

INA3221EVM Evaluation Board and Software Tutorial

This user's guide describes the characteristics, operation, and use of the INA3221EVM evaluation board. It discusses how to set up and configure the software and hardware, and reviews various aspects of the program operation.

Throughout this document, the terms *evaluation board*, *evaluation module*, and *EVM* are synonymous with the INA3221EVM. 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 [INA3221](#) is a three-channel, high-side current sensor and bus voltage monitor with an I²C™ interface. The INA3221 monitors both shunt drops and bus supply voltages with programmable conversion times and averaging modes. The INA3221 offers both critical and warning alerts to detect multiple programmable out-of-range conditions for each channel.

This document gives a general overview of the INA3221EVM, and provides a general description of the features and functions to be considered while using this evaluation module.

1.1 INA3221EVM Kit Contents

[Table 1](#) summarizes the contents of the INA3221EVM kit. [Figure 1](#) shows all included hardware. Contact the [Texas Instruments Product Information Center](#) nearest you if any component is missing. It is highly recommended that you also check the [INA3221 product folder](#) on the TI web site at www.ti.com to verify that you have the latest versions of the related software.

Table 1. INA3221EVM Kit Contents

Item	Quantity
INA3221EVM PCB test board	1
SM-USB-DIG platform PCB	1
USB extender cable	1
SM-DIG connector ribbon cable	1
User's guide CD-ROM	1

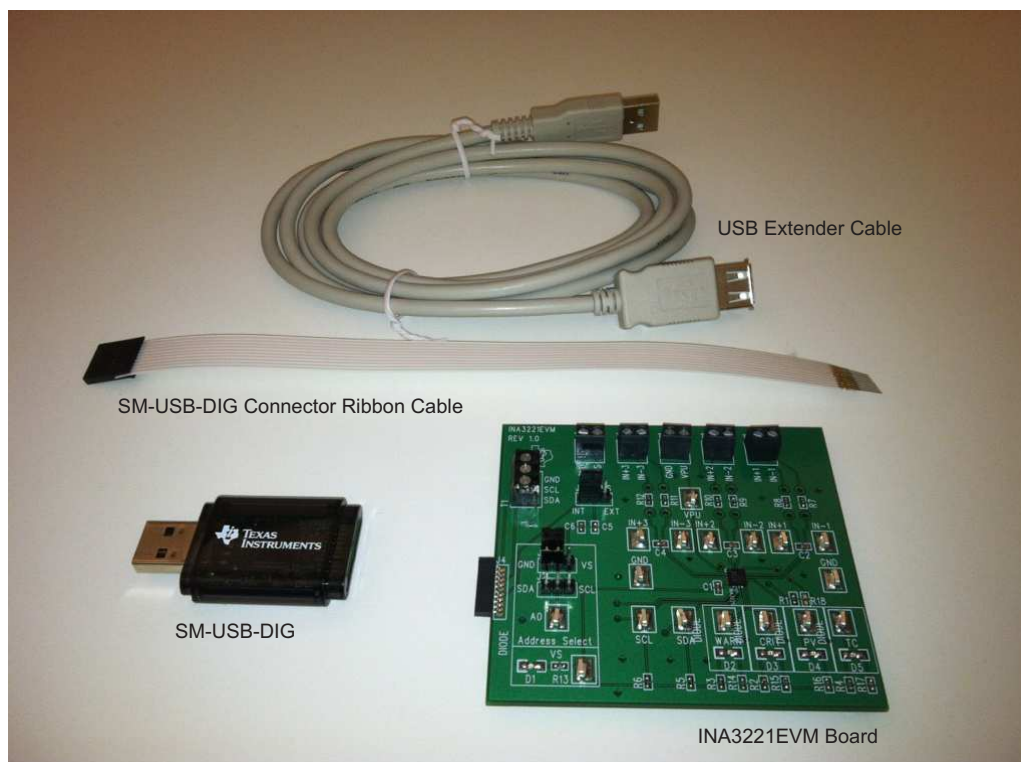


Figure 1. Hardware Included with INA3221EVM Kit

1.2 Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instruments' integrated circuits used in assembly of the INA3221EVM. This user's guide is available from www.ti.com under literature number SBOU126. 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 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.

Table 2. Related Documentation

Document	Literature Number
INA3221 product data sheet	SBOS576
SM-USB-DIG platform user guide	SBOU098
USB DIG platform user's guide	SBOU058

2 INA3221EVM Hardware Setup

Figure 2 shows the overall INA3221EVM system setup. The PC runs software that communicates with the SM-USB-DIG platform, which in turn generates the analog and digital signals used to communicate with the INA3221 test board. The INA3221 test board connectors allow the user to connect to the system under test conditions in order to monitor power, current, and voltage.

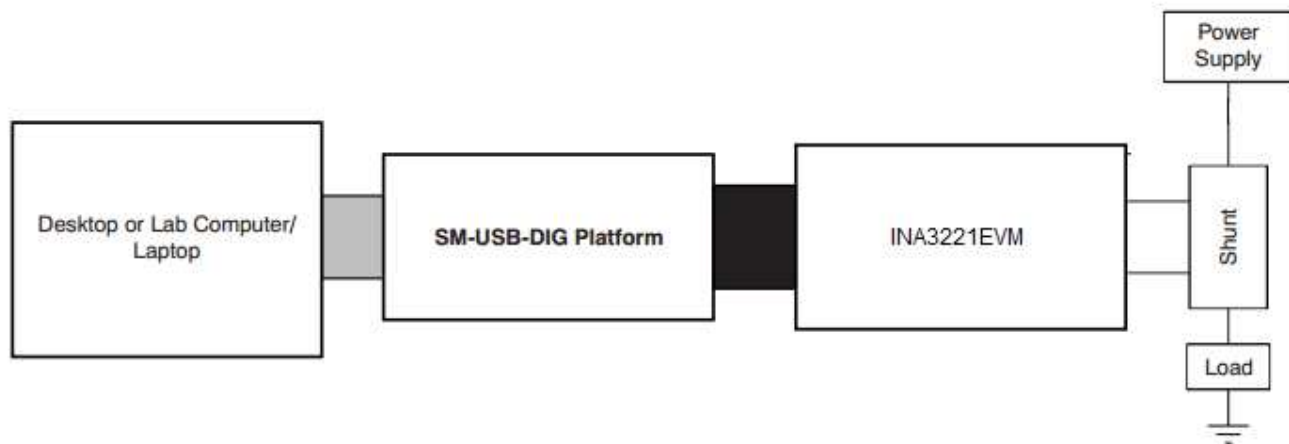


Figure 2. INA3221EVM Hardware Setup

2.1 INA3221 Hardware Theory of Operation

A block diagram of the INA3221 test board hardware setup is shown in Figure 3. PCB functionality provides connections to the I²C interface and general-purpose inputs/outputs (GPIOs) on the SM-USB-DIG platform board. The PCB also provides connection points for external shunt voltage, bus voltage, and ground connections.

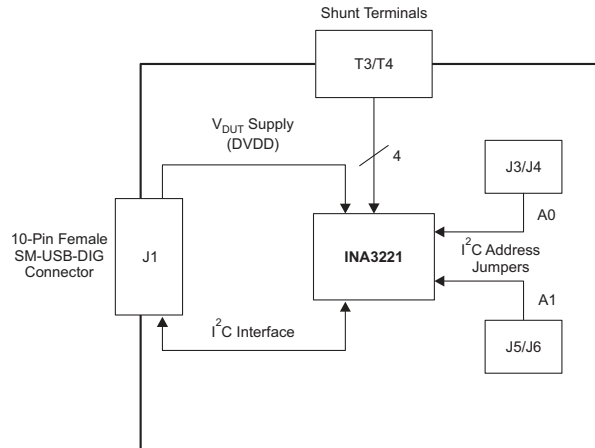


Figure 3. INA3221EVM Test Board Block Diagram

2.2 H1 Signal Definitions (10-Pin Male Connector Socket)

Table 3 lists the pinout for the 10-pin connector socket used to communicate between the INA3221EVM and the SM-USB-DIG. It should be noted that the INA3221EVM only uses the necessary I²C communication lines (pins 1 and 3) and the V_{DUT} and GND pins (pin 6 and pin 8) to issue commands to the INA3221 chip.

