TPS2H000-Q1 Evaluation Module (EVM)

The TPS2H000-Q1 evaluation module is designed to evaluate the TPS2H000-Q1 integrated circuit. This user's guide provides the connectors and test point descriptions, the schematic, bill of materials, and board layout of the EVM.

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1 Introduction

Texas Instruments' TPS2H000-Q1 evaluation module contains a TPS2H000-Q1 integrated circuit (IC), supporting dual-channel high-side switch application. The purpose of this EVM is to facilitate evaluation of the TPS2H000-Q1 for resistive, capacitive, and inductive load.

1.1 Descriptions

The TPS2H000-Q1 family is a fully protected dual-channel high-side power switch, with integrated NMOS power FET and charge pump.

Full diagnostics and highly accurate current sense features enable intelligent control of the load. The device diagnostic reporting has two versions to support both digital status output and analog current sense. The diagnostics can be disabled for multiplexing the sense pin between different devices. Thermal shutdown behaviors such as latch off or auto-retry are internally fixed in the part.

The externally-adjustable current limit improves the reliability of the whole system by limiting the inrush or overload current.

1.2 Applications

The EVM is used in the following applications:

1. Multi-channel LED drivers
2. Multi-channel high-side power switches
3. Multi-channel high-side relay drivers

1.3 Features

The EVM has the following features:

1. Operating voltage: 3.4–40 V
2. Operating junction temperature: –40 to 150°C
3. Highly accurate current sense
4. Adjustable current limit with external resistor
5. Multiplex high accuracy current sense or ST report
6. Tested according to AECQ100-12

2 TPS2H000-Q1 Schematic

Figure 1 and Figure 2 illustrate the EVM schematic.

