TPS259230-41EVM: Evaluation Module for TPS259230/41

This user's guide describes the evaluation module (EVM) for the TPS259230 and TPS259241. TPS259230/TPS259241 are simple 5-V/12-V eFuse Protection Switches with overcurrent and reverse current blocking features.

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1 Introduction

The TPS259230-41EVM allows reference circuit evaluation of TI's TPS259230/41 devices. The TPS259230 and TPS259241 devices are Simple 5V/12V eFuse Protection Switches and are available with latching and auto-retry operation, respectively.

NOTE: User can also evaluate TPS259270 and TPS259271 devices on this EVM by just replacing TPS259230 and TPS259241 with TPS259270 and TPS259271.

1.1 EVM Features

General TPS259230-41EVM features include:

- 4.5-V to 5.5-V (TYP) operation (TPS259230DRC)
  - CH1 Rising input voltage turn-on threshold – 4.57 V (TYP)
  - CH1 Rising output voltage clamp threshold (OVP) – 6.1 V (TYP)
  - CH2 Falling input voltage turn-off threshold (UVLO) – 4.4 V (TYP)
- 4.5-V to 13.5-V (TYP) operation (TPS259241DRC)
  - CH2 Rising input voltage turn-on threshold – 10.8 V (TYP)
  - CH2 Falling input voltage turn-off threshold (UVLO) – 10.35 V (TYP)
  - CH2 Rising output voltage clamp threshold (OVP) – 15 V (TYP)
- 2.1 A to 5.1 A programmable current limit
- Reverse current protection
- Programmable VOUT slew rate
- Latched-off TPS259230DRC
- Auto-retry TPS259241DRC
  - Push button RESET signal
  - On-board transorb is for overvoltage transient protection
  - Reverse polarity protection feature

1.2 EVM Applications

The TPS259230-41EVM works with the following applications:

- White goods/appliances
- HDD and SSD drives
- Thunderbolt host ports
- Hot-swap boards
- PCI/PCIe Cards
- Servers
- Set-top boxes, DVD, and Blu-ray™ units

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2 Description

The TPS259230-41EVM enables full evaluation of the TPS259230/41 devices. The EVM supports two versions (Latched and Auto- Retry) of the devices on two Channels (CH1 and CH2 respectively). Input power is applied at T1 (CH1) and, T3 (CH2) while T2 (CH1) and T4 (CH2) provide the output connection to the load, Refer to the schematic in figure1, and EVM test setup in figure 2.

D3/C3 (CH1), D7/C9 (CH2) provide input protection for TPS259230/41 (U1 and U2 respectively) while D4/C2 (CH1), D8/C7 (CH2) provide output protection and inrush current demand from the load. S1 and S2 allow U1 and U2 respectively to be RESET or disabled. A fault indicator is provided by D1 and D5 LEDs for CH1 and CH2, respectively.

Table 1. TPS259230-41EVM Options and Settings

Part Number	EVM Function	Channel	Vin Range	UVLO	OVP	Current Limit			Fault Response
						Lo Setting	No Jumper	Hi Setting	
TPS259230-41EVM	5-V/12-V eFuse protection switches	CH1	4.5 V–5.5 V	4.57 V	6.1 V	2.1 A	5.1 A	3.7 A	Latched
		CH2	4.5 V–13.5 V	10.8 V	15 V	2.1 A	5.1 A	3.7 A	Auto-retry

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3 Schematics

Figure 1 illustrates the TPS259230-41EVM schematic.

