User's Guide
SBAU184–June 2011

ADS1118EVM User Guide and Software Tutorial

This user guide describes the characteristics, operation, and use of the ADS1118EVM evaluation board. This evaluation module (EVM) allows evaluation of all aspects of the ADS1118, a 16-bit, delta-sigma analog-to-digital converter (ADC). This guide discusses how to set up and configure the software and hardware, and reviews various aspects of the program operation. It also includes information regarding operating procedures and input/output connections. This user guide also includes an electrical schematic, printed circuit board (PCB) layout drawings, and a parts list for the EVM. Throughout this document, the terms *evaluation board*, *evaluation module*, and *EVM* are synonymous with the ADS1118EVM.

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1 EVM Overview

1.1 Features

The ADS1118 is a precision ADC. It features onboard reference and oscillator, as well as 16 bits of resolution. The ADS1118 can perform up to 860 samples per second (SPS) and has an onboard programmable gain amplifier (PGA) that allows input ranges from ±256 mV to ±6.144 V. It also contains an input multiplexer that allows each input to be used with reference to ground, or two differential inputs. The ADS1118EVM is a platform for evaluating the ADS1118. This document provides an overview of the ADS1118EVM, and provides a general description of the features and functions to be considered while using this evaluation module.

1.2 ADS1118EVM Kit Contents

Table 1 details the contents of the ADS1118EVM kit. Contact the Texas Instruments Product Information Center nearest you if any component is missing. It is highly recommended that you check the TI web site at http://www.ti.com to verify that you have the latest versions of the related software.

Table 1. ADS1118EVM Kit Contents

Item	Quantity
ADS1118 PCB Evaluation Board	1
SM-USB-DIG Platform PCB	1
USB Extender Cable	1
SM-Dig Connector Ribbon Cable	1
K-Type Thermocouple	1
User's Guide CD-ROM	1

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Figure 1 shows all of the hardware included with the ADS1118EVM kit.

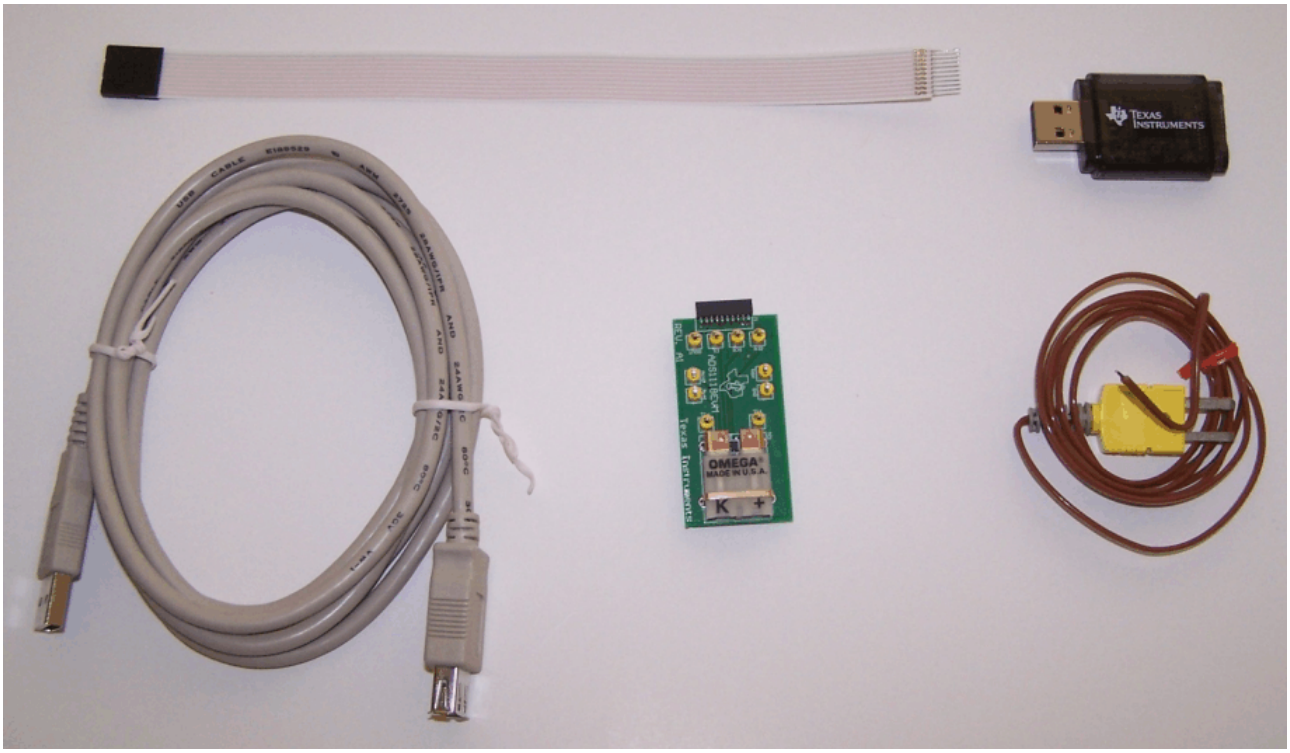

Figure 1. Hardware Included with ADS1118EVM Kit

1.3 Related Documentation from Texas Instruments

Table 2 lists several related documents are available through the Texas Instruments web site at http://www.ti.com. These documents provide information about the circuits used in the assembly of the ADS1118EVM. This user's guide is available from the TI web site under literature number ***SBAU184***. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions may be available from the TI web site, or call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Table 2. Related Documentation

Device	Literature Number
ADS1118 Product Data Sheet	SBAS457A
SM-USB-DIG Platform User's Guide	SBOU098

1.4 If You Need Assistance

If you have questions about the ADS1118EVM, join the Data Converters discussion forum on the e2e website at http://e2e.ti.com. TI provides customer support through this user community which is monitored by application engineers. If you post a request there, an applications engineer will respond to you, usually within 24 hours.

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2 ADS1118EVM Hardware Setup

This section discusses the overall system setup for the ADS1118EVM. The PC runs software that communicates with the SM-USB-DIG Platform, while provides power and the digital signals used to communicate with the ADS1118EVM board. Connectors on the ADS1118EVM board allow the user to connect various inputs as well as the provided thermocouple. Figure 2 illustrates the typical hardware setup for the ADS1118EVM.

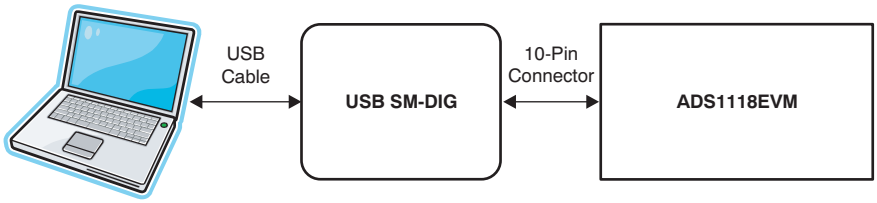

Figure 2. ADS1118EVM Hardware Setup

2.1 Theory of Operation for ADS1118 Hardware

A block diagram of the ADS1118 test board hardware setup is shown in Figure 3. The board provides test points to the serial peripheral inputs (SPI) as well as power and ground connections on the SM-USB-DIG Platform board. It also provides test points for the analog inputs of the ADS1118.

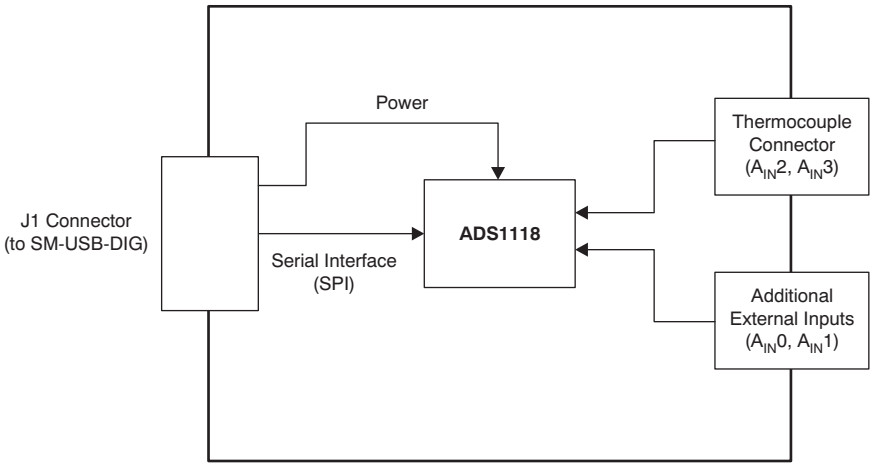

Figure 3. ADS1118 Test Board Block Diagram

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

Table 3 shows the pinout for the 10-pin connector socket used to communicate between the ADS1118EVM and the SM-USB-DIG Platform. It should be noted that the ADS1118EVM only uses the SPI communication lines and the VDUT and GND (Pins 6 and 8) as well as the CTRL/MEAS4 pin.

