

## **PGA112EVM and PGA113EVM User's Guide**

This user's guide describes the characteristics, operation, and use of the PGA112EVM and PGA113EVM evaluation boards. It also describes how to set up and configure the software and hardware, and reviews various aspects of program operation. Throughout this document, the terms PGA112EVM, PGA113EVM, PGA112EVM/PGA113EVM, evaluation board, evaluation module, and EVM are synonymous with the PGA112EVM and PGA113EVM. This user's guide also includes information regarding operating procedures and input/output connections, an electrical schematic, printed circuit board (PCB) layout drawings, and a parts list for the EVM.

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## 1 Overview

The PGA112 And PGA113 are programmable gamma-voltage generators featuring two banks of 16 programmable gamma channels and programmable, high slew rate VCOM channels. All channels are programmable through a high-speed, I<sup>2</sup>C™ interface and support up to 20-V supply-voltage operation.

### 1.1 EVM Kit Contents

**Table 1** lists the contents of the PGA112EVM or PGA113EVM kit. Contact the Texas Instruments Product Information Center nearest you if any component is missing. It is highly recommended that you check the TI web site at <http://www.ti.com> to verify that you have the latest versions of the related software.

**Table 1. Contents of PGA112EVM or PGA113EVM Kit**

| Item                                        | Quantity |
|---------------------------------------------|----------|
| PGA112EVM or PGA113EVM PCB Evaluation Board | 1        |
| SM-USB-DIG Platform PCB                     | 1        |
| USB Extender Cable                          | 1        |
| SM-USB-DIG Connector Ribbon Cable           | 1        |
| User's Guide CD-ROM                         | 1        |

### 1.2 Related Documentation from Texas Instruments

The following document provides information regarding Texas Instruments integrated circuits used in the assembly of the PGA112EVM and PGA113EVM. This user's guide is available from the TI web site under literature number [SBOU073](#). Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions may be available from the TI web site at <http://www.ti.com/>, or call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

| Document                                         | Literature Number       |
|--------------------------------------------------|-------------------------|
| <a href="#">PGA112/PGA113</a> Product Data Sheet | <a href="#">SBOS424</a> |
| SM-USB-DIG Platform User's Guide                 | <a href="#">SBOU098</a> |

## 2 EVM Hardware Setup

This section describes the overall system setup for the PGA112EVM and PGA113EVM. The SM-USB-DIG Platform provides power and the digital signals used to communicate with the PGA112EVM or PGA113EVM board through software installed on your PC. An input signal and multimeter can be attached to the available connectors on the PGA112EVM and PGA113EVM boards. [Figure 1](#) shows the hardware setup.

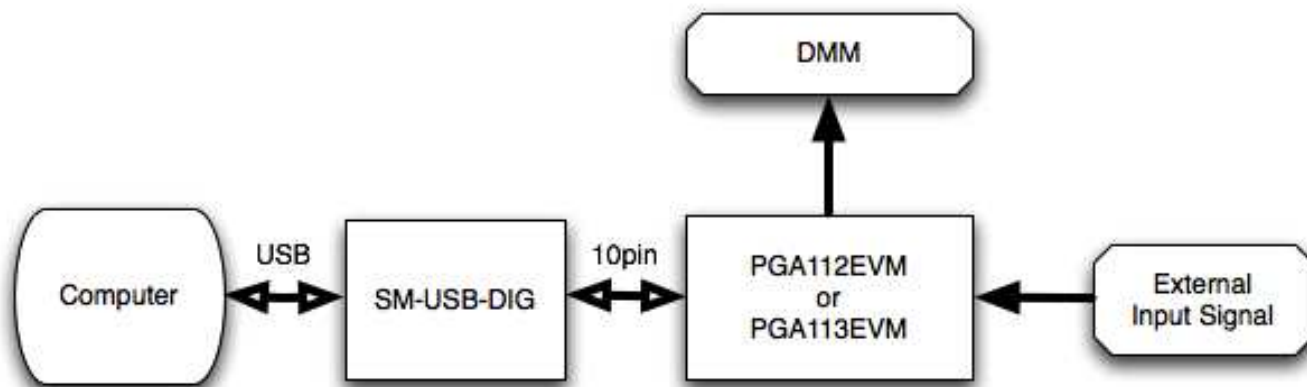


Figure 1. Hardware Setup

### 2.1 Theory of Operation for the PGA112 and PGA113 Hardware

A block diagram of the test-board hardware setup is shown in [Figure 2](#). The EVM board provides test points to the communication inputs. The EVM board also provides power and ground connections (from the SM-USB-DIG Platform board or an external power supply; see [Section 3.4](#)). The EVM board also provides test points for the analog inputs and output of the PGA112 (or PGA113) device. The PGA112EVM and PGA113EVM feature a test point for the VREF input of the PGA112 and PGA113, respectively. By default, VREF is shorted to ground, but can be disconnected with the removal of R2.

