TPS62800EVM-892 Evaluation Module

The TPS62800EVM-892 (PWR892-001) facilitates the evaluation of the TPS6280x family of 1-A, step-down converters with 2.3-µA 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. The smallest circuit occupies 5.7 mm^2 with a maximum height of 0.65 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- × 0.7-mm wafer chip-scale package (WCSP) with 0.35-mm pitch. The PWR892 EVM contains 3 completely independent circuits, each for a different IC version. See Table 1 for a summary of the PWR892 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. PWR892 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 (V_{IN} > 2.3 V)
TPS62800EVM-892 (PWR892-001)	TPS62800 (U11)	0.6 V	0.7 V	0.4 - 0.775 V (adjustable)	1000 mA
	TPS62801 (U21)	0.9 V	1.2 V	0.8 - 1.55 V (adjustable)	1000 mA
	TPS62802 (U31)	3.3 V	1.8 V	1.8 - 3.3 V (adjustable)	1000 mA

1.1 Performance Specification

Table 2 provides a summary of the TPS62800EVM-892 performance specifications.

Table 2. Performance Specification Summary

Specification	Test Conditions	Min	Typ	Max	Unit
Input voltage		1.8	3.6	5.5	V
Output voltage setpoint		See Table 1			V
Output current		0		See Table 1	mA

1.2 Modifications

The printed-circuit board (PCB) for this EVM is designed to accommodate both the fixed and 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 Fixed Output Voltage Operation

Ux1 can be replaced with the fixed output voltage version of the IC for evaluation. For fixed output voltage version operation, remove Rx1. The VSEL/MODE input pin now only operates as a MODE pin.

1.2.2 Adjusting the Output Voltage

When an IC with an adjustable output voltage is installed, the output voltage may be adjusted though 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.

1.2.3 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.

1.2.4 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-Ω 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*.

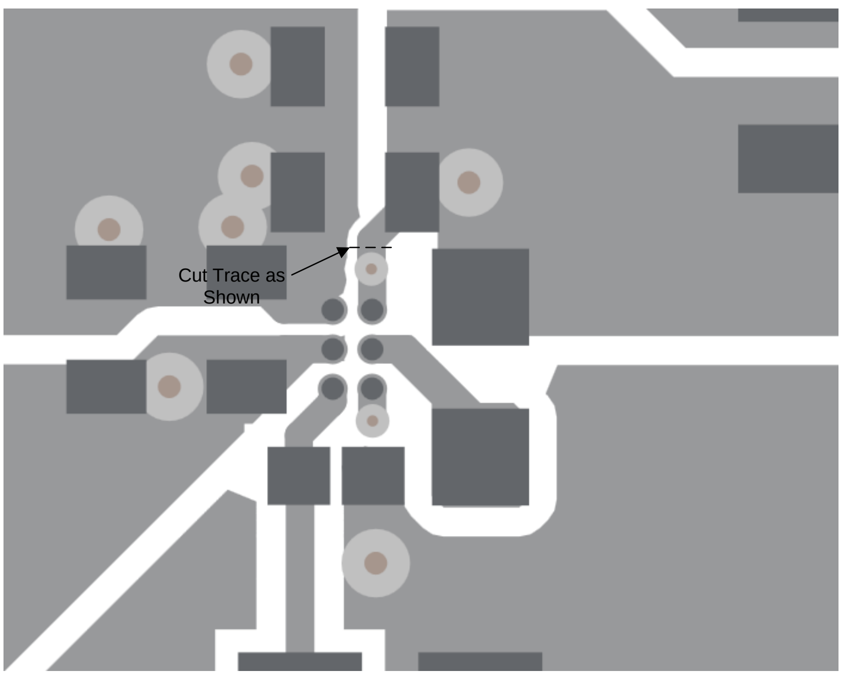

Figure 1. Loop Response Measurement Modification

2 Setup

This section describes how to properly use the TPS62800EVM-892.

