User's Guide

TPS53015 Buck Controller Evaluation Module User's Guide

Table of Contents

Trademarks

1 Introduction

The TPS53015EVM-126 evaluation module (EVM) presents an easy-to-use reference design for a typical point-of-load application in a standalone module using the TPS53015 controller in cost-sensitive applications.

2 Description

The TPS53015EVM-126 provides the user with a convenient way to evaluate the TPS53015 D-CAP2™ mode control in a cost-sensitive application. Providing a 1.05-V output at up to 8 A from a loosely regulated 12-V (8 V–22 V) source, the TPS53015EVM-126 is designed to demonstrate the TPS53015 in a typical point-of-load application while providing a number of test points to evaluate the performance of the TPS53015.

2.1 Typical Applications

- Point-of-load regulations in low-power systems for a wide range of applications
  - Digital TV power supply
  - Network home terminals
  - Digital set top box (STB)
  - DVD player/recorder
  - Game consoles and others

2.2 Features

The TPS53015EVM-126 features:

- D-CAP2™ Mode Control
  - Fast Transient Response
  - No External Parts Required For Loop Compensation
  - Compatible with Ceramic Output Capacitors
- Auto-Skip Eco-mode™ for High Efficiency at Light load
- 500-kHz switching frequency
- Power Good Indication
- Non-Sinking Pre-Biased Soft Start
- Cycle-by-Cycle Over-Current Limit
- Over-current, over-voltage, under-voltage and over-temperature protections
- Convenient test points for probing critical waveforms

3 Electrical Performance Specifications

Table 3-1. TPS53015EVM-126 Electrical Performance Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics					
Voltage range	V_{IN}	8.0	12	22	V
Maximum input current	V_{IN} = 12 V, I_{OUT} = 8 A		0.9		A
No load input current	V_{IN} = 12 V, I_{OUT} = 0 A		0.6		mA
Output Characteristics					
Output voltage			1.05		V
Output voltage regulation	Setpoint accuracy (V_{IN} = 12 V, IOUT = 8 A)	–2%		2%	
	Line regulation (V_{IN} = 8.0 V–22 V, I_{OUT} = 8 A)		1%		
	Load regulation (V_{IN} = 12 V, I_{OUT} = 0 A – 8 A)		1.5%		
Output voltage ripple	V_{IN} = 12 V, I_{OUT} = 8 A		20		mVpp
Output load current		0		8.0	A
Over current limit	V_{IN} = 12 V		11		
Systems Characteristics					
Switching frequency			500		kHz
Peak efficiency	V_{IN} = 12 V, I_{OUT} = 3.2 A		86.5%		
Full load efficiency	V_{IN} = 12 V, I_{OUT} = 8.0 A		81.4%		
Operating temperature			25		°C

4 Schematic

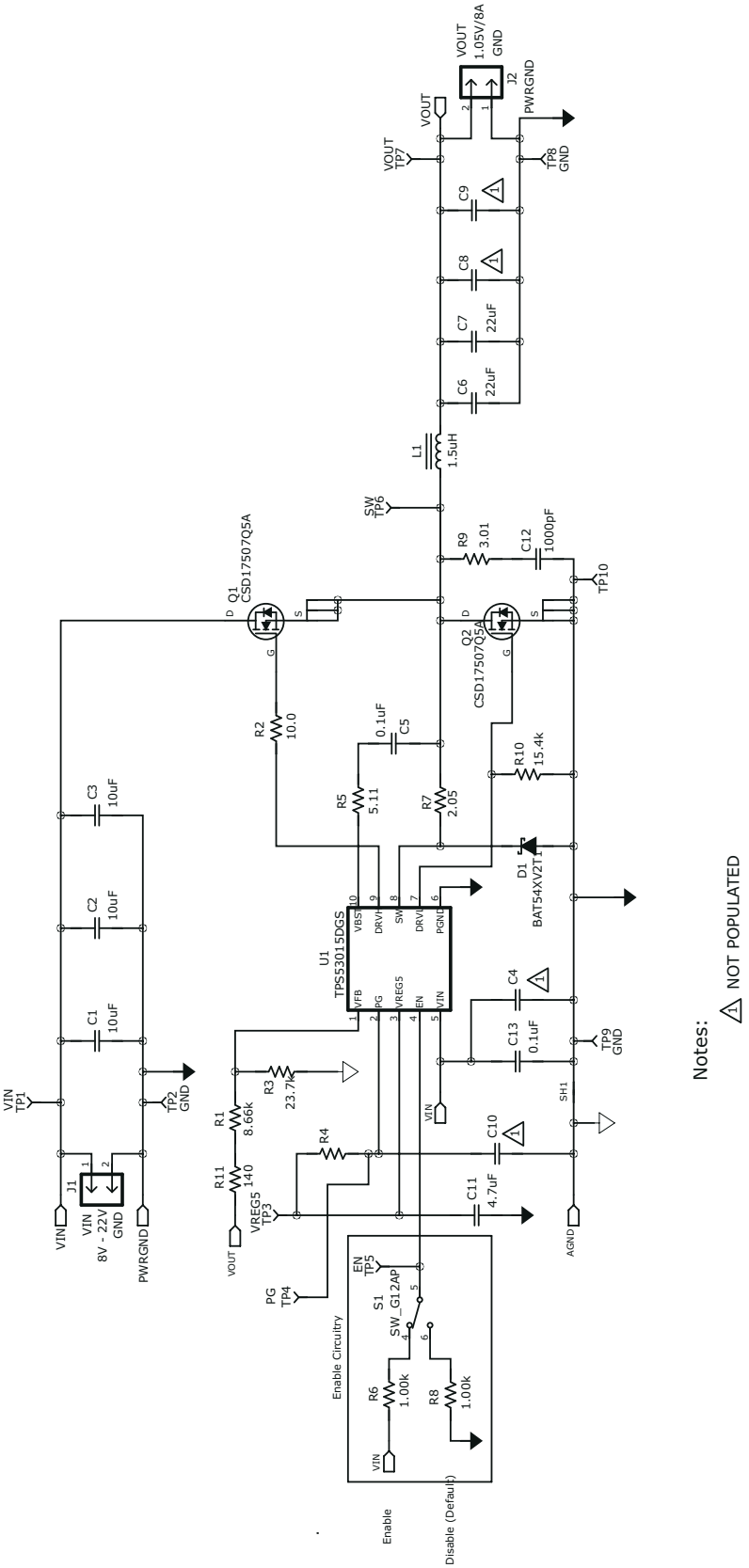

Figure 4-1. TPS53015EVM-126 Schematic

5 Test Setup

5.1 Test Equipment

Voltage Source:

- **VIN:** The input voltage source, V_{IN}, should be a 0-V to 30-V variable DC source capable of supplying 2 A_{DC}. Connect VIN to J1 as shown in Figure 5-2.

