

## **TPS61089-PWR742 Evaluation Module**

This user's guide describes the characteristics, operation, and the use of the TPS61089EVM-742 evaluation module (EVM). The EVM contains the TPS61089, which is a 7-A boost converter with 12.6-V maximum output voltage. This user's guide includes EVM specifications, recommended test setup, test results, a schematic diagram, bill of materials (BOM), and the board layout.

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## 1 Introduction

### 1.1 Performance Specification

Table 1 provides a summary of the TPS61089EVM performance specifications. All the specifications are given for an ambient temperature of 25°C.

**Table 1. Performance Specification Summary**

Specification	Test Conditions	MIN	TYP	MAX	Unit
Input voltage		3.0	3.6	5	V
Output voltage	TPS61089EVM, $V_{IN} = 3.6\text{ V}$ , $I_O \leq 2\text{ A}$	8.7	9	9.3	V

### 1.2 Modification

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

### 1.3 Input Capacitor

A 150- $\mu\text{F}$  tantalum capacitor, C1, is added as the input capacitor in the EVM. The ESR of the tantalum capacitor is 0.1  $\Omega$ , 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.

## 2 Setup

This section describes how to properly connect, set up, and use the TPS61089EVM-742.

### 2.1 Input/Output Connector Descriptions

The input and output connector descriptions are described in this section:

<b>J1-VIN</b>	Positive input connection from the input supply for the EVM
<b>J2-GND</b>	Return connection from the input supply for the EVM
<b>J3-VOUT</b>	Output voltage connection
<b>JP1-Vin_control</b>	The VIN (internal control circuit's power supply) voltage select pin of the TPS61089. Put a jumper across it to let it directly connect to the power stage input voltage, or pull off the jumper to use a user-defined voltage.
<b>JP2-EN</b>	EN pin input jumper. Place a jumper across EN and pin 1 to turn on the IC, place a jumper across EN and pin 3 to turn off the IC

### 3 Test Results

#### 3.1 Startup Waveform

The startup waveform is shown in Figure 1.

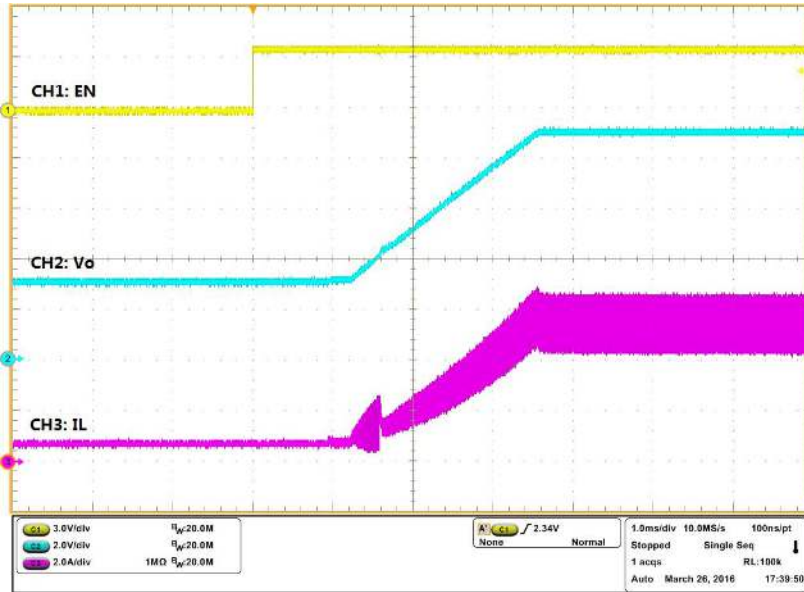


Figure 1. Startup Waveforms ( $V_{IN} = 3.6\text{ V}$ ,  $V_O = 9\text{ V}$  /  $I_O = 2\text{ A}$ )

#### 3.2 Efficiency

The conversion efficiency is shown in Figure 2.

