EVM User's Guide: ADS122S14EVM-PDK

ADS122S14EVM and ADS122C14EVM Evaluation Module

Description

The ADS122S14EVM and ADS122C14EVM evaluation modules (EVM) allow users to evaluate the functionality of the ADS122S14 with Serial-Peripheral Interface (SPI) and ADS122C14 with Inter-Integrated Circuit (I2C) interface. These devices are precision, low-power, 8-channel, 24-bit, 64-kSPS Delta-Sigma (ΔΣ) analog to digital converters (ADC) with a flexible input multiplexer and a low-noise programmable gain amplifier (PGA). The EVM kit includes the ADC device and an accompanying precision ADC motherboard (PAMB) used as a USB-to-PC Graphical User Interface (GUI) communication bridge that enables the computer software to communicate with the ADC over the USB for data capture, configuration, and data analysis.

Get Started

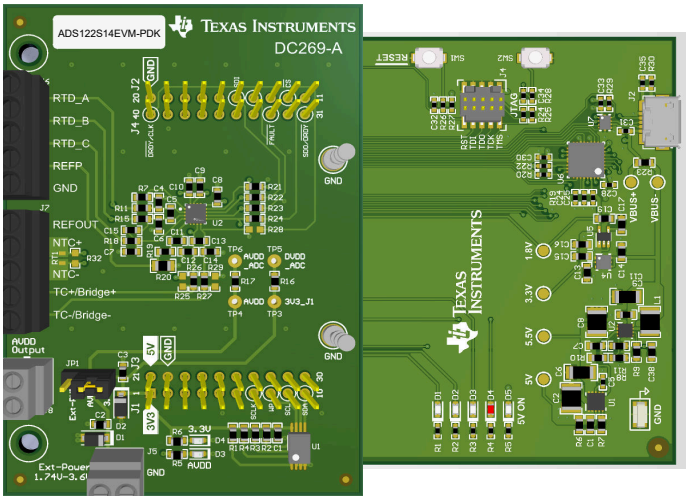
1. Order ADS122S14EVM-PDK or ADS122C14EVM-PDK
2. Download and install ADS122S14EVM-PDK-GUI
3. Connect the EVM to the computer with the included USB cable
4. Launch the ADS122X14EVM GUI software
5. Refer to the ADS122S14 or ADS122C14 data sheet for device details
6. Visit the E2E forums for support and questions

Features

- ADS122S14 or ADS122C14 with 8 independently selectable inputs
- Wide supply range for analog voltage (AVDD) and digital voltage (DVDD)
- Multiple voltage reference options: internal programmable 1.25V or 2.5V voltage reference or external ratiometric reference supplied by the input terminal blocks
- Input terminal blocks that enable easy measurement of many types of analog temperature or bridge sensors
- SPI or I2C interface for communication and configuration

Applications

- Temperature Sensor Measurements:
  - Thermistors
  - Thermocouples
  - Resistance Temperature Detectors (RTDs): 2-, 3-, or 4-Wire Types
- Resistive Bridge Sensor Measurements:
  - Pressure Sensors
  - Strain Gauges
  - Weigh Scales
- Field transmitter & sensor:
  - Flow transmitter
  - Pressure transmitter
  - Temperature transmitter
- Factory automation and control



1 Evaluation Module Overview

1.1 Introduction

This user guide describes the operation and use of the ADS122S14 and ADS122C14 evaluation module.

Table 1-1. Device Information

Part Number	Resolution	Analog inputs	Interface	EVM	GUI
ADS122S14	24-bit	8	SPI	ADS122S14 EVM	ADS122X14EVM-PDK-GUI
ADS122C14	24-bit	8	I2C	ADS122C14 EVM	ADS122X14EVM-PDK-GUI
ADS112S14	16-bit	8	SPI	ADS122S14 EVM	ADS122X14EVM-PDK-GUI
ADS112C14	16-bit	8	I2C	ADS122C14 EVM	ADS122X14EVM-PDK-GUI

Table 1-1 shows that the devices in the ADS122S14 ADC family have very similar characteristics other than the communication interface and ADC resolution. For simplicity, the rest of this document uses the ADS122S14EVM as an example of the behavior and operation of all devices. If applicable, each section describes any differences between the ADS122S14EVM and the other devices shown in Table 1-1.

The ADS122S14EVM is a fully assembled evaluation platform designed to highlight the ADS122S14 device performance and functionality of operation that make this device designed for measuring different type of analog sensors. The EVM sits on top of the PAMB controller card, which is used as a USB-to-PC GUI communication bridge. This board combination also serves as an example implementation of connecting a microcontroller (MCU) to communicate with the ADS122S14 device through an SPI. Figure 1-1 shows a functional block diagram of the system setup.

This EVM user guide describes the characteristics and operation of the ADS122S14EVM. The ADS122S14EVM eases the evaluation of the ADC with hardware, software, and computer connectivity through the universal serial bus (USB) interface. This EVM user guide includes complete circuit descriptions, schematic diagrams, and a bill of materials. Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the ADS122S14EVM

The PAMB receives commands from the ADS122S14EVM GUI and returns data to the GUI for display and analysis. If the PAMB is not used, the EVM plug-in module allows for an alternative external host to communicate with the ADS122S14 through headers J1 through J4. Refer to Section 2.3 for more information.

1.2 Kit Contents

The ADS122S14 evaluation module kit includes the following features:

- The hardware and software required for diagnostic testing as well as an accurate performance evaluation of the ADS122S14.
- The PAMB controller card that provides a convenient communication interface to the ADS122S14 over USB 2.0 (or higher)
- Windows® 10 and 11 operating systems support.
- Easy-to-use evaluation software for 64-bit Microsoft® Windows®.
- The software includes a graphical tool for register configurations, data capture, histogram analysis, and spectral analysis of the ADS122S14. This suite has a provision for exporting data to a text file for post-processing.

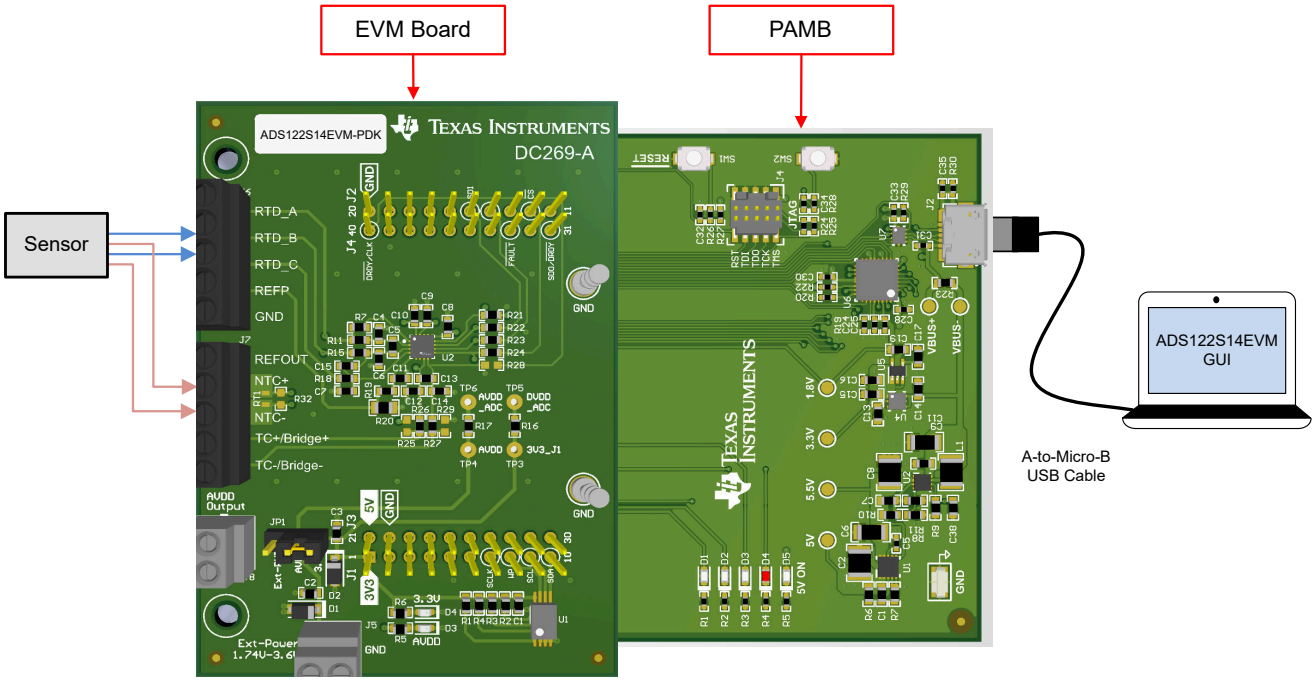


Figure 1-1. DC269A Connection for Evaluation

1.3 Specification

The following specifications are applicable to the ADS122S14EVM board and the PAMB.

Table 1-2. ADS122S14EVM-PDK Specifications

PARAMETER	CONDITIONS	VALUE
Temperature	Recommended operating free-air temperature range, T_A	15°C ≤ T_A ≤ 35°C
AVDD to GND (Recommended voltage range, external source)	AVDD to GND,speed mode 3 or I_{IDAC} > 500µA	+2.7V ≤ AVDD ≤ +3.6V
	AVDD to GND,speed mode 0, 1, 2, and I_{IDAC} ≤ 500µA	+1.74V ≤ AVDD ≤ +3.6V
DVDD to GND (Recommended voltage range, external source)	Recommended voltage range, external source	+1.65V ≤ DVDD ≤ +3.6V
Power supply current range (external power supply)	Supply current range $\|I_s\|$	$\|I_s\|$ ≤ 0.5A
Input voltage range	Absolute input voltage verses GND for input on J6 and J7	GND-0.3V ≤ Vin≤ AVDD+0.3V
External clock	Recommended frequency range (f_{CLK})	3MHz ≤ f_{CLK} ≤ 4.15MHz
External digital IO (GPIOs)	General-Purpose inputs	GND ≤ V_{IO} ≤ AVDD
Digital Inputs	Other than GPIOs	GND ≤ V_{DI} ≤ DVDD
Reference REFP to REFN/GND (external source)	Recommended voltage range, external source	0.5V ≤ VREFP-VREFN≤ AVDD

1.4 Device Information

Please refer to ADS122S14 data sheet for complete specifications.

Table 1-3. ADS122S14 Specifications

DEVICE SPECIFICATION		VALUE
Package size	WQFN	3.00mm × 3.00mm
	DSBGA	2.00mm × 2.00mm
Operating temperature range		-40°C to 125°C
AVDD to GND supply voltage		+1.74V to +3.6V
DVDD to GND supply voltage		+1.65V to +3.6V
Voltage reference inputs		+0.5V to AVDD

1.5 Getting Started With the ADS122S14EVM

The following steps provides an overview to quickly get the ADS122S14EVM setup and operational. The subsequent sections in this document expand on each step to explain in detail the available features on the ADS122S14EVM and the corresponding GUI. Links below are provided to navigate from this quick-start guide to the appropriate section at each step, where applicable.

1. Remove the ADS122S14EVM, PAMB controller card, and USB cable from the ADS122S14EVM-PDK box.
2. If the PAMB controller card and the ADS122S14EVM are not already assembled, connect the ADS122S14EVM to the PAMB controller card as shown in the left image in Figure 1-2.
3. Set the JP1 jumper to the desired location by choosing one of the following options:
   a. Use integrated 3.3V power supply for AVDD on the ADS122S14 (pin 1-2 on JP1, default position).
   b. Use external power supply from J5 for AVDD on the ADS122S14 (pin 2-3 on JP1).
4. Download the GUI from TI.com and install the GUI using the instructions in Section 3.2.
5. Connect the micro-USB-to-USB cable from the PAMB directly to a USB port on the computer. Do not connect the USB cable through a USB hub.
6. Open up the GUI software. Check if a green signal displays and the hardware connected indicator shows in the bottom status ribbon in the GUI (see Section 4.1.3).
7. Connect the sensors or signals to the input terminal blocks (J6 and J7).
8. Configure the internal registers from the Register Configuration or ADC capture page in the GUI.
9. Capture and analyze data by clicking the *Capture* button on the Time Domain Display page in the GUI.

