User's Guide

TPS564242 and TPS564247 Step-Down Converter Evaluation Module User's Guide

ABSTRACT

This user's guide introduces the TPS564242EVM and TPS564247EVM. These two devices differ in their light load behavior. The TPS564242 operates in Eco mode and the TPS564247 operates in FCCM mode. This user's guide contains information for the TPS564242 and TPS564247 as well as support documentation for the TPS564242EVM and TPS564247EVM evaluation modules. This document also includes the performance specifications, board layout, schematic, and the list of materials of the TPS564242EVM and TPS564242EVM.

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1 Introduction

In light-load conditions, the TPS564242 operates in Eco mode to enable higher efficiency by varying its switching frequency, and the TPS564247 operates in FCCM to maintain constant switching frequency. The main difference is at light loading, but the other behaviors are similar. This user's guide mainly introduces the TPS564242 and includes some features about the TPS564247 that are different from the TPS564242.

The TPS56424x is a single, adaptive on-time, D-CAP3™ mode, synchronous buck converter requiring a very low external component count. The D-CAP3 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 1200 kHz. The high-side and low-side switching MOSFETs are incorporated inside the TPS56424x package along with the gate-drive circuitry. The low drain-to-source on resistance of the MOSFETs and fast switching slew rate allow the TPS56424x to achieve high efficiencies and helps keep the junction temperature low at high output currents. The TPS56424x DC/DC synchronous converter is designed to provide up to a 4-A output from an input voltage source of 3 V to 16 V. The output voltage range is from 0.6 V to 7 V. Rated input voltage and output current ranges for the evaluation module are given in Table 1-1.

The TPS564242EVM evaluation module (EVM) is a single, synchronous buck converter providing 1.05 V at 4 A from 3-V to 16-V input. This user’s guide describes the TPS564242EVM performance.

Table 1-1. Input Voltage and Output Current Summary

EVM	Input Voltage Range	Output Current Range
TPS564242EVM	V_{IN} = 3 V to 16 V	0 A to 4 A
TPS564247EVM	V_{IN} = 3 V to 16 V	0 A to 4 A

2 Performance Specification Summary

A summary of the TPS564242EVM performance specifications is provided in Table 2-1.Specifications are given for an input voltage of V_{IN} = 12 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 2-1. Performance Specifications Summary

Specifications	Test Conditions	MIN	TYP	MAX	Unit
Input voltage range		3	12	16	V
Output voltage set point			1.05		V
Operating frequency	V_{IN} = 12 V, I_O = 4 A		1.2		MHz
Output current range		0		4	A
Over current limit	V_{IN} = 12 V, L_O = 0.82 µH		6		A
Output ripple voltage	V_{IN} = 12 V, I_O =4 A		8		mV_{PP}

3 Modifications

These evaluation modules are designed to provide access to the features of the TPS564242. Some modifications can be made to this module.

3.1 Output Voltage Setpoint

The output voltage of the EVM can be selected by changing the value of resistor R_4 (R_{UPPER}) and R_5 (R_{LOWER}). The value of R_4 for a specific output voltage can be calculated using Equation 1.

$$R_4 = \frac{R_5 \times (V_{out} - 0.6V)}{0.6V} \quad (1)$$

4 Test Setup and Results

This section describes how to properly connect, set up, and use the TPS564242EVM. 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
- Start-up
- Shutdown

4.1 Input/Output Connections

The TPS564242EVM is provided with input/output connectors and test points as shown in Table 4-1. Figure 4-1 shows connectors and jumpers placement on the TPS564242EVM board. A power supply capable of supplying 4 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 4 A. Wire lengths must be minimized to reduce losses in the wires. Test point TP2 provides a place to monitor the V_{IN} input voltages with TP6 providing a convenient ground reference. TP3 is used to monitor the output voltage with TP10 as the ground reference.