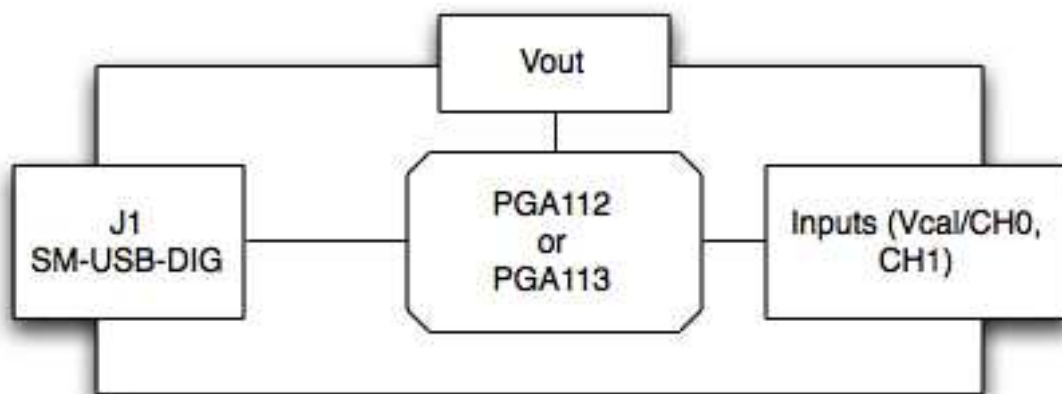


Figure 2. EVM Block Diagram

## 2.2 Signal Definitions of J1 (10-Pin Male Connector Socket)

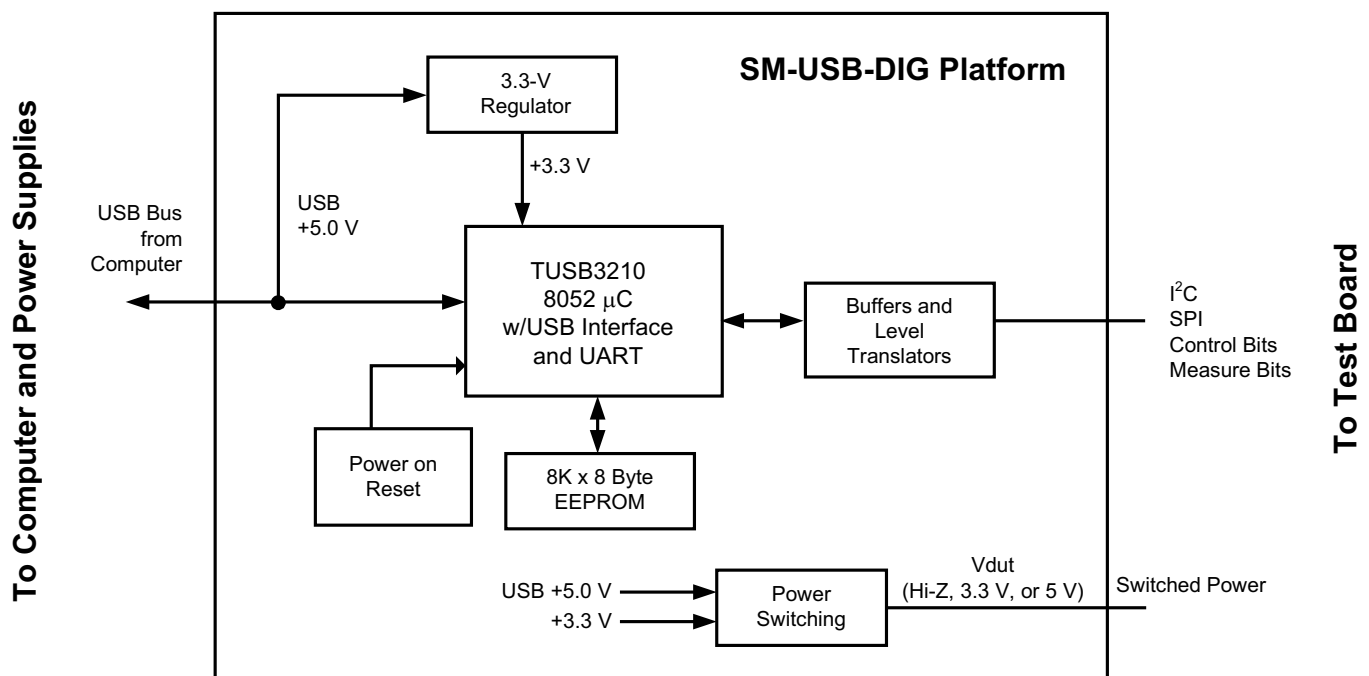
Table 2 shows the pin out for the 10-pin connector socket used to communicate between the EVM and the SM-USB-DIG. Note that the EVM uses only the I<sup>2</sup>C communication lines, VDUT (pin 6), GND (pin 8), and CTRL/MEAS4 (pin 2).

**Table 2. SM-USB-DIG Pin Definitions**

| Pin on U1 | Signal     | Description                                                                                                                |
|-----------|------------|----------------------------------------------------------------------------------------------------------------------------|
| 1         | I2C_SCL    | I <sup>2</sup> C clock signal (SCL)                                                                                        |
| 2         | CTRL/MEAS4 | GPIO. Control output or measure input                                                                                      |
| 3         | I2C_SDA1   | I <sup>2</sup> C data signal (SDA)                                                                                         |
| 4         | CTRL/MEAS5 | GPIO. Control output or measure input                                                                                      |
| 5         | SPI_DOUT1  | SPI data output (MOSI)                                                                                                     |
| 6         | VDUT       | Switchable DUT power supply: +3.3 V, +5 V, Hi-Z (disconnected).<br>NOTE: When VDUT is Hi-Z, all digital I/O are also Hi-Z. |
| 7         | SPI_CLK    | SPI clock signal (SCLK)                                                                                                    |
| 8         | GND        | Power return (GND)                                                                                                         |
| 9         | SPI_CS1    | SPI chip select signal ( $\overline{CS}$ )                                                                                 |
| 10        | SPI_DIN1   | SPI data input (MISO)                                                                                                      |

## 2.3 Theory of Operation for SM-USB-DIG Platform

Figure 3 shows the block diagram for the SM-USB-DIG Platform. This platform is a general-purpose data acquisition system that is used on several different Texas Instruments evaluation modules. The details of its operation are included in the SM-USB-DIG Platform User's Guide ([SBOU098](#)). The block diagram shown in Figure 3 is given as a brief overview of the platform.



