IO Expander EVM

This document is the user's guide for the IO Expander Evaluation Module (EVM). The IO Expander EVM allows for evaluation of the IO expander line of TI parts. The TCA6424A and TCA9539 come installed on the board and the 24-pin TSSOP footprint also supports TCA6408A, TCA6416A, TCA9534, TCA9534A, TCA9535, TCA9538, TCA9554, TCA9554A, and TCA9555.

Contents

List of Figures

List of Tables

1 About This Manual

This user's guide describes the IO Expander EVM. This guide contains an introduction, setup instructions, the EVM schematic, top and bottom printed-circuit-board (PCB) layouts, and a bill of materials (BOM).

2 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. 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 Items Required For Operation

The IO Expander EVM requires the following items:

- IO Expander EVM
- MSP430 LaunchPad™
  - Recommended rev 1.5
  - MSP430G2553 installed
- USB standard-A to mini-B cable
- Computer with graphical user interface (GUI) software installed (SLVC564) from www.ti.com

The following items are recommended for evaluating the firmware:

- Computer with Code Composer studio installed
- Downloaded firmware (SLVC564) from www.ti.com

4 Introduction

This document is the user's guide for the IO Expander EVM. The IO Expander EVM comes populated with the TCA6424A and the TCA9539. If the TCA9539 is removed from the EVM, the layout of the 24-pin TSSOP footprint also supports the TCA6408A, TCA6416A, TCA9534, TCA9534A, TCA9535, TCA9538, TCA9554, TCA9554A, and TCA9555.

The IO Expander EVM provides a simple way to evaluate a large number of the available IO expanders that TI offers. There is also firmware for the MSP430G2553 to help in developing an application using any of the supported IO expanders. Figure 1 shows the IO Expander EVM board.

Table 1. Device and Package Configurations

IO Expander	IC	Package
U1	TCA6424ARGJR	µQFN-32
U2	TCA9539PWR	TSSOP-24

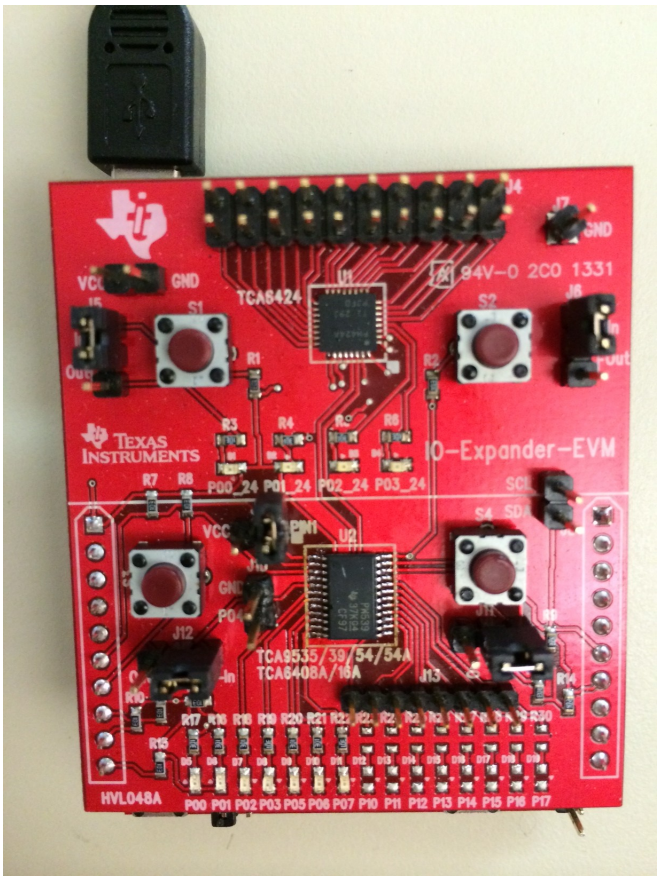


Figure 1. IO Expander EVM

5 Setup

This section describes the headers and jumper connections on the EVM, installation of the firmware on the MSP430 LaunchPad, installation of the software (GUI) on the computer, and getting started using the IO Expander EVM with any of the supported devices.

5.1 Header and Jumper Connection Descriptions

5.1.1 J1 and J2: MSP430 LaunchPad Interface

Headers J1 and J2 allow the EVM to interface with the MSP430 LaunchPad.

5.1.2 J3 and J7: VCC and GND Connections

Header J3 (un-labeled, in the top left portion of the board, below the TI logo), can be used to probe VCC and GND when the MSP430 LaunchPad is attached. Alternatively, if the IO Expander EVM will be used separate from the LaunchPad, J3 can be used to supply power to the IO Expander EVM. Pins 1 and 2 of J3 should **NEVER** be connected with a jumper. Header J7 provides an additional pin for GND.

5.1.3 J4, J13, and J8: Breakout pins

Header J4 allows for breakout of all remaining IOs of the TCA6424A. Header J13 allows for breakout of all the remaining IOs of the TCA9539 or other supported 8-bit and 16-bit IO expanders. Header J8 allows for probing of the SCL and SDA lines communicating between the MSP430 and the IO expanders.

5.1.4 J5, J6, J11, and J12: Input/Output Jumpers for Switches and LEDs

Switches S1 and S2 are connected to P00_24 and P01_24, respectively, and provide high- and low-logic inputs to the TCA6424A P00 and P01 ports. To use these switches as inputs, jumpers on J5 and J6 must be connected as “In” on the board. To configure P00 and P01 as outputs to turn on/off the respective LEDs, jumpers on J5 and J6 must be connected as “Out” on the board (this is the default position).