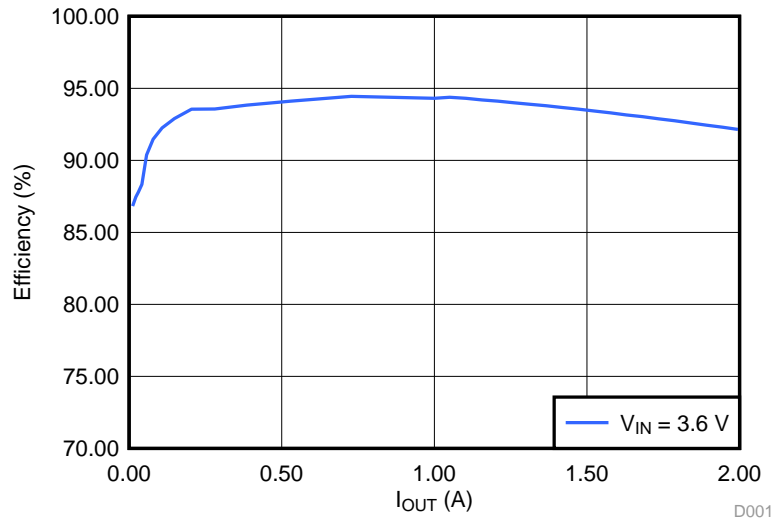


Figure 2. TPS61089EVM Efficiency ( $V_O = 9\text{ V}$ )

### 3.3 Load Transient

The load transient waveform is shown in Figure 3. Note that the effective output capacitance is about 34  $\mu\text{F}$  under 9-V DC bias, although three 22- $\mu\text{F}$  ceramic capacitors are used in the EVM. Larger effective capacitance helps improve the load transient.

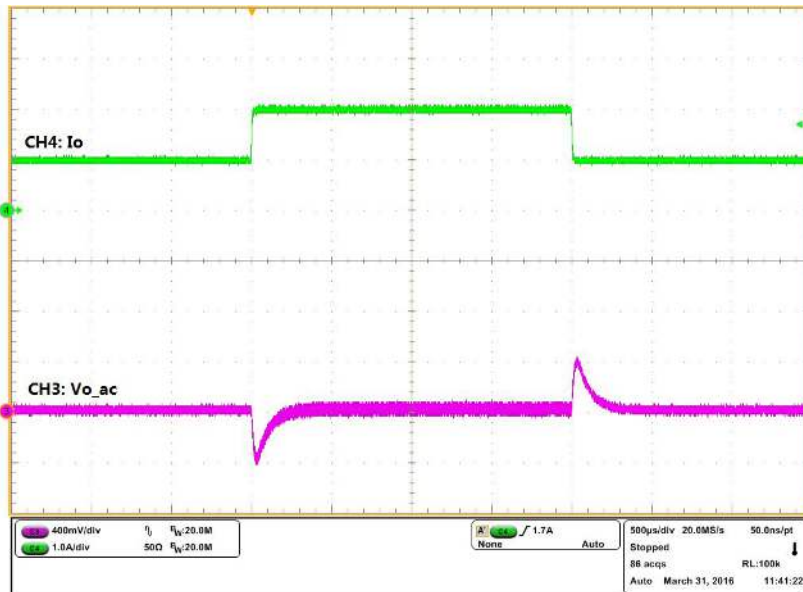


Figure 3. Load Transient ( $V_O = 9\text{ V} / I_O = 1\text{ A to } 2\text{ A}$ )

### 3.4 Loop Characteristics

The loop Bode plot is shown in Figure 4.

