User's Guide

TPS281C30 Evaluation Module

ABSTRACT

The TPS281C30EVM is a hardware evaluation module (EVM) used to enable hardware engineers to evaluate the full performance and functionality of the TPS281C30 industrial high side switch. The TPS281C30EVM contains everything needed to test and assess the TPS281C30 before designing it into part of a greater application's power system. The evaluation module is designed to either be used as a standalone board with an attached voltage supply and output load 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 digital output module, safe torque off (STO), and holding brake are enabled and visible through use of this evaluation module. This EVM is populated with the QFN version of TPS281C30.

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

Table of Contents

List of Figures

List of Tables

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1 Introduction

The Texas Instruments TPS281C30EVM is an evaluation module that is used to demonstrate and showcase all of the features of the underlying TPS281C30 industrial high side switch. This evaluation board provides a seamless way to connect a set of power supplies to the inputs of the TPS281C30, connect loads to the output channels, and switch on and off the device using the control pins of the chip itself. An on-board 3.3-V LDO is included on the EVM to simplify controlling signals to the TPS281C30 and easily assert and deassert logic signals by the use of a set of external hardware jumpers. Additionally, this EVM includes BoosterPack plug-in module headers allowing the user to easily connect the TPS281C30 high side switch to an underlying microcontroller and write software to control and configure the device.

Features of the TPS281C30EVM include:

- Adjustable current limit with on-board potentiometer
- Configurable current sense with either fixed resistor or on-board potentiometer
- BoosterPack plug-in module headers allowing power switch to be controlled by external microcontroller
- On-board 3.3-V LDO allowing for control signals to be manipulated by a set of jumpers
- Ideal board layout and copper area for thermal performance
- Ability to support versions A, B, C, and D of the TPS281C30
- Jumper at the output to support different clamp configurations for inductive discharge (version C, D of TPS281C30)
- Optional footprint to populate TVS diode for VDS clamp for faster inductive discharge (version C, D of TPS281C30)

2 Compatibility Across Silicon Versions

Table 2-1. Device Comparison Table

Device Version	Part Number	Current Limit Range	Integrated Clamp for Inductive Loads
A	TPS281C30A	1 A–5 A	Yes
B	TPS281C30B	2 A–10 A	Yes
C	TPS281C30C	1 A–5 A	No
D	TPS281C30D	2 A–10 A	No

Table 2-1 shows the comparison across different device versions. Version A and B have built-in integrated clamp for inductive load discharge, while version C and D are for non-inductive load driving, or for the need of an external clamp for higher energy dissipation capabilities.

The TPS281C30EVM is compatible across all versions of the TPS281C30. A table of the versions of TPS281C30 and considerations that have to be taken can be found in Table 2-2.

Table 2-2. EVM Considerations Across Silicon Versions

TPS281C30 Version	EVM Considerations
A, B	With internal VDS clamp, external clamp is not needed. Make sure *D2*, *R5* are not populated and *J9* is disconnected. The current sense potentiometer, *R1*, setting can be different between version A and B depending on the loading conditions. For connections of other jumpers, please refer to *Connection Descriptions*.
C, D	Without internal VDS clamp, external clamp is needed for inductive load discharge. To clamp the output voltage to 0 V during inductive turn-off, please populate jumper, *J9*, for a slower discharge. For a faster discharge rate, please disconnect *J9* and populate *R5*, and the output is clamped by the TVS diode, *D5*. The current sense potentiometer, *R1*, setting can be different between version C and D depending on the loading conditions. For connections of other jumpers, please refer to *Connection Descriptions*.

3 BoosterPack™ Plug-in Module Operation

While the TPS281C30EVM can be used as a standalone evaluation board without the need of any external microcontroller, the EVM also comes populated with *BoosterPack plug-in module headers* (*J13, J14*) to enable easy interface with a Texas Instruments microcontroller. Additionally, by populating jumper *J12* the user has the ability to power the underlying LaunchPad™ development kit through the integrated 3.3-V LDO on the TPS281C30EVM. 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 TPS281C30EVM

BoosterPack Plug-in Module Pin	Function	Note
1	3.3-V power rail	Disconnect *J12* if powering LaunchPad development kit through USB.
5	FLT pin used to detect faults	Open drain input. Pullup source can be controlled using jumper *J10*.
6	Current sense output from IC	Configure current sense resistor with *J14*.
38	Configure DIAG_EN	Make sure J7 is not populated if using microcontroller output.
39	Configure EN_IC	Make sure J6 is not populated if using microcontroller output.
40	Configure OL_IC	Make sure J8 is not populated if using microcontroller output.