Table 3. Pin Connections

Pin on U1	Signal	Description
1	I2C_SCL	I ² C clock signal (SCL)
2	CTRL/MEAS4	GPIO: control output or measure input
3	I2C_SDA1	I ² 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) ⁽¹⁾
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)

⁽¹⁾ When VDUT is Hi-Z, all digital I/O are Hi-Z as well.

2.2.1 SM-USB-DIG Platform Theory of Operation

Figure 4 shows a 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 a separate document. The block diagram shown in Figure 4 is given as a brief overview of the platform.

The primary control device of the SM-USB-DIG platform is the [TUSB3210](#). The TUSB3210 is an 8052 microcontroller that has a built-in USB interface. The microcontroller receives information from the host computer that it interprets into power, I²C, SPI, and other digital I/O patterns. 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.

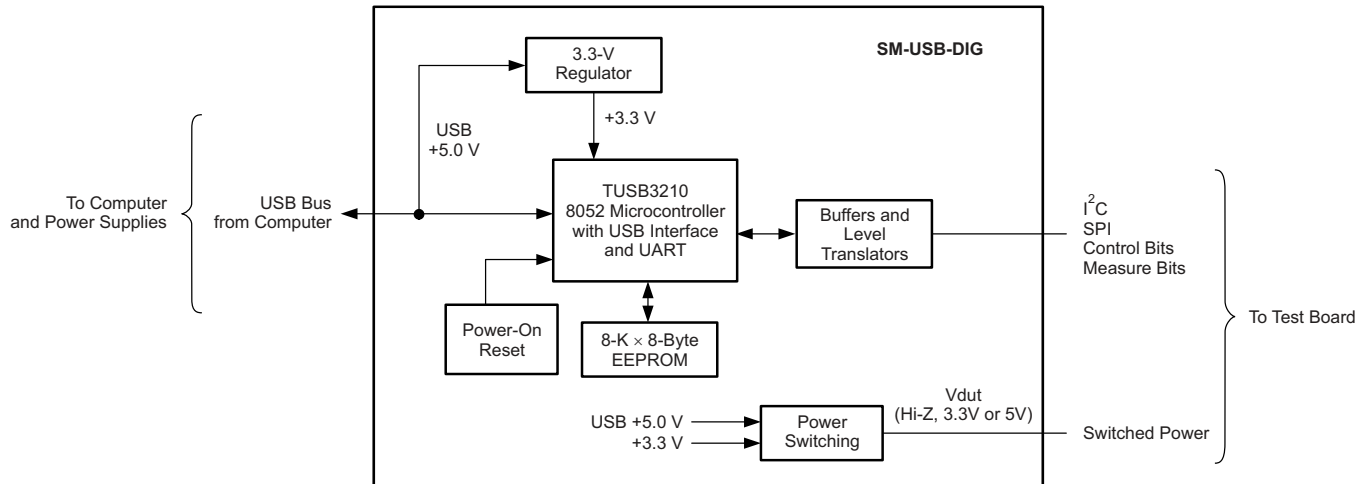


Figure 4. SM-USB-DIG Platform Block Diagram

3 INA3221EVM Hardware Overview

Setting up the INA3221EVM hardware involves connecting the two EVM PCBs together, applying power, connecting the USB cable, and setting the jumpers. This section presents the details of this procedure.

3.1 Electrostatic Discharge Warning

CAUTION

Many of the components on the INA3221EVM 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 INA3221EVM and SM-USB-DIG platform together, gently slide the male and female ends of the 10-pin connectors together. Make sure that the two connectors are completely pushed together; loose connections may cause intermittent operation.

3.3 Connecting Power

After the EVM and SM-USB-DIG are conjoined, as shown in [Figure 5](#), connect the channels intended to be measured. The source for V_{IN} is not included with the kit, and its voltage may differ depending on specific testing requirements.

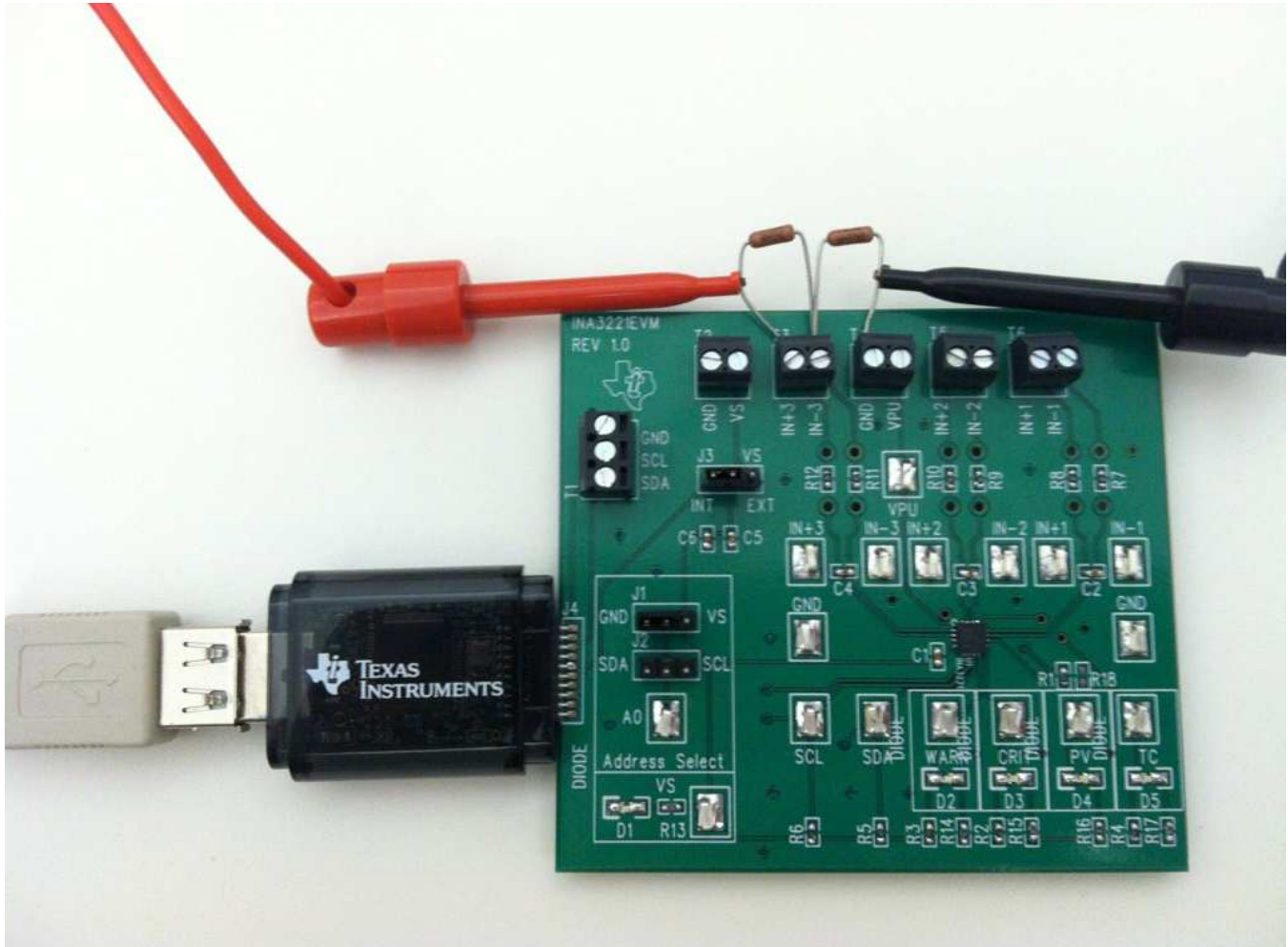


Figure 5. Typical INA3221EVM Hardware Test Connections

3.4 Connecting the USB Cable to the SM-USB-DIG Platform

Figure 6 shows the typical response to connecting the SM-USB-DIG platform board to a PC USB port for the first time. The connection between the SM-USB-DIG and PC USB port is shown in Figure 7. Typically, the computer responds with a *Found New Hardware, USB Device* pop-up dialog. The pop-up window typically 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.

