

**ABSTRACT**

This user's guide describes the evaluation module (EVM) for the TPS25210 eFuse. The TPS25210 device is a 2.7 V to 5.7 V, 4-A eFuse with integrated 31 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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1 Introduction

The *TPS25210EVM eFuse Evaluation Board* allows reference circuit evaluation of Texas Instruments (TI) TPS25210 eFuse. The TPS25210 device is a 2.7 V to 5.7 V, 4-A eFuse with integrated 31 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 TPS25210EVM eFuse evaluation board features include:

- 2.7 V to 5.7 V (typ) operation
- 0.5 A to 4.44 A programmable current limit using onboard jumpers
- Programmable output voltage slew rate control
- Programmable transient current blanking timer
- Programmable current limit
- TVS diode for input transient protection
- On-board Schottky diode at output prevents negative spike during overcurrent faults
- LED status for Power Good and Input Reverse Polarity Fault indication

1.2 EVM Applications

This EVM can be use on the following applications:

- Power MUX/ORing
- Adapter input protection
- Storage – eSSD/cSSD
- e-Meters
- Smart speakers
- Headphones
- USB power accessories

2 Description

The TPS25210EVM eFuse Evaluation Board enables the evaluation of TPS25210A and TPS25210L eFuses from TPS25210 family. The input power is applied at connector J1, while J2 provides the output connection to the load; refer to the schematic in [Figure 3-1](#) and EVM test setup in [Figure 5-1](#). TVS diodes D3 provides input protection from transient overvoltages while Schottky diode D2 provides output protection for the TPS25210 eFuses.

S1 allows U1 to be RESET or disabled. A power good (PG) indicator is provided by D5. Scaled device current can be monitored at TP8 with a scale factor of 0.13 V/A.

Table 2-1. TPS25210EVM eFuse Evaluation Board Options and Setting

EVM Function	Vin UVLO Threshold	Vin OVC Threshold	ITimer	Output Slew Rate, dVdT	Current Limit	
					Low Setting	Hi Setting
Performance evaluation of TPS25210, 2.7 V to 5.7 V, 4-A eFuse	4.5 V	Selectable OVC - 3.8 V and 5.7 V	Selectable - 0.183 ms, 1.83 ms, 18.3 ms	Selectable - 0.6 mV/us, 0.2 mV/us, 0.09 mV/us	0.5 A	4.44 A

3 Schematic

Figure 3-1 illustrates the EVM schematic.

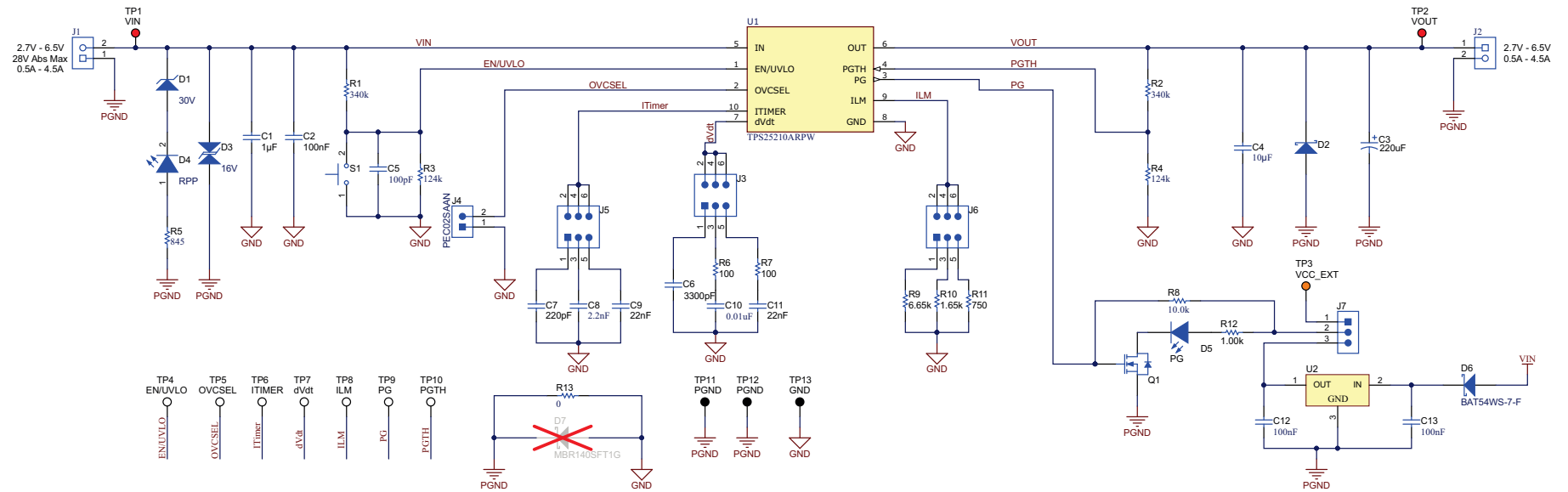


Figure 3-1. TPS25210EVM eFuse Evaluation Board Schematic

4 General Configurations

4.1 Physical Access

Table 4-1 lists the TPS25210EVM eFuse Evaluation Board input and output connector functionalities. Table 4-2 and Table 4-3 describe the availability of test points and the functionalities of the jumpers. Table 4-4 describes the functions of signal LEDs.

Table 4-1. Input and Output Connector Functionality

Connector	Label	Description
J1	VIN(+), PGND(-)	Input Power to the eFuse
J2	VOUT(+), PGND(-)	Output Power from the eFuse

Table 4-2. Test Points Description

Test Points	Label	Description
TP1	VIN	Input voltage
TP2	VOUT	Output voltage
TP3	VCC_EXT	External VCC voltage for Power Good indicator
TP4	EN/UVLO	EN/UVLO signal
TP5	OVCSEL	OVCSEL signal
TP6	ITIMER	ITIMER signal
TP7	dVdT	Output voltage ramp control
TP8	ILM	Current limit and monitor signal
TP9	PG	Power good signal
TP10	PGTH	Power good threshold signal
TP11 and TP12	PGND	Power GND signal
TP13	GND	IC GND signal

Table 4-3. Jumper Descriptions and Default Positions

Jumper	Label	Description	Default Jumper Position
J3	dVdT	1-2 Position sets Output Slew Rate to 0.6 V/ms	3-4
		3-4 Position sets Output Slew Rate to 0.2 V/ms	
		5-6 Position sets Output Slew Rate to 0.09 V/ms	
J4	OVCSEL	1-2 Position sets input OVC threshold at 3.87 V	No jumper
		No jumper connection sets input OVC threshold at 5.73 V	
J5	ITIMER	1-2 Position sets the transient current blanking period to 0.183 ms	3-4
		3-4 Position sets the transient current blanking period to 1.83 ms	
		5-6 Position sets the transient current blanking period to 18.3 ms	
J6	ILM	1-2 Position sets the current limit to 0.5 A	5-6
		3-4 Position sets the current limit to 2 A	
		5-6 Position sets the current limit to 4.44 A	
J7	VCC Connection	1-2 Position connects external voltage, VCC_EXT as reference for PG	2-3
		2-3 Position connects on board generated voltage , VCC as reference for PG	

Table 4-4. LED Descriptions

LED	Description
D4	When ON, indicates that reverse polarity voltage is applied at the input
D5	When ON, indicates that Power Good is asserted

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

Minimum a Digital Multi Meter (DMM) 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's guide, the test procedure is described for TPS25210A and TPS25210L devices. Make sure the evaluation board has default jumper settings as shown in [Table 5-1](#). The default under voltage lock out (UVLO) setting is at 4.5 V for this evaluation board. Therefore, the resistances R3 and R4 should be changed to 200 kΩ for the performance evaluation of TPS25210x device at VIN of 3.3 V.

