Using the TPS84259: Negative Output Voltage, up to 15-W, Integrated Power Solution EVM

Introduction

The TPS84259EVM-001 Evaluation Module is designed as an easy-to-use platform that facilitates an extensive evaluation of the features and performance of the Integrated Power Solution (IPS) device. This guide provides information on the correct usage of the EVM and an explanation of the numerous test points on the board.

Description

The EVM features a TPS84259 device configured for operation from a 4.5 V to 40 V input supply. The TPS84259 is a non-synchronous, buck-boost (negative output) converter optimized for output voltages between -3 V and -17 V. The TPS84259 operates at a fixed frequency of typically 800 kHz. The output voltage can be set to one of four popular values by using a simple configuration jumper. The EVM can supply up to 2 A of output current depending on the input and output voltage (See Figure 1). A minimal amount of input and output capacitance is used on the board. Component pads are provided for additional input and output capacitors if desired. Test points are provided that allow measurement of efficiency, power dissipation, input ripple, output ripple, line and load regulation, soft-start behavior, transient response, and UVLO behavior. The EVM uses a recommended PCB layout that maximizes thermal performance and minimizes output ripple and noise.

Getting Started

The host power supply is connected to the EVM at terminal block TB1. The VIN and GND terminals are clearly marked. The terminal block can accept up to number 16 AWG wire. For a complete evaluation, the host supply should be adjustable up to 40 V and be capable of delivering at least 3 A of current. The output of the EVM is presented to terminal block TB2. An electronic or resistive load can be connected to the block.

Input and output voltage test points are provided near the terminal blocks. These test points are intended to be used as voltage monitoring points where voltmeters can be connected to measure V_{IN} and V_{OUT}. Do not use these test points as the input supply or output load connection points. The PCB traces connecting to the test points are not designed to support high currents.

Before applying power, make certain that the V_{OUT} SELECT (J3) jumper is present and properly positioned for the intended output voltage. Always remove power before changing the jumper settings.

Once the jumper setting has been confirmed, set the host input supply to a voltage level between 4.5 V to 40 V, making sure that the sum of V_{IN} + $|V_{OUT}|$ does not exceed 50 V. See Table 1 for the maximum input voltages for the four preset V_{OUT} settings. Turn the host supply ON and then confirm that the selected output voltage is obtained.

Table 1. Output Voltage Settings and Maximum V_{IN}

V_{OUT} SELECT , J3 (V)	MAXIMUM V_{IN} (V)
-3.3	40
-5	40
-12	38
-15	35

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Test Point Description

A number of wire loop test points have been provided as convenient connection points for DVMs or oscilloscope probes to aid in the evaluation of this device. A description of each test point is given in the following text.

V_{IN}	Input voltage monitoring point. Connect DVM to this point for efficiency measurements.
$-V_{OUT}$	Negative output voltage monitoring point. Connect DVM to this point for efficiency, line regulation, and load regulation measurements.
J1 (V_{IN})	Connect an oscilloscope probe with a short grounding tip to this pair of holes to measure input ripple voltage.
J2 ($-V_{OUT}$)	Connect an oscilloscope probe with a short grounding tip to this pair of holes to measure output ripple voltage and transient response.
SS	The voltage on the soft-start capacitor can be monitored here.
INH / UVLO	Ground this terminal to Inhibit power conversion via an on-board level-shifter. When open, the voltage on this pin is the voltage of the UVLO resistor divider network.
GND	Ground points for meters and oscilloscope probes.
PH	A via test point for monitoring the Phase pin (Switching Node) of the device with an oscilloscope. This test point can be used to measure the switching frequency of the regulator. Only a x10 oscilloscope probe should be used to monitor this point. The operation of the device can be affected by the stray capacitance of conventional cables or x1 probes.

Operation Notes

The UVLO threshold of the factory-stock EVM is approximately 4.5 V. The input voltage must be above the UVLO threshold before power conversion begins. The UVLO threshold is set by resistors R6 and R7. See the data sheet (SLVSBA0) for information on setting the UVLO voltage.

