

# TPS61088EVM-677 Evaluation Module

This user's guide describes the characteristics, operation, and the use of the TPS61088EVM-677 evaluation module (EVM). The EVM contains the 20 kHz–2.2 MHz, 12.6-V step-up DC-DC converter TPS61088 with a switch current of 10 A. This user's guide includes EVM specifications, recommended test setup, test result, schematic diagram, bill of materials, and the board layout.

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## 1 Introduction

### 1.1 Performance Specification

Table 1 provides a summary of the TPS61088EVM 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
$V_{IN}$		3.0	3.6	5	V
$V_{OUT}$	TPS61088EVM, $V_{IN} = 3.3$ V, $I_o < 3$ A, $f_{sw} = 600$ KHz	8.7	9	9.3	V

## 2 Setup

This section describes how to properly connect, set up, and use the TPS61088EVM-677.

### 2.1 Input/Output Connector Descriptions

<b>J1-VIN</b>	Positive connection to the input power supply
<b>J2-GND</b>	Return connection to the input power supply
<b>J3-OUTPUT</b>	Output voltage connection
<b>JP1-Vin_control</b>	TPS61088's VIN pin voltage selection. Place a jumper across it to let it directly connect to the power stage input voltage. Take off the jumper for a user-defined voltage.
<b>JP2-Mode</b>	Operation mode selection pin for the device in light-load condition. When this pin is connected to ground, the device works in PWM mode. When this pin left floating, the device works in PFM mode.
<b>JP3-EN</b>	EN pin. Place a jumper across EN and pin1 to turn on the IC, place a jumper across EN and pin 3 to turn off the IC.

### 2.2 Modifications

This EVM board is designed to provide access to the feature of the TPS61088. Some modifications can be made to this EVM board.

#### 2.2.1 Output Voltage

The output voltage of this part is set by the resistor divider network of R2 and R3. To change the output voltage of the EVM, it is necessary to change the value of the resistors. The value of R2 for a specific output voltage and specific resistor R3 can be calculated by following equation:

$$R_2 = R_3 \left( \frac{V_O}{V_{ref}} - 1 \right) \quad (1)$$

Table 2 lists the R2 and R3 values for some output voltages under PFM mode

**Table 2. Changing Output Voltage with R2 and R3**

$V_{OUT}(V)$	R2 (k $\Omega$ )	R3 (k $\Omega$ )
5	357	115
9	768	120
12	1000	113

### 2.2.2 Peak Current Limit Setting

The peak switch current limit is set by the external resistor R5. Ensure that the current limit is higher than the required peak switch current at the lowest input voltage and highest output power condition. The current limit value under PFM mode can be calculated by the following equation:

$$I_{LIM} = \frac{1190000}{R_5} \tag{2}$$

Where:

- R<sub>5</sub> is the resistance connected between the ILIM pin and ground
- I<sub>LIM</sub> is the peak switch current limit

Considering the device variation and the tolerance over temperature, the minimum current limit at the worst case can be 1.3 A lower than the value calculated by Equation 2. So the calculated value I<sub>LIM</sub> minus 1.3 A should be higher than the peak switch current. When V<sub>IN</sub> = 3.3 V, to ensure the converter can output maximum power (V<sub>O</sub> = 9 V, I<sub>O</sub> = 3 A) under the PFM mode, we choose R<sub>5</sub> = 100 kΩ and I<sub>LIM</sub> = 11.9 A.

If the converter works in the PWM mode (MODE pin short to ground), the current limit value is 1.6 A lower than that of the PFM mode. We need to change R<sub>5</sub> to 86.6 kΩ to ensure the maximum output power (V<sub>O</sub> = 9 V, I<sub>O</sub> = 3 A) under V<sub>IN</sub> = 3.3 V condition.

## 3 Test Results

### 3.1 Startup Waveform

Figure 1 shows the startup waveform.

