

EVM User's Guide:

TPSM8281xEVM-089 Evaluation Module



ABSTRACT

The TPSM8281xEVM-089 evaluation module (EVM) facilitates the evaluation of the TPSM82816, a 6-A pin-to-pin compatible step-down power module with frequency synchronization in a 3-mm × 4-mm × 1.6-mm MicroSiP™ package and the TPSM82810, a 4-A pin-to-pin compatible step-down power module with frequency synchronization in a 3-mm × 4-mm × 2.4-mm MicroSiP package. The EVMs provide a 1.8-V output voltage with 1% accuracy for input voltages up to 6 V. The TPSM8281x is a high-efficiency and small solution for point-of-load (POL) power in applications such as optical modules, test and measurement, patient monitoring and diagnostics, wireless infrastructure, and ruggedized communication.

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Trademarks

MicroSiP™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

1 Introduction

The TPSM82810SILR and TPSM82816SIER are synchronous, step-down converter power modules that support frequency synchronization in a small 3-mm × 4-mm μ SiP package. The TPSM82810 is 2.4-mm tall and supports 4 A of output current. The TPSM82816 is 1.6-mm tall and supports 6 A of output current.

1.1 Performance Specification

Table 1-1 provides a summary of the TPSM8281xEVM-089 performance specifications.

Table 1-1. Performance Specification Summary

SPECIFICATION	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input voltage	TPSM82810EVM-089	2.75	5	6	V
	TPSM82816EVM-089	2.7	5	6	V
Output voltage setpoint			1.8		V
Output current	TPSM82810EVM-089	0		4	A
	TPSM82816EVM-089	0		6	A

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 can be added. Also, the switching frequency, spread spectrum, control loop compensation, and soft-start time can be changed. Finally, the loop response can be measured and a precise turn-on voltage can be implemented.

1.2.1 Input and Output Capacitors

C7, 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.

C8, C9, and C10 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 [TPSM82816 2.7-V to 6-V Input 6-A Step-Down MicroSiP Power Module with Integrated Inductor and Frequency Synchronization data sheet](#) for proper operation.

C8 must be populated with a 47- μ F capacitor to improve the load regulation and transient response for output voltages below 1 V.

1.2.2 Switching Frequency, Spread Spectrum and Control Loop Compensation

R4 sets the switching frequency and control loop compensation setting of the converter. On the TPSM82816 device only, it also enables or disables spread spectrum. See the [TPSM82816 2.7-V to 6-V Input 6-A Step-Down MicroSiP Power Module with Integrated Inductor and Frequency Synchronization data sheet](#) for details.

1.2.3 Soft-Start Time

C4 controls the soft-start time of the output voltage. C4 can be changed for a faster or slower ramp-up of the output voltage. Note that the soft-start time is different (with the same C4 value) for the TPSM82810 and TPSM82816.

1.2.4 Loop Response Measurement

The loop response can be measured by adding a 50- Ω resistor between VOUT and R1/C6.

1.2.5 Precise Turn-on Voltage

With the jumper on JP1 removed, R5 and R7 can be modified to create a precise turn-on voltage. See [Achieving a Clean Start-up by Using a DC/DC Converter with a Precise Enable-pin Threshold technical brief](#) for details.

2 Setup

This section describes how to correctly use the TPSM8281xEVM-089.

2.1 Hardware Setup

To operate the EVM, set jumpers JP1 and JP2 to the desired positions per [Input, Output Connector and Jumper Descriptions](#). Connect the input supply to J1, between VIN and GND, and connect the load to J2 between VOUT and GND.

