PGA308EVM

User's Guide

TEXAS INSTRUMENTS

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PGA308EVM

About This Manual

This user's guide describes the characteristics, operation, and use of the PGA308 evaluation module (EVM). It discusses the processes and procedures required to properly use this EVM board. This document also includes the physical printed circuit board (PCB) layout, schematic diagram, and circuit descriptions.

Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instruments integrated circuits used in the assembly of the PGA308EVM. These documents are available from the TI web site under the respective literature number (for example, SBxxnnn). Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this User's Guide. Newer revisions may be available from the TI web site at 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
PGA308	SBOS440
XTR116	SBOS124
TUSB3210	SLLS466
USB DAQ Platform	SBOU056

Information About Cautions and Warnings

This document contains caution statements.

> **CAUTION**
>
> This is an example of a caution statement. A caution statement describes a situation that could potentially damage your software or equipment.

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

FCC Warning

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of 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 is required to take whatever measures may be required to correct this interference.

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All other trademarks are the property of their respective owners.

Overview

This document provides the information needed to set up and operate the PGA308EVM evaluation module, a test platform for the PGA308 *Programmable Bridge Sensor*. For a more detailed description of this device, see the PGA308 product data sheet (SBOS440) available from the Texas Instruments web site at www.ti.com. Support documents are listed in the section of this guide entitled *Related Documentation from Texas Instruments*.

The PGA308EVM is an evaluation module that is used to fully evaluate the PGA308 device. The PGA308 is a mixed-signal programmable gain amplifier that has high resolution gain and offset adjustment capability.

The PGA308EVM consists of two PCBs. One board generates the digital signals (USB DAQ Platform) required to communicate with the PGA308 (PGA308_Test_Board), and the second board contains the PGA308, as well as support and configuration circuitry.

Throughout this document, the abbreviation EVM and the term *evaluation module* are synonymous with the PGA308EVM.

1.1 PGA308EVM Hardware

Figure 1-1 shows the hardware included with the PGA308EVM kit. Contact the factory if any component is missing. TI highly recommendeds that you check the TI web site (at http://www.ti.com) to verify that you have the latest software.

The complete kit includes the following items:

- PGA308 test PCB
- USB DAQ platform PCB
- USB cable
- Power cord
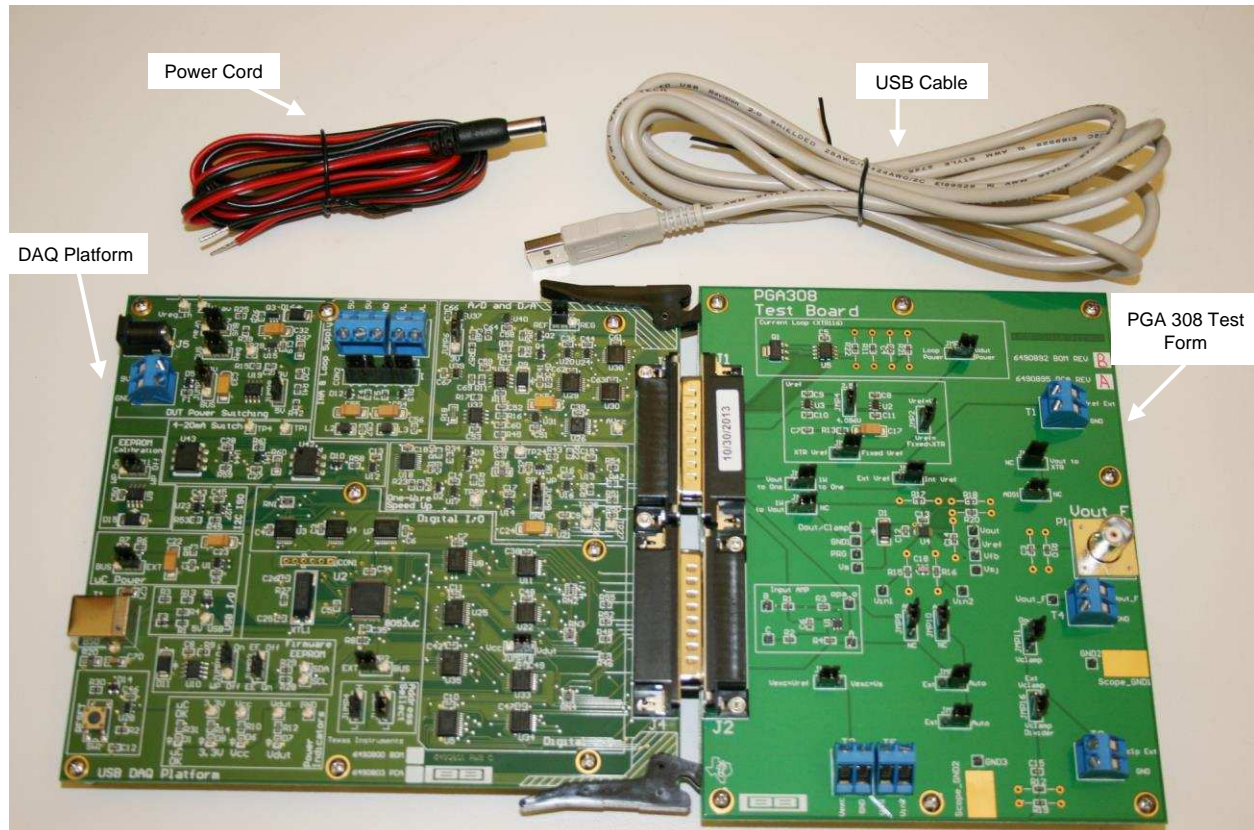
Figure 1-1. Hardware Included With the PGA308EVM

System Setup

Figure 2-1 shows the system setup for the PGA308EVM. The PC runs software that communicates with the USB DAQ platform. The USB DAQ platform generates the digital signals used to communicate with the PGA308 test board. Connectors on the PGA308 test board allow for connection to the system that will be monitored by the user.

Minimim PC operating requirements:

- Microsoft® Windows® XP or higher (including Windows Vista™)
- USB port
- Works on US or European regional settings
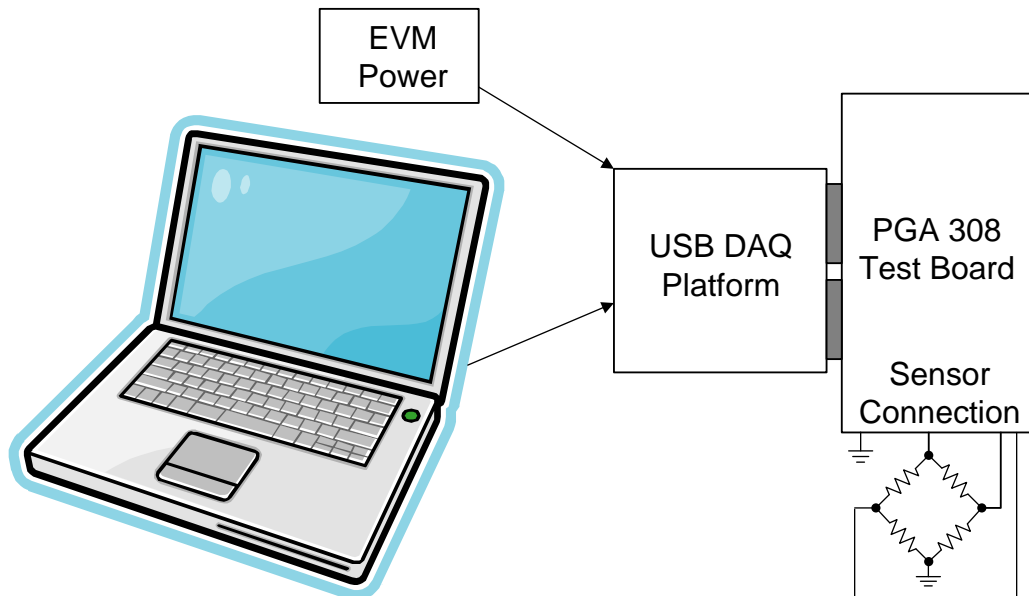
Figure 2-1. Hardware Setup for the PGA308EVM