**Figure 3. SM-USB-DIG Platform Block Diagram**

The primary component of the SM-USB-DIG Platform is the [TUSB3210](#), an 8052 microcontroller with a built-in USB interface. The microcontroller receives information from the host computer that is interpreted into power, I<sup>2</sup>C, SPI, and other digital I/O methods. During the digital I/O transaction, the microcontroller reads the response of any device connected to the I/O interface. The response from the device is sent back to the PC, where it is interpreted by the host computer.

### 3 EVM Hardware Overview

Using the PGA112EVM or PGA113EVM hardware requires connecting the SM-USB-DIG Platform and the EVM together, applying power, connecting the USB cable, and providing the input signal. This section presents the details of these procedures.

#### 3.1 Electrostatic Discharge Warning

Many of the components on the PGA112EVM and PGA113EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

#### 3.2 Connecting the Hardware

To connect the EVM board and the SM-USB-DIG Platform together, firmly slide the male and female ends of the 10-pin connectors together, as shown in [Figure 4](#). Make sure that the two connectors are completely pushed together; loose connections may cause intermittent operation.



**Figure 4. Typical EVM Hardware Connections**

#### 3.3 Connecting the USB Cable to the SM-DIG-Platform

[Figure 5](#) shows the typical response when connecting the SM-USB-DIG Platform board to a PC USB port for the first time. Typically, the computer responds with a *Found New Hardware, USB Device* pop-up dialog. The pop-up window then usually changes to *Found New Hardware, USB Human Interface Device*. This pop-up indicates that the device is ready to be used. The SM-USB-DIG Platform uses the human interface device drivers that are part of the Microsoft Windows™ operating system.



**Figure 5. Confirmation of SM-USB-DIG Platform Driver Installation**

In some cases, the *Windows Add Hardware Wizard* starts. If this prompt appears, allow the system device manager to install the human interface drivers by clicking Yes when requested to install drivers.

### 3.4 Powering the EVM

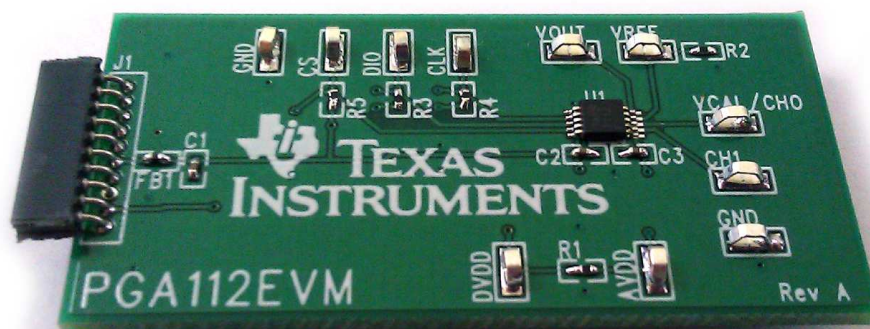
By default, a 0- $\Omega$  resistor (R1) is used to short DVDD and AVDD together, with both being supplied by the SM-USB-DIG Platform. If a different supply is desired for AVDD, R1 can be removed and the supply can be connected to the AVDD and GND test points. The SM-USB-DIG Platform can supply 5 V or 3.3 V to the EVM.

### 3.5 EVM Features

This section describes some of the hardware features present on the PGA112EVM and PGA113EVM boards. Note that these two EVMs are identical except for the device name.

#### 3.5.1 Communication Test Points

The PGA112EVM and PGA113EVM boards feature test points (CS, DIO, and CLK) for monitoring communication between the SM-USB-DIG Platform and the PGA112 (or PGA113) device, as shown in [Figure 6](#). The test points allow external signals to be connected if the EVM is integrated into a custom application or prototype. Note that if the SM-USB-DIG Platform is not being used, an external power source must be connected to DVDD and AVDD.



**Figure 6. PGA112EVM Hardware**  
(Note that the PGA113EVM is identical except for the device name)

#### 3.5.2 Output Test Points

Test point VOUT is used for measuring the output of the EVM.

#### 3.5.3 Voltage Reference

For simplicity, the VREF input of the EVM is shorted to ground through 0- $\Omega$  resistor R2 by default. If a different VREF is desired, R2 can be removed.

#### 3.5.4 Analog Input Signals

Test points VCAL/CH0 and CH1 are used for connecting the input signals to the EVM, as shown in [Figure 6](#).

## 4 EVM Software Setup

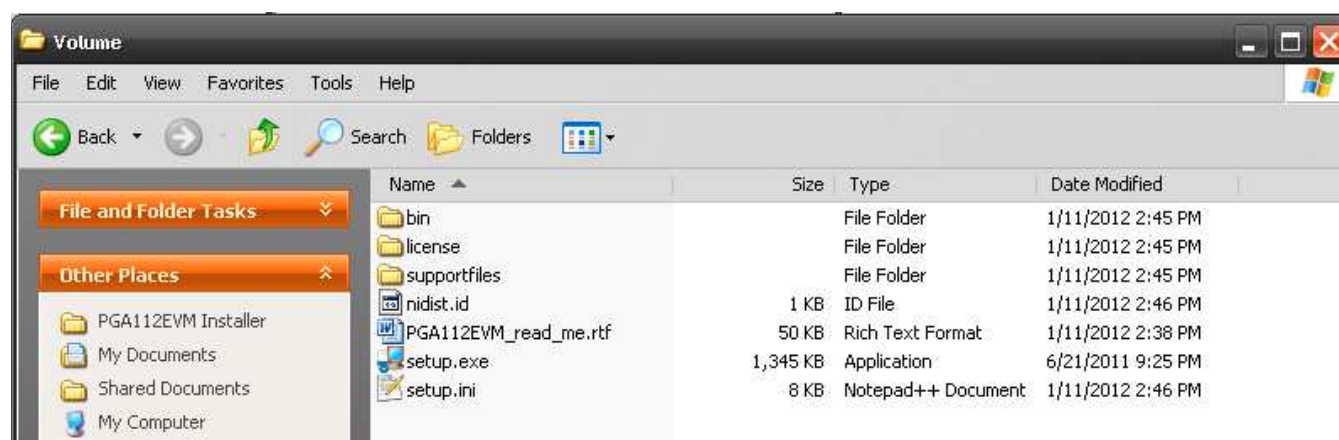
This section discusses how to install the EVM software.

