

# TPS566238 Buck Converter Evaluation Module User's Guide



## ABSTRACT

This user's guide contains information for the TPS566238 as well as support documentation for the TPS566238EVM evaluation module. Included are the performance specifications, schematic, and the list of materials of the TPS566238EVM.

## Table of Contents

<b>1 Introduction</b> .....	3
<b>2 Performance Specification Summary</b> .....	3
<b>3 Output Voltage Setpoint</b> .....	3
<b>4 Test Setup and Results</b> .....	4
4.1 Input/Output Connections.....	4
4.2 Start-Up Procedure.....	4
4.3 Start-Up.....	5
4.4 Shut-Down.....	5
4.5 Output Voltage Ripple.....	6
<b>5 Board Layout</b> .....	7
5.1 Layout.....	7
<b>6 Board Profile, Schematic, List of Materials, and Reference</b> .....	10
6.1 Board Profile.....	10
6.2 Schematic.....	11
6.3 List of Materials.....	12
6.4 Reference.....	12
<b>7 Revision History</b> .....	12

## List of Figures

Figure 4-1. Start-Up Relative to EN, $I_{OUT} = 3A$ .....	5
Figure 4-2. Shut-Down Relative to EN, $I_{OUT} = 3A$ .....	5
Figure 4-3. TPS566238 Output Voltage Ripple, $I_{OUT} = 0.01A$ .....	6
Figure 4-4. TPS566238 Output Voltage Ripple, $I_{OUT} = 6A$ .....	6
Figure 5-1. Top Assembly.....	7
Figure 5-2. Top Layer.....	8
Figure 5-3. Inner1 Layer.....	8
Figure 5-4. Inner2 Layer.....	9
Figure 5-5. Bottom Layer.....	9
Figure 6-1. Top View of TPS566238EVM.....	10
Figure 6-2. Bottom View of TPS566238EVM.....	10
Figure 6-3. TPS566238EVM Schematic Diagram.....	11

## List of Tables

Table 1-1. Input Voltage and Output Current Summary.....	3
Table 2-1. TPS566238EVM Performance Specifications Summary.....	3
Table 3-1. Recommended Component Values.....	3
Table 4-1. Connection and Test Points.....	4
Table 6-1. List of Materials <sup>(1)</sup> .....	12

## Trademarks

D-CAP3™ is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

## 1 Introduction

The TPS566238 is a single, D-CAP3™ mode, synchronous buck converter requiring a very low external component count. The TPS566238 is a cost effective, high-voltage input, synchronous buck converter with integrated FETs. One of the key features of the TPS566238 operates in continuous current mode, which maintains lower output ripple during all load conditions.

The TPS566238 operates with wider supply input voltage ranging from 3 V to 18 V. It uses DCAP3™ control mode to provide a fast transient response, good line, load regulation, no requirement for external compensation, and supports low ESR output capacitors. The TPS566238 is a high-efficiency converter, and provides complete protection OVP, UVP, OCP, OTP. See [Table 1-1](#).

The TPS566238EVM evaluation module (EVM) is a single, synchronous buck converter providing 1 V at 6 A from 3-V to 18-V input. This user's guide describes the TPS566238EVM performance.

**Table 1-1. Input Voltage and Output Current Summary**

EVM	Input Voltage (V <sub>IN</sub> ) Range	Output Current (I <sub>OUT</sub> ) Range
TPS566238EVM	3 V to 18 V	0 A to 6 A

## 2 Performance Specification Summary

A summary of the TPS566238EVM performance specifications is provided in [Table 2-1](#). Specifications are given for an input voltage of 12 V and an output voltage of 1 V, unless otherwise noted. The ambient temperature is 25°C for all measurement, unless otherwise noted.

**Table 2-1. TPS566238EVM Performance Specifications Summary**

Specifications		Test Conditions	MIN	TYP	MAX	Unit
V <sub>IN</sub>	Input voltage		3	12	18	V
	Output voltage			1		V
	Operating frequency	V <sub>IN</sub> = 12 V, I <sub>OUT</sub> = 6 A		600		kHz
CH1	Output current range		0		6	A
	Over current limit	V <sub>IN</sub> = 12 V, L <sub>OUT</sub> = 1 μH		7.4		A
	Output ripple voltage	V <sub>IN</sub> = 12 V, I <sub>OUT</sub> = 6 A		10		mV <sub>PP</sub>

## 3 Output Voltage Setpoint

To change the output voltage of the EVM, it is necessary to change the value of resistor R4 (Rupper) and R5 (Rlower). The value of R4 and R5 for a specific output voltage can be calculated using [Equation 1](#) and refer to [Table 3-1](#) for some recommendation values.