2.1 Theory of Operation for the PGA308 Test Board Hardware

Figure 2-2 shows the block diagram of the PGA308 test board. The PGA308 test board functionality is relatively simple. It provides connections to the one-wire interface, digital-to-analog converter (DAC), analog-to-digital converter (ADC), and general-purpose inputs/outputs (GPIOs) on the USB DAQ platform. It also provides connection points for external connection of the bridge sensor, reference, and outputs.
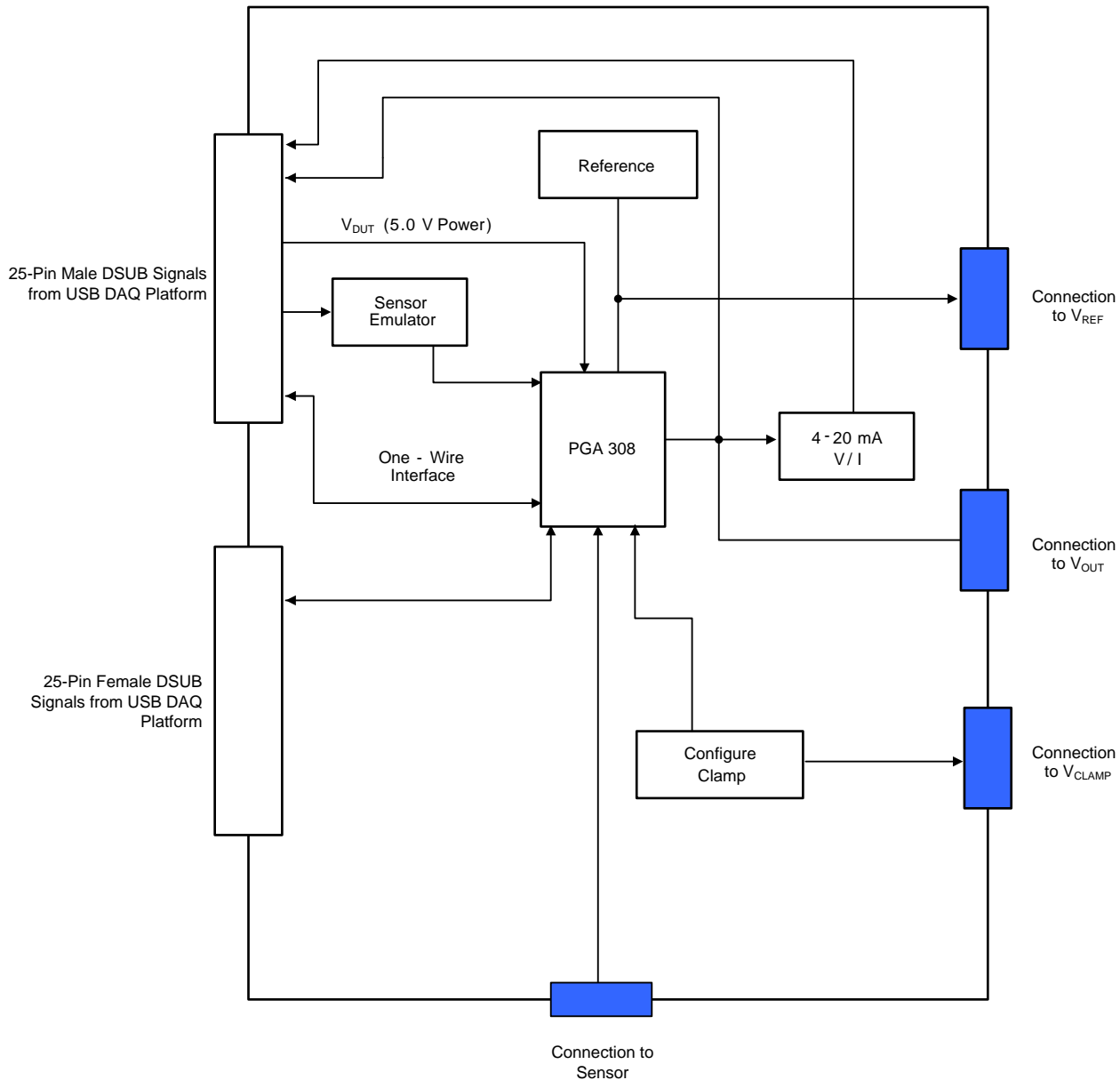
Figure 2-2. Block Diagram of the PGA308 Test Board

See SBOR004 for the PGA308 test board schematic, available for download at www.ti.com.

2.2 Signal Definition of J1 (25-Pin Male DSUB) on the PGA308 Test Board

Table 2-1 shows the different signals connected to J1 on the PGA308 test board. Table 2-1 also identifies signals connected to pins on J1 that are not used on the PGA308 test board.

Table 2-1. Signal Definition of J1

| Pin Number	Signal Name from USB DAQ Platform	Description
1	DAC_A	To input amplifier (sensor emulator); 16-bit string DAC A output.
2	DAC_B	To input amplifier (sensor emulator); 16-bit string DAC B output.
3	DAC_C	To input amplifier (sensor emulator); 16-bit string DAC C.
4	DAC_D	Not used
5	ADS1_V_{IN+}	To PGA308 output; 16-bit delta-sigma ($\Delta\Sigma$) ADC #1 positive input.
6	ADS1_V_{IN-}	Grounded for single-ended measurements; 16-bit $\Delta\Sigma$ ADC #1 negative input.
7	ADS2_V_{IN+}	PGA308 V_{IN2} input; 16-bit $\Delta\Sigma$ ADC #2 positive input.
8	ADS2_V_{IN-}	PGA308 V_{IN1} input; 16-bit $\Delta\Sigma$ ADC #2 negative input.
9	I^{2}C_SCK	Not used
10	I^{2}C_SDA2	Not used
11	ONE_WIRE	PGA308 1W pin; one-wire signal (derived from the UART on the TUSB3210 device).
12	I^{2}C_SDA_ISO	Not used
13	I^{2}C_SCK_ISO	Not used
14	XTR+LOOP	To XTR116 pin 7 on EVM. Current-loop positive-loop connection; this signal is connected to the positive-loop supply.
15	XTR–LOOP	To XTR116 pin 4 on EVM. Current-loop negative-loop connection; this signal connects the DUT current output to the current measurement circuit.
16	INA–	Not used
17	V_{DUT}	To PGA308 VS power-supply pin; switched 3 V or 5 V supply.
18	V_{CC}	Not used
19	+15V	Not used
20	–15V	Not used
21	GND	Ground
22	SPI_SCK	Not used
23	SPI_CS1	Not used
24	SPI_DOUT1	Not used
25	SPI_DIN1	Not used

2.3 Signal Definition of J2 (25-Pin Female DSUB) on the PGA308 Test Board

Table 2-2 shows the different signals connected to J2 on the PGA308 test board. Table 2-2 also identifies signals connected to pins on J2 that are not used on the PGA308 test board.

