bq25890, bq25892 Dual Cascade Charger EVM (PWR692)

This user's guide provides detailed testing instructions for the PWR692 evaluation modules (EVM) using the bq25890 (U1) and bq25892 (U2) configured in cascade configuration. The PMID of U1 supplies VBUS of U2 while both charger's BAT pins connect to the same battery. U1 provides the only system connection. In this configuration, with higher input voltages (that is, 12-V), the dual chargers can provide more than their 5 A maximum charge currents and distribute the heat loss across the board more efficiently. Also included are descriptions of the necessary equipment, equipment setup, and procedures. The reference documentation contains the printed-circuit board layouts, schematics, and the bill of materials (BOM).

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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	Document
bq25890/bq25892	SLUSBU7

The bq2589x evaluation module (EVM) is a complete charger modules for evaluating an I^2C-controlled single NVDC-1 charge using the bq2589x device.

This EVM does not include the USB-to-GPIO interface board. To evaluate the EVM, a USB-to-GPIO interface board must be ordered separately.

1.2 I/O Descriptions

Table 2 lists the jumper connections available on this EVM.

Table 2. EVM Connections

Jack	Description
J1–VBUS	Input: positive terminal
J1–GND	Input: negative terminal (ground terminal)
J2–PMID1	PMID pin connection for U1 / VBUS pin connection for U2 when R2 = 0 ohm
J2–GND	Ground output negative terminal
J3–SYS	Connected to system
J3–GND	Ground
J4–BAT+	Connected to battery pack
J4–GND	Ground
J5	Input mini-USB port
J6	Output mini-USB port
J7	I2C 4-pin connector for U2 - connected to J8 if J14 and J13 shunts are installed
J8	I2C 4-pin connector for U1- connected to J7 if J14 and J13 shunts are installed

Table 3 lists the EVM jumper connections.

Table 3. Jumper Connections

Jack	Description	Factory Setting
JP1	For bq25892/6 input current setting: Low: adaptor port; High: USB input	bq25890/5: Not installed
JP2	D-/PG pin selection	bq25890/5: short to D-
JP3	STAT, PG, /CE, INT, OTG pins internal pull-up source (VSYS or BAT)	Short to VSYS
JP4	D-/PG pin selection	bq25892/6: installed
JP5	Input current limit setting (short D+ and D-):	bq25890/5: installed
JP6	USB current limit selection pin during buck mode and PSEL is high/ Enable pin during boost mode for bq25892/6	Not installed
JP7	$\overline{CE}$ pin setting: pull low to enable the charge for bq25892/6	Installed
JP8	TS pin to GND	Not Installed
JP9	TS resistor divider pull-up source (REGN) connection	Installed
JP10	Internal 10k to GND to TS pin	Installed
JP11	$\overline{CE}$ pin setting: pull low to enable the charge for bq25890/5	Not installed (pulled down by 10-kΩ resistor)
JP12	USB current limit selection pin during buck mode and PSEL is high/ Enable pin during boost mode for bq25890/5	Not installed
JP13	Short SCL1 and SCL2, install when two charger have different addresses	Installed
JP14	Short SCL1 and SCL2, install when two charger have different addresses	Installed
JP15	Pull up source for I2C bus	Installed
JP16	Not installed if ICHG2 to charge at minimum ILIM	Installed

Table 4 lists the recommended operating conditions for this EVM.

Table 4. Recommended Operating Conditions

Symbol	Description	MIN	TYP	MAX	Unit
Supply voltage, V_{IN} bq25890	Input voltage from AC adapter	3.9		14	V
Battery voltage, V_{BAT}	Voltage applied at V_{BAT} terminal	0		4.5	V
I_{BAT}	Fast charging current			9	A
	Discharging current through internal MOSFET	9			A
Supply current, I_{IN}	Maximum input current from AC adapter input	0		3.25	A

2 Test Summary

2.1 Equipment

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

1. **Power Supplies**
   Power supply #1 (PS#1): a power supply capable of supplying up to 14 V at 4 A is required.
2. **Load #1** (4-Quadrant Supply, Constant Voltage < 4.5 V)
   Kepco load: BOP 20–5M, DC 0 to ±20 V, 0 to ±5 A (or higher).
3. **Load #2** – Use with Boost Mode
   PMID 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 10 A+ current.
5. **Computer**
   A computer with at least one USB port and a USB cable. The bq2589xEVM evaluation software must be properly installed.
6. **USB-to-GPIO Communication Kit** (EV2300 USB-Based PC Interface Board)
7. **Software**
   Double click the “BatteryManagementStudio-1.3.35_Build2-windows-installer” installation file, follow the installation steps. The software supports the Microsoft® Windows® XP and Windows 7 operating systems.

   Install EV2300 Software

   For Windows 7 64-bit users:
   http://e2e.ti.com/support/power_management/battery_management/m/videos__files/458983.aspx.
   Verify the computer Windows 7 settings by right clicking on computer and selecting properties:

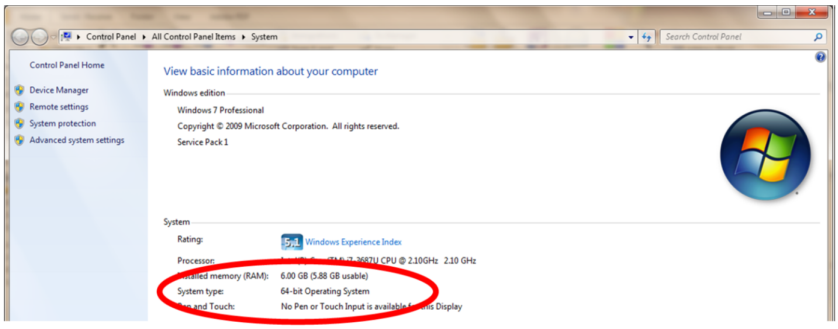


Figure 1. Verify Windows 7 Properties

Windows XP or Windows 7 32-bit users must access the following: http://www.ti.com/litv/zip/slec003a.