Note that for all IO and analog signals being attached to the BoosterPack plug-in module, the relevant 10-kΩ protection resistors are populated in series with the pin for reverse current protection.

To power the attached LaunchPad development kit from the on-board LDO of the TPS281C30EVM, connect the jumper *J12*. Note that this feeds the output of the 3.3-V LDO on the TPS281C30EVM into the 3.3-V rail on the LaunchPad development kit . If there is another power supply trying to power the LaunchPad development kit (such as the integrated USB power on the LaunchPad development kit itself), this can potentially cause issues with the separate power sources fighting for contention.

Jumpers *J6 through J8* are used to manually configure the control signals going into the TPS281C30. When using a microcontroller to control these signals, these jumpers must be unpopulated to allow for the microcontroller to drive them high or low.

For correct and accurate current sense, please configure jumper *J14* to use either potentiometer or fixed resistor. The maximum voltage out on the SNS pin is clamped to V_{SNSFH} internally, so there is no need for external clamp.

4 TPS281C30EVM Schematic

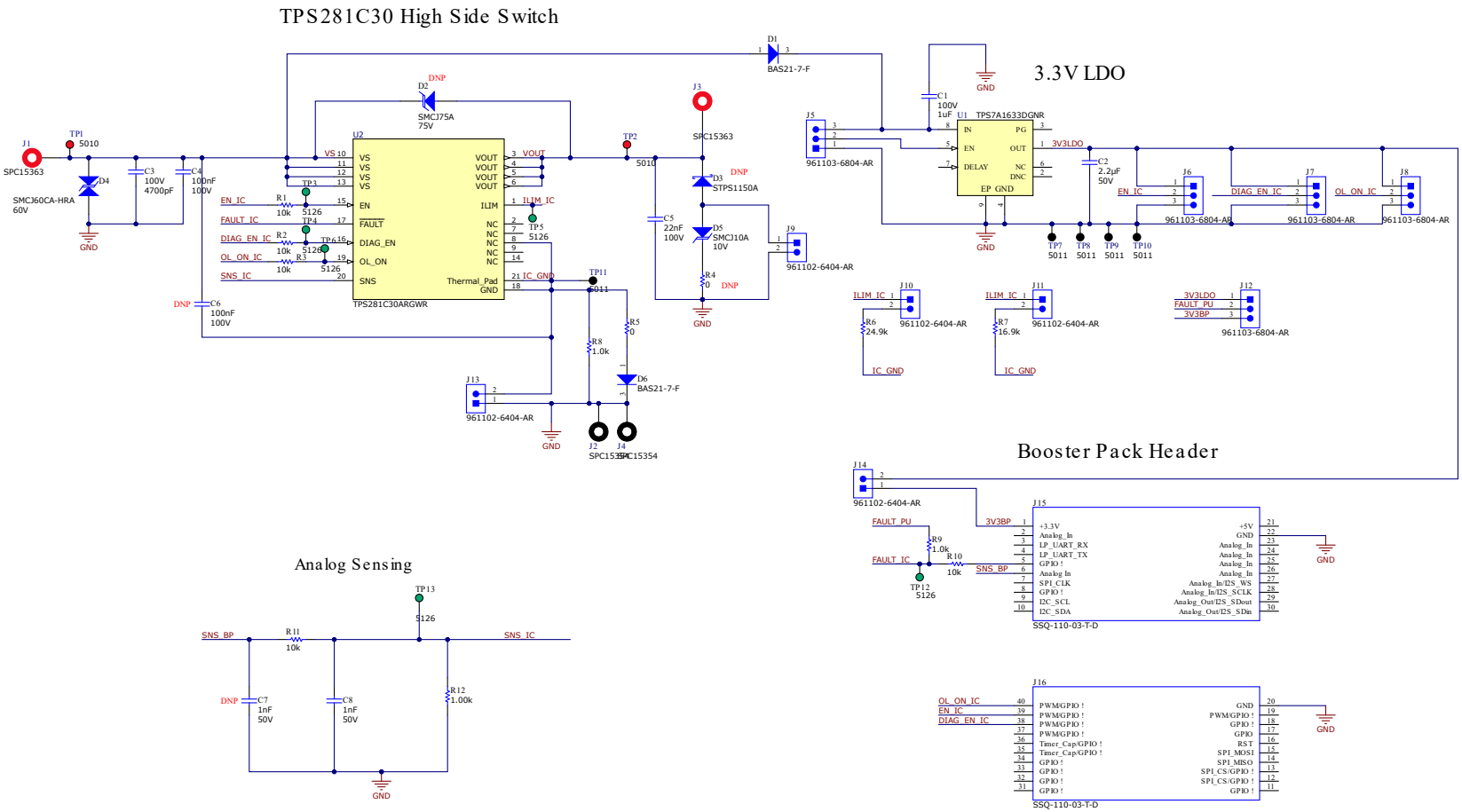

Figure 4-1. TPS281C30EVM Schematic Drawing

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
