User's Guide

TPS25947EVM: Evaluation Module for TPS25947 eFuse

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ABSTRACT

This user's guide describes the evaluation module (EVM) for the TPS25947xx eFuse. The TPS25947xx device is a 2.7 V to 23 V, 5.5 A eFuse with integrated 28 mΩ FET with reverse current protection, input reverse polarity protection, over current, inrush current protection,adjustable over current transient blanking timer, programmable under voltage and over voltage protection.

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Trademarks

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1 Introduction

The *TPS25947EVM eFuse Evaluation Board* allows reference circuit evaluation of Texas Instruments (TI) TPS25947xx eFuse. The TPS25947xx device is a 2.7 V to 23 V, 5.5 A eFuse with integrated 28 mΩ FET with reverse current protection, input reverse polarity protection, over current, inrush current protection,adjustable over current transient blanking timer, programmable under voltage and over voltage protection.

1.1 EVM Features

General TPS25947EVM eFuse evaluation board features include:

- 2.7V to 23V (typ) operation
- 0.5 A to 6 A programmable current limit using onboard jumpers
- Programmable output voltage slew rate control
- Programmable transient current blanking timer
- Programmable current limit
- Power Mux and Parallel configurations
- TVS diode for input transient protection
- On-board Schottky diode at output prevents negative spike during overcurrent faults
- LED status for Power Good and Fault indication

1.2 EVM Applications

This EVM can be use on the following applications:

- Hot-Swap, Hot-Plug
- Server standby rails
- Optical Modules
- PCIe, SSDs and HDDs
- Routers and Switches
- Industrial PC
- Digital TV

2 Description

The TPS25947EVM eFuse Evaluation Board has 4 channels and enables evaluation of TPS259470L, TPS259472A and TPS259474L eFuses from TPS25947xx family. Channels 1 and 4 are standalone channels and provide programmable OVCSEL, OVLO, ITIMER, dVdt and ILM settings. Channels 2 and 3 share a common ground plane and provide option to evaluate power muxing and parallel opertaion capabilities of TPS25947xx eFuse. The input power is applied at connectors J1 , J9, J12, J16 while J2, J8, J11, J15 provides the output connection for Channels 1, 2 3 and 4 respectively; refer to the schematic in Figure 3-1, and EVM test setup in Figure 5-1. TVS diodes D1, U7, D14 and D5 provide input protection from transient overvoltages while Schottky diode D2, D12, D15 and D6 provide output protection for the TPS25947xx eFuses in Channels 1, 2 ,3 and 4 respectively.

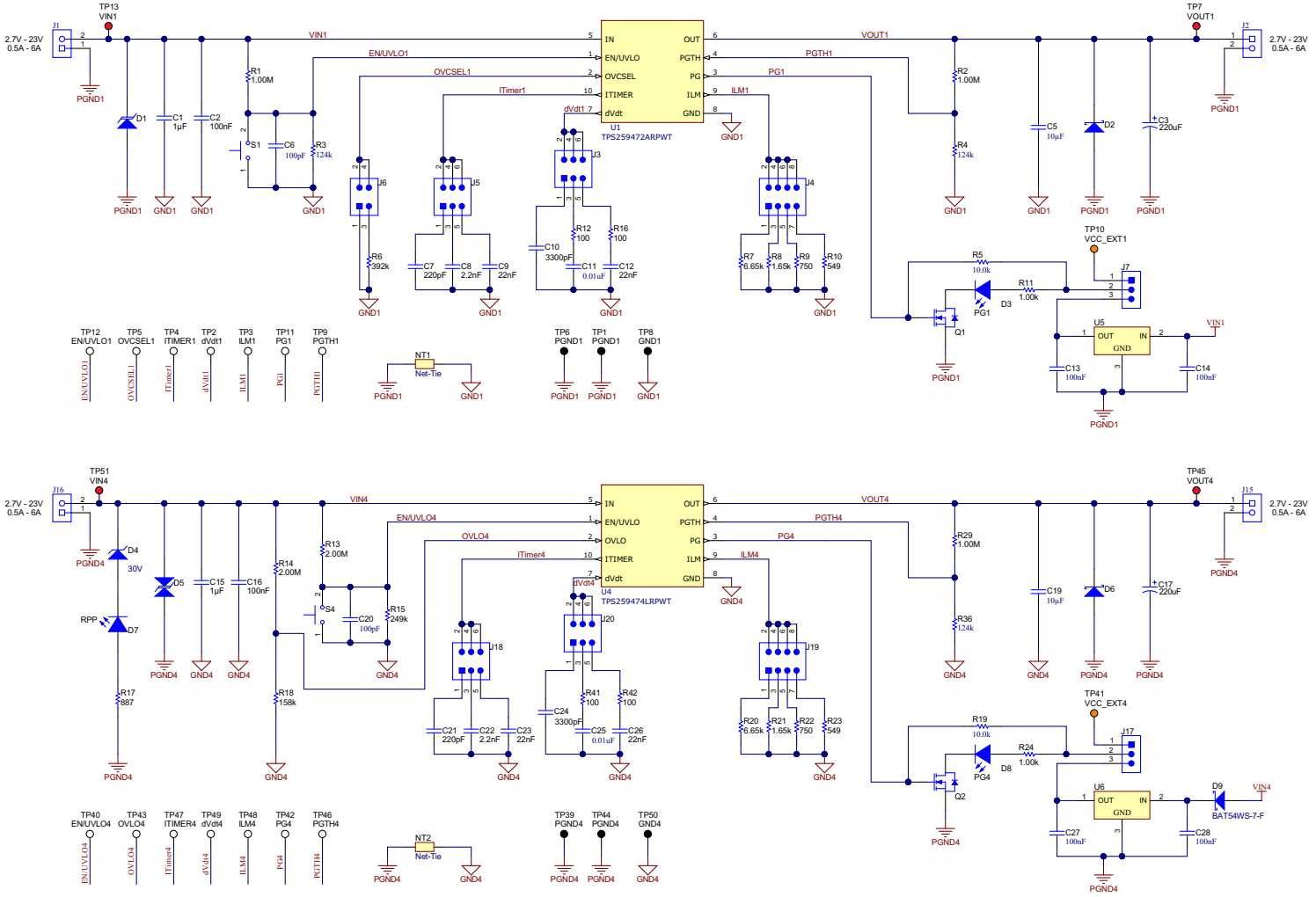
S1, S2, S3 and S4 allows U1, U2, U3 and U4 to be RESET or disabled. A power good (PG) indicator is provided by D3. Scaled device current can be monitored at TP15 with a scale factor of 0.13 V/A.

Table 2-1. TPS25947EVM eFuse Evaluation Board Options and Setting

EVM Function	Channel	Vin UVLO Threshold	Vin OV LO/OVC Threshold	ITimer	Output Slew rate, dVdt	Current Limit	
						Low Setting	Hi Setting
2.7 V to 23 V, 5.5 A eFuse	CH1	10.87V	Selectable OVC - 3.87V, 5.73V, 13.84V	Selectable - 183ns, 1.83ms, 18.3ms	Selectable - 0.6mV/us, 0.2mV/us, 0.09mV/us	0.5 A	6 A
	CH2	10.87V	OVLO Disabled	1.83ms	0.2mV/us	6A	
	CH3	10.87V	16.44V	1.83ms	0.2mV/us	6A	
	CH4	10.83V	16.38V	Selectable - 183ns, 1.83ms, 18.3ms	Selectable - 0.6mV/us, 0.2mV/us, 0.09mV/us	0.5A	6A

3 Schematic

Figure 3-1 illustrates the EVM schematic.



