

## **TPS62806-7-8EVM083 Evaluation Module**

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The TPS62806-7-8EVM083 (BSR083-001) facilitates the evaluation of the TPS6280x family of 600-mA, step-down converters with 2.3- $\mu$ A  $I_Q$  in tiny 1.05-mm by 0.7-mm WCSP packages with 0.35-mm pitch. The EVM contains 3 separate circuits to create output voltages between 0.4 V and 3.3 V from higher input voltages between 1.8 V and 5.5 V. All circuits have a maximum height of 1 mm. The TPS6280x is a highly efficient and tiny solution for point-of-load (POL) converters for space-constrained applications, such as wearables and smart phones.

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### **Trademarks**

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## 1 Introduction

The TPS6280x is a family of synchronous, step-down converters in a 1.05- x 0.7-mm wafer chip-scale package (WCSP) with 0.35-mm pitch. The BSR083 EVM contains 3 completely independent circuits, each for a different IC version. See [Table 1](#) for a summary of the BSR083 EVMs.

The reference designator order is grouped together by sub-circuit. Reference designators beginning with '1' (for example, R1x, J1x, C1x) are part of one sub-circuit. The second digit of each reference designator is the same for the same component in different sub-circuits. R11, R21, and R31, for example, refer to the same resistor in each sub-circuit.

**Table 1. BSR083 Circuit Options**

EVM Version	IC Installed	Output Voltage Setpoint (VSEL/MODE = open at startup)	Output Voltage Setpoint (VSEL/MODE = PFM at startup)	Output Voltage Setpoint Range	Output Current
TPS62806-7-8EVM083 (BSR083-001)	TPS62806 (U11)	0.6 V	0.7 V	0.4 - 0.775 V (adjustable)	600 mA
	TPS62807 (U21)	0.9 V	1.2 V	0.8 - 1.55 V (adjustable)	600 mA
	TPS62808 (U31)	3.3 V	1.8 V	1.8 - 3.3 V (adjustable)	600 mA

### 1.1 Performance Specification

[Table 2](#) provides a summary of the TPS62806-7-8EVM083 performance specifications.

**Table 2. Performance Specification Summary**

SPECIFICATION	MIN	TYP	MAX	UNIT
Input voltage	1.8	3.6	5.5	V
Output voltage setpoint	See <a href="#">Table 1</a>			V
Output current	0		See <a href="#">Table 1</a>	mA

### 1.2 Modifications

The printed-circuit board (PCB) for this EVM uses the adjustable output voltage versions of this integrated circuit (IC). Additional input and output capacitors can also be added. Finally, the loop response of the IC can be measured.

#### 1.2.1 Adjusting the Output Voltage

The output voltage is adjusted through the choice of Rx1 and Rx2 resistors. Since Rx1 and Rx2 are in parallel, only Rx1 or Rx2 should be installed at the same time. Rx1 is an 0201 size to represent a typical final solution. However, such a small size is difficult to manually replace. Therefore, Rx2 is provided in an 0603 size to easily change the output voltage. Simply remove Rx1 and install Rx2 in the desired value.

### 1.2.2 Input and Output Capacitors

Cx2 is provided for an additional input capacitor. This capacitor is not required for proper operation but can be used to reduce the input voltage ripple.

Cx5, Cx6, and Cx7 are provided for additional output capacitors. These capacitors are not required for proper operation but can be used to reduce the output voltage ripple and to improve the load transient response. The total output capacitance must remain within the recommended range in the data sheet for proper operation.

### 1.2.3 Loop Response Measurement

The loop response of the EVM can be measured with two simple changes to the circuitry. First, cut the trace between the VOS pin and the output capacitor on the top layer. This change is shown in [Figure 1](#). Second, install a 10- $\Omega$  resistor across the resistor pads on the back of the PCB at Rx3. The pads are spaced to allow installation of an 0603-sized resistor. With these changes, an ac signal (10-mV, peak-to-peak amplitude recommended) can be injected into the control loop across the added resistor. Details of measuring the control loop of DCS-Control devices are found in [How to Measure the Control Loop of DCS-Control™ Devices](#).



