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

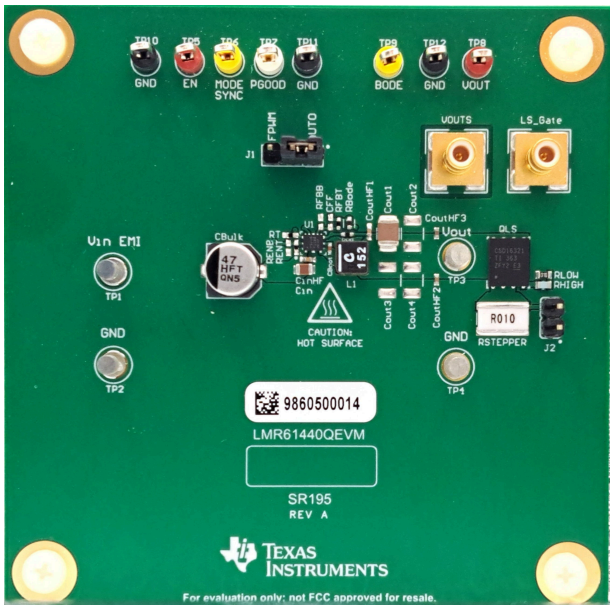
1. Order the EVM here.
2. Prepare the bench setup per the user's guide instructions.
3. Power up the EVM by following the recommended steps.
4. Run tests and measurements. Beware of possible high component temperatures.

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 capabilityu 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.

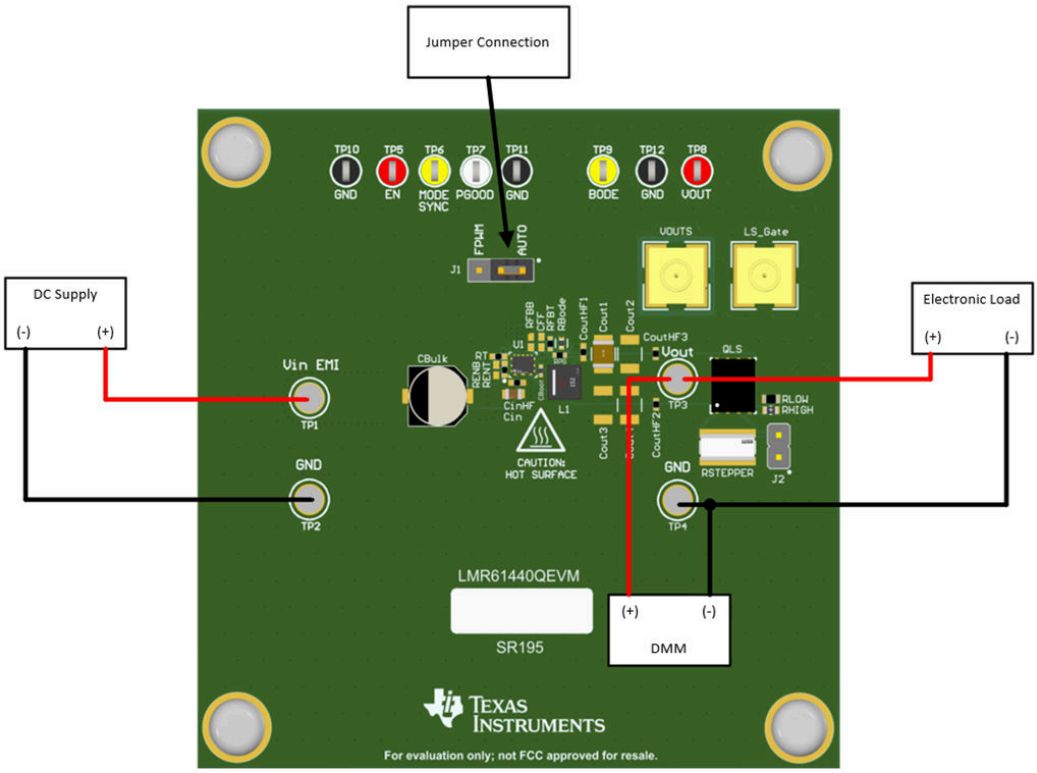


Figure 2-1. EVM Board Connections

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 VOUTS) 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.

