EVM User's Guide:

BQ25628 and BQ25629 Evaluation Modules

ABSTRACT

This user's guide provides detailed testing instructions for the BQ25628 and BQ25629 evaluation modules (EVM). 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).

Throughout this user's guide, the abbreviations *EVM*, *BQ25628EVM*, *BQ25629EVM*, *BMS050*, and the term *evaluation module* are synonymous with the BMS050 evaluation module, unless otherwise noted.

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Trademarks

1 Introduction

The BMS050 evaluation module (EVM) is a complete charger module for evaluating the BQ25628 and BQ25629 devices. The BQ25628 and BQ25629 are I^{2}C-controlled single-cell chargers with NVDC Power Path Management, Integrated ADC, and OTG Output.

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

Table 1-1. Device Data Sheets

Device	Data Sheet	EVM Label
BQ25628	SLUSEG4	BQ25628EVM
BQ25629	SLUSEG4	BQ25629EVM

1.1 EVM Features

This EVM supports the following features:

- Evaluation module for the BQ25628 or BQ25629 devices.
- Narrow VDC (NVDC) power path management for powering the systems and charging the battery.
- Supports I^{2}C communication for systems configuration and status reporting.
- Test points for key signals available for testing purposes.
- Jumpers for easy configuration.
- One push-button for wake-up and reset input with adjustable timers.
- Charge status (STAT) LED for charging monitoring and reverse boost mode output (VPB) LED for boost monitoring.
- Connections for EV2400 or USB2ANY interface board controllers.

This EVM does not include the EV2400 or USB2ANY interface boards. To evaluate the EVM, an EV2400 or USB2ANY must be ordered separately.

1.2 General Descriptions

Table 1-2 lists the input and output connections available on this EVM and their respective descriptions.

Table 1-2. EVM I/O Connections

Jack	Description
J1(2) - VIN	Positive rail of the charger input voltage
J1(1) - GND	Ground
J2(1) - SYSTEM	Positive rail of the charger system output voltage, typically connected to the system load
J2(2) - GND	Ground
J3(1) - VPB	Positive rail of the charger output voltage for power bank applications in reverse boost mode (OTG). This output also shares the rail with the VIN input rail in forward buck mode
J3(2)-GND	Ground
J4(3) - BATTERY	Positive rail of the charger battery input, connected to the positive terminal of the external battery
J4(2) - ext_ts	Connection available for external thermistor if required
J4(1) - GND	Ground
J5	Input source Micro B USB port
J6	I^{2}C connector for the USB2ANY interface board
J7	I^{2}C connector for the EV2400 interface board

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

Table 1-3. EVM Jumper Shunt and Switch Installation

Jack	Description	BQ25628 Setting	BQ25629 Setting
JP1	Connect PMID_GD gate drive circuitry to on board external PFET	Installed	Installed
JP2	SCL pull-up rail. not required if using EV2400 or USB2ANY	Not Installed	Not Installed
JP3	SDA pull-up rail. not required if using EV2400 or USB2ANY	Not Installed	Not Installed
JP4	Connect PMID_GD gate drive circuitry to on board external PFET.	Installed	Installed
JP5	Connects ILIM pin resistor to ILIM pin. Not applicable to BQ25629 IC	Installed	Not Installed
JP6	Micro B USB input D- connection to charger D- pin	Not Installed	Installed
JP7	$\overline{PG}$ pin LED indicator connection. On $\overline{PG}$ enabled chargers, this indicates the Power Good status	Not Installed	Not Installed
JP8	STAT pin LED indicator connection. This indicates the current charger status	Installed	Installed
JP9	Micro B USB input D+ connection to charger D+ pin	Not Installed	Installed
JP10	USB2ANY pull-up rail. Not required if using EV2400	Not Installed	Not Installed
JP11	TS resistor divider pull-up rail.	Short pins 2-3	Short pins 1-2
JP12	Charger D+ pin and charger D- pin short connection. Connect this on D+/D- detection enabled chargers to simulate the connection of a DCP-type USB port as defined by USB BC1.2 and set IINDPM register to highest setting.	Not Installed	Installed
JP13	Connect 10k in parallel with TS resistor network to simulate a battery at 25 C. Disconnect if using external thermistor.	Installed	Installed
JP14	$\overline{CE}$ pin connection to ground to enable charging. When removed, $\overline{CE}$ pin pulls up to disable charge	Installed	Installed
JP15	VPB status LED indicator connection. On power bank PMID_GOOD enabled chargers, this indicates VPB rail is active	Installed	Installed
S1	$\overline{QON}$ control switch. Press either for exiting Shipping Mode or System Reset.	Default Off	Defai;t Off

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

Table 1-4. Recommended Operating Conditions

Symbol	Description	Min	Typ	Max	Unit
V_{VBUS}, V_{VAC}	Input voltage applied to VBUS pin	3.9		18.0	V
V_{BAT}	Battery voltage applied to BAT pin	0	4.208	4.8	V
I_{VBUS}	Input current into VBUS	0		3.2	A
I_{SW}	Output current from SW flowing to SYS pin load and battery at BAT pin			3.5	A
I_{BAT}	Fast charging current into battery at BAT pin	0		2.0	A
	Continuous RMS discharge current through internal BATFET			6	A

2 Testing Procedures

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 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 for simulating a battery:** 4-Quadrant Supply, Constant Voltage < 4.5 V) "Kepco" Load, BOP, 20-5M, DC 0 to ±20 V, 0 to ±3.5 A (or higher)
   Alternative Option: A 0–20V/0–3.5 A, > 30-W DC electronic load set in a constant voltage loading mode
3. **Load #2 for simulating a load at SYS or load at VPB in reverse/OTG mode:** Electronic or Resistive Load capable sinking up to 5-A from up to 9V (or higher)
4. **Meters:** 4x "Fluke 75" multi-meters, (equivalent or better).
   Alternative Option: (2x) equivalent voltage meters and (2x) equivalent 3-A or higher rated current meters.
5. **Computer:** A Windows 10 based computer with at least one USB port and a USB cable. Must have the latest version of Battery Management Studio installed.
6. **USB-TO-GPIO Communication Kit:** EV2400 USB-based PC interface board.
7. **Software:** BQStudio software with latest .bqz file for BQ25628/9 provided by Texas Instruments. Download and install bqStudio from https://www.ti.com/tool/BQSTUDIO.

