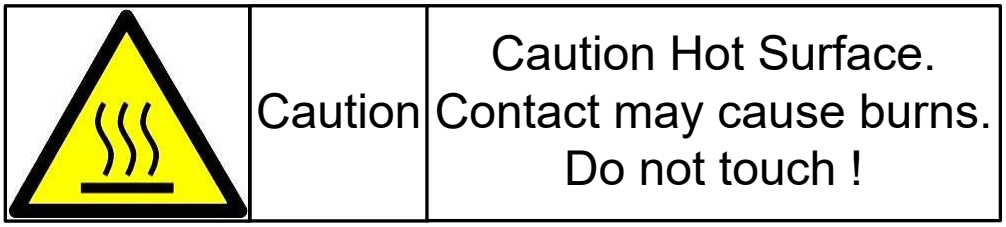
User's Guide

TPS25985EVM: Evaluation Module for TPS25985 eFuse

ABSTRACT

This user's guide describes the evaluation module (EVM) for the TPS25985 eFuse. The TPS25985 device is a 4.5-V to 16-V and 70-A stackable eFuse with an accurate and fast current monitor. This device supports parallel connection of multiple eFuses for higher current designs by actively synchronizing the device states and sharing the loads during start-up and steady state. The TPS25985 eFuse has an integrated FET with ultra-low ON resistance of 0.59-mΩ, adjustable and robust overcurrent and short-circuit protections, precise load current monitoring, fast overvoltage protection (fixed 16.7-V threshold), adjustable output slew rate control for inrush current protection, and overtemperature protection to ensure FET safe operating area (SOA). TPS25985 eFuse also has an adjustable overcurrent transient blanking timer to support load transients, adjustable undervoltage protection, integrated FET health monitoring and reporting, analog die temperature monitor output, dedicated fault and power good indication pins, and an uncommitted general purpose fast comparator.



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1 Introduction

The *TPS25985EVM eFuse Evaluation Board* allows reference circuit evaluation of Texas Instruments (TI) TPS25985 eFuse. he TPS25985 device is a 4.5-V to 16-V and 70-A stackable eFuse with an accurate and fast current monitor. This device supports parallel connection of multiple eFuses for higher current designs by actively synchronizing the device states and sharing the loads during start-up and steady state. The TPS25985 eFuse has an integrated FET with ultra-low ON resistance of 0.59-mΩ, adjustable and robust overcurrent and short-circuit protections, precise load current monitoring, fast overvoltage protection (fixed 16.7-V threshold), adjustable output slew rate control for inrush current protection, and overtemperature protection to ensure FET safe operating area (SOA). TPS25985 eFuse also has an adjustable overcurrent transient blanking timer to support load transients, adjustable undervoltage protection, integrated FET health monitoring and reporting, analog die temperature monitor output, dedicated fault and power good indication pins, and an uncommitted general purpose fast comparator.

1.1 EVM Features

TPS25985EVM comes with two TPS25985 eFuses connected in parallel to evaluate a 12-V (typical) and 100-A (steady state) design. General TPS25985EVM eFuse evaluation board features include:

- 5-V to 16-V (typical) operation
- 28-A to 100-A programmable circuit breaker threshold using onboard jumpers
- Adjustable reference voltage for overcurrent protection and active current sharing blocks
- Adjustable output voltage slew rate control
- Adjustable transient current blanking timer
- Adjustable current limit during start-up and active current sharing threshold using onboard jumpers
- TVS diode for input and Schottky diode for output transient protections
- LED status for power good and fault indications
- Onboard test points to use the general purpose comparator in implementing the PROCHOT#™ functionality
- Options to engage the power cycle and the quick output discharge (QOD)
- Option to apply custom load transients using onboard MOSFETs and gate drive circuit
- Options to emulate single point failures on ITIMER, IMON, ILIM, and IREF pins

1.2 EVM Applications

This EVM can be used on the following applications:

- Input hotswap/hotplug
- Server motherboard/add-on cards
- Graphics/accelerator cards
- Switches/routers
- Fan trays

2 Description

The TPS25985EVM enables the evaluation of TPS259850x and TPS259851x eFuses from TPS25985 family. This EVM has two TPS259850x eFuses connected in parallel. The input power is applied across the connectors J1 and J4, while J2 and J3 provide the output connection for the EVM; refer to the schematic in Figure 3-1 and EVM test setup in Figure 5-1. TVS diode D1 provides the input protection from transient overvoltages, while Schottky diode D3 serves as the output protection for the TPS25985.

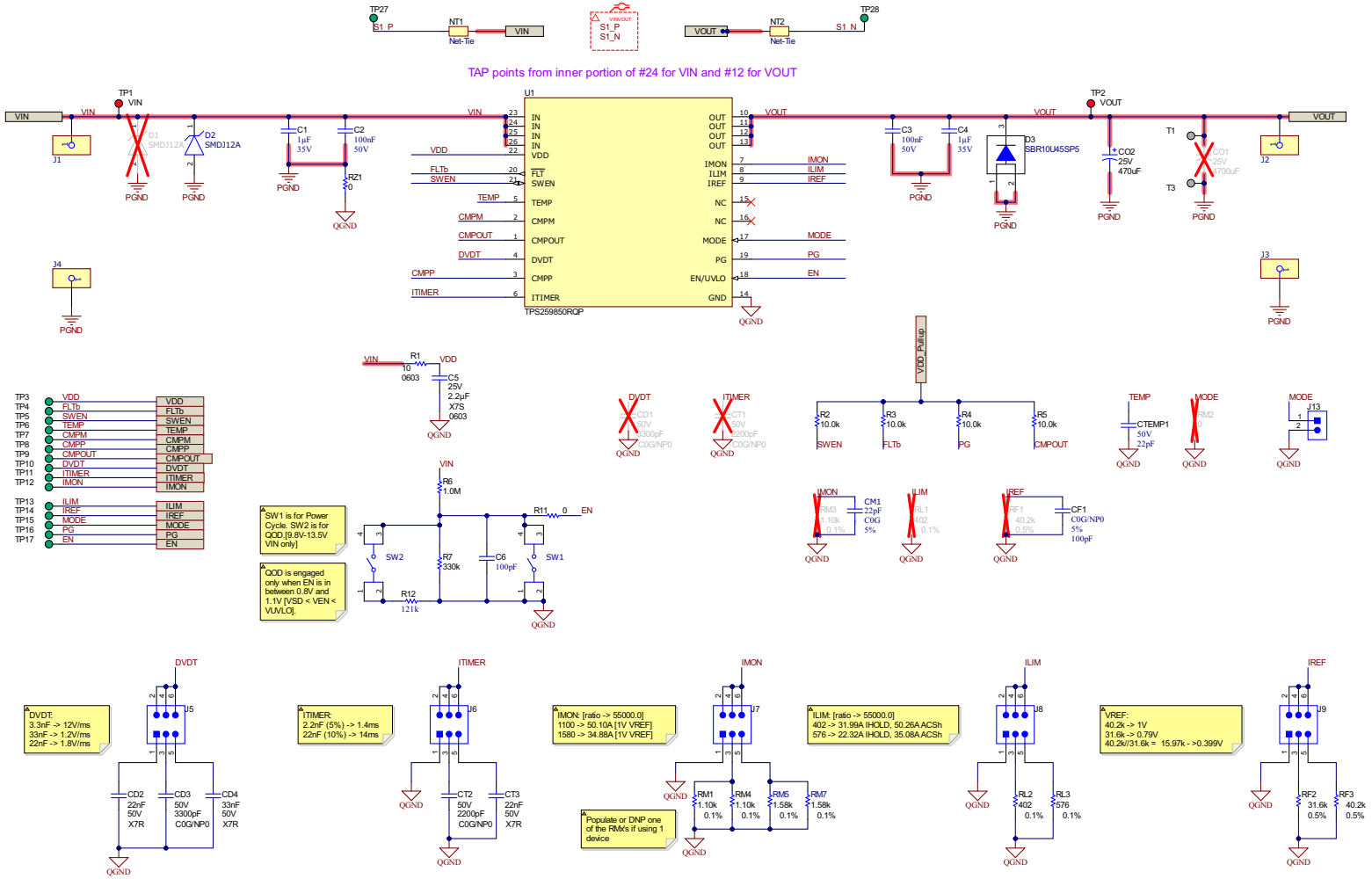
Power cycle and quick output discharge (QOD) are enabled via SW1 and SW2, respectively. Power Good (PG) and fault (FLTb and FLTb2) indicators are provided by LED DG1, DR1, and DR2 respectively.

