

EVM User's Guide: ADS124S18EVM-PDK

ADS124S18 Evaluation Module



Description

The ADS124S18EVM evaluation module (EVM) allows users to evaluate the functionality of the ADS124S18 with Serial-Peripheral Interface (SPI). The ADS124S18 is a precision, low-power, 18-channel, 128-kSPS delta-sigma ($\Delta\Sigma$) analog to digital converter (ADC) with a flexible input multiplexer and a low-noise programmable gain amplifier (PGA). The EVM kit includes an ADS124S18EVM with ADS124S18 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 universal serial bus (USB) interface for data capture, configuration, and data analysis.

Get Started

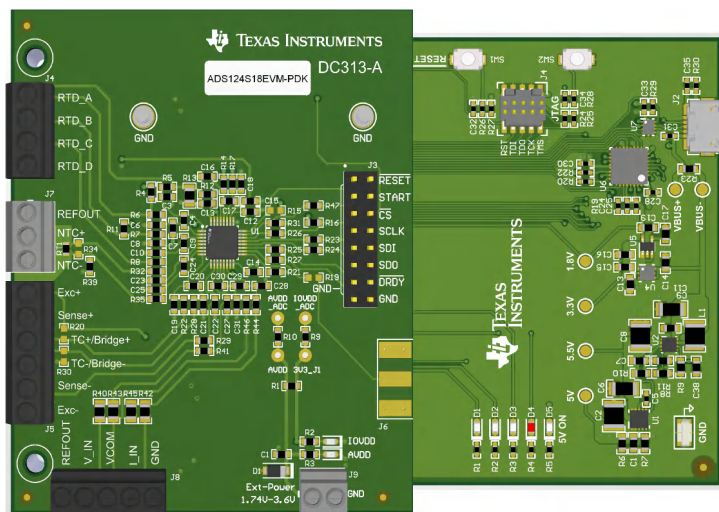
1. Order ADS124S18EVM-PDK from [TI.com](https://www.ti.com)
2. Download and install [ADS124S18EVM-PDK-GUI](#)
3. Connect the EVM to the computer with the included USB cable
4. Launch the ADS124S18 EVM GUI software
5. Refer to the [ADS124S18 data sheet](#) data sheet for device details
6. Visit the [E2E forums](#) for support and questions

Features

- 18 independently selectable analog inputs
- Wide supply range for analog voltage (AVDD) and digital voltage (IOVDD)
- 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 for communication and configuration

Applications

- **Temperature Sensor Measurements:**
 - Thermistors
 - Thermocouples
 - RTDs
- **Resistive Bridge Sensor Measurements:**
 - Pressure Sensors
 - Strain Gauges
 - Weigh Scales
- **Field transmitter & sensor:**
 - Flow transmitter
 - Pressure transmitter
 - Temperature transmitter
- **Factory automation & control**



1 Evaluation Module Overview

1.1 Introduction

[Table 1-1](#) shows that the devices in the ADS1x4S1x family have very similar characteristics other than the amount of input channels and ADC resolution. For simplicity, the rest of this document uses the ADS124S18EVM as an example of the behavior and operation of all devices. If applicable, each section describes any differences between the ADS124S18EVM and the other devices shown in [Table 1-1](#).

Table 1-1. Device Information

Part Number	Resolution	Analog inputs	Interface
ADS124S18	24-bit	18	SPI
ADS124S14	24-bit	8	SPI
ADS114S18	16-bit	18	SPI
ADS114S14	16-bit	8	SPI

This user guide describes the operation and use of the ADS124S18 evaluation module. The ADS124S18EVM is a fully assembled evaluation platform designed to highlight the ADS124S18 device performance and functionality of operation that make this device designed for measuring different type of analog sensors. The evaluation module (EVM) sits on top of the PAMB, 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 ADS124S18 device through a SPI. [Figure 1-1](#) shows a functional block diagram of the system setup.

This EVM user guide describes the characteristics and operation of the ADS124S18EVM. The ADS124S18EVM 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 ADS124S18EVM.

The PAMB receives commands from the ADS124S18EVM 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 ADS124S18 through headers J1 and J2. Refer to [Section 2.3](#) and [Section 2.6](#) for more information.

1.2 Kit Contents

The ADS124S18 evaluation module kit includes the following features:

- Hardware and software required for diagnostic testing as well as functionality and accurate performance evaluation for the ADS124S18 device.
- The PAMB that provides a convenient communication interface to the ADS124S18 over USB 2.0 (or higher)
- Windows® 10 or 11 operating systems.
- 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 ADS124S18. This suite has a provision for exporting data to a text file for post-processing.

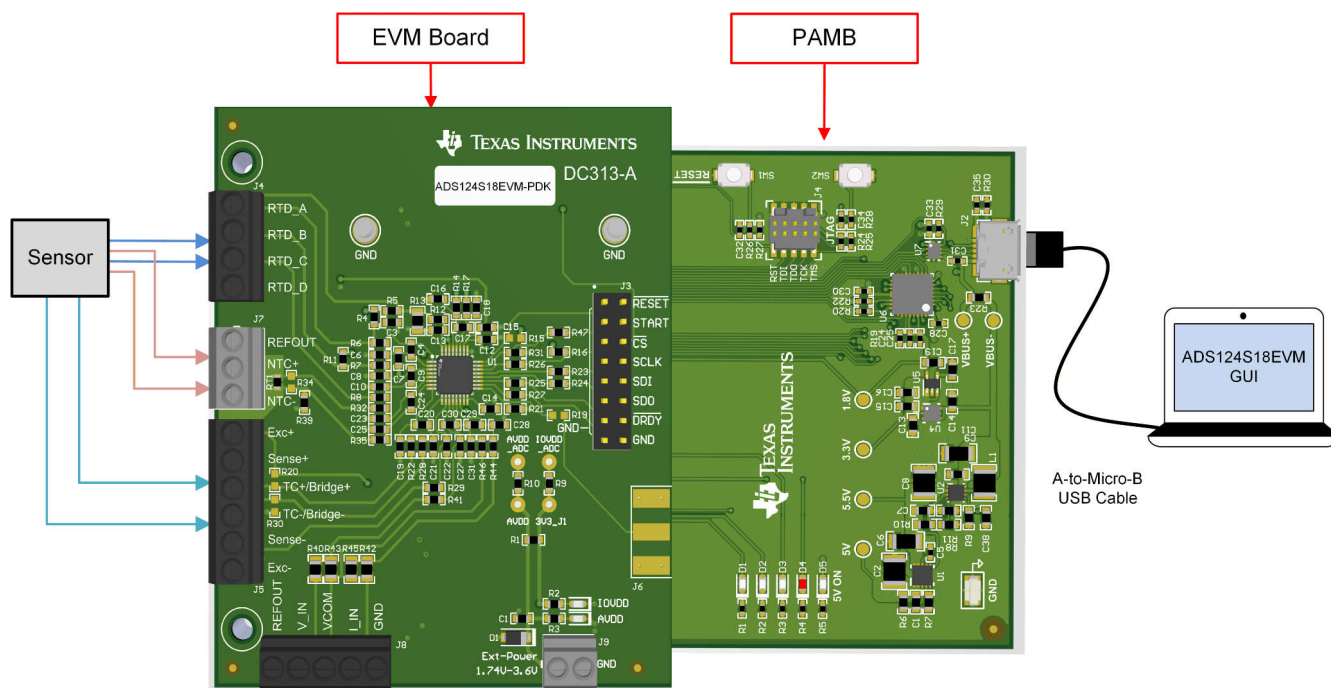


Figure 1-1. DC313A Connection for Evaluation

1.3 Specification

The following specifications are applicable to the ADS124S18EVM board and the PAMB.

Table 1-2. ADS124S18EVM-PDK Specifications

PARAMETER	CONDITIONS	VALUE
Temperature	Recommended operating free-air temperature range, T_A	$15^{\circ}\text{C} \leq T_A \leq 35^{\circ}\text{C}$
AVDD to AVSS (Recommended voltage range, external source)	IDAC $\leq 500\mu\text{A}$	$+1.74\text{V} \leq \text{AVDD} \leq +3.6\text{V}$
	IDAC $> 500\mu\text{A}$, or internal $V_{\text{REF}}=2.5\text{V}$	$+2.7\text{V} \leq \text{AVDD} \leq +3.6\text{V}$
IOVDD to DGND	Recommended voltage range, external source	$+1.65\text{V} \leq \text{IOVDD} \leq +5.25\text{V}$
Power supply current range (external power supply)	Supply current range $ I_s $	$ I_s \leq 0.5\text{A}$
Input voltage range	Absolute input voltage verses AVSS for analog input on J4, J5, J7 and J8	$\text{AVSS}-0.3\text{V} \leq V_{\text{in}} \leq \text{AVDD}+0.3\text{V}$
External clock	Recommended frequency range (f_{CLK})	$3\text{MHz} \leq f_{\text{CLK}} \leq 4.15\text{MHz}$
External digital IO	General-Purpose inputs (GPIOs)	$\text{AVSS} \leq V_{\text{IO}} \leq \text{AVDD}$
Digital Inputs	Other than GPIOs	$\text{DGND} \leq V_{\text{DI}} \leq \text{IOVDD}$
REFPx to REFNx	Recommended voltage range, external reference source	$0.5\text{V} \leq V_{\text{REFPx}} - V_{\text{REFNx}} \leq \text{AVDD}$

1.4 Device Information

Please refer to [ADS124S18 datasheet](#) for complete specifications.

Table 1-3. ADS124S18 Specifications

DEVICE SPECIFICATION	VALUE
Package size PBS (TQFP, 32)	7.00mm × 7.00mm
Operating temperature range	-40°C to 125°C
AVDD to AVSS supply voltage	+1.74V to +3.6V
IOVDD to DGND supply voltage	+1.65V to +5.25V
Voltage reference inputs	+0.5V to AVDD

1.5 Getting Started With the ADS124S18EVM

The following steps provides an overview to quickly get the ADS124S18EVM setup and operational. The subsequent sections in this document expand on each step to explain in detail the available features on the ADS124S18EVM 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 ADS124S18EVM, PAMB controller card, and USB cable from the ADS124S18EVM-PDK box.
2. If the PAMB controller card and the ADS124S18EVM are not already assembled, connect the ADS124S18EVM to the PAMB controller card as shown in the left image in [Figure 1-2](#).
3. Download the GUI from [TI.com](#) and install the GUI using the instructions in [Section 3.2](#).
4. 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.
5. 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 [Register Configurations](#)).
6. Configure the internal registers from the [Register Configurations](#) or [ADC Capture Settings](#) page in the GUI.
7. Connect external sensors or signals to J4, J5, J7 or J8 on the ADS124S18EVM as shown in [Figure 1-1](#).
8. Capture and analyze data by clicking the *Capture* button on the [Time Domain Display](#) page in the GUI.

