

TPS54326 Step-Down Converter Evaluation Module User's Guide



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1 Introduction

This user's guide contains background information for the TPS54326 as well as support documentation for the TPS54326EVM-540 evaluation module. This user's guide also includes the performance specifications, schematic, and the bill of materials for the TPS54326EVM-540.

1.1 Background

The TPS54326 is a single, adaptive on-time D-CAP2™ mode synchronous buck converter requiring a very low external component count. The D-CAP2 control circuit is optimized for low-ESR output capacitors such as POSCAP, SP-CAP, or ceramic types, and features fast transient response with no external compensation. The switching frequency is internally set at a nominal 700 kHz. The high-side and low-side switching MOSFETs are incorporated inside the TPS54326 package along with the gate drive circuitry. The low drain-to-source on resistance of the MOSFETs allow the TPS54326 to achieve high efficiencies and helps keep the junction temperature low at high output currents. The TPS54226 also has an auto-skip mode to enable higher efficiency at light loads. The TPS54326 DC/DC synchronous converter is designed to provide up to a 2-A output from an input control voltage source of 4.5 V to 18 V, input power voltage source of 2 V to 18 V, and output voltage from 0.76 V to 5.5 V. Rated input voltage, output voltage, and output current range for the evaluation module are given in [Table 1-1](#).

Table 1-1. Input Voltage and Output Current Summary

EVM	Input Voltage Range	Output Voltage and Current Range
TPS54326EVM-540	$V_{IN} = 4.5 \text{ V to } 18 \text{ V}$	$V_{OUT} = 1.05 \text{ V, } 0 \text{ A to } 2 \text{ A}$

1.2 Performance Specification Summary

[Table 1-2](#) provides a summary of the TPS54326EVM-540 performance specifications. Specifications are given for an input voltage of $V_{IN} = 12 \text{ V}$ and an output voltage of 1.05 V, unless otherwise noted. The ambient temperature is 25°C for all measurement, unless otherwise noted.

Table 1-2. TPS54326 EVM and Performance Specifications Summary

Specifications		Test Conditions	Min	Typ	Max	Unit
Input voltage range (V_{IN})			4.5	12	18	V
CH1	Output voltage			1.05		V
	Operating frequency	$V_{IN} = 12 \text{ V, } I_O = 1 \text{ A}$		700		kHz
	Output current range		0		3	A
	Over current limit	$V_{IN} = 12 \text{ V}$		4.1		A
	Output ripple voltage	$V_{IN} = 12 \text{ V, } I_O = 3 \text{ A}$		7		mV _{pp}

1.3 Modifications

These evaluation modules are designed to provide access to the features of the TPS54326. Some modifications can be made to this module.

1.3.1 Output Voltage Set Point

To change the output voltage of the EVMs, change the value of resistor R1. Changing the value of R1 can change the output voltage above 0.765 V. The value of R1 for a specific output voltage can be calculated using [Equation 1](#) and [Equation 2](#).

For output voltage from 0.76 V to 2.5 V:

$$V_O = 0.765 \times \left(1 + \frac{R1}{R2} \right) \quad (1)$$

For output voltage over 2.5 V:

$$V_O = (0.763 + 0.0017 \times V_O) \times \left(1 + \frac{R1}{R2} \right) \quad (2)$$

[Table 1-3](#) lists the R1 values for some common output voltages. For higher output voltages, a feedforward capacitor is required. Pads for this component (C2) are provided on the printed circuit board. C2 is used for faster load transient response and is recommended for auto skip mode stability. Note that the values given in [Table 1-3](#) are standard values, and not the exact value calculated using [Table 1-3](#).

Table 1-3. Output Voltages

Output Voltage (V)	R1 (kΩ)	R2 (kΩ)	C2 (pF)	L1 (μH)
1.0	6.81	22.1		1.5
1.05	8.25	22.1		1.5
1.2	12.7	22.1		1.5
1.8	30.1	22.1	10 - 47	2.2
2.5	49.9	22.1	10 - 47	2.2
3.3	73.2	22.1	10 - 47	2.2
5.0	121	22.1	10 - 47	3.3

2 Test Setup and Results

This section describes how to properly connect, set up, and use the TPS54326EVM-540. The section also includes test results typical for the evaluation modules and the following:

- Efficiency
- Output load regulation
- Output line regulation
- Load transient response
- Output voltage ripple
- Input voltage ripple
- Start-up
- Switching frequency

2.1 Input/Output Connections

The TPS5326EVM-540 is provided with input/output connectors and test points as shown in [Table 2-1](#). A power supply capable of supplying 3 A must be connected to J1 through a pair of 20 AWG wires. The load must be connected to J2 through a pair of 20 AWG wires. The maximum load current capability is 3 A. Wire lengths must be minimized to reduce losses in the wires. Test point TP1 provides a place to monitor the V_{IN} input voltages with TP2 providing a convenient ground reference. TP8 is used to monitor the output voltage with TP9 as the ground reference.

