EVM User's Guide: TPSM33620QEVM

TPSM33620QEVM Evaluation Module

Description

This evaluation module (EVM) contains the typical components for use with the TPSM33620-Q1 to provide a 2A load current from an input voltage of up to 36V. The TPSM33620QEVM features an output voltage of 3.3V at a switching frequency of 2.2MHz. This EVM is populated with the TPSM33620S3QRDNRQ1. This EVM can support the entire TPSM336xx-Q1 and TPSM336x5 family of devices by changing out the IC with the other variants and modifying the surrounding components to the respective data sheet recommendations.

Features

- 4.5V to 36V wide input voltage range
- Fixed 3.3V output with optional feedback divider footprints for an adjustable output voltage
- Fixed 2.2MHz switching frequency with external sync capability and mode select
- Differential input EMI filter for compliance testing
- PGOOD output signal available with jumpers

Applications

- Rear camera
- Medium, short range radar
- Body control module (BCM)

TPSM33620QEVM Board

1 Evaluation Module Overview

1.1 Introduction

The Texas Instruments TPSM33620QEVM helps designers evaluate the operation and performance of the TPSM33620-Q1 wide-input voltage buck module. The EVM provides many test points to help evaluate the IC and is constructed on a 4-layer PCB.

1.2 Kit Contents

The box includes the TPSM33620QEVM on nylon standoffs for evaluating on a lab bench. Contact the Texas Instruments Product Information Ceneter nearest if any components are missing or the EVM is deffective.

1.3 Specification

Table 1-1 provides a summary of the TPSM33620QEVM performance specifications. Specifications are given for 13.5V input voltage and 3.3V output voltage from –40°C to 150°C, unless otherwise noted.

Table 1-1. TPSM33620QEVM Performance Specifications Summary

Specifications		Test Conditions	MIN	TYP	MAX	Unit
V_{OUT}	Output voltage	V_{IN} = 3.6V to 36V, FPWM mode	3.27	3.3	3.33	V
F_{SW}	Switching frequency	Mode/sync set to GND or VCC, SpSp ON	1980	2200	2420	kHz
I_{OUT}	Output current range		0		2	A
PGD_{UV}	PGOOD upper threshold - falling	% of VOUT/FB	89	91	94.2	%
$V_{EN-WAKE}$	EN wakeup threshold		0.5	0.7	1	V

1.4 Device Information

The Texas Instruments TPSM33620QEVM evaluation module helps designers evaluate the operation and performance of the TPSM33620-Q1 wide-input buck module. The TPSM33620-Q1 is an easy-to-use synchronous step-down voltage module capable of driving up to 2A of load current from an input voltage of up to 36V. The EVM also features test points for EN, SYNC, PGOOD, VCC, VOUT, and GND. See the *TPSM336xx-Q1 3V to 36V Input, 1V to 7V Output, 0.6A, 1A, and 2A Automotive Synchronous Buck Converter Power Module in a HotRod™ QFN Package* data sheet for the TPSM33620-Q1 for additional features, detailed descriptions, and available options.

Table 1-2. Device Populated on the TPSM33620QEVM

U1	Frequency	Spread Spectrum	Current	Pin 11 Trim
TPSM33620S3QRDNRQ1	2.2MHz	ENABLED	2A	MODE/SYNC

2 Hardware

2.1 Setup

This section shows the typical setup of external loading devices that are necessary to connect, set up, and use the TPSM33620QEVM. Please see Figure 2-1 for a visual aid on these connections in relation to the EVM.

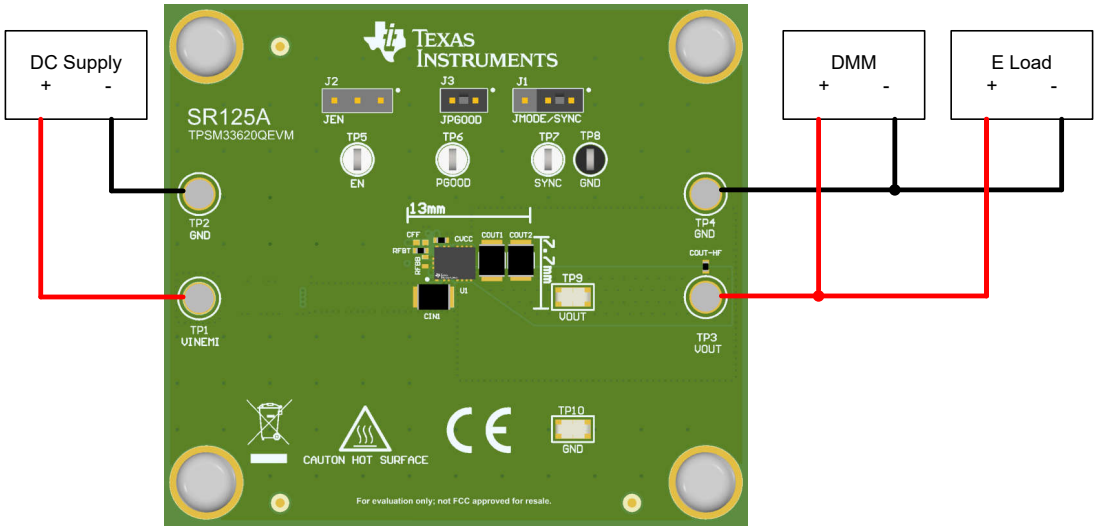

Figure 2-1. TPSM33620QEVM Board Connections

2.2 Jumper Information

- J1 – connect J1: 1-2 to set the IC operation to auto mode or J2: 2-3 to FPWM (fixed frequency) mode. If synchronization to an external clock source is required, remove the J2 jumper and hook the clock up to TP7 and TP8.
- J2 – connect J2: 2-3 to enable the device or J2: 1-2 to disable the device.
- J3 – connect J3: 1-2 for a VCC pullup voltage on PGOOD. The PGOOD signal can also be connected to an external supply of up to 20V using pin 2 of this jumper.