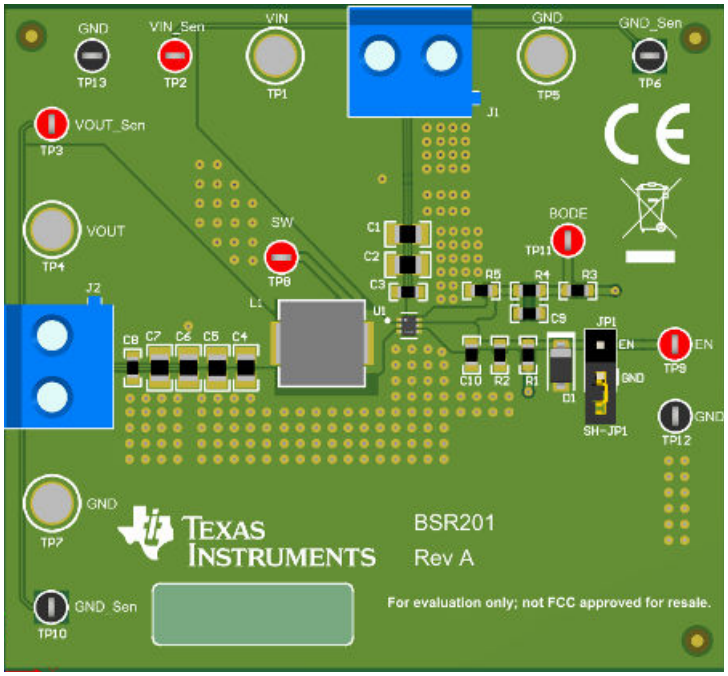

Figure 4-1. TPS564242EVM Connectors and Jumpers Placement

Table 4-1. 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 4-A maximum
JP1	EN control. Shunt EN to GND to disable
TP1	V_{IN} positive power point
TP2	V_{IN} positive monitor point
TP3	V_{OUT} positive monitor point
TP4	V_{OUT} positive power point
TP5, TP7	GND power point
TP6, TP10, TP12,TP13	GND monitor point
TP8	Switch node test point
TP9	EN test point
TP11	Test point for loop response measurements

4.2 Start-Up Procedure

1. Ensure that the jumper at JP1 (Enable control) pins 1 and 2 are covered to shunt EN to GND, disabling the output.
2. Apply appropriate V_{IN} voltage to VI (J1-2) and GND (J1-1).
3. Move the jumper at JP1 (Enable control) pins 1 and 2 (EN and GND) to enable the output.

4.3 Efficiency

Figure 4-2 shows the efficiency for the TPS564242EVM at an ambient temperature of 25°C.

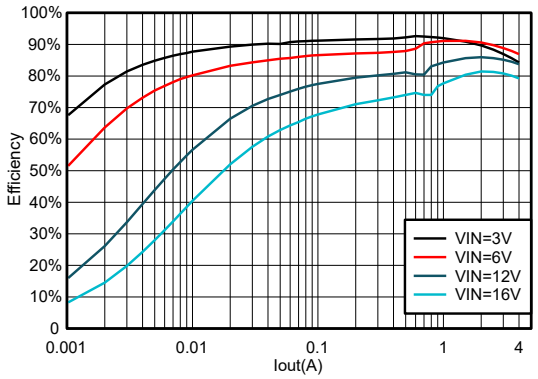

Figure 4-2. TPS564242EVM Efficiency

4.4 Load Regulation

The load regulation for the TPS564242EVM is shown in Figure 4-3.

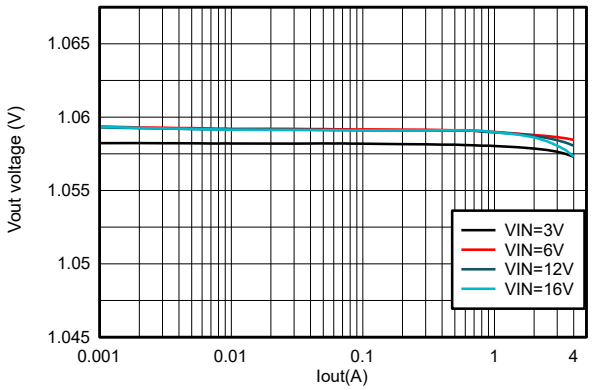

Figure 4-3. TPS564242EVM Load Regulation

4.5 Line Regulation

The line regulation for the TPS564242EVM is shown in Figure 4-4.

