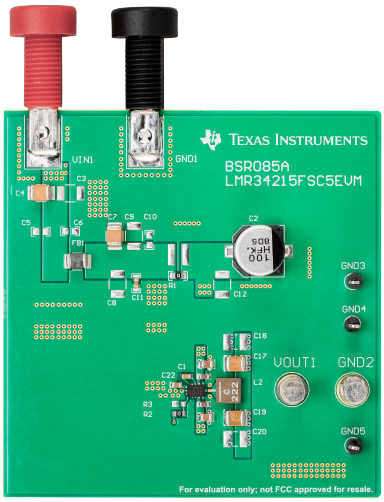
LMR34215FSC5EVM User's Guide

The Texas Instruments LMR34215FSC5EVM evaluation module (EVM) helps designers evaluate the operation and performance of the LMR34215-Q1 wide-input buck regulator. The LMR34215-Q1 is an easy-to-use synchronous step-down DC/DC converter capable of driving up to 1.5 A of load current from an input voltage of up to 42 V. The LMR34206-Q1 can use the same EVM, but some components may need to change for the 0.6 A device. The LMR34215FSC5EVM features a LMR34215-Q1 fixed output voltage of 5 V and a switching frequency 2.1 MHz. See the *LMR34206-Q1 4.2-V to 42-V, 0.6-A Ultra-Small Synchronous Step-Down Converter Data Sheet* and the *LMR34215-Q1 4.2-V to 42-V, 1.5-A Ultra-Small Synchronous Step-Down Converter Data Sheet* for additional features, detailed descriptions, and available options.

Table 1 shows the variant used for the LMR34215FSC5EVM.

Table 1. Device and Package Configuration

EVM	U1	SPREAD SPECTRUM	FPWM	FREQUENCY	OUTPUT VOLTAGE	OUTPUT CURRENT
LMR34215FSC5EVM	LMR34215FSC5RNXTQ1	Yes	Yes	2100 kHz	5-V Fixed	1.5 A



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Trademarks

All trademarks are the property of their respective owners.

1 Posts, Probes, and Jumpers

This section describes the test points and connectors on the EVM and how to properly connect, set up, and use the LMR34215FSC5EVM.

1.1 Input and Output Terminals

The terminals on the top of the board can be used to connect to the input and output of the EVM. See Figure 1 for the terminal connections. The functions of the terminal connections are:

VIN— Input supply to EVM including EMI filter. Connect to a suitable input supply. See the *LMR34206-Q1 4.2-V to 42-V, 0.6-A Ultra-Small Synchronous Step-Down Converter Data Sheet* and *LMR34215-Q1 4.2-V to 42-V, 1.5-A Ultra-Small Synchronous Step-Down Converter Data Sheet* for input supply requirements.

GND— System ground

VOUT— Output of EVM — connect to desired load.