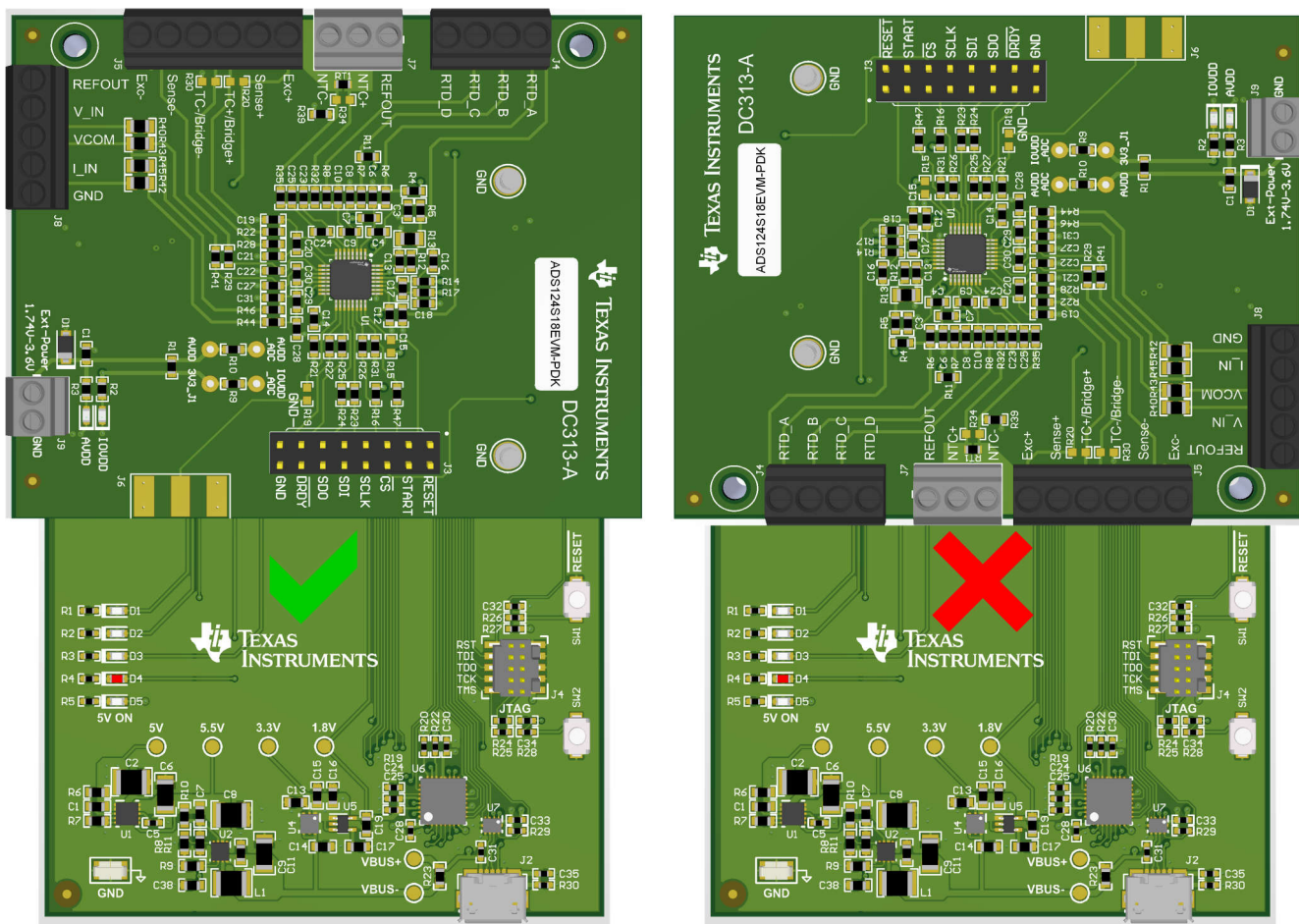


Figure 1-2. Connecting the ADS124S18EVM to the PAMB Controller Card

2 Hardware

The ADS124S18EVM 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 ADS124S18 supports a wide unipolar AVDD range from 1.74V to 3.6V. By default, the ADS124S18EVM 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, an external power supply between +1.74V and +3.6V can be provided on the J9 terminal block on the ADS124S18EVM.

Figure 2-1 shows the connection options for the AVDD and IOVDD power supply that are required for normal operation on the ADS124S18EVM.

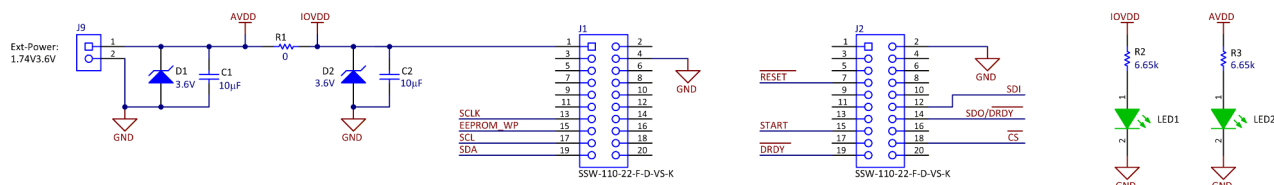


Figure 2-1. Power Supply Connection

Figure 2-2 shows that two LEDs light up on the PAMB controller card when the USB cable is plugged into the computer. LED D1 on the PAMB indicates that the ADS124S18EVM-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 ADS124S18EVM that indicate a valid power supply. IOVDD LED denotes that the IOVDD power supply is active. AVDD LED indicates that the AVDD power supply is active.

The ADS124S18 accepts an IOVDD power supply range from +1.65V to +5.25V. On the ADS124S18EVM, the ADS124S18 IOVDD is a fixed value of 3.3V. As with AVDD, this 3.3V IOVDD is sourced from the USB power supply voltage and is used as the power supply 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 IOVDD and AVDD power supply for the ADS124S18 on the EVM when the PAMB board is not used and an external MCU is used to communicate with the ADS124S18. Remove resistor R1 if the IOVDD power supply voltage is different from the AVDD power supply voltage when using an external MCU.

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

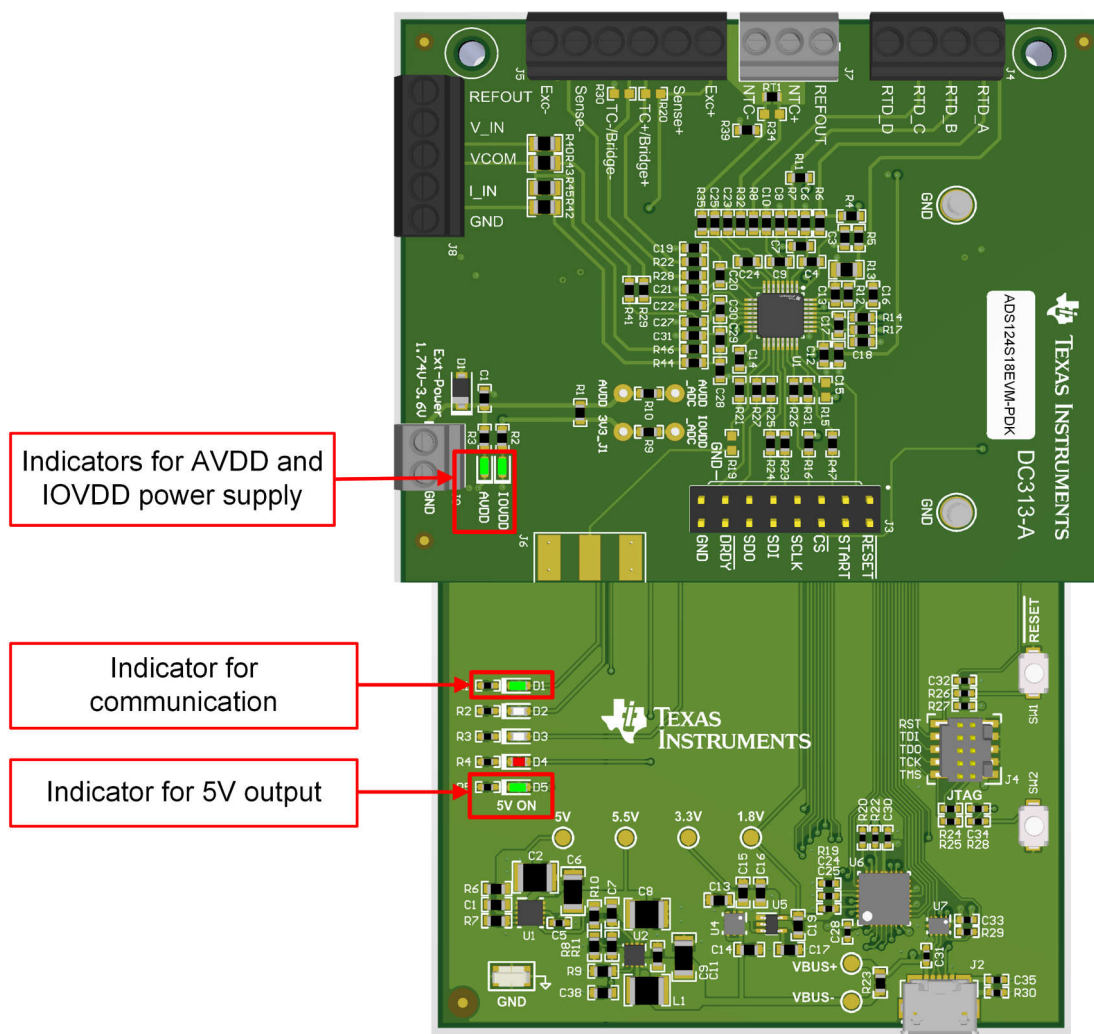


Figure 2-2. LED Indicators on the DC313A and the PAMB

2.2 Analog Input Connections

Each terminal block on the ADS124S18EVM has a function for connecting external sensors and power. RTD_A, RTD_B, and RTD_C on terminal block J4 are designed for connecting a 2-, 3-, or 4-wire RTD for temperature measurement. RTD_D 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 R13 resistor using the RTD_D pin on J4.

Terminal block J5 provides connections for thermocouples and bridge sensors. TC+/Bridge+ and TC-/Bridge- are inputs for a thermocouple or bridge-based sensor. Terminal block J5 provides AVDD output that can be used as an excitation voltage for an external bridge sensor.

Terminal block J7 provides connections for a thermistor. NTC+ and NTC- are inputs for connecting the thermistor. REFOUT provides an option to use the internal voltage reference output (1.25V or 2.5V) from the ADS124S18 to excite the thermistor.

Finally, terminal block J8 provides connections for an external voltage and current measurement. Use resistor R45 as a shunt resistor to measure an external current input. Replace resistors R40 and R43 to meet ADS124S18 input range requirement for an external voltage input.

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

Table 2-1. ADS124S18EVM Terminal Block Description

Terminal Block Input	Label	Description
J4:1	RTD_A	RTD connection point A
J4:2	RTD_B	RTD connection point B
J4:3	RTD_C	RTD connection point C
J4:4	RTD_D	RTD connection point D
J5:1	Exc+	Positive excitation input
J5:2	Sense+/REFP0	Positive remote sensing input
J5:3	Bridge+/TC+	Positive bridge or thermocouple input
J5:4	Bridge-/TC-	Negative bridge or thermocouple input
J7:5	Sense-/REFN0	Negative remote sensing input
J7:6	Exc-	Negative excitation input
J7:1	REFOUT	Output from ADS124S18 integrated VREF
J7:2	NTC+	Positive thermistor input
J7:3	NTC-	Negative thermistor input
J8:1	REFOUT	Output from ADS124S18 integrated VREF
J8:2	V_IN	Voltage input
J8:3	VCOM	Common-mode input
J8:4	I_IN	Current input
J8:5	GND	Analog ground

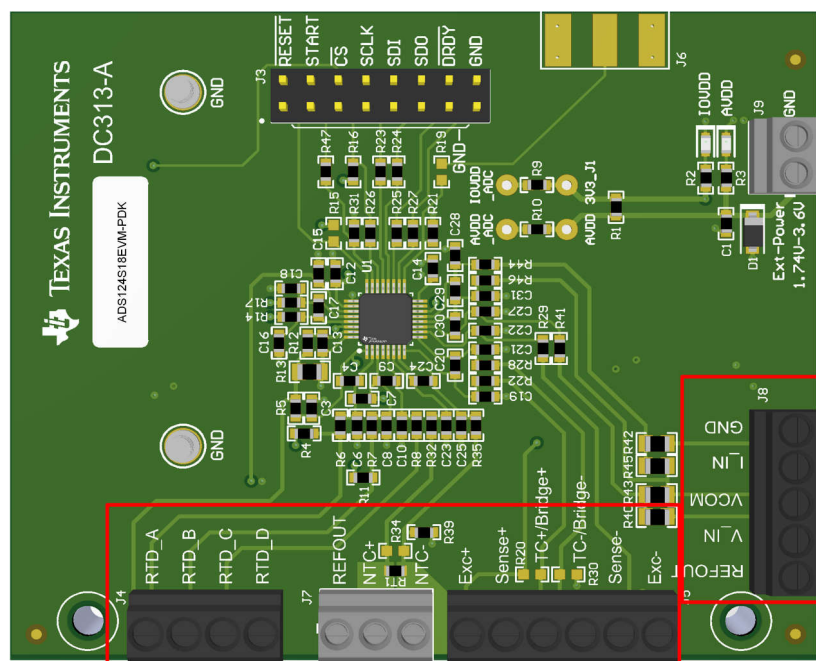


Figure 2-3. DC313A: Analog Input (J4, J7, J5, J8)

