

EVM User's Guide: LMR61440QEVM

LMR61440-Q1 Evaluation Module



Description

The Texas Instruments LMR61440QEVM evaluation module helps designers evaluate the operation and performance of the LMR604x0-Q1 wide-input buck converters. The EVM operates over a wide input voltage range of 8V to 36V to provide a regulated 3.3V output up to 4A load at 2.2MHz switching frequency.

Get Started

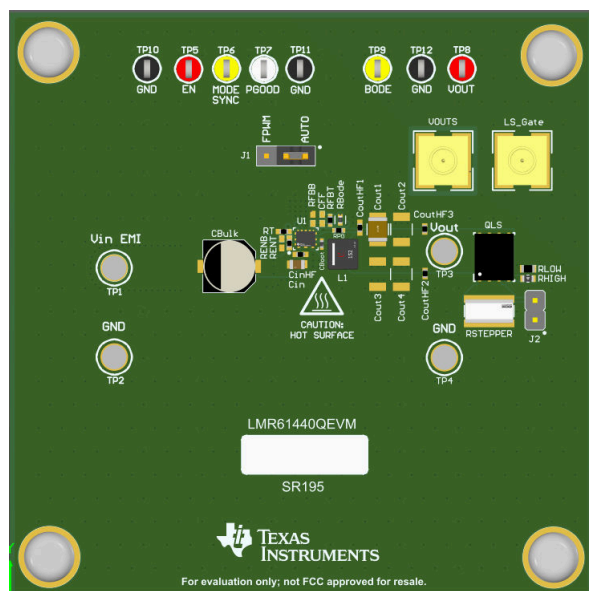
1. Order the EVM [here](#).
2. Prepare the bench setup per the user's guide instructions.
3. Power up the EVM by following the recommended steps.
4. Run tests and measurements. Beware of possible high component temperatures.

Features

- Input voltage range: 8V to 36V
- Output voltage: fixed at 3.3V/adjustable with a resistive ladder
- Load current: 0 to 4A
- Switching frequency: 2.2MHz
- SMB test point for output voltage noise measurements
- Internal spread spectrum capability
- Selectable forced pulse-width modulation or pulse-frequency modulation
- Supports other variants of the IC by replacing some components

Applications

- [Advanced driver assistance systems \(ADAS\)](#)
- [Body electronics and lighting](#)
- [Infotainment and cluster](#)



LMR61440QEVM

1 Evaluation Module Overview

1.1 Introduction

The Texas Instruments LMR61440QEVm evaluation module helps designers evaluate the operation and performance of the LMR604x0-Q1 wide-input buck converters. The LMR61440-Q1 is an easy-to-use, synchronous step-down DC/DC converter capable of delivering up to 4A of load current from an input voltage of 3V up to 36V. The LMR61440QEVm features an output voltage of 3.3V and a switching frequency of 2.2MHz that can support a load up to 4A. The LMR61440QEVm can support output voltage regulation accuracy better than 1% and the output voltage set-point is adjustable using an external resistor divider.

The LMR61440-Q1 is available in a 9-pin RAK WQFN package with pre-programmed settings to reduce component count and achieve high density designs. The LMR61440QEVm comes with the variant of the LMR614403SRAKRQ1, which allows for adjustable output voltage, external synchronization, and spread spectrum options at a fixed 2.2MHz switching frequency. See the LMR614x0-Q1 datasheet for the detailed information of all four variants of the device. The EVM uses the LMR61440-Q1 with the following features:

- Wide input voltage range
- Wide duty-cycle range
- Integrated high-side and low-side power MOSFETs
- Cycle-by-cycle over current protection
- Internal loop compensation
- Designed for low electromagnetic interference (EMI) requirements

1.2 Kit Contents

The package includes:

1. LMR61440-Q1 evaluation module (LMR61440QEVm) that includes the LMR614403SRAKRQ1
2. EVM Disclaimer Read Me

1.3 Specification

The following table gives a summary of the LMR61440QEVm performance. Due to variations in test setup, expect deviations from the measurements listed.