Switches S4 and S3 are connected to P00 and P01, respectively, and provide high- and low-logic inputs to the TCA9539 P00 and P01 ports. To use these switches as inputs, jumpers on J11 and J12 must be connected as “In” on the board. Configure P00 and P01 as outputs to turn on/off the respective LEDs by connecting jumpers on J5 and J6 as “Out” on the board (this is the default position).

5.1.5 J9 and J10: Alternate Device Headers

Header J10 connects GND on any 8-bit IO expander, and a jumper must be installed for operation of these devices. Header J9 connects VCCI directly to power the power rail of the MSP430 for the TCA6408A, and a jumper must be installed for operation of this device.

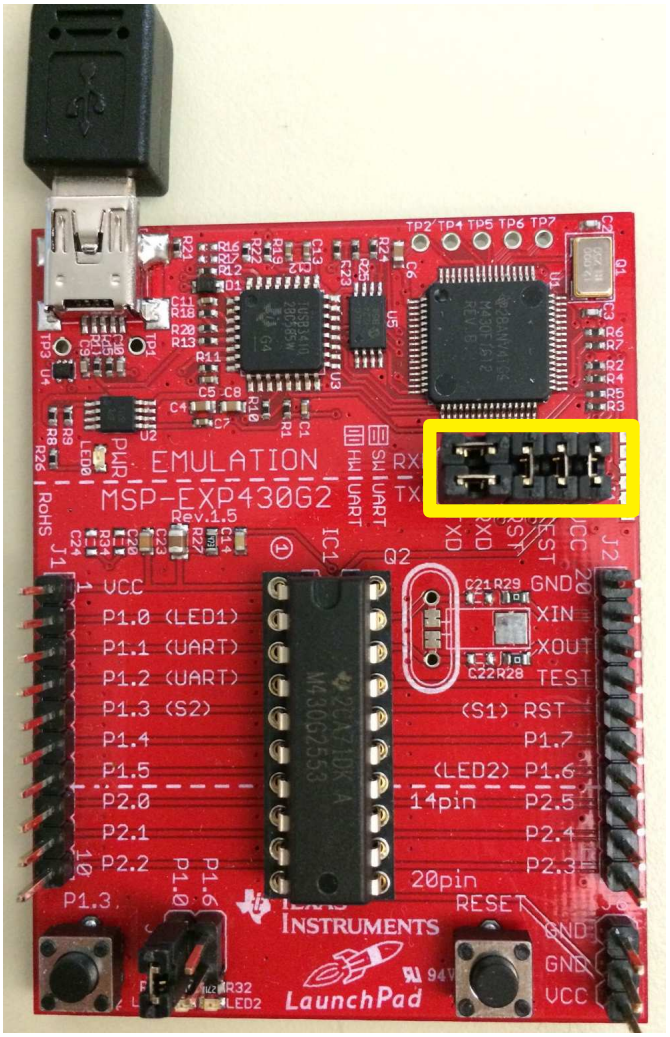
5.2 LED Outputs

All LED outputs are labeled in silk screen with the associated port output number. Pxx_24 are the ports that are associated with the TCA6424A. Pxx are the outputs associated with the TCA9539 and the other supported 8-bit and 16-bit IO expanders. P02_24 and P03_24 connected to the TCA6424A as well as P02, P03, and P05-P07 connected to the TCA9539 are hardwired to LEDs to be used only as outputs for demonstration purposes.

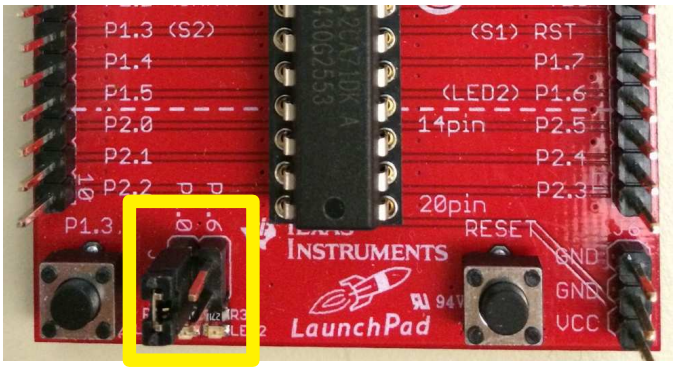
5.3 LaunchPad Hardware and Firmware Setup

The MSP430 LaunchPad board needs to be configured properly in order to flash the processor with the IO expander firmware. Follow steps 1 through 9 before using the IO Expander EVM in conjunction with the LaunchPad:

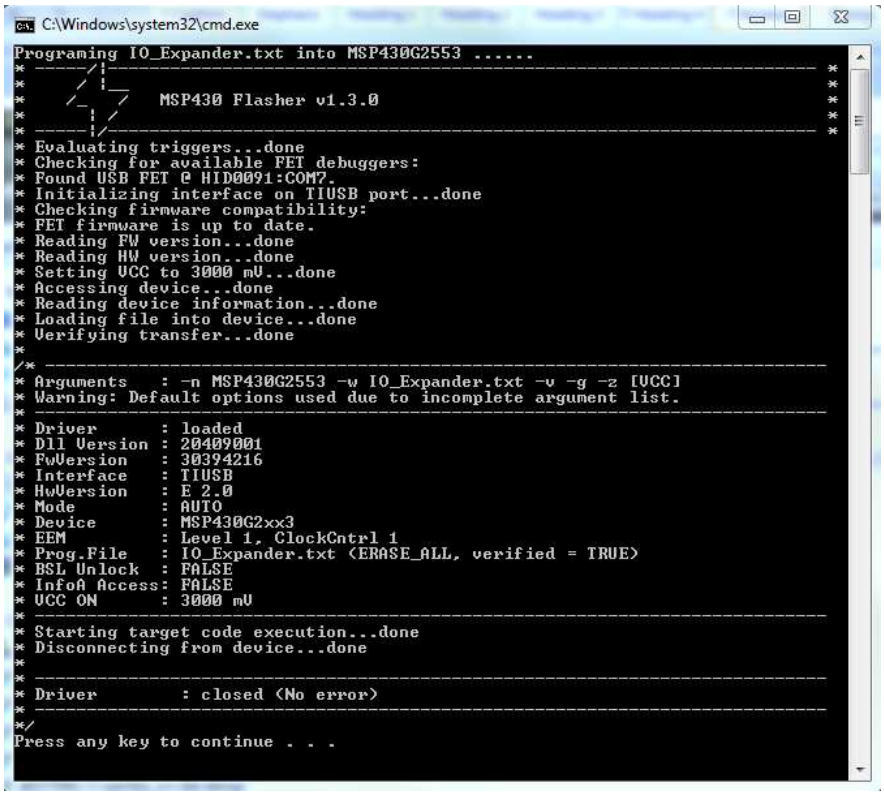
1. Download the firmware (for the MSP430) and software (graphical user interface, or GUI) in a zipped folder located here (SLVC564).
2. Create a folder on the computer to be connected to the EVM and extract all files to this folder.
3. (Optional) Download Code Composer Studio from here to use or modify the “IO Expander” source code.
4. With the LaunchPad unplugged, configure the headers on the LaunchPad to be in HW UART mode by matching header J3 on the LaunchPad with the yellow box in the following image:



5. With the LaunchPad still unplugged, remove the rightmost jumper on P1.6 to match the yellow box in the following image:

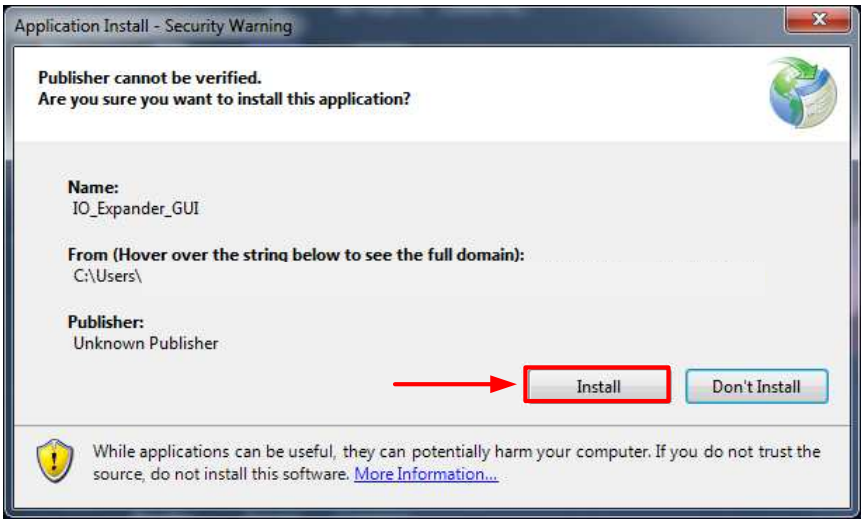


6. Connect the female headers of the IO Expander EVM PCB to J1and J2 of the LaunchPad. To ensure the IO Expander EVM is oriented correctly, verify the TI Logo is at the top left corner, directly above the USB mini connector on the LaunchPad.
7. Connect the LaunchPad to your computer with a USB standard-A to mini-B cable. A green LED should turn on, labeled “PWR” and “LED0”, to signify power to the LaunchPad.
8. Navigate to the previously extracted folder and run *IO Expander Flash.bat*.
   - This flashes the firmware to the LaunchPad using the *MSP430Flasher.exe* and *IO_Expander.txt* files.
9. A successful flash of the firmware result in the following command line prompt:

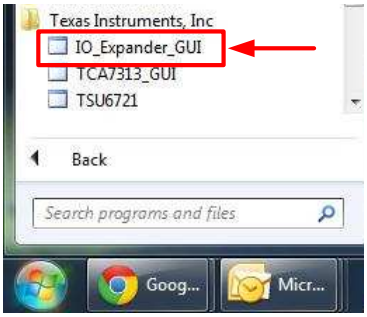


5.4 GUI Software Setup

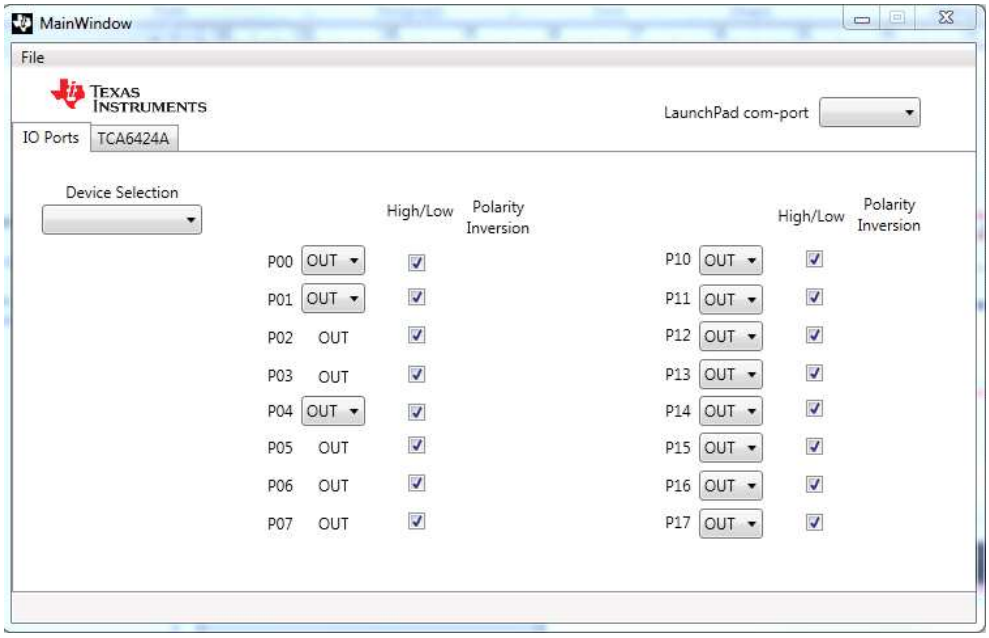
1. Install the GUI from the previously extracted folder by double-clicking *setup.exe*.



