TSU6721EVM Micro-USB Switch Evaluation Module

This document is the user's guide for the TSU6721EVM micro-USB switch evaluation module (EVM). The TSU6721EVM is designed to evaluate and demonstrate the functionality of TI's TSU6721 micro-USB switch.

This guide contains an introduction, setup instructions, the EVM schematic, top and bottom board layouts, and a bill of materials.

Contents

List of Figures

List of Tables

1 About This Manual

1.1 Information about Cautions and Warnings

The information in a caution or a warning is provided for your protection. Please read each caution and warning carefully.

CAUTION

This EVM contains components that can potentially be damaged by electrostatic discharge (ESD). Always transport and store the EVM in its supplied ESD bag when not in use. Handle while using an antistatic wristband. Operate on an antistatic work surface. For more information on proper handling, see the *Electrostatic Discharge (ESD)* application note (SSYA008).

1.2 Items Required for Operation

The following items are required to use the TSU6721EVM:
- TSU6721EVM
- TSU6721 datasheet (SCDS338) from www.ti.com
- Two power supplies for VBAT and VDDIO
  - 3.3 V at 100 mA recommended for each

1.3 Items Recommended for Operation

The following items are recommended for use with the TSU6721EVM:
- MSP430™ LaunchPad™
  - Recommended rev 1.5
  - MSP430G2553 installed
- USB standard-A to mini-B cable
- Computer running Microsoft® Windows® 7 with 2 available USB ports
- TSU6721EVM software, available from the TSU6721EVM webpage

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2   Introduction

The TSU6721EVM can be used as a standalone board or paired with the MSP-EXP430G2 LaunchPad to facilitate power and I²C communication. When paired with the LaunchPad, The TSU6721EVM graphical user interface (GUI) can be used to read from or write to internal registers of the TSU6721 micro-USB switch, allowing the user to observe or control the switching of the device through I²C.

Table 1. Device and Package Configurations

MICRO-USB Switch	IC	Package
U1	TSU6721YFFR	DSBGA-32
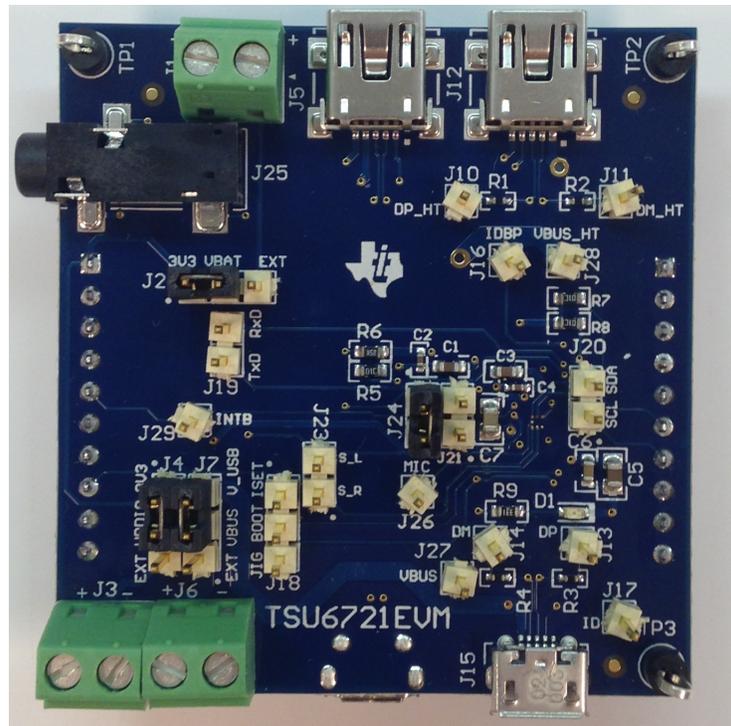
Figure 1. TSU6721EVM

3   Setup

This section describes the header and jumper connections on the TSU6721EVM, installation of the firmware on the MSP430 LaunchPad, installation of the software (GUI) on the computer, and getting started using the TSU6721EVM.

3.1   Header and Jumper Connection Descriptions

3.1.1   J2, J4, and J7: Power Input Selectors

Header J2 allows VBAT input from the LaunchPad or external supply. The range is 3 V to 4.4 V.

Header J4 allows VDDIO input from the LaunchPad or external supply. The range is 1.65 V to 3.6 V.

Header J7 allows VBUS input from an external supply or input from micro-USB connector J15 (V_USB). The range is 4 V to 6.5 V.

3.1.2   J1, J3, and J6: External Power Inputs

Terminal J1 is the external supply connector for J2.

Terminal J3 is the external supply connector for J4.

Terminal J6 is the external supply connector for J7.

3.1.3 J8 and J9: MSP430 LaunchPad Interface Headers

Headers J8 and J9 are the connectors for the MSP430 LaunchPad to the TSU6721EVM.

3.1.4 J12 and J15: USB Device Path

Connector J12 is a mini-USB connector at the output of the TSU6721.

Connector J15 is a micro-USB connector at the input of the TSU6721.

3.1.5 J5 and J22: USB Through-Path

Connectors J5 and J22 are wired as a short-circuit for through-path evaluation.

3.1.6 J13, J14, J17, and J27: USB Connector-Side Test Points

Test point J13 is for the DP pin/lines.

Test point J14 is for the DM pin/lines.

Test point J17 is for the ID pin/lines.