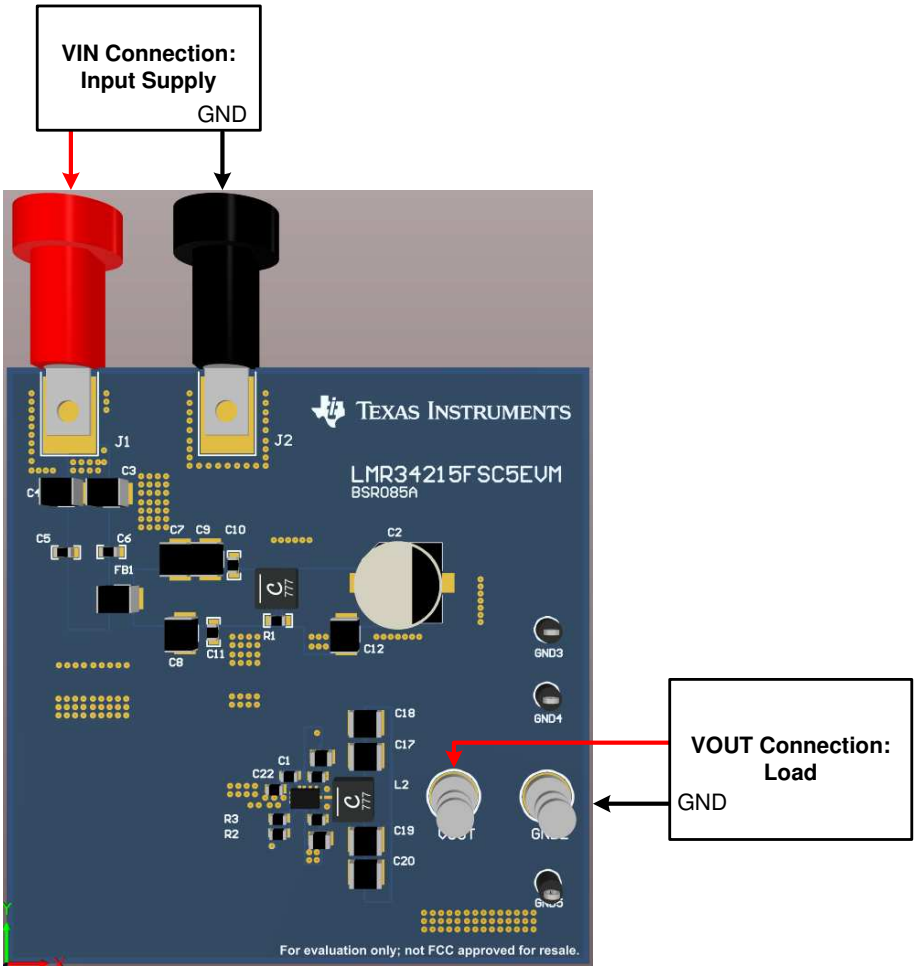

Figure 1. EVM Board Connections

1.2 Test Points

VOUT— Output voltage sense connection; connect to DMM. Also, use for frequency response analyzer connection.

GND2, GND3, GND4, and GND5— Ground sense point for analog measurements; connect to DMM.

2 Operation

2.1 Quick Start

1. Connect the voltage supply between VIN and GND banana jack connectors using short and thick wires.
2. Connect the load between VOUT and GND connectors using short and thick wires.
3. Set the supply voltage at an appropriate level between 4.2 V to 42 V.
4. Set the current limit of the supply to an appropriate level.
5. Turn on the power supply. With the default configuration, the EVM powers up and provides V_{OUT} = 5 V.
6. Monitor the output voltage. The maximum load current must be 1.5 A with the LMR34215-Q1 device or 600 mA with the LMR34206-Q1 device.

2.2 Efficiency Measurement

1. Connect the power supply to VIN and GND terminal connectors and make sure the power supply provides sufficient current.

   NOTE: There is no reverse polarity protection or fuse on the evaluation board.

2. Connect the electronic load to VOUT and GND terminal connectors. It is preferable to use twisted lab wires for all power wires. If the power supply wires are very long (> 50 cm), solder an additional 470-µF, 100-V bulk capacitor to posts VIN and GND. Use sufficient power wires to avoid voltage drops, and use short sense probe connection for the measurement.

   NOTE: These sense lines are not designed to carry power.

3. Use the connectors and test points to accurately sense input and output voltages. Alternatively, sense wires can be soldered directly over input capacitors C_{13} or C_{14} and the output capacitors C_{17} or C_{19}.

2.3 Measure Load Transient

1. Connect power supply to VIN and GND banana jack connectors, and make sure the power supply can provide sufficient peak current.

   NOTE: There is no reverse polarity protection or fuse on the evaluation board.

2. Connect the transient load to VOUT and GND terminal connectors. Use preferable twisted lab wires for all power wires. If the power supply wires are very long (> 50 cm), solder an additional 470-µF, 100-V bulk capacitor to posts VIN and GND. Use short sense probe connection for the measurement.
3. To accurately sense the output voltage, place the scope probe directly over the output capacitors C_{17} or C_{19}. Connect scope probe GND ring directly to the output capacitor GND pad for minimal ground loop. Ground loops can introduce ringing in observed waveforms, which is an artifact and not present on the PCB. Alternatively, use differential probe over output capacitors C_{17} or C_{19}. Do not use wires to differential probe and always probe directly with shortest possible pins.

