EVM User's Guide: TPS542021EVM

TPS542021 Step-Down Converter Evaluation Module

Description

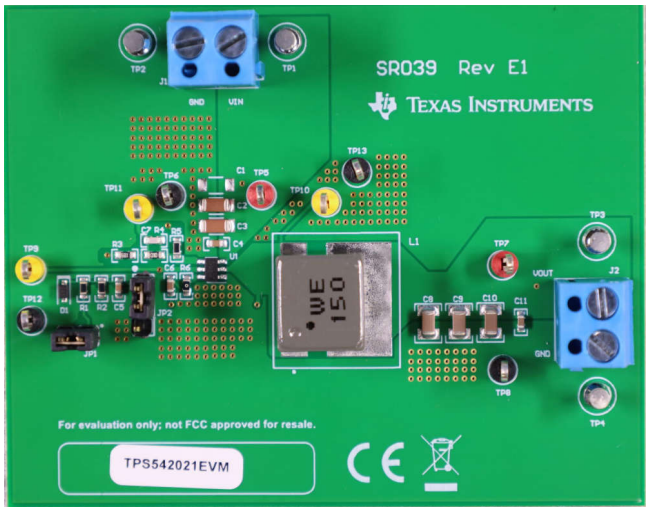
The TPS542021 evaluation module (EVM) is a simple, easy-to-use, 2A synchronous step-down converter in SOT236 package. The TPS542021EVM is a fully assembled and tested circuit for evaluating the TPS542021 step-down converter. The TPS542021EVM operates from 5V to 30V input, 24V nominal, and provides a 5V output at 2A. The EVM also includes AC signal injection terminals for feedback loop measurements.

Features

- 4.5V to 30V input voltage range
- Adjustable output voltage
- 2A continuous output current capability
- Support low drop out
- Eco-mode at light load

Applications

- 12V, 24V distributed power-bus supply
- Industrial applications
  - Appliances
- Consumer application
  - Audio
  - STB, DTV
  - Printer



TPS542021EVM (Top View)

1 Evaluation Module Overview

1.1 Introduction

The TPS542021 is a high efficiency, easy-to-use synchronous buck converter. With the wide input voltage range of 4.5V to 30V, the TPS542021 is an excellent choice for systems powered from 5V, 12V, 19V, 24V power bus rails. The device supports up to 2A continuous output current. The device employs fixed frequency peak current control mode for fast transient response and good line and load regulation. The optimized internal loop compensation eliminates the external compensation components over a wide range of output voltage.

This user's guide contains information for the TPS542021 and support documentation for the TPS542021EVM evaluation module. This user's guide includes the performance specifications, schematic and the bill of materials of the TPS542021EVM.

1.2 Kit Contents

- One TPS542021EVM Board
- EVM disclaimer Read Me

1.3 Specification

A summary of the TPS542021EVM performance specifications is provided in Table 1-1. Specifications are given for an input voltage of V_{IN} = 24V and an output voltage of 5V, unless otherwise noted. The ambient temperature is 25°C for all measurement, unless otherwise noted.

Table 1-1. Performance Specifications Summary

Specifications	Test Conditions	MIN	TYP	MAX	Unit
Input voltage range		5	24	30	V
Output voltage set point			5		V
Operating frequency	V_{IN} = 24V, I_O = 2A		500		kHz
Output current range		0		2	A
Output ripple voltage	V_{IN} = 24V, I_O = 2A		10		mV_{PP}

1.4 Device Information

Rated input voltage and output current ranges for the evaluation module are given in Table 1-2.

Table 1-2. Input Voltage and Output Current Summary

EVM	Input Voltage (V_{IN}) Range	Output Current (I_{OUT}) Range
TPS542021EVM	V_{IN} = 5V to 30V	0A to 2A

2 Hardware

2.1 Input and Output Connections

The TPS542021EVM is provided with input and output connectors and test points as shown in Table 2-1. Figure 2-1 shows connectors and jumpers placement on the TPS542021EVM board.

