TPS624xxEVM-167

This user's guide describes the characteristics, operation, and use of the TPS624xxEVM-167 evaluation module (EVM). This EVM demonstrates the Texas Instruments TPS624xx family of 2.25-MHz, dual step down converters. The EVM is available in three different dash-numbered assemblies:

- -001: Configured for the TPS62400
- -002: Configured for the TPS62401
- -003: Configured for the TPS62420

Each dash number is assembled with a different member of the TPS624xx family of ICs. This user's guide includes setup instructions, a schematic diagram, a bill of materials, and PCB layout drawings for all versions of the evaluation module.

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1 Introduction

1.1 Requirements

To operate this EVM, connect and properly configure the following components:

Personal Computer Requirements

A personal computer (PC) with a USB port is required to operate this EVM. The TPS624xxEVM-167 interface software runs on the PC and communicates with the EVM via the PC's USB port. Commands can be sent to the internal registers of the TPS624xx through the USB port.

- Windows® 2000 or Windows XP or Windows 7 operating system
- USB port
- Minimum of 30MB of free hard disk space (100 MB recommended)
- Minimum of 256MB of RAM
- .NET Framework 3.5 SP1 or higher

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Printed-Circuit Board Assembly

The TPS624xxEVM-167 PCB contains one of the TPS624xx ICs (depending on which dash number is used) and its required external components. This board contains several jumpers and connectors that enable the user to customize the board for specific operating conditions.

USB Interface Adapter

The USB interface adapter is the link that allows the PC and the EVM to communicate. One end of the USB interface adapter connects to the PC with the supplied USB cable; the other side of the USB interface adapter connects to the EVM with the supplied ribbon cable.

When a command is written to the EVM, the interface program running on the PC sends the commands to the PC USB port. The USB interface adapter receives the USB command, converts the signal to an EasyScale™ protocol, and then sends the converted signal to the TPS624xxEVM board.

Software

Texas Instruments has provided software to assist in evaluating this EVM. The software can be installed from the supplied CD or downloaded from the Texas Instruments web site at www.ti.com/tool/tps62400evm-167.

2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the TPS624xxEVM-167.

2.1 Input/Output Connector Descriptions

2.1.1 J1 – VIN

This is the positive input supply voltage. The leads to the input supply should be twisted and kept as short as possible to minimize EMI transmission.

2.1.2 J2 – GND

This is the return connection for the input power supply.

2.1.3 J3 – EasyScale™ Input

This connector is the EasyScale input. Pin 6 is ground, and pin 10 is the MODE/DATA pin of the TPS624xx.

2.1.4 J4 – VOUT2

This is the positive connection from the output of converter 2. Connect this pin to the positive input of the load to be powered by the second output of the converter.

2.1.5 J5 – GND

This is the return connection for VOUT2. Connect this pin to the negative input of the load.

2.1.6 J6 – VOUT1

This is the positive connection from the output of converter 1. Connect this pin to the positive input of the load to be powered by the first output of the converter.

2.1.7 J7 – GND

This is the return connection for VOUT1. Connect this pin to the negative input of the load.

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2.1.8 JP1 – Mode

This jumper is connected to the MODE/DATA pin of the TPS624xx and is used to select the operating mode of TPS624xx. Place a jumper between pins 1 and 2 (PU and MODE) when using the EasyScale interface to provide a pullup resistor for EasyScale communications. If the EasyScale interface is not used, then JP1 is used to select between fixed PWM mode or PFM mode. The converter operates in a fixed-frequency PWM mode when a jumper is installed between pins 1 and 2 (PU and MODE). Shorting pins 2 and 3 (MODE and GND) allows the controller to use a power-saving PFM mode at low output currents.

2.1.9 JP2 – EN1

This jumper enables or disables converter 1. Connect the shorting jumper from the center EN pin to either the ON or OFF position. Never leave this pin floating.

2.1.10 JP3 – EN2

This jumper enables or disables converter 2. Connect the shorting jumper from the center EN pin to either the ON or OFF position. Never leave this pin floating .

