

LMR33640EVM User's Guide

The Texas Instruments LMR33640EVM evaluation module (EVM) helps designers evaluate the operation and performance of the LMR33640 buck regulator. The LMR33640 is an easy-to-use synchronous step-down DC/DC converters capable of driving up to 4 A of load current from an input voltage of 3.8 V to 36 V. The LMR33640EVM features a selectable output voltage of 3.3 V or 5 V and a switching frequency of either 400 kHz. See the [LMR33640 SIMPLE SWITCHER 3.8-V to 36-V, 4-A Step-Down Converter Data Sheet](#) for additional features, detailed description, and available options.

Table 1 shows the EVM configuration.

Table 1. Device and Package Configurations

EVM	DEVICE	FREQUENCY/OUTPUT CURRENT
LMR33640EVM	LMR33640ADDA	400 kHz / 4 A

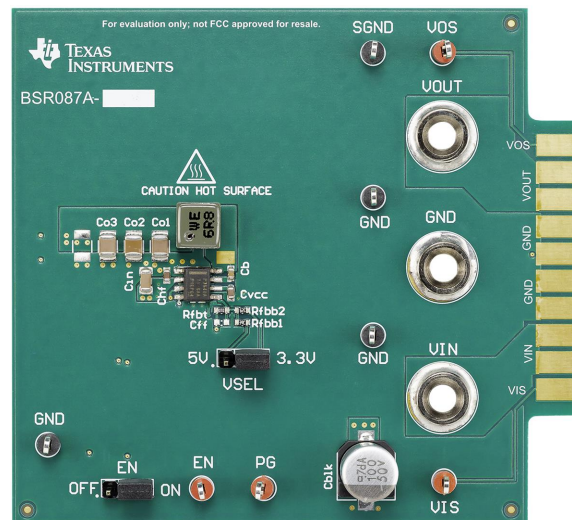


Figure 1. EVM Board Image

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Trademarks

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1 Setup

This section describes the test points and connectors on the EVM and how to properly connect, set up, and use the LMR33640EVM. Either the banana jacks and test points on the top of the board or the card edge connector can be used for connections. See [Figure 2](#) for the top of board connections and [Figure 3](#) for the card edge connections. The following are the functions of the connections:

- **VIN** - Input supply to EVM. Connect to a suitable input supply. See the [LMR33640 SIMPLE SWITCHER 3.8-V to 36-V, 4-A Step-Down Converter Data Sheet](#) for input supply requirements.
- **GND** - System ground
- **VOUT** - Output of EVM. Connect to desired load.
- **VOS** - Output voltage sense connection
- **VIS** - Input voltage sense connection
- **GNDS** - Ground sense point for analog measurements

