EVM User's Guide: TPSM82866AA0PEVM, TPSM82866CA3PEVM

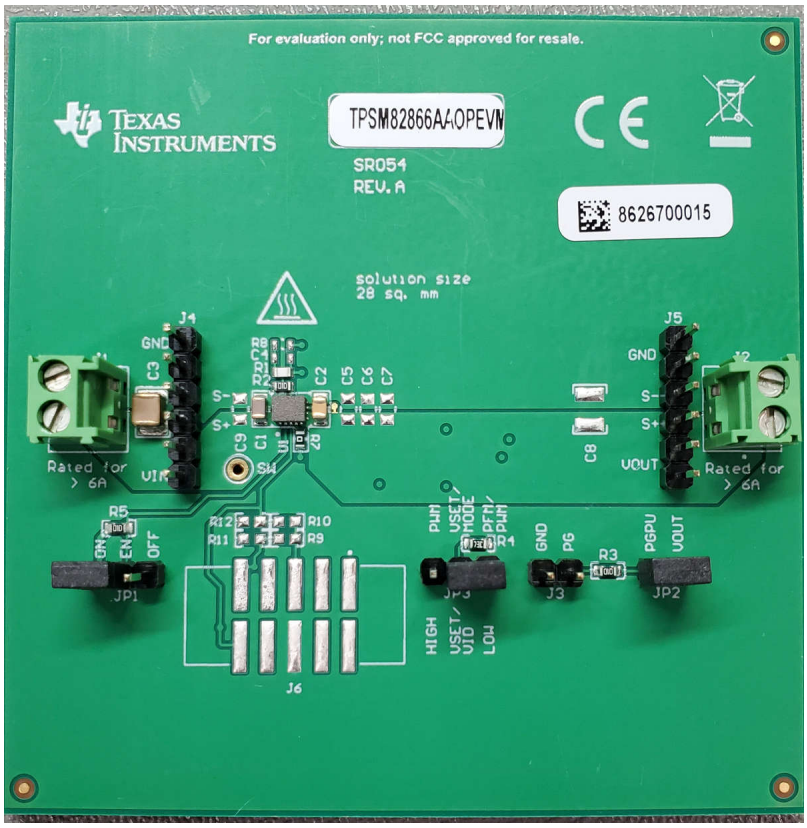
MagPack™ Technology 6A Power Module Evaluation Module

Description

The TPSM82866AA0PEVM and TPSM82866CA3PEVM evaluation modules (EVM) facilitate the evaluation of the TPSM82866AA0PRCFR and TPSM82866CA3PRCFR, 6A pin-to-pin compatible step-down power modules in a 2.3mm × 3mm x 1.95mm MagPack™ package. The TPSM82866AA0PEVM provides an adjustable output voltage down to 0.6V, with 1% accuracy from input voltages from 2.4V to 5.5V. The TPSM82866CA3PEVM provides an I^2C adjustable output voltage down to 0.8V, with 1% accuracy from input voltages from 2.4V to 5.5V.

Features

- 6A output current power module with integrated inductor in a MagPack package
- 2.3mm x 3mm power module provides 28mm^2 total solution-size with 1.95mm height
- Excellent thermal performance (θ_{JA} = 29.7 °C/W)
- Start-up output voltage adjustable to 1 of 16 values (TPSM82866CA3PEVM, with I^2C)
- Highly accurate output voltage with excellent transient response



1 Evaluation Module Overview

1.1 Introduction

The TPSM82866 EVMs enables evaluation of the TPSM82866 power module in a typical, step-down converter application. The TPSM82866AA0PRCFR and TPSM82866CA3PRCFR are high-efficiency, high-accuracy and small point-of-load (POL) power designs in applications such as the core supply for FPGAs, ASICs, DDR memory, optical modules, medical imaging, industrial transport, factory automation and control, and other space-limited applications.

1.2 Kit Contents

The TPSM82866 EVM box (the kit) includes a PCB (SR054) with which to evaluate the TPSM82866 device in a typical application. To evaluate the TPSM82866CA3PEVM using TI's TPSM8286xC EVM GUI to operate the I^2C bus, order the USB2ANY adapter EVM separately.