Test point J27 is for the VBUS pin/lines.

3.1.7 J10, J11, J16, and J28: USB Host-Side Test Points

Test point J10 is for the DP_HT pin/lines.

Test point J11 is for the DM_HT pin/lines.

Test point J16 is for the IDBP pin/lines.

Test point J28 is for the OUT pin/lines (indicated as VBUS_HT on the board).

3.1.8 J19, J23, and J26: Non-USB Host-Side Output Test Points

Test point J19 is for the TxD and RxD (UART) pin/lines.

Test point J23 is for the S_L and S_R (Audio) pin/lines.

Test point J17 is for the MIC output pin/lines.

3.1.9 J21 and J24: VBUS OUT Path Jumpers

Header J21 connects the TSU6721's OUT pin to VBUS_HT on the board.

Header J24 connects the TSU6721's OUT pin to a green LED.

3.1.10 J20: I²C Interface

Header J20 is for the SDA and SCL I2C lines. They can be used to probe I2C communications between the TSU6721 and the LaunchPad, or they can be used as I2C inputs/outputs when the LaunchPad is not present.

3.1.11 J18 and J29: Hardware Interface Output Test Points

Header J18 is for the JIG, BOOT, and ISET hardware outputs.

Test point J29 is for the INTB interrupt output.

3.2   *LaunchPad Hardware and Firmware Setup*

If using the TSU6721EVM GUI, the MSP430 LaunchPad board must be configured properly in order to flash the processor with the TSU6721EVM firmware. The following steps are provided to use the TSU6721EVM in conjunction with the LaunchPad.

1. With the LaunchPad unplugged, configure the headers on the LaunchPad to be in HW UART mode by attaching jumpers on the headers indicated by the yellow boxes in Figure 2:


Figure 2. Proper Jumper Configuration on the LaunchPad

2. Place the TSU6721EVM on top of the LaunchPad (see Figure 3) so that all connectors on J1 and J2 of the LaunchPad are inserted into J8 and J9 of the TSU6721EVM and the mini-USB connectors on both boards are facing the same direction.
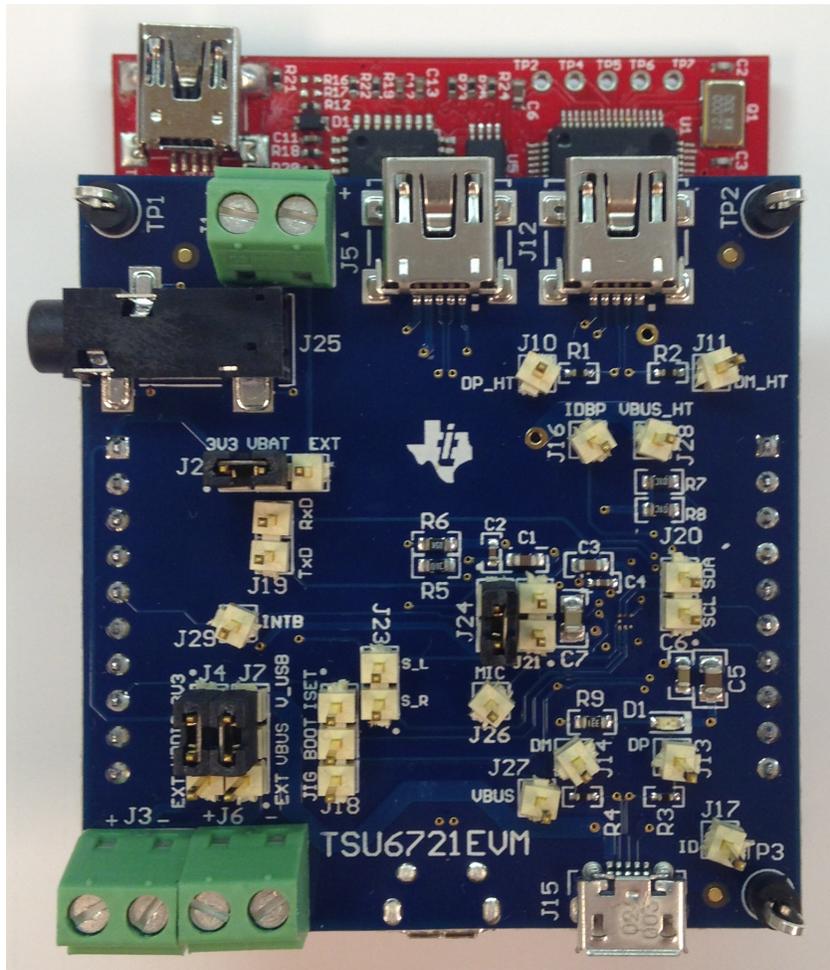
Figure 3. Proper Orientation for the TSU6721EVM on the LaunchPad.

3. The following jumper configurations on the TSU6721EVM are required for power to be supplied from the LaunchPad:

   (a) J2: 3V3 to VBAT

   (b) J4: 3V3 to VDDIO

4. Download the firmware (for the MSP430) and graphical user interface (GUI) software in a zipped folder located on the TSU6721EVM webpage on www.ti.com.