In some cases, the Windows *Add Hardware Wizard* may pop up. If this prompt appears, allow the system device manager to install the human interface drivers by clicking **Yes** when requested to install drivers. Windows then confirms installation of the drivers with the message shown in Figure 6.



Figure 6. Confirmation of SM-USB-DIG Platform Driver Installation

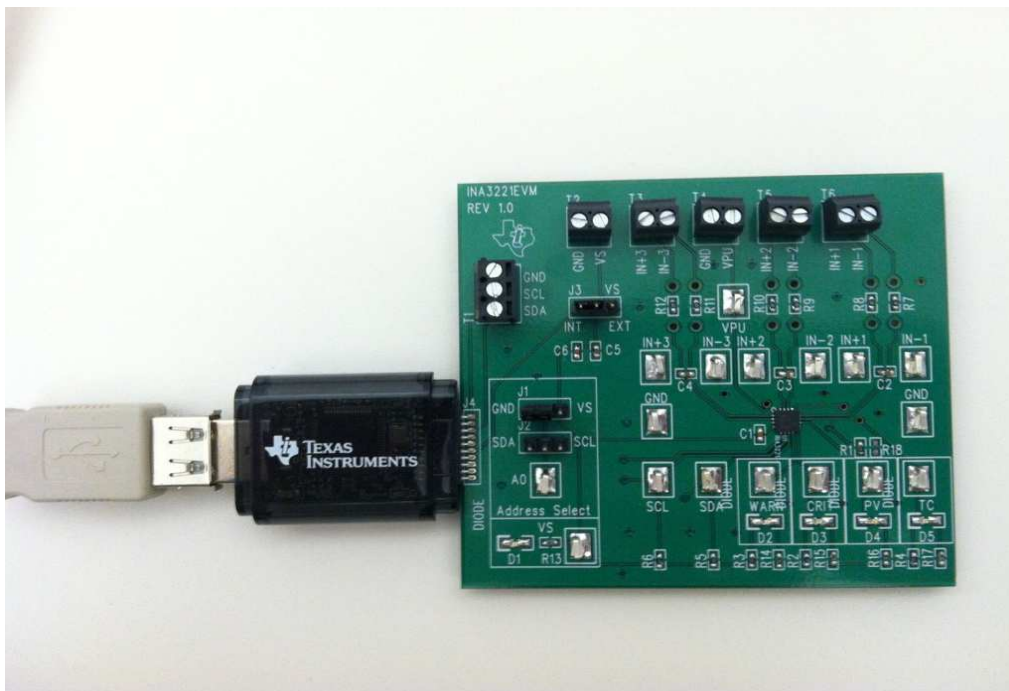


Figure 7. Connecting the USB Cable to the SM-USB-DIG Platform

3.5 INA3221EVM Default Jumper Settings

Figure 8 shows the default jumper configuration for the INA3221EVM. Some of the jumpers on the INA3221EVM board can be changed to match specific configuration requirements. For example, a specific I²C address can be set by configuring jumpers J1 and J2.

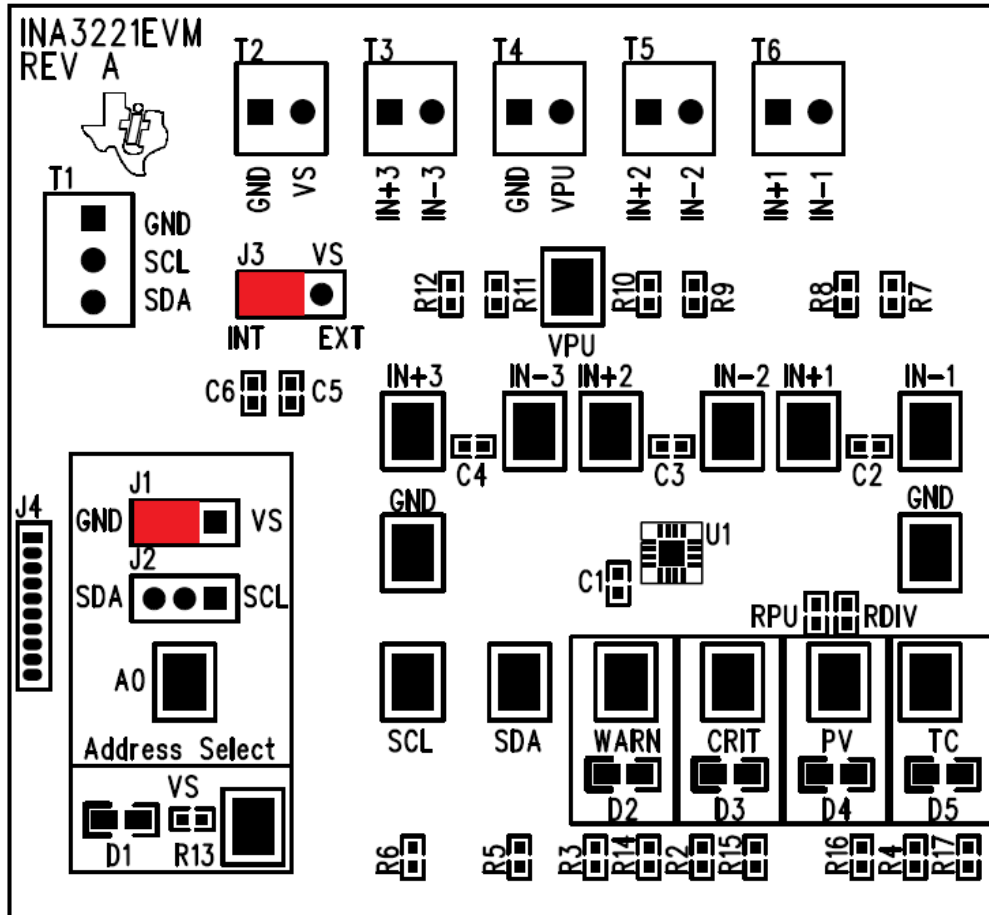


Figure 8. INA3221EVM Default Jumper Settings

Jumper 3 on the INA3221EVM is typically set to the INT position. When set to the INT position, the INA3221 supply voltage is generated and controlled by the SM-USB-DIG platform. When this jumper is set to the EXT position, VS connects to terminal strip T2.

Jumpers J1 and J2 control the INA3221 I²C address pin. **These jumpers can set the address (A0) pin to either high, low, SCL, or SDA. Make sure to only connect one jumper at a time, never both.** Failure to properly connect jumpers can cause shorts or interruptions in the communication lines. For more information on the INA3221 addressing, refer to the [INA3221 product data sheet](#).

Table 4 summarizes the function of the INA3221 test board jumpers. For most applications, all jumpers should be left in the respective default configurations.