Table 3. H1 Pin Connector Signal Definitions

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

(1) When V_{DUT} is Hi-Z, all digital I/O are Hi-Z as well.

2.3 Theory of Operation for SM-USB-DIG Platform

Figure 4 shows the block diagram for the SM-USB-DIG Platform. This platform is a general-purpose data acquisition system that is used on several different Texas Instruments evaluation modules. The details of its operation are included in a separate document (SBOU098), also available from Texas Instruments. The block diagram shown in Figure 4 is given as a brief overview of the platform.

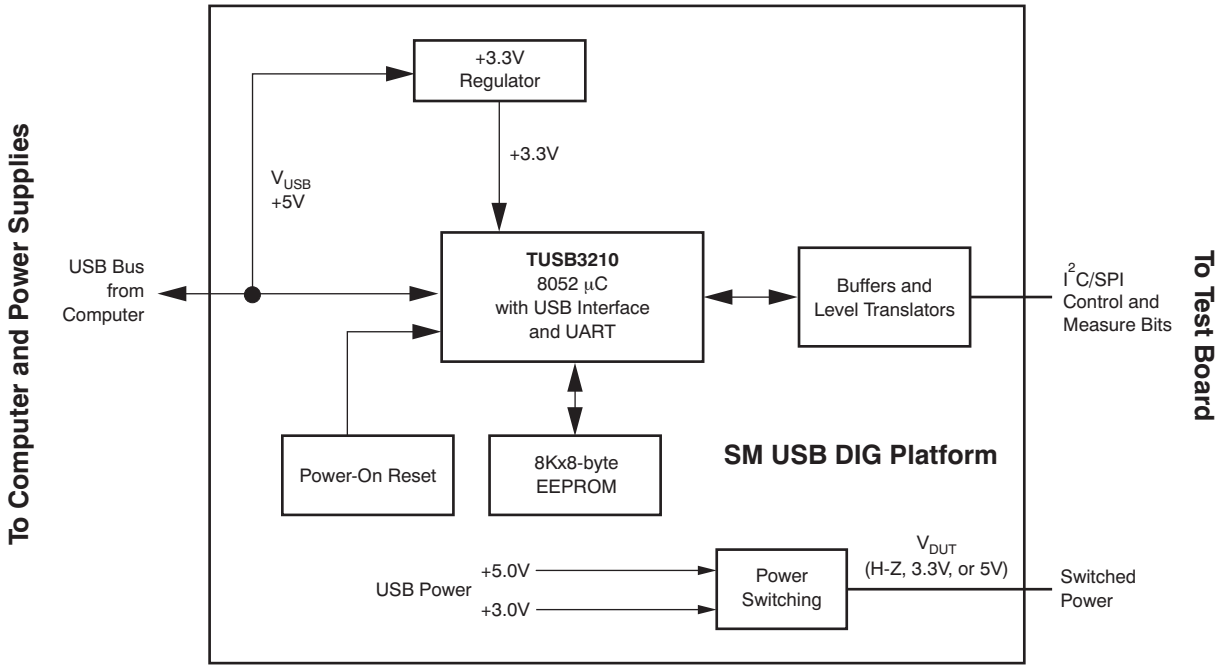

Figure 4. SM-USB-DIG Platform Block Diagram

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3 ADS1118EVM Hardware Overview

Setting up the ADS1118EVM hardware involves connecting the two PCBs of the EVM together, applying power, connecting the USB cable, and setting the jumpers. This section presents the details of this procedure.

3.1 Electrostatic Discharge Warning

CAUTION

Many of the components on the ADS1118EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

3.2 Connecting the Hardware

To connect the ADS1118 test board and the SM-USB-DIG Platform together, firmly slide the male and female ends of the 10-pin connectors together as shown in Figure 5. Make sure that the two connectors are completely pushed together; loose connections may cause intermittent operation.

Always connect the two boards together before connecting the USB cable to avoid any issues if the connectors are misaligned.

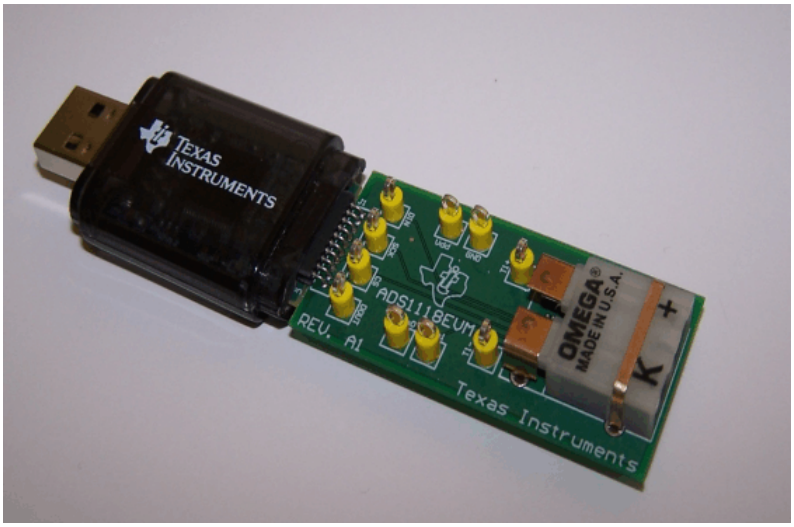

Figure 5. Typical Hardware Test Connections on the ADS1118EVM

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

Figure 6 shows the typical response to connecting the SM-USB-DIG Platform board to a PC USB port for the first time. Typically, the computer responds with a *Found New Hardware, USB Device* pop-up dialog. The pop-up window generally then changes to *Found New Hardware, USB Human Interface Device*. This pop-up indicates that the device is ready to be used. The SM-USB-DIG uses the human interface device drivers that are part of the Microsoft® Windows® operating system (OS).

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

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3.4 ADS1118EVM Features

This section describes some of the hardware features present on the ADS1118EVM board.

3.4.1 Communication Test Points

The ADS1118EVM board, as shown in Figure 7, features test points for monitoring the communication between the SM-USB-DIG and the ADS1118. It also allows external signals to be connected if the EVM is to be integrated into a custom application or prototype. Note that if the SM-USB-DIG is not being used, an external power source should also be connected.