2.2 Hardware Setup

Use the following list to set up the EVM testing equipment:

1. Review EVM jumper connections in Table 1-3
2. Set PS #1 for 5-V DC, 2-A current limit and then turn off the supply.
3. Connect the output of PS#1 in series with a current meter to J1 (VBUS and PGND).
4. Connect a voltage meter across TP10 (VBUS) and TP27 (PGND), or across J1.
5. Turn on Load #1, set to constant voltage mode, and output to 2.5-V. Disable Load. Connect Load in series with a current meter (multimeter), ground side, to J4 (BAT and PGND) as shown in Figure 2-1 in not using a source meter with current measuring capabilities.
6. Connect a voltage meter across TP13 (BAT) and TP29 (PGND), or across J4-3 and J4-1 as in Figure 2-1
7. Connect a voltage meter across TP14 (SYS) and TP29 (PGND), or across J2-1 and J2-2 as in Figure 2-1
8. Connect a voltage meter across TP12 (PMID) or TP11 (VPB) and TP28 (PGND), or across J3-1 and J3-2 as in Figure 2-1
9. Connect the EV2400 USB interface board to the computer with a USB cable and from I2C port to J5 with the 4-pin cable as in Figure 2-1
10. Install shunts as shown in Table 1-3. Note that the shunts in Figure 2-1 are not necessarily installed per the table.

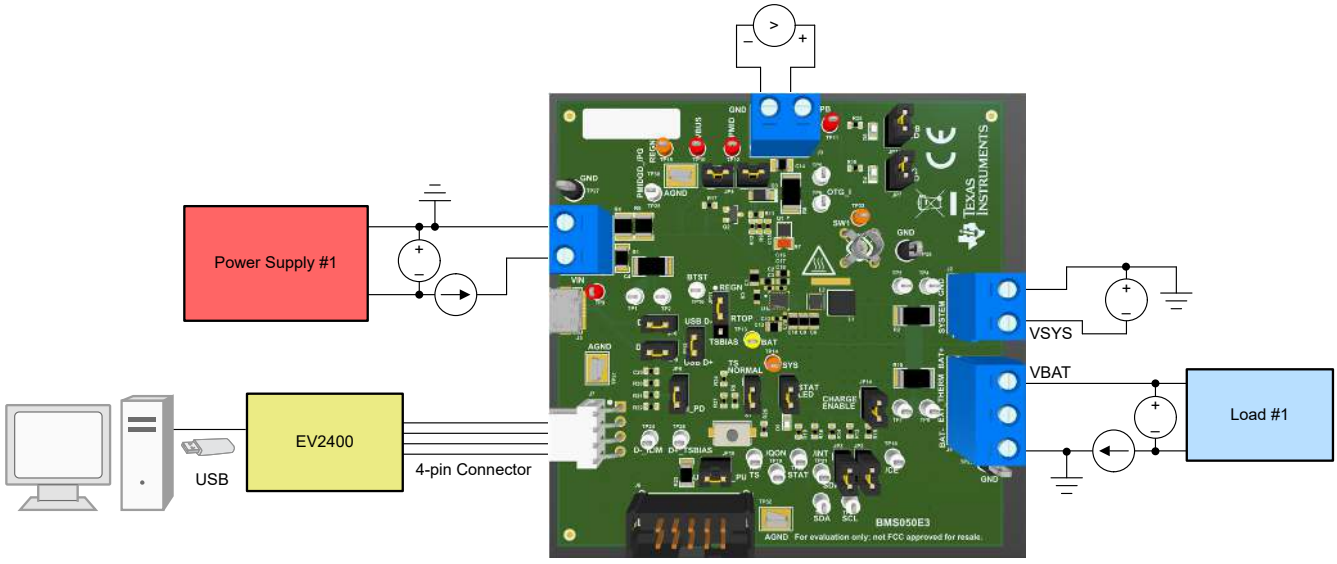


Figure 2-1. Test Setup for BQ25628EVM and BQ25629EVM

2.3 Software Setup

Use the following to set up the EVM testing software:

1. On the computer connected to the EV2400 interface board, launch Battery Management Studio (BQStudio). Select Charger as seen in Figure 2-2.

