

High Side Switch Motherboard Evaluation Module



ABSTRACT

The HSS-MOTHERBOARDEVM evaluation module is designed to evaluate the < 50-mΩ Ron devices in TI's high side switch portfolio. These devices include TPS27SA08, TPS1HA08-Q1, TPS2HB08-Q1, TPS2HB16-Q1, TPS2HB35-Q1, and TPS2HB50-Q1. This board does not come with the devices populated but allows any of the devices to be soldered down on the sample daughter card and used in the main motherboard. This user's guide provides the connectors and test point description, schematic, bill of materials (BOM), and board layout of the EVM.

Note

This EVM does **NOT** come with devices populated on the board. The user **MUST** order samples separately.

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1 Introduction

Texas Instruments' HSS-MOTHERBOARD EVM evaluation module has a central socket for the supporting daughtercard with the high side switch device to be populated. The EVM supports the entire single-channel and dual channel low Ron ($\leq 50\text{-m}\Omega$) high-side driver applications. The purpose of this EVM is to facilitate evaluation of the low Ron high side switches for the diagnostic features and drive resistive, capacitive, and inductive loads.

The EVM is a combination of a central motherboard and a row of daughterboards. The mother board has all connectors, jumpers, and test points. The daughter board has different footprints to support the low Ron family of TI's high side switch portfolio. The daughter board also has limiting resistors for the channel devices (TPS2HBxx-Q1) and since the 1 channel device (TPS1HA08-Q1) has a NC pin in that location the daughtercards will work for all of the devices.

The daughterboards have 2 different footprints: 24-pin PWP and 16-pin PWP. For installation, a single board from the panel has to be broken, a device soldered down onto the main footprint, and connected to the motherboard.

Note

Caution must be taken when soldering down the device as the main power pad on the back needs to be soldered correctly as to not affect performance. Please see [PowerPAD Thermally Enhanced Package](#) app note for more details about the solder profile and techniques.

The current-limiting resistors are on the bottom side of the daughterboard. They are all 10-k Ω , 0805 package. For the desired current limit value, the resistor can be replaced with different value. Also for the single channel devices the second resistor should be depopulated.

The jumpers are not installed. Refer to [Table 3-1](#) and [Table 3-2](#) for installation.

1.1 Descriptions

The Texas Instruments HSS-MOTHERBOARD EVM helps designers evaluate the operation and performance of the TPS27SA08, TPS1HA08-Q1, TPS2HB08-Q1, TPS2HB16-Q1, TPS2HB35-Q1 and TPS2HB50-Q1 devices.

These devices are fully-protected high-side switches, with an 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 supports load current status and device temperature on an analog sense output pin SNS. The SNS pin sources a current proportional to the selected parameter. By adding a pulldown resistor on the SNS pin, the developed voltage is proportional to the selected parameter as well. The diagnostics can be disabled for multiplexing the sense pin between different devices.

1.2 Applications

The EVM is used in the following applications:

- High-side relay drivers
- High-side power switch for submodule power supply
- Bulb driver
- General resistive, inductive, and capacitive loads
- Replace electromechanical relays and fuses

1.3 Features

The EVM supports the following features:

- Single or Dual-channel high-side power switches, tested according to AECQ100-12
- Operating voltage 3 V to 18V
- Operating temperature: -40°C to 125°C
- Microcontroller input control: 3.3-V and 5-V logic compatible
- High-accuracy current sense
 - Analog current sense as a ratio of the load current or device temperature
- Protection:
 - Reverse battery protection with external ground network
 - Short-circuit protection
 - Overvoltage protection
 - Thermal shutdown and thermal swing with self-recovery
 - ESD protection
- Diagnostic:
 - On and off state output open or short to battery detection
 - Overload and short-to-ground detection and power limiting
 - Thermal shutdown and thermal swing diagnostic
 - Immediate shutdown or continuous clamping during fault current condition
 - Diagnostic enable function for multiplexing of MCU analog or digital port

2 HSS-MOTHERBOARD EVM Schematic

[Figure 2-1](#) and [Figure 2-2](#) illustrate the HSS-MOTHERBOARD EVM motherboard and daughterboard schematics, respectively.

