

# **TPS61088Q1EVM-037 Evaluation Module User's Guide**

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This user's guide describes the characteristics, operation, and the use of the TPS61088Q1EVM-037 evaluation module (EVM). The EVM contains the TPS61088Q1, which is a high performance, high efficiency synchronous boost converter with 10 A switch current. The user's guide includes EVM specifications, recommended test setup, test result, schematic diagram, bill of materials, and the board layout.

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## **Trademarks**

All trademarks are the property of their respective owners.

## 1 Introduction

### 1.1 Performance specification

[Table 1](#) provides a summary of the TPS61088Q1 EVM performance specifications. All specifications are given for an ambient temperature of 25°C.

**Table 1. Performance Specification Summary**

SPECIFICATIO N	TEST CONDITIONS	MIN TYP MAX	UNIT
VIN		3.0, 3.6, 5	V
VOUT	TPS61088Q1EVM, VIN = 3.3 V, I <sub>o</sub> ≤ 2 A, f <sub>sw</sub> = 400 KHz	8.7, 9, 9.3	V

### 1.2 Modification

The printed-circuit board (PCB) for this EVM is designed to accommodate some modifications by the user. The external component can be changed according to the real application.

### 1.3 Input capacitor

A 100-μF tantalum capacitor C1 is added as the input capacitor in the EVM. The ESR of the tantalum capacitor is 0.1 Ω which helps to damp the ringing of the input voltage when the EVM is powered by a power supply with a long cable. The capacitor is not required for proper operation and can be removed in a real application.

### 1.4 Output Capacitor Selection

Four 22-μF ceramic capacitors C4, C5, C6 and C7 are added as the output capacitors. These capacitors can ensure the low output ripple at heavy load.

## 2 Setup

This section describes how to properly connect, set up, and use the TPS61088Q1EVM-037.

### 2.1 *Input/Output Connector Descriptions*

J1-VIN: Positive input connection from the input supply for the EVM

J2-GND: Return connection from the input supply for the EVM

J3-VOUT: Positive connection for the output voltage

J4-GND: Return connection for the output voltage

### 3 Schematic, Bill of Materials, and Board Layout

This section provides the TPS61088Q1EVM-037 schematic, bill of materials (BOM), and board layout.