Multimeters:

- **V1:** VIN at TP1 (VIN) and TP2 (GND), 0-V to 30-V voltmeter
- **V2:** VOUT at TP7 (VOUT) and TP8 (GND)
- **A1:** VIN input current, 0 A_{DC} to 2 A_{DC} Ammeter

Output Load: The output load should be an electronic constant resistance mode load capable of 0 A_{DC} to 8 A_{DC} at 1.05 V.

Oscilloscope: A digital or analog oscilloscope can be used to measure the output ripple. The oscilloscope should be set for the following:

- 1-MΩ impedance
- 20-MHz bandwidth
- AC coupling
- 1-µs/division horizontal resolution
- 50-mV/division vertical resolution

Test points TP7 and TP8 can be used to measure the output ripple voltage by placing the oscilloscope probe tip through TP7 and holding the ground barrel on TP8 as shown in Figure 5-1. Using a leaded ground connection can induce additional noise due to the large ground loop.

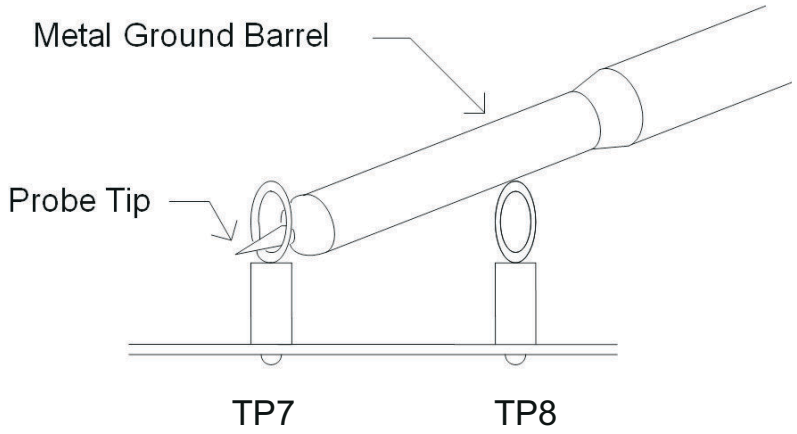

Figure 5-1. Tip and Barrel Measurement for V_{OUT} Ripple

Fan: Some of the components in this EVM can approach temperatures of 85°C during operation. A small fan capable of 200 LFM to 400 LFM is recommended to reduce component temperatures while the EVM is operating. The EVM should not be probed while the fan is not running.

Recommended Wire Gauge:

- **VIN to J1:** The recommended wire size is 1x AWG #16 per input connection, with the total length of wire less than four feet (2-feet input, 2-feet return).
- **J2 to LOAD:** The minimum recommended wire size is 1x AWG #16, with the total length of wire less than four feet (2-feet output, 2-feet return)

5.2 Recommended Test Setup

Figure 5-2 is the recommended test setup to evaluate the TPS53015EVM-126. Working at an ESD workstation, make sure that any wrist straps, bootstraps, or mats are connected referencing the user to earth ground before power is applied to the EVM.

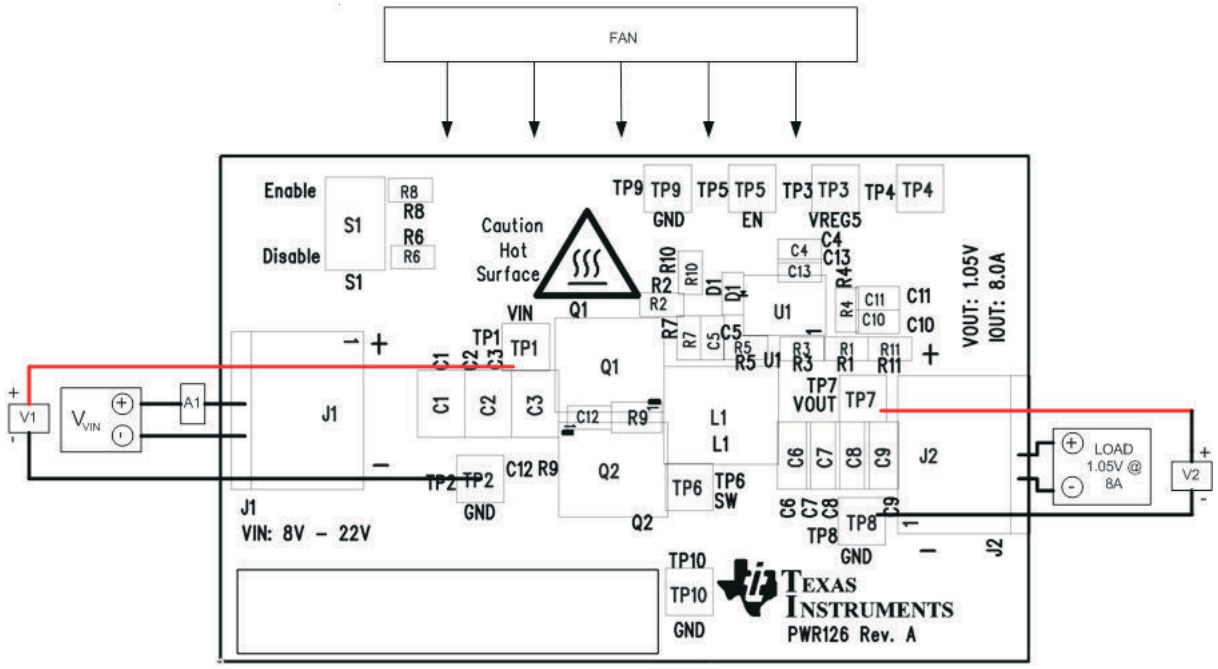

Figure 5-2. TPS53015EVM-126 Recommended Test Setup

Input Connections:

- Prior to connecting the DC input source V_{IN}, it is advisable to limit the source current from VIN to 2-A maximum. Make sure VIN is initially set to 0 V and connected to J2 as shown in Figure 5-2.
- Connect a current meter A1 between VIN and J1 to measure the input current.
- Connect a voltmeter V1 at TP1 (VIN) and TP2 (GND) to measure the input voltage.

Output Connections:

- Connect Load to J2 and set load to constant resistance mode to sink 0 A_{DC} before VIN is applied.
- Connect a voltmeter V2 at TP7 (VOUT) and TP8 (GND) to measure the output voltage.

Other Connections: Place a fan as shown in Figure 5-2 and turn on, making sure air is flowing across the EVM.

6 Configurations

6.1 Enable/Disable Switch S1

The TPS53015EVM-126 is equipped with a switch (S1) to drive the EN pin of the TPS53015. When S1 is in the Enable position, EN is connected to VIN, and the TPS53015 is enabled and generates a regulated 1.05-V output. When S1 is in the Disable position, EN is connected to GND, and the TPS53015 enters a high impedance output state.

Default setting: Set S1 to the Disabled position to disable the controller.