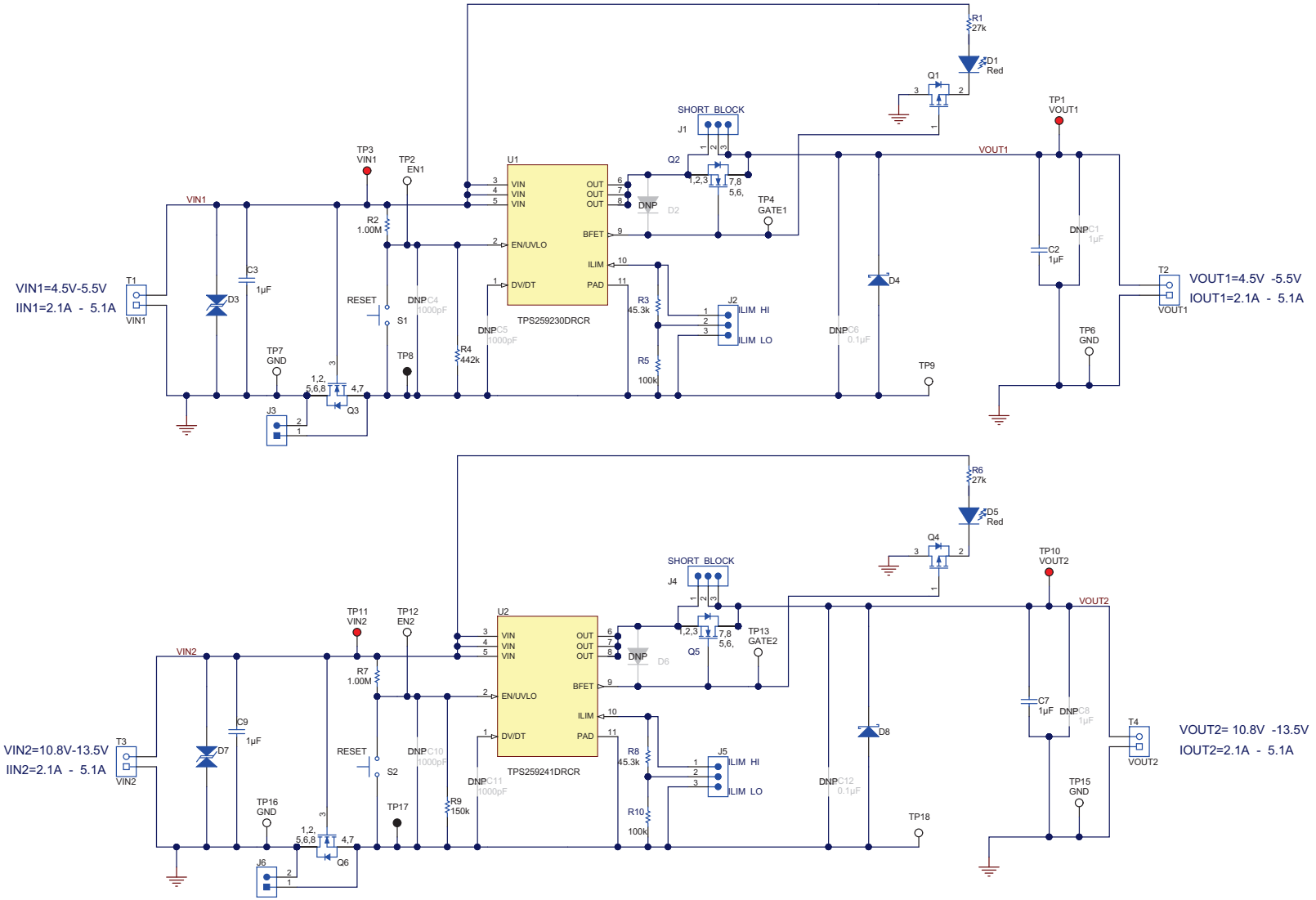


Figure 1. TPS259230-41EVM Schematic

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4 General Configurations

4.1 Physical Access

Table 2 lists the TPS259230-41EVM input and output connector functionality, Table 3 describes the test point availability, and Table 4 describes the jumper functionality.

Table 2. Input and Output Connector Functionality

Connector		Label	Description
T1	CH1	VIN1(+), GND(–)	CH1 Input power supply to the EVM
T2		VOUT1(+), GND(–)	CH1 Output power from the EVM
T3	CH2	VIN2(+), GND(–)	CH2 Input power supply to the EVM
T4		VOUT2(+), GND(–)	CH2 Output power from the EVM

