TPS6125xEVM-766, 3.5-MHz High Efficiency Step-Up Converter In Chip Scale Packaging EVM

This user's guide describes the characteristics, operation, and use of the TPS6125xEVM-766 evaluation module (EVM). This EVM enables test and evaluation of the Texas Instruments' TPS61253, TPS61258, and TPS61259 devices, a series of 3.5-MHz, up to 5.1-V, step-up dc-dc converters. This user's guide includes EVM specifications, the schematic diagram, bill of materials, and board layout.

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1 Introduction

1.1 Requirements

The TPS61253, TPS61258, and TPS61259 devices provide a power-supply solution for products powered by either a three-cell alkaline, NiCd or NiMH battery, or a single-cell Li-Ion or Li-polymer battery. The wide input voltage range is ideal for portable power applications such as mobile phones or computer peripherals. In addition, these devices maintain their output biased at the input voltage level. In this mode, the synchronous rectifier is current-limited, and allows external loads (for example, an audio amplifier) to be powered with a restricted supply. In this mode, quiescent current is reduced to 22 µA. Input current in shutdown mode is less than 5 µA in order to maximize battery life.

1.2 Requirements

The TPS6125xEVM-766 is designed to operate over the full input voltage range and produces a fixed output voltage. See Table 1 for fixed output voltage and required input voltages for each version options.

1.3 Applications

- USB Charging Port
- Li-Ion Applications
- Audio Applications
- RF-PA Buffers

1.4 Features

- Up to 92% Efficiency
- V_{IN} Range from 2.65 V to 4.85 V for TPS61253/9 and to 4.35 V for the TPS61258
- 22-µA Quiescent Current in Standby Mode
- 5-µA Shutdown Current
- 100% Duty-Cycle Mode when $V_{IN} > V_{OUT}$
- Selectable Standby Mode or True Load Disconnect During Shutdown
- Double-sided, two-active-layer printed circuit board (PCB) with all components on top side
- Active converter area of approximately 25 mm^2

1.5 EVM ordering Options

Table 1 provides the ordering information for the various EVM options.

Table 1. Table 1. TPS6125xEVM-766 Output and Input Voltage Options and Ordering Information

Orderable EVM Number	Device Part Number	Input Voltage Range	Output Voltage
HPA766-001	TPS61253	2.65 V(1) to 4.85 V	5 V
HPA766-002	TPS61258	2.65 V(1) to 4.35 V	4.5 V
HPA766-003	TPS61259	2.65 V(1) to 4.85 V	5.1 V

(1) Up to 1000 mA peak output current.