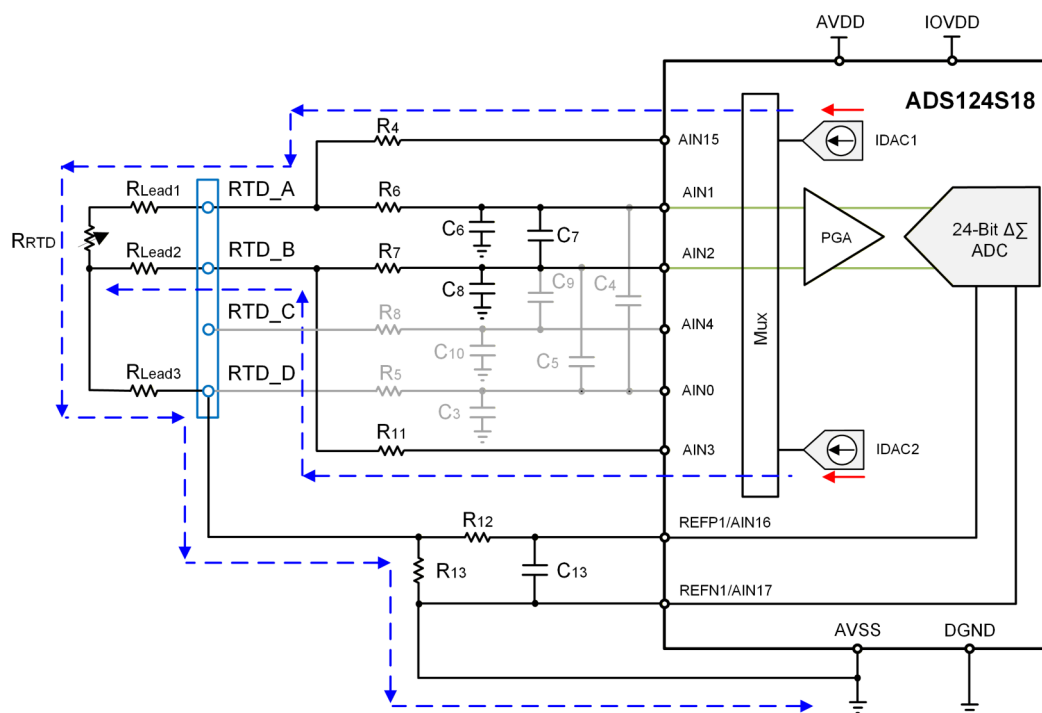
Table 2-2 summarizes the required IDAC, and analog input channel settings to measure each RTD configuration with the ADS124S18EVM.

Table 2-2. ADS124S18EVM Settings for Different RTD Types

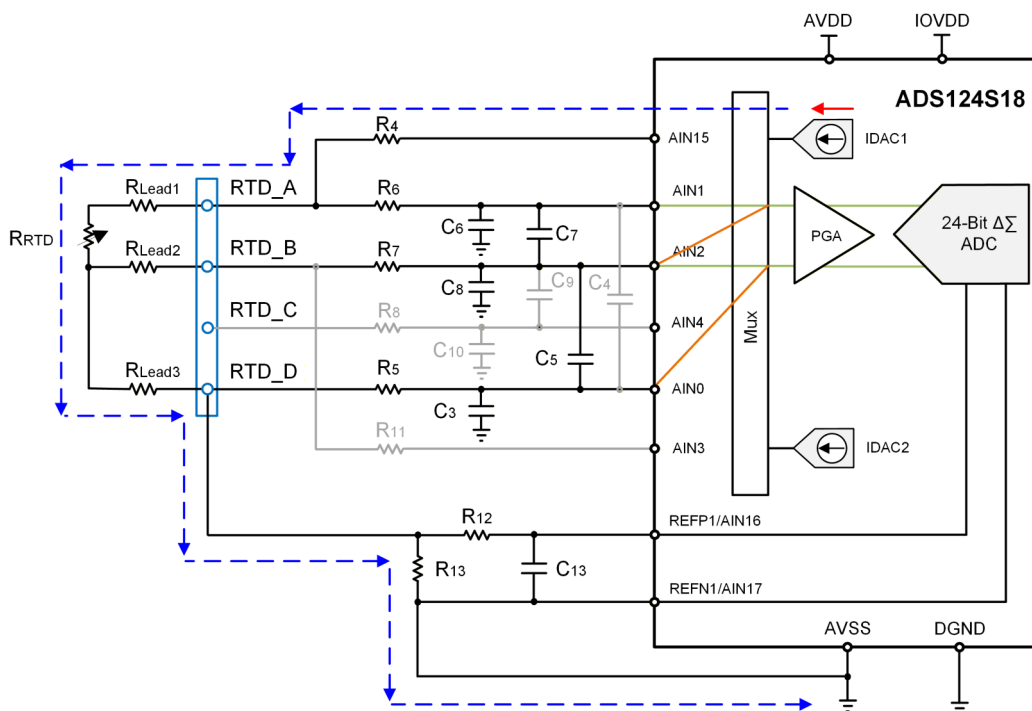
RTD	No. of IDACs	RREF Resistor	IDAC Channels	AINP	AINN
2-Wire	1	Low-Side	AIN15	AIN1	AIN0
3-Wire	1	Low-Side	AIN15	AIN1 ⁽¹⁾	AIN2 ⁽¹⁾
				AIN2 ⁽²⁾	AIN0 ⁽²⁾
	2	Low-Side	AIN15, AIN3	AIN1	AIN2
4-Wire	1	Low-Side	AIN15	AIN2	AIN4

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

Figure 2-4 and Figure 2-5 show the configuration diagrams for 2-, 3-, 4-wire RTD measurements supported by the ADS124S18EVM.

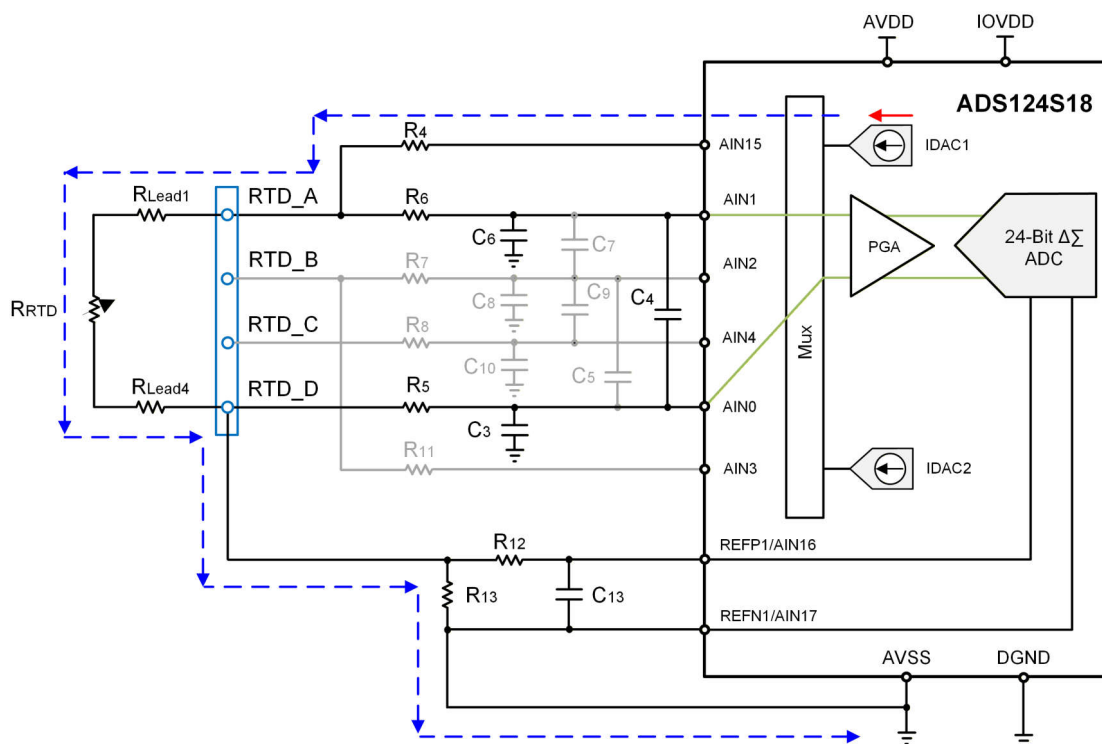


3-Wire RTD: Two IDACs One Measurement (AIN1-AIN2)

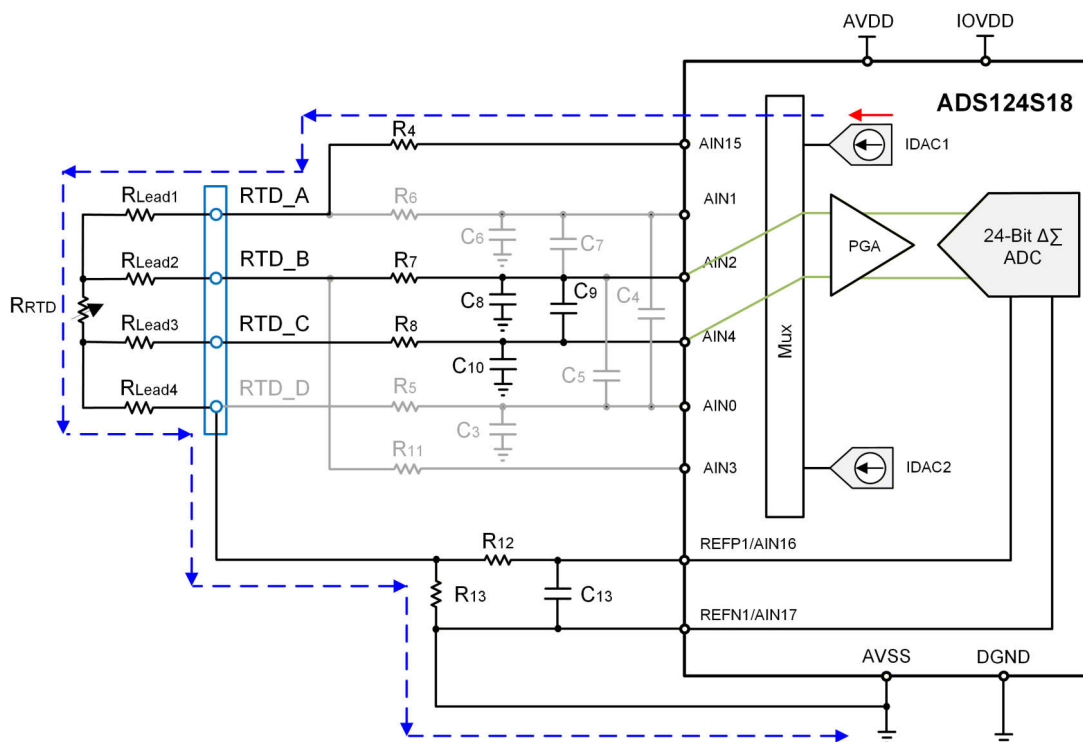


3-Wire RTD: One IDAC Two Measurements (AIN1-AIN2, AIN2-AIN0)

Figure 2-4. ADS124S18EVM: 3-wire RTD Measurement With One and Two IDACs



2-Wire RTD: One IDAC, One Measurement (AIN1-AIN0)



4-Wire RTD: One IDAC, One Measurement (AIN2-AIN4)

Figure 2-5. ADS124S18EVM: 2-, 4-Wire RTD Measurement With One IDAC

Figure 2-6 shows a circuit to bias the thermocouple sensor that the ADS124S18EVM supports. The circuit uses a thermistor for cold-junction compensation (CJC). The red arrows indicate 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](#).

