EVM User's Guide: TPS61287EVM-042

TPS61287 Evaluation Module

Description

The TPS61287EVM helps to evaluate the behavior and performance of the TPS61287 at different input voltages, output voltages, and load conditions. This EVM is designed for 3.3V to 4.2V input voltage and 18V output voltage applications. This EVM has test points of TP1 and TP2 for input voltage measurement, TP3 and TP6 for output voltage measurement, TP7 for SW measurement, TP4 and TP5 for loop test, respectively.

Features

- Output current 3A
- Up to 92.3% efficiency at VIN = 3.6V to VOUT = 18V, and IOUT = 2A
- Programmable switching valley current limit from 5A to 20A
- Selectable auto PFM and forced PWM mode
- Output overvoltage protection
- Synchronization capability to external clock

TPS61287EVM-042

1 Evaluation Module Overview

1.1 Introduction

The TPS61287EVM contains the TPS61287, which is a high-power density, synchronous boost converter that integrates an 8mΩ high-side synchronous rectifier FET and uses an external FET. The MODE jumper (J3) controls the operating mode of the device. When MODE is connected to high, the device operates in forced PWM mode. When MODE is connected to low, the device operates in auto PFM mode. The current limit, feedback divider and compensation network can be modified for other application conditions as per the data sheet. This user's guide describes the characteristics, operation, and the use of the TPS61287EVM evaluation module (EVM). This user's guide includes EVM specifications, connectors, schematic diagram, bill of materials, and the board layout of the evaluation module (EVM) for the TPS61287.

1.2 Kit Contents

Table 1-1. Kit List

Designator	Quantity	Description	Material Type	Packaging
PCB1	1	TPS61287EVM; circuit board;	EEE	Bag, ESD
BOX1	1	Box, cardboard	Cardboard	Box
FM1	2	Foam, antistatic	Plastic	Foam
LBL1	1	Label, small and large standard labels	Paper or card stock	Paper
LIT1	1	Literature, EVM Disclaimer Read Me	Paper or card stock	Paper
LIT2	1	Literature, EVM Disclaimer Read Me	Paper or card stock	Paper

1.3 Specification

The summary of the TPS61287EVM performance specifications is shown in Table 1-2. All the specifications are given for an ambient temperature of 25°C.

Table 1-2. Performance Specification

Parameter	Test Condition	Value	Unit
Input voltage		3.3-4.2	V
Output voltage		18	V
Efficiency	VIN = 3.6V to VOUT =18V, and IOUT = 2A	92.3	%
Default switching frequency		320	kHz

1.4 Device Information

The TPS61287 is a high-power density, synchronous boost converter that integrates the high side synchronous rectifier MOSFET and uses an external low side MOSFET to provide a high efficiency and small solution size. The TPS61287 has a wide input voltage range from 2.5V to 23V and the output voltage covers up to 25V with 20A switching valley current capability. The TPS61287 has output overvoltage protection and overcurrent protection to prevent the device from over heat.

2 Hardware

2.1 Connectors and Test Points Information

This EVM includes connectors and test points as shown in Table 2-1.

Table 2-1. Connectors and Test Points

Reference Designator	Description
J1	Input voltage positive connection.
J2	Input voltage negative connection.
J3	Output voltage positive connection.
J4	Output voltage negative connection.
TP1	Input voltage positive sensing node for measuring efficiency.
TP2	Input voltage negative sensing node for measuring efficiency.
TP3	Output voltage positive sensing node for measuring efficiency.
TP4	Test point to measure bode plot.
TP5	Test point to measure bode plot.
TP6	Output voltage negative sensing node for measuring efficiency.
TP7	Test point to measure SW pin waveform.
JP1	SYNC pin input jumper. Place a jumper across input and GND when SYNC function not used. Leave JP1 open and connect nput to external SYNC signal when SYNC function is used.
JP2	EN pin input jumper. Place a jumper across EN and High to turn on the IC. Place a jumper across EN and Low to turn off the IC.
JP3	MODE pin input jumper. Place a jumper across MODE and High to set the device in forced PWM mode. Put the jumper across MODE and Low to set the device in auto PFM mode.

3 Hardware Design Files

3.1 Schematics

The TPS61287 EVM schematic is shown in Figure 3-1.

