TS3A227E EVM User's Guide

This document is the EVM user guide for the TS3A227E-EVM which provides an easy evaluation of TI's autonomous audio jack switch with integrated key-press detection and power off noise removal.

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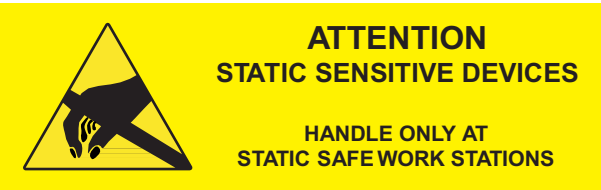
1 About this Manual

This user's guide describes the TS3A227E evaluation module (EVM) and its intended use. This guide contains the EVM schematics, bill of materials, and board layer information.

2 Information About Cautions and Warnings

The information in a caution or a warning is provided for personal protection. Read each caution and warning carefully.



CAUTION

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

3 Introduction

The TS3A227E-EVM is an evaluation module for TI's autonomous audio jack switch with integrated key-press detection and power off noise removal. Designed to interact with the audio jack, the device automatically detects the presence of 3- or 4-pole audio accessories and also features an integrated switch matrix for automatic routing of the MICBIAS, codec ground sense, and ground connections.

The device also incorporates a high-resolution ADC for distinguishing from up to four keys in the default mode. Additionally, the TS3A227E features the ability for on-the-fly key-press bin adjustment and a raw ADC output mode to add the ability for the system to define non-standard key-press bins, as desired.

The evaluation board is designed both as a demonstration and development board by using the MSP430 LaunchPad™ as a base platform for interacting with the device. There is an example firmware stack and GUI provided with the EVM. Figure 1 is a block diagram of the EVM structure.

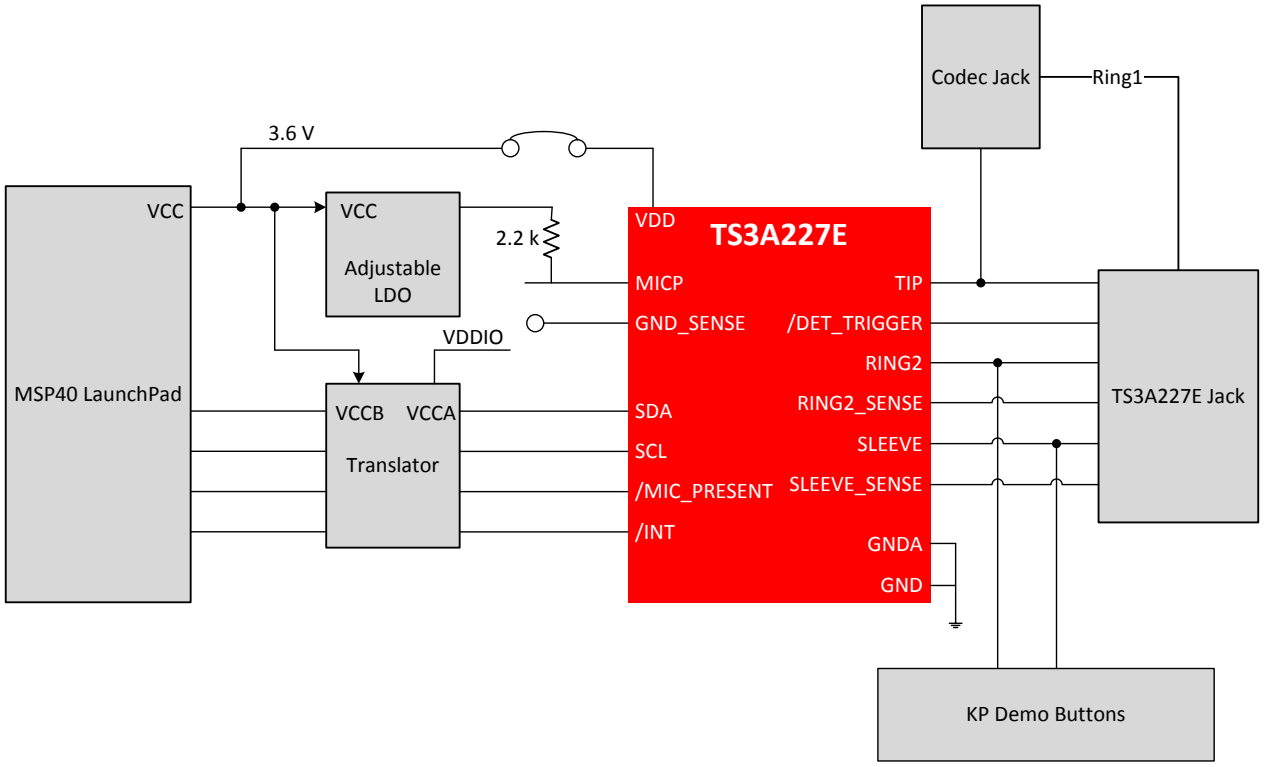


Figure 1. TS3A227E-EVM Block Diagram

3.1 Hardware Items for Operation

The following items are required for EVM evaluation:

- TS3A227E-EVM
- MSP-EXP430G2 LaunchPad Rev 1.5
- MSP430G2553
- USB cable

The following items are optional for EVM evaluation:

- 4-pole headset
- 3-pole headset
- Code Composer Studio™ (CCS)
- Visual Studio 2012

4 TS3A227E-EVM Connections Overview

This section contains information about TS3A227E-EVM design under test, power, test points, translator, on-board MICBIAS output, key-press matrix, and external codec interface.

4.1 TS3A227E Design Under Test (DUT)

The TS3A227E audio lines are connected to audio jack J4. Plug a headset into audio jack J4 for testing. The audio jack used on the EVM is normally a closed jack that has the wrong transition polarity for an insertion event (low to high). The $\overline{\text{DET\_TRIGGER}}$ pin has an internal 1-MΩ resistor and Q1 is used to invert the polarity of the insertion event and create a high-to-low transition.

The supply voltage for the TS3A227E is VDD and the digital IO lines are pulled up to VDDIO.

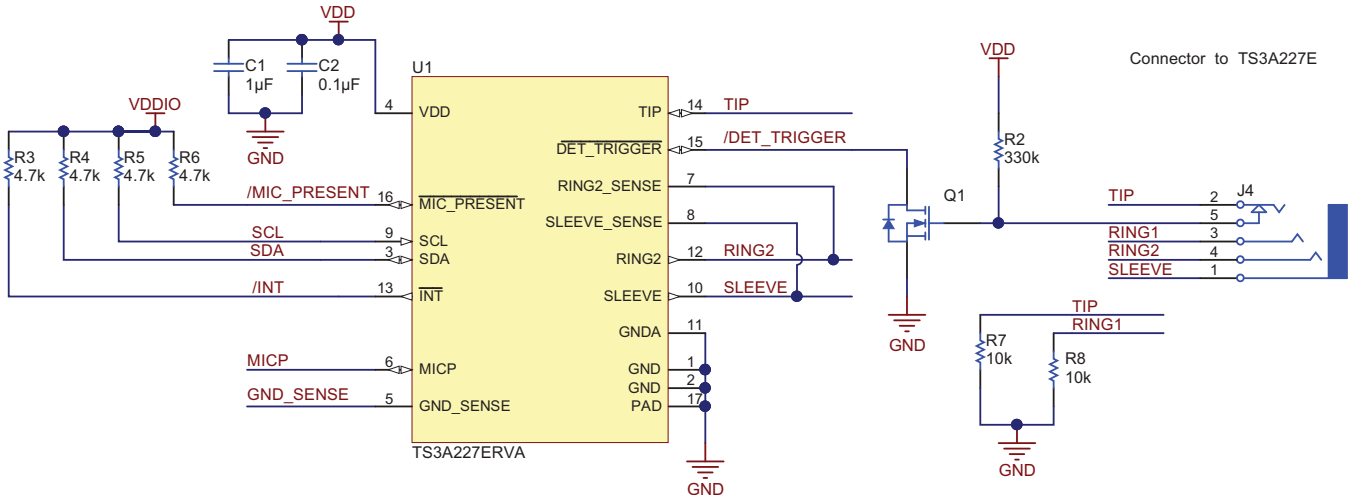


Figure 2. Connector to TS3A227E

4.2 Power

The TS3A227E-EVM derives its power from the LaunchPad. The EVM board power is labeled VCC in the schematic and the power supplied to the TS3A227E is labeled VDD. Header connection explanations follow:

- Header J1 provides a point to check VCC or to provide the board power if the LaunchPad is not being used.
- Header J2 provides a means to power the TS3A227E from the board power. Populate this jumper to connect VDD to VCC. If external power is being applied to the TS3A227E, remove this jumper.
- The blue diode D1 lights up when board power is applied.
- J3 selects the digital IO pull-up voltage. By shorting pins 1 and 2, the digital IO lines are pulled up to the board supply voltage. Shorting pins 2 and 3 allows an external pull-up voltage to be used (such as 1.8 V) from J5.
- J5 provides a connection for supplying an external IO voltage.

