User's Guide

TPS5102 Buck Controller Evaluation Module User's Guide

![TEXAS INSTRUMENTS]

Table of Contents

Trademarks

All trademarks are the property of their respective owners.

1 Introduction

The TPS2330/TPS2331 is a Texas Instruments hotswap controller that eliminates high-frequency hot-plug or hot-removal transients, reduces inrush cur- rent, and provides overcurrent protection. The TPS5102 is a dual-channel DC-to-DC controller, designed for notebook PC power but suitable for many other DC/DC applications. The InfiniBand Trade Association (IBTA), led by seven computing-industry leaders and supported by more than 200 computer, network and electronics companies, is developing a new common I/O specification to deliver a channel-based, switched-fabric technology that the entire industry can adopt.

One of the core components of an InfiniBand system is an InfiniBand module or card, and a hot-swappable power-management solution is essential in each InfiniBand module/card. Using the TPS233x hot-swap controller and the TPS5102 DC/DC controller achieves the required power management specified in Infiniband Specification 1.0 released in October 2000.

The evaluation module (EVM) and interface card can help designers evaluate the devices and simulate hot-insertion and hot-removal actions under varied conditions.

Users need a dc voltage supply to test the operation of the EVM.

2 InfiniBand Bulk-Power EVM

The TPS2330/TPS2331 single-channel hot-swap controller uses external N-channel MOSFETs as high-side switches in power applications. The devices integrate features such as overcurrent protection, inrush current control, output-power status reporting, and separation of load transients from actual load increases, which are the critical requirements for hot-swap applications. For a detailed description of functions and characteristics of the *TPS2300 and TPS2301 Dual Hot-Swap Power Controllers w/Independent Circuit Breaker & Power-Good Rep* data sheet.

The TPS5102 is a dual-channel high-efficiency controller that drives a synchronous-rectifier buck converter. With PWM and skip operating modes, dead-time control, and very low quiescent current, the controller allows power to be conserved under all load conditions. For a detailed description of functions and characteristics of the *TPS5102 Dual High Efficiency Controller For Notebook PC Power* data sheet.

Refer to the data sheets to select appropriate peripheral components for the controllers. For different applications, a gate capacitor at the TPS2330/TPS2331 GATE output can be required to limit excessive inrush current or very heavy load. Recommended input capacitors can help hold the input voltage in the designed range.

To learn more about InfiniBand power-management requirements, users can go to www.infinibandta.org for a copy of the InfiniBand specification 1.0, and can also read the application report Power-Management Solutions for InfiniBand I/O Modules from Texas Instruments on .

To assist designers in the evaluation of the hot-swap controllers, a set of evaluation modules has been developed: one is the InfiniBand bulk power EVM, and the other is an interface card.

3 Schematics of the EVM and the Interface

To demonstrate a hot-plug or hot-removal application, the evaluation system includes two boards: one is the hot-swappable InfiniBand bulk power EVM (SLVP185 board) where the TPS2331 and TPS5102 reside and control power MOSFETs; the other is an interface card (SLVP155 board) that supplies power and a control signal to the InfiniBand bulk power EVM.

Figure 3-1 and Figure 3-2 show the schematic of the interface card and the schematic of the hot-swappable EVM, respectively.

Since the interface card was originally designed for universal application purposes, some of the components shown in the schematic above may not be on the board when shipped with this EVM kit. Refer to Table 3-1 for a complete components list.

