

ABSTRACT

The ADS7142-Q1 BoosterPack™ plug-in module (BOOSTXL-ADS7142-Q1) allows users to evaluate the functionality of Texas Instruments' ADS7142-Q1 nanopower, dual-channel programmable sensor monitor. This user's guide describes both the hardware platform showcasing the ADS7142-Q1 device and the graphical user interface (GUI) software used to configure the various modes of operation of this device.

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Chrome™ is a trademark of Google LLC..

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1 Introduction

The ADS7142-Q1 BoosterPack™ is a fully-assembled evaluation platform designed to highlight the ADS7142-Q1 features and various modes of operations that makes this device suitable for ultra-low-power, small-size sensor monitor applications.

The accompanying Precision ADC Motherboard (PAMB) development kit is used as a USB-to-PC GUI communication bridge, and example implementation of a master MCU to communicate with the ADS7142-Q1 through its I²C interface.

Note

The BOOSTXL-ADS7142-Q1 requires an external master controller to evaluate the ADS7142-Q1.

The PAMB is controlled by commands received from the ADS7142-Q1 GUI, and returns data to the GUI for display and analysis. If the PAMB is not used, the BoosterPack™ plug-in module format of the BOOSTXL-ADS7142-Q1 board allows an alternative external host to communicate with the ADS7142-Q1.

The BOOSTXL-ADS7142-Q1 incorporates all required circuitry and components with the following features:

- ADS7142-Q1 nano power, ultra-small, dual-channel sensor monitor with I²C interface and alert output
- Optional low power voltage reference, TI's REF3133-Q1, to generate a 3.3-V output to power the ADS7142-Q1 AVDD supply pin when the 5-V USB power from the PAMB
- Optional adjustable linear regulator, TI's TPS79933-Q1, to generate stable output voltage to power the ADS7142-Q1 DVDD pin when using the 5-V USB power from the PAMB
- I²C interface for communication and configuration of modes available on the ADS7142-Q1

Figure 1-1 shows the ADS7142-Q1EVM architecture, identifying the key components and blocks previously listed.

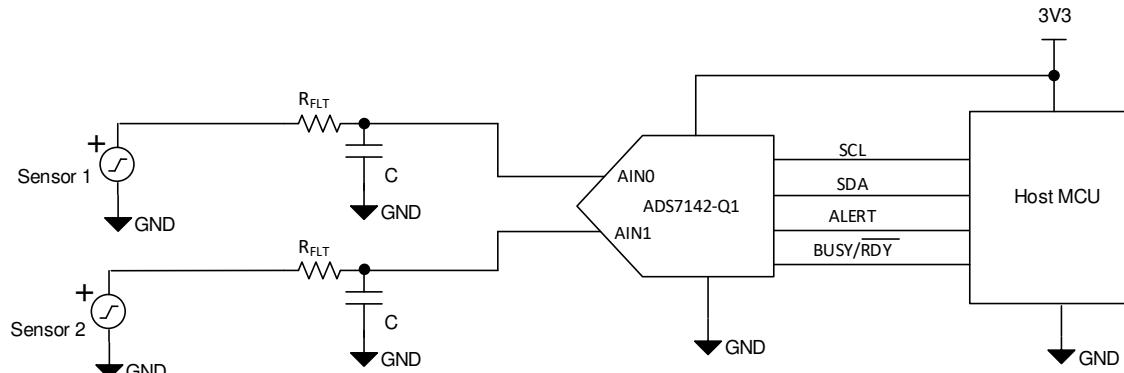


Figure 1-1. ADS7142-Q1 EVM Block Diagram

2 BOOSTXL-ADS7142-Q1 EVM Overview

This section describes various onboard components that are used to interface analog input, digital interface, and provide power supply to BOOSTXL-ADS7142-Q1. [Figure 2-1](#) shows a BOOSTXL-ADS7142-Q1 overview.

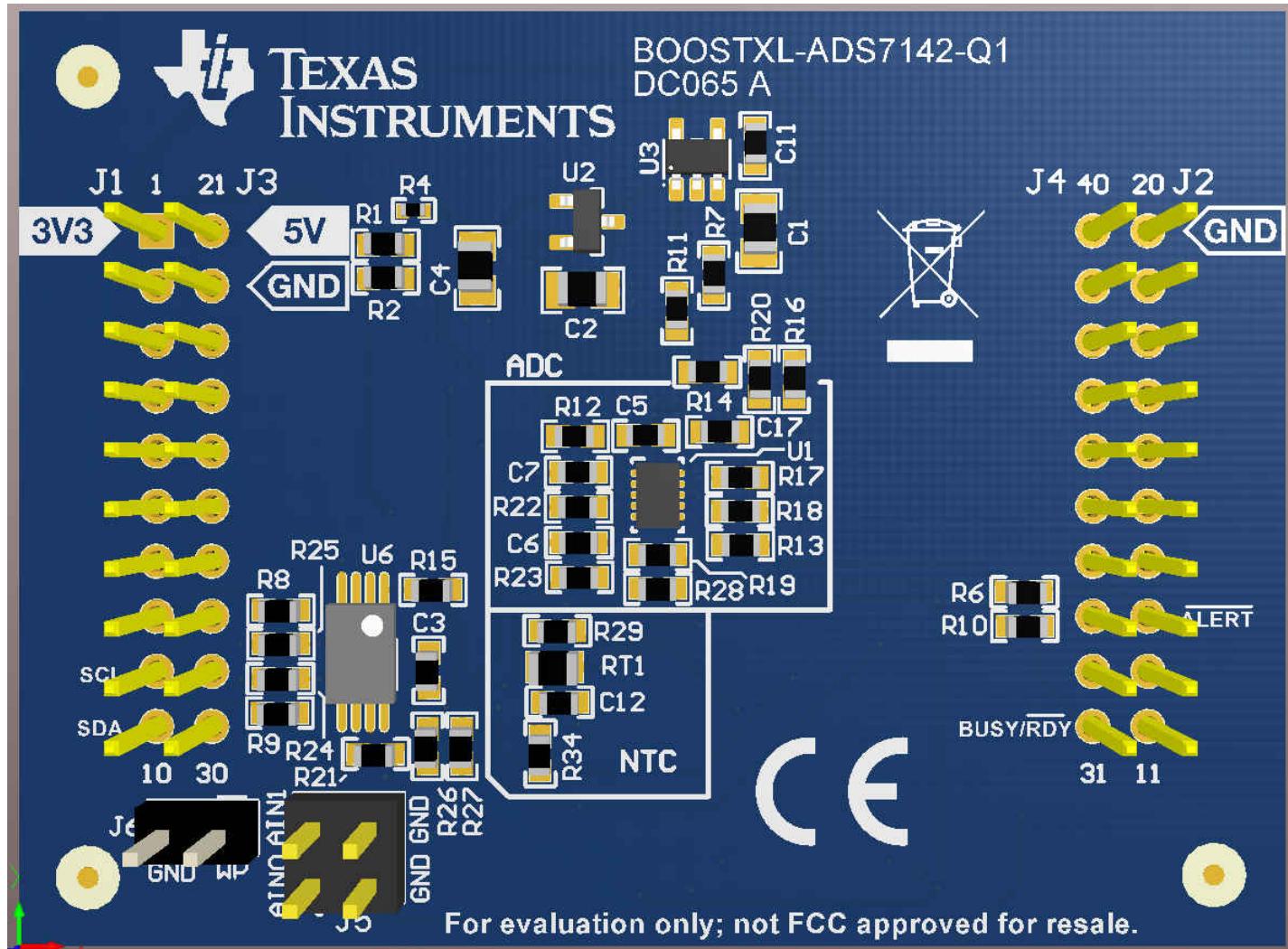


Figure 2-1. BOOSTXL-ADS7142-Q1 Top Level Overview

2.1 Connectors for Single-Ended Analog Input

The BOOSTXL-ADS7142-Q1 is designed for easy interface to an external, analog, single-ended source through a 100-mil header. Connector J5 allows analog source connectivity. [Table 2-1](#) lists the analog input connector and input channel configuration.

Table 2-1. Input Connector and Channel Configuration

J5 Connector Pin	Description
J5:1	Single-ended analog input for channel 0 of ADC
J5:2	Single-ended analog input for channel 1 of ADC
J5:3 and J5:4	BoosterPack™ ground

2.2 Digital Interface

As noted in [Section 1](#), the BOOSTXL-ADS7142-Q1 interfaces with the PAMB, which in turn communicates with the computer over USB. The two devices on the booster pack that the PAMB communicates over I²C are the ADS7142-Q1 ADC and the EEPROM. The EEPROM comes preprogrammed with the information required to configure and initialize the BOOSTXL-ADS7142-Q1 platform. Once the hardware is initialized, the EEPROM is no longer used.

2.3 ADS7142-Q1 Digital I/O Interface

The BOOSTXL-ADS7142-Q1 supports the I²C digital interface and functional modes as detailed in the [ADS7142-Q1 data sheet](#). The PAMB is capable of operating at a 3.3 V logic level and is directly connected to the digital I/O lines of the ADC.

2.4 Power Supplies

The device supports a wide range of operation on its analog supplies. The AVDD can operate from 1.65 V to 3.6 V. The DVDD operates from 1.65 V to 3.6 V, independent of the AVDD supply. The 3.3 V voltage regulator available on the PAMB is used to supply 3.3 V to both AVDD and DVDD on the BOOSTXL-ADS7142-Q1.

There is an onboard option to use an ultra-low power voltage reference REF3133-Q1 (U2) to generate 3.3 V supply for the ADS7142-Q1 AVDD pin. Voltage variants of REF3330 can be used to generate supply other than 3.3 V for the ADS7142-Q1 AVDD pin. To generate a DVDD supply other than 3.3 V, an adjustable version of the TPS799-Q1 regulator (U3) can be used.