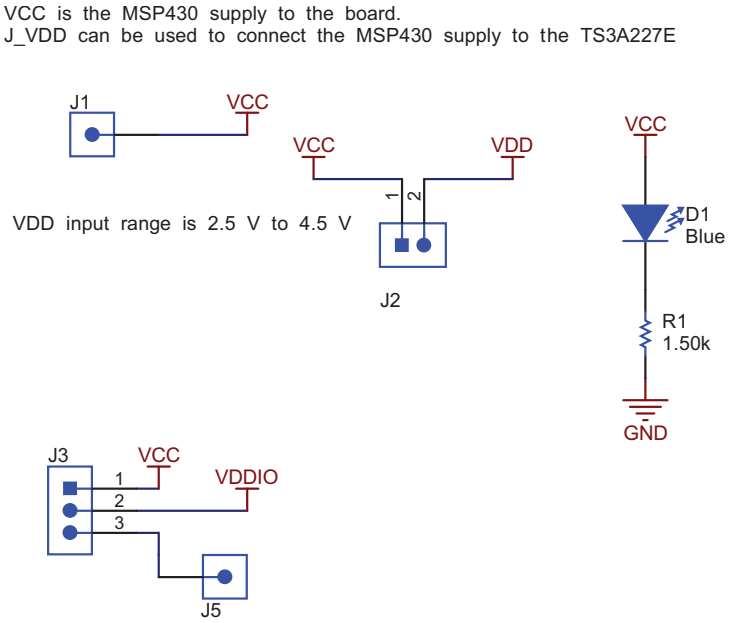


Figure 3. Power Connections

4.3 Test Points

The headers in Figure 4 provide breakout test points on the EVM for connecting to external hosts and systems.

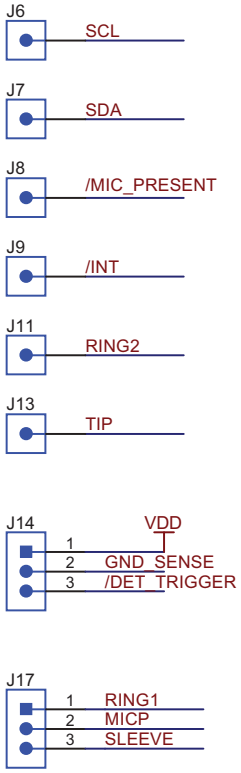


Figure 4. Breakout Test Point Headers

4.4 Translator

Because the TS3A227E VDDIO supply can vary from 1.8 V to 4.5 V, a translator is needed to translate the VDDIO voltage domain to the LaunchPad 3.6-V domain. U3 provides this functionality.

If the LaunchPad is not used, remove the jumpers on J27.

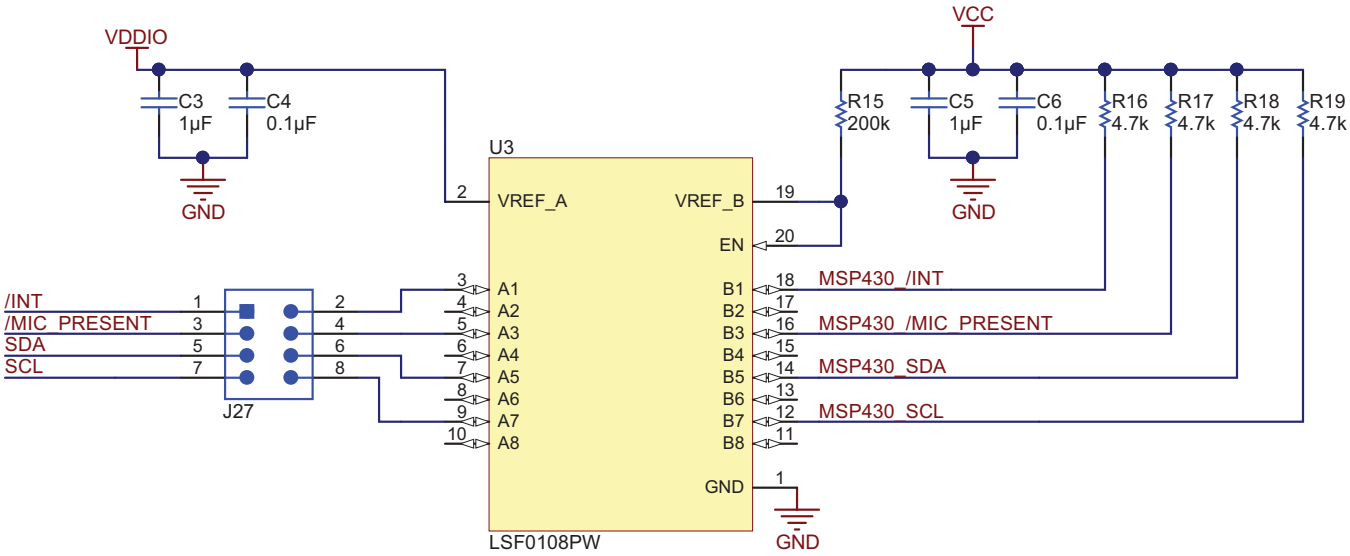


Figure 5. Translator

4.5 On-Board MICBIAS Output

U2 provides the following MICBIAS outputs by moving the jumper position on J22 and shorting different sets of pins. The EVM also has a spare 0603 resistor and jumper position if a different MICBIAS voltage is desired.

- Pins 7–8 → 2.2 V
- Pins 5–6 → 2.5 V
- Pins 3–4 → 2.8 V
- Pins 1–2 → user-populated resistor

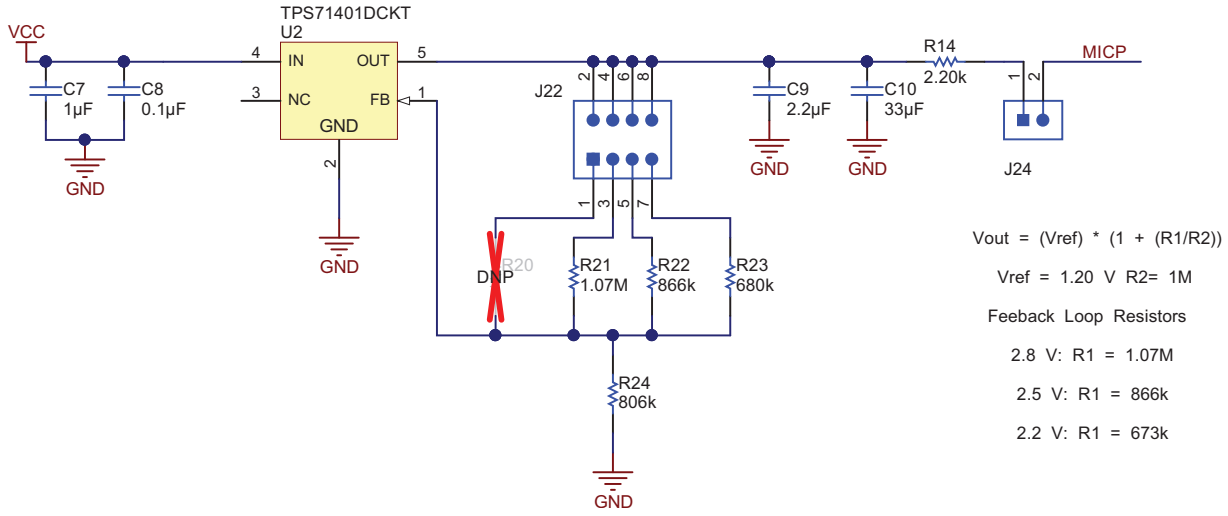


Figure 6. On-Board MICBIAS Output

4.6 Key-Press Matrix

The TS3A227E EVM features on-board keys for quick evaluation of the key press functionality. Setting up the EVM for key press is discussed in Section 7.3.1. By placing a jumper on both headers J15 and J20, the matrix is attached to the TS3A227E SLEEVE and RING2 pins allowing the keys to be used.

The on-board microphone is used to simulate a headset microphone in parallel with the keys and can be disconnected by removing the jumper on J16. R9 is not populated to allow for headset manufacturers to develop key resistances that fall accurately into the buckets.