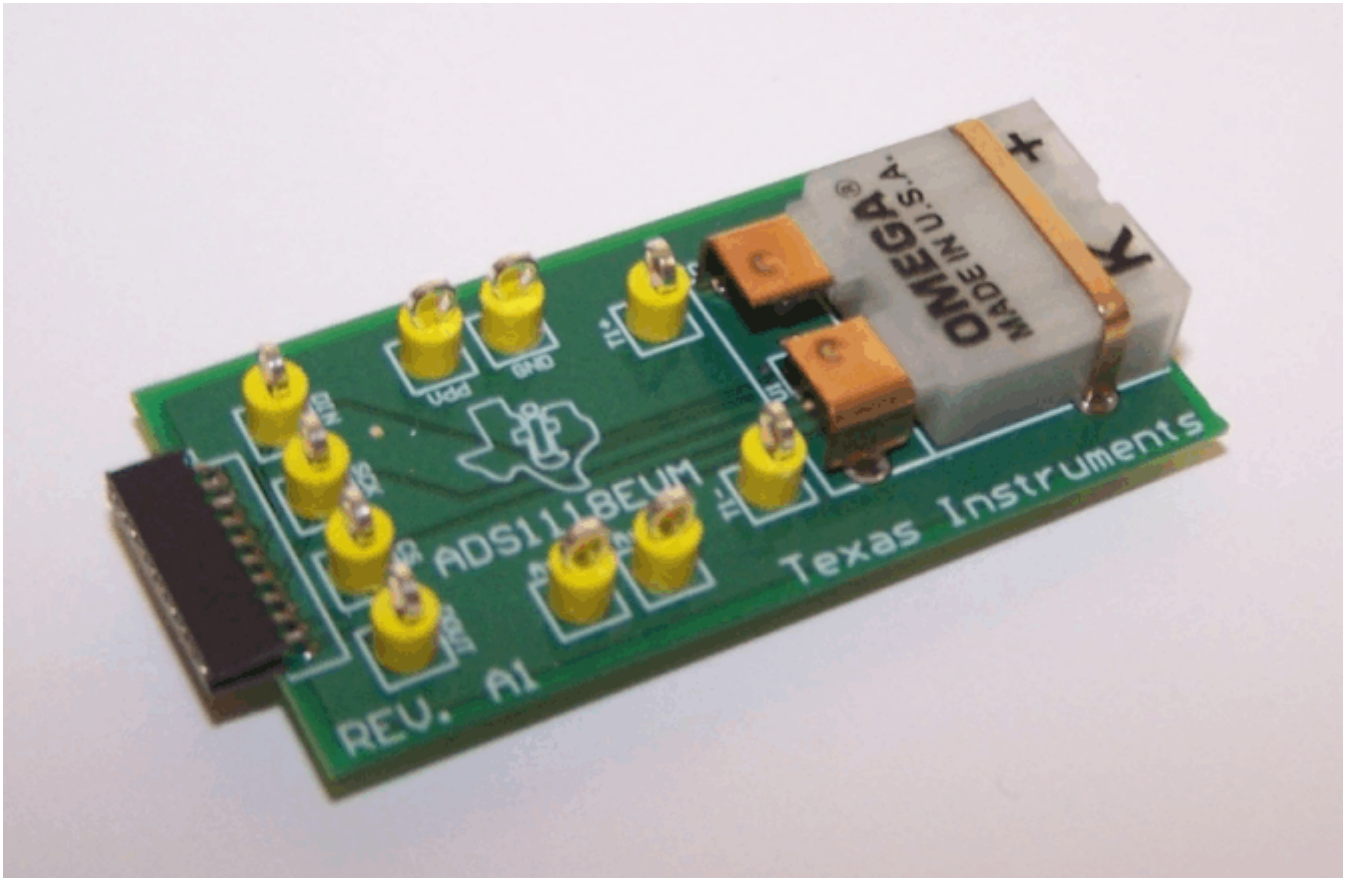

Figure 7. ADS1118EVM Hardware Features

3.4.2 Power Source Test Points

The Vdd and GND test points allow for external power to be connected to the ADS1118EVM. The power must stay in the acceptable range of 2.0 V to 5.5 V. Note that the SM-USB-DIG should not be connected when an external power source is being used.

3.4.3 Thermocouple Connector and Analog Input Test Points

The ADS1118EVM features a connector for a K-type thermocouple. The thermocouple connector has a low-pass filter attached to it, as well as to two test points (T1+ and T1–). The connector uses the $A_{IN}2$ and $A_{IN}3$ inputs, and therefore the ADS1118 must measure the inputs differentially to determine the voltage across the thermocouple. The $A_{IN}0$ and $A_{IN}1$ test points do not have any additional filtering and can be used as single-ended inputs or differentially.

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4 ADS1118EVM Software Setup

This section discusses how to install the ADS1118EVM software.

4.1 Hardware Requirements

The ADS1118 software has been tested on the Microsoft Windows XP OS platform with United States and European regional settings. The software should also function on other Windows-based OSs.

4.2 ADS1118 Software Installation

The ADS1118EVM software is included on the CD that is shipped with the EVM kit. It is also available through the ADS1118EVM product folder on the TI web site. Be sure to check the website to verify that you have the latest versions of the software. To download the software to your system, insert the disc into an available CD-ROM drive. Navigate to the drive contents and open the ADS1118EVM software folder. Locate the compressed file (*ADS1118EVM.zip*) and open it using WinZIP® or a similar file compression program; then extract the ADS1118EVM files into a specific ADS1118EVM folder (for example, *C:\ADS1118EVM*) on your hard drive.

Once the files are extracted, navigate to the ADS1118EVM folder you created on your hard drive. Locate the setup.exe file and execute it to start the installation, as shown in Figure 8. The ADS1118 software installer file then opens to begin the installation process.

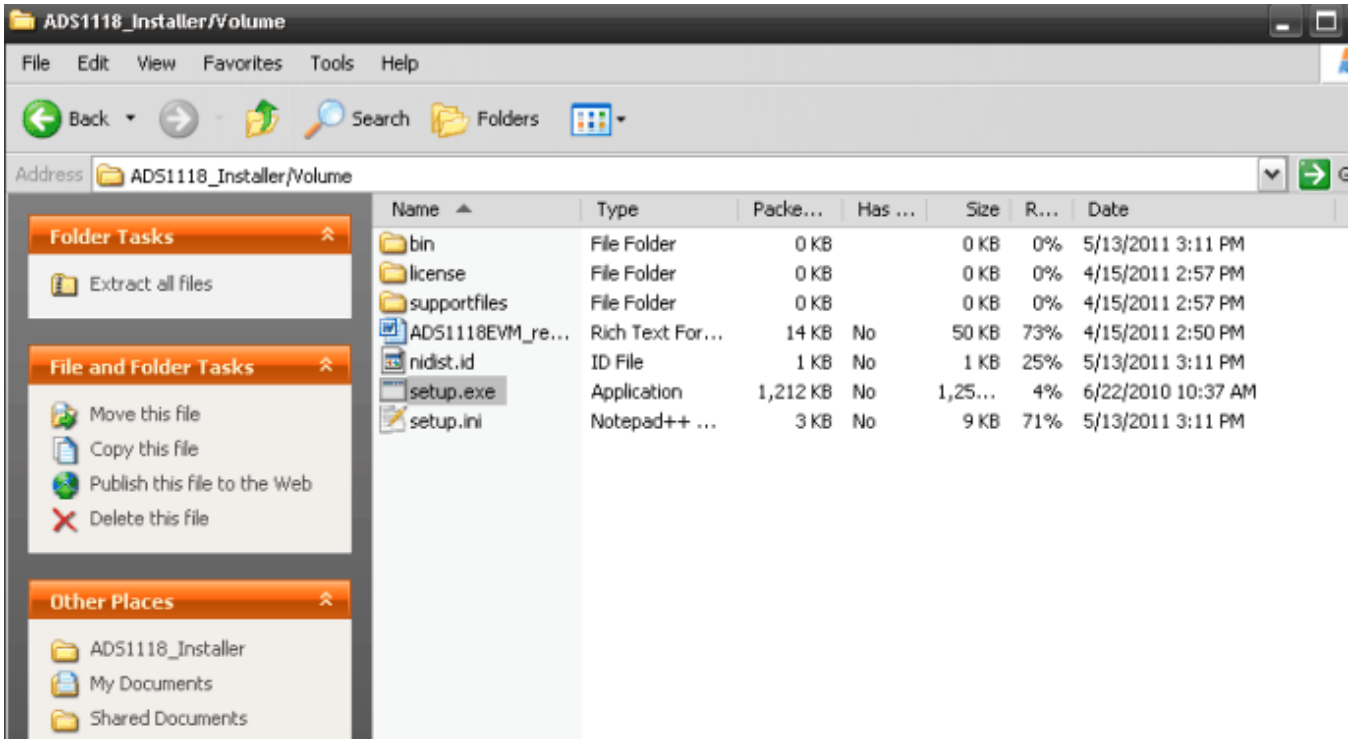

Figure 8. ADS1118EVM Installer

After the installation process initializes, the user is given the choice of selecting the directory where the program is to be installed; these options usually default to *C:\Program Files\ADS1118EVM* and *C:\Program Files\National Instruments* as shown in Figure 9. Following these selections, the user must accept two license agreements that are presented, as shown in Figure 10. After accepting the Texas Instruments and National Instruments license agreements, the progress bar opens and shows the installation of the software. Once the installation process is completed, click **Finish**.

