TPL0401EVM

Contents

List of Figures

List of Tables

Windows is a trademark of Microsoft Corporation.

1 Features

- Works with low cost MSP430 based LaunchPad platform
- Simple GUI to control EVM
- EVM can be operated in three different modes
  - Auto run LED mode
  - Adjustable Voltage reference mode
  - Variable gain mode
- Board is powered by USB

2 Introduction

The TPL0401 is an I2C bus controlled, single channel, linear-taper digital potentiometer with 128 wiper positions. TPL0401A/B have an end-to-end resistance of 10k ohms and the low terminal internally connected to ground. The position of the wiper can be adjusted using an I^2C interface. The TPL0401 is available in a 6-pin SC-70 package with a specified temperature range of –40°C to 125°C. The part has a 10k end-to-end resistance and can operate with a supply voltage range of 2.7V to 5.5V.

THE TPL0401EVM also consists of multiple other TI products (port expanders, LED drivers etc.). However, the scope of this document is to illustrate the use of the EVM to evaluate the TPL0401. The TPL0401EVM is designed to operate with the Texas Instruments LaunchPad (MSP-EXP430G2). The TPL0401EVM comes 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 TPL0401EVM has three different evaluation modes:

Mode 1 – **LED mode** – This is the standard mode the TPL0401 comes up in when powered up. In this mode the TPL0401 devices are used to control the color mixing on the RGB LEDs. The DPOTs are used to set the current limit for the TLC59108 LED driver. This mode is and auto run mode that does not have any GUI control. The flashing lights and color mixing is controlled by the keys on the board and other TI products on the board.

Mode 2 – **Adjustable voltage reference mode** – in this mode the TPL0401 is used in conjunction with an LMV321 op amp as an adjustable voltage reference circuit.

Mode 3 – **Variable gain mode** – in this mode the TPL0401 is 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. **LED Mode**

   Connect Jumpers 1 and 2 of J6
   Connect +5V supply to J3
   Connect LaunchPad to computer through USB cable

   NOTE: It can be possible to power up the LEDs by connecting a wire from the VCC pin of J1 to the positive pin of J3. A 5V supply might be required because the max voltage drop across the blue LED plus the drop across the TLC59108 is larger than the supply voltage of the LaunchPad.

2. **Voltage reference mode**

   Start up the board in LED mode as described earlier
   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.

Press keys SW2 and SW3 simultaneously
Start GUI software on computer

3. **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 (SMA or SMB connector may need to be populated).
   Press keys SW2 and SW3 simultaneously
   Start GUI software on computer
   Connect the LaunchPad and TPL0501EVM to a computer through the USB connector

4 Jumpers Connections

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

   These connectors mate with the male headers on the LaunchPad

2. **J3** – **External LED Power**

   This connector is where the external +5V supply is attached to power the two RGB LEDs.

3. **J4** – **TCA7408 GPIO**

   This is a pin out of the four unused GPIO pins from the TCA7408, GPIO4-GPIO7.

4. **J5** – **Feedback loop**

   For the TPL0401A 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.

5. **J6** – **LED or Op-amp**

   This header controls what the TPL0401B is attached to. When shorted across position 1 and 2 the TPL0401B is connected in series with the external resistor to control the current through the LED driver. When shorted across position 2 and 3 the TPL0401B is connected to the inverting input of the op-amp to change the gain of the circuit.

6. **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 TPL0401A 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.

7. **J9** – **Test Points**

   This connector offers test points for the serial data lines, SDA, SCL and the DIN that drives the TCA5405

Table 1. Description of Connectors and Jumpers

Label	Description
J1, J2	Connectors to interface with LaunchPad
J3	External 5V for LED
J4	GPIO4-GPIO7 from TCA7408
J5	Control jumper to short feedback loop
J6	Jumper to control LED or Op-Amp
J7	Jumper to control input to Op-Amp
J8	SMA/B Footprint for external input
J9	Test points for DIN, SDA and SCL

5 Software Setup

The EVM does not require any software set up to operate in the LED mode. The keys SW1-SW4 control the blinking rate of the LEDs and the color mixing of the LEDs, without any additional software setup.

To operate the EVM in any other mode, GUI software is required. The GUI software is available in a zip

file located on the TPL0401 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 TPL0401_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 TPL0401EVM is setup in the desired mode and connected to the PC through a USB port.