#### 3.1 Schematic

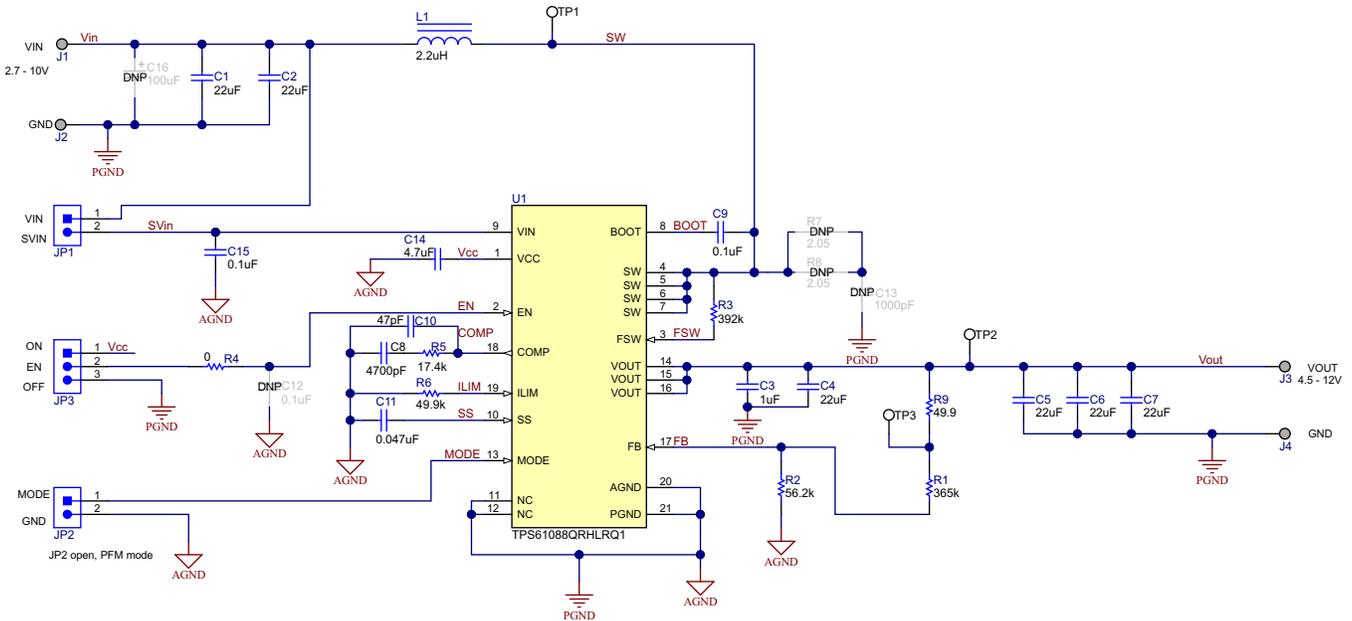


Figure 1. TPS61088Q1EVM-037 Schematic

#### 3.2 Bill of Materials

**Table 2. TPS61088Q1EVM-037 Bill of Materials**

Designator	QTY	Value	Description	Package	PartNumber	MFG
C1, C2	2	22 uF	CAP, CERM, 22 µF, 16 V,+/- 10%, X5R, 1206	1206	GRM31CR61C226KE15L	MuRata
C3	1	1 uF	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0603	0603	GRM188R71E105KA12D	MuRata
C4, C5, C6, C7	4	22 uF	CAP, CERM, 22 µF, 25 V,+/- 10%, X7R, 1210	1210	GRM32ER71E226KE15L	MuRata
C8	1	4700 pF	CAP, CERM, 4700 pF, 50 V, +/- 10%, X5R, 0402	0402	GRM155R61H472KA01D	MuRata
C9, C15	2	0.1 uF	CAP, CERM, 0.1 uF, 16 V, +/-10%, X5R, 0402	0402	GRM155R61C104KA88D	MuRata
C10	1	47 pF	CAP, CERM, 47 pF, 50 V, +/- 1%, C0G, 0402	0402	GRM1555C1H470FA01D	MuRata
C11	1	0.047 uF	CAP, CERM, 0.047 µF, 16 V, +/- 10%, X7R, 0402	0402	GRM155R71C473KA01D	MuRata
C14	1	4.7 uF	CAP, CERM, 4.7 uF, 10 V, +/-10%, X5R, 0603	0603	0603ZD475KAT2A	AVX
J1, J2, J3, J4	4	Double	Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
JP1, JP2	2		Header, 100 mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
JP3	1		Header, 100 mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
L1	1	2.2 uH	Inductor, Shielded, Composite, 2.2 µH, 12.7 A, 0.012 ohm, SMD	IND_6.4x3.1x6.6	XAL6030-222MEB	Coilcraft
R9	1	49.9	RES, 49.9 ohm, 1%, 0.063 W, 0402	0402	CRCW040249R9FKED	Vishay-Dale
R1	1	365 k	RES, 365 k, 1%, 0.063 W, 0402	0402	CRCW0402365KFKED	Vishay-Dale
R2	1	56.2 k	RES, 56.2 k, 1%, 0.063 W, 0402	0402	CRCW040256K2FKED	Vishay-Dale
R3	1	392 k	RES, 392 k, 1%, 0.063 W, 0402	0402	CRCW0402392KFKED	Vishay-Dale
R4	1	0	RES, 0 ohm, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America
R5	1	17.4 k	RES, 17.4 k ohm, 1%, 0.063 W, 0402	0402	CRCW040217K4FKED	Vishay-Dale
R6	1	49.9 k	RES, 49.9 k, 1%, 0.063 W, 0402	0402	CRCW040249K9FKED	Vishay-Dale
U1	1		10-A Fully-Integrated Synchronous Boost Converter, RHL0020A (VQFN-20)	RHL0020A	TPS61088QRHLRQ1	Texas Instruments
C16	0	100 uF	CAP, TA, 100 µF, 16 V, +/- 10%, 0.1 ohm, SMD	7343-43	T495X107K016ATE100	Kemet
C12	0	0.1 uF	CAP, CERM, 0.1 uF, 16 V, +/-10%, X5R, 0402	0402	GRM155R61C104KA88D	MuRata
C13	0	1000 pF	CAP, CERM, 1000 pF, 100 V, +/- 10%, X7R, 0603	0603	GRM188R72A102KA01D	MuRata
R7, R8	0	2.05	RES, 2.05, 1%, 0.1 W, 0603	0603	CRCW06032R05FKEA	Vishay-Dale