When the input voltage rises above the UVLO threshold, power conversion begins and the output voltage will ramp to its final value in approximately 10 ms. If desired, this soft-start interval can be increased by adding capacitance at location C4 on the bottom side of the EVM. This location is not populated on the factory-stock EVM.

The switching frequency of the factory-stock EVM is set to 800 kHz (typ) by populating resistor R8 with a 0-Ω resistor. The switching frequency can be changed to 500 kHz by changing R8 to 93.1 kΩ. See the datasheet for switching frequency limits.

The CLK input pin (pin 31) has not been brought out to a test point on the factory-stock EVM.

The TPS84259 is not designed to endure a sustained short circuit on its output. It survives momentary shorts (< 5 seconds), but sustained short circuits may cause permanent damage to the device.

The maximum output current is dependent on the input and output voltage. Figure 1 shows the output current limits for four common output voltages over the input voltage range.

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Maximum Output Current

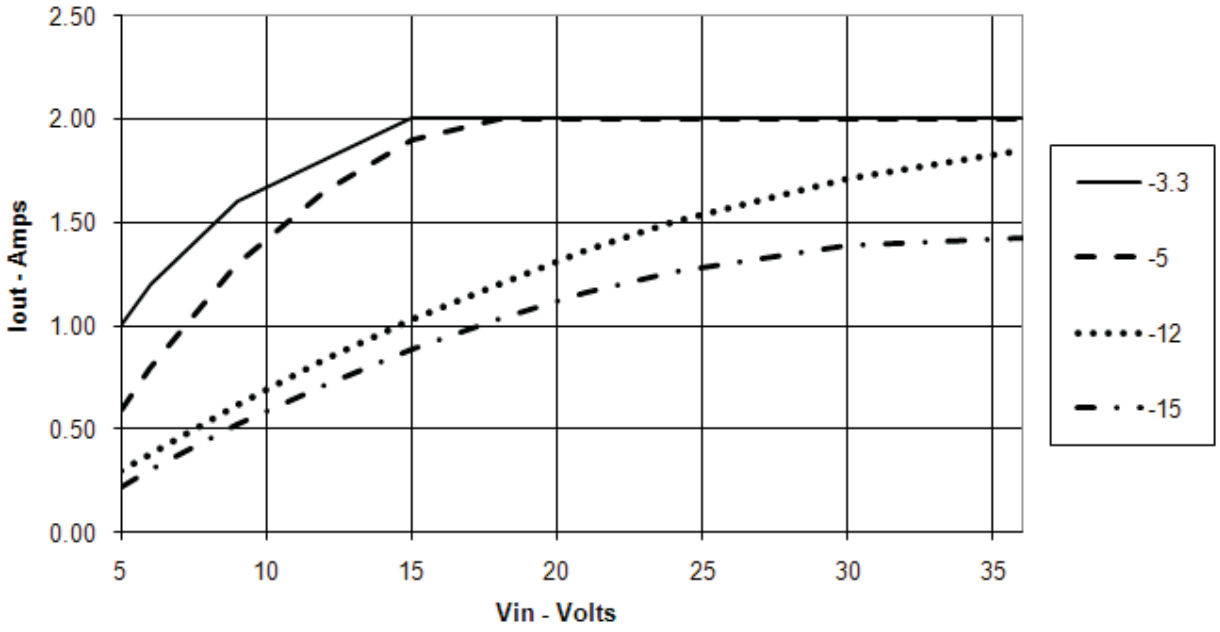


Figure 1. TPS84259 Safe Output Current

Schematic

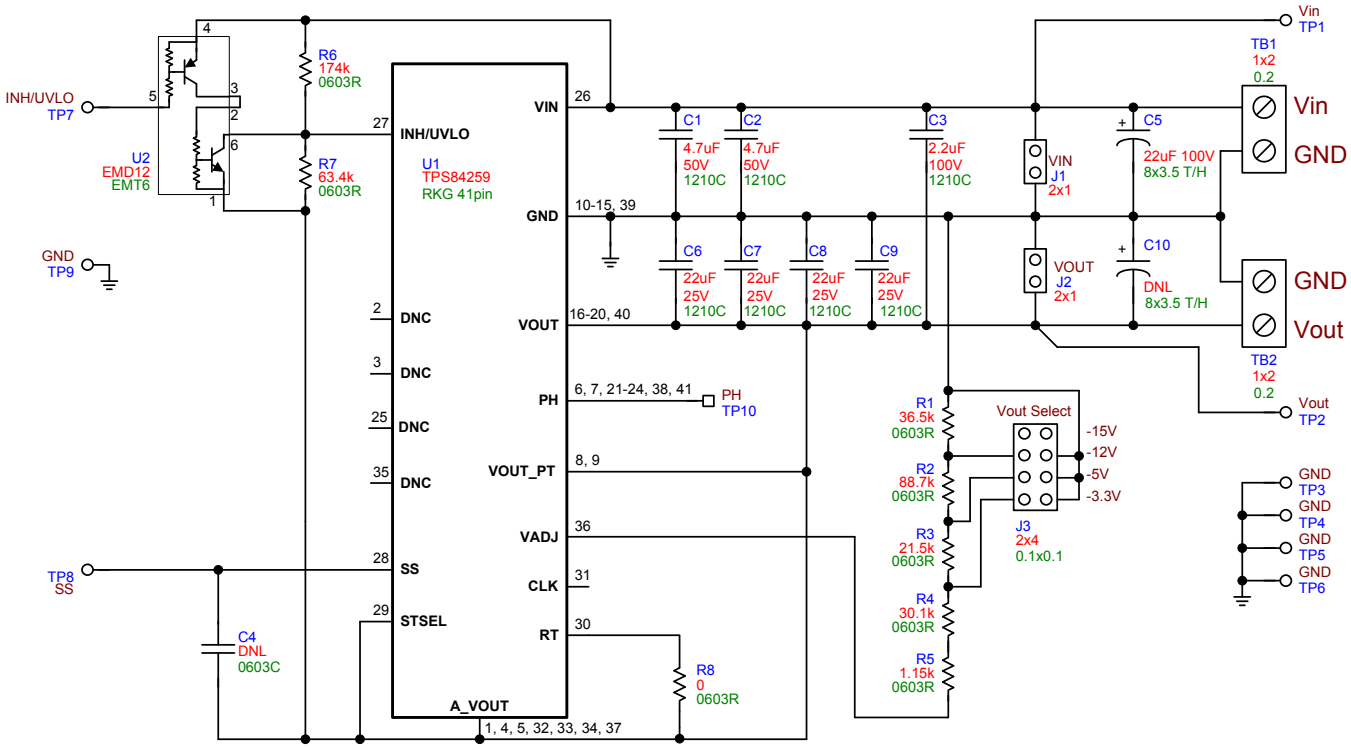


Figure 2. Schematic, TPS84259 EVM

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EVM Assembly Drawings and PCB Layout