Table 2-2. Signal Definition of J2

Pin Number	Signal Name from USB DAQ Platform	Description
1	P3.3	Not used
2	CTRL1	Not used
3	CTRL2	Not used
4	CTRL3	Not used
5	CTRL4	Not used
6	CTRL5	Not used
7	CTRL6	Not used
8	CTRL7	Not used
9	CTRL8	Not used
10	MEAS1	To D_{OUT} on the PGA308. This pin is a measure bit that can read logic signals; it is part of an 8-bit group.
11	MEAS2	Not used
12	MEAS3	Not used
13	MEAS4	Not used
14	MEAS5	Not used
15	MEAS6	Not used
16	MEAS7	Not used
17	MEAS8	Not used
18	SPI_SCK	Not used
19	SPI_CS2	Not used
20	SPI_DOUT2	Not used
21	SPI_DIN2	Not used
22	V_{DUT}	Not used
23	V_{CC}	Not used
24	GND	Not used
25	GND	Not used

2.4 Theory of Operation For the USB DAQ Platform

Figure 2-3 shows the block diagram for the USB DAQ platform. This platform is a general-purpose data acquisition system that is used on several different Texas Instruments evaluation modules. The block diagram shown in Figure 2-3 illustrates the general platform outline. The core component of the USB DAQ platform is the TUSB3210.
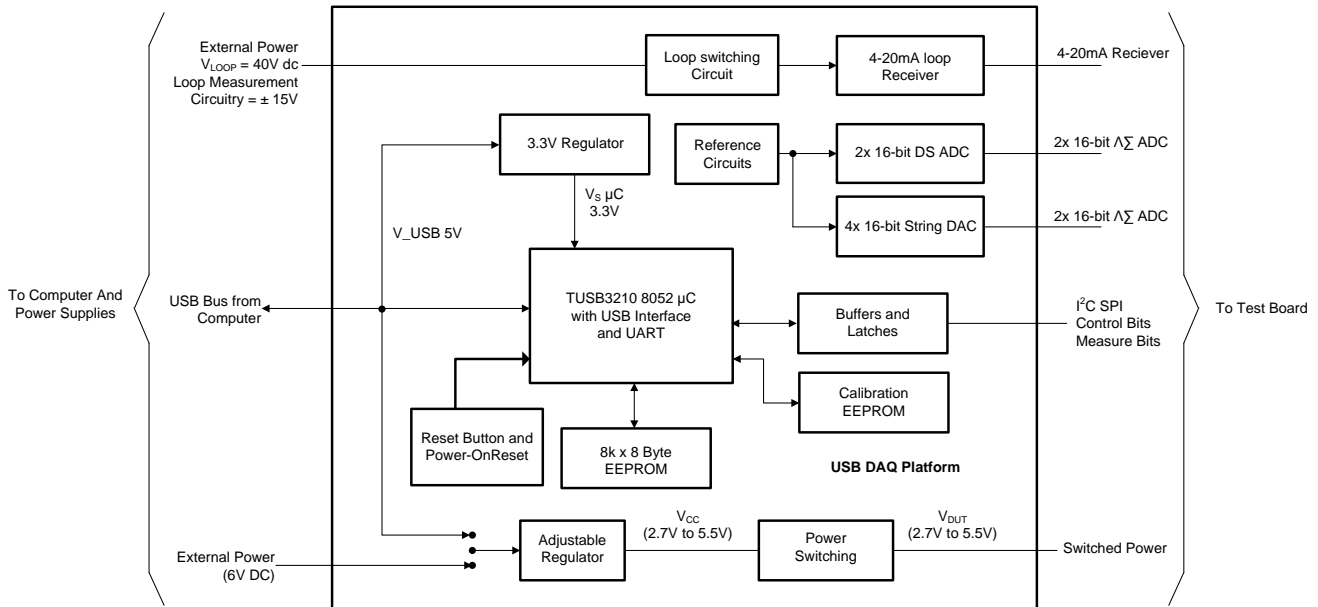

Figure 2-3. Theory of Operation For the USB DAQ Platform

Hardware Connections and Jumper Settings

Many of the components on the PGA308EVM 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.

CAUTION

Failure to observe ESD handling procedures may result in damage to EVM components.

3.1 Typical Hardware Connections

A typical PGA308EVM hardware setup connects the two EVM PCBs, then supplies power and connects an external shunt and load. The external connections may be the real-world system to which the PGA308 will be connected. Figure 3-1 shows the typical hardware connections.
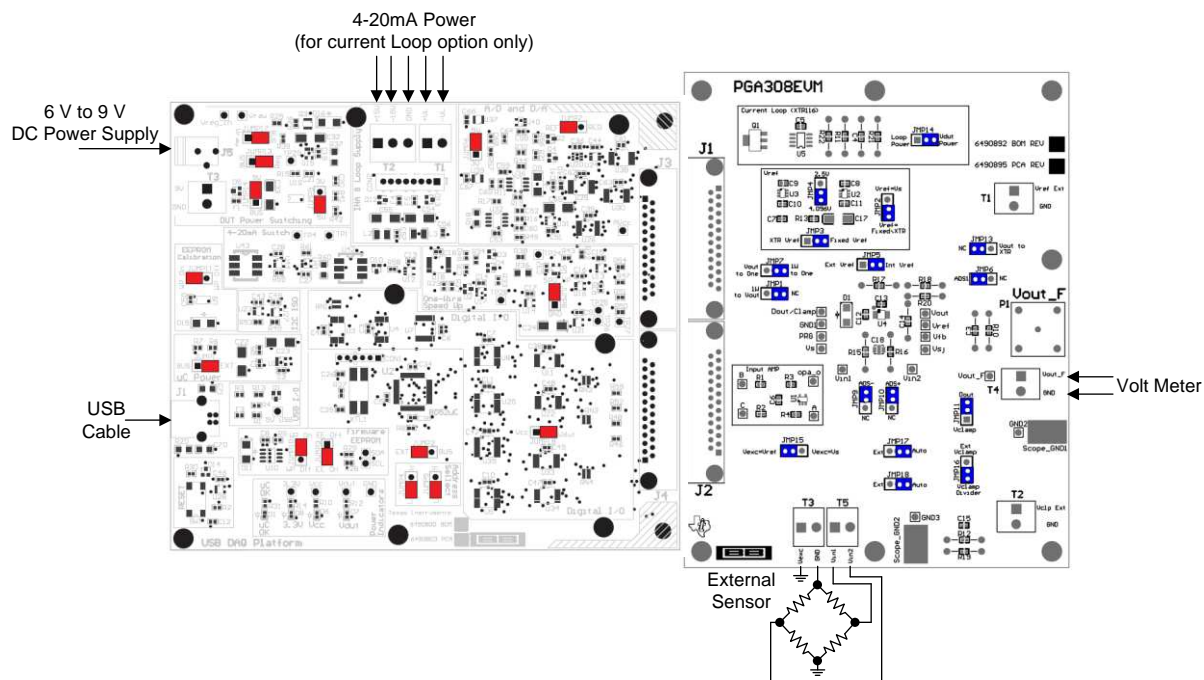

Figure 3-1. Typical Hardware Connections

3.2   Connecting the Hardware

The best way to connect the two PGA308EVM PCBs together is to gently push on both sides of the DSUB connectors, as shown in Figure 3-2. Make sure that the two connectors are completely socketed together; loose connections may cause intermittent EVM operation.