J1, TP1	Supply voltage VS
J3, TP2	Output voltage VOUT
J2, J4, TP7-TP10	System GND
TP3	ENABLE test point
TP4	DIAG_EN test point
TP5	ILIM test point
TP6	OL_ON test point
TP11	GND_IC test point
TP12	FAULT test point
TP13	SNS_IC test point

Table 5-2 shows the relevant configuration jumpers of the TPS281C30EVM as well as the associated values. Please refer to the TPS281C30 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
J5	Connect 1 and 2 to disable on-board LDO; connect 2 and 3 to enable on-board LDO.
J6	Connect 1 and 2 to pull ENABLE high; connect 2 and 3 to pull ENABLE low.
J7	Connect 1 and 2 to pull DIAG_EN high; connect 2 and 3 to pull DIAG_EN low.
J8	Connect 1 and 2 to pull OL_ON high; connect 2 and 3 to pull OL_ON low.
J9	Connect to keep output at 0 V during inductive turn-off; disconnect for TVS clamp to clamp the output (default to –10 V) during inductive turn-off.
J10	Connect the 24.9 kΩ resistor to ILIM pin. Resistor will be paralleled if J11 is also connected.
J11	Connect the 16.9 kΩ resistor to ILIM pin. Resistor will be paralleled if J11 is also connected.
J12	Connect 1 and 2 to use LDO for FAULT pullup; connect 2 and 3 to use BoosterPack plug-in module 3.3 V for FAULT pullup.
J13	Connect to bypass GND network. Disconnect to use GND network.
J14	Connect to power the BoosterPack plug-in module with LDO.