5. Extract the zip folder.
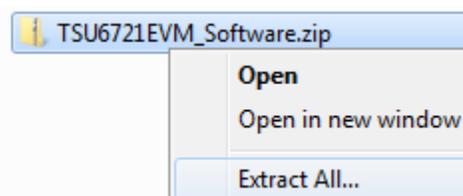
6. Plug the MSP430 LaunchPad into the computer.

setup

www.ti.com
Setup

7. Open the *Device Manager* by typing "devmgmt.msc" into the Start Menu and pressing ENTER.
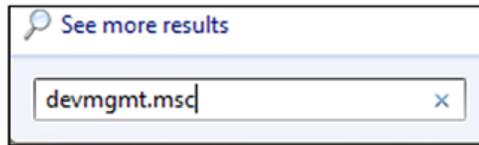
8. Select the MSP430 Application, right click → Properties, and click *Update Driver Software....* The MSP430 Application may appear either in *Ports* or *Other Devices*.
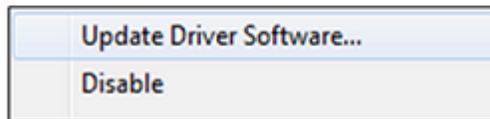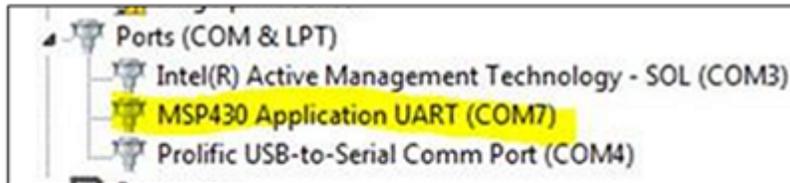
9. Select the *Browse...* button in the *Browse my computer for driver software* dialog box.
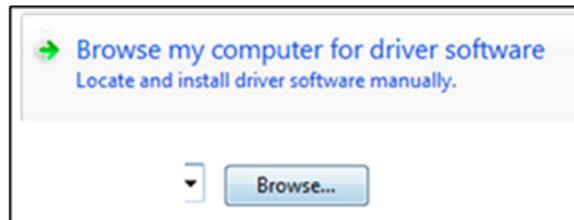
10. Select the folder where you extracted TSU6721EVM_Software.zip
11. Click the *Next* button. Click *Close* after you see the following image:
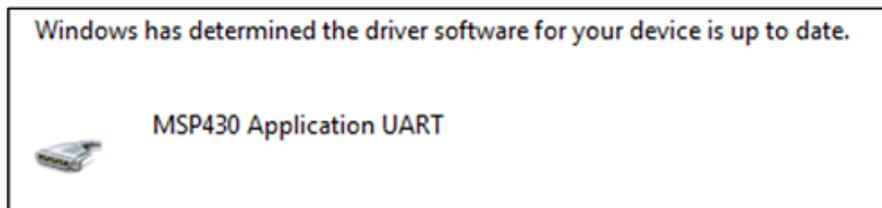
12. Flash the MSP430 by double-clicking *TSU6721_Flasher.bat* in the *TSU6721EVM LaunchPad files* folder where you extracted TSU6721EVM_Software.zip.

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7
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13. Verify that the command window says *no errors*, the device has been recognized as the MSP430G2, and TSU6721.txt has been programmed into the MSP430, as seen in the following image. A successful flash of the firmware results in the following command line prompt:

14. Close the window by pressing any key.

3.3 GUI Software Setup

1. Run *setup.exe* located in the TSU6721_GUI folder. From now on, the TSU6721 software is available under the Start menu in Programs → Texas Instruments, Inc → TSU6721.exe.

2. If the GUI does not launch automatically, run the installed *TSU6721-EVM GUI* program from the Start Menu.

3. The GUI looks like Figure 4 when it is opened and the LaunchPad is connected:

Figure 4. TSU6721EVM GUI Without LaunchPad

3.4 Getting Started Using the TSU6721 Micro-USB Switch EVM

3.4.1 Evaluating the TSU6721EVM without the GUI

1. The TSU6721EVM can be powered with or without the LaunchPad. If you have a LaunchPad available and have completed steps 1–3 in Section 3.2, continue to step 2. If you do not have a LaunchPad, attach the jumper on J2 from VBAT to EXT, and attach jumper on J4 to VDDIO to EXT. Next, apply 3 V to 4.4 V on J1 and apply 1.65 V to 3.6 V on J3.

2. Connect a 150-kΩ resistor between ID (J17) and GND (TP1, TP2, or TP3). By default, the TSU6721 closes the appropriate switches as specified in Table 2 of the TSU6721 (SCDS338) datasheet.

3. While referencing the on-resistance values for each signal path in the TSU6721 datasheet, measure the following resistance values to verify that the switches have been closed:
   (a) DM (J14) to TxD (J19)
   (b) DP (J13) to RxD (J19)

4. Remove the 150-kΩ resistor.

5. Attach a micro-USB cable from the PC to J15 on the TSU6721EVM. As most PCs are considered USB Standard Downstream Port (SDP) or Charging Downstream Port (CDP) chargers, the TSU6721 closes the appropriate switches as specified in Table 4 on the TSU6721 datasheet.

6. While referencing the on-resistance values for each signal path in the TSU6721 datasheet, measure the following resistance values to verify that the switches have been closed:
   (a) DM (J14) to DM_HT (J11)
   (b) DP (J13) to DP_HT (J10)

7. Remove the micro-USB cable from the PC.

8. Choose any desired charger type or ID resistor specified in either **Table 2** or **Table 4** of the TSU6721 datasheet to observe the behavior of the TSU6721 switch. The datasheet describes the switch behavior for each condition.

