

**ABSTRACT**

The TPSM8286xAA0xEVM facilitates the evaluation of the TPSM82864AA0SRDJR and TPSM82866AA0SRDJR 4-A and 6-A pin-to-pin compatible step-down power modules with DCS-Control in a 3.5-mm × 4-mm × 1.4-mm overmolded QFN package and the TPSM82864AA0HRDMR and TPSM82866AA0HRDMR 4-A and 6-A pin-to-pin compatible step-down power modules with DCS-Control in a 3.5-mm × 4-mm × 1.8-mm overmolded QFN package. The EVMs provide a 1.2-V output voltage with 1% accuracy for input voltages from 2.4 V to 5.5 V. The TPSM82864A and TPSM82866A are high-efficiency and small solutions for the following:

- Point-of-load (POL) power in applications such as the core supply for FPGAs, CPUs, and ASICs
- Optical modules
- Medical imaging
- Industrial transport
- Solid state drives (SSDs)
- Other space-limited applications

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Trademarks

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1 Introduction

The TPSM82866AA0SRDJR and TPSM82864AA0SRDJR are synchronous, step-down converter power modules in a small 3.5-mm × 4-mm overmolded QFN package with 1.4-mm height. The TPSM82866AA0HRDMR and TPSM82864AA0HRDMR are synchronous, step-down converter power modules in a small 3.5-mm × 4-mm overmolded QFN package with 1.8-mm height. The four devices in this family support 4-A or 6-A output currents.

1.1 Performance Specification

Table 1-1 provides a summary of the TPSM8286xAA0xEVM performance specifications.

Table 1-1. Performance Specification Summary

| SPECIFICATION | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-------------------------|-------------------------------|-----|-----|-----|------|
| Input voltage | | 2.4 | 5 | 5.5 | V |
| Output voltage setpoint | | | 1.2 | | V |
| Output current | TPSM82866AA0SEVM (BSR182-001) | 0 | | 6 | A |
| | TPSM82864AA0SEVM (BSR182-002) | 0 | | 4 | |
| | TPSM82866AA0HEVM (BSR182-003) | 0 | | 6 | |
| | TPSM82864AA0HEVM (BSR182-004) | 0 | | 4 | |

1.2 Modifications

The printed-circuit board (PCB) for this EVM is designed to accommodate some modifications by the user. Additional input and output capacitors or a feedforward capacitor can be added. Also, the MODE setting and output voltage setting configuration can be changed. Finally, the loop response can be measured.

1.2.1 Input and Output Capacitors

C9, shown in Figure 6-1, 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.

C5, C6, C7, and C8 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.

1.2.2 Feedforward Capacitor

C4 is provided as an optional feedforward capacitor (C_{FF}).

1.2.3 VSET/MODE Resistor

R4 selects the MODE setting (PSM or FPWM) and output voltage setting configuration. When using the VSET configuration for setting the output voltage, short R1 and remove R2. See the [TPSM8286x 4-A and 6-A High Efficiency Step-Down Converter QFN Power Module data sheet](#) for details of the various settings.

1.2.4 Loop Response Measurement

The loop response can be measured with simple changes to the circuitry. First, install a 10-Ω resistor across the pads of R6 on the back of the PCB. The pads are spaced to allow installation of an 0603-sized resistor. Next, cut the short section of trace on the top layer between the via near R1 and the V_{OUT} plane. Figure 1-1 shows this change. With these changes, an AC signal (10-mV, peak-to-peak amplitude recommended) can be injected into the control loop across the added 10-Ω resistor. Figure 4-3 shows the results of this test.