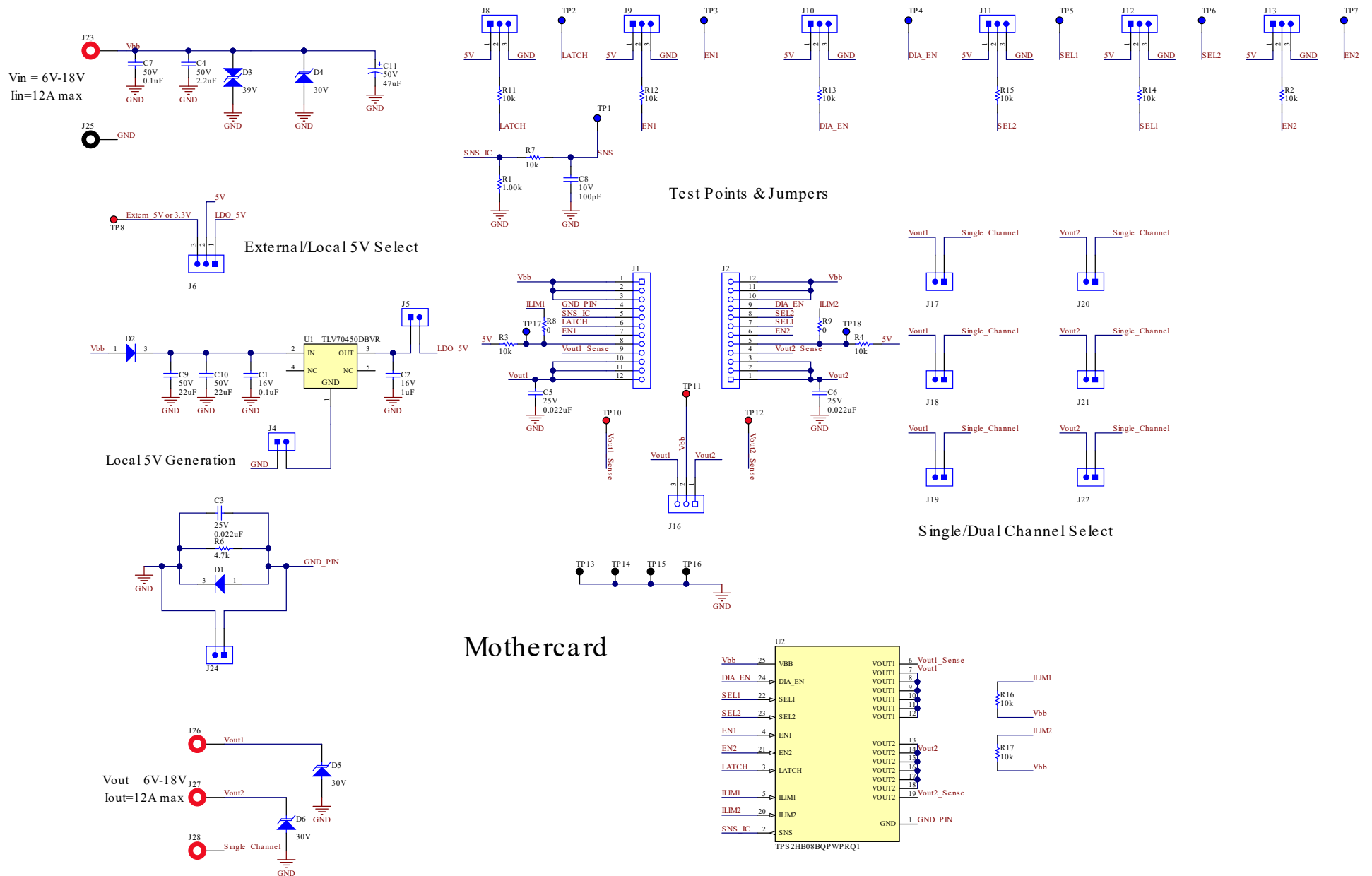


Figure 2-1. HSS-MOTHERBOARDDEV Motherboard Schematic

HSS-MOTHERBOARD EVM Schematic

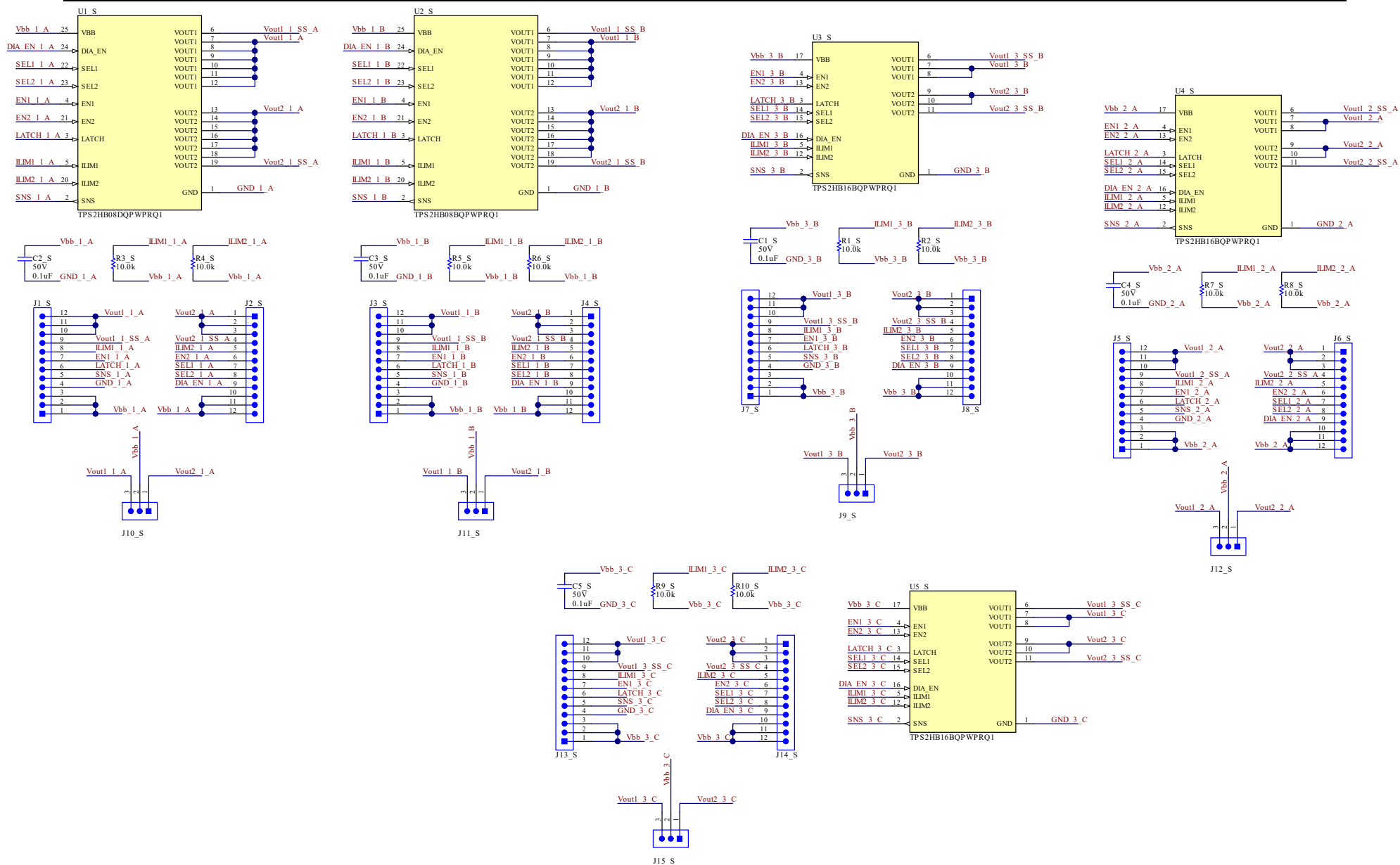


Figure 2-2. HSS-MOTHERBOARD EVM Sample Daughter Card Schematic

3 Connections Descriptions

3.1 Connectors and Test Points

Table 3-1 lists the EVM connector and test point descriptions.

Table 3-1. Connector and Test Point Descriptions

Connectors and Test Points	Descriptions
J23	High-current input terminal for VBB.
J26	High-current output for VOUT1.
J27	High-current output for VOUT2.
J28	High-current output for paralleling 2 channels into single channel VOUT.
J25	High-current input terminal for GND.
Vbb_Sense (TP11)	Test point used to measure VBB Voltage.
Vout1_Sense (TP10)	Test point to measure VOUT1 Voltage.
Vout2_Sense (TP12)	Test point to measure VOUT2 Voltage.
EN1 (TP3)	Test point used to apply power to EN1, only use when J9 is not connected to 5 V or GND.