3 BOOSTXL-ADS7142-Q1 EVM Initial Setup

3.1 Running ADS7142-Q1 GUI Online and TI Cloud Agent Application Installation

The following steps describe the ADS7142-Q1 GUI software installation:

1. Go to the [BOOSTXL-ADS7142-Q1](#) TI website and *Download* the BOOSTXL-ADS7142-Q1 GUI software. It might require to login user account privileges to use the online version as well as installation of the applications.
2. Click on the BOOSTXL-ADS7142-Q1 GUI icon. First time users may be prompted to download and install the browser extension for Firefox™ or Chrome™ and the TI Cloud Agent Application, as shown in [Figure 3-1](#).

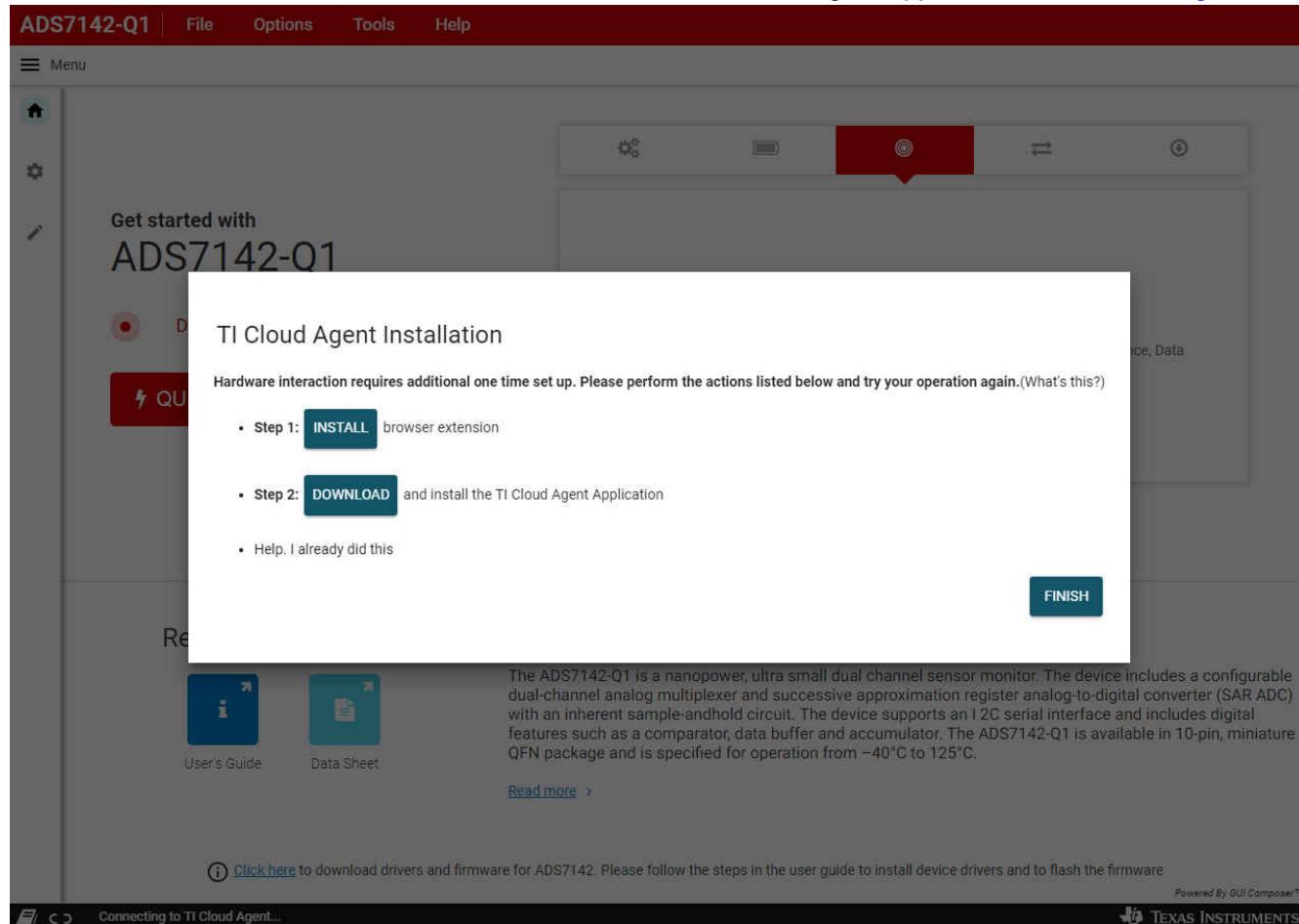


Figure 3-1. Installation of Browser Extension and TI Cloud Agent

3.2 Hardware Setup Instructions

The following are the instructions to set up the BOOSTXL-ADS7142-Q1 for evaluation:

1. Stack the BOOSTXL-ADS7142-Q1 on the PAMB. Make sure the 20-pin connector (J1 and J3) on BOOSTXL-ADS7142-Q1 is mapped against the left PAMB connector and the connector (J4 and J2) on BOOSTXL-ADS7142-Q1 is mapped against the right PAMB connector. Pin 1 of BOOSTXL-ADS7142-Q1 must align with pin 1 of left PAMB connector (3V3)
2. Connect the micro USB from data port o PAMB to available USB port on PC.
3. [Figure 3-2](#) shows the assembled BOOSTXL-ADS7142-Q1 and PAMB configuration.

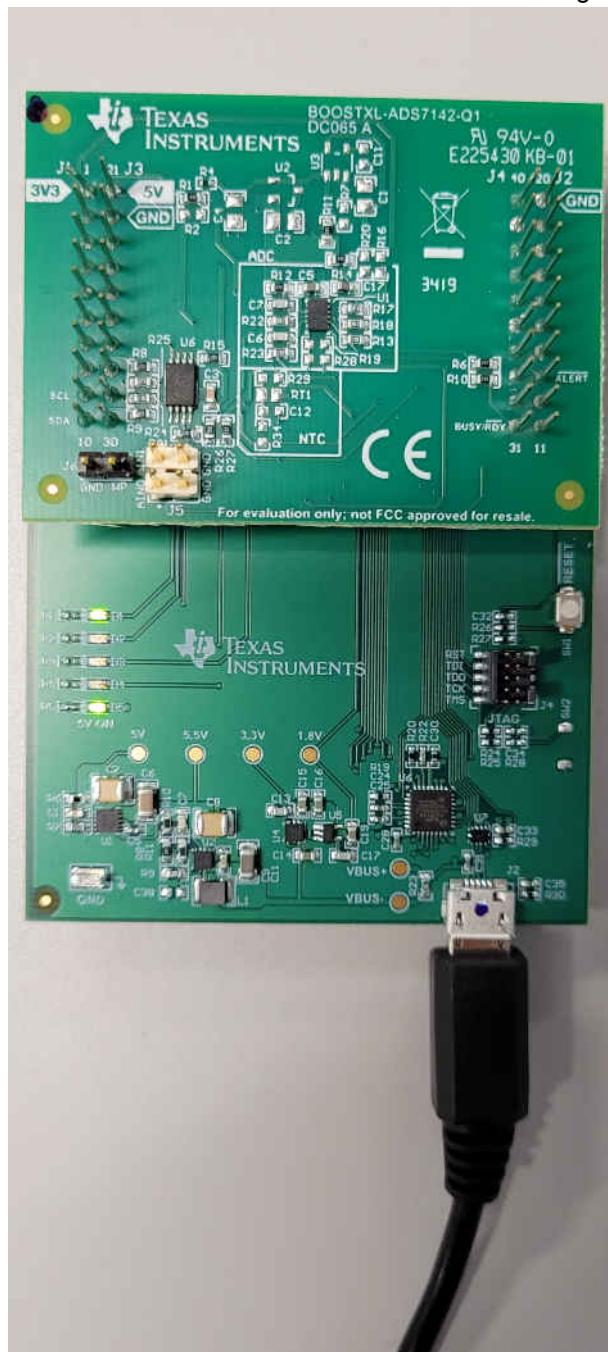


Figure 3-2. BOOSTXL-ADS7142-Q1 Stacked on PAMBoard

3.3 ADS7142-Q1 GUI Description

3.3.1 Description

Figure 3-3 shows the landing page of the ADS7142-Q1 GUI. This page provides a high-level overview of the ADS7142-Q1 device. The left corner shows the tabs required to navigate through the ADS7142-Q1 register map and the ADS7142-Q1 functional modes page. When the PAMB with the BOOSTXL-ADS7142-Q1 stacked is connected to the PC through the micro USB cable, the GUI detects the BoosterPack™ by reading the onboard EEPROM. Once detected and connected, the GUI indicates this status as *CONNECTED*. At the bottom left corner of the GUI, there is an option to connect and disconnect the hardware from the GUI.