2.1 Input/Output Connector Descriptions

Jx1, Pin 1 and 2 – VIN	Positive input connection from the input supply for the EVM.
Jx1, Pin 3 and 4 – S+/S-	Input voltage sense connections. Measure the input voltage at this point.
Jx1, Pin 5 and 6 – GND	Input return connection from the input supply for the EVM.
Jx2, Pin 1 and 2 – VOUT	Output voltage connection.
Jx2, Pin 3 and 4 – S+/S-	Output voltage sense connections. Measure the output voltage at this point.
Jx2, Pin 5 and 6 – GND	Output return connection.
JPx1 – VSEL/MODE	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 Table 1. 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.
JPx2 – EN	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.

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.

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 TPS62800EVM-892 Test Results

The TPS62800EVM-892 was used to take all the data in *TPS62801 1.8-V to 5.5-V, 1-A, 2.3-µA I_Q Step Down Converter in a 6 Pin, 0.35 mm Pitch WCSP Package*. See the device data sheet for the performance of this EVM. The only difference is the inductor used on the TPS62800 sub-circuit. This sub-circuit was designed for the smallest solution size and uses a 0402-size inductor. The data sheet inductor achieves higher efficiency but is a 0603 size.

Figure 2 and Figure 3 show the thermal performance of the EVM.

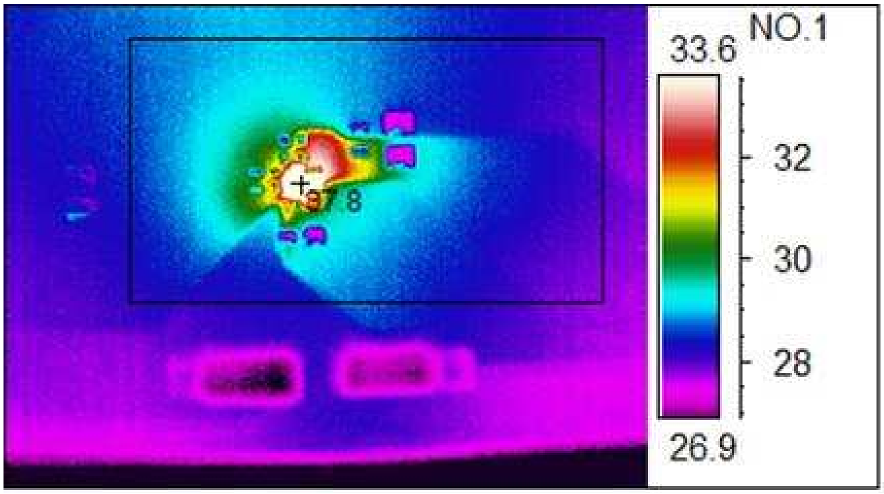

Figure 2. TPS62801 Thermal Performance (V_{IN} = 5 V, V_{OUT} = 1.2 V, I_{OUT} = 1000 mA)

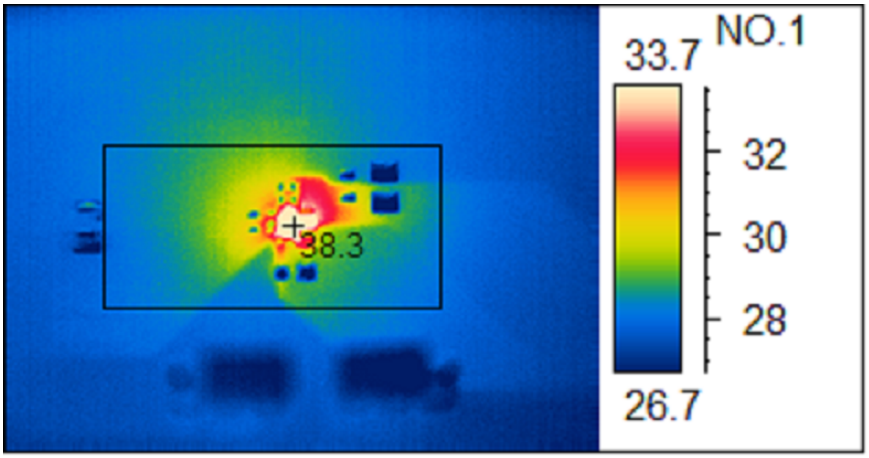

Figure 3. TPS62802 Thermal Performance (V_{IN} = 3.6 V, V_{OUT} = 1.8 V, I_{OUT} = 1000 mA)

4 Board Layout

This section provides the TPS62800EVM-892 board layout and illustrations in Figure 4 through Figure 6. The Gerbers are available on the EVM product page: TPS62800EVM-892. Revision B of the PCB just changed silkscreen items.

