Texas Instruments

User's Guide
SLVUAS9–August 2016

TPS2H160-Q1 Evaluation Module (EVM)

The TPS2H160-Q1 evaluation module is designed to evaluate the TPS2H160-Q1 integrated circuit. This user's guide provides the connectors and test point description, the schematic, bill of materials, and board layout of the EVM.

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1 Introduction

Texas Instruments' TPS2H160-Q1 evaluation module contains a TPS2H160-Q1 integrated circuit (IC), supporting dual-channel high-side switch application. The purpose of this EVM is to facilitate evaluation of the TPS2H160-Q1 for resistive, capacitive, and inductive load.

1.1 Descriptions

The TPS2H160-Q1 family is a fully protected dual-channel high-side power switch, with integrated NMOS power FET and charge pump.

Full diagnostics and high-accuracy 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 reports. The diagnostics can be disabled for multiplexing the sense pin between different devices. Thermal shutdown behaviors as latch off or auto-retry are internally fixed in the part.

External programmable current limit improves the reliability of the system by limiting the inrush or overload current.

1.2 Applications

The device can be used in the following applications:

- Multi-channel LED drivers, bulb drivers
- Multi-channel high-side power switches
- Multi-channel high-side relay drivers

1.3 Features

This EVM supports the following features:

- Operating voltage of 3.4–40 V
- Operating junction temperature: –40°C to 150°C
- Highly accurate current sense
- Adjustable current limit with external resistor
- Multiplex high accuracy current sense or ST report
- Tested according to AECQ100-12
- Certification of ISO7637-2 and ISO16750-2

2 TPS2H160-Q1 Schematic

Figure 1 illustrates the EVM schematic.

Vin range 4-40V. Vout range <=40V. Iout range <=2.5A.

