User's Guide

TPSM41625 2-Phase Power Module Evaluation Module User's Guide

ABSTRACT

The TPSM41625-2X evaluation module (EVM) is designed as an easy-to-use platform that facilitates an extensive evaluation of the features and performance of two TPSM41625 devices combined to operate together in a stack-able configuration for increased current. The EVM operates over the entire input voltage range, 4-V to 16-V, of the TPSM41625. The output voltage can be set to several popular values by using configuration jumpers. Similarly, the switching frequency can be set to one of four values with a jumper. The full shared output current rating (50-A) of the device can be supplied by the EVM. Input and output capacitors are included on the board to accommodate the entire range of input and output voltages. Monitoring test points are provided to allow measurement of the following:

- Efficiency
- Power dissipation
- Input ripple
- Output ripple
- Line and load regulation
- Transient response

Control test points and component footprints are provided for use of the enable (EN), power good (PGOOD), SYNC, current sharing (ISH) and voltage sharing (VSH) features of the device. The EVM uses a recommended PCB layout that maximizes theermal performance and minimizes output ripple and noise.

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Trademarks

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1 EVM Setup

Figure 1-1 highlights the user interface items associated with the EVM. The PVIN Power terminal block (J5) is used for connection to the host input supply and the VOUT Power terminal block (J3) is used for connection to the load. Terminal block J5 accepts up to a 10-AWG wire, J6 to a 14-AWG, and J3 & J4 accept up to a 6-AWG wire.

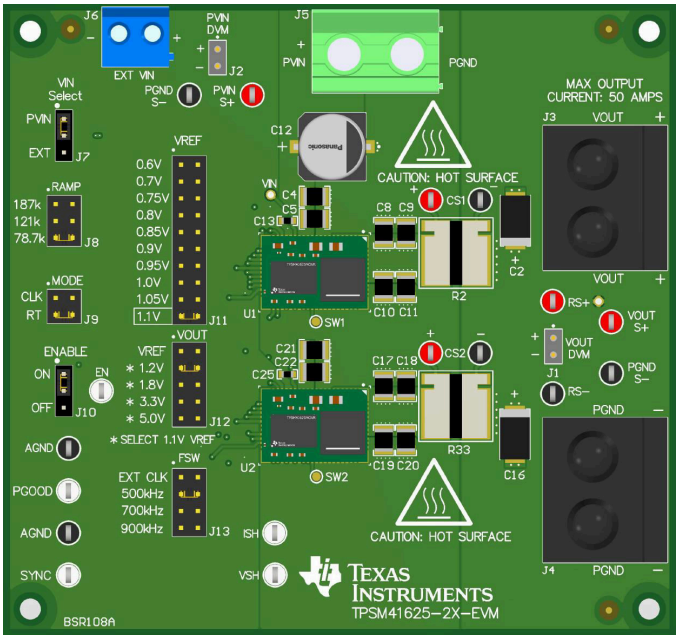

Figure 1-1. EVM User Interface

- The PVIN S+ and PVIN S- input voltage test points as well as the RS+ and RS- output voltage test points, located near the power terminal blocks are intended to be used as voltage monitoring points where voltmeter scan be connected to measure PVIN and VOUT. **Do not use these S+ and S- monitoring test points as the input supply or output load connection points.** The PCB traces connecting to these test points are not designed to support high currents.
- The PVIN Scope (J2) and VOUT Scope (J1) sockets can be used to monitor PVIN and VOUT waveforms with an oscilloscope. These test points are intended for use with un-hooded scope probes outfitted with a low inductance ground lead (ground spring) mounted to the scope probe barrel. The two sockets of each test point are on 0.1 inch centers. The scope probe tip should be inserted into the socket marked with a + sign, and the scope ground lead should be inserted into the other socket.
- The control test points located around the device are made available to test the features of the device. Refer to the EVM Connectors and Test Points for more information on the individual control test points. Other features, such as UVLO (R10, R13), ILIM (R12), SS (R15) and MODE (R29) can be altered by manually adding or changing the value on the associated footprints for each component located on the bottom-side of the EVM.
- The VREF jumper (J11), VOUT jumper (J12), FSW jumper (J13), and the RAMP jumper (J8) are provided for selecting the internal reference voltage, switching frequency, desired output voltage, and appropriate RAMP setting. Before applying power to the EVM, make sure that the jumpers are present and properly positioned for the intended output voltage. Ensure to set the internal reference voltage prior to selecting the desired output voltage (selecting the highest reference voltage will result in the most accurate output voltage set point). Refer to Table 1-1 and Table 1-2 for the recommended jumper settings.

Table 1-1. PVIN = 5 V Recommended Jumper Settings

OUTPUT VOLTAGE	VREF SELECT (J11)	VOUT SELECT (J12)	F_{SW} SELECT (J13)	RAMP (J8)
0.6 V - 7.5 V	0.6 V - 0.75 V	V_{REF}	500 kHz	187 kΩ
			700 kHz - 1 MHz	78.7 kΩ
0.8 V - 0.95 V	0.8 V - 0.95 V	V_{REF}	500 kHz - 700 kHz	78.7 kΩ
			1 MHz	78.7 kΩ
1 V - 1.1 V	1 - 1.1 V	V_{REF}	400 kHz - 1 MHz	187 kΩ
1.2 V	1.1 V	1.2 V	400 kHz - 1 MHz	187 kΩ
1.8 V	1.1 V	1.8 V	400 kHz - 1 MHz	187 kΩ
3.3 V	1.1 V	3.3 V	400 kHz - 1 MHz	78.7 kΩ