**Figure 1. Loop Response Measurement Modification**

## 2 Setup

This section describes how to properly use the TPS62806-7-8EVM083.

### 2.1 Input/Output Connector Descriptions

<b>Jx1, Pin 1 and 2 – VIN</b>	Positive input connection from the input supply for the EVM.
<b>Jx1, Pin 3 and 4 – S+/S-</b>	Input voltage sense connections. Measure the input voltage at this point.
<b>Jx1, Pin 5 and 6 – GND</b>	Input return connection from the input supply for the EVM.
<b>Jx2, Pin 1 and 2 – VOUT</b>	Output voltage connection.
<b>Jx2, Pin 3 and 4 – S+/S-</b>	Output voltage sense connections. Measure the output voltage at this point.
<b>Jx2, Pin 5 and 6 – GND</b>	Output return connection.
<b>JPx1 – VSEL/MODE</b>	VSEL/MODE pin input jumper. Before startup, leave the jumper floating to select the output voltage corresponding to the installed Rx1 or Rx2 value. Alternatively, connect the jumper between VSEL/MODE and PFM to select the output voltage corresponding to that shown in <a href="#">Table 1</a> . After startup, connect this jumper between VSEL/MODE and PFM to operate with highest efficiency or between VSEL/MODE and PWM to operate with lowest ripple.
<b>JPx2 – EN</b>	EN pin input jumper. Place the supplied jumper across ON and EN to turn on the IC. Place the jumper across OFF and EN to turn off the IC.

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**NOTE:** Changes to JPx1 during operation only affect the operating mode (PFM or PWM) and have no effect on the output voltage. To achieve a different output voltage, it is required to disable and re-enable the device.

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### 2.2 Setup

To operate the EVM, set jumpers JPx1 and JPx2 to the desired position per [Section 2.1](#). Connect the input supply to Jx1 and connect the load to Jx2.

### 3 TPS62806-7-8EVM083 Test Results

The TPS62806-7-8EVM083 was used to take all the data in [TPS6280x 1.8-V to 5.5-V, 0.6A / 1-A, 2.3- \$\mu\$ A  \$I\_o\$  Step Down Converter in a 6 Pin, 0.35 mm Pitch WCSP Package](#). See the device data sheet for the performance of this EVM.

Figure 2 shows the thermal performance of the EVM.

