LMR36015xxxEVM User's Guide

The Texas Instruments LMR36015FSCEVM and LMR36015AEVM evaluation modules (EVM) help designers evaluate the operation and performance of the LMR36015-Q1 wide-input buck regulators. The LMR36015-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 60 V. The LMR36015FSCEVM features a selectable output voltage of 3.3 V or 5 V and a switching frequency of 2.1 MHz. The LMR36015AEVM features a selectable output voltage of 3.3 V or 5 V and a switching frequency of 400 kHz. See the LMR36015-Q1 data sheets for additional features, detailed descriptions, and available options.

The EVM options are found in Table 1.

Table 1. Device and Package Configurations

EVM	U1	FREQUENCY	FPWM	SPREAD SPECTRUM	CURRENT
LMR36015AEVM	LMR36015-Q1	400 kHz	Disabled	Disabled	1.5 A
LMR36015FSCEVM	LMR36015-Q1	2.1 MHz	Enabled	Enabled	1.5 A

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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 LMR36015AEVM and the LMR36015FSCEVM.

1.1 Screw Terminal Connectors

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

- **VIN -** Input supply to EVM. Connect to a suitable input supply. See LMR36015-Q1 data sheet for input supply requirements.
- **GND -** System ground.
- **IN+ -** Input supply to EVM including an EMI filter. Connect to a suitable input supply. See LMR36015-Q1 data sheet for input supply requirements.
- **IN– -** System ground including an EMI filter.
- **VOUT -** Output of EVM — connect to desired load.

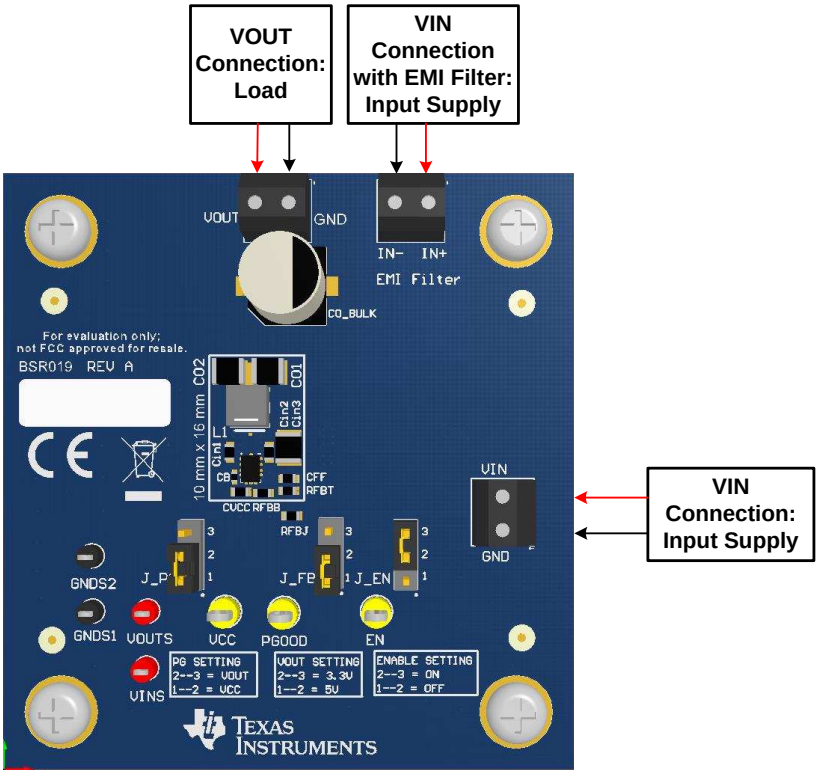


Figure 1. EVM Board Connections

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1.2 Jumpers

See Figure 2 for jumper locations.

- **EN -** This jumper allows the ENABLE input to be connected to either GND (OFF) or VIN (ON). The 2-to-3 position enables the device; while the 1-to-2 position disables the device. Remove this jumper to allow an external logic signal to control the EN function.
- **VOUT -** Use this jumper to select one of the two pre-defined output voltages. The 2-to-3 position provides a 3.3-V output; while the 1-to-2 position provides a 5-V output.
- **PGOOD -** Use this jumper to select the PGOOD pullup configuration. PGOOD can be connected to either VOUT or VCC. The 2-to-3 position connects PGOOD to VOUT, while the 1-to-2 position connects PGOOD to VCC.

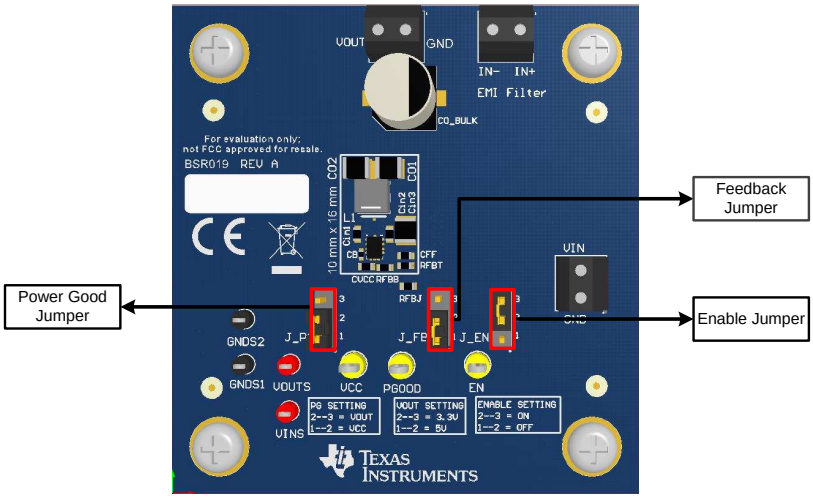


Figure 2. Jumper Locations

1.3 Test Points

- **VOUTS -** Output voltage sense connection; connect to DMM. Also, use for frequency response analyzer connection.
- **VINS -** Input voltage sense connection; connect to DMM.
- **GNDS1 and GNDS2 -** Ground sense point for analog measurements; connect to DMM.
- **VCC -** Test point to measure internal VCC of device; approximately 5 V.
- **EN -** Connection for external EN logic input. Remove EN jumper and connect controlling logic to EN test point for external enable control.
- **PGOOD -** Power-good flag output. This test point is connected to VCC or VOUT through a 100-kΩ resistor. The power-good function can be monitored at this test point.

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2 Operation

2.1 Quick Start

1. Connect the voltage supply between VIN and GND screw terminal connectors using short and thick wires.
2. Connect the load between VOUT and GND screw terminal connectors using short and thick wires.
3. Set the supply voltage at an appropriate level between 4.2 V to 60 V. Set the current limit of the supply to an appropriate level.
4. Turn on the power supply. With the default configuration, the EVM powers up and provides V_{OUT} = 5 V.
5. Monitor the output voltage. The maximum load current must be 1.5 A with the LMR36015-Q1 device.

2.2 Efficiency Measurement

1. Connect power supply to VIN and GND screw 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 electronic load to VOUT and GND screw terminal connectors. For all power wires it is preferable to use twisted lab 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. To accurately sense input and output voltage use the test points VINS, VOUTS, and GNDS. Alternatively, sense wires can be soldered directly over input capacitors C_{IN1} or C_{IN2} and the output capacitors C_{O1} or C_{O2}.
4. Make sure the IC is enabled by having jumper J5 set to [EN-VIN] and check that test point EN is driven high. While measuring I_Q (unloaded input current) remove all the input and output voltage probes that are most likely causing additional current draw.