A power supply capable of supplying 2A must be connected to J1 through a pair of 20AWG wires. The load must be connected to J2 through a pair of 20-AWG wires. The maximum load current capability is 2A. Wire lengths must be minimized to reduce losses in the wires. Test point TP5 provides a place to monitor the V_{IN} input voltages with TP6 providing a convenient ground reference. TP7 is used to monitor the output voltage with TP8 as the ground reference.

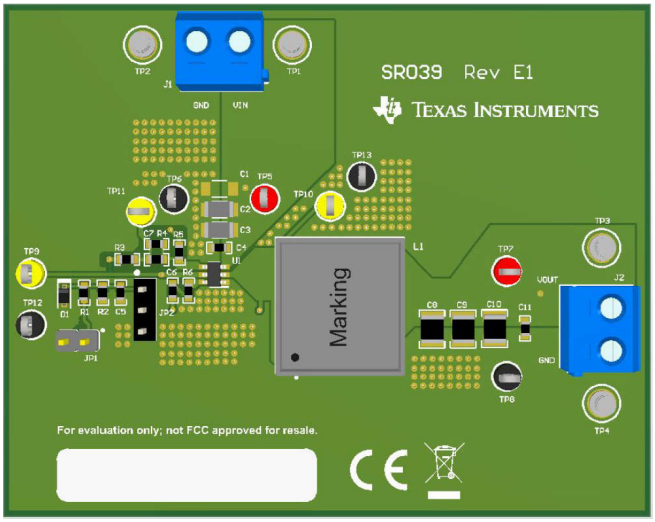


Figure 2-1. TPS542021EVM Connectors and Jumpers Placement

Table 2-1. Connection and Test Points

Reference Designator	Function
J1	V_{IN}
J2	V_{OUT}, 5V at 2A maximum
JP1	V_{IN} divider
JP2	EN control. Shunt EN to GND to disable
TP1	V_{IN} positive power point
TP5	V_{IN} positive monitor point
TP7	V_{OUT} positive monitor point
TP3	V_{OUT} positive power point
TP2, TP4	GND power point
TP6, TP8, TP12, TP13	GND monitor point
TP10	Switch node test point
TP9	EN test point
TP11	Test point for loop response measurements

3 Implementation Results

3.1 Test Setup and Results

This section describes how to properly connect, set up, and use the TPS542021EVM. The section also includes test results typical for the evaluation modules and the following:

- Load transient response
- Start-up
- Shutdown
- Output voltage ripple

3.1.1 Start-Up Procedure

1. Make sure that the jumper at JP2 (enable control) pins 2 and 3 are covered to shunt EN to GND, disabling the output.
2. Apply appropriate input voltage to VIN (J1-1) and GND (J1-2).
3. Move the jumper at JP2 (Enable control) pin 2 and 3 (EN and GND) to enable the output.

3.1.2 Load Transient Response

The TPS542021EVM response to load transient is shown in Figure 3-1, Figure 3-2 and Figure 3-3. The current steps slew rate is set as 0.8A/µs. The total peak-to-peak voltage variation is indicated in the figure with 20MHz scope bandwidth.