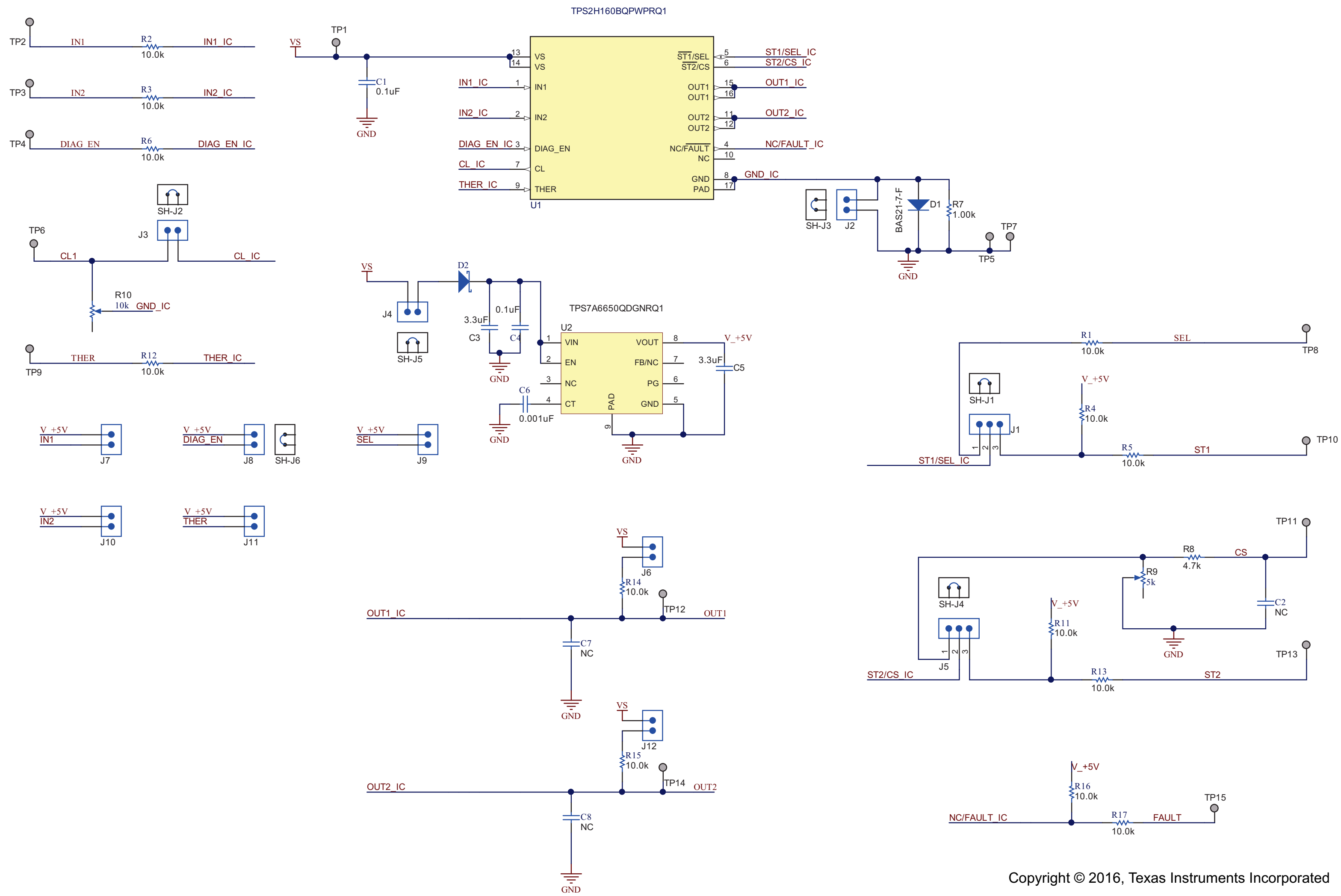

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Figure 1. TPS2H160-Q1EVM Schematic

3 Connection Descriptions

3.1 Connectors

Table 1 lists the connectors and their descriptions.

Table 1. Connector Descriptions

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

3.2 Jumpers

Table 2 lists the jumpers and their descriptions.

Table 2. Jumper Descriptions

Jumper	Description
J1	Selects SEL/ST1 functions, version A short pin 2 and pin 3, version B short pin 2 and pin 1
J2	Shorts 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.
J3	Isolates CL_IC from CL
J4	Sets a power supply for LDO when connected, for easy-test usage
J5	Selects CS/ST2 functions, version A short pin 2 and pin 3, version B short pin 2 and pin 1
J6	Sets a pullup for OUT1, if off-state, an open load/ short to battery are required
J7	When floating, IN1 is controlled by outsource. When connected, IN1 is pulled up to 5 V, for easy-test usage.
J8	When floating, DIAG_EN is controlled by outsource. When connected, DIAG_EN is pulled up to 5 V, for easy-test usage.
J9	When floating, SEL is controlled by outsource. When connected, SEL is pulled up to 5 V, for easy-test usage.
J10	When floating, IN2 is controlled by outsource. When connected, IN2 is pulled up to 5 V, for easy-test usage.
J11	When floating, THER is controlled by outsource. When connected, THER is pulled up to 5 V, for easy-test usage.
J12	Sets a pullup for OUT1, if off-state, open load/ short to battery are required

4 TPS2H160-Q1 EVM Assembly Drawings and Layout

Figure 2 through Figure 5 show the design of the TPS2H160-Q1 printed-circuit board (PCB). The EVM has been designed using FR4 material, four-layer (2s2p), 2 × 70 µm, Cu in top and bottom layers, and 2 × 35 µm, Cu in internal plane layers. With all components in an active area on the top side and all active traces to the top and bottom layers to allow the user to easily view, probe, and evaluate. Moving components to both sides of the PCB can offer additional size reduction for space-constrained systems.