6 TPS281C30EVM Assembly Drawings and Layout

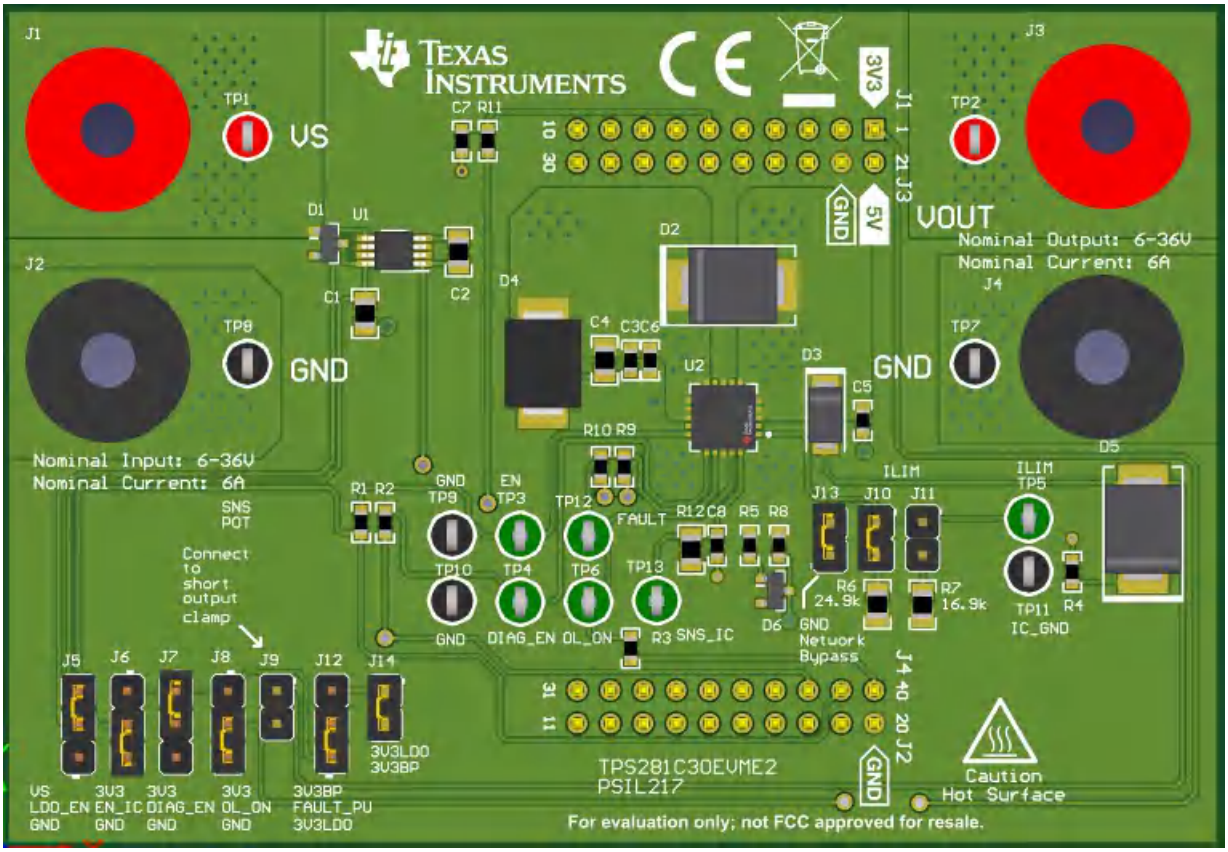

Figure 6-1. 3D Representation