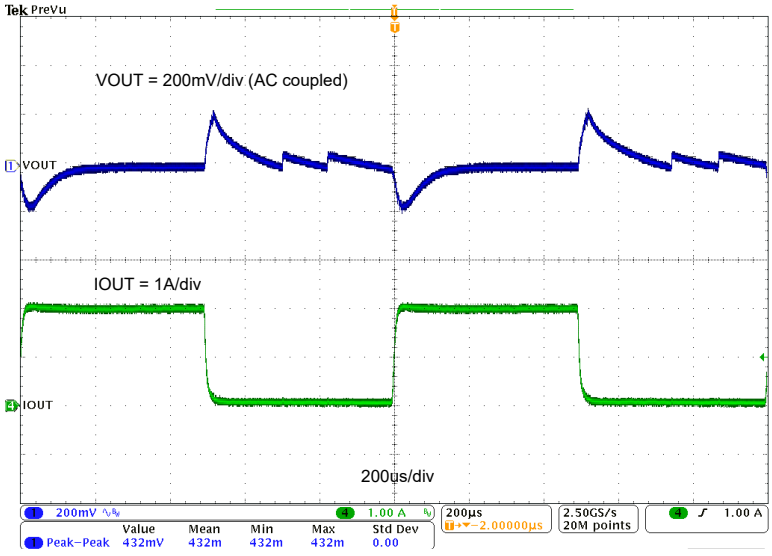


Figure 3-1. TPS542021EVM Load Transient Response, 0A to 2A Load Step

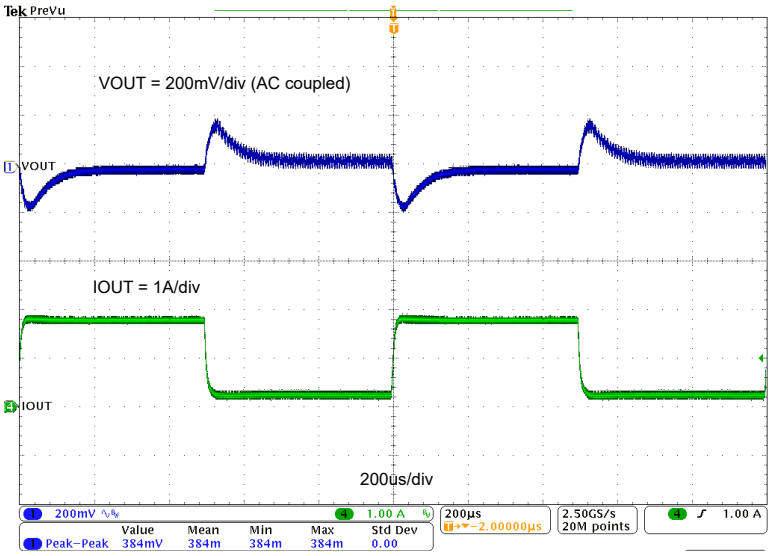


Figure 3-2. TPS542021EVM Load Transient Response, 0.2A to 1.8A Load Step

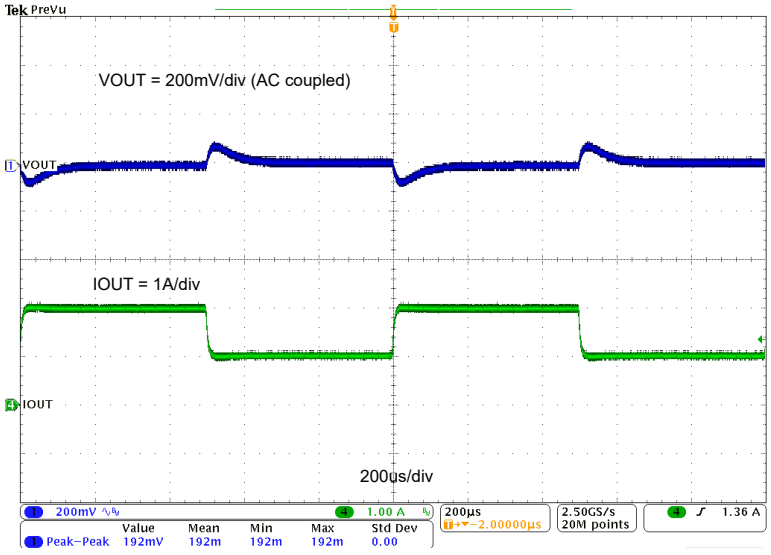


Figure 3-3. TPS542021EVM Load Transient Response, 1A to 2A Load Step

3.1.3 Start-Up

Figure 3-4 shows the TPS542021EVM start-up waveform relative to V_{IN}. The load is 2A.