2.2 Equipment Setup

1. Set PS#1 for 12-V DC, 5-A current limit and then turn off the supply.
2. Connect the output of PS#1 in series with a current meter#1 to J1 (VBUS and GND)..
3. Turn on the Load, set to constant voltage mode and output to 2.5 V. Turn off (disable) Load. Connect Load in series with current meter #2 to J4 (BAT+ and GND) as shown in Figure 2.
4. Connect voltage meter#1 across TP3 (VBUS) and TP6 (PGND).
5. Connect voltage meter#2 across TP5 (BAT+) and TP6 (PGND).
6. Connect voltage meter#3 across TP4 (SYS1) and TP6 (PGND).
7. Connect voltage meter#4 across TP2 (PMID1) and TP1 (PGND).
8. Connect the EV2300 USB interface board to the computer with a USB cable and from I2C port to J7 with the 4-pin cable. The connections are shown in Figure 2.

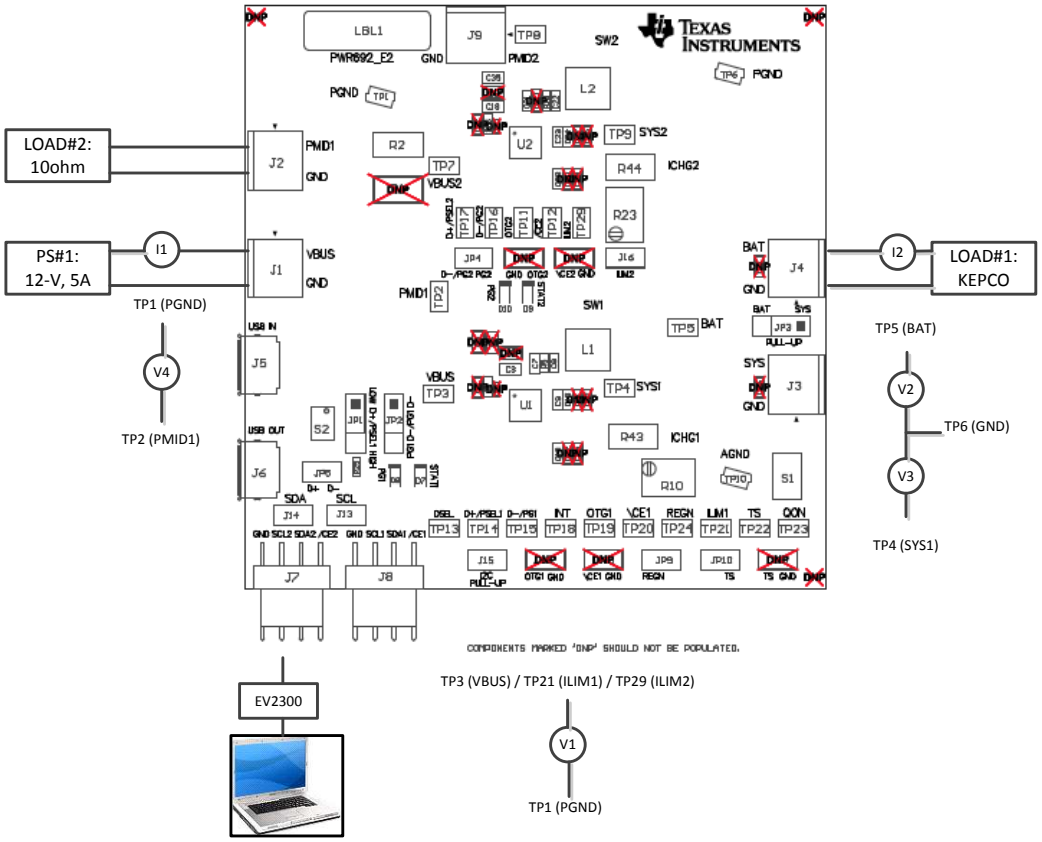


Figure 2. Original Test Setup for PWR692 (bq2589x EVM)

9. Install shunts as shown in Table 3.

10. Turn on the computer. Launch the bq2589x evaluation software, choose *Charger* then *Charger_1_00-bq25890.bqz*, as shown in Figure 3 and Figure 4 .