$$V_{OUT} = 0.6 \times \left(1 + \frac{R_{UPPER}}{R_{LOWER}}\right) \quad (1)$$

**Table 3-1. Recommended Component Values**

V <sub>OUT</sub> (V)	R <sub>LOWER</sub> (kΩ)	R <sub>UPPER</sub> (kΩ)	L <sub>OUT</sub> (μH)			C <sub>OUT</sub> (μF)		C <sub>FF</sub> (PF)
			MIN	TYP	MAX	MIN	MAX	
0.6	10	0	0.68	1	4.7	44	220	-
1	30	20	0.68	1	4.7	44	220	-
1.8	20	40	1	1.5	4.7	44	220	0-50
3.3	20	90	1.5	2.2	4.7	44	220	10-100
5.0	30	220	1.5	2.2	4.7	44	220	10-100

## 4 Test Setup and Results

This section describes how to properly connect, set up, and use the TPS566238EVM. The section also includes test results typical for the evaluation modules, includes power on/off, voltage ripple.

### 4.1 Input/Output Connections

The TPS566238EVM is provided with input/output connectors and test points as shown in [Table 4-1](#). A power supply capable of supplying 6 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 6 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 TP7 providing a convenient ground reference. TP5 is used to monitor the output voltage with TP13 as the ground reference.

**Table 4-1. Connection and Test Points**

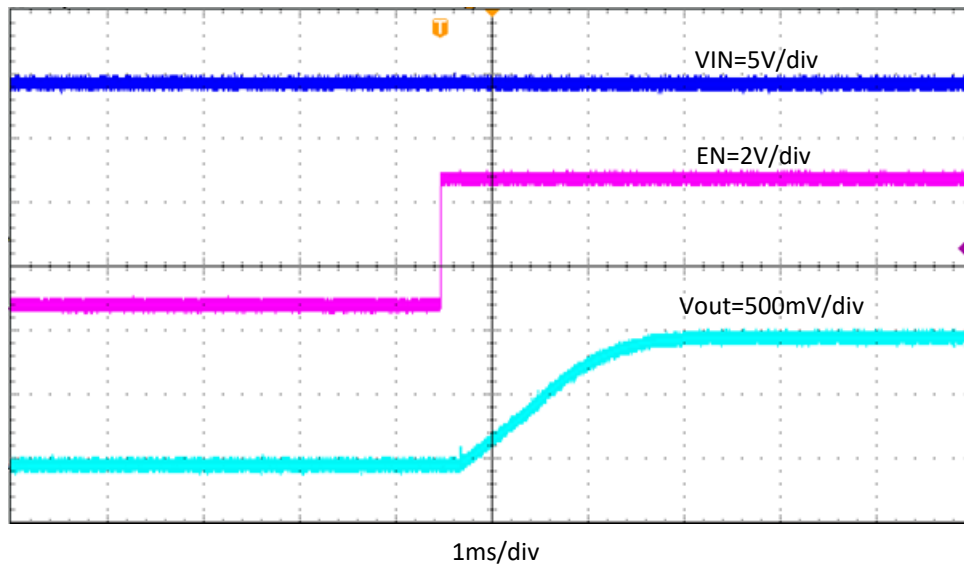
Reference Designator	Function
J1	$V_{IN}$ (see <a href="#">Table 1-1</a> for $V_{IN}$ range)
J2	$V_{OUT}$ , 1V at 6-A maximum
JP1	Two resistor dividers connected to $V_{IN}$ to enable EN.
JP2	En Control, short pin1 and pin2 to make EN High, short pin2 and pin3 to make EN low.
TP1	$V_{IN}$ positive monitor point
TP2	$V_{IN}$ positive monitor point
TP3	Switch node test point
TP4	$V_{OUT}$ positive monitor point
TP5	$V_{OUT}$ positive monitor point
TP6	GND monitor test point
TP7	GND monitor test point
TP8	$V_{CC}$ monitor test point
TP9	EN Test point
TP10	GND monitor test point
TP11	Loop test point
TP12	GND monitor test point
TP13	GND monitor test point

### 4.2 Start-Up Procedure

1. Ensure 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  $V_{IN}$  (J1-1) or TP1 and GND (J1-2) or TP6. The input lines should be connected between J1 and external power source first before turning on the power source.
3. Move the jumper at JP2 (Enable control) from pins 2 and 3 (EN and OFF), to pins 1 and 2 (EN and ON) and make JP1 pin 1 and pin 2 are covered, then the output can be enabled.
4. Apply the loading to  $V_{out}$  (J2-1) or TP4 and GND (J2-2) or TP10.