3 Schematic

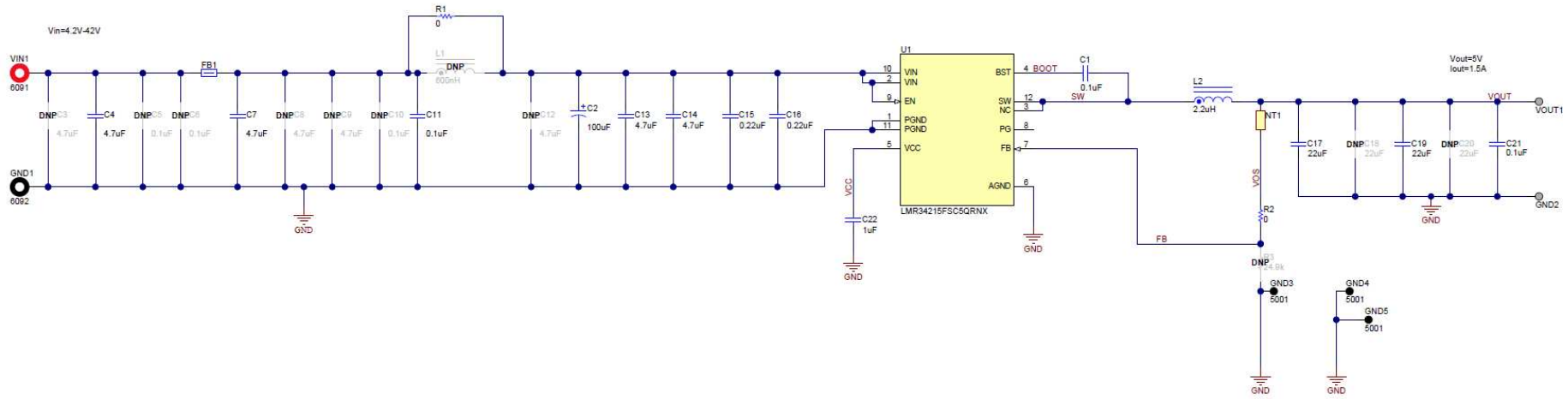

Figure 2. LMR34206 and LMR34215 EVM Schematic

4 Board Layout

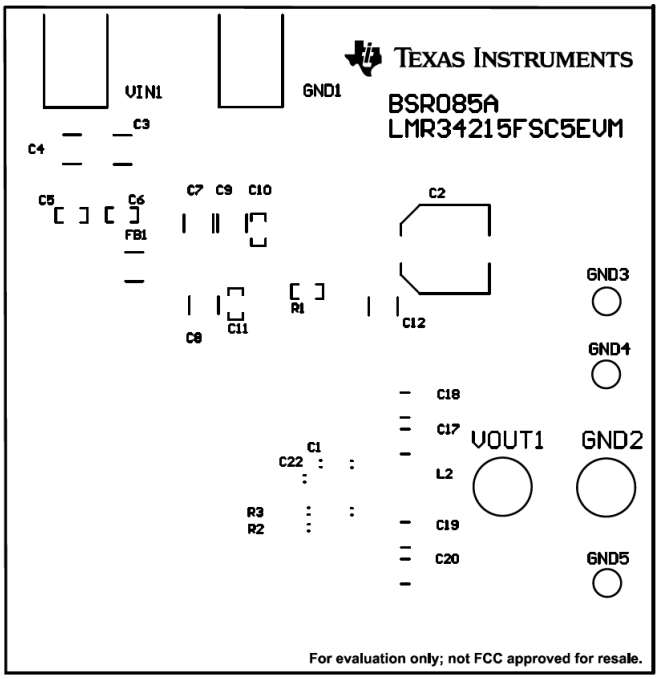

Figure 3. Top View of the EVM

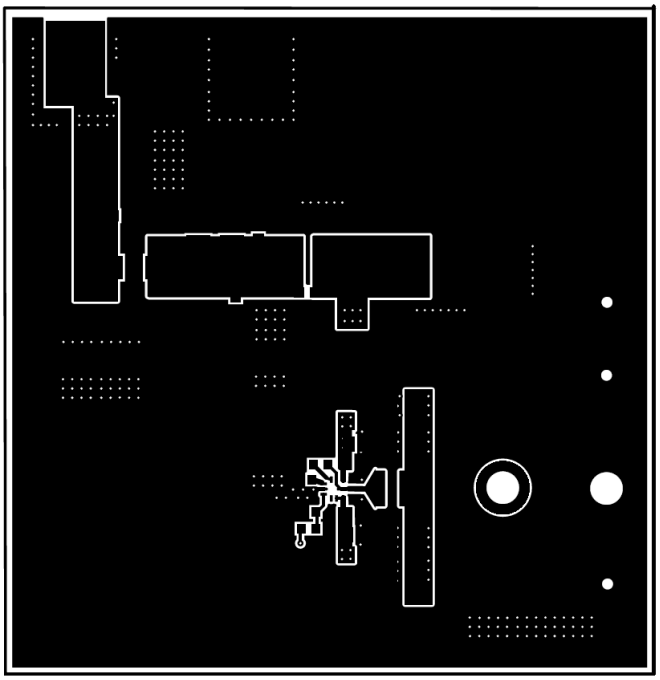

Figure 4. EVM Top Copper Layer

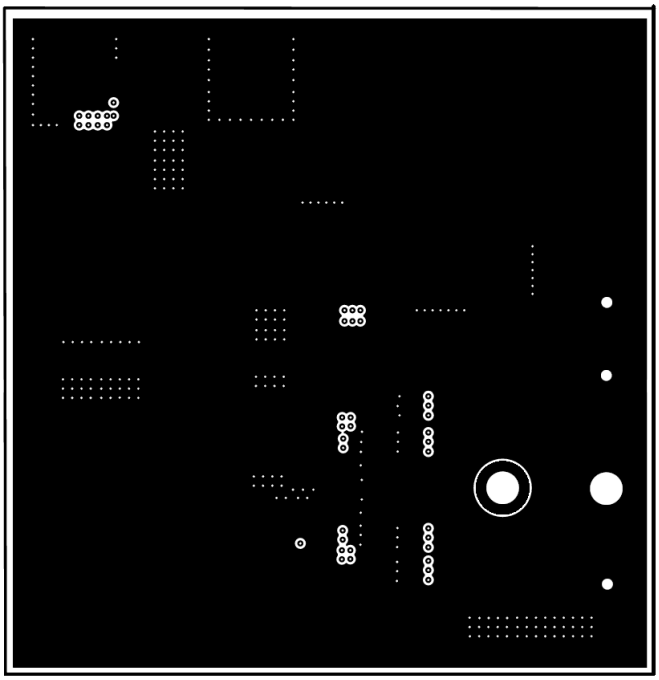

Figure 5. EVM Mid-Layer One

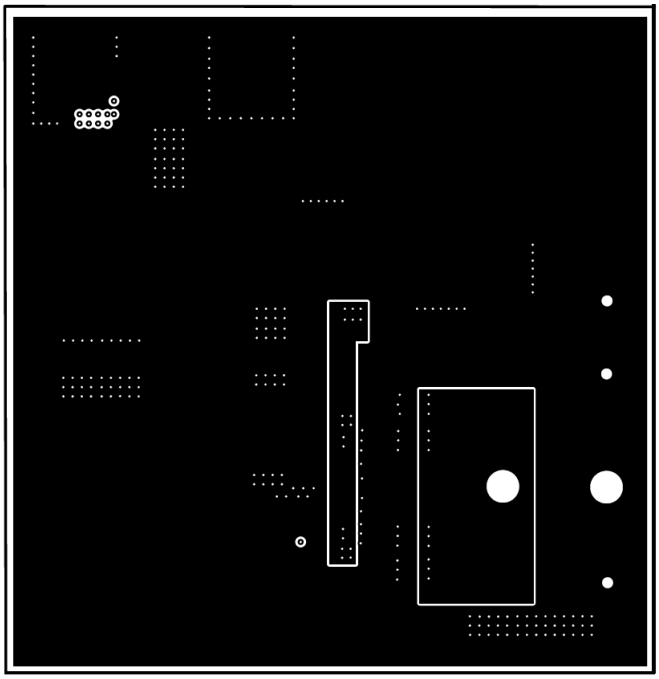

Figure 6. EVM Mid-Layer Two

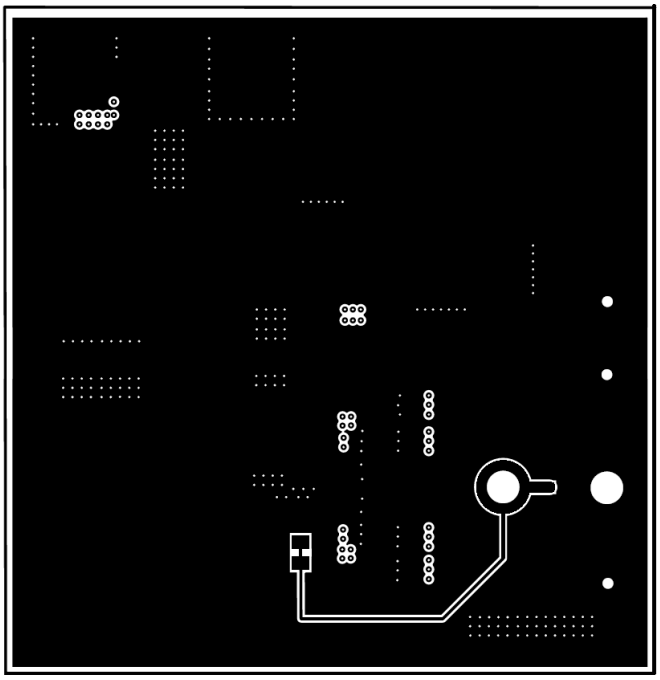

Figure 7. EVM Bottom Copper Layer

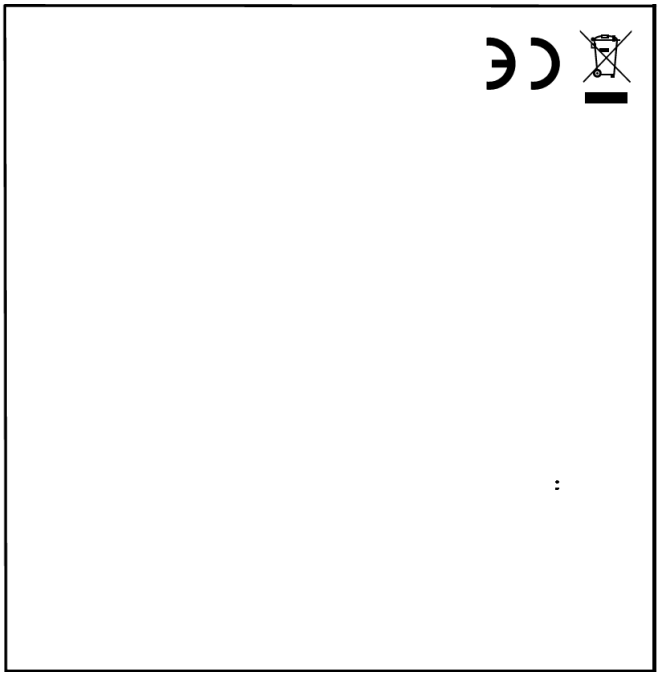

Figure 8. EVM Bottom View

5 Bill of Materials

Table 2. Bill of Materials

DESIGNATOR	DESCRIPTION	MANUFACTURER	PART NUMBER	QUANTITY
C1, C21	CAP, CERM, 0.1 µF, 25 V, ±10%, X7R, 0603	AVX	06033C104KAT2A	2
C2	CAP, AL, 100 µF, 50 V, ±20%, 0.34 Ω, AEC-Q200 Grade 2, SMD	Panasonic	EEE-FK1H101P	1
C4, C7	CAP, CERM, 4.7 µF, 50 V, ±20%, X7R, AEC-Q200 Grade 1, 1210	TDK	CGA6P3X7R1H475M250AB	2