Table 5-1. Default Jumper Setting for TPS25210EVM eFuse Evaluation Board

J3	J4	J5	J6	J7
3-4	No jumper	3-4	5-6	2-3

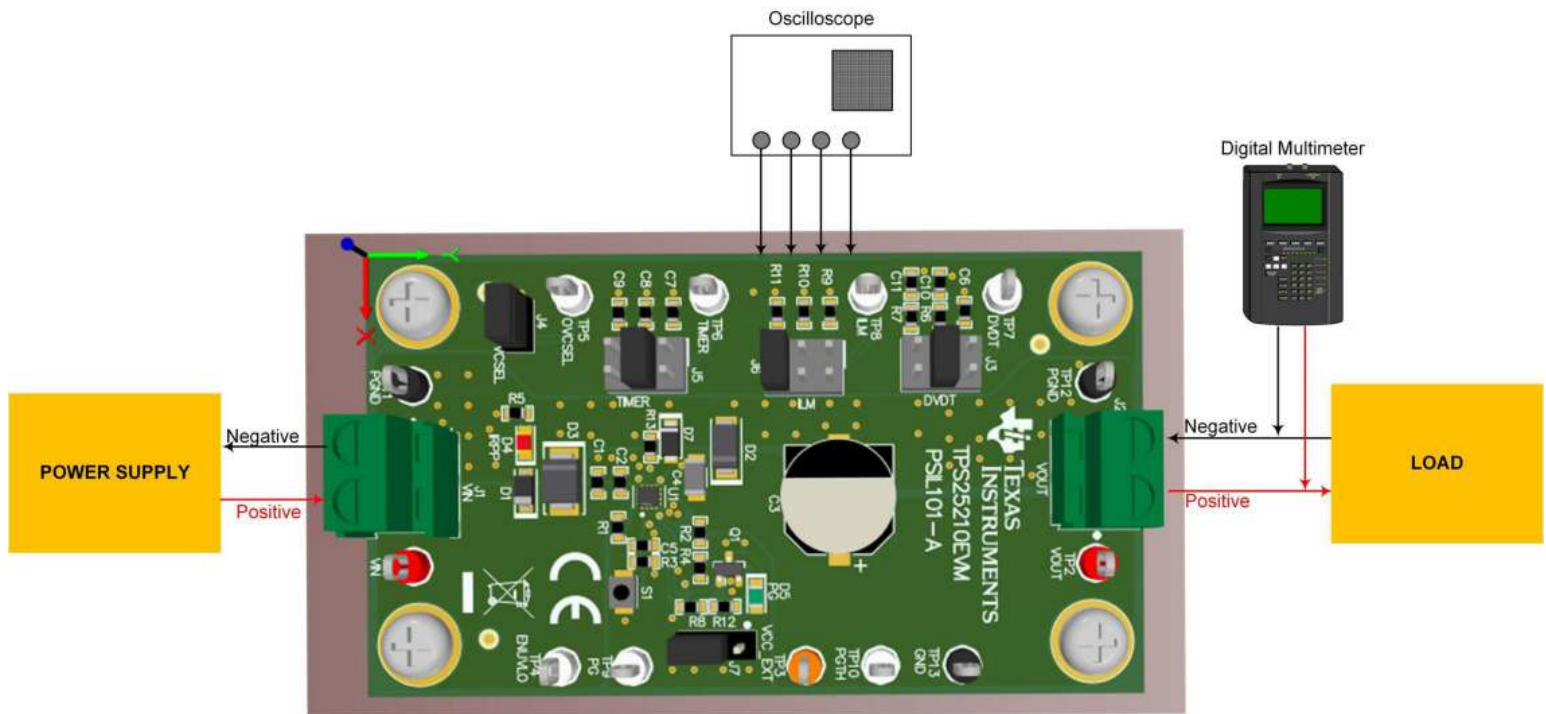


Figure 5-1. TPS25210EVM Setup with Test Equipment

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 5 V, current limit to 10 A.
- Turn OFF the power supply.
- Set the jumper setting on EVM to default position as shown in [Table 5-1](#).

5.1 Start up the eFuse

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

1. Set Jumper J3 position to desired slew rate as mentioned in [Table 4-3](#).
2. Set the input supply voltage VIN to 5 V and current limit of 10 A.
3. Connect the supply between VIN and PGND points of connector J1. Enable the power supply.
4. Observe the waveform at VOUT (TP2) and input current with an oscilloscope to measure the slew rate and rise time of the eFuse with a given input voltage of 5 V.

[Figure 5-2](#) and [Figure 5-3](#) shows example of inrush current captured on the TPS25210EVM eFuse Evaluation Board.