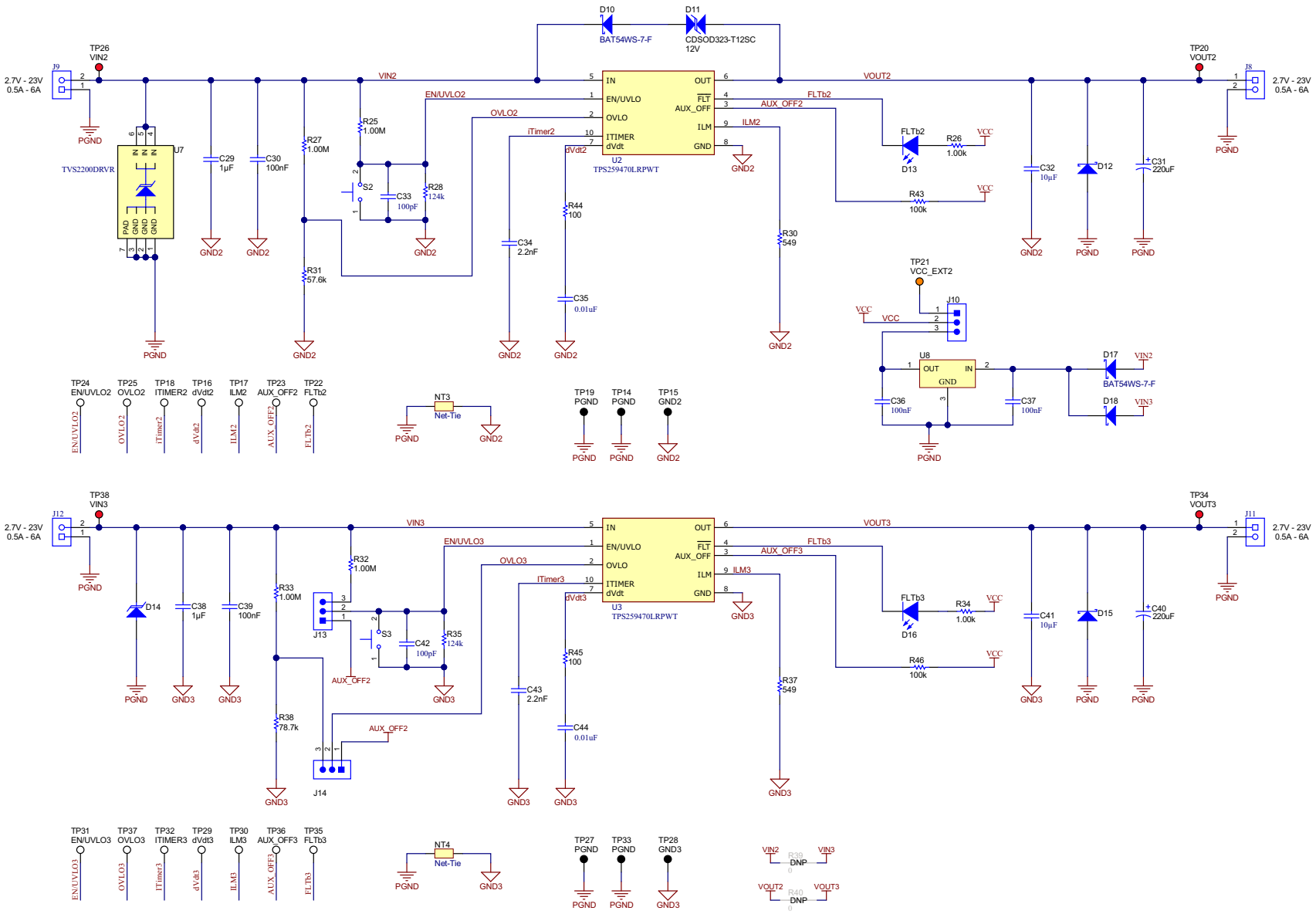


Figure 3-1. TPS25947EVM eFuse Evaluation Board Schematic

4 General Configurations

4.1 Physical Access

Table 4-1 lists the TPS25947EVM eFuse Evaluation Board input and output connector functionality. Table 4-2 and Table 4-3 describe the test point availability and the jumper functionality. Table 4-4 describes the function of signal LEDs.

Table 4-1. Input and Output Connector Functionality

Channel	Connector	Label	Description
CH1	J1	VIN1(+), GND(–)	Intput of CH1
	J2	VOUT1(+), GND(–)	Output of CH1
CH2	J9	VIN2(+), GND(–)	Intput of CH2
	J8	VOUT2(+), GND(–)	Output of CH2
CH3	J12	VIN3(+), GND(–)	Intput of CH3
	J11	VOUT3(+), GND(–)	Output of CH3
CH4	J16	VIN4(+), GND(–)	Intput of CH4
	J15	VOUT4(+), GND(–)	Output of CH4

Table 4-2. Test Points Description

Channel	Test Points	Label	Description
CH1	TP13	VIN1	CH1 Input voltage
	TP7	VOUT1	CH1 Output voltage
	TP12	EN/UVLO1	CH1 EN/UVLO signal
	TP5	OVCSEL1	CH1 OVCSEL signal
	TP4	ITIMER1	CH1 ITIMER signal
	TP2	dVdt1	CH1 Output voltage ramp control
	TP3	ILM1	CH1 Current limit and monitor signal
	TP11	PG1	CH1 Power good signal
	TP9	PGTH1	CH1 Power good threshold signal
	TP10	VCC_EXT1	CH1 external VCC voltage point
	TP8	GND1	CH1 IC GND signal
	TP6, TP1	PGND1	CH1 Power GND signal
CH2	TP26	VIN2	CH2 Input voltage
	TP20	VOUT2	CH2 Output voltage
	TP24	EN/UVLO2	CH2 EN/UVLO signal
	TP25	OVLO2	CH2 OVLo signal
	TP18	ITIMER2	CH2 ITIMER signal
	TP16	dVdt2	CH2 Output voltage ramp control
	TP17	ILM2	CH2 Current limit and monitor signal
	TP23	AUX_OFF2	CH2 AUX_OFF signal

Table 4-2. Test Points Description (continued)

Channel	Test Points	Label	Description
	TP22	FLTb2	CH2 Fault signal
	TP15	GND2	CH2 IC GND signal
CH2 & CH3	TP21	VCC_EXT2	External VCC voltage point for CH2 and Ch3
	TP19, TP14, TP27, TP33	PGND	Common Power GND for CH2 and CH3
CH3	TP38	VIN3	CH3 Input voltage
	TP34	VOUT3	CH3 Output voltage
	TP31	EN/UVLO3	CH3 EN/UVLO signal
	TP37	OVLO3	CH3 OVLO signal
	TP32	ITIMER3	CH3 ITIMER signal
	TP29	dVdt3	CH3 Output voltage ramp control
	TP30	ILM3	CH3 Current limit and monitor signal
	TP36	AUX_OFF3	CH3 AUX_OFF signal
	TP35	FLTb3	CH3 Fault signal
	TP28	GND3	CH3 IC GND signal
CH4	TP51	VIN4	CH4 Input voltage
	TP45	VOUT4	CH4 Output voltage
	TP40	EN/UVLO4	CH4 EN/UVLO signal
	TP43	OVLO4	CH4 OVLO signal
	TP47	ITIMER4	CH4 ITIMER signal
	TP49	dVdt4	CH4 Output voltage ramp control
	TP48	ILM4	CH4 Current limit and monitor signal
	TP42	PG4	CH4 Power good signal
	TP46	PGTH4	CH4 Power good threshold signal
	TP41	VCC_EXT4	CH4 external VCC voltage point
	TP50	GND4	CH4 IC GND signal
	TP39, TP44	PGND4	CH4 Power GND signal

