User's Guide

TPS548B27EVM-162 20-A, Buck Converter Evaluation Module User Guide

ABSTRACT

This user's guide contains information for the TPS548B27EVM-162 evaluation module (EVM) as well as for the TPS548B27 DC/DC converter. Also included are the performance specifications, the schematic, and the list of materials for the TPS548B27EVM.

Table of Contents

List of Figures

List of Tables

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1 Introduction

The TPS548B27 is a D-CAP3™ synchronous buck converter designed for 20-A output current, and the evaluation module is designed to demonstrate the small printed-circuit-board areas that may be achieved when designing with the device. The high-side and low-side switching MOSFETs are integrated in the device package along with their gate drive circuitry. Rated input voltage and output current ranges for the evaluation module are given in Table 3-1.

2 Safety Warnings

Figure 2-1. Hot Surface. Contact may cause burns. Do not touch.

3 Background

The EVM is setup to allow the user to evaluate the performance of the TPS548B27 IC, and easily make changes to multiple settings. The low drain-to-source on resistance of the MOSFETs allows the device to achieve high efficiencies and keep the junction temperature low at high output currents. There is no need for external compensation components since this device is designed with D-CAP3™ control topology. On the EVM, the switching frequency and the operation mode are externally selectable using a jumper to set the resistor from the MODE pin to AGND. An external resistor divider allows for an adjustable output voltage. Additionally, the device provides adjustable soft start, adjustable OC limit threshold, external reference input, and an open-drain power good indicator. Lastly the TPS548B27 device has a fixed internal VIN under voltage lockout and externally adjustable UVLO using a resistor divider at the EN pin.

Table 3-1. Input Voltage and Output Current Summary

EVM	Input Voltage Range	Output Current Range
TPS548B27	V_{IN} = 4 V to 16 V	0 A to 20 A

4 Performance Specification Summary

A summary of the TPS548B27EVM performance specifications is provided in Table 4-1. Specifications are given for an input voltage of V_{IN} = 12 V and an output voltage of 1.0 V, unless otherwise specified. The TPS548B27EVM is designed and tested for V_{IN} = 8 V to 14 V. The ambient temperature is 25°C for all measurements, unless otherwise noted. The design can be modified to perform over 4 V to 16 V.

Table 4-1. Performance Specification Summary

Specification	Test Conditions	MIN	TYP	MAX	Unit
V_{IN} voltage range (without internal Bias)		8	12	14	V
Output voltage setpoint			1.0		V
Output current range	V_{IN} = 8 V to 14 V	0	20	20	A
Internal LDO Voltage			3.0		V
Operating frequency			800		kHz

5 Modifications

These evaluation modules are designed to provide access to the features of the TPS548B27. Some modifications can be made to this module.

5.1 Output Voltage Setpoint

To change the output voltage of the EVM, it is necessary to change the value of resistor R8 and R9. R13 is fixed at 10 kΩ. Changing the total value of R8 plus R9 can change the output voltage above the 0.6-V reference voltage V_{INTREF}. A two resistor configuration of R8 + R9 is implemented to give the exact desired output voltage setting. The value of R8 and R9 for a specific output voltage can be calculated using Equation 1.

$$R_{FB\_HS} = \frac{V_O - V_{INTREF}}{V_{INTREF}} \times R_{FB\_LS} \quad (1)$$

where

- V_{INTREF} = 0.6 V
- $R_{FB\_HS} = R_8 + R_9$
- $R_{FB\_LS} = R_{13}$ = 10 kΩ

5.2 Frequency and Operation Mode Setting

To change the frequency and operation mode of the part, the MODE pin is used. J4 and the surrounding circuitry allows for an easy change to the frequency and operation mode setting. Table 5-1 shows all 6 options offered by J4.

Table 5-1. TPS548B27EVM Mode Pin Selection

Switching Frequency (F_{SW})	Operation Mode Under Light Load	Mode Pin Connections	
		Connection	Jumper Setting
600 kHz	Skip Mode	Short to VCC	Short Pins 1 and 2
800 kHz	Skip Mode	243 kΩ ±10% to AGND	Short Pins 3 and 4
1000 kHz	Skip Mode	121 kΩ ±10% to AGND	Short Pins 5 and 6
1000 kHz	Forced CCM	60.4 kΩ ±10% to AGND	Short Pins 7 and 8
800 kHz	Forced CCM	30.1 kΩ ±10% to AGND	Short Pins 9 and 10
600 kHz	Forced CCM	Short to AGND	Short Pins 11 and 12

5.3 Enable Pin Selection

The converter can be enabled and disabled by J3.