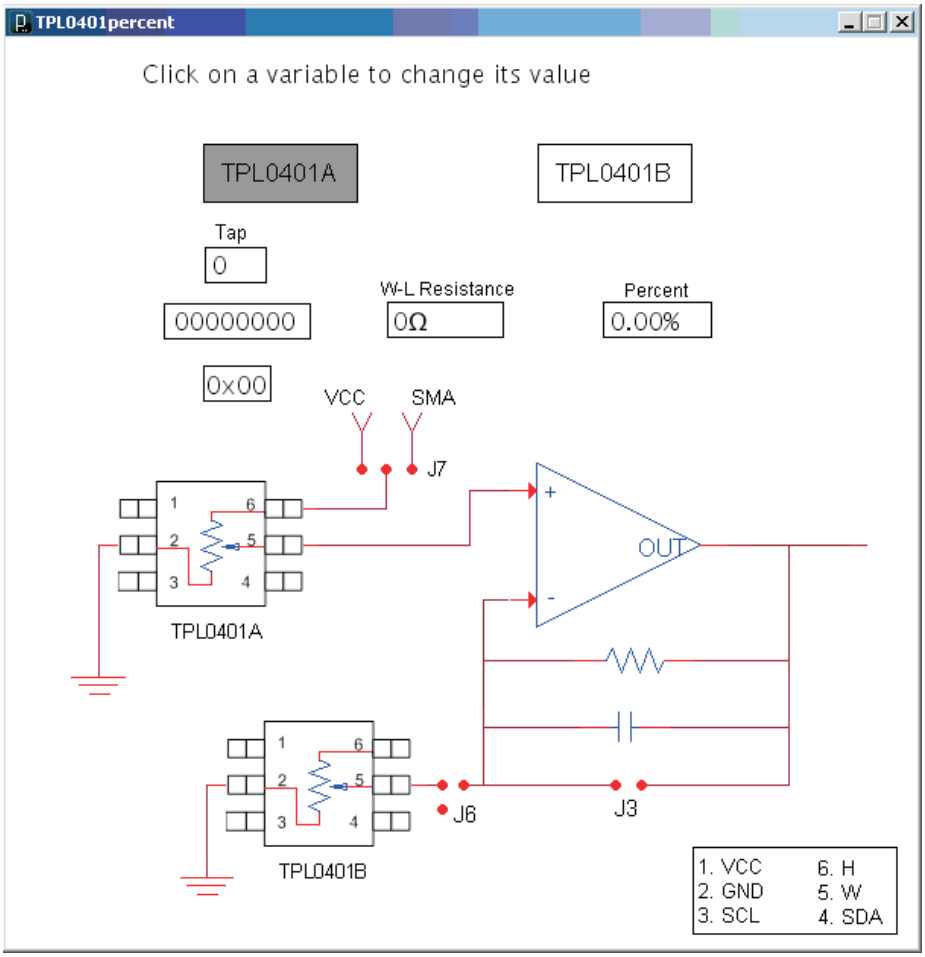

Figure 1. GUI for DPOT Control

There are three methods to adjust the value of the TPL0401A/B. Start by clicking one of the buttons circled in GREEN to select the corresponding TPL0401 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 TPL0401A and the GUI will reflect the value you just entered.

To adjust the TPL0401 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 typical values; the actual value will be within 20% of the displayed value

5.1 Voltage Reference Mode

Make sure the EVM is set up in voltage reference mode as described in Section 3. With the GUI open and TPL0401A selected you are also given the option to change the voltage divider ratio of the TPL0401A as a percent value. To do this simply click the box that says percent and you will be prompted to input a percent value between 0 and 100; decimal values can be used. After pressing enter, the GUI will find and send the tap value that is closest to the chosen percent value.

Using any of the methods to change the tap value of the TPL0401A will update the output voltage at TP1. The output will be a percent of the supply voltage, 3.6V.

5.2 Variable Gain Mode

The 430Boost-TPL0401EVM allows for a variable gain setup to evaluate the bandwidth of the TPL0401. After following the setup instructions in **section 2.3.2 ?**, the circuit will look as follows:

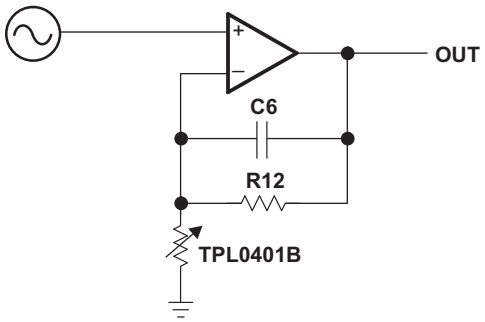

Figure 2. TPL0401B Variable Gain

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 TPL0401B works the same as described in the beginning of section 3.1.

