LM5141-Q1 EVM

User's Guide

Literature Number: SNVU522
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LM5141-Q1 EVM User's Guide

1 Introduction

The LM5141-Q1 evaluation module helps designers evaluate the operation and performance of the LM5141-Q1 synchronous buck controller. The EVM operates over the input voltage range of 5.5 V to 42 V. The EVM provides a 5-V output with a maximum load current of 5 A. The device offers configurability and can be setup to switch at 440 kHz or 2.2 MHz.

2 Features and Performance

The EVM supports the following features and performance capabilities:

- The LM5141-Q1 is Qualified to AEC-Q100 Grade 1 (–40ºC to +125ºC Operating Junction Temperature)
- VIN 5.5 to 42 V
- Fixed 5-V output, or Adjustable From 1.5–15 V
- Shutdown mode I_Q: 10 µA
- Low IQ Standby: 42 µA Typical (Output in Regulation, No Load)
- Fixed 2.2 MHz, or 440 kHz Oscillator Frequency
- Oscillator Can Shift From the Fundamental With a Resistor From the RT Pin to Ground, or an Analog
- Voltage of 0 V to 0.6 V
- The Internal Oscillator can be Synchronized to an External Clock
- Spread Spectrum
- EN Enable Output
- Hiccup Mode for Sustained Overload
- Power Good
- Gate Drive With Slew Rate Control
- Diode Emulation or Forced Pulse-Width Modulation

Table 1 shows the electrical performance data for this EVM.

Table 1. Electrical Performance

PARAMETER	TEST CONDITION	MIN	TYP	MAX	UNIT
INPUT CHARACTERISTICS					
Input Voltage	5-V Output	5.5	42		V
OUTPUT CHARACTERISTICS					
Output Voltage 2	I_{LOAD} = 5 A	4.95	5	5.05	V
Output Current				5	A
SYSTEM CHARACTERISTICS					
Switching Frequency		2	2.2	2.4	MHz
Full Load Efficiency	VIN = 12 V, VOUT 5 V at 5 A		81%		

3 Setup

This section describes the input and output connections to the LM5141-Q1 HD EVM and other functional settings.

Table 2. Jumpers and Test Points

PIN NAME	DESCRIPTION	COMMENTS
J1-1	The + (positive) V_{IN} power for the EVM.	
J1-2	The - (negative) V_{IN} power for the EVM.	
J2 (1-2)	PG indicator open collector output which goes low if V_{OUT} is outside the regulation window.	Factory default open
J3 (1-2)	FPWM (Forced PWM	
J3 (2-3)	DEMB (Diode Emulation)	Factory default setting
J4 (1-2)	VCCX connected to V_{OUT}	Factory default setting
J5 (1-2)	Spread Spectrum	Factory default setting disabled (remove header to enable)
J6 (1-2)	EN-Enable V_{OUT}	
J6 (2-3)	EN-Disable V_{OUT}	Factory default setting
J7 (1-2)	Feedback divider resistors	Factory default open
J8 (1-2)	Disable RT	Factory fault setting
J8 (2-3)	Enable RT	
J9 (1-2)	V_{OUT} 3.3 V	
J9 (2-3)	V_{OUT} 5 V	Factory default setting
TP1	SYNC IN	
TP2	PG an open collector output which goes low if V_{OUT} is outside the regulation window.	
TP3	$+V_{OUT}$ regulated output voltage	
TP4	$-V_{OUT}$ ground (GND) connection	
TP5	Sets RT= 44.2 kΩ	
TP6	Sets RT = 50.1 kΩ	
TP7	VRT input 0 V to 0.6 V	

4 Setup Input and Loads

The input voltage range for the EVM is 5.5 V to 42 V. The EVM output is configured for 5 V, and is rated for 5-A continuous.

4.1 Enabling the Outputs

To enable V_{OUT} place a header from J6 (2-3) to J6 (1-2). The EVM outputs can be enabled before or after V_{IN} has be applied.

5 Test Equipment

5.1 Power Supply

The Power Supply should be capable of 50 V / 10 A.

5.2 Electronic Loads

The Electronic Load should be capable of 10 V / 10 A used in Constant Current Mode.

5.3 Meters

A current meter is required to measure the input current accurately. The maximum current rating of the meter should be carefully considered. The input current can be as high as 4.5 A with the output at full load at the minimum input voltage. The output voltage should be monitored with a voltage meter capable of monitoring up to 10 V.

5.4 Oscilloscope

A oscilloscope and 10x probes with at least 20-MHz bandwidth is required.

6 Test Procedure

Read the LM5141-Q1 datasheet (SNVSAJ6) before using the EVM. The power supply and loads should be capable of handling the input and output voltage and current rating of the board.

NOTE: Prior to applying power to the EVM, make sure that jumpers J3, J4, J5, J6, J7, J8, and J9 are set in the correct positions, see Table 2.

1. Connect the power supply and ground connections V_{IN} (J1-2) and GND (J1-2) to the power supply
2. Connect an ammeter in series with the input, if needed.
3. Connect a DVM from TP3 (+) to TP4 (-).
4. Connect a resistive load or an electronic load across terminals (V_{OUT}) TP3 (+) and GND (TP4).
5. An ammeter can be inserted in series with the load to observe the load current.
6. Refer to Table 2 for the jumper setting to enable V_{OUT}.
7. With the load initially set to no load, set the power supply to 12 V and turn-on the power supply. Check for V_{OUT} 5 V at the output.
8. Once the output is at the expected target (5 V), increase the load gradually within the operating range.

