

## Using the TPSM84209EVM

The TPSM84209 evaluation module (EVM) is designed as an easy-to-use platform that facilitates an extensive evaluation of the features and performance of the TPSM84209 power module. This guide provides information on the correct usage of the EVM and an explanation of the numerous test points on the board.

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## Trademarks

### 1 Description

This EVM features the TPSM84209 synchronous buck power module configured for operation with a 4.5-V to 28-V input voltage range. The output voltage can be set to one of five popular values by using a configuration jumper. The full 2.5-A output current rating 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 efficiency, power dissipation, input ripple, output ripple, line and load regulation, and transient response. A control test point is provided to control the ENABLE feature and component footprints are provided for UVLO resistors and additional input and output capacitors. The EVM uses a recommended PCB layout that maximizes thermal performance and minimizes output ripple and noise.

### 2 Getting Started

Figure 1 highlights the user interface items associated with the EVM. The *VIN Power* terminal block (J1) is used for connection to the host input supply and the *VOUT Power* terminal block (J2) is used for connection to the load. These terminal blocks can accept up to 16-AWG wire.

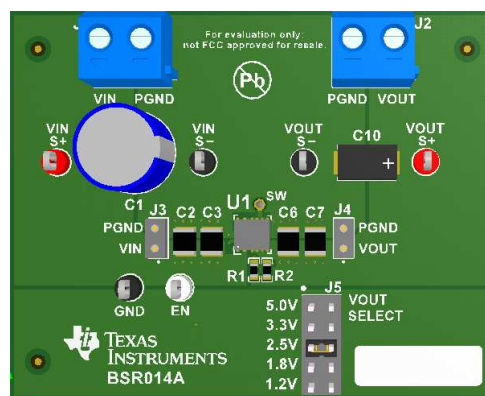


Figure 1. TPSM84209 EVM User Interface

The S+ and S- test points for both VIN and VOUT, located near the power terminal blocks are intended to be used as voltage monitoring points where voltmeters can be connected to measure VIN 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 VIN Scope (J3) and VOUT Scope (J4) test points can be used to monitor VIN 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 must be inserted into the socket marked with a white dot, and the scope ground lead must be inserted into the other socket.

The Enable (EN) and ground (GND) test points located to the left of the device are made available to enable or disable the device. Leaving the EN test point floating enables the device when a valid input voltage is applied, while connecting EN to GND disables the device. Refer to the [Test Points Descriptions](#) section of this guide for more information on the individual control test points.

The VOUT SELECT jumper (J5) is provided for selecting the desired output voltage. Before applying power to the EVM, ensure that the jumper is present and properly positioned for the intended output voltage. Always remove input power before changing the jumper setting.

### 3 Test Point Descriptions

Wire-loop test points and two scope probe test points have been provided as convenient connection points for digital voltmeters (DVM) or oscilloscope probes to aid in the evaluation of the device. A description of each test point follows:

**Table 1. Test Point Descriptions<sup>(1)</sup>**

<b>VIN S+</b>	Input voltage monitor. Connect the positive lead of a DVM to this point for measuring efficiency.
<b>VIN S-</b>	Input voltage monitor. Connect the negative lead of a DVM to this point for measuring efficiency.
<b>VOUT S+</b>	Output voltage monitor. Connect the positive lead of a DVM to this point for measuring efficiency, line regulation, and load regulation.
<b>VOUT S-</b>	Output voltage monitor. Connect the negative lead of a DVM to this point for measuring efficiency, line regulation, and load regulation.
<b>AGND</b>	Analog ground test point.
<b>VIN Scope (J3)</b>	Input voltage scope monitor. Connect an oscilloscope to this set of points to measure input ripple voltage.
<b>VOUT Scope (J4)</b>	Output voltage scope monitor. Connect an oscilloscope to this set of points to measure output ripple voltage and transient response.
<b>EN</b>	Enable test point. Connect this test point to AGND to disable the device. Leave this test point open to enable the device. The UVLO resistor divider (R9 and R10) is connected at this point.

<sup>(1)</sup> Refer to the TPSM84209 datasheet for absolute maximum ratings associated with above features.

## 4 Performance Data

Figure 2 through Figure 7 demonstrate the TPSM84209EVM performance. For more data regarding the TPSM84209 please see the product data sheet.