EN2 (TP7)	Test point used to apply power to EN2, only use when J13 is not connected to 5 V or GND. Only for 2 channel devices.
DIA_EN (TP4)	Test point used to apply power to DIA_EN, only use when J10 is not connected to 5 V or GND.
SEL1 (TP5)	Test point used to apply power to SEL1, only use when J12 is not connected to 5 V or GND.
SEL2 (TP6)	Test point used to apply power to SEL2, only use when J11 is not connected to 5 V or GND.
LATCH (TP2)	Test point used to apply power to LATCH, only use when J8 is not connected to 5 V or GND.
SNS (TP1)	Test point used to measure SNS.
TP17	Connects to ISNS1 on the daughtercard.
TP18	Connects to ISNS2 on the daughtercard. Only for 2 channel devices.
TP8	5-V external input terminal for 5-V EVM.
TP13, TP14, TP15, TP16	This is a direct connection to the GND plane of the EVM.

3.2 Jumpers

Table 3-2 lists the EVM jumper descriptions.

Table 3-2. Jumper Descriptions

Jumpers	Description
J9	This jumper is used to connect the EN1 pin to 5 V (1-2) or GND (2-3).
J13	This jumper is used to connect the EN2 pin to 5V (1-2) or GND (2-3). Only for 2 channel devices.
J10	This jumper is used to connect the DIA_EN pin to 5 V (1-2) or GND (2-3)
J12	This jumper is used to connect the SEL1 pin to 5 V (1-2) or GND (2-3).
J11	This jumper is used to connect SEL2 pin to 5 V (1-2) or GND (2-3).
J4	This jumper connects the TLV70450DBVR ground pin 1 to EVM GND. This with J5 enables LDO.
J24	This jumper is used to bypass the ground network used for reverse polarity protection.
J3	This jumper is used to power the 5-V TLV70450DBVR LDO with the VBB input for the EVM.
J8	This jumper is used to connect the LATCH pin to 5 V (1-2) or GND (2-3).
J5	This jumper connects TLV70450DBVR output to LDO_5V. This with J4 enables LDO.
J6	This jumper connects LDO_5V to the 5-V supply net on the EVM (1-2) or Extern_5V (2-3).
J1, J2, J16	These jumpers connect the motherboard to the daughterboard.
J17, J18, J19	Connect Vout1 to single channel.
J20, J21, J22	Connect Vout2 to single channel.

