EVM User's Guide: TPS61299QEVM

TPS61299EVM-016 Evaluation Module

Description

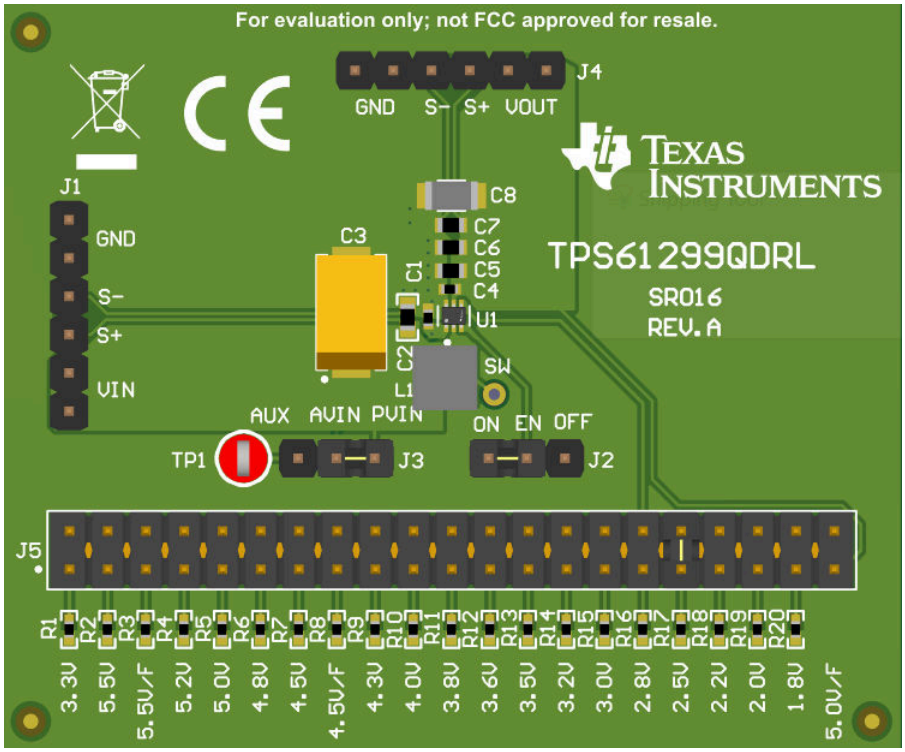
The TPS61299 is a synchronous boost converter with 95nA ultra-low quiescent current, input current limits and fast transient response selection. The device provides a power design for portable equipment with alkaline battery and coin cell battery. The TPS61299 has wide input voltage range from 0.5V to 5.5V and output voltage range from 1.8V to 5.5V. The device has different versions for average input current limit from 5mA to 1.9A. This EVM is designed with 0.7V to 5.5V input voltage and the output voltage can be selected by jumpers, ranging from 1.8V to 5.5V.

Features

- Input voltage range: 0.5V to 5.5V
- 0.7V minimum input voltage for start-up
- Input operating voltage down to 150mV with signal V_{IN} > 0.7V
- Output voltage range: 1.8V to 5.5V VSEL pin select output voltage
- Average input current limit: 1.2A
- 95nA typical quiescent current from VOUT
- 60nA typical shutdown current from VIN and SW
- Up to 91 % efficiency at V_{IN} = 3.6V, V_{OUT} = 5V, and I_{OUT} = 10µA
- Up to 94 % efficiency at V_{IN} = 3.6V, V_{OUT} = 5V, and I_{OUT} = 200mA
- True disconnection at EN low
- Automatic PFM/PWM mode transition
- Auto pass-through at V_{IN} > V_{OUT}
- Output SCP and thermal shutdown protections
- SOT563 package (1.6mm x 1.6mm)

Applications

- Smart watch, smart band
- Portable medical equipment
- TWS



TPS61299-016 EVM

1 Evaluation Module Overview

1.1 Introduction

The TPS61299 is a synchronous boost converter with 95nA ultra-low quiescent current and average input current limit. The device support both WCSP and SOT package; the latter is integrated in this EVM. The output current mainly depends on the input voltage, because the inductor peak current is limited at typical 1.2A. The EVM supports typical 0.8A from a 3.6V input voltage.

This user's guide describes the schematic, layout, bill of materials (BOM), and setup of the evaluation module (EVM) for the TPS61299.