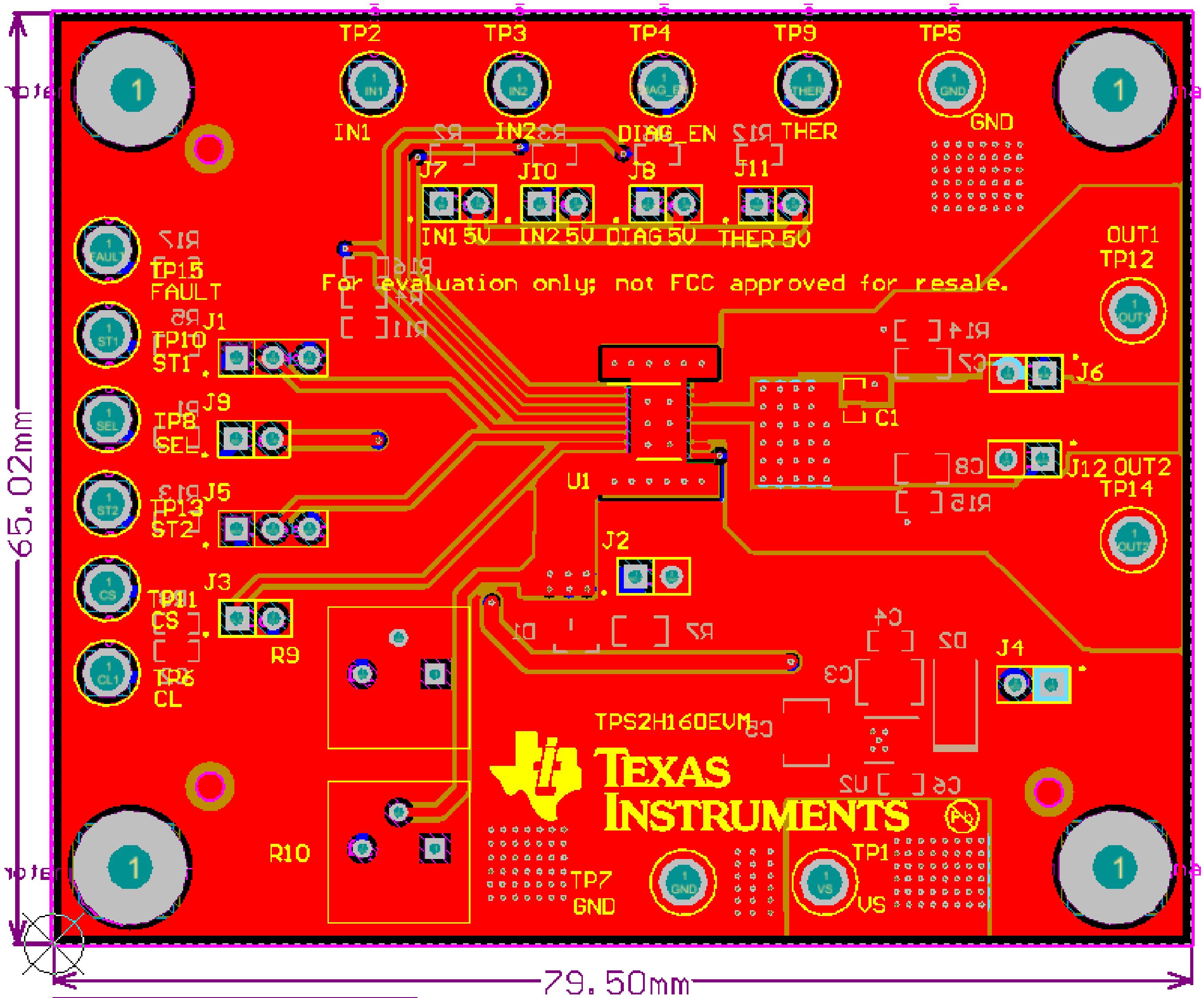

Figure 2. TPS2H160-Q1EVM First Layer (Top View)