Table 1-2. 12 V Recommended Jumper Settings

OUTPUT VOLTAGE	VREF SELECT (J11)	VOUT SELECT (J12)	F_{SW} SELECT (J13)	RAMP (J8)
0.6 V - 7.5 V	0.6 V - 0.75 V	V_{REF}	400 kHz - 700 kHz	78.7 kΩ
0.8 V - 0.95 V	0.8 V - 0.95 V	V_{REF}	500 kHz - 700 kHz	78.7 kΩ
1 V - 1.1 V	1 - 1.1 V	V_{REF}	400 kHz - 1 MHz	78.7 kΩ
1.2 V	1.1 V	1.2 V	500 kHz	187 kΩ
			700 kHz - 1 MHz	121 kΩ
1.8 V	1.1 V	1.8 V	500 kHz	187 kΩ
			700 kHz - 1 MHz	78.7 kΩ
3.3 V	1.1 V	3.3 V	700 kHz - 1 MHz	187 kΩ
5.0 V	1.1 V	5.0 V	700 kHz - 1 MHz	187 kΩ

For example, if an output voltage of 1.8 V is desired and is supplied by a 12-V input, then a proper configuration is as follows:

1. Set VREF (J11) as 1.1 V.
2. Set VOUT (J12) as 1.8 V.
3. Set FSW (J13) as 500 kHz, 700 kHz, or 900 kHz.
4. Set RAMP (J8) as 187 kΩ if 500 kHz has been selected, or set RAMP as 78.7 kΩ if 700 kHz or 900 kHz has been selected.

Another example, if an output voltage of 1.0 V is desired and is supplied by a 12-V input, then a proper configuration is as follows:

1. Set VREF (J11) as 1.0 V.
2. Set VOUT (J12) as VREF.
3. Set FSW (J13) as 500 kHz, 700 kHz, or 900 kHz.
4. Set RAMP (J8) as 78.7 kΩ

2 EVM Connectors and Test Points

Wire-loop test points and scope probe sockets are included for digital voltmeters (DVM) or oscilloscope probes to aid in the evaluation of the device. Table 2-1 describes each test point (1).

Table 2-1. Test Point Descriptions

Test Point	Description
PVIN S+	Input voltage monitor. Connect the positive lead of a DVM to this point for measuring efficiency.
PVIN S-	Input voltage monitor. Connect the negative lead of a DVM to this point for measuring efficiency.
RS+	Output voltage monitor. Connect the positive lead of a DVM to this point for measuring efficiency, line regulation and load regulation.
RS-	Output voltage monitor. Connect the negative lead of a DVM to this point for measuring efficiency, line regulation and load regulation.
AGND	Analog ground test point.
PGND	Power ground test point.
PVIN Scope (J2)	Input voltage scope monitor. Connect an oscilloscope probe to this set of points to measure input ripple voltage.
VOUT Scope (J1)	Output voltage scope monitor. Connect an oscilloscope probe to this set of points to measure output ripple voltage and transient response.
ENABLE (J10)	Enable test point. This test point can be used to monitor the EN voltage or to connect the EN pin to AGND to disable the device using a jumper wire. Additionally, for ease of use, J10 can be set in the ON position to enable the device or in the OFF position to disable the device.
PGOOD	Monitors the power good signal of the device. This is an open drain signal.
SYNC	Frequency synchronization pin. Connect the clock signal to the SYNC and AGND test points when synchronizing to an external clock. Additionally, set MODE jumper (J9) to CLK.
ISH	Current sharing test point. This test point can be used to monitor the shared current between the two devices.
VSH	Voltage sharing test point. This test point can be used to monitor the shared voltage between the two devices.

(1) Refer to the product data sheet for absolute maximum ratings associated with above features.

3 Test Results

Figure 3-1 and Figure 3-2 demonstrate the enable ON/OFF performance of the EVM. Figure 3-3 shows the typical output voltage ripple with a 25-A load. All figures shown below are under the following conditions: 12-V input voltage, 1.2-V output voltage and a switching frequency of 700 kHz. Additional output capacitor footprints are available on the EVM if an improved load transient response or output voltage ripple is needed. See the data sheet for more information on the respective devices.