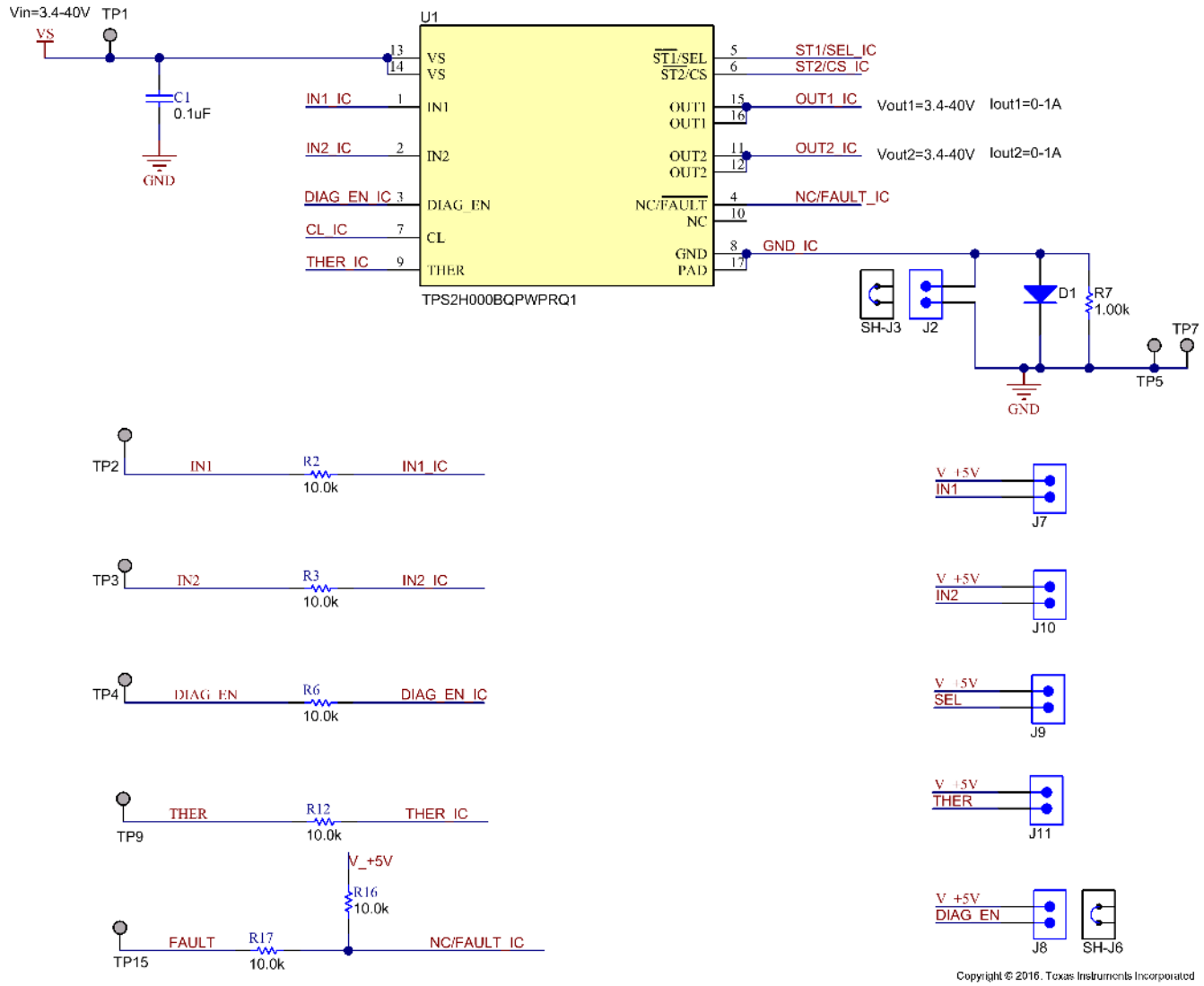

Figure 1. TPS2H000-Q1EVM Schematic 1

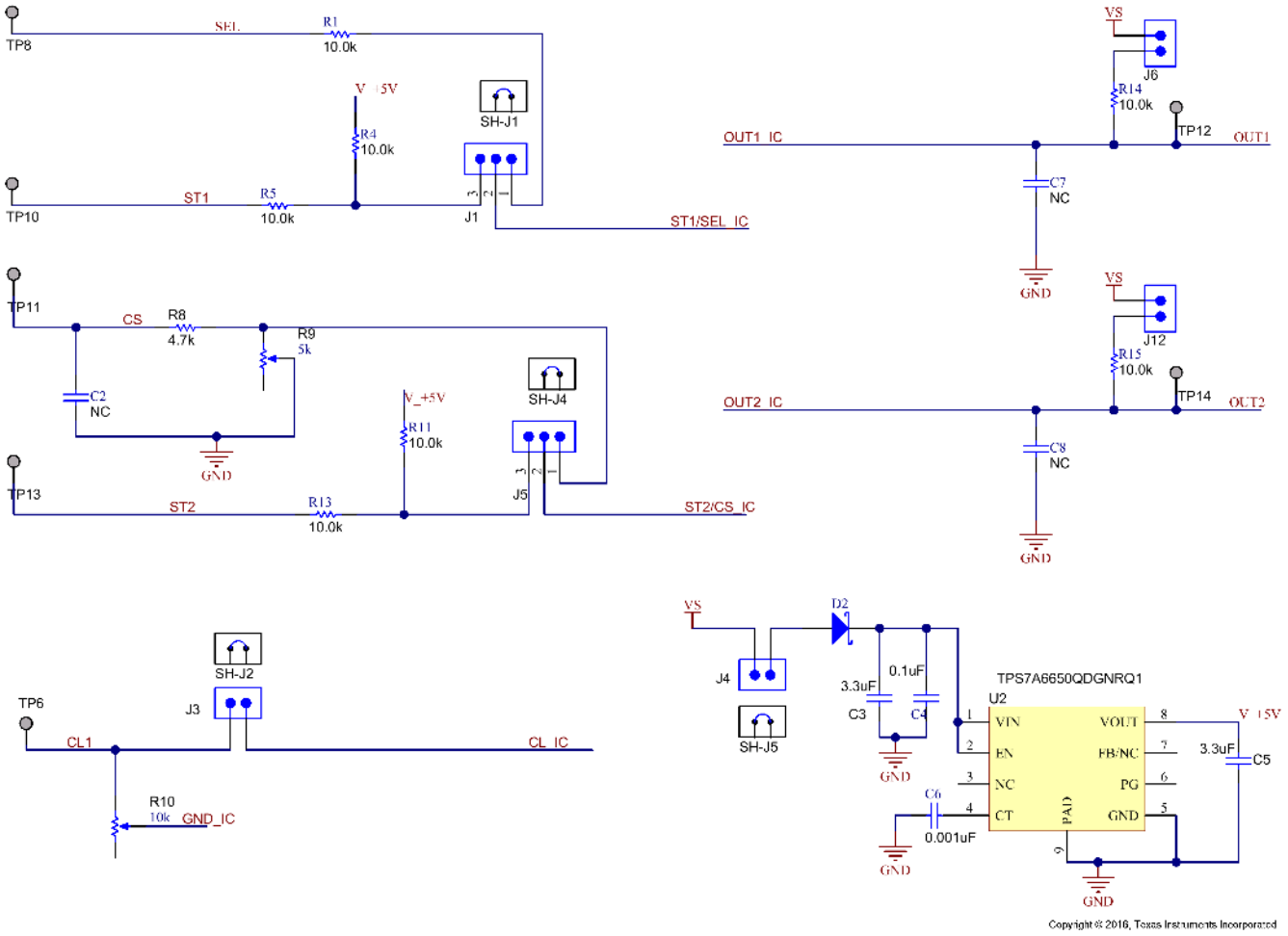

Figure 2. TPS2H000-Q1EVM Schematic 2

3 Connections Descriptions

Table 1 lists and describes the connectors.

Table 1. Connectors

Connector	Description
VS	The board positive input supply voltage connector, the drain terminal of DMOS.
GND	The board GND connector, the return connection to the input power supply.
IN1	The board input connector, controls CH1 output. 3.3-V or 5-V control signal connection pin.
IN2	The board input connector, controls CH2 output. 3.3-V or 5-V control signal connection pin.
OUT1	CH1 output pin connector, the source terminal of DMOS.
OUT2	CH2 output pin connector, the source terminal of DMOS.
ST1	CH1 status output connector, only works with version A.
ST2	CH2 status output connector, only works with version A.
SEL	The channel selection connector, used to select which channel the CS pin sense is for, only effective for version B.
FAULT	The board state report connector, only works with version B, can get the OR value for the fault of 2CH.
CS	The board current sense output connector, only works with version B.
CL	The board current limit output connector.
DIAG_EN	The board DIAG_EN input connector, 3.3-V or 5-V control signal connection pin.
THER	The thermal shutdown behavior control connector.

Table 2 lists and describes the jumpers.

Table 2. Jumpers

Jumper	Description
J1	This jumper is used to select the SEL/ST1 functions, version A short pin 2 and pin 3, version B short pin 2 and pin 1.
J2	This jumper is used to short IC GND and board GND. When floating, there will be a diode in parallel with a resistor between IC GND and board GND, which is designed for the reverse polarity protection.