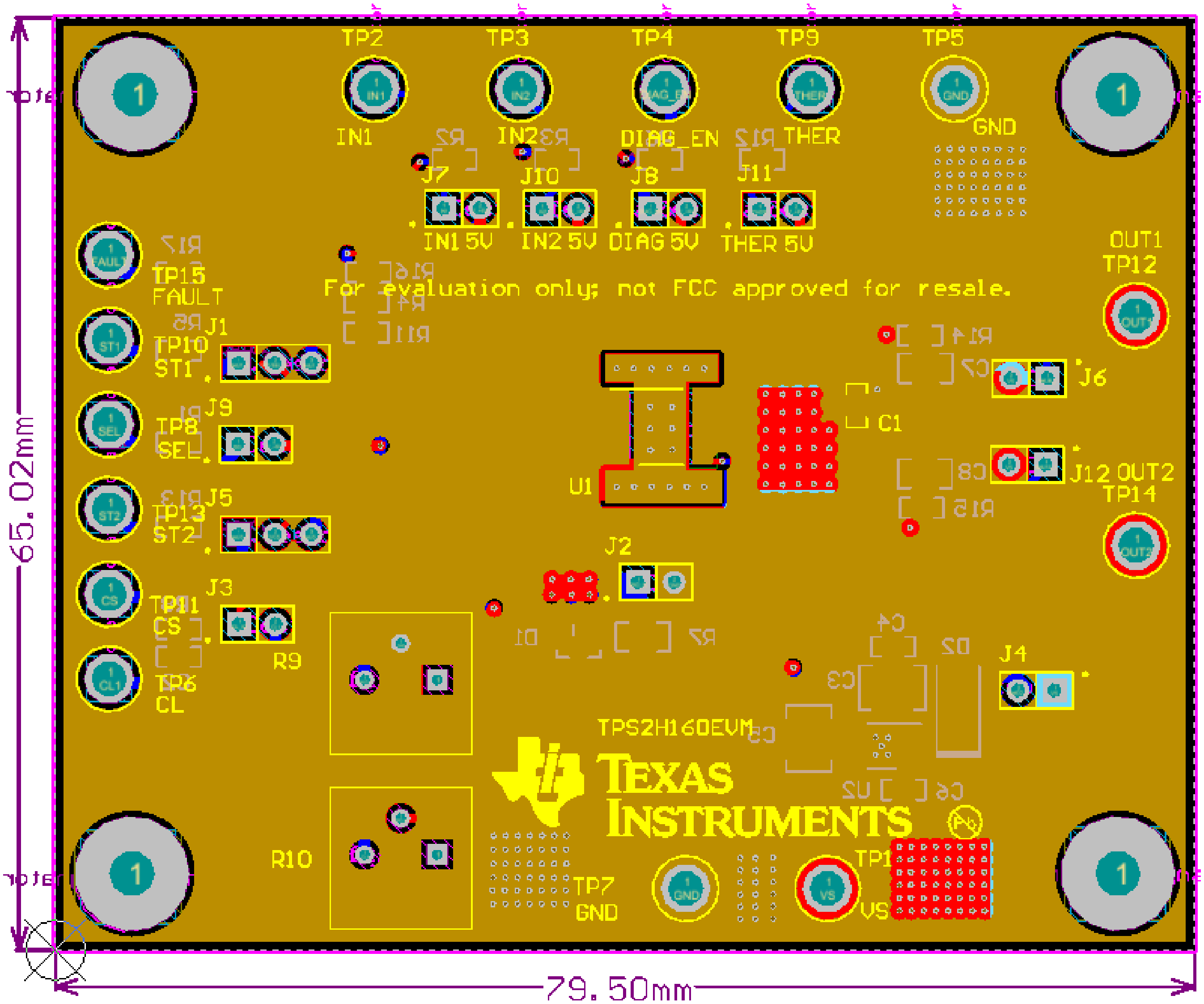

Figure 3. TPS2H160-Q1EVM Second Layer GND (Top View)