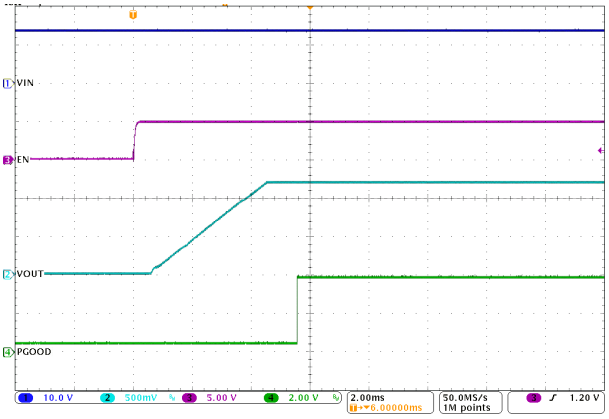

Figure 3-1. ENABLE Start-Up Waveform

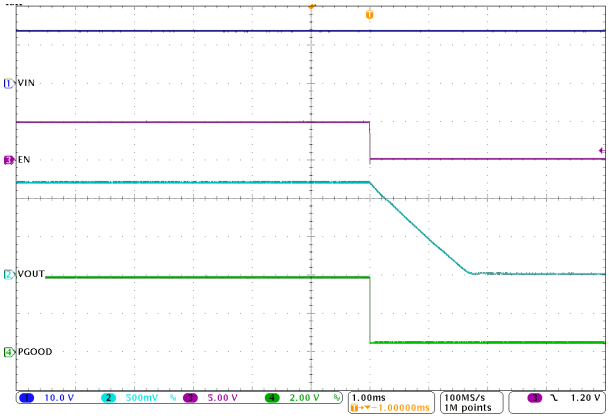

Figure 3-2. ENABLE Shutdown Waveform

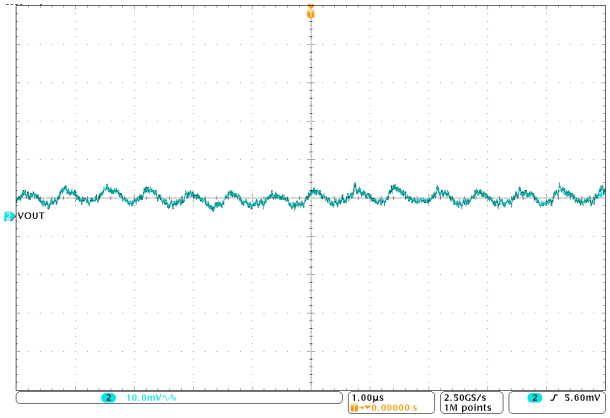

Figure 3-3. 25-A Output Voltage Ripple

4 PCB Layouts

Figure 4-1 through Figure 4-10 show the PCB layers of the EVM.

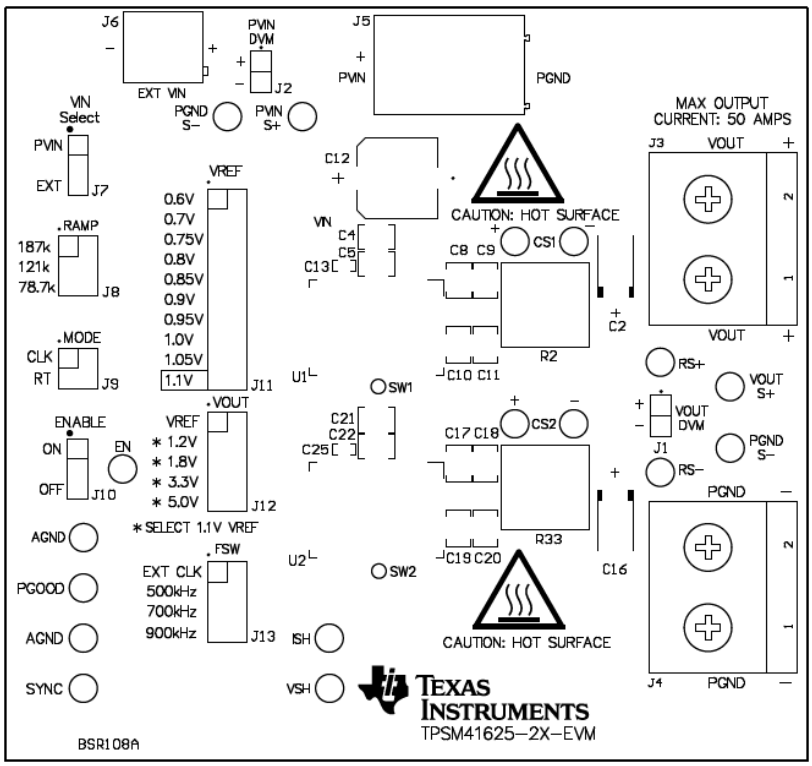

Figure 4-1. Top Silk Screen (Top View)

