TPS62130EVM-505, TPS62140EVM-505, and TPS62150EVM-505 Evaluation Modules

This user's guide describes the characteristics, operation, and use of the Texas Instruments TPS62130, TPS62140, and TPS62150 evaluation modules (EVM). These EVMs are designed to help the user easily evaluate and test the operation and functionality of the TPS62130, TPS62140, and TPS62150. This user's guide includes setup instructions for the hardware, printed-circuit board layouts for the EVMs, a schematic diagram, a bill of materials, and test results for the EVMs. After the release of the A-version devices in the summer of 2013, these EVMs are assembled with the TPS62130A, TPS62140A, or TPS62150A.

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1 Introduction

The TPS62130 is a 3-A, synchronous, step-down converter in a 3x3-mm, 16-pin QFN package. Both fixed and adjustable output voltage units are available.

The TPS62140 is a 2-A, synchronous, step-down converter in a 3x3-mm, 16-pin QFN package. Both fixed and adjustable output voltage units are available.

The TPS62150 is a 1-A, synchronous, step-down converter in a 3x3-mm, 16-pin QFN package. Both fixed and adjustable output voltage units are available.

1.1 Background

The TPS62130EVM-505 (HPA505-001) uses the TPS62130A adjustable version and is set to a 3.3-V output. The EVM operates with full-rated performance with an input voltage between 3.7 V and 17 V.

The TPS62140EVM-505 (HPA505-002) uses the TPS62140A adjustable version and is set to a 3.3-V output. The EVM operates with full-rated performance with an input voltage between 3.7 V and 17 V.

The TPS62150EVM-505 (HPA505-003) uses the TPS62150A adjustable version and is set to a 3.3-V output. The EVM operates with full-rated performance with an input voltage between 3.7 V and 17 V.

1.2 Performance Specification

Table 1 provides a summary of the TPS621x0EVM-505 performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 1. Performance Specification Summary

Specification	Test Conditions	Min	Typ	Max	Unit
Input Voltage		3.7		17	V
Output Voltage	PWM Mode of Operation	3.268	3.327	3.387	V
Output Current	TPS62130EVM-505	0		3000	mA
	TPS62140EVM-505	0		2000	mA
	TPS62150EVM-505	0		1000	mA
Peak Efficiency	TPS62130EVM-505, FSW = LOW (high frequency)		93.2 %		
Peak Efficiency	TPS62140EVM-505 and TPS62150EVM-505, FSW = HIGH (low frequency)		95.0 %		
Soft-Start Time			1.65		ms

1.3 Modifications

The printed-circuit board (PCB) for this EVM is designed to accommodate both the fixed and adjustable voltage versions of this integrated circuit (IC). Additional input and output capacitors can also be added, and the soft-start time can be changed. Finally, the loop response of the IC can be measured.

1.3.1 Fixed Output Operation

U1 can be replaced with the fixed-voltage version of the IC for evaluation. For fixed-voltage version operation, replace R2 with a 0-Ω resistor and remove R1.

1.3.2 Input and Output Capacitors

C2 is provided for an additional input capacitor. This capacitor is not required for proper operation but can be used to reduce the input voltage ripple.

C7 is provided for an input capacitor on the AVIN pin. This capacitor is required and populated on the TPS62130EVM-505. It may be added on the other EVM versions but is not required.

C4 is provided for an additional output capacitor. This capacitor is not required for proper operation but can be used to reduce the output voltage ripple and to improve the load transient response. The total output capacitance must remain within the recommended range in the data sheet for proper operation.

1.3.3 Soft-Start Time

C5 controls the soft-start time of the output voltage on the TPS621x0EVM-505. It can be changed for a shorter or slower ramp up of Vout. Note that as the value of C5 is decreased, the inrush current increases.

1.3.4 Loop Response Measurement

The loop response of the TPS621x0EVM-505 can be measured with two simple changes to the circuitry. First, install a 10-Ω resistor across the pads in the middle of the back of the PCB. The pads are spaced to allow installation of 0805- or 0603-sized resistors. Second, cut the trace between the via on the output voltage and the trace that connects to the VOS pin via. These changes are shown in Figure 1. With these changes, an ac signal (10-mV, peak-to-peak amplitude recommended) can be injected into the control loop across the added resistor.

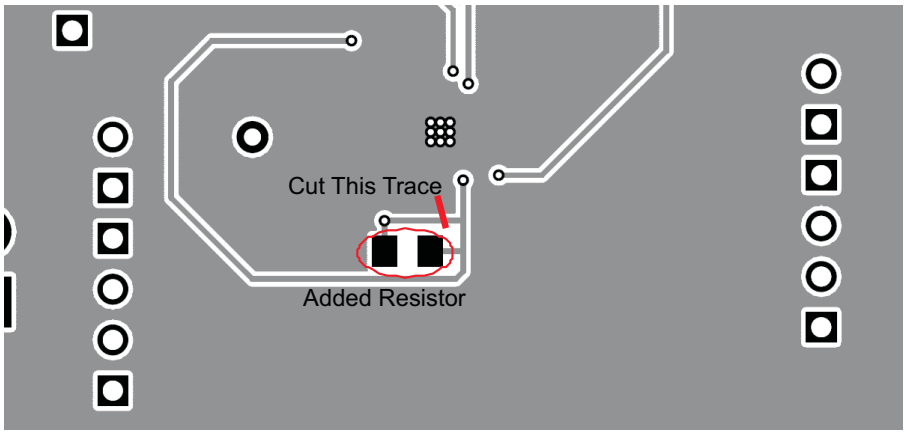

Figure 1. Loop Response Measurement Modification

2 Setup

This section describes how to properly use the TPS621x0EVM-505.

2.1 Input/Output Connector Descriptions

J1 – VIN	Positive input connection from the input supply for the EVM. Use when the steady-state input current is less than 1 A. Otherwise, use J8.
J2 – S+/S–	Input voltage sense connections. Measure the input voltage at this point.
J3 – GND	Return connection from the input supply for the EVM. Use when the steady-state input current is less than 1 A. Otherwise, use J8.
J4 – VOUT	Output voltage connection. Use when the steady-state output current is less than 1 A. Otherwise, use J9.
J5 – S+/S–	Output voltage sense connections. Measure the output voltage at this point.

J6 – GND	Output return connection. Use when the steady-state output current is less than 1 A. Otherwise, use J9.
J7 – PG/GND	The PG output appears on pin 1 of this header with a convenient ground on pin 2.
J8 – VIN/GND	Pin 1 is the positive input connection with pin 2, serving as the return connection. Use this terminal block if the steady-state input current is greater than 1 A.
J9 – VOUT/GND	Pin 2 is the output voltage connection with pin 1, serving as the output return connection. Use this terminal block if the steady-state output current is greater than 1 A.
J10 – SS/TR & GND	The SS/TR input appears on pin 1 of this header with a convenient ground on pin 2
JP1 – EN	EN pin input jumper. Place the supplied jumper across ON and EN to turn on the IC. Place the jumper across OFF and EN to turn off the IC.
JP2 – DEF	DEF pin input jumper. Place the supplied jumper across HIGH and DEF to set the output voltage at 5% above nominal. Place the jumper across LOW and DEF to set the output voltage at the nominal level.
JP3 – FSW	FSW pin input jumper. Place the supplied jumper across 1.25MHz and FSW to operate the IC at a reduced switching frequency of nominally 1.25 MHz. Place the jumper across 2.5MHz and FSW to operate the IC at the full switching frequency of nominally 2.5 MHz.
JP4 – PG Pullup Voltage	PG pin pullup voltage jumper. Place the supplied jumper on JP4 to connect the PG pin pullup resistor to Vout. Alternatively, the jumper can be removed and a different voltage can be supplied on pin 2 to pull up the PG pin to a different level. This externally applied voltage must remain below 7 V.

