TPS65131EVM User's Guide

This user's guide describes the characteristics, operation, and use of the TPS65131 evaluation module (EVM). It includes the EVM specifications, the recommended setup, the schematic diagram, the board layouts, and the bill of materials (BOM).

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Trademarks

1 Introduction

The TPS65131 EVM uses a TPS65131 multichannel output IC to provide both a positive and negative power rail. The goal of the EVM is to make performance evaluation of the TPS65131 easier.

1.1 Modifications

To demonstrate the small size of this power solution, the EVM is designed with components having 0402 footprints where possible, and small inductors. Changing components can improve or degrade EVM performance. For example, using inductors with larger dc resistance reduces efficiency of the solution. Resistors R10 and R11 are for test purposes only. They can be replaced by a 51.1- to 100-Ω resistor and used to measure the loop gain with a loop-gain analyzer. They are not required in a real application.

1.2 Performance Specification Summary

All specifications are given for an ambient temperature of 25°C. Although the EVM operates with input voltages over the 2.7-V to 5.5-V recommended operating input voltage range of the TPS65131 IC, the power supply designs on the EVM were optimized for an input voltage of 3.3 V ±10%.

Table 1. Typical Performance Specification Summary

	Condition	Voltage Range (V)			Current Range (mA)		
		MIN	TYP	MAX	MIN	TYP	MAX
VIN		3	3.3	3.6			5000
VPOS	V_I = 3.3 V	11.6	12	12.4			400
VNEG	V_I = 3.3 V	–12.4	–12	–11.6			200

2 Schematic

Figure 1 illustrates the EVM schematic.