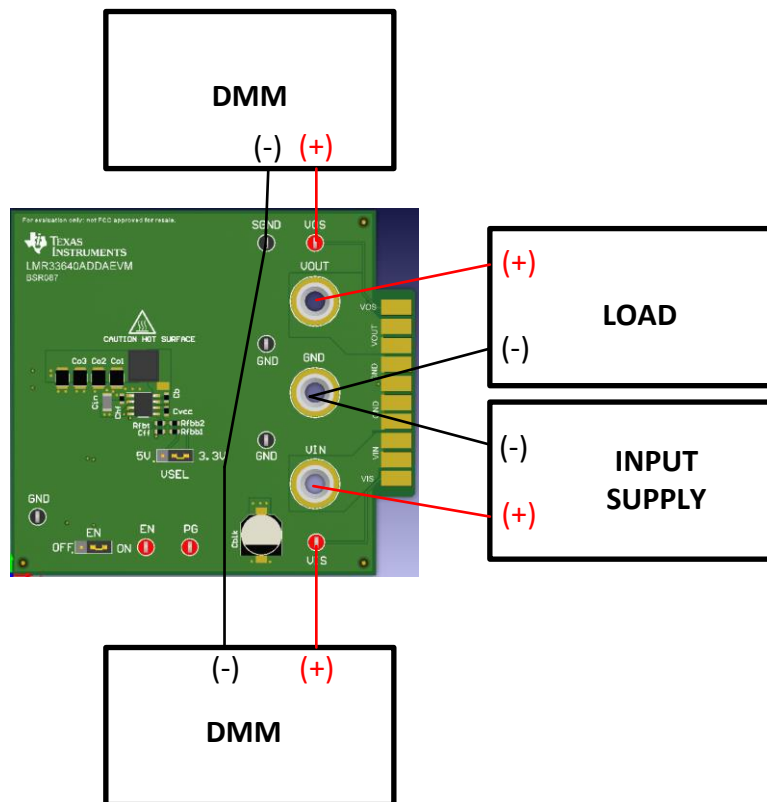


Figure 2. EVM Board Connections

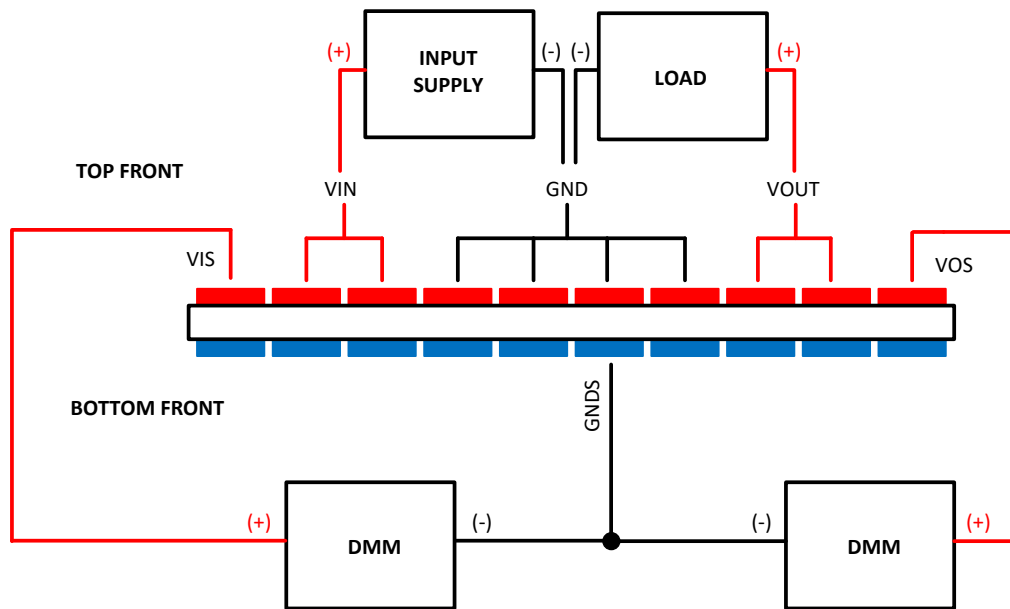


Figure 3. EVM Card Edge Connections

1.1 Jumpers

See [Figure 4](#) for jumper locations.

- **EN** - This jumper allows the EN input to be connected to either ground (OFF) or VIN (ON). Remove this jumper to allow an external logic signal to control the EN function.
- **VOUT** - This jumper is used to select one of the two pre-defined output voltages. The "3.3V" position provides a 3.3 V output while the "5V" position provides a 5 V output.

