

EVM User's Guide: TPS61383QEVM-167

TPS61383-Q1 评估模块



说明

TPS61383QEVM-167 在 0V 至 12V 的宽备用电池电压范围和 0V 至 40V 的主电池 (VBAT 端口) 电压范围内工作, 可实现双向操作。EVM 在升压模式下支持 6V BUB 和 12V 输出时高达 7.5A 的负载输出, 在充电器模式下支持 50mA 至 5A 充电电流。

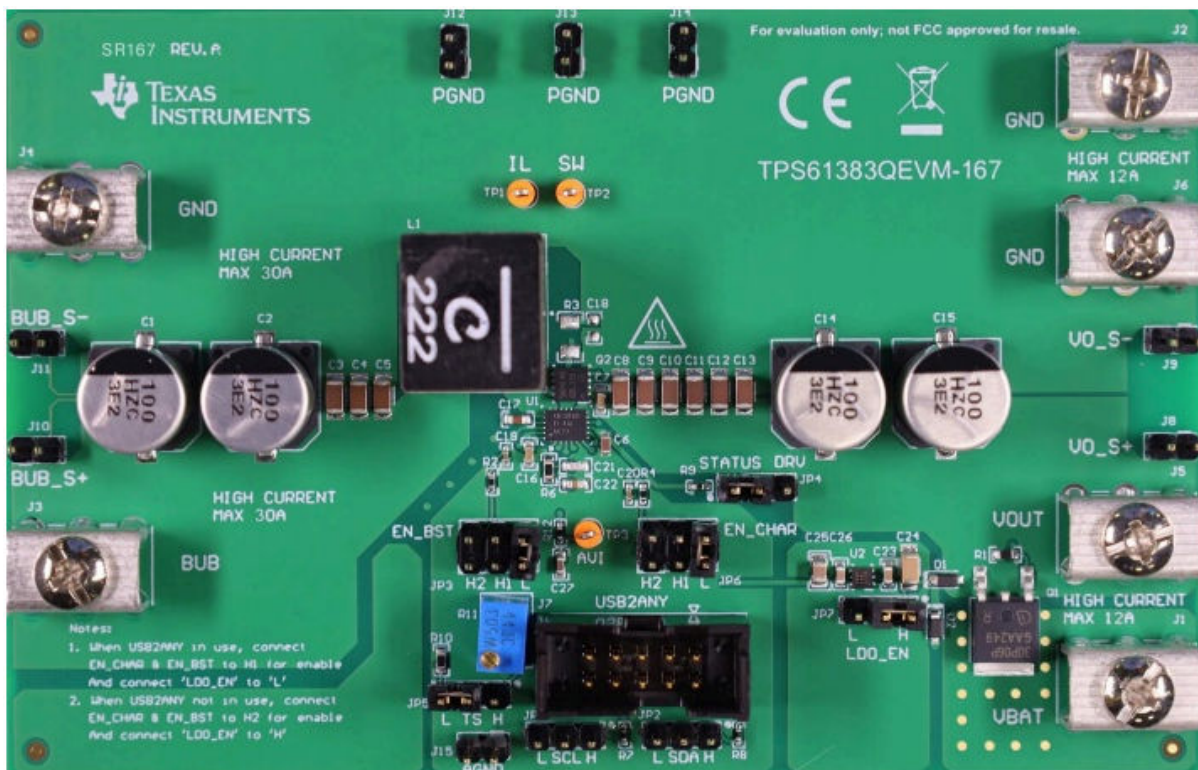
TPS61383QEVM-167 在升压模式下支持 2.5% 的输出电压调节精度, 在充电器模式下支持 1% 的电压精度。器件功能可通过 I2C 接口调节。

特性

- 升压模式下的备用电池 (BUB) 电压: 0.5V 至 12V, 启动所需的最小电压为 3V
- 支持的绝对最大值 (VOUT 引脚) 最高达 40V
- 升压输出电压: 最高达 12V
- 通过 STATUS 引脚和 I2C 指示故障或运行状态
- 备用电池运行状况 (SOH) 检测
- 频率: 汽车应用为 400kHz

应用

- [紧急呼叫 \(eCall\)](#)
- [车门把手模块](#)
- [故障指示灯 \(FI\)](#)



TPS61383QEVM-167

1 评估模块概述

1.1 简介

TPS61383-Q1 是一款 40V、30A、双向升压转换器和降压充电器，集成了电池健康状态检测功能。本用户指南描述了 TPS61383-Q1 评估模块 (EVM) 的特性、运行和使用情况。EVM 包含 TPS61383-Q1 双向升压转换器，集成了充电器、升压和健康状态 (SOH) 检测功能。本用户指南涵盖 EVM 规格、推荐测试设置、测试结果、原理图、物料清单以及电路板布局。

1.2 套件内容

- 一个用于评估 TPS61383-Q1 的 EVM
- EVM 免责声明自述文件

1.3 规格

表 1-1 对 TPS61383QEVM-167 性能规格进行了汇总。除非另有说明，所有测量的环境温度均为 25°C。

表 1-1. 升压模式性能规格汇总

参数	测试条件	值	单位
备用电池 (BUB) 电压	不适用	1 - 12	V
输出电压	不适用	5 - 12	V
最大输出电流	BUB 3V、VOUT 12V	3.5	A
	BUB 6V、VOUT 12V	7.5	
	BUB 9V、VOUT 12V	9.5	
默认开关频率	不适用	400	kHz

表 1-2. 充电器模式性能规格汇总

参数	测试条件	值	单位
备用电池 (BUB) 电压	不适用	0 - 12	V
输出电压	不适用	$V_{BUB} + 0.1V - 40$	V
充电电流	不适用	0.05 - 5	A

1.4 器件信息

TPS61383QEVM-167 的目的是展示 TPS61383-Q1 器件的典型应用。此 EVM 需要相应的 I2C 接口，例如 TI USB2ANY。该评估模块旨在评估 TPS61383-Q1，其为一款 I2C 兼容型、低 I_q 、AEC-Q100 合格双向升压转换器和降压充电器，集成了电池健康检测功能。该器件为电子门锁等备用电源系统提供集成电源设计。TPS61383-Q1 的 VOUT 引脚支持高达 40V 的绝对最大电压，可承受负载突降情况，并支持直接连接 12V 汽车电池系统。TPS61383-Q1 可监控系统电压，并在汽车电池发生故障和系统侧检测到压降时，自动切换到升压模式。

2 硬件

2.1 连接器、测试点和跳线说明

本节介绍了如何正确连接、设置和使用 TPS61383QEVm-167。

2.1.1 连接器和测试点说明

如[连接器和测试点](#)中所示，此 EVM 包含 I/O 连接器和测试点。将备用电池连接到 BUB 连接器 J3 及 J4。将负载连接到输出连接器 J5 及 J6。将汽车主电池连接至 V_{BAT} 连接器 J1 和 J2。

表 2-1. 连接器和测试点

参考位号	说明
J1	汽车主电池正极连接
J2	汽车主电池回路连接
J3	备用电池正极连接
J4	备用电池回路连接
J5	升压输出正极连接
J6	升压输出回路连接
J7	USB2ANY 接口连接器
J8	升压输出电压正极检测点
J9	升压输出电压负极检测点
J10	备用电池电压正极检测点
J11	备用电池电压负极检测点
J12、J13、J14	PGND 检测点
J15	AGND 检测点
TP1	IL 引脚测试点
TP2	SW 引脚测试点
TP3	AVI 引脚输出测试点