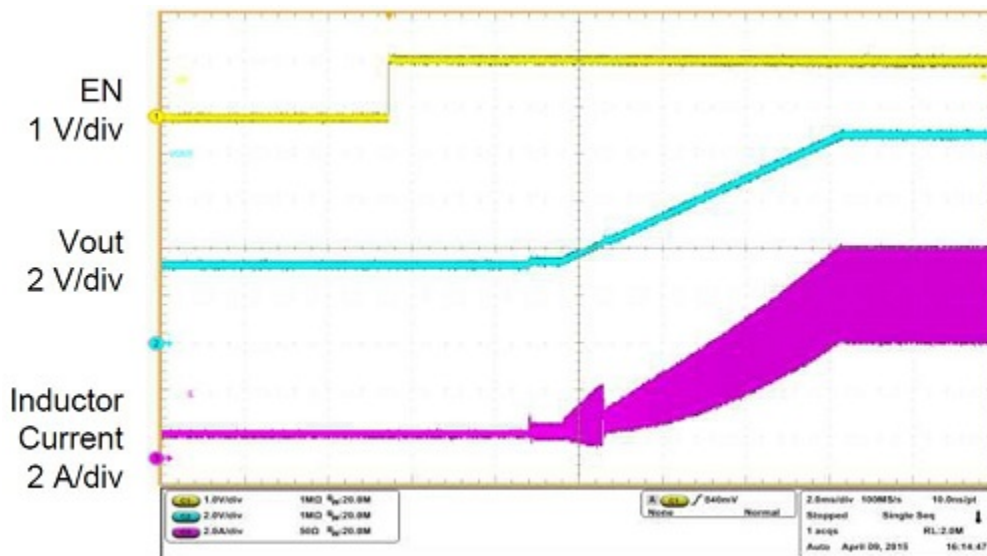


Figure 1. Startup Waveforms

### 3.2 Load Transient

The load transient waveform is shown in [Figure 2](#). Please note that the effective output capacitance is only about 50  $\mu\text{F}$  under  $V_{\text{OUT}} = 9\text{ V}$  DC bias, although four 22- $\mu\text{F}$  ceramic capacitors are used in the EVM. Larger effective capacitance will help to improve the load transient performance.

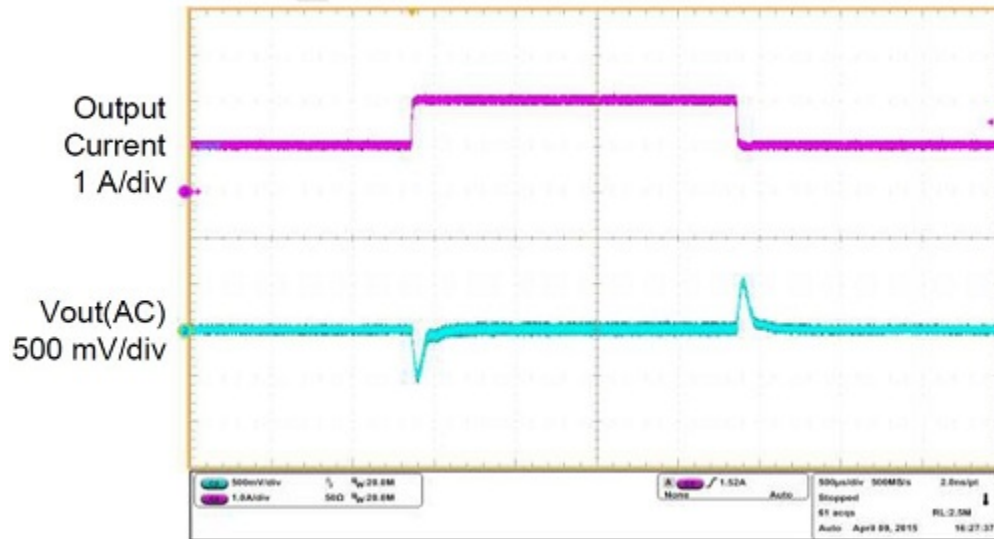


Figure 2. Load Transient ( $V_o = 9\text{ V}$ ,  $I_o = 1\text{ to }2\text{ A}$ )

### 3.3 Loop Characteristics

Figure 3 shows the loop Bode plot.

