User's Guide

TLV61070A Boost Converter Evaluation Module User's Guide

ABSTRACT

The TLV61070AEVM-095 evaluates the performance of the TLV61070A, which is a 2.5-A boost converter with 0.5-V ultra-low input voltage. This user's guide describes the following:

- Input and output ranges
- EVM setup
- Bill of materials (BOM)
- Schematic
- PCB layout

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Trademarks

1 Introduction

1.1 Performance

Table 1-1 provides a summary of the TLV61070AEVM performance characteristics tested at 25°C ambient temperature.

Table 1-1. EVM Characteristics

	Test Conditions	MIN	TYP	MAX	Unit
Input voltage			3.6		V
Output voltage	TLV61070AEVM, V_{IN} = 3.6 V, I_O ≤ 1 A		5		V
Output current	V_{IN} = 3.6 V			1	A
	V_{IN} = 1.8 V			0.5	

1.2 Modification

The EVM is designed to support some modifications by the user. The external component can be changed according to the real application.

1.3 Input Capacitor

A 150-µF tantalum capacitor, C2, is added as the input capacitor in the EVM, The ESR of the tantalum capacitor is 0.1Ω, 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 Feedforward Capacitor

A feedforward capacitor, C9, can help to improve the response performance and the phase margin if the value is properly selected. Refer to the *Feedforward Capacitor Makes Boost Converter Fast and Stable* application note to select the feedforward capacitor if required.

2 Setup

This section describes the setup of the TLV61070AEVM-095.

2.1 Input/Output Connector Descriptions

Connector	Description
TP1-VIN	Positive input connection from the input supply for the EVM
TP2-VOUT	Positive connection for the output voltage
TP3-GND	Return connection from the input supply for the EVM
TP4-GND	Return connection for the output voltage
J1-VIN_S	Input voltage sensing for measuring efficiency. S+ is for positive input and S– is for negative input.
J2-VOUT_S	Output voltage sensing for measuring efficiency. S+ is for output positive node and S– is for output negative node.
JP1-EN	EN pin input jumper. Place a jumper across EN and ON to turn on the IC. Place a jumper across EN and OFF to turn off the IC.

3 Schematic and Bill of Materials

This section provides the TLV61070AEVM-095 schematic, bill of materials (BOM), and board layout.

3.1 Schematic

Figure 3-1 is the EVM schematic.