1.3 Specification

Table 1-1 provides a summary of the TPSM82866 EVM 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	TPSM82866CA3PEVM (SR054-001)	0.8	1.2	3.35	V
	TPSM82866AA0PEVM (SR054-002)	0.6	1.2	V_{IN}	V
Output current		0		6	A

1.4 Device Information

The TPSM82866 is a family of pin-to-pin compatible 6A power modules, which integrate the inductor. The TPSM82866C devices use an I^2C interface to fine tune the output voltage to precisely match the needs of processor cores. The device can be operated without the I^2C interface to provide a high current, fixed-output-voltage power supply.

2 Hardware

2.1 Safety Instructions

WARNING

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

WARNING

High currents can be present on the input and output.

2.2 Header Information

J1 – VIN/GND	Input and return connections from the input supply to the EVM. This connector supports currents over 3A and accepts up to 16 AWG wire.
J2 – VOUT/GND	Output and return connections from the EVM to the load. This connector supports currents over 3A and accepts up to 16 AWG wire.
J3 – PG/GND	TPSM82866AA0PEVM only. 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 3A.
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 3A.
J5, Pin 1 and 2 – VOUT	Output voltage connection. Do not use for currents above 3A.
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 3A.

2.3 Jumper Information

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 Pull-up	TPSM82866AA0PEVM only. PG pin pull-up 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 6V.
JP3 – VSET/VID	TPSM82866CA3PEVM only. Remove the jumper before taking EN high to start-up at the output voltage set by R4. After start-up, install the jumper across VSET/VID and HIGH or LOW to control which VOUT register is active.
JP3 – VSET/MODE	TPSM82866AA0PEVM only. Remove the jumper before taking EN high to start-up at the output voltage set by R4. Or place the jumper across PWM and VSET/MODE or PFM/PWM and VSET/MODE to operate the IC with an output voltage determined by R1 and R2. After start-up, place the supplied jumper across PWM and VSET/MODE to operate the IC in Forced PWM mode or place the jumper across PFM/PWM and VSET/MODE to operate the IC in PFM/PWM mode.

To properly set the start-up voltage with R4, the jumper on JP3 (VSET/VID or VSET/MODE) must be removed before EN is applied.

2.4 Interfaces

J6 – I^2C	TPSM82866CA3PEVM only. I^2C adapter connection. Connect the 10-pin ribbon cable from the USB2ANY adapter EVM to this header to communicate with the device over the I^2C bus through the TPSM8286xC EVM GUI. This header is keyed to prevent backwards installation. The TPSM82866CA3PEVM does not require the USB2ANY EVM to operate.

2.5 Test Points

TP1 – SW	SW node test point. Measure the SW node at this point. This test point is not installed.

3 Software

The TPSM8286xC EVM GUI is provided on the TPSM82866CA3PEVM tool folder to communicate with the device over the I^2C bus through the USB2ANY adapter EVM. A valid input voltage must be applied and EN must be high.

The GUI automatically connects to the EVM. If this does not happen, then click either the *Connect* button at the top right of the GUI or the *link* symbol at the very bottom left of the GUI.

4 Implementation Results

The TPSM82866AA0PEVM and TPSM82866CA3PEVM were used to take all the data in the *TPSM8286xx 2.4V to 5.5V Input, 4A/6A Step-Down MagPack™ Power Module with Integrated Inductor and I²C interface* and *TPSM82864A, TPSM82866A 2.4V to 5.5V Input, 4A/6A Step-Down Power Module With an Integrated Inductor in a Thin Overmolded QFN Package and MagPack™ Package* data sheets. See the device data sheets for the performance of the EVMs.

4.1 Evaluation Setup

4.1.1 VSET/VID Resistor (TPSM82866CA3PEVM only)

R4 sets the start-up voltage. To select the desired start-up voltage, leave the jumper off of JP3 when enabling the device. After being enabled, JP3 becomes a VID input pin and selects which V_{OUT} register is active. See the TPSM8286xx 2.4V to 5.5V Input, 4A/6A Step-Down MagPack™ Power Module with Integrated Inductor and I²C interface data sheet for details of the various settings.

4.1.2 VSET/MODE Resistor (TPSM82866AA0PEVM only)

R4 selects the MODE setting (PFM or FPWM) and output voltage setting configuration. When using the VSET configuration for setting the output voltage, short R1 and remove R2. See the *TPSM82864A, TPSM82866A 2.4V to 5.5V Input, 4A/6A Step-Down Power Module With an Integrated Inductor in a Thin Overmolded QFN Package and MagPack™ Package* data sheet for details of the various settings.