2 TPS6125xEVM-766 Schematic

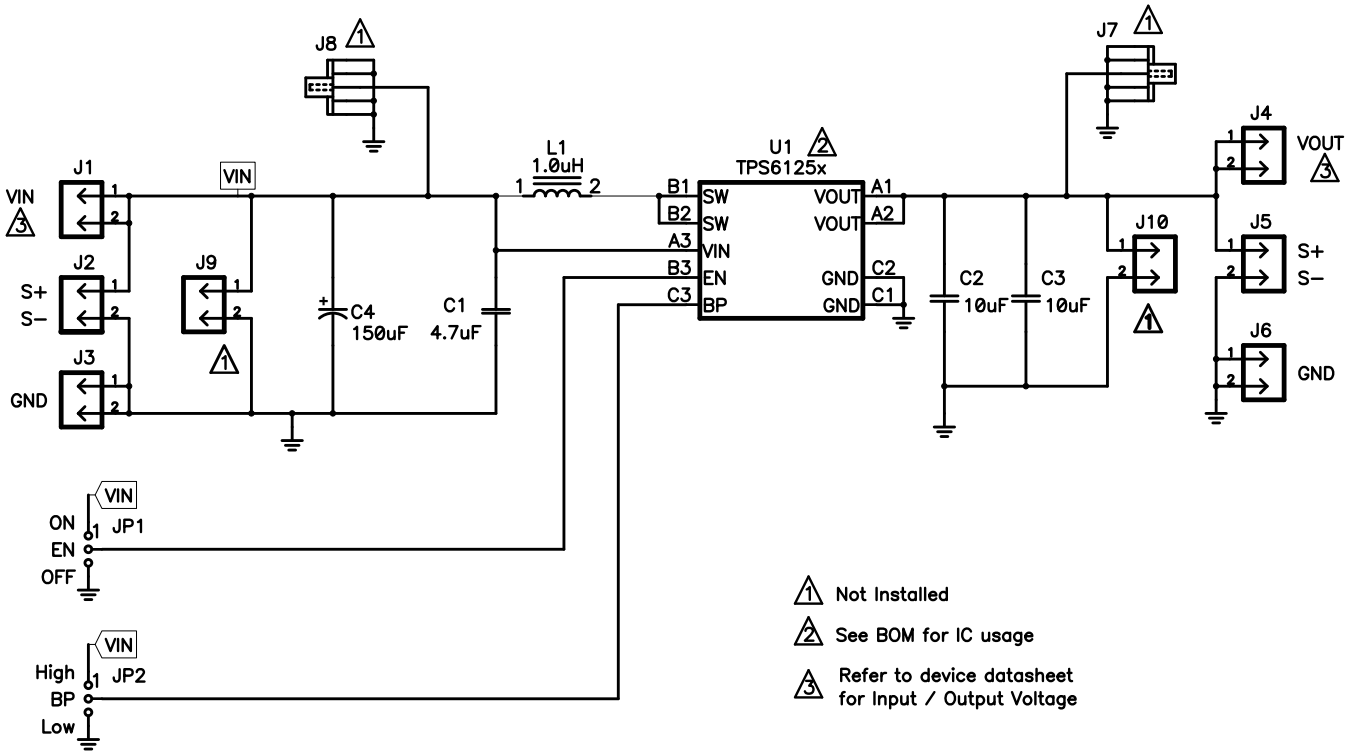

Figure 1. TPS6125xEVM-766 Schematic

3 Connector and Test Point

3.1 Input Connectors

3.1.1 J1: VIN

This header is the positive connection to the input power supply. The power supply must be connected between these pins and J3 (GND). Twist the leads to the input supply and keep them as short as possible. The input voltage must be as provided in Table 1.

3.1.2 J2: Input Sense Connector

This header is intended to measure the input voltage directly on the input capacitor. Therefore, a four-wire power and sense supply can be connected. Twist the leads to the sensing connector.

3.1.3 J3: GND

This header is the return connection to the input power supply. Connect the power supply between these pins and J1 (V_{IN}). Twist the leads to the input supply and keep them as short as possible. The input voltage must be as shown in Table 1.

3.2 Output Connectors

3.2.1 J4: VOUT

This header is the positive connection of the output voltage. Connect the load between these pins and J6 (GND).

3.2.2 J5: Output Sense Connector

This header is intended to measure the output voltage directly on the output capacitors.

3.2.3 J6: GND

This header is the return connection of the output voltage. Connect the load between these pins and J4 (V_{OUT}).

3.3 Other Connectors

3.3.1 J7: SMA Output Connector

This SMA connector is connected to the output voltage of the converter. It can be used to analyze the noise spectrum of the output voltage with a spectrum analyzer. By default, J7 is not assembled on the EVM.

3.3.2 J8 SMA Input Connector

This SMA connector is connected to the input voltage of the converter. It can be used to analyze the noise spectrum of the input voltage with a spectrum analyzer. By default, J8 is not assembled on the EVM.

3.4 Jumpers

3.4.1 JP1: Enable Jumper

Placing a jumper across pins EN and ON ties the EN pin to V_{IN}, and enables the device. Placing a jumper across pins EN and OFF ties the EN pin to GND, this disables the device.

3.4.2 JP2 Bypass

JP2 is the operating mode selection pin of the device and is only of relevance when the device is disabled (EN = low). Placing a jumper between BP and Low selects shutdown (that is, true load disconnect mode); thus, the device is in shutdown mode when EN is pulled low.

Placing a jumper between BP and High selects bypass mode. The output is biased at the input voltage level with a maximum load current capability of approximately 150 mA when EN is pulled low. In this mode, the device consumes only a standby current of 22 µA (typical).

4 Test Results

This section provides typical performance waveforms for the TPS6125xEVM-766 characteristic of this EVM design.