SPECIFICATIONS		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V _{IN}	Input voltage		8	12	36	V
V _{OUT}	Output voltage	V _{IN} = 13.5V		3.3	3.32	V
F _{SW}	Switching frequency			2.2		MHz
I _{OUT}	Output current range		0		4	A
Peak efficiency		I _{OUT} = 2.2A, V _{IN} = 13.5V		89.4%		

1.4 Device Information

The LMR61440-Q1 is a 36V, 4A, DC/DC buck converter that features synchronous rectification to achieve high conversion efficiency in a small footprint.

Table 1-1. Device and Package Configurations

EVM	U1	FREQUENCY	SPREAD SPECTRUM	CURRENT	PIN 1 TRIM
LMR61440QEVm	LMR614403SRAKRQ1	2.2MHz	Enabled	4A	Adjustable output voltage and MODE select

2 Hardware

2.1 EVM Setup

This section describes the test points and connectors on the EVM and how to properly connect, set up, and use the LMR61440QEVM.

The EVM uses the LMR61440-Q1 converter, which includes MODE/SYNC capability. This capability means that the device can operate in pulse frequency modulation (PFM) light-load mode when this pin is tied to GND. TI has observed additional output voltage ripple at input voltages close to the output voltage when the device is operating in PFM light-load mode. To see improved performance, TI recommends to configure the EVM to operate in forced pulse width modulation (FPWM) mode.

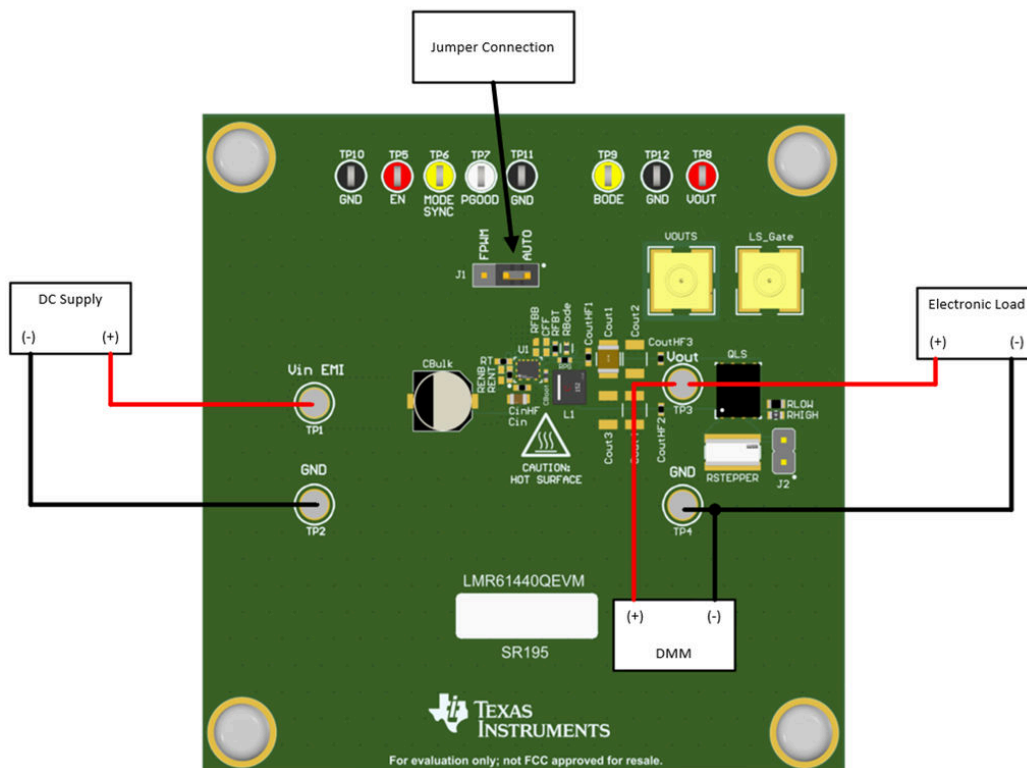


Figure 2-1. EVM Board Connections

The test setup consists of the following instruments in addition to the EVM board:

- **Power supply:** the input DC voltage source must be capable of supplying 36V and 4A.
- **Load:** the load must be an electronic, constant-current (CC) or constant-resistance (CR) mode load, capable of supporting 4A of load current at 3.3V. Disconnect the electronic load when performing no-load input current tests.
- **Multimeters:**
 - **Voltmeter 1:** measures input voltage at VIN (TP1) and GND (TP2).
 - **Voltmeter 2:** measures output voltage at VOUT (TP3 or UOUTS) and GND (TP4).
 - **Ammeter 1:** measures input current.
 - **Ammeter 2:** measures output current.
- **Oscilloscope:** with the scope set to 20MHz bandwidth and AC coupling, measure the output voltage ripple directly across an output capacitor with a short ground lead. Place the oscilloscope probe tip on the positive terminal of the output capacitor, and the ground lead on the negative terminal of the output capacitor. TI does not recommend using a long-leaded ground connection because the connection can induce additional noise due to a large ground loop. To measure other waveforms, adjust the oscilloscope as necessary.
- **Load current transient:**

A load transient generator is provided on the EVM. Connect a suitable pulse generator to the "LS_gate" SMB connector and adjust the load current pulse amplitude and duration as desired, while monitoring the voltage at J2. A 10mΩ sense resistor is used, providing a scale factor of 10mV/A. The pulse duty cycle must be kept low to avoid damaging the MOSFET. The output voltage can be monitored use the VOUTS SMB or directly across the output capacitors. TI recommends use of a high speed differential probe. See also [Figure 2-2](#).

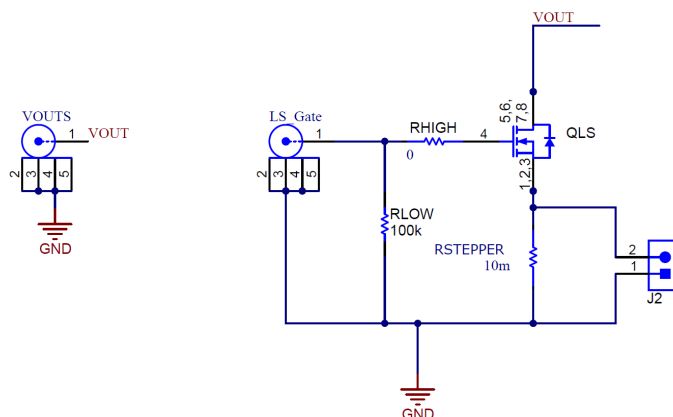


Figure 2-2. Load Transient Generator

2.1.1 Quick Start

1. Connect the voltage supply between the VIN+ and VIN- test points.
2. Connect the load between the VOUT and GND test points.
3. Set the supply voltage at an appropriate level between 8V to 36V. 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 $V_{OUT} = 3.3V$.
5. Monitor the output voltage. The load current must be 4A or less with the LMR61440-Q1 device.

2.1.2 Test Points

The test points on the top of the board are used for connecting to the input and output of the EVM. See [Table 2-1](#) for a description of the test points.

Table 2-1. EVM Test Points

TEST POINT	SIGNAL	DESCRIPTION
TP1	VIN	Input supply to EVM including an EMI filter. Connect to a good input supply. Connect at this point for conducted EMI test.
TP2	GND	Ground connection for the input supply
TP5	EN	This test point is connected to the EN pin from the IC.
TP7	PGOOD	This test point is connected to the PGOOD pin from the IC. The test point is an open-drain output of the PGOOD pin. Using the resistor R3, the PGOOD pin can be tied to VOUT through a pullup resistor or left open.
TP6	MODE/SYNC	This test point is connected to the MODE/SYNC pin from the IC. This test point is connected to GND through R8.
TP10, TP11	GND	This test point is connected to GND.
TP3	VOUT	Output voltage to EVM
TP4	GND	Ground connection for load
TP8, TP9, TP12	VOUT/BODE/GND	Used to connect FRA to measure Bode plot
J2	Isense	Used to sense load current transient when using transient current generator
LS_gate	Load transient input	Used to provide gate drive to load transient current generator
VOUTS	Output voltage sense point	Used to provide high quality output voltage sensing to oscilloscope or other sensitive instrument

3 Implementation Results

3.1 Performance Data and Results

Actual performance data can be affected by measurement techniques and environmental variables. These curves are presented for reference and can differ from actual field measurements. Unless otherwise stated, $V_{in} = 13.5V$, $V_{out} = 3.3V$, and $F_{sw} = 2.2MHz$.