4.1.3 Input and Output Capacitors

C9, shown in Figure 5-1 and Figure 5-2, 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.

4.1.4 Feedforward Capacitor

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

4.1.5 Loop Response Measurement

The loop response can be measured with simple changes to the circuitry. First, install a 10Ω 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 C2 and C5 to separate the via on V_{OUT} from the plane. Figure 4-1 shows this cut. With these changes, an AC signal (10mV, peak-to-peak amplitude recommended) can be injected into the control loop across the added 10Ω resistor. Figure 4-4 shows the results of this test.

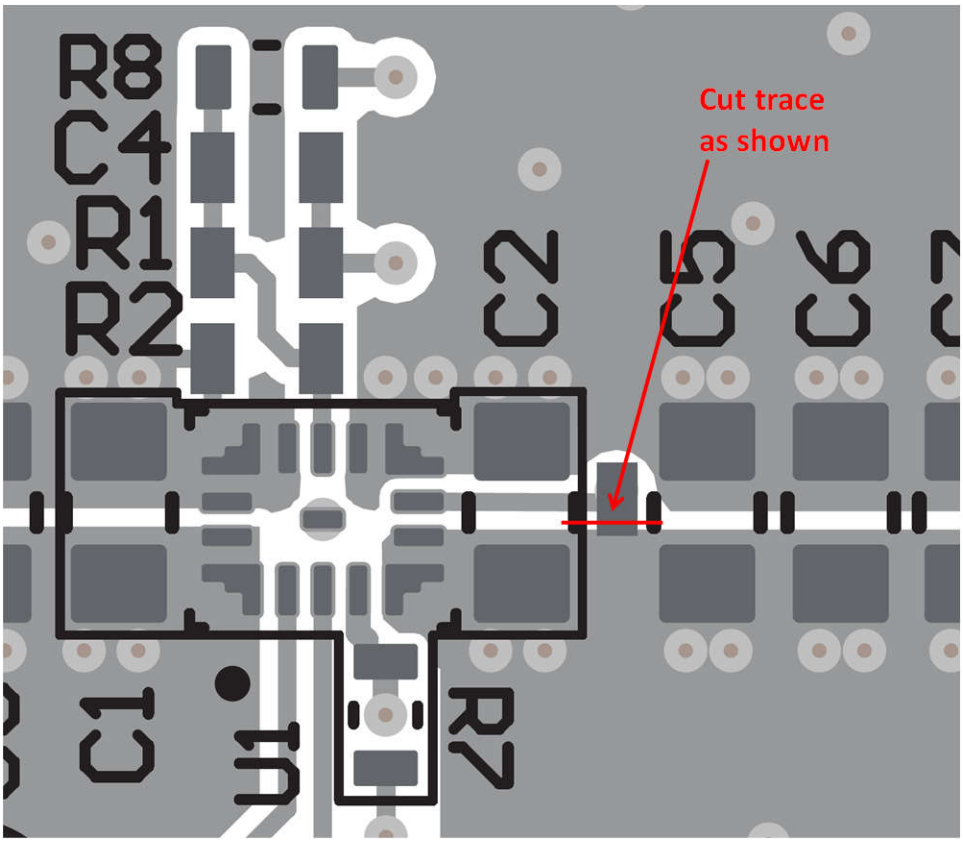


Figure 4-1. Loop Response Measurement Modification

4.2 Performance Data and Results

Figure 4-2 shows the thermal performance of the TPSM82866AA0PEVM.

Figure 4-2. Thermal Performance (TPSM82866AA0PEVM, V_{IN} = 5V, V_{OUT} = 1.2V, I_{OUT} = 6A)

Figure 4-3 shows the thermal performance of the TPSM82866CA3PEVM.