2.1.2 跳线配置

2.1.2.1 JP1 和 JP2 (启用 I2C 接口)

JP1 跳线用于配置 I2C 接口的 SCL。默认情况下，此跳线保留开路，器件使用 USB2ANY 适配器内部上拉。将此跳线设置到 H 位置可启用 EVM 上的上拉电路。将跳线置于 L 位置可禁用 SCL。

JP2 跳线用于启用 I2C 接口的 SDA。默认情况下，此跳线保留开路，器件使用 USB2ANY 适配器内部上拉。将此跳线设置到 H 位置可启用 EVM 上的上拉电路。将跳线置于 L 位置可禁用 SDA。

2.1.2.2 JP3 (升压启用)

J5 跳线用于启用升压功能。默认情况下，此跳线设置在 H2 位置，使用 EVM 上的 LDO 上拉 EN_BST 引脚并启用升压功能。将此跳线置于 H1 位置，可使用 USB2ANY 适配器上拉 EN_BST 引脚并启用升压功能。将此跳线置于 L 位置可禁用升压功能。

2.1.2.3 JP4 (STATUS 或 DRV 引脚)

JP4 跳线用于配置 Status 或 DRV 引脚。默认情况下，此跳线设置在 STATUS 位置，可启用上拉电路以实现 STATUS 指示灯功能。将跳线置于 DRV 位置可连接 PMOS 驱动器。

2.1.2.4 JP5 (TS 引脚)

JP5 跳线用于测试 TS 引脚。默认情况下，该跳线设置在 L 位置，将 TS 引脚以 10k Ω 连接至 GND，从而禁用 TS 引脚监控功能。将此跳线置于 H 位置，将 TS 引脚连接到电位计，以设置和测试 TS 引脚电阻。移除跳线并将中间引脚连接到 NTC 网络以用于温度检测。

2.1.2.5 JP6 (充电器启用)

JP6 跳线可启用充电器功能。默认情况下，此跳线设置在 H2 位置，使用 EVM 上的 LDO 拉高 EN_CHGR 引脚并启用充电器功能。将此跳线置于 H1 位置，可使用 USB2ANY 适配器拉高 EN_BST 引脚并启用充电器功能。将此跳线置于 L 位置可禁用充电器功能。

2.1.2.6 JP7 (LDO 启用)

JP1 跳线可启用 LDO，其可为器件的 EN 引脚供电。默认情况下，将此跳线置于 H 位置。将跳线置于 L 位置可禁用 LDO。

2.2 测试程序

TPS61383-Q1 集成了充电器、升压和 SOH 功能，适用于备用电源应用。通过这三种功能验证器件。

2.2.1 验证升压功能

1. 准备 1 个电源、1 个电池模拟器和 1 个电子负载。
2. 将电源电流限值设置为 2A。将电源电压设置为 14V。关闭电源输出，将电源的正极输出连接至 J1，负极输出连接至 J2。
3. 将电池模拟器电流限制设为 +15A、-5A。将电池电压设置为 3V。关闭电源输出，将电源的正极输出连接至 J3，负极输出连接至 J4。
4. 将电子负载设置为 CC 模式，CC 电流设置为 1A，关闭负载，将负载的正输出端连接至 J5，负输出端连接至 J6。
5. 按图 2-1 配置跳线。
6. 首先打开电源，连接 USB2ANY 适配器 J7，并在 PC 上连接 TPS61383Q GUI。然后，打开电池模拟器和电子负载。
7. 关闭电源输出，验证当 VBAT 端口电压降到 12V 以下时 VOUT 电压是否约为 12V。

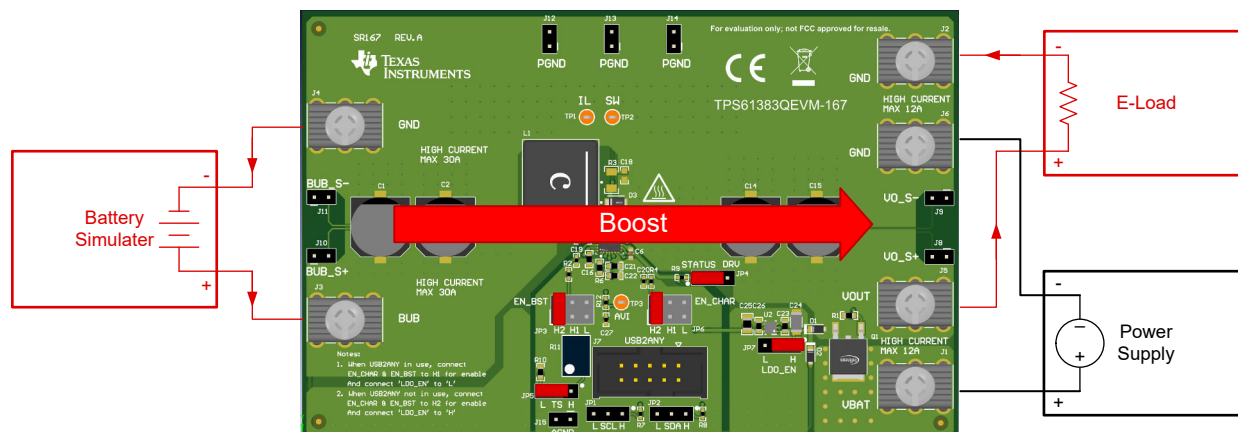


图 2-1. 验证升压功能

2.2.2 验证充电器功能

1. 保持与节 2.2.1 中的步骤 1-6 类似的硬件连接。
2. 转至 GUI *Charger Settings* 页面，在 'Choose the Battery type' 栏中选择 "Super Capacitor"，将 Battery CV 设置为 2.7V，将电池编号设置为 "3cell"，并将充电电流设置为 "2A"。
3. 将顶部栏上的 *Charger, SOH* 设置为 'Enable Charger'。
4. 验证电池模拟器是否以约 2A 的电流充电

5. 关闭电源输出。验证当 **VOUT** 电压降至 12V 以下时，电池模拟器是否停止充电并开始输出电流。如果器件正常工作，当 **VOUT** 电压降至 12V 以下时，**VOUT** 电压需要保持在约 12V。

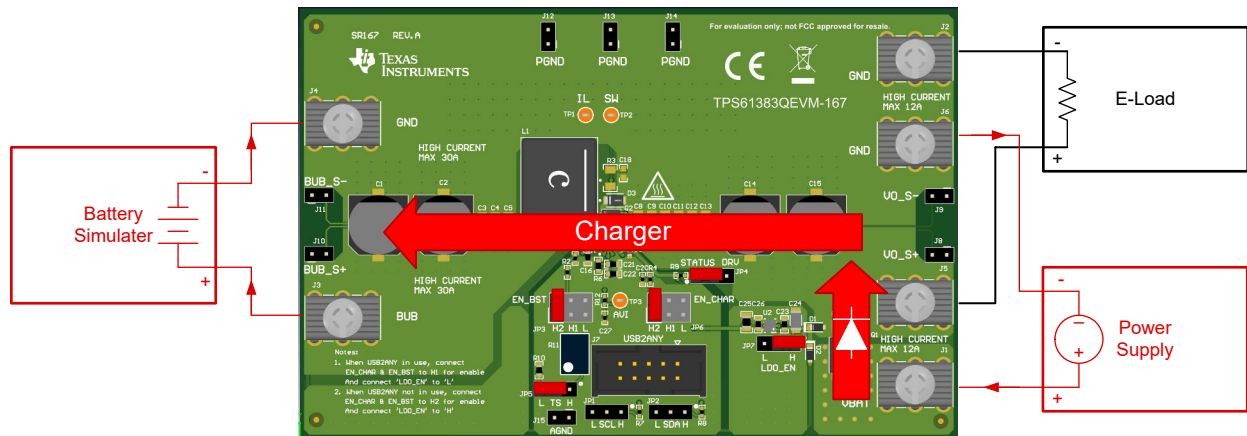


图 2-2. 验证充电器功能

2.2.3 验证 SOH 功能

1. 保持与节 2.2.1 中的步骤 1-6 类似的设置。
2. 进入 GUI **SOH Settings** 页面，通过 GUI 将 **Enable AVI Pin Output** 设置为 **Battery voltage**，并将 '**AVI Pin Ratio to The Backup Battery Voltage**' 设置为 '1/2'。
3. 将 AVI 引脚与放电电流的比率设置为 '4'。
4. 将充电器，**SOH** 设置为启用 **SOH**。检查 AVI 引脚电压是否约为 1.5V。
5. 使用 GUI 将 **SOH 放电电流** 设为 200mA，检查电池模拟器是否放电约 200mA。
6. 将 **Enable AVI Pin Output** 设置为 **Discharge Current**，并检查 AVI 引脚电压是否约为 0.8V。