9. The user may develop software that uses I²C to communicate with the internal registers of the TSU6721. See *Standard I²C Interface Details* on page 18 of the TSU6721 datasheet.

3.4.2 Evaluating the TSU6721EVM with the GUI

1. After completing the steps in Section 3.2 and Section 3.3, launch the TSU6721EVM software. The screen looks like Figure 5:

Figure 5. TSU6721EVM GUI After Connecting the LaunchPad to the Computer

2. Connect a 150-kΩ resistor between ID (J17) and GND (TP1, TP2, or TP3). The TSU6721 closes the appropriate switches as specified in Table 2 of the TSU6721 datasheet. The ATTACH interrupt will go high until its register is read.

3. The GUI looks like Figure 6. Notice the change in ADC[4] through ADC[0] in register 0x07, as well as the *UART* bit going high in register 0x0A.

Figure 6. TSU6721EVM GUI Showing ID Detection of a UART Cable

4. Remove the 150-kΩ resistor.
5. Attach a micro-USB cable from the PC to J15 on the TSU6721EVM. As most PCs are considered USB Standard Downstream Port (SDP) or Charging Downstream Port (CDP) chargers, the TSU6721 closes the appropriate switches as specified in Table 4 on the TSU6721 datasheet.

6. Click *Read All*. When the micro-USB cable is attached to the PC, the GUI looks like Figure 7. Notice the change in register 0x0A, where the SDP bit has gone high after detection.

Figure 7. TSU6721EVM GUI Showing SDP Charger Detection

7. Disconnect the micro-USB cable from the PC.

8. The TSU6721EVM GUI can write to each register specified as *Read/Write* in the TSU6721 datasheet. Click on register 0x02, bit 2 (Manual SW). The box turns grey, which means that 0x02 bit 2 has been set to 0.

Figure 8. TSU6721EVM GUI Showing Manual Switching Mode

According to page 23 of the TSU6721 datasheet, the TSU6721 is now in manual switching mode.

Attach VBUS or a valid ID resistance to the TSU6721EVM. The attachment will not determine the switch status, but it will ensure that the TSU6721 does not enter sleep mode, allowing manual switching to work properly.

9. Connect an ohmmeter between DM (J14) and DM_HT (J11), and connect another ohmmeter between DP (J13) and DP_HT (J10).

10. On register 0x13, click *DM SW[0]* and *DP SW[0]* (bits 5 and 2). Figure 9 shows that they turn yellow, indicating they have been set to 1.

Figure 9. TSU6721EVM GUI Showing Manually Closed DM and DP Switches

11. According to page 29 of the TSU6721 datasheet, DP has been connected to DP_HT and DM has been connected to DM_HT:

While referencing to the specified on-resistance values for each signal path in the TSU6721 datasheet, measure the following resistance values to verify that the switches have been closed:

(a) DM (J14) to DM_HT (J11)

(b) DP (J13) to DP_HT (J10)

4   Schematic

[Figure 10](#) shows the schematic for the TSU6721EVM.
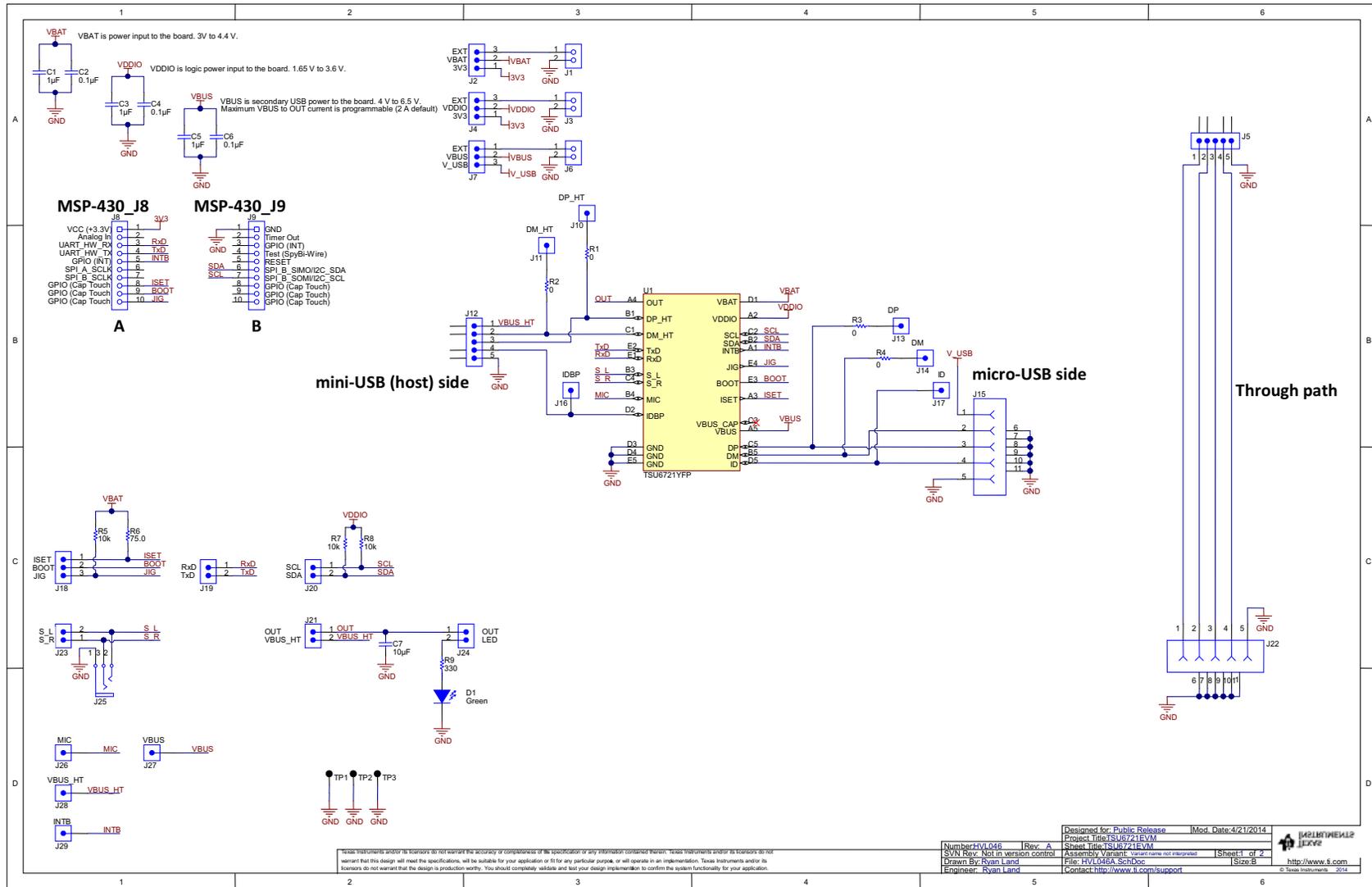
Figure 10. TSU6721EVM Schematic