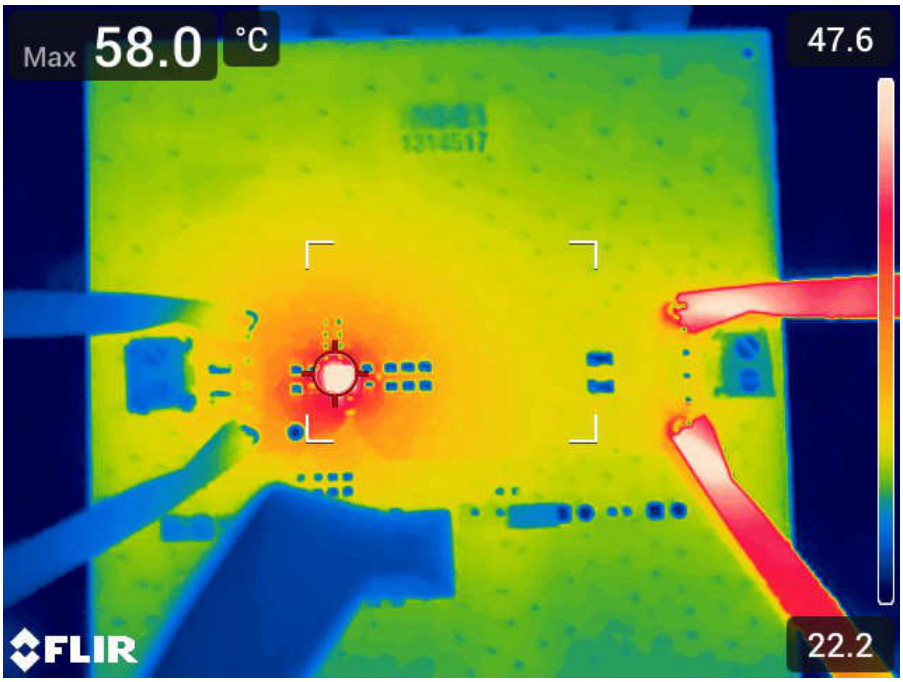


Figure 4-3. Thermal Performance (TPSM82866CA3PEVM, V_{IN} = 5V, V_{OUT} = 1.2V, I_{OUT} = 6A)

Figure 4-4 shows the loop response measurement of the TPSM82866 EVM.

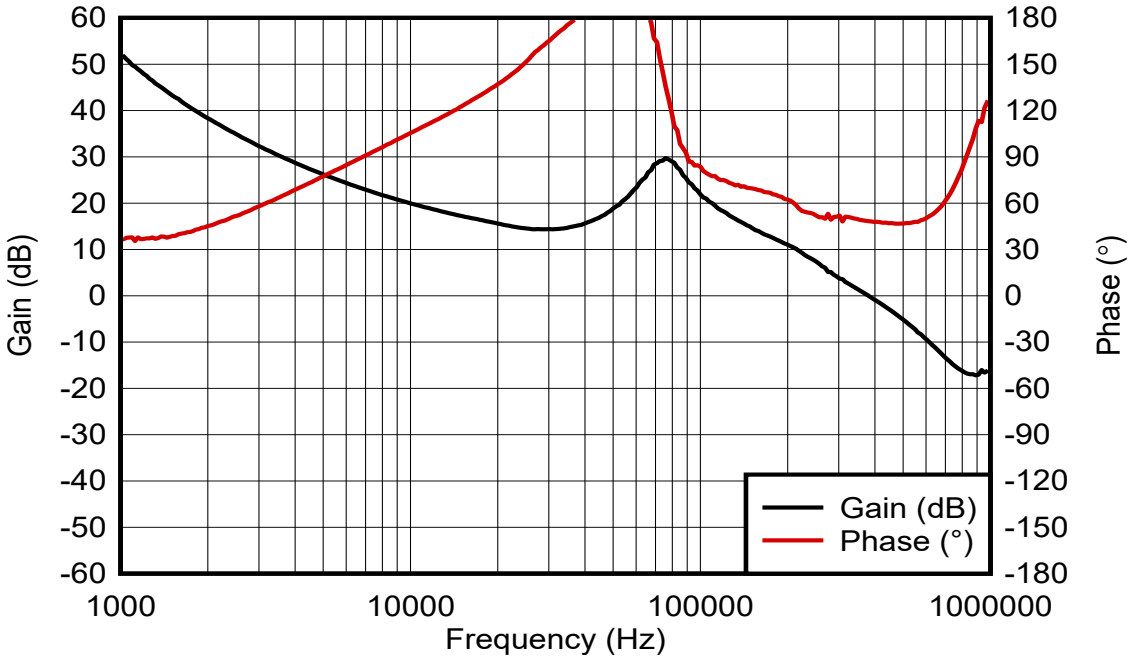


Figure 4-4. Loop Response Measurement (V_{IN} = 5V, V_{OUT} = 1.2V, I_{OUT} = 6A)

5 Hardware Design Files

5.1 Schematics

Figure 5-1 and Figure 5-2 show the EVM schematics.