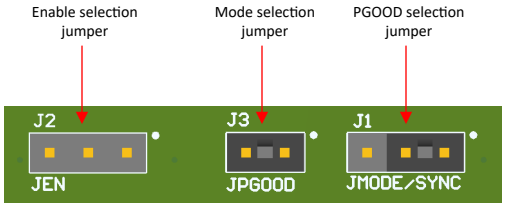

Figure 2-2. Jumper Locations

2.3 Test Points

See Figure 2-1 for typical test setup. The functions of the test point connections are:

- VINEMI (TP1) - input supply connection to the EVM
- GND (TP2) - ground connection for the input supply
- VOUT (TP3) - output connection for the load
- GND (TP4) - ground connection for the load
- EN (TP5) - enable signal test point
- PGOOD (TP6) - Pgood signal test point
- SYNC (TP7) - sync signal input connection to the EVM (for use with an external clock)
- GND (TP8) - ground connection for the sync signal
- VOUT (TP9) - sense connection point for the output voltage
- GND (TP10) - extra ground connection test point

3 Implementation Results

3.1 Evaluation Setup

The EVM was configured in PFM mode at a 2.2MHz switching frequency and populated with the TPSM33620S3QRDNRQ1. The device has both RFBT and RINJ shorted, with RFBB and CFF left depopulated to set the device to a fixed output voltage of 3.3V. A power supply capable of at least 36V at 2A was attached to the TP1 (VINEMI) and TP2 (GND) input terminals of the EVM.