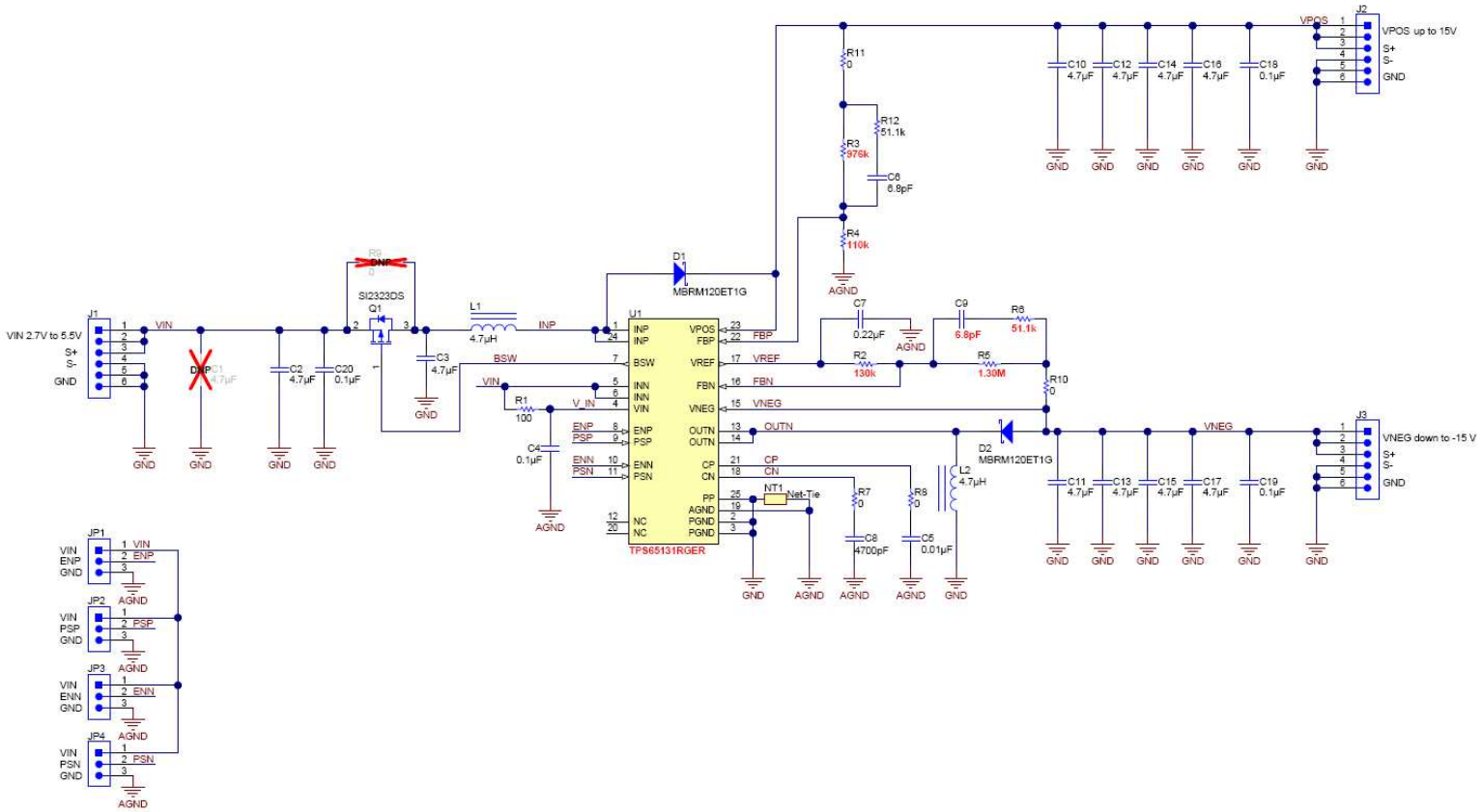

Figure 1. TPA65131EVM Schematic

3 Connectors and Jumpers

Table 2 and Table 3 give an overview of the connector and jumper connections of the EVM.

Table 2. Connector Overview

Connector		Signal	Pin	Description	Remarks
J1	Input Supply	VIN	1, 2	Input Supply	Connect a 2.7- to 5.5-V dc power supply to J1. To minimize parasitic inductance, use a short (< 20 cm) cable and twist the conductors.
J2	Input Supply Sense	S+	1	Input Supply Sense	
J3	Ground	GND	1, 2	Ground	This is the return connection to the input power supply.
J4	Positive Output	VPOS	1, 2	Positive Output	A load can be connected between the positive output and ground or between the positive and negative outputs.
J5	Positive Output Sense	S+	1	Positive Output Sense	
J6	Ground	GND	1, 2	Ground	This is the return connection for the load on the positive converter of the device.
J7	Negative Output	VNEG	1, 2	Negative Output	A load can be connected between the negative output and ground or between the positive and negative outputs.
J8	Negative Output Sense	S–	1	Negative Output Sense	
J9	Ground	GND	1, 2	Ground	This is the return connection for the load on the negative converter of the device.

Table 3. Jumper Overview

Jumper		Signal	Pin	Description	Remarks
JP1	Positive Converter Enable or Disable	VIN ENP GND	1 2 3	Input Supply Positive Converter Enable Ground	Connect a jumper between pins 1 and 2 to enable the positive converter, or between pins 2 and 3 to disable it.
JP2	Positive Converter Power-save Mode Enable or Disable	VIN PSP GND	1 2 3	Input Supply Positive Converter Power-save Mode Enable Ground	Connect a jumper between pins 1 and 2 to enable the positive converter power-save mode, or between pins 2 and 3 to disable it.
JP3	Negative Converter Enable or Disable	VIN ENN GND	1 2 3	Input Supply Negative Converter Enable Ground	Connect a jumper between pins 1 and 2 to enable the positive output, or between pins 2 and 3 to disable it.
JP1	Negative Converter Power-save Mode Enable or Disable	VIN PSN GND	1 2 2	Input Supply Negative Converter Power-save Mode Enable Ground	Connect a jumper between pins 1 and 2 to enable the negative converter power-save mode, or between pins 2 and 3 to disable it.