2. Run the installed *IO_Expander_GUI* program from the Start Menu.



3. The GUI looks like the following picture when it is opened (before initiating a connection to the LaunchPad).

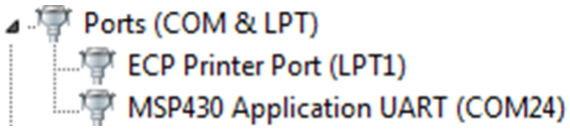


5.5 Getting Started Using the IO Expander EVM

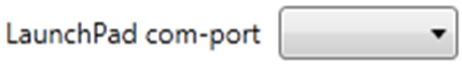
5.5.1 Initiating Connection (from GUI to LaunchPad)

1. Open the device manager on your PC and determine which of the COM ports is associated with the LaunchPad.

   (a) In the following case, the COM port is COM24 as shown in the image:



2. Run the GUI program from the Start Menu.
3. Next to *LaunchPad com-port* is a drop-down menu box which is blank on startup of the GUI.



4. Click on this box and a list of COM ports drops down. Select the COM port that is associated with the LaunchPad, which was identified in step 1.

   (a) In this example, the COM port is COM24.

5.5.2 TCA6424A tab (24-bit IO Expander)

1. The TCA6424A tab controls the TCA6424A device permanently installed on the IO Expander EVM. Figure 2 shows the TCA6424A tab on the GUI.

