EVM User's Guide: TPS61371EVM

带 I2C 接口的 TPS61371 升压转换器评估模块

说明

TPS61371EVM-155 旨在演示 TPS61371 器件的特性和功能，后者是一款具有 I^2C 接口的高性能、高效率同步降压/升压转换器。TPS61371EVM 的出厂默认设置允许在 2.7V 至 5.5V 的输入电压范围内运行。

开始使用

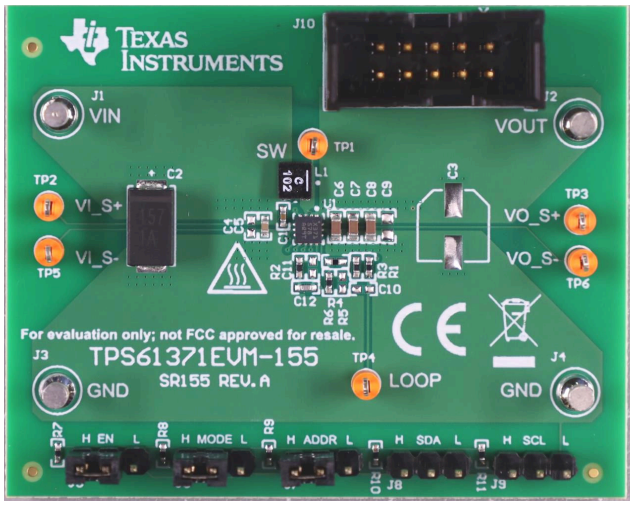
1. 在 ti.com 上订购 EVM。
2. 请仔细阅读本用户指南。
3. 按照说明准备工作台设置。在处理 EVM 时采取预防措施，防止 ESD 造成损坏。
4. 按照建议的步骤为 EVM 上电。
5. 运行测试和测量。在测试期间，请注意 EVM 产生的高压和高温。

特性

- V_{IN} 范围为 2.7V 至 5.5V
- 通过 I^2C 实现可编程参考电压（0.324V 至 0.959V），默认 0.594V
- 可选择输出放电
- 关断期间负载断开
- 引脚可选的 PFM/FPWM 模式
- 采用锁存类型的输出短路和过压保护

应用

- NAND 闪存
- 光学传感器驱动器
- 射频功率放大器



TPS61371EVM

1 评估模块概述

1.1 简介

该 EVM 专为 2.7V 至 5.5V 输入电压和 11V 输出电压应用而设计。EN 跳线 (J5) 控制器件的导通和关断。MODE 跳线 (J6) 控制切换轻载时的 PFM 或 FPWM 模式。ADDR 跳线 (J7) 控制 I2C 地址。该 EVM 具有分别用于 SW 电压和环路测量的 TP1 和 TP4 测试点。可以根据数据表修改反馈分压器，以适合其他应用条件。

本用户指南介绍了 TPS61371EVM-155 评估模块的特性和操作。本文档提供了有关如何使用评估模块的说明。本文档中的评估板、评估模块和 EVM 等术语均指 TPS61371EVM-155。本文档还包含原理图、参考印刷电路板 (PCB) 布局和完整的物料清单 (BOM)。

小心

表面高温！接触会导致烫伤。请勿触摸！

1.2 套件内容

表 1-1 详细说明了 EVM 套件的内容。

表 1-1. EVM 套件物品

项目	数量
TPS61371EVM-155	1

1.3 规格

表 1-2 提供了 TPS61371EVM 性能规格的汇总。所有规格均为在 25°C 环境温度下的值。

表 1-2. 性能规格汇总

参数	测试条件	值	单位
输入电压		2.7 – 5.5	V
输出电压		11	V
最大输出电流	V_{IN} ≥ 3.3V，V_{OUT} = 11V	0.6	A

1.4 器件信息

TPS61371 是内置了负载断开功能的完全集成型同步升压转换器。该器件可支持高达 16V 的输出电压（电流限制为 3.8A）。输出电压可通过反馈电阻器或 I^2C 控制的基准电压 V_{REF} 更改。输入电压的范围为 2.7V 至 5.5V，可支持通过单节锂离子电池或 3.3V/5V 总线供电的应用。