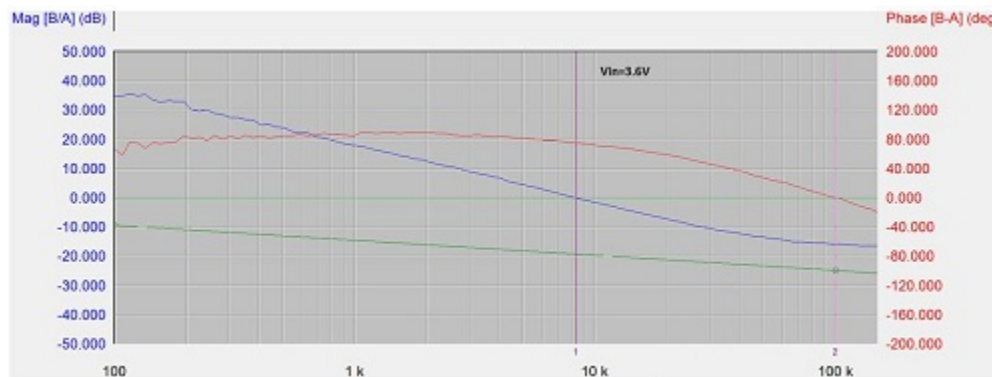


Figure 3. Loop Bode Plot ( $V_o = 9\text{ V}$ ,  $I_o = 3\text{ A}$ )

### 3.4 Output Voltage Ripple

Figure 4 shows the output voltage ripple, inductor current ripple, and the switching waveforms in CCM mode.

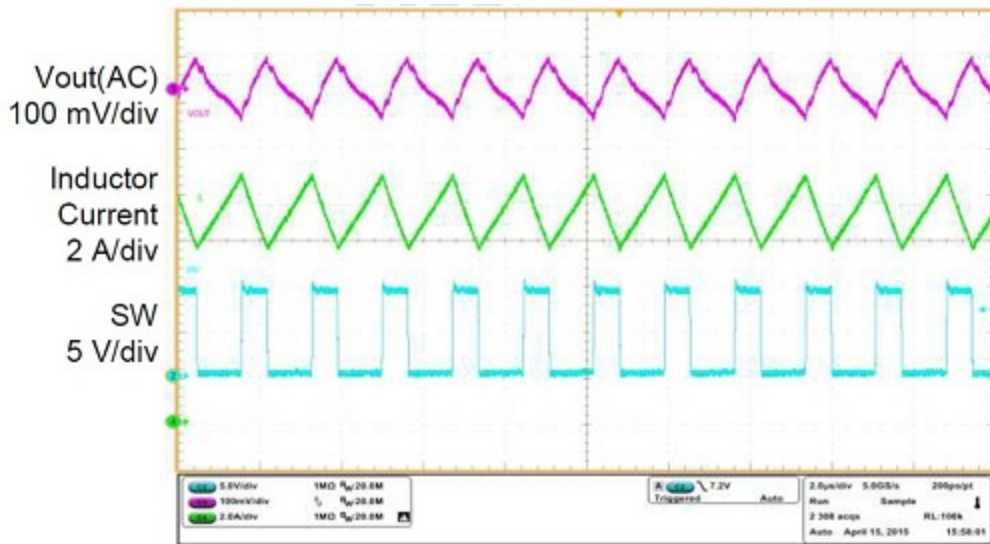


Figure 4. Output Ripple in CCM

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

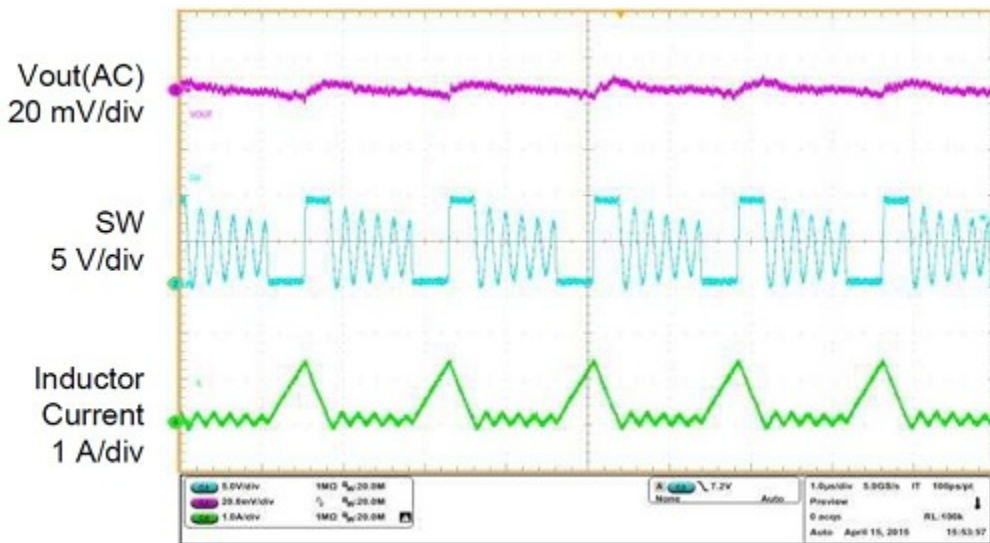


Figure 5. Output Ripple in DCM

Figure 6 shows the output voltage ripple, inductor current ripple, and the switching waveforms in PFM mode when the converter operating at light load.