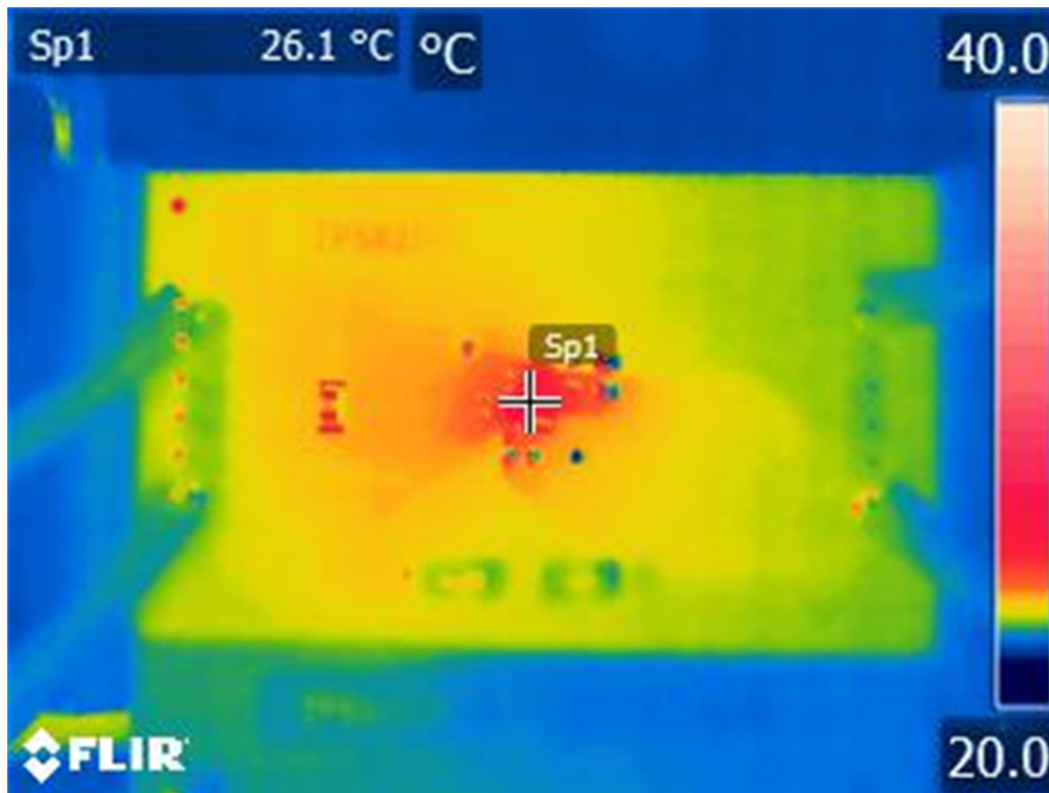


Figure 2. TPS62808 Thermal Performance ( $V_{IN} = 5\text{ V}$ ,  $V_{OUT} = 1.8\text{ V}$ ,  $I_{OUT} = 600\text{ mA}$ )

### 4 Board Layout

This section provides the TPS62806-7-8EVM083 board layout and illustrations in [Figure 3](#) through [Figure 5](#). The Gerbers are available on the EVM product page: [TPS62806-7-8EVM083](#).