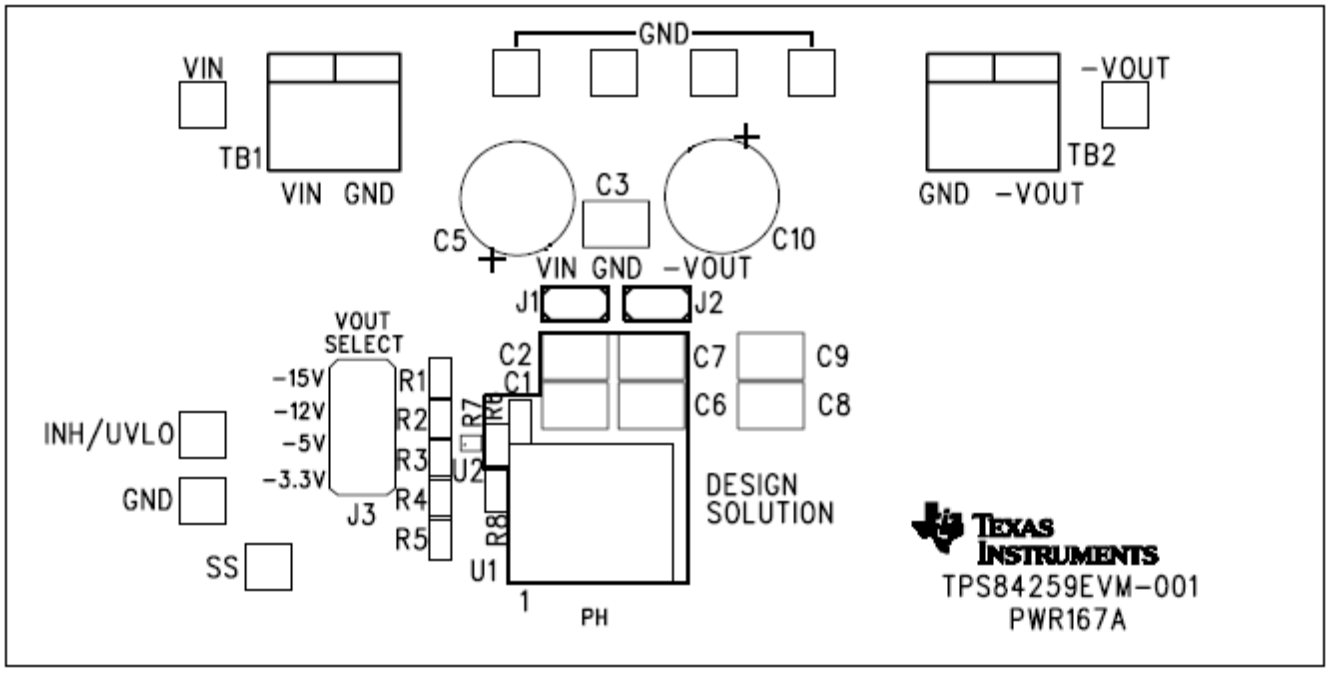


Figure 3. Top Side Components

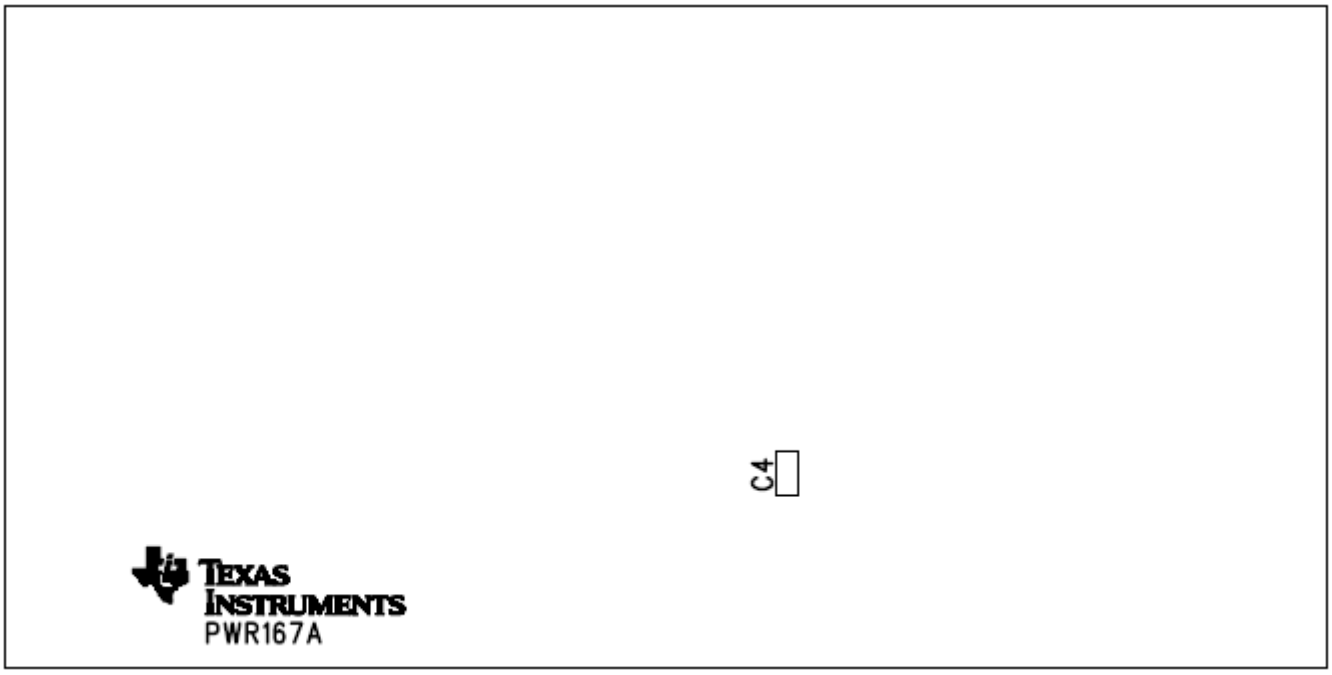