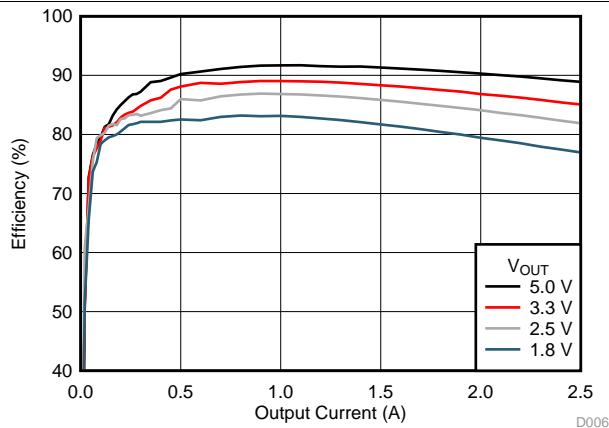


Figure 2. Efficiency ( $V_{IN} = 12\text{ V}$ )

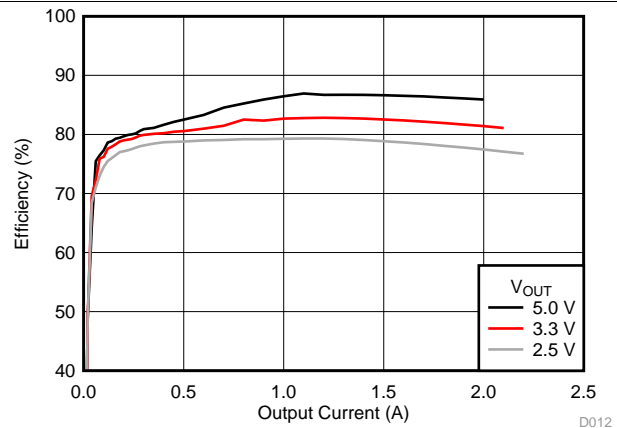


Figure 3. Efficiency ( $V_{IN} = 24\text{ V}$ )