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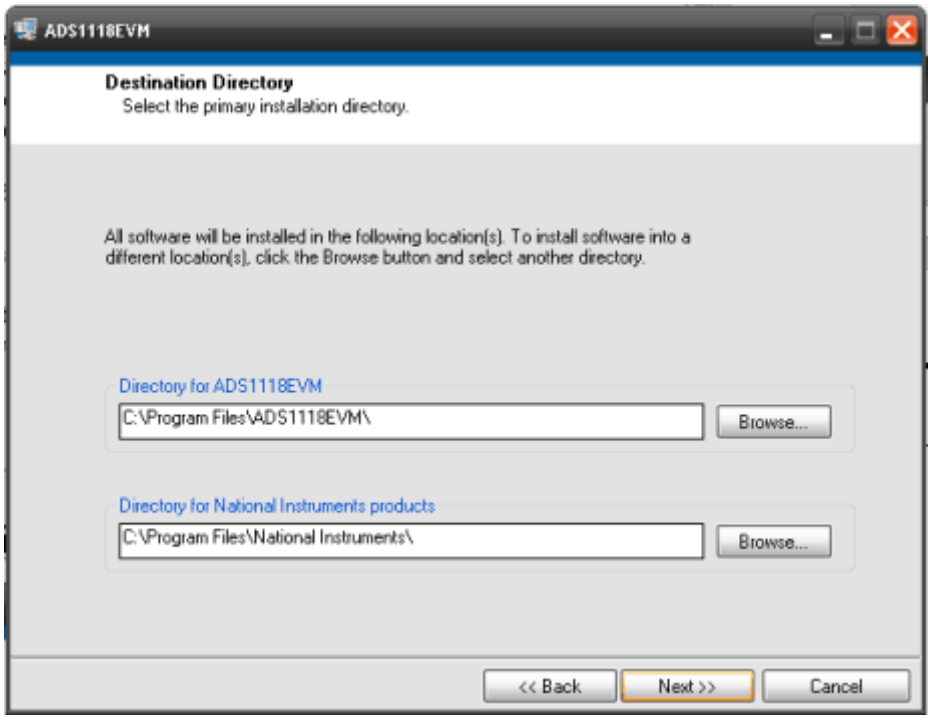

Figure 9. ADS1118EVM Install Path

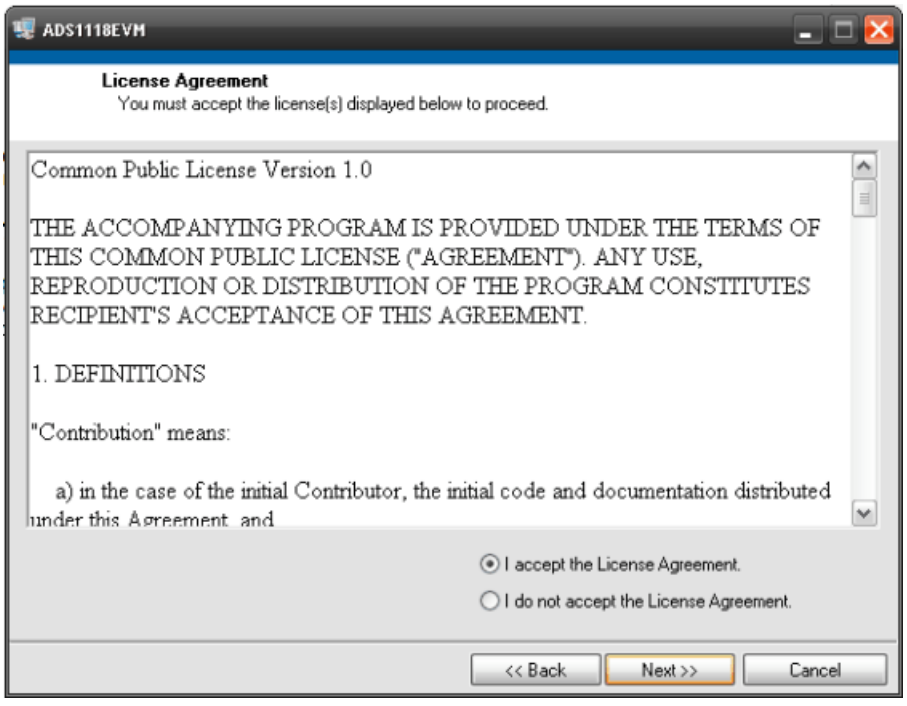

Figure 10. ADS1118EVM Software License Agreements

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5 ADS1118EVM Software Overview

This section discusses how to use the ADS1118EVM software. The software operation contains a two-step process: ADS1118 configuration and operation.

5.1 Starting the ADS1118EVM Software

The ADS1118 software can be operated through the Start menu in Windows. From the Start menu, select All Programs, and then select the ADS1118EVM program. Figure 11 illustrates how the software should appear when launched if the ADS1118EVM is functioning properly.