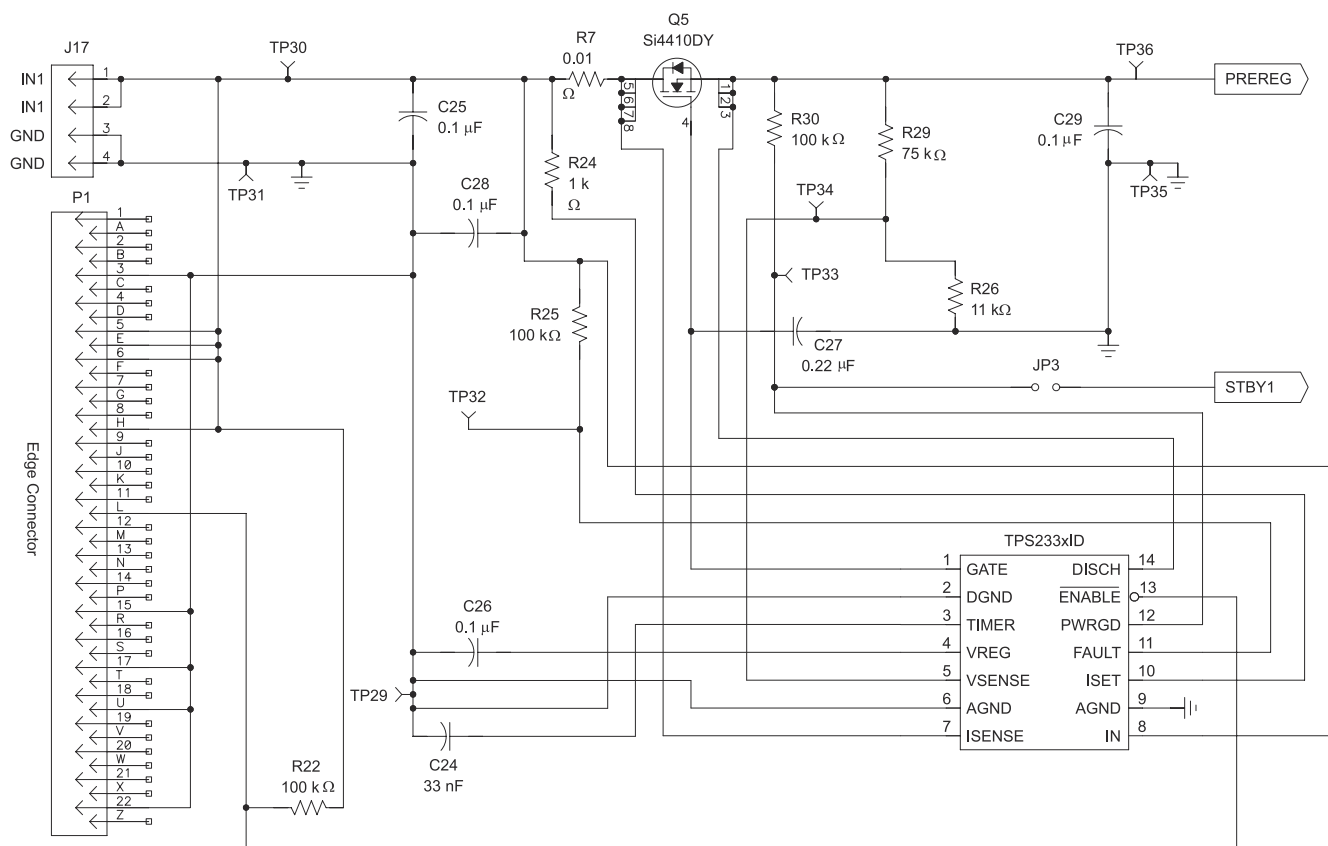When testing the EVM, set the slide switch S1 on the interface card (SVLP155) to HI (marked on the board), because the hot-swap controller TPS2331 is an active-high enabling device. The user can replace the TPS2331 with TPS2330 in order to evaluate the latter, but will need to switch S1 to LO to perform the evaluation.

Figure 3-1. Schematic of the Interface Card (SLVP155)

NOTE: A 14-V Zener diode in parallel with C25 is recommended for noisy applications to limit the input voltage within the operation range of TPS2331

