EVM User's Guide: BQ25758EVM

BQ25758 Evaluation Module

Description

The BQ25758EVM evaluation module (EVM) is a complete evaluation system for the BQ25758 IC, a buck-boost controller with a wide input range of 4.2V to 60V, a wide output voltage range of up to 60V, and bi-directional capabilities.

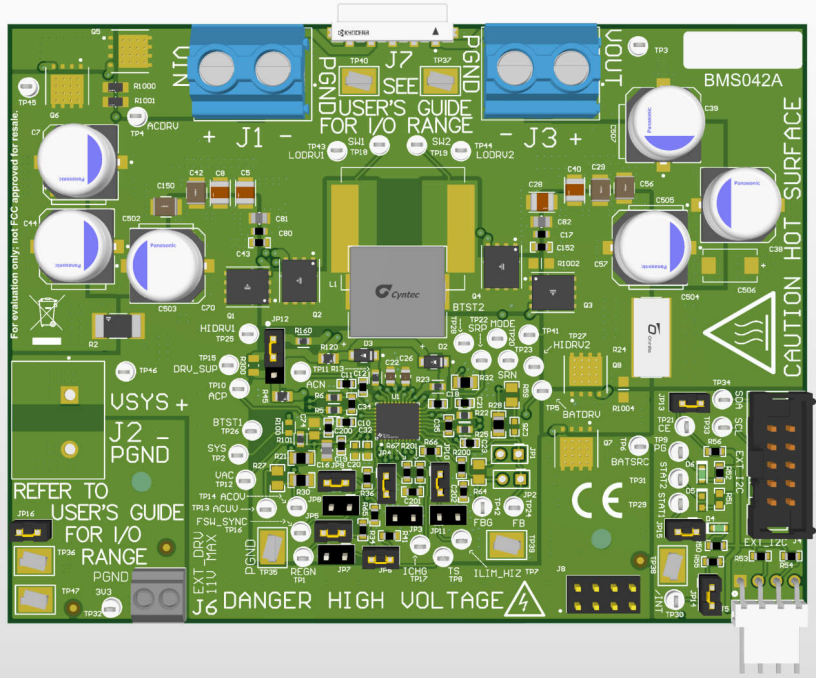
The BQ25758EVM has a max input and output of 55V and a max output current of 10A.

Get Started

1. Order the EVM on ti.com
2. Order the EV2400 to communicate with the EVM
3. Download the BQ25758 BQZ file
4. Download the BQ25758 EVM design files on ti.com

Features

- Wide input voltage operating range: 4.2V to 55V
- Wide output operating range: up to 55V
- Synchronous buck-boost DC/DC controller with NFET drivers
  - Adjustable switching frequency from 200kHz to 600kHz
  - Optional synchronization to external clock
  - Optional gate driver supply input for optimized efficiency
- I^2C-controlled for optimal system performance with resistor-programmable option
- Power up from battery (reverse mode) output 4V to 55V
- High safety integration
  - Adjustable input overvoltage and undervoltage protection
  - Output overvoltage and overcurrent protection



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1 Evaluation Module Overview

1.1 Introduction

The BQ25758EVM can be evaluated for the full 240 W range of USB Extended Power Range (EPR) in forward and reverse power direction. Typical applications include USB-PD extended power range applications, docking stations, monitors, and Portable Power Supplies.

This EVM does not include the EV2400 or USB2ANY interface device and does not provide any electrical isolation for the digital interfaces. EV2400 or USB2ANY must be ordered separately to evaluate the BQ25758EVM 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.

The BQ25758EVM has smaller clearance and creepage than normally used on high voltage boards as well as not having an isolation boundary. If you apply high voltage to this board, all terminals must be considered high voltage and hazardous live. Electric shock is possible when connecting the board to live wire. The board must 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.

1.2 Kit Contents

This EVM kit includes:

- 1 BQ25758 EVM

1.3 Device Information

The BQ25758EVM evaluation module (EVM) is an evaluation system for the BQ25758 IC. The BQ25758 IC is a buck-boost controller with a wide input range of 4.2 V to 60 V, a wide output voltage range of up to 60 V, and bi-directional capabilities.

The device offers high-efficiency DC/DC conversion over a wide voltage range. The device integrates all the loop compensation for the buck-boost converter, thereby providing a high density method with ease of use.

Besides the I^2C host-controlled mode, the device also supports programmable hardware limits. Input current, and output current regulation targets can be set with single resistor on the IIN, and IOUT pins, respectively.

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1.4 General Texas Instruments High Voltage Evaluation (TI HV EMV) User Safety Guidelines

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help verify your personal safety and those working around you. Contact TI's Product Information Center http://ti.com/customer support for further information.

Save all warnings and instructions for future reference.

> **WARNING**
> Failure to follow warnings and instructions can result in personal injury, property damage or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is *intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments.* If you are not suitably qualified, then you need to immediately stop from further use of the HV EVM.

1. Work Area Safety:
   a. Keep work area clean and orderly.
   b. Qualified observers must be present anytime circuits are energized.
   c. Effective barriers and signage must be present in the area where the TI HV EVM and the interface electronics are energized, indicating operation of accessible high voltages can be present, for the purpose of protecting inadvertent access.
   d. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes, and other related apparatus used in a development environment exceeding 50Vrms/75VDC must be electrically located within a protected Emergency Power Off EPO protected power strip.
   e. Use stable and non-conductive work surface.
   f. Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
2. Electrical Safety:
   a. As a precautionary measure, a good engineering practice to assume is that the entire EVM can have fully accessible and active high voltages.
   b. De-energize the TI HV EVM and all the inputs, outputs and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   c. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   d. Once EVM readiness is complete, energize the EVM as intended.

   > **WARNING**
   > While the EVM is energized, never touch the EVM or the electrical circuits, as the electrical circuits and EVM can be at high voltages capable of causing electrical shock hazard.
3. Personal Safety
   a. Wear personal protective equipment e.g. latex gloves or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.

Limitation for safe use:

EVMs are not to be used as all or part of a production unit.

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1.4.1 General Safety Information

The following warnings and cautions are noted for the safety of anyone using or working close to the BQ25758 EVM. Observe all safety precautions.

 **Warning. Caution**	The BQ25758EVM 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 BQ25758EVM 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 in the Section 2.3.

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.

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CAUTION

The default settings of the BQ25758 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 has no fuse installed and relies on the external voltage source current limit to verify circuit protection.