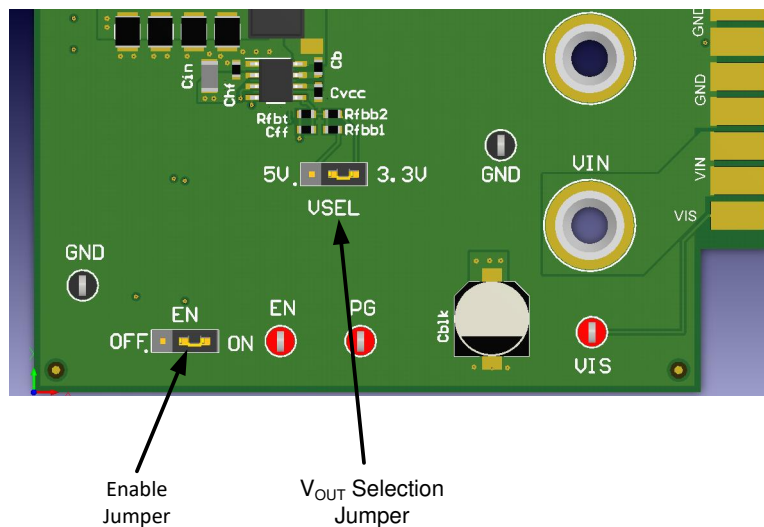


Figure 4. Jumper Locations

1.2 Test Points

- **VIN** - Input supply to EVM. Connect to a suitable input supply. See the [LMR33640 SIMPLE SWITCHER 3.8-V to 36-V, 4-A Step-Down Converter Data Sheet](#) for input supply requirements.
- **GND** - System power ground

- **VOUT** - Power output of EVM. Connect to desired load.
- **VOS** - Output voltage sense connection. Connect to DMM. This is also used for frequency response analyzer connection.
- **VIS** - Input voltage sense connection. Connect to DMM.
- **GNDS** - Ground sense point for analog measurements. Connect to DMM.
- **VCC** - Test point to measure internal VCC of device; approximately 5 V. An on-board PGOOD pullup resistor is connected to VCC.
- **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 through a 20 k Ω resistor. The power good function can be monitored at this test point.
- **A** - Connection for frequency response analyzer (on bottom of board). See [Figure 5](#).