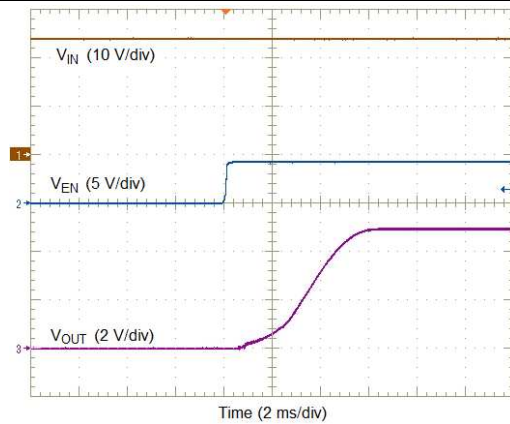


Figure 4. EN Start-Up Waveforms

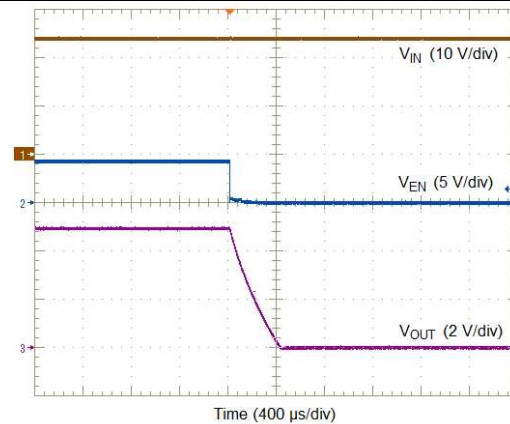


Figure 5. EN Shutdown Waveforms

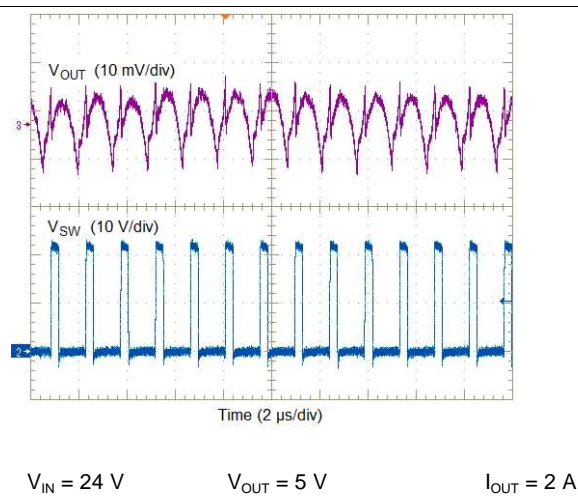


Figure 6. Output Ripple and SW Node

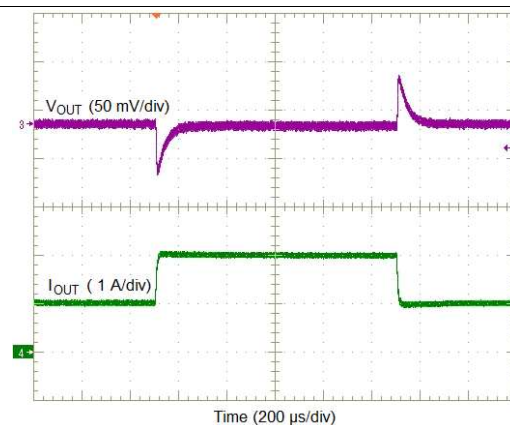


Figure 7. Transient Performance

## 5 Bill of Materials (BOM)

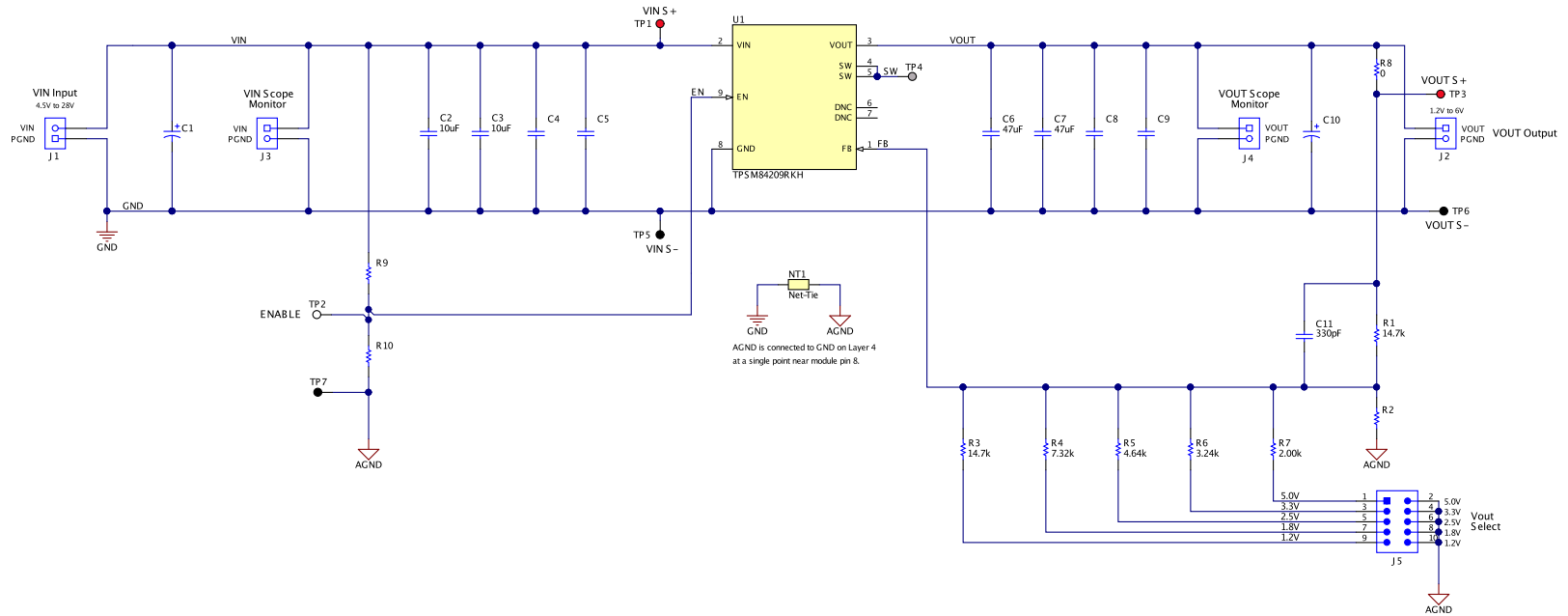
See [Table 2](#) for the TPSM84209 bill of materials.