3.1.1 Efficiency, Load Regulation, and Noise

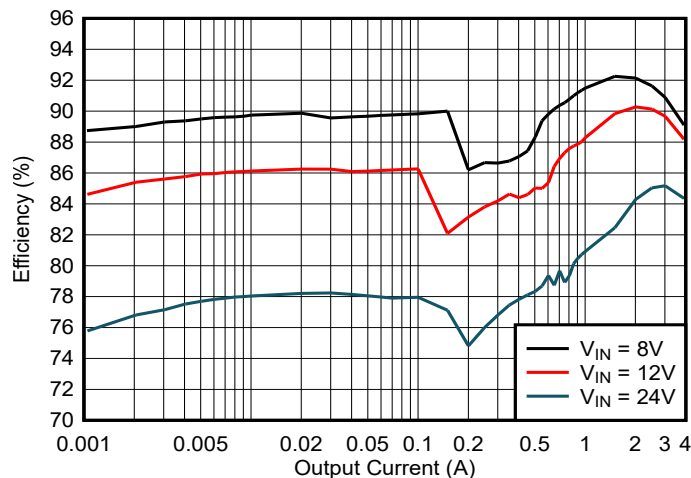


Figure 3-1. Conversion Efficiency (2.1MHz)

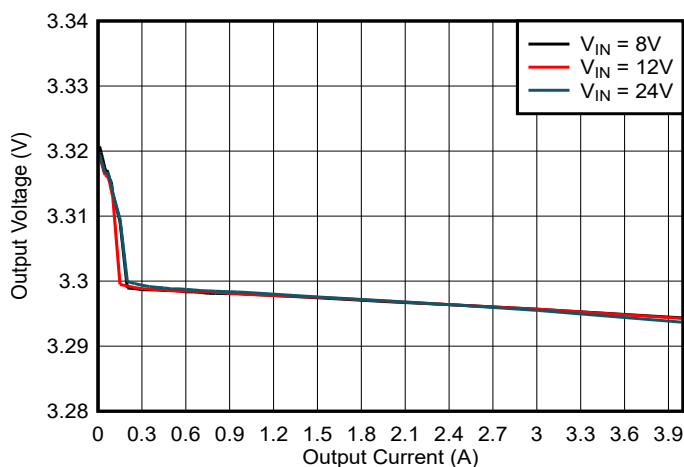