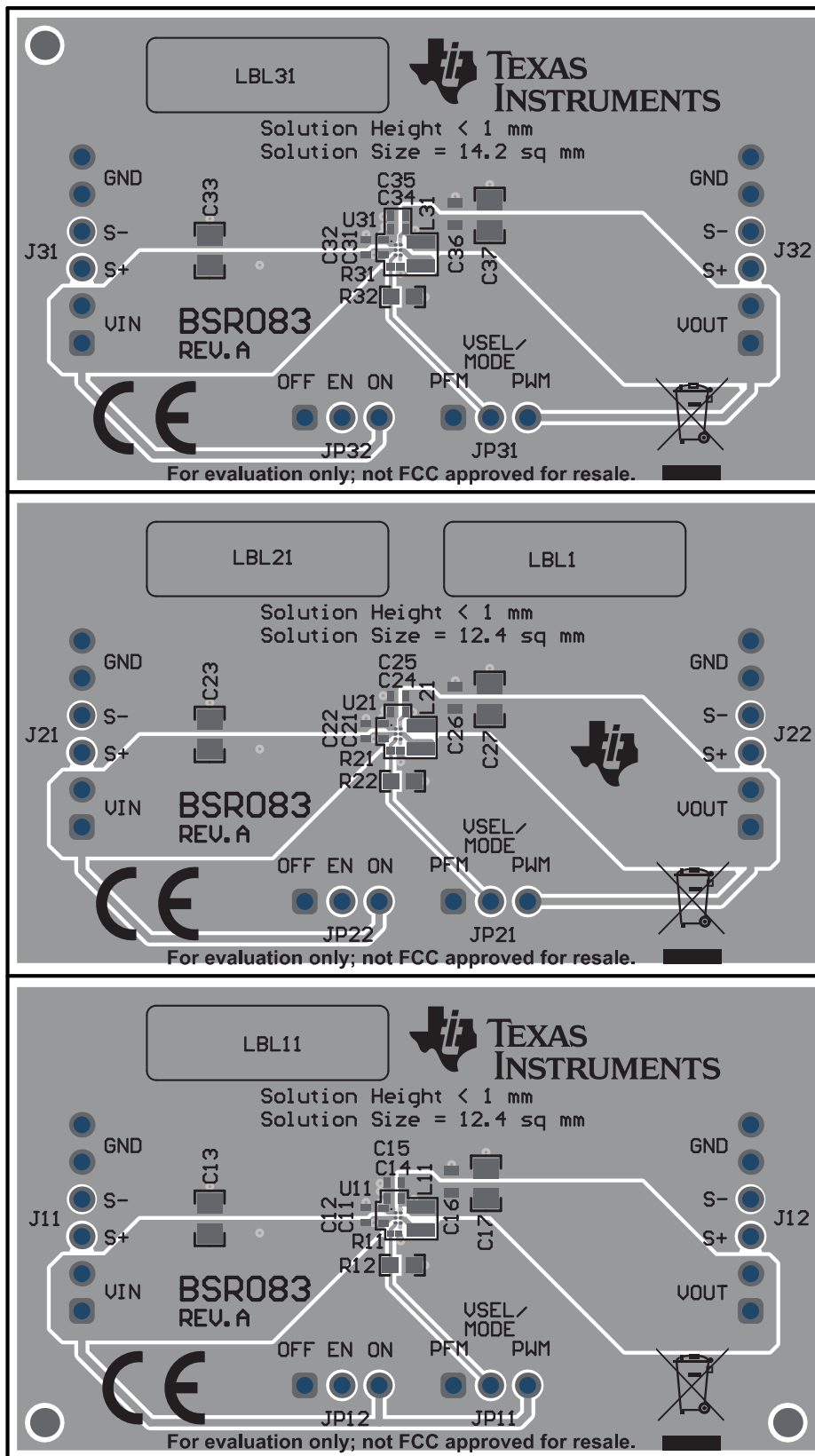


Figure 3. Top Assembly

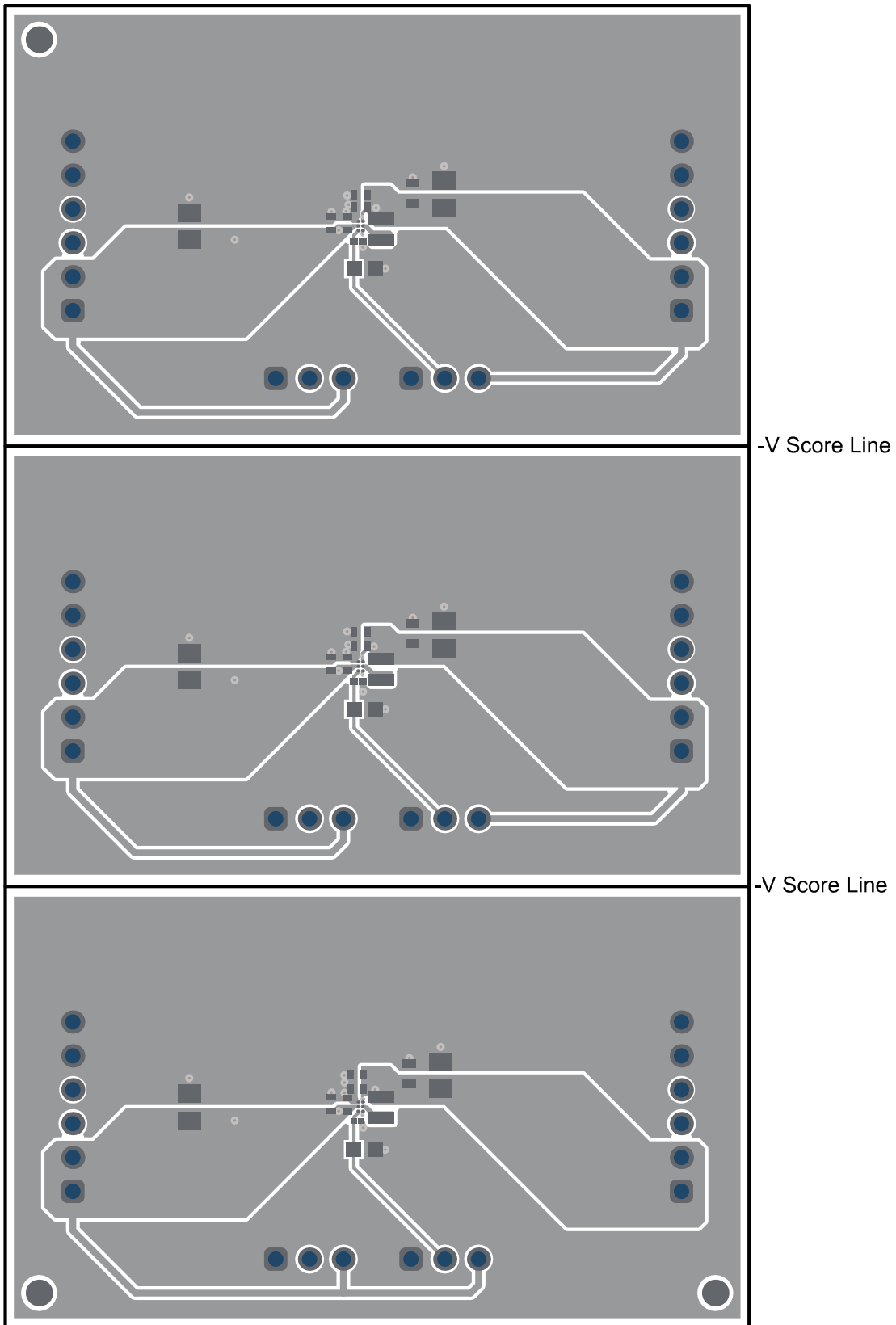


Figure 4. Top Layer

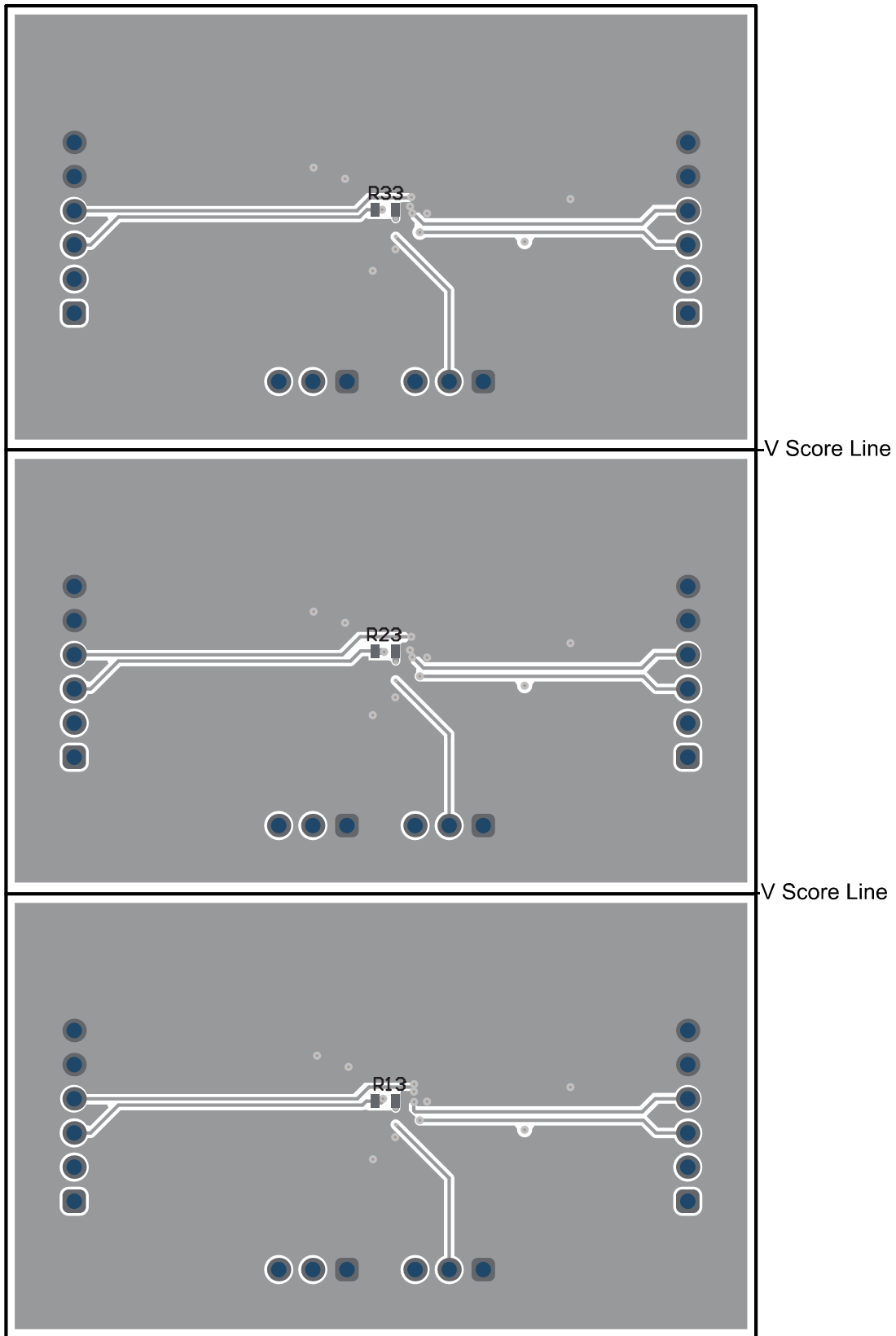


