Using the UCC3817EVM

User's Guide

Literature Number: SLUU077D
September 2000–Revised November 2014

WARNING

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and the safety of those working around you. Contact TI's Product Information Center http://support/ti./com for further information.

Save all warnings and instructions for future reference.

Failure to follow warnings and instructions may result in personal injury, property damage, or death due to electrical shock and/or burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise, and knowledge of electrical safety risks in development and application of high-voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments. If you are not suitably qualified, you should immediately stop from further use of the HV EVM.

1. **Work Area Safety:**
   (a) Keep work area clean and orderly.
   (b) Qualified observer(s) must be present anytime circuits are energized.
   (c) Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
   (d) All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50 V_{RMS}/75 VDC must be electrically located within a protected Emergency Power Off (EPO) protected power strip.
   (e) Use a stable and non-conductive work surface.
   (f) Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
2. **Electrical Safety:**
   (a) De-energize the TI HV EVM and all its inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   (b) With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   (c) Once EVM readiness is complete, energize the EVM as intended.

   WARNING: while the EVM is energized, never touch the EVM or its electrical circuits as they could be at high voltages capable of causing electrical shock hazard.
3. **Personal Safety:**
   (a) Wear personal protective equipment e.g. latex gloves and/or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.
4. **Limitation for Safe Use:**
   (a) EVMs are not to be used as all or part of a production unit.

UCC3817EVM BiCMOS Power Factor Preregulator Evaluation Board

1 Introduction

This user's guide details the Texas Instruments (TI) UCC3817EVM BiCMOS Power Factor Preregulator Evaluation Module (EVM). It includes a list of EVM features, a brief description of the module illustrated with pictorial, schematic diagram and an EVM specification.

The UCC3817EVM evaluation board is designed to illustrate the performance of the controller in a 250-W boost converter with Power Factor Correction (PFC). The board is designed to handle a universal input operating voltage range (85 V_{AC} to 265 V_{AC}) with a regulated 385-V DC output.

CAUTION

Proper precautions must be taken when working with the board.

- High voltage levels are present on the evaluation board whenever it is energized.
- The output capacitor has high levels of energy storage and it must be discharged before the load is removed.
- Improper handling of the evaluation board could cause serious injury.
- It is important to maintain the ambient temperature around the evaluation board to below 40°C during operation.

Description

The UCCx817 provides all the functions necessary for active power-factor-corrected preregulators. The controller achieves near-unity power factor by shaping the AC input-line current waveform to correspond to that of the ac input-line voltage. Average current-mode control maintains stable, low-distortion, sinusoidal line current.

The controller's operation is similar to previously designed Unitrode preregulators with an added feature to reduce the RMS-current in the boost capacitor. The controller uses leading-edge modulation that, when synchronized properly with a downstream DC-to-DC converter, reduces the RMS current in the boost capacitor.

1.1 Features

- Designed for Compliance with IEC 1000-3-2 (Low Total Harmonic Distortion)
- Worldwide Line Operation 85 V_{RMS} to 265 V_{RMS}
- Regulated 385-V, 250-W(max), DC Output
- Accurate Power Limiting
- Accurate Overvoltage Protection

