

EVM User's Guide: BQ24810EVM

BQ24810 Evaluation Module



Description

The BQ24810 evaluation module (EVM) is an evaluation system for the BQ24810 IC. The BQ24810 IC is a buck-only battery charge controller with hybrid power boost mode, battery-only boost, and processor hot monitoring capability. The input voltage range is between 4.5V and 24V, with a programmable output of 1–4 cells charge voltage and 128mA to 8.128A charge current.

Get Started

1. Order the EVM on ti.com
2. Order the [EV2400](#) to communicate with the EVM using bqStudio,
3. Download the BQ24810 BQZ file
4. Download the BQ24810 EVM design files on ti.com

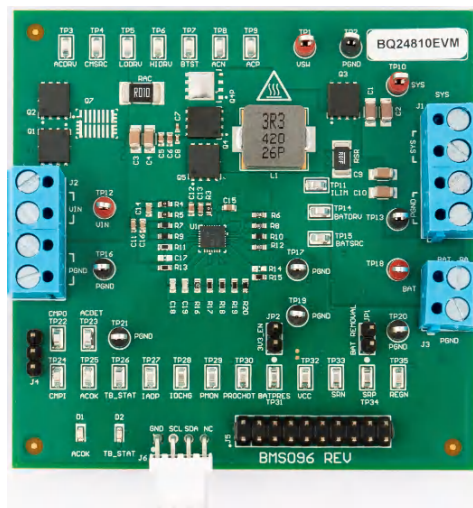
Features

- Hybrid Power Boost Mode to power up system from adapter and battery together
 - Ultra-fast transient response of 100 μ s to enter Hybrid Power Boost Mode
- Battery Only Boost Mode to support larger system transients and extend battery run time
- Peak power two-level input current limit to maximize the power from adapter and minimize battery discharge

- Supports charging 1- to 4-cell battery pack from 4.5V to 24V adapter
- High accuracy power and current monitoring for CPU throttling
 - Comprehensive PROCHOT profile
 - $\pm 2\%$ Current monitor accuracy
 - $\pm 5\%$ System Power Monitor Accuracy (PMON)
- Automatic NMOS /Bi-directional GAN power source selection from adapter or battery
 - ACFET fast turn on in 100 μ s when exiting learn mode from battery removal
- Programmable input current, charge voltage, charge and discharge current limit
 - $\pm 0.4\%$ Charge voltage (16mV/step)
 - $\pm 2\%$ Input current (64mA/step)
 - $\pm 2\%$ Charge current (64mA/step)
 - $\pm 2\%$ Discharge current (512mA/step)
- Switching frequency: 300kHz, 400kHz, 600kHz, and 800kHz

Applications

- [Notebook](#), ultrabook, detachable, and [tablet](#) PC
- [Industrial](#) and [medical](#) equipment
- System with [battery backup](#)
- [Portable equipment](#)



1 Evaluation Module Overview

1.1 Introduction

The BQ24810 evaluation module (EVM) is an SMBus 1- to 4-cell hybrid power boost mode battery charge controller with battery-only boost and processor hot monitoring. The input voltage range is between 4.5V and 24V, with a programmable output of 1–4 cells charge voltage and 128mA to 8.128A charge current. Typical applications include Notebook, tablets, medical equipment, and portable equipment

This EVM does not include the EV2400 interface device and does not provide any electrical isolation for the digital interfaces. EV2400 must be ordered separately to evaluate the BQ24810EVM and electrical safety considerations must be considered when interfacing between the PC and the EVM board. When interfacing the EVM to the PC through the digital interfaces, digital isolators with isolation boundary is recommended.

1.2 Kit Contents

This EVM kit includes:

- 1 BQ24810EVM

1.3 Specification

Table 1-1. Recommended Operating Conditions

Description			MIN	TYP	MAX	UNIT
V _{IN}	Supply voltage	Input voltage from AC adapter input ⁽¹⁾	18	19–20	24	V
V _{BAT}	Battery voltage	Voltage applied at V _{BAT} terminal		0–17.6	19.2	V
I _{AC}	Supply current	Maximum input current from AC adapter input			8	A
I _S	Output current	Output current (SYS and CHG)			8	A
T _J	Operating junction temperature range		0		125	°C

- (1) ACDET bias, R5 and R6, is set for this range. For lower adapter voltages, this divider has to be modified. With the proper bias, V_{IN MIN} can be as low as 4.5VDC. See the data sheet ([SLUSFR7](#)) for more information.

1.4 General Safety Information

The following warnings and cautions are noted for the safety of anyone using or working close to the BQ24810 EVM. Observe all safety precautions.



Warning

The BQ24810EVM circuit module can become hot during operation due to dissipation of heat. Avoid contact with the board. Follow all applicable safety procedures applicable to your laboratory.

CAUTION

Hot surface. Contact can cause burns. Do not touch!



Warning

The BQ24810EVM has smaller clearance and creepage than normally used on high voltage boards as well as not having an isolation boundary. If the user applies high voltage to this board, then all terminals are considered high voltage and hazardous live. Electric shock is possible when connecting the board to live wire. The board needs to be handled with care by a professional. For safety, use of isolated test equipment with various protection features (such as overvoltage and overcurrent) is recommended.



Warning

High voltages that can cause injury exist on this evaluation module (EVM). Please verify all safety procedures are followed when working on this EVM. Never leave a powered EVM unattended.



Warning

High voltage can be present on board capacitors after power down. Properly check and discharge all on-board energy reservoir after EVM power down.



Caution

Do not leave EVM powered when unattended.

CAUTION

The communication interfaces are not isolated on the EVM. The use of digital isolators is recommended. Verify all high voltage safety precautions are observed during testing.

CAUTION

Connections for rated current must be made at the terminal block. Test points are not rated for the board current.

CAUTION

The circuit module can be damaged by over temperature. To avoid damage, monitor the temperature during evaluation and provide cooling, as needed, for your system environment. Do not operate beyond the current and voltage limits

CAUTION

Test equipment can be damaged by application of external voltages. Check your equipment requirements and use blocking diodes or other isolation techniques, as needed, to prevent damage to your equipment.

CAUTION

The circuit module has signal traces, components, and component leads on the bottom of the board. This can result in exposed voltages, hot surfaces or sharp edges. Do not reach under the board during operation.

CAUTION

The default settings of the BQ24810 is possibly not designed for the user's application. Verify the EVM settings are set appropriately for test setup before device power up. Set all protections appropriately and limit current for safe operation.

CAUTION

The board does not have a fuse installed and relies on the external voltage source current limit to verify circuit protection.

1.5 Hardware

1.5.1 IO and Jumper Descriptions

Table 1-2. Connector/Port Description

Jack	Description
J1– SYS	Connect to System
J1– GND	Power ground
J2 – DCIN	Connect to AC adapter positive output
J2 – GND	Connect to AC adapter, negative output
J3 – BAT	Connect to battery positive
J3 - GND	Connect to battery negative
J4 - 1 CMPIN	Independent Comparator Input
J4 - 2 GND	Analog Ground

Table 1-2. Connector/Port Description (continued)

Jack	Description
J4-3 CMPOUT	Independent Comparator Output
J6 - 1 GND	Communication interface
J6 - 2 SCL	
J6 - 3 SDA	
J6 - 4 NC	

Table 1-3. Jumper Description

Jumper	Description	Factory Default
JP1	Use JP1 to connect BQ24810 BATPRES pin to BQ24810 REGN pin	Installed
JP2	Use JP2 to connect BQ24810 VIN/VSYS to TPS70933 VCC pin	Installed

2 Software

2.1 Communication Interface Setup

The charger is controlled by a state machine that uses SMBus registers and the state machine makes decisions based off of the SMBus registers. Software only helps with reading and writing to those registers.