C11	CAP, CERM, 0.1 µF, 50 V, ±10%, X7R, 0603	MuRata	GCM188R71H104KA57D	1
C13, C14	CAP, CERM, 4.7 µF, 50 V, ±10%, X5R, 0805	TDK	C2012X5R1H475K125AB	2
C15, C16	CAP, CERM, 0.22 µF, 50 V, ±10%, X7R, 0603	TDK	C1608X7R1H224K080AB	2
C17, C19	CAP, CERM, 22 µF, 25 V, ±10%, X5R, 1210	Samsung Electro-Mechanics	CL32A226KAJNNNE	2
C22	CAP, CERM, 1 µF, 25 V, ±10%, X7R, 0603	Wurth Elektronik	885012206076	1
FB1	Ferrite Bead, 600 Ω at 100 MHz, 3 A, 1210	Taiyo Yuden	FBMH3225HM601NT	1
GND1	Standard Banana Jack, Insulated, Black	Keystone	6092	1
GND2, VOUT1	Terminal, Turret, TH, Double	Keystone	1503-2	2
GND3, GND4, GND5	Test Point, Miniature, Black, TH	Keystone	5001	3
L2	Inductor, Shielded, Composite, 2.2 µH, 5.5 A, 0.04 Ω, AEC-Q200 Grade 1, SMD	Coilcraft	XAL4020-222MEB	1
R1, R2	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06030000Z0EA	2
