ADS1282-SP Evaluation Module (ADS1282EVM-CVAL)

This user's guide provides an overview of the evaluation module (EVM) including hardware and software features and functions to be considered while using this module. This manual is applicable to the ADS1282-SP EVM which is synonymous with ADS1282EVM-CVAL, the orderable part number. The EVM provides a platform for evaluating the ADC under various signal and clock configurations.

Contents

List of Figures

List of Tables

1 ADS1282-SP EVM (ADS1282EVM-CVAL)

The ADS1282-SP EVM is ideal for evaluating the ADS1282-SP, a dual-channel, high-precision ADC. Figure 1 shows an overview of the evaluation setup. The ADS1282-SP EVM is mated to the MSP430FR5969 LaunchPad™ (must be purchased separately) which communicates on an SPI bus via USB cable to the ADS1282-SP software GUI. The GUI allows for configuration of the ADS1282-SP device and gives time domain and frequency domain analysis of captured data with the option to export captured data to a file.

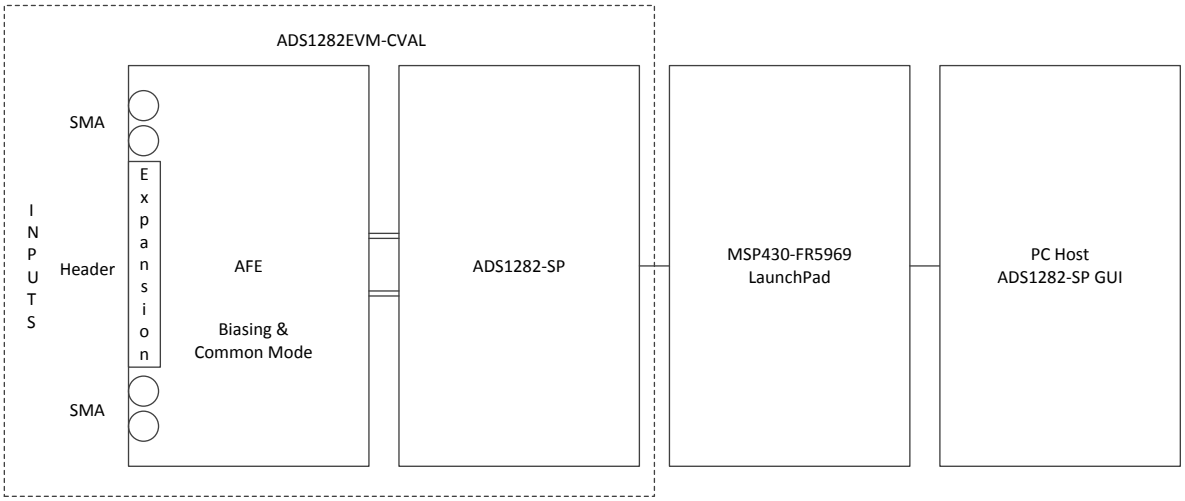


Figure 1. ADS1282-SP EVM with MSP430 LaunchPad

2 ADS1282-SP Software GUI Installation

Download the *ADS1282-SP Software GUI Installer* (SBAC150) from the product web page.

Unzip the installer, launch the executable, and follow all instructions. Refer to Appendix A for detailed software installation instructions.

3 Flashing MSP430FR5969 LaunchPad with ADS1282-SP Firmware

The completion of the ADS1282-SP Software GUI installation in Section 2 results in the README file shown in Figure 2. As stated in this file, data capture from the ADS1282-SP EVM to the MSP430 EVM is not possible until the correct firmware is flashed into the MSP430 LaunchPad. Refer to the *MSP430FR5969 LaunchPad Firmware Flashing Guide for ADS1282-SP* (SBAC149) for full instructions. This document is also provided in the GUI installation path as indicated in the README file, for your convenience.

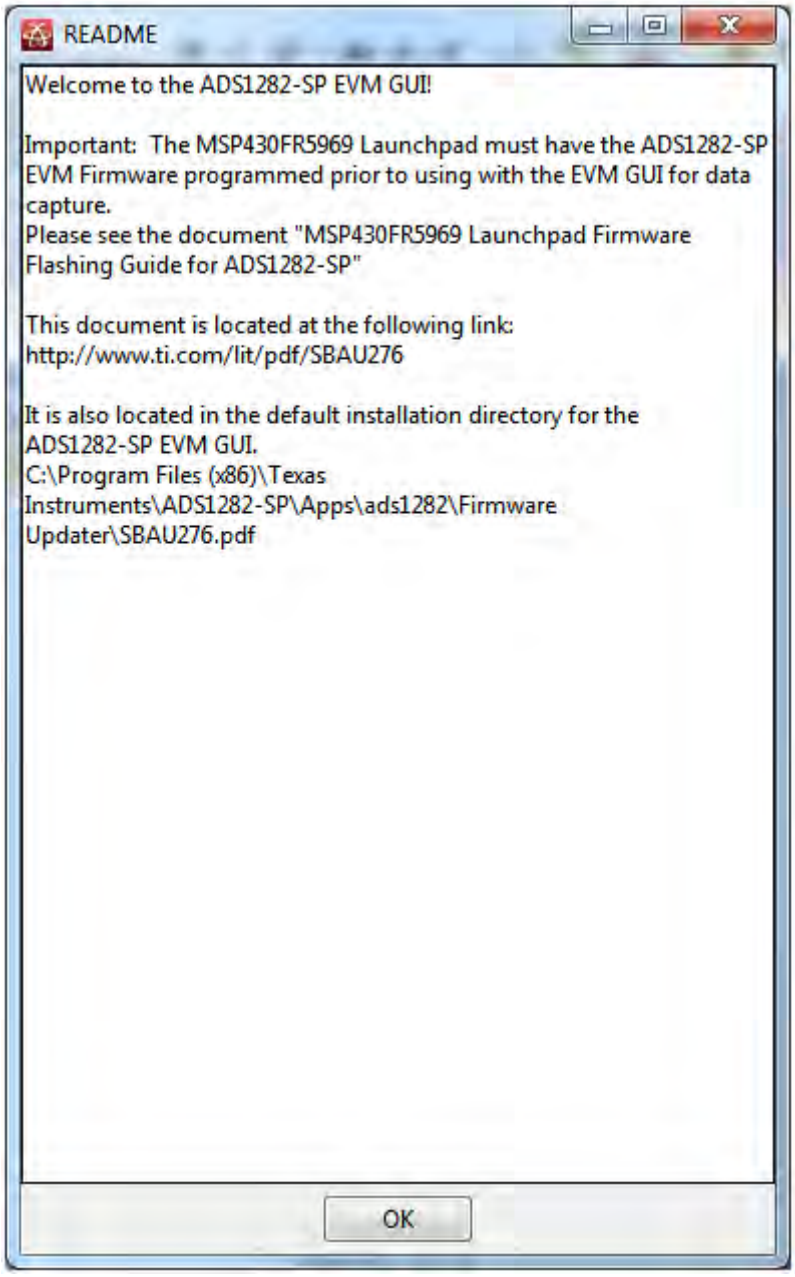


Figure 2. ADS1282-SP Software GUI README File

4 ADS1282-SP Setup and Quick Test

This section provides the minimum procedures required to begin testing, including a section discussing hardware setup and another section describing the software setup and capture process. Refer to subsequent sections of this guide for more details on EVM and GUI features.

NOTE: Ensure that Section 2 and Section 3 of this guide have been completed before continuing.

4.1 ADS1282-SP and MSP430FR5969 Setup

Figure 3 illustrates the necessary hardware connections to begin testing.

(A) With care, mate connectors J21 and J22 of the ADS1282EVM-CVAL to connectors J5 and J4 of the MSP430FR5969, respectively.

(B) Provide power to the ADS1282-SP EVM connecting **either**

- A 12 V AC/DC adaptor to connector J1, **or**
- 12 V and 0 V to banana jacks J3 and J2, respectively

(C) Connect USB to Micro-USB cable (provided with the MSP430 LaunchPad kit) between MSP430 LaunchPad and PC.

(D) Connect differential analog input signal to SMA's J18 and J15 with either a floating common mode voltage or a 2.5-V common mode voltage. [An AP SYS2722 instrument is used as the signal source in the following examples. Figure 3 has the outputs turned off in order to measure the noise floor.]

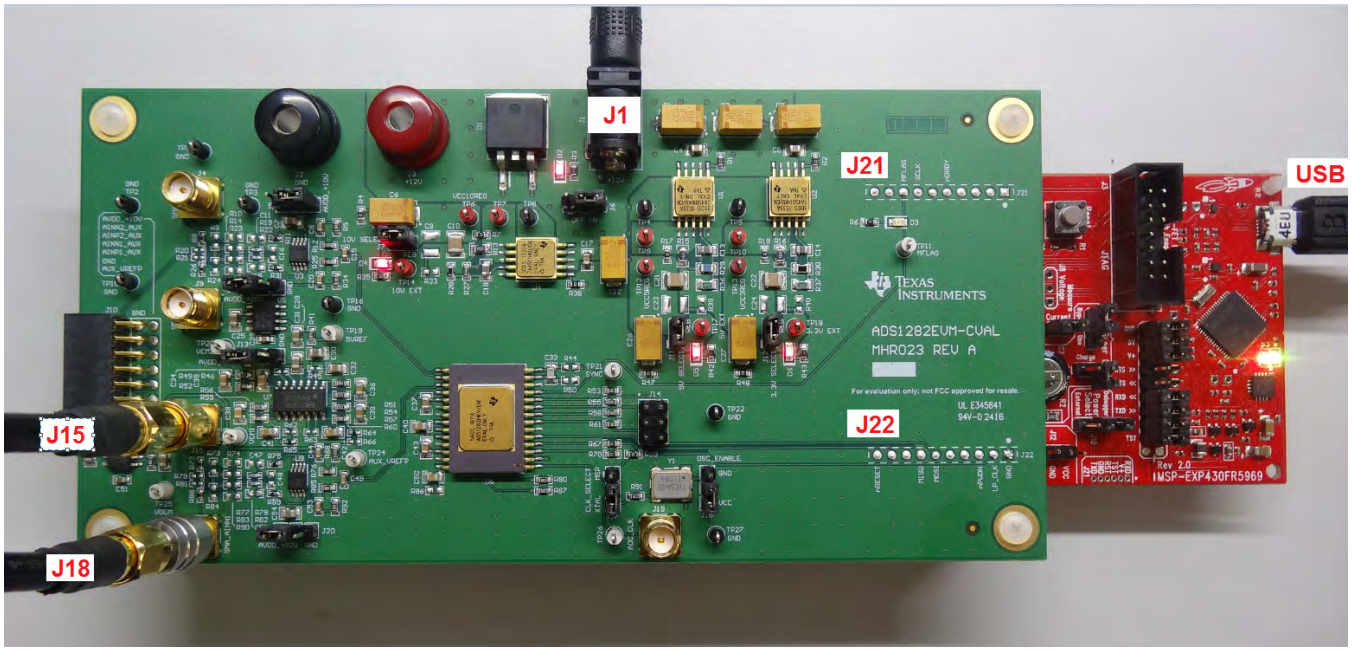


Figure 3. ADS1282-SP+MSP430 LaunchPad Hardware Setup

4.2 ADS1282-SP GUI Setup

Launch the ADS1282-SP GUI by double clicking the icon created on the desktop during installation.

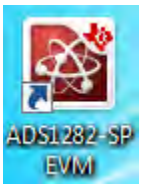


Figure 4. ADS1282-SP EVM GUI Icon

The home page of the GUI appears (see Figure 5). The green **Connected** button will appear if **all** of the following is true:

1. MSP430 firmware has been loaded properly
2. MSP430 LaunchPad is connected to PC via USB cable
3. ADS1282-SP EVM is mated correctly to MSP430 LaunchPad
4. 12-V power supply is provided to ADS1282-SP EVM

NOTE: If a green **Connected** button does not appear, follow the Error messages and guidance that appears.

Click the *Quick Start* icon (lightning bolt) in the bottom left corner of the *Home Page*.

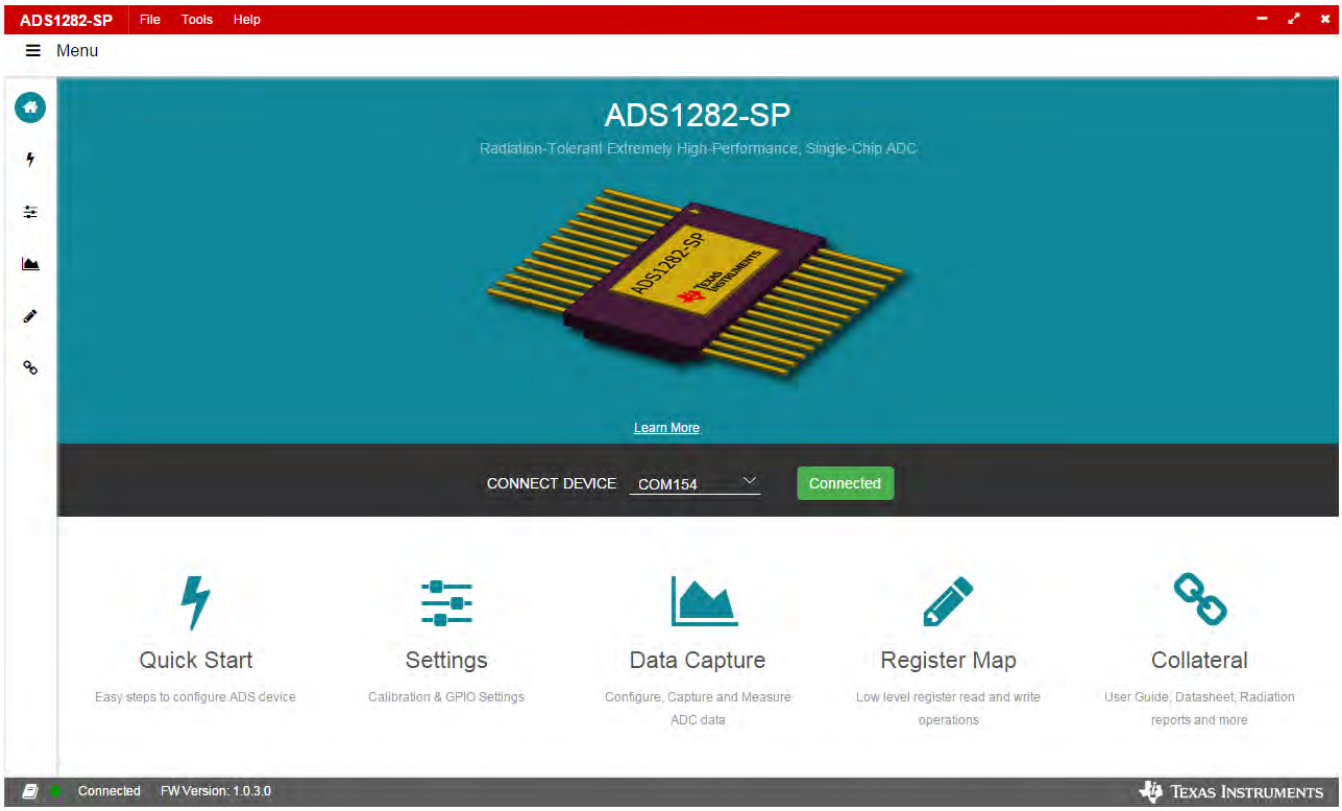


Figure 5. ADS1282-SP EVM GUI Home Page

Complete **STEP-1** of the **Quick Start** page by clicking the **Reset device** button followed by the **Next** button.

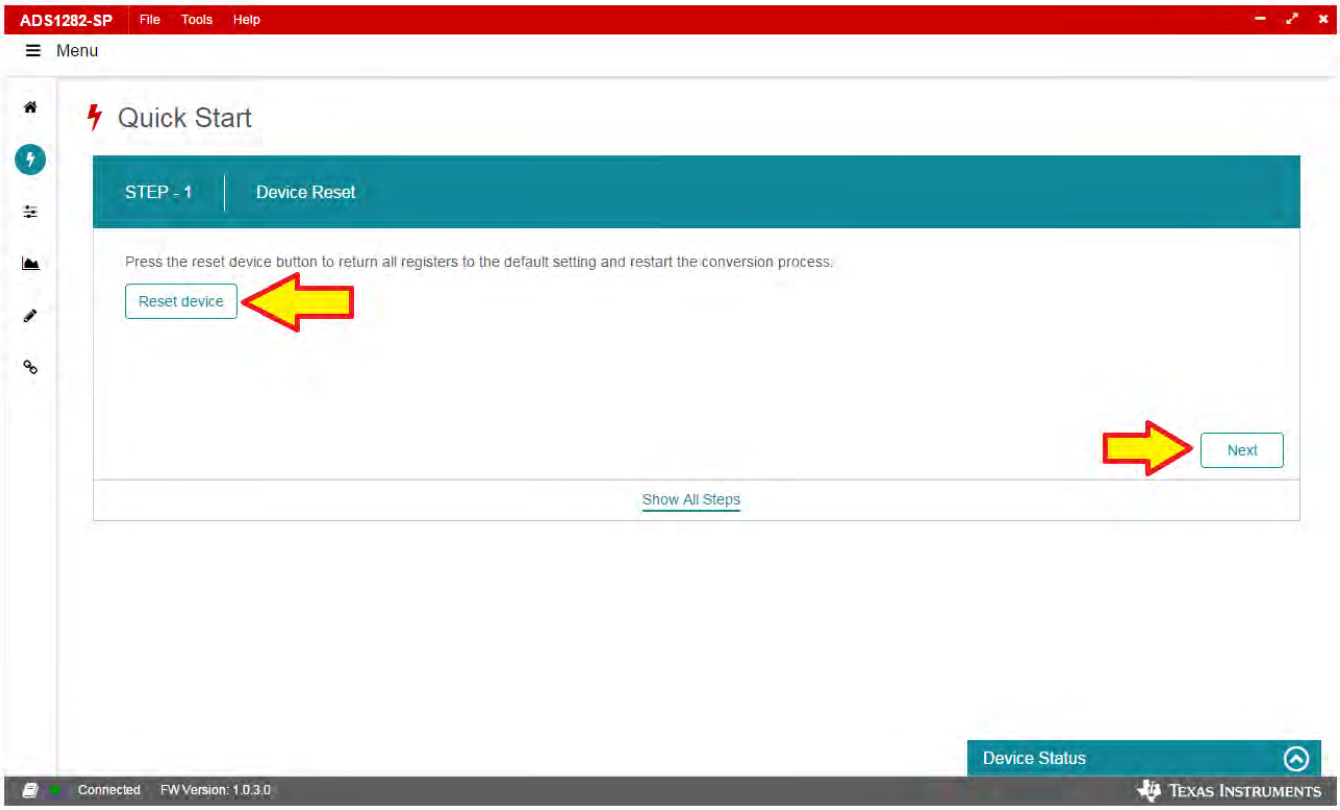


Figure 6. ADS1282-SP EVM GUI Quick Start Step 1

Complete **STEP-2** of the **Quick Start** page by leaving the **Device Clock Selection** as the default setting and clicking the **Next** button.

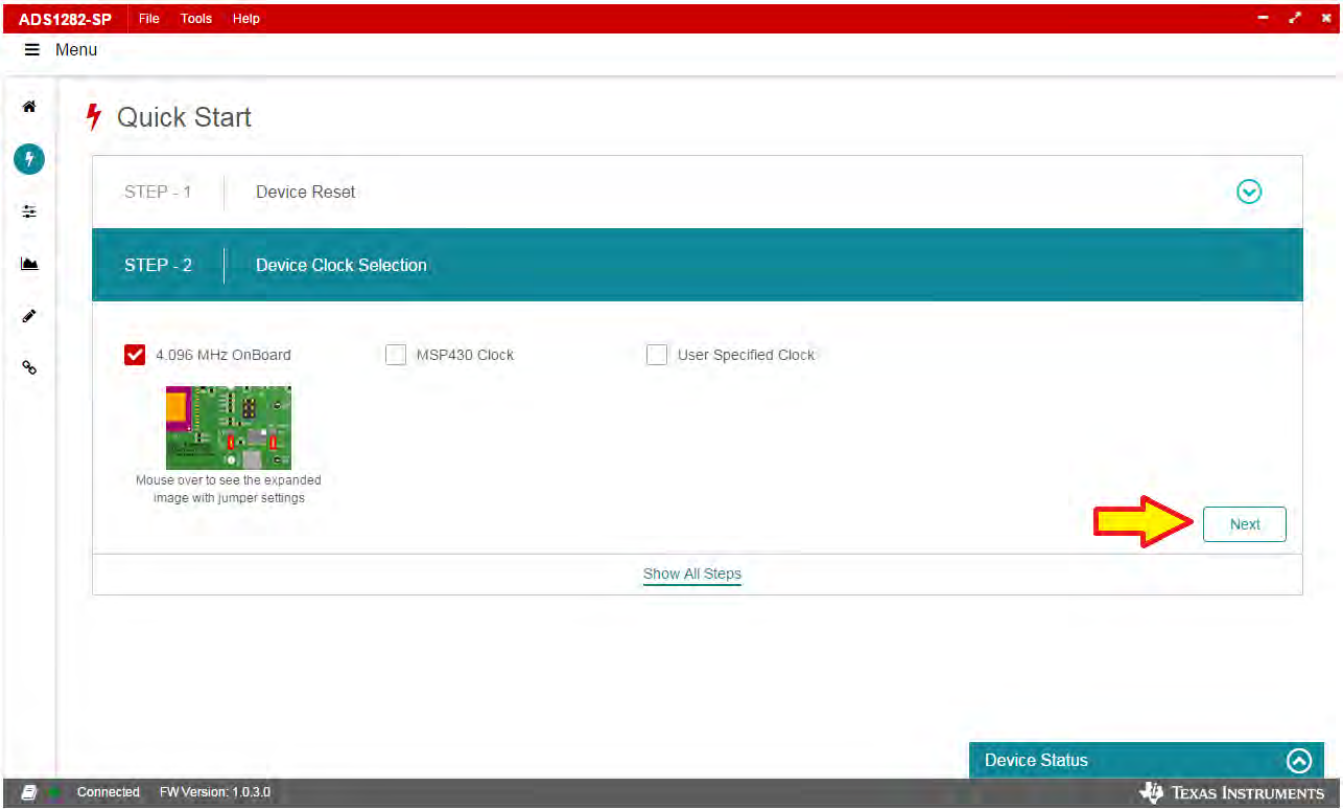


Figure 7. ADS1282-SP EVM GUI Quick Start Step 2

Complete **STEP-3** of the **Quick Start** page by leaving the **Filter and Data Selection** configuration as the default setting and clicking the **Next** button.