2 硬件

本节介绍了如何正确连接、设置和使用 TPS61371EVM-155。

2.1 连接器和测试点说明

此 EVM 包含 I/O 连接器和测试点，如 表 2-1 中所示。电源必须连接到输入连接器 J1 和 J3。负载必须连接到输出连接器 J2 和 J4。

表 2-1. 连接器和测试点

参考指示符	说明
J1	输入电压正连接
J3	输入电压负连接
TP2	输入电压正检测连接
TP5	输入电压负检测连接
J2	输出电压正连接
J4	输出电压负连接
TP3	输出电压正检测连接
TP6	输出电压负检测连接
J10	I^2C USB2ANY 连接器

2.2 跳线配置

2.2.1 J5（使能）

J5 跳线可启用器件。默认情况下，将此跳线置于 L 位置。将跳线置于 H 位置可启用器件。

2.2.2 J6（模式）

J6 跳线选择 TPS61371 的轻负载运行模式。在 H 位置放置该跳线，将器件设置为 FPWM 模式。默认情况下，将该跳线置于 L 位置可将器件设置为 PFM 模式，但在这种情况下，也可以通过设置寄存器中的 FPWM 位，将器件设置为 FPWM 模式。

2.2.3 J7（I^2C 目标地址选择）

J7 跳线用于 I^2C 目标地址选择。默认情况下此跳线设为 L 位置，器件 I^2C 目标地址为 74H。使跳线跨接 GPIO 和 H，以将 I^2C 目标地址设置为 72H。将跳线保持悬空状态，以将 I^2C 目标地址设置为 73H。

2.3 测试程序

1. 将电源电流限值设置为 4A。将电源电压设置为约 3.3V。关闭电源。将电源的正输出连接到 J1，负输出连接到 J3。
2. 将负载连接到 J2 实现正连接，将负载连接到 J4 实现负连接。
3. 打开电源。
4. 将 J5 跳线设为跨接 EN 和 H。默认输出电压为 11V。
5. 在 GUI 用户界面页面上将输出电压设为目标值。
6. 缓慢增大负载，同时监控 J2 和 J4 之间的输出电压。当负载电流小于 0.6A 时，让输出电压保持在调节的范围内。
7. 从 2.7V 至 5.5V 缓慢扫描输入电压。负载电流低于 表 1-2 中指定的最大负载电流时，让输出电压保持在调节范围内。
8. 关闭负载和电源。

3 软件

3.1 软件用户界面

3.1.1 安装 USB2ANY Explorer

从 USB2ANY 下载并安装 USB2ANY Explorer。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)。GUI 允许通过 TI USB2ANY 器件对器件进行简单而方便的编程。

1. 下载所需平台的 zip 文件。
2. 下载 GUI Composer Runtime。
3. 提取 zip 文件夹并安装 GUI。
4. 执行安装步骤。安装向导会显示 GUI Composer Runtime 提示，该过程将自动完成。
5. 打开 GUI。

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 TPS61371EVM-155 连接器 J10 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。