Figure 3-2. Connecting the Two EVM PCBs
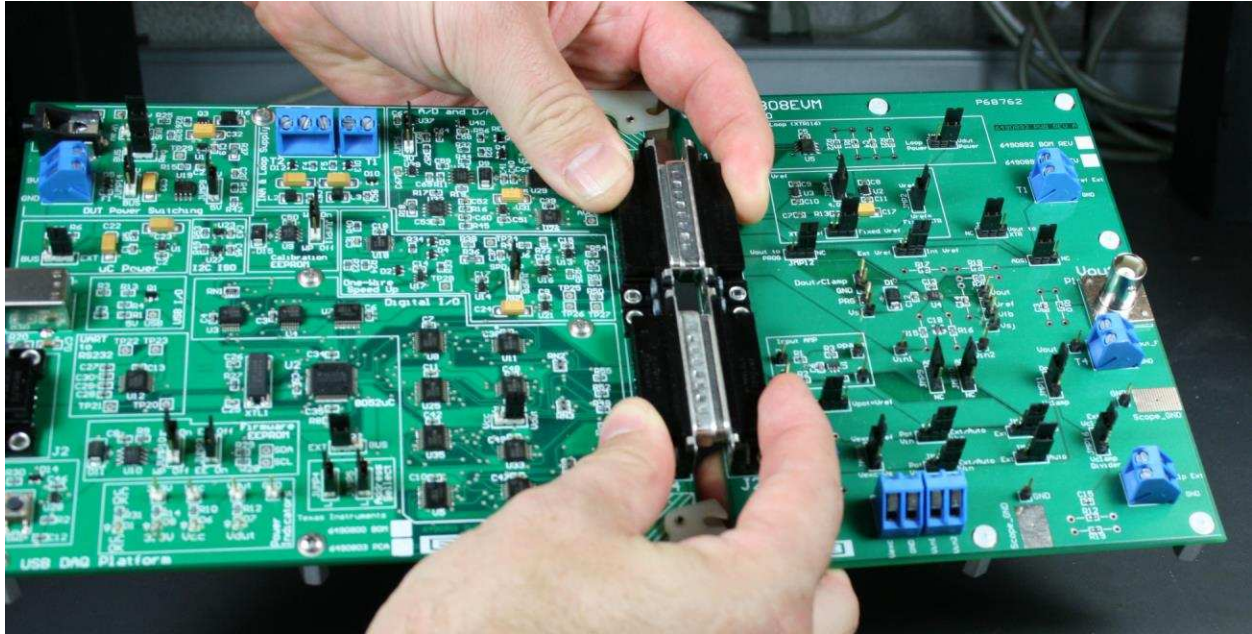
3.3   Connecting Power

Connect the two PGA308EVM PCBs before connecting a power source, as shown in Figure 3-3. Always connect power before connecting the USB cable. If the USB cable is connected before the power is supplied, the computer will attempt to communicate with an unpowered device, and the device will not be able to respond.
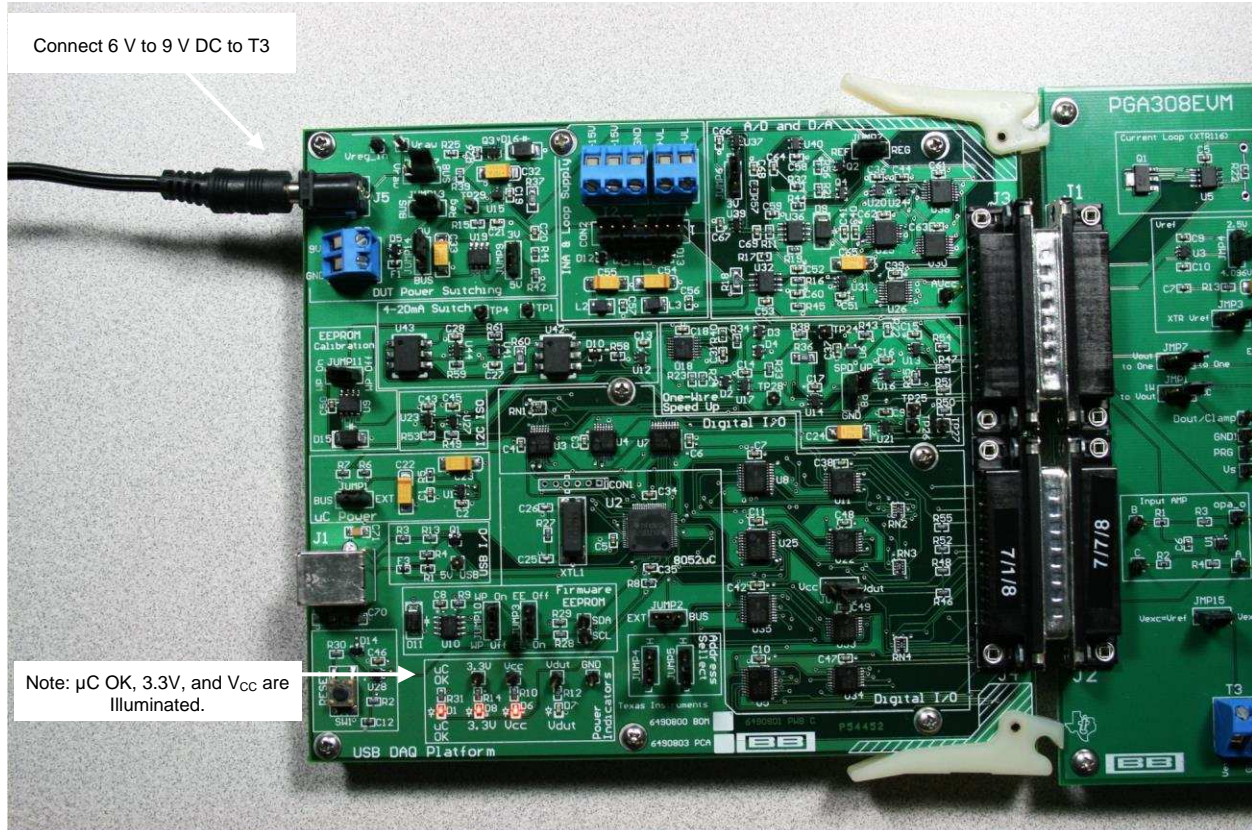

Figure 3-3. Connecting Power to the EVM

3.4   Connecting the USB Cable to the PGA308EVM

Figure 3-4 shows the typical response to connecting the USB DAQ platform to a PC USB port for the first time. Note that the EVM must be powered up before connecting the USB cable. Typically, the computer will respond with a *Found New Hardware*, *USB Device* pop-up. The pop-up typically changes to *Found New Hardware*, *USB Human Interface Device*. This pop-up indicates that the device is ready to be used. The USB DAQ platform uses the Human Interface Device Drivers that are part of the Microsoft Windows operating system. In some cases, the *Windows Add Hardware Wizard* will pop-up. If this prompt occurs, allow the system device manager to install the Human Interface Drivers by clicking *Yes* when requested to install drivers.