Figure 3-2. Schematic of the InfiniBand Bulk Power Evaluation Module (EVM) Part 1
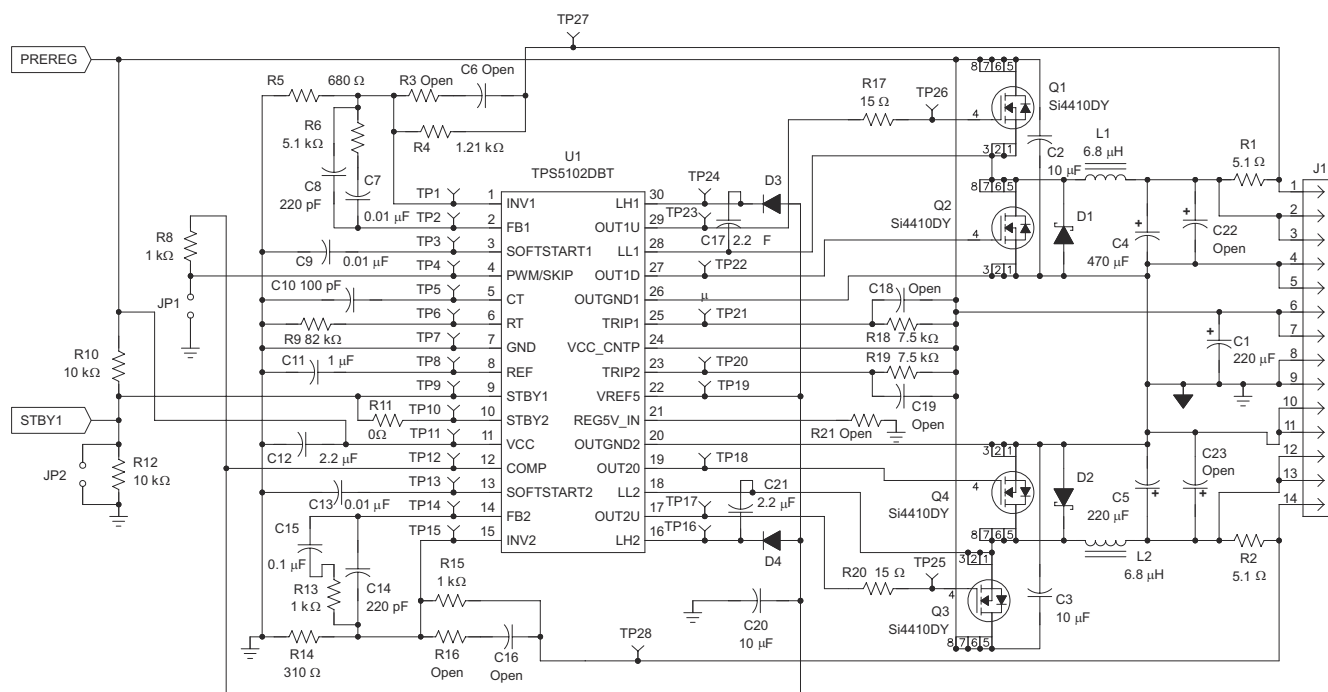

Figure 3-3. Schematic of the InfiniBand Bulk Power Evaluation Module (EVM) Part 2

The schematic for InfiniBand bulk power EVM (Figure 3-2) shows three jumpers (JP1, JP2, and JP3). JP1 is used to set the DC/DC converter stage in PWM (normal) or skip (power-saving) mode. For normal operation,

short JP1, then the converter will be in PWM mode. JP2 is used to shut down the DC/DC converter when it is shorted, so this jumper should not be shorted if the DC/DC conversion is required. JP3 should be shorted for InfiniBand bulk power evaluation because the InfiniBand specification recommends the power-good signal of the hot-swap stage to enable the DC/DC converter.

A 14-V Zener diode in parallel with C25 is recommended if the backplane power is noisy or has potential high voltage spikes, higher than 14 V.

Several components along with the jumpers and test points are only for evaluation purposes and are not necessary for the hot-swap, DC/DC, or both applications. Refer to the data sheets to optimize the designs.

A key is installed in the edge connector on the interface board (SLSP155) to ensure that the board can only be inserted in the correct direction.

The bills of materials (BOM) for both boards are shown in Table 3-1 and Table 3-2, respectively.

Table 3-1. Components on the Interface Card (SLVP155) Bill of Materials

Ref Des	Qty	Part Number	Description	MFG	Size
C1, C3	Not used				
C2	1	LSR100/16DK125	Capacitor, tantalum, 100 µF, 16 V, 10%	NEMCO	D case
C4, C6	Not used				
C5	1	GMK325F106ZH	Capacitor, ceramic, 1 µF, 16 V	Taiyo Yuden	1210
C7, C9	Not used				
C8	1	GRM40X7R105K16	Capacitor, ceramic, 1 µF, 16 V	MuRata	0805
J3, J4	2	3267	Connector, banana jack, uninsulated	Pomona	
J1, J2, J5, J6	Not used				
P1	1	40-22SN-11	Connector, 44-pin edge w/ mtg tabs (for 0.06-inch PCB)	Cinch	
R1, R2	2	Std	Resistor, chip, 10 kΩ, 1/10 W, 5%	Std	1206
S1	1	EG1218	SW-1C-200 MA-SL		
TP1	1	240-345	Test point, red, 1 mm	Farnell	
TP5	1	240-333	Test point, black, 1 mm	Farnell	
TP2-TP4, TP6	Not used				
Key	1	50-PK-3	Key for P1 (Newark #57F3275)	Cinch	
	4	534-1804	Spacer, aluminum, 4-40 female, 0.625 inches long	Mouser	
	4		Screw, pan head Philips, 4-40 × 0.25 inches		

Table 3-2. Components of the InfiniBand Bulk Power EVM (SLVP185) Bill of Materials