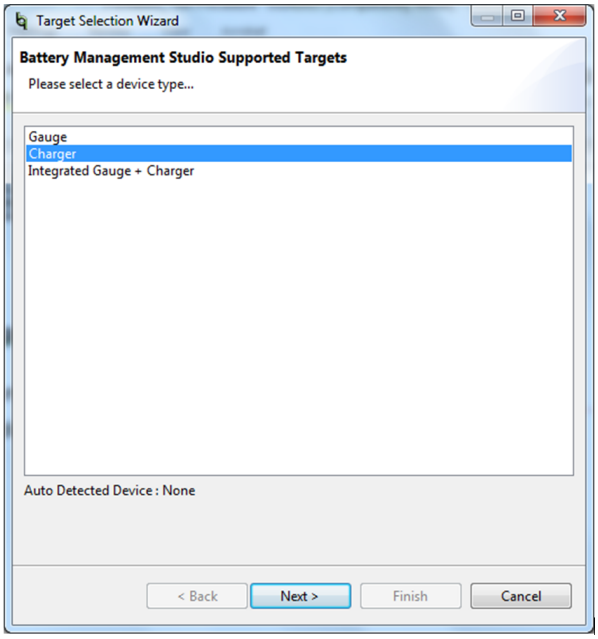


Figure 3. Start Window of the bq2589x Evaluation Software

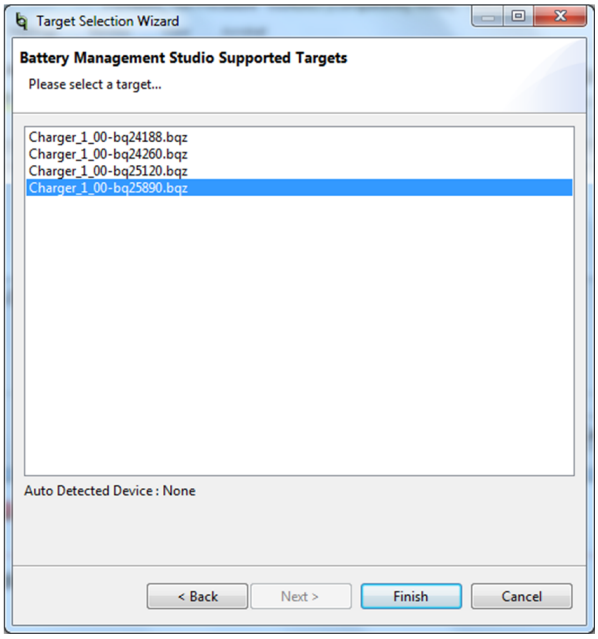


Figure 4. Part Select Window of the bq2589x Evaluation Software

11. If an error pops up stating the communications adapter was not found (Figure 5), click OK to proceed. Next, unplug and re-plug the adapter.

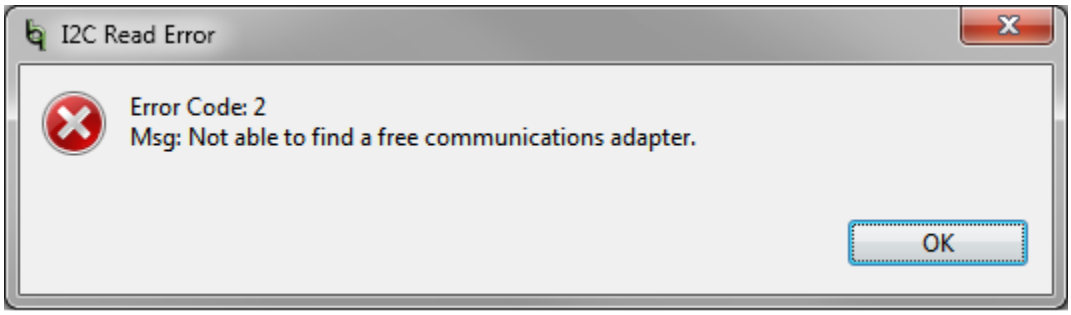


Figure 5. Communications Adapter Error

If an error pops up stating there is no acknowledge from the device (Figure 6), click OK to proceed and then pick the appropirate I2C address from the drop-down menu in the GUI (see the Procedure section).

Figure 6. Acknowledge Error

Check the connection status of the EV2300 in bqStudio by going to *View* → *DashBoard*. A panel on the left-hand side should appear, with the status of the EV2300 at the top (Figure 7).