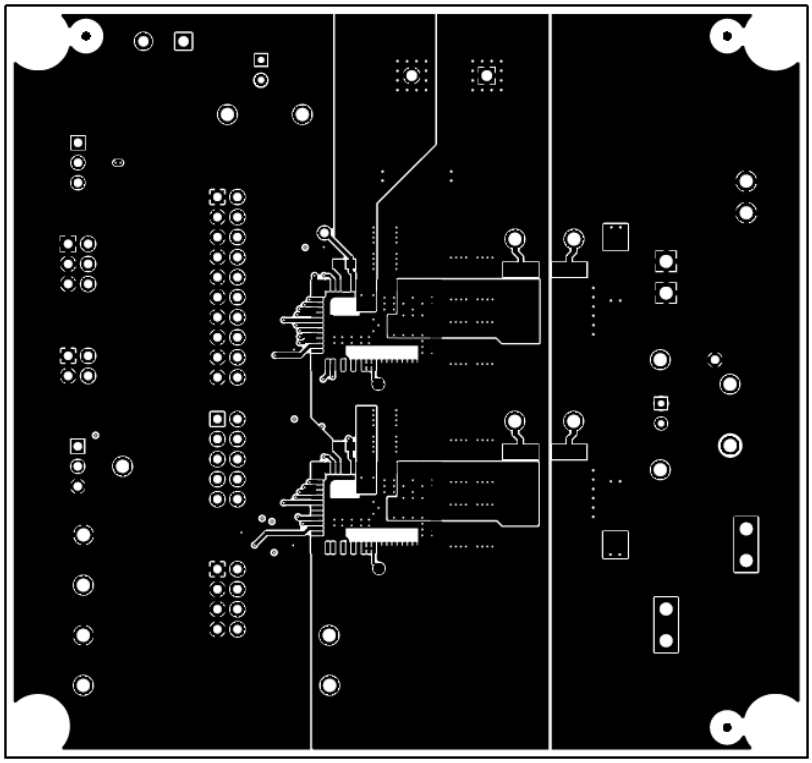

Figure 4-2. Top Layer

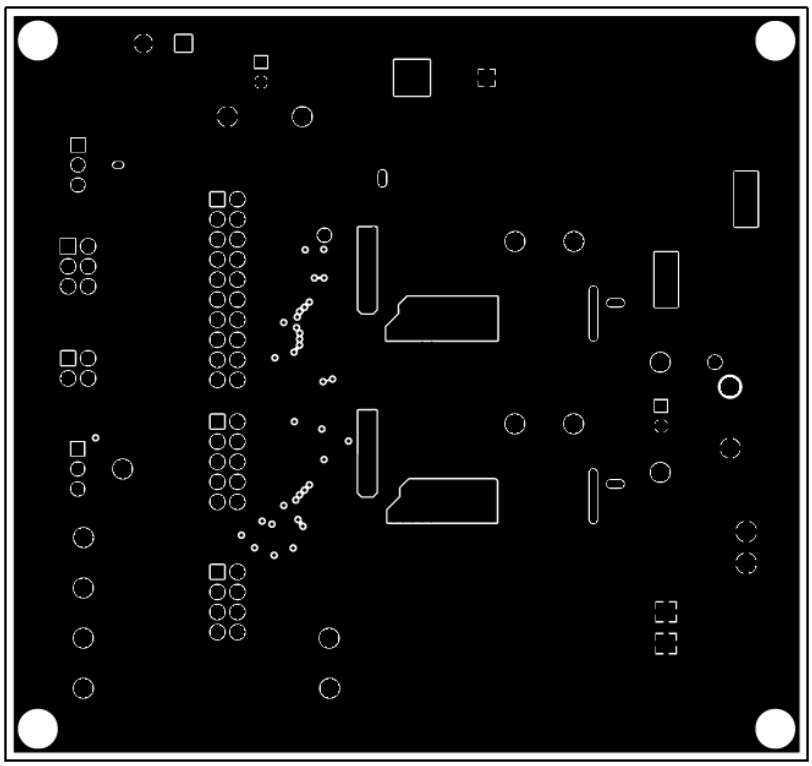

Figure 4-3. Signal Layer 1

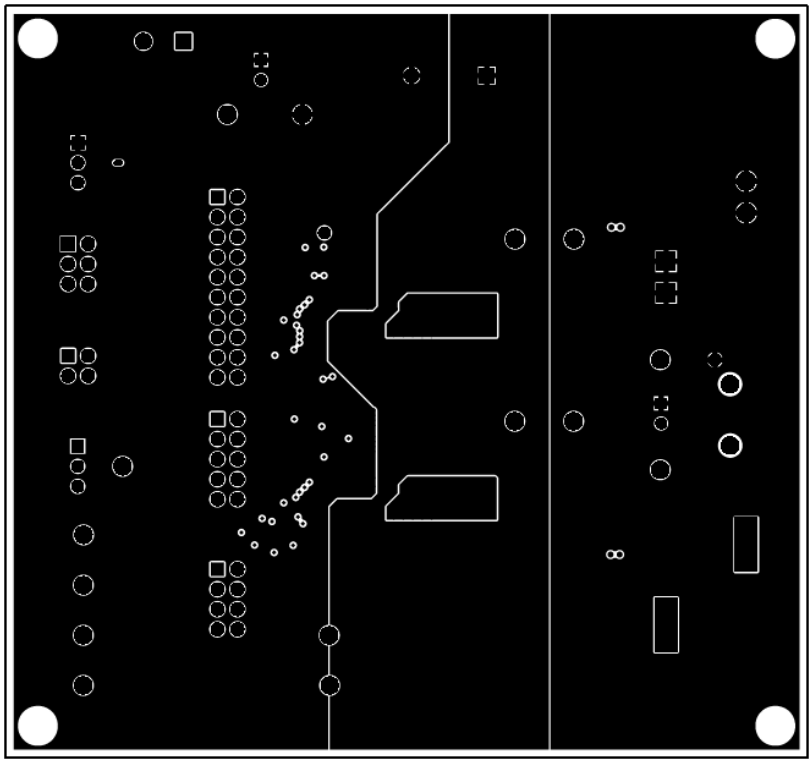

Figure 4-4. Signal Layer 2

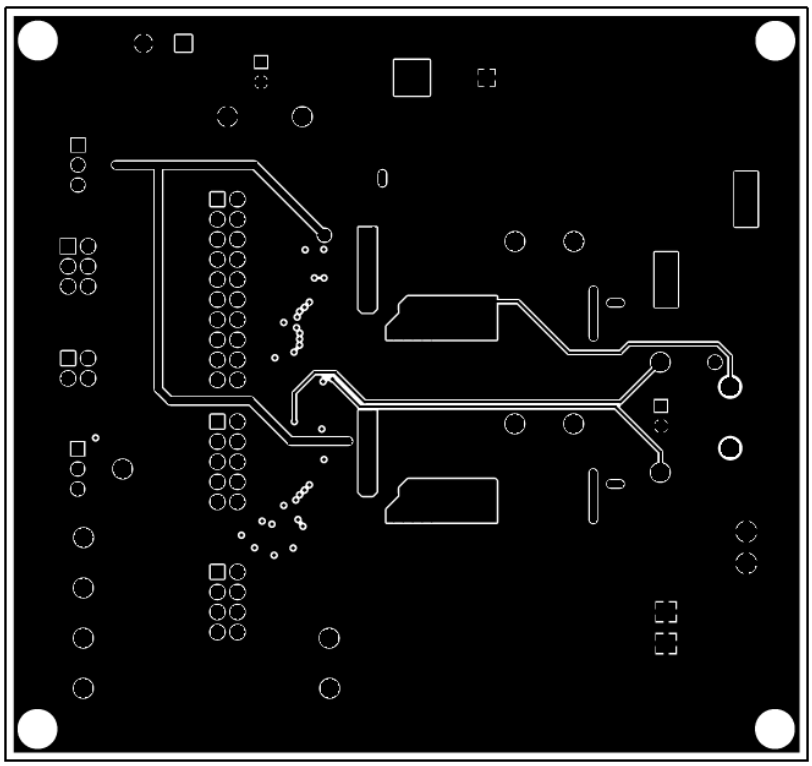