5 Board Layout

Figure 11 through Figure 14 illustrate the PCB layout drawings for this EVM.
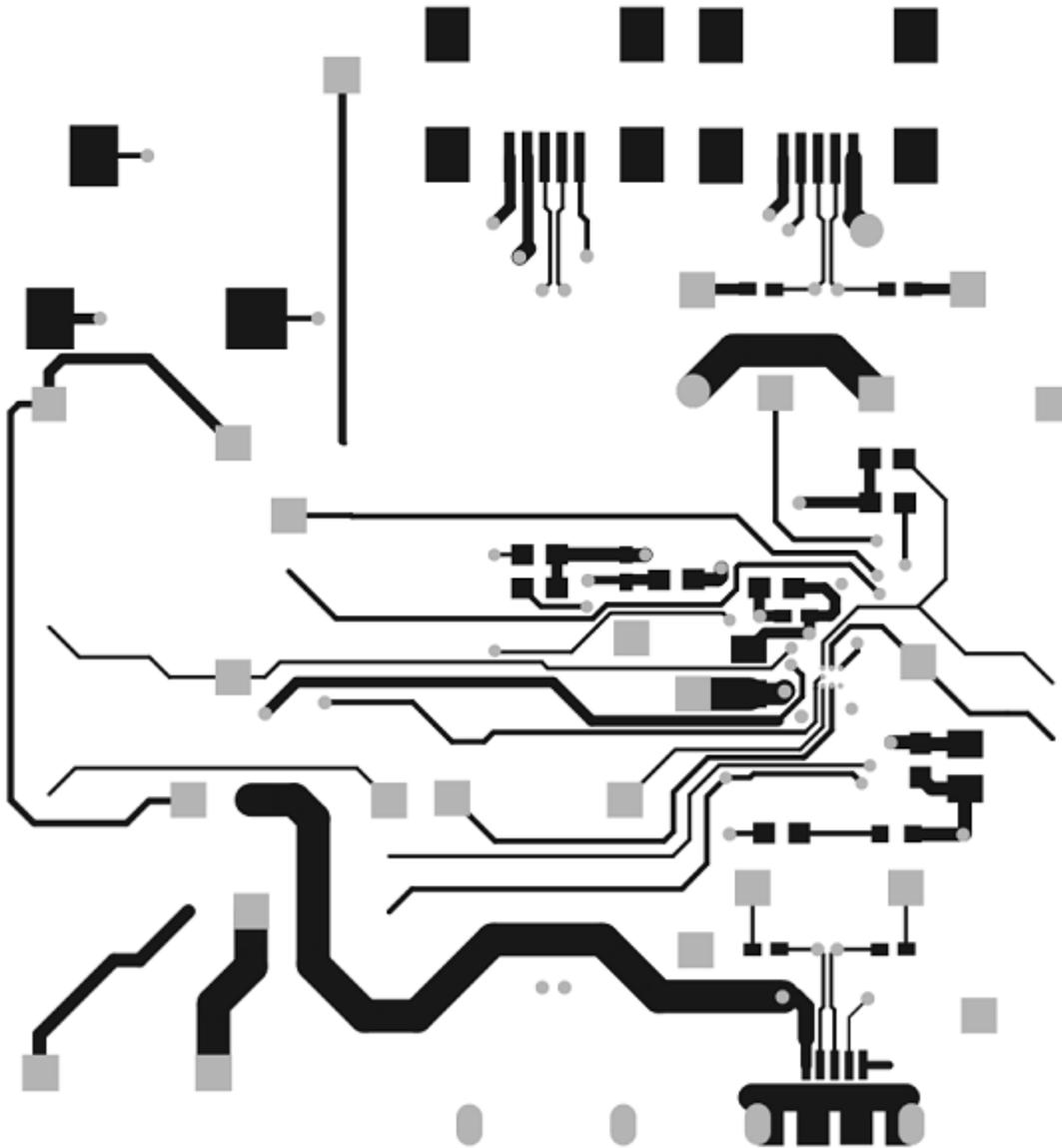