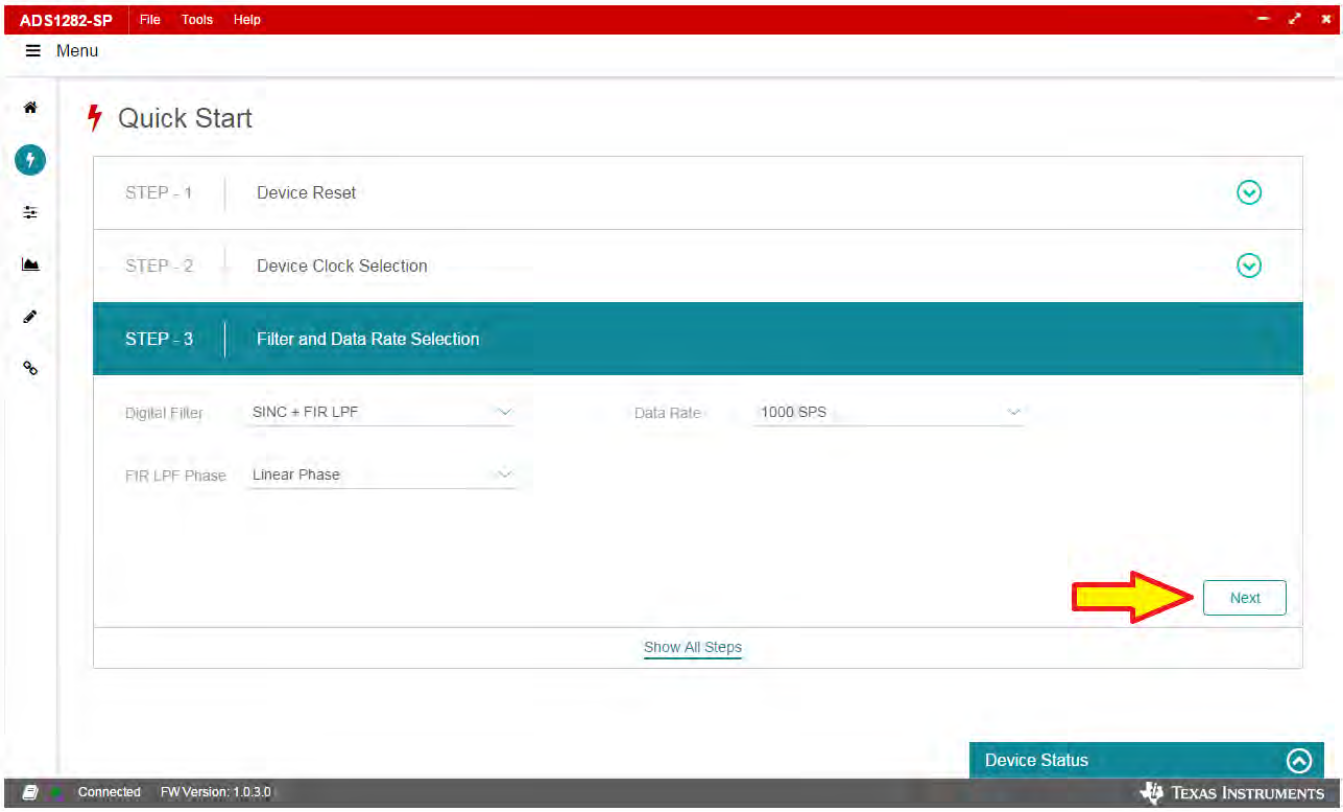


Figure 8. ADS1282-SP EVM GUI Quick Start Step 3

Complete **STEP-4** of the **Quick Start** page by leaving the **MUX and PGA Gain Selection** configuration as the default setting and clicking the **Go To Data Capture** button.

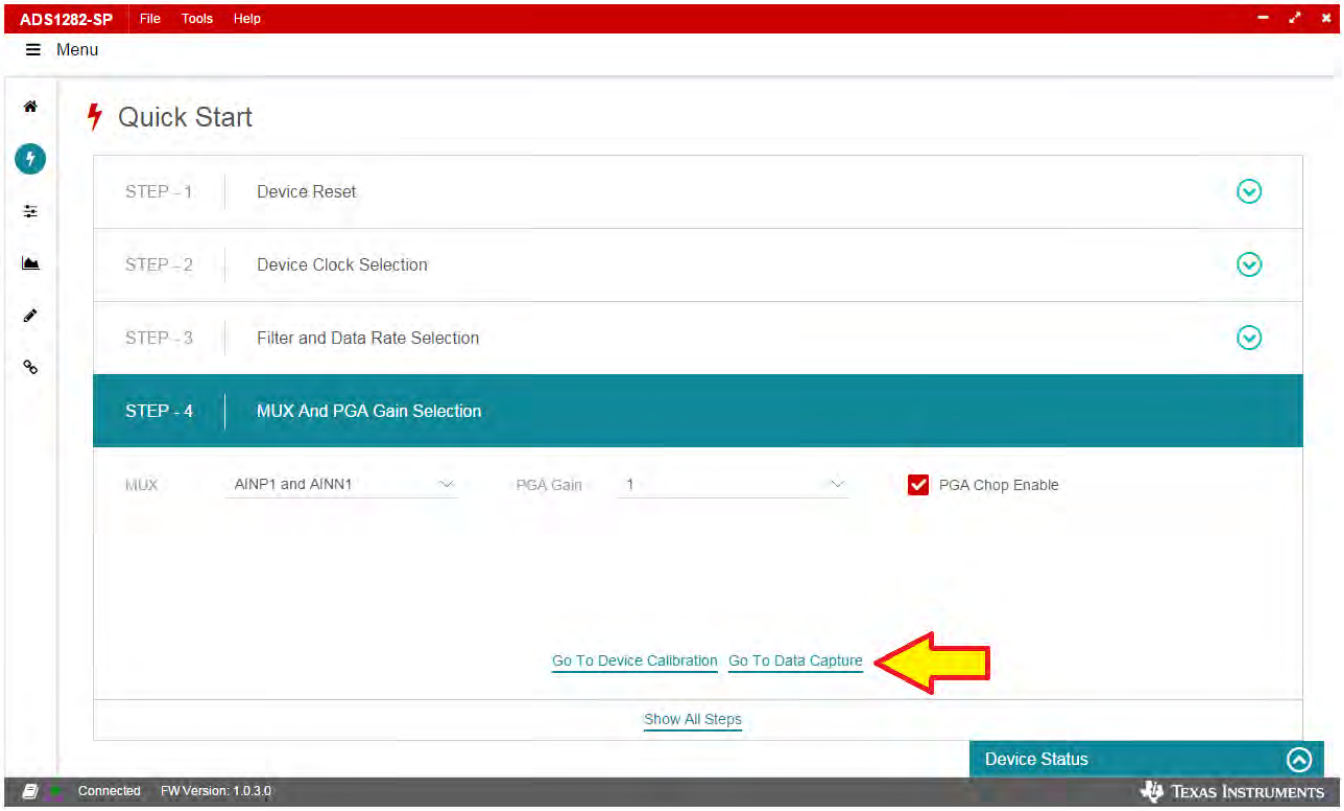


Figure 9. ADS1282-SP EVM GUI Quick Start Step 4

Click the **Start Capture** button to plot data from the ADC. Click the **Frequency Domain** button to measure the integrated signal-to-noise (**SNR**) in dBFS. In the following example, the 1st Nyquist integrated SNR is 123.71 dBFs, very close to the typical datasheet value of 124 dBFs for this device configuration.

Figure 10. ADS1282-SP EVM GUI Data Capture Frequency Domain

Turning on the AP signal source with a 5-Vpp differential signal and changing plot type to Time Domain results in Figure 11. The zoom function is achieved by clicking and holding the mouse button on the plot and dragging the mouse to vertical or horizontal zoom extents.

NOTE: Although the ADS1282-SP is designed to handle a 5-Vpp differential analog input, the analog front end of this EVM is limited by the OPA1632 amplifier. Because only unipolar power was used to bias this amplifier, the OPA1632 inputs are limited to 4-Vpp differential with a common mode voltage of 2.5 V. The EVM can easily be configured to bypass this amplifier.

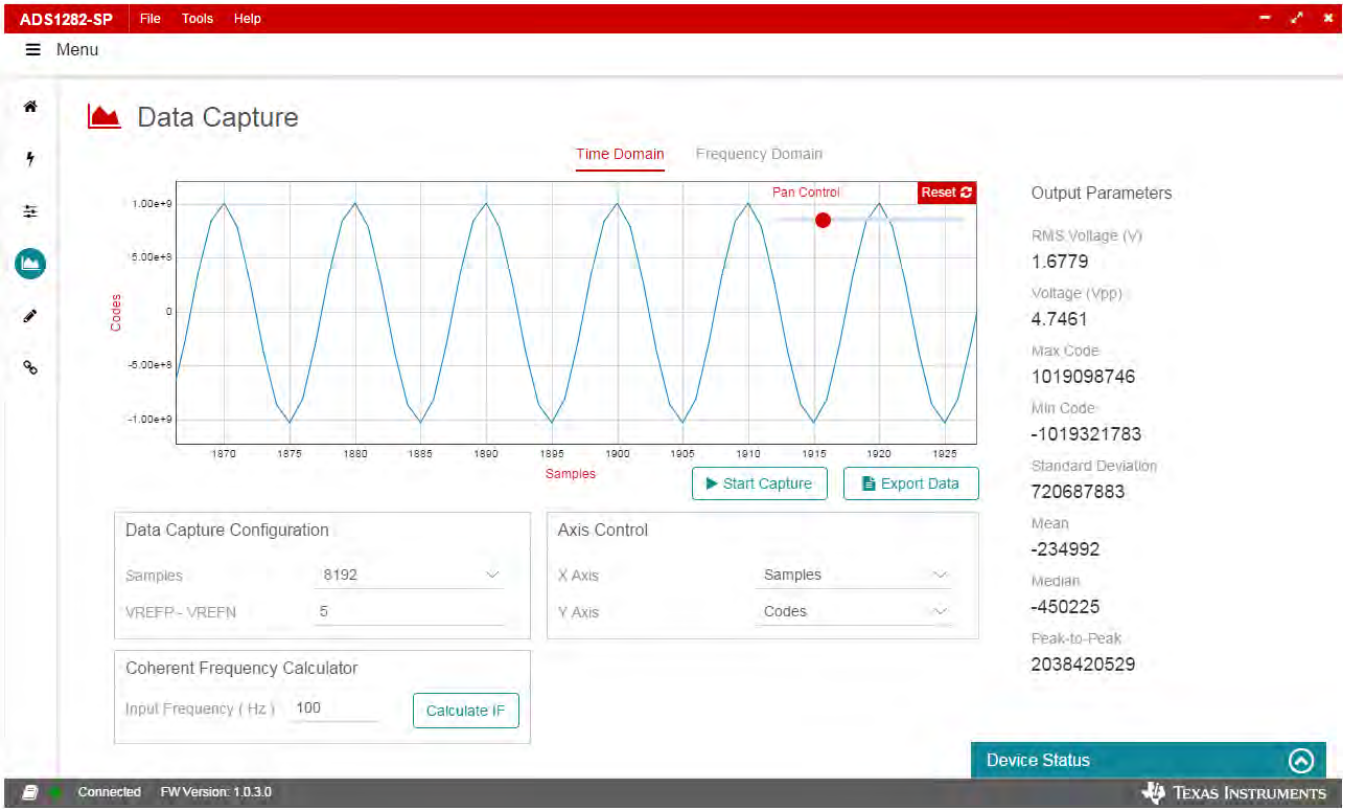


Figure 11. ADS1282-SP EVM GUI Data Capture Time Domain

For convenience of changing ADS1282-SP configurations quickly, click the **Show All Steps** link at the bottom of the **Quick Start** page to see all the controls in one view, as shown in Figure 12.

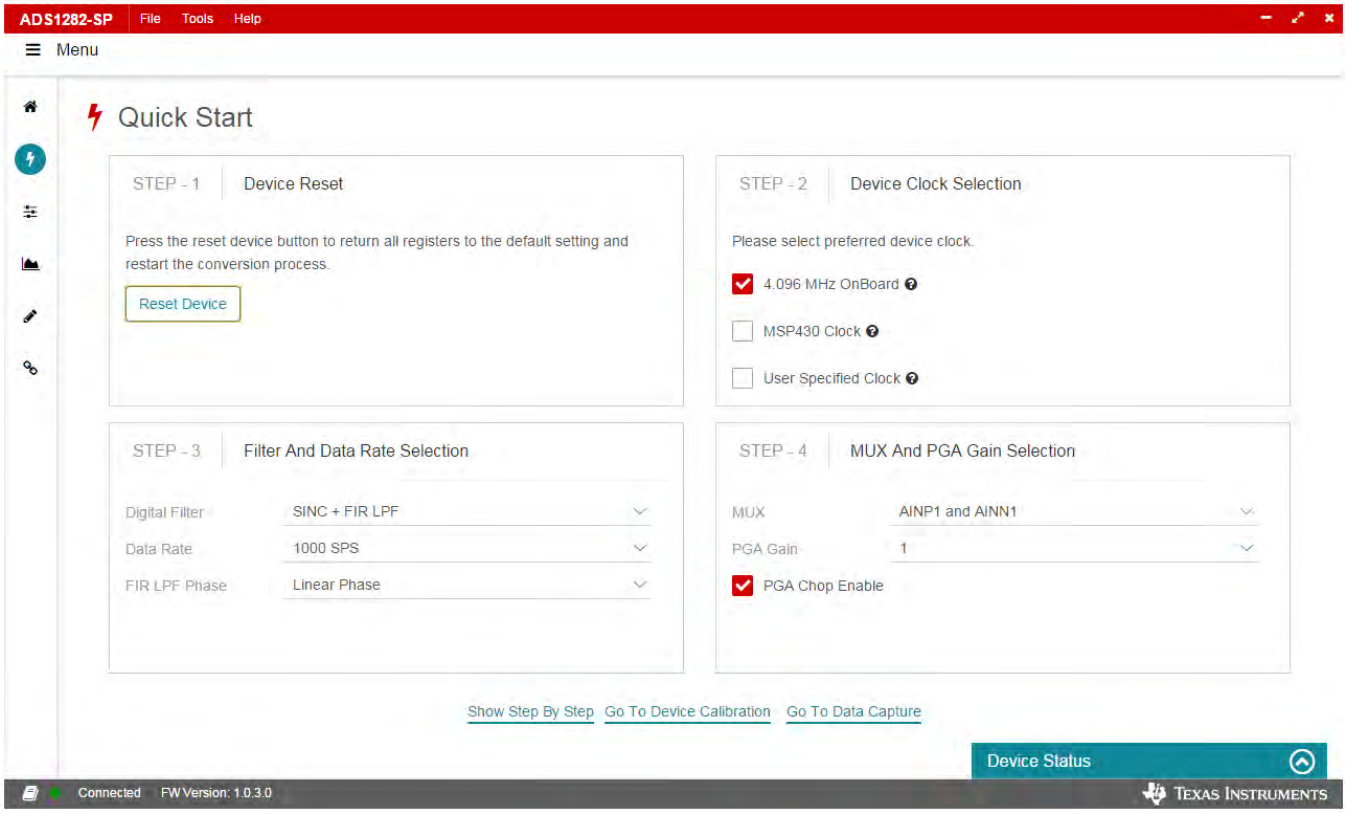


Figure 12. ADS1282-SP EVM GUI Show All Steps

5 ADS1282-SP EVM Detailed Description

The following sub-sections describe the ADS1282-SP EVM in detail.

5.1 ADS1282-SP Clock Configuration Options

The EVM provides three options for providing the sampling clock to the ADS1282-SP device:

1. On-board 4.096-MHz XTAL oscillator (default)
2. Programmable clock (through GUI) from MSP430
3. External clock provided to TP26 or SMA J19, ADC_CLK (allows coherent sampling)

Each option is determined by the position of several jumpers as is illustrated in the graphics on the **Device Clock Selection** section of the **Quick Start** page of the GUI.

5.2 ADS1282-SP Analog Inputs

Figure 13 shows the default assembly of the analog input to Channel 1 (Channel 2 is configured identically). The input signal passes through a unity gain amplifier **U9** and a low pass filter created by R85, R76, and C49 before entering the ADS1282-SP device. There are placeholders available in the analog path allowing for several custom configurations.

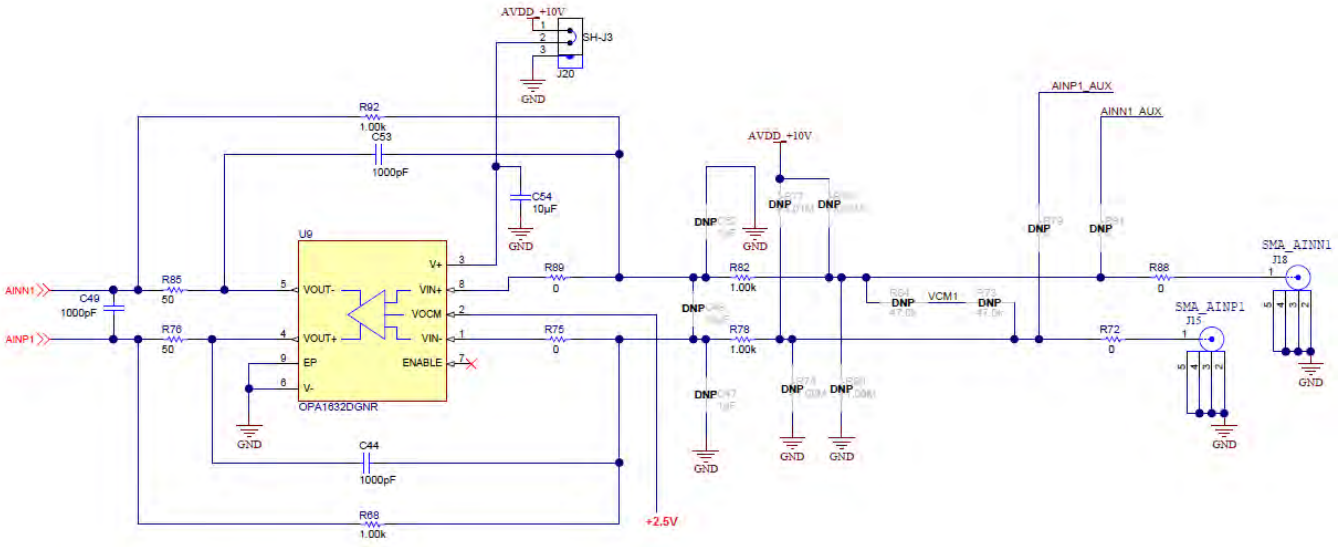


Figure 13. ADS1282-SP Analog Channel 1 Schematic

5.3 ADS1282-SP MFLAG Overdrive Indicator

As specified in the datasheet, the MFLAG output provides an indication if the full scale digital code is exceeded. On the EVM, **MFLAG** can be monitored at **TP11** and also with **LED D3**.

5.4 ADS1282-SP EVM Header Configuration

The ADS1282-SP EVM is flexible in its configurability through the use of 2- and 3-pin headers. The default configuration of the EVM is set to facilitate initial testing by requiring no changes. Table 1 describes the default position while Figure 14 shows the default position on the EVM.

Table 1. ADS1282-SP Header Configuration

Reference Designator	# of Pins	Default Config	Pin 1 Silk Screen	Pin 2 or 3 Silk Screen	Default Function (Alternate Function)
J6	3	Short pins 2-3	OFF	ON	Shorts 12 V to inputs of 3 regulators. (Shorts GND to inputs of 3 regulators)
J7	2	Short pins 1-2	10V SELECT	REG	Shorts 10-V output of regulator to analog section of EVM. (Open circuit allows for external 10-V supply)
J11	2	Short pins 1-2	5V SELECT	REG	Shorts 5-V output of regulator to ADS1282-SP pin 19. (Open circuit allows for external 5-V supply)
J12	2	Short pins 1-2	3.3V SELECT	REG	Shorts 3.3-V output of regulator to ADS1282-SP pin 26. (Open circuit allows for external 3.3-V supply)
J16	3	Short pins 1-2	VCC	GND	Enables the 4.096-MHz crystal oscillator. (Disables the oscillator)
J17	3	Short pins 2-3	MSP	XTAL	Selects 4.096-MHz crystal oscillator as clock source. (Selects external clock as clock source via sma J19 or testpoint TP26)
J5	3	Short pins 1-2	AVDD_+10V	GND	Powers on analog amplifier channel 2. (Powers Off analog amplifier channel 2)
J20	3	Short pins 1-2	AVDD_+10V	GND	Powers on analog amplifier channel 1. (Powers Off analog amplifier channel 1)
J8	3	Short pins 1-2	AVDD_+10V	GND	Powers on 5-V reference source, REF5050. (Powers Off REF5050)
J13	3	Short pins 1-2	AVDD_+10V	GND	Powers on OPA4277 buffer amps. (Powers Off OPA4277)
J14	6	Open	n/a	n/a	Header from which to take modulator outputs from ADS1282-SP pins MCLK, M0, M1.