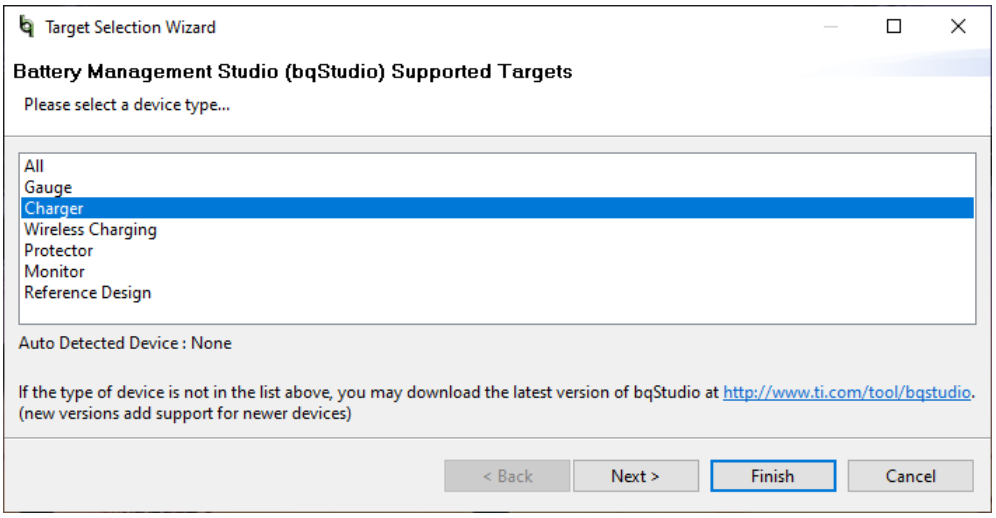


Figure 2-2. BQStudio Device Type Selection Window

2. Select the appropriate configuration file based on the device from the window shown in Figure 2-3.

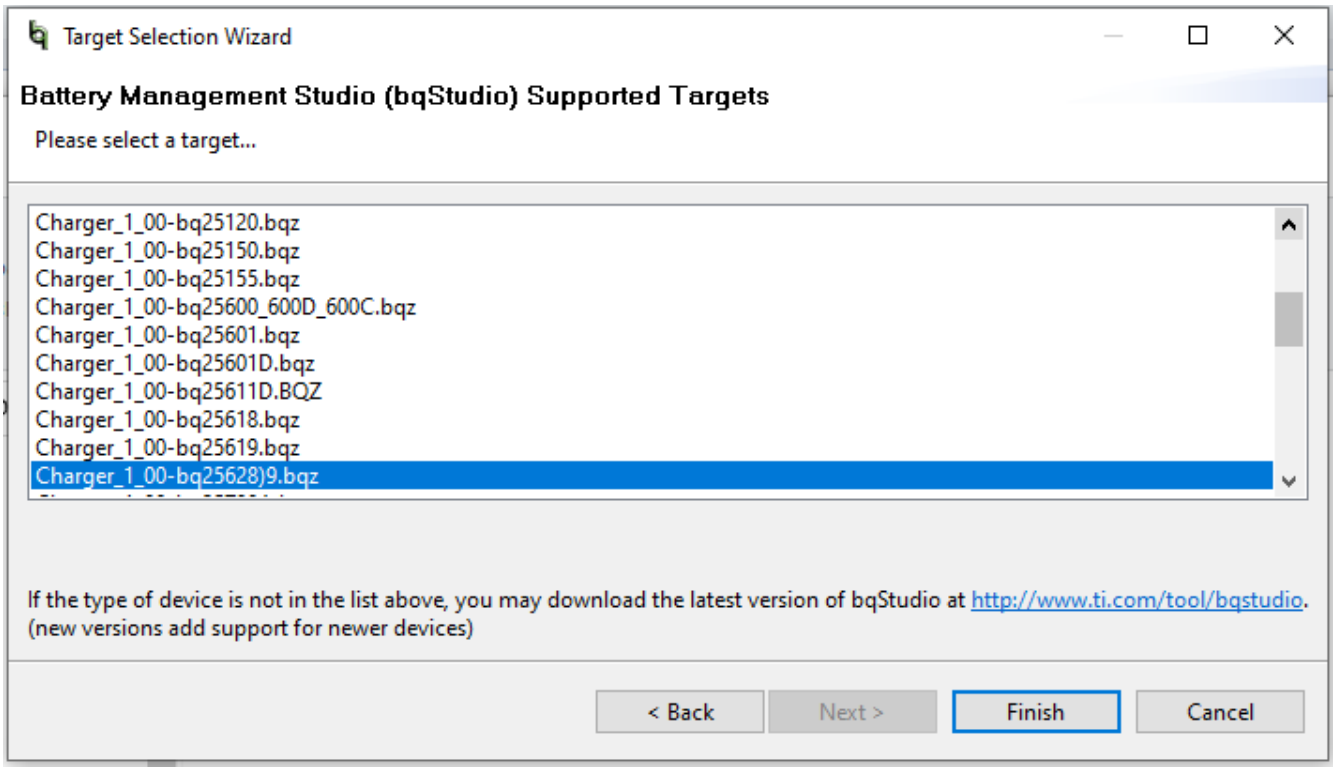
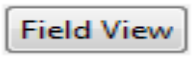


Figure 2-3. BQStudio Charger Selection Window

3. Choose 

, on the window that appears, and the main window of the BQ2562X EVM software will appear, as shown in Figure 2-4.