### 4.3 Start-Up

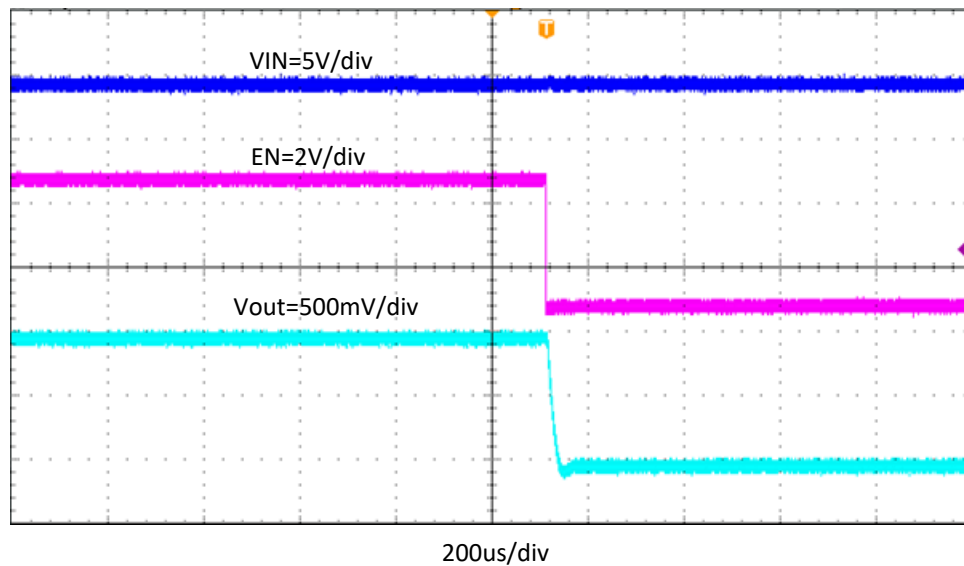
The TPS566238EVM start-up waveform relative to EN is shown in [Figure 4-1](#).



**Figure 4-1. Start-Up Relative to EN,  $I_{OUT}= 3A$**

### 4.4 Shut-Down

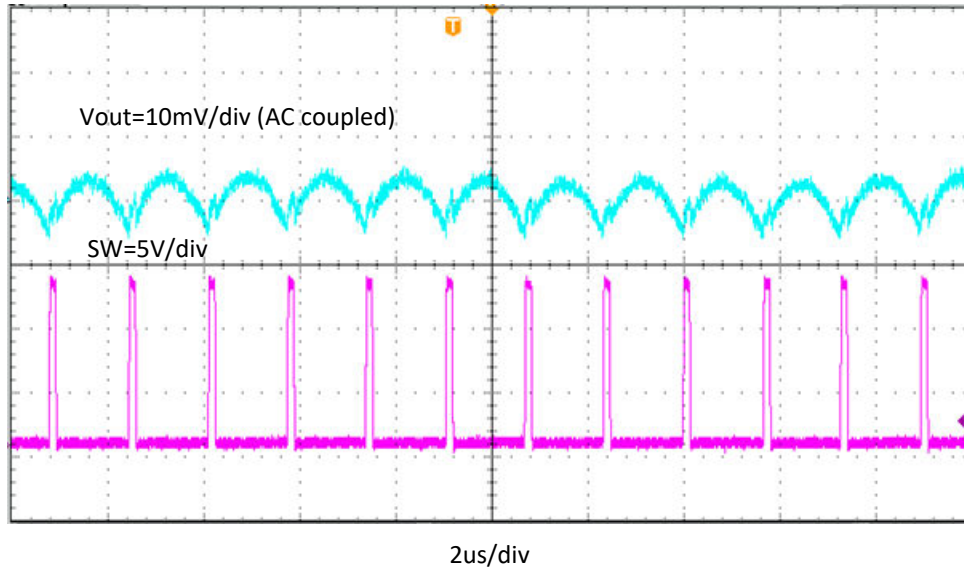
The TPS566238EVM shut-down waveform relative to EN is shown in [Figure 4-2](#).