Figure 3-4. Connecting the USB Cable

3.5 Jumper Settings

Figure 3-5 shows the default jumper configuration for the PGA308EVM. In general, the jumper settings of the USB DAQ platform do not need to be changed. However, you may want to change some of the jumpers on the PGA308 test board to match your specific device configuration (for example, to change the reference configuration).
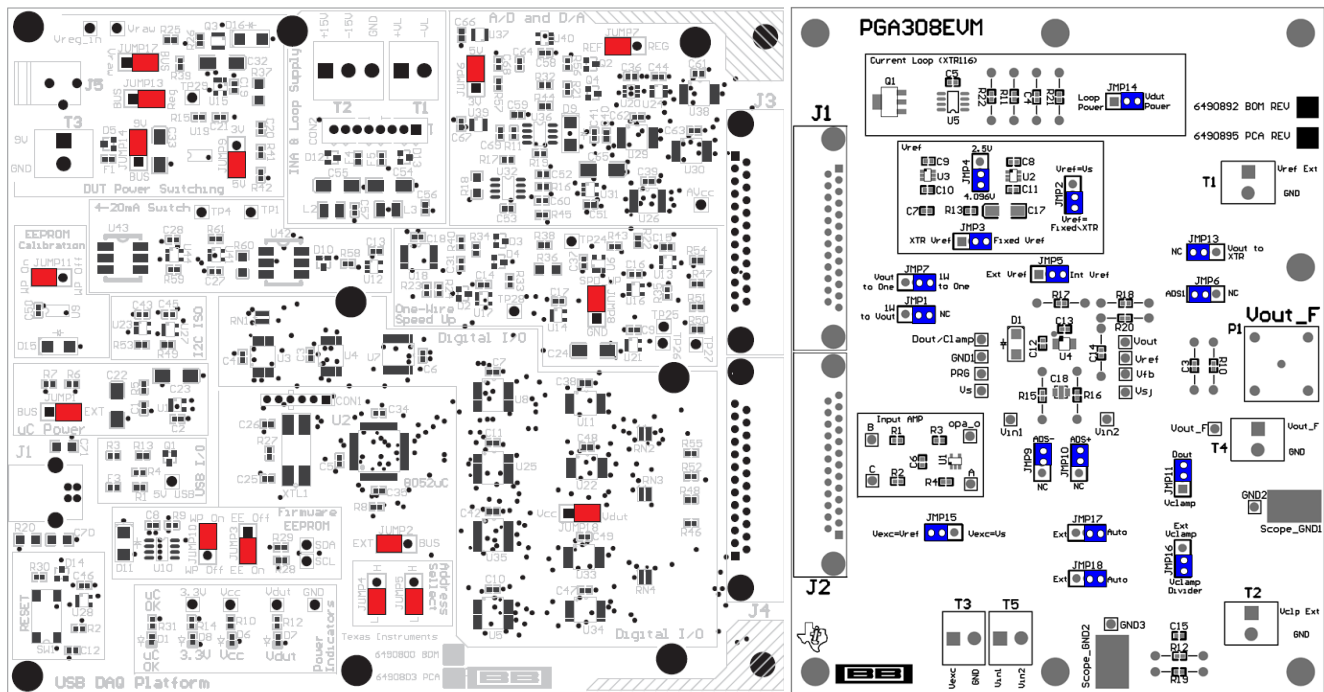

Figure 3-5. Default Jumper Settings

Table 3-1 explains the function of the jumpers on the PGA308 test board.

Table 3-1. PGA308 Test Board Jumper Function

Jumper	Default	Purpose
JMP2	V_{REF} = Fixed/XTR	Select ratiometric or absolute sensor configuration
JMP3	Fixed V_{REF}	Fixed references on the EVM or XTR reference
JMP4	4.096 V	4.096 V or 2.5 V allows selection between the two fixed references on the EVM.
JMP5	Internal V_{REF}	Internal references or external references. (Note: internal references are references on the EVM. The PGA308 does not have a reference inside the device.)
JMP6	ADS1	*ADS1* or *NC* allows you to connect or disconnect the ADC on the USB DAQ platform to the PGA308 output.
JMP17	Auto	*Auto* or *EXT* allows connection of an external sensor or the onboard sensor emulator signal source. The sensor emulator is useful tool during initial development; that is, learn how the device works before connecting the real sensor.
JMP18	Auto	*Auto* or *EXT* allows connection of an external sensor or the onboard sensor emulator signal source. The sensor emulator is a useful tool during initial development; that is, learn how the device works before connecting the real sensor.
JMP9	ADS–	*ADS–* or *NC* allows you to connect or disconnect the ADC on the USB DAQ platform to the PGA308 input. Note that the ADC has a switched capacitor input, so it can affect the input signal. It is recommended that ADCs be disconnected when using a real-world sensor.
JMP10	ADS+	*ADS+* or *NC* allows you to connect or disconnect the ADC on the USB DAQ platform to the PGA308 input. Note that the ADC has a switched capacitor input, so it can affect the input signal. It is recommended that ADCs be disconnected when using a real-world sensor.
JMP13	NC	*V_{OUT} to XTR or NC.* Allows connection of the current-loop transmitter (XTR). In the *NC* position, the EVM output if voltage only. In the V_{OUT} to XTR position, the output is 4 mA to 20 mA.
JMP1	NC	*V_{OUT} to 1W or NC.* In the *V_{OUT} to 1W* position, the communication line (1W) to the analog output (V_{OUT}). This configuration is called a three-wire module because it only requires V_S, V_{OUT}, and GND outputs.
JMP7	One to 1W	*One to V_{OUT} or One to 1W.* In the *One to V_{OUT}* position, the communication line (1W) to the analog output (V_{OUT}). This configuration is called a three-wire module because it only requires V_S, V_{OUT}, and GND outputs. In the *One to 1W position*, the communication line is separate from V_{OUT}.
JMP15	V_{EXC} = V_{REF}	V_{EXC} = V_{REF} or V_{EXC} = V_S allows choice of either the power supply (such as ratiometric) or the reference to excite the sensor (that is, absolute mode).
JMP11	Dout	D_{OUT} or V_{CLAMP} allows choice between a digital output or a clamp input.
JMP16	V_{CLAMP} Divider	V_{CLAMP} divider or Ext V_{CLAMP}

Table 3-2 summarizes the function of the USB DAQ platform jumpers. For most applications, the default jumper position should be used. A separate document (SBOU056) gives details regarding the operation and design of the USB DAQ platform.