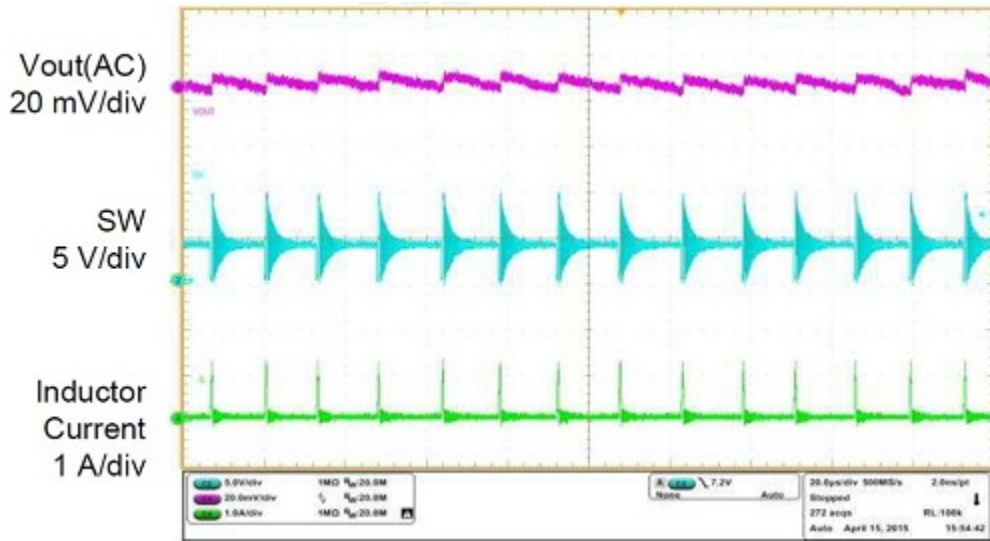


Figure 6. Output Ripple in PFM Mode

## 4 Schematic and Bill of Materials

This section provides the TPS61088EVM-677 schematic and bill of materials (BOM).

### 4.1 Schematic

Figure 7 is the schematic of the EVM.