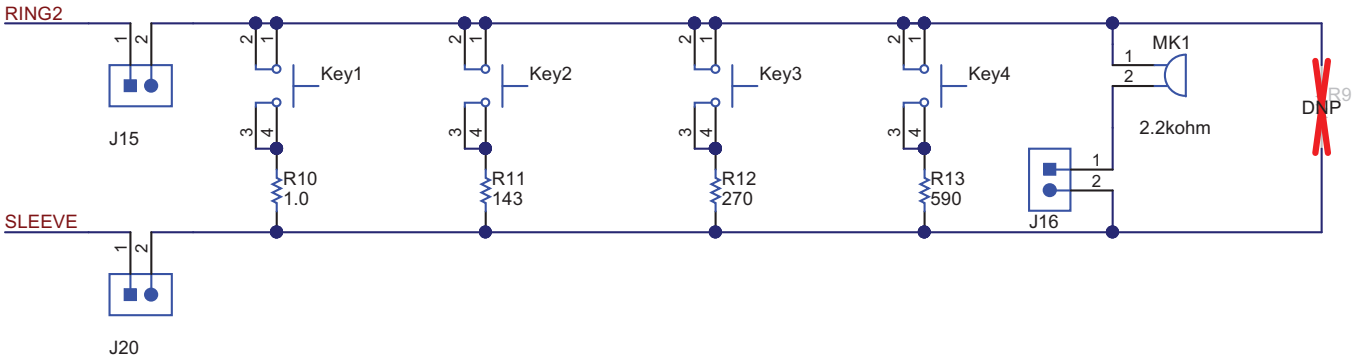


Figure 7. Key Press Schematic

4.7 External CODEC Interface

J10 provides a means to connect an external codec to the TS3A227E-EVM through a 3.5-mm jack. J12 is provided to switch the microphone and ground of the EVM between the SLEEVE and RING2 pins. Shorting pins 1-2 and pins 3-4 connects MICP to RING2 and SLEEVE to ground. Shorting pins 2–4 and 1–3 connects MICP to SLEEVE and RING2 to ground.

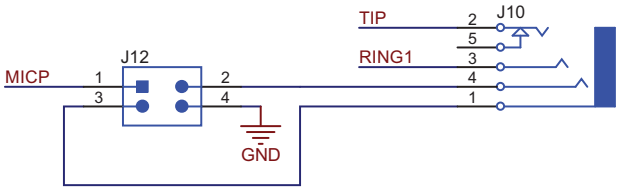


Figure 8. External CODEC Interface

5 LaunchPad Setup

Use the following steps to set up the LaunchPad:

1. With the LaunchPad unplugged, configure the headers on the LaunchPad to match the yellow box in Figure 9.

   The right 3 headers are vertical and the left are horizontal.

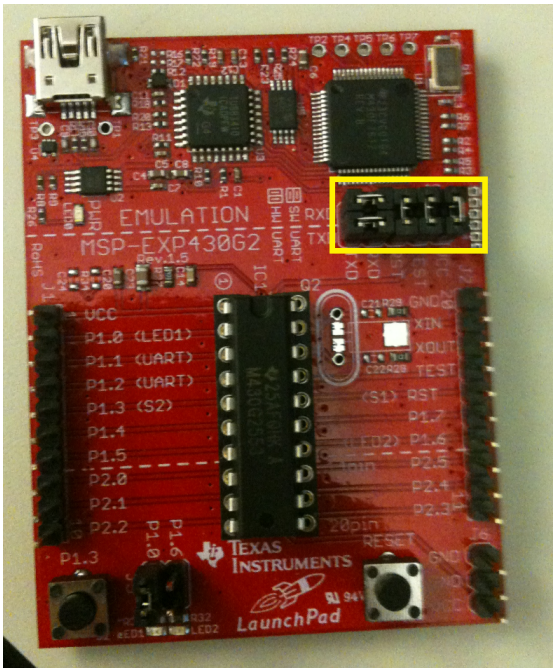


Figure 9. LaunchPad Header Connections

2. With the LaunchPad still unplugged, remove the right-most jumper on the J5 header to match the yellow box in Figure 10.

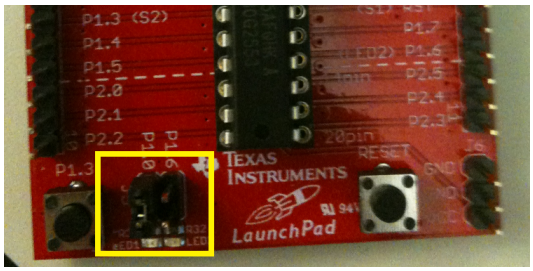


Figure 10. LaunchPad J5 Header Connections

3. Connect the LaunchPad to a computer with a USB-to-mini cable. A green LED and a red LED now turn on as shown in Figure 11.

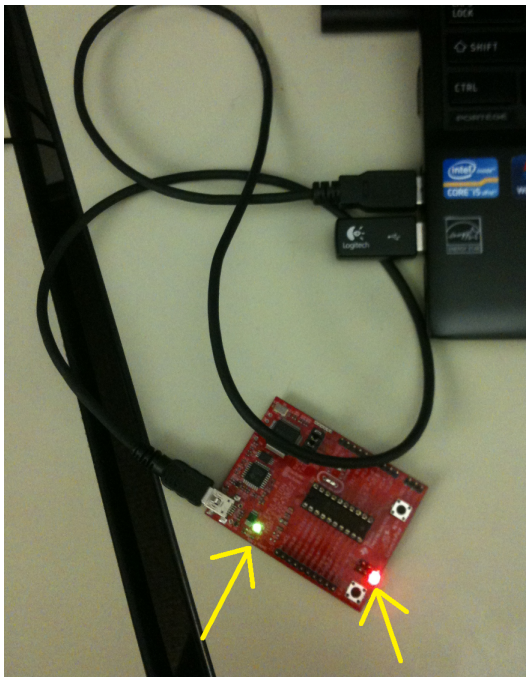


Figure 11. LaunchPad LED Indicators

This is sufficient to setup the LaunchPad to interact with the EVM. If using CCS to do firmware development, continue the following steps:

4. Download Code Composer Studio.
5. Extract the *TS3A227E_GUI_Fimware.zip* to any folder.

   Example: C:\Users*USER*\Documents \TS3A227E
6. Open Code Composer Studio and create a new workspace. Select the *Project* drop-down menu and click on *Import existing CCS/CCE Eclipse Project*. Select *Browse* on the *Select-search directory* option and select the location where the source code is stored. Click the **Finish** button and select **debug launch** to load the code to the MSP430G2553 microcontroller. Once completed, disconnect the USB cable from the LaunchPad.
7. CCS can also be used as a firmware development/experimentation platform and the EVM/GUI will work while using the debugging functionality of Code Composer Studio.
8. If the LaunchPad is running and the TS3A227E-EVM daughter board is disconnected, the I^2C communication fails. Pause the debugger, reset the MSP430, and then rerun the code.

6 Installing the GUI

Install the GUI using the following steps:

1. Extract the *TS3A227E_GUI_Fimware.zip* contents to any destination folder.
2. Double click *setup.exe* located in the /TS3A227E_GUI_Firmware/TS3A227E_GUI folder that was extracted in step 1.
3. The Application Install - Security Warning window pops up. Click the **Install** button.

