Application Note 2212 LM3017 Evaluation Board

User's Guide

Literature Number: SNOU094
September 2012

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1 Introduction

The LM3017 is a versatile low-side NFET controller incorporating true shutdown and input side current limiting. The ability to drive an external high-side NMOS provides for true isolation of the load from the input. Linear current limiting on the input ensures that inrush and short-circuit currents are always under control. The high switching frequency allows for the smallest components and overall solution size. In shutdown mode, the LM3017 draws 1µA from the input supply. The LM3017 incorporates built in thermal shutdown, cycle-by-cycle current limit, short circuit protection, output over-voltage protection, and soft-start. This evaluation board demonstrates the flexibility of the LM3478 in a boost topology.

2 Features

- 8V to 12V Input Voltage Range
- 15V Output Voltage (Default Setting)
- Up to 1000 mA Output Current
- Low Shutdown Current (< 1µA)
- 600 KHz Fixed Switching Frequency
- True Shutdown
- PCB Size: 27.5 mm x 46.5 mm

3 Operation Modes

The part can operate in three different modes by varying the voltage on the EN/MODE pin:

- V_{EN} < 0.4V Shutdown Mode
- 1.6V < V_{EN} < 2.2V Run Mode
- V_{EN} > 2.6V Standby Mode

Note that the EN pin should not be left floating.

4 Adjusting the Output Voltage

The output voltage can be changed from 15V to another voltage by adjusting the feedback resistors using the following equation:

$$V_{OUT} = V_{FB}(1+(R_{FBT}/R_{FBB})) \quad (1)$$

Where V_{FB} is 1.275V. For more information on components selection and features see literature number SNOSC66.