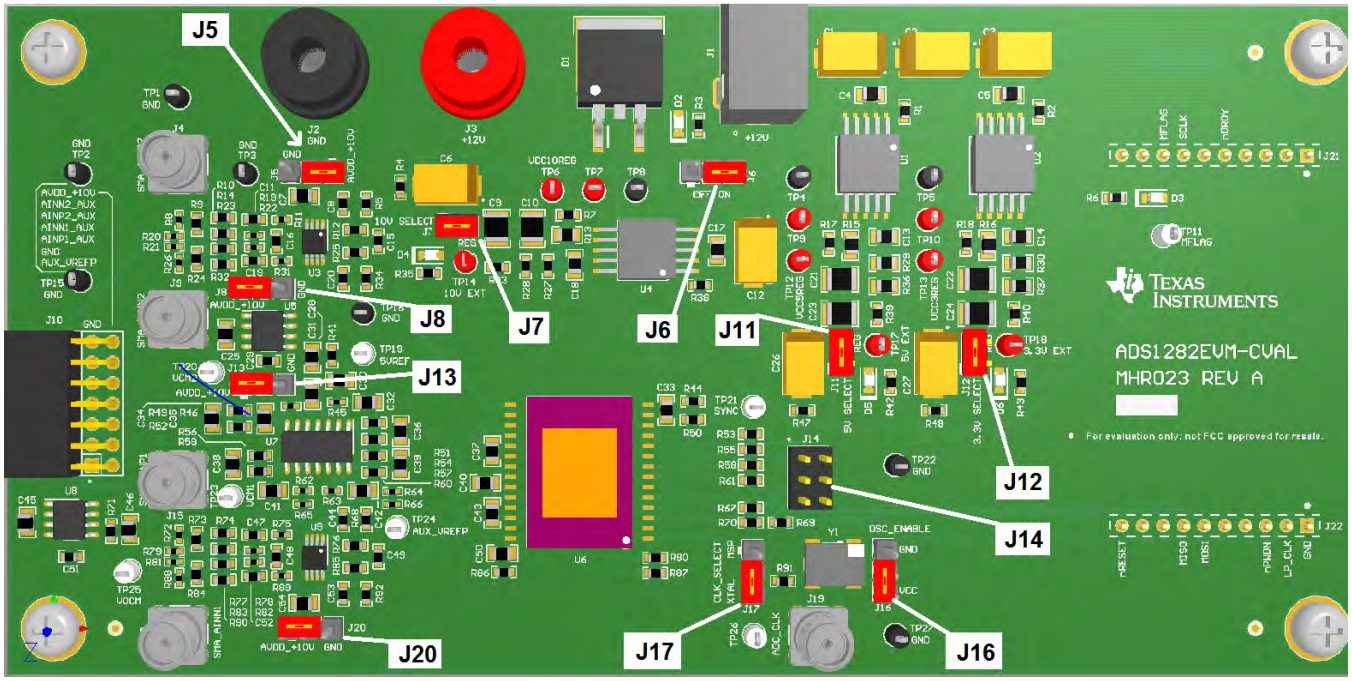


Figure 14. ADS1282-SP EVM Default Header Configuration

5.5 ADS1282-SP EVM Test Points

Table 2 lists all test points on the ADS1282-SP EVM.

Table 2. ADS1282-SP EVM Test Points Description

Test Point	Silk Screen	Schematic Page	Description
TP1	GND	Power	Global Ground Plane
TP2	GND	ADC	Global Ground Plane
TP3	GND	ADC	Global Ground Plane
TP4	GND	Power	Global Ground Plane
TP5	GND	Power	Global Ground Plane
TP6	VCC10REG	Power	10-V Regulator Output b
TP7	N/A	Power	10-V Regulator Output a
TP8	GND	Power	Global Ground Plane
TP9	N/A	Power	5-V Regulator Output a
TP10	N/A	Power	3.3-V Regulator Output a
TP11	MFLAG	ADC	MFLAG Overdrive Indicator Signal
TP12	VCC5REG	Power	5-V Regulator Output b
TP13	VCC3REG	Power	3.3-V Regulator Output b
TP14	10V EXT	Power	Option for 10-V external supply
TP15	GND	ADC	Global Ground Plane
TP16	GND	Power	Global Ground Plane
TP17	5V EXT	Power	Option for 10-V external supply
TP18	3.3V EXT	Power	Option for 3.3-V external supply
TP19	5VREF	Analog	REF5050 5-V Output
TP20	VCCM2	Analog	Common Mode Node of Channel 2
TP21	SYNC	ADC	SYNC pin input
TP22	GND	Power	Global Ground Plane

Table 2. ADS1282-SP EVM Test Points Description (continued)

Test Point	Silk Screen	Schematic Page	Description
TP23	VCCM1	Analog	Common Mode Node of Channel 1
TP24	AUX_REFP	Analog	ADC REFP from J10
TP25	VOCM	Analog	REF5025 2.5-V Output
TP26	ADC_CLK	ADC	External Clock to ADC
TP27	GND	ADC	Global Ground Plane

5.6 ADS1282-SP EVM Layout

The device distinguishes between two different grounds: AVSS (analog ground) and DGND (digital ground). In low-frequency applications such as temperature sensing with thermocouples, laying out the printed circuit board (PCB) to use a single ground plane is adequate but care must be taken so that ground loops are avoided. Ground loops act as loop antennas picking up interference currents which transform into voltage fluctuations. These fluctuations are effectively noise which can degrade system performance in high-resolution applications. When placing components and routing over the ground plane, pay close attention to the path that ground currents will take. Avoid having return currents for digital functions pass close to analog-sensitive devices or traces.

Additionally, the proximity of digital devices to an analog signal chain has the potential to induce unwanted noise into the system. One primary source of noise is the switching noise from any digital circuitry such as the data output serializer or the microprocessor receiving the data. For the device, care must be taken to ensure that the interaction between the analog and digital supplies within the device is kept to a minimal amount. The extent of noise coupled and transmitted from the digital and analog sections depends on the effective inductances of each of the supply and ground connections. Smaller effective inductances of the supply and ground pins results in better noise suppression. For this reason, multiple pins are used to connect to the digital ground. Low inductance properties must be maintained throughout the design of the PCB layout by use of proper planes and layer thickness.

To avoid noise coupling through supply pins, TI recommends to keep sensitive input pins (such as AINN1, AINP1, AINN2, and AINP2) away from the DVDD and DGND planes. For example, do not route the traces or vias connected to these pins across these planes; that is, avoid the digital power planes under the analog input pins. An exception may be acceptable to share DGND and AVSS when utilizing a unipolar supply for AVDD. As in the example below, DGND is shared with AVSS. Care should be taken to minimize inductance and route digital signals away from the analog section. The analog inputs represent the most sensitive node of the ADC as the total system accuracy depends on how well the integrity of this signal is maintained. The analog differential inputs to the ADC should be routed tightly-coupled and symmetrical for common mode rejection. These inputs should be as short in length as possible, to minimize exposure to potential sources of noise.

6 ADS1282-SP GUI Software in Detail

The ADS1282-SP GUI software comprises six pages: (1) *Introduction*, (2) Quick Start, (3) Settings, (4) Data Capture, (5) Register Map, (6) Collateral Page. A section is dedicated to describing each page in detail.

6.1 *Introduction (Home) Page*

The *Introduction* page is the starting point for the GUI when launched and appears as shown in Figure 15. If an ADS1282-SP EVM is powered and connected to an MSP430 LaunchPad that has the correct firmware loaded, then the green **Connected** button will appear. The top half of the **Introduction** page provides key features of the device as well as a functional block diagram when pressing **Learn More**. The bottom half of the **Introduction** page contains links to the five other GUI pages. The icons are identical to those locked in the left-most border.

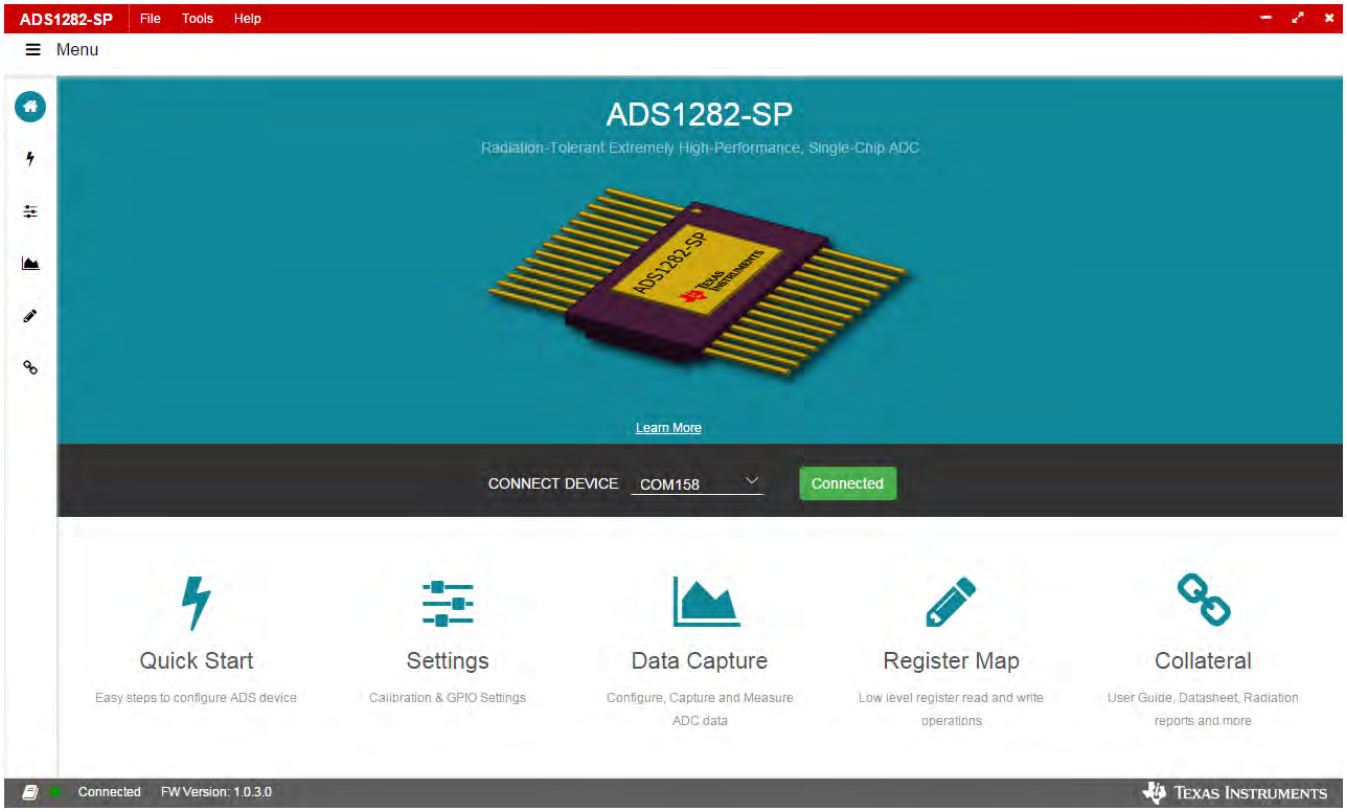


Figure 15. ADS1282-SP Introduction Page (a)

6.1.1 GUI Borders

The top-most, left-most, and bottom-most borders will remain unchanged regardless of the GUI page being accessed.

The top-most border contains three menu drop-down windows (1) **File**, (2) **Tools**, and (3) **Help** as shown in Figure 16. The **File** menu allows users to save and reload register configurations. The **Tools** menu enables view of a Log pane of all GUI actions while the **About** menu provides links to resources and support for the GUI.

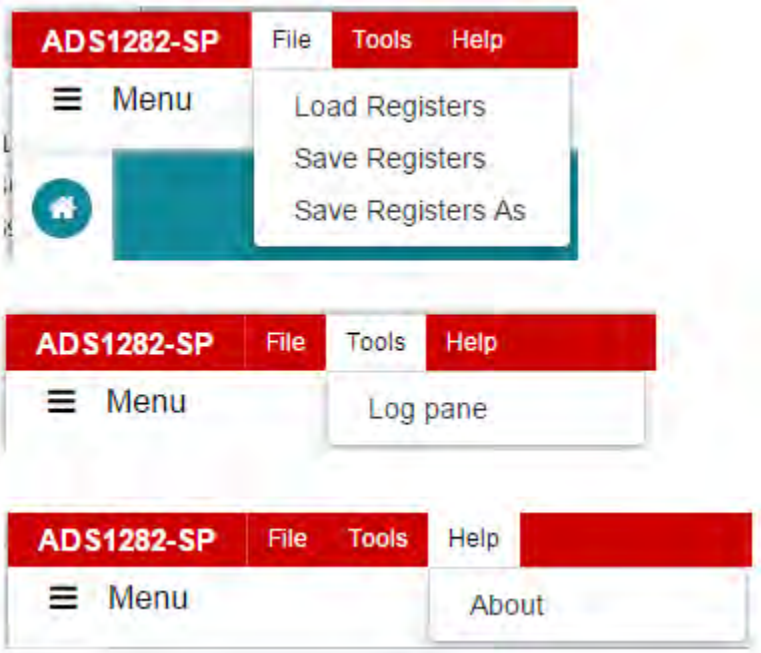


Figure 16. ADS1282-SP GUI Top-Most Border

The left-most border contains icon links to the six pages of the GUI. The selected icon is highlighted to indicate what page is presently being displayed.

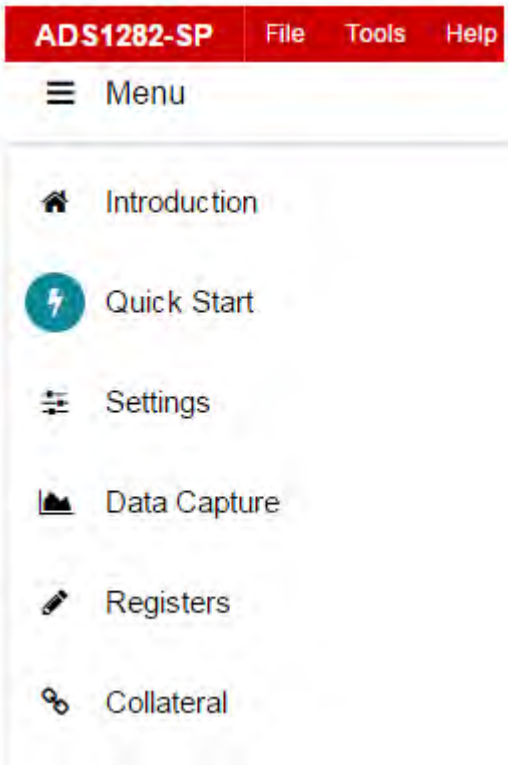


Figure 17. ADS1282-SP GUI Left-Most Border

The bottom-most border displays the state of the connection, the firmware revision detected and access to the log pane by clicking on the book icon as shown in Figure 18.

Figure 18. ADS1282-SP GUI Bottom-Most Border

6.2 Quick Start Page

The **Quick Start** page (accessed by clicking the lightning bolt icon) provides a quick and easy way to start evaluating the device. The first time the GUI is used, this page defaults to a step-by-step process. This step-by-step process can be bypassed by clicking the **Show All Steps** link.

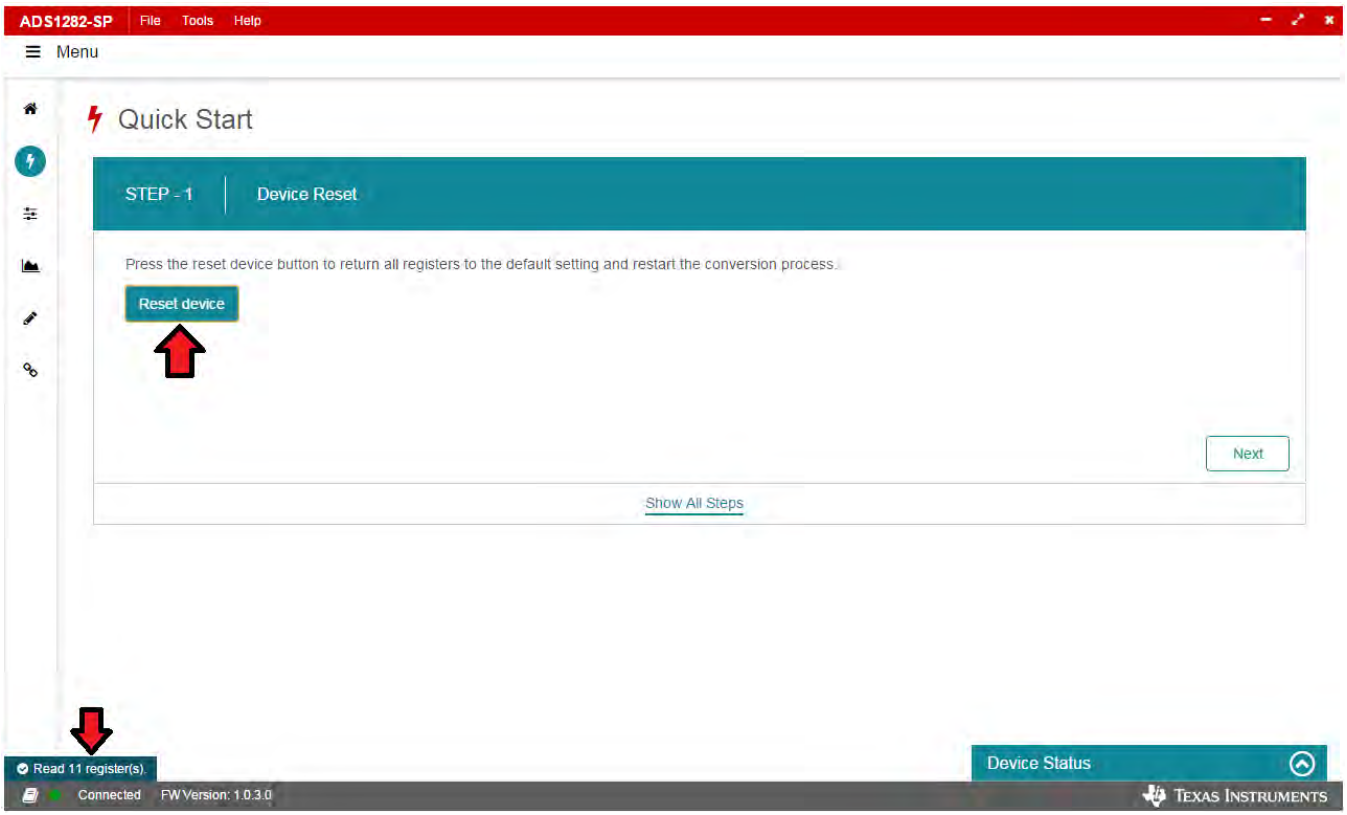


Figure 19. ADS1282-SP GUI Quick Start STEP-1

STEP-2 of the **Quick Start** page is **Device Clock Selection** as shown in Figure 20. There are three options for configuring the clock (1) **4.096 MHz On Board XTAL** (default), (2) **MSP430 Clock**, and (3) **User Specified Clock**.

Figure 20 shows the default clock configuration which uses a on-board 4.096-MHz crystal oscillator. By hovering over the picture with the mouse, the graphic is enlarged showing the jumper locations needed for the selected clock configuration.

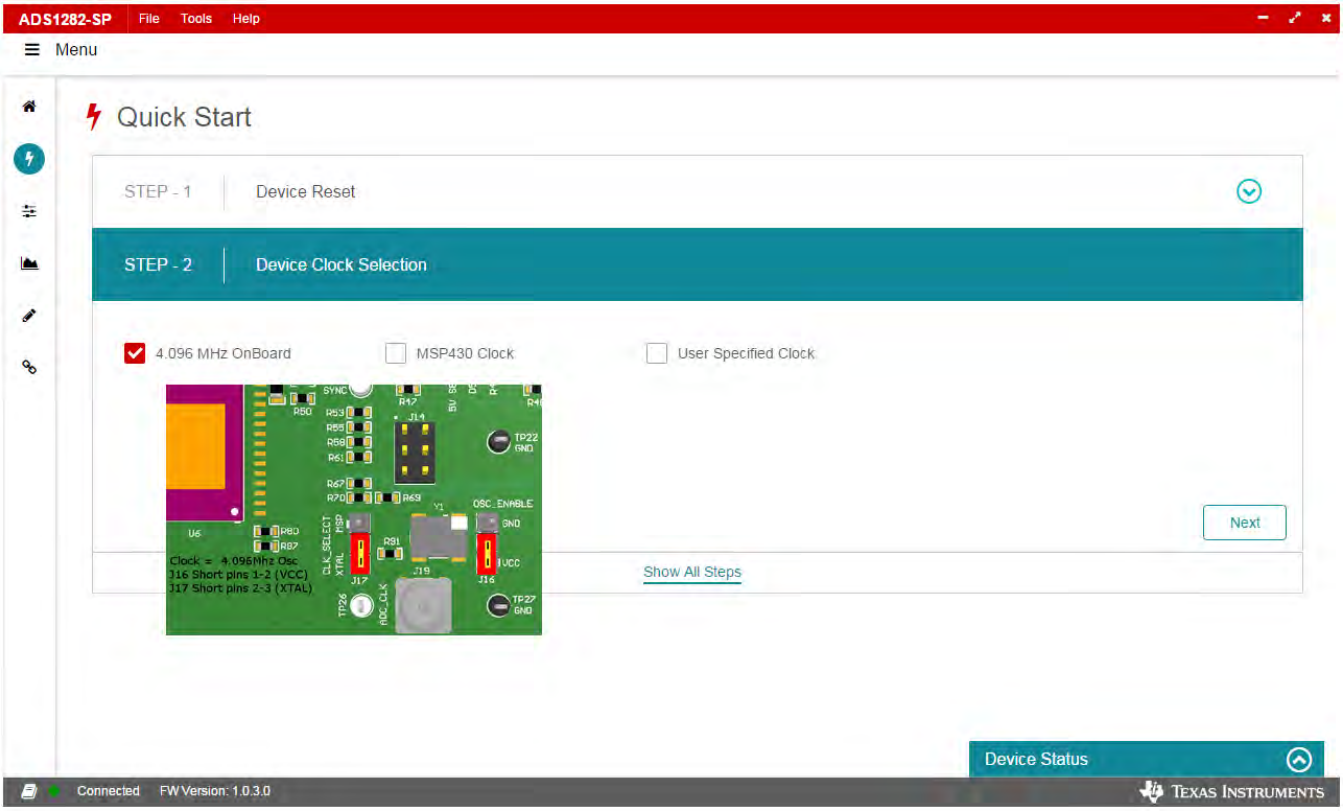


Figure 20. ADS1282-SP GUI Quick Start STEP-2

If an MSP430 clock is the desired clock source, there are twelve discrete clock rates available from the drop-down menu as shown in Figure 21. Ensure the jumpers have been moved to use this configuration.