Figure 11. PCB Layer 1 (Top Layer)
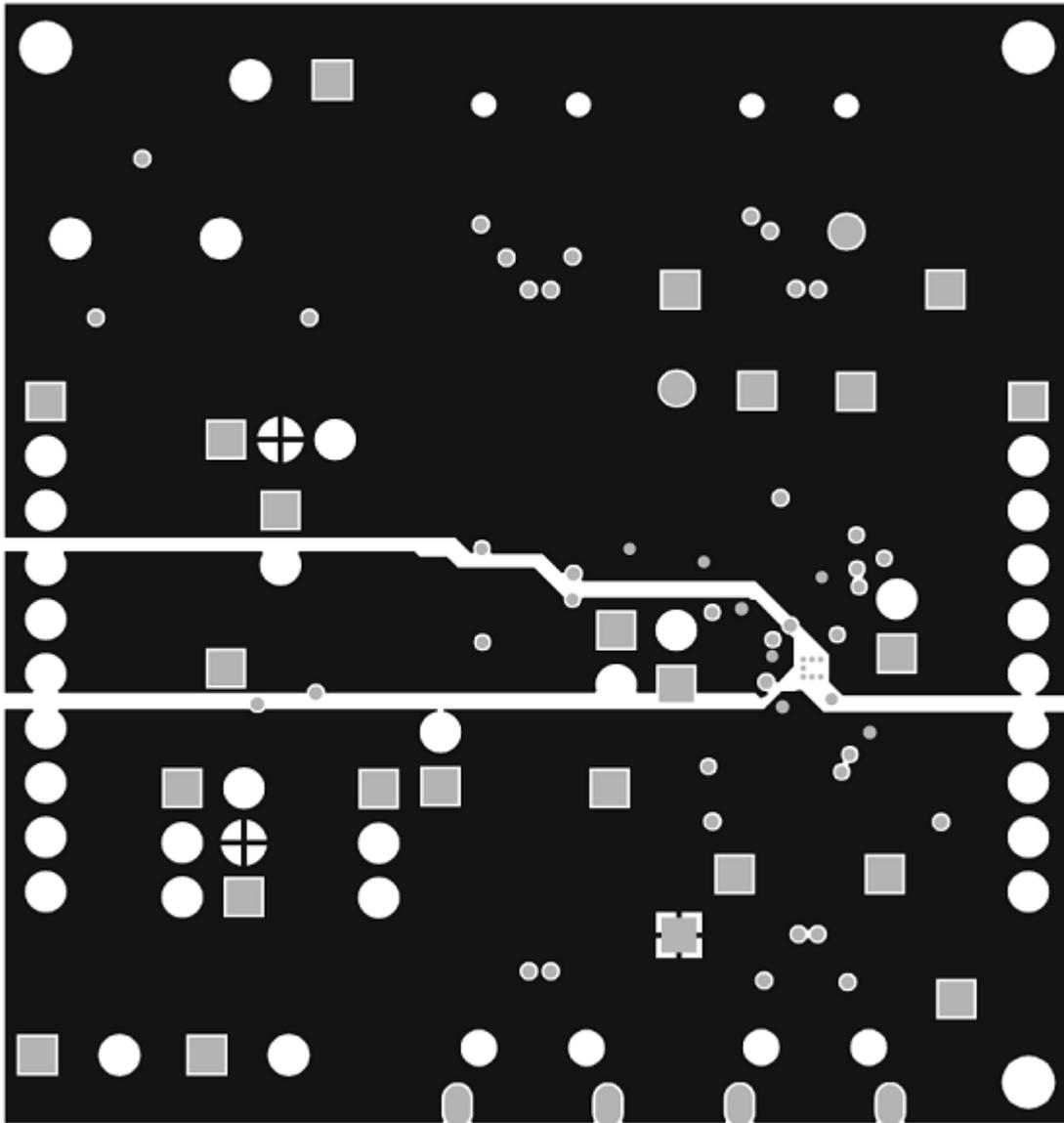
Figure 12. PCB Layer 2 (VBUS)