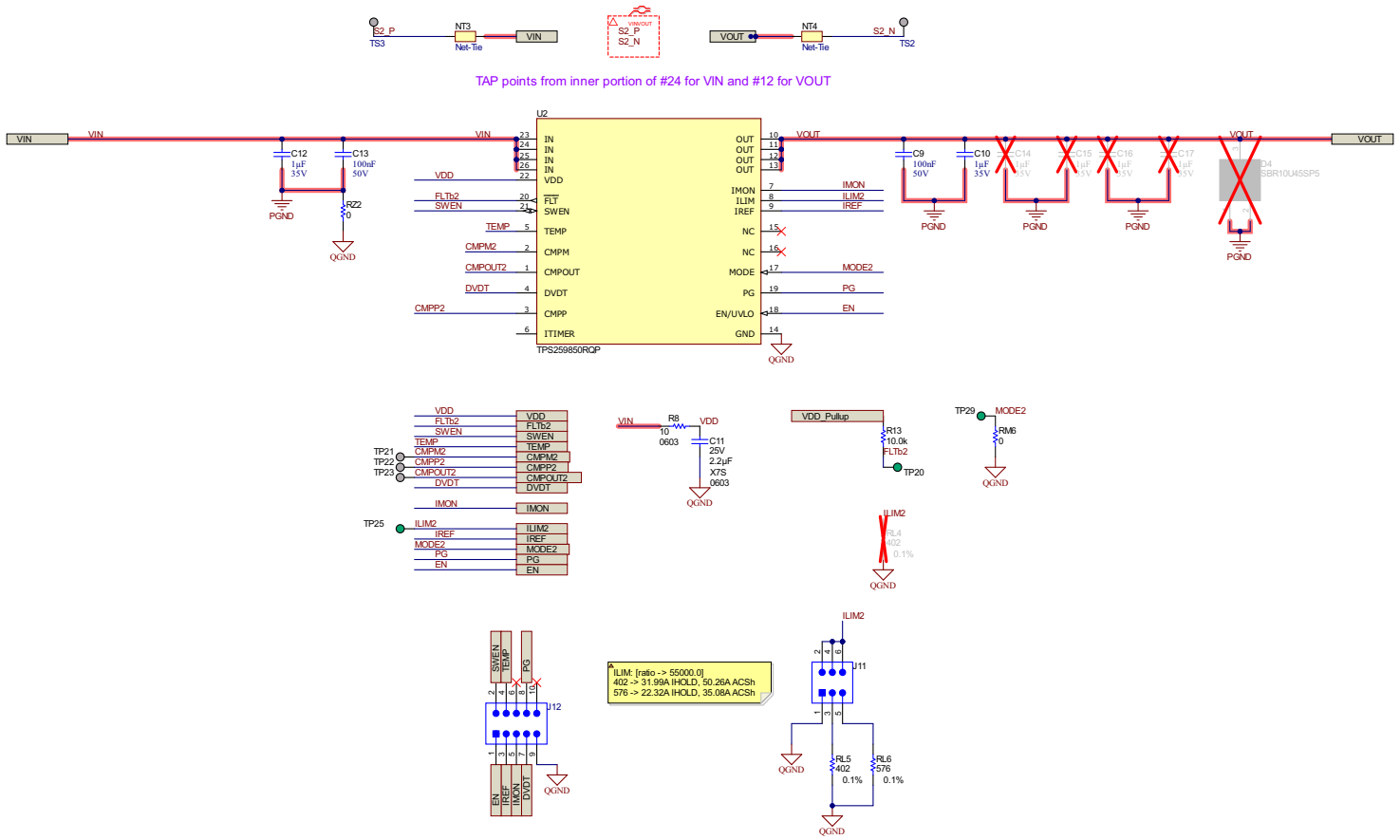
Table 2-1. TPS25985EVM eFuse Evaluation Board Options and Setting

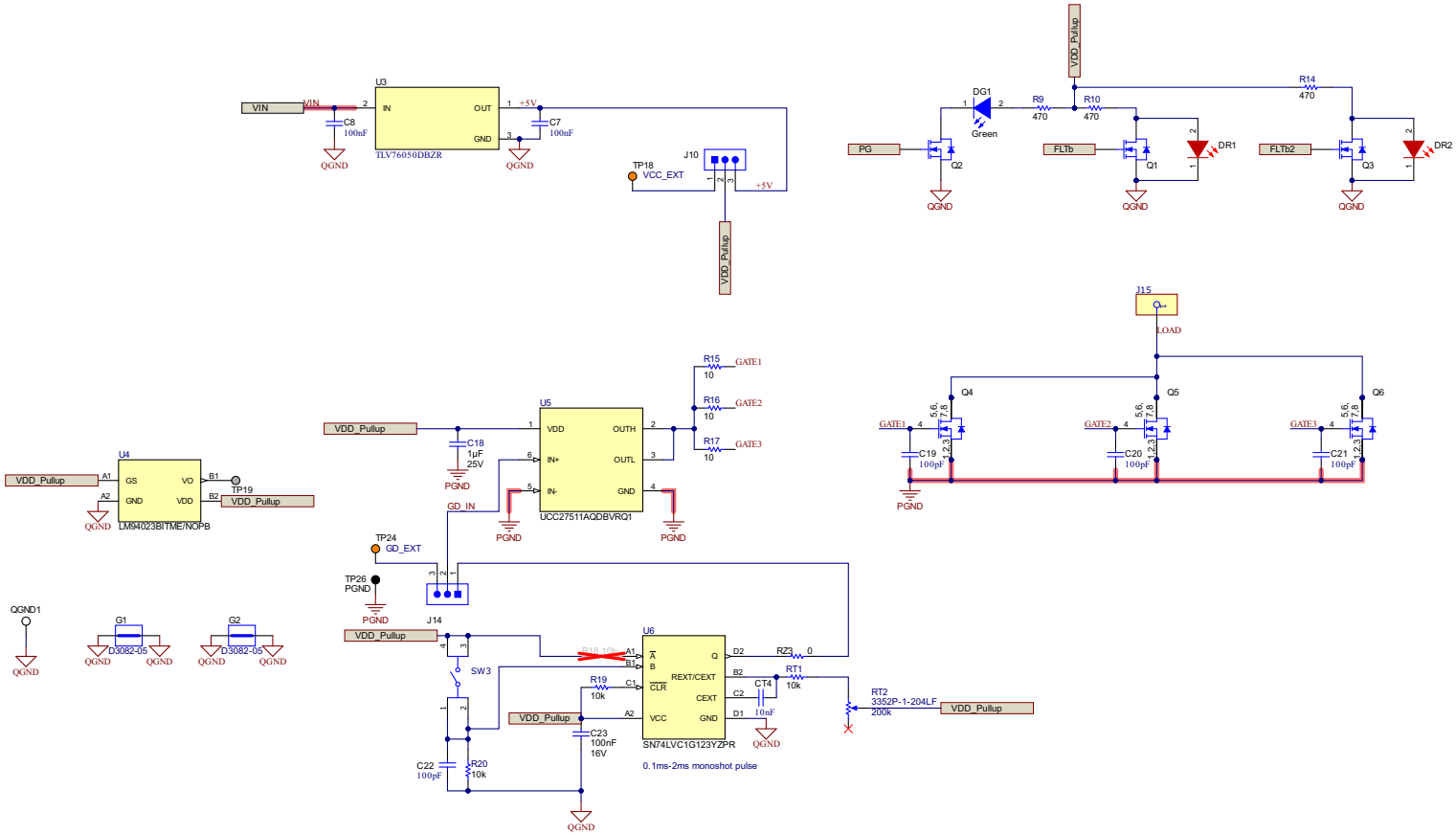
EVM Function	Vin UVLO Threshold	Vin OVLO Threshold	ITIMER	Output Slew Rate (dv/dt)	IMON	ILIM	ILIM2	IREF
Performance evaluation of TPS25985, 4.5-V to 16-V, 70-A eFuse	5 V	16.7 V	Selectable - 1.4-ms and 14-ms	Selectable - 1.2-V/ms, 1.8-V/ms, and 12-V/ms	Selectable - 100-A and 70-A with VREF of 1-V	Selectable - 32-A and 22-A of inrush current limit and 50-A and 35-A of active current sharing threshold with VREF of 1-V	Selectable - 32-A and 22-A of inrush current limit and 50-A and 35-A of active current sharing threshold with VREF of 1-V	Selectable - 1-V and 0.8-V

3 Schematic

Figure 3-1 illustrates the EVM schematic.







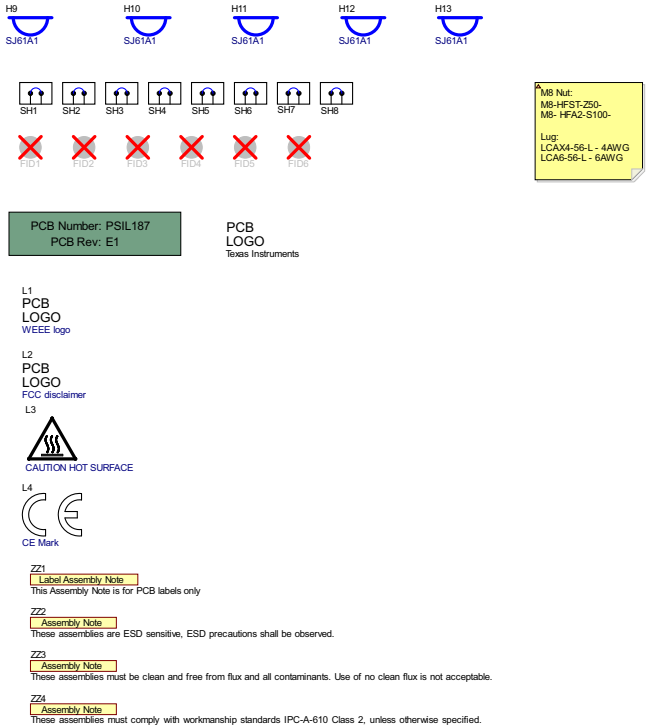


Figure 3-1. TPS25985EVM eFuse Evaluation Board Schematic

4 General Configurations

4.1 Physical Access

Table 4-1 lists the TPS25985EVM eFuse Evaluation Board input and output connectors functionalities. Table 4-2 and Table 4-3 describe the availability of test points and the functionalities of the jumpers. Table 4-4 presents the function of the signal LED indicators.