7 Test Setup

Figure 1 shows the test setup for the LM5141-Q1 EVM.

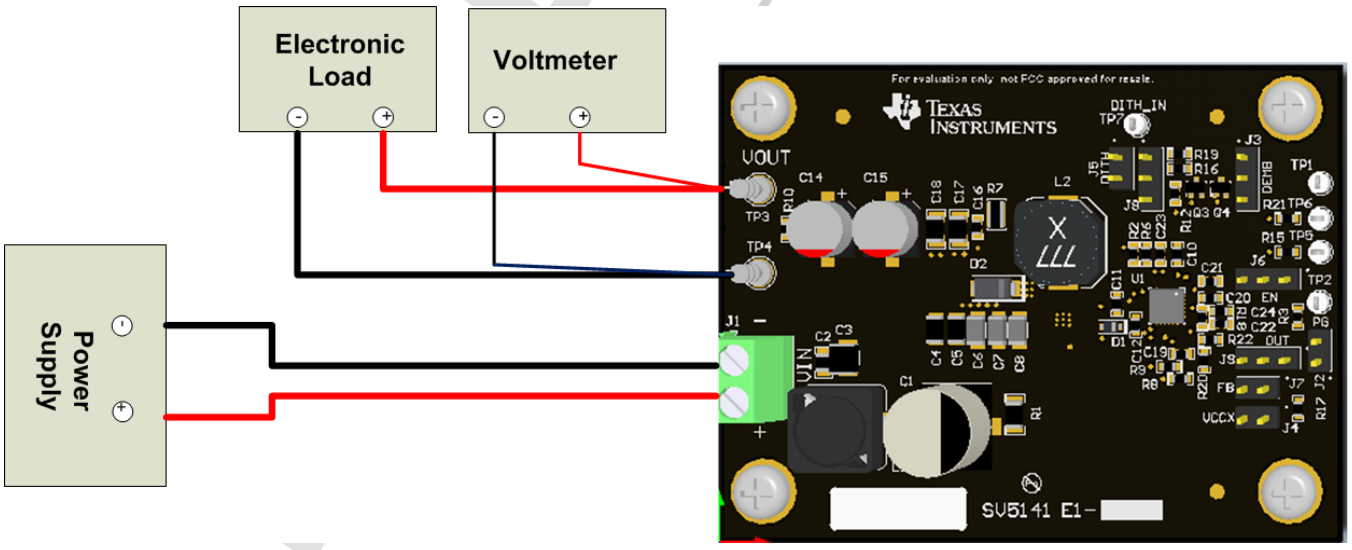

Figure 1. EVM Connections

8 Test Data

8.1 Efficiency

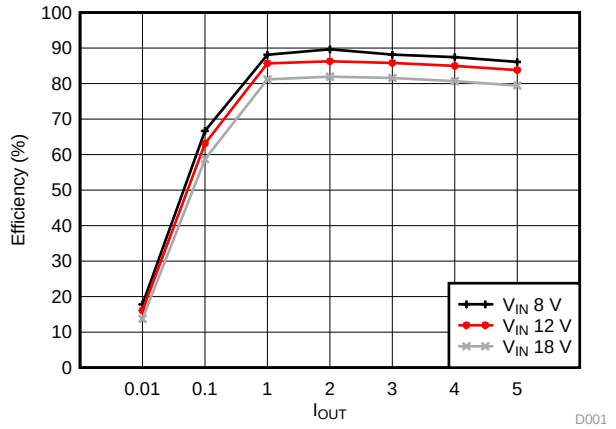

Figure 2. Efficiency FPWM Load 100 mA to 5 A, 2.2 MHz

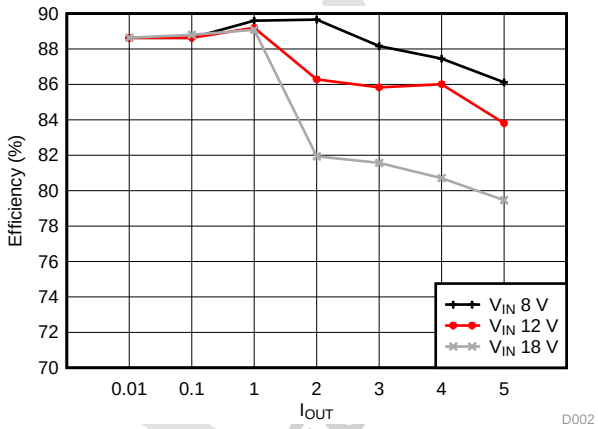

Figure 3. Efficiency DEMB Load 100 mA to 5 A

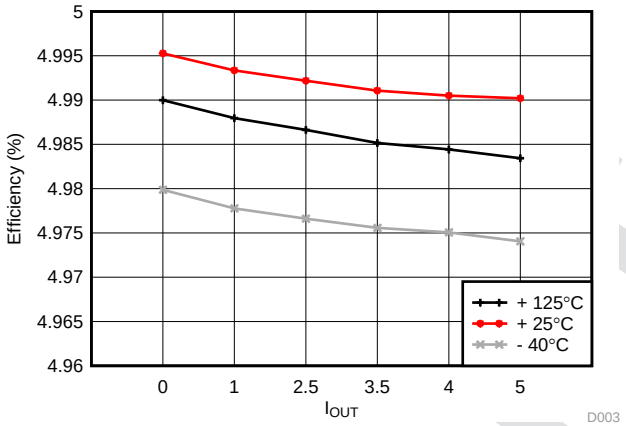

Figure 4. 5-V Output Voltage Regulation

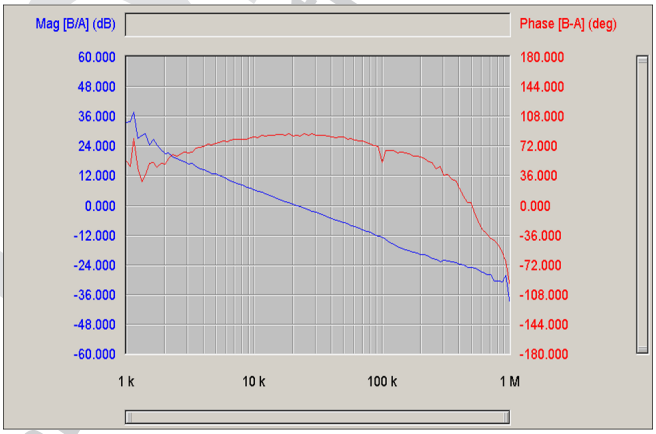

Figure 5. Bode Plot 5-V Output 5-A Load

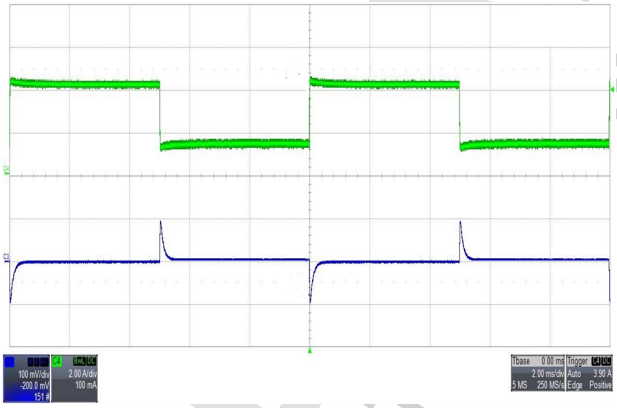

Figure 6. 5-V Output Transient Response 2 A to 4 A (0.5 A/µs)

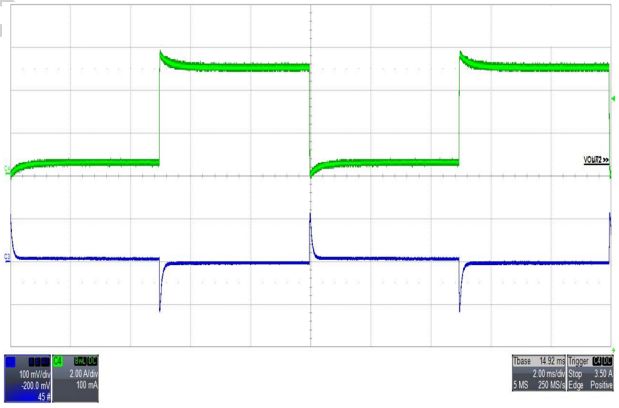

Figure 7. 5-V Output Transient Response 0 A to 5 A (0.5 A/µs)