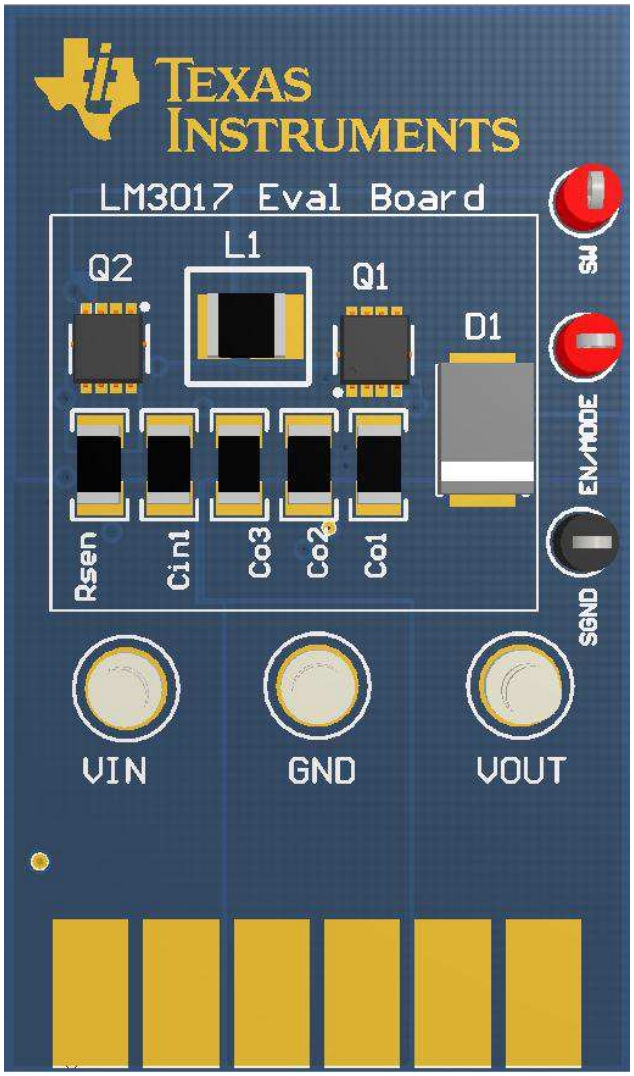

Figure 1. LM3017 Eval Board - Top View

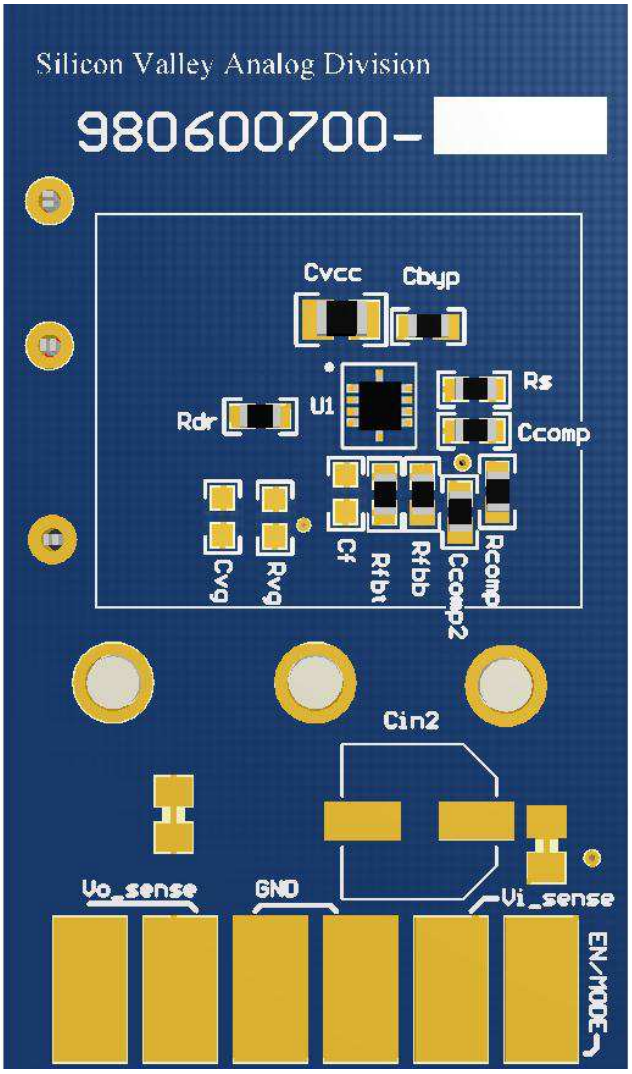

Figure 2. LM3017 Eval Board - Bottom View

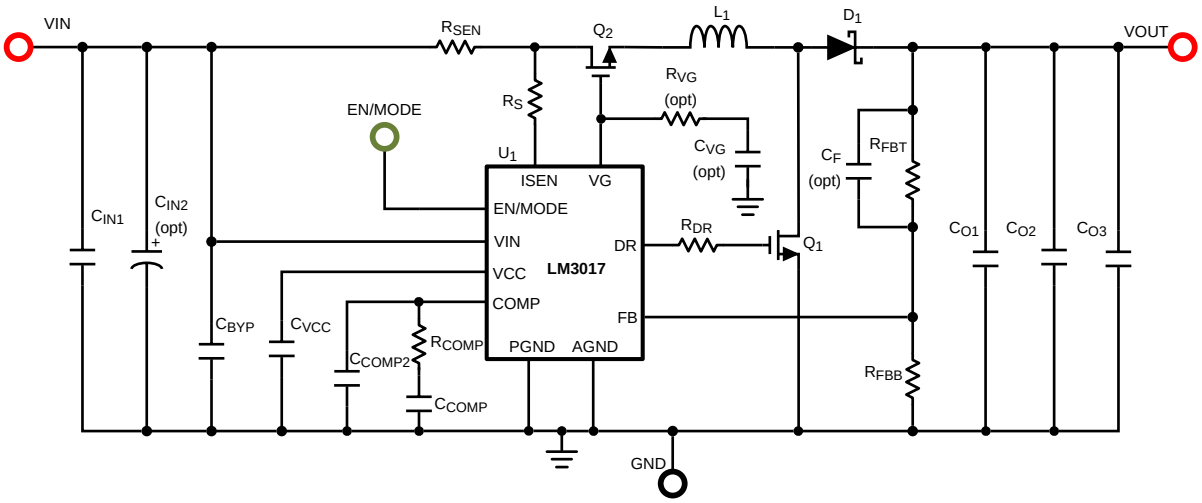

Figure 3. LM3017 Evaluation Board Schematic

Table 1. Bill of Materials (BOM) LM3017

Designation	Description	Size	Manufacturer Part #	Vendor
C_{IN1}	Cap 22µF 25V X5R	1206	GRM31CR61E226KE15L	Murata
C_{IN2}	optional			
C_{O1},C_{O2}, C_{O3}	Cap 22µF 25V X5R	1206	GRM31CR61E226KE15L	Murata
C_{COMP}	Cap 0.01µF	0603	C0603C103J1RACTU	Kemet
C_{COMP2}	Cap 100pF	0603	C1608C0G1H101J	TDK
C_{BYP}	Cap 0.1µF 25V X7R	0603	06033C104KAT2A	AVX
C_{VCC}	Cap 0.47µF 16V X7R	0805	C2012X7R1C474K	TDK
C_{VG}	optional			
C_F	optional			
R_{VG}	optional			
R_{COMP}	RES, 3.4kΩ, 1%, 0.1W	0603	CRCW06033K40FKEA	Vishay
R_{FBT}	RES, 21.5kΩ, 1%, 0.1W	0603	CRCW060321K5FKEA	Vishay
R_{FBB}	RES, 2kΩ, 1%, 0.1W	0603	CRCW06032K00FKEA	Vishay
R_{DR}	RES, 0Ω, 1%, 0.1W	0603	CRCW06030000Z0EA	Vishay
R_S	RES, 100Ω, 1%, 0.1W	0603	CRCW0603100RFKEA	Vishay
R_{SEN}	RES, 0.03Ω, 1%, 1W	1206	WSLP1206R0300FEA	Vishay
Q_1	NexFET™ N-CH, 25V, 60A, $R_{DS(on)}$= 4.4mΩ	8-SON	CSD16323Q3	TI
Q_2	NexFET™ N-CH, 25V, 60A, $R_{DS(on)}$= 4.3mΩ	8-SON	CSD16340Q3	TI