7 Test Procedure

7.1 Line/Load Regulation and Efficiency Measurement Procedure

1. Set up the EVM as described in Section 5 and Figure 5-2.
2. Ensure Load is set to constant resistance mode and to sink 0 A_{DC}.
3. Ensure the switch S1 is set per Section 6.
4. Increase V_{IN} from 0 V to 12 V. Using V1 to measure V_{IN} voltage.
5. Set the switch S1 to Enable position to enable the controller.
6. Use V2 to measure V_{OUT} voltage and A1 to measure VIN current.
7. Vary load from 0 A–8 A_{DC}. V_{OUT} should remain in load regulation.
8. Vary V_{IN} from 8.0 V to 22 V. V_{OUT} should remain in line regulation.
9. Set the switch S1 to Disable position to disable the controller.
10. Decrease load to 0 A.
11. Decrease VIN to 0 V.

7.2 List of Test Points

Table 7-1. Test Point Functions

TEST POINTS	NAME	DESCRIPTION
TP1	VIN	Input voltage
TP2	GND	GND
TP3	VREG5	Output of 5-V linear regulator
TP4	PG	Power good
TP5	EN	Enable pin
TP6	SW	Switching node
TP7	VOUT	Output voltage
TP8	GND	GND
TP9	GND	GND
TP10	GND	GND

7.3 Equipment Shutdown

1. Shut down VIN.
2. Shut down Load.
3. Shut down FAN.

8 Performance Data and Typical Characteristic Curves

Figure 8-1 through Figure 8-11 present typical performance curves for TPS53015EVM-126.