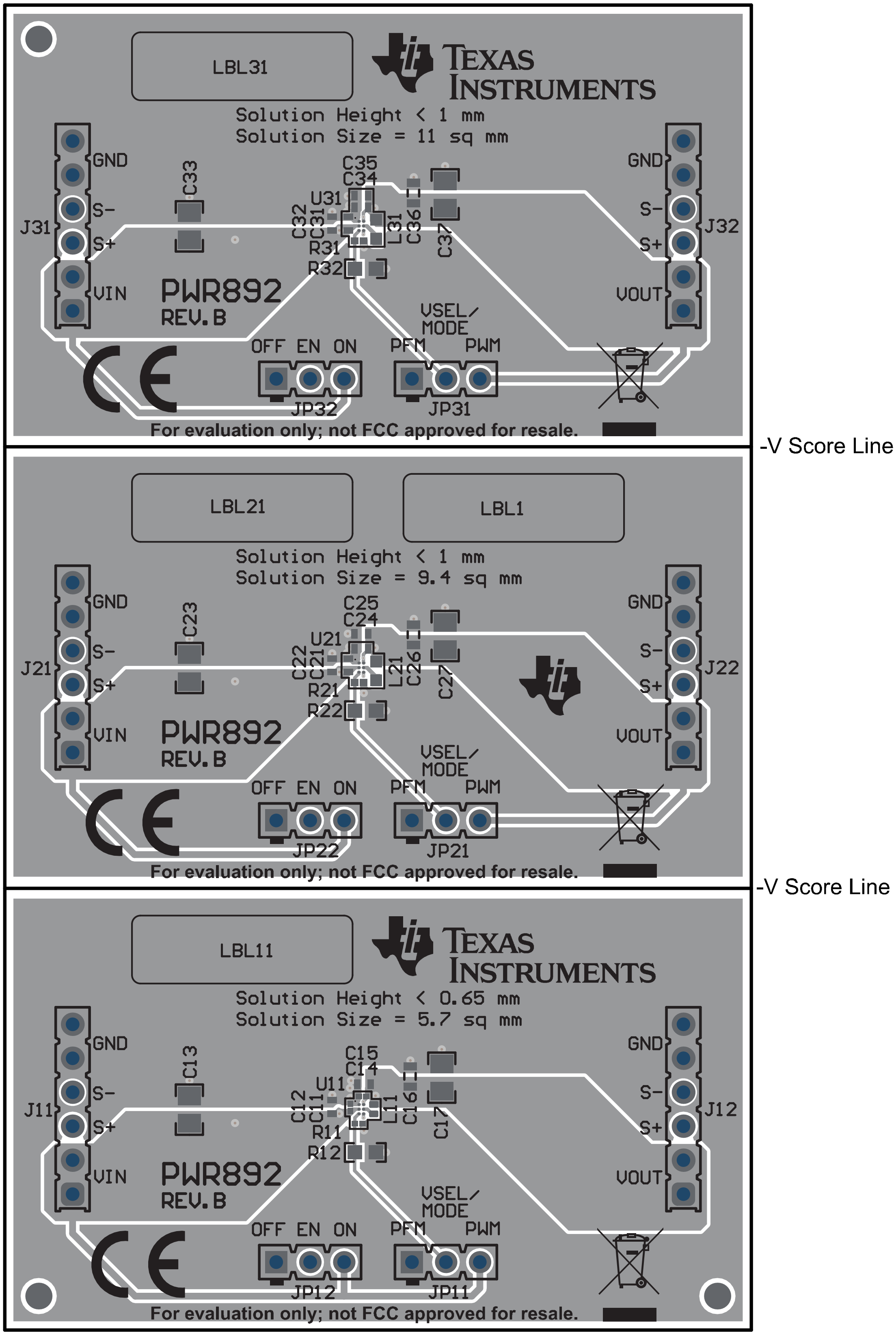

Figure 4. Top Assembly

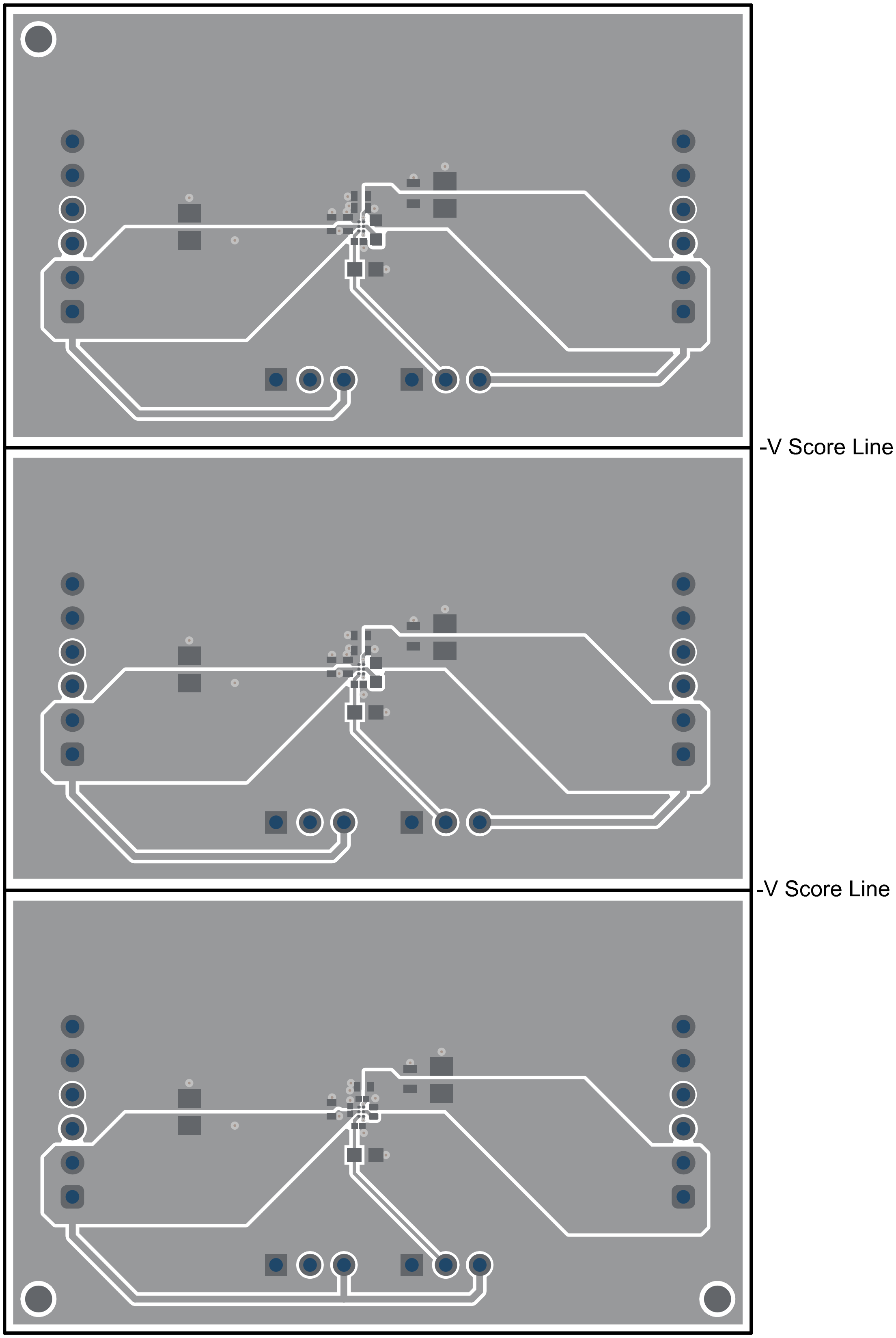

