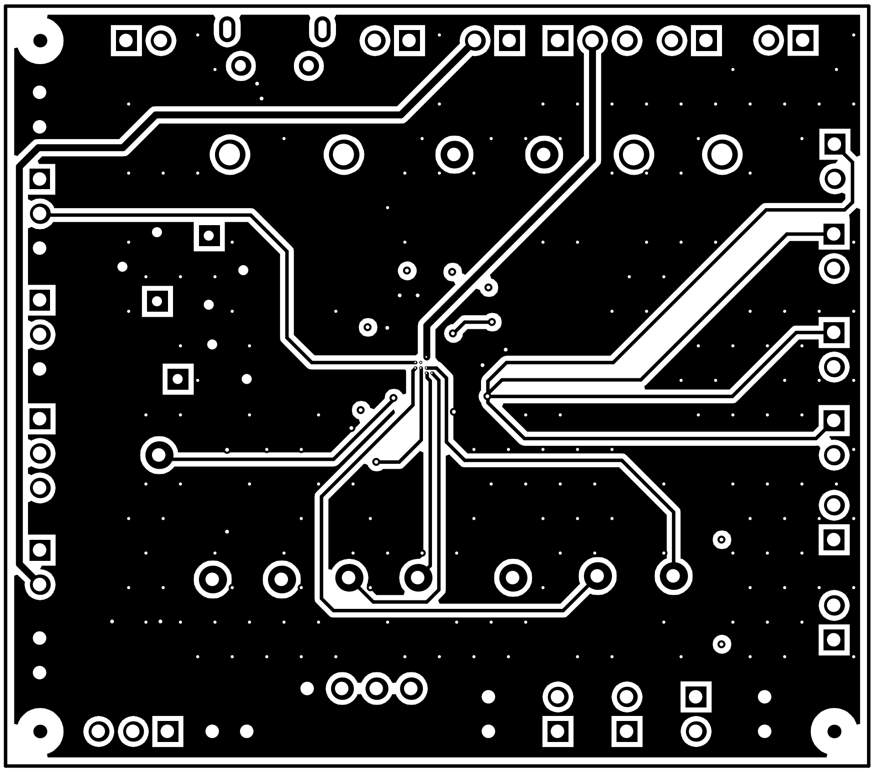

Figure 13. Bottom Solder Mask

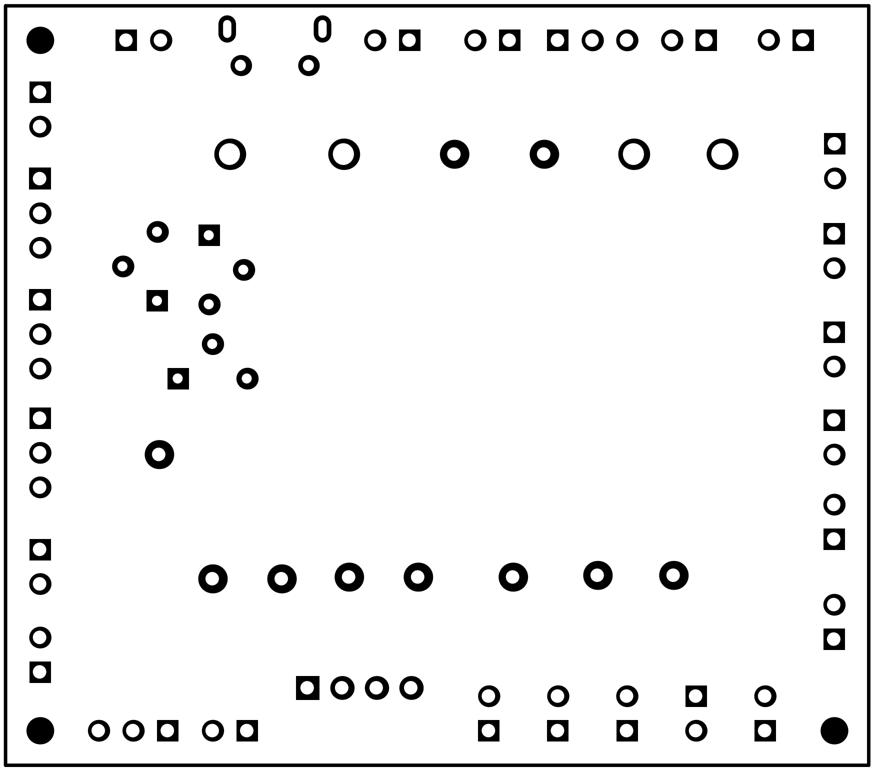

Figure 14. Bottom Overlay

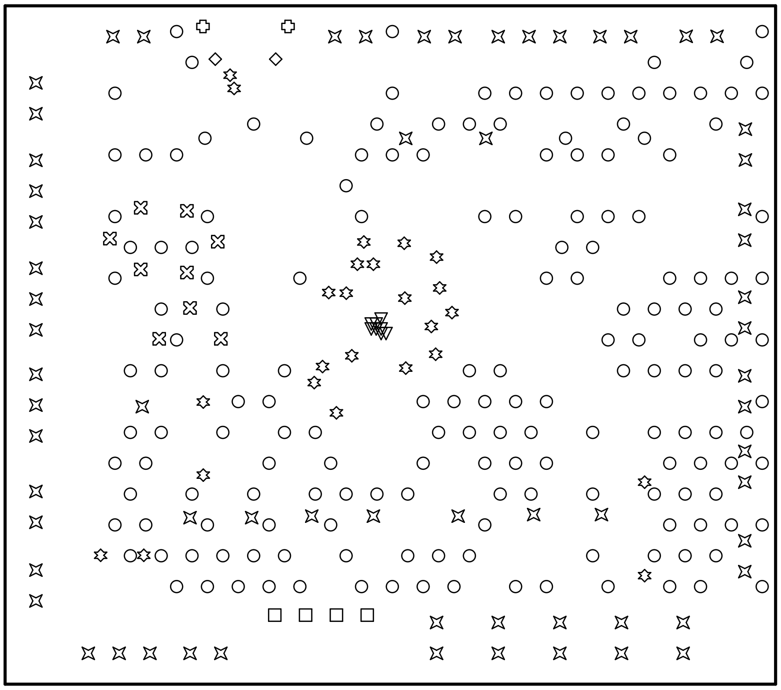