J3	This jumper is used to isolate CL_IC from CL.
J4	This jumper is used to set a power supply for LDO when connected, for easy test use.
J5	This jumper is used to select the CS/ST2 functions, version A short pin 2 and pin 3, version B short pin 2 and pin 1.
J6	This jumper is used to set a pullup for OUT1, if off-state open load/ short to battery are required.
J7	When floating, IN1 is controlled by outsource. When connected, IN1 is pulled up to version, for easy test use.
J8	When floating, DIAG_EN is controlled by outsource. When connected, DIAG_EN is pulled up to version, for easy test use.
J9	When floating, SEL is controlled by outsource. When connected, SEL is pulled up to version, for easy test use.
J10	When floating, IN2 is controlled by outsource. When connected, IN2 is pulled up to version, for easy test use.
J11	When floating, THER is controlled by outsource. When connected, THER is pulled up to version, for easy test use.
J12	This jumper is used to set a pullup for OUT2, if off-state open load/ short to battery are required.

4 TPS2H000-Q1 EVM Assembly Drawings and Layout

Figure 3 through Figure 6 show the design of the TPS2H000-Q1 printed-circuit board (PCB). The EVM has been designed using FR4 material, four-layer (2s2p), 2-µm × 70-µm Cu in the top and bottom layers, and 2-µm × 35-µm Cu in internal plane layers. All components are in an active area on the top side and all active traces connect to the top and bottom layers allowing easy viewing, probing, and evaluation. Moving components to both sides of the PCB can offer additional size reduction for space-constrained systems.