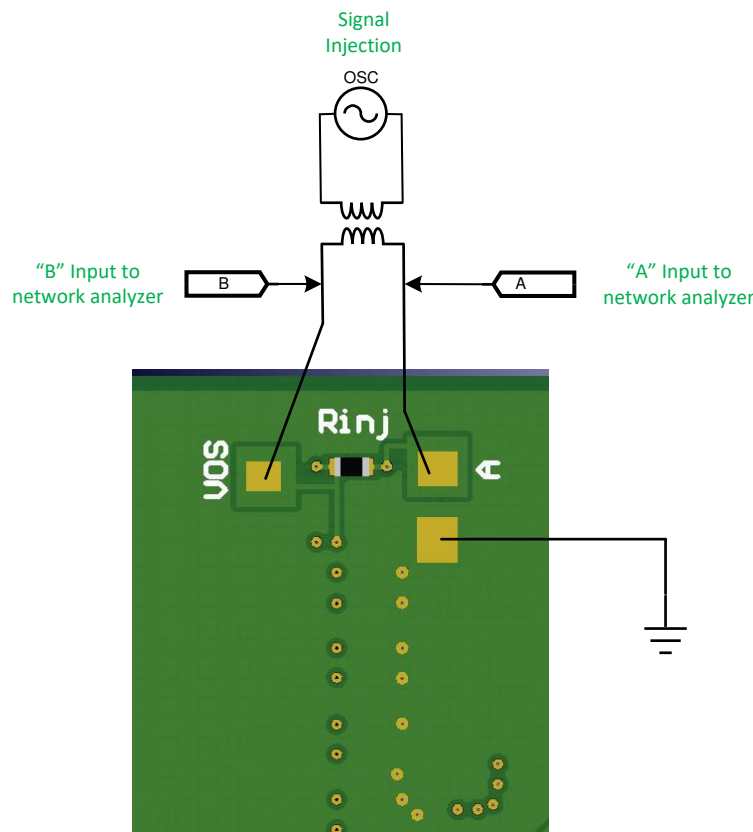


Figure 5. FRA Setup

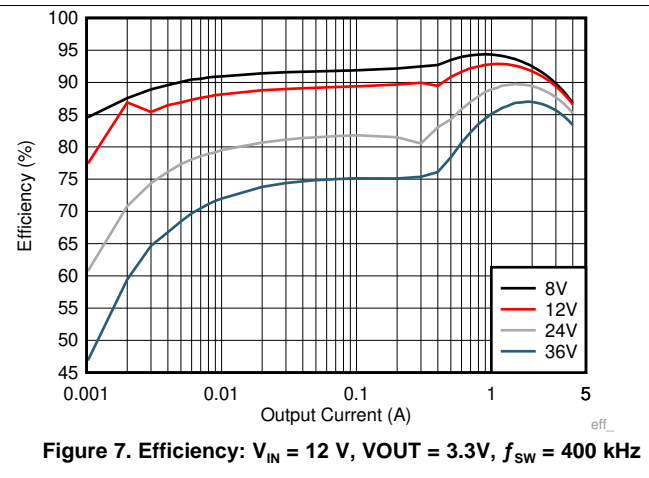
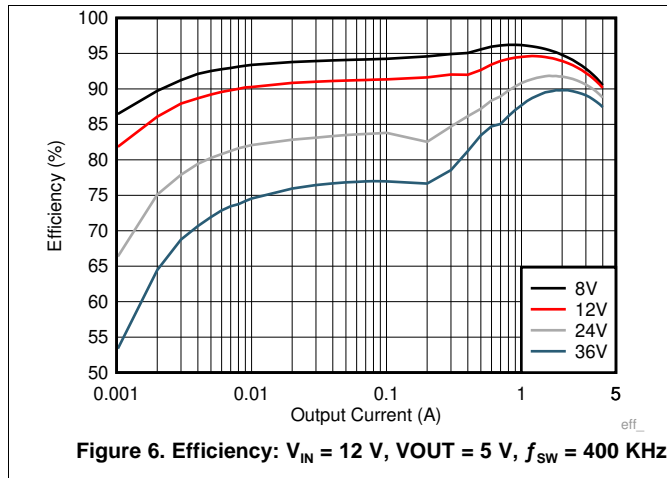
2 Operation

Once the previously described connections are made and the appropriate jumpers are set, the EVM is ready to use. If external control of the EN input is desired, remove the EN jumper and apply the external signal to the EN test point and GND. The PGOOD output is pulled up to VCC through a 20-k Ω resistor. This way, the PGOOD signal swings from 0 V to about 5 V to indicate when the output voltage is either outside or inside of the PGOOD window, respectively. If an external pullup and supply is desired for the PGOOD function, remove the 20-k Ω resistor and pull the PGOOD test point up to the desired voltage through an appropriate resistance. See the [LMR33640 SIMPLE SWITCHER 3.8-V to 36-V, 4-A Step-Down Converter Data Sheet](#) for more details.

The output voltage of the EVM can be selected by the VOUT jumper to either 3.3 V or 5 V. Other values of output voltage can be programmed by changing the value of R_{FBB} on the EVM. In addition, the values of the inductor and the output capacitance may also need to be changed. See the [LMR33640 SIMPLE SWITCHER 3.8-V to 36-V, 4-A Step-Down Converter Data Sheet](#) for more information.

The EVM has been designed for maximum flexibility regarding component selection. This allows the user to place preferred components, such as the inductor and capacitors, on the board and test the performance of the regulator. The power supply system can be tested before committing the design to production.