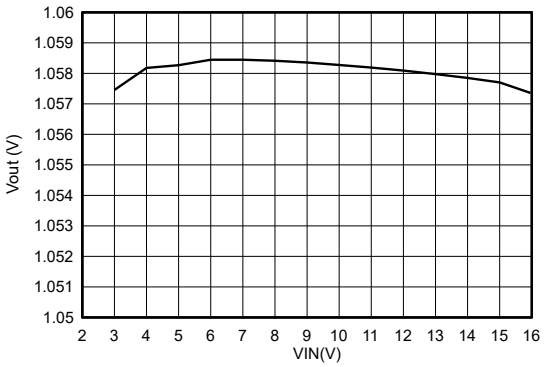

Figure 4-4. TPS564242EVM Line Regulation

4.6 Load Transient Response

The TPS564242EVM response to load transient is shown in Figure 4-5. The current steps slew rates is 2.5 A/µs.

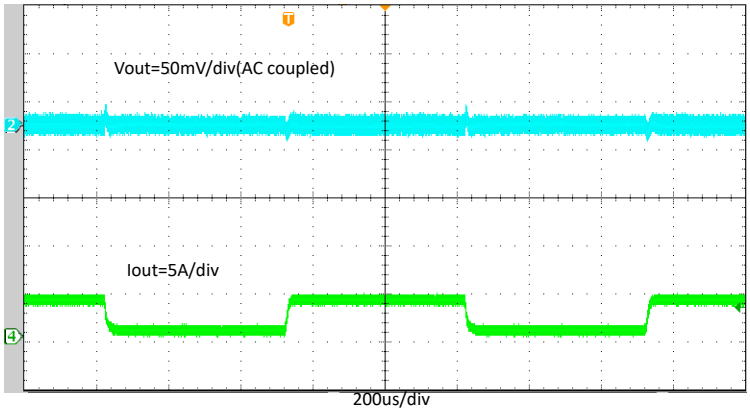

Figure 4-5. TPS564242EVM Load Transient Response, 10% to 90% (0.4-A–3.6-A) Load Step

4.7 Output Voltage Ripple

The TPS564242EVM output voltage ripple is shown in Figure 4-6, Figure 4-7, and Figure 4-8. The output currents are as indicated.