### 3.3 Board Layout

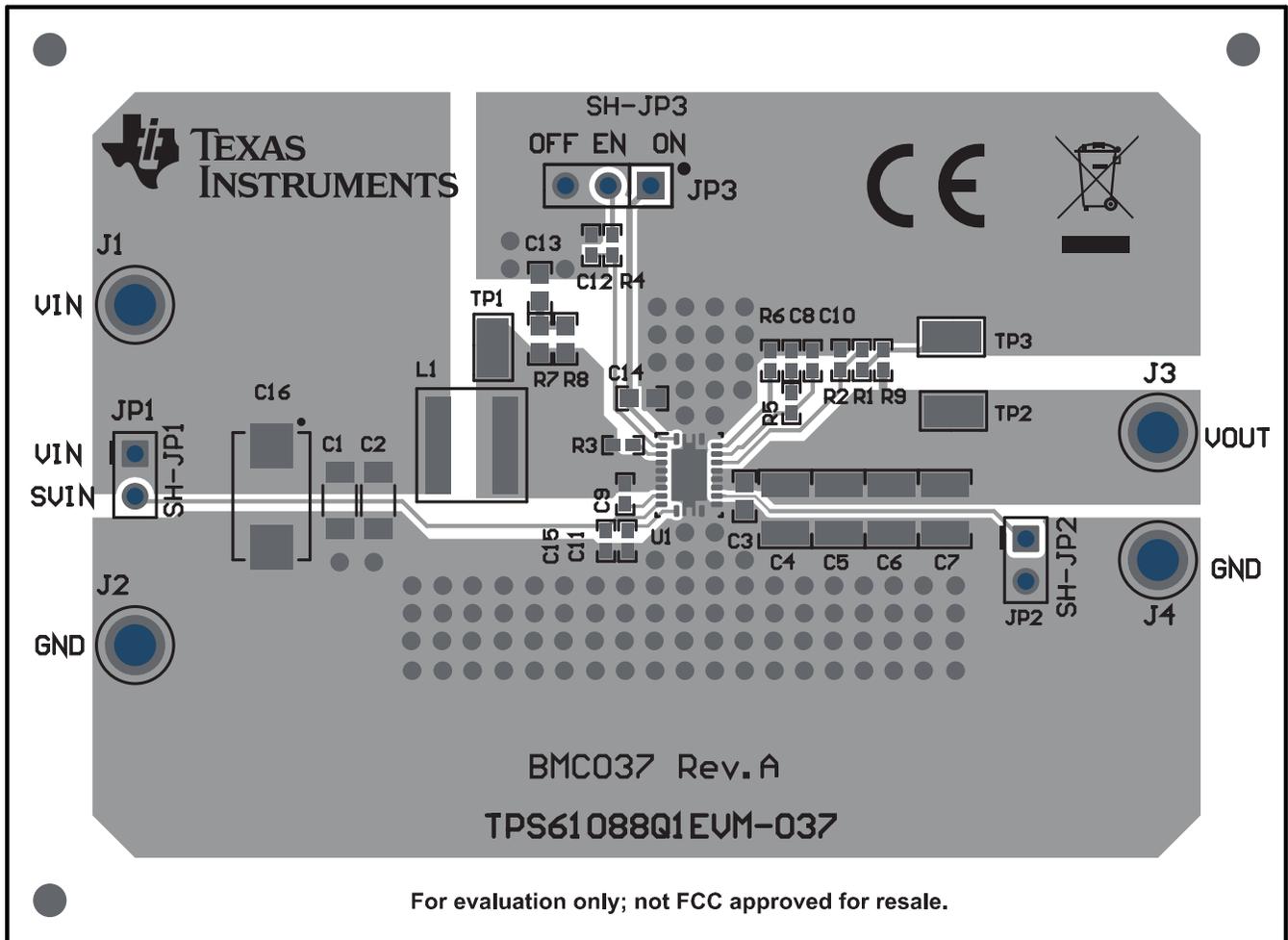