6 Schematics, Layout and Bill of Materials

6.1 Schematics

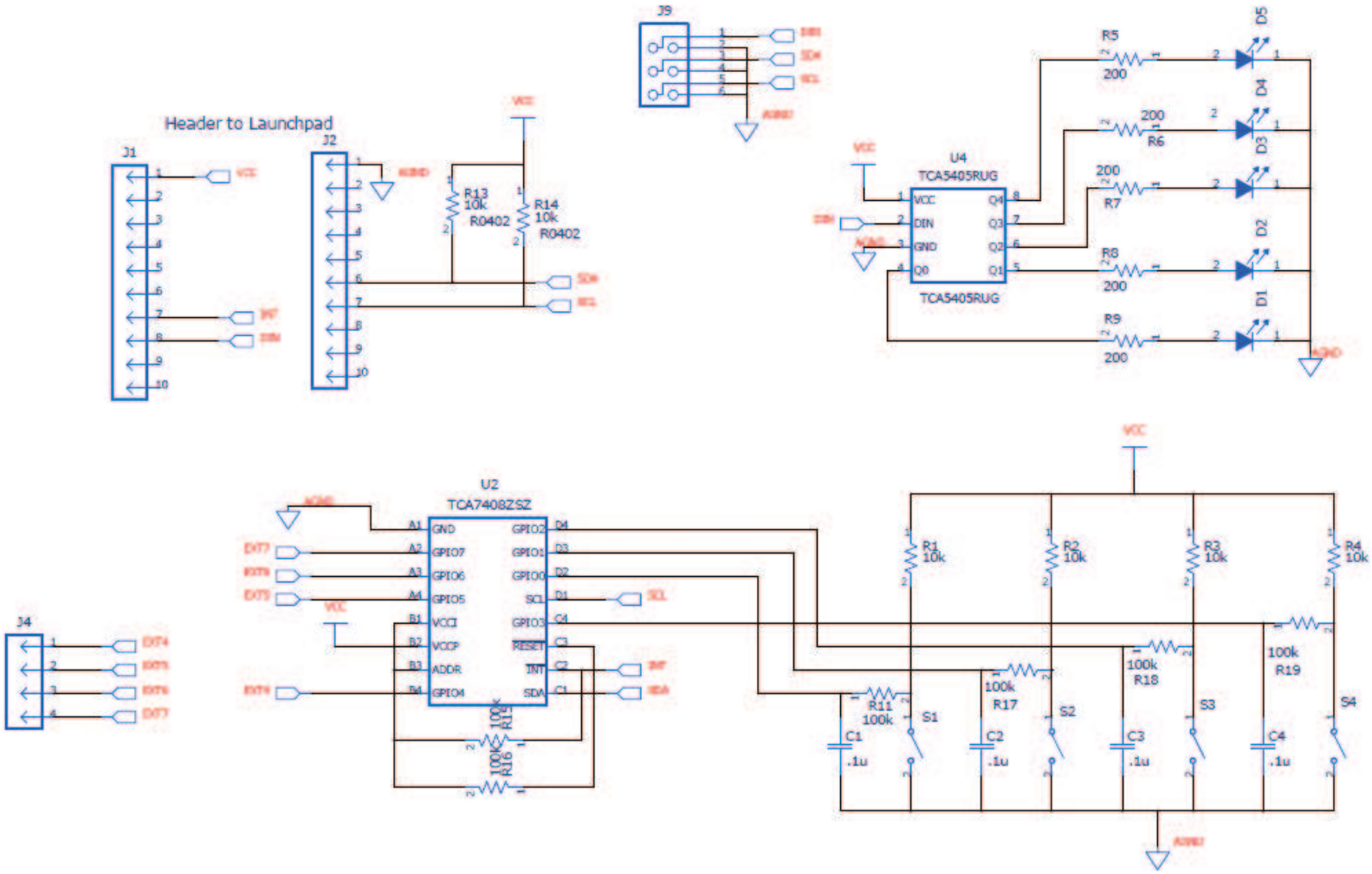

Figure 3. TCA5405, TCA7408 Schematic

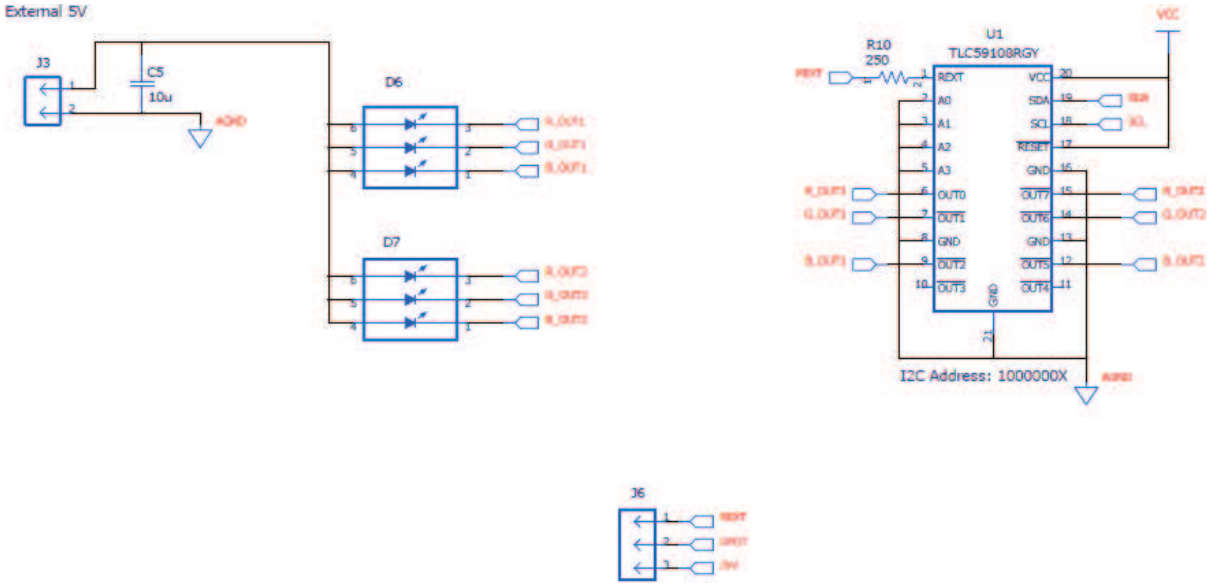

Figure 4. TLC59108 Schematic

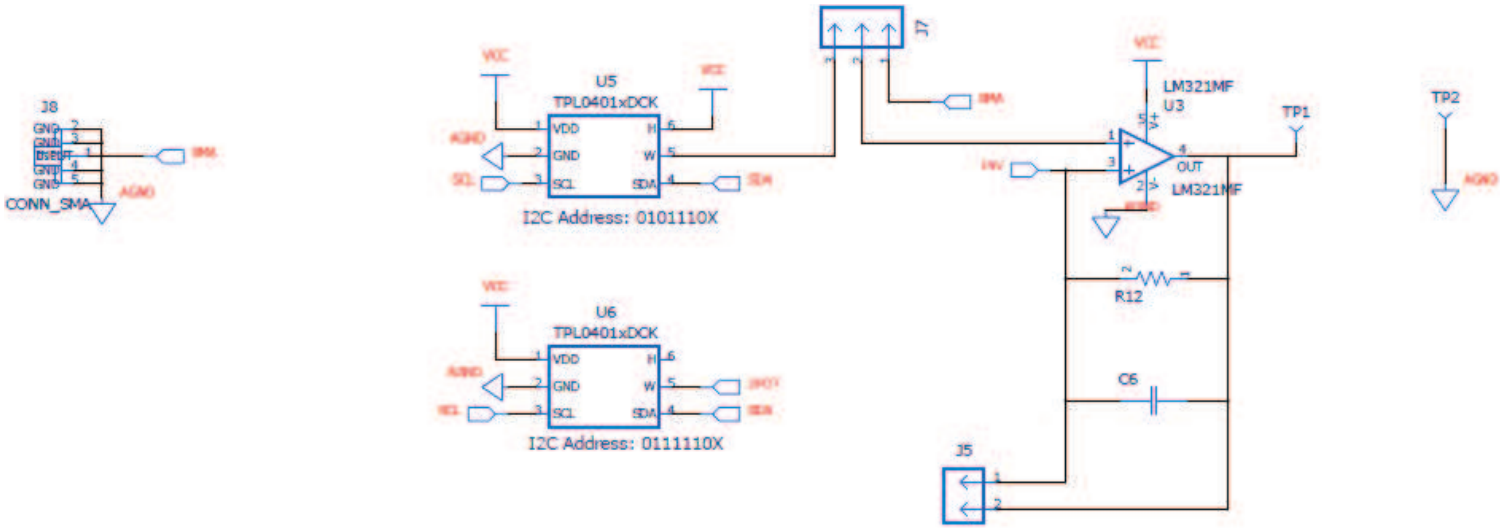

Figure 5. TPL0401 Schematic

6.2 Layouts

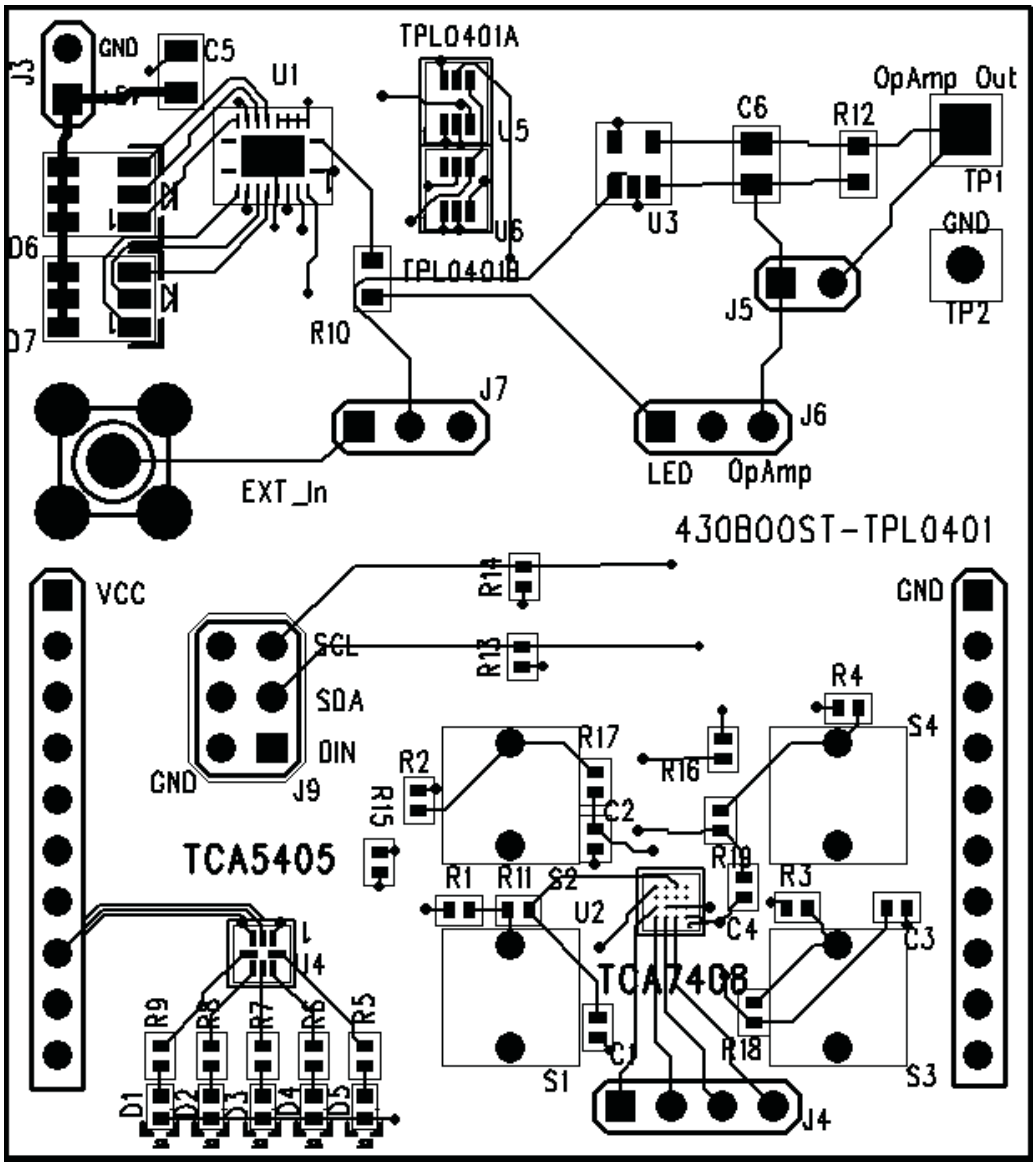

Figure 6. Routing, Assembly and Silkscreen Top

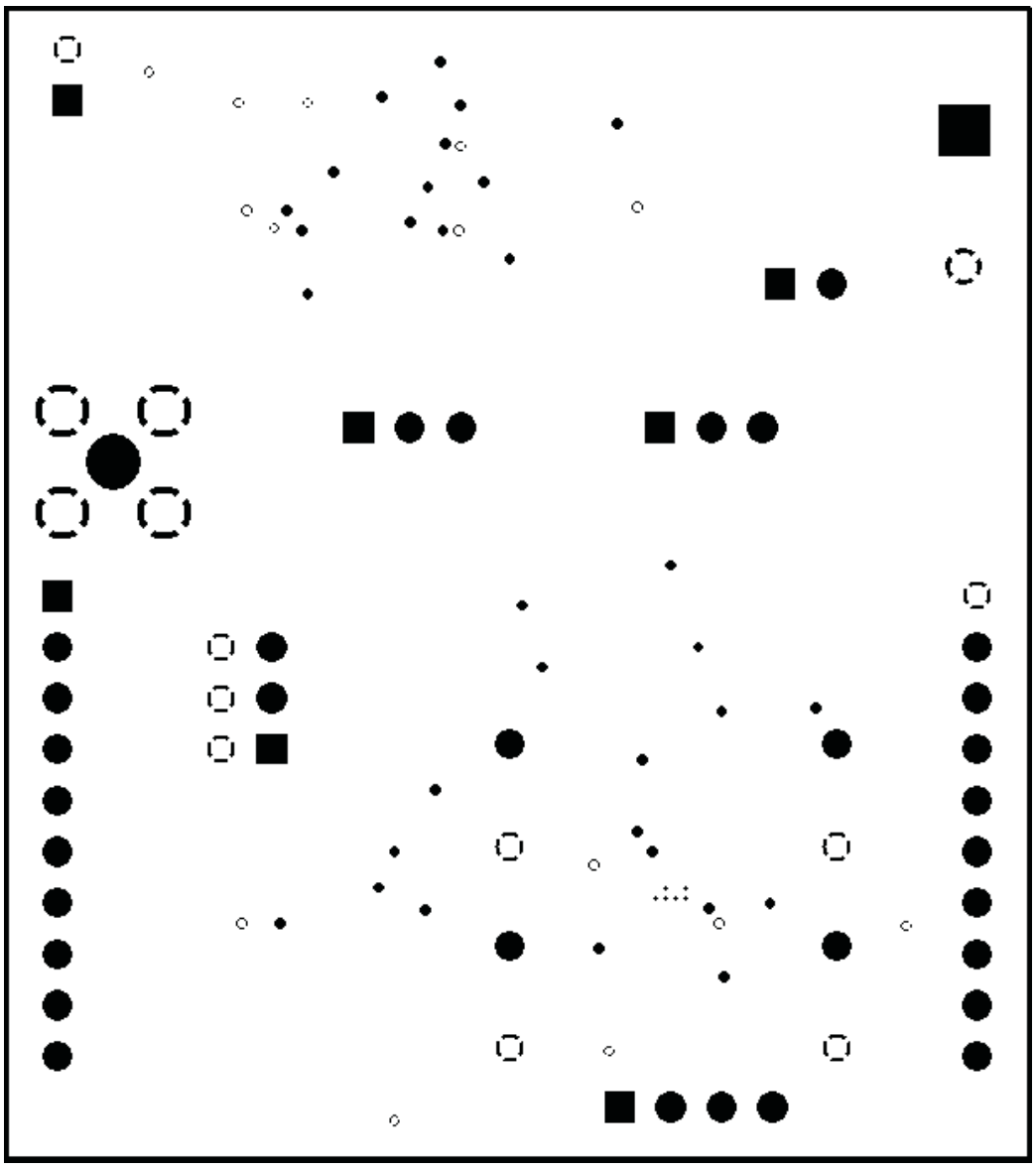

Figure 7. Layer 2 Power Plane

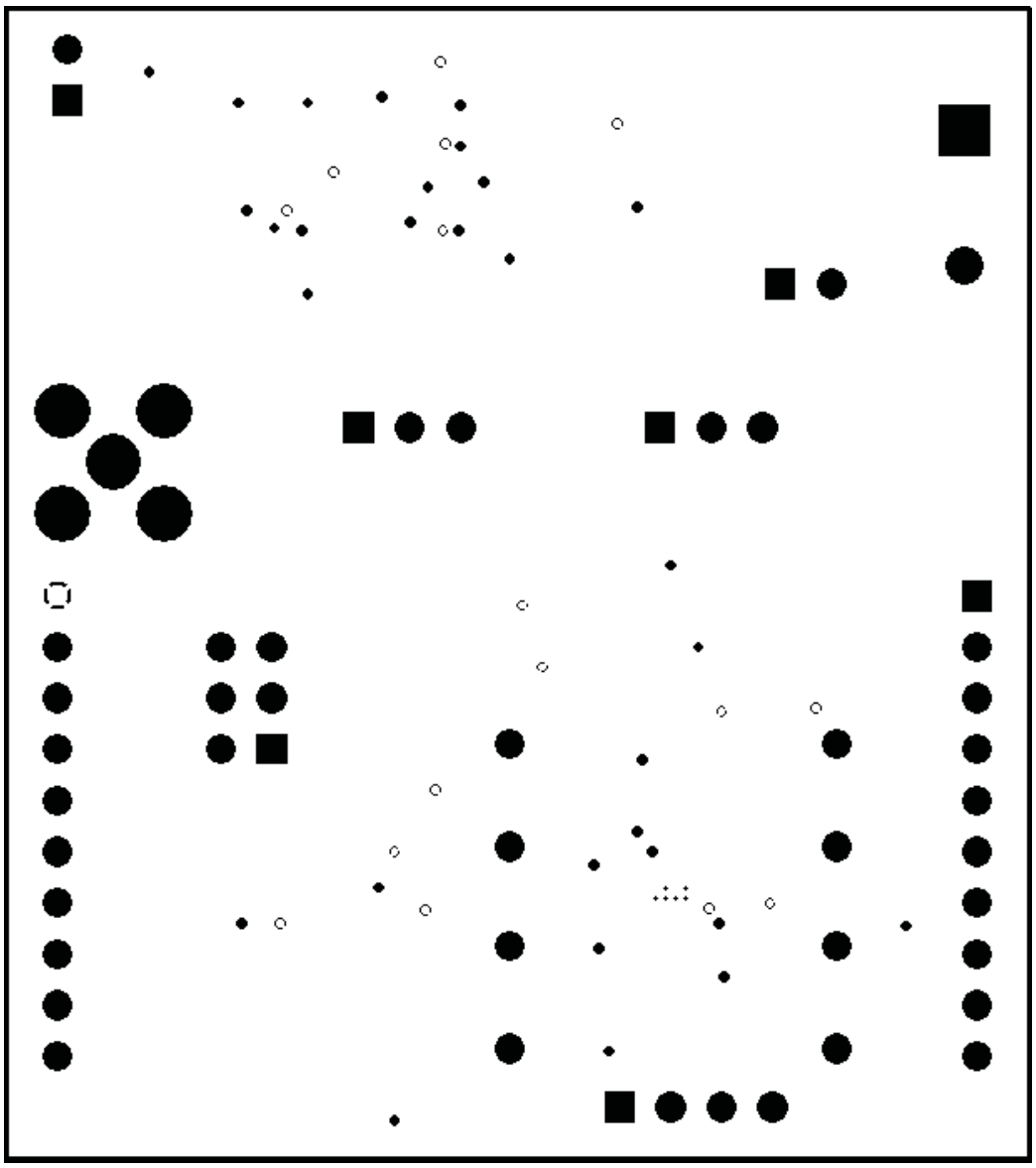

Figure 8. Layer 3 Ground Plane

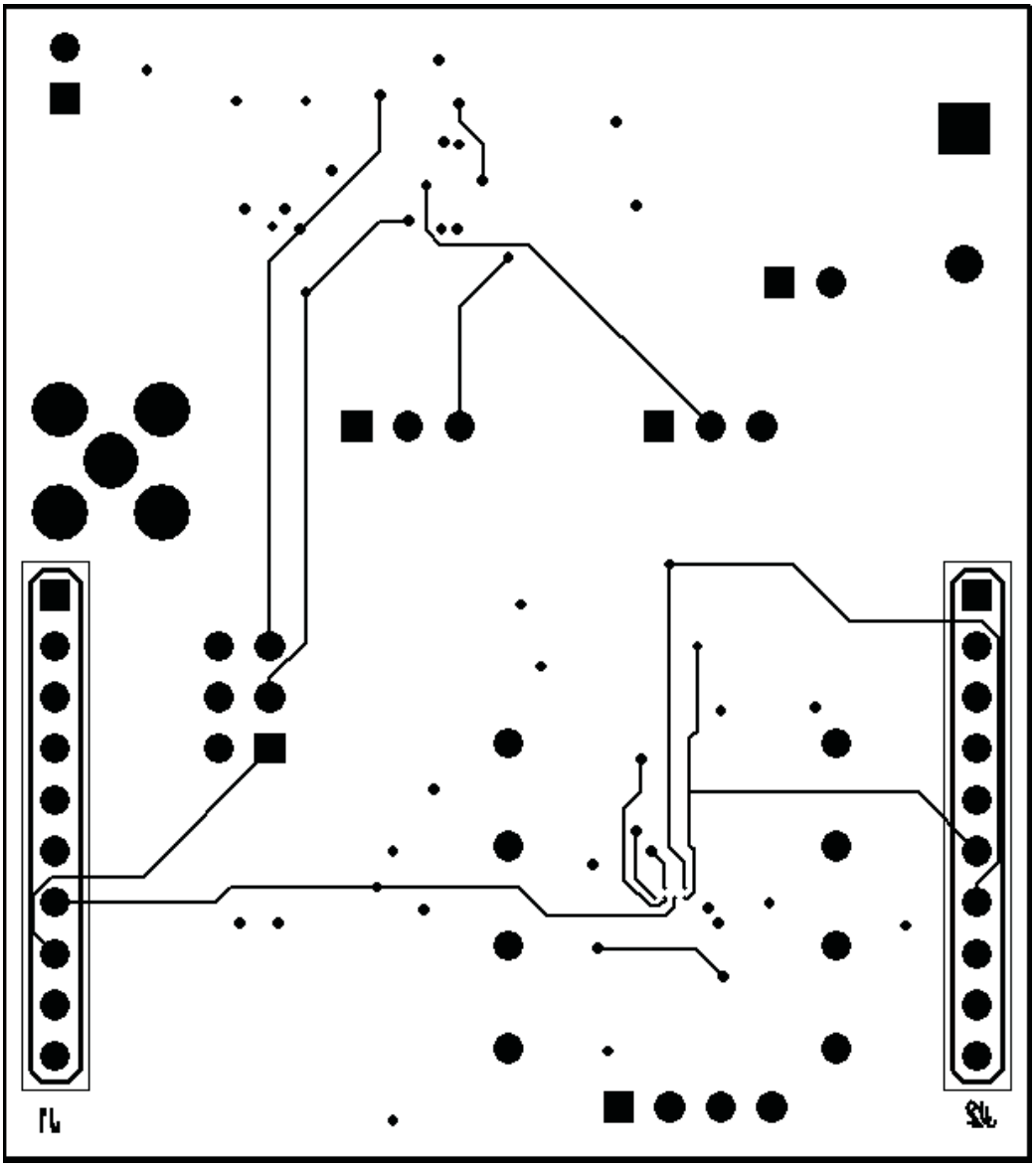

Figure 9. Routing and Assembly Bottom

6.3 Bill of Materials

Table 2. 430Boost-TPL0401EVM Bill of Material

Qty	RefDes	Value	Description	Part Number	MF	Notes