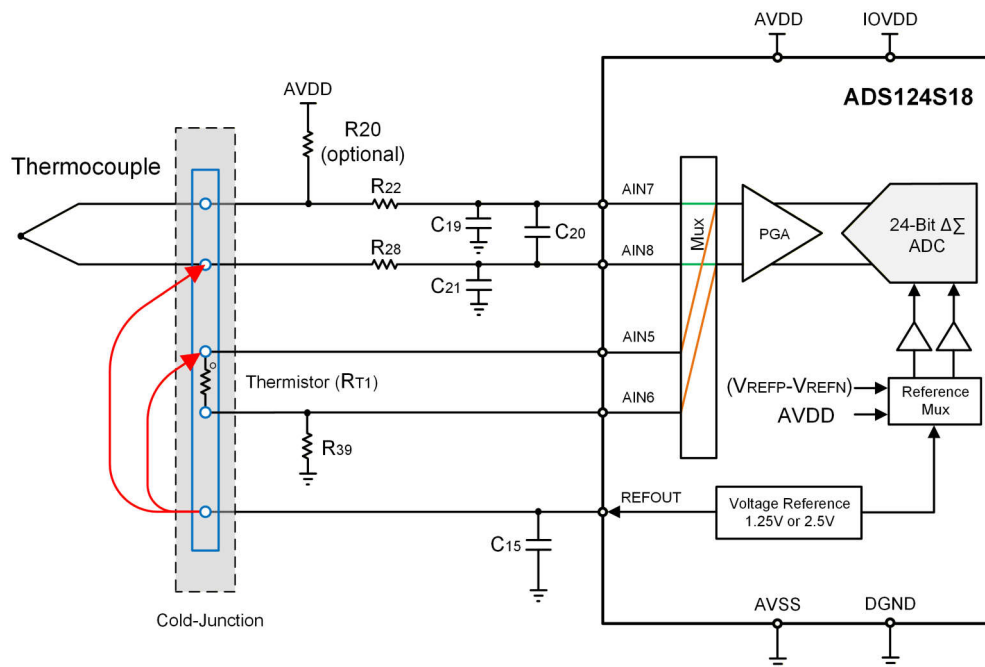


Figure 2-6. ADS124S18EVM: Thermocouple Measurement With a Thermistor for CJC

Figure 2-7 shows a circuit for a bridge measurement that the ADS124S18EVM supports. The circuit uses a thermistor for temperature compensation of the bridge. The red arrows indicate 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](#).

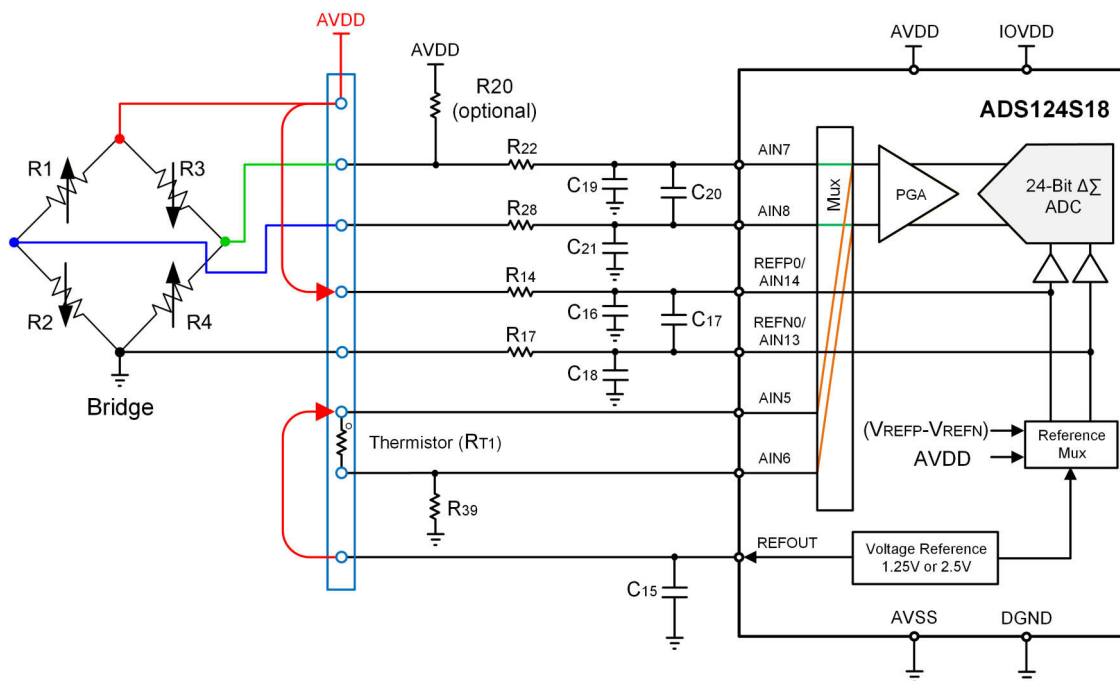
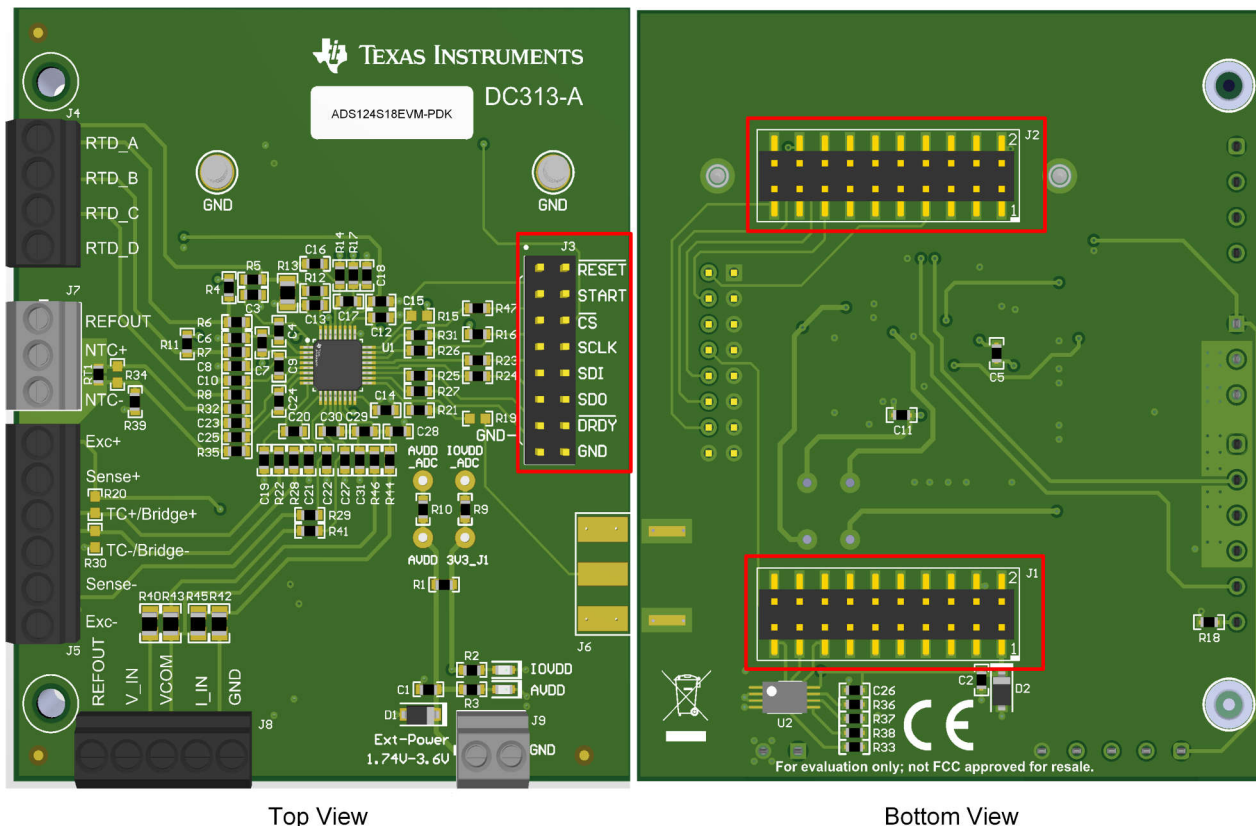


Figure 2-7. ADS124S18EVM: Resistive Bridge Measurement With a Thermistor for Compensation

2.3 Digital Signal and Connection

The connection between the ADS124S18EVM and the PAMB controller card includes the power supply, SPI and I2C interfaces, and a fault output signal from the ADS124S18. Figure 2-8 shows header J3 on the top of the ADS124S18EVM and headers J1 and J2 on the bottom of the ADS124S18EVM. Table 2-3 show the pinout of headers J1 and J2 for the communication between the ADS124S18 and the PAMB controller card. Use the connection points of header J3 for troubleshooting the SPI communication with a logic analyzer or to attach an external MCU to control the ADS124S18EVM without the PAMB.



Top View

Bottom View

Figure 2-8. ADS124S18EVM-to-PAMB Connections

Table 2-3. ADS124S18EVM Header Pinout and Description

Description	Connector	Connector	Description	Description	Connector	Connector	Description
3.3V	J1:1	J1:2			J2:1	J2:2	GND
	J1:3	J1:4	GND		J2:3	J2:4	
	J1:5	J1:6			J2:5	J2:6	
	J1:7	J1:8		RESET	J2:7	J2:8	
	J1:9	J1:10			J2:9	J2:10	
	J1:11	J1:12			J2:11	J2:12	SDI
SCLK	J1:13	J1:14			J2:13	J2:14	SDO/DRDY
EEPROM_WP	J1:15	J1:16		START	J2:15	J2:16	
SCL	J1:17	J1:18			J2:17	J2:18	CS
SDA	J1:19	J1:20		DRDY	J2:19	J2:20	

2.4 Serial Interface

The ADS124S18EVM uses SPI interface to communicate with the 24-bit ADS124S18. The EVM PCB layout is same for the ADCs with SPI and I2C. Figure 2-9 shows the digital connections between the ADS124S18EVM and the PAMB controller card. The ADS124S18 uses SPI serial communication CPOL = 0, CPHA = 1 to configure the internal registers and retrieve conversion data. The ADS124S18EVM provides 47Ω resistors on all digital signals to aid with signal integrity because fast signal edges can cause overshoot during high-speed SPI communication. These 47Ω resistors slow down the signal edges to minimize signal overshoot. Header J3 provides test points to measure the digital signals between the ADS124S18EVM and the PAMB controller card.

The maximum operating voltage level for the digital signals on headers J1 and J2 is 3.6V. Exceeding this voltage level or applying a digital signal before the ADS124S18EVM has been powered-up can cause permanent damage to the ADS124S18.