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2 Hardware

2.1 Board Parameters

Table 2-1. Default Board Setup for BQ25758EVM

	Description	Value	Unit
ACUV	Input undervoltage	4.2	V
ACOV	Input overvoltage	55	V
IIN	Input current of the EVM	8	A
IOUT	Output current of the EVM	10	A
FSW_SYNC	Switching frequency of the power stage	450	kHz
VOUT	Output Voltage	5	V
IAC Sense Resistor	Input current sense resistor	5	mΩ

Table 2-2. PCB and Mechanical Parameters

	Value	Unit
Board size (X dimension, or length)	112	mm
Board size (Y dimension, or width)	84	mm
IC + power stage max height	5	mm
Total copper layers	6	layer
Copper weight per layer	2	oz
Total board thickness	62	mil

2.2 IO and Jumper Descriptions

Table 2-3. Connector/Port Description

Jack	Description
J1-VIN	Input: positive terminal
J1-PGND	Input: negative terminal (ground terminal)
J3-VOUT	Connected to load output
J3-PGND	Ground
J4-EXT_I2C	Communication port for the USB2ANY
J5-I2C	Communication port for the EV2400
J6-EXT_DRV	Connection for external gate drive
J7-Power Connector	Connection for VAC and BAT
J8-Communication Port	Connection for EXT_DRV, /INT, I2C, /PG, and 3.3 V

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Table 2-4. Jumper Description

Jumper	Description	Factory Default
JP3	Use JP3 to connect external IOUT resistor. JP3 can be shorted to PGND to disable hardware output current limiting.	Not installed
JP4	Shunt JP4 to use default IOUT resistor. By closing JP4, the default IOUT current is set to 10 A.	Installed
JP5	Shunt JP5 to bias TS.	Installed
JP6	With JP5 shunted (REGN connected for voltage divider). Shunt JP6 to set TS status to normal.	Installed
JP7	With JP5 shunted (REGN connected for voltage divider). Use JP7 to connect external resistor to change TS status.	Not installed
JP8	Use JP8 to connect external FSW_SYNC resistor.	Not installed
JP9	Shunt JP9 to use default FSW_SYNC resistor. By closing JP9, the default switching frequency is set to 250 kHz.	Installed
JP10	Shunt JP10 to use default IIN resistor. By closing JP10, the maximum input current is set to 8 A.	Installed
JP11	Use JP11 to connect external IIN resistor. JP11 can be shorted to PGND to disable hardware input current limiting.	Not installed
JP12	Use JP12 to select the gate driver source. Shunt pin1 to pin2 to use IC internal LDO REGN output. Shunt pin2 to pin3 to use external gate drive supply. Maximum external gate drive supply can be up to 11 V.	Pin1 and pin2 shunted
JP13	Shunt JP13 to enable controller in forward mode. Open JP13 to disable controller. The /CE pin can also be used as a general purpose indicator.	Installed
JP14	Shunt JP14 to connect /INT to a pullup rail.	Installed
JP15	Shunt JP15 to connect STAT1 to a pullup rail. The STAT1 pin can also be used as a general purpose indicator.	Installed
JP16	Shunt JP16 to generate on board 3.3-V pullup rail.	Installed

2.3 Recommended Operating Conditions

Table 2-5. Recommended Operating Conditions for BQ25758EVM

	Description	MIN	TYP	MAX	UNIT
VIN (J1)	Input voltage to the EVM	4.2		55(1)	V
VOUT (J3)	Output voltage of the EVM	3.3		55(1)	V
IIN (J1)	Input current of the EVM			10(3) (4)	A
IOUT (J3)	Output current of the EVM			10(3)	A
Regulator output power	Output power of the EVM			400(3)	W
EXT_DRV (J6)	Voltage applied to DRV_SUP pin of the regulator	4		11	V
EVM operating ambient temperature (T_A)			25(2)		°C

(1) Due to the high di/dt and dv/dt electrical flow associated with switch-mode power supplies, nodes on the EVM can have high spike above input voltage (in buck mode) or output voltage (in boost mode) level. Switch node voltage can swing up to "input or output + inductive spike" level. High side gate drives can swing up to "switch node voltage + 11 V (DRV_SUP supply voltage dependent) + gate drive inductive spike" level. Safety precautions must be observed at all times.
(2) Connectors, bump-ons, jumpers on the EVM are not a good choice for evaluation under temperature greatly deviated from room temperature of 25°C. Please refer to BOM for temperature rating of board components.
(3) Thermal monitoring (for example, using a thermal camera) is recommended if power stage output current > 5 A or total output power > 100 W.
(4) Default EVM input current limit is set to 8 A through the IIN pin. The current limiting feature can be disabled by setting EN_IIN_PIN bit to '0', changing IIN pin resistor, or shorting IIN pin to PGND through JP11.

2.4 Equipment

The following list of equipment is recommended when testing with a constant voltage electronic load.

1. **Power Supplies:**

   A power supply capable of supplying 40 V at 8 A is required. While this part can handle larger voltage and current, larger power levels are not necessary for this procedure.

2. **Load #1:**

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An Eload: Kikusui PLZ164WA 0-150V, 0-33A, or equivalent

3. **Meters:**

   Six Fluke 75 multimeters, (equivalent or better) or: Three equivalent voltage meters and three equivalent current meters.

4. **Computer:**

   A computer with at least one USB port and a USB cable.

5. **EV2400 Communication Kit:**

   Order here: https://www.ti.com/tool/EV2400

6. **Software:**

   Download and properly install bqStudio from https://www.ti.com/tool/BQSTUDIO.