Table 4. INA3221EVM Test Board Jumper Functions

Jumper	Default	Purpose
J1	GND	These jumpers select the I ² C A0 address selection. Four separate I ² C addresses can be selected, depending upon whether J1 is set high or low or whether J2 is set to SDA or SCL.
J2	Open	
J3	INT	This jumper selects whether the INA3221 DVDD pin is connected to the V _{DUT} signal generated from the SM-USB-DIG platform or whether the digital supply pin is connected to terminal T2, allowing for an external supply to power the digital circuitry. The default INT position connects the DVDD pin to the V _{DUT} control signal.

3.6 INA3221EVM Features

This section describes some of the hardware features present on the INA3221EVM test board.

3.6.1 J3: I²C V_s Control Setting

Jumper J3 selects what the INA3221 supply pin is connected to. If J3 is set to the INT position, the VS pin is connected to the switchable V_{DUT} signal generated from the SM-USB-DIG platform. This voltage can be set to either 3.3 V or 5 V, depending on how it is configured in the software. While J3 is set in the INT position, the VS Power button in the INA3221EVM software is able to control whether the V_{DUT} supply voltage is turned on or off. When J3 is set in the EXT position, an external supply connected to terminal T2 can be used to provide the INA3221 supply voltage.

3.6.2 J1 and J2: I²C Address Hardware Setting (A0)

Jumpers J1 and J2 are used to set the hardware setting for the A0 I²C address pin on the INA3221. Using J1, the A0 address can be set to either a logic '1' or a logic '0'. Using J2, the A0 address can be set to either the SCL or SDA communication line. Make sure to only have either J1 or J2 connected individually; failure to keep these lines separate can lead to board shorts and problems with the I²C communication lines. See [Section 5.2.1](#) on how to configure the INA3221EVM software to match the J1 and J2 hardware setting.

3.6.3 External I²C Lines and Terminal Block T1

The INA3221EVM I²C communication lines are tied to two sources: the internal I²C communication lines from the SM-USB-DIG and terminal block T1. If the user wants to add external signals separate from the SM-USB-DIG, simply disconnect the SM-USB-DIG from the INA3221EVM board and hook up the necessary SDA, SCL, and GND lines. Also, remember to apply an external DVDD to the lines compatible with the I²C communication device being used.

NOTE: Failure to disconnect the SM-USB-DIG while using external I²C communication can cause damage to the SM-USB-DIG or any connected external communication devices.

3.6.4 Shunt Monitor Configuration and Terminal Blocks T3, T5, and T6

The INA3221 is typically used in a high-side shunt configuration, as shown in [Figure 9](#). Terminal blocks T3, T5, and T6 represent V_{IN+} and V_{IN-} for channels 1, 2, and 3, respectively. Depending on application requirements, either of these configurations may be used without applying changes to the INA3221EVM board or software.

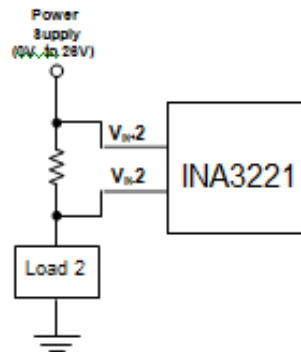


Figure 9. INA3221 Shunt Configurations

4 INA3221EVM Software Setup

This section discusses how to install the INA3221EVM software.

4.1 *INA3221EVM Software Operating Systems*

The INA3221EVM software has been tested on Microsoft® Windows® XP operating systems (OS) with United States and European regional settings. The software should also function on other Windows OS platforms.

4.2 Software Installation

The INA3221EVM software is included on the CD shipped with the EVM kit. It is also available through the [INA3221EVM product folder](#) on www.ti.com. To install the software to your system, insert the disc into an available CD-ROM drive. Navigate to the drive contents and open the INA3221EVM software folder. Locate the compressed file (*INA3221EVM.zip*) and open it. Using WinZIP®, or a similar file compression program, extract the INA3221EVM files into a specific INA3221EVM folder (for example, *C:\INA3221EVM*) on your hard drive.

When the files are extracted, navigate to the INA3221EVM folder you created on the hard drive. Locate the *setup.exe* file and execute it to start the installation. The INA3221 software installer file then begins the installation process, as shown in [Figure 10](#).

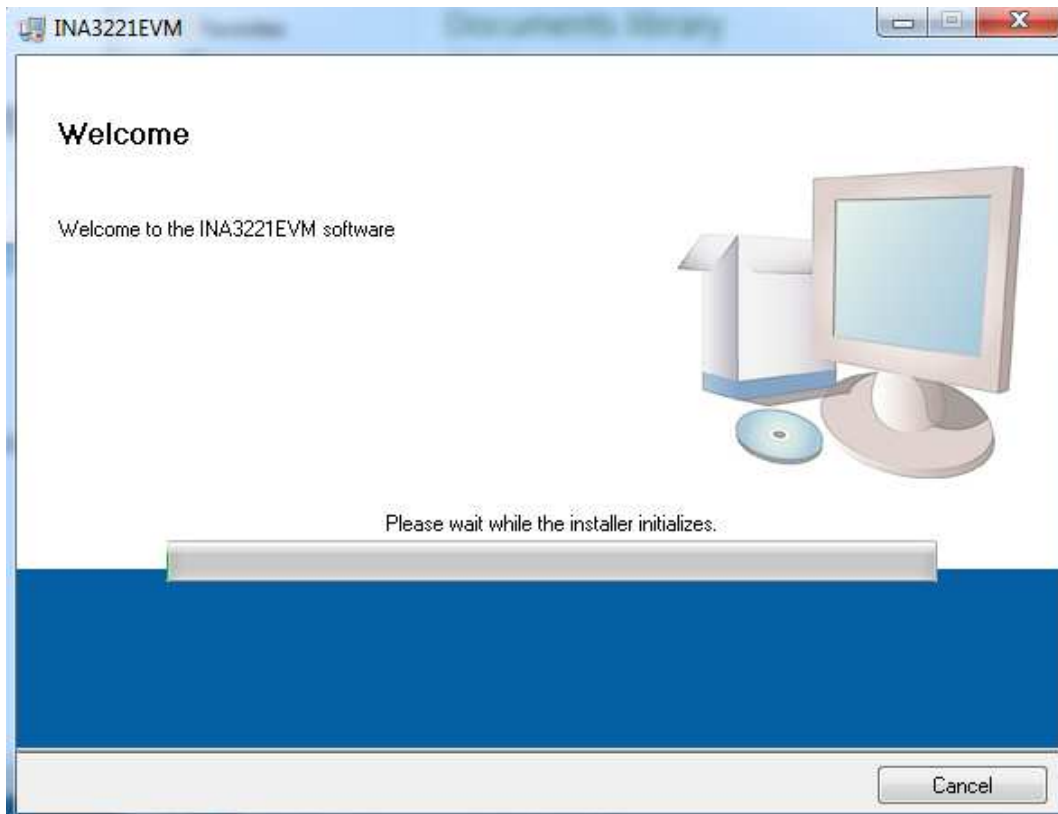


Figure 10. INA3221EVM Software Installation Window

After the installation process initializes, the user is given the choice of selecting the directory in which to install the program; the default location is *C:\Program Files\INA3221* and *C:\Program Files\National Instruments*. Following this option, two license agreements are presented that must be accepted, as illustrated in [Figure 11](#). After accepting the Texas Instruments and National Instruments license agreements, the progress bar opens and shows the installation of the software, refer to [Figure 12](#). When the installation process is completed, click **Finish**.