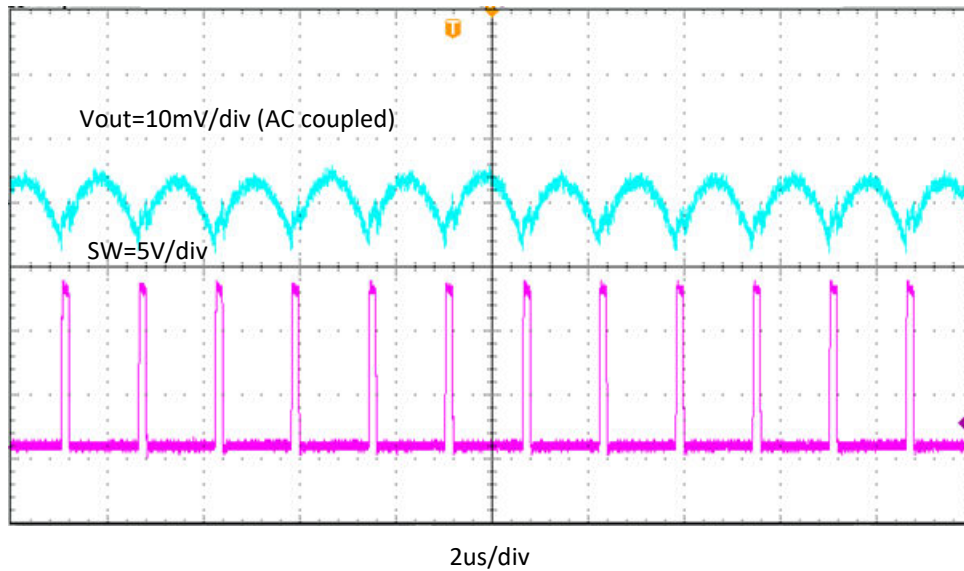
**Figure 4-2. Shut-Down Relative to EN,  $I_{OUT}= 3A$**

## 4.5 Output Voltage Ripple

The TPS566238EVM output voltage ripple is shown in [Figure 4-3](#) and [Figure 4-4](#). The output currents are as indicated.



**Figure 4-3. TPS566238 Output Voltage Ripple,  $I_{OUT} = 0.01A$**



**Figure 4-4. TPS566238 Output Voltage Ripple,  $I_{OUT} = 6A$**

## 5 Board Layout

This section provides a description of the TPS566238EVM, board layout, and layer illustrations.

### 5.1 Layout

The board layout for the TPS566238EVM is shown in [Figure 5-1](#) and [Figure 5-2](#) to [Figure 5-5](#). TPS566238EVM is with four layers, The top layer contains the main power traces for VIN, VOUT and GND. Also on the top layer are connections for the pins of the TPS566238 and a large area filled with ground. Most of the signal traces are also located on the top side. The input decoupling capacitors, C1, C2, C3 and C4 are located as close to Vin pins and PGND pins of 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 signal ground copper fill and the feed back trace from the point of regulation to the top of the resistor divider network. Two inner layers are ground plane.