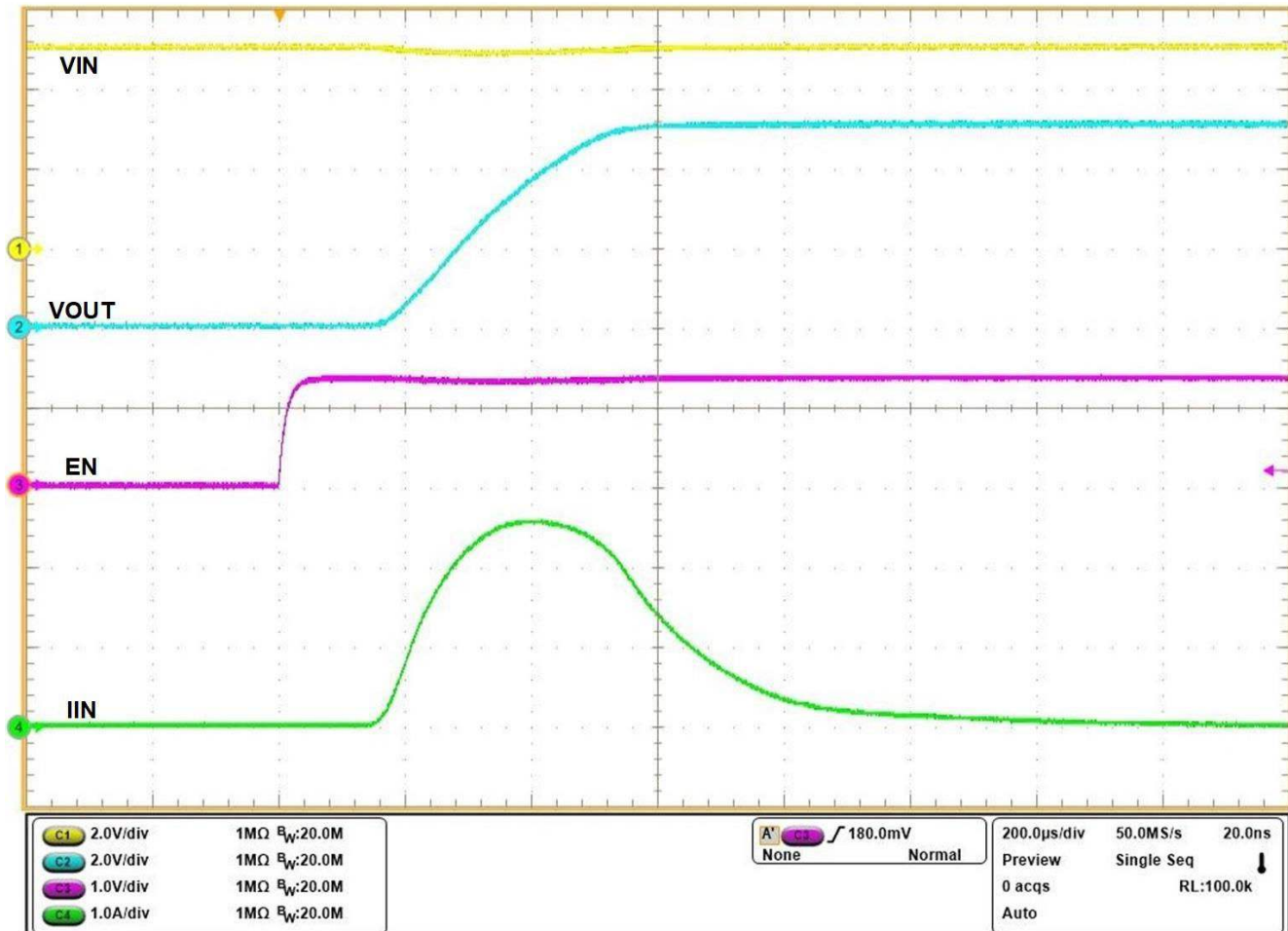


Figure 5-2. TPS25210x Start Up with Enable at VIN = 5 V, Cout = 220 uF, CdVdT = OPEN

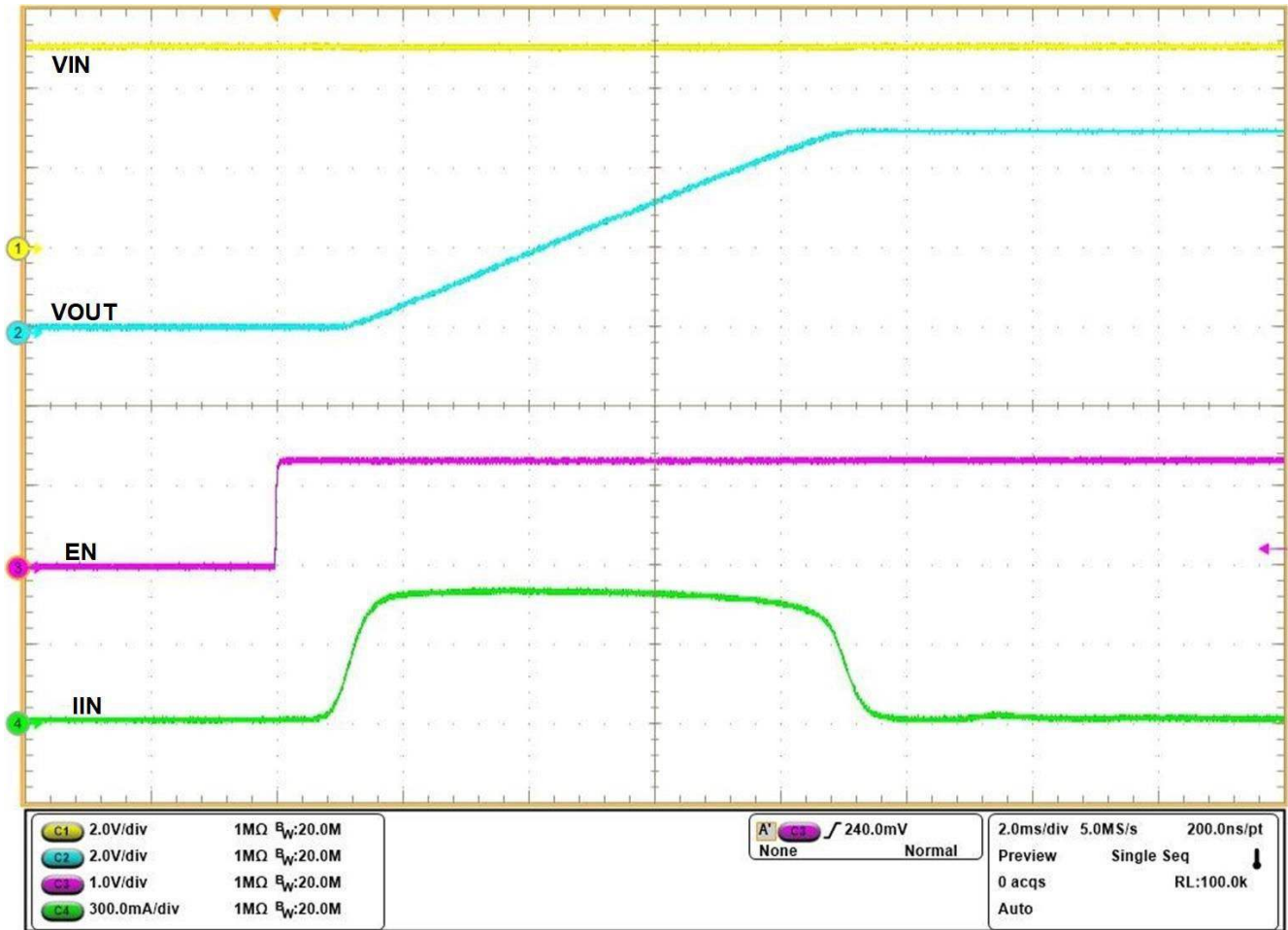


Figure 5-3. TPS25210x Inrush Current with Capacitive Load at VIN = 5 V, Cout = 690 uF, CdVdT = 3300 pF

5.2 Over Current Test

Use the following instructions to perform over current test on TPS25210 eFuse:

1. Place jumper J5 to an appropriate position to obtain required blanking period as per [Table 4-3](#).
2. Set the input supply voltage VIN to 5 V and current limit of 10 A and enable the power supply.
3. Place jumper J6 in suitable position to set required current limit as per [Table 4-3](#).
4. Now apply an over load greater than the set current limit between VOUT and PGND (Use a resistive load to apply over current).
5. The device responds to output over current condition by actively limiting the current after a user adjustable transient fault blanking interval. During active current limit, the output voltage will drop resulting in increased device power dissipation. If the device internal temperature exceeds the thermal shutdown threshold, the device will turn off.

