User's Guide

TPS62120 Buck Converter Evaluation Module User's Guide

ABSTRACT

This user's guide describes the characteristics, operation, and use of the TPS62120 evaluation module (EVM). The TPS62120EVM-640 is a fully assembled and tested circuit for evaluating the performance of the TPS62120 high-input voltage step-down converter. This document includes schematic diagrams, a printed circuit board (PCB) layout, bill of materials, and test data. Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the TPS62120EVM-640 unless otherwise noted.

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Trademarks

1 Introduction

The TPS62120 is a high-efficiency, synchronous step-down, dc-dc converter optimized for low-power applications. The wide operating input voltage range of 2 V to 15 V supports energy harvesting and battery-powered as well 9-V or 12-V line-powered applications.

The TPS62120EVM-640 is a fully assembled and tested platform for evaluating the operation and performance of the TPS62120 converter. The TPS62120EVM-640 has an input voltage range from 2.0 V up to 15 V, and the output voltage is adjustable with an external feedback divider network in the range of 1.2 V to 5.5 V. The maximum output current of the EVM circuit is 75 mA.

1.1 Features

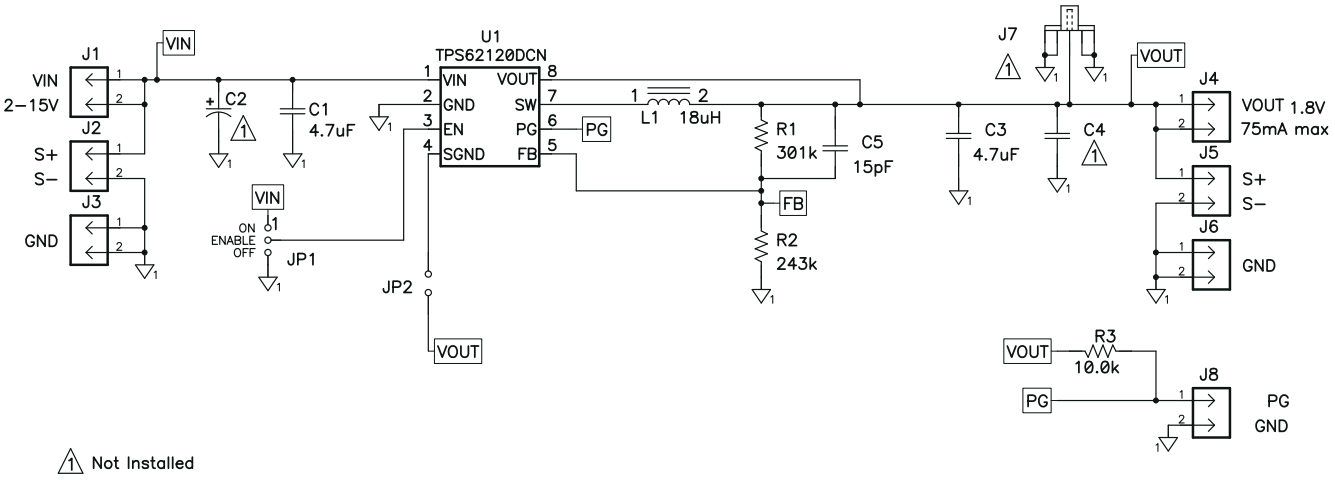
- High input voltage range: 2.0 V up to 15 V
- Adjustable output voltage: 1.2 V up to 5.5 V
- Up to 75-mA output current
- Up to 800-kHz switching frequency

1.2 Applications

- Ultralow-power microcontroller supply
- Energy harvesting
- Industrial measurement

2 TPS62120EVM Schematic

TPS62120EVM Schematic illustrates the TPS62120EVM-640 schematic.



For reference only; see Table 7-1 for specific values.

Figure 2-1. TPS62120EVM Schematic

3 Connector and Test Point Descriptions

3.1 Enable Jumpers/Switches (RefDes) TPS62120

3.1.1 J1 VIN

This header is the positive connection to the input power supply. The power supply must be connected between J1 and J3 (GND). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 2.0 V and 15.0 V.

3.1.2 J2 S+/S–

J2 S+/S– are the sense connection for the input of the converter. Connect a voltmeter, sense connection of a power supply, or oscilloscope to this header.

3.1.3 J3 GND

This header is the return connection to the input power supply. Connect the power supply between J3 and J11 (VIN). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 2.0 V and 15.0 V.

3.1.4 J4 VOUT

This header is the positive output of the step-down converter. The output voltage of the TPS62120 is adjustable, with the feedback resistors R1 and R2. On the EVM, the output voltage can be adjusted in the range of 1.2 V to 5.5 V.

Note: A feed-forward capacitor is required. Refer to the TPS62120 data sheet (SLVSAD5) for detailed information.

3.1.5 J5 S+/S–

J5 S+/S– are the sense connection for the output of the converter. Connect a voltmeter, sense connection of an electronic load, or oscilloscope to this header.

3.1.6 J6 GND

J6 is the return connection of the converter. A load can be connected between J4and J6 (VOUT). The converter is able to support a load current of up to 75 mA.