4 Test Setup

Connect a power supply set between 2.7 V and 5.5 V output voltage with a current limit set to at least 3 A. Short pins 1−2 on jumpers JP1 and JP3 to enable both rails.

5 Efficiency Test Results

Figure 2 and Figure 3 show the efficiency results using this EVM:

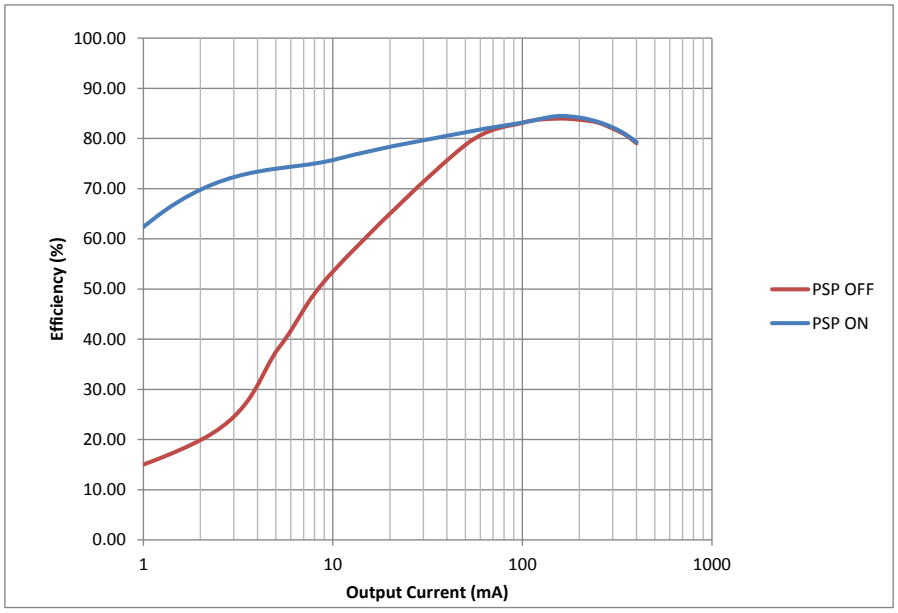

Figure 2. TPS65131 VPOS Efficiency

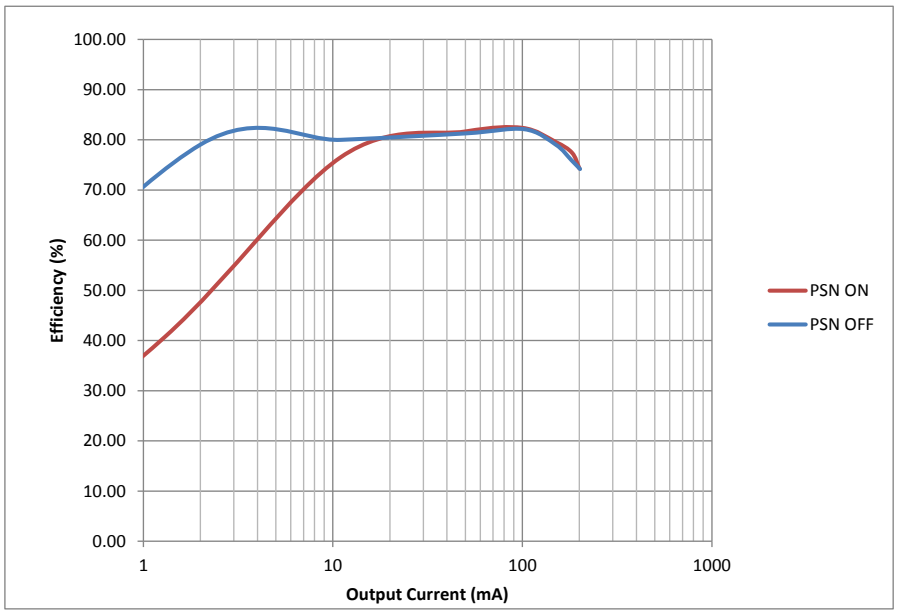

Figure 3. TPS65131 VNEG Efficiency

6 PCB Layout

Figure 4 through Figure 8 show the design of the TPS65131 EVM printed-circuit-board (PCB). The EVM has been designed using a four-layer, 35-µm (1 oz), copper-clad circuit board. All components are on the top side, and all signal traces on the top and bottom layers allow the user to easily view, probe, and evaluate the TPS65131 IC. Moving components to both sides of the PCB offers additional size reduction for space-constrained systems.