**Table 2. EVM Bill of Materials**

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C2, C3	2	10µF	CAP, CERM, 10 µF, 50 V,+/- 10%, X5R, 1210	1210	GRM32ER61H106KA12L	MuRata
C6, C6	2	47µF	CAP, CERM, 47 µF, 10 V,+/- 10%, X7R, 1210	1210	GRM32ER71A476KE15L	MuRata
J1, J2	2		Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J3, J4	2		Socket Strip, 2x1, 100mil, Black, Tin, TH	Socket Strip, 100mil, 2pin	310-43-102-41-001000	Mill-Max
J5	1		Header, 100mil, 5x2, Tin, TH	Header, 5x2, 100mil, Tin	PEC05DAAN	Sullins Connector Solutions
R1, R3	2	14.7k	RES, 14.7 k, 1%, 0.1 W, 0603	0603	CRCW060314K7FKEA	Vishay-Dale
R4	1	7.32k	RES, 7.32 k, 1%, 0.1 W, 0603	0603	CRCW06037K32FKEA	Vishay-Dale
R5	1	4.64k	RES, 4.64 k, 1%, 0.1 W, 0603	0603	CRCW06034K64FKEA	Vishay-Dale
R6	1	3.24k	RES, 3.24 k, 1%, 0.1 W, 0603	0603	CRCW06033K24FKEA	Vishay-Dale
R7	1	2.00k	RES, 2.00 k, 1%, 0.1 W, 0603	0603	CRCW06032K00FKEA	Vishay-Dale
R8	1	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
SH-J1,	1	1x2	Shunt, 2mm, Gold plated, Black	2mm Shunt, Closed Top	2SN-BK-G	Samtec
TP1, TP3	2		Test Point, Multipurpose, Red, TH	Multipurpose Testpoint Red	5010	Keystone
TP2	1		Test Point, Multipurpose, White, TH	Multipurpose Testpoint White	5012	Keystone
TP5, TP6, TP7	3		Test Point, Multipurpose, Black, TH	Multipurpose Testpoint Black	5011	Keystone
U1	1		4.5V to 28V Input, 1.2V to 6.0V Output, 2.5A	RKH0009A	TPSM84209RKH	Texas Instruments
C1	0		CAP, ALUM, TH	10x16mm		
C4	0		CAP, CERM, 1210	1210		
C5	0		CAP, CERM, 0603	0603		
C8, C9	0		CAP, CERM, 1210	1210		
C10	0		CAP, Tantalum Polymer, 7343-40 SMD	7343-40		
C11	0		CAP, CERM, 0603	0603		
R2, R9, R10	0		RES, 0.1 W, 0603	0603		

## 6 Schematic

[Figure 8](#) is the schematic for the TPSM84209EVM.



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Figure 8. TPSM84209EVM Schematic

## 7 PCB Layout

Figure 9 through Figure 14 show the PCB layers of the TPSM84209EVM.

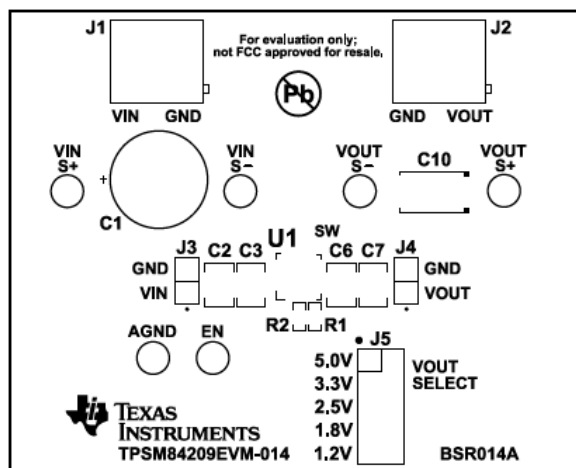


Figure 9. Topside Component Layout (Top View)

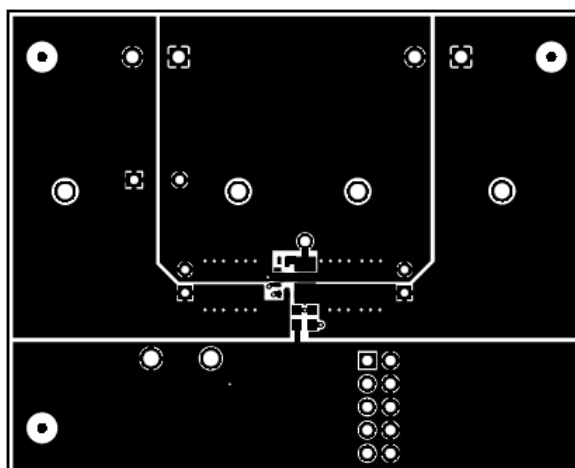


Figure 10. Topside Copper (Top View)