3.1.7 JP1 EN

This jumper enables/disables the TPS62120 on the EVM. The shorting jumper JP1 between the center pin and ON turns on the unit. Shorting the jumper between the center pin and OFF turns the unit off.

3.1.8 JP2 SGND

JP2 connects the output capacitor of the TPS62120 to the open drain output SGND. SGND is low when the TPS62120 is in shutdown mode, thus discharging the output capacitor. If the TPS62120 is enabled, the open drain output SGND is high impedance.

3.1.9 J7 VOUT (SMA)

The J7 SMA connector is connected to the output voltage of the TPS62120. The noise spectrum of the output voltage can be easily analyzed with a spectrum analyzer.

By default, J7 is not assembled on the EVM.

3.1.10 J8 PG/GND

J8 pin 1 is connected to the Power Good (PG) output of the TPS62120. This open drain output is pulled up to VOUT with R3. PG output goes high when the FB voltage rises above 95% (typ) of its nominal value. PG goes low when the FB voltage drops below 90% (typ) of its nominal value.

4 Test Configuration

4.1 Hardware Setup

Figure 4-1 illustrates a typical hardware test configuration.

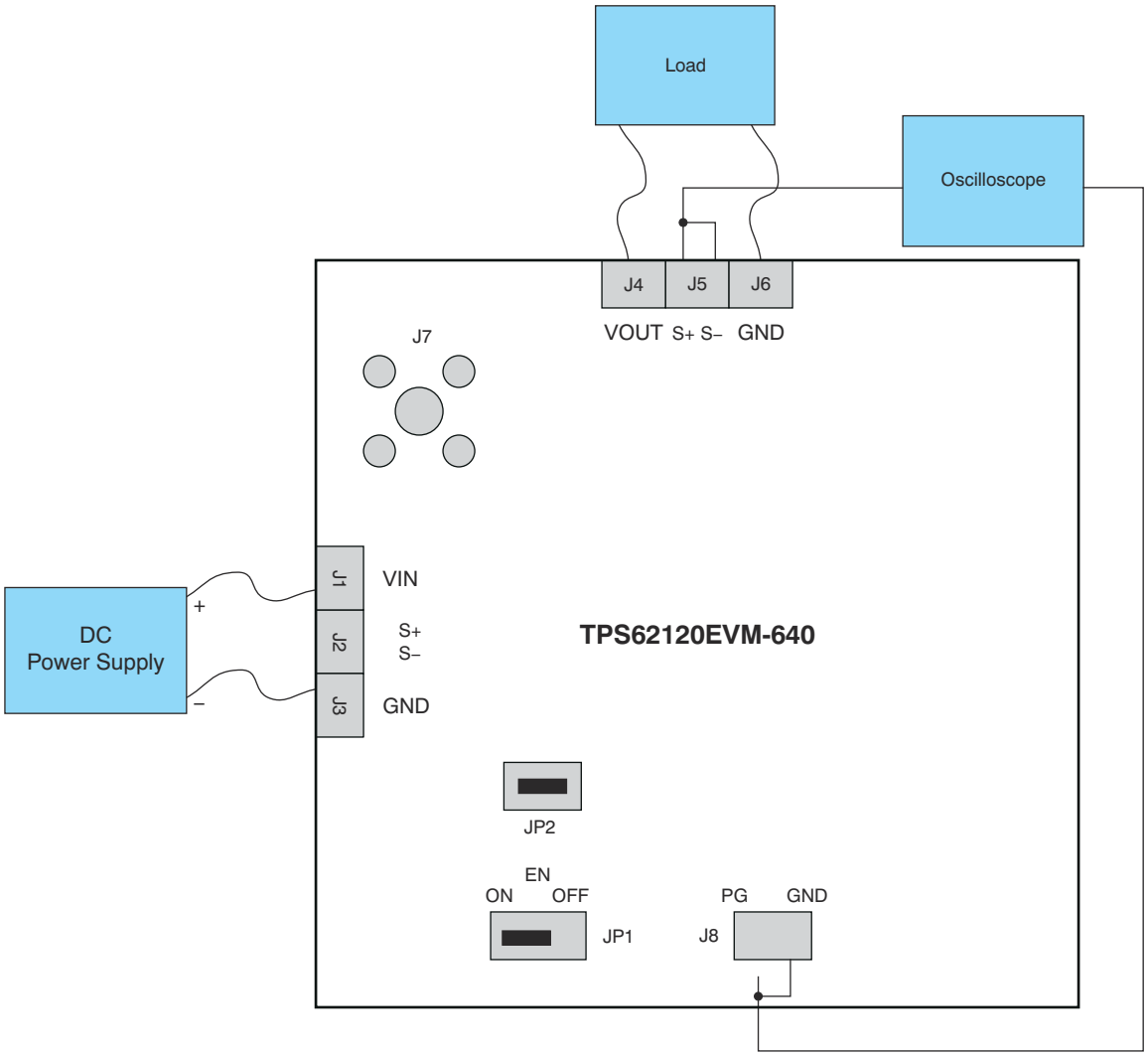


Figure 4-1. Hardware Board Connection

4.2 Procedure

Follow these procedures when configuring the EVM for testing.