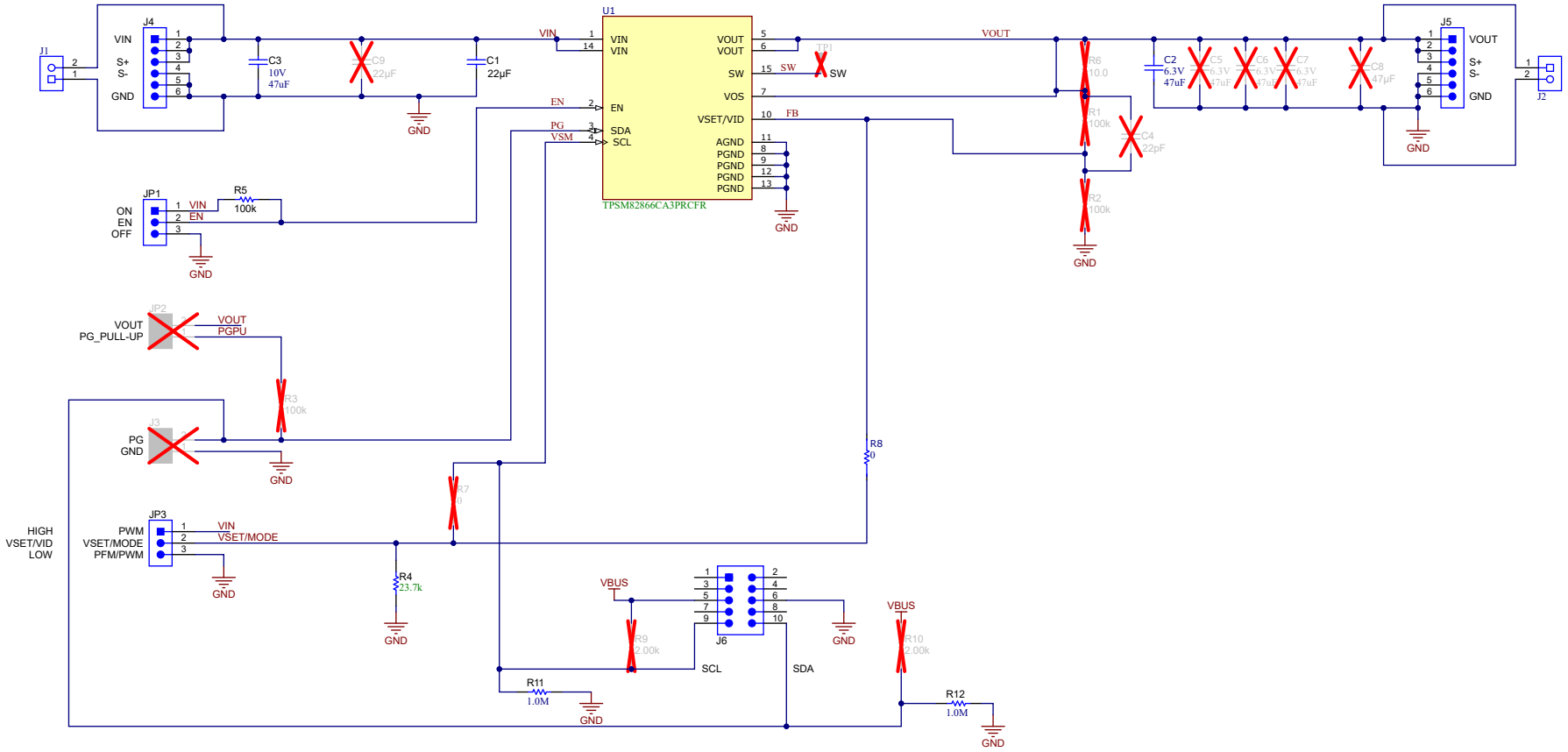


Figure 5-1. TPSM82866CA3PEVM (SR054-001) Schematic

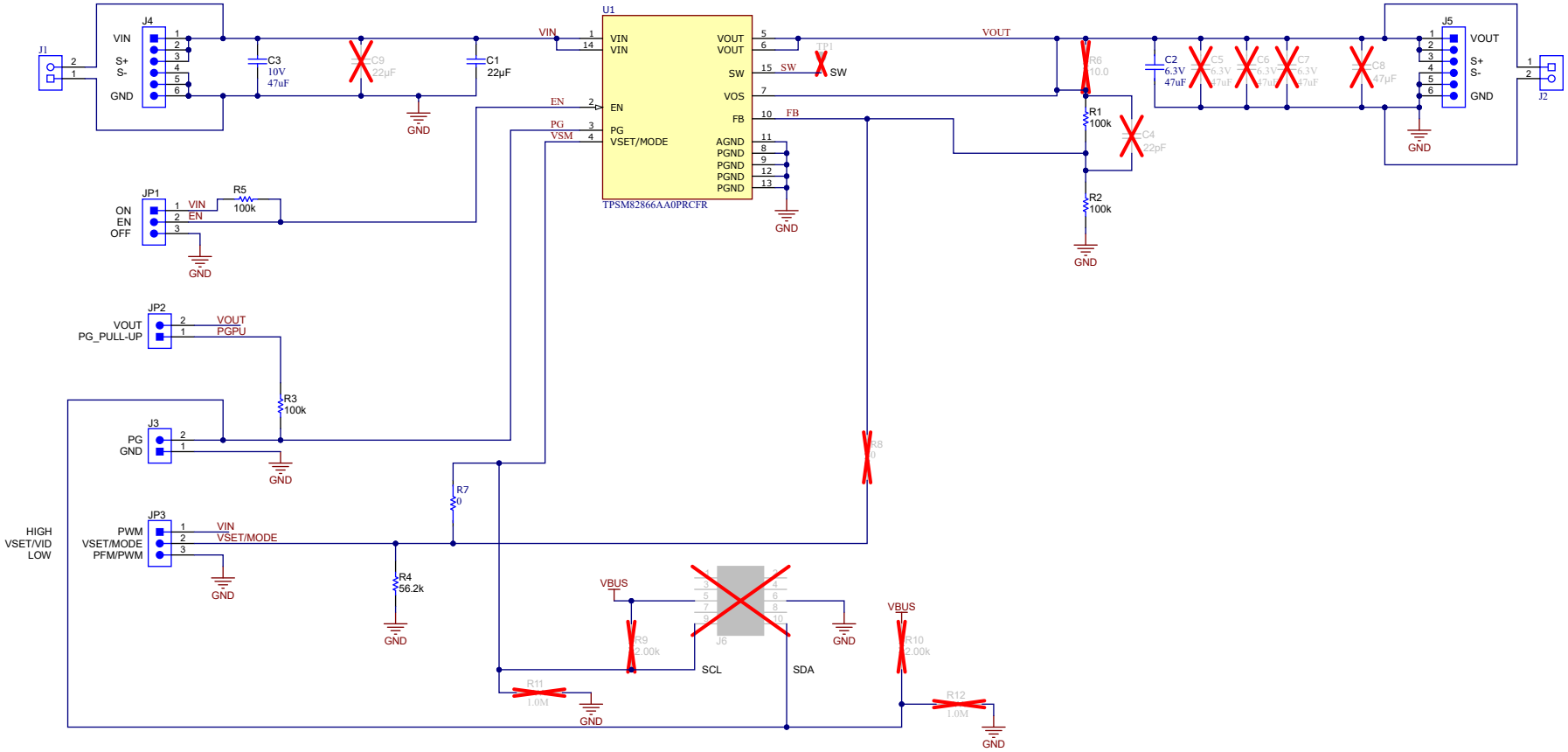


Figure 5-2. TPSM82866AA0PEVM (SR054-002) Schematic

5.2 PCB Layouts

This section provides the TPSM82866 EVM board layout (SR054). The Gerber files are available on the TPSM82866AA0PEVM tool folder. All four layers use 2-ounce copper.