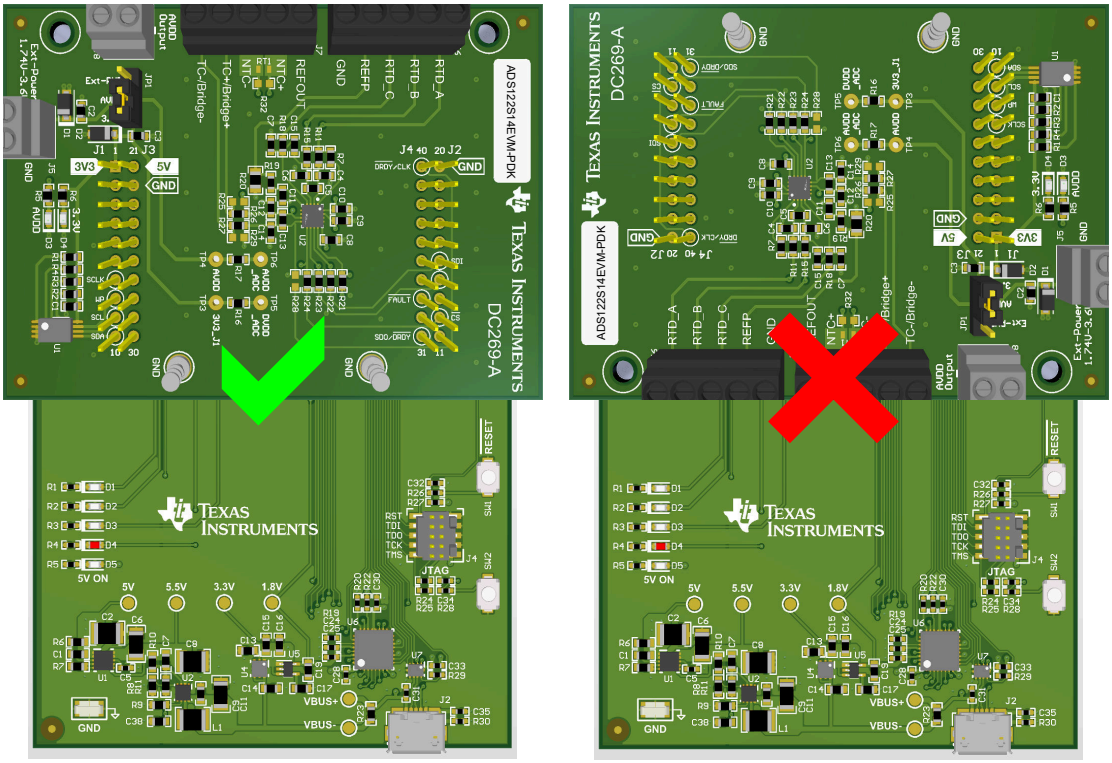


Figure 1-2. Connecting the DC269A to the PAMB Controller Card

2 Hardware

The ADS122S14EVM is designed for easy interfacing with analog sources and the PAMB controller card. This section covers the details of power supplies, analog input, digital signal and connection, serial interface.

2.1 Analog and Digital Power Supplies

The ADS122S14 supports a wide unipolar analog supply voltage (AVDD) range from 1.74V to 3.6V. By default, the ADS122S14EVM AVDD uses 3.3V power supply from the PAMB controller card. The PAMB controller card generates the 3.3V supply using the 5V rail provided by USB. Alternatively, a jumper can be installed between pin 2 and 3 on the JP1 header and then an external power supply between +1.74V and +3.6V can be provided on the J5 terminal block on the ADS122S14EVM.

Figure 2-1 shows the connection options for the AVDD and DVDD power supply that are required for normal operation on the ADS122S14EVM.

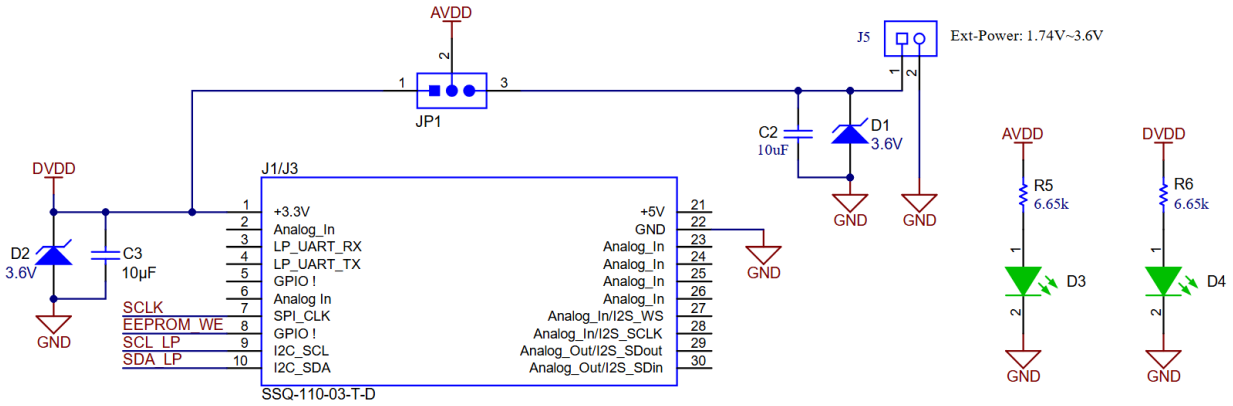


Figure 2-1. Power Supply Selection and Connection

Two LEDs light up on the PAMB controller card, as shown in Figure 2-2, when the USB cable is plugged into the computer. LED D1 on the PAMB indicates that the ADS122S14EVM-PDK is ready to communicate with the GUI software. LED D5 on the PAMB controller card indicates that the 5V output is active.

Figure 2-2 shows two LEDs on the ADS122S14EVM that help to indicate when power supply is valid. LED D4 denotes that the 3.3V output is active. LED D3 indicates that AVDD is active after the shunt selection on jumper JP1 is made.

The ADS122S14 accepts a digital supply voltage (DVDD) range from 1.65V to 3.6V. On the ADS122S14EVM, the ADS122S14 DVDD is a fixed value of 3.3V. As with AVDD, this 3.3V DVDD is sourced from the USB power supply voltage and is used as the DVDD on the PAMB controller card. Alternatively, an external power supply between +1.74V and +3.6V can be provided to the pin 1 of J1 header as the DVDD power supply for the ADS122S14 on the EVM when the PAMB board is not used and an external MCU is used to communicate with the ADS122S14.

The RESET button on the PAMB controller board can be pressed to reset the PAMB controller board if necessary.

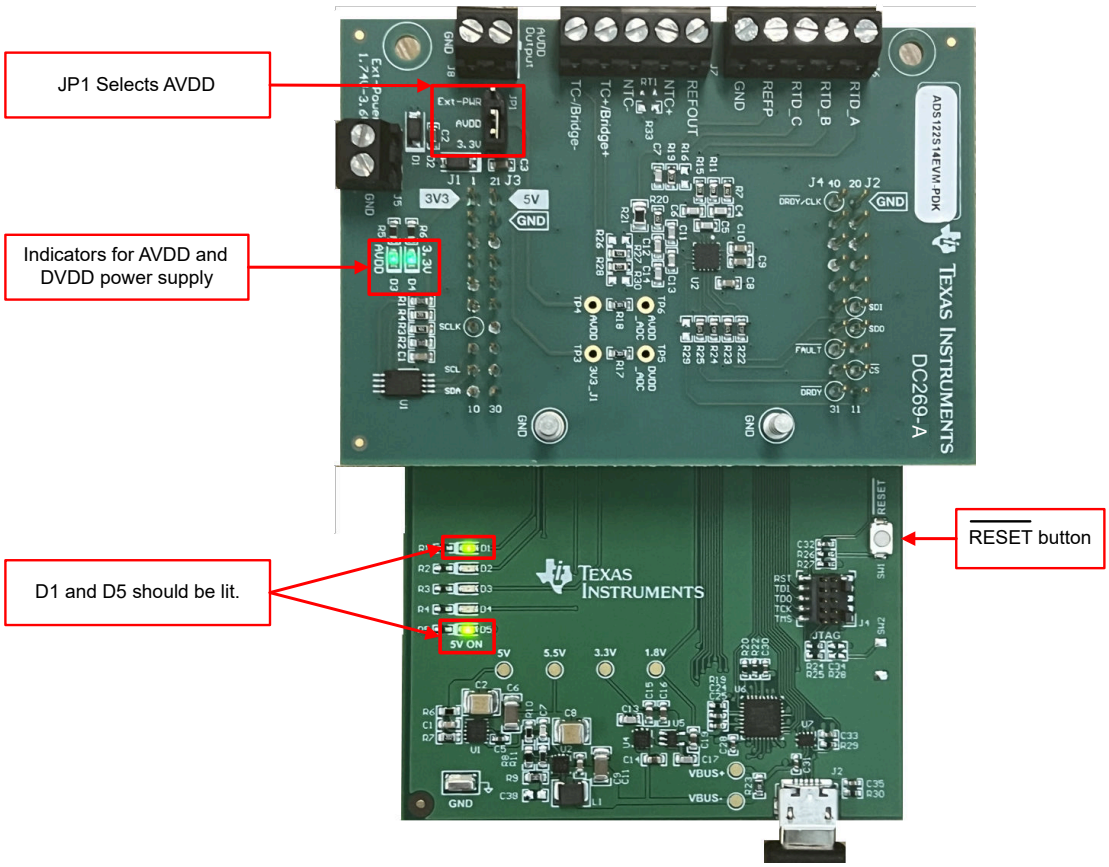


Figure 2-2. LED Indicators and Jumper(JP1) Selection for AVDD Power Supply

2.2 Analog Input Connections

Each terminal block on the ADS122S14EVM has a function for connecting external sensors and power. RTD_A, RTD_B, and RTD_C on terminal block J6 are designed for connecting a 2-, 3-, or 4-wire RTD for temperature measurement. REFP is an external input as the positive input of the voltage reference for radiometric measurement in RTD design, the reference voltage is generated when a current flows through R20 resistor using the REFP pin on J6.

The terminal block J7 provides connections for thermocouples and thermistors as well as bridge sensors. TC+/Bridge+ and TC-/Bridge- are inputs for a thermocouple or bridge-based sensor. NTC+ and NTC- are inputs for connecting a thermistor. REFOUT provides an option to use the internal voltage reference output (1.5V or 2.5V) from the ADS122S14 to excite the thermistor or bias the thermocouple sensor.

Finally, the terminal block J8 provides AVDD output that can be used as an excitation voltage for an external bridge sensor.

Table 2-1 shows the details for the screw terminal blocks:

Table 2-1. ADS122S14EVM Terminal Block Description

Terminal Block	Description	Function
J5:1	Ext-Power	External power supply input (1.74V to 3.6V)
J5:2	GND	Analog ground for the external power supply
J6:1	RTD_A	RTD connection point A
J6:2	RTD_B	RTD connection point B
J6:3	RTD_C	RTD connection point C
J6:4	REFP	Voltage reference positive input
J6:5	GND	Analog ground for the Voltage reference negative input
J7:1	REFOUT	Internal voltage reference output
J7:2	NTC+	Positive thermistor input
J7:3	NTC-	Negative thermistor input
J7:4	TC+/Bridge+	Positive thermocouple or bridge input
J7:5	TC-/Bridge-	Negative thermocouple or bridge input
J8:1	AVDD output	AVDD power supply output
J8:2	GND	Analog ground for the AVDD output

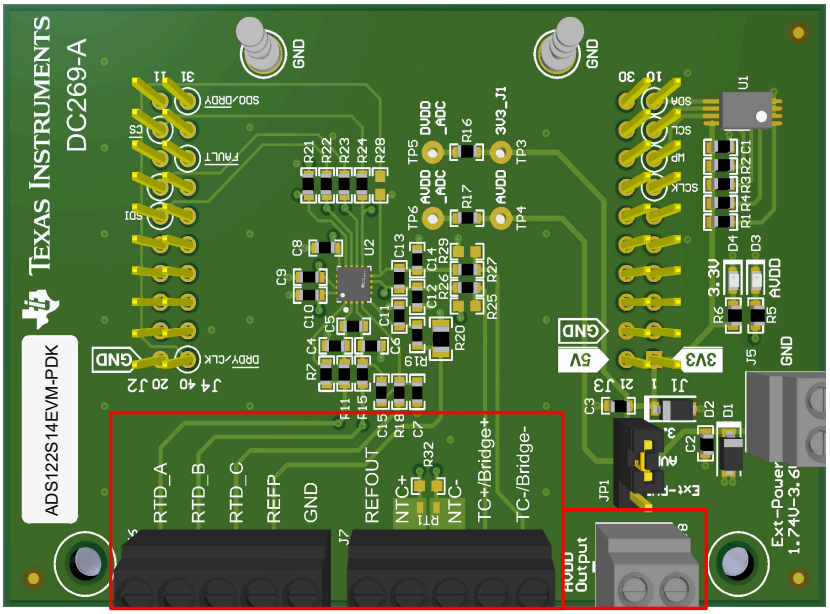


Figure 2-3. DC269A: Analog Input (J6, J7) and AVDD Output (J8)

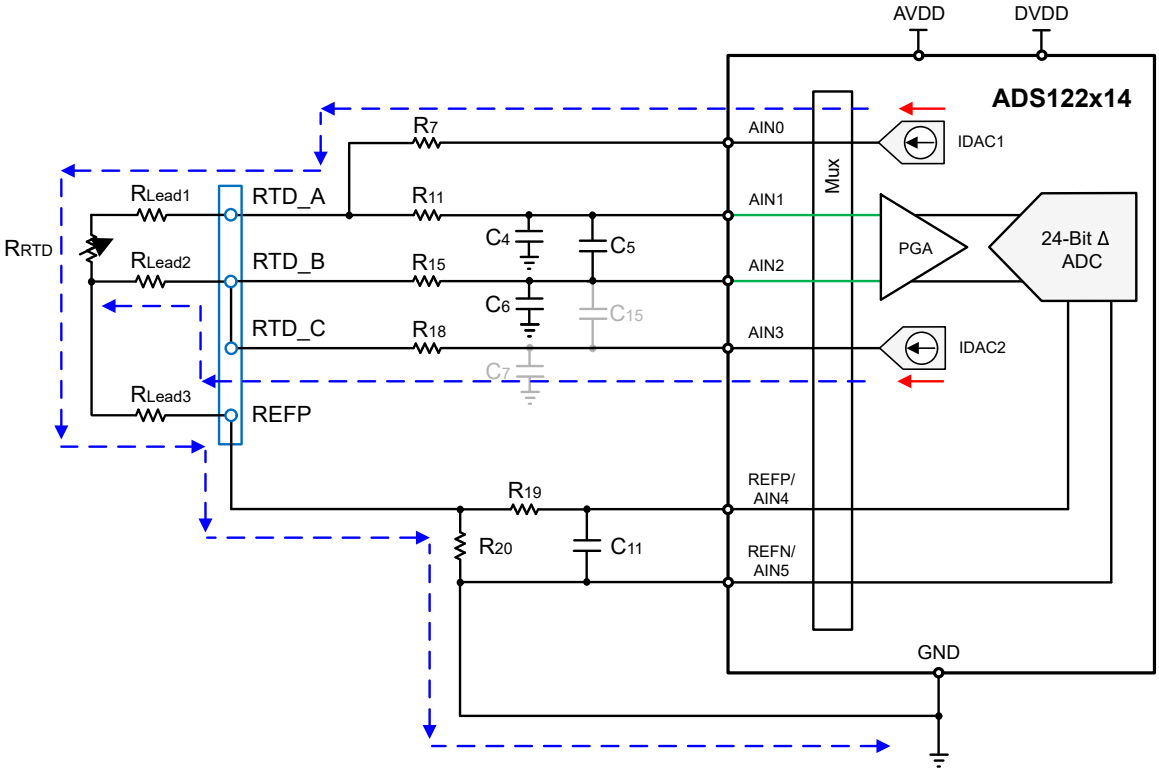
Table 2-2 summarizes the required IDAC, and analog input channel settings to measure each RTD configuration when use the ADS122S14EVM or ADS122C14EVM.