Figure 5-4 shows an example of active current limit test on the TPS25210EVM

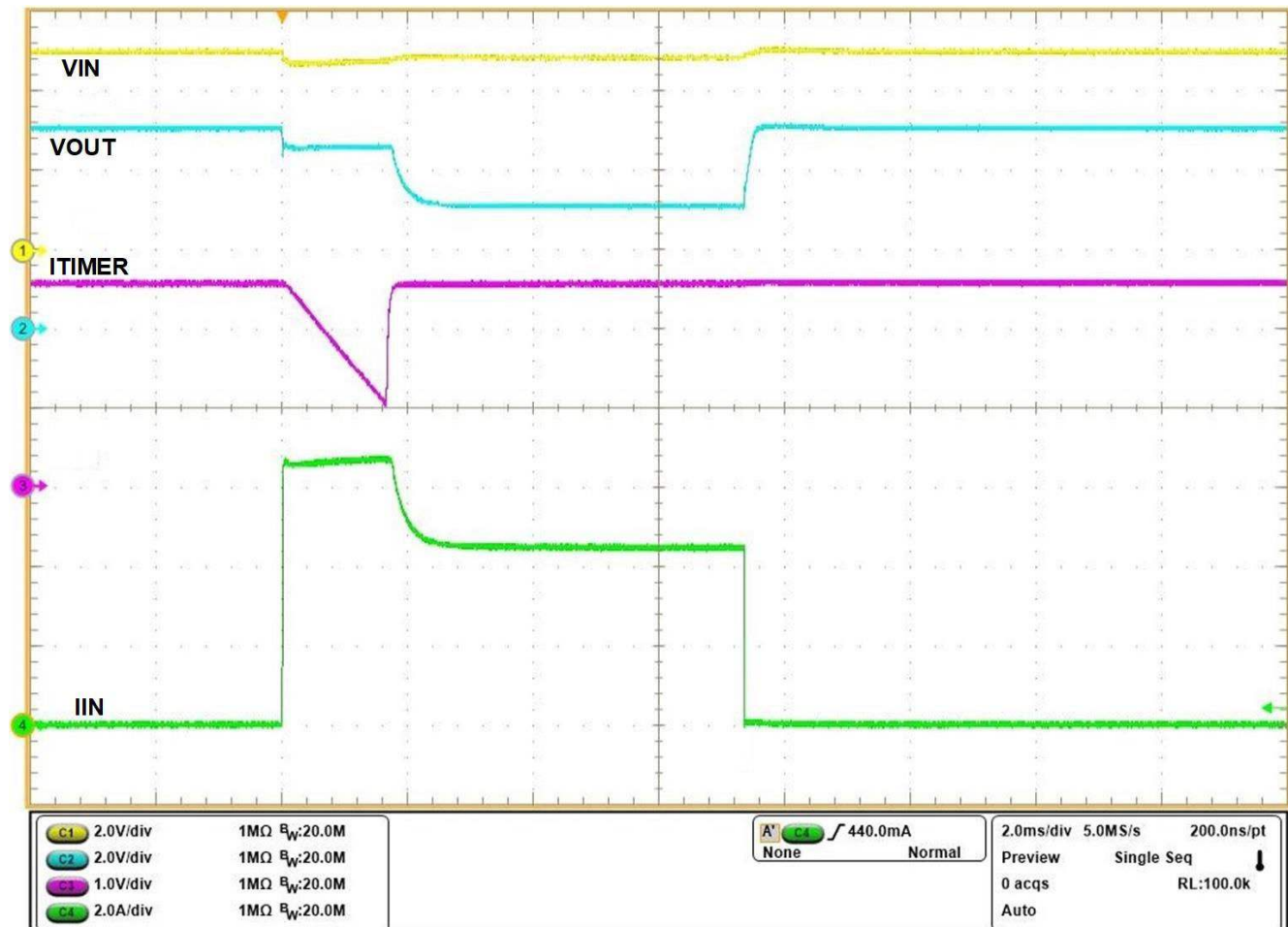


Figure 5-4. Over Current Response of TPS25210x for 4.44-A Current Limit Setting

5.3 Output Hot-Short Test

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

1. Set the input supply voltage V_{IN} to 5 V and current limit of as high as possible. Turn ON the power supply.
2. Short the output of the device for example, V_{OUT} to PGND with a very short cable.
3. Observe the waveforms using an oscilloscope.

Figure 5-5 shows the test waveform of output hot-short on TPS25210EVM eFuse Evaluation Board.