Figure 4. Bottom Side Components

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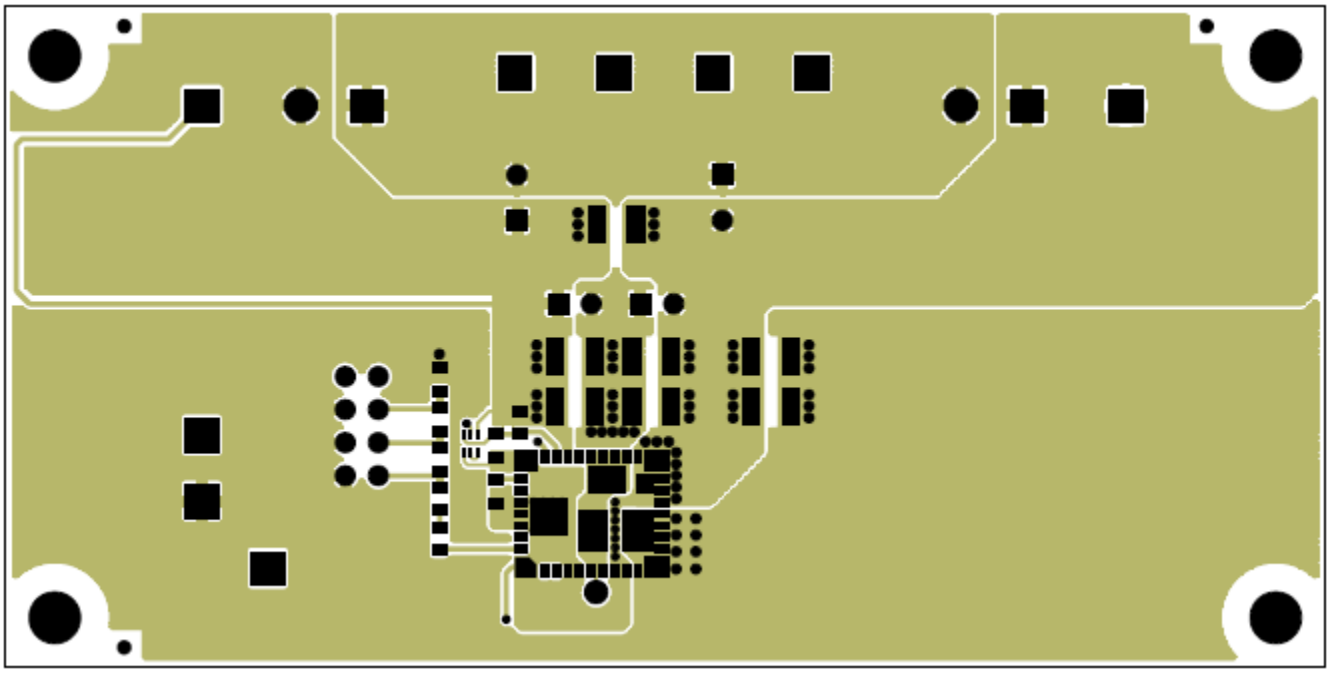