3 Performance Curves



4 Schematic

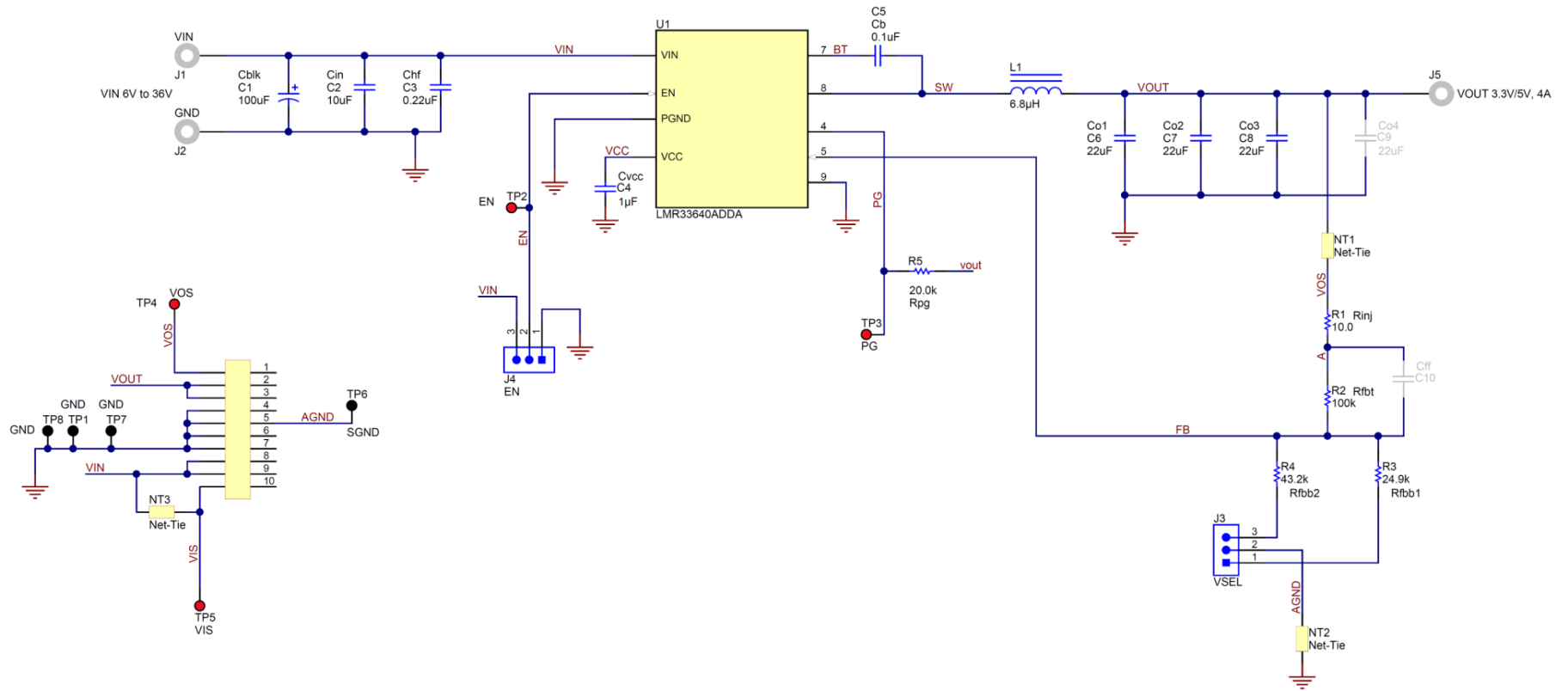


Figure 8. LMR33640EVM Schematic

5 Board Layout

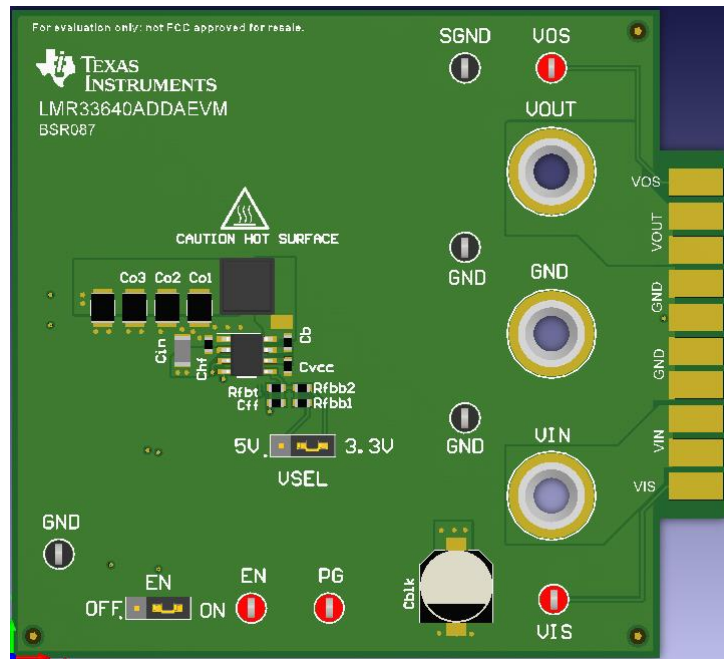


Figure 9. Top View of EVM

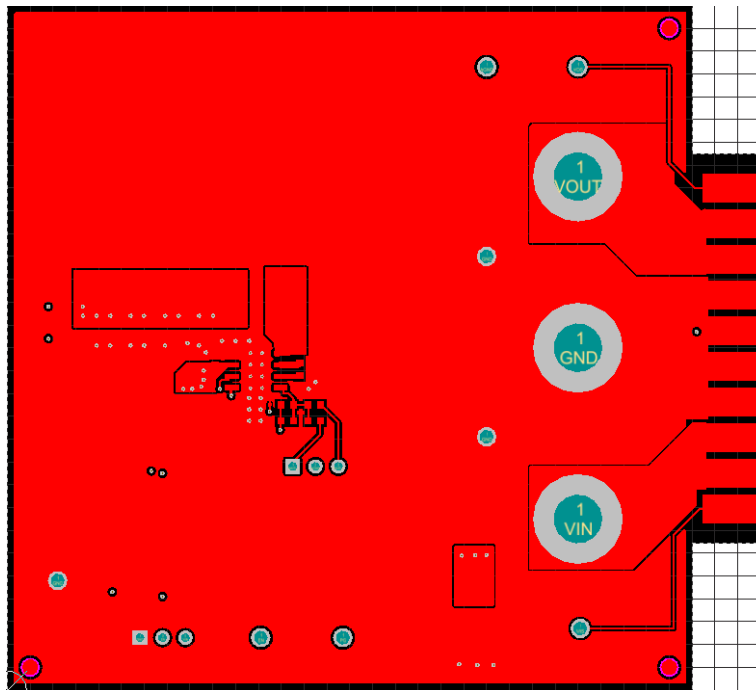


Figure 10. EVM Top Copper Layer

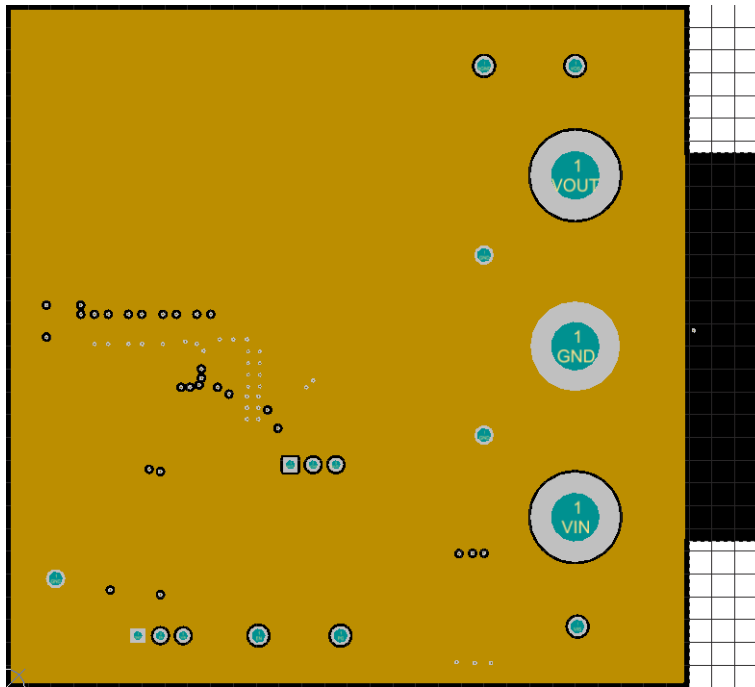


Figure 11. EVM Mid Layer One

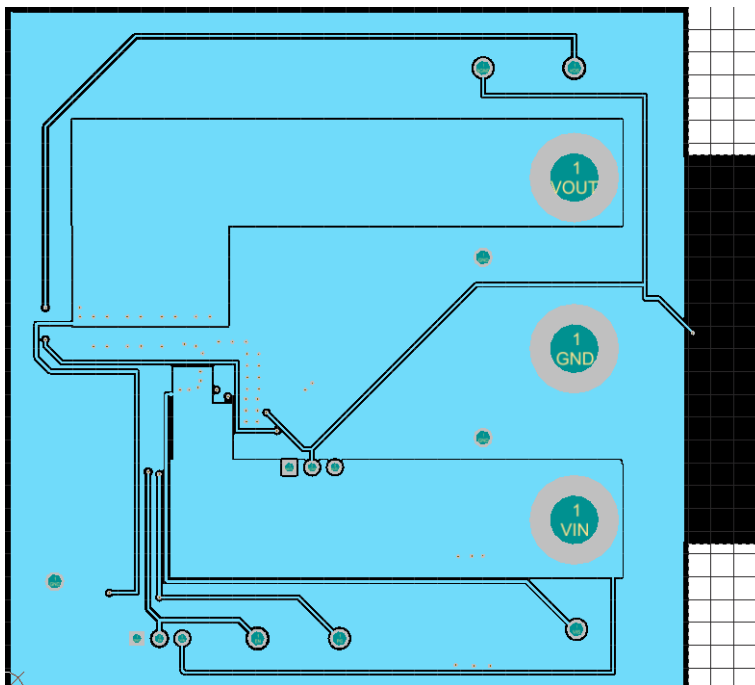


Figure 12. EVM Mid Layer Two

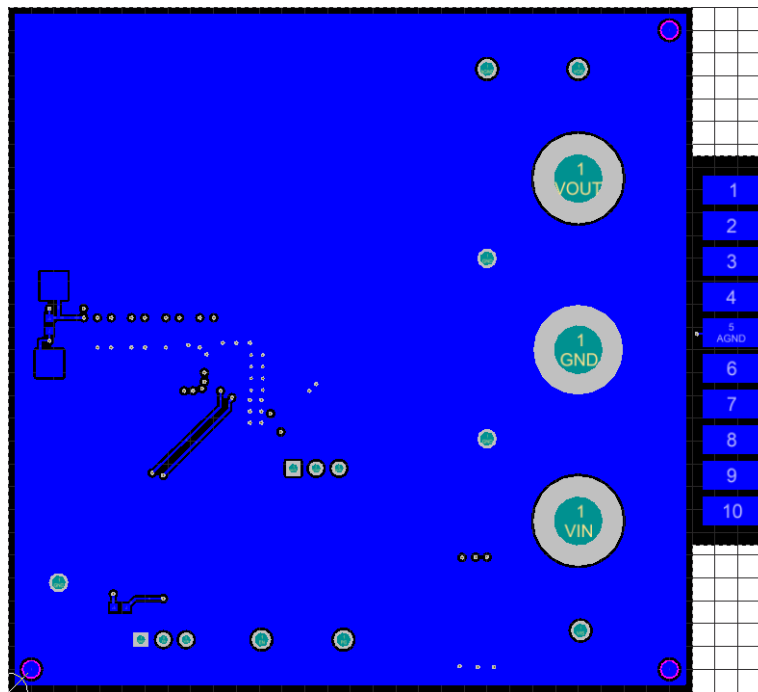


Figure 13. EVM Bottom Copper Layer

6 Bill of Materials

Table 2. BOM for LMR33640EVM

DESIGNATOR	IDENTIFIER	DESCRIPTION	MANUFACTURER	PART NUMBER	QTY
C1	Cblk	CAP, AL, 100 μ F, 50 V, \pm 20%, SMD	Chemi-Con	EMVA500ADA101MHA0G	1
C2	Cin	CAP, CERM, 10 μ F, 50 V, \pm 10%, X5R, 1206_190	Samsung	CL31A106KBHNNNE	1
C3	Chf	CAP, CERM, 0.22 μ F, 50 V, \pm 10%, X7R, 0603	MuRata	GRM188R71H224KAC4D	1