Table 2-2. ADS122x14EVM Settings for Different RTD Types

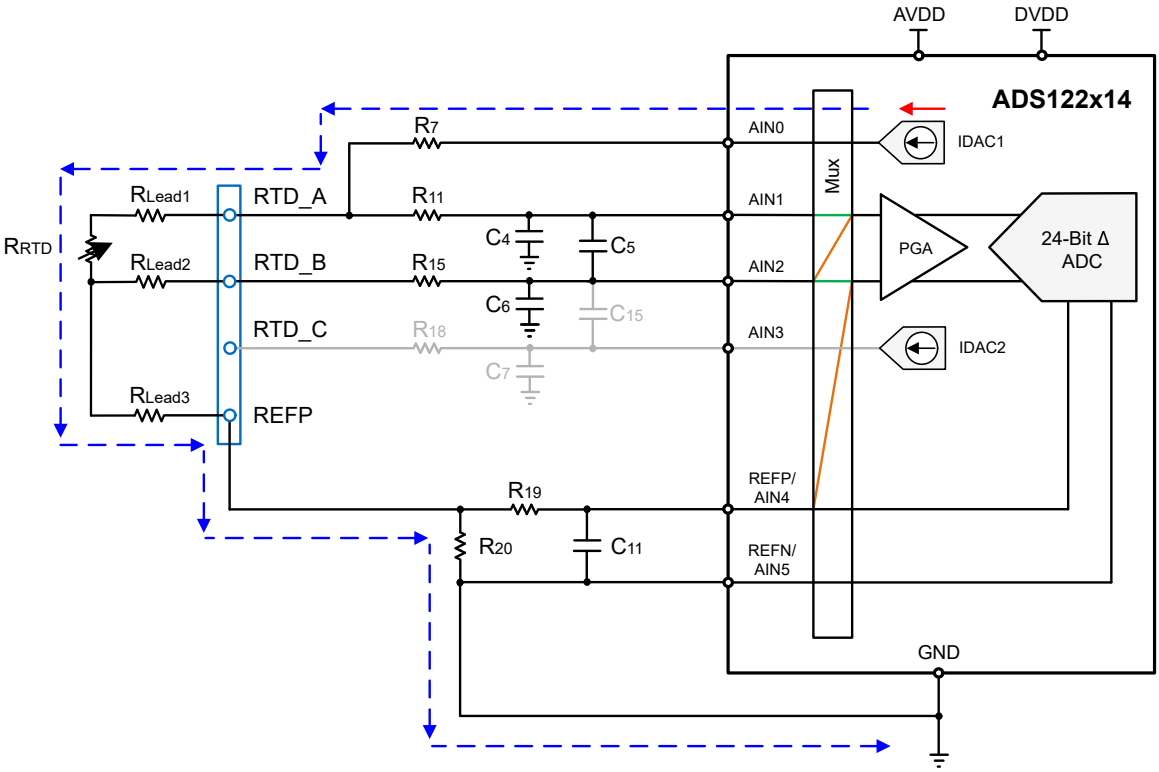
RTD	No. of IDACs	RREF resistor	IDAC Channels	AINP	AINN
2-Wire	1	Low-Side	AIN0	AIN1	AIN4
3-Wire	1	Low-Side	AIN0	AIN1(1)	AIN2(1)
				AIN2(2)	AIN4(2)
	2	Low-Side	AIN0, AIN3	AIN1	AIN2
4-Wire	1	Low-Side	AIN0	AIN2	AIN3

(1) First measurement.
(2) Second measurement.

Figure 2-4 and Figure 2-5 show the diagrams for 2-, 3-, 4-wire RTD measurements supported by the ADS122S14EVM and ADS122C14EVM support.

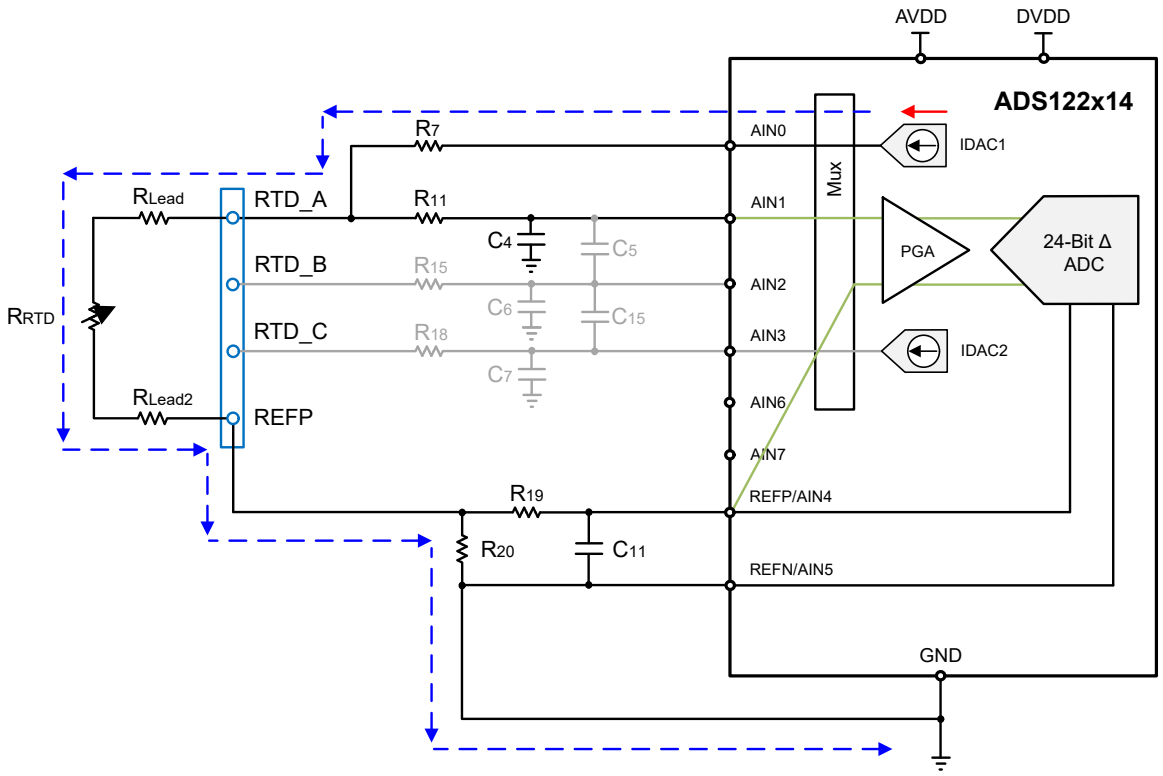


3-Wire RTD: Two IDACs, One Measurement (AIN1-AIN2)

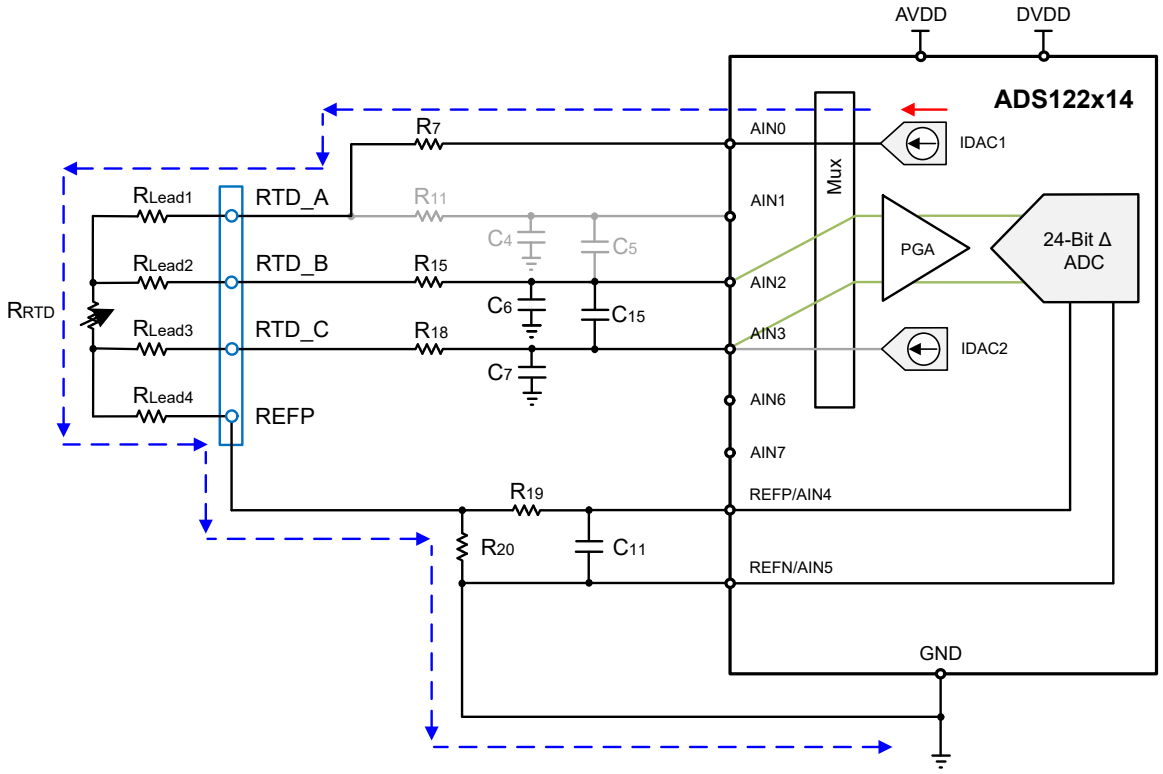


3-Wire RTD: One IDAC, Two Measurements (AIN1-AIN2, AIN2-AIN4)

Figure 2-4. DC269A: 3-wire RTD Measurement With One and Two IDACs



2-Wire RTD: One IDAC, One Measurement (AIN1-AIN4)



4-Wire RTD: One IDAC, One Measurement (AIN2-AIN3)

Figure 2-5. DC269A: 2-, 4-Wire RTD Measurement With One IDAC

Figure 2-6 shows a circuit to bias the thermocouple sensor that the ADS122S14EVM and ADS122C14EVM support. The circuit uses the thermistor for Cold-Junction Compensation (CJC). The red arrows are external

jumper wires that must be provided by the user. Refer to the application note for more information on thermocouple measurement: A Basic Guide to Thermocouple Measurements.

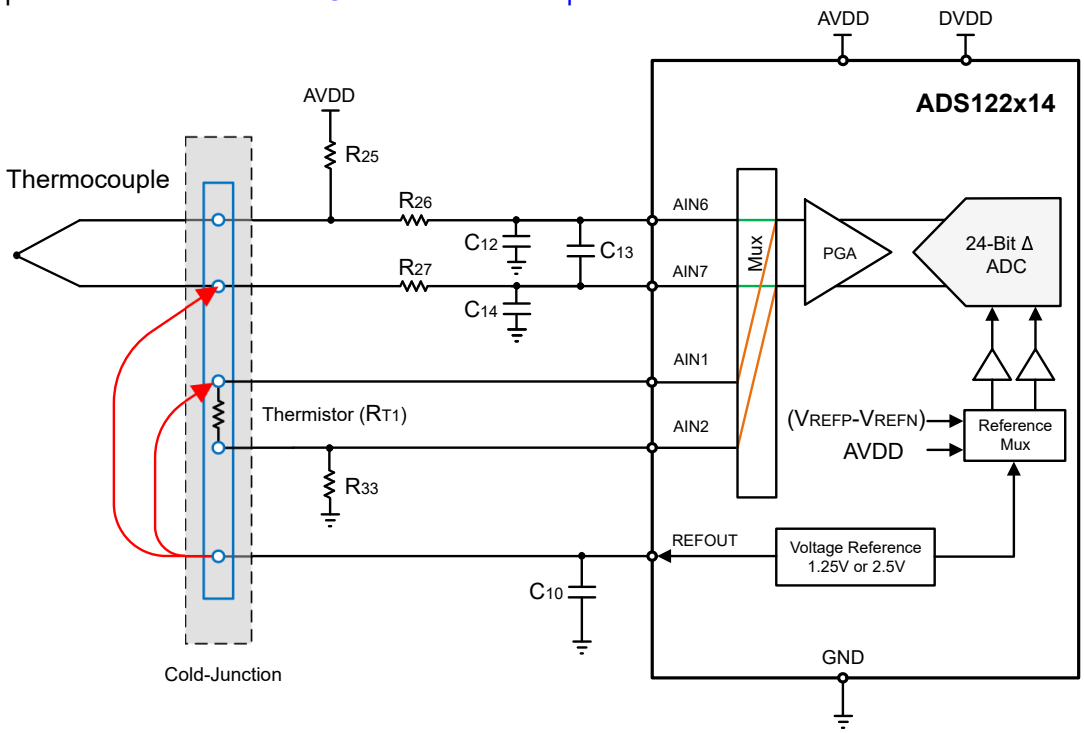


Figure 2-6. DC269A: Thermocouple Measurement With a Thermistor for CJC

Figure 2-7 shows a circuit for a bridge measurement that the ADS122S14EVM and ADS122C14EVM support. The circuit use the thermistor for temperature compensation of the bridge. The red arrows are external jumper wires that must be provided by the user. Refer to the application note for more information on thermocouple measurement: A Basic Guide to Bridge Measurements.