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

1.2 Kit Contents

Table 1-1. Kit List

Designator	Quantity	Description	Material Type	Packaging
PCB1	1	'TPS61299EVM-016; Circuit Board;	EEE	Bag, ESD
BOX1	1	Box, Cardboard	Cardboard	Box
FM1	2	Foam, Antistatic	Plastic	Foam
LBL1	1	Label, Small & Large standard labels	Paper/card stock	Paper
LIT1	1	Literature, EVM Disclaimer Read Me	Paper/card stock	Paper
LIT2	1	Literature, EVM Disclaimer Read Me	Paper/card stock	Paper

1.3 Specification

Table 1-2 provides the summary of the TPS61299EVM performance specifications. All the specifications are given for an ambient temperature of 25°C.

Table 1-2. Performance Specification

Parameter	Test Condition	Value	Unit
Input voltage		0.7-5.5	V
Output voltage		1.8-5.5	V
Typical average input current limit		1.2	A

1.4 Device Information

The TPS61299 is a synchronous step-up converter and operates in a hysteretic control scheme. The TPS61299 has a wide input voltage supply range between 0.5V and 5.5V (0.7V rising voltage for start-up). The TPS61299 only consumes 95nA quiescent current and can achieve up high efficiency under light load condition. The TPS61299 family provide wide input current limit from 5mA to 1.9A and support optional true shutdown function or force pass through function at EN is low. TPS61299 provides a fast transient performance mode and accurate load regulation mode for different system.

2 Hardware

2.1 Power Requirements

The TPS61299 has a built-in under-voltage lockout (UVLO) circuit to make sure the device working properly. When the input voltage is above the UVLO rising threshold of 0.7V, the TPS61299 can be enabled to boost the output voltage. After the TPS61299 starts up and the output voltage is above 1.8V, the TPS61299 can work with the input voltage as low as 0.5V.

2.2 Setup

Jumper	Description
J1-VIN	Input voltage positive connection.
J1-GND	Input voltage negative connection.
J1-S+	Input voltage positive sensing node for measuring efficiency.
J1-S-	Input voltage negative sensing node for measuring efficiency.
J2	EN pin input jumper. Place a jumper across EN and ON to turn on the IC. Place a jumper across EN and OFF to turn off the IC. Output voltage return connection.
J3	AVIN selector. Place a jumper across AVIN and PVIN to share the same power input and signal input. Place a jumper across AVIN and AUX to separate the signal input and power input.
J4-VOUT	Output voltage positive connection.
J4-GND	Output voltage negative connection.
J4-S+	Output voltage positive sensing node for measuring efficiency.
J4-S-	Output voltage negative sensing node for measuring efficiency.
TP1	Auxiliary signal input.
SW	Test point to measure SW pin waveform.

3 Hardware Design Files

3.1 Schematic

Figure 3-1 shows the schematic of the TPS61299EVM-016. Use a jumper cap on J5 to connect different resistors for different output voltages (refer to Figure 3-2 for more details). The tantalum capacitor, C3, is used to stabilize the input voltage for the TPS61299, in case the cable between the power supply and the EVM is too long. In most applications, the tantalum capacitor is unnecessary. The definition of the connectors is explained as follows:

- PIN 1 and PIN 2 of J1 are used for the ground of the input power supply.
- PIN 5 and PIN 6 of J1 are used for the positive input of the power supply.
- PIN 3 and PIN 4 of J1 are used to sense the input voltage closed to the IC (see the PCB; Section 3.2).
- PIN 1 and PIN 2 of J4 are used for the negative input of the load.
- PIN 5 and PIN 6 of J4 are used for the positive input of the load.
- PIN 3 and PIN 4 of J4 are used to measure the output voltage closed to the IC (see the PCB; Section 3.2).
- JP2 is used to enable or disable the IC through the EN pin.
- JP3 is used to connect AVIN to the input rail or external aux input.
- JP5 is used to select different output voltage with a jumper cap.