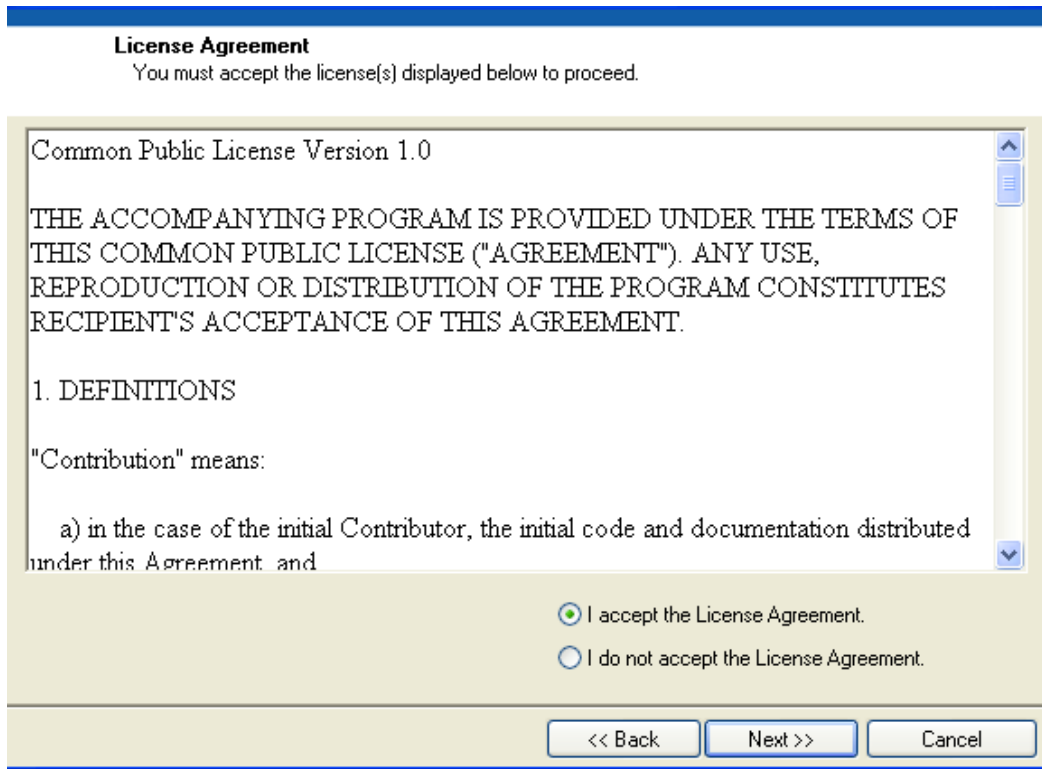


Figure 11. INA3221EVM License Agreements

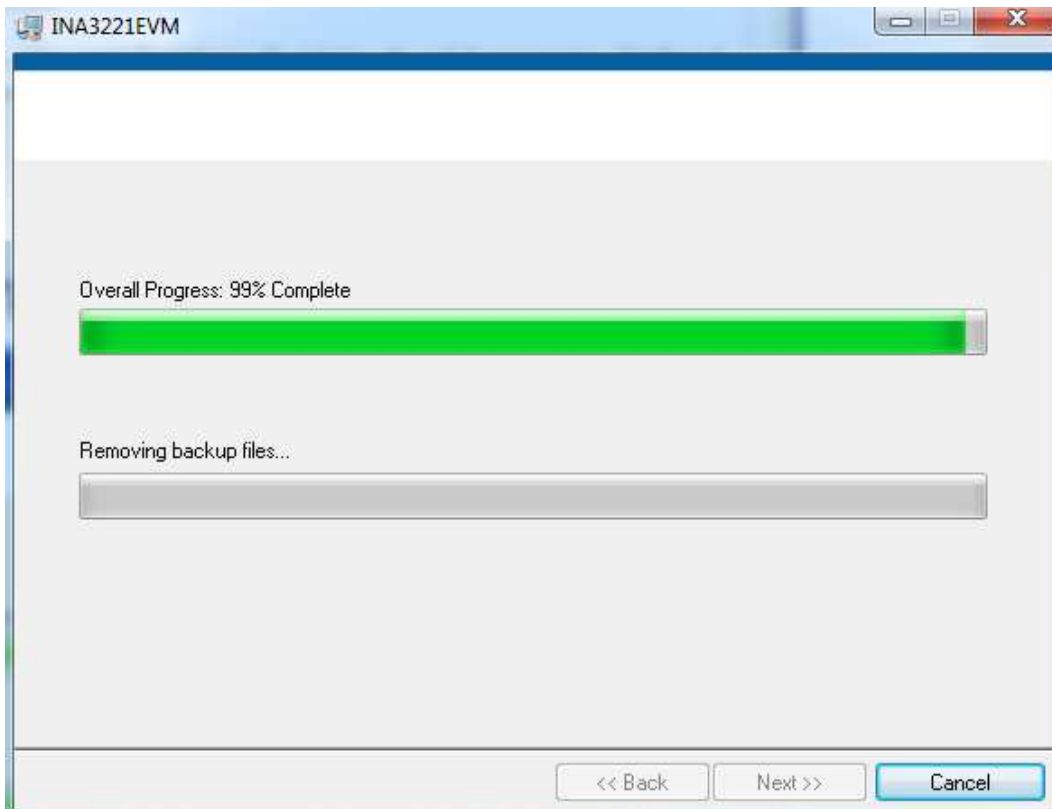


Figure 12. INA3221EVM Software Installation Progress

5 INA3221EVM Software Overview

This section discusses how to use the INA3221EVM software. Software operation involves a two-step process: INA3221 configuration and operation.

5.1 Starting the INA3221EVM Software

The INA3221 software can be operated through the Windows *Start* menu. From *Start*, select *All Programs*; then select the *INA3221EVM* program.

Figure 13 illustrates how the software should appear if the INA3221EVM is functioning properly.