2.1.1 BQSTUDIO using EV2400

Download the latest version of [BQSTUDIOTEST](#). Double click the *Battery Management Studio* installation file and follow the installation steps. The software supports Microsoft® Windows® XP, 7, and 10 operating systems. Launch BQSTUDIO and select *Charger*. If the EVM configuration file for BQSTUDIO does not appear in the Charger, close BQSTUDIO and either download the .BQZ file from the EVM product folder at [www.ti.com](#) or request the file via [e2e.ti.com](#). The file must be saved into C:\XXX\BatteryManagementStudio\config, where XXX is the directory you selected to install BQSTUDIO.

3 BQ24810 EVM Evaluation

Section 3.1 and Section 3.2 explain the equipment and the equipment setup.

3.1 Equipment

- **Power Supplies:**
 - Power Supply #1 (PS#1): a power supply capable of supplying 20V at 5A is required.
 - Power Supply #2 (PS#2): a power supply capable of supplying 20V at 3A is required.
- **Load:**
 - LOAD #1: A 30V (or above), 5A (or above) electronic load that can operate at constant current mode.
 - LOAD #2: An HP 6060B 3–60V/0–60A, 300W system DC electronic load, or equivalent.
- **Meters:** Six Fluke 75 multimeters, (equivalent or better) or: Three equivalent voltage meters and three equivalent current meters.
- **Computer:** A computer with at least one USB port and a USB cable.
- **EV2400 Communication Kit**
- **Software:** For software setup, refer to the Communication Interface Setup.

3.2 Equipment Setup

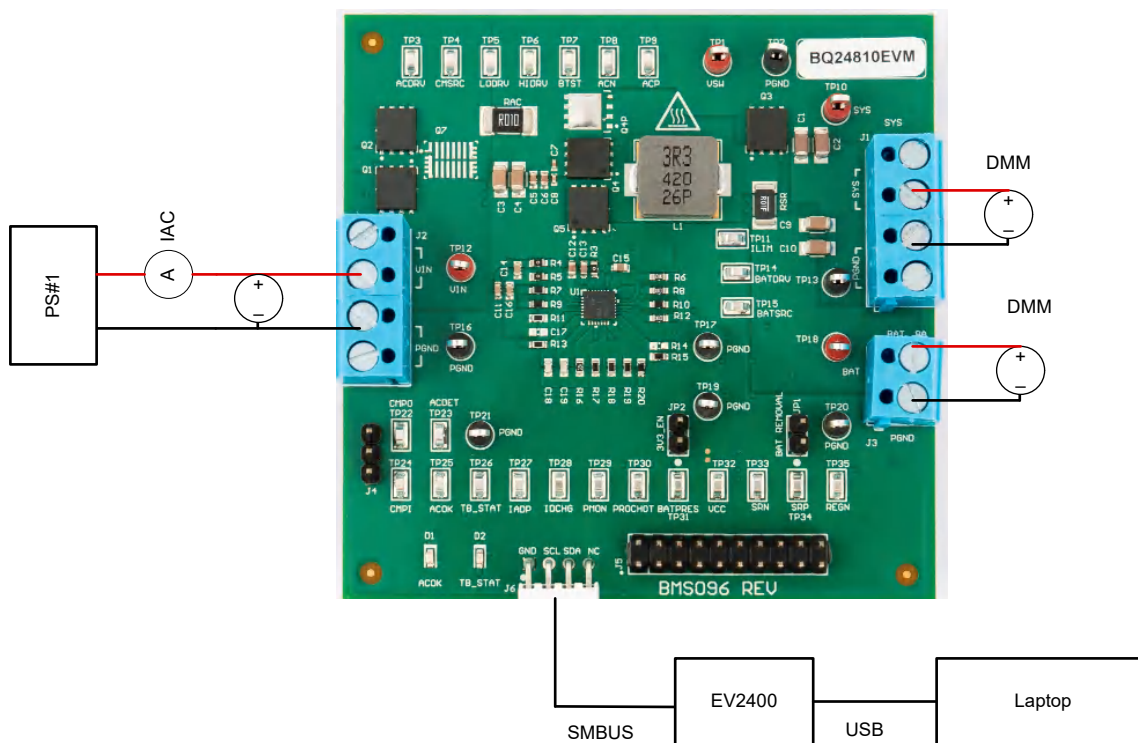
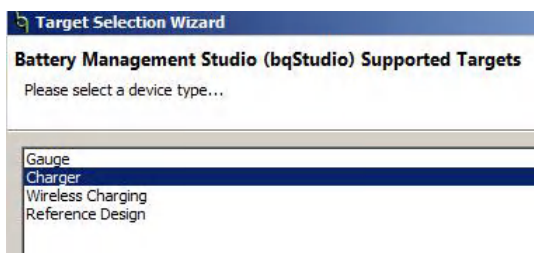


Figure 3-1. Equipment Setup for BQ24810 EVM

Use the following guidelines to set up the equipment:

1. Set power supply #1 (PS#1) for 20V \pm 100mVDC, with the current limit set to > 5A. Turn off supply.
2. Connect PS#1 output in series with a current meter (multimeter) to J2 (VIN, GND)
3. Connect a voltage meter across J2 (VIN, GND)
4. Connect a voltage meter across J3 (BAT, GND)
5. Connect a voltage meter across J1 (SYS, GND)
6. Make sure the jumpers are installed as indicated in IO and Jumper Descriptions.
7. For SMBus Communication, use the following steps:
 - a. Connect J6 to the EV2400. Connect J5 to the SMB PORT 1 on the EV2400
 - b. Turn on the computer and PS#1. Open the bqStudio software.
 - c. Select *Charger* and click the *Next* button.



- Select *Charger_1_00_BQ24810.bqz* on the *Select a Target Page*.
- And then click the *Registers* button.
- After selecting the target device, click the *Read Register* button.
- Set WATCHDOG to disabled.

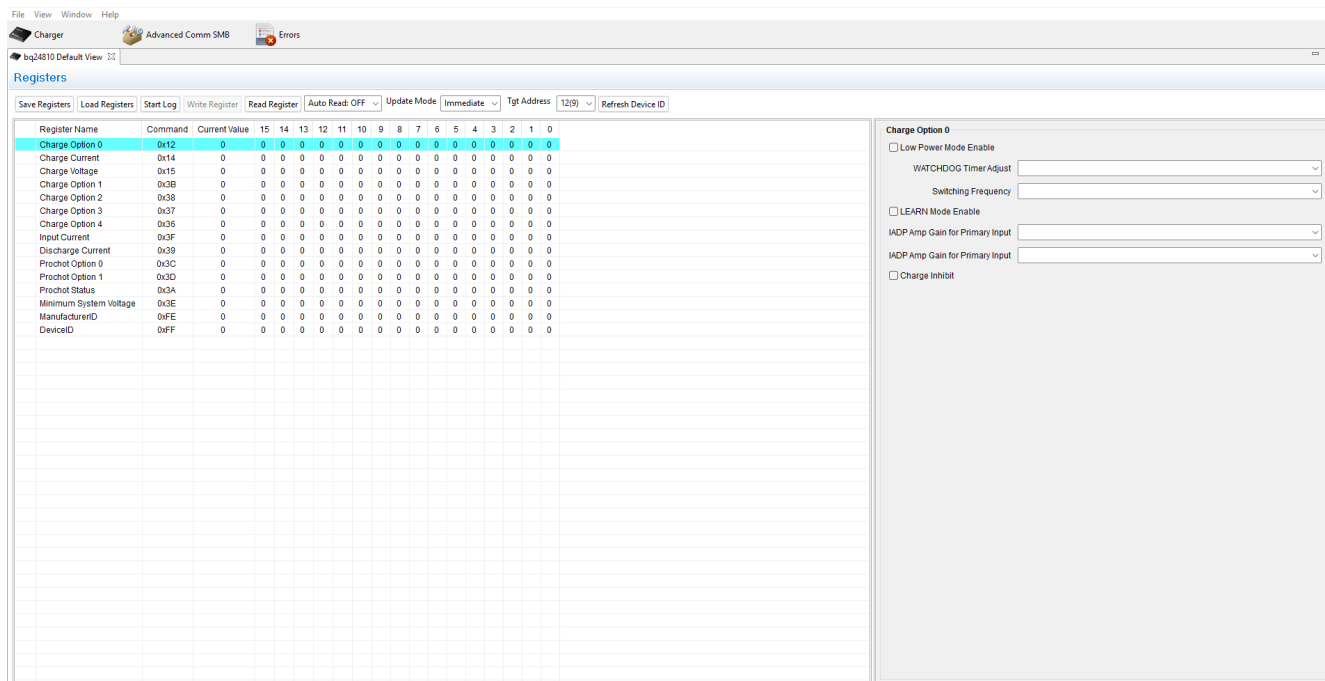


Figure 3-2. Main Window of BQ24810Evaluation Software

3.3 BQ24810 EVM Test Procedure

3.3.1 AC Adapter Detection Threshold

Use the following steps for AC adapter detection threshold:

1. Make sure that the [Equipment Setup](#) steps are followed.
2. Turn on PS#1

Load #1 and Load #2 are not connected during this step.