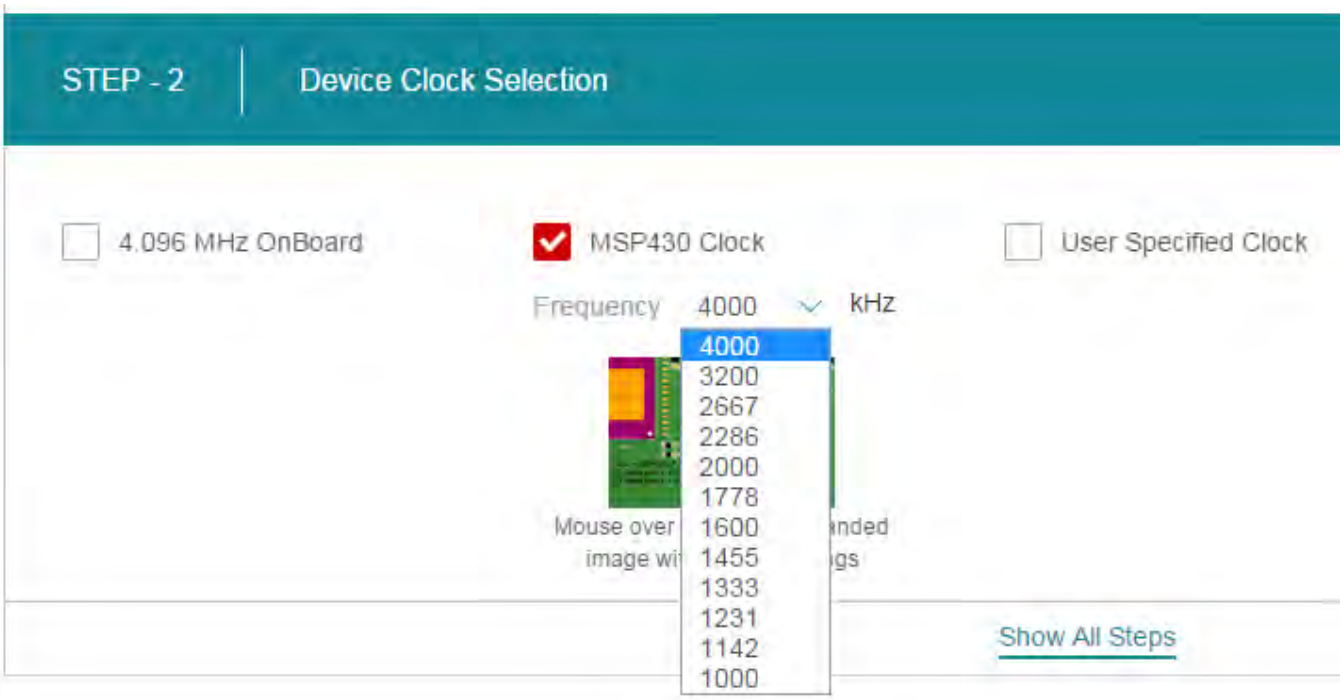


Figure 21. ADS1282-SP GUI Quick Start STEP-2

It is also possible for the user to specify and supply a clock to the EVM. This is required if coherent sampling is desired where the phase relationship between the analog signal and the clock signal is deterministic. The desired frequency is entered and is constrained to values between 1000 kHz and 4096 kHz. Any value entered outside this range will default to this min or max value.

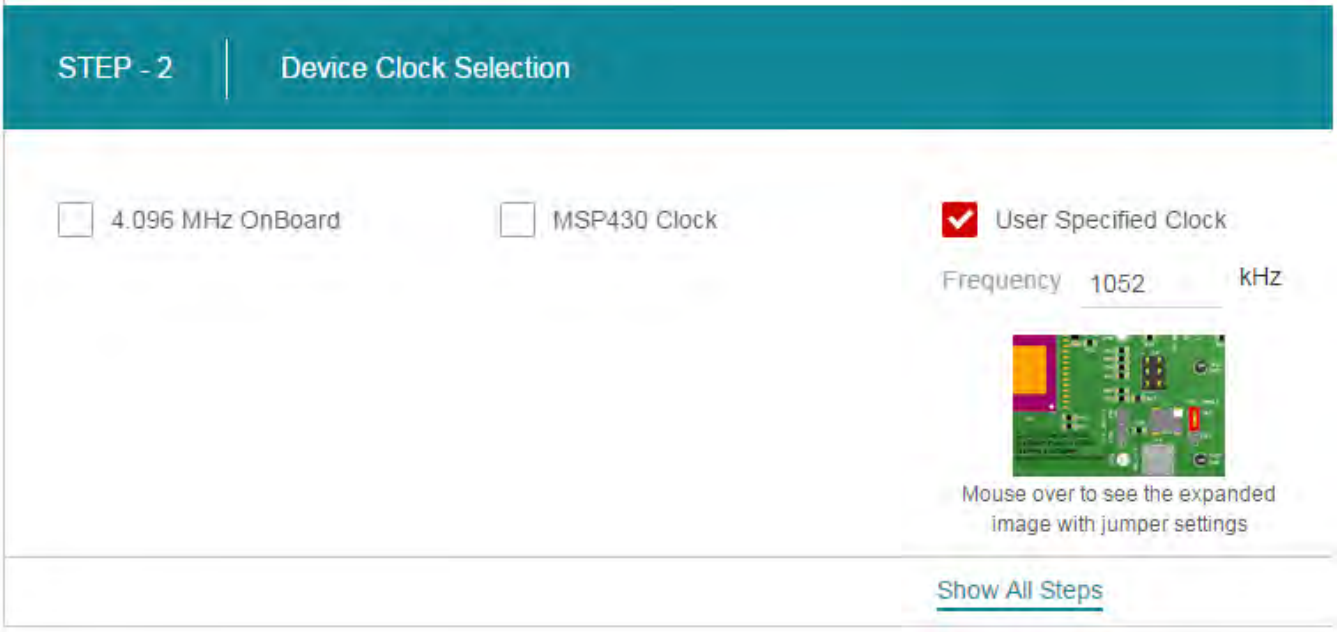


Figure 22. ADS1282-SP GUI Quick Start Step 2

STEP-3 of the **Quick Start** page is **Filter and Data Rate Selection** as shown in Figure 23. The default state of the device is to take digital data from the **SINC+FIR LPF** at **1000 SPS** with the **FIR LPF phase** set to **Linear Phase**.

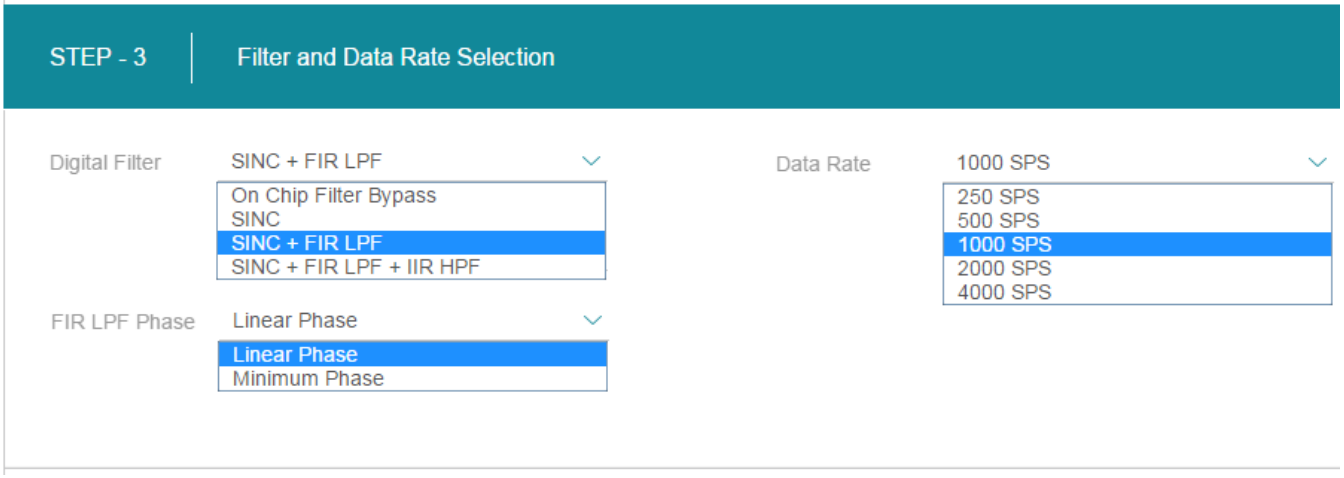


Figure 23. ADS1282-SP GUI Quick Start STEP-3

The **Digital Filter** control determines what other controls become visible and active. As an example, if the IIR high-pass filter is enabled then the corner frequency of this filter becomes a new visible input as shown in Figure 24.

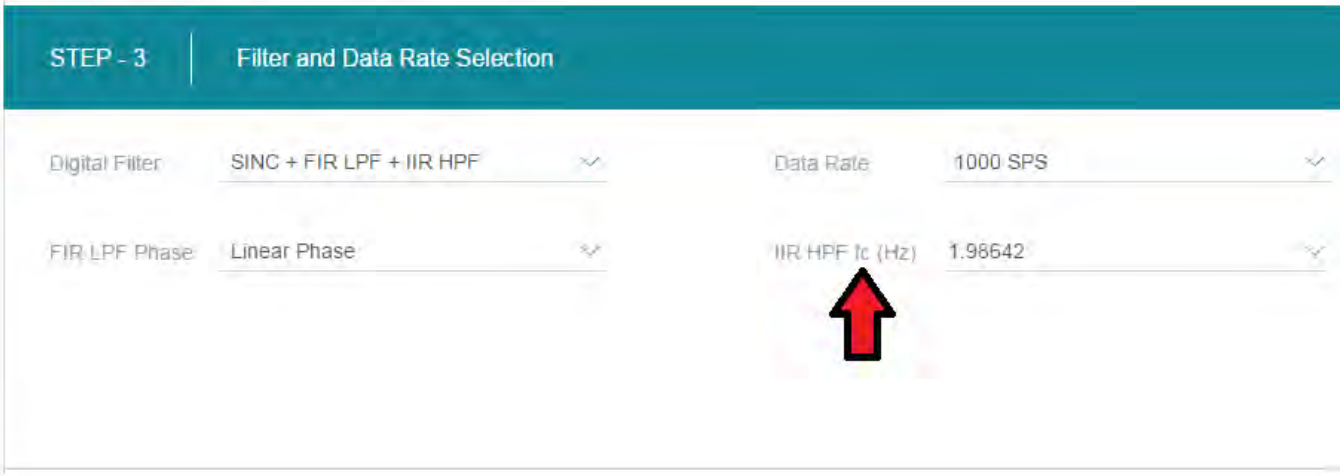


Figure 24. ADS1282-SP GUI Quick Start Step-3

STEP-4 of the **Quick Start** page is **MUX And PGA Gain Selection** as shown in Figure 25.

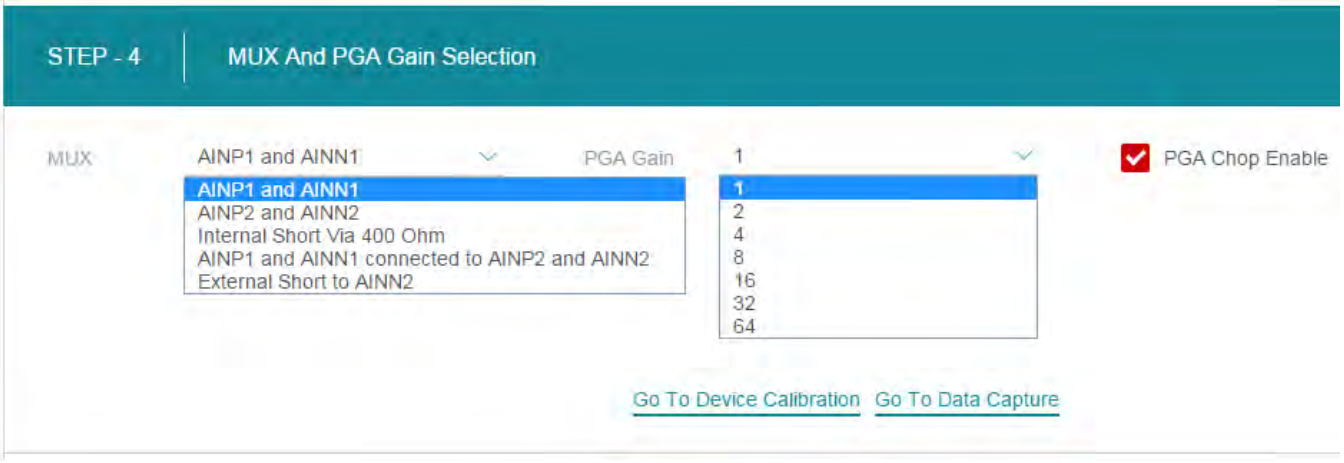


Figure 25. ADS1282-SP GUI Quick Start STEP-4

Once a user is familiar with the GUI and device, it is convenient to display all controls of the **Quick Start** page in one view. This is achieved by clicking the link **Show All Steps** at the bottom of the page.

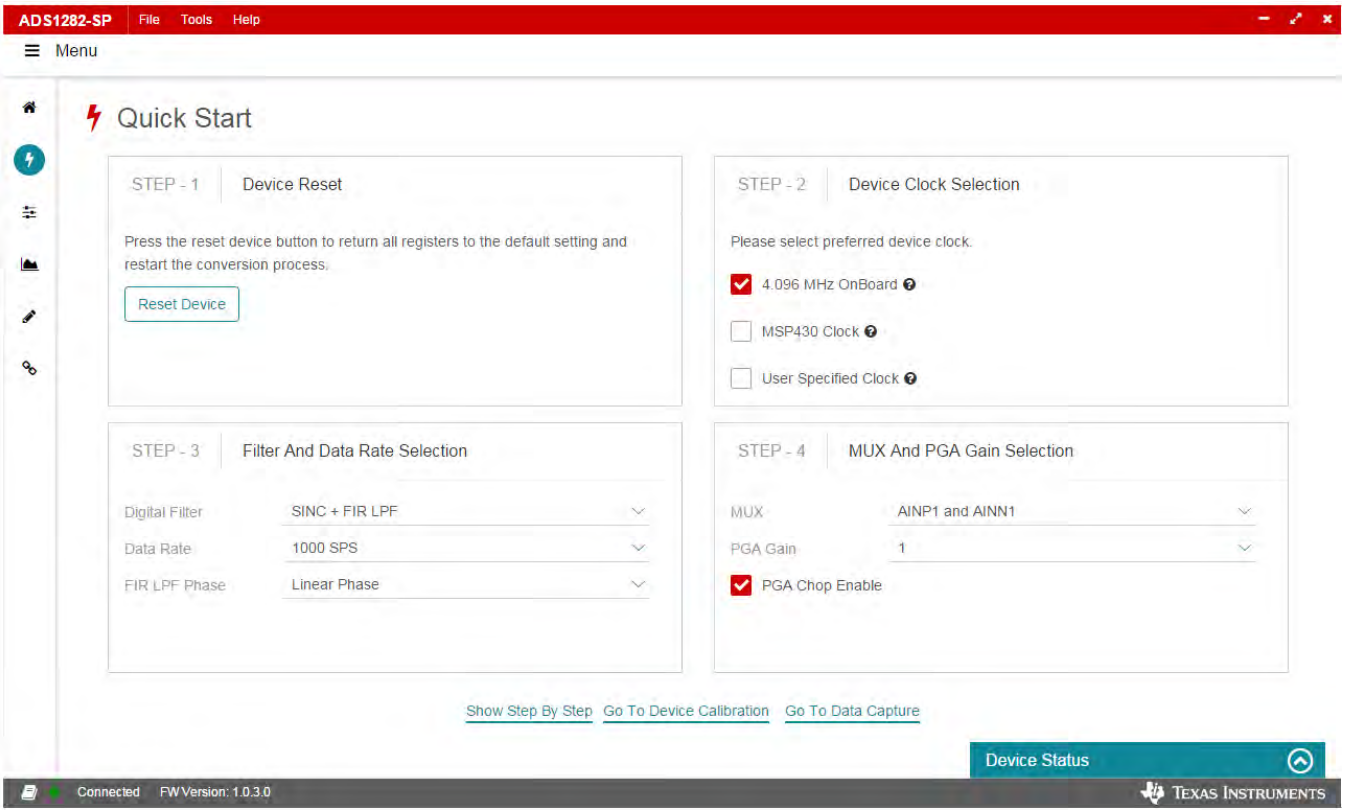


Figure 26. ADS1282-SP GUI Quick Start Show All Steps

6.3 Settings Page

The **Settings** page consists of two sections: (1) **Calibration** and (2) **GPIO Controls** as shown in Figure 27.

The **Calibration** section is split into two sections (1) **Offset Calibration** and (2) **Gain Calibration**. The question marks provide information pertinent to each calibration.

Clicking the **Calibrate Offset** button invokes computation internal to the device that determines the mean digital code and then applies a digital offset of the same magnitude so as to bring the mean digital code near code 0. No signal should be applied during the offset calibration. If a signal is applied, the proper offset may not be obtained.

Clicking the **Calibrate Gain** button invokes computation internal to the device that determines the difference between positive and negative full scale codes and the mean of the maximum and minimum digital codes, respectively. The average of these two differences is applied as a digital offset resulting in a full scale output signal.

The **GPIO Controls** section consists of three inputs and one **Output**. The state of **MFLAG** output can be poled by pressing the **Read All Pins** button. Since MFLAG detects a digital code saturation, the frequency by which MFLAG is tripped is dependent on the frequency of the input signal in addition to the amplitude of that signal. In applications, it is recommended to latch a low to high transition on this signal to set a flag that saturation has occurred. Both Power Down PWDN and RESET inputs can be manually controlled from the GPIO controls section.

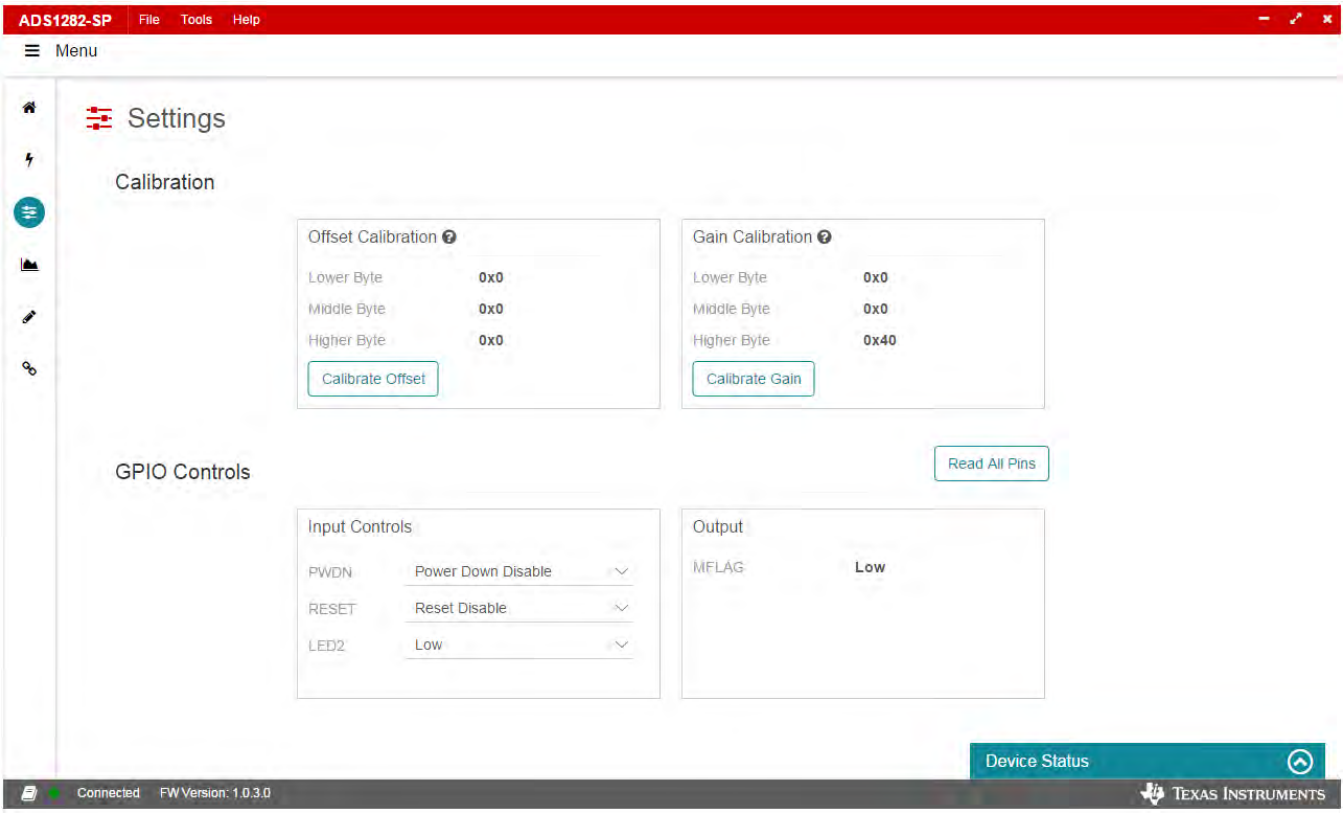


Figure 27. ADS1282-SP GUI Settings Page

6.4 Data Capture Page

The **Data Capture** page, shown in Figure 28, displays and processes data when the **Start Capture** button is pressed. The two modes of graphing, (1) **Time Domain** and (2) **Frequency Domain**, are selected by clicking the link above the graph with the same name.

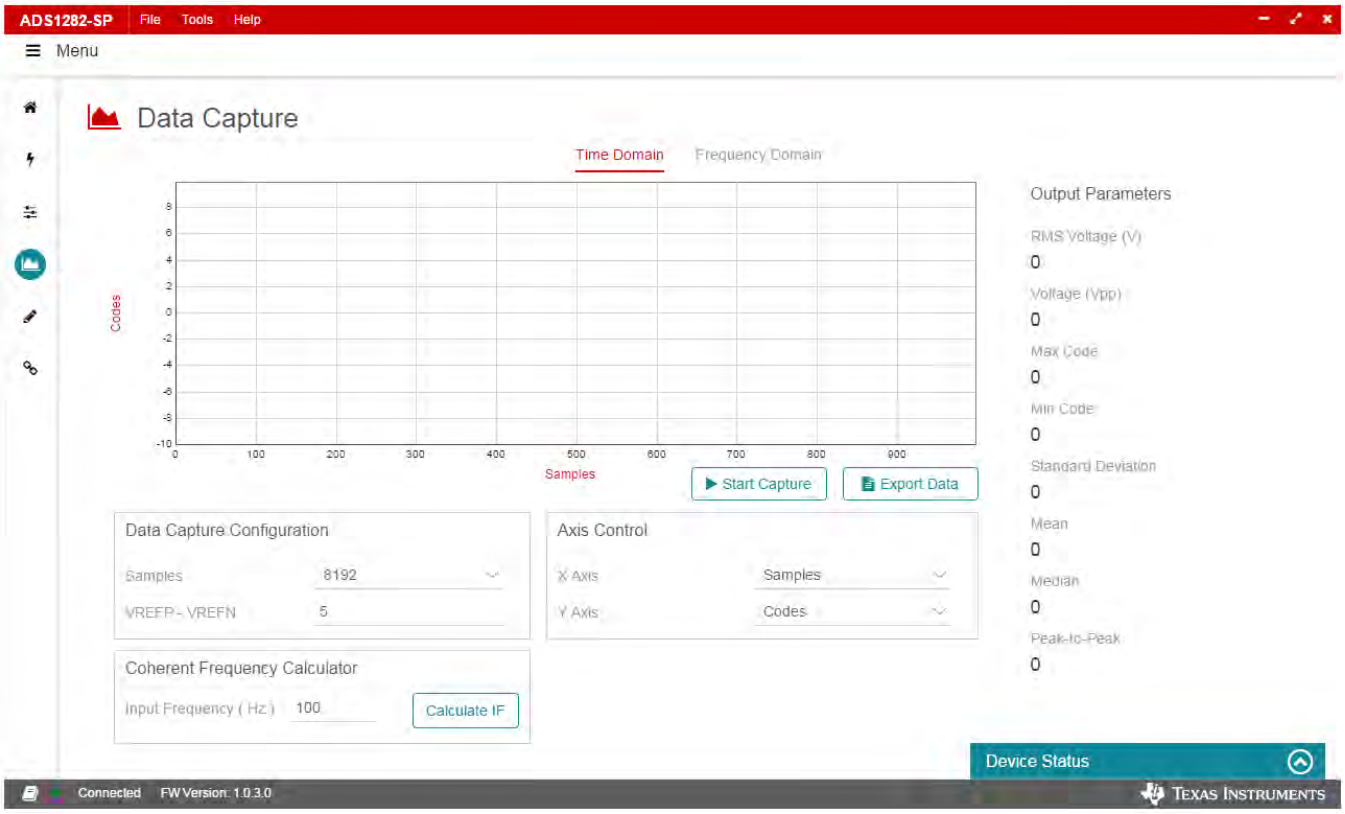


Figure 28. ADS1282-SP GUI Data Capture

The **Data Capture** page, shown in Figure 28, is where captured data is displayed and analyzed. The two modes of graphing, (1) **Time Domain** and (2) **Frequency Domain**, are selected by clicking the link above the graph with the same name.