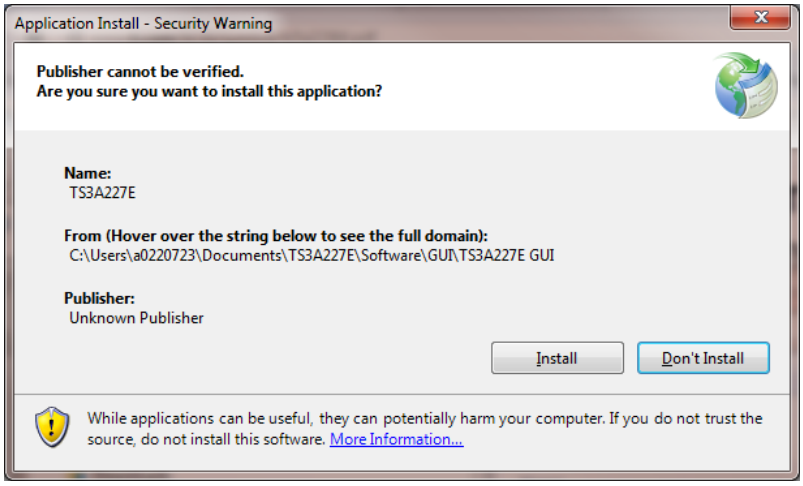


Figure 12. Application Install - Security Warning Window

4. After the installation finishes, the GUI opens. The GUI is illustrated in Figure 13.

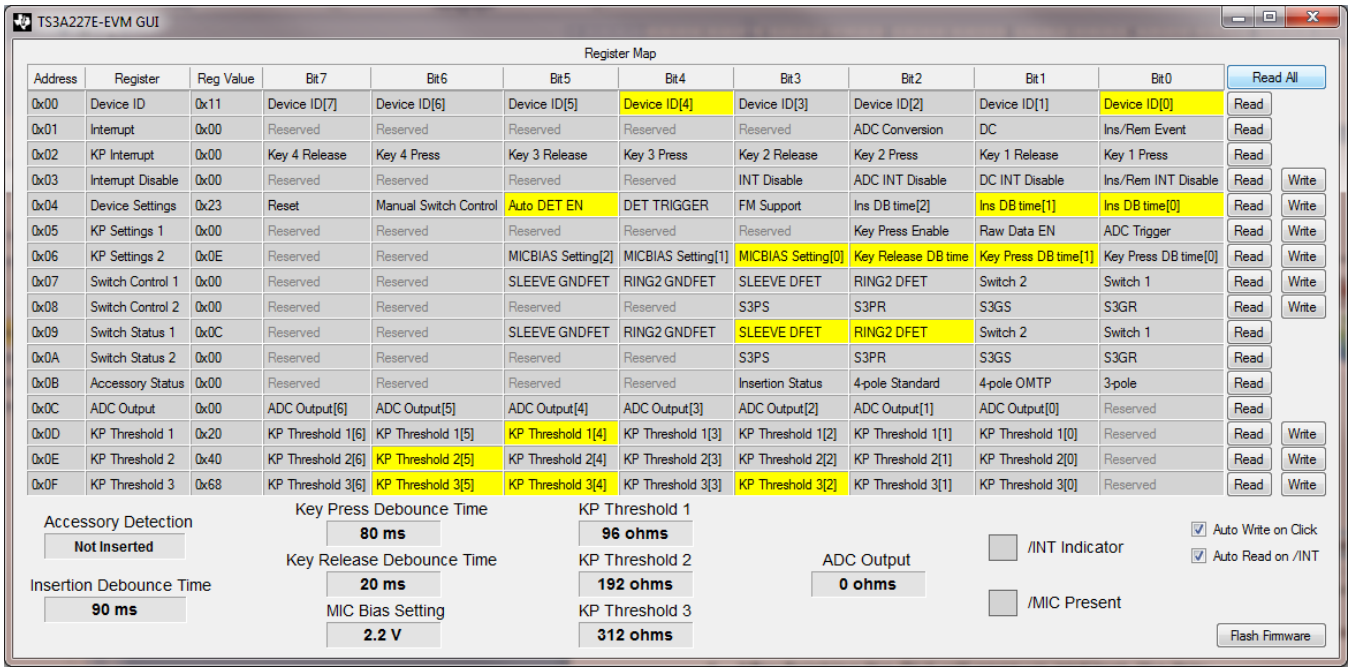


Figure 13. TS3A227E-EVM GUI Window

If the window shown in Figure 14 appears, verify that the EVM is plugged into the PC.

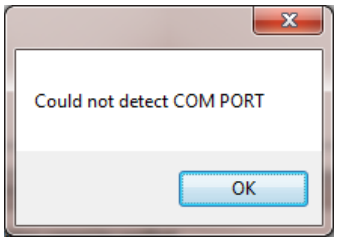


Figure 14. COM PORT Detection Error Window

5. When launching the GUI in the future, open it by double clicking the TS3A227E.application file.

7 Using the GUI

This section includes instructions for connecting the LaunchPad to the EVM and PC, GUI window descriptions, GUI operation, headset development, power off noise removal evaluation, and slow plug-in issues.

7.1 Connecting the LaunchPad to the EVM and PC

Use the following steps to connect the LaunchPad to the EVM and PC.

1. Connect the MSP430 LaunchPad to the EVM as shown in Figure 15. The EVM sits on top of the LaunchPad so there is minimal overlap.

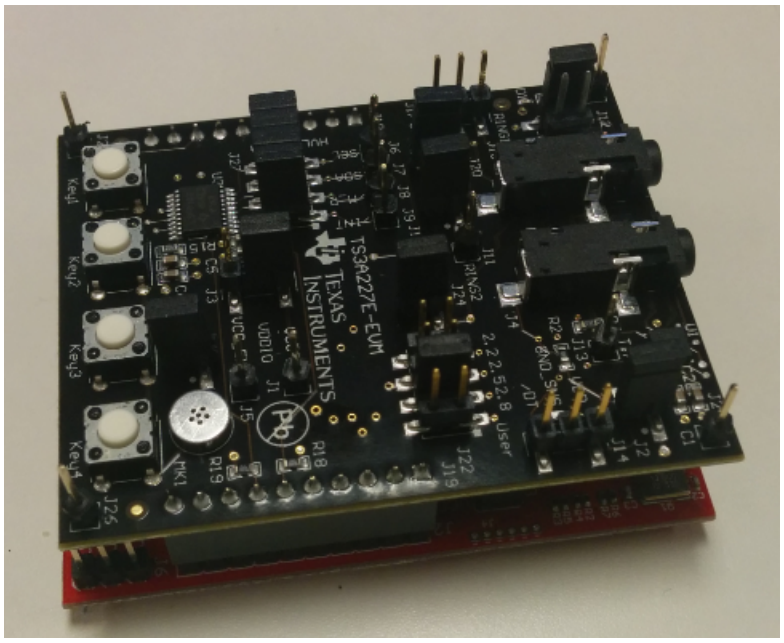


Figure 15. LaunchPad to EVM Connection

2. The jumper locations for default operation are listed in Table 1.

Table 1. Default Jumper Locations

Reference Designator	Jumper Locations
J2	Populated
J3	Pins 1–2
J12	Pins 1–2 Pins 3–4
J15	Not Populated
J16	Populated
J20	Not Populated
J22	Pins 7–8 **only** No jumper on other pins
J24	Populated
J27	Pins 1–2 Pins 3–4 Pins 4–5 Pins 7–8

3. Connect the LaunchPad to the PC. A blue LED now lights up along with the red and green LEDs on the LaunchPad.

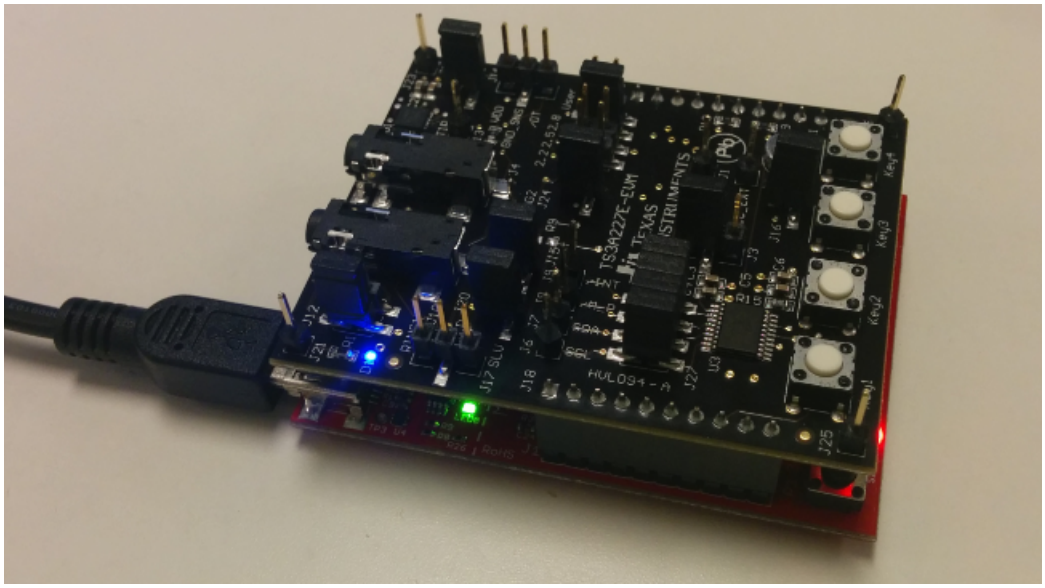


Figure 16. LaunchPad LED Indicators

7.2 GUI Area Descriptions and Use

This section describes the various sections of the GUI. Figure 17 shows the TS3A227E-EVM GUI.