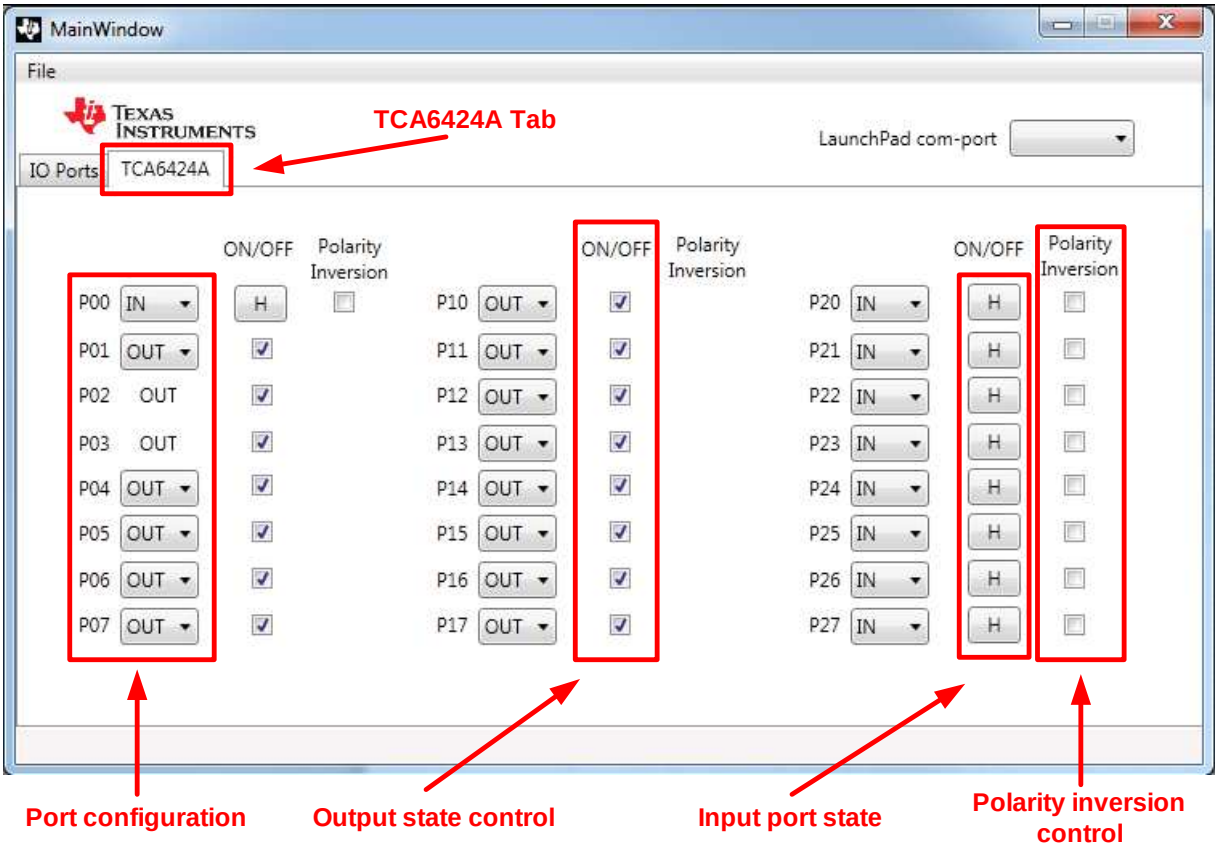


Figure 2. TCA6424A Tab (24-bit IO Expander) on GUI

2. P00 (P00_24 on PCB) and P01 (P01_24 on PCB) are configured as outputs when the jumpers on J5 and J6 are connected to “Out” and the GUI reads “OUT” for port configuration. P00 and P01 are set up in an open-drain configuration, thus an H (check-box is checked) written to P00 or P01 turns off the LED while an L (check-box is un-checked) written to P00 or P01 turns on the LED. The procedure for using these ports as outputs is the same as described for the TCA6424A.
3. P02 (P02_24 on PCB) and P03 (P03_24 on PCB) are always configured as push-pull outputs on the IO Expander EVM and the respective LEDs are controlled using the GUI. An H (check-box is checked) written to P02 or P03 turns on the LED while writing an L (check-box is un-checked) turns off the LED.
4. P04 through P27 are fanned out to header J4 for evaluation.
5. Switches S1 and S2 are connected to P00 (P00_24 on PCB) and P01 (P01_24 on PCB), respectively, and can be used to evaluate the input configuration of the TCA6424A.
   (a) Change the jumper settings on J5 and J6 to “In” in order to connect the switches to the ports.
   (b) Change the port configuration on the GUI to read “IN”.
   (c) The default input state is H on the switches and changes to L when the switch is pressed.
   (d) Setting the polarity inversion control high (check-box checked) on the GUI results in the TCA6424A inverting this configuration.

5.5.3 IO Ports Tab (16-bit part installed: TCA9539, TCA6416A, TCA9535, or TCA9555)

1. The IO Ports tab offers control for the TCA9539 and any of the other supported 16-bit IO expanders if one is alternately installed on the PCB. Figure 3 shows the IO Ports tab on the GUI for a 16-bit part.

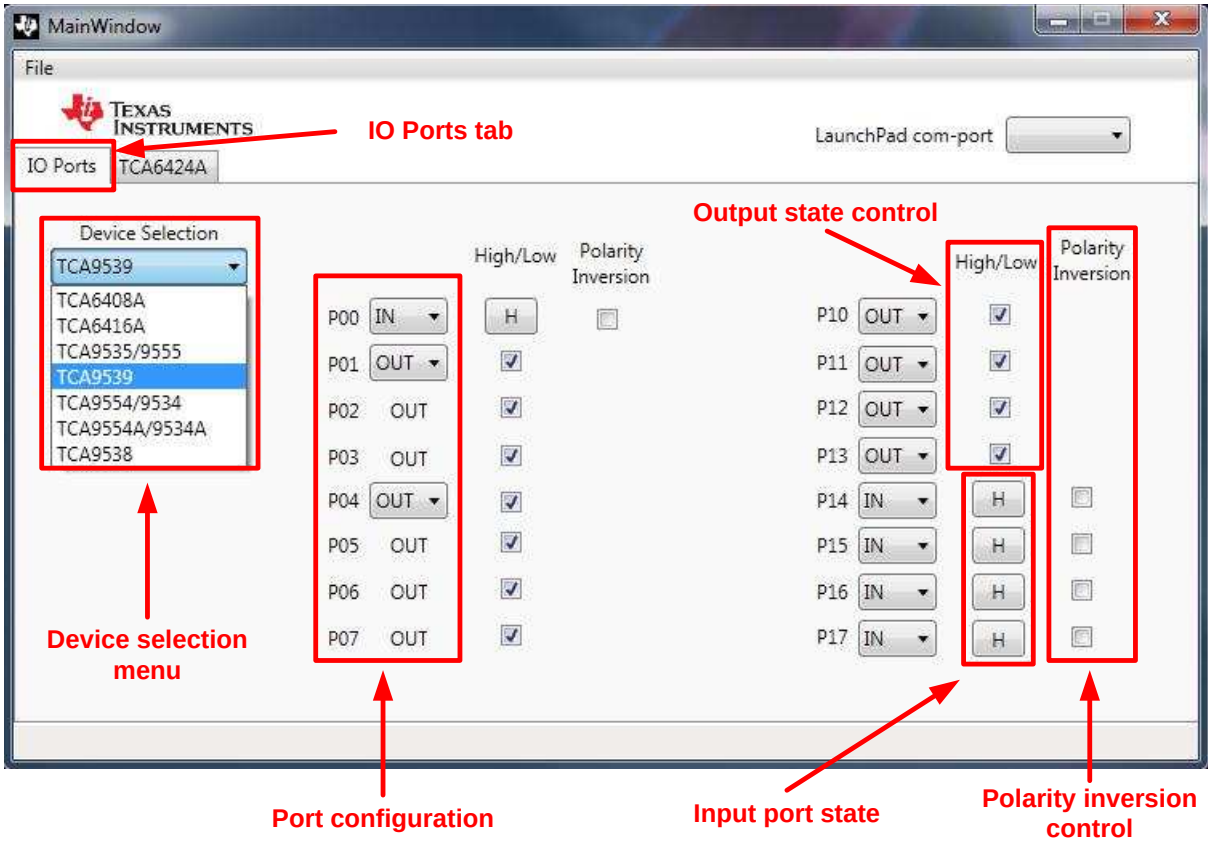


Figure 3. IO Ports Tab (16-bit Part Installed) on GUI

2. P00 and P01 are setup in an open-drain configuration, thus an H written to P00 or P01 turns off the LED while an L written to P00 or P01 turns on the LED. The procedure for using these ports as outputs is the same as described for the TCA6424A.
3. P02, P03, and P05-P07 are always configured as push-pull outputs on the IO Expander EVM and the respective LEDs are controlled using the GUI. An H written to these Pxx ports turns on the LED while writing an L turns off the LED.
4. P04 can be tested on header J10 (this pin is used as a GND connection for the 8-bit IO expanders).
5. P10 through P17 are broken out to header J13 for evaluation.
6. S4 and S3 are connected to P00 and P01, respectively, and can be used to evaluate the input configuration of the 16-bit expander in the same manner as described for the TCA6424A setup.