Table 2-1. Connection and Test Points

Reference Designator	Function
J1	V_{IN} (see Table 1-1 for V_{IN} range)
J2	V_{OUT} , 1.05 V at 3 A maximum
JP1	EN control. Connect EN to OFF to disable, connect EN to ON to enable.
TP1	V_{IN} test point at V_{IN} connector
TP2	GND test point at V_{IN}
TP3	EN test point
TP4	V_{CC} test point
TP5	Analog ground test point
TP6	Switch node test point
TP7	Power good test point
TP8	Output voltage test point
TP9	Ground test point at output connector

2.2 Start-Up Procedure

1. Make sure the jumper at JP1 (Enable control) is set from EN to OFF.
2. Apply appropriate V_{IN} voltage to VIN and PGND terminals at J1.
3. Move the jumper at JP1 (Enable control) to cover EN and ON. The EVM will enable the output voltage.

2.3 Efficiency

Figure 2-1 shows the efficiency for the TPS54326EVM-540 at an ambient temperature of 25°C.

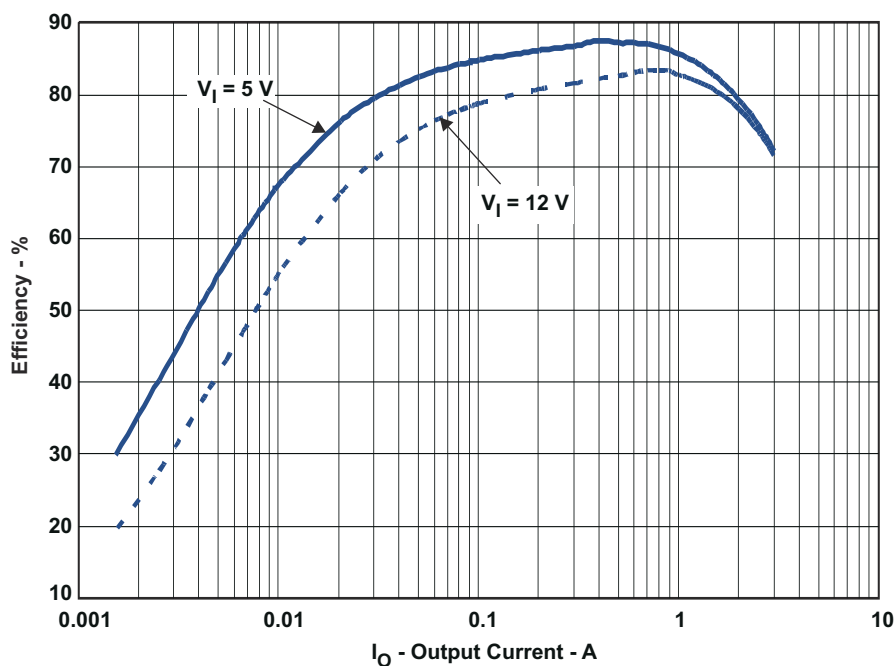


Figure 2-1. TPS54326EVM-540 Efficiency

2.4 Load Regulation

The load regulation for the TPS54326EVM-540 is shown Figure 2-2.

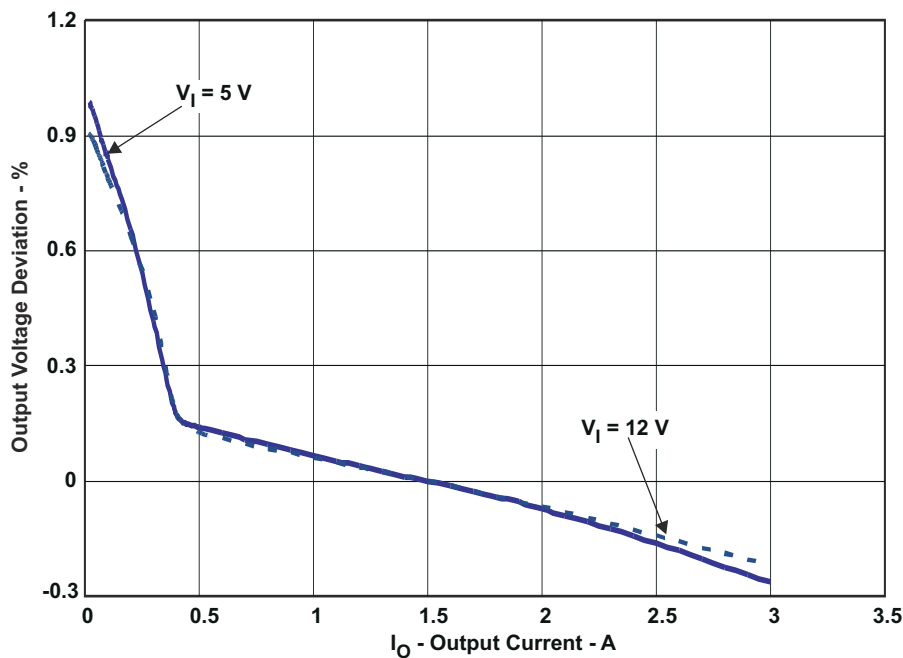


Figure 2-2. TPS54326EVM-540 Load Regulation

2.5 Line Regulation

The line regulation for the TPS54326EVM-540 is shown [Figure 2-3](#).