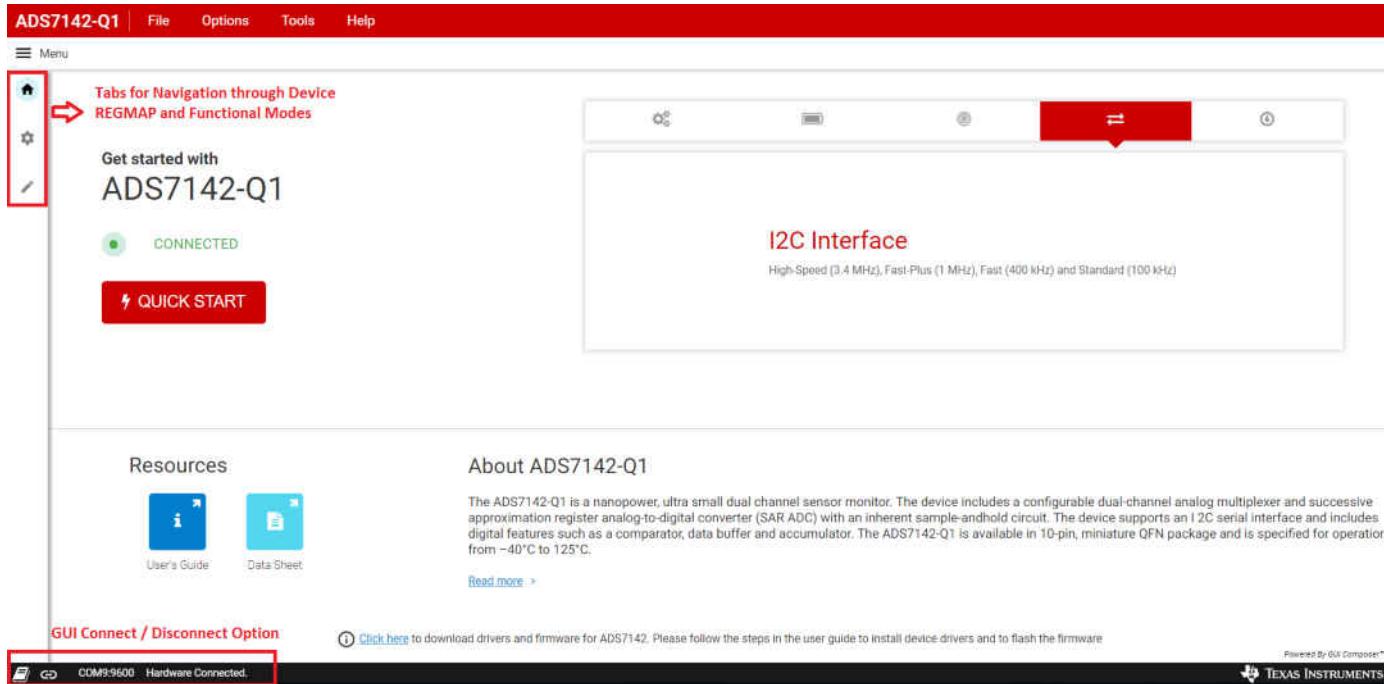


Figure 3-3. ADS7142-Q1 GUI Landing Page

3.3.2 REGMAP

Figure 3-4 shows register map page for the ADS7142-Q1. On the top right corner, options to read registers individually, read all the registers at once, or write individual register are available. Users can choose to have the register values modified in the GUI to be written on the device instantaneously by selecting the *Immediate* option or later using the *Deferred* option.

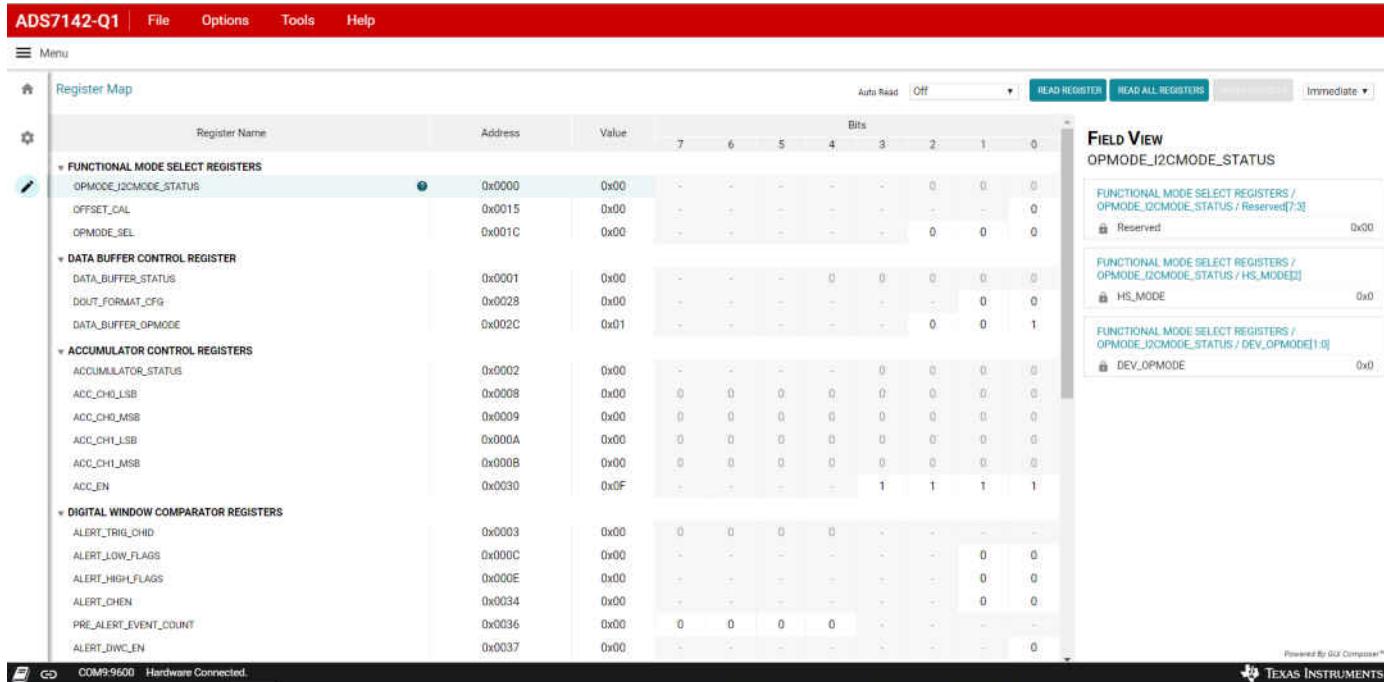


Figure 3-4. ADS7142-Q1 Register Map Page

3.3.3 Functional Mode

Figure 3-5 shows the functional mode page of the ADS7142-Q1 GUI. This page enables the user to navigate and *SET* various functional modes of the device (Autonomous and I²C command mode) and set channel-specific configurations. On the top right corner is an option to enable all ADC channels and enable alert functionality. TI recommends enabling these blocks and then to enable or disable the preferred ADC channel based on user preference.

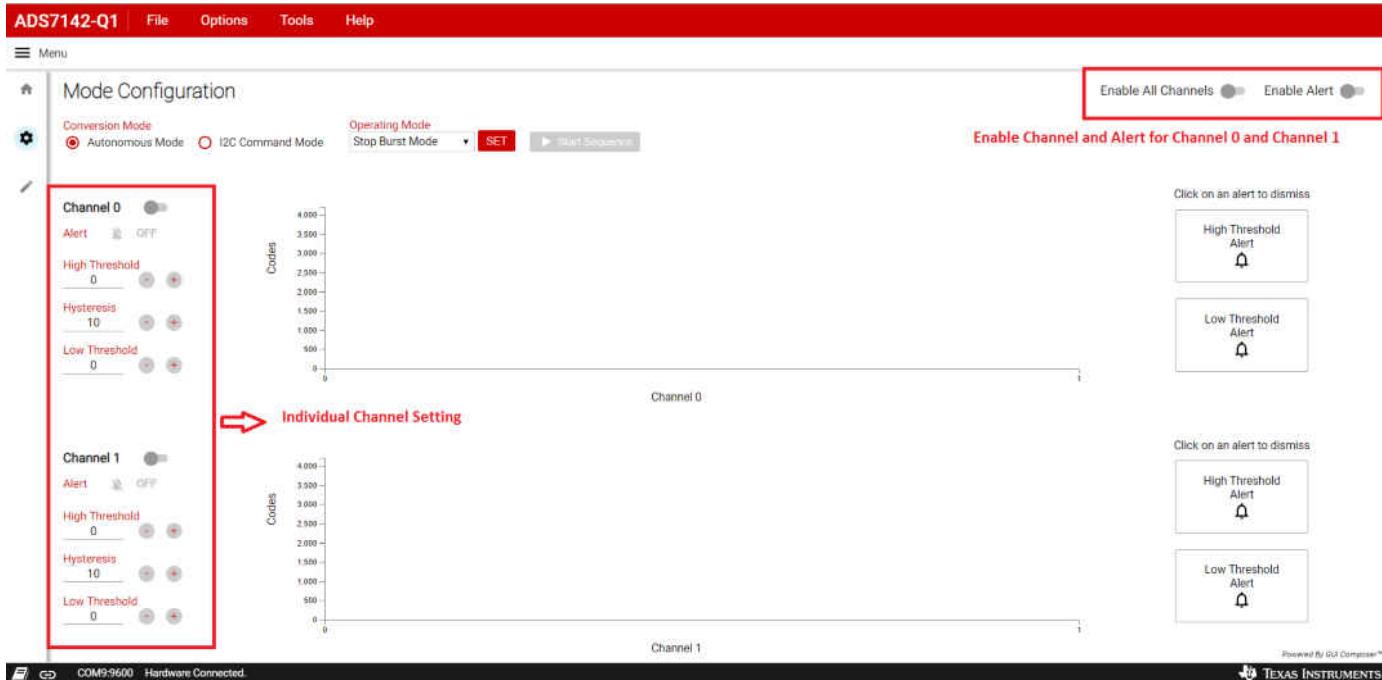


Figure 3-5. ADS7142-Q1 Mode Configuration Page

3.3.4 General Instructions

This section describes the steps involved in selecting functional modes of operation or channel-specific configurations and capturing the data in the selected functional mode:

1. *Enable All Channels* and *Enable Alert* on the top right corner of GUI page.
2. Enter channel-specific configurations such as high and low thresholds, hysteresis, and Alert functionality.
3. Select *Conversion Mode* by clicking on either *Autonomous Mode* or *Manual Mode*.
4. Select the *Operating Mode* from drop-down menu and click *SET* to write register specific to that particular mode.
5. Press *Start Sequence* to capture conversion data from ADS7142-Q1.

Note

The *Start Sequence* button will remain disabled until the selected *Functional Mode* is *SET* as step 4 indicates.