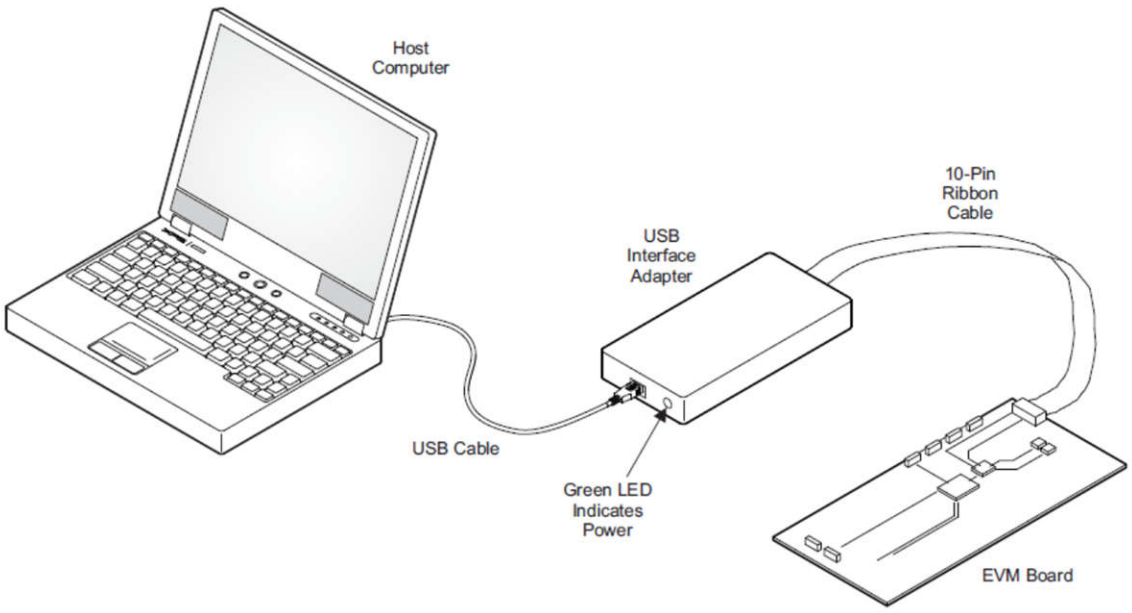


图 3-1. 快速连接概览

3.1.4 用户界面操作

请按照以下步骤启用 TPS61371EVM 板以运行：

1. 将 J5 置于 ON 位置。打开电源。
2. 打开 GUI。
3. 单击目标地址小部件页面左下角的 *Auto Connect*（自动连接）按钮（图 3-2）。该按钮将自动检查目标地址（0x72、0x73、0x74），并将 GUI 与器件连接。

图 3-2. GUI 自动连接按钮

4. 选择 *Start*（开始）按钮。该按钮将显示 TPS61371EVM-155 的 GUI 用户界面（图 3-3）。

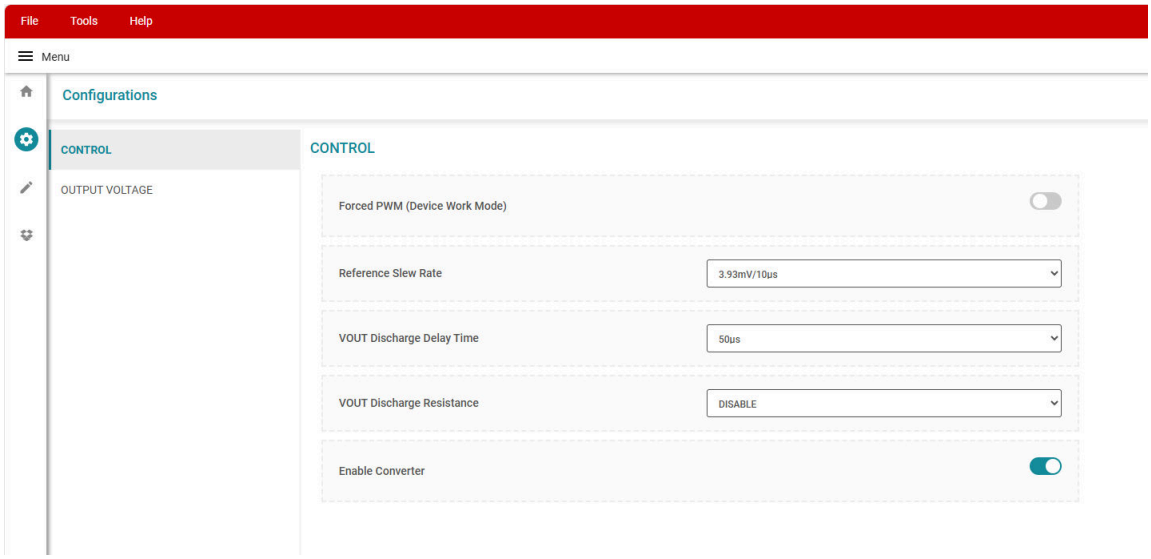


图 3-3. TPS61371EVM-155 的 GUI 用户界面

3.1.5 寄存器映射屏幕

*Register Map 屏幕*展示了寄存器的所有参数。在此处，单一寄存器可被读取或写入器件（如果适用）。另请参阅 *TPS61371 具有负载断开功能的 16V、3.8A 同步升压数据表*，了解有关 TPS61371 寄存器的详细说明。