2.3 Measure Load Transient

1. Connect power supply to VIN and GND screw terminal 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 transient load to VOUT and GND screw terminal connectors. For all power wires use preferable twisted lab 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_{O1} or C_{O2}. Make sure to 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_{O1} or C_{O2}. Do not use wires to differential probe and always probe directly with shortest possible pins. Make sure the IC is enabled by having jumper J5 set to [EN-VIN] and check test point EN is driven high and not drooping during the load transient.

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3 Schematic

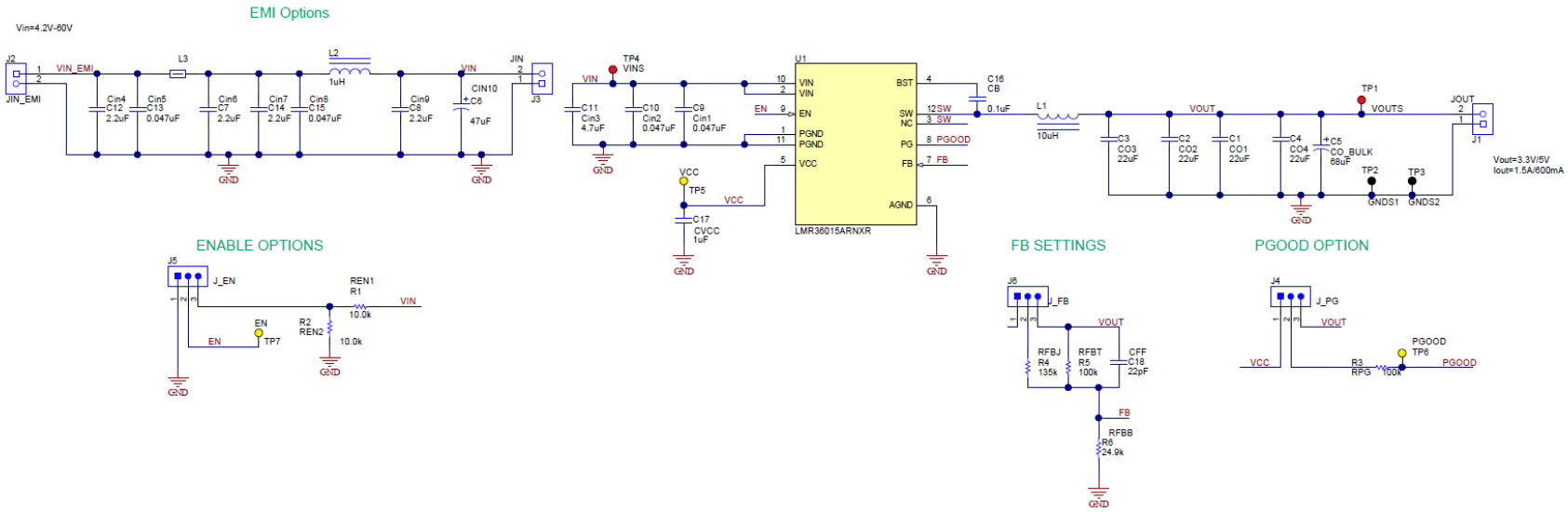


Figure 3. LMR36015xxxEVM Schematic

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4 Board Layout

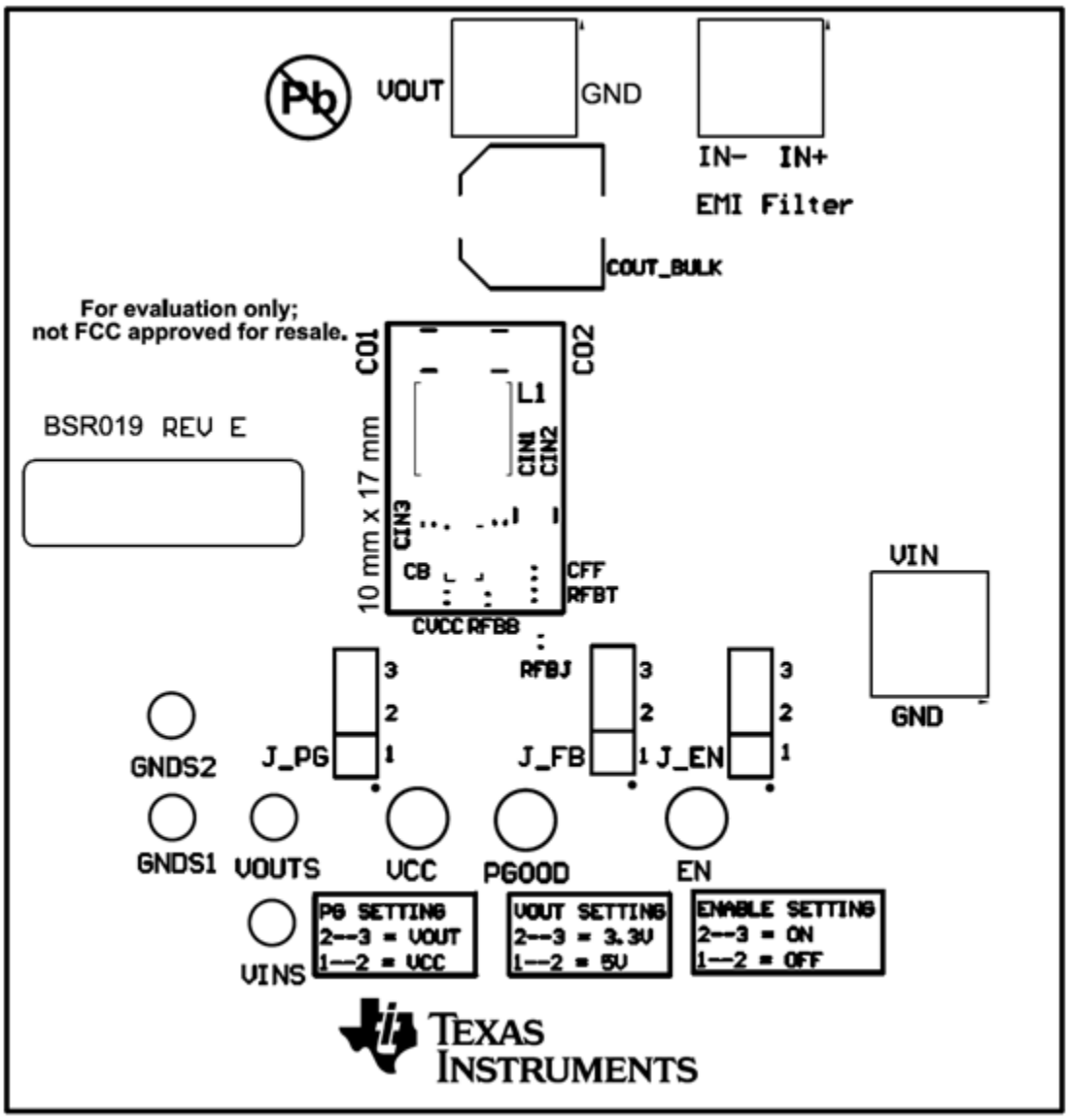


Figure 4. Top View of EVM

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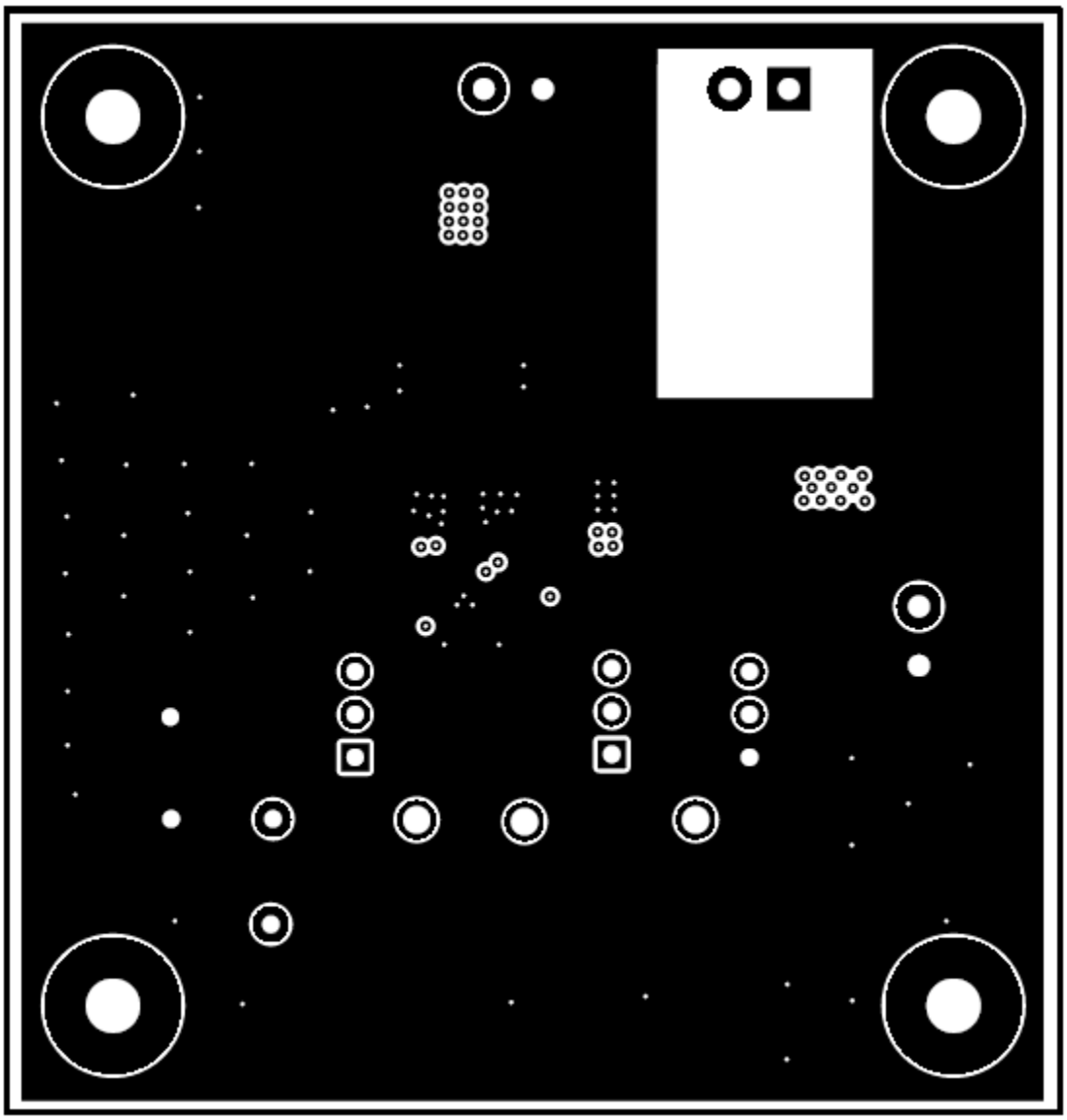


Figure 5. EVM Top Copper Layer

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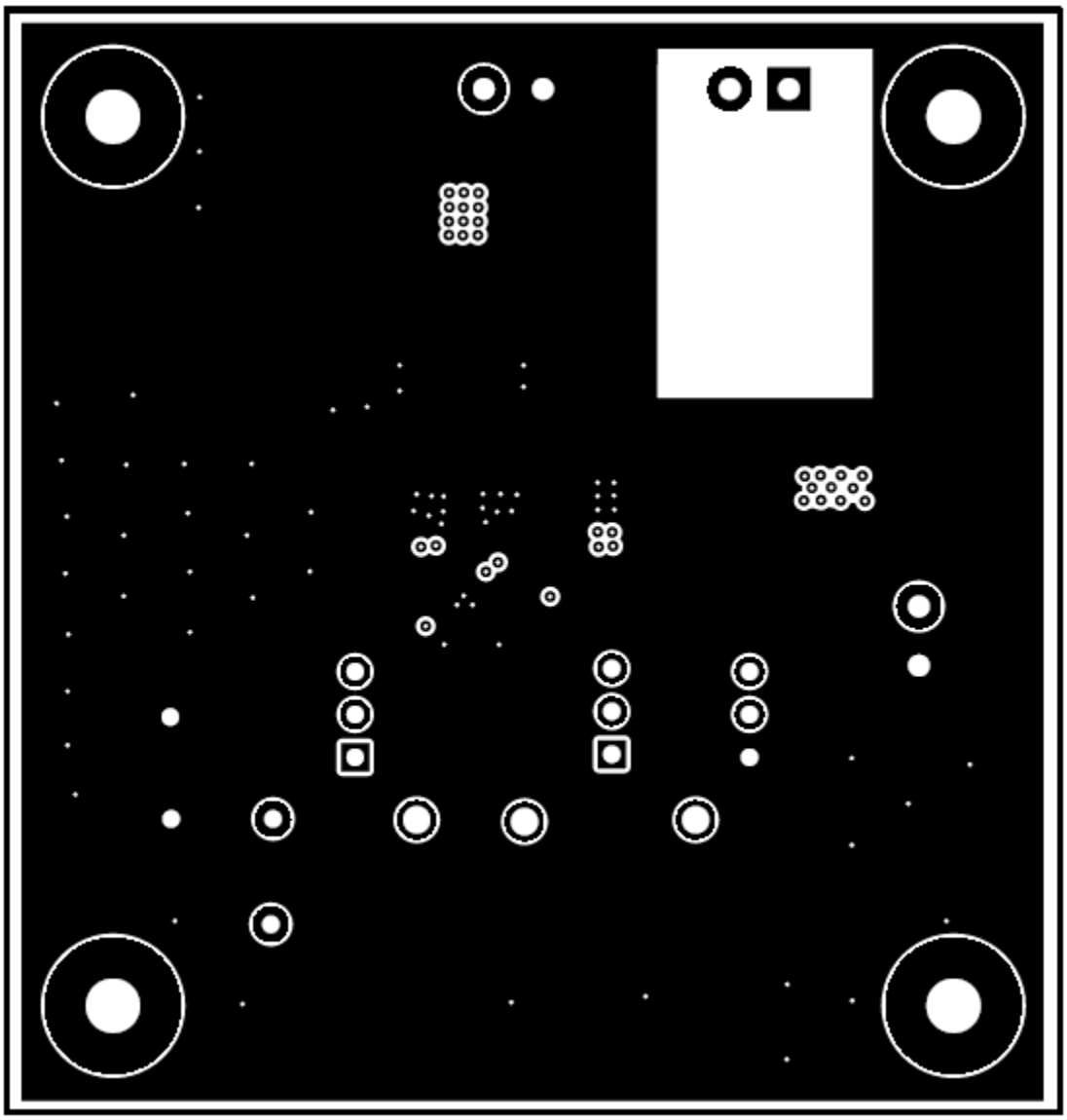