Figure 15. Drill Drawing

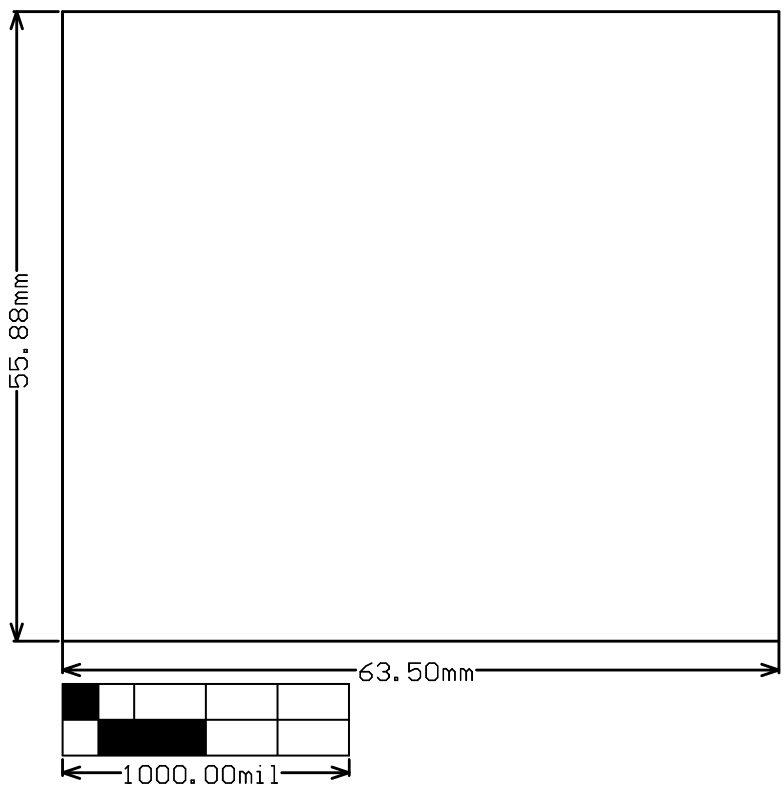

Figure 16. Board Dimensions

5.2.2 PWR812 Layout

Figure 17 illustrates the PWR812 PCB composite layout.