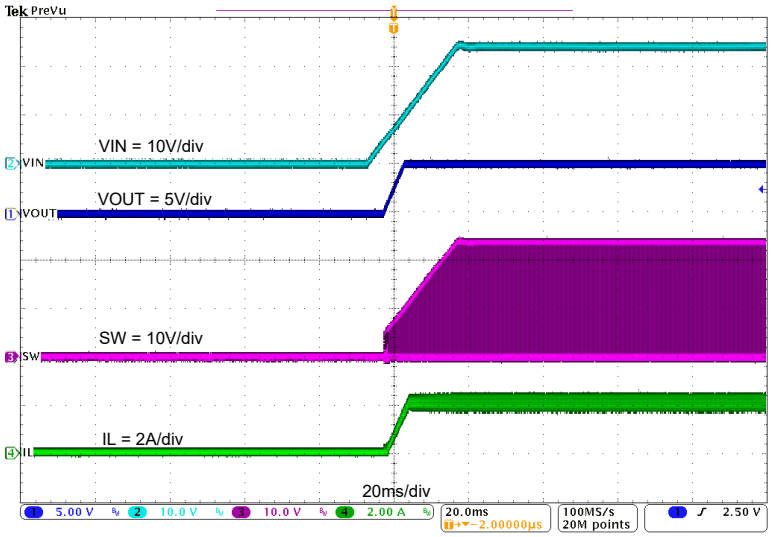


Figure 3-4. TPS542021EVM Start-Up Relative to V_{IN}

3.1.4 Shutdown

Figure 3-5 shows the TPS542021EVM shutdown waveform relative to V_{IN}. The load is 2A.

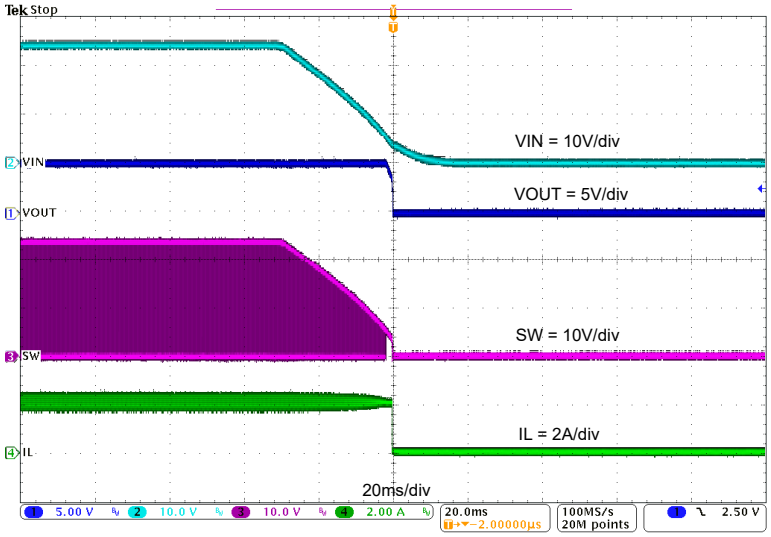


Figure 3-5. TPS542021EVM Shutdown Relative to V_{IN}

3.1.5 Output Voltage Ripple

The TPS542021EVM output voltage ripple is shown in Figure 3-6, Figure 3-7, Figure 3-8, and Figure 3-9. The output currents are as indicated and all waveforms are tested with 20MHz scope bandwidth.