Figure 6. EVM Mid Layer One

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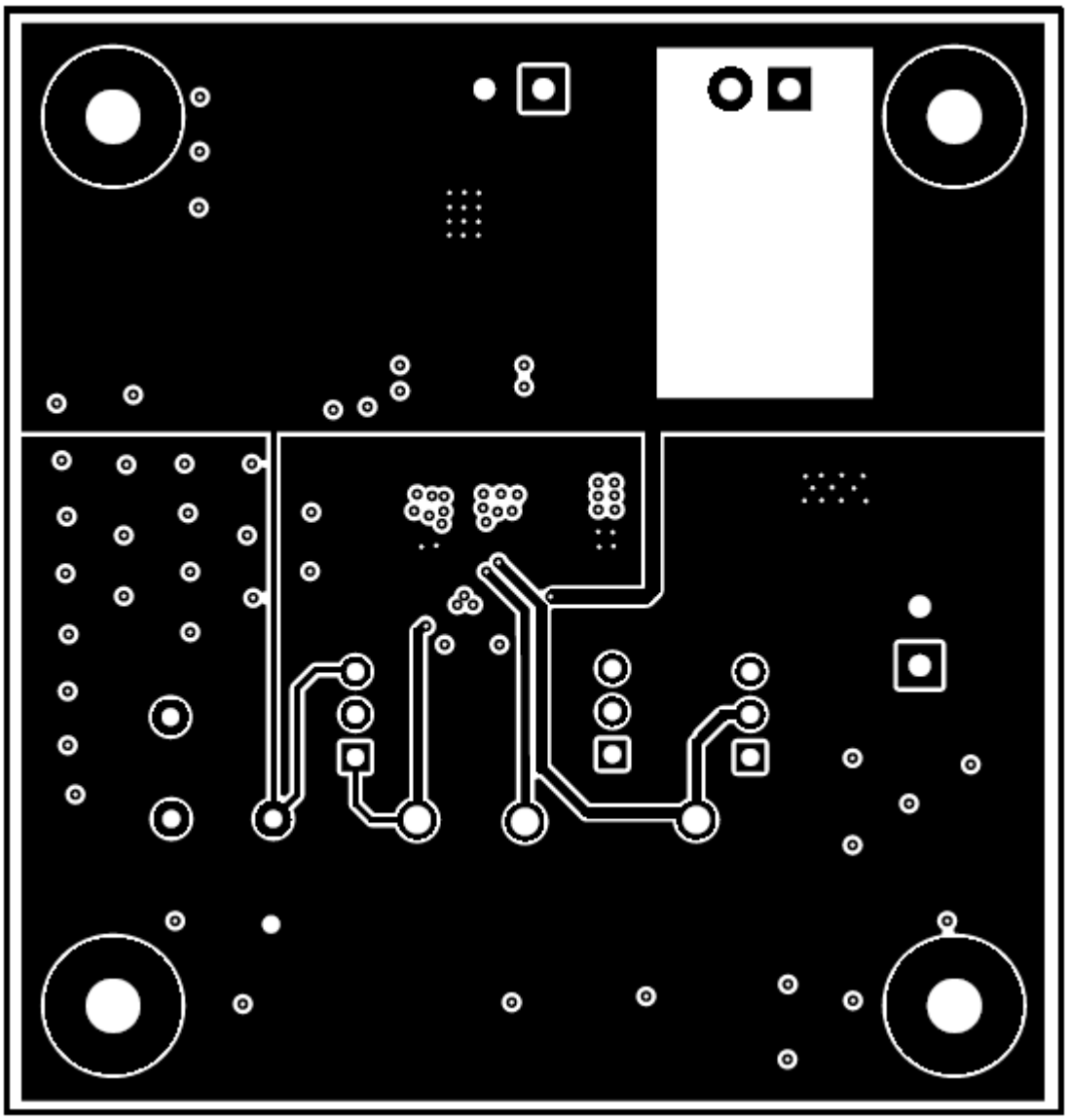


Figure 7. EVM Mid Layer Two

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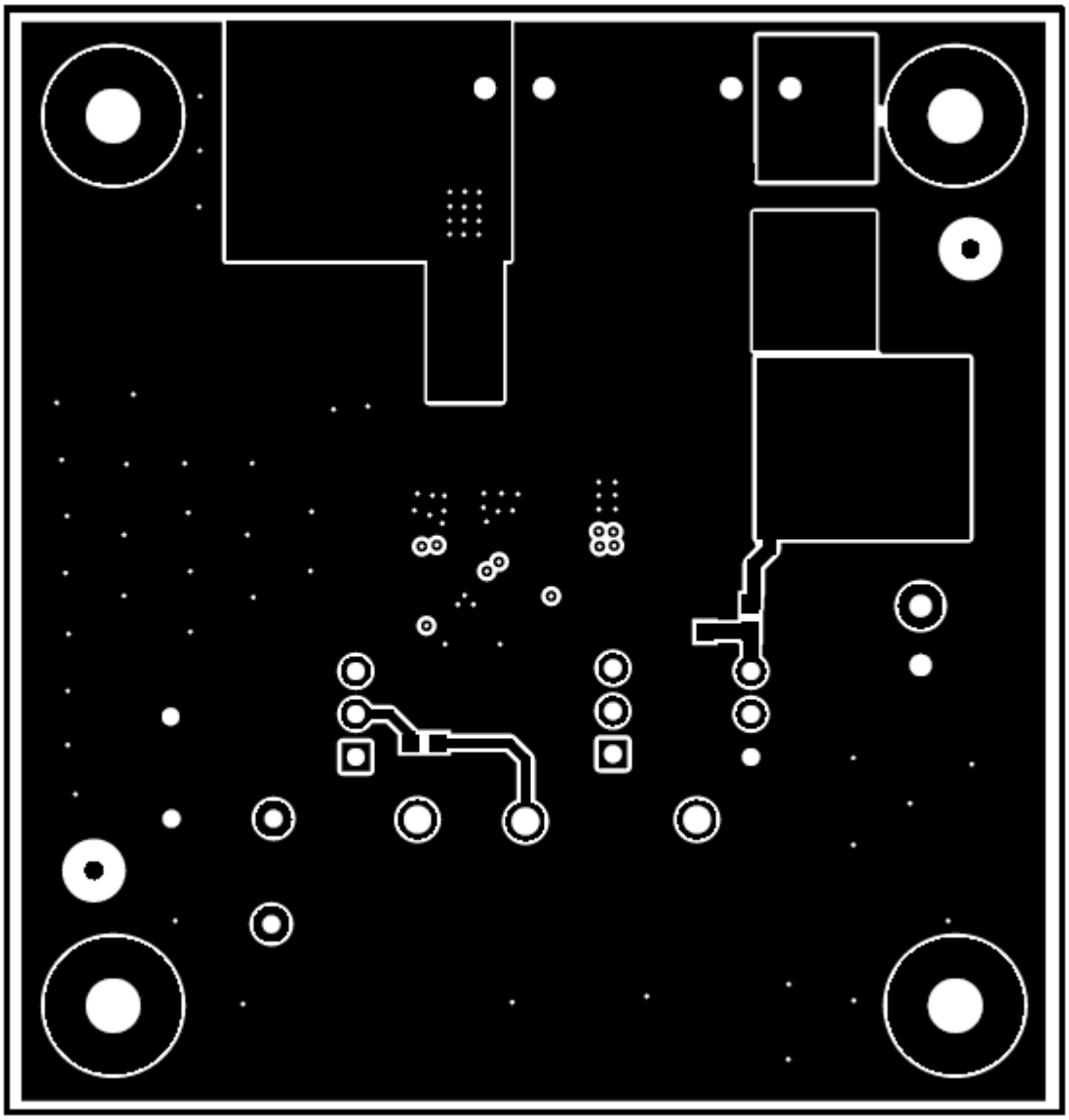