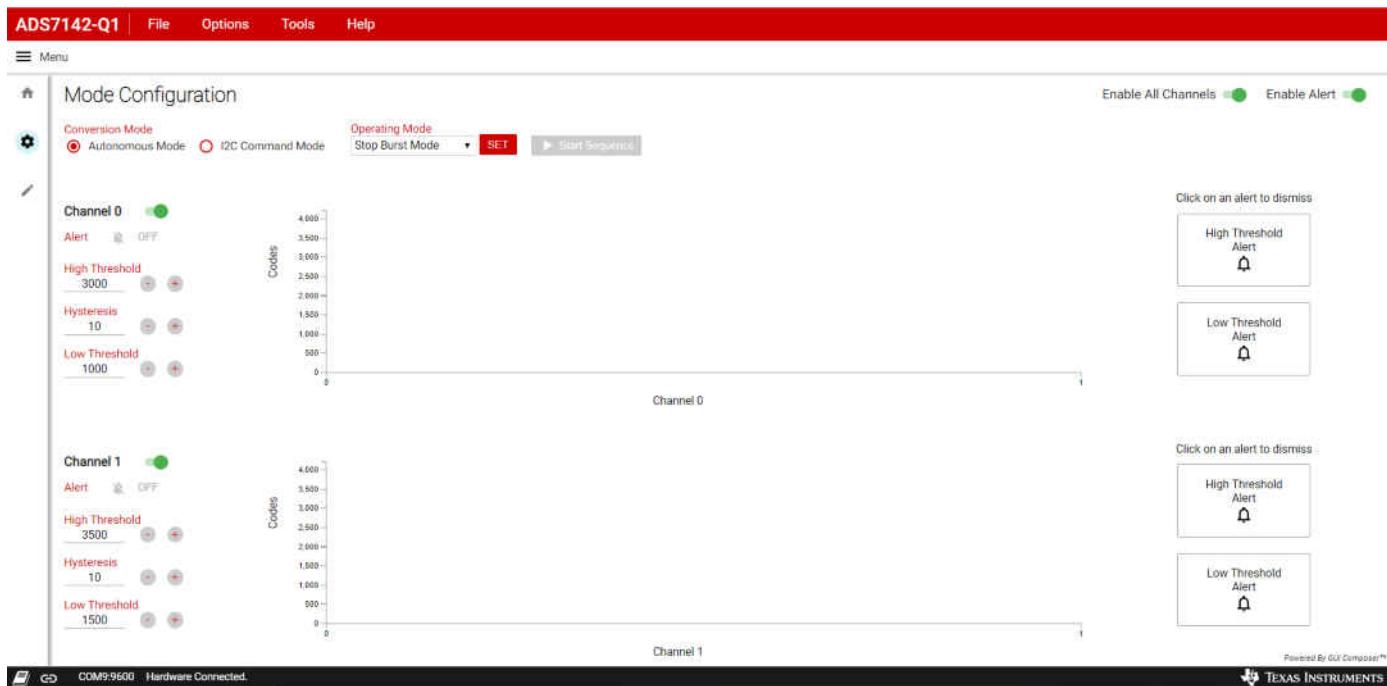


Figure 3-6. ADS7142-Q1 General Instructions Page

4 ADS7142-Q1 GUI Functional Modes

The ADS7142-Q1 device has the following functional modes:

- **Manual Mode:** In this mode, the host provides I²C frames to control conversion and read data after each conversion.
- **Autonomous Mode:** The device features an internal data buffer that can store the conversion results of the ADC in *Autonomous Mode* without the host controlling the conversion.
- **High Precision Mode:** In *High Precision Mode*, the results stored in the internal data buffer are accumulated to increase the precision of the conversion results.

The device powers up in *Manual Mode* and can be configured into any of the functional modes by writing the configuration registers for the desired mode.

4.1 Autonomous Mode

In the *Autonomous Conversion Mode*, the device generates the start of conversion pulses using an internal oscillator on receiving the first start of conversion pulse from the host. This can be configured by selecting *Autonomous Mode* as the *Conversion Mode*, selecting one of the *Operating Modes* from the drop-down menu, and pressing the *SET* button. The ADS7142-Q1 device then generates the subsequent start of conversion signals autonomously. The *Operating Modes* offered in *Autonomous Mode* are described in the following sections.

4.1.1 Start Burst Mode

When *Start Burst Mode* is selected from the *Operating Modes* drop-down menu and the *SET* button is pressed, the device is configured to store 16 conversion results into the data buffer of the device. The device will stop converting once the data buffer is filled. To understand the steps required to configure the device in this mode, refer to the [ADS7142-Q1 data sheet](#).

Figure 4-1 highlights the ADS7142-Q1 GUI working in *Start Burst Mode*.

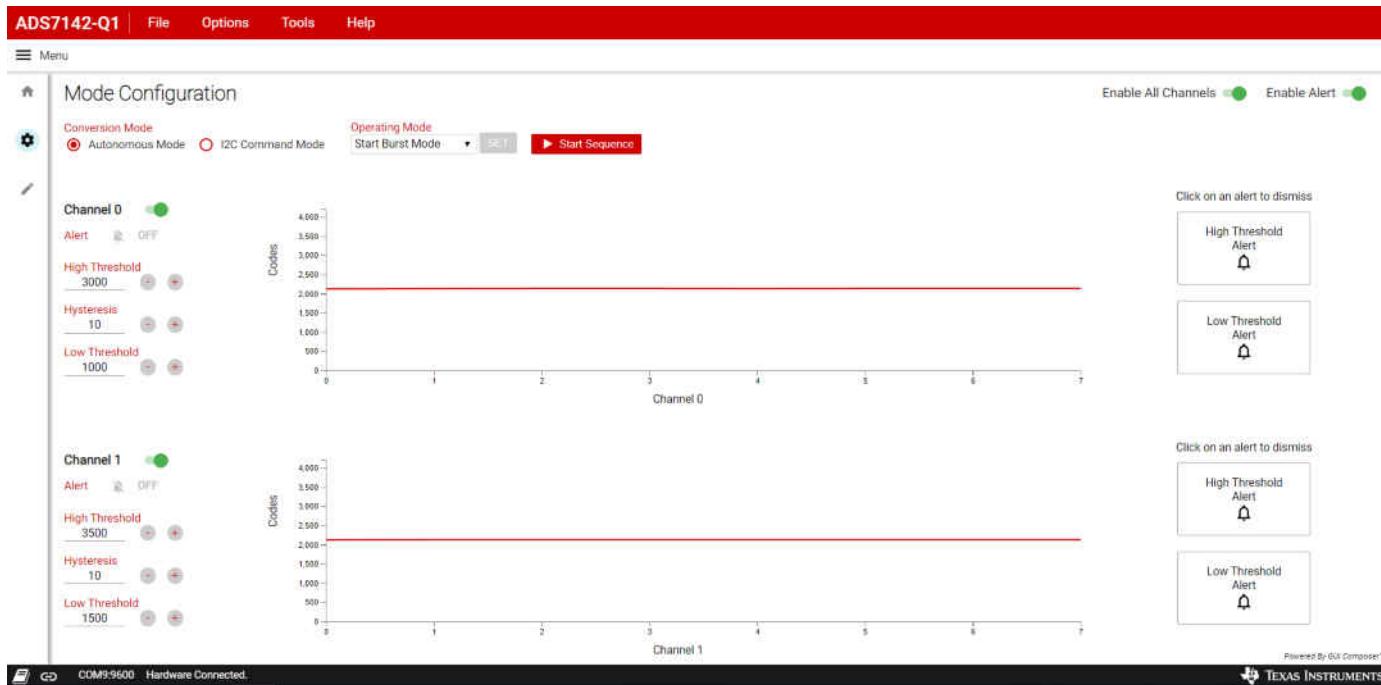


Figure 4-1. Data Capture in Start Burst Mode

4.1.2 Stop Burst Mode

When *Stop Burst Mode* is selected from the *Operating Modes* drop-down menu and the *SET* button is pressed, the device will keep on sampling input signals and storing the conversion results in the data buffer unless the user initiates the command to abort the sequence by pressing the *Abort Sequence* button in the GUI and stops filling the data buffer. To understand the steps required to configure the device in this mode, refer to the ADS7142-Q1 data sheet.

Figure 4-2 highlights the ADS7142-Q1 GUI working in *Stop Burst Mode*.



Figure 4-2. Data Capture in Stop Burst Mode

4.1.3 Pre Alert Mode

When *Pre Alert Mode* is selected from the *Operating Modes* drop-down menu and the *SET* button is pressed, the device starts conversions and stores the data in the data buffer until the input signal crosses either the high or low threshold for the channels selected in the sequence. If the user aborts the sequence before the data buffer is filled, the device will abort the sequence and stop storing the conversion results. To understand the steps required to configure the device in this mode, refer to the ADS7142-Q1 data sheet.

Figure 4-3 shows the ADS7142-Q1 GUI configured in *Pre Alert Mode* with the Alert functionality enabled on channel 0. In this example, the *High Threshold*, *Hysteresis*, and *Low Threshold* are set. The thresholds are marked on the graph in pink and hysteresis is indicated by the dotted line.