4	C1-4	0.1µ	Capacitor, Ceramic,			
1	C5	10µ	Capacitor, Ceramic,			
1	C6		Capacitor, Ceramic,			DNI
1	J8		Connector, SMA , Straight, PC mount	901-144-8RFX	AMP	DNI
5	D1-5	SML-P12PTT86	Diode, LED, GREEN 2.2V 20mA	SML-P12PTT86	ROHM	
2	D6-7	APF3236SURKZGQBDC	LED SMD TRI Color	APF3236SURKZGQBDC	Kingbright	
2	J3 J5		Header, Male 2-pin, 100mil spacing,		Sullins	
2	J6-7		Header, Male 3-pin, 100mil spacing,		Sullins	
1	J4		Header, Male 4-pin, 100mil spacing,		Sullins	

Table 2. 430Boost-TPL0401EVM Bill of Material (continued)

Qty	RefDes	Value	Description	Part Number	MF	Notes
2	J1-2	PPTC101LFBN-RC	Header, Female 10-pin, 100mil spacing,	PPTC101LFBN-RC	Sullins	
1	J9		Header, Male 2x3-pin, 100mil spacing		Sullins	DNI
2	R15-16	100k	Resistor, Chip, 1/16W 5%			
10	R1-4 R11 R13-14 R17-19	10k	Resistor, Chip, 1/16W 5%			
5	R5-9	200	Resistor, Chip, 1/16W 1%			
1	R10	250	Resistor, Chip, 1/16W, 1%			
1	R12	{value}	Resistor, Chip, 1/16W, 5%			DNI
1	TP2	5001	Test Point, Black, Thru Hole Color Keyed	5001	Keystone	
1	TP1	5013	Test Point, Orange, Thru Hole	5013	Keystone	
4	S1-4	EVQ221304M	Switch, SPST, 20-mA, 15-V	EVQ21304M; EVQ21305R; EVQ21307K	Panasonic	Prefer EVQ21304M if unavailable use 305R or 307K
1	U3	LMV321IDBVR	IC Low Power Single Op-amp	LMV321IDBVR	TI	
1	U4	TCA5405RUG	IC, Low Voltage 5-Bit Self-Timed, Single-Wire Output Expander	TCA5405RUG	TI	
1	U2	TCA7408ZSZ	IC, Low-Voltage 8-Bit I2C and SMBus I/O Expander	TCA7408ZSZ	TI	
1	U1	TLC59108RGY	IC, 8-BIT Fm+ I2C-Bus Constant-Current LED Sink Driver	TLC59108RGY	TI	
1	U5	TPL0401ADCK	IC, Digital POT, 1Chan, 128Tap	TPL0401ADCK	TI	
1	U6	TPL0401BDCK	IC, Digital POT, 1Chan, 128Tap	TPL0401BDCK	TI	

Evaluation Board/Kit Important Notice

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit 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. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

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 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.

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. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

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.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive.**

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

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 contact the TI application engineer or visit www.ti.com/esh.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

FCC Warning

This evaluation board/kit 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 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments 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.

EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 0 V to 0.5V and the output voltage range of 0 V to 0.5V .

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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used. TI currently deals with a variety of customers for products, and therefore our arrangement with the user is not exclusive. TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.

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 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.

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

http://www.tij.co.jp

【ご使用にあたっての注】

本開発キットは技術基準適合証明を受けておりません。

本製品のご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。

日本テキサス・インスツルメンツ株式会社
東京都新宿区西新宿６丁目２４番１号
西新宿三井ビル
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. 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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

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.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265