Table 3. Test Points Description

Channel	Test Points	Label	Description
CH1	TP3	VIN1	CH1: Input power supply to the EVM
	TP2	EN1	CH1: Active high enable and undervoltage input
	TP1	VOUT1	CH1: Output from the EVM
	TP6	GND	GND
	TP7	GND	GND
	TP8	-	GND1(IC GND)
	TP9	-	GND1(IC GND)
CH2	TP11	VIN2	CH2: Input power supply to the EVM
	TP12	EN2	CH2: Active high enable and undervoltage input
	TP10	VOUT2	CH2: Output from the EVM
	TP16	GND	GND
	TP15	GND	GND
	TP17	-	GND1(IC GND)
	TP18	-	GND1(IC GND)

Table 4. Jumper and LED Descriptions

Jumper	Label	Description
J2	LIM HI –LIM-LO	CH1 current setting
J5	LIM HI –LIM-LO	CH2 current setting
D1 LED	D1 Red	CH1 fault indicator
D5 LED	D5 Red	CH2 fault indicator

4.2 Test Equipment and Set Up

4.2.1 Power Supplies

One adjustable power supply: 0-V to 20-V output, 0-A to 6-A output current limit.

4.2.2 Meters

One digital multimeter (DMM), minimum, needed and may require more, if simultaneous measurements are needed.

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4.2.3 Oscilloscope

A DPO2024 or Lecroy 424 oscilloscope, 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 6-ADC load at 12 V and at 5 V and are capable of output short.

4.3 Test Setup and Procedures

Figure 2 shows a typical test setup for the TPS259230-41EVM. Connect T1/T3 to the power supply and T2/T4 to the load. The white boundary around the IC shows the minimum components and the PCB space required to implement the functionality.