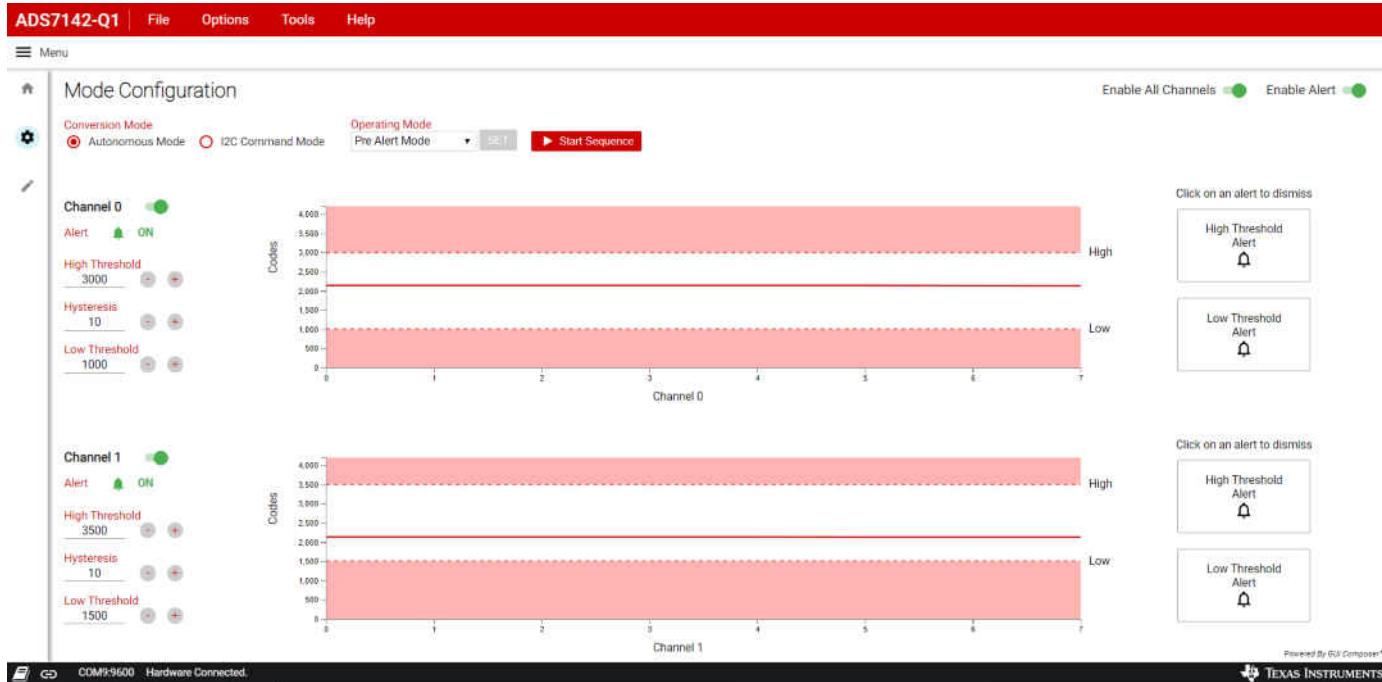


Figure 4-3. Operation in Pre Alert Mode

Figure 4-4 shows the GUI after an Alert condition is encountered. In this example, Channel 0 has reached the *High Threshold*. This is indicated by the *High Threshold* indicator on the right side of the corresponding graph. Since the device is configured for *Pre Alert Mode* operation with both channels enabled, the conditions prior to reaching the *Alert* condition are displayed. The *Alert* condition must be cleared, by clicking on the *Threshold* indicator before the next sequence is run to ensure normal operation of the device.

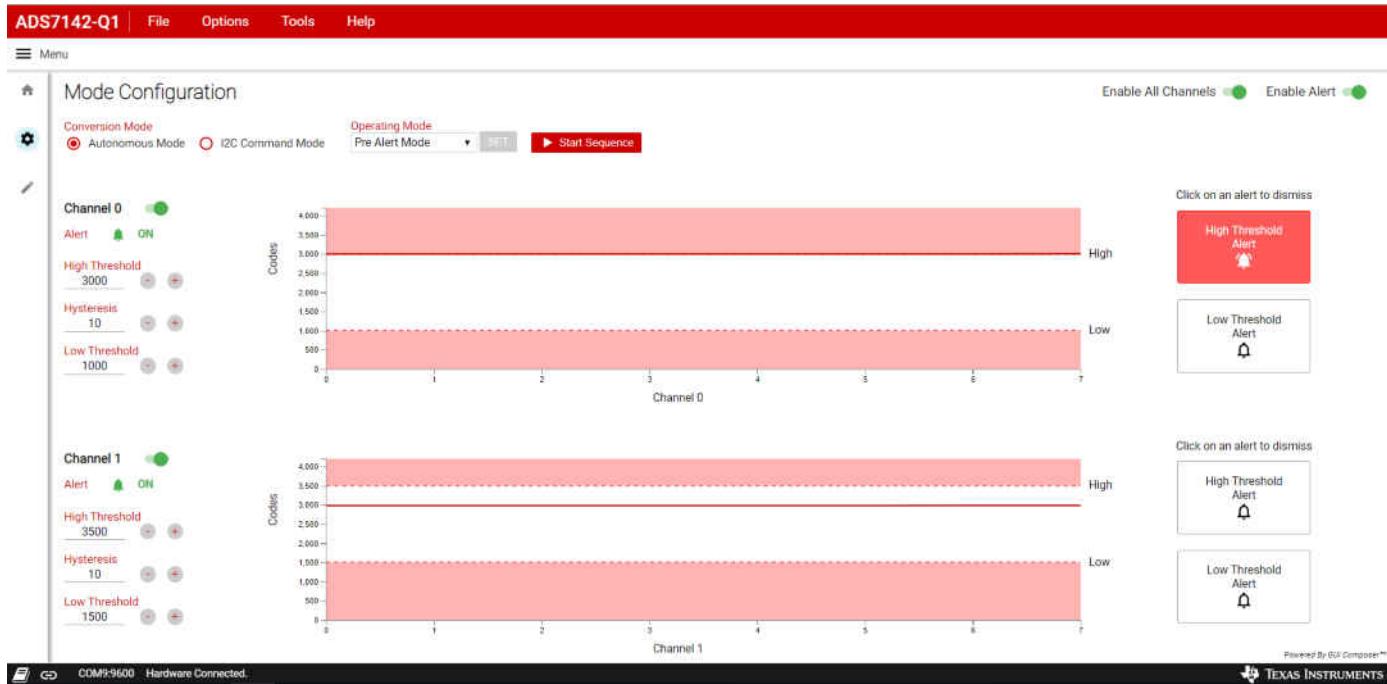


Figure 4-4. Operation After Alert Condition

4.1.4 Post Alert Mode

When the device is configured in *Post Alert Mode* operation, the device starts converting the input signal and storing the data in the data buffer only after it reaches one of the *Alert* thresholds set for the channels selected in the sequence. If the user aborts the sequence before the data buffer is filled, the device stops storing the conversion results. To understand the steps required to configure the device in this mode, refer to the ADS7142-Q1 data sheet.

Figure 4-5 highlights the ADS7142-Q1 GUI working in *Post Alert Mode*. Once either of the low or high thresholds is reached, make sure to read the *Alert* by clicking on the highlighted *Alert* block in red before running the next sequence.

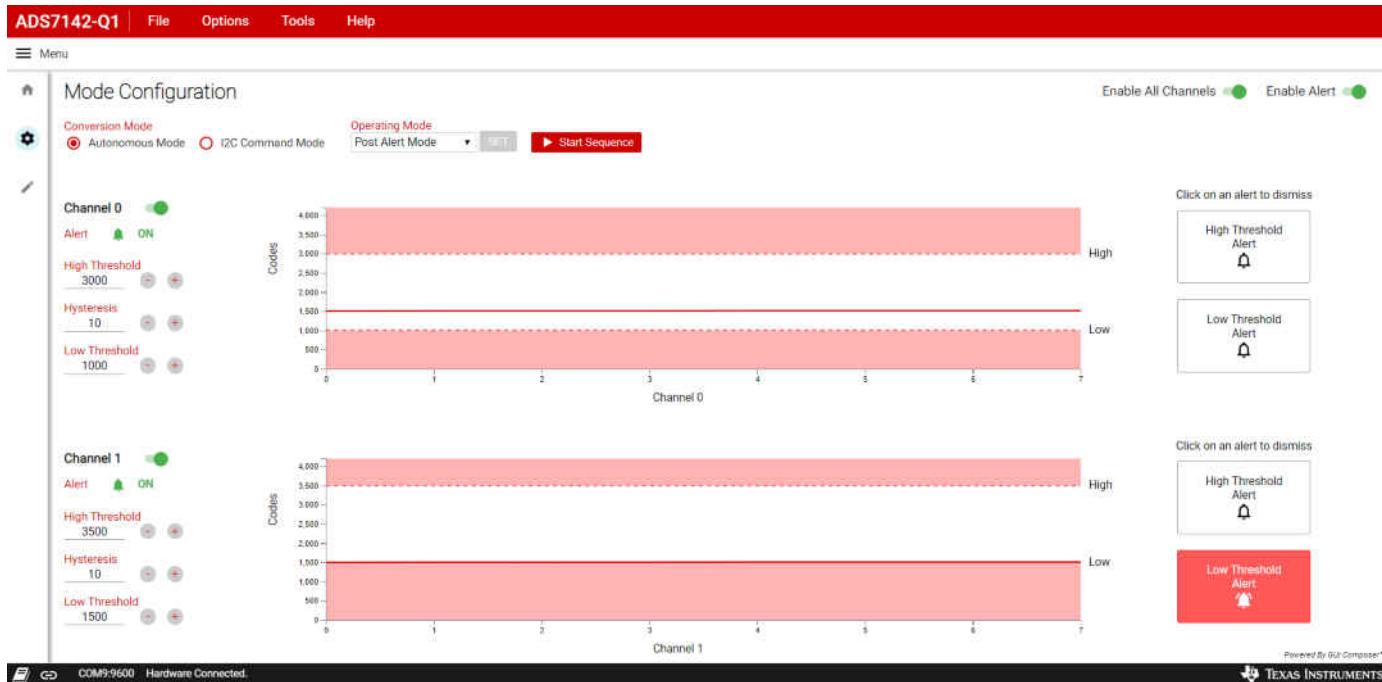


Figure 4-5. Operation in Post Alert Mode

4.2 High Precision Mode

The *High Precision Mode* increases the accuracy of the data measurement to 16-bit accuracy. This is useful for applications where the level of precision required to accurately measure the sensor output needs to be higher than 12-bits. When *High Precision Mode* is selected from the *Operating Modes* drop-down menu and the *SET* button is pressed, the device starts conversions and starts accumulating the conversion results in an accumulator. The device stops accumulating the conversion results in the accumulator after 16 conversions. If the user aborts the sequence before 16 conversions, then the device will abort the sequence. To understand the steps required to configure the device in this mode, refer to the ADS7142-Q1 data sheet.

Figure 4-6 highlights the ADS7142-Q1 GUI working in *High Precision Mode*. The maximum number of accumulator count that can be entered into the ACCUMULATOR_CFG register is 15 (0x0F) which corresponds to 16 conversions.