2.1.11 JP4 – DEF1

This jumper is used to configure the DEF_1 pin of the TPS62401. A shorting jumper should only be installed when evaluating the TPS62401 on the HPA167-002 assembly version of the EVM. Installing a jumper with other versions of the IC produces incorrect output voltages. Leave this jumper open for those EVMs. The TPS62401 output voltage of converter 1 is defined by the internal register REG_DEF_1_LOW when a shunt is placed across pins 2 and 3 of JP4 (DEF1 and GND). With a shunt across pins 1 and 2 of JP4 (DEF1 and VIN), the output voltage of converter 1 is defined by the internal register REG_DEF_1_HIGH.

2.2 Setup

The TPS624xx needs an input voltage between 2.5 V and 6 V. The input voltage must be higher than the highest output voltage in order to maintain voltage regulation.

Configure JP4 using a shorting jumper, as needed. For the TPS62400 (-001 board) and the TPS62420 (-003 board) do not install a jumper on JP4. For the TPS62401 (-002 board) this jumper is used to set the DEF_1 pin of the IC to a logic high or a logic low to define the output voltage at power up. For proper operation, do not leave this pin floating.

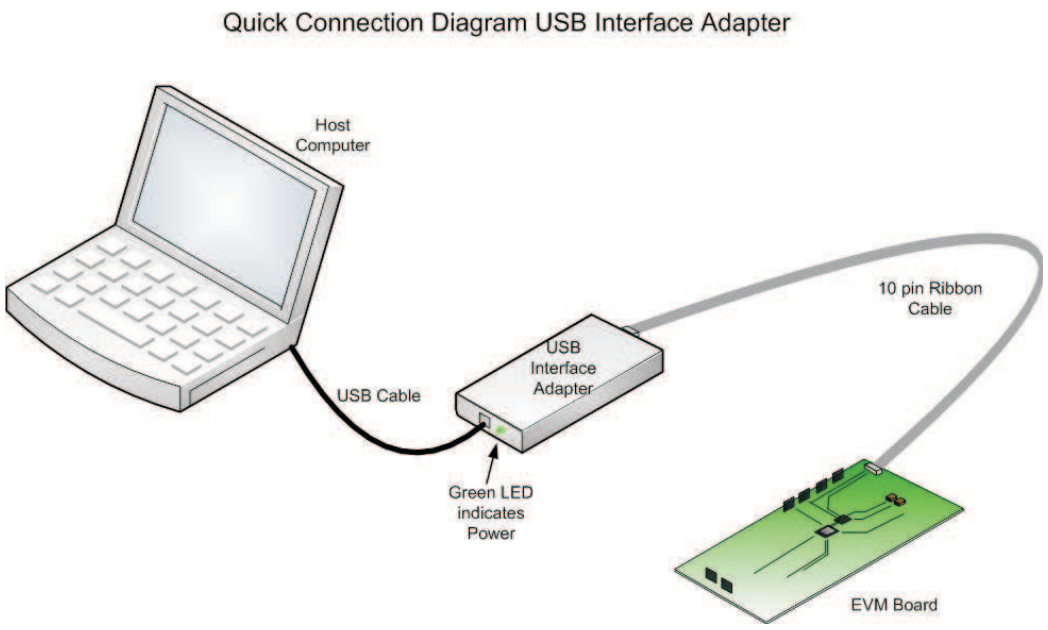
Configure the jumper on JP1 to the desired setting. This jumper configures the MODE/DATA pin of the TPS624xx. Normally, a shorting jumper is placed between pin 1 and pin 2 (PU and MODE) which provides a pullup resistor for the MODE/DATA pin. Short pins 1 and 2 when using the USB interface adapter for EasyScale communications. When the USB interface adapter is not used, then JP1 can be used to drive the MODE/DATA pin to a logic high (short pins 1 and 2) or low (short pins 2 and 3).