Table 4-1. Input and Output Connector Functionality

Connector	Label	Description
J1	VIN (+)	Positive terminal for the input power to the EVM
J2	VOUT (+)	Positive terminal for the output power from the EVM
J3	PGND (–)	Negative terminal for the output power from the EVM
J4	PGND (–)	Negative terminal for the input power to the EVM
J15	LOAD (+)	Positive terminal to connect transient loads

Table 4-2. Test Points Description

Test Points	Label	Description
TP1	VIN	Input voltage
TP2	VOUT	Output voltage
TP3	VDD	Controller input power
TP4	FLTb	Open-drain active low fault indication: Device 1
TP5	SWEN	Open-drain signal to indicate and control eFuse ON and OFF status
TP6	TEMP	Device die temperature monitor analog voltage output
TP7	CMPM	General purpose comparator negative input: Device 1
TP8	CMPP	General purpose comparator positive input: Device 1
TP9	CMPOUT	General purpose comparator open-drain output: Device 1
TP10	DVDT	Start-up output slew rate control
TP11	ITIMER	Overcurrent blanking timer
TP12	IMON	Load current monitor and overcurrent & fast-trip thresholds during steady state
TP13	ILIM	Current limit & fast-trip thresholds during start-up and active current sharing threshold during steady-state: Device 1
TP14	IREF	Reference voltage for overcurrent & short-circuit protections, and active current sharing blocks
TP15	MODE	MODE selection: Device 1
TP16	PG	Open-drain active high power good indication
TP17	EN	Active high enable input
TP18	VCC_EXT	External pullup power supply
TP19	PCB TEMP	Board temperature monitor analog voltage output
TP20	FLTb2	Open-drain active low fault indication: Device 2
TP21	CMPM2	General purpose comparator negative input: Device 2
TP22	CMPP2	General purpose comparator positive input: Device 2
TP23	CMPOUT2	General purpose comparator open-drain output: Device 2
TP24	GD_EXT	External gate signal for custom load transient

Table 4-2. Test Points Description (continued)

Test Points	Label	Description
TP25	ILIM2	Current limit & fast-trip thresholds during start-up and active current sharing threshold during steady-state: Device 2
TP26	PGND	Supply ground
TP27	S1_P	Kelvin sensing points to measure the ON-resistance: Device 1
TP28	S1_N	
TP29	MODE2	MODE selection: Device 2
TS2	S2_N	Kelvin sensing points to measure the ON-resistance: Device 2
TS3	S2_P	

Table 4-3. Jumper Descriptions and Default Positions

Jumper	Label	Description	Default Jumper Position
J5	DVDT	1-2 Position sets the output slew rate to 1.8-V/ms	5-6
		3-4 Position sets the output slew rate to 12-V/ms	
		5-6 Position sets the output slew rate to 1.2-V/ms	
J6	ITIMER	1-2 Position emulates the single point failure: ITIMER pin shorted to GND: Device 1	3-4
		3-4 Position sets the overcurrent blanking timer to 1.4-ms	
		5-6 Position sets the overcurrent blanking timer to 14-ms	
J7	IMON	1-2 Position emulates the single point failure: IMON pin shorted to GND: Device 1 and 2	3-4
		3-4 Position sets the circuit breaker threshold to 100-A with V_{IREF} of 1-V	
		5-6 Position sets the circuit breaker threshold to 70-A with V_{IREF} of 1-V	
J8	ILIM	1-2 Position emulates the single point failure: ILIM pin shorted to GND: Device 1	3-4
		3-4 Position sets the inrush current limit to 32-A and the active current sharing threshold to 50-A with V_{IREF} of 1-V: Device 1	
		5-6 Position sets the inrush current limit to 22-A and the active current sharing threshold to 35-A with V_{IREF} of 1-V: Device 1	
J9	IREF	1-2 Position emulates the single point failure: IREF pin shorted to GND: Device 1 and 2	5-6
		3-4 Position sets the reference voltage for overcurrent, short-circuit protection, and active current sharing blocks to 0.8-V	
		5-6 Position sets the reference voltage for overcurrent, short-circuit protection, and active current sharing blocks to 1-V	
J10	VDD PULLUP POWER SUPPLY	1-2 Position provides the VDD pullup supply from the external power source	2-3
		2-3 Position provides the VDD pullup supply from the onboard 12-V to 5-V LDO	
J11	ILIM2	1-2 Position emulates the single point failure: ILIM pin shorted to GND: Device 2	3-4
		3-4 Position sets the inrush current limit to 32-A and the active current sharing threshold to 50-A with V_{IREF} of 1-V: Device 2	
		5-6 Position sets the inrush current limit to 22-A and the active current sharing threshold to 35-A with V_{IREF} of 1-V: Device 2	
J14	EXTERNAL GATE SIGNAL	1-2 Position provides the GATE signal to the MOSFETs (Q4 – Q6) from the onboard monoshot	1-2
		2-3 Position provides the GATE signal to the MOSFETs (Q4 – Q6) from the external signal generator	

Table 4-4. LED Descriptions

LED	Description
DG1	When ON, indicates that PG is asserted
DR1	When ON, indicates that FLTb is asserted
DR2	When ON, indicates that FLTb2 is asserted

4.2 Test Equipment and Setup

4.2.1 Power supplies

One adjustable power supply with 0-V to 30-V output and 0-A to 200-A output current limit.

4.2.2 Meters

A Digital Multi Meter (DMM) is a minimum requirement.

4.2.3 Oscilloscope

A DPO2024 or equivalent, three 10x voltage probes, and a DC 150-A current probe.

4.2.4 Loads

One resistive load or equivalent which can tolerate up to 200-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 TPS25985 eFuse. Make sure the evaluation board has default jumper settings as shown in Table 5-1.

Table 5-1. Default Jumper Setting for TPS25985EVM eFuse Evaluation Board

J5	J6	J7	J8	J9	J10	J11	J14
5-6	3-4	3-4	3-4	5-6	2-3	3-4	1-2

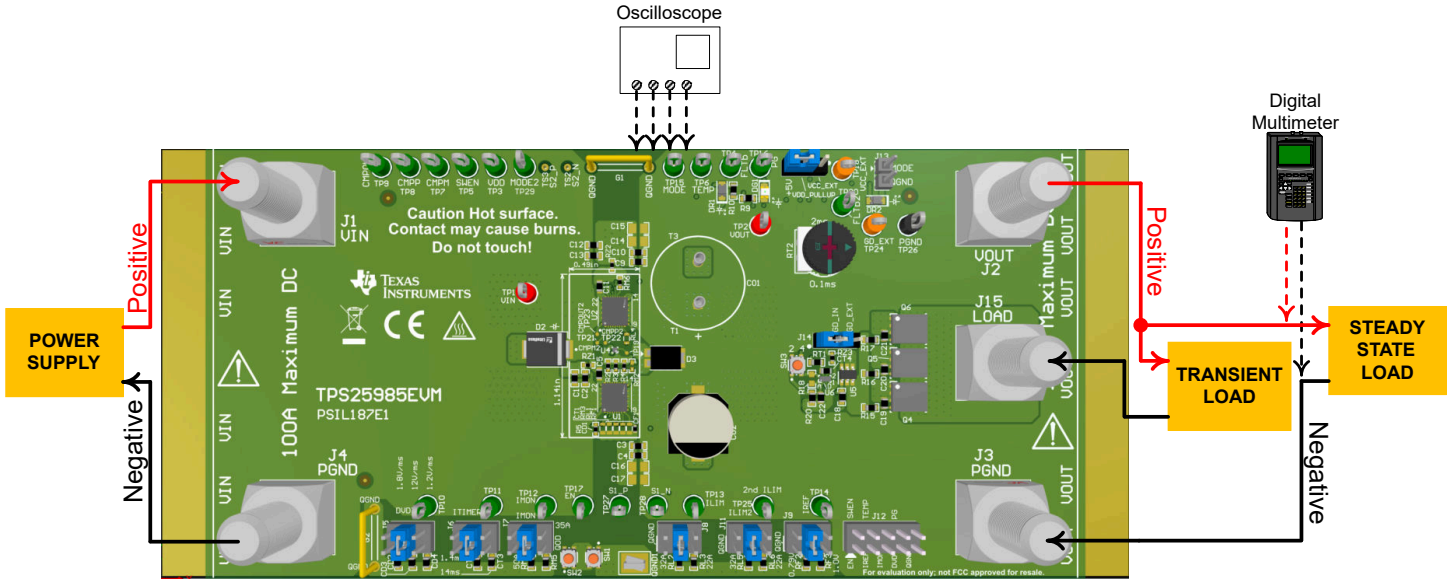


Figure 5-1. TPS25985EVM Setup with Test Equipment

Before starting any test, read the instructions below and repeat them again before moving on to the 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 to 200-A.
- Turn OFF the power supply.
- Set the jumper setting on EVM to the default positions as shown in Table 5-1.

5.1 Hot Plug

Use the following instructions to measure the inrush current during a hot plug event:

1. Set Jumper J5 position to appropriate slew rate as mentioned in Table 4-3.
2. Set Jumper J8 position to desired current limit during start-up as mentioned in Table 4-3.
3. Set Jumper J9 position to desired reference voltage for overcurrent protection and active current sharing as specified in Table 4-3.
4. Set the input supply voltage VIN to 12-V and current limit to 100-A. Enable the power supply.
5. Connect a load of 1.2-Ω between VOUT (Connector J2) and PGND (Connector J3).
6. Connect the negative terminal of the power supply at connector J4.
7. Hot plug the positive terminal of the power supply at connector J1.
8. Observe the waveforms at VOUT (TP2) and input current using an oscilloscope to measure the slew rate and rise time of the eFuse with a given input voltage of 12-V.

Figure 5-2 and Figure 5-3 show the examples of inrush current captured on the TPS25985EVM eFuse Evaluation Board with two devices in parallel during the hot plug event.