8.1 Efficiency

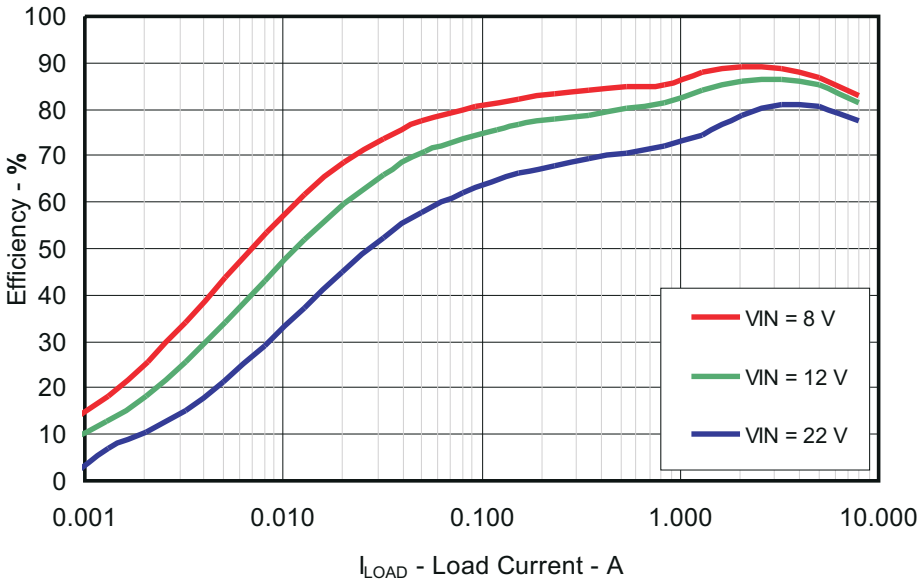

Figure 8-1. Efficiency

8.2 Load Regulation

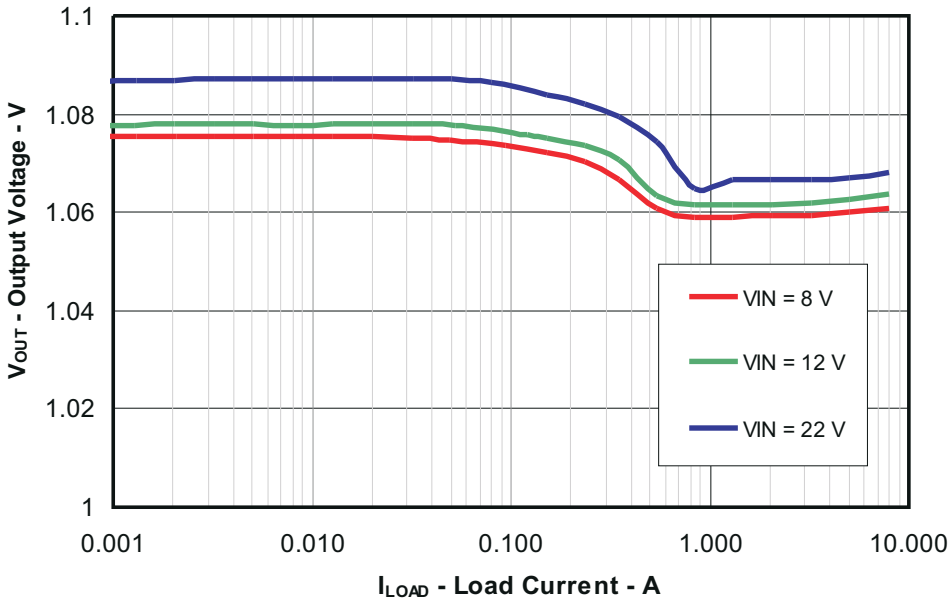

Figure 8-2. Load Regulation

8.3 Line Regulation

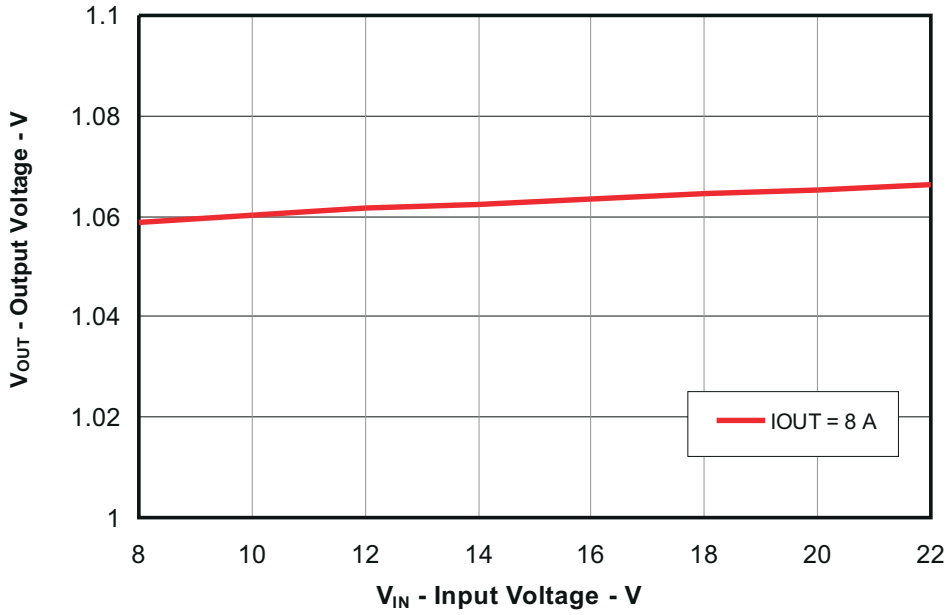

Figure 8-3. Line Regulation

8.4 Load Transient

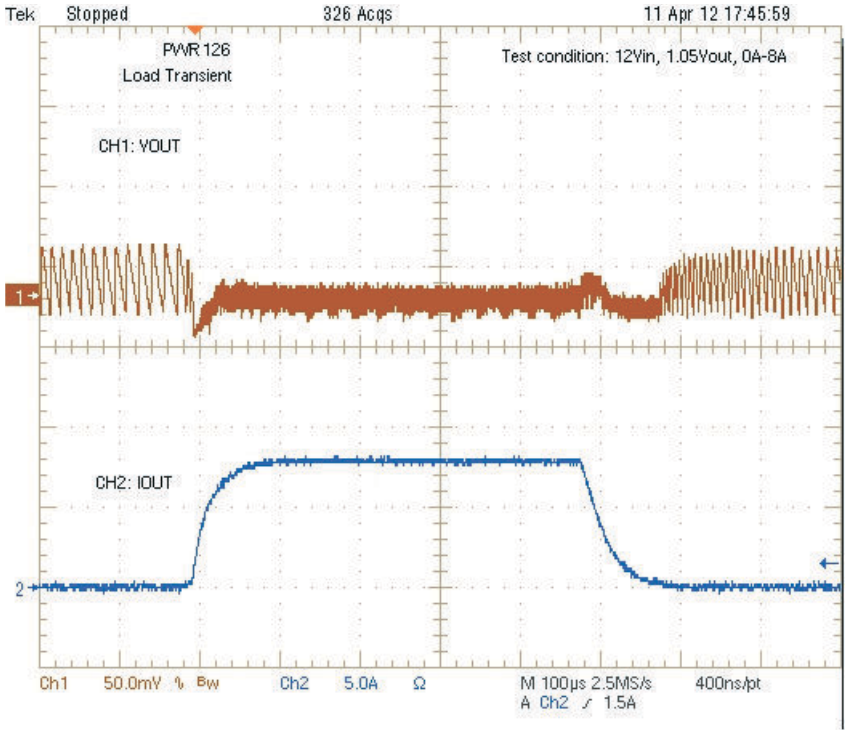

Figure 8-4. Output Load 0-A to 8-A Transient (12-V V_{IN}, 1.05-V V_{OUT})

8.5 Output Ripple

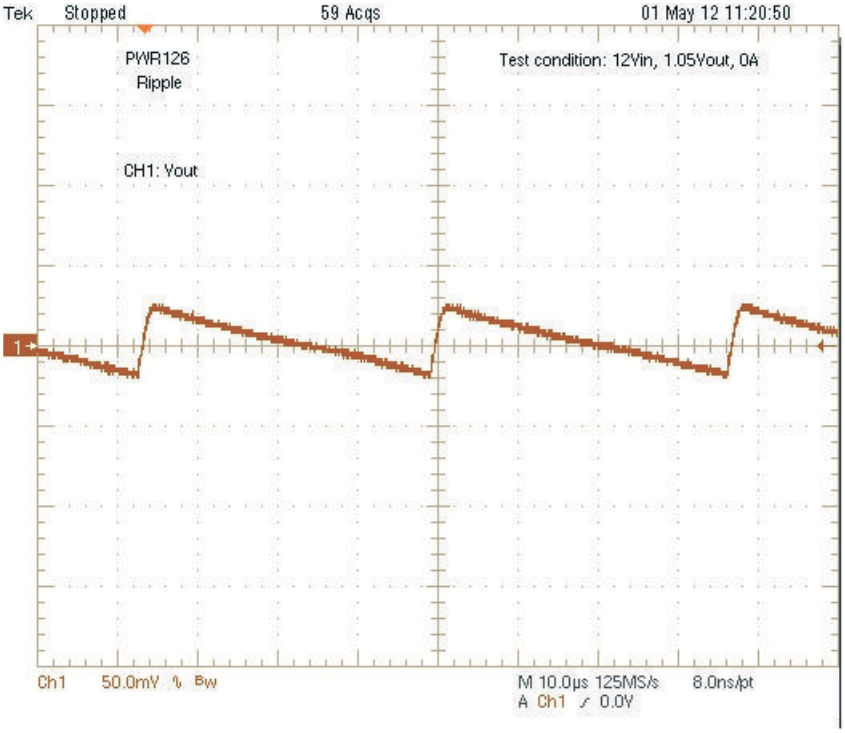

Figure 8-5. Output Ripple at No Load (12-V V_{IN}, 1.05-V V_{OUT}, 0 A)

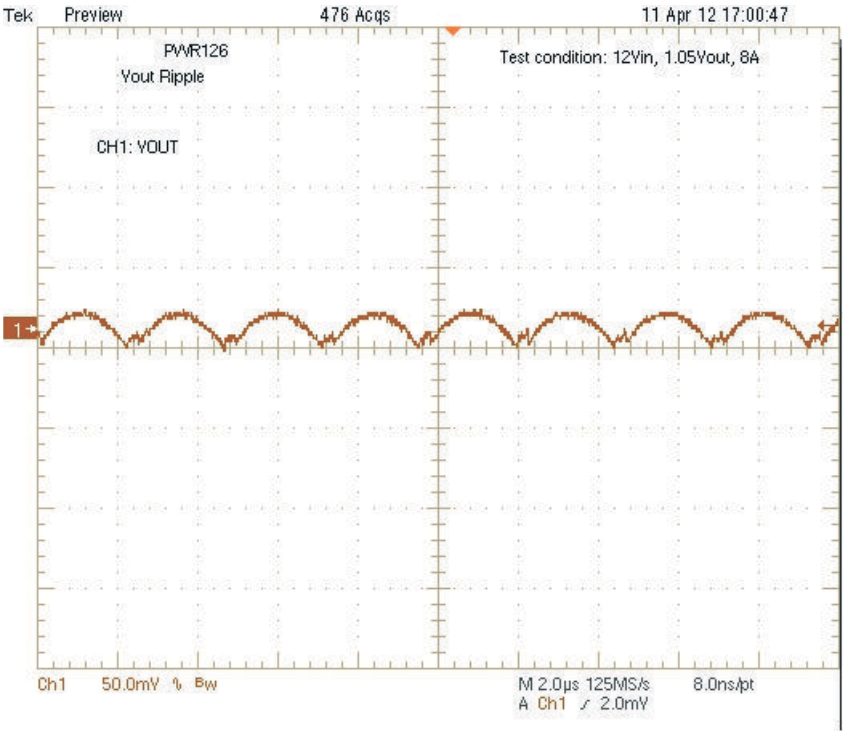

Figure 8-6. Output Ripple at Full Load (12-V V_{IN}, 1.05-V V_{OUT}, 8 A)