4.1 Power Save Mode Operation

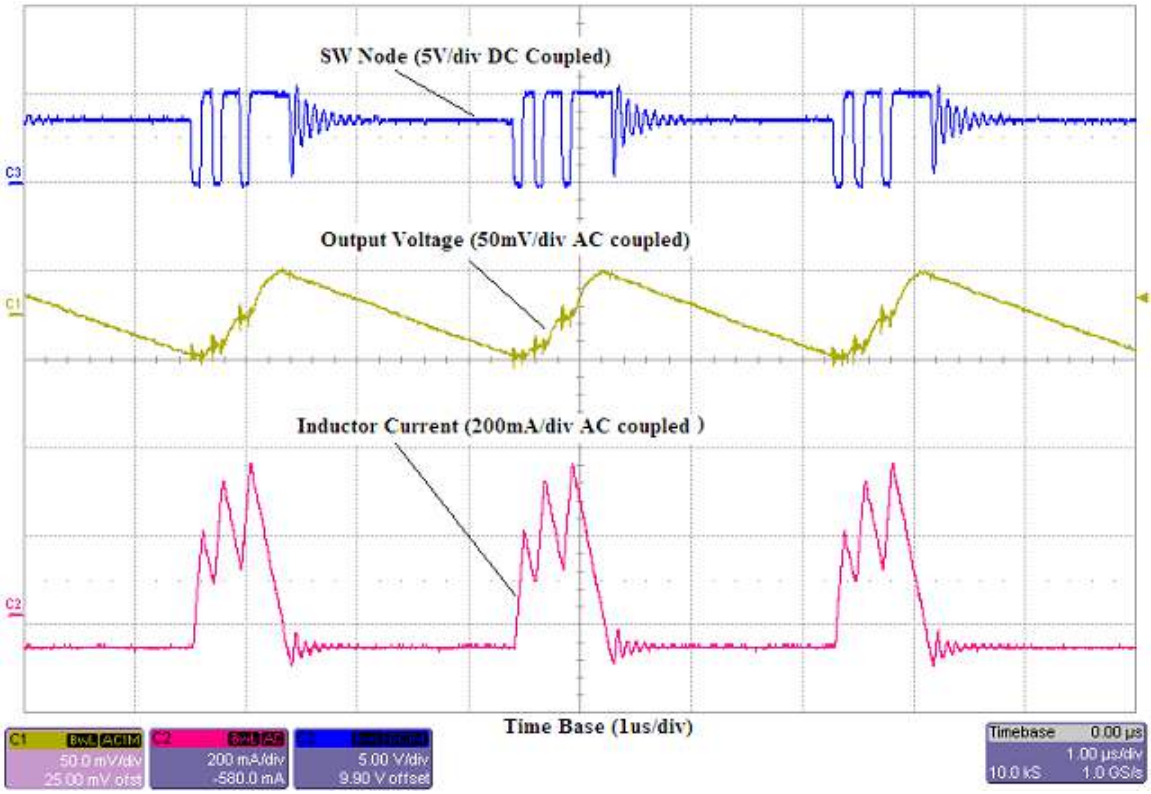

Figure 2. TPS61253 in Power Save Mode Operation with 40-mA load

4.2 PWM Operation

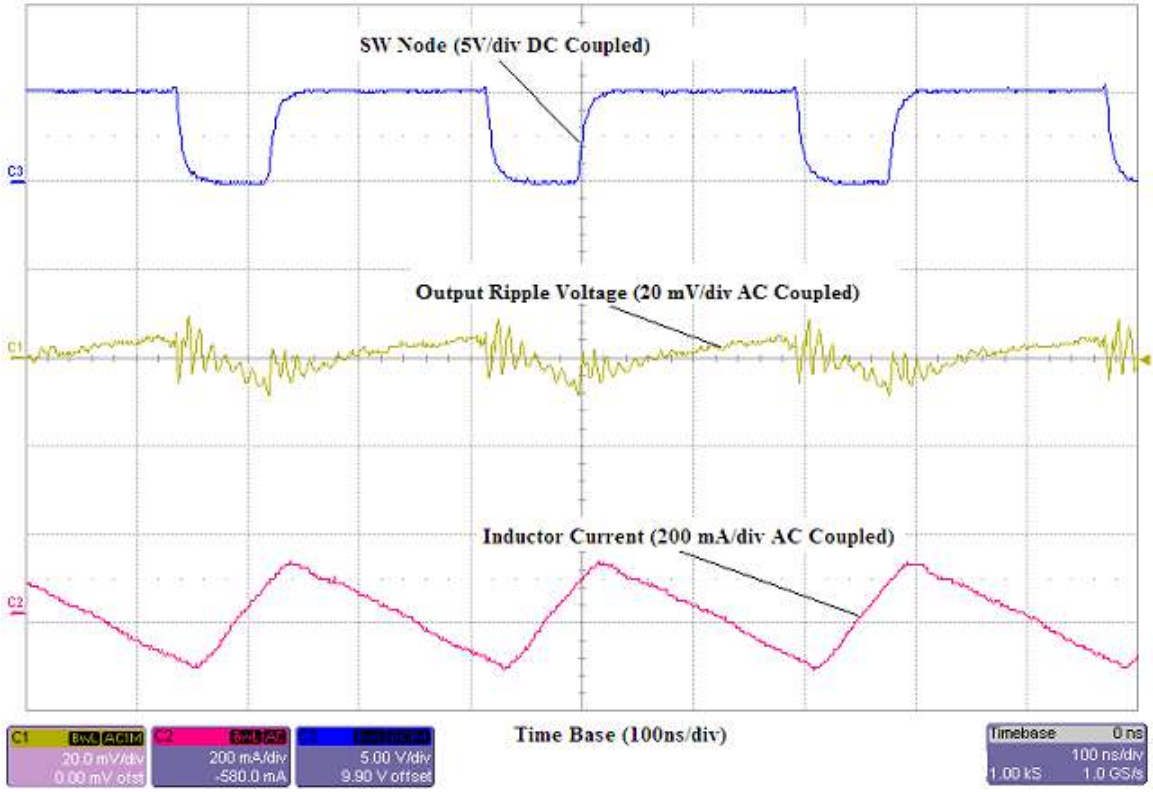

Figure 3. TPS61253 in PWM Operation with 260-mA Load

4.3 Load Transient

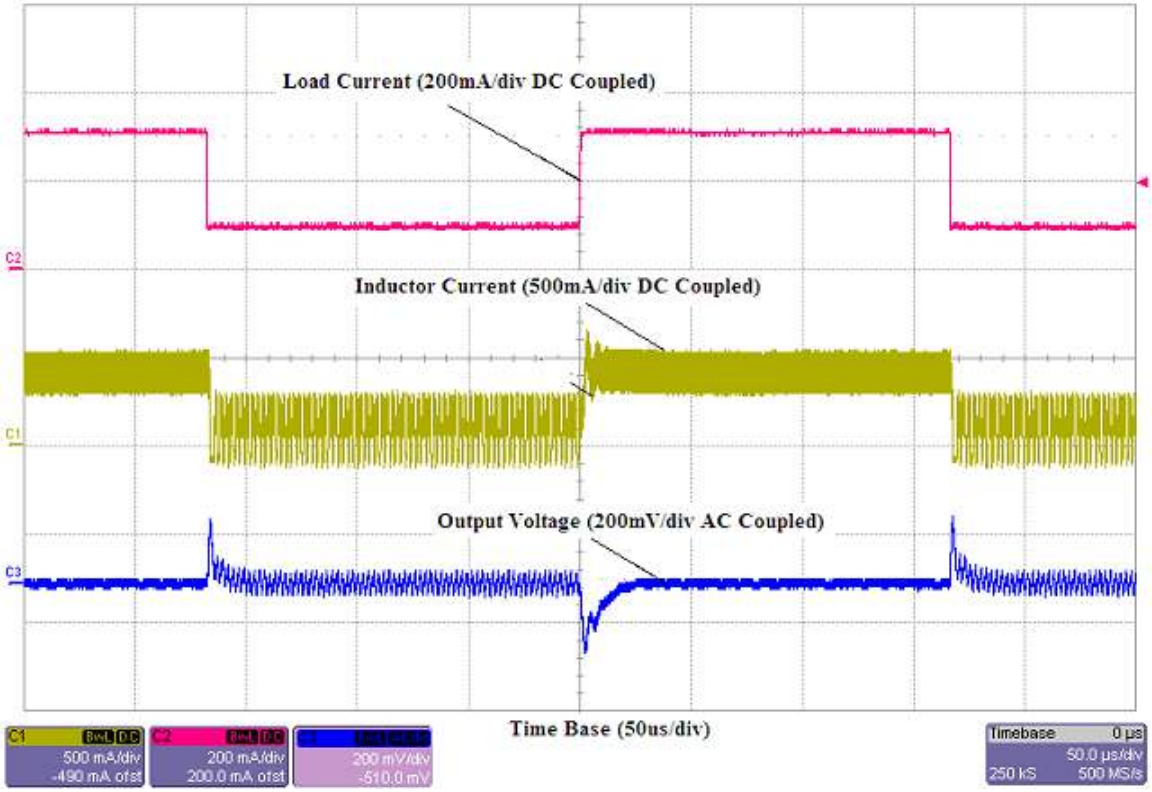

Figure 4. TPS61253 Load Transient from 100 mA to 300 mA

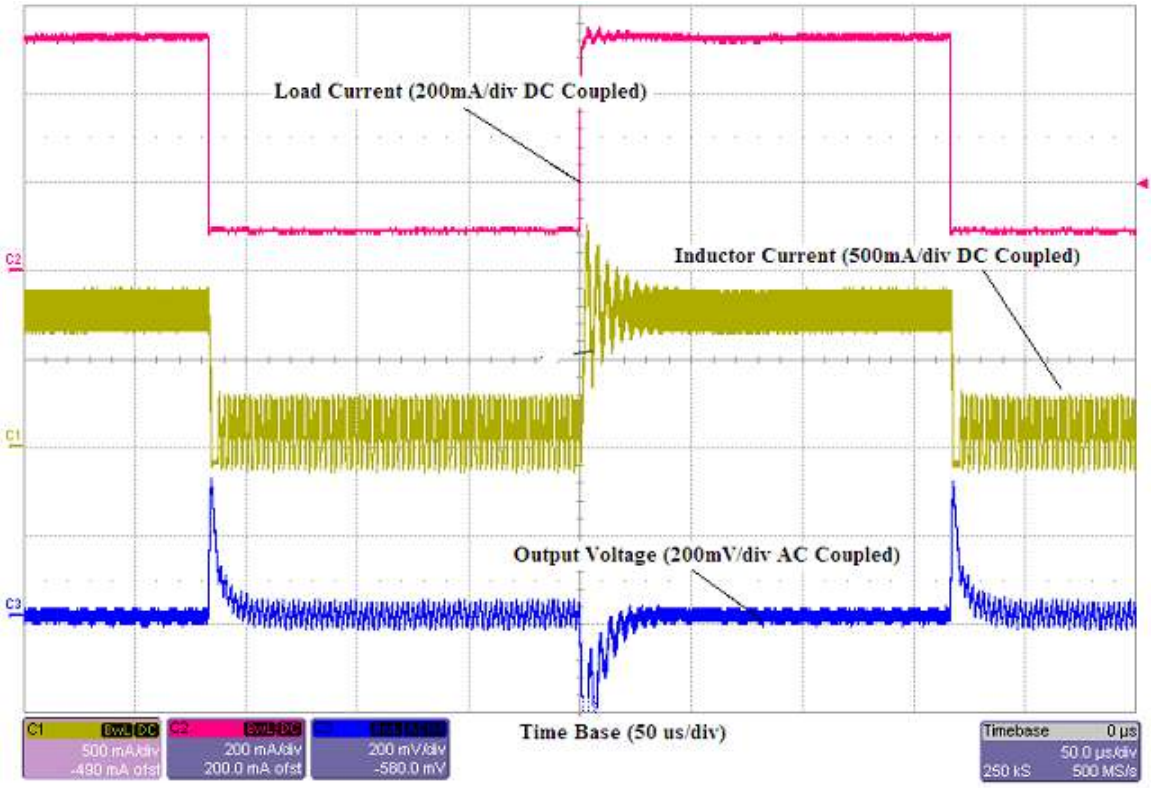

Figure 5. TPS61253 Load Transient from 100 mA to 500 mA

5 TPS6125xEVM-766 Assembly Drawing and Layout

Figure 6 through Figure 10 show the design of the TPS6125xEVM-766 PCBs. The EVM has been designed using a four-layer, 1-ounce copper-clad PCB with all components in an active area on the top side of the board. Moving components to both sides of the PCB can offer additional size reduction for space-constrained systems.