8.2 CISPR 25 Class 5 LM5141 EVM 2.2 MHz

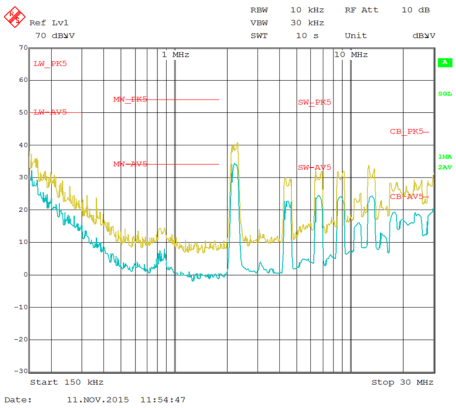

Figure 8. CISPR 25 Class 5 Peak Detection 150 kHz to 30 MHz

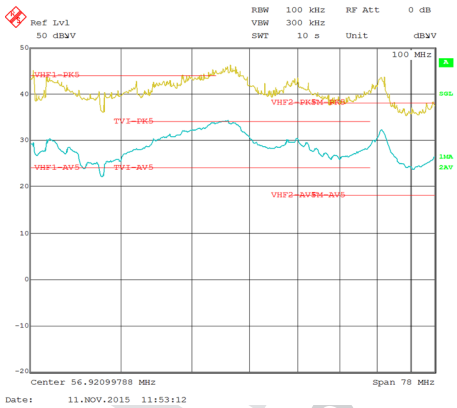

Figure 9. CISPR 25 Class 5 Peak Detection 30 MHz to 108 MHz

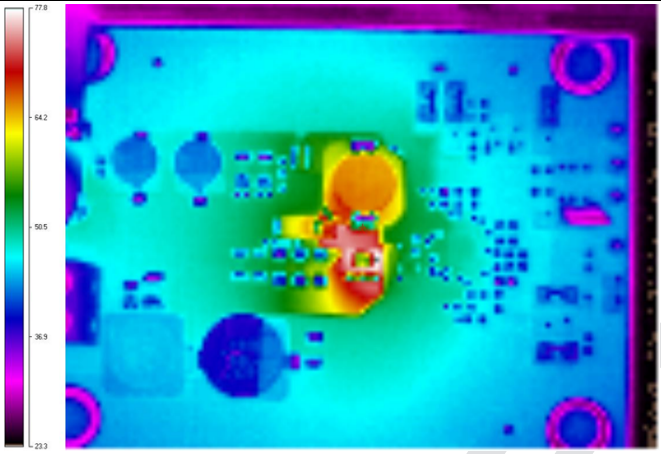

Figure 10. Thermal Image PCB Top Side

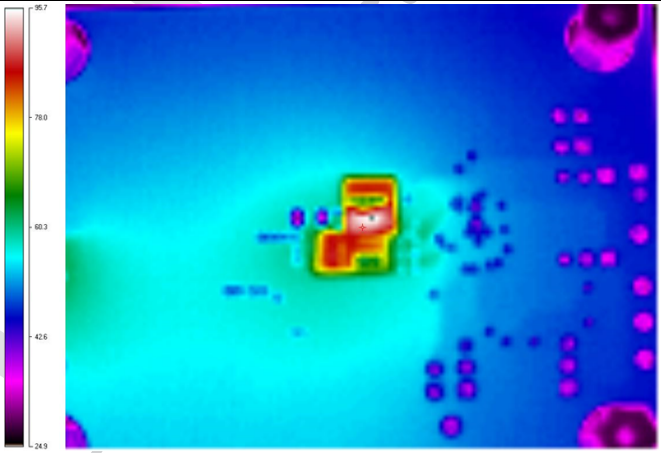

Figure 11. Thermal Image PCB Bottom Side

9 Design Files

9.1 Schematics

To download the schematics for each board, see the design files at http://www.ti.com/tool