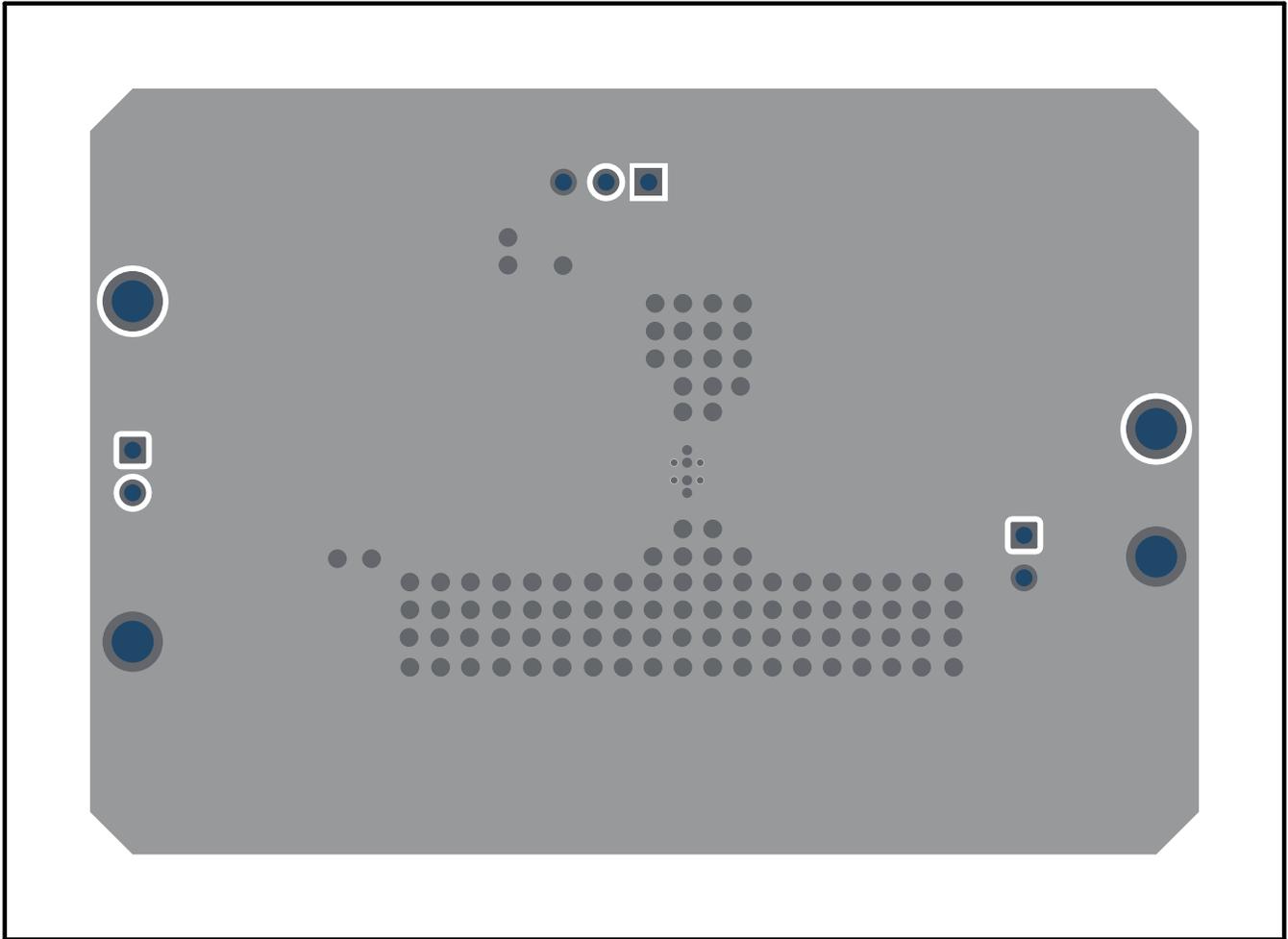


