TPL0501EVM User Guide

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1 Features

- Works with low cost MSP430 based LaunchPad platform
- Simple GUI to control EVM
- EVM can be operate two different modes
  - Adjustable Voltage reference mode
  - Variable gain mode
- Board is entirely powered by USB

2 Introduction

The TPL0501 is a single channel, linear-taper digital potentiometer with 256 wiper positions. This device can be used as a three-terminal potentiometer or as a two-terminal rheostat. The TPL0501 has an end –to-end resistance of 100kΩ. The internal registers of the TPL0501 can be accessed using a SPI-compatible interface. The TPL0501 has a nominal temperature coefficient of 35ppm/°C. The TPL0501 is available in an 8-pin SOT-23 and 8-microQFN package with a specified temperature range of –40°C to 125°C.

The TPL0501EVM is designed to operate with the Texas Instruments LaunchPad (MSP-EXP430G2). The TPL0501EVM come with a preprogrammed MSP430G2553 microcontroller which is to be inserted in the DIP socket on the LaunchPad. The LaunchPad can be separately purchased at www.ti.com/launchpad .

The TPL0501EVM has two different evaluation modes:

Mode 1 – **Adjustable voltage reference mode** – in this mode the TPL0501 is used in conjunction with an LMV321 op amp as an adjustable voltage reference circuit.

Mode 2 – **Variable gain mode** – in this mode the TPL0501is configured as part of a variable gain non-inverting amplifier. The gain of the amplifier can be controlled by a digital interface. This mode can be used to evaluate the bandwidth of the TPL0501.

The EVM is operated by connecting the LaunchPad to a PC that has Windows™ (with .NET) via the USB Port. Other standard lab equipment such as Signal generator, multimeter, spectrum analyzer etc may be required for detailed analysis of the TPL0501 performance using this EVM.

3 Mode Selection

To setup any of these two modes, begin by connecting the EVM to the LaunchPad. Note the location of the VCC and GND pins on headers J1 and J2 on both the LaunchPad and the EVM to ensure correct installation.

1. **Voltage reference mode**

   Connect pins 1 and 2 of Jumper J7.
   Connect pins 1 and 2 of Jumper J5.
   Connect the LaunchPad and TPL0501EVM to a computer through the USB connector.

2. **Variable Gain mode**

   Connect pins 2 and 3 of jumper J6.
   Connect pins 1 and 2 of jumper J7.
   Attach a signal generator to the EXT_IN connector.
   Connect the LaunchPad and TPL0501EVM to a computer through the USB connector

4 Jumper Connections

1. **J1** & **J2** – **LaunchPad Headers**

   These connectors mate with the male headers on the LaunchPad.

2. **J5** – **Feedback loop**

   For the TPL0501 to function as a voltage reference circuit the negative feedback loop must be shorted, placing a jumper across this header will short the inverting input to the output.

3. **J6** – **Inverting Op-amp select**

   When shorted across pins 2 and 3, the wiper of TPL0501-100 (U1) is connected to the inverting input of the op-amp for evaluation of a non-inverting variable gain amplifier. This header can also be used as a pin out of the TPL0501-100 (U1). Pin 1 is the H terminal, pin 2 is the W terminal but the L terminal is always connected to ground.

4. **J7** – **Op-amp input**

   This header controls the input to the non-inverting pin of the LMV321. When shorted across position 1 and 2, the TPL0501-100 (U2) in a voltage divider mode is attached to the non-inverting input of the LVM321. This setup is used to test the voltage reference setup. When shorted across pins 2 and 3, the SMA connector is attached to the non-inverting input.