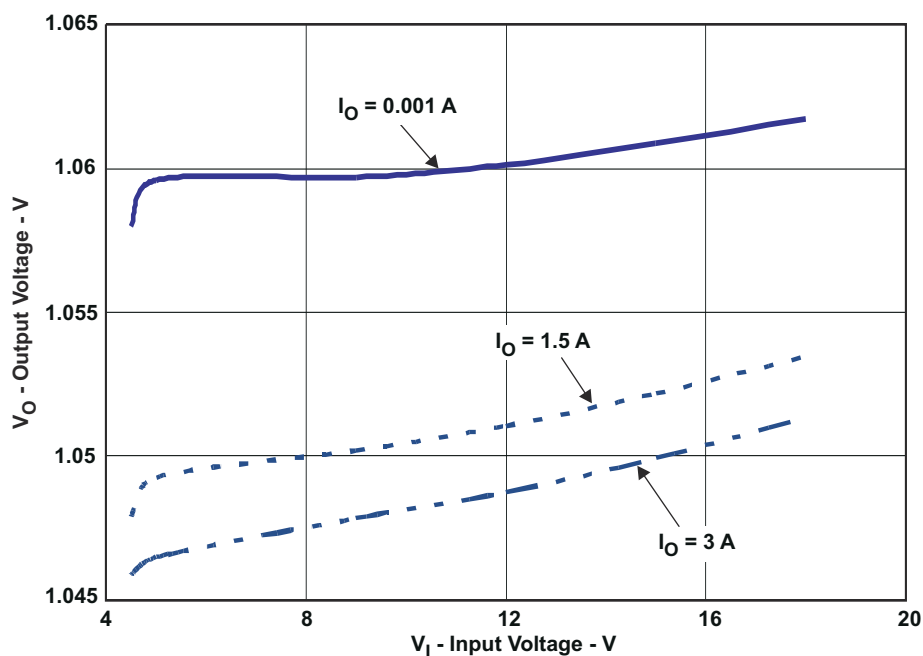


Figure 2-3. TPS54326EVM-540 Line Regulation

2.6 Load Transient Response

The TPS54326EVM-540 response to load transient is shown in [Figure 2-4](#). The current step is from 0.75 A to 2.25 A (25% to 75% of rated load). Total peak-to-peak output voltage variation is as shown.

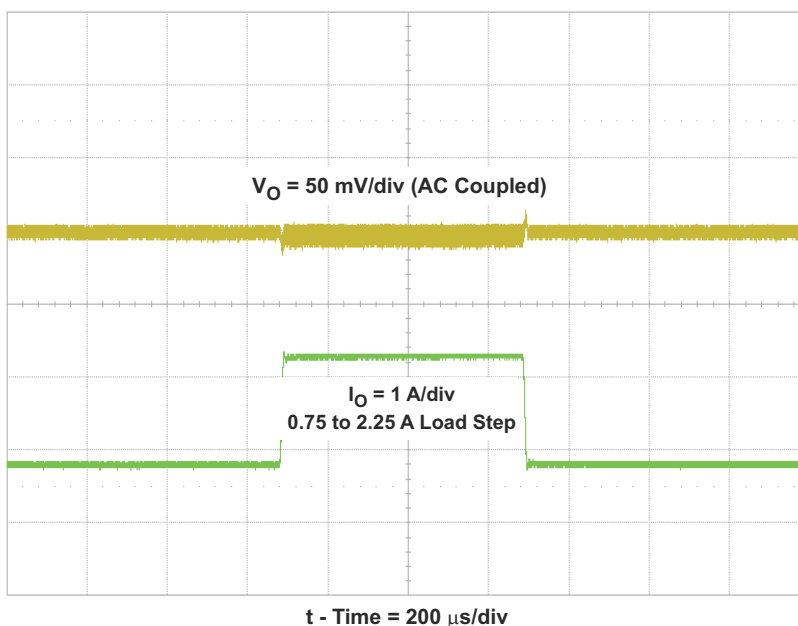


Figure 2-4. TPS54326EVM-540 Load Transient Response

2.7 Output Voltage Ripple

The TPS54326EVM-540 output voltage ripple is shown in [Figure 2-5](#). The output current is the rated full load of 3 A.