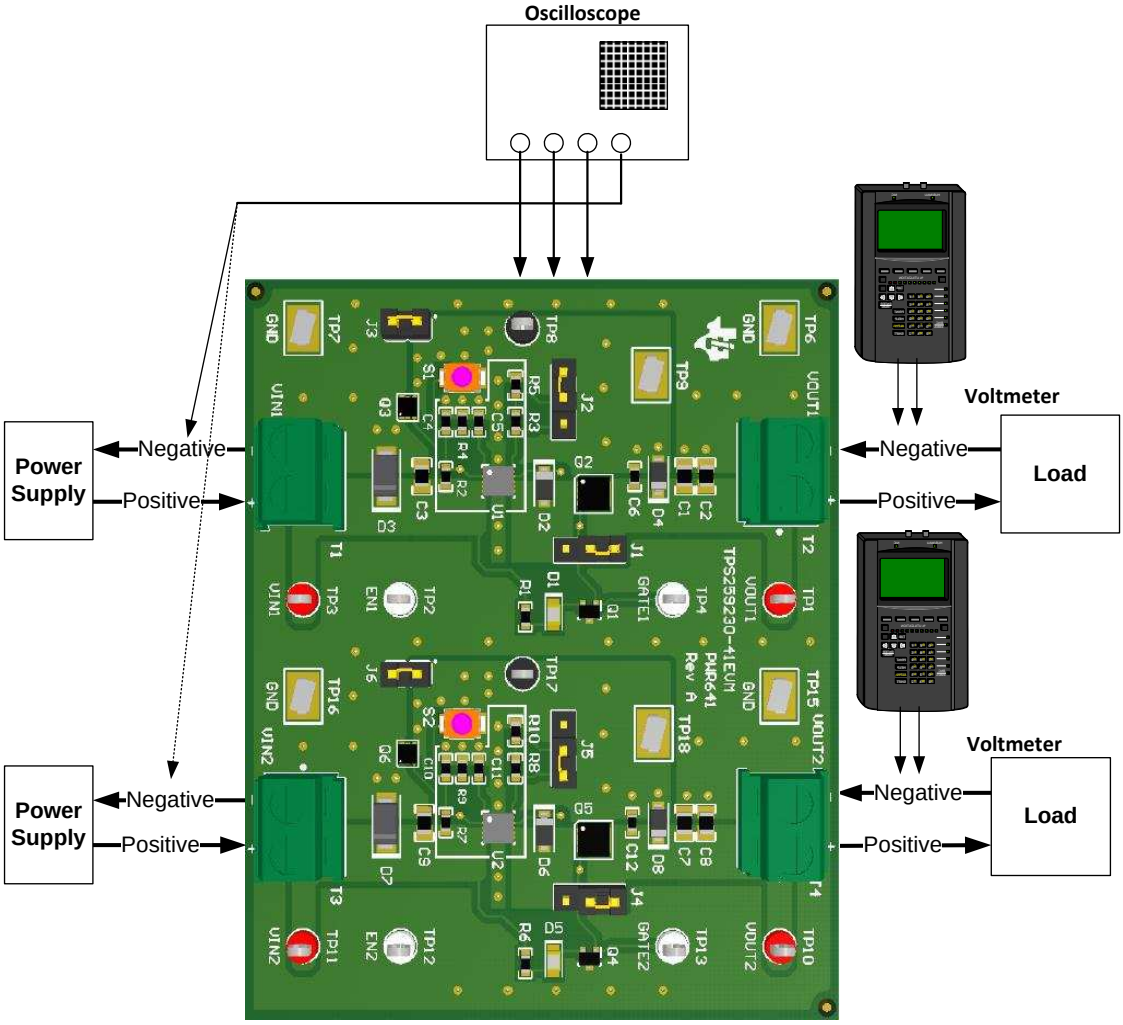


Figure 2. EVM Setup With Test Equipment

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4.3.1 Test Procedure

- Set the power-supply output VIN to 0 V.
- Turn on the power supply and set the output voltage and current limit according to Table 5:

Table 5. Power Supply Setting for TPS259230-41EVM

EVM	Channel	Voltage Set Point	Power Supply Current Limit
TPS259230-41EVM	CH1(T1)	5 ±0.1 VDC	6 A ±0.25 ADC
	CH2(T3)	12 ±0.2 VDC	

- Turn off the power supply. Hook up CH1 and CH2 of the TPS259230-41EVM assembly as shown in Figure 1.
- The default EVM jumper setting is shown in Table 6:

Table 6. Default Jumper Setting for TPS259230-41EVM

J1 (CH1)	J2 (CH1)	J3 (CH1)	J4 (CH2)	J5 (CH2)	J6 (CH2)
1-2	2-3	Install	1-2	2-3	Install

- CH1 and CH2 can be tested one by one for TPS259230-41EVM.
- Ensure that the output load is disabled and the power supply is set properly for the DUT. Connect the negative probe of DMM to TP7 (CH1) or TP16 (CH2) test points and positive probe as in Table 3. Turn on the power supply. Verify that the voltages shown in Table 3 are obtained.
- Connect the 2-A load current at T2 and T4.

Table 7. TPS259230-41EVM DMM Readings at Different Test Points

Voltage Test on (CH1)	Measured Voltage Reading	Voltage Test on (CH2)	Measured Voltage Reading
VIN1 (TP1)	5 ±0.2 VDC	VIN2 (TP10)	12 ±0.5 VDC
EN1 (TP2)	4.5 ±0.2 VDC	EN2 (TP11)	6.4 ±0.5 VDC
VOUT1 (TP3)	5 ±0.2 VDC	VOUT2 (TP12)	12 ±0.5 VDC

4.3.1.1 For CH1 (J1)

- Press the EVM RST switch, S1, and verify that the voltage at VOUT1 (TP1) starts falling below 5 V. Release S1.
- Reduce the input voltage on VIN1 (TP3) and monitor VOUT1. Verify that VOUT1 (TP1) starts falling and is fully turned off when VIN1 (TP3) reaches 4.4 V (±0.3 V).
- Increase the input voltage on VIN1 and monitor VOUT1. Verify that VOUT1 (TP1) starts increasing and clamped at 6.1 V (±0.4 V), VIN1 exceeds 6.1 V.
- Adjust the power supply voltage to 5 V.
- Turn off the power supply.

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4.3.1.2 For CH2 (J6)

- Press the EVM RST switch, S2, and verify that the voltage at VOUT2 (TP10) starts falling below 12 V. Release S1.
- Reduce the input voltage on VIN2 (TP11) and monitor VOUT2. Verify that VOUT2 (TP10) starts falling and is fully turned off when VIN2 (TP11) reaches 10.3 V (±0.3V).
- Increase the input voltage on VIN2 and monitor VOUT2. Verify that VOUT2 starts increasing and clamped at 15.1 V (±0.4 V), VIN1 exceeds 15.1 V.
- Adjust the power supply voltage to 12 V.
- Turn off the power supply.

