User's Guide

TPS274C65 Evaluation Module

ABSTRACT

The TPS274C65EVM is a hardware evaluation module (EVM) used to enable hardware engineers to evaluate the full performance and functionality of the TPS274C65 industrial high side switch. The TPS274C65EVM contains everything needed to test and assess the TPS274C65 before designing it into part of a greater application's power system. *The TPS274C65EVM is compatible with AS and BS version of TPS274C65*. To use the SPI interface of TPS274C65AS and TPS274C65BS correctly, the evaluation module is designed to either use external microcontroller with jumper wires or in conjunction with an underlying Texas Instruments microcontroller by using the standardized BoosterPack™ plug-in module headers. A wide range of application features such as SPI communication, adjustable current limiting, and various protection and diagnostics are enabled and visible through use of this evaluation module.

	**Caution**	**Caution hot surface** **Contact can cause burns** **Do not touch!**

Table of Contents

List of Figures

List of Tables

Trademarks

BoosterPack™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

1 Introduction

The Texas Instruments TPS274C65EVM is an evaluation module that is used to demonstrate and showcase all of the features of the underlying TPS274C65AS and TPS274C65BS industrial high side switch. This evaluation board provides a seamless way to connect a set of power supplies to the inputs of the TPS274C65, connect loads to the output channels, and switch on and off the device through SPI communication. An on-board 3.3-V buck-converter LMR36506 is included on the EVM to showcase the use of external VDD. Additionally this EVM includes BoosterPack plug-in module headers allowing the user to easily connect the TPS274C65 high side switch to either external microcontroller with jumper wires or a Texas Instruments microcontroller and write software to control and configure the device through SPI communication.

Features of the TPS274C65EVM include:

- BoosterPack plug-in module pins for SPI communication
- On-board 3.3-V buck-converter allowing for external VDD and lower device Iq
- Ability to support versions AS and BS of the TPS274C65
- On-board DIP switches for addressable SPI address configurations
- Analog sensing configuration with potentiometer or fixed resistor
- On-board LEDs to demostrate LED driving capabilities (AS version)
- On-board Reverse Current Blocking (RCB) FETs to demostrate reverse current blocking driver functionality (AS version)

2 Compatibility Across Silicon Versions

Table 2-1. Device Comparison Table

Device Version	Part Number	Interface	Reverse Current Blocking (RCB)	Integrated LED Driver	Integrated ADC	Fault Diagnosis
AS	TP274C65AS	SPI	Yes	Yes	Yes	Global fault output and single channel information available through SPI
BS	TP274C65BS	SPI	No	No	No	Global fault output and single channel information available through SPI
CP	TP274C65CP	GPIO	Yes	No	No	Per channel fault output

Table 2-1 shows the comparison across different device versions. *Please note that TPS274C65EVM supports version AS and BS.*

Version AS and BS are using SPI interface. AS has full features sets including LED driver, RCB blocking FET driver and integrated ADC for digital current, temperature and voltage senses. The BS version is using SPI communication, but does not have LED driver, RCB blocking FET driver or integrated ADC. Version CP is using traditional GPIO interface with RCB driver.

A table of the versions of TPS274C65 and considerations that have to be taken can be found in Table 2-2.

Table 2-2. EVM Considerations Across Silicon Versions

TPS274C65 Version	EVM Considerations
AS	Default version populated on EVM. Leave *J19, J20, J21, J22* open to enable the RCB FETs. Make sure *R1* and *R5* are populated to enable LED driving. For the rest of the connections, follow desired settings from *Connection Descriptions*.
BS	Populate *J19, J20, J21, J22* to bypass the RCB FETs. Do not populate *R1* and *R5* as there is no LED driving capability for this version. For the rest of the connections, follow desired settings from *Connection Descriptions*.

3 BoosterPack™ Plug-in Module Operation

BoosterPack plug-in module headers (*J5, J10*) are used to communicate with TPS274C65's SPI interface. The header can be used to easily communicate with a Texas Instruments microcontroller, or can be paired with a custom microcontroller with jumper wires. A list of pins connected to the BoosterPack plug-in module header can be seen below in Table 3-1:

Table 3-1. Connected BoosterPack™ Plug-in Module Header Pins on TPS274C65EVM

BoosterPack Plug-in Module Pin	Function	Note
1	3.3-V power rail	3.3-V output from microcontroller
6	Current sensing through the SNS pin for version BS (current sense for AS is through SPI line)	Optional for AS
7	SPI CLK from microcontroller	The maximum SPI clock rate is 10MHz
12	CS_IC from microcontroller	SPI chip select
14	SDI_BP	*Serial data input for microcontroller*, must be connected to **SDO** of the IC if using addressable SPI. Alternatively, it can be connected to SDI of the IC for daisy chain operations.
15	SDO_BP	*Serial data input for microcontroller*, must be connected to **SDI** of the IC if using addressable SPI. Alternatively, it can be connected to SDO of the IC for daisy chain operations.
17	Configure DO_EN pin	Setting this pin low disables ALL the inputs.
18	Configure DSPI pin	Pulling this pin high enables daisy chain SPI mode. Pulling this pin low enables addressable SPI mode.
33	READY pin output from IC	Logic low output indicating the IC is ready for SPI communication.
34	FAULT pin output from IC	Optional for AS and BS as the fault output is available through SPI

Note that there are no series resistors with I/O ports for reverse current protection due to the high speed of SPI communications. Please use diode or TI's ideal diode solutions for reverse current protection.

To power the attached LaunchPad from the on-board buck converter of the TPS274C65EVM, use a 1 × 3 shunt to connect *J16*. Note that this feeds the output of the buck converter on the TPS274C65EVM into the 3.3-V rail on the LaunchPad. If there is another power supply trying to power the LaunchPad (such as the integrated USB power on the LaunchPad itself) this can potentially cause issues with the separate power sources fighting for contention.

Jumpers *J14* is used to manually configure the control signals going into the TPS274C65. When using a microcontroller to control these signals, these jumpers must be unpopulated to allow for the microcontroller to drive them high or low.

The current sense value can be reported digitally through internal ADC. However, current sense value can be read directly without SPI through pin 34. Please make sure *D3* is populated to clamp the pin voltage properly.