Figure 8. EVM Bottom Copper Layer

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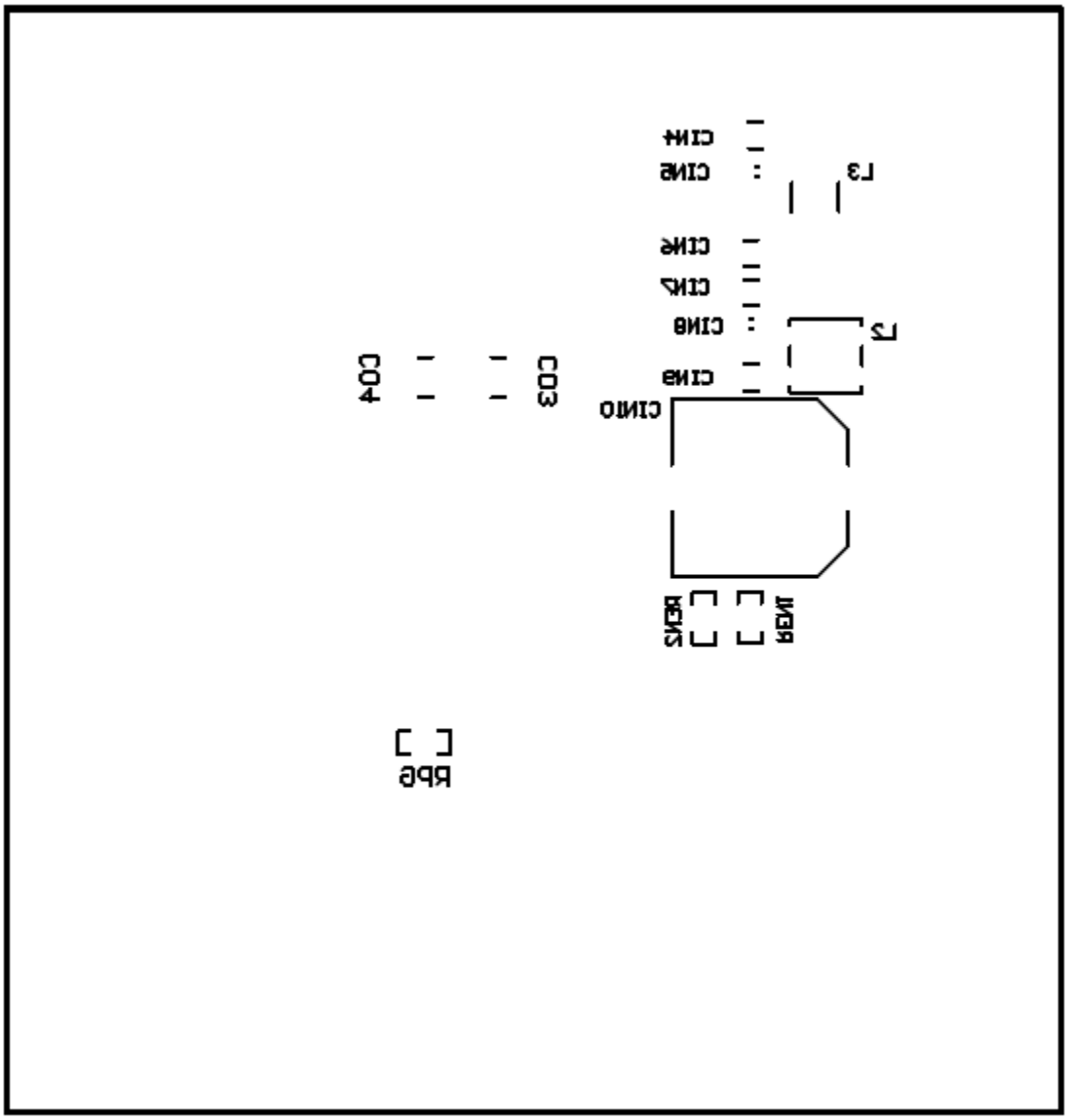


Figure 9. EVM Bottom View

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5 Bill of Materials

Table 2. Bill of Materials

Designator	Description	Manufacturer	Part Number	Quantity
C5	CAP, AL, 68 µF, 63 V, +/- 20%, 0.65 ohm, AEC-Q200 Grade 2, SMD	Panasonic	EEE-FK1J680UP	0
C7, C8	CAP, CERM, 2.2 µF, 100 V,+/- 10%, X7R, 1206	MuRata	GRM31CR72A225KA73L	2
C9, C10, C13	CAP, CERM, 0.047 µF, 100 V, +/- 10%, X7S, 0603	TDK	CGA3E3X7S2A473K080AB	3
C11	CAP, CERM, 4.7 µF, 100 V, +/- 10%, X7S, AEC-Q200 Grade 1, 1210	TDK	CGA6M3X7S2A475K200A	1
C16	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0402	MuRata	GRM155R71E104KE14D	1
C17	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, 0603	TDK	C1608X7R1E105K080AB	1
C18	CAP, CERM, 22 pF, 50 V,+/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	TDK	CGA3E2C0G1H220J080AA	1
H1, H2, H3, H4	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	B&F Fastener Supply	NY PMS 440 0025 PH	2
H5, H6, H7, H8	Standoff, Hex, 0.5"L #4-40 Nylon	Keystone	1902C	4
J1, J2, J3	Terminal Block, 3.5mm Pitch, 2x1, TH	On-Shore Technology	ED555/2DS	3
J4, J5, J6	Header, 100mil, 3x1, Gold, TH	Samtec	HTSW-103-07-G-S	3
L2	Inductor, Shielded, Composite, 1 uH, 8.75 A, 0.01 ohm, SMD	Coilcraft	XAL4020-102MEB	1
L3	Ferrite Bead, 600 ohm @ 100 MHz, 3 A, 1210	Taiyo Yuden	FBMH3225HM601NT	1
LBL1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	Brady	THT-14-423-10	1
R1, R2	RES, 10.0 k, 1%, 0.1 W, 0603	Vishay-Dale	CRCW060310K0FKEA	2
R3	RES, 100 k, 1%, 0.1 W, 0603	Vishay-Dale	CRCW0603100KFKEA	1
R4	RES, 135 k, 0.1%, 0.1 W, 0603	Yageo America	RT0603BRD07135KL	1
R5	RES, 100 k, 1%, 0.1 W, 0603	Yageo America	RC0603FR-07100KL	1
R6	RES, 24.9 k, 1%, 0.1 W, 0603	Vishay-Dale	CRCW060324K9FKEA	1
SH-J1, SH-J2, SH-J3	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA	3
TP1, TP4	Test Point, Multipurpose, Red, TH	Keystone	5000	2
TP2, TP3	Test Point, Multipurpose, Black, TH	Keystone	5001	2
TP5, TP6, TP7	Test Point, Multipurpose, Yellow, TH	Keystone	5014	3
LMR36015AEVM: Adjustable 3.3V/5V Output, 400kHz, 1.5A				
U1	4.2V to 60V, 1.5A Synchronous Step-Down	Texas Instruments	LMR36015AQRNXRQ1	1
C1, C2, C3, C4	CAP, CERM, 22 µF, 16 V, +/- 10%, X7R, 1210	MuRata	GRM32ER71C226KE18L	4
C12, C14	CAP, CERM, 2.2 µF, 100 V,+/- 10%, X7R, 1206	MuRata	GRM31CR72A225KA73L	2
C15	CAP, CERM, 0.047 µF, 100 V, +/- 10%, X7S, 0603	TDK	CGA3E3X7S2A473K080AB	1
L1	Inductor, Shielded, Composite, 10 uH, 3 A, 0.084 ohm, SMD	Coilcraft	XAL4040-103MEB	1
LMR36015FSCEVM: Adjustable 3.3V/5V Output, 2.1MHz, 1.5A				
U1	4.2V to 60V, 1.5A Synchronous Step-Down	Texas Instruments	LMR36015FSCQRNXRQ1	1
C1, C2	CAP, CERM, 22 µF, 16 V, +/- 10%, X7R, 1210	MuRata	GRM32ER71C226KE18L	2
C6	CAP, AL, 47 uF, 80 V, +/- 20%, 0.7 ohm, SMD	Chemi-Con	EMZA800ADA470MJA0G	1

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Table 2. Bill of Materials (continued)

Designator	Description	Manufacturer	Part Number	Quantity
L1	Inductor, Shielded, Composite, 2.2 uH, 5.6 A, 0.04 ohm, SMD	Coilcraft	XAL4020-222MEB	1

6 Test Results

Section 6.1 details the test results from the LMR36015AEVM variant. Section 6.2 details the test results from the LMR36015FSCEVM.