3.2 Performance Data and Results

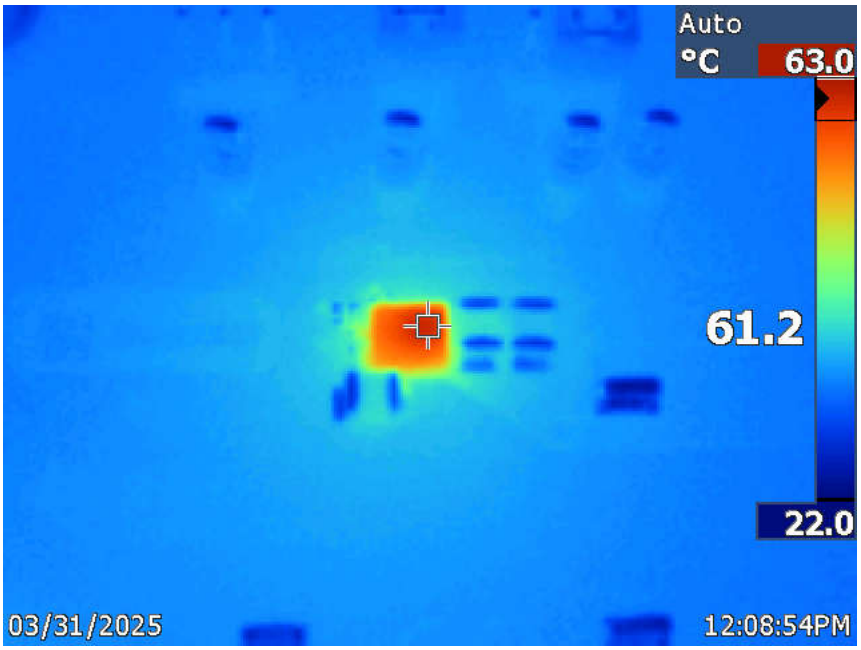

Figure 3-1. Thermal Capture, 13.5VIN, 3.3VOUT, 2.2MHz, 2A

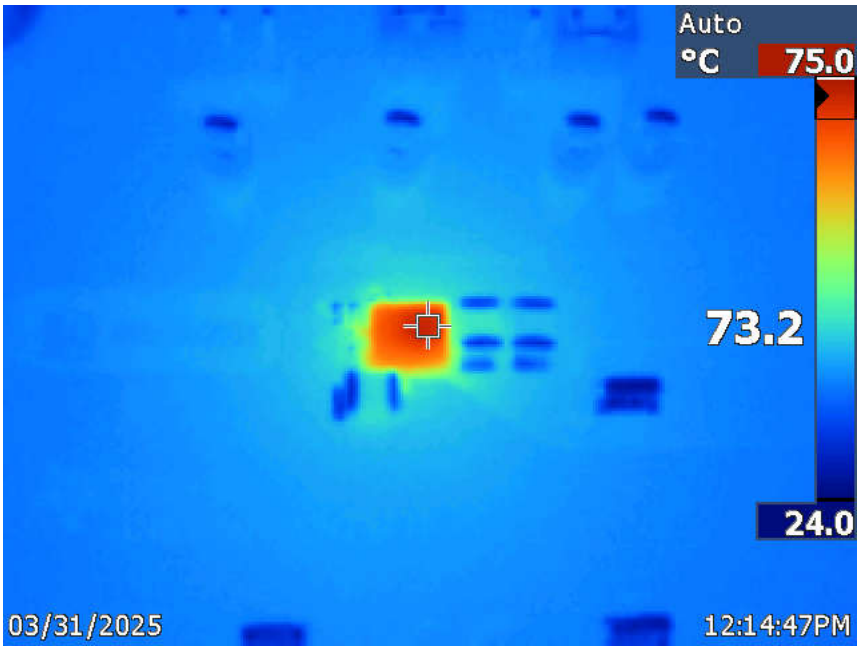

Figure 3-2. Thermal Capture, 36VIN, 3.3VOUT, 2.2MHz, 2A

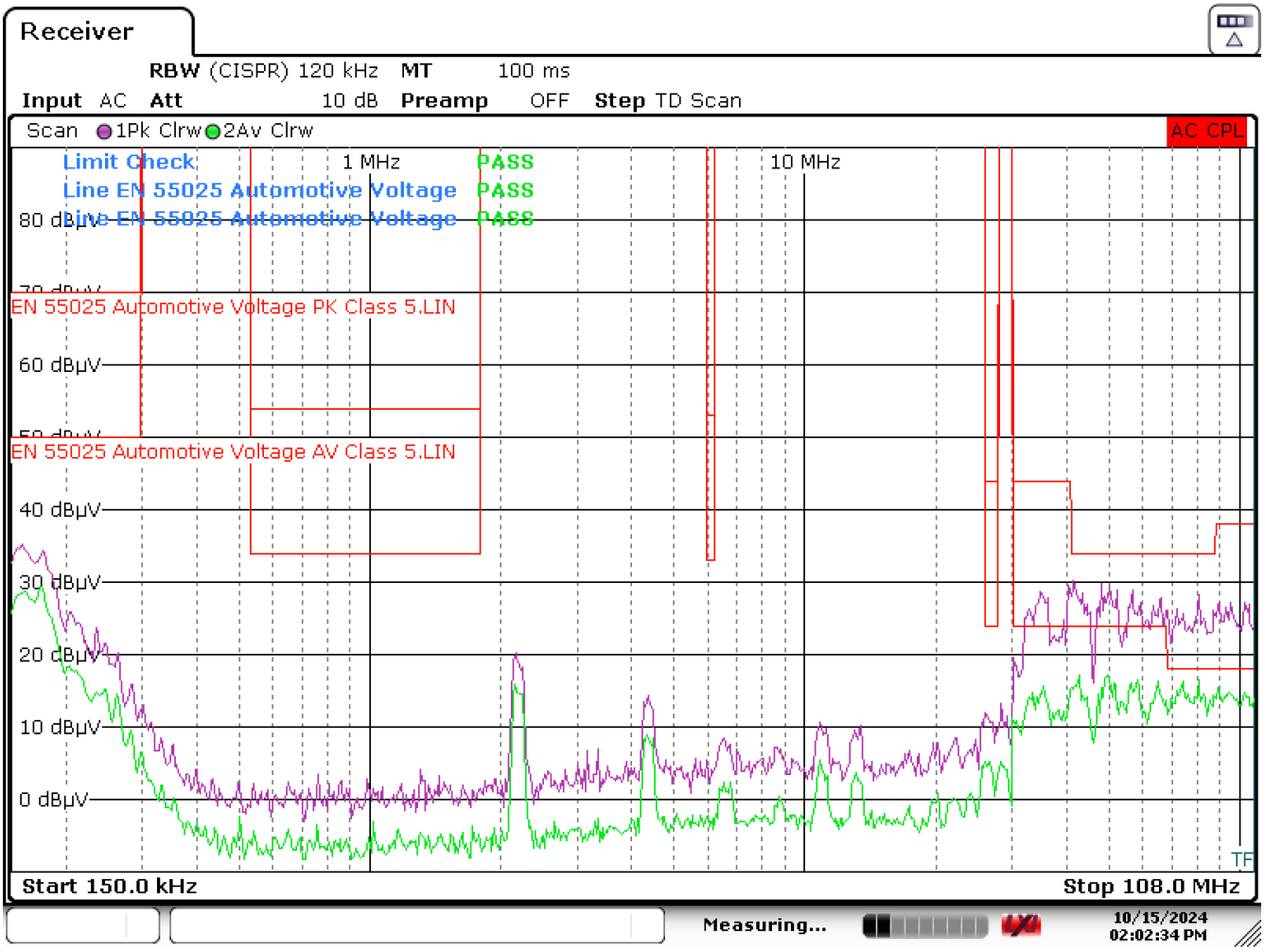

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Figure 3-3. TPSM33620QEVM Conducted EMI Results, 13.5VIN, 3.3VOUT, 2A (Green-Average Scan, Purple-Peak Scan)