4 TPS274C65EVM Schematic

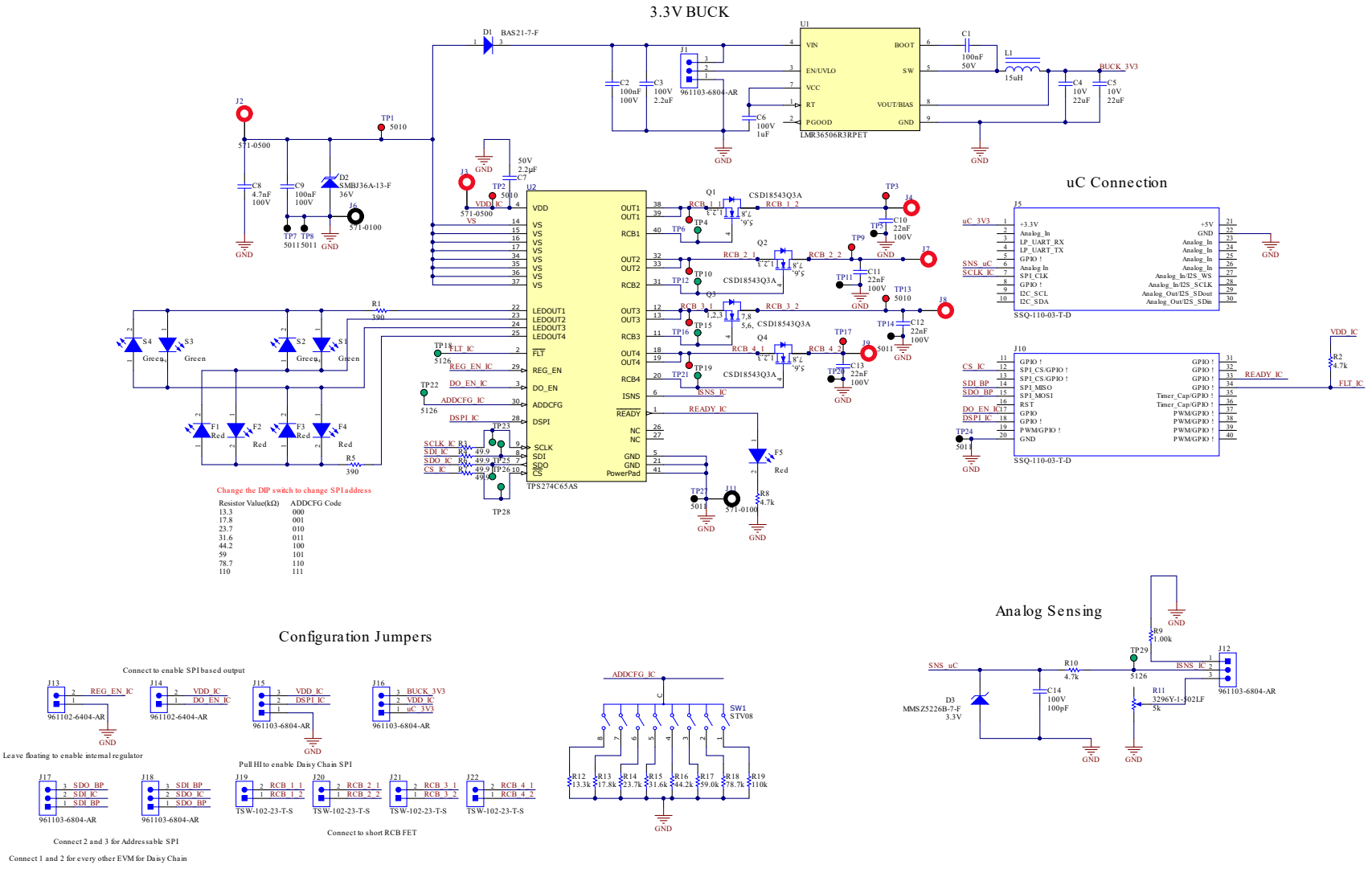

Figure 4-1. TPS274C65EVM Schematic Drawing

5 Connection Descriptions

Table 5-1 shows the test points populated on the board as well as the signal connectors.

Table 5-1. Connections and Test Points

Connector and Test Point	Description
J2, TP1	Supply Voltage VS
J3, TP2	VDD voltage. Connect a supply if internal regulator is disabled
J4, TP3	Output voltage 1 (VOUT1)
TP4	RCB1 signal
J7, TP9	Output voltage 2 (VOUT2)
TP10	RCB2 signal
J8, TP13	Output voltage 3 (VOUT3)
TP15	RCB3 signal
J9, TP17	Output voltage 4 (VOUT4)
TP19	RCB4 signal
J5, J10	BoosterPack plug-in module headers. Can be used to connect to TI microcontroller directly, or use jumpers to pair with other microcontrollers.
J6, J11, TP5, TP7, TP8, TP11, TP14, TP20, TP24, TP27	Ground
TP18	FAULT Signal
TP22	ADDCFG pin
TP23	SCLK pin on IC
TP25	SDI pin on IC
TP26	SDO pin on IC
TP28	CS pin on IC
TP29	ISNS pin on IC

Table 5-2 shows the relevant configuration jumpers of the TPS274C65EVM as well as the associated values. Please refer to the TPS274C65 data sheet for detailed information on each pin's functionality.

Please note that a white mark on the jumper silkscreen is reflecting the position 1 of the jumper.

Table 5-2. Jumper Configurations

Jumper	Function/Settings
J1	Connect 1 and 2 to disable on-board buck converter; connect 2 and 3 to enable on-board buck converter.
J12	Connect 1 and 2 to use fixed 1-kΩ resistor; connect 2 and 3 to use on-board potentiometer.
J13	Disconnect to use the internal regulator; do not use external VDD. Connect to disable the internal regulator; use external VDD in this case.
J14	Connect to enable SPI communications.
J15	Connect 1 and 2 to enable daisy chain mode SPI communication; connect 2 and 3 to use addressable SPI.
J16	Connect 2 and 3 to power VDD using internal buck converter; connect 1 and 2 to power VDD with microcontroller voltage output; leave open when using internal regulator.
J17	Connect 2 and 3 if using addressable SPI; connect 1 and 2 for every other EVM if using multiple EVMs in daisy chain mode.
J18	Connect 2 and 3 if using addressable SPI; connect 1 and 2 for every other EVM if using multiple EVMs in daisy chain mode.
J19, J20, J21, J22	Connect to bypass the RCB FETs; leave open for reverse current blocking.

Please refer to Table 5-3 for ADDCFG DIP switch configuration.