6.1 LMR36015AEVMTest Results

The LMR36015AEVM variant is used for all figures from Figure 10 to Figure 19 variant.

6.1.1 Efficiency and Load Regulation

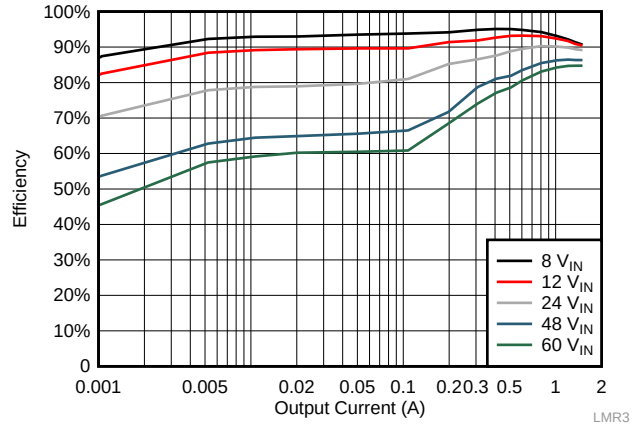


Figure 10. LMR36015AEVM 5 V_{OUT} Efficiency

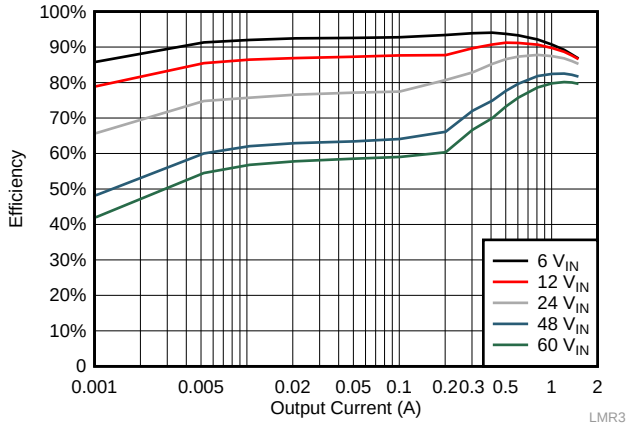


Figure 11. LMR36015AEVM 3.3 V_{OUT} Efficiency

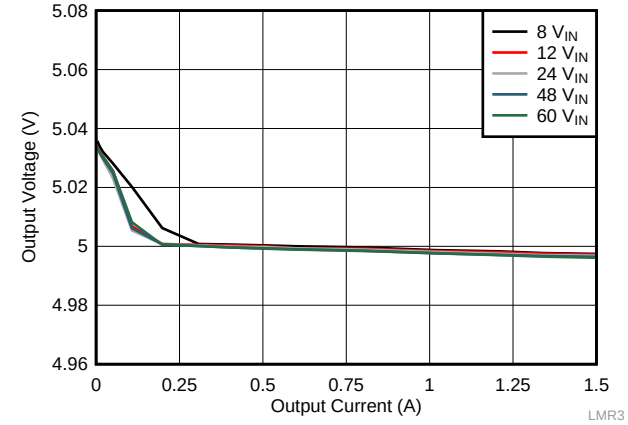


Figure 12. LMR36015AEVM 5 V_{OUT} Load Regulation

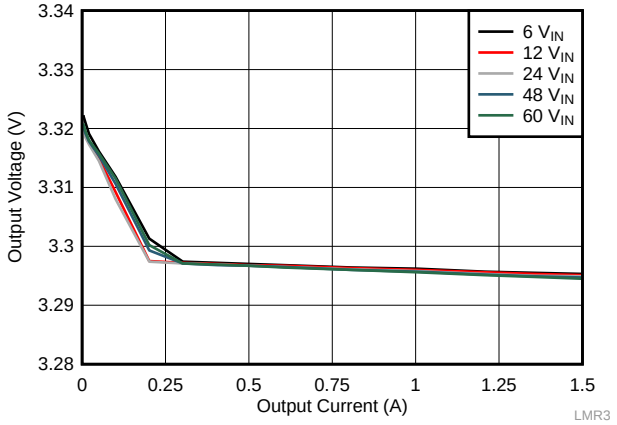


Figure 13. LMR36015AEVM 3.3 V_{OUT} Load Regulation

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6.1.2 Load Transients

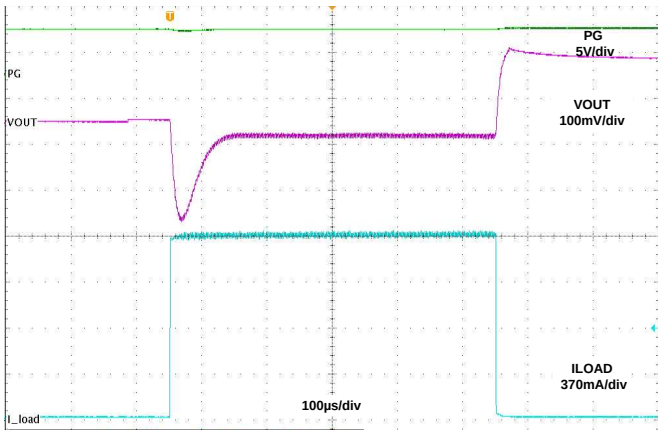


Figure 14. LMR36015AEVM 5 V_{OUT} Load Transient, 24 V_{IN}, I_{OUT} = 0 A to 1.5 A, T_R = T_F = 1 µs

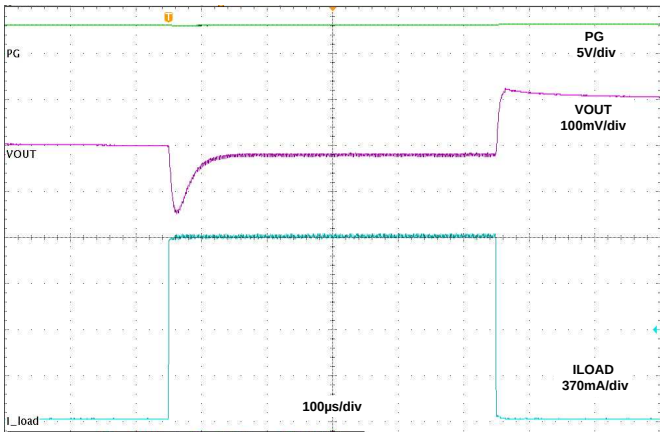


Figure 15. LMR36015AEVM 3.3 V_{OUT} Load Transient, 24 V_{IN}, I_{OUT} = 0 A to 1.5 A, T_R = T_F = 1 µs