4 HSS-MOTHERBOARD EVM Assembly Drawings and Layout

Figure 4-1 show the design of the HSS-MOTHERBOARD EVM and daughterboard PCB. The EVM was designed using FR4 material on a two-layer board. All components are located in an active area on the top side and active traces are provided in 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.

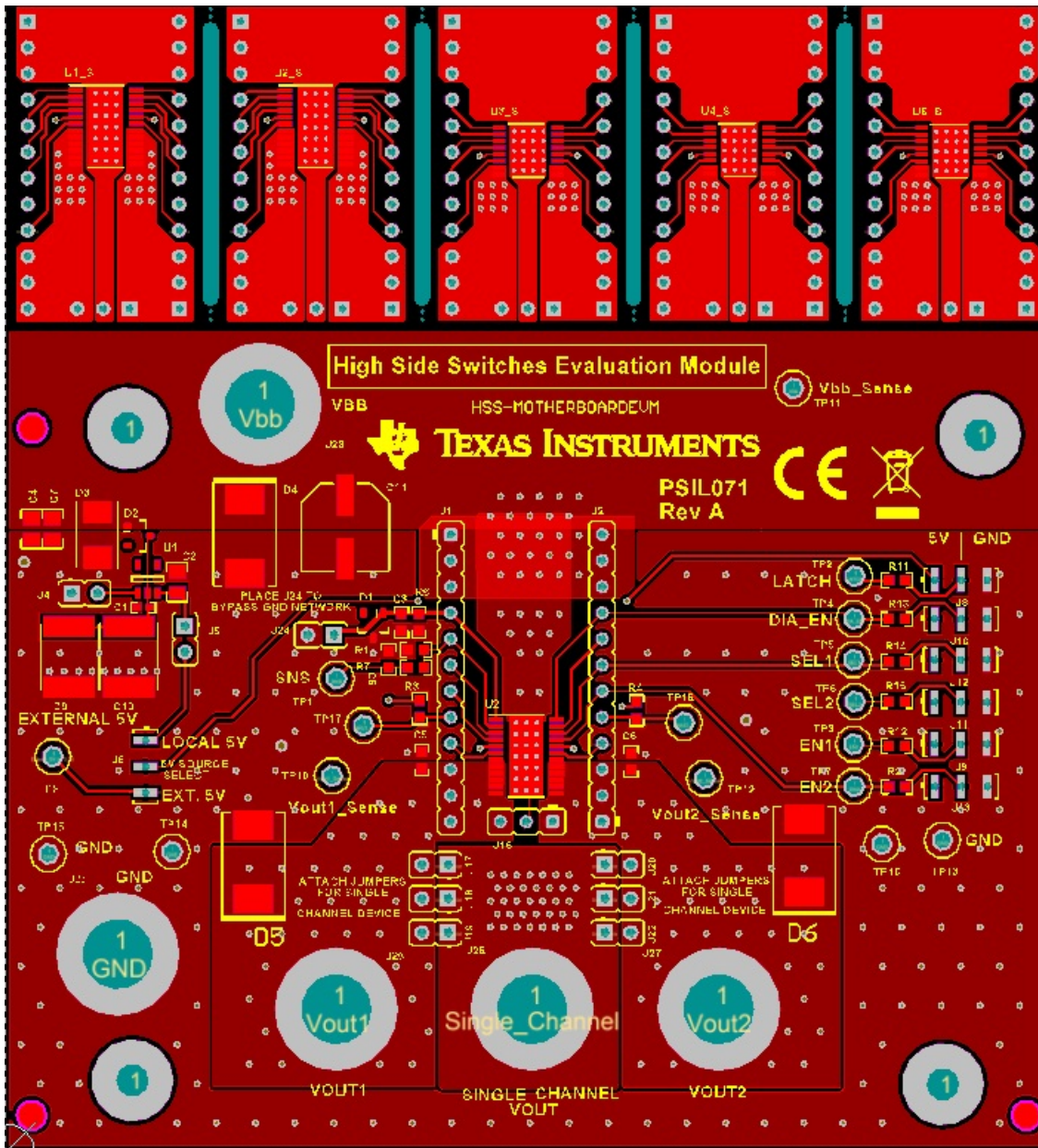


Figure 4-1. HSS-MOTHERBOARD EVM Layout and Routing (Top View)