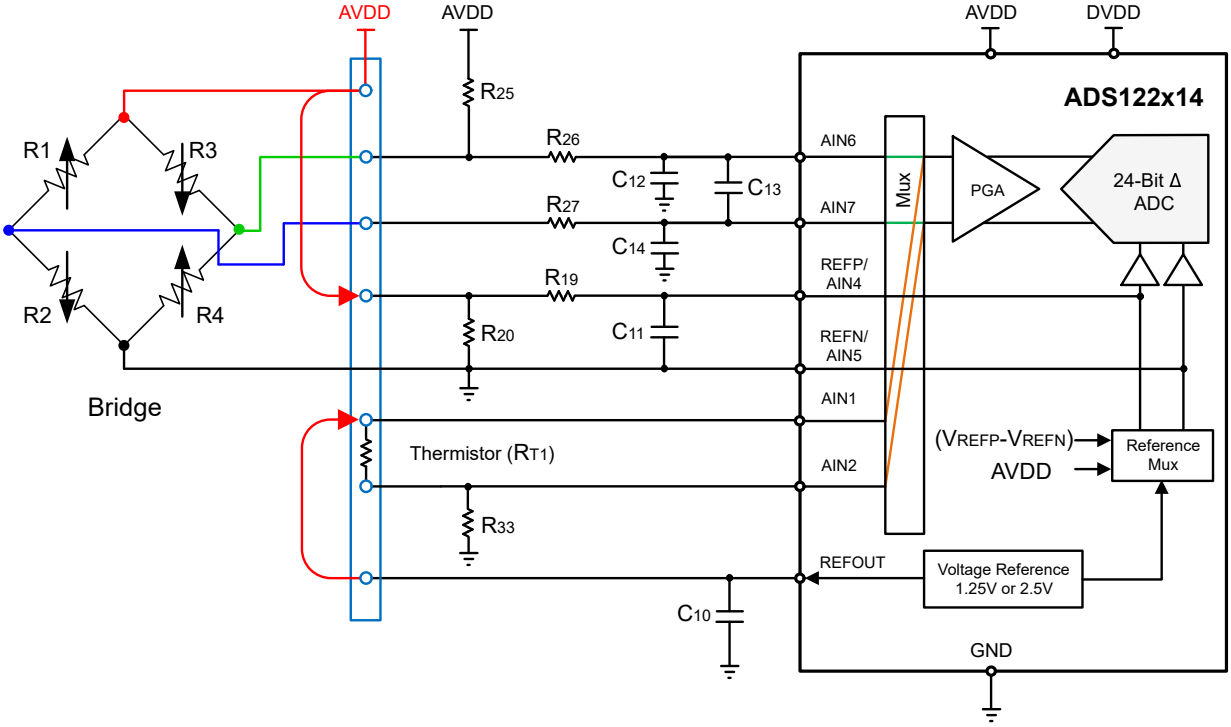


Figure 2-7. DC269A: Resistive Bridge Measurement With a Thermistor for Temperature Compensation

2.3 Digital Signal and Connection

The digital interface between the ADS122S14EVM and the PAMB controller card includes power supply, SPI or I2C, and a fault output signal from the ADS122S14. Figure 2-8 shows the header pinout and description on the ADS122S14EVM. Use these connection points for troubleshooting the SPI communication with a logic analyzer or to attach an external MCU to control the ADS122S14EVM without the PAMB.

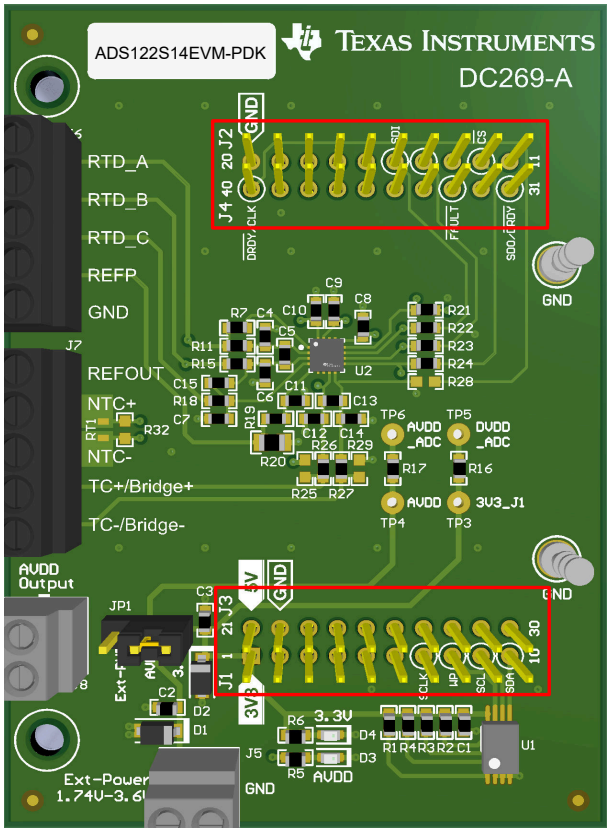


Figure 2-8. ADS122S14EVM-to-PAMB Connections

Table 2-3. ADS122S14EVM Header Pinout and Description

Description	Connector	Connector	Description	Description	Connector	Connector	Description
3.3V	J1:1	J3:21	5V		J2:11	J4:31	SDO/DRDY
	J1:2	J3:22	GND	CS	J2:12	J4:32	
	J1:3	J3:23			J2:13	J4:33	FAULT
	J1:4	J3:24		SDO/DRDY	J2:14	J4:34	
	J1:5	J3:25		SDI	J2:15	J4:35	
	J1:6	J3:26			J2:16	J4:36	
SCLK	J1:7	J3:27			J2:17	J4:37	
EEPROM_WE	J1:8	J3:28			J2:18	J4:38	
SCL_LP	J1:9	J3:29			J2:19	J4:39	
SDA_LP	J1:10	J3:30		GND	J2:20	J4:40	DRDY/CLK

2.4 Serial Interface

The ADS122S14EVM uses an SPI to communicate with the 24-bit ADS122S14 and 16-bit ADS112S14. The ADS122C14EVM uses an I2C interface to communicate with the 24-bit ADS122C14 and 16-bit ADS112C14. The EVM PCB layout is same for the ADCs with SPI and I2C. Table 2-4 shows the components required for each interface on the EVM boards.

Table 2-4. ADS1x2x14EVM Variants and Component Installation

EVM	Resolution/Device supported	Interface	R8	R12	R13	R14	R22	R23	R24	R25
ADS122S14EVM	24-bit/ ADS122S14	SPI	Not Installed				**Installed**			
	16-bit/ ADS112S14									
ADS122C14EVM	24-bit/ ADS122C14	I2C	**Installed**				Not Installed			
	16-bit/ ADS112C14									

Figure 2-9 shows the digital connections between the ADS122S14EVM and the PAMB controller card. The ADS122S14 uses SPI serial communication CPOL = 0, CPHA = 1 to configure the internal registers and retrieve conversion data. The serial clock (SCLK) frequency can be as fast as 16.66MHz, the ADS122S14EVM provides 47Ω resistors between the digital signals to aid with signal integrity. Typically, in high-speed SPI communication, fast signal edges can cause overshoot. These 47Ω resistors slow down the signal edges to minimize signal overshoot. Headers J1/J3 and J2/J4 provide test points to measure the digital signals or to connect the ADS122S14EVM to the PAMB controller card.

> The maximum operating voltage level for the digital signals on headers J1/J3, and J2/J4 is 3.6V. Exceeding this voltage level or applying a digital signal before the ADS122S14EVM has been powered-up can cause permanent damage to the ADS122S14.

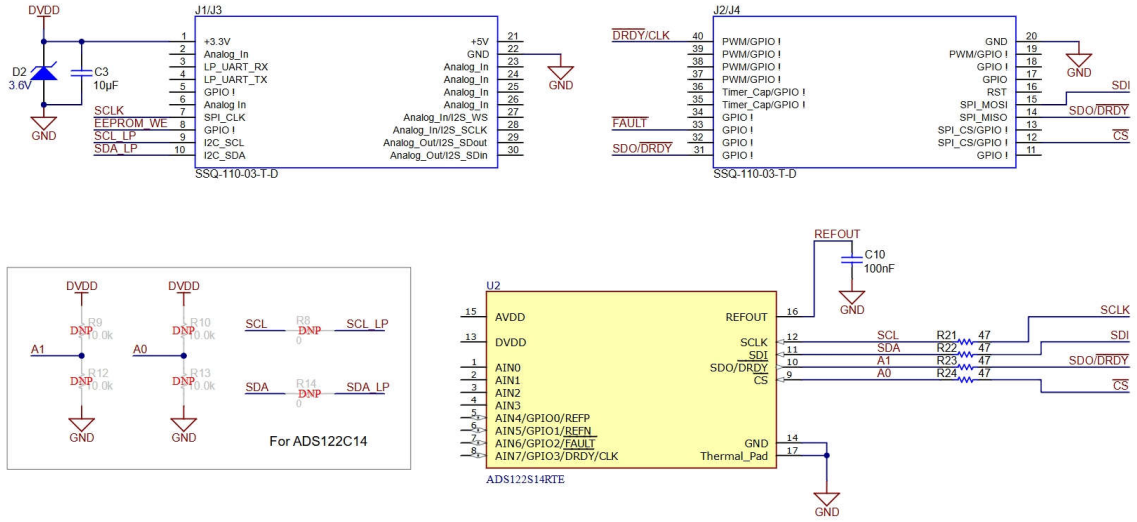


Figure 2-9. Connections to Digital Signals on the PAMB

2.5 EEPROM

Figure 2-10 shows an EEPROM circuit that is used with the PAMB controller card for EVM identification only. The EEPROM communicates with the PAMB controller card over an I2C bus that is shared with the ADS122C14 on ADS122C14EVM. This circuit is not required by the ADS122S14 or ADS122C14 for operation and the circuit can be powered down when not used the PAMB controller card.

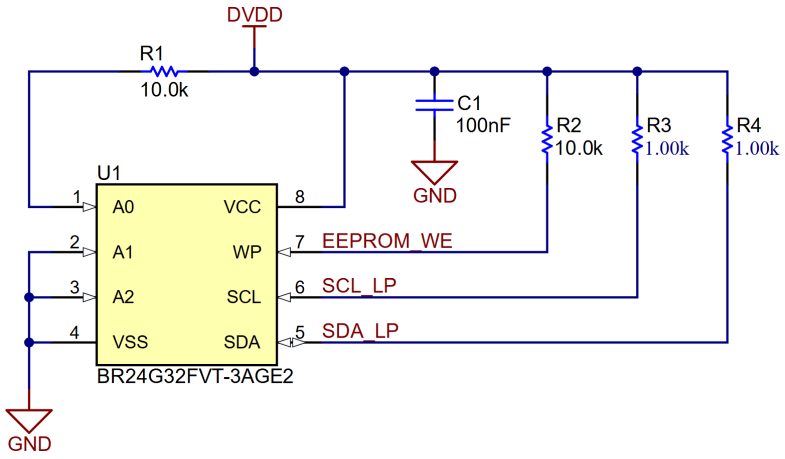


Figure 2-10. EEPROM for EVM ID

2.6 Connecting to an External Controller

Complete the following steps to connect an external controller with the ADS122S14EVM or ADS122C14EVM:

1. Unplug the USB cable from the PAMB controller card.
2. Disconnect the ADS122S14EVM from the PAMB controller card.
3. Connect digital signals (the SPI on ADS122S14EVM or I2C interface on ADS122C14EVM) from the ADS122S14EVM to the external controller board. Refer to Section 2.3 and Section 2.4 for details.
4. Connect the AVDD/DVDD and the ground from the ADS122S14EVM to the external controller board. Refer to Section 2.1 for details.
5. Connect the sensor signal to the ADS122S14EVM. Refer to Section 2.2 for details.
6. Install R28 and uninstall R27 as shown in Section 5.1, then connect the DRDY/CLK signal from the ADS122S14EVM to the external controller circuit board to use an external clock.
7. Develop and run the corresponding software in the external controller to communicate with the EVMs.

3 Software

3.1 Software Description

The *ADS122X14EVM-PDK-GUI* software includes graphical tools for data capture, full ADS122S14 register configuration, time domain analysis, histogram analysis, and spectral analysis. This suite also has a provision for exporting data to a text file for post-processing.

3.2 ADS122S14EVM Software Installation

Download the latest version of the EVM GUI installer from the Tools and Software of the ADS122S14EVM Tool Folder and run the GUI installer to install the EVM GUI software on the computer that the EVM and PAMB are not connected to before installing the GUI software.

CAUTION

Manually disable any antivirus software running on the computer before downloading the EVM GUI installer onto the local hard disk. Depending on the antivirus settings, an error message can possibly appear or the installer.exe file can be deleted.