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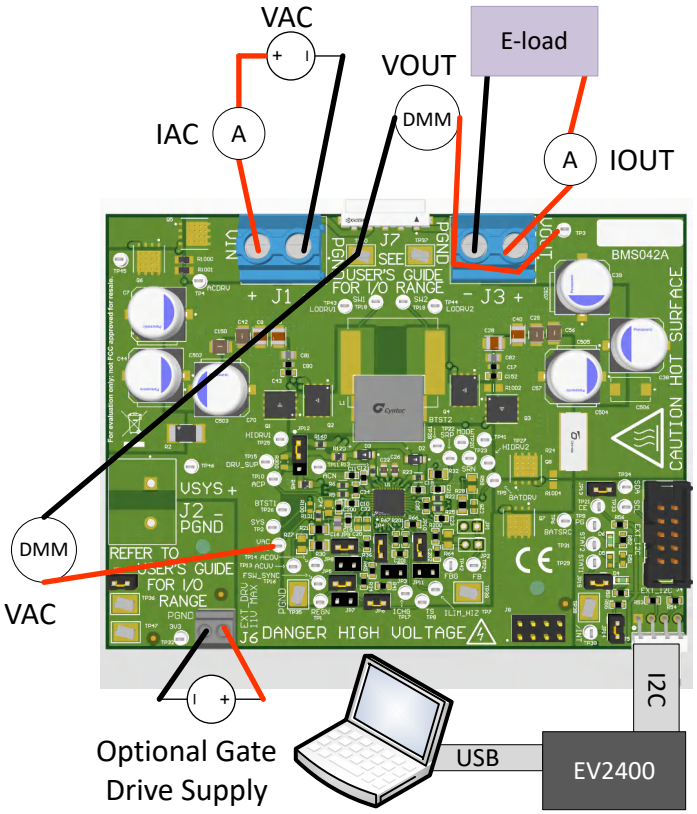
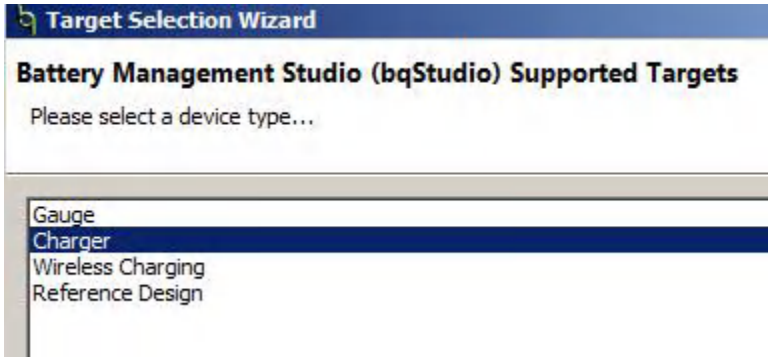
2.5 Equipment Setup



Use the following guidelines to set up the equipment:

1. Set power supply #1 for 20 VDC, 8 A current limit and then turn off the supply.
2. Connect the output of power supply #1 in series with a current meter to J1 (VIN and PGND).
3. Connect a voltage meter across J1 (VIN) and J1 (PGND).
4. Connect load #1 in series with a current meter to J3 (VOUT and PGND).
5. Connect a voltage meter across J3 (VOUT and PGND).
6. Set electronic load to CC mode at 4A. Turn off load #1.
7. Connect J5 to the EV2400. Connect J5 to the I^2C PORT 2 on the EV2400.
8. Make sure the jumpers are installed as indicated in IO and Jumper Descriptions.
9. Turn on the computer and power supply #1. Open the bqStudio software.
   a. Select *Charger* and click the *Next* button.



   b. Select *Charger_1_00_BQ25758.bqz* on the *Select a Target Page*.
   c. After selecting the target device, click *Field View* and then click the *Read Register* button.

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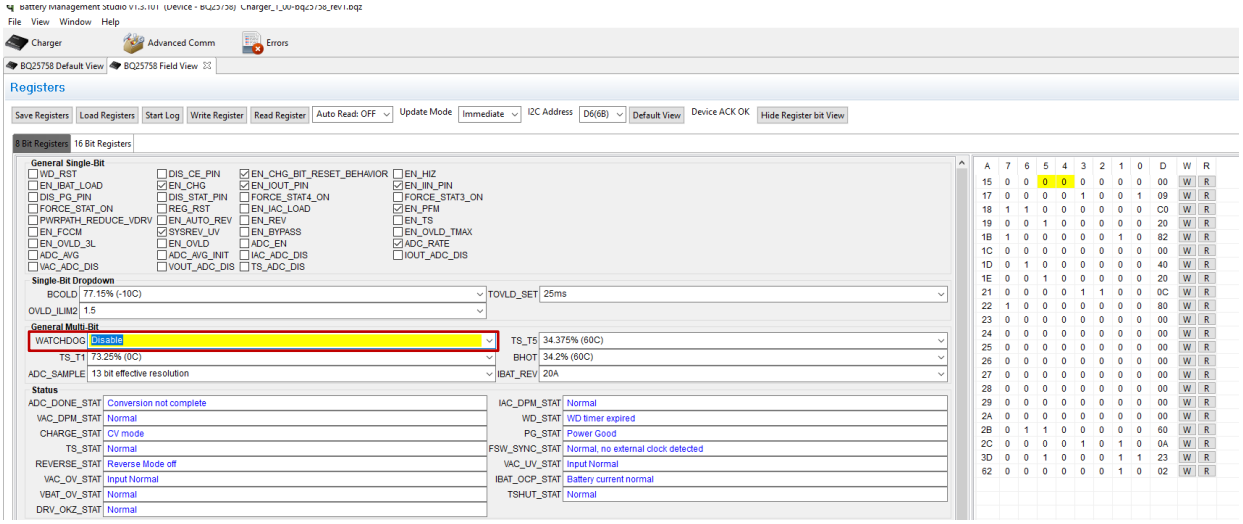
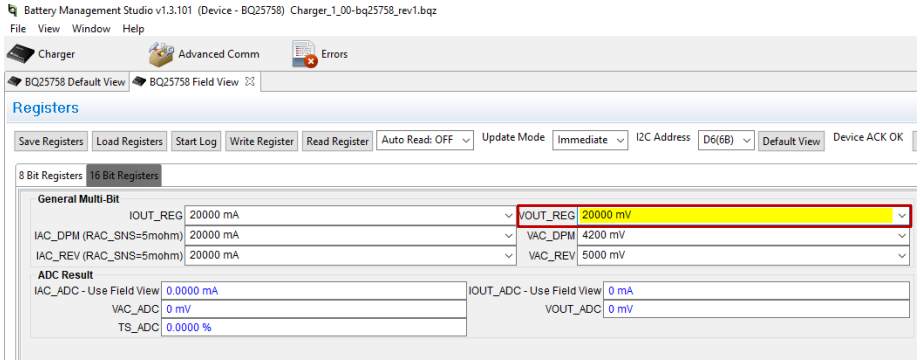


10. Set WATCHDOG to disabled.



11. In *16 Bit Registers*, VOUT_REG default is 5000mV
12. **Buck Test**: Set VOUT_REG to 5V (5000mV), measure

    V(J1(VAC)) = 20 V ± 0.5 V

    I(J1(IAC)) = 1 A ± 0.5 A

    V(J3(VOUT)) = 5 V ± 0.5 V

    I(J3(IOUT)) = 4 A ± 0.5 A
13. **Buck-Boost Test**: Set VOUT_REG to 20V (20000mV), measure

    V(J1(VAC)) = 20 V ± 0.5 V

    I(J1(IAC)) = 4 A ± 0.5 A

    V(J3(VOUT)) = 20 V ± 0.5 V

    I(J3(IOUT)) = 4 A ± 0.5 A
14. **Boost Test** : Set VOUT_REG to 36V (360000mV), measure

    V(J1(VAC)) = 20 V ± 0.5 V

    I(J1(IAC)) = 7.2 A ± 0.5 A

    V(J3(VOUT)) = 38 V ± 0.5 V

    I(J3(IOUT)) = 4 A ± 0.5 A

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3 Hardware Design Files

The following sections include the hardware design files for the BQ25758EVM. The sections include the schematics, board layouts, and Bill of Materials (BOM).