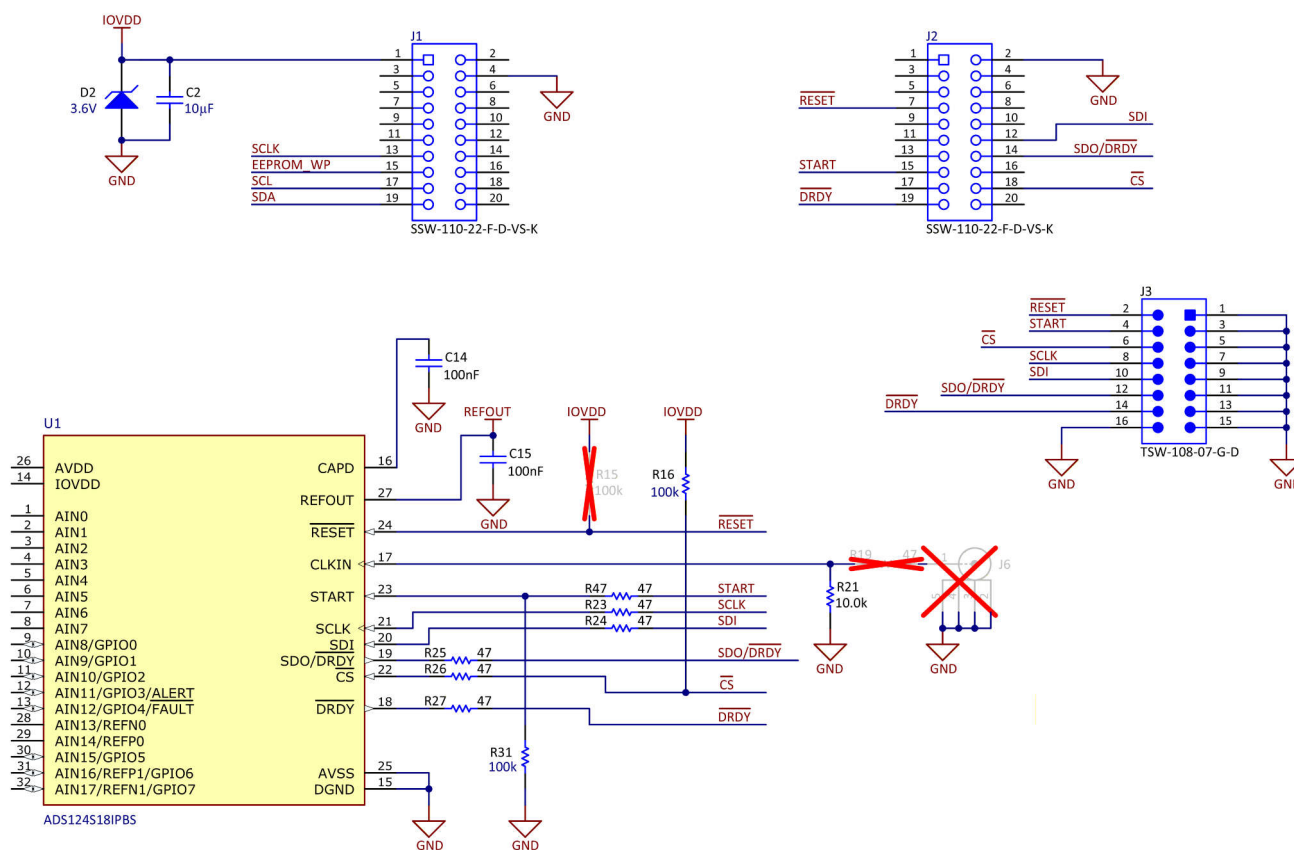


Figure 2-9. Connections to Digital Signals on the PAMB

2.5 EEPROM

Figure 2-10 shows an EEPROM circuit used with the PAMB controller card for EVM identification only. The EEPROM communicates with the PAMB controller card over an I2C bus. This circuit is not required by the ADS124S18 for operation and the circuit can be powered down when not used the PAMB controller card.

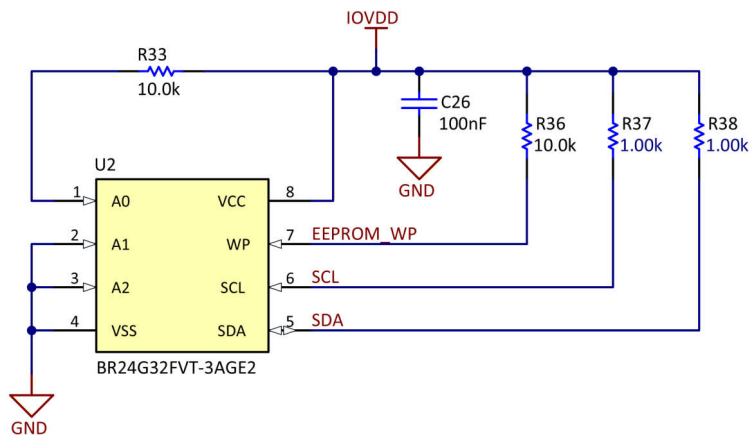


Figure 2-10. EEPROM for EVM ID

2.6 Connecting to an External Controller

Complete the following steps to connect an external controller with the ADS124S18EVM:

1. Unplug the USB cable from the PAMB controller card.
2. Disconnect the ADS124S18EVM from the PAMB controller card.
3. Connect SPI digital signals from the ADS124S18EVM to the external controller board. Refer to [Section 2.3](#) and [Section 2.4](#) for details.
4. Connect the AVDD/IOVDD and the ground from the ADS124S18EVM to the external controller board. Refer to [Section 2.1](#) for details.
5. Connect the sensor signal to the ADS124S18EVM. Refer to [Section 2.2](#) for details.
6. Install resistor R19 and connector J6, remove resistor R21 as shown in [Section 5.1](#), then connect an external clock source to connector J6 as a main clock for the ADS124S18 when using the CLK_SEL bit in ADC_CFG register to select an external clock source. This is an optional step when using an external controller with the ADS124S18EVM.
7. Develop and run the corresponding software in the external controller to communicate with the ADS124S18EVM.

3 Software

3.1 Software Description

The ADS124S18EVM-PDK-GUI software includes graphical tools for data capture, full ADS124S18 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 ADS124S18EVM Software Installation

Download the latest version of the EVM GUI installer from the Tools and Software folder of the [ADS124S18EVM](#) and run the GUI installer to install the EVM GUI software on your computer. Note that the EVM and the PAMB should be disconnected from the computer 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.

As shown in [Figure 3-1](#), accept the license agreement and follow the on-screen instructions 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 the installation.

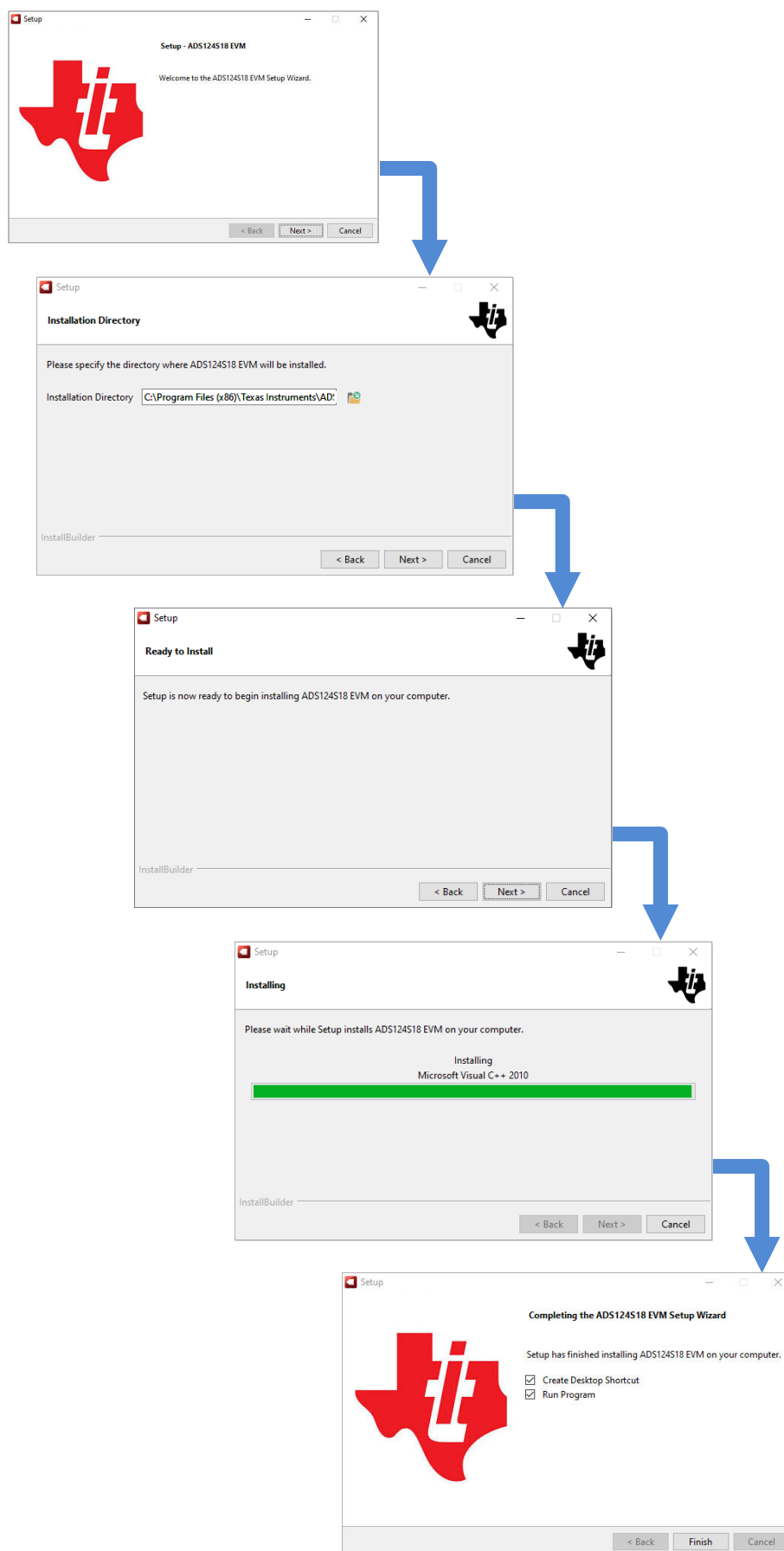


Figure 3-1. Software Installation and Prompts

3.3 Device Manager Check

Check the device manager and verify that the driver is properly installed on the computer as shown in [Figure 3-2](#). The actual port number for the communication depends on the computer.

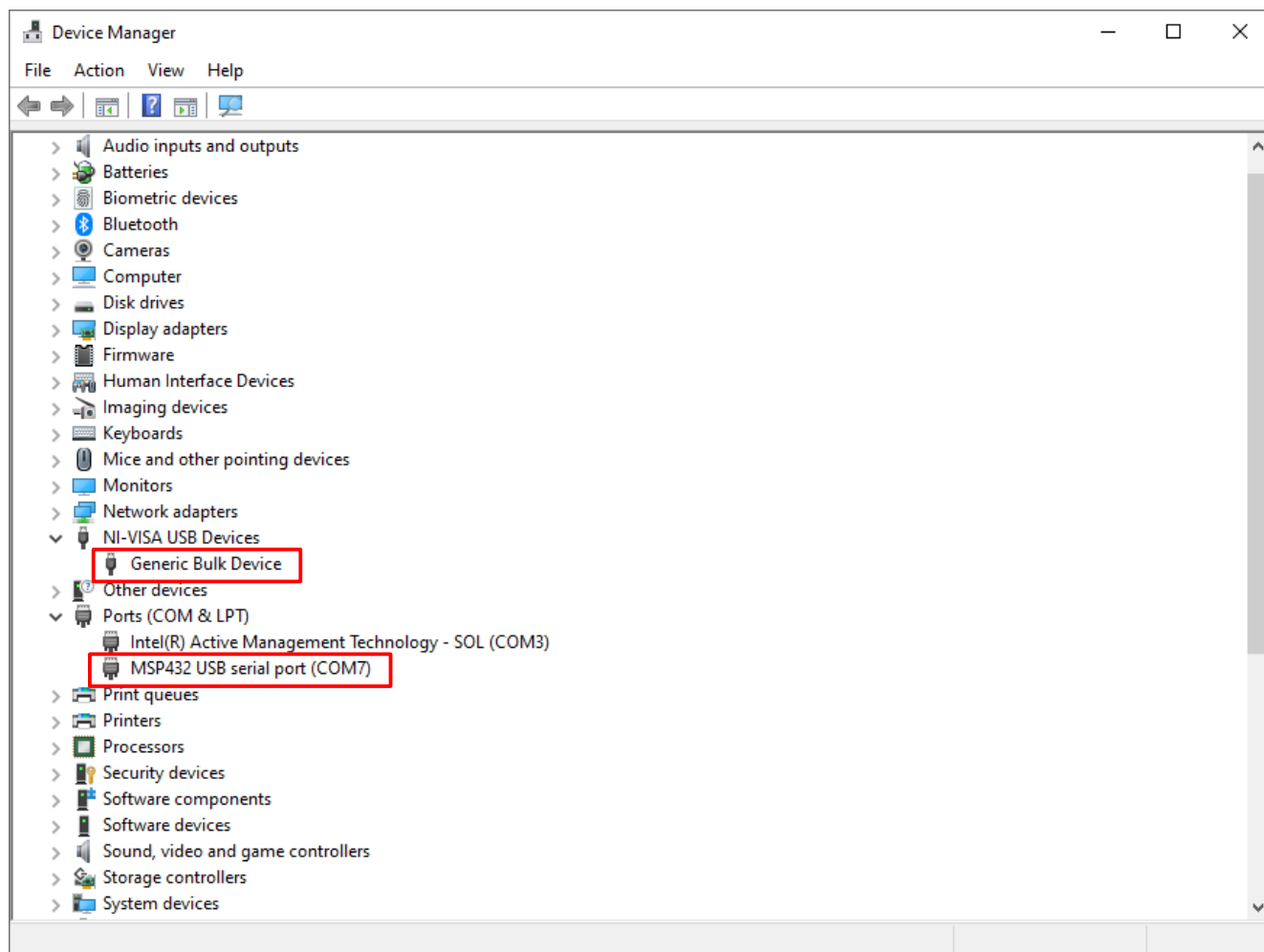


Figure 3-2. Check the Device Manager for the GUI Installation

4 EVM Operation and Implementation Results

4.1 Evaluation Setup

Figure 4-1 shows how to connect the ADS124S18EVM after installing the GUI software:

1. Connect the ADS124S18EVM to the PAMB controller card by connecting J1 and J2 of the ADS124S18EVM to the connectors of the PAMB controller card if the PAMB controller card and the ADS124S18EVM are not already assembled. Refer to Figure 1-2 to verify the correct connection.
2. Connect the micro-USB-to-USB cable from the PAMB directly to a USB port on the computer..
3. LED D1 and LED 5 on the PAMB lights up to indicate that the PAMB is powered up and connected.
4. AVDD LED and IOVDD LED on the ADS124S18EVM light up to indicate that the ADS124S18EVM board is powered up.
5. 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 ADS124S18EVM 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.
6. Configure the registers before capturing data.
7. Connect external sensors or signals to J4, J5, J7 or J8 on the ADS124S18EVM as shown in Figure 4-1.
8. Press the *Capture* button in the GUI to capture the data.