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 1 of this header with ground on pin 2.
J4 – SS/TR and GND	The SS/TR signal appears on pin 2 of this header with ground on pin 1. A tracking signal can be applied on the SS/TR pin.
J5, Pin 1 and 2 – VIN	Positive input connection from the input supply for the EVM Do not use for currents above 3 A.
J5, Pin 3 and 4 – S+/S–	Input voltage sense connections. Measure the input voltage at this point.
J5, Pin 5 and 6 – GND	Input return connection from the input supply for the EVM. Do not use for currents above 3 A.
J6, Pin 1 and 2 – VOUT	Output voltage connection Do not use for currents above 3 A.
J6, Pin 3 and 4 – S+/S–	Output voltage sense connections. Measure the output voltage at this point.
J6, 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. Remove the jumper to create a precise turn-on voltage with R5 and R7.
JP2 – MODE/SYNC	MODE/SYNC pin input jumper. Place the supplied jumper across PWM and MODE/SYNC to operate the IC in Forced PWM mode. Place the jumper across PFM/PWM and MODE/SYNC to operate the IC in PFM/PWM mode. Remove the jumper to apply a synchronization signal on the MODE/SYNC pin.

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 TPSM8281xEVM-089 Test Results

The TPSM8281xEVM-089 was used to take all the data in the [TPSM82816 2.7-V to 6-V Input 6-A Step-Down MicroSiP Power Module with Integrated Inductor and Frequency Synchronization data sheet](#). See the device data sheet for the performance of this EVM.

5 Board Layout

This section provides the TPSM8281xEVM-089 board layout. The Gerber files are available on the [TPSM82816EVM-089](#) tool folder. All four layers use 1-ounce copper.