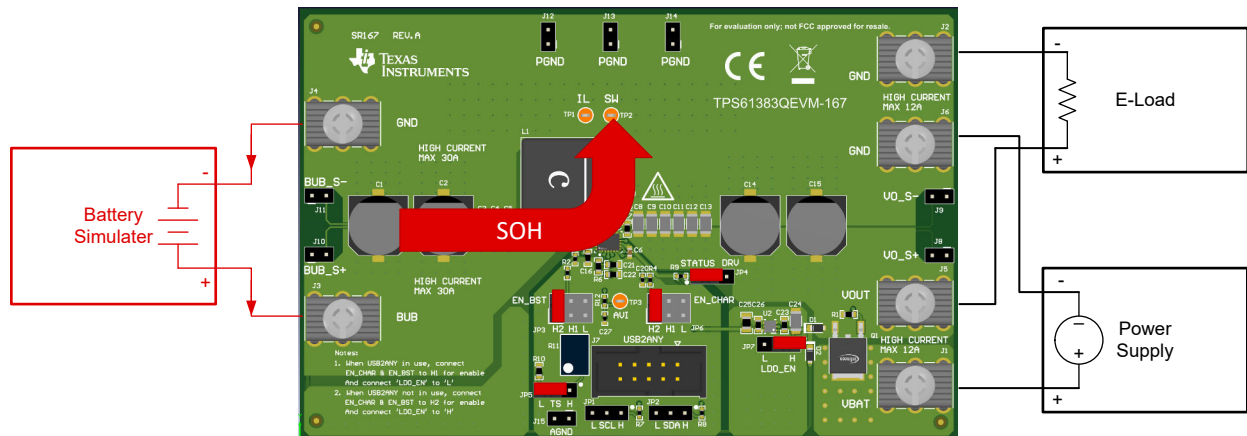


图 2-3. 验证 SOH 功能

3 软件

3.1 软件用户界面

3.1.1 安装 USB2ANY Explorer

从以下位置下载并安装 USB2ANY Explorer : <http://www.ti.com.cn/tool/cn/USB2ANY>。将固件版本升级到 2.8.2.0。

3.1.2 GUI 安装

可通过此处获取图形用户界面 (GUI) :

[TPS61382A-Q1_TPS61383-Q1 GUI 下载](#)

GUI 允许通过 TI USB2ANY 器件对器件进行简单而方便的编程。

- 下载所需平台的 zip 文件。
- 提取 zip 文件夹并安装 GUI。
- 执行安装步骤。安装向导会提示 GUI Composer Runtime。这是自动完成的。
- 打开 GUI → TPS61383Q1。

3.1.3 接口硬件设置

使用提供的 USB 线缆将 USB2ANY 适配器与 PC 连接在一起。使用提供的 10 引脚带状电缆将 TPS61383EVM 连接器 J6 连接至 USB2ANY 适配器。带状电缆上的连接器键控可防止安装错误。