Schematic

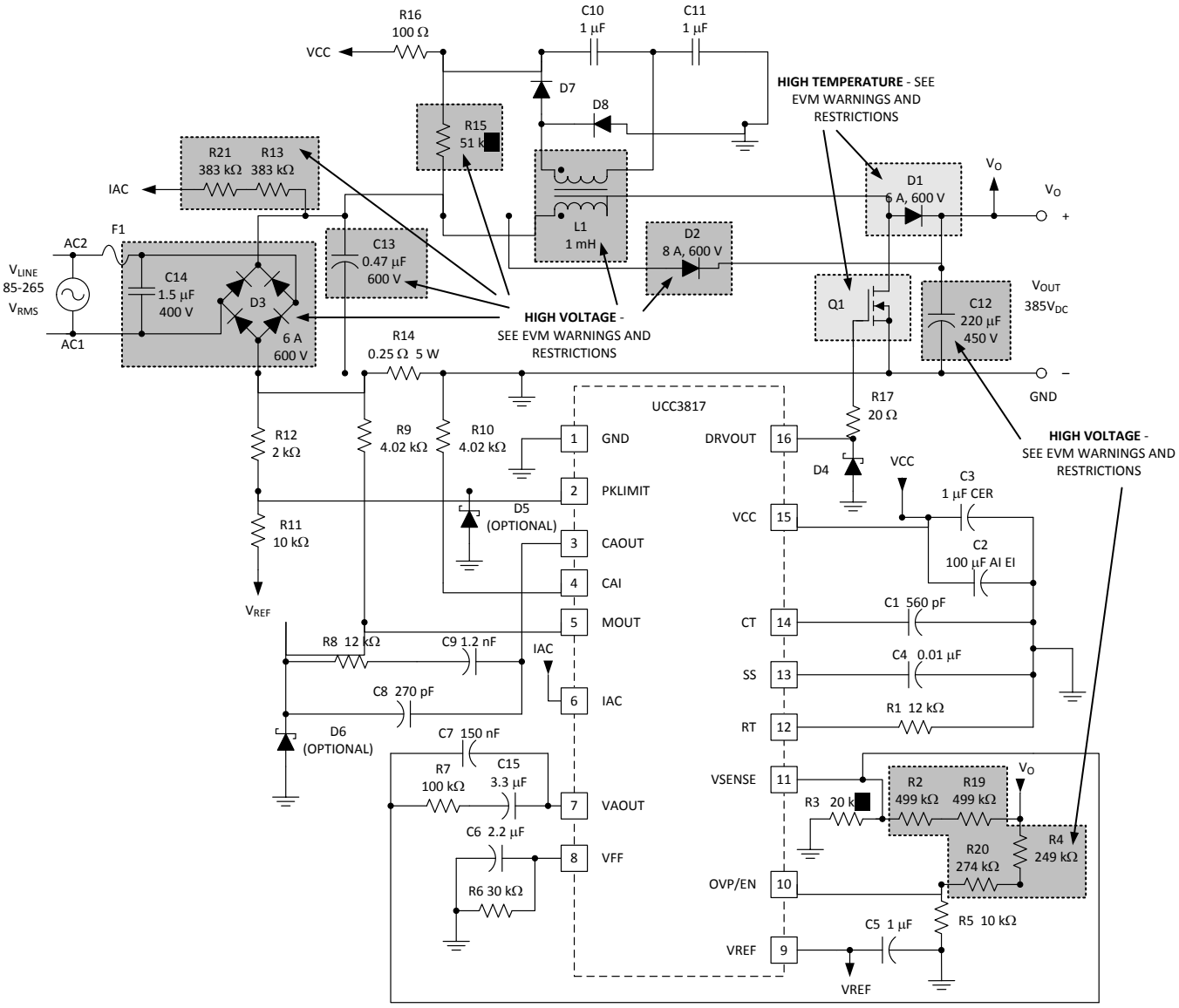

Figure 1. UCC3817EVM Schematic

NOTE: High-voltage component. See EVM Warnings and Restrictions at the back of this document.

High-temperature component. See EVM Warnings and Restrictions at the back of this document.

Operating Guidelines

The operating guidelines for the evaluation board are provided with reference to the schematic in Figure 1.

NOTE: In order for the output voltage to regulate, a load of 10 W must be applied to the evaluation board's output. In order to maintain power factor near unity, the voltage loop is designed with a slow frequency response. Large transient steps in output current can cause the evaluation module to go out of regulation.

Step 1, Load Connections

A resistive or electronic load should be applied to the output connections of V_O and GND.

NOTE: For safety reasons the load should be connected before power is supplied to the evaluation board.

Step 2, Applying Input Power

A 50-Hz or 60-Hz AC power source not exceeding 265 V_{RMS} and providing an isolated output needs be applied across terminals AC1 and AC2 for proper operation. If an isolated AC output is unavailable, or if the EVM will be evaluated with the AC wall outlet as power source, then an isolation line transformer MUST be inserted between the AC source/wall outlet and the AC input connector of the EVM.