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3.1 Schematics

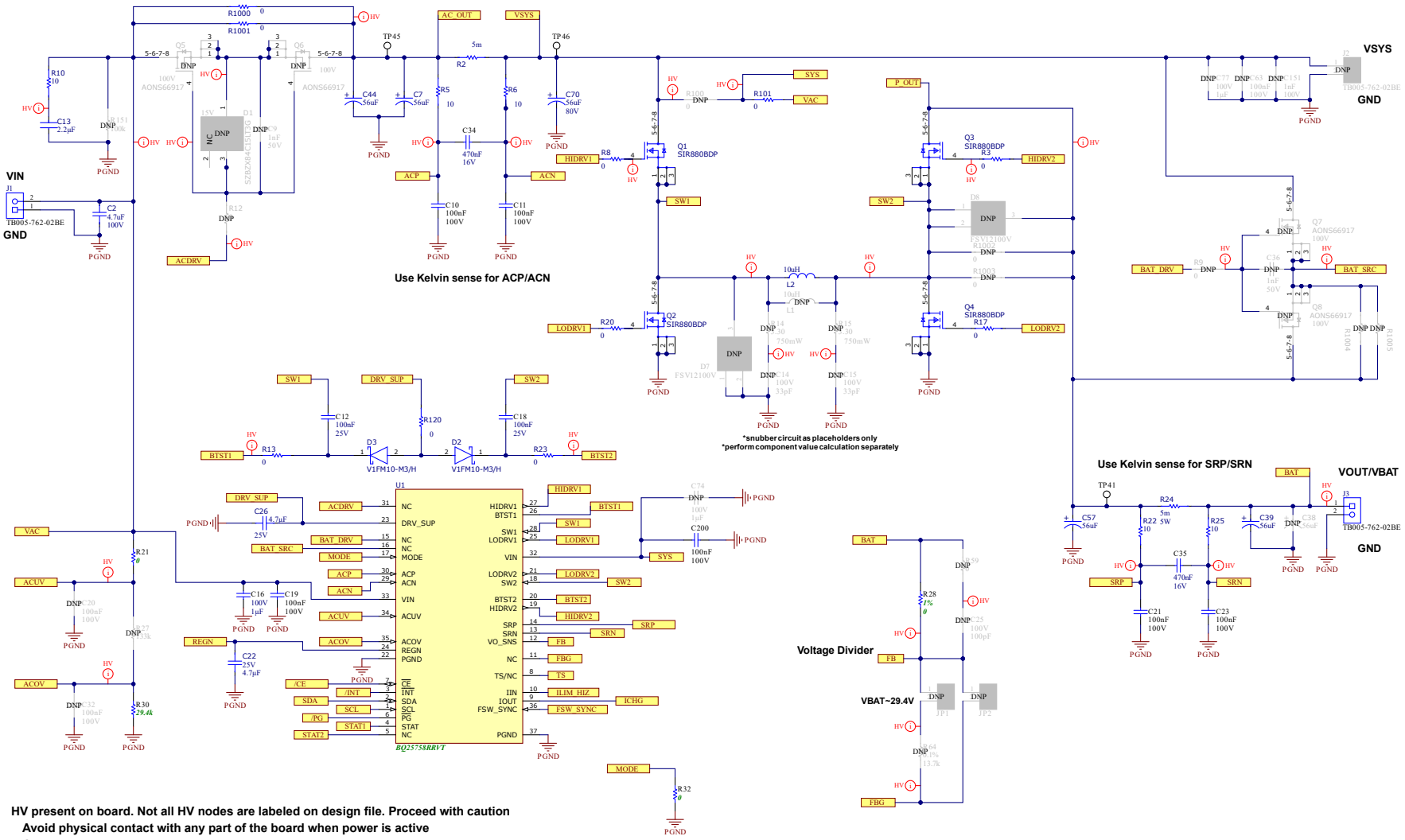

Figure 3-1. BQ25758 EVM Schematic1

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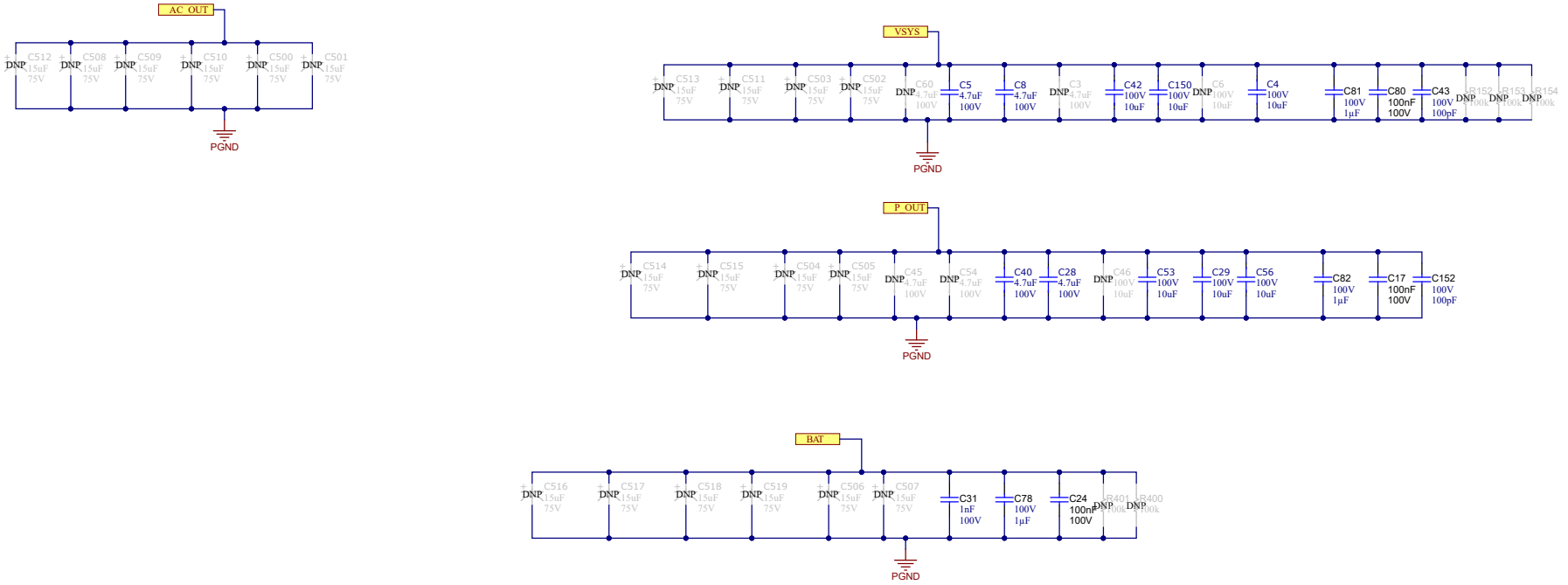