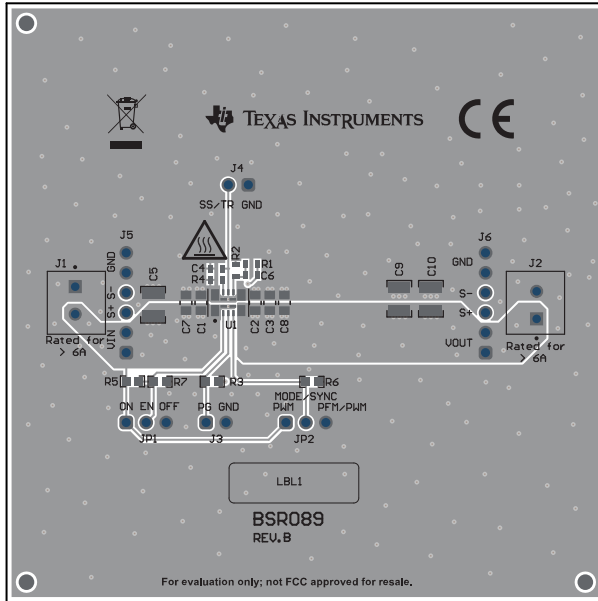


Figure 5-1. Top Assembly

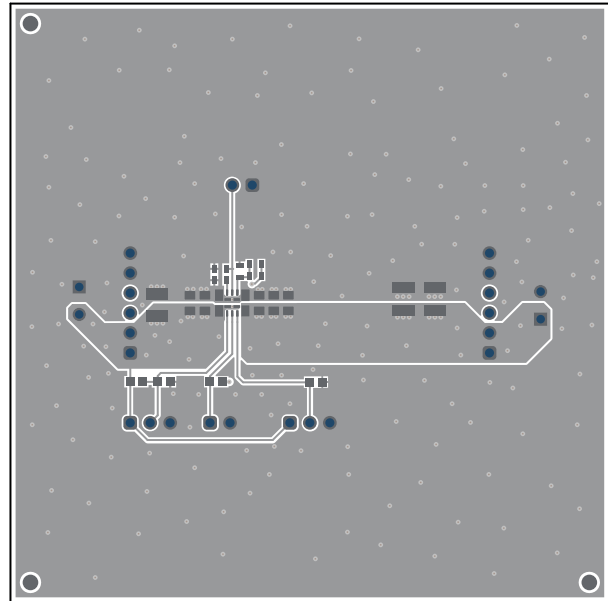


Figure 5-2. Top Layer

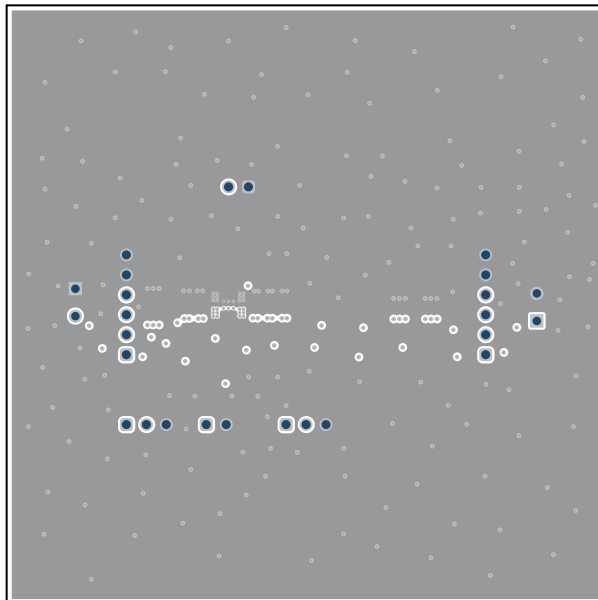


Figure 5-3. Internal Layer 1

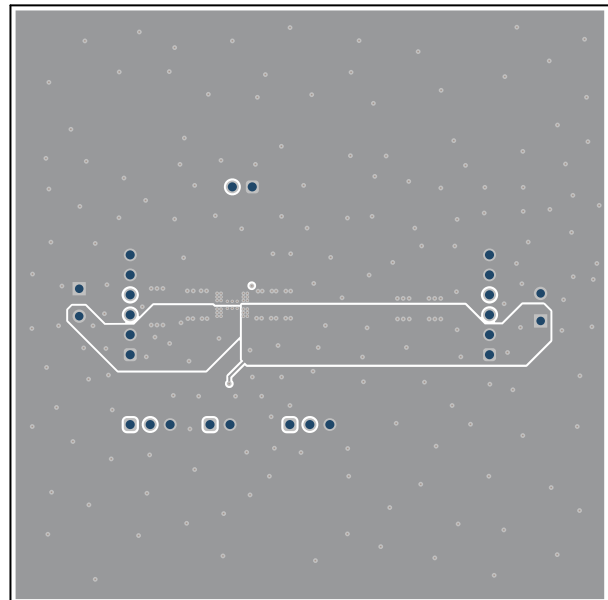


Figure 5-4. Internal Layer 2

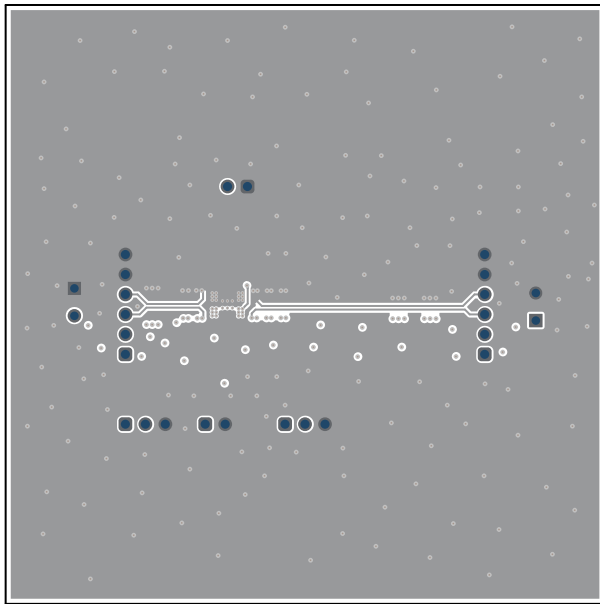


Figure 5-5. Bottom Layer