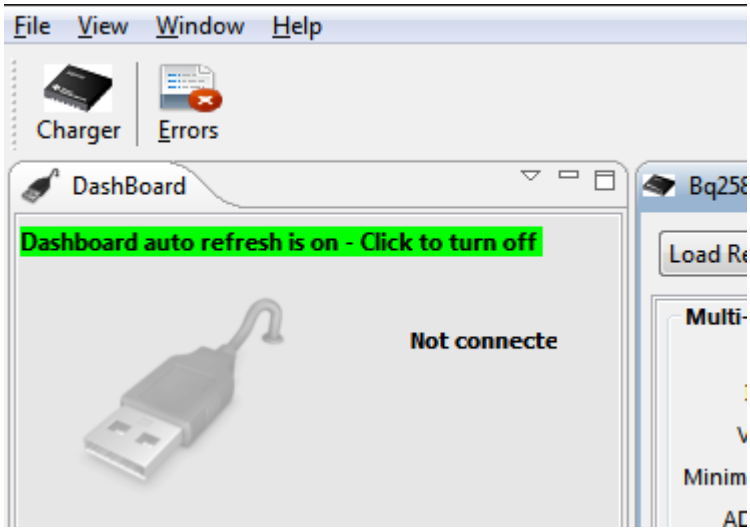


Figure 7. DashBoard Status Tab

12. Choose *Field View*, as shown in Figure 8. The main window of the bq2589x software is shown in Figure 9.

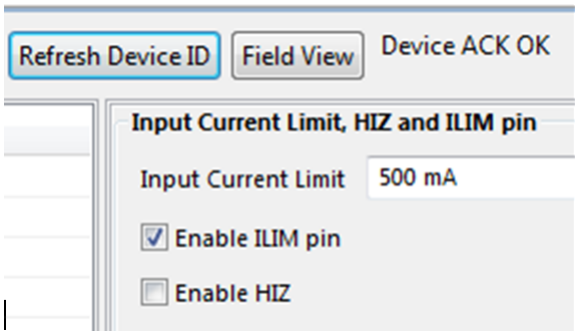


Figure 8. Select Field View

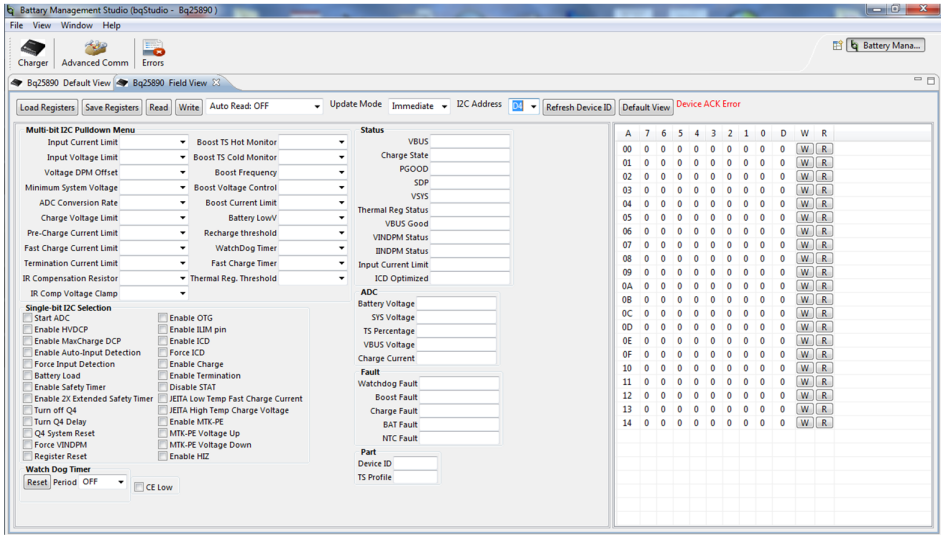
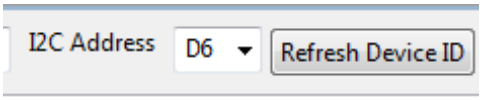


Figure 9. Main Window of the bq2589x Evaluation Software

2.3 Procedure

2.3.1 Communication Verification

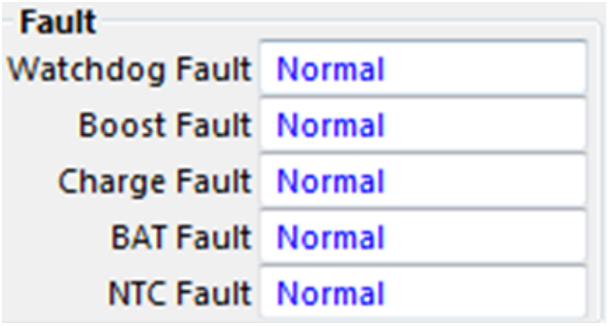
1. In the EVM software, specify device “I2C Address” as D6 for bq25892/6.



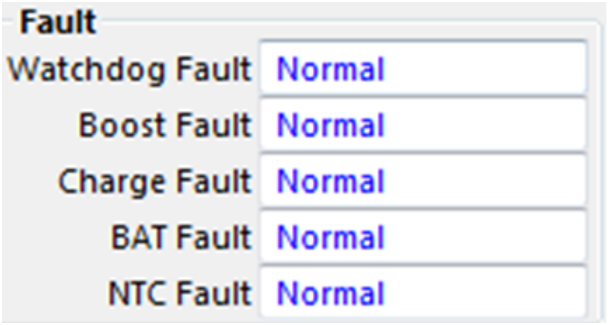
2. Enable PS#1 and Load#1 from Section 2.2. Click the **Read** button
3. In the EVM software, make the following changes as necessary:
   - Select “Disabled” for the “Watchdog Timer”
   - Deselect “Enable ILIM pin"
   - Set “Input Voltage Limit” to 11
   - Set “Input Current Limit” to 3.0A
   - Set “Charge Voltage Limit” to 4.208 V
   - Set “Fast Charge Current” ICHG to 2.048 A
   - Set “Pre-Charge Current” to 256 mA
4. Click READ button to confirm that all of the above changes are retained.
5. Change I2C address to D4 for bq25890/5 and repeat steps 3 and 4 above.

2.3.2 Charger Mode Verification

1. Turn on PS#1, and with I2C address = D4 click the ***Read*** button twice:
   - **Observe** → Everything *Normal* at *Fault* box



   - **Observe** → D7 (STAT1) is on for U1
2. Set I2C address = D6 click the ***Read*** button twice:
   - **Observe** → Everything *Normal* at *Fault* box



   - **Observe** → D9 (STAT2) is on for U2
   - **Observe** → D10 (/PG2) is on for U2
3. Measure the voltage across J3 and J4 as follows:
   - **Measure** → V(TP4(SYS1), TP6(GND)) = 3.65 V ±300 mV
   - **Measure** → V(TP5(BAT), TP6(GND)) = 2.5 V ±200 mV
4. Change load to 3.7 V +/- 100 mV
   - **Measure** → V(TP5(BAT), TP6(GND)) = 3.7 V ±200 mV (adjust load if necessary)
   - **Measure** → IBAT through I2 = 4 A ±400 mA