### 4.1 Operating Systems for EVM Software

The EVM software has been tested on the Microsoft Windows XP™ operating system (OS) with United States and European regional settings. The software should also function on other Windows operating systems.

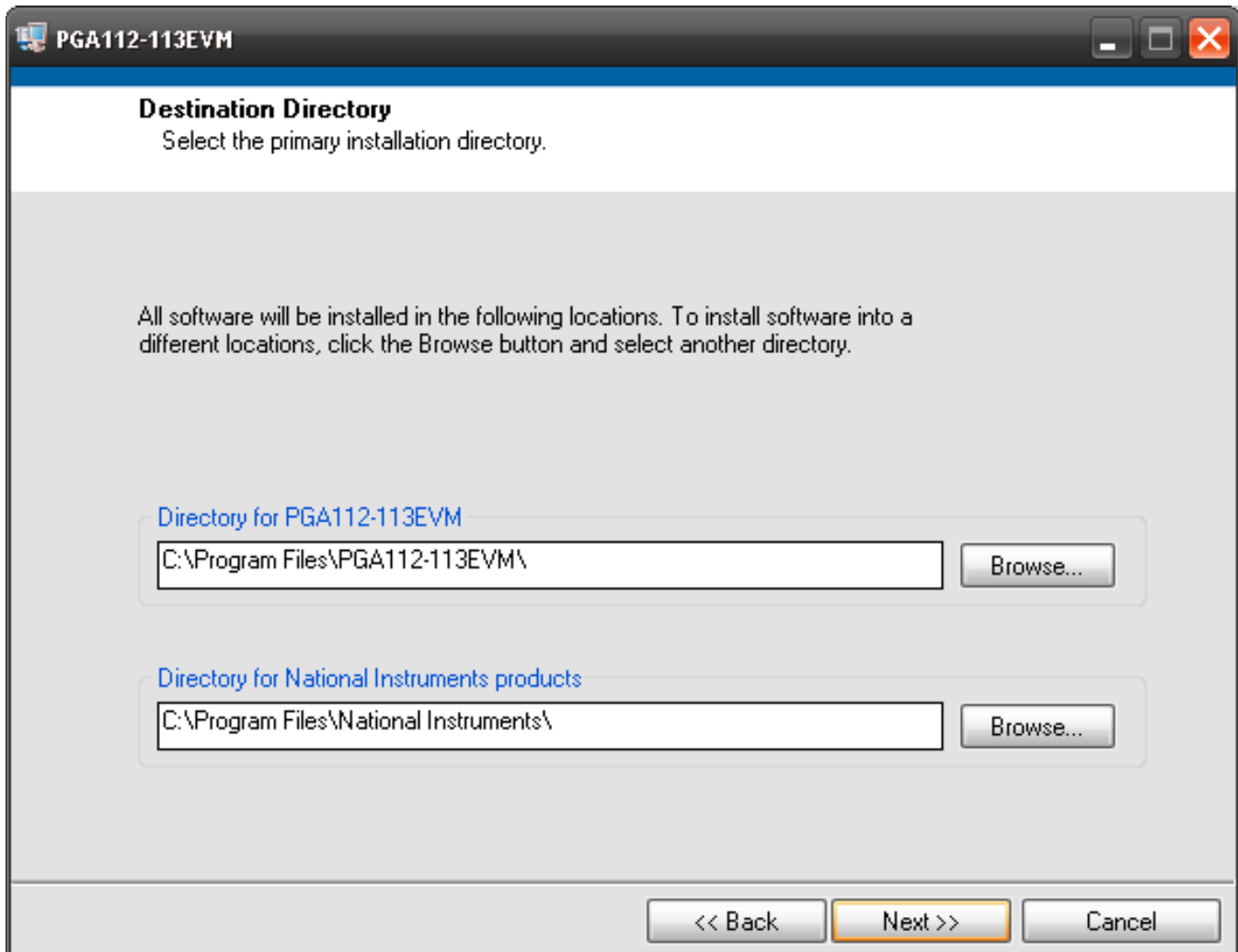
### 4.2 Software Installation

The EVM software is included on the CD that is shipped with the EVM kit. It is also available through the PGA112EVM or PGA113EVM product folder on the TI web site. To install the software to your system, insert the disc into an available CD-ROM drive and navigate to the drive contents. Locate the compressed file (*PGA112-113EVM-Software*), open it, find the *setup.exe* file (as shown in [Figure 7](#)), and run it to start the installation. The PGA112-113EVM software installer then begins the installation process.



**Figure 7. EVM Installer Files**

After the install initializes, choose the directory where the program is installed; usually, the default directory is *C:\Program Files\PGA112-113EVM\* and *C:\Program Files\National Instruments\*, as shown in [Figure 8](#). Following this step, two license agreements are presented that must be accepted. After accepting the Texas Instruments and National Instruments license agreements, the progress bar opens and shows the installation of the software. After the installation process is completed, click *Finish*.



**Figure 8. Install Path**

## 5 EVM Software Overview

This section describes how to use the EVM software.