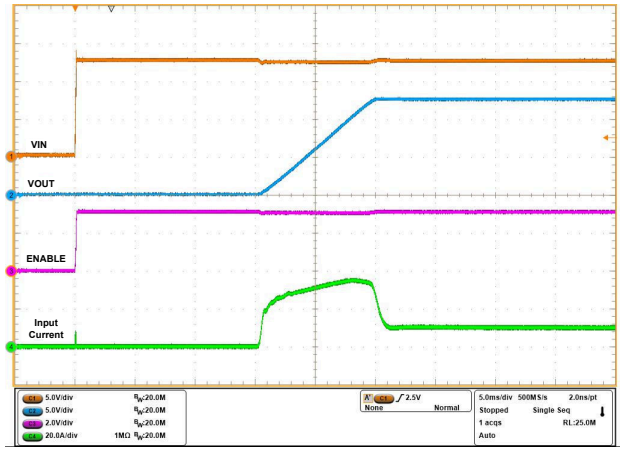


Figure 5-2. TPS25985 eFuse Hot Plug Profile (V_{IN} Stepped Up from 0 V to 12 V, C_{OUT} = 18.47 mF, C_{DVDT} = 33 nF, and R_{LOAD} = 1.2 Ω)

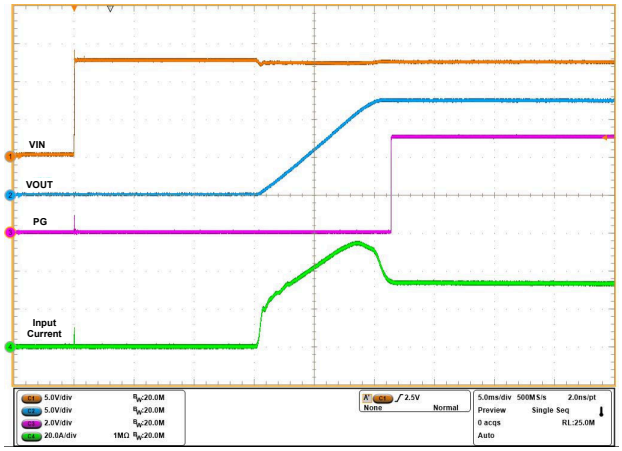


Figure 5-3. TPS25985 eFuse Hot Plug Profile (V_{IN} Stepped Up from 0 V to 12 V, C_{OUT} = 18.47 mF, C_{DVDT} = 33 nF, and R_{LOAD} = 0.37 Ω)

5.2 Start-up with Enable

Use the following instructions to power up the TPS25985 eFuse with ENABLE:

1. Set Jumper J5 position to desired slew rate as mentioned in Table 4-3.
2. Set Jumper J8 position to desired current limit during start-up as mentioned in Table 4-3.
3. Set Jumper J9 position to desired reference voltage for overcurrent protection and active current sharing as mentioned in Table 4-3.
4. Set the input supply voltage VIN to 12-V and current limit to 100-A.
5. Connect a load of 1.2-Ω between VOUT (Connector J2) and PGND (Connector J3).
6. Connect the input supply between VIN (Connector J1) and PGND (Connector J4).
7. Turn on the power supply by keeping the device disabled using the switch SW1.
8. Enable the eFuse by releasing the switch SW1.
9. Observe the waveform at VOUT (TP2) and input current using an oscilloscope to measure the slew rate and rise time of the eFuse with a given input voltage of 12-V.

Figure 5-4 shows the start-up profile of TPS25985 eFuse with ENABLE using two devices in parallel.

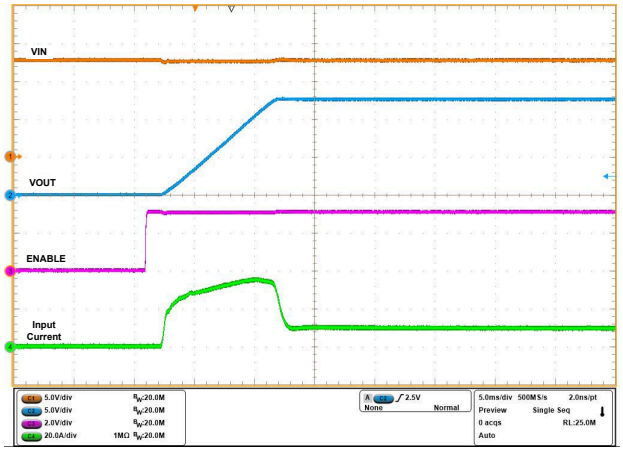


Figure 5-4. TPS25985 eFuse Start-up Profile with ENABLE (V_{IN} = 12 V, EN Stepped Up from 0 V to 3 V, C_{OUT} = 18.47 mF, R_{LOAD} = 1.2 Ω, and C_{DVDT} = 33 nF)

5.3 Difference Between Current Limit and DVDT Based Start-up Mechanisms

Use the following instructions to perform the start-up with current limit test:

1. Set Jumper J5 position to desired slew rate as mentioned in Table 4-3.
2. Set Jumper J8 position to desired current limit during start-up as mentioned in Table 4-3.
3. Set Jumper J9 position to desired reference voltage for overcurrent protection and active current sharing as mentioned in Table 4-3.
4. Set the input supply voltage VIN to 12-V and current limit to 100-A.
5. Connect a load of 0.9-Ω between VOUT (Connector J2) and PGND (Connector J3).
6. Connect the input supply between VIN (Connector J1) and PGND (Connector J4).
7. Turn on the power supply by keeping the device disabled using the switch SW1.
8. Enable the eFuse by releasing the switch SW1.
9. Observe the waveform at VOUT (TP2) and input current using an oscilloscope. The main intention of this test is to observe the output voltage & input current profiles and time required to complete the inrush with two different ILIM set points having all other test conditions identical. The inrush current hits the current limit set point in one case, but does not in the next.

Figure 5-5 and Figure 5-6 show the difference between the current limit and DVDT based start-up mechanisms on the TPS25985EVM eFuse Evaluation Board having two devices in parallel for R_{ILIM} of 680 and R_{LIM2} of 680 Ω and R_{ILIM} of 402 and R_{LIM2} of 402 Ω respectively.

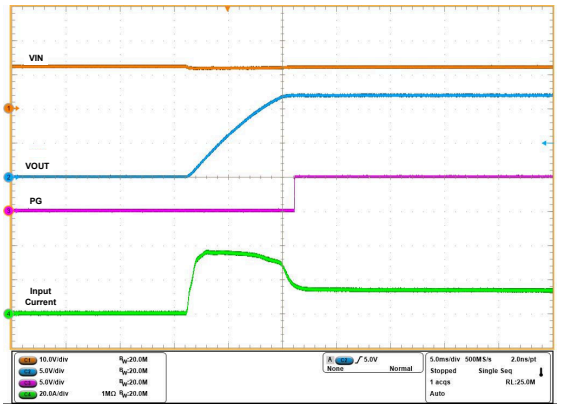


Figure 5-5. Start-up with Current Limit Response of TPS25985 eFuse (V_{IN} = 12 V, EN Stepped Up from 0 V to 3 V, R_{ILIM} = 680 Ω, R_{LIMI2} = 680 Ω, R_{IREF} = 40.2 kΩ, C_{OUT} = 18.47 mF, R_{LOAD} = 0.9 Ω, and C_{DVDT} = 33 nF)

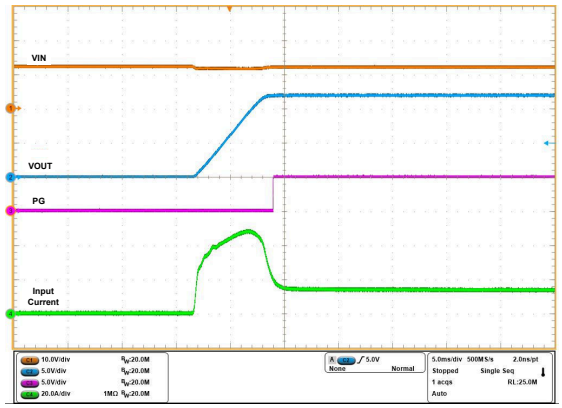


Figure 5-6. Start-up with Output Slew Rate Control (only) Response of TPS25985 eFuse (V_{IN} = 12 V, EN Stepped Up from 0 V to 3 V, R_{ILIM} = 402 Ω, R_{ILIM2} = 402 Ω, R_{IREF} = 40.2 kΩ, C_{OUT} = 18.47 mF, R_{LOAD} = 0.9 Ω, and C_{DVDT} = 33 nF)

5.4 Power-up into Short

Use the following instructions to perform the power-up into short test:

1. Set the input supply voltage VIN to 12-V and current limit to 100-A. Keep the power supply OFF.
2. Connect a short and thick cable between VOUT (Connector J2) and PGND (Connector J3). Make sure that the short-circuited path impedance is as minimum as possible.
3. Set Jumper J9 position to desired reference voltage for overcurrent protection and active current sharing as mentioned in Table 4-3.
4. Set Jumper J8 position to desired current limit during start-up as mentioned in Table 4-3.
5. Keep the TPS25985 eFuse disabled by pushing the switch SW1.
6. Turn ON the power supply.
7. Enable the TPS25985 eFuse by releasing the switch SW1.

Figure 5-7 and Figure 5-8 show the test waveforms of power up into output short on the TPS25985EVM eFuse Evaluation Board with two devices in parallel. Note that during powerup into short, a thermal foldback will result in the current flowing through the device being less than the calculated value of the current limit during start-up.