Table 5-3. ADDCFG DIP Switch Configurations

DIP Switch Position	Resistor Value	ADDCFG Code
1	110 kΩ	111
2	78.7 kΩ	110
3	59 kΩ	101
4	44.2 kΩ	100
5	31.6 kΩ	011
6	23.7 kΩ	010
7	17.8 kΩ	001
8	13.3 kΩ	000

6 TPS274C65EVM Assembly Drawings and Layout

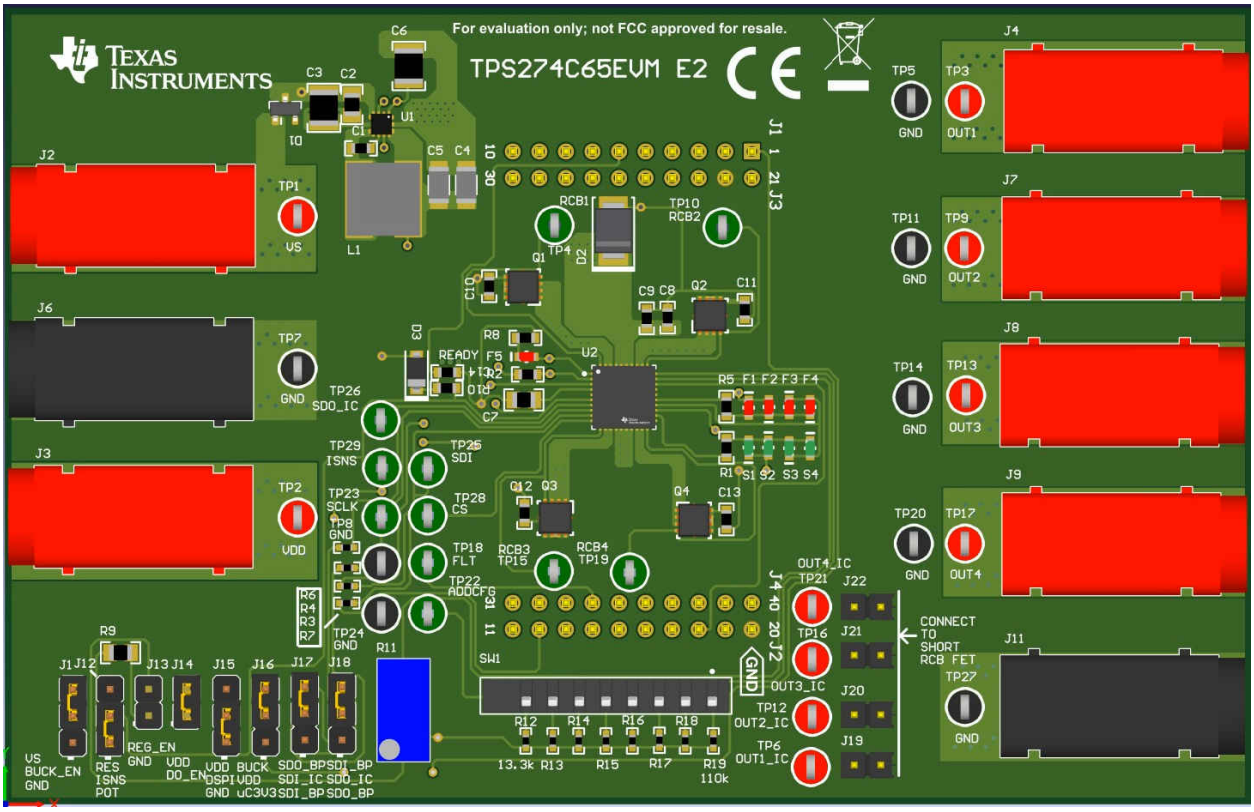

Figure 6-1. 3D Representation