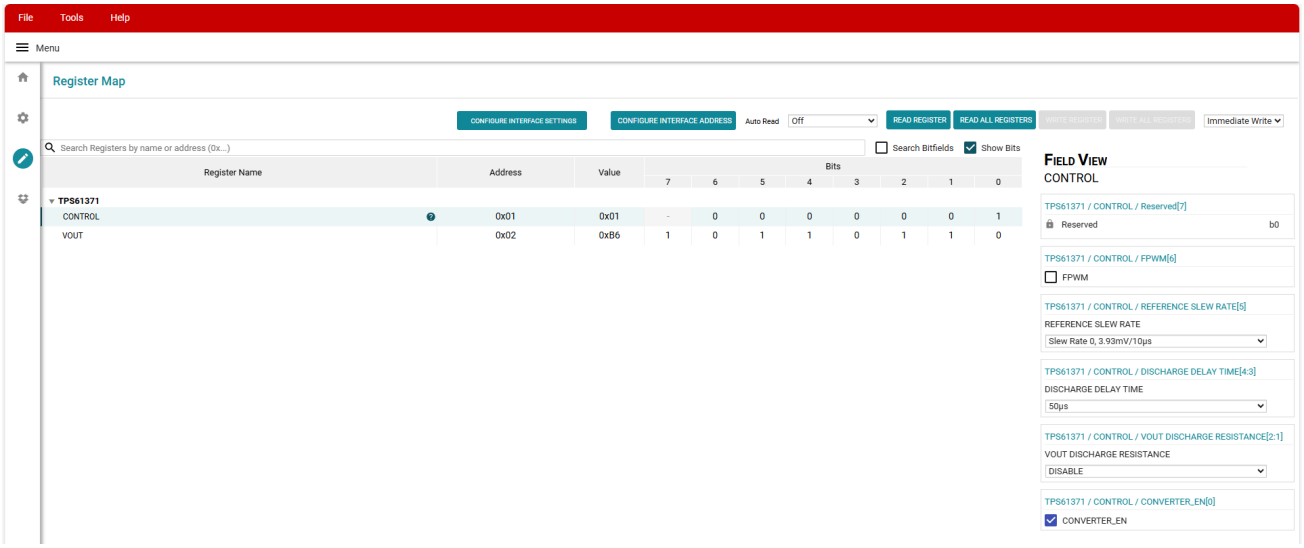


图 3-4. GUI 寄存器映射屏幕

4 硬件设计文件

本节提供了 TPS61371EVM-155 原理图、电路板布局布线和物料清单 (BOM)。

4.1 原理图

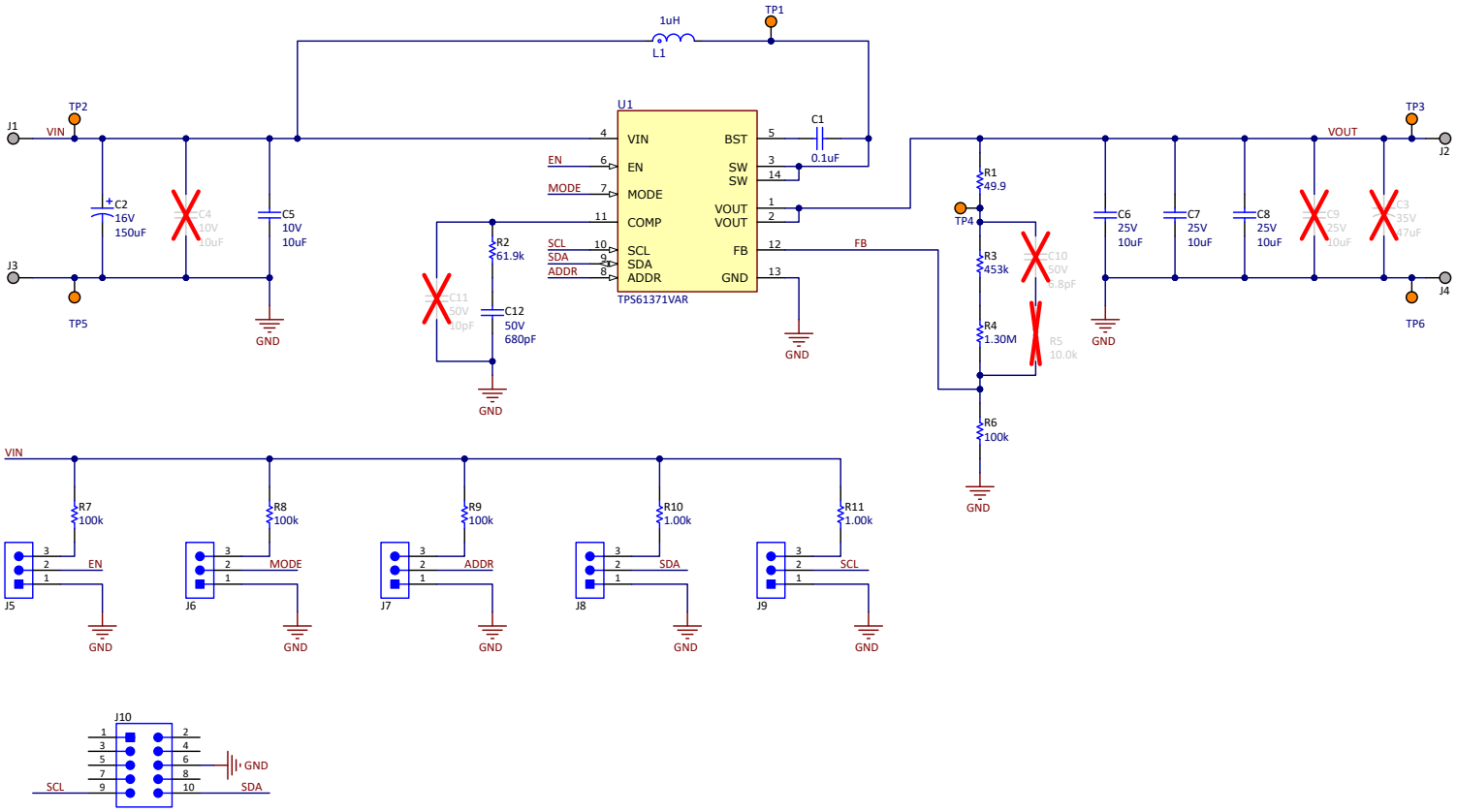


图 4-1. TPS61371EVM-155 原理图

4.2 PCB 布局

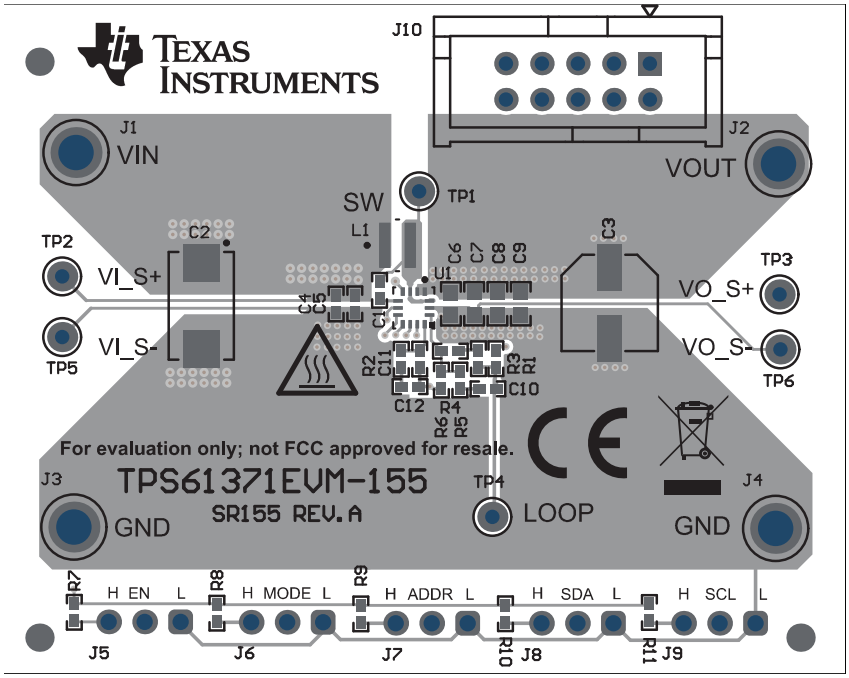


图 4-2. TPS61371EVM-155 顶面布局

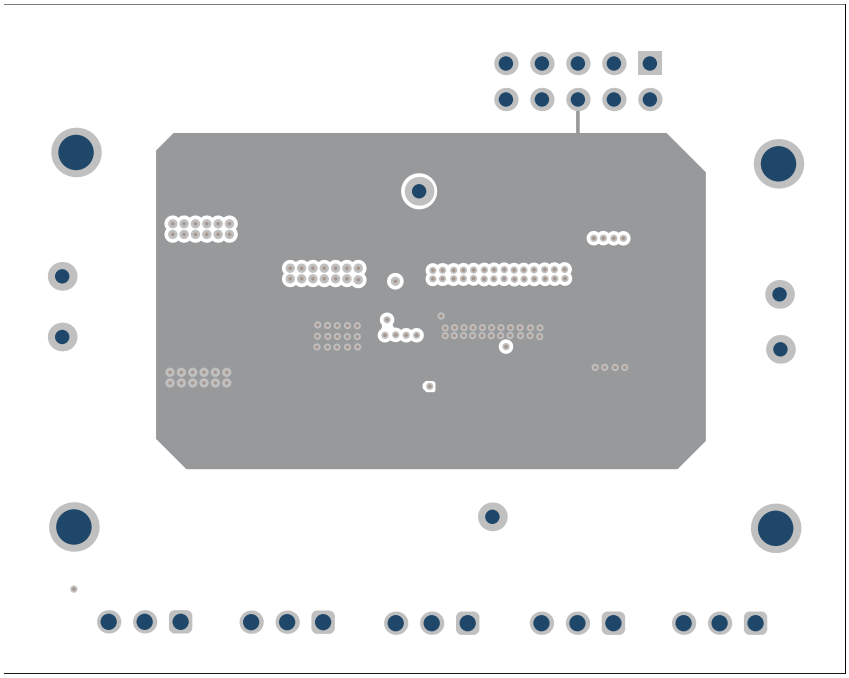


图 4-3. TPS61371EVM-155 内层 1

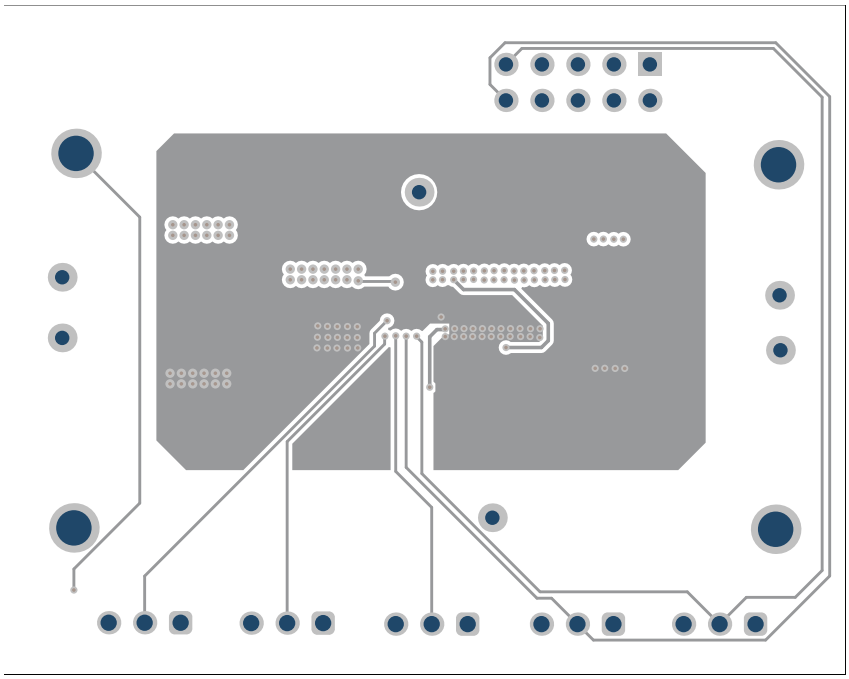


图 4-4. TPS61371EVM-155 内层 2

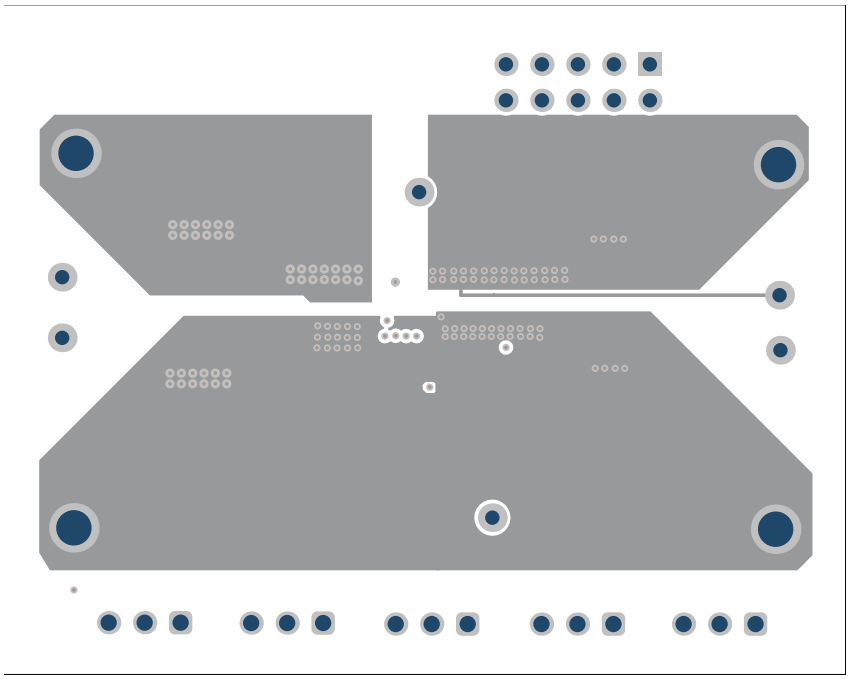


图 4-5. TPS61371EVM-155 底面布局

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	1	0.1uF	电容，陶瓷，0.1µF，16V，+/-10%，X5R，0402	0402	GRM155R61C104KA88D	MuRata