D_1	Diode Schottky, 30V, 2A	SMB	20BQ030TRPBF	Vishay
L_1	Shielded Inductor, 4.7µH, 2.3A	4mm L x 4.5mm W x 1.85mm H	MPI4040R3-4R7-R	Coiltronics
U_1	LM3017		LM3017LE/NOPB	TI

5 Optional components

R_{VG},C_{VG} sustain the voltage generated by the internal charge pump.

C_{IN2} is an input bulk capacitor. The bulk capacitor should belocated near the Power-supply connection point. The purposeof the bulk capacitor is to overcome the inductive effects ofbench wiring.

C_F increases the gain of the dynamic loop during load transients

6 Test Setup

Table 2. Demonstration Board Quick Setup Procedures

Step	Description	Notes
1	Connect a power supply to V_{IN} and GND terminals	V_{IN} range: 8V to 12V
2	Connect a power supply to EN/MODE and GND terminals	EN/MODE range : 0V to 5V
3	Turn on V_{IN} with 0A load applied and V_{EN} = 0V, check V_{OUT}	V_{OUT} = 0V
4	Turn on V_{IN} with 0A load applied and V_{EN} = 2.7V, check V_{OUT}	$V_{OUT} = V_{IN} - V_{diode}$
5	Apply a 0.5A load, check V_{OUT}	$V_{OUT} = V_{IN} - V_{diode}$
6	with 0A load applied reduce V_{EN} to 1.8V, check V_{OUT}	V_{OUT} = 15V
7	Apply a 1.0A load, check V_{OUT}	V_{OUT} = 15V