Table 3-2. USB DAQ Platform Jumper Settings (5-V Power Supply)

Jumper	Default	Purpose
JUMP17	BUS	*BUS* or V_{RAW}. *BUS* is the safe mode. The V_{RAW} option is only used for special test modes. In the V_{RAW} position it is possible to damage the USB DAQ platform with voltages above 5.5 V.
JUMP13	REG	*REG* or *BUS*. In the *REG* position the regulator provides V_{DUT} power.
JUMP14	9 V	*9 V* or *BUS*. In the *9-V* position an external power supply provides power to the EVM. In the *BUS* position the USB bus powers the EVM.
JUMP9	5 V	*5 V* or *3 V*. In the *5-V* position a variable regulator is resister programmed to 5 V. In the *3-V* position a variable regulator is resistor programmed to 3 V.
JUMP6	5 V	*5 V* or *3 V*. In the *5-V* position, a stacked 5-V reference is connected to the ADCs and DACs on the USB DAQ platform. In the *3-V* position, a 3-V reference is connected to the ADCs and DACs on the USB DAQ platform.
JUMP7	Ref	*Ref* or *Reg*. In the *Ref* position, a calibrated reference is connected to the USB DAQ platform ADC and DAC. In the Reg position, the regulator output (such as a power-supply voltage) is connected to the USB DAQ platform ADC and DAC.
JUMP1	EXT	*EXT* or *BUS*. In the external position the USB DAQ platform receives power from an external dc power source (such as through J5 or T3). The *BUS* position allows for the USB bus to power the EVM. External mode is recommended.
JUMP11	WP_ON	*WP_ON* or *WP_OFF*. In the *WP_ON* position, the calibration EEPROM is write protected. In the WP_OFF position, the calibration EEPROM is not write protected.
JUMP8	SPD_UP	*SPD_UP* or *GND*. In the *SPD_UP* position, the one-wire signal has a boost on the rising edge to allow for transmission over long cables. In the *GND* position, the speed-up feature is turned off.
JUMP10	WP_ON	*WP_ON* or *WP_OFF*. In the *WP_ON* position, the firmware EEPROM is write protected. In the *WP_OFF* position, the firmware EEPROM is not write protected.
JUMP3	EE ON	*EE ON* or *EE OFF*. In the *EE ON* position, the firmware EEPROM is connected to the microcontroller for normal operation. In the *EE OFF* position, the firmware EEPROM is disconnected to the microcontroller; this mode is used to program the EEPROM.
JUMP2	EXT	*EXT* or *BUS*. In the external position the USB DAQ platform receives power from an external dc power source (such as through J5 or T3). The *BUS* position allows for the USB bus to power the EVM. External mode is recommended.
JUMP18	V_{DUT}	V_{CC} or V_{DUT}. In the V_{DUT} position, the digital output pull-up resistors are connected to V_{CC}. In the V_{CC} position, the digital output pull-up resistors are connected to V_{CC}.
JUMP4	L	*L* or *H*. This jumper sets the USB DAQ platform USB address.
JUMP5	L	*L* or *H*. This jumper sets the USB DAQ platform USB address.

PGA308 Software Overview

This section explains how to install and use the PGA308 software.

4.1 Operating Systems for the PGA308 Software

The PGA308 software has been tested on Windows XP with United States and European regional settings. The software should also function on other Windows operating systems, including Windows Vista. Please report any compatibility issues to precisionamps@list.ti.com.

4.2 PGA308EVM Software Install

Install the PGA308EVM software by following these steps:

1. Software can be downloaded from the PGA308EVM web page, or from the disk included with the PGA308EVM, which contains a folder called *Install_software/*.
2. Find the file called *setup.exe*. Double-click the file to start the installation process.
3. Follow the on-screen prompts to install the software.
4. To remove the application, use the Windows Control Panel utility, *Add/Remove Software*.

4.3 Starting the PGA308EVM Software

Use the Windows Start menu to start the PGA308 software. From Start, select All Programs, then select the PGA308EVM program. Figure 4-1 shows the software display if the EVM is functioning properly.
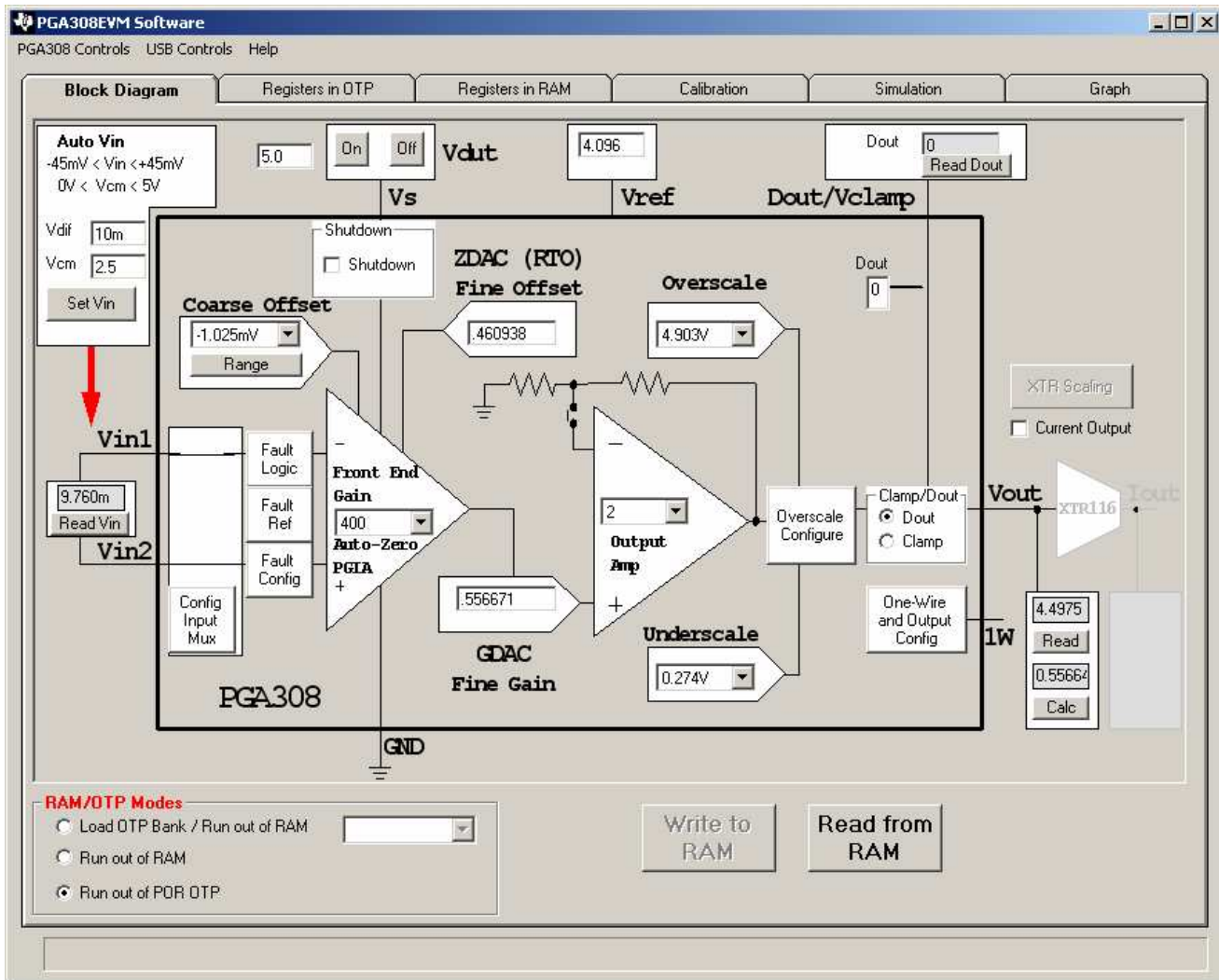

Figure 4-1. PGA308EVM Software—Functioning Properly

Figure 4-2 shows an error that appears if the computer cannot communicate with the EVM. If this error occurs, check to see that the USB cable is connected. This error can also happen if the USB cable is connected before connecting the USB DAQ platform 9V power supply. Another possible reason for this error message is a problem with the USB human interface device driver of the computer. Make sure that the computer recognizes the device when the USB cable is plugged in. If the sound is on, you will hear the distinctive sound that you expect when a USB device is properly connected to a PC with the Windows operating system.