Figure 5. Bottom Layer



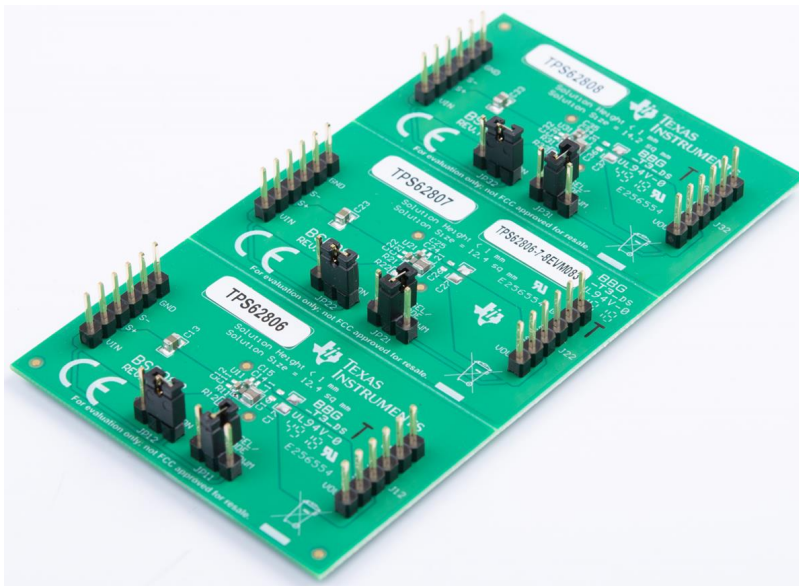


Figure 6. TPS62806-7-8EVM083 Angled View

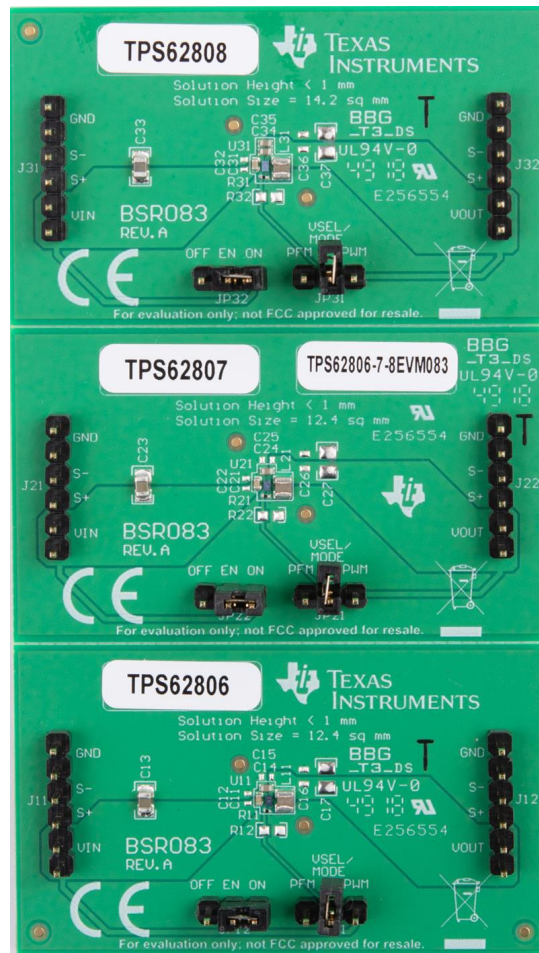


Figure 7. TPS62806-7-8EVM083 Overhead View

## 5 Schematic and List of Materials

This section provides the TPS62806-7-8EVM083 schematic and List of materials.