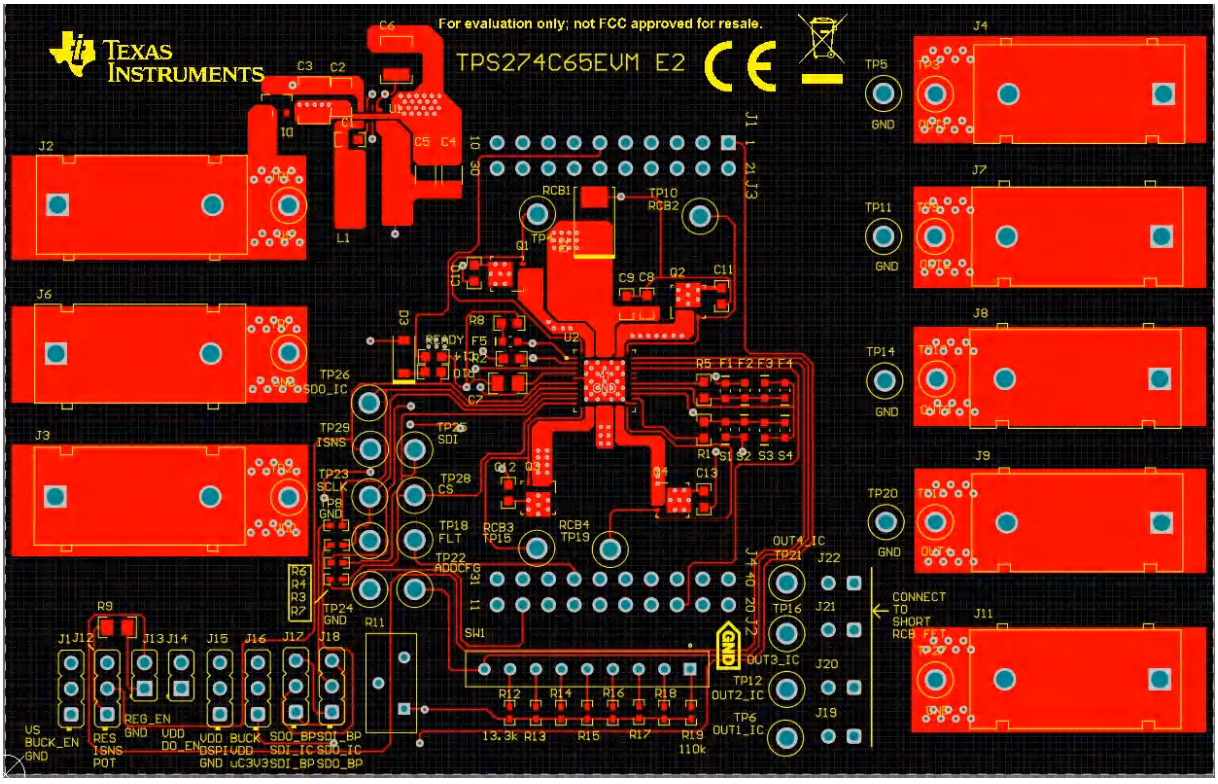

Figure 6-2. Top Layer

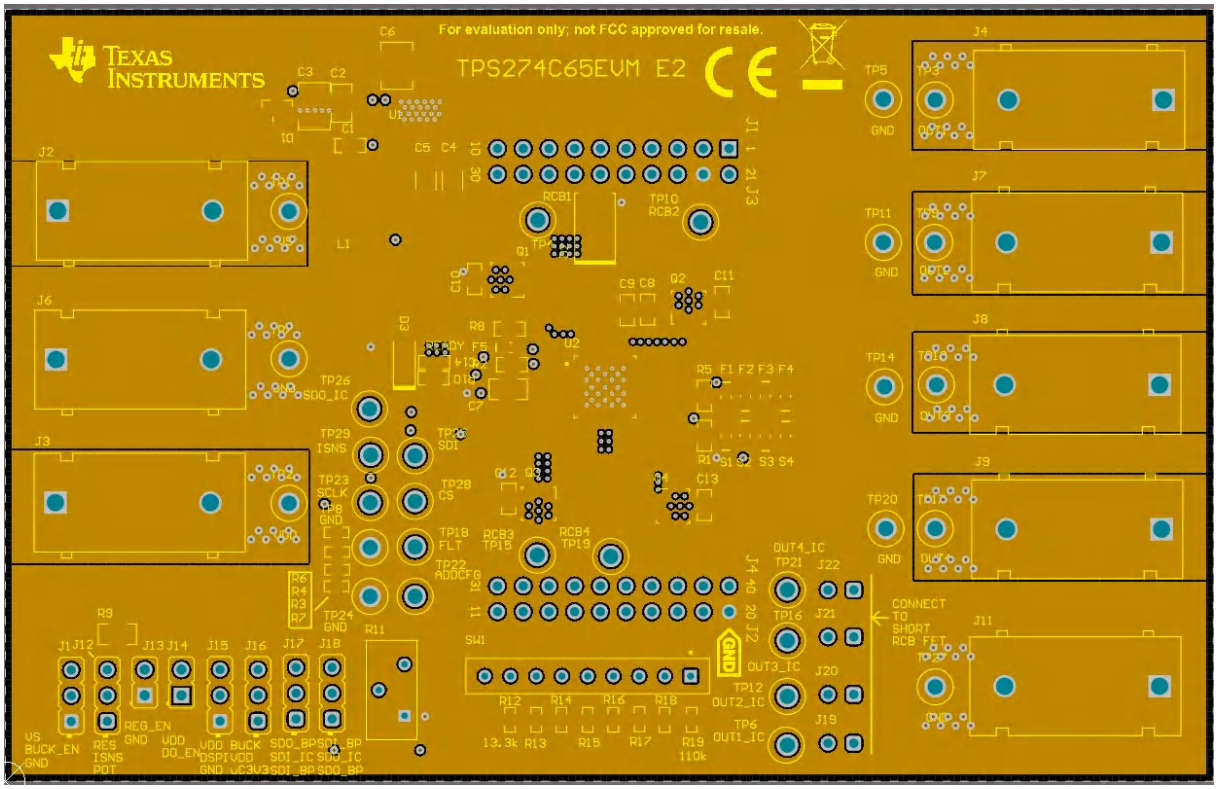

Figure 6-3. Ground Layer

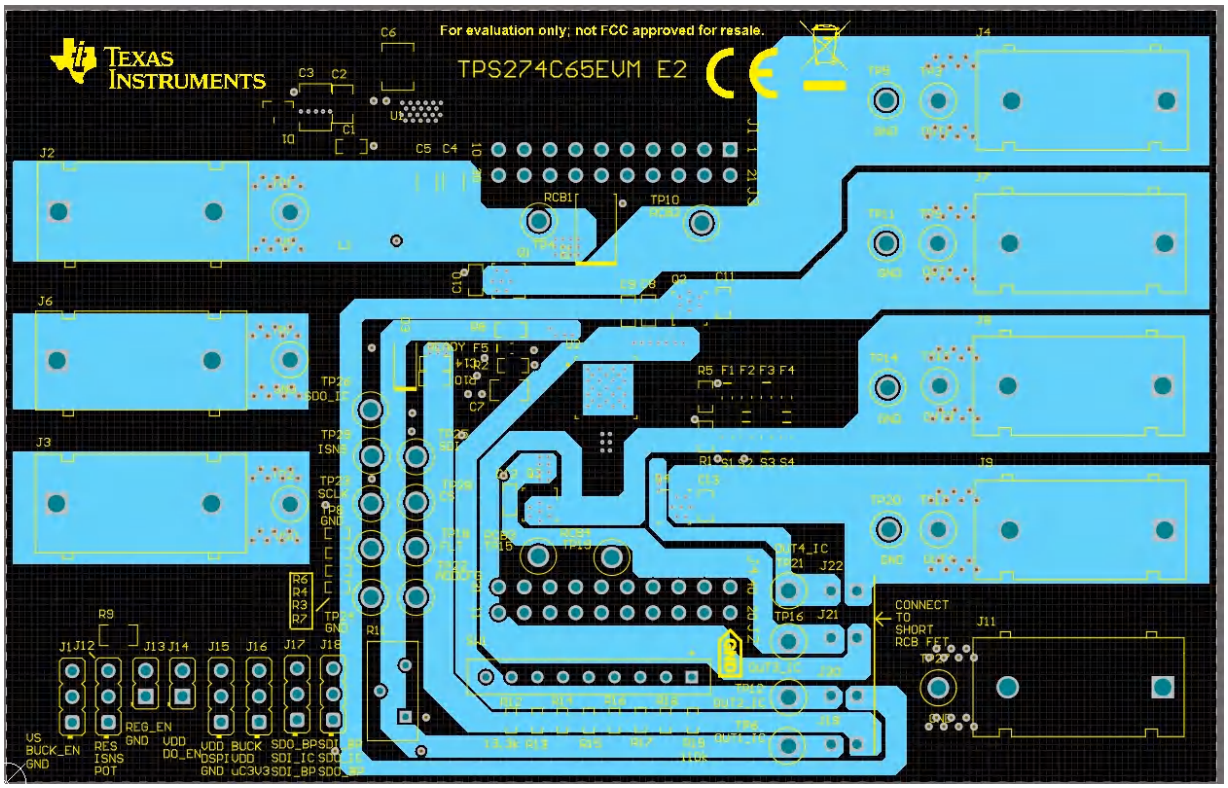