4.3.1.3 Current Limit Test

- Verify all three current limits (CH1 and CH2, with only 1 channel powered at a time) and verify the latch and auto-retry feature. Setup the oscilloscope as shown in Table 8.

Table 8. TPS259230-41EVM Oscilloscope Setting for Current Limit Test

Oscilloscope Setting	CH1 Probe Points	CH2 Probe Points
Channel 1 = 5 V/div	TP1 = VOUT1	TP10 = VOUT2
Channel 2 = 5 V/div	TP3 = VIN1	TP11 = VIN2
Channel 4 = 2 A/div	Input current into J1 +ve wire	Input current into J6 +ve wire
Trigger source = Channel 4		
Trigger level = 2.5 A ±0.1 A		
Trigger polarity = +ve		
Trigger Mode = Single Sequence		
Time base	400 ms/div	40 ms/div

NOTE: If an electronic load is used, ensure that the output load is set to constant-resistance mode and not constant-current mode.

NOTE: Measuring current limit values on the oscilloscope can easily cause 8% error from anticipated values listed in Table 9.

- The jumper settings for the different current limit tests are shown in Table 9.

Table 9. TPS259230-41EVM Jumper Setting for Current Limits

Jumper Position		Load Current Limit
J2 (CH1)	J5 (CH2)	
2-3 (ILIM LO)	2-3 (ILIM LO)	2.1 A ±0.2 A
1-2 (ILIM HI)	1-2 (ILIM HI)	3.7 A ±0.3 A
No Jumper	No Jumper	5.1 A ±0.5 A

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- Set the output load at 0.5 ±0.1 Ω on CH1 and then enable the load. Turn on the VIN1 power supply, verify that input current is limited as per the setting in Table 9 and the device is in latched mode, as shown in Figure 3. The level of the current pulse should match with the load current limit (based on the respective jumper setting) as per Table 9.

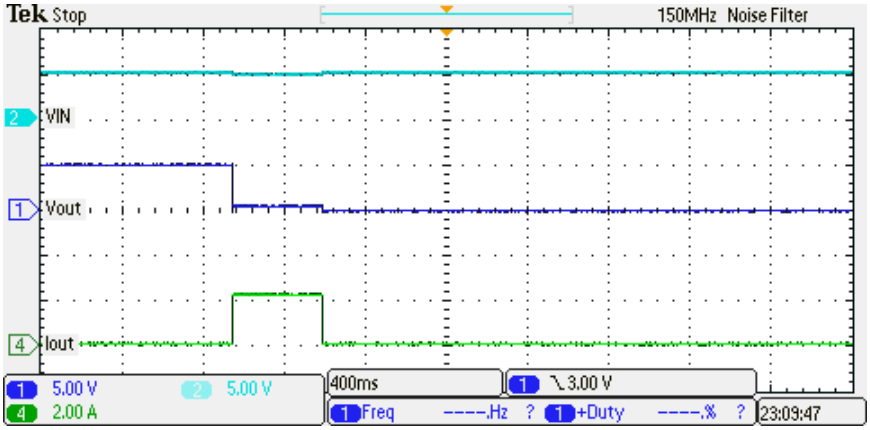


Figure 3. J3 = ”ILIM-LO” Current Limit (2.1 A) Test-Latched Feature (CH1)

- Set the output load at 1.0 ±0.5 Ω on CH2 and then enable the load. Turn on the VIN2 power supply, verify that input/output current is limited as per the setting in Table 9 and the device is in auto-retry mode, as shown in Figure 4. The level of the current pulse should match with the load current limit (based on the respective jumper setting) as per Table 9.