Figure 2. TPS61088Q1EVM-037 Top-Side Layout



**Figure 3. TPS61088Q1EVM-037 Bottom-Side Layout**

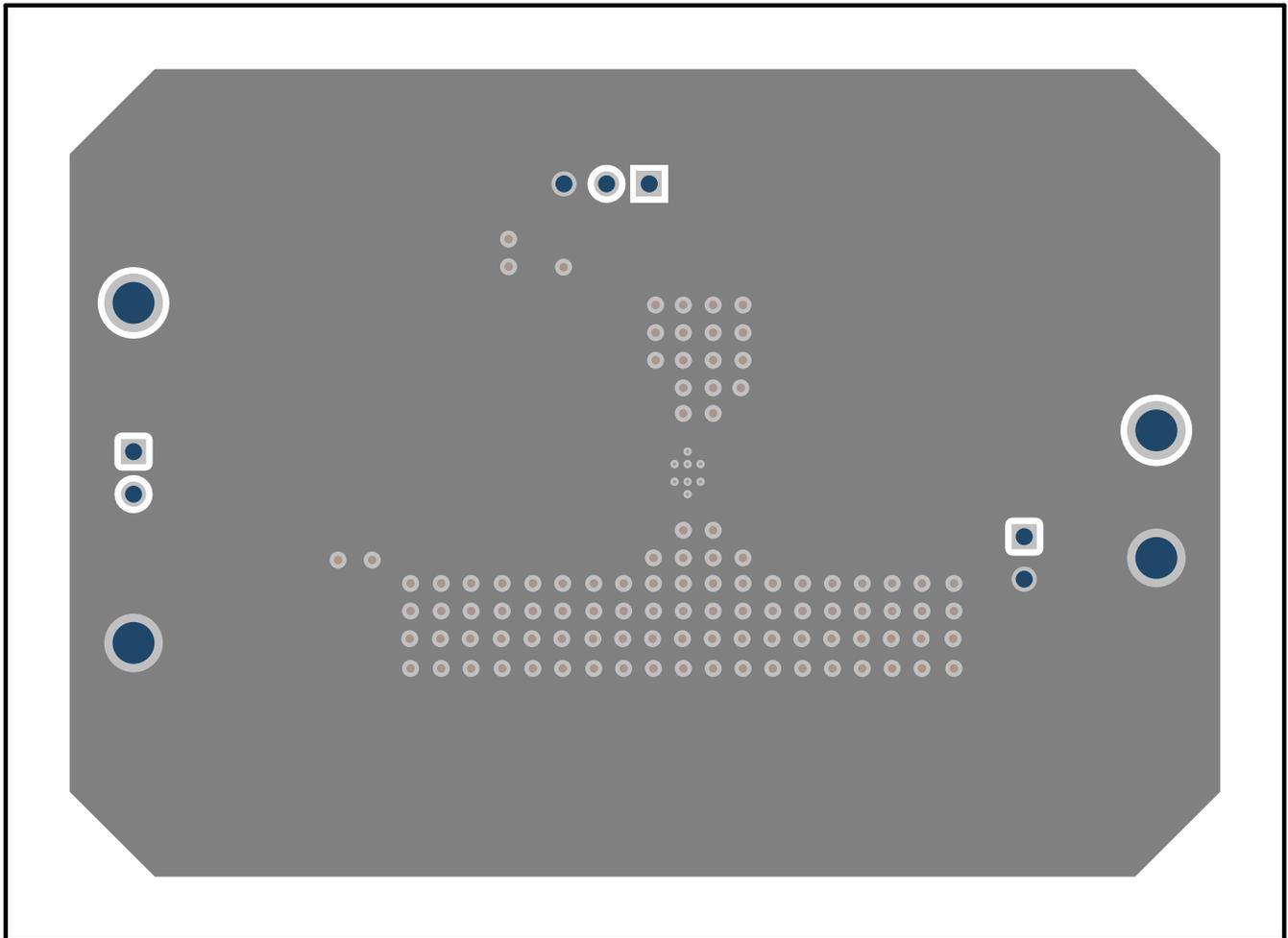


Figure 4. TPS61088Q1EVM-037 Inner Layer 1 Layout

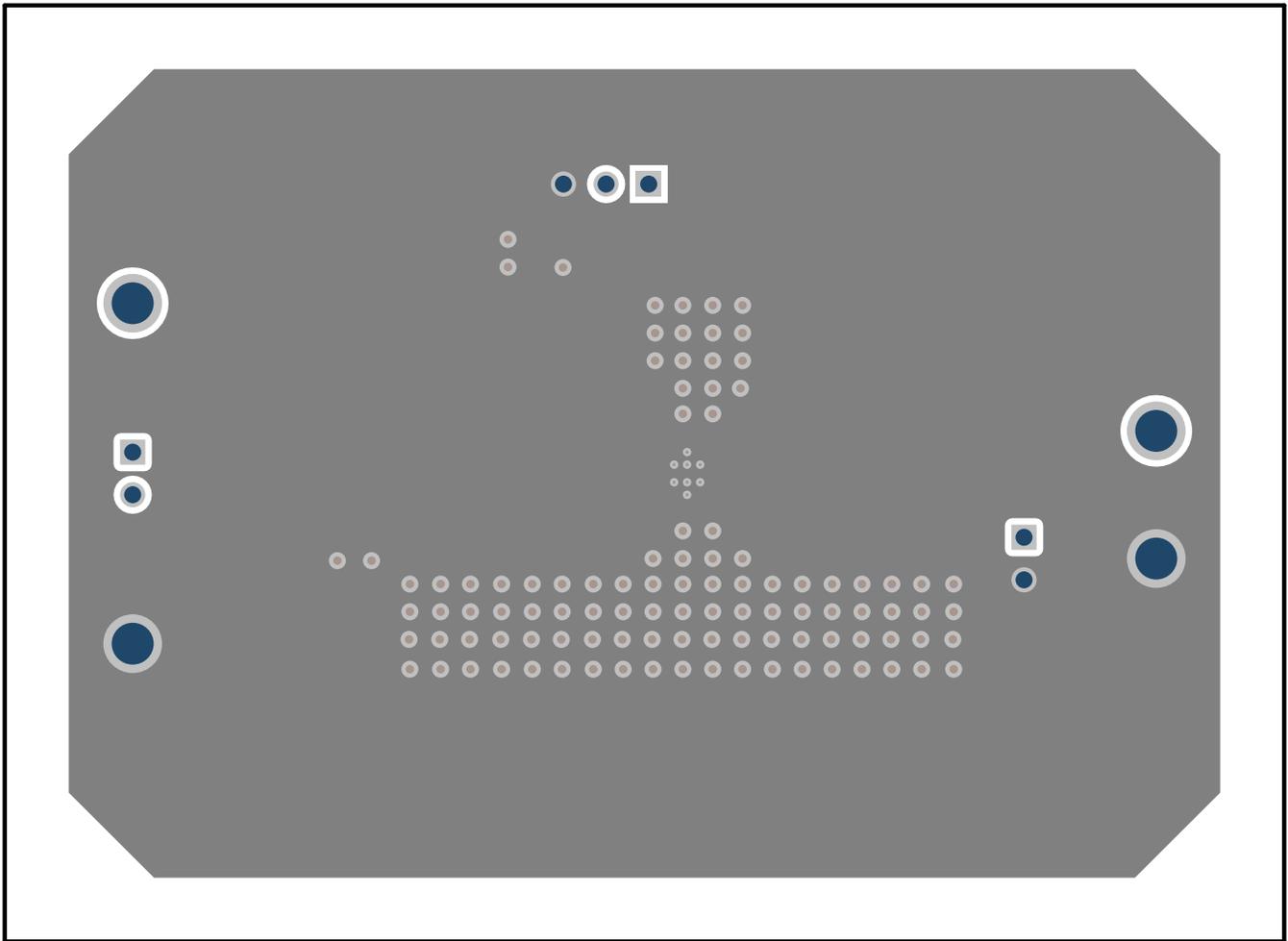


Figure 5. TPS61088Q1EVM-037 Inner Layer 2 Layout

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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.
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### **WARNING**

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

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

**NOTE:**

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

### 3 Regulatory Notices:

#### 3.1 United States

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

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

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

#### **CAUTION**

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

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

#### **FCC Interference Statement for Class A EVM devices**

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

#### **FCC Interference Statement for Class B EVM devices**

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

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

#### 3.2 Canada

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

#### **Concerning EVMs Including Radio Transmitters:**

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

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

#### **Concernant les EVMs avec appareils radio:**

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

#### **Concerning EVMs Including Detachable Antennas:**

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

### Concernant les EVMs avec antennes détachables

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

#### 3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page) 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

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

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

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

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

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2. 実験局の免許を取得後ご使用いただく。
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#### 3.4 European Union

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

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

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- 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.
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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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