There are several features or sections of the **Data Capture** page that remain unchanged for **Time Domain** and **Frequency Domain** graphing. These are: (1) **Zooming** function, (2) **Device Status**, (3) **Start Capture** button, (4) **Export Data** button, (5) **Data Capture Configuration** section, (6) **Coherent Frequency Calculator** section, and (7) **Output Parameters** section.

Zooming is done in the x and y dimension independently by holding the left mouse button down and dragging to the zoom extent before releasing the mouse button as shown in Figure 29 and Figure 30. Press the Red **Reset** button in upper right corner of graph to remove zoom functions.

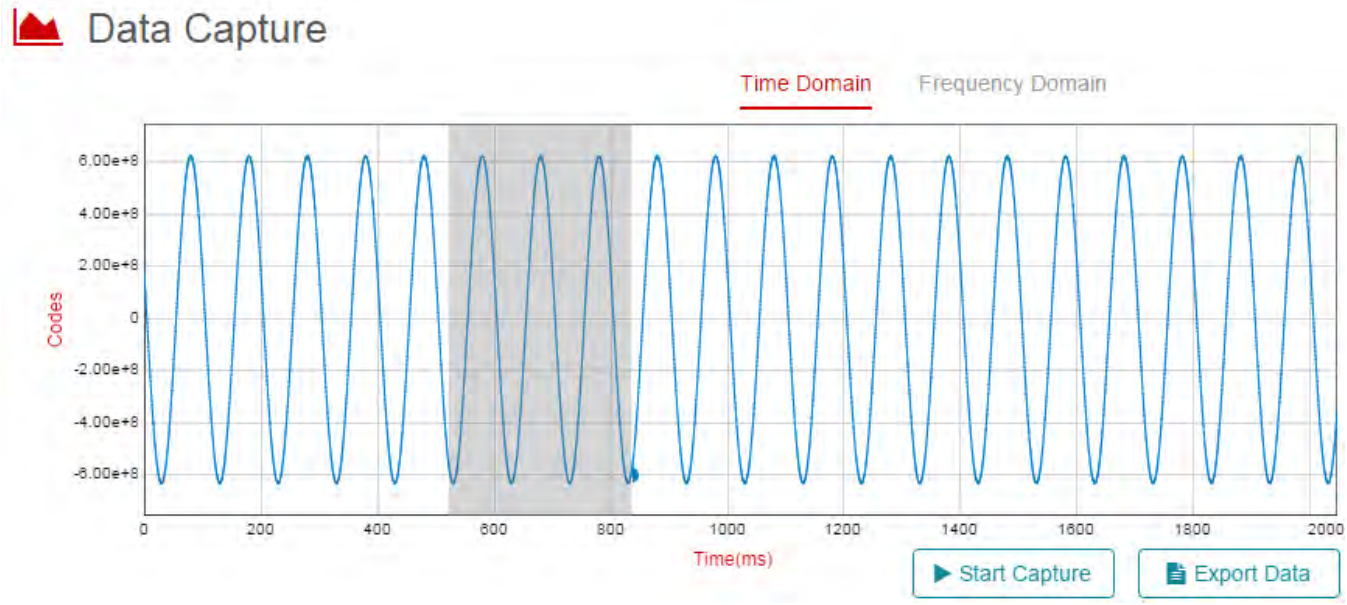


Figure 29. ADS1282-SP Data Capture Zooming

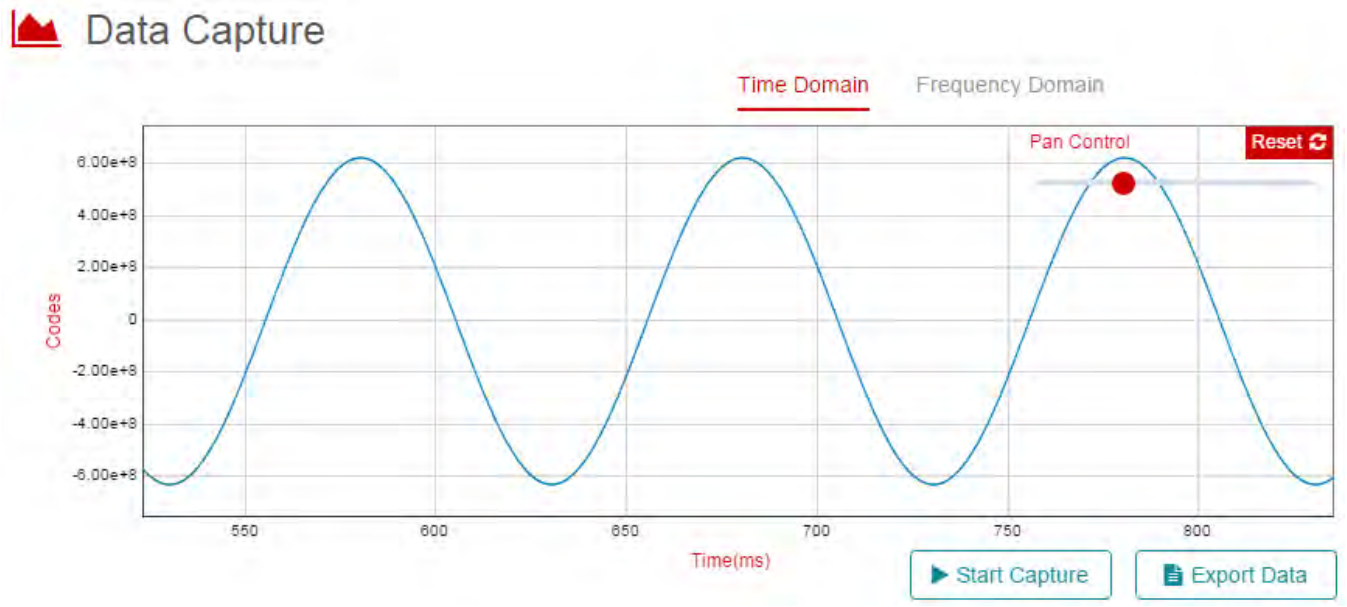


Figure 30. ADS1282-SP Data Capture Zooming

As seen in Figure 28, there is a small panel in the bottom right corner of the GUI labeled **Device Status**. Click this panel to see the present configuration of the device as shown in Figure 31. This panel is available on all GUI pages with the exception of the **Introduction** page and the **Collateral** page.

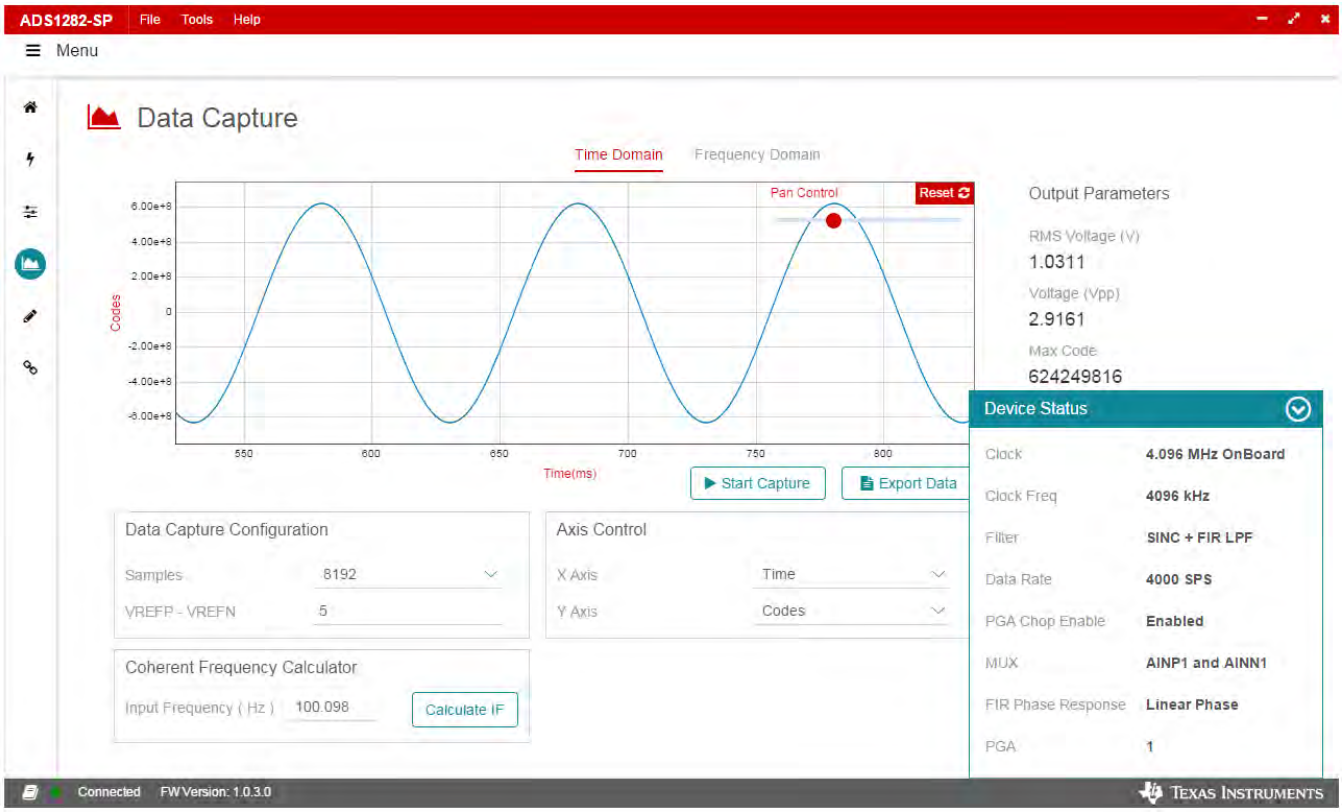


Figure 31. ADS1282-SP Data Capture Zooming

The **Start Capture** button initiates the transfer of the requested # of Samples to the GUI.

The **Export Data** button allows the flexibility of saving captured data to a file for additional analysis and processing, if needed.

The **Data Capture Configuration** allows user to change the number of samples to be processed and displayed.

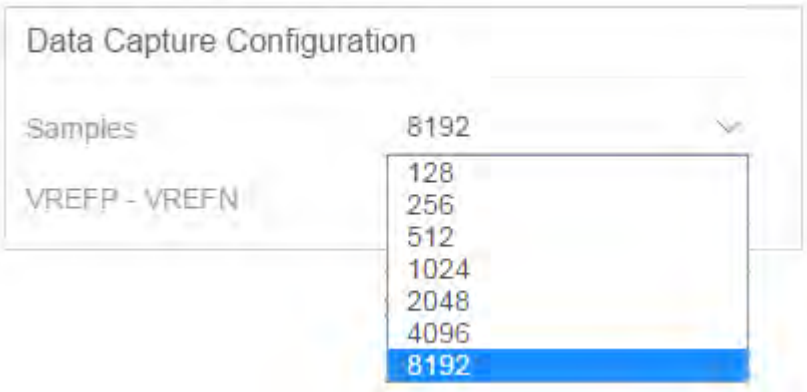


Figure 32. ADS1282-SP GUI Data Capture Configuration

The *VREFP-VREFN* input allows user to change the full scale range of the ADC to be plotted so as to match the actual reference voltage provided to the device.

NOTE: This value must match the actual voltage potential between pins VREFP and VREFN in order for the displayed results to be accurate. The default EVM configuration provides a 5-V reference voltage

The *Coherent Frequency Calculator* determines the nearest coherent frequency to a desired input frequency, taking into consideration the number of samples and the sample rate. The calculation is invoked by pressing the **Calculate IF** button.

Figure 33. ADS1282-SP GUI Coherent Frequency

The **Output Parameters** section to the right of the graph contains calculations relevant to the graph type being displayed. So even though this section is common to both time domain and frequency domain graphs, the parameters within the section are not common.

6.4.1 Time Domain Graphing and Analysis

The sections of data capture view that are unique to a time domain plot are (1) **Axis Control** and (2) **Output Parameters**.

The **Axis Control** section allows users to change X-axis between samples and time and the Y-axis between codes and voltage.

The Time Domain **Output Parameters** are shown in Figure 34.

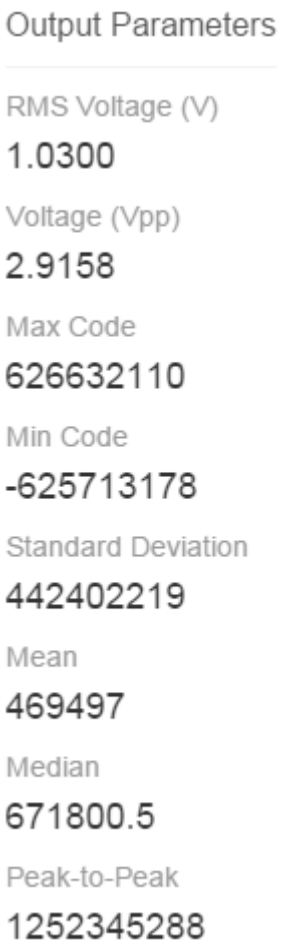


Figure 34. ADS1282-SP Data Capture Time Domain Parameters

6.4.2 Frequency Domain Graphing Analysis

The **Frequency Domain** data capture view shown in Figure 35 has an **FFT Filter Parameters** section which allows removal and inclusion of selected frequency bins. The default filter settings are to remove 25 bins around the detected fundamental, remove 25 bins at DC, and include 5 harmonics of the detected fundamental.

NOTE: The GUI simply determines the fundamental to be the bin with the highest power.

The **No. of Harmonics** is applied differently to the SNR computation. For this calculation, the **No. of Harmonics** value determines the number of bins to remove from the calculation instead of include.

Figure 35. ADS1282-SP Data Capture Time Domain Parameters

6.5 Register Map Page

The **Register Map** page shown in Figure 36 allows low-level access to all SPI registers of the ADS1282-SP device. Clicking the question mark to the right of the **Register Name** will bring up an extraction from the datasheet describing that register. Clicking on a specific **Register Name** will populate the **Field View** to on the right side of the screen. The **Field View** describes each bit field within that register.

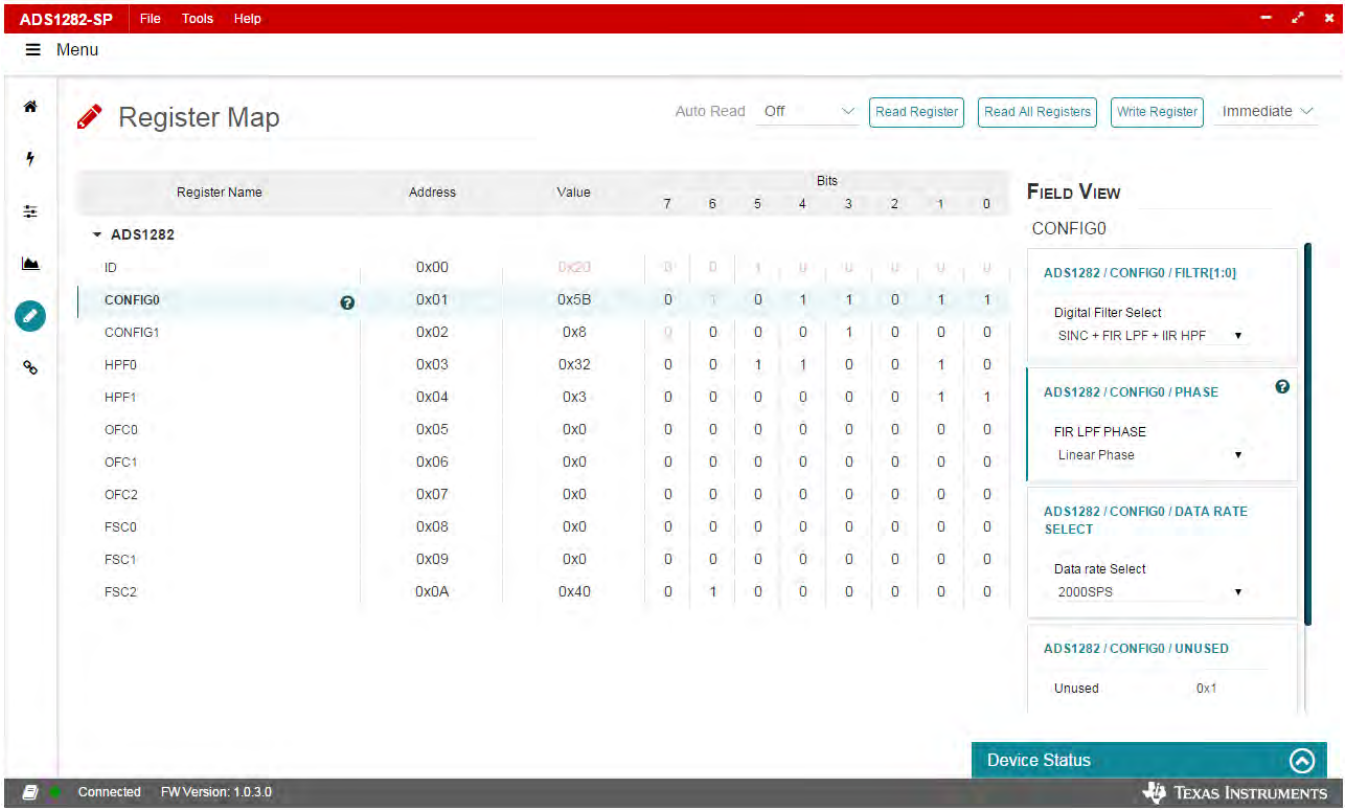


Figure 36. ADS1282-SP Register Map Page

Clicking the question mark within each field view will display a description of that field as shown in Figure 37.

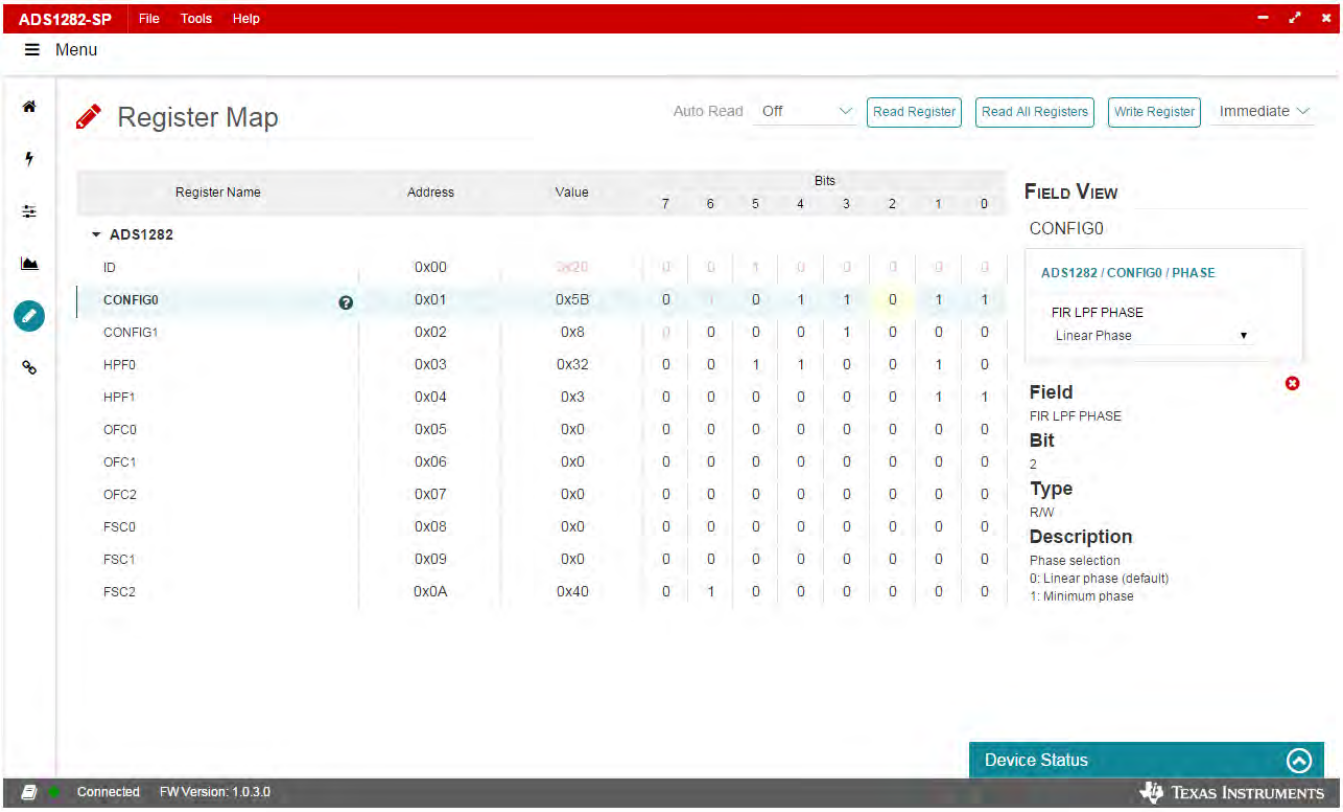


Figure 37. ADS1282-SP Register Map Page

6.6 Collateral Page

The last page of the GUI is the **Collateral** page (Figure 38) which contains links to web documents pertinent to the ADS1282-SP and its EVM. The page is divided into five sections: (1) **User Guide**, (2) **Datasheet**, (3) **Application Notes**, (4) **Radiation Reports**, and (5) **MSP430 Firmware**.