Figure 3-2. Output Voltage Regulation

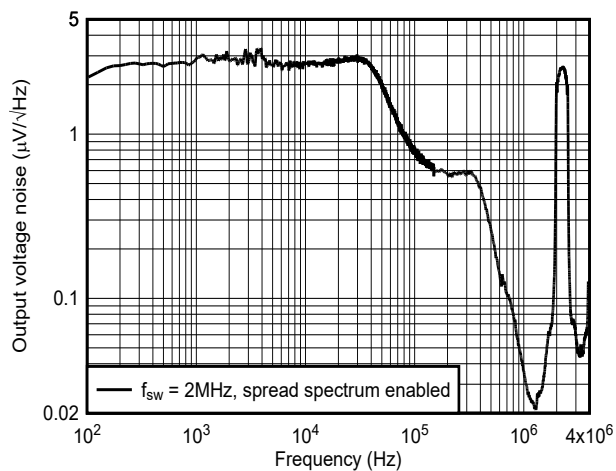
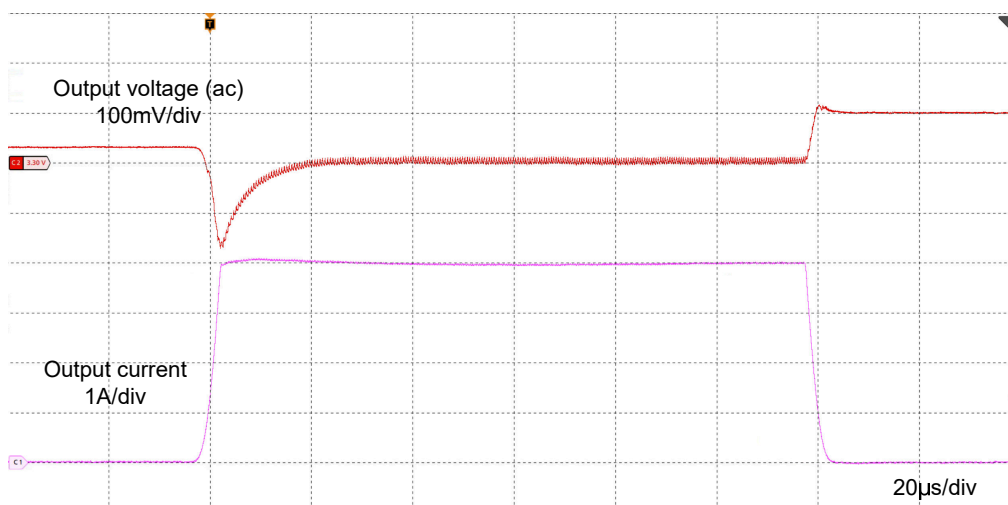
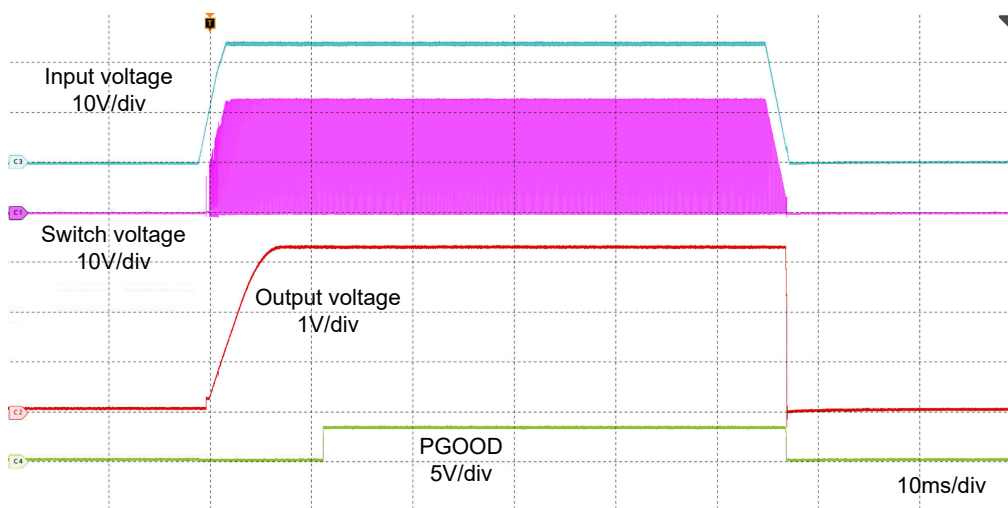