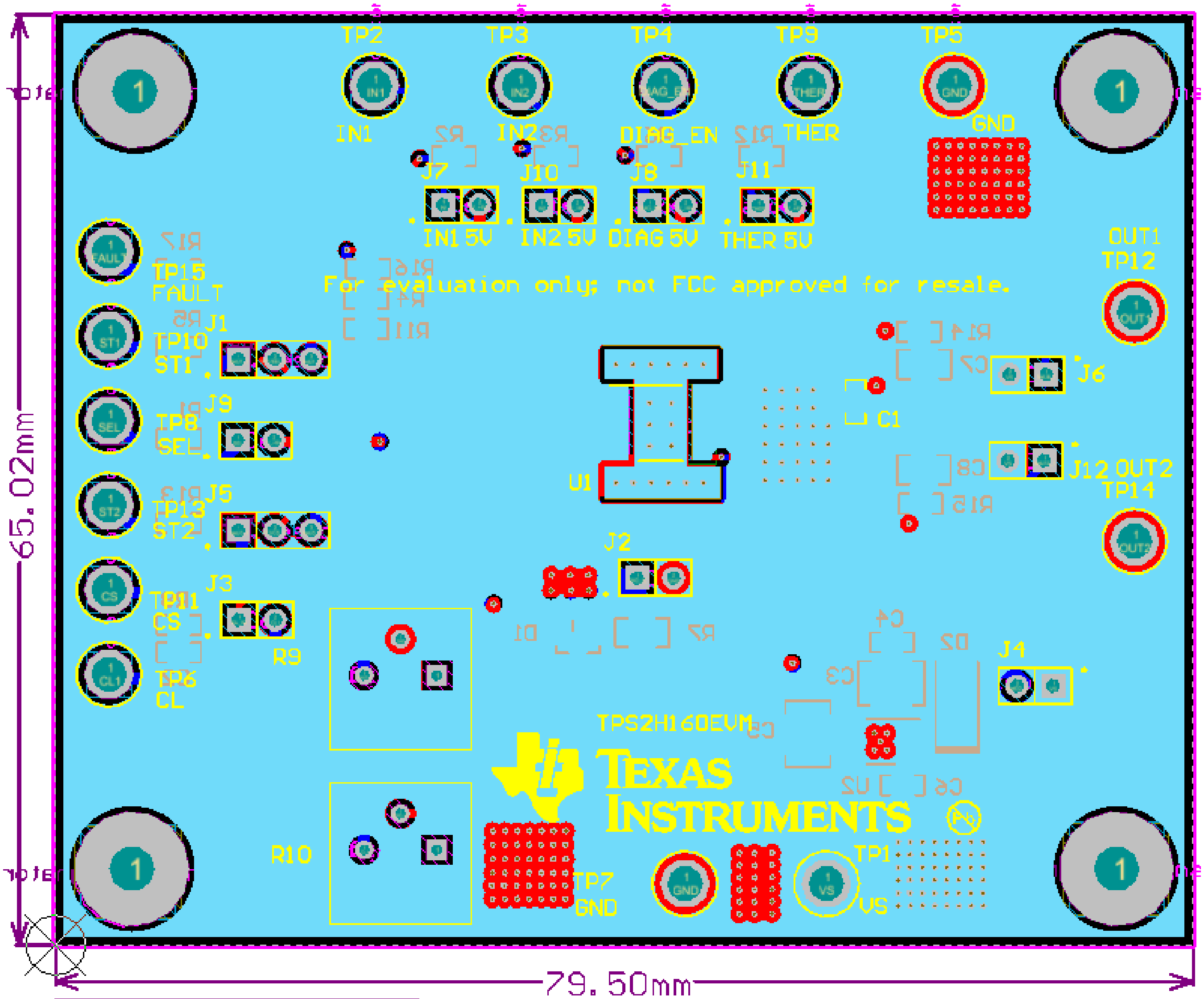

Figure 4. TPS2H160-Q1EVM Third Layer VCC (Top View)