Figure 5. Top Layer

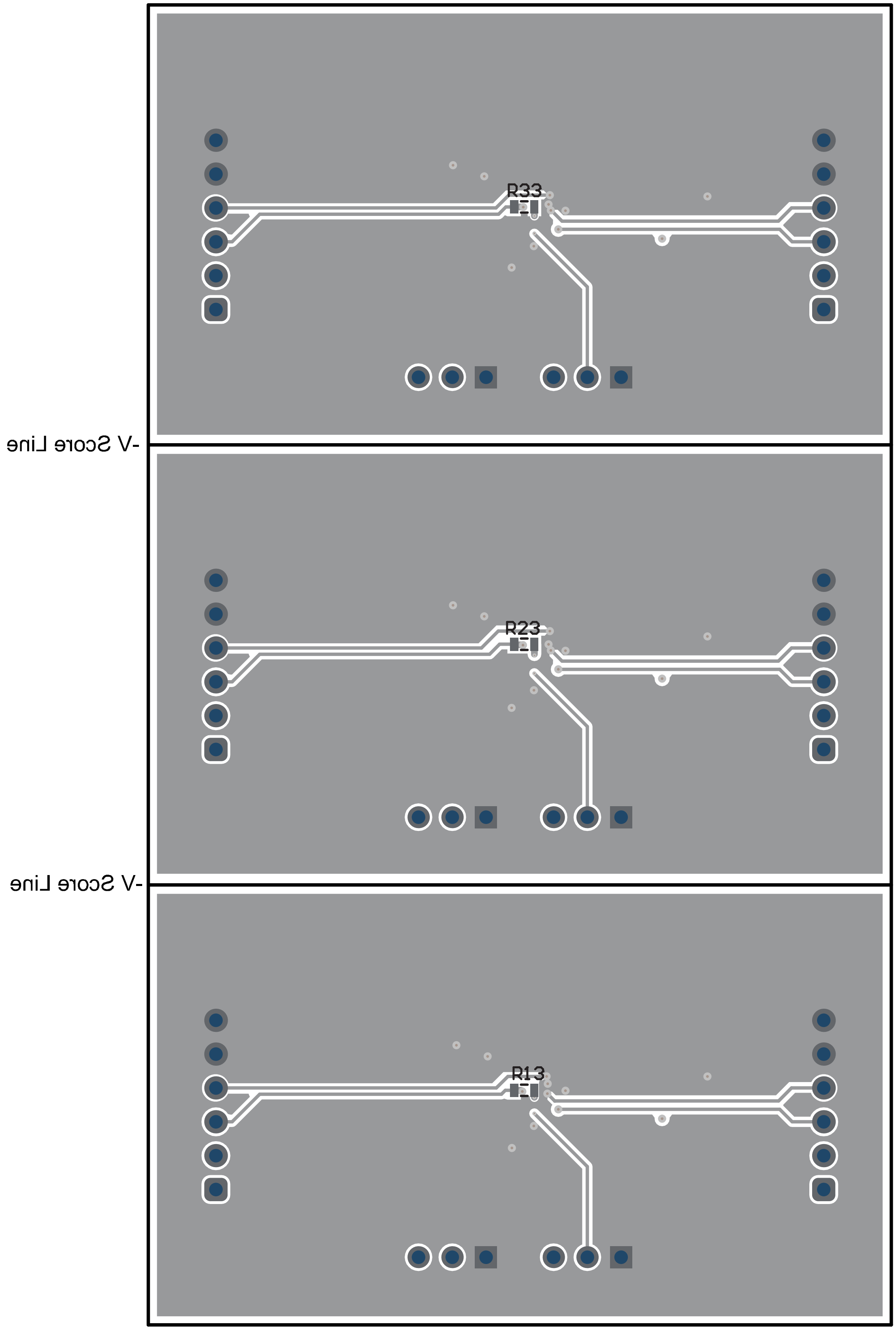

Figure 6. Bottom Layer

5 Schematic and Bill of Materials

This section provides the TPS62800EVM-892 schematic and bill of materials (BOM).