U1	LMR342XX-Q1 SIMPLE SWITCHER® 42-V, 600-mA/1.5-A Synchronous Buck Converter, RNX0012B (VQFN-HR-12)	Texas Instruments	LMR34215FSC5RNXTQ1	1
VIN1	Standard Banana Jack, Insulated, Red	Keystone	6091	1
C3, C8, C9, C12	CAP, CERM, 4.7 µF, 50 V, ±20%, X7R, AEC-Q200 Grade 1, 1210	TDK	CGA6P3X7R1H475M250AB	0
C5, C6, C10	CAP, CERM, 0.1 µF, 50 V, ±10%, X7R, 0603	MuRata	GCM188R71H104KA57D	0
C18, C20	CAP, CERM, 22 µF, 25 V, ±10%, X5R, 1210	Samsung Electro-Mechanics	CL32A226KAJNNNE	0
L1	Inductor, Shielded, Composite, 600 nH, 10.38 A, 0.01 Ω, AEC-Q200 Grade 1, SMD	Coilcraft	XAL4020-601MEB	0
R3	RES, 24.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW060324K9FKEA	0

6 Test Results

Section 6.1 details the test results from the LMR34215FSC5EVM.

6.1 LMR34215FSC5EVM Test Results

The LMR34215FSC5EVM variant is used for all figures from Figure 9 to Figure 22.