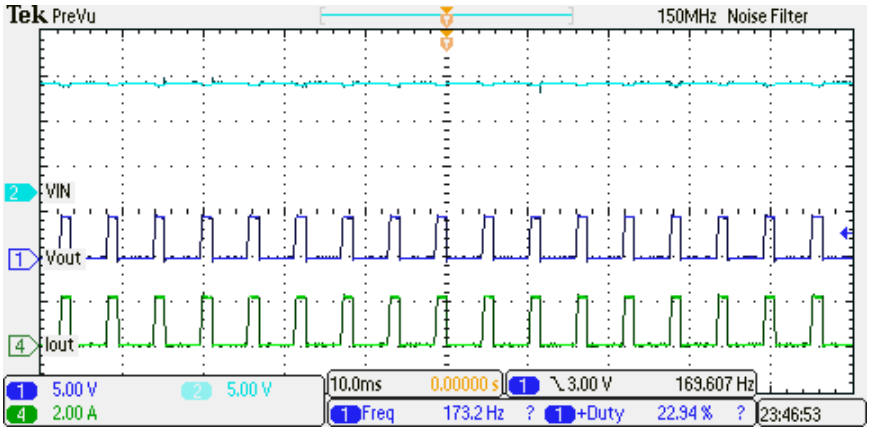


Figure 4. J3 = “ILIM-LO” Current Limit (2.1 A) Test Auto-Retry (CH2)

- Set the input power supply to zero volts and disconnect all equipment from the DUT.

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5 EVM Assembly Drawings and Layout Guidelines

5.1 PCB Drawings

Figure 5 through Figure 7 show component placement and layout of the EVM.