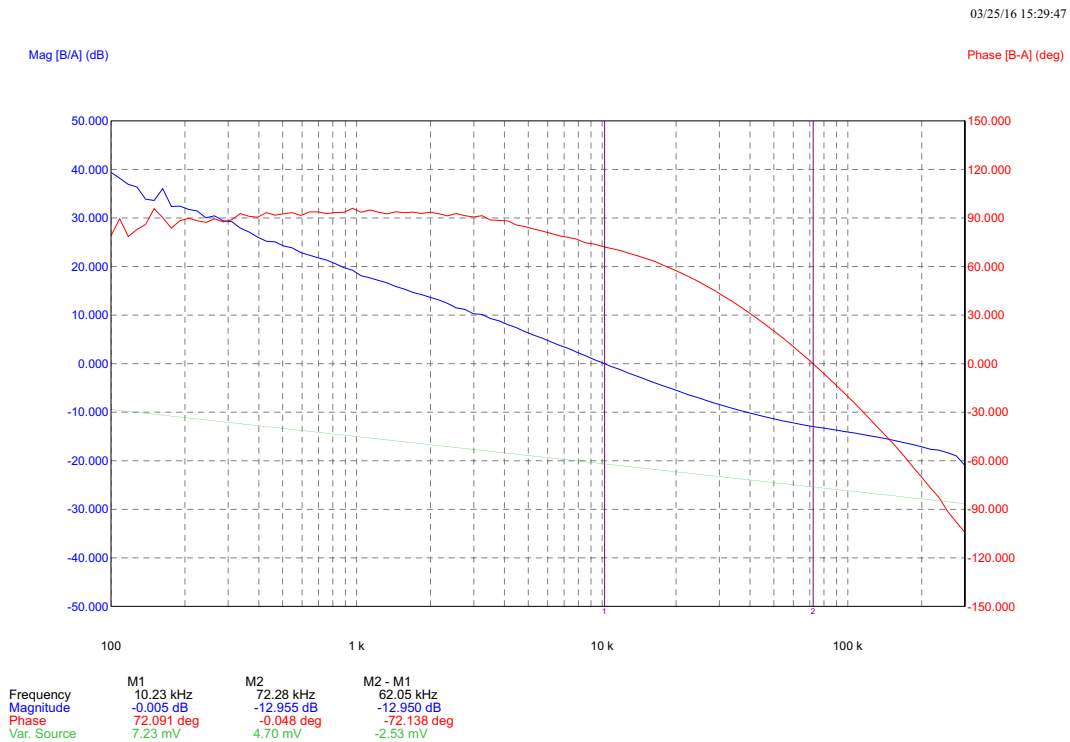


Figure 4. Loop Bode Plot ( $V_{IN} = 3.6\text{ V}, V_O = 9\text{ V} / I_O = 2\text{ A}$ )

### 3.5 Output Voltage Ripple

Figure 5 shows the output voltage ripple, switching waveforms, and the inductor current in CCM mode.

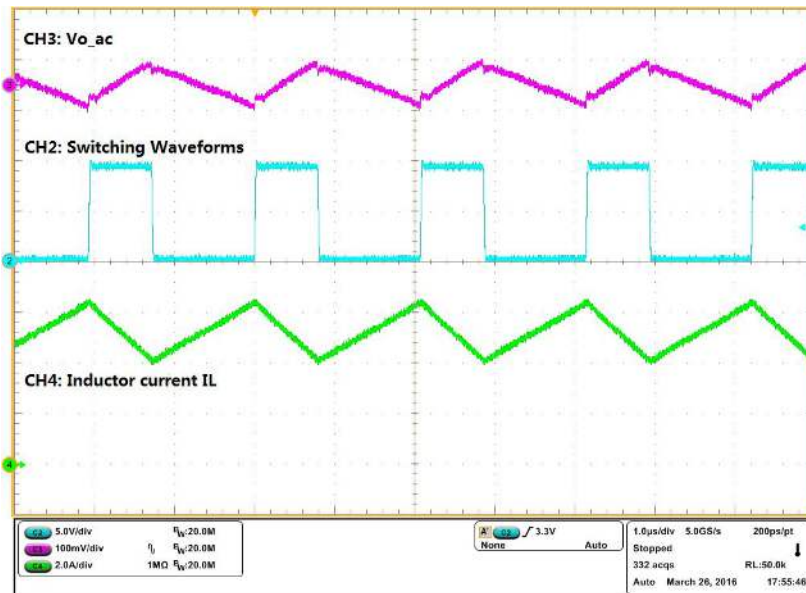


Figure 5. Output Ripple in CCM ( $V_{IN} = 3.6\text{ V}$ ,  $V_O = 9\text{ V}$  /  $I_O = 2\text{ A}$ )

Figure 6 shows the output voltage ripple, switching waveforms, and the inductor current in DCM mode.