Figure 3-3. Output Voltage Noise

3.1.2 Load Transients

Figure 3-4. Load Transient, $I_{\text{OUT}} = 0\text{mA}$ to 4A

3.1.3 Start-Up and Shutdown

Figure 3-5. V_{in} Start and Stop, $I_{\text{OUT}} = 4\text{A}$

4 Hardware Design Files

4.1 Schematic

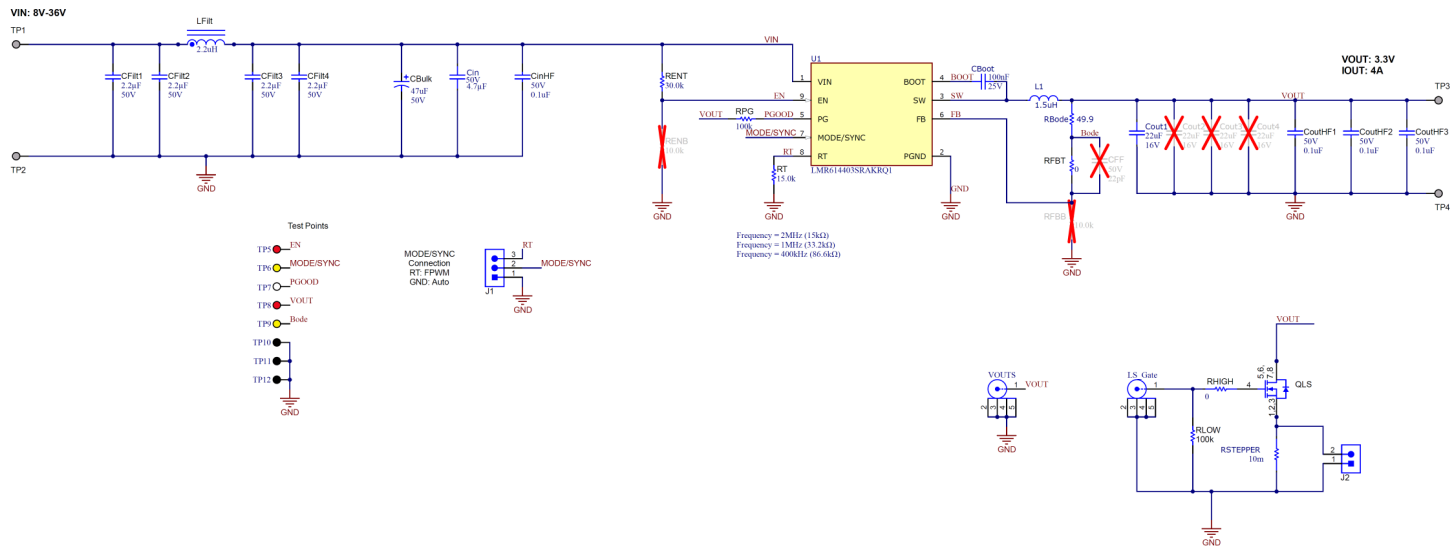


Figure 4-1. LMR61440QEVMSchematic

4.2 Board Layout

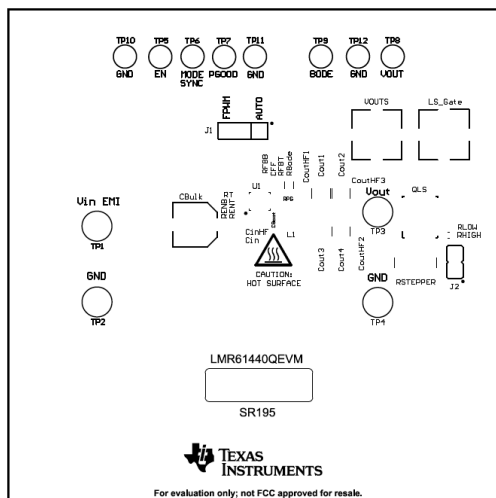


Figure 4-2. EVM Top Overlay

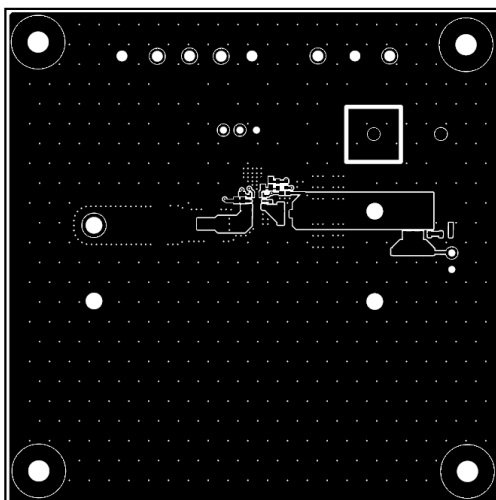


Figure 4-3. EVM Top Copper Layer

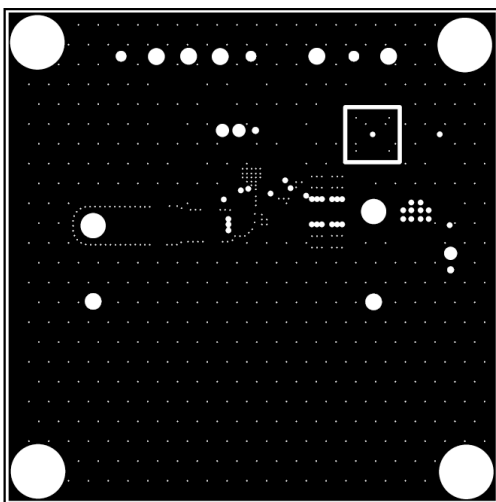


Figure 4-4. EVM Mid Layer One

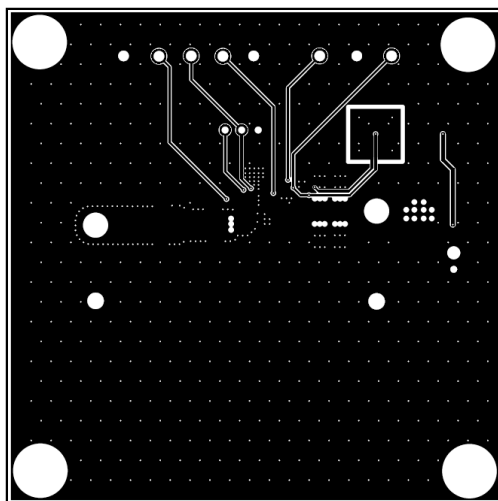


Figure 4-5. EVM Mid Layer Two

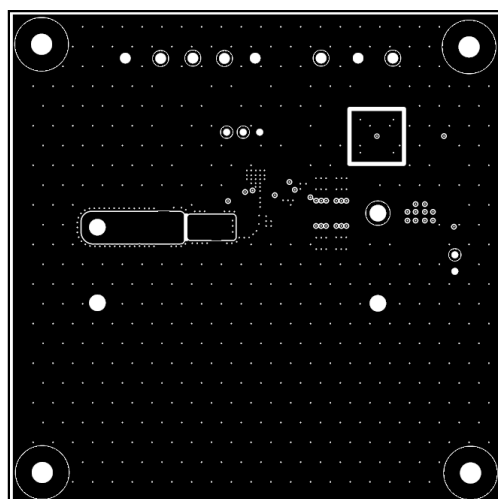


Figure 4-6. EVM Bottom Copper Layer

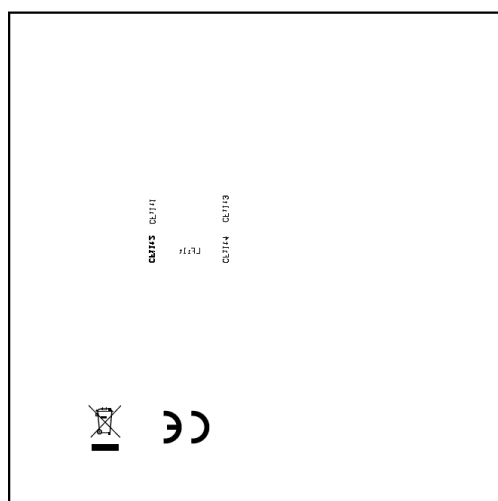


Figure 4-7. EVM Bottom Overlay

4.3 Bill of Materials

Table 4-1. Bill Of Materials

DESIGNATOR	QUANTITY	DESCRIPTION	PART NUMBER	PACKAGE	MANUFACTURER
!PCB1	1	Printed Circuit Board	SR195		Any
CBoot	1	0.1 μ F $\pm$ 10% 25V Ceramic Capacitor X7R 0402 (1005 Metric)	CS0402KRX7R8BB104	FP-CS0402KRX7R8BB104_0402-MFG	Yageo
CBulk	1	CAP, AL, 47 μ F, 50V, +/- 20%, 0.68ohm, AEC-Q200 Grade 2, SMD	EEE-FT1H470AP	Panasonic_D	Panasonic
CFilt1, CFilt2	2	CAP, CERM, 2.2 μ F, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	CGA4J3X7R1H225K125AB	0805_HV	TDK
CFilt3, CFilt4	2	CAP, CERM, 2.2 μ F, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	CGA4J3X7R1H225K125AB	0805L	TDK
Cin	1	4.7 μ F $\pm$ 10% 50V Ceramic Capacitor X7R 0805 (2012 Metric)	C2012X7R1H475K125AC	FP-C2012X7R1H475K125AC_0805-MFG	TDK
CinHF, CoutHF1	2	CAP, CERM, 0.1 μ F, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	GCM155R71H104KE02D	0402	MuRata
Cout1	1	Cap Ceramic 22 μ F 16V X7R 20% Pad SMD 1210 +125°C Automotive T/R	CGA6P1X7R1C226M250AC	FP-CGA6P1X7R1C226M250AC_1210-MFG	TDK