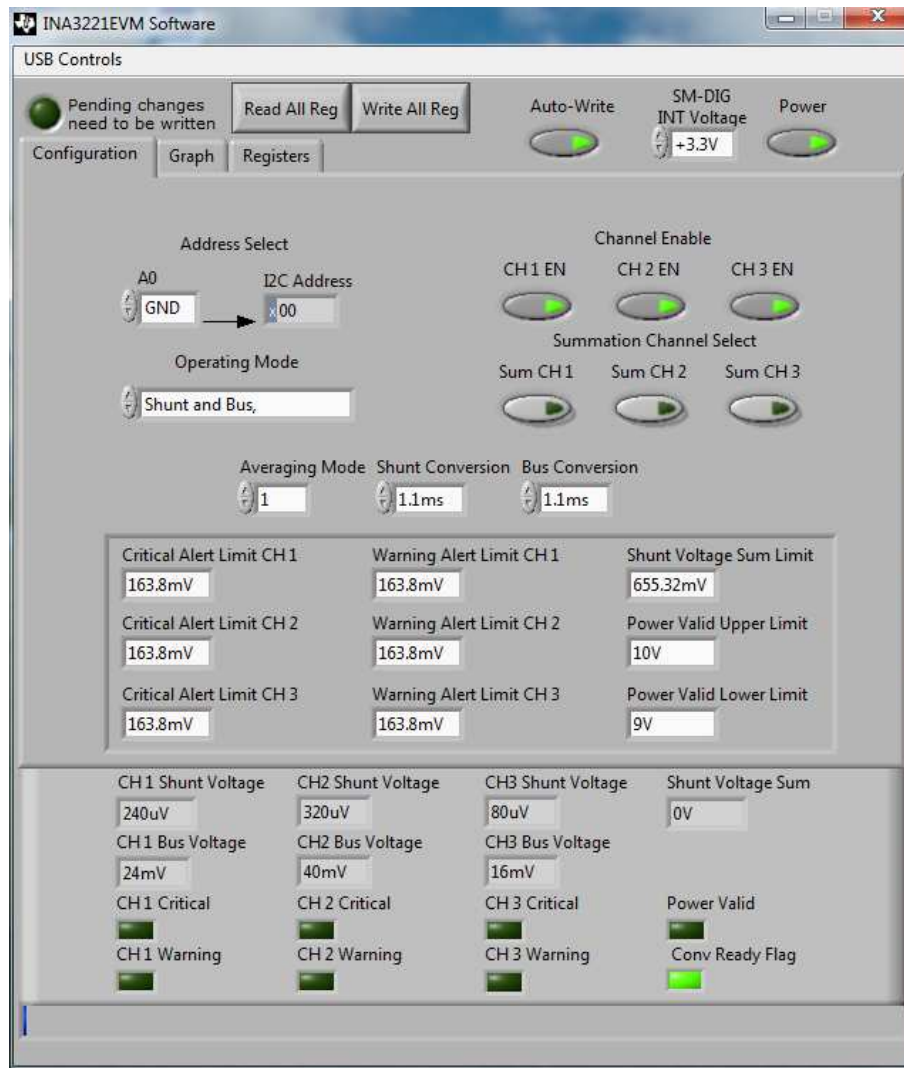


Figure 13. INA3221EVM Software Interface

Figure 14 shows an error window that pops up if the computer cannot communicate with the EVM. If this error is received, first ensure that the USB cable is properly connected on both ends. This error can also occur if the USB cable is connected before the SM-USB-DIG platform power source. Another possible source for this error is a problem with the PC USB Human Interface Device driver. Make sure that the device is recognized when the USB cable is plugged in; recognition is indicated by a Windows-generated confirmation sound.

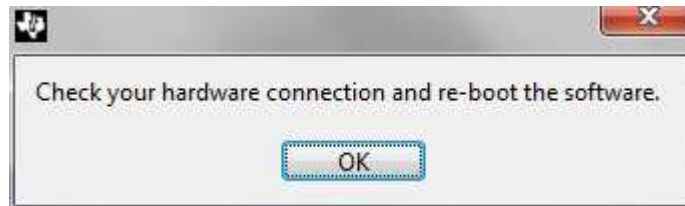


Figure 14. INA3221EVM Software: Communication Error with the SM-USB-DIG Platform

5.2 Using the INA3221EVM Software

This section describes the basic operation of the device, and offers guidelines for interpreting the graphic user interface (GUI).

5.2.1 INA3221 Bus Voltage, Shunt Voltage, and Shunt Voltage Sum Reading Bar

The bottom bar of the INA3221 software, as shown in Figure 15, allows the user to constantly check the status of the INA3221 device. These values are updated each time the **Read All Reg** button is pressed at the top of the software. In addition to the register values stored in the device, the software also includes flags for when the device is ready to trigger another conversion and when the Critical, Warning, and Power Valid flags are triggered.

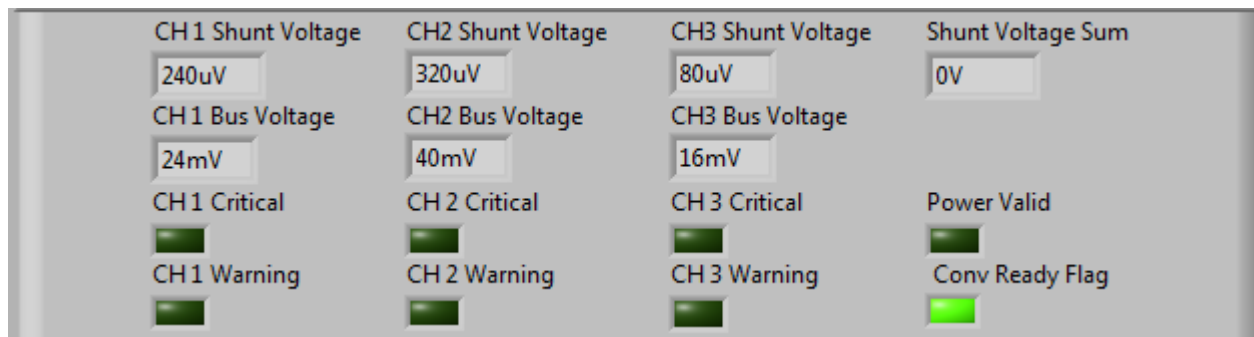


Figure 15. INA3221 Results Bar

5.2.2 Register Tab

The Register tab contains information on the internal INA3221 registers. Each register can be changed on a bit-by-bit basis to allow the user to have total control of the device beyond the general functionality of the GUI alone. Most of this functionality is displayed in the Configuration tab, but by selecting the appropriate register and clicking on the **Help With Reg** button on the Register tab, as shown in Figure 16, the individual uses of each bit in each register can be diagnosed.

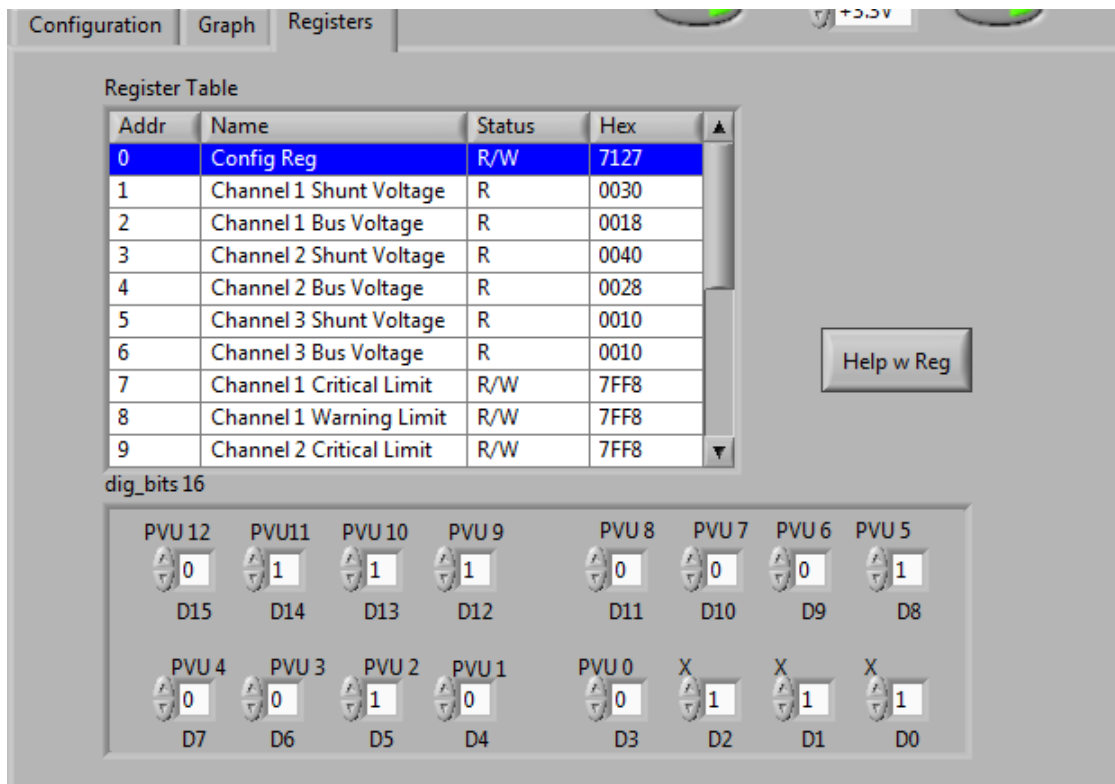


Figure 16. Registers Tab

5.2.3 Graph Tab

The Graph tab, shown in Figure 17, contains a plot window that shows the progression of data over time on the INA3221. All seven variables at the bottom of the EVM software (CH1 V_{SHUNT} , CH2 V_{SHUNT} , CH3 V_{SHUNT} , CH1 V_{BUS} , CH2 V_{BUS} , CH3 V_{BUS} , and V_{SHUNT} Sum) can be plotted using the drop-down box directly above the graph. After the desired plot has been selected, toggle the **Continuously Poll Data** button above the graph to begin polling for data. If the user desires to save the data from the plot, simply select the *USB Controls* drop-down at the top of the page, then select the *Start Graph Log* option. When the *Start Graph Log* is selected, the user is prompted to select a location for the data and to name the file.