6.1.1 Efficiency and Load Regulation

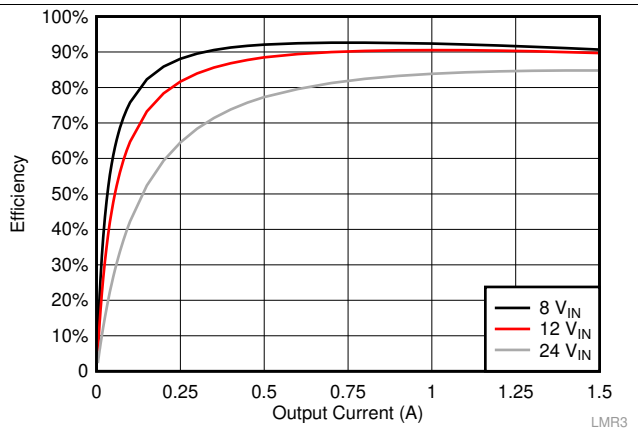

Figure 9. LMR34215FSC5EVM 5 V_{OUT} Efficiency

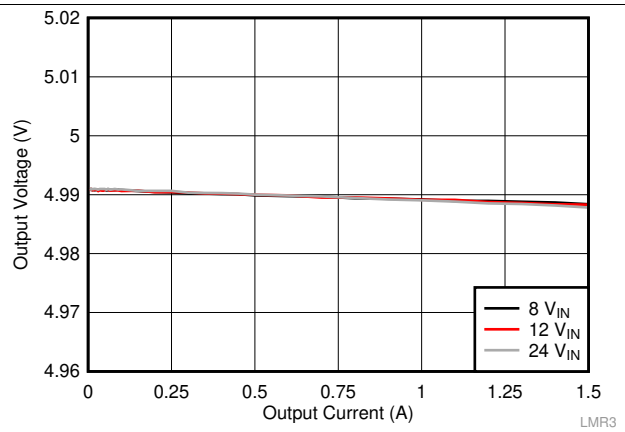

Figure 10. LMR34215FSC5EVM 5 V_{OUT} Load Regulation

6.1.2 Load Transients and Start-up Waveforms

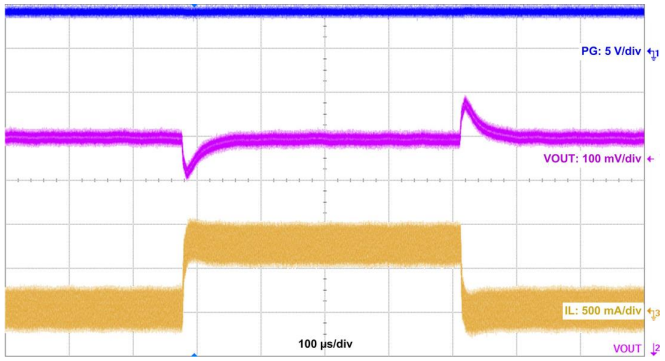

Figure 11. LMR34215FSC5EVM 5 V_{OUT} Load Transient, I_{OUT} = 0 A to 1.5 A, Slew Rate = 1 A/µs

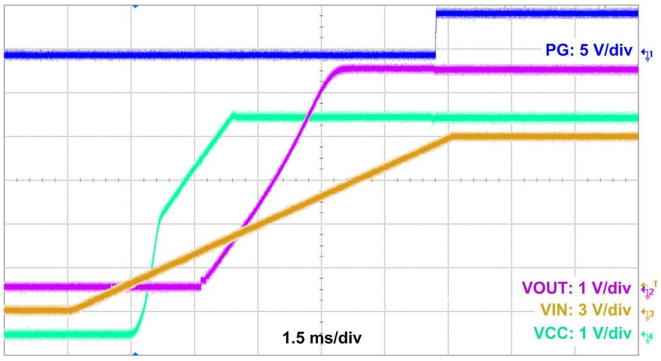

Figure 12. LMR34215FSC5EVM 5 V_{OUT} Start-Up Waveform

6.1.3 Conducted EMII

Conducted EMI testing is done versus CISPR25 peak and average limits. The yellow waveforms are the peak signals and the blue waveforms are the average signals. The test is done with 13.5 V input voltage, 5.0 V output voltage, and 1.5 A load current.