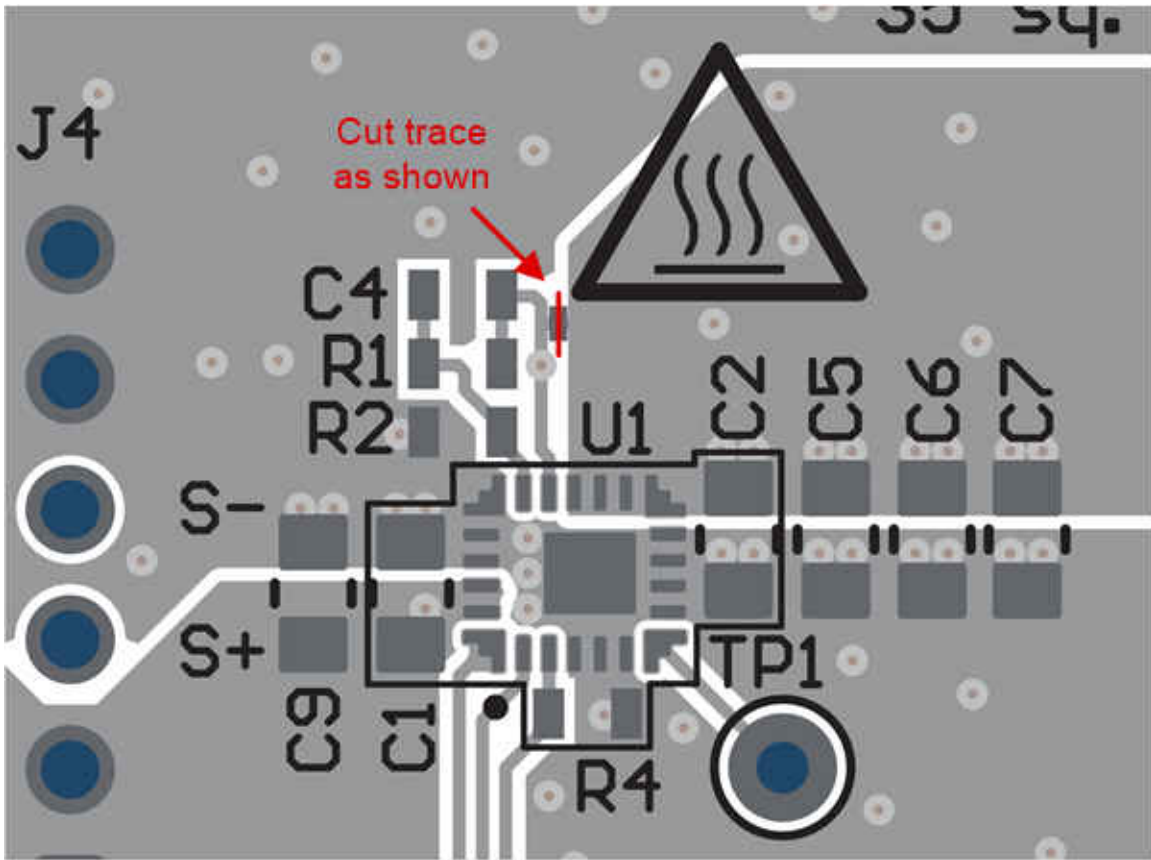


Figure 1-1. Loop Response Measurement Modification

2 Setup

This section describes how to properly use the TPSM8286xAA0xEVM.

2.1 Setup

To operate the EVM, set jumper JP1 between ON and EN to turn on the device as shown in [Input, Output Connector and Jumper Descriptions](#). Connect the input supply to J1 and connect the load to J2.