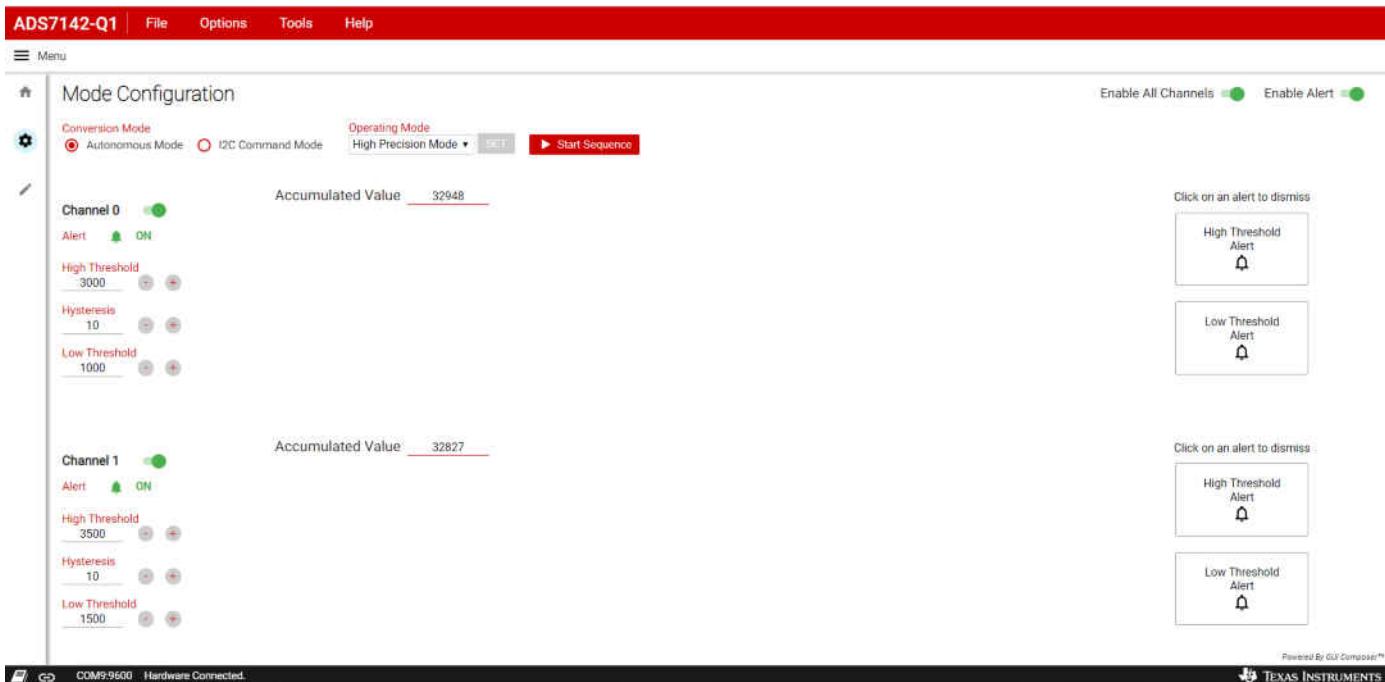


Figure 4-6. Operation in High Precision Mode

4.3 Manual Mode

Manual Mode allows the external host processor to directly request and control when the data is sampled. The data capture is initiated by an I²C command from the host processor and the captured data is then returned over the I²C bus. *Manual Mode* can work one of the following states based on power up or user-initiated conditions.

4.3.1 Default Mode

On power up, the device is in *Manual Mode* with single-ended and dual-channel configuration and it samples the analog input applied on Channel 0 (AIN0-GND). In this mode, the device uses high-frequency oscillator for conversions. [Figure 4-7](#) highlights the ADS7142-Q1 GUI working in *Manual Mode: Default State*.

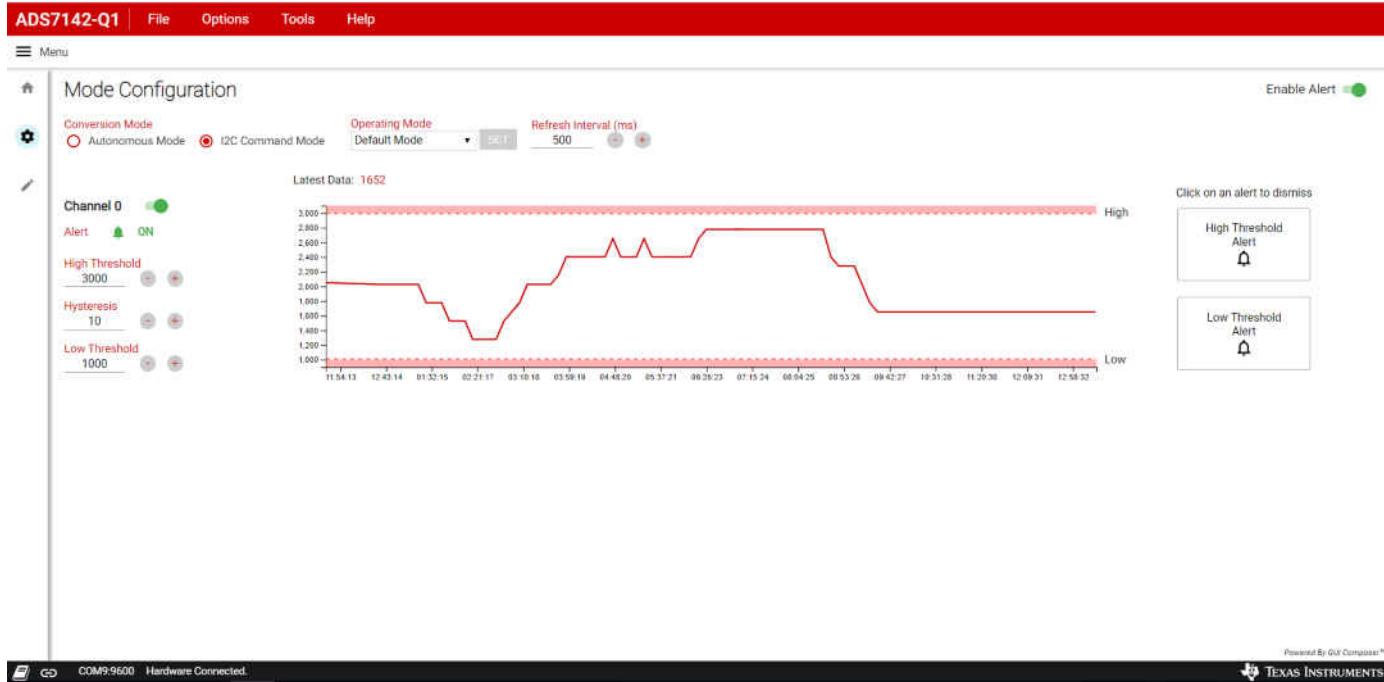


Figure 4-7. Operation in Default Manual Mode

4.3.2 Auto Mode

The host can either configure the device to scan through one channel or both channels by configuring the CHANNEL_IP_CFG register and AUTO_SEQ register. The host has to provide continuous clock (SCL) to the device to scan through the channels and read the data from the device. [Figure 4-8](#) highlights the ADS7142-Q1 GUI working in *Manual Mode: Default State*.

To understand the steps required to configure the device in *Manual Mode*, refer to the ADS7142-Q1 data sheet.



Figure 4-8. Operation in Auto Manual Mode

4.4 Temperature Monitoring Using BOOSTXL-ADS7142-Q1

The BOOSTXL-ADS7142-Q1 has a provision for an onboard NTC-based temperature monitoring circuit. By default, the NTC monitoring section is not populated. The NTC-based temperature monitoring can be enabled on CH0. To enable temperature monitoring, make the changes to the evaluation board as shown in [Table 4-1](#).

Table 4-1. Modification Required for NTC Monitoring

Components	EVM Default Status	Modification Required for NTC Monitoring
R26	Assemble	Do Not Populate
R29, R34, RT1, and C12	Do Not Populate	Assemble

4.5 Input Signal Conditioning Block on the BOOSTXL-ADS7142-Q1

For applications where the input signal requires additional conditioning before being interfaced to the ADC, the BOOSTXL-ADS7142-Q1 has an optional signal conditioning path that can be populated between the input signal and the ADS7142-Q1. The board has a provision to introduce a dual-channel operational amplifier (U4) which can be configured in either a non-inverting buffer or inverting gain configuration based on the signal conditioning requirement. By default, this signal conditioning block is not populated on the evaluation board. In order to use this block, populate the operational amplifier U4 and the associated biasing components based on the required op-amp configuration (non-inverting buffer or inverting configuration). See [Section 5.3](#) for more details.

5 Bill of Materials, Printed-Circuit Board Layout, and Schematics

This section contains the BOOSTXL-ADS7142-Q1 bill of materials (BOM), printed-circuit board (PCB) layout, and schematics.

5.1 Bill of Materials

Table 5-1 lists the bill of materials (BOM) for the PGA460-Q1 EVM.