Figure 17. TS3A227E-EVM GUI

- The blue section of the GUI denotes the *Register Address*, *Register Name*, and the current stored *Reg Value* at that register in Hex. These fields cannot be edited and clicking them has no effect.
- The green section of the *Register Map* indicates Read-only registers. These values are only updated with data from the MSP430 LaunchPad
- The red section of the *Register Map* indicates Read/Write registers. Clicking on any bit of these registers not labeled *Reserved* toggles that bit. If *Auto Write on Click* is checked, clicking on a bit also sends a command to the MSP430 to write the value entered to the TS3A227E.
  - For example, if register 0x03 currently has the value 0x01 and bit 1 of that register is clicked, bit 1 toggles from a value of '0' to a new value of '1'. The GUI then sends the new register value of 0x03 to the LaunchPad to write to the TS3A227E.
  - Bits that a colored in yellow are == 1. Bits that are colored gray are == 0.
- The pink section of the GUI denotes the Read/Write buttons.
  - Clicking a **Read** button reads the value of the corresponding register it is adjacent to (for example, clicking the top-most **Read** button reads register 0x01 and updates the GUI contents).
  - Clicking a **Write** button writes the currently shown value for the adjacent register in the GUI to the TS3A227E.
  - Clicking the **Read All** button reads the entire register map and also updates the pin status.

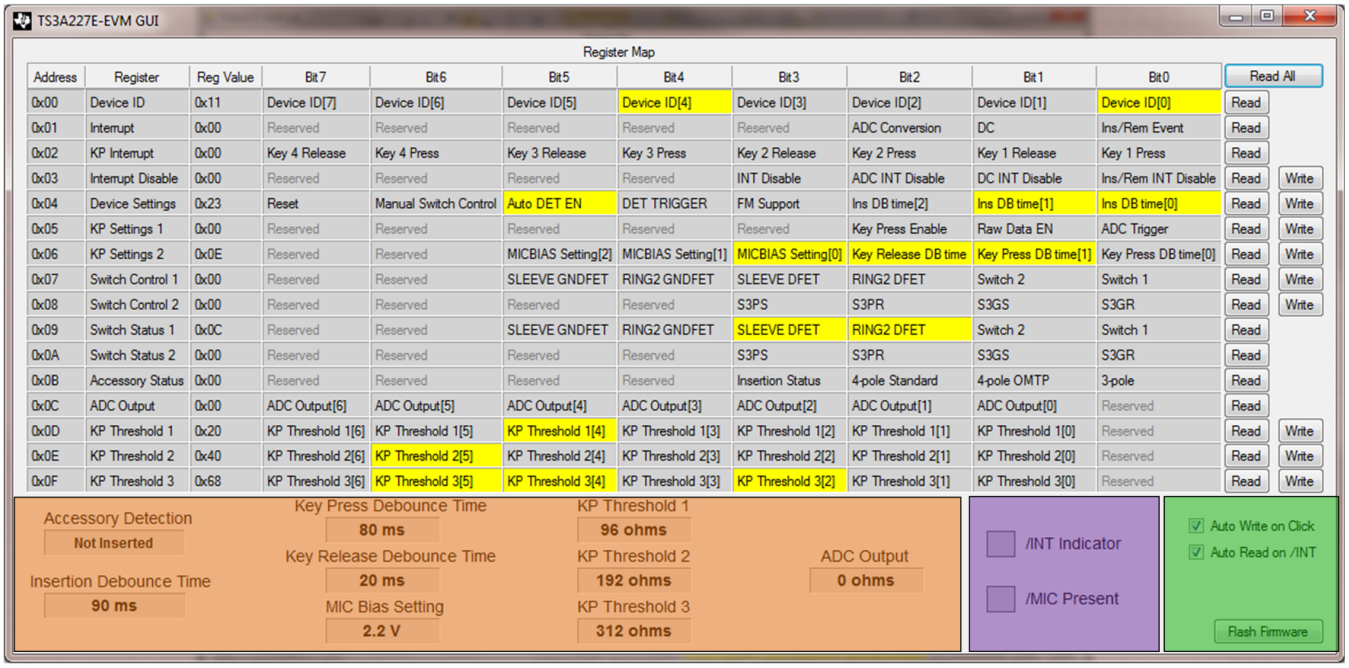


Figure 18. TS3A227E-EVM GUI Details

Figure 18 highlights areas of the EVM GUI that are explained in the following:

- The orange section runs algorithms to determine the real-world values corresponding to the output of the TS3A227E, that is, the *Accessory Detection* box in the top left monitors the *Accessory Type* register (0x08) to determine what is attached.
- The purple section of the GUI denotes the current status of the MSP430 GPIOs, in addition to indicating when a key is pressed:
  - Green indicates an active(true) GPIO
  - Gray indicates an inactive(false) GPIO
- The green section of the GUI are user input controls for the EVM:
  - Un-checking *Auto Write on Click* disables the auto-write feature when a bit is clicked. Use the 5 **Write** buttons to write to the device instead of a simple click of a bit cell.
  - *Auto Read on /INT* controls whether the firmware automatically reads the TS3A227E device registers and sends the values back to the GUI when an *Interrupt* occurs. Unchecking this box makes the firmware only update the GUI that an interrupt has occurred.
  - The **Flash Firmware** button installs the default firmware that comes with the GUI onto the LaunchPad without opening CCS.

7.3 GUI Operation

The GUI automatically searches to see if the LaunchPad is connected upon startup and immediately attempts to read the register values from the LaunchPad. If the message in Figure 19 appears, the GUI was unable to detect the LaunchPad and starts up without reading the registers. Ensure that the LaunchPad is connected to the PC correctly.

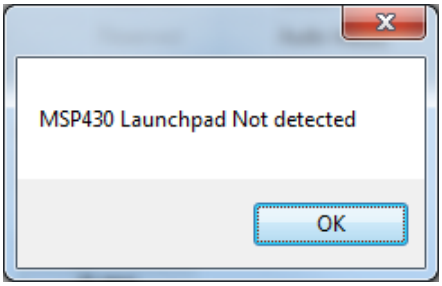


Figure 19. MSP430 LaunchPad Warning Window

If there are no connection issues, try unplugging the LaunchPad and plugging it back in, since windows sometimes encounters errors with COM Ports. Try to read from the device when the LaunchPad is plugged back in, there is no need to restart the GUI. If not connected, the GUI tries to connect every time a read or write is attempted on the LaunchPad. This allows the LaunchPad to be unplugged without having to close the GUI.

If *Auto Write on Click* is enabled and a *Reserved* register bit in one of the R/W registers is clicked, the GUI does not populate that bit as a '1' in the register map. The GUI still writes the existing value to the register. If *Auto Write on Click* is disabled, nothing happens.

7.3.1 Using the TS3A227E-EVM On-Board Keys

Make sure nothing is inserted into the EVM jack.

1. Setup the jumpers on the EVM to the positions listed in Table 2:

Table 2. Jumper Locations for On-Board Keys

Reference Designator	Jumper Location
J2	Populated
J3	Pins 1-2
J12	Not Populated
J15	Populated
J16	Populated
J20	Populated
J22	Pins 7-8 only No jumper on other pins
J24	Populated
J27	Pins 1-2 Pins 3-4 Pins 4-5 Pins 7-8

2. Enable the following switches by clicking on the appropriate bits in the GUI:
   - S3GR
   - S3PS
   - RING2 GNDFET
   - Manual switch control
3. Enable key press by pressing the *Key Press Enable* bit.
4. The GUI should now appear as shown in Figure 20.