Default setting: EN pin connected to VIN.

Table 5-2. Enable Pin Selection

Set On Connection	Enable Selection
Pins 2-3 Shorted	EN pin connected to VIN pins through resistor divider
J3 Open	EN pin is left floating
Pins 1-2 Shorted	EN pin connected to PGND

5.4 Remote Sensing

The EVM is not set-up for remote sensing by default. To set up remote sensing follow these steps:

1. Replace R10 and R14 with 100-Ω resistors
2. Connect your sense points to the Vsns+ and Vsns- test points

5.5 Adjustable UVLO

The undervoltage lockout (UVLO) can be adjusted externally using R2 and R9. See the *TPS548B27 4-V to 16-V Input, 15-A/20-A Synchronous Step-Down Converter Data Sheet* for detailed instructions for setting the external UVLO.

6 Schematic

Figure 6-1 illustrates the TPS548B27EVM schematic.

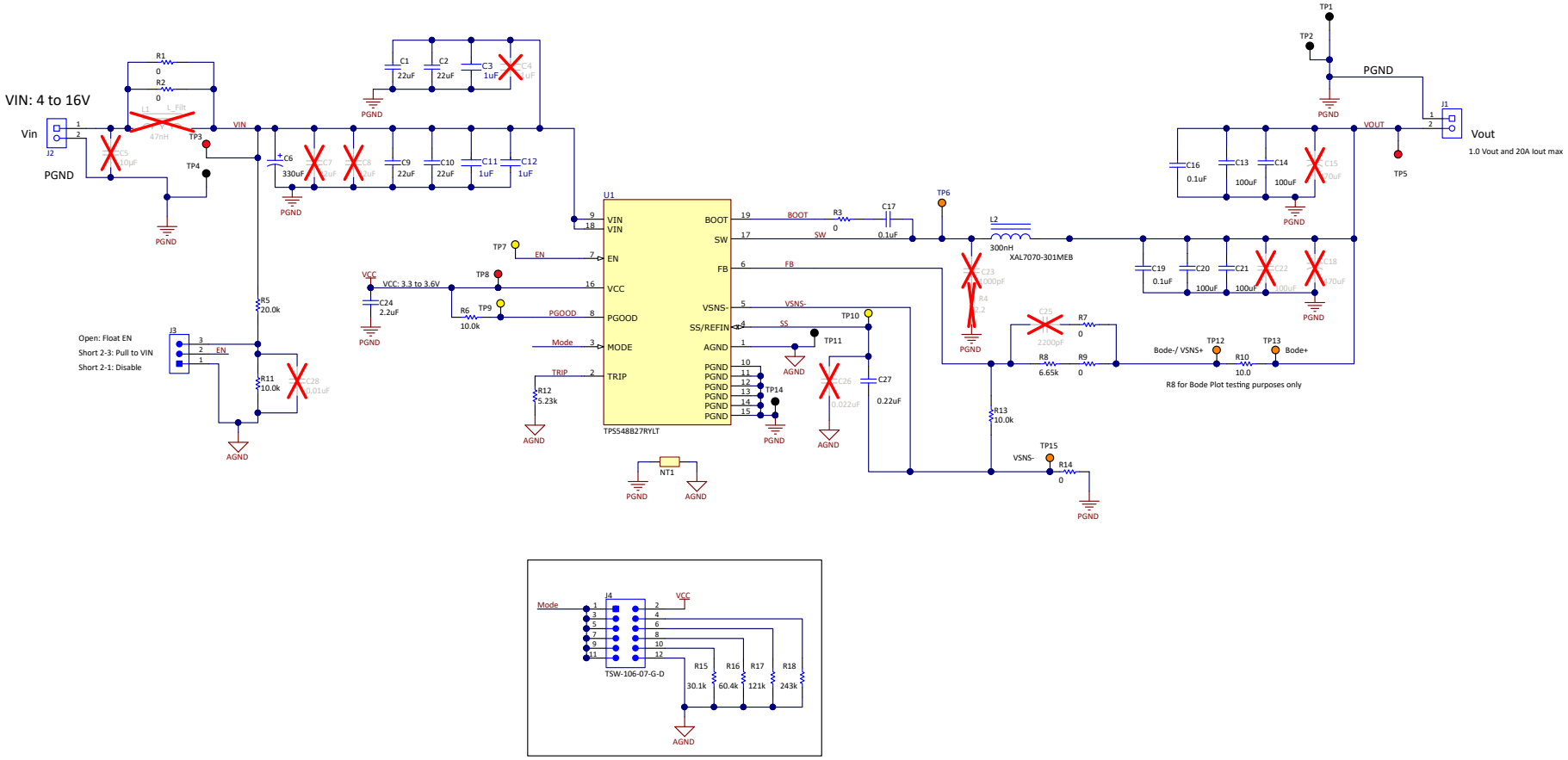

Figure 6-1. TPS548B27EVM Schematic

7 List of Materials

Table 7-1 presents the list of materials for the TPS548B27EVM.