Table 5-1. Bill of Materials

Designator	Quantity	Description	Manufacturer Part Number	Manufacturer
BOOSTXL-ADS7142-Q1	1	Printed Circuit Board	DC010	Any
C3	1	CAP, CERM, 0.1 μ F, 25 V, \pm 10%, X7R, AEC-Q200 Grade 1, 0603	CGA3E2X7R1E104K080AA	TDK
C5, C17	2	CAP, CERM, 1 μ F, 16 V, \pm 10%, X7R, AEC-Q200 Grade 1, 0603	GCM188R71C105KA64D	Murata
C6, C7	2	CAP, CERM, 470 pF, 50 V, \pm 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	06035A471JAT2A	Murata
J1/J3, J2/J4	2	Receptacle, 2.54 mm, 10x2, Tin, TH	SSQ-110-03-T-D	Samtec
J5	1	Header, 100 mil, 2x2, Gold, TH	TSW-102-07-G-D	Samtec
J6	1	Header, 100 mil, 2x1, Tin, TH	PEC02SAAN	Sullins Connector Solutions
R1, R6, R8, R9, R10, R11, R12, R14, R26, R27	10	RES, 0, 5%, 0.1 W, 0603	RC0603JR-070RL	Yageo
R4	1	RES, 10.0, 0.1%, 0.063 W, 0402	CPF0402B10RE1	TE Connectivity
R13, R17, R18, R22, R23, R24, R25	7	RES, 1.0 k, 5%, 0.1 W, 0603	RC0603JR-071KL	Yageo
R15, R21	2	RES, 10 k, 5%, 0.1 W, 0603	RC0603JR-0710KL	Yageo
U1	1	Nanopower, Dual-Channel, Programmable Sensor Monitor, DMG0010A (WSON-10)	ADS7142QDQCRQ1	Texas Instruments
U6	1	I ² C BUS EEPROM (2-Wire), TSSOP-B8	BR24G32FVT-3AGE2	R Ω
C1, C2	0	CAP, CERM, 3.3 μ F, 10 V, \pm 10%, X5R, 0805	C0805C335K8PACTU	Kemet
C4	0	CAP, CERM, 10 μ F, 16 V, \pm 20%, X5R, 0805	0805YD106MAT2A	AVX
C8, C9, C11, C13, C14	0	CAP, CERM, 0.01 μ F, 50 V, \pm 10%, X7R, 0603	GRM188R71H103KA01D	Murata
C10	0	CAP, CERM, 0.1 μ F, 25 V, \pm 10%, X7R, AEC-Q200 Grade 1, 0603	CGA3E2X7R1E104K080AA	TDK
C12	0	CAP, CERM, 1 μ F, 16 V, \pm 10%, X7R, AEC-Q200 Grade 1, 0603	GCM188R71C105KA64D	Murata
C15, C16	0	CAP, CERM, 1000 pF, 50 V, \pm 5%, C0G/NP0, 0603	C0603C102J5GAC	Kemet
R2, R5 R7, R16, R20, R32, R33, R34, R37, R38, R39, R40, R43, R44, R45, R46, R49, R50, R52	0	RES, 0, 5%, 0.1 W, 0603	RC0603JR-070RL	Yageo
R3, R29, R51	0	RES, 10 k, 5%, 0.1 W, 0603	RC0603JR-0710KL	Yageo
R19, R28	0	RES, 100 k, 5%, 0.1 W, 0603	CRCW0603100KJNEAC	Vishay-Dale
R30, R31	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GE0R00X	Panasonic
R35, R36	0	RES, 1.0 k, 5%, 0.1 W, 0603	RC0603JR-071KL	Yageo
R41, R42	0	RES, 1.0 M, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04021M00JNED	Vishay-Dale
R47, R48	0	RES, 330 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402330KJNED	Vishay-Dale
RT1	0	Thermistor NTC, 10k Ω , 5%, 0402	NCP15XH103J03RC	Murata

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Description	Manufacturer Part Number	Manufacturer
U2	0	Automotive 20 ppm / °C Maximum, 100 µA, SOT23-3 Series Voltage Reference, DBZ0003A (SOT-23-3)	REF3133AQDBZTQ1	Texas Instruments
U3	0	Single Output High PSRR LDO, 200 mA, Fixed 3.3 V Output, 2.7 to 6.5 V Input, with Low IQ, 5-pin SOT (DDC), -40 to 125 °C, Green (RoHS & no Sb/Br)	TPS79933QDDCRQ1	Texas Instruments
U4	0	Dual-Channel 425 nA Precision Nanopower Operational Amplifiers, DGK0008A (VSSOP-8)	LPV812DGKR	Texas Instruments
U5	0	Micro-Power (50 µA), Zero-Drift, Rail-to-Rail-Out Instrumentation Amplifier, DGK0008A (VSSOP-8)	INA317IDGKT	Texas Instruments

5.2 PCB Layout

Figure 5-1, Figure 5-2, and Figure 5-3 illustrate the EVM PCB layout.