### 5.1 Starting the EVM Software

The EVM software can be operated through the Start menu in Windows. From the Start menu, select *All Programs*, and then select the PGA112-113EVM program. Figure 9 illustrates how the software should appear at launch if the PGA112EVM (or PGA113EVM) is functioning properly.

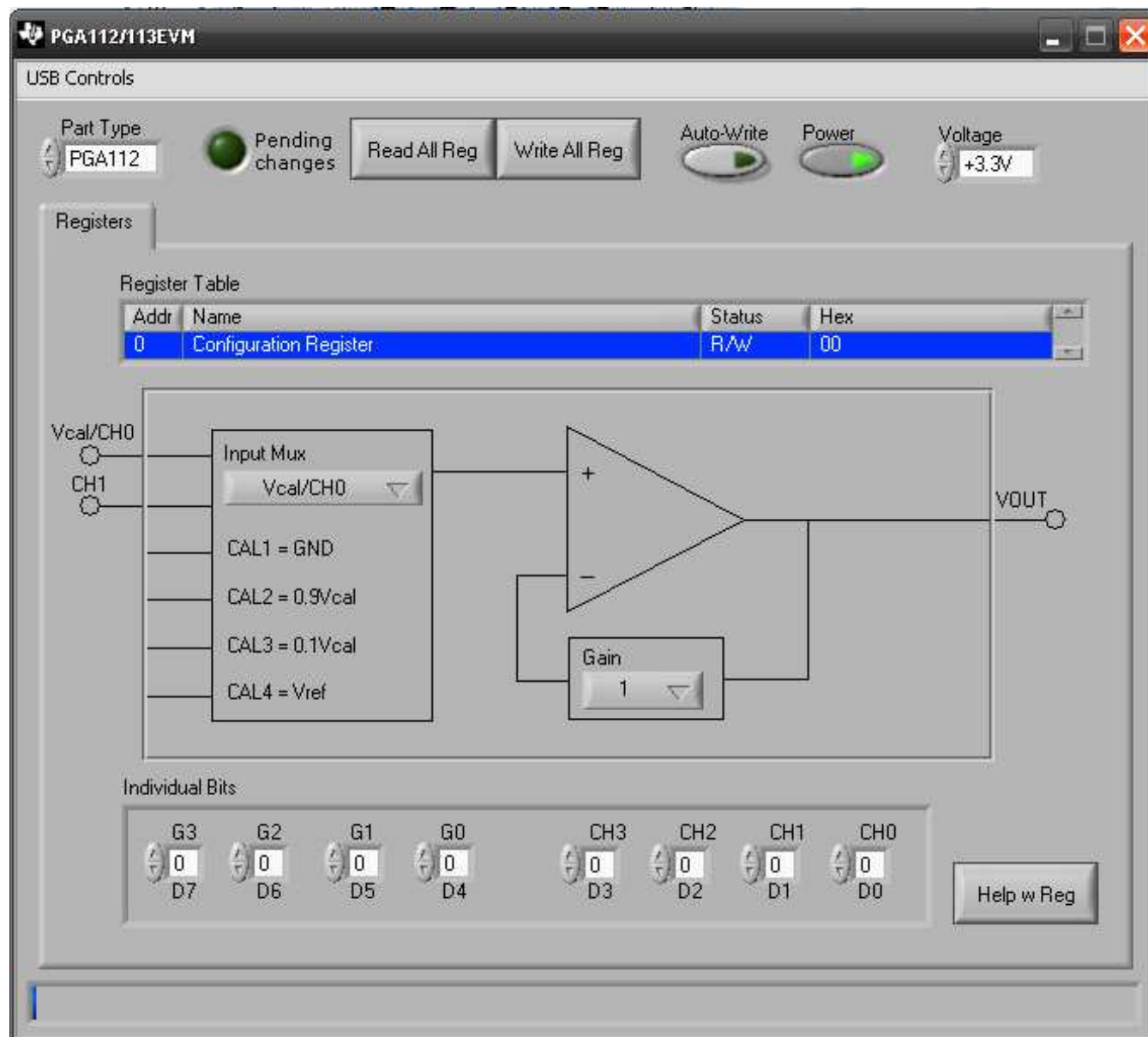
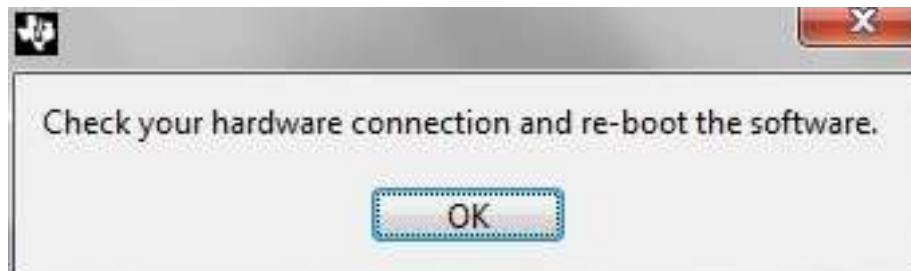


Figure 9. EVM Software Interface

Figure 10 shows the error that appears if the computer cannot communicate with the EVM. In the event you receive this error, first ensure that the both ends of the USB cable are properly connected. This error can also occur if you connect the USB cable before the EVM is powered on (if using an external supply as described in Section 3.4). Another possible source for this error is a problem with your computer USB human interface device (HID) driver. Make sure that the device is recognized when the USB cable is plugged in, indicated by a Windows-generated confirmation sound.