4 Hardware Design Files

4.1 Schematics

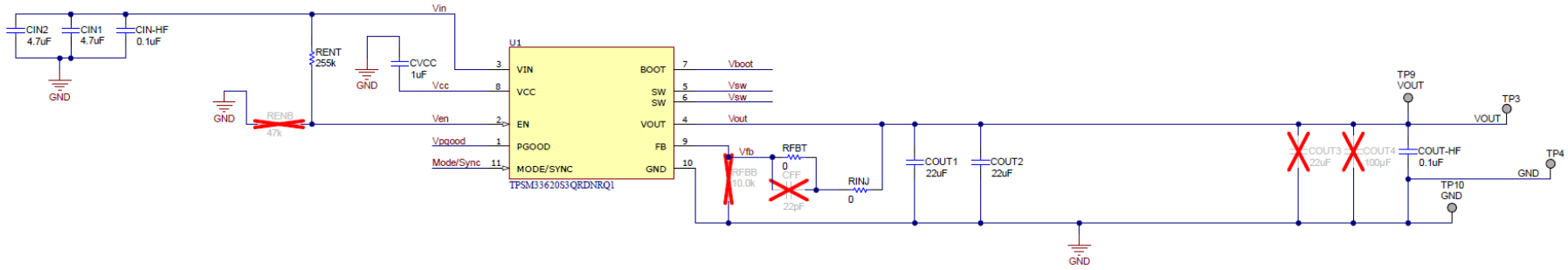

Figure 4-1. TPSM33620QEVM Schematic

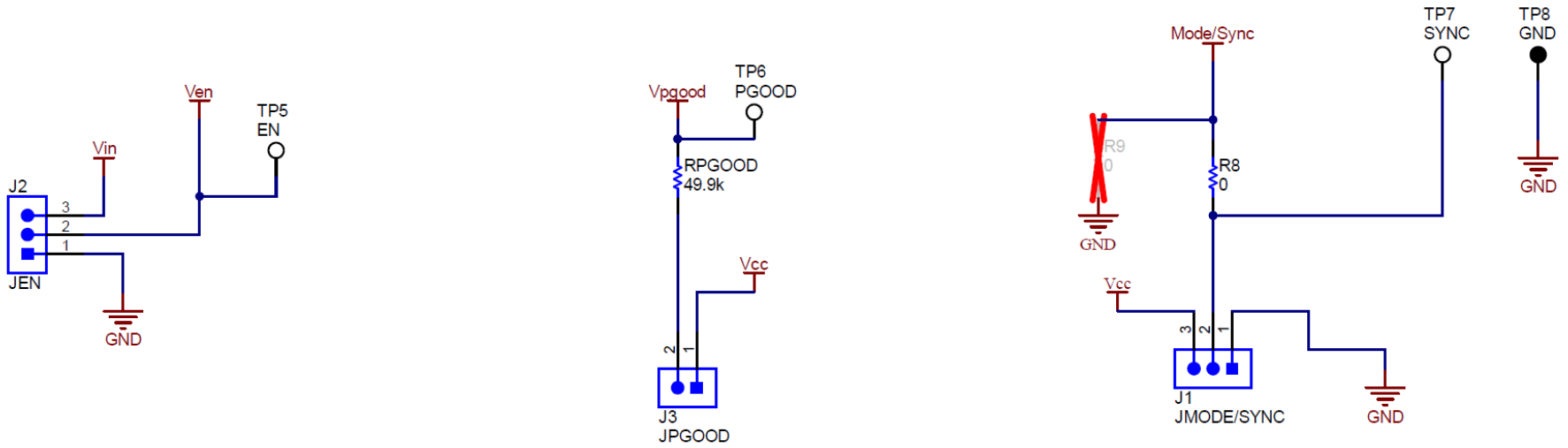

Figure 4-2. TPSM33620QEVM Jumper Schematics

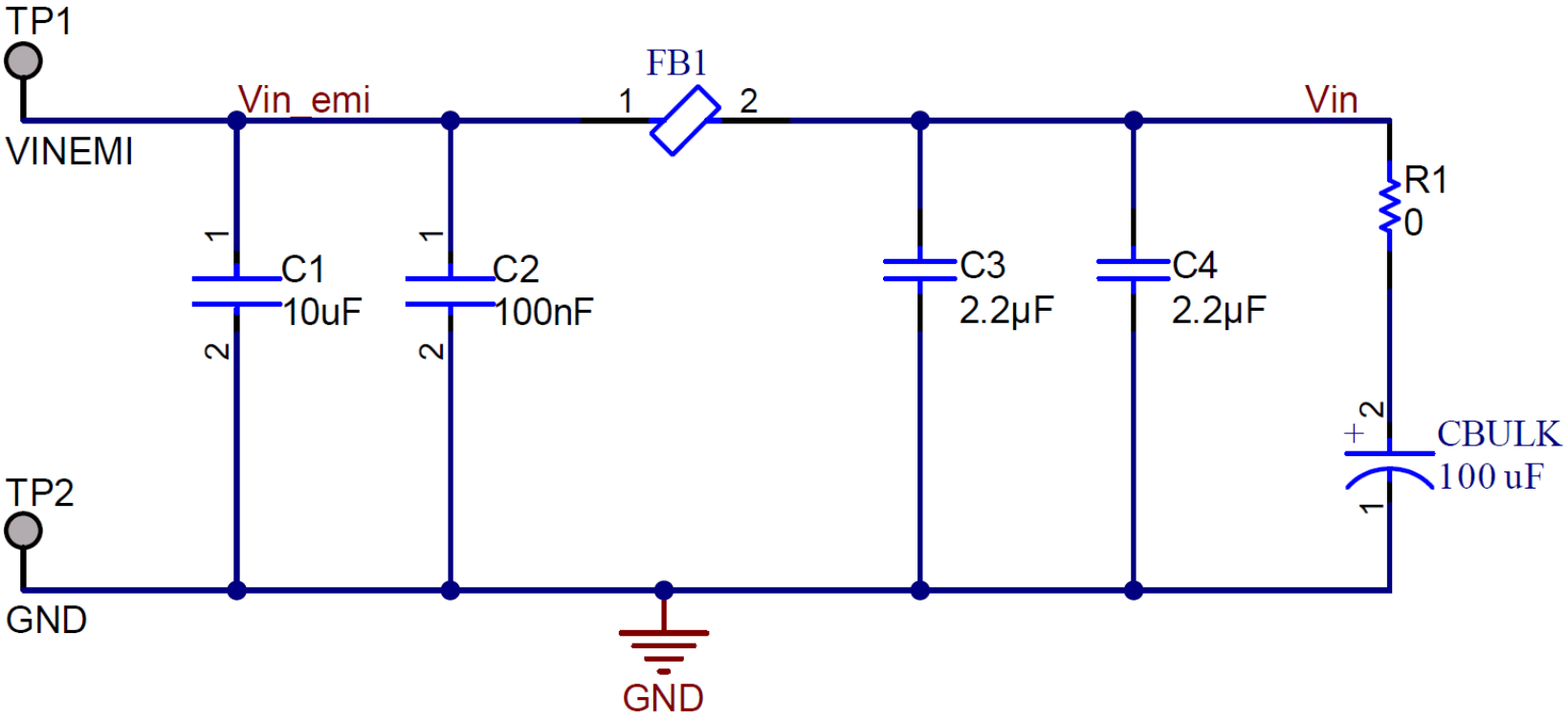

Figure 4-3. TPSM33620QEVM EMI Compliance Filter

4.2 PCB Layouts

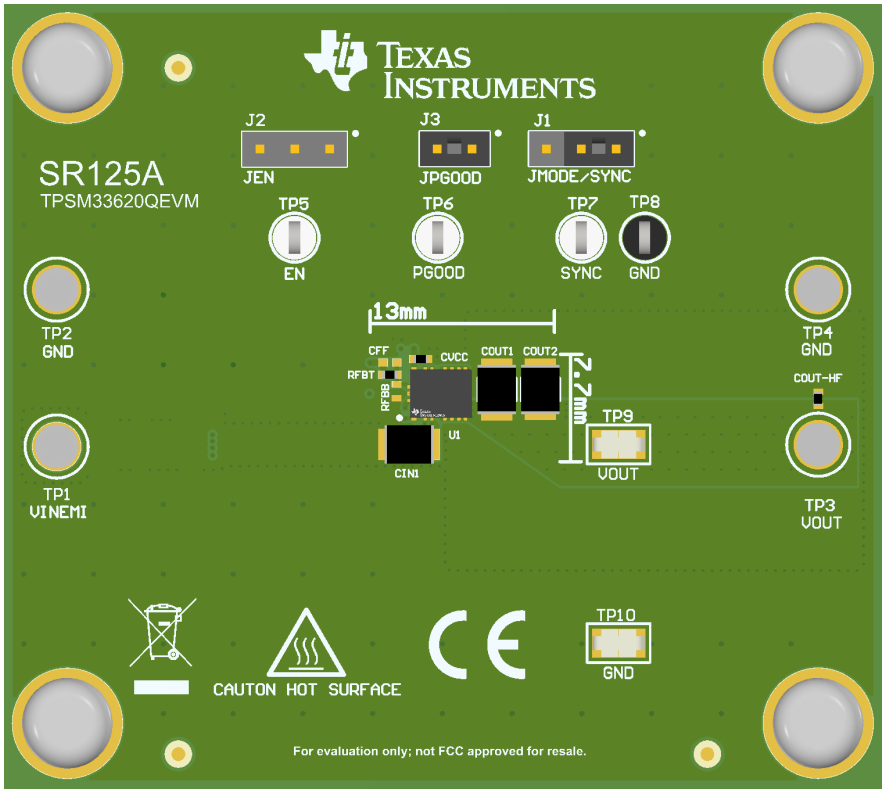

Figure 4-4. Top View of EVM

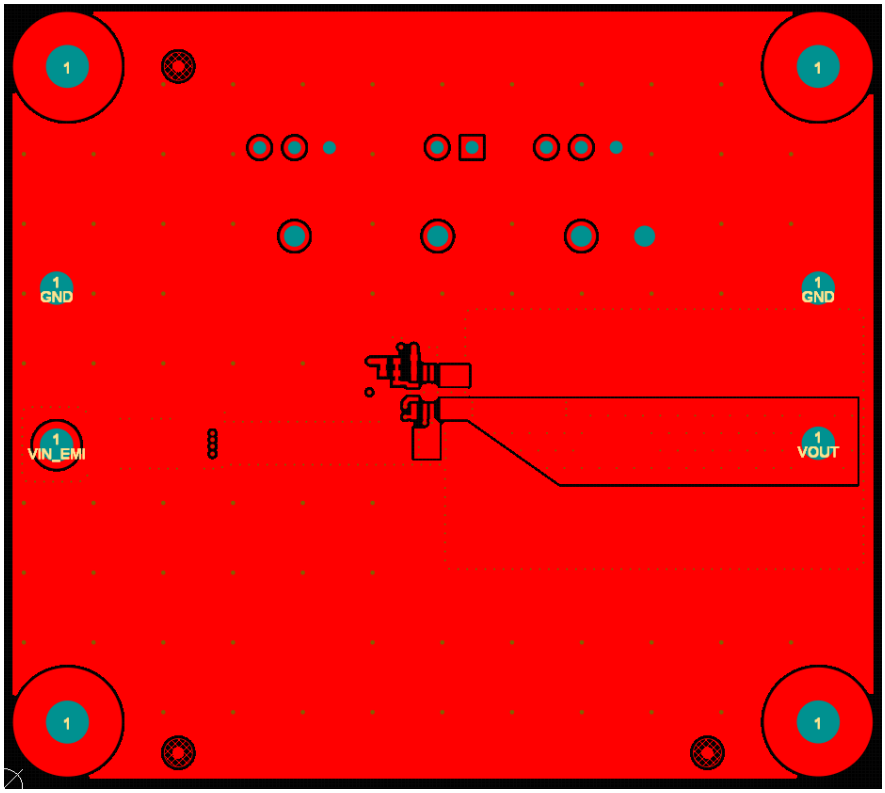

Figure 4-5. EVM Top Copper Layer

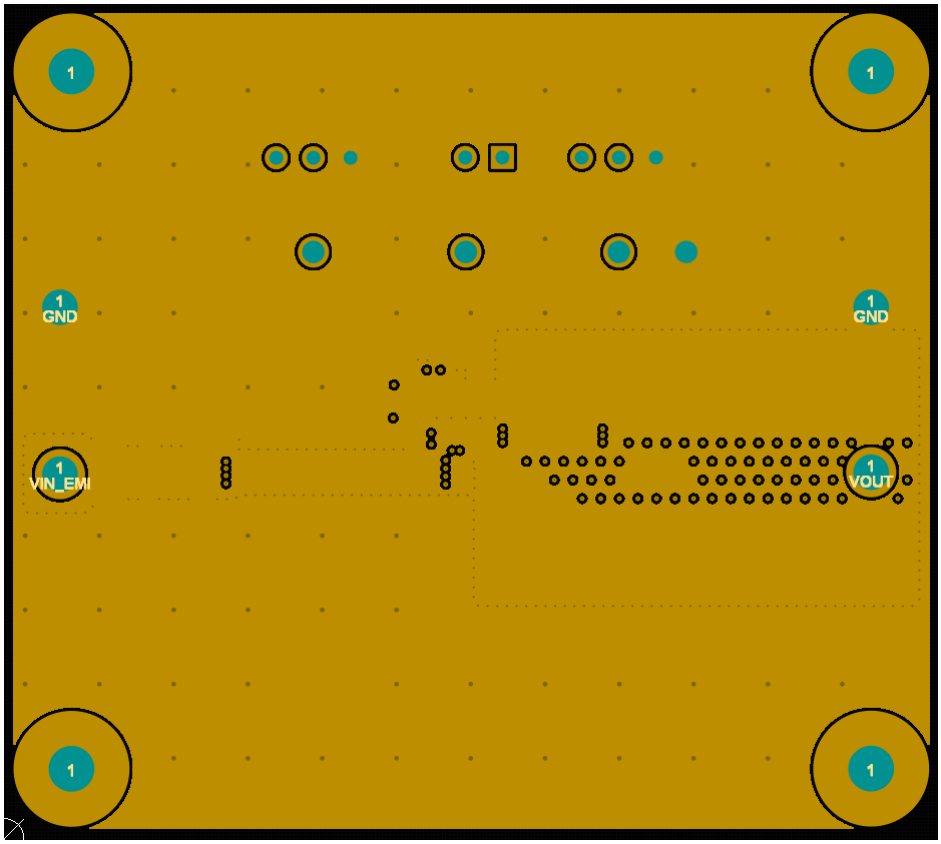

Figure 4-6. Mid-Layer One

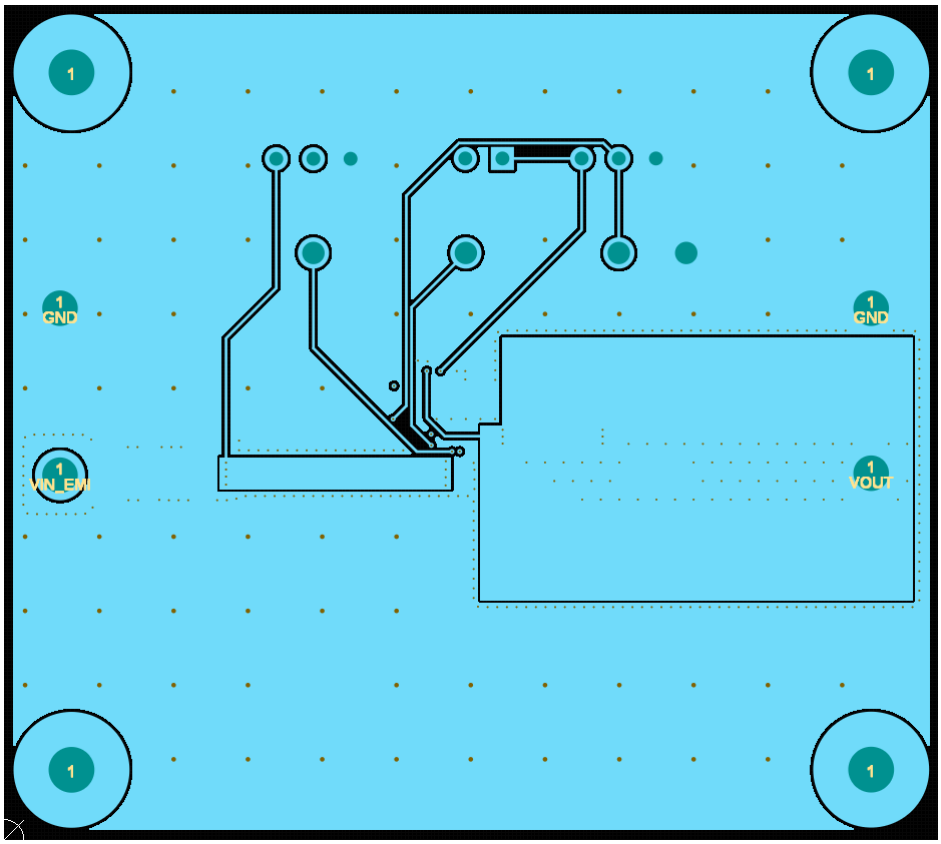

Figure 4-7. Mid-Layer Two

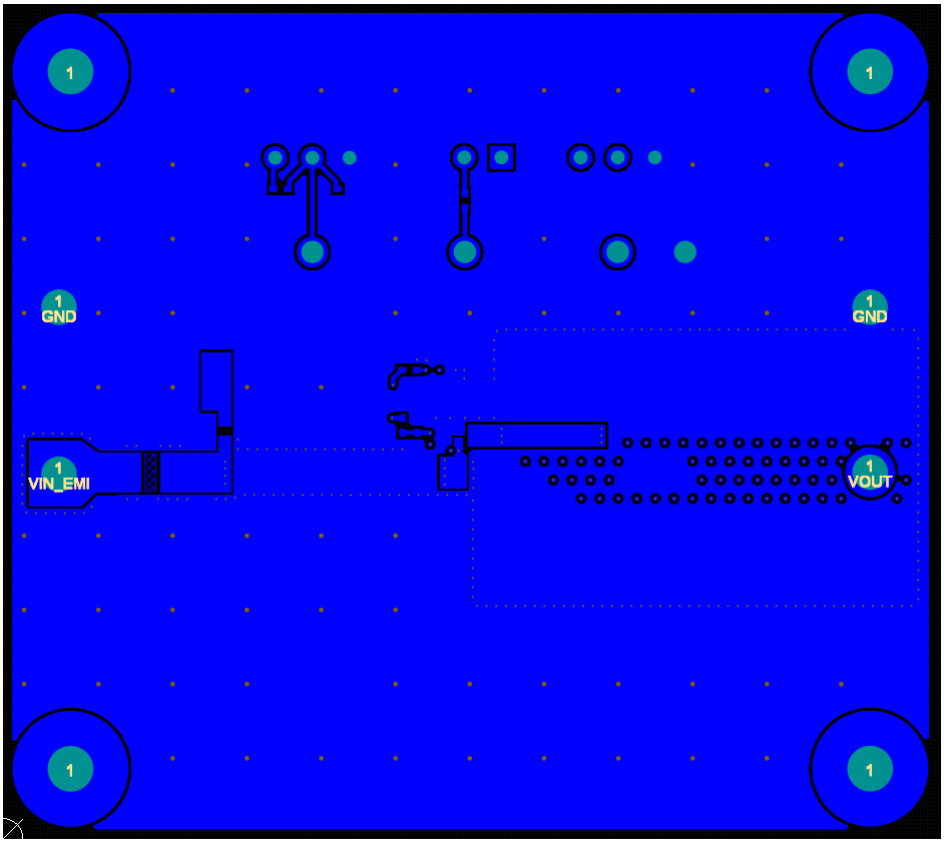