Step 3, Measuring the Evaluation Board's Performance

With the AC source set between 85 V_{RMS} and 265 V_{RMS}, the output voltage should be regulated and the input current should track the input-voltage shape with near-unity power factor. The operation of the circuit is verified over the line and load range and shows efficiency in the 90% to 95% range. At lighter loads, there may be some distortion in the line current due to DCM operation. Please refer to Figure 3 and Figure 4 for typical evaluation board performance.

Evaluation Board Layouts

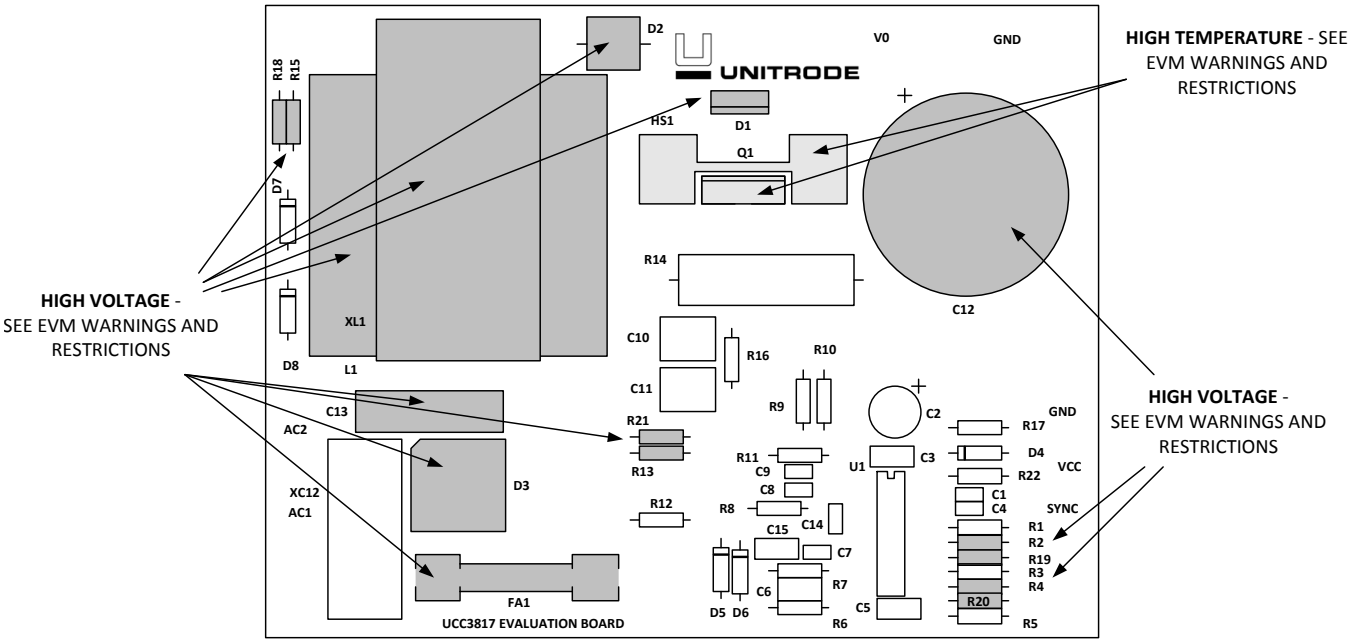

Figure 2. UCC3817EVM Evaluation Board Layout Assembly

NOTE: High-Voltage component. See EVM Warnings and Restrictions at the back of this document.

High-Temperature component. See EVM Warnings and Restrictions at the back of this document.