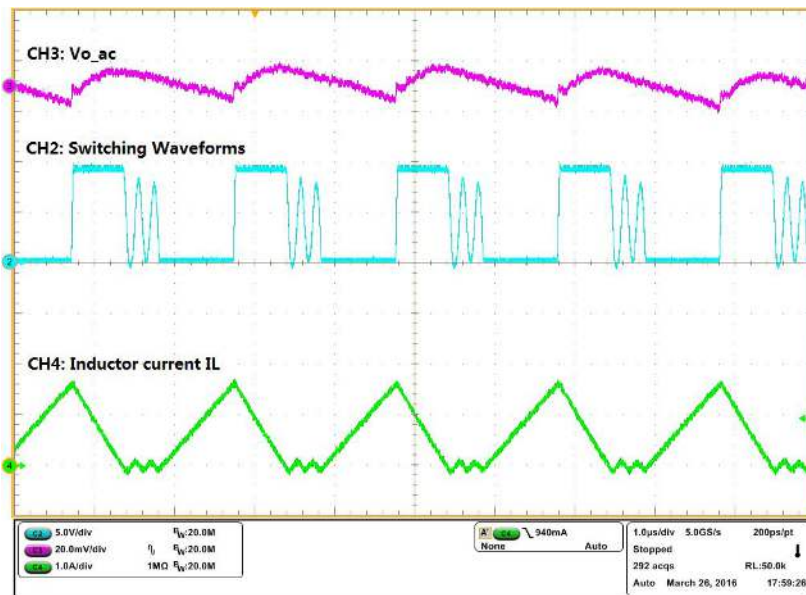


Figure 6. Output Ripple in DCM ( $V_{IN} = 3.6\text{ V}$ ,  $V_O = 9\text{ V}$  /  $I_O = 0.25\text{ A}$ )

Figure 7 shows the output voltage ripple, switching waveforms, and the inductor current in PFM mode when the converter is operating at light load.