Figure 5. Layer 1

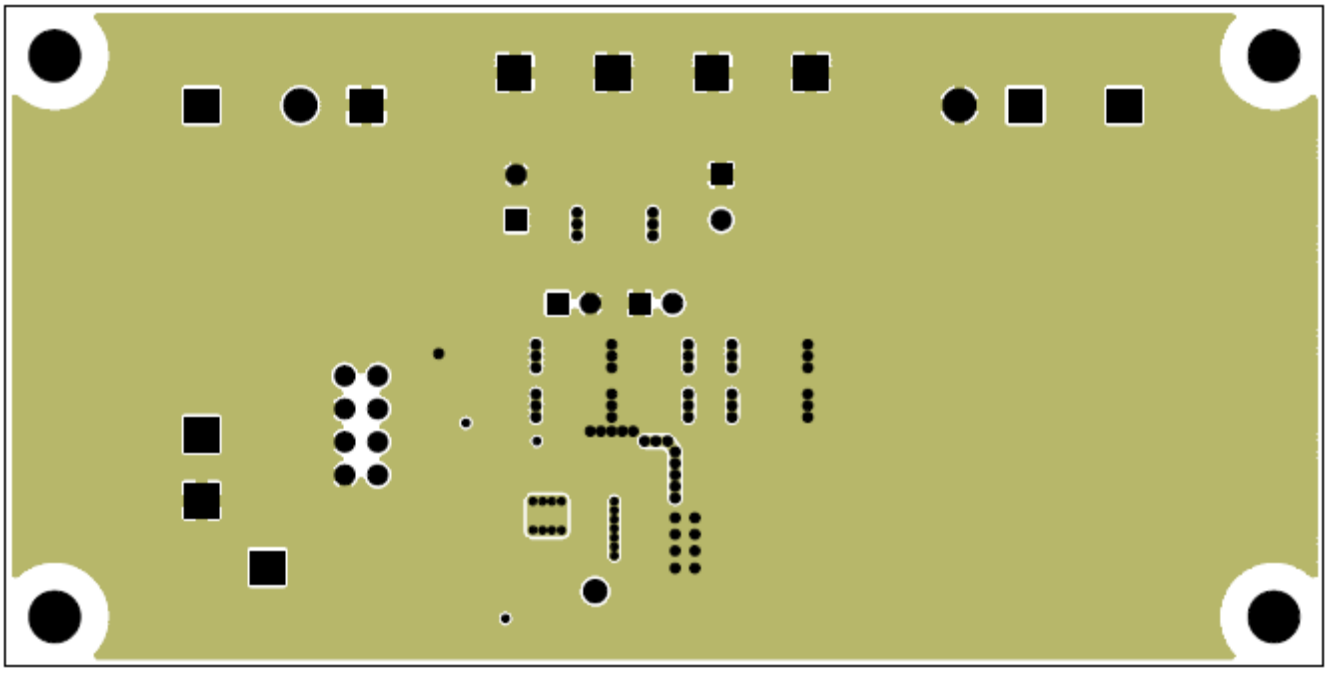


Figure 6. Layer 2