Typical Performance

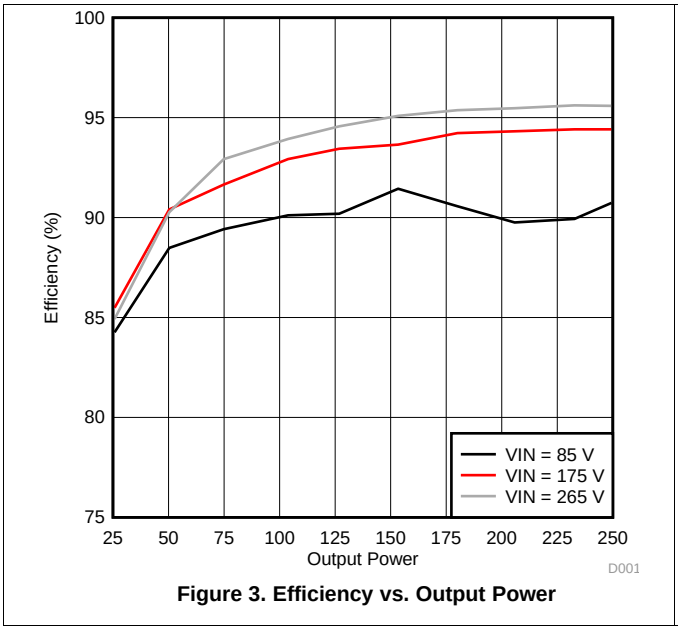

Figure 3. Efficiency vs. Output Power

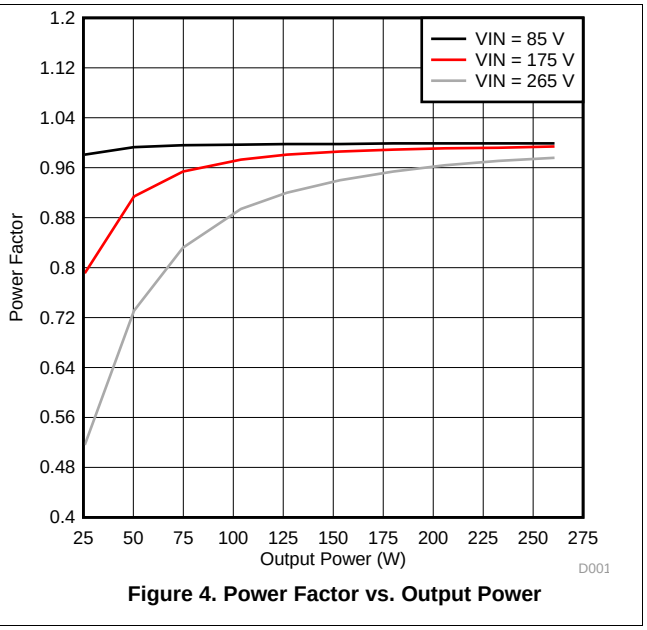

Figure 4. Power Factor vs. Output Power

List of Materials

UCC3817EVM List of Materials[1]