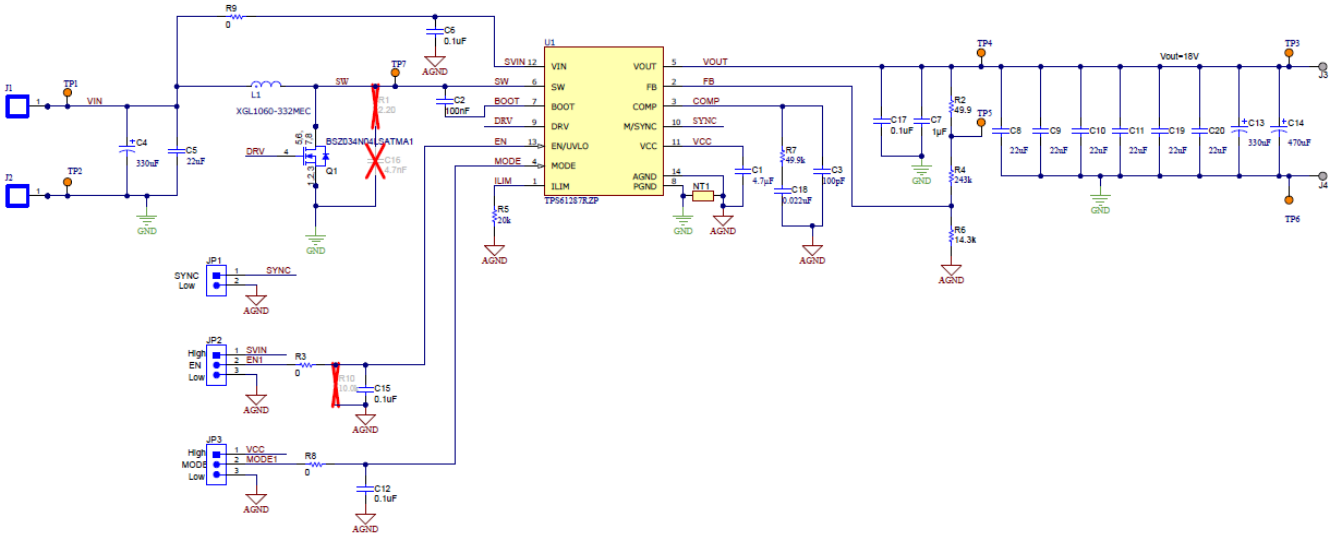

Figure 3-1. TPS61287EVM-042 Schematic

3.2 PCB Layouts

The TPS61287EVM-042 board is a 4-layer PCB. The top and bottom layers copper thickness are 2-oz. The two inner layers copper thickness are 1-oz. The top view and bottom view are shown in Figure 3-2 and Figure 3-3, respectively. The inner layer 1 and inner layer 2 are shown in Figure 3-4 and Figure 3-5, respectively.