C4	Cvcc	CAP, CERM, 1 μ F, 16 V, \pm 20%, X7R, 0603	Samsung	CL10B105MO8NNWC	1
C5	Cb	CAP, CERM, 0.1 μ F, 25 V, \pm 10%, X7R, 0603	AVX	06033C104KAT2A	1
C6	Co1	CAP, CERM, 22 μ F, 16 V, \pm 20%, X7R, AEC-Q200 Grade 1, 1210	TDK	CGA6P1X7R1C226M250AC	1
C7	Co2	CAP, CERM, 22 μ F, 16 V, \pm 20%, X7R, AEC-Q200 Grade 1, 1210	TDK	CGA6P1X7R1C226M250AC	1
C8	Co3	CAP, CERM, 22 μ F, 16 V, \pm 20%, X7R, AEC-Q200 Grade 1, 1210	TDK	CGA6P1X7R1C226M250AC	1
C9	Co4	CAP, CERM, 22 μ F, 16 V, \pm 20%, X7R, AEC-Q200 Grade 1, 1210	TDK	CGA6P1X7R1C226M250AC	0
C10	Cff	CAP, CERM, 10 pF, 50 V, \pm 5%, C0G/NP0, 0603	TDK	CGA3E2NP01H100D080AA	0
J1	VIN	Standard Banana Jack, Uninsulated, 8.9 mm	Keystone	575-8	1
J2	GND	Standard Banana Jack, Uninsulated, 8.9 mm	Keystone	575-8	1
J5	VOUT	Standard Banana Jack, Uninsulated, 8.9 mm	Keystone	575-8	1