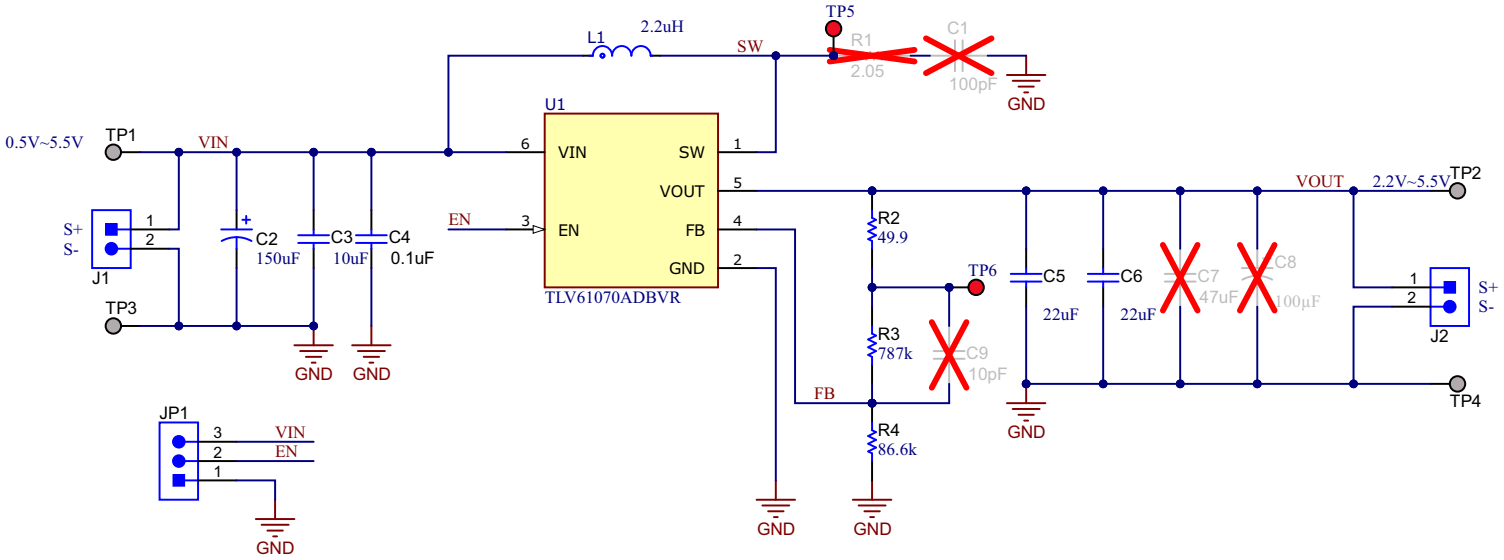

Figure 3-1. TLV61070AEVM-095 Schematic

3.2 Bill of Materials

Table 3-1 shows the EVM bill of materials.

Table 3-1. TLV61070AEVM-095 Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C2	1	150 µF	CAP, TA, 150 µF, 10 V, ±10%, 0.1 Ω, SMD	7343-31	T495D157K010ATE100	Kemet
C3	1	10 µF	CAP, CERM, 10 µF, 10 V, ±20%, X5R, 0603	0603	GRM188R61A106MAALD	MuRata
C4	1	0.1 µF	CAP, CERM, 0.1 µF, 10 V, ±10%, X5R, 0402	0402	GRM155R61A104KA01D	MuRata
C5, C6	2	22 µF	CAP, CERM, 22 µF, 10 V, ±20%, X5R, 0603	0603	GRM187R61A226ME15D	MuRata
J1, J2	2		Header, 2.54 mm, 2 × 1, Gold, TH	Header, 2.54 mm, 2 × 1, TH	61300211121	Wurth Elektronik
JP1	1		Header, 100 mil, 3 × 1, Gold, TH	3 × 1 Header	TSW-103-07-G-S	Samtec
L1	1	2.2 µH	Inductor Power Shielded Wirewound 2.2 µH 20% 1 MHz Composite 8.7 A 15 mΩ DCR Automotive T/R	SMT_IND_4MM0_4MM0	XGL4030-222MEC	Coilcraft
R2	1	49.9	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060349R9FKEA	Vishay-Dale
R3	1	787 k	RES, 787 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603787KFKEA	Vishay-Dale
R4	1	86.6 k	RES, 86.6 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060386K6FKEA	Vishay-Dale
SH-JP1	1		Shunt, 100 mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1, TP2, TP3, TP4	4		Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
TP5, TP6	2		Test Point, Compact, Red, TH	Red Compact Testpoint	5005	Keystone
U1	1		2.5-A Boost Converter with 0.5-V Ultra-low Input Voltage	SOT23-6	TLV61070ADBVR	Texas Instruments
C1	0	100 pF	CAP, CERM, 100 pF, 50 V, ±5%, C0G/NP0, 0603	0603	GRM1885C1H101JA01D	MuRata
C7	0	47 µF	CAP, CERM, 47 µF, 10 V, ±10%, X5R, 1206	1206	GRM31CR61A476KE15L	MuRata
C8	0	100 µF	CAP, Aluminum Polymer, 100 µF, 25 V, ±20%, 0.03 Ω, AEC-Q200 Grade 2, D6.3 × L7.7 mm SMD	D6.3 × L7.7 mm	EEH-ZA1E101XP	Panasonic
C9	0	10 pF	CAP, CERM, 10 pF, 10 V, ±10%, X7R, 0603	0603	0603ZC100KAT2A	AVX
R1	0	2.05	RES, 2.05, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06032R05FKEA	Vishay-Dale

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Table 3-1 shows the EVM bill of materials.