Ref Des	Qty	Part Number	Description	MFR	Size
C7, C9, C13	3	GRM40X7R103K25	Capacitor, ceramic, 0.01 µF, 25 V	MuRata	805
C25, C26, C28, C29	4	C0805C104K5RAC	Capacitor, ceramic, 0.1 µF, 50 V	Kemet	805
C15	1	C0805C104K5RAC	Capacitor, ceramic, 0.1 µF, 50 V	Kemet	805
C27	1	PCCC1832TR–ND	Capacitor, ceramic, 0.22 µF, 25 V	Panasonic	805
C11	1	GRM40X7R105K16	Capacitor, ceramic, 1 µF,16 V	MuRata	805
C24	1	GRM40X7R333K25	Capacitor, ceramic, 33 nF, 16 V	MuRata	805
C10	1	GRM40X7R105K16	Capacitor, ceramic, 100 pF, 16 V	MuRata	805
C8	2	GRM33X7R221K6	Capacitor, ceramic, 220 pF, 16 V	MuRata	805

Table 3-2. Components of the InfiniBand Bulk Power EVM (SLVP185) Bill of Materials (continued)

Ref Des	Qty	Part Number	Description	MFR	Size
C14		GRM33X7R221K6	Capacitor, ceramic, 220 pF, 16 V	MuRata	805
C6, C16, C18, C19	4	OPEN	OPEN		805
C12, C17, C21	3	GMK316F225ZG	Capacitor, ceramic, 2.2 µF,35 V	Taiyo Yuden	1206
C2, C3	2	GMK325F106ZH	Capacitor, ceramic, 10 µF,35 V	Taiyo Yuden	1210
C20	1	GRM325F106ZH	Capacitor, ceramic, 10 µF,35 V	Taiyo Yuden	1210
C5	1	10TPB220M	Capacitor, POSCAP, 220 µF, 4 V	Sanyo	D Case
C4	1	4TPB470M	Capacitor, POSCAP, 470 µF, 4 V	Sanyo	D Case
C22, C23	2	OPEN	OPEN		D Case
C1	1	RV–35V221MH10–R	Capacitor, electrolytic, 220 µF, 35 V	ELNA	10 × 10 mm
P1	1	N/A	44-pin edge	N/A	
D1	2	MBRS340T3	Diode, Schottky, 40 V, 3 A	Motorola	SMC
D2		MBRS340T3	Diode, Schottky, 40 V, 3 A	Motorola	SMC
D3	2	SD103–AWDICT	Diode, switching, 200 mA, 40 V	Diodes Inc	DL-35
D4		SD103–AWDICT	Diode, switching, 200 mA, 40 V	Diodes Inc	DL-35
J17	1	PTC36SAAN	Header, 4-pin, 100-mil spacing (36-pin strip)	Sullins	
J1	1	PTC36SAAN	Header, 14-pin, 100-mil spacing (36-pin strip)	Sullins	
L1, L2	2	DO3316P-682	Inductor, SMT 6.8 µH, 4.4 A	Colicraft	
JP1, JP2, JP3	3	PTCSAAN	Header, 2-pin, 100-mil spacing (36-pin strip)	Sullins	
R11	1	Std	Resistor, chip, 0 Ω, 1/10 W, 5%	Std	805
R8, R13, R15	3	Std	Resistor, chip, 1 kΩ, 1/10 W, 5%	Std	0805
R4	1	Std	Resistor, chip, 1.21 kΩ,1/10 W, 1%	Std	0805
R1, R2	2	Std	Resistor, chip, 5.1 Ω, 1/10 W, 5%	Std	805
R6	1	Std	Resistor, chip, 5.1 kΩ,1/10 W, 5%	Std	805
R18, R19	2	Std	Resistor, chip, 7.5 kΩ, 1/10 W, 5%	Std	805
R10	2	Std	Resistor, chip, 10 kΩ, 1/10 W, 5%	Std	805
R12		Std	Resistor, chip, 10 kΩ, 1/10 W, 5%	Std	805
R17, R20	2	Std	Resistor, chip, 15 Ω, 1/10 W, 5%	Std	805
R9	1	Std	Resistor, chip, 82 kΩ, 1/10 W, 5%	Std	805
R14	1	Std	Resistor, chip, 310 Ω, 1/10 W, 1%	Std	805
R5	1	Std	Resistor, chip, 680 Ω, 1/10 W, 1%	Std	805
R3, R16, R21	3	Std	OPEN		805
R24	1	Std	Resistor, chip, 1 Ω, 1/8 W, 5%	Std	1206
R26	1	Std	Resistor, chip, 11 Ω, 1/8 W, 5%	Std	1206
R29	1	Std	Resistor, chip, 75 Ω, 1/8 W, 5%	Std	1206
R22, R25, R30	3	Std	Resistor, chip, 100 Ω, 1/8 W, 5%	Std	1206
R7	1	WSL–2512–01, 1%,R86	Resistor, chip, 0.01 Ω, 1 W, 1%	Dale	2512
U2	1	TPS2330ID	Single hot-swap P/controller w/ circuit breaker and PG	TI	SO14
U1	1	TPS5102DBT	IC, dual controller, PWM/skip mode	TI	DBT30
TP7,TP29, TP31, TP35	4	240–333	Testpoint, black, 1 mm	Farnell	DBT30
TP1–TP6,TP8–TP28,TP30, TP32, TP33, TP34, TP36	32	240–345	Testpoint, red, 1 mm	Farnell	
Q1–Q5	5	Si4410DY	MOSFET, N-ch, 30 V, 10 A, 13 mW	Siliconix	SO8