3. Increase the output voltage of PS#1 to 20.0V
 - a. Measure $\rightarrow V[TP23(VCC)] = 19.6V \pm 0.5V$
 - b. Measure $\rightarrow V[TP12(ACDET)] = 2.7V \pm 0.1V$
 - c. Measure $\rightarrow V[TP13(ACOK)] = 3.3V \pm 0.1V$
 - d. Measure $\rightarrow V[TP3(SYS)] = 20.0V \pm 0.5V$
 - e. Measure $\rightarrow V[TP22(REGN)] = 6V \pm 0.6V$
 - f. Measure $\rightarrow V[TP20(ILIM)] = 0.79V \pm 0.1V$

3.3.2 Charger Parameter Settings

In the main software window, click the *Refresh* button on the top right corner. Make sure there is no error information.

1. Type "512" (mA) in *ChargeCurrent* Register and click *OK*. This sets the battery charge current regulation threshold.
2. Type "12592" (mV) in *ChargeVoltage* Register and click *OK*. This sets the battery voltage regulation threshold.
3. Measure $\rightarrow V[TP5(BAT)] = 12.6V \pm 200mV$

3.3.3 Charge Current and AC Current Regulation (DPM)

1. Connect Load #2 in series with a current meter (multimeter) to J3 (BAT, GND). Make sure a voltage meter is connected across J2 (BAT, GND). Turn on Load #2. Use the constant voltage mode. Set output voltage to 10.5V.
2. Connect the output of Load #1 in series with a current meter (multimeter) to J1 (SYS, GND). Make sure a voltage meter is connected across J1 (SYS, GND). Turn on the power of Load #1.
3. Type "2944" (mA) in *ChargeCurrent* Register and click *OK*.
This sets the battery charge current regulation threshold to 2.944A.
 - Measure $\rightarrow IBAT = 3000mA \pm 300mA$
 - Measure $\rightarrow V[TP14(IIADP)] = 340mV \pm 40mV$
4. Set Load #1 current to 3.0A $\pm 50mA$ but disable the output. Make sure $ISYS = 0A \pm 10mA$. Enable the output of Load #1.
 - Measure $\rightarrow ISYS = 3000mA \pm 300mA$
 - Measure $\rightarrow IBAT = 1800mA \pm 300mA$
 - Measure $\rightarrow IIN = 4100mA \pm 400mA$
 - Measure $\rightarrow V[TP14(IADP)] = 820mV \pm 100mV$
5. Turn off the Load #1.
 - Measure $\rightarrow ISYS = 0 \pm 100mA$
 - $IBAT = 3000mA \pm 300mA$

3.3.4 Hybrid Boost Mode

Use the following steps for hybrid boost mode:

1. Enter "1A44" in *ChargeOption3* value to enable the hybrid boost function
2. Change Load #2 with PS#2. Make sure a voltage meter is connected across J2 (BAT, GND).
3. Enable the output of PS#2. Make sure the output voltage is 10V $\pm 500mV$ and 3A current limit.

4. Set Load #1 load current to 5.0A \pm 50mA. Enter boost mode.
 - Measure \rightarrow ISYS = 5000mA \pm 500mA
 - Measure \rightarrow IBAT = -2000mA \pm 600mA
 - Measure \rightarrow IIN = 4100mA \pm 400mA
 - Measure \rightarrow V[TP15(IIDCHG)] = 270mV \pm 100mV
5. Set Load #1 load current to 0.5A \pm 50mA. Exit boost mode. Back to charging mode.
 - Measure \rightarrow ISYS = 500mA \pm 50mA
 - Measure \rightarrow IBAT = 3000mA \pm 300mA
 - Measure \rightarrow IIN = 2100mA \pm 400mA

3.3.5 Battery-only Boost Mode

The setup for battery-only boost selection follows:

1. Disconnect PS#1 from J2 (VIN,GND)
2. Enter "00C0" in *ChargeOption2* value to enable the battery-only boost function
3. Enter "0108" in *ChargeOption0* value to disable low power mode and disable the watchdog timer.
4. Enter "2800" in *MinSysVoltage* value to set the entry threshold for battery boost to 10.24V.
5. Reduce the voltage of PS#2 to 9.0V to enter battery-only boost mode
 - Measure \rightarrow V[TP3(VBATT)] = 9.0V \pm 300mV
 - Measure \rightarrow V[TP2(VSYS)] = 12.0V \pm 600mV

3.3.6 Power Path Selection

The setup for power path selection follows:

1. Change Load #2 with PS#2. Make sure a voltage meter is connected across J3 (BAT, GND)
2. Enable the output of PS#2. Ensure the output voltage is 10V \pm 500mV and 3A current limit.
3. Set Load #1 load current to 0.5A \pm 50mA
4. Enter "E109" in *ChargeOption0*, this disables charging
5. Make sure a voltage meter is connected across J2 (BAT, GND)
 - Measure \rightarrow V[TP3(SYS)] = 19.5V \pm 1V (adapter connected to system)
6. Turn off PS#1
 - Measure \rightarrow V[TP5(BAT)] = 10V \pm 1V
 - Measure \rightarrow V[TP3(SYS)] = 10V \pm 1V (battery connected to system)