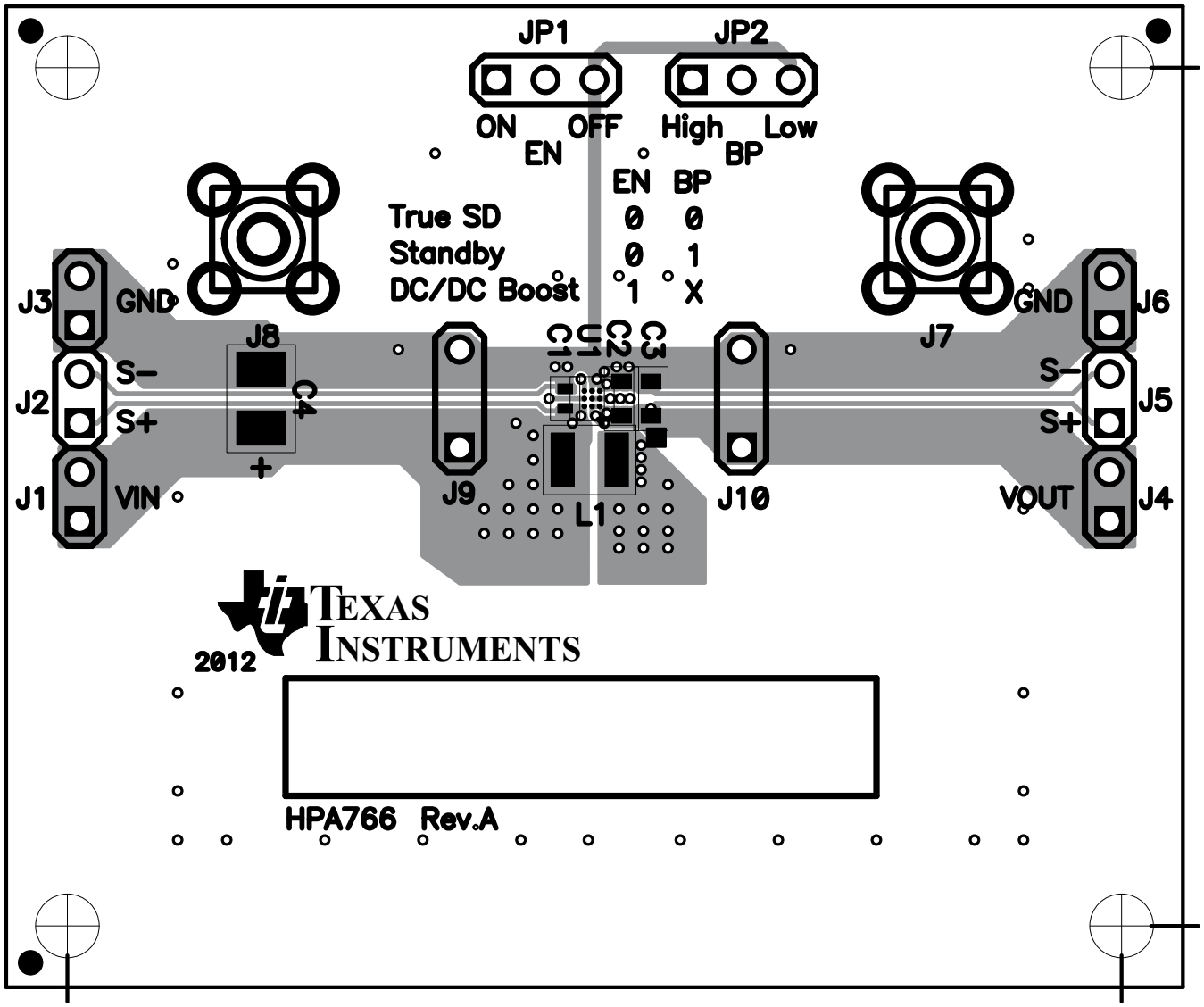

Figure 6. TPS6125xEVM-766 Component Placement (Viewed TOP)