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L1	1	2.2 µH	Inductor Power Shielded Wirewound 2.2 µH 20% 1 MHz Composite 8.7 A 15 mΩ DCR Automotive T/R	SMT_IND_4MM0_4MM0	XGL4030-222MEC	Coilcraft
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C9	0	10 pF	CAP, CERM, 10 pF, 10 V, ±10%, X7R, 0603	0603	0603ZC100KAT2A	AVX
R1	0	2.05	RES, 2.05, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06032R05FKEA	Vishay-Dale

4 Board Layout

The PCB of the TLV61070AEVM has four layers. Figure 4-1 and Figure 4-4 illustrate top and bottom side PCB layout. The two inner layers are ground plane helping improve the thermal performance.

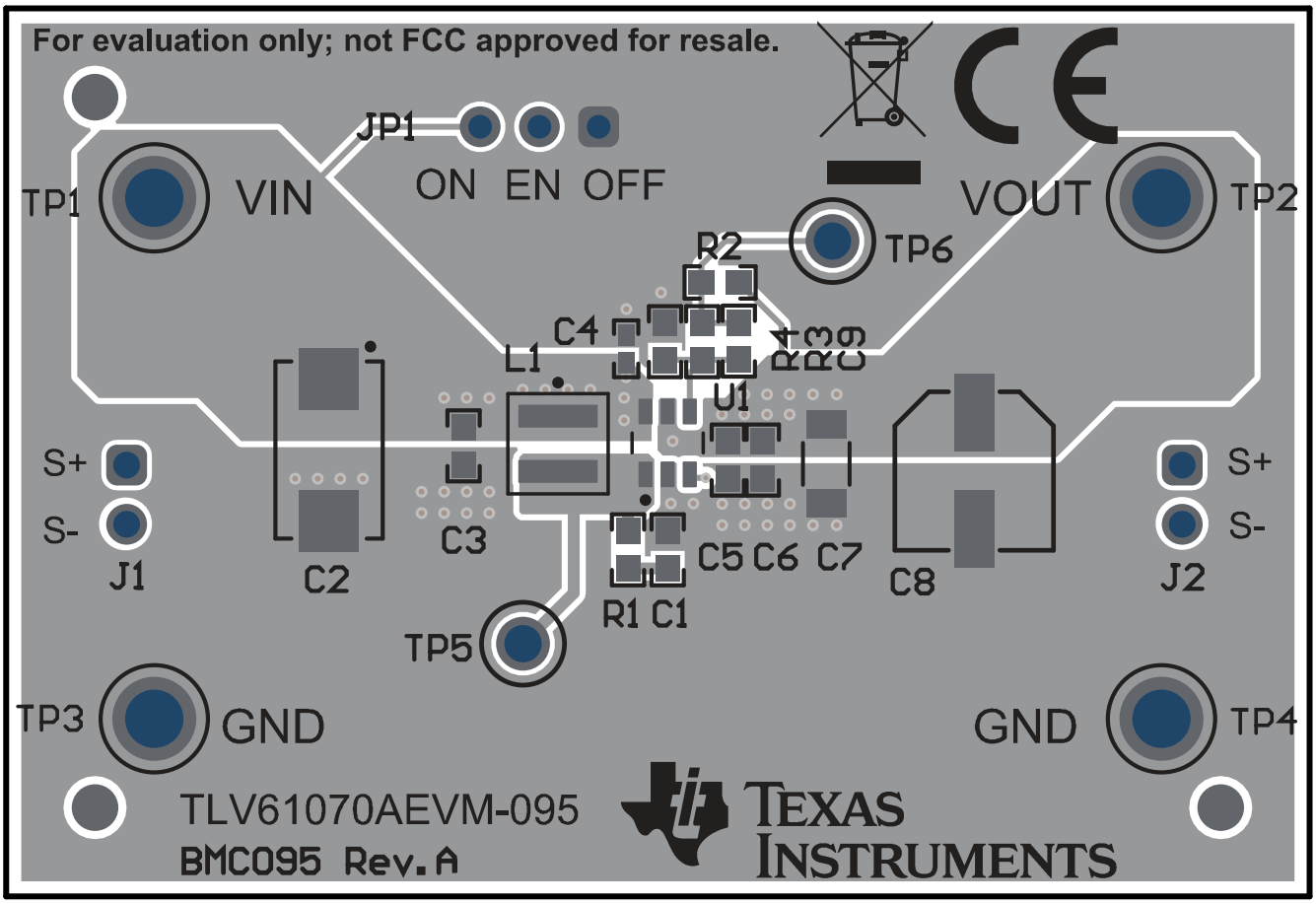

Figure 4-1. TLV61070AEVM-095 Top-Side Layout

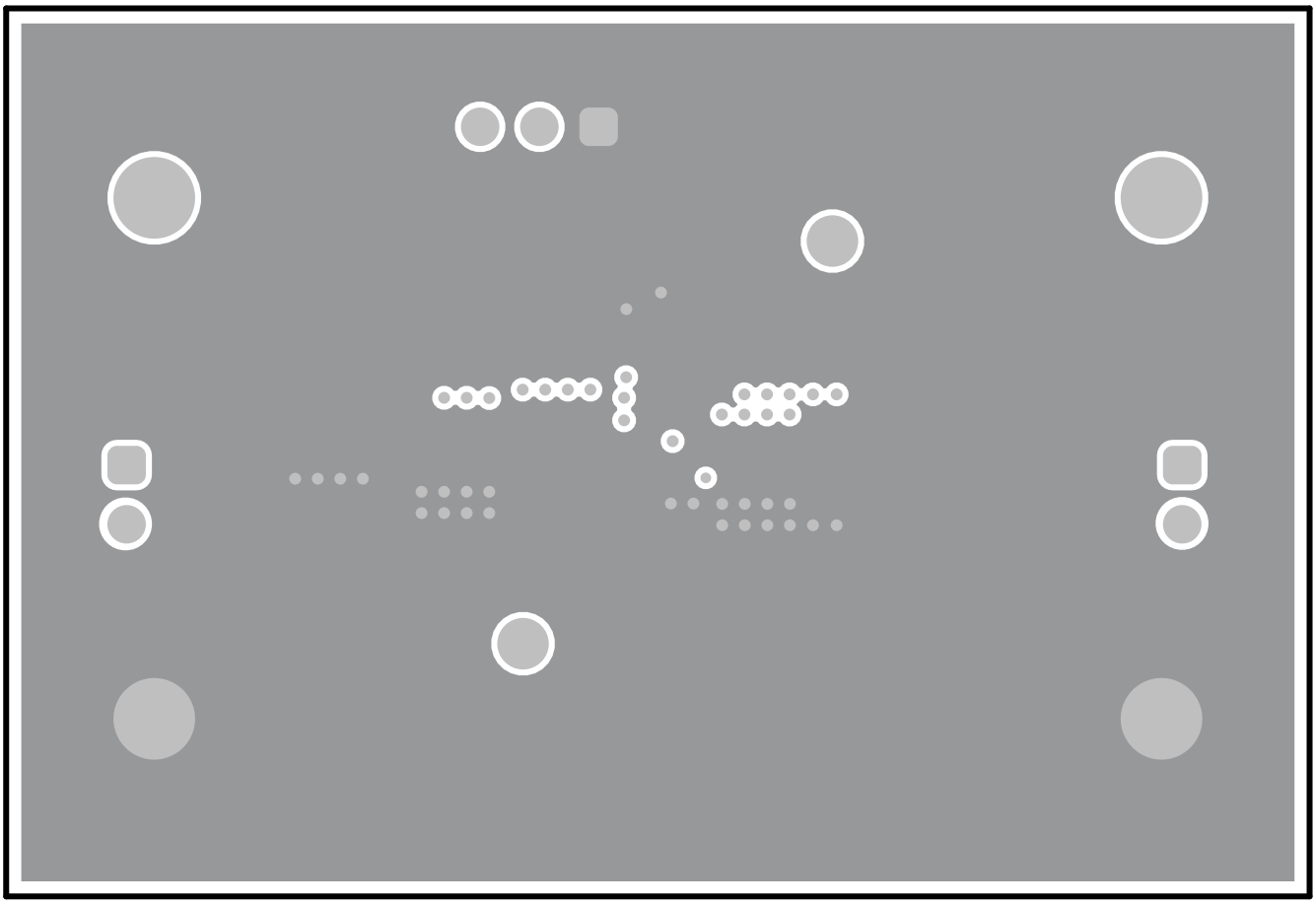

Figure 4-2. TLV61070AEVM-095 Inner Layer 1 Layout

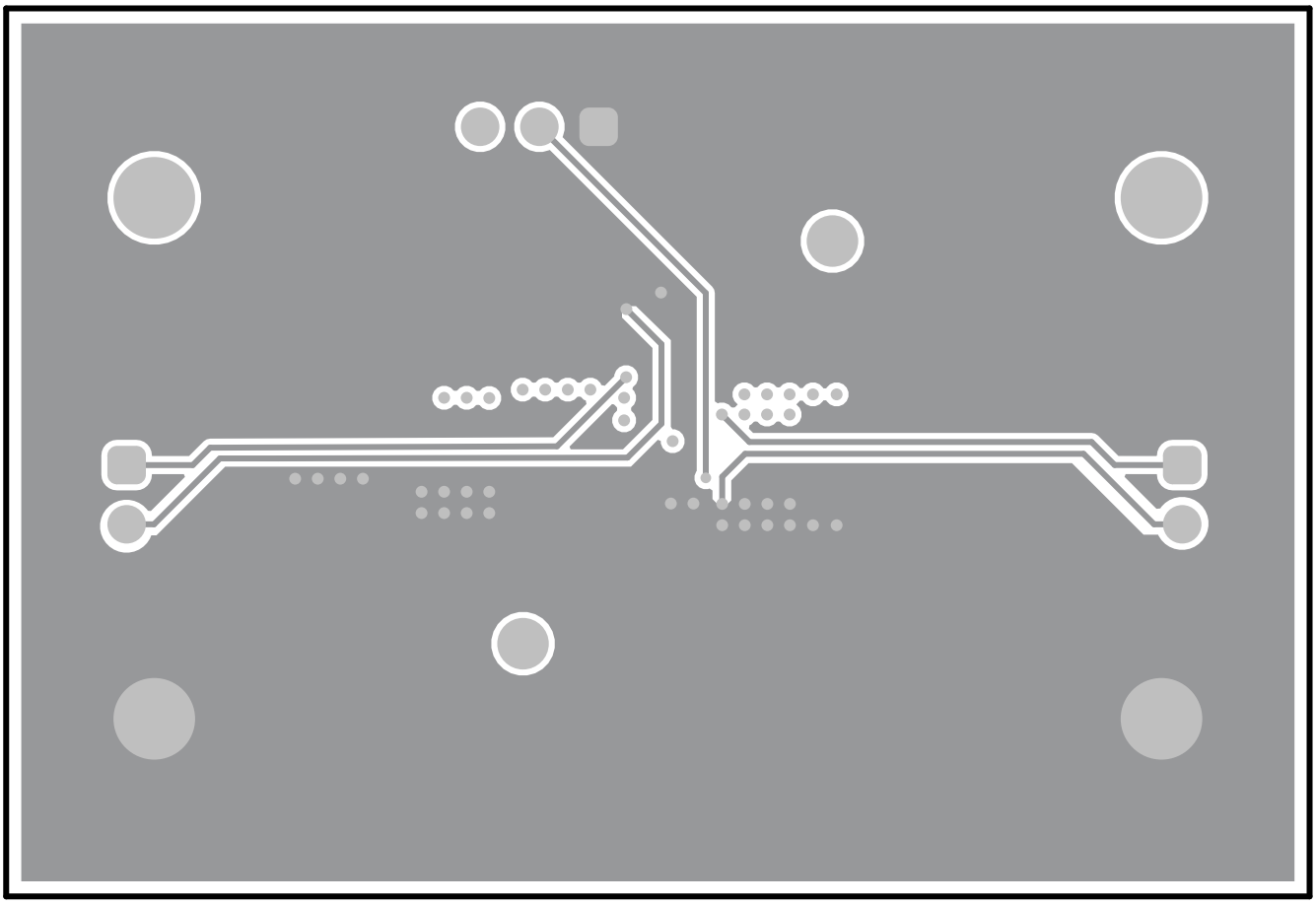