2.3.3 Boost Mode Verification

1. Turn off and disconnect PS#1
2. With I2C address = D6, click Read button and confirm that “Enable OTG” box is not checked and “Enable HiZ” is checked in the GUI.
3. 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 one, set to 3.7-V and 2-A current limit and connect between BAT+ and GND
4. Change I2C address to D4 and check the "Enable OTG" box in the GUI.
5. Apply 10 Ω (5 W or greater) across J2 (PMID(+) to GND(–))
   - **Measure: V:** (TP2 (PMID) and TP6 (GND)) = 5.0 V ±200 mV

3 Equipment Shutdown

- Shut down and disconnect all loads
- Shutdown and disconnect all power supplies
- No additional special power down procedure needed.

4 Board Layout, Schematic, and Bill of Materials

This section contains the board layouts, schematics, and BOM.

4.1 PWR692 PCB Layouts

Figure 10 and Figure 13 show the PCB layouts for the PWR692 EVM.

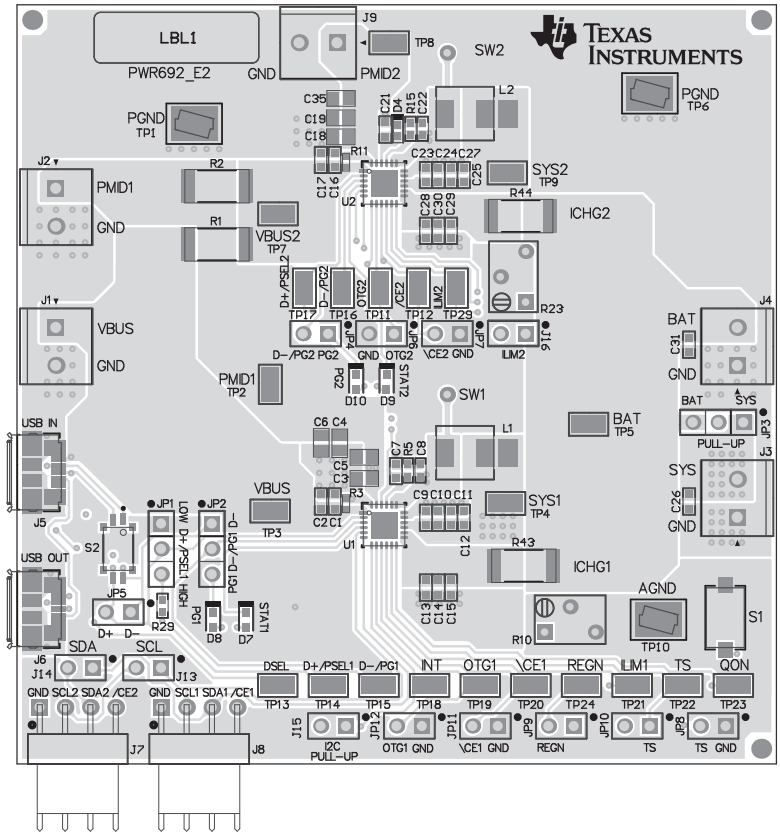


Figure 10. Top Assembly

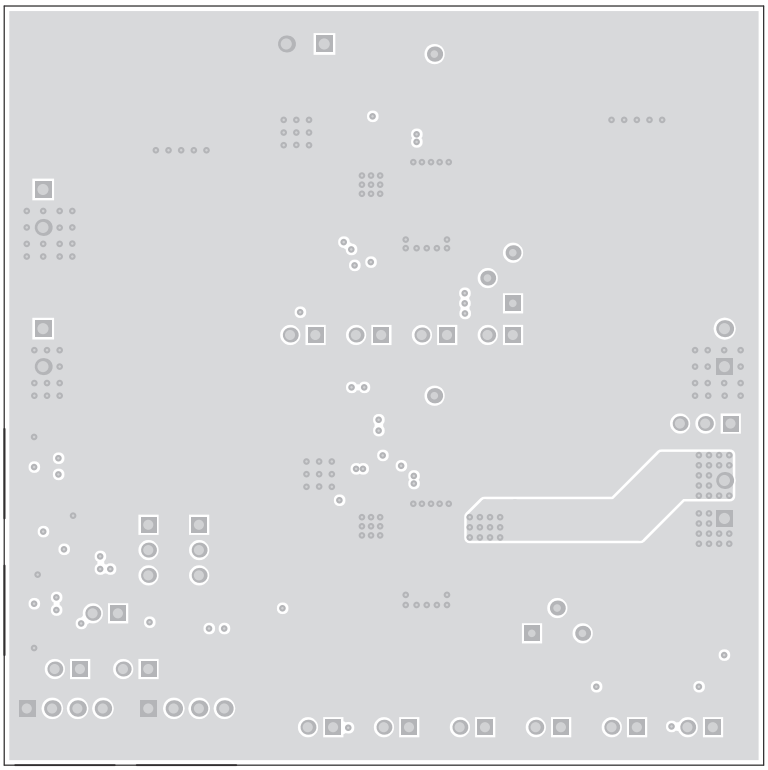


Figure 11. Internal Layer 1

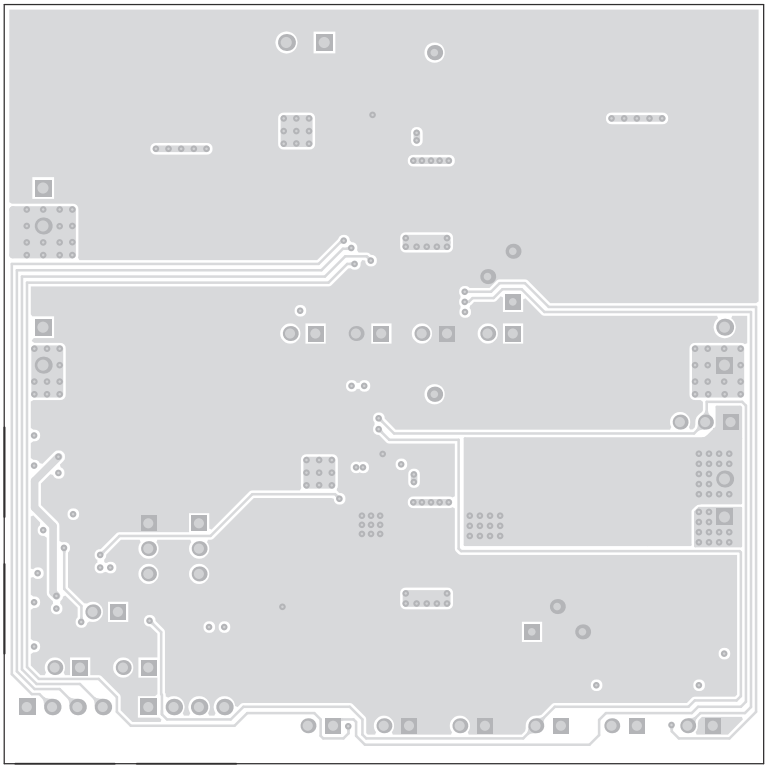


Figure 12. Internal Layer 2

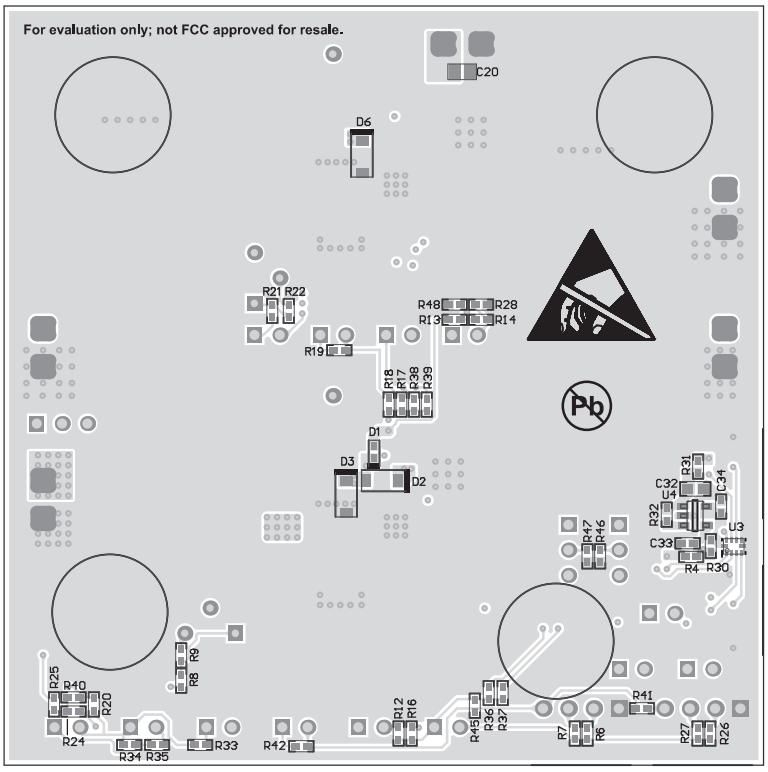


Figure 13. Top Layer

4.2 Schematics

The bq2589xEVM (Figure 14) schematics are provided for reference.