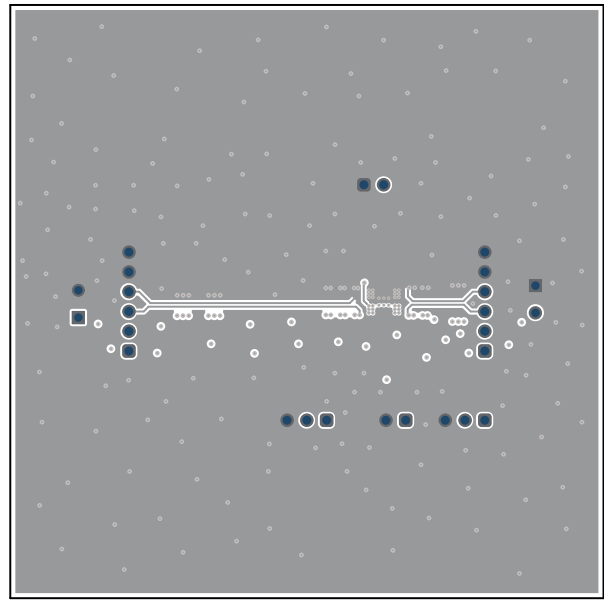


Figure 5-6. Bottom Layer (Mirrored)

6 Schematic and Bill of Materials

This section includes the TPSM8281xEVM-089 schematic and bill of materials.

6.1 Schematic

Figure 6-1 shows the EVM schematic.

The TPSM82810EVM-089 uses the TPSM82810SILR IC.

The TPSM82816EVM-089 uses the TPSM82816SIEP IC.