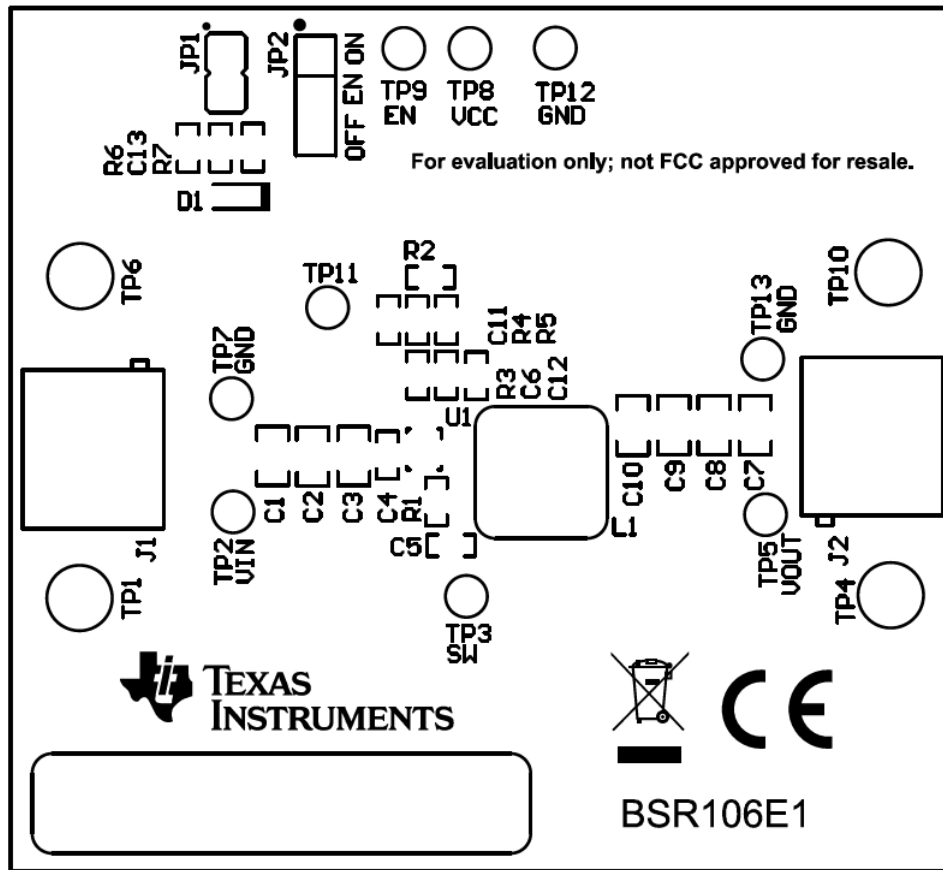


Figure 5-1. Top Assembly

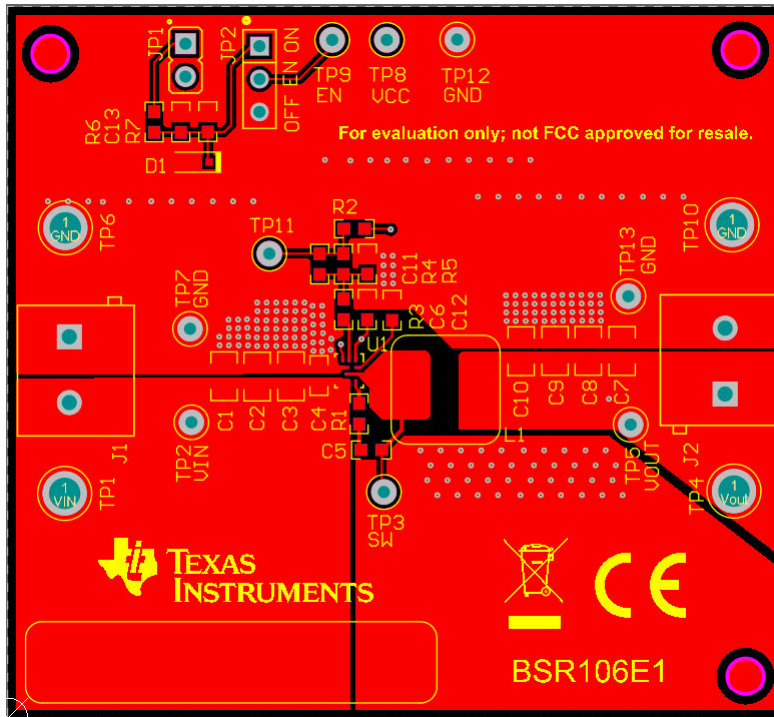


Figure 5-2. Top Layer

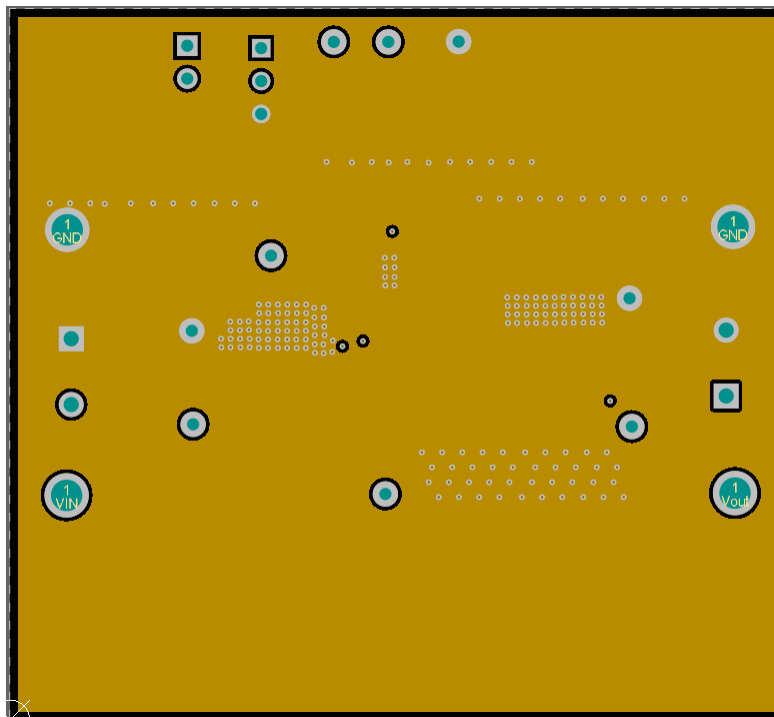