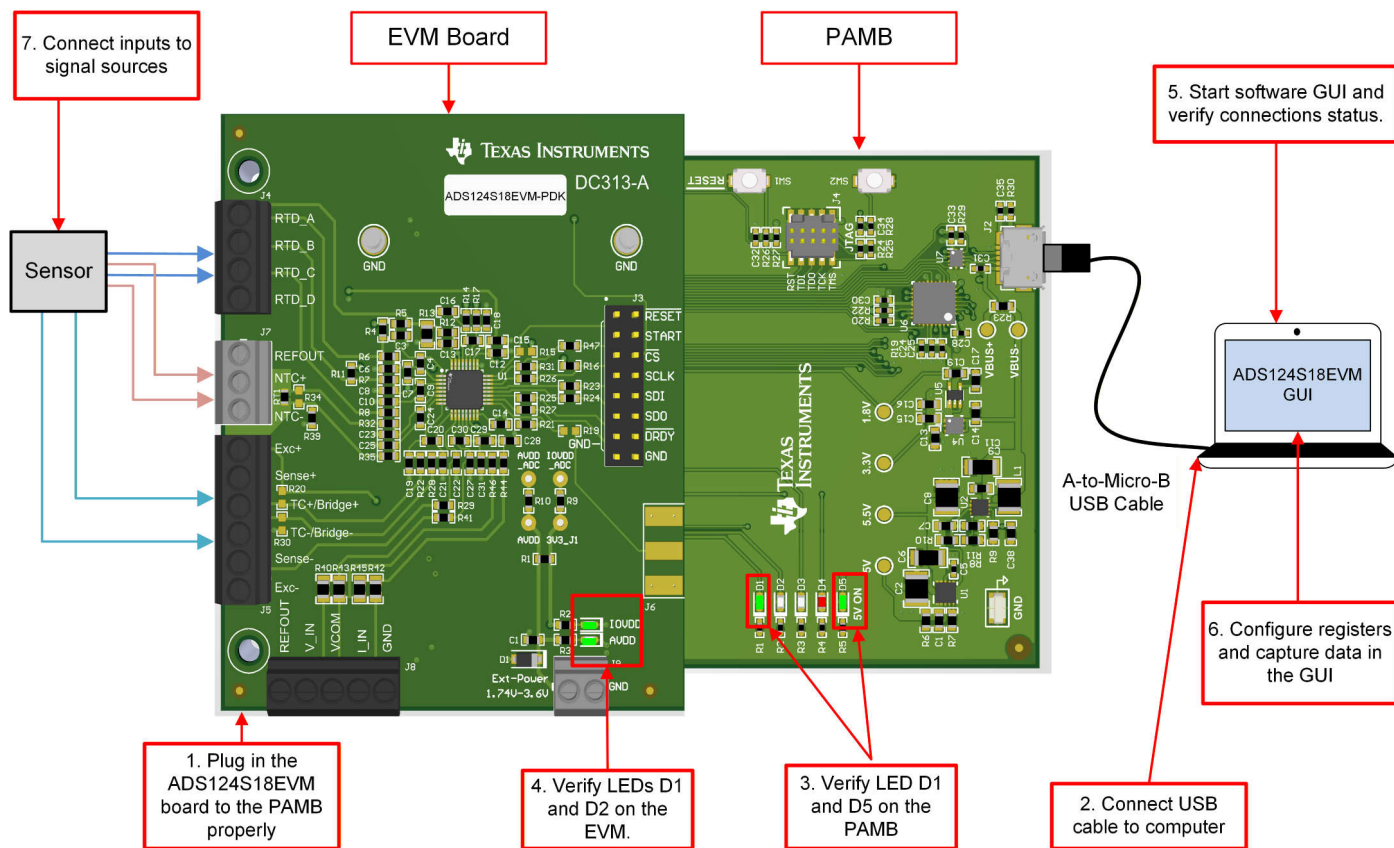


Figure 4-1. Connecting the Hardware to the ADS124S18EVM

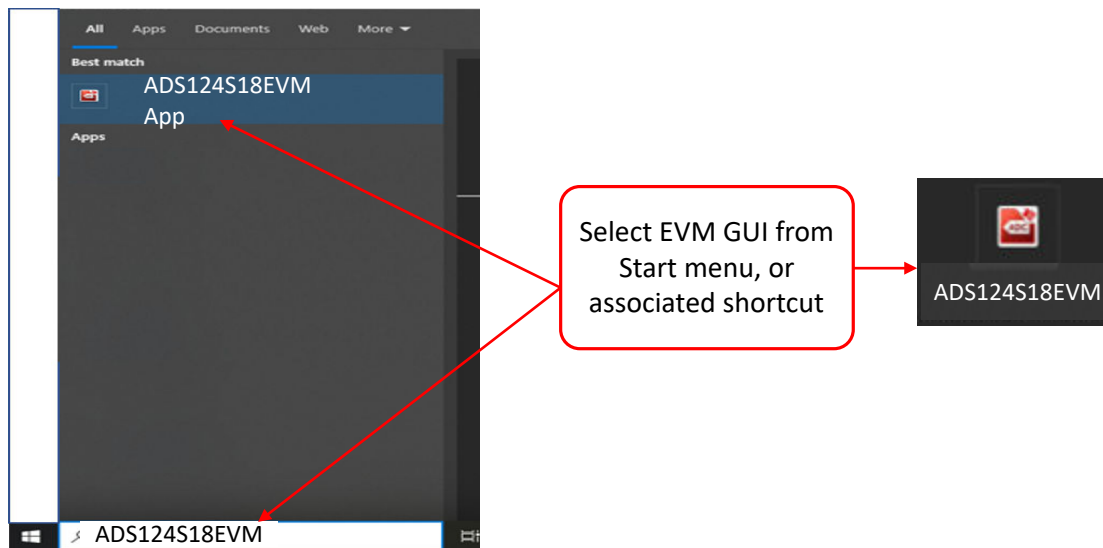


Figure 4-2. Launch the ADS124S18EVM GUI Software

4.2 ADC Capture Settings

Figure 4-3 shows the *ADC Capture Settings* page that allows easy configuration of multiple ADC settings and is an alternative method to using the *Register Configurations* page. The tab on the *ADC Capture Settings* page includes input channel selection, gain setting, system monitor selection, internal or external reference selection, filter selection, OSR configuration, IDAC selection and configuration. The *ADC Capture Settings* page has configuration to select internal reference voltage and speed mode, and the indicators for full scale range and data rate. Changing these settings updates the values on the *Register Configurations* page. Use the check box of *Demo Mode* in the upper right corner to disconnect or reconnect the ADS124S18EVM and the PAMB controller card to the GUI software. The green *Connected* indicator in the lower right corner in the GUI indicates the ADS124S18EVM and the PAMB controller card are successfully connected and communicating with the GUI software.

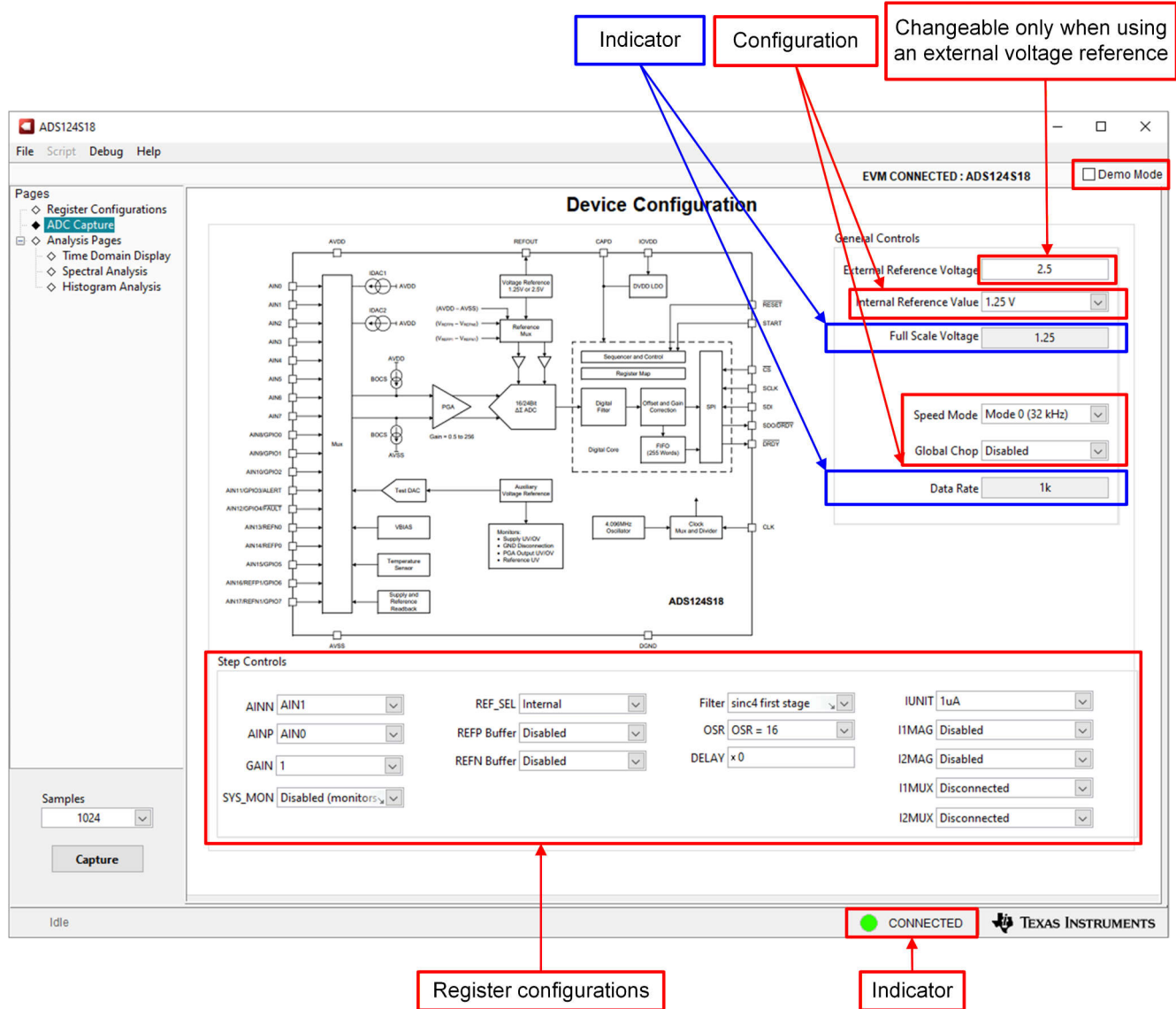


Figure 4-3. ADC Capture

4.3 Register Configurations

Figure 4-4 shows the ADC register settings for ADS124S18. 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.