Table 4-3. Jumper Descriptions and Default Positions

Channel	Jumper	Label	Description	Default Jumper Position
CH1	J6	OVCSEl1	1-2 Position sets input OVC threshold at 3.87 V	3-4
			3-4 Position sets input OVC threshold at 13.84V	
			No jumper connection sets input OVC threshold at 5.73V	
	J5	ITIMER1	1-2 Position sets the transient current blanking period to 183ns	3-4
			3-4 Position sets the transient current blanking period to 1.83ms	
			5-6 Position sets the transient current blanking period to 18.3ms	
	J3	dVdt1	1-2 Position sets Output Slew Rate to 0.6 mV/us	3-4
			3-4 Position sets Output Slew Rate to 0.2 mV/us	
			5-6 Position sets Output Slew Rate to 0.09 mV/us	
	J4	ILM1	1-2 Position sets the current limit to 0.5A	7-8
			3-4 Position sets the current limit to 2A	
			5-6 Position sets the current limit to 4.44A	
			7-8 Position sets the current limit to 6A	
	J7	VCC Connection	1-2 Position connects external voltage, VCC_EXT1 as reference for PG1	2-3
			2-3 Position connects on board generated voltage , VCC as reference for PG1	
CH2	J10	VCC Connection Ch-2,3	1-2 Position connects external voltage, VCC_EXT2 as pullup for digital signals of U2 and U3	2-3
			2-3 Position connects on board generated voltage, VCC as reference for digital signals of U2 and U3	
CH3	J13	EN/UVLO3	1-2 Position connects the AUX_OFF2 with EN/UVLO3. Use this setting for Parallel operation of U2 and U3	2-3
			2-3 Position sets the EN/UVLO threshold to 10.83 V	
	J14	OVLO3	1-2 Position connects the AUX_OFF2 with OVLO3. Use this setting for Power Muxing operation of U2 and U3	2-3
			2-3 Position sets the OVLO threshold to 16.38 V	
CH4	J17	VCC Connection Ch-4	1-2 Position connects external voltage, VCC_EXT4 as reference for PG4	2-3
			2-3 Position connects on board generated voltage, VCC as reference for PG4	
	J18	ITIMER4	1-2 Position sets the transient current blanking period to 183ns	3-4
			3-4 Position sets the transient current blanking period to 1.83ms	
			5-6 Position sets the transient current blanking period to 18.3ms	
	J19	ILM4	1-2 Position sets the current limit to 0.5A	7-8
			3-4 Position sets the current limit to 2A	
			5-6 Position sets the current limit to 4.44A	
			7-8 Position sets the current limit to 6A	
	J20	dVdt4	1-2 Position sets Output Slew Rate to 0.6 mV/us	3-4
			3-4 Position sets Output Slew Rate to 0.2 mV/us	
			5-6 Position sets Output Slew Rate to 0.09 mV/us	

Table 4-4. LED Descriptions

LED	Description
D3	When ON, indicates that PG is asserted for Channel-1
D13	When ON, indicates that FLTb is asserted for Channel-2
D16	When ON, indicates that FLTb is asserted for Channel-3
D8	When ON, indicates that PG is asserted for Channel-4

4.2 Test Equipment and Set up

4.2.1 POWER SUPPLIES

One adjustable power supply 0 V to 30 V output, 0 A to 10 A output current limit.

4.2.2 METERS

One DMM minimum needed.

4.2.3 OSCILLOSCOPE

A DPO2024 or equivalent, three 10x voltage probes, and a DC current probe.

4.2.4 LOADS

One resistive load or equivalent which can tolerate up to 10 A DC load at 24 V and capable of the output short.

5 Test Setup and Procedures

In this user guide, the test procedure is described for TPS259472A, TPS259474L, TPS259470L devices. Following similar test steps, all other variants from TPS25947xx family can also be evaluated.

Make sure the evaluation board has default jumper settings as shown in Table 5-1.

Table 5-1. Default Jumper Setting for TPS25947EVM eFuse Evaluation Board

J3	J4	J5	J6	J7	J10	J13	J14	J17	J18	J19	J20
3-4	7-8	3-4	3-4	2-3	2-3	2-3	2-3	2-3	3-4	7-8	3-4

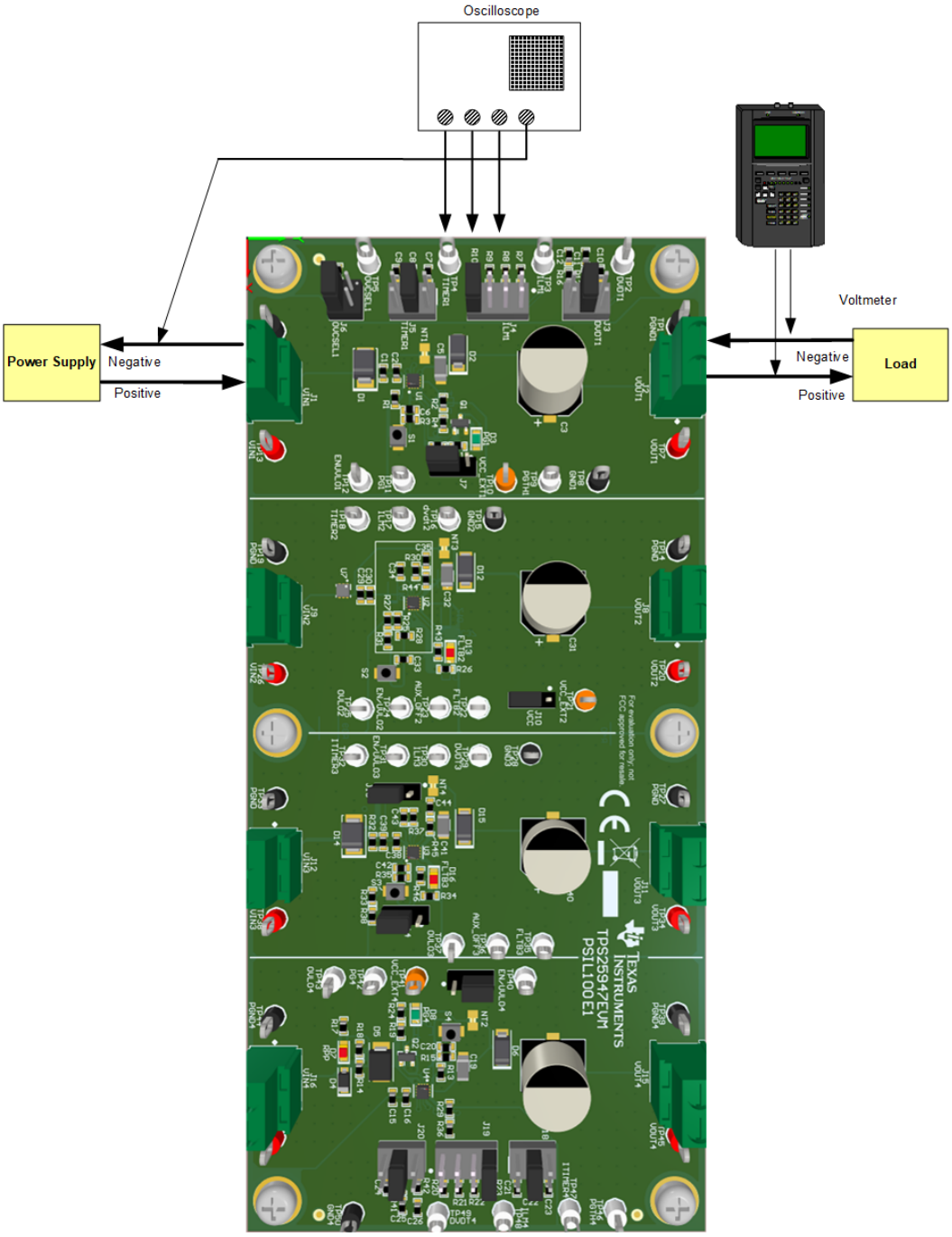


Figure 5-1. TPS25947EVM Setup with Test Equipment

Follow these instructions before starting any test and repeat again before moving to next test:

- Set the power supply output (VIN) to zero volts.
- Turn ON the power supply and set the power supply output (VIN) to 12 V, current limit = 10 A.
- Turn OFF the power supply.
- Set the jumper setting on EVM to default position as shown in Table 5-1.