CoutHF2, CoutHF3	2	CAP, CERM, 0.1 μ F, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	GCM155R71H104KE02D	0402S	MuRata
H1, H2, H3, H4	4	Machine Screw, Round, #4-40x 1/4, Nylon, Philips panhead	NY PMS 440 0025PH	NY PMS 440 0025PH	B&F Fastener Supply
H5, H6, H7, H8	4	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone_1902C	Keystone
J1	1	Header, 100mil, 3x1, Gold, TH	HTSW-103-07G-S	Samtec_HTSW-103-07G-S	Samtec
J2	1	Header, 100mil, 2x1, Gold, TH	PBC02SAAN	Sullins_PBC02SAAN	Sullins Connector Solutions
L1	1	Inductor, Shielded, Composite, 1.5 μ H, 3.2A, 0.014ohm, AEC-Q200 Grade 1, SMD	XGL4020-152MEC	FP-XGL4020-152MEC_SMD2-MFG	Coilcraft
LBL1	1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Label_650x200	Brady
LFilt	1	Inductor, Shielded, Composite, 2.2 μ H, 5.5A, 0.04ohm, AEC-Q200 Grade 1, SMD	XAL4020-222MEC	XAL4020	Coilcraft
LS_Gate, VOUTS	2	Connector, SMT, SMB Jack Assembly 50ohm	131-3711-201	Johnson_131-3711-201	Cinch Connectivity
QLS	1	MOSFET, N-CH, 25V, 100A, DQH0008A (VSON-CLIP-8)	CSD16321Q5	DQH0008A	Texas Instruments
RBode	1	49.9 Ohms $\pm$ 1% 0.063W, 1/16W Chip Resistor 0402 (1005 Metric) Anti-Sulfur, Automotive AEC-Q200 Thick Film	AF0402FR-0749R9L	FP-AF0402FR-0749R9L_0402-MFG	YAGEO

Table 4-1. Bill Of Materials (continued)

DESIGNATOR	QUANTITY	DESCRIPTION	PART NUMBER	PACKAGE	MANUFACTURER
RENT	1	RES, 30.0k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	CRCW040230K0FKED	0402	Vishay-Dale
RFBT	1	RES, 0, 5%, 0.063W, 0402	RC0402JR-070RL	0402L	Yageo America
RHIGH	1	CRCW Series 0603 0.1W 00hm Jumper Surface Mount Thick Film Chip Resistor	CRCW06030000Z0EAC	FP-CRCW06030000Z0EAC_0603-MFG	Vishay
RLOW	1	RES, 100k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	CRCW0603100KFKEA	0603S	Vishay-Dale