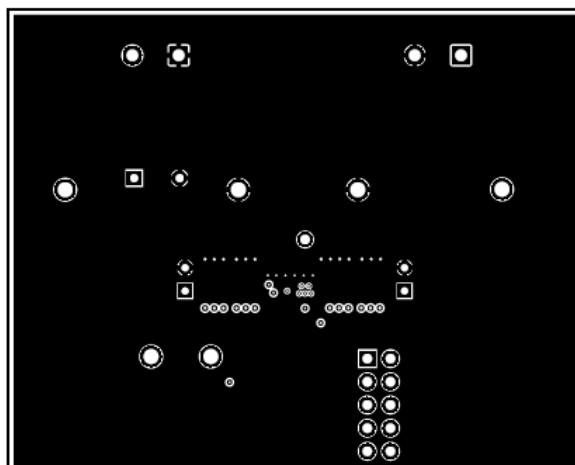
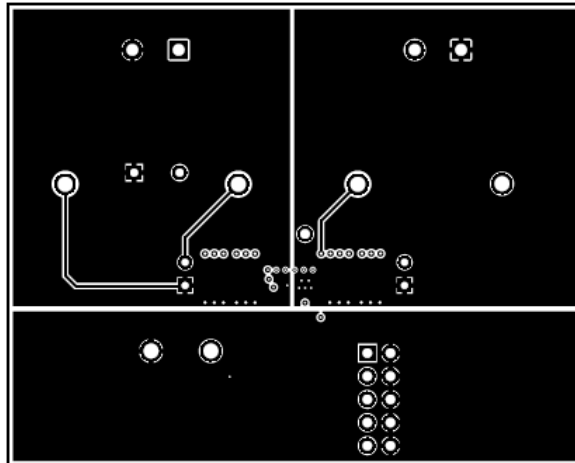
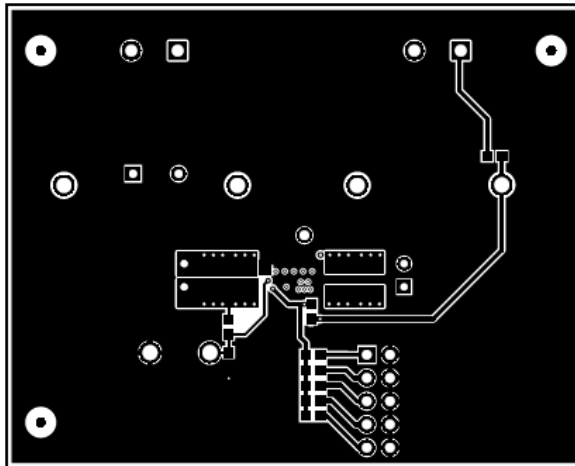


Figure 11. Layer 2 Copper (Top View)

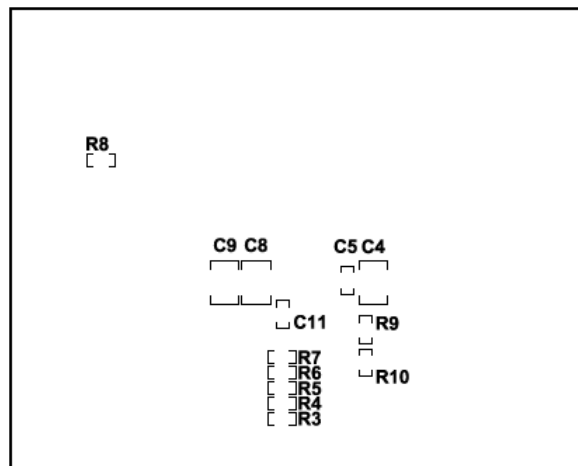




**Figure 12. Layer 3 Copper (Top View)**



**Figure 13. Bottom-Side Copper (Top View)**



**Figure 14. Bottom-Side Component Layout (Bottom View)**

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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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  - 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.
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](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:*

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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