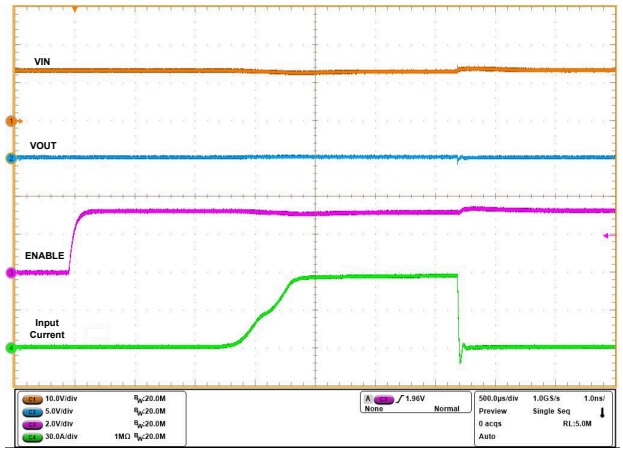


Figure 5-7. Power-up into Output Short Response of TPS25985 eFuse (V_{IN} = 12 V, EN Stepped Up from 0 V to 3 V, R_{ILIM} = 402 Ω, R_{ILIM2} = 402 Ω, R_{IREF} = 40.2 kΩ, C_{ITIMER} = 22 nF, and OUT Shorted to PGND)

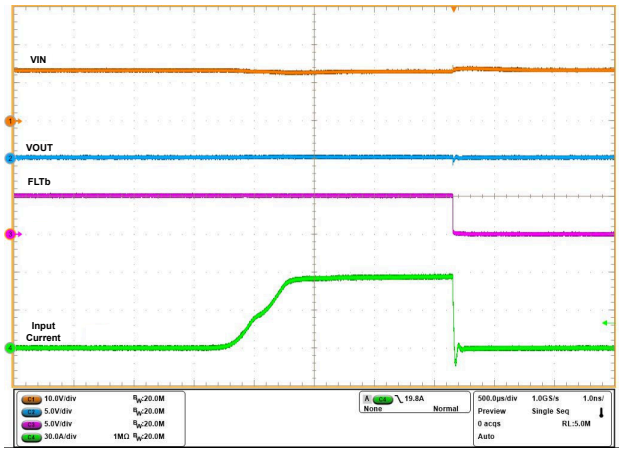


Figure 5-8. Power-up into Output Short Response of TPS25985 eFuse (V_{IN} = 12 V, EN Stepped Up from 0 V to 3 V, R_{ILIM} = 402 Ω, R_{ILIM2} = 402 Ω, R_{IREF} = 40.2 kΩ, C_{ITIMER} = 22 nF, and OUT Shorted to PGND)

5.5 Overvoltage Lockout

Use the following instructions to perform the overvoltage protection test:

1. Set the input supply voltage VIN to 12-V and current limit to 100-A. Apply the supply between VIN (Connector J1) and PGND (Connector J4) and enable the power supply.
2. Apply a load of 1.2-Ω between VOUT (Connector J2) and PGND (Connector J3).
3. Increase the input supply VIN from 12-V to 18-V and observe the waveforms using an oscilloscope.

Figure 5-9 shows overvoltage lockout response of TPS25985 eFuse on TPS25985EVM eFuse Evaluation Board.

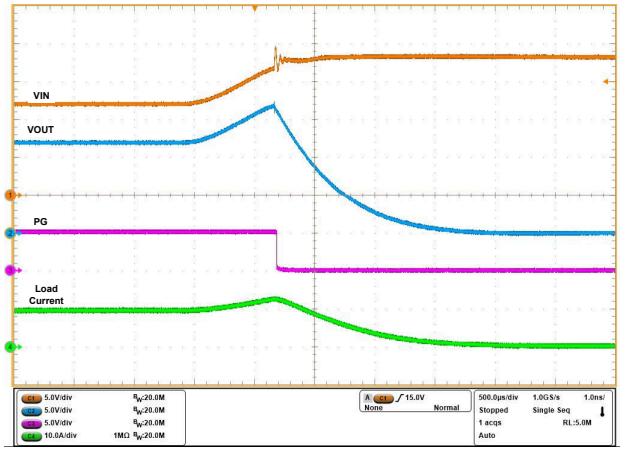


Figure 5-9. Overvoltage Lockout Response of TPS25985 eFuse (V_{IN} Ramped Up from 12 V to 18 V, C_{OUT} = 470 µF, and R_{LOAD} = 1.2 Ω)

5.6 Transient Overload Performance

Use the following instructions to observe the transient overload performance:

1. Place jumper J6 to an appropriate position to obtain required overcurrent blanking period (t_{TIMER}) as per Table 4-3.
2. Set Jumper J9 position to desired reference voltage for overcurrent protection and active current sharing as mentioned in Table 4-3.
3. Place jumper J7 in a suitable position to set required circuit breaker threshold (I_{OCP}) as per Table 4-3.
4. Set the input supply voltage VIN to 12-V and current limit of 200-A.
5. Connect the power supply between VIN (Connector J1) & PGND (Connector J4) and enable the power supply.
6. Now apply an overload in the range of $I_{OCP} < I_{LOAD} < 2 \times I_{OCP}$ between VOUT (Connector J2) and PGND (Connector J3) for a time duration less than t_{TIMER} decided by using jumper J6.
7. Observe the waveforms using an oscilloscope.

Figure 5-10 shows transient overload performance of TPS25985 eFuse on TPS25985EVM eFuse Evaluation Board with two devices in parallel.

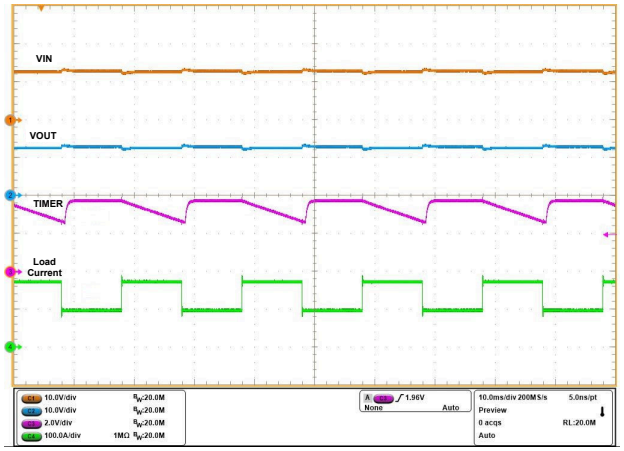


Figure 5-10. Transient Overload Performance of TPS25985 eFuse (V_{IN} = 12 V, C_{ITIMER} = 22 nF, C_{OUT} = 470 µF, R_{IMON} = 1.1 ‖ 1.1 kΩ, R_{IREF} = 40.2 kΩ, I_{OUT} Ramped from 100 A to 175 A then 100 A within 10 ms)

5.7 Provision to Apply Load Transient and Overcurrent Event Using an Onboard Switching Circuit

Use the following instructions to apply a load transient using the onboard switching circuit implemented with Q4, Q5, and Q6 MOSFETs:

1. Set the input supply voltage VIN to 12-V and current limit to 200-A. Turn ON the power supply.
2. Connect a steady state load between VOUT (Connector J2) and PGND (Connector J3).
3. Apply a transient load between VOUT (Connector J2) and LOAD (Connector J15).
4. Use the potentiometer RT2 to fix the transient load turn on duration.
5. Press the switch SW3 to turn on the Q4, Q5, and Q6 MOSFETs, which connect the load transient load between VOUT and PGND.
6. Observe the waveforms of VIN (TP1), VOUT (TP2), MOSFET GATE, and load current using an oscilloscope.

Note

There is an another option to apply a custom load transient using an external function generator, connected between TP24 and TP26 and shunt of the jumper J14 is placed at 2-3 position. Make sure to limit the transient load current magnitude by 40-A to have the safe and reliable operation of the Q4, Q5, and Q6 MOSFETs.

Figure 5-11 shows the test waveforms of transient overload using the onboard switching circuit.

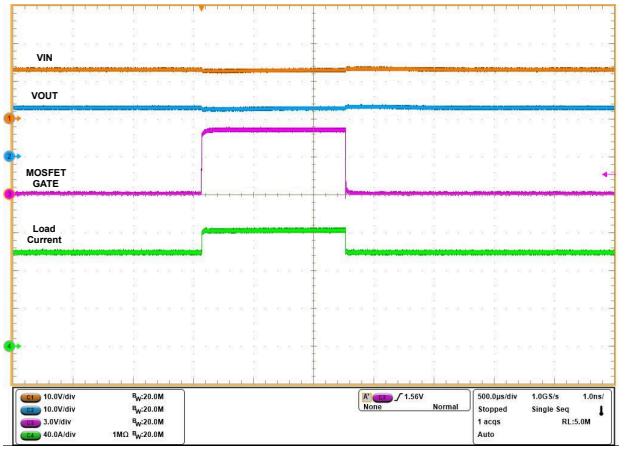


Figure 5-11. Transient Overload Performance of TPS25985 eFuse (V_{IN} = 12 V, C_{ITIMER} = 22 nF, C_{OUT} = 470 µF, R_{IMON} = 1.1 ‖ 1.1 kΩ, R_{IREF} = 40.2 kΩ, $I_{OUT(Steady-State)}$ = 100 A, and $I_{OUT(Transient)}$ = 20 A for 1.2 ms)

5.8 Overcurrent Event

Use the following instructions to perform the overcurrent test on TPS25985 eFuse:

1. Place jumper J6 to an appropriate position to obtain required overcurrent blanking period (t_{TIMER}) as per Table 4-3.
2. Set Jumper J9 position to the desired reference voltage for overcurrent protection and active current sharing as mentioned in Table 4-3.
3. Place jumper J7 in a suitable position to set required circuit breaker threshold (I_{OCP}) as per Table 4-3.
4. Set the input supply voltage VIN to 12-V and current limit to 200-A.
5. Connect the power supply between VIN (Connector J1) and PGND (Connector J4) and enable the power supply.
6. Now apply an overload in the range of $I_{OCP} < I_{LOAD} < 2 \times I_{OCP}$ between VOUT (Connector J2) and PGND (Connector J3) for a time duration more than t_{TIMER} decided by using jumper J6.
7. Observe the waveforms using an oscilloscope.