5.5.4 IO Ports Tab (8-bit Part Installed: TCA6408A, TCA9534, TCA9534A, TCA9538, TCA9554, or TCA9554A)

1. The IO Ports tab also offers control for any of the supported 8-bit IO expanders if one is alternately installed on the PCB. Figure 4 shows the IO Ports tab on the GUI for a 8-bit part.
2. A jumper must be inserted on header J10 to connect GND on any 8-bit IO expander.
3. If the TCA6408A is installed, a jumper must be inserted on header J9 to directly supply VCCI to the device.

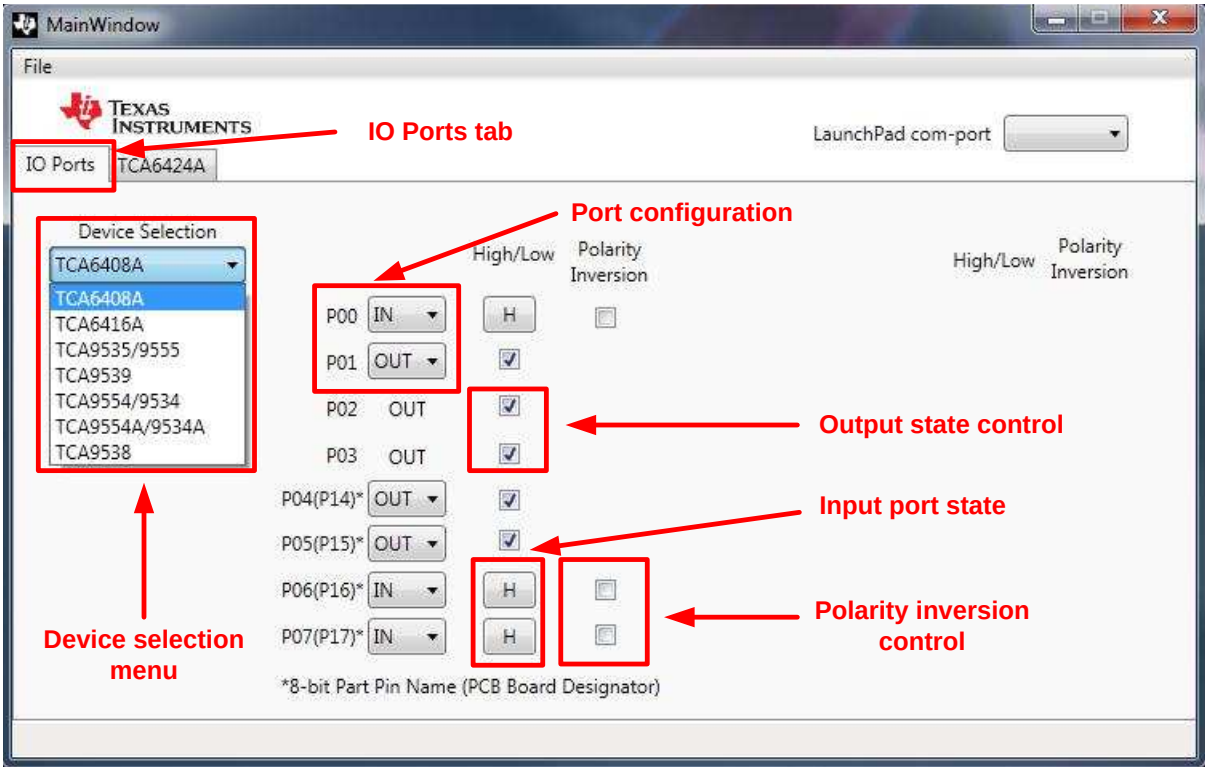


Figure 4. IO Ports Tab (8-bit Part Installed) on GUI

4. P00 and P01 are set up in an open-drain configuration, thus an H written to P00 or P01 turns off the LED while an L written to P00 or P01 turns on the LED. The procedure for using these ports as outputs is the same as described for the TCA6424A.
5. P02 and P03 are always configured as push-pull outputs on the IO Expander EVM and the respective LEDs are controlled using the GUI. An H written to these Pxx ports turns on the LED while writing an L turns off the LED.
6. P04 through P07 (P14-P17 on PCB) are broken out to header J13 for evaluation
7. S4 and S3 are connected to P00 and P01, respectively, and can be used to evaluate the input configuration of the 8-bit IO expander in the same manner as described for the TCA6424A setup.

6 Schematic

The circuit diagram in Figure 5 shows the schematic for the IO Expander EVM.