4 Hardware Design Files

4.1 Schematic

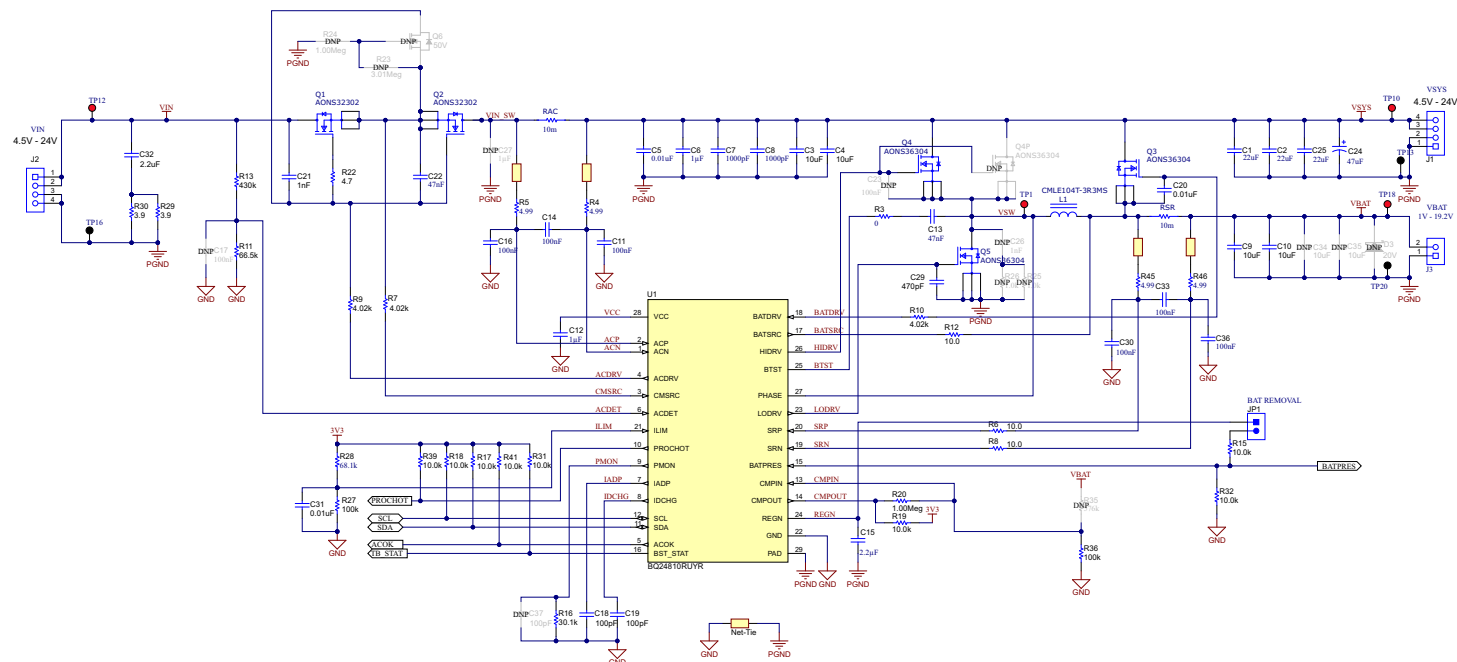
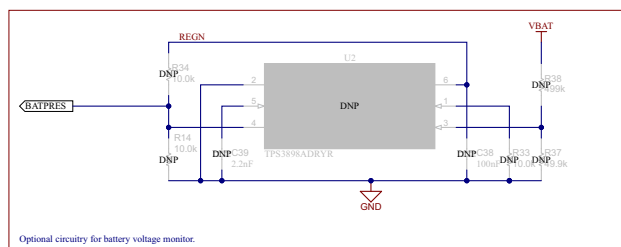


Figure 4-1. BQ24810EVM Schematic



4.2 BQ24810EVM PCB Layouts

Figure 4-2 through Figure 4-7 show the PCB layouts for the BQ24810EVM.