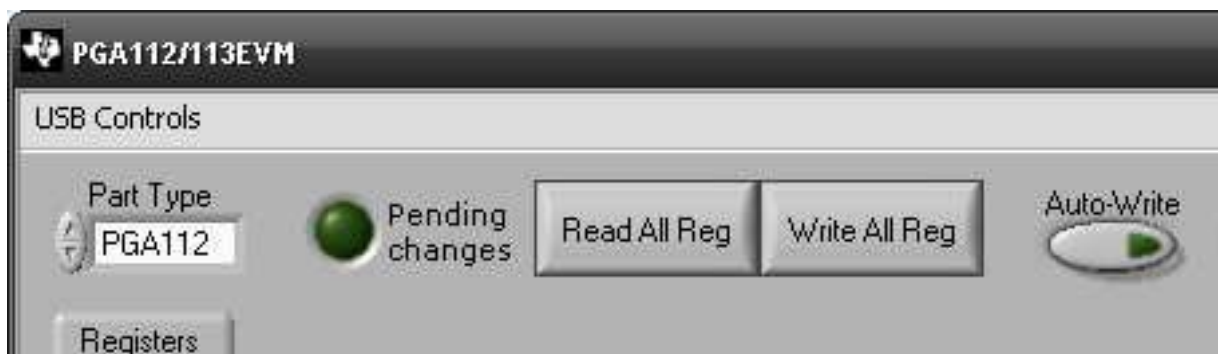


**Figure 10. Communication Error with SM-USB-DIG Platform**

## 5.2 EVM Software Features

### 5.2.1 Selecting Correct EV

The EVM software can be configured to communicate to either the PGA112EVM or the PGA113EVM. The *Part Type* selection field is used to select the correct device, as shown in Figure 11. This setting is automatically saved.



**Figure 11. Read, Write, and Auto-Write Buttons**

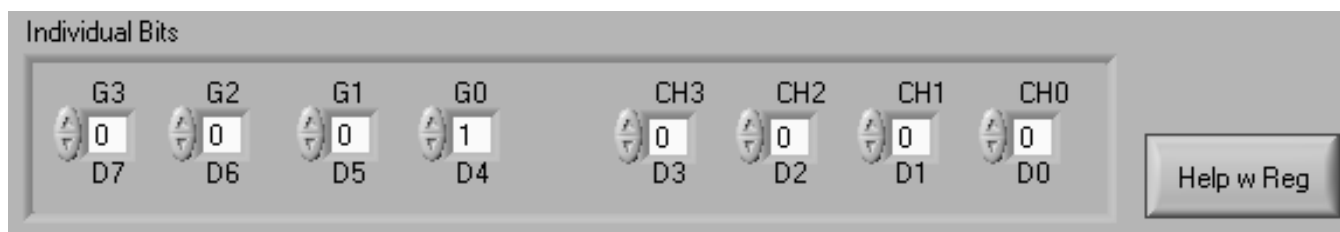
### 5.2.2 Reading and Writing to Registers

The EVM software only reads and writes to the PGA112 (or PGA113) registers at the user's command. This is accomplished with the *Read All Reg* and *Write All Reg* buttons, as shown in Figure 11. When any change is made to the configuration register, the green light is lit to show that changes are pending. Pressing the *Write All Reg* button writes the pending changes to the PGA112 (or PGA113). In addition, by enabling the *Auto-Write* button, changes are written to the configuration register automatically.

The PGA112 is read only when the *Read All Reg* button is pressed. To verify that the PGA112 (or PGA113) successfully stored the data, read from the device after writing to the configuration register.

### 5.2.3 Setting Individual Bits

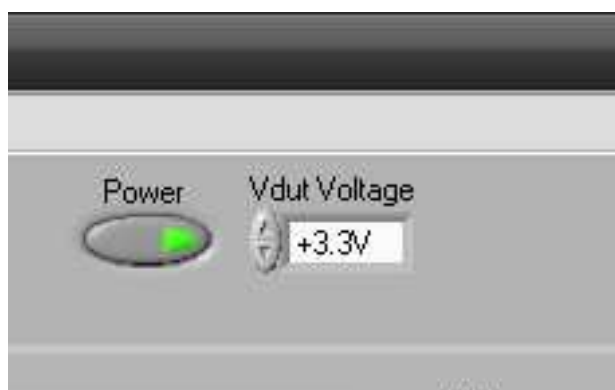
Use the *Individual Bits* panel to set the individual bits of the PGA112 (or PGA113) configuration register. The panel, shown in [Figure 12](#), has a settable bank for all bits in the register. Press the *Help w Reg* button for information about the register.



**Figure 12. Individual Bits Panel and Help w Reg Button**

### 5.2.4 Setting DVDD and AVDD

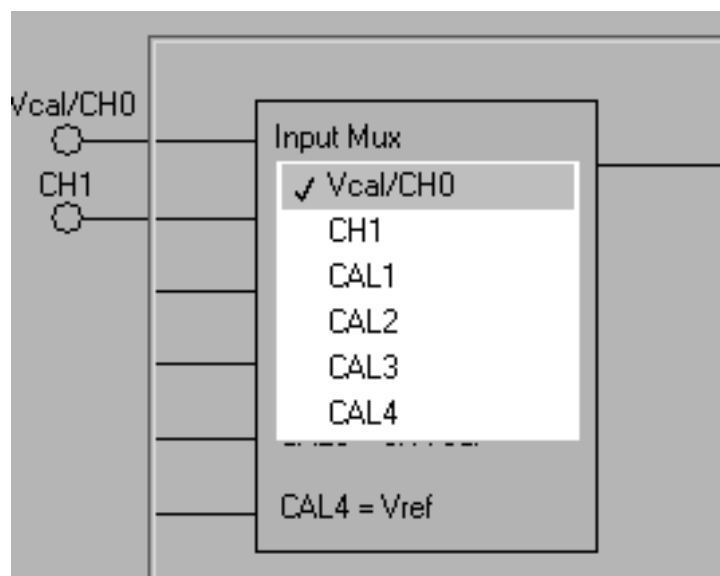
The SM-USB-DIG Platform supports two logic-level voltages: 3.3 V and 5 V. Set the voltage by using the *Vdut Voltage* menu, as shown in [Figure 13](#). Disable the voltage from the SM-USB-DIG Platform by toggling the *Power* button.