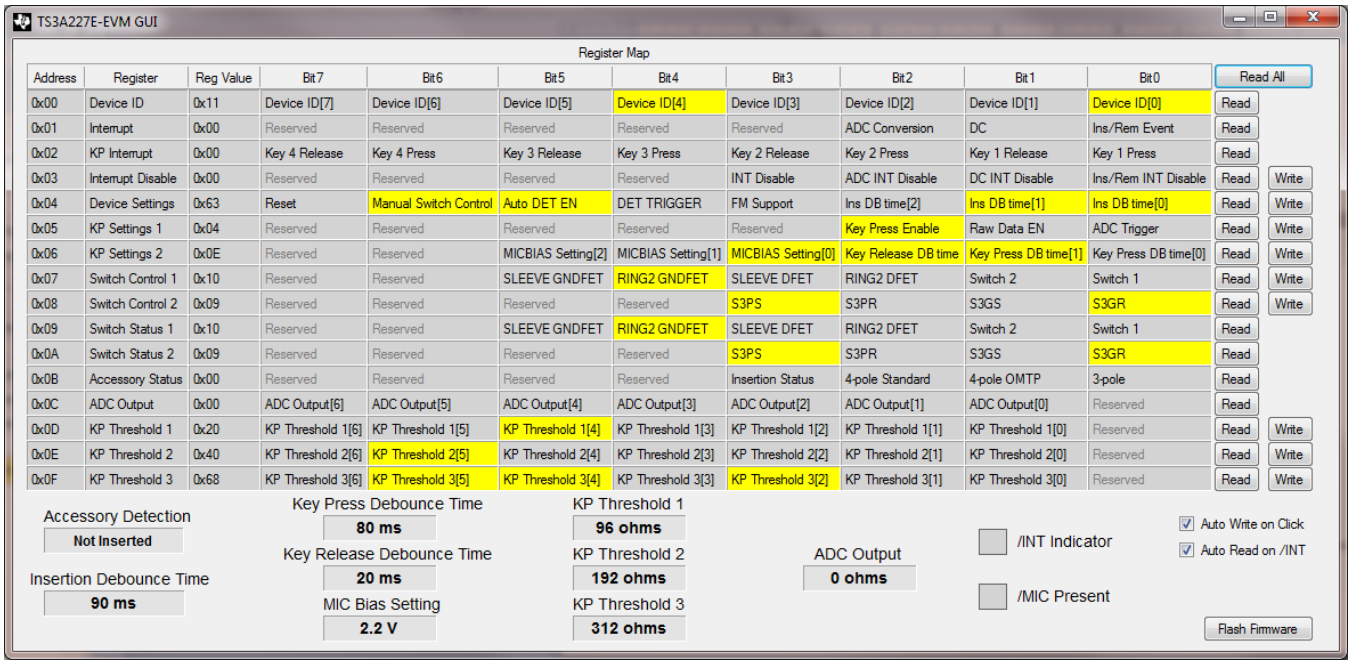


Figure 20. EVM GUI Settings When Using On-Board Keys

5. Now press any of the keys and watch the various interrupts fire. The *Auto Read on /INT* checkbox can be unclicked to view what occurs if the interrupt is not read after numerous key presses.

For more information on key press operation, refer to the datasheet (SCDS358).

7.4 Using the TS3A227E to Develop a Headset

If the EVM is being used to test/develop headset keys by a manufacturer, there are multiple ways to test this:

Method One

If there is an existing headset that the manufacturer is looking to add keys to without changing the microphone, insert the headset into audio jack J4. Place jumpers on J15 and J20 and remove the jumper on J16. Enable key-press detection in the GUI and enable raw data mode. Enabling raw data mode shows the exact detected resistance instead of the bin the resistor falls in.

Once setup, attach the parallel or resistor between the SLEEVE and RING2 pins, not between one of the SLEEVE/RING2 pins and ground. The TS3A227E sees this drop in voltage on the MIC line and detects the parallel resistance combination.

Method Two

Creating a new headset with a prototype microphone.

If the headset is in development and testing the key resistance values is needed, use the following method:

1. Enable Manual Switch control
2. Set the S3 matrix so the ground and microphone are routed to the appropriate pin:
   - S3PS → MIC on SLEEVE
   - S3PR → MIC on RING2
   - S3GS → ground on SLEEVE
   - S3GR → ground on RING2
3. Turn on the appropriate GNDFET for the location of the ground pin.
4. Place jumpers on J15 and J20 and remove the jumper on J16.

5. Attach the external microphone between the SLEEVE and RING2 and match the microphone ground to the location of the ground chosen in step 3.
6. Enable *Key Press Detection* and *Raw Data*.
7. Attach the key and the GUI now reports the detected resistance.

7.5 Power Off Noise Removal Evaluation

The depletion FETs of the TS3A227E provide a ground connection when the device is unpowered, eliminating the humming noise phenomenon associated with previous-generation audio jack switches. The EVM provides an easy means to evaluate this performance with the following procedure:

1. Remove both jumpers from J12. This floats the ground lines of the codec audio jack J10 and simulates what the TS3A227E would be like without the depletion FETs.
2. Insert the speakers into jack J10.
3. Turn on the speakers and turn the volume up until a humming noise appears.
4. Turn off the speakers.
5. Remove the jumper from J2. This removes power from the TS3A227E.
6. Insert the speakers into the TS3A227E audio jack J4.
7. Turn on the speakers and turn the volume up and the humming noise is no longer present.

7.6 Slow Plug-In Issue

Any system which utilizes an audio jack must overcome the slow plug-in issue to deliver a positive end-user experience. On the TS3A227E-EVM, the audio jack follows the guideline of having the detection mechanism on the tip pin but the mechanical structure of the jack trips too early for a standard insertion. This causes an incorrect detection because the RING2 pin is not making contact when the detection algorithm runs, resulting in a false OMTP detection when a 4-pole standard or 3-pole is inserted.

To remove this issue, there are two immediate options:

- Increase the insertion de-bounce period to compensate for the mechanical shortcomings of the jack:
  - This option can be tested with the TS3A227E-EVM and GUI. Increase the insertion de-bounce incrementally and observe how the detection passes. At 150 ms de-bounce, the slow plug-in issue is eliminated.
  - Conversely, the de-bounce can be reduced to observe the effects of having a shorter de-bounce.
- Change the audio jack to a better mechanical structure:
  - This is the best option, by choosing a jack with the detection mechanism further inside the jack it would ensure that the headset is fully inserted and is entirely reliant on the de-bounce

TI recommends developers that use the TS3A227E utilize the EVM test points for the audio jack pins and connect the EVM to the audio jack that is planned for implementation. This allows the system designer to test how the TS3A227E and the audio jack perform together and makes changes as necessary.

8 Board Documentation

This section includes the TS3A227E-EVM schematic, BOM, and board layouts.

8.1 Schematic

Figure 21 illustrates the TS3A227E-EVM schematic.

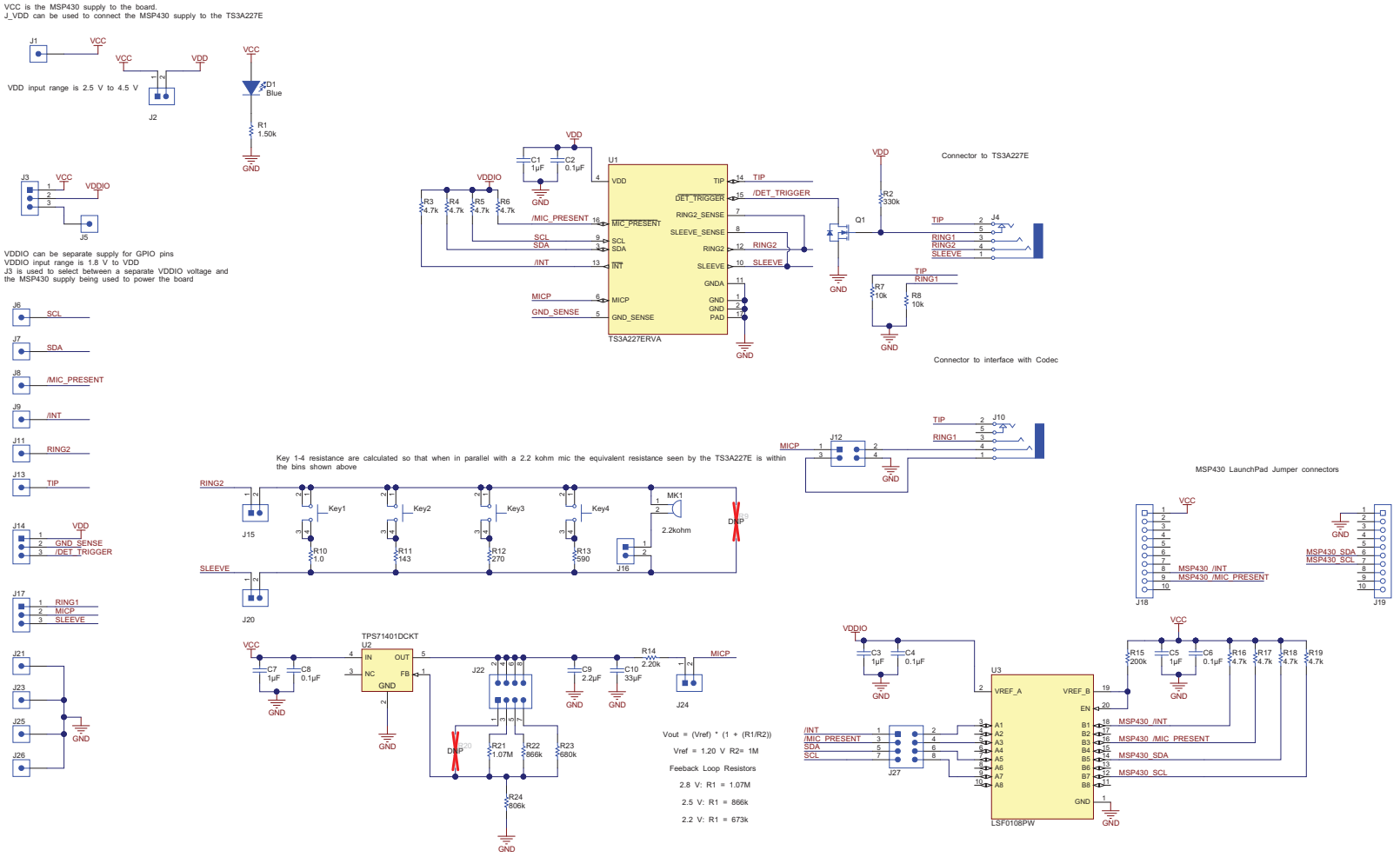


Figure 21. Schematic

8.2 Bill of Materials

Table 3 lists the TS3A227E-EVM BOM.