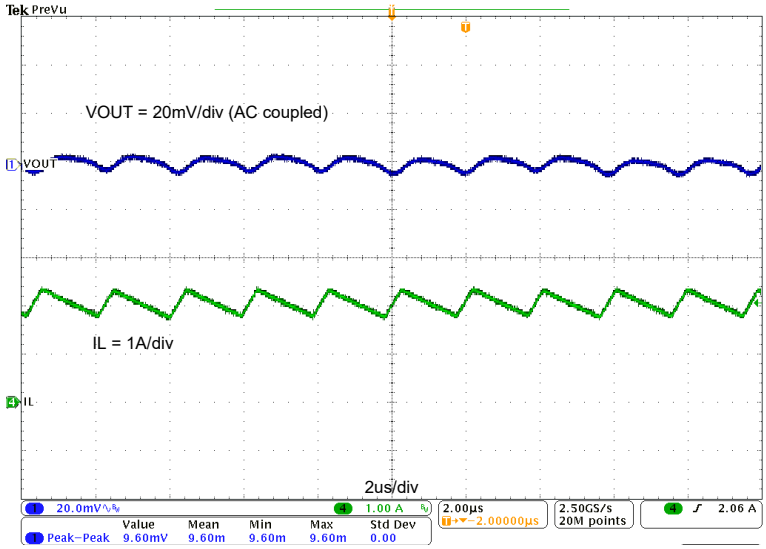


Figure 3-6. TPS542021EVM Output Voltage Ripple, I_{OUT} = 2A

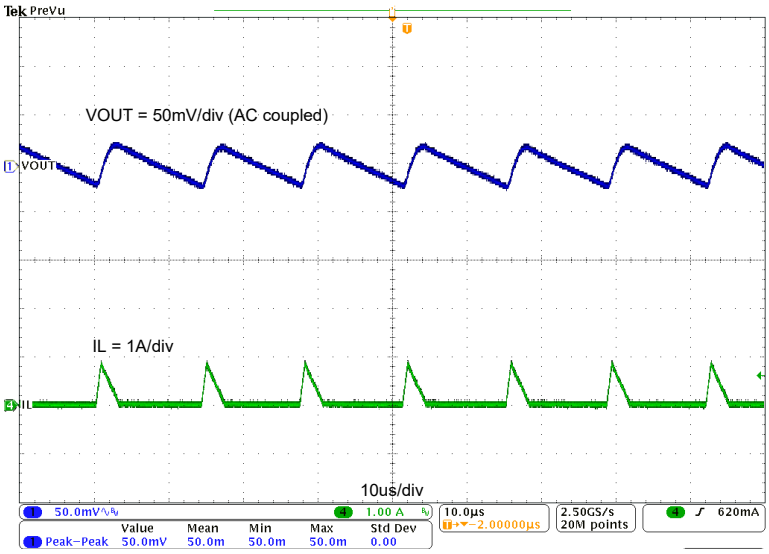


Figure 3-7. TPS542021EVM Output Voltage Ripple, I_{OUT} = 0.1A

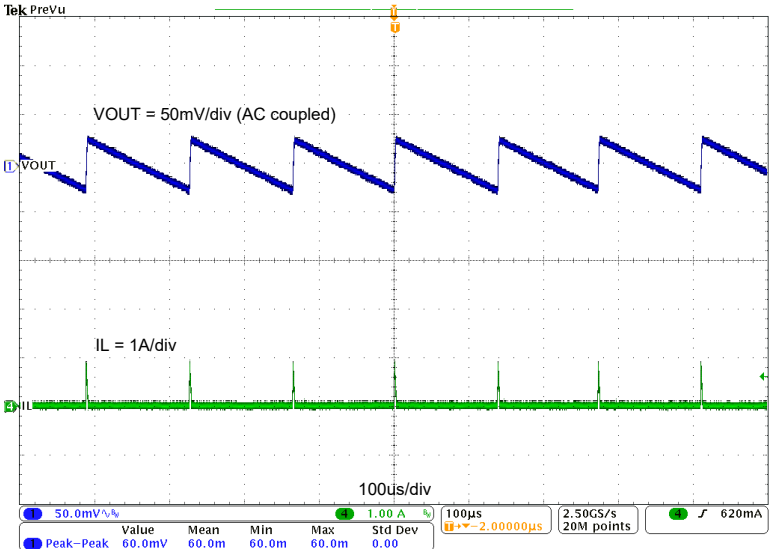


Figure 3-8. TPS542021EVM Output Voltage Ripple, I_{OUT} = 0.01A

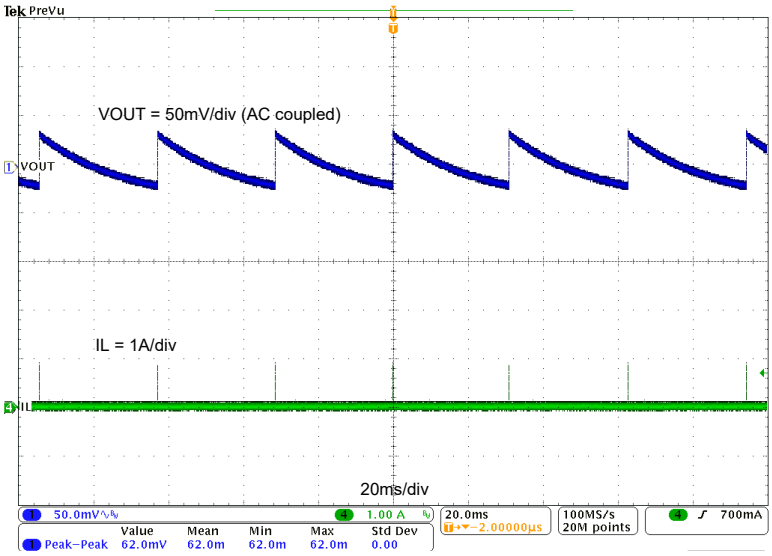


Figure 3-9. TPS542021EVM Output Voltage Ripple, I_{OUT} = 0A

3.2 Output Voltage Setpoint

The output voltage of the EVM can be selected by changing the value of resistor R_4 (R_{FBT}) and R_5 (R_{FBB}). TI recommends using 1% tolerance or better divider resistors. Start with a 100kΩ for R_4 (R_{FBT}) and use Equation 1 to calculate R_5 (R_{FBB}). To improve efficiency at light loads, consider using larger value resistors. If the values are too high, the regulator is more susceptible to noise and voltage errors from the FB input current are noticeable.