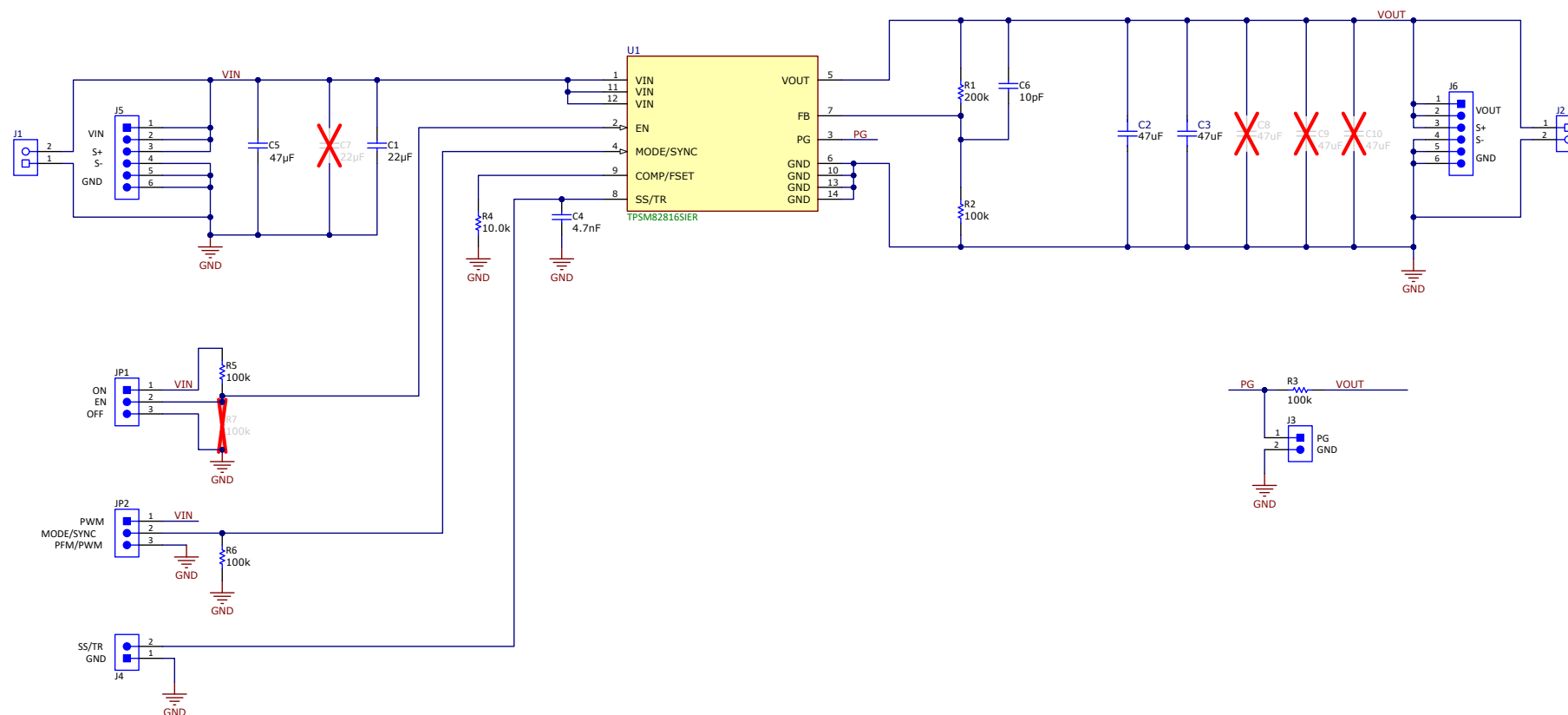


Figure 6-1. TPSM8281xEVM-089 Schematic

6.2 Bill of Materials

Table 6-1 lists the BOM for this EVM.

Table 6-1. TPSM8281xEVM-089 BOM

QUANTITY		REF DES	VALUE	DESCRIPTION	SIZE	PART NUMBER	MFR
-001	-002						
1	1	C1	22 μ F	Ceramic Capacitor, 6.3 V, X7R	0805	GRM21BZ70J226ME44L	Murata
2	2	C2, C3	47 μ F	Ceramic Capacitor, 6.3 V, X6S	0805	GRM21BC80J476ME01L	Murata
1	1	C4	4700 pF	Ceramic Capacitor, 50 V, X7R	0603	Std	Std
1	1	C5	47 μ F	Ceramic Capacitor, 10 V, X7R	1210	LMK325B7476MM-PR	Taiyo Yuden
1	1	C6	10 pF	Ceramic Capacitor, 50 V, X7R	0603	Std	Std
1	1	R1	200 k Ω	Resistor 1%, 0.1 W	0603	Std	Std
4	4	R2, R3, R5, R6	100 k Ω	Resistor 1%, 0.1 W	0603	Std	Std
1	1	R4	10.0 k Ω	Resistor 1%, 0.1 W	0603	Std	Std
1	0	U1		4-A Step-Down MicroSiP Power Module with Integrated Inductor and Frequency Synchronization	3 mm \times 4 mm	TPSM82810SILR	Texas Instruments
0	1	U1		6-A Step-Down MicroSiP Power Module with Integrated Inductor and Frequency Synchronization	3 mm \times 4 mm	TPSM82816SIER	Texas Instruments

A Appendix - Rev.A EVM

This appendix contains the information about the original Revision A TPSM82810EVM-089 EVM, which is now Revision B.

A.1 Rev.A - Setup

This section describes how to correctly use the TPSM82810EVM-089 Rev.A.