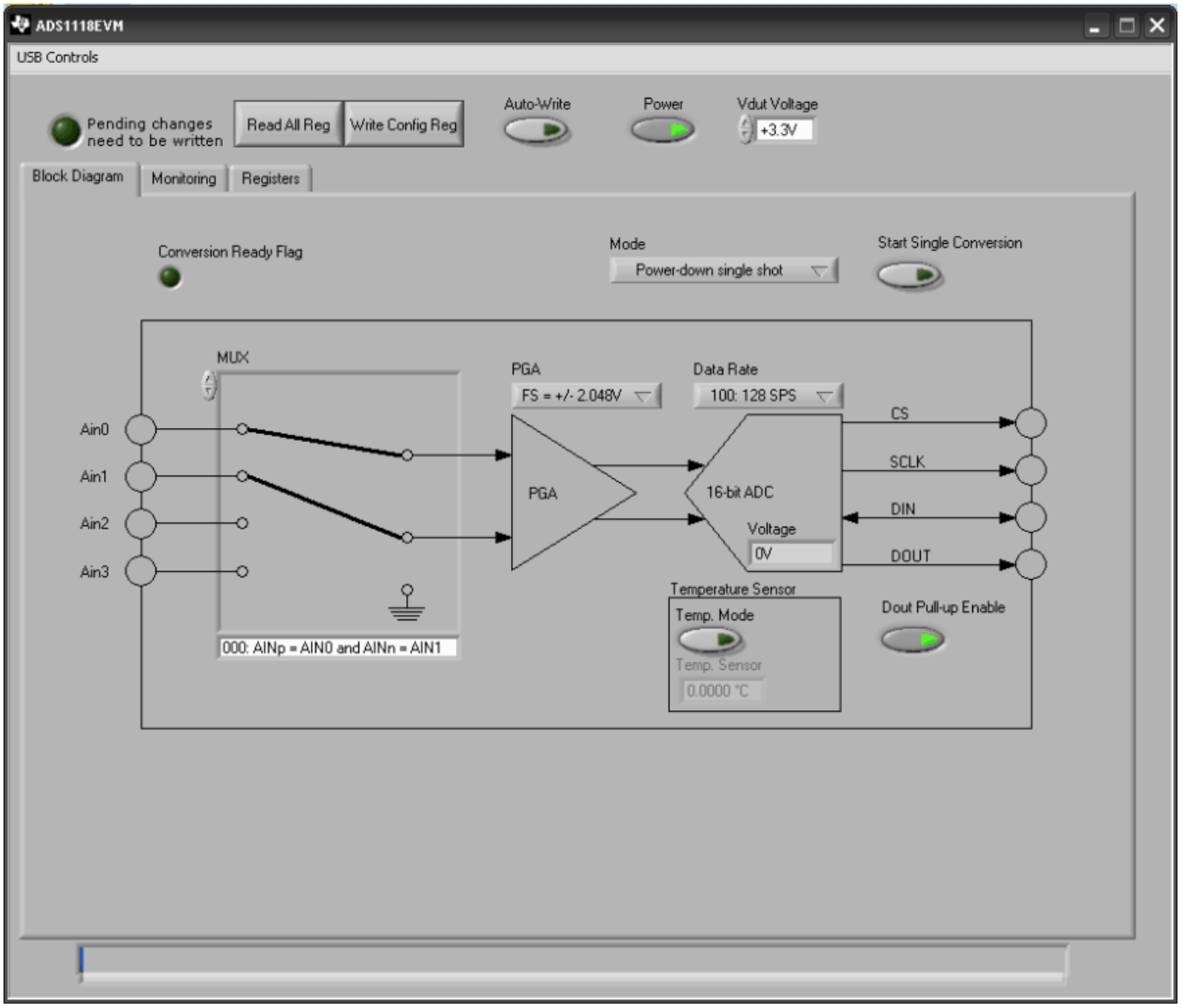

Figure 11. ADS1118EVM Software Interface

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Figure 12 shows an error that pops up if the computer cannot communicate with the EVM. If you receive this error, first ensure that the USB cable is properly connected on both ends. This error can also occur if you connect the USB cable before the SM-USB-DIG Platform power source. Another possible source for this error is a problem with the USB Human Interface Device driver on your PC. Make sure that the device is recognized when the USB cable is plugged in, indicated by a Windows-generated confirmation sound.

Figure 12. Communication Error with SM-USB-DIG Platform

5.2 ADS1118EVM Software Features

5.2.1 Registers Tab

The ADS1118EVM software features a tab devoted to reading and writing directly to the two physical registers found on the ADS1118, as shown in Figure 13. By selecting the Config Register in the register table, the individual bits can be set in the Bits section of the tab. The function of each bit can be found in the ADS1118 product data sheet or by clicking the **Help w/ Reg** button. The Conversion Register cannot be written to because it is a read-only register, but the register will display the value contained in it.

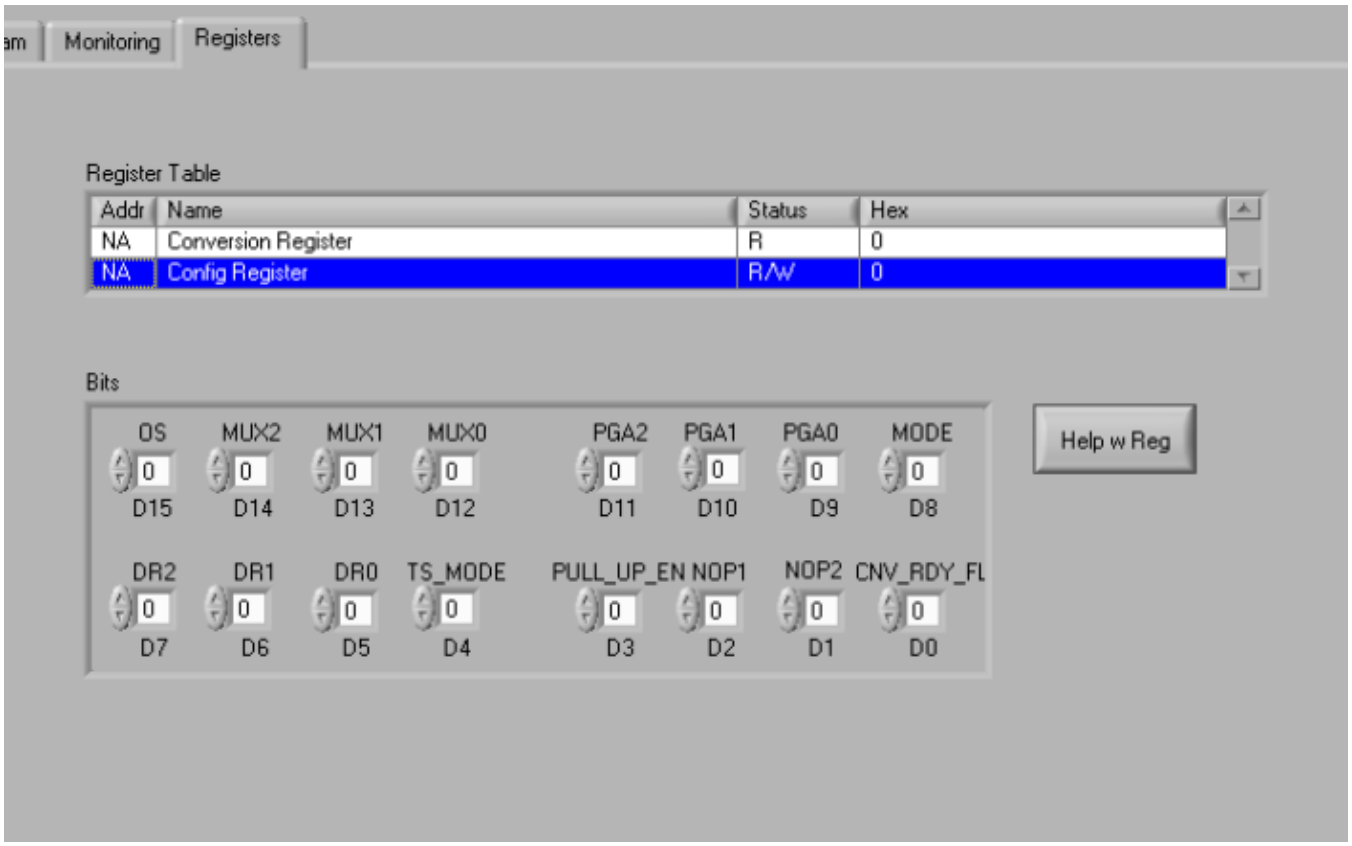

Figure 13. ADS1118EVM Software: Registers Tab

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5.2.2 Reading From and Writing to Registers

The ADS1118EVM software only reads from and writes to the ADS1118 registers at a user command. These actions are accomplished with the **Read All Reg** and **Write Config Reg** buttons. When any change is made to the configuration register on the Registers tab or the Block Diagram tab, the green light turns on to show that changes are pending, as Figure 14 illustrates. Pressing the **Write Config Reg** button writes the pending changes to the ADS1118. In addition, by enabling the **Auto-Write** button, changes will be written to the configuration register automatically.

The ADS1118 is only read when the **Read All Reg** button is pressed. It is recommended to read from the device after writing to the configuration register to verify that the ADS1118 has successfully stored the data.

Figure 14. ADS1118EVM Software: Read, Write, and Auto-Write Buttons

5.2.3 Changing Vdut Voltage

Figure 15 shows the **Power** button as well as the *Vdut Voltage* selector. By default, launching the ADS1118EVM software turns on power to the ADS1118 at 3.3 V. The **Power** button can be used to power off or reset the device, while the *Vdut Voltage* selector can change the power from 3.3 V to 5.0 V.

Figure 15. ADS1118EVM Software: Configuring Power

5.2.4 Mode Selection

The Mode selector, shown in Figure 16, determines the operating mode that the ADS1118 enters after performing a write to the configuration register. In *Power-down single shot* mode, the ADS1118 does not produce a conversion on the next read unless the **Start Single Conversion** is enabled. If it is enabled, and written to the configuration register, the next read returns the voltage read or temperature. *Continuous Conversion* mode returns the detected voltage or temperature on every read. The **Start Single Conversion** button does not serve a function and is inactive while the ADS1118 is in *Continuous Conversion* mode.

Figure 16. ADS1118EVM Software: Mode Selection

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5.2.5 Mux Input Selection

Figure 17 shows the Mux Input selector. The ADS1118 allows for every input pin to be used with reference to ground, as well as four different differential input combinations. The thermocouple found on the ADS1118EVM test board is connected to $A_{IN}2$ and $A_{IN}3$, which can be read by selecting the *011: AINp = AIN2 and AINn = AIN3* option.