Figure 5-3. Inner1 Layer



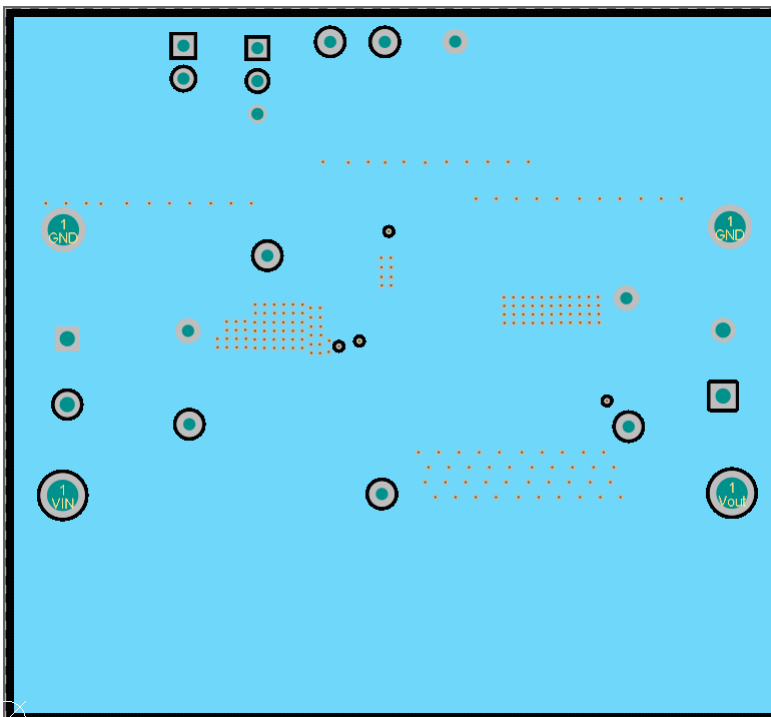


Figure 5-4. Inner2 Layer

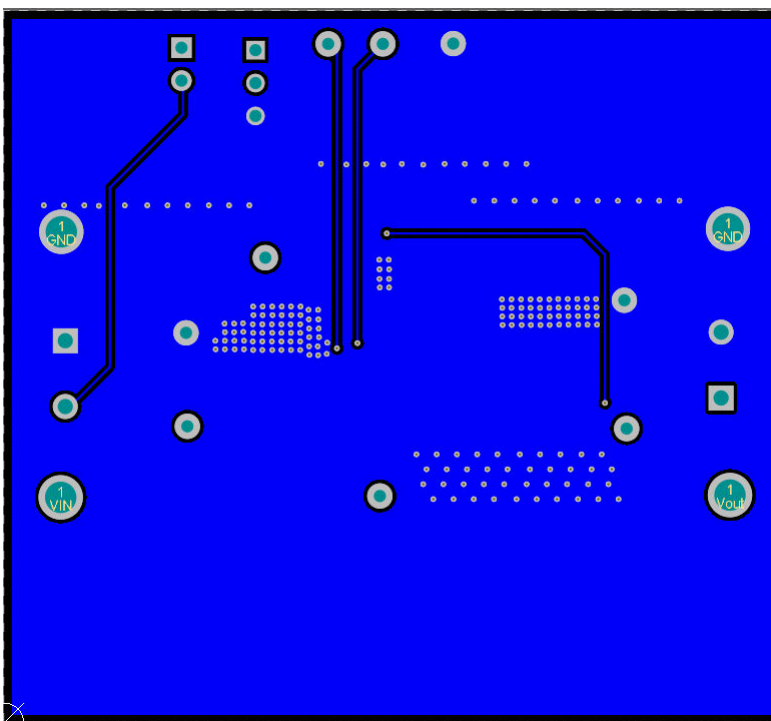
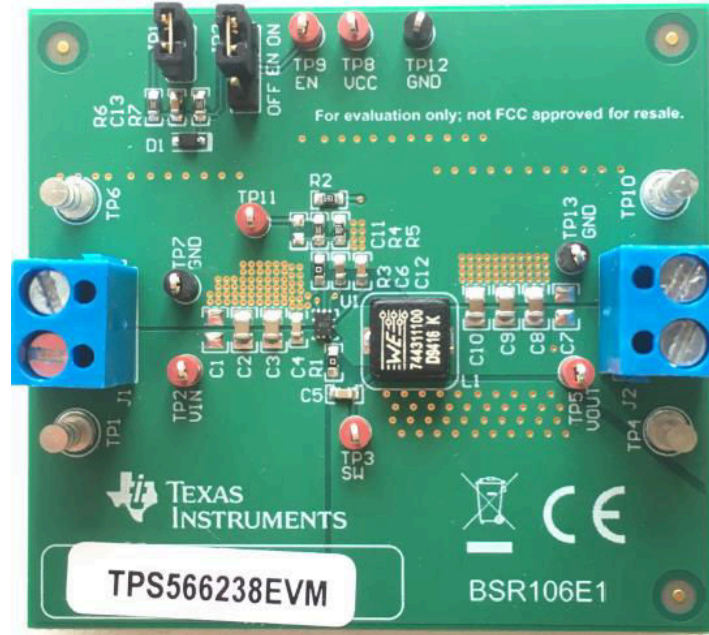