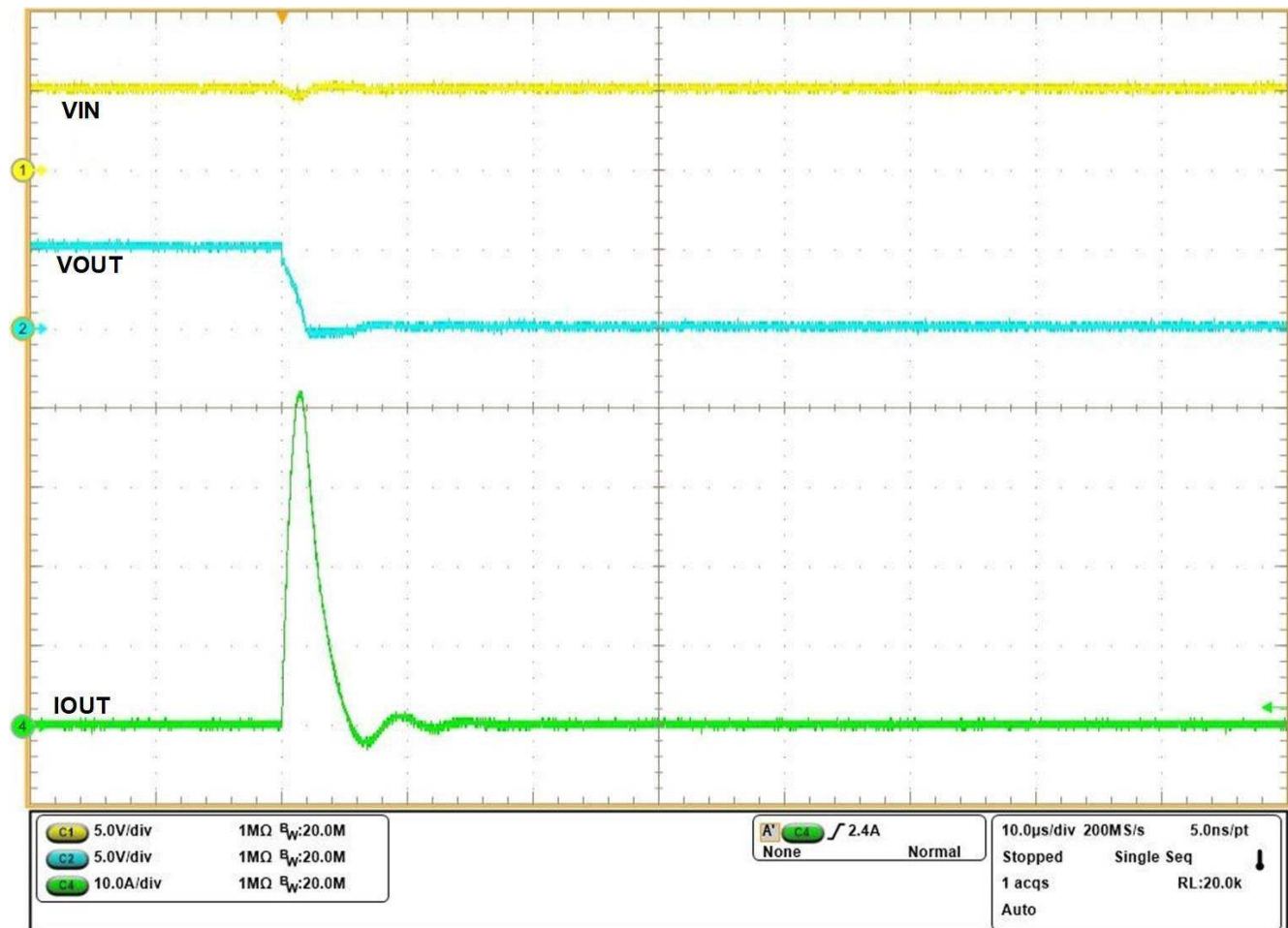


Figure 5-5. Output Hot-Short Response of TPS25210x Device at $V_{IN} = 5\text{ V}$, $C_{out} = 10\text{ }\mu\text{F}$, $RLIM = 750\text{ }\Omega$

5.4 Power Up into Short Test

Use the following instructions to perform wakeup into short test:

1. Set the input supply voltage V_{IN} to 5 V and current limit of 10 A. Keep the power supply OFF.
2. Short the output of the device for example, V_{OUT} to PGND with a very short cable.
3. Turn ON the power supply.

Figure 5-6 shows test waveform of power up into output short on the TPS25210EVM eFuse Evaluation Board.

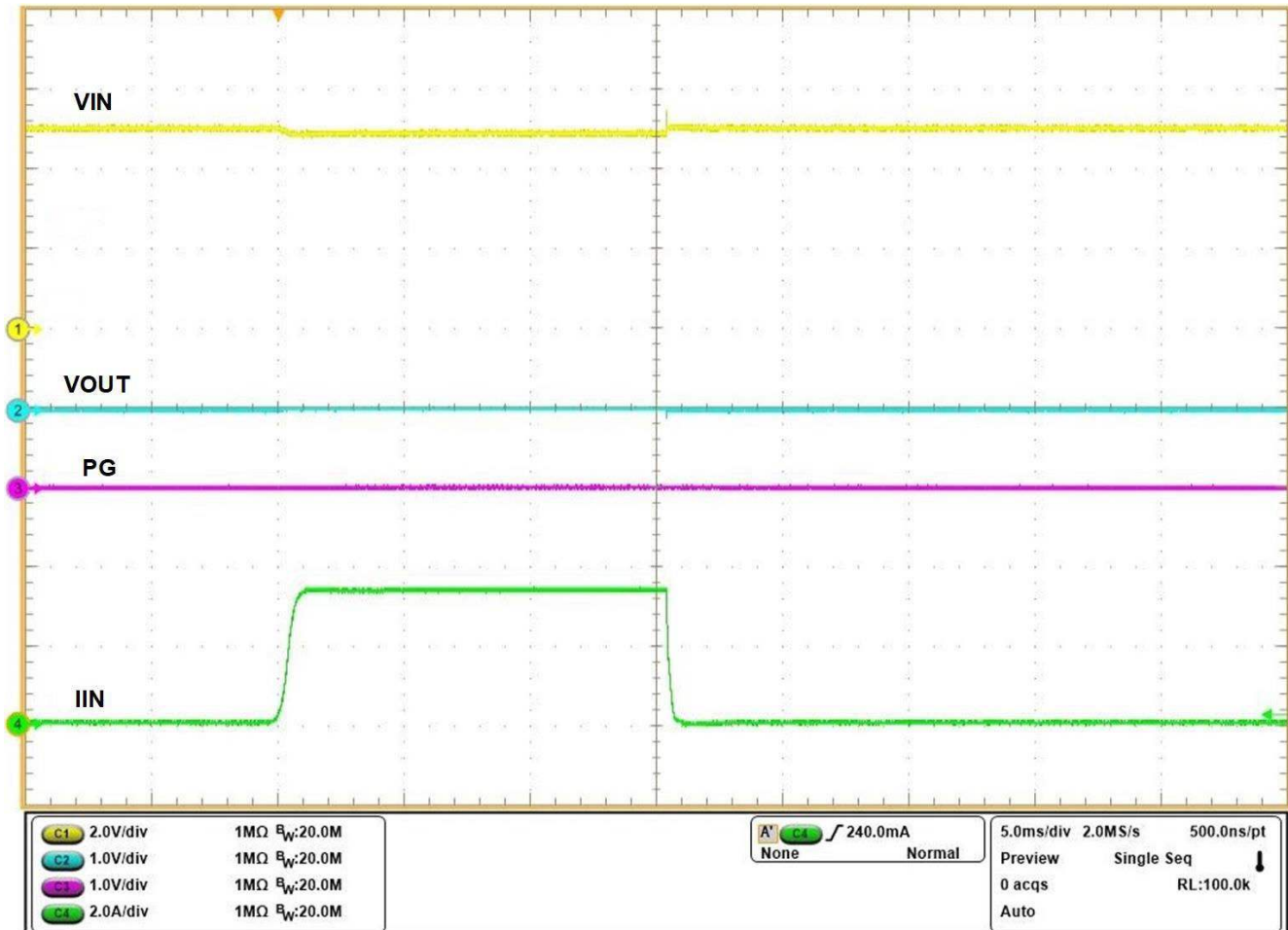


Figure 5-6. Power Up into Output Short Response of TPS25210x Device at $V_{IN} = 5\text{ V}$, $C_{out} = 220\text{ }\mu\text{F}$, $R_{ILM} = 750\text{ }\Omega$, $CITIMER = 2.2\text{ nF}$

5.5 Overvoltage Clamp Test

Use the following instructions to perform overvoltage protection test:

1. Place jumper J4 in suitable position to set required overvoltage clamp voltage as per [Table 4-3](#).
2. Set the input supply voltage VIN to 5 V (Jumper J4 is open) or 3.3 V (Jumper J4 is shorted) and current limit of 10 A. Apply the supply between VIN and PGND at connector J1 and enable the power supply.
3. Increase the input supply VIN from 5 V to 8V (Junper J4 is open) or from 3.3 V to 6 V (Jumper J4 is shorted) and observe the waveforms using an oscilloscope.