$$R_4 = \frac{R_5 \times (V_{out} - 0.596\,V)}{0.596\,V} \quad (1)$$

4 Hardware Design Files

4.1 Schematic

Figure 4-1 is the schematic for the TPS542021EVM.

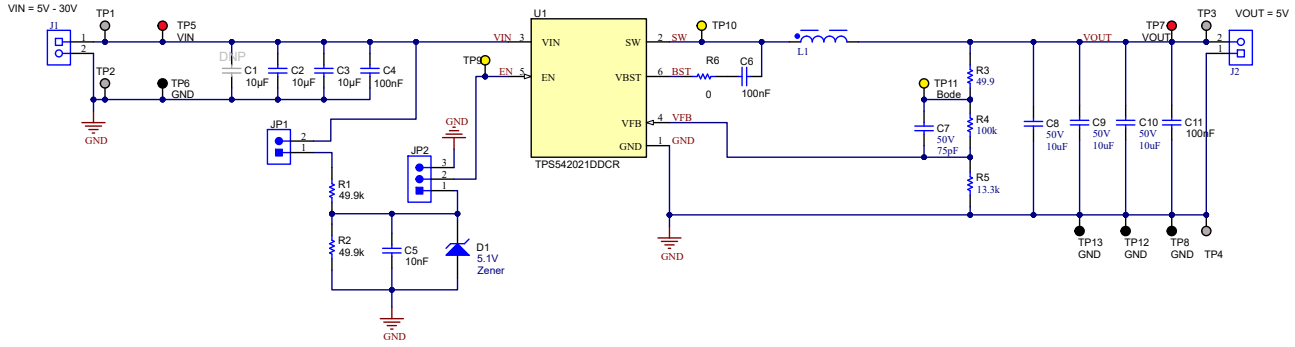


Figure 4-1. TPS542021EVM Schematic Diagram

4.2 Layout

Figure 4-2, Figure 4-3, and Figure 4-4 show the board layout for the TPS542021EVM. The top layer contains the main power traces for VIN, VOUT, and ground. Connections for the pins of the TPS542021 and a large area filled with ground are also on the top layer. Most of the signal traces are also located on the top side. The input decoupling capacitors C2, C3, and C4 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.