Table 7-1. TPS548B27EVM List of Materials

Designator	QTY	Description	Part Number	Manufacturer
C1, C2, C9, C10	4	CAP, CERM, 22 uF, 25 V, +/- 20%, X6S, 1206_190	GRM31CC81E226ME11L	Murata
C3, C11, C12	3	CAP CER 1UF 25V X6S 0402	GRM155C81E105KE11D	Murata
C6	1	CAP, AL, 330 uF, 25 V, +/- 20%, 0.15 ohm, SMD	EEE-FC1E331P	Panasonic
C13, C14, C20, C21	4	CAP, CERM, 100 uF, 4 V, +/- 20%, X6S, 1206_190	C3216X6S0G107M160AC	TDK
C16, C19	2	CAP, CERM, 0.1 uF, 6.3 V, +/- 10%, X7R, 0402	GRM155R70J104KA01D	MuRata
C17	1	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	CGA2B3X7R1H104K050BB	TDK
C24	1	CAP, CERM, 2.2 uF, 10 V, +/- 20%, X5R, 0402	GRM155R61A225ME95	Murata
C25	1	CAP, CERM, 2200 pF, 16 V, +/- 10%, X7R, 0402	GRM155R71C222KA01D	Murata
C26	1	CAP, CERM, 0.022 uF, 16 V, +/- 10%, X7R, 0402	GRM155R71C223KA01D	Murata
C27	1	CAP, CERM, 0.22 uF, 10 V, +/- 10%, X7R, 0402	GRM155R71A224KE01D	Murata
C28	1	CAP, CERM, 0.01 uF, 16 V, +/- 10%, X5R, 0402	GRM155R61C103KA01D	Murata
H1, H2, H3, H4	4	Bumpon, Hemisphere, 0.44 X 0.20, Clear	SJ-5303 (CLEAR)	3M
J1, J2	2	Therminal Block, 5 mm, 2-pole, Tin, TH	282856-2	TE Connectivity
J3	1	Header, 100mil, 3x1, Gold, TH	HTSW-103-07-G-S	Samtec
J4	1	Header, 100mil, 6x2, Gold, TH	TSW-106-07-G-D	Samtec
L2	1	Inductor, Shielded, Composite, 300 nH, 33.4 A, 0.00106 ohm, SMD	XAL7070-301MEB	Coilcraft
LBL1	1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady
R1, R2	2	RES, 0, 1%, 0.5 W, 1206	5108	Keystone
R3, R7, R9, R14	4	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GE0R00X	Panasonic
R5	1	RES, 20.0 k, 0.1%, 0.1 W, 0603	RT0603BRD0720KL	Yageo America
R6, R13	2	RES, 10.0 k, 1%, 0.1 W, 0402	ERJ-2RKF1002X	Panasonic
R8	1	RES, 6.65 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04026K65FKED	Vishay-Dale
R10	1	RES, 10.0, 1%, 0.063 W, 0402	CRCW040210R0FKED	Vishay-Dale
R11	1	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060310K0FKEA	Vishay-Dale
R12	1	RES, 5.23 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04025K23FKED	Vishay-Dale
R15	1	RES, 30.1 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060330K1FKEA	Vishay-Dale
R16	1	RES, 60.4 k, 1%, 0.1 W, 0603	RC0603FR-0760K4L	Yageo
R17	1	RES, 121 k, 1%, 0.1 W, 0603	RC0603FR-07121KL	Yageo
R18	1	RES, 243 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW0603243KFKEA	Vishay-Dale
SH-J1, SH-J2	2	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G	Samtec
TP1, TP2, TP4, TP11, TP14	5	Test Point, Multipurpose, Black, TH	5011	Keystone
TP3, TP5, TP8	3	Test Point, Multipurpose, Red, TH	5010	Keystone
TP6	1	Test Point, Compact, Orange, TH	5008	Keystone
TP7, TP9, TP10	3	Test Point, Compact, Yellow, TH	5009	Keystone
TP12, TP13, TP15	3	Test Point, Multipurpose, Orange, TH	5013	Keystone
U1	1	2.7V - 16V, 20A Synchronous Step-Down Converter With Differential Remote Sense	TPS548B27RYLT	Texas Instruments
C4	0	CAP CER 1UF 25V X6S 0402	GRM155C81E105KE11D	Murata
C5	0	CAP, CERM, 10 uF, 25 V, +/- 10%, X7R, 0805	GRM21BZ71E106KE15L	Murata
C7, C8	0	CAP, CERM, 22 uF, 25 V, +/- 20%, X6S, 1206_190	GRM31CC81E226ME11L	Murata
C15, C18	0	CAP, Tantalum Polymer, 470 uF, 6.3 V, +/- 20%, 0.01 ohm, 7343-40 SMD	6TPF470MAH	Panasonic
C22	0	CAP, CERM, 100 uF, 4 V, +/- 20%, X6S, 1206_190	C3216X6S0G107M160AC	TDK
C23	0	CAP, CERM, 1000 pF, 50 V, +/- 5%, X7R, 0603	CL10C102JB8NNNC	Samsung Electro-Mechanics
'FID1, FID2, FID3, FID4, FID5, FID6	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A