图 3-1 是快速连接概览。

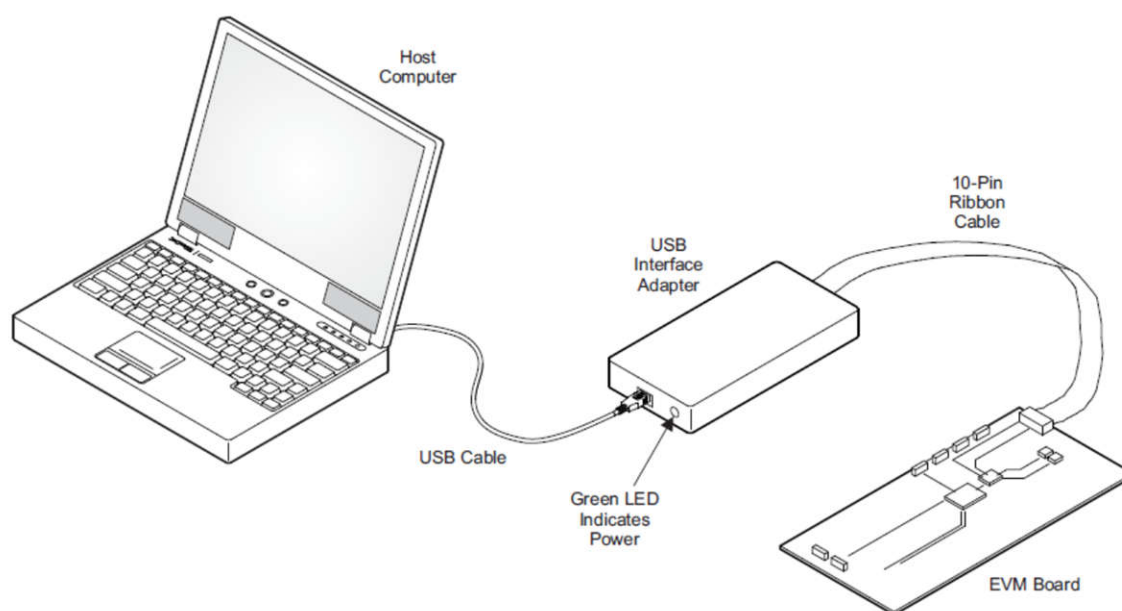


图 3-1. 快速连接概览

3.1.4 用户配置屏幕

按照以下步骤启用 TPS61383Q1EVM-167 电路板：

1. 按照节 2.2.1 中的步骤 1-6 设置 EVM 硬件。打开电源。
2. 打开 TPS61383-Q1EVM GUI。

3. 单击底部栏上的连接按钮，如图 3-2 所示。GUI 和器件连接后，GUI 读取所有寄存器，并显示一条通知。

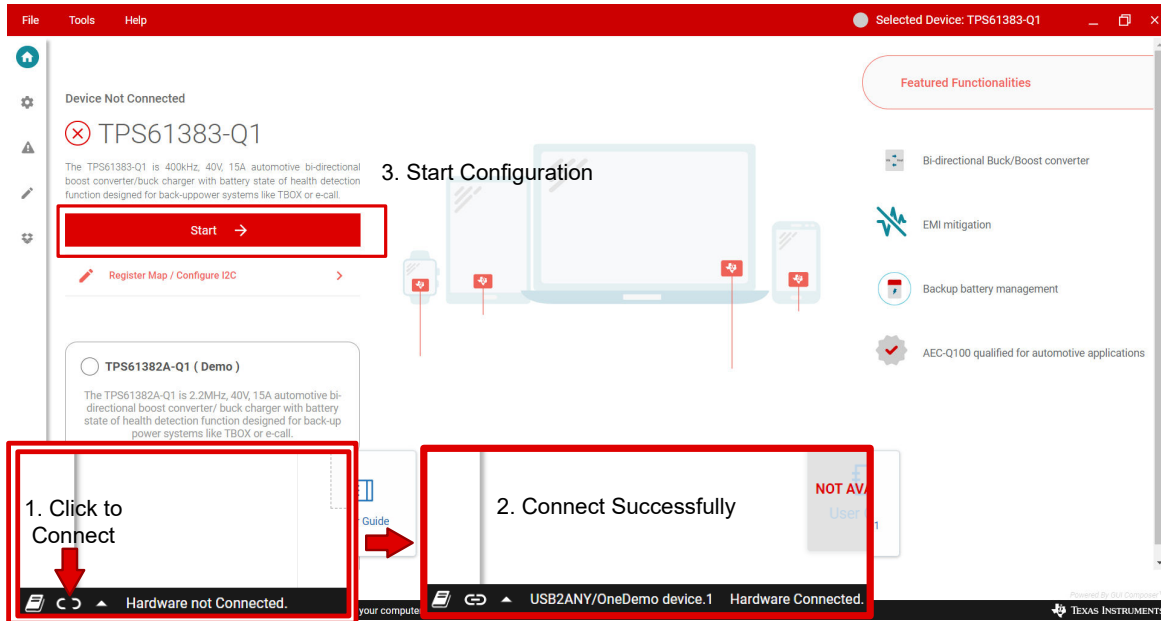


图 3-2. 连接和启动

4. 单击 **Start** 按钮，GUI 将自动打开 **Configuration** 屏幕（请参阅图 3-3）。默认情况下启用 TPS61383 升压的设置。默认输出电压为 12V。根据设计目标设置升压模式输出电压、电流限制点等。

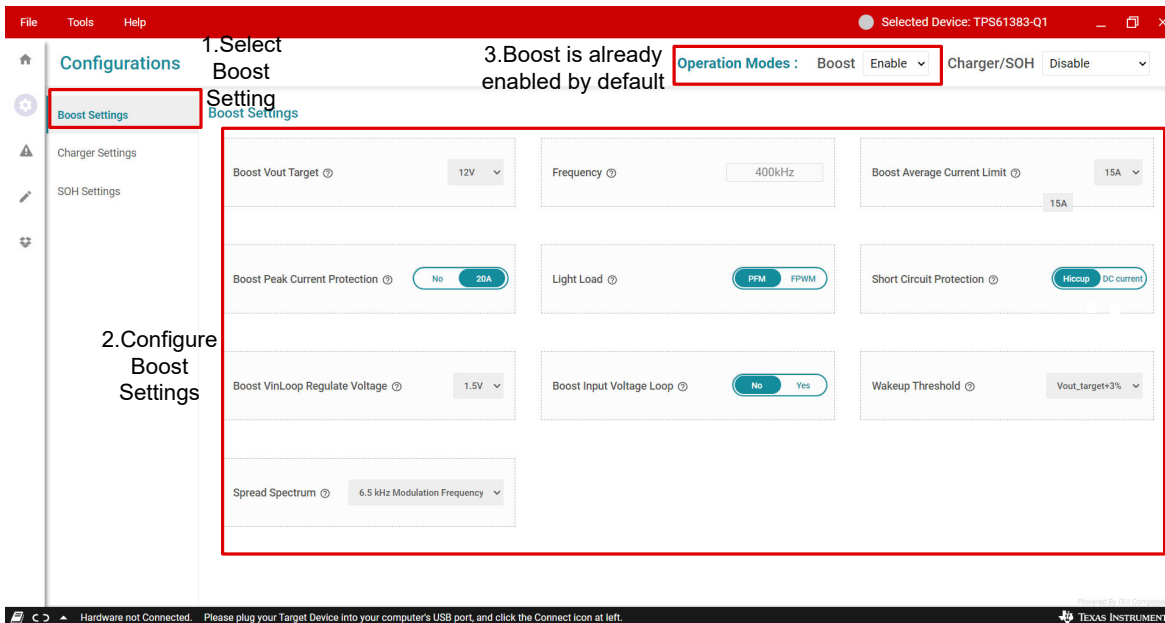


图 3-3. 升压设置表

- 单击 **Charger Settings** 按钮，切换到充电器设置表 (请参阅图 3-4)。充电器的默认设置为锂离子模式。根据设计目标设置充电器模式电池类型、电池数量、CC 电流等。

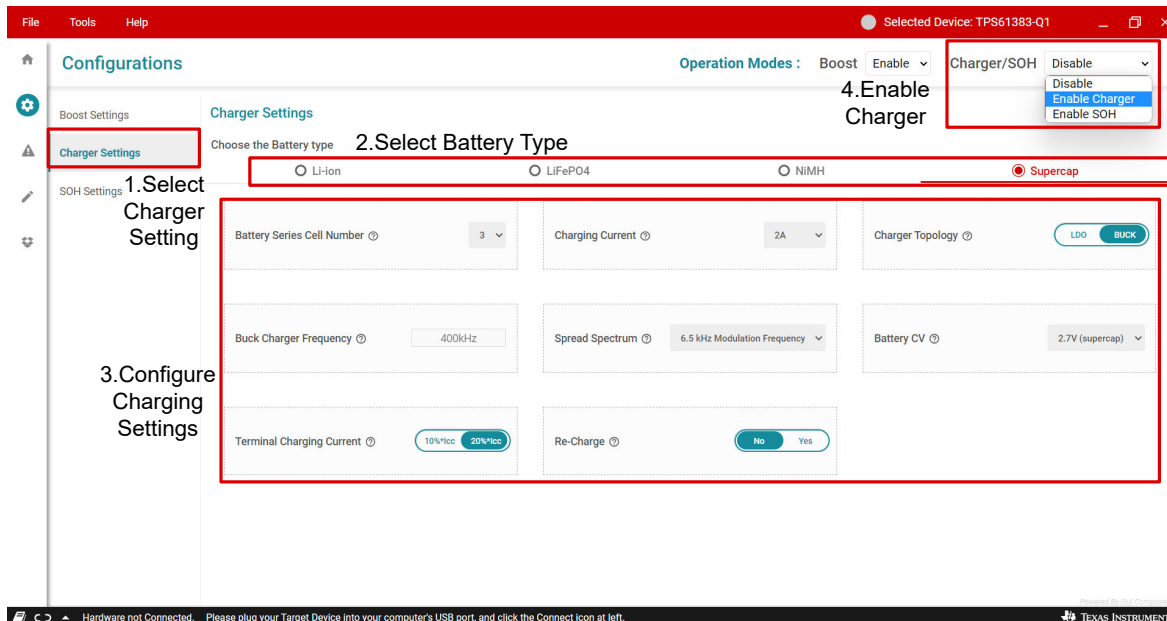


图 3-4. 充电器设置表

- 单击 **SOH Settings** 按钮，切换到 SOH 设置表 (请参阅图 3-5)。根据设计目标设置 SOH 放电电流、AVI 引脚输出比、AVI 输出等。