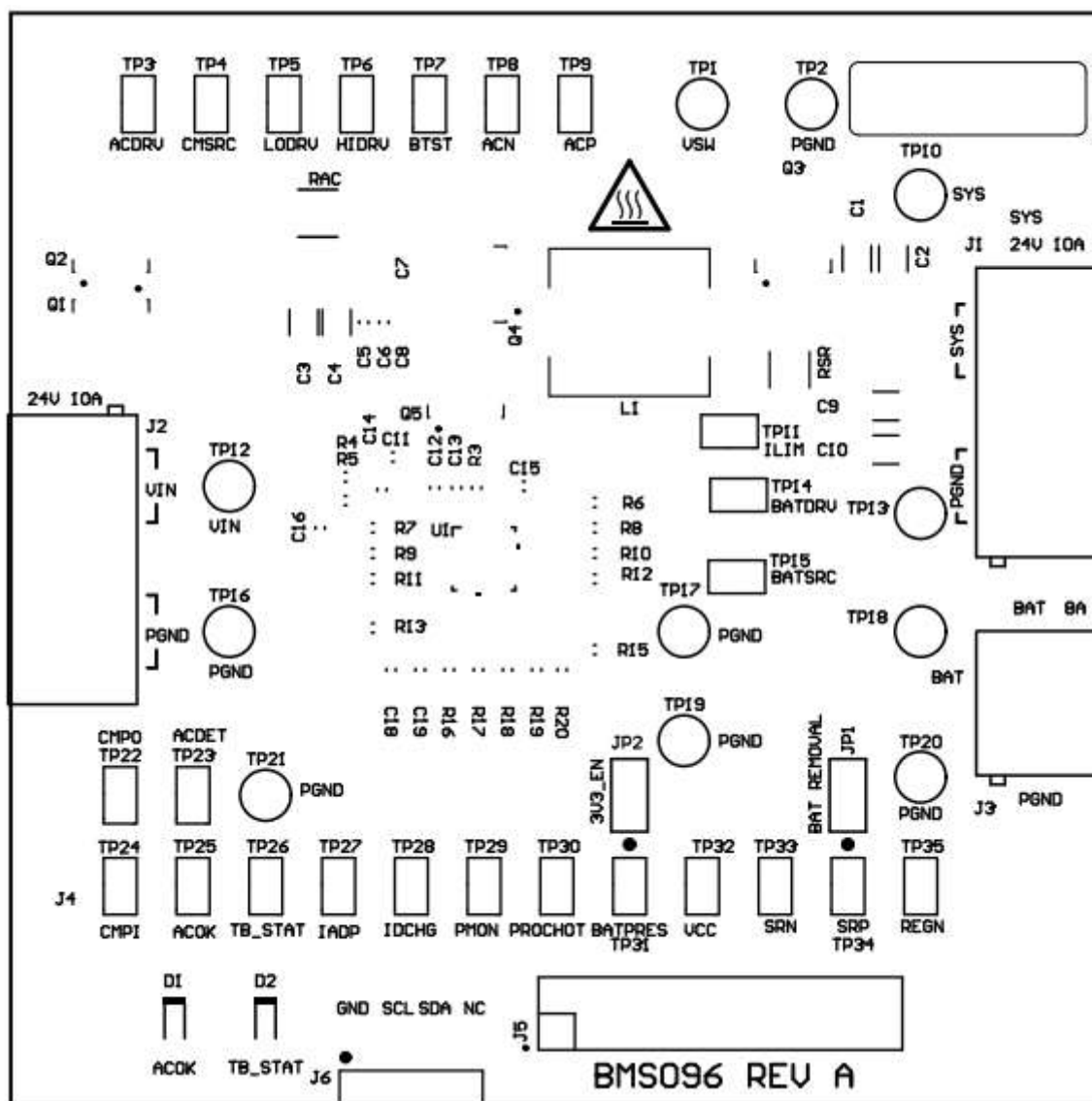


Figure 4-2. Top Assembly

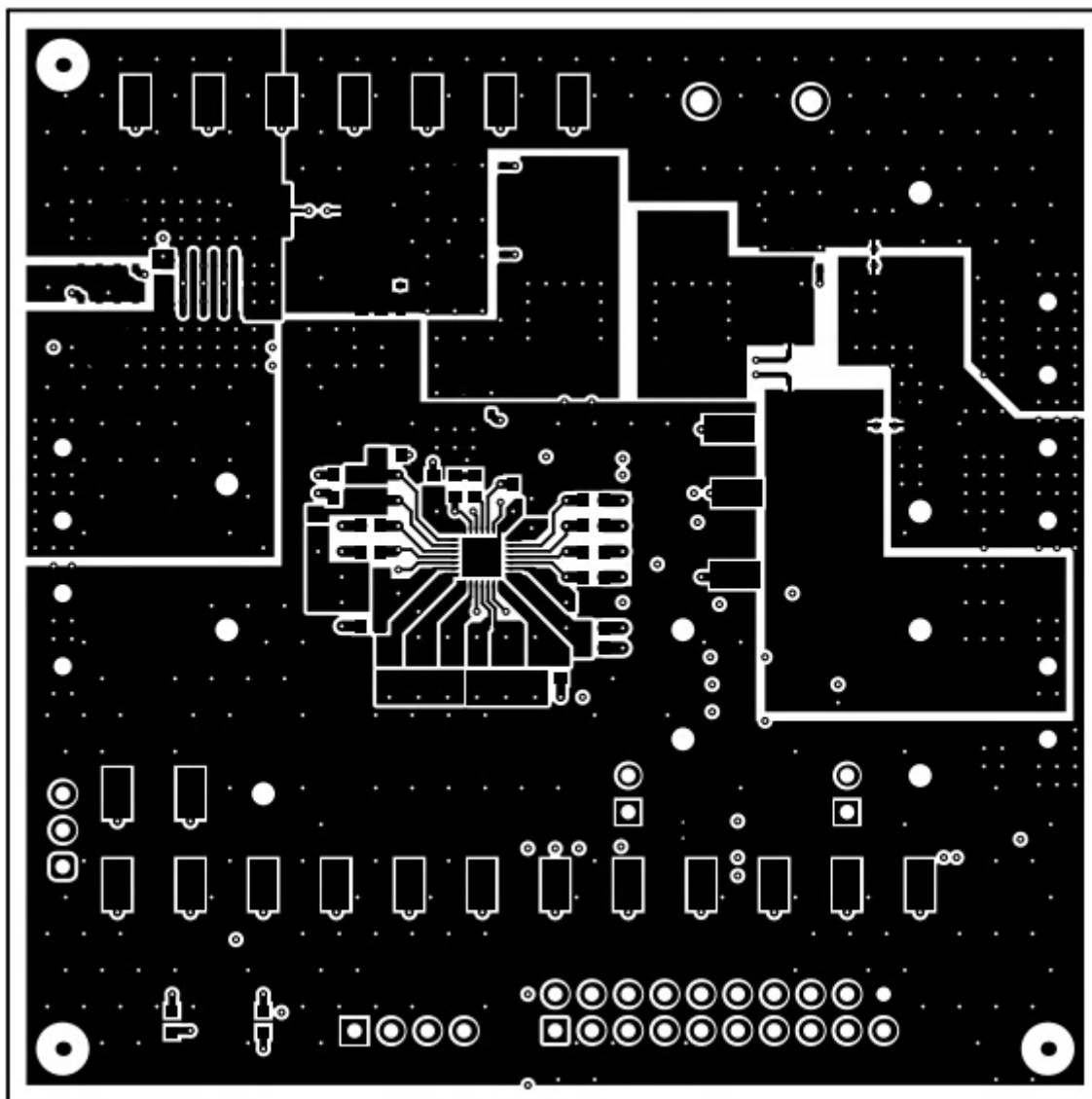


Figure 4-3. Top Layer

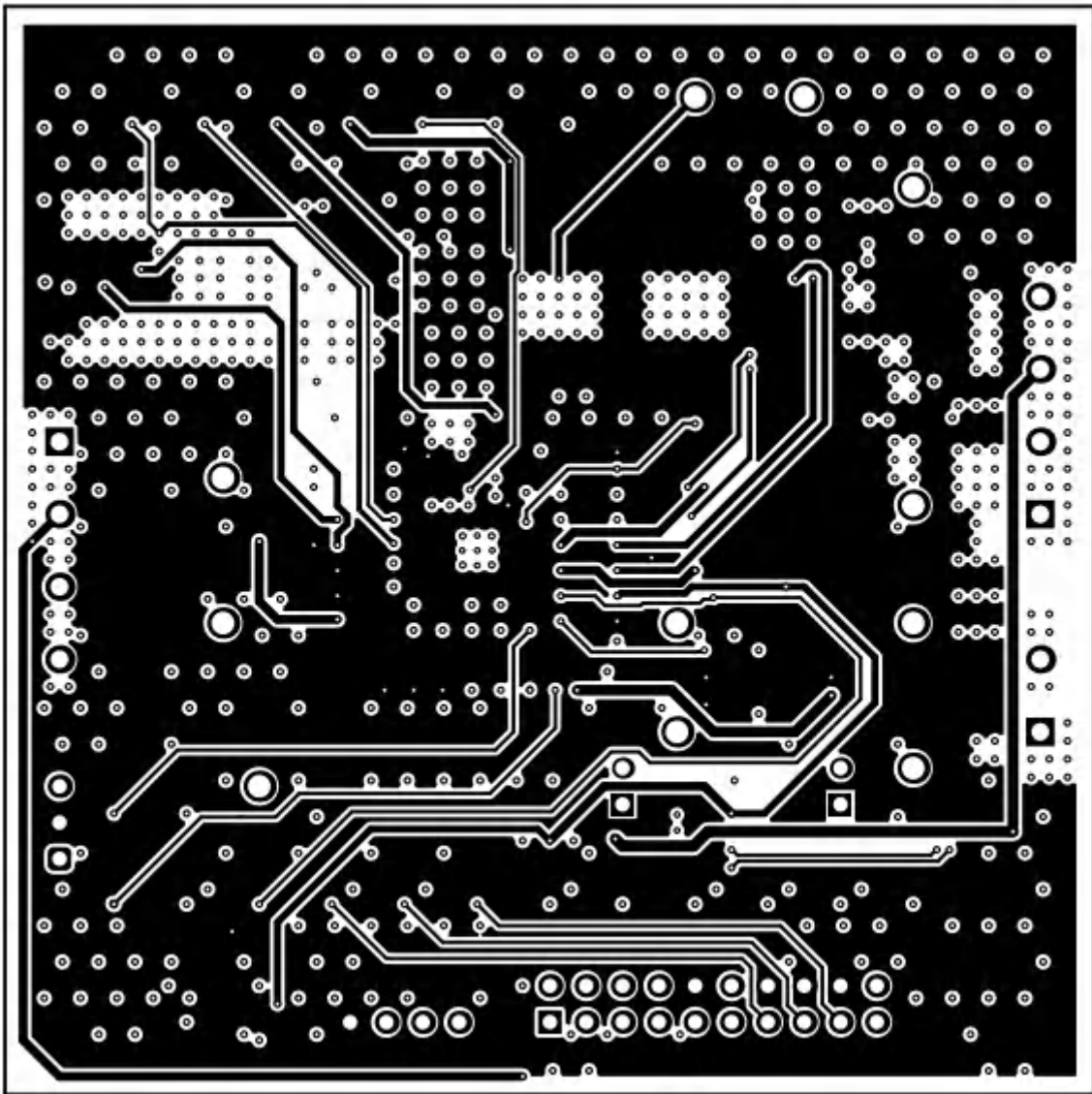


Figure 4-4. Mid-Layer 1

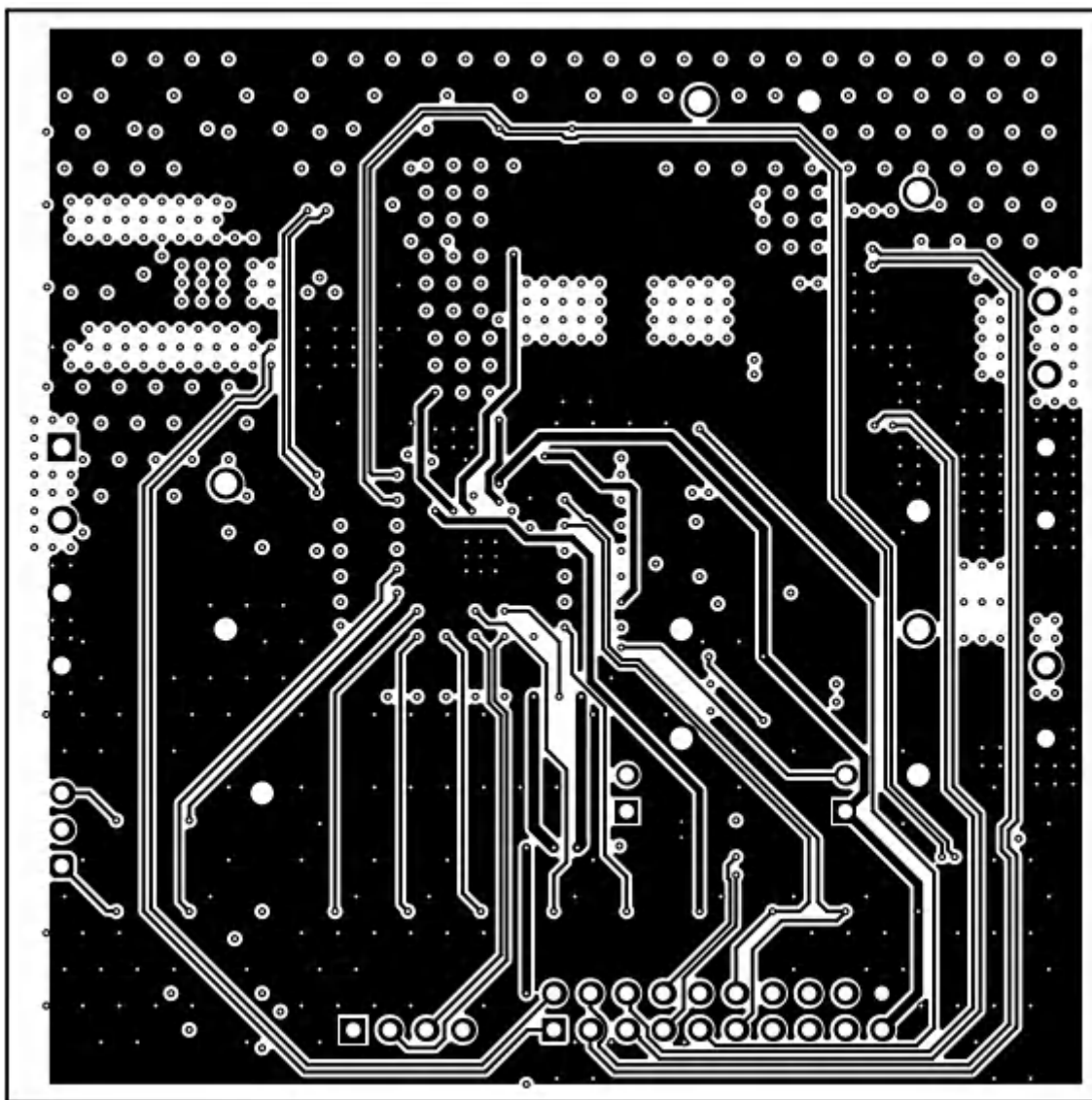


Figure 4-5. Mid-Layer 2

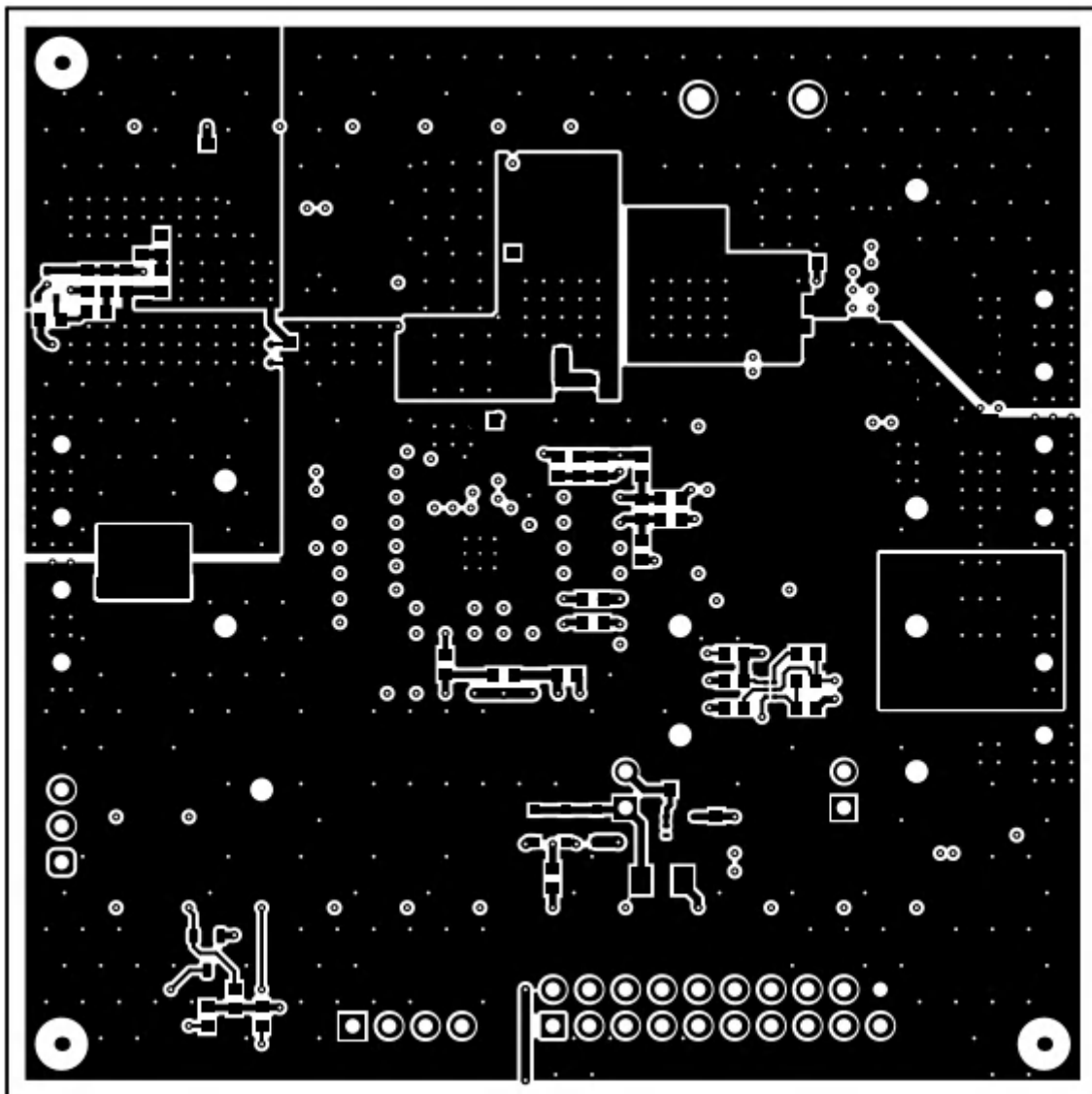


Figure 4-6. Bottom Layer

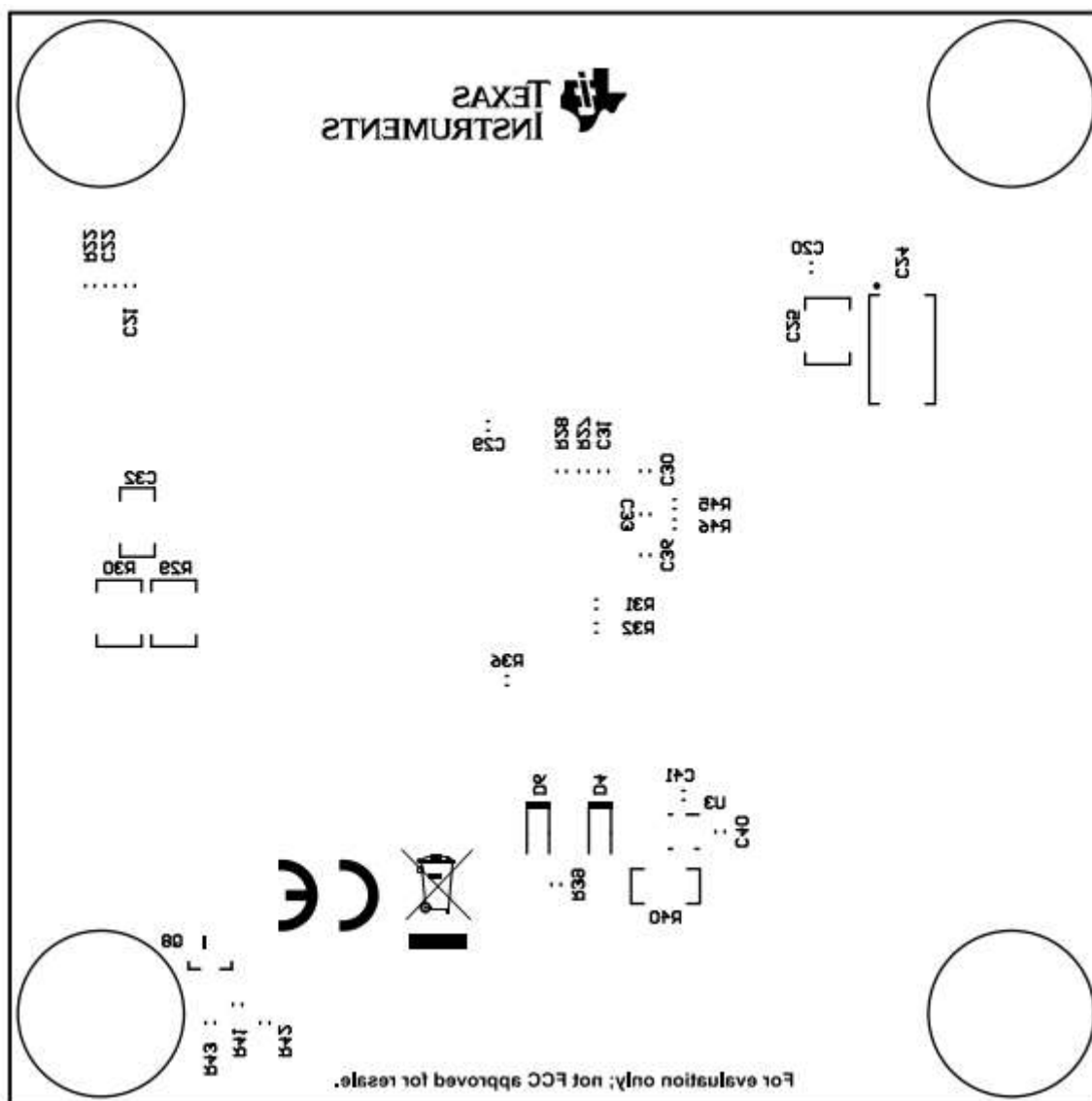


Figure 4-7. Bottom Assembly

4.3 Bill of Materials

Table 4-1. BQ24810EVM Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
PCB1	1		Printed Circuit Board		BMS096	Any
C1	1	0.01μF	CAP, CERM, 0.01μF, 25V, ±5%, C0G/NP0, 0603	0603	C0603H103J3GACTU	Kemet
C2	1	1000pF	CAP, CERM, 1000pF, 25V, ±10%, X7R, 0402	0402	885012205044	Wurth Elektronik
C3	1	47μF	CAP, TA, 47μF, 25V, ±10%, 0.125Ω, SMD	7343-31	TPSD476K025R0125	AVX
C4, C5	2	22μF	CAP, CERM, 22μF, 25V, ±20%, X5R, 1206_190	1206_190	C3216X5R1E226M160AB	TDK
C6, C20	2	1μF	CAP, CERM, 1μF, 25V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603	GCM188R71E105KA64D	MuRata
C7, C8, C22, C23	4	10μF	CAP, CERM, 10μF, 25V, ±10%, X7R, 1206_190	1206_190	TMK316B7106KL-TD	Taiyo Yuden
C9	1	22μF	CAP, CERM, 22μF, 25V, ±10%, X5R, 1210	1210	CL32A226KAJNNNE	Samsung Electro-Mechanics
C10	1	2.2μF	CAP, CERM, 2.2μF, 25V, ±10%, X5R, 1206	1206	12063D225KAT2A	AVX
C11, C16, C19, C26, C28, C29	6	0.1μF	CAP, CERM, 0.1μF, 25V, ±5%, X7R, 0603	0603	C0603C104J3RACTU	Kemet
C12, C31	2	0.01μF	CAP, CERM, 0.01μF, 50V, ±10%, X7R, 0603	0603	C0603X103K5RACTU	Kemet