Figure 5-12 and Figure 5-13 show the circuit breaker response of TPS25985 eFuse on TPS25985EVM eFuse Evaluation Board with two devices in parallel.

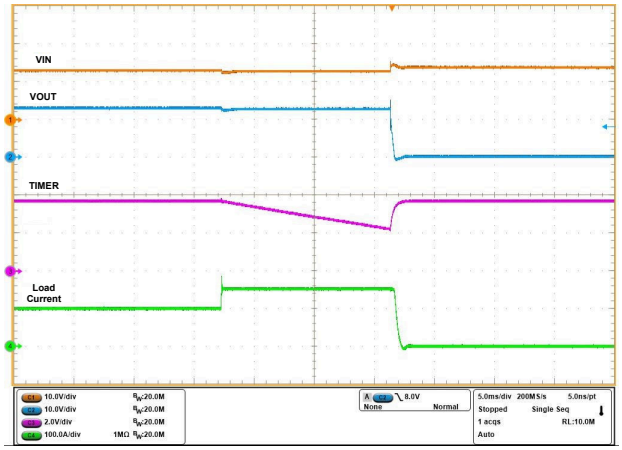


Figure 5-12. Overcurrent Performance of TPS25985 eFuse (V_{IN} = 12 V, C_{ITIMER} = 22 nF, C_{OUT} = 470 µF, R_{IMON} = 1.1 ‖ 1.1 kΩ, R_{IREF} = 40.2 kΩ, I_{OUT} Ramped from 100 A to 150 A for 20 ms)

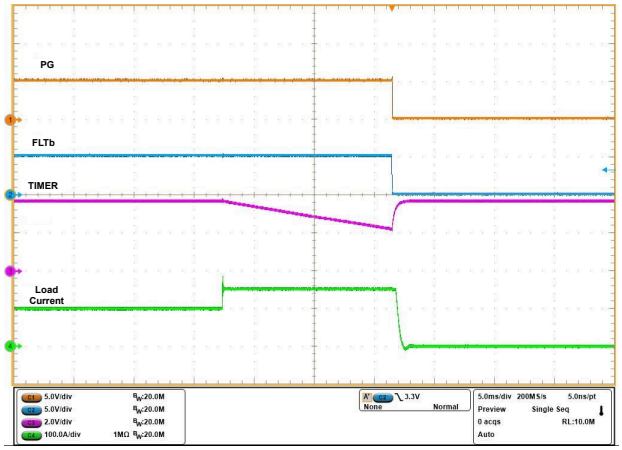


Figure 5-13. Overcurrent Performance of TPS25985 eFuse (V_{IN} = 12 V, C_{ITIMER} = 22 nF, C_{OUT} = 470 µF, R_{IMON} = 1.1 ‖ 1.1 kΩ, R_{IREF} = 40.2 kΩ, I_{OUT} Ramped from 100 A to 150 A for 20 ms)

5.9 Output Hot Short

Use the following instructions to perform the output hot short test:

1. Set the input supply voltage VIN to 12-V and current limit to 200-A. Keep the power supply OFF.
2. Connect a short and thick cable between VOUT (Connector J2) and LOAD (Connector J15) . Make sure the short-circuited path impedance is as minimum as possible.
3. Turn ON the power supply.
4. Short the output of the device by pushing SW3. As a result, the MOSFETs Q4, Q5, and Q6 will turn on, creating a short between VOUT and PGND.
5. Observe the waveforms using an oscilloscope.

Figure 5-14 shows the test waveforms of output hot short on the TPS25985EVM eFuse Evaluation Board with two devices in parallel.

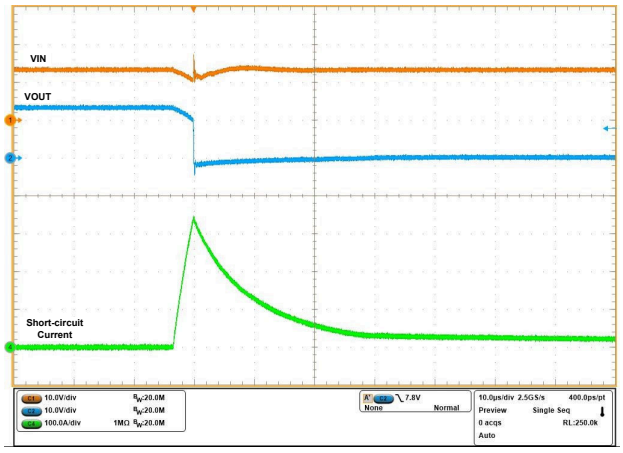


Figure 5-14. Output Hot Short Response of TPS25985 eFuse (V_{IN} = 12 V, R_{IMON} = 1.1 ‖ 1.1 kΩ, R_{IREF} = 40.2 kΩ, and C_{OUT} = 10 µF)

Note that it is very difficult to obtain repeatable and similar short-circuit testing results. The following contributes to the variation in results:

- Source bypassing
- Input leads
- Board layout
- Component selection

- Output shorting method
- Relative location of the short
- Instrumentation

The actual short exhibits a certain degree of randomness because it microscopically bounces and arcs. Ensure that configuration and methods are used to obtain realistic results. Hence, do not expect to see waveforms exactly like the waveforms in this user's guide because every setup is different.

5.10 PROCHOT#™ Implementation Using General Purpose Comparator

Use the following instructions to implement PROCHOT# functionality using in-built general purpose comparator:

1. Set the input supply voltage VIN to 12-V and connect the power supply between VIN (Connector J1) and PGND (Connector J4).
2. Set Jumper J9 position to desired reference voltage (V_{IREF}) for overcurrent protection and active current sharing as mentioned in Table 4-3.
3. Place jumper J7 in a suitable position to set required circuit breaker threshold (I_{OCP}) as per Table 4-3.
4. Connect a DC power supply at CMPM (TP7) and set the output voltage of this power supply at suppose 80% of V_{IREF}.
5. Connect CMPP (TP8) with IMON (TP12).
6. Now apply a transient load in the range of $0.7 \times I_{OCP} < I_{LOAD} < 0.95 \times I_{OCP}$ (as example) between VOUT (Connector J2) and PGND (Connector J3) for a specified time duration, as example 20-ms.
7. Observe the waveforms of CMPM (TP7), CMPP (TP8), CMPOUT (TP9), and load current using an oscilloscope.

Figure 5-15 shows the experimental waveforms of PROCHOT# implementation on the TPS25985EVM eFuse Evaluation Board.

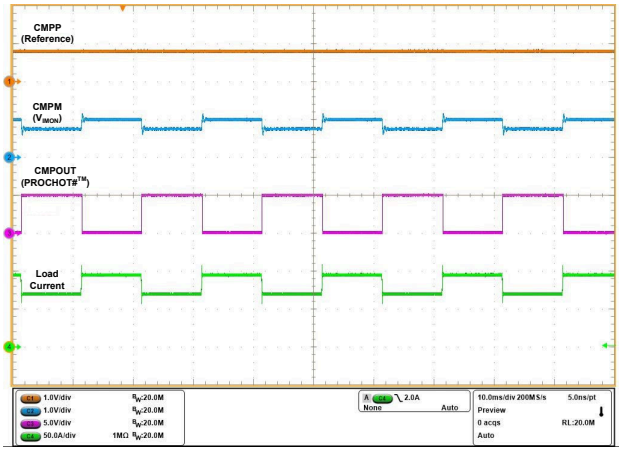


Figure 5-15. PROCHOT#™ Implementation on TPS25985 eFuse (V_{IN} = 12 V, R_{IMON} = 1.1 ‖ 1.1 kΩ, R_{IREF} = 40.2 kΩ, V_{CMPM} = 0.8 V, and I_{OUT} Ramped from 70 A to 95 A then 70 A within 20 ms)

5.11 Quick Output Discharge (QOD)

Use the following instructions to observe the Quick Output Discharge (QOD) functionality:

1. Set the input supply voltage VIN to-12 V and current limit to 10-A. Turn ON the power supply.
2. Use the switch SW1 to connect the EN/UVLO pin to ground to do power cycling.
3. Use the switch SW2 to enable the QOD by making the voltage at EN/UVLO pin in the range of 0.8-V to 1.1-V with the input voltage of 9.8-V to 13.5-V.
4. Observe the waveforms of VIN (TP1), VOUT (TP2), PG(TP16), and EN(TP17) using an oscilloscope.

In Figure 5-16, the turn-off performance of the TPS25985 eFuse with QOD enabled is shown, whereas Figure 5-17 illustrates the turn-off performance with QOD disabled on the TPS25985EVM eFuse Evaluation Board.