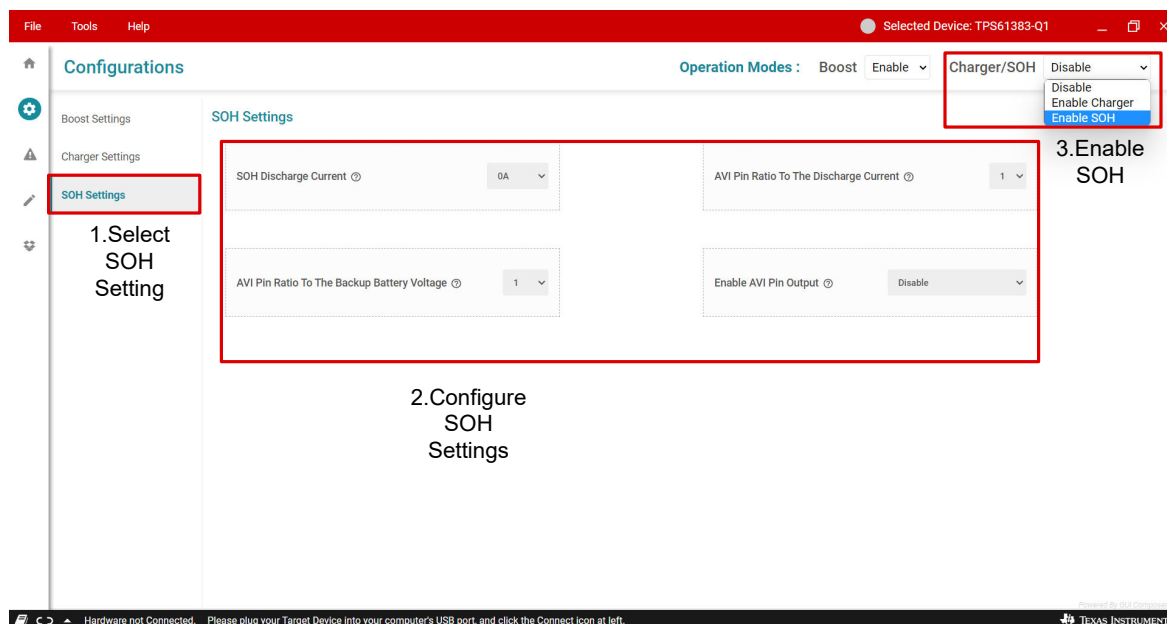


图 3-5. SOH 设置表

3.1.5 状态和故障指示屏幕

TPS61383-Q1 GUI 提供多种器件状态和故障指示功能。进入状态和故障指示屏幕以检查器件的状态和故障状况。

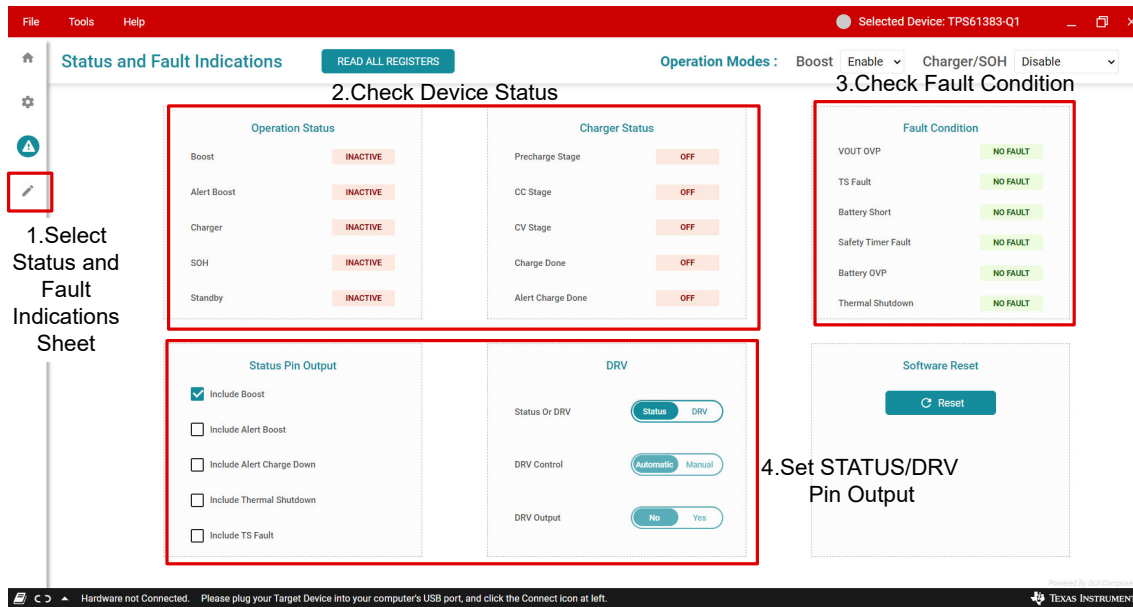


图 3-6. 状态和故障指示屏幕

3.1.6 寄存器映射屏幕

寄存器映射屏幕 (请参阅节 3.1.6) 以寄存器形式展示了所有参数。可在此屏幕中找到每个寄存器位的详细说明。进入该屏幕以读取并更新寄存器位。

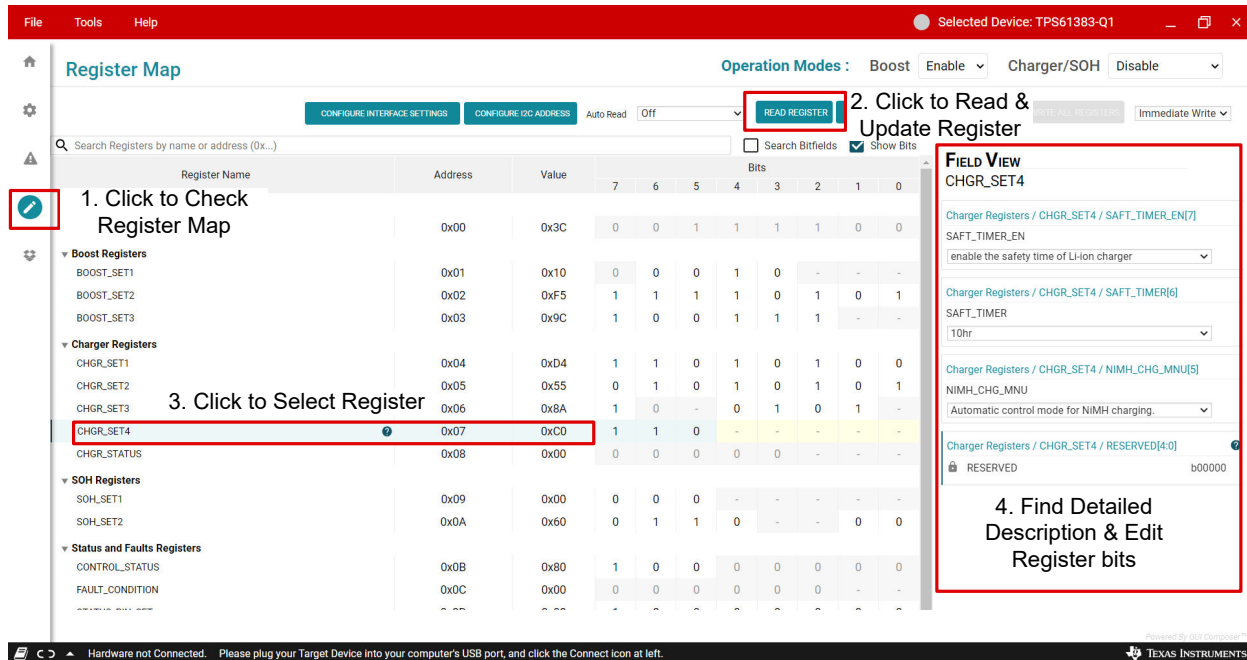


图 3-7. 寄存器映射屏幕

3.2 修改

此 EVM 需要适当的 I²C 接口 (例如 TI USB2ANY) 来配置 TPS61383-Q1。

4 硬件设计文件

4.1 原理图

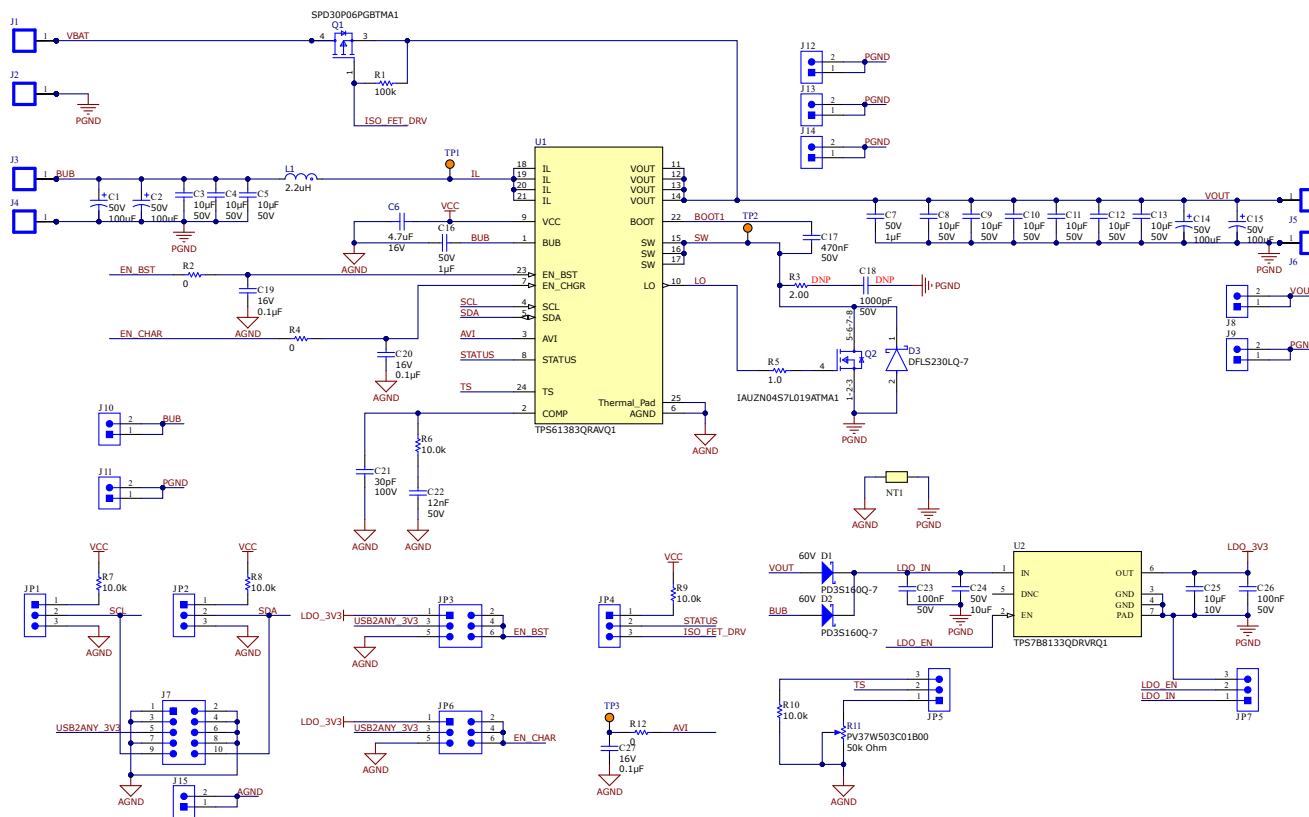


图 4-1. TPS61383QEVM-167 原理图

4.2 PCB 布局

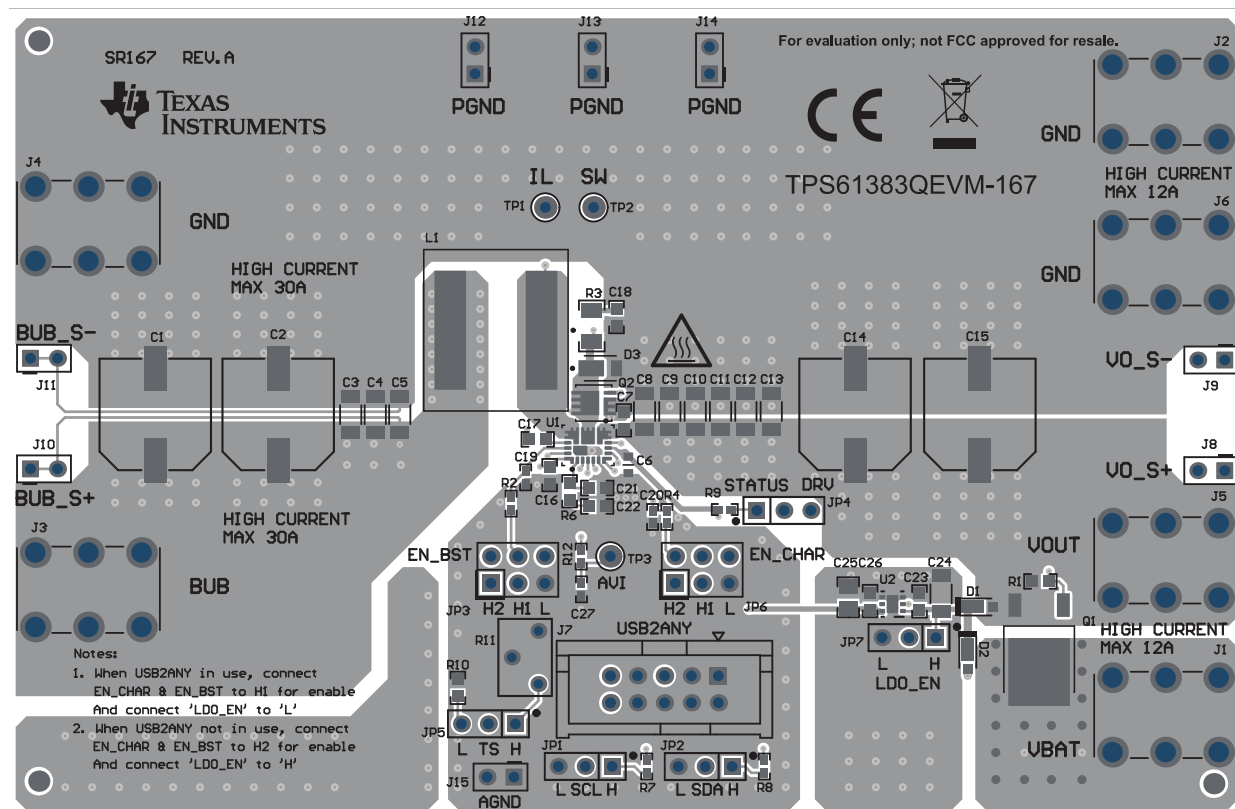


图 4-2. TPS61383QEVm-167 顶面布局

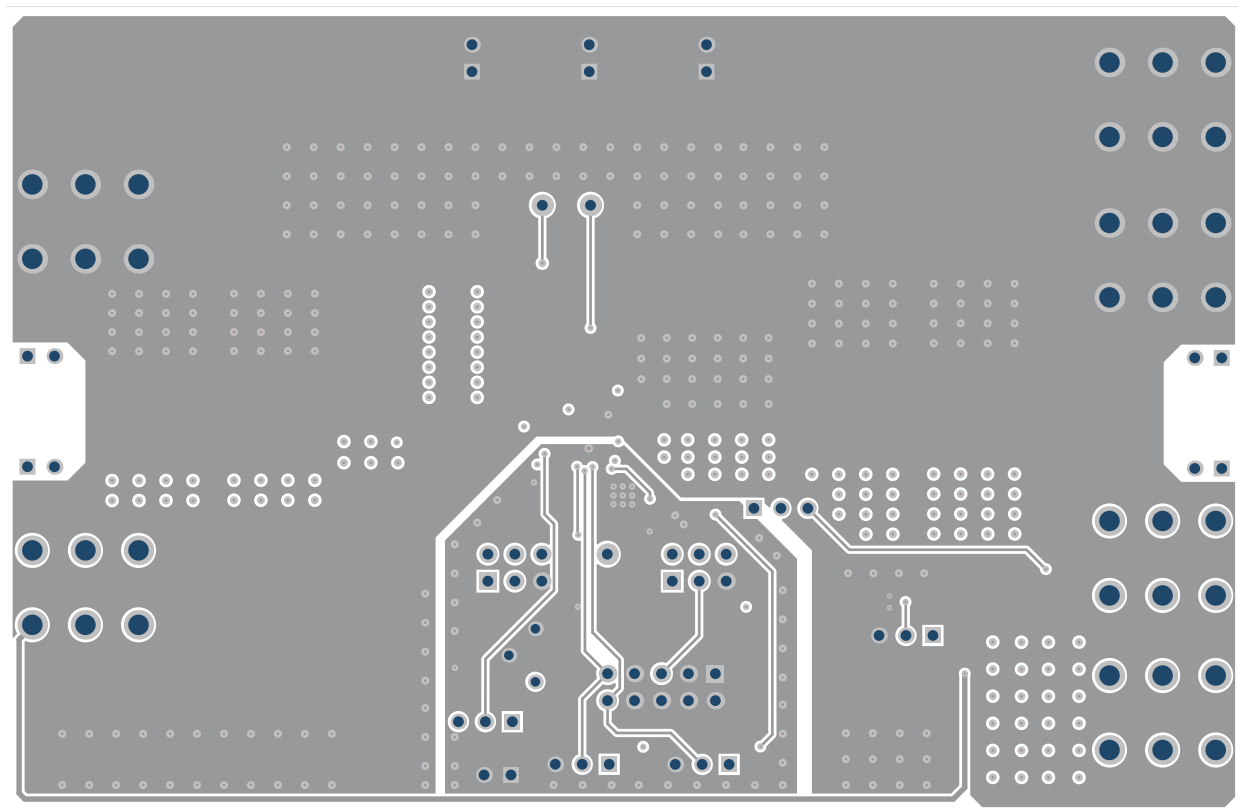


图 4-3. TPS61383QEVm-167 内层 1

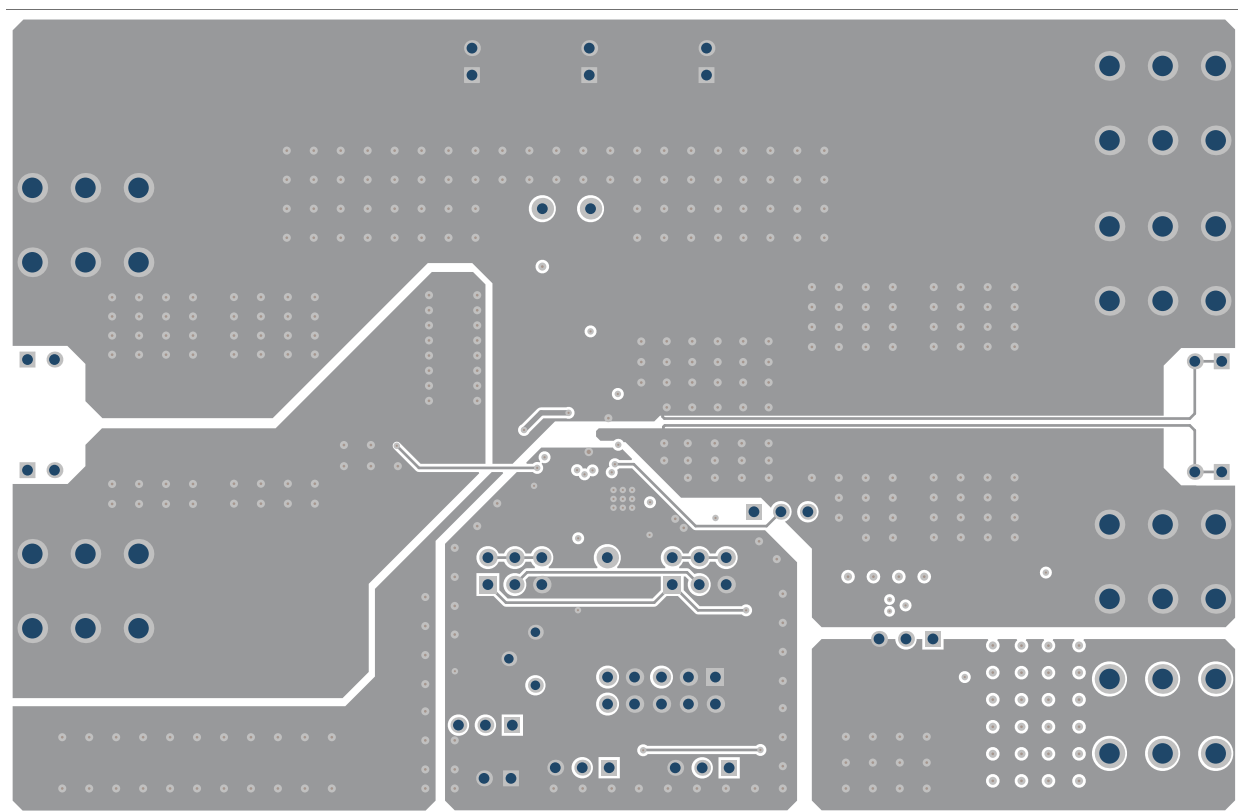


图 4-4. TPS61383QEVm-167 内层 2

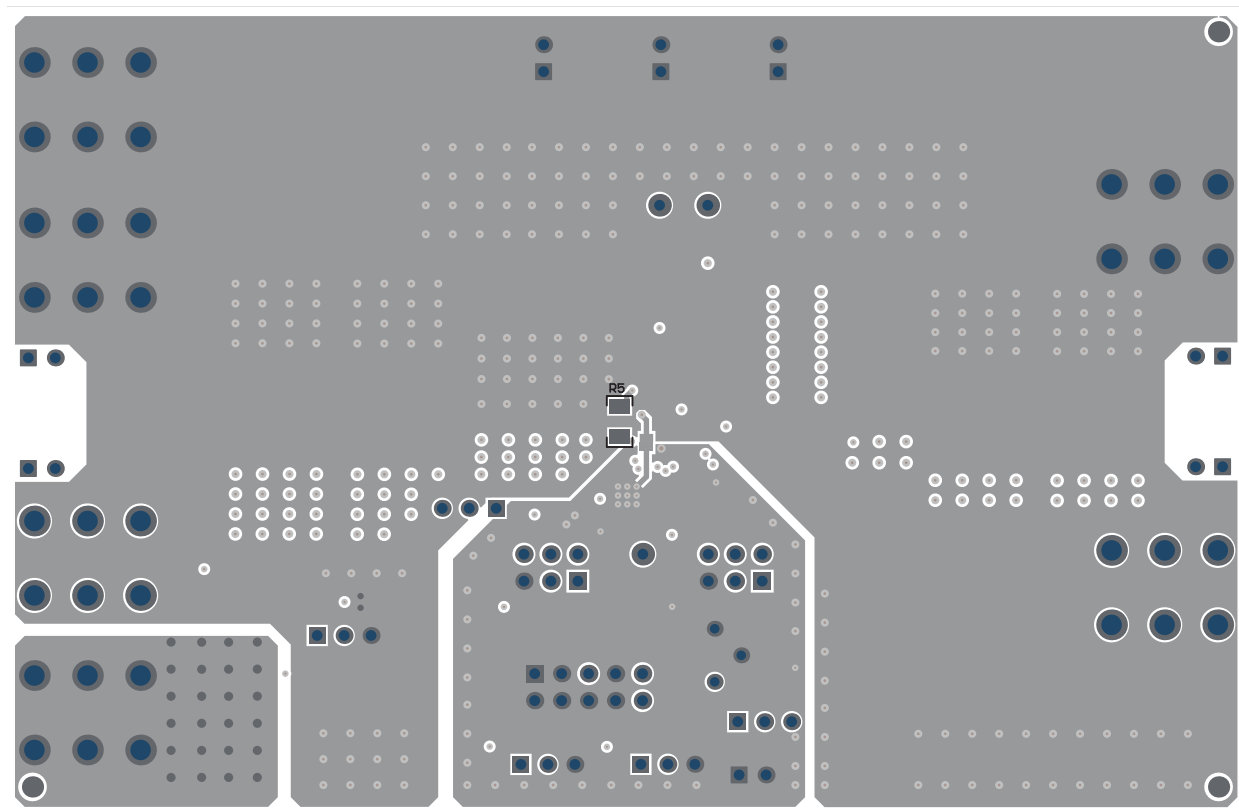


图 4-5. TPS61383QEVm-167 底面布局

4.3 物料清单

表 4-1. 物料清单

位号	数量	值	说明	封装	器件型号	制造商
C1、C2、C14、C15	4	100uF	电容，混合聚合物，100μF，50V，+/-20%，0.028 Ω，AEC-Q200 1 级，D10xL10.2mm SMD	Panasonic_G	EEH-ZC1H101P	Panasonic
C3、C4、C5、C8、C9、C10、C11、C12、C13	9	10uF	电容，陶瓷，10μF，50V，+/-10%，X7R，AEC-Q200 1 级，1206	1206_190	CGA5L1X7R1H106K160AC	TDK