C2	1	150uF	150µF 10V 铝聚合物电容器 2917（公制 7343）10mΩ	2917	ECASD61A157M010KA0	MuRata
C5	1	10uF	电容，陶瓷，10µF，10V，+/-20%，X5R，0402	0402	GRM155R61A106ME11D	MuRata
C6、C7、C8	3	10uF	电容，陶瓷，10µF，25V，+/-20%，X5R，0603	0603	GRM188R61E106MA73D	MuRata
C12	1	680pF	电容，陶瓷，680pF，50V，+/-5%，C0G/NP0，0402	0402	GRM1555C1H681JA01D	MuRata
J1、J2、J3、J4	4		引脚，双转塔，TH	Keystone1502-2	1502-2	Keystone
J5、J6、J7、J8、J9	5		接头，2.54mm，3x1，金，TH	接头，2.54mm，3x1，TH	61300311121	Wurth Elektronik
J10	1		接头（有罩），100mil，5x2，金，TH	5x2 有罩接头	5103308-1	TE Connectivity
L1	1	1µH	1µH 屏蔽模压电感器，4.9A，32.2mΩ（最大值，非标准）	SMD2	XGL3512-102MEC	Coilcraft
R1	1	49.9	电阻，49.9，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW040249R9FKED	Vishay-Dale
R2	1	61.9k	电阻，61.9k，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW040261K9FKED	Vishay-Dale
R3	1	453k	电阻，453k，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW0402453KFKED	Vishay-Dale
R4	1	1.30Meg	电阻，1.30M，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW04021M30FKED	Vishay-Dale
R6、R7、R8、R9	4	100k	电阻，100k，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW0402100KFKED	Vishay-Dale
R10、R11	2	1.00k	电阻，1.00k，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW04021K00FKED	Vishay-Dale
SH-J1、SH-J2、SH-J3	3		分流器，2.54mm，金，黑色	分流器，2.54mm，黑色	60900213421	Wurth Elektronik
TP1、TP2、TP3、TP4、TP5、TP6	6		测试点，微型，橙色，TH	橙色微型测试点	5003	Keystone Electronics
U1	1		具有负载断开功能的 16V、3.8A 同步升压转换器	WQFN-HR14	TPS61371VARR	德州仪器 (TI)

5 其他信息

5.1 商标

所有商标均为其各自所有者的财产。

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.

【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。
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。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 番 1 号

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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