Figure 4-5. Signal Layer 3

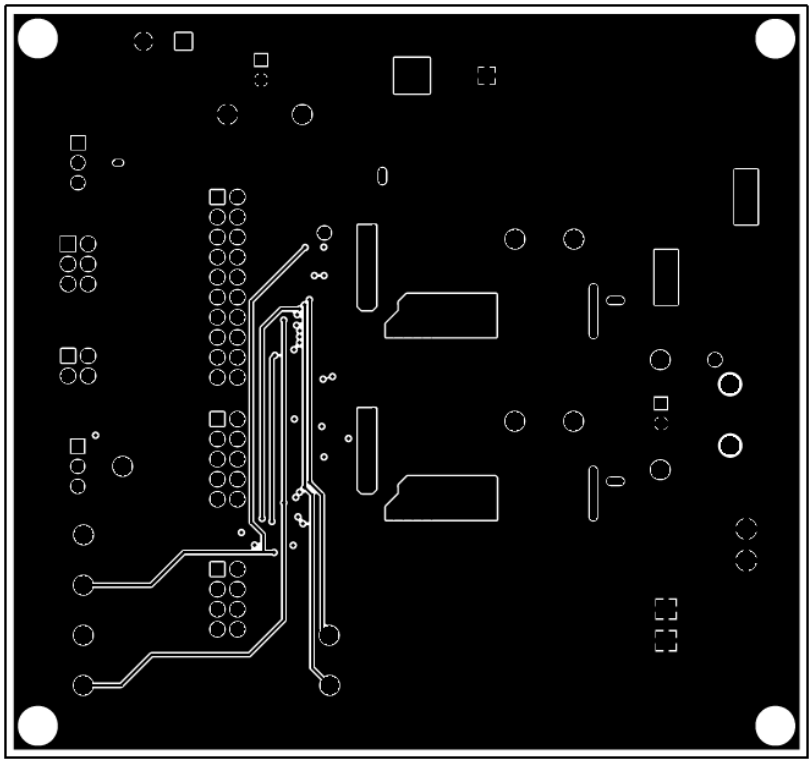

Figure 4-6. Signal Layer 4

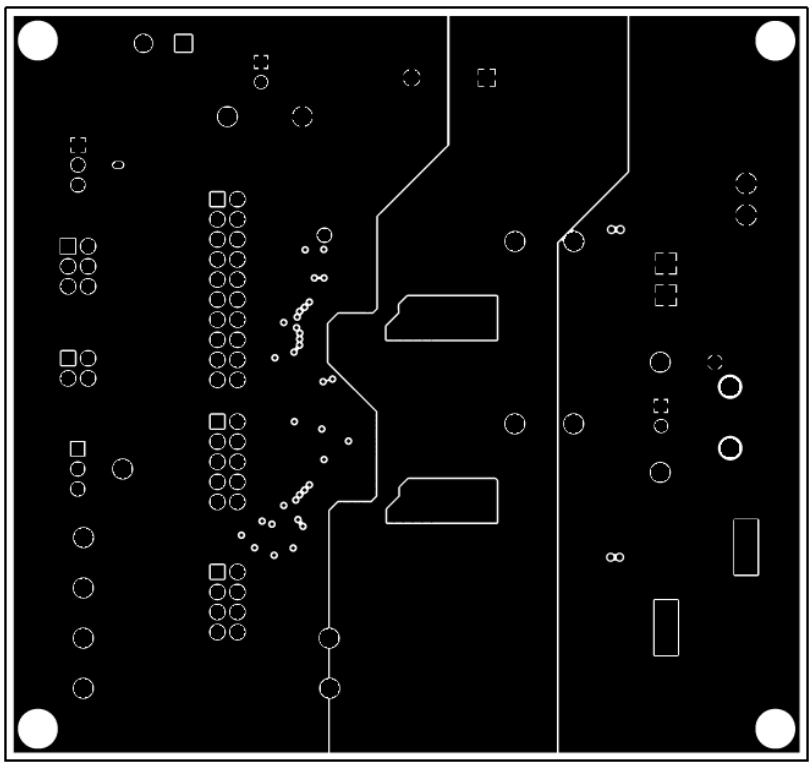

Figure 4-7. Signal Layer 5

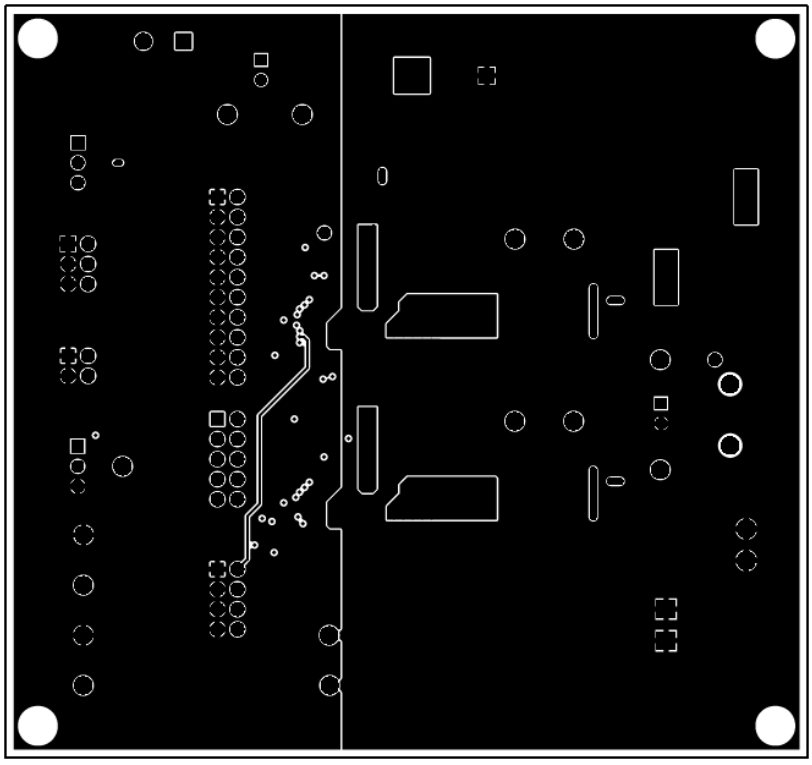

Figure 4-8. Signal Layer 6