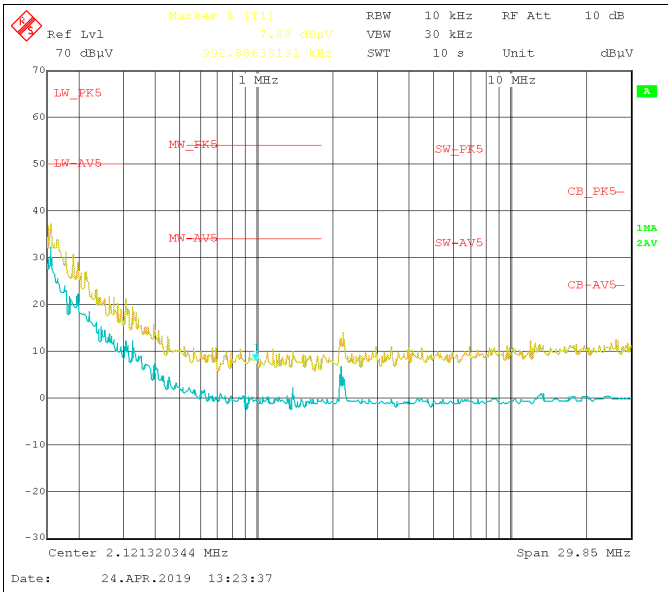

Figure 13. Conducted EMI Versus CISPR25 Limits, 150 kHz to 30 Mhz

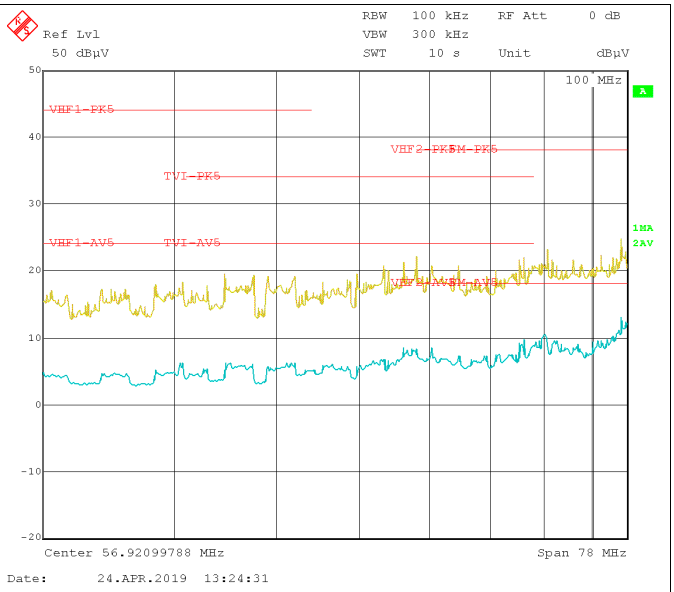

Figure 14. Conducted EMI Versus CISPR25 Limits, 30 Mhz to 108 MHz

6.1.4 Radiated EMII

Radiated EMI testing is done versus CISPR25 peak and average limits. The black waveforms are the peak signals and the blue waveforms are the average signals. The test is done with 13.5 V input voltage, 5.0 V output voltage, and 1.5 A load current.

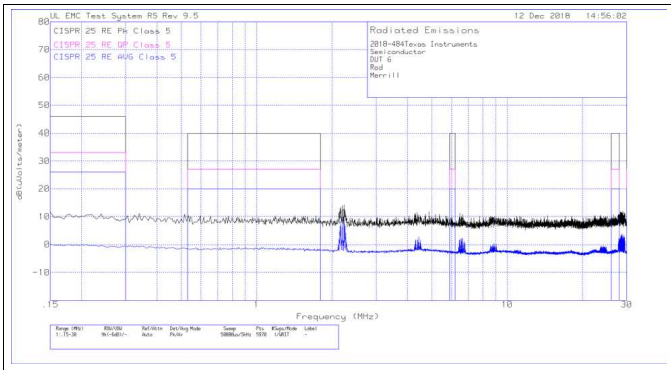

Figure 15. . Radiated EMI Rod Versus CISPR25 Limits, 150 kHz to 30 MHz

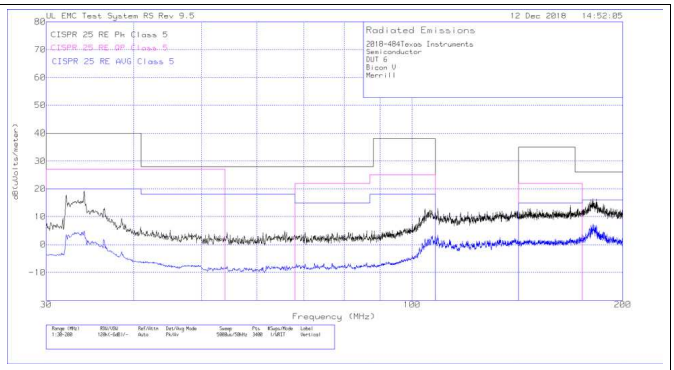

Figure 16. Radiated EMI Bicon Vertical Versus CISPR25 Limits, 30 MHz to 200 MHz

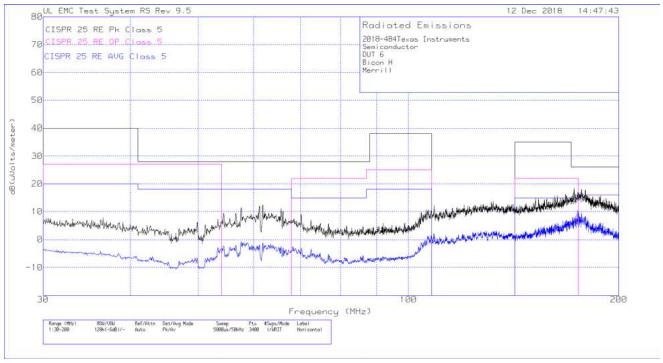

Figure 17. Radiated EMI Bicon Horizontal Versus CISPR25 Limits, 30 MHz to 200 MHz