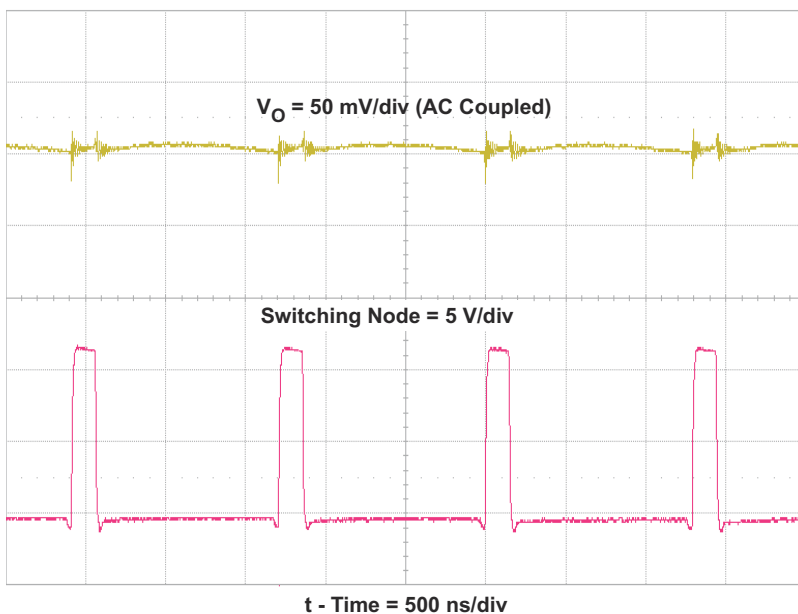


Figure 2-5. TPS54326EVM-540 Output Voltage Ripple

2.8 Input Voltage Ripple

The TPS54326EVM-540 input voltage ripple is shown in [Figure 2-6](#). The output current is the rated full load of 3 A.

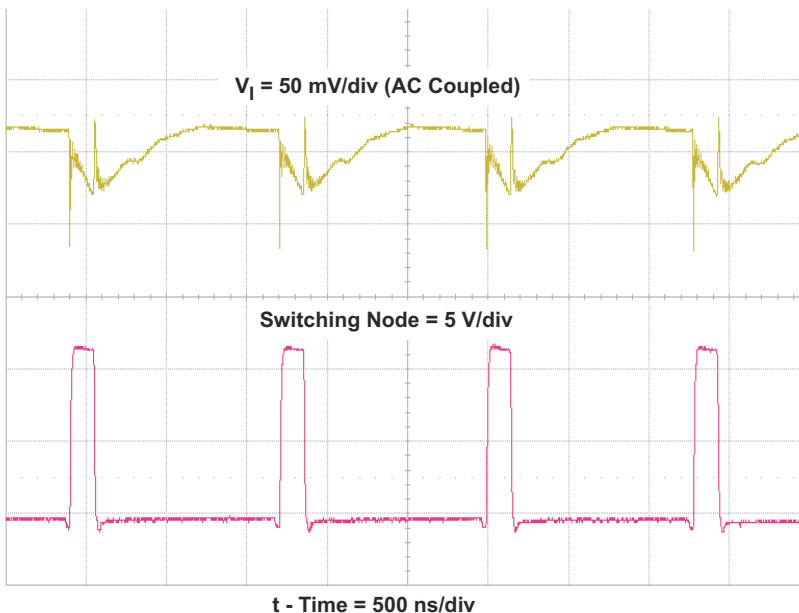


Figure 2-6. TPS54326EVM-540 Input Voltage Ripple

2.9 Start-Up

The TPS54326EVM-540 start-up waveform is shown in [Figure 2-7](#).

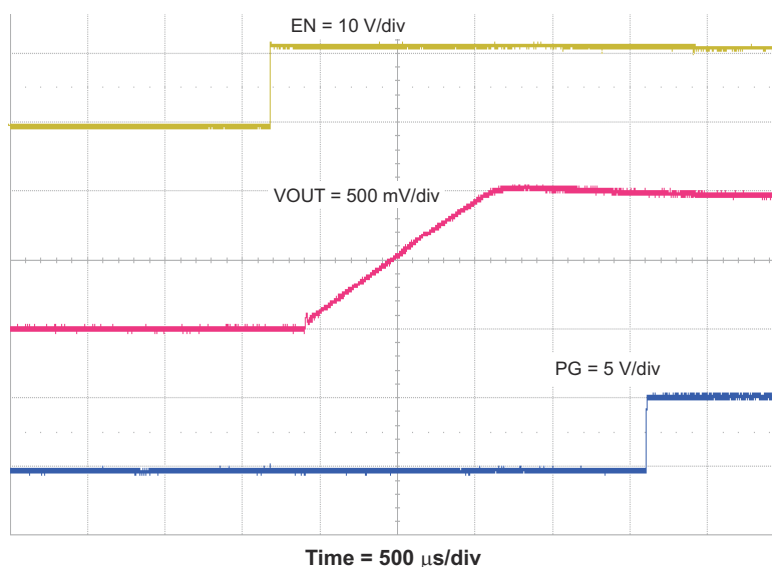


Figure 2-7. TPS54326EVM-540 Start-Up

2.10 Switching Frequency

The TPS54326EVM-540 switching frequency is shown in [Figure 2-8](#).