Figure 4-2. PGA308EVM Software—No Communication with the USB DAQ Platform

Figure 4-3 shows an error that will occur if the PGA308 test board is not communicating with the USB DAQ platform. If you get this error, check the connectors between the two boards; make sure the two 25-pin DSUB connectors are completely pushed together. Another possible cause for this error is it that the PGA308 test board jumpers are set in the wrong positions.
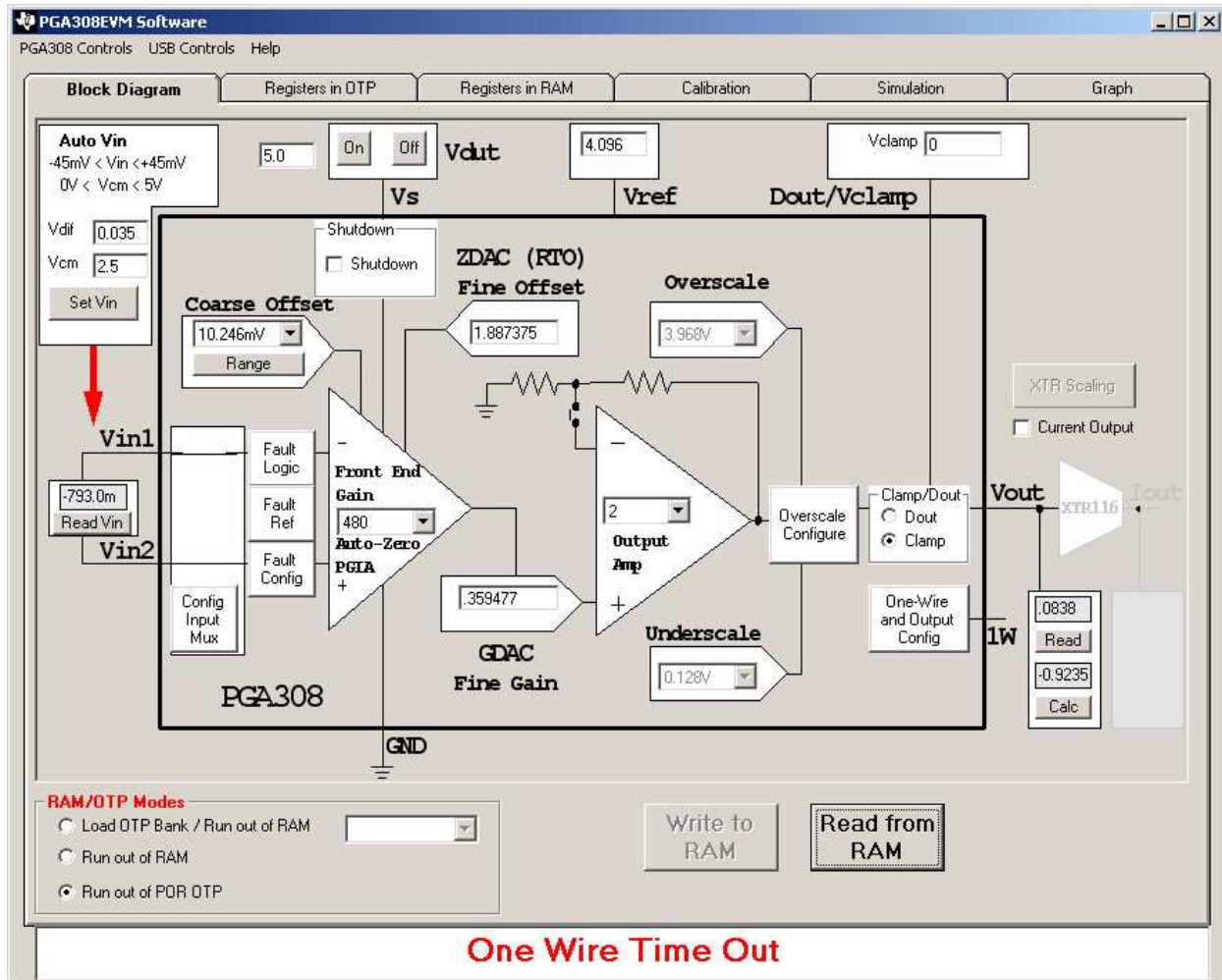

Figure 4-3. PGA308EVM Software—No Communication from USB DAQ Platform to PGA308

4.4 Using the PGA308 Software

The PGA308EVM software has six different tabs that allow you to access different features of the PGA308. Each of these tabs are intended to have an intuitive graphical interface that allows users to develop a better understanding of the PGA308.

4.4.1 Block Diagram

This tab provides full control of the PGA308. It has the following features:
- Allow control of gains, offsets, overscale limits, and clamps
- Measure VOUT, IOUT, VIN, and DOUT
- Control Automatic VIN voltage (sensor emulator signal generated on the USB DAQ EVM)
- Turn on and off the power supply; select reference voltage

4.4.2 Registers in OTP

This tab allows you to read and write to the OTP registers on the PGA308:
- Select and copy RAM to seven banks of user OTP
- Write to final test OTP

4.4.3 Registers in RAM

This tab has the following controls:
- Ability to read from/write to each register
- Detailed help for each register

4.4.4 Calibration

This tab has the following controls:
- Calibrate an external sensor input or sensor emulator input
- Calibrate voltage out or 4mA to 20mA out
- Verify post calibration accuracy (expect 0.1% or better)

4.4.5 Simulation

This tab allows you to do the following tasks:
- Simulation of all the PGA308, including internal nodes
- Common-mode and differential voltages are adjustable
- This feature is useful in checking for design margin

4.4.6 Graph

This tab allows users to:
- Graph voltage output or current output versus time
- Adjust input with sensor emulator or use external sensor

4.5 EVM Pull-Down Menus

4.5.1 *PGA308 Controls*

The PGA308 configuration (such as register settings) can be saved or loaded using the EVM Controls pull-down menu, as shown in Figure 4-4. The file that the configuration is saved into is a simple text file and can be viewed with any text editor.