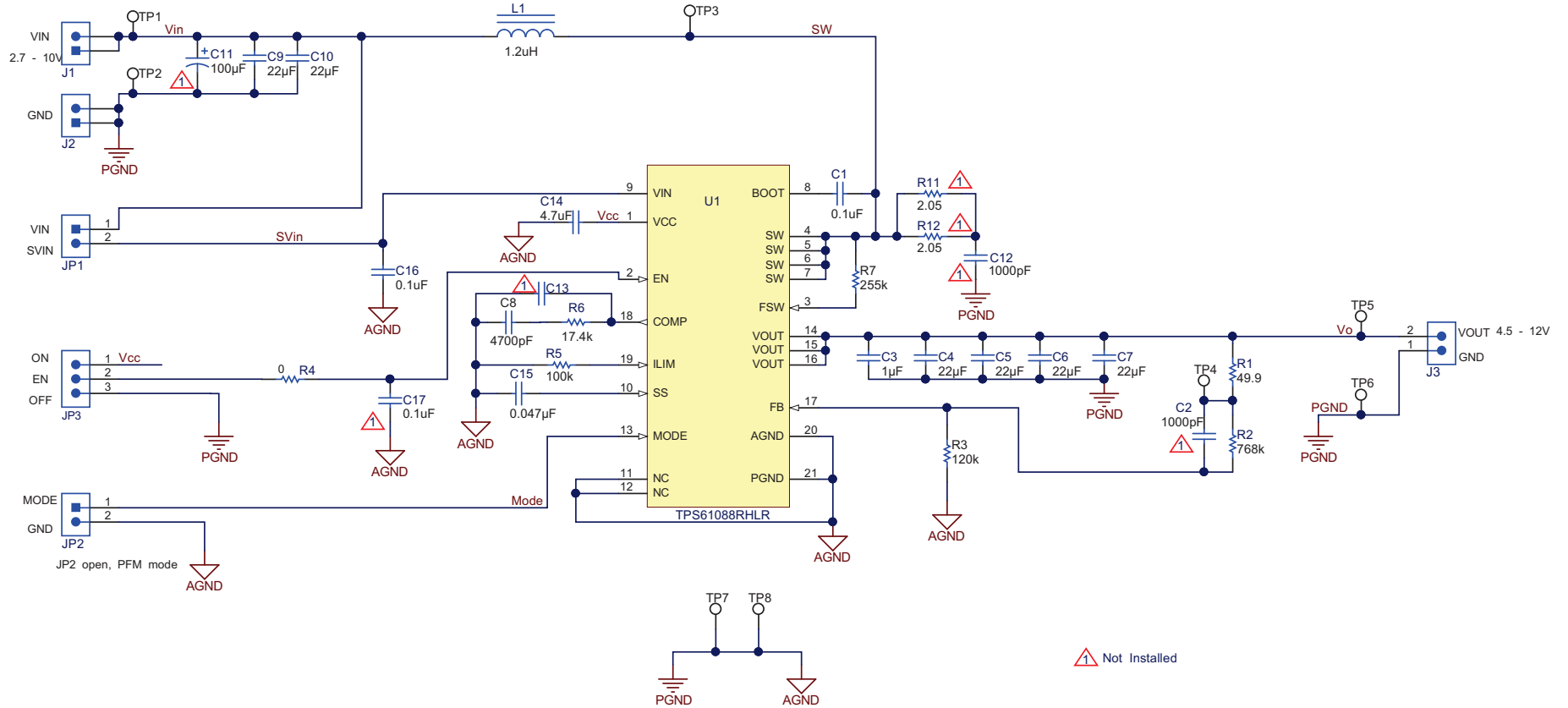


Figure 7. TPS61088EVM-677 Schematic



## 4.2 Bill of Materials

Table 3 presents the bill of materials of the EVM.

**Table 3. TPS61088EVM-677 Bill of Materials**

Designator	QTY	Value	Description	Package	Part Number	MFG
C1, C16	2	0.1uF	CAP, CERM, 0.1uF, 16V, +/-10%, X5R, 0402	0402	GRM155R61C104KA88D	Murata
C3	1	1uF	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, 0603	0603	GRM188R71E105KA12D	Murata
C4, C5, C6, C7	4	22uF	CAP, CERM, 22 uF, 25 V, +/- 10%, X7R, 1210	1210	GRM32ER71E226KE15L	Murata
C8	1	4700pF	CAP, CERM, 4700 pF, 50 V, +/- 10%, X5R, 0402	0402	GRM155R61H472KA01D	Murata
C9, C10	2	22uF	CAP, CERM, 22 uF, 16 V, +/- 10%, X5R, 1206	1206	GRM31CR61C226KE15L	Murata
C14	1	4.7uF	CAP, CERM, 4.7uF, 10V, +/-10%, X5R, 0603	0603	0603ZD475KAT2A	AVX
C15	1	0.047uF	CAP, CERM, 0.047 uF, 16 V, +/- 10%, X7R, 0402	0402	GRM155R71C473KA01D	Murata
J1, J2, J3	3		Terminal Block, 6A, 3.5mm Pitch, 2-Pos, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
JP1, JP2	2		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
JP3	1		Header, 100mil, 3x1, Tin plated, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
L1	1	1.2uH	Inductor, Shielded Drum Core, Metal Composite, 1.2 uH, 12.9 A, 0.007 ohm, SMD	9.5x8.7mm	CDMC8D28NP-1R2MC	Sumida
R1	1	49.9	RES, 49.9 ohm, 1%, 0.063W, 0402	0402	CRCW040249R9FKED	Vishay-Dale
R2	1	768k	RES, 768 k, 1%, 0.063 W, 0402	0402	CRCW0402768KFKED	Vishay-Dale
R3	1	120k	RES, 120 k, 1%, 0.063 W, 0402	0402	CRCW0402120KFKED	Vishay-Dale
R4	1	0	RES, 0 ohm, 5%, 0.063W, 0402	0402	RC0402JR-070RL	Yageo America
R5	1	100k	RES, 100k ohm, 1%, 0.063W, 0402	0402	CRCW0402100KFKED	Vishay-Dale
R6	1	17.4k	RES, 17.4k ohm, 1%, 0.063W, 0402	0402	CRCW040217K4FKED	Vishay-Dale
R7	1	255k	RES, 255 k, 1%, 0.063 W, 0402	0402	CRCW0402255KFKED	Vishay-Dale
U1	1		13.2-V Output, Synchronous Boost Converter with 10-A Switch, RHL0020A	RHL0020A	TPS61088RHLR	Texas Instruments
C2	0	1000pF	CAP, CERM, 1000pF, 25V, +/-5%, C0G/NP0, 0402	0402	C1005C0G1E102J	TDK
C11	0	100uF	CAP, TA, 100 uF, 16 V, +/- 10%, 0.1 ohm, SMD	7343-43	T495X107K016ATE100	Kemet
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
C17	0	0.1uF	CAP, CERM, 0.1uF, 16V, +/-10%, X5R, 0402	0402	GRM155R61C104KA88D	Murata
R11, R12	0	2.05	RES, 2.05, 1%, 0.1 W, 0603	0603	CRCW06032R05FKEA	Vishay-Dale