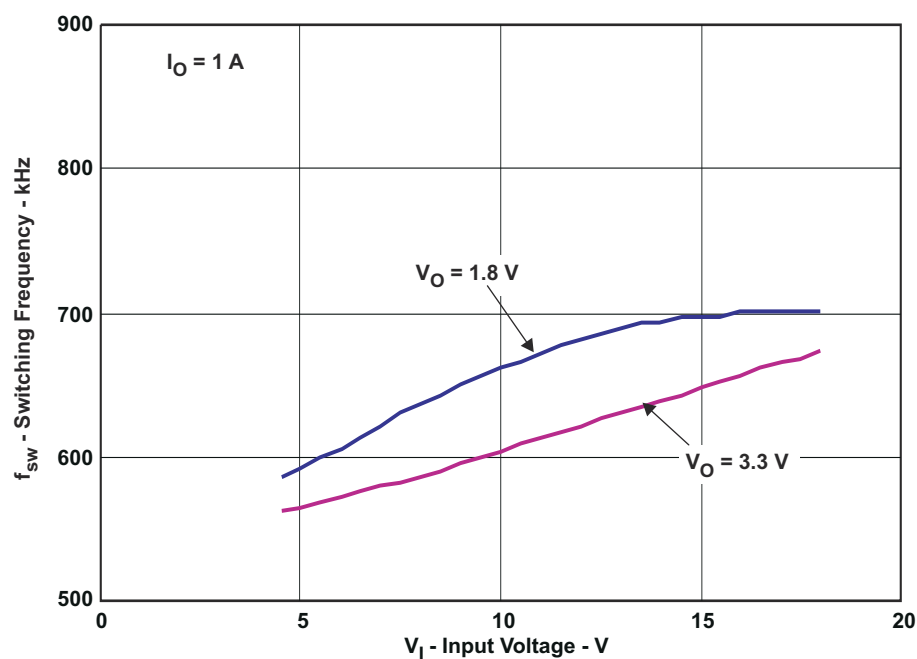


Figure 2-8. TPS54326-540 Switching Frequency

3 Board Layout

This section provides description of the TPS54326EVM-540, board layout, and layer illustrations.

3.1 Layout

The board layout for the TPS54326EVM-540 and is shown in Figure 3-1 through Figure 3-6. The top layer contains the main power traces for VIN, VO, and ground. Also on the top layer are connections for the pins of the TPS54326 and a large area filled with ground. Many of the signal traces are also located on the top side. The input decoupling capacitors are located as close to the IC as possible. The input and output connectors, test points, and most of the components are located on the top side. R3, the 0-Ω resistor that connects VIN to VCC and R4, the power-good pullup, are located on the back side. Analog ground and power ground are connected at a single point on the top layer near pin 5 of the TPS54326. The internal layer 1 is a split plane containing analog and power grounds. The internal layer 2 is primarily power ground. There is also a fill area of VIN and a trace routing VCC to the enable control jumper JP1. The bottom layer is primarily analog ground. There are also traces to connect VIN to VCC through R3, traces for the power good signal, and the feedback trace from VOUT to the voltage setpoint divider network.