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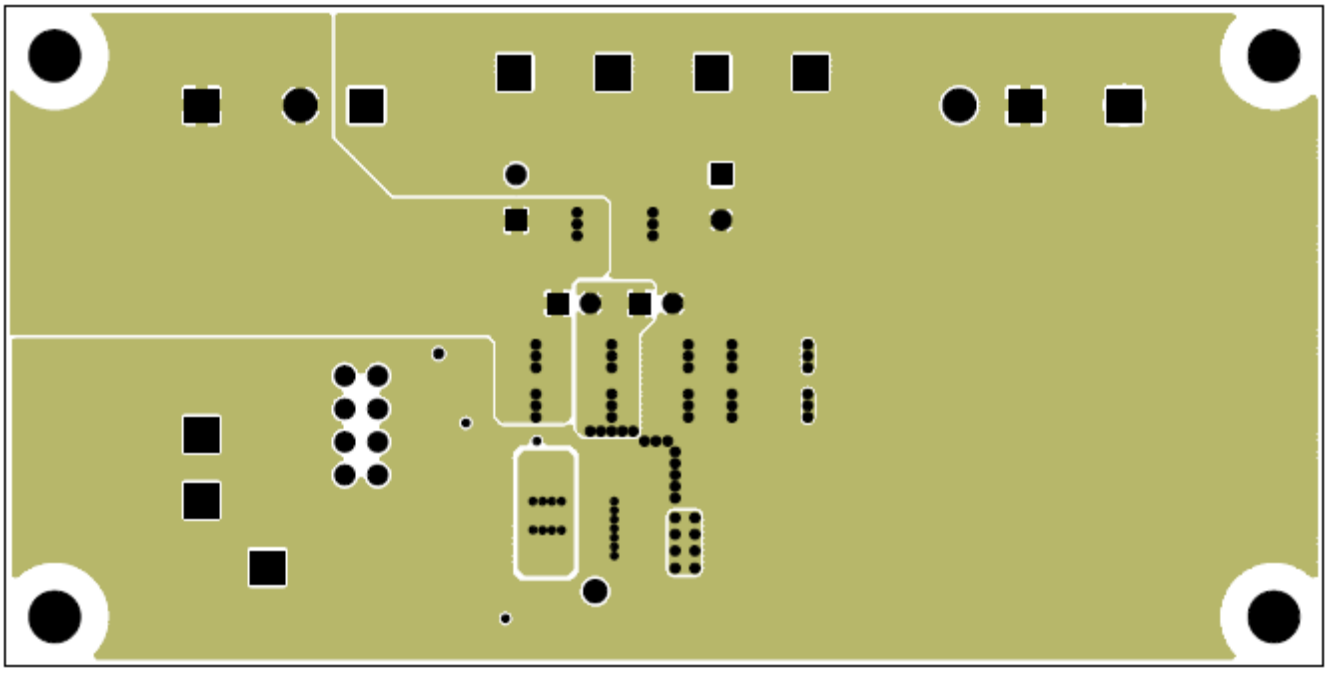