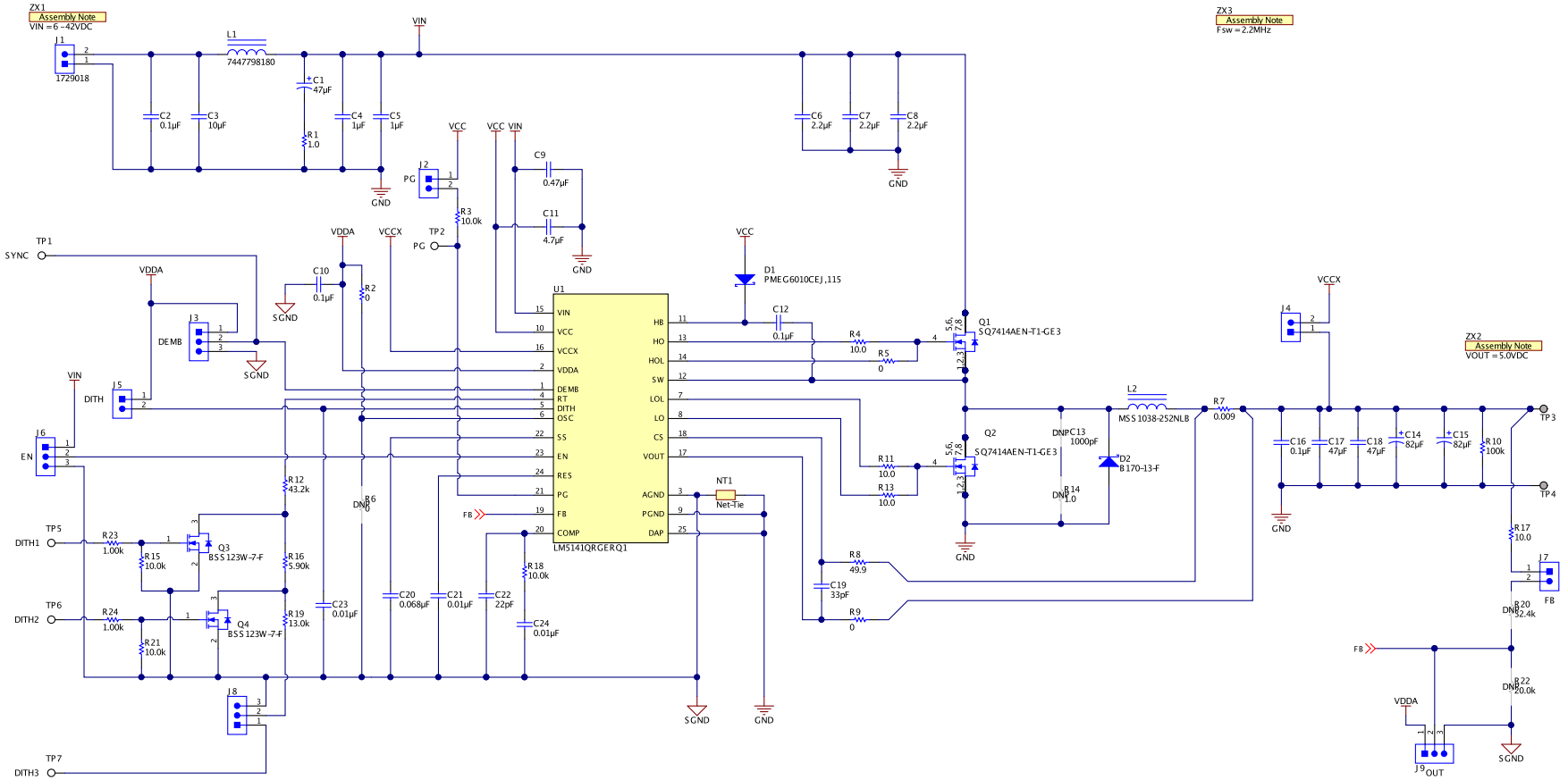

Figure 12. EVM Schematic 2.2 MHz

9.2 Bill of Materials

Table 3. Bill of Materials

DESCRIPTION	DESIGNATOR	PART NUMBER	QUANTITY	MANUFACTURER
Printed Circuit Board	!PCB1	SV601264	1	Any
CAP, AL, 47 µF, 50 V, ±20%, 0.3 Ω, SMD	C1	EEE-FC1H470P	1	Panasonic
CAP, CERM, 0.1 µF, 100 V, ±10%, X7R, 0805	C2	C0805C104K1RACTU	1	Kemet
CAP, CERM, 10 µF, 50 V, ±20%, x7R, 1210	C3	C3225X7R1H106M250AC	1	TDK
CAP, CERM, 1 µF, 100 V, ±20%, X7R, 1206	C4, C5	C3216X7R2A105M160AA	2	TDK
CAP, CERM, 2.2 µF, 100 V, ±10%, X7R, 1206_190	C6, C7, C8	CL31B225KCHSNNE	3	Samsung Electro-Mechanics
CAP, CERM, 0.47 µF, 100 V, ±10%, x7R, 0805	C9	GRM21BR72A474KA73L	1	MuRata
CAP, CERM, 0.1 µF, 50 V, ±10%, x7R, 0603	C10, C12, C16	C0603C104K5RACTU	3	Kemet
CAP, CERM, 4.7 µF, 25 V, ±10, X5R, 0603	C11	GRM188R61E475KE11D	1	MuRata
CAP, Aluminum Polymer, 82 µF, 16 V, ±20%, 0.03 Ω, D6.3 × L5.8 mm SMD	C14, C15	875105344009	2	Wurth Elektronik
CAP, CERM, 47 µF, 16 V, ±15%, X5R, 1206	C17, C18	C3216X5R1C476M160AB	2	TDK
CAP, CERM, 33 pF, 50 V, ±5%, C0G/NP0, 0603	C19	06035A330JAT2A	1	AVX
CAP, CERM, 0.068 µF, 25 V, ±10%, X7R, 0603	C20	GRM188R71E683KA01D	1	MuRata
CAP, CERM, 0.01 µF, 50 V, ±10%, X7R, 0603	C21, C23, C24	GCM188R71H103KA37D	3	MuRata
CAP, CERM, 22 pF, 50 V, ±5%, C0G/NP0, 0603	C22	GRM1885C1H220JA01D	1	MuRata
Diode, Schottky, 60 V, 1 A, SOD-323F	D1	PMEG6010CEJ,115	1	NXP Semiconductor
Diode, Schottky, 70 V, 1 A, SMA	D2	B170-13-F	1	Diodes Inc.
Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	H1, H2, H3, H4	NY PMS 440 0025 PH	4	B&F Fastener Supply
Standoff Hex, 0.5"L #4-40 Nylon	H5, H6, H7, H8	1902C	4	Keystone
TERM BLOCK 2POS 5mm, TH	J1	1729018	1	Phoenix Contact
Header, 100mil, 2x1, Gold, TH	J2, J4, J5, J7	61300211121	4	Wurth Elektronik
Header, 100mil, 3x1, Gold, TH	J3, J6, J8, J9	61300311121	4	Wurth Elektronik
Inductor, Shielded, Metal Composite, 1.8 µH, 12.8 A, 0.0038 ohm, SMD	L1	7447798180	1	Wurth Elektronik
Inductor, Shielded Drum Core, Ferrite, 2.5 µH, 6.65 A, 0.01Ω, SMD	L2	MSS1038-252NLB	1	Coilcraft
MOSFET, N-CH, 60 V, 20 A, PG-TSDSON-8	Q1, Q2	SQ7414AEN-T1-GE3	2	Vishay-Dale
MOSFET, N-CH, 100 V, 0.17 A, SOT-323	Q3, Q4	BSS123W-7-F	2	Diodes Inc.
RES, 1.0, 5%, 0.25 W, 1206	R1	CRCW12061R00JNEA	1	Vishay-Dale

Table 3. Bill of Materials (continued)