CAUTION

Many of the components on the TPS62120EVM-640 are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap, bootstraps, or mats at an approved ESD workstation. An electrostatic smock and safety glasses should also be worn.

1. Work at an ESD workstation. Make sure that any wrist straps, bootstraps, or mats are connected and reference the user to earth ground before power is applied to the EVM. Electrostatic smock and safety glasses should also be worn.
2. Connect a dc power supply between J1 and J3 on the TPS62120EVM. Note that the input voltage should range from 2.0 V to 15 V. Keep the wires from the input power supply to EVM as short as possible and twisted.
3. Connect a dc voltmeter or oscilloscope to the output sense connection (J5) of the EVM.
4. A load of up to 75 mA can be connected between J4 and J6 on the TPS62120EVM.
5. To enable the converter, connect the shorting bar on JP1 between EN and ON on the TPS62120EVM.

5 TPS62120EVM Test Data

Figure 5-1 through Figure 5-9 present typical performance graphs for the TPS62120EVM. Actual performance data can be affected by measurement techniques and environmental variables; therefore, these curves are presented for reference and may differ from actual results obtained by some users.

5.1 Efficiency

Figure 5-1 shows the typical efficiency performance for the TPS62120EVM.

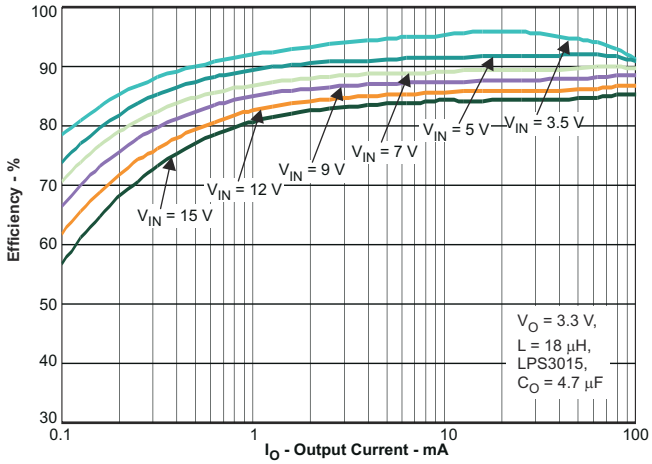


Figure 5-1. TPS62120EVM Efficiency versus Load Current

5.2 Start-Up

Figure 5-2 through Figure 5-5 show the typical start-up performance for different TPS62120EVM boards.

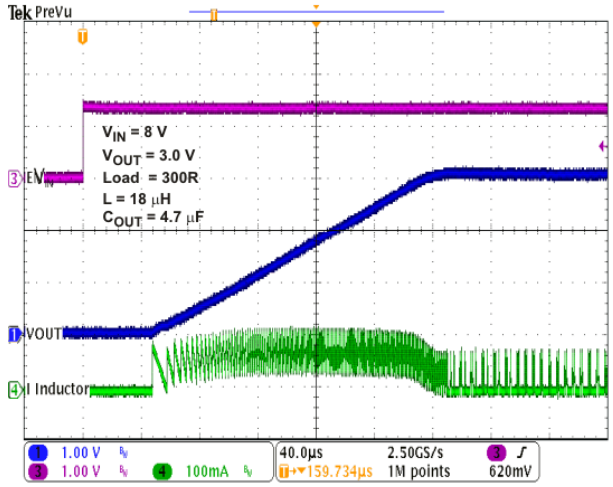


Figure 5-2. TPS62120EVM Startup into 300-Ω Load(V_{IN} = 8.0 V, V_{OUT} = 3.0 V)

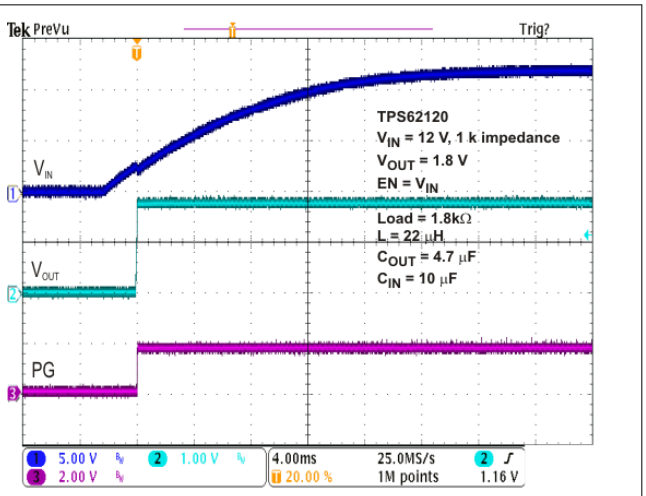


Figure 5-3. TPS62120EVM Start-Up from a High-Impedance Source(V_{IN} = 12.0 V, V_{OUT} = 3.0 V)