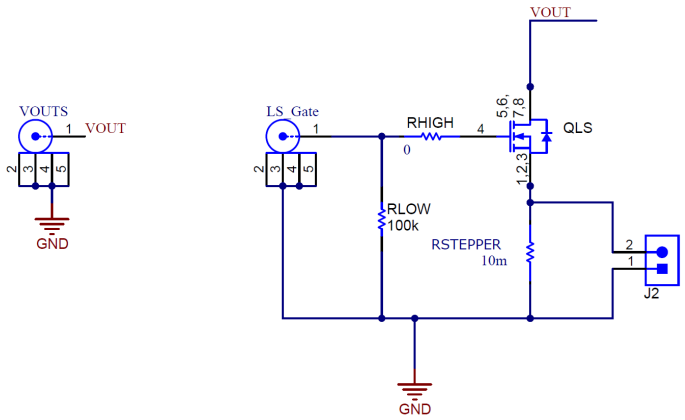


Figure 2-2. Load Transient Generator

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

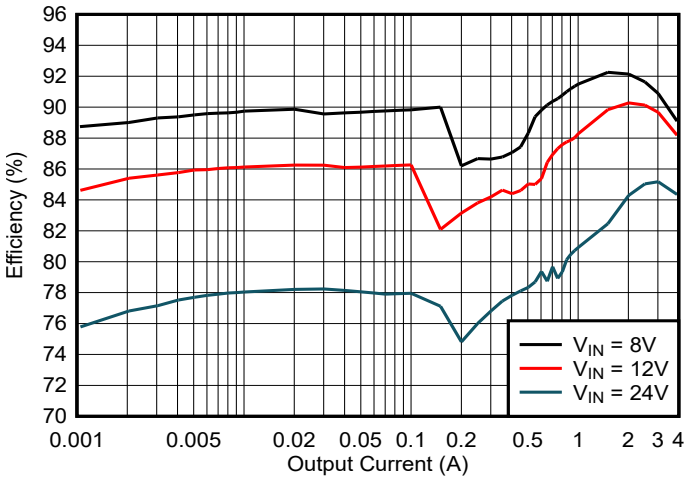


Figure 3-1. Conversion Efficiency (2.1MHz)