DESCRIPTION	DESIGNATOR	PART NUMBER	QUANTITY	MANUFACTURER
RES, 0, 5%, 0.1 W, 0603	R2, R5, R9	CRCW06030000Z0EA	3	Vishay-Dale
RES, 10.0 k, 1%, 0.1 W, 0603	R3, R15, R18, R21	CRCW060310K0FKEA	4	Vishay-Dale
RES, 10.0, 1%, 0.25 W, 0603	R4, R11, R13, R17	CRCW060310R0FKEAHP	4	Vishay-Dale
RES, 0.009, 1%, 1 W, 0612	R7	PRL1632-R009-F-T1	1	Susumu Co Ltd
RES, 49.9, 1%, 0.1 W, 0603	R8	CRCW060349R9FKEA	1	Vishay-Dale
RES, 100 k, 1%, 0.1 W, 0603	R10	CRCW0603100KFKEA	1	Vishay-Dale
RES, 43.2 k, 1%, 0.1 W, 0603	R12	CRCW060343K2FKEA	1	Vishay-Dale
RES, 5.90 k, 1%, 0.1 W, 0603	R16	CRCW06035K90FKEA	1	Vishay-Dale
RES, 23.7 k, 1%, 0.1 W, 0603	R19	CRCW060313K0FKEA	1	Vishay-Dale
RES, 1.00 k, 1%, 0.1 W, 0603	R23, R24	RC0603FR-071KL	2	Yageo America
Shunt, 2.54mm, Gold, Black	SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6	60900213421	6	Wurth Elektronik
Test Point, Miniature, White, TH	TP1, TP2, TP5, TP6, TP7	5002	5	Keystone
Terminal, Turret, TH, Triple	TP3, TP4	1598-2	2	Keystone
IC, PWM, Buck Controller	U1	LM5141	1	Texas Instruments

10 Board Layout

The EVM offers resistors and PWB mounted switches to program the output voltage, oscillator frequency, and DEM/FPWM of operation. Figure 13 to Figure 18 show the board layout for the PCB. The QFN-25 package allows for a compact leadless IC package for a synchronous buck converter solution. See the LM5140-Q1 datasheet (SNVSAJ6) for details.