Table 1. Description of Connectors and Jumpers

Label	Description
J1, J2	Connectors to interface with LaunchPad
J3	SMA/B Footprint for external input
J5	Control jumper to short feedback loop
J6	Jumper to control inverting input
J7	Jumper to control input to Op-Amp

5 Software Setup

The GUI software is available in a zip file located on the TPL0501 product page on www.ti.com. Download the zip file and extract its contents to a desired location on your PC. You will see an executable file called TPL0501_GUI.exe in the extracted folder. Double click the file to open it and the GUI program should launch. **IMPORTANT:** Before launching the GUI please make sure the TPL0501EVM is setup in the desired mode and connected to the PC through a USB port.

6 Operation

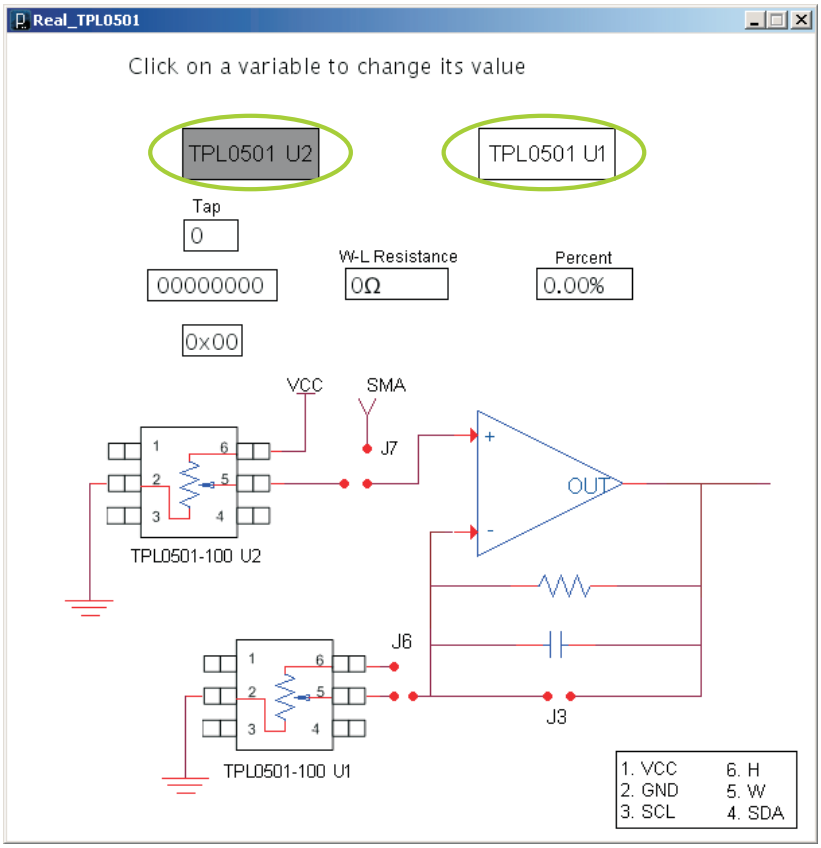

Figure 1. GUI for DPOT Control

There are three methods to adjust the value of the TPL0501A/B. Start by clicking one of the buttons circled in GREEN to select the corresponding TPL0501 device.

To adjust the tap value directly simply click the box that says tap and you will be prompted to input a tap value between 0 and 127. After typing in the desired value press enter and the tap value will be sent to the TPL0501A and the GUI will reflect the value you just entered.

To adjust the TPL0501 by inputting a wiper to low terminal resistance, click the box that says W-L Resistance. You will then be prompted to input a value between 0 and 10,000 ohms; press enter after you have input a value. The GUI will use the theoretical resistance values to find a tap that is closest to the value that was input.

NOTE: All W-L resistance values are theoretical; the actual value will be within 20% of the displayed value.

6.1 Voltage Reference Mode

Make sure the EVM is set up in Mode 1 as described in Section 3. The TPL0501-100 U2 is used in the adjustable voltage reference mode. Select the corresponding device from the GUI. Change the value the DPOT using any of the methods described above. Measure the voltage on TP1 using a multimeter. You will see the voltage change with the value of the TPL0501 resistance.