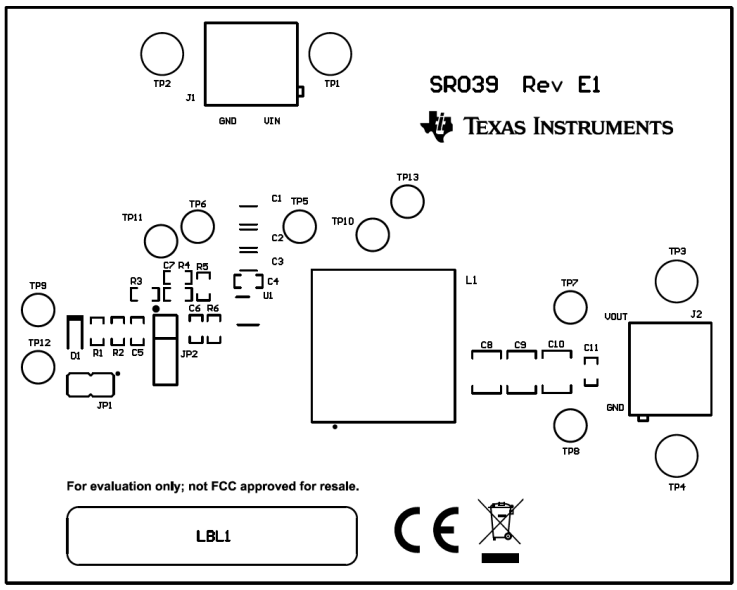


Figure 4-2. TPS542021EVM Top Assembly

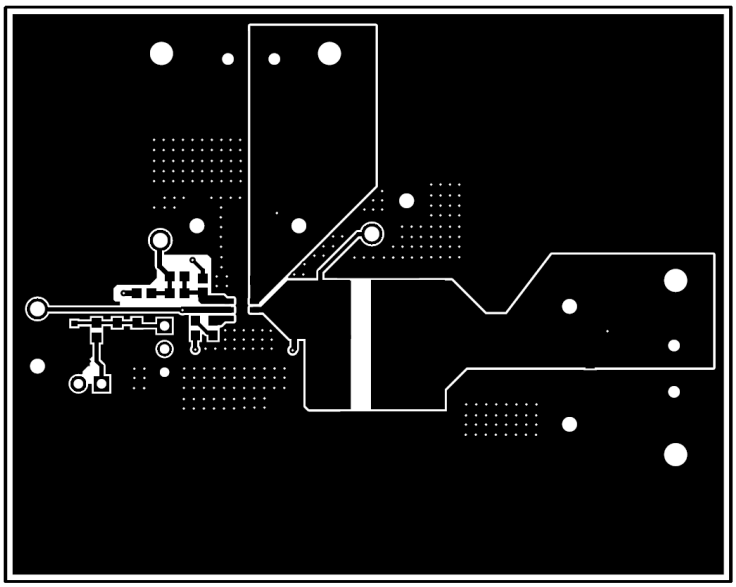


Figure 4-3. TPS542021EVM Top Layer

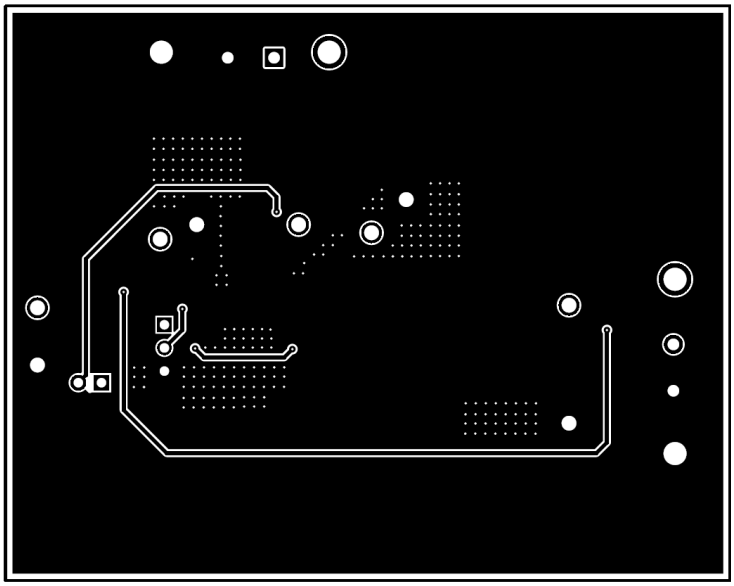


Figure 4-4. TPS542021EVM Bottom Layer

4.3 Bill of Materials

Table 4-1. Bill of Materials

Des	Qty	Description	Part Number	Manufacturer
!PCB1	1	Printed Circuit Board	SR039	Any
C2, C3	2	CAP, CERM, 10µF, 50V,+/- 10%, X7R, AEC-Q200 Grade 1, 1206	CGA5L1X7R1H106K160AC	TDK
C4, C6, C11	3	CAP, CERM, 0.1µF, 50V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	C0603C104K5RACAUTO	Kemet
C5	1	CAP, CERM, 0.01uF, 50V, +/- 5%, X7R, 0603	C0603C103J5RACTU	Kemet
C7	1	CAP, CERM, 75pF, 50V, +/- 5%, C0G/NP0, 0603	GRM1885C1H750JA01D	MuRata
C8, C9, C10	3	CAP, CERM, 10uF, 50V, +/- 10%, X6S, 1206	GRM31CD71H106KE11L	MuRata
D1	1	Diode, Zener, 5.1V, 200mW, SOD-323	MMSZ5231BS-7-F	Diodes Inc.
J1, J2	2	Terminal Block, 5.08mm, 2x1, Brass, TH	ED120/2DS	On-Shore Technology
JP1	1	Header, 100mil, 2x1, Gold, TH	PBC02SAAN	Sullins Connector Solutions
JP2	1	Header, 100mil, 3x1, Tin, TH	PEC03SAAN	Sullins Connector Solutions