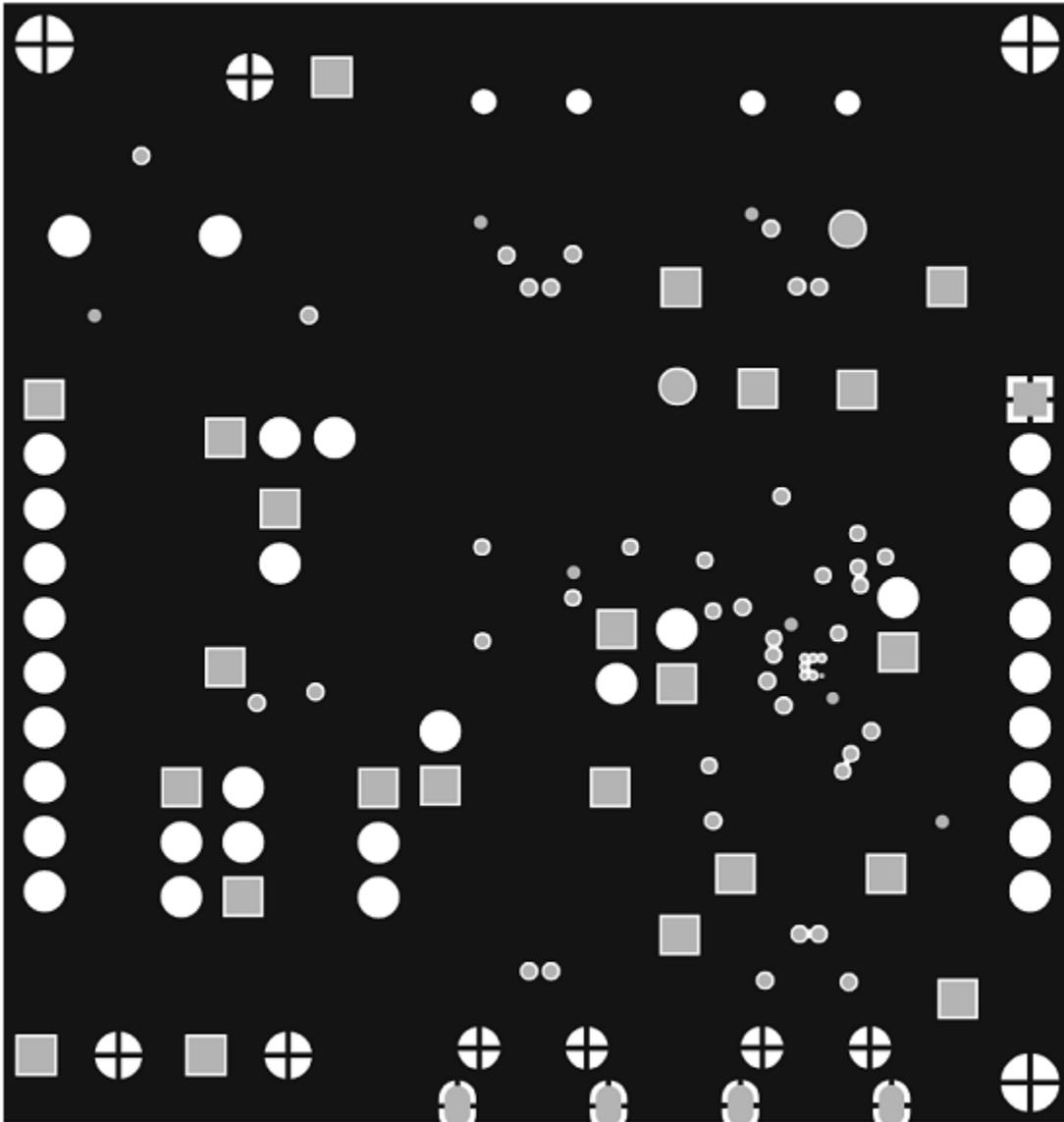
Figure 13. PCB Layer 3 (GND)
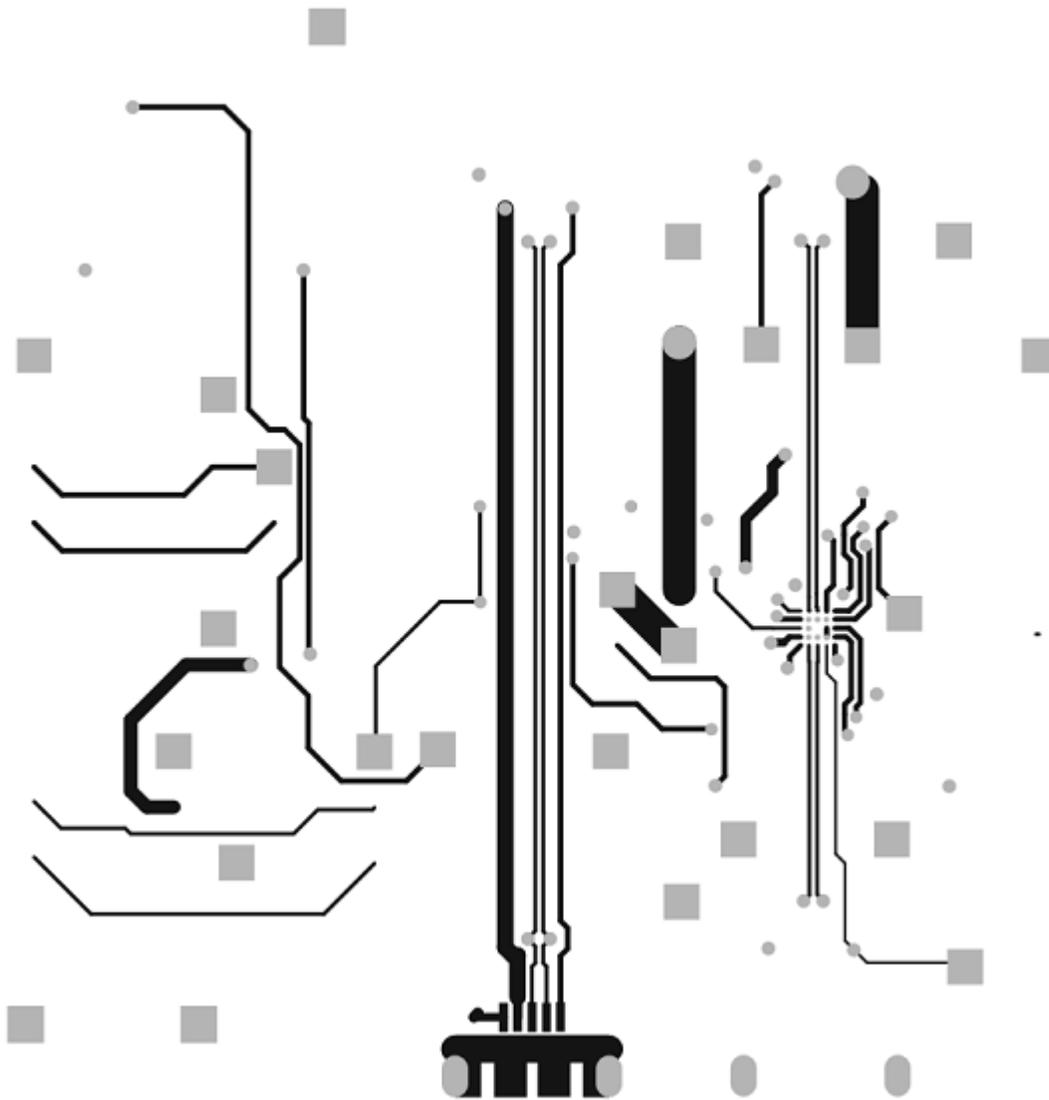
Figure 14. PCB Layer 4 (Bottom layer)