Accept the license agreement and follow the on-screen instructions in Figure 3-1 to complete the installation. If the LabVIEW™ run-time engine has not already been installed, then a prompt shows to accept this license agreement and to reboot the computer to complete installation.

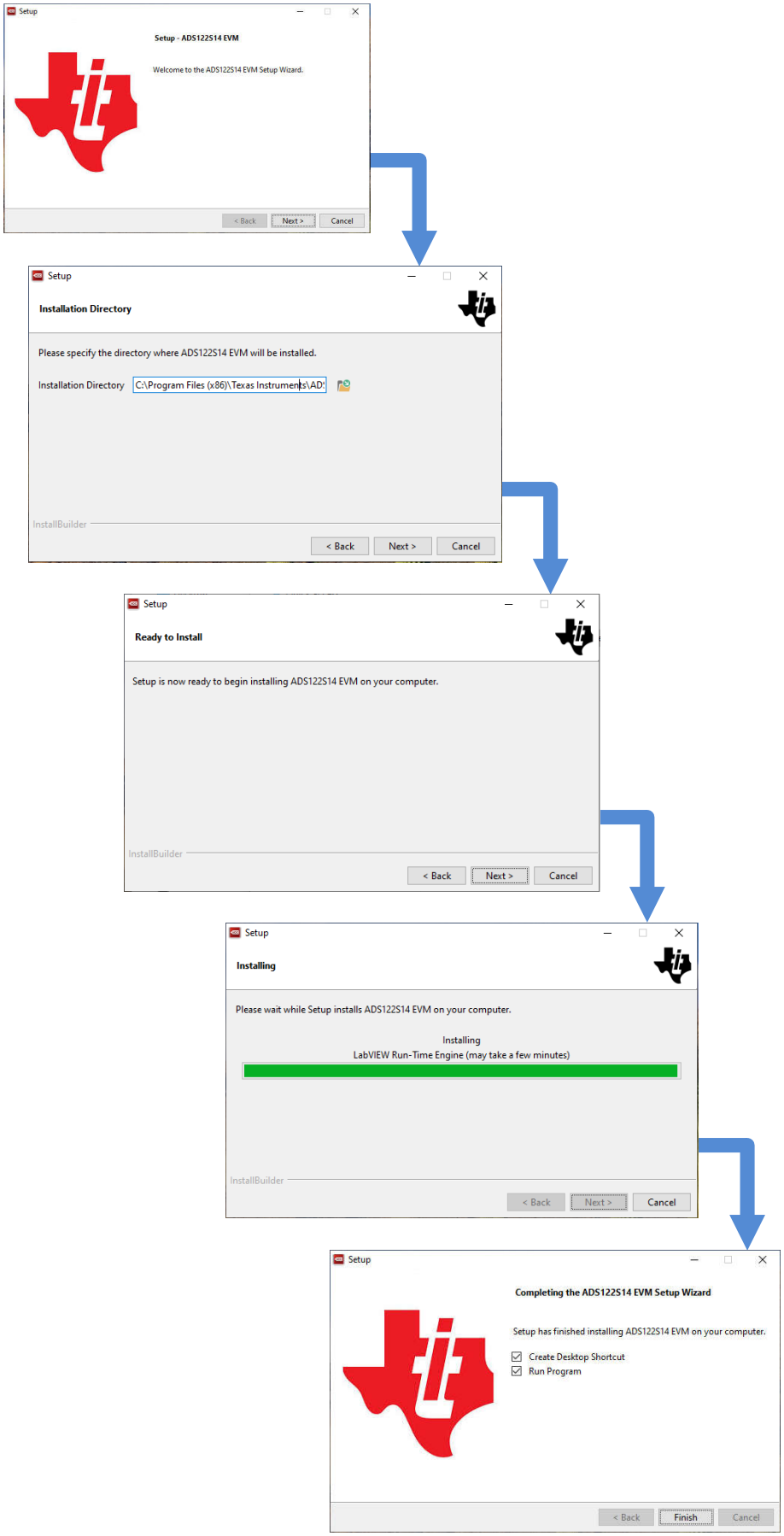


Figure 3-1. Software Installation and Prompts

3.3 Device Manager Check

Check the device manager and verify if the driver is properly installed on the computer as shown in Figure 3-2.

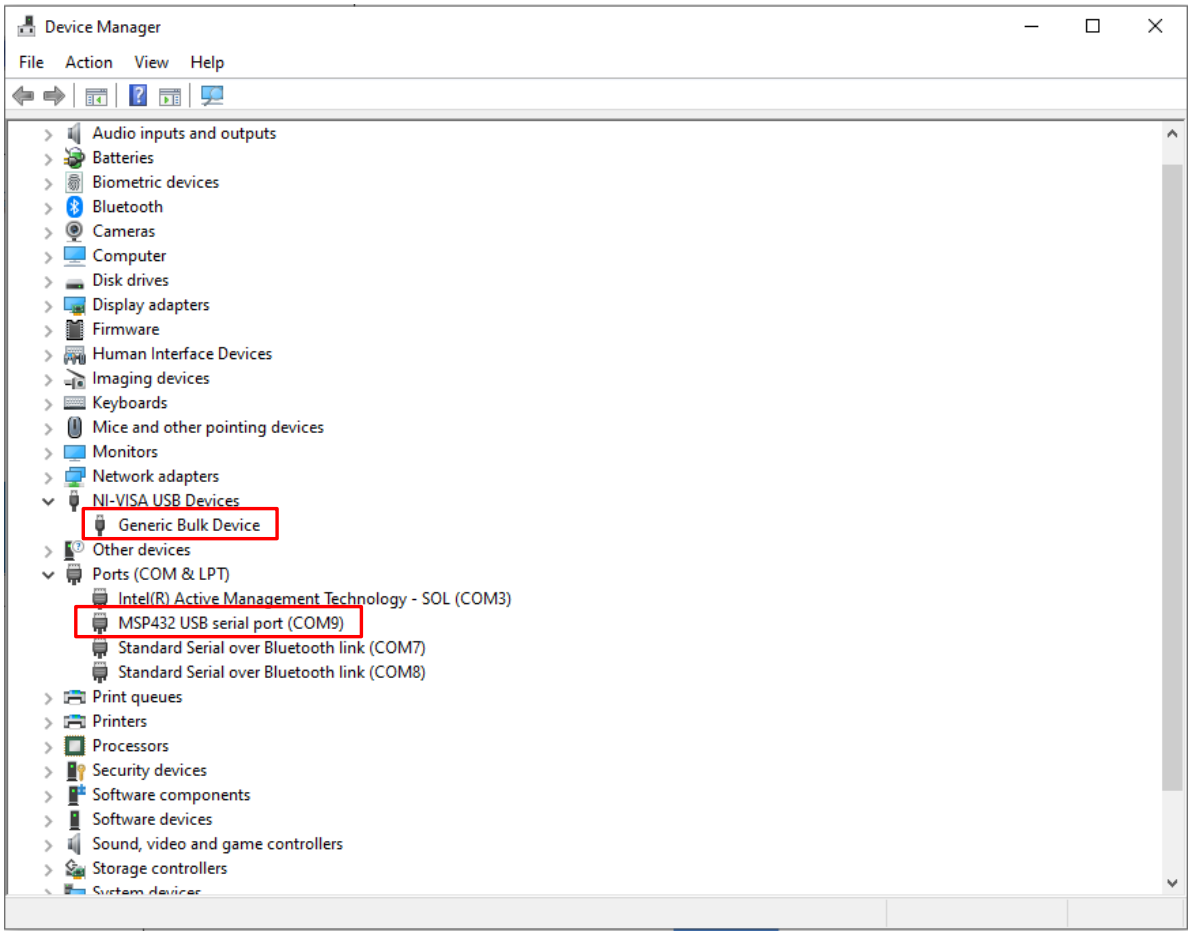


Figure 3-2. Device Manager Check for the GUI Installation

4 Implementation Results

4.1 EVM Operation

4.1.1 Evaluation Setup

Figure 4-1 shows how to connect the ADS122S14EVM after installing the GUI software:

1. If the PAMB controller card and the ADS122S14EVM are not already assembled, properly attach the ADS122S14EVM to the PAMB controller card by connecting J1/J3 and J2/J4 of the ADS122S14EVM to the connectors of the PAMB controller card. Refer to Figure 1-2 to verify the correct connection.
2. Verify the jumper position on JP1 on the EVM.
3. Connect the USB cable between the PAMB controller card and the computer.
4. LED D1 and LED 5 on the PAMB lights up, indicating that the PAMB is powered up and connected.
5. LED D3 and LED D4 on the ADS122S14EVM lights up to indicate that the ADS122S14EVM board is powered up.
6. Launch the GUI software by using the start menu as shown in Figure 4-2 or the installed icon. Check if the *Connected* indicator in the lower right corner in the GUI is green which indicates the ADS122S14EVM and PAMB controller card are successfully connected and communicated with the GUI. If the indicator is gray, check the *Demo Mode* in the upper right corner of the GUI, then uncheck the mode to switch back to normal data capture mode.
7. Configure the registers before capturing data.
8. Connect external sensors or signals to J6 or J7 on the ADS122S14EVM.
9. Press the *Capture* button in the GUI to capture the data.