Figure 3-2. BQ25758 EVM Schematic2

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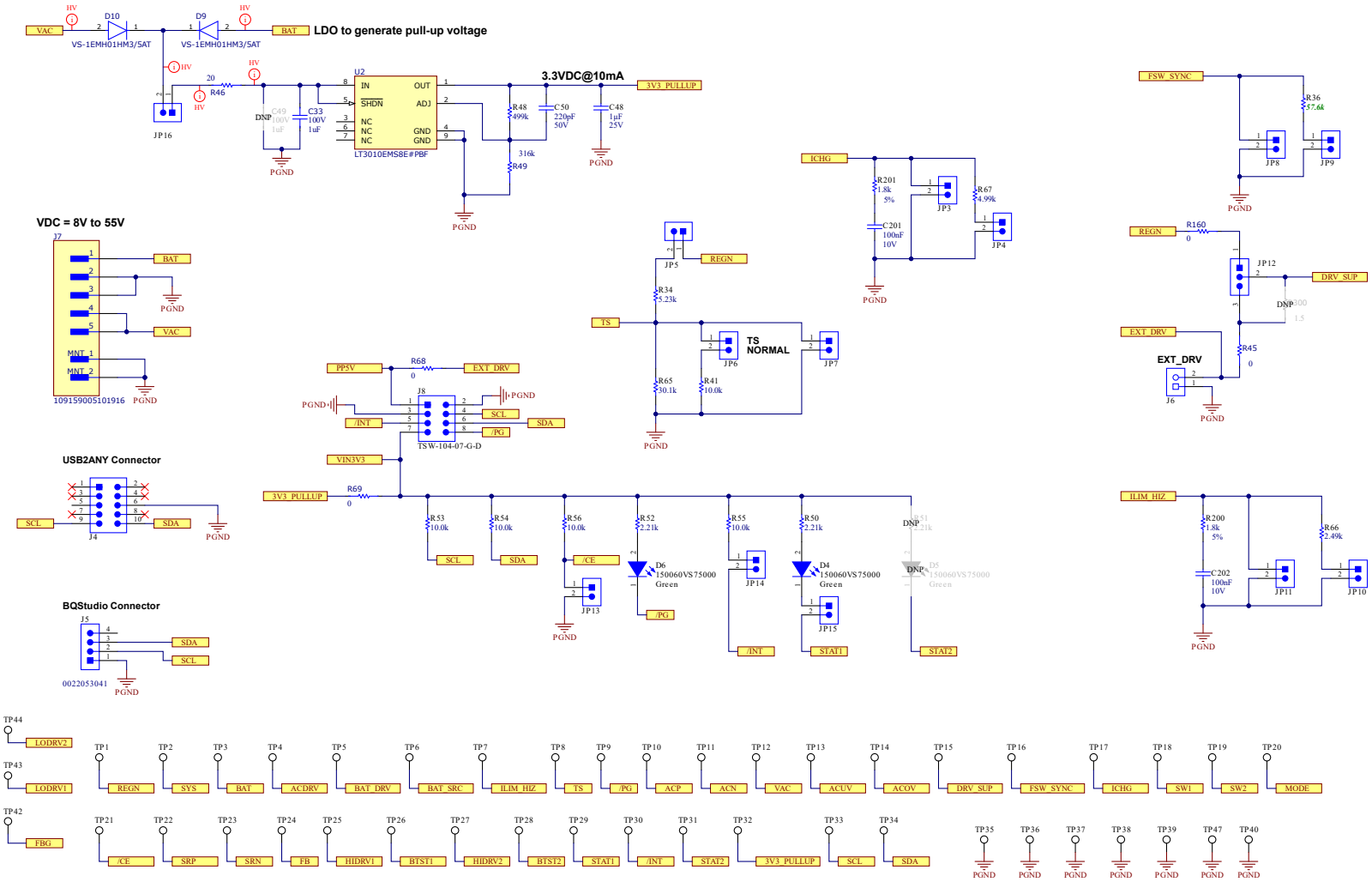

Figure 3-3. BQ25758 EVM Schematic3

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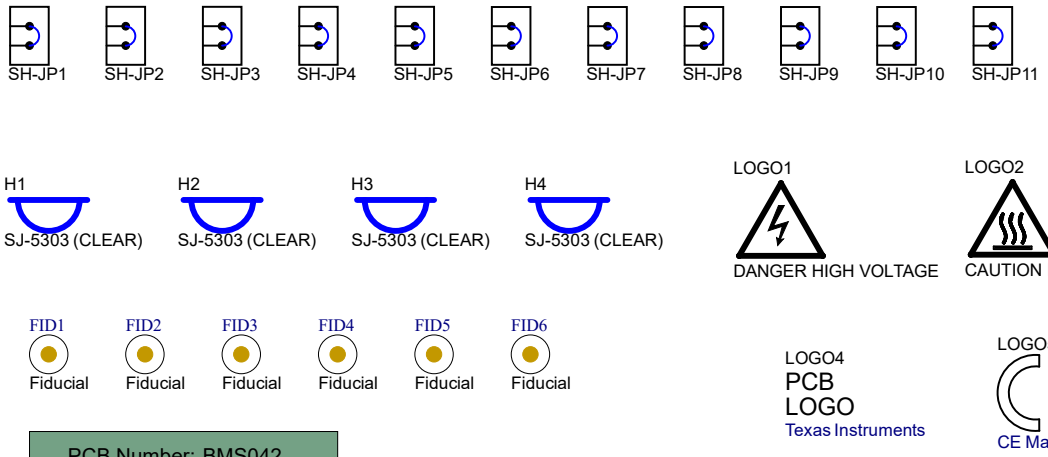

Figure 3-4. BQ25758 EVM Schematic4

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1. DNP means "Do Not Populate".