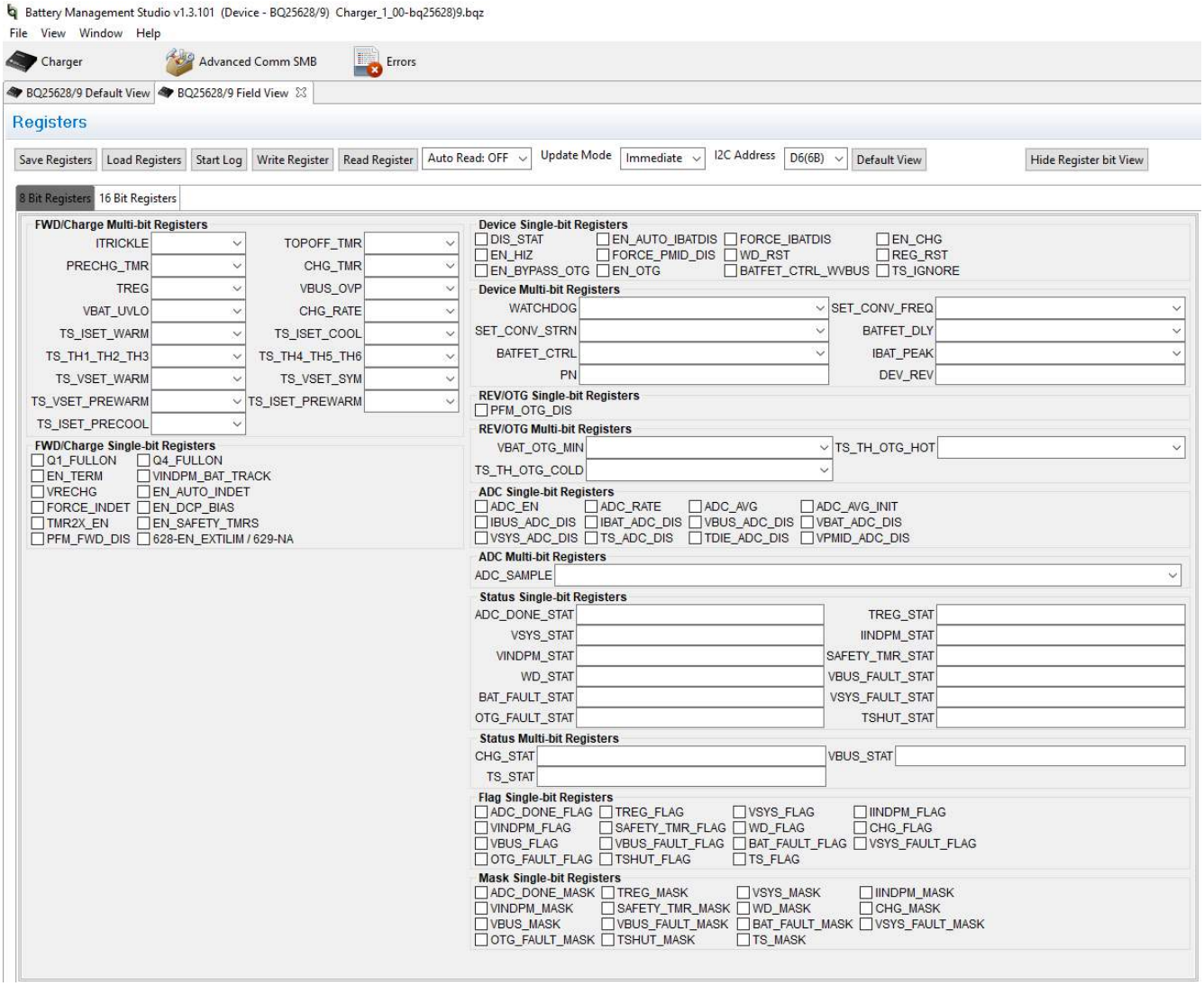


Figure 2-4. Main Window of BQ25628/9 EVM Software

2.4 Test Procedure

2.4.1 Initial Power Up

Use the following steps for enabling the EVM test setup:

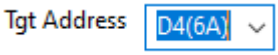
1. Ensure that Section 2.2 steps have been followed.
2. Ensure that Section 2.3 steps have been followed.
3. Turn on PS #1:
   - **Measure** → V_{SYS} (SYS-TP14 and PGND-TP28) = 3.70V ±0.2V

Note

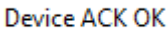
Completely disconnect Load #1 from BATTERY connections if different value is seen.

2.4.2 I²C Register Communication Verification

Use the following steps for communication verification :

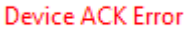
1. In the EVM software, change the Tgt Address 

. Please also make this change when transitioning to the Field View.
2. In the EVM software, click the 

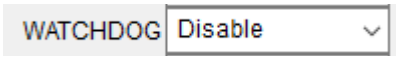
button
   - Verify that the GUI reads 

in the top right corner.

Note

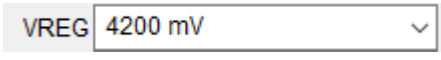
If the device reads 

verify Section 2.2 and Section 2.4.1 steps have been followed.

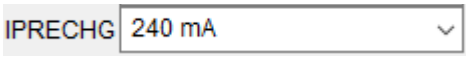
3. In the Field View (see Figure 2-4), make the following changes as necessary:
   - Set 

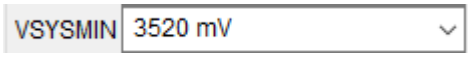
   - Set 

   - Set 

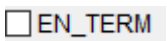
   - Set 

   - Set 

   - Set 

   - Set 

   - Check 

   - Uncheck 

2.4.3 Charger Mode Verification

Use the following steps for charger mode verification:

1. PS #1 should be on from Section 2.4.1. In the EVM software, click 

twice.
   - Verify that all Fault statuses read "Normal"

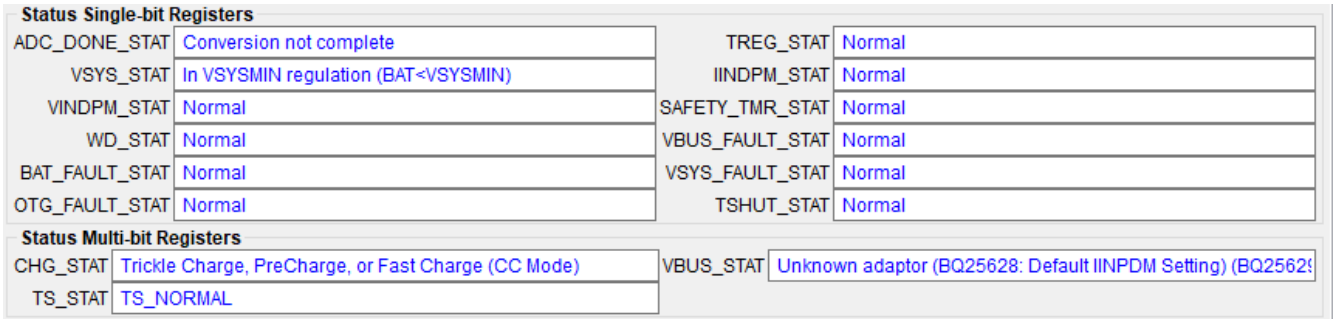


Figure 2-5. Verification of Fault Statuses

2. To confirm SYS voltage regulation, enable Load #1 (see Section 2.2) and take DMM measurements as follows:
   - **Measure** → V_{SYS} (SYS-TP14 and PGND-TP27 or TP28 or TP29) = 3.65V ±0.3V
   - **Measure** → V_{BAT} (BAT-TP13 and PGND-TP27 or TP28 or TP29) = 2.5V ±0.2V
   - **Measure** → I_{BAT} = 240mA ±50mA
3. To confirm battery charge current regulation, change Load #1 to 3.7V and take DMM measurements as follows:
   - **Measure** → V_{SYS} (SYS-TP14 and PGND-TP27 or TP28 or TP29) = 3.8V ±0.3V
   - **Measure** → V_{BAT} (BAT-TP13 and PGND-TP27 or TP28 or TP29) = 3.7V ±0.2V
   - **Measure** → I_{BAT} = 480mA ±100mA
4. To confirm input current limit operation, in the EVM software on the 16-bit tab, set fast charge current to 1040mA and then take DMM measurement (or PS #1 measurement if accurate) as follows:
   - **Measure** → I_{IN} = 500mA ±200mA

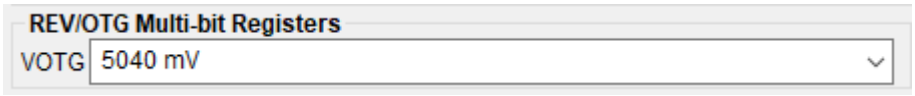
2.4.4 Boost Mode Verification

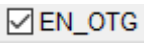
Use the following steps for boost mode verification:

1. Turn off and disconnect PS #1.
2. Set Load #1, the battery simulator, to 3.7V and 2A current limit.

> **Note**
>
> If Load #1 connected from BATTERY-J4(3) to GND-J4(1) is not a four quadrant supply, remove Load #1 and use PS #1, set to 3.7V, 2A current limit and connect to BATTERY-J4(3) and GND-J4(1).