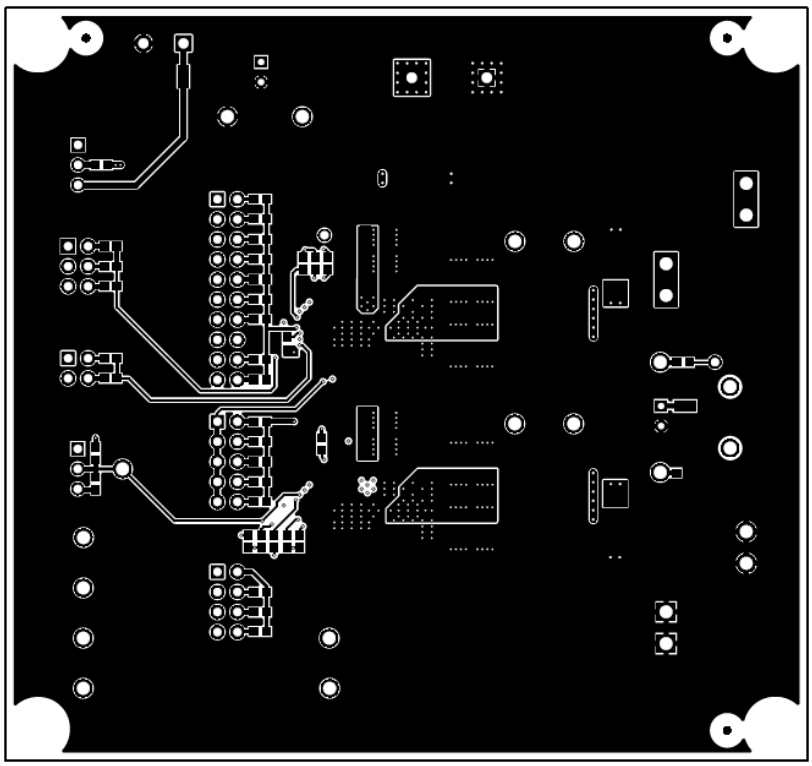

Figure 4-9. Bottom Layer

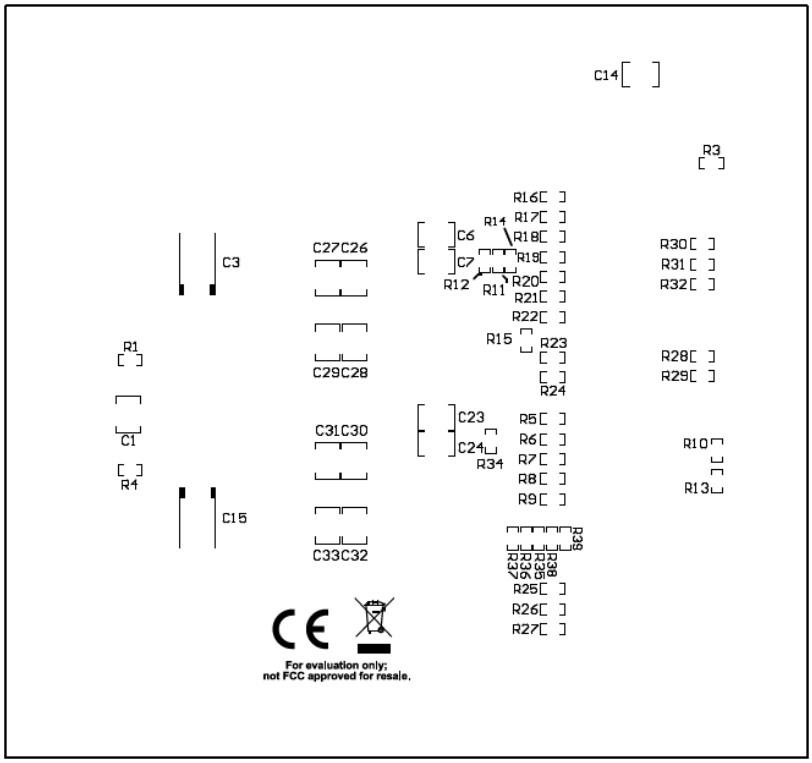

Figure 4-10. Bottom Layer Silk Screen (Bottom View)

5 Schematics

Figure 5-1 is the schematic for the device configured as primary.