2.2 Setup

To operate the EVM, set jumpers JP1 through JP4 to the desired positions per Section 2.1. Connect the input supply to either J1 and J3 or J8, and connect the load to either J4 and J6 or J9.

3 TPS621x0EVM-505 Test Results

This section provides test results of the TPS621x0EVM-505.

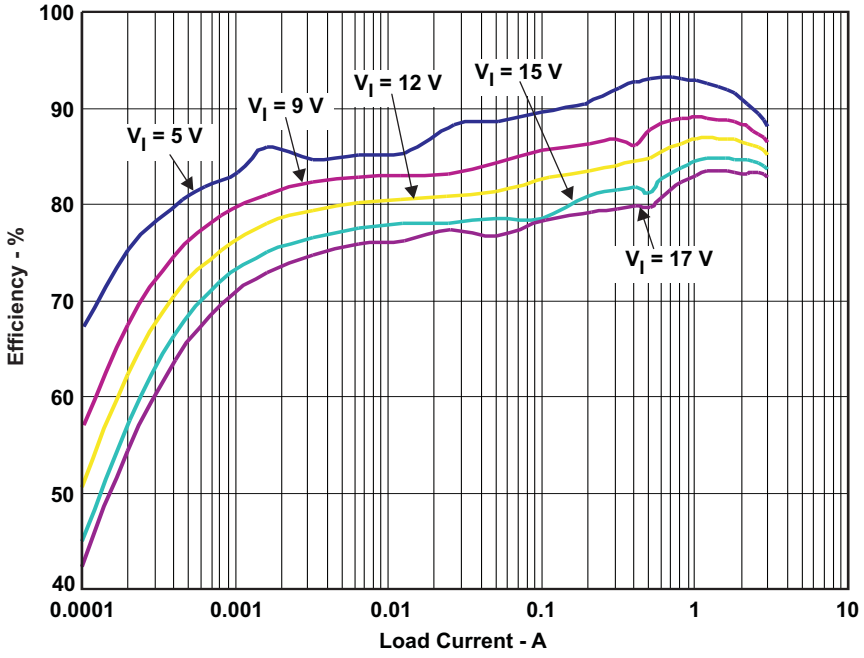

Figure 2. Efficiency With 1-µH Inductor and FSW = LOW (high frequency)

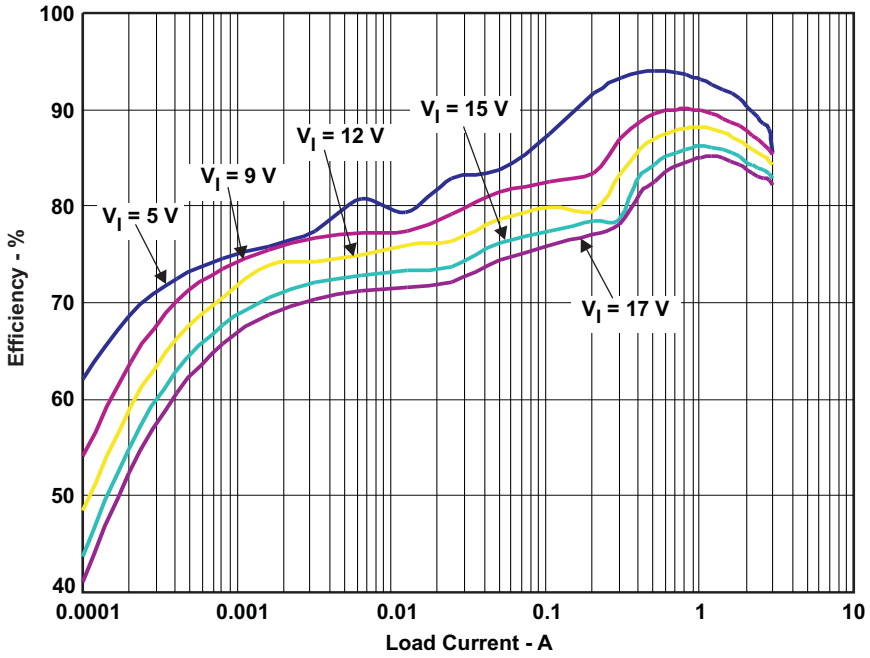

Figure 3. Efficiency With 2.2-µH Inductor and FSW = LOW (high frequency)

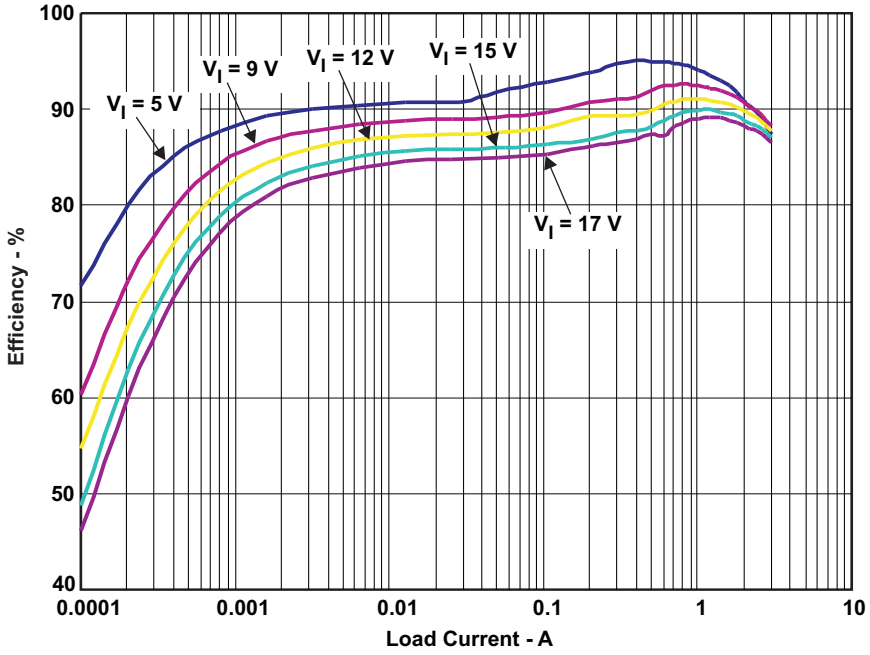

Figure 4. Efficiency With 2.2-µH Inductor and FSW = HIGH (low frequency)

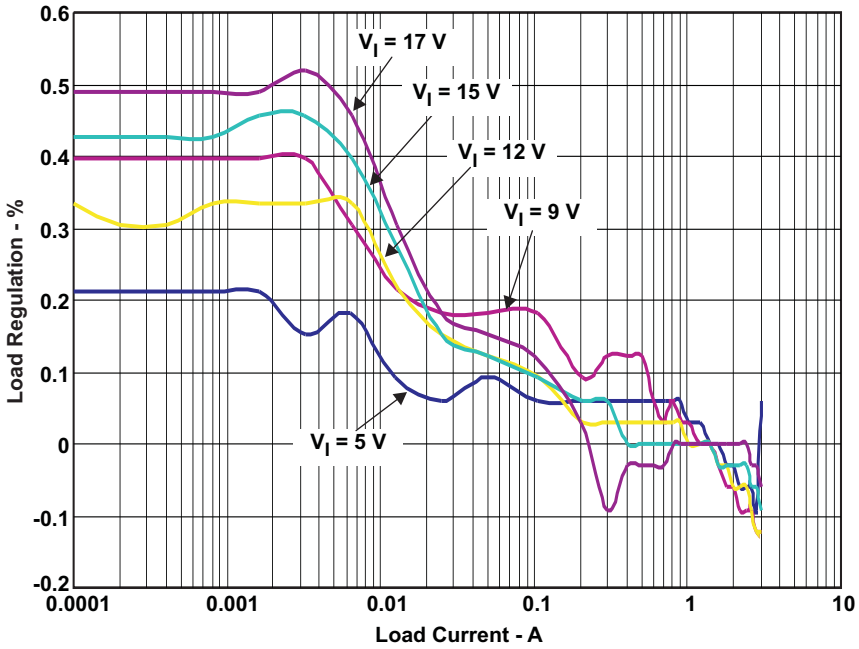

Figure 5. Load Regulation With 2.2-µH Inductor and FSW = LOW (high frequency)