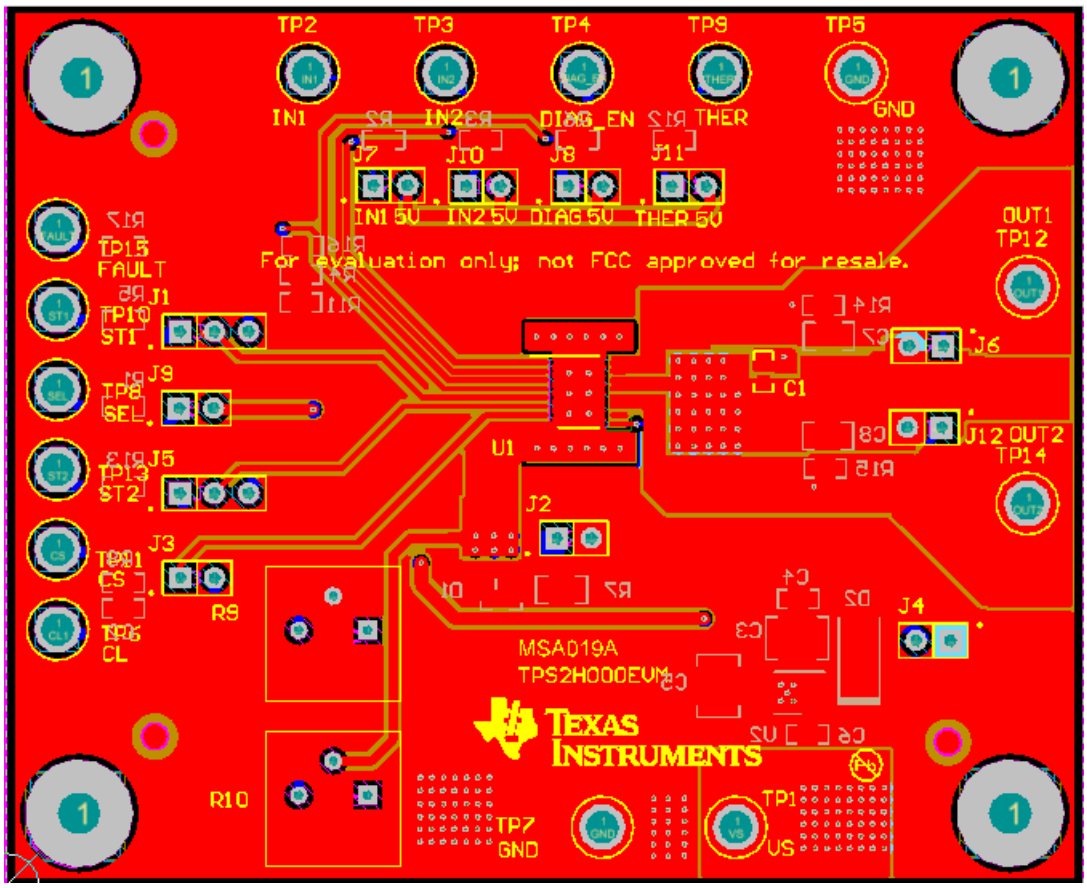

Figure 3. TPS2H000-Q1EVM First Layer (Top View)