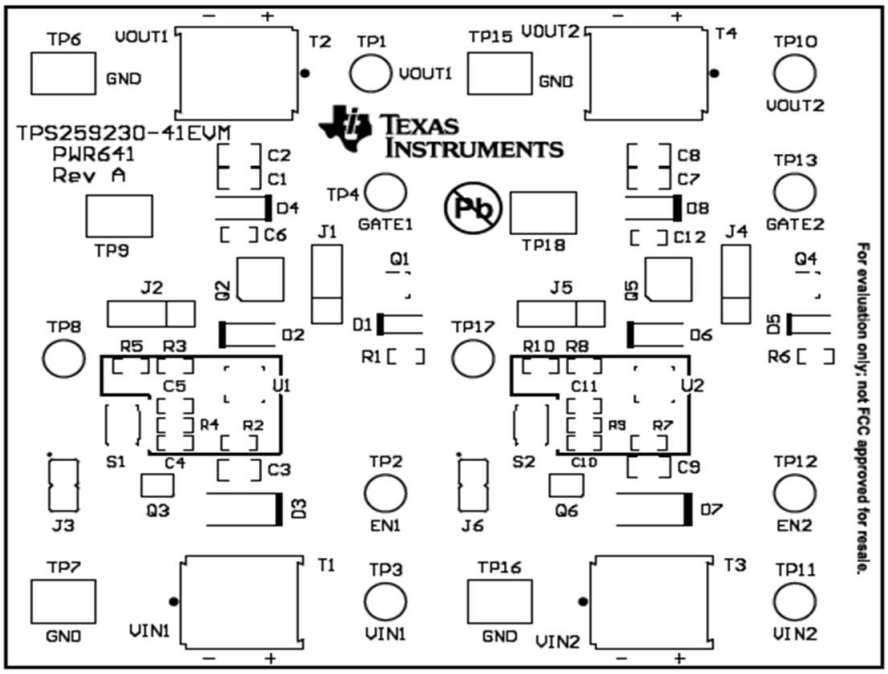


Figure 5. Top Side Placement

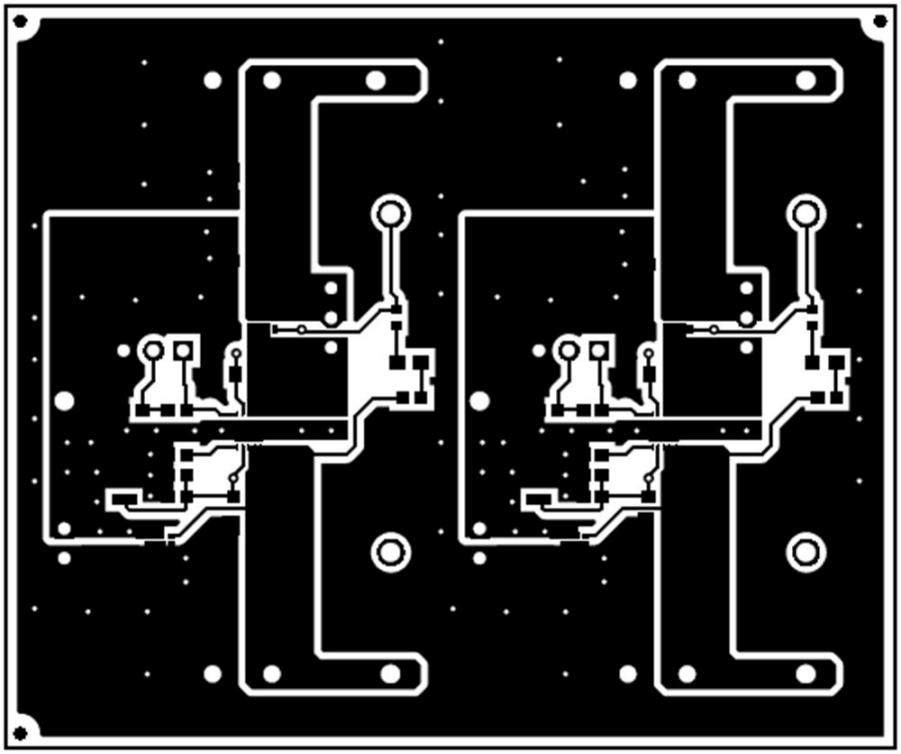


Figure 6. Top Layer

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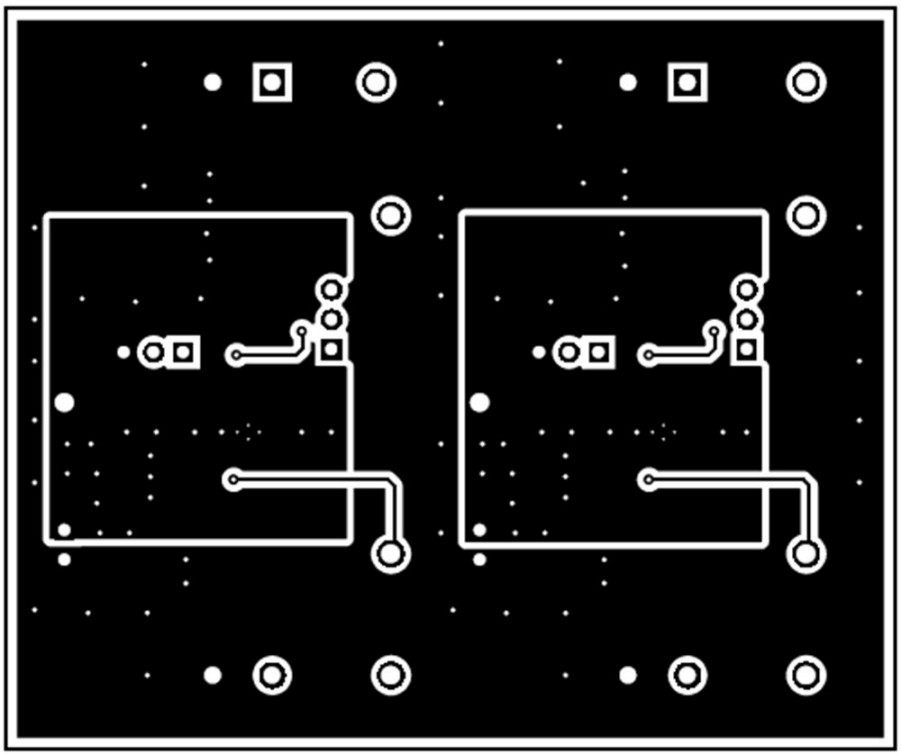


Figure 7. Bottom Layer

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6 Bill of Materials (BOM)

Table 10 lists the BOM for this EVM.