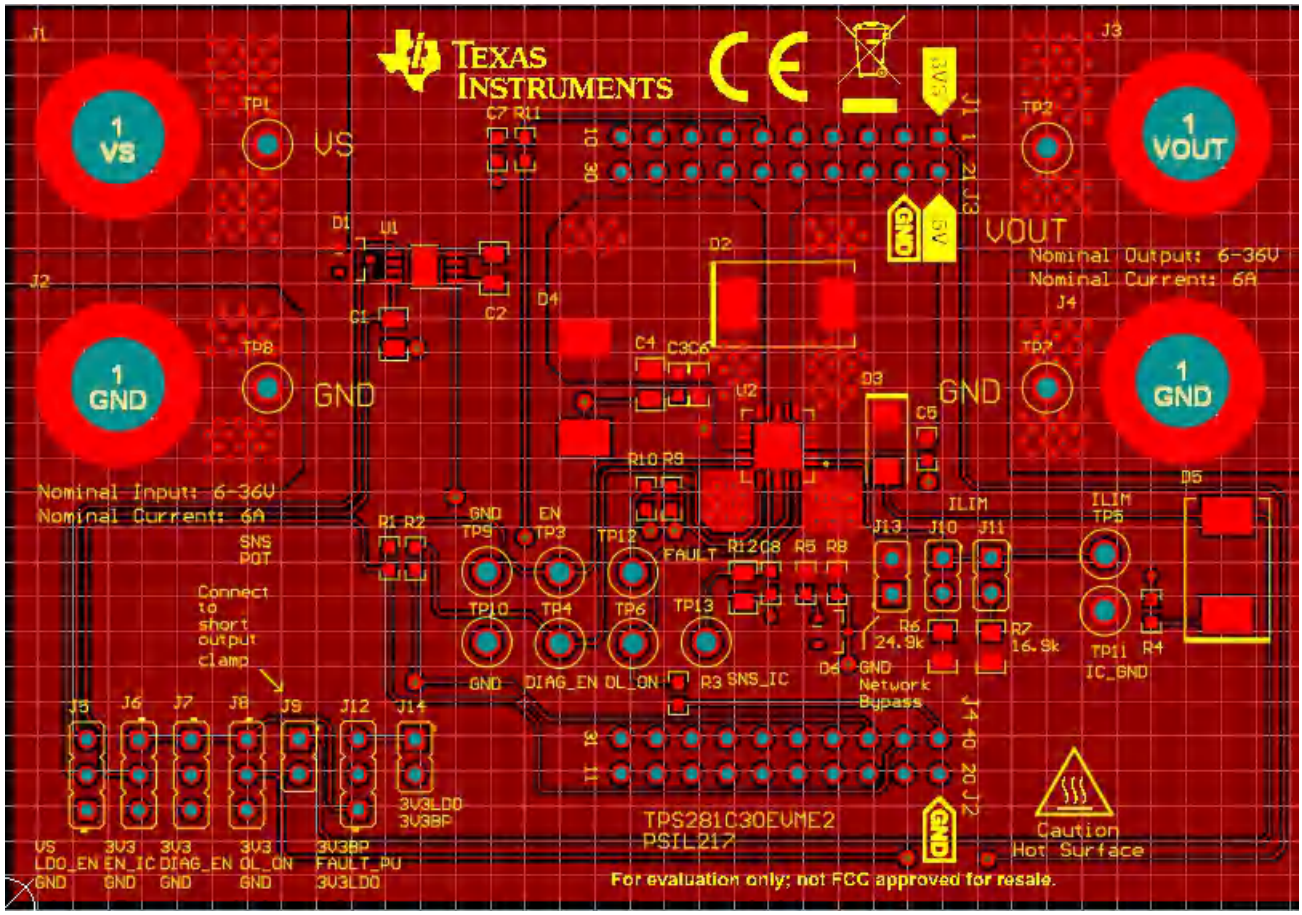

Figure 6-2. Top Layer

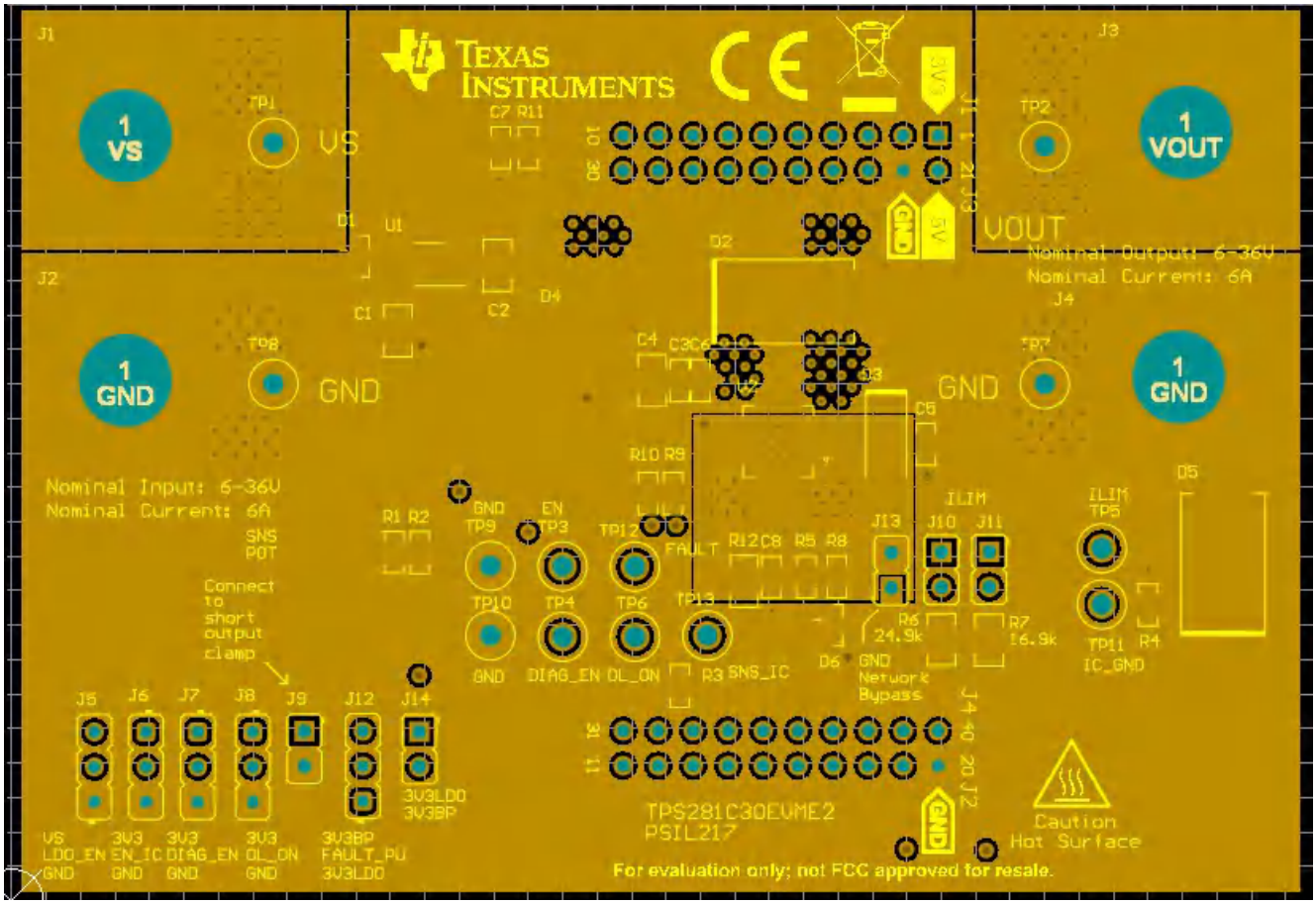