Figure 6-4. Power Layer

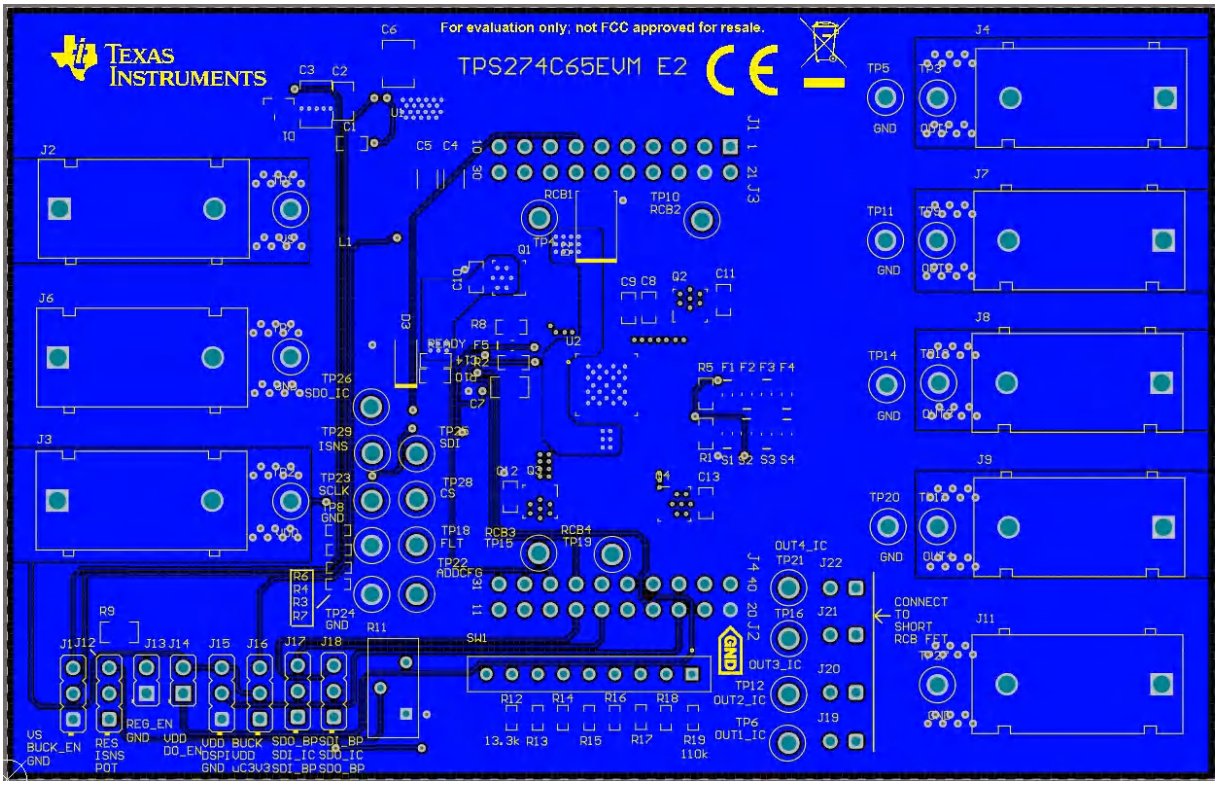

Figure 6-5. Bottom Layer

7 Bill of Materials

Table 7-1 lists the TPS274C65 Bill of Materials.