Figure 5-7 and Figure 5-8 shows over voltage response on TPS25210EVM eFuse Evaluation Board.

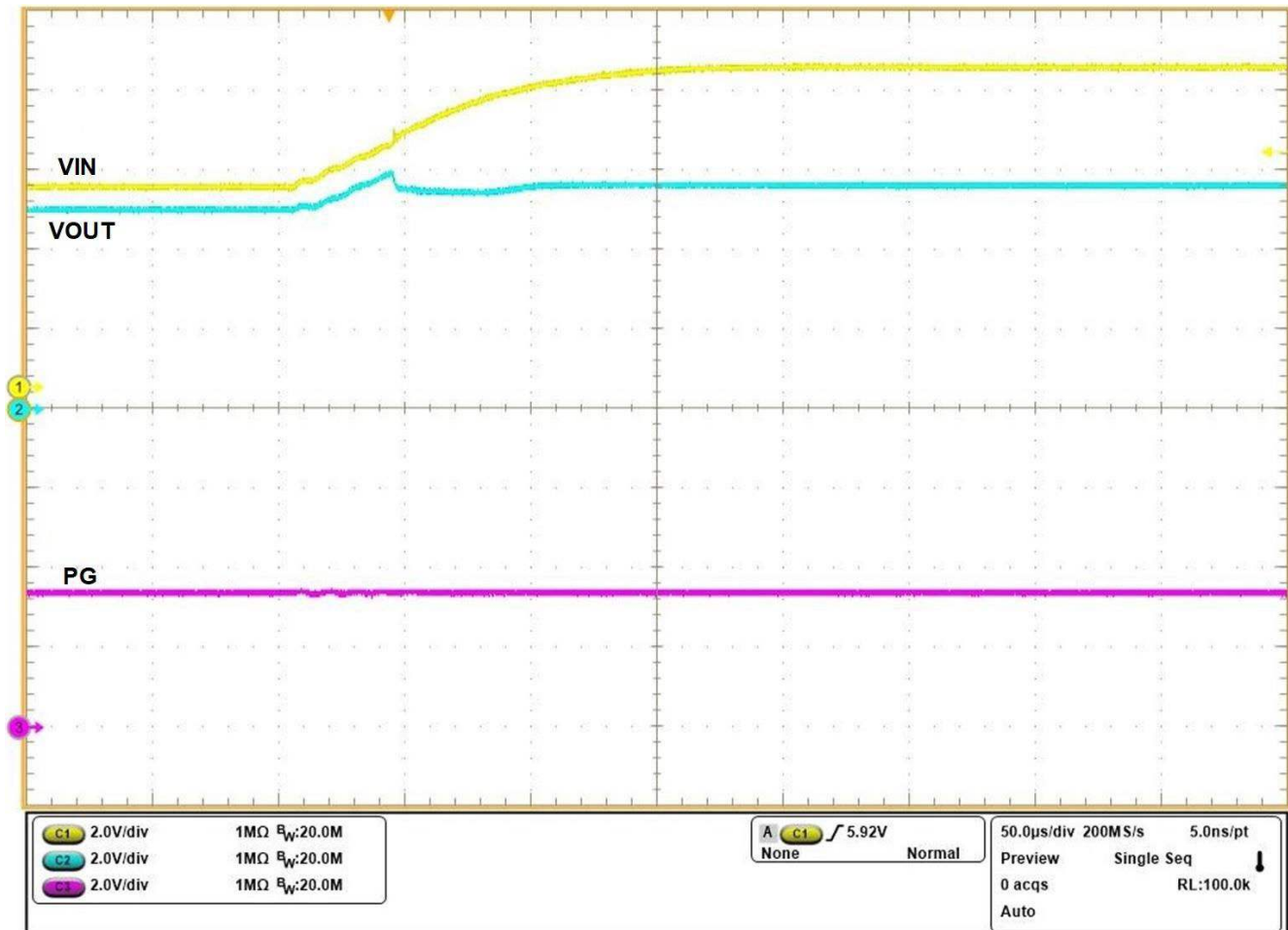


Figure 5-7. Over Voltage Protection Response of TPS25210x Device at ROVCSEL = OPEN, Cout = 220 µF, Iout = 150 mA, VIN ramped up from 5 V to 8 V