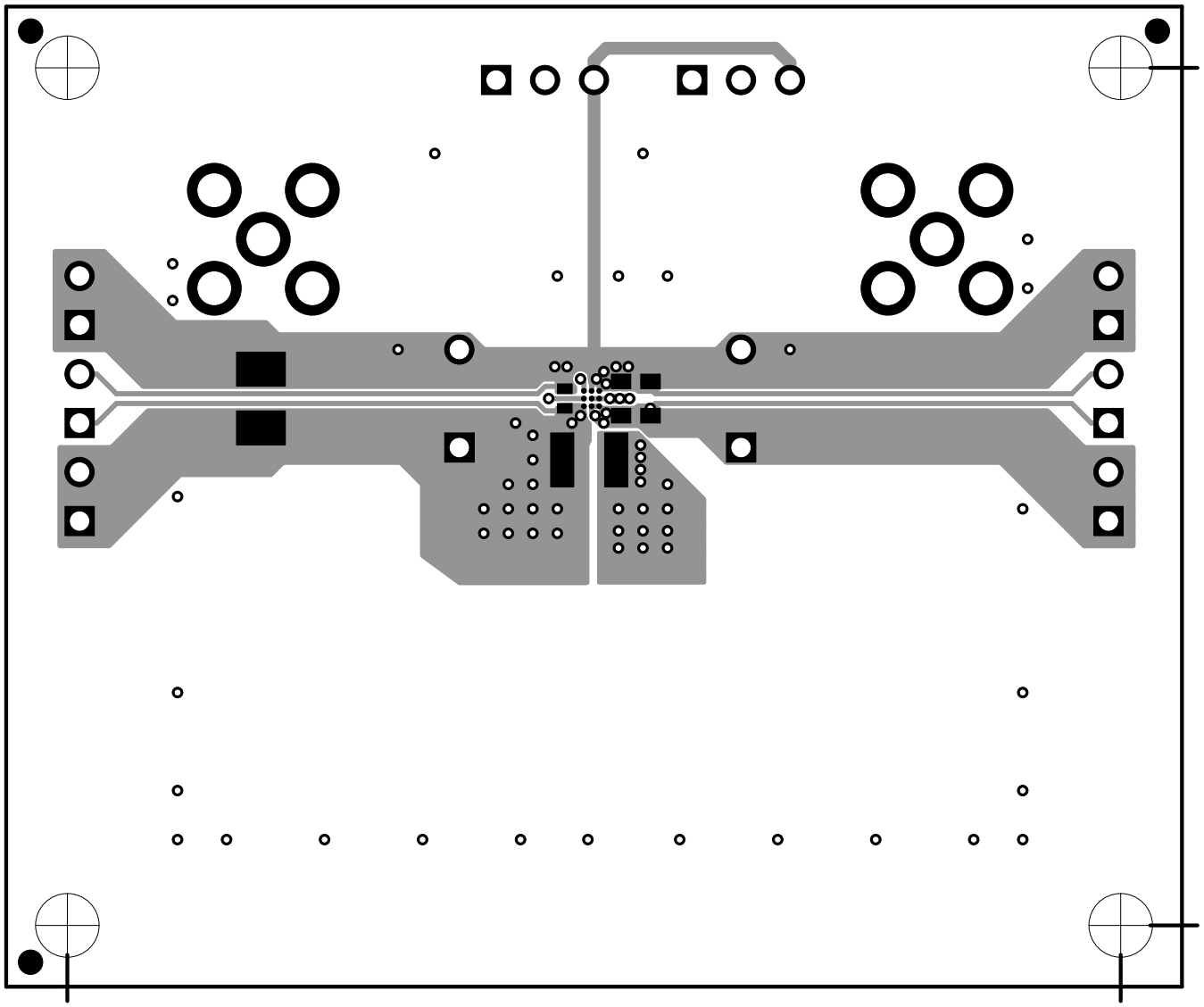

Figure 7. TPS6125xEVM-766 Top Copper (Viewed from Top)