2.2 Input, Output Connector and Jumper Descriptions

| | |
|--------------------------------|--|
| J1 – VIN/GND | Input and return connections from the input supply for the EVM. This connector supports currents over 3 A and accepts up to 16 AWG wire. |
| J2 – VOUT/GND | Input and return connections from the EVM to the load. This connector supports currents over 3 A and accepts up to 16 AWG wire. |
| J3 – PG/GND | The PG output appears on pin 2 of this header with ground on pin 1. |
| J4, Pin 1 and 2 – VIN | Positive input connection from the input supply for the EVM Do not use for currents above 3 A. |
| J4, Pin 3 and 4 – S+/S– | Input voltage sense connections. Measure the input voltage at this point. |
| J4, Pin 5 and 6 – GND | Input return connection from the input supply for the EVM. Do not use for currents above 3 A. |
| J5, Pin 1 and 2 – VOUT | Output voltage connection Do not use for currents above 3 A. |
| J5, Pin 3 and 4 – S+/S– | Output voltage sense connections. Measure the output voltage at this point. |
| J5, Pin 5 and 6 – GND | Output return connection Do not use for currents above 3 A. |
| JP1 – EN | EN pin input jumper. Place the supplied jumper across ON and EN to turn on the module. Place the jumper across OFF and EN to turn off the module. |
| JP2 – PG Pullup Voltage | PG pin pullup voltage jumper. Place the supplied jumper on JP2 to connect the PG pin pullup resistor to VOUT. Alternatively, the jumper can be removed and a different voltage can be supplied on pin 1 to pull up the PG pin to a different level. This externally applied voltage must remain below 6 V. |
| JP3 – VSET/MODE | VSET/MODE pin input jumper. Place the supplied jumper across PWM and VSET/MODE to operate the IC in Forced PWM mode. Place the jumper across PFM/PWM and VSET/MODE to operate the IC in Auto PFM/PWM mode. Remove the jumper to operate the IC with a fixed output voltage, which is set by R4. For the fixed output voltage configuration, R4 must be installed, R2 removed, and R1 shorted. |

3 Safety Instructions

WARNING



Hot surface. Contact may cause burns. Do not touch.

WARNING

High currents may be present on the input and output. Use connectors J1 and J2 if the current exceeds 3 A.

4 Test Results

The TPSM8286xAA0xEVM was used to take all the data in the [TPSM8286x 4-A and 6-A High Efficiency Step-Down Converter QFN Power Module data sheet](#). See the device data sheet for the performance of this EVM.

Figure 4-1 shows the thermal performance of the TPSM82866AA0SEVM and Figure 4-2 shows the thermal performance of the TPSM82866AA0HEVM. Figure 4-3 shows the loop response measurement of all EVMs.

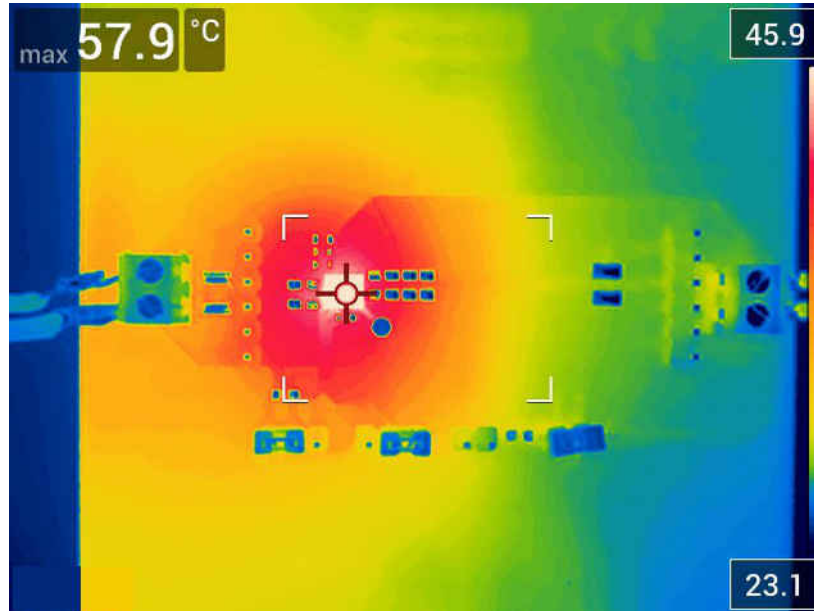


Figure 4-1. Thermal Performance (TPSM82866AA0SEVM, $V_{IN} = 5\text{ V}$, $V_{OUT} = 1.2\text{ V}$, $I_{OUT} = 6\text{ A}$)