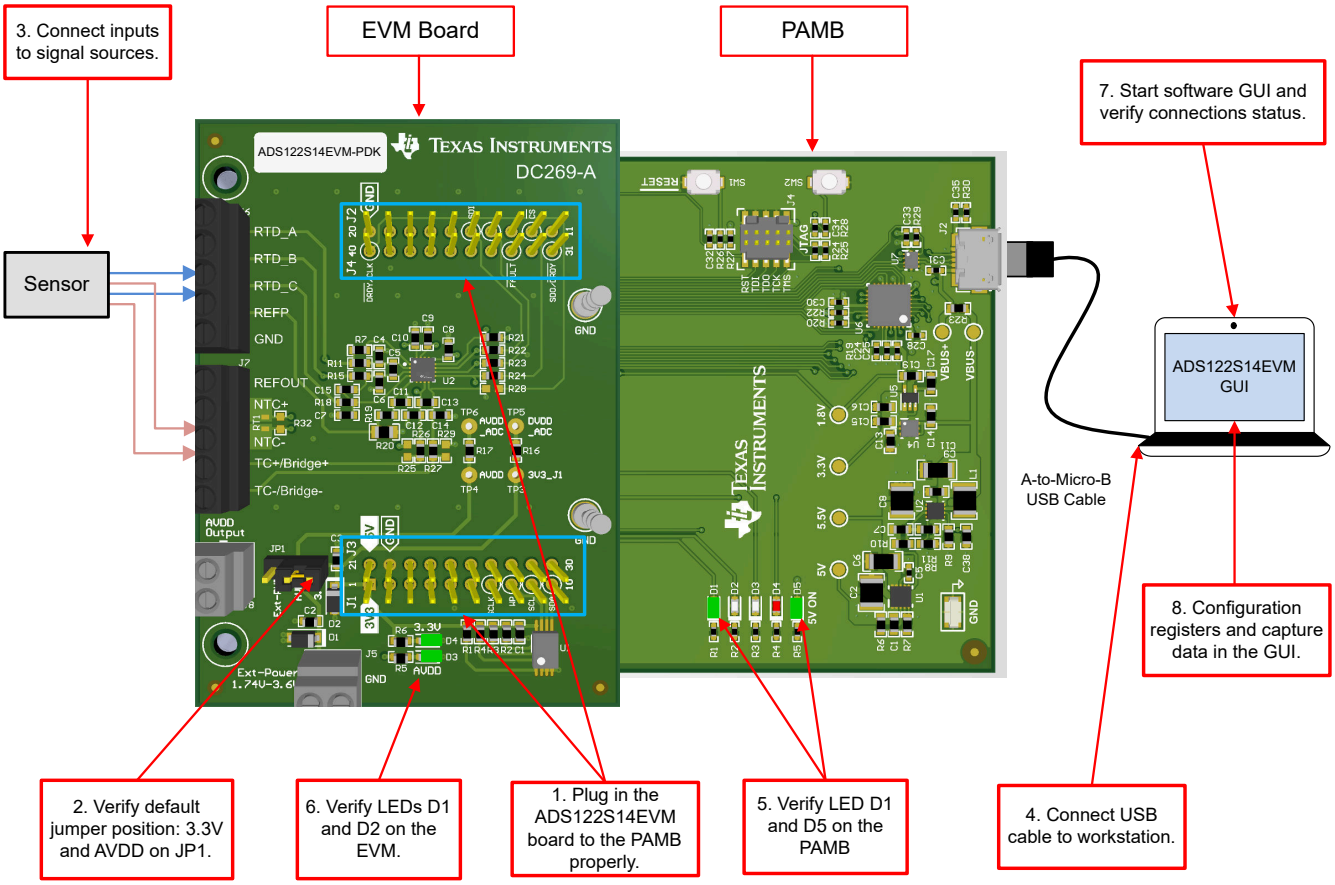


Figure 4-1. DC269A Connections

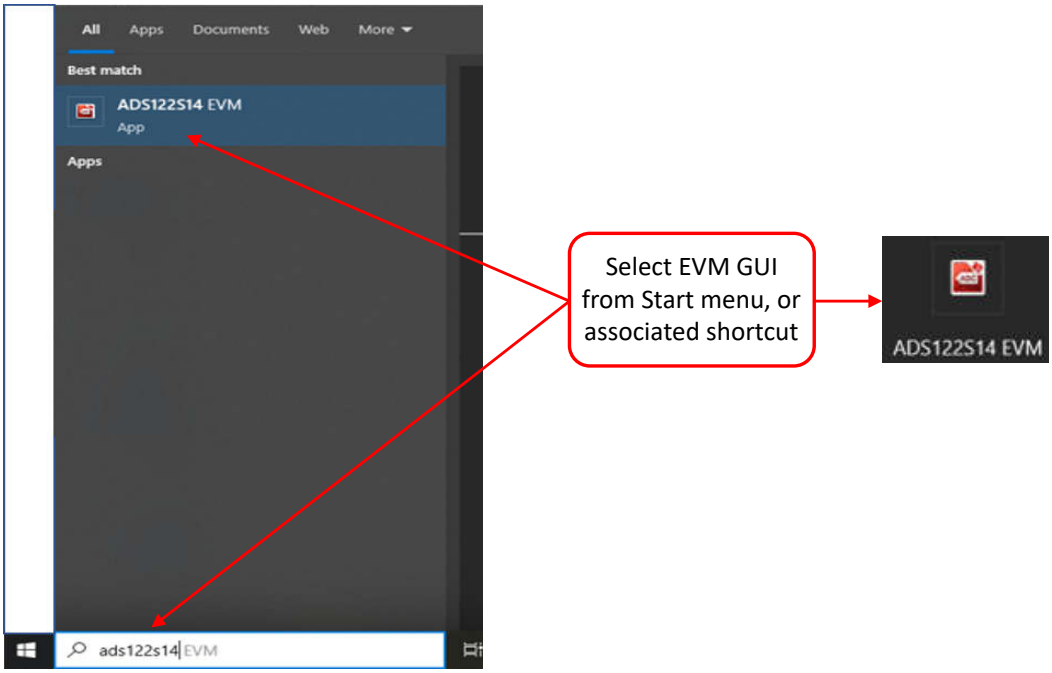


Figure 4-2. Launch the ADS122S14EVM GUI

4.1.2 ADC Capture Settings

The *ADC Capture Settings* page allows easy configuration of multiple ADC settings and is an alternative method to using the *Register Configurations* page. There are multiple tabs on the *ADC Capture Settings* page, including *General*, *Mux Control*, *IDAC and BOCS Configuration* and *Status*. Changing these settings updates the values on the *Register Configurations* page. Use the check box of *Demo Mode* in the upper right conner to disconnect or reconnect the ADS122S14EVM and the PAMB controller card to the GUI software. The green *Connected* indicator in the lower right corner in the GUI indicates the ADS122S14EVM and PAMB controller card are successfully connected and communicating with the GUI software.

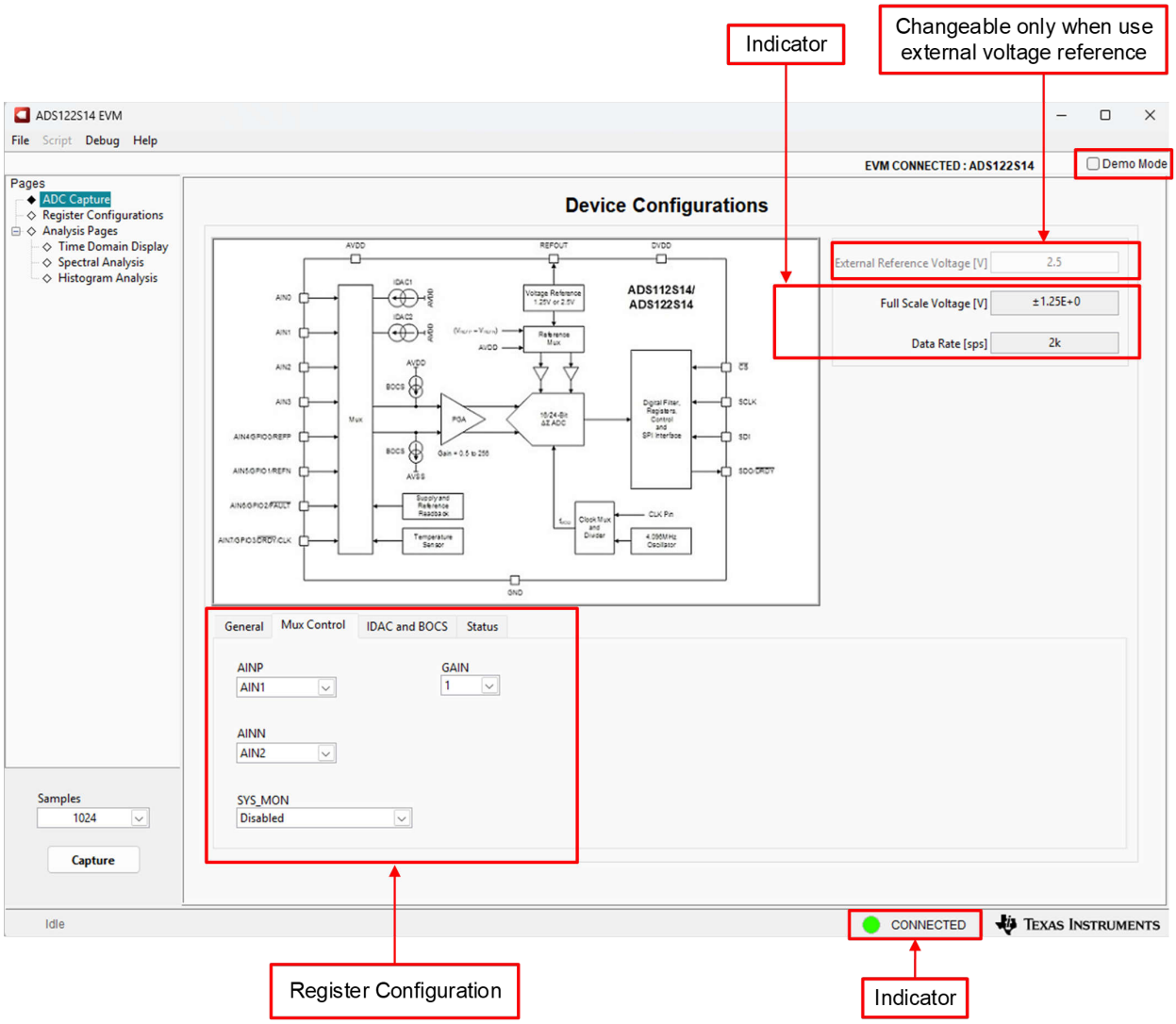


Figure 4-3. ADC Capture

4.1.3 Register Configurations

Figure 4-4 shows the ADC register settings for ADS122S14. Selecting the *Register Configurations* under the Pages on the left side of the GUI software can access these register settings. Change these register values to set the different device modes (such as filter settings and power settings). Use the register operation tool to read and write a selected register, read all registers, save the configurations into a file, read a configuration file to load the setting of the registers.

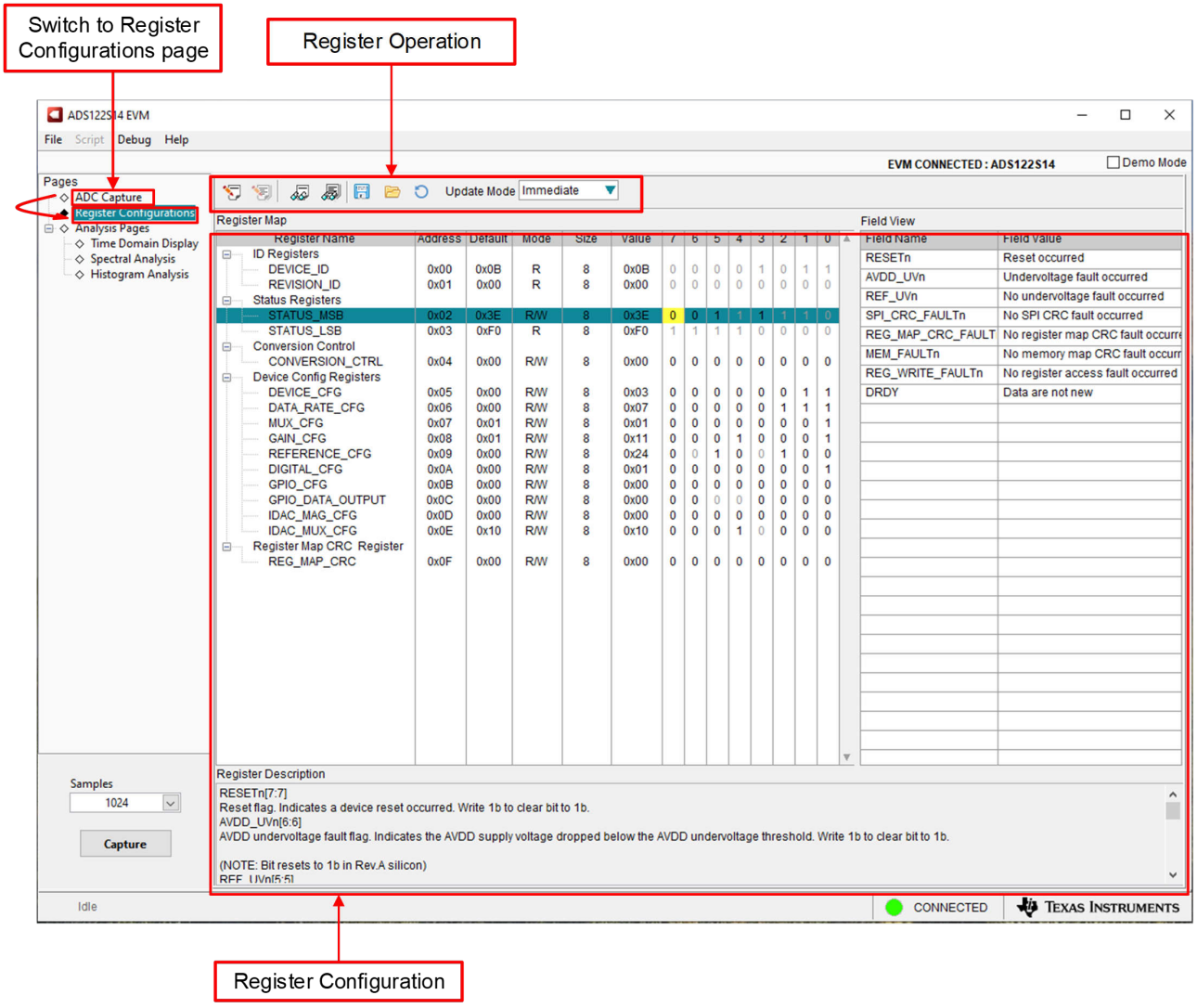


Figure 4-4. Register Configurations

4.1.4 Time Domain Display

The time domain display tool allows visualization of the ADC response to a given input signal. This tool is useful for both studying the behavior of and debugging any gross problems with the ADC. The user can trigger a data capture of the selected number of samples from the ADS122S14EVM, as per the current interface mode settings indicated in Figure 4-5 by using the *Capture* button. The sample indices on the x-axis and the y-axis show the corresponding equivalent analog voltages based on the specified reference voltage. Switching pages to any of the analysis tools described in the subsequent sections causes calculations to be performed on the same set of data. Use the image zoom tool to zoom in or out the displayed waveform. Use the right-click menu tool to save data to an excel file for further analysis.

Figure 4-5. Time Domain Display

4.1.5 Spectral Analysis Display

The spectral analysis tool, shown in Figure 4-6, is intended to evaluate the dynamic performance (SNR, THD, THD+N, SFDR, and Dynamic Range) of the ADS122S14 ADC through single-tone sinusoidal signal Fast Fourier transform (FFT) analysis using the 7-term Blackman-Harris window setting. The FFT tool includes windowing options that are required to mitigate the effects of non-coherent sampling (this discussion is beyond the scope of this document). The *7-Term Blackman-Harris* window is the default option and has sufficient dynamic range to resolve the frequency components of up to a 24-bit ADC. The *Rectangle* option corresponds to not using a window (or a rectangular window) and is not recommended. Figure 4-6 shows the noise spectrum while the ADS122S14 input is shorted and the data is captured by the GUI.

Figure 4-6. Frequency Domain Display

4.1.6 Histogram Analysis Display

Noise degrades ADC resolution and the histogram tool can be used to estimate effective resolution. The cumulative effect of noise coupling to the ADC output from sources (such as the input drive circuits, reference drive circuit, ADC power supply, and the ADC) is reflected in the standard deviation of the ADC output code histogram that is obtained by performing multiple conversions of a dc input applied to a given channel. Figure 4-7 shows the histogram corresponding to a dc input after clicking the *Capture* button in the GUI.