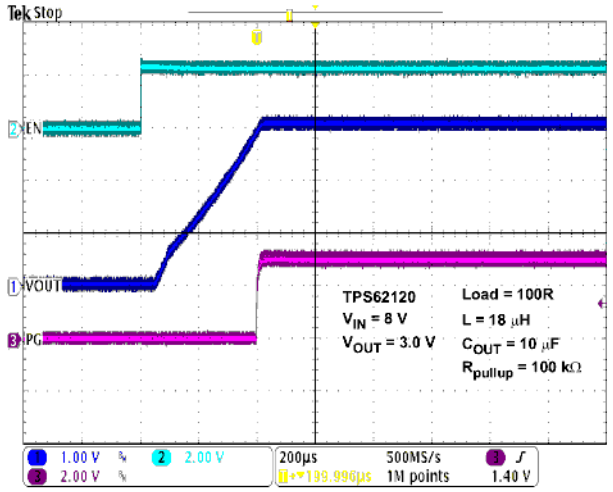


Figure 5-4. Power Good Output During Start-Up

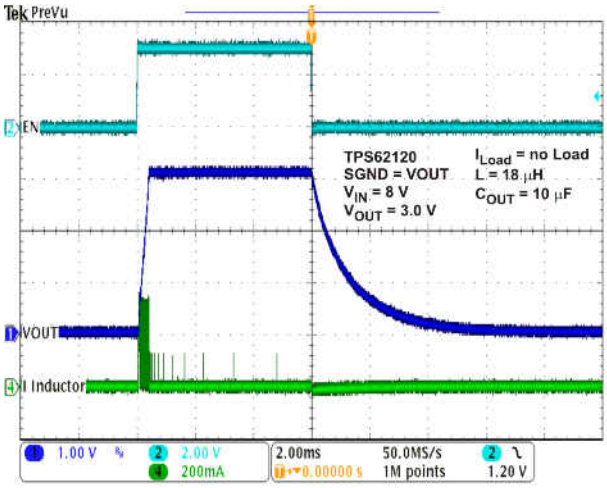


Figure 5-5. Output Discharge with SGND Pin Connected to VOUT

5.3 Load Transient Response

Figure 5-6 illustrates the load transient response for the TPS62120.

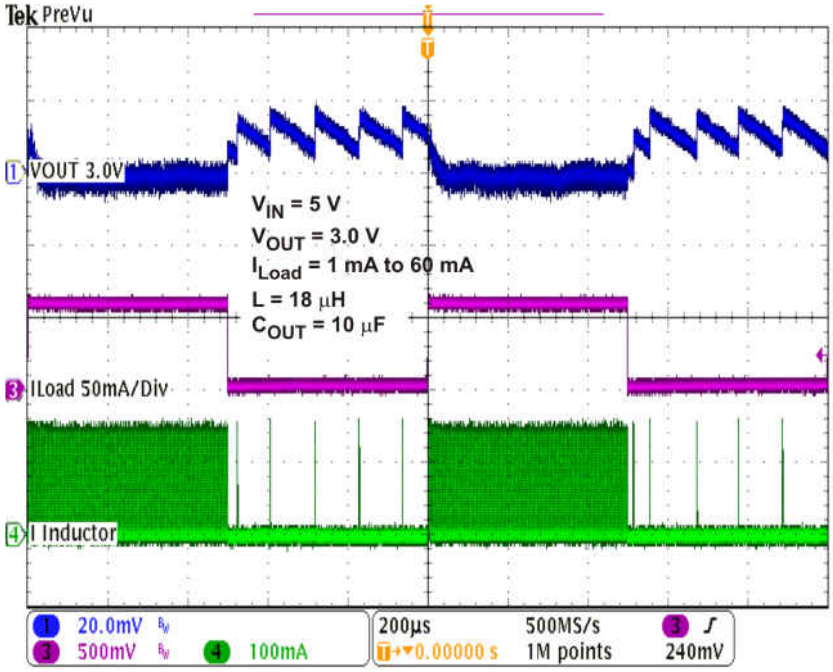


Figure 5-6. TPS62120 Load Transient Response(V_{IN} = 8.0 V, V_{OUT} = 1.8 V)

5.4 Typical Operation, 60 mA

Figure 5-7 illustrates the typical output voltage ripple for the TPS62120 with a 60-mA load.

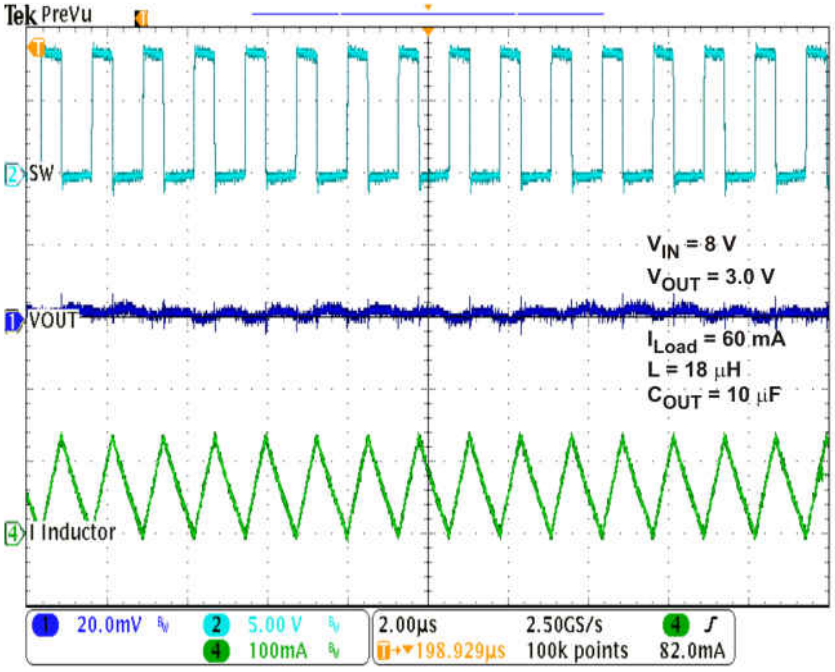


Figure 5-7. TPS62120EVM Output Ripple, 60-mA Load(V_{IN} = 8.0 V, V_{OUT} = 3.0 V)