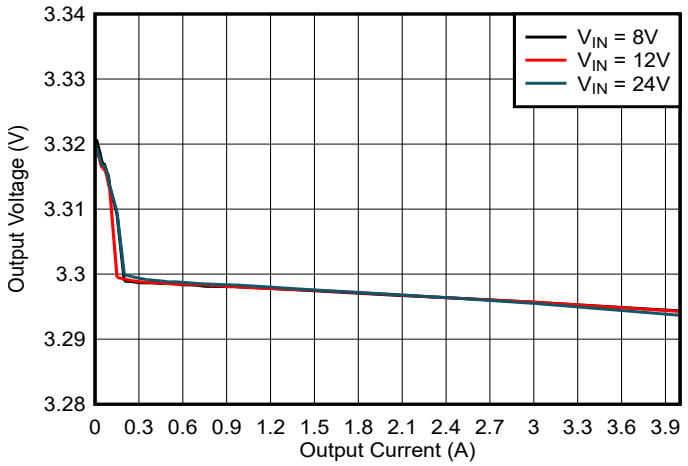


Figure 3-2. Output Voltage Regulation

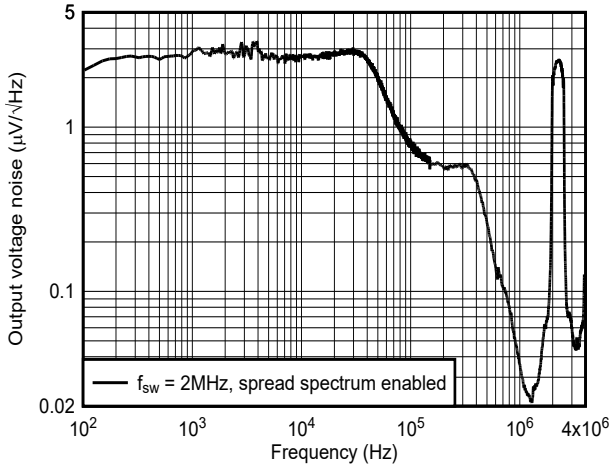


Figure 3-3. Output Voltage Noise

3.1.2 Load Transients

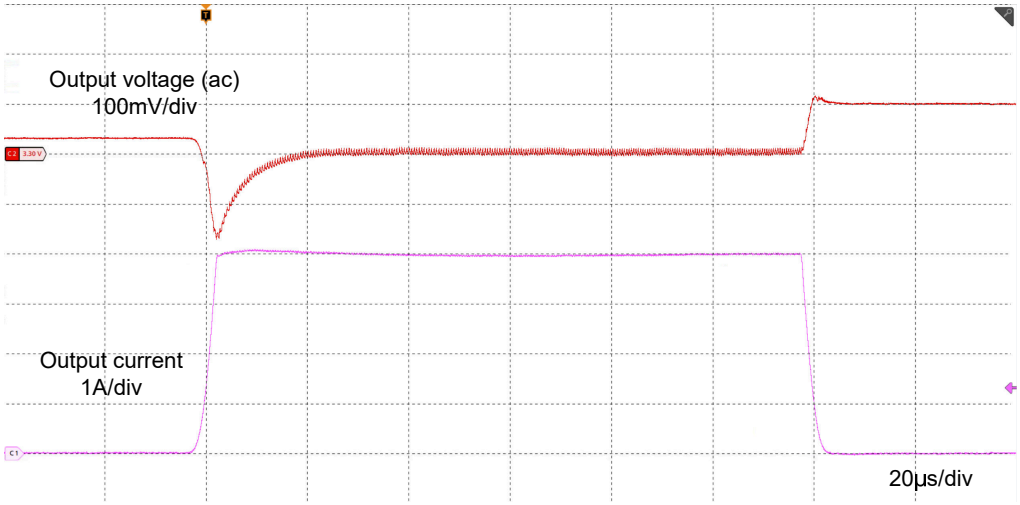


Figure 3-4. Load Transient, I_{OUT} = 0mA to 4A

3.1.3 Start-Up and Shutdown

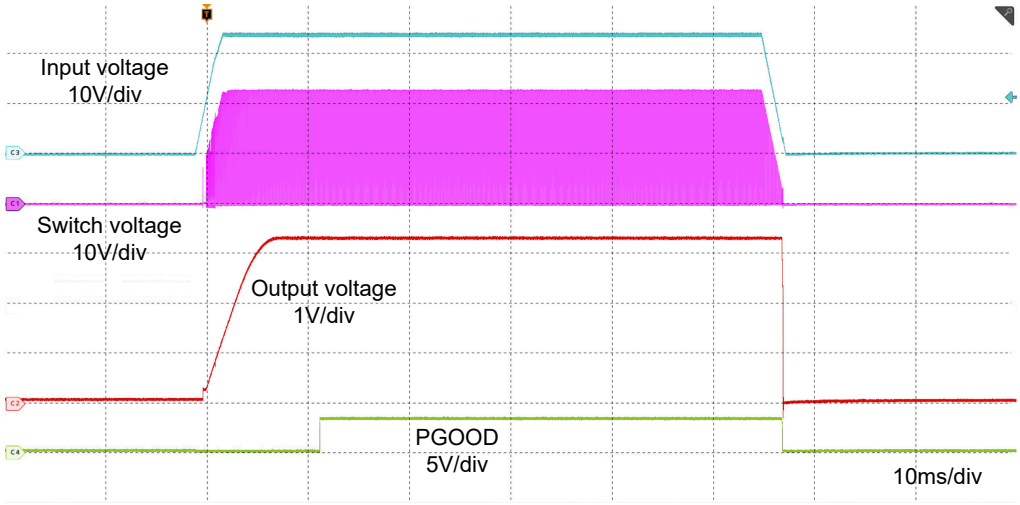


Figure 3-5. Vin Start and Stop, I_{OUT} = 4A

4 Hardware Design Files

4.1 Schematic

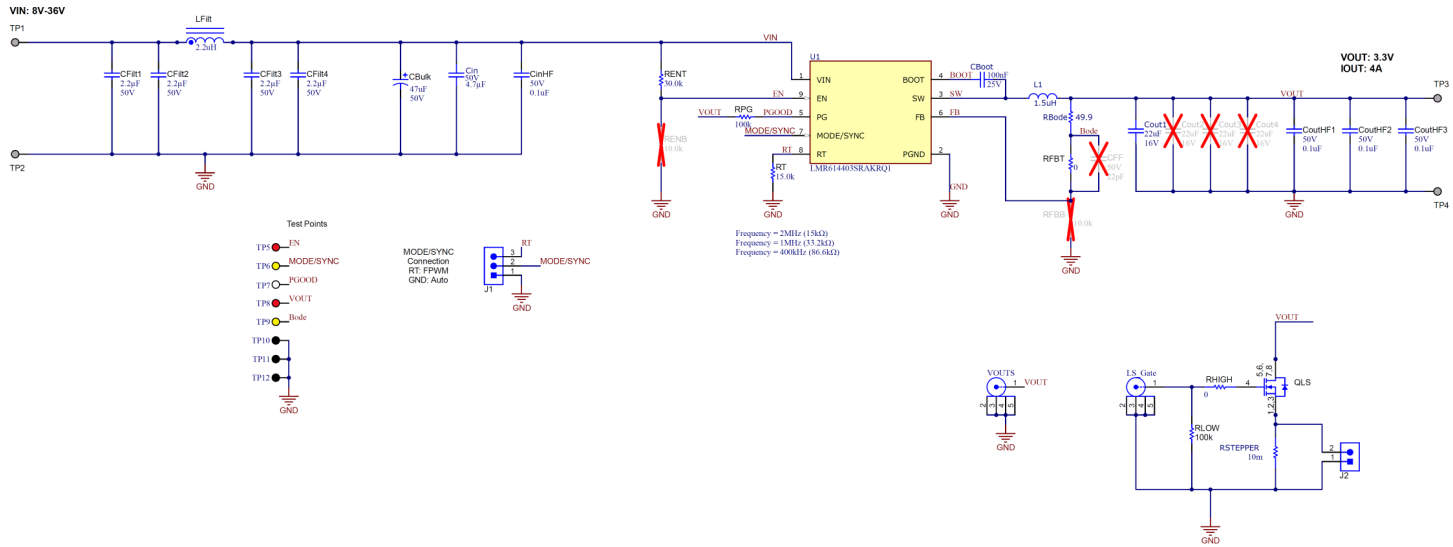


Figure 4-1. LMR61440QEVM Schematic

4.2 Board Layout

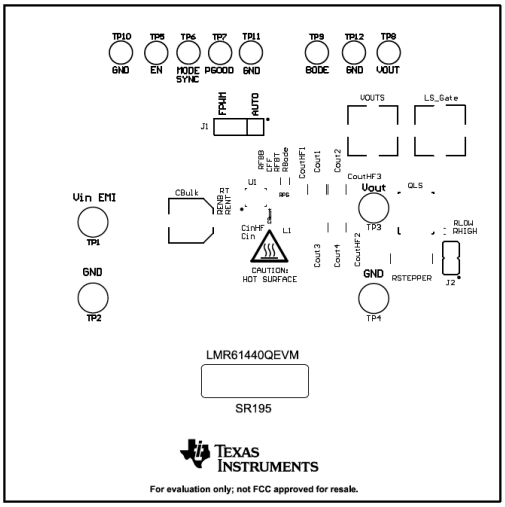


Figure 4-2. EVM Top Overlay

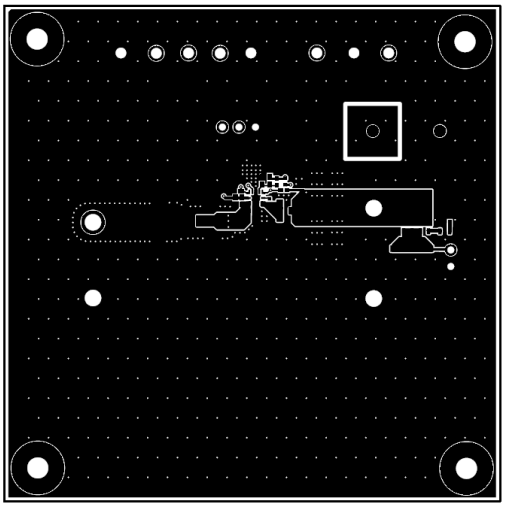


Figure 4-3. EVM Top Copper Layer

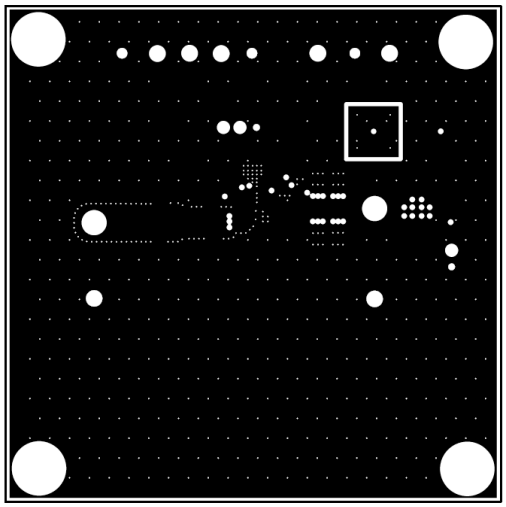


Figure 4-4. EVM Mid Layer One

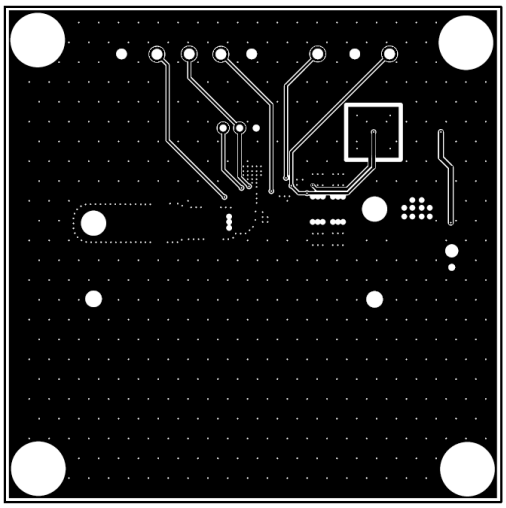


Figure 4-5. EVM Mid Layer Two