Configure JP2 and JP3 as desired. Shorting between ENx and ON (pin 1 and 2) enables the corresponding converter. Shorting between ENx and OFF (pin 2 and 3) disables the corresponding converter of the TPS624xx.

On the TPS62400 or TPS62420 EVMs, if it is desired to adjust the output voltage via EasyScale of converter 1, then R7 should be replaced with a 0-Ω resistor and R6 removed. If it is desired to adjust the output voltage via EasyScale of converter 2, then R4 may be replaced with a 0-Ω resistor and R5 removed. This is not a required change for converter 2.

Connect the USB interface adapter to your PC using the supplied USB cable. Connect the TPS624xxEVM board to the USB interface adapter using the supplied 10-pin ribbon cable. The connectors on the ribbon cable are keyed to prevent incorrect installation.

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Connect an input voltage supply to the TPS624xxEVM board. The TPS624xx uses an input voltage between 2.5 V and 6 V. Connect the positive input voltage to J1. Connect the input voltage return (ground) connection to J2.

2.3 Operation

Once connected, turn on the input voltage source to the EVM board. Then, start the TPS624xx evaluation software on the host computer. Once started, the software first asks which device (EVM dash number) you are testing. Select the proper radio button and click *Select IC* to continue.

If the *TPS62400/TPS62420* radio button is selected, the software then asks if certain hardware modifications (described in Section 2.2) have been made to the EVM. Select the appropriate radio buttons and click *GO* to continue.

The software then displays the main screen (shown in Figure 1). This screen allows the user to read and change the values of the internal registers of the TPS624xx.

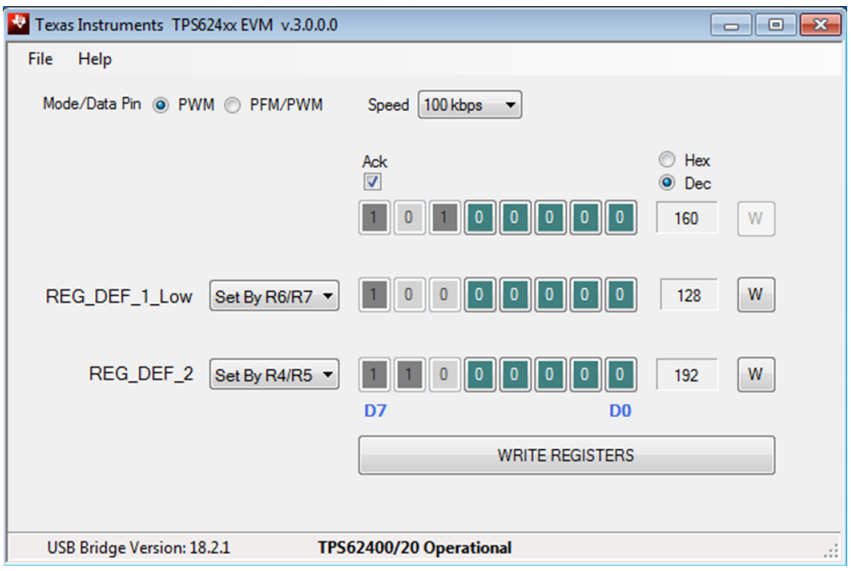


Figure 1. Main Screen for the TPS62400/TPS62420

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The output voltage pulldown boxes show the target output voltage based on the 32 combinations of bits. The voltages in the pulldown boxes are preprogrammed to match the TPS624xx device on the EVM board. The output voltages shown are based on the nominal output voltage, by device, while in PWM mode. All TPS624xx devices dynamically adjust the nominal output voltage in PFM mode so the pulldown boxes do not exactly match the actual output voltage in PFM mode. Changing the output voltage via the pulldown happens instantly without needing to write the registers manually.

The register bit representation panel on the right side of the screen allows the register values to be altered bit by bit. Clicking on the colored boxes changes the bit high or low. The actual TPS624xx register is not updated with the new value until the *W* or *WRITE REGISTERS* button is pushed. This allows the user to change all of the bits before updating the register.