Figure 4-3. TLV61070AEVM-095 Inner Layer 2 Layout

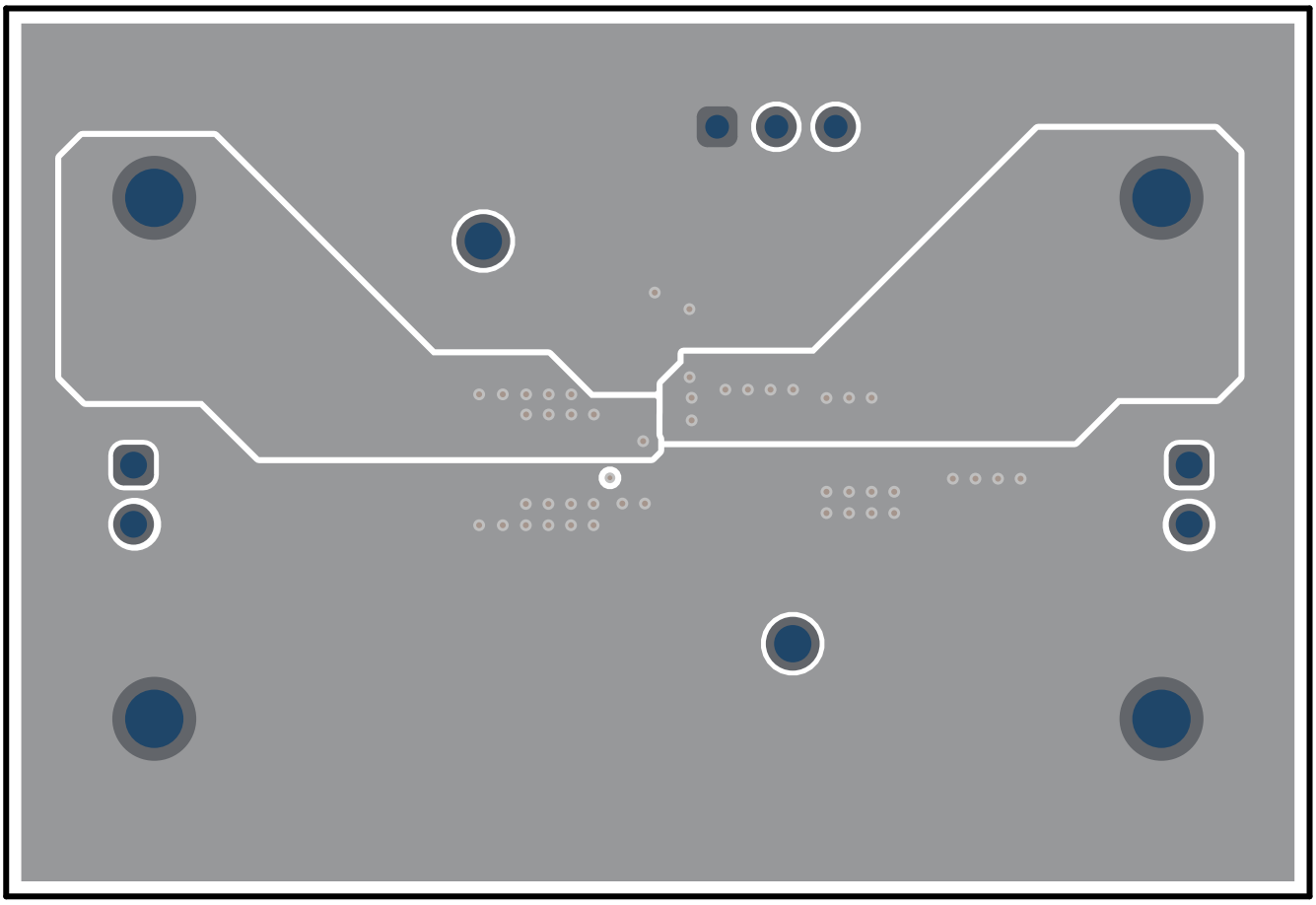

Figure 4-4. TLV61070AEVM-095 Bottom-Side Layout

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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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   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。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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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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。

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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。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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.

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