A.1.1 Rev.A - Connector Descriptions

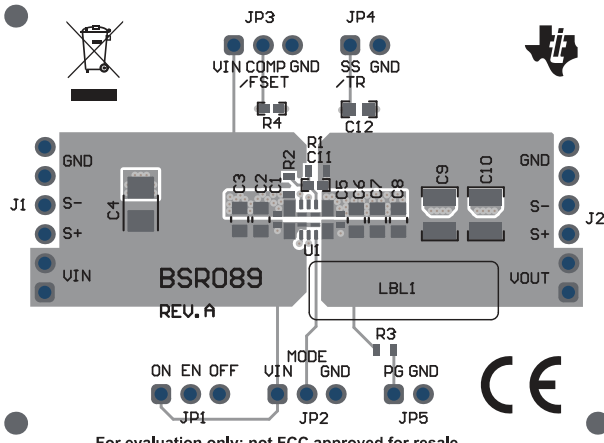
J1, Pin 1 and 2 – VIN	Positive input voltage connection from the input supply for the EVM
J1, Pin 3 and 4 – S+/S–	Input voltage sense connections; measure the input voltage at this point.
J1, Pin 5 and 6 – GND	Input return connection from the input supply for the EVM
J2, Pin 1 and 2 – VOUT	Positive output voltage connection
J2, Pin 3 and 4 – S+/S–	Output voltage sense connections; measure the output voltage at this point.
J2, Pin 5 and 6 – GND	Output return connection
JP1 – EN	EN pin 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.
JP2 – MODE/SYNC	MODE/SYNC pin jumper. Place the supplied jumper across VIN and MODE/SYNC to force the device in fixed frequency PWM operation at all load currents. Place the jumper across MODE/SYNC and GND to enable power save mode. Connect a clock signal to MODE/SYNC referenced to GND to synchronize the switching frequency to the clock signal.
JP3 – COMP/FSET	Device compensation and frequency set input. When the jumper is open, the resistor R4 from this pin to ground defines the compensation of the control loop as well as the switching frequency if it is not externally synchronized. The COMP/FSET pin connects pin 1 and 2 and is tied to VIN. Comp setting 1 (for smallest output capacitance) is set and the switching frequency is internally fixed at 2.25 MHz. The COMP/FSET pin connects pin 2 and 3 and is tied to GND. Comp setting 3 (for large output capacitance) is set and the switching frequency is internally fixed at 2.25 MHz.
JP4 – SS/TR	SS/TR input. A voltage connected on pin 1 of this header referenced to GND on pin 2 can be used to control the output voltage (tracking). Change the capacitor from SS/TR pin to GND to adjust the soft-start ramp time.
JP5 – PG	The PG output appears on pin 1 of this header with a convenient ground on pin 2.

A.1.2 Rev.A - Hardware Setup

To operate the EVM, set jumpers JP1, JP2, and JP3 to the desired positions per [Rev.A - Connector Descriptions](#). Connect the input supply to J1, between VIN and GND, and connect the load to J2 between VOUT and GND.

A.2 Rev.A - Board Layout

This section provides the TPSM82810EVM-089 Revision A board layout.



For evaluation only; not FCC approved for resale.
Figure A-1. Rev.A - Top Assembly