8.6 Switching Node

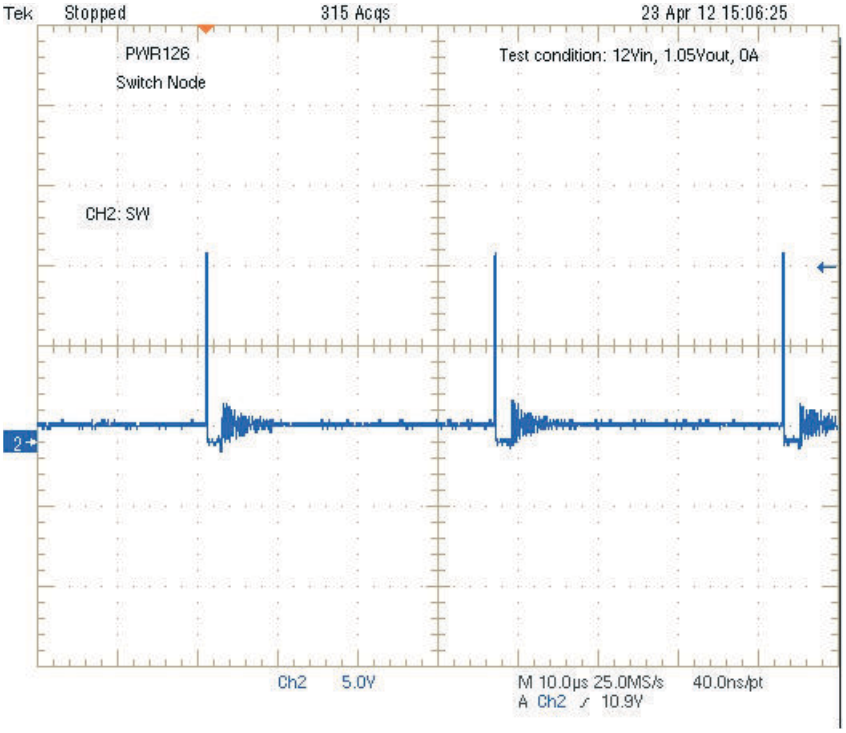

Figure 8-7. Switching Node at No Load (12-V V_{IN}, 1.05-V V_{OUT}, 0 A)

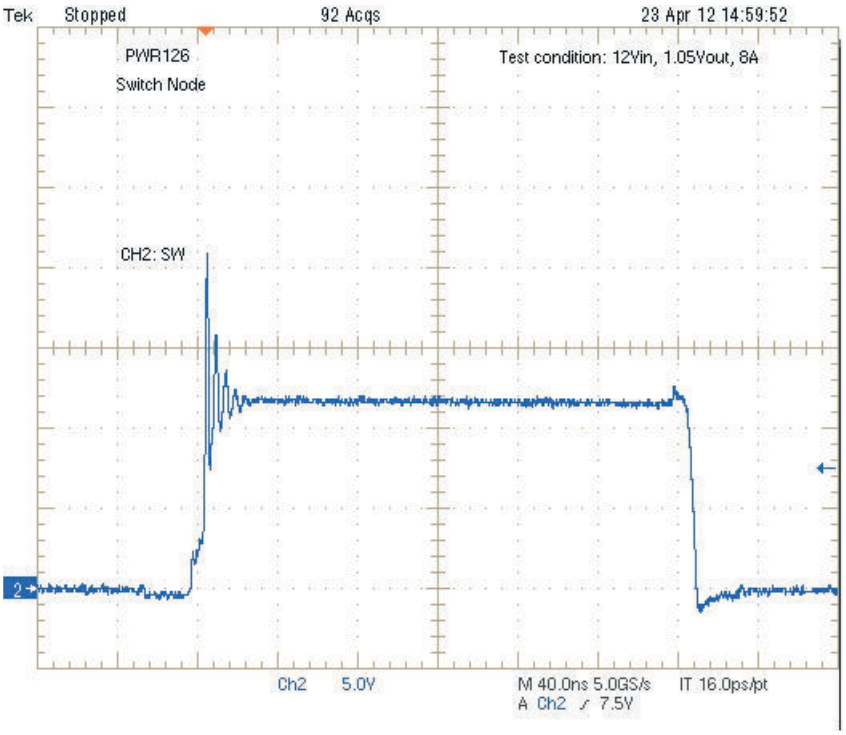

Figure 8-8. Switching Node at Full Load (12-V V_{IN}, 1.05-V V_{OUT}, 8 A)

8.7 Enable Start-Up

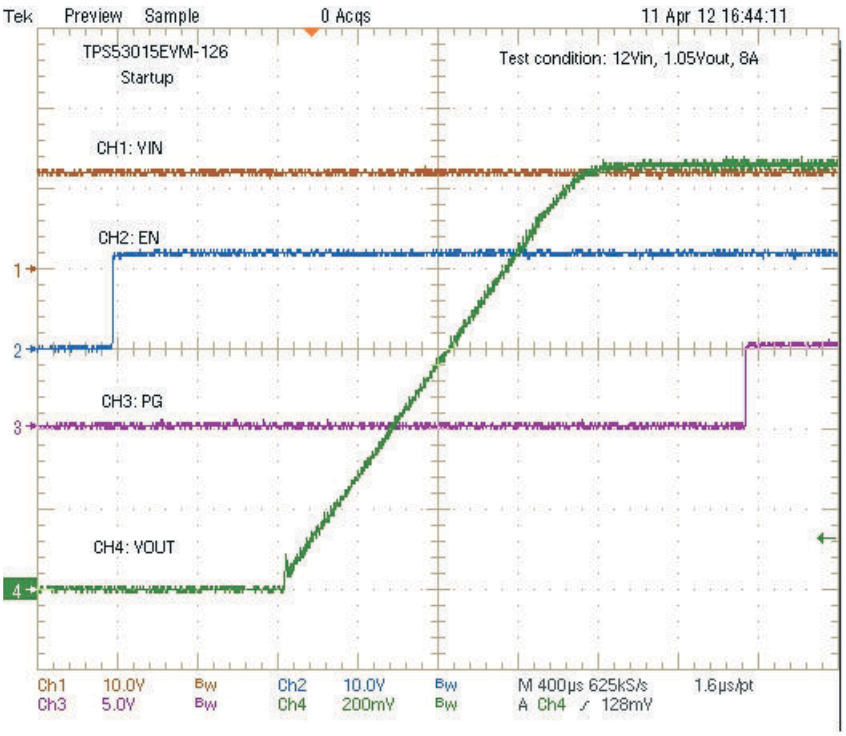

Figure 8-9. Start-Up Waveform (12-V V_{IN}, 1.05-V V_{OUT}, 8-A I_{OUT})