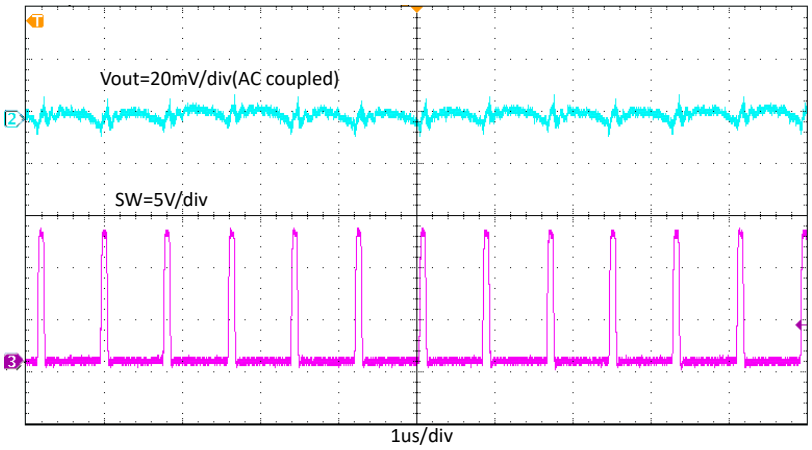

Figure 4-6. TPS564242EVM Output Voltage Ripple, I_{OUT} = 4 A

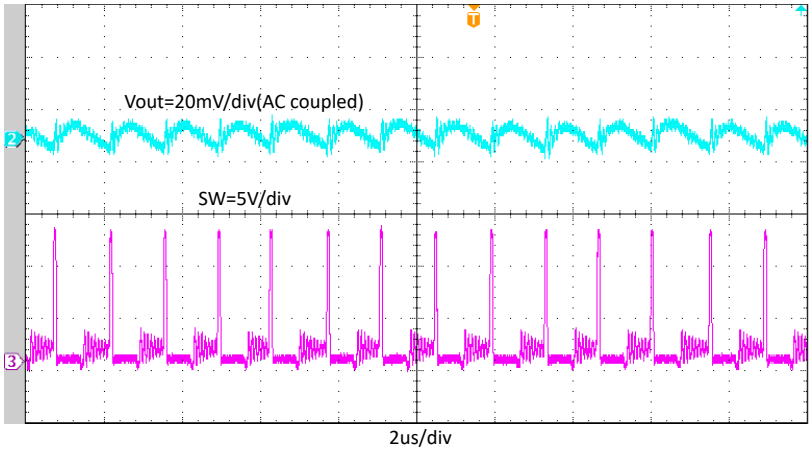

Figure 4-7. TPS564242EVM Output Voltage Ripple, I_{OUT} = 300 mA

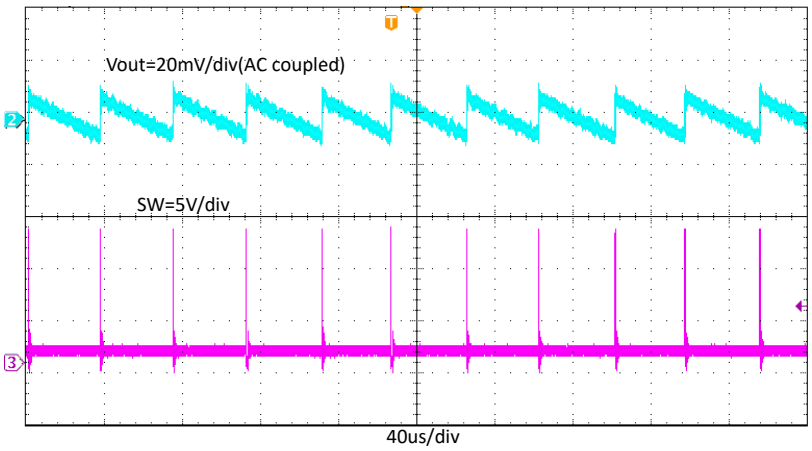

Figure 4-8. TPS564242EVM Output Voltage Ripple, I_{OUT} = 10 mA

4.8 Start-Up

The TPS564242EVM start-up waveform relative to V_{IN} is shown in Figure 4-9. Load is 4 A.

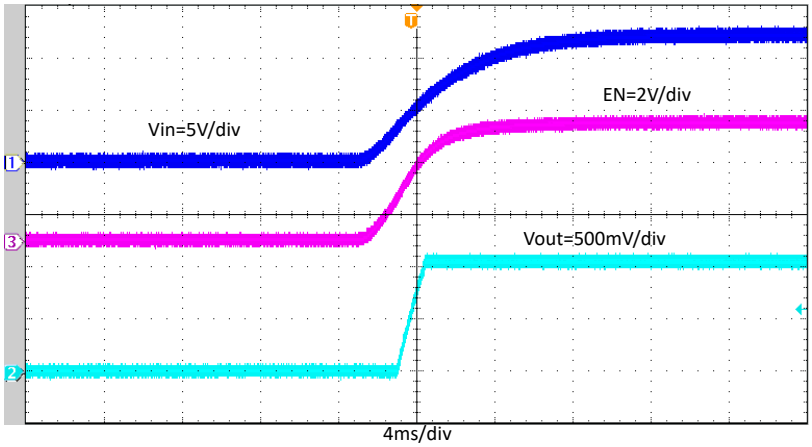

Figure 4-9. TPS564242EVM Start-Up Relative to V_{IN}

The TPS564242EVM start-up waveform relative to enable (EN) is shown in Figure 4-10. Load is 4 A.