3. In the EVM software on the 16-bit tab, confirm that VOTG, the OTG regulation voltage, is set to 5.04V.



4. In the EVM software on the 8-bit tab under the Device Single Bit registers, enable OTG (EN_CHG can remain enabled). 

5. Connect Load #2 across VPB-J3(1) and PGND-J3(2).
6. Set Load #2 to 500mA constant current load (or resistance of 2.5 W) and the turn on the load.
7. To confirm the VOTG regulation,
   - **Measure**→ V_{PMID} = 5.04 V ± 25 mV
8. Turn off and disconnect the power supply.
9. Remove Load #2 from the connection.

2.4.5 Helpful Tips

1. 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, that shunts JP11 and JP13 are in place.
2. When using a source meter that can source and sink current as your battery simulator, TI highly recommends adding a large (>=1000+ µF) capacitor at the EVM BATTERY and GND connector 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 properly connected in order to prevent accidental overvoltage by the power leads.
3. For precise measurements of input and output current, especially near termination, the current meter in series with the battery or battery simulator should not be set to auto-range and may need to be removed entirely. An alternate method for measuring charge current is to either use an oscilloscope with hall effect current probe or by a differential voltage measurement across the relevant sensing resistors populated on the BQ2526xEVM.

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. For lowest switching noise during forward/charge mode, place the decoupling PMID capacitor and then bulk PMID capacitor positive terminals as close as possible to PMID pin. Place the capacitor ground terminal close to the GND pin using the shortest copper trace connection or GND plane on the same layer as the IC.
2. For lowest switching noise during reverse/OTG mode, place the SYS output capacitors' positive terminals near the SYS pin. The capacitors' ground terminals must be via'd down through multiple vias to an all ground internal layer that returns to IC GND pin through multiple vias under the IC.
3. Since REGN powers the internal gate drivers, place the REGN capacitor positive terminal close to REGN pin to minimize switching noise. The capacitor's ground terminal must be via'd down through multiple vias to an all ground internal layer that returns to IC GND pin through multiple vias under the IC.
4. Place the VBUS and BAT capacitors' positive terminals as close to the VBUS and BAT pins as possible. The capacitors' ground terminals must be via'd down through multiple vias to an all ground internal layer that returns to IC GND pin through multiple vias under the IC.
5. Place the inductor input pin near the positive terminal of the SYS pin capacitors. Due to the PMID capacitor placement requirements, the inductor's switching node terminal must be via'd down with multiple via's to a second internal layer with a wide trace that returns to the SW pin with multiple vias. Using multiple vias ensures that the via's additional resistance is negligible compared to the inductor's dc resistance and therefore does not impact efficiency. The vias additional series inductance is negligible compared to the inductor's inductance.
6. Place the BTST capacitor on the opposite side from the IC using vias to connect to the BTST pin and SW node.
7. A separate analog GND plane for non-power related resistors and capacitors is not required if those components are placed away from the power components traces and planes.
8. Ensure that the I^2C SDA and SCL lines are routed away from the SW node.

Additionally, it is important that the PCB footprint and solder mask cover the entire length of each of the pins. GND, SW, PMID, SYS and BAT pins extend further into the package than the other pins. Using the entire length of these pins reduces parasitic resistance and increases thermal conductivity from the package into the board.

See the EVM design for the recommended component placement with trace and via locations.

4 Board Layout, Schematic, and Bill of Materials

4.1 Board Layout

The following figures illustrate the PCB board layers.