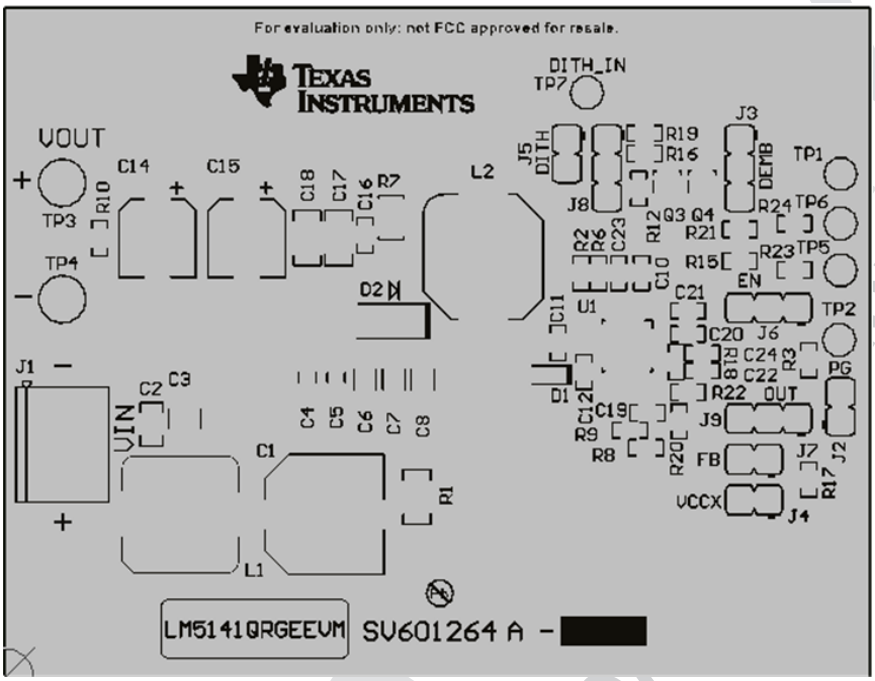

Figure 13. EVM Top Layer Silkscreen

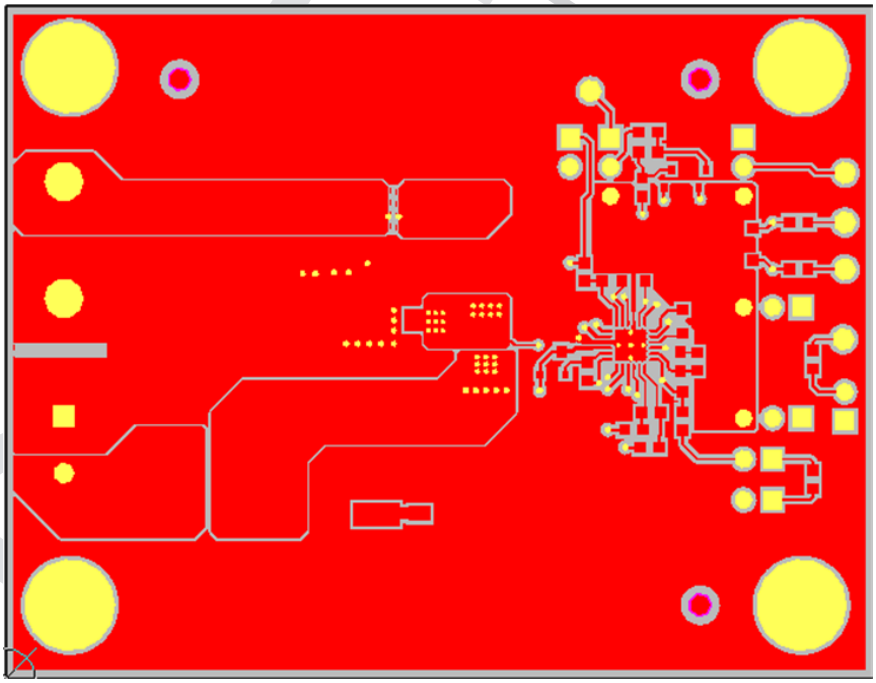

Figure 14. EVM Top Layer Copper