6.2 Variable Gain Mode

The variable gain mode is primarily intended to test the bandwidth of the TPL0501. After setting up the EVM as described in Section 3, the circuit will look as follows:

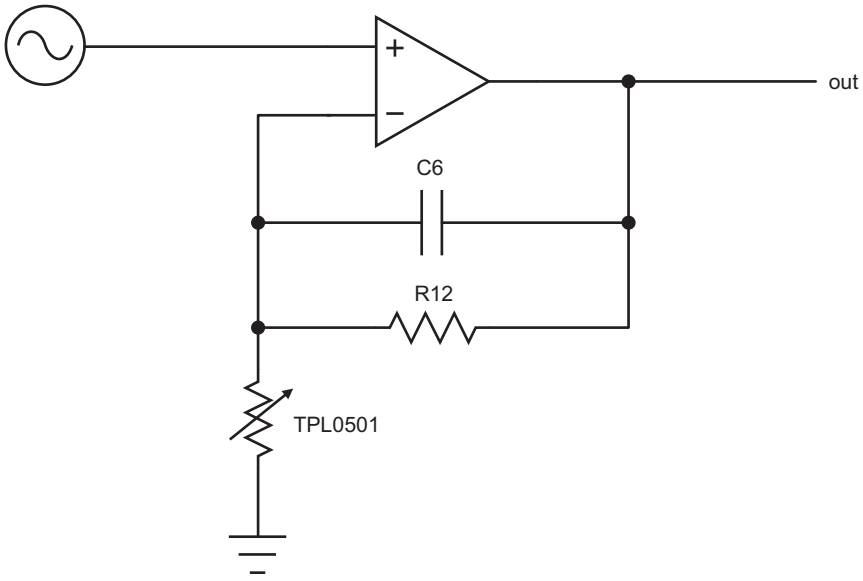

Figure 2. TPL0501 Variable Gain

The capacitor C6 and the resistor R12 are unpopulated and should be set by the user. R12 will set the possible gain values and C6 will keep the loop stable. Changing the value of the TPL0501 works the same as described in the beginning of this section by selecting device TPL0501-100 U1.