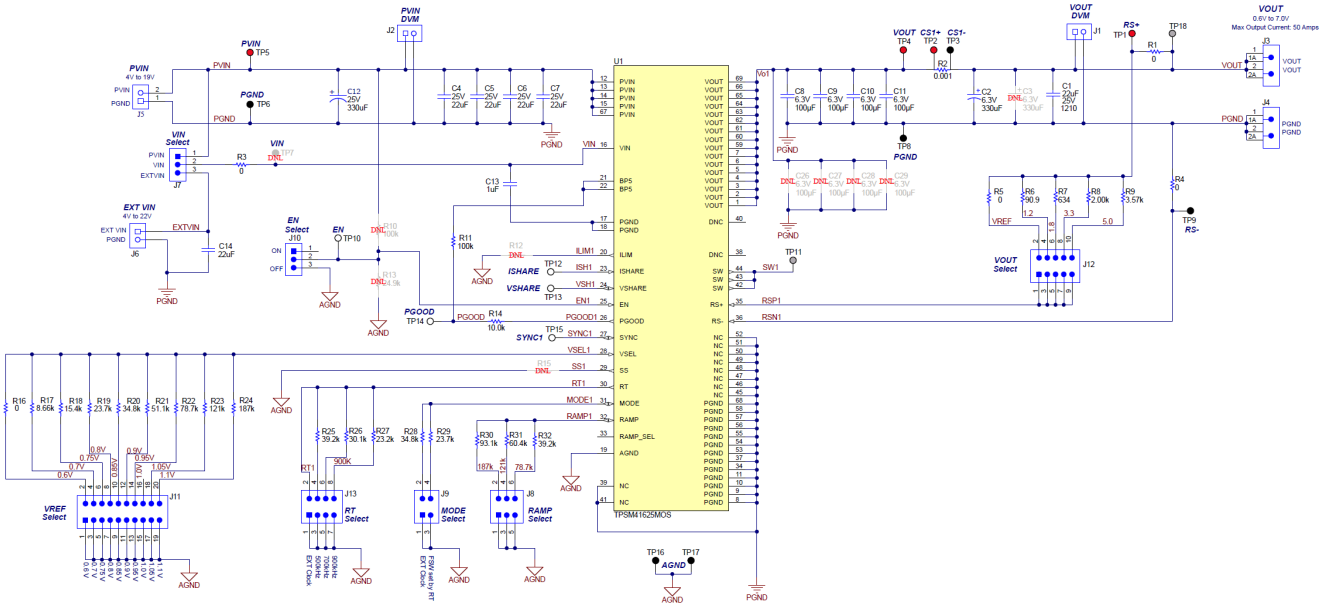

Figure 5-1. Primary Schematic

Figure 5-2 is the schematic for the device configured as secondary.