5.5 Typical Operation, 10 mA

Figure 5-8 illustrates the typical output voltage ripple for the TPS62120 with a 10-mA load.

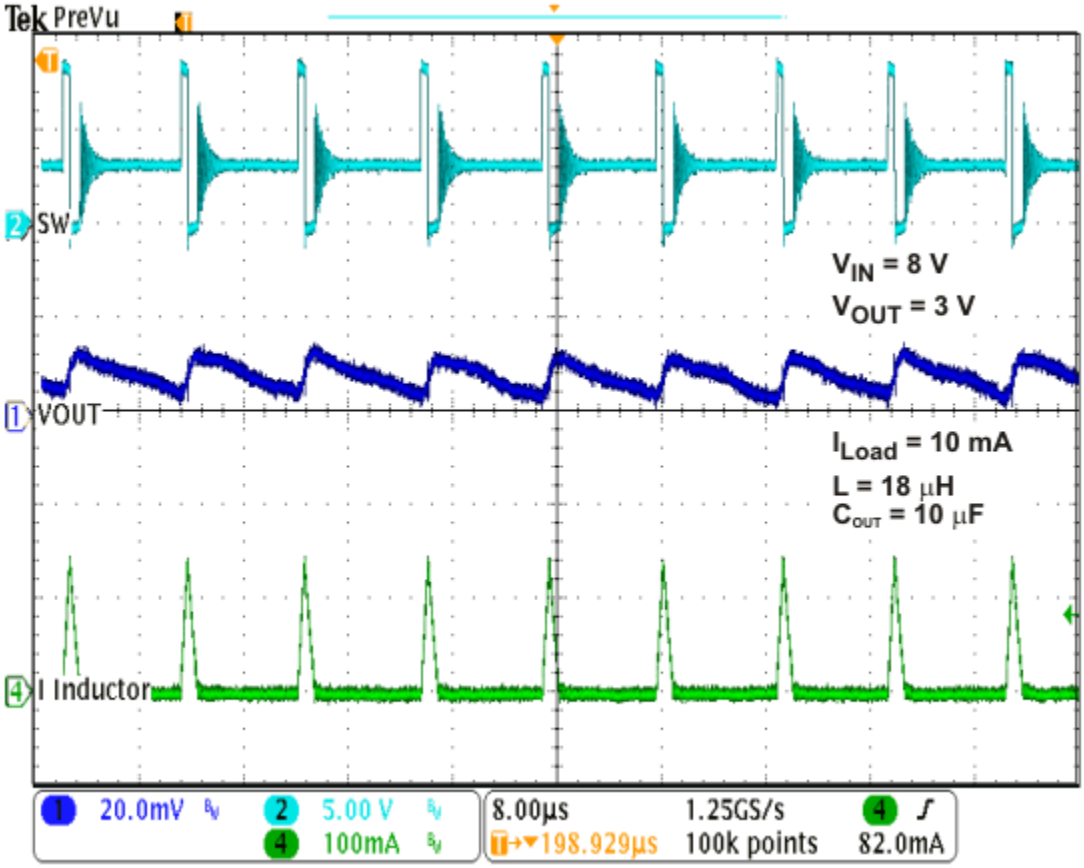


Figure 5-8. TPS62120EVM Output Ripple, 10-mA Load(V_{IN} = 8.0 V, V_{OUT} = 3.0 V)

5.6 Current Limit Operation

Figure 5-9 shows the current limit operation of the TPS62120.