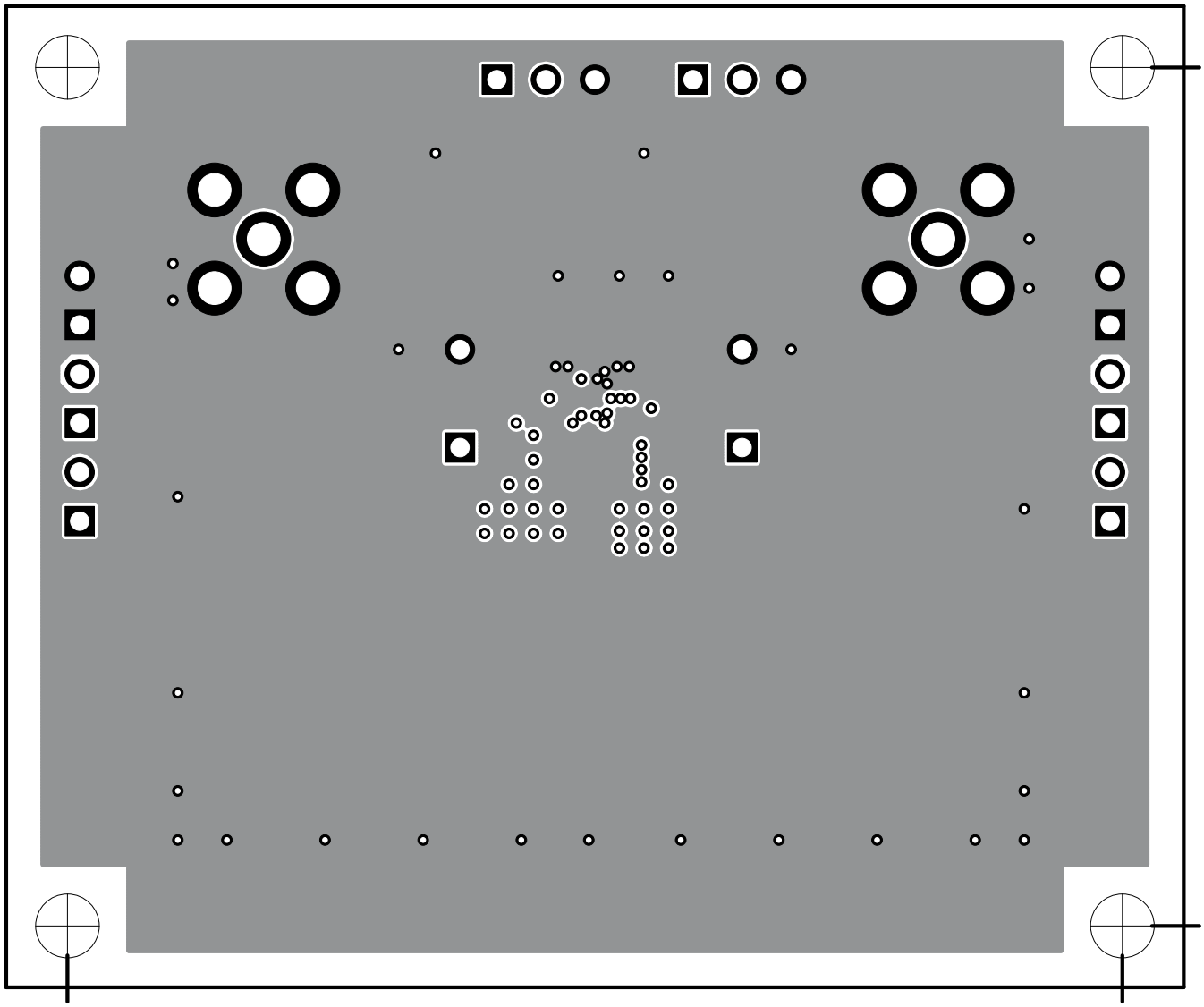

Figure 8. TPS6125xEVM-766 Inner Layer 1 (Viewed from Top)

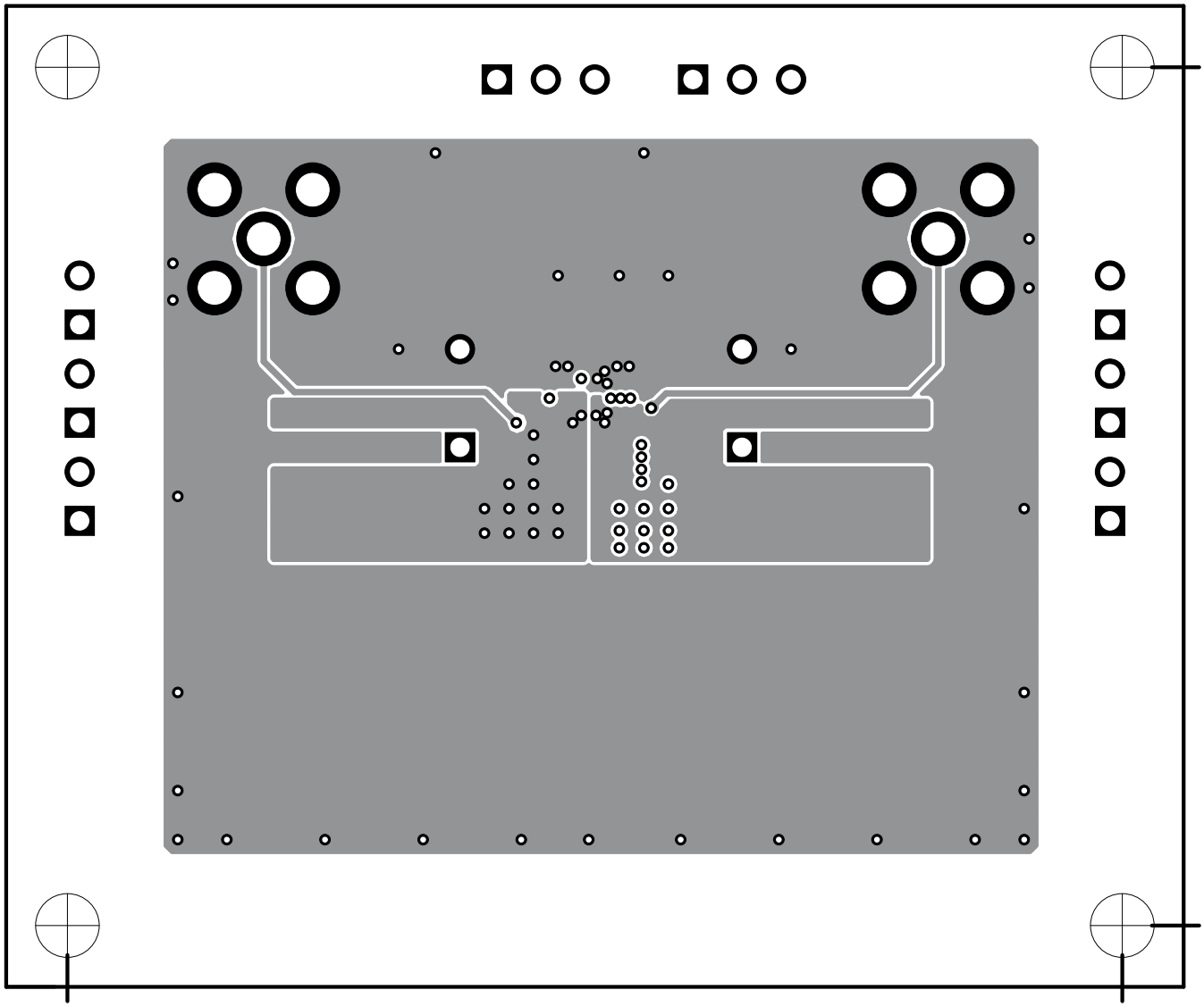

Figure 9. PS6125xEVM-766 Inner Layer 2 (Viewed from Top)