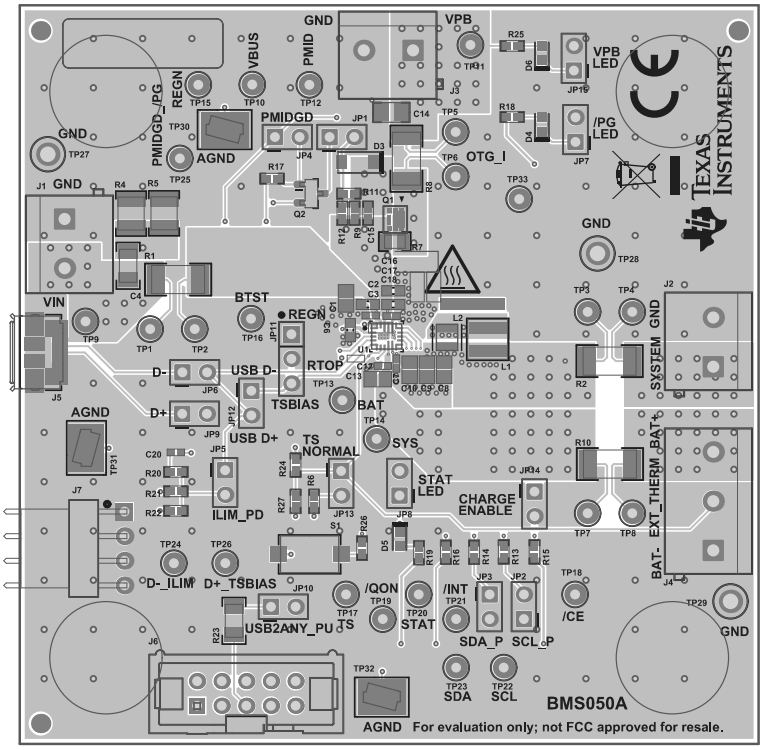


Figure 4-1. BMS050 Top Layer

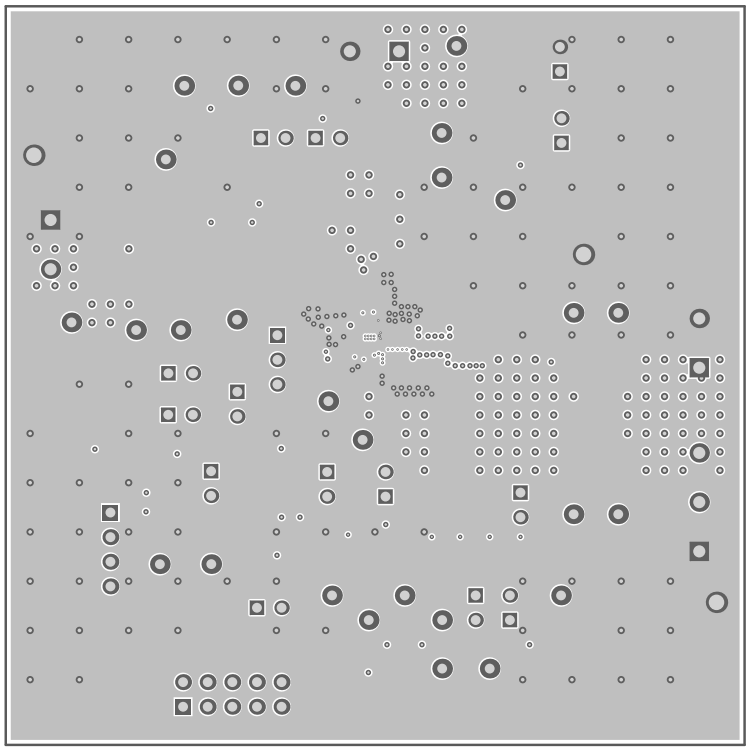


Figure 4-2. BMS050 Internal Layer 1

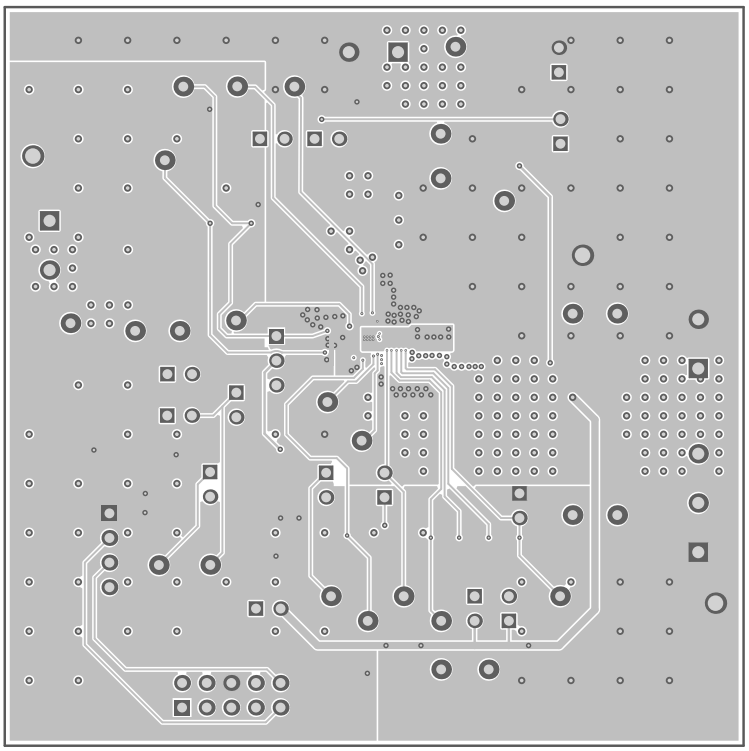


Figure 4-3. BMS050 Internal Layer 2

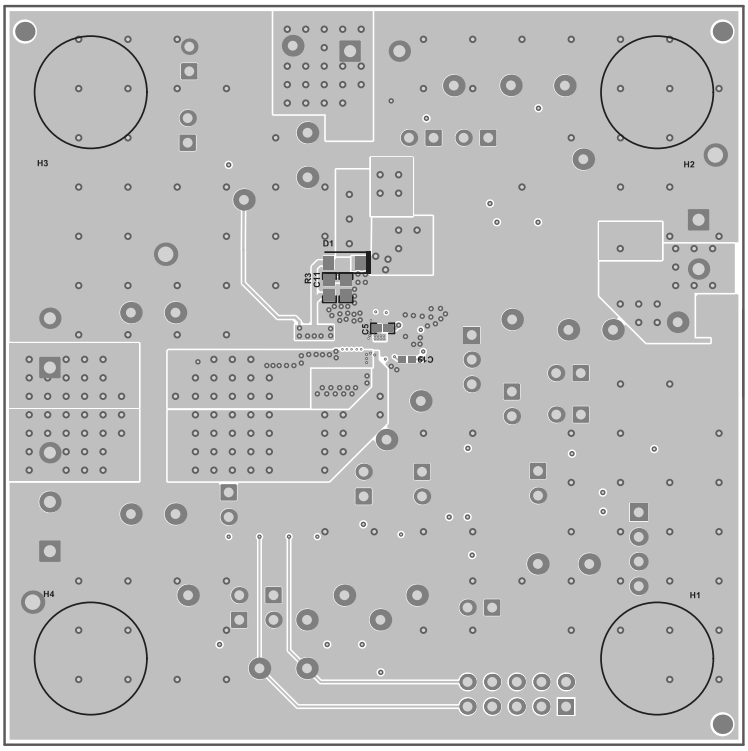


Figure 4-4. BMS050 Bottom Layer

4.2 Schematic

Figure 4-5 illustrates the schematic for the BQ25628EVM and Figure 4-6 illustrates the schematic for the BQ25629EVM.