Table 7-1. TPS548B27EVM List of Materials (continued)

Designator	QTY	Description	Part Number	Manufacturer
L1	0	Inductor, Wirewound, Ceramic, 47 nH, 0.5 A, 0.31 ohm, SMD	0805CS-470XJLB	Coilcraft
R4	0	RES, 2.2, 5%, 0.5 W, 1206	CRM1206-JW-2R2ELF	Bourns

8 Layout

The board layout for the TPS548B27EVM is shown in Figure 8-3 through Figure 8-6. The top-side layer of the EVM is laid out in a manner typical of a user application. The top, bottom, and internal layers are 2-oz. copper.

The top layer contains the main power traces for V_{IN}, V_{OUT}, and SW. Also on the top layer are connections for the remaining pins of the TPS548B27 and the majority of the signal traces. The top layer has a dedicated ground plane for quiet analog ground that is connected to the main power ground plane at a single point. The internal layer-1 is a large ground plane. The internal layer-2 contains an additional large ground copper area as well as an additional V_{OUT} copper fill. The bottom layer is another ground plane with two additional traces for the output voltage feedback and various signals routed to test points and headers. There are also additional V_{IN} and V_{OUT} planes on the bottom layer. The top-side ground traces are connected to the bottom and internal ground planes with multiple via groupings placed around the board.

The input decoupling capacitors and bootstrap capacitor are all located as close to the IC as possible. Additionally, the voltage set point resistor divider components are kept close to the IC. The voltage divider network ties to the output voltage at the point of regulation, the copper V_{OUT} trace at the TP4 test point. An additional input bulk capacitor is used to limit the noise entering the converter from the input supply. Critical analog circuits that are noise sensitive are terminated to the quiet analog ground island on the top layer.