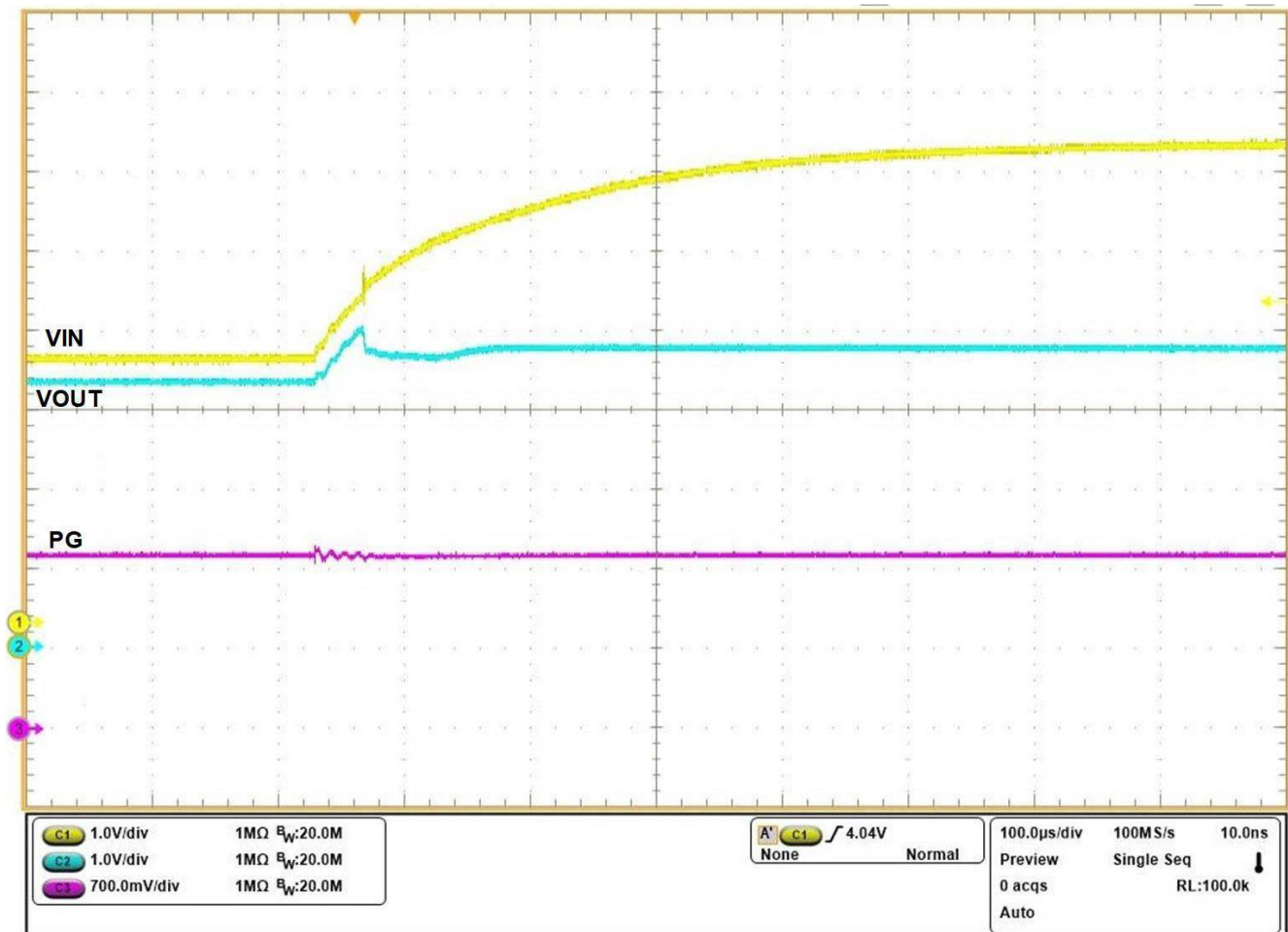


Figure 5-8. Over Voltage Protection Response of TPS25210x Device at ROVCSEL = 0 Ω, Cout = 220 μF, Iout = 120 mA, VIN ramped up from 3.3 V to 6 V

5.6 Reverse Current Blocking Test

Use the following instructions to perform reverse current blocking test:

1. Set the input supply voltage V_{IN} to 5 V and current limit of 10 A. Enable the power supply.
2. Take another power supply, set the output voltage at 10 V, and apply between V_{OUT} and PGND points of connector J2.
3. Observe the input voltage, output voltage, and input current using the oscilloscope.

Figure 5-7 shows reverse current blocking performance on TPS25210EVM eFuse Evaluation Board.

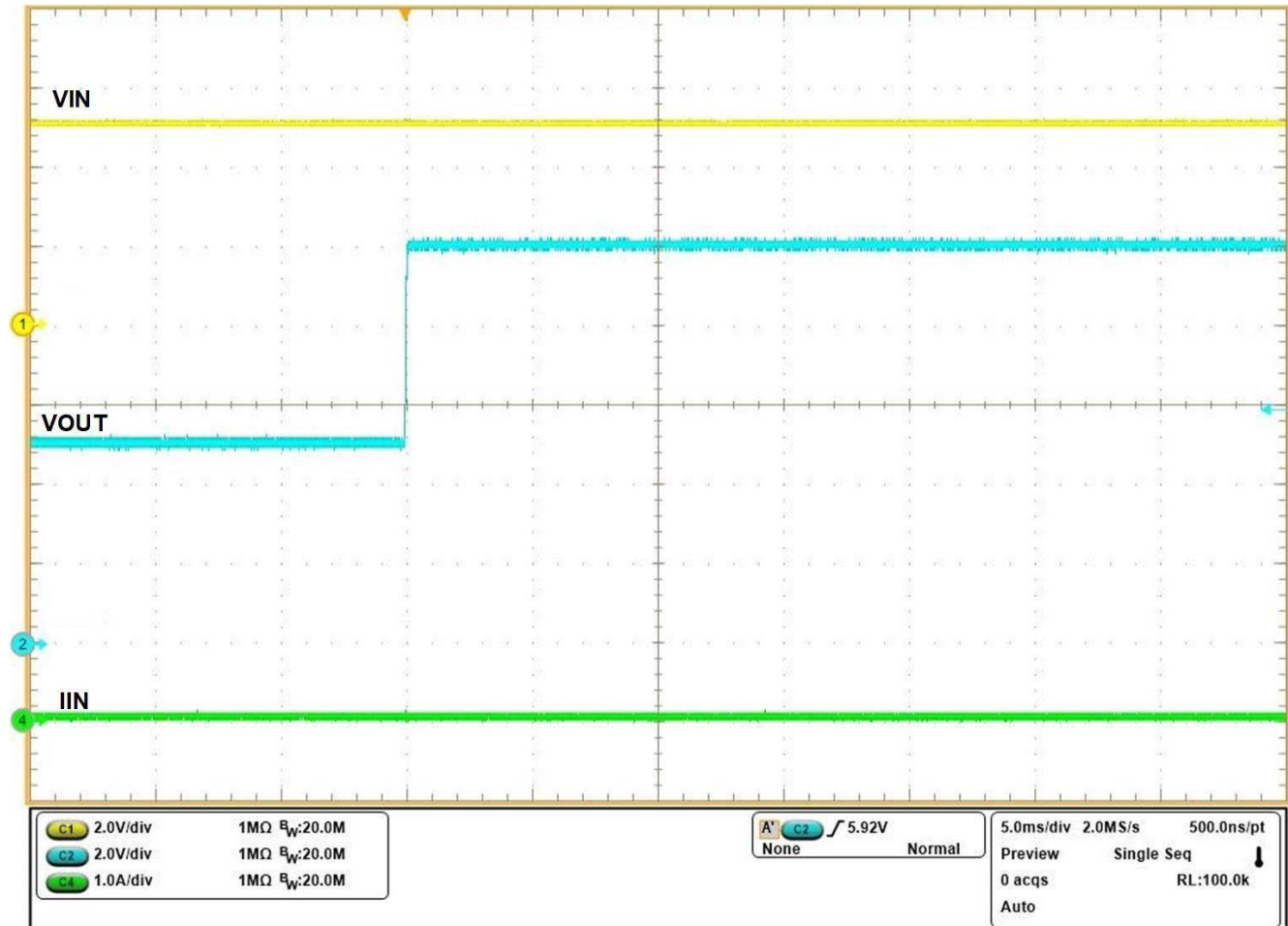


Figure 5-9. Reverse Current Blocking Performance on TPS25210x at $V_{IN} = 5$ V, $C_{out} = 220$ μ F, $V_{OUT} = 10$ V Initially Disconnected and Then Connected