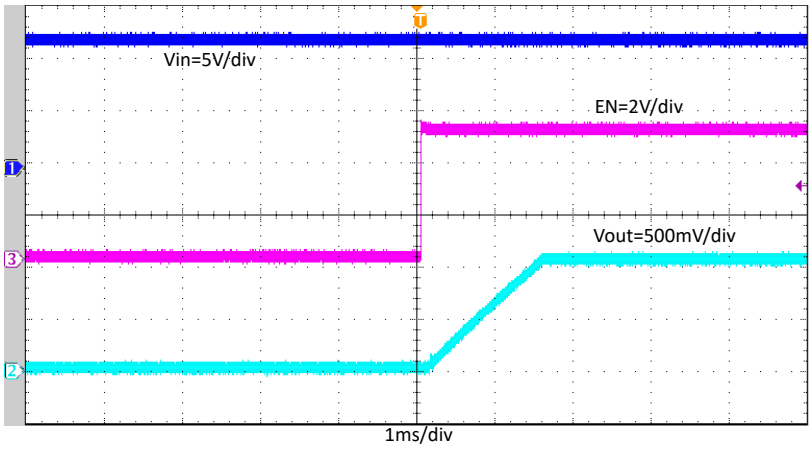

Figure 4-10. TPS564242EVM Start-Up Relative to EN

4.9 Shutdown

The TPS564242EVM shutdown waveform relative to V_{IN} is shown in Figure 4-11. Load is 4 A.

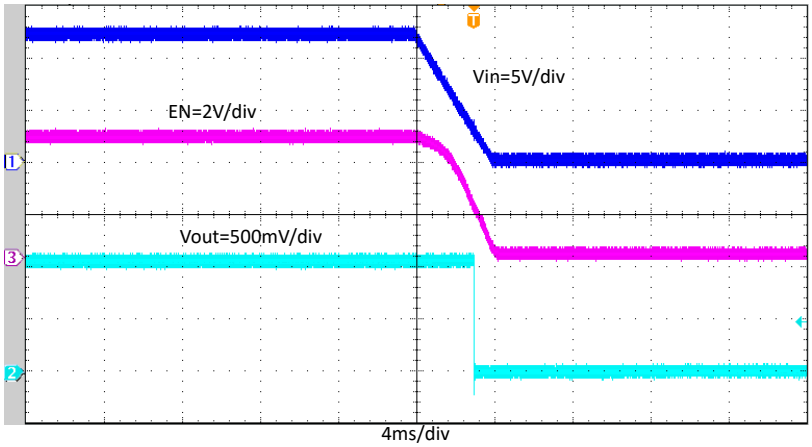

Figure 4-11. TPS564242EVM Shutdown Relative to V_{IN}

The TPS564242EVM shut-down waveform relative to EN is shown in Figure 4-12. Load is 4 A.

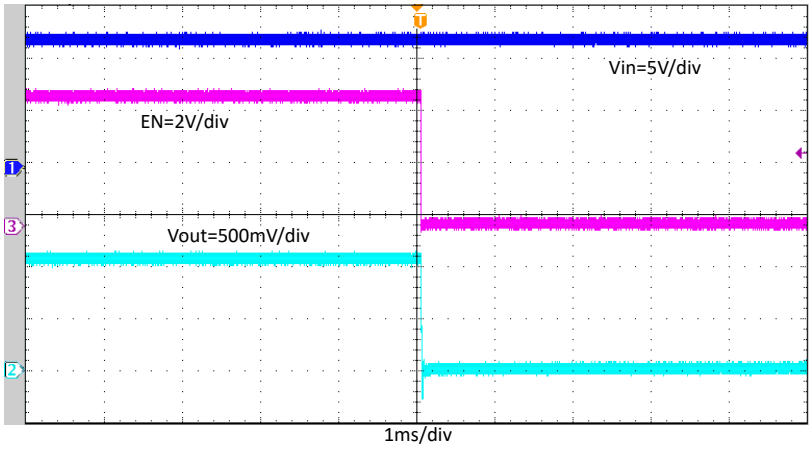

Figure 4-12. TPS564242EVM Shutdown Relative to EN

5 Board Layout

This section provides a description of the TPS56424xEVM, board layout, and layer illustrations.