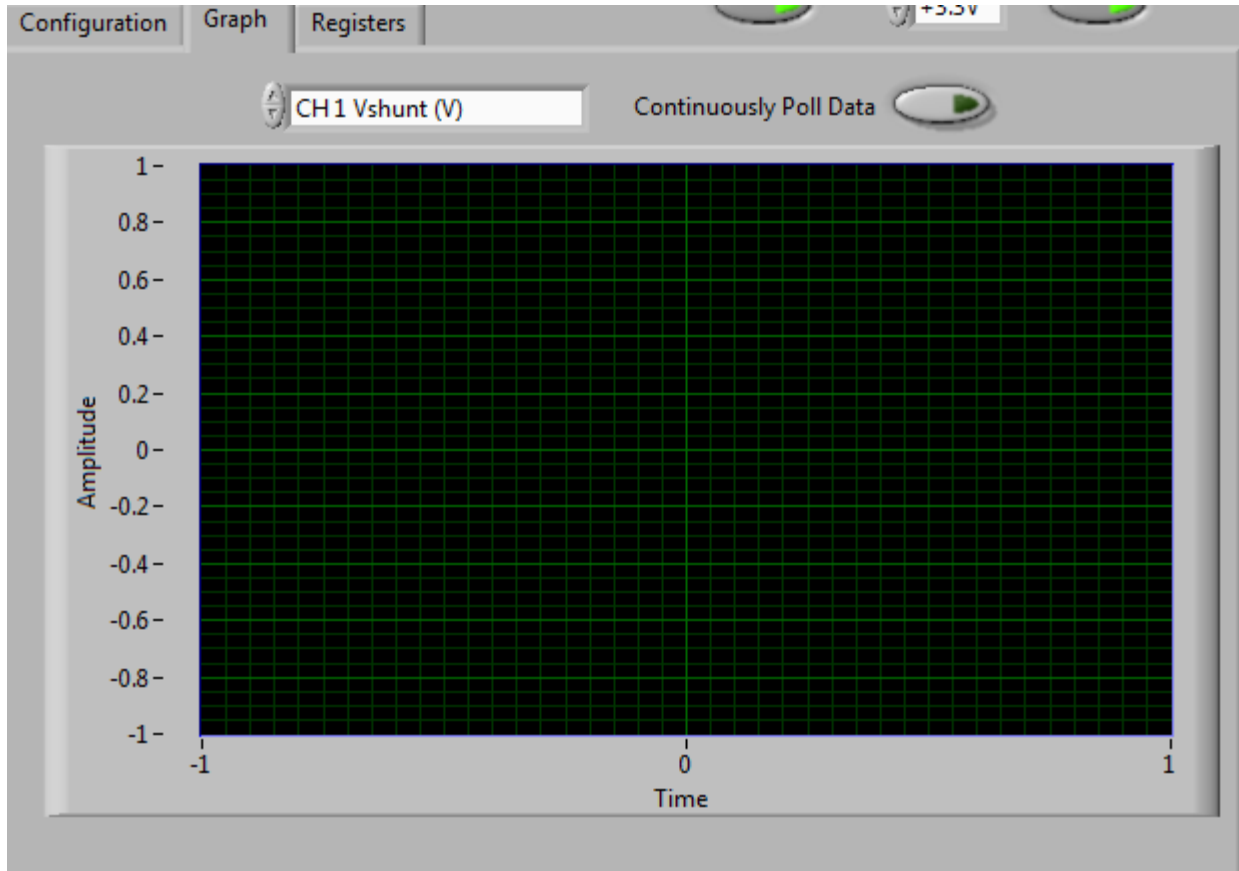


Figure 17. Graphing INA3221 Data

5.2.4 Auto-Write and DVDD Voltage

The INA3221EVM software allows customization of the board level voltage, regulated by the SM-USB-DIG. By selecting either 3.3 V or 5 V, the user can designate which voltage the device should operate at.

The software also includes an Auto-Write feature, as shown in Figure 18, which is enabled by default. This feature automatically updates the register table whenever a change is made. When this feature is enabled, the **Write All Registers** button serves little purpose and is only used as an alternative to when this button is disabled.



Figure 18. Auto-Write, Power Button, and Voltage Control

6 INA3221EVM Documentation

This section contains the complete bill of materials, schematic diagram, and PCB layout for the INA3221EVM. Documentation information for the USB DIG Platform can be found in the [USB DIG Platform User's Guide \(SBOU058\)](#), available for download at www.ti.com.

6.1 Schematic

Figure 19 shows the INA3221EVM schematic.