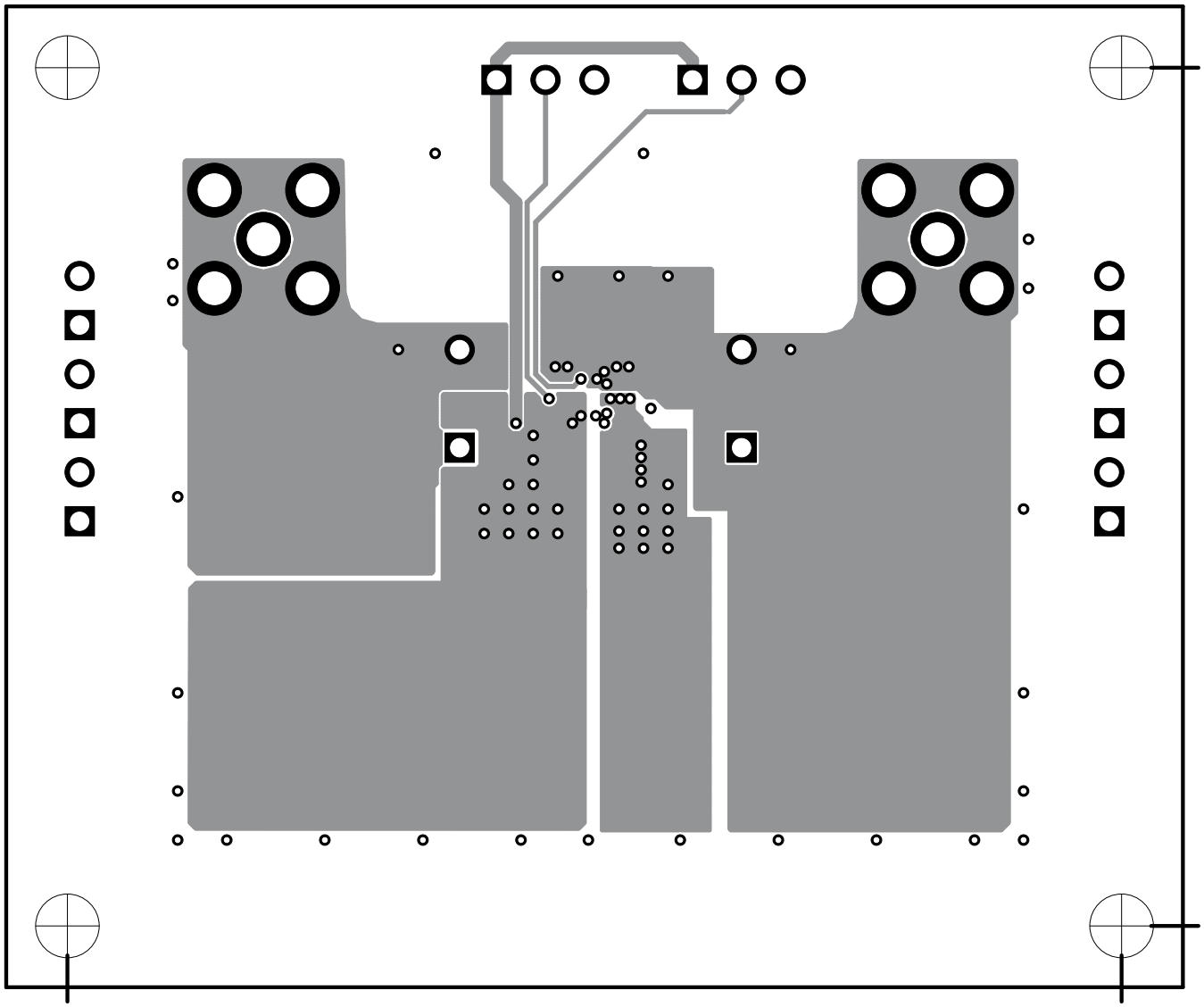

Figure 10. TPS6125xEVM-766 Bottom Copper (Viewed from Bottom)

6 Bill of Materials

Table 2 lists the EVM components as configured according to the schematic shown in Figure 1.

Table 2. TPS6125xEVM-766 Bill of Materials[(1)]

-001	-002	-003	RefDes	VALUE	Description	Size	Part Number	MFR
1	1	1	C1**	4.7 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0402	GRM155R60J475U	muRata
2	2	2	C2, C3**	10 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	GRM188R60J106ME84D	muRata
1	1	1	C4	150 µF	Capacitor, 6.3V, Temp 15%, ±20%, 70mOhm	3528(B)	T520B157M006ATE070	Kemet
6	6	6	J1, J2, J3, J4, J5, J6	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
0	0	0	J7, J8	Open	Connector, SMA , Straight, PC mount	0.210 sq inch	901-144-8RFX	AMP
0	0	0	J9, J10	Open	Header, Male 2-pin, 200mil spacing,	0.100 inch x 2	PEC03SAAN	Sullins
2	2	2	JP1, JP2	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	PEC03SAAN	Sullins
1	1	1	L1**	1.0 µH	Inductor, SMT Multi-layer, 3.7A, 34milliohm	3225	DFE322512C1R0	TOKO
1	0	0	U1	TPS61253	IC, TINY 1.5-A 3.5-MHz BOOST CONVERTER, 5.0V	BGA	TPS61253YFF	TI
0	1	0	U1	TPS61258	IC, TINY 1.5-A 3.5-MHz BOOST CONVERTER, 4.5V	BGA	TPS61258YFF	TI
0	0	1	U1	TPS61259	IC, TINY 1.5-A 3.5-MHz BOOST CONVERTER, 5.1V	BGA	TPS61259YFF	TI

(1) 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 label in silkscreened box after final wash. Text shall be 8 pt font. Text shall be per Table 1.

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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.

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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.

Texas Instruments Japan Limited
(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan

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http://www.tij.co.jp

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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.

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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 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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【ご使用にあたっての注】

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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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TI has specifically designated certain components which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

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