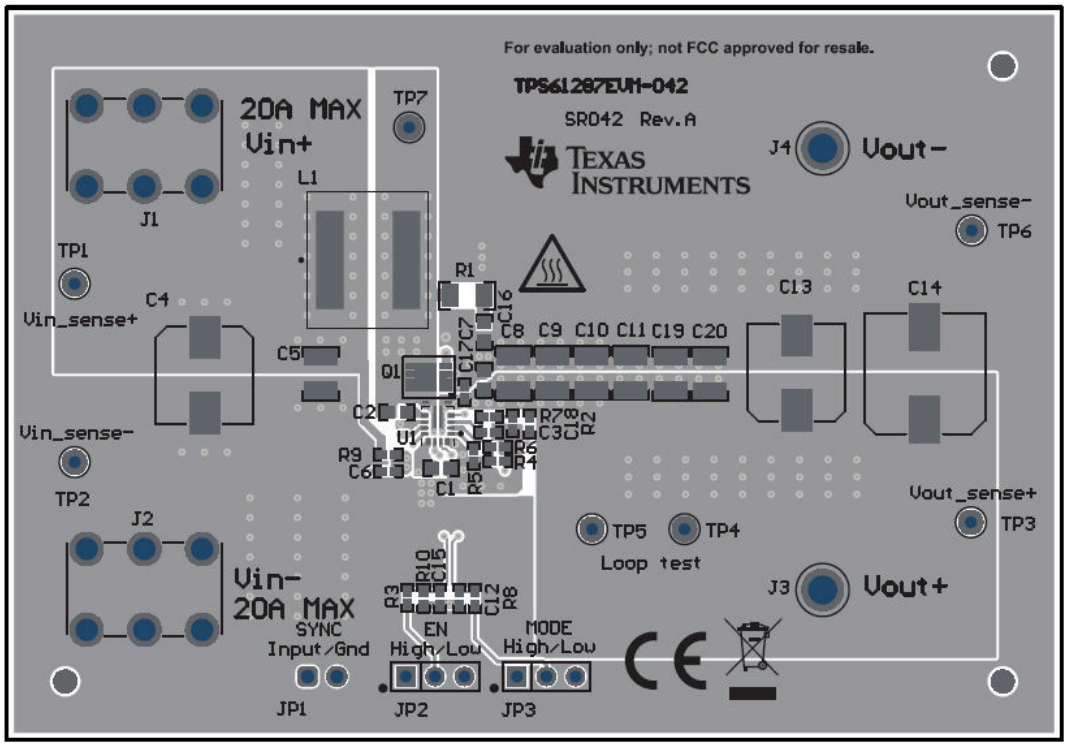

Figure 3-2. TPS61287EVM-042 Top-Side Layout

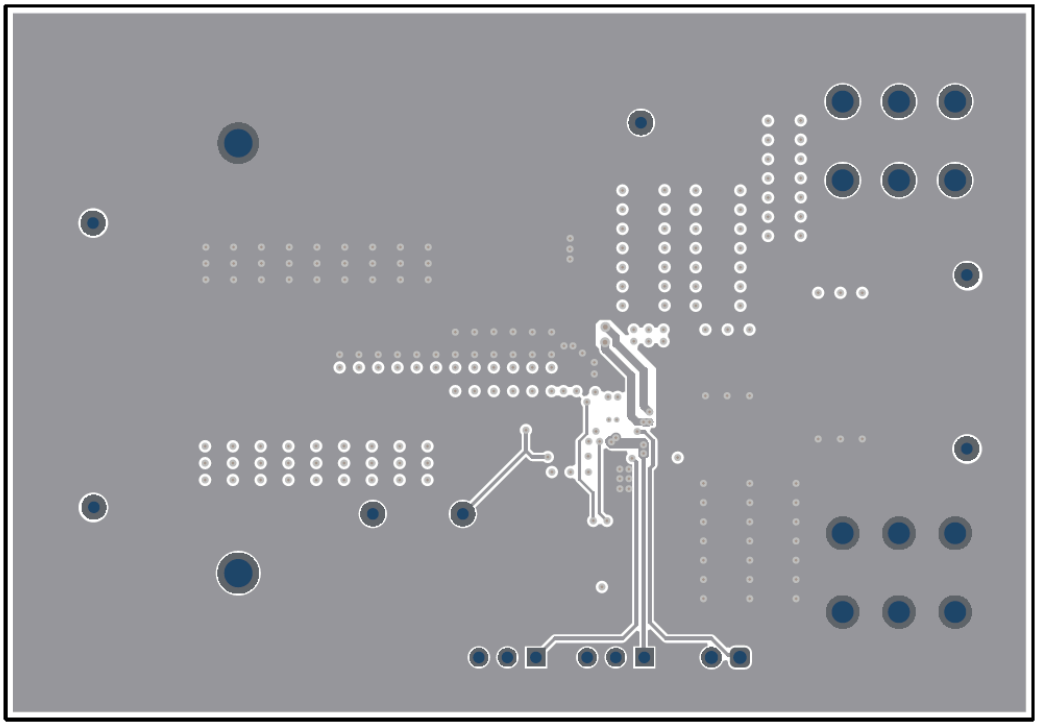

Figure 3-3. TPS61287EVM-042 Bottom-Side Layout

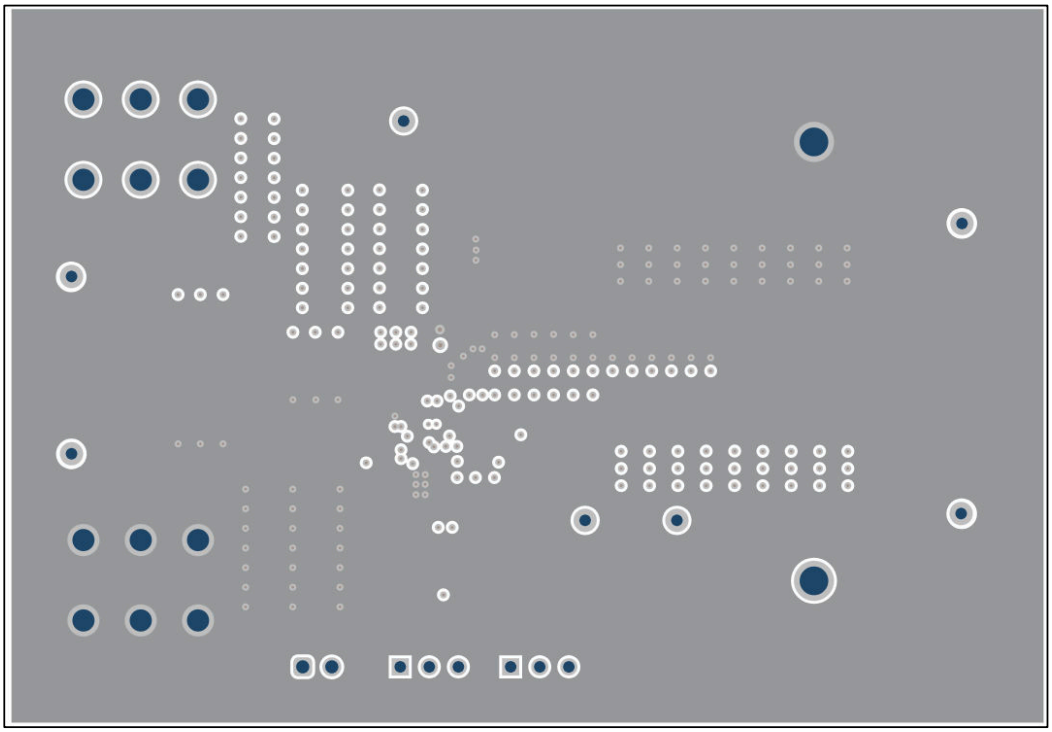

Figure 3-4. TPS61287EVM-042 Inner Layer1 Layout

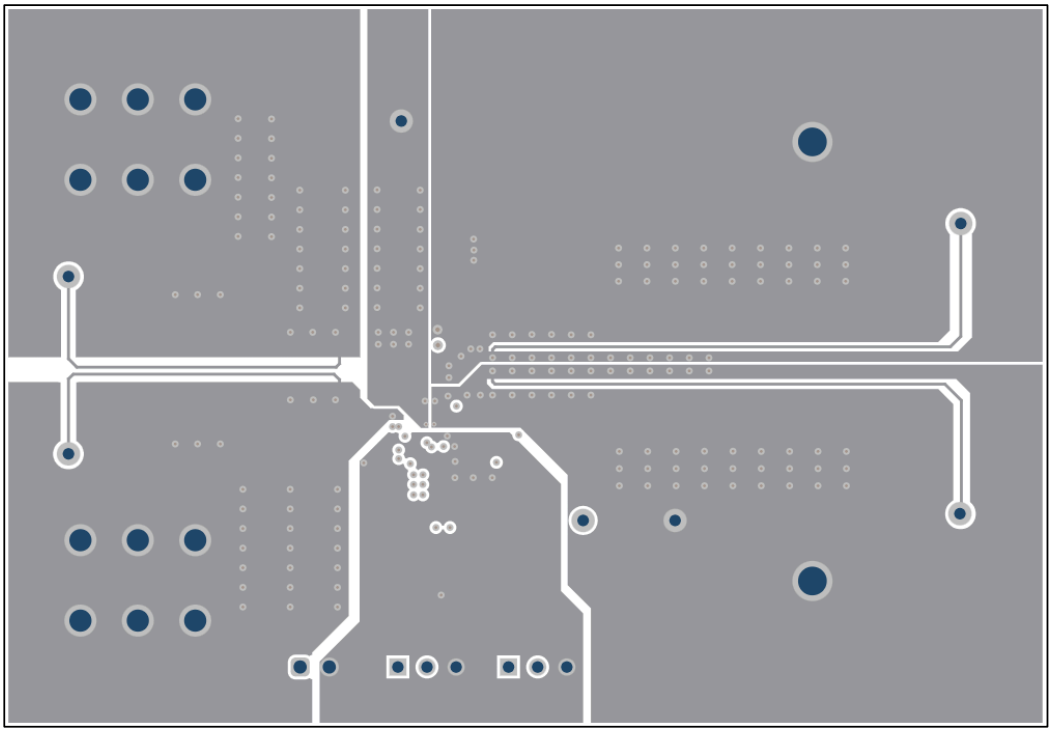

Figure 3-5. TPS61287EVM-042 Inner Layer2 Layout

3.3 Bill of Materials (BOM)

The bill of materials of TPS61287EVM-042 is listed in Table 3-1.

Table 3-1. Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
C1	1	4.7µF	CAP, CERM, 4.7µF, 16V,+/- 10%, X5R, AEC-Q200 Grade 3, 0603	0603	GRT188R61C475KE13D	MuRata
C2	1	0.1µF	CAP, CERM, 0.1µF, 50V, +/- 10%, X7R, 0603	0603	GCM188R71H104KA57D	MuRata
C3	1	10pF	CAP, CERM, 100pF, 50V, +/- 5%, C0G/NP0, 0402	0402	GRM1555C1H101JA01D	MuRata
C4, C13	2	330µF	CAP, AL, 330µF, 25V, +/- 20%, 0.17 ohm, SMD	8x10	UUD1E331MNL1GS	Nichicon
C5, C8, C9, C10, C11, C19, C20	7	22µF	CAP, CERM, 22µF, 25V, +/- 10%, X7R, 1210	1210	GRM32ER71E226KE15L	MuRata
C6, C12, C15, C17	4	0.1µF	CAP, CERM, 0.1µF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H104K050BB	TDK
C7	1	1µF	CAP, CERM, 1µF, 50V,+/- 20%, X5R, AEC-Q200 Grade 3, 0603	0603	GRT188R61H105ME13D	MuRata
C14	1	470µF	CAP, AL, 470µF, 25V, +/- 20%, 0.09 ohm, SMD	10x10	UUD1E471MNL1GS	Nichicon