6.1.3 Start Up Waveforms

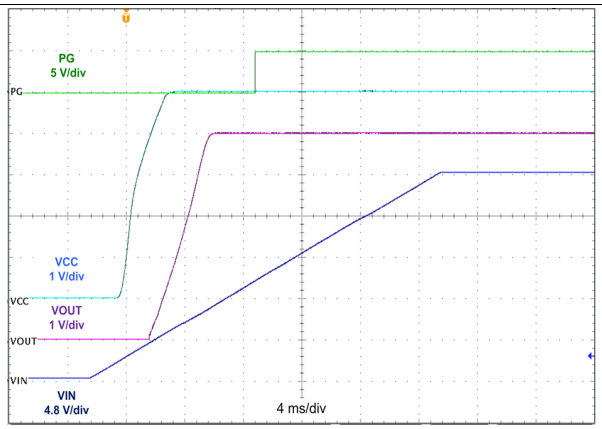


Figure 16. LMR36015AEVM 5 V_{OUT} Start-Up Waveform, 24 V_{IN},1.5 A Load

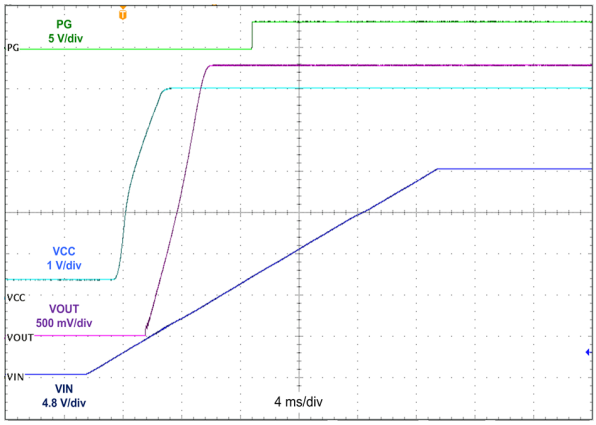


Figure 17. LMR36015AEVM 3.3 V_{OUT} Start-Up Waveform, 24 V_{IN},1.5 A Load

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6.1.4 Conducted EMI

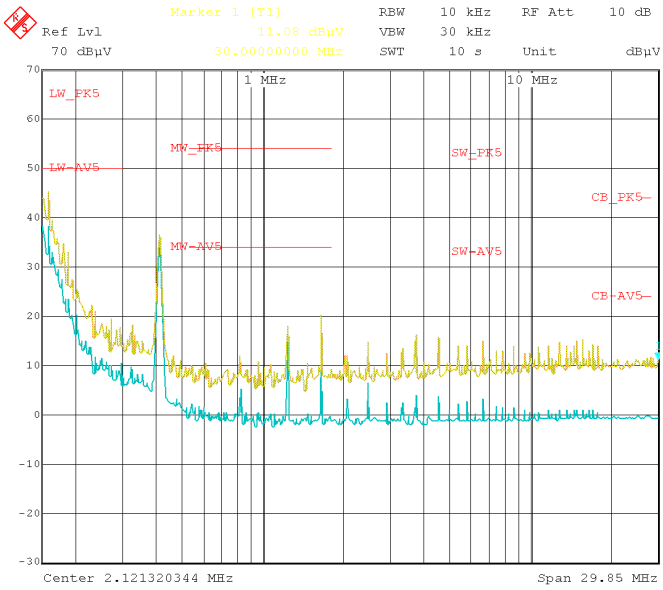


Figure 18. LMR36015A Low Frequency Conducted EMI Results for 5 V_{OUT} (Blue-Average and Yellow-Peak)

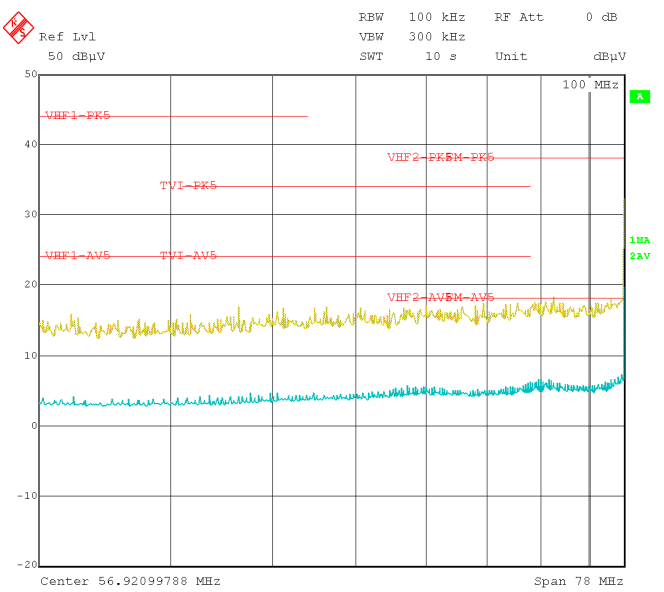


Figure 19. LMR36015AEVM High Frequency Conducted EMI Results for 5 V_{OUT} (Blue-Average and Yellow-Peak)

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6.2 LMR36015FSCEVM Test Results

The LMR36015FSCEVM variant is used for all figures from Figure 20 to Figure 29.