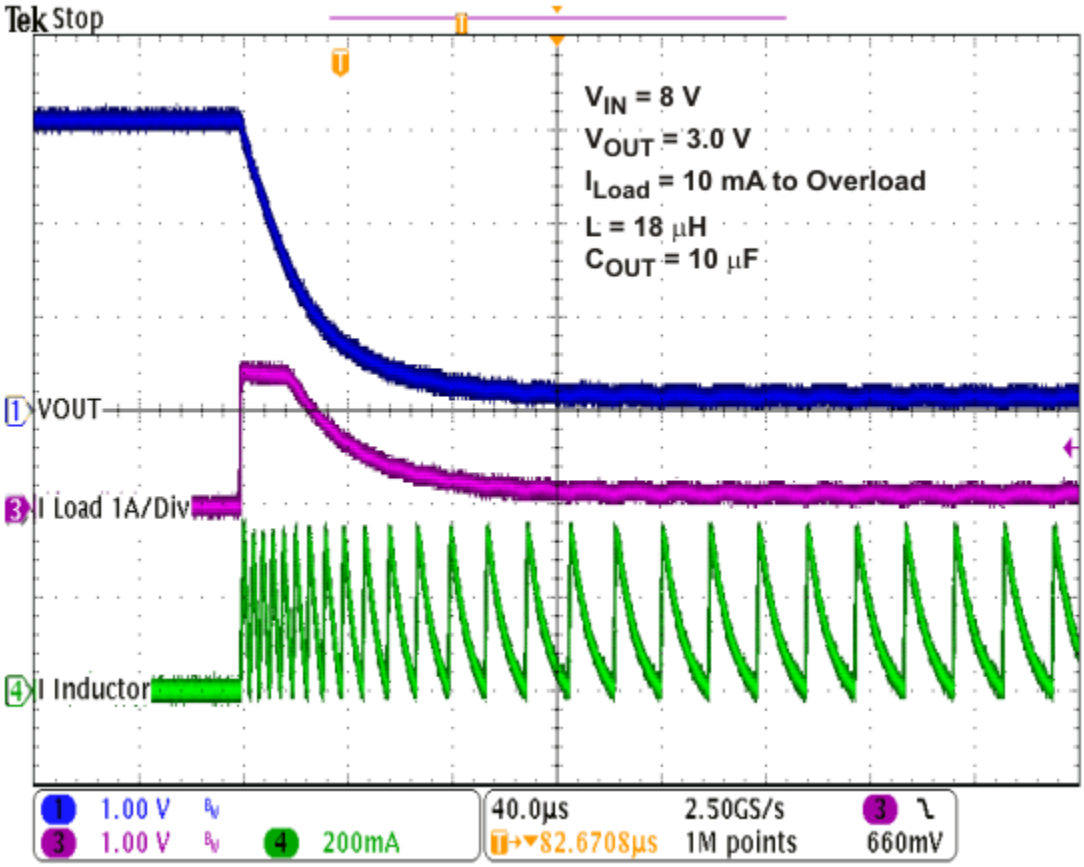


Figure 5-9. Current Limit Operation

6 TPS62120EVM Assembly Drawings and Layout

Figure 6-1 through Figure 6-3 show the design of the show the design of the TPS62120EVM-640 printed circuit board. The EVM has been designed using a four-layer, 1-ounce copper-clad PCB.

Note

Board layouts are not to scale. These figures are intended to show how the board is laid out; they are not intended to be used for manufacturing TPS62120EVM-640 PCBs.