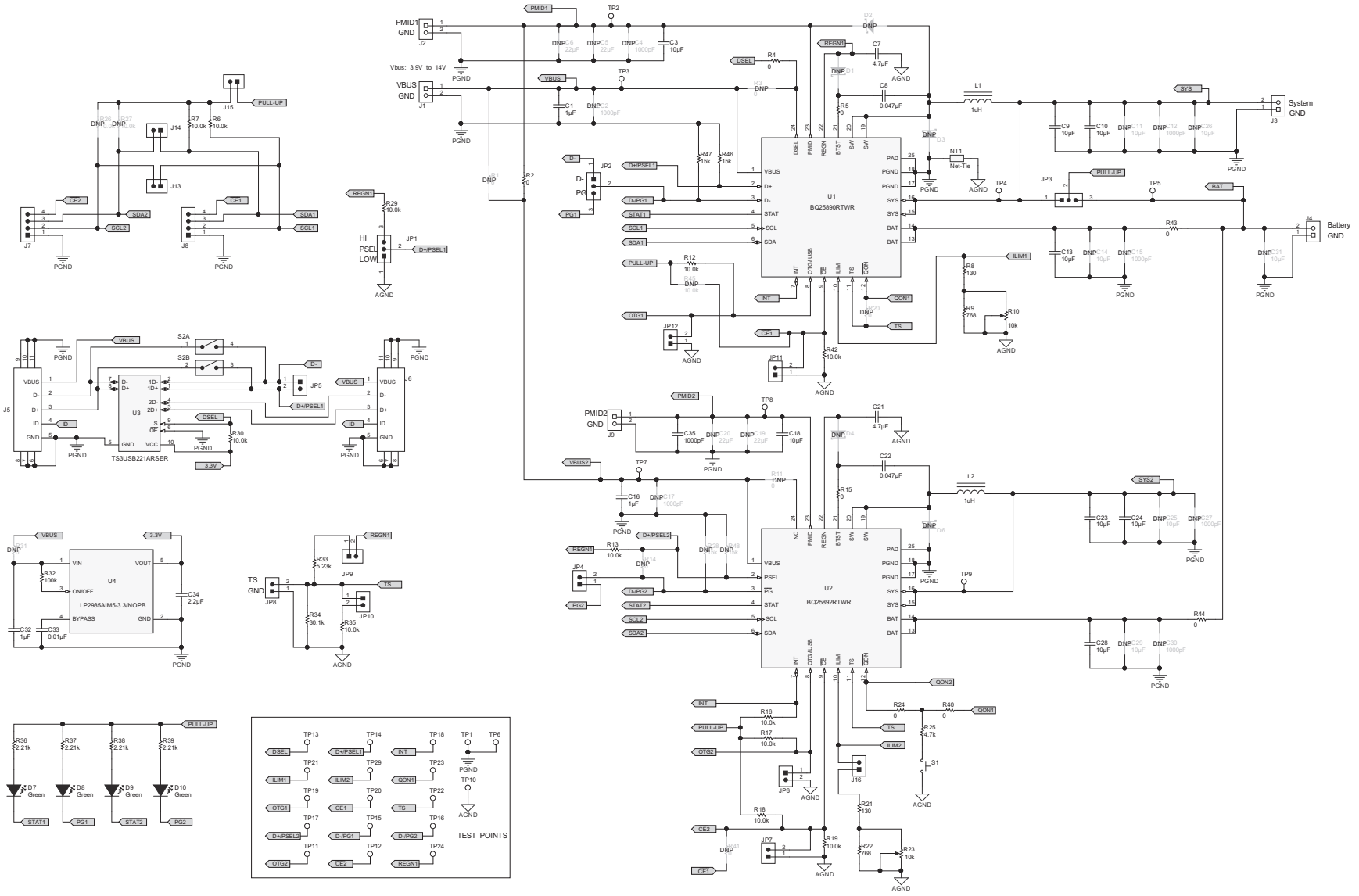


Figure 14. bq2589x EVM Schematic

4.3 Bill of Materials

Table 5 lists the bq2589xEVM-692 BOM.

Table 5. bq25892EVM-692 Bill of Materials

Designator	Qty.	Value	Description	Package Reference	PartNumber	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB	1		Printed Circuit Board		PWR655	Any	-	-
C1, C16, C32	3	1uF	CAP, CERM, 1uF, 25V, +/-10%, X7R, 0603	0603	C1608X7R1E105K080AB	TDK		
C3, C18	2	10uF	CAP, CERM, 10uF, 25V, +/-10%, X5R, 0805	0805	C2012X5R1E106K125AB	TDK		
C7, C21	2	4.7uF	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	0603	GRM188R61C475KAAJ	MuRata		
C8, C22	2	0.047uF	CAP, CERM, 0.047uF, 25V, +/-10%, X7R, 0402	0402	GRM155R71E473KA88D	MuRata		
C9, C10, C23, C24	4	10uF	CAP, CERM, 10uF, 10V, +/-10%, X5R, 0805	0603	GRM21BR61A106KE19L	Murata		
C13, C28	2	10uF	CAP, CERM, 10uF, 10V, +/-20%, X5R, 0603	0603	C1608X5R1A106M	TDK		
C33	1	0.01uF	CAP, CERM, 0.01uF, 25V, +/-10%, X7R, 0402	0402	C1005X7R1E103K	TDK		
C34	1	2.2uF	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0402	0402	C1005X5R1A225K050BC	TDK		
C35	1	1000pF	CAP, CERM, 1000 pF, 25 V, +/- 10%, X7R, 0805	0805	GRM216R71E102KA01D	MuRata		
D7, D8, D9, D10	4	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, J4, J9	5	2x1	Conn Term Block, 2POS, 3.81mm, TH	2POS Terminal Block	1727010	Phoenix Contact		
J5, J6	2		Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	7.5x2.45x5mm	0473460001	Molex		
J7	1		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex		
J8	1		Header, 100mil, 4x1, R/A, TH	4x1 R/A Header	22-05-3041	Molex		
J13, J14, J15, J16	4		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
JP1, JP2, JP3	3		Header, 100mil, 3x1, Tin plated, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
JP4, JP5, JP6, JP7, JP8, JP9, JP10, JP11, JP12	9		Header, 100mil, 2x1, Tin plated, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
L1, L2	2	1uH	Inductor, Shielded Drum Core, Powdered Iron, 1uH, 7A, 0.0181 ohm, SMD	5.49x2x5.18mm	IHLP2020BZER1R0M11	Vishay-Dale		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady	-	-
R2, R43, R44	3	0	RES, 0, 5%, 1 W, 2512	2512	CRCW25120000Z0EG	Vishay-Dale		
R4	1	0	RES, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
R5, R15, R24, R40	4	0	RES, 0 ohm, 5%, 0.063W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
R6, R7, R12, R13, R16, R17, R18, R19, R29, R30, R35, R42	12	10.0k	RES, 10.0k ohm, 1%, 0.063W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R8, R21	2	130	RES, 130 ohm, 1%, 0.063W, 0402	0402	CRCW0402130RFKED	Vishay-Dale		
R9, R22	2	768	RES, 768 ohm, 1%, 0.063W, 0402	0402	CRCW0402768RFKED	Vishay-Dale		
R10, R23	2	10k	Trimmer, 10k ohm, 0.25W, TH	4.5x8x6.7mm	3266W-1-103LF	Bourns		
R25	1	4.7k	RES, 4.7k ohm, 5%, 0.063W, 0402	0402	CRCW04024K70JNED	Vishay-Dale		