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3.2 PCB Layout

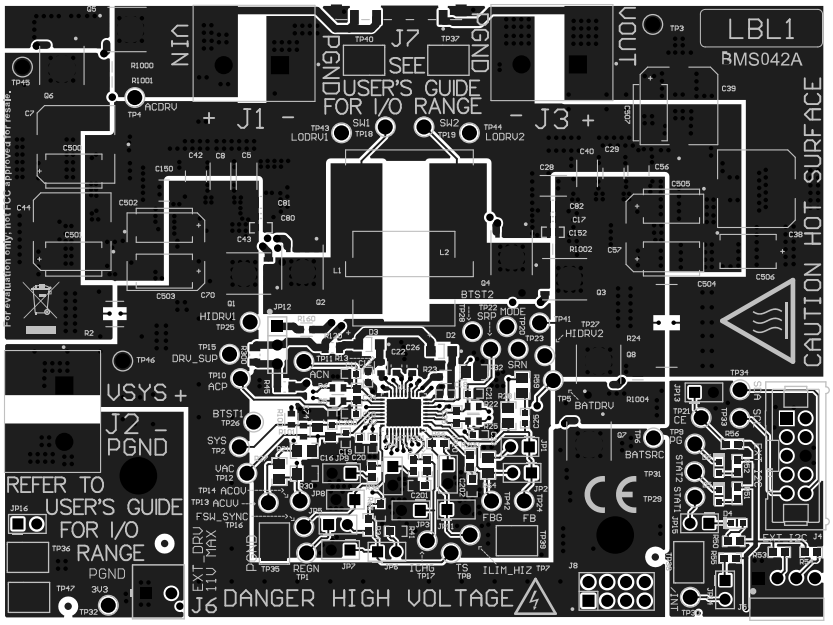

Figure 3-5. Top Layer and Overlay

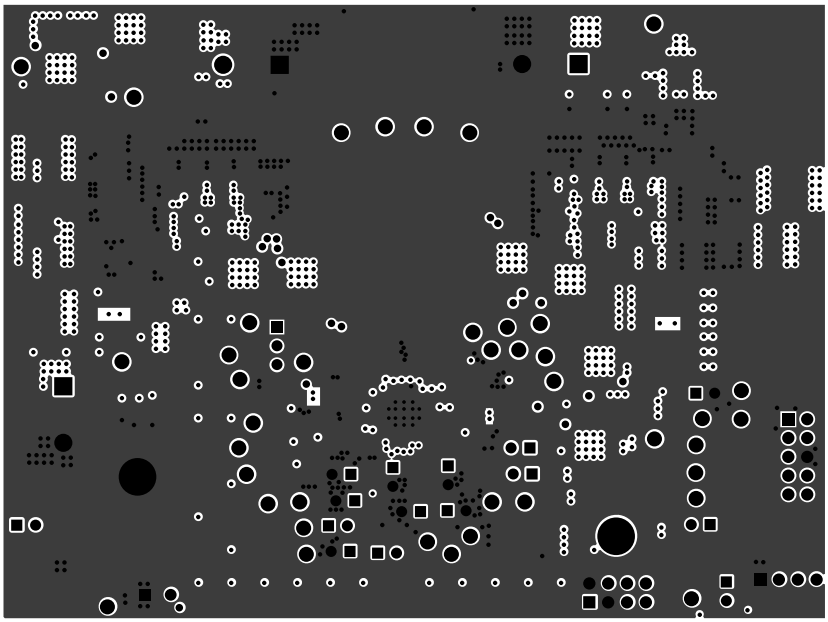

Figure 3-6. Layer 2 -GND

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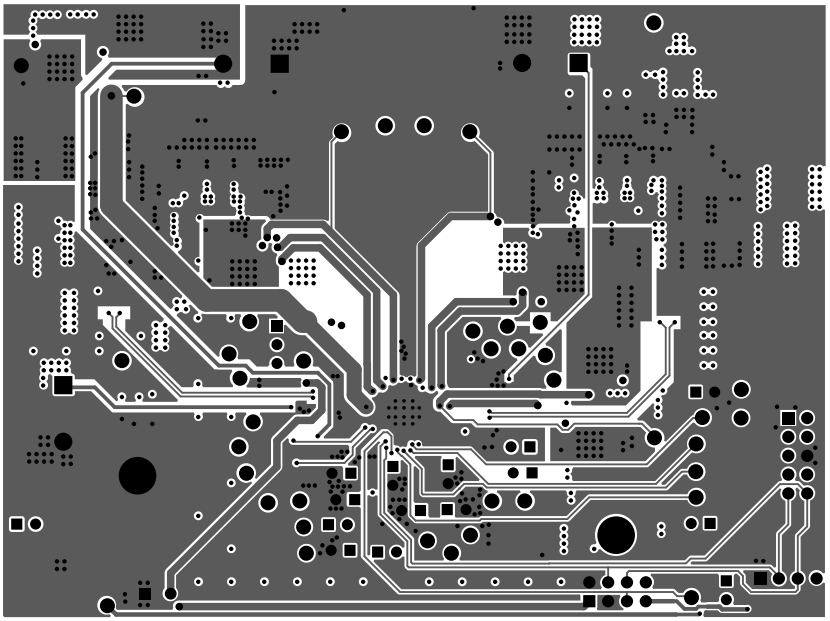