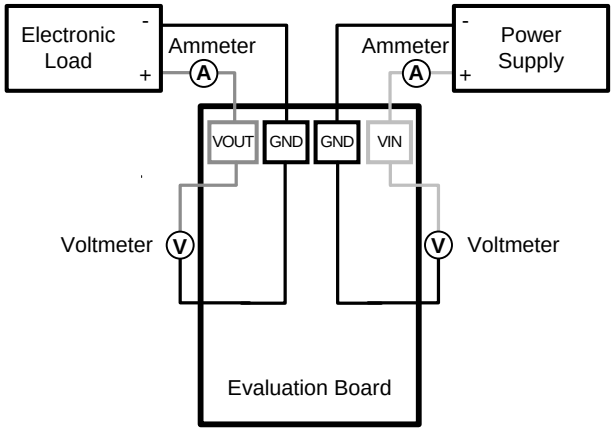

Figure 4. Efficiency Measurements

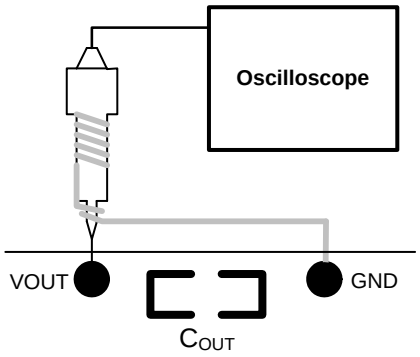

Figure 5. Voltage Ripple Measurements

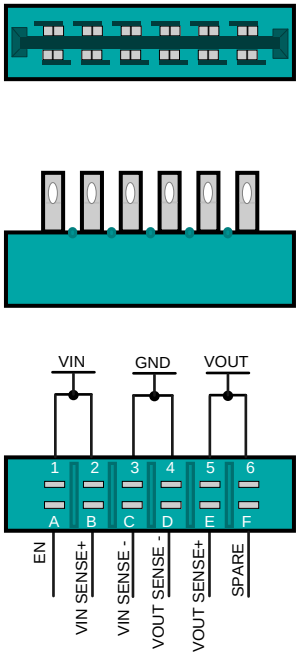

Figure 6. Edge Connector Schematic

7 Typical Performance Characteristics for LM3017 Evaluation Board

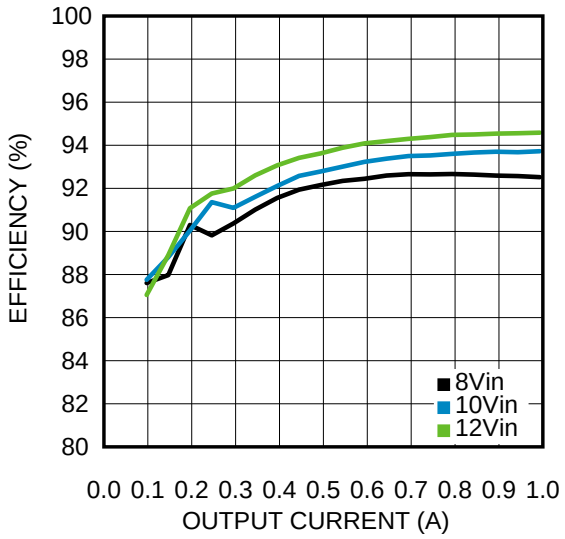

Figure 7. Efficiency vs. Load Current

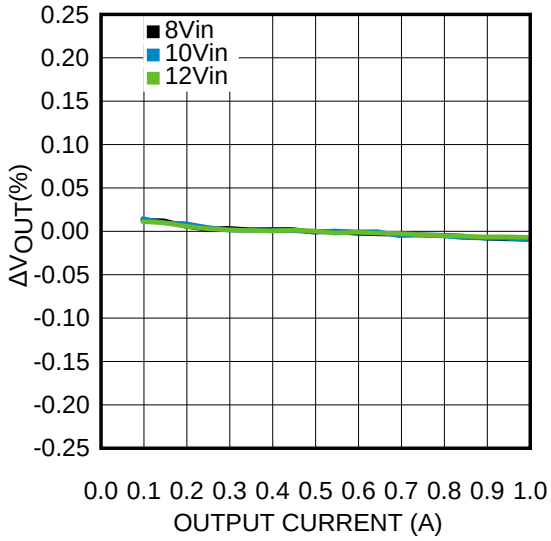

Figure 8. Load Regulation

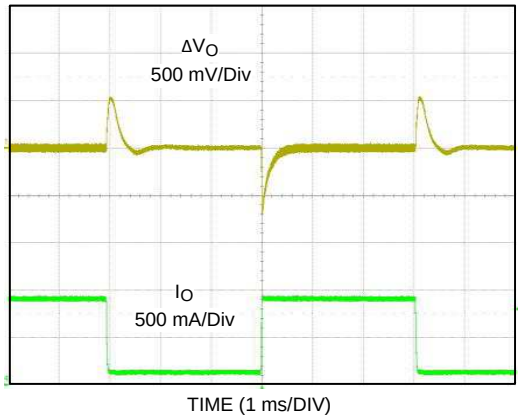

Figure 9. Load Transient Waveforms 100mA to 900mA, $8V_{IN}$

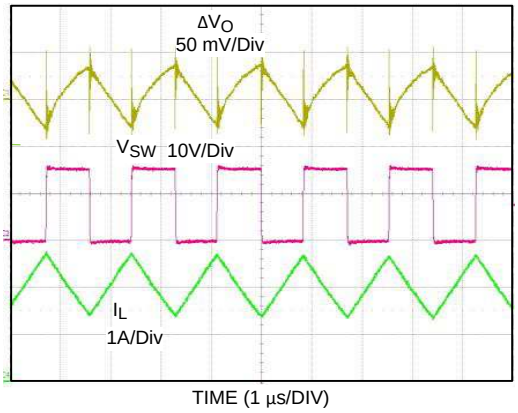