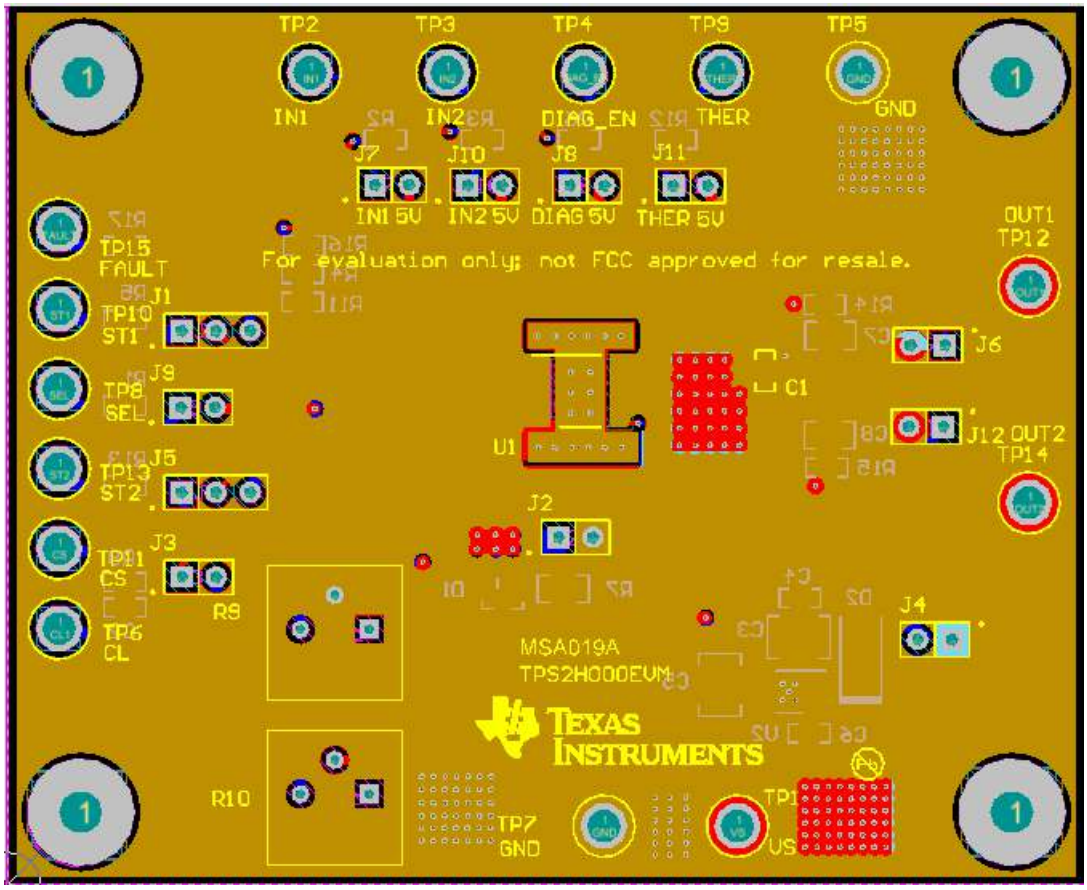

Figure 4. TPS2H000-Q1EVM Second Layer GND (Top View)