Figure 7. Layer 3

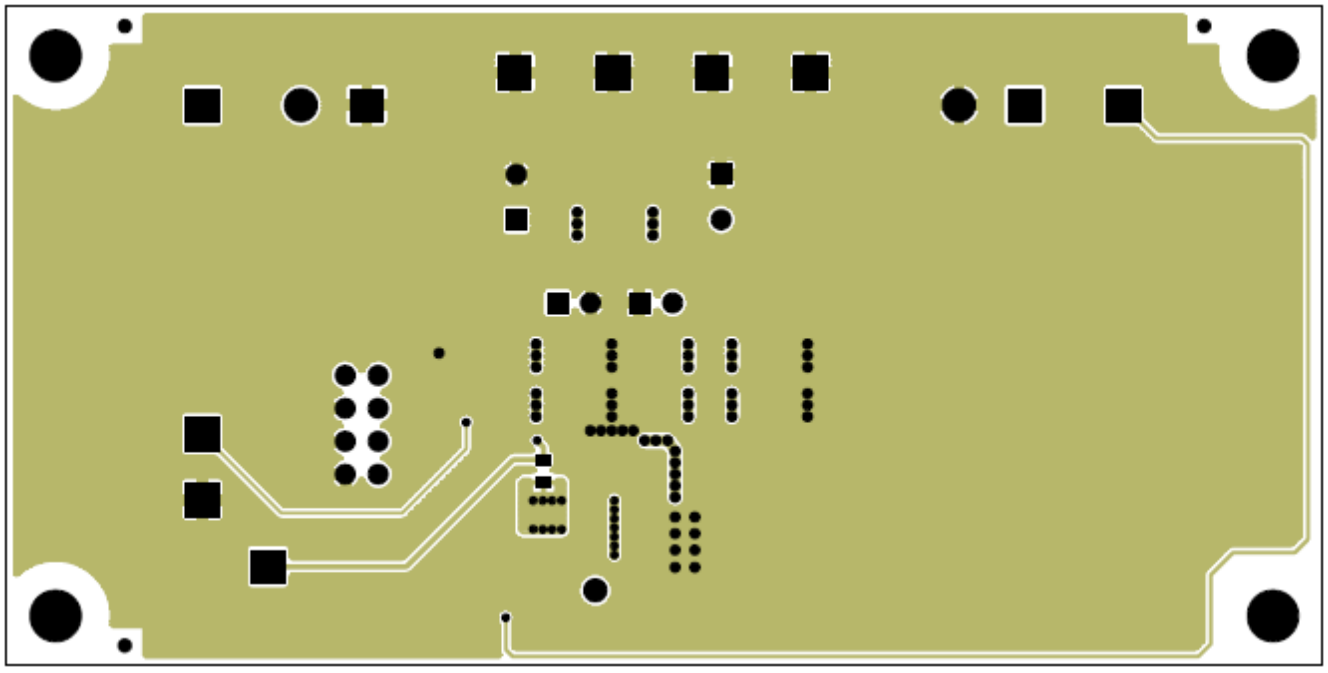


Figure 8. Layer 4

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Bill of Material

Table 2. TPS84259 EVM Bill of Material

Qty	RefDes	Value	Description	Size	Part Number	Mfr
2	C1, C2	4.7uF	Capacitor, Ceramic, 50V, X7R, 20%	1210	GRM32ER71H475K	Murata
1	C3	2.2uF	Capacitor, Ceramic, 100V, X7R, 10%	1210	GRF32ER72A225K	Murata
0	C4		Do Not Load	0603		
1	C5	22uF	Capacitor, Electrolytic, 100V	8 x 3.5 (mm)	EEU-FC2A220	Panasonic
4	C6, C7, C8, C9	22uF	Capacitor, Ceramic, 25V, X5R, 20%	1210	GRM32ER61E226K	Murata
0	C10		Do Not Load	8 x 3.5 (mm)		
0	J1, J2		Do Not Load			
1	J3	PEC04DAAN	Header, Male 2x4-pin, 100mil spacing	2 X 4 100mil	PEC04DAAN	Sullins
1	R1	36.5k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R2	88.7k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R3	21.5k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R4	30.1k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R5	1.15k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R6	174k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R7	63.4k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R8	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	TB1, TB2	ED120/2DS	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 x 0.35 inch	ED120/2DS	OST
1	TP1	5010	Test Point, Red, Thru Hole	0.125 x 0.125 inch	5010	Keystone
1	TP2	5014	Test Point, Yellow, Thru Hole	0.125 x 0.125 inch	5014	Keystone
5	TP3-6,9	5011	Test Point, Black, Thru Hole	0.125 x 0.125 inch	5011	Keystone
2	TP7,8	5012	Test Point, White, Thru Hole	0.125 x 0.125 inch	5012	Keystone
0	TP10		Do Not Load			
1	U1**	TPS84259RKG	IC, 5-36V Input, 2A, Buck-Boost, IPS Module	QFN	TPS84259RKG	TI
1	U2	DCX144EH-7	Trans, Prebias, NPN/PNP	SOT-563	DCX144EH-7	Diodes
1	--		PCB, TPS84259 Sample Eval Bd	2 x 4 x 0.062 inch	074-01047	Any
1		929950-00	Shunt, Black	100-mil	929950-00	3M
1			EVM Plastic Base, 2 x 4 inch		076-00447	TI
4			4-40 x 1/4 Stainless Steel Panhead Screw	4-40 x 1/4 inch	Std	Std
4		SJ-5003	BUMPON HEMISPHERE .44X.20 BLACK		SJ-5003	3M

Notes:

1. These assemblies are ESD sensitive, ESD precautions shall be observed
2. These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with an asterisk ('**') cannot be substituted. All other components can be substituted with equivalent MFG's components.
5. Install the shunt in the header J3.

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User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

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If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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