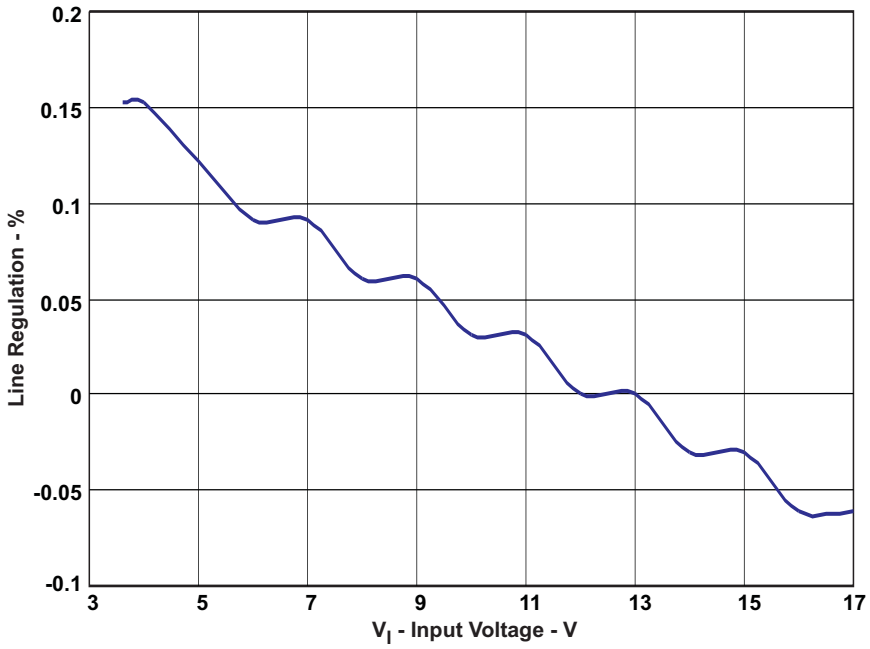

Figure 6. Line Regulation With 2.2-µH Inductor and FSW = LOW (high frequency) and Iout = 1 A

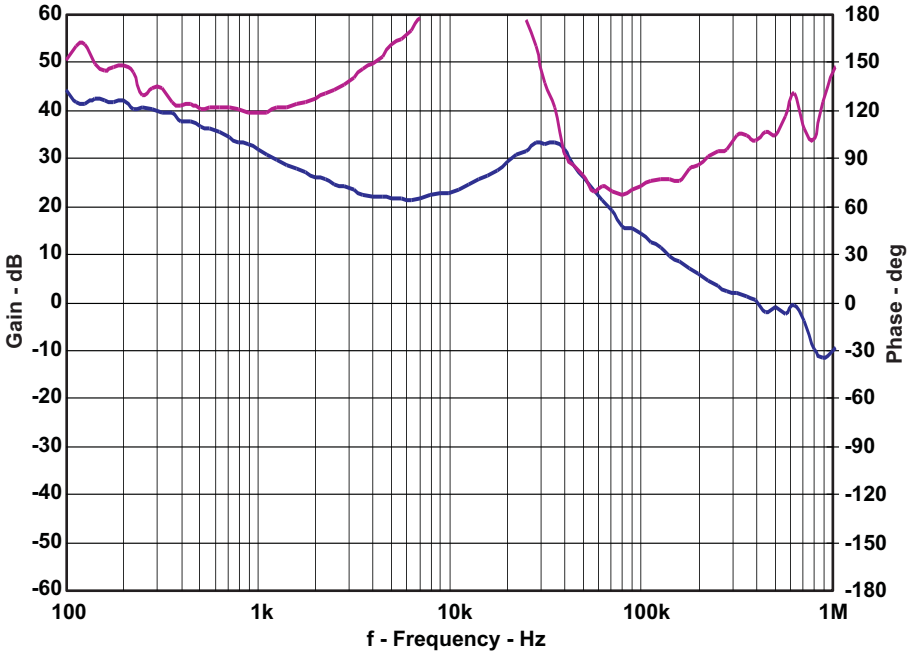

Figure 7. Loop Response With 2.2-µH Inductor and FSW = LOW (high frequency) and V_{IN} = 12 V and I_{OUT} = 1 A

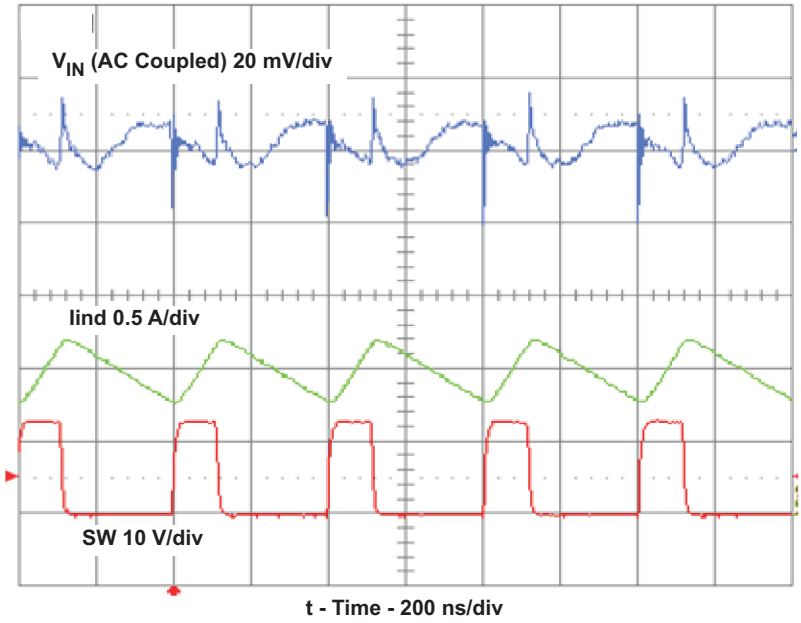

Figure 8. Input Voltage Ripple With 2.2-µH Inductor and FSW = LOW (high frequency) and Vin = 12 V and Iout = 1 A