C6	1	4.7μF	适用于符合 AEC-Q200 标准的信息娱乐用片状多层陶瓷电容器 4.7uF ±10% 16V X7S SMD 0603	FP-GRT188C71C475KE13D_0603-MFG	GRT188C71C475KE13D	Murata
C7、C16	2	1uF	电容，陶瓷，1μF，50V，+/-20%，X5R，AEC-Q200 3 级，0603	0603	GRT188R61H105ME13D	MuRata
C17	1	0.47uF	电容，陶瓷，0.47μF，50V，+/- 10%，X7R，AEC-Q200 1 级，0603	0603	CGA3E3X7R1H474K080AB	TDK
C19、C20、C27	3	0.1uF	电容，陶瓷，0.1μF，16V，±5%，X7R，AEC-Q200 1 级，0402	0402	GCM155R71C104JA55D	MuRata
C21	1	30pF	电容器，陶瓷，30pF，100V，+/-1%，C0G/NP0，AEC-Q200 1 级，0603	0603	GCM1885C2A300FA16D	MuRata
C22	1	0.012uF	电容，陶瓷，1μF，50V，+/-10%，X7R，AEC-Q200 0.012 级，0603	0603	C0603C123K5RAC TU	Kemet
C23、C26	2	0.1uF	电容，陶瓷，1μF，50V，+/-10%，X7R，AEC-Q200 0.1 级，0603	0603	06035C104KAZ2A	AVX
C24	1	10uF	电容，陶瓷，10μF，50V，+/- 10%，X5R，AEC-Q200 1 级，1206	1206_180	GRT31CR61H106KE01L	MuRata
C25	1	10uF	电容，陶瓷，10μF，10V，+/-10%，X7R，AEC-Q200 1 级，0805	0805_HV	GCJ21BR71A106KE01L	MuRata
D1、D2	2	60V	二极管，肖特基，60V，1A，AEC-Q101，PowerDI323	PowerDI323	PD3S160Q-7	Diodes Inc.
D3	1		二极管，肖特基，30V，2A，表面贴装 PowerDI123	FP-DFLS230LQ-7_PowerDI123-MFG	DFLS230LQ-7	Diodes Inc.

表 4-1. 物料清单 (续)

位号	数量	值	说明	封装	器件型号	制造商
FID1、 FID2、 FID3、 FID4、 FID5、FID6	6		基准标记。没有需要购买或安装的元件。	Fiducial10-20	不适用	不适用
J1、J2、 J3、J4、 J5、J6	6		端子螺钉 PC 30AMP , TH	SCREW_TERMINAL_8199	8199	Keystone