### 5.1 Schematic

Figure 8 illustrates the TPS62806 EVM schematic.

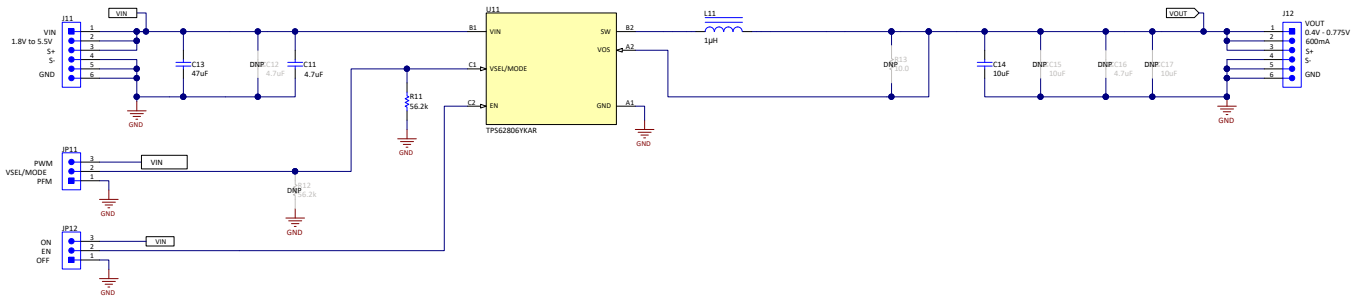


Figure 8. TPS62806 Schematic

Figure 9 illustrates the TPS62807 EVM schematic.

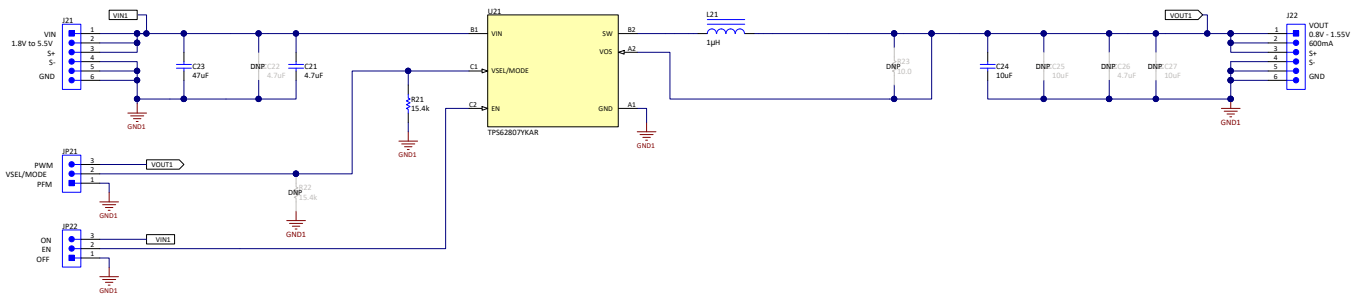


Figure 9. TPS62807 Schematic

Figure 10 illustrates the TPS62808 EVM schematic.