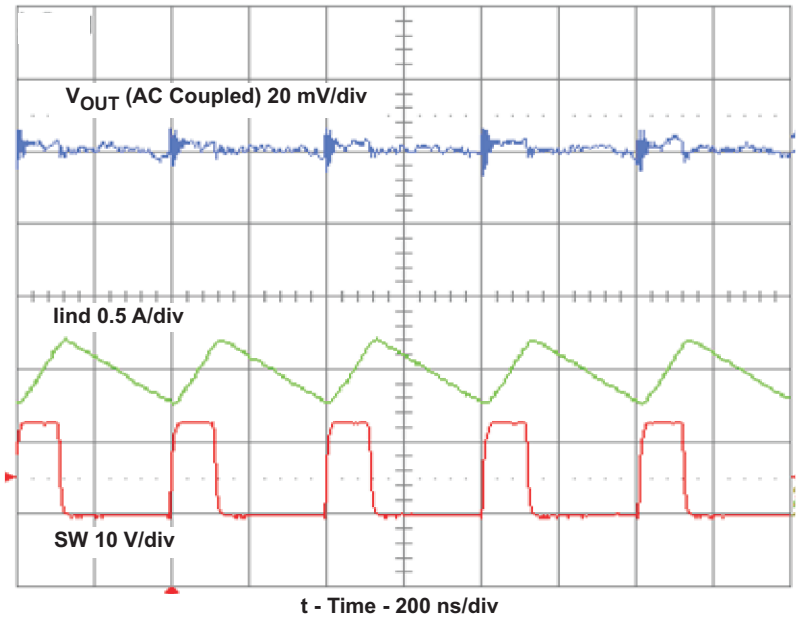

Figure 9. Output Voltage Ripple With 2.2-µH Inductor and FSW = LOW (high frequency) and Vin = 12 V and Iout = 1 A

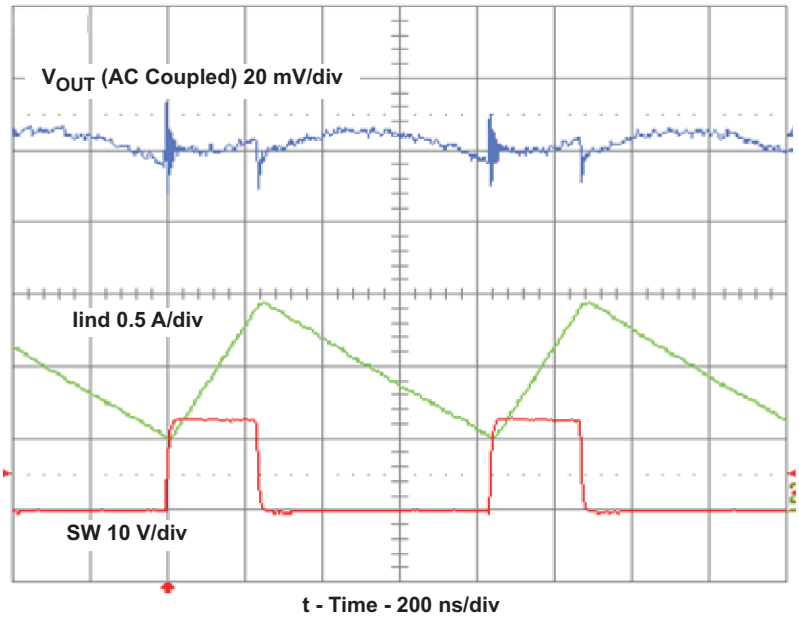

Figure 10. Output Voltage Ripple With 2.2-µH Inductor and FSW = HIGH (low frequency) and Vin = 12 V and Iout = 1 A