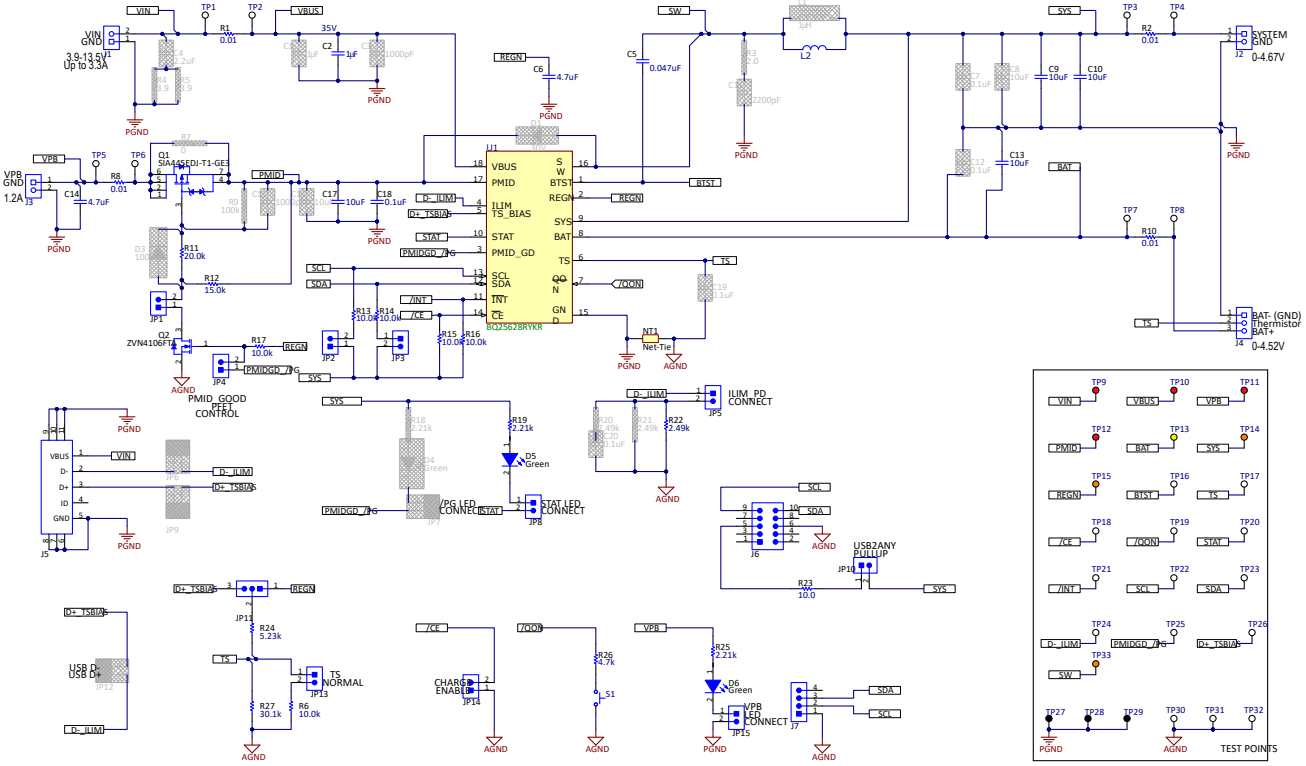


Figure 4-5. BQ25628EVM Schematic

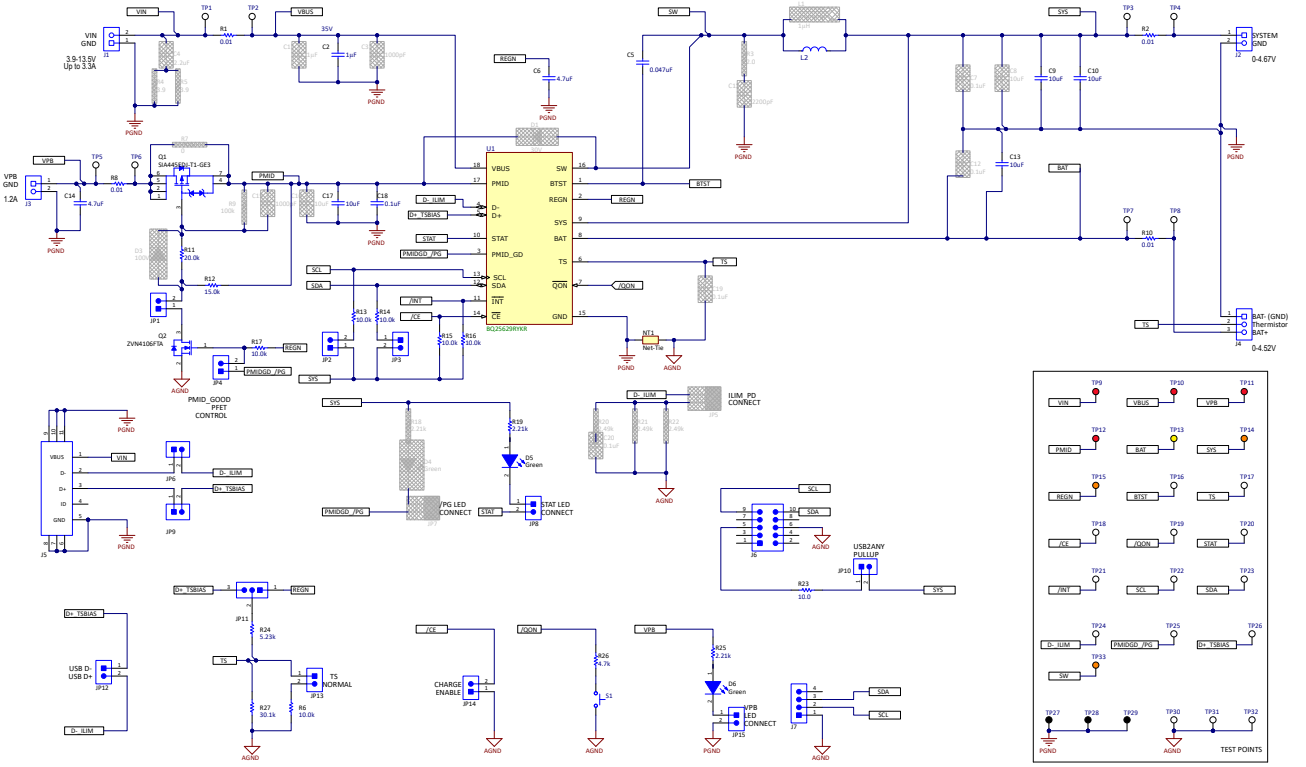


Figure 4-6. BQ25629EVM Schematic

4.3 Bill of Materials

Table 4-1 lists the BQ25628EVM and BQ25629EVM BOM.