RPG	1	RES, 100k, 5%, 0.063W, AEC-Q200 Grade 0, 0402	CRCW0402100KJNED	0402L	Vishay-Dale
RSTEPPER	1	10 mOhms $\pm$ 1% 3W Chip Resistor Wide 2512 (6432 Metric), 1225 Automotive AEC-Q200, Current Sense Metal Foil	KRL6432E-M-R010F-T1	FP-KRL6432E-M-R010F-T1_2512-MFG	Susumu
RT	1	RES, 15.0k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	CRCW040215K0FKED	0402	Vishay-Dale
SH-J1	1	CONN JUMPER S2 (1x 2) Position Shunt Connector Black Open Top 0.100" (2.54mm) GoldHORTING .100" GOLD	QPC02SXGN-RC	FP-QPC02SXGN-RC_JUMPER-MFG	Sullins
TP1, TP2, TP3, TP4	4	Terminal, Turret, TH, Double	1502-2	Keystone1502-2	Keystone
TP5, TP8	2	Test Point, Multipurpose, Red, TH	5010	Keystone5010	Keystone Electronics
TP6, TP9	2	Test Point, Multipurpose, Yellow, TH	5014	Keystone5014	Keystone Electronics
TP7	1	Test Point, Multipurpose, White, TH	5012	Keystone5012	Keystone Electronics
TP10, TP11, TP12	3	Test Point, Multipurpose, Black, TH	5011	Keystone5011	Keystone Electronics
U1	1	LMR614403SRAKRQ1	LMR614403SRAKRQ1	VBC0009A-MFG	Texas Instruments

5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

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 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 instructions, 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/sds/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。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

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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2. 実験局の免許を取得後ご使用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_02.page

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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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