C18	1	0.022µF	CAP, CERM, 0.022µF, 25V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	GCM155R71E223KA55D	MuRata
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
J1, J2	2		TERMINAL SCREW PC 30AMP, TH	12.9x6.3x7.9mm	8199	Keystone
J3, J4	2		Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
JP1	1		Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Wurth Elektronik
JP2, JP3	2		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
L1	1	3.3µH	Shielded Power Inductors 3.3µH 22A 5.7mOhm	SMT2_10MM0_11MM3	XGL1060-332MEC	Coilcraft
Q1	1	40V	MOSFET, N-CH, 40V, 40A, 8-PG-TSDSON	8-PG-TSDSON	BSZ034N04LSATMA1	Infineon Technologies
R2	1	49.9	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040249R9FKED	Vishay-Dale
R3, R8, R9	3	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R4	1	243k	RES, 243 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402243KFKED	Vishay-Dale
R5	1	20k	RES, 20 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040220K0JNED	Vishay-Dale

Table 3-1. Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
R6	1	14.3k	RES, 14.3 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040214K3FKED	Vishay-Dale
R7	1	49.9k	RES, 49.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF4992X	Panasonic
SH-JP1, SH-JP2, SH-JP3	3		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1, TP2, TP3, TP4, TP5, TP6, TP7	7		Test Point, Miniature, Orange, TH	Orange Miniature Test point	5003	Keystone Electronics
U1	1		25Vout, 20A Isw Synchronous Boost Converter with Stackable Multi-phase function	VQFN-HR14	TPS61287RZP	Texas Instruments
C16	0	4700pF	CAP, CERM, 4700pF, 100V, +/- 10%, X7R, 0603	0603	06031C472KAT2A	AVX
R1	0	2.20	RES, 2.20, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	ERJ-8RQF2R2V	Panasonic
R10	0	10k	RES, 10.0 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1002X	Panasonic

4 Additional Information

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All trademarks are the property of their respective owners.

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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.

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   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.

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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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8. *Limitations on Damages and Liability:*

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   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

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