Table 3-2. Components of the InfiniBand Bulk Power EVM (SLVP185) Bill of Materials (continued)

Ref Des	Qty	Part Number	Description	MFR	Size
Shuntsfor JP1, JP2	2	929950-00	Jumper shunt	3M	

4 Layouts of the EVM and the Interface Card

Figure 4-1 through Figure 4-4 illustrate the placements of the components and the top-layer layouts for both the InfiniBand bulk power EVM and the interface card, respectively. All the components are placed on the top layers only. The bottom layers are ground planes except for a few short traces on the InfiniBand bulk power EVM.
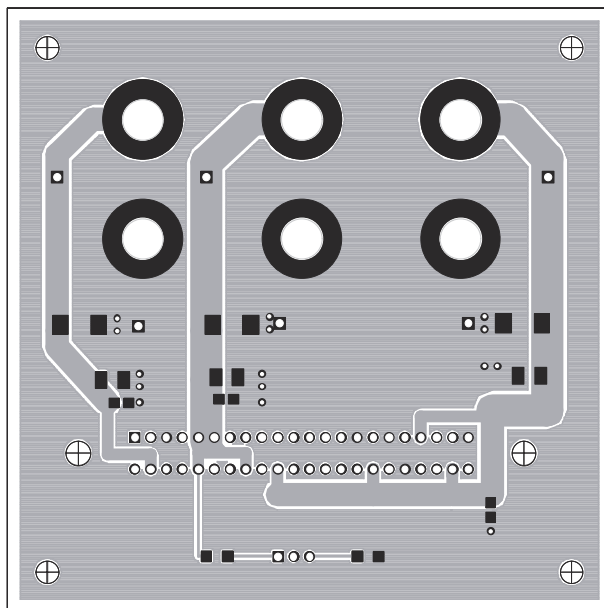

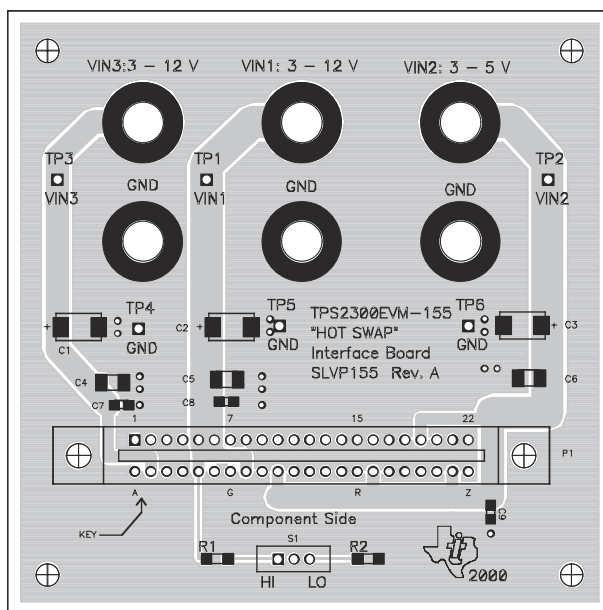**Figure 4-1. Top Layer of the Interface Card and Placement of the Components (Top Layer)**