J3	VSEL	Header, 100 mil, 3x1, Gold, TH	Samtec	HTSW-103-07-G-S	1
J4	EN	Header, 100 mil, 3x1, Gold, TH	Samtec	HTSW-103-07-G-S	1
L1	L1	Inductor, Shielded, Hyperflux, 6.8 μ H, 6.5 A, 0.01936 Ω , SMD	Wurth Elektronik	74439346068	1
R1	Rinj	RES, 10.0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW060310R0FKEA	1
R2	Rfbt	RES, 100 k, 1%, 0.1 W, 0603	Yageo America	RC0603FR-07100KL	1
R3	Rfbb1	RES, 24.9 k, 1%, 0.1 W, 0603	Yageo America	RC0603FR-0724K9L	1
R4	Rfbb2	RES, 43.2 k, 1%, 0.1 W, 0603	Yageo America	RC0603FR-0743K2L	1
R5	Rpg	RES, 20.0 k, 1%, 0.1 W, 0603	Yageo America	RC0603FR-0720KL	1
SH-J1, SH-J2		Shunt, 100 mil, Gold plated, Black	3M	969102-0000-DA	2
TP-2, TP-3, TP-4, TP-5		Test Point, Multipurpose, Red, TH	Keystone	5010	4
TP-1, TP-6, TP-7, TP-8		Test Point, Multipurpose, Black, TH	Keystone	5011	4
U1		SIMPLE SWITCHER 3.8-V to 36-V, 4-A Synchronous Step-Down Converter	Texas Instruments	LMR33640ADDA	1

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.
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 - 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.
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 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
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 - 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 DEGRADATION 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/lstds/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/lstds/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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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.
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