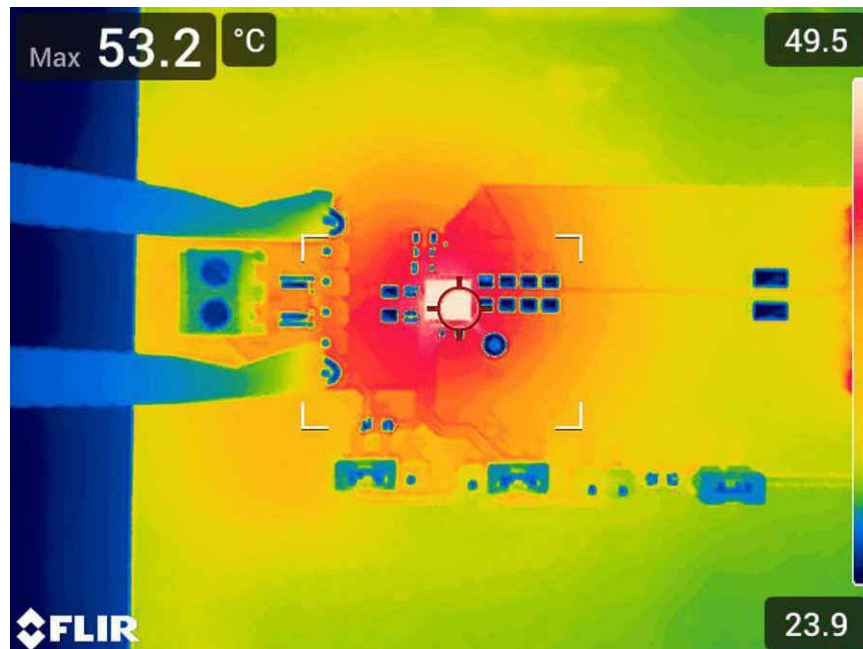


Figure 4-2. Thermal Performance (TPSM82866AA0HEVM, $V_{IN} = 5\text{ V}$, $V_{OUT} = 1.2\text{ V}$, $I_{OUT} = 6\text{ A}$)