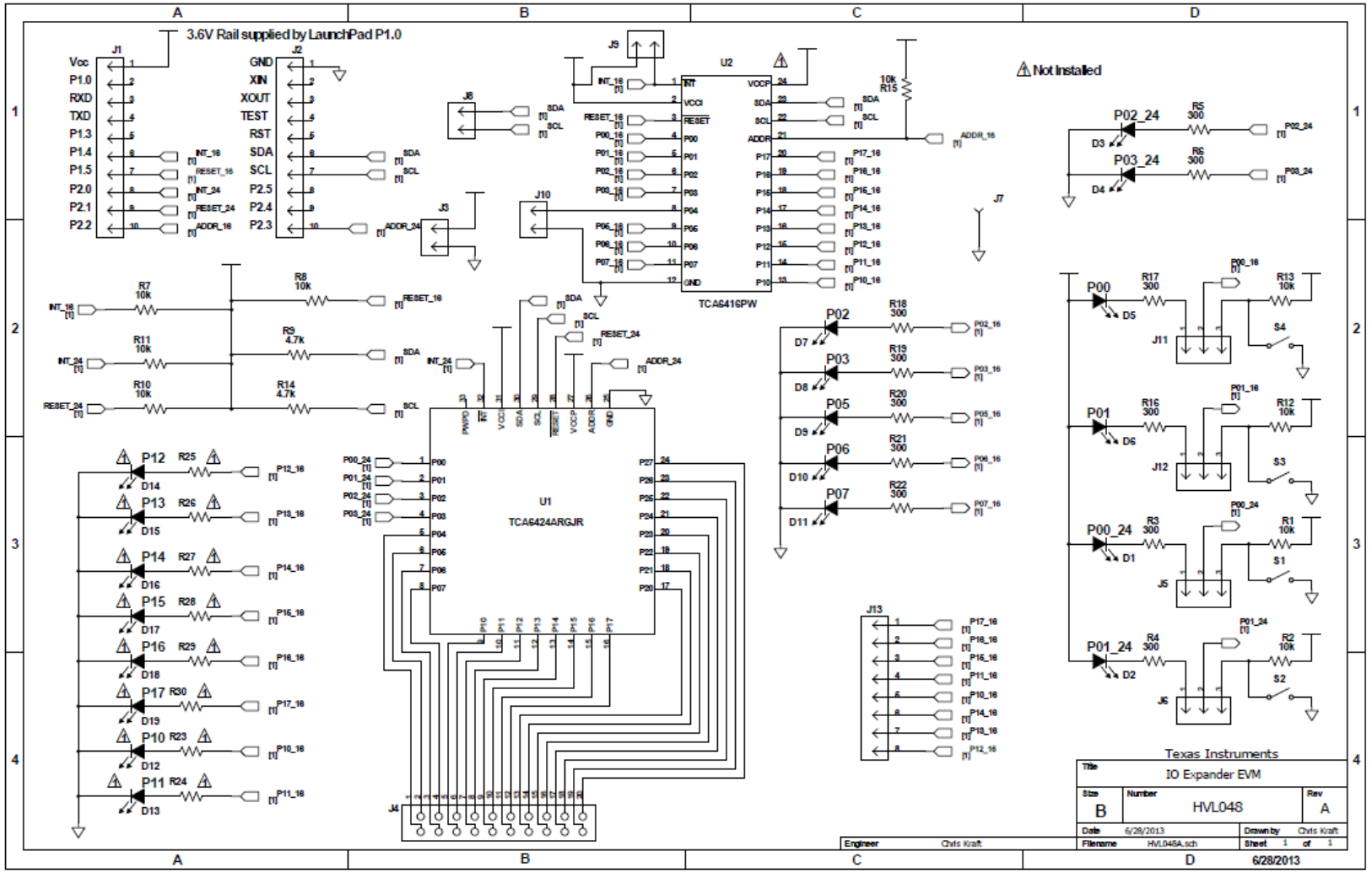


Figure 5. IO Expander EVM Schematic

7 Board Layout

Figure 6 and Figure 7 illustrate the PCB layout.

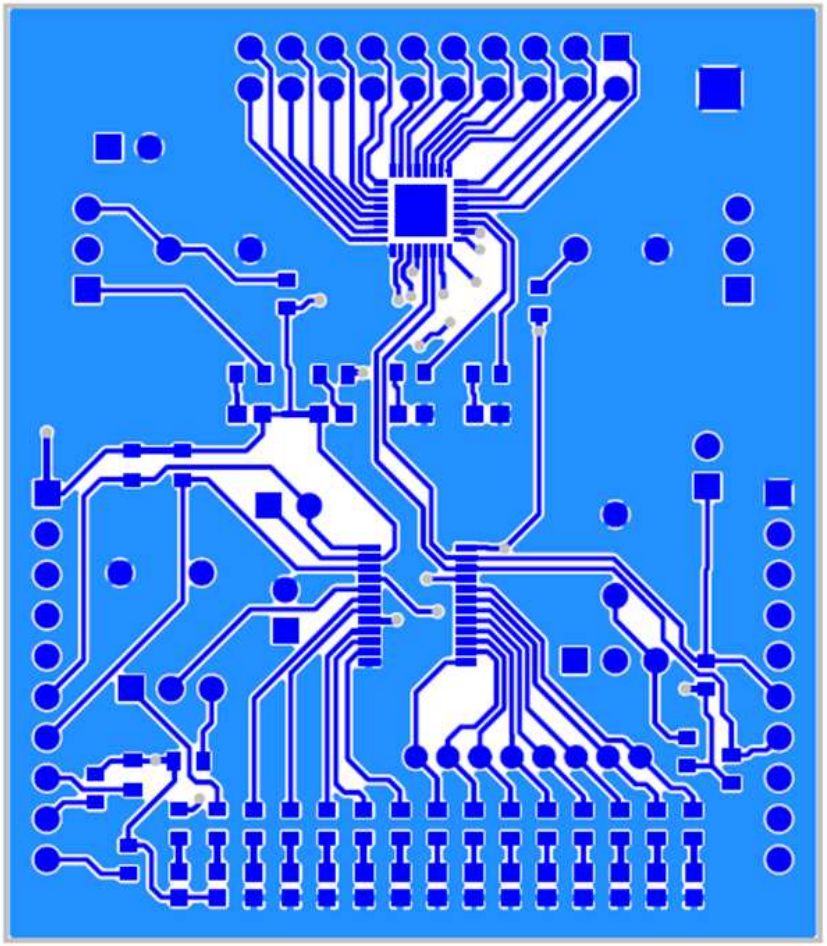


Figure 6. PCB Layer 1 (Top Layer)