5.1 Hot-Plug Test

Use the following instructions to measure the inrush current during Hot-Plug event on Channel 1:

1. Set Jumper J3 position to desired slew rate as mentioned in Table 4-3 .
2. Set the input supply voltage VIN to 12 V and current limit of 10 A. Enable the power supply.
3. Hot-plug the supply between VIN1 and PGND1 points of connector J1.
4. Observe the waveform at VOUT1 (TP7) and input current with an oscilloscope to measure the slew rate and rise time of the eFuse with a given input voltage of 12 V.

Figure 5-2 shows an example of inrush current captured on the TPS25947EVM eFuse Evaluation Board.

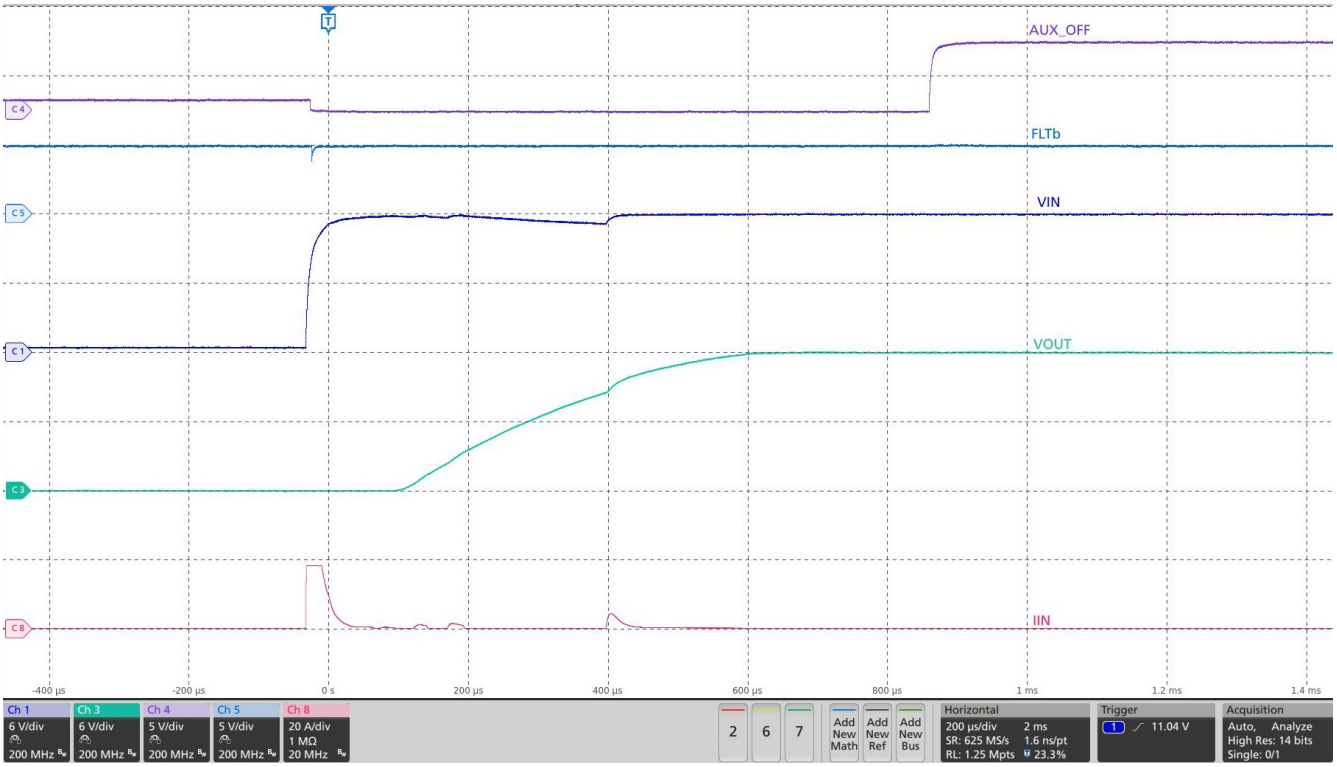


Figure 5-2. TPS259470x Output Rise Profile (VIN = 12 V, Cout=10uF, CdVdT = OPEN, ILIM =549Ω, No-load)

5.2 Over Current Test

Use the following instructions to perform over current test on circuit breaker variant (TPS259474x) of TPS25947xx eFuse:

1. Place jumper J18 to appropriate position to obtain required blanking period as per Table 4-3.
2. Set the input supply voltage VIN to 12 V and current limit of 10 A and enable the power supply.
3. Place jumper J19 in suitable position to set required current limit as per Table 4-3.
4. Now apply an overload greater than the set current limit between VOUT and GND. (While testing current limit variant of TPS25947xx, use a resistive load to apply over current)
5. The device allows the overload current for the programmed ITIMER period and then switches OFF.

Figure 5-3 shows an example of circuit breaker test on the TPS25947EVM

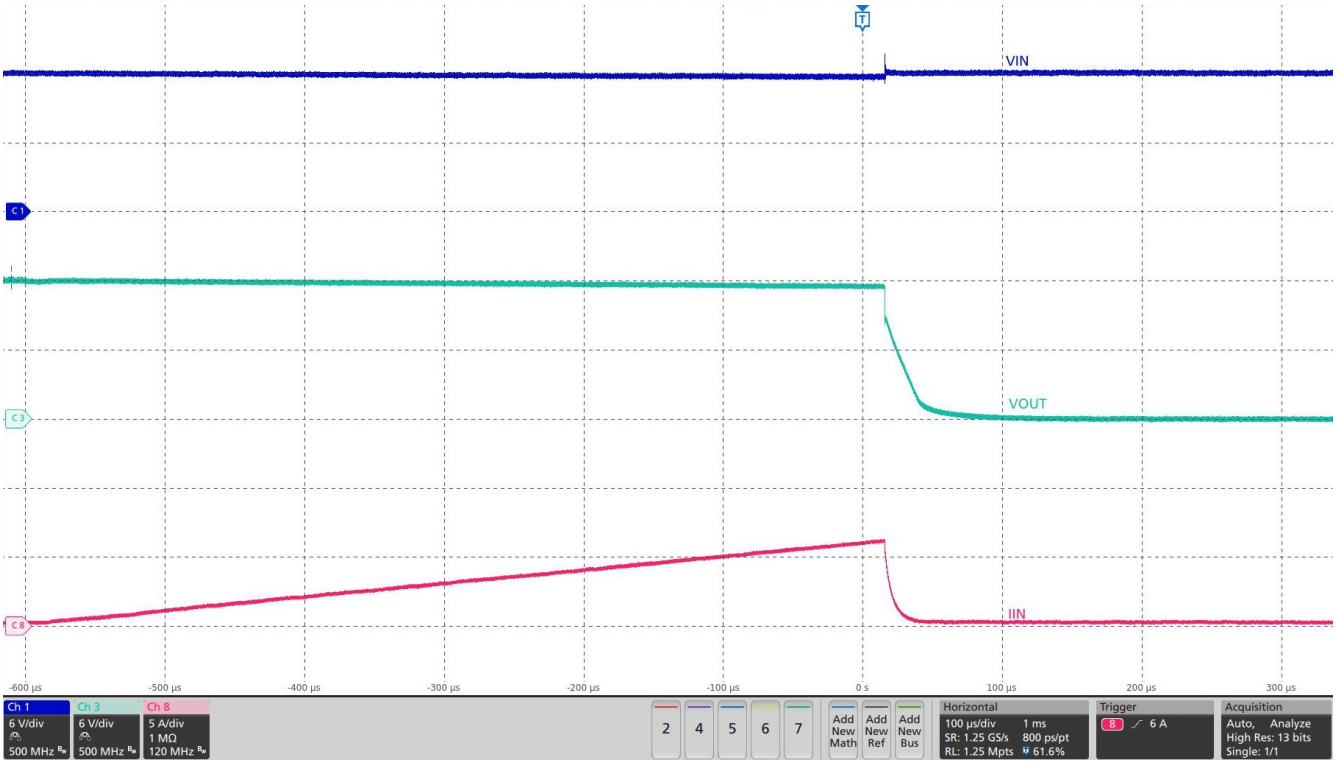


Figure 5-3. Over Current Response of TPS259474x for 6 A Current Limit Setting

5.3 Output Hot-Short Test

Use the following instructions to perform output Hot-Short test:

1. Set the input supply voltage VIN to 12 V and current limit of 10 A. Turn ON the power supply.
2. Short the output of the device for example, VOUT to GND with a shorter cable.
3. Observe the waveforms using an oscilloscope.