**Figure 13. Setting DVDD Voltage**

### 5.2.5 Setting the Input Multiplexer

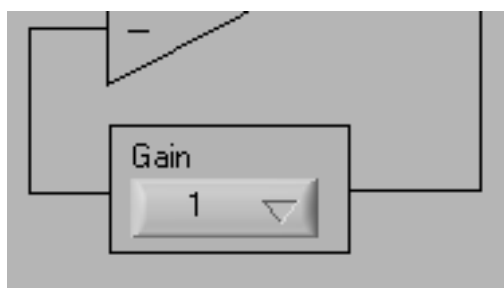
The input multiplexer (mux) of the PGA112 (or PGA113) device can be set by the *Input Mux* drop-down menu shown in [Figure 14](#). External test points VCAL/CH0 and CH1 can be selected in this menu, as well as the various calibration inputs.



**Figure 14. Input Mux Configuration**

### 5.2.6 Setting Gain

Use the *Gain* drop-down menu shown in [Figure 15](#) to configure the PGA112 (or PGA113) device gain value.



**Figure 15. Setting the Gain**

## 6 EVM Documentation

This section contains the complete bill of materials, schematic diagram, and PCB layout for the PGA112EVM and PGA113EVM. Documentation information for the SM-USB-DIG Platform can be found in the *SM-USB-DIG Platform User's Guide*, [SBOU098](#), available for download at [www.ti.com](#).

### 6.1 PGA112EVM and PGA113 Bill of Materials

[Table 3](#) lists the bill of materials for both the PGA112EVM and PGA113EVM test boards.

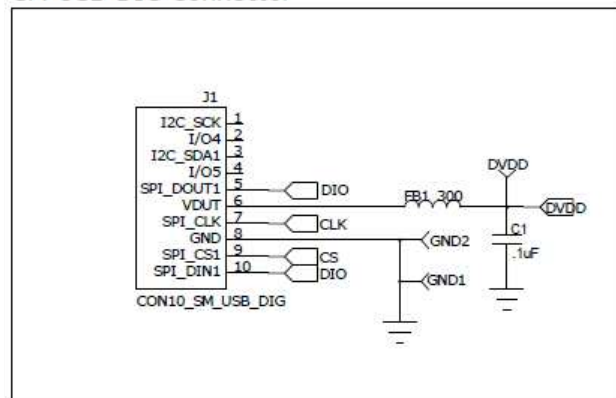
**Table 3. EVM Bill of Materials**

| Quantity                       | Value         | Ref Des                                                      | Description                                                       | Vendor                           | Part Number          |
|--------------------------------|---------------|--------------------------------------------------------------|-------------------------------------------------------------------|----------------------------------|----------------------|
| <b>PGA112EVM and PGA113EVM</b> |               |                                                              |                                                                   |                                  |                      |
| 1                              | N/A           | J1                                                           | CONN SOCKET 10PIN .050 R/A SNGL                                   | Mill-Max Manu. Corp.             | 851-43-010-20-001000 |
| 2                              | N/A           | 1, 2                                                         | BUMPON CYLINDRICAL .375X.135 BLK                                  | 3M                               | SJ61A8               |
| 11                             | N/A           | AVDD, CH1, VCAL/CH0, CLK, CS, DIO, DVDD, VOUT, VREF, GND(x2) | TEST POINT, MINIATURE                                             | Keystone Electronics             | 5015                 |
| 3                              | 0.1 $\mu$ F   | C1, C2, C3                                                   | CAPACITOR CER .1UF 16V, 0402                                      | Murata Electronics North America | GRM155R71C104KA88D   |
| 2                              | 0 $\Omega$    | R1, R2                                                       | RESISTOR, 0 $\Omega$ , 0402                                       | Yageo                            | RC0402JR-070RL       |
| 3                              | 10 k $\Omega$ | R3, R4, R5                                                   | RESISTOR, 10K $\Omega$ , 0402, 1/16W, 5%                          | Yageo                            | RC0402JR-0710KL      |
| 1                              | N/A           | FB1                                                          | FERRITE BEAD, 300 $\Omega$ , .2A, 0402                            | Würth                            | 74279272             |
| <b>PGA112EVM Only</b>          |               |                                                              |                                                                   |                                  |                      |
| 1                              | N/A           | U1                                                           | PG112, Zero-Drift, Programmable Gain Amplifier with MUX, MSOP-10  | Texas Instruments                | PGA112AIDGSR         |
| <b>PGA113EVM Only</b>          |               |                                                              |                                                                   |                                  |                      |
| 1                              | N/A           | U1                                                           | PGA113, Zero-Drift, Programmable Gain Amplifier with MUX, MSOP-10 | Texas Instruments                | PGA113AIDGSR         |