C14	1	1000pF	CAP, CERM, 1000pF, 50V, ±10%, X7R, 0603	0603	CL10B102KB8NNNC	Samsung Electro-Mechanics
C15, C17	2	0.047μF	CAP, CERM, 0.047μF, 50V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E2X7R1H473K080AA	TDK
C27	1	470pF	CAP, CERM, 470pF, 50V, ±10%, X7R, 0603	0603	C0603C471K5RACTU	Kemet
C32	1	2.2μF	CAP, CERM, 2.2μF, 16V, ±10%, X7R, 0603	0603	EMK107BB7225KA-T	Taiyo Yuden
C33	1	2200pF	CAP, CERM, 2200pF, 50V, ±10%, X7R, 0805	0805	08055C222KAT2A	AVX
C34	1	0.1μF	CAP, CERM, 0.1μF, 25V, ±10%, X7R, 0603	0603	C0603C104K3RACTU	Kemet
C35	1	1μF	CAP, CERM, 1μF, 35V, ±20%, X5R, 0402	0402	GRM155R6YA105ME11D	MuRata
C36	1	2.2μF	CAP, CERM, 2.2μF, 10V, ±20%, X5R, 0402	0402	885012105013	Wurth Elektronik
C37, C39	2	100pF	CAP, CERM, 100pF, 50V, ±5%, C0G/NP0, 0603	0603	GRM1885C1H101JA01D	MuRata
D4, D5	2	30V	Diode, Schottky, 30V, 0.2 A, SOD-323	SOD-323	BAT54HT1G	ON Semiconductor
D7, D8, D9, D10	4	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
H2, H3, H4	3		Machine Screw, Round, #4-40 x 1/4, Nylon, Phillips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2, J3	3		Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J4	1		Terminal Block, 3.5mm Pitch, 3x1, TH	10.5x8.2x6.5mm	ED555/3DS	On-Shore Technology
J5	1		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	22/05/3041	Molex
JP1, JP2, JP3, JP4, JP5	5		Header, 100mil, 2x1, Gold, TH	Header, 2x1, 100mil	5-146261-1	TE Connectivity