The switching nodes with high-frequency noise are isolated from the noise-sensitive feedback circuitry, and careful attention has been given to the routing of high-frequency current loops. See *TPS6513x Positive and Negative Output DC-DC Converter* for more specific layout guidelines.

To ensure that the IC provides its maximum designed output power, it is highly recommended that users follow the EVM board layout when laying out their boards, especially the separate analog and power ground paths and the small footprint, closely-spaced feedback components.

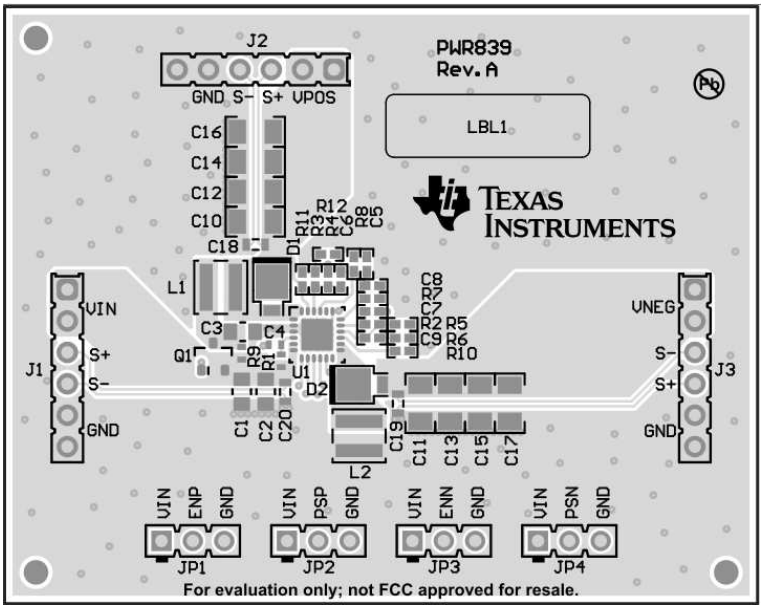

Figure 4. Top Assembly Layer

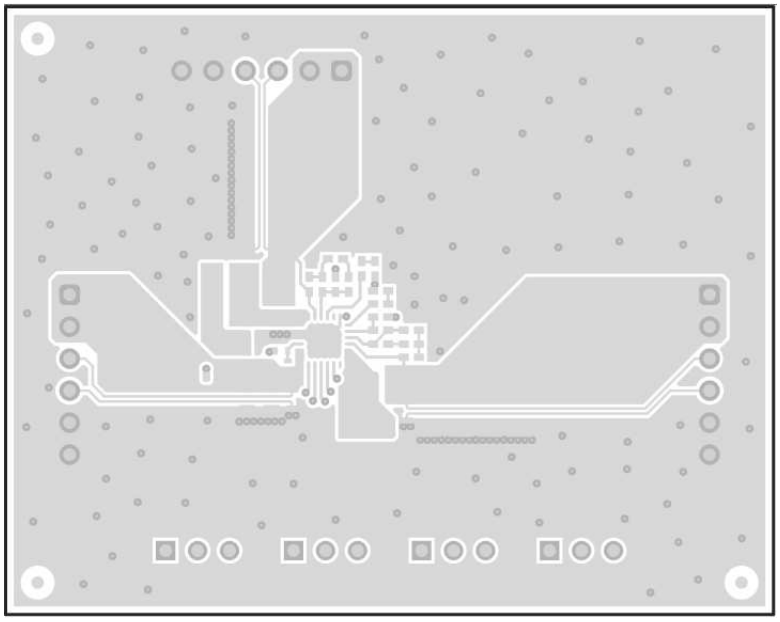

Figure 5. Top Layer

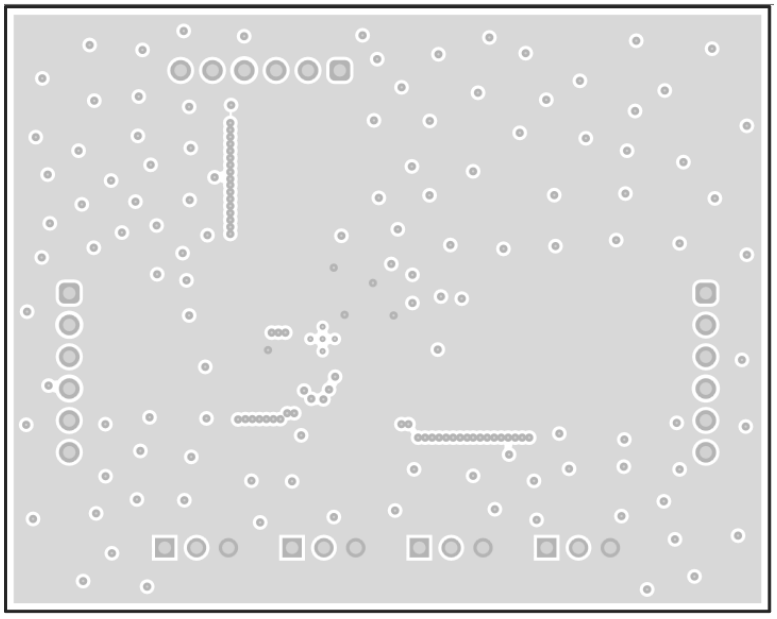

Figure 6. Inner Layer 1

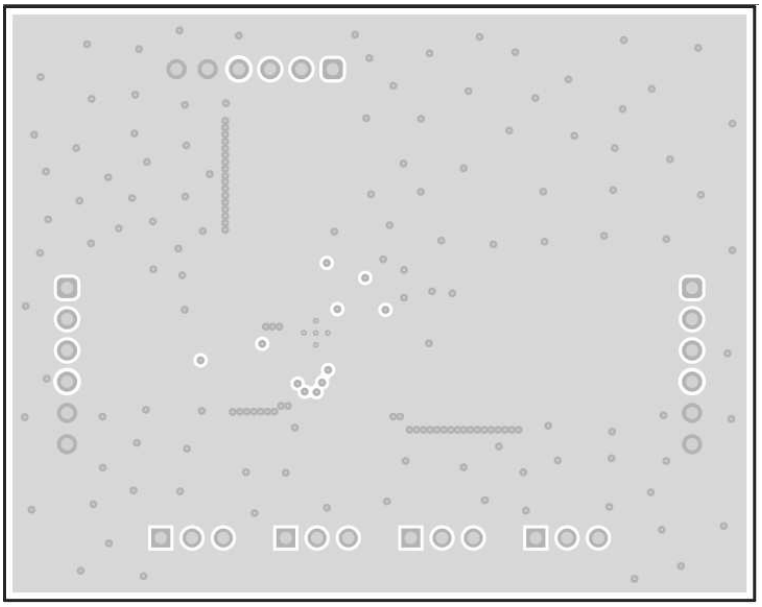

Figure 7. Inner Layer 2

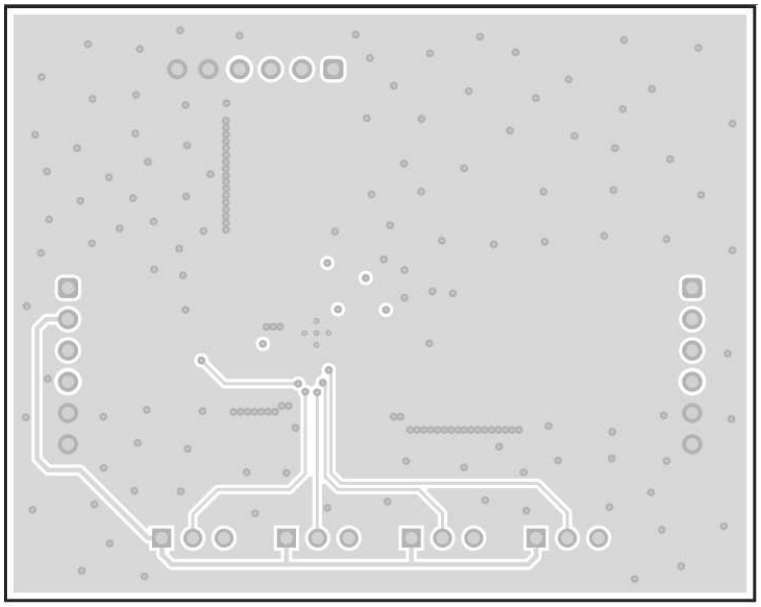

Figure 8. Bottom Layer

7 List of Materials

Table 4 details the EVM BOM.

Table 4. TPS65131EVM-839 Bill of Materials

Count	REFDES	Value	Description	Size	Part Number	MFR
0	C1	Open	Capacitor, Ceramic, 6.3V, X5R, 10%	0805		