Table 5. bq25892EVM-692 Bill of Materials (continued)

Designator	Qty.	Value	Description	Package Reference	PartNumber	Manufacturer	Alternate Part Number	Alternate Manufacturer
R32	1	100k	RES, 100k ohm, 1%, 0.063W, 0402	0402	CRCW0402100KFKED	Vishay-Dale		
R33	1	5.23k	RES, 5.23k ohm, 1%, 0.063W, 0402	0402	CRCW04025K23FKED	Vishay-Dale		
R34	1	30.1k	RES, 30.1k ohm, 1%, 0.063W, 0402	0402	CRCW040230K1FKED	Vishay-Dale		
R36, R37, R38, R39	4	2.21k	RES, 2.21k ohm, 1%, 0.063W, 0402	0402	CRCW04022K21FKED	Vishay-Dale		
R46, R47	2	15k	RES, 15 k, 5%, 0.063 W, 0402	0402	CRCW040215K0JNED	Vishay-Dale		
S1	1		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C and K Components		
S2	1		DIP Switch, SPST, 2Pos, Slide, SMT	SW, 4.7x1.45x3mm	CVS-02TB	Copal Electronics		
SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP5, SH-JP9, SH-JP10, SH-JP13, SH-JP14, SH-JP15, SH-JP16	11	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
TP1, TP6, TP10	3	SMT	Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone		
TP2, TP3, TP4, TP5, TP7, TP8, TP9, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP29	22	SMT	Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone		
U1	1		I2C Controlled 5A Single Cell Charger with NVDC Power Path Management and MaxChargeTM High Voltage Adapter Support, RTW0024H	RTW0024H	BQ25890RTWR	Texas Instruments	BQ25890RTWT	Texas Instruments
U2	1		I2C Controlled 5A Single Cell Charger with NVDC Power Path Management and MaxChargeTM High Voltage Adapter Support, RTW0024H	RTW0024H	BQ25892RTWR	Texas Instruments	BQ25892RTWT	Texas Instruments
U3	1		ESD Protected,High-Speed USB 2.0 (480-Mbps) 1:2 Multiplexer / Demultiplexer Switch, 1:2 Mux / Demux, 6 ohm RON, 2.5 to 3.3V, -40 to 85 degC, 10-Pin UQFN (RSE), Green (RoHS & no Sb/Br)	RSE0010A	TS3USB221ARSER	Texas Instruments	Equivalent	None
U4	1		Micropower 150 mA Low-Noise Ultra Low-Dropout Regulator in SOT-23 Package, DBV0005A	DBV0005A	LP2985AIM5-3.3/NOPB	Texas Instruments		None
C2, C12, C15, C17, C27, C30	0	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H102JA01D	MuRata		
C4	0	1000pF	CAP, CERM, 1000 pF, 25 V, +/- 10%, X7R, 0805	0805	GRM216R71E102KA01D	MuRata		
C5, C6, C19, C20	0	22uF	CAP, CERM, 22 µF, 25 V, +/- 20%, X5R, 0805	0805	GRM21BR61E226ME44	MuRata		
C11, C14, C25, C26, C29, C31	0	10uF	CAP, CERM, 10uF, 10V, +/-20%, X5R, 0603	0603	C1608X5R1A106M	TDK		
D1, D4	0	40V	Diode, Schottky, 40V, 0.38A, SOD-523	SOD-523	ZLLS350TA	Diodes Inc.		
D2, D3, D6	0	30V	Diode, Schottky, 30 V, 1 A, SOD-123	SOD-123	B130LAW-7-F	Diodes Inc.		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
R1	0	0	RES, 0, 5%, 1 W, 2512	2512	CRCW25120000Z0EG	Vishay-Dale		
R3, R11	0	0	RES, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		

Table 5. bq25892EVM-692 Bill of Materials (continued)

Designator	Qty.	Value	Description	Package Reference	PartNumber	Manufacturer	Alternate Part Number	Alternate Manufacturer
R14, R20, R31, R41	0	0	RES, 0 ohm, 5%, 0.063W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
R26, R27, R45	0	10.0k	RES, 10.0k ohm, 1%, 0.063W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R28, R48	0	15k	RES, 15 k, 5%, 0.063 W, 0402	0402	CRCW040215K0JNED	Vishay-Dale		
SH-JP6, SH-JP7, SH-JP8, SH-JP11, SH-JP12	0	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec

Revision History

Changes from Original (May 2015) to A Revision **Page**

- Changed From: "Cascode Charger" To: "Cascade Charger" in the document title 1
- Changed "cascode configuration." To: "cascade configuration." in the introduction text. 1
- Changed existing assembly images, and added 2 new images in the *PWR692 PCB Layouts* section. 11

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

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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

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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.

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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.

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