L1	1	3.3μH	Inductor, Shielded, Powdered Iron, 3.3μH, 9.2A, 0.0177Ω, SMD	322x158x322mil	IHLP3232DZER3R3M01	Vishay-Dale
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
Q1	1	50V	MOSFET, N-CH, 50V, 0.2A, SOT-323	SOT-323	BSS138W-7-F	Diodes Inc.
Q2, Q3, Q4, Q5, Q6	5	30V	MOSFET, N-CH, 30V, 47A, DQG0008A (VSON-CLIP-8)	DQG0008A	CSD17308Q3	Texas Instruments
Q7	1	60V	MOSFET, N-CH, 60V, 0.26A, SOT-23	SOT-23	2N7002ET1G	ON Semiconductor
R1, R33	2	1.00Meg	RES, 1.00 M, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031M00FKEA	Vishay-Dale
R2	1	3.01Meg	RES, 3.01 M, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06033M01FKEA	Vishay-Dale
R3, R9	2	0.01	RES, 0.01, 1%, 1W, 1206	1206	WSLP1206R0100FEA	Vishay-Dale
R4	1	430k	RES, 430 k, 1%, 0.1W, 0603	0603	RC0603FR-07430KL	Yageo
R5	1	4.7	RES, 4.7, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06034R70JNEA	Vishay-Dale
R6, R7	2	3.9	RES, 3.9, 5%, 0.5W, 1210	1210	ERJ-14YJ3R9U	Panasonic
R8	1	6.8	RES, 6.8, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06036R80JNEA	Vishay-Dale
R10	1	66.5k	RES, 66.5 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060366K5FKEA	Vishay-Dale
R12, R15	2	0	RES, 0, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R13, R14, R16	3	4.02k	RES, 4.02 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06034K02FKEA	Vishay-Dale
R17, R20, R21	3	10.0	RES, 10.0, 1%, 0.1W, 0603	0603	RC0603FR-0710RL	Yageo
R19	1	10.0	RES, 10.0, 1%, 0.25W, AEC-Q200 Grade 0, 1206	1206	ERJ-8ENF10R0V	Panasonic