Figure 3-7. Signal Layer 1

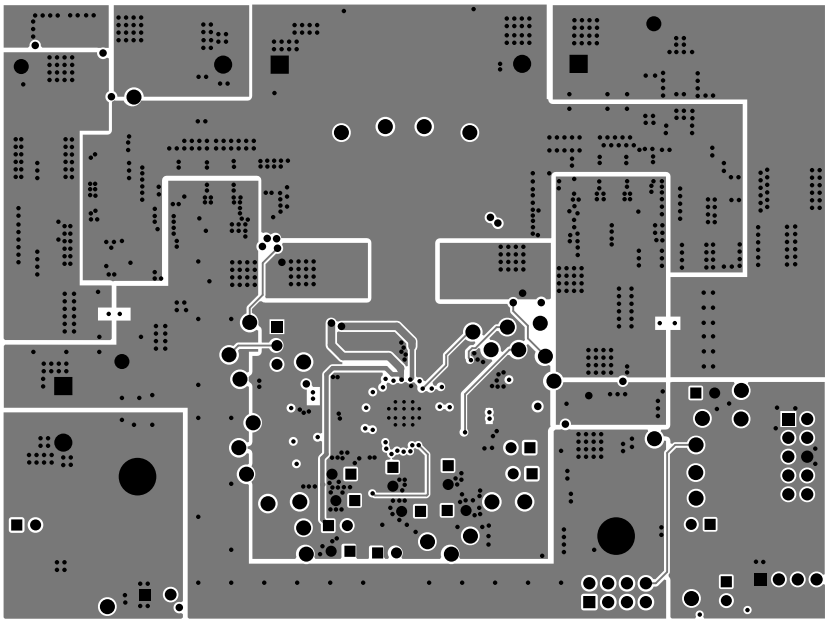

Figure 3-8. Signal Layer 2

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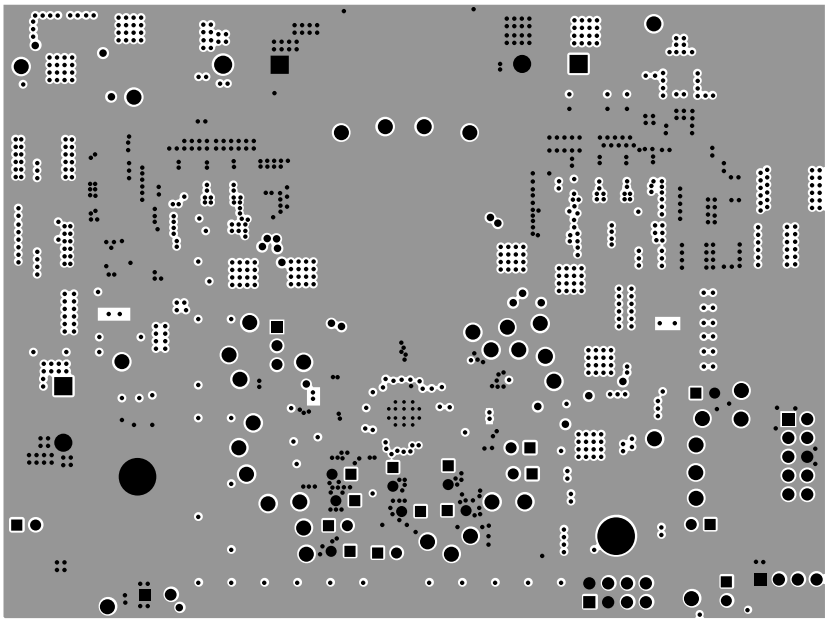

Figure 3-9. Layer 5 - GND

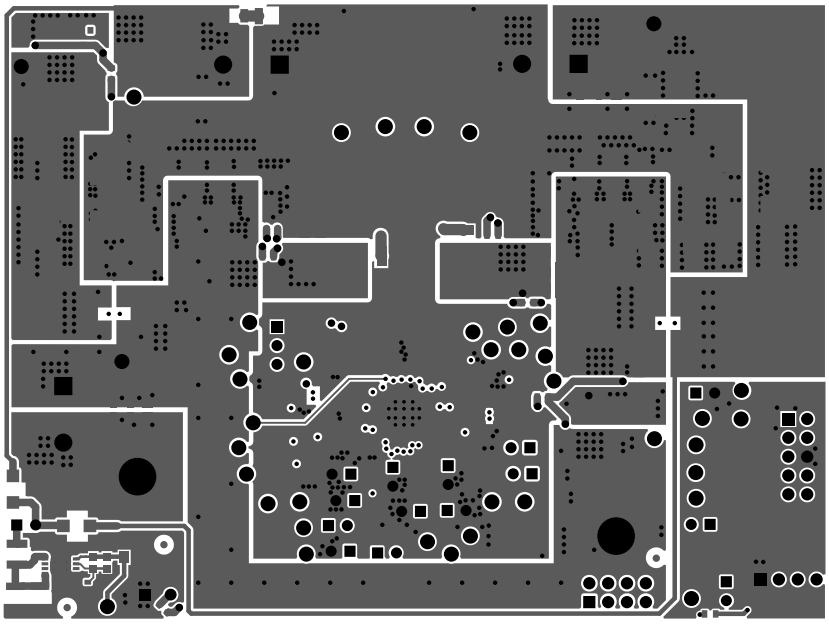

Figure 3-10. Bottom Layer

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3.3 Bill of Materials

Table 3-1. Bill of Materials

Item Number	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
1	C2, C5, C8, C28, C40	5	4.7µF	GCJ32DC72A475KE01L	Murata	4.7uF ±10% 100V Ceramic Capacitor X7S 1210 (3225 Metric)	1210
2	C4, C29, C42, C53, C56, C150	6	10µF	C3225X7R2A106K250AC	TDK	10 µF ±10% 100V Ceramic Capacitor X7R 1210 (3225 Metric)	1210
3	C7, C39, C44, C57, C70	5	56µF	80SXV56M	Panasonic	56 µF 80 V Aluminum - Polymer Capacitors Radial, Can - SMD 28mOhm 1000 Hrs @ 125°C	SMT_CAP_10MM3_10MM3
4	C10, C11, C17, C19, C21, C23, C24, C80, C200	9	0.1uF	HMK107B7104KAHT	Taiyo Yuden	CAP, CERM, 0.1 µF, 100 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	603
5	C12, C18	2	0.1uF	06033C104KAT2A	AVX	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	603
6	C13	1		CGA6N3X7R2A225K230AE	TDK Corporation	Cap Ceramic 2.2uF 100V X7R 10% SMD 1210 FlexiTerm 125C Plastic T/R	1210
7	C16, C78, C81, C82	4	1uF	08051C105K4Z2A	AVX	CAP, CERM, 1 µF, 100 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0805	805
8	C22, C26	2	4.7µF	CGA4J1X7R1E475K125AE	TDK Corporation	Cap Ceramic 4.7uF 25V X7R 10% Pad SMD 0805 +125°C Automotive T/R	805
9	C31	1	1000pF	CGA3E2X7R2A102K080AA	TDK	Multilayer Ceramic Capacitors MLCC - SMD/SMT CGA 0603 100V 1000pF X7R 10% AEC-Q200	603
10	C33	1	1µF	12101C105KAT2A	AVX	General Purpose Ceramic Capacitor, 1210, 1uF, 10%, X7R, 15%, 100V	1210
11	C34, C35	2	0.47uF	C0603C474K4RACTU	Kemet	CAP, CERM, 0.47 uF, 16 V, +/- 10%, X7R, 0603	603
12	C43, C152	2	100pF	CGA3E2C0G2A101J080AA	TDK	Multilayer Ceramic Capacitors MLCC - SMD/SMT CGA 0603 100V 100pF C0G 5% AEC-Q200	603
13	C48	1	1uF	C0805C105K3RACTU	Kemet	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, 0805	805
14	C50	1	220pF	C0603C221K5RACTU	Kemet	CAP, CERM, 220 pF, 50 V, +/- 10%, X7R, 0603	603
15	C201, C202	2	0.1uF	C0603C104K8RACTU	Kemet	CAP, CERM, 0.1 uF, 10 V, +/- 10%, X7R, 0603	603
16	D2, D3	2		V1FM10-M3/H	Vishay	Diode Schottky 1A Surface Mount DO-219AB (SMF)	DO-219AB
17	D4, D6	2	Green	150060VS75000	Wurth Elektronik	LED, Green, SMD	LED_0603
18	D9, D10	2		VS-1EMH01HM3/5AT	Vishay	Diode Standard 100 V 1A Surface Mount DO-214AC (SMA)	DO-214AC