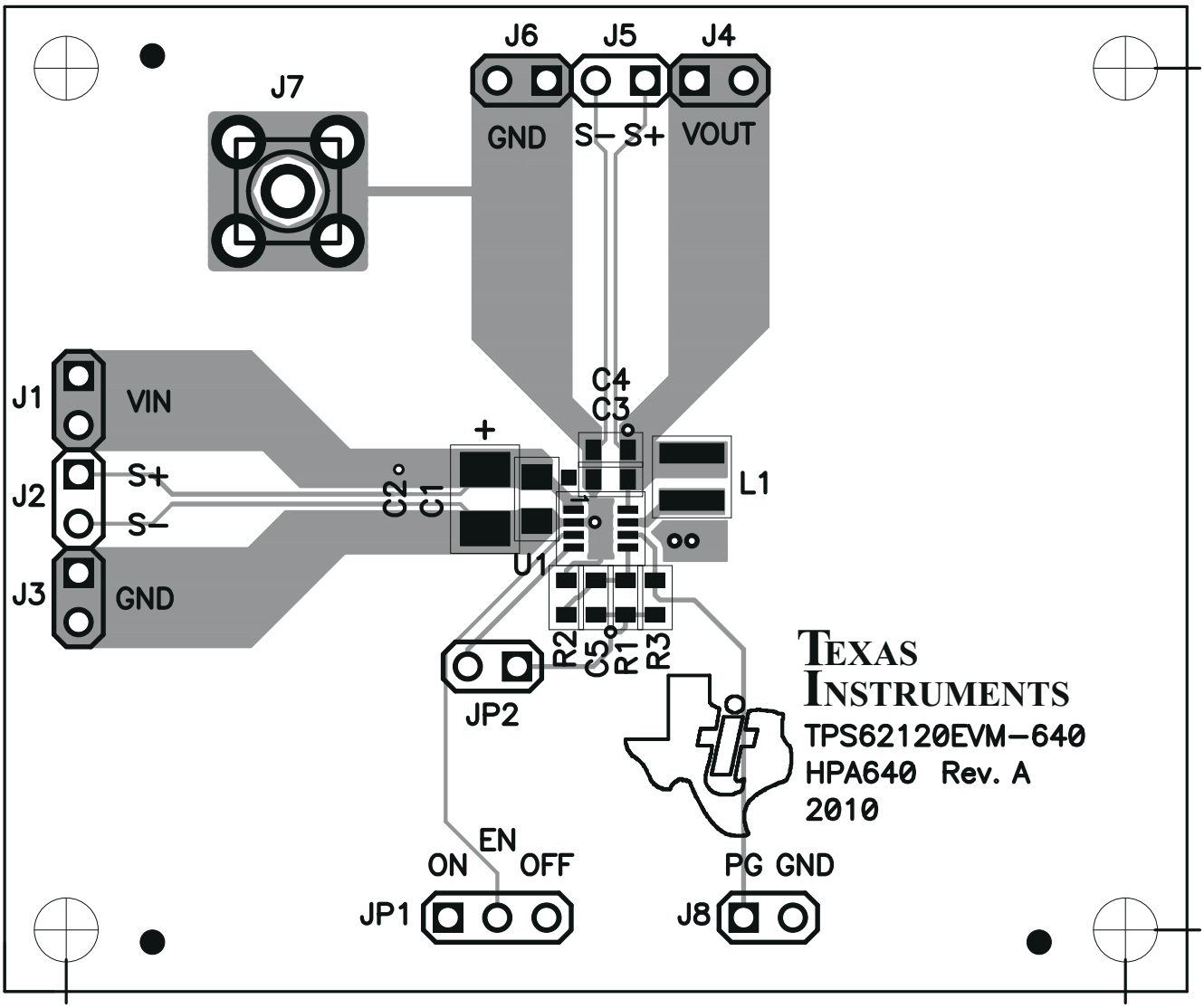


Figure 6-1. TPS62120EVM Component Placement (Top View)

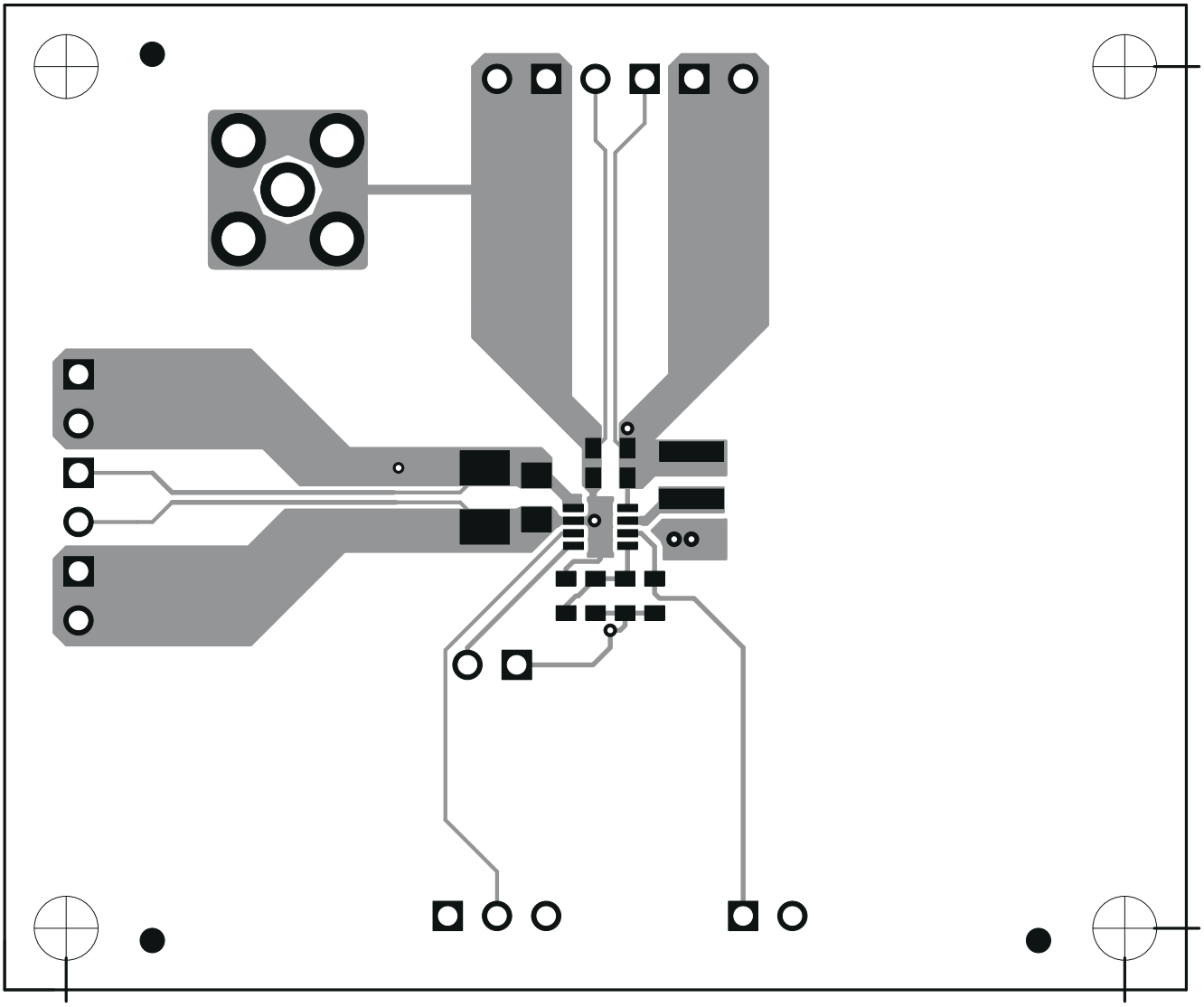


Figure 6-2. TPS62120EVM Top-Side Copper (Top View)