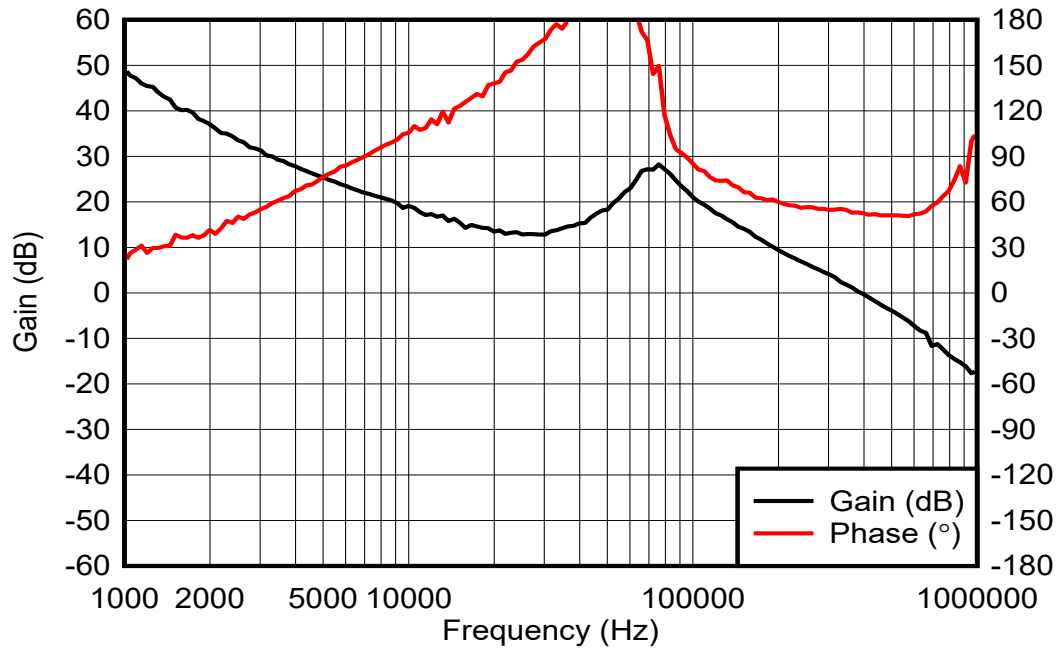


Figure 4-3. Loop Response Measurement ($V_{IN} = 5\text{ V}$, $V_{OUT} = 1.2\text{ V}$, $I_{OUT} = 6\text{ A}$)

5 Board Layout

This section provides the TPSM8286xAA0xEVM board layout and illustrations in [Figure 5-1](#) through [Figure 5-6](#). The Gerbers are available on the [TPSM82866AA0SEVM tool folder](#). All four layers use 2-ounce copper.