QTY	REF DES	DESCRIPTION	MANUFACTURER	PART NUMBER
1	C1	Capacitors, ceramic, 560 pF, 50 V	Panasonic	ECU–S1H561JCA
1	C2	Capacitors, electronic, 100 µF, 25 V	Panasonic	EEU–FC1V101S
2	C3, C5	Capacitors, ceramic, 1 µF, 50 V	Panasonic	ECU–S1H105MEB
1	C4	Capacitors, ceramic, 0.01 µF, 50 V	Panasonic	ECU–S1H103KBA
2	C6, C15	Capacitors, ceramic, 2.2 µF, 50 V	Panasonic	ECU–S1H225MEB
1	C7	Capacitors, ceramic, 150 nF, 50 V, ±10%	Panasonic	ECU–S1H154KBB
1	C8	Capacitors, ceramic, 270 pF, 50 V, ±10%	Panasonic	ECU–S1H271JCA
1	C9	Capacitors, ceramic, 1.2 nF, 50 V, ±10%	Panasonic	ECU–S1H122JCB
2	C10, C11	Capacitors, stacked metal poly, 1 µF, 50 V	Panasonic	ECQ–V1H105JL
1	C12	Capacitors, electronic, 220 µF, 450 V	Panasonic	ECO–S2WB221DA
1	C13	Capacitors, 0.47 µF, 600 V (optional for user, not used on EVM)	Panasonic	ECQ–E6474KF
1	C14	Capacitors, Poly, 1.5 µF, 400 V	Panasonic	ECW–F4155JB
1	C16	Capacitors, Not used	Panasonic	ECU–S2A330JCA
1	D1	Diodes, 6 A, 600 V, ultra fast diode	International Rectifier	HFA08TB60
1	D2	Diodes, 8 A, 600 V, 400 A surge	General Instruments	GI756CT
1	D3	Diodes, 6 A, 600 V, bridge	General Instruments	PB66
4	D4, D5, D7, D8	Diodes, 1 A, 40 V, schottky	STD	1N5819
1	D6	Diodes, 100 mA, 20 V, schottky	STD	BAT85
1	D9	Not used	STD	STD
1	F1	Fuses, 6 A, 250 V, 3 AG glass fast acting cartridge type	STD	STD
2	FH1, FH2	Fuses, 3AG fuse clip	STD	STD
1	HS1	Heat sink for Q1	Aavid	513201
1	HS2	Heat sink for D1	Aavid	579302 B 0 00 00
1	L1	Inductor, 1 mH, 5.5 A, 20:1 TR	Cooper Electronic Technologies	CTX08–13679–02
1	Q1	MOSFETs	International Rectifier	IRFP450
1	R1	Resistors, 12.1 kΩ, 1/4 W	STD	STD
1	R3	Resistors, 20 kΩ	STD	STD
1	R4	Resistors, 249 kΩ	STD	STD
2	R5, R11	Resistors, 10 kΩ	STD	STD
1	R6	Resistors, 30.1 kΩ	STD	STD
1	R7	Resistors, 100 kΩ	STD	STD
1	R8	Resistors, 12.1 kΩ	STD	STD
2	R9, R10	Resistors, 4.02 kΩ	STD	STD
1	R12	Resistors, 2 kΩ	STD	STD
2	R12, R21	Resistors, 383 kΩ	STD	STD
1	R14	Resistors, 0.25 Ω, 3 W	STD	STD
2	R15, R18	Resistors, 24 kΩ, 1W, metal oxide/metal film	Panasonic	ERG 1S G 243
1	R16	Resistors, 100 Ω	STD	STD
1	R17	Resistors, 20 Ω	STD	STD
1	R18	Resistors, 24 kΩ, 1W, metal oxide/metal film	Panasonic	ERX 1S G 243
2	R2, R19	Resistors, 499 kΩ	STD	STD
1	R20	Resistors, 274 kΩ	STD	STD

(1) Unless otherwise specified, all resistors are 0.25 W metal film with a 1% tolerance.

UCC3817EVM List of Materials[1] (continued)

QTY	REF DES	DESCRIPTION	MANUFACTURER	PART NUMBER
1	R22	Resistors, 0-Ω jumper or 26 AWG wire	STD	STD
1	U1	UCC3817N	Texas Instruments	UCC3817N
1	X at U1	Socket, 16 pin DIP socket	STD	STD
1	PCB	Board, UCC3817 bare pc board	STD	STD
1	X1 at Q1	Hardware, Thermal pad silicone TO220	STD	STD
1	X2 at HS1	Hardware, Screw pan head #6–32 X 3/8	STD	STD
1	X3 at HS1	Hardware, Nut #6X32	STD	STD

Additional Information

For more information, pin description and specifications for the UCC3817 PFC Controller, please refer to the UCC3817 datasheet, Texas Instruments Literature Number SLUS395, or contact the Texas Instruments Semiconductor Product Information Center at 1–800–336–5236 or 1–972–644–5580. Product information can also be found on the at http://www.ti.com.

This evaluation module can also be used to evaluate the performance of the UCC3818 PFC control device by removing R16 and applying the bias voltage to the VCC pin through a separate bias supply.

Revision History

Changes from C Revision (November 2002) to D Revision **Page**

- Added first-page EVM warnings. 2

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

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   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 and conditions 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 and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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 are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】

本開発キットは技術基準適合証明を受けておりません。

本製品のご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。

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東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

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

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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:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

   6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS AND CONDITIONS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

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