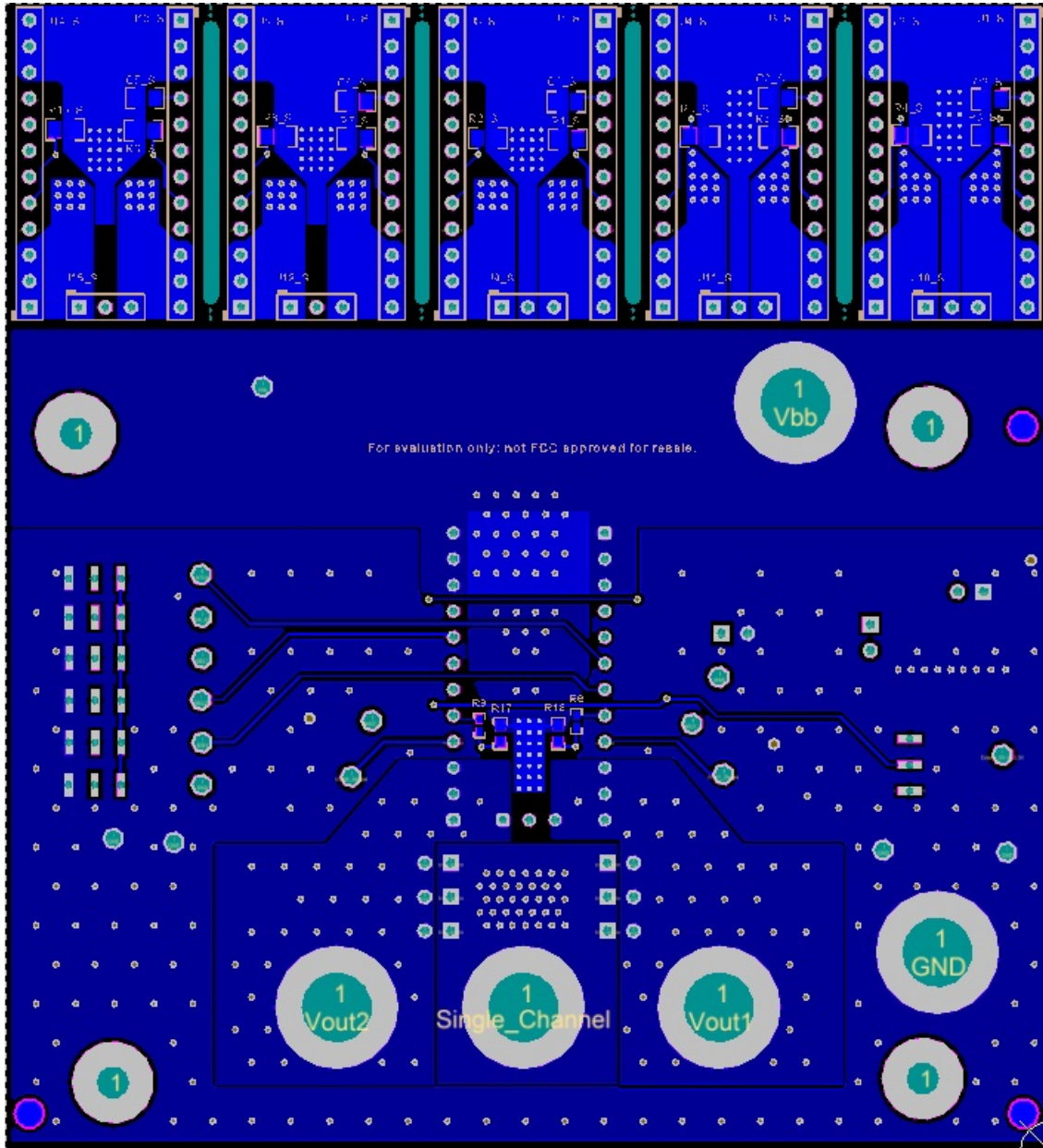


Figure 4-2. HSS-MOTHERBOARDEVM Layout and Routing (Bottom View)