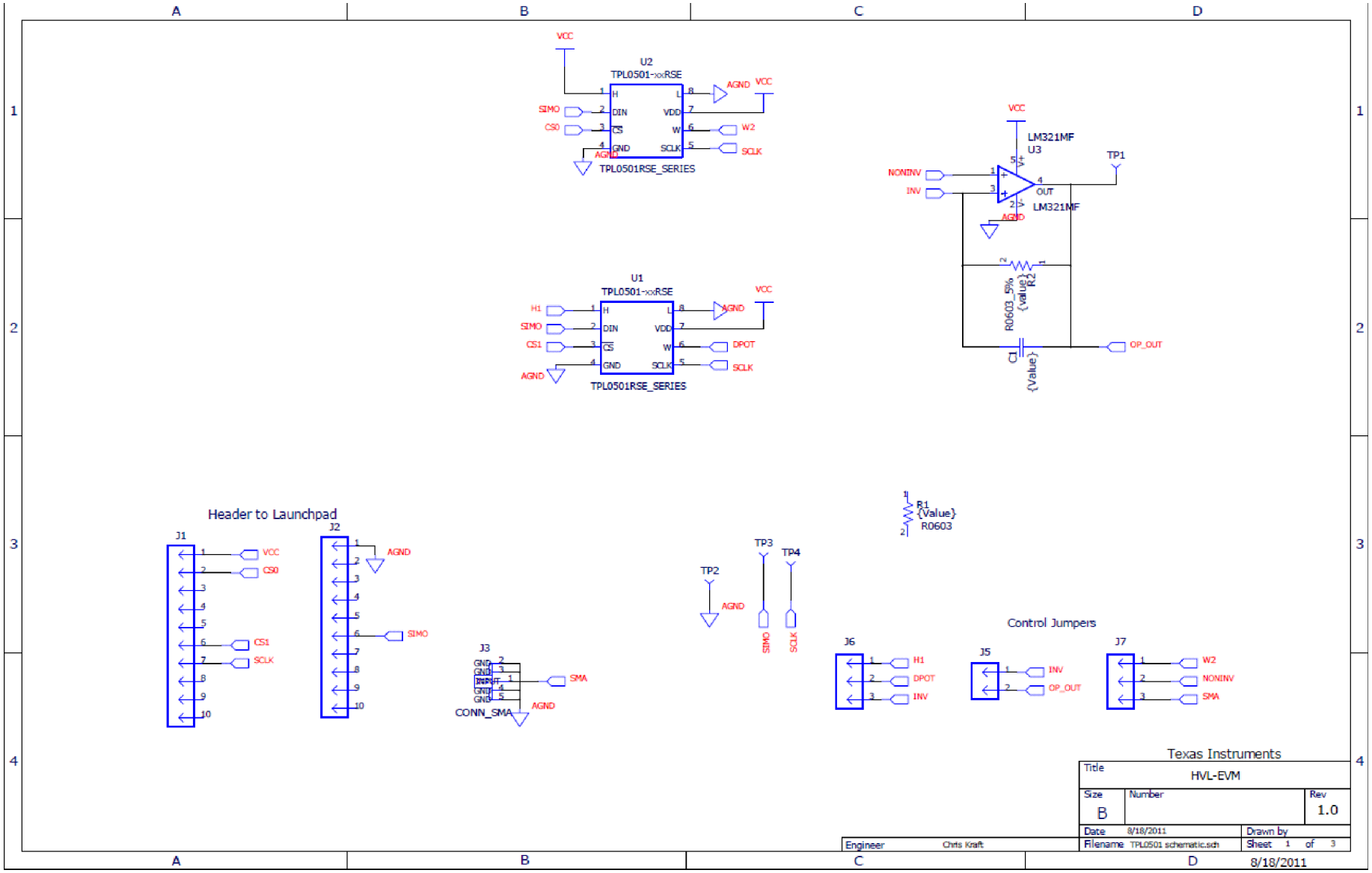

Figure 3. TPL0501EVM Schematic

7 Layouts

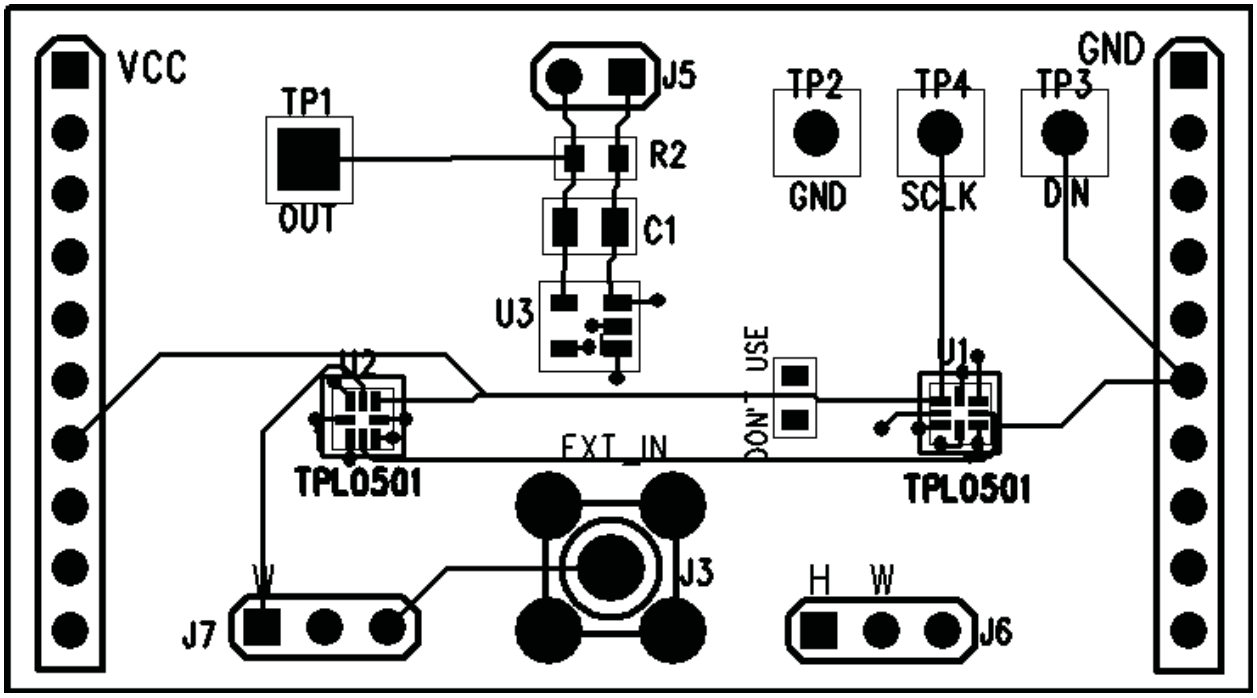

Figure 4. Routing, Assembly and Silkscreen Top

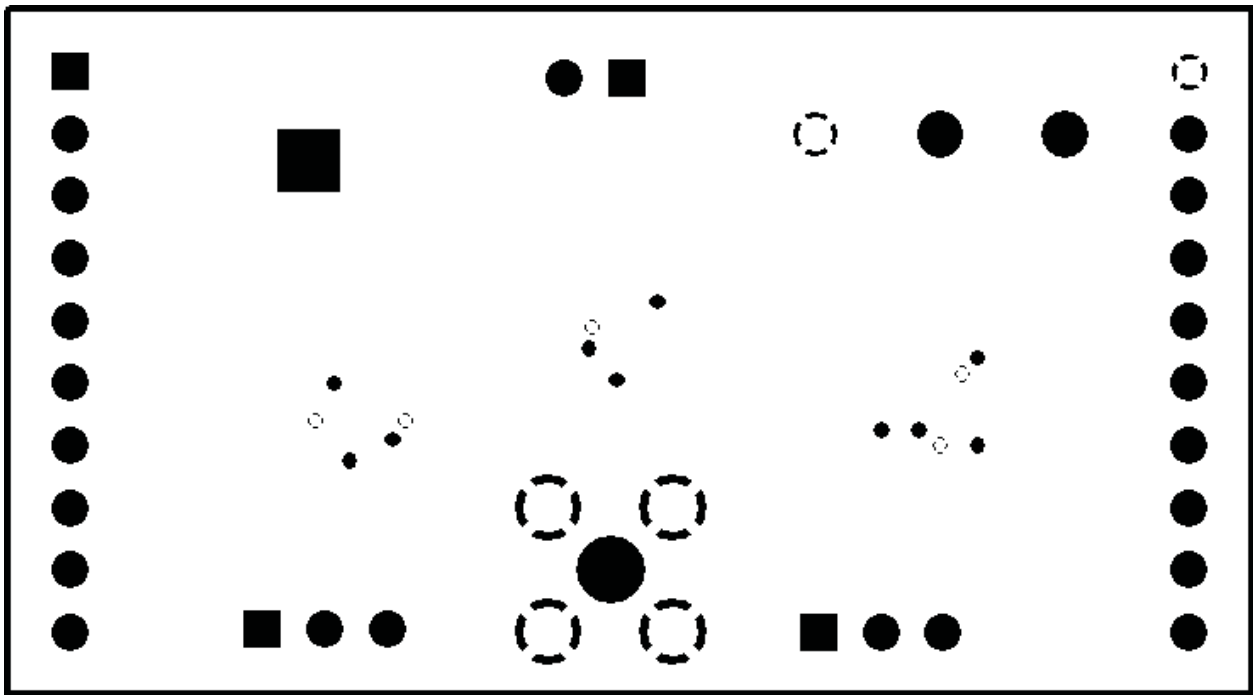

Figure 5. Layer 2 Ground Plane

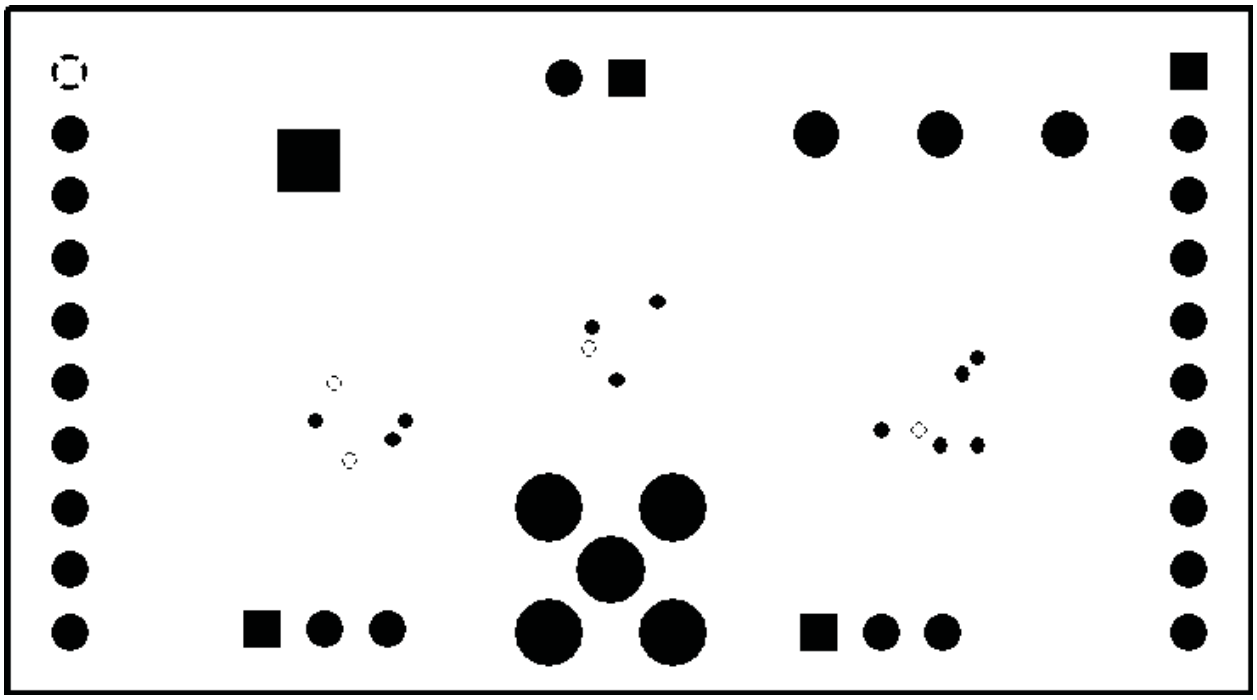

Figure 6. Layer 3 Power Plane

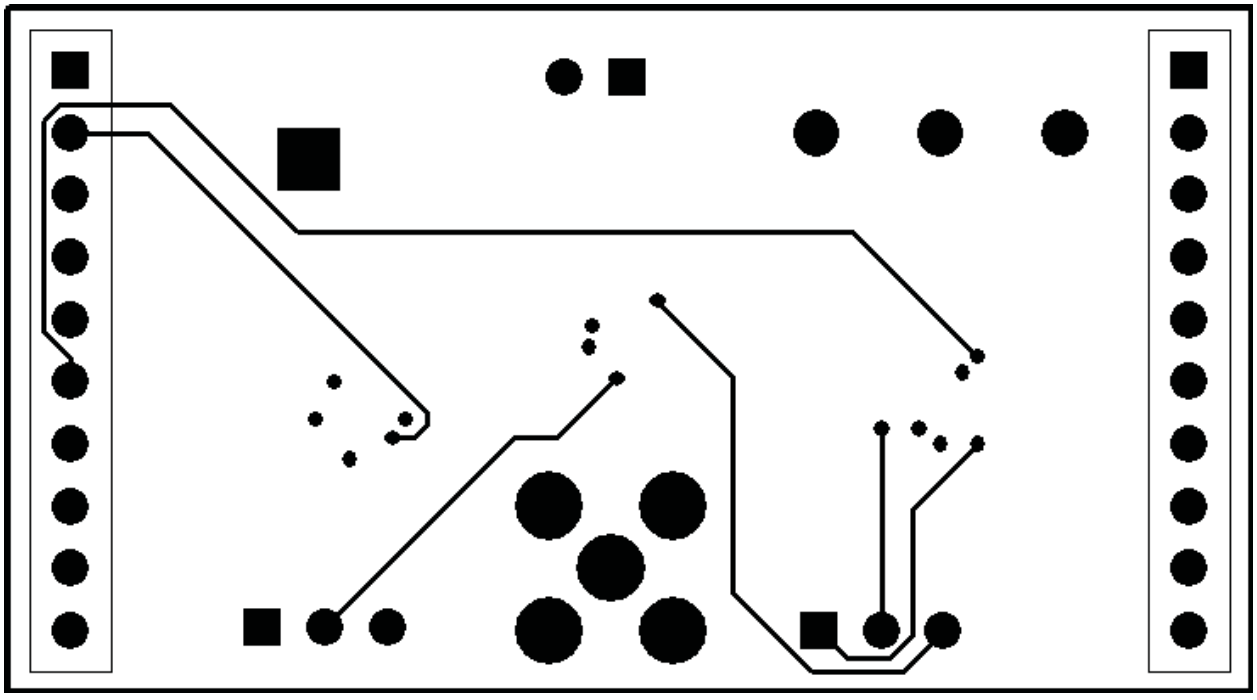

Figure 7. Routing and Assembly Bottom

8 Bill of Materials

Table 2. 430Boost-TPL0501EVM Bill of Material (DPOT Only)

Count	RefDes	Value	Description	Size	Part Number	MFR	Notes