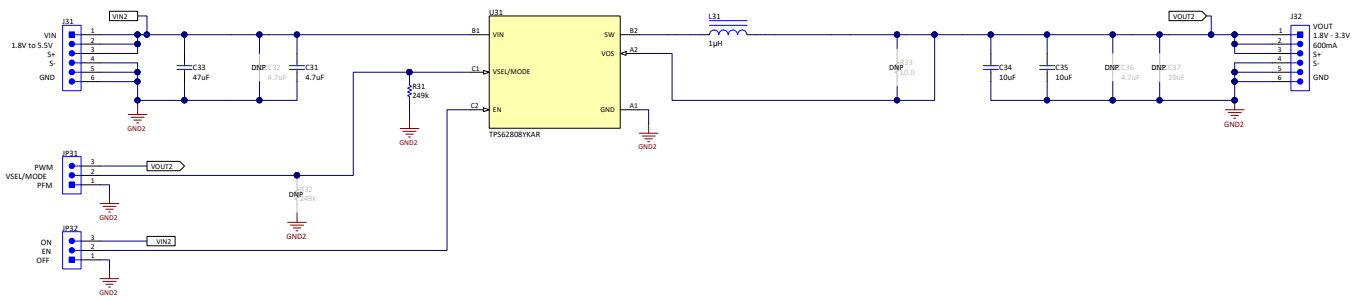


Figure 10. TPS62808 Schematic

## 5.2 List of Materials

Table 3 lists the TPS62806 EVM list of materials.

**Table 3. TPS62806 List of Materials**

DES	QTY	DESCRIPTION	PART NUMBER	MANUFACTURER
C11	1	CAP, CERM, 4.7 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0402	GRM155R60J475ME47D	Murata
C13	1	CAP, CERM, 47 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0805	GRM21BR60J476ME15L	Murata
C14	1	CAP, CERM, 10 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0402	GRM155R60J106ME15D	Murata
L11	1	Inductor, Shielded, Metal Composite, 1 $\mu$ H, 2.7 A, 0.057 ohm, SMD	DFE201610E-1R0M=P2	Cyntec
R11	1	RES, 56.2 k $\Omega$ , 1%, 0.05 W, 0201	Std	Std
U11	1	1.8V to 5.5V, 600mA, 2.3 $\mu$ A I <sub>Q</sub> Step Down Converter in 0.35mm pitch WCSP Package, 1.05 mm x 0.70 mm	TPS62806YKA	Texas Instruments

Table 4 lists the TPS62807 EVM BOM.

**Table 4. TPS62807 List of Materials**

DES	QTY	DESCRIPTION	PART NUMBER	MANUFACTURER
C21	1	CAP, CERM, 4.7 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0402	GRM155R60J475ME47D	Murata
C23	1	CAP, CERM, 47 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0805	GRM21BR60J476ME15L	Murata
C24	1	CAP, CERM, 10 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0402	GRM155R60J106ME15D	Murata
L21	1	Inductor, Shielded, Metal Composite, 1 $\mu$ H, 2.7 A, 0.057 ohm, SMD	DFE201610E-1R0M=P2	Murata
R21	1	RES, 15.4 k $\Omega$ , 1%, 0.05 W, 0201	Std	Std
U21	1	1.8V to 5.5V, 600mA, 2.3 $\mu$ A I <sub>Q</sub> Step Down Converter in 0.35mm pitch WCSP Package, 1.05 mm x 0.70 mm	TPS62807YKA	Texas Instruments

Table 5 lists the TPS62808 EVM BOM.

**Table 5. TPS62808 List of Materials**

DES	QTY	DESCRIPTION	PART NUMBER	MANUFACTURER
C31	1	CAP, CERM, 4.7 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0402	GRM155R60J475ME47D	Murata
C33	1	CAP, CERM, 47 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0805	GRM21BR60J476ME15L	Murata
C34, C35	2	CAP, CERM, 10 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0402	GRM155R60J106ME15D	Murata
L31	1	Inductor, Shielded, Metal Composite, 1 $\mu$ H, 2.7 A, 0.057 ohm, SMD	DFE201610E-1R0M=P2	Murata
R31	1	RES, 249 k $\Omega$ , 1%, 0.05 W, 0201	Std	Std
U31	1	1.8V to 5.5V, 600mA, 2.3 $\mu$ A I <sub>Q</sub> Step Down Converter in 0.35mm pitch WCSP Package, 1.05 mm x 0.70 mm	TPS62808YKA	Texas Instruments

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##### 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。  
[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)

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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#### 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.
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