Figure 5-5. Bottom Layer

## 6 Board Profile, Schematic, List of Materials, and Reference

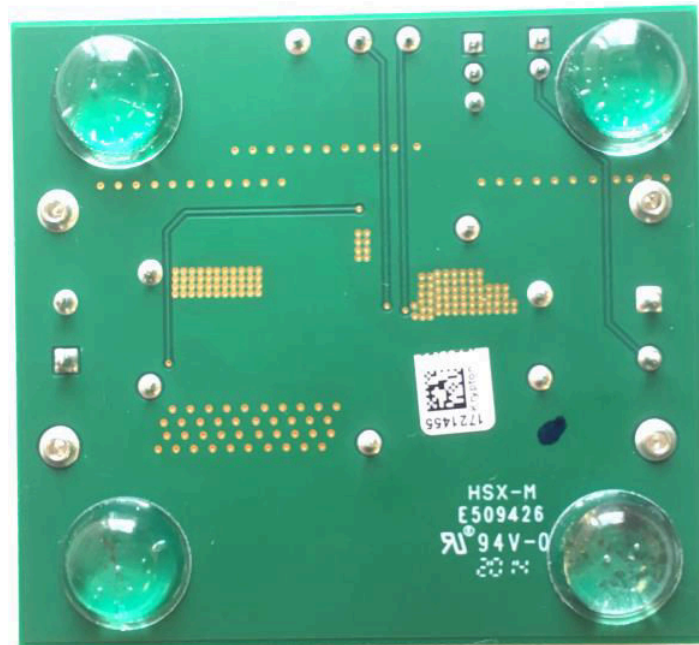
### 6.1 Board Profile

Figure 6-1 is the top view for the TPS566238EVM.



**Figure 6-1. Top View of TPS566238EVM**

Figure 6-2 is the bottom view for the TPS566238EVM.



**Figure 6-2. Bottom View of TPS566238EVM**

## 6.2 Schematic

Figure 6-3 is the schematic for the TPS566238EVM.

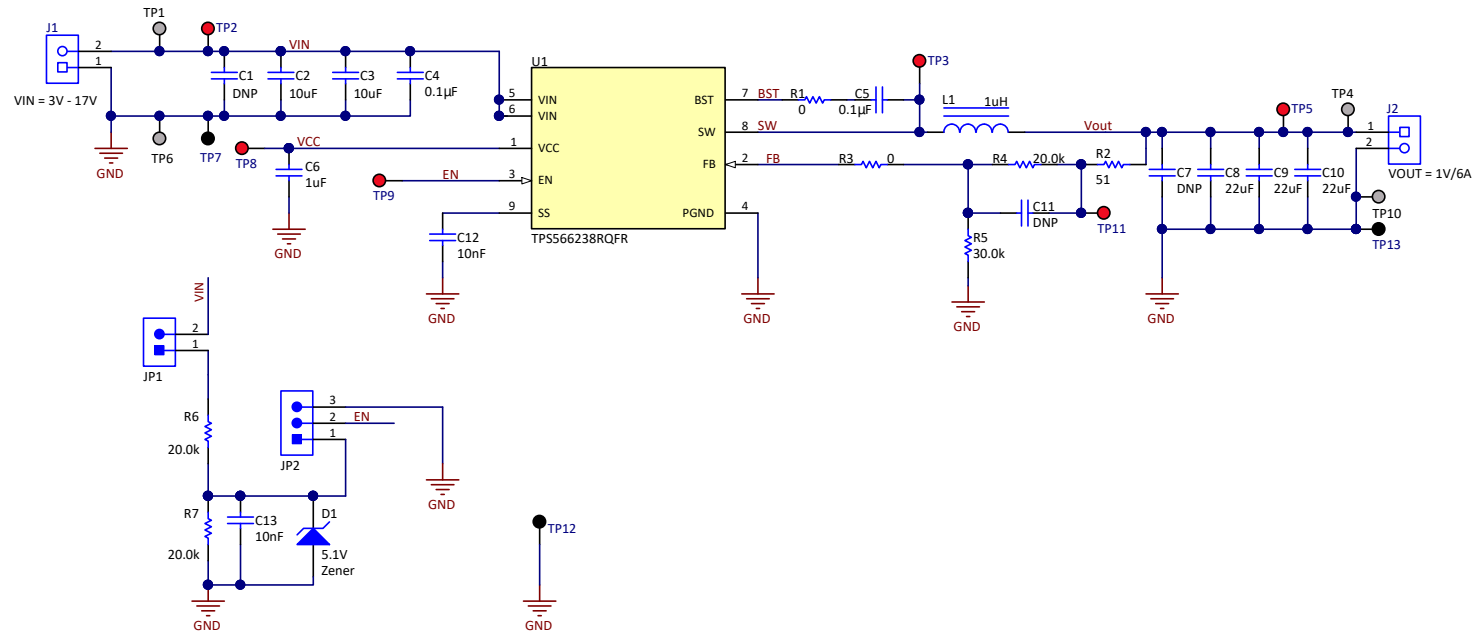


Figure 6-3. TPS566238EVM Schematic Diagram

## 6.3 List of Materials

Table 6-1 displays the TPS566238EVM list of materials.