1	TP1	5013	Test Point, Orange, Thru Hole	0.125 x 0.125 inch	5013	Keystone	DNI
1	TP2	5001	Test Point, Black, Thru Hole	0.100 x 0.100 Inch	5001	Keystone	DNI
1	TP3	5000	Test Point, Red, Thru Hole	0.100 x 0.100 Inch	5000	Keystone	DNI
1	TP4	5002	Test Point, White, Thru Hole	0.100 x 0.100 Inch	5002	Keystone	DNI
1	C1	{VALUE}	Capacitor, Ceramic,	0805			DNI
1	J3	901-144-8RFX	Connector, SMA , Straight, PC mount	0.210 sq inch	901-144-8RFX, 1408332-1	Amphenol	DNI
2	R1-2	{VALUE}	Resistor, Chip, 1/16W, 5%	0603			DNI
1	U3	LMV321IDBVR	IC, Low Power, Single Op-Amp	SOT23-5	LMV321IDBVR	TI	
1	J5	961102-6404-AR	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	961102-6404-AR		
2	J6-7	961103-6404-AR	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	961103-6404-AR		
2	J1-2	PPTC101LFBN-RC	Header, Female 10-pin 100mil spacing	0.100 inch x 10	PPTC101LFBN-RC		
2	U1-2	TPL0501-10RSE	IC, 10KOhm, 256 Taps Single Chan Digital W/SPI Interface	QFN	TPL0501-10RSE	TI	

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It is important to operate this EVM within the input voltage range of 0 V to 5.5 V and the output voltage range of 0 V to 5.5 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. 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 50° C. The EVM is designed to operate properly with certain components above 50° C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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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.

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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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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