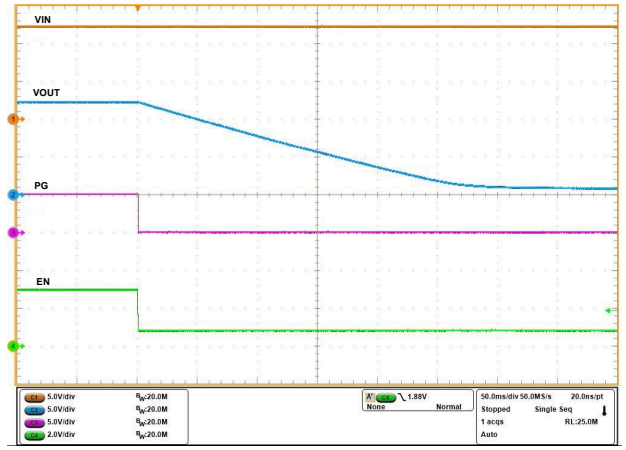


Figure 5-16. QOD Enabled on TPS25985 eFuse (V_{IN} = 12 V, C_{OUT} = 470 µF, and EN Pulled Low to 0.8 V)

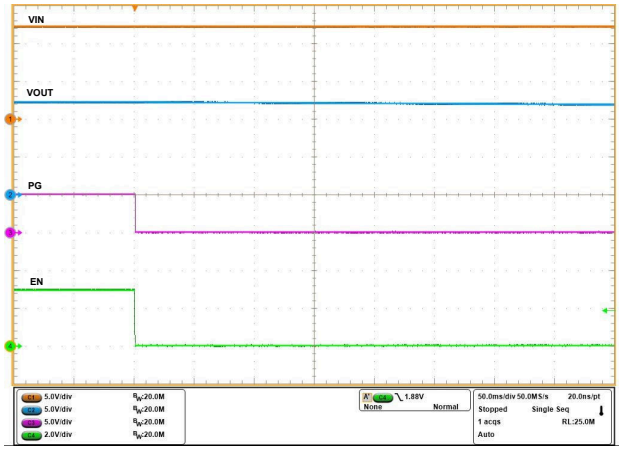


Figure 5-17. QOD Disabled on TPS25985 eFuse (V_{IN} = 12 V, C_{OUT} = 470 µF, and EN Pulled Low to 0 V)

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.

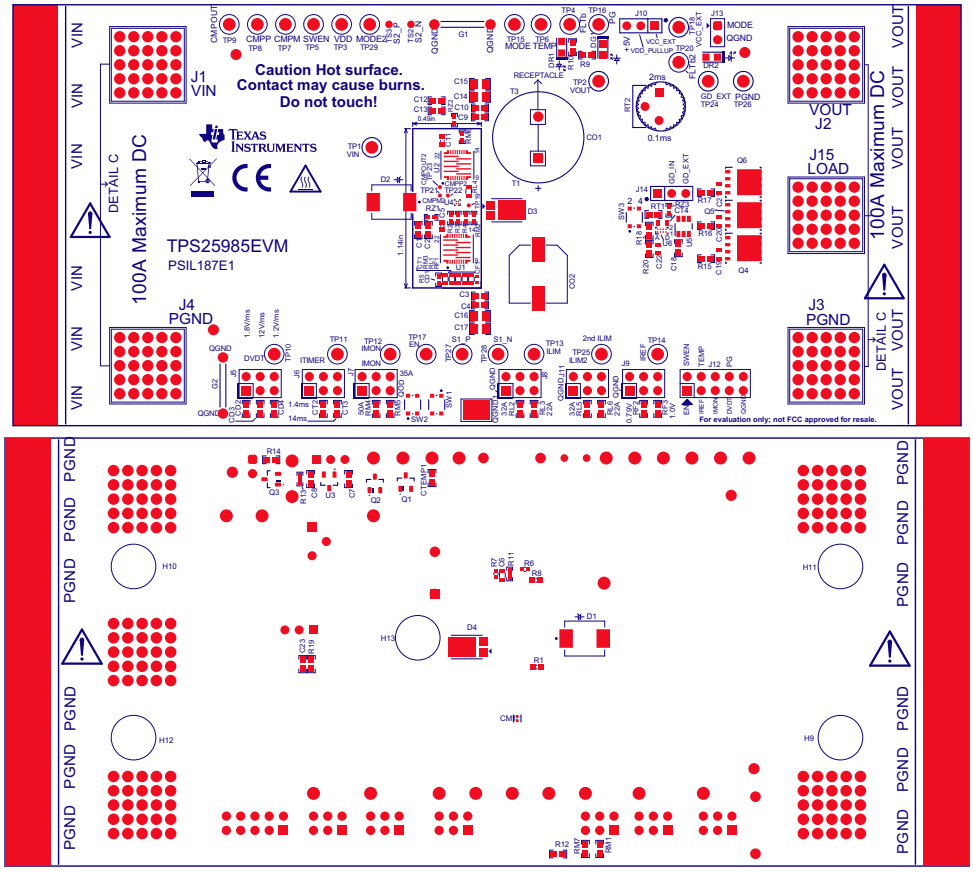


Figure 6-1. TPS25985EVM Board (a) Top Assembly (b) Bottom Assembly

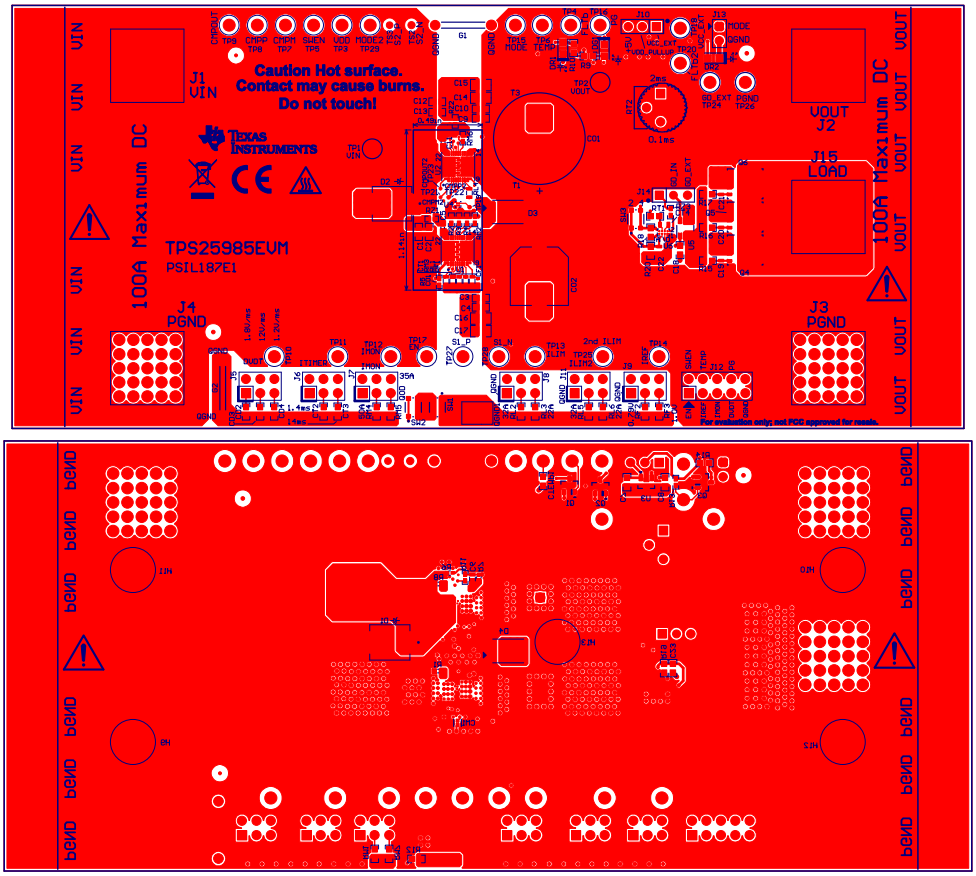


Figure 6-2. TPS25985EVM Board (a) Top Layer (b) Bottom Layer

Note

Analog signal nets, such as IREF, IMON, and TEMP, should be routed away as much as possible from power nets, such as VIN, VOUT, and PGND.

7 Bill Of Materials (BOM)

Table 7-1 lists the EVM BOM.

Table 7-1. TPS25985EVM Bill of Materials

Designator	Quantity	Value	Description	Footprint	Part Number	Manufacturer	Comments
!PCB1	1		Printed Circuit Board		PSIL187	Any	
C1, C4, C10, C12	4	1uF	CAP, CERM, 1 uF, 35 V, +/- 10%, X7R, 0603	0603	C1608X7R1V105K080AC	TDK	
C2, C3, C9, C13	4	0.1uF	CAP, CERM, 0.1 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	C0603C104K5RACAUTO	Kemet	
C5, C11	2	2.2uF	CAP, CERM, 2.2 µF, 25 V,+/- 10%, X7S, 0603	0603L	GRM188C71E225KE11D	MuRata	
C6, C19, C20, C21, C22	5	100pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603S	885012006057	Wurth Elektronik	
C7, C8	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A	AVX	
C18	1	1uF	CAP, CERM, 1 µF, 25 V,+/- 10%, X7R, 0603	0603	GRJ188R71E105KE11D	MuRata	
C23	1	0.1uF	CAP, CERM, 0.1 µF, 16 V,+/- 10%, X7R, 0603	0603	CL10B104KO8WPNC	Samsung Electro-Mechanics	
CD2, CT3	2	0.022uF	CAP, CERM, 0.022 uF, 50 V, +/- 10%, X7R, 0603	0603	GRM188R71H223KA01D	MuRata	
CD3	1	3300pF	CAP, CERM, 3300 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H332JA01D	MuRata	
CD4	1	0.033uF	CAP, CERM, 0.033 uF, 50 V, +/- 10%, X7R, 0603	0603	GRM188R71H333KA61D	MuRata	
CF1	1	100pF	CAP, CERM, 100 pF, 25 V, +/- 5%, C0G/NP0, 0402	0402S	C0402C101J3GACTU	Kemet	
CM1	1		CAP 0402 22pF 5% C0G 100V 30ppm	FP-GRT1555C2A220JA02D_0402-IPC_C	GRT1555C2A220JA02D	Murata	
CO2	1	470uF	CAP, AL, 470 uF, 25 V, +/- 20%, SMD	CAPSMT_62_JA0	EMVE250ADA471MJA0G	Chemi-Con	
CT2	1	2200pF	CAP, CERM, 2200 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H222JA01D	MuRata	
CT4	1	10nF	CAP CER 10000PF 50V C0G/NP0 0603	0603S	GRM1885C1H103JA01J	Murata Electronics	
CTEMP1	1	22pF	CAP, CERM, 22 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H220JA01D	MuRata	
D2	1		19.9V Clamp 150.8A Ipp Tvs Diode Surface Mount DO-214AB (SMCJ)	FP-SMDJ12A_DO214AB-MFG	SMDJ12A	Littelfuse Inc	