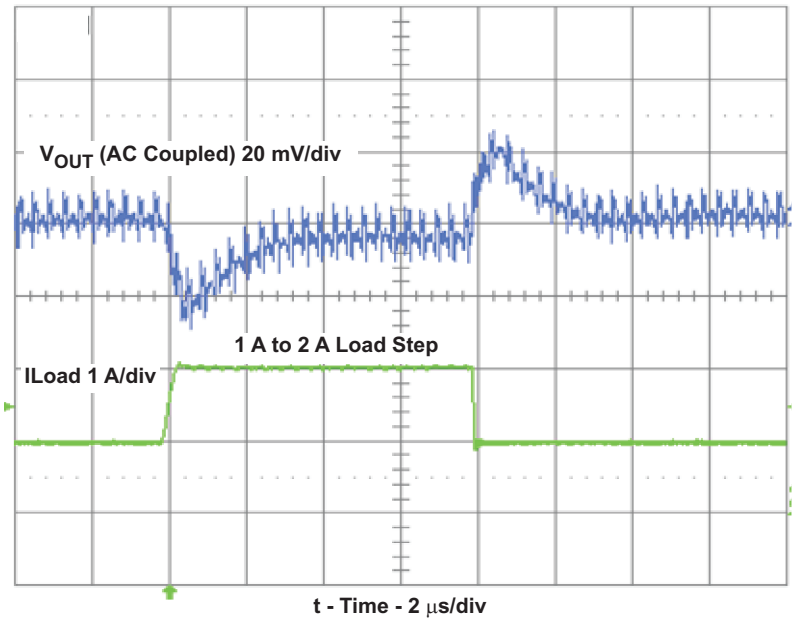

Figure 11. Load Transient Response With 1-µH Inductor and Vin = 12 V

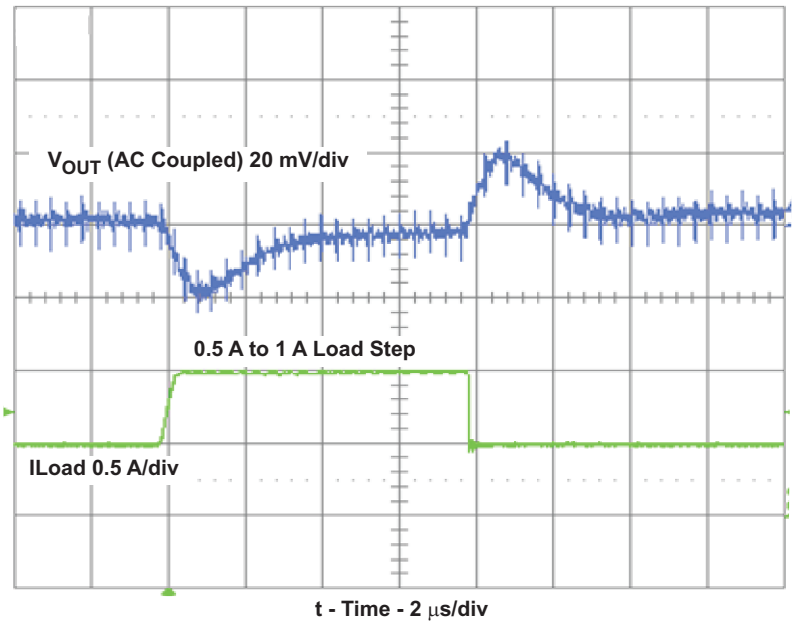

Figure 12. Load Transient Response With 2.2-µH Inductor and Vin = 12 V

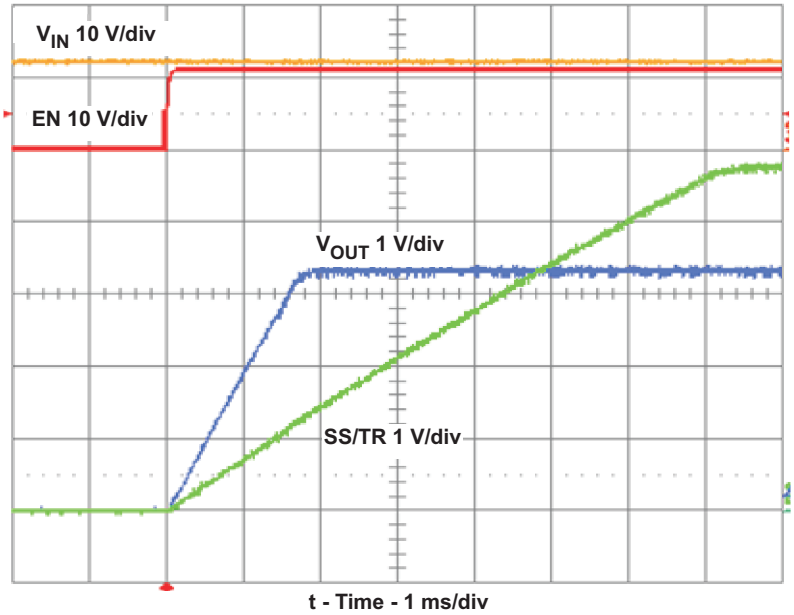

Figure 13. Start-Up on EN with 1 A Load and Vin = 12 V

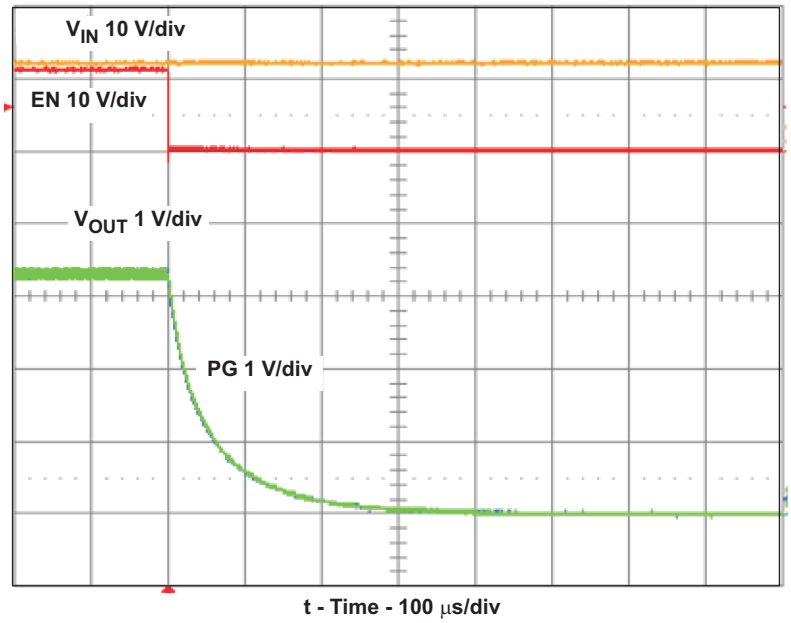

Figure 14. Shutdown on EN with 1 A Load and Vin = 12 V

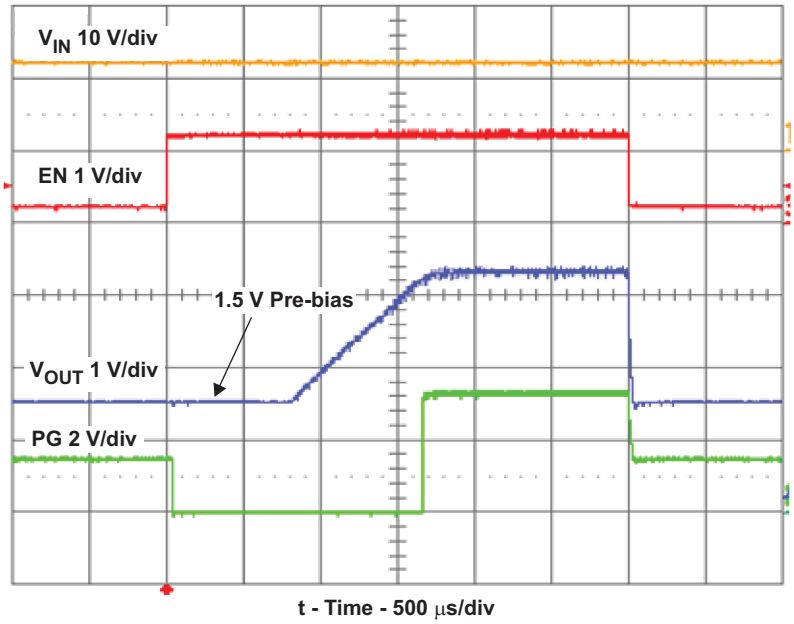

Figure 15. TPS62130 Prebias Start-Up and Shutdown on EN With 1-A Load and Vin = 12 V

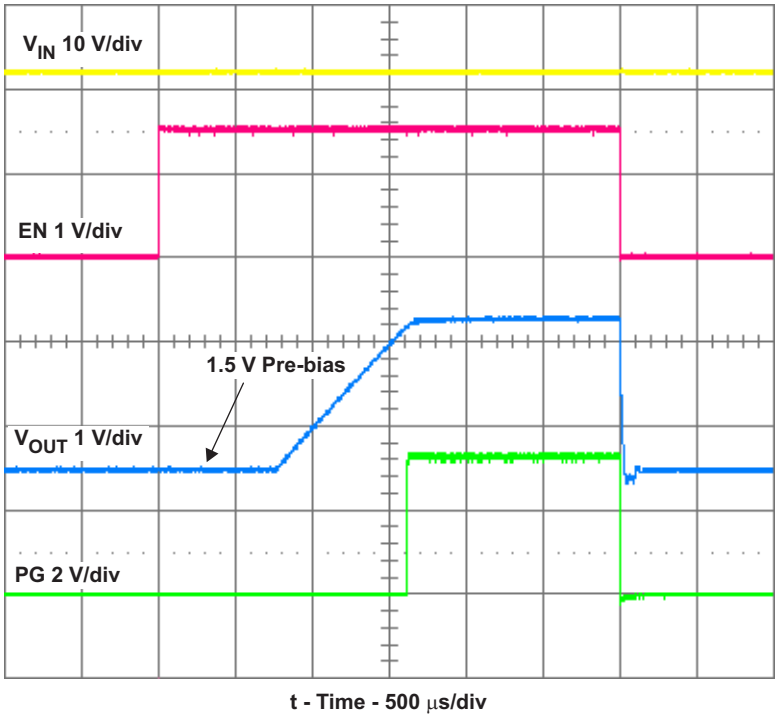

Figure 16. TPS62130A Prebias Start-Up and Shutdown on EN With 1-A Load and Vin = 12 V