L1	1	15µH Shielded Molded Inductor 8.3A 14.8mOhm	74439369150	Wurth Elektronik
LBL1	1	Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll	THT-13-457-10	Brady
R1, R2	2	RES, 49.9 k, 1%, 0.1 W, 0603	RC0603FR-0749K9L	Yageo
R3	1	RES, 49.9, 1%, 0.1 W, 0603	CRCW060349R9FKEA	Vishay-Dale
R4	1	RES, 100 k, 1%, 0.1 W, 0603	CRCW0603100KFKEA	Vishay-Dale
R5	1	RES, 13.3 k, 1%, 0.1 W, 0603	CRCW060313K3FKEA	Vishay-Dale
R6	1	RES, 0 ohm, 5%, 0.1 W, 0603	ERJ-3GEY0R00V	Panasonic
TP1, TP2, TP3, TP4	4	Terminal, Turret, TH, Double	1502-2	Keystone
TP5, TP7	2	Test Point, Multipurpose, Red, TH	5010	Keystone
TP6, TP8, TP12, TP13	4	Test Point, Multipurpose, Black, TH	5011	Keystone
TP9, TP10, TP11	3	Test Point, Multipurpose, Yellow, TH	5014	Keystone
U1	1	4.5V to 30V Input, 2A Synchronous Buck Converter, SOT-236	TPS542021DDCR	Texas Instruments

5 Additional Information

Trademarks

All trademarks are the property of their respective owners.

6 Reference

1. Texas Instruments, *TPS542021, 4.5V to 30V Input, 2A, 500kHz, Synchronous Buck Converter*, data sheet

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