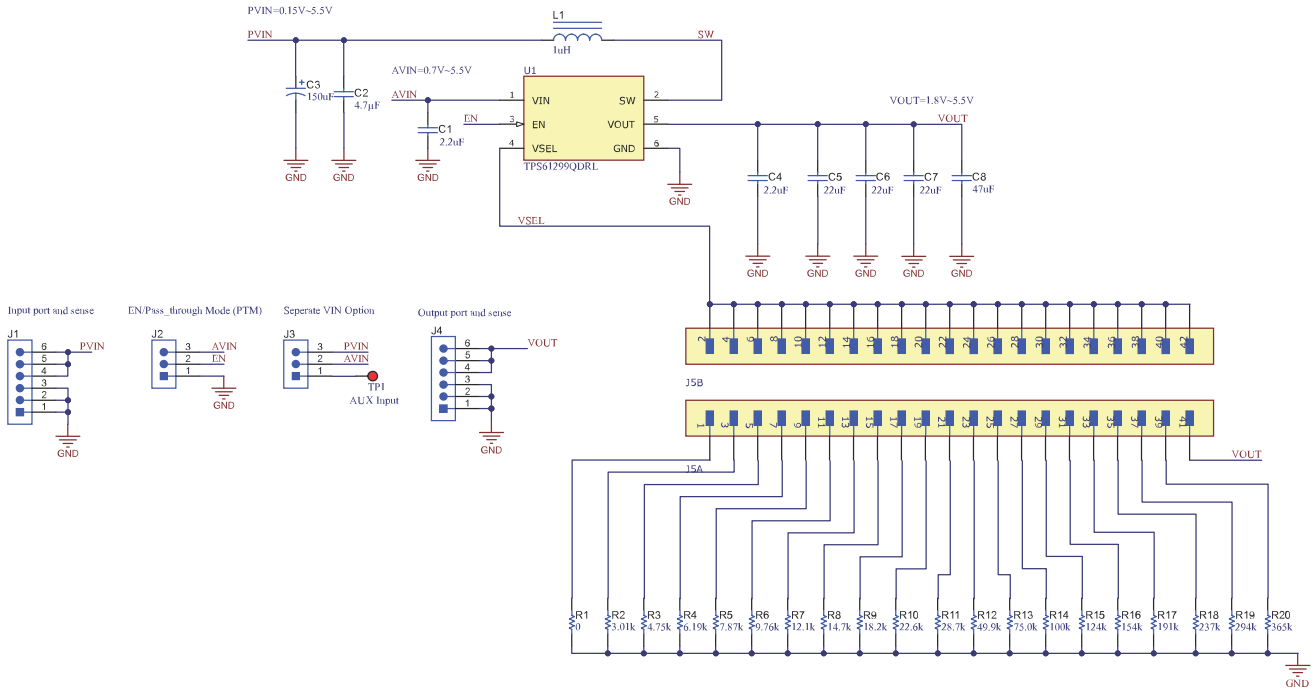


Figure 3-1. TPS61299EVM-016 Schematic

3.2 PCB Layout

The TPS61299EVM-016 is built with a two-layer PCB. The thickness of each layout is 1 oz. All the components are placed on the top layer, as shown in Figure 3-2.

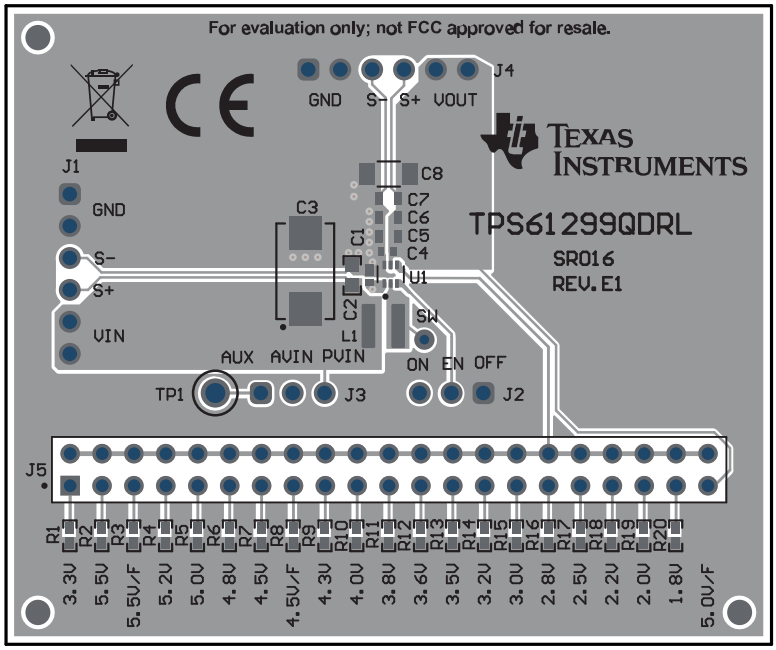


Figure 3-2. Top Layer of TPS61299EVM-016

The bottom layer is the ground panel, as shown in Figure 3-3.