5 Current Limit

When I_{OUT} reaches the current limit threshold, $I_{CL} = K_{CL} / R_{LIM}$, the device can switch off immediately, or the device can remain enabled and limit I_{OUT} . The HSS-MOTHERBOARD EVM enables multiple variants use case as any device can be populated in the snap-off daughtercards or on the footprint directly on the board. In the case that the device remains enabled (and limits I_{OUT}), the thermal shutdown or energy limit protection feature may be triggered due to the high amount of power dissipation in the device. Check the data sheet for the device being used to see what the range of current limit can be.

6 Current Sense

High-accuracy current sensing allows real-time monitoring and more diagnostics without further calibration. A current mirror is used to source a 1/5000 of the load current on SNS pin. The 1-k Ω R1 resistor is connected to the SNS pin to convert the current source into a voltage:

$$V_{SNS} = 1000 \times I_{OUT} / 5000$$

For multiple channel devices see the data sheet for the SELx configuration to know which channel is being monitored.

7 Transient Protection

The HSS-MOTHERBOARD EVM comes with large footprints for TVS diodes if they are needed for any transient testing. D3 is an SMB footprint while D4, D5, and D6 are SMC footprints. In addition, there are also some capacitor footprints that can be populated if need be such as C4 or C11.

8 Soldering Down U2

The HSS-MOTHERBOARD EVM allows the user to solder down a device directly to the board without going through the daughtercard. As noted in the [Section 1](#), care must be taken when soldering down the device.

9 Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1	1	0.1 uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X5R, 0402	0402	160R07X104KV4T	Johanson Technology
C1_S, C2_S, C3_S, C4_S, C5_S, C7	6	0.1 uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	0805	GCM21BR71H104KA37K	MuRata
C2	1	1 uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X5R, 0805	0805	0805YD105KAT2A	AVX
C5, C6	2	0.022 uF	CAP, CERM, 0.022 uF, 25 V, +/- 10%, X7R, 0603	0603	C0603C223K3RAC TU	Kemet
C8	1	100 pF	CAP, CERM, 100 pF, 10 V, +/- 10%, X7R, 0603	0603	0603ZC101KAT2A	AVX
C9, C10	2	22 uF	CAP, CERM, 22 uF, 50 V, +/- 20%, X5R, 6x5x5 mm	6x5x5 mm	CKG57NX5R1H226M500JH	TDK
D1, D2	2	200 V	Diode, Switching, 200 V, 0.2 A, SOT-23	SOT-23	BAS21-7-F	Diodes Inc.
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Phillips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2	2		Receptacle, 2.54 mm, 12x1, Gold, TH	Receptacle, 2.54 mm, 12x1, TH	801-47-012-10-012 000	Mill-Max
J1_S, J2_S, J3_S, J4_S, J5_S, J6_S, J7_S, J8_S, J13_S, J14_S	10		Header, 100 mil, 12x1, TH	Header, 12x1, 100 mil, TH	800-10-012-10-001 000	Mill-Max
J4, J5, J17, J18, J19, J20, J21, J22, J24	9		Header, 2.54 mm, 2x1, Tin, TH	Header, 2.54 mm, 2x1, TH	22284023	Molex