Figure 5-4 shows test waveform of output hot-short on the TPS25947EVM eFuse Evaluation Board .

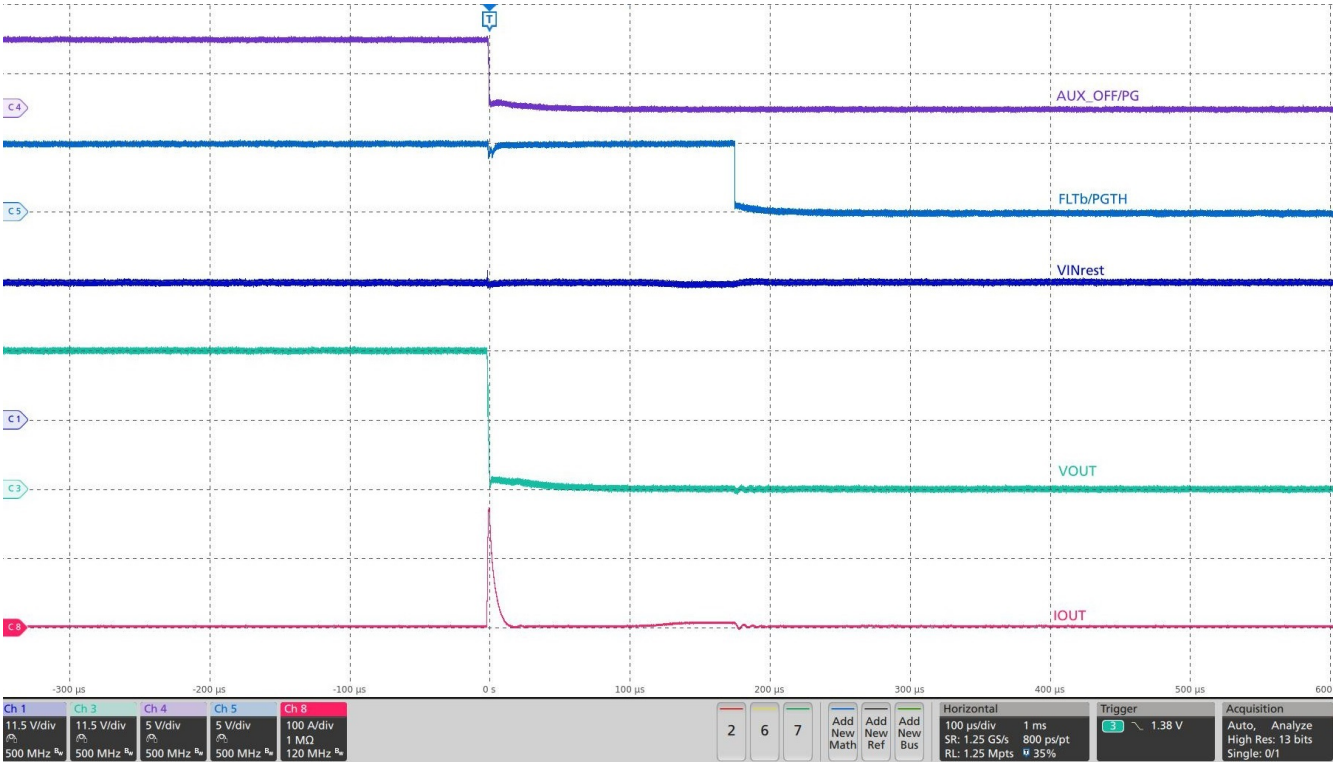


Figure 5-4. Output Hot-short response of TPS25947xx device at Vin = 23V, Cout = 10uF, ITIMER = OPEN, ILIM = 549Ω

5.4 Wakeup into Short Test

Use the following instructions to perform wakeup into short test:

1. Set the input supply voltage VIN to 12 V and current limit of 10 A. Turn OFF the power supply.
2. Short the output of the device for example, VOUT to GND with a shorter cable.
3. Turn ON the power supply.

Figure 5-5 shows test waveform of wakeup into output short on the TPS25947EVM eFuse Evaluation Board.

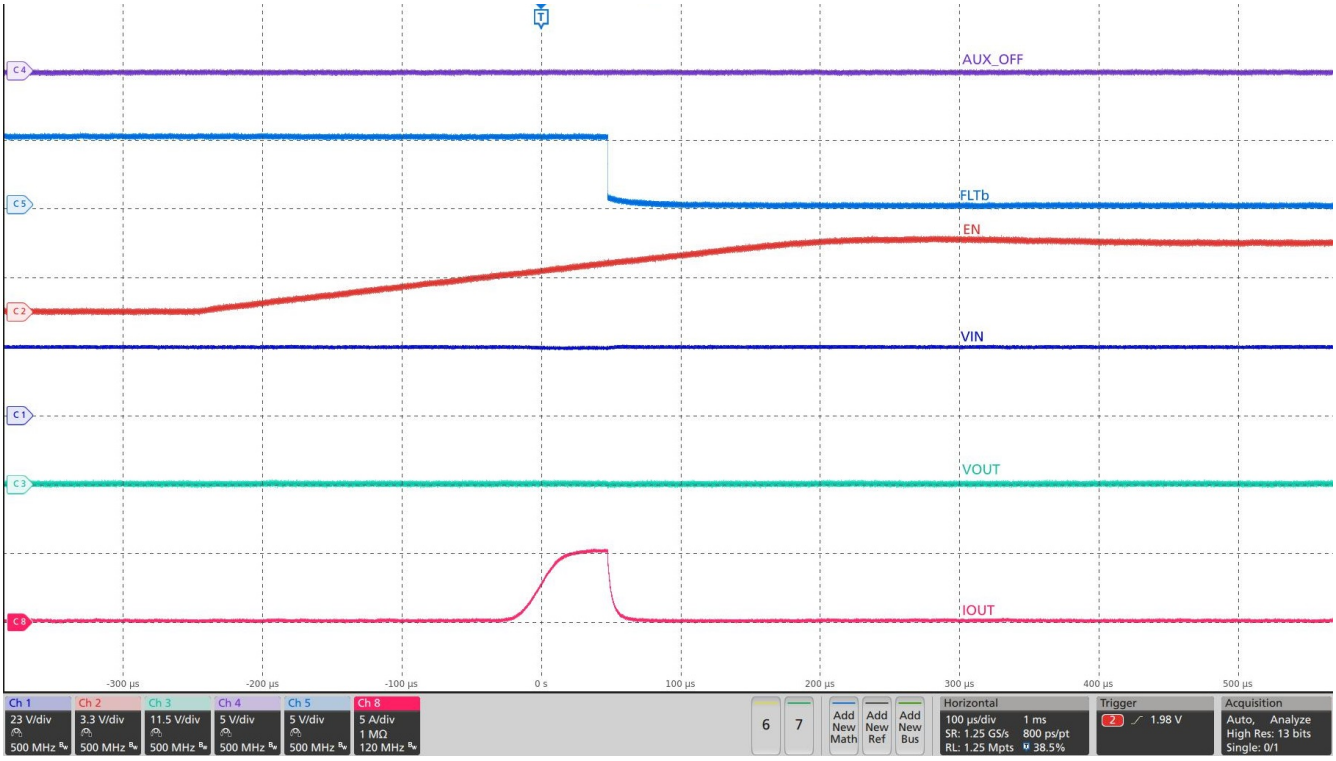


Figure 5-5. Test Waveform of Wakeup Into Output Short for TPS25947xx Device at Vin = 23V, dVdt = OPEN, Cout = 470 uF, ILIM = 549Ω

5.5 Overvoltage Clamp Test

Use the following instructions to perform overvoltage protection test:

1. Remove input TVS diodes.
2. Set the input supply voltage VIN to 12 V and current limit of 10 A. Apply the supply between VIN1 and PGND1 at connector J1 and enable the power supply.
3. Increase the input supply VIN from 12 V to 16 V and observe the waveforms using an oscilloscope.