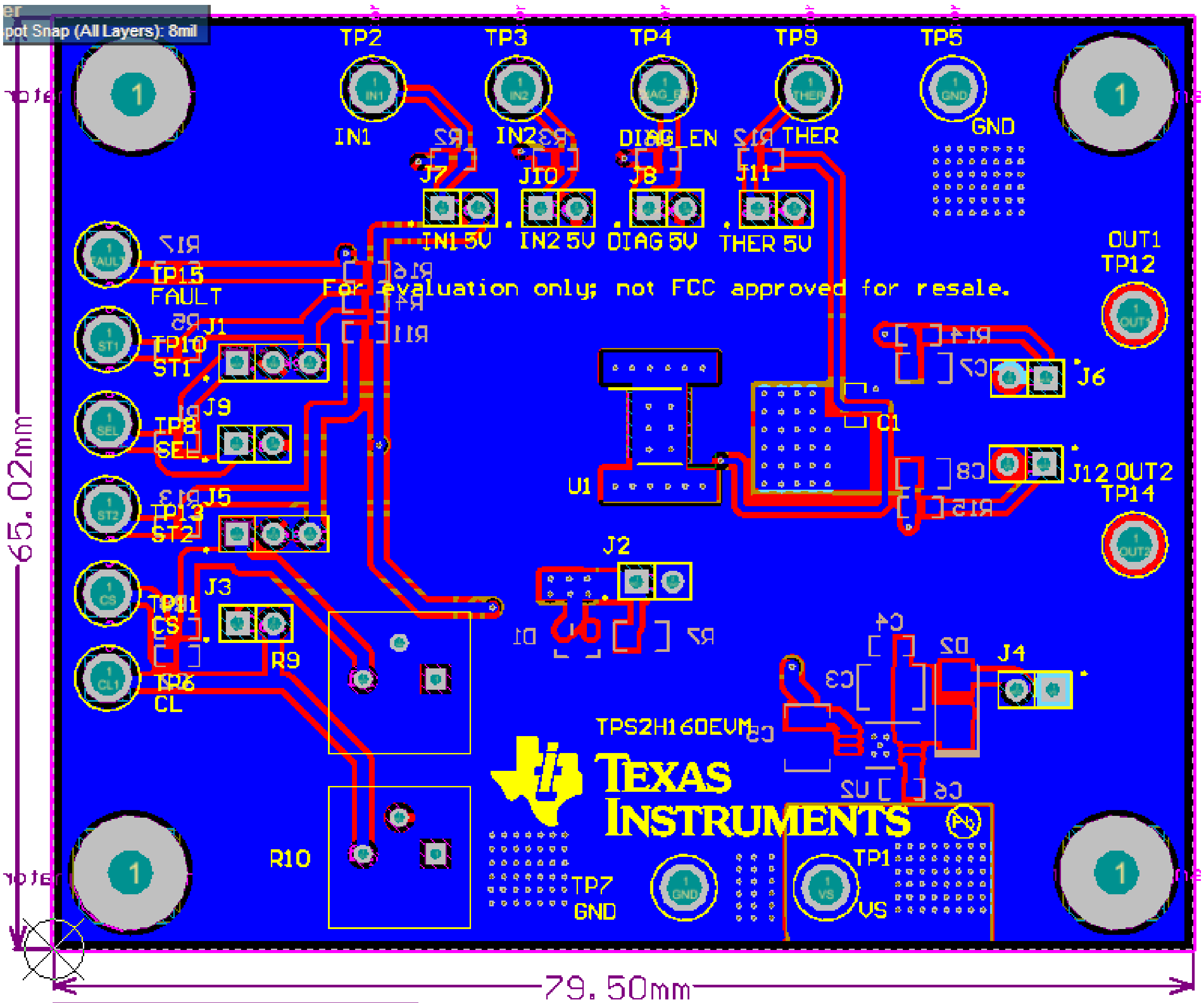

Figure 5. TPS2H160-Q1EVM Fourth Layer (Top View)

5 Variable Resistor for CS and CL

5.1 Current Sense Resistor

For version B, high-accuracy current-sensing allows better real-time monitoring effect and more accurate diagnostics without further calibration.

It provides real-time output current monitoring. A current mirror is used to source 1/K of the load current, and reflected as $V_{CS} = I_{CS} \times R_{CS}$. Ensure the CS voltage is in the linear region (0–4 V) when in normal operation.

Also, when a fault condition occurs, it will work as a diagnostics report pin. When open load/ short to battery happen in on-state, V_{CS} almost equals to zero. When current limit, thermal shutdown or thermal swing, open load/ short to battery in off-state happen, the voltage will be clamped at V_{CS},H.

$$R_{CS} = \frac{V_{CS}}{I_{CS}} = \frac{V_{CS} \times K_{CS}}{I_{OUT}} \tag{1}$$

R25 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 (Ilim,nom) is still present when using an external current limit. The smaller of the internal or external set value will decide the actual nominal current limit. If the decision is made to not use external programmable current, the CL pin should be tied to ground.

Equation 2 is an example of setting the current limit at 5 A.

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

$$R_{CL} = \frac{V_{CL,th} \times K_{CL}}{I_{OUT}} \tag{2}$$

R8 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; therefore, the internal current limit will be active.

6 Bill of Materials

Table 3 lists the EVM BOM.

Table 3. Bill of Materials

Designator	Comment	Description	Footprint	Quantity
C1, C2, C4	GRM188R71H104KA93D	CAP, CERM, 0.1uF, 50V, +/-10%, X7R, 0603	0603	3
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
C7, C8	08051C103JAT2A	NC	0805_HV	2
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	3
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
J1, J5	TSW-103-07-G-S	Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	TSW-103-07-G-S	2
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
R1, R2, R3, R4, R5, R6, R11, R12, R13, R14, R15, R16, R17	CRCW060310K0FKEA	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	13
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
R10	3386P-1-103LF	TRIMMER, 10k 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
TP1, TP2, TP3, TP4, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15	Suggest using a net name here	Terminal, Turret, TH, Double	Keystone1502-2	14
TP5	GND	Terminal, Turret, TH, Double	Keystone1502-2	1
U1	TPS2H160BQPWPRQ1	40 V/140 mohm Dual Channels Smart High Side Power Switch, PWP0016J	PWP0016J_N	1
U2	TPS7A6650QDGNRQ1	High-Voltage Ultralow-Iq Low-Dropout Regulator, DGN0008D	DGN0008D_N	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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