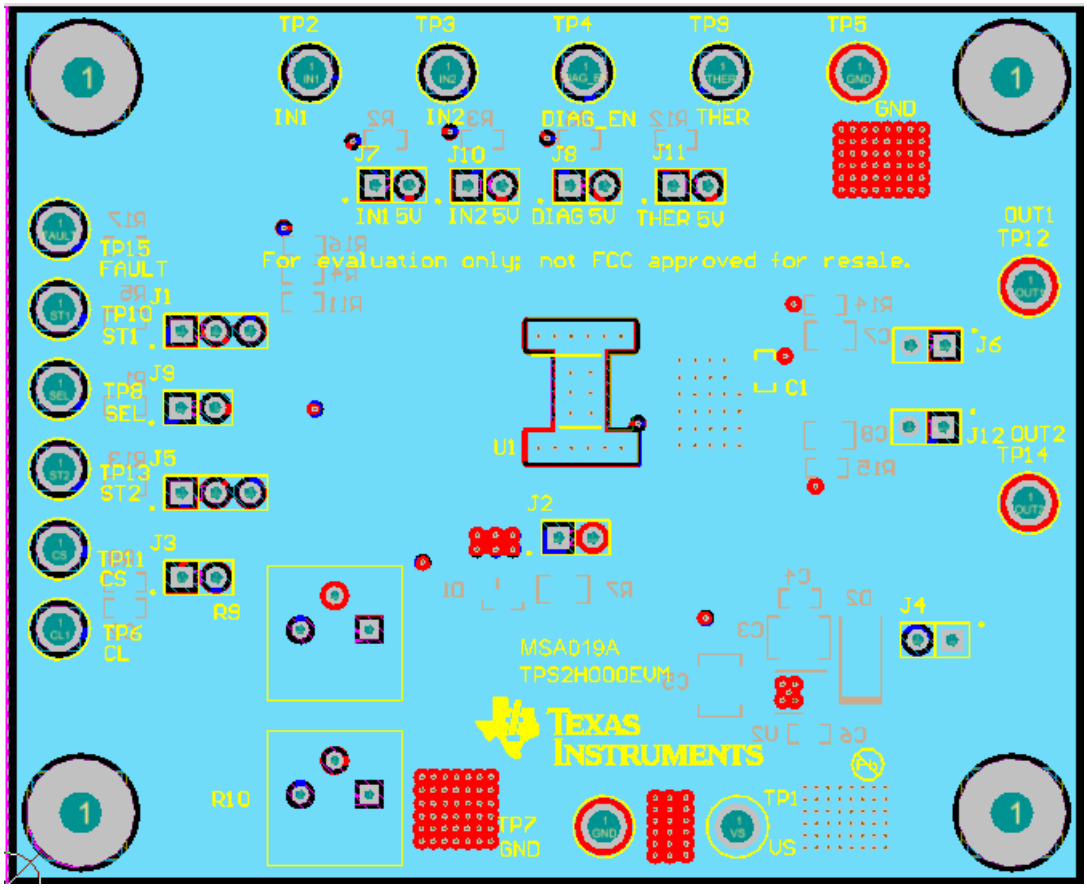

Figure 5. TPS2H000-Q1EVM Third Layer VCC (Top View)

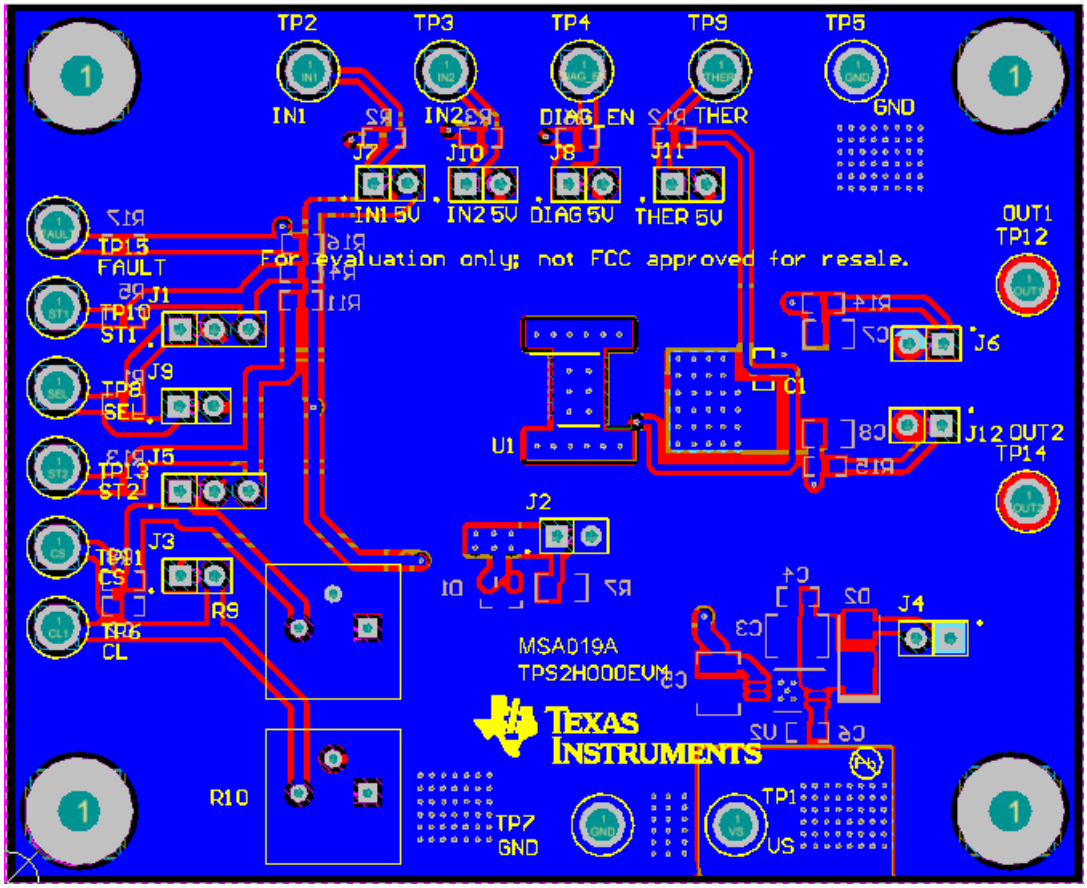

Figure 6. TPS2H000-Q1EVM Fourth Layer (Top View)

5 Variable Resistor for CS and CL

5.1 Current Sense Resistor

For version B, highly accurate current sensing allows for better real-time monitoring and more accurate diagnostics, without further calibration. It provides realtime output current monitoring. A current mirror is used to source 1/K of the load current, and is reflected as $V_{CS} = I_{CS} \times R_{CS}$. Please ensure the CS voltage is in the linear region (0 V–4 V) when in normal operation.