Figure 4-2. Top Layer of the Interface Card and Placement of the Components (Top Assembly)
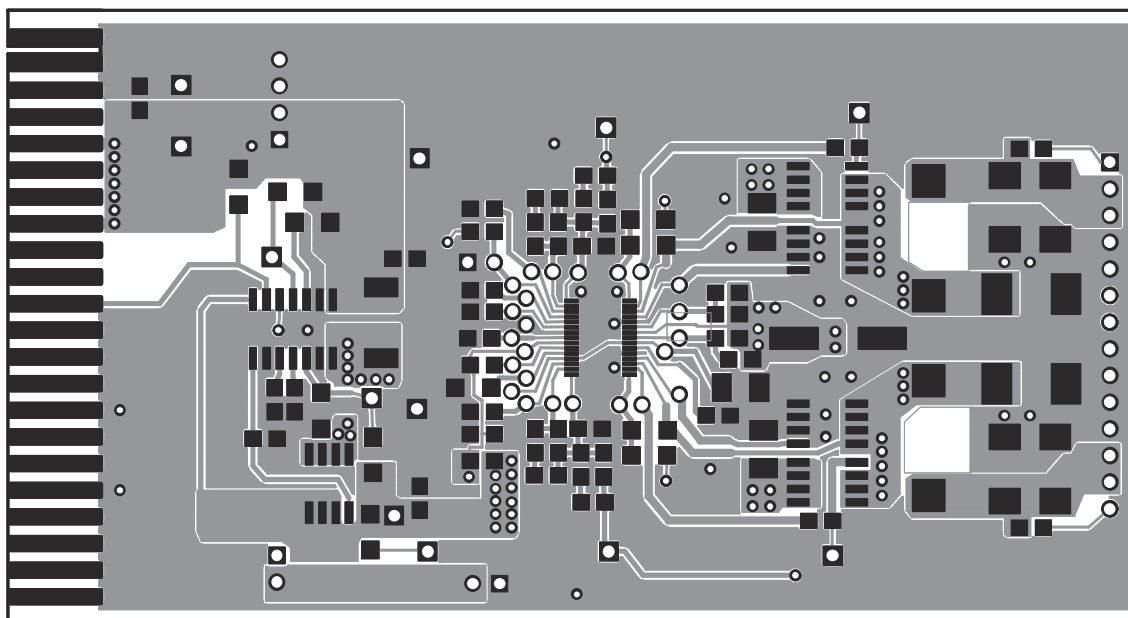
Figure 4-3. Top Layer of the InfiniBand Bulk Power EVM and Placement of the Components (Top Layer)
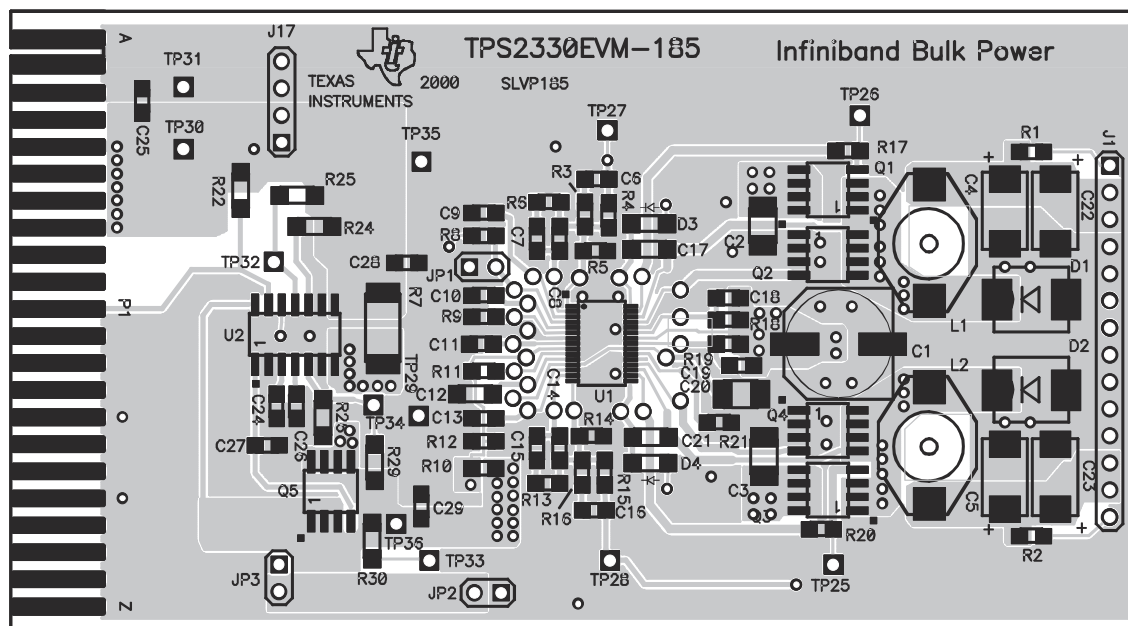

Figure 4-4. Top Layer of the InfiniBand Bulk Power EVM and Placement of the Components (Top Assembly)

5 EVM Setup

For proper operation of the EVM, one 12-V 1-A power supply, two resistive loads, and a couple of voltage meters are required.