5.1 Schematic

Figure 7 illustrates the TPS62800 EVM schematic.

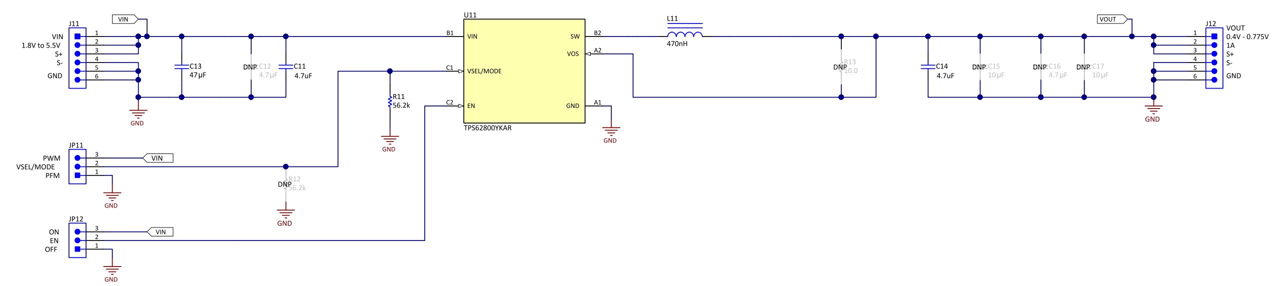

Figure 7. TPS62800 Schematic

Figure 8 illustrates the TPS62801 EVM schematic.

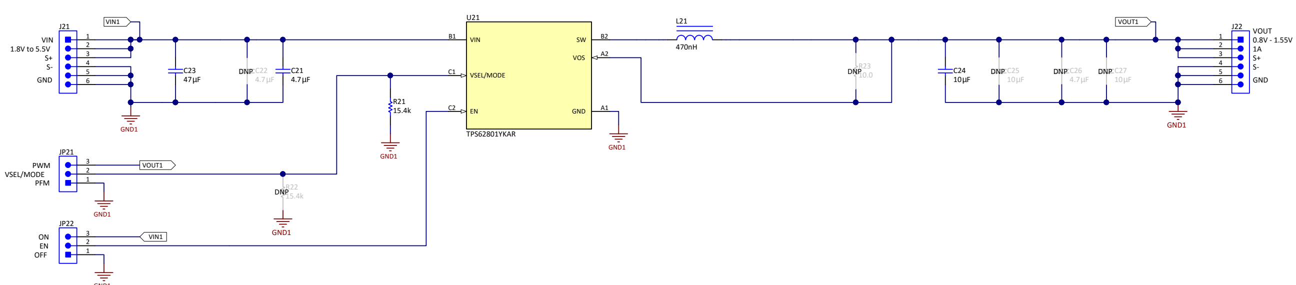

Figure 8. TPS62801 Schematic

Figure 9 illustrates the TPS62802 EVM schematic.

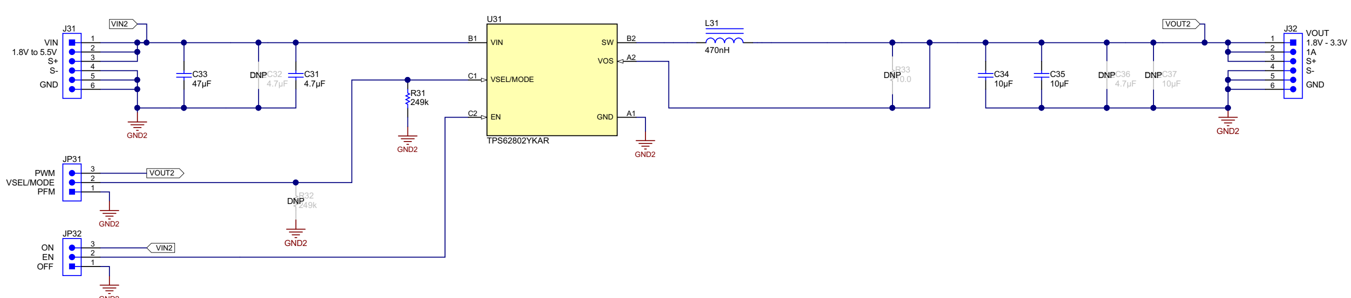

Figure 9. TPS62802 Schematic

5.2 Bill of Materials

Table 3 lists the TPS62800 EVM BOM.