Figure 10. Switching Waveforms CCM, 1A, $8V_{IN}$

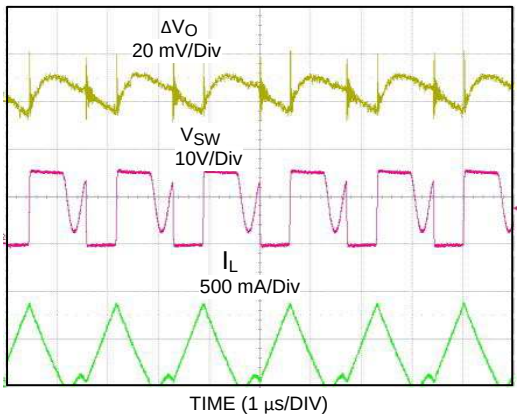

Figure 11. Switching Waveforms DCM, 150mA, $8V_{IN}$

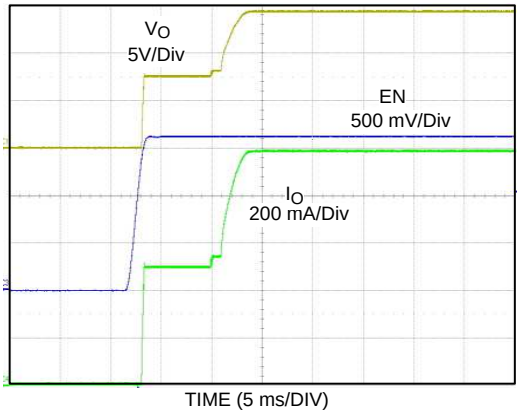

Figure 12. Startup Waveforms V_{IN} = 8V

8 Layout

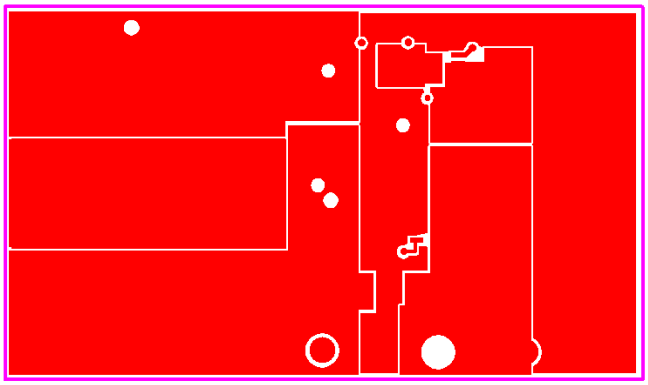

Figure 13. Top Layer

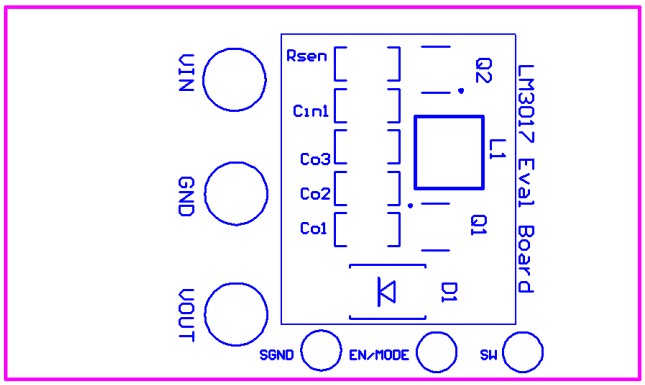

Figure 14. Top Silkscreen

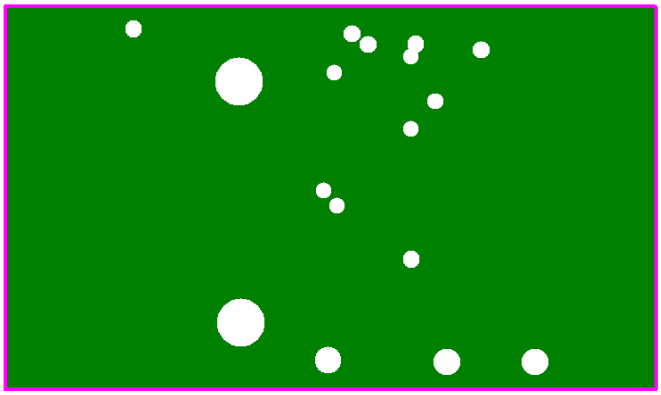

Figure 15. Mid Layer 1

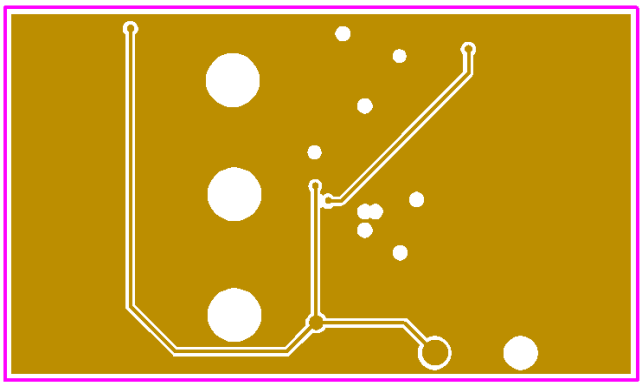

Figure 16. Mid Layer 2

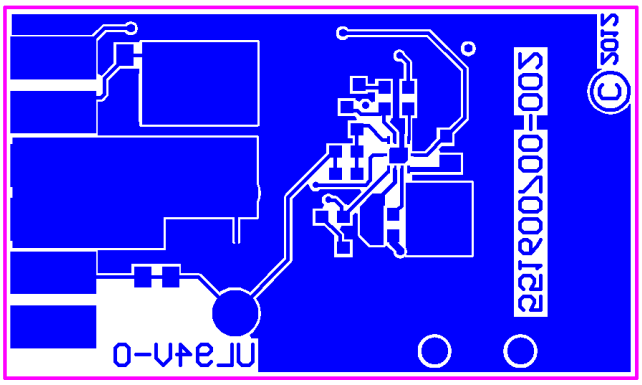

Figure 17. Bottom Layer

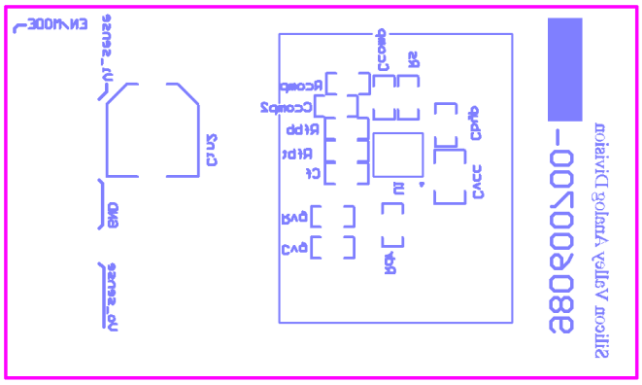

Figure 18. Bottom Silkscreen

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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 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

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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。
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If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of 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.

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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.

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