8.8 Disable

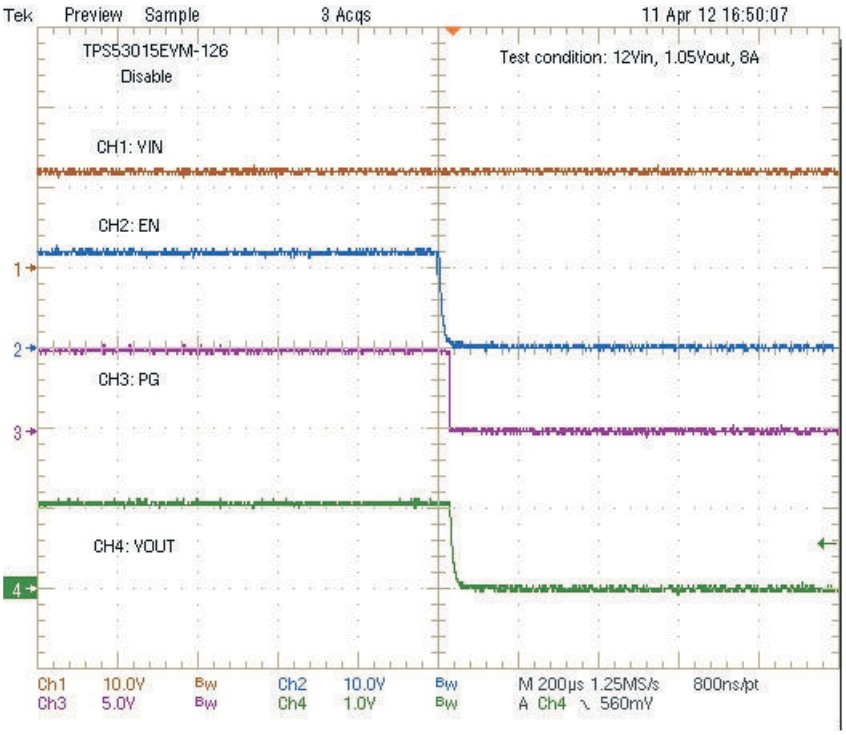

Figure 8-10. Shutdown Waveform (12-V V_{IN}, 1.05-V V_{OUT}, 8-A I_{OUT})

8.9 Thermal Image

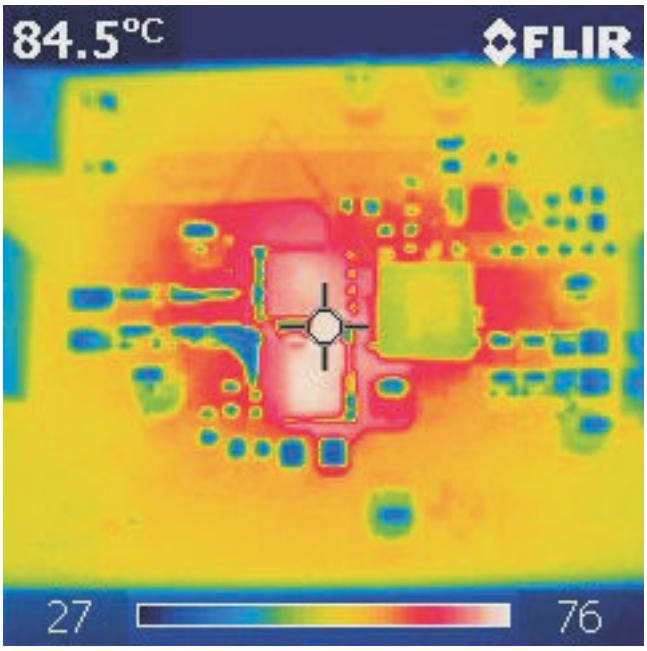

Figure 8-11. Thermal Image (22-V V_{IN}, 1.05-V V_{OUT}, 8-A I_{OUT}, no Air Flow)

Note

The hottest spot is the surface of snubber resistor and power MOSFET, not the surface of TPS53015 controller device.

9 EVM Assembly Drawing and PCB Layout

The following figures (Figure 9-1 through Figure 9-5) show the design of the TPS53015EVM-126 printed circuit board. The EVM has been designed using a 4-layer, 2-ounce copper circuit board.

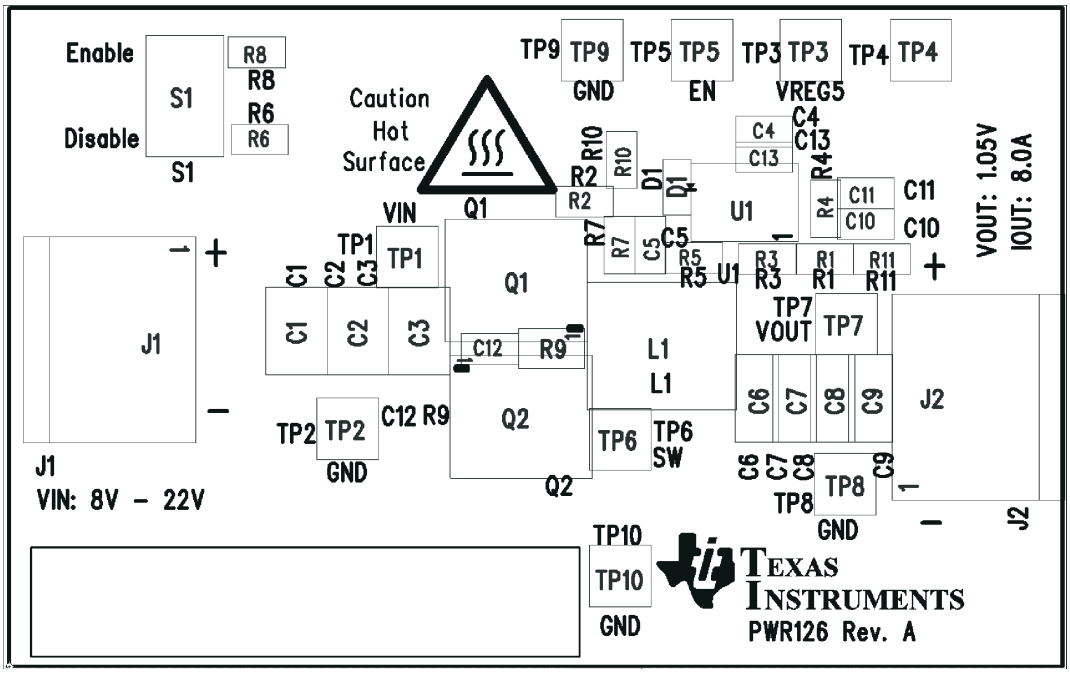

Figure 9-1. TPS53015EVM-126 Top Layer Assembly Drawing (Top View)