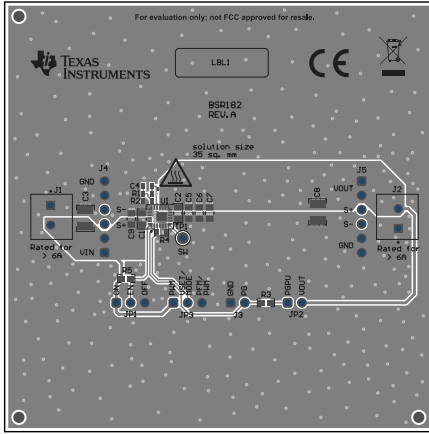


Figure 5-1. Top Assembly

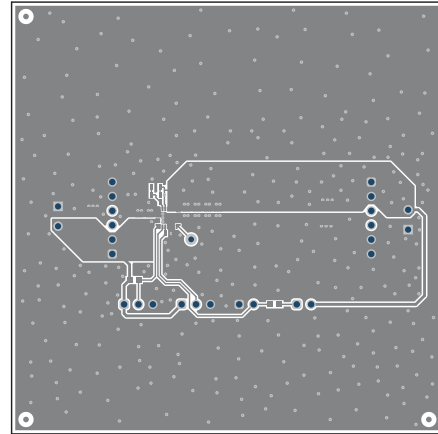


Figure 5-2. Top Layer

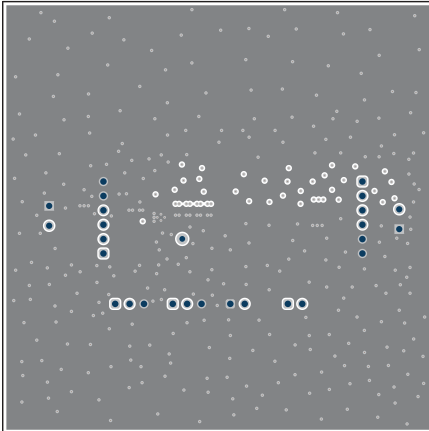


Figure 5-3. Internal Layer 1

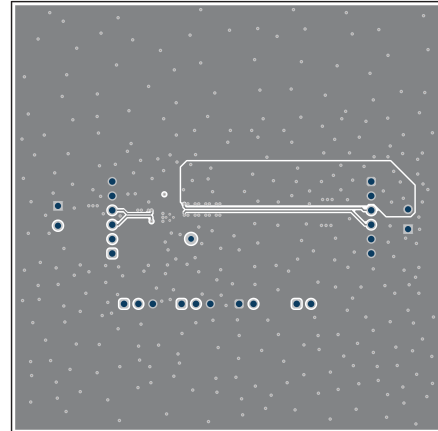


Figure 5-4. Internal Layer 2

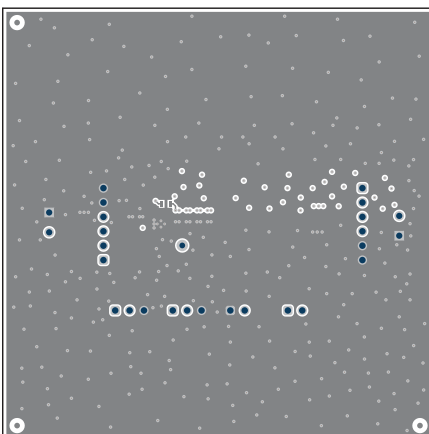


Figure 5-5. Bottom Layer

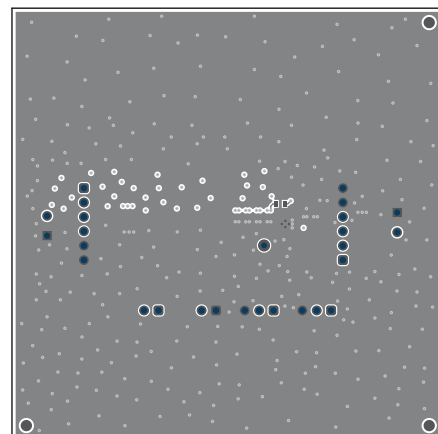


Figure 5-6. Bottom Layer (Mirrored)

6 Schematic and Bill of Materials

This section provides the TPSM8286xAA0xEVM schematic and bill of materials (BOM).

6.1 Schematic

Figure 6-1 illustrates the EVM schematic.

The TPSM82864AA0SEVM uses the TPSM82864AA0SRDJR IC.

The TPSM82866AA0SEVM uses the TPSM82866AA0SRDJR IC.

The TPSM82866AA0HEVM uses the TPSM82866AA0HRDMR IC.

The TPSM82866AA0HEVM uses the TPSM82864AA0HRDMR IC.