Table 7-1. TPS274C65 Bill of Materials

Designator	Value	Description	Package Reference	Part Number	Manufacturer
C1	0.1 uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	C1608X7R1H104K080AA	TDK
C2	0.1 uF	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7R, 0805	0805	C0805C104K1RACTU	Kemet
C3	2.2 uF	CAP, CERM, 2.2 uF, 100 V, +/- 10%, X7R, 1210	1210	C1210C225K1RACTU	Kemet
C4, C5	22 uF	CAP, CERM, 22 uF, 10 V, +/- 10%, X7R, 1206	1206	GRM31CR71A226KE15L	MuRata
C6	1 uF	CAP, CERM, 1 uF, 100 V, +/- 10%, X7R, 1210	1210	C3225X7R2A105K200AA	TDK
C7	2.2 uF	CAP, CERM, 2.2 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	0805	CGA4J3X7R1H225K125AB	TDK
C8	4700 pF	CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E2X7R2A472K080AA	TDK
C9	0.1 uF	CAP, CERM, 0.1 uF, 100 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	GCJ188R72A104KA01D	MuRata
C10, C11, C12, C13	0.022 uF	CAP, CERM, 0.022 uF, 100 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E2X7R2A223K080AA	TDK
C14	100 pF	CAP, CERM, 100 pF, 100 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	0603	GCM1885C2A101JA16D	MuRata
D1	200 V	Diode, Switching, 200 V, 0.2 A, SOT-23	SOT-23	BAS21-7-F	Diodes Inc.
D2	36 V	Diode, TVS, Uni, 36 V, 58.1 Vc, SMB	SMB	SMBJ36A-13-F	Diodes Inc.
D3	3.3 V	Diode, Zener, 3.3 V, 500 mW, SOD-123	SOD-123	MMSZ5226B-7-F	Diodes Inc.
F1, F2, F3, F4, F5	Red	LED, Red, SMD	SMD, 2-Leads, Body 1.3x0.8mm	LS L29K-G1J2-1-Z	OSRAM
J1, J12, J15, J16, J17, J18		Header, 2.54mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	961103-6804-AR	3M
J2, J3, J4, J7, J8, J9		Standard Banana Jack, insulated, 10A, red	571-0500	571-0500	DEM Manufacturing
J5, J10		Receptacle, 2.54mm, 10x2, Tin, TH	10x2 Receptacle	SSQ-110-03-T-D	Samtec
J6, J11		Standard Banana Jack, insulated, 10A, black	571-0100	571-0100	DEM Manufacturing
J13, J14		Header, 2.54mm, 2x1, TH	Header, 2.54mm, 2x1, TH	961102-6404-AR	3M
J19, J20, J21, J22		Header, 2.54mm, 2x1, Tin, TH	Header, 2.54mm, 2x1, TH	TSW-102-23-T-S	Samtec
L1	15 uH	Inductor, Shielded Drum Core, Ferrite, 15 uH, 1.1 A, 0.08 ohm, SMD	SMD, 2-Leads, Body 6.8x6.8mm	744062150	Wurth Elektronik
Q1, Q2, Q3, Q4	60 V	MOSFET, N-CH, 60 V, 35 A, DNH0008A (VSONP-8)	DNH0008A	CSD18543Q3A	Texas Instruments
R1, R5	390	RES, 390, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603390RJNEA	Vishay-Dale
R2, R8, R10	4.7 k	RES, 4.7 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ-3GEYJ472V	Panasonic
R3, R4, R6, R7	49.9	RES, 49.9, 1%, 0.063 W, 0402	0402	RC0402FR-0749R9L	Yageo America
R9	1.00 k	RES, 1.00 k, 1%, 0.25 W, 0805	0805	ERJ-P06F1001V	Panasonic

Table 7-1. TPS274C65 Bill of Materials (continued)

Designator	Value	Description	Package Reference	Part Number	Manufacturer
R11	5k	TRIMMER, 5k ohm, 0.5W, TH	9.5x10x4.8mm	3296Y-1-502LF	Bourns
R12	13.3 k	RES, 13.3 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF1332X	Panasonic
R13	17.8 k	RES, 17.8 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040217K8FKED	Vishay-Dale
R14	23.7 k	RES, 23.7 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF2372X	Panasonic
R15	31.6 k	RES, 31.6 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040231K6FKED	Vishay-Dale
R16	44.2 k	RES, 44.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040244K2FKED	Vishay-Dale
R17	59.0 k	RES, 59.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040259K0FKED	Vishay-Dale
R18	78.7 k	RES, 78.7 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040278K7FKED	Vishay-Dale
R19	110 k	RES, 110 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402110KFKED	Vishay-Dale
S1, S2, S3, S4	Green	LED, Green, SMD	1.7x0.65x0.8mm	LG L29K-G2J1-24-Z	OSRAM
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
SW1		Dip Switch SPST 8 Position Through Hole Slide (Standard) Actuator 10mA 5VDC	DIP8	STV08	TE Connectivity
TP1, TP2, TP3, TP6, TP9, TP12, TP13, TP16, TP17, TP21		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP4, TP10, TP15, TP18, TP19, TP22, TP23, TP25, TP26, TP28, TP29		Test Point, Multipurpose, Green, TH	Green Multipurpose Testpoint	5126	Keystone
TP5, TP7, TP8, TP11, TP14, TP20, TP24, TP27		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
U1		LMR36503/06-Q1 Wide Input 60-V Synchronous, DC-DC Buck Converter, RPE0009A (VQFN-9)	RPE0009A	LMR36506R3RPET	Texas Instruments
U2		65-mΩ, Quad-Channel Smart High-Side Switch with SPI interface and Diagnostics	VQFN40	TPS274C65AS	Texas Instruments

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 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