Figure 5-6 shows over voltage response of TPS259472x on TPS25947EVM eFuse Evaluation Board.

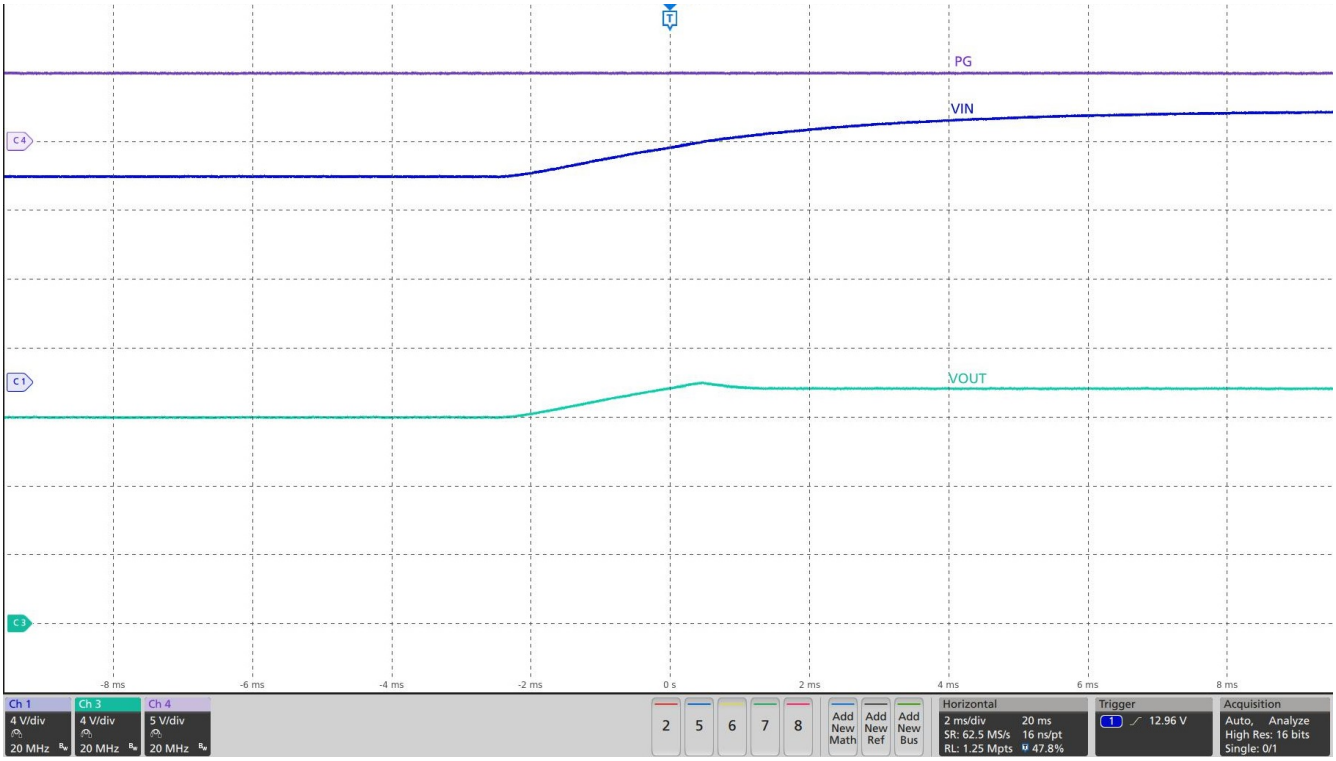


Figure 5-6. Over Voltage Protection Response of TPS259472x Device

5.6 Priority PowerMux Test

Use the following instructions to perform PowerMux test:

1. Use Channel 2 and Channel 3 to test PowerMuxing capability of TPS25947xx.
2. Populate R40 with 0Ω resistor to connect VOUT2 and VOUT3.
3. Connect J14 jumper setting to 2-3 to connect AUX_OFF signal of Channel 2 to OVLO signal of Channel 3. This setting will make the Channel 2 as primary and Channel 3 as secondary channels.
4. Change the UVLO threshold setting for each channel as per the voltage intended to be applied.
5. Apply primary voltage on Channel 2 and Secondary voltage on Channel 3.
6. Test various conditions
   a. Turn off primary channel to see output being powered from secondary channel.
   b. Turn back on primary channel to see output connected back to primary from secondary channel.

Test Waveform of PowerMux configuration when primary voltage = 5V, secondary voltage =12v , ouput transitioning from primary to secondary voltage as primary loses power

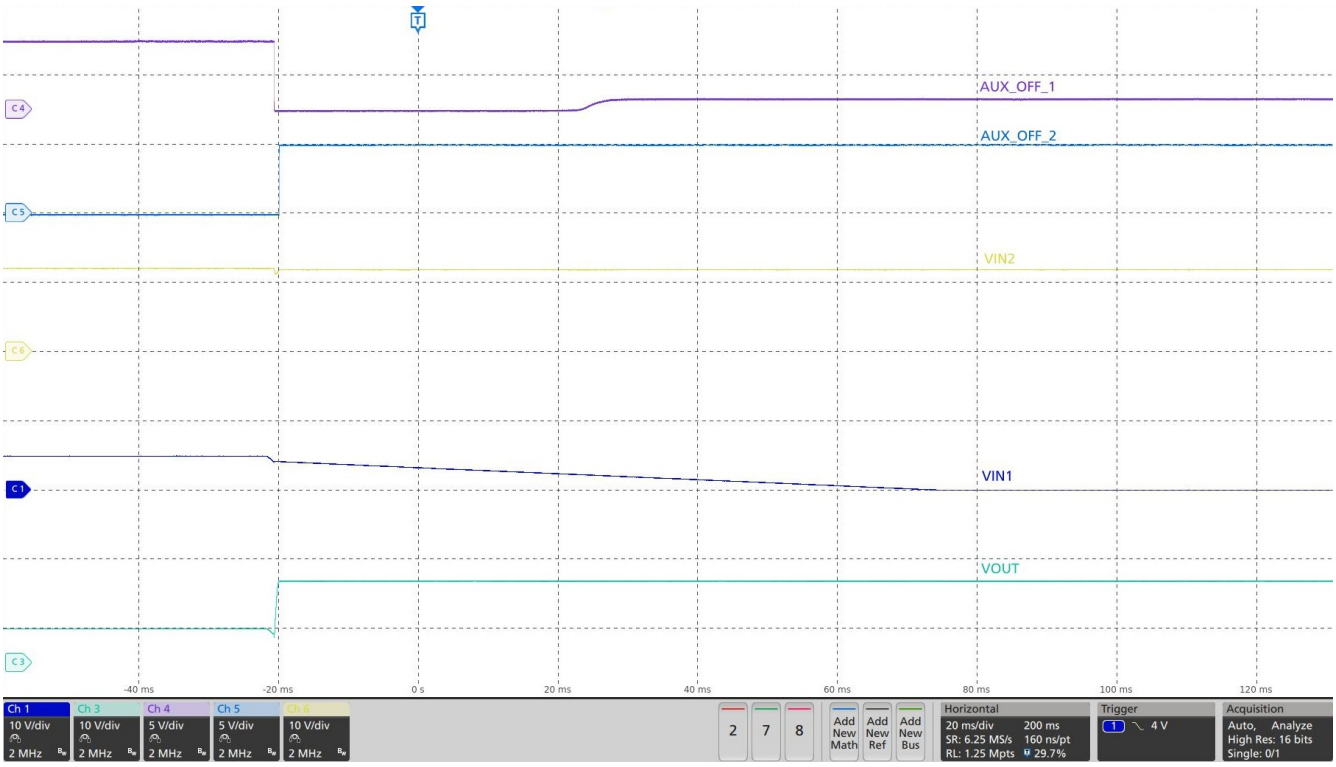


Figure 5-7. Priority PowerMux test on TPS259470x

6 EVAL Board Assembly Drawings and Layout Guidelines

6.1 PCB Drawings

Figure 6-1 shows component placement of the EVAL Board. Figure 6-2 shows PCB layout images.