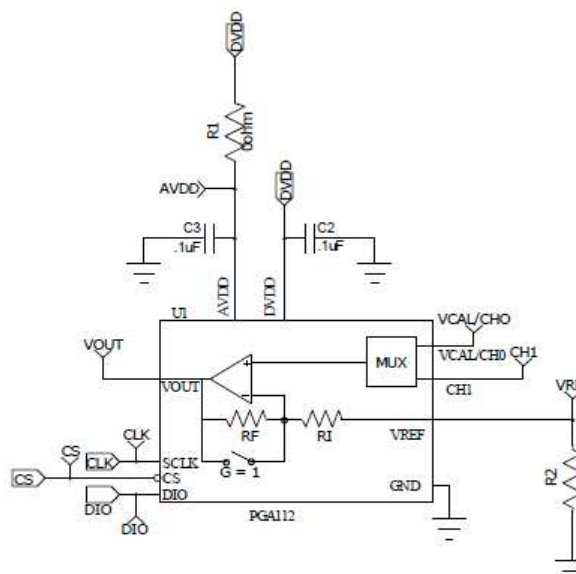
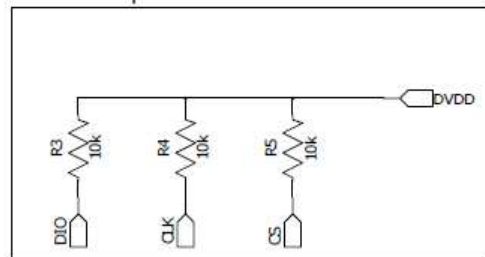
## 6.2 EVM Schematic

Figure 16 shows the schematic for the PGA112EVM. Note that the PGA113 schematic is identical except for the device name.

SM-USB-DIG Connector



SPI Pull-ups



R1 is used to separate AVdd from Vdut. This requires an addition supply to be connected to the EVM

R2 is used to disconnect Vref from ground if a specific Vref is desired

Figure 16. EVM Schematic

### 6.3 PCB Layout

Figure 17 shows the layout of the components for the PGA112EVM board. Note that the PGA113EVM layout is identical, except for the device name.

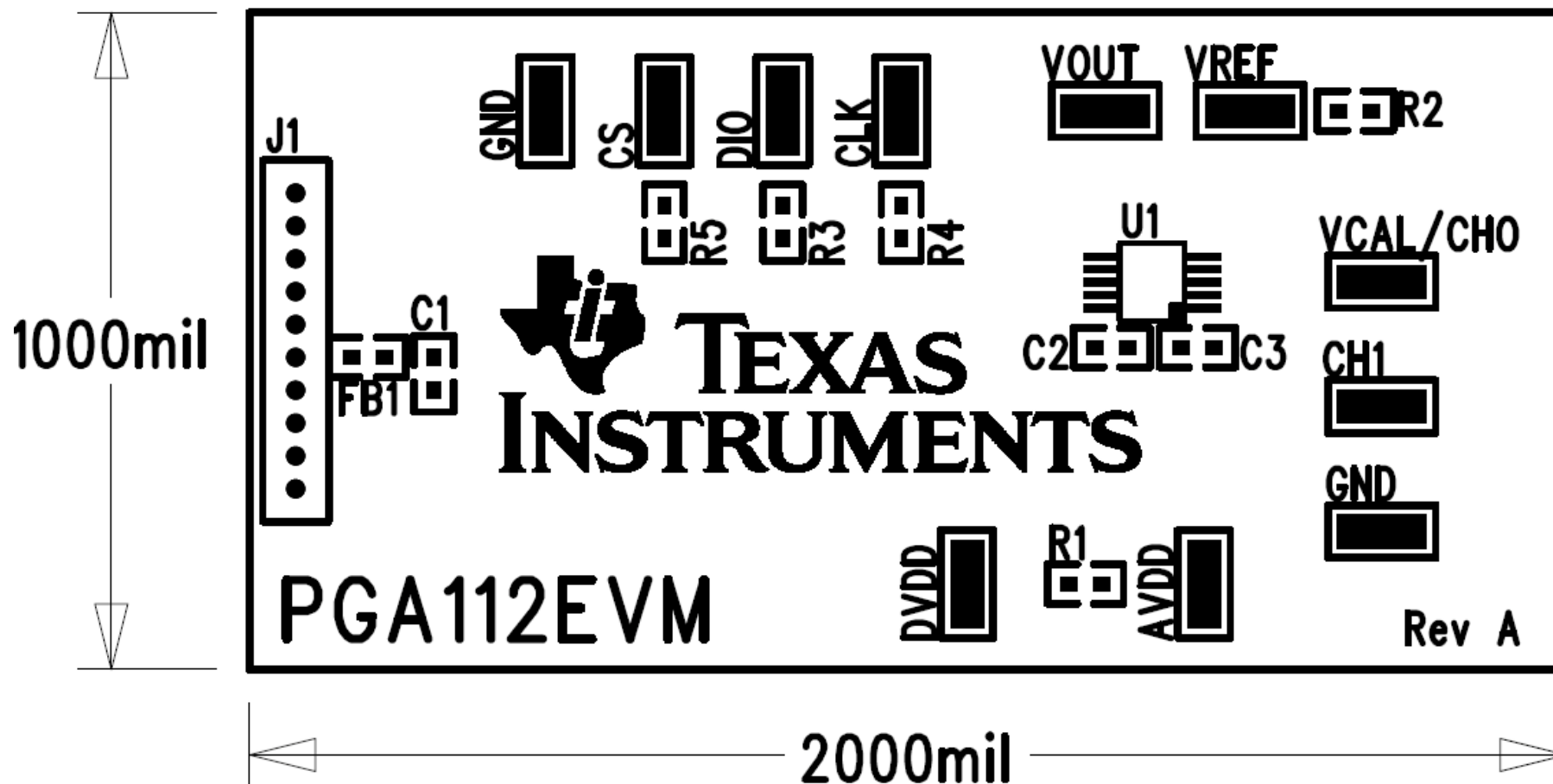


Figure 17. PCB Component Layout

## 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.

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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 0V to 5V and the output voltage range of 0 V to 5 V.

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

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than +25°C. The EVM is designed to operate properly with certain components above +125°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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