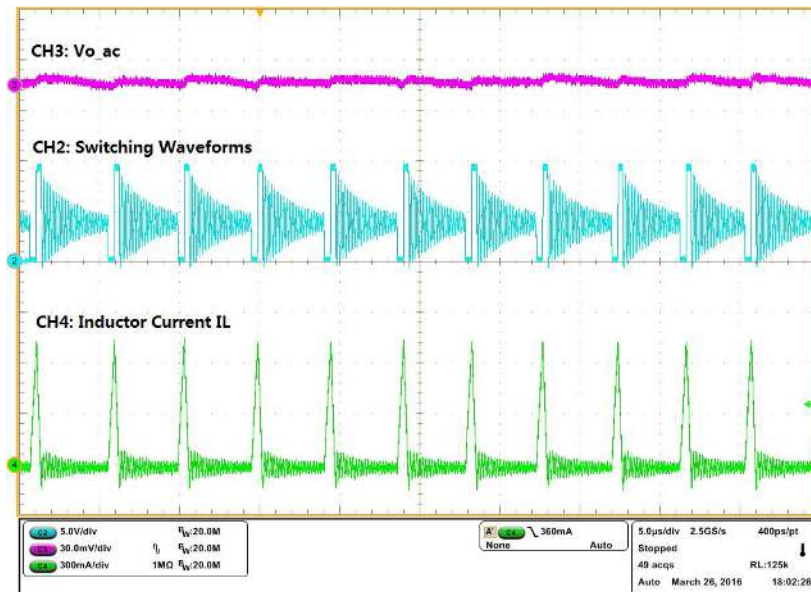


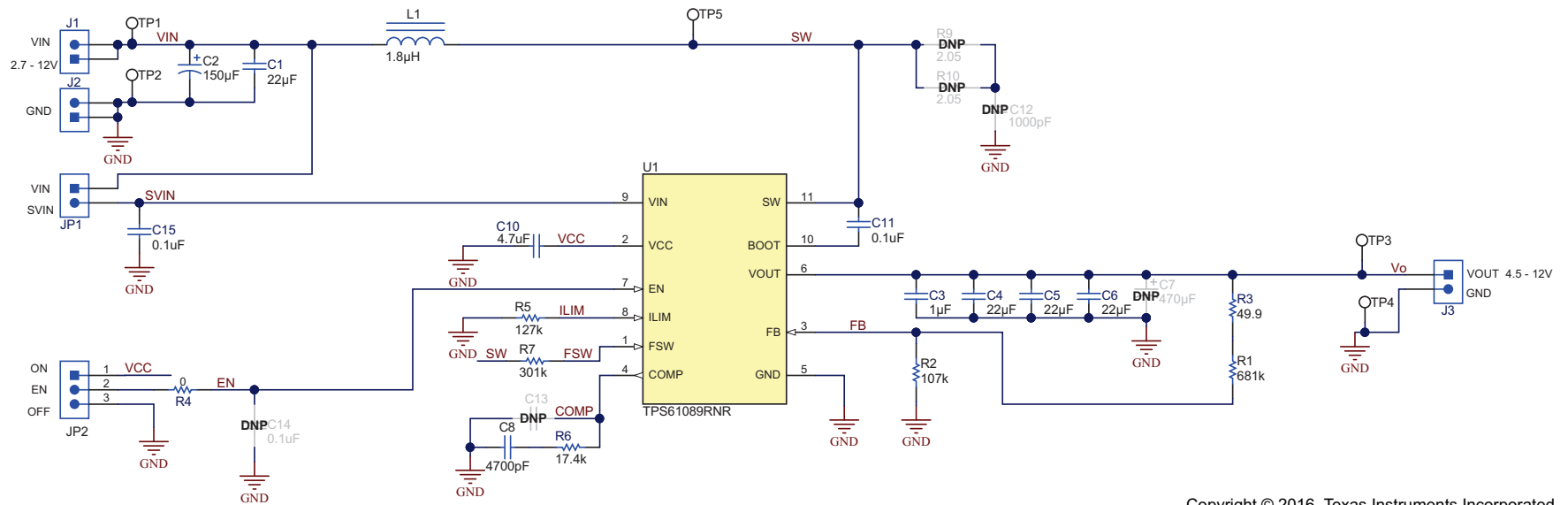
Figure 7. Output Ripple in PFM ( $V_{IN} = 3.6\text{ V}$ ,  $V_O = 9\text{ V}$  /  $I_O = 20\text{ mA}$ )

## 4 Schematic and Bill of Materials

This section provides the TPS61089EVM-742 schematic, bill of materials (BOM), and board layout.

### 4.1 Schematic

Figure 8 illustrates the EVM schematic.



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**Figure 8. TPS61089EVM-742 Schematic**

## 4.2 Bill of Materials

Table 2 displays the EVM bill of materials.