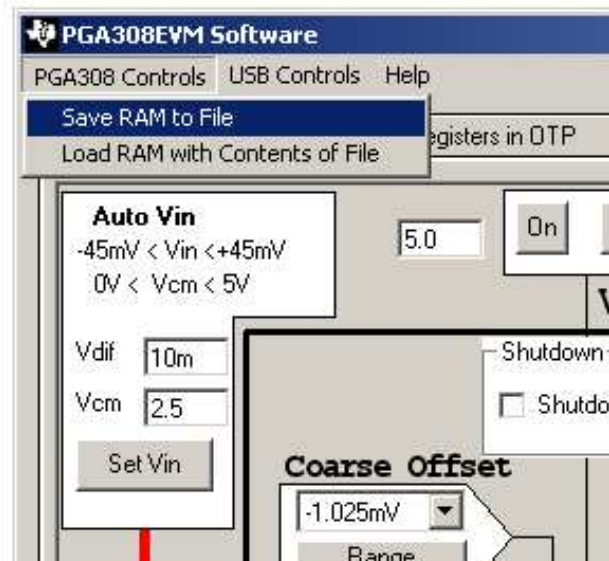**Figure 4-4. PGA308 Controls**

4.5.2 *USB Controls*

The USB Controls feature allows for direct control of communication on the USB DAQ Platform. For example, direct One-Wire, DAC, and ADC control are possible through this feature. Figure 4-5 illustrates the USB controls.

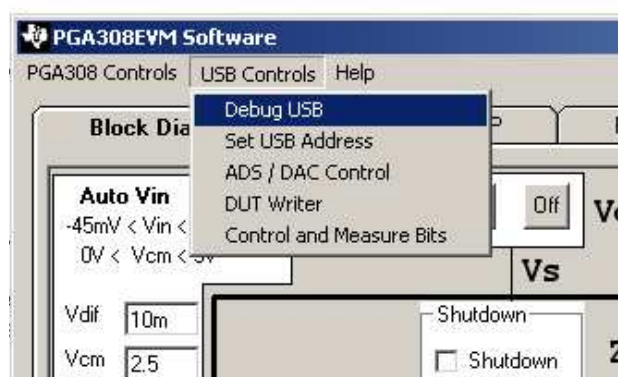**Figure 4-5. USB Controls**

4.5.3 Help

The About feature can be used to check the current revision. This document is based on revision 1.2.17, as shown in Figure 4-6.
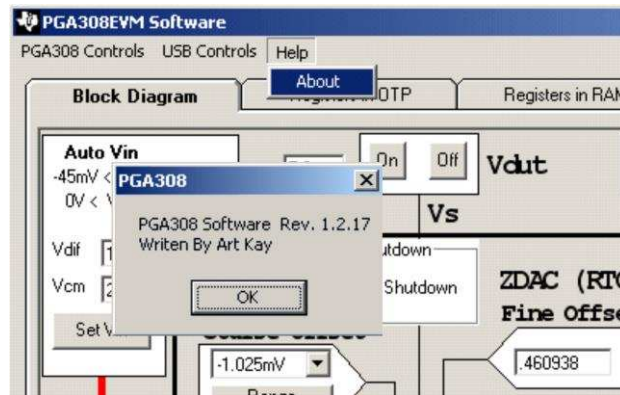

Figure 4-6. Current Revision of Software

Bill of Materials

A.1 Resistors and Capacitors

Table A-1. Bill of Materials

QTY	VALUE	REF DES	DESCRIPTION	VENDER	PART NUMBER
1	4.7 µF	C17	Capacitor Tantalum 4.7mF 25V 10% SMD 6032-28 (EIA)	Kemet	T491C475K025AT
10	0.1 µF	C6–C15	Capacitor 0.10mF 25V CERAMIC Y5V 0603	Kemet	CC0603ZRY5V8BB104
2	10 nF	C3, C5	Capacitor 10000pF 50V CERAMIC X7R 0603	Kemet	C0603C103K5RACTU
1	0.02 µF	C4	Capacitor 0.022mF 50V CERAMIC X7R 0603	Kemet	C0603C223K5RACTU
1	1000 pF	C18	Capacitor 1000pF, Ceramic Multilayer, X2Y, 1206	JOHANSON DIELECTRICS	501R18W102KV4E
2	100 kΩ	R1, R2	Resistor 100kΩ 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF1003V
2	1 kF	R3, R4	Resistor 1kΩ 1/10W 1% 0603 SMD	Yageo Corporation	RC0603FR-071KL
4	µF	R10–R12, R23	Resistor 10kΩ 1/10W 1% 0603 SMD	Yageo Corporation	RC0603FR-0710KL
1	µF	R20	Resistor 100Ω 1/10W 1% 0603 SMD	Yageo Corporation	RC0603FR-07100RL
1	µF	R22	Resistor 191kΩ 1/10W 1% 0603 SMD	Yageo Corporation	ERJ-3EKF1913V
1	µF	R13	Resistor 33Ω 1/10W 1% 0603 SMD	Yageo Corporation	RC0603FR-0733RL
1	µF	R21	Resistor 11.3kΩ 1/10W 1% 0603 SMD	Yageo Corporation	ERJ-3EKF1132V
2	µF	R15, R16	Resistor 39.2kΩ 1/10W 1% 0603 SMD	Yageo Corporation	RC0603FR-0739K2L
1	µF	R19	Resistor 6.04kΩ 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF6041V
Omit	µF	R17, R18	Omit	—	—

A.2 Active Devices and Miscellaneous

Table A-2. Bill of Materials

QTY	VALUE	REF DES	DESCRIPTION	VENDER	PART NUMBER
1	BNC	P1	CONN JACK BNC VERT 50Ω PCB	Tyco Electronics/Amp	5227699-1
1	OPA333AIDBVT	U1	IC OP AMP 1.8V 0-DRIFT SOT23-5	Texas Instruments	OPA333AIDBVT
1	REF3240	U2	IC LDO VOLT REF 4.096V SOT23-6	Texas Instruments	REF3240AIDBVT
1	REF3225	U3	IC LDO VOLT REF 2.5V SOT23-6	Texas Instruments	REF3225AIDBVT
1	XTR116	U5	IC 4 TO 20mA TRANSMITTER 8-SOIC	Texas Instruments	XTR116UA
1	6.8V Transorb	D1	TVS ZENER UNIDIR 600W 6.8V SMB	ON Semiconductor	P6SMB6.8AT3
1	NPN	Q1	IC TRANS NPN SS GP 1.5A SOT223-4	Fairchild Semiconductor	BCP55
5	ED300/2	T1-T5	2-position terminal strip, cage clamp, 45°, 15A, dove-tailed	On-Shore Technology Inc	ED300/2
16	HEADER STRIP	JMP1–JMP7, JMP9–JMP11, JMP13–JMP18	CONN HEADER 0.100 SNGL STR 36POS	3M/ESD	929647-09-36-I
16	SHUNT LP W/HANDLE 2 POS 30AU	Jumpers for JMP1–JMP7, JMP9–JMP11, JMP13–JMP18	Jumper shorting units	Tyco Electronics/Amp	881545-2
6	Standoffs	NA	Standoffs, Hex , 4–40 threaded, 0.500" length, 0.250" OD, aluminum iridite finish	Keystone	2203
6	Screws	NA	Machine screw, 4–40´3/8" Phillips PanHead, steel, zinc plated	Building Fasteners	PMS 440 0038 PH

Revision History

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

Changes from Original (July, 2008) to A Revision **Page**

- Changed Figure 1-1 6
- Deleted Quick Start Video from list of PGA308EVM Hardware 6

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

    1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software

    1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2   *Limited Warranty and Related Remedies/Disclaimers*:

    2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

    2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

    2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

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 may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of 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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けて

いないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの

措置を取っていただく必要がありますのでご注意ください。

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

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

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

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

   6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS AND CONDITIONS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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