Figure 6-3. Ground Layer

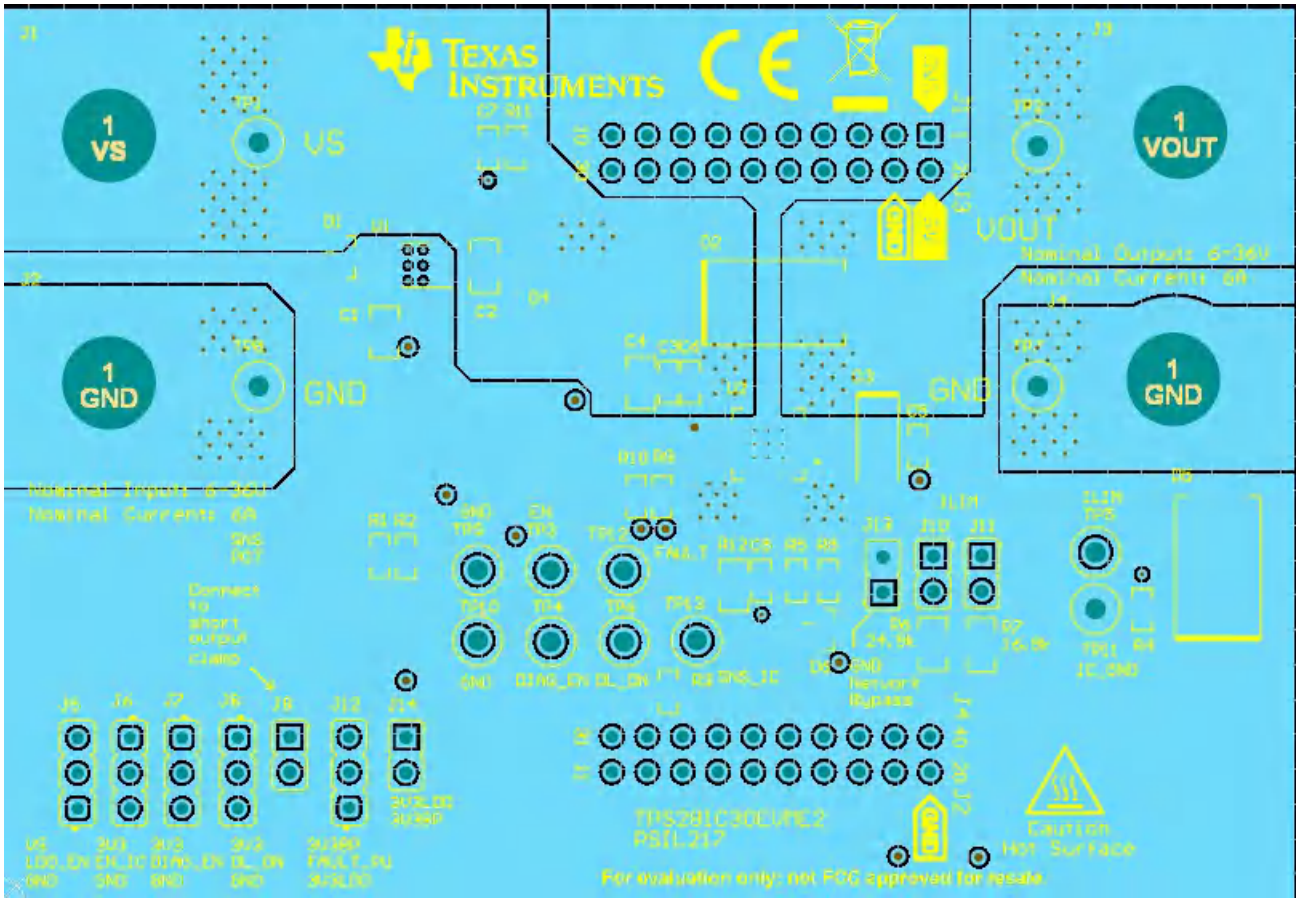

Figure 6-4. Power Layer

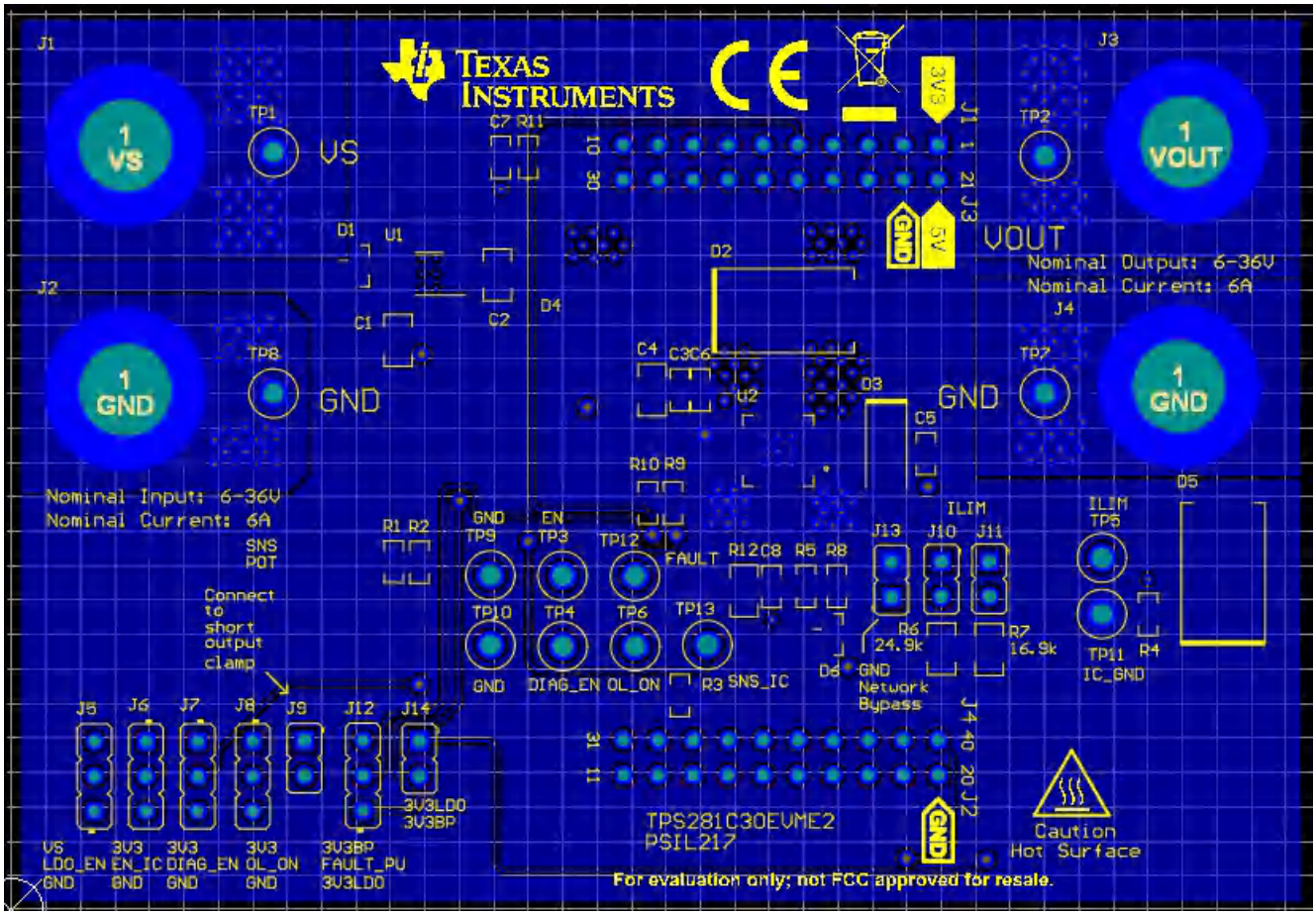

Figure 6-5. Bottom Layer

7 Bill of Materials

The table below lists the TPS281C30 Bill of Materials.