6.2.1 Efficiency and Load Regulation

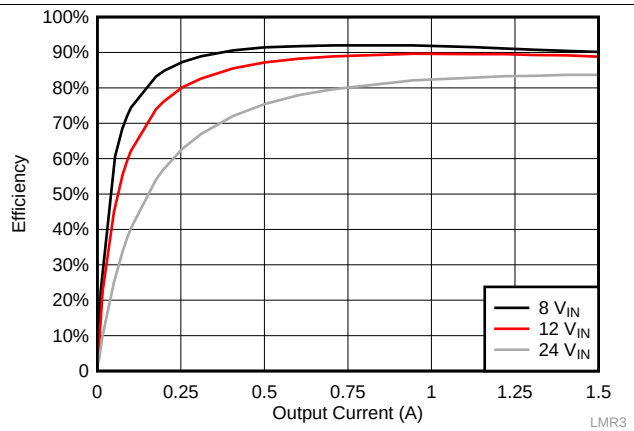


Figure 20. LMR36015FSCEVM 5 V_{OUT} Efficiency

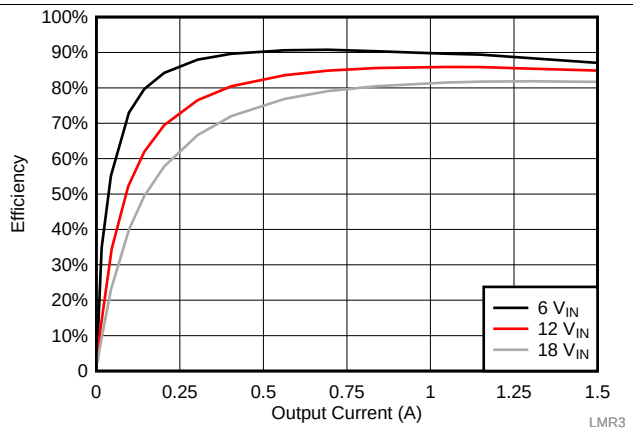


Figure 21. LMR36015FSCEVM 3.3 V_{OUT} Efficiency

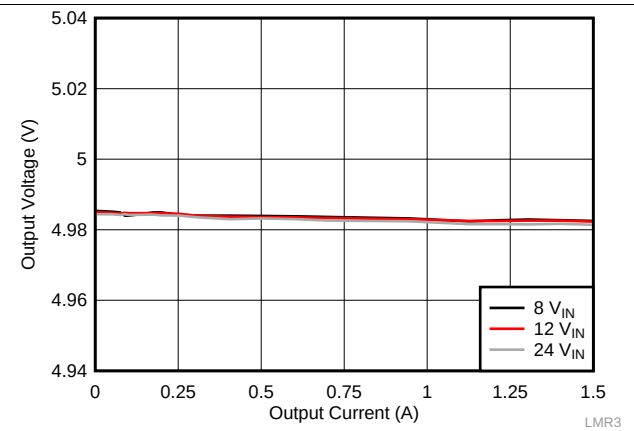


Figure 22. LMR36015FSCEVM 5 V_{OUT} Load Regulation

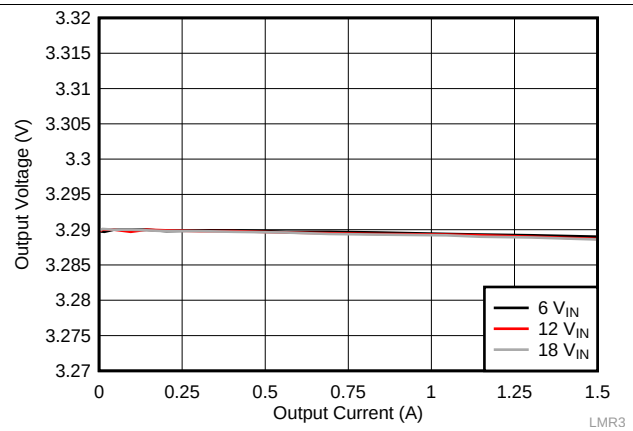


Figure 23. LMR36015FSCEVM 3.3 V_{OUT} Load Regulation

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6.2.2 Load Transients

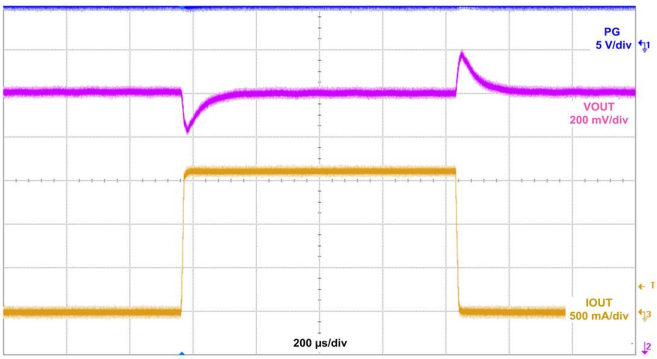


Figure 24. LMR36015FSCEVM 5 V_{OUT} Load Transient, 12 V_{IN}, I_{OUT} = 0 A to 1.5 A, T_R = T_F = 1 µs

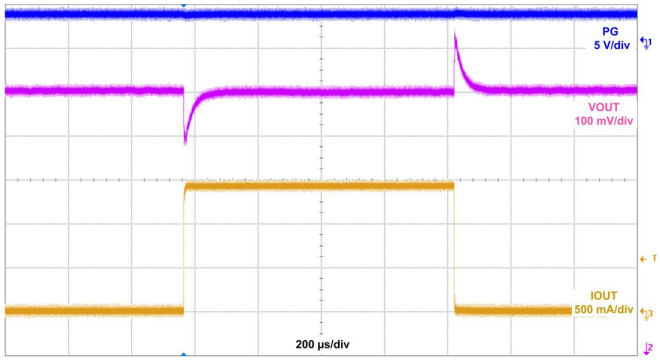


Figure 25. LMR36015FSCEVM 3.3 V_{OUT} Load Transient, 12 V_{IN}, I_{OUT} = 0 A to 1.5 A, T_R = T_F = 1 µs

6.2.3 Start Up Waveforms

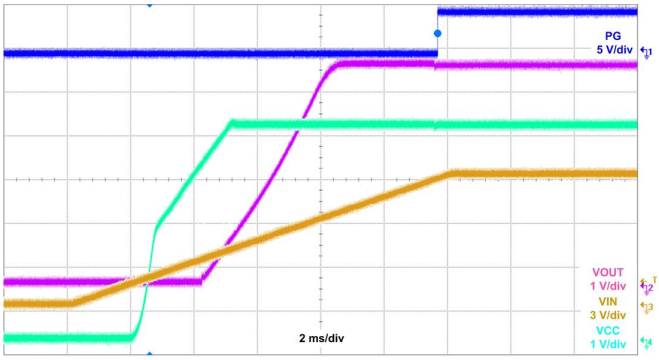


Figure 26. LMR36015FSCEVM 5 V_{OUT} Start-Up Waveform, 12 V_{IN},1.5 A Load

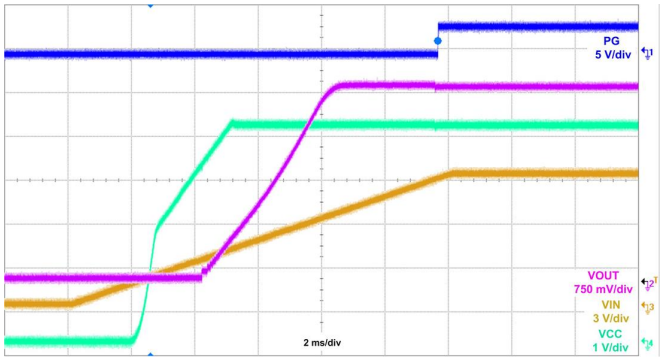


Figure 27. LMR36015FSCEVM 3.3 V_{OUT} Start-Up Waveform, 24 V_{IN},1.5 A Load

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6.2.4 Conducted EMI Results

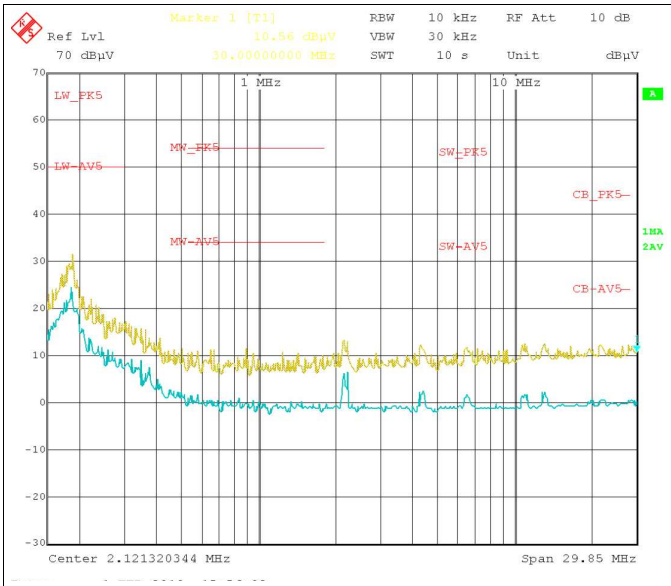


Figure 28. LMR36015FSCEVM Low Frequency Conducted EMI Results for 3.3 V_{OUT} With Spread Spectrum (Blue-Average and Yellow-Peak)

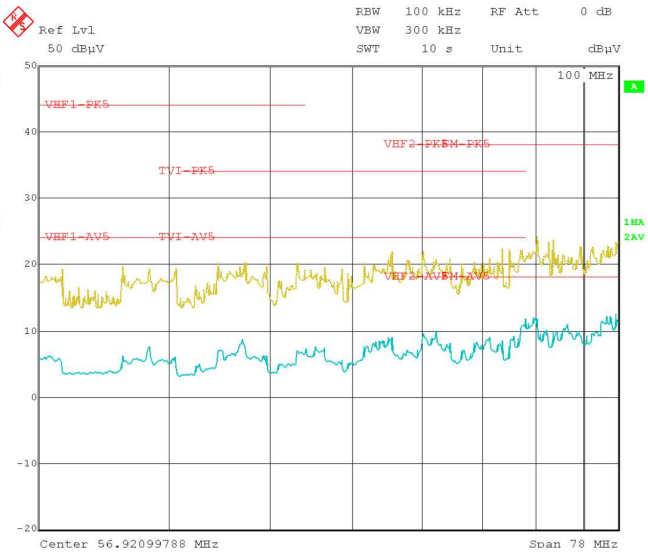


Figure 29. LMR36015FSCEVM High Frequency Conducted EMI Results for 3.3 V_{OUT} With Spread Spectrum (Blue-Average and Yellow-Peak)

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   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.

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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西新宿三井ビル

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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.

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9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

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