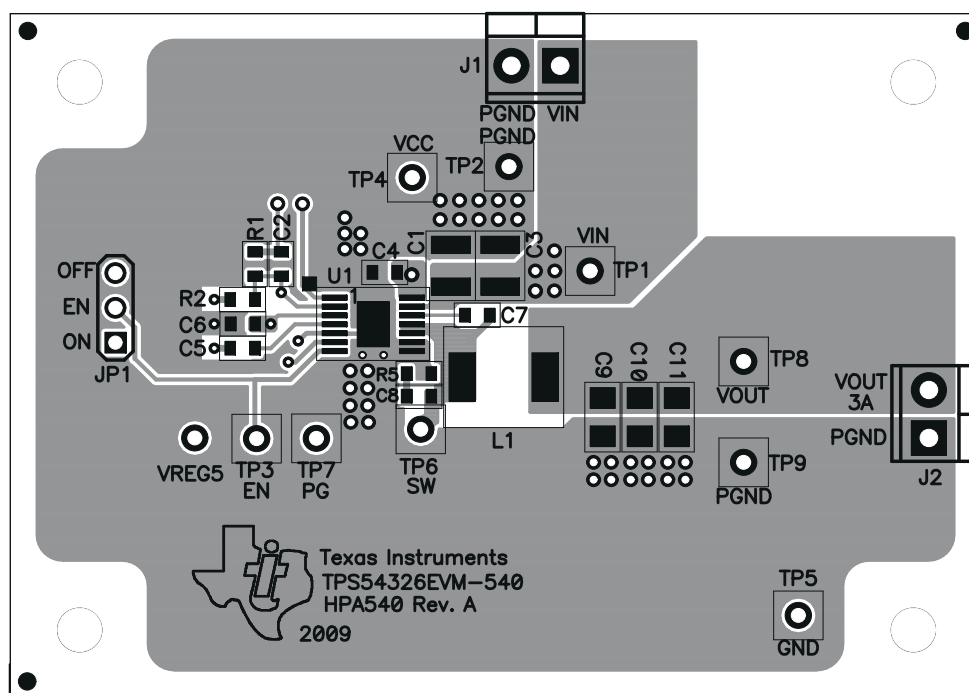


Figure 3-1. Top Assembly

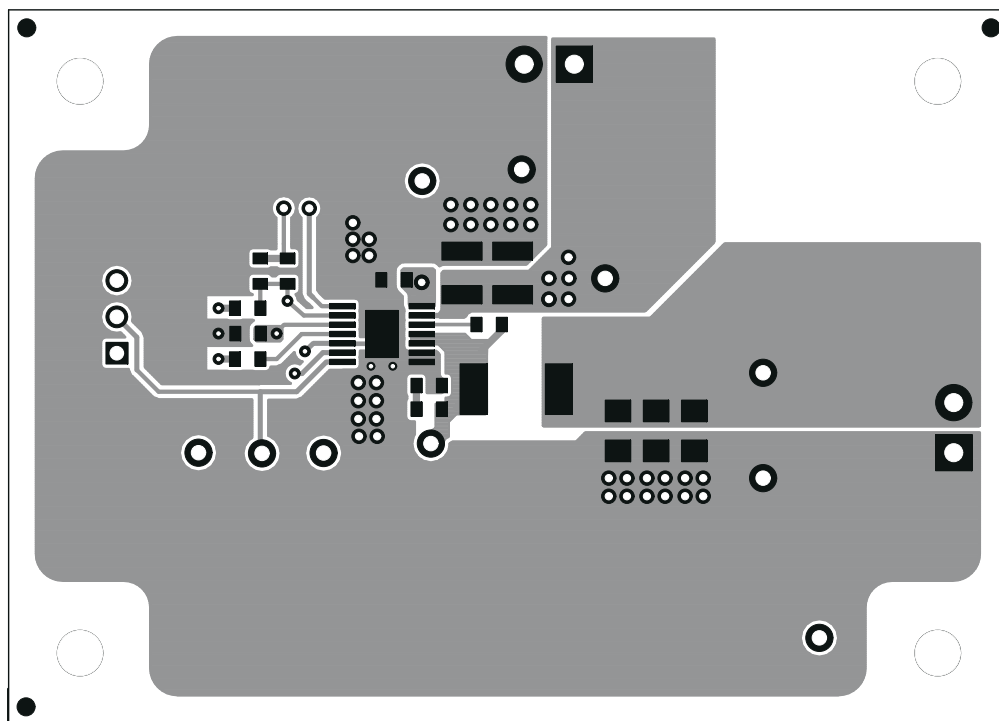


Figure 3-2. Top Layer

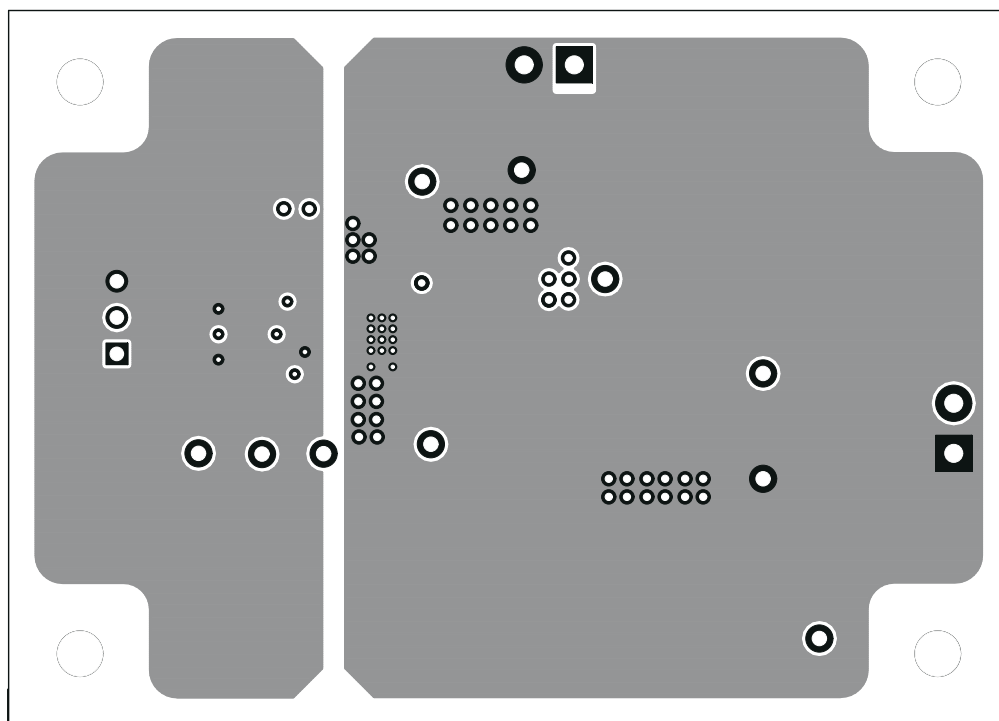


Figure 3-3. Internal Layer 1

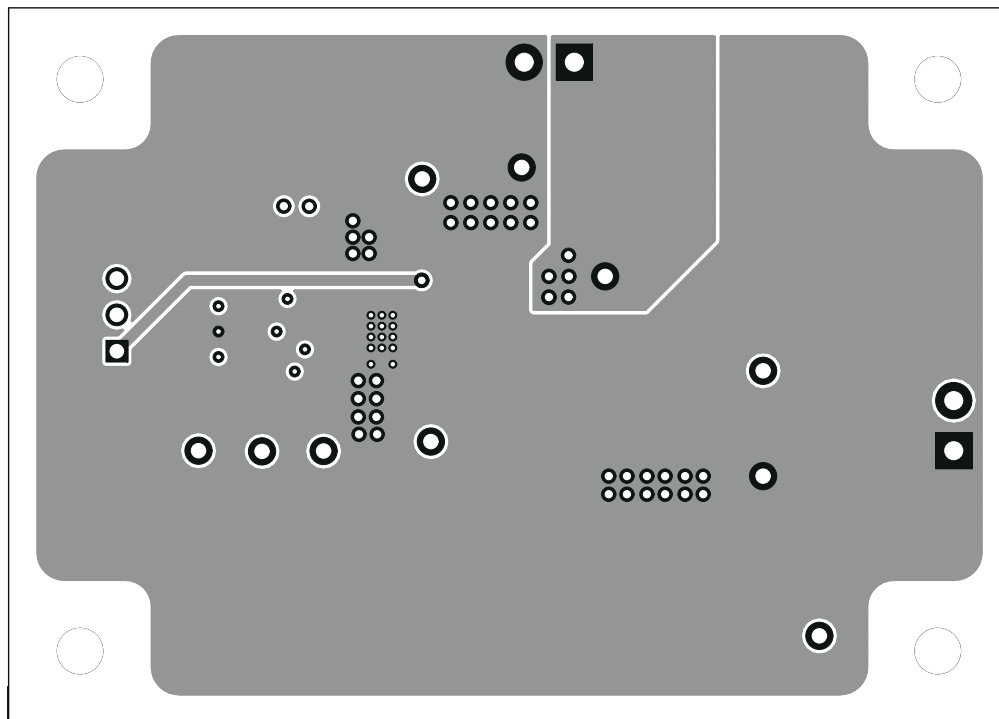


Figure 3-4. Internal Layer 2

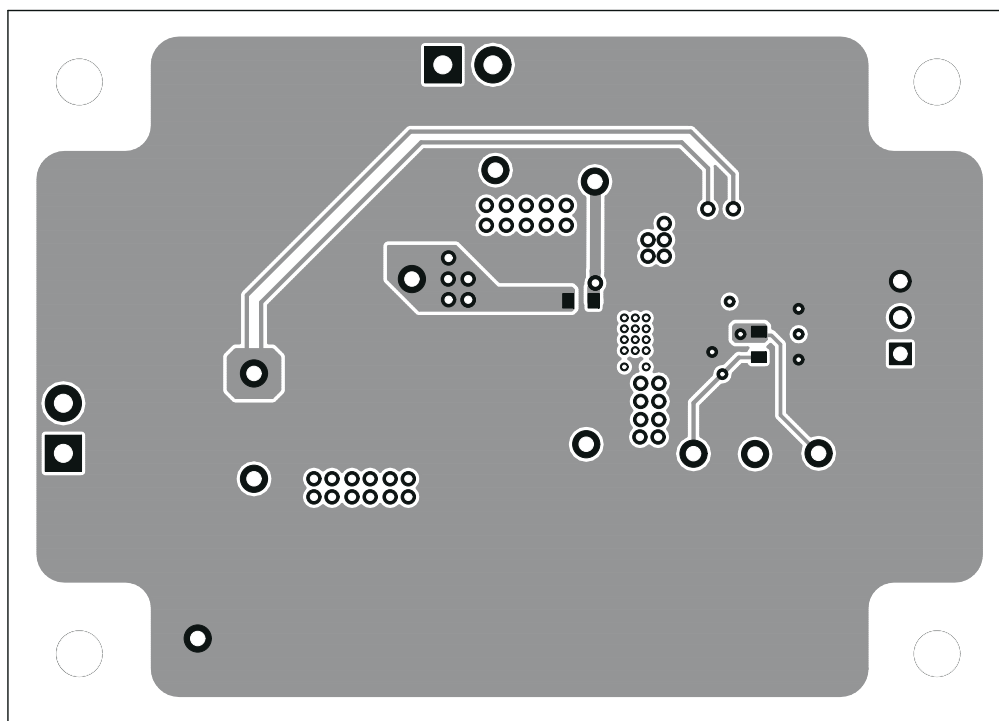


Figure 3-5. Bottom Layer

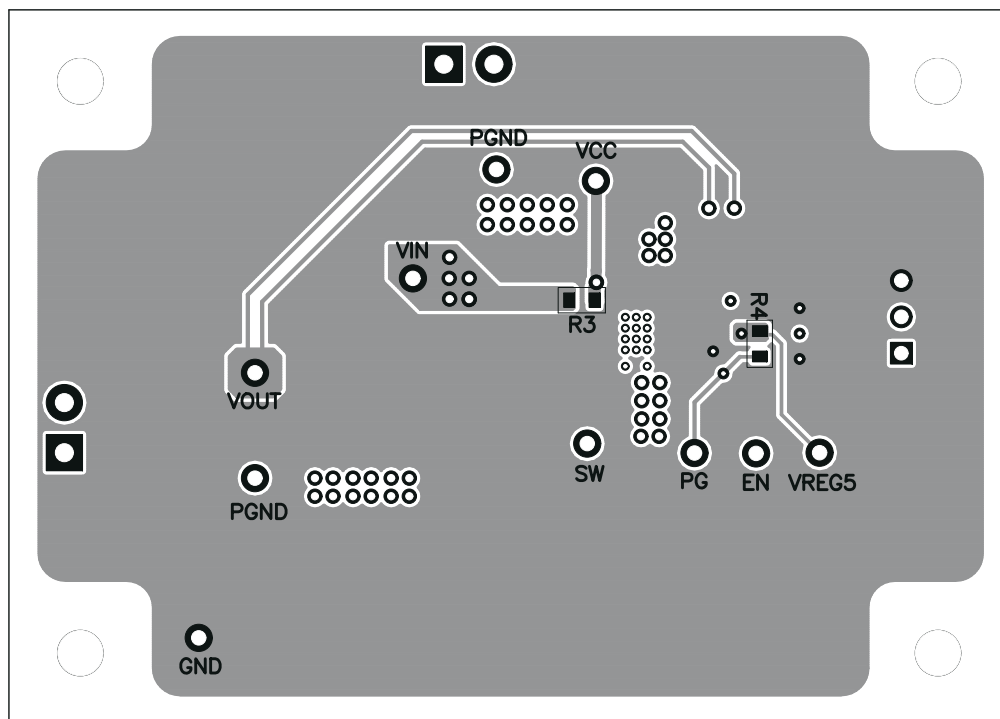


Figure 3-6. Bottom Assembly

This section presents the TPS54326EVM-540 schematic, bill of materials, and reference.

Figure 4-1 is the schematic for the TPS54326EVM-540.



4.2 Bill of Materials

Table 4-1. Bill of Materials

RefDes	QTY	Value	Description	Size	Part Number	MFR
C1, C3	2	10 μ F	Capacitor, Ceramic, 25 V, X5R, 20%	1210	C3225X5R1E106M	TDK
C11	0	Open	Capacitor, Ceramic	1206	Std	Std
C2, C4, C8	0	Open	Capacitor, Ceramic	0603	Std	Std