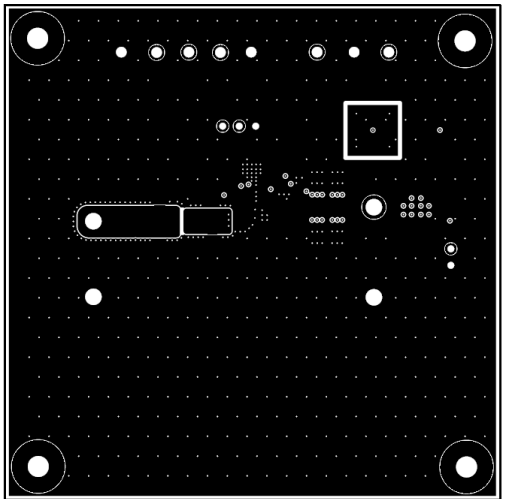


Figure 4-6. EVM Bottom Copper Layer

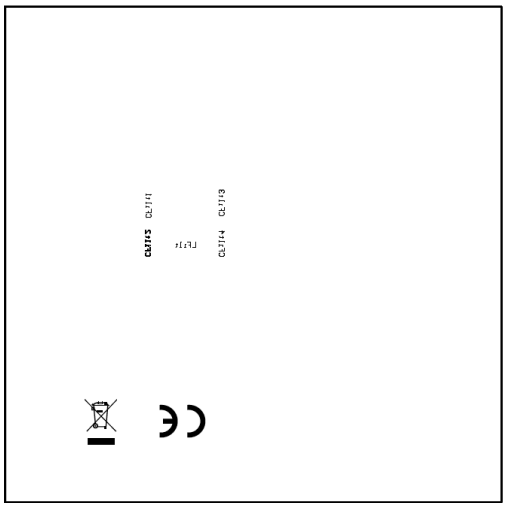


Figure 4-7. EVM Bottom Overlay

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	0.1µF ±10% 25V Ceramic Capacitor X7R 0402 (1005 Metric)	CS0402KRX7R8BB104	FP-CS0402KRX7R8BB104_0402-MFG	Yageo
CBulk	1	CAP, AL, 47uF, 50V, +/- 20%, 0.68ohm, AEC-Q200 Grade 2, SMD	EEE-FT1H470AP	Panasonic_D	Panasonic
CFilt1, CFilt2	2	CAP, CERM, 2.2uF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	CGA4J3X7R1H225K125AB	0805_HV	TDK
CFilt3, CFilt4	2	CAP, CERM, 2.2uF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	CGA4J3X7R1H225K125AB	0805L	TDK
Cin	1	4.7µF ±10% 50V Ceramic Capacitor X7R 0805 (2012 Metric)	C2012X7R1H475K125AC	FP-C2012X7R1H475K125AC_0805-MFG	TDK
CinHF, CoutHF1	2	CAP, CERM, 0.1uF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	GCM155R71H104KE02D	0402	MuRata
Cout1	1	Cap Ceramic 22uF 16V X7R 20% Pad SMD 1210 +125°C Automotive T/R	CGA6P1X7R1C226M250AC	FP-CGA6P1X7R1C226M250AC_1210-MFG	TDK
CoutHF2, CoutHF3	2	CAP, CERM, 0.1uF, 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, 1.5µH, 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, 2.2µH, 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 ±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 0Ohm 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 ±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.

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (July 2026) to Revision A (July 2026)	Page
• Updated the hardware image to a high-quality image of the board	1

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