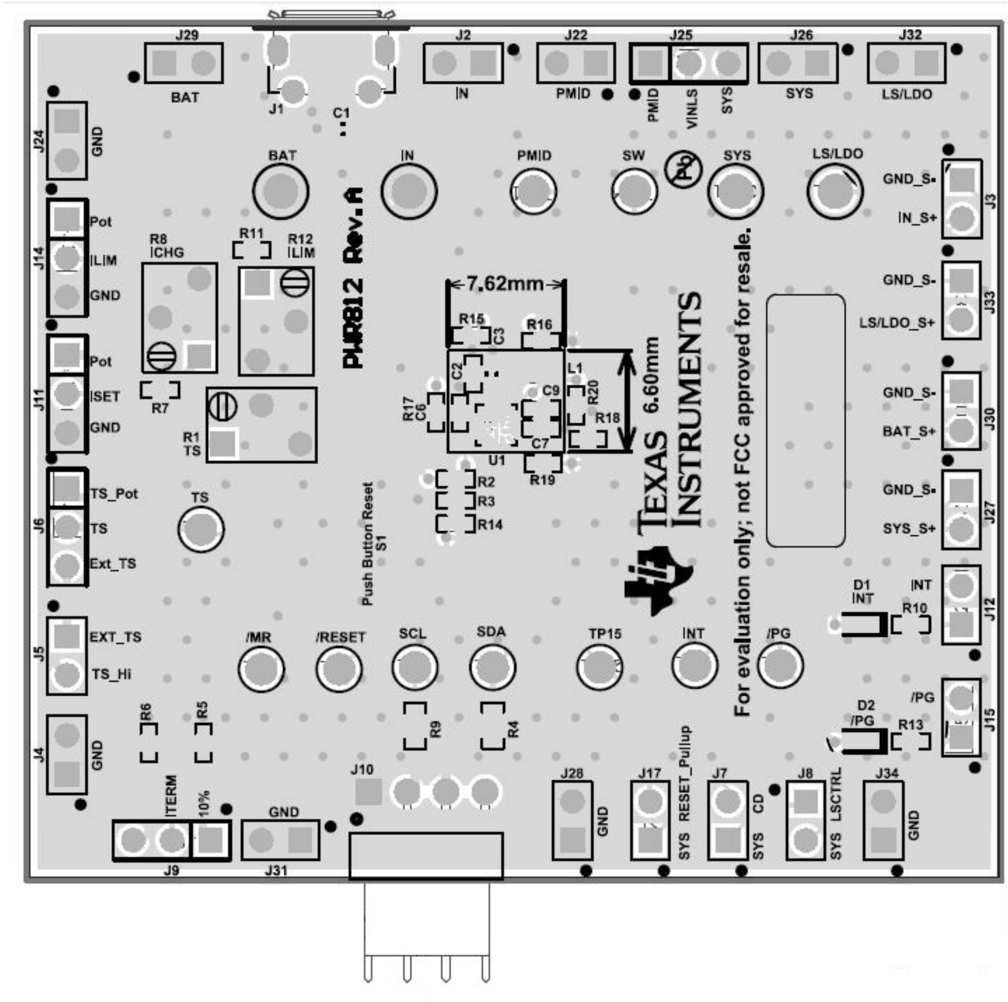

Figure 17. PWR812 Composite Layout

Revision History

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

Changes from Original (August 2015) to A Revision	Page
• Changed user's guide globally to accommodate both the bq25120 and bq25121 EVMs.	1
• Replaced existing BOM with PWR812A BOM.	11

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   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 and conditions 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 and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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.

3 *Regulatory Notices:*

   3.1 *United States*

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

   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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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。 http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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

東京都新宿区西新宿６丁目２４番１号

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。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs 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 assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

   6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS AND CONDITIONS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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