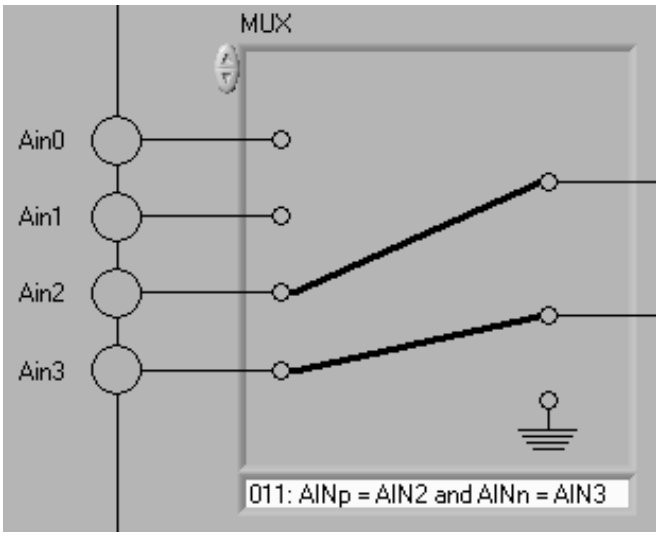

Figure 17. ADS1118EVM Software: Mux Input Selection

5.2.6 PGA/Full-Scale Voltage

The PGA selector determines the full-scale voltage that the ADS1118 uses when calculating the input voltage. Note that the ADS1118 is capable of determining input voltages that exceed the V_{SD} level.

Figure 18 shows the PGA setting area of the ADS1118EVM software window.

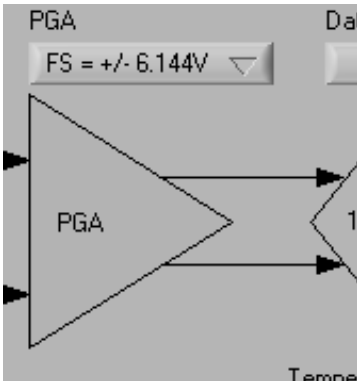

Figure 18. ADS1118EVM Software: PGA Setting

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5.2.7 Temperature Mode and Voltage Output

Enabling the **Temp. Mode** makes the ADS1118 output the detected temperature of the chip itself instead of the input voltage, as Figure 19 shows. When the ADS1118EVM software has the **Temp. Mode** button enabled, the *Voltage* field is disabled. When the **Temp. Mode** button is disabled (default), the *Voltage* field displays the detected voltage based on the mux input.

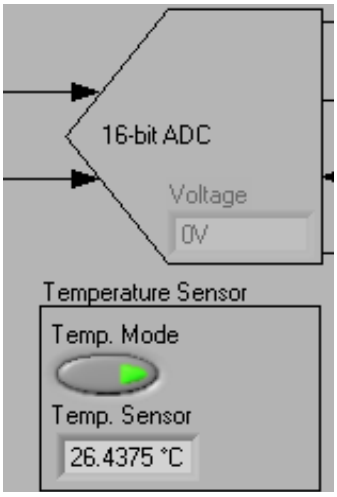

Figure 19. ADS1118EVM Software: Temperature Sensor

5.2.8 Data Rate Selection

The Data Rate selector sets the samples per second on the ADS1118, as shown in Figure 20.

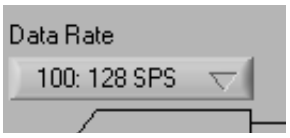

Figure 20. ADS1118EVM Software: Data Rate

5.3 Using the ADS1118EVM Monitoring Tab

The ADS1118EVM software also features an example experiment to demonstrate the usefulness of the temperature sensor on the ADS1118 when used in a thermocouple application. The onboard temperature sensor allows for accurate cold-junction compensation (CJC) as the temperature of the cold-junction changes. The Monitoring tab compares thermocouple temperatures using CJC with the ADS1118-detected temperature against the thermocouple temperature with a constant cold-junction temperature.

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Figure 21 shows the layout of the Monitoring tab. Many of the options on the tab have the same functionality as on the Block Diagram tab; the **Help** button reviews these functions in detail.

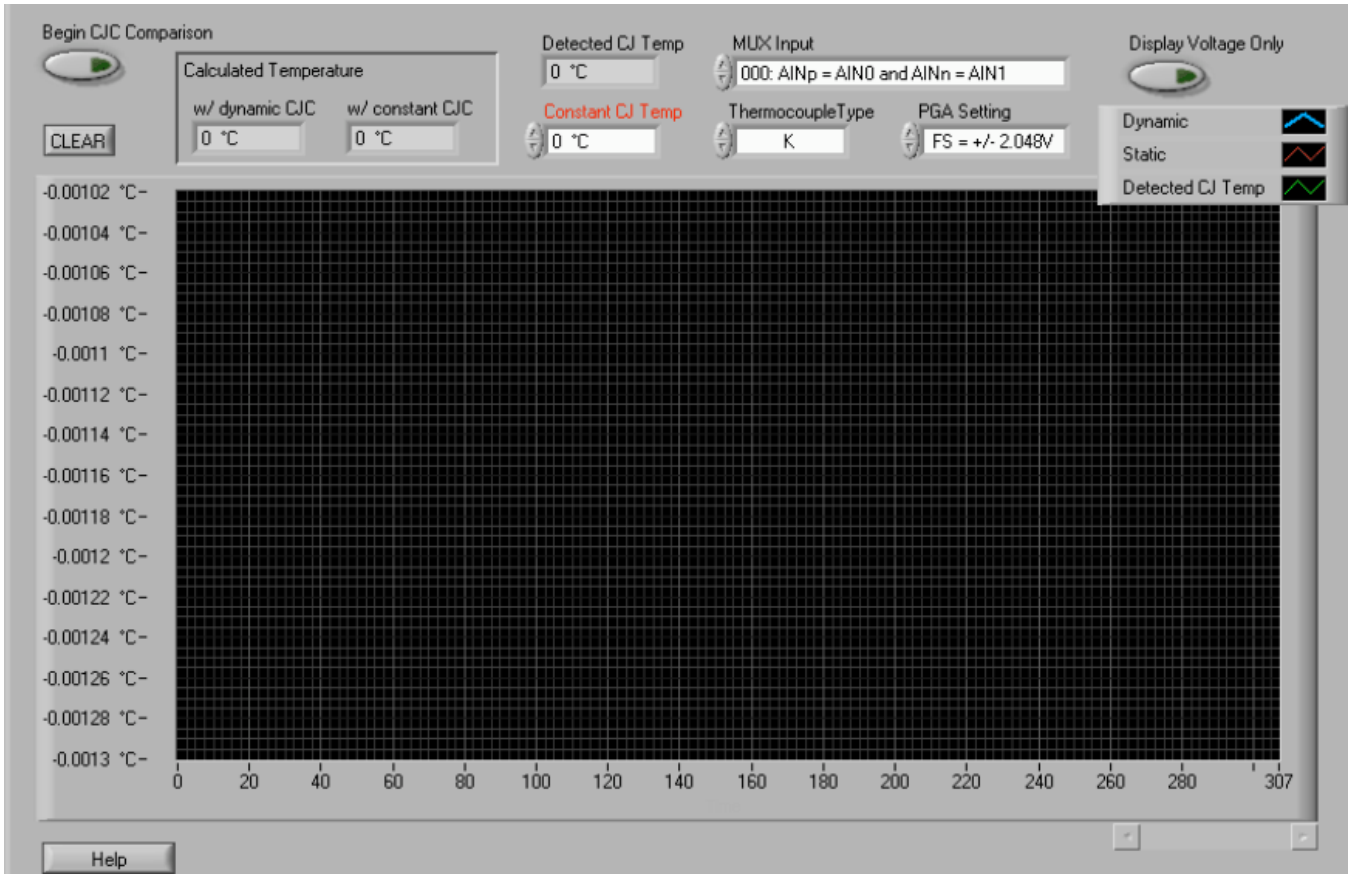

Figure 21. ADS1118EVM Software: Monitoring Tab

5.3.1 Configuring the Monitoring Tab

To run the CJC comparison experiment, the Monitoring tab must first be configured properly. The options allow for any input to be used, but to use the onboard thermocouple connector on the ADS1118EVM, the *Mux Input* must be set to *011: AINp=AIN2 and AINn = AIN3* and the *Thermocouple Type* must be set to *K*. The comparison will work with any PGA setting, but for the best resolution, the value should be set to *FS = ±0.256V*. The **Display Voltage Only** toggle button allows the graph to display the input voltage only, without any CJC.