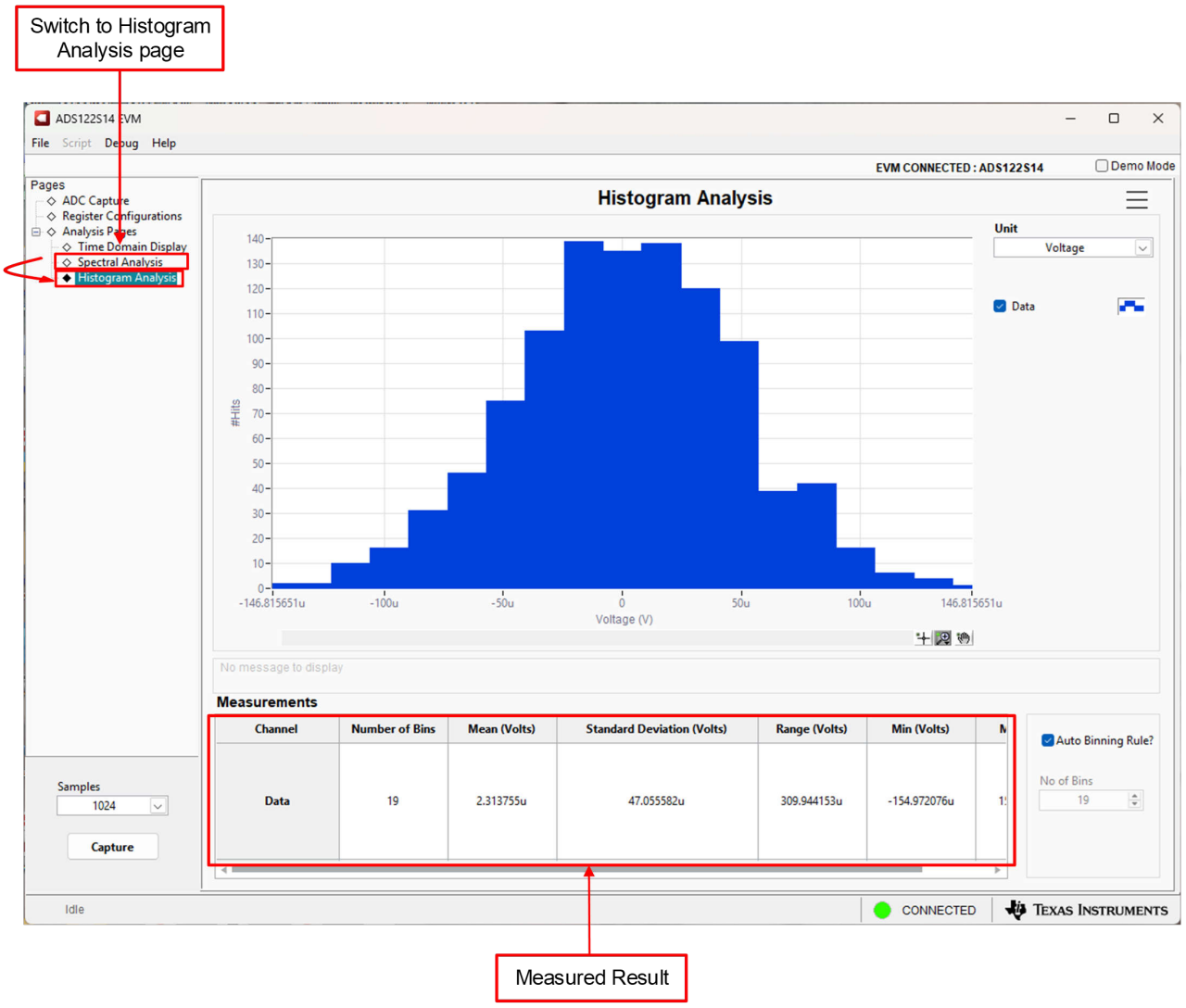


Figure 4-7. Histogram Display

5 Hardware Design Files

5.1 Schematics

Figure 5-1 shows the ADS122S14EVM schematic. Figure 5-2 shows the ADS122C14EVM schematic. Figure 5-3 shows the hardware for the EVMs.

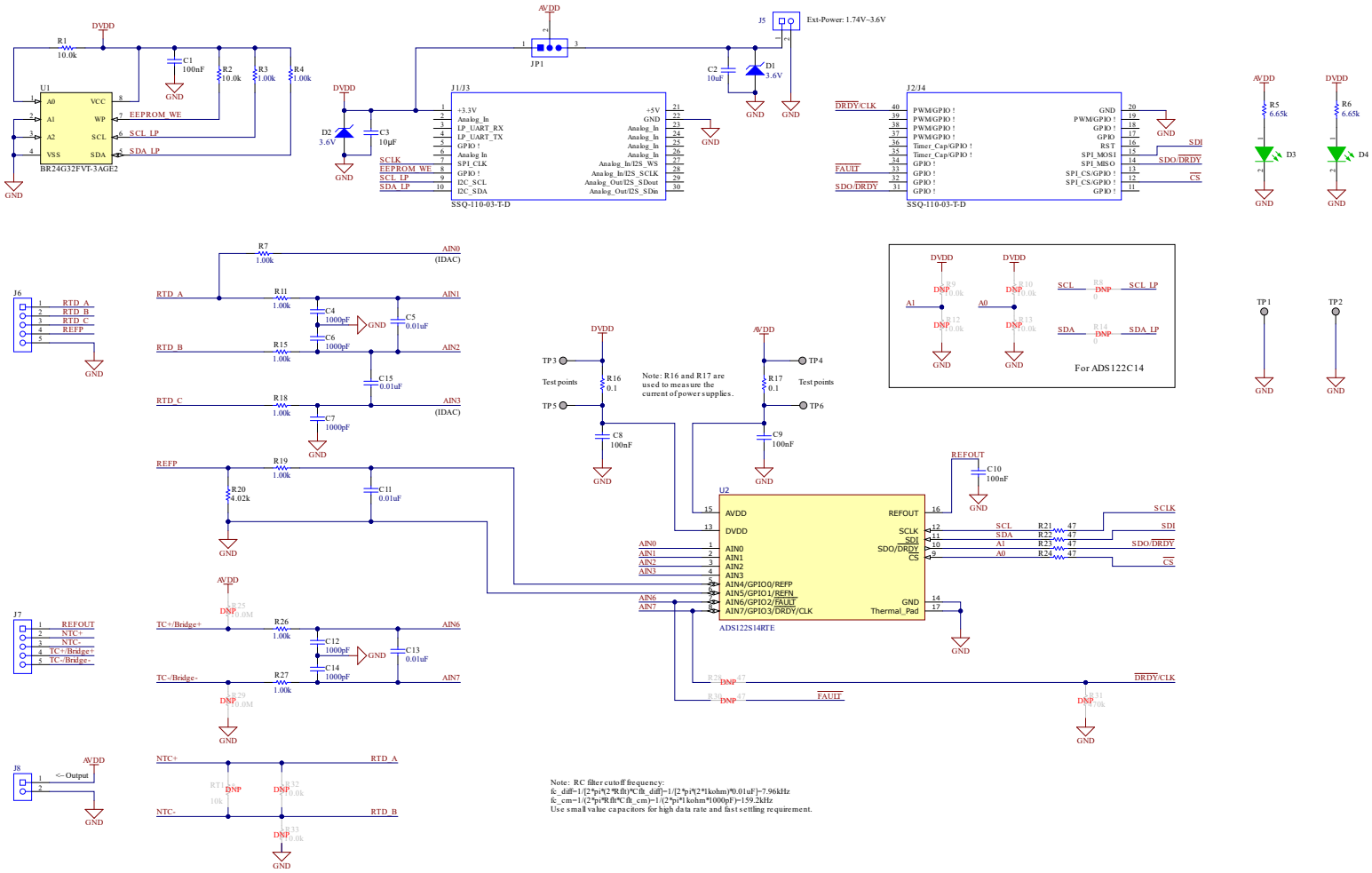


Figure 5-1. ADS122S14EVM Main Schematic

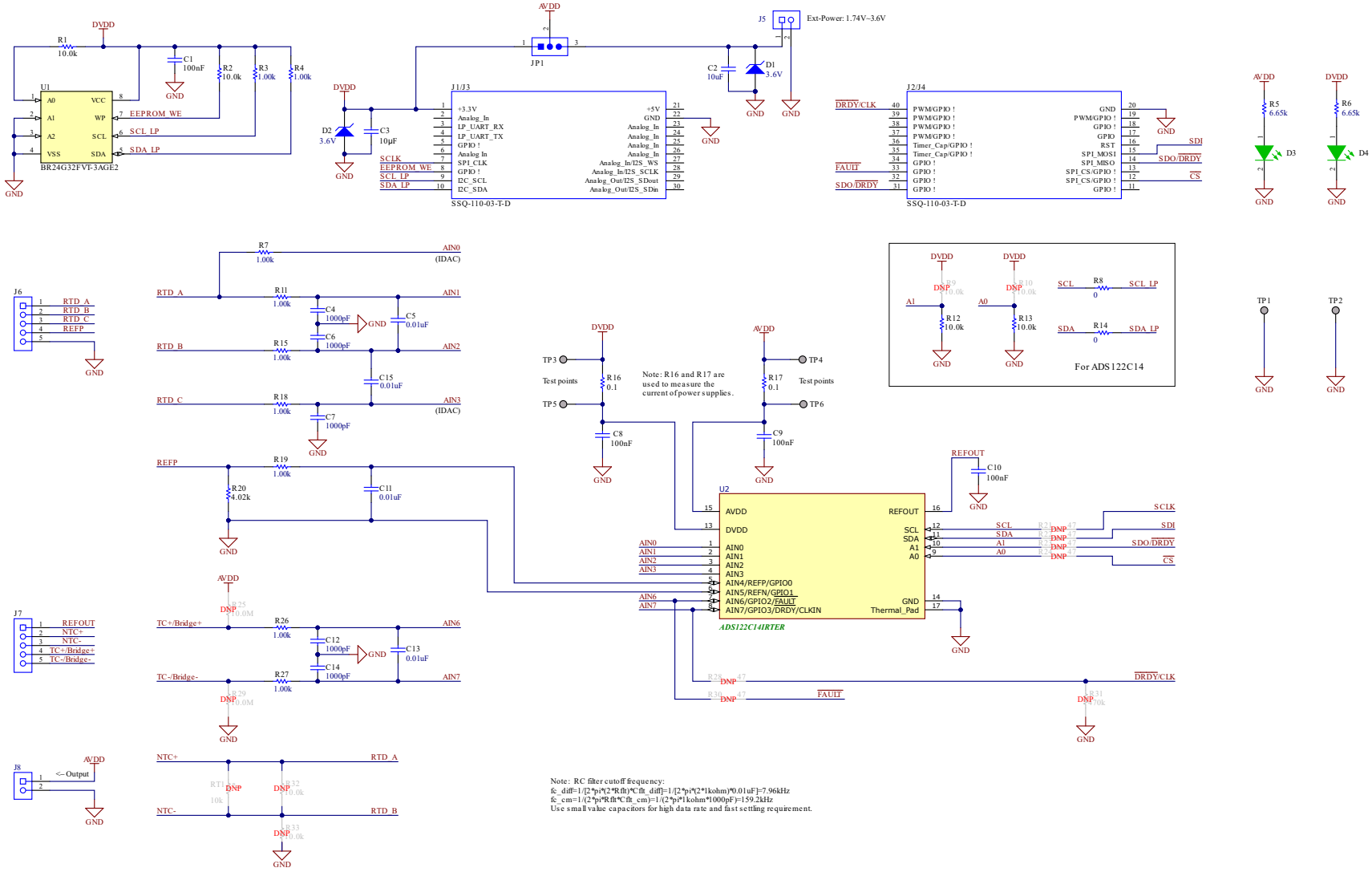


Figure 5-2. ADS122C14EVM Main Schematic

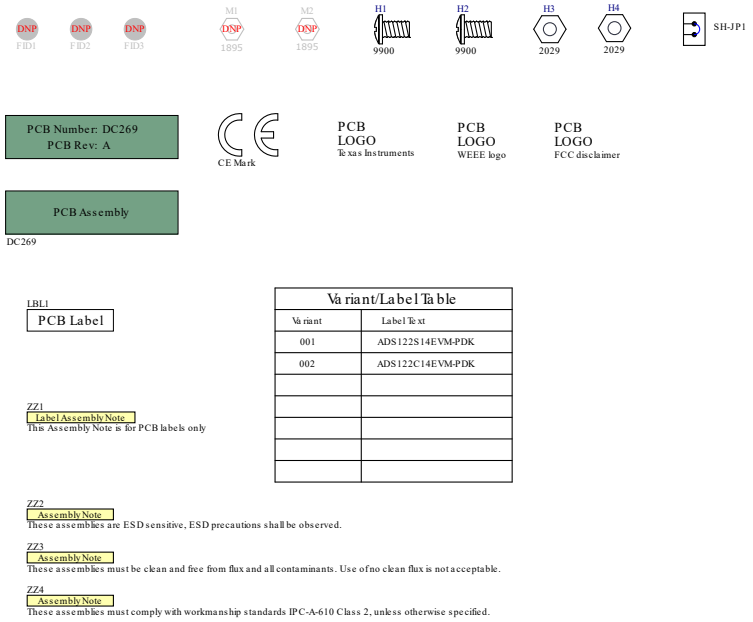


Figure 5-3. ADS122C14EVM Hardware Schematic

5.2 PCB Layouts

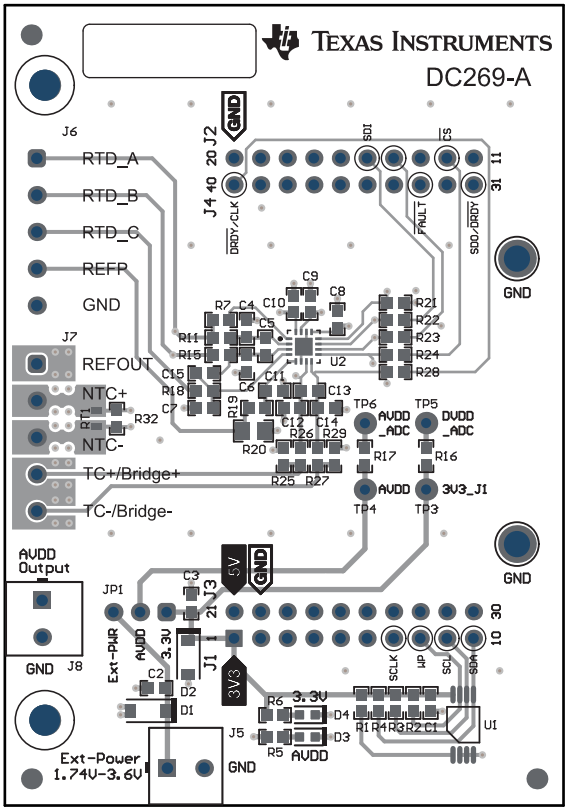


Figure 5-4. PCB Layout for the ADS122x14EVM (Top View)