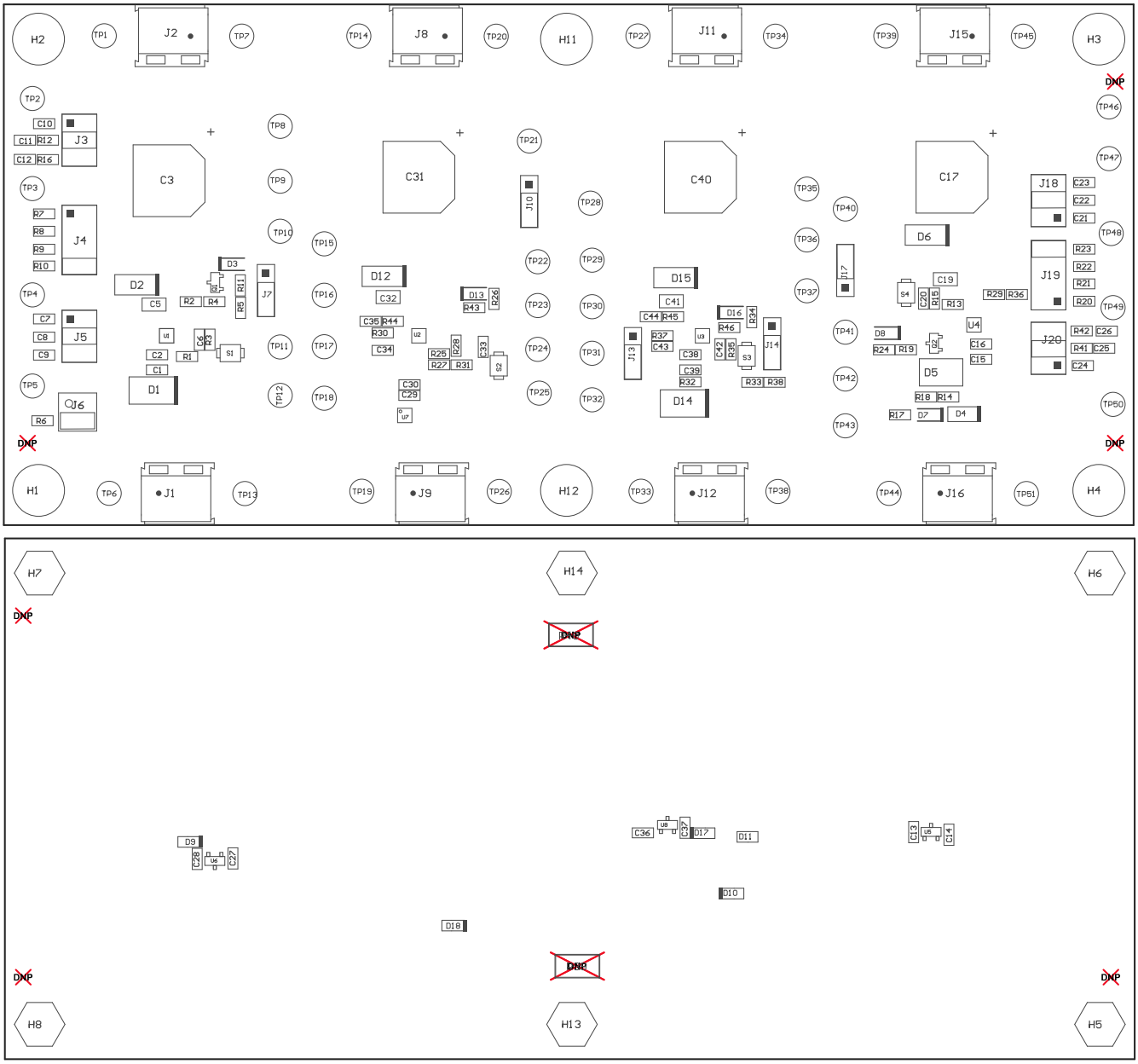


Figure 6-1. TPS25947EVM Board (a) Top Assembly (b) Bottom Assembly

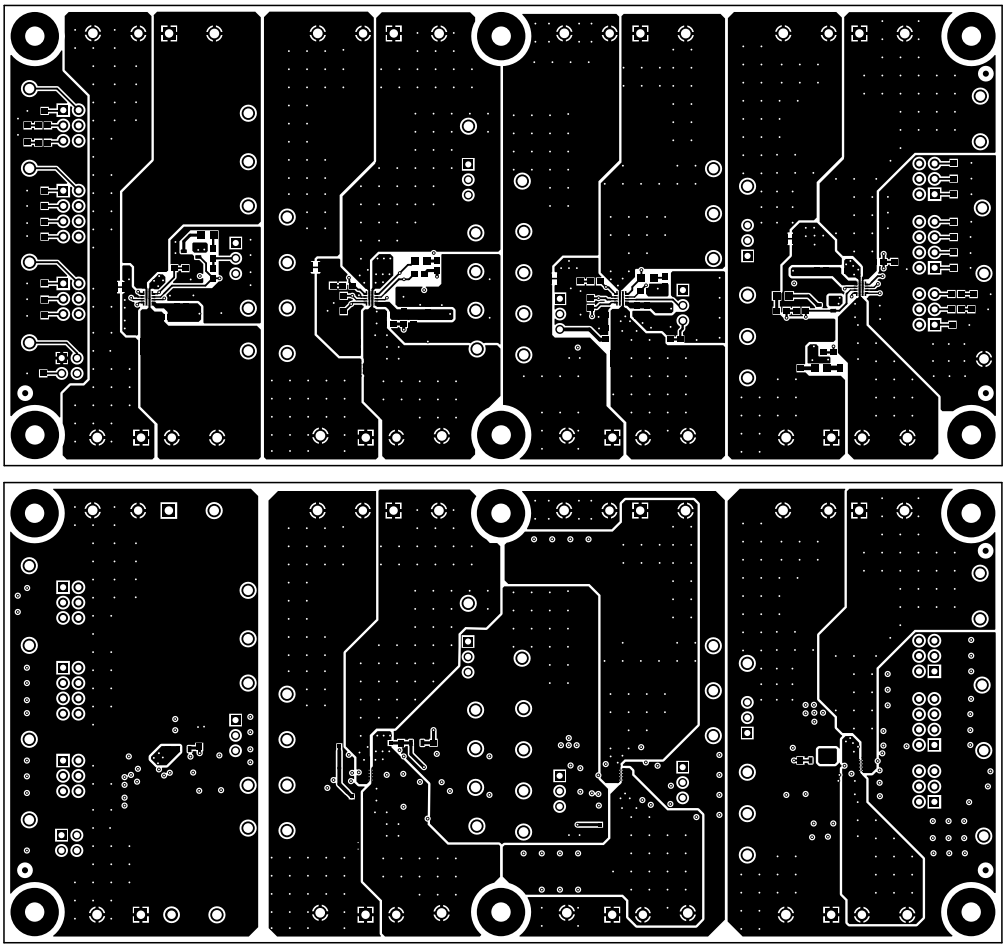


Figure 6-2. TPS25947EVM Board (a) Top Layer (b) Bottom Layer

7 Bill Of Materials (BoM)

Table 7-1 lists the EVM BOM.