Also, when a fault condition occurs, current sensing works as a diagnostic report pin. When an open load or short to the battery happens in on-state, V_{CS} almost equals to zero. When a current limit, thermal shutdown/swing, open load or short to battery occurs in off-state, the voltage is clamped at $V_{CS,H}$.

$$R_{CS} = \frac{V_{CS}}{I_{CS}} = \frac{V_{CS} \times K_{CS}}{I_{out}} \quad (1)$$

R9 is a variable resistor, from 0 Ω to 5 kΩ (clockwise direction to minimum, counter-clockwise direction to the maximum). The CS resistor can be changed through R9.

5.2 Current Limit Resistor

An external resistor is used to convert a proportional load current into a voltage, which is compared with an internal reference voltage. When the voltage on the CL pin exceeds the reference voltage, the current is clamped.

The inherent current limit is still present when using an external current limit. The smaller one of the internal or external set values will decide the actual nominal current limit. When not using an externally adjustable current, tie the CL pin to ground.

Equation 2 is an example of setting the current limit at 0.5 A.

$$I_{CL} = \frac{V_{CL,th}}{R_{CL}} = \frac{I_{out}}{K_{CL}}$$

$$R_{CL} = \frac{V_{CL,th} \times K_{CL}}{I_{out}} \quad (2)$$

R10 is a variable resistor, from 0 Ω to 10 kΩ (clockwise direction to minimum, counter-clockwise direction to the maximum). The CL resistor can be changed through R10. When 0 Ω, there is no external current limit function, internal current limit will be active.

6 Bill of Materials

Table 3 lists the TPS2H000-Q1 BOM.

Table 3. TPS2H000-Q1 Bill of Materials

Designator	Comment	Description	Footprint	Qty
C1, C2, C4	GRM188R71H104KA93D	CAP, CERM, 0.1uF, 50V, +/-10%, X7R, 0603	0603	3
C7, C8	08051C103JAT2A	NC	0805_HV	2
C3, C5	C3225X7R1H335M	CAP, CERM, 3.3uF, 50V, +/-20%, X7R, 1210	1210	2
C6	06035A102KAT2A	CAP, CERM, 1000pF, 50V, +/-10%, C0G/NP0, 0603	0603	1
'TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15	Suggest using a net name here	Terminal, Turret, TH, Double	Keystone1502-2	15
D1	BAS21-7-F	Diode, Switching, 200V, 0.2A, SOT-23	SOT-23	1
D2	B150-13-F	Diode, Schottky, 50V, 1A, SMA	SMA	1
FID1, FID2, FID3	Fiducial	Fiducial mark. There is nothing to buy or mount.	Fiducial10-20	0
H1, H2, H3, H4	NY PMS 440 0025 PH	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	4
H5, H6, H7, H8	1902C	Standoff, Hex, 0.5"L #4-40 Nylon	Keystone_1902C	4
J2, J3, J4, J6, J7, J8, J9, J10, J11, J12	TSW-102-07-G-S	Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	10
J1, J5	TSW-103-07-G-S	Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	TSW-103-07-G-S	2
R1, R2, R3, R4, R5, R6, R11, R12, R13, R14, R15, R16, R17	CRCW060310K0FKEA	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	13
R10	3386P-1-103LF	TRIMMER, 10k ohm, 0.5W, TH	BOURNS_3386P	1
R7	CRCW08051K00FKEA	RES, 1.00k ohm, 1%, 0.125W, 0805	0805_HV	1
R8	CRCW06034K70JNEA	RES, 4.7k ohm, 5%, 0.1W, 0603	0603	1
R9	3386P-1-502LF	TRIMMER, 5k ohm, 0.5W, TH	BOURNS_3386P	1
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6	969102-0000-DA	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G	6
U1	TPS4H000AQPWPRQ1	40 V/1000 mohm Quad Channels Smart High Side Power Switch, PWP0020N	PWP0020N	1
U2	TPS7A6650QDGNRQ1	High-Voltage Ultralow-Iq Low-Dropout Regulator, DGN0008D	DGN0008D	1

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      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

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3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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