**Table 2. TPS61089EVM-742 Bill of Materials**

Designator	QTY	Value	Description	Package	Part Number	MFG
C1	1	22uF	CAP, CERM, 22 $\mu$ F, 16 V, +/- 10%, X5R, 1206	1206	GRM31CR61C226KE15L	Murata
C2	1	150uF	CAP, TA, 150 $\mu$ F, 10 V, +/- 10%, 0.1 ohm, SMD	7343-31	T495D157K010ATE100	Kemet
C3	1	1uF	CAP, CERM, 1 $\mu$ F, 25 V, +/- 10%, X7R, 0603	0603	GRM188R71E105KA12D	Murata
C4, C5, C6	3	22uF	CAP, CERM, 22 $\mu$ F, 25 V, +/- 10%, X7R, 1210	1210	GRM32ER71E226KE15L	Murata
C8	1	4700pF	CAP, CERM, 4700 pF, 50 V, +/- 10%, X5R, 0402	0402	GRM155R61H472KA01D	Murata
C10	1	4.7uF	CAP, CERM, 4.7uF, 10V, +/-10%, X5R, 0603	0603	0603ZD475KAT2A	AVX
C11, C15	2	0.1uF	CAP, CERM, 0.1uF, 16V, +/-10%, X5R, 0402	0402	GRM155R61C104KA88D	Murata
J1, J2, J3	3		Terminal Block, 6A, 3.5mm Pitch, 2-Pos, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
JP1	1		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
JP2	1		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
L1	1	1.8uH	Inductor, Shielded Drum Core, Metal Composite, 1.8 $\mu$ H, 9.3 A, 0.0126 ohm, SMD	9.5x8.7mm	CDMC8D28NP-1R8MC	Sumida
R1	1	681k	RES, 681 k, 1%, 0.063 W, 0402	0402	CRCW0402681KFKED	Vishay-Dale
R2	1	107k	RES, 107 k, 1%, 0.063 W, 0402	0402	CRCW0402107KFKED	Vishay-Dale
R3	1	49.9	RES, 49.9 ohm, 1%, 0.063W, 0402	0402	CRCW040249R9FKED	Vishay-Dale
R4	1	0	RES, 0 ohm, 5%, 0.063W, 0402	0402	RC0402JR-070RL	Yageo America
R5	1	127k	RES, 127 k, 1%, 0.063 W, 0402	0402	CRCW0402127KFKED	Vishay-Dale
R6	1	17.4k	RES, 17.4k ohm, 1%, 0.063W, 0402	0402	CRCW040217K4FKED	Vishay-Dale
R7	1	301k	RES, 301 k, 1%, 0.063 W, 0402	0402	CRCW0402301KFKED	Vishay-Dale
U1	1		12.6-V, 7-A FULLY INTEGRATED SYNCHRONOUS BOOST CONVERTER IN 2.0mm x 2.5mm QFN PACKAGE, RNR0011A	RNR0011A	TPS61089RNR	Texas Instruments
C7	0	470uF	CAP, AL, 470 $\mu$ F, 25 V, +/- 20%, 0.053 ohm, TH	2-Pin Radial, Dia 10 mm, Height 12.5 mm, Pin Spacing 5 mm	25ZLJ470M10X12.5	Rubycon
C12	0	1000pF	CAP, CERM, 1000 pF, 100 V, +/- 10%, X7R, 0603	0603	GRM188R72A102KA01D	Murata
C13	0	47pF	CAP, CERM, 47 pF, 50 V, +/- 1%, C0G, 0402	0402	GRM1555C1H470FA01D	Murata
C14	0	0.1uF	CAP, CERM, 0.1uF, 16V, +/-10%, X5R, 0402	0402	GRM155R61C104KA88D	Murata
R9, R10	0	2.05	RES, 2.05, 1%, 0.1 W, 0603	0603	CRCW06032R05FKEA	Vishay-Dale



## 5 Board Layout

Figure 9 through Figure 12 show the TPS61089EVM-742 PCB layout.