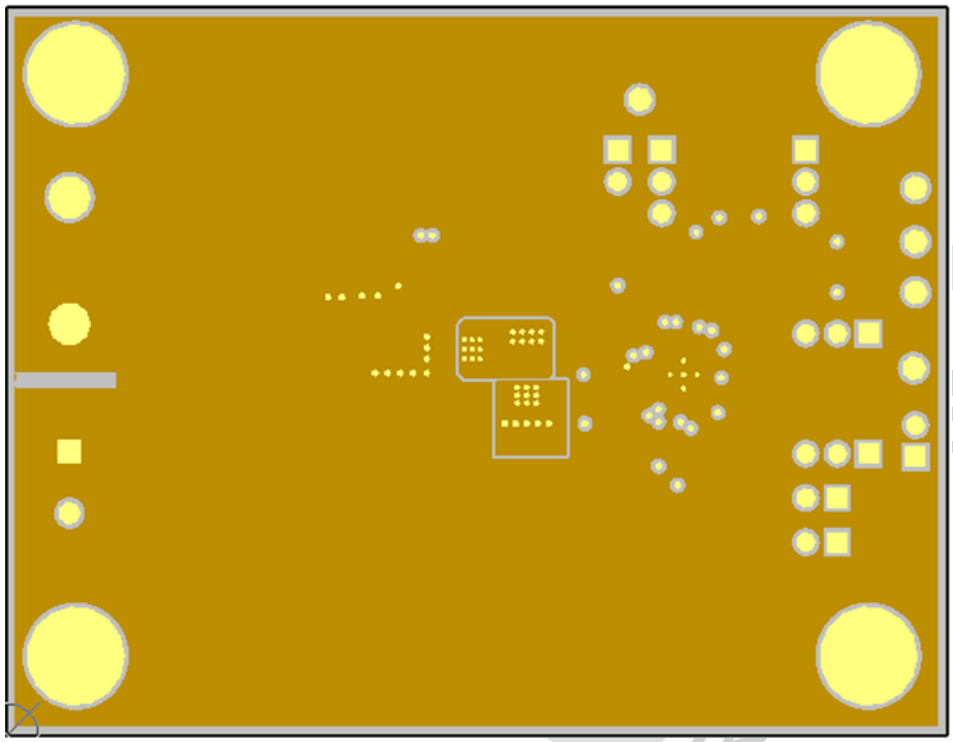

Figure 15. EVM Middle Layer 1

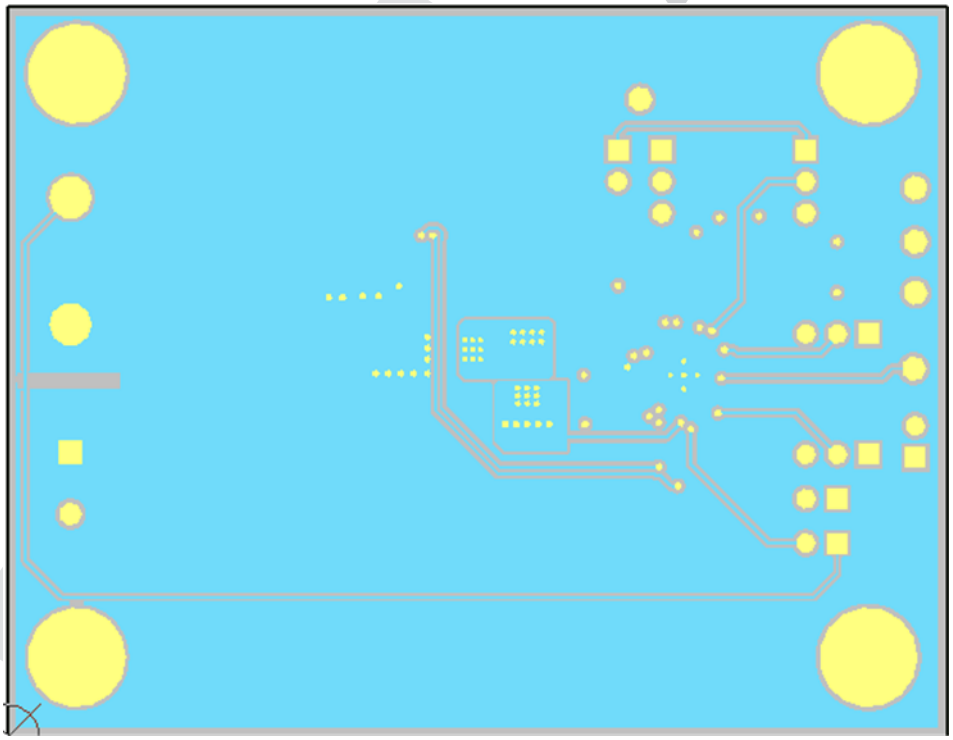

Figure 16. EVM Middle Layer 2

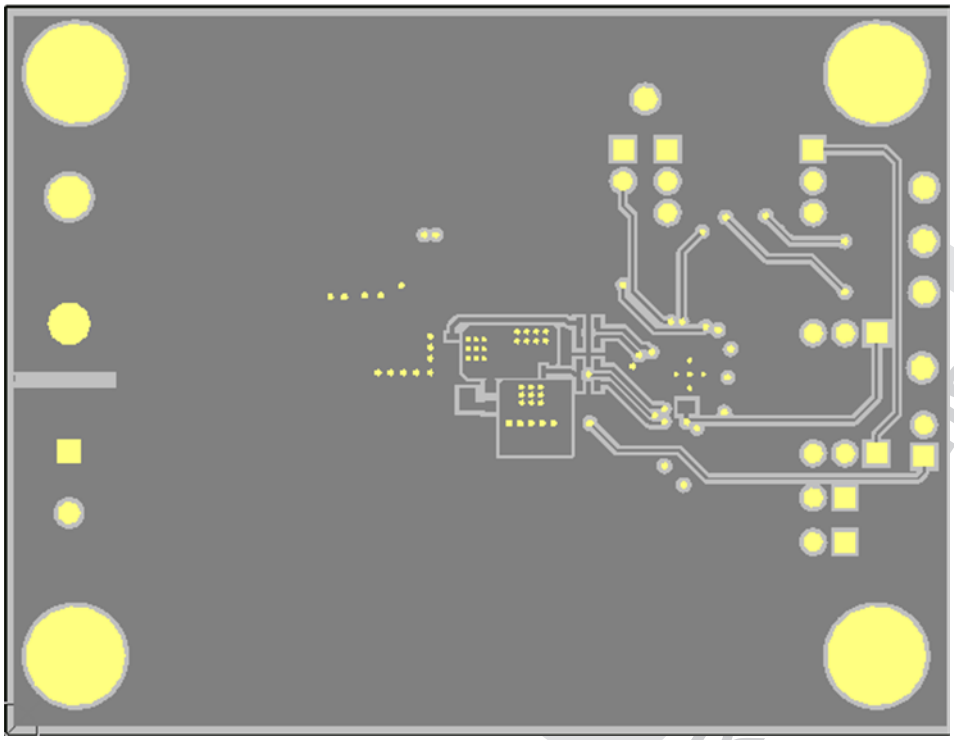