**Table 6-1. List of Materials<sup>(1)</sup>**

Designator	Qty	Description	Part Number	Manufacturer
PCB1	1	Printed Circuit Board	BSR106	
C2, C3	2	Capacitor, ceramic, 10 uF, 25 V, +/- 20%, X5R, 0805	GRM21BR61E106MA73L	MuRata
C4, C5	2	Capacitor, ceramic, 0.1 uF, 25 V, +/- 10%, X5R, 0603	CL10A104KA8NUNC	Samsung Electro-Mechanics
C6	1	Capacitor, ceramic, 1 uF, 10 V, +/- 10%, X5R, 0603	C1608X5R1A105K080AC	TDK
C8, C9, C10	3	Capacitor, ceramic, 22 uF, 10 V, +/- 20%, X5R, 0805	GRM21BR61A226ME44L	MuRata
C12, C13	2	Capacitor, ceramic, 0.01 uF, 16 V, +/- 10%, X7R, 0603	C0603C103K4RACTU	Kemet
D1	1	Diode, Zener, 5.1 V, 200 mW, SOD-323	MMSZ5231BS-7-F	Diodes Inc.
H1, H2, H3, H4	4	Bumpon, Hemisphere, 0.44 X 0.20, Clear, Transparent	SJ-5303 (CLEAR)	3M
J1, J2	2	Terminal Block, 5.08 mm, 2x1, Brass, TH	ED120/2DS	On-Shore Technology
JP1	1	Header, 100mil, 2x1, Gold, TH, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions
JP2	1	Header, 100mil, 3x1, Tin, TH, 3 PIN	PEC03SAAN	Sullins Connector Solutions
L1	1	Inductor, Shielded Drum Core, WE-Superflux200, 1 uH, 15 A, 0.0046 ohm, SMD	744311100	Würth Elektronik
LBL1	1	Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll	THT-13-457-10	Brady
R1, R3	2	Resistor, 0, 5%, 0.1 W, 0603	RC0603JR-070RL	Yageo
R2	1	Resistor, 51, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060351R0JNEA	Vishay-Dale
R4, R6, R7	3	Resistor, 20.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060320K0FKEA	Vishay-Dale
R5	1	Resistor, 30.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	ERJ-3EKF3002V	Panasonic
SH-JP1, SH-JP2	2	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G or 969102-0000-DA	Samtec or 3M
TP1, TP4, TP6, TP10	4	Terminal, Turret, TH, Triple	1598-2	Keystone
TP2, TP3, TP5, TP8, TP9, TP11	6	Test Point, Miniature, Red, TH	5000	Keystone
TP7, TP12, TP13	3	Test Point, Miniature, Black, TH	5001	Keystone
U1	1	TPS566238RQFR, RQF0009A (VQFN-HR-9)	TPS566238RQFR	Texas Instruments
C1	0	Capacitor, ceramic, 10 uF, 25 V, +/- 20%, X5R, 0805	GRM21BR61E106MA73L	MuRata
C7	0	Capacitor, ceramic, 22 uF, 10 V, +/- 20%, X5R, 0805	GRM21BR61A226ME44L	MuRata
C11	0	Capacitor, ceramic, 10 pF, 10 V, +/- 10%, X7R, 0603	0603ZC100KAT2A	AVX
FID1, FID2, FID3	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A

(1) Unless otherwise noted in the *Alternate Part Number* or *Alternate Manufacturer* columns, all parts may be substituted with equivalents.

## 6.4 Reference

1. Texas Instruments, [TPS566238 3 V to 17 V Input, 6-A Synchronous Step-Down Voltage Regulator](#) data sheet.

## 7 Revision History

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

Changes from Revision A (January 2021) to Revision B (June 2021)	Page
• Changed user's guide title.....	3

Changes from Revision * (May 2020) to Revision A (January 2021)	Page
• Updated Vin Max Voltage from 17 V to 18 V.....	3
• Deleted comment about hot plug in.....	4

## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](http://ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2022, Texas Instruments Incorporated