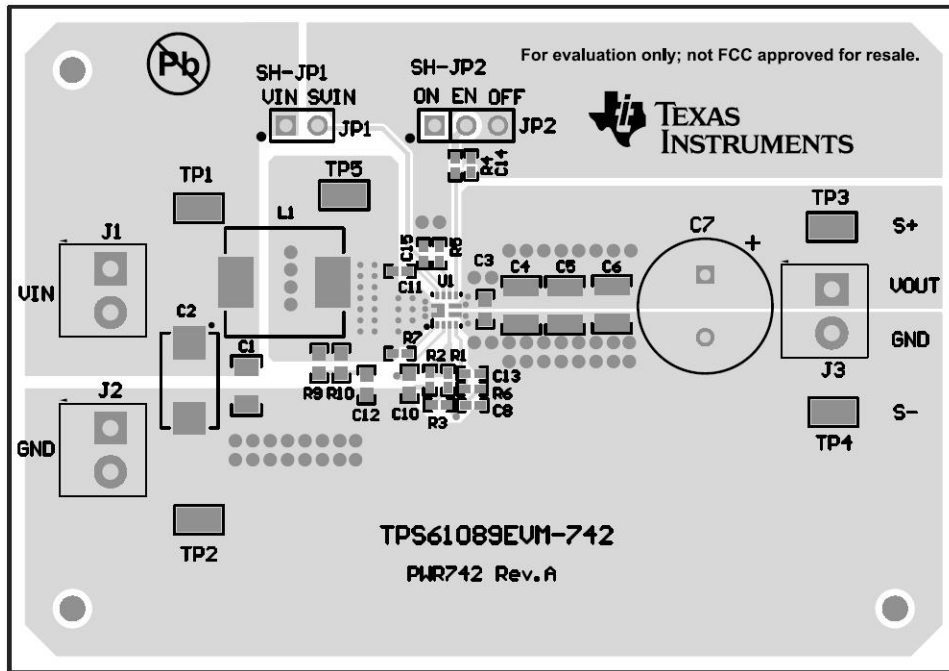


Figure 9. TPS61089EVM-742 Top-Side Layout

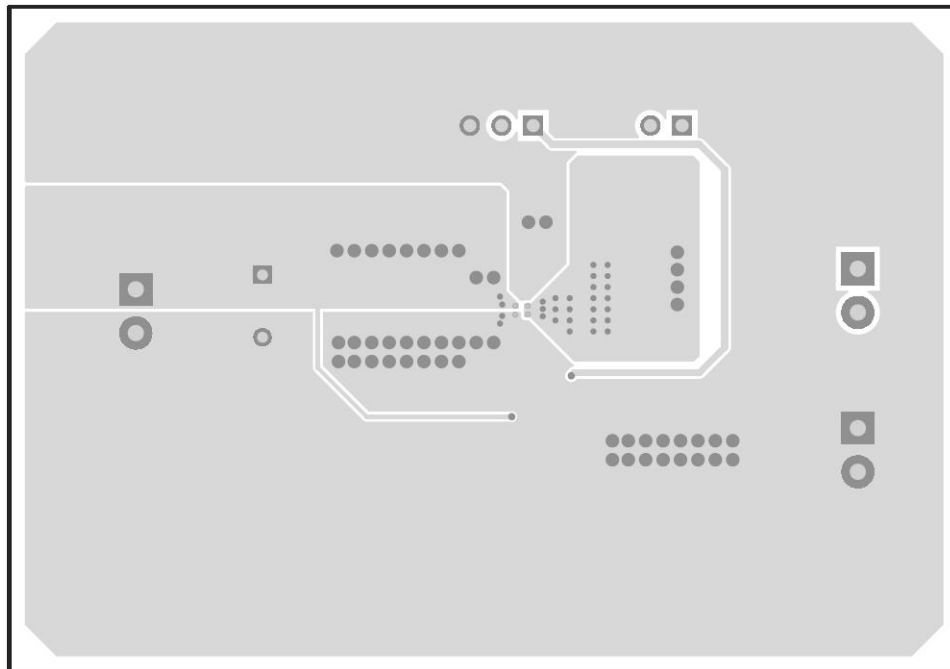
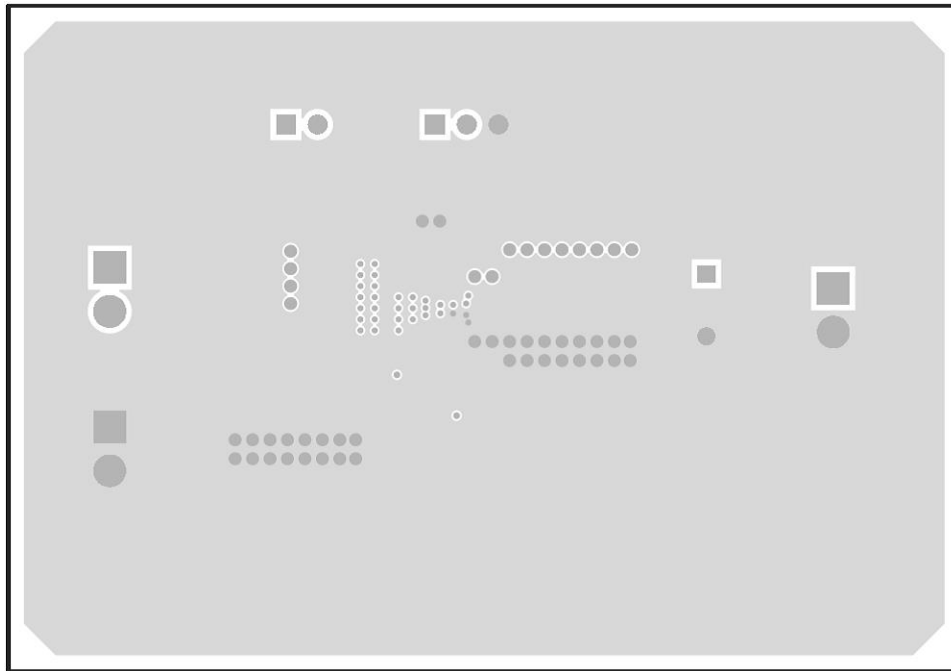
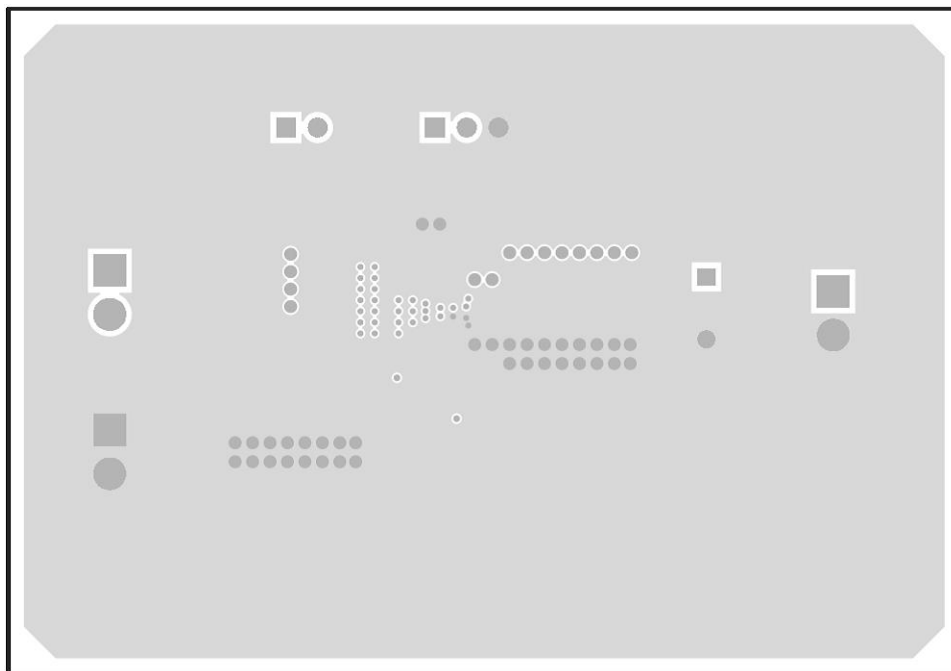


Figure 10. TPS61089EVM-742 Bottom-Side Layout



**Figure 11. TPS61089EVM-742 Internal Layer 1**



**Figure 12. TPS61089EVM-742 Internal Layer 2**

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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.
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### 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.

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## FCC Interference Statement for Class B EVM devices

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- 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

#### Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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.

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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.

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If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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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.

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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.

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