Table 3. TS3A227E-EVM Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		HVL094	Any
C1, C3, C5, C7	4	1uF	CAP, CERM, 1uF, 6.3V, +/-10%, X7R, 0603	0603	GRM188R70J105KA01D	MuRata
C2, C4, C6, C8	4	0.1uF	CAP, CERM, 0.1uF, 6.3V, +/-10%, X7R, 0603	0603	GRM188R70J104KA01D	MuRata
C9	1	2.2uF	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0603	0603	C0603C225K8PACTU	Kemet
C10	1	33uF	CAP, CERM, 33uF, 6.3V, +/-20%, X5R, 1210	1210	GRM32DR60J336ME19L	MuRata
D1	1	Blue	LED, Blue, SMD	Blue LED	SMLP12BC7TT86	Rohm
J1, J5, J6, J7, J8, J9, J11, J13, J21, J23, J25, J26	12		Header, TH, 100mil, 1pos, Gold plated, 230 mil above insulator	Testpoint	TSW-101-07-G-S	Samtec
J2, J15, J16, J20, J24	5		Header, 100mil, 2x1, Gold with Tin Tail, SMT	2x1 Header	TSM-102-01-L-SV	Samtec
J3, J14, J17	3		Header, 100mil, 3x1, Gold, SMT	Samtec_TSM-103-01-X-SV	TSM-103-01-L-SV	Samtec
J4, J10	2		Audio Jack, 3.5mm, Stereo, R/A, SMT	3.5 mm Audio Jack Connector, Body 17 x 6 mm	SJ-43515TS-SMT-TR	CUI Inc.
J12	1		Header, 100mil, 2x2, Tin, SMT	2x2 100mil Tin Header	15-91-2040	Molex
J18, J19	2		Receptacle, 100mil, 10x1, Tin, TH	Receptacle, 10x1, 100mil, Tin	PPTC101LFBN-RC	Sullins Connector Solutions
J22, J27	2		Header, 100mil, 4x2, Gold, SMT	Header, 100mil, 4x2, SMT	0015910080	Molex
Key1, Key2, Key3, Key4	4		SWITCH TACTILE SPST-NO 0.02A 15V, TH	6x4.3x6mm	EVQ-PAD04M	Panasonic
MK1	1		Microphone, Omnidirectional, -38DB, TH	TH, 2-Leads, Dia 5.8mm, Pitch 1.9mm	ROM-2238P-NF-R	PUI Audio
Q1	1	60V	MOSFET, N-CH, 60 V, 0.24 A, SOT-23	SOT-23	2N7002E-T1-E3	Vishay-Siliconix
R1	1	1.50k	RES, 1.50 k, 1%, 0.1 W, 0603	0603	CRCW06031K50FKEA	Vishay-Dale
R2	1	330k	RES, 330 k, 5%, 0.1 W, 0603	0603	CRCW0603330KJNEA	Vishay-Dale
R3, R4, R5, R6, R16, R17, R18, R19	8	4.7k	RES, 4.7 k, 5%, 0.1 W, 0603	0603	CRCW06034K70JNEA	Vishay-Dale
R7, R8	2	10k	RES, 10 k, 5%, 0.1 W, 0603	0603	CRCW060310K0JNEA	Vishay-Dale
R10	1	1.0	RES, 1.0, 5%, 0.1 W, 0603	0603	CRCW06031R00JNEA	Vishay-Dale
R11	1	143	RES, 143, 1%, 0.1 W, 0603	0603	CRCW0603143RFKEA	Vishay-Dale
R12	1	270	RES, 270, 1%, 0.1 W, 0603	0603	RC0603FR-07270RL	Yageo America
R13	1	590	RES, 590, 1%, 0.1 W, 0603	0603	CRCW0603590RFKEA	Vishay-Dale
Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R14	1	2.20k	RES, 2.20 k, 1%, 0.1 W, 0603	0603	RC0603FR-072K2L	Yageo America
R15	1	200k	RES, 200 k, 1%, 0.1 W, 0603	0603	RC0603FR-07200KL	Yageo America
R21	1	1.07Meg	RES, 1.07 M, 1%, 0.1 W, 0603	0603	CRCW06031M07FKEA	Vishay-Dale
R22	1	866k	RES, 866 k, 1%, 0.1 W, 0603	0603	RC0603FR-07866KL	Yageo America
R23	1	680k	RES, 680 k, 1%, 0.1 W, 0603	0603	RC0603FR-07680KL	Yageo America
R24	1	806k	RES, 806 k, 1%, 0.1 W, 0603	0603	RC0603FR-07806KL	Yageo America
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13	13	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M

Table 3. TS3A227E-EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
U1	1		Autonomous Audio Accessory Detection and Configuration Switch, RVA0016A	RVA0016A	TS3A227ERVA	Texas Instruments
U2	1		Single Output LDO, 80 mA, Adjustable 1.2 to 8.8 V Output, 2.5 to 10 V Input, with Low IQ, 5-pin SC70 (DCK), -40 to 125 degC, Green (RoHS & no Sb/Br)	DCK0005A	TPS71401DCKT	Texas Instruments
U3	1		8 Channel Bidirectional Multi-Voltage Level Translator for Open-Drain and Push-Pull Application, PW0020A	PW0020A	LSF0108PW	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A
R9, R20	0	38.8k	RES, 38.8k ohm, 0.1%, 0.1W, 0603	0603	RT0603BRD0738K8L	Yageo America

8.3 PCB Layout

Figure 23 through Figure 25 illustrate the TS3A227E-EVM PCB layouts.