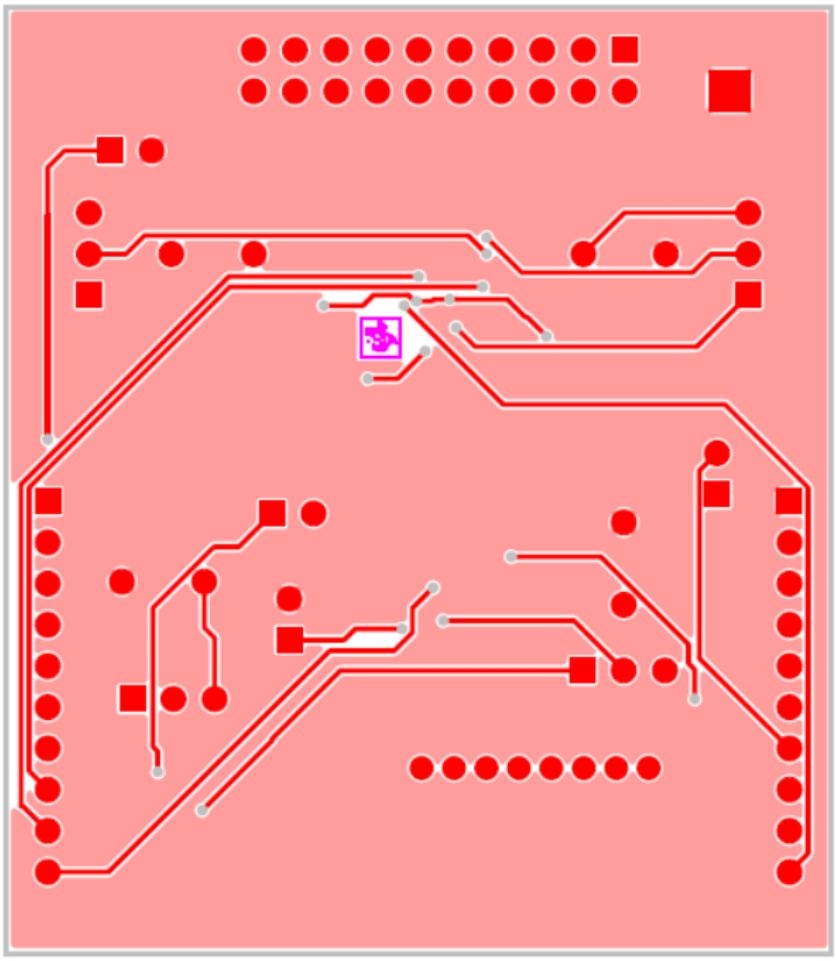


Figure 7. PCB Layer 2 (Bottom Layer)

8 Bill of Materials

Table 2 lists the BOM for the IO Expander EVM.

Table 2. Bill of Materials

Count	RefDes	Value	Description	Part Number	MFR
1	!PCB1		Printed Circuit Board	HVL048	Any
11	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11		Diode, LED, RED 2V, 20-mA, 80 mcd	LTST-C190KRKT	Lite On
0	D12, D13, D14, D15, D16, D17, D18, D19	Uninstalled	Diode, LED, RED 2V, 20-mA, 80 mcd	LTST-C190KRKT	Lite On
2	J1, J2		CONN HEADER FMALE 10POS .1" GOLD	PPPC101LFBN-RC	Sullins
1	J13		CONN HEADER 8POS 2MM VERT T/H	951108-8622-AR	3M
1	J7		BERGSTIK II .100" SR STRAIGHT	68001-101HLF	FCI
1	J4		CONN HEADER 20POS .100 STR TIN	67996-420HLF	FCI
4	J5, J6, J11, J12		BERGSTIK II .100" SR STRAIGHT	68000-103HLF	FCI
4	J3, J8, J9, J10		CONN HEADER 2POS VERT T/H	77311-118-02LF	FCI
9	R1, R2, R7, R8, R10, R11, R12, R13, R15	10k	RES 10K OHM 1/10W 5% 0603 SMD	RC0603JR-0710KL	Yageo
0	R23, R24, R25, R26, R27, R28, R29, R30	Uninstalled			
11	R3, R4, R5, R6, R16, R17, R18, R19, R20, R21, R22	300	RES 300 OHM 1/10W 5% 0603 SMD	RC0603JR-07300RL	Yageo
2	R9, R14	4.7k	RES 4.7k OHM 1/10W 5% 0603 SMD	RC0603JR-074K7L	Yageo
4	S1, S2, S3, S4		SWITCH TACTILE SPST-NO 0.02A 15V	EVQ-21505R	Panasonic
5	N/A		Jumper	382811-8	TE
1	U1		IC, LOW-VOLTAGE 24-BIT I2C AND SMBus I/O EXPANDER	TCA6424ARGJR	TI
1	U2		IC, LOW-VOLTAGE 16-BIT I2C AND SMBus I/O EXPANDER	TCA9539PWR	TI

Revision History

Changes from Original (March 2014) to A Revision **Page**

- Added TCA9534, TCA9534A, and TCA9538 to the list of supported devices in the *Abstract*. 1
- Added TCA9534, TCA9534A, and TCA9538 to the list of supported devices in the *Introduction* 3
- Changed the *IO Ports Tab (16-bit Part Installed) on GUI* image. 9
- Changed the *IO Ports Tab (8-bit Part Installed) on GUI* image. 10
- Added TCA9534, TCA9534A, and TCA9538 to the *IO Ports Tab* header. 11

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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User Power/Frequency Use Obligations: For EVMs including a radio, the radio included in such EVMs is intended for development and/or professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability in such EVMs and their development application(s) must comply with local laws governing radio spectrum allocation and power limits for such EVMs. 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 TI unless user has obtained appropriate experimental and/or development licenses from local regulatory authorities, which is the sole responsibility of the user, including its acceptable authorization.

U.S. Federal Communications Commission Compliance

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.

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.

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.

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

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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