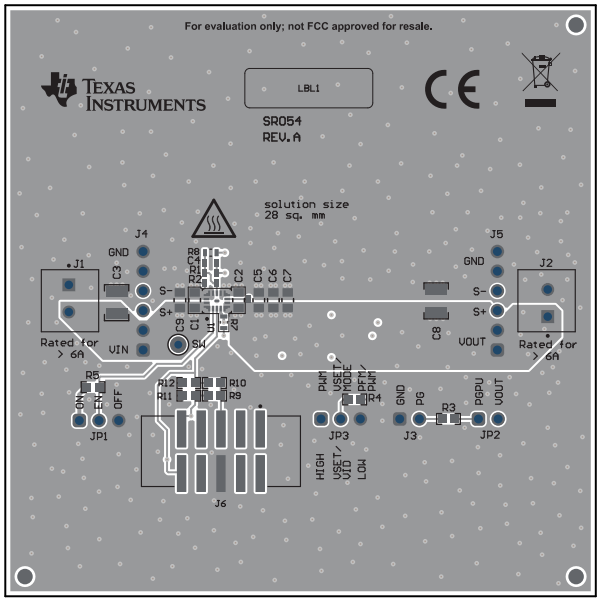


Figure 5-3. Top Assembly

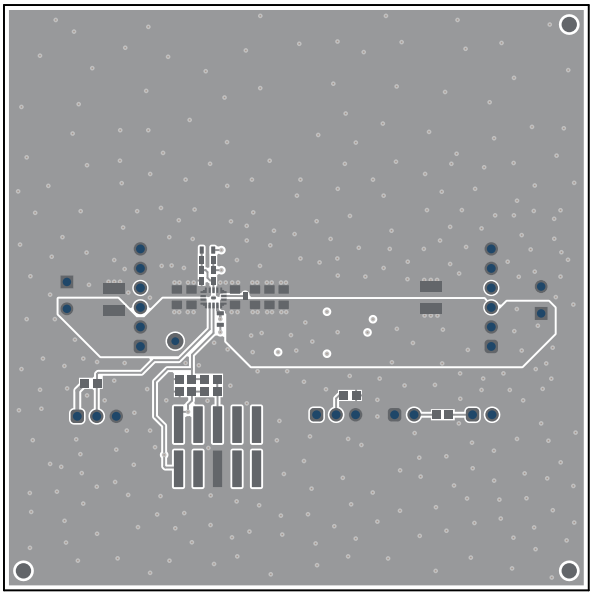


Figure 5-4. Top Layer

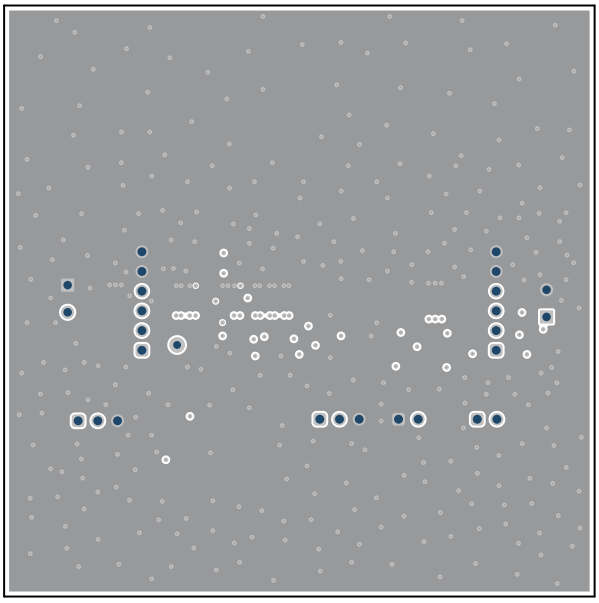


Figure 5-5. Internal Layer 1

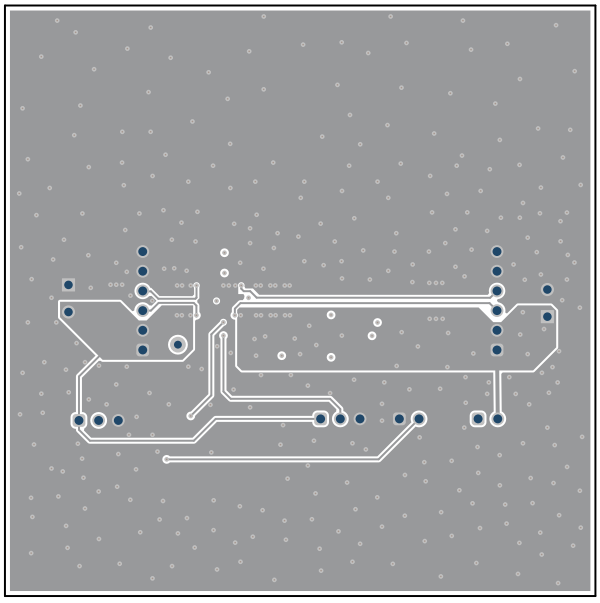


Figure 5-6. Internal Layer 2

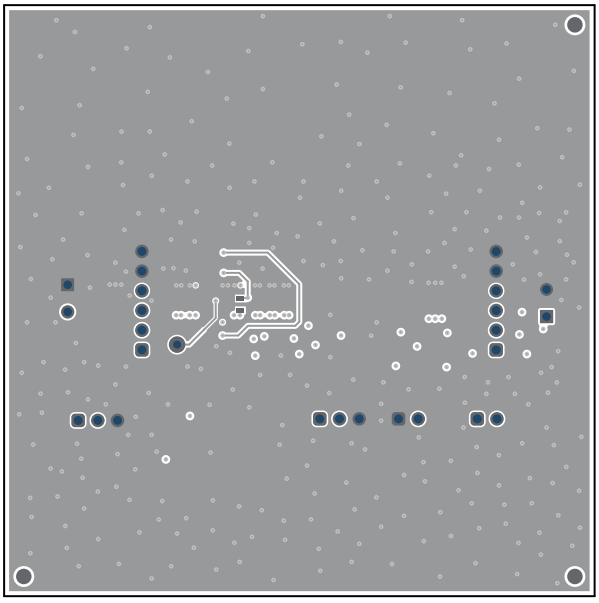


Figure 5-7. Bottom Layer

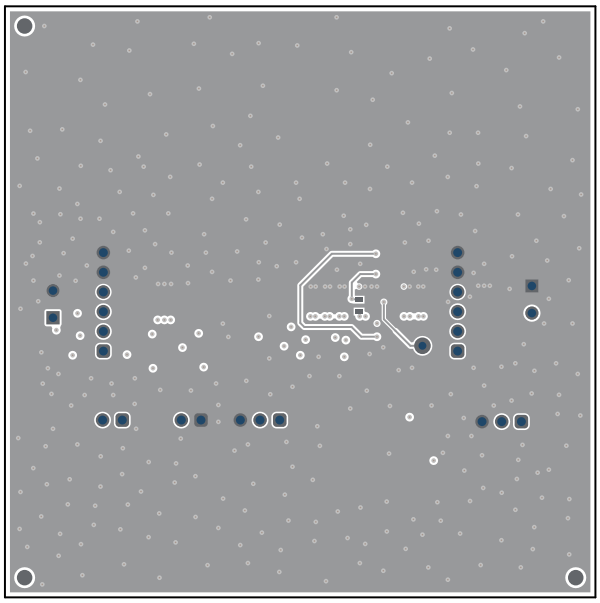


Figure 5-8. Bottom Assembly (Mirrored)

5.3 Bill of Materials (BOM)

Table 5-1 lists the BOM for this EVM.

Table 5-1. TPSM82866 EVM (SR054-00x) Bill of Materials

QUANTITY		REF DES	VALUE	DESCRIPTION	SIZE	PART NUMBER	MANUFACTURER
-001	-002						
1	1	C1	22µF	Ceramic Capacitor, 6.3V, X7R	0805	GRM21BZ70J226ME44L	Murata
1	1	C2	47µF	Ceramic Capacitor, 6.3V, X6S	0805	GRM21BC80J476ME01L	Murata
1	1	C3	47µF	Ceramic Capacitor, 10V, X7R	1210	GRM32ER71A476ME15L	Murata
0	3	R1, R2, R3	100kΩ	Resistor 1%, 0.1 W	0603	Std	Std
1	0	R4	23.7kΩ	Resistor 1%, 0.1 W	0603	Std	Std
0	1	R4	56.2kΩ	Resistor 1%, 0.1 W	0603	Std	Std
1	1	R5	100kΩ	Resistor 1%, 0.1 W	0603	Std	Std
0	1	R7	0Ω	Resistor 5%, 0.1 W	0603	Std	Std
1	0	R8	0Ω	Resistor 5%, 0.1 W	0603	Std	Std
1	0	U1(1)		6A Step-Down Power Module with Integrated Inductor and I^2C interface	2.3mm × 3mm	TPSM82866CA3PRCFR	Texas Instruments
0	1	U1		6A Step-Down Power Module With an Integrated Inductor in an Overmolded QFN Package	2.3mm × 3mm	TPSM82866AA0PRCFR	Texas Instruments

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

6 Additional Information

6.1 Trademarks

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   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.

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NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION 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/lsds/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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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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西新宿三井ビル

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

6. *Disclaimers:*

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