Figure 4-8. EVM Bottom Copper Layer

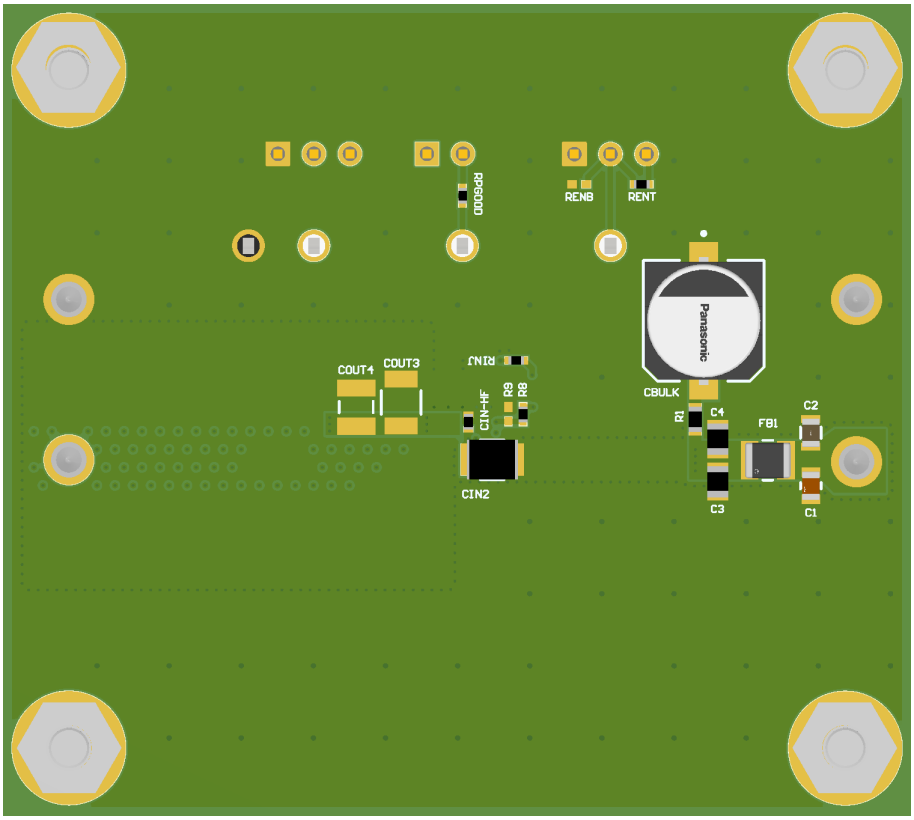

Figure 4-9. Bottom View of EVM

4.3 Bill of Materials (BOM)

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1	1	10µF	Chip Multilayer Ceramic Capacitors for General Purpose, 0805, 10uF, X5R, 15%, 10%, 50V	0805	GRM21BR61H106KE43L	Murata
C2	1	100nF	Cap Ceramic 100nF 50V X8R 10% Pad SMD 0805 +150°C Automotive T/R	0805	CGA4J2X8R1H104K125AA	TDK
C3, C4	2	2.2µF	CAP, CERM, 2.2uF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	0805	CGA4J3X7R1H225K125AB	TDK
CBULK	1	100µF	CAP ALUM 100UF 20% 50V SMD	RADIAL	EEE-FK1H101P	Panasonic