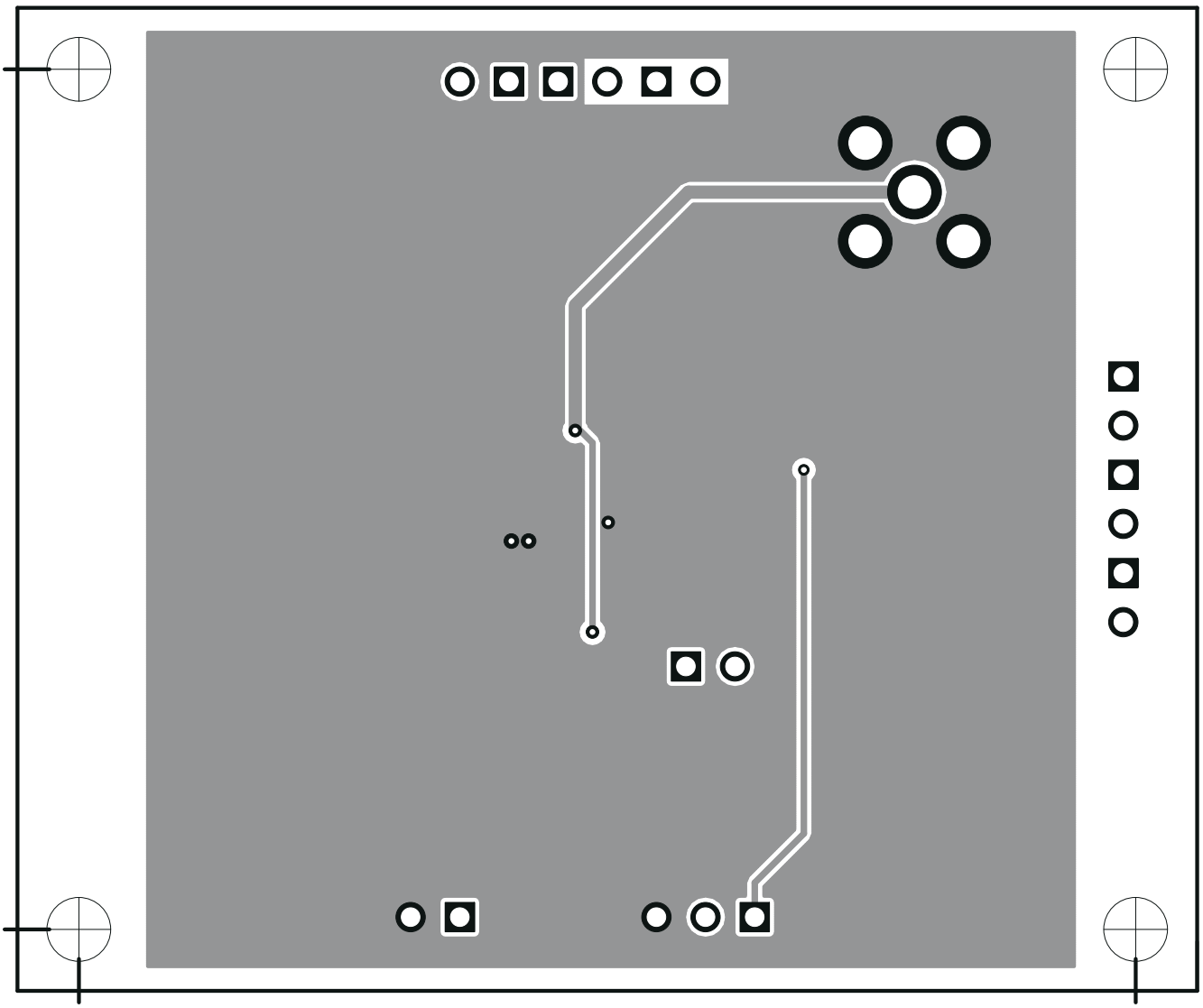


Figure 6-3. TPS62120EVM Bottom-Side Copper (Bottom View)

7 Bill of Materials

Table 7-1 lists the bill of materials for the TPS62120EVM.

Table 7-1. TPS62120EVM-640 Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C1	4.7 µF	Capacitor, Ceramic, 25 V, X5R, 20%	0805	GRM21BR61E475MA12L	muRata
1	C3	4.7 µF	Capacitor, Ceramic, Low Inductance, 6.3 V, X5R, 20%	0603	GRM188R60J475ME19D	muRata
1	C5	15 pF	Capacitor, Ceramic, 50 V, C0G-NP0, 5%	0603	Std	Std
1	L1	18 µH	Inductor, SMT, 0.56 A, 750 mΩ	0.118 x 0.118 inch	LPS3015-183ML	Coilcraft
1	R1	301k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R2	243k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R3	10.0 kΩ	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	U1	TPS62120DRV	IC, 15-V, 75-mA High-Efficiency Buck Converter with Snooze Mode	SSOP	TPS62120DCN	TI

8 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (September 2010) to Revision A (June 2021) **Page**

- Updated the numbering format for tables, figures, and cross-references throughout the document. 2
- Updated user's guide title..... 2

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1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   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

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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。
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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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。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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:*

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