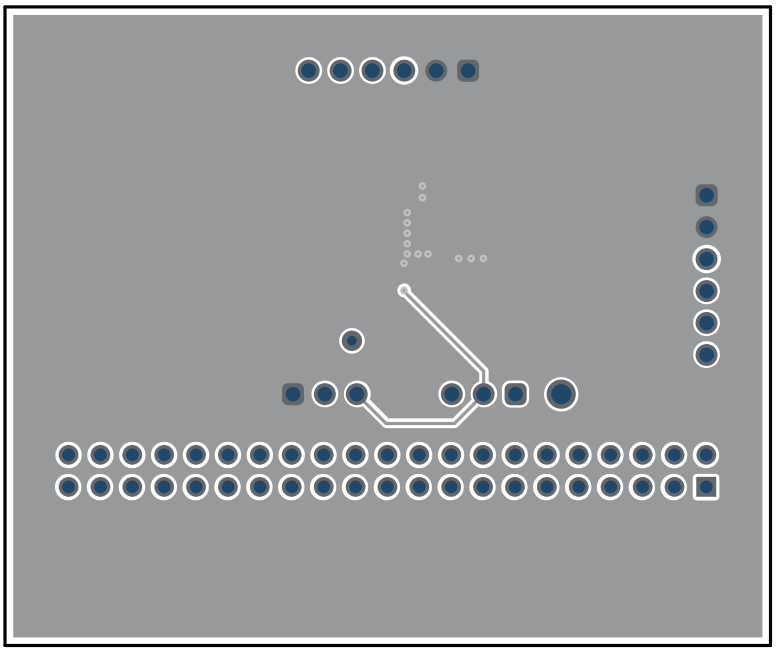


Figure 3-3. Bottom Layer of TPS61299EVM-016

3.3 Bill of Materials

Table 3-1 lists the TPS61299EVM-016 BOM.

Table 3-1. Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
!PCB	1		Printed Circuit Board		SR016	Any
C1, C4	2	2.2uF	CAP, CERM, 2.2uF, 10V, +/- 20%, X5R, 0402	0402	GRM155R61A225ME95	MuRata
C2	1	4.7uF	CAP, CERM, 4.7uF, 10V, +/- 20%, X7R, 0603	0603	GRM188Z71A475ME15D	MuRata
C3	1	150uF	CAP, TA, 150uF, 10V, +/- 10%, 0.1 ohm, SMD	7343-31	T495D157K010ATE100	Kemet
C5, C6	2	22uF	CAP, CERM, 22uF, 10V, +/- 20%, X5R, 0603	0603	GRM187R61A226ME15D	MuRata
J1, J4	2		Header, 2.54mm, 6x1, Gold, TH	Header, 2.54mm, 6x1, TH	61300611121	Wurth Elektronik
J2, J3	2		Header, 2.54mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	61300311121	Wurth Elektronik
J5	1		Connector Header Through Hole 42 position 0.100" (2.54mm)	HDR42	TSW-121-23-L-D	Samtec
L1	1	1uH	Inductor, Shielded, Composite, 1uH, 9A, 0.0133 ohm, AEC-Q200 Grade 1, SMD	0603	XEL4020-102MEB	Coilcraft
R1	1	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R2	1	3.01k	RES, 3.01 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04023K01FKED	Vishay-Dale
R3	1	4.75k	RES, 4.75 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K75FKED	Vishay-Dale
R4	1	6.19k	RES, 6.19 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04026K19FKED	Vishay-Dale
R5	1	7.87k	RES, 7.87 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04027K87FKED	Vishay-Dale
R6	1	9.76k	RES, 9.76 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04029K76FKED	Vishay-Dale
R7	1	12.1k	RES, 12.1 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040212K1FKED	Vishay-Dale
R8	1	14.7k	RES, 14.7 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040214K7FKED	Vishay-Dale
R9	1	18.2k	RES, 18.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040218K2FKED	Vishay-Dale
R10	1	22.6k	RES, 22.6 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040222K6FKED	Vishay-Dale
R11	1	28.7k	RES, 28.7 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040228K7FKED	Vishay-Dale

Table 3-1. Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
R12	1	49.9k	RES, 49.9 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040249K9FKED	Vishay-Dale
R13	1	75.0k	RES, 75.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040275K0FKED	Vishay-Dale
R14	1	100k	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100KFKED	Vishay-Dale
R15	1	124k	RES, 124 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402124KFKED	Vishay-Dale
R16	1	154k	RES, 154 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402154KFKED	Vishay-Dale
R17	1	191k	RES, 191 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402191KFKED	Vishay-Dale
R18	1	237k	RES, 237 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402237KFKED	Vishay-Dale
R19	1	294k	RES, 294 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402294KFKED	Vishay-Dale
R20	1	365k	RES, 365 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402365KFKED	Vishay-Dale
SH-JP1, SH-JP2, SH-JP3	3		Single Operation 2.54mm Pitch Open Top Jumper Socket	Single Operation 2.54mm Pitch Open Top Jumper Socket	M7582-05	Harwin
TP1	1		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone Electronics
U1	1		Synchronous Boost Converter with Ultra-Low Quiescent Current 0.7-5.5V Output Voltage: 1.8-5.5V Adjustable	SOT563	TPS61299DRL	Texas Instruments

4 Additional Information

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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.

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