Refer to the setup diagram in Figure 5-1 and follow these steps for hot plug:

1. Verify that the power-supply voltage is set at 12 V. Make sure the supply has the capability to provide the needs of the current load. Turn off the supply.
2. Connect the loads to the two output pins – one load connected from VO1 (pin 2 or 3 of J1 on SLVP185) to ground (pin 4 or 5 of J1 on SLVP185), and the other load from VO2 (pin 12 or 13 of J1 on SLVP185) to ground. Monitor the voltages from VO1 and VO2 to ground, respectively.
3. Plug the supply into the interface card; connect the supply from IN1 to ground, then turn the power supply on. Check the voltage from VIN1 to GND. It should be about 12 V.
4. Slide the switch S1 on the interface board (SLVP155) to HI if the hot-swap controller U2 on SLVP185 is the TPS2331 (or to LO if the hot-swap controller U2 on SLVP185 is the TPS2330). Otherwise, the supply will not be connected to the loads, because the TPS2331 is an active-high-enabling device and the TPS2330 is an active-low-enabling device.
5. Short jumpers JP1 and JP3 on the hot-swap board (SLVP185). *Do not* short the jumper JP2.
6. Plug the hot-swap board (SLVP185) into the interface board (SLVP155). The key installed between pins 1 and 2 of the edge connector ensures that the board can only be inserted in the correct direction.
7. Test points or headers are provided for oscilloscope probes, multimeters, or both. Read the voltage from the multimeters connecting from VO1 (pin 2 or 3 of J1 on SLVP185) and VO2 (pin 12 or 13 of J1 on SLVP185) to GND (pin 4 or 5 of J1 on SLVP185). The values on the meter should be about 5 V and 3.3 V, respectively. Otherwise, the board can have problems or the testing may not be correct.
8. Unplug the SLVP185 board from the interface card.
9. The current limits for VO1 and VO2 were set to be less than 3 A on the EVM. If higher currents are required, adjust the resistor values as indicated in the TPS5102 and TPS2331 data sheets, and use a supply with a higher current rating.
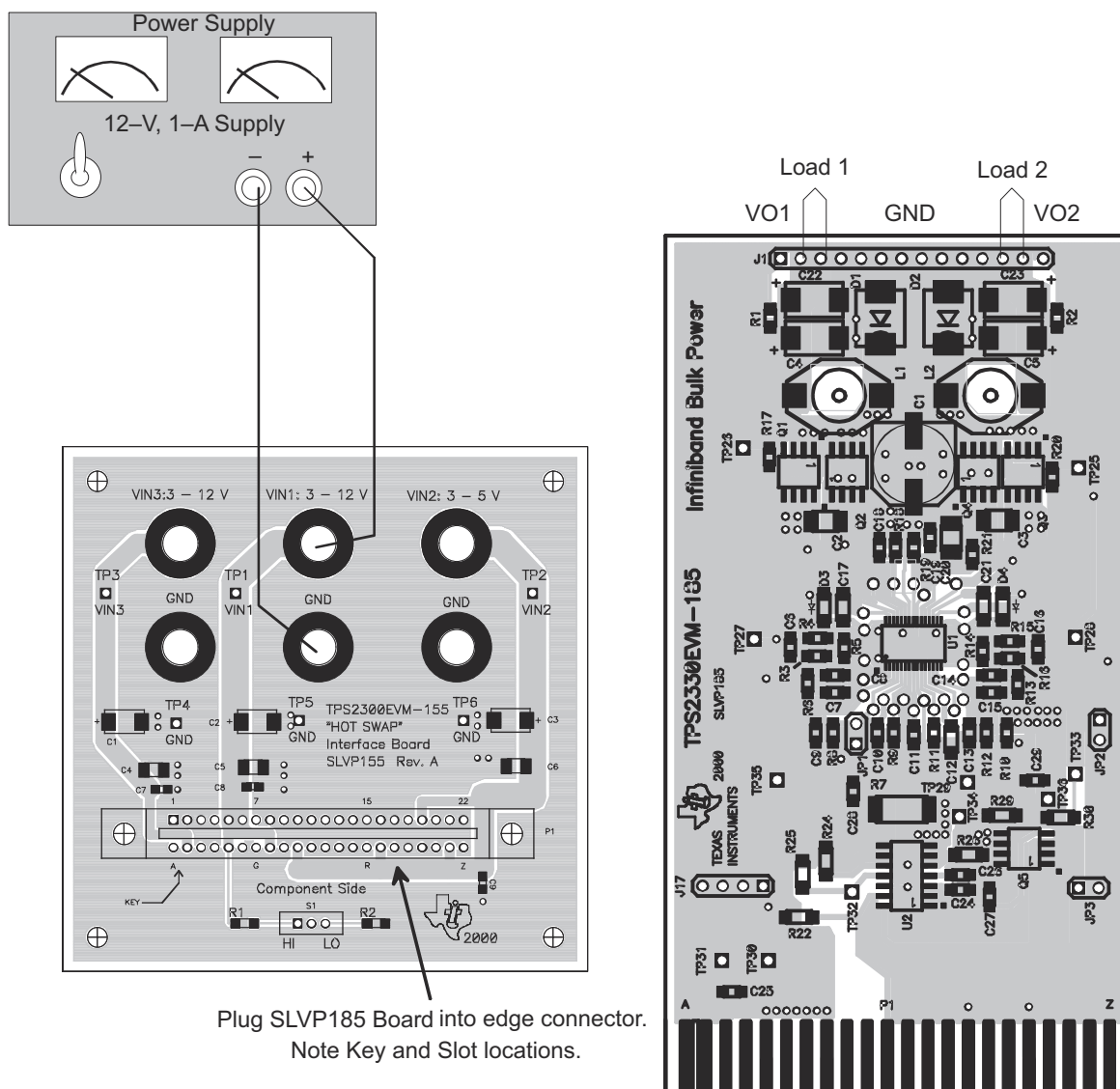
Figure 5-1. Evaluation Setup of the InfiniBand Bulk Power EVM