Table 7-1. TPS25947EVM BoM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB	1		Printed Circuit Board		PSIL100	Any
C1, C15, C29, C38	4	1uF	CAP, CERM, 1 uF, 35 V, +/- 10%, X7R, 0603	0603	C1608X7R1V105K080AC	TDK
C2, C16, C30, C39	4	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	C1608X7R1H104K080AA	TDK
C3, C17, C31, C40	4	220uF	CAP, AL, 220 uF, 35 V, +/- 20%, 0.15 ohm, SMD	SMT Radial G	EEE-FC1V221P	Panasonic
C5, C19, C32, C41	4	10uF	CAP, CERM, 10 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 1206	1206	CGA5L1X7R1H106K160AC	TDK
C6, C20, C33, C42	4	100pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	885012006057	Wurth Elektronik
C7, C21	2	220pF	CAP, CERM, 220 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603C221K5RACTU	Kemet
C8, C22, C34, C43	4	2200pF	CAP, CERM, 2200 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603C222K5RAC	Kemet
C9, C12, C23, C26	4	0.022uF	CAP, CERM, 0.022 uF, 50 V, +/- 10%, X7R, 0603	0603	C0603X223K5RACTU	Kemet
C10, C24	2	3300pF	CAP, CERM, 3300 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603X332K5RACTU	Kemet
C11, C25, C35, C44	4	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H103JA01D	MuRata
C13, C14, C27, C28, C36, C37	6	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A	AVX
D1, D14	2	16V	Diode, TVS, Uni, 16 V, 26 Vc, SMB	SMB	SMBJ16A-13-F	Diodes Inc.
D2, D6, D12, D15	4	30V	Diode, Schottky, 30 V, 3 A, SMA	SMA	B330A-13-F	Diodes Inc.
D3	1	PG1	LED, Green, SMD	LED_0805	LTST-C170KGKT	Lite-On

Table 7-1. TPS25947EVM BoM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
D4	1	30V	Diode, Zener, 30 V, 500 mW, SOD-123	SOD-123	DDZ30D-7	Diodes Inc.
D5	1	16V	Diode, TVS, Bi, 16 V, SMB	SMB	SMBJ16CA	Littelfuse
D7	1	RPP	LED, Red, SMD	Red 0805 LED	LTST-C170KRKT	Lite-On
D8	1	PG4	LED, Green, SMD	LED_0805	LTST-C170KGKT	Lite-On
D9, D10, D17, D18	4	30V	Diode, Schottky, 30 V, 0.2 A, SOD-323	SOD-323	BAT54WS-7-F	Diodes Inc.
D11	1	12V	Diode, TVS, Bi, 12 V, 29.5 Vc, SOD323, 2-Leads, Body 1.9x1.45mm, No Polarity Mark	SOD323, 2-Leads, Body 1.9x1.45mm, No Polarity Mark	CDSOD323-T12SC	Bourns
D13	1	FLTb2	LED, Red, SMD	Red 0805 LED	LTST-C170KRKT	Lite-On
D16	1	FLTb3	LED, Red, SMD	Red 0805 LED	LTST-C170KRKT	Lite-On
H1, H2, H3, H4, H11, H12	6		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8, H13, H14	6		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2, J8, J9, J11, J12, J15, J16	8		Terminal Block, 2x1, 5.08mm, TH	10.16x15.2x9mm	282841-2	TE Connectivity
J3, J5, J18, J20	4		Header, 100mil, 3x2, Tin, TH	3x2 Header	PEC03DAAN	Sullins Connector Solutions
J4, J19	2		Header, 100mil, 4x2, Tin, TH	Header, 4x2, 100mil, Tin	PEC04DAAN	Sullins Connector Solutions
J6	1		Header, 100mil, 2x2, Tin, TH	Header, 2x2, 2.54mm, TH	PEC02DAAN	Sullins Connector Solutions
J7, J10, J13, J14, J17	5		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
Q1, Q2	2	60V	MOSFET, N-CH, 60 V, 115 A, SOT-23	SOT-23	2N7002	Fairchild Semiconductor
R1, R2, R25, R27, R29, R32, R33	7	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0603	0603	RC0603FR-071ML	Yageo, Yageo America

Table 7-1. TPS25947EVM BoM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R3, R4, R28, R35, R36	5	124k	RES, 124 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603124KFKEA	Vishay-Dale
R5, R19	2	10.0k	RES, 10.0 k, 0.1%, 0.1 W, 0603	0603	RG1608P-103-B-T5	Susumu Co Ltd
R6	1	392k	RES, 392 k, 1%, 0.1 W, 0603	0603	RC0603FR-07392KL	Yageo
R7, R20	2	6.65k	RES, 6.65 k, 1%, 0.1 W, 0603	0603	RC0603FR-076K65L	Yageo
R8, R21	2	1.65k	RES, 1.65 k, 1%, 0.1 W, 0603	0603	RC0603FR-071K65L	Yageo
R9, R22	2	750	RES, 750, 1%, 0.1 W, 0603	0603	RC0603FR-07750RL	Yageo
R10, R23, R30, R37	4	549	RES, 549, 1%, 0.1 W, 0603	0603	RC0603FR-07549RL	Yageo
R11, R24, R26, R34	4	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	0603	RC0603FR-071KL	Yageo
R12, R16, R41, R42, R44, R45	6	100	RES, 100, 1%, 0.1 W, 0603	0603	RC0603FR-07100RL	Yageo
R13, R14	2	2.00Meg	RES, 2.00 M, 1%, 0.1 W, 0603	0603	RC0603FR-072ML	Yageo
R15	1	249k	RES, 249 k, 1%, 0.1 W, 0603	0603	RC0603FR-07249KL	Yageo
R17	1	887	RES, 887, 1%, 0.1 W, 0603	0603	RC0603FR-07887RL	Yageo
R18	1	158k	RES, 158 k, 1%, 0.1 W, 0603	0603	RC0603FR-07158KL	Yageo
R31	1	57.6k	RES, 57.6 k, 1%, 0.1 W, 0603	0603	RC0603FR-0757K6L	Yageo
R38	1	78.7k	RES, 78.7 k, 1%, 0.1 W, 0603	0603	RC0603FR-0778K7L	Yageo
R43, R46	2	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	RC0603FR-07100KL	Yageo
S1, S2, S3, S4	4		SWITCH TACTILE SPST-NO 0.05A 12V	3x1.6x2.5mm	B3U-1000P	Omron Electronic Components
SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J10, SH-J11, SH-J12, SH-J13, SH-J16, SH-J19, SH-J20	12	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions

Table 7-1. TPS25947EVM BoM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
TP1, TP6, TP8, TP14, TP15, TP19, TP27, TP28, TP33, TP39, TP44, TP50	12		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
TP2, TP3, TP4, TP5, TP9, TP11, TP12, TP16, TP17, TP18, TP22, TP23, TP24, TP25, TP29, TP30, TP31, TP32, TP35, TP36, TP37, TP40, TP42, TP43, TP46, TP47, TP48, TP49	28		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone
TP7, TP13, TP20, TP26, TP34, TP38, TP45, TP51	8		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP10, TP21, TP41	3		Test Point, Multipurpose, Orange, TH	Orange Multipurpose Testpoint	5013	Keystone
U1	1		2.7- 23V, 5.5 A, 28 mΩ Reverse Current Blocking eFuse with Input Reverse Polarity Protection	VQFN-HR10	TPS259472ARPWT	Texas Instruments
U2, U3	2		2.7- 23V, 5.5 A, 24.5 mΩ Reverse Current Blocking eFuse with Input Reverse Polarity Protection	VQFN-HR10	TPS259470LRPWT	Texas Instruments
U4	1		2.7- 23V, 5.5 A, 28 mΩ Reverse Current Blocking eFuse with Input Reverse Polarity Protection	VQFN10		Texas Instruments
U5, U6, U8	3		100 mA, Quasi Low-Dropout Linear Voltage Regulator, 3-pin SOT-23, Pb-Free	DBZ0003A	LM3480IM3-3.3/NOPB	Texas Instruments
U7	1		22-V Precision Surge Protection Clamp, DRV0006A (WSON-6)	DRV0006A	TVS2200DRVR	Texas Instruments
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R39, R40	0	0	RES, 0, 5%, 1 W, 2512	2512	RC6432J000CS	Samsung

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
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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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

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8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

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9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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