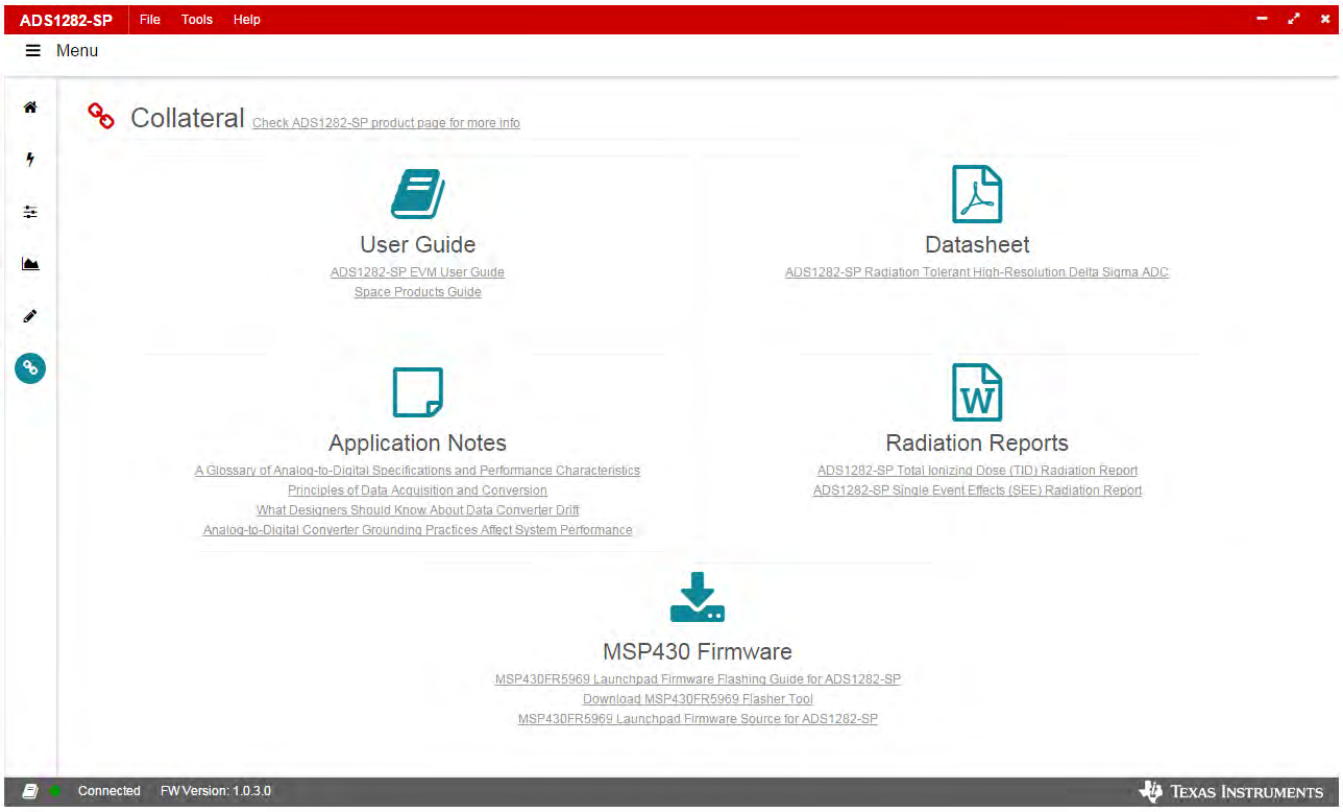


Figure 38. ADS1282-SP Collateral Page

7 ADS1282-SP EVM Schematic

Figure 39, Figure 40, and Figure 41 illustrate the EVM schematics.

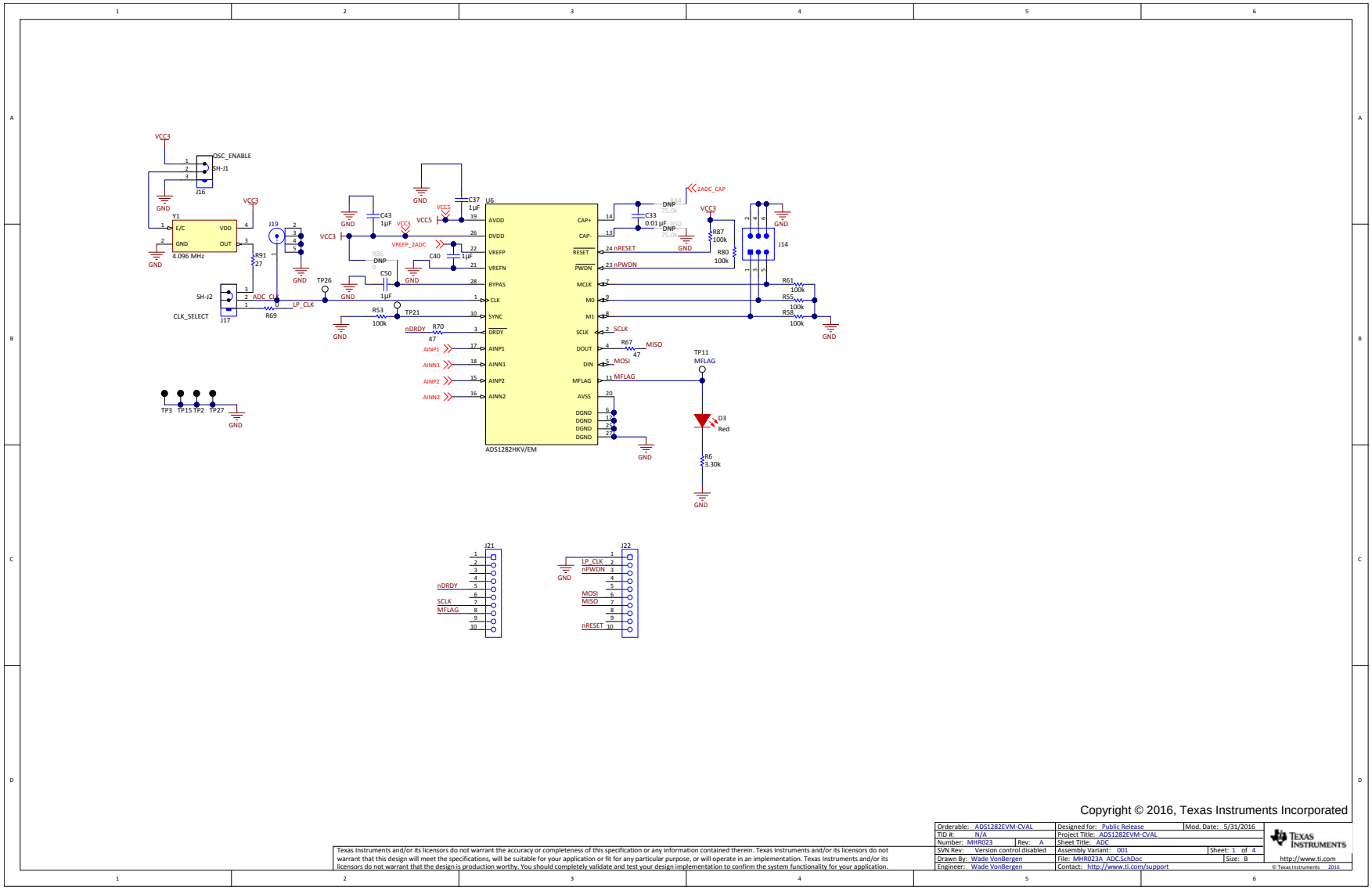


Figure 39. ADS1282-SP EVM Schematic ADC

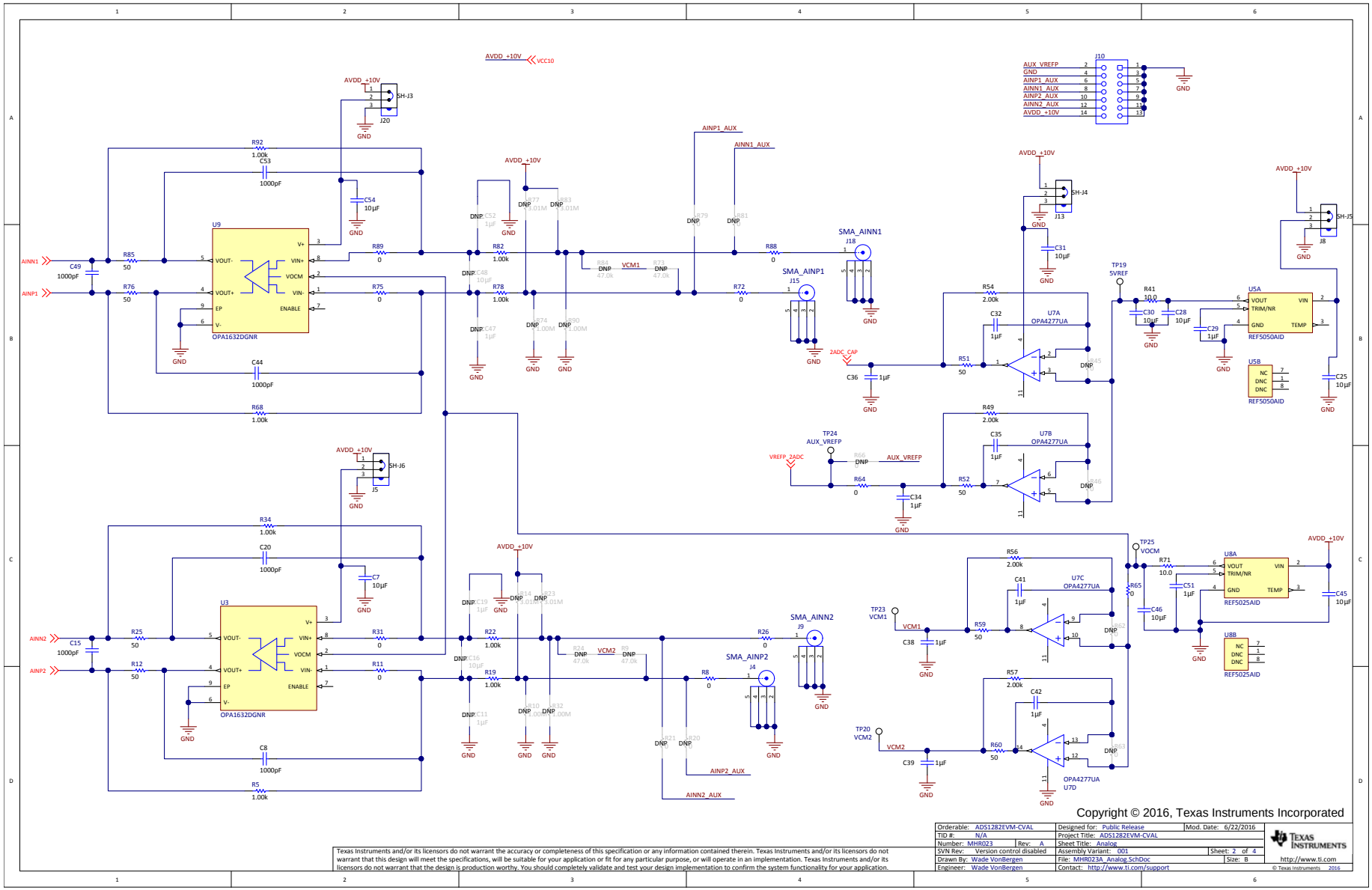


Figure 40. ADS1282-SP EVM Schematic Analog

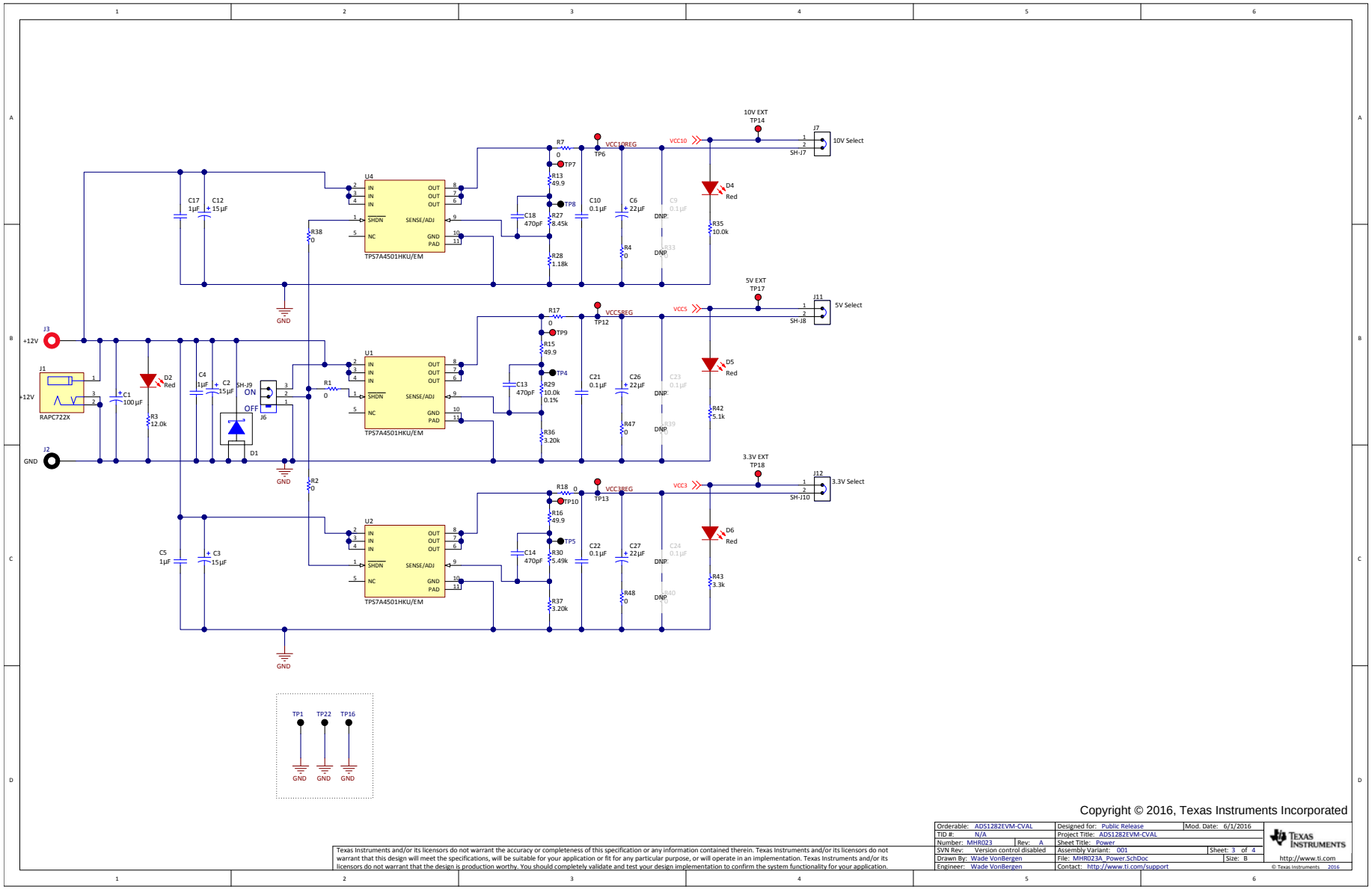


Figure 41. ADS1282-SP EVM Schematic Power

8 ADS1282-SP EVM Bill of Materials (BOM)

Table 3 lists the EVM BOM.

Table 3. ADS1282-SP EVM Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		MHR023	Any
C1	1	100uF	CAP, TA, 100 µF, 20 V, +/- 10%, 0.5 ohm, SMD	7343-43	293D107X9020E2TE3	Vishay-Sprague
C2, C3, C12	3	15uF	CAP, TA, 15uF, 50V, +/-20%, 0.3 ohm, SMD	7343-43	T495X156M050ATE300	Kemet
C4, C5, C17	3	1uF	CAP, CERM, 1uF, 50V, +/-10%, X7R, 0805	0805	08055C105KAT2A	AVX
C6, C26, C27	3	22uF	CAP, TA, 22uF, 25V, +/-20%, 0.2 ohm, SMD	7343-31	T495D226K025ATE200	Kemet
C7, C25, C28, C30, C31, C45, C46, C54	8	10uF	CAP, CERM, 10 µF, 6.3 V, +/- 20%, X5R, 0805	0805	C2012X5R0J106M	TDK
C8, C15, C20, C44, C49, C53	6	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	C1608C0G1H102J	TDK
C10, C21, C22	3	0.1uF	CAP, CERM, 0.1uF, 50V, +/-10%, X7R, 1210	1210	C1210C104K5RACTU	Kemet
C13, C14, C18	3	470pF	CAP, CERM, 470pF, 50V, +/-5%, C0G/NP0, 0805	0805	CGJ4C2C0G1H471J060AA	TDK
C29, C51	2	1uF	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0603	0603	C1608X7R1E105K080AB	TDK
C32, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C50	12	1uF	CAP, CERM, 1 µF, 10 V, +/- 10%, X5R, 0805	0805	0805ZD105KAT2A	AVX
C33	1	0.01uF	CAP, CERM, 0.01 µF, 50 V, +/- 5%, C0G/NP0, 0805	0805	GRM2195C1H103JA01D	Murata
D1	1	15V	Diode, Schottky, 15 V, 25 A, DDPAK	DDPAK	MBRB2515LT4G	ON Semiconductor
D2, D3, D4, D5, D6	5	Red	LED, Red, SMD	LED_0805	150080SS75000	Wurth Elektronik
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 1"L #4-40 Nylon	Standoff	1902E	Keystone
J1	1		Power Jack, mini, 2.1mm OD, R/A, TH	Jack, 14.5x11x9mm	RAPC722X	Switchcraft
J2	1		BANANA JACK, SOLDER LUG, BLACK, TH	Black Insulated Banana Jack	SPC15354	Tenma
J3	1		BANANA JACK, SOLDER LUG, RED, TH	Red Insulated Banana Jack	SPC15363	Tenma
J4, J9, J15, J18, J19	5		SMA Jack, Straight, 50 Ohm, Gold, TH	TH, 5-Leads, Body 7x7mm	SMA-J-P-H-ST-TH1	Samtec
J5, J6, J8, J13, J16, J17, J20	7		Header, 2.54 mm, 3x1, Tin, TH	Header, 2.54 mm, 3x1, TH	TSW-103-07-T-S	Samtec
J7, J11, J12	3		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J10	1		Receptacle, 100mil, 7x2, Gold, R/A, TH	SSQ-107-02-G-D-RA	SSQ-107-02-G-D-RA	Samtec
J14	1		Header, 100mil, 3x2, Gold, TH	3x2 Header	TSW-103-07-G-D	Samtec
J21, J22	2		Receptacle, 100mil, 10x1, Tin, TH	Receptacle, 10x1, 100mil, Tin	PPTC101LFBN-RC	Sullins Connector Solutions
R1, R2, R4, R7, R17, R18, R38, R47, R48, R69	10	0	RES, 0, 5%, 0.1 W, 0603	0603	ERJ-3GEY0R00V	Panasonic
R3	1	12.0k	RES, 12.0 k, 1%, 0.1 W, 0603	0603	ERJ-3EKF1202V	Panasonic
R5, R34, R68, R92	4	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	0603	ERJ-3EKF1001V	Panasonic
R6	1	3.30k	RES, 3.30 k, 1%, 0.1 W, 0603	0603	RC0603FR-073K3L	Yageo America

Table 3. ADS1282-SP EVM Bill of Materials (continued)

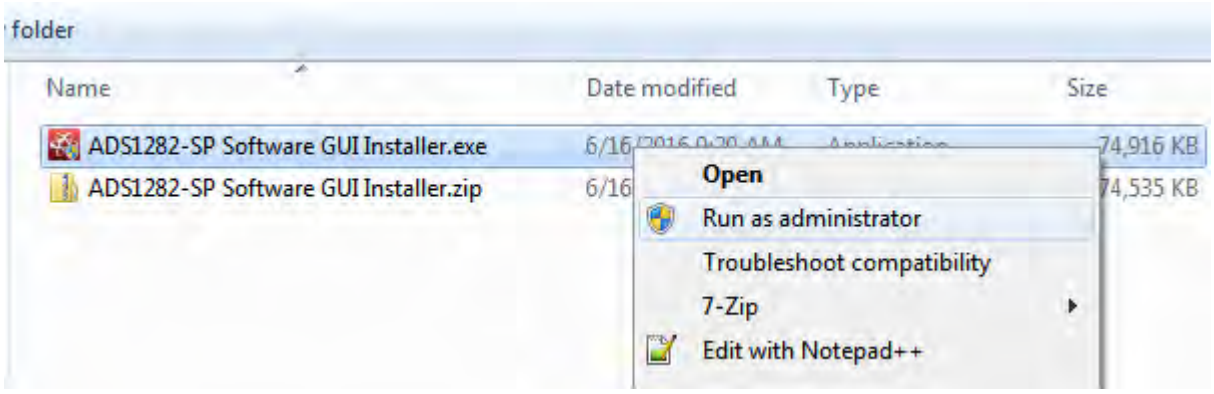
Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R8, R11, R26, R31, R64, R65, R72, R75, R88, R89	10	0	RES, 0, 1%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America
R12, R25, R51, R52, R59, R60, R76, R85	8	50	RES, 50, 1%, 0.1 W, 0603	0603	CRCW060350R0FKEA	Vishay-Dale
R13, R15, R16	3	49.9	RES, 49.9, 1%, 0.125 W, 0805	0805	CRCW080549R9FKEA	Vishay-Dale
R19, R22, R78, R82	4	1.00k	RES, 1.00 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1001X	Panasonic
R27	1	8.45k	RES, 8.45 k, 1%, 0.1 W, 0603	0603	RC0603FR-078K45L	Yageo America
R28	1	1.18k	RES, 1.18 k, 0.1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERA-3AEB1181V	Panasonic
R29	1	10.0k	RES, 10.0k ohm, 0.1%, 0.125W, 0805	0805	RT0805BRD0710KL	Yageo America
R30	1	5.49k	RES, 5.49 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD075K49L	Yageo America
R35	1	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	ERJ-3EKF1002V	Panasonic
R36, R37	2	3.20k	RES, 3.20k ohm, 0.1%, 0.125W, 0805	0805	TNPW08053K20BEEN	Vishay-Dale
R41, R71	2	10.0	RES, 10.0, 1%, 0.1 W, 0603	0603	CRCW060310R0FKEA	Vishay-Dale
R42	1	5.1k	RES, 5.1 k, 5%, 0.1 W, 0603	0603	CRCW06035K10JNEA	Vishay-Dale
R43	1	3.3k	RES, 3.3 k, 5%, 0.1 W, 0603	0603	CRCW06033K30JNEA	Vishay-Dale
R49, R54, R56, R57	4	2.00k	RES, 2.00 k, 0.1%, 0.063 W, 0603	0603	CPF0603B2K0E	TE Connectivity
R53, R55, R58, R61, R80, R87	6	100k	RES, 100 k, 5%, 0.1 W, 0603	0603	CRCW0603100KJNEA	Vishay-Dale
R67, R70	2	47	RES, 47, 5%, 0.1 W, 0603	0603	CRCW060347R0JNEA	Vishay-Dale
R91	1	27	RES, 27, 5%, 0.1 W, 0603	0603	CRCW060327R0JNEA	Vishay-Dale
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10	10		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1, TP2, TP3, TP4, TP5, TP8, TP15, TP16, TP22, TP27	10	Black	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
TP6, TP7, TP9, TP10, TP12, TP13, TP14, TP17, TP18	9	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP11, TP21, TP26	3	White	Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
TP19, TP20, TP23, TP24, TP25	5		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
U1, U2, U4	3		2.3V to 20V, 750-mA LOW-DROPOUT VOLTAGE REGULATOR, HKU0010_CUSTOM_A	HKU0010_CUSTOM_A	TPS7A4501HKU/EM	Texas Instruments
U3, U9	2		High-Performance, Fully-Differential AUDIO OPERATIONAL AMPLIFIER, DGN0008D	DGN0008D	OPA1632DGNR	Texas Instruments
U5	1		Low Noise, Very Low Drift, Precision Voltage Reference, -40 to 125 degC, 8-pin SOIC (D), Green (RoHS & no Sb/Br)	D0008A	REF5050AID	Texas Instruments
U6	1		ADS1282, HKV0028A	HKV0028_CUSTOM_A	ADS1282HKV/EM	Texas Instruments