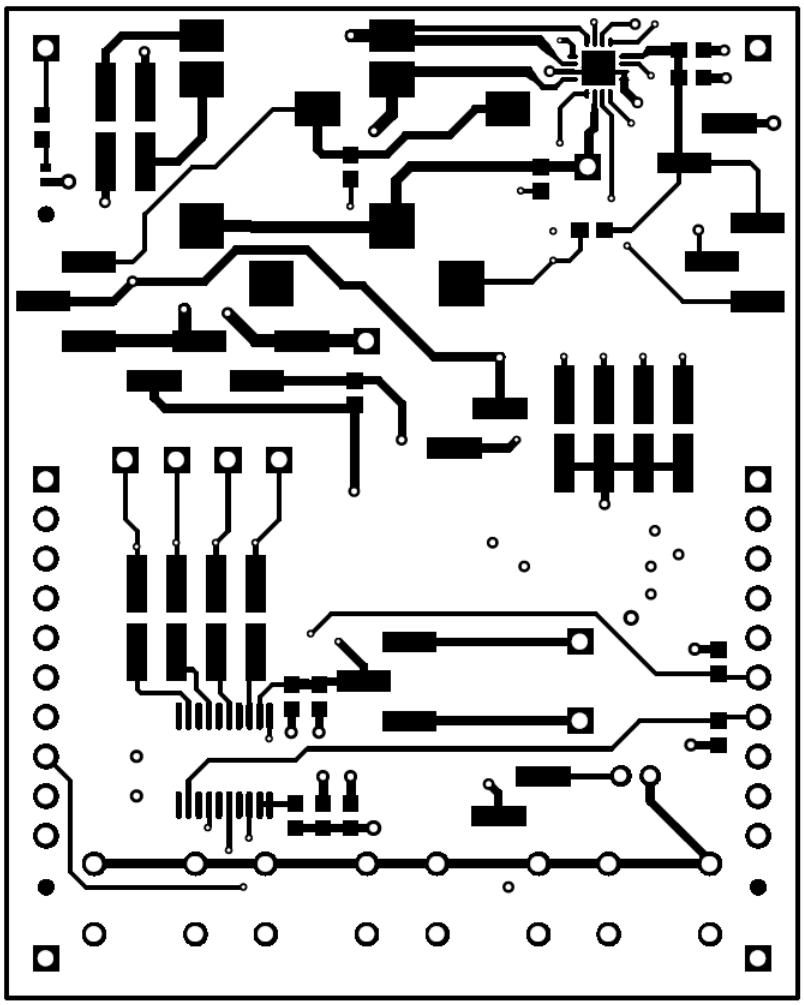


Figure 22. Top Copper

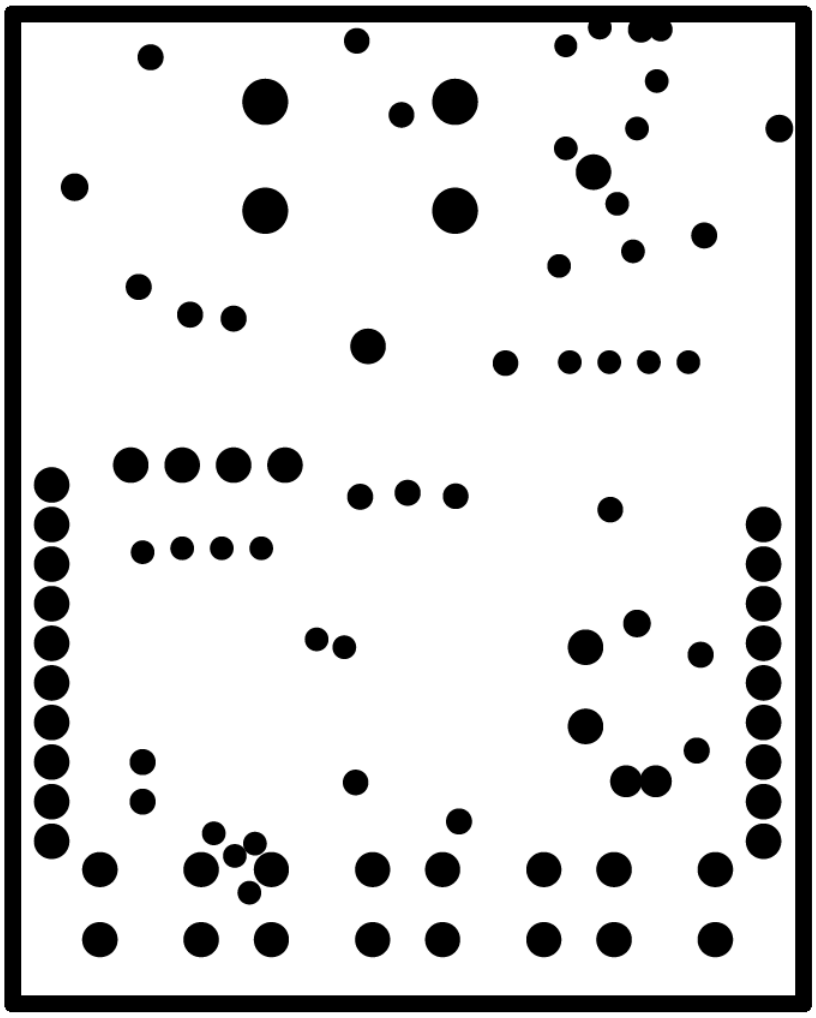


Figure 23. Ground Plane (Negative Image)

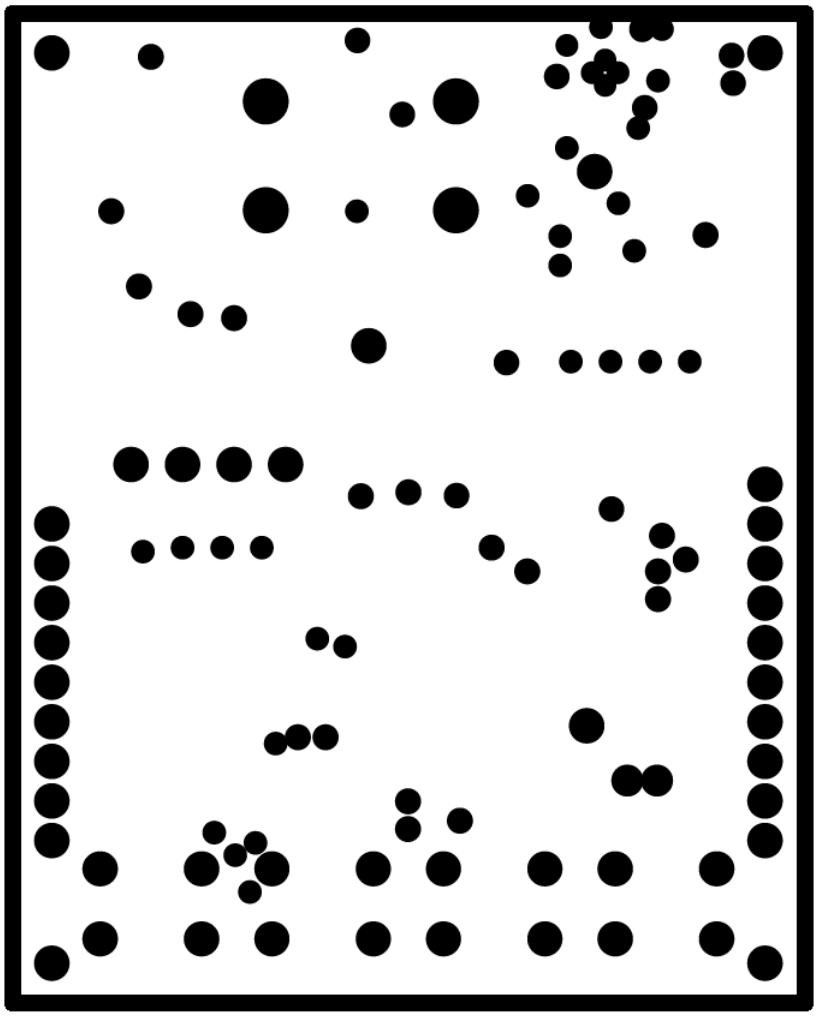


Figure 24. Power Plane (Negative Image)

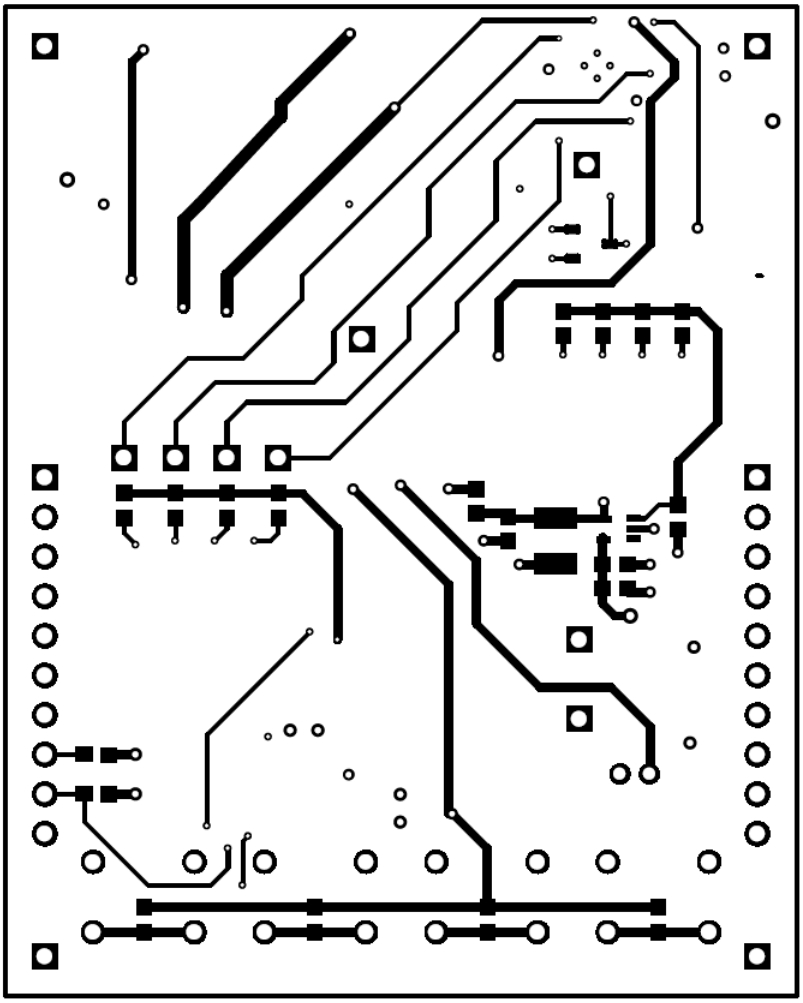


Figure 25. Bottom Copper

9 Related Documentation

- Product page: http://www.ti.com/product/ts3a227e?qgpn=ts3a227e
- Datasheet link: http://www.ti.com/lit/ds/symlink/ts3a227e.pdf
- Link to software: TBD
- Link to Code Composer Studio Wiki: http://www.ti.com/tool/CCSTUDIO
- Link to MSP430 LaunchPad: http://www.ti.com/tool/msp-exp430g2

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3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *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

      NOTE: 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

NOTE: 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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-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.

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.

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.

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

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *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.

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4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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