## 5 Board Layout

Figure 8 through Figure 10 illustrate the board layouts for this EVM.

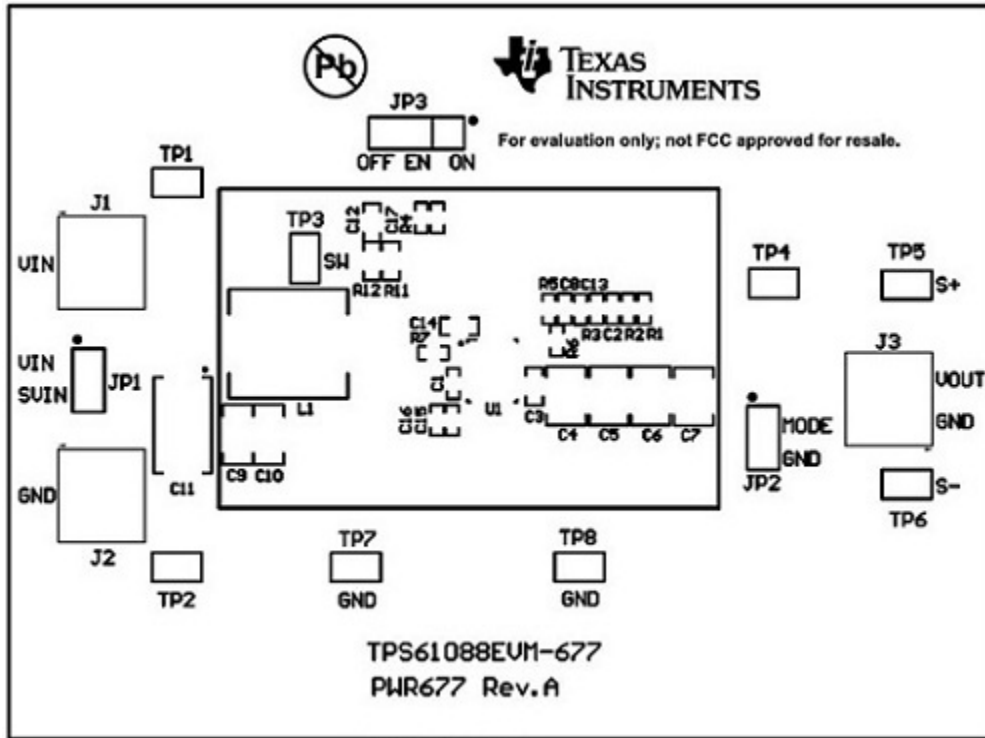


Figure 8. TPS61088EVM-677 Top-Side Assembly

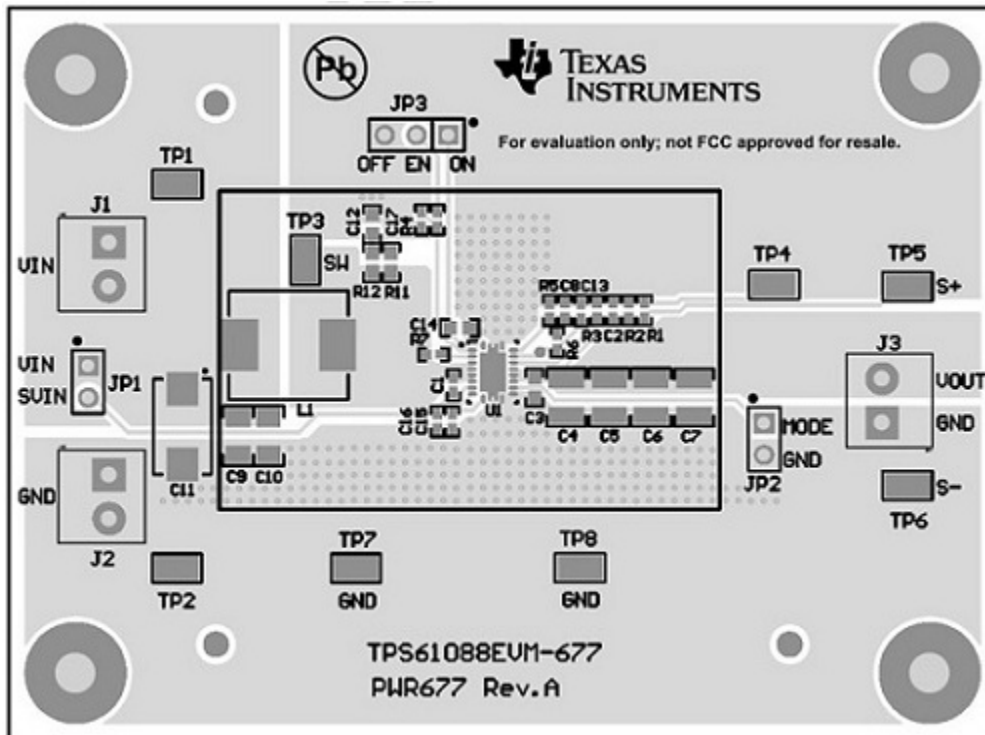
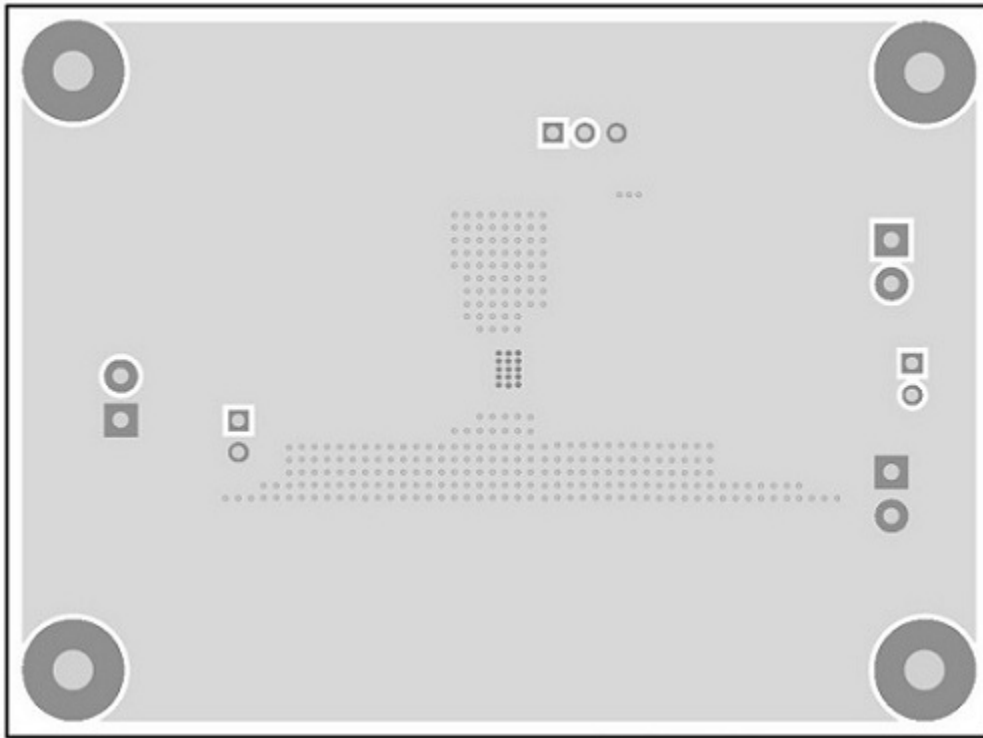


Figure 9. TPS61088EVM-677 Top-Side Layout



**Figure 10. TPS61088EVM-677 Bottom-Side Layout**

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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.
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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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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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