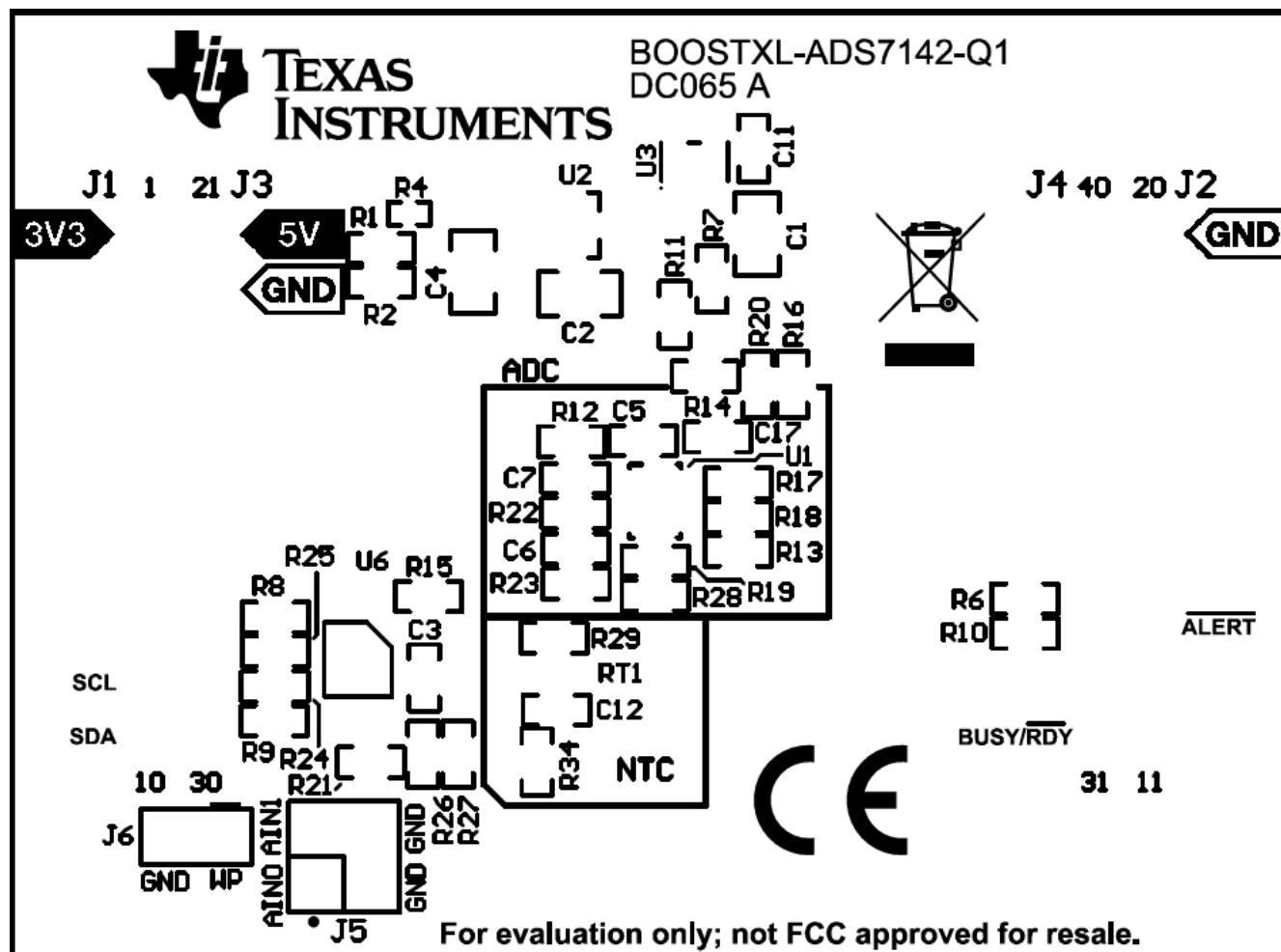


Figure 5-1. BOOSTXL_ADS7142-Q1 PCB Top Overlay

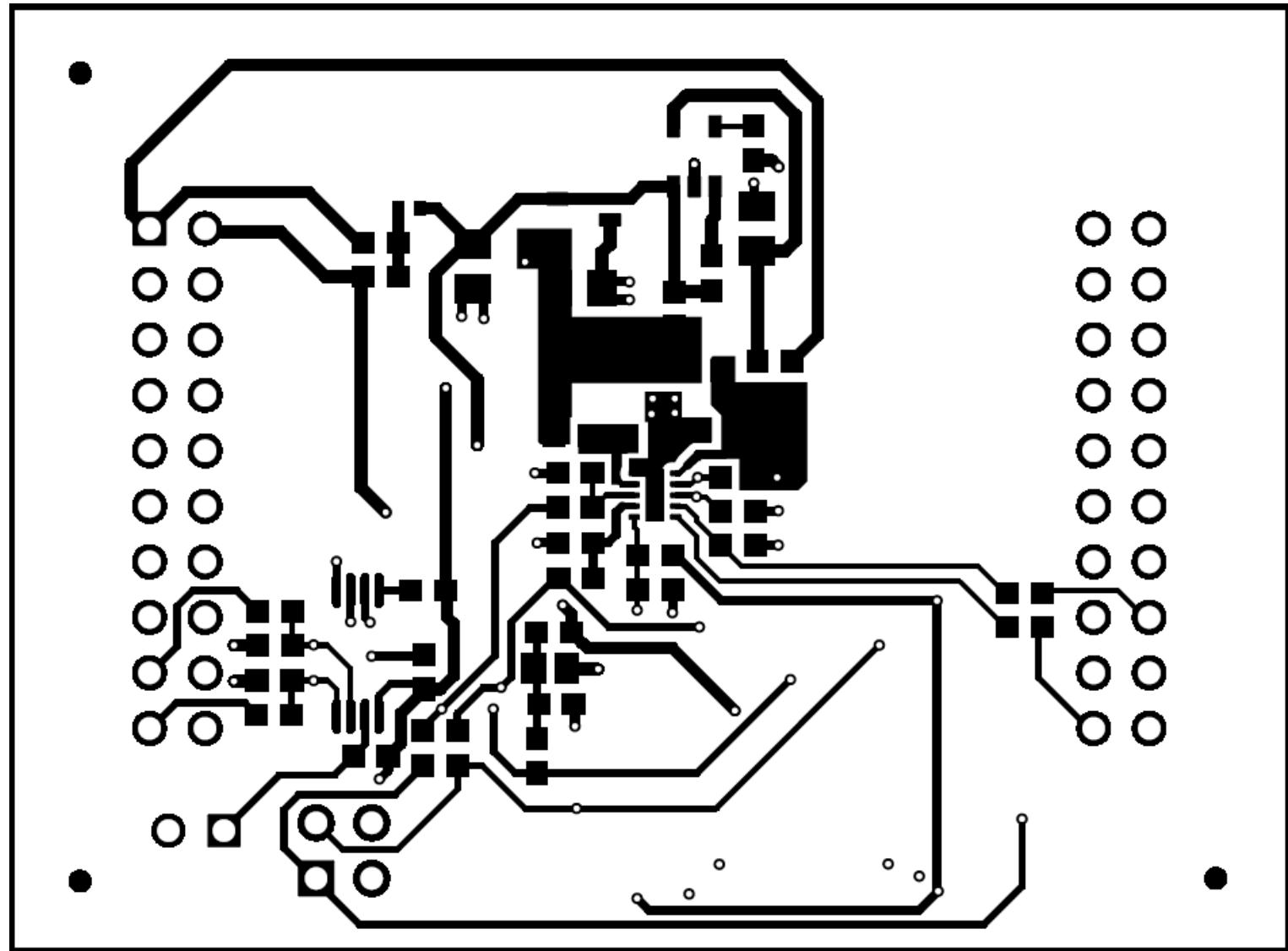


Figure 5-2. BOOSTXL-ADS7142-Q1 Top Layer Copper and Silkscreen

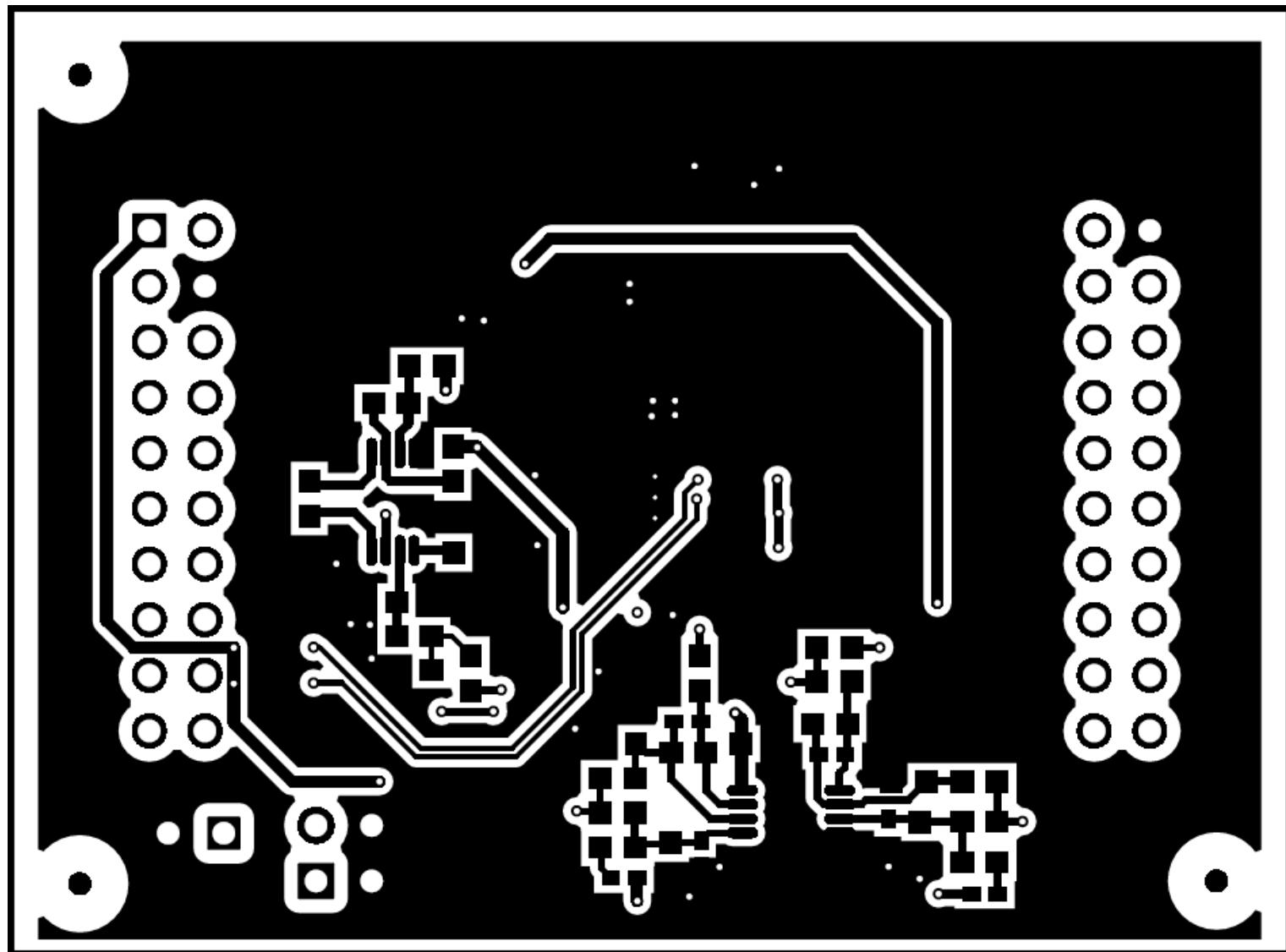


Figure 5-3. BOOSTXL-ADS7142-Q1 Bottom Layer Copper and Silkscreen

5.3 Schematics

Figure 5-4 shows the ADS7142-Q1 BoosterPack™ schematics.

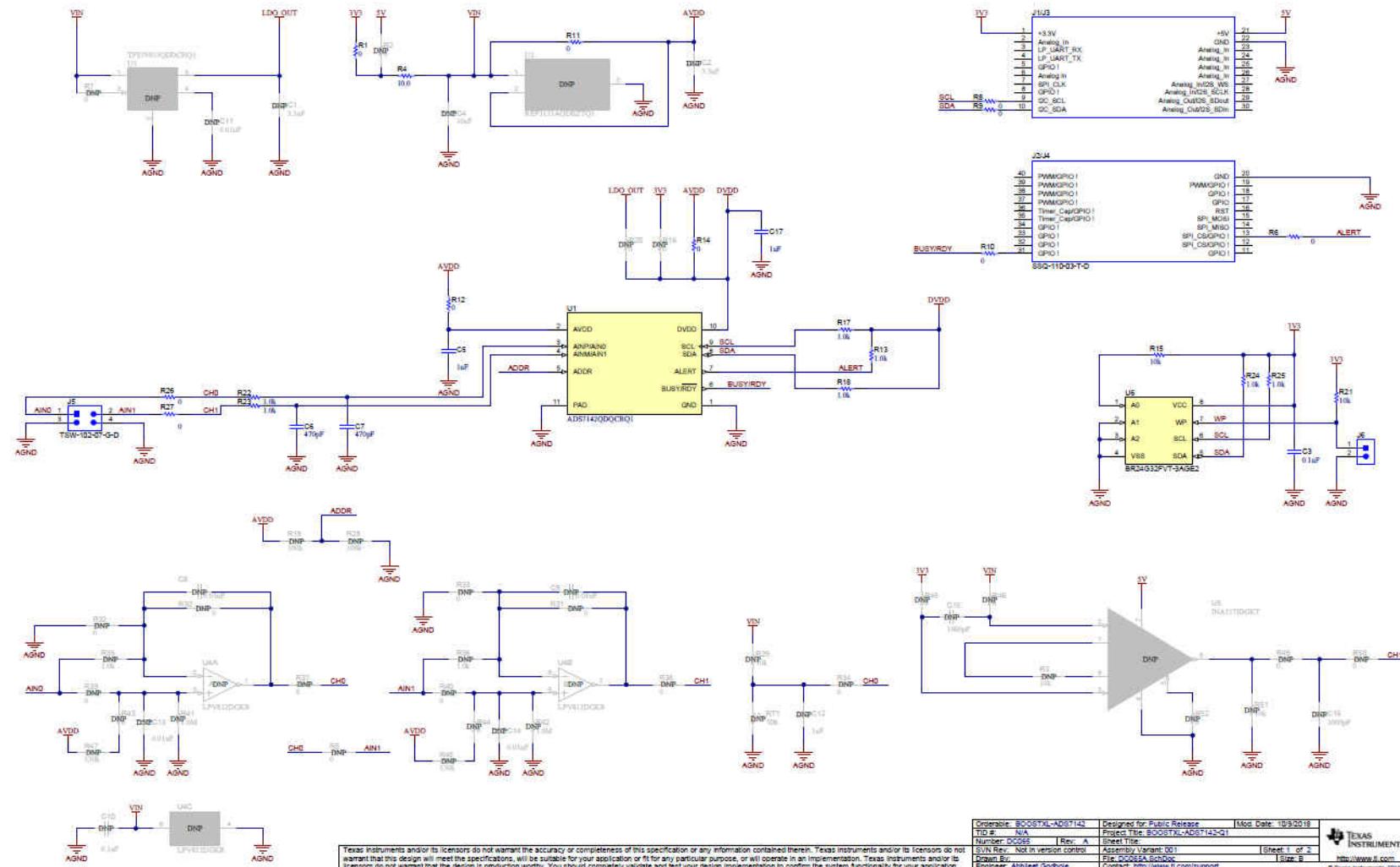


Figure 5-4. ADS7142-Q1 BoosterPack™ Schematic Diagram

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (August 2019) to Revision B (June 2021)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	2
• Changed MSP-EXP432E401Y to PAMB throughout the document.....	2
• Added the <i>Hardware Setup Instructions</i> section.....	6
• Removed the <i>UNIFLASH Programmer for MSP-EXP432E401Y Software Programming</i> section.....	7

Changes from Revision * (November 2018) to Revision A (August 2019)	Page
• Changed Section 3	5
• Deleted <i>Driver Installation Steps for Analog EVM Controller for Windows Platform</i> section.....	6
• Changed C6, C7 manufacturer part number in <i>Bill of Materials</i> table.....	20

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