Table 4-1. BQ24810EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R22	1	316k	RES, 316 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW0603316KFKEA	Vishay-Dale
R23, R24, R25, R26, R27, R30, R32, R34, R35	9	10.0k	RES, 10.0 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R28	1	499k	RES, 499 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW0603499KFKEA	Vishay-Dale
R29	1	140k	RES, 140 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW0603140KFKEA	Vishay-Dale
R31, R37	2	100k	RES, 100 k, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KJNEA	Vishay-Dale
R36	1	49.9k	RES, 49.9 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060349K9FKEA	Vishay-Dale
R38	1	30.1k	RES, 30.1 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060330K1FKEA	Vishay-Dale
R39, R40, R41, R42	4	2.00k	RES, 2.00 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06032K00FKEA	Vishay-Dale
TP1, TP3, TP5	3		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP2, TP4, TP6	3		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone
C1, C2	2	22uF	CAP, CERM, 22µF, 25V, ±20%, X5R, 1206_190	1206_190	C3216X5R1E226M160AB	TDK
C3, C4, C9, C10	4	10uF	CAP, CERM, 10µF, 25V, ±10%, X7R, 1206_190	1206_190	TMK316B7106KL-TD	Taiyo Yuden
C5, C20, C31	3	0.01uF	CAP, CERM, 0.01µF, 50V, ±10%, X7R, 0603	0603	C0603X103K5RACTU	Kemet
C6, C12, C41	3	1uF	CAP, CERM, 1µF, 35V, ±10%, X7R, AEC-Q200 Grade 0, 0603	0603	GMK107AB7105KAHT	Taiyo Yuden
C7, C8	2	1000pF	CAP, CERM, 1000pF, 50V, ±10%, X7R, 0402	0402	GRM155R71H102KA01D	MuRata
C11, C14, C16, C30, C33, C36	6	0.1uF	CAP, CERM, 0.1µF, 25V, ±10%, X7R, 0603	0603	C0603C104K3RACTU	Kemet
C13, C22	2	0.047uF	CAP, CERM, 0.047µF, 50V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E2X7R1H473K080AA	TDK
C15, C40	2	2.2uF	CAP, CERM, 2.2µF, 16V, ±10%, X7R, 0603	0603	EMK107BB7225KA-T	Taiyo Yuden
C18, C19	2	100pF	CAP, CERM, 100pF, 50V, ±5%, C0G/NP0, 0603	0603	GRM1885C1H101JA01D	MuRata
C21	1	1000pF	CAP, CERM, 1000pF, 50V, ±10%, X7R, 0603	0603	CL10B102KB8NNNC	Samsung Electro-Mechanics
C24	1	47uF	CAP, TA, 47µF, 25V, ±10%, 0.125Ω, SMD	7343-31	TPSD476K025R0125	AVX
C25	1	22uF	CAP, CERM, 22µF, 25V, ±10%, X5R, 1210	1210	CL32A226KAJNNNE	Samsung Electro-Mechanics
C29	1	470pF	CAP, CERM, 470pF, 50V, ±10%, X7R, 0603	0603	C0603C471K5RACTU	Kemet
C32	1	2.2uF	CAP, CERM, 2.2µF, 25V, ±10%, X5R, 1206	1206	12063D225KAT2A	AVX
D1	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
D2	1	Red	LED, Red, SMD	Red LED, 1.6x0.8x0.8mm	LTST-C190KRKT	Lite-On
D4, D6	2	30V	Diode, Schottky, 30V, 0.2 A, SOD-323	SOD-323	BAT54HT1G	ON Semiconductor
H1, H2, H3, H4	4		Bump, Hemisphere, 0.44 X 0.20, Clear	Transparent Bump	SJ-5303 (CLEAR)	3M
J1, J2	2		Terminal Block, 5.08mm, 4x1, Brass, TH	4x1 5.08 mm Terminal Block	ED120/4DS	On-Shore Technology
J3	1		Terminal Block, 5.08mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J4	1		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J5	1		Header, 100mil, 10x2, Gold, TH	10x2 Header	TSW-110-07-G-D	Samtec
J6	1		Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header	0022053041	Molex
JP1, JP2	2		Header, 100mil, 2x1, Gold, TH	Header, 2x1, 100mil	5-146261-1	TE Connectivity
L1	1		Fixed Inductor 3.3uH 20% 100kHz 13A 10mΩ	SMT_IND_10MM85_10MMO	CMLE104T-3R3MS	Cyntec
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
Q1, Q2	2		MOSFET N-ch 30V 1.9mΩ 8-PIN DFN EP T/R	DFN5x6-8	AONS32302	Alpha & Omega Semiconductor
Q3, Q4, Q5	3		MOSFET N-ch 30V 3.5mΩ 8-PIN DFN EP T/R	DFN5x6-8	AONS36304	Alpha & Omega Semiconductor
Q8	1	60V	MOSFET, N-CH, 60V, 0.26A, SOT-23	SOT-23	2N7002ET1G	ON Semiconductor
R3	1	0	RES, 0, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060300000Z0EA	Vishay-Dale
R4, R5, R45, R46	4	4.99	RES, 4.99, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06034R99FKEA	Vishay-Dale
R6, R8, R12	3	10.0	RES, 10.0, 1%, 0.1W, 0603	0603	RC0603FR-0710RL	Yageo

Table 4-1. BQ24810EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R7, R9, R10	3	4.02k	RES, 4.02 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06034K02FKEA	Vishay-Dale
R11	1	66.5k	RES, 66.5 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060366K5FKEA	Vishay-Dale
R13	1	430k	RES, 430 k, 1%, 0.1W, 0603	0603	RC0603FR-07430KL	Yageo
R15, R17, R18, R19, R31, R32, R39, R41	8	10.0k	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R16	1	30.1k	RES, 30.1 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060330K1FKEA	Vishay-Dale
R20	1	1.00Meg	RES, 1.00 M, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06031M00FKEA	Vishay-Dale
R22	1	4.7	RES, 4.7, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06034R70JNEA	Vishay-Dale
R27, R36	2	100k	RES, 100 k, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KJNEA	Vishay-Dale
R28	1	68.1k	RES, 68.1 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060368K1FKEA	Vishay-Dale
R29, R30	2	3.9	RES, 3.9, 5%, 0.5W, 1210	1210	ERJ-14YJ3R9U	Panasonic
R40	1	10.0	RES, 10.0, 1%, 0.25W, AEC-Q200 Grade 0, 1206	1206	ERJ-8ENF10R0V	Panasonic
R42, R43	2	2.00k	RES, 2.00 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06032K00FKEA	Vishay-Dale
RAC	1		10 mΩ ±0.5% 2W Chip Resistor 2512 (6432 Metric) Automotive AEC-Q200, Current Sense, Moisture Resistant Metal Film	2512	PCS2512DR0100ET	Ohmite
RSR	1	10m	10 mΩ ±1% 2W Chip Resistor 2010 (5025 Metric) Anti-Sulfur, Automotive AEC-Q200, Current Sense, Moisture Resistant, Pulse Withstanding Metal Element	2010	WSP2010R0100FEA	Vishay
TP1, TP10, TP12, TP18	4		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone Electronics
TP2, TP13, TP16, TP17, TP19, TP20, TP21	7		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone Electronics
TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP11, TP14, TP15, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP35	24		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone Electronics
U1	1		1- to 4-Cell Hybrid Power Boost Mode Battery Charge Controller With Battery Only Boost Mode and Power Monitoring, RUY0028A (WQFN-28)	RUY0028A	BQ24810RUYR	Texas Instruments
U3	1		150mA, 30V, Ultra-Low IQ, Wide Input Low-Dropout Regulator with Reverse Current Protection, DRV0006A (WSO6-6)	DRV0006A	TPS70933DRVR	Texas Instruments

5 Additional Information

5.1 Trademarks

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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 DEGRADATION 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/sds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

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

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

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

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

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

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
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東京都新宿区西新宿 6 丁目 2 4 番 1 号
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_02.page

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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.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS 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, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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.

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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.

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