5.1 Layout

The board layout for the TPS564242EVM is shown in Figure 5-1, Figure 5-2, and Figure 5-3. The top layer contains the main power traces for VIN, VOUT, and ground. Also on the top layer are connections for the pins of the TPS564242 and a large area filled with ground. Most of the signal traces are also located on the top side. The input decoupling capacitors C3 are located as close to the IC as possible. The input and output connectors, test points, and all of the components are located on the top side. The bottom layer is a ground plane along with the signal ground copper fill and the feedback trace from the point of regulation to the top of the resistor divider network. Both the top layer and bottom layer use 2-oz copper thickness.

Figure 5-4 and Figure 5-5 are the TPS564242EVM board top view and bottom view, respectively.

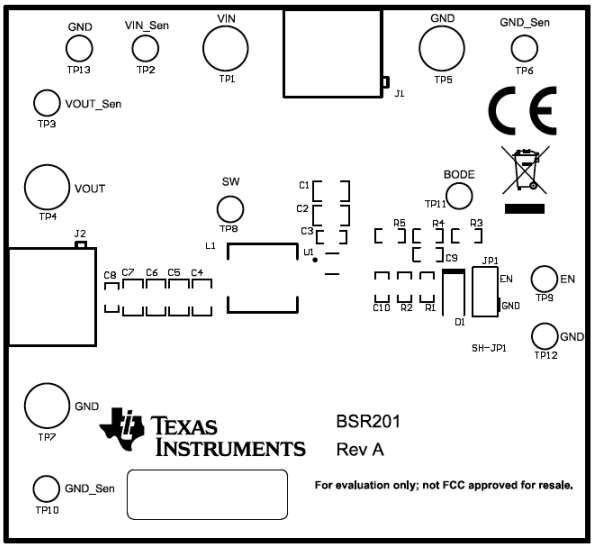

Figure 5-1. TPS564242EVM Top Assembly

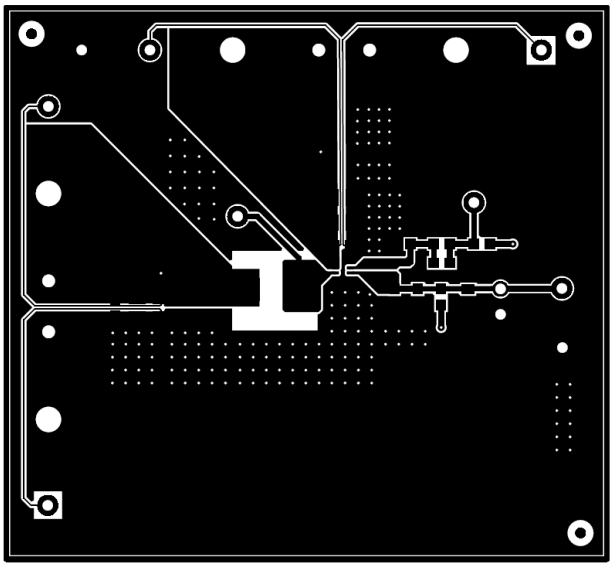

Figure 5-2. TPS564242EVM Top Layer

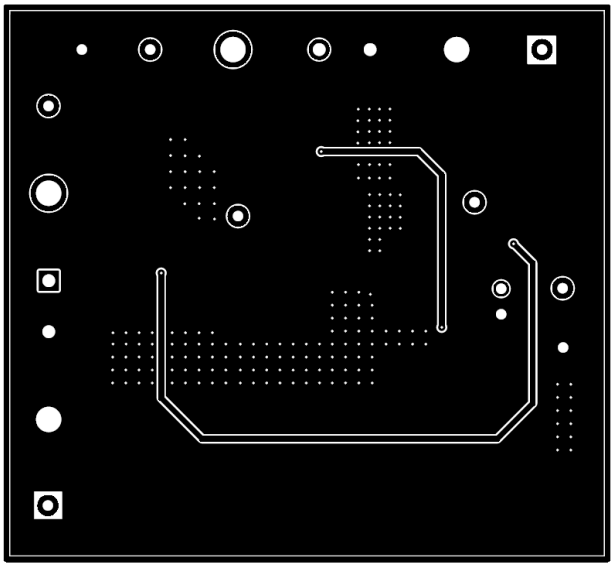

Figure 5-3. TPS564242EVM Bottom Layer

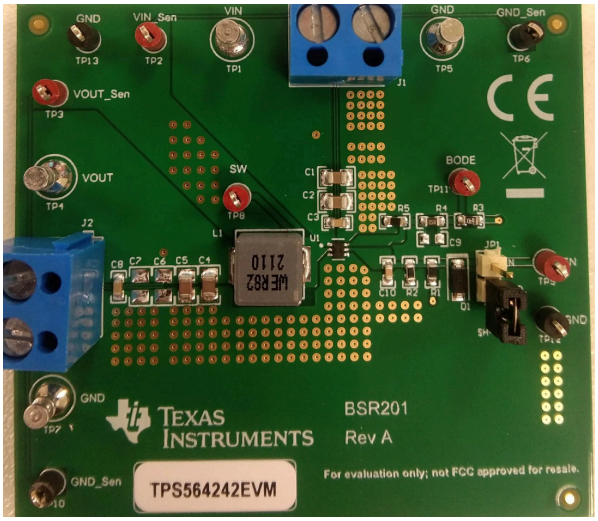

Figure 5-4. TPS564242EVM Board (Top View)

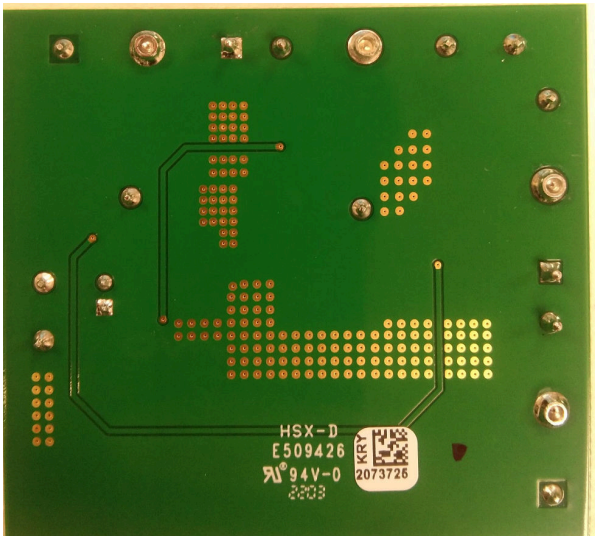

Figure 5-5. TPS564242EVM Board (Bottom View)

6 Schematic, List of Materials, and Reference

6.1 Schematic

Figure 6-1 is the schematic for the TPS564242EVM.