CIN1, CIN2	2	4.7µF	CAP, CERM, 4.7uF, 50V, +/- 10%, X7R, 1210	1210	C3225X7R1H475K250AB	TDK
CIN-HF, COUT-HF	2	0.1µF	CAP, CERM, 0.1uF, 50V, +/- 20%, X5R, 0402	0402	GRM155R61H104ME14D	MuRata
COUT1, COUT2	2	22µF	CAP, CERM, 22uF, 16V, +/- 20%, X7R, AEC-Q200 Grade 1, 1210	1210	CGA6P1X7R1C226M250AC	TDK
CVCC	1	1µF	CAP, CERM, 1uF, 16V, +/- 10%, X5R, 0402	0402	EMK105BJ105KVHF	Taiyo Yuden
FB1	1		Ferrite Bead, 600Ω at 100MHz, 3A, 1210	1210	FBMH3225HM601NT	Taiyo Yuden
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1	1		Header, 100mil, 3x1, Gold, TH	Header	HTSW-103-07-G-S	Samtec
J2	1		Header, 100mil, 3x1, Gold, TH		HTSW-103-07-G-S	Samtec
J3	1		Header, 100mil, 2x1, Gold, TH		HTSW-102-07-G-S	Samtec
R1	1	0ohm	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R8, RFBT, RINJ	3	0ohm	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
RENT	1	255kohm	RES, 255 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402255KFKED	Vishay-Dale
RPGOOD	1	49.9kohm	RES, 49.9 k, 1%, 0.063 W, 0402	0402	CRCW040249K9FKED	Vishay-Dale
SH-J1, SH-J2	2		Shunt, 100mil, Gold plated, Black	Shunt	881545-2	TE Connectivity
TP1, TP2, TP3, TP4	4		Terminal, Turret, TH, Double		1502-2	Keystone
TP5, TP6, TP7	3		Test Point, Multipurpose, White, TH		5012	Keystone Electronics
TP8	1		Test Point, Multipurpose, Black, TH		5011	Keystone Electronics
TP9, TP10	2		Test Point, Miniature, SMT		5019	Keystone
U1	1		3V to 36V Input, 1V to 7V Output, 2A Automotive Synchronous Buck Converter Power Module, QFN-FCMOD11		TPSM33620S3QRDNRQ1	Texas Instruments

5 Additional Information

5.1 Trademarks

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   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。

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

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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/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.

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