Other functionality of the software includes: changing the communication speed of the EasyScale interface, changing the register display from hex to decimal, requesting the TPS624xx to output an *acknowledge* bit after correctly receiving a command, accessing the device data sheets (in the *Help* menu), saving or loading user defined configurations of the software settings (in the *File* menu), and finally holding the MODE/DATA pin high or low when not communicating. This final function sets PWM (high) or PFM/PWM (low) operation of the TPS624xx.

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3 Board Layout

This section provides the TPS624xxEVM-167 board layout and illustrations.

3.1 Layout

Board layout is critical for all high-frequency, switch-mode power supplies. Figure 2, Figure 3, and Figure 4 show the board layout for the TPS624xxEVM-167 PCB. The nodes with high-switching frequencies and currents are kept as short as possible to minimize trace inductance. Careful attention has been given to the routing of high-frequency current loops and a single-point grounding scheme is used. See the TPS62400 and TPS62401 data sheet (SLVS681) or the TPS62420 data sheet (SLVS676) for specific layout guidelines.

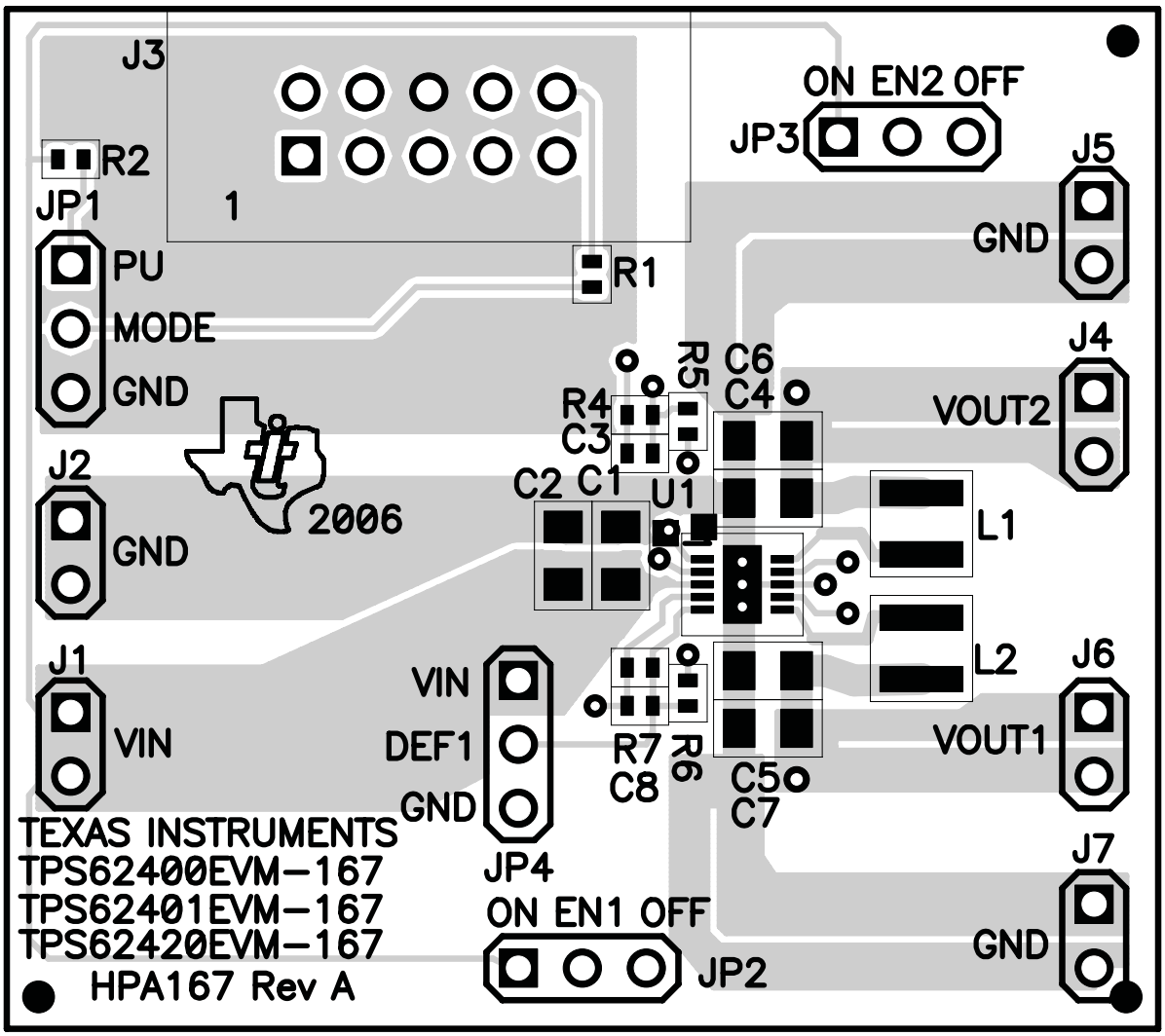


Figure 2. Assembly Layer

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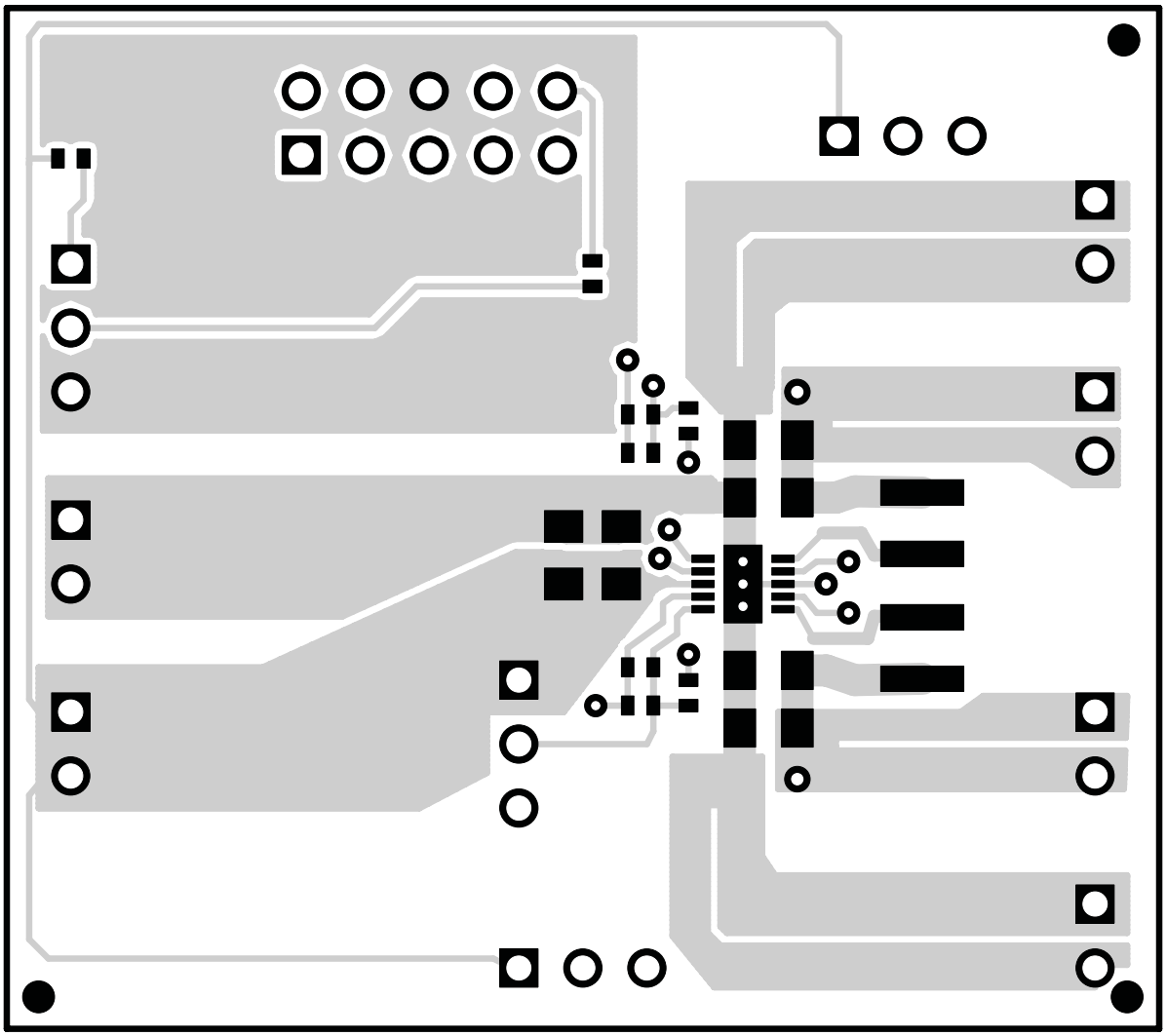