Table 10. TPS259230-41EVM Bill of Materials(1)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		TPS259230-41EVM	Any	-	-
C2, C3, C7, C9	4	1uF	CAP, CERM, 1uF, 25V, +/-10%, X5R, 0805	0805	08053D105KAT2A	AVX	-	-
D1, D5	2	Red	LED, Red, SMD	LED_0805	LTST-C170KRKT	Lite-On		
D3, D7	2	15V	Diode, TVS, Bi, 15 V, 400 W, SMA	SMA	SMAJ15CA	Littelfuse		
D4, D8	2	0.47V	Diode, Schottky, 30V, 1A, SOD-123	SOD-123	MBR130T1G	ON Semiconductor	Equivalent	Any
H1, H2, H3, H4	4		Bumpon, Cylindrical, 0.312 X 0.200, Black	Black Bumpon	SJ61A1	3M		
J1, J2, J4, J5	4	1x3	Header, TH, 100mil, 1x3, Gold plated, 230 mil above insulator	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions	Equivalent	Any
J3, J6	2		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions		
Q1, Q4	2	-50V	MOSFET, P-CH, -50 V, -0.13 A, SOT-323	SOT-323	BSS84W-7-F	Diodes Inc.		None
Q2, Q5	2		MOSFET, N-CH, 25V, 56A, SON 3.3x3.3mm	SON 3.3x3.3mm	CSD16411Q3	Texas Instruments		None
Q3, Q6	2	20V	MOSFET, N-CH, 20V, 10A, SON 2x2mm	SON 2x2mm	CSD15571Q2	Texas Instruments		None
R1, R6	2	27k	RES, 27 k, 5%, 0.1 W, 0603	0603	CRCW060327K0JNEA	Vishay-Dale		
R2, R7	2	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0603	0603	CRCW06031M00FKEA	Vishay-Dale		
R3, R8	2	45.3k	RES, 45.3 k, 1%, 0.1 W, 0603	0603	CRCW060345K3FKEA	Vishay-Dale		
R4	1	442k	RES, 442 k, 1%, 0.1 W, 0603	0603	CRCW0603442KFKEA	Vishay-Dale		
R5, R10	2	100k	RES, 100k ohm, 1%, 0.1W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale		
R9	1	150k	RES, 150 k, 1%, 0.1 W, 0603	0603	CRCW0603150KFKEA	Vishay-Dale		
S1, S2	2		Switch, Push Button, SMD	2.9x2x3.9mm SMD	SKRKAEE010	Alps	Equivalent	Any
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6	6	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
T1, T2, T3, T4	4		Terminal Block, 2x1, 5.08mm, TH	10.16x15.2x9mm	282841-2	TE Connectivity		
TP1, TP3, TP10, TP11	4	Red	Test Point, TH, Multipurpose, Red	Keystone5010	5010	Keystone	Equivalent	Any
TP2, TP4, TP12, TP13	4	White	Test Point, TH, Multipurpose, White	Keystone5012	5012	Keystone	Equivalent	Any
TP6, TP7, TP9, TP15, TP16, TP18	6	SMT	Test Point, SMT, Compact	Testpoint_Keystone_Compact	5016	Keystone	Equivalent	Any
TP8, TP17	2	Black	Test Point, TH, Multipurpose, Black	Keystone5011	5011	Keystone	Equivalent	Any
U1	1		12-V eFuse with Over Voltage Protection and Blocking FET Control, DRC0010J	DRC0010J	TPS259230DRCR	Texas Instruments	TPS259230DRCT	Texas Instruments
U2	1		12-V eFuse with Over Voltage Protection and Blocking FET Control, DRC0010J	DRC0010J	TPS259241DRCR	Texas Instruments	TPS259241DRCT	Texas Instruments
C1, C8	0	1uF	CAP, CERM, 1uF, 25V, +/-10%, X5R, 0805	0805	08053D105KAT2A	AVX	-	-
C4, C5, C10, C11	0	1000pF	CAP, CERM, 1000pF, 100V, +/-20%, X7R, 0603	0603	06031C102MAT2A	AVX	-	-
C6, C12	0	0.1uF	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0603	0603	06033C104KAT2A	AVX	-	-
D2, D6	0	1.25V	Diode, Ultrafast, 100V, 0.15A, SOD-123	SOD-123	1N4148W-7-F	Diodes Inc.		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		

(1) Unless otherwise noted in the alternate part number or alternate manufacturer columns, all parts may be substituted with equivalents.

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Revision History

Changes from Original (August 2015) to A Revision	Page
• In the note in the *Introduction* section, the device names were changed.	2

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

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STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   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 and conditions 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 and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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.

3 *Regulatory Notices:*

   3.1 *United States*

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

      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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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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:*

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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.

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