The *Constant CJC Temp*. field is where the constant temperature is entered for the cold junction compensation (the red waveform). The ADS1118 provides the dynamic temperature for the other (blue) waveform; this temperature is displayed in the *Detected CJC Temp.* field.

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5.3.2 Beginning Comparison and Interpreting Results

To begin the CJC comparison, toggle the **Begin CJC Comparison** button. The ADS1118EVM software begins to populate the graph with data points over time. The waveforms can be cleared and the comparison can be restarted by pressing the **Clear** button. Toggling the **Begin CJC Comparison** button into the disabled position pauses or stops the experiment.

Ideal results after running the CJC comparison would show how the calculated temperature (with a static cold junction temperature) would differ from the measured temperature (using a dynamic cold junction temperature). Figure 22 shows an example set of waveforms. The yellow line indicates the constant CJC temperature, while the green line indicates the temperature detected by the ADS1118. During the comparison, the ambient temperature around the ADS1118EVM was changed, as the waveforms indicate. It can be seen that as the static CJC temperature and measured CJC temperature diverge, the blue line (dynamic CJC calculated thermocouple temperature) and the red line (static CJC calculated temperature) diverge as well. It should also be noted that during this example, the bath containing the thermocouple was actually warming up as well, from +8.4°C to +13.3°C.

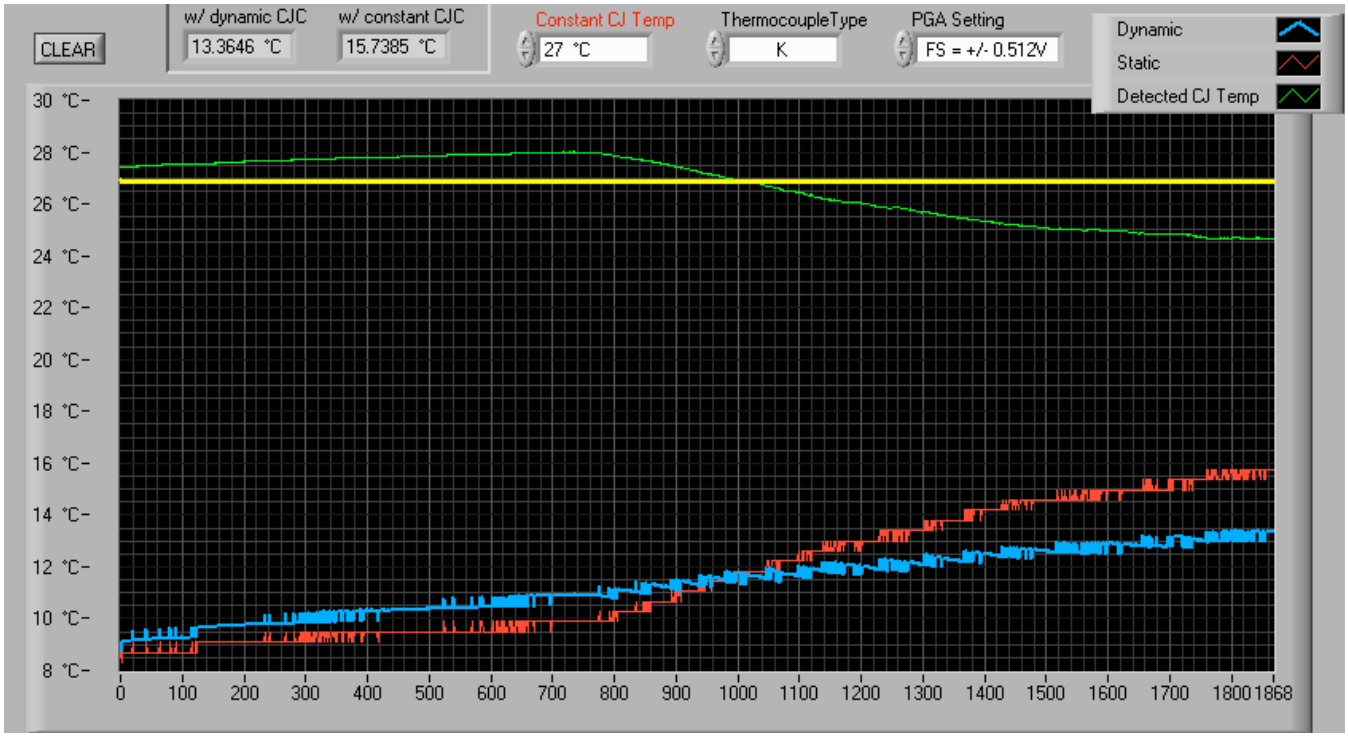

Figure 22. ADS1118EVM Software: Example Results

6 ADS1118EVM Documentation

This section contains the complete bill of materials and schematic diagram for the ADS1118EVM. Documentation information for the SM-USB-DIG Platform can be found in the SM-USB-DIG Platform User's Guide, SBOU098, available through the TI web site.

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6.1 ADS1118EVM Board Schematic

Figure 23 shows the schematic for the ADS1118EVM board.

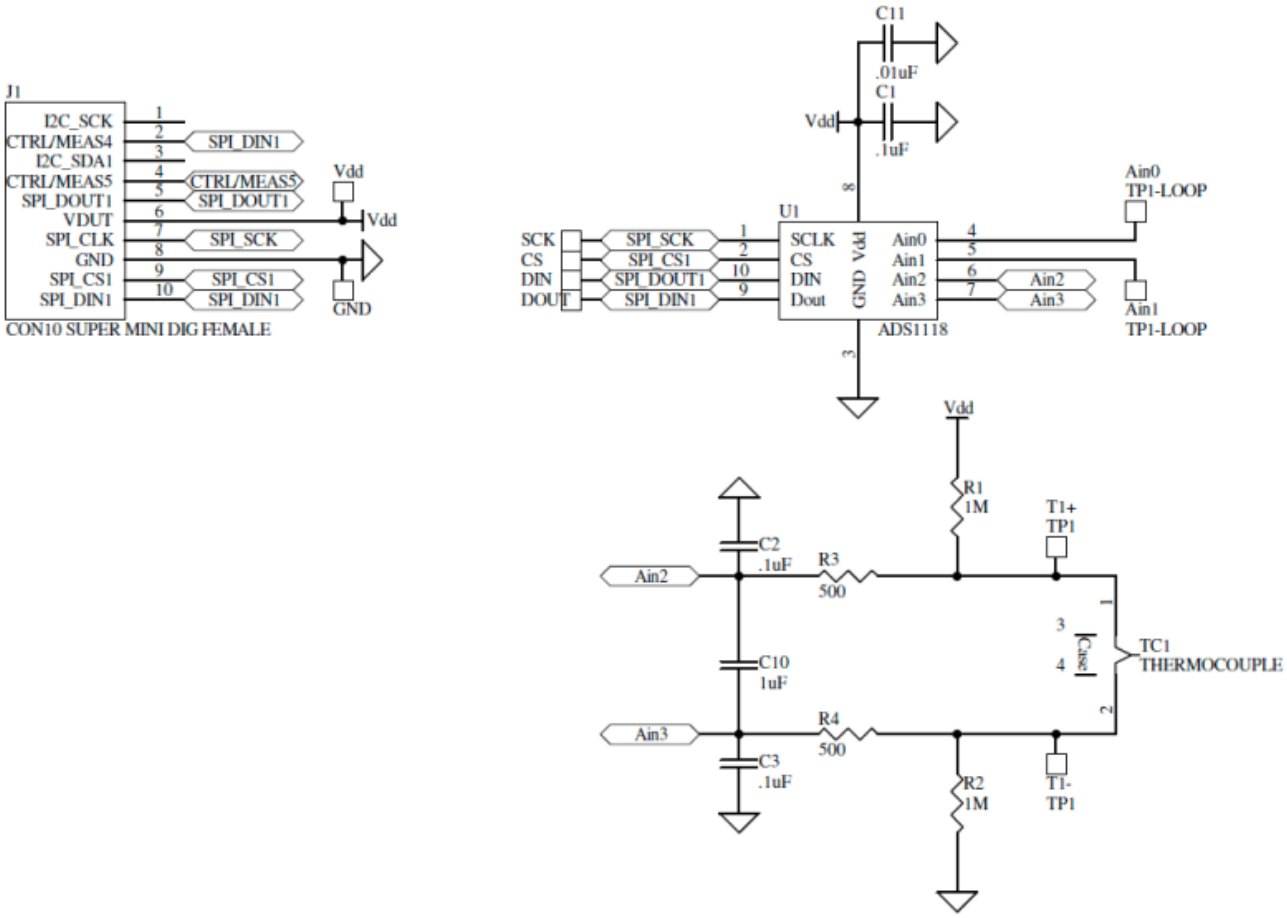

Figure 23. ADS1118EVM Schematic

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6.2 ADS1118EVM PCB Component Layout

Figure 24 shows the layout of the components for the ADS1118EVM board.