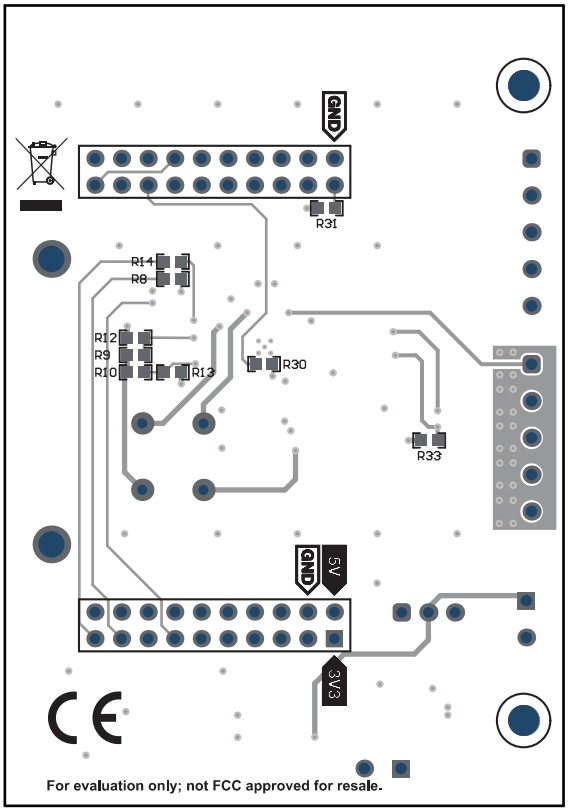


Figure 5-5. PCB Layout for the ADS122x14EVM (Bottom View)

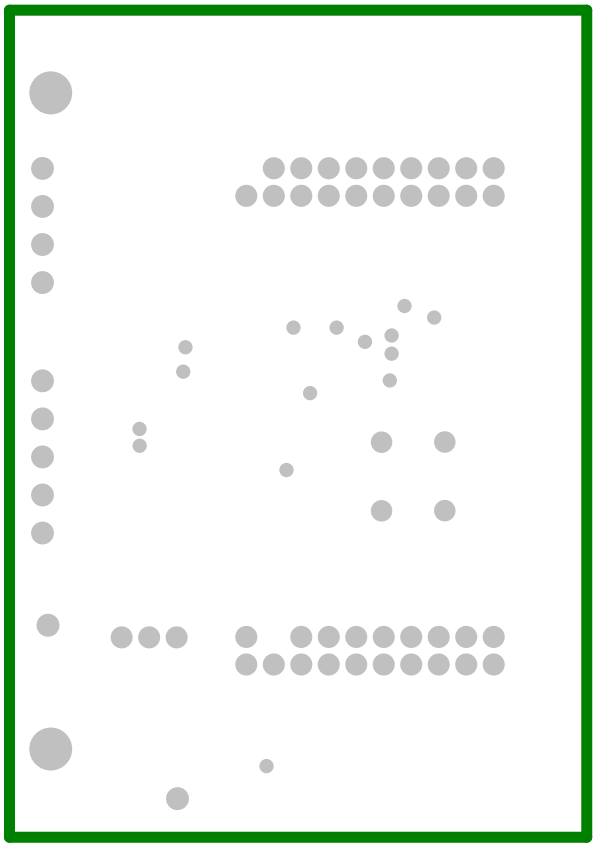


Figure 5-6. PCB Layout (Internal GND Plane 1) for the ADS122x14EVM

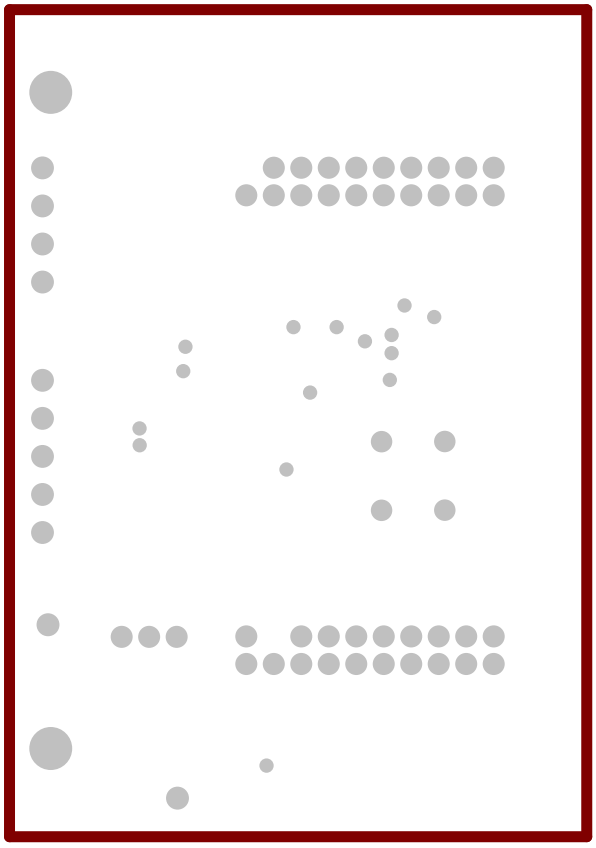


Figure 5-7. PCB Layout (internal GND Plane 2) for the ADS122x14EVM

5.3 Bill of Materials (BOM)

Table 5-1. ADS122S14EVM - Bill of Materials (BOM)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
PCB1	1		'Printed Circuit Board		DC269	Any
C1, C8, C9, C10	4	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R	0603	C0603C104K3RACTU	Kemet
C2, C3	2	10uF	CAP, CERM, 10 uF, 25 V, +/- 20%, X5R	0603	GRT188R61E106ME13D	MuRata
C4, C6, C7, C12, C14	5	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0	0603	GRM1885C1H102JA01D	MuRata
C5, C11, C13, C15	4	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0	0603	GRM1885C1H103JA01D	MuRata
D1, D2	2	3.6V	Diode, Zener, 3.6 V, 500 mW	SOD-123	MMSZ4685T1G	ON Semiconductor
D3, D4	2	Green	LED, Green, SMD	Body1.6x0.8mm	LTST-C193TGKT-5A	Lite-On
J1/J3, J2/J4	2		Receptacle, 2.54mm, 10x2, Tin, TH	10x2 Receptacle	SSQ-110-03-T-D	Samtec
J5, J8	2		Terminal Block, 3.5 mm, 2x1, Tin, TH	Terminal Block, 3.5 mm, 2x1, TH	0393570002	Molex
J6, J7	2		Terminal Block, 3.5mm, 5x1, Tin, TH	Terminal Block, 3.5mm, 5x1, TH	393570005	Molex
JP1	1		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
R1, R2	2	10.0kΩ	RES, 10.0 k, 1%, 0.1 W	0603	RC0603FR-0710KL	Yageo
R3, R4, R7, R11, R15, R18, R19, R26, R27	9	1.00kΩ	RES, 1.00 k, 0.1%, 0.1 W	0603	RG1608P-102-B-T5	Susumu Co Ltd
R5, R6	2	6.65kΩ	RES, 6.65 k, 1%, 0.1 W	0603	RC0603FR-076K65L	Yageo
R16, R17	2	0.1Ω	RES, 0.1, 1%, 0.1 W, AEC-Q200 Grade 1	0603	ERJ-L03KF10CV	Panasonic
R20	1	4.02kΩ	RES, 4.02 k, 0.1%, 0.125 W	0603	RT0805BRD074K02L	Yageo America
R21, R22, R23, R24	4	47Ω	RES, 47, 5%, 0.1 W, AEC-Q200 Grade 0	0603	CRCW060347R0JNEA	Vishay-Dale
SH-JP1	1	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2	2		Terminal, Turret, TH, Triple	Keystone1598-2	1598-2	Keystone
U1	1		I2C BUS EEPROM (2-Wire), TSSOP-B8	TSSOP-8	BR24G32FVT-3AGE2	Rohm
U2	1		Low-power, 24-Bit, 8-Channel, 64-kSPS, Delta-Sigma ADC with SPI, PGA, and Voltage Reference	WQFN16	ADS122S14RTE	Texas Instruments
H1, H2	2		MACHINE SCREW PAN PHILLIPS 4-40		9900	Keystone

Table 5-1. ADS122S14EVM - Bill of Materials (BOM) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
H3, H4	2		3/16 Round Female Standoff		2029	Keystone
M1, M2	0		Hex Standoff Threaded #4-40 Aluminum 0.750" (19.05mm) 3/4"	HEX_STANDOFF_4-40	1895	Keystone
R8, R14	0	0	RES, 0, 5%, 0.1 W	0603	RC0603JR-070RL	Yageo
R9, R10, R12, R13, R32, R33	0	10.0kΩ	RES, 10.0 k, 1%, 0.1 W	0603	RC0603FR-0710KL	Yageo
R25, R29	0	10.0MΩ	RES, 10.0 M, 1%, 0.1 W, AEC-Q200 Grade 0	0603	CRCW060310M0FKEA	Vishay-Dale
R28, R30	0	47Ω	RES, 47, 5%, 0.1 W, AEC-Q200 Grade 0	0603	CRCW060347R0JNEA	Vishay-Dale
R31	0	470kΩ	RES, 470 k, 1%, 0.1 W	0603	RC0603FR-07470KL	Yageo
RT1	0	10kΩ	Thermistor NTC, 10k ohm, 3%, 0603	0603	ERT-J1VR103H	Panasonic

Table 5-2. ADS122C14EVM - Bill of Materials (BOM)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
PCB	1		Printed Circuit Board		DC269	Any
C1, C8, C9, C10	4	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	0603	C0603C104K3RACTU	Kemet
C2, C3	2	10uF	CAP, CERM, 10 uF, 25 V, +/- 20%, X5R, 0603	0603	GRT188R61E106ME13D	MuRata
C4, C6, C7, C12, C14	5	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H102JA01D	MuRata
C5, C11, C13, C15	4	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H103JA01D	MuRata
D1, D2	2	3.6V	Diode, Zener, 3.6 V, 500 mW, SOD-123	SOD-123	MMSZ4685T1G	ON Semiconductor
D3, D4	2	Green	LED, Green, SMD	Body1.6x0.8mm	LTST-C193TGKT-5A	Lite-On
J1/J3, J2/J4	2		Receptacle, 2.54mm, 10x2, Tin, TH	10x2 Receptacle	SSQ-110-03-T-D	Samtec
J5, J8	2		Terminal Block, 3.5 mm, 2x1, Tin, TH	Terminal Block, 3.5 mm, 2x1, TH	0393570002	Molex
J6, J7	2		Terminal Block, 3.5mm, 5x1, Tin, TH	Terminal Block, 3.5mm, 5x1, TH	393570005	Molex
JP1	1		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
R1, R2, R12, R13	4	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0710KL	Yageo

Table 5-2. ADS122C14EVM - Bill of Materials (BOM) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R3, R4, R7, R11, R15, R18, R19, R26, R27	9	1.00k	RES, 1.00 k, 0.1%, 0.1 W, 0603	0603	RG1608P-102-B-T5	Susumu Co Ltd
R5, R6	2	6.65k	RES, 6.65 k, 1%, 0.1 W, 0603	0603	RC0603FR-076K65L	Yageo
R8, R14	2	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
R16, R17	2	0.1	RES, 0.1, 1%, 0.1 W, AEC-Q200 Grade 1, 0603	0603	ERJ-L03KF10CV	Panasonic
R20	1	4.02k	RES, 4.02 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD074K02L	Yageo America
SH-JP1	1	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2	2		Terminal, Turret, TH, Triple	Keystone1598-2	1598-2	Keystone
U1	1		I2C BUS EEPROM (2-Wire), TSSOP-B8	TSSOP-8	BR24G32FVT-3AGE2	Rohm
U2	1		ADS122C14IRTER	WQFN16	ADS122C14IRTER	Texas Instruments
H1, H2	2		MACHINE SCREW PAN PHILLIPS 4-40		9900	Keystone
H3, H4	2		3/16 Round Female Standoff	2029, 3/16 Round Female Standoff	2029	Keystone
M1, M2	0		Hex Standoff Threaded #4-40 Aluminum 0.750" (19.05mm) 3/4"	HEX_STANDOFF_4-40	1895	Keystone
R9, R10, R32, R33	0	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0710KL	Yageo
R21, R22, R23, R24, R28, R30	0	47	RES, 47, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060347R0JNEA	Vishay-Dale
R25, R29	0	10.0Meg	RES, 10.0 M, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310M0FKEA	Vishay-Dale
R31	0	470k	RES, 470 k, 1%, 0.1 W, 0603	0603	RC0603FR-07470KL	Yageo
RT1	0	10k	Thermistor NTC, 10k ohm, 3%, 0603	0603	ERT-J1VR103H	Panasonic

6 Additional Information

6.1 Trademarks

LabVIEW™ is a trademark of National Instruments.
Windows® and Microsoft® are registered trademarks of Microsoft Corporation.
All trademarks are the property of their respective owners.

7 Related Documentation

7.1 Supplemental Content

Table 7-1 shows the related documentation from Texas Instruments.

Table 7-1. Related Documentation

Document	Literature Number
ADS122S14 product data sheet	SBASAI9

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying 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 set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

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

FCC NOTICE: 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 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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 to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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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。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

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。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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 MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS 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 EPIDEMIC FAILURE WARRANTY OR 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 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, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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. 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.

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