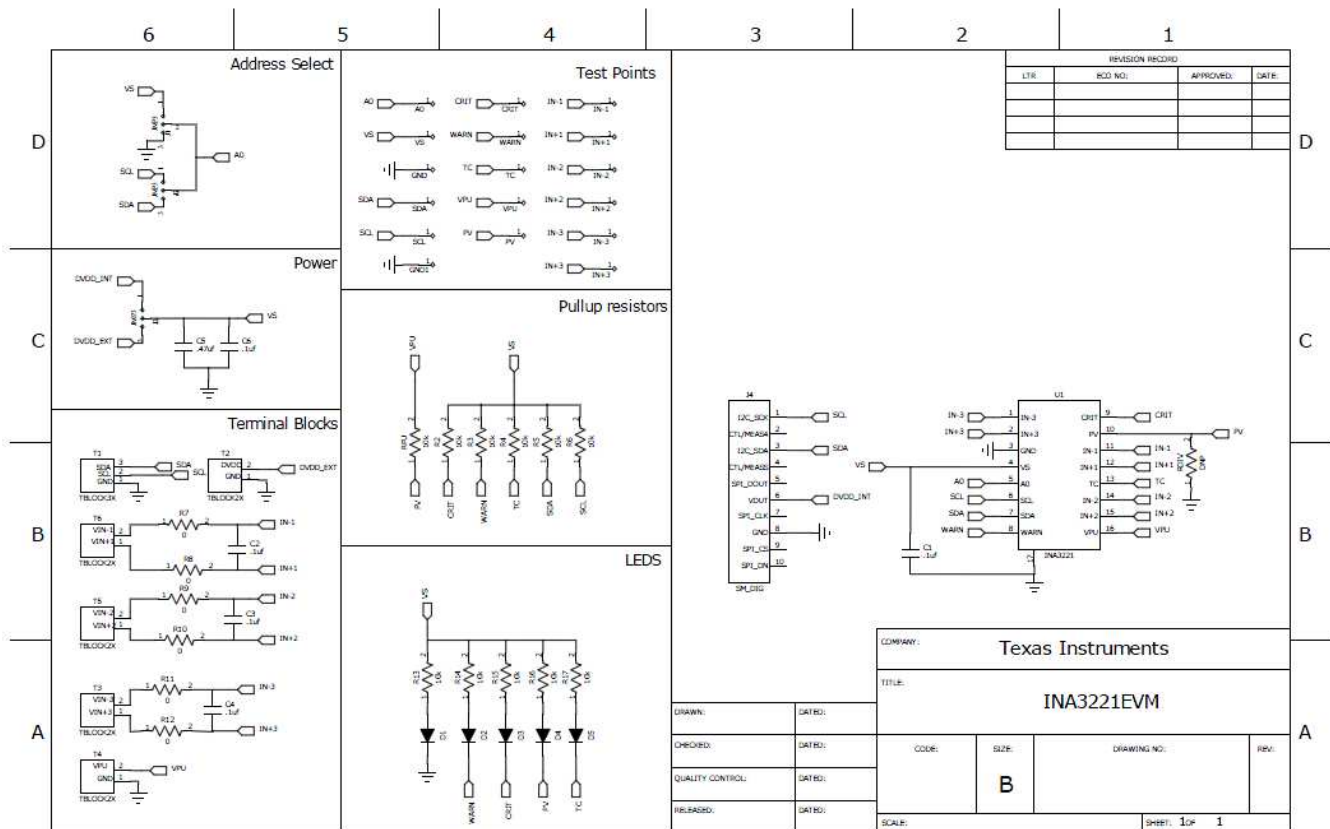


Figure 19. INA3221EVM Schematic

6.2 PCB Layout

Figure 20 shows the INA3221EVM PCB component layout.

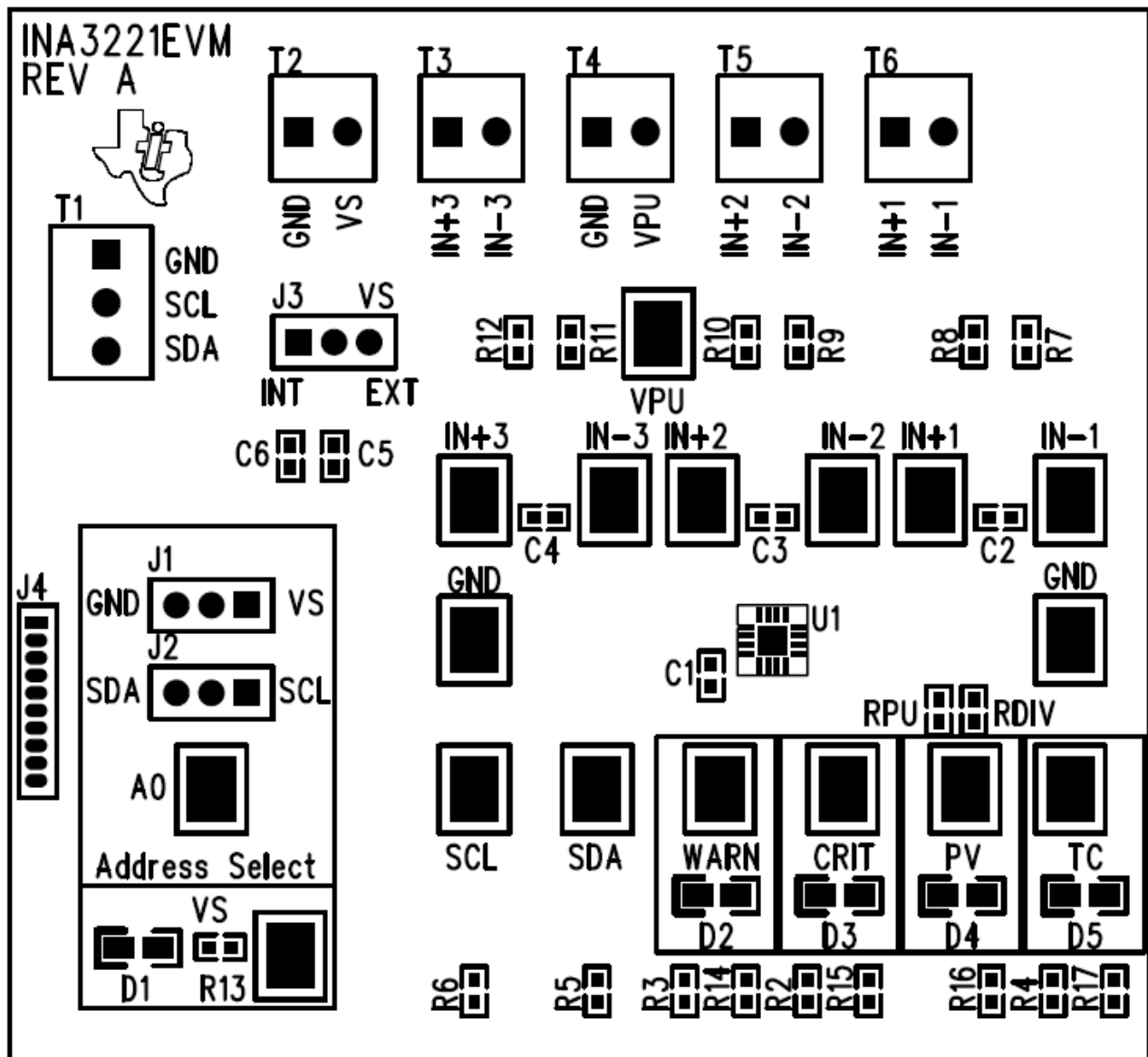


Figure 20. INA3221EVM PCB Top Layer (Component Side)

6.3 Bill of Materials

Table 5 lists the INA3221EVM bill of materials.

Table 5. Bill of Materials

Item No.	Ref Des	Description	Vendor/Mfr	Digi-Key Part Number	Manufacturer Part Number
1	RPU, R2-R6	RES 10K OHM 1/10W 5% 0603 SMD	Stackpole Electronics	RMCF0603JT10K0CT-ND	RMCF0603JT10K0
2	R13-R17	RES 300 OHM 1/10W 5% 0603 SMD	Panasonic	P300GCT-ND	ERJ-3GEYJ301V
3	R7-R12	RES 0.0 OHM 1/10W 0603 SMD	Stackpole Electronics	RMCF0603ZT0R00CT-ND	RMCF0603ZT0R00
4	RDIV	DNI	—	—	—
5	C5	CAP CER 4.7UF 16V 10% X5R 0603	TDK Corp.	445-7412-2-ND	C1608X7R1V474K
6	C1-C4, C6	CAP CER .10UF 25V X7R 10% 0603	TDK Corp.	445-1316-1-ND	C1608X7R1E104K
7	D1-D5	LED GREEN WIDE ANGLE 0603 SMD	Panasonic	P14140CT-ND	LNJ3W0C83RA
8	U1	INA3221	Texas Instruments	—	—
9	Jumpers, All	CONN HEADER 50POS .100" SGL GOLD	Samtec	SAM1029-50-ND	TSW-150-07-G-S
10	J3, J1	SHUNT LP W/HANDLE 2 POS 30AU	Tyco Electronics	A26242-ND	881545-2
11	Test Points, All	PC TEST POINT COMPACT SMT	Keystone Electronics	5016KCT-ND	5016
12	T1	3Block Terminal 3.5mm	On Shore Technology Inc	ED1515-ND	ED555/3DS
13	T2-T6	2Block Terminal 3.5mm	On Shore Technology Inc	ED1514-ND	ED555/2DS
14	Bumpsons	BUMPON HEMISPHERE .50X.14 CLEAR	3M	SJ5312-7-ND	SJ-5312 (CLEAR)
15	J4	CONN SOCKET RT ANG 1POS .050	Mill-Max Manufacturing	ED8850-ND	851-93-10-20-001000

Evaluation Board/Kit Important Notice

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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.

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 0 V to 26 V and the output voltage range of 2.7 V to 5.5 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 +25°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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EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

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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 LIMITED 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. 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.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

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REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module 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 or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment 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.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. 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 Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

Concernant les EVMs avec appareils radio

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. 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 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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TI has specifically designated certain components which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

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