Table 7-1. TPS281C30 Bill of Materials

Designator	Description	PartNumber	Manufacturer
C1	Capacitor, ceramic, 1 µF, 100 V, +/- 10%, X7S, AEC-Q200 Grade 1, 0805	CGA4J3X7S2A105K125AB	TDK
C2	Capacitor, ceramic, 2.2 µF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	CGA4J3X7R1H225K125AB	TDK
C3	Capacitor, ceramic, 4700 pF, 100 V, +/- 5%, C0G/NP0, 0603	C0603C472J1GAC7867	Kemet
C4	Capacitor, ceramic, 0.1 µF, 100 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	CGA4J2X7R2A104K125AA	TDK
C5	Capacitor, ceramic, 0.022 µF, 100 V, +/- 10%, X7R, 0603	C1608X7R2A223K080AA	TDK
C8	Capacitor, ceramic, 1000 pF, 50 V, +/- 5%, X7R, AEC-Q200 Grade 1, 0603	C0603C102J5RACAUTO	Kemet
D1, D6	Diode, switching, 200 V, 0.2 A, SOT-23	BAS21-7-F	Diodes Inc.
D4	Diode, TVS, Bi, 60 V, 96.8 Vc, SMC, DO-214AB (no polarity)	SMCJ60CA-HRA	Littelfuse
D5	Diode, TVS, Uni, 10 V, SMC	SMCJ10A	Bourns
J1, J3	Insulated banana jack, solder lug, red, TH	SPC15363	Tenma
J2, J4	Insulated banana jack, solder lug, black, TH	SPC15354	Tenma
J5, J6, J7, J8, J12	Header, 2.54 mm, 3x1, gold, TH	961103-6804-AR	3M
J9, J10, J11, J13, J14	Header, 2.54 mm, 2x1, TH	961102-6404-AR	3M
J15, J16	Receptacle, 2.54 mm, 10x2, Tin, TH	SSQ-110-03-T-D	Samtec
R1, R2, R3, R10, R11	Resistor, 10 kΩ, 5%, 0.1 W, 0603	RC0603JR-0710KL	Yageo
R5	Resistor, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW06030000Z0EA	Vishay-Dale
R6	Resistor, 24.9 kΩ, 0.5%, 0.1 W, 0805	RR1220P-2492-D-M	Susumu Co Ltd
R7	Resistor, 16.9 kΩ, 0.5%, 0.1 W, 0805	RR1220P-1692-D-M	Susumu Co Ltd
R8, R9	Resistor, 1.0 kΩ, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	RCA06031K00JNEA	Vishay-Dale
R12	Resistor, 1.00 kΩ, 1%, 0.25 W, 0805	ERJ-P06F1001V	Panasonic
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G	Samtec
TP1, TP2	Test Point, Multipurpose, Red, TH	5010	Keystone
TP3, TP4, TP5, TP6, TP12, TP13	Test Point, Multipurpose, Green, TH	5126	Keystone
TP7, TP8, TP9, TP10, TP11	Test Point, Multipurpose, Black, TH	5011	Keystone
U1	Single Output LDO, 100 mA, Fixed 3.3 V Output, 3 to 60 V Input, with Enable and Power Good, 8-pin MSOP (DGN), -40 to 125 degC, Green (RoHS & no Sb/Br), DGN0008C	TPS7A1633DGNR	Texas Instruments
U2	60-V Tolerant, 30-mΩ, Single-Channel Smart High-Side Switch VQFN20	TPS281C30ARGWR	Texas Instruments

8 Revision History

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

Changes from Revision * (August 2022) to Revision A (December 2022)	Page
• First release of TPS281C30EVM user's manual	1
• Updated Figure 4-1	5
• Updated schematics for E2	5
• Updated Figure 6-1 through Figure 6-5	7
• Updated all plots for E2	7

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