Table 3. ADS1282-SP EVM Bill of Materials (continued)

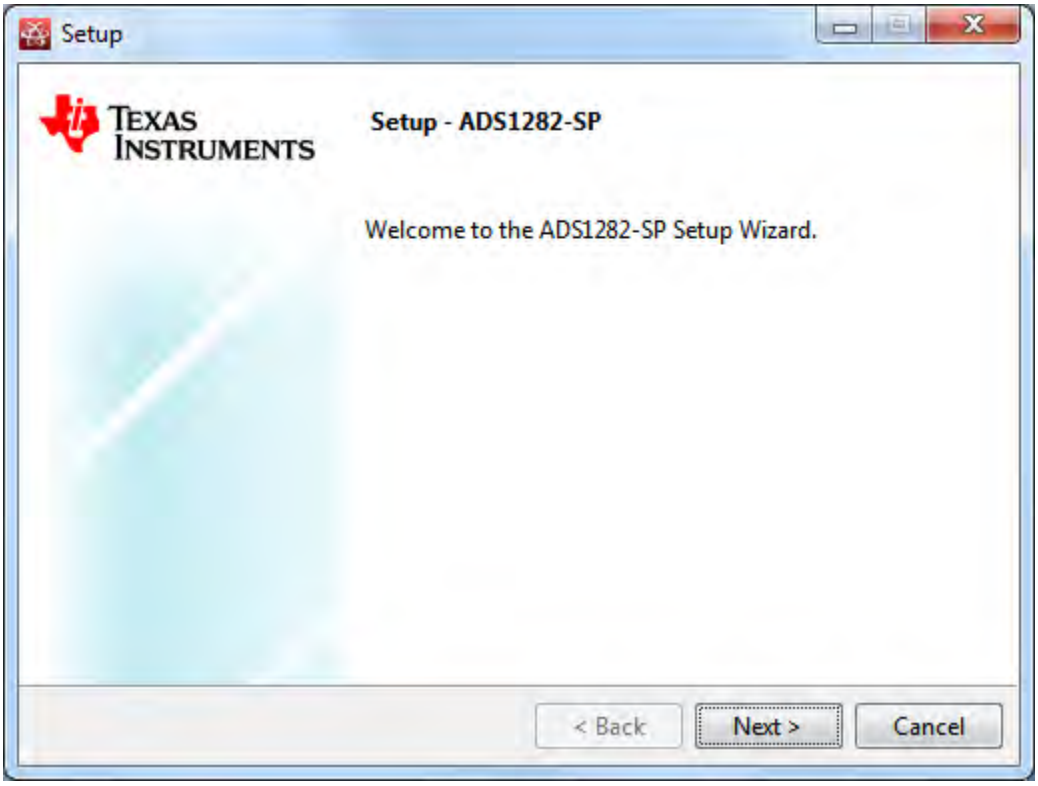
Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
U7	1		High Precision Operational Amplifier, 4 to 36 V, -40 to 85 degC, 14-pin SOIC (D0014A), Green (RoHS & no Sb/Br)	D0014A	OPA4277UA	Texas Instruments
U8	1		Low Noise, Very Low Drift, Precision Voltage Reference, -40 to 125 degC, 8-pin SOIC (D), Green (RoHS & no Sb/Br)	D0008A	REF5025AID	Texas Instruments
Y1	1		Crystal, 4.096MHz, 3.3V, SMD	7x5mm	7W-4.096MBB-T	TXC Corporation
C9, C23, C24	0	0.1uF	CAP, CERM, 0.1uF, 50V, +/-10%, X7R, 1210	1210	C1210C104K5RACTU	Kemet
C11, C19, C47, C52	0	1uF	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0603	0603	C1608X7R1E105K080AB	TDK
C16, C48	0	10uF	CAP, CERM, 10 µF, 6.3 V, +/- 10%, JB, 0603	0603	C1608JB0J106K080AB	TDK
R9, R24, R73, R84	0	47.0k	RES, 47.0 k, 0.1%, 0.1 W, 0603	0603	RG1608P-473-B-T5	Susumu Co Ltd
R10, R32, R74, R90	0	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0603	0603	CRCW06031M00FKEA	Vishay-Dale
R14, R23, R77, R83	0	3.01Meg	RES, 3.01 M, 1%, 0.1 W, 0603	0603	CRCW06033M01FKEA	Vishay-Dale
R20, R21, R45, R46, R62, R63, R66, R79, R81	0	0	RES, 0, 1%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America
R33, R39, R40, R86	0	0	RES, 0, 5%, 0.1 W, 0603	0603	ERJ-3GEY0R00V	Panasonic
R44, R50	0	75.0k	RES, 75.0 k, 0.1%, 0.1 W, 0603	0603	RG1608P-753-B-T5	Susumu Co Ltd

A.1 ADS1282-SP Software GUI Installation

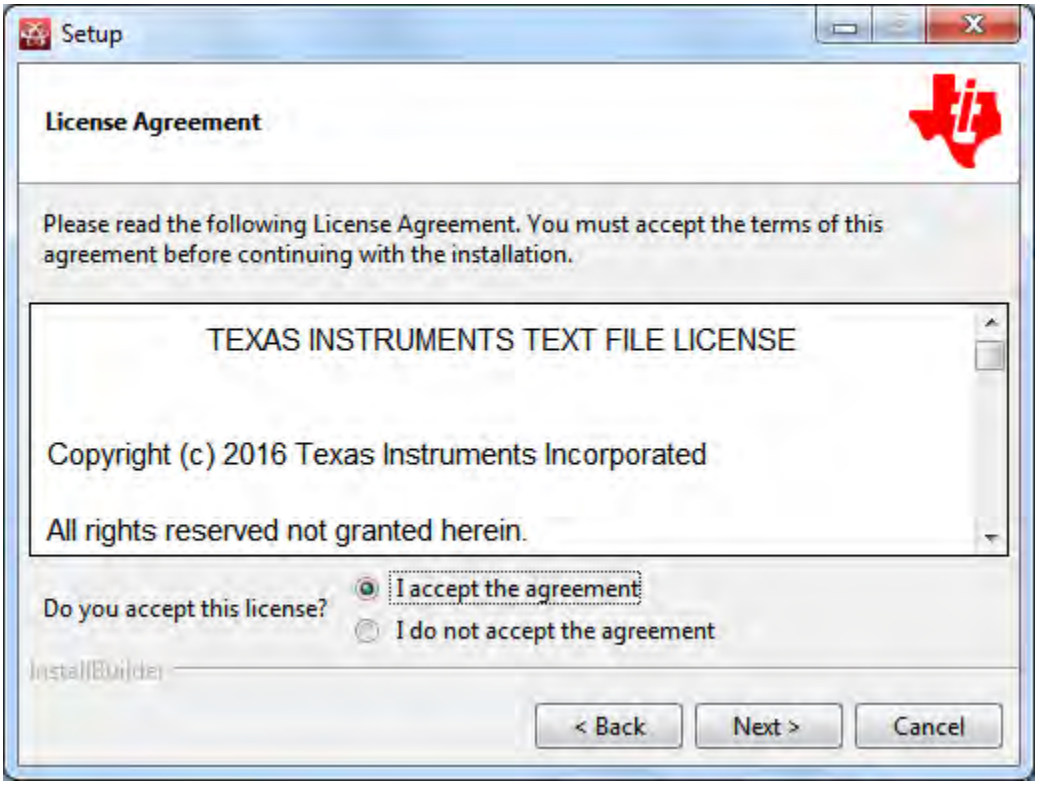
1. Unzip the GUI installer file *ADS1282-SP Software GUI Installer.zip*
2. Invoke the installer executable file as administrator by right clicking and choosing the option *Run as administrator*



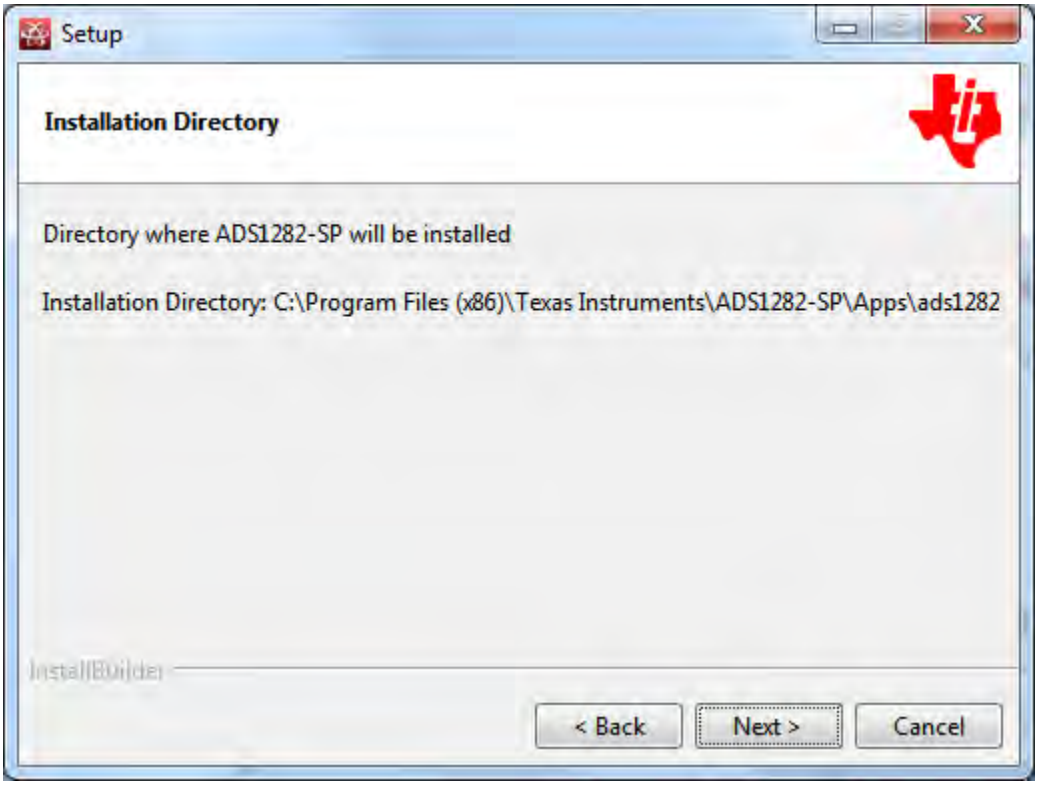
3. Click *Next*



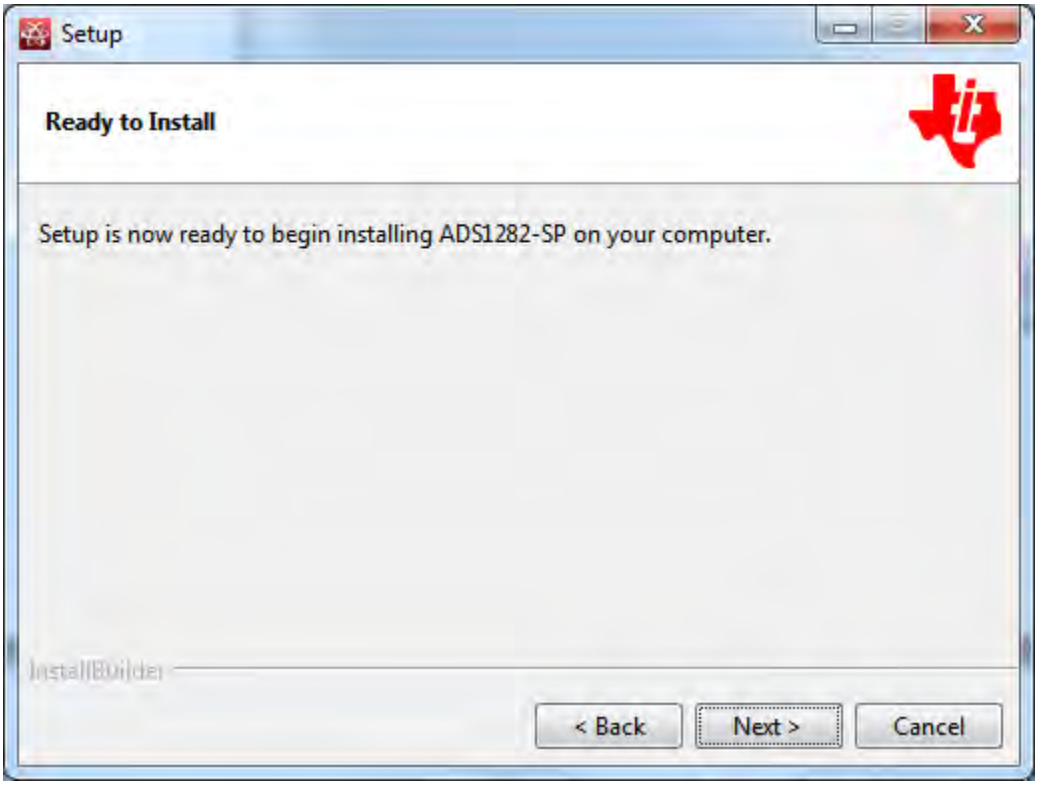
4. Read the License Agreement and click the *I accept the agreement* button and click *Next*