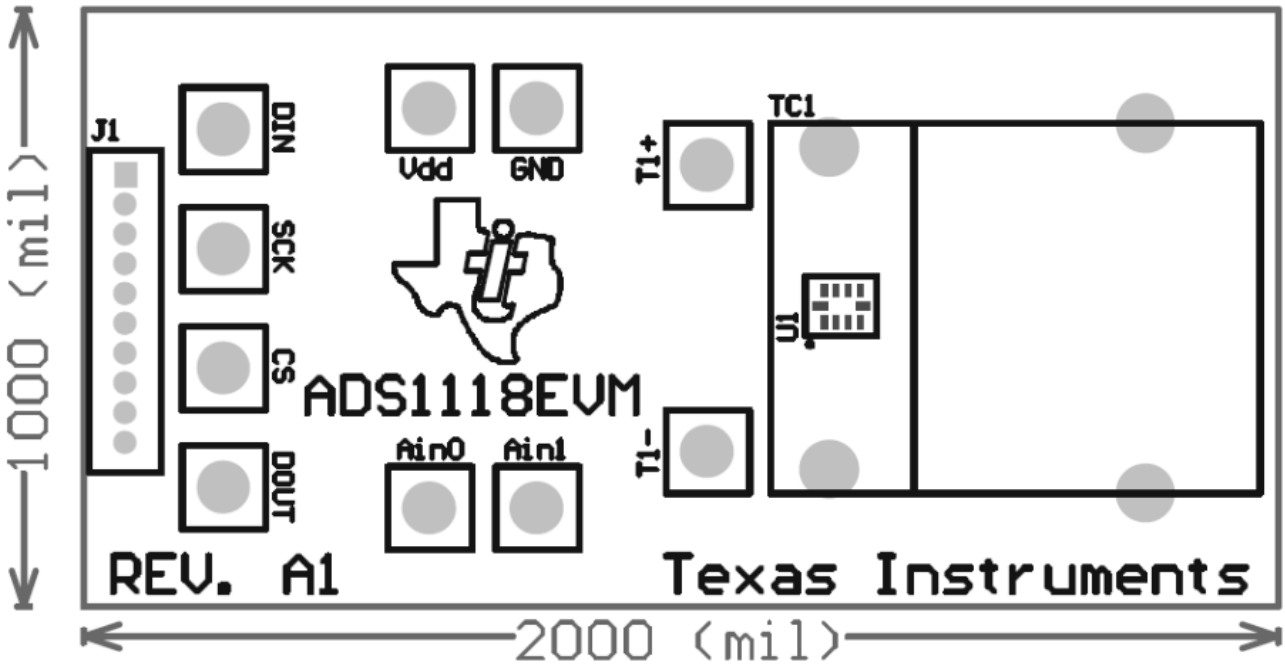

Figure 24. ADS1118EVM PCB Component Layout

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6.3 ADS1118 Test Board Bill of Materials

The bill of materials is provided in Table 4.

NOTE: All components should be compliant with the European Union Restriction on Use of Hazardous Substances (RoHS) Directive. Some part numbers may be either leaded or RoHS. Verify that purchased components are RoHS-compliant. (For more information about TI's position on RoHS compliance, see the TI web site.)

Table 4. ADS1118EVM Bill of Materials

Reference Designator	Description	Vendor	Digi-Key Part Number	Manufacturer Part Number
TC1	Thermocouple connector	Omega	N/A	PCC-SMP-K-5
N/A	Thermocouple	Omega	N/A	5SRTC-TT-K-24-36
J1	Connector, Socket 10-pin .050 R/A Sngl	Mill-Max Manu. Corp.	N/A	851-43-010-20-001000
R1, R2	Resistor, 1 MΩ 1/16W 5% 0402 SMD	Stackpole Electronics Inc	RMCF0402JT1M00 CT-ND	RMCF0402JT1M00
C11	Capacitor, ceramic .010 µF 25 V X7R 0402	Yageo	311-1337-1-ND	CC0402KRX7R8BB103
C1-3	Capacitor, ceramic .10 µF 16 V X7R 0402	TDK Corporation	445-4952-1-ND	C1005X7R1C104K
C10	Capacitor, ceramic 1.0 µF 16 V X5R 0402	TDK Corporation	445-4978-1-ND	C1005X5R1C105K
R3, R4	Resistor, 510 Ω 1/16W .5% 0402 SMD	Susumu	RR05P510DCT-ND	RR0510P-511-D
CS, DIN, DOUT, GND, SCK, Vdd,T1+, T1–, Ain0, Ain1	Test point PC Compact .063"D YLW	Keystone Electronics	5009K-ND	5009
1, 2	Bumpon HemispherE .50 x .14 Clear	3M	SJ5312-7-ND	SJ-5312 (CLEAR)
U1	ADS1118, RUG Package	Texas Instruments	NA	ADS1118

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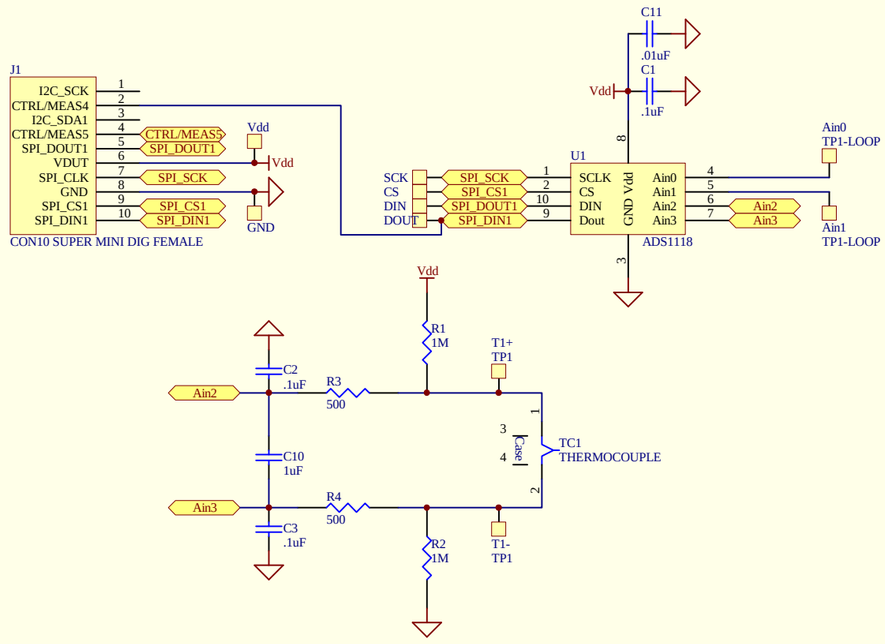

Title		
Size: B	Number	Revision
Date: 17-May-2011	Sheet of	
File: C:\DOCUME~1\a0873100\LOCALS~1\Temp\Temporary Directory 1 for ADS1118EVM-DDB-A1.zip\ADS1118EVM.ddb	Drawn By:	

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 2 V to 5.5 V and the output voltage range of 2 V to 5.5 V.

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

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During normal operation, some circuit components may have case temperatures greater than +40°C. The EVM is designed to operate properly with certain components above +40°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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