Figure 3. Top Layer Routing

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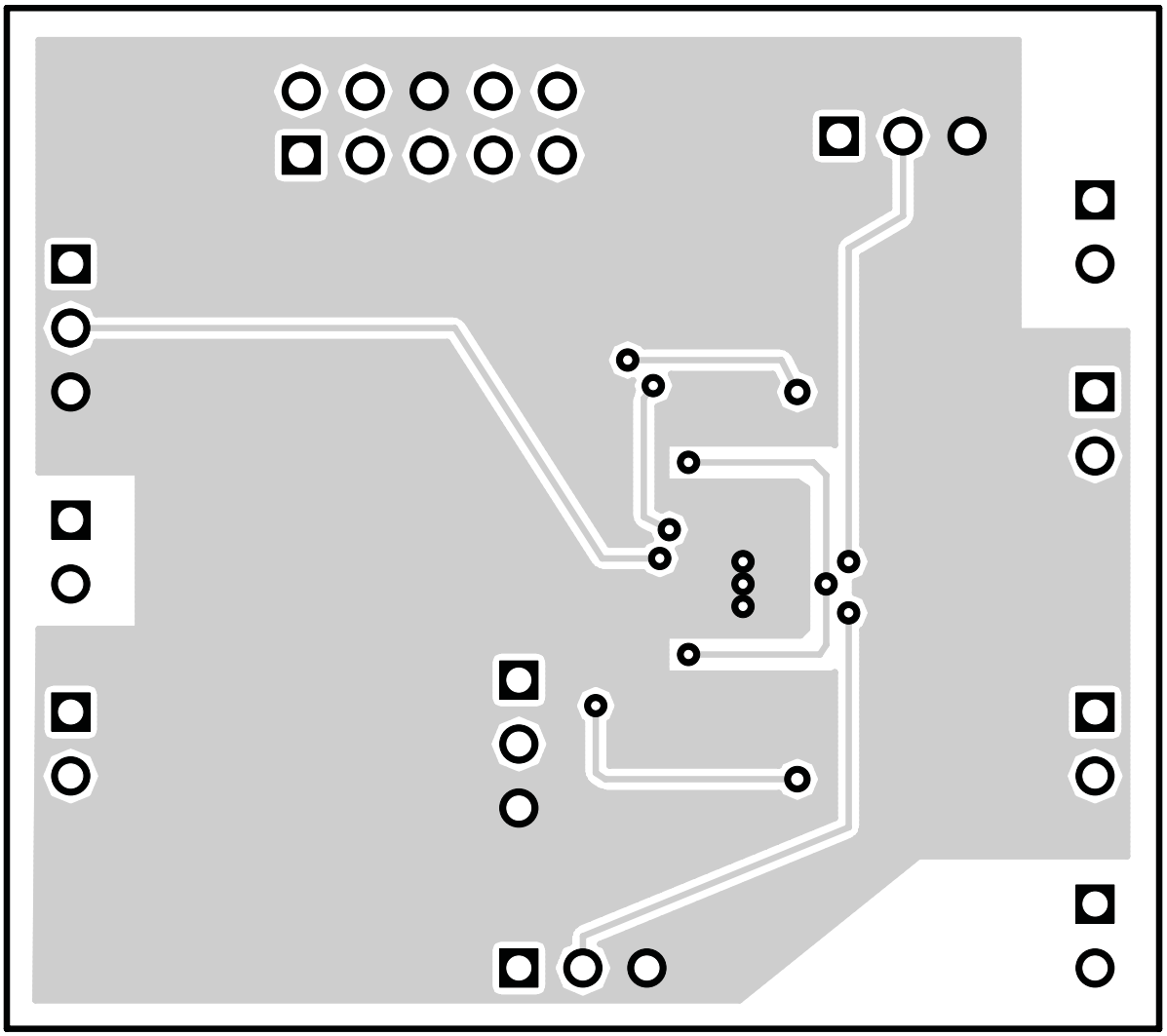