Register Configurations page

Register operation

Register configurations

Register Name	Address	Default	Mode	Size	Value	7	6	5	4	3	2	1	0
General Config													
DEVICE_ID	0x00	0x30	R	8	0x30	0	0	1	1	0	0	0	0
REVISION_ID	0x01	0x00	R	8	0x00	0	0	0	0	0	0	0	0
STATUS_MSB	0x02	0x04	R/W	8	0x04	0	0	0	0	0	0	0	0
STATUS_LSB	0x03	0xFF	R	8	0xFF	1	1	1	1	1	1	1	1
SUPPLY_STATUS	0x04	0xFF	R/W	8	0xFF	1	1	1	1	1	1	1	1
ADC_STATUS	0x05	0xFF	R/W	8	0xFF	1	1	1	1	1	1	1	1
DIGITAL_STATUS	0x06	0xFF	R/W	8	0xFF	1	1	1	1	1	1	1	1
COMP_ALERT_STATUS	0x07	0xFF	R	8	0xFF	1	1	1	1	1	1	1	1
GPIO_DATA_INPUT	0x08	0x00	R	8	0x00	0	0	0	0	0	0	0	0
FIFO_SEQ_STATUS	0x09	0x07	R/W	8	0x07	0	0	0	0	0	1	1	1
FIFO_DEPTH	0x0A	0x00	R	8	0x00	0	0	0	0	0	0	0	0
CONVERSION_CTRL	0x0B	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
RESET	0x0C	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
ADC_CFG	0x10	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
DIGITAL_CFG	0x11	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
VBIAS	0x12	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
GPIO_CFG0	0x13	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
GPIO_CFG1	0x14	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
GPIO_CFG2	0x15	0x08	R/W	8	0x08	0	0	0	0	1	0	0	0
MONITOR_CFG	0x16	0x04	R/W	8	0x04	0	0	0	0	0	1	0	0
DIAGNOSTIC_CFG	0x17	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
SPARE_REG	0x18	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
SEQUENCER_CFG	0x19	0x40	R/W	8	0x40	0	1	0	0	0	0	0	0
SEQUENCE_STEP_EN	0x1A	0x01	R/W	8	0x01	0	0	0	0	0	0	0	1
SEQUENCE_STEP_EN	0x1B	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
SEQUENCE_STEP_EN	0x1C	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
FIFO_CFG	0x1D	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
FIFO_THRES_A	0x1E	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
FIFO_THRES_B	0x1F	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
REG_MAP_CRC	0x3D	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0
PAGE_INDICATOR	0x3E	0x00	R	8	0x00	0	0	0	0	0	0	0	0
PAGE_POINTER	0x3F	0x00	R/W	8	0x00	0	0	0	0	0	0	0	0

Field View

Field Name	Field Value
STEP_INDICATOR[4:0]	0
SAD_FAULTn	No fault occurred
RESETn	Reset occurred
DRDY	Data are not new

Register Description

STATUS_MSB_STEP_INDICATOR[7:3]
Sequence step indicator. Indicates the step page configuration that was used for the latest conversion result, which is currently available for readout. The step indicator resets to 00h after a device reset, in powerdown mode, or when writing to the SEQUENCER_CFG register. At the same time the conversion counter (CONV_COUNT[3:0]) resets to Fh, the sequence counter (SEQ_COUNT[3:0]) resets to 0h, and the conversion data clears.

STATUS_MSB_SAD_FAULTn[2:2]
Supply, ADC, and digital fault flag. Indicates if any of the individual fault flags in the SUPPLY_STATUS, ADC_STATUS, or DIGITAL_STATUS registers are set. For this bit to clear, all bits in the SUPPLY_STATUS, ADC_STATUS, and DIGITAL_STATUS registers must be cleared to 1h. The COMP_ALERTn bit can be masked from setting the SAD_FAULTn flag in

Figure 4-4. Register Configurations

4.4 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 ADS124S18EVM, 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

4.5 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 ADS124S18 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 ADS124S18 input is shorted and the data are captured by the GUI software.

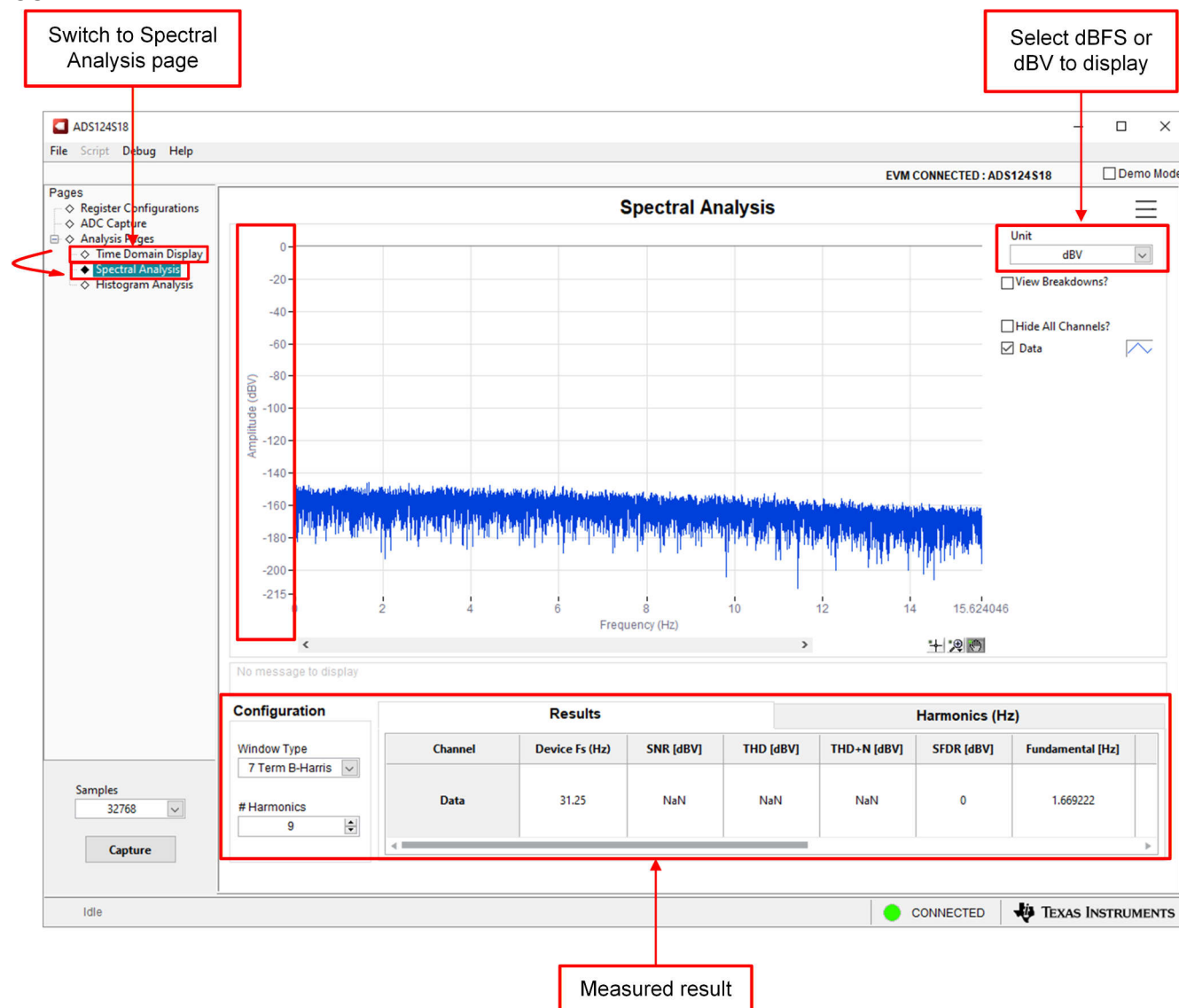


Figure 4-6. Frequency Domain Display

4.6 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 schematic for the ADS124S18EVM.

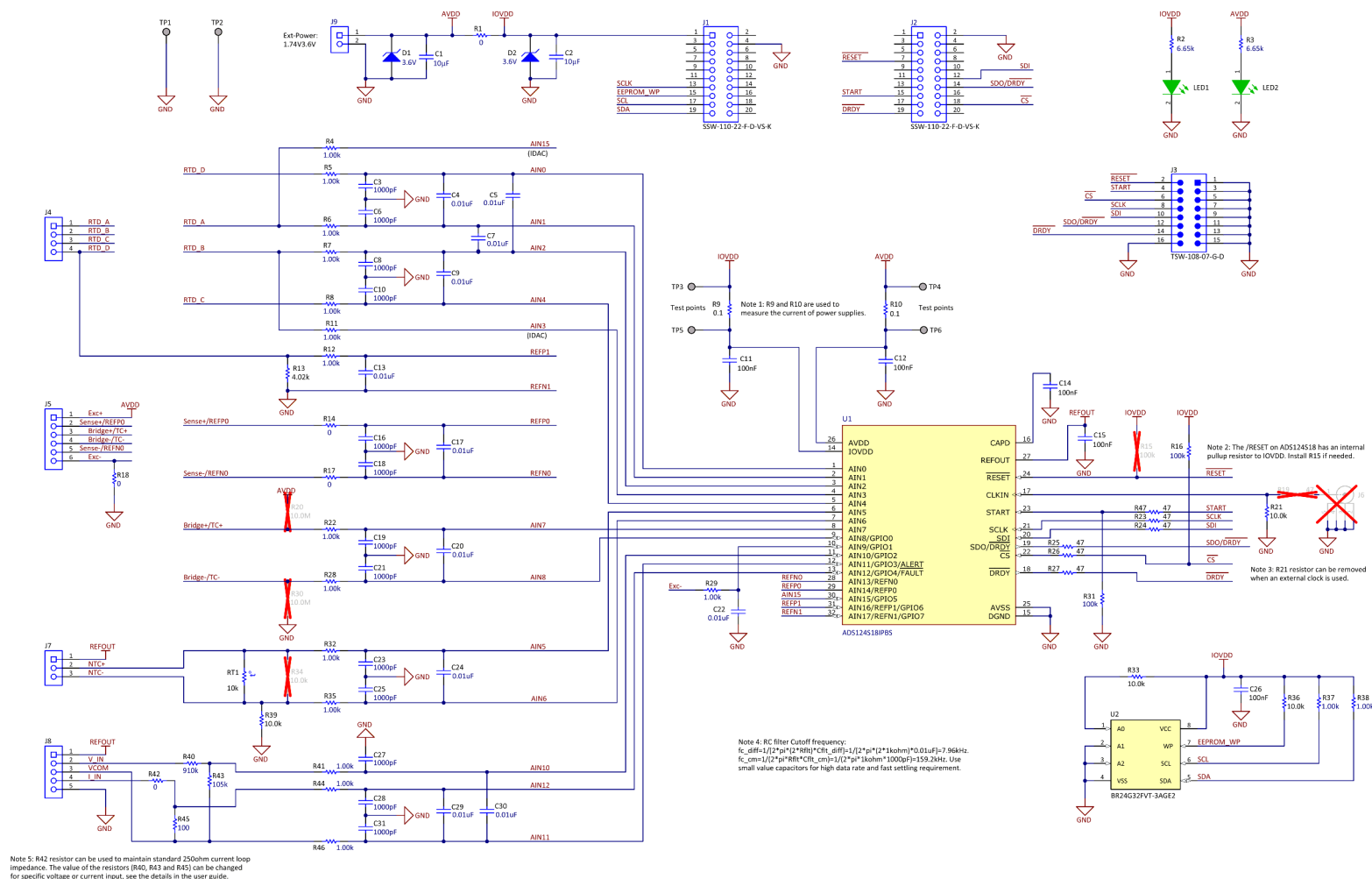


Figure 5-1. ADS124S18EVM Main Schematic

Figure 5-2 shows the hardware for the ADS124S18EVM.



PCB Number: DC313

PCB Rev: A

CE Mark

CE Mark

PCB LOGO

Texas Instruments

PCB LOGO

WEEE logo

PCB LOGO

FCC disclaimer

PCB Assembly

DC313

LBL1

PCB Label

ZZ1

Label Assembly Note

This Assembly Note is for PCB labels only

ZZ2

Assembly Note

These assemblies are ESD sensitive, ESD precautions shall be observed.

ZZ3

Assembly Note

These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

ZZ4

Assembly Note

These assemblies must comply with workmanship standards IPC-A-610 Class 2, unless otherwise specified.