Bill of Materials

J6, J8, J9, J10, J11, J12, J13	7		Header, 2.54 mm, 3x1, Gold, TH	Header, 2.54 mm, 3x1, TH	5-146280-3	TE Connectivity
J9_S, J10_S, J11_S, J12_S, J15_S	5		Header, 100 mil, 3x1, TH	Header, 3x1, 100 mil, TH	800-10-003-10-001000	Mill-Max
J16	1		Receptacle, 2.54 mm, 3x1, Tin, TH	Receptacle, 2.54 mm, 3x1, TH	801-47-003-10-012000	Mill-Max
J23, J26, J27, J28	4		BANANA JACK, SOLDER LUG, RED, TH	Red Insulated Banana Jack	SPC15363	Tenma
J25	1		BANANA JACK, SOLDER LUG, BLACK, TH	Black Insulated Banana Jack	SPC15354	Tenma
R1	1	1.00 k	RES, 1.00 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031K00FK EA	Vishay-Dale
R1_S, R2_S, R3_S, R4_S, R5_S, R6_S, R7_S, R8_S, R9_S, R10_S	10	10.0 k	RES, 10.0 k, 0.5%, 0.125 W, 0805	0805	RT0805DRE0710KL	Yageo America
R2, R7, R11, R12, R13, R14, R15	7	10 k	RES, 10 k, 5%, 0.1 W, 0603	0603	RC1608J103CS	Samsung Electro-Mechanics
R6	1	4.7 k	RES, 4.7 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06034K70JN EA	Vishay-Dale
R16, R17	2	10 k	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0JN EA	Vishay-Dale
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10	10	1x2	Shunt, 100 mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP17, TP18	9		Test Point, Multipurpose, Blue, TH	Blue Multipurpose Testpoint	5127	Keystone
TP8, TP10, TP11, TP12	4		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP13, TP14, TP15, TP16	4		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
U1	1		Single Output LDO, 150 mA, Fixed 5-V Output, 2.5 to 24-V Input, with Ultra-Low IQ, 5-pin SOT-23 (DBV), -40 to 125 degC, Green (RoHS & no Sb/Br)	DBV0005A	TLV70450DBVR	Texas Instruments
C3	0	0.022 uF	CAP, CERM, 0.022 uF, 25 V, +/- 10%, X7R, 0603	0603	C0603C223K3RAC TU	Kemet
C4	0	2.2 uF	CAP, CERM, 2.2 uF, 50 V, +/- 10%, X6S, 0805	0805	C2012X6S1H225K125AB	TDK
C11	0	47 uF	CAP, AL, 47 uF, 50 V, +/- 20%, 0.68 ohm, AEC-Q200 Grade 2, SMD	SMT Radial E	EEE-FK1H470P	Panasonic
D3	0	39 V	Diode, TVS, Bi, 39 V, SMB	SMB	SM6T39CA	STMicroelectronics
D4, D5, D6	0	30 V	Diode, TVS, Uni, 30 V, SMC	SMC	SMCJ30A	Fairchild Semiconductor
R3, R4	0	10 k	RES, 10 k, 5%, 0.1 W, 0603	0603	RC1608J103CS	Samsung Electro-Mechanics
R8, R9	0	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0 ED	Vishay-Dale
U1_S	0		40-V, 8-mOhm Dual-Channel Smart High-Side Switch, PWP0024L (TSSOP-24)	PWP0024L	TPS2HB08DQPWP RQ1	Texas Instruments

U2, U2_S	0		40-V, 8-mOhm Dual-Channel Smart High-Side Switch, PWP0024L (TSSOP-24)	PWP0024L	TPS2HB08BQPWP RQ1	Texas Instruments
U3_S, U4_S, U5_S	0		40-V, 16-mOhm Dual-Channel Smart High-Side Switch, TPS1HA08-Q1 (TSSOP-16)	TPS1HA08-Q1	TPS2HB16BQPWP RQ1	Texas Instruments

Revision History

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

Changes from Revision A (December 2018) to Revision B (October 2020)

Page

- Updated the numbering format for tables, figures and cross-references throughout the document.....2

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