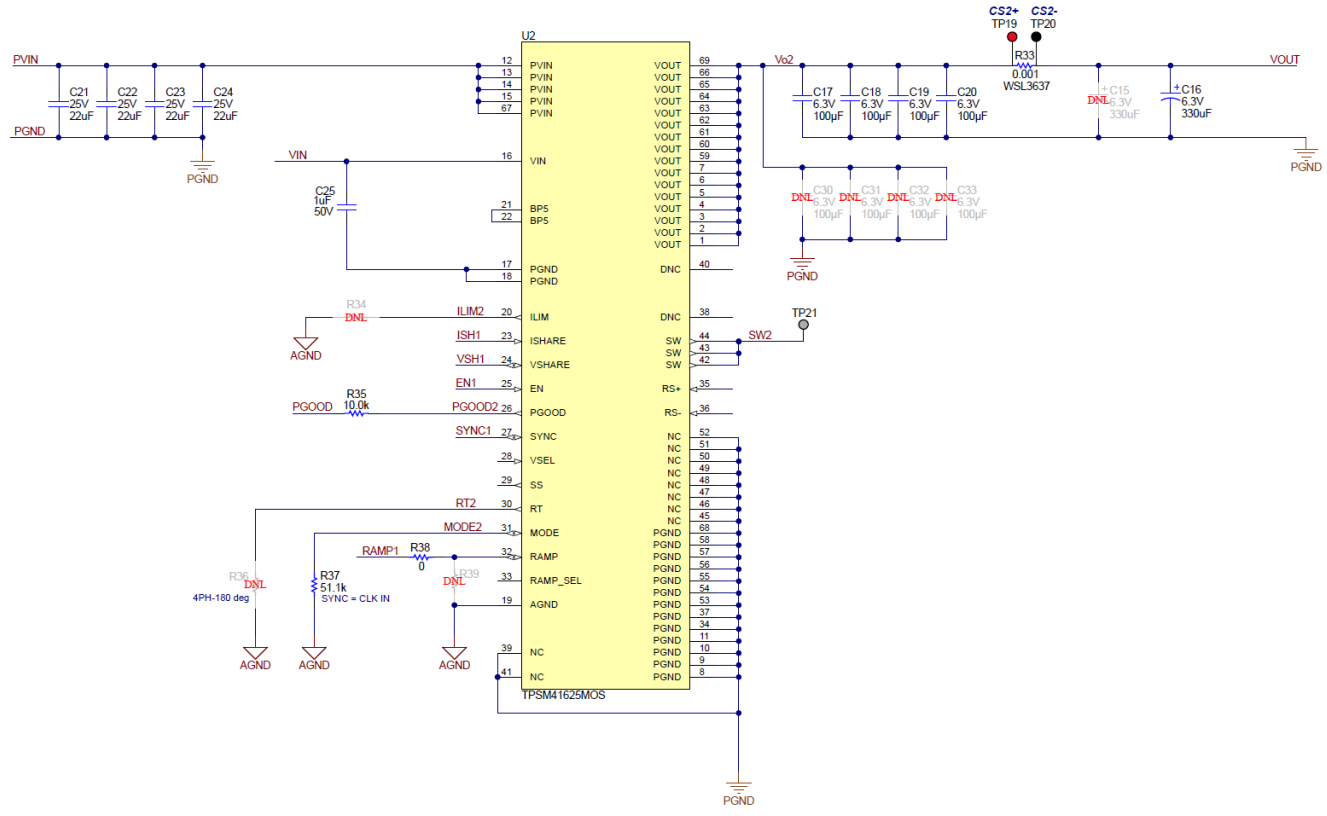

Figure 5-2. Secondary Schematic

6 Bill of Materials

Table 6-1. TPSM41925 Evaluation Module Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number
C1, C4, C5, C6, C7, C14, C21, C22, C23, C24	10	22uF	CAP, CERM, 22 uF, 25 V, X7R	1210	GRM32ER71E226KE15L
C2, C16	2	330uF	CAP, Tantalum Polymer, 330 uF, 6.3 V	2917	6TPE330MAA
C8, C9, C10, C11, C17, C18, C19, C20	8	100uF	CAP, CERM, 100 µF, 6.3 V, X7S	1210	GRM32EC70J107ME15L
C12	1	330µF	330µF 25V Aluminum Electrolytic Capacitors	RADIAL	EEE-FC1E331AP
C13, C25	2	1uF	CAP, CERM, 1 uF, 50 V, X7R,	0603	UMK107AB7105KA-T
J1, J2	2		Socket Strip, 2x1, Black	100mil, 2pin	310-43-102-41-001000
J3, J4	2		Terminal Block, 60A, 10.16mm Pitch, 2-Pos	21.8x30x19 mm	399100102
J5	1		Receptacle	9.52mm, 2x1	1714971
J6	1		Terminal Block	2x1 5.08 mm, 2x1	ED120/2DS
J7, J10	2		Header	3 PIN, 100mil	PEC03SAAN
J8	1		Header	3x2, 100mil	TSW-103-07-G-D
J9	1		Header	2x2, 100mil	TSW-102-07-G-D
J11	1		Header	10x2, 100mil	TSW-110-07-G-D
J12	1		Header	5x2, 100mil	TSW-105-07-G-D
J13	1		Header	4x2, 100mil	TSW-104-07-G-D
R1, R3, R4, R5, R16, R38	6	0	RES, 0, 5%, 0.1 W	0603	CRCW06030000Z0EA
R2, R33	2	0.001	RES, 0.001, 1%, 3W	WSL3637	WSL36371L000FEA
R6	1	90.9	RES, 90.9, 1%, 0.1 W	0603	CRCW060390R9FKEA
R7	1	634	RES, 634, 1%, 0.1 W	0603	CRCW0603634RFKEA
R8	1	2.00k	RES, 2.00 k, 1%, 0.1 W	0603	ERJ3EKF2001V
R9	1	3.57k	RES, 3.57 k, 1%, 0.1 W	0603	CRCW06033K57FKEA
R11	1	100k	RES, 100 k, 1%, 0.1 W	0603	CRCW0603100KFKEA
R14, R35	2	10.0k	RES, 10.0 k, 1%, 0.1 W	0603	CRCW060310K0FKEA
R17	1	8.66k	RES, 8.66 k, 1%, 0.1 W	0603	CRCW06038K66FKEA
R18	1	15.4k	RES, 15.4 k, 1%, 0.1 W	0603	CRCW060315K4FKEA
R19, R29	2	23.7k	RES, 23.7 k, 1%, 0.1 W	0603	CRCW060323K7FKEA
R20, R28	2	34.8k	RES, 34.8 k, 1%, 0.1 W	0603	CRCW060334K8FKEA
R21, R37	2	51.1k	RES, 51.1 k, 1%, 0.1 W	0603	CRCW060351K1FKEA
R22	1	78.7k	RES, 78.7 k, 1%, 0.1 W	0603	CRCW060378K7FKEA
R23	1	121k	RES, 121 k, 1%, 0.1 W	0603	CRCW0603121KFKEA
R24	1	187k	RES, 187 k, 1%, 0.1 W	0603	CRCW0603187KFKEA
R25, R32	2	39.2k	RES, 39.2 k, 1%, 0.1 W	0603	CRCW060339K2FKEA
R26	1	30.1k	RES, 30.1 k, 1%, 0.1 W	0603	RC0603FR-0730K1L
R27	1	23.2k	RES, 23.2 k, 1%, 0.1 W	0603	CRCW060323K2FKEA
R30	1	93.1k	RES, 93.1 k, 1%, 0.1 W	0603	CRCW060393K1FKEA
R31	1	60.4k	RES, 60.4 k, 1%, 0.1 W	0603	CRCW060360K4FKEA
TP1, TP2, TP4, TP5, TP19	5		Test Point, Red	Red Multipurpose Testpoint	5010
TP3, TP6, TP8, TP9, TP16, TP17, TP20	7		Test Point, Black	Black Multipurpose Testpoint	5011
TP10, TP12, TP13, TP14, TP15	5		Test Point, White	White Multipurpose Testpoint	5012

Table 6-1. TPSM41925 Evaluation Module Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number
U1, U2	2		4-V to 16-V Input, 25-A DC/DC power module	QFM69	TPSM41625MOVR
C3, C15	0			2917	
C26, C27, C28, C29, C30, C31, C32, C33	0			1210	
R10, R12, R13, R15, R34, R36, R39	0			0603	

7 Revision History

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

Changes from Revision * (December 2020) to Revision A (May 2021)	Page
• Updated user's guide title	3

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 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。
http://www.tij.co.jp/lsds/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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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。
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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
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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.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

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