6 Test Points

Two test points are available on the interface card (SLVP155):

TP1	VIN1 (input voltage)
TP5	GND (ground)

On the InfiniBand bulk power EVM, there are total 36 test points:

TP1	Pin 1 (INV1) of the TPS5102
TP2	Pin 2 (FB1) of the TPS5102
TP3	Pin 3 (SOFTSTART1) of the TPS5102
TP4	Pin 4 (PWM/SKIP) of the TPS5102
TP5	Pin 5 (CT) of the TPS5102
TP6	Pin 6 (RT) of the TPS5102
TP7	Pin 7 (GND) of the TPS5102
TP8	Pin 8 (REF) of the TPS5102
TP9	Pin 9 (STBY1) of the TPS5102
TP10	Pin 10 (STBY2) of the TPS5102
TP11	Pin 11 (VCC) of the TPS5102
TP12	Pin 12 (COMP) of the TPS5102
TP13	Pin 13 (SOFTSTART2) of the TPS5102
TP14	Pin 14 (FB2) of the TPS5102
TP15	Pin 15 (INV2) of the TPS5102
TP16	Pin 16 (LH2) of the TPS5102
TP17	Pin 17 (OUT2U) of the TPS5102
TP18	Pin 19 (OUT2D) of the TPS5102
TP19	Pin 22 (VREF5) of the TPS5102
TP20	Pin 23 (TRIP2) of the TPS5102
TP21	Pin 25 (TRIP1) of the TPS5102
TP22	Pin 27 (OUT1D) of the TPS5102 and gate of Q2 SI4410DY
TP23	Pin 29 (OUT1U) of the TPS5102
TP24	Pin 30 (LH1) of the TPS5102
TP25	Gate of Q3 SI4410DY
TP26	Gate of Q1 SI4410DY
TP27	Pin 1 of J1 (channel 1 control feedback)
TP28	Pin 14 of J1 (channel 2 control feedback)
TP29	GND
TP30	Input, pin 1 and 2 of J17
TP31	GND
TP32	ENABLE pin of the TPS2331
TP33	PWRGD pin of the TPS2331
TP34	VSENSE pin of the TPS2331
TP35	GND
TP36	Output of hot-swap stage and input of the DC/DC converter

In addition to all the above listed test points, the header J1 on the InfiniBand bulk power EVM can be used as a test point for VO1 and VO2 or connecting loads.

Pin 1 of J1	Same as TP27
Pins 2 and 3 of J1	VO1
Pins 4 and 5 of J1	GND
Pins 6 and 7 of J1	Same as TP36
Pins 8 and 9 of J1	GND
Pins 10 and 11 of J1	GND
Pins 12 and 13 of J1	VO2
Pins 14 of J1	Same as TP28

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

Changes from Revision * (February 2022) to Revision A (March 2022)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document. 2	
• Updated the user's guide title.. 2	

Submit Document Feedback

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.