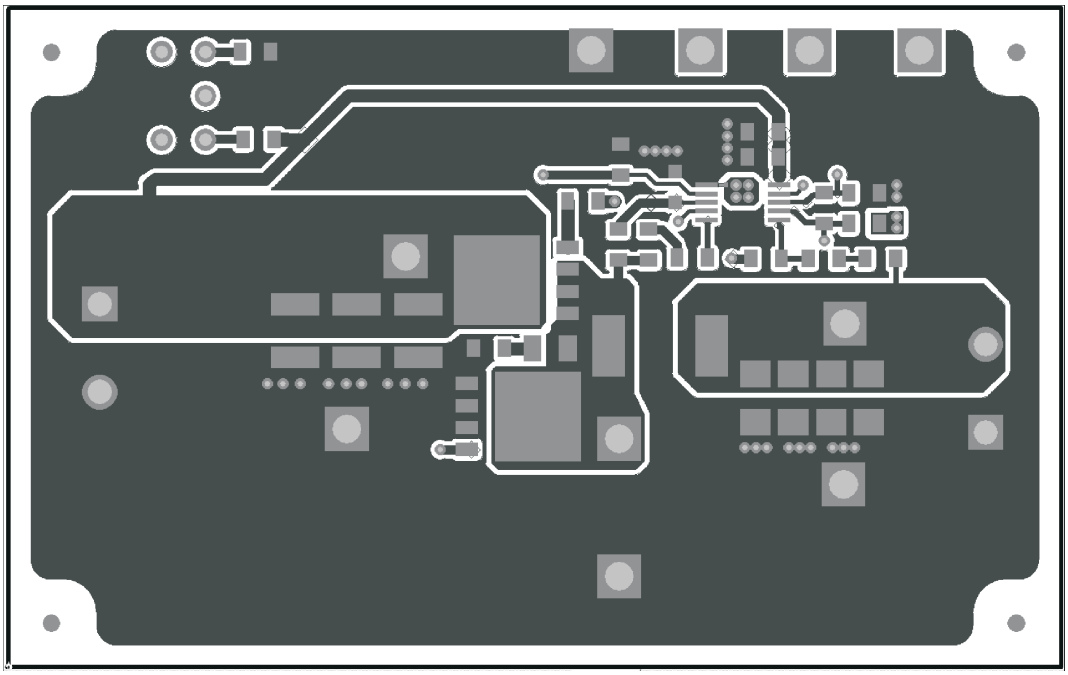

Figure 9-2. TPS53015EVM-126 Top Copper (Top View)

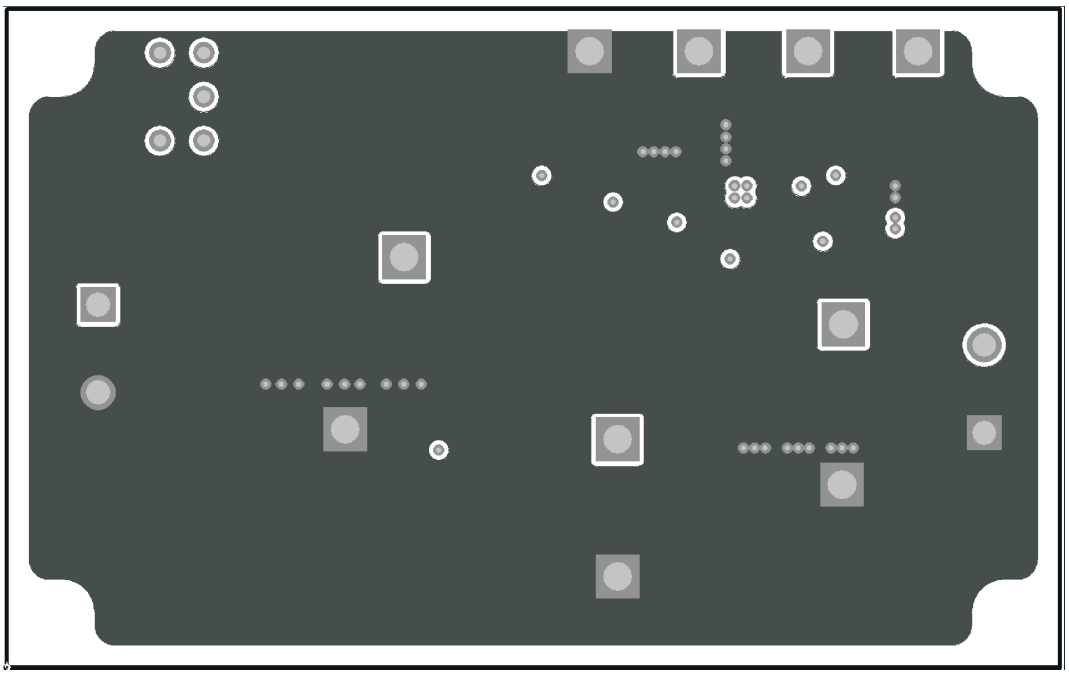

Figure 9-3. TPS53015EVM-126 Layer 2 (Top View)

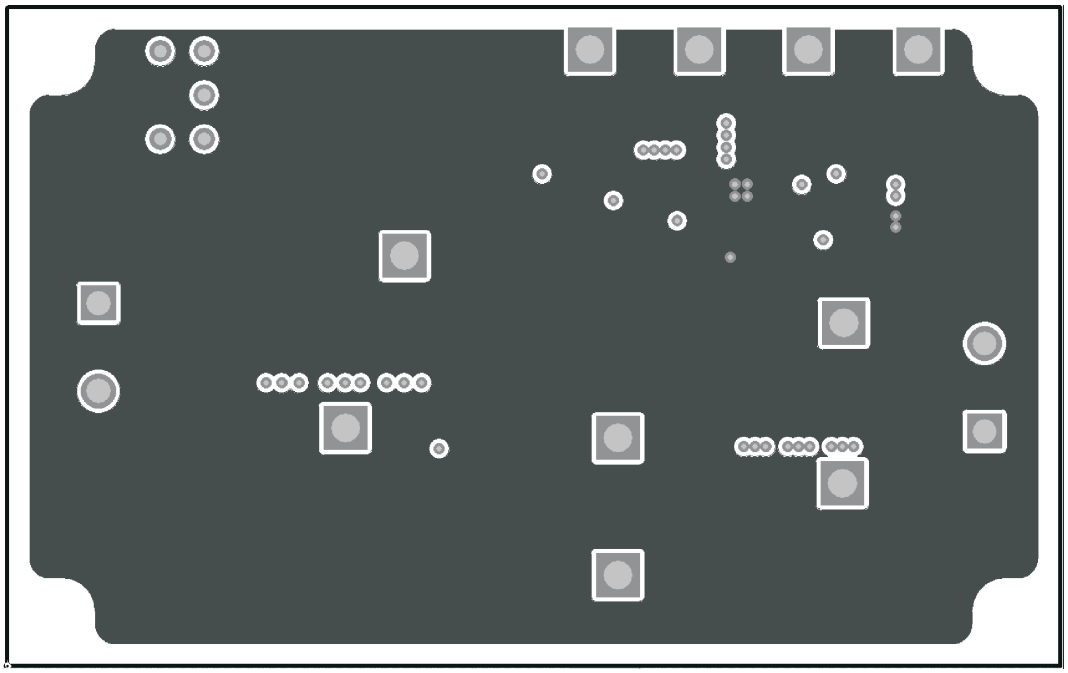

Figure 9-4. TPS53015EVM-126 Layer 3 (Top View)