Table 7-1. TPS25985EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Footprint	Part Number	Manufacturer	Comments
D3	1	45V	Diode, Super Barrier Rectifier, 45 V, 10 A, PowerDI5	POWERDI5	SBR10U45SP5	Diodes Inc.	
DG1	1	Green	LED, Green, SMD	LG_R971_Green	LG R971-KN-1	OSRAM	
DR1, DR2	2	Red	LED, Red, SMD	LS_R976_Red	LS R976-NR-1	OSRAM	
G1, G2	2		1mm Uninsulated Shorting Plug, 10.16mm spacing, TH	Harwin_D3082-05	D3082-05	Harwin	
H9, H10, H11, H12, H13	5		Bumpon, Cylindrical, 0.312 X 0.200, Black	Bumpon_SJ61A1	SJ61A1	3M	
J1, J2, J3, J4, J15	5		25 Pin Shank Terminal M8 Through Hole	FP-7460719_SCREW_CONN-MFG	7460719	Wurth	
J5, J6, J7, J8, J9, J11	6		Header, 100mil, 3x2, Tin, TH	SULLINS_PEC03DAAN	PEC03DAAN	Sullins Connector Solutions	
J10, J14	2		Header, 100mil, 3x1, Tin, TH	CONN_PEC03SAAN	PEC03SAAN	Sullins Connector Solutions	
J12	1		Header, 100mil, 5x2, Tin, TH	CONN_PEC05DAAN	PEC05DAAN	Sullins Connector Solutions	
J13	1		Header, 2.54 mm, 2x1, Tin, TH	Samtec_TSW-102-07-T-S	TSW-102-07-T-S	Samtec	
Q1, Q2, Q3	3	60V	MOSFET, N-CH, 60 V, 115 A, SOT-23	SOT-23	2N7002	Fairchild Semiconductor	
Q4, Q5, Q6	3	40V	MOSFET, N-CH, 40 V, 42 A, DNK0008A (VSON-CLIP-8)	DNK0008A	CSD18510Q5B	Texas Instruments	
QGND1	1		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone	
R1, R8	2	10	RES, 10, 5%, 0.25 W, 0603	0603L	CRCW060310R0JNEAHP	Vishay-Dale	
R2, R3, R4, R5, R13	5	10.0k	RES, 10.0 k, 1%, 0.063 W, 0402	0402	RC0402FR-0710KL	Yageo America	
R6	1	1.0Meg	RES, 1.0 M, 5%, 0.063 W, 0402	0402L	CRCW04021M00JNED	Vishay-Dale	
R7	1	330k	RES, 330 k, 5%, 0.063 W, 0402	0402L	CRCW0402330KJNED	Vishay-Dale	
R9, R10, R14	3	470	RES, 470, 5%, 0.1 W, 0603	0603	RC0603JR-07470RL	Yageo	
R11, RZ1, RZ2, RZ3	4	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale	
R12	1	121k	RES, 121 k, 1%, 0.1 W, 0603	0603	RC0603FR-07121KL	Yageo	
R15, R16, R17	3	10	RES, 10, 5%, 0.1 W, 0603	0603	CRCW060310R0JNEA	Vishay-Dale	
R19, R20, RT1	3	10k	RES, 10 k, 5%, 0.1 W, 0603	0603	RC0603JR-0710KL	Yageo	
RF2	1	31.6k	RES, 31.6 k, 0.5%, 0.1 W, 0603	0603	RT0603DRE0731K6L	Yageo America	
RF3	1	40.2k	RES, 40.2 k, 0.5%, 0.1 W, 0603	0603	RT0603DRE0740K2L	Yageo America	
RL2, RL5	2	402	RES, 402, 0.1%, 0.1 W, 0603	0603	RT0603BRD07402RL	Yageo America	

Table 7-1. TPS25985EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Footprint	Part Number	Manufacturer	Comments
RL3, RL6	2	576	RES, 576, 0.1%, 0.1 W, 0603	0603	RT0603BRD07576RL	Yageo America	
RM1, RM4	2	1.10k	RES, 1.10 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD071K1L	Yageo America	
RM5, RM7	2	1.58k	RES, 1.58 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD071K58L	Yageo America	
RM6	1	0	RES, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale	
RT2	1	200k	Trimmer, 200 K, 0.5 W, TH	Bourns_3352P	3352P-1-204LF	Bourns	
SH1, SH2, SH3, SH4, SH5, SH6, SH7, SH8	8		Shunt, 2.54mm, Gold, Blue	Wurth_60900213621	60900213621	Wurth Elektronik	See Assembly Notes
SW1, SW2, SW3	3		Tactile Switch SPST-NO Top Actuated Surface Mount	FP-PTS830GM140SMTRLFS_SMT_3MM05_2MM6-MFG	PTS830GM140SMTRLFS	C&K Components	
T1, T3	2		Connector, Receptacle, Pin, TH	CONN_0300-2-15-01-47-01-10-0	0300-2-15-01-47-01-10-0	Mill-Max	Receptacle for CO1 "EKMQ250EIV472ML25S" part.
TP1, TP2	2		Test Point, Multipurpose, Red, TH	Keystone5010	5010	Keystone	
TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP20, TP25, TP27, TP28, TP29	20		Test Point, Multipurpose, Green, TH	Keystone5126	5126	Keystone	
TP18, TP24	2		Test Point, Compact, Orange, TH	Keystone5008	5008	Keystone	
TP26	1		Test Point, Multipurpose, Black, TH	Keystone5011	5011	Keystone	
U1, U2	2		TPS259850RQP	RQP0026A-MFG	TPS259850RQP	Texas Instruments	
U3	1		100-mA, 30-V, Fixed-Output, Linear-Voltage Regulator, DBZ0003A (SOT-23-3)	DBZ0003A_N	TLV76050DBZR	Texas Instruments	
U4	1		1.5V, Dual-Gain Analog Temperature Sensor with Class AB Output, 4-pin Micro SMD, Pb-Free	YFQ0004ACAC	LM94023BITME/NOPB	Texas Instruments	
U5	1		Single-Channel High-Speed Low-Side Gate Driver with 5V Negative Input Voltage Handling Ability, DBV0006A (SOT-23-6)	DBV0006A_N	UCC27511AQDBVRQ1	Texas Instruments	
U6	1		Single Retriggerable Monostable Multivibrator with Schmitt-Trigger Inputs, YZP0008ADAD, LARGE T&R	YZP0008ADAD	SN74LVC1G123YZPR	Texas Instruments	

Table 7-1. TPS25985EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Footprint	Part Number	Manufacturer	Comments
C14, C15, C16, C17	0	1uF	CAP, CERM, 1 uF, 35 V, +/- 10%, X7R, 0805	0805_HV	GMK212B7105KG-T	Taiyo Yuden	DNL
CD1	0	3300pF	CAP, CERM, 3300 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603S	GRM1885C1H332JA01D	MuRata	DNL
CO1	0	4700uF	CAP, AL, 4700 uF, 25 V, +/- 20%, TH	KMQ_1600x2500	EKMQ250EIV472ML25S	Chemi-Con	DNL
CT1	0	2200pF	CAP, CERM, 2200 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603S	GRM1885C1H222JA01D	MuRata	DNL
D1	0		19.9V Clamp 150.8A Ipp Tvs Diode Surface Mount DO-214AB (SMCJ)	FP-SMDJ12A_DO214AB-MFG	SMDJ12A	Littelfuse Inc	DNL
D4	0	45V	Diode, Super Barrier Rectifier, 45 V, 10 A, PowerDI5	POWERDI5	SBR10U45SP5	Diodes Inc.	DNL
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	Fiducial6.4-20	N/A	N/A	DNL
R18	0	10k	RES, 10 k, 5%, 0.1 W, 0603	0603	RC0603JR-0710KL	Yageo	DNL
RF1	0	40.2k	RES, 40.2 k, 0.5%, 0.1 W, 0603	0603S	RT0603DRE0740K2L	Yageo America	DNL
RL1, RL4	0	402	RES, 402, 0.1%, 0.1 W, 0603	0603S	RT0603BRD07402RL	Yageo America	DNL
RM2	0	0	RES, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale	DNL
RM3	0	1.10k	RES, 1.10 k, 0.1%, 0.1 W, 0603	0603S	RT0603BRD071K1L	Yageo America	DNL
Nut for "7460719" part	5		Steel Hex Nut, Medium-Strength, Class 8, M8 x 1.25 mm Thread	90592A022	90592A022	McMaster	Nut for "7460719" part
Lug for "7460719" part	5		Terminal Connector Rectangular Rectangular Tongue 4 AWG 5/16 Stud	LCAX4-56-L - 4AWG	LCAX4-56-L - 4AWG	Panduit Corp	Terminal for "7460719" part

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