C5	1	3300 pF	Capacitor, Ceramic, 25 V, X7R, 10%	0603	Std	Std
C6	1	1 μ F	Capacitor, Ceramic, 16 V, X7R, 10%	0603	Std	Std
C7	1	0.1 μ F	Capacitor, Ceramic, 50 V, X7R, 10%	0603	Std	Std
C9, C10	2	22 μ F	Capacitor, Ceramic, 6.3 V, X5R, 20%	1206	C3216X5R0J226M	TDK
J1, J2	2	ED555/2DS	Terminal Block, 2-pin, 6 A, 3.5 mm	0.27 × 0.25 inch	ED555/2DS	Sullins
JP1	1	PEC03SAAN	Header, Male 3-pin, 100-mil spacing	0.100 inch × 3	PEC03SAAN	Sullins
L1	1	1.5 μ H	Inductor, SMT, 11.5 A, 9.7 m Ω	0.256 × 0.280 inch	SPM6530T-1R5M100	TDK
R1	1	8.25 k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
R2	1	22.1 k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
R3	1	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
R4	1	100 k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
R5	0	Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
TP1, TP3, TP4, TP6, TP7, TP8, TP9	3	5000	Test Point, Red, Thru Hole Color Keyed	0.100 × 0.100 inch	5000	Keystone
TP2, TP5, TP9	3	5001	Test Point, Black, Thru Hole Color Keyed	0.100 × 0.100 inch	5001	Keystone
U1	1	TPS54326PWP	IC, 2-A Output Single Sync. Step-Down	—	TPS54326PWP	TI
—	1	—	Shunt, 100-mil, Black	0.100	929950-00	3M
—	1	—	PCB, 2.76 inch × 1.97 inch × 0.062 inch	—	HPA540	Any

4.3 Reference

Texas Instruments, [TPS54326 Single Synchronous Converter with Integrated High Side and Low Side MOSFET Data Sheet](#)

5 Revision History

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

Changes from Revision * (November 2009) to Revision A (October 2021)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document.	2
• Updated the user's guide title	2

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