6 EVAL Board Assembly Drawings and Layout Guidelines

6.1 PCB Drawings

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

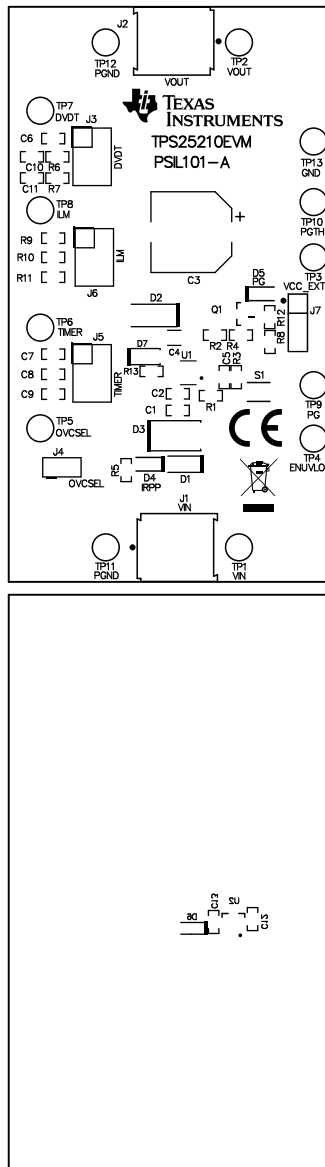


Figure 6-1. TPS25210EVM Board (a) Top Assembly (b) Bottom Assembly

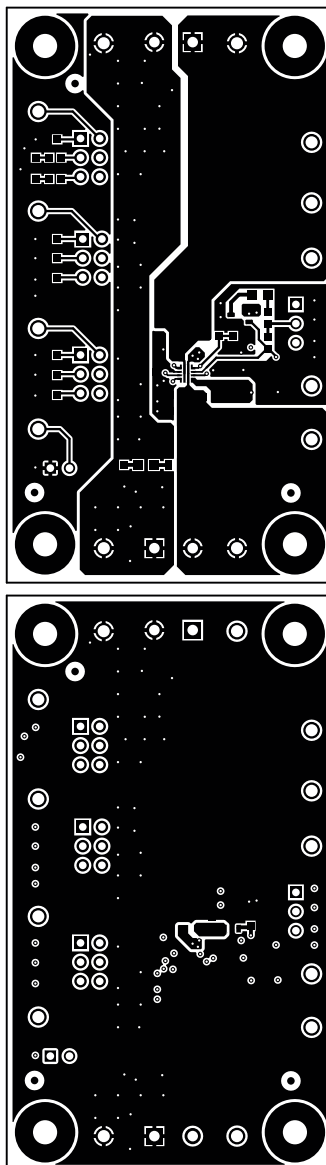


Figure 6-2. TPS25210EVM Board (a) Top Layer (b) Bottom Layer

7 Bill Of Materials (BoM)

Table 7-1 lists the EVM BOM.

Table 7-1. TPS25210EVM BoM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
PCB	1		Printed Circuit Board		PSIL101	Any
C1	1	1uF	CAP, CERM, 1 uF, 35 V, +/- 10%, X7R, 0603	0603	C1608X7R1V105K080AC	TDK
C2	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	C1608X7R1H104K080AA	TDK
C3	1	220uF	CAP, AL, 220 uF, 35 V, +/- 20%, 0.15 ohm, SMD	SMT Radial G	EEE-FC1V221P	Panasonic
C4	1	10uF	CAP, CERM, 10 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 1206	1206	CGA5L1X7R1H106K160AC	TDK
C5	1	100pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NPO, 0603	0603	885012006057	Würth Elektronik
C6	1	3300pF	CAP, CERM, 3300 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603X332K5RACTU	Kemet
C7	1	220pF	CAP, CERM, 220 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603C221K5RACTU	Kemet
C8	1	2200pF	CAP, CERM, 2200 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603C222K5RACTU	Kemet
C9, C11	2	0.022uF	CAP, CERM, 0.022 uF, 50 V, +/- 10%, X7R, 0603	0603	C0603X223K5RACTU	Kemet
C10	1	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NPO, 0603	0603	GRM1885C1H103JA01D	MuRata
C12, C13	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A	AVX
D1	1	30V	Diode, Zener, 30 V, 500 mW, SOD-123	SOD-123	DDZ30D-7	Diodes Inc.
D2	1	30V	Diode, Schottky, 30 V, 3 A, SMA	SMA	B330A-13-F	Diodes Inc.
D3	1	16V	Diode, TVS, Bi, 16 V, SMB	SMB	SMBJ16CA	Littlefuse
D4	1	LED-RPP	LED, Red, SMD	LED-0805- Red	LTST-C170KRKT	Lite-On
D5	1	LED-PG	LED, Green, SMD	LED-0805-Green	LTST-C170KGKT	Lite-On
D6	1	30V	Diode, Schottky, 30 V, 0.2 A, SOD-323	SOD-323	BAT54WS-7-F	Diodes Inc.
D7	1	40V	Diode, Schottky, 40 V, 1 A, SOD-123FL	SOD-123FL	MBR140SFT1G	ON Semiconductor

Table 7-1. TPS25210EVM BoM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
H1, H2, H3, H4	4		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	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2	2		Terminal Block, 2x1, 5.08mm, TH	10.16x15.2x9mm	282841-2	TE Connectivity
J3, J5, J6	3		Header, 100mil, 3x2, Tin, TH	3x2 Header	PEC03DAAN	Sullins Connector Solutions
J4	1		Header, 100mil, 2x1, Tin, TH	2x1 Header	PEC02SAAN	Sullins Connector Solutions
J7	1		Header, 100mil, 3x1, Tin, TH	3x1 Header	PEC03SAAN	Sullins Connector Solutions
Q1	1	60V	MOSFET, N-CH, 60 V, 115 A, SOT-23	SOT-23	2N7002	Fairchild Semiconductor
R1, R2	2	340k	RES, 340 k, 1%, 0.1 W, 0603	0603	RC0603FR-07340KL	Yageo
R3, R4	2	124k	RES, 124 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603124KFKEA	Vishay-Dale
R5	1	845	RES, 845, 1%, 0.1 W, 0603	0603	RC0603FR-07845RL	Yageo
R6, R7	2	100	RES, 100, 1%, 0.1 W, 0603	0603	RC0603FR-07100RL	Yageo
R8	1	10k	RES, 10.0 k, 0.1%, 0.1 W, 0603	0603	RG1608P-103-B-T5	Susumu
R9	1	6.65k	RES, 6.65 k, 1%, 0.1 W, 0603	0603	RC0603FR-076K65L	Yageo
R10	1	1.65k	RES, 1.65 k, 1%, 0.1 W, 0603	0603	RC0603FR-071K65L	Yageo
R11	1	750	RES, 750, 1%, 0.1 W, 0603	0603	RC0603FR-07750RL	Yageo
R12	1	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	0603	RC0603FR-071KL	Yageo
R13	1	0	RES, 0, 5%, 0.1 W, 0603	0603	ERJ-3GEY0R00V	Panasonic Electronic
S1	1		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	5	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions
TP11, TP12, TP13	3		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
TP4, TP5, TP6, TP7, TP8, TP9, TP10	7		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone

Table 7-1. TPS25210EVM BoM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
TP1, TP2	2		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP3	1		Test Point, Multipurpose, Orange, TH	Orange Multipurpose Testpoint	5013	Keystone
U1	1	TPS25210	TPS25210, 2.7- 6.5, 4 A, 30 mO Reverse Current Blocking eFuse with Input Reverse Polarity Protection	VQFN-HR10	TPS25210ARPW	Texas Instruments
U2	1	LM3480	100 mA, Quasi Low-Dropout Linear Voltage Regulator, 3-pin SOT-23, Pb-Free	SOT-23	LM3480IM3-3.3/NOPB	Texas Instruments
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A

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