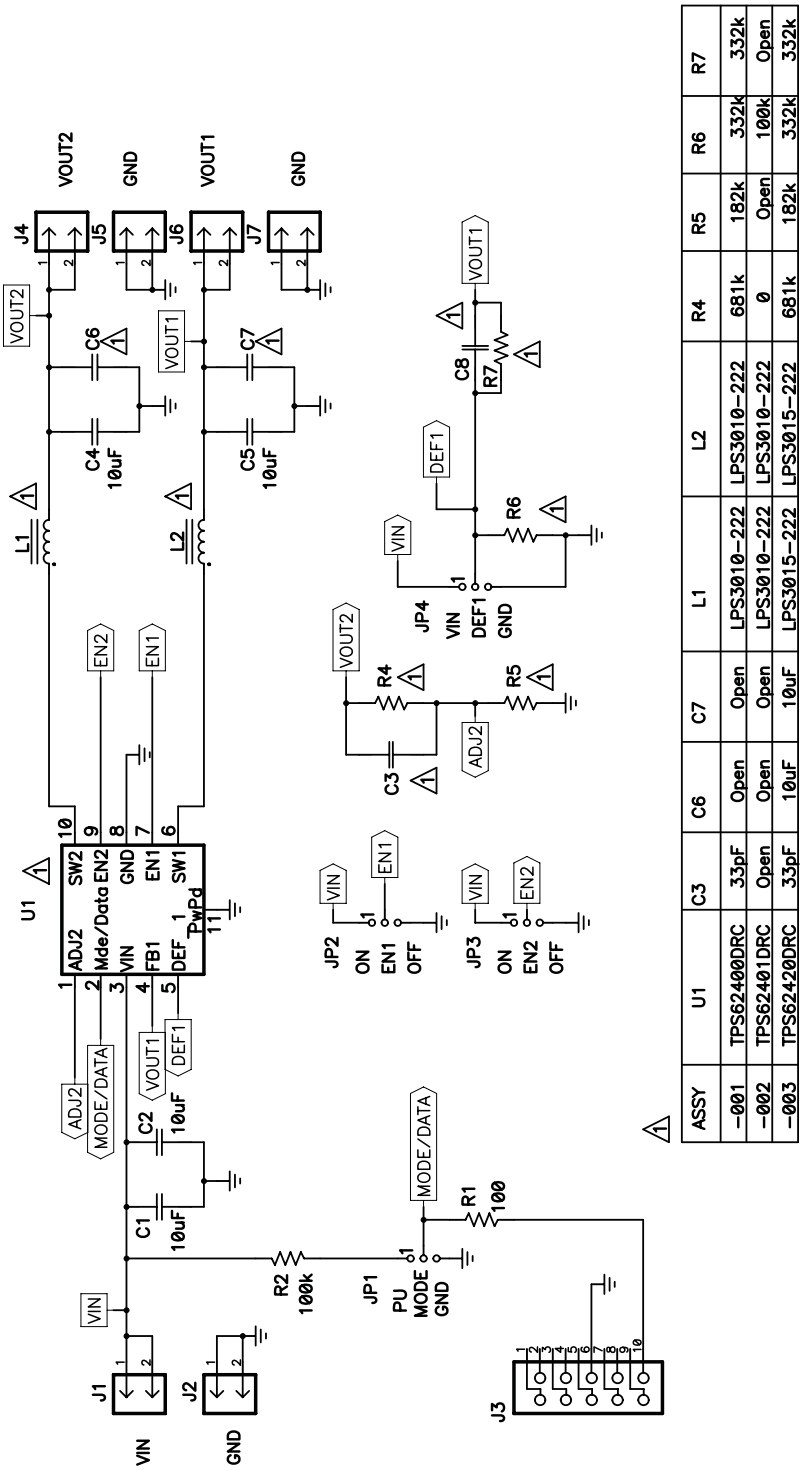
Figure 4. Bottom Layer Routing

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4 Schematic and Bill of Materials

This section provides the TPS624xxEVM-167 schematic and bill of materials.

4.1 Schematic



ASSY	U1	C3	C6	C7	L1	L2	R4	R5	R6	R7
-001	TPS62400DRC	33pF	Open	Open	LPS3010-222	LPS3010-222	681k	182k	332k	332k
-002	TPS62401DRC	Open	Open	Open	LPS3010-222	LPS3010-222	0	Open	100k	Open
-003	TPS62420DRC	33pF	10uF	10uF	LPS3015-222	LPS3015-222	681k	182k	332k	332k

Figure 5. TPS624xxEVM-167 Schematic

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4.2 Bill of Materials

Table 1. HPA167A Bill of Materials

Count			Ref Des	Value	Description	Size	Part Number	MFR
-001	-002	-003						
4	4	4	C1, C2, C4, C5	10µF	Capacitor, ceramic, 10V, X5R, 10%	0805	C2012X5R1A106K	TDK
1	0	1	C3	33pF	Capacitor, ceramic, 50V, C0G, 5%	0402	C1608C0G1H330J	TDK
0	0	2	C6, C7	10µF	Capacitor, ceramic, 10V, X5R, 10%	0805	C2012X5R1A106K	TDK
2	2	0	L1, L2	2.2µH	Inductor, SMT, 1.2A, 90mΩ	0.118 × 0.188	LPS3010-222ML	Coilcraft
0	0	2		2.2µH	Inductor, SMT, 1.5A, 110mΩ	0.118 × 0.188	LPS3015-222ML	Coilcraft
1	1	1	R1	100	Resistor, Chip, 1.16W, 1%	0402	Std	Std