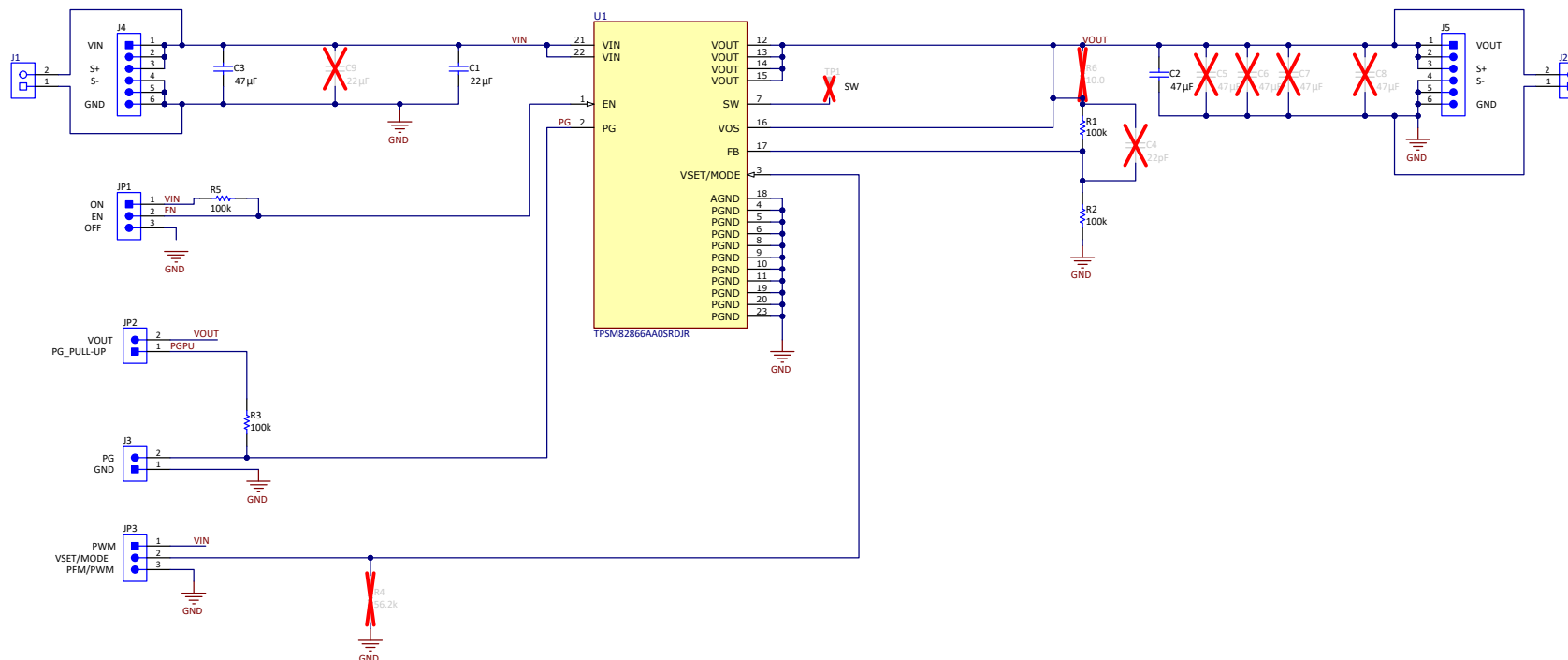


Figure 6-1. TPSM8286xAA0xEVM Schematic

6.2 Bill of Materials

Table 6-1 lists the BOM for this EVM.

Table 6-1. TPSM8286xAA0xEVM Bill of Materials

| COUNT | | | | DESIGNATOR | VALUE | DESCRIPTION | SIZE | PART NUMBER | MANUFACTURER |
|-------|------|------|------|-------------------|----------------|----------------------------------|------------|--------------------|-------------------|
| -001 | -002 | -003 | -004 | | | | | | |
| 1 | 1 | 1 | 1 | C1 | 22 μ F | CAP, CERM, 6.3 V, \pm 20%, X7R | 0805 | GRM21BZ70J226ME44L | Murata |
| 1 | 1 | 1 | 1 | C2 | 47 μ F | CAP, CERM, 6.3 V, \pm 20%, X6S | 0805 | JMK212BC6476MG-T | Taiyo Yuden |
| 1 | 1 | 1 | 1 | C3 | 47 μ F | CAP, CERM, 10 V, \pm 20%, X7R | 1210 | LMK325B7476MM-PR | Taiyo Yuden |
| 4 | 4 | 4 | 4 | R1, R2, R3, R5 | 100 k Ω | RES, 100 k Ω , 1%, 0.1 W | 0603 | Std | Std |
| 1 | 0 | 0 | 0 | U1 | | | 3.5 x 4 mm | TPSM82866AA0SRDJR | Texas Instruments |
| 0 | 1 | 0 | 0 | U1 | | | 3.5 x 4 mm | TPSM82864AA0SRDJR | Texas Instruments |
| 0 | 0 | 1 | 0 | U1 ⁽¹⁾ | | | 3.5 x 4 mm | TPSM82866AA0HRDMR | Texas Instruments |
| 0 | 0 | 0 | 1 | U1 ⁽¹⁾ | | | 3.5 x 4 mm | TPSM82864AA0HRDMR | Texas Instruments |

(1) These U1 devices may not contain the correct top side markings. They are still fully tested and functional devices.

7 Revision History

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

| Changes from Revision * (September 2021) to Revision A (November 2022) | Page |
|--|------|
| • Added the TPSM82866AA0HEVM and TPSM82864AA0HEVM throughout..... | 2 |
| • Added Figure 4-2 | 5 |
| • Added -003 and -004 variants to Table 6-1..... | 9 |

STANDARD TERMS FOR EVALUATION MODULES

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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 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
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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 DEGRADATION 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/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。
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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:*
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