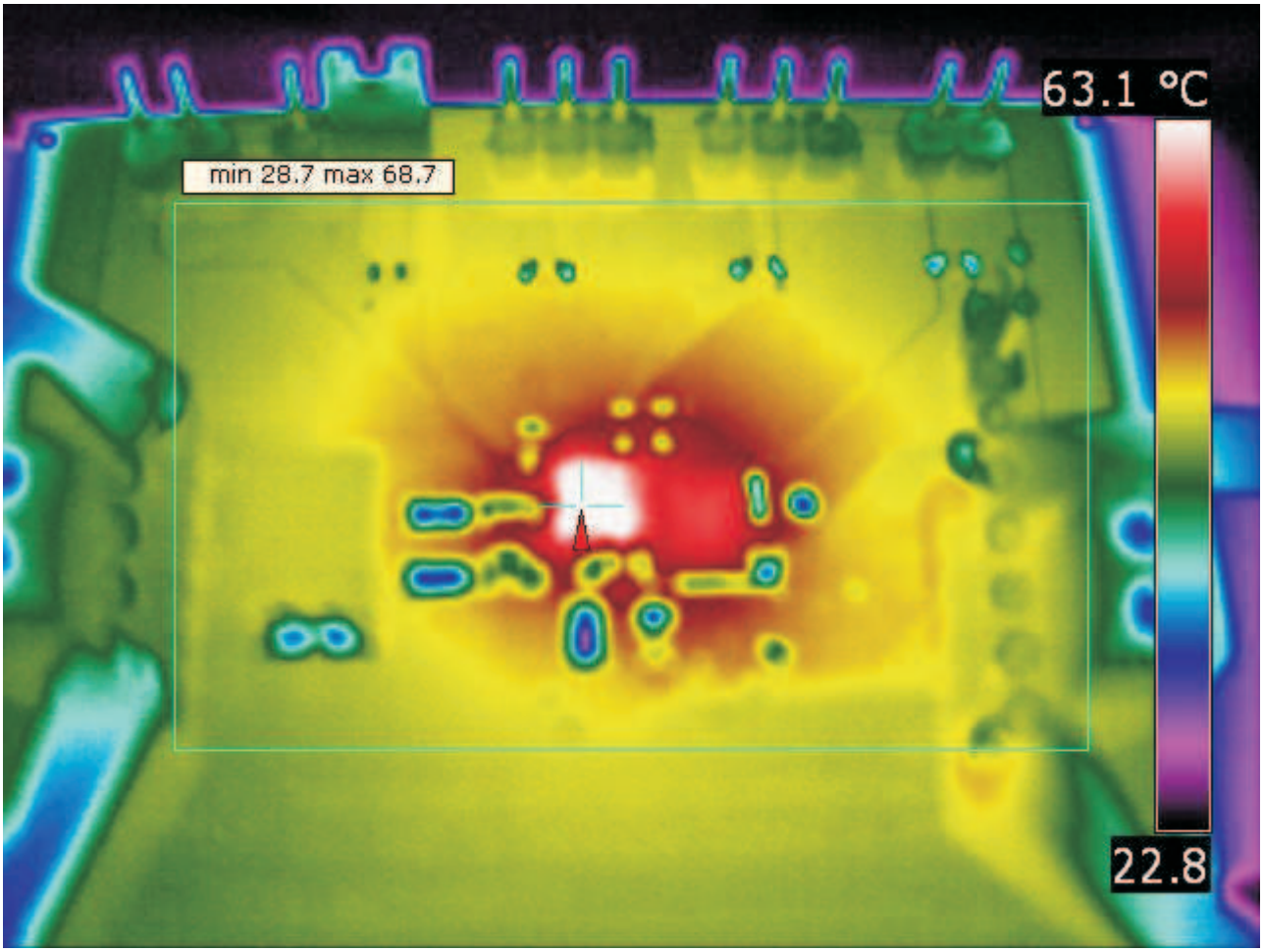

Figure 17. Thermal Performance With 1-µH Inductor and Vin = 12 V and Iout = 3 A and FSW = LOW (high frequency)

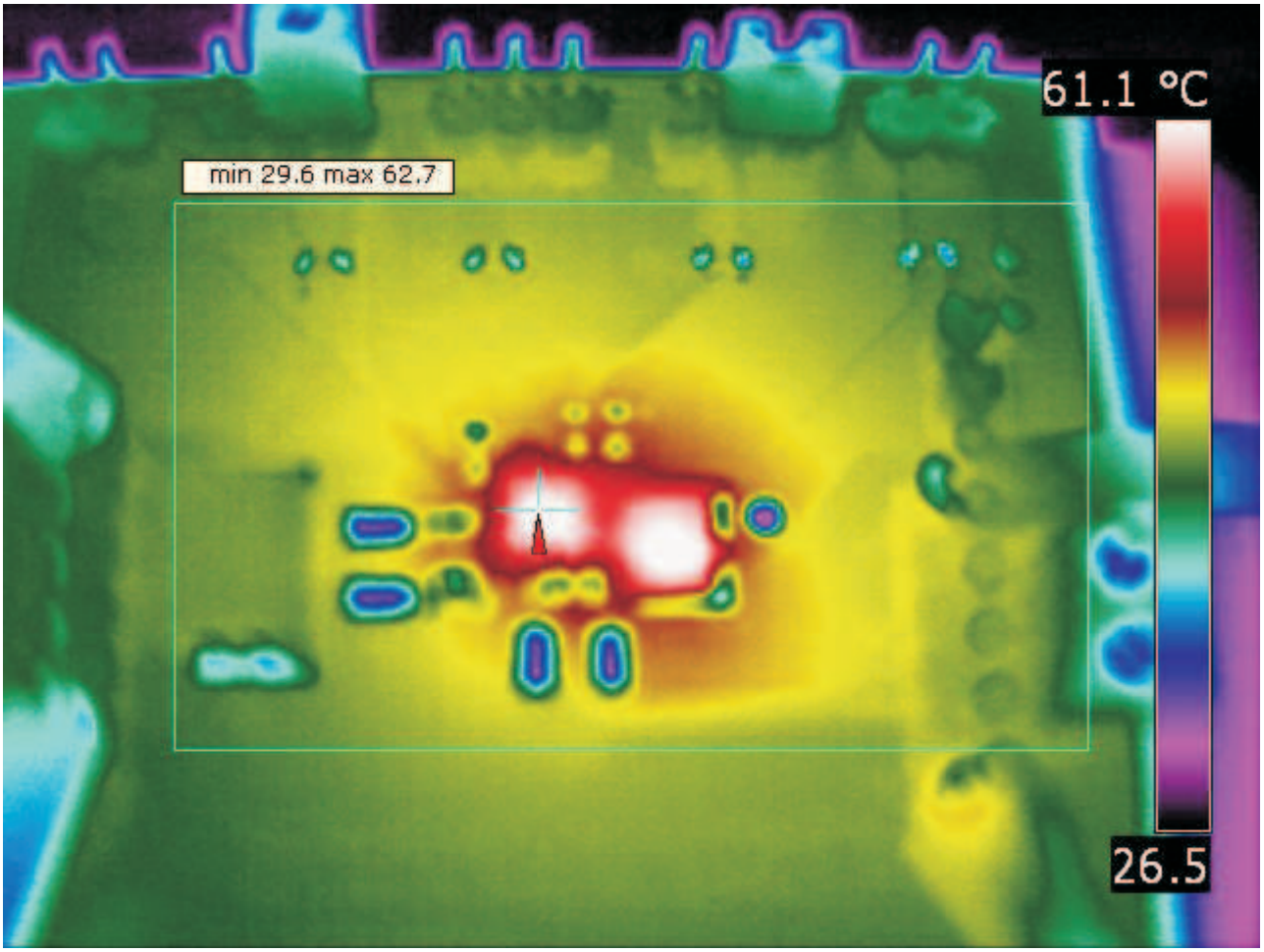

Figure 18. Thermal Performance With 2.2-µH Inductor Vin = 12 V and Iout = 3 A and FSW = HIGH (low frequency)

4 Board Layout

This section provides the TPS621x0EVM-505 board layout and illustrations.