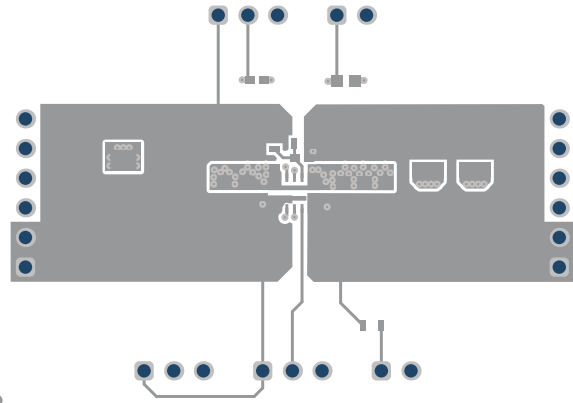


Figure A-2. Rev.A - Top Layer

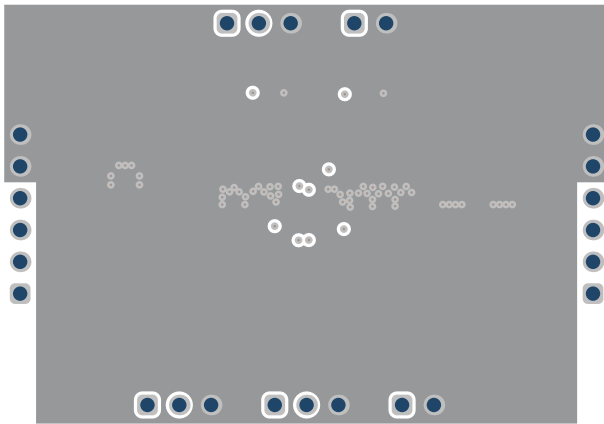


Figure A-3. Rev.A - Internal Layer 1

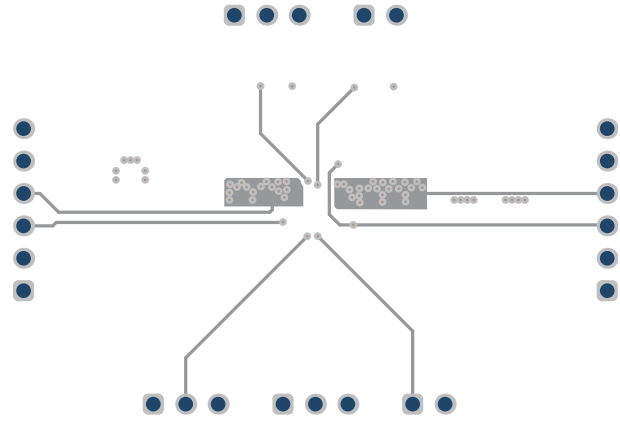


Figure A-4. Rev.A - Internal Layer 2

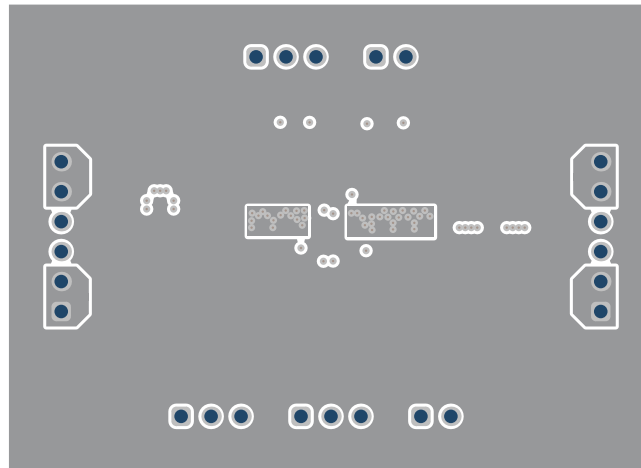


Figure A-5. Rev.A - Bottom Layer

A.3 Rev.A - Schematic and Bill of Materials

This section includes the TPSM82810EVM-089 Rev.A schematic and bill of materials.

A.3.1 Rev.A - Schematic

Figure A-6 shows the Rev.A EVM schematic.