Figure 17. EVM Bottom Layer Copper

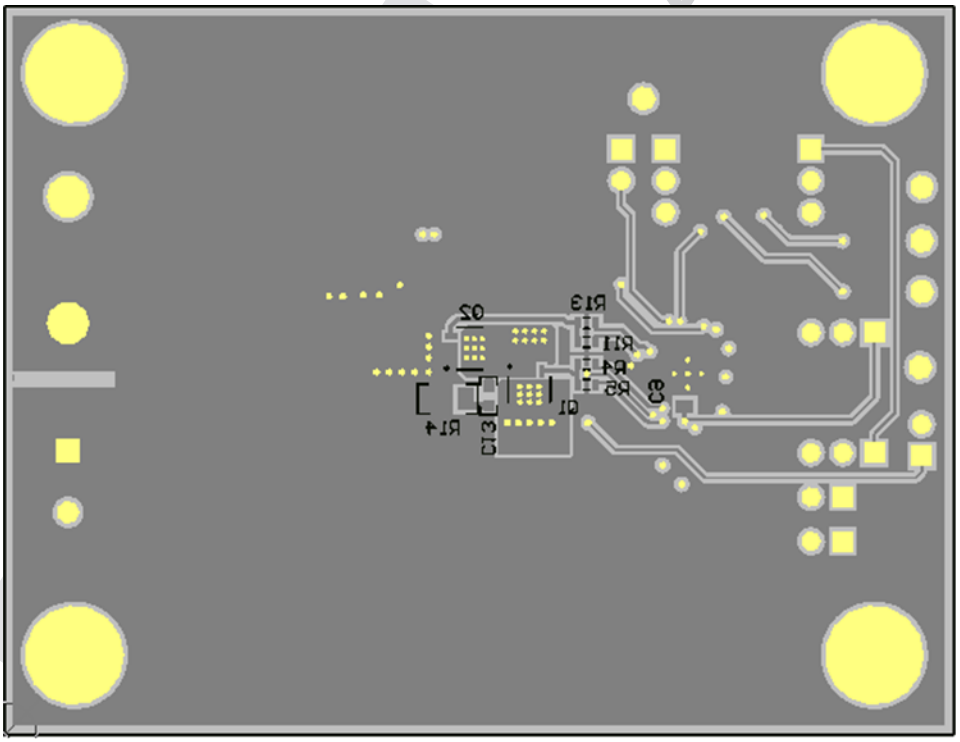

Figure 18. EVM Bottom Layer Silkscreen

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