Variant/Label Table

Variant	Label Text
001	ADS124S18EVM-PDK

Figure 5-2. ADS124S18EVM Hardware Schematic

5.2 PCB Layouts

Figure 5-3 to Figure 5-6 show the layout drawing for all ADS124S18EVM PCB layers.

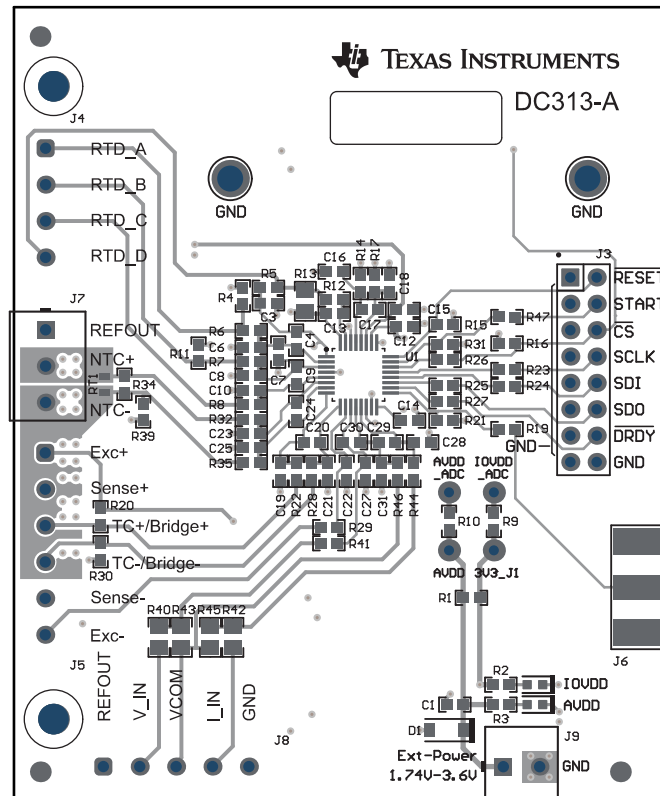


Figure 5-3. ADS124S18EVM PCB Layout - Top Layer

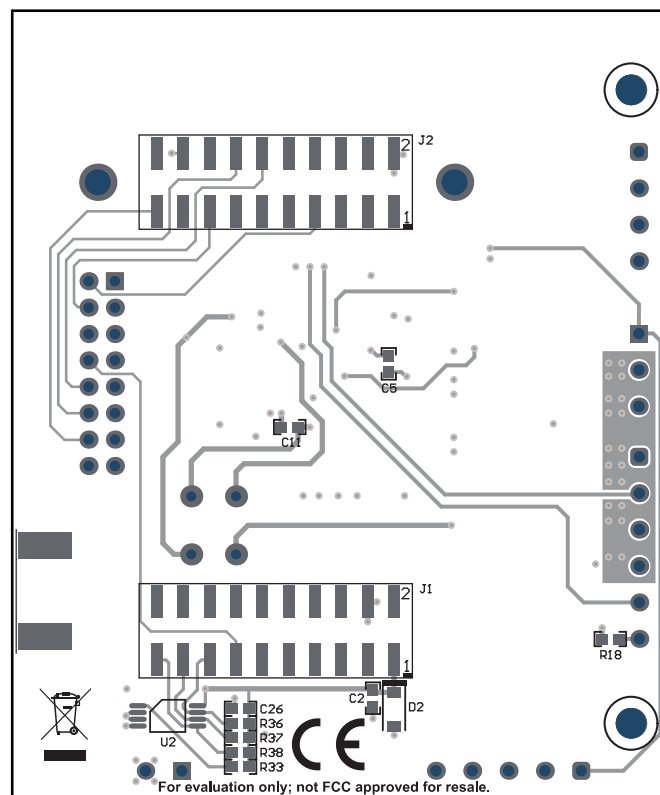


Figure 5-4. ADS124S18EVM PCB Layout - Bottom Layer

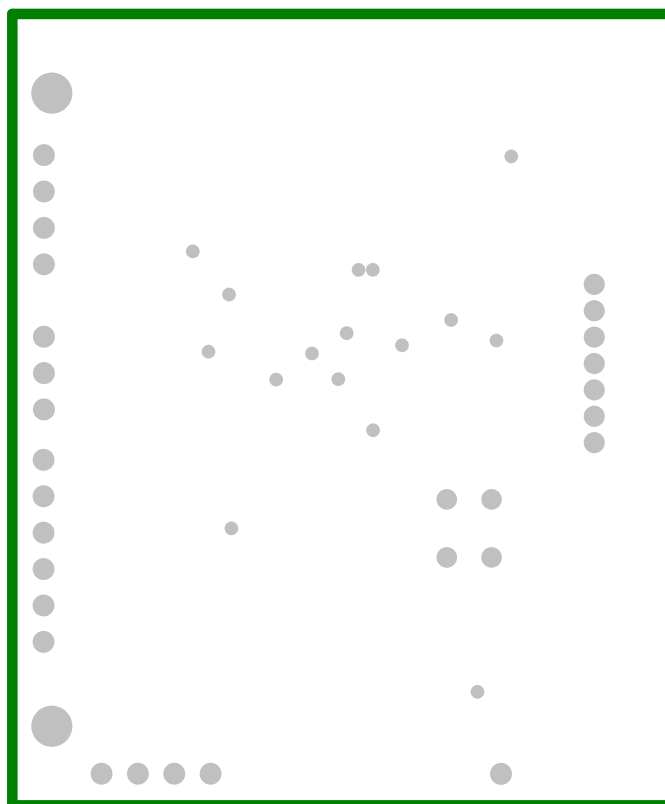


Figure 5-5. ADS124S18EVM PCB Layout - internal Ground (GND) layer 1

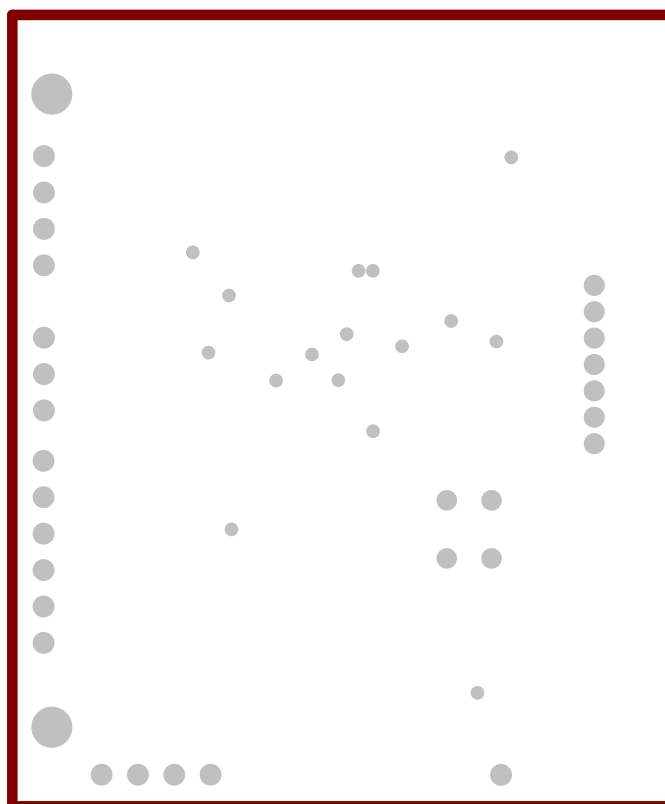


Figure 5-6. ADS124S18EVM PCB Layout - internal Ground (GND) layer 2

5.3 Bill of Materials (BOM)

Table 5-1 lists the bill of materials (BOM) for the ADS124S18EVM.

Table 5-1. ADS124S18EVM BOM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2	2	10uF	Chip Multilayer Ceramic Capacitors for General Purpose	0603	GRM188Z71A106KA73D	Murata
C3, C6, C8, C10, C16, C18, C19, C21, C23, C25, C27, C28, C31	13	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H102JA01D	MuRata
C4, C5, C7, C9, C13, C17, C20, C22, C24, C29, C30	11	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H103JA01D	MuRata
C11, C12, C14, C15, C26	5	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	0603	C0603C104K3RACTU	Kemet
D1, D2	2		Diode, Zener, 3.6 V, 500 mW, SOD-123	SOD-123	MMSZ4685T1G	ON Semiconductor
H1, H2	2		MACHINE SCREW PAN PHILLIPS 4-40		9900	Keystone
J1, J2	2		Connector, Receptacle, 100mil, 10x2, Gold plated, SMD	10x2 Receptacle	SSW-110-22-F-D-VS-K	Samtec
J3	1		Header, 100mil, 8x2, Gold, TH	8x2 Header	TSW-108-07-G-D	Samtec
J4	1		Terminal Block, 3.5mm, 4x1, Tin, TH	Terminal Block, 3.5mm, 4x1, TH	0393570004	Molex
J5	1		Terminal Block, 3.5mm, 6x1, Tin, TH	Terminal Block, 3.5mm, 6x1, TH	0393570006	Molex
J7	1		Terminal Block, 3.5 mm, 3x1, Tin, TH	Terminal Block, 3.5 mm, 3x1, TH	0393570003	Molex
J8	1		Terminal Block, 3.5mm, 5x1, Tin, TH	Terminal Block, 3.5mm, 5x1, TH	393570005	Molex
J9	1		Terminal Block, 3.5 mm, 2x1, Tin, TH	Terminal Block, 3.5 mm, 2x1, TH	0393570002	Molex
LED1, LED2	2	Green	LED, Green, SMD	Body1.6x0.8mm	LTST-C193TGKT-5A	Lite-On

Table 5-1. ADS124S18EVM BOM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
M1, M2	2		3/16 Round Female Standoff	2029, 3/16 Round Female Standoff	2029	Keystone
R1, R14, R17, R18	4	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R2, R3	2	6.65k	RES, 6.65 k, 1%, 0.1 W, 0603	0603	RC0603FR-076K65L	Yageo
R4, R5, R6, R7, R8, R11, R12, R22, R28, R29, R32, R35, R37, R38, R41, R44, R46	17	1.00k	RES, 1.00 k, 0.1%, 0.1 W, 0603	0603	RG1608P-102-B-T5	Susumu Co Ltd
R9, R10	2	0.1	RES, 0.1, 1%, 0.1 W, AEC-Q200 Grade 1, 0603	0603	ERJ-L03KF10CV	Panasonic
R13	1	4.02k	RES, 4.02 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD074K02L	Yageo America
R16, R31	2	100k	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R21, R33, R36, R39	4	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0710KL	Yageo
R23, R24, R25, R26, R27, R47	6	47	RES, 47, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060347R0JNEA	Vishay-Dale
R40	1	910k	RES, 910 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD07910KL	Yageo America
R42	1	0	RES, 0, 5%, 0.125 W, 0805	0805	RC0805JR-070RL	Yageo America
R43	1	105k	RES, 105 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD07105KL	Yageo America
R45	1	100	RES, 100, 0.1%, 0.125 W, 0805	0805	RT0805BRD07100RL	Yageo America
RT1	1	10k	Thermistor NTC, 10k ohm, 3%, 0603	0603	ERT-J1VR103H	Panasonic
TP1, TP2	2		Terminal, Turret, TH, Triple	Keystone1598-2	1598-2	Keystone
U1	1		ADS124S18IPBS	TQFP32	ADS124S18IPBS	Texas Instruments

Table 5-1. ADS124S18EVM BOM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
U2	1		I2C BUS EEPROM (2-Wire), TSSOP-B8	TSSOP-8	BR24G32FVT-3AGE2	Rohm
J6	0		Connector, End launch SMA, 50 ohm, SMT	SMA End Launch	142-0701-851	Cinch Connectivity
R15	0	100k	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R19	0	47	RES, 47, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060347R0JNEA	Vishay-Dale
R20, R30	0	10.0Meg	RES, 10.0 M, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310M0FKEA	Vishay-Dale
R34	0	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0710KL	Yageo

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
ADS124S18 product data sheet	SBASB61

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 DEGRADATION 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 instructions, 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/sds/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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2. 実験局の免許を取得後ご使用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/sds/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:

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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.

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