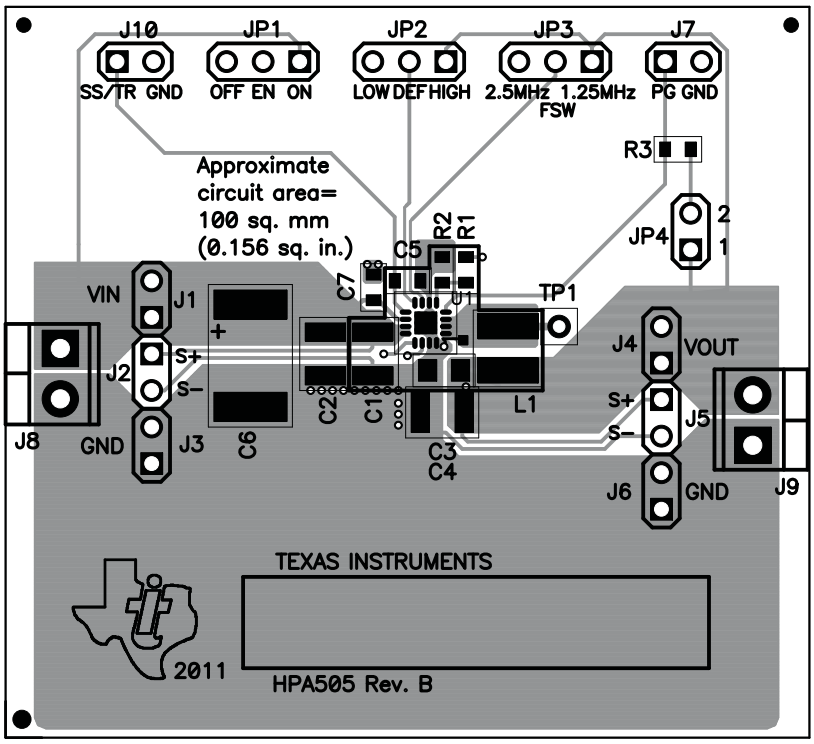

Figure 19. Assembly Layer

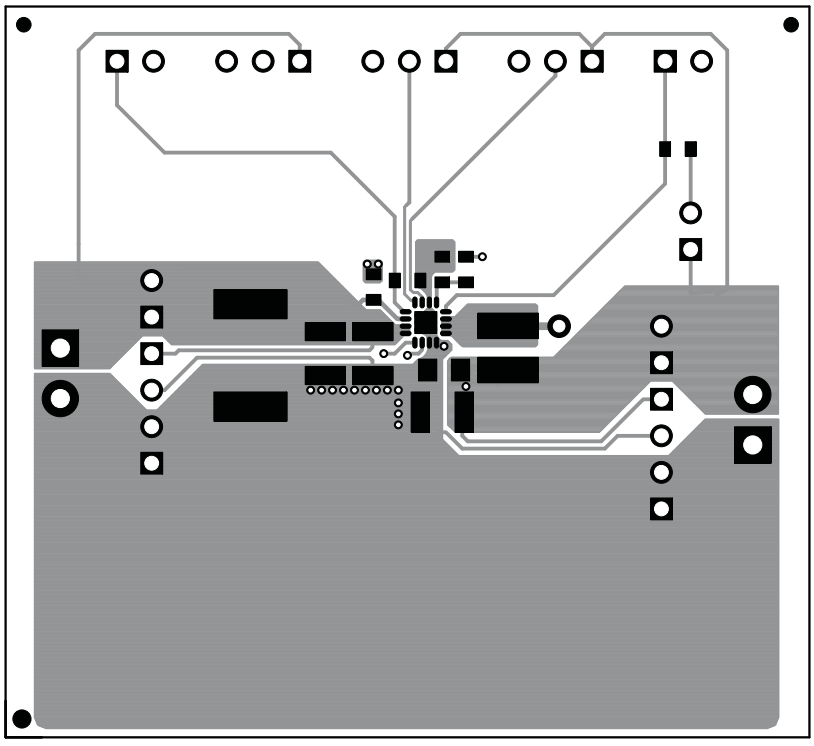

Figure 20. Top Layer Routing

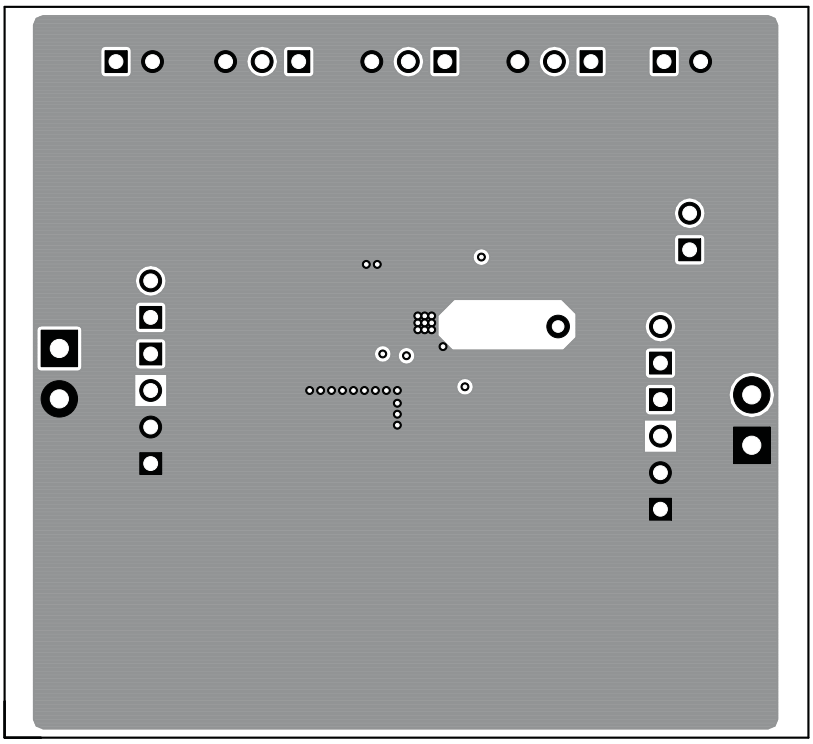

Figure 21. Internal Layer-1 Routing

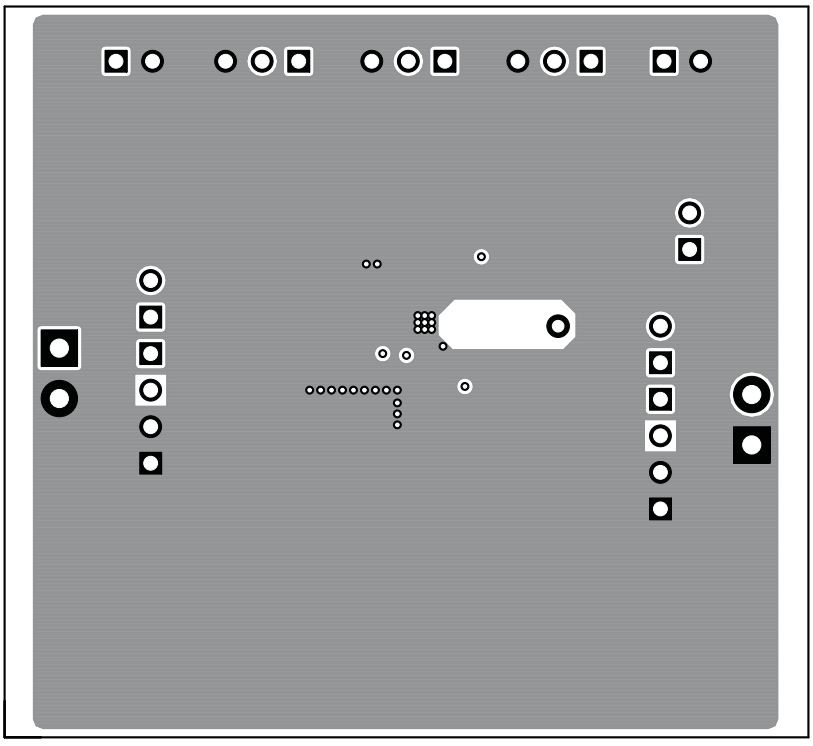

Figure 22. Internal Layer-2 Routing

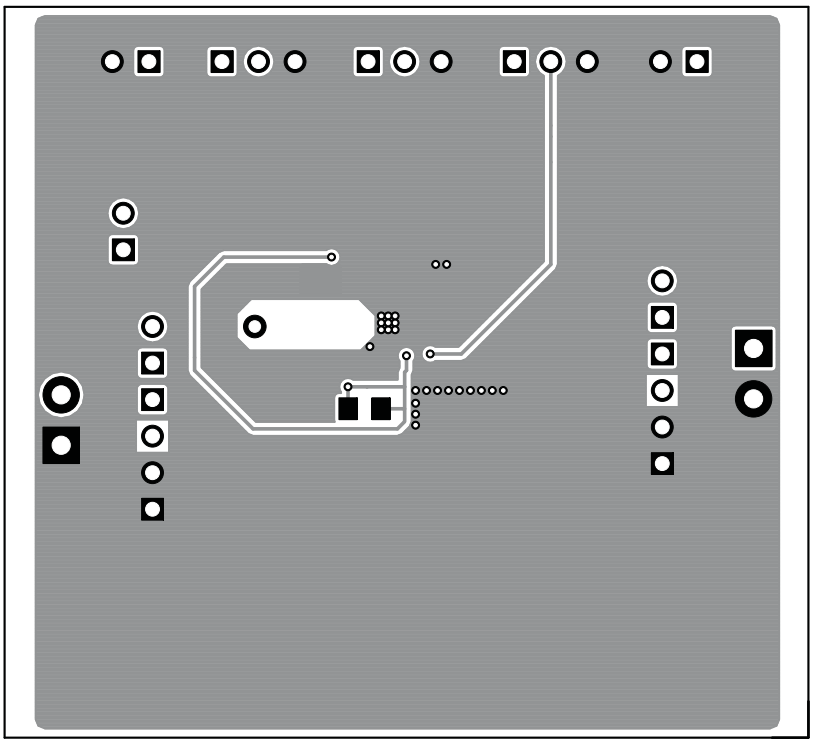

Figure 23. Bottom Layer Routing

5 Schematic and Bill of Materials

This section provides the TPS621x0EVM-505 schematic and bill of materials.

5.1 Schematic

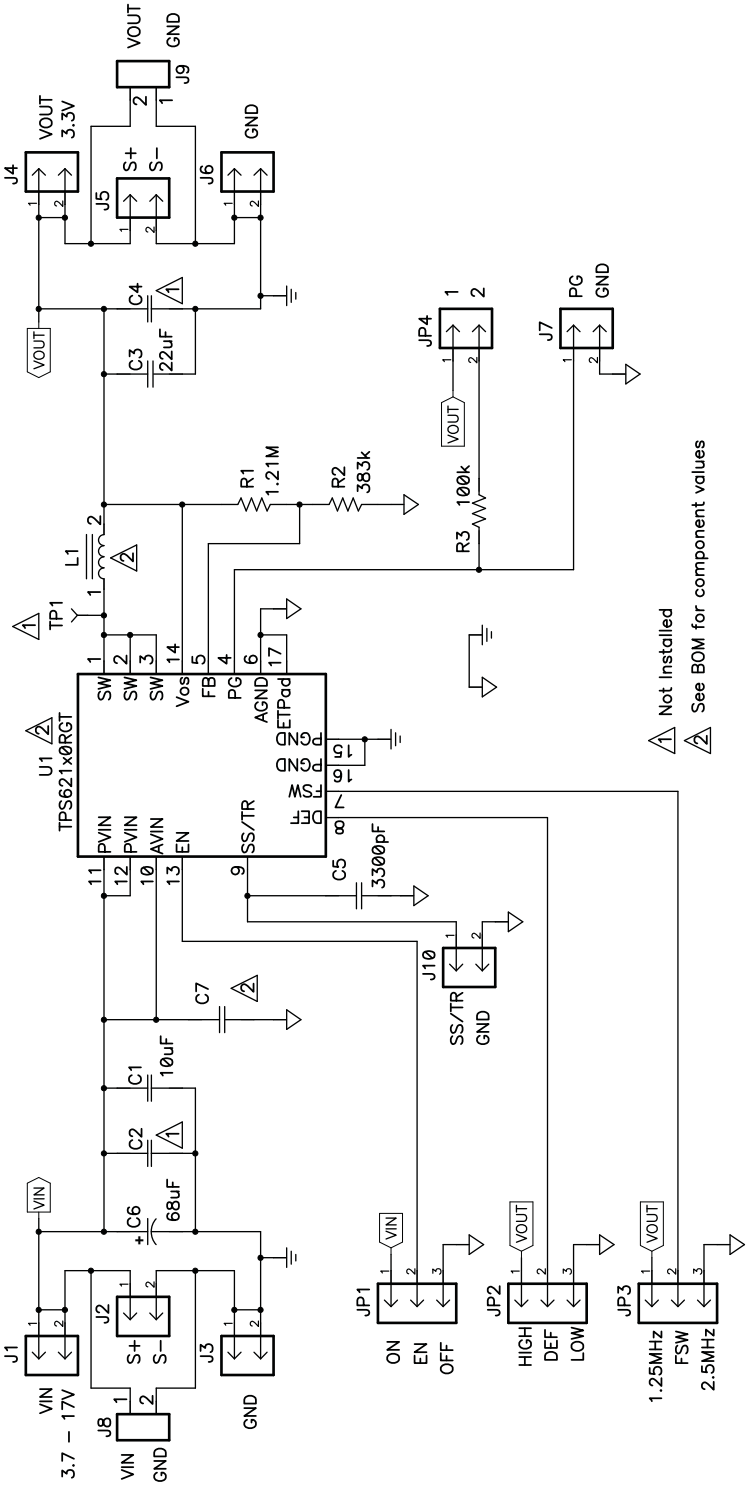

Figure 24. TPS621x0EVM-505 Schematic

5.2 Bill of Materials

Table 2. TPS621x0EVM-505 Bill of Materials

Count								
-001	-002	-003	RefDes	Value	Description	Size	Part Number	MFR
1	1	1	C1	10 µF	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
1	1	1	C3	22 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	Std	Std
1	1	1	C5	3300 pF	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
1	1	1	C6	68 µF	Capacitor, Tantalum, 35V, 68uF, ±20%	7361[V]	TPSV686M035R0150	AVX
1	0	0	C7	0.1 µF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
1	0	0	L1	1.0 µH	Inductor, Power, 5.1A, ±20%	0.165 x 0.165 inch	XFL4020-102ME	Coilcraft
0	1	1	L1	2.2 µH	Inductor, Power, 3.5A, ±20%	0.165 x 0.165 inch	XFL4020-222ME	Coilcraft
1	1	1	R1	1.21M	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R2	383k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R3	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	0	0	U1 (1)	TPS62130ARGT	IC, 17V 3A Step-Down Converter in 3 mm x 3 mm QFN Package	3 x 3 mm QFN	TPS62130ARGT	TI
0	1	0	U1 (1)	TPS62140ARGT	IC, 17V 2A Step-Down Converter in 3 mm x 3 mm QFN Package	3 x 3 mm QFN	TPS62140ARGT	TI
0	0	1	U1 (1)	TPS62150ARGT	IC, 17V 1A Step-Down Converter in 3 mm x 3 mm QFN Package	3 x 3 mm QFN	TPS62150ARGT	TI

(1) EVMs made before August of 2013 use the non-A version of U1. The only difference between these devices is the operation of the PG pin when the device is disabled, as shown in Figure 15 and Figure 16.

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

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REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

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

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

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 EVMs for RF Products 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. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. 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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