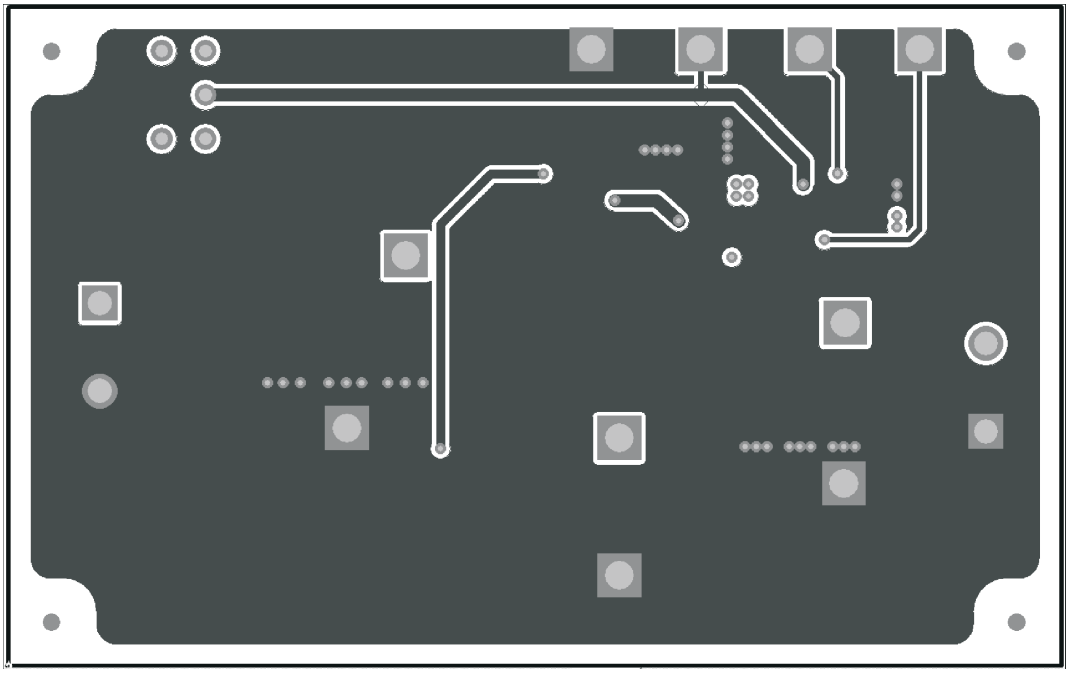

Figure 9-5. TPS53015EVM-126 Bottom Layer (Top View)

10 List of Materials

The EVM components list according to the schematic shown in Figure 4-1.

Table 10-1. TPS53015EVM-126 List of Materials

QTY	REF DES	DESCRIPTION	PART NUMBER	MFR
3	C1, C2, C3	Capacitor, ceramic, 35 V, X5R, 20%, 10 µF, 1210	Std	Std
0	C4	Capacitor, ceramic, 35 V, X7R, 10%, 1 µF, 0603	Std	Std
1	C5	Capacitor, ceramic, 10 V, X7R, 10%, 0.1 µF, 0603	Std	Std
2	C6, C7	Capacitor, ceramic, 10 V, X5R, 20%, 22 µF, 1206	Std	Std
0	C8, C9	Capacitor, ceramic, 10 V, X5R, 20%, 22 µF, 1206	Std	Std
0	C10	Capacitor, ceramic, 10 V, X7R, 10%, 0.01 µF, 0603	Std	Std
1	C11	Capacitor, ceramic, 10 V, X7R, 10%, 4.7 µF, 0603	Std	Std
1	C12	Capacitor, ceramic, 50 V, X7R, 10%, 1000 pF, 0603	Std	Std
1	C13	Capacitor, ceramic, 50 V, X7R, 10%, 0.1 µF, 0603	Std	Std
1	D1	Diode, Schottky, 10 mA, 30 V, SOD523	BAT54XV2T1G	On Semi
2	J1, J2	Connector, 15 A, 300 V, male 2 pole, 5.08 mm, 9 mm × 12 mm	ED120/2DS	On Shore Tech
1	L1	Inductor, 11 A, 6 mΩ, ±20%, 1.5 µH, 6.6 mm × 7 mm	PCMB065T-1R5MS	Cyntec
2	Q1, Q2(1)	MOSFET, N-channel, 30 V, 13 A, 11.8 mΩ, SON, 5 mm × 6 mm	CSD17507Q5A	TI
		MOSFET, N-channel, 30 V, 14 A, 9.0 mΩ, SON, 5 mm × 6 mm	CSD17551Q5A	
1	R1	Resistor, chip, 1/10 W, 1%, 8.66 kΩ, 0603	Std	Std
1	R2	Resistor, chip, 1/10 W, 1%, 10.0 Ω, 0603	Std	Std
1	R3	Resistor, Chip, 1/10 W, 1%, 23.7 kΩ, 0603	Std	Std
1	R4	Resistor, chip, 1/10 W, 1%, 100 kΩ, 0603	Std	Std
1	R5	Resistor, chip, 1/10 W, 1%, 5.11 Ω, 0603	Std	Std
2	R6, R8	Resistor, chip, 1/10 W, 1%, 1.00 kΩ, 0603	Std	Std
1	R7	Resistor, chip, 1/10 W, 1%, 2.05 Ω, 0603	Std	Std
1	R9	Resistor, chip, 1/4 W, 1%, 3.01 Ω, 0805	Std	Std
1	R10	Resistor, chip, 1/10 W, 1%, 15.4 kΩ, 0603	Std	Std
1	R11	Resistor, chip, 1/10 W, 1%, 140 Ω, 0603	Std	Std
1	S1	Switch, on-none-on, 0.28 inch × 0.18 inch	G12AP-RO	NKK
4	TP1, TP3, TP6, TP7	Test point, red, thru hole, 0.125 inch × 0.125 inch	5010	Keystone
4	TP2, TP8, TP9, TP10	Test point, black, thru hole, 0.125 inch × 0.125 inch	5011	Keystone
2	TP4, TP5	Test point, white, thru hole, 0.125 inch × 0.125 inch	5012	Keystone
1	U1	IC, Single Synchronous Step-Down Controller, VSSOP	TPS53015DGS	TI
1	--	PCB, 2.4 inch × 1.5 inch × 0.062 inch	PWR126	TI

(1) The CSD17551Q5A can be used as alternate part to the CSD17507Q5A.

11 Revision History

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

Changes from Revision * (June 2012) to Revision A (December 2021) **Page**

- Updated the numbering format for tables, figures, and cross-references throughout the document. 2
- Updated the user's guide title....2
- Edited user's guide for clarity....2

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