1	1	1	R2	100k	Resistor, Chip, 1.16W, 1%	0402	Std	Std
0	1	0	R4	0	Resistor, Chip, 1.16W, 1%	0402	Std	Std
1	0	1		681k	Resistor, Chip, 1.16W, 1%	0402	Std	Std
1	0	1	R5	182k	Resistor, Chip, 1.16W, 1%	0402	Std	Std
1	0	1	R6	332k	Resistor, Chip, 1.16W, 1%	0402	Std	Std
0	1	0		100k	Resistor, Chip, 1.16W, 1%	0402	Std	Std
1	0	1	R7	332k	Resistor, Chip, 1.16W, 1%	0402	Std	Std
1	0	0	U1		IC, 2.25MHz dual step down converter	3 x 3 mm	TPS62400DRC	TI
0	1	0				3 x 3 mm	TPS62401DRC	TI
0	0	1				3 x 3 mm	TPS62420DRC	TI

5 Related Documentation From Texas Instruments

(A) *TPS62400/TPS62401, 2.25MHz 400mA/600mA Dual Step Down Converter in Small 3x3mm QFN Package* data sheet (SLVS681)

(B) *TPS62420, 2.25MHz 600mA/1000mA Dual Step Down Converter in Small 3x3mm QFN Package* data sheet (SLVS676)

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EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

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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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http://www.tij.co.jp

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.

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