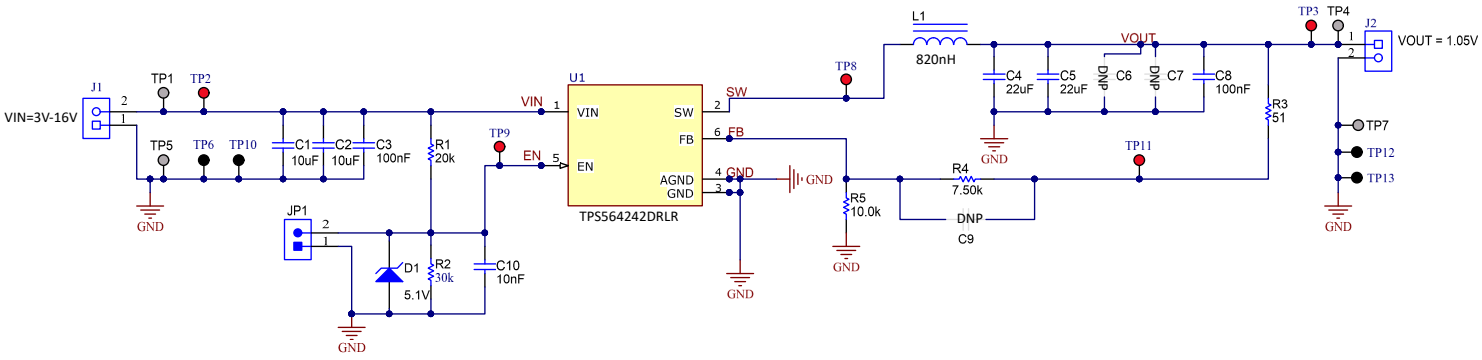

Figure 6-1. TPS564242EVM Schematic Diagram

6.2 List of Materials

Table 6-1. List of Materials

DES	QTY	DESCRIPTION	PART NUMBER	MANUFACTURER
!PCB1	1	Printed Circuit Board	BSR201	Any
C1, C2	2	Capacitor, ceramic, 10 µF, 25 V, ±20%, X5R, 0805	GRM21BR61E106MA73L	MuRata
C3, C8	2	Capacitor, ceramic, 0.1 µF, 25 V, ±10%, X7R, 0603	C0603C104J3RACAUTO	KEMET
C4, C5	2	Capacitor, ceramic, 22 µF, 10 V, ±20%, X5R, 0805	GRM21BR61A226ME44L	MuRata
C10	1	Capacitor, ceramic, 0.01 µF, 50 V, ±10%, X7R, 0603	C1608X7R1H103K080AA	TDK
J1, J2	2	Terminal block, 5.08 mm, 2 × 1, Brass, TH	ED120/2DS	On-Shore Technology
JP1	1	Header, 100 mil, 2 × 1, tin, TH	PEC02SAAN	Sullins Connector Solutions
L1	1	Inductor, shielded drum core, powdered iron, 820 nH, 11.25 A, 0.0046 Ω, SMD	744373490082	Wurth Elektronik
LBL1	1	Thermal transfer printable labels, 0.650" W × 0.200" H - 10,000 per roll	THT-14-423-10	Brady
R1	1	Resistor, 20 kΩ, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW06030000Z0EA	Vishay-Dale
R2	1	Resistor, 30 kΩ, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060320K0JNEA	Vishay-Dale
R3	1	Resistor, 51 Ω, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060351R0JNEA	Vishay-Dale
R4	1	Resistor, 7.5 kΩ, 1%, 0.1 W, 0603	RC0603FR-073K09L	Yageo
R5	1	Resistor, 10.0 kΩ, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060310K0FKEA	Vishay-Dale
SH-JP1	1	Shunt, 100 mil, gold plated, black	SNT-100-BK-G	Samtec
TP1, TP4, TP5, TP7	4	Terminal, turret, TH, double	1502-2	Keystone
TP2, TP3, TP8, TP9, TP11	5	Test point, miniature, red, TH	5000	Keystone
TP6, TP10, TP12, TP13	4	Test Point, miniature, black, TH	5001	Keystone
D1	1	Diode, Zener, 5.1 V, 500 mW, SOD-123	MMSZ5231B-7-F	Diodes Inc.
U1	1	3-V to 16-V Input, 4-A Synchronous Buck Converter, DRL0006A (SOT-563)	TPS564242DRLR	Texas Instruments

7 Reference

Texas Instruments, *TPS56424x 3-V to 16-V Input Voltage 4-A 1.2-MHz Synchronous Buck Converter in SOT563* data sheet

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