Table 4-1. BMS050 Bill of Materials

Designator	628EVM	629EVM	Value	Description	Package Reference	Part Number	Manufacturer
C2	1	1	1uF	CAP, CERM, 1 uF, 35 V, +/- 10%, X7R, AEC-Q200 Grade 0, 0603	603	GMK107AB7105KAHT	Taiyo Yuden
C5	1	1	0.047uF	CAP, CERM, 0.047 uF, 25 V, +/- 10%, X7R, 0402	402	GRM155R71E473KA88D	MuRata
C6	1	1	4.7uF	CAP, CERM, 4.7 uF, 25 V, +/- 10%, X5R, 0603	603	GRM188R61E475KE11D	MuRata
C9, C10, C13	3	3	10uF	CAP, CERM, 10 uF, 25 V, +/- 10%, X5R, 0805	805	C2012X5R1E106K125AB	TDK
C14	1	1	4.7uF	CAP, CERM, 4.7 uF, 25 V, +/- 10%, X5R, 0805	805	C0805C475K3PACTU	Kemet
C17	1	1	10uF	CAP, CERM, 10 uF, 25 V, +/- 20%, X5R, 0603	603	GRT188R61E106ME13D	MuRata
C18	1	1	0.1uF	CAP, CERM, 0.1 uF, 50 V,+/- 10%, X7R, 0402	402	C1005X7R1H104K050BE	TDK
D5, D6	2	2	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
H1, H2, H3, H4	4	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
J1, J2, J3	3	3		Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J4	1	1		Terminal Block, 5.08 mm, 3x1, Brass, TH	3x1 5.08 mm Terminal Block	ED120/3DS	On-Shore Technology
J5	1	1		Connector, Receptacle, Micro-USB Type B, R/A, Bottom Mount SMT	7.5x2.45x5mm	473460001	Molex
J6	1	1		Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	5x2 Shrouded header	N2510-6002-RB	3M
J7	1	1		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	22/05/3041	Molex

Table 4-1. BMS050 Bill of Materials (continued)

Designator	628EVM	629EVM	Value	Description	Package Reference	Part Number	Manufacturer
JP1, JP2, JP3, JP4, JP8, JP10, JP13, JP14, JP15	9	9		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
JP5	1	0		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
JP6, JP9, JP12	0	3		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
JP7	0	0		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
JP11	1	1		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
L2	1	1	1uH	1µH @ 20% Shielded Molded Inductor 4.2A 42mOhm Max 1008 Isat: 4.6A (2520 Metric) -	SMT_IND_2MM0_2MM5	252012CDMCDDS-1R0MC	Sumida
Q1	1	1	-20V	MOSFET, P-CH, -20 V, -12 A, PowerPAK SC-70	PowerPAK SC-70	SIA445EDJ-T1-GE3	Vishay-Siliconix
Q2	1	1	60V	MOSFET, N-CH, 60 V, 0.2 A, AEC-Q101, SOT-23	SOT-23	ZVN4106FTA	Diodes Inc.
R1, R2, R8, R10	4	4	0.01	RES, 0.01, 1%, 1 W, 2010	2010	WSL2010R0100FEA18	Vishay-Dale
R6, R13, R14, R15, R16, R17	6	6	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040210K0FKED	Vishay-Dale
R11	1	1	20.0k	RES, 20.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040220K0FKED	Vishay-Dale
R12	1	1	15.0k	RES, 15.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040215K0FKED	Vishay-Dale
R19, R25	2	2	2.21k	RES, 2.21 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022K21FKED	Vishay-Dale
R22	1	0	2.49k	RES, 2.49 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022K49FKED	Vishay-Dale
R23	1	1	10	RES, 10.0, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	ERJ-8ENF10R0V	Panasonic

Table 4-1. BMS050 Bill of Materials (continued)

Designator	628EVM	629EVM	Value	Description	Package Reference	Part Number	Manufacturer
R24	1	1	5.23k	RES, 5.23 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04025K23FKED	Vishay-Dale
R26	1	1	4.7k	RES, 4.7 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04024K70JNED	Vishay-Dale
R27	1	1	30.1k	RES, 30.1 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040230K1FKED	Vishay-Dale
S1	1	1		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C&K Components
SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP8, SH-JP10, SH-JP11, SH-JP13, SH-JP14, SH-JP15	10	10	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
SH-JP5	1	0	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
SH-JP6, SH-JP9, SH-JP12	0	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
SH-JP7	0	0	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26	19	19			Test Point, Miniature, White, TH	White Miniature Testpoint	5002
TP9, TP10, TP11, TP12	4	4		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP13	1	1		Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone
TP14, TP15, TP33	3	3		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone
TP27, TP28, TP29	3	3		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
TP30, TP31, TP32	3	3		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone

Table 4-1. BMS050 Bill of Materials (continued)

Designator	628EVM	629EVM	Value	Description	Package Reference	Part Number	Manufacturer
U1	1	0		I2C Controlled, 2-A, Maximum 18V Input, Charger with NVDC Power Path Management and OTG Output	WQFN-HR18	BQ25628RYKR	Texas Instruments
U1	0	1		I2C Controlled, 2-A, Maximum 18V Input, Charger with NVDC Power Path Management and OTG Output	WQFN-HR18	BQ25629RYKR	Texas Instruments

5 Revision History

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

DATE	REVISION	NOTES
January 2023	*	Initial Release

STANDARD TERMS FOR EVALUATION MODULES

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

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

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

2 *Limited Warranty and Related Remedies/Disclaimers*:

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

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

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

WARNING

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

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

NOTE:

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

3 *Regulatory Notices:*

3.1 *United States*

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

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 *Japan*

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

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

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

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

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

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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。

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3.4 *European Union*

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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 MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS 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 EPIDEMIC FAILURE WARRANTY OR 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.

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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. 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 OR THE USE OF THE EVMS , 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 TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM 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.

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