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Table 3-1. Bill of Materials (continued)

Item Number	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
19	FID1, FID2, FID3, FID4, FID5, FID6	6		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A
20	H1, H2, H3, H4	4		SJ-5303 (CLEAR)	3M	Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon
21	J1, J3	2		TB005-762-02BE	CUI Devices		TERM_CONN
22	J4	1		N2510-6002-RB	3M	Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	5x2 Shrouded header
23	J5	1		22053041	Molex	Header (friction lock), 100mil, 4x1, R/A, TH	4x1 R/A Header
24	J6	1		393570002	Molex	Terminal Block, 3.5 mm, 2x1, Tin, TH	Terminal Block, 3.5 mm, 2x1, TH
25	J7	1		1.09159E+14	KYOCERA AVX	Conn Board to Board HDR 5 POS 3mm Solder RA SMD T/R	CONN_SSL_PLUG5
26	J8	1		TSW-104-07-G-D	Samtec	Header, 100mil, 4x2, Gold, TH	4x2 Header
27	JP3, JP4, JP5, JP6, JP7, JP8, JP9, JP10, JP11, JP13, JP14, JP15, JP16	13		PEC02SAAN	Sullins Connector Solutions	Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin
28	JP12	1		PEC03SAAN	Sullins Connector Solutions	Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin
29	L2	1	10uH	CMLB135T-100MS	Cyntec	Power Choke Coil 10uH 20% 9A 22mOhm	SMT2_13MM45_12Mm6
30	LBL1	1		THT-14-423-10	Brady	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch
31	PCB1	1		BMS042	Any	Printed Circuit Board	
32	Q1, Q2, Q3, Q4	4		SIR880BDP-T1-RE3	Vishay	N-Channel 80 V 18.6A (Ta), 70.6A (Tc) 5W (Ta), 71.4W (Tc) Surface Mount PowerPAK® SO-8	SO-8
33	R2	1	5m	WSL25125L000FEA	Vishay	Res Metal Strip 2512 0.005 Ohm 1% 1W 110ppm/C Molded SMD SMD Embossed Plastic T/R	2512
34	R3, R8, R13, R17, R20, R23, R68, R69, R101, R160	10	0	CRCW06030000Z0EA	Vishay	Thick Film Resistors - SMD 1/10watt ZEROohm Jumper	603
35	R5, R6, R22, R25	4	10	CRCW060310R0FKEB	Vishay	RES Thick Film, 10Ω, 1%, 0.1W, 100ppm/°C, 0603	603
36	R10	1	10	CRCW120610R0FKEAHP	Vishay Dale	RES Thick Film, 10Ω, 1%, 0.75W, 100ppm/°C, 1206	1206
37	R21, R32	2	0	CRCW08050000Z0EA	Vishay-Dale	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	805

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Table 3-1. Bill of Materials (continued)

Item Number	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
38	R24	1	5m	FCSL110R005FER	Ohmite	5 mOhms ±1% 5W Chip Resistor Wide 4320 (11050 Metric), 2043 Current Sense, Moisture Resistant Metal Foil	WIDE_4320
39	R28	1	0	RC0805FR-070RL	Yageo America	Thick Film Resistors - SMD 0 Ohms 125 mW 0805 1%	805
40	R30	1	29.4k	ERJ-6ENF2942V	Panasonic	RES, 29.4 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805
41	R34	1	5.23k	RC0603FR-075K23L	Yageo	RES, 5.23 k, 1%, 0.1 W, 0603	603
42	R36	1	57.6k	RC0603FR-0757K6L	Yageo	RES, 57.6 k, 1%, 0.1 W, 0603	603
43	R41, R53, R54, R55, R56	5	10.0k	RC0603FR-0710KL	Yageo	RES, 10.0 k, 1%, 0.1 W, 0603	603
44	R45, R120	2	0	CRCW08050000Z0EA	Vishay	Thick Film Resistors - SMD 1/8watt ZEROohm Jumper	805
45	R46	1	20	CRCW121020R0FKEAHP	Vishay Dale	Thick Film Resistors - SMD 3/4watt 20ohms 1% High Power AEC-Q200	1210
46	R48	1	499k	RC0603FR-07499KL	Yageo	RES, 499 k, 1%, 0.1 W, 0603	603
47	R49	1	316k	CR0603-FX-3163ELF	Bourns	Thick Film Chip Resistors 0603 316kΩ 0.1W 1% 100ppm/°C	603
48	R50, R52	2	2.21k	RC0603FR-072K21L	Yageo	RES, 2.21 k, 1%, 0.1 W, 0603	603
49	R65	1	30.1k	RC0603FR-0730K1L	Yageo	RES, 30.1 k, 1%, 0.1 W, 0603	603
50	R66	1	2.49k	RC0603FR-072K49L	Yageo	RES, 2.49 k, 1%, 0.1 W, 0603	603
51	R67	1	4.99k	CRCW06034K99FKEAC	Vishay-Dale	RES, 4.99 k, 1%, 0.1 W, 0603	603
52	R200, R201	2	1.8k	RC0603JR-071K8L	Yageo	RES, 1.8 k, 5%, 0.1 W, 0603	603
53	R1000, R1001	2	0	JR0805X35E	Ohmite	0 Ohms Jumper 0.245W Chip Resistor 0805 (2012 Metric) - Metal Element	805
54	SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP5, SH-JP6, SH-JP7, SH-JP8, SH-JP9, SH-JP10	10	1x2	SNT-100-BK-G	Samtec	Shunt, 100mil, Gold plated, Black	Shunt

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Table 3-1. Bill of Materials (continued)

Item Number	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
55	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP41, TP42, TP43, TP44, TP45, TP46	40		5002	Keystone	Test Point, Miniature, White, TH	White Miniature Testpoint
56	TP35, TP36, TP37, TP38, TP39, TP40, TP47	7		5016	Keystone	Test Point, Compact, SMT	Testpoint_Keystone_Compact
57	U1	1		BQ25758RRVT	Texas Instruments	Standalone_I2C Controlled, 70V Buck-Boost Multi-Chemistry Battery Charge Controller	VQFN36
58	U2	1		LT3010EMS8E-PBF	Analog Devices	Linear Voltage Regulator IC Positive Adjustable 1 Output 50mA 8-MSOP-EP	MSOP8

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4 Revision History

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

DATE	REVISION	NOTES
March 2024	*	Initial Release

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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 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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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

   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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