J7	1		接头 (有罩) , 100mil , 5x2 , 金 , TH	CONN_5103308-1	5103308-1	TE Connectivity
J8、J9、 J10、J11、 J12、J13、 J14、J15	8		接头 , 100mil , 2x1 , 锡 , TH	CONN_PEC02SAAN	PEC02SAAN	Sullins Connector Solutions
JP1、JP2、 JP4、JP5、 JP7	5		接头 , 100mil , 3x1 , 锡 , TH	CONN_PEC03SAAN	PEC03SAAN	Sullins Connector Solutions
JP3、JP6	2		接头 , 100mil , 3x2 , 锡 , TH	SULLINS_PEC03DAAN	PEC03DAAN	Sullins Connector Solutions
L1	1	2.2uH	屏蔽式功率电感器 2.2uH 20% 28.5A 1.6mΩ DCRmax , AECQ200 , 13.4x15.0x13.0mm SMT	FP- XGL1313-222MED_SMT_I ND_13MM4_15MM0-MFG	XGL1313-222MED	Coilcraft
Q1	1		P 沟道 60V 30A (Tc) 125W (Tc) 表面贴装 PG-TO252-3	FP- SPD30P06PGBTMA1_TO2 52-3-MFG	SPD30P06PGBTMA1	Infineon
Q2	1		N 沟道 40V 154A (Tj) 83W (Tc) 表面贴装 PG-TSDSON-8-44	FP- IAUZN04S7L019ATMA1_T SDSON8-MFG	IAUZN04S7L019ATMA1	Infineon
R1	1	100k	电阻 , 100k , 1% , 0.1W , AEC-Q200 0 级 , 0603	0603	CRCW0603100KFEA	Vishay-Dale
R2、R4、 R12	3	0	电阻 , 0 , 5% , 0.063W , AEC-Q200 0 级 , 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R5	1	1.0	电阻 , 1.0 , 5% , 0.5W , 1206	1206	CRM1206-JW-1R0ELF	Bourns

表 4-1. 物料清单 (续)

位号	数量	值	说明	封装	器件型号	制造商
R6、R10	2	10.0k	电阻, 10.0k, 1%, 0.1W, AEC-Q200 0 级, 0603	0603	CRCW060310K0FK EA	Vishay-Dale
R7、R8、R9	3	10.0k	电阻, 10.0k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW040210K0FK ED	Vishay-Dale
R11	1	50k Ω	微调电位计、铅密封型多圈 PV37 系列、TH	Bourns_PV37W	PV37W503C01B00	Bourns
SH-J1、SH-J2、SH-J3、SH-J4、SH-J5	5		分流器, 2.54mm, 金, 黑色	Wurth_60900213421	60900213421	Wurth Elektronik
TP1、TP2、TP3	3		测试点, 微型, 橙色, TH	Keystone5003	5003	Keystone Electronics
U1	1		TPS61383QRAVQ1	RAV0024A-MFG	TPS61383QRAVQ1	德州仪器 (TI)
U2	1		汽车类、150mA、高电压、超低 IQ 低压降 (LDO) 线性稳压器, DRV0006A (WSON-6)	DRV0006A	TPS7B8133QDRVR Q1	德州仪器 (TI)

5 其他信息

5.1 商标

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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 instructions, 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。

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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

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.

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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, INDEMNITY 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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