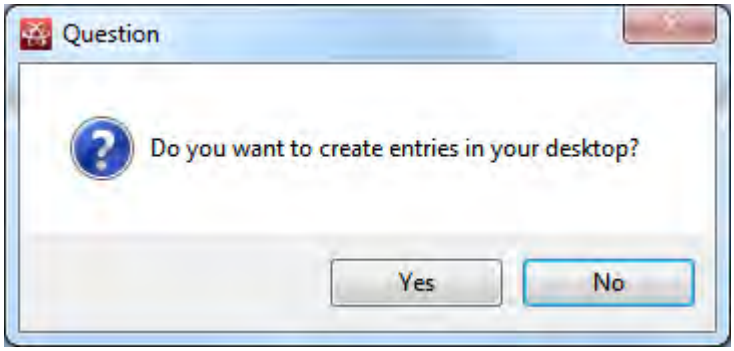
5. Click *Next*



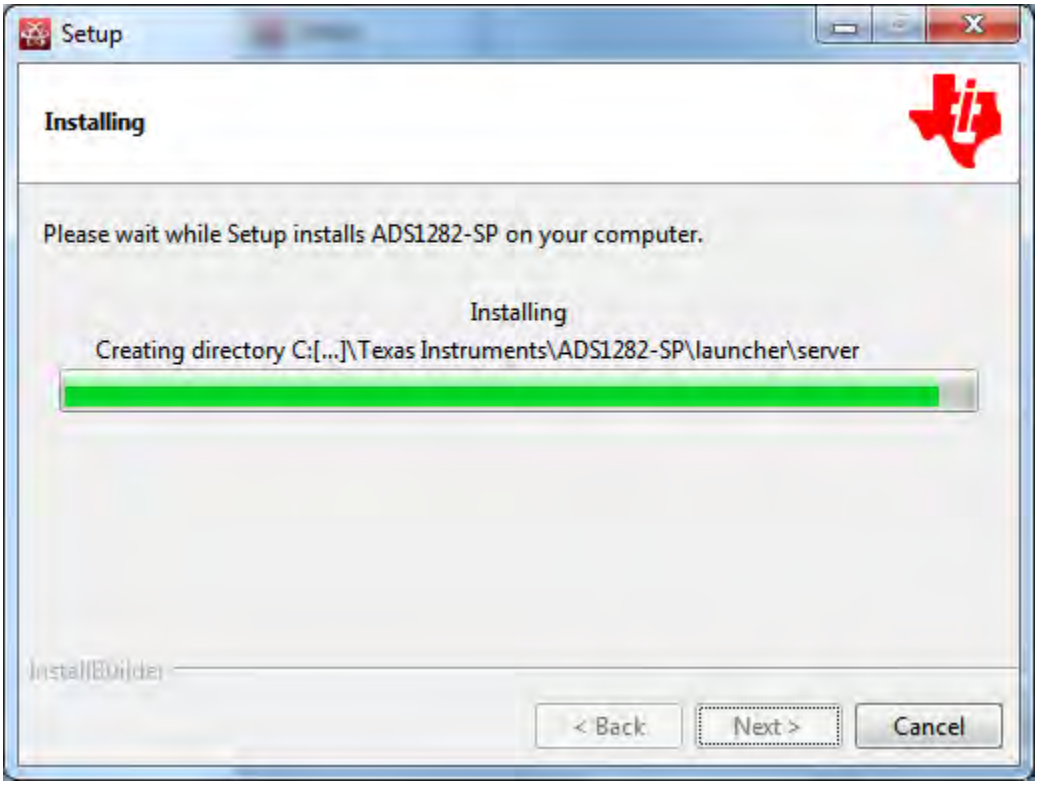
6. Click *Next*

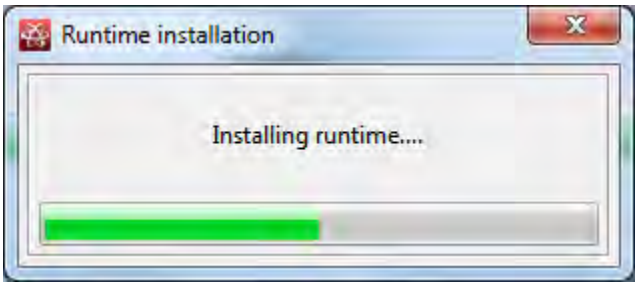


7. Click *Yes* to create a desktop icon

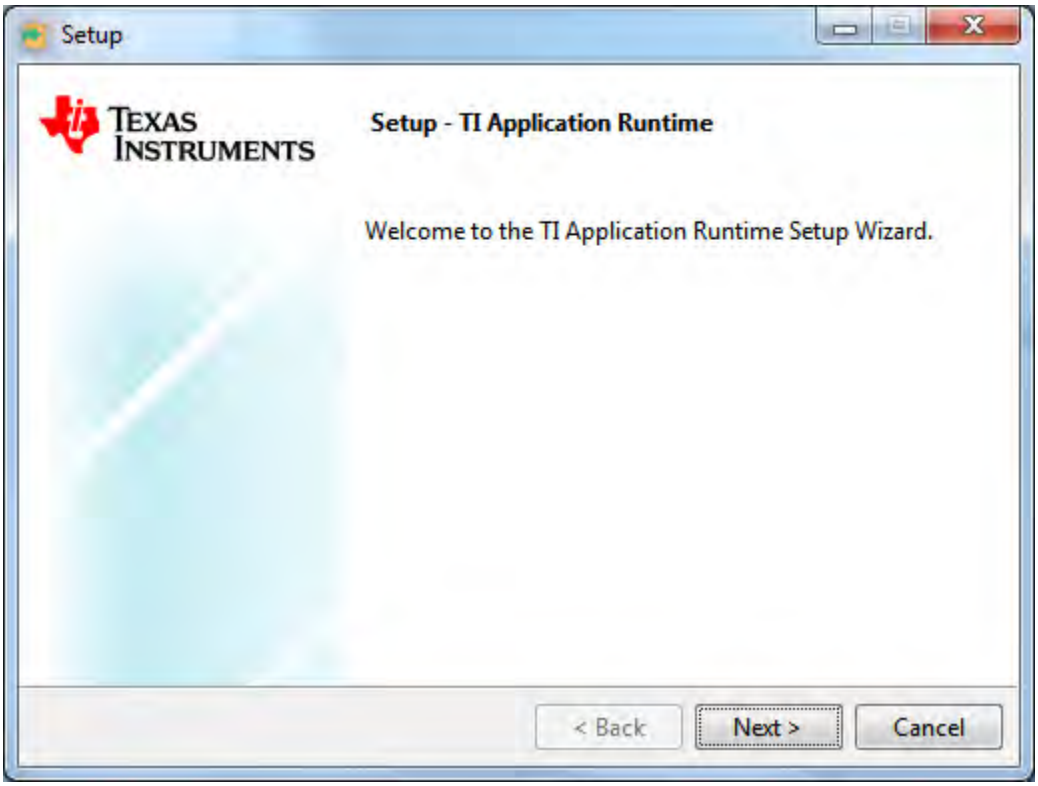


8. Installation commences

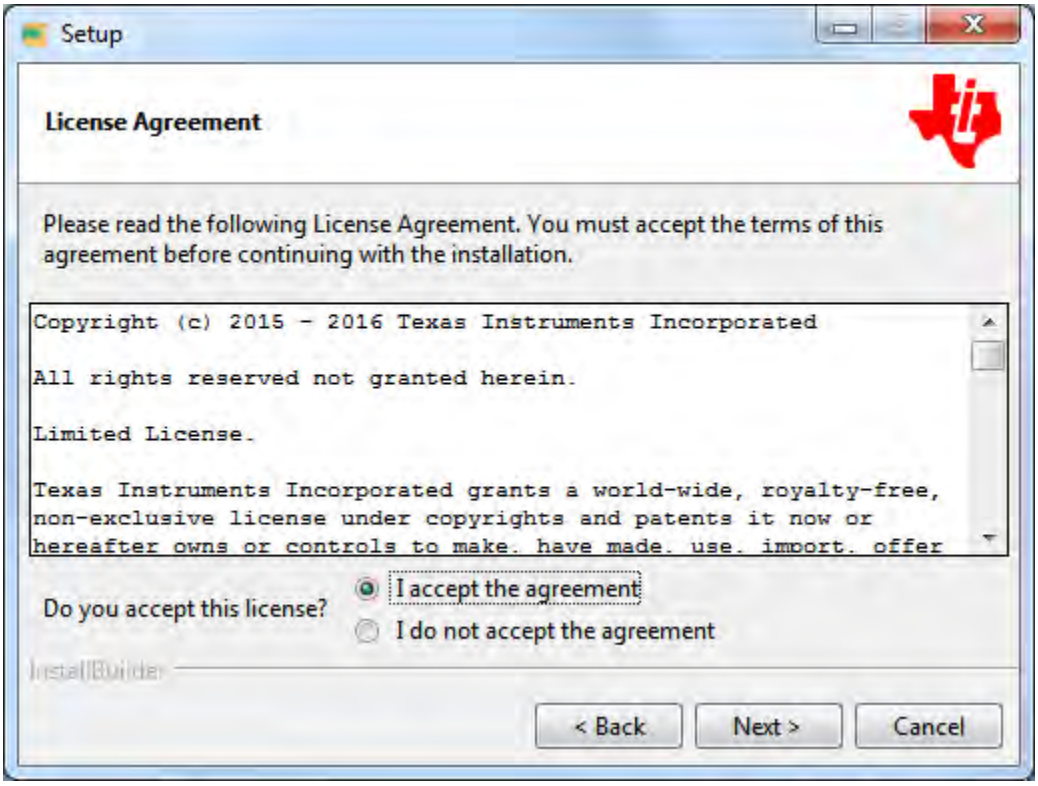




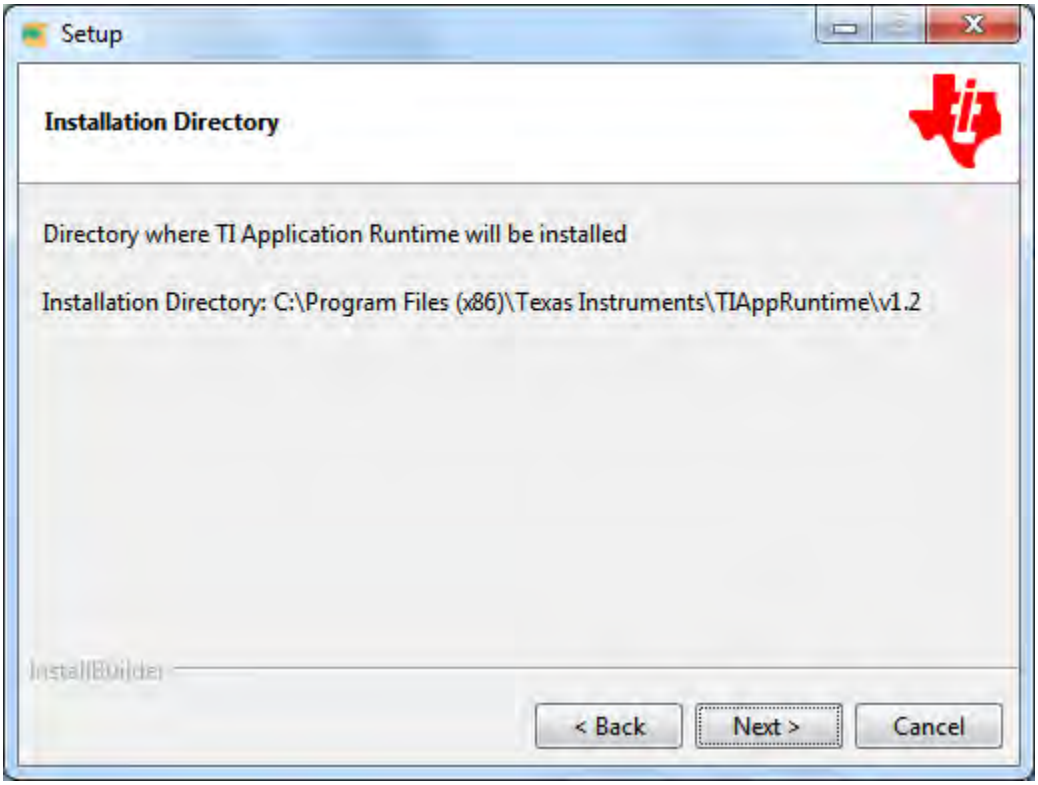
9. Click *Next*



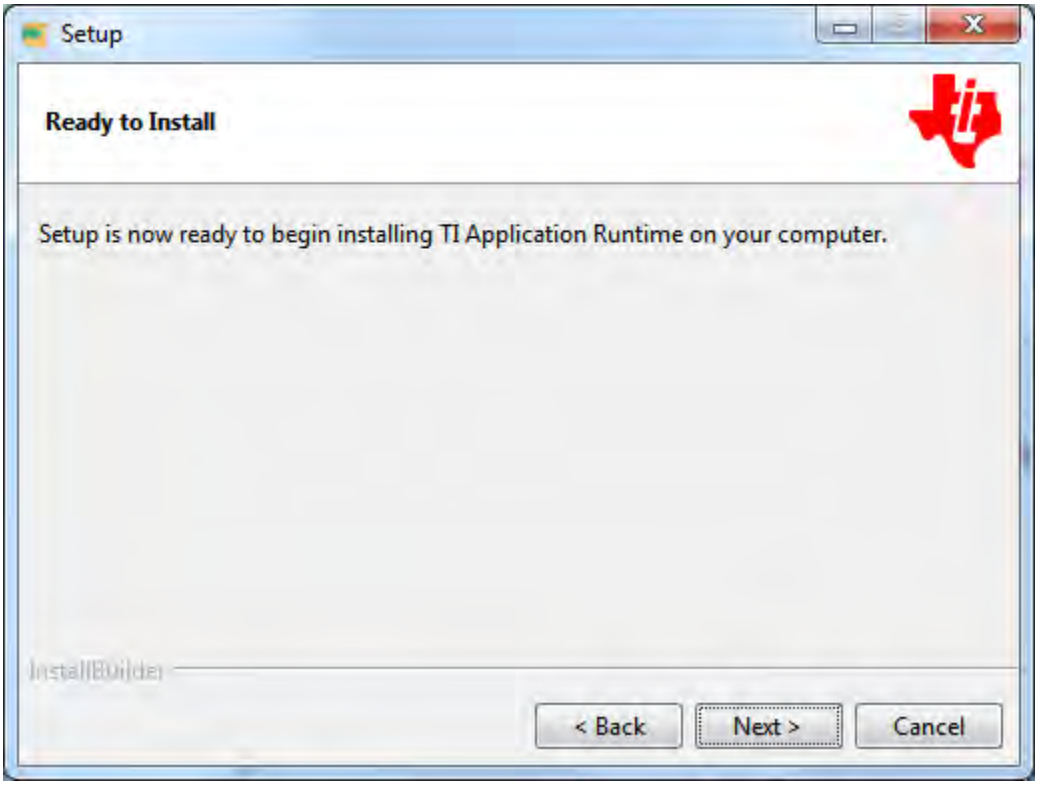
10. Read the License Agreement and click the *I accept the agreement* button and click *Next*

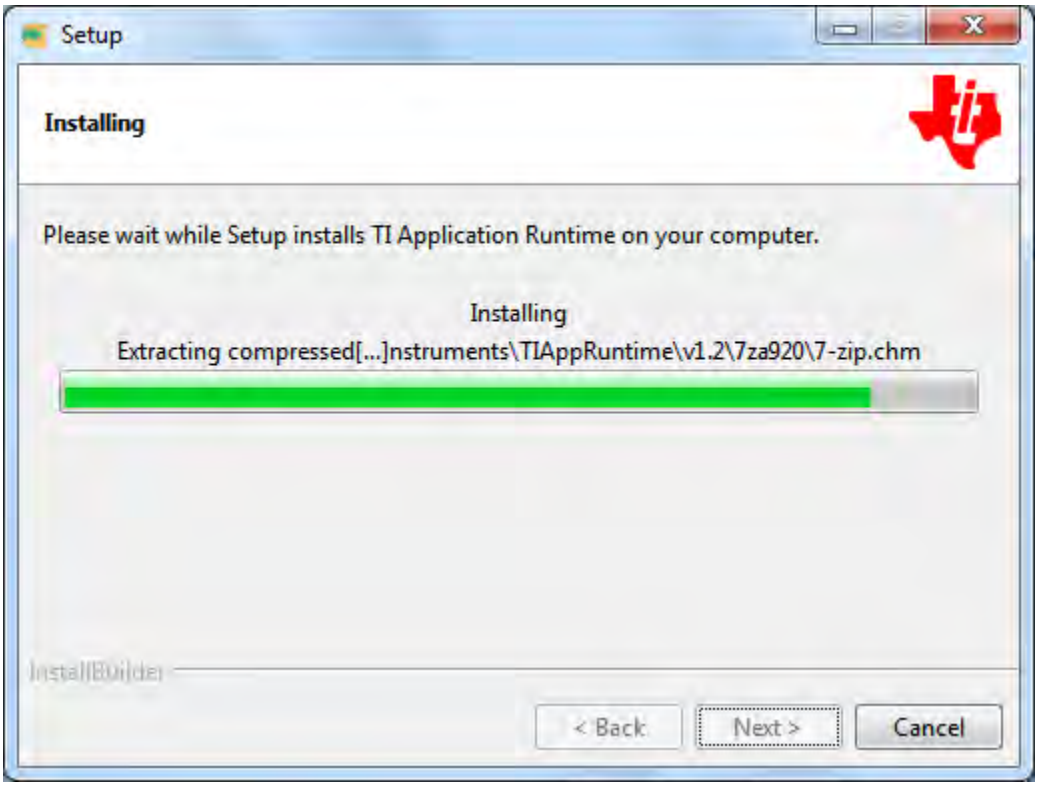


11. Click *Next* to install Runtime in default location

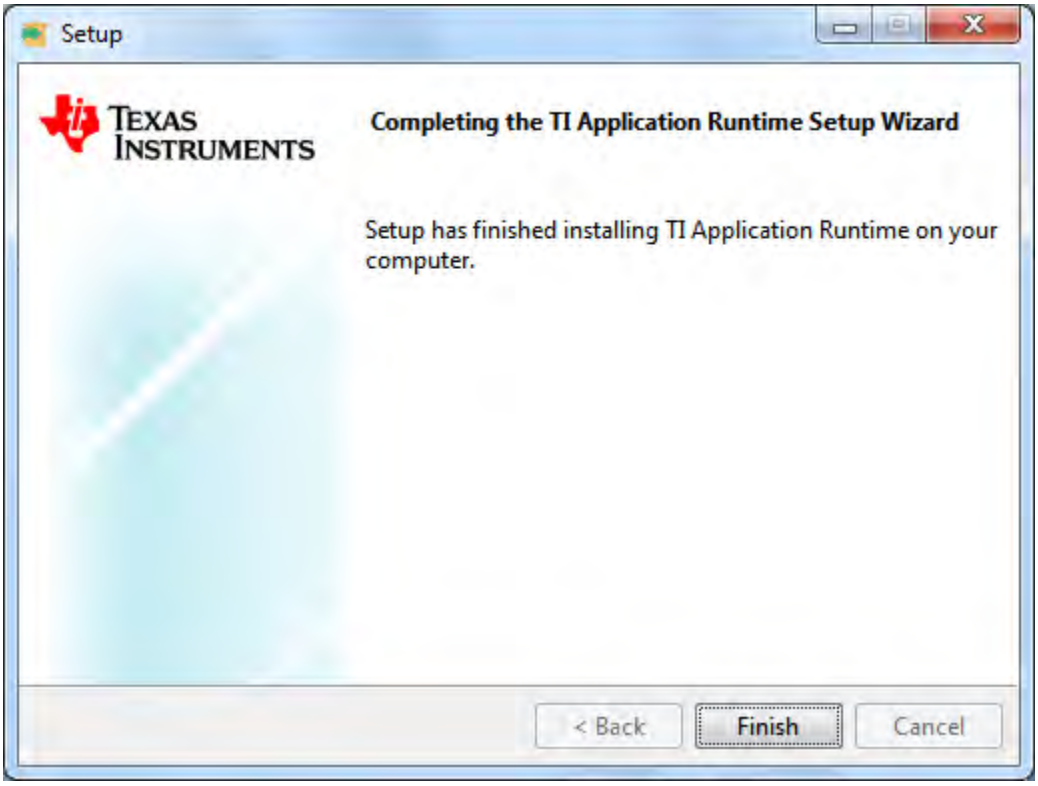


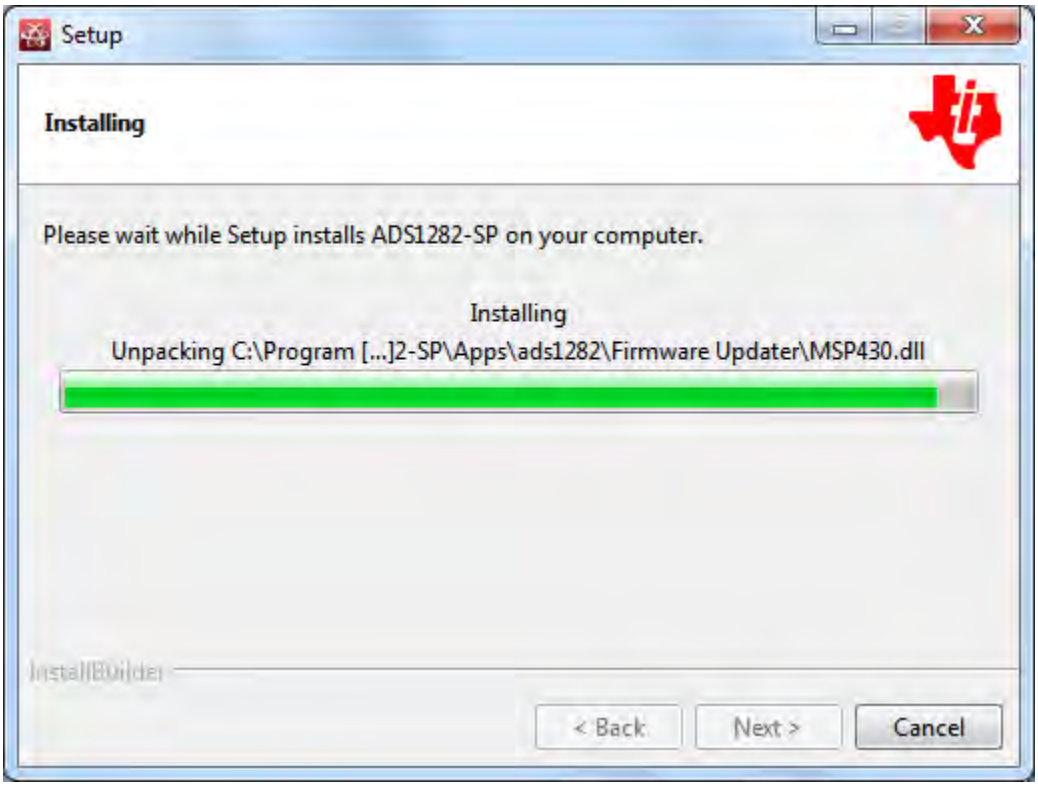
12. Click *Next*



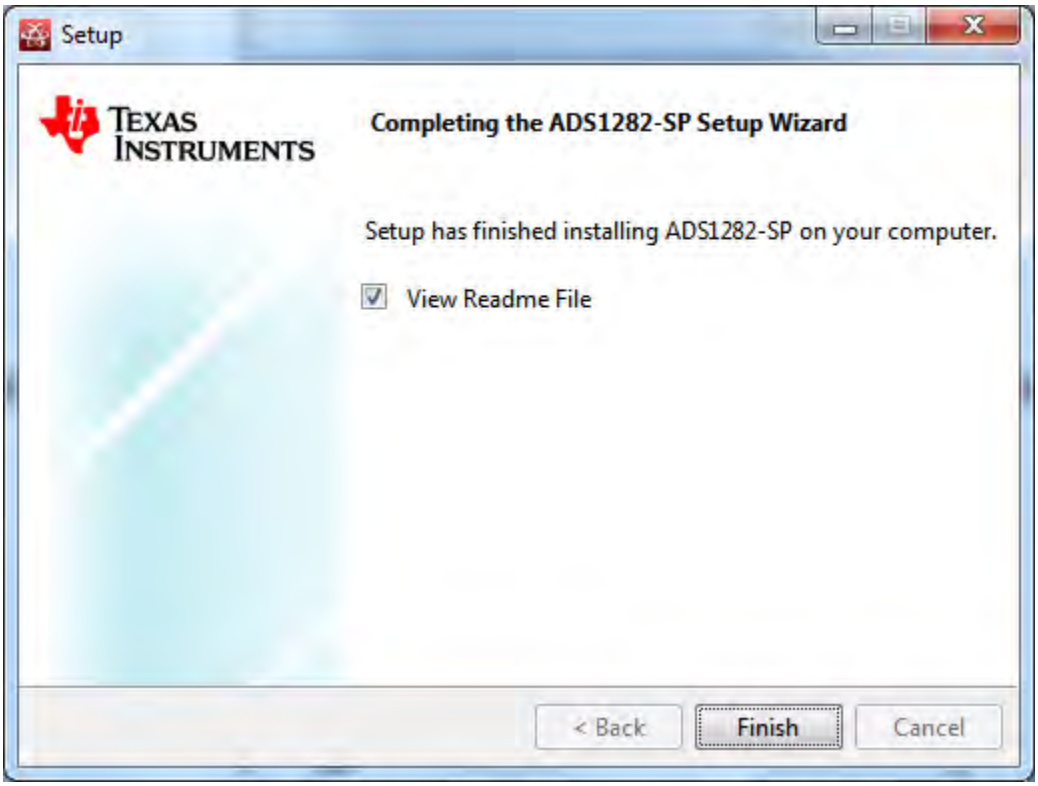


13. Click *Finish*

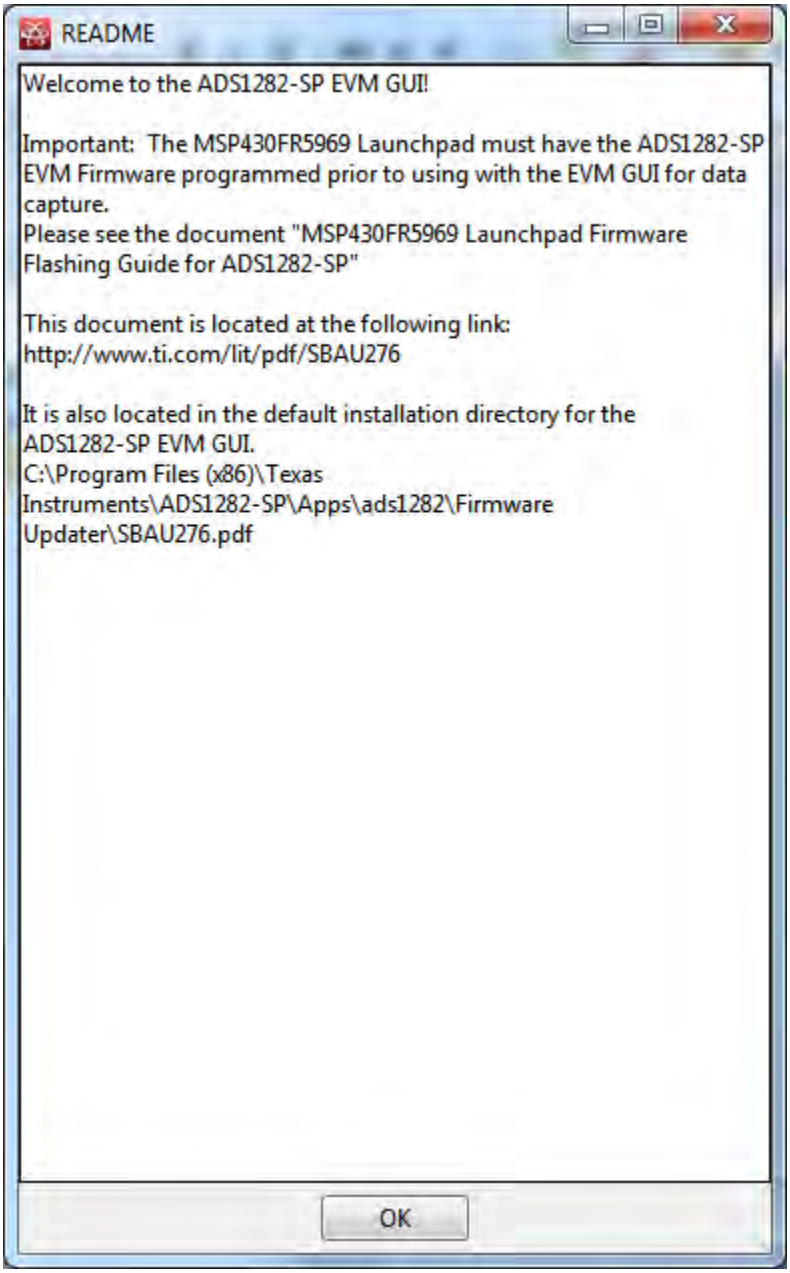




14. Click *Finish*



15. The README file contains important information related to the MSP430 LaunchPad firmware load. Links are provided to the instructions for flashing the ADS1282-SP firmware onto the MSP430 LaunchPad. **NOTE:** The ADS1282-SP GUI will not capture data until this procedure is completed.



STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

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

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

2 *Limited Warranty and Related Remedies/Disclaimers*:

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

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

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

3 *Regulatory Notices:*

   3.1 *United States*

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

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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

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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。
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4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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

6. *Disclaimers:*

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

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

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

8. *Limitations on Damages and Liability:*

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

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

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

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

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

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