6 Bill of Materials

Table 2 lists the BOM for the TSU6721EVM.

Table 2. TSU6721EVM Bill of Materials

Designator	Qty.	Value	Description	Package Reference	Part Number	Manufacturer
PCB1	1		Printed Circuit Board		HVL046	Any
C1, C3	2	1uF	CAP, CERM, 1µF, 16V, ±10%, X5R, 0603	603	GRM188R61C105KA93D	Murata
C2, C4	2	0.1uF	CAP, CERM, 0.1µF, 16V, ±10%, X7R, 0402	402	GRM155R71C104KA88D	Murata
C5	1	1uF	CAP, CERM, 1µF, 50V, ±10%, X7R, 0805	805	GRM21BR71H105KA12L	Murata
C6	1	0.1uF	CAP, CERM, 0.1µF, 100V, ±10%, X7R, 0603	603	GRM188R72A104KA35D	Murata
C7	1	10uF	CAP, CERM, 10µF, 16V, ±10%, X5R, 0805	805	GRM21BR61C106KE15L	Murata
D1	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
J1, J3, J6	3	2x1	Conn Term Block, 2POS, 3.81mm, TH	PhoenixConact_1727010	1727010	Phoenix Contact
J2, J4, J7, J18	4		Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	TSW-103-07-G-S	TSW-103-07-G-S	Samtec, Inc.
J5, J12	2		Conn Rcpt Mini USB2.0 Type B 5POS SMD	USB Mini Type B	1734035-2	TE Connectivity
J8, J9	2		Receptacle 100mil 10x1, Tin, TH	Receptacle, 10x1, 100mil, Tin	PPTC101LFBN-RC	Sullins Connector Solutions
J10, J11, J13, J14, J16, J17, J26–J29	10		Header, TH, 100mil, 1pos, Gold plated, 230 mil above insulator	Testpoint	TSW-101-07-G-S	Samtec, Inc.
J15, J22	2		Receptacle, Micro-USB-B, Right Angle, SMD		105017-0001	Molex
J19–J21, J23, J24	5		Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	TSW-102-07-G-S	Samtec, Inc.
J25	1		Connector, Audio Jack, 3.5mm, Stereo, SMD	Audio Jack SMD	SJ-3523-SMT	CUI Inc.
R1–R4	4	0	RES, 0 Ω, 5%, 0.063W, 0402	402	CRCW04020000Z0ED	Vishay-Dale
R5, R7, R8	3	10k	RES, 10 kΩ, 5%, 0.1W, 0603	603	CRCW060310K0JNEA	Vishay-Dale
R6	1	75	RES, 75.0 Ω, 1%, 0.1W, 0603	603	CRCW060375R0FKEA	Vishay-Dale
R9	1	330	RES, 330 Ω, 5%, 0.1W, 0603	603	CRCW0603330RJNEA	Vishay-Dale
SH-J1–SH-J4	4	1x2	Shunt, 100 mil, Gold plated, Black	Shunt	969102-0000-DA	3M
TP1–TP3	3	Black	Test Point, TH, Multipurpose, Black	Keystone5011	5011	Keystone
U1	1		MCPC Compatible USB Port Multimedia Switch Supports USB, UART, Audio, ID, MIC, and Load Switch, custom YFP0025	YFP0025_TSU2721	TSU6721YFP	Texas Instruments
FID1–FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A

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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 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 its own expense.

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- 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.

Industry Canada Compliance (English)

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.

Canada Industry Canada Compliance (French)

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 Considered "Radio Frequency Products" in Japan

EVMs entering Japan are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If user uses EVMs in Japan, user is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs 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 EVMs only after user obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after user obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless user gives the same notice above to the transferee. Please note that if user does not follow the instructions above, user will be subject to penalties of Radio Law of Japan.

http://www.tij.co.jp

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IMPORTANT NOTICE

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