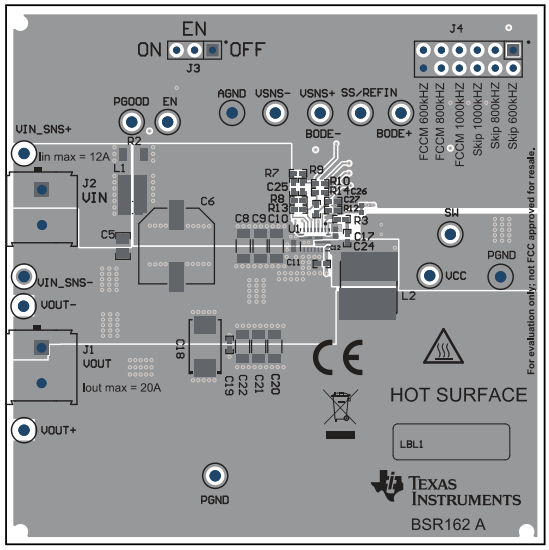

Figure 8-1. TPS548B27EVM Top-Side Composite View

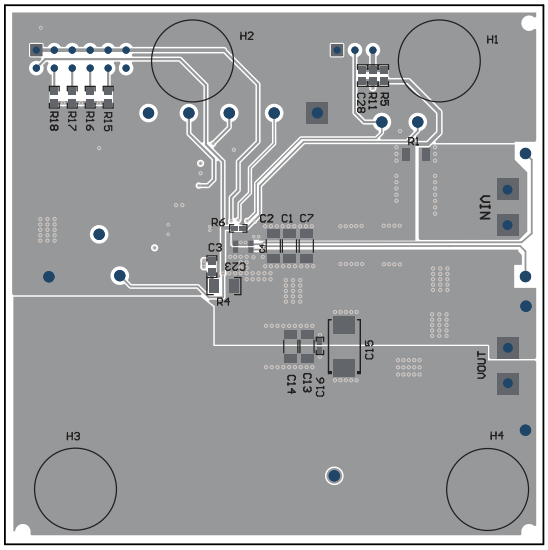

Figure 8-2. TPS548B27EVM Bottom-Side Composite View

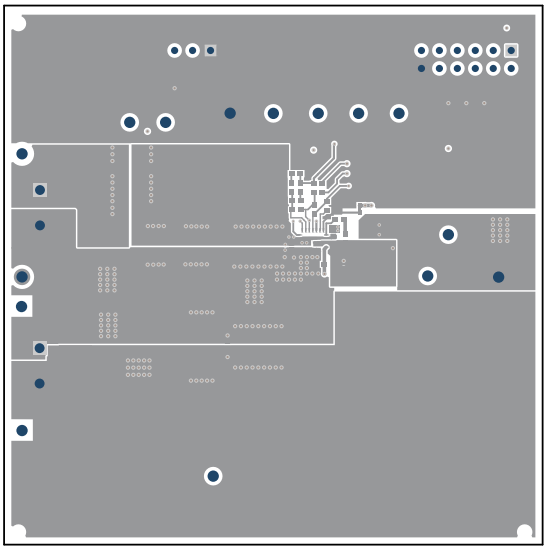

Figure 8-3. TPS548B27EVM Top-Side Layout

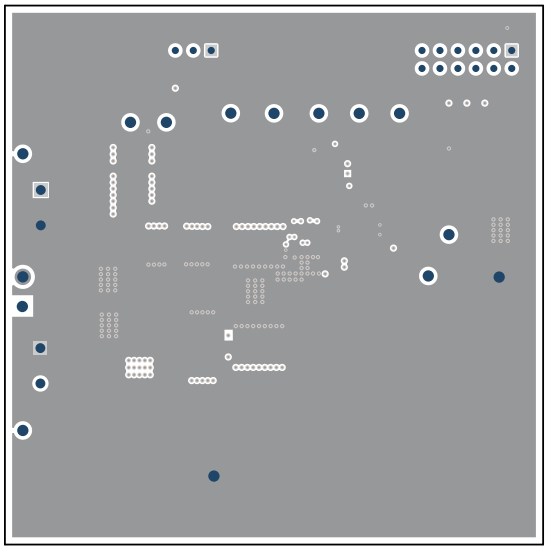

Figure 8-4. TPS548B27EVM Internal Layer-1 Layout

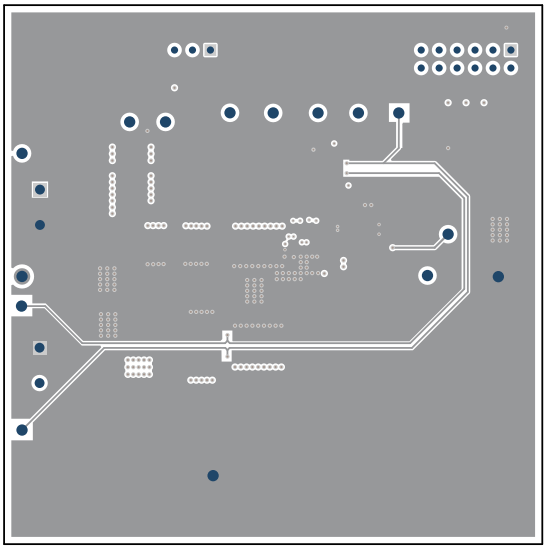

Figure 8-5. TPS548B28EVM Internal Layer-2 Layout

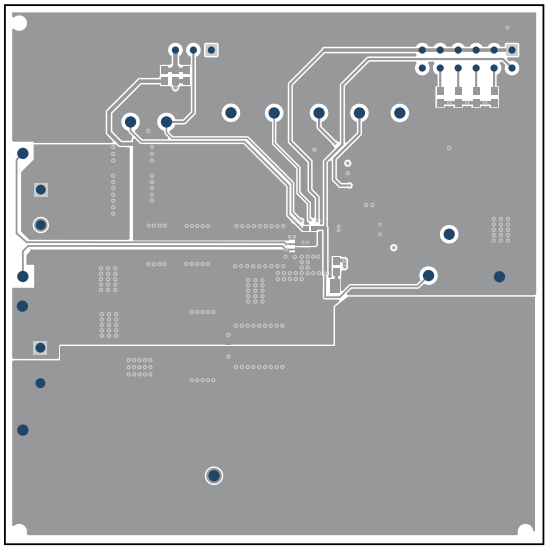

Figure 8-6. TPS548B27EVM Bottom-Side Layout

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