Table 3. TPS62800 Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
C11, C14	2	4.7µF	CAP, CERM, 4.7 µF, 6.3 V, ±20%, X5R, 0201	0201	GRM035R60J475ME15D	Murata
C13	1	47µF	CAP, CERM, 47 µF, 6.3 V, ±20%, X5R, 0805	0805	GRM21BR60J476ME15L	Murata
L11	1	470nH	Inductor, Shielded, 470 nH, 1.0 A, 0.145 ohm, SMD	0402	HTET1005FE-R47MSR-11	Cyntec
R11	1	56.2kΩ	RES, 56.2 kΩ, 1%, 0.05 W, 0201	0201	Std	Std
U11	1		1.8V to 5.5V, 1A, 2.3µA I_Q Step Down Converter in 0.35mm pitch WCSP Package	1.05 mm x 0.70 mm	TPS62800YKA	Texas Instruments

Table 4 lists the TPS62801 EVM BOM.

Table 4. TPS62801 Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
C21	1	4.7µF	CAP, CERM, 4.7 µF, 6.3 V, ±20%, X5R, 0402	0402	GRM155R60J475ME47D	Murata
C23	1	47µF	CAP, CERM, 47 µF, 6.3 V, ±20%, X5R, 0805	0805	GRM21BR60J476ME15L	Murata
C24	1	10µF	CAP, CERM, 10 µF, 6.3 V, ±20%, X5R, 0402	0402	GRM155R60J106ME15D	Murata
L21	1	470nH	Inductor, Shielded, Metal Composite, 470 nH, 3.1 A, 0.045 ohm, SMD	0603	DFE18SANR47MG0L	Murata
R21	1	15.4kΩ	RES, 15.4 kΩ, 1%, 0.05 W, 0201	0201	Std	Std
U21	1		1.8V to 5.5V, 1A, 2.3µA I_Q Step Down Converter in 0.35mm pitch WCSP Package	1.05 mm x 0.70 mm	TPS62801YKA	Texas Instruments

Table 5 lists the TPS62802 EVM BOM.

Table 5. TPS62802 Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
C31	1	4.7µF	CAP, CERM, 4.7 µF, 6.3 V, ±20%, X5R, 0402	0402	GRM155R60J475ME47D	Murata
C33	1	47µF	CAP, CERM, 47 µF, 6.3 V, ±20%, X5R, 0805	0805	GRM21BR60J476ME15L	Murata
C34, C35	2	10µF	CAP, CERM, 10 µF, 6.3 V, ±20%, X5R, 0402	0402	GRM155R60J106ME15D	Murata
L31	1	470nH	Inductor, Shielded, Metal Composite, 470 nH, 3.1 A, 0.045 ohm, SMD	0603	DFE18SANR47MG0L	Murata
R31	1	249kΩ	RES, 249 kΩ, 1%, 0.05 W, 0201	0201	Std	Std
U31	1		1.8V to 5.5V, 1A, 2.3µA I_Q Step Down Converter in 0.35mm pitch WCSP Package	1.05 mm x 0.70 mm	TPS62802YKA	Texas Instruments

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from A Revision (April 2018) to B Revision	Page
• Changed Board Layout images (3 places)	5
• Added TPS62800 EVM schematic	9
• Added *TPS62800 Bill of Materials*	10

Changes from Original (January 2018) to A Revision	Page
• Added TPS62802 to the *PWR892 Circuit Options* table.	2
• Added *Figure 3*.	5
• Added TPS62802 schematic.	9
• Added *TPS62802 Bill of Materials*.	10

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

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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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      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

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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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3.2 *Canada*

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

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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.

4.3 *Safety-Related Warnings and Restrictions:*

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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.

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