8	C10 - C17	4.7uF	Capacitor, Ceramic, 25V, X7R, 10%	1206	C3216X7R1E475K085AB	TDK
2	C2, C3	4.7uF	Capacitor, Ceramic, 10V, X7R, 10%	0805	GRM21BR71A475KA73L	Murata
1	C4	0.1uF	Capacitor, 16V, X7R, 10%	0402	GCM155R71C104KA55D	Murata
1	C5	0.01uF	Capacitor, 16V, X7R, 10%	0402	C1005X7R1C103K050BA	TDK
1	C8	0.0047uF	Capacitor, 50V, X7R, 5%	0402	CGA2B2X7R1H472K050BA	TDK
1	C6	6.8pF	Capacitor, 50V, C0G, 5%	0402	GRM1555C1H6R8CA01D	Murata
1	C7	0.22uF	Capacitor, 10V, X7R, 10%	0402	GRM155R71A224KE01D	Murata
1	C9	12pF	Capacitor, 50V, C0G, 5%	0402	C0402C120J3GACAUTO	Kemet
2	D1, D2		Diode, Schottky, 1A, 20V	457-04	MBRM120ET1G	On Semi
9	J1 - J9		Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 x 2	TSW-102-07-G-S	Samtec
4	JP1 - JP4		Header, 3 pin, 100mil spacing, (36-pin strip)	0.100 x 3	TSW-103-07-G-S	Samtec
2	L1, L2	4.7uH	Inductor, SMT, 4.5A, 40.1milliohms	0.150 X 0.150	XAL4030-472MEB	Coilcraft
1	Q1		MOSFET,P-ch, -12 V, 4 A, 51 milliOhm	SOT23	Si2323DS	Vishay
1	R1	100	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R2	130k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R3	976k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R4	110k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R5	1.3M	Resistor, Chip, 1/16W, 1%	0402	Std	Std
2	R6, R12	51.1k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
4	R7, R8, R10, R11	0	Resistor, Chip, 1/16W, 5%	0402	Std	Std
0	R9	Open	Resistor, Chip, 1/16W, 1%	0402		
1	U1		IC, Positive and Negative Output DC-DC Converter	QFN24	TPS65131RGER	TI
4	--		Shunt, 100 mil, Black	0.100	SPC02SYAN	Sullins

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Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than . The EVM is designed to operate properly with certain components above as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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      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

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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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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:*

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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.

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