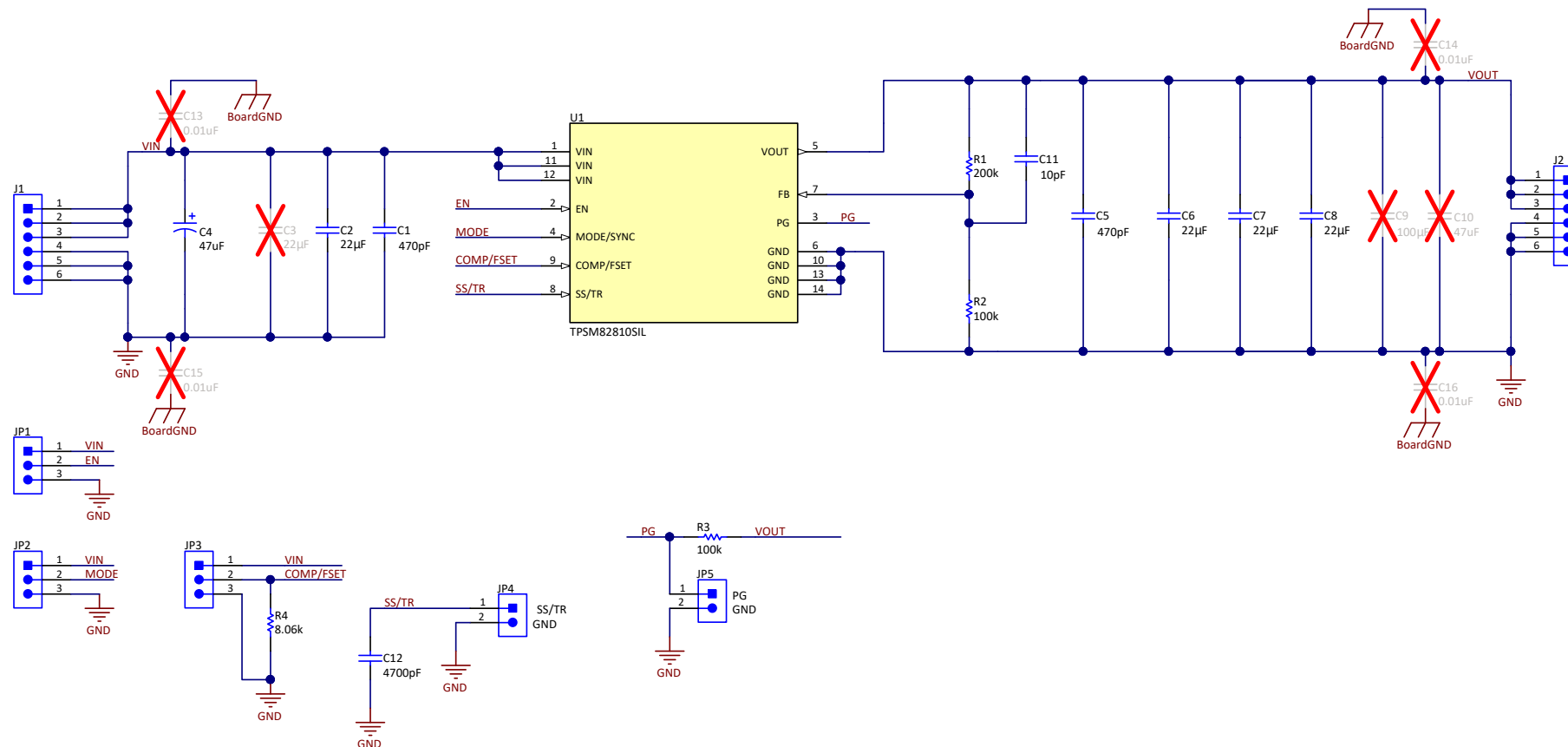


Figure A-6. TPSM82810EVM-089 Revision A Schematic

A.3.2 Rev.A - Bill of Materials

Table A-1 lists the Revision A BOM for this EVM.

Table A-1. TPSM82810EVM-089 Rev. A BOM

QUANTITY	REF DES	VALUE	DESCRIPTION	SIZE	PART NUMBER	MFR
2	C1, C5	470 pF	Ceramic Capacitor, 50 V, X7R	0402	GCM155R71H471KA37D	Murata
4	C2, C6, C7, C8	22 µF	Ceramic Capacitor, 10 V, X7T	0805	GRM21BD71A226ME44L	Murata
1	C4	47 µF	Tantalum Capacitor, 10 V	3528-21	TPSB476K010R0250	AVX
1	C11	10 pF	Ceramic Capacitor, 50 V, X7R	0402		Any
1	C12	4700 pF	Ceramic Capacitor, 50 V, X7R	0603	GCM188R71H472KA37D	Murata
1	R1	200 kΩ	Resistor 1%, 0.1 W	0603		Any
2	R2, R3	100 kΩ	Resistor 1%, 0.1 W	0603		Any
1	R4	8.06 kΩ	Resistor 1%, 0.1 W	0402		Any
1	U1		4-A Step-Down MicroSiP Power Module with Integrated Inductor and Frequency Synchronization	3 mm × 4 mm	TPSM82810SILR	Texas Instruments

B Revision History

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

Changes from Revision * (July 2019) to Revision A (December 2022)	Page
• Updated trademark information.....	1
• Updated the document title.....	1
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	2
• Revised TPSM82810EVM-089 from Rev.A to Rev.B.....	2
• Added TPSM82816EVM-089 Rev.B.....	2
• Moved Rev. A files to Appendix.....	8

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.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

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。
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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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page
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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.

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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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