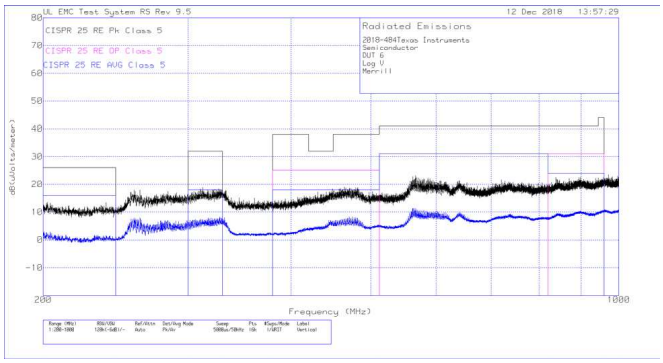

Figure 18. 4. Radiated EMI Log Vertical Versus CISPR25 Limits, 200 MHz to 1 GHz

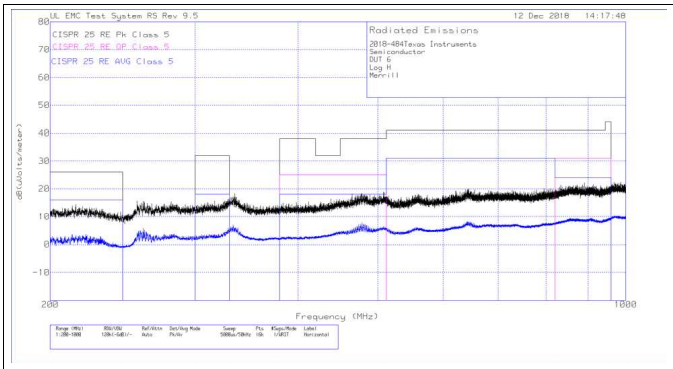

Figure 19. Radiated EMI Log Horizontal Versus CISPR25 Limits, 200 Mhz to 1 GHz

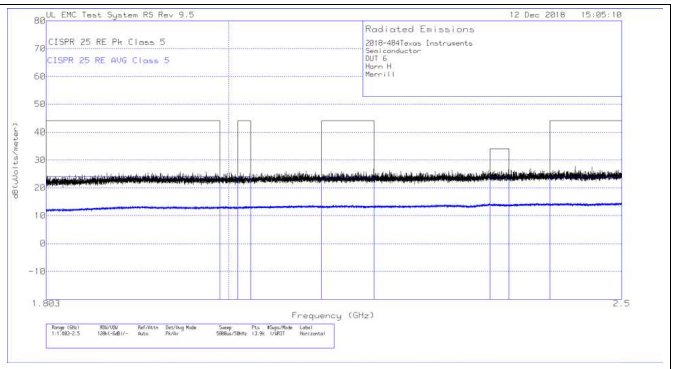

Figure 20. Radiated EMI Horn Vertical Versus CISPR25 Limits, 1.8 GHz to 2.5 GHz

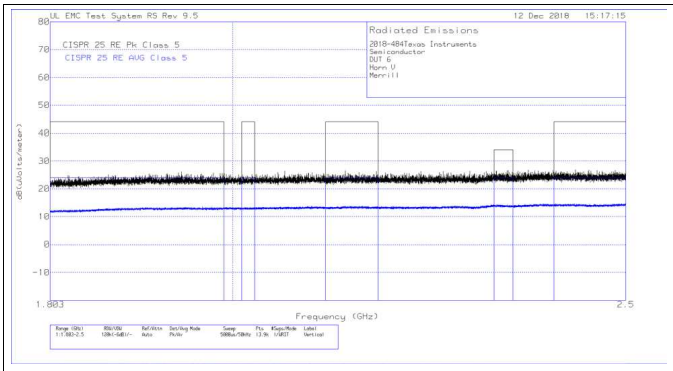

Figure 21. Radiated EMI Horn Horizontal Versus CISPR25 Limits, 1.8 GHz to 2.5 GHz

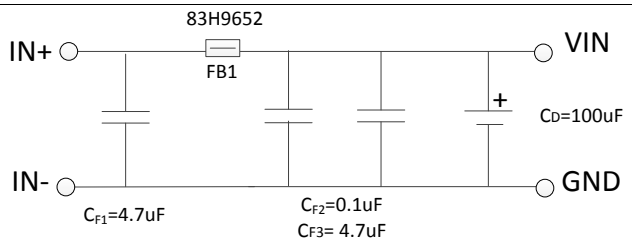

Figure 22. Recommended Input EMI Filter

STANDARD TERMS FOR EVALUATION MODULES

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

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

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

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
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.

【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】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもの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。
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東京都新宿区